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CHINA AEROSPACE STUDIES INSTITUTE

The PRC State & Defense Laboratory System

Part Two: Defense S&T Key Lab Directory

Prepared by BluePath Labs

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Table of Contents

Introduction

The following directory is Part Two of *The PRC State & Defense Laboratory System*, a report released by the China Aerospace Studies Institute and BluePath Labs in April 2022. Part One of the report, entitled *The PRC State & Defense Laboratory System: An Overview,*[i] described the general structure and organization of the PRC's state research system. It particularly focused on the PRC's Defense S&T Key Laboratories (DSTKL) [国防科技重点实验室], first established in 1991 as the PRC's highest-level network of defense labs. These labs receive the most funding and conduct what the PRC considers to be its most critical military research.

To conduct this research, the authors utilized a list of 60 DSTKLs circulating on the internet, apparently from a since-deleted PRC government website. Accounting for duplicates and labs since downgraded in status left a sample of 56 labs. Extensive open-source research was conducted on each of these labs. However, while Part One of the report did discuss topline key findings from this research, including discussion of prominent research trends, it did not present the data itself, or even name the 56 labs. This directory has thus been created for researchers interested in the details of the labs themselves. It lists out all 56 labs (as well as the three former labs), along with all relevant data that could be found on each, including research foci, real-world applications of that research, funding, facilities and equipment, domestic and international collaborations, leadership and personnel, aliases, and any other information which may be of interest to researchers of PRC defense technology. Some labs contained considerably more information than others; some were very public-facing, with official websites and no shortage of laudatory state media coverage of their work, while others had very little public information at all. Generally, university-run labs tended to be more open about their work than SOE-run labs. The authors hope that this data will both provide greater insight into the inner workings and priorities of DSTKLs, as well as raise awareness of these labs and their attempts to collaborate with U.S. institutions.

[i] Part One can be found at: https://www.bluepathlabs.com/uploads/1/1/9/0/119002711/2022-04-11_the_prc_state___defense_laboratory_system_-_an_overview.pdf

PRC Defense Lab Cooperation with U.S. Institutions

In the course of this research, the authors found significant evidence of collaboration between these defense labs and universities, companies, and research institutions in the United States, as well as in Europe, Australia, Japan, and others.[ii] This collaboration ranged from one-off visits, research papers, fellowships, and conference participation and co-hosting, all the way up to official, long-term institutional cooperation.

To give just a few of the many examples of such cooperation detailed in this directory, the DSTKL of Antennas and Microwave Technology, which conducts research into advanced military radars, claims to have cooperative relationships with the University of California, University of Pennsylvania, MIT, and others, gave an honorary professorship to an employee of IBM, conducted academic exchanges with Duke and Penn State Universities, and had at least one of its researchers studying at a U.S. university as recently as 2019. Another advanced radar DSTKL, the DSTKL of Radar Signal Processing, has established a joint research center with Syracuse University under a national plan specifically aimed at encouraging tech transfer, has hosted conferences with speakers from Columbia, NYU, University of California, Bell Labs, and others, and has hosted scholar exchanges and guest lecturers from the University of California, University of Florida, Boeing, and others. Likewise, the DSTKL of Communications Anti-Jamming Technology, dedicated to research of military communications equipment, claims to have joint graduate training agreements with Princeton and Columbia Universities as well as schools in Canada, the U.K., Australia, and Switzerland, and claims to have worked with Intel, Siemens, Nokia, Philips, and other international corporations.

In some cases, the research also revealed the use of U.S., European, and Japanese equipment by these labs, possibly in violation of export controls. Despite this, the labs oftentimes openly boast about their access to cutting-edge foreign equipment, listing it on their websites. For example, despite its presence on the U.S. Commerce Department Entity List since 2001, numerous labs under Northwestern Polytechnical University (NWPU) in Xi’an list out their bounty of U.S. and other foreign equipment on their websites, in some cases even specifying its national origin and (in case there was any remaining doubt as to its legality) year of acquisition. Thus, we know for example that the DSTKL of Underwater Information and Control at NWPU, which conducts research into underwater warfare, apparently has access to numerous pieces of U.S.-origin high-tech equipment, including a research UUV which is also used by the U.S. military.

[ii] While this directory focuses primarily on the U.S., further information is available about other states’ cooperation with these labs upon request.

Discovery of Previously Undisclosed Labs and Next Steps for This Project

To this point, it has been unclear exactly how many DSTKLs the PRC funds. The authors of this report, assuming the list of DSTKLs circulating online to be comprehensive, began with the assumption that the PRC currently funds approximately 60 such labs, while the Australian Strategic Policy Institute (ASPI) gives a slightly higher figure of 74 as of 2009.[1] However, our research found that the actual count of DSTKLs appears to be much higher than previously estimated, as the PRC funds dozens of DSTKLs which do not appear in the online list. As of writing, we have identified as many as 48 other labs using the "Defense S&T Key Lab" moniker, indicating that the actual number of DSTKLs could be over 100. While it is possible that some of these are being identified as DSTKLs in error (given the PRC's tendency to play fast and loose with lab titles, as noted in Part One of this report), it is obvious that many are in fact DSTKLs that have not been identified as such in official sources. For example, the PLA Rocket Force apparently oversees two DSTKLs,[2] neither of which is included in the online list, and neither of which has been publicly named.[iii] Likewise, the National University of Defense Technology allegedly oversees seven DSTKLs, even though only three are publicly identified in the online list.[3]

Many of these "off the books" labs are not public facing and offer only the scantest clues to their existence. This suggests the possibility that they are not publicly discussed due to their particularly sensitive research, making them all the more interesting. However, it is just as likely that the secrecy around these labs is merely a symptom of the PRC's overall lack of transparency; indeed, no official catalog of DSTKLs currently exists, forcing researchers to rely on a single dated list, taken from a since-deleted source, which is apparently far from comprehensive.

DSTKLs are the PRC's largest, best funded, and highest-level defense research labs, conducting its most critical national-levelmilitary research.[iv] Despite this, the existence of many of these key labs has not been previously described in English-language sources. This has led to the specter of a major gap in our knowledge of the PRC's defense research system, one which until now we did not even know existed. Given this fact, for the next step of this project we intend to document and research these additional DSTKLs in the same way that we have documented the 56 "official" DSTKLs below. In this way we hope to close an important knowledge gap in both the actual number and nature of the PRC's DSTKLs.

[iii] While not explicitly stated, one of these is likely a DSTKL focused on defeating adversary anti-ballistic missile systems which was revealed in a 2017 news article. See: "Chinese government reveals the Defense S&T Key Laboratory of Ballistic Missile Penetration Technology, providing much information" [中国官方曝光弹道导弹突防技术国防科技重点实验室，信息量大], kknews, 20 May 2017. https://kknews.cc/zh-my/military/ao8r2ln.html

[iv] While DSTKLs are, as a rule, national-level labs, in recent years at least some provinces appear to be establishing provincial-level DSTKLs, adding a further dimension to the PRC's defense lab system. See, for example, "Hunan Province Department of Industry and Information Technology on the issuance of the "Hunan Provincial Defense Science and Technology Key Laboratory Management Measures" notice" [湖南省工业和信息化厅关于印发《湖南省国防科技重点实验室管理办法》的通知], *Hunan Province Department of Industry and Information Technology* [湖南省工业和信息化厅], 3 February 2018, http://fgcx.bjcourt.gov.cn:4601/law?fn=lar1550s108.txt

DSTKL Mission, Management, and Leadership

According to the 2003 guidelines for management of these labs, DSTKLs are primarily tasked with "carrying out applied basic research that is exploratory, innovative, and based on major key technologies, in accordance with the needs of national defense S&T and the development of weapons and equipment, centered on national defense S&T strategic objectives and the development trends of weapons and equipment development." Further, they are responsible for establishing "internationally advanced and domestically leading-edge research platforms which utilize civil-military integration and advance the development of dual use technologies."[4]

While DSTKLs are officially tasked with *applied basic* research,[v] and on the whole appear to focus more heavily on basic and early-stage applied research, all DSTKLs carry out a combination of basic and applied research according to their mission. That is, some DSTKLs are heavily theoretical in their output while others aid in design of finished products, with most falling somewhere inside this continuum. As highlighted in Part 1 of the report, while the labs profiled here encompass a wide range of research foci, they are disproportionately focused on a relatively limited number of fields. These include air and space vehicles, rocket launch, missiles, new materials, and various aspects of the electromagnetic spectrum, suggesting that these are priority areas for PRC defense S&T. A 2018 document establishing provincial-level DSTKLs in Hunan Province largely confirms this, claiming that national-level priorities for defense S&T innovation include air and space vehicles, missile and rocket launch, new materials, and electronic weapons and equipment. The list also includes nuclear weaponry and military nuclear power, ships, and armaments, all of which are represented in this sample of DSTKLs, albeit less prominently.[5]

All DSTKLs are overseen jointly by the PRC State Council State Administration for Science, Technology and Industry for National Defense (SASTIND) and the PLA Central Military Commission Equipment Development Department (EDD).[vi] Of these two, SASTIND appears to be preeminent, as DSTKL guidelines suggest that it plays a more prominent day to day role in lab management and is solely responsible for some functions, such as approval of lab directors.[6]

Institutions wishing to establish a DSTKL must submit an application to SASTIND and the EDD, demonstrating that the proposed lab will fill a requirement in the PRC's defense needs as laid out by these two organizations. Institutions must also show that they possess infrastructure and expertise in the field that will allow them to conduct research at an internationally advanced and domestically leading-edge level. Following initial approval, labs typically undergo a probationary period of around two years, during which it is already conducting research, before receiving final approval.[7] In some cases, this probationary period has lasted significantly longer (in some cases up to seven years), suggesting some labs struggle to gain final approval.

[v] The PRC has further split the concept of applied research into two categories: the first is *applied basic research*, which is directed at specific practical applied goals or objectives for obtaining new knowledge of applied principles (mechanisms, laws). The second is *applied technical research*, which is directed at specific practical applied goals or objectives to obtain new applied technical knowledge. See Ji Chengyi [计承宜], ""An analysis of the concept of applied basic research" [关于应用基础研究概念的剖析], National Natural Science Foundation of China [国家自然科学基金], 1991, shorturl.at/joBKV

[vi] Prior to recent reforms which saw the replacement of these organizations by SASTIND and the EDD, these tasks were carried out by the former Commission for Science, Technology and Industry for National Defense (COSTIND) and the PLA General Armaments Department (GAD), respectively.

Oversight for the labs is provided by a SASTIND pool of experts, who are responsible for ensuring each lab's development strategy, planning, and project demonstrations.[vii] SASTIND is tasked with conducting "regular" evaluations at unspecified intervals, and labs that fail these evaluations are given an unspecified period of time to rectify their shortcomings or risk losing their status.[8][viii] However, DSTKL guidelines state that annual inspections are not conducted by SASTIND, but via self-reporting by the parent institutions, possibly disincentivizing negative evaluations. The fact that only one example of SASTIND revoking a lab's status was found (in 2006, when three labs were suddenly demoted), further suggests a lack of oversight or consequences for labs which fail to meet standards.

DSTKLs are structured with a Director (approved by SASTIND) at the top, followed by one to three Deputy Directors (who sometimes serve as Directors of subordinate lab branches). Given the pole position of DSTKLs in the PRC's research ecosystem, the position of Director is highly prestigious and signifies that the individual is one of the (if not *the*) top Chinese academics in this field. DSTKL Directors have typically already been elected as Academicians to the Chinese Academy of Sciences or Engineering, signifying a high level of career achievement, and many have studied in the U.S. or Europe. This was noted in the directory wherever it was the case.

Each Lab also has an academic committee of 15-20 experts in the field (no more than one-third coming from the parent institution) and overseen by a separate Academic Committee Director. The Academic Committee oversees the lab's annual research plans, training, exchanges, and major academic activities. Academic committee members typically serve in three-year stints, and at least one-third must be replaced each term.[9]

Finally, most labs have a kind of emeritus position filled by a (typically elderly) leading light in the field, who oftentimes founded or revolutionized this field in China. For example, DSTKL of Remanufacturing Technology founder Xu Binshi, a CAE Academician and retired PLA Major General, is referred to as the "Father of Chinese Remanufacturing." These emeritus Directors retain an unofficial position as a sort of philosophical director, whose example and guidance are referred to and followed by the lab.

In addition to these leadership personnel, this directory also includes any other key personnel who are worth noting for their research, achievements, or history (e.g. work or study in the U.S.).

[vii] The guidelines are unclear if there is a single expert pool overseeing all labs, or individual expert pools for each lab.
[viii] Guidelines for the newer provincial DSTKLs are more specific, stating that labs that fail evaluations two years in a row will lose their status. See, for example, "Hunan Province Department of Industry and Information Technology on the issuance of the "Hunan Provincial Defense Science and Technology Key Laboratory Management Measures" notice" [湖南省工业和信息化厅关于印发《湖南省国防科技重点实验室管理办法》的通知], *Hunan Province Department of Industry and Information Technology* [湖南省工业和信息化厅], 3 February 2018, http://fgcx.bjcourt.gov.cn:4601/law?fn=lar1550s108.txt

Notes on the Data Presented in this Directory

Translations of Lab Names and Attempts at Obfuscation

All lab names given in this directory are direct translations of their names from the original Chinese. While "official" English names were found for some labs, these names oftentimes have little to no connection to the lab's actual Chinese name, and are often much more vague as to the lab's true purpose. Most importantly, English translations of lab names almost always remove any mention of "defense," or any mention of explicitly military technologies. As noted in Part One of the report, this is almost certainly intentional and designed to obfuscate the lab's military purposes to an English-speaking audience, minimizing scrutiny and lowering barriers to foreign cooperation. Further, the "official" English names oftentimes translate awkwardly (e.g. "Science and Technology on Plasma Dynamics Laboratory"), and sometimes casually change depending on the source (as in the example of the Key Laboratory of Radar Signal Processing given in Part One of the report), leaving some doubt as to how "official" they even are. Thus, this directory uses direct translations of the labs' names from their original Chinese, which provide better insight into the labs' true missions and how the PRC views them. "Official" English names, where found, are also provided in the data.

Chinese Names and Aliases

As noted in Part One of the report, Chinese state labs tend to play fast and loose with their names in Chinese as well as English, switching between using the characters for "Defense," "Key," and "State/National" seemingly interchangeably. The labs will oftentimes use slight variations on their names in both Chinese and English. Thus, any lab names which appear similar to, but not exactly the same as, the lab's "official" name are worthy of further investigation. We have done our best to capture all of these slight name variations, where they occur, in the "Known Aliases" section. Further, we have given the "Defense" version of each name as the "Official" Chinese name, even when this is not the most commonly used name, while noting where this is the case. For example, the DSTKL of Computational Fluid Dynamics [国家计算流体力学国防科技重点实验室] is more frequently, though not always, called the *National* Laboratory of Computational Fluid Dynamics [国家计算流体力学实验室] in Chinese. Once again, without any kind of official list from Chinese sources, we are left to guess what is actually a DSTKL and what is not.

Research Fields

Research fields listed in this directory were determined for each lab in three ways, and in descending order of specificity: first, by determining the lab's domain or research field in the most general sense (aerospace, maritime, or ground), then determining which specific technology or piece of equipment its research focuses on (e.g. aircraft, UAVs, missiles, etc.), and finally its functional research area (e.g. propulsion, aerodynamics, stealth, etc.). These categories are somewhat subjective and limited to publicly available information, but can give a good idea of a lab's general area of focus. In the data below, research fields are presented as "Domain – Equipment – Functional focus," e.g. "Aerospace – Aircraft – Propulsion." Secondary foci are also presented in parenthesis and italics.

Lab Affiliations

This section lists all known parent institutions responsible for managing the lab, including any aliases. State-owned research institutions will generally have both a full name and a more generic numerical identifier. For example, AECC's Beijing Institute of Aeronautical Materials is also known as the 621st Research Institute. Both are given, with preference for the full name. In the case of universities, the term *xueyuan* [学院] is typically translated interchangeably as either "School" or "College." The author tried to use the official English translation wherever it could be found.

"Key Data" Fields

This section contains information on the lab's date of establishment, official start of operations, funding, physical size, and number of personnel, where this information was forthcoming.

Research Direction

Most labs have an official "research direction" [研究方向], a short list of research areas which summarize the lab's primary research foci, which are listed here, along with any other notable research areas.

Notable Applications

This section lists any real-world applications of the lab's research that the author found, with an emphasis on the defense sector. It varies in specificity: in some cases, it was possible to trace the lab's work to a specific piece of defense equipment, (e.g. "this lab's research into carbon composites was applied to braking technology for the J-10 combat aircraft"), while in other cases it was only possible to discern general applications (e.g. "this lab's research contributes to a wide range of rocket, missile, and ammunition propellants").

Notable Collaborations

This section lists any particularly interesting collaborations between this lab and other institutions. It is not meant to be an exhaustive list of all collaborations. Rather, it focuses primarily on collaborations with military, defense industry, or defense research partners, as well as research with major PRC corporations. As noted above, there is also a dedicated subsection for international collaboration. This oftentimes involves hosting for visits or study, individual or institutional research collaboration, conference co-hosting, or alleged long-term institutional partnerships between these labs and U.S. or allied universities, companies, or research institutions.

Lab Equipment

This section lists any equipment or facilities the lab is known to possess, along with any publicly available technical specifications. Particular emphasis was given to possession of equipment from U.S., EU, or Japanese companies which may violate export controls.

Translations

The author has made every effort to be accurate and consistent with Chinese translations. Any inconsistencies or mistakes in translation are the author’s own.

Special Thanks

The author would like to give special thanks to BPL analyst Taylor A. Lee, who provided invaluable research support for several of these labs.

Lab Data

List of Labs by Year Founded

YEAR	#	*DEFENSE S&T KEY LABORATORY OF…*
1991	4	Ballistics Helicopter Rotor Dynamics Radar Signal Processing Solid Rocket Engine Combustion, Thermal Structure, and Inner Flow Field
1992	8	Airfoil and Blading Aerodynamics Antennas and Microwave Technology Aero-Engine Thermodynamics Electromechanical Engineering and Control High Power Microwave Vacuum Electronic Component Technology Precision Guidance and ATR *Ultra-precision Machining Technology** Vehicle Transmission
1993	6	Electronic Information Control Electromagnetic Compatibility High-Energy Beam Processing Technology Hydroacoustic Technology Radio Wave Environmental Char and Modeling Tech Underwater Information and Control
1994	5	Advanced Composite Materials Communications Anti-Jamming Technology Explosive Combustion High-Power Semiconductor Lasers Tunable Gas Lasers
1995	2	Computational Fluid Dynamics Space Microwave Technology
1996	1	Sonar Technology
1997	2	Aerospace Systems Simulation Marine Corrosion and Protection
1998	1	New Ceramic Fiber and Composite Materials
1999	2	Fire Control Technology *Pulsed Power Technology**
2000	4	Composite Material Technology in Special Environments Environmental Materials Behavior and Evaluation Tech Remanufacturing Technology Super High Temperature Structural Composites
2001	1	UAV Special Technology
2002	1	Military Underwater Intelligent Robotic Technology
2003	2	Metrology and Calibration Technology Space Intelligent Control Technology
2004	0	
2005	3	Communications Countermeasures Technology Lightweight, High-strength Structural Materials Multi-spectral Information Processing Technology
2006	2	Advanced High-Temperature Structural Materials Electromagnetic Environment Effects
2007	1	Vessel Integrated Power Technology
2008	1	Reliability & Environmental Engineering Technology
2009	0	
2010	3	Aviation Plasma Dynamics Inertial Technology Space Flight Dynamics Technology
2011	1	Materials Technology in Impact Environments
U/I	9	Aircraft Control and Integration Technology (final approval in 2010) Electronic Measurement Technology (final approval in 2002) Detonator Safety and Reliability *Flexible Manufacturing Systems Technology** Helicopter Transmission Technology (final approval in 2018) High-Power Microwave Technology Parallel and Distributed Processing (final approval in 2011) Precision Hot Processing of Metals (final approval in 1996) Specialized Integrated Circuits

**No longer classified as a Defense S&T Key Lab*

List of Labs by Location

CITY	#	*DEFENSE S&T KEY LAB OF…*
BEIJING	15	Advanced Composite Materials Advanced High-Temperature Structural Materials Aero-Engine Thermodynamics Aerospace Systems Simulation *Aircraft Control and Integration Technology** Computational Fluid Dynamics High-Energy Beam Processing Technology *High Power Microwave Vacuum Electronic Technology** Inertial Technology Materials Technology in Impact Environments Metrology and Calibration Technology Radio Wave Environmental Char and Modeling Tech Reliability & Environmental Engineering Technology Remanufacturing Technology Space Intelligent Control Technology Vehicle Transmission
XI'AN	13.5	Antennas and Microwave Technology *Aircraft Control and Integration Technology** Airfoil and Blading Aerodynamics Aviation Plasma Dynamics Detonator Safety and Reliability Electromechanical Engineering and Control Explosive Combustion Radar Signal Processing Solid Rocket Engine Combustion, Thermal Structure, and Inner Flow Field Space Flight Dynamics Technology Space Microwave Technology Super High Temperature Structural Composites Underwater Information and Control UAV Special Technology
HARBIN	6	Composite Material Technology in Special Environments Environmental Materials Behavior and Evaluation Tech Hydroacoustic Technology Military Underwater Intelligent Robotic Technology Precision Hot Processing of Metals Tunable Gas Lasers
CHANGSHA	3.5	Lightweight, High-strength Structural Materials New Ceramic Fiber and Composite Materials Parallel and Distributed Processing *Precision Guidance and Automatic Target Recognition**
NANJING	3	Ballistics Helicopter Rotor Dynamics Helicopter Transmission Technology
WUHAN	3	Electromagnetic Compatibility Multi-spectral Information Processing Technology Vessel Integrated Power Technology
CHENGDU	2.5	Communications Anti-Jamming Technology Electronic Information Control *High Power Microwave Vacuum Elec. Com. Technology**
SHIJIAZHUANG	2	Electromagnetic Environment Effects Specialized Integrated Circuits
QINGDAO	2	Electronic Measurement Technology Marine Corrosion and Protection
CHANGCHUN	1	High-Power Semiconductor Lasers
HANGZHOU	1	Sonar Technology
JIAXING	1	Communications Countermeasures Technology
LUOYANG	1	Fire Control Technology
MIANYANG	1	High-Power Microwave Technology
SHENZHEN	.5	*Precision Guidance and Automatic Target Recognition**

**Co-located in two cities, counted as .5 for each*

List of Labs by Parent Institution

PARENT INSTITUTION	#	*DEFENSE S&T KEY LAB OF…*	SUBORINDATE INSTITUTION	PARTNER(S)
STATE-OWNED ENTERPRISES AND RESEARCH INSTITUTIONS				
AECC	3	Advanced Composite Materials	621 RI	
		Advanced High-Temperature Structural Materials	621 RI	
		Helicopter Transmission Technology	608 RI	NUAA
AVIC	5	Aircraft Control and Integration Technology	618 RI	Beihang
		Fire Control Technology	613 RI	
		Helicopter Rotor Dynamics	602 RI	NUAA
		High-Energy Beam Processing Technology	625 RI	
		Metrology and Calibration Technology	304 RI	CASIC, CNNC
CETC	7	Antennas and Microwave Technology	14 RI	Xidian
		Communications Countermeasures Technology	36 RI	
		Electronic Information Control	29 RI	
		Electronic Measurement Technology	41 RI	NUC
		High Power Microwave Vacuum Elec. Component Tech	12 RI	UESTC
		Radio Wave Environmental Char and Modeling Tech	22 RI	
		Specialized Integrated Circuits	13 RI	
CASC	5	Reliability & Environmental Engineering Technology	511 RI, CALT	Beihang
		Solid Rocket Engine Combustion, Thermal Structure…	41 RI	NWPU
		Space Environmental Materials Behavior and Eval Tech	510 RI	HIT
		Space Intelligent Control Technology	12 RI	
		Space Microwave Technology	504 RI	
CAEP	1	High-Power Microwave Technology		
CASIC	3	Aerospace Systems Simulation	BSS	
		Inertial Technology	33 RI	Beihang
		Metrology and Calibration Technology	203 RI	AVIC, CNNC
CNNC	1	Metrology and Calibration Technology		AVIC, CASIC
CSSC	5	Electromagnetic Compatibility	701 RI	
		Marine Corrosion and Protection	725 RI	
		Sonar Technology	715 RI	
		Underwater Information and Control	705 RI	NWPU
		Vessel Integrated Power Technology	712 RI	PLAN
NORINCO	5	Detonator Safety and Reliability	213 RI	
		Electromechanical Engineering and Control	212 RI	BIT
		Explosive Combustion	204 RI	
		Materials Technology in Impact Environments	52 RI	BIT
		Vehicle Transmission	201 RI	BIT
CIVILIAN UNIVERSITIES				
BEIHANG UNIVERSITY	5	Aero-Engine Aerodynamics and Thermodynamics		
		Aircraft Control and Integration Technology		AVIC
		Computational Fluid Dynamics		PLASSF
		Inertial Technology		CASIC
		Reliability & Environmental Engineering Technology		CASC
BEIJING INSTITUTE OF TECHNOLOGY (BIT)	3	Electromechanical Engineering and Control		Norinco
		Materials Technology in Impact Environments		Norinco
		Vehicle Transmission		Norinco
CENTRAL SOUTH UNIVERSITY	1	Lightweight, High-strength Structural Materials		
CHANGCHUN UNIVERSITY OF S&T	1	High-Power Semiconductor Lasers		
HARBIN ENGINEERING UNIVERSITY	2	Hydroacoustic Technology		
		Military Underwater Intelligent Robotic Technology		
HARBIN INSTITUTE OF TECHNOLOGY (HIT)	4	Composite Material Technology in Special Environments		
		Precision Hot Processing of Metals		
		Space Environmental Materials Behavior and Eval Tech		CASC
		Tunable Gas Lasers		
HUAZHONG UNIVERSITY OF S&T	1	Multi-spectral Information Processing Technology		
NANJING UNIV OF AERONAUTICS AND ASTRONAUTICS (NUAA)	2	Helicopter Rotor Dynamics		AVIC
		Helicopter Transmission Technology		AECC
NANJING UNIVERSITY OF S&T	1	Ballistics		

NORTH UNIVERSITY OF CHINA	1	Electronic Measurement Technology		CETC
NORTHWESTERN POLYTECHNICAL UNIVERSITY (NWPU)	6	Airfoil and Blading Aerodynamics Solid Rocket Engine Combustion, Thermal Structure Space Flight Dynamics Technology Super High Temperature Structural Composites UAV Special Technology Underwater Information and Control		 CASC PLASSF CSSC
SHENZHEN UNIVERSITY	1	Precision Guidance and Automatic Target Recognition		NUDT
UNIV OF ELECTRONIC SCIENCE AND TECHNOLOGY OF CHINA (UESTC)	2	Communications Anti-Jamming Technology High Power Microwave Elec. Vacuum Component Tech		 CETC
XIDIAN UNIVERSITY	2	Antennas and Microwave Technology Radar Signal Processing		CETC
MILITARY INSTITUTIONS				
NATIONAL UNIVERSITY OF DEFENSE TECHNOLOGY (NUDT)	3	New Ceramic Fiber and Composite Materials Parallel and Distributed Processing Precision Guidance and Automatic Target Recognition		 Shenzhen Univ
PLA ARMY (PLAA)	2	Electromagnetic Environment Effects Remanufacturing Technology	PLAA Eng Univ PLAA AAF	
PLA AIR FORCE (PLAAF)	1	Aviation Plasma Dynamics	PLAAF Eng Univ	
PLA NAVY (PLAN)	1	Integrated Power Technology	PLAN Eng Univ	CSSC
PLA STRATEGIC SUPPORT FORCE (PLASSF)	2	Computational Fluid Dynamics Space Flight Dynamics Technology	CARDC Space Eng Univ	Beihang

List of Labs by Research Area[ix]

AREA	PRIMARY RESEARCH AREA	#	SECONDARY RESEARCH AREA	#	TOTAL
AEROSPACE	Advanced Composite Materials Advanced High-Temp Structural Materials Aero-Engine Aerodynamics and Thermodynamics Aerospace Systems Simulation Aircraft Control and Integration Technology Airfoil and Blading Aerodynamics Aviation Plasma Dynamics Composite Material Tech. in Special Environments Computational Fluid Dynamics Fire Control Technology Helicopter Rotor Dynamics Helicopter Transmission Technology High-Energy Beam Processing Technology High Power Microwave Electronic Vacuum… Inertial Technology Lightweight, High-strength Structural Materials Multi-spectral Information Processing Technology New Ceramic Fiber and Composite Materials Precision Guidance and Automatic Target Rec. Precision Hot Processing of Metals Radar Signal Processing Reliability & Environmental Engineering Solid Rocket Engine Combustion… Space Environmental Materials Behavior and Eval. Space Flight Dynamics Technology Space Flight Intelligent Control Technology Super High Temperature Structural Composites Space Microwave Technology Tunable Gas Lasers UAV Special Technology	30	Antennas and Microwave Technology Communications Anti-Jamming Tech. Materials Technology in Impact Env. Electromagnetic Compatibility Electromagnetic Environment Effects Electromechanical Engineering and Control Electronic Information Control Electronic Measurement Technology Explosive Combustion High-Power Microwave Technology High-Power Semiconductor Lasers Metrology and Calibration Technology Parallel and Distributed Processing Radio Wave Env. Char. and Modeling Remanufacturing Technology	15	45
GROUND	Vehicle Transmission	1	Antennas and Microwave Technology Communications Anti-Jamming Tech. Detonator Safety and Reliability Electromagnetic Compatibility Electromagnetic Environment Effects Electromechanical Engineering and Control Electronic Information Control Electronic Measurement Technology Explosive Combustion Fire Control Technology High-Power Microwave Technology High-Power Semiconductor Lasers Materials Technology in Impact Env. Remanufacturing Technology	14	15
MARITIME	Electromagnetic Compatibility Hydroacoustic Technology Marine Corrosion and Protection Sonar Technology Underwater Information and Control Underwater Intelligent Robotic Technology Vessel Integrated Power Technology	7	Airfoil and Blading Aerodynamics Antennas and Microwave Technology Communications Anti-Jamming Tech. Electronic Information Control Electronic Measurement Technology Fire Control Technology High-Power Microwave Technology Materials Technology in Impact Env. Radio Wave Env. Char. and Modeling Reliability & Environmental Engineering	10	17
MULTIPLE	Antennas and Microwave Technology Ballistics Communications Anti-Jamming Technology Communications Countermeasures Technology Detonator Safety and Reliability Electronic Information Control Electronic Measurement Technology Electromagnetic Environment Effects Electromechanical Engineering and Control	17			17

[ix] Following further data refinements, this list and the other two research lists differ slightly in some categories from the data presented in Part One of the report. The overall findings in Part One of the report remain unchanged.

	Explosive Combustion High-Power Microwave Technology High-Power Semiconductor Lasers Materials Technology in Impact Environments Metrology and Calibration Technology Parallel and Distributed Processing Radio Wave Env. Char. and Modeling Tech Remanufacturing Technology				
UNKNOWN	Specialized Integrated Circuits	1			1

List of Labs by Equipment Research

EQUIPMENT	PRIMARY RESEARCH AREA	#	SECONDARY RESEARCH AREA	#	TOTAL
AIR/MISSILE DEFENSE		0	Aerospace Systems Simulation Electronic Information Control Precision Guidance and Automatic Target Rec. Space Flight Intelligent Control Technology	4	4
AIRCRAFT	Advanced Composite Materials Advanced High-Temp. Structural Mat. Aero-Engine Aerodynamics… Aircraft Control and Integration Tech. Airfoil and Blading Aerodynamics Aviation Plasma Dynamics High-Energy Beam Processing Tech. Super High Temp. Structural Composites	8	Composite Material Tech. in Special Env. Computational Fluid Dynamics Electromagnetic Compatibility Electromagnetic Environment Effects Fire Control Technology Lightweight, High-strength Structural Mat. Metrology and Calibration Technology Multi-spectral Information Processing Tech. New Ceramic Fiber and Composite Materials Reliability & Env. Engineering Tech. Remanufacturing Technology	11	19
BALLISTIC MISSILES		0	Aerospace Systems Simulation Electronic Measurement Technology Inertial Technology Solid Rocket Engine Combustion… Space Flight Intelligent Control Technology	5	5
COMMS EQUIPMENT	Communications Anti-Jamming Tech.	1	Communications Countermeasures Tech. Electromagnetic Compatibility Radio Wave Env. Char. and Modeling Tech. Sonar Tech Space Microwave Technology Specialized Integrated Circuits Tunable Gas Lasers Underwater Information and Control	8	9
COMPUTERS	Parallel and Distributed Processing	1	Electromagnetic Compatibility	1	2
ELECTRONIC WARFARE EQUIPMENT	Electronic Information Control High-Power Microwave Technology	2	Aerospace Systems Simulation Communications Countermeasures Tech. UAV Special Technology	2	5
GROUND VEHICLES	Vehicle Transmission	1	Fire Control Technology Remanufacturing Technology	2	3
HELICOPTERS	Helicopter Rotor Dynamics Helicopter Transmission Technology	2	Advanced Composite Materials Aircraft Control and Integration Technology Airfoil and Blading Aerodynamics Fire Control Technology	4	6
HIGH-ENERGY WEAPONS		0	Vessel Integrated Power Technology	1	1
MISSILES (NON-BALLISTIC)	Precision Guidance and Auto. Target Rec.	1	Aerospace Systems Simulation Aircraft Control and Integration Technology Electromechanical Engineering and Control Electronic Information Control Explosive Combustion Inertial Technology Space Flight Dynamics Technology Super High Temp. Structural Composites Materials Technology in Impact Environments Multi-spectral Information Processing Tech. New Ceramic Fiber and Composite Materials Space Flight Intelligent Control Technology	12	13
MUNITIONS	Ballistics Detonator Safety and Reliability Electromechanical Eng. and Control Explosive Combustion Materials Technology in Impact Env.	5	Electromagnetic Environment Effects Electronic Measurement Technology High-Power Semiconductor Lasers Lightweight, High-strength Structural Mat.	4	9
RADAR	Antennas and Microwave Technology High Power Microwave Elec. Vac. Comp. Radar Signal Processing	3	Electromagnetic Compatibility Electromagnetic Environment Effects Electronic Information Control Electronic Measurement Technology New Ceramic Fiber and Composite Materials Precision Guidance and Automatic Target Rec. Radio Wave Env. Char. and Modeling Tech. Specialized Integrated Circuits	8	11

SPACE VEHICLES	Composite Material Tech. in Special Env. Computational Fluid Dynamics Inertial Technology Reliability & Env. Engineering Tech. Solid Rocket Engine Combustion… Space Flight Dynamics Technology Space Env. Materials Behavior and Eval. Space Microwave Technology Tunable Gas Lasers	9	Advanced Composite Materials Aircraft Control and Integration Technology Electromagnetic Environment Effects Electronic Measurement Technology Explosive Combustion High-Energy Beam Processing Technology Lightweight, High-strength Structural Mat. Metrology and Calibration Technology New Ceramic Fiber and Composite Materials Parallel and Distributed Processing Radio Wave Env. Char. and Mod. Tech. Space Flight Intelligent Control Technology Super High Temp. Structural Composites	13	
SURFACE VESSELS	Electromagnetic Compatibility Marine Corrosion and Protection Vessel Integrated Power Technology	3	Fire Control Technology Reliability & Env. Engineering Tech.	2	5
UAVS	UAV Special Technology	1	Advanced Composite Materials Aircraft Control and Integration Technology Airfoil and Blading Aerodynamics Fire Control Technology Multi-spectral Information Processing Tech. Space Flight Intelligent Control Technology	6	7
UNDERWATER VEHICLES	Hydroacoustic Technology Underwater Information and Control Underwater Intelligent Robotic Tech. Sonar Technology	4	Airfoil and Blading Aerodynamics Multi-spectral Information Processing Tech.	2	6
MULTIPLE	Aerospace Systems Simulation Communications Anti-Jamming Tech. Communications Countermeasures Tech. Electromagnetic Environment Effects Electronic Measurement Technology Fire Control Technology High-Power Semiconductor Lasers Lightweight, High-strength Struc. Mat. Metrology and Calibration Technology Multi-spectral Info. Processing Tech. New Ceramic Fiber and Composite Mat. Radio Wave Env. Char. and Mod. Tech. Remanufacturing Technology Space Flight Intelligent Control Tech. Specialized Integrated Circuits	15			
UNKNOWN	Precision Hot Processing of Metals	1			1

List of Labs by Functional Research Areas

RESEARCH AREA	PRIMARY RESEARCH AREA	#	SECONDARY RESEARCH AREA	#	TOTAL
ACOUSTICS	Hydroacoustic Technology Sonar Technology	2	Underwater Intelligent Robotic Technology	1	3
AERO-DYNAMICS	Airfoil and Blading Aerodynamics Ballistics Computational Fluid Dynamics Helicopter Rotor Dynamics	4	Aero-Engine Aerodynamics… Aviation Plasma Dynamics	2	6
ARMOR		0	Materials Technology in Impact Environments	1	1
COMMS TECHNOLOGIES	Communications Anti-Jamming Tech. Communications Countermeasures Tech. Tunable Gas Lasers	3	Electromagnetic Compatibility Hydroacoustic Technology Radio Wave Env. Char. and Modeling Tech. Sonar Technology Space Microwave Technology Specialized Integrated Circuits Underwater Information and Control	10	13
COUNTER-MEASURES		0	Aerospace Systems Simulation Communications Countermeasures Tech. Electronic Information Control Fire Control Technology Space Microwave Technology	5	5
ELECTRICAL POWER	Vessel Integrated Power Technology	1	Advanced High-Temp. Structural Materials	1	2
ELECTRO-MAGNETICS	Electromagnetic Compatibility Electromagnetic Environment Effects Electronic Measurement Technology High Power Micro. Elec. Vac. Comp. Tech. High-Power Microwave Technology Radio Wave Env. Char. and Mod. Tech. Space Microwave Technology	7	Antennas and Microwave Technology Electronic Information Control	2	9
EMP		0	Electromagnetic Compatibility Electromagnetic Environment Effects	2	2
FIRE CONTROL	Fire Control Technology	1	Antennas and Microwave Technology	1	2
GNC	Aircraft Control and Integration Tech. High-Power Semiconductor Lasers Inertial Technology Space Flight Intelligent Control Technology Underwater Information and Control	5	Aerospace Systems Simulation Helicopter Rotor Dynamics Metrology and Calibration Technology Multi-spectral Information Processing Tech. Radio Wave Env. Char. and Modeling Tech. Precision Guidance and Automatic Target Rec. Sonar Technology Space Flight Dynamics Technology UAV Special Technology Underwater Intelligent Robotic Technology	10	15
HYPERSONIC TECHNOLOGIES		0	Aero-Engine Aerodynamics… Aircraft Control and Integration Technology Computational Fluid Dynamics Explosive Combustion New Ceramic Fiber and Composite Materials Space Flight Intelligent Control Technology Super High Temp. Structural Composites Space Flight Dynamics Technology	8	8
IMAGING		0	Multi-spectral Information Processing Tech. Radar Signal Processing	2	2
IMPACT & DAMAGE		0	Detonator Safety and Reliability Explosive Combustion Materials Technology in Impact Environments Space Env..Materials Behavior and Eval.	4	4
INFORMATION & SIGNAL PROCESSING	Radar Signal Processing	1	Communications Anti-Jamming Technology Multi-spectral Information Processing Tech. Precision Guidance and Automatic Target Rec. Sonar Technology Underwater Information and Control	6	7
INTELLIGENT TECHNOLOGIES		0	Aerospace Systems Simulation Aircraft Control and Integration Technology Communications Anti-Jamming Technology Communications Countermeasures Tech. Composite Material Tech. in Special Env.	12	12

			Electronic Information Control Multi-spectral Information Processing Tech. Precision Guidance and Automatic Target Rec. Precision Hot Processing of Metals Radar Signal Processing Space Flight Intelligent Control Technology Underwater Intelligent Robotic Technology		
LASER TECH		0	High-Energy Beam Processing Technology High-Power Semiconductor Lasers Materials Tech in Impact Environments Multi-spectral Information Processing Tech. Tunable Gas Lasers	5	5
MANNED SPACEFLIGHT		0	Space Flight Dynamics Technology	1	1
MANUFACT-URING	High-Energy Beam Processing Technology Remanufacturing Technology	2	Aerospace Systems Simulation Composite Material Tech. in Special Env.	2	4
MATERIALS	Advanced High-Temp Structural Materials Composite Material Tech in Special Env. Lightweight, High-strength Structural Mat. Marine Corrosion and Protection Materials Technology in Impact Env. New Ceramic Fiber and Composite Mat. Precision Hot Processing of Metals Space Env Materials Behavior and Eval. Super High Temp. Structural Composites	9	Helicopter Rotor Dynamics High-Energy Beam Processing Technology High-Power Semiconductor Lasers Specialized Integrated Circuits	4	13
MEASUREMENT TECHNOLOGIES	Metrology and Calibration Technology	1	Electromagnetic Compatibility Space Flight Intelligent Control Technology Space Microwave Technology Tunable Gas Lasers	4	5
MICROWAVE TECHNOLOGIES	Antennas and Microwave Technology				
MILLIMETER WAVE TECHNOLOGIES		0	Aerospace Systems Simulation Electronic Information Control Electronic Measurement Technology High Power Microwave Elec. Vac. Comp. Precision Guidance and Automatic Target Rec.	5	5
MISC. SPACE OPERATIONS	Space Flight Dynamics Technology	1	Antennas and Microwave Technology Communications Anti-Jamming Technology Composite Material Tech. in Special Env. Computational Fluid Dynamics Electromagnetic Environment Effects Electronic Measurement Technology Inertial Technology Metrology and Calibration Technology New Ceramic Fiber and Composite Materials Radio Wave Env. Char. and Modeling Tech. Reliability and Environmental Engineering Tech. Solid Rocket Engine Combustion… Space Env. Materials Behavior and Eval. Space Flight Intelligent Control Technology Space Microwave Technology Super High-Temp. Structural Composites Tunable Gas Lasers	17	18
MUNITIONS TECHNOLOGIES	Detonator Safety and Reliability Electromechanical Engineering and Control	2	Explosive Combustion	1	3
NUCLEAR TECH[x]		0	Lightweight, High-strength Structural Mat. Metrology and Calibration Technology Parallel and Distributed Processing Super High-Temp. Structural Composites	4	4
OPTO-ELECTRONICS		0	High-Power Semiconductor Lasers Tunable Gas Lasers	2	2
PLASMA TECHNOLOGIES		0	Aviation Plasma Dynamics Ballistics High-Energy Beam Processing Technology Pulsed Power Technology	4	4
POSITIONING		0	Hydroacoustic Technology	2	2

[x] Includes research related to nuclear weapons, nuclear energy, and any other applications.

			UAV Special Technology		
PROPULSION	Aero-Engine Aerodynamics… Explosive Combustion Solid Rocket Engine Combustion…	3	Advanced High-Temperature Structural Mat. Aviation Plasma Dynamics High-Energy Beam Processing Technology New Ceramic Fiber and Composite Materials Super High Temp. Structural Composites UAV Special Technology Vessel Integrated Power Technology	7	10
RELIABILITY & ENV. ENG.	Reliability & Environmental Eng. Tech.	1	Space Env. Materials Behavior and Eval.	1	2
ROBOTICS		0	Communications Anti-Jamming Technology Helicopter Rotor Dynamics Underwater Intelligent Robotic Technology	3	3
SEMI-CONDUCTORS	High-Power Semiconductor Lasers Specialized Integrated Circuits	2	Precision Hot Processing of Metals	1	3
SENSING		0	Aircraft Control and Integration Technology Electronic Measurement Technology Hydroacoustic Technology Multi-spectral Information Processing Tech. Precision Guidance and Automatic Target Rec. Space Microwave Technology Tunable Gas Lasers Underwater Intelligent Robotic Technology	8	8
SHIPBUILDING		0	Electronic Measurement Technology Marine Corrosion and Protection	2	2
SIMULATION & MODELING	Aerospace Systems Simulation Parallel and Distributed Processing	2	Composite Material Tech. in Special Env. Computational Fluid Dynamics Electromagnetic Compatibility Electromagnetic Environment Effects Electromechanical Engineering and Control Electronic Information Control Fire Control Technology Helicopter Rotor Dynamics Hydroacoustic Technology Materials Technology in Impact Environments Radar Signal Processing Radio Wave Env. Char. and Modeling Tech. Reliability & Env. Engineering Tech. Solid Rocket Engine Combustion… Space Env. Materials Behavior and Eval. Space Flight Dynamics Technology Space Flight Intelligent Control Technology Super High Temp. Structural Composites UAV Special Technology	19	21
STEALTH TECHNOLOGIES		0	Advanced Composite Materials Antennas and Microwave Technology Aviation Plasma Dynamics Electronic Information Control New Ceramic Fiber and Composite Materials UAV Special Technology	6	6
TARGET DETECTION & RECOGNITION	Precision Guidance and Auto. Target Rec.	1	Fire Control Technology Hydroacoustic Technology Multi-spectral Information Processing Tech. Radar Signal Processing Sonar Technology Underwater Intelligent Robotic Technology	6	7
TERAHERTZ TECHNOLOGIES		0	Communications Anti-Jamming Technology Electronic Measurement Technology High Power Microwave Elec. Vacuum Com. Precision Guidance and ATR Specialized Integrated Circuits Space Microwave Technology Tunable Gas Lasers	7	7
VEHICLE PARTS & TECH	Helicopter Transmission Technology Vehicle Transmission	2	Remanufacturing Technology	1	3
MULTIPLE	Aviation Plasma Dynamics Electronic Information Control Intelligent Robotic Technology Multi-spectral Information Processing Tech. UAV Special Technology	5			5

Abbreviations

AECC	Aero Engine Corporation of China
AUV	Autonomous Underwater Vehicle
AVIC	Aviation Industry Corporation of China
BACC	Beijing Aerospace Control Center (PLASSF)
BAMTRI	Beijing Aeronautical Manufacturing Technology Research Institute (AVIC)
BIAM	Beijing Institute of Aeronautical Materials (AECC)
BIRM	Beijing Institute of Radio Metrology and Measurement (CASIC)
BISEE	Beijing Institute of Spacecraft Environment Engineering (CASC)
BIT	Beijing Institute of Technology
BPEI	Beijing Precision Engineering Institute for Aircraft Industry (AVIC)
CAE	Chinese Academy of Engineering
CAEP	China Academy of Engineering Physics
CALT	China Academy of Launch Vehicle Technology
CARDC	China Aerodynamics Research and Development Center (PLASSF)
CAS	Chinese Academy of Sciences
CASC	China Aerospace Science and Technology Corporation
CASIC	China Aerospace Science and Industry Corporation
CAST	China Academy of Space Technology (CASC)
CETC	China Electronics Technology Group Corporation
CHRDI	China Helicopter Research and Development Institute (AVIC)
CIAE	China Institute of Atomic Energy (CNNC)
CIMM	Changcheng Institute of Metrology & Measurement (AVIC)
CMC	Central Military Commission
CNNC	China National Nuclear Corporation
COSTIND	Commission for Science, Technology and Industry for National Defense
CRIRP	China Research Institute of Radio Wave Propagation (CETC)
CSSC	China State Shipbuilding Corporation
CSU	Central South University
CUST	Changchun University of Science and Technology
DSTKL	Defense S&T Key Laboratory
EMC	Electromagnetic Compatibility
EMP	Electromagnetic Pulse
EW	Electronic Warfare
FACRI	Xi'an Flight Automatic Control Research Institute (AVIC)
GAD	PLA General Armaments Department
GNC	Guidance, Navigation, and Control
GSD	PLA General Staff Department
HEU	Harbin Engineering University
HIT	Harbin Institute of Technology
HUST	Huazhong University of Science and Technology
IFV	Infantry Fighting Vehicle

ISR	Intelligence, Surveillance, and Reconnaissance
LSMRI	Luoyang Ship Material Research Institute (CSSC)
MCF	Military-civil Fusion
MCRI	Xi'an Modern Chemistry Research Institute (Norinco)
MIIT	Ministry of Industry and Information Technology
MOST	Ministry of Science and Technology
MRAP	Mine-Resistant Ambush Protected Vehicle
MTI	Manufacturing Technology Institute (AVIC)
NEU	PLA Naval Engineering University
NJUST	Nanjing University of Science and Technology
NSFC	National Natural Science Foundation of China
Norinco	China Ordnance Industries Group Corporation
NUAA	Nanjing University of Aeronautics and Astronautics
NUC	North University of China
NUDT	National University of Defense Technology
NWPU	Northwestern Polytechnical University
PLA	People's Liberation Army
PLAA	PLA Army
PLAAF	PLA Air Force
PLAN	PLA Navy
PLARF	PLA Rocket Force
PLASSF	PLA Strategic Support Force
RI	Research Institute
SASTIND	State Administration of Science, Technology and Industry for National Defense
SEEE	School of Electrical and Electronic Engineering (HUST)
SLBM	Sea-launched ballistic missile
SWIEE	Southwest Institute of Electronic Equipment (CETC)
SOE	State-owned Enterprise
TT&C	Telemetry, Tracking, and Command/Control
UAV	Unmanned Aerial Vehicle
UESTC	University of Electronic Science and Technology of China
UUV	Unmanned Underwater Vehicle

1. Defense S&T Key Laboratory of Advanced Composite Materials

Official English Name: National Key Laboratory of Advanced Composites (LAC)

Chinese Name: 先进复合材料国防科技重点实验室

Research Field(s): Aerospace – Aircraft (*Also: Helicopters, Space Vehicles, UAVs*) – Materials (*Also: Stealth Technologies*)

Affiliations:

- Aero Engine Corporation of China (AECC) [中国航空发动机集团][xi]
  - Beijing Institute of Aeronautical Materials (BIAM) [北京航空材料研究院]
    - *(a.k.a. AECC 621st Research Institute [621 研究所])*

Key Data:

- Established: 1994
- Total Funding: Unknown
- Personnel: Unknown[10] [11]
- Official start of operations: 1996
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory conducts research into resin, ceramic matrix, and metal matrix composite materials to create aerospace materials with improved performance, including reduced weight and superior toughness, durability, and heat resistance.[12] [13]

The lab officially began operations in 1996, and was expanded (via approval of COSTIND), possibly to its current Defense S&T Key Lab status, in 2004.[14]

The lab's parent institution, the Beijing Institute of Aeronautical Materials (a.k.a. the 621st RI), was established in 1956 as the PRC's first institution devoted to high-temp structural materials. Its advanced materials are utilized in the engines and other parts of aircraft and helicopters. It was added to the U.S. Commerce Department Entity List for export control in December 2020.[15] [16] [17]

Further Information:

- This lab released a book in 2006 about its achievements for the first ten years written by (former?) director Yi Xiaosu, "Advanced Composite Materials Technology, Research, and Development" [先进复合材料技术研究与发展]. Yi Xiaosu also wrote a large two-volume set of books in English on Composite Materials Engineering. [18] [19]
- The BIAM website speaks of a similarly named S&T Key Lab of Advanced Composite Materials [先进复合材料科技重点实验室] (sans out the word "Defense") which is

[xi] BIAM appears to have been transferred in recent years from AVIC to AECC. Most online sources still associate it with AVIC, but its official website and more recent sources state AECC.

presumed to be the same lab. If so, it may go by the internal name of "28th Research Office" [第二十八研究室].[20]

Research Direction:

1. Resin matrix composites [树脂基复合材料]
2. Ceramic matrix composites [陶瓷基复合材料]
3. Metal matrix composites [金属基复合材料][21]

Other Notable Research areas:

- High temperature structural ceramic matrix composites
- Nanoceramic composites
- Laminated ceramic composites
- Self-toughened Si3N4 ceramics
- Continuous fiber reinforced ceramic matrix composites
- Ceramic composite powder preparation technology
- Ceramic parts net proximity molding technology
- Ceramic substrate preparation technology
- Functional and smart materials
- Positive temperature coefficient (PTC) ceramic materials
- Piezoelectric ceramics and smart structures
- Advanced thermosetting and thermoplastic resin systems and composites
- Advanced composite liquid molding technologies
- Non-hot press tank molding technologies
- Structural/functional integrated composites
- Composite material automation technology
- High-performance continuous fibers and their composites
- Structurally/functionally integrated aluminum matrix composites
- Particle-reinforced aluminum matrix composites prepared by stirring method and its precision casting process technology
- Synthesis methods of functional composite ceramic powders
- Self-toughened silicon nitride high-temperature structural ceramic materials
- Broadband wave-transparent ceramic radome materials
- Precision molding technology for gel injection molding of ceramic parts
- Extrusion molding and preparation technology of multi-purpose thin-walled honeycomb ceramics
- Material physical and chemical properties characterization
- Theoretical and experimental analysis of material microstructure, properties and failure
- Liquid forming processes numerical simulation and online testing[22] [23]

Notable Applications:

- This lab's composites have been used in advanced fighter aircraft, large transport aircraft, helicopters, new UAVs, and early warning aircraft. It has developed aerospace composites for aircraft primary structures, control rudders, propellers, engines, and S-shaped inlets for UAVs.[24] [xii]
- This lab has developed resin matrix composites with good radar absorption properties for use on stealth aircraft.[25]
- This lab may have produced the return capsule hatch door for the Shenzhou manned spacecraft.[26]
- Yi Xiaosu has worked to create ESTM fabric, an advanced aerospace fabric which dramatically improves damage tolerance of liquid-formed composites. The U.S. equivalent, an epoxy resin called RTM6, is embargoed to China, forcing China to develop an indigenous equivalent.[27]
- Yi Xiaosu developed a new reinforced fabric based on inter-layering structuring [层间结构化] which was applied to the KJ-2000 early warning aircraft, which reduced fatigue on parts. The U.K.'s University of Manchester was also involved in testing.[28]
- Lab Director Chen Xiangbao announced in 2017 that the J-20 fighter would soon have an indigenous engine, implying this lab is involved somehow in the J-20 engine project. However it is possible Chen is simply making the announcement on behalf of AECC or BIAM as a senior executive, rather than as a representative of this lab.[29]
- Composites developed by this lab were allegedly used in the indigenous C919 large passenger aircraft, including design and manufacturing techniques of tougher, more damage tolerant materials, including epoxy resins, bismaleimide, polyphenylbenzoxazine and polyimide resin-based aerospace composites. These have been marketed to international buyers as well.[30]
- Yi Xiaosu led a team to develop highly conductive composite materials for aircraft. One advantage of these materials is resilience to lightning strikes. The materials have been used on civilian aircraft such as the AG300, AG600, SR2X, and SF50.[31]

Leadership and Key Personnel:

- Director: Either Chen Xiangbao [陈祥宝] or Yi Xiaosu [益小苏][32] [33] [34] [35]
    - Both individuals have been described as the lab’s Director.
    - Chen Xiangbao is a CAE Academician, BIAM Deputy Director, and Director of the PLA Equipment Development Department Advanced Materials Technology experts group [先进材料技术专业组]. Chen's advances have been utilized in PRC UAVs, fighters, and transport aircraft, including high temperature resistant and high toughness composite materials, low temperature curing high performance composite materials, structural absorbing integrated composite materials,

[xii] Further information about specific materials is available upon request.

composite materials manufacturing process simulation optimization, automatic lay-up technology, and improved resin matrix composite materials.
    - Yi Xiaosu did his graduate work in Germany. His focus is on high-performance structural composite materials, functional composite materials, materials process and engineering, and polymeric materials.
- Deputy Director: Bao Jianwen [包建文][36]

Notable Collaborations:

Domestic

- This lab is associated with the Composite Materials and Applications Lab [复合材料及应用研究室] at BIAM, which is involved in wide-scale production of civilian products such as parts for X-ray machines, blood vessel machines, and CT equipment.[37]
- Work with Shanghai Jiaotong University on green composites and recycling of composite materials.[38]

International

- Parent institution BIAM claims to have extensive international relationships, including with U.S. company Kirkhill-TA, Airbus (France/Germany), SECMA (France), and SELL (Germany). It is unclear to what extent BIAM's 2020 addition to the Entity List for export control will affect its international relationships.[39]
- Yi Xiaosu's team signed a research agreement with Airbus in 2017 to develop composite materials with good conductivity.[40]
- A new reinforced fabric based on inter-layering structuring [层间结构化] which was later applied to the PLA's KJ-2000 early warning aircraft was tested by the University of Manchester in the U.K.[41]
- This lab participated in a Super-Light Composite Material Wing/Bridge [超轻复合材料机翼/桥梁] competition in 2009, which was sponsored by U.S. company Boeing.[42]
- Yi Xiaosu was also Director of the Asia-Australia Composites Council.[43]
- Yi Xiaosu took part in a 2018 Sino-German High-end Manufacturing Summit [2018 中德高端制造峰会][44]

Lab Equipment:

No information

Address:

None found, possibly co-located with BIAM at No. 8 Hangcai Avenue, Haidian District, Beijing[45]

Website:

None Found

Known Aliases:

- National Key Laboratory of Advanced Composite Materials [先进复合材料国家重点实验室]
- Science and Technology on Advanced Composites Laboratory [先进复合材料重点实验室]
- S&T Key Laboratory of Advanced Composite Materials [先进复合材料科技重点实验室]
- BIAM 28th Research Office [第二十八研究室]
  - Presumed to be the same lab

2. Defense S&T Key Laboratory of Advanced High-Temperature Structural Materials

Official English Name: Unknown

Chinese Name: 先进高温结构材料国防科技重点实验室

Research Field: Aerospace – Aircraft – Materials (*Also*: *Electrical Power, Propulsion*)

Affiliations:

- Aero Engine Corporation of China (AECC) [中国航空发动机集团][xiii]
  - Beijing Institute of Aeronautical Materials (BIAM) [北京航空材料研究院]
    - *(a.k.a. AECC 621st Research Institute [621 研究所])*

Key Data:

- Established: 2006
- Total Funding: Unknown
- Personnel: nearly 100 researchers[46 47]
- Official start of operations: Unknown
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Advanced High-Temperature Structural Materials conducts research into the development of structural materials capable of operating under high temperatures, complex stresses, and corrosive environments. Research areas include casting,

[xiii] BIAM appears to have been transferred in recent years from AVIC to AECC. Most online sources still associate it with AVIC, but its official website and more recent sources state AECC.

forging, injection molding, alloy deformation, and powder metallurgy. The lab's research is critical to the creation of high-temperature alloys used in aero-engines for its parent organization, the Beijing Institute of Aeronautical Materials. It is also a key lab tasked with breaking the foreign stranglehold on gas turbine blades and nozzles. Beside this, the lab's research is also applied in the fields of shipping, electronics, oil drilling, and nuclear power.[48] [49] [50]

The lab's parent institution, the Beijing Institute of Aeronautical Materials (a.k.a. the 621st RI), was established in 1956 as the PRC's first institution devoted to high-temp structural materials. Its advanced materials are utilized in the engines and other parts of aircraft and helicopters. It was added to the U.S. Commerce Department Entity List for export control in December 2020.[51] [52] [53]

Further Information:

- The lab has a Powder Turbine Disc Research and Applications Technical Engineering Center [粉末涡轮盘研究与应用技术工程中心] which is a leading institution for manufacturing aerosolized powder and near-size forming technology. It is engaged in powder metallurgy for high temperature alloys, high-speed steel, die steel, stainless steel, low-alloy steel, binary alloys, titanium alloys, and other special high-quality metal materials and parts manufacturing.[xiv] [54]
- A source from 2011 stated that the PRC's gas turbine technology is 20-30 years behind other countries' and still has much catching up to do. BIAM created the "Advanced High Temperature Alloy Precision Formed Parts High Technology Industrialization Demonstration Project" [先进高温合金精密成型件高技术产业化示范工程] in 2006 to break the foreign stranglehold on gas turbine blades and nozzles, so that the PRC would no longer have to rely on imports.[55]
- In 2012, BIAM released a book based on the basic research of this lab, called Advanced High Temperature Structural Materials and Technology, available for online purchase.[56]

Research Direction:

1. High-temperature structural material casting and applications [铸造高温结构材料及应用]
2. High-temperature structural material injection molding and high-temperature alloy deformation applications [喷射成形高温结构材料及变形高温合金应用]
3. High temperature powder structural material applications [粉末高温结构材料应用]
4. Mechanical properties and testing technology for high-temperature structural materials [高温结构材料力学性能测试技术][57] [58]

[xiv] A list of specific materials manufactured by this Center is available upon request.

Notable Applications:

- High-temperature alloy turbine blades and turbine discs developed by this lab have been key to the PRC's development of advanced aero-engines. Perhaps most notably, this lab was involved in the development of both the DD6 and DD9 single-crystal high-temperature alloys (although the DD6 was first developed in the 1990s before the creation of this lab, so the lab's exact role in development of the former is a bit unclear). These single-crystal alloys are critical to the development of advanced aircraft engines and are considered a "crown jewel" of aero-engine development that only a select few countries have mastered. The DD6 has been used in the WS-10 engine (utilized by combat aircraft like the J-10, J-11, J-15, and J-16) and WS-20 engine (utilized by the Y-20), while the more advanced DD9 is used in the WS-15 (utilized by the J-20) and WS-13 (utilized by the J-31 and J-17).[59] [60] [61] [62] [63]
- Creation of a corrosion-resistant alloy, DZ466, which is comparable to U.S. company General Electric's DS GTD111.[64]

Leadership and Key Personnel:

- Director: Zhang Guoqing [张国庆][65] [66]
    - Oversees several unidentified Sino-European aerospace cooperation projects.
- Deputy Directors: Li Jiarong [李嘉荣]; Xiao Chengbo [肖程波]; Guo Zhonglou [桂忠楼][67]
- Standing Deputy Director: Tang Dingzhong [唐定中][68]

Notable Collaborations:

Domestic

- Work, or at least some form of broad coordination, on new materials research with PRC company AT&M (Antai) [安泰科技].[69]
- Other labs working in the area of single crystal high-temperature alloys for aircraft turbines include the CAS Institute of Metals, and particularly its Department of High-Temperature Alloy Research [中国科学院金属研究所高温合金研究部], and Shaanxi Liangshi [陕西炼石].[70]

International

- One source from 2011 shows BIAM collaborating with an unidentified French organization.[71]
- For further information on BIAM cooperation internationally, see the *International Collaborations* section for the Defense S&T Key Laboratory of Advanced Composite Materials above.

Lab Equipment:

No Information

Address:

None found, possibly co-located with BIAM at No. 8 Hangcai Avenue, Haidian District, Beijing[72]

Website:

None Found

Known Aliases:

- National Key Laboratory of Advanced High Temperature Structural Materials [先进高温结构材料国家级重点实验室]
- Key Laboratory of Advanced High Temperature Structural Materials [先进高温结构材料重点实验室]
- National Key Laboratory of Science and Technology on Advanced High Temperature Structural Materials
- Science and Technology on Advanced High Temperature Structural Materials Laboratory

3. Defense S&T Key Laboratory of Aero-Engine Aerodynamics and Thermodynamics

Official English Name: National Key Laboratory on Aero-Engine Thermodynamics (AEL)[73]

Chinese Name: 航空发动机气动热力国防科技重点实验室

Research Field: Aerospace – Aircraft – Propulsion (*Also: Aerodynamics, Hypersonic Technologies*)

Affiliations:

- Beihang University [北京航空航天大学]
  - School of Energy and Propulsion Engineering [能源与动力工程学院]

Key Data:

- Established: 1992
- Total Funding: 22.06m RMB

- Personnel: Unknown[74 75]
- Official start of operations: 1995
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Aero-Engine Thermodynamics conducts research on aerodynamics and related thermal research for aircraft engines.[76]

Further Information:

None Found

Research Direction:

1. Flow coupling mechanisms of aero-engine compression systems [航空发动机压缩系统流动耦合机理]
2. Exploring new concepts and principles for aero-engine aerodynamic and thermal force [航空发动机气动热力新概念原理探索]
3. Internal flow mechanisms of compressors and turbines under non-constant conditions [非定常条件下压气机及涡轮内部流动机理]
4. High-performance combustion mechanisms [高性能燃烧机理]
5. Advanced aero-engine cooling mechanisms [航空发动机先进冷却机理][77]

Other Notable Research areas:

- Inherent non-constant aerodynamic thermodynamics of impellers
- Non-linear turbulent flow, vortex and fluctuating hydrodynamics
- Real flow in impellers
- High-performance liquid mist combustion science
- Fundamental research of rotational heat transfer
- High performance liquid mist combustion[78 79]

In 2019, this lab's research fund was interested in funding the following topics:

1. Research on oil-electric hybrid-based all-electric propulsion power system configurations and turbine power generation systems for new concept micro-scale aero-engine technology
2. Numerical simulation techniques for variable cross-sectional pipe flow with non-constant excitation for advanced aero-engine pressurization technology
3. High-frequency absorption spectroscopy of non-constant temperature of cyclonic flames for diagnosis and control of aero-engine cyclonic combustion instability

4. Graphene surface microstructures coupled with pulsating airflow to enhance blade cooling technology for aero-engine blade cooling design technology
5. Design and process study of a miniature permanent magnet rotary motor based on MEMS three-dimensional coil for new concept micro-scale aero-engine technology[80]

Notable Applications:

- Research by Zou Zhengping [邹正平] into unidentified aircraft turbine engine components, including advances in weight reduction and component size, improving thrust-to-weight ratio and turbine blade number reduction.[81]
- Researcher Chen Maozhang [陈懋章] seems to be involved in some unidentified fashion with the development of the Taihang [太行] aircraft engine, used in the Y-20 heavy transport aircraft. Additionally, images on Chen's team homepage show what looks like a military helicopter and at least two types of space planes.[82] [83]
- Cheng Maozhang's team, under both this lab and the Beihang National Aerospace S&T Lab [航空科学与技术国家实验室], has made several strides in aero-engine technology, including:
    - A "low-speed, large-size compressor experimental device and rotor flow field dynamic measurement technology" allowing for research on the internal flow mechanism of compressors. This project won a 1st Class National S&T Progress Award in 1993.
    - A "pressure engine processor magazine with curved twist spoiler" which has been utilized in multiple types of combat aircraft and eliminates mid-air engine stalling and other failures in the air. This award won a 2nd Class National Technical Invention Award in 1999.
    - A "small and large blade axial flow compressor technology" with 15% higher pressurization ratio than the U.S. F-22 fighter aircraft and providing support for the next generation of high thrust-to-weight engines. This won a 2nd Class National Technical Invention Award in 2011.
    - A "turning turbine design technology" with an internal flow organization method of counter-rotating turbines and counter-rotating turbine aerodynamic design technology, with significantly reduced weight and length. This will provide the turbine engines for the PRC's 4th generation of aircraft.
    - Hypersonic pre-cooling aero-engine technology, including design breakthroughs in heat exchange and high-temperature alloy array microfine tube low melt corrosion brazing process technology.[84]

Leadership and Key Personnel:

- Director: Tao Zhi [陶智][85] [86]
    - Studied at Strathclyde University in U.K.

- Not a Communist Party member
    - CPPCC Representative (possibly as minor political party member) and Beihang Vice President
- Academic Committee Director: Zhou Sheng [周盛][87]
- Deputy Directors: Gao Ge [高歌]; Li Qiushi [李秋实]; Lu Lifeng [陆利蓬][88] [89] [90]
    - Li Qiushi was a visiting scholar to MIT 2007-2008

Key Personnel:

- Zhao Yongjun [赵拥军][91] [92]
    - Researches aero-engine performance, fault diagnosis and health management, system simulation and multidisciplinary optimization.
    - PhD from Georgia Institute of Technology (GIT) in U.S.
    - Worked at both the GIT Aerospace Systems Design Lab and U.S. company General Electric.
- Zou Zhengping [邹正平][93] [94]
    - Research into improved aero-engine design and improved cooperation between academia and industry, as well as likely research into hypersonic space planes.
- Chen Maozhang [陈懋章]
    - Involved in development of Taihang aircraft engine and several other notable advances in aircraft engines (see "Notable Applications" section).

Notable Collaborations:

Domestic

- This lab is associated with the Advanced Aero-Engine Collaborative Innovation Center [先进航空发动机协同创新中心], a 2013 collaboration between Beihang and AVIC that was part of the first batch of 14 Ministry of Education collaboration and innovation centers. [xv] [95] [96]
- This lab provided "academic support" to the China Aerospace Third Professional Information Network's 37th Technical Exchange Conference and the 1st Joint Conference on Air and Space Propulsion in 2016, primarily organized by CASC, with support from several other institutions including the PLA Rocket Force Engineering University. Other participants included a wide range of CASC, CASIC, and other subsidiaries, the Naval Engineering College, and the Air Force Engineering University.[97]
- A team under Academician Chen Maozhang [陈懋章] at Beihang is subordinate to both this lab and the Beihang National Aerospace S&T Lab [航空科学与技术国家实验室], and is a major part of the Ministry of Educations's 2011 AeroEngine Collaboration Center

[xv] A complete list of organizations is available upon request.

[教育部 2011 航空发动机协同中心]. It has over 70 affiliated researchers. See Notable Applications for more information.[98]

International

- French researcher Jacques Renvier, an expert in aero-engines and longtime senior engineer at U.S. company General Electric, has given guest lectures at this lab and has been named an honorary professor at Beihang.[99] [100]
- The Department of Thermal Engineering [热能工程系], which oversees this lab, claims to have partnerships with multiple western academic institutions, including U.S. institutions Princeton, Purdue University, University of Connecticut, and Georgia Institute of Technology, as well as Oxford University in the U.K., and Ecole Centrale in France. A professor from Princeton has been named as an honorary professor, and a professor from Purdue has established a Sino-foreign joint combustion basic research team.[101]

Lab Equipment:

- Lab equipment includes
  - Transonic fan test bench
  - Medium-speed large-size compressor experimental device
  - Full-ring rotating turbine blade external heat transfer test bench[102]

Address:

- None found, possibly co-located with Beihang University at No. 37 Xueyuan Road, Haidian District, Beijing [北京市海淀区学院路 37 号]
- Second location at or near No. 28 Dongfang Street, Gu'an County, Langfang, Hebei Province [河北省廊坊市固安县东方街 28 号附近][103]
- The lab has its own three-story building, as well as a second research area at Beihang's "Southern Campus" (possibly a reference to the lab's secondary facility in the city of Langfang).[104] [105]

Website:

https://web.archive.org/web/20181012112026/http://sepe.buaa.edu.cn/xygk/xssz/gjzdsys/index.htm

Known Aliases:

- National Key Laboratory of Science and Technology on Aero-Engine Aero-thermodynamics [航空发动机气动热力国家级重点实验室]
- National Defense Key Laboratory on Aero-Engine Aero-thermodynamics [航空发动机气动热力国防重点实验室]
- National Key Laboratory on Aero-engines
- National Key Laboratory of Aero-engine

4. Defense S&T Key Laboratory of Aerospace Systems Simulation

Official English Name: Unknown

Chinese Name: 航天系统仿真国防科技重点实验室

Research Field: Aerospace – Multiple (Air/Missile Defense, Ballistic Missiles, Electronic Warfare, Non-ballistic Missiles) – Simulation and Modeling (*Also: Countermeasures, GNC, Intelligent Technologies, Manufacturing, Microwave Technologies, Millimeter Wave Technologies*)

Affiliations:

- China Aerospace Science and Industry Corporation (CASIC) [中国航天科工集团]
  - Beijing Simulation Center [北京仿真中心]
  - Also possibly associated with CASIC 2nd Academy, 2nd Department [二院二部][106]

Key Data:

- Established: 1997
- Total Funding: Unknown
- Personnel: 65[107]
- Official start of operations: Unknown
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Aerospace Systems Simulation claims to be the only Defense S&T Key Lab focused on simulation technology. It is responsible for research into realistic simulation and modeling technology for missile guidance, control, and countermeasures, as well as a wide range of other strategic uses, including air and missile defense, space defense, intelligence, electronic warfare, and AI.

This lab was probably known as the Defense S&T Key Laboratory of Missile Control Systems Simulation [导弹控制系统仿真国防科技重点实验室] until around 2011, when it changed to its current name (see "Further Information" for more). Today, it is much more commonly known in Chinese as the “Key Laboratory of Aerospace Systems Simulation” [航天系统仿真重点实验室], usually (but not always) omitting “Defense S&T” from its name. It is thus possible that this lab is no longer a Defense S&T Key Lab, though no evidence could be found to confirm this either way.

The lab’s parent institution, the Beijing Simulation Center, was established in 1996, and is focused on development of simulations for aerospace systems to advance the PRC's weapons and equipment development.[108]

Further Information:

- *Evidence for the lab's change of name in 2011*: Besides the similar names, the former Missile Control Systems Simulation Lab disappeared from public sources around 2011, and the Aerospace Systems Simulation Lab first appeared in public sources around 2012. The Aerospace Systems Simulation lab is occasionally referred to as being a Defense S&T Key Lab, and continues to do work on missile guidance and control, indicating overlapping missions. Finally, Ma Jing and Tao Yuhui are associated with both labs.[109] [110] [111] [112] [113]

Research Direction:

- Missile control simulation technology [导弹武器控制系统仿真总体技术]
- Microwave and millimeter wave guidance simulation technologies [微波、毫米波寻的制导仿真技术]
- Simulation applications software and integrated, comprehensive simulation environments [仿真应用软件及一体化综合仿真环境]
- Missile guidance system accuracy and confidence simulations [导弹制导系统仿真精度与置信度]
- System simulation technology for precision guided weapons development [精确制导武器研制的系统仿真技术]
- Semi-physical simulations of microwave-millimeter wave guidance seeking [在微波/毫米波寻的制导半实物仿真]
- Simulation of offensive and defense countermeasures [攻防对抗仿真]
- Multi-disciplinary virtual prototyping [多学科虚拟样机]
- RF semi-physical simulations of complex ground and sea clutter/interference [复杂的地海杂波/干预射频半实物仿真]
- Self-developed platforms for distributed simulation software support and virtual prototype support software [自主研发了分布仿真软件支撑平台和虚拟样机支撑软件平台][114]

Notable Applications:

- This lab's research is primarily used in simulations and modeling for a wide range of military uses. This includes missile guidance systems, ballistic missile defenses, networked air defense system survivability, space defenses, intelligence, electronic warfare, AI and automation, and civilian technologies like intelligent manufacturing and industrial internet.[115] [116] [117] [118] [119] [120]
- One project under this lab researched simulation of AI countermeasures in cognitive electronic warfare.[121]

Leadership and Key Personnel:

- Director: Xiong Xinping [熊新平][122]

Notable Collaborations:

Domestic

- This lab is associated with the China Simulation Federation's Aerospace Systems Simulation Experts Committee [中国仿真学会航空航天系统仿真专业委员会][123]
- This lab has hosted an annual conference, the China Targeting and Environmental Modeling and Simulation Technology Conference [中国目标与环境建模仿真技术大会], since 2015.
    - The 2015 Conference was focused on RF targeting and environmental modeling and simulation, and also discussed environmental modeling and simulation for jamming countermeasures and simulation of precision guided equipment in military operations in a complex environment, among many other topics.
    - The fourth Conference in 2018 featured several PLA and military-industrial participants, including the PLAAF Research Institute, CASC 8th Academy 8th Department, CMC Equipment Development Department Simulation Pre-research Specialist Team, Academy of Military Science Evaluation and Demonstration Center , PLARF Research Academy Construction Development Institute, PLAN Test and Training Base, PLAN Research Academy Surface Warfare Institute, AVIC China Air-to-air Missile Research Institute, and others. The theme was "Complex opto-electronic targets, jamming, and environmental characteristics modeling and simulation technology" [复杂光电目标、干扰与环境特性建模仿真技术], including development of a new generation of advanced defensive weapons systems under complex battlefield environments.
    - The fifth conference in 2019 was co-hosted with the University of Electronic Science and Technology of China and featured personnel of PLASSF Base 29 (CARDC), a PLAAF Test and Training Base, CASC, CASIC (including 4th Academy 17th RI), AVIC, CSSC, Norinco, CETC, Hubei Anxin Intelligent

Technology Co. [湖北安心智能科技有限公司等产业公司], Shenyang Dongrui S&T Co. [沈阳东睿科技有限公司], and several universities. The topic was "Complex target, jamming, and environmental characteristics modeling and simulation technology [复杂目标、干扰与环境特性建模仿真技术]. One topic of discussion with military implications was ground and sea clutter/interference modeling and simulation.
  - The sixth conference in 2020 had the theme of Advanced Electronic Countermeasures Technology / Photoelectric Detection Target and Simulation Technology [先进电子对抗技术/光电探测目标与仿真技术]. Topics included the strategic importance of electromagnetic compatibility and electromagnetic security to the success of informatized and intelligentized operations, microwave millimeter wave integrated circuits, and new challenges in modeling and simulation of warfare systems for things like joint warfare and cyber warfare. It featured participants from CASIC and the National Defense University Joint Operations College [国防大学联合作战学院].[124] [125] [126] [127]
- This lab has taken part in several other noteworthy conferences with military institutions:
  - The 2010 China Guidance, Navigation, and Control Academic Conference [2010 中国制导、导航与控制学术会议] (CGNC2010). Other notable participants included multiple AVIC institutions, the PLAAF Equipment Research Academy Aviation Equipment Institute [空军装备研究院航空装备研究所], Air Force Engineering University, Naval Aviation Engineering College, and the National University of Defense Technology.
  - A major 2016 VR/AR summit that featured major players in both government and industry, indicating the lab's interest in simulation extends to these fields.
  - The 2017 Simulation Technology Exchange [2017 年仿真技术学术交流会], alongside personnel of the PLAN, PLAAF, and PLARF Research Academies.
  - The 2018 China Simulation Conference [2018 年中国仿真大会] which also featured personnel of CASC 1st, 5th, and 8th Academies, CASIC 2nd and 3rd Academies, Baidu, and the National Defense University (including Major General Hu Xiaofeng [胡晓峰], a well known thought-leader in the area of military AI and wargames), among other universities and institutions.
  - A 2021 conference on photo-electric detection technology [光电探测技术]. Topics included infrared, terahertz, laser, quantum, microwave, space, and intelligent detection technologies, all with military uses. The summit claimed to be international, but no names of international participants were given.[128] [129] [130] [131] [132]

International

None found

Lab Equipment:

No information

Address:

CASIC's 2nd Department Building #75, Beijing[133]

Website:

None found

Known Aliases:

- Key Laboratory of Aerospace Systems Simulation [航天系统仿真重点实验室]
    - This is the much more common name. "Defense S&T" [国防科技] is typically but not always omitted.
- Defense S&T Key Laboratory of Missile Control Systems Simulation [导弹控制系统仿真国防科技重点实验室]
    - Name that appears on the original online list of DSTKLs, apparently out of use since 2011.
- Defense S&T Key Laboratory of Beijing Simulation Center [北京仿真中心国防科技重点实验室]
- State Key Laboratory of Control System Simulation
- Science and Technology on Space System Simulation Laboratory
- Science and Technology on Special System Simulation Laboratory

5. Defense S&T Key Laboratory of Aircraft Control and Integration Technology

Official English Name: Science and Technology on Aircraft Control Laboratory[134]

Chinese Name: 飞行器控制一体化技术国防科技重点实验室

Research Field: Aerospace – Aircraft (*Also: Helicopters, Non-ballistic Missiles, Space Vehicles, UAVs*) – GNC (*Also: Hypersonic Technologies, Intelligent Technologies, Sensing*)

Affiliations:

- Beihang University [北京航空航天大学]
  - School of Automation Science and Electrical Engineering [自动化科学与电气工程学院]
- Aviation Industry Corporation of China (AVIC) [中国航空工业集团]
  - Xi'an Flight Automatic Control Research Institute (FACRI) [西安飞行自动控制研究所]
    - *(a.k.a. AVIC 618th Research Institute [618 研究所])*

Key Data:

- Established: Unknown
- Total Funding: Unknown
- Personnel: Unknown[135]
- Official start of operations: 2010
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Aircraft Control and Integration Technology conducts research on advanced aircraft control systems, with a focus on flight attitude control, aircraft decisionmaking, and intelligent sensing.

The lab's research focuses on automatic and intelligent control, inertial technology, guidance, precision mechanics, microcomputers, sensors, hydraulics, and electronics, for use with combat aircraft, transport aircraft, helicopters, and UAVs. It may also be known as the AVIC Navigation, Guidance and Control (GNC) Technology R&D Center [中国航空工业导航、制导与控制(GNC)技术研发中心].[136] [137] [138] [139]

This lab is jointly controlled by Beihang University and AVIC Xi'an Flight Automatic Control Research Institute (FACRI) (a.k.a. the AVIC 618th Research Institute). This collaboration is not immediately apparent at first glance (possibly by design) and is not stated on the website for either this lab or FACRI. FACRI was placed on the U.S. Commerce Department Entity List in December 2020 as a "military end user."

Further Information:

- This lab manages the Beihang Space Intelligent and Autonomous Systems Research Center [空间智能自主系统研究中心]. This Center utilizes military-civil fusion [军民融合] and has 230m RMB of funding. Its research has been applied to multiple missiles, satellites, and UAVs.[140]
- This lab manages several Research Teams, including:
  - Bionic Autonomous Flight System Research Team [仿生自主飞行系统研究组] focused on autonomous unmanned system swarm control [无人系统集群自主控制], bionic vision and intelligent sensing [仿生视觉及智能感知], advanced flight control [先进飞行控制], and biological swarm intelligence [生物群体智能].
  - Aircraft Anti-Jamming Control Innovation Team [飞行器抗干扰控制创新团队], associated with the Ministry of Education Changjiang Scholars program [教育部长江学者]
  - Aircraft Advanced Navigation and Control Systems Innovation Team [飞行器先进导航与控制系统技术创新团队], associated with the Ministry of Science and Technology.[141] [142]

Research Direction:

1. Aircraft control system research [飞行器控制体制研究]
2. Flight attitude control [飞行姿态控制]
3. Aircraft decisionmaking management and control [飞行器决策管理与控制]
4. Integration of intelligence sensing and control [智能感知与控制一体化][143]

The Bionic Autonomous Flight System Research Team has its own research direction:

1. Autonomous unmanned system swarm control [无人系统集群自主控制]
2. Bionic vision and intelligent sensing [仿生视觉及智能感知]
3. Advanced flight control [先进飞行控制]
4. Biological swarm intelligence [生物群体智能][144]

Other Notable Research areas:

- Use of low-cost "loyal wingman" UAVs to be launched from high-cost combat aircraft in denied environments, protecting expensive aircraft from missiles
- Deep learning for hypersonic vehicle guidance
- UAV swarming
- Anti-jamming filtering methods in bionic intelligent navigation systems[145] [146] [147] [148]

Notable Applications:

- In addition to its development of aircraft control systems, this lab has been involved in research of unidentified missile, satellite, and UAV technology.[149]
- The lab's parent institution, FACRI, has been involved in the development of the J-10 combat aircraft, as well as the flight control systems for the J-11, J-15, and J-16 combat aircraft. While no information was found directly connecting this lab to those projects, it is likely that it did, given its mission.[150] [151]

Leadership and Key Personnel:

- Director: Jiao Zongxia [焦宗夏][152]
- Deputy Directors: Lu Zhengren [卢正人]; Ren Zhang [任章]; Guo Lei [郭雷][153] [154] [155]
    - Guo Lei has conducted research in the U.K., France, and Japan, with a focus on jamming and anti-jamming, control theory of uncertain and stochastic systems, and high-precision navigation.
    - Ren Zhang researches hypersonic vehicle flight control.

Key Personnel:

- Duan Haibin [段海滨][156]
    - Part of the first batch of young talents with Ten Thousand Talents Plan [万人计划].
    - Research focus on autonomous control of UAVs based on bionic intelligence.

Notable Collaborations:

Domestic

- In 2019, this lab partnered with other Beihang labs and the COMAC Shanghai Aeroplane Design & Research Institute [上海飞机设计研究院] to establish the Large Aircraft Innovation Valley Joint Laboratory [大飞机创新谷联合实验室], focused on large aircraft flight control, hydraulics, landing gear, and brake technology.[157]
- In 2019, this lab established an Intelligent Flight Technology Joint Innovation Center [智能飞行技术联合创新中心] with the Beihang University School of Astronautics, signing a strategic cooperation agreement.[158]
- This lab collaborated with the CASC Infrared Detection Technology R&D Center [红外探测技术研发中心] and Shanghai Institute of Spaceflight Control Technology [上海航天控制技术研究所] to research quadrotor aircraft attitude control.[159]
- This lab collaborated with the CETC 10th RI [中国电子科技集团公司第十研究所] on airborne refueling.[160]

- In 2017, this lab co-hosted the 2nd Summit on New Navigation Technology and Applications [第二届新型导航技术及应用研讨会]. Notable participants included personnel from CASC’s 1st, 5th, 8th, and 9th Academies, CASIC’s 2nd, 3rd, and 4th Academies (more info on specific RIs in source), the National University of Defense Technology, Air Force Engineering University, and Rocket Force Engineering University. Another co-host was the Key Laboratory of Advanced Cruise Missile Guidance and Control Technology [巡航导弹先进制导控制技术重点实验室]. The conference discussed spacecraft flight control, guidance and control technology for hypersonic vehicles, and intelligent/autonomous aerospace systems.[161]
- In 2020, this lab collaborated on the 4th Chinese Conference on Swarm Intelligence and Cooperative Control with multiple organizations, including the Chinese Institute of Command and Control, the 2nd Department-Beihang Swarm Intelligent Control Joint Lab [二部-北航集群智能控制联合实验室], and other labs. Representatives from the PLAN and PLAAF Research Academies, CASC 5th Academy, and National University of Defense Technology participated.[162]

International

- This lab co-hosts the annual International Conference on Guidance, Navigation and Control [国际制导、导航与控制学术会议]. International participants are not named, but a list of regional chairs includes several participants from U.S. universities[xvi] alongside PLA personnel. The conference included PLAAF and PLARF participants, and discussed military topics. Another sponsor is the Chinese Institute of Command and Control [中国指挥与控制学会], an organization which conducts military research.[163] [164]
- This lab co-hosts an annual International Aerial Robotics Competition along with AVIC Shenyang Aircraft Design Institute, AVIC 631st RI, and others. U.S. university MIT has been among the participants.[165]
- The lab’s parent institution, FACRI, signed a joint agreement with U.S. aerospace company Honeywell in 2018 to jointly develop a commercial flight control system. This includes building a 10,000 sqm research and production base in Xi'an. The venture will be called HonFei Flight Technology Co and will research and manufacture advanced flight control technologies, including fly-by-wire controls. HonFei also provides flight systems for the C919 passenger jet.[166]

Lab Equipment:

- A list of major lab equipment includes several pieces of equipment sourced from U.S. or western companies, possibly in violation of export controls:
    - Copterworks AF25B Remote Control Helicopter, from U.S. company Copterworks
    - MS07104A Mixed Signal Oscillator, from U.S. company Agilent

[xvi] A full list of regional chairs, including international participants, is available upon request.

- Mercury Winrunner 9.0, from U.S. company HP
    - VxWorks 6.7, from U.S. company Wind River Systems
    - Vicon Mx3+ Indoor Positioning System (plus 7500 connection cable), from U.S. company Vicon
    - Custom-made ARINC629 communication simulation software, from Germany company Kunbus
    - Novatel OEMV-3 GPS device, from Canadian company Novatel
    - RTLAB 8.0 Software, from Canadian company Opal-RT
- Other lab equipment includes:
    - Residual Computer System
    - VME computer
    - PDM software
    - Pioneer 3 Mobile Research Platform
    - TT-XLC Remote Control Helicopter
    - SSC-01 UAV
    - 6U VPX Single Board Computer
    - Cybertouch Data Glove
    - XL50 Data Helmet
    - Flock of Bird (sic) Tracker
    - Reliability Airborne Software Verification Methodology Research Unit 1.0
    - Hardware Environment Simulation System
    - Software Modeling Tool 7.0
- The lab utilizes the following data models：
    - UAV General Planning Methodology
    - Terrain Data Model
    - 3D solid model of moving bodies
    - Domestic and international military and civilian dynamics, kinematic models[167]

Address:

None found, possibly co-located with Beihang and FACRI at No. 37 Xueyuan Road, Haidian District, Beijing [北京市海淀区学院路 37 号] and No. 92 Dianzi 1st Road, AVIC No. 618 Institute, Xi’an, Shaanxi Province [西安市电子一路 92 号], respectively

Website:

http://dept3.buaa.edu.cn/zdsys/gjzdsys.htm

Known Aliases:

- Key Laboratory on Aircraft Control [飞行器控制一体化技术重点实验室]
    - More commonly used name on FACRI side

6. Defense S&T Key Laboratory of Airfoil and Blading Aerodynamics

Official English Name: National Key Laboratory of Aerodynamic Design and Research[168]

Chinese Name: 翼型、叶栅空气动力学国防科技重点实验室

Primary Research Field: Aerospace (*Also: Maritime*) – Aircraft (*Also: Helicopters, UAVs, Underwater Vehicles*) – Aerodynamics

Affiliations:

- Northwestern Polytechnical University (NWPU) [西北工业大学]
    - School of Aeronautics [航空学院] (Airfoil Section)
    - School of Power and Energy [动力与能源学院] (Blading Section)

Key Data:

- Established: 1992
- Total Funding: Unknown
- Personnel: 50 (45 w/ PhD)[169]
- Official start of operations: 1995
- Floor Space: 8,350 sqm

Lab Overview:

The Defense S&T Key Laboratory of Aerodynamic Design and Research claims to be the only lab in the PRC focused on basic and applied basic research in the field of airfoil aerodynamics, particularly aerodynamic design, analysis, and verification of aircraft and aero-engine airfoils and blading. This lab is helping to create a new generation of advanced military and civilian aircraft, helicopters, and UAVs, with the goal of enabling China to independently develop high performance aerospace vehicles through research of advanced aerodynamic designs, analysis, and experimental technology. It does work on aircraft engines, airfoils (including aircraft wings, helicopter rotors, and propellers), optimization and design of aircraft aerodynamic configurations, design methods, evaluation, and verification, and new concepts for airfoil and aircraft wing designs based on flow control technology.[170] [171]

The lab was originally conceived due to the urgent need for indigenous aircraft wing design, as this technology was under foreign embargo. As NWPU was already a leading researcher of airfoil design, COSTIND decided to put this new lab at NWPU and invest in the NF-3 wind tunnel, which was approved in 1988 and completed in 1994. The NF-3 was awarded a 1994 1st Class Aviation Science and Technology Progress Award. Today, the lab revolves around the capabilities of its suite of advanced wind tunnels (see below for more).

Further Information:

- The lab has five major research teams:
  - Design Aerodynamics Research Team [设计空气动力学研究团队] under Professor Gao Zhenghong [高正红]
  - Flow Control Research Team [流动控制研究团队] under Professor Cai Jinsheng [蔡晋生]
  - Fluid-Solid Coupling Interdisciplinary Research Team [流固耦合交叉学科研究团队] under Professor Ye Zhengyin [叶正寅]
  - New Flight Vehicle Exploration Research Team [新型飞行器探索研究团队] under Professor Song Bifeng [宋笔锋]
  - Blading Aerodynamics Research Team [叶栅空气动力学研究团队] under Professor Liu Bo [刘波][172]

Research Direction:

1. Basic airfoil theory, design methods, and applications [翼型的基础理论、设计方法及其应用] toward future aircraft needs
2. Research into experimental aerodynamics, wind tunnel experimental methods, and experimental techniques for airfoils and their application to aircraft design [翼型及其应用于飞行器设计的风洞实验方法和实验技术研究]
3. Theoretical, computational, and aerodynamic studies of blading [叶栅的理论、计算与空气动力研究][173]

Other Notable Research areas:

- Airfoil/wing design theory and methods
- Airfoil/wing experimental techniques
- Flow control research
- New concepts of aerodynamic layout design
- Advanced aeronautical impeller research
- Aircraft aerodynamic design optimization
- Numerical computation of Reynolds-averaged Navier-Stokes (RANS) equations for complete aircraft at high angles of attack
- RANS calculation of hover and forward flight for helicopter rotors
- Aero elasticity analysis
- Static/dynamic measurements of pressure over wings, airplanes, and in inlets[174]

Notable Applications:

This lab is involved in the development of advanced airfoils and blading for many of the PRC's aircraft, helicopters, and UAVs. Publicly-named examples include:

- This lab was involved in the design of the air intakes for the Y-20 military heavy transport aircraft, an unnamed bomber aircraft (presumably a variant of the H-6), the KJ-200 early warning aircraft, and the air intakes and parafoils of the C919 passenger aircraft, via the NF-3 and NF-6 wind tunnels.[175] [176]
- In addition to aircraft, the lab has used its wind tunnels to do experiments involving airborne paratroopers.[177]
- This lab also developed the PRC's first aerodynamic export software: the Multi-microcomputer network parallel computing system [微机网络并行计算系统], the CADR3D advanced complex shape full machine aerodynamic computing software system [CADR3D 先进复杂外形全机气动计算软件系统], and a non-structural mesh aerodynamic analysis system [非结构网格气动分析系统]. It has also developed other software systems for aerodynamic research, including an on-structural grid aerodynamics software analysis system, vehicle dynamic derivative calculation software system, and a civil aircraft aerodynamic calculation software system.[178] [179]

Leadership and Key Personnel:

- Director: Han Zhonghua [韩忠华]
- Academic Committee Director: Li Tian [李天]
- Deputy Directors: Gao Yongwei [高永卫]; Xu Heyong [许和勇]; Gao Limin [高丽敏][180] [181]

Notable Collaborations:

Domestic

- Collaboration with AVIC Avicopter (creators of the Z-10, Z-19, and multiple other military helicopters) on a new, optimized helicopter rotor blade.[182]
- The NF-6 wind tunnel was constructed with the help of AVIC (then known as CAVIC).[183]
- Research collaboration with PLA military units 95939, 95949, 96215, and 63837.[184]
- Helped organize the 2012 China Aerostat Conference [中国浮空器大会] at NWPU, attended by the PLAAF Equipment Research Academy [空军装备研究院], CASIC Base 068, China Special Aircraft Research Institute [中国特种飞行器研究所], and the CETC 38th RI [38 研究所]. The conference discussed military uses for aerostats, including airborne early warning, emergency command and communications, counterterrorism, and anti-submarine warfare.[185]

- Helped host the 5th Western China Young Scholars of Mechanics Academic Salon [西部力学青年学者学术沙龙]. Military participants included the PLA Air Force Engineering University [空军工程大学] and the PLA GAD's 19th Test and Training Base [总装二十九试验训练基地].[186]

International

- This lab formed an Aircraft Complex Flow and Control Innovation and Intelligence Base [飞行器复杂流动与控制创新引智基地] with several foreign academic institutions, including UC Irvine in the U.S., Oxford University in the U.K., and other schools from Germany, Netherlands, Singapore, and Hong Kong.[187]
- This lab formed a "Behavioral Science and Technology of Structural Mechanics" Innovation and Intelligence Base between 2007 and 2016 with multiple foreign academic institutions, including Akron University in the U.S., as well as universities in Australia, France, and the Netherlands.[188]

Lab Equipment:

- The total value of the lab's equipment is 137.1 million RMB.[189]
- NF-3 wind tunnel
  - Asia's largest low-speed wing wind tunnel [低速翼型风洞], equipped with three experimental sections, including a binary experimental section [二元实验段], ternary experimental section [三元实验段], and propeller experimental section [螺旋桨实验].
  - Maximum wind speed of 145 m/s, highest test Reynolds number greater than 7 million for airfoil tests, wind tunnel turbulence less than 0.05%.
  - Binary experimental section: experimental section size 8m×3m×1.6m, maximum wind speed 130m/s, average turbulence 0.045%, maximum experimental Reynolds number 7×106, suitable for new concept airfoil flow mechanism research and engineering design verification.
  - Ternary experimental section: experimental section size 12m×3.5m×2.5m, maximum wind speed 90m/s, average turbulence 0.08%.
  - Propeller experimental section: cross-section is positive octagonal, distance between opposite sides is 2.2m, length is 4.5m, the maximum wind speed is 145m/s, the incoming flow speed and the Mach number of the propeller tip can be simulated at the same time, and it has an Eiffel-type anechoic chamber, which can carry out propeller noise tests.[190] [191]
- NF-6 wind tunnel
  - The only pressurized continuous high-speed wing wind tunnel [增压连续式高速翼型风洞], commissioned in 2000 and finished in 2003.

- Mach number range of 0.25-1.2, wing experimental Reynolds number up to 2.3 × 107, with a fixed Mach number and variable Reynolds number test capabilities. Wind tunnel Mach number stability accuracy can reach 0.001, suitable for flow mechanism research and engineering design verification.[192]

- Continuous high-subsonic leaf grid wind tunnel
  - Basic experimental facility for aero-engines, which has been in use since 1993 and conducts blowing tests with very high reliability.
  - The maximum air outlet size of the test section is 100×300mm, the range of inlet Mach numbers is 0.3 to 0.9, and the range of airflow angle adjustment is 0 to 90 degrees.[193]
- China's only set of axial flow double-row counter-rotating compressor experimental devices [轴流式双排对转压气机实验装置]
  - Completed in 2006 these devices provide an important platform for advanced research into aviation power systems, including in the development of China's first counter-rotating aero-engine. The counter-rotating impeller machinery is a key technology to substantially improve engine performance. The axial double-row counter-rotating compressor test stand is a key piece of experimental equipment to provide verification for the development of high thrust-to-weight ratio counter-rotating aero-engines.[194]
- Low-speed and high-speed small research wind tunnels, including:
  - 1.5 m diameter low-speed ternary wind tunnel
  - 300 mm × 300 mm Mach 0.3 to 4.5 high-speed wind tunnel
  - Adaptive wall wind tunnel
  - Low turbulence wind tunnel[195]
- Low (or varying) turbulence intensity wind tunnel
  - An advanced low-speed, low-noise, low-turbulence research wind tunnel with tandem ternary and binary experimental sections and a cross-sectional ratio of about 3:1. The shrinkage ratio of the first shrinkage section is 7.11, the shrinkage ratio of the second shrinkage section is 3.18, and the total shrinkage ratio is 22.6. Between the two shrinkage sections, a variable turbulence grille can be installed to change the turbulence of the test section.[196]
- Other wind tunnels:
  - No.2 wind tunnel
  - Ice wind tunnel
  - Supersonic multifunctional wind tunnel (under construction as of 2020)
  - Tri-sonic (sub-, trans-, and super-sonic) wind tunnel
  - Open-jet low-speed wind tunnel[197]
- Parallel-type microcomputer computing system with a computer networking facility of 400 billion times/sec.[198]
- DANTEC (a Danish company) 3-d laser velocimeter system
  - DAS1800 dynamic data acquisition and TVS thermal infrared imaging systems[199]

Address:

This lab may be located in NWPU's Youyi campus, at No. 127 Youyi West Road, Xi'an, Shaanxi Province [陕西省西安市友谊西路 127 号]

Website:

http://kypt.nwpu.edu.cn/index.php?c=content&a=show&id=260

Known Aliases:

- National Key Laboratory of Science and Technology on Aerodynamic Design and Research
- 翼型叶栅空气动力学国防科技重点实验室 (Alternative spelling with no comma)

7. Defense S&T Key Laboratory of Antennas and Microwave Technology

Official English Name: National Key Laboratory of Science and Technology on Antennas and Microwaves[200]

Chinese Name: 天线与微波技术国防科技重点实验室

Research Field: Multi-domain (Aerospace, Ground, Maritime) – Radar – Microwave Technology (*Also: Electromagnetics, Fire Control, Stealth Technologies*)

Affiliations:

- Xidian University [西安电子科技大学]
- China Electronics Technology Group Corporation (CETC) [中国电子科技集团]
  - Nanjing Research Institute of Electronic Technology [南京电子技术研究所]
    - *(a.k.a. CETC 14th Research Institute [14 研究所])*

Key Data:

- Established: 1992
- Total Funding: Unknown[xvii]
- Personnel: 62[xviii] [201]
- Official start of operations: 1998
- Floor Space: 5,136 sqm[xix]

xvii Described in source as "several hundred million RMB"
xviii Unclear if this refers to all personnel or just the Xi'an branch

xix 4,971 sqm of research space and 165 sqm of office space; also has an 897 sqm anechoic chamber

Lab Overview:

The Defense S&T Key Laboratory of Antennas and Microwave Technology conducts research into various aspects of antenna and microwave technology, primarily for radars.

The CETC 14th RI is referred to as the birthplace of Chinese radar, and is a current pioneer in the field of cutting edge radars. It is on the U.S. Commerce Department Entity List for export control.[202] [203]

Further Information:

- The lab receives over 30 million RMB per year in research funding. During the period of the 12th Five Year Plan, it completed 251 projects funded at 105.596 million RMB. 230 of these were related to national defense and were worth 88.218 million RMB, 84% of funding. Research areas included antenna and microwave measurement theory, technology, analysis, and design. From 2017 to 2018, the lab's research funding rose by 70%.[204] [205]
- The lab has a "Military Photonic/Phononic Crystal Basic Research Group " [军用光子/声子晶体基础研究课题组][206]

Research Direction:

1. Modern antenna and microwave measurement theory and technology [现代天线微波测量理论与技术]

2. Antenna and microwave analysis and design technology [天线微波分析与设计技术]

3. New theories and technologies for antennas and microwaves

Other Notable Research areas:

- Phased array, low, and ultra-low subflap antennas
- Electromagnetic scattering
- Radar cross section[207] [208]

Notable Applications:

- According to an unverified passage that may have appeared in a previous iteration of the lab's description on its website, this lab has been involved with developing a wide array of radars, including the PRC's first airborne early warning solid-state active phased array radar, first phased array ballistic measurement radar, first shipboard multifunctional solid-state active phased array radar, first satellite-based solid-state active synthetic aperture radar, first skywave over-the-horizon radar, first solid-state active phased array target characteristic measurement radar, first solid-state active phased array precision tracking measurement radar, first airborne fire-controlled phased array radar, and first large airborne early warning radar radome. It is involved with satellite phased array technology, integrated aperture technology, component technology, active sub-array technology, and stealth technology, and has made major strides in long-range and airborne early warning, airborne fire control and guidance, shipboard functions, manned spaceflight measurement and control, and missile and ballistic measurement.[209]

- The 14th RI which oversees this lab has been involved in multiple notable recent projects, including the alleged development of a stealth-defeating quantum radar, and the anti-stealth JY-27 long-range surveillance radar. It is responsible for the majority of the PRC's ground based anti-missile radars, large ship-based main battle phased array radars, aircraft fire control radars, and space measurement and control radars. It was responsible for the development of the KJ-2000 early warning aircraft's radar, overcoming a foreign technology blockade, the "Sea Star" [海之星] Type 346 radar installed on PLAN destroyers, and measurement and control radars related to the Shenzhou, Tianzhou, and Chang'e space missions. It is likely that this lab has played a role in many of these projects, especially since 14th RI Director Hu Mingchun also serves as Director of this lab's Nanjing branch.[210] [211] [212] [213]
- The AEMC Group within this lab specializes in microwave fillers and multiplexers, and has developed multiple types of ultra-shortwave multiplexer equipment [超短波多路耦合器设备] for the PLAN, including those deployed on the Liaoning aircraft carrier and dozens of destroyers.[214]

Leadership and Key Personnel:

- Directors: Liu Ying [刘英] (Xi'an); Hu Mingchun [胡明春] (Nanjing)[215] [216] [217]
    - Hu Mingchun is also the Director of the CETC 14th RI
- Academic Committee Director: Duan Baoyan [段宝岩] (Xi'an)[218]
- Deputy Directors: Su Tao [苏涛], Jiang Wen [姜文], Zhang Yanfeng [张严锋] (Xi'an)[219]

Key Personnel:

- Lu Hongmin [路宏敏][220]
    - Lu's CV contains several partially redacted studies that may give insight to the lab's research goals, including:
        - "Simulation analysis of the effect of radar pulse[xx] electromagnetic signal on the general layout of the whole vehicle" [雷达脉冲 电磁信号对整车总体布局影响的仿真分析]
        - "Electromagnetic jamming/sensitivity modeling and testing techniques for (REDACTED) Equipment" [XXX 设备电磁干扰/敏感度建模与试验技术]

[xx] "Pulse" is redacted in his public CV

- "Multifunctional (REDACTED) Sensor EMC Simulation Analysis" [多功能 XXX 传感器 EMC 仿真分析]
- (REDACTED) Numerical analysis of electromagnetic environmental information monitoring" [XXX 电磁环境信息监测的数值分析],
- "Electromagnetic compatibility of (REDACTED) bus and fast charging system" [XXX 总线与快速充电系统的电磁兼容性研究与改进]

Notable Collaborations:

Domestic

- In 2018, Xidian University and Huawei formed the Xidian-Huawei Terminal Antenna Joint Laboratory [西安电子科技大学-华为终端天线联合实验室]. Xidian's contributions will be run through this lab. This joint lab was formed in line with Li Keqiang's directive to improve enterprise innovation and integrate industry-university research. It will focus on R&D of mobile communication terminal antennas.[221]
- This lab's Xi'an Branch has a strategic cooperation agreement with the Shanghai Supercomputing Center [上海超级计算中心], forming the Ultra-Large Scale Parallel Electromagnetic Computing Joint Laboratory [超大规模并行电磁计算联合实验室] in 2010. This joint lab will develop and build large-scale electromagnetic computing platforms based on the Shanghai supercomputing platform. By 2010, the joint lab had successfully conducted trial calculations of the American HOBBIES software with more than 1024 CPU cores, which is the first high-precision 3D general electromagnetic simulation software with more than 1,000 cores successfully deployed and run by the Shanghai Supercomputing Center so far.[222]
- This lab has cooperative relationships with several private communications companies, including Huawei [华为技术有限公司], Tongyu Communications [广东通宇通讯股份有限公司], Shenglu [广东盛路通信科技股份有限公司], Kenli Technology [江苏肯立科技股份有限公司], and Hollywave [上海霍莱沃电子系统技术股份有限公司].[223]
- This lab has cooperative relationships with the CETC 20th RI (Xi'an Institute of Navigation Technology [西安导航技术研究所] and 5th RI. It also lists CSSC, Norinco, CASC, and CASIC as long-term partners.[224]
- The 2017 Annual Academic Conference of the Key Laboratory of Antenna and Microwave Technology [2017 学术年会] was attended by personnel of PLA Army Engineering University, Air Force Engineering Univeristy, the CETC 14th, 20th, 29th, 39th, and 55th RIs, and the Xi'an Branch of the CASC 5th Academy.[225]
- The 2018 Annual Academic Conference of the Key Laboratory of Antenna and Microwave Technology and Lectures on Electromagnetic Spatial Perception Technology [天线与微波技术重点实验室学术年会暨电磁空间感知技术名家讲坛] was held by this lab, as well as several others in the antenna and microwave field. Participants included personnel

of the Air Force Engineering University, CETC 14th and 39th RIs, and Norinco 39th and 206th RIs. Professor Qu Shaobo [屈绍波] of Air Force Engineering University lectured on electromagnetic metamaterials and surface equipartition excitations [电磁超材料与表面等离激元研究概述"的报告].[226]

- This lab has collaborated on research with PLA Units 61255, 93567, 95989, the Air Force Engineering University, and research related to cruise missiles with the Air Force Engineering University's Missile College [导弹学院].

International

- This lab claims to have cooperative relationships with a number of institutions around the world, including several U.S. universities: University of California, University of Texas, Ohio State University, University of Pennsylvania, MIT, and University of Houston, as well as exchanges with others. One photo shows an employee of IBM being given an honorary professorship.[227]
- Numerous exchanges and visits from U.S. academics are described on the lab's website, including from Duke University and Penn State University. One lab academic was allegedly sent to study at University of Wisconsin from 2017 to 2019. Another allegedly studied at Ohio State University for several months in 2015.[228]
- Professor Tong Meisong [童美松] of Tongji University has lectured at this lab. Tong studied in the U.S., and has led or participated in 11 research projects (eight of which he led) funded by the USAF Office of Scientific Research, Air Force Research Laboratory (AFRL), Army Research Laboratory, Intel, and IBM. He then returned to the PRC and has led projects for NSFC, MOST, state key labs, and others. He specializes in electromagnetic fields, antennas, and microwaves.[229]
- The lab's foreign collaboration page claims a large number of exchanges, including with British, German, Swiss, Japanese, and Singaporean researchers on topics that include 5G (from Kent University) and satellite communications.[230] [xxi]
- In 2017, this lab took part in the 7th IEEE MAPE international conference, which was co-hosted by Xidian University that year, and included multiple foreign researchers.[231]
- A scholar from the U.K.'s Kent University has guest lectured on 5G terminals.[232]

Lab Equipment:

- This lab has several pieces of equipment from foreign sources, including:
  - N5244A 10MHz-43.5GHz Two-port vector network analyzer from U.S. company Agilent
  - N5230A 300KHz-20GHz Four-port vector network analyzer from U.S. company Agilent
  - 2 Hz-50 GHz signal spectrum analyzer from German company Rohde & Schwarz

[xxi] A full list of institutions is available upon request.

- Other lab equipment includes:
    - Large microwave darkroom (anechoic chamber)
    - Antenna near and far field measurement systems
- The lab has invested over 20 million RMB in its major lab equipment (primarily its anechoic chamber and field measurement systems), including an 8 million RMB near-field measurements darkroom.
- The total value of the lab's fixed property is 37.8039 million RMB, including 739 pieces of equipment worth 36.3197 million RMB. Equipment includes 27 pieces of major equipment worth over 300,000 RMB.[233]

Address:

S&T Lab Building #10, No. 2 Taibai South Road, Xi'an, Shaanxi Province [陕西省西安市太白南路 2 号科技实验楼 10 楼]

The given English address is 10-11 F, Sci-tech Building, North Campus[234]

Website:

https://amt.xidian.edu.cn/index.html

Known Aliases:

- (Xidian) Antenna Institute [天线所]
- Key Laboratory of Antenna and Microwave Technology [天线与微波技术重点实验室]
- National Key Laboratory of Antenna and Microwave Technology [天线与微波技术国家重点实验室]
- Antennas and Microwave Technology Key Laboratory of National Defense
- Defense S&T Key Laboratory of Antennas and Microwave Technology
- Science and Technology on Antenna and Microwave Laboratory
- State Key Laboratory of Antennas and Microwave Technology
- National Laboratory of Antennas and Microwave Technology
- National Key Laboratory of Science and Technology on Antenna and Microwave

8. Defense S&T Key Laboratory of Aviation Plasma Dynamics

Official English Name: Science and Technology on Plasma Dynamics Laboratory[235]

Chinese Name: 航空等离子体动力学国防科技重点实验室

Research Field: Aerospace – Aircraft – Multiple (Aerodynamics, Propulsion, Plasma Technologies, Stealth Technologies)

Affiliations:

- PLA Air Force Engineering University [空军工程大学]
  - Aeronautics and Astronautics Engineering College [航空航天工程学院]

Key Data:

- Established: 2010
- Official start of operations: 2011
- Total Funding: Unknown
- Personnel: Unknown[236 237]
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Aviation Plasma Dynamics conducts research into the use of plasma technology for military aviation, including for improved aircraft propulsion, aerodynamics, and stealth. The lab is led by a PLAAF corps deputy leader-grade Major General who is a leading expert in aircraft propulsion.[238 239 240]

Further Information:

- Plasma can be used to increase combustion power and efficiency in aircraft engines, as well as significantly improving aircraft aerodynamics, drag, lift, angle of attack, and maneuverability, as well as decreasing fuel use. It can also theoretically be used to increase the stealthiness of future aircraft. Based on this lab's research output, it appears to be actively engaged in researching the use of plasma technology for all these applications.[241]

Research Direction:

No official research direction was found. A 2019 document details 25 key projects for the upcoming year. Interesting topics of study include research into aero-engines, aerodynamics, and stealth technology. A sampling of topics includes:[xxii]

- Engine nozzle design
- Liquid fuel injection
- Intelligent materials for aero-engines
- Aerodynamic designs using plasma control technology
- Control mechanisms of plasma flow on supersonic surfaces
- Aircraft rudder design

[xxii] The full list, including project descriptions and final goals, is available upon request.

- Single crystal turbine blades
- Deep learning for manufacturing processes
- Plasma-based composite materials
- Aero-engine fatigue
- Stealth aircraft technology
- Aircraft honeycomb damage detection and repair[242]

Other Notable Research areas:

- Research into plasma flow technology for aerospace, still in early stages of development[243]

Notable Applications:

- This lab's research will be applied to improved propulsion, aerodynamics, and stealth for future military aircraft.
- This lab is developing plasma active flow control technology for use in flying-wing aircraft, improving control and obviating the need for elevators and rudders (thus improving stealth). According to one article, the B-2 Spirit already utilizes this technology. This technology is likely to end up in the future H-20 stealth bomber.[244] [245]
- Re-ignition after engine flameouts at high altitudes, high speeds, and/or cold environments (including the Tibetan Plateau, where PLA combat aircraft operate) is currently a major problem (unclear if this means generally, or for Chinese engines specifically). Researcher Wu Yun has successfully developed plasma jet igniters [多路等离子体点火器], greatly widening ignition boundary and shortening ignition delay, allowing aircraft to re-ignite without losing altitude and improving combat effectiveness. This tech can be applied to higher speed sub-combustion ramjet engines, super-combustion ramjet engines, and turbo ramjet combination engines, allowing ignition even at Mach 3-5. It may be applied to the future H-20 stealth bomber. This research was conducted in collaboration with Xi'an Aerospace Engine & Smart Manufacturing Institute Co. [西安空天能源动力智能制造研究院有限公司.[246] [247] [248]
- Researchers under Wu Yun have also developed a "thermal knife" [热刀] device which can be used for rapid de-icing of aircraft in flight over harsh environments.[249]
- He Weifeng conducts research into aircraft engine fatigue fractures and solutions using laser impact strengthening technology [激光冲击强化技术]. He also conducts research into improving engine resilience against sand inhalation and preventing sand erosion of engines, using nano multi-element coatings [纳米多元涂层] to mask engine blades.[250]

Leadership and Key Personnel:

- Director: Li Yinghong [李应红][251] [252] [253]

- Corps Deputy Leader-grade Major General, CAE Academician, and Director since the lab's opening in 2011.
- Considered the leading authority in the PLAAF on the topic of plasma dynamics.
- 19th Party Congress representative.
- Director of the PLAAF Eningeering University's "Aircraft Propulsion Technology High-Tech Center" [飞机推进技术高新技术中心].

Key Personnel:

- Wu Yun [吴云][254] [255]
  - A leader in plasma applications in aero-engines, whose research will likely be used in the future H-20 stealth bomber.
  - Member of the International Committee on Plasma Dynamics and Lasers of the American Institute of Aeronautics and Astronautics (AIAA) and a review expert for both the U.S. National Science Foundation and the U.S. Department of Energy.

Notable Collaborations:

Domestic

- This lab collaborated with Xi'an Aerospace Engine & Smart Manufacturing Institute Co. [西安空天能源动力智能制造研究院有限公司] to develop a new plasma igniter [多路等离子体点火器] for aircraft in colder or high-altitude environments, which may be applied to the future H-20 bomber. AESM is a joint venture of Xi'an Jiaotong University and the Xi'an Aerospace Base [西安航天基地].[256] [257]
- This lab collaborates with Xi'an Aerospace Purple Discharge Plasma Tech Co., a private enterprise focused on (it seems) civilian uses for plasma technology, including disinfectant and treatments for air pollution and waste water. This company is a subsidiary of Xi'an Aerospace, which per its website conducts military and aerospace research in support of the Made in China 2025 program.[258]
- This lab has collaborated on research with PLA units/institutions: Unit 94314, 95156, and the PLA Military Representative Office to Xi'an Aircraft.[259]

International

- This lab co-sponsored the 1st International Symposium on Thermal-Fluid Dynamics in Xi'an, along with several other institutions, including Sheffield Hollam University in the U.K. Participants came from the U.S., U.K., Canada, Japan, Singapore, and India. Participants included researchers from UC Santa Barbara and Georgia Institute of Technology. Professor Wu Yun, confirmed to work on military aircraft projects, was a key organizer.[260]

- Wu Yun is a member of the International Committee on Plasma Dynamics and Lasers of the American Institute of Aeronautics and Astronautics (AIAA) and a review expert for both the U.S. National Science Foundation and the U.S. Department of Energy.[261]
- This lab helped organize the 9th International Workshop on Detonation for Propulsion (IWDP 2018) in 2018 at Tsinghua University. Researchers came from the University of Michigan in the U.S., Russia, France, Japan, Singapore, Korea, Poland, and Germany. Researchers from the PLA's National University of Defense Technology were present, along with personnel of this lab.[262]

Lab Equipment:

No Information

Address:

No. 1 Baling Road, Baqiao District, Xi'an, Shaanxi Province [陕西省西安市灞桥区霸陵路 1 号等离子体实验室][263]

Website:

None Found

Known Aliases:

- National Key Laboratory of Plasma Dynamics [等离子体动力学国家级重点实验室]
    - In addition to oftentimes removing the "Defense" from its name, as is common for these labs, this lab often removes the "Aviation" from its name, especially in international fora, perhaps further obscuring its purpose.
- Plasma Dynamic Laboratory [等离子体动力学重点实验室]
- Key Laboratory of Science and Technology on Plasma Dynamics

9. Defense S&T Key Laboratory of Ballistics

Official English Name: National Key Laboratory of Transient Physics

Chinese Name: 弹道国防科技重点实验室

Research Field: Multi-domain (Aerospace, Ground, Maritime) – Munitions – Aerodynamics (*Also: GNC, Impact and Damage, Plasma Technologies, Simulation & Modeling*)

Affiliations:

- Nanjing University of Science and Technology (NJUST) [南京理工大学]

Key Data:

- Established: 1991
- Total Funding: Unknown
- Personnel: 59[264] [265] [266]
- Official start of operations: 1995
- Floor Space: 4,036 or 5,470 sqm

Lab Overview:

The Defense S&T Key Laboratory of Ballistics is focused on the national key discipline of "armament launch theory and technology" [兵器发射理论与技术]. It conducts research related to munitions guidance and control, launch, flight, and chemical dynamics, as well as fluid, explosive, and damage mechanics, plasma and thermal physics, and associated test and simulation technologies.[267]

The lab is also frequently referred to, particularly in English Language sources, as the Key Laboratory of Transient Physics [瞬态物理国家重点实验室]. The two names are used interchangeably, although "Ballistics" may be more frequently used in more military contexts. The Ballistics Lab also has a slightly different founding date, holding its opening ceremony in December 1992, so it is possible these two labs started out as different entities, although today they are one and the same.[268]

Further Information:

- This lab has a subordinate Underwater Ballistics Team [水中弹道团队]. The team was formed by Li Hongzhi in 2016 and won a major Defense S&T award in 2020. It leads a major Underwater Ballistics Cooperation and Innovation Center [水中弹道协同创新中心] with 11 other work units. This team has formed a joint research team with an unidentified PLA Navy Center [海军某中心].[269] [270]
- The lab has 6 research offices [研究室], one admin office, and one fund management office.[271]
- According to different sources, this lab is "cared for, guided and supported" [关心、指导与支持] by COSTIND (now SASTIND) and the GAD, and "managed" [主管] by MIIT.[272] [273]

Research Direction:

1. Armament launch theory and technology [兵器发射理论与技术]

2. Ultra-high-speed launch dynamics [超高速发射动力学]
3. Flight dynamics [飞行动力学]
4. Chemical dynamics and fluid mechanics [化学动力学以及流体力学]
5. Explosion mechanics [爆炸力学]
6. Modern damage mechanics [现代损伤力学]
7. Guidance and control [制导与控制]
8. Plasma physics [等离子物理]
9. Engineering thermal physics [工程热物理]
10. High simulation technology [高仿真技术]
11. Transient test technology [瞬态测试技术][274]

Notable Applications:

- This lab's basic research likely filters into a wide range of munitions, including small arms, artillery, missiles, and torpedoes, as well as satellite and flight vehicle GNC.
- This lab has allegedly been researching Electrothermal Chemical Launch (ETC) Technology for weapons firing systems since 1993, and has presided over multiple projects related to this technology, making significant progress in areas like super capacitor pulse power source + solid powder electro-thermal chemical emissions systems [超级电容脉冲功率源+固体火药电热化学发射系统]. This technology holds promise for superior firing range and velocity.[275] [276]

Leadership and Key Personnel:

- Director: Li Baoming [栗保明][277]
- Academic Committee Director: Bao Weimin [包为民][278]
    - CAS Academician.
- Deputy Directors: Ding Rongjun [丁荣军]; Weng Chunsheng [翁春生]; Wang Jinxiang [王金相][279] [280] [281]
    - Ding Rongjun is a CAE Academician.
- Party Committee Secretary: Qian Jianping [钱建平][282]

Key Personnel:

- Li Hongzhi [李鸿志][283] [284] [285]
    - CAE Academician, former Director and founder of this lab.
    - Founder of the field of ultra high-speed electrothermal emission technology [超高速电热发射技术].

- Has given talks on torpedo ballistics [鱼雷弹道的现状和发展趋势], sonar in an oceanic environment [声纳与海洋环境], and high-speed underwater ballistics [高速水中弹道学的研究现状].

Notable Collaborations:

Domestic

- This lab is associated with the Underwater Ballistics Collaborative Innovation Center [水中弹道协同创新中心] at NJUST, along with personnel of the CMC Equipment Development Department Research and Acquisitions Bureau, Comprehensive Planning Bureau, PLAN Equipment Research Academy, Harbin Engineering University, CSSC 716th, 713th, and 705th RIs, Norinco 202nd RI, Xi'an Kunlun Industry Group [西安昆仑工业集团有限公司], and Shaanxi Huatong Mechanical and Electrical Manufacturing Co. [陕西华通机电制造有限公司].[286]
- This lab collaborated with the PLAN Equipment Research Academy to co-host the Military Engineering Society Ballistics Experts Committee's 2016 Ballistics Academic Conference [中国兵工学会弹道专业委员会 2016 年弹道学术会议] in Beijing. Li Hongzhi of this lab gave talks on torpedo ballistics, sonar in an oceanic environment, and high-speed underwater ballistics. In 2017, this lab again co-hosted the same conference, this time with the CSIC 713th RI. Topics included naval artillery defense systems [舰炮防御系统] and flight-controlled artillery technology [飞行控制炮弹技术]. The 2021 iteration of this event was co-hosted with Inner Mongolia North Heavy Industries Group Corp [内蒙古北方重工业集团有限公司]. Topics included new firing technology for firearms, internal ballistics and new dynamic technology for rocket engines, external ballistics of hypersonic vehicles, warhead terminal ballistics, etc.[287] [288] [289]
- The lab's Underwater Ballistics Team formed a joint research team with an unidentified PLA Navy Center and won a major Defense S&T award in 2020.[290]
- Weng Chunsheng of this lab was part of a NJUST delegation which met with CASC, the PLA General Armaments Department, and senior PLARF personnel in 2017.[291]
- This lab collaborated with the CETC 27th RI on metal welding research.

International

- This lab invited Clive Woodley of the U.K.'s Imperial College and the International Ballistics Society to speak in 2016. Woodley gave a talk with explicitly military applications, on the topics of electrothermal chemical and electrothermal ignition guns. Further, Woodley's talk may have been in some way sponsored by or affiliated with British defense company QineqtiQ. Woodley is a leading expert on artillery ballistics, propellants, and combustion, and advanced charge loading.[292]

Lab Equipment:

- The lab possesses a Microscopic imaging differential scanning calorimeter system from U.S. company Mettler Toledo[293]
- Other lab equipment and facilities include:[xxiii]
    - Rail signal controller system
    - Heating and ventilation integrated testing device
    - High-speed camera system
    - X-ray machine
    - Transient recorder
    - Digital coherent full-field strain test system
    - Digital turning center
    - High overload simulation test platform
    - Echo-free anechoic test system
    - Millimeter-wave test system
    - Multi-chip assembly equipment
    - Submillimeter-wave circuit design software
    - Infrared imaging system
    - Comprehensive ballistic target path
        - Launch weapon caliber: not more than 37mm
        - Launch initial velocity: not more than 6000m/s
        - Target path test distance: 240m
        - Static explosion equivalent: not more than 3TNT[294] [295]
- An unofficial source[xxiv] lists further equipment:
    - 240m full ballistic target path
    - Explosion and impact laboratory
    - Target path measurement and control system
    - Orthogonal spark flash shadow photography system
    - Ultra-high speed launch test system
    - Pulse forming network and pulse power measurement and control system
    - VXI virtual instrument bus integrated measurement and control system
    - Stationary blast propulsion experiment system
    - Combustion-explosion reaction experimental platform - integrated measurement and control system
    - Fluid control and drag reduction experimental system
    - YA16 high-speed shadow photography system
    - Flash X-ray imaging system
    - Hopkinson rod experiment system
    - Computation and Data Processing Center - Microcomputer Parallel Computing Cluster System
    - Electromagnetic Orbital Emission Outdoor Integrated Test Site[296]

[xxiii] Photos for much of this equipment are available upon request

[xxiv] The source's unofficial nature means this information should be taken with caution, but likely originates from a now-deleted official source

- The current facility is the only laboratory that can conduct ultra-high speed (projectile velocity 6000m/s) ballistic tests.[297]

Address:

No. 200 Xiaolingwei Subdistrict, Nanjing, Jiangsu Province [江苏省南京市孝陵卫街道 200 号][298]

Website:

http://zdsys.njust.edu.cn/main.htm

Known Aliases:

- National Key Laboratory of Transient Physics [瞬态物理国家重点实验室]
- National Defence Research Laboratory of Ballistic

10. Defense S&T Key Laboratory of Communications Anti-Jamming Technology

Official English Name: National Key Laboratory of Science and Technology on Communications[299]

Chinese Name: 通信抗干扰技术国防科技重点实验室

Research Field: Multi-Domain (Aerospace, Ground, Maritime) – Communications Equipment – Multiple (Acoustics, GNC, Intelligent Technologies, Robotics, Sensing, Target Detection/Recognition)

Affiliations:

- University of Electronic Science and Technology of China (UESTC) [电子科技大学]

Key Data:

- Established: 1994
- Total Funding: 199m RMB
- Personnel: 77 (researchers)[300 301]
- Official start of operations: 1997
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Communications Anti-Jamming Technology conducts research into wireless, mobile, and satellite communications networks, broadband, signal processing, communications security, and integrated circuits for communications. It has also been involved in terahertz spectrum research, likely primarily for communications applications, and has been at the forefront of the PRC's 5G and 6G communications research.

Further Information:

- The lab may have at one time been called the Key Laboratory of "Tactical Communications and anti-Jamming Technology," a far more military sounding name than the anodyne Key Laboratory of "Communications," as it is known in English. The use of the word "Tactical" in this lab's name is rarely seen, with the exception of the lab's research fund [战术通信抗干扰技术国防科技重点实验室基金], which still includes the term.[302]
- This lab (like all of these labs) confers graduate degrees. It sends the largest group of graduates to Huawei and ZTE. Smaller numbers found defense positions at CETC, the 9th Academy, and the Research Institute of Nuclear Power Operation. Students have also gone on to CETC 10th, 29th, 30th, and 54th RIs, as well as private companies like Ali, China Mobile, China Unicom, and China Telecom.[303] [304]
- Research teams under this lab include:
  - Broadband Wireless Communication Systems and Intelligent Jamming Team [宽带无线通信系统与智能抗干扰研究团队]
  - Communication Coding and Transmission Team [通信编码与传输研究团队]
  - Wireless Communication Signal Processing Team [无线通信信号处理研究团队]
  - Communication Signal Processing and Special Integrated Circuit Team [通信信号处理与专用集成电路研究团队]
  - Intelligent Network and Robotic Studies Team [智能网络与机器学习团队]
  - Intelligent Wireless Self-Organizing Networks Team [智能无线自组织网络团队].[xxv] [305]
- This lab oversees at least two research centers: the Sichuan Terahertz Communications Engineering Research Center [四川省太赫兹通信工程研究中心] and the Intelligent Communications and Future Networks Research Center [智能通信与未来网络研究中心].[306] [307]
- 90% of the lab's research is basic and applied basic research.[308]

Research Direction:

1. Military-civil fusion wireless communications jamming technology [军民融合的无线通信干扰技术]
2. 5G/6G mobile communication technology and systems [5G/6G 移动通信技术与系统]

[xxv] Detailed information about each of these teams is available upon request.

3. Wireless big data and intelligent communications technology [无线大数据与智能通信技术]
4. Millimeter wave, terahertz, new spectrum resources communications technology [毫米波，太赫兹新频谱资源通信技术]
5. Special broadband multimedia trunking communications technology [专用宽带多媒体集群通信技术]
6. Satellite communication technology [卫星通信技术]
7. Space-ground integrated network technology [天地一体化网络技术]
8. Antenna sensing and positioning technology [天线感知与定位技术]
9. Special chip design and technology for wireless communications [无线通信专用芯片设计技术][309]

Other Notable Research areas:

- Fourth generation mobile communications technology
- Broadband wireless access technology
- Ultra-broadband radio technology
- Cognitive radio technology and networks
- Self-organized wireless communication networks
- Adaptive spread spectrum hopping technology
- Shortwave communications technology
- Cooperative wireless communications technology
- Air-time frequency multi-dimensional signal processing technology
- High-speed signal processing and implementation technology
- Satellite communications and networking technology
- Efficient compilation code technology
- Cryptography and information security technology
- Wireless communications positioning technology
- Sensor network technology
- Wireless communications system-on-chip design technology
- Spread spectrum hopping communications anti-jamming real technology
- Adaptive signal processing anti-jamming technology
- Wireless communications network anti-jamming technology
- Wireless and mobile communications systems and technology
- Satellite communications key technologies
- Communications special integrated circuit design technology
- New anti-jamming communication theories[310]

Notable Applications:

- This lab's research into the terahertz spectrum has widespread military implications, including for secure communications, anti-stealth radar, and ISR. The lab may have also been involved in using THz for space situational awareness and inter-satellite comms. A UESTC satellite, Tianyan-05 天雁 05 卫星] was launched in 2020 with THz comms equipment. Lab Director Li Shaoqian is involved in projects using terahertz technology for both anti-stealth radar and communications.[311] [312]
- This lab and its Director Li Shaoqian led a major National 863 Project during the 11th Five Year Plan called "Spectrum Resource Sharing Wireless Communication Systems." The project achieved a breakthrough around 2012 and will be used in a new generation of mobile communications, including for security and military communications.[313]
- This lab is heavily involved in the development of 5G and 6G in China.[314] [315]

Leadership and Key Personnel:

- Director: Li Shaoqian [李少谦][316]
  - See “Notable Applications” section for more information.
- Deputy Director: Zhou Liang [周亮][317]

Key Personnel:

- Gao Xiang [高翔][318]
  - Studied at Lund University in Sweden, worked for Sony Ericsson and in Silicon Valley in the U.S. on 5G-related projects.
  - Projects currently funded by Huawei.
- Liang Yingchang [梁应敞][319]
  - Academician with Acadamia Europaea, also worked in Silicon Valley for unknown U.S. company.
  - Since returning to PRC in 2015, has specialized in intelligent networks.
- Liu Hao [刘皓][320]
  - Previously worked for Motorola

Notable Collaborations:

Domestic

- This lab has a joint 5G lab with Huawei. It is already working with Huawei on 6G technologies.[321]
- According to its website, this lab cooperates with major military aerospace, electronic, and armaments industry institutions, including CETC 7th RI, 54th RI, 30th RI, and 10th RI, CAS Software Institute, PLA GSD 61st RI, 63rd RI, and 57th RI, the PLA GAD

Measurement and Control Institute, CSSC 722nd RI, CASC 1st Academy, 5th Academy, and 8th Academy, Huawei, ZTE Datang, Changhong, and the 783 Factory.[322]

- The lab has conducted collaborations with PLA Units 63981 and 78006, and provided funding for research of the PLA GSD's 63rd RI and PLA Army Engineering University Communications Engineering College through its fund.[323]
- This lab co-hosted the 2020 Space Electronic Information Academic Exchange Conference [2020 空间电子信息学术交流大会]. Topics included space communications technology and space internet technology, space exploration technology, space remote sensing technology, basic theories of space information, and space microwave, millimeter wave and terahertz technology. Discussions topics included the Beidou space navigation system, satellite communications, and space terahertz communications.[324]

International

- This lab claims grad student joint training agreements with Columbia and Princeton Universities in the U.S., as well as Canadian, British, Australian, and Swiss universities.[325]
- This labs claims to have cooperated with Intel, Siemens, Nokia, DoCoMo, National Semiconductor, Philips, France Telecom, LG, STMicroelectronics, and the Swiss government. Its grad students have allegedly gone on to work at Texas Instruments, Lucent, and Ericsson.[326]
- The lab established the Cisco-UESTC Joint Research Center for Green Technology [思科公司-电子科技大学绿色技术联合研究中心] with U.S. company Cisco.[327]
- This lab established a Joint Research Center for Wireless Communications [联合无线通信研究中心] with the KTH Royal Institute of Technology in Sweden.[328]

Lab Equipment:

No Information

Address:

Main Building, Area B3, UESTC Qingshuihe Campus, Xiyuan Boulevard, Chengdu, Sichuan Province [四川省成都市西源大道电子科技大学清水河区主楼 B3 区][329]

Website:

https://www.ncl.uestc.edu.cn/index.htm

Known Aliases:

- Defense S&T Key Laboratory of Tactical Communications Anti-Jamming Technology [战术通信抗干扰技术国防科技重点实验室]
- State Key Laboratory of Science and Technology on Communications [通信抗干扰技术国家级重点实验室]
- 抗干扰技术国防科技重点实验室
- 通信抗干扰技术国家级重点实验室
- National Key Laboratory of Communication
- National Anti-Interference Communication Technology Lab
- National Key Laboratory of Communication Anti-interference Technology
- National Key Laboratory of Anti-Interference Communication Technology
- National Key Laboratory of Anti-jamming Communications Technology

11. Defense S&T Key Laboratory of Communications Countermeasures Technology

Official English Name: Science and Technology on Communication Information Security Control Laboratory[330]

Chinese Name: 通信对抗技术国防科技重点实验室

Research Field: likely Multi-domain – Multiple (Communications Equipment, Electronic Warfare) – Communications Technologies (*Also: Countermeasures, Intelligent Technologies*)

Affiliations:

- China Electronics Technology Group Corporation (CETC) [中国电子科技集团]
  - CETC 36th Research Institute [36 研究所]

Key Data:

- Established: 2005
- Total Funding: Unknown
- Personnel: Unknown[331]
- Official start of operations: 2007
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Communications Countermeasures Technology conducts research into communications technologies, including information control and security, signal processing, communications in complex electromagnetic environments, communications jamming and countermeasures, electronic warfare, and information warfare.[332]

This lab is also frequently referred to as the Key Laboratory of Communications Information Control and Security Technology [通信信息控制和安全技术重点实验室].[333]

The lab’s parent institution, the CETC 36th Research Institute, was established in 1978 and is located in Jiaxing. It is responsible for research into communications and information control systems and equipment. Today, it is concerned with research into mobile communications security, 5G and the internet of things.[334]

Further Information:

- This lab, along with the 36th RI, oversees an academic journal called "Communications Countermeasures" [通信对抗]. It is focused on communications electronic warfare and information warfare.[335]
- This lab released a translation of Richard Poisel's “Modern Communications Jamming Principles and Techniques.” Richard Poisel is a senior engineer at Raytheon and formerly the chief scientist at U.S. Army Research, Development and Engineering Command who has written a large number of books on electronic and information warfare.[336] [337]
- The lab's Innovation Team [创新团队] was named as part of the 1st batch of National Defense Industry, Science, and Technology Innovation Teams [国防工业科技创新团队] in June 2007. A photo of the Innovation Team shows 14 members, all men.[338] [339]

Research Direction:

No formal research direction was found. Informally, the research direction may be:

1. Communications and information control and security technology [通信信息控制和安全技术]
2. Communications signal processing [通信信号处理][340] [341]

Notable Applications:

- This lab’s research has been applied to cognitive electronic warfare [认知电子战] (i.e., the use of AI, networks, deep learning, etc. in electronic warfare).[342]
- A team made up primarily of members of this lab designed an anti-UAV defense system utilizing tracking and jamming of UAVs for protection of nuclear power plants and other sensitive targets.[343]
- Yang Xiaoniu's team has developed AI for information control systems, allowing deep learning to drive end-to-end target identification technology for electromagnetic signals. It also developed the first portable equipment for signal target identification, improving electromagnetic signal target identification capabilities.[344]

- There was speculation in PRC media that Yang Xiaoniu's team was involved in the development of the CETC millimeter-wave anti-stealth radar, but this is not backed up by hard evidence.[345]

Leadership and Key Personnel:

- Director: Zhao Ming [赵明][346]
    - Also serves as 36th RI Director.
- Academic Committee Director: Yang Xiaoniu [杨小牛][347]
    - CAE Academician
    - Expert on signal processing and software radio [软件无线电] technology.
    - Invented an advanced broadband digital receiver [宽带数字接收机] in early 1990s which filled a major domestic need.
    - Developed PRC's first comprehensive electronic information control system [综合电子信息控制系统] in the early 2000s, with significant military benefits.
    - Created command system for an unidentified satellite payload.
    - Created a new generation of systems architecture for a military electronic information system.
    - Based on number of mentions, Yang seems to be the leading light of this lab rather than Director Zhao.

Notable Collaborations:

Domestic

- Yang Xiaoniu was a co-chairman of the 2017 China Electronic Warfare Exchange Conference [2017 全国电子战学术交流大会], and the lab's journal, "Electronic Countermeasures," was a supporting media for the event.[348]
- This lab co-hosted a conference on big data, with topics including big data for national defense, network defense, AI and deep learning, and Beidou satellite navigation. Yang Xiaoniu spoke on the subject of signal data.[349]
- This lab participated in a conference on radio wave propagation [电波传播] in 2019 which featured participants from PLA Naval Aviation University and the National University of Defense Technology.[350]

International

- This lab co-hosted the 12th International Symposium on Antennas, Propagation and EM Theory in December 2018. It featured multiple international speakers and participants, including speakers from American, Canadian, U.K., Singaporean, and Japanese universities. Researchers from Virginia Tech and URSI USA served as keynote speaker and conference co-chair, respectively, and several other U.S. researchers participated in the conference's international committee.[351]

- This lab participated in a conference on micro and nano optics in 2020 which featured foreign participants, including professors from UC Irvine and UCLA.[352]

Lab Equipment:

- The lab has over 120 pieces of equipment related to RF testing [射频测试], simulation testing [仿真测试], and electromagnetic compatibility testing [电磁兼容测试].[353]

Address:

No. 387 Hongxing Road, Jiaxing, Zhejiang Province [浙江省嘉兴市洪兴路 387 号][354]

Website:

None Found

Known Aliases:

- Key Laboratory of Communications Information Control and Security Technology [通信信息控制和安全技术重点实验室]
    - This is the far more common name used in Chinese sources.
- 通信信息控制与安全技术重点实验室
    - Same name as above, but swaps a single character (与 instead of 和)
- Key National Laboratory of Communications Systems Information Control and Security Technology [通信系统信息控制技术国家级重点实验室]
- Defense Key Lab of Communications Information Control Technology [通信信息控制技术国防重点实验室]
- Key Laboratory of Communications Information Control Technology [通信信息控制技术重点实验室]
- Defense S&T Key Laboratory of Low Interception Probability Signal detection [低截获概率信号侦测国防科技重点实验室]
    - There is a single public mention of this lab, and it is unclear if it is the same or a different lab.
- National Laboratory of Information Control Technology for Communication System
- Science and Technology on Communication Information Security Control Laboratory
- Key Laboratory of Communication Information Control and Security Technology

- Communication Information Controlling Safety Technology Laboratory

12. Defense S&T Key Laboratory of Composite Material Technology in Special Environments

Official English Name: National Key Laboratory of Science and Technology on Advanced Composites in Special Environments[355]

Chinese Name: 特种环境复合材料技术国防科技重点实验室

Research Field: Aerospace – Space Vehicles (*Also: Aviation*) – Materials (*Also: Intelligent Technologies, Manufacturing, Simulation & Modeling)*

Affiliations:

- Harbin Institute of Technology (HIT) [哈尔滨工业大学]
    - School of Astronautics [航天学院]

Key Data:

- Established: 2000
- Total Funding: over 90m RMB
- Personnel: 78[356]
- Official start of operations: 2008
- Floor Space: 9,205 sqm

Lab Overview:

The Defense S&T Key Laboratory of Composite Material Technology in Special Environments researches key technologies related to advanced composite materials and structures under extreme environmental conditions. These "special environments" include ultra-high and ultra-low temperatures, ultra-high pressure, and irradiated environments. The research is primarily geared toward the PRC's space program, but is also utilized by aviation and other fields requiring advanced materials.[357] [358]

Further Information:

- This lab may have seen a major increase in size and funding since 2018, when it allegedly had only 60 full-time personnel, 6,180 sqm of space, and 112 million RMB of equipment (as opposed to 78 personnel, 9,205 sqm, and 174m RMB of equipment by 2020).[359]
- This lab is also associated with the HIT Composite Materials and Structures Research Institute [复合材料与结构研究所]. According to one source, the Institute "relies upon" this lab, and there is overlap in personnel and leadership. The Institute's research focuses on ultra-high temperature anti-insulation materials [超高温防隔热材料], lightweight

structural composites [轻质结构复合材料], and intelligent composites and structures [智能复合材料与结构]. Special composite materials created by the Institute are mainly utilized for aerospace applications, most notably in the C919 aircraft.[360]

- The lab's Innovation Team [创新团队] has made advances in space heat defense materials [航天热防护材料], lightweight structures [轻量化结构], special opto-electronic functional materials [特种光电功能材料], and intelligent materials [智能材料]. It has been designated as a Ministry of Science and Technology National-Level International Joint Research Center [科技部国家级国际联合研究中心].[361]
- In 2020, HIT began construction of a Key Lab Cluster [重点实验室集群] in Shenzhen featuring research space for several of its key labs, including this one. The cluster will focus on automated products [自动化产品], high-end equipment design and distribution [高端装备设计开发], technical transformation and improvements [技术改造提升], and guided production applications and industrialization [指导生产应用和产业化]. It is set to open in December 2023.[362]

Research Direction:

1. Simulation and design optimization of special environment composites [特种环境复合材料模拟表征与优化设计]
2. Composite and organizational property control technology [复合与组织性能控制技术]
3. Property testing and analysis techniques [性能测试与分析技术][363]

Other Notable Research areas:

- Material-environment coupling mechanisms
- Material design and low-cost manufacturing
- Material performance characterization and evaluation
- Space heat protective materials
- Lightweight structures and structural composites
- Special opto-electronic functional materials
- Ultra-high temperature anti-insulation materials
- Intelligent composites and structures

Notable Applications:

- This lab developed composite materials and instruments for multiple space vehicles. Public examples include materials for the Long March-5 rocket, a measurement sensor for spacecraft re-entry vehicles, an inflated deployable discrete reinforced membrane boom for satellite attitude control, and the world's first shape-memory polymer composite–based flexible solar array used in space.[364]

- The HIT Composite Materials and Structures Research Institute, which relies heavily on this lab for research, was involved in creating composite materials for the C919 passenger aircraft.[365]

Leadership and Key Personnel:

- Director: He Xiaodong [赫晓东][366]
- Deputy Directors: Zhang Xinhong [张幸红]; Lu Haibao [吕海宝]; He Fei [何飞]; Xiong Jian [熊健][367]

Notable Collaborations:

Domestic

- A study on ultra-high temp ceramics was conducted in collaboration with PLAAF Unit 93413 1st Flight Group [93413 部队飞行一大队].[368]
- In 2010, this lab ran a joint experts group with the Defense S&T Key Laboratory of Precision Hot Forming of Metals [金属精密热加工两个国家级重点实验室] for SASTIND and the PLA General Armaments Department.[369]
- In 2019, this lab hosted a conference, the National Academic Conference on Ultra-High Speed Collisions [全国超高速碰撞学术会议], with two other labs: the Key National Lab of Space Environment Materials Behavior and Evaluation Technology [空间环境材料行为与评价技术国家级重点实验室] and the National Defense S&T Key Lab for Micro-Spacecraft Technology [微小型航天器技术国防重点实验室].[370]

International

- As of 2015, the HIT Composite Materials and Structures Research Institute [复合材料与结构研究所], which is closely associated with this lab, claimed to have an overseas joint lab with Harvard University, as well as long-term exchange and cooperation with Stanford and Northwestern University in the U.S., Australia's Sydney University, and the University of Bristol in the U.K. It claims to have various agreements with institutions in France, Russia, Ukraine, and Singapore.[371]
- This lab collaborates with several other HIT labs on the HIT Functional Composite Materials Lab [功能复合材料实验室], an interdisciplinary lab which allegedly cooperates with unnamed universities in the U.S., Germany, Belgium, Russia, and Singapore.[372]

Lab Equipment:

- This lab has 1,726 pieces of equipment worth 174 million RMB.[373]

Address:

Co-located with HIT School of Astronautics at No. 92 Dazhi West Road, Nangang District, Harbin, Heilongjiang Province [哈尔滨市南岗区西大直街 92 号][374]

Website:

http://sa.http://sa.hit.edu.cn/2020/1225/c6640a250512/page.htmhit.edu.cn/2020/1225/c6640a250512/page.htm

Known Aliases:

- National Key S&T Laboratory on Advanced Composites in Special Environments [特种环境复合材料技术国家级科技重点实验室]
- National Key Laboratory on Advanced Composites in Special Environment

13. Defense S&T Key Laboratory of Computational Fluid Dynamics

Official English Name: National Laboratory for Computational Fluid Dynamics

Chinese Name: 计算流体力学国防科技重点实验室

Research Field: Aerospace – Space Vehicles (*Also: Aircraft*) – Aerodynamics (*Also: Hypersonic Technologies, Simulation & Modeling*)

Affiliations:

- Beihang University [北京航空航天大学]
    - School of Aeronautic Science and Engineering [航空科学与工程学院]
- PLA Strategic Support Force (PLASSF)
    - China Aerodynamics Research and Development Center (CARDC) [中国空气动力研究与发展中心]
        - *(a.k.a. PLASSF Base 29 [29 基地])*
        - *(a.k.a. Unit 63820 [63820 部队])*

Key Data:

- Established: 1995
- Total Funding: 53.82m RMB
- Personnel: 15-23[375] [376]
- Official start of operations: 1997
- Floor Space: 2,818 sqm

Lab Overview:

The Defense S&T Key Laboratory of Computational Fluid Dynamics conducts research into aerodynamics for military and civilian aerospace. It was first established in the 1990s under the First National Expert Committee of the National 863 Plan in the field of space [国家 863 计划第一届航天领域专家委员] to advance China's space science and engineering capabilities, particularly around China's manned space program.[377]

The lab is jointly managed by Beihang University's School of Aeronautic Science and Engineering and the China Aerodynamics Research and Development Center (CARDC), a PLA research institute which conducts research into aerodynamics. Previously associated with the Academy of Military Science and the PLA General Armaments Department, it is now directly subordinate to the PLA Strategic Support Force. It does not mention its military status on its website (even dressing its military leadership in civilian clothing for their headshots), and its military association is in no way apparent at first glance. The lab's subordination to CARDC thus means that it is directly administered by a PLA unit while actively attempting to hide this association.[378]

While it appears on the "official" online list of DSTKLs, this lab is far more commonly referred to as the National Laboratory for Computational Fluid Dynamics [国家计算流体力学实验室].

Further Information:

- The lab's original funding came from the 863 Plan for aerospace [863 计划航天领域].[379]

Research Direction:

1. Computational methods, including DNS, LES, DES, DSMC
2. Physical model research, including:
    - Compressible turbulence [可压缩湍流]
    - Combustion [燃烧]
    - Chemical reactions [化学反应]
    - Real gas effects [真实气体效应]
    - Thermal radiation [热辐射]
3. Applied basic research, including:
    - Aerodynamic layout design methods [气动布局设计方法]
    - Precision aerodynamic/thermal calculations [气动力/热精确计算]
    - Complex flow mechanisms [复杂流动机理]
    - Multiphase flow simulation methods [多相流模拟方法]

- Multidisciplinary coupled dynamics [多学科耦合动力][380]

Other Notable Research areas:

- Computational theory and method research
- Flow mechanism research
- Flight vehicle aerodynamics research
- Laboratory computer system environment and technology development
- Numerical simulation calculations of aerodynamic/thermal/chemical reactions and thermal radiation
- Research into hypersonics, including flight vehicles[381] [382] [383] [384]

Notable Applications:

- This lab utilized the Wuxi Supercomputing Center's [超算无锡中心] Sunway TaihuLight [神威·太湖之光] supercomputer to calculate the return path of the Tiangong-1 [天宫一号] space station. The study utilized 16,384 processors (1/8 of TaihuLight's total) and achieved in 20 days what would have otherwise taken 12 months.[385] [386]
- This lab helped played a role in research for the C919 large passenger aircraft, by utilizing the Tianhe-1 [天河一号] Supercomputer to conduct complex aerodynamic numerical simulations.[387]
- The lab has developed better security for facial recognition technology.[388]

Leadership and Key Personnel:

- Director: Li Chunxuan [李椿萱] [389] [390]
  - CAE Academician, received PhD in U.S. in 1972.
- Academic Committee Director: Zhang Hanxin [张涵信][391]
  - Academician at CARDC
- Deputy Director: Ye Youda [叶友达][392]

Notable Collaborations:

Domestic

- According to the lab's former (and now defunct) homepage, this lab has cooperated on projects with CASC 1st, 2nd, 3rd, 4th, 5th, and 7th Academies, and with AVIC 601st and 611th Research Institutes.[393]

- This lab has a cooperation agreement with the Wuxi Supercomputing Center [超算无锡中心], utilizing the Sunway TaihuLight [神威·太湖之光] supercomputer to do aerospace research.[394]

International

None Found

Lab Equipment:

- Dawning Sky Tide computer cluster [“曙光”天潮计算机集群拥]
    - TC 4600E (85 nodes) and nearly 3,000 CPU cores, with a computing peak of more than 30 trillion times/second.[395]
- ACANS numerical simulation platform
    - Utilizes the lab’s own proprietary CFD software, capable of numerical simulation calculations of aerodynamic/thermal/chemical reactions and thermal radiation in the full Mach number range.
    - Sophisticated numerical simulation software for N-S equations.[396] [397]
- Dedicated National CFD Lab [国家 CFD 实验室].[398]

Address:

Co-located with Beihang University at No. 37 Xueyuan Road, Haidian District, Beijing [北京海淀区学院路 37 号][399]

Website:

http://www.ase.buaa.edu.cn/info/1123/9958.htm

Alias:

- National Laboratory for Computational Fluid Dynamics [国家计算流体力学实验室]
    - This is the far more common name for this lab.

14. Defense S&T Key Laboratory of Detonator Safety and Reliability

Official English Name: Unknown

Chinese Name: 火工品安全性可靠性技术国防科技重点实验室

Research Field: likely Multi-domain – Munitions – Munitions Technologies (*Also: Damage & Impact*)

Affiliations:

- China Ordnance Industries Group Corporation (Norinco) [中国兵器工业集团]
  - Shaanxi Institute of Applied Physical Chemistry [陕西应用物理化学研究所]
    - *(a.k.a. Norinco 213th Research Institute [213 研究所])*

Key Data:

- Established: prior to 2006
- Total Funding: Unknown
- Personnel: Unknown[400]
- Official start of operations: Unknown
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Detonator[xxvi] Safety and Reliability conducts research into new detonators/initiating devices for explosives, including the most advanced third and fourth generation detonators. It also researches explosions, blast mechanics, and energetic materials.[401]

The Shaanxi Institute of Applied Physical Chemistry (a.k.a. the Norinco 213th RI), claims to be the only national institute for research into the physical and chemical analysis and performance of detonators, pyrotechnics, and blasting equipment. Its products appear in both civilian and military equipment, and are exported to the U.S., U.K., Germany, and France.[402]

Further Information:

None

Research Direction:

1. New technologies for detonator action mechanisms and malfunction suppression [新技术火工品作用机理与故障抑制技术]
2. Detonator system integration technologies [火工系统集成技术]
3. Advanced explosive detonator technologies [先进火工药剂技术]

[xxvi] 火工品 could also be translated as "initiator," "initiating device," or "pyrotechnic." "Detonator" seems like the clearest translation based on its research.

4. Detonator safety and reliability testing and assessment technologies [火工品安全性可靠性试验与评估技术][403]

Notable Applications:

- Development of third and fourth generation of detonators for PLA munitions.[404]
- New sensitivity testing methods and standards[405]
- The 213th RI played a role in the launching of the Jilin-1 Gaofen-3 satellite group into space via a Long March 11 rocket, although it is unclear if this lab played a role.[406]

Leadership and Key Personnel:

- Director: Chu Enyi [褚恩义][407]
- Deputy Director: Zhang Rui [张蕊][408]

Notable Collaborations:

Domestic

- In 2020, this lab established a joint Opto-electric Testing and Applied Innovation Lab [光电测试与应用创新实验室] with Xi'an Technological University as a military-civil integration[xxvii] project.[409]
- In 2019 this lab signed a strategic cooperation agreement with the State Key Laboratory of Explosive Science and Technology [爆炸科学与技术国家重点实验室] and the Defense S&T Key Laboratory of Explosive Combustion [火炸药燃烧国防科技重点实验室] to form the Energetic Materials Innovation Alliance Laboratory [含能材料创新联盟实验室].[410]
- This lab is associated with Norinco Special Energy Group Ltd. [特种能源集团], which is a joint effort of multiple Norinco entities responsible for research, production, and sales of various Norinco firearms, explosives, and civilian products.[411]
- In 2013, this lab signed a cooperation agreement to work on new innovations with the Defense S&T Key Laboratory for Micro/Nanofabrication Technology [微米／纳米加工技术国防科技重点实验室] at Shanghai Jiaotong University and the Defense S&T Key Laboratory for Fuze Dynamic Characteristics [引信动态特性国防科技重点实验室] of Norinco Xi'an Institute of Electromechanical Information Technology. [xxviii] [412]

[xxvii] Uses the term 军民结合, rather than the more common "Military-civil Fusion" [军民融合].
[xxviii] Neither of the DSTKLs named in this bulletpoint are listed on the "official" list.

- In 2016 this lab took part in the 11th National Academic Conference on Explosive Mechanics [全国爆炸力学学术会议]. The conference featured researchers from the fields of military engineering, aerospace, and marine technology, among others. Participants came from PLA Engineering University National Key Lab of Blast Shock Disaster Prevention and Mitigation [爆炸冲击防灾减灾国家重点实验室], CAEP, the Norinco 208th RI, among other universities and labs.[413]
- In 2015 this lab co-hosted the 1st Workshop on Nanostructured Energetic Materials and their Application Technologies (NSEMS WORK SHOP 2015) [纳米结构含能材料及其应用技术"学术研讨会] with Nanjing University of Science and Technology and the Chinese Academy of Engineering Institute of Chemical Materials [中国工程物理研究院化工材料研究所].[414]

International

- This lab co-hosted the 4th International Symposium on Nanostructured Energetic Materials and Applied Technology [国际纳米结构含能材料及其应用技术研讨会] in 2018. International participants included the U.K.'s Royal Society of Chemistry (who also co-hosted the event), as well as institutions from France, South Africa, Russia, and Belarus.[415]

Lab Equipment:

No information

Address:

No address found, possibly co-located with 213th RI at No. 213 Zhuque Street, Xi'an, Shaanxi Province 710061 [西安市朱雀大街 213 号][416]

Website:

None found

Known Aliases:

- 火工品安全性可靠性国防科技重点实验室
  - Same name without the characters 技术 (“technology”). This is the name that appears on the “official” online list of DSTKLs.

15. Defense S&T Key Laboratory of Electromagnetic Compatibility (EMC)

Official English Name: Unknown

Chinese Name: 电磁兼容性国防科技重点实验室

Research Field: Maritime (*Also: Aerospace, Ground*) – Surface Vessels (*Also: Aircraft, Communications Equipment, Computer Technologies, Radar*) – Electromagnetics (*Also: Communications Technologies, EMP, Measurement Technologies, Microwave Technologies, Simulation & Modeling*)

Affiliations:

- China State Shipbuilding Corporation (CSSC) [中国船舶集团]
  - CSSC Research and Design Center [中国舰船研究设计中心]
    - *(a.k.a. CSSC 701st Research Institute [701 研究所])*

Key Data:

- Established: 1993
- Total Funding: Unknown
- Personnel: 35[417]
- Official start of operations: 1996
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Electromagnetic Compatibility (EMC) claims to be the PRC's largest and most advanced EMC research base, and the only national key lab devoted to research of EMC. Electromagnetic compatibility represents the ability of electronic systems to function in a given electromagnetic environment with minimal interference.

The lab is primarily tasked with R&D of EMC equipment for naval warfare, but also works in other areas. The lab's advanced EMC test facility cluster [试验设施群] is focused on naval vessels, but also does research into aircraft, combat vehicles, missiles, and other combat platforms for air and ground forces. The lab's EMC research extends to radar, communications, automatic control, computer applications, measurement instruments, and other equipment.[418] [419] [420]

The lab's parent institution, the CSSC Research and Design Center (a.k.a. the CSSC 701st RI, formerly known as the Wuhan Ship Development and Design Institute [武汉船舶设计研究院] and formerly subordinate to CSIC prior to the 2019 CSIC-CSSC merger) is a major institution for research and overall design of the PRC's warships, and is known variously as the "cradle of warships" or the "cradle of Chinese aircraft carriers." It is headquartered in Wuhan, with a branch in Shanghai. It is on the U.S. Commerce Department Entity List for export control.[421] [422] [423]

Further Information:

- This lab, along with the 701st RI, oversees the CSSC EMC Testing Center [中国船舶工业电磁兼容性检测中心], which provides EMC testing of weapons and equipment for aerospace, aviation, armaments, electronics, and naval weapon platforms.[424]

Research Direction:

1. Limited space electromagnetic interference control [有限空间电磁干扰控制]
2. Electromagnetic environment characteristics and electromagnetic radiation hazard protection [电磁环境特性与电磁辐射危害防护]
3. Electromagnetic compatibility prediction and analysis [电磁兼容性预测和分析]
4. Electromagnetic compatibility experiments and testing [电磁兼容性试验与测试][425]

Other Notable Research areas:

- System platform-level overall EMC prediction simulation and analysis evaluation
- Experimental verification of multi-antenna centralized and optimized arrangement models
- Ship RCS prediction and model test validation
- Equipment, system and platform EMC experiments and research
- Diagnosis, control and evaluation of electromagnetic interference in equipment, systems, and platforms
- System-level electromagnetic environment prediction effects testing and evaluation
- Strong EMP damage and protection simulation research
- EMC test method research and standard specifications development
- EMC test instrumentation development and research
- Electromagnetic interference control product development and research
- EMC test facility design and test system integration[426]

Notable Applications:

- This lab, working under the "cradle of warships" 701st RI, is primarily responsible for ensuring the EMC of the PRC's warship designs, including safeguarding surface vessels from an electromagnetic pulse (EMP). For instance, personnel associated with this lab were involved in the design of the PRC's first domestic aircraft carrier. In addition to these tasks, it seems to also do some EMC work in other areas, such as aerospace, munitions, and other military electronics.[427] [428] [429] [430]
- This lab ensures the EMC of military equipment in the South China Sea.[431]

Leadership and Key Personnel:

- Director: Sun Guangsu [孙光甦][432] [433]
    - Deputy chief designer of PRC's first domestic aircraft carrier.
- Academic Committee Director: Lu Jianxun [陆建勋][434]
    - CAE Academician
- Deputy Director: Zhou Kaiji [周开基][435]

Key Personnel:

- Xiao Long [肖龙][436]
    - Promising young researcher who developed the world's first on-chip free electron radiation source [片上自由电子辐射源], with an index three orders of magnitude greater than that of MIT. Also developed the first microwave diffraction-free technology [微波无衍射技术], along with a high-power device to solve a bottleneck problem with miniaturization.
- Liu Qifeng [刘其凤][437]
    - Chief designer for a national defense project related to orderly use of electromagnetic space (avoiding signal interference) in the South China Sea. Currently deputy lead designer for an unidentified warship design.
- Zhu Yingfu [朱英富][438] [439]
    - CAE Academician and head designer of several types of PLAN warships, including the Liaoning aircraft carrier.

Notable Collaborations:

Domestic

- Other key labs in this field include the Key Laboratory of Electromagnetic Environmental Effects and Optoelectronic Engineering [电磁环境效应与光电工程重点实验室], the Electromagnetic Environmental Effects (likely the Defense S&T Key Lab of the same name) [电磁环境效应国防科技重点实验室], and the Key Laboratory of Aerospace Science and Technology for Electromagnetic Environmental Effects [电磁环境效应航空科技重点实验室]. These labs appear to be frequent partners for collaboration due to their overlapping research. In 2016 this lab co-hosted an academic conference on electromagnetic compatibility with these labs.[440]
- In 2021 this lab co-hosted the 4th National Conference on Complex Electromagnetic Environment Technology and Applications [第四届全国复杂电磁环境技术及应用学术会议] in Hangzhou. Participants came from CAEP, the Military Aircraft Radar Defense Laboratory [军用飞机雷电防护实验室], CETC, and a large number of labs and private

companies.[xxix] Defense-related topics included complex electromagnetic environments faced by weapons and equipment [武器装备面临的复杂电磁环境特性], electromagnetic environment predictions for combat operations platforms [作战平台电磁环境预测], mechanisms of complex electromagnetic environment effects on weapons and equipment [武器装备复杂电磁环境效应机理], complex electromagnetic environment effect suppression and utilization technology [复杂电磁环境效应抑制与利用技术], and intelligent electromagnetic spectrum operations technology [智能电磁频谱作战技术].[441]

International

- In 2020, this lab co-hosted the 2020 IEEE International Microwave Symposium Series on Advanced Materials and Processes for RF and Terahertz Applications [2020 IEEE MTT-S 国际微波研讨会系列-应用于射频及太赫兹的先进材料和工艺] (IEEE MTT-S IMWS-AMP 2020) in Singapore. It co-hosted the event with National Singapore University and several other PRC institutions. Participants came from the U.S., U.K., Germany, Canada (University of Montreal), and Australia.[442]
- In 2020, this lab co-hosted the 6th IEEE Global Electromagnetic Compatibility Conference (GEMCCon 2020) [6th IEEE Global Electromagnetic Compatibility Conference, GEMCCon 2020] in Xi'an. Participants included CAEP and the CETC 33rd RI. Notable international participants included researchers from the U.S., Japan, Australia, Germany, Russia, the U.K., Switzerland, Italy, and Brazil.[443]
- In 2019 this lab co-hosted the Asia Electromagnetics Conference [亚洲电磁学国际会议] (ASIAEM 2019), featuring personnel of AVIC and CAEP. International participants included the President of the U.S. Metatech Corporation, as well as personnel from Germany, France, Japan, Italy, Switzerland, Korea, Russia, Sweden (SAAB), UAE, and Sri Lanka.[444] [445]
- In 2011 this lab participated in the IEEE International Symposium on Microwave, Antenna, Propagation, and EMC Technologies for Wireless Communications (MAPE 2011), alongside the European School of Antennas and the IEEE Antennal and Electric Wave Dissemination Association.[446]

Lab Equipment:

- The CSSC EMC Testing Center [中国船舶工业电磁兼容性检测中心], which is overseen by this lab and the CSSC 701st RI, provides EMC testing of weapons and equipment for aerospace, aviation, armaments, electronics, and naval weapon platforms, has over 400 major pieces of equipment, including:
    - Asia's only antenna layout test field and shielded semi-electric dark room
    - Strong EMP laboratory
    - Reverberation room

[xxix] A full list is available upon request.

- Shielding room
- EMC digital and physical simulation laboratory
- Electromagnetic interference control laboratory within/between systems
- EMC testing experimental technology research laboratory[447]

Address:

CSSC EMC Testing Center, #5 No. 268 Zhangzhidong Road, Wuchang District, Wuhan, Hubei Province 460064 [武汉市武昌区张之洞路 268 号 5 号 460064][448]

Website:

None found

Known Aliases:

- National Key Lab of Defence Technology for EMC [电磁兼容性国家级重点实验室/电磁兼容性国家重点实验室]
- Science and Technology on Electromagnetic Compatibility Laboratory
- Defense S&T Electromagnetic Compatibility Key Laboratory [国防科技电磁兼容性重点实验室]
- Key Laboratory of Electromagnetic Compatibility [电磁兼容性重点实验室]

16. Defense S&T Key Laboratory of Electromagnetic Environment Effects

Official English Name: Unknown

Chinese Name: 电磁环境效应国防科技重点实验室

Research Field: Multi-Domain (Aerospace, Ground) – Multiple (Aircraft, Munitions, Radar, Space Vehicles) – Electromagnetics (*Also: EMP, Simulation & Modeling*)

Affiliations:

- PLA Army Engineering University [陆军工程大学][xxx]

Key Data:

- Established: 2006
- Total Funding: Unknown
- Personnel: Unknown[449] [450]
- Official start of operations: 2007

[xxx] Formerly known as the Ordnance Engineering College [军械工程学院]

- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Electromagnetic Environment Effects is tasked with improving weapons and equipment survivability and capabilities in difficult electromagnetic environments. It conducts simulation, testing, and assessment of equipment in strong electromagnetic fields, and is capable of simulating a wide variety of complex electromagnetic environments. The lab's research has been applied to numerous fields, including EMP hardening, aviation, radar, and the PRC's space program.[451] [452]

Further Information:

- There is some confusion about the relationship between this lab and the National S&T Key Laboratory on Electromagnetic Environmental Effects and Electro-optical Engineering [电磁环境效应与光电工程国家级重点实验室]. The two have in some cases been mistaken as the same lab, but the latter is probably a different lab with a similar name based at the PLA University of Science and Technology's former campus in Nanjing. There are numerous instances of the two labs being listed separately for conferences, and the latter also has a different director. PLAUST merged with this university in 2017, but so far it appears that both labs continue to exist separately under this university, one in Shijiazhuang, one in Nanjing.

Research Direction:

1. Electrostatic safety [静电安全性]
2. Environmental simulation and testing of strong electromagnetic fields [强电磁场的环境模拟与测试]
3. Environmental effects assessment of strong electromagnetic fields [强电磁场环境效应评估]
4. Strong electromagnetic field protection [强电磁场防护][453]

Notable Applications:

- This lab designed an electrostatic discharge device for testing effects of electromagnetic pulse radiation. This can be used to test the safe operation of both military and civilian spacecraft. Further, former Director Liu Shanghe was involved in the design of the Shenzhou 5 and Shenzhou 7 manned spacecraft. Liu helped design the return capsule of the Shenzhou 5 and the static safety work for the Shenzhou 5 and 7.[454] [455]

- This lab has conducted extensive experimentation on radiation effects on radar.[456]
- This lab has conducted research into the effects of electrostatic discharge interference on aircraft satellite navigation.[457]
- This lab is involved in efforts to better protect equipment, infrastructure, and people from lightning strikes. This includes the invention of a mobile lightning protection and monitoring vehicle which can be used for better and safer all-weather military training.[458]
- Liu Shanghe won a 1st Class National S&T Progress award for his work on ammunition anti-static theory, leading to safer munitions storage.[459]
- Liu Shanghe has done research into protection of military equipment against EMPs.[460]

Leadership and Key Personnel:

- Director: Chen Yazhou [陈亚洲][461]
- Deputy Directors: Pan Xiaodong [潘晓东][462]; Hu Xiaofeng [胡小锋][463]

Key Personnel

- Liu Shanghe [刘尚合][464] [465] [466]
    - PLA Corps Leader Grade senior civilian cadre, CAE Academician, and former Director of this lab.
    - Expert on electromagnetic compatibility and protection, considered a pioneer of electrostatic safety engineering and electromagnetic environment effects on equipment.
    - Also serves as Director of Military-Civil Fusion Electromagnetic Environment Effects Center [军民融合电磁环境效应中心]
    - Once intentionally shocked himself with 71,000 volts to make a point about the human body's ability to survive extreme voltage.

Notable Collaborations:

Domestic

- This lab is associated with the Military-Civil Fusion (MCF) Electromagnetic Environment Effects Center [军民融合电磁环境效应中心]. This Center is a joint effort of this lab, Shijiazhuang Tiedao University [石家庄铁道大学], and China Tonghao Research and Design Academy Group [中国通号研究设计院集团]. The Center focuses on national defense, rail transport, and Hebei regional development, using MCF to advance electromagnetic compatibility and electromagnetic protection.[467] [468]
- In 2014 this lab co-hosted a symposium on Electromagnetic Protection Bionics [电磁防护仿生学术研讨会].[469]

- In 2019 this lab co-hosted the Annual Academic Seminar on Electromagnetic Environmental Effects and the Subject Expert Group Meeting on Electromagnetic Fields and Electromagnetic Environmental Effects [2019 年度电磁环境效应学术研讨会议暨电磁场与电磁环境效应学科专家组会议]. Aerospace, maritime, electronics, military-industrial, national defense, and other experts were present. Topics included blockchain technology, electromagnetic effects on electronic information equipment, and electromagnetic effects on high-speed rail.[470]
- This lab participated in a "Space Static Electricity" [航天静电] conference. Hu Xiaofeng of this lab spoke about static electricity effects and protection for space vehicles.[471]
- This lab co-sponsored the 2021 National Complex Electromagnetic Environment Technology and Applications Academic Conference [2021 全国复杂电磁环境技术及应用学术会议]. Speakers came from National University of Defense Technology, Naval Engineering University, Beijing Institute of Applied Physics and Computational Mathematics [北京应用物理与计算数学研究所[, Beijing Institute of Satellite Environment Engineering [北京卫星环境工程研究所], and the CSSC China Ship Research Design Center [中国舰船研究设计中心], as well as this lab. The conference discussed topics with military applications, including intelligent electromagnetic frequency operations technology, network electromagnetic space attack and defense technology, and complex electromagnetic environment characteristics faced by weapons and equipment.[472]

International

- This lab has co-hosted the annual China-US International Symposiums on Electrostatic Protection and Standardization [静电防护与标准化国际研讨会]. The 4th (2015) symposium was hosted along with CAST, the U.S. Trade and Development Agency, the American National Standards Institute, and the U.S. Electrostatic Discharge Association. Reps of the CASC 514th RI (Beijing Dongfang Institute of Measurement and Testing [北京东方计量测试研究所]) and U.S. company IBM were also present. The symposium discussed standardization and electrostatic discharge related to intelligent manufacturing, internet of things, and smart hardware. The 5th symposium in 2016 also featured representation from the SASTIND Explosives Measurement Station [国防科技工业火炸药一级计量站]. The 8th symposium in 2019 featured most of the same institutions on both sides, as well as the CASC Institute of Standardization [中国航天标准化研究所] (708th RI) and the CAST Space S&T Information Institute [北京空间科技信息研究所] (512th RI), as well as others.[473] [474] [475]
- In 2019 this lab co-hosted the 2019 Asian Electromagnetics Conference [2019 亚洲电磁学国际会议], which was attended by a large number of international scholars, including U.S. scholars.[476]

Lab Equipment:

No Information

Address:

PLA Engineering University Shijiazhuang Campus, No. 97 Heping West Road, Xinhua District, Shijiazhuang, Hebei Province [河北省石家庄市新华区和平西路 97 号][477]

Website:

None Found

Known Aliases:

- National Laboratory of Electromagnetic Environment Effects [电磁环境效应国家级重点实验室]
  - This is the far more common name for this lab.
- Defense S&T Key Laboratory of Electromagnetic Protection [电磁防护国防科技重点实验室]
  - This is listed as the lab's name in the "official" online list of DSTKLs, but is actually a far less common name.
- Key Laboratory of Electromagnetic Protection [电磁防护重点实验室]
- NOT to be confused with the Defense S&T Key Laboratory of Electromagnetic Environmental Effects and Electro-Optical Engineering [电磁环境效应与电光工程国防科技重点实验室], which is a different lab.

17. Defense S&T Key Laboratory of Electromechanical Engineering and Control

Official English Name: Science and Technology on Electromechanical Dynamic Control Laboratory[478]

Chinese Name: 机电工程与控制国防科技重点实验室

Research Field: Multi-Domain (Aerospace, Ground) – Munitions (*Also: Non-ballistic Missiles)* – Munitions Technologies (*Also: Simulation & Modeling*)

Affiliations:

- Beijing Institute of Technology (BIT) [北京理工大学]
- China Ordnance Industries Group Corporation (Norinco) [中国兵器工业集团]

- Xi'an Electromechanical Information Technology Institute [西安机电信息技术研究所]
  - *(a.k.a. Norinco 212th Research Institute [212 研究所])*

Key Data:

- Established: 1992
- Total Funding: Unknown
- Personnel: over 30 (just BIT)[479] [480] [481]
- Official start of operations: 1996
- Floor Space: 9,600 sqm

Lab Overview:

The Defense S&T Key Laboratory of Electromechanical Engineering and Control is focused on R&D of various mechanical and electromechanical fuses, via both fuse simulations and dynamic analysis of environmental simulations and tests. It has been awarded for its development of mortar fuses.[482]

The lab has branches in Beijing, overseen by Beijing Institute of Technology, and Xi'an, overseen by Norinco's Xi'an Electromechanical Information Technology Institute (a.k.a. Norinco 212th RI). Its primary headquarters is in Xi'an. The Xi'an Electromechanical Information Technology Institute is focused on electromechanical system integration technology, near-field target characteristics research and testing technology, electromechanical, optical, magnetic, acoustic, and composite detection technologies, and dynamic properties testing technology. It is the PRC's premier institute focused on weapon fuse technology. It also conducts research into electronic jamming and anti-jamming technology, special energy, physical and digital simulation technology, and miniaturized high-overload telemetry technology. Its products include maritime, meteorological, and port control radars, satellite and microwave communications devices, and various civilian applications.[483] [484] [485] [486] [487]

Further Information:

- This lab is also frequently referred to as the State/National Key Laboratory of Electromechanical Dynamic Control [机电动态控制国家重点实验室]. There is sufficient evidence to believe this is the same lab:
  - Both lab names can be found being used interchangeably.
  - Both are described as being founded in 1996 and being joint BIT-212th RI labs.
  - Chen Xi is associated with both labs.[488] [489] [490] [491]

Research Direction:

1. Mechanical and electromechanical fuses [机械引信、机电引信]
2. Fuse system simulations [引信系统仿真]

3. Dynamic properties analysis of multiple types of environmental simulations and tests [动态特性分析多种环境模拟试验][492]

Notable Applications:

- Unidentified mortar fuses.[493]
- There is a relative dearth of information about end products produced by this lab, but given the work of its parent Xi'an Electromechanical Information Technology Institute, it is safe to say it researches a wide range of fuses, including mechanical, electronic, laser, infrared, magnetic, acoustic, etc. This includes fuses for everything from artillery and small munitions to air-to-air missiles. Fuse safety and security also seems to be an area of interest.[494] [495] [496] [497] [498] [499]

Leadership and Key Personnel:

- Director: Chen Xi [陈曦][500]
- Academic Committee Director: Ma Baohua [马宝华][501]
- Deputy Directors: Tan Huimin [谭惠民][502]; Dang Ruirong [党瑞荣][503]
    - Tan Huimin is also Director of the Beijing Branch

Notable Collaborations:

Domestic

- This lab collaborates with the China Ordnance Society [中国兵工学会] and the Xi'an Electro-mechanical Institute [西安机电信息研究所] to publish an academic journal, the Journal of Detection & Control [探测与控制学报].[504]
- This lab may have worked with the CASC Information Association Guidance and Fuse Information Network [中国航天信息协会制导与引信信息网] as part of an academic conference around 2010. The conference was focused on precision strike systems geared toward future information warfare, including precision target detection and identification technology. It featured personnel from Shanghai Aerospace 802nd RI [上海航天 802 所], CASIC 2nd Academy 25th RI [航天科工集团二院 25 所], CASIC 3rd Academy 3rd Department [航天科工集团三院三部], 35th RI, [35 所], 310th RI [310 所], AVIC China Air-to-Air-Missile Institute [中国空空导弹研究院], Norinco New Technology Promotion Research Institute [中国兵器工业新技术推广研究所], Norinco 212st RI [兵器 212 所], and Beijing Special Electro-mechanical Technology Institute [北京特种机电技术研究所]. Topics included fuse detection and control, signal processing and target identification, and simulation and testing.[505]

International

- The lab's parent institution, the 212th RI, has allegedly established extensive contacts with multiple countries, including the U.S.[506]

Lab Equipment:

- The lab has 140m RMB of fixed assets (including 110m RMB of equipment assets).[507]
- The lab's facilities and equipment include:
    - Full ballistic synthetic environment laboratory
    - Domestic advanced gas gun group
    - Accelerometer calibration device up to 200,000g
    - Motion and dynamics analysis software such as ADAMS and ANSYS
    - Signal processing and microwave analysis software such as MENTOR and ANSOFT
    - Micro-mechanical testing equipment, including high-performance vector network analyzers, spectrum analyzers, microwaves, millimeter-wave RF monitoring equipment, and X-ray inspection imaging systems[508]

Address:

No. 6 Jixiang Road, Xi'an, Shaanxi Province [陕西省西安市吉祥路 6 号][509]

Website:

None Found

Known Aliases:

- Key Laboratory of Electromechnical Dynamic Control [机电动态控制重点实验室]
- National Key Laboratory of Electromechnical Dynamic Control [机电动态控制国家级重点实验室]
- State Key Laboratory of Electromechnical Dynamic Control [机电动态控制国家重点实验室]
- State Key Laboratory of Mechatronics Engineering and Control [机电工程与控制国家级重点实验室]
- National Key Laboratory of Mechatronic Engineering and Control [机电工程与控制国家重点实验室]
- National Key Laboratory of Electromechanical Engineering and Control

- National Laboratory for Mechatronic and Control
- National Lab of Mechatronic Engineering and Control

18. Defense S&T Key Laboratory of Electronic Information Control

Official English Name: Unknown

Chinese Name: 电子信息控制国防科技重点实验室

Research Field: Multi-domain (Aerospace, Ground, Maritime) – Electronic Warfare (*Also: Air/Missile Defense, Non-ballistic Missiles, Radar)* – Multiple (Countermeasures, Electromagnetics, Intelligent Technologies, Millimeter Wave Technologies, Simulation & Modeling, Stealth Technologies)

Affiliations:

- China Electronics Technology Group Corporation (CETC) [中国电子科技集团]
    - Southwest Institute of Electronic Equipment (SWIEE) [西南电子设备研究所]
        - *(a.k.a. CETC 29th Research Institute [29 研究所])*

Key Data:

- Established: 1993
- Total Funding: Unknown
- Personnel: Unknown[510]
- Official start of operations: Unknown
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Electronic Information Control conducts research into electronic warfare (EW), with possible foci on EW systems simulation technology and new concepts, theories, and technologies for EW.

This lab was originally known as the Defense S&T Key Laboratory of Electronic Countermeasures [电子对抗国防科技重点实验室]. Around 2006, it changed its name to the Defense S&T Key Laboratory of Information Comprehensive Control [信息综合控制国防科技重点实验室], and changed to its current name around 2012.[511] [512] [513]

The lab's parent institution, the CETC Southwest Institute of Electronic Equipment (SWIEE) (a.k.a. CETC 29th RI), specializes in electronic warfare research, and is able to design, develop, and produce electronic information systems equipment for land, sea, air, and space platforms, as well as for missiles. It may have worked closely with the former PLA GSD 4th Department (4PLA), which has since been absorbed by the PLASSF. It is on the U.S. Commerce Department Entity List for export control.[514] [515]

Further Information:

- The lab has its own journal, Electronic Information Countermeasures Technology [电子信息对抗技术], previously known as Electronic Countermeasures Technology [电子对抗技术], founded in 1986 (which could suggest that the predecessor to this lab had been founded at that time). The journal studies new concepts, new theories and new technologies of electronic warfare [电子战] and information warfare [信息战].[516]
- The lab also has or had another publication called International Electronic Warfare [国际电子战] (previously called 电子战技术文选).[517]

Research Direction:

1. Electronic warfare system simulation technology [电子战系统仿真技术]
2. New concepts, theories, and technologies for electronic warfare [电子战概念、新理论、新技术][518]

Other notable research areas:

- Stealth and anti-stealth technology
- Airborne Sensor Systems
- Detection and warning for air-to-air missiles
- Aircraft countermeasures against missiles
- Path planning for aircraft penetration against enemy radar network
- MIMO Radar
- Multi-false-targets jamming
- Airborne location and positioning
- Interferometry
- Millimeter wave reconnaissance technology[519] [520]

Notable Applications:

- The lab's research has been put to the following uses:
    - Simulation of radar signals of various systems in order to form complex battlefield electromagnetic signals in the laboratory for assessment tests
    - Electronic countermeasures, jamming, and anti-jamming equipment
    - AI signal recognition technology
    - GPS and phased array jamming technology, and other jamming/interference technologies
    - Integrated air defense electronic warfare systems

- A PLAN C3I-EW system[521]

Leadership and Key Personnel:

- Director: He Tao [何涛][522]
- Deputy Directors: Zhang Li [张礼]; Gu Jie [顾杰][523]

Notable Collaborations:

Domestic

- A survey of the lab's research in two scientific databases reveals extensive cooperation with the PLAAF, PLAN, PLAA, PLASSF, PLARF, and the Chengdu Military Representative Office, mainly having to do with electronic warfare and the technologies described in the Research Direction section.

International

- In the 1990s to an unspecified date, this lab allegedly carried out work in cooperation with Russia, including analyzing the combat effectiveness of electronic warfare equipment [电子战装备作战效能分析] and early warning aircraft jamming modeling and computer simulation development [对预警机干扰的建模和计算机模拟开发].[524]

Lab Equipment:

No information

Address:

None found, possibly co-located with 29th RI at No. 496 Yingkang West Road, Jinniu District, Chengdu, Sichuan Province [四川省成都市金牛区营康西路 496 号][525]

Website:

None found

Known Aliases:

- Key Laboratory of Electronic Information Control [电子信息控制重点实验室]

- Defense Key Lab of Electronic Information Control [电子信息控制国防重点实验室]
- GF S&T Key Lab of Electronic Information Control [电子信息控制 GF 科技重点实验室]
- State Key Lab of Electronic Information Control [电子信息控制国家重点实验室]
- National Key Lab of Electronic Information Control [电子信息控制国家级重点实验室]
- Key Laboratory of Electronic Countermeasures [电子对抗重点实验室]
- State Key Laboratory of Electronic Countermeasures [电子对抗国家重点实验室]
- Defense Key Lab of Electronic Countermeasures [电子对抗国防重点实验室]
- Key Laboratory for Information Comprehensive Control [信息综合控制重点实验室]
- National Information Control Laboratory/Lab (NICL)
- State Key Laboratory of Information Comprehensive Control [信息综合控制国家重点实验室]
- Key Laboratory of Electronic Information Comprehensive Control [电子信息综合控制重点实验室]
- Electronic Information Comprehensive Control Laboratory
- National Electronic Countermeasures Laboratory
- National EW Laboratory (NEWL)
- National Key Laboratory of Electronic Warfare
- National Key Laboratory of Electronic Countermeasure
- Science and Technology on Electronic Information Control Laboratory
- Key Electronic Information Control Lab

19. Defense S&T Key Laboratory of Electronic Measurement Technology

Official English Name: Unknown

Chinese Name: 电子测试技术国防科技重点实验室

Research Field: Multi-domain (Aerospace, Ground, Maritime) – Multiple (Ballistic Missiles, Munitions, Radar, Space Vehicles) – Electromagnetics (*Also: Microwave Technologies, Millimeter Wave Technologies, Sensing, Shipbuilding, Terahertz Technologies*)

Affiliations:

- China Electronics Technology Group Corporation (CETC) [中国电子科技集团]
    - East China Electronic Measuring Instruments Research Institute [华东电子测量仪器研究所]
        - *(a.k.a. CETC 41st Research Institute [41 研究所])*
- North University of China (NUC) [中北大学]
    - School of Instrument and Electronics [仪器与电子学院]

Key Data:

- Established: Unknown
- Total Funding: Unknown
- Personnel: 32 (Taiyuan Branch)[526] [527]
- Official start of operations: 2002
- Floor Space: approx. 10,000 sqm (both campuses combined)

Lab Overview:

The Defense S&T Key Laboratory of Electronic Measurement Technology conducts research into various types of testing technology, including dynamic, photoelectric, microwave, millimeter wave, automatic, and electromagnetic information security testing technologies. The lab's research has been utilized in a wide variety of fields that require precision testing for position, attitude, temperature, pressure, speed, impact, penetration, damage, and the electromagnetic spectrum, including the PRC's space, aviation, munitions, radar, and shipbuilding programs.[528]

The CETC East China Electronic Measuring Instruments Research Institute (a.k.a. the CETC 41st RI), established in 1968, claims to be the PRC's only specialized research institute for electronic measuring instruments, and conducts research into microwave/millimeter wave, photoelectric communications, digital communications, and general-purpose measuring instruments and automatic test systems. It also provides testing methods for the development and production of military and civilian electronic components. Its products have been used in satellites, navigation, radar, and China's Shenzhou manned space program. In 2015 it was combined with the CETC 40th RI to form China Electronics Technology Instruments Co., Ltd (CETI) [中电科仪器仪表有限公司/中电科思仪科技股份有限公司/中电仪器] (a.k.a. Ceyear [思仪]).

The lab's main campus is located in Qingdao with the 41st RI, with a subordinate branch in Taiyuan with NUC.[529] [530]

Further Information:

- There seem to be a division of labor between the lab's two branches, with the 41st RI (Qingdao) branch in charge of microwave and millimeter wave testing, automatic testing, and electromagnetic information security testing technologies, and the NUC (Taiyuan) branch in charge of dynamic testing technology. Both are responsible for photoelectric testing technology.[531]
- From 2015-2018, the lab has received an average annual scientific research funding of nearly 100 million RMB. Since 2014 the lab (or possibly just the Taiyuan branch) has undertaken more than 300 high-level scientific research projects from the former PLA GAD, SASTIND, and the Ministry of Science and Technology.[532] [533]
- The Taiyuan branch has disciplines and specialties in the fields of applied physics, sensors, microelectronics, measurement and control, information processing, and automation. The Taiyuan branch is mainly oriented toward the development needs of manned spaceflight,

deep space exploration, "assassin's mace" weapons, and other major national projects and key weapons models for national defense.[534]

Research Direction:

1. Dynamic testing technology [动态测试技术]
2. Photoelectric testing technology [光电测试技术]
3. Microwave and millimeter wave testing technology [微波毫米波测试技术]
4. Automatic testing technology [自动测试技术]
5. Electromagnetic information security testing technology [电磁信息安全测试技术][535]

The NUC (Taiyuan) branch has its own research direction:

1. Dynamic information acquisition and calibration technology in harsh environments [恶劣环境下动态信息获取与校准技术]
2. Micro-nano sensing and testing technology [微纳传感与测试技术]
3. Transient physical field detection and reconstruction technology [瞬态物理场探测与重建技术]
4. Photoelectric sensor and application technology [光电传感与应用技术][536]

Notable Applications:

- The lab's research has provided more than 1,300 sets of test equipment and systems for more than 30 key weapon models for the PLAA, PLAN, and PLAAF, including for space, aviation, weapons, and ships.[537]
- The lab has provided key testing techniques for manned spaceflight and deep space exploration. Further, since 2003, the lab has been involved in research on measurement tasks related to the Long March 3 rocket. The research results from more than 200 sets of measurement products developed for the rocket have been applied to various types of rocket measurement systems.[538] [539]

Leadership and Key Personnel:

- Director: Nian Fushun [年夫顺][540]
- Deputy Director/Taiyuan Branch Director: Xue Chenyang [薛晨阳][541] [542] [543]
    - NPC delegate
    - Visiting scholar at Oxford in 2008, MIT in 2011.
    - Has carried out industry-university research cooperation with a number of defense companies to promote military-to-civilian technical fusion.

- ○ Xue's team's research has been applied in the Long March rockets, manned spaceflight program, and deep space exploration programs.

Key Personnel:

- Jiang Wanshun [姜万顺][544]
  - ○ Has worked with Director Nian on terahertz systems. In October 2020, was quoted as saying "Our millimeter wave and terahertz measurement system successfully broke the foreign technology blockade."
- Liu Jun [刘俊][545]
  - ○ Previous deputy director
  - ○ Former UC Berkeley visiting scholar
  - ○ National Hundred, Thousand, and Ten Thousand Talents candidate
  - ○ Former GAD inertial technology professional group expert and Secretary-General of the Testing Technology Branch of the China Ordnance Society
  - ○ Research includes Nano/Micro-Electro-Mechanical systems (MEMS/NMEMS) and dynamic testing technologies for weapons systems in harsh environments

Notable Collaborations:

Domestic

- This lab and the Defense S&T Key Lab of Radar Signal Processing at Xidian University set up a "New-System Radar Research and Test Base" [新体制雷达研究试验基地] in the Qingdao Development Zone in 2005 to research new radar detection technologies, design and manufacture an indigenously-developed new radar system, and develop new informationized weapons and equipment. There is little to no information available on the base after its founding, and only one joint study between the two labs appears to have been published.[546] [547]
- The Institute of Dynamic Measurement and Control and Intelligent Instruments [动态测控与智能仪器研究所] of the NUC School of Electrical and Control Engineering is overseen by this lab and other NUC entities. It works in measurement and control for the aerospace, armaments, and shipbuilding fields.[548]
- The lab and the Ministry of Education Key Laboratory of Instrumentation Science and Dynamic Measurement [仪器科学与动态测试教育部重点实验室] have collaborated in various projects since 2003, including joint research on measurement tasks related to the Long March 3 rocket [长征三号火箭].[549]

International

None Found

Lab Equipment:

No Information

Address:

None found, possibly co-located with the CETC 41st RI and NUC at No. 98 Xiangjiang Road, Qingdao Development Zone, Shandong Province [山东省青岛开发区香江路 98 号] and No. 3 Xueyuan Road, Taiyuan City, Shanxi Province [山西省太原市学院路 3 号], respectively

Website:

https://web.archive.org/web/20190402225600/http://6y.nuc.edu.cn/xsyyj/pthjd/gfkjzdsys.htm

Known Aliases:

- (possibly) Defense S&T Key Laboratory of Signal Detection [信号检测国防科技重点实验室]
- (possibly) Key Laboratory of Signal Detection [信号检测重点实验室]
- National Key Laboratory for Electronic Measurement Technology [电子测试技术国家级重点实验室]
- State Key Laboratory for Electronic Measurement Technology [电子测试技术国家重点实验室]
- Key Laboratory for Electronic Measurement Technology [电子测试技术重点实验室]
- Defense Key Laboratory for Electronic Measurement Technology [电子测试技术国防重点实验室]
- China Electronics Technology Instruments Co., Ltd (CETI) Key Laboratory for Electronic Measurement Technology [中电科仪器仪表有限公司电子测试技术重点实验]
- CETC 41st RI Key Laboratory for Electronic Measurement Technology [中国电子科技集团公司第四十一研究所电子测试技术重点实验室]
- North University of China Key Laboratory for Electronic Measurement Technology [中北大学电子测试技术重点实验室]
- North University of China School of Instrument and Electronics Key Laboratory for Electronic Measurement Technology [中北大学仪器与电子学院电子测试技术重点实验室]
- North University of China School of Electronics and Computer Science & Technology Key Laboratory for Electronic Measurement Technology [中北大学电子与计算机科学技术学院电子测试技术国家重点实验室]

20. Defense S&T Key Laboratory of Explosive Combustion

Official English Name: National Key Laboratory of Science and Technology on Combustion and Explosion[550]

Chinese Name: 火炸药燃烧国防科技重点实验室

Research Field: Multi-domain (Aerospace, Ground) – Munitions (*Also: Non-ballistic Missiles, Space Vehicles*) – Propulsion (*Also: Hypersonic Technologies, Impact & Damage, Munitions Technologies*)

Affiliations:

- China Ordnance Industries Group Corporation (Norinco) [中国兵器工业集团]
    - Xi'an Modern Chemistry Research Institute (MCRI) [西安近代化学研究所]
        - *(a.k.a. Norinco 204th Research Institute [204 研究所])*

Key Data:

- Established: 1994
- Total Funding: Unknown
- Personnel: Unknown[551]
- Official start of operations: likely 1996
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Explosive Combustion appears to be focused on projectile propellants for a variety of munitions, ranging from rocket and missile engines to smaller munitions, explosive and energetic materials, and studying object shock and impact.

This lab is subordinate to the Norinco Modern Chemistry Research Institute (a.k.a. Norinco 204th RI). This Research Institute claims to be the PRC's only institution dedicated to research of explosives and destructive technologies [火炸药及毁伤技术], with a focus on energetic materials, functional materials, special chemical materials, organic chemistry, polymer materials, chemical machinery, and engineering mechanics. This research is applied to military explosives, propulsion, metrology, and ammunition, as well as military and civilian catalytic reaction engineering technology, new opto-electronic materials technology, and fine chemical technology.[552] [553]

Further Information:

- This lab is divided into five subordinate research labs and one work station:
    1. *Explosive Pyrolisis Lab* [火炸药热分解研究室]: Researches pyrolisis and dynamics of explosives, as well as the decomposition course and patterns of explosives during combustion.
    2. *(Ammunition) Propellant*[xxxi] *Combustion Lab* [发射药燃烧研究室]: Researches propellant ignition, igniter train/flash hole/flash vent (?) [传火] research, ammo propellant burn speed measurements, ammo propellant dynamic simulation, liquid propellant aerosol combustion, new types of propellant and liquid propellant igniter trains, high-pressure static or dynamic combustion laws and combustion principles, and propellant design supply theory.
    3. *Solid (Engine/Rocket) Propellant Combustion Lab* [柜体推进剂燃烧研究室]: Researches solid propellant steady state combustion, unstable combustion formulation principles, smoke plume properties (?) [羽烟特性] and generation principles, combustion performance tuning, combustion catalyst principles, and unstable combustion formulation principles. It researches theories and technology for solid propellants having to do with combustion performance. Its equipment includes a flame structure measurement system [火焰结构测定系统], smoke plume environment box (?) [羽烟环境箱], and flame measurement system [烟焰测定系统].
    4. *Explosive Combustion Explosion Lab* [火炸药燃烧爆炸研究室]: Researches principles and influencing factors of solid propellant [推进剂] and ammunition propellant [发射药] in engine and chamber combustion rotating explosive bursts (?) [转爆轰]. It also assesses the safety of new ammunition and engine/rocket propellants [推进剂 and 发射药].
    5. *Modern Combustion Diagnostic Technology Lab* [现代燃烧诊断技术实验室]: Researches laser spectroscopy applications for explosive combustion [火炸药燃烧]. Measures temperature and components of transients in gunpowder combustion flames by non-interference diagnostic laser spectroscopy. It provides accurate gunpowder combustion temperature measurement data.
    6. *Graphics Work Station* [图形工作站]: provides graphic processing for numerical simulations and data for combustion characteristics.

Research Direction:

The lab's research direction is never explicitly stated, but can be reasonably surmised from its five subordinate labs:

[xxxi] This Lab uses two different words for "propellant", 发射药 and 推进剂. The former refers to gunpowder propellant inside ammunition, while the latter refers to solid or liquid propellant for larger missiles or rockets.

1. Explosive Pyrolisis
2. (Ammunition) Propellant Combustion
3. Solid (Engine/Rocket) Propellant Combustion
4. Explosive Combustion Explosion Lab
5. Modern Combustion Diagnostic Technology[554]

Other Notable Research areas:

- Thermal decomposition chemical research[555]

Notable Applications:

- This lab's research contributes to a wide range of rocket, missile, and ammunition propellants.
- Director Zhao Fengqi has written extensively on solid rocket propellants for a wide range of military uses, including for hypersonic missiles (specifically with boron-rich fuel).[556] [557]
- This lab has conducted research into solid-state hydrogen storage materials for military use (potential uses include vehicle-mounted equipment, fuel cells, and solid propellants).[558]
- The 2020 launch of a Long March 5 rocket carrying the Tianwen 1 Mars probe utilized a propellant designed by the 204th RI, and it is possible this lab was involved in the research given its mission.[559]

Leadership and Key Personnel:

- Director: Zhao Fengqi [赵凤起][560]

Key Personnel

- Liu Zijia [刘子如][561]
    - Expert on energetic materials and thermal decomposition chemical dynamics.
    - Founding member of lab, possibly retired, over 80 years old now.

Notable Collaborations:

Domestic

- There has been close cooperation for over two decades between this lab and the Chemical Engineering School at Northwestern Polytechnical University.[562]
- In October 2021 this lab took part in a conference held by the Chinese Chemical Society [中国化学会] called the National Seminar on Issues of Public Security in Chemistry [全国"公共安全领域中的化学问题"研讨会]. Other participants included the CAEP 903

Institute and the SASTIND Level 1 Chemical Defense Measurements Station [国防科技工业防化一级计量站], among others.[563]

International

- The lab's parent institution, the 204th RI, allegedly sends personnel to the U.S., Japan, Germany, Switzerland, Canada, and Russia for further studies and exchanges.[564]

Lab Equipment:

- The Explosive Pyrolisis Lab possesses equipment from U.S. company TA, including a high-pressure DSC (Differential Scanning Calorimetry) system, thermogravimeter [热重仪], and other instruments.[565]
- This lab possesses an advanced CARS system.[566]

Address:

Possibly co-located with the 204th RI at Jintai Road, Yanta District, Xi'an, Shaanxi Province [陕西省西安市雁塔区金石路][567]

Website:

None found

Known Aliases:

None

21. Defense S&T Key Laboratory of Fire Control Technology

Official English Name: Unknown

Chinese Name: 火力控制技术国防科技重点实验室

Research Field: Aerospace (*Also: Ground, Maritime*) – Multiple (Aircraft, Ground Vehicles, Helicopters, Surface Vessels, UAVs) – Fire Control (*Also: Countermeasures, Simulation & Modeling, Target Detection/Recognition*)

Affiliations:

- Aviation Industry Corporation of China (AVIC) [中国航空工业集团]

- Luoyang Institute of Electro-optical Equipment [洛阳电光设备研究所]
    - *(a.k.a. AVIC Optronics [航空工业光电所])*
    - *(a.k.a. AVIC 613th Research Institute [613 研究所])*

Key Data:

- Established: 1999
- Total Funding: Unknown
- Personnel: Unknown[568]
- Official start of operations: 2006
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Fire Control Technology conducts research into various aspects of fire control systems, as well as detection, countermeasures, and targeting displays for airborne, maritime, and ground-based platforms.

AVIC's Luoyang Institute of Electro-optical Equipment, (a.k.a. AVIC Optronics, a.k.a. the AVIC 613th RI), was established in 1970 and is responsible for research of airborne fire control systems. It produces sensors, IR, and visual spectrum cameras, including the Dragoneye optical pods for attack helicopters and UAVs, night vision goggles, displays, and Sharp Sight head-mounted displays. It does not appear to be on the U.S. Commerce Department Entity List.[569] [570]

Further Information:

- The lab is composed of three subordinate units [单元]: Fire Control Principles Research [火控原理研究], Fire Control Systems Integrated Research [火控系统综合研究], and Target Sensor Simulation [目标传感器仿真].[571]
- This lab and its parent organization were originally subordinate to AVIC I, before AVIC I and AVIC II were re-consolidated in 2008. AVIC I was primarily focused on larger combat aircraft, including fighters and bombers.[572]

Research Direction:

1. New principles of fire control [火力控制新原理]
2. Key technologies of fire control systems [火力控制系统关键技术]
3. Closed-loop simulations and integrated test technologies for fire control systems. [火力控制系统闭环仿真和综合试验技术][573]

Other Notable Research areas:

- Control and command[xxxii]
- Photoelectric detection and countermeasures
- Research into targeting displays
- Research into task distribution for UAV swarm attacks[574] [575]

Notable Applications:

- None found, but it is likely this lab has been involved in most modern combat aircraft fire control systems, as well as other recent 613th RI products, such as head-mounted targeting displays.

Leadership and Key Personnel:

- Director: Wang Jiangang [王建刚][576]
  - Also serves as Director of 613th RI
- Academic Committee Director: Gu Songfen [顾诵芬][577]
  - CAS and CAE Academician
  - Prominent aircraft designer
- Deputy Director: Chen Xiaodong [陈哨东][578]

Notable Collaborations:

Domestic

- This lab co-hosted the "Model Wings: 3rd China UAV Conference and Exhibition" [尖兵之翼 - 第三届中国无人机大会暨展览会] in June 2020. Co-hosts included universities with strong military links like Beihang, Nanjing University of Aeronautics and Astronautics, and Northwestern Polytechnical University, as well as the PLA GSD 60th Institute [总参 60 所] (although the GSD didn't exist by 2020, so this may be outdated).[579]
- In 2010, this lab co-hosted a conference with the Defense S&T Key Laboratory of Integrated Technology for Avionics Systems [航空电子系统综合技术国防科技重点实验室].[xxxiii] The conference covered avionics systems, fire control systems for airborne weapons, and integrated technologies for avionics systems.[580]
- In 2009, this lab co-hosted the first annual Academic Conference on National Information Integration [全国信息融合学术年会] with the PLAN Aviation College (now university) [海军航空工程学院], Defense S&T Key Laboratory of C4ISR [C4ISR 技术国防科技重

[xxxii] 控制指挥, as opposed to "Command and control" [指挥控制]
[xxxiii] Not listed in the "official" list of DSTKLs

点实验室],[xxxiv] and Hangzhou Dianzi University [杭州电子科技大学]. Participants came from National University of Defense Technology, CSIC, and AVIC, among other places.[581]

International

None Found

Lab Equipment:

- Lab equipment includes:
    - Flight simulators
    - Opetoelectronic simulation axis rotary table(s)
    - Multi-target frequency injection simulation equipment, and other simulation facilities
- Utilizes a variety of advanced experimental means, software models, and a large model library to simulate and model fire control systems, optimize designs, develop fire control system software, and simulate target sensors.
- All lab equipment is connected by a fiberoptic network, allowing them to be dynamically combined depending on the experiment.[582]

Address:

None found, possibly co-located with parent institution at No. 25 Kaixuan West Road, Xigong District, Luoyang, Henan Province [河南省洛阳市西工区凯旋西路 25 号][583]

Website:

None Found

Parent institution website at http://m.avic-optronics.com/

Known Aliases:

- National Key Laboratory of Fire Control Technology
- National Defence Science and Technology Lab of Fire Control Technology
- Key Laboratory of National Defense Science and Technology on Fire Control Technology

[xxxiv] Another DSTKL not in the "official" list

22. Defense S&T Key Laboratory of Helicopter Rotor Dynamics

Official English Name: Unknown

Chinese Name: 直升机旋翼动力学国防科技重点实验室

Research Field: Aerospace – Helicopters – Aerodynamics (*Also: GNC, Materials, Robotics, Simulation &Modeling*)

Affiliations:

- Nanjing University of Aeronautics and Astronautics (NUAA) [南京航空航天大学]
  - College of Aerospace Engineering Helicopter Department [航空学院直升机系]
- Aviation Industry Corporation of China (AVIC) [中国航空工业集团]
  - Chinese Helicopter Research and Development Institute (CHRDI) [中国直升机设计研究所]
    - *(a.k.a. AVIC 602nd Research Institute [602 研究所])*

Key Data:

- Established: 1991
- Total Funding: Unknown
- Personnel: 52[584] [585]
- Official start of operations: 1995
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Helicopter Rotor Dynamics conducts basic theoretical research into various aspects of helicopter design, including helicopter dynamics and control, rotorcraft configurations, vibration noise control, actuator design, and helicopter hardware and software.

The lab is jointly overseen by Nanjing University of Aeronautics and Astronautics (NUAA) and AVIC's Chinese Helicopter Research and Development Institute (CHRDI) (a.k.a. AVIC 602nd RI). CHRDI, established in 1969, is the PRC's primary center for helicopter model development and is known as the "cradle of Chinese helicopters." It has developed over 40 helicopter models, including the Z-8, Z-9, Z-10, Z-11, and Z-19 military helicopters. NUAA is a major center for helicopter R&D in the PRC, with six labs and the PRC's only dedicated academic department for helicopter research. Over 80% of technical backbone and management personnel in the helicopter field in China studied at NUAA. The lab's headquarters is housed at NUAA, with CHRDI hosting a subordinate branch.[586] [587] [588]

Further Information:

- The lab has several subordinate research teams:
  - Lu Yang's team is responsible for research into *rotorcraft dynamics and control* [旋翼类飞行器开展动力学与控制]. This includes helicopter vibration noise active and semi-active control technology, advanced materials-based helicopter vibration noise control technology, actuator sensor selection technology, advanced actuator design technology, new concepts for rotorcraft design, helicopter flight safety warning technology measurement and control software, and hardware system development.[589]
  - Zhu Qinghua's team is responsible for research into *overall design of new rotorcraft configurations* [新构型旋翼类飞行器总体设计]. This includes comprehensive overall rotorcraft design technology, overall aerodynamics and control of new helicopter configurations, new concept rotor and multi-robotic vehicles, and airworthiness of light aircraft.[590]
  - Li Jianbo's team is responsible for research into *advanced helicopters and overall analysis of new rotorcraft configurations* [先进直升机和新构型旋翼飞行器总体分析]. Research areas include helicopter overall, aerodynamic, and flight mechanics technology, design technology for unmanned helicopter systems, and optimization of rotorcraft software.[591]
- The lab has 205 graduate students (48 PhD and 157 Master's).[592]

Research Direction:

No official research direction list was found, but the known research teams may be used as proxies:

1. Rotorcraft dynamics and control [旋翼类飞行器开展动力学与控制]
2. Overall design of new rotorcraft configurations [新构型旋翼类飞行器总体设计]
3. Advanced helicopters and overall analysis of new rotorcraft configurations [先进直升机和新构型旋翼飞行器总体分析]

Other Notable Research areas:

- Helicopter vibration noise active/semi-active control technology
- Advanced materials-based helicopter vibration noise control technology
- Actuator sensor selection technology
- Advanced actuator design technology
- New concept rotorcraft design
- Helicopter flight safety warning technology measurement and control software and hardware system development
- Comprehensive overall rotorcraft design technology
- Overall aerodynamics and control of new helicopter configuration

- New concept rotor and multi-robotic vehicles
- Airworthiness of light aircraft
- Helicopter overall, aerodynamic, and flight mechanics technology
- Unmanned helicopter system integrated design technology
- Optimization of rotorcraft software[593] [594] [595]

Notable Applications:

- It is highly likely that this lab has had a hand in research and design of many if not all PRC military helicopters of the past 25 years. Images imply that this lab was associated with the development of the Z-10 and Z-19 attack helicopters and the Z-20 medium-lift utility helicopter. According to another source, this lab has provided research support to the latest models of the Z-8, Z-9, and Z-10 military helicopters.[596] [597]
- One of the founders of the lab, Wang Shicun, was involved in the development of the Z-8, Z-9, and Z-11 military helicopters. The former two came before the creation of this lab however.[598]
- Another source strongly implies that NUAA was associated with the development of the Z-10 and is vital to the development of helicopters for PLAA Aviation. Similarly, CHRDI is responsible for design of the Z-8, Z-9, Z-10, Z-11, and Z-19 helicopters, as well as the U8 unmanned helicopter.[599] [600]
- Although outside of this lab's core mission, researcher Zhao Qijun also researches stealth technology and has been involved in the design of the PRC's future 6th-generation stealth aircraft.[601]

Leadership and Key Personnel:

- Director: Xia Pinqi [夏品奇][602]
- Deputy Director: Zhao Qijun [招启军][603]
- Founder: Wang Shicun [王适存][604]
    - Considered a pioneer and major influence in PRC helicopter design.
    - Died in 2011.

Key Personnel

- Lu Yang [陆洋]
    - Leads a team focused on rotorcraft dynamics and control (see above).
- Zhu Qinghua [朱清华]
    - Leads a team focused on overall design of new rotorcraft structures (see above).
- Li Jianbo [李建波]
    - Leads a team focused on advanced helicopters and overall analysis of new rotorcraft configurations (see above).

Notable Collaborations:

Domestic

- This lab, along with the NUAA Micro Air Vehicle Research Center [微型飞行器研究中心], is associated with the Nanjing-based private company Taoxun Aviation [韬讯航空], which designs small dual-rotor helicopter drones for both civilian and military use (mainly for patrol, reconnaissance, and security).[605]
- This lab established a "Joint Laboratory of Rotorcraft and Control Technology" [旋翼飞行器及控制技术联合实验室] with the private Chongqing Tonghang Group [重庆通航集团] in 2016. It is focused on solving problems related to rotorcraft and is jointly developing the CG111 single piston light helicopter [单发活塞轻型直升机].[606]
- This lab is closely associated with NUAA's Helicopter Research Academy [直升机研究院], which works closely with PLAA Aviation.[607]

International

- This lab is affiliated with the China chapter of the American Vertical Flight Society, and claims to have established joint research centers, cooperative labs, and lecture visits with multiple foreign universities and research institutions.[608]
- This lab has hosted the 2nd, 3rd, and 4th International Conferences on Rotorcraft Fundamentals, as well as the annual Asia-Australia Helicopter Conference.[609]
- This lab has signed agreements to create a Joint Research Center for Helicopter Technology [直升机技术联合研究中心] with Glasgow University in the U.K. and an International Joint Research Center for Helicopter Configuration [直升机结构国际联合研究中心] with the University of Nottingham in the U.K.[610]
- This lab has allegedly signed an agreement with the Russian Technological University to create a Sino-Russian Joint Laboratory.[611]

Lab Equipment:

- The lab's major equipment includes:
  - Helicopter low-speed wind tunnel
    - Used to test helicopter aerodynamics and described by one source as the “most mysterious and most important place for helicopter research at NUAA;” currently the busiest piece of equipment in the laboratory.
    - All-steel structure containing a power section, a pressure expansion section, a stabilization section, as well as a closed second test section and an open main test section.

    - The open main test section measures 3.4m x 2.4m, and the closed second test section measures 5.0m x 3.5m, which is equipped with a set of honeycomb rectifiers and two layers of 14-mesh damping mesh.
    - Powered by a 1000 KW DC speed-controlled motor, which drives a fan to generate airflow, and the fan is composed of 8 blades of FRP material.
  - Rotor arm model rotor maneuvering flight test machine
    - Used to simulate a variety of helicopter maneuvers as a way of testing rotor aerodynamic characteristics in flight.
  - Helicopter model rotor test bench
    - "Indispensable" facility for helicopter rotor wind tunnel tests.
    - Consists of a rotor hub, six-component rotor balance, rotor shaft torque balance, manipulating actuator, DC speed control motor, etc.
    - The test stand can be tilted forward by 20°, the motor power is 55Kw, the maximum speed is 2500r/m.
    - Uses a speed control device from German company Siemens. The speed regulation accuracy is plus or minus 1rpm, according to different test requirements; using an articulated or non-articulated propeller hub, the rotor table leaves a fuselage balance interface and can carry out combined fuselage/rotor tests.
  - Rotorcraft flight dynamics and flight control ground simulation verification system
    - Solves the problem of nonlinear real-time flight dynamics and flight control mathematical modeling of rotorcraft full system coupling, and develops a high immersion scenery system and simulated cockpit system.
    - Has high confidence, realistic view, and can conduct flight simulations under various conditions such as day, night, wind, frost, rain, snow, etc.
    - Provides an excellent platform for advanced flight control evaluation and verification of rotorcraft.
  - Helicopter vibration and noise active control system
  - Maneuvering demonstration helicopter
  - Rotor model test system
  - Dynamic rotor test bench (six degrees of freedom)
  - Vertical water tunnel
  - Fatigue test system
  - Tiltable rotor test bench
  - High-speed co-axial rotor test system
  - Wing/body co-stability test bench
  - Electronically controlled rotor model test bench
  - High-speed culvert vector thrust test bench
  - Pressure and velocimetry instruments[612] [613] [614] [615]

Address:

Building A5, NUAA Minggugong Campus, No. 29 Yudao Street, Qinzhun District, Nanjing, Jiangsu Province [江苏省南京市秦淮区御道街 29 号南航明故宫校区 A5 楼][616]

Website:

https://aero.nuaa.edu.cn/2017/0224/c9601a78296/page.htm

Known Aliases:

- National Key Laboratory of Rotorcraft Aerodynamics [直升机旋翼动力学国家级重点实验室]
- 中国直升机设计研究所直升机旋翼动力学重点实验室
- National Key Laboratory of Science and Technology on Rotorcraft Aeromechanics
- Science and Technology on Rotorcraft Aeromechanics Laboratory

23. Defense S&T Key Laboratory of Helicopter Transmission Technology

Official English Name: Unknown

Chinese Name: 直升机传动技术国防科技重点实验室

Research Field: Aerospace – Helicopters – Vehicle Parts & Technology

Affiliations:

- Nanjing University of Aeronautics and Astronautics (NUAA) [南京航空航天大学]
  - College of Mechanical & Electrical Engineering [机电学院]
- Aero Engine Corporation of China (AECC) [中国航空发动机集团]
  - Hunan Aviation Powerplant Research Institute [湖南动力机械研究所]
    - *(a.k.a. 608th Research Institute [608 研究所])*

Key Data:

- Established: Unknown
- Total Funding: Unknown
- Personnel: Unknown[617]
- Official start of operations: 2018
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Helicopter Transmission Technology conducts research into helicopter transmissions, which are a key component of the PRC's goal of building a new generation of helicopters with high power-to-weight ratio, high speed-reduction ratio, high survivability, high reliability, and easy maintenance. This lab is the newest Defense S&T Key Lab on the list, having been ratified by SASTIND and the CMC Equipment Development Department in April 2018.[618]

The lab is jointly managed by the Nanjing University of Aeronautics and Astronautics (NUAA) and AECC's Hunan Aviation Powerplant Research Institute (a.k.a. the AECC 608th RI). NUAA is a major center for helicopter R&D, with six labs related to helicopters and the PRC's only dedicated academic department for helicopter research. Over 80% of technical backbone and management personnel in the helicopter field in China studied at NUAA. The AECC 608th RI, founded in 1968, is the PRC's primary institute for research into helicopter engines and transmissions.[619] [620] [621] [622]

Further Information:

- The lab has subordinate labs for High Power Density Gearing [高功率密度齿轮传动], Friction and Lubrication [摩擦与润滑], Intelligent Manufacturing [智能制造], Precision Machining [精密机械加工], and Additive Manufacturing [增材制造].[623]

Research Direction:

1. High power density gear transmission technology [高功率密度齿轮传动技术]
2. Friction and lubrication technology [摩擦与润滑技术]
3. New transmission configurations and new materials for gear transmissions [新型传动结构及新材料齿轮传动技术][624]

Notable Applications:

- This lab is probably still too new to have seen its research applied to many projects, but its official introduction made clear that it is dedicated to helping create a new generation of advanced helicopters. It is thus likely that this lab will have a hand in any future (post 2018) PRC military helicopter projects.

Leadership and Key Personnel:

- Director: Zhu Rupeng [朱如鹏][625]
- Academic Committee Director: Yin Zeyong [尹泽勇][626]

- Deputy Directors: Zhu Di [朱荻]; Nie Meijun [廖梅军][627]
    - CAS Academician.

Notable Collaborations:

Domestic

None Found

International

None Found

Lab Equipment:

No Information

Address:

The likeliest address is in Building A6, NUAA Minggugong Campus, No. 29 Yudao Street, Qinzhun District, Nanjing, Jiangsu Province [江苏省南京市御道街 29 号][628] [629]

Website:

http://cmee.nuaa.edu.cn/2019/1220/c11625a190575/page.htm

Known Aliases:

- National Key Laboratory of Science and Technology on Helicopter Transmission [直升机传动技术国家级重点实验室]

24. Defense S&T Key Laboratory of High-Energy Beam Processing Technology

Official English Name: Laboratory for High Energy Density Beam Processing Technology[630]

Chinese Name: 高能束流加工技术国防科技重点实验室

Research Field: Aerospace – Aircraft (*Also: Space Vehicles*) – Manufacturing (*Also: Laser Technologies, Materials, Plasma Technologies, Propulsion*)

Affiliations:

- Aviation Industry Corporation of China (AVIC) [中国航空工业集团]
    - Manufacturing Technology Institute (MTI) [制造技术研究院]
        - *(a.k.a. AVIC Manufacturing Institute [制造院])*

Key Data:

- Established: 1993
- Total Funding: Unknown
- Personnel: Unknown[631]
- Official start of operations: 1996
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of High-Energy Beam Processing Technology conducts research into advanced manufacturing techniques for new materials used in aircraft, aerospace, electronics, armaments, and other defense products. This includes new technologies for processing, welding, hole making, cutting, coating, and surface modification.[632]

The lab's parent institution, the Beijing Aeronautical Manufacturing Technology Research Institute (BAMTRI) [北京航空制造工程研究所] (a.k.a. the AVIC 625th RI), was reconstituted into the AVIC Manufacturing Technology Institute (MTI) in 2016. MTI specializes in advanced manufacturing for aviation and national defense, with a focus on aviation materials, manufacturing process technologies, and specialized equipment for the PRC's new aircraft, aero-engines, missiles, and other aviation equipment. MTI also provides advanced manufacturing technology for aerospace, electronics, armaments, shipping, and other national defense industries. It is on the U.S. Commerce Department Entity List for export control.[633] [634]

Further Information:

- As of 2019, the lab has undertaken a total of 135 topics related to national and national defense missions [担国家任务、国防任务等各类课题].[635]

Research Direction:

1. High-energy beam processability and process optimization technology for new materials and difficult-to-process materials [新型材料及难加工材料高能束流可加工性及工艺优化技术]
2. New processing methods and key process equipment for laser beams, electron beams, and plasma beams with new structures [新结构的激光束、电子束、等离子束的新加工方法及关键工艺装备]

3. Improving high-energy beam source performance, processing control, and quality monitoring technology [提高高能束流束源性能及加工过程控制和质量监控技术][636]

Other Notable Research areas:

- High-energy beam current processing technology
- High-energy beam welding technology
- High-energy beam surface engineering technology
- High-energy beam rapid manufacturing technology[637]

Notable Applications:

- The lab has developed special equipment for high-energy beam processing, which have been widely used in aviation, aerospace, electronics, armaments and other defense and civil industries. This includes equipment for laser welding and cutting, laser hole making, (vacuum) electron beam welding, thermal spraying, ion implantation, abrasive flow processing/abrasive flow machine tools, and powder feeders.[638] [639]
- This lab developed a high-temperature wearable coating for an aero-engine turbine outer ring, a key component. for aero-engine gas circuit sealing[640]
- The lab developed a laser/electron beam precision additive forming for aerospace equipment.[641]
- This lab has made breakthroughs in aircraft and rocket engine laser-selective and electron beam-selective melting and forming of complex structures.[642]

Leadership and Key Personnel:

- Director: Li Zhiqiang [李志强][643]
  - Also President of AVIC MTI
- Deputy Director: Gong Shuili [巩水利][644]

Key Personnel:

- Guan Qiao [关桥][645]
  - CAE Academician.

Notable Collaborations:

Domestic

- Per a search of two scientific databases, this lab has collaborated on materials research with numerous PLAAF institutions, including the PLAAF Beijing Military Representative Office (on alloys and welding technology for gas turbines and aero-engines), the PLAAF

Equipment Department, Air Force Aviation University, and the PLAAF Shenyang Aircraft Corporation Military Representative Office.

- This lab has collaborated with numerous defense industry partners, including X'an Aero Engine Group, Chengdu Aircraft Industry Co., Shenyang Liming Aero Engine Co., Harbin Dong'an Engine Co, Shaanxi Aircraft Industry Group Corporation], Guizhou Liyang Machinery Factory, CASC wst Academy (a.k.a. CALT), CASIC 3rd Academy, Dongfang Steam Turbine Co., and Norinco 52nd Research Institution.[646]

International

- This lab has hosted most or all iterations of the International Conference on Power Beam Processing Technologies (ICPBPT) [高能束流加工技术国际学术会议] with The Welding Institute (TWI) of the U.K., with various international participants from the University of Nebraska – Lincoln in the U.S., Royal Academy of Engineering and Manchester University in the U.K., Toshiba Corporation in Japan, and others from Germany, Korea, and Ukraine.[647]

Lab Equipment:

- The lab's high-energy beam processing equipment includes:[xxxv]
    - Laser processing technology for laser drilling, laser welding, and laser cutting, including CNC laser machines.
    - Electron beam processing technology for electron beam brazing, electron beam welding, electron beam surfi-sculpting, electron beam freeform fabrication, and electron beam melting, including electron beam welders.
    - Electron guns
    - Electron beam processing power supply
    - Plasma processing technology, including spray systems and power feeders, air spray pump shell, plasma spray ingot plate, and plasma spray high speed robots
    - Microwave plasma omni-directional ion implantation and deposition equipment.[648]
- Other equipment/processes include:
    - Laser direct deposition for damage repair of integral impellers
    - Electron beam fusion deposition of titanium alloy structural parts
    - Ion coating equipment
    - Laser shock peening equipment
    - Dual beam laser welding equipment
    - Additive manufacturing parts[649] [650]

[xxxv] Further technical details and photos of much of this equipment is available upon request.

Address:

No. 1 Chaoyang Road, Chaoyang District, Beijing [北京市朝阳区朝阳路 1 号][651]

Website:

https://web.archive.org/web/20210121070642/https://www.avicmti.avic.com/gxwm/xfbs/cdsys/index.shtml

Known Aliases:

- National Key Laboratory for High-Energy Beam Processing Technology [高能束流加工技术国家级重点实验室]
- Key Laboratory for High-Energy Beam Processing Technology [高能束流加工技术重点实验室]
- Laboratory for High Energy Density Beam Processing Technology [高能束流加工技术研究室]
- State Key Laboratory of High-Energy Beam Processing Technology
- Science and Technology on Power Beam Processes Laboratory

25. Defense S&T Key Laboratory of High-Power Microwave Technology

Official English Name: Unknown

Chinese Name: 高功率微波技术国防科技重点实验室

Research Field: Multi-domain (Aerospace, Ground, Maritime) – Electronic Warfare – Electromagnetics

Affiliations:

- China Academy of Engineering Physics (CAEP) [中国工程物理研究院]
    - Institute of Applied Electronics [应用电子学研究所]

Key Data:

- Established: Unknown
- Total Funding: Unknown
- Personnel: Unknown
- Official start of operations: Unknown
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of High-Power Microwave Technology conducts research into high-power microwave systems, including microwave emissions, reception, transmission, and control, toward the development of both EMP weaponry and shielding.[652]

The lab's parent institution, the Institute of Applied Electronics, is under the Chinese Academy of Engineering Physics (CAEP), which is the primary institution tasked with the PRC's nuclear weapons development. The Institute of Applied Electronics conducts research into technologies and equipment related to lasers, microwaves, complex electromagnetic environments, free electronic lasers, terahertz spectrum technology, and radiation imaging.[653]

Further Information:

- The Northwest Institute of Nuclear Technology (NINT) [西北核技术研究所] also hosts a National Key Laboratory of High-Power Microwave Technology [高功率微波技术国家级重点实验]. Despite having the same name, there is no evidence the two labs are connected. NINT is likely also subordinate to PLASSF Base 21 (Unit 63650) in Malan, Xinjiang, meaning this second lab is subordinate to the PLASSF.[654] [655]

Research Direction:

1. High-power microwave source technology [高功率微波源技术]
2. High-power microwave emission and reception technology [高功率微波发射与接收技术]
3. High-power microwave transmission and control technology [高功率微波传输与控制技术]
4. High-power microwave protection technology [高功率微波防护技术]

Notable Applications:

- This lab (or possibly its NINT counterpart of the same name) is allegedly developing a new conventional EMP munition [电磁脉冲武器] which destroys local electronic signals, eliminating all enemy combat capabilities which rely on these signals. It is specifically advertised for its ability to knock out a U.S. carrier battle group. This research was conducted in collaboration with Hunan Vanguard Group [湖南云箭集团], which is designing munitions for the J-20. This new EMP munition may be employed by the J-20.[656]
- This lab (or possibly its NINT counterpart of the same name) is also allegedly involved in the development of the WB-1 ground-based microwave weapon. This weapon can reportedly be used against both humans (causing immense but non-lethal pain) or

electronics at ranges of up to 1 km. It can be used for riot control, or at sea to enforce maritime claims in the South and East China Seas. As with its airborne EMP munitions, the lab is collaborating with Hunan Yunjian Group.[657]

Leadership and Key Personnel:

- Director: Unknown

Key Personnel

- One source lists eight lab personnel on a research team. They are: Xu Zhou [许州], Meng Fanbao [孟凡宝], Jin Xiao [金晓], Ma Hongge [马弘舸], Deng Jianjun [邓建军], Chang Anbi [常安碧], Xie Weiping [谢卫平], Hu Jinguang [胡进光][658]

Notable Collaborations:

Domestic

- Collaboration with Hunan Yunjian Group [湖南云箭集团] on a new conventional EMP weapon which would be employed by the J-20, as well as on the WB-1 ground-based microwave weapon (see above).
- Likely military sources of collaboration include the Institute of High-Power Microwave Technology [高功率微波技术研究所] at the National University of Defense Technology, the Key Laboratory of High-Power Microwave Technology at the Northwest Institute of Nuclear Technology, which is subordinate to PLASSF Base 21, and the PLASSF Information Engineering University.[659]
- In 2017, this lab co-hosted the 5th National Pulsed Power Conference [第五届全国脉冲功率会议]. Among the attendees were personnel from the National University of Defense Technology.[660]

International

- None found

Lab Equipment:

- Unknown

Address:

No. 64 Mianshan Road, Youxian District, Mianyang, Sichuan Province [四川省绵阳市游仙区绵山路 64 号][661]

Website:

None Found

Known Aliases:

- Key Laboratory of High-Power Microwave Technology [高功率微波技术重点实验室]
- Science and Technology on High Power Microwave Laboratory

26. Defense S&T Key Laboratory of High-Power Microwave Vacuum Electronic Component Technology

Official English Name: Unknown

Chinese Name: 大功率微波电真空器件技术国防科技重点实验室

Research Field: Aerospace – Radar – Electromagnetics (*Also: Microwave Technologies, Millimeter Wave Technologies, Terahertz Technologies*)

Affiliations:

- University of Electronic Science and Technology of China (UESTC) [电子科技大学]
  - School of Physical Electronics [电子科技大学物理电子学院][xxxvi]
- China Electronics Technology Group Corporation (CETC) [中国电子科技集团]
  - 12th Research Institute [12 研究所]

Key Data:

- Established: 1992
- Total Funding: Unknown
- Personnel: 27 (UESTC only)[662 663]
- Official start of operations: 1998
- Floor Space: 4,320 sqm (UESTC only)

Lab Overview:

The Defense S&T Key Laboratory of High-Power Microwave Electronic Vacuum Component Technology was established with the goal of accelerating R&D of high-power

[xxxvi] May now be known as the School of Physics. See "School of Physics," UESTC, 1 January 2022. https://en.uestc.edu.cn/info/1015/1403.htm

microwave, millimeter wave, and electronic vacuum devices required for the creation of advanced electronic equipment.[664]

Beginning in the 1990s, there was a growing realization that semiconductors, which had replaced vacuum tube technology beginning in the 1960s, were not always able to meet the growing demands placed on high-precision radars. Researchers thus began looking at high-power microwave electronic vacuum technology for future military radars, electronic warfare, directed energy weapons, and space communications.[665]

The lab was expanded and upgraded (possibly to its current status as a Defense S&T Key Lab) in 2005. It has branches in Beijing (under the 12th RI, responsible for manufacturing and tube production) and Chengdu (Under UESTC, responsible for basic theoretical research, key technology breakthroughs, and personnel training). The Beijing branch serves as the main headquarters.[666] [667]

UESTC is the top university in China for specialized research into these technologies, and claims to be the only university in China capable of conducting high level research and computer simulations on high-power microwave and millimeter-wave devices via both cold and thermal testing. The CETC 12th RI was established in 1957 and is focused on microwave electronic vacuum devices for both military and civilian products. [668] [669] [670]

Further Information:

- The lab received an initial investment of 2m RMB in research funds. It was expanded and improved in 2004 and 2008, and its mission expanded into the research of high-power microwave devices, micro-vacuum electronics, microwave and millimeter wave sources, new cathodes and their applications in microwave tubes, and research of new materials and processes in the application of microwave tubes.[671] [672]
- During the 11th Five Year Plan (2006-2010), this lab was tasked with building new high-power microwave, millimeter wave, and short millimeter wave research platforms, terahertz wave spectral analysis systems and signal detection platforms, exploring theories for new electromagnetic materials and new radiation mechanisms based on new millimeter wave cyclotron devices, and designing methods to lay a foundation for the application of new technologies in the terahertz spectrum frequency.[673]

Research Direction:

1. Theories and technology for high-power microwave and millimeter wave devices [大功率微波毫米波器件的理论和技术]
2. Theories, technologies, and devices for micro-vacuum electronics [微真空电子学的理论，技术和器件]

3. High-power microwave and millimeter wave sources [大功率微波毫米波源的理论，技术，器件和应用]
4. High-emission density and long-life cathodes, field emission array cathodes, and other new cathodes and their applications [高发射密度和长寿命阴极，场发射阵列阴极，其他新型阴极及其应用]
5. Applications for new microwave tube materials and processes [新材料，新工艺在微波管中的应用研究][674]

Other Notable Research areas:

- Space traveling wave tubes and cesium beam tubes
- Millimeter wave traveling wave tubes (Ka-band and W-band)
- Terahertz vacuum radiation sources
- Microfabrication technology (DRIE and LIGA)
- Vacuum micro and nanoelectronics
- High-power cyclotron devices
- Microwave tube CAD
- High current density cathodes
- Microwave power modules
- CVD diamonds
- High-power devices and micro processing technology of electronic vacuum devices[675] [676]

Notable Applications:

- This lab, and in particular Liu Shenggang and his team, made critical advances toward producing superior millimeter-wave radars, particularly in the development of the PRC's first domestically-produced cyclotron, which is critical for millimeter wave radar. Liu Shenggang's team also developed the world's first dual-band cyclotron, which allows high-power millimeter-wave radar and electronic jamming systems to work simultaneously in multiple millimeter-wave bands. Millimeter wave technology is a key tech for rendering stealth aircraft visible to radar. Millimeter wave devices can also be used for secure communications and large-scale wireless data transmission. The JY-27 anti-stealth radar utilizes this technology.[677] [678] [679]
- The lab has also been involved in the development of terahertz radar, another key technology for defeating stealth that the PRC has been developing. The PLA view terahertz technologies as a critical component of electronic warfare.[680] [681] [682] [683]
- In recent years, the lab has developed the first W-band pulsed and continuous wave traveling wave tubes in China, the first Ka-band space traveling wave tube in China, the first millimeter wave space traveling wave tube with a whole-tube efficiency over 50% in China, the first Ka-band cyclotron traveling wave tube in China, and the first 220GHz cyclotron tube in China.[684]

Leadership and Key Personnel:

- Director: Yan Tiechang [闫铁昌][685]
- Deputy Directors: Cai Jun [蔡军]; Gong Yubin [宫玉彬][686]
    - Cai Jun also serves as Director of the lab's Beijing Branch.
    - Gong Yubin also serves as Director of the lab's Chengdu Branch.

Key Personnel:

- Liu Shenggang [刘盛纲][687] [688] [689]
    - Academician and major influence in this lab's founding and work, known as the "Father of Vacuum Electronics in China."
    - Developed PRC's first domestically-produced cyclotron, which was a critical component in the development of millimeter wave radars.
    - Founded the High Energy Electronics Research Institute [高能电子学研究所].

Notable Collaborations:

Domestic

- This lab's annual academic conference in December 2016 featured representatives from the CETC 12th and 14th RIs (the 14th RI being a major institute for military radar research), the Nanjing 772 Factory [南京 772 厂], the CAS Institute of Electronics [中科院电子所], and the Chengdu 776 Factory [成都 776 厂].[690]
- This lab may be associated with the CETC 12th RI's Vacuum Company [真空公司], also known as the Beijing Vacuum Electronic Technology Co. [北京真空电子科技总公司].[691] [692] [693]

International

None Found

Lab Equipment:

- This lab has 22.4m RMB of fixed assets and 18.2m RMB of equipment.[694]
- The 12th RI is equipped with a domestically-produced 18-40G Power Amplifier-RS103,200V/m Test [18-40G 功率放大器-RS103,200V/m 测试]. It has a series of microwave power amplifiers in different frequency bands, covering frequencies from 1 to 100GHz, with continuous wave output power from tens to hundreds of watts and pulse output power from hundreds of watts to tens of kilowatts, forming a multi-series microwave power amplifier product used in various experiments, tests, industrial

chemicals, scientific research, communications, and other fields. These include TA-K-50/100/150C01A (18 to 26.5GHz 50/100/150W) and TA-Ka-40/100/150C01A (26.5 to 40GHz 40/100/150W). It is also equipped with at least 10 pulse amplifiers: 1. TA-C-800P01A (4-8GHz 800W); 2. TA-CKu-2kP01A (6-18GHz 2000W); 3. TA-X-8kP01A (8-10GHz 8000W); 4. TA-X-4k/6kP01A (8-11GHz 4000/6000W); 5. TA-Ku-700P01A (14-17GHz 700W); 6. TA-Ka-600/800/1kP01A; 7. (26.5-40GHz(1G) 600/800/1000W); 8. TA-W-150P01A (80-100GHz（4G）150W); 9. TA-CKu200/X1kCP01A; 10. (6 to 18GHz 200W and X（1GHz）1000W). These are manufactured by Beijing Jiazhao Huaming Electronic Technology Co. [北京嘉兆华明电子科技有限公司].[695]

Address:

Possibly co-located with UESTC at No. 4 Section 2 Jianshe North Road, Chengdu, Sichuan Province [四川省成都市建设北路二段四号] and the 12th RI in Zhongguancun, Haidian District, Beijing [北京市海淀区中关村]

Website:

None Found

Known Aliases:

- Key Laboratory of High-Power Vacuum Electronic Technology [大功率微波电真空器件技术重点实验室]
- National Key Laboratory of Microwave Vacuum Electronic Technology [微波电真空器件国家级重点实验室]
- Vacuum Electronics National Laboratory
- National Key Laboratory of High-Power Vacuum Electronics
- National Laboratory of Vacuum Electronics

27. Defense S&T Key Laboratory of High-Power Semiconductor Lasers

Official English Name: Unknown

Chinese Name: 高功率半导体激光国防科技重点实验室

Research Field: Multi-Domain (Aerospace, Ground) – Semiconductors (*Also: Munitions*) – Semiconductors (*Also: GNC, Materials, Laser Technologies, Optoelectronics*)

Affiliations:

- Changchun University of Science and Technology (CUST) [长春理工大学]
  - School of Opto-Electronic Engineering [光电工程学院]

Key Data:

- Established: 1994
- Total Funding: Unknown
- Personnel: 36[696] [697]
- Official start of operations: 1997
- Floor Space: >=5,900 sqm

Lab Overview:

The Defense S&T Key Laboratory of High-Power Semiconductor Lasers conducts research into high-power semiconductor laser physics, including for new semiconductor and laser materials and devices. Its research has been applied to a variety of areas, including guidance systems and smart munitions.

Further Information:

- The lab has subordinate research offices for Semiconductor Materials [半导体材料研究室], Opto-Electronics [光电子器件研究室], and Opto-Electronic Technology Applications [光电子技术应用研究室], as well as a Semiconductor Process Research Platform [半导体工艺研究平台].[698]
- The lab's academic committee [学术委员会] has members from a variety of other state, defense, and industry research institutes, including the former PLA GSD 54th RI (now part of the PLASSF) [原总参 54 所], the CAS Institute of Semiconductors [中科院半导体研究所], the CAS Suzhou Institute of Nano-Tech and Nano-Bionics (SINANO) [中科院苏州纳米所], Norinco's 209th RI [兵器 209 所], CETC's 11th RI [中电 11 所], and CASC's China Academy of Aerospace Electronics Technology [中国航天电子技术研究所].[699]

Research Direction:

1. High-power semiconductor laser active materials and physical properties [高功率半导体激光器有源材料及其物性]
2. High power semiconductor laser devices and their model optimization design [高功率半导体激光器件及其模型优化设计]
3. High power semiconductor laser device process and evaluation methods [高功率半导体激光器件工艺及其评价方法]

4. High power semiconductor laser output properties and testing [高功率半导体激光器输出特性及测试][700]

Other Notable Research Areas:

- Epitaxial growth theory and technology of gallium antimonide (GaSb) materials[701]

Notable Applications:

- The beam-riding guidance semiconductor laser transmitter [驾束制导半导体激光发射器] developed by this lab was successfully used in the PLA's active main battle tank weapon system.[702]
- A laser sensor component [激光敏感器组件] developed by this lab has been used in a certain model of PLAAF terminal sensitive submunition (appears to be a type of smart munition) [空军某型号末敏子弹药] and will be utilized by multiple weapons platforms.[703]
- In terms of semiconductor laser research, the lab has developed semiconductor laser single tubes [半导体激光器单管] with output power of over 10 watts, and fiber coupling modules [光纤耦合模块] greater than 100 watts. Its high-frequency modulation [高频调制], pulse output [脉冲输出] and other semiconductor laser components [半导体激光器组件] are at the leading level for China.[704]

Leadership and Key Personnel:

- Director: Ma Xiaohui [马晓辉][705]
- Academic Committee Director: Wang Lijun [王立军][706]
- Deputy Directors: Wei Zhipeng [魏志鹏]; Zou Yonggang [邹永刚][707] [708]
  - Zou Yonggang was a visiting scholar at UCLA in 2013-2014.

Notable Collaborations:

Domestic

- The lab has published several articles with the PLA GAD Armored Forces Changchun Region Military Representative Office [总装备部装甲兵驻长春地区军事代表室].[709]

International

- In 2015, the lab co-hosted, along with several other institutions including the Harbin Institute of Technology and the North China Research Institute of Electro-Optics (NCRIEO) [华北光电技术研究所固体激光技术重点实验室] (a.k.a. the CETC 11th RI), an

International Conference on opto-electronics and Microelectronics [光电子与微电子国际学术会议] at CUST. The conference had over 200 participants from multiple countries and regions and was supported by the NSFC, the Chinese Society for Optical Engineering [中国光学工程学会], and the U.S.-based Institute of Electrical and Electronics Engineers (IEEE) Electron Devices Society's (EDS) Harbin branch [美国 IEEE-EDS 哈尔滨分会].[710]

- The lab's website mentions collaborations with domestic and foreign schools as well as international meetings without providing further details.[711]

Lab Equipment:

- The lab has a total of 120 million RMB worth of equipment and assets [设备资产].[712]
- The lab's equipment includes:
    - MBE (molecular-beam epitaxy), MOCVD (metal organic chemical vapor deposition) and other advanced semiconductor material epitaxial growth equipment [半导体材料外延生长设备]
    - SEM (scanning electron microscope)
    - XRD (X-ray diffraction?), PL (photoluminescence) and other complete material analysis and testing methods [完善的材料分析检测手段]
    - Electron beam evaporation, magnetron sputtering, chip cleavage, placement, laser welding, parallel sealing welding, comprehensive testing, and other process equipment [电子束蒸发、磁控溅射、芯片解理、贴片、激光焊接、平行封焊、综合测试等工艺设备][713]
- The lab has a scientific research and office floor space of 3,800 square meters, a clean (bench) lab [超净实验室] floorspace of 1,500 square meters, and a production & development platform [生产开发平台] with 600 square meters of floorspace, with 200 of which being clean (bench) lab [超净实验室] floorspace.[714]

Address:

A209, Science and Technology Building, No. 7186 Weixing Road, Changchun, Jilin Province [吉林省长春市卫星路 7186 号科技大厦 A209][715]

Website:

https://web.archive.org/web/20190913190700/http://hpld.cust.edu.cn/

https://web.archive.org/web/20210328205429/http://hpld.cust.edu.cn/index.htm

Known Aliases:

- State Key Laboratory of High Power Semiconductor Laser of Changchun University of Science and Technology
- State Key Laboratory on High-Power Semiconductor Lasers [高功率半导体激光国家重点实验室]
- National Key Laboratory on High Power Semiconductor Laser [高功率半导体激光国家级重点实验室]
- Key Laboratory on High Power Semiconductor Laser [高功率半导体激光重点实验室]
- Defense Key Laboratory on High Power Semiconductor Laser [高功率半导体激光国防重点实验室]

28. Defense S&T Key Laboratory of Hydroacoustic Technology

Official English Name: National Key Laboratory of Underwater Acoustic Science and Technology[716]

Chinese Name: 水声技术国防科技重点实验室

Research Field: Maritime – Underwater Vehicles – Acoustics (*Also: Communications Technologies, Positioning, Sensing, Simulation & Modeling, Target Detection/Recognition*)

Affiliations:

- Harbin Engineering University (HEU) [哈尔滨工程大学]
    - College of Underwater Acoustic Engineering [水声工程学院]

Key Data:

- Established: 1993
- Total Funding: Unknown
- Personnel: 79[717] [718]
- Official start of operations: 1997
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Hydroacoustic Acoustic Technology conducts research on a variety of topics related to underwater acoustics, including underwater acoustic physics, communications, target detection and positioning, noise control and stealth, and transducer technology.

Further Information:

- This lab is currently (as of an unknown date, likely after 2017) responsible for 202 projects with total funding of 222.64M RMB. Between 2012-17 it undertook over 400 projects worth over 470m RMB. In recent years it has produced 428 PhD and 1265 Master's graduates.[719] [720]
- The School of Underwater Acoustic Engineering has at least nine subordinate research teams, most or all of which are led and staffed by personnel from this lab:
  - *Ocean Acoustics Research Team* [海洋声学研究团队] (501 Team)
    - Led by Yang Shi'e [杨士莪] and Pu Shengchun [朴胜春].
    - Engaged in research on ocean acoustics, hydroacoustic propagation, ocean environment noise field and reverberation field characteristics, submarine sediment layer acoustics, very low frequency remote sound detection, detection of weak signals in water, extraction and identification of target features in water, and array signal processing.
  - *Underwater Target Properties Testing and Control Research Team* [水中目标特性测试与控制技术团队] (502 Team)
    - Ten-member team led by Yang Desen [杨德森].
    - Research focus on naval acoustic frequency characteristics testing and control, vibration noise testing for submarines, torpedoes, and other underwater vehicles, noise source testing and identification, and underwater targeting.
    - Has carried out successful research in the areas of underwater structure excited vibration acoustic radiation mechanisms and prediction, vibration noise testing and analysis, noise source testing and identification, underwater target acquisition and analysis, and underwater vector acoustics.
    - Research funding of 100m RMB over the last ten years.
  - *Underwater Vibration and Noise Research Team* [水下振动噪声研究团队] (503 Team)
    - Ten member team led by Professors Li Qi [李琪] and Shang Dejiang [商德江].
    - Research on physical mechanisms of underwater noise sources and noise fields, as well as radiation, measurement, identification and control of underwater structure vibration noise.
    - Has made key progress in underwater complex sound source radiation and sound power measurements based on reverberation methods, propeller acoustic shield design, acoustic insulation performance testing, and others.
  - *Hydroacoustic Transducer Research Team* [水声换能器研究团队] (504 Team)
    - Five member team led by Professor Lan Yu [蓝宇].
    - Research on hydroacoustic transducer and base arrays, underwater acoustic systems, acoustic sensors and acoustic finite element analysis.

- *Hydroacoustic Positioning and Target Detection Research Team* [水声定位与目标探测研究团队] (505 Team)
    - At least 15 member team led by Professor Liang Guolong [梁国龙].
    - Research on hydroacoustic detection, positioning, navigation, countermeasures, signal processing, unmanned acoustic systems, and imaging sonar.
    - Developed the first set of unmanned passive detection sonars and the first set of three-dimensional imaging sonars in China.
    - This team's hydroacoustic positioning, navigation and underwater measurement equipment has been incorporated into almost all new models of torpedoes, mines and submarines in China.
- *Seafloor Target Characterization Detection Research Team* [海底目标特性探测研究团队] (506 Team)
    - At least eight member team led by Professor Li Haisen [李海森].
    - Research on acoustic remote sensing of underwater spatial environments, information and sensitive target characteristics, detection of seafloor topography and geomorphology, underwater target localization, and imaging and information transmission.
    - Applications include ocean mapping, marine fisheries, and oil pipeline detection.
- *Hydroacoustic Communication and Network Technology Research Team* (507 Team)
    - Led by Professor Qiao Gang.
    - Research on hydroacoustic communications and networks, hydroacoustic detection, hydroacoustic positioning, hydroacoustic OFDM high-speed communications, spread spectrum communications, bionic communications, digital voice communications, hydroacoustic communications network technology, bionic detection, and distributed positioning.
- *Deep Sea Underwater Information Technology Research Team* [深海水下信息技术研究团队] (508 Team)
    - 18 member team led by Professor Sun Dajun [孙大军].
    - Research on deep-sea hydroacoustic positioning and navigation, deep-sea hydroacoustic detection, and deep-sea remote hydroacoustic communications networking.
    - Applications include deep-sea resource investigation, scientific research, oil and gas resources development, and national defense.
    - Has aided in development of PRC's deep sea submersibles, including the Jiaolong and cable-controlled submersible Sea Dragon. and deep-sea underwater acoustic tugs.
    - Currently working on ten projects worth over 60m RMB.

    - *Polar Acoustics and Simulation Technology Research Team* (509 Team)
        - Seven member team led by professor Yin Jingwei [殷敬伟].
        - Research on hydroacoustic technology in polar environments, hydroacoustic physics in complex propagation media, environmental cognitive hydroacoustic communications, multidimensional information perception of underwater targets, high performance simulation of hydroacoustic systems, and underwater measurement and analysis equipment.[721]
- In 2017, this lab received 200 million RMB in funding for facilities maintenance, underwater acoustic technology funding, key laboratory development and improvement funding, and acoustic stealth project funding. It has constructed an underwater acoustic experimental complex building and updated all fundamental experimental facilities and most of its experimental equipment.[722]
- The Underwater Acoustics Engineering College put out a promotional music video, "Underwater Acoustics Await You!" which features shots of the inside of the college building. It can be found at https://www.bilibili.com/video/av55647544/.

Research Direction:

1. Underwater acoustic physics
2. Underwater acoustic target detection and positioning
3. Underwater acoustic transducer technology
4. Underwater acoustic communications technology[723]

Other Notable Research areas:

- Underwater target noise control technology
- Remote target detection technology
- Vector array underwater early warning technology
- Reverberation-based radiation noise measurement technology
- Underwater Beidou acoustic positioning technology
- Bionic camouflage underwater acoustic communications technology
- Polar acoustic technology[724]

Notable Applications:

- This lab has been involved with development of hydroacoustic positioning, navigation, and measurements technologies for underwater warfare, including for submarines, torpedoes, and mines.[725]
- This lab is also involved in other research with strategic significance, including Polar research and underwater stealth technology.

- This lab was involved in development of the Jiaolong [蛟龙] and Hailong [海龙] deep-sea submersibles.[726] [727]

Leadership and Key Personnel:

- Director: Pu Shengchun [朴胜春][728]

Key personnel:

- Yang Desen [杨德森][729]
  - Leading PRC scholar in underwater acoustics, with expertise in Sonar and underwater vehicle stealth.
  - Member of PLA GAD Submarine Vibration and Noise Reduction Technology Specialist Team [解放军总装备部潜艇减振降噪技术专业组] and PLAN Equipment Department Underwater Target Properties and Transmission Technology Team [解放军海军装备部水中目标特性与传输技术组].
  - Visiting Scholar at Woods Hole Oceanographic Institution in the United Station in 1998-99.
- Sun Dajun [孙大军]:[730]
  - Former Director of this lab.
  - Specializes in underwater positioning, navigation, communications, sensing, and underwater information support technology, with breakthroughs in high-precision underwater acoustics positioning.
  - Involved in development of SOA research vessels Xuezhe 1, Dayang 1, and Xiangyang 9, as well as Jialong deep-sea submersible.
- Shang Dejiang [商德江][731]
  - Specializes in underwater acoustic signal paths and sonar system environments, underwater acoustic target sensing and positioning, and stealth technology.
  - Conducted research at Auburn University in 2010.

Notable Collaborations:

Domestic

- Underwater Target Properties Testing and Control Research Team [水中目标特性测试与控制技术团队] (see above) is a joint effort between this lab and the Key Laboratory of Marine Information Acquisition and Security.[732]
- This lab has taken a leading role in several conferences with strategic significance: In 2017, it co-hosted a conference on acoustics with the Acoustical Society of China [中国声学学会] and Harbin Engineering University (HEU), in which speakers talked about the creation of a blue-water navy and the importance of acoustics to China's underwater security. In

2019, it co-sponsored another conference on Oceanic Information Technology and Equipment, with HEU and the HEU Key Laboratory of Marine Information Acquisition and Security, which was attended by PLAN personnel.[733] [734]

International

- This lab co-sponsored, along with five other acoustics key labs, the 2016 IEEE Oceanic Engineering Society China Marine Acoustics Symposium [IEEE/OES 中国海洋声学研讨会], which featured participation of both foreign and domestic experts. The six key labs involved in hosting this event were the Key Labs of Underwater Acoustic Technology, Underwater Acoustic Countermeasures, Underwater Measurement and Control Technology, Acoustic Fields and Acoustic Information, and Ship Vibration and Noise. The event was held in Harbin and co-hosted by Harbin Engineering University and the Belgian university Université Libre de Bruxelles. The Chinese language announcement for this symposium explicitly connects the hydroacoustic research of this symposium to the PRC's national strategy of becoming an oceanic power for economic development, national sovereignty, and military power. The event was the brainchild of Professor Yang Desen of this lab, and Jean-Pierre Hermand of Université Libre de Bruxelles. A similar conference was scheduled to be held in 2021.[735] [736]
- In April 2020, this lab co-hosted the International Forum of Ocean Information 2020 with HEU, the Key Laboratory of Marine Information Acquisition and Security, and the Heilongjiang Ocean Information Technology Key Laboratory. This international conference featured numerous researchers from North America and Europe. Research topics were civilian in nature, but some topics were potentially dual-use, including acoustic surveys of the American and Canadian west coasts, polar acoustic detection and communications, fiber-optic sensing, and mine hunting sonar.[737]
- Researchers from this lab collaborated on a 2017 Paper on underwater wireless sensor networks with researchers from University of Houston and Embry-Riddle Aeronautical University.[738]
- Researchers from this lab collaborated on a 2019 paper with Southampton University in the U.K.: "Simulation and experimental validation of near-range high-speed hydroacoustic millimeter wave communications" [近程高速水声毫米波通信仿真与试验验证].[739]
- As of 2013, the School of Underwater Acoustics Engineering to which this lab is subordinate claims to have undergraduate exchange programs with MIT, as well as with universities in France and Belgium. It is unclear if these programs are still extant, as HEU was placed on the U.S. Commerce Department Entity List for export control in 2020.[740] [741]

Lab Equipment:

- The lab has 3,034 pieces of equipment worth 138.14 million RMB.
- The underwater acoustic experimental complex building is a leading test site for underwater acoustics in China. Its equipment includes:

- Full frequency reverberation pool
- High frequency channel simulation pool (including high frequency acoustic anechoic pool)
- Low noise gravity water hole
- High pressure cans
- Reverberation chamber
- Sound-proof chamber, and other measurement chambers for aeroacoustics
- Truck-mounted crane with maximum load of 10 tons
- Overhead crane on top of the pools
- Corresponding experimental instruments[742]

Address:

Underwater Acoustics Building [水声楼] at Harbin Engineering University, No. 145 Nantong Road, Nangang District, Harbin, Heilongjiang Province [哈尔滨市南岗区南通大街 145 号][743]

Website:

webcache.googleusercontent.com/search?q=cache%3Auae.hrbeu.edu.cn%2Fen5%2F2017%2F1129%2Fc6266a174685%2Fpage.htm&rlz=1C1CHB

Known Aliases:

- Key Laboratory of Underwater Acoustic Technology [水声技术重点实验室]

29. Defense S&T Key Laboratory of Inertial Technology

Official English Name: Unknown

Chinese Name: 惯性技术国防科技重点实验室

Research Field: Aerospace – Space Vehicles (*Also: Ballistic Missiles, Non-ballistic Missiles*) – GNC

Affiliations:

- Beihang University [北京航空航天大学]
    - School of Instrumentation and Optoelectronic Engineering [仪器科学与光电工程学院]
- China Aerospace Science and Industry Corporation (CASIC) [中国航天科工集团]

- 3rd Academy Beijing Automation & Control Equipment Institute [三院北京自动化控制设备研究所]
  - *(a.k.a. CASIC 33rd Research Institute [33 研究所])*

Key Data:

- Established: 2010
- Total Funding: Unknown
- Personnel: 101[xxxvii] [744] [745]
- Official start of operations: 2011
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Inertial Technology conducts research primarily into precision navigation and guidance instruments for aerospace, including satellites and missiles.

A previous incarnation of the lab, the Aviation Gyroscope and Inertial Navigation Research Office [航空陀螺及惯性导航"研究室], was established in the 1950s at the suggestion of Qian Xuesen, the "Father of Chinese Rocketry," to meet the inertial guidance needs of China's first nuclear bomb and satellite programs. It contributed significantly to China's early missile and aerospace programs.[746] [747]

Today, the lab is jointly administered by Beihang University's School of Instrumentation and Optoelectronic Engineering and CASIC's Beijing Automation & Control Equipment Institute (a.k.a. the CASIC 33rd RI). The 33rd RI is primarily tasked with R&D of missile inertial and control systems. It is on the U.S. Commerce Department Entity List for export control.[748]

Further Information:

- The lab is divided into two underground floors with ten functional laboratories.[749]

Research Direction:

No formal research direction found. Notable research areas include:

- Magnetic suspension/levitation
- Magnetic bearing
- Permanent magnetic synchronous motors
- Magnetic force
- Fiber optics/gyro
- (Strapdown) inertial navigation systems
- Accelerometers

[xxxvii] As of 2012

- Motors and rotors[750]

Notable Applications:

- In 2007, the lab developed new technologies for satellite attitude control and energy storage dual-purpose flywheel technology.[751]
- In 2008, the lab developed a small high-precision CMOS star sensor technology.[752]
- In 2009, the lab developed a new high-precision fiber optic gyroscope.[753]
- In 2013, a radiation-resistant, highly reliable fiber optic gyroscope combination developed by this lab was successfully launched with a satellite, and a multi-axis integrated fiber optic gyroscope prototype developed by the lab successfully completed a flight test mission.[754]
- The lab has made breakthroughs in many key technologies for small high-precision fiber optic gyroscopes for munitions, including significant progress in quartz/silicon MEMS gyroscopes, vibrating beam accelerometers, high-overload long-range MEMS inertial navigation, SERF atomic spin gyroscopes, nuclear magnetic resonance gyroscopes, and atomic interference gyroscopes. [755]
- The lab (or possibly its previous incarnation, or at least a team led by the lab's director) successfully researched magnetic levitation inertial flywheel technology, improving satellite lifespan and attitude stability control accuracy, and may have also successfully developed magnetic levitation control torque/moment gyroscopes.[756]

Leadership and Key Personnel:

- Director: Fang Jiancheng [房建成][757]
  - CAS Academician, Beihang Executive Vice President, and Director since lab's establishment.
  - GNC expert, with focus on spacecraft attitude control magnetic levitation inertial actuators and inertial navigation technology.
  - Director of Sino-U.K. Space Science & Technology Joint Laboratory [中英空间科学技术联合实验室] since its establishment in 2007.
  - Instructor at PLAN Submarine Academy conventional submarine department from 1988-1993.

Notable Collaborations:

Domestic

- Since 2015, this lab has had a Branch Office at CASC's 803rd Research Institute [航天803所分室], also known as the CASC 8th Academy Control Institute [中国航天科技集

团公司八院控制所] or the Shanghai Aerospace Control Technology Research Institute [上海航天控制技术研究所]).[758]

- The lab jointly founded Nanjing Shenwei Photoelectric Tech Research Institute Co. Ltd. [南京申威光电技术研究院] with the Nanjing Economic and Technological Development Zone Management Committee [京经济技术开发区管委会] and the Hunan Rate Control Technology Co., Ltd. [湖南率为控制科技有限公司]. This research institute works on intelligent perception, photoelectric reconnaissance, and unmanned driving technology with the aim of developing China's intelligent unmanned equipment, vehicle transport, and opto-electronic reconnaissance equipment for future military individual combat systems.[759]
- The lab also appears to be involved in Aviation Gyro (Beijing) Photoelectricity Technology Co., Ltd. [中航捷锐（北京）光电技术有限公司], a joint venture between Beihang and the AVIC 618th Research Institute [618 所] whose products are used in aerospace, shipping, armaments, electronics and other defense industries.[760]

International

- Despite being immersed in the PRC's military research system, lab Director Fang Jiancheng is also Director of the PRC Branch of the Joint Sino-U.K. Space Science & Technology Laboratory [中英空间科学技术联合实验室].[761]

Lab Equipment:

No Information

Address:

- Block B, New Main Building, Beihang University, No. 37 Xueyuan Road, Haidian District, Beijing [北京市海淀区学院路 37 号北京航空航天大学新主楼 B 座][762]

Website:

https://web.archive.org/web/20190521030532/http://yqgdxy.buaa.edu.cn/content.jsp?urltype=news.NewsContentUrl&wbtreeid=1089&wbnewsid=1824

Known Aliases:

- Inertial Technology Key Laboratory of National Defense Science and Technology
- National Key Laboratory of Inertial Technology [惯性技术国家级重点实验室]
- State Key Laboratory of Inertial Technology [惯性技术国家重点实验室]

- Key Laboratory of Inertial Technology [惯性技术重点实验室]

30. Defense S&T Key Laboratory of Lightweight, High-strength Structural Materials

Official English Name: State Key Laboratory for Light Weight and High Strength Structural Materials[763]

Chinese Name: 轻质高强结构材料国防科技重点实验室

Research Field: Aerospace – Multiple (Aircraft, Munitions, Space Vehicles) – Materials (*Also: Nuclear Technologies*)

Affiliations:

- Central South University (CSU) [中南大学]
  - Powder Metallurgy Research Institute [粉末冶金研究院]

Key Data:

- Established: 2005
- Total Funding: Unknown
- Personnel: Unknown[764 765]
- Official start of operations: 2016
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Lightweight, High-strength Structural Materials conducts research into lightweight structural materials for aviation and aerospace uses.[766]

The lab is subordinate to CSU's Powder Metallurgy Institute, which conducts research on (among other things) lightweight alloy materials which are widely used in aviation, aerospace, weapons, shipbuilding, electronics, the nuclear industry, and other industrial sectors.[767]

Further Information:

- There is another key lab with a very similar name - the Jiangxi Province Key Laboratory of Lightweight and High Strength Structural Materials [(江西省)轻质高强结构材料重点实验室] at Nanchang University. The two labs do not appear to be connected.

Research Direction:

No formal research direction available. Descriptions include work in materials science, material processing, material shaping and control (micro)structures, and performance control, processing, and forming of aluminum alloys or titanium alloys.[768]

Notable Applications:

- The lab's research has been applied to aircraft and aerospace equipment. No further details available.

Leadership and Key Personnel:

- Director: Liu Wensheng [刘文胜][769]
- Deputy Directors: Zhang Fuqin [张福勤]; Gan Xueping [甘雪萍][770] [771]

Notable Collaborations:

Domestic

- The lab has co-hosted (at least through the 2nd-6th iterations, from 2013-2019) the High-end Forum on Aerospace Engineering and High-Performance Materials Demand and Application [航天工程和高性能材料需求与应用高端论坛]. The main hosts have been the Chinese Materials Research Society [中国材料研究学会] and the Chinese Society of Astronautics [中国宇航学会]. CASC's China Academy of Space Technology (CAST) [中国空间技术研究院], which is responsible for designing and manufacturing China's satellites, has been a frequent co-host. CASC's 1st Academy 703rd RI has also co-hosted multiple times. This forum focuses on conducting academic exchanges on major aerospace engineering fields such as China's manned spaceflight, deep space exploration, Beidou satellite navigation, the Chang'e moon exploration program, satellites, and future aerospace development directions, as well as the application of high-performance new materials, new structures, integration of structural functions, and meeting demand for advanced manufacturing technologies and industrialization of aerospace materials.[772]

International

None Found

Lab Equipment:

No Information

Address:

No. 932 Lushan S. Road, Changsha City, Hunan Province [湖南省长沙市岳麓山(南路 932 号)][773]

Website:

None Found

Known Aliases:

- (Central South University) National Key Laboratory for High-strength Structural Materials [(中南大学)轻质高强结构材料国家(级)重点实验室]
- National Key Laboratory of Science and Technology for National Defence on High-strength Structural Materials [轻质高强结构材料(国家)重点实验室]
- National Key Laboratory of Science and Technology for National Defence on High-strength Lightweight Structural Materials
- Key Laboratory on High-strength Lightweight Structural Materials [轻质高强国防科技重点实验室]

31. Defense S&T Key Laboratory of Marine Corrosion and Protection

Official English Name: Key Laboratory of Marine Corrosion and Protection of Defense Science and Technology

Chinese Name: 海洋腐蚀与防护国防科技重点实验室

Research Field: Maritime – Surface Vessels – Materials (*Also: Shipbuilding*)

Affiliations:

- China State Shipbuilding Corporation (CSSC) [中国船舶集团]
  - Luoyang Ship Material Research Institute (LSMRI) [洛阳船舶材料研究所]
    - *(a.k.a. CSSC 725th Research Institute (Qingdao Branch) [725 研究所])*
    - *(a.k.a. (Qingdao) Sunrui Company [(青岛)双瑞公司])*

Key Data:

- Established: 1997
- Total Funding: Unknown
- Personnel: Unknown[774] [775] [776]
- Official start of operations: 2004
- Floor Space: approx. 3,400 sqm

Lab Overview:

The Defense S&T Key Laboratory of Marine Corrosion and Protection researches corrosion and corrosion defense for marine-environment materials. It is CSSC's primary institution for corrosion and protection testing.[777] [778]

This lab's parent institution, the CSSC Luoyang Ship Material Research Institute (LSMRI) specializes in ship materials and technology [舰船材料与工艺及] and has made important contributions to the development of naval weapons and equipment. It is on the U.S. Commerce Department Entity List for export control.[779] [780]

Further Information:

- The lab has several subordinate labs:[781]
    - *Marine Environment Simulation and Accelerated Corrosion Lab* [海洋环境模拟与加速腐蚀实验室]
    - *Coating Layer Performance Testing Lab* [涂覆层性能检测实验室]
    - *Biomaterials Technology Lab* [生物材料技术实验室]
    - *Public Basic Lab* [公共基础实验室]
    - *Corrosion Electrochemical Performance Testing Office* [腐蚀电化学性能测试室]
- The lab's original location (co-located with the 725th RI) was 3,200 square meters, but by 2015 it had moved into a new harbor laboratory [海港实验室] with a total area of 3,400 square meters. There is a Xijiang Science and Technology Exchange Center [西姜科技交流中心] at this location, which may be a possible alternate name for the lab.[782] [783] [784]
- The lab is also a/the China Shipbuilding Industry Corrosion and Protection Testing Station [中国船舶工业腐蚀与防护检测站] and China Classification Society's Marine Material Verification Test Center Corrosion and Protection Inspection Station.[785]

Research Direction:

1. Corrosion of materials in marine environments and modern corrosion test methods [材料在海洋环境中的腐蚀和现代腐蚀试验方法研究]
2. New electrochemical anti-corrosion and anti-fouling technologies [电化学防腐防污新技术研究]
3. Coating layer protection mechanisms and technology [涂覆层防护机理及技术研究]
4. Biological anti-corrosion and anti-fouling technology [生物防腐防污技术以及腐蚀控制工程基础研究]
5. Fundamentals of corrosion control engineering [腐蚀控制工程基础][786]

Notable Applications:

- This lab has developed marine anti-corrosive technologies for both surface vessels as well as various other materials in a marine environment, including shipboard ballast water treatment equipment, shipboard sewage treatment equipment, shipboard exhaust gas treatment equipment, marine concrete structures, and seawater desalinization plants.[787]

Leadership and Key Personnel:

- Director: Xu Likun [许立坤][788]
- Deputy Director: Sun Mingxian [孙明先][789]

Notable Collaborations:

Domestic

- Research collaboration with various PLA units and institutions on corrosion and anti-fouling, including PLASSF Unit 63796, PLAN Unit 91922, PLAN Luoyang 407 Factory Military Representative Office, and the PLAN Equipment Department.

International

- None Found

Lab Equipment:

- The lab has internationally-advanced corrosion test equipment and (large-scale) analysis and testing instruments, including:
    - Salt spray test chamber
    - Dynamic water simulation test device
    - Stress corrosion testing machine
    - Environmental scanning electron microscope (ESEM)
    - Scanning probe microscope (SPU)
    - X-ray diffractometer
    - Laser Raman spectrometer
    - Scanning Kelvin probe and corrosion electrochemical measurement systems[790]
- The lab has China's only actual-sea/seawater environmental testing web system [实海环境试验网站体系], with stations in Qingdao, Xiamen (Fujian Province), Sanya (Hainan Province), the "deep sea" (possibly the South China Sea), and possibly elsewhere.[791] [792] [793]

Address:

No. 8-5, Laoshan Road, Laoshan District, Qingdao, Shandong Province [山东省青岛市崂山区崂山路 8-5 号][794] [795]

Website:

None Found

Known Aliases:

- Corrosion and Protection Testing Institution [腐蚀与防护检测机构]
- Marine Material Testing and Verification Center [船舶材料检测与验证中心]
- Navy Ship Material Testing Center [海军舰船材料检测中心]
- Xijiang Science and Technology Exchange Center [西姜科技交流中心]
- Key Laboratory of Marine Corrosion and Protection [海洋腐蚀与防护重点实验室]
- State Key Laboratory for Marine Corrosion and Protection [海洋腐蚀与防护国家重点实验室]
- Defense Key Laboratory of Marine Corrosion and Protection Technology [海洋腐蚀与防护技术国防重点实验室]
- Key Laboratory of Marine Corrosion and Protection [海洋腐蚀与防护国防重点实验室]
- State S&T Key Laboratory of Marine Corrosion and Protection [海洋腐蚀与防护国家科技重点实验室]
- National Key Laboratory of Marine Corrosion and Protection [海洋腐蚀与防护国家级重点实验室]

32. Defense S&T Key Laboratory of Materials Technology in Impact Environments

Official English Name: National Key Laboratory of Science and Technology on Materials under Shock and Impact[796]

Chinese Name: 冲击环境材料技术国防科技重点实验室

Research Field: Multi-Domain (Aerospace, Ground, Maritime) – Munitions (*Also: Non-ballistic Missiles)* – Materials (*Also: Armor, Impact & Damage, Laster Technologies, Simulation & Modeling)*

Affiliations:

- Beijing Institute of Technology (BIT) [北京理工大学]
- (possibly) China Ordnance Industries Group Corporation (Norinco) [中国兵器工业集团]
  - Inner Mongolia Institute of Metal Materials [内蒙古金属材料研究所]
    - *(a.k.a. Norinco 52nd Research Institute [第五二研究所])*

Key Data:

- Established: Unknown
- Total Funding: over 80m RMB
- Personnel: over 40[797] [798] [799] [800]
- Official start of operations: 2011
- Floor Space: over 5,000 sqm

Lab Overview:

The Defense S&T Key Laboratory of Materials Technology in Impact Environments conducts research into new materials, with a focus on material damage and protection. Much of its work is on high-density, ultra high-strength and ductile high-entropy alloys, including nanostructures. Among its primary tasks are developing key structures and materials for warheads and protective materials for military use, as well as materials for armor-piercing ammunition, high-explosive anti-tank munitions, missiles, armor, and laser weapons.[801] [802] [803] [804]

The lab is overseen by the Beijing Institute of Technology, and possibly Norinco's Inner Mongolia Institute of Metal Materials (a.k.a. the Norinco 52nd RI) as well. While Norinco has a national key lab of the same name that is probably the same lab, no direct evidence connecting the two was found. BIT's other two Defense S&T Key Labs both have partnerships with Norinco entities. The 52nd RI is engaged in research of metal materials and process technology, including metal matrix composites and ceramic composites.[805] [806]

Further Information:

- This lab has five subordinate research labs:
  - Protective Materials and Composite Structures Lab [防护材料与复合结构研究室]
  - Destructive Materials and Munitions Mating Lab[xxxviii] [毁伤材料及弹药匹配研究室]
  - Simulation and Material Design Lab [模拟仿真与材料设计研究室]
  - Materials Testing and Characterization Lab [材料测试与表征研究室]
  - Operational Effectiveness Evaluation and Special Protection Lab [使用效能评估与特种防护研究室][807]

[xxxviii] Alternative translation: Destructive Materials and Munitions Compatibility Lab

- The lab has a subordinate "National Defense S&T Innovation Team of Material Damage and Protection" [毁伤与防护材料国防科技创新团队]. This appears to be a major source of the lab's research output. This team is designing new materials for warheads.[808 809]
- The lab hosts a National Materials Corrosion and Protection Data Center [国家材料腐蚀与防护科学数据中心].[810]

Research Direction:

No formal research direction was found, but the lab's five subordinate research labs give a good idea of the likely research direction:

1. Protective Materials and Composite Structures [防护材料与复合结构]
2. Destructive Materials and Munitions Mating/Compatibility [毁伤材料及弹药匹配]
3. Simulation and Material Design [模拟仿真与材料设计]
4. Materials Testing and Characterization [材料测试与表征]
5. Operational Effectiveness Evaluation and Special Protection [使用效能评估与特种防护][811]

A list of lab topics of research for 2020 included four categories:

1. Genomic and Big Data Technologies in the Field of Destructive and Protective Materials [毁伤与防护材料领域基因组与大数据相关技术]
2. New Multifunctional Destructive or Protective Materials Technology [新型多功能毁伤或防护材料技术]
3. Integrated Design Technology of Materials and Structures in the Field of High-Performance Destruction or Protection [高性能毁伤或防护领域的材料与结构一体化设计技术]
4. Material High Strain Rate Response Testing and Characterization or Simulation Technology [材料高应变率响应测试表征或模拟仿真技术][812]

Notable Applications:

- The National Defense S&T Innovation Team of Material Damage and Protection [毁伤与防护材料国防科技创新团队] under this lab develops unidentified armor-piercing materials, new multi-functional special destructive metamaterials [新型多功能特种毁伤元材料] and lightweight protective armor materials (a possible reference to the Type-15 light tank, which BIT was involved in designing).[813 814]
- This lab conducts research into new alloys and high entropy alloys for advanced weapons systems. A research team under this lab has utilized this research for new aerospace, weaponry, and shipbuilding mandated by national strategic requirements.[815]

- The lab has designed a nanostructure with a new strengthening mechanism that increases the strength of the alloy while maintaining ductility. The multi-alloy has stronger corrosion and oxidation resistance, making it an ideal material for protective coatings.[816]
- This lab developed a new titanium alloy material and its shaped parts, which is "urgently needed" to develop an unidentified new piece of equipment.[817]

Leadership and Key Personnel:

- Director: Li Shukui [李树奎][818]
- Academic Committee Director: Cai Hongnian [才鸿年][819]
    - CAE Academician.
- Deputy Director: Cheng Xingwang [程兴旺][820]

Key Personnel:

- Xue Yunfei [薛云飞][821]
    - Was a visiting Scholar at University of Michigan in the U.S.
    - Xue's team has been involved in creating new alloys for aerospace, weaponry, and shipbuilding.
- Wang Fuchi [王富耻]
    - Former Director. Also serves as head of the National Defense S&T Innovation Team of Material Damage and Protection.[822]

Notable Collaborations:

Domestic

- This lab is affiliated with the Norinco Yantai Research Institute (Norinco 52nd RI Yantai Branch), which is itself affiliated with the Shandong Province Metal Powder Materials and Application Engineering Technology Center [山东省金属粉体材料及应用工程技术中心] and the China and Russia New Materials Cooperation Research Center [山东省中俄新材料合作研究中心]. It specializes in vehicle armor protection, special ceramic materials, refractory metal materials, powder materials, and functional materials.[823]
- BIT and CASC signed a joint cooperation agreement in 2020 to deepen cooperation in a variety of areas, including AI, big data, software engineering, sensing, and communications networks. CASC representatives visited this lab prior to the signing, implying it may be involved in this cooperation.[824]
- This lab signed an agreement with Xiamen Tungsten Industry Co. [厦门钨业股份有限公司] in 2018 to produce a new titanium alloy for military use.[825]

International

- In 2012, a professor from the University of Michigan Additive Manufacturing Process Laboratory visited this lab and conducted discussions on furthering cooperation between the two labs.[826]
- This lab was a key organizer of the 2014 International Fall Conference on Experimental Mechanics and International Symposium on Strong Dynamic Loads and Their Effects [2014 年国际实验力学秋季会议暨国际强动载及其效应研讨会] in Beijing. The conference featured participants from 15 countries, including the U.S., Japan, Australia, Germany, France, Korea, etc. American speakers came from Purdue University, University of Rhode Island, NC State University, and Case Western Reserve University.[827]
- This lab also co-organized the 2018 International Symposium on Advanced Materials Research [2018 年先进材料研究国际研讨会], which featured scholars from multiple countries. U.S. scholars came from Princeton, Purdue, Northeastern, Utah University, and Akron University. Interestingly, a list of topics of interest for this conference listed "military-use materials," but a similar list of topics on the more prominent front page of the announcement does not include this.[828]
- In 2018, this lab and others at BIT invited a Professor University of California-San Diego to come speak.[829]
- At an unidentified date, a Professor from the German Ludwig Maximilians-Munchen University who was a member of the research team behind the world's first attosecond laser visited this lab. He also discussed long-term cooperation, including establishing a joint surface engineering lab with BIT and his university.[830]
- The lab was visited by a Professor of the French National Glass and Ceramics Lab, who lectured on the topic of infrared and thermal (night vision) imaging technologies and new materials.[831]
- The lab frequently encourages its researchers to go abroad for further study.[832]

Lab Equipment:

- The lab has over 100 major pieces of equipment worth over 100m RMB. It is equipped with a complete range of metal material preparation, testing (thermal expansion meter, Gleeble thermal simulation tester, Hopkinson compression bar, elastic modulus tester, universal tester, micro hardness tester, etc.), characterization instruments (advanced simulation platform, OM, SEM, EBSD, TEM, XRD, etc.) and advanced simulation platforms (Thermo-Calc, DICTRA, Micress, Ansys, LS-DYNA, etc.).[833] [834]

Address:

No. 5 Zhongguancun S. Street, Haidian District, Beijing [北京市海淀区中关村南大街 5 号][835]

Website:

None Found

Known Aliases:

- Key Laboratory of Armor Protection [装甲防护重点实验室]
- National Key Laboratory of Science and Technology on Materials in Impact Environment [冲击环境材料技术国家级重点实验室]
- Science and Technology on Materials in Impact Environment Laboratory
- 冲击环境材料技术重点实验室
- 冲击环境材料技术国防重点实验室
- 毁伤与防护国防科技重点实验室
    - Listed as such in the "official" list of DSTKLs, but likely a typo. The Lab does have a subordinate team of this name, which could be the reason for the confusion.

33. Defense S&T Key Laboratory of Metrology and Calibration Technology

Official English Name: Unknown

Chinese Name: 计量与校准技术国防科技重点实验室

Research Field: Multi-domain (Aerospace, likely others) – Multiple (Aviation, Space Vehicles) – Measurement Technologies (*Also: GNC, Nuclear Technologies*)

Affiliations:

- China Aerospace Science and Industry Corporation (CASIC) [中国航天科工集团]
    - Beijing Institute of Radio Metrology and Measurement (BIRM [北京无线电计量测试技术研究所]
        - *(a.k.a. CASIC 2nd Academy 203rd Research Institute) [二院 203 研究所])*
- Aviation Industry Corporation of China (AVIC) [中国航空工业集团]
    - Changcheng Institute of Metrology & Measurement (CIMM) [北京长城计量测试技术研究所]
        - *(a.k.a. AVIC 304th RI [304 研究所])*
        - *(a.k.a. AVIC Metrology Institute [航空工业计量所])*
        - *(a.k.a. National Defense Science and Technology Industry 1st Metrology and Testing Research Center [国防科技工业第一计量测试研究中心])*
- China National Nuclear Corporation (CNNC) [中国核工业集团有限公司]
    - China Institute of Atomic Energy (CIAE) [中国原子能科学研究院]

Key Data:

- Established: 2003
- Total Funding: Unknown
- Personnel: Unknown[836]
- Official start of operations: 2011
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Metrology and Calibration Technology conducts research into precision measurement technology, including atomic frequency standards, calibration, and time synchronization, for both aerospace and nuclear research applications.

CASIC's Beijing Institute of Radio Metrology and Measurement (BIRM) (a.k.a. CASIC 203rd RI) is responsible for the lab's day-to-day work. However, the lab is composed of three research offices under three different organizations: a Radio Time (and) Frequency Office [无线电时间频率分室] under BIRM, a Long Thermal Office [长热力分室] under the Changcheng Institute of Metrology & Measurement (CIMM) (a.k.a. AVIC 304th RI), and an Ionizing Radiation Office [电离辐射分室] under the China Institute of Atomic Energy (CIAE), a research institution under China National Nuclear Corporation.[837]

The Beijing Institute of Radio Metrology and Measurement conducts research into measurement and test technology, traceability, measurement calibration technology, frequency control technology, automatic testing technology, and comprehensive support technology. It is on the U.S. Commerce Department Entity List for export control. The Changcheng Institute of Metrology & Measurement is a comprehensive research institute that integrates measurement technology research and industry management. The China Institute of Atomic Energy focuses on nuclear research.[838] [839] [840] [841]

Further Information:

- The lab's CIAE Ionizing Radiation Office is referred to as the Metrology and Testing Department [计量测试部], the Ionizing Radiation Level One Metering Station for National Defense Science & Technology Industry [国防科技工业电离辐射一级计量站], and the Nuclear Industry Radioactivity Measurement and Testing Center [核工业放射性计量测试中心]. It has around 48 personnel and multiple defense/military certifications. It is responsible for researching and establishing the highest-standard ionizing radiation measurement instruments and calibration devices [电离辐射最高计量标准器具和校准装置] required by the defense industry, and undertaking value transfer and value traceability work for the ionizing radiation specialty.[842]

Research Direction:

1. Atomic frequency standards [原子频标]
2. Remote calibration and time synchronization technology [远程校准和时间同步技术]
3. Continuous wave medium- and high-power and pulsed high-power measurement and calibration technology [连续波中大功率和脉冲大功率测量与校准技术][843]

Other notable research areas:

The lab's Ionizing Radiation Office's main research and work directions include:

- Ionizing radiation measurement and measurement methods
- Establishment of measurement standards devices and improvement and enhancement of technical capabilities
- Expansion of the types of reference materials
- Improvement of measurement value transmission methods
- Improvement of value traceability systems
- Improvement of ionizing radiation measurement technology
- Radioactivity, radiation dosage and neutron metrology[844]

Notable Applications:

- The lab's research on satellite-based high-precision and high-reliability atomic frequency standards technology and nanosecond-level time synchronization have been applied to the Beidou satellite navigation system, the development of China's atomic frequency standards, remote calibration and time synchronization technology, and continuous wave medium and high power/pulsed high power measurement and calibration technology.[845] [846]
- The lab's Ionizing Radiation Office has established 19 highest-standard measurement devices, of which five devices are unique to national defense. These devices meet the needs for development and testing of strategic weapons, nuclear materials and radioisotope production, power reactor and nuclear power plant operation, nuclear fuel cycle and spent fuel reprocessing, nuclear facility decommissioning and radioactive waste management, nuclear technology applications, nuclear accident response and anti-nuclear terrorism, and other areas.[847]

Leadership and Key Personnel:

- Director: Unknown
- Deputy Directors: Yang Renfu [杨仁福]; Zhang Shengkang [张升康]; Zhang Li [张力][848] [849] [850]
    - Yang Renfu has neem a visiting scholar at UC Berkeley in the U.S. and Dresden Institute of Technology in Germany.

- Ionizing Radiation Office Director: Liu Yuntao [刘蕴韬][851]
- Ionizing Radiation Office Deputy Director: Cai Yueli [蔡跃鹂][852]

Notable Collaborations:

Domestic

- This lab has co-hosted the National Defense Metrology and Testing Academic Exchange Conference [国防计量与测试学术交流会] series, at least for the 2010, 2015, 2016, 2018, and 2020 iterations. The conference is guided by the SASTIND Science & Technology and Quality Department [科技与质量司], with the National Defense Science and Technology Industry Second Metrology and Testing Research Center [国防科技工业第二计量测试研究中心], International Union of Radio Science (URSI) China National Committee on Electromagnetic Metrology Specialized Committee [URSI 中国国家委员会电磁计量专业委员会], and Chinese Society of Astronautics Metrology and Testing Specialized Committee [中国宇航学会计量与测试专业委员会] also co-hosting. Participants came from defense industries such as nuclear, aviation, aerospace, shipbuilding, weapons, electronics, etc., and the PLA.[853]

International

- German company Rohde & Schwarz participated in at least one iteration of the above-mentioned National Defense Metrology and Testing Academic Exchange Conference, in 2016.[854]
- The lab's Ionizing Radiation Office is an observer party of the International Committee for Weights and Measures' (ICWM) Consultative Committee for Ionizing Radiation (CCRI) (Neutron Branch) [国际电离辐射咨询委员会（中子分会）观察员单位] and an International Atomic Energy Agency (IAEA) Secondary Standard Dosimetry Laboratory (SSDL).[855]

Lab Equipment:

No Information

Address:

None found, possibly co-located with BIRM at No. 50 Yongding Road, Haidian District, Beijing [北京海淀区永定路 50 号][856]

Website:

The Ionizing Radiation Office has websites at http://www.ciae.ac.cn/subpage/danwei_7.htm and http://www.ciae.ac.cn/subpage/shiyanshi_6.htm

Known Aliases:

- National Key Laboratory of Metrology and Calibration Technology [“计量与校准技术”国家级重点实验室]
- National Metrology and Calibration Technology Key Laboratory [国家级计量校准技术重点实验室]
- Stake Key Laboratory of Metrology and Calibration Technology [计量与校准技术国家重点实验室]
- Science and Technology on Metrology and Calibration Laboratory [计量与校准技术重点实验室]
- Key Laboratory of Science and Technology on Metrology ＆ Calibration
- 计量校准技术国防科技重点实验室
    - Missing the character 与 (“and”)

34. Defense S&T Key Laboratory of Military Underwater Intelligent Robotic Technology

Official English Name: Unknown

Chinese Name: 军用水下智能机器人技术国防科技重点实验室

Research Field: Maritime – Underwater Vehicles – Multiple (Acoustics, GNC, Intelligent Technologies, Robotics, Sensing, Target Detection/Recognition)

Affiliations:

- Harbin Engineering University (HEU) [哈尔滨工程大学]
    - College of Shipbuilding Engineering [船舶工程学院]

Key Data:

- Established: 2002
- Total Funding: 16.757m RMB
- Personnel: 50[857] [858] [859]
- Official start of operations: 2009
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Military Underwater Intelligent Robotic Technology conducts research into intelligent underwater robotics in line with the PRC's oceanic development strategy and naval equipment needs. It is heavily involved in research into unmanned and autonomous underwater robotic systems, swarm intelligence, and green technologies for both civilian and military use. Harbin Engineering University had been working on intelligent underwater robotics as early as the early 1990s, when the 8th Five Year Plan elevated this field to a key project.[860 861 862]

Further Information:

- Lab Administrative Divisions include an S&T Division [科技处], Development Planning Division [发展计划处], Finance Division [财务处], Infrastructure Division [基建处], and a Lab and Property Management Division [实验室与资产管理处].[863]
- HEU's AUV efforts have been linked to industrial espionage. In one case, a Chinese national purchased and re-exported items related to AUVs to HEU, including underwater acoustic locator devices, underwater cables and connectors, PC104 computer processing units, 907 multiplexers, underwater pressure sensors, and control sticks and button strips. In another case from 2018, two individuals were charged in the United States for attempting to steal trade secrets related to syntactic foam. Their company was closely tied to HEU and cooperating in construction of AUVs.[864 865]
- A team from HEU won the 2018 and 2019 RoboSub AUV competitions in San Diego. The team is not officially connected to the lab in promotional material, but can be seen utilizing this lab's facilities to train their AUV in a promotional video.[866 867]

Research Direction:

1. Systems Architecture and Intelligent Control Technology [体系结构与智能控制技术]
2. Acoustic and Non-acoustic Environmental and Target Sensing Technology [声与非声环境与目标感知技术]
3. Oceanic Environment Adaptation Technology [海洋环境适配技术][868]

Other Notable Research areas:

- Autonomous AUV and underwater robotics technology
- Intelligent Control of Underwater Robotics
- Environmental and Target Sensing
- Oceanic Environment Adaptation Technology
- Underwater Micro-robotics[869 870 871]

Notable Applications:

- A 2006 article written by researchers from this lab describes the potential military uses for AUVs, including for intel acquisition, precision attack, and "asymetric intelligent acupunctural warfare."[872]
- There are unconfirmed reports that this lab may have been involved in development of the PLAN's first military AUV, the HSU001, first revealed at the 2019 National Day parade.[873]
- A team from this lab, including Deputy Director Li Ye, built the Wukong [悟空] AUV. This AUV is designed to operate autonomously at extreme depths. It is capable of autonomous navigation, obstacle avoidance, hydrolocation with a precision of 1.5 meters, and acoustic communications to a range of 10.8km. In November 2019, the team tested Wukong in the Paracel Islands as part of a National Key R&D Plan Project, referred to as the "All-depths AUV Key Technical Research" [全海深无人潜水器 AUV 关键技术研究] project. There are plans to test Wukong at depths of 11,000m in the Mariana Trench. HEU already holds the PRC record for AUV depth at 6,000 meters.[874]
- This lab has been involved in the Zhishui [智水] series of intelligent AUVs. These AUVs are designed for underwater target sensing and differentiation [水下探测与识别], oceanic resource exploration and sampling [海底资源探查采样], seafloor geography mapping [海底地形勘测], and oceanic engineering and repair [海洋工程维护]. Zhishui-III was the first AUV to achieve autonomous recognition of underwater targets and drawing of target maps. As early as 2003 this lab, only recently established, was developing the Zhishui-IV with advanced sensors for depth, elevation, GPS, compasses, velocity, collision avoidance sonar, 3D imaging sonar, and TV. Zhishui-IV completed a 110km autonomous journey and conducted autonomous sensing of targets, autonomous placement of targets, and autonomous gathering and testing of oceanic environmental information. The lab developed the Zhishui-V around 2011 with improved capabilities, including underwater autonomous mapping of geography and landforms, autonomous target tracking, and automatic patrol and inspection of seafloor pipes and power lines.[875] [876]

Leadership and Key Personnel:

- Director: Qin Hongde [秦洪德][877]
- Deputy Directors: Li Ye [李晔][878]; Han Duanfeng [韩端锋][879]
- Founder: Xu Yuru [徐玉如][880]
    - CAE Academician and one of China's leading scholars in the field of intelligent AUV technology.
    - Died in 2012.

Key Personnel:

- Su Yumin [苏玉民][881] [882]
    - Expert on marine propulsion.

   - PhD at Yokohama National University in Japan and has studied abroad in U.S., U.K., and France.
   - Served as lab Director in 2015.

Notable Collaborations:

Domestic

- No information found.

International

- Personnel from this lab have allegedly completed their PhDs at unidentified institutions in Japan and the U.S.[883]

Lab Equipment:

- This lab controls 1,072 pieces of surface and underwater intelligent equipment worth over 1.6 million RMB.[884]

Address:

No address specified, likely co-located with HEU at 145 Nantong Road, Nangang District, Harbin, Heilongjiang Province [哈尔滨市南岗区南通大街 145 号].[885]

Website:

http://webcache.googleusercontent.com/search?q=cache%3Asec.hrbeu.edu.cn%2F2015%2F1204%2Fc469a1096%2Fpage.htm&rlz=1C1CHBD_enUS895US895&oq=cache%3Asec.hrbeu.edu.cn%2F2015%2F1204%2Fc469a1096%2Fpage.htm&aqs=chrome.0.69i59j69i58j69i60.1680j0j4&sourceid=chrome&ie=UTF-8

Known Aliases:

- Defense S&T Key Laboratory of Underwater Intelligent Robotic Technology [水下智能机器人技术国防科技重点实验室]
   - Omits reference to military
- Defense S&T Key Laboratory of Underwater Robotic Technology [水下机器人技术国防科技重点实验室]

- National Key Laboratory of Underwater Robotic Technology [水下机器人技术国家级重点实验室]
- National Key Laboratory of Science and Technology on Autonomous Underwater Vehicle

35. Defense S&T Key Laboratory of Multi-spectral Information Processing Technology

Official English Name: Unknown

Chinese Name: 多谱图像信息处理技术国防科技重点实验室

Research Field: Aerospace (*Also: Maritime*) – Multiple (Aircraft, Non-ballistic missiles, UAVs, Underwater Vehicles) – Multiple (GNC, Information Processing, Imaging, Intelligent Technologies, Laser Technologies, Sensing, Target Detection/Recognition)

Affiliations:

- Huazhong University of Science and Technology (HUST) [华中科技大学]
  - School of Artificial Intelligence and Automation [人工智能与自动化学院]

Key Data:

- Established: 2005
- Total Funding: Unknown
- Personnel: Unknown[886]
- Official start of operations: 2012
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Multi-spectral Information Processing Technology conducts research into multi-spectral imagery processing for guidance, navigation, target recognition, and route planning for aerospace, and, to a lesser extent, underwater vehicles.

Further Information:

- The construction cost of this lab was 46.4 million RMB.[887]
- The lab has research offices/platforms for each of its four research directions.[888]
- There is a similarly-named lab under the same School, the Key Laboratory of Ministry of Education for Image Processing and Intelligent Control [图像信息处理与智能控制(教育部)重点实验室] which was founded in the 1990s and may have some level of overlap with this lab in terms of the fields they work in. There is some information online suggesting that this was a previous incarnation of the lab, and while that may be possible, at this point in time they are separate entities.[889]

- The lab's parent institution has gone through multiple iterations and mergers. It was formerly known as the Institute for Pattern Recognition & Artificial Intelligence (IPRAI) [图像识别与人工智能研究所 (图像所)], then the School of Automation [华中科技大学自动化学院] and now the School of Artificial Intelligence and Automation. IPRAI was jointly established in 1978 by the Ministry of Education and Ministry of Space. IPRAI may have been under HUST's National Defense Institute [华中科技大学国防院], and may have carried out multispectral image guidance work involving visual scene matching positioning for Chinese key "asssassin's mace" and other missiles and weapons systems.[890]

Research Direction:

1. (Ground object fine) spectral property mechanisms [(地物精细)波谱特性机理]
2. (Multispectral) image guidance information processing (theory and methods) [(多谱)图（像）制导信息处理(理论与方法)]
3. (Multispectral) target detection (theory and methods) [(多谱)目标探测(的理论和方法)]
4. (Multispectral) new sensor design and real-time information processing (technology) [(多谱)新型传感器设计与实时信息处理(技术)].[891]

Notable Applications:

- The lab is mainly focused on the aerospace domain, specifically on guidance, navigation, and route planning for non-space flight vehicles (aircraft and missiles) as well as unmanned aerial, and to a lesser extent underwater, vehicles. The lab has also published significant work on target detection and recognition, including of ground objects (like military airports for missile targeting), ships, and aircraft like stealth aircraft.[892] [893] [894] [895] [896] [897]

Leadership and Key Personnel:

- Director: Unknown
- Deputy Director: Hu Fei [胡飞][898]
    - Research interests in millimeter wave and terahertz technology, as well as signal processing in target detection.
    - Previously a visiting scholar at the University of Tennessee.

Notable Collaborations:

Domestic

- Worked on several projects involving lasers/Lidar with the Tianjin Jinhang Technical Physics Institute [天津津航技术物理研究所]) (a.k.a. CASIC Third Academy's 8358th RI [航天三院 8358 所])[899]

International

None Found

Lab Equipment:

No Information

Address:

Possibly co-located with School at No. 1037 Luoyu Road, Hongshan District, Wuhan, Hubei Province [湖北省武汉市洪山区珞瑜路 1037 号][900]

Website:

http://aia.hust.edu.cn/yxgk/xkjd/dpxxcljsgjjz.htm

https://web.archive.org/web/20190215015421/http://auto.hust.edu.cn/yxgk/xkjd/dpxxcljsgjjz.htm

Known Aliases:

- National Key Laboratory of Science and Technology on Multi-spectral Information Processing
- National Key Laboratory of Multi-spectral Information Processing Technology [多谱信息处理技术国家级重点实验室]
- State Key Laboratory for Multispectral Information Processing Technologies
- 多谱信息处理技术国防科技重点实验室
- 多谱图像信息处理技术重点实验室

36. Defense S&T Key Laboratory of New Ceramic Fiber and Composite Materials

Official English Name: National Key Laboratory of New Ceramic Fibres and Composites (CFC)[901]

Chinese Name: 新型陶瓷纤维及其复合材料国防科技重点实验室

Research Field: Aerospace – Multiple (Aircraft, Non-ballistic Missiles, Radar, Space Vehicles) – Materials (Hypersonic Technologies, Propulsion, Stealth Technologies)

Affiliations:

- PLA National University of Defense Technology [国防科技大]
    - College of Aerospace Science and Engineering [国防科技大学空天科学学院]

Key Data:

- Established: 1998
- Total Funding: Unknown
- Personnel: over 38[902]
- Official start of operations: 2003
- Floor Space: 5,500 sqm (lab space)

Lab Overview:

The Defense S&T Key Laboratory of New Ceramic Fiber and Composite Materials conducts research into new materials for advanced aerospace applications, including stealth and heat-resistant materials for aircraft, space vehicles, missiles, and aircraft and rocket engines.

Further Information:

- The lab has several subordinate offices:
    - Special Ceramic Fibers Research Office [特种陶瓷纤维研究室]
    - Ceramic Thermal Structure Materials Research Office [陶瓷热结构材料研究室]
    - Stealth Functional Materials Research Office [隐身功能材料研究室][903]
- During China's 10th Five Year Plan (2001-2005), the laboratory undertook over 100 research projects with annual research funds per person exceeding 500,000 RMB[904]

Research Direction:

1. Materials design and preceramic polymer pyrolysis technology [材料设计与先驱体转化技术]
2. Ceramic fibers preparation technology [陶瓷纤维制备技术]

3. Preceramic polymer pyrolysis composite (material) preparation technology [先驱体转化复合材料制备技术]
4. Material performance measurement and evaluation [材料的性能测试与评估]
5. Camouflage and stealth technology [伪装隐身技术] and nano-materials [纳米材料与技术][905] [906]

Notable Applications:

- The lab's research has likely been used in aircraft, missile radomes, hypersonic missiles, space vehicles, aircraft and rocket engines, and aircraft stealth technology. [907] [908] [909] [910] [911]
- The lab has achieved a series of significant breakthroughs and innovative achievements in the design and synthesis of preceramic polymers, continuous SiC fibers, nitride wave-transparent ceramic fibers and their composites, fiber-reinforced SiC-based composites, nanoporous thermal insulation composites, and high-temperature stealth composites, and has provided technical support for the development of a new generation of Chinese aerospace vehicles. It has also produced composite nozzle adjusting pieces and inner cones, SiC/SiC composite nozzle adjusting plates and inner cones, and aerogel insulations.[912] [913]

Leadership and Key Personnel:

- Director: Ma Qingsong [马青松][914]
- Deputy Director: Liu Rongjun [刘荣军][915]

Notable Collaborations:

Domestic

- The lab has significant cooperation with Central South University (CSU) [中南大学] and its Defense S&T Key Laboratory of Lightweight, High-strength Structural Materials [轻质高强结构材料国防科技重点实验室]. Both labs are located in Changsha. The two labs have co-hosted the Special Powder Metallurgy and Composite Materials Preparation/Processing [特种粉末冶金及复合材料制备/加工] academic conferences, along with the CAS Institute of Metals Research [中国科学院金属研究所] and others. The conference focused on the latest developments in refractory metals, high-temperature alloys, powder metallurgy, cemented carbide, high-performance alloys, metal-matrix and ceramic composites, friction materials, structural materials, surface coating and protection technologies, and preparation and processing technologies.[916]

International

- The lab claims to have established academic relationships with Tokyo University and the National Materials Institute of Japan, Sydney University in Australia, University of Bordeaux and Lyon University in France, Chungnam National University in Korea, and Nanyang Technological University in Singapore.[917]

Lab Equipment:

- The lab has over 38m RMB of experimental equipment.
- The lab has the following equipment and facilities:
  - Continuous silicon carbide fiber production test line with 500kg annual output
  - Ceramic base composite material design and molding system
  - Functional composite material design and processing system
  - Advanced materials analysis and testing platform[918] [919]

Address:

CFC Key Laboratory, 1st Courtyard, National University of Defense Technology, No.109 Deya Road, Kaifu District, Changsha City, Hunan Province [湖南省长沙市开福区德雅路 109 号国防科大一院 CFC 重点实验室][920]

Website:

https://web.archive.org/web/20150501040729/http://www.nudt.edu.cn/ArticleShow.asp?ID=80

Known Aliases:

- CFC Key Lab, National University of Defense Technology [国防科技大学陶瓷纤维及其复合材料重点实验室]
- National Key Laboratory of New Ceramic Fibers and Composites [新型陶瓷纤维及其复合材料国家级重点实验]
- Defense S&T Key Laboratory of CFC [CFC 国防科技重点实验室]
- Key Laboratory of CFC [CFC 重点实验室]
- Key Laboratory of Novel Ceramic Fibers & Composites
- 新型陶瓷纤维及复合材料国防科技重点实验室

37. Defense S&T Key Laboratory of Parallel and Distributed Processing

Official English Name: Unknown

Chinese Name: 并行与分布处理国防科技重点实验室

Research Field: Multi-Domain (Aerospace, likely others) – Computer Technology (*Also: Space Vehicles*) – Simulation & Modeling (*Also: Nuclear Technologies*)

Affiliations:

- National University of Defense Technology (NUDT) [国防科技大学]
    - College of Computer Science and Technology [计算机学院]

Key Data:

- Established: Unknown
- Total Funding: Unknown
- Personnel: Unknown[921] [922]
- Official start of operations: 2011
- Floor Space: 2,850 sqm

Lab Overview:

The Defense S&T Key Laboratory of Parallel and Distributed Processing conducts research into parallel and distributed processing algorithms, software, and architecture. It is heavily involved in the development of high-performance computer technology, particularly the development of the Yinhe and Tiane line of supercomputers and their associated technologies. It also conducts research into other cutting-edge computing fields, such as big data processing. At its founding it was lauded as an important step in the development of high-performance computing in the PRC.[923]

Further Information:

- This lab has a High-Performance Computing Innovation Team [高性能计算创新团队] and a Petaflop High-Performance Computing Key Technology Innovation and Research Team [千万亿次高性能计算关键技术创新研究群体][924]

Research Direction:

1. Parallel algorithms and applications [并行算法与应用]
2. Parallel and distributed processing system software [并行与分布处理系统软件]
3. Parallel and distributed processing architecture [并行与分布处理体系结构]

4. Parallel and distributed processing system performance evaluation [并行与分布处理系统性能评测][925]

Other Notable Research areas:

- S&T monitoring applications for big data[926]

Notable Applications:

- NUDT's School of Computers houses the Tianhe [天河] supercomputers, which are among the fastest in the world, and this lab seems to have played a key role in the development of these supercomputers. Researcher Lu Kai, who is affiliated with this lab, was deputy lead designer for the Yinhe-Y, Yinhe-Z, Tianhe-1, and Tianhe-2 supercomputers. Researcher Yang Xuejun was the chief designer for the Tianhe-1 Supercomputer. Current Director Liao Xiangke was a leading researcher for the Tianhe-1 and Tianhe-2, as well as for the Kylin [麒麟] operating system used by these supercomputers. The Tianhe-2 Supercomputer has been cited for its use in nuclear weapons research and has been subjected to export control by the U.S. Government for that reason.[927] [928] [929] [930] [931] [932]
- This lab's personnel provided key research for the Yinhe-series [银河系列] of supercomputers in the 1980s and 1990s. These supercomputers led to advancements in nuclear science, space simulations, and meteorology, and were utilized by the Ministry of Space Beijing Simulation Center [航天部北京仿真中心], the 3rd Academy Simulation Center [三院仿真中心], and the 1st Academy 12th Research Institute [一院 12 所], becoming an important tool for the development of strategic weapons. The Yinhe-3 was used by the GSD, GAD, and PLAAF for military meteorology, nuclear technology, computational fluid dynamics, and other applications. Professor Lu Xicheng was involved in the development of the Yinhe-3 and Yinhe-4 supercomputers and Yinhe Yuheng 9108 Core Router [银河玉衡 9108 核心路由器].[933] [934]
- Recent and ongoing projects include a new generation supercomputers, key technologies toward an ultra high-performance parallel supercomputer funded by the NSFC, and a "core router" [核心路由器] program funded by the 863 Plan.[935]

Leadership and Key Personnel:

- Director: Liao Xiangke [廖湘科][936] [937]
  - PLA Major General and CAE academician.
  - Involved in Yinhe-series, Tianhe-1, and Tianhe-2 supercomputers, and Kylin OS.
- Academic Committee Director: Lu Xicheng [卢锡城][938] [939] [940]
  - CAE Academician.
  - Directed development of Yinhe-2 (in 1980s) and Yinhe-3 parallel supercomputers in 1990s.

- In 2006, served as PLA GAD Deputy Director of Science and Technology Committee, and currently working with CMC Science and Technology Committee.
- Did early career work at University of Massachusetts in the U.S. (1982-84).

- Deputy Director: Li Dongsheng [李东升][941]
- Deputy Managing Director: Dou Yong [窦勇][942]

Key Personnel:

- Zhou Xingming [周兴铭][943]
  - Born in 1938, Corps Leader grade Major General and CAS Academician.
  - Participated in early development of Chinese transistor computers, integrated circuit computers, and China's first supercomputers (Yinhe series).
- Peng Yuxing [彭宇行][944]
  - Research interests in distributed computing technology and big data processing.
- Lu Kai [卢凯][945] [946]
  - Expert in military uses of computers.
  - Assistant lead designer for Yinhe-Y, Yinhe-Z, Tianhe-1, and Tianhe-2 supercomputers.

Notable Collaborations:

Domestic

- In May 2020, this lab co-hosted a forum, "Integrating Artificial Intelligence and Computing Systems" [人工智能与计算系], featuring personnel from Coretronic Microelectronics Co. [芯创智（北京）微电子有限公司], Alibaba, Tsinghua, Shanghai Jiaotong University, Huazhong S&T University, USTC, Peking University, National University of Defense Technology, and CAS, as well as Duke University.[947] [948]
- Professor Dou Yong of this lab spoke about computer systems architecture at a 2018 conference hosted by the CAEP Center for High Performance Numerical Simulation [中物院高性能数值模拟软件中心]. CAEP is responsible for research related to China's nuclear weapons. Likewise, Professor Lu Xicheng spoke at the 8th Academic Conference of CAEP in 2012.[949] [950]

International

- In May 2020, this lab co-hosted a forum, Integrating AI and Computing Systems [人工智能与计算系] (see above), which featured Chinese personnel from military, academic, and private institutions, and also featured a Professor from U.S. Duke University.[951] [952]
- The lab allegedly has established long-term cooperative relationships with academic and research institutes in the U.K., Germany, and Singapore.[953]

Lab Equipment:

- According to an unofficial source, the lab's internal Gigabit LAN is connected to the NUDT campus network.[954]
- Facilities include:
    - High-performance parallel computing system
    - High-performance microprocessor design and testing facilities
    - Virtual computing environment test facilities
    - High-performance simulation computing platform
    - Parallel computing system evaluation environment[955]

Address:

Possibly co-located with the NUDT School of Computers at No. 109 Deya Road, Kaifu District, Changsha, Hunan Province [湖南省长沙市开福区德雅路 109 号][956]

Website:

None Found

Known Aliases:

- State Key Laboratory on Parallel and Distributed Processing [并行与分布处理国家重点实验室]
- National Key Laboratory of Parallel & Distributed Processing [并行与分布处理国家级重点实验室]
- State Key Laboratory for Parallel and Distributed Processing
- National Laboratory for Parallel and Distributed Processing
- Science and Technology on Parallel and Distributed Processing Laboratory
- Parallel and Distributed Laboratory

38. Defense S&T Key Laboratory of Precision Guidance and Automatic Target Recognition

Official English Name: Unknown

Chinese Name: 精确制导自动目标识别国防科技重点实验室

Research Field: Aerospace – Non-ballistic Missiles (*Also: Radar*) – Target Detection/Recognition (*Also: Air/Missile Defense, GNC, Information Processing, Intelligent*

Technologies, Microwave Technologies, Millimeter Wave Technologies, Sensing, Terahertz Technologies)

Affiliations:

- National University of Defense Technology (NUDT) [国防科技大学]
  - College of Electronic Engineering [电子科学学院]
- Shenzhen University
- Additional branches of unknown subordination at Xiamen University, Beihang University, and University of Electronic Science and Technology of China (UESTC)

Key Data:

- Established: 1992
- Total Funding: Unknown
- Personnel: 14 (Shenzhen)[957] [958]
- Official start of operations: Unknown
- Floor Space: 2,153 sqm (Shenzhen)

Lab Overview:

The Defense S&T Key Laboratory of Precision Guidance and Automatic Target Recognition conducts research on automatic target recognition (ATR) for radar and missile guidance. This lab has taken a leading role in the development of ATR technology for precision weapons in China.[959]

While the lab's primary headquarters is at NUDT, it has a second, co-equal branch, called the ATR Defense S&T Key Laboratory Intelligent Information Processing Lab [ATR 国防科技重点实验室智能信息处理实验室], at Shenzhen University. It also has satellite branches at Xiamen University, known as the 6th Research Office [第六研究室], Beihang University, and the University of Electronic Science and Technology of China in Chengdu.[960] [961] [962]

Further Information:

- Far more information is available about the lab's Shenzhen branch. The ATR Defense S&T Key Laboratory of Intelligent Information Processing [ATR 国防科技重点实验室智能信息处理实验室] was established in April 2001 and formally inaugurated on 18 October 2001. It was inspected and approved on 18 September 2003 by the Shenzhen Science, Technology, and Information Bureau. It was a joint project of the PLA GAD and Shenzhen municipal government, and overseen by the GAD (now CMC Equipment Development Department) and COSTIND (now SASTIND). Its research focuses on sensor networking systems, sensor information fusion, sensor network information security, infrared, optical, and remote sensing image processing, and terahertz imaging technology. It houses nine specialist labs, including a multi-sensor networking system laboratory, embedded system laboratory, RF laboratory, infrared radar laboratory, microwave radar laboratory, terahertz laboratory, remote sensing laboratory, information security laboratory and image and video laboratory. As of 2017, it has 14 fixed personnel, with 19 PhD students and 59 master's degree students.[963] [964]

- This lab oversees the subordinate ATR-3 Lab at NUDT, which conducts research into optical image automatic target recognition, embedded information processing, and intelligent image processing services for the aerospace, security, and surveillance industries.[965]
- A recruitment notice from 2016 for this lab indicates it was interested in recruiting optical, mechanical, laser, and circuit development engineers, as well as radar target recognition technology developers.[966]

Research Direction:

1. Sensor networking systems [传感器组网系统]
2. Sensor information fusion [传感器信息融合]
3. Sensor network information security [传感器网络信息安全]
4. Infrared, optical, remote sensing image processing [红外、光学、遥感图像处理]
5. Terahertz imaging technology [太赫兹成像技术][967]

Other Notable Research areas:

- The lab has an "ATR Spring Rain" Fund [ATR 春雨基金] which allocates funding for three areas related to ATR:
  - Advanced detection systems
  - Data knowledge engineering
  - Intelligent algorithm applications[968]
- In 2020, the lab provided funding for six research areas (providing 300k RMB in funding for each):
  - Static image data dynamization technology for photoelectric sensors
  - Target representation model construction for unmanned platform information assurance applications
  - Underwater target detection technology in hyperspectral image data
  - Intelligent separation technology of complex backgrounds and low-observable targets
  - Measurement and extraction of motion features based on vortex light
  - Embedded intelligent information processing systems architecture and implementation specifications[969]
- Per a 2017 Shenzhen Branch recruitment notice, the lab is recruiting in the following areas:
  - Intelligent sensing network systems
  - Image processing and recognition
  - Information fusion[970]
- Detection and tracking of small infrared targets[971]

- Millimeter-wave automatic target recognition[972]
- Infrared automatic target recognition[973]

Notable Applications:

- This lab has played a major role in the development of the PRC's recent air and missile defense systems. This lab's Technical Innovation Team [技术创新团队] has been working on air and missile defense target information processing projects since the 8th Five Year Plan (1991-1995). This team specializes in developing the "brains" and "eyes" for these missiles (likely reference to the missile's internal computer and guidance systems), making them more accurate. Known examples of missile development include:
    - In 2001, the lab worked on an unidentified "Assassin's Mace" weapon. Current Deputy Director Xie Honghong was on this team.
    - The lab developed the guidance system for a major new missile system utilizing ATR around 2007. This was considered a turning point and led increased PLA interest in incorporating ATR. This could be a reference to the KT-1 [开拓者一号] anti-satellite missile, which conducted a successful launch in 2007.
    - During the 11th Five Year Plan (2006-2010) the lab's Technical Innovation Team developed an unidentified piece of equipment which contributed to China's first land-based mid-course anti-missile test [陆基中段反导试验]. This is an apparent reference to the PRC's first anti-ballistic missile test in 2010. It also successfully tested equipment in the 10th, 12th, and 13th Five Year Plans.
    - The Technical Innovation Team conducted a successful anti-missile defense test in the Gobi Desert in July 2017 which introduced AI into target recognition. It again tested this missile in February 2018. This is likely a reference to the DN-3 [动能三号] anti-ballistic missile system (which held launches around both these dates), implying that this lab helped develop the ATR guidance functions of the DN-3.
- In July 2020, this lab's New Systems Technical Research Office [新体制技术研究室], which specializes in precision strike weapons, researched a new weapons system (from context, a missile system). This team develops missile "brains" [大脑], and is concerned with radar and infrared guidance. It incorporates ATR in order to lift the electronic "fog" from the modern battlefield. Unofficial observers speculated that this test may be referring to the CJ-100 cruise missile.[974 975 976]
- This lab provided technical support to improve the ATR capabilities for an unidentified new precision-guided weapons system. The lab established a new research lab fusing millimeter wave ATR and infrared ATR to conduct research on new intelligent target recognition technologies for precision weapons.[977]
- Former Director Guo Guirong has been involved in development of ship radar target automatic identification systems, air target electromagnetic feature extraction and identification systems, broadband radar target automatic identification systems for ships,

armor, aircraft and other targets, radar anti-interference systems, and radar jamming automatic identification systems.[978]

- This lab's Xiamen University branch developed computer chips for the Beidou satellite. It also developed technology related to "self-organizing network communications."[979]

Leadership and Key Personnel:

- Director, Shenzhen Branch: Xie Weixin [谢维信][980]
- Director, Xiamen Branch: Shi Jianghong [石江宏][981]
- Deputy Directors: Zhuang Zhaowen [庄钊文]; Xie Honghong [谢红红][982 983 984]
    - Zhuang Zhaowen holds the rank of either Major General or senior uniformed civilian cadre in the PLA. He is a member of the American Society for opto-electronic Engineering, and is an expert in signal processing and ATR for radar and precision guidance.
- Deputy Managing Director: Wang Zhuang [王壮][985]

Key Personnel:

- Guo Guirong [郭桂蓉][986 987]
    - Lieutenant General, CAE Academician, and lab director from inception in 1992 to 2017, still serving as honorary director.
    - Designed a wide range of ship and aircraft radar and target recognition systems.

Notable Collaborations:

Domestic

- This lab has established a joint base with the China Association for Science and Technology (CAST).[988]
- This lab co-hosted the 2nd Aerospace Cup [空天杯] competition in 2019 with multiple other institutions, including SASTIND, CASIC, the SASTIND Space Defense Innovation Center [国防科技工业空天防御创新中心], the Chinese Society of Astronautics [中国宇航学会], CASIC 2nd Academy 2nd Department [中国航天科工二院二部], the Defense S&T Innovation Base Strategic Alliance [国防科技创新基地战略联盟], CASC 8th Academy 8th Department [中国航天科技八院八部], CASIC 10th Academy 10th Department [中国航天科工十院十部], the Beijing Simulation Center [北京仿真中心], DaoCloud, and multiple key laboratories and universities.[989]
- Personnel of this lab, including Guo Guirong and Xiamen Branch Director Shi Jianghong, are associated with an experts group in collusion with the Xiamen Yaxun Network Co.[厦门雅迅网络股份有限公司], which is itself a subsidiary of the CETC 30th RI [中国网安] and conducts research into satellite navigation, among other things.[990]

International

- Lab Deputy Director Zhuang Zhaowen, a senior PLA officer and expert in automatic target recognition in radars, is also allegedly a member of the American Society for Opto-electronic Engineering.[991]
- This lab was heavily involved in a 2009 Conference held at Shenzhen University, the 2nd Shenzhen International Conference on Advanced Science and Technology, with the lab's Shenzhen director chairing.[992]

Lab Equipment:

- The lab's Shenzhen Branch website includes extensive writeups of its nine subordinate labs, including lists of specific equipment owned by the labs. This includes advanced equipment from U.S. companies Agilent, Intel, and others, possibly in violation of U.S. Government export controls.[xxxix] [993]
- Shenzhen has nearly 550 sets of instruments (another source from 2017 claims 680), and over 30m RMB (per the same 2017 source, 33.35m RMB) in fixed assets. It has over 12m RMB in "valuable" (i.e. worth over 300k RMB) equipment.[994] [995]

Address:

NUDT Courtyard 1, No. 109 Deya Road, Kaifu District, Changsha, Hunan Province [湖南省长沙市开福区德雅路 109 号国防科技大学一号院内][996]

Shenzhen Branch: Shenzhen University S&T Building 15 [广东省深圳市南海大道深圳大学科技楼 15 楼][997]

Website:

Shenzhen Branch website: https://it.szu.edu.cn/gfkjzdsys/index.htm

Known Aliases:

- National Key Laboratory of Automatic Target Recognition (ATR) [自动目标识别(ATR)国家级重点实验室]
  - This name is more common: the "Precision Guidance and…" [精确制导与] part is oftentimes omitted

[xxxix] Lists of lab equipment are available upon request.

- National Key Laboratory of Precision Guidance and Automatic Target Recognition [精确制导与自动目标识别(ATR)国防科技实验室]
- Defense S&T Key Laboratory of Automatic Target Recognition (ATR) [自动目标识别(ATR)国防科技重点实验室]
- ATR Key Laboratory [ATR 重点实验室]
- ATR Key Laboratory of Defense Science and Technology [ATR 国防科技重点实验室]
- National Lab of ATR (or ATR National Lab)
- Key Lab of ATR
- Automatic Target Recognition Laboratory of National University of Defense Technology

39. Defense S&T Key Laboratory of Precision Hot Processing of Metals

Official English Name: National Key Laboratory for Precision Hot Processing of Metals[998]

Chinese Name: 金属精密热加工国防科技重点实验室

Research Field: Aerospace – Unknown – Materials (*Also: Intelligent Technologies, Semiconductors*)

Affiliations:

- Harbin Institute of Technology (HIT) [哈尔滨工业大学]
    - School of Materials Science and Engineering [材料科学与工程学院]

Key Data:

- Established: Unknown
- Total Funding: 80m RMB (as of 2016)
- Personnel: Unknown[999]
- Official start of operations: 1996
- Floor Space: 6,600 sqm

Lab Overview:

The Defense S&T Key Laboratory of Precision Hot Processing of Metals conducts research into advanced hot processing, including precision casting and forming, welding, heat management, and automation and intelligentization of these processes. It is a significant source of national defense funding related to precision hot processing technology.[1000]

Further Information:

- This lab may have a subordinate Rapid Solidification Lab [快速凝固实验室] as well as a Fluid High-pressure Forming Technology Research Results Hall [流体高压成形技术研究成果展厅].[1001] [1002]

- In September 2020, personnel with the State Nuclear Power Technology Corporation took a tour of this lab, indicating a possible role in materials related to nuclear technology.[1003]

Research Direction:

1. Precision hot processing and forming of advanced materials
2. Precision casting [精密铸造]
3. Precision plastic forming [精密塑性成形]
4. Special heat management [特种热处理]
5. Automation and intelligentization for precision hot processing [精密热加工工艺过程自动化和智能化][1004]

Notable Applications:

- Little information could be found about the applications of this lab's research. It is a member of a joint project on aerospace materials.

Leadership and Key Personnel:

- Director: Yuan Shijian [苑世剑][1005]
- Deputy Director: Su Yanqing [苏彦庆][1006]

Notable Collaborations:

Domestic

- This lab established the Joint Laboratory of Aerospace Metallic Materials [航空航天金属材料联合实验室] and Joint Laboratory for Welding of Metallic Materials [金属材料焊接联合实验室] with three National Key Labs in 2019. The three other labs were the State Key Laboratory of Advanced Welding and Joining [先进焊接与连接国家重点实验室], State Key Laboratory of Comprehensive Utilization of Vanadium and Titanium Resources [钒钛资源综合利用国家重点实验室], and State Key Laboratory of Metal Materials for Marine Equipment and Their Applications [海洋装备用金属材料及其应用国家重点实验室]. The SOE Ansteel Group [鞍钢集团] was also involved in this effort.[1007]

International

- A researcher at this lab, Shen Hongxian, was a visiting scholar at South Florida University from 2014-2015 and has since written at least four collaborative papers on microwires with researchers from this university.[1008]

- Lab researchers wrote a 2018 paper on “Advances in the research of metal-intermetallic compound laminated composites” with University of Waikato, New Zealand.[1009]

Lab Equipment:

- This lab is equipped with numerous pieces of foreign-made equipment, including U.S. equipment (possibly in violation of U.S. Government export controls), including:
    - Vacuum/atmosphere hot pressing sintering furnace (U.S.)
    - Rapid mold making system (U.S.)
    - Wax pressing machine (U.S.)
    - Dewaxing machine (U.S.)
    - PHI5700XPS/AES surface analysis system (U.S.)
    - High-temperature high-pressure gas quenching furnace (France)
    - Medium water-cooled copper crucible vacuum induction melting furnace (Germany)
        - 6TP, melting temp 2500C, vacuum level 5x10^{-5}mbar)
    - Double-roller thermal precision spinning machine (Spain)
    - Multi-arc ion plating device (Russia)
- Other lab equipment includes:
    - Rapid solidifying powder and jet forming machine
    - Vacuum high temperature roasting furnace
    - 5000 KN Super Plastic Forming Machine
    - 10000 KN high energy screw press
    - 50 KJ Electromagnetic forming machine
    - 20000 KN internal high pressure forming machine
    - Plasma source ion injection device
    - Semiconductor laser welding machine[1010]

Address:

There are multiple addresses associated with this lab:

- Address in Baidu Map: Building A2, Office 108, Fuhua 2nd Road, Nangang District, Harbin, Heilongjiang Province [黑龙江省哈尔滨市南岗区复华二道街 A2 栋 108 室]
- Harbin Institute of Technology, Building 10 [哈工大精密热加工国防科技重点实验室 10 号楼][1011]
- Harbin Institute of Technology 1st School District, Hot Processing Building [哈尔滨工业大学一校区热加工楼][1012]

Website:

http://mse.hit.edu.cn/2015/0708/c3817a99884/page.htm

Known Aliases:

- National Key Laboratory for Precision Hot Forming of Metals [金属精密热加工国家级重点实验室]

40. Defense S&T Key Laboratory of Radar Signal Processing

Official English Name: National Key Laboratory of Science and Technology on Radar Signal Processing *or* National Lab of Radar Signal Processing[1013] [1014]

Chinese Name: 雷达信号处理国防科技重点实验室

Research Field: Aerospace – Radar – Information Processing (*Also: Imaging, Intelligent Technologies, Simulation & Modeling, Target Detection/Recognition*)

Affiliations:

- Xidian University [西安电子科技大学]
  - School of Electronic Engineering [电子工程学院]

Key Data:

- Established: 1991
- Total Funding: Unknown
- Personnel: 64[1015]
- Official start of operations: 1995
- Floor Space: 5,200 sqm

Lab Overview:

The Defense S&T Key Laboratory of Radar Signal Processing was part of the first batch of key labs established in 1991. It conducts research related to radar signal and data processing, detection systems, and information acquisition and processing. This lab is ranked first in China in the field of signal and information processing.

The predecessor to this lab was the Digital Signal Processing Small Group [数字信号处理小组], established in 1974. In 1980, it became the Electronic Engineering Research Institute [电子工程研究所] (also known as the "Electronics Institute" [电子所], as it is still sometimes referred to today).[1016] [1017]

Of note, the field of target recognition was a long-term bottleneck technology for the PRC. It was considered a high difficulty area and faced many setbacks and little progress for a long period before the arrival of current Director Liu Hongwei at this lab. Liu's team eventually made a major breakthrough in target classification for which it won a 2nd Class National Technology Invention Award [国家技术发明二等奖] in 2015. This research has since become standard on PLA radars, giving them the ability to identify targets and other detailed information.[1018] [1019] [1020]

Further Information:

- On this lab's website, all images of the banner including the words "National Defense" [国防] are censored out. Similarly, the lab's origins are simply described as coming from generic "government investment" on the English website.[1021]
- This lab has 5 subordinate Research Offices [研究室], numbered 1 to 5:
    - *1st Office*: oversees research into New System Radars [新体制雷达] and Precision Guided Radars [精确制导雷达]
    - *2nd Office*: oversees High Speed Time-Realistic Signal Processing [高速时实信号处理] and Radar System Modeling Simulation [雷达系统建模仿真].
    - *3rd Office*: oversees Array Signal Processing [阵列信号处理] and Adaptive Signal Processing [自适应信号处理]
    - *4th Office*: oversees Radar Imaging [雷达成像] and Battlefield Reconnaissance Radar [战场侦察雷达]
    - *5th Office*: oversees Radar Target Identification [雷达目标识别], Broadband Radar Signal Processing [宽带雷达信号处理], and Network Radar Technology [网络雷达技术][1022] [1023]
- In 2019, Liu Hongwei was put in charge of the National-Local Joint Engineering Research Center [民用雷达国家地方联合工程研究中心], which aims to take radar technology developed for military use and transfer it to civilian applications.[1024]

Research Direction:

1. Radar data and signal processing [雷达数据信号处理]
2. Radar detection system technology [雷达探测系统技术]
3. Intelligent information acquisition and processing [智能信息获取与处理]
4. Radar imaging and target identification [雷达成像与目标识别]
5. Multi-dimensional multi-channel information acquisition and processing [多维多通道信息获取与处][1025]

Other Notable Research areas:

- STAP and array signal processing
- Radar imaging and automatic target recognition

- Radar system and emerging radar techniques
- High speed parallel processing algorithm
- Radar system modeling and simulation
- High-speed digital signal processor design
- Distributed Small Satellite SAR InSAR-GMTI Processing
- Adaptive side flap phase cancellation
- Array signal processing
- Space-time two-dimensional adaptive signal processing
- Sparse array integrated pulse aperture radar technology
- Radar imaging
- Radar automatic target identification
- Research into Rydberg atomic receivers
    - Considered a high difficulty subject with little relation to signal processing, but will have major implications for future radars[1026] [1027] [1028]

Notable Applications:

- This lab is involved in the development of the PRC's most advanced radar systems. Of particular note is its development of an anti-stealth meter-wave radar [反隐身米波雷达] (possibly the JY-26 or JY-27?), the first in the world, which is allegedly capable of detecting the F-22 aircraft and leaving stealth technology obsolete. It first detected an F-22 near China in February 2016.[1029]
- This lab has worked on intelligent target recognition technology, giving PRC radars the ability to ascertain aircraft type and other useful data.[1030]
- Also related to anti-stealth radar, this lab is developing an L-band 16-transmit 16-receiver MIMO radar test system.[1031]
- In 2013, this lab developed an airborne/satellite-mounted radar ground motion target Detection (GMTI) system [机载/星载雷达地面运动目标检测(GMTI)系统] for military use.[1032]
- The lab's 3rd Research Office oversees research on Battlefield Reconnaissance Radars.[1033]
- The lab's Remote Sensing and Imaging Innovation Team [遥感成像新技术创新团队] has made unspecified major gains in military remote sensing, reconnaissance, and precision guidance.[1034]

Leadership and Key Personnel:

- Director: Liu Hongwei [刘宏伟][1035]
    - Became the PRC's youngest Key Lab Director at 35.
    - Specializes in radar target recognition [雷达目标识别], cognitive detection [认知探测], cooperative detection [协同探测], and new system radars [新体制雷达].

    - Previously worked in the U.S. before returning to the PRC.
- Deputy Directors: Zhang Linrang [张林让]; Su Hongtao [苏洪涛]; Liu Feng [刘峰][1036] [1037] [1038]
- Founder: Bao Zheng [保铮][1039]
    - CAS academician, considered a pioneer in the development of Chinese radar technology.
    - Died in 2020.

Key Personnel:

- Chen Bo [陈渤][1040] [1041]
    - Previously a senior research scientist at Duke University in the U.S. from 2008 to 2013, returned to PRC as part of Thousand Talents Plan.
- Liao Guisheng[1042]
    - Involved in several important projects for both military and civilian radar, improving aircraft and satellite-mounted radars, single-station multi-satellite measurement and control [测控站单站多星测控], satellite navigation anti-jamming [卫星导航系统抗干扰], and conventional radar comprehensive anti-jamming [常规雷达系统的综合抗干]. Completed projects include "Space-based SAR/AMTI/GMTI Concept Research," "Multi-dimensional Anti-jamming Technology for Satellite Navigation Systems," "Distributed Microwave Imaging Radar Information Acquisition and SAR Image Target Identification Technology Research," "Distributed Microwave Imaging Radar Information Acquisition and SAR Image Target Identification Technology Research," "Small Satellite Distributed[xl] Radar Imaging and Data Processing Methods," and "Space Based[xli] Early Warning Radar System Technology Research."

Notable Collaborations:

Domestic

- This lab has (or had) joint labs with Chinese companies SBS, ALTEA (Laboratory of Programmable Devices [可编程器件实验室]), and Cadence (Northwest China Technical Support and Training Center [中国西北技术支持与培训中心]).[1043]
- This lab has collaborated with ZTE on the project, "W-CDMA system simulation and software radio implementation structure using intelligent antenna space-time signal processing technology" [利用智能天线空时信号处理技术的 W-CDMA 系统仿真和软件无线电实现结构].[1044]

[xl] "Small Satellite Distributed" is redacted in most public publications
[xli] "Space Based" is redacted in most public publications

- This lab cooperated with Norinco 212th RI [212 所] on the project, "Fuze System Modeling and Simulation" [引信系统建模与仿真].[1045]
- This lab helped establish the Radar Signal Processing Lab at Xiamen University.[1046]
- As part of Plan 2011 [2011 计划], this lab is part of a collaborative effort with CETC and possibly others to form a "Collaborative Innovation Center of Information Perception Technology."[1047]
- This lab and the Defense S&T Key Laboratory of Electronic Measurement Technology set up a "New-System Radar Research and Test Base" [新体制雷达研究试验基地] in the Qingdao Development Zone in 2005 to research and explore new radar detection technologies, design and manufacture an autonomously-developed new radar system, and contribute to the development informationized national defense technology. There is little to no information available on the base after its founding, and only one joint study between the two labs appears to have been published.[1048] [1049]
- This lab hosted the 4th Electronic Information Young Scholars Forum in 2019. A professor from the Air Force Engineering University gave a talk on key problems in cognitive electronic warfare [认知电子战].[1050]
- In 2012 the lab hosted a conference, "Seminar on Advanced Radar and Countermeasures Technology" [雷达与对抗先进技术研讨]. Participants came from the PLAAF Equipment Research Department, CASIC 2nd Academy 23rd RI, CETC 38th RI and 14th RI, and the National University of Defense Technology. Topics included the development of air defense and early warning radar systems, countermeasures for early warning and surveillance radars, airborne early warning radars, system radar-distributed aperture phase-reference synthetic radars, target detection and identification based on polarized SAR, radar detection technology for shallow buried targets on the surface, multi-source heterogeneous information fusion algorithm based on random set theory, cooperative visual computing, and parametric radar signal processing theory and applications.[1051]
- As of 2018, this lab's academic committee includes individuals from the PLAAF Equipment Research Academy, PLAN Equipment Research Academy, Joint Staff Department Survey and Mapping Research Institute (now possibly the PLASSF Battlefield Research Institute), NORINCO, CALT Research and Development Center, CETC 14th and 20th RIs, CETC 2nd Academy 23rd RI, NORINCO 206th RI, and National University of Defense Technology.[xlii] [1052]

International

- This lab controls a 111 Plan Innovation Base ["111 计划"创新引智基地] for "Radar Cognitive Detection and Imaging Recognition" [雷达认知探测成像识别]. The 111 Plan's stated aim is to establish such innovation bases to attract top foreign talent to the PRC, spurring tech transfer. This 111 Plan Innovation Base has already established joint research centers with Syracuse University and the University of Pisa in Italy. The Syracuse collaborative center is called the International Center for Information Fusion. According

[xlii] A complete list with individual names is available upon request.

to a Syracuse press release, this technology can be applied to "health, the environment, and security." The Pisa collaboration is known as the Joint Center for Cognitive Signal Processing [认知信号处理联合研究中心]. This 111 Plan Base is dedicated to development of radar technology in China, focusing on cognitive detection theory and methods, intelligent radar theory and methods, unmanned aircraft swarm cooperative detection theory and methods, etc. It states "introduction of foreign talents" as one of its goals. Liu Hongwei, who has played a major role in the foreign relations of this base, works on target recognition for military radars.[1053] [1054]

- In 2019, the lab's 111 Plan Innovation Base held the 2nd International Workshop on Signal and Information Intelligent Learning and Processing (SIILP 2019) [信号与信息智能学习与处理国际研讨会]. Foreign speakers came to this 111 Plan base from Columbia University, New York University, University of Maryland, University of California, University of Oklahoma, Akron University, and Bell Labs in the U.S., as well as academic institutions from the U.K., Italy, Switzerland, and Australia.[xliii] Topics discussed included cognitive learning, deep learning, compressed perception, big data processing, metamaterials, intelligent modeling, and learning and processing of model parameters in different kinds of signals and information such as radar, communications, images, hydroacoustics, and language. The base is dedicated to development of radar technology in China, focusing on cognitive detection theory and methods, intelligent radar theory and methods, unmanned aircraft swarm cooperative detection theory and methods, etc. It states "introduction of foreign talents" as one of its goals. Liu Hongwei, who has played a major role in the foreign relations of this base, works on target recognition for military radars.[1055]
- A researcher from Bell Labs in the U.S. was invited by this lab in 2016 to speak about recent advances in compressive sensing, focusing on the hardware implementation of video compression-aware cameras and reconstruction algorithms.[1056]
- French expert Francois Le Chevalier from THALES, an expert on radar target identification and electronic warfare, came to the lab in 2007 and lectured on MIMO radar, and development of the RIAS system (a French air surveillance radar project).[1057]
- In 2007, this lab signed a cooperation agreement with the German high-tech electronics company Rohde & Schwarz.[1058]
- This lab has a "Model International Science and Technology Cooperation Base" about which no other information was found.[1059]
- Each year the lab invites 10 foreign scholars for exchanges, and frequently brings in foreign guest lecturers. The lab's website has both images and articles documenting multiple visits and exchanges with U.S. researchers, including researchers from Boeing, RAS, University of California, University of Florida, University of Minnesota, Villanova, San Francisco State University, University of Texas-Pan Am, and University of Connecticut, as well as researchers from France, the U.K., and Germany. Another page listing exchanges with

[xliii] A complete list of topics is available request.

foreign scholars between 2001-2005 also includes U.S. companies such as Motorola, MRI Devices, and Broadcom.[xliv] [1060]

Lab Equipment:

- A list of equipment possessed by this lab includes a high amount of foreign equipment, including American-manufactured equipment from companies like Agilent, HP, IBM, and Tektronics.[xlv]
- The lab has a signal generator, logic analyzer, oscilloscope, and high-performance cluster computing system. It also has advanced instruments for signal generation, test and analysis, data acquisition, and electronic system automation and design.[1061]

Address:

(Xidian University) S&T Building, North Campus [北校区新科技楼][1062]

No. 2 Taibai South Road, Xi'an, Shaanxi Province [陕西省西安市太白南路 2 号][1063]

Website:

https://rsp.xidian.edu.cn

Known Aliases:

- Xidian Electronics Research Institute [西电电子所]
- National Key Laboratory of Radar Signal Processing [雷达信号处理国家重点实验室]
- Key Laboratory for Radar Signal Processing
- State Laboratory of Radar Signal Processing
- National Laboratory of Radar Signal Processing

41. Defense S&T Key Laboratory of Radio Wave Environmental Characteristics and Modeling Technology

Official English Name: National Key Laboratory of Electromagnetic Environment (LEME)[1064]

Chinese Name: 电波环境特性及模化技术国防科技重点实验室

[xliv] Full list available upon request.
[xlv] A detailed spreadsheet of this Lab's equipment is too long to list here but is available upon request.

Research Field: Multi-domain (Aerospace, Maritime) – Multiple (Communications Equipment, Radar, Space Vehicles) – Electromagnetics (*Also: Communications Technologies, GNC, Simulation & Modeling*)

Affiliations:

- China Electronics Technology Group Corporation (CETC) [中国电子科技集团]
  - China Research Institute of Radio Wave Propagation (CRIRP) [中国电波传播研究所]
    - *(a.k.a. CETC 22nd Research Institute* [22 研究所]*)*

Key Data:

- Established: 1993
- Total Funding: Unknown
- Personnel: 33 (as of 2006)[1065] [1066] [1067]
- Official start of operations: 1994
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Radio Wave Environmental Characteristics and Modeling Technology conducts research on radio waves and ionospheric characteristics and how these environments affect signals in the aerospace and maritime domains. Applications include radar, communications, and navigation, including for surface vessels and satellites.

The lab's parent institution, CETC's China Research Institute of Radio Wave Propagation (a.k.a. the CETC 22nd RI), focuses on the propagation characteristics of radio/electromagnetic waves across the electromagnetic spectrum in various media, and their applications. Its research is widely used in radar, communications, navigation, electronic warfare, measurement & control, remote sensing, space, radio interference/jamming, and other fields. It has participated in national key engineering tasks such as the "two bombs and one satellite" (the PRC's first nuclear weapons and satellite), Antarctic communications and research, and the manned space program.[1068]

Further Information:

- As of 2006-2007, the lab had three research offices [研究室], which focus on propagation characteristics and modeling of radio waves in the troposphere and ionosphere [电波在对流层、电离层的传播特性与建模], research and modeling of radio wave propagation characteristics in mobile or combat environments [移动或作战环境的电波传播特性研究与建模] and research of special radio wave environment propagation theory and new mechanisms [特种电波环境传播理论与新机理研究], respectively. It also has a database that provides data storage query and computing services.[1069]

- The lab allegedly has a nationwide network of radio environmental monitoring stations [电波环境监测站网] and has built four radio environment observation stations [电波环境观测站] in Singapore and the Artic (Tromso in Norway, Sodankyla and Oulu in Finland). It has a thirteen-station radio wave observation network at home and abroad which was supported by the PLA GAD Technical Infrastructure Bureau [总装备部技术基础局]. The lab's radio wave environment database is networked with domestic observation stations [观测站] and foreign data centers.[1070] [1071]
- The lab integrates measurement, data collection, database modeling and prediction simulation [集测量、数据采集、建库建模、预测仿真于一体].[1072]

Research Direction:

1. Propagation characteristics and modeling of radio waves in the troposphere and ionosphere [电波在对流层、电离层的传播特性与建模] and near-Earth space environments [近地空间环境]
2. Propagation characteristics and modeling of radio waves in mobile environments [波在移动环境中的传播特性与建模] and combat environments [作战环境]
3. Propagation mechanisms of radio waves in special media or environments [特殊媒质或环境下电波传播机理]
4. Special radio wave propagation theory and special environment propagation mechanisms [特种电波传播理论研究及特殊环境传播机理][1073] [1074] [1075]

Other Notable Research areas:

- Use of fundamental data of various radio wave propagation environments
- Spatial/temporal characteristics, variation (laws) and generation mechanisms of loss, reflection, refraction, diffraction, dispersion, scintillation, scattering, polarization, and other higher order effects of radio wave propagation in the entire space environment from the earth (sea) surface to the troposphere and ionosphere
- Development of radio wave environment and propagation prediction and forecasting methods
- Development of a model suitable for the prediction of practical radio wave environmental characteristics and the correction of radio wave propagation effects required for the operation of China's information technology and aerospace technology
- Predictive modeling, effect simulation, environmental simulation re-engineering, decision-making assistance/support, and adaptive technology
- Millimeter wave propagation characteristics[1076] [1077] [1078]

Notable Applications:

- The lab has done work with radar, including over-the-horizon radar [超视距雷达], as well as GPS. [1079] [1080] [1081]
- A list of achievements includes the following:
  - Artificial Neural Network Technology to Improve Ionospheric Harassment Forecasting
  - Radar target environment testing technology, ground and sea surface foreground scattering characteristics and modeling
  - Very Low Frequency (VLF) radio system electric wave field strength and phase calculation standards
  - Phase prediction corrections (PPC) model for underwater navigation
  - Shortwave frequency management forecasting system
  - Station intelligence pass-through broadcast/monitoring/frequency selection system[1082]

Leadership and Key Personnel:

- Director: Wu Jian [吴健][1083]
- Deputy Director: Li Qingliang [李清亮][1084]

Notable Collaborations:

Domestic

- The lab has collaborated on research with the PLAN, including the PLAN 704 Factory Communication and Electronic Warfare Workshop [海军 704 厂通信与电子对抗车间] in a 2017 study, "Application of Wideband Delphi technique in Software Assessments" [Widebandelphi 技术在软件估算中的应用], and with PLAN Unit 92493 in the 2013 study, "Channel Analysis and Application of Troposphere Duct over Sea" [海洋大气波导信道特性分析与应用] involving over-the-horizon radar detection [超视距探测] for shore- and ship-based information systems.[1085] [1086]

International

- The lab allegedly has monitoring stations in Singapore, Norway, and Finland (see "Further Information" section for more).
- The lab claims to participate in international organizations and international co-operative research, such as Study Group 3 of the UN's International Telecommunication Union Radiocommunication Sector (ITU-R), Commissions F and G of the International Union of Radio Science (URSI), the European Incoherent Scatter Scientific Association (EISCAT), the Area Pacific Space Cooperation Organization (APSCO), and the International Space

Environment Service (ISES). The lab also serves as ISES's Beijing Ionospheric Warning Center [北京电离层警报中心].[1087] [1088]

- Many of the lab's research results support the forming or revising of the recommendations of ITU-R P serials such as ITU-R.P 617, 530, 841, 676.[1089]
- The lab claims unspecified relationships with research and academic institutions in the U.S., U.K., Germany, France, Italy, Norway, Finland, Japan, Australia, Singapore, Chile and others.[1090]
- The lab has hosted and organized many international academic conferences and activities, including co-hosting the 2010 and 2018 International Symposium on Antennas, Propagation and EM Theory (ISAPE) conferences, and the 11th-16th iterations of the Chinese National Symposium on Radio Propagation (CNSRP) [全国电波传播学术讨论年会].[1091] [1092] [1093]

Lab Equipment:

- The lab had an original equipment value of 8.67 million RMB.[1094]
- As of 2006-2007, the lab's instruments and equipment included various types of signal sources, radio comprehensive testers, digital storage oscilloscopes, field strength comprehensive analyzers, high-precision frequency standards, test tools for various routine tests, and a computer network that integrates measurement, acquisition, library building, modeling, calculation, and simulation.[1095]

Address:

No. 503, Dingfu Huangzhuang, Beijing [北京市定福皇庄 503 号][1096]

Website:

https://web.archive.org/web/20080409182755/http://leme.ac.cn/

Known Aliases:

- Key Laboratory of Electromagnetic Environment [电波环境特性及模化技术重点实验室]
- State Key Laboratory of Electromagnetic Environment [电波环境特性及模化技术国家重点实验室]
- Defense Key Laboratory of Electromagnetic Environment [电波环境特性及模化技术国防重点实验室]

- 电波环境特性与模化国防科技重点实验室[xlvi]

42. Defense S&T Key Laboratory of Reliability and Environmental Engineering Technology

Official English Name: Unknown

Chinese Name: 可靠性与环境工程技术国防科技重点实验室

Research Field: Aerospace (*Also: Maritime)* – Space Vehicles (*Also: Aircraft, Surface Vessels)* – Reliability/Environmental Engineering (*Also: Simulation & Modeling*)

Affiliations:

- Beihang University [北京航空航天大学]
  - School of Automation Science and Electrical Engineering [自动化科学与电气工程学院]
- China Aerospace Science and Technology Corporation (CASC) [中国航天科技集团]
  - China Academy of Space Technology (CAST) Beijing Institute of Spacecraft Environment Engineering (BISEE) [北京卫星环境工程研究所]
    - *(a.k.a. CASC 5th Academy Final Assembly and Environmental Engineering Department [五院总装与环境工程部])*
    - *(a.k.a. CASC 511th Research Institute [511 研究所])*
  - China Academy of Launch Vehicle Technology (CALT) Beijing Institute of Strength and Environment [北京强度环境研究所]

Key Data:

- Established: 2008
- Total Funding: Unknown
- Personnel: 55[1097] [1098] [1099]
- Official start of operations: 2010
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Reliability & Environmental Engineering Technology conducts research into reliability and environmental engineering for primarily spaced-based applications, as well as military and civilian aircraft, military and civilian maritime vessels, and other large, high-tech projects which require reliable operation in challenging environments.

This lab appears to be a major arm of the PRC's research into reliability engineering, particularly for military projects. A chart of key research platforms in this field shows this lab alongside six other entities from the PLA GAD, PLAAF, and AVIC. Further, Professor Kang Rui

[xlvi] Missing the characters 技术 "technology"

from this lab, in an interview, discusses the importance of reliability in manufacturing technology to the Made in China 2025 initiative.[1100] [1101]

This was the first key lab established by three parties. It is jointly run by Beihang University's School of Reliability and Systems Engineering, as well as two CASC institutions, the Beijing Institute of Spacecraft Environment Engineering (BISEE) (a.k.a. the CASC 511th Research Institute) and the Beijing Institute of Strength and Environment. BISEE is responsible for final assembly, integration, specialized testing, and environmental testing/simulation for the PRC's manned spacecraft and satellites (including navigation, communications, ground sensing, lunar, deep space, and research satellites). The Beijing Institute of Strength and Environment is tasked with testing the structural strength and environmental reliability of the PRC's space systems, including rockets, satellites, and ground equipment. It was added to the U.S. Commerce Department Entity List for export control in 1999 for "missile end-uses." [1102] [1103] [1104] [1105]

Research Direction:

1. Reliability technology and environmental simulations, as well as accelerated experimentation and verification technology [可靠性技术与环境模拟、加速试验与验证技术的研究与开发]
2. Software reliability test and evaluation technology [软件可靠性测试与评价技术]
3. Maintenance simulation, design, and evaluation technology [维修性虚拟设计与评价技术]
4. Engineering model applications and technical support [工程型号应用与技术支持工作]
5. Teaching and talent training in this field [课程教学、人才培养工作][1106]

Notable Applications:

- In an advertisement meant to entice male students to come study at Beihang (titled, "*I'm at Beihang waiting for you…*"), models posing as Beihang students talk about their time volunteering at this lab. They claim to have provided technical support to the J-10 fighter, the Shenzhou-series of spacecraft, the Long March series of rockets, and PLAN aircraft carriers. Another source confirms that the School to which this lab is subordinate did indeed work on the J-10, Shenzhou, Long March, and aircraft carrier. Other likely projects include development of new materials for various space vehicles, including for the manned space program and Beidou satellites.[1107] [1108] [1109]

Leadership and Key Personnel:

- Director: Liu Bin [刘斌][1110]
- Academic Committee Director: Kang Rui [康锐][1111]

Key Personnel:

- Lu Shen [吕琛][1112]
  - Previously studied at University of Wisconsin and in France.
  - Research interests in prognostics and health management [故障预测与健康管理], intelligent repair systems [智能维护系统].
- Chen Yunxia [陈云霞][1113]
  - Research interests in project failure science, complex systems reliability modeling and simulation, high reliability and long life product design and testing techniques.

Notable Collaborations:

Domestic

- In November 2020, this lab took part in the 8th Equipment Vibration and Noise Control Youth Forum and Mechanical Metamaterials/Structural Theory and Applications Workshop. Relevant participants included the Key Lab of Ship Vibration and Sound (under the Naval Engineering University and 701st and 702nd RIs of CSSC), and the National University of Defense Technology Key Lab of Integrated Equipment Support Technology.[1114]

International

- This lab hosted an international conference in 2011 on the topic of space vacuum hot environment simulation which included researchers from Spain and Ukraine.[1115]
- While unclear if it involves this lab in particular, BISEE has allegedly provided products and services to multiple foreign countries, including Russia for its GVU-600 large space environment simulator.[1116] [1117]

Lab Equipment:

No Information

Address:

Possibly co-located with Beihang University at No. 37 Xueyuan Road, Haidian District, Beijing [北京市海淀区学院路 37 号]

Website:

None Found

Known Aliases:

- Key Laboratory on Reliability & Environmental Engineering [可靠性与环境工程技术重点实验室]
- Science and Technology on Reliability and Environment Engineering Laboratory
- National Defense Science & Technology Laboratory on Reliability & Environmental Engineering

43. Defense S&T Key Laboratory of Remanufacturing Technology

Official English Name: National Key Laboratory for Remanufacturing[1118]

Chinese Name: 装备再制造技术国防科技重点实验室

Research Field: Multi-Domain (Aerospace, Ground, Maritime) – Multiple (Aircraft, Ground Vehicles) – Manufacturing (*Also: Vehicle Parts & Technology*)

Affiliations:

- PLA Army Academy of Armored Forces [陆军装甲兵学院][xlvii]

Key Data:

- Established: 2000
- Total Funding: Unknown
- Personnel: 42 (research)[1119]
- Official start of operations: 2003
- Floor Space: over 9,000 sqm

Lab Overview:

The Defense S&T Key Laboratory of Remanufacturing Technology conducts research into remanufacturing technology for equipment life extension and battlefield emergency repairs. The lab's research is applied to tank and aircraft engines and other parts, as well as to other vehicles.[1120] [1121]

On the civilian side, this lab is part of a larger effort to create a national circular economy. It is involved in a range of remanufacturing products, including car engines and tires. Following the 12th Five Year Plan (2011-2015), it also works to remanufacture construction machinery, mining equipment, and electrochemical products. Over the first decade of its existence, this lab is said to have gone from *repair* and *surface* engineering to full *remanufacturing* engineering, developing means of remanufacturing used equipment.[1122] [1123] [1124]

[xlvii] Former Armored Forces Engineering College [装甲兵工程学院]

Further Information:

- Remanufacturing is focused on the specialized repair and replacement of individual machinery parts to restore original functionality, reducing resource consumption and extending overall lifespan. The PRC is determined to catch up to the U.S. in this regard, as annual losses from friction and corrosion of machinery account for 10% of GDP in the PRC, vs 4-5% in developed countries. Remanufacturing has begun to play an increasingly important role in the national defense field. Laser additive remanufacturing is now used for aero-engine and ship blades, as well as for other load-bearing parts. Equipment remanufacturing can be used on damaged or scrap parts, utilizing failure analysis, lifespan predictions, whole lifecycle cost analysis, use of high-tech surface engineering technology, rapid forming technology, and other advanced manufacturing technologies, in order to quickly restore original technical performance and remanufacture new parts.[1125] [1126] [1127]

Research Direction:

1. Remanufacturing Engineering Design Fundamentals [再制造工程设计基础]
2. Remanufacturing Quality Control [再制造质量控制]
3. Emergency Repairs [应急维修]
4. Key Remanufacturing Technologies [再制造关键技术][1128]

Other Notable Research areas:

- Nanometer surface engineering
- Automatic surface engineering
- Rapid fusing and forming
- Quality control systems
- Laser additive remanufacturing technology
- Remanufacturing life assessment
- Remanufacturing forming technology
- Remanufacturing multi-lifecycle theory
- Remanufacturing life assessment and prediction theory
- Micro- and nano-surface engineering technology
- Automated surface engineering technology
- Remanufacturing of equipment while in operation (self-healing technology)[1129] [1130] [1131] [1132]

Notable Applications:

- This lab is involved in the development of remanufactured tank engines. This has improved a major bottleneck in tank lifespan, as engines tended to wear out more quickly than other parts. It has effectively doubled the time between overhaul cycles for certain tank engines. Lab founder Xu Binshi has even been referred to as the "Tank Nanny" [坦克保姆].[1133] [1134]

- This lab has developed anti-wear lubricants for new, high-tech military vehicle engines. It has also worked on nano friction-reducing self-repairing additives for military jeeps and tanks. These additives self-repair engines and improve engine power, torque, and fuel consumption.[1135] [1136]
- This lab has also worked with the 5719 Factory [5719 厂] on remanufacturing technology for PLAAF combat aircraft engines. The lab has worked on remanufacture of imported aircraft engine compressor blades [进口飞机发动机压气机叶片].[xlviii] [1137] [1138]

Leadership and Key Personnel:

- Director: Zhu Sheng [朱胜][1139] [1140]
  - Division Deputy Grade Senior Colonel
- Deputy Directors: Wang Haidou [王海斗]; Xu Yi [许一][1141] [1142]
- Founder: Xu Binshi [徐滨士][1143] [1144] [1145]
  - CAE Academician and PLA Major General.
  - Expert in remanufacturing engineering and surface engineering.
  - Called the "Father of Chinese Remanufacturing" and the "Tank Nanny."

Key Personnel

- Dong Shiyun [董世运][1146]
  - Key researcher on tank engine remanufacturing and lifespan increase.

Notable Collaborations:

Domestic

- In 2013, this lab signed a three-way agreement with Yanshan University and XCMC Group [徐工集团] to cooperate in engineering and machinery remanufacturing.[1147]
- In 2020, Director Xu Bin and his team began collaboration with Zhangjiakou Bochuang Intelligent Manufacturing Incubator Co. [张家口博创智造孵化器有限公司] to build a machinery manufacturing industry cluster and equipment manufacturing base, among other things. Research will focus on remanufacturing of key construction machinery parts, including gears, drive shafts, and engine parts, extending product lifecycles and reducing maintenance and replacement costs. It will have 500,000 RMB in research funding.[1148]
- The lab established a Recycling Economy Manufacturing Technology Innovation Industry Strategic Alliance [循环经济再制造技术创新产业战略联盟] with Huizhou Zhongrunda Remanufacturing Co. [惠州中润达再制造科技有限公司].[1149]

[xlviii] More technical details about remanufacture of imported engine compressor blades is available upon request.

- The lab oversees the National Green Manufacturing Standardization Technology Committee [全国绿色制造标技术准化技术委员会再制造分技术委员会].[1150]
- In July 2017, the PRC established the Equipment Parts Remanufacturing Industry Alliance [设备零部件再制造产业联盟], consisting of this lab, North China University of Technology, and Beijing Aoyu Kexin Equipment Remanufacturing Research Institute [北京奥宇可鑫装备再制造技术研究院].[1151]
- This lab, along with the Machine Product Remanufacturing National Engineering Research Center [机械产品再制造国家工程研究中心], established the Beijing-Tianjin-Hebei Remanufacturing Industry Technology Research Institute [京津冀再制造产业技术研究院], which focuses on auto parts, oil mining machinery, agricultural machinery, and engineering machinery, and aims to be one of the top such centers in the world.[1152]

International

- According to an overview from 2011, this lab has allegedly established close relationships with unnamed U.S., U.K., French, Japanese, Polish, and German institutions.[1153]
- This lab hosted a delegation from the U.K. in 2016, including personnel of the U.K. government and University of Brighton. It was organized by a Professor at the University of Brighton who was serving as a visiting scholar to this lab. Cutting edge remanufacturing practices in the U.K. were discussed. The U.K. and PRC delegations agreed to more closely cooperate in research, innovation, technical development, and joint funding and investment. No mention is made of the lab's PLA affiliation, and all personnel are in civilian dress (although this is not particularly unusual). Cooperation between the two sides has continued into 2018.[1154] [1155]

Lab Equipment:

- Lab facilities include:
  - Surface analysis instruments
  - Rapid forming systems
  - Surface coating preparation facilities[1156]

Address:

Dujiakan, Fengtai District, Beijing [北京市丰台区杜家坎][1157]

Website:

None Found

Known Aliases:

- National Defense Key Laboratory for Remanufacturing Technology
- Key Laboratory of National Defense Science and Technology of Equipment Remanufacturing Technology
- Key Laboratory of Remanufacturing Technology [装备再制造技术重点实验室]

44. Defense S&T Key Laboratory of Solid Rocket Engine Combustion, Thermal Structure, and Inner Flow Field

Official English Name: State Key Laboratory of Combustion, Thermal Structure and Inner Flow Field[1158]

Chinese Name: 固体火箭发动机燃烧、热结构与内流场国防科技重点实验室

Research Field: Aerospace – Space Vehicles (*Also: Ballistic Missiles*) – Propulsion (*Also: Simulation & Modeling*)

Affiliations:

- Northwestern Polytechnical University (NWPU) [西北工业大学]
  - School of Astronautics [航天学院]
- China Aerospace Science and Technology Corporation (CASC) [中国航天科技集团]
  - 4th Academy Xi'an Aerospace Propulsion Research Institute [第四研究院西安航天动力研究所]
    - *(a.k.a. CASC 41st Research Institute [41 研究所])*

Key Data:

- Established: 1991
- Total Funding: over 200m RMB[xlix]
- Personnel: 37-48[1159] [1160] [1161]
- Official start of operations: 1995
- Floor Space: approx. 15,000 sqm

Lab Overview:

The Defense S&T Key Laboratory of Solid Rocket Engine Combustion, Thermal Structure, and Inner Flow Field claims to be the PRC's only national key lab dedicated to solid rocket propulsion, with a particular focus on advanced spaceflight propulsion technology, combustion flow, heat transfer, ablation mechanisms for spaceflight propulsion, and engine insulation.[1162]

The lab is jointly managed by NWPU and CASC's 41st Research Institute, and is a major research base for the 41st RI's rocket engine products. The 41st RI, established in 1964, has been

[xlix] At founding

responsible for over 80 types of solid rocket engines (as well as some liquid engines) for spaceflight and missiles, including the Long March line of rockets and the JL-series of SLBMs. It has also developed various other products for spaceflight (including the docking mechanism for the Tiangong 1 space station and escape system for the Shenzhou spacecraft) and guidance and control systems for air-to-ground missiles.[1163] [1164] [1165] [1166] [1167]

Further Information:

- The lab oversees three National Defense S&T Innovation Teams. It has also established a Space Propulsion Technology Cooperation and Innovation Center [航天动力技术协同创新中心] for the Ministry of Industry and Information Technology [工信部] and the Shaanxi Aerospace Power Research Institute [陕西省空天动力研究院] for the Shaanxi provincial government.[1168]
- In 2010, this lab received a significant expansion, providing better conditions for the lab's mission of improving the PRC's independent innovation capabilities in the field of solid rocket engines. SASTIND's Science, Technology, and Quality Division [科技与质量司] was responsible for overseeing the expansion.[1169]
- CASC’s 4th Academy relied on this lab to establish its Solid Rocket Engine R&D Center [固体火箭发动机研发中心].[1170]

Research Direction:

1. Advanced spaceflight power technology [先进宇航动力技术]
2. Combustion, flow, heat transfer, and ablation mechanisms related to spaceflight power [先进宇航动力中的燃烧、流动、传热、烧蚀机理][1171]

Other notable research areas:

- Engine insulation, throat lining and ablation mechanisms
- Unstable combustion
- Combustion of energetic materials
- Boron-holding flame-rich propellants
- Rocket-base combined cycle engines
- Energy-managed solid engines and microwave electric propulsion
- Advanced designs and simulation platforms for propulsion systems
- Metal particle combustion
- Unsteady flow
- Two-phase flow in engines
- Numerical simulation of combustion and flow
- Gas flow regulation
- Heat transfer and thermal protection material ablation mechanisms
- Space propulsion technologies like solid micro-propulsion and electric propulsion
- Solid rocket ram engines
- Energy management solid engines
- Powder rocket engines[1172]

Notable Applications:

- As part of the 41st RI, this lab was likely involved in development of propulsion systems for various spaceflight and missile programs, including the Long March rockets and the JL-series SLBMs. Lab researcher Hou Xiao was lead designer for the JL-2 SLBM.[1173]
- This lab has worked with the PLARF/PLASAF on missile combustion reliability.[1174]

Leadership and Key Personnel:

- Director: He Guoqiang [何国强][1175]

Key Personnel:

- Hou Xiao [侯晓][1176]
  - CAE Academician.
  - Lead engineer for JL-2 SLBM.

Notable Collaborations:

Domestic

- This lab participated in the CASC's 3rd Specialist Information Network's 37th Technical Exchange Conference and 1st Joint Aerospace Power Conference [中国航天第三专业信息网第三十七届技术交流会暨第一届空天动力联合会议]. Other participants included multiple CASC and CASIC subsidiaries, Rocket Force Engineering University, Beijing Aerospace Long March S&T Information Research Institute [北京航天长征科技信息研究所], AVIC China Air-to-air Missile Research Institute [中国空空导弹研究院], National University of Defense Technology [国防科技大学], Navy Aviation Engineering College [海军航空工程学院], Air Force Engineering University [空军工程大学], CARDC (PLASSF Base 29), and dozens of other universities and research institutes.[1177]
- This lab participated in the 1st China Aerospace Propulsion Technology Forum [中国空天推进技术论坛] in 2018. Notable collaborators included CASC, multiple spaceflight-oriented labs, the National Defense S&T Key Laboratory of Hypersonic Ramjet Technology [高超声速冲压发动机技术国防科技重点实验室], the National University of Defense Technology, and Rocket Force Engineering University.[1178]
- This lab is associated in some way with the Xi'an Bell Petrochemical Technology Co [西安贝尔石油化工科技有限责任公司], a petrochemical and fracking company which may utilize solid rocket engines.[1179]

International

- In 2019, this lab organized that year's International Workshop on Space Propulsion in Xi'an along with the Xi'an National Civilian Aerospace Industrial Base [西安国家民用航天产业基地], the CASC Xi'an Aerospace Propulsion Research Institute (41st RI) Key Lab of Liquid Rocket Engine Technology [西安航天动力研究所液体火箭发动机技术重点实验室], and Germany's Technical University of Munich. Conference participants came from Stanford University, Bundeswehr University Munich (a major German military academy), University of Stuttgart, CERFACS (a major European research institute for high-performance computation), ONERA (the French national aerospace research center), Sweden's Lund University, and Moscow State University. The 2018 conference also featured He Guoqiang of this lab as a speaker, along with multiple international speakers, including a rocket propellant expert from Purdue University in the U.S.[1180] [1181]

Lab Equipment:

- The lab’s total equipment value is around 40m RMB. The original value of the lab's equipment is 300,000 RMB.
- Lab equipment includes:
  - Flow stability numerical simulation equipment
  - ECR electric thrusters
  - Advanced power design platform
  - X-ray real-time screen analysis system
  - Rocket ramming combination engine test system
  - PDPA and PLIF high-speed motion analyzers
  - PLIF (Planar Laser Induced Fluorescence) experimental system[1182] [1183]

Address:

Likely co-located with NWPU at 127 Youyi West Road, Xian, Shaanxi Province [陕西省西安市友谊西路 127 号]

Website:

kypt.nwpu.edu.cn/index.php?c=content&a=show&id=359

Known Aliases:

- National Key Laboratory of Combustion, Flow and Thermo-Structure
- National Key Laboratory of Combustion, Thermostructure and Flow of SRM

- 固体火箭发动机燃烧结构与内流场国防科技重点实验室
    - Same name as official, but with no comma
- Defense S&T Key Laboratory of Solid Rocket Engines [固体火箭发动机国防科技重点实验室]
- 固体火箭发动机国防重点实验室
- 固体火箭发动机重点实验室

45. Defense S&T Key Laboratory of Sonar Technology

Official English Name: Unknown

Chinese Name: 声纳技术国防科技重点实验室

Research Field: Maritime – Underwater Vehicles – Acoustics (*Also: Communications Technologies, GNC, Information Processing, Target Detection/Recognition*)

Affiliations:

- China State Shipbuilding Corporation (CSSC) [中国船舶集团]
    - Hangzhou Institute of Applied Acoustics [杭州应用声学研究所]
        - *(a.k.a. CSSC 715th Research Institute [715 研究所])*

Key Data:

- Established: c. 1996
- Total Funding: Unknown
- Personnel: 31[1184] [1185] [1186]
- Official start of operations: Unknown
- Floor Space: 3,114 sqm

Lab Overview:

The Defense S&T Key Laboratory of Sonar Technology is tasked with the development of new types of sonar, as well as research into maritime acoustics, detection, navigation, communications, and signal processing.

Prior to its founding, likely around 1996, this lab may have been known as the 715th Research Institute Submarine Sonar Research Office [715 所潜艇声纳研究室]. Its predecessor likely dates back to at least 1962, making it one of the PRC's oldest sonar R&D institutions.[1187]

The lab's parent institution, the CSSC Hangzhou Institute of Applied Acoustics (a.k.a. the CSSC 715th RI), was established in 1958. It conducts research into maritime hydroacoustics, as well as optical and magnetic sensing equipment. It is on the U.S. Commerce Department Entity List for export control.[1188] [1189] [1190]

Further Information:

- Much of the lab and its parent Institute's research is conducted out of Hangzhou's West Lake [西湖], specifically the west side of the lake.[1191]

Research Direction:

No formal declaration of research direction was found, but prominent research areas include:

1. New types of underwater acoustic transducers
2. Signal processing technology
3. Communications networks
4. Research of underwater target detection and tracking, navigation, and communications

Other Notable Research areas:

- Sonar information processing and resolution
- Low-frequency, high-power acoustic transmitter technology
- Remote weak signal detection and resolution technology
- New types of energy transfer between electric energy and acoustic energy
- Low-frequency broadband transducer technology for new transducer materials, structures, and mechanisms[1192] [1193]

Notable Applications:

- This lab is primarily tasked with developing new types of sonar for PRC vessels, including waveguide sonar [波导声纳].[1194]
- This lab (via lead designer Zhou Lisheng) was involved in the development of the PRC's Haiyan [海眼] long-range towed-array anti-submarine monitoring sonar. It also incorporates a database system which records signals from adversary ships and submarines and distributes them to PLAN subs, aircraft, and intelligent mines to ID, track, and strike these targets.[1195] [1196]
- Lab Director Gong Xianyi was a driving force behind the PRC's 1st, 2nd, and 3rd-generation sonars for its nuclear and conventional submarines. Most of this was before the formal establishment of this lab (when it was still a research office under the 715th RI), but the SQG-207 sonar (utilized on Yuan and Shang class submarines), was developed under Gong in the 1990s, possibly in the early years of this lab.[1197] [1198] [1199]
- This lab also develops other related technologies, including underwater communications and alarm systems.[1200]

Leadership and Key Personnel:

- Director: Du Shuanping [杜拴平][1201]
- Academic Committee Director: Yang Desen [杨德森][1202]
    - Also associated with the Defense S&T Key Laboratory of Hydroacoustic Technology at Harbin Engineering University, see that entry for more.
- Founder: Gong Xianyi [宫先仪][1203] [1204] [1205] [1206] [1207] [1208]
    - CAE Academician and one of the PRC's leading sonar experts.
    - Studied at U.S. Case Western Reserve University 1985-87.
    - Gong has helped develop the PRC's 1st, 2nd, and 3rd-generation submarine sonar systems. He has also conducted comprehensive assessments of acoustic conditions in the South China Sea. He developed the PRC's first indigenously designed submarine sonar (Type 603), a two-type comprehensive sonar used by the PRC's second generation conventional submarines, and the first sonar system with a centralized display [集中显示] and comprehensive control [综合控制] (the 265 Sonar, in the late 1980s), and a new outboard array sonar. He was involved in the development SQG-207 sonar in the 1990s.

Notable Collaborations:

Domestic

- This lab is one of the main PRC institutions for research into hydroacoustics. It has collaborated in multiple projects in this area over the years. It frequently collaborates with other such institutions, including the Key Labs of Hydroacoustic Technology, Underwater Acoustic Countermeasures, Underwater Measurement and Control Technology, Acoustic Fields and Acoustic Information, and Ship Vibration and Noise.[1209] [1210]

International

- In an unidentified year (prior to 2006), this lab allegedly worked with the Institute of Applied Physics at the University of Washington in the U.S. to conduct acoustic experiments on the seafloor, including acoustic scattering, seafloor reverberation, and inversion of seafloor parameters, as well as modeling of high-frequency acoustic scattering. The cooperation continued on afterward for an indeterminate length of time.[1211]
- This lab participated in the 2005 7th International Conference on Theoretical and Computational Acoustics, where a Canadian researcher was said to be impressed with their results and expressed a desire to collaborate. As of 2006, this lab has ongoing cooperation agreements with several foreign institutions, and has invited multiple foreign experts to come lecture.[1212]
- This lab co-sponsored, along with five other acoustic research labs, the 2016 IEEE Oceanic Engineering Society China Marine Acoustics Symposium [IEEE/OES 中国海洋声学研讨会], which featured participation of both foreign and domestic experts. The six key labs

involved in hosting this event were the Key Labs of Hydroacoustic Technology, Underwater Acoustic Countermeasures, Underwater Measurement and Control Technology, Acoustic Fields and Acoustic Information, and Ship Vibration and Noise, in addition to this lab. The event was held in Harbin and co-hosted by Harbin Engineering University and the Belgian university Université Libre de Bruxelles. The Chinese language announcement for this symposium even explicitly connects the hydroacoustic research of this symposium to the PRC's national strategy of becoming an oceanic power for economic development, national sovereignty, and military power. The event was the brainchild of Professor Yang Desen of HEU, who is also closely associated with the Defense S&T Key Lab of Hydroacoustic Technology, and Jean-Pierre Hermand of Université Libre de Bruxelles. A similar conference was scheduled to be held in 2021.[1213] [1214]

Lab Equipment:

- This lab has access to the 715th RI's anechoic pool (the world's largest indoor low and medium frequency anechoic poll) and variable temperature and pressure acoustic testing equipment.[1215] [1216]

Address:

715th RI Building #3, Pinfeng Village, Xihu Distrist, Hangzhou, Zhejiang Province [杭州市西湖区屏峰村][1217]

An alternative address is No. 715 Pinfeng Street, Liuxia Subdistrict, Xihu District, Hangzhou, Zhejiang Province 310023 [浙江省杭州市西湖区留下街道屏峰 715 号 邮编：310023][1218]

Website:

None found, but the 715th RI has a website at https://www.715.com.cn/

Known Aliases:

- Science and Technology on Sonar Laboratory
- National Key Lab of the 715th Research Institute [七一五所国家重点实验室]
- Key Laboratory of Sonar Technology [声纳技术重点实验室]

46. Defense S&T Key Laboratory of Space Environmental Materials Behavior and Evaluation Technology

Official English Name: National Key Laboratory of Space Environmental Materials Behavior and Evaluation Technology

Chinese Name: 空间环境材料行为及评价技术国防科技重点实验室

Research Field: Aerospace – Space Vehicles – Materials (*Also: Impact & Damage, Reliability/Environmental Engineering, Simulation & Modeling*)

Affiliations:

- Harbin Institute of Technology (HIT) [哈尔滨工业大学]
  - School of Materials Science and Engineering [材料科学与工程学院]
- (Unconfirmed) China Aerospace Science and Technology Corporation (CASC) [中国航天科技集团][l]
  - China Academy of Space Technology (CAST) Lanzhou Institute of Physics [兰州空间技术物理研究所]
    - *(a.k.a. CASC 510th Research Institute [510 研究所])*

Key Data:

- Established: 2000
- Total Funding: Unknown
- Personnel: 16[li] [1219] [1220] [1221]
- Official start of operations: 2012
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Space Environmental Materials Behavior and Evaluation Technology conducts research into materials in space environments, primarily for the PRC's space program. This includes development of new space materials and protective technologies and evaluating the reliability and lifespans for materials and components in orbit.

In addition to being subordinate to Harbin Institute of Technology, this lab may also be subordinate to CASC's Lanzhou Institute of Physics, but this is unconfirmed (see below).

Further Information:

- This lab may share an affiliation with the CASC Lanzhou Institute of Physics (a.k.a. the CASC 510th Research Institute), but the nature of this relationship, and indeed whether one exists at all, remains unclear. What is known is that the 510th RI also has a subordinate

[l] The 510th RI's involvement with this Lab is unconfirmed

[li] This may apply only to the Harbin branch.

National Defense Key Lab of the exact same name, located in Lanzhou. However no evidence could be found directly linking the Laznhou lab to its Harbin counterpart, and individual researchers are associated with one or the other, with no apparent overlap. The two labs can be found interacting, but this appears to be primarily due to their similar research aims. The exact nature of the relationship between these two institutions thus remains unclear, although it is probable the two labs are affiliated, as many such labs are joint ventures between SOEs and universities but oftentimes do not make that connection clear. However, until a relationship can be firmly established, this entry concerns itself solely with the Harbin Lab.[1222] [1223]

Research Direction:

1. Reliability evaluation and lifespan assessment for materials and components in orbital service [航天器用材料及元器件在轨服役期间可靠性评价及寿命评估所需解决的基础理论及相关技术]
2. New space materials and protective technologies [新型空间材料及防护技术][1224]

Other Notable Research areas:

- Material interactions in a space environment
- Simulation of space environment effects and other effectiveness criteria
- Acceleration testing principles
- Damage theory
- Performance evaluation theory
- Orbital lifespan prediction and protection theory
- Key technologies for evaluating effects of space materials
- New materials and protection technologies for spacecraft
- Low temperature, vacuum, and radiation technologies[1225]

Notable Applications:

- This lab's research is likely applied to the materials utilized by a wide range of PRC space vehicles, including its various rockets, spacecraft, and satellites.

Leadership and Key Personnel:

- Director: Geng Lin [耿林][1226] [1227]
- Deputy Director: Wu Yiyong [吴宜勇][1228]
    - Research on environmental effects and damage mechanisms of space solar cells, irradiation damage and atomic oxygen erosion mechanisms of polymeric materials,

material irradiation and conductivity effects, and material surface science and technology.

Key Personnel:

- Li Chundong [李春东][1229]
    - Researches space environment equivalent simulations and accelerated test technology, principles, and methods, space damage behavior, protection and new materials for spacecraft thermal control materials, preparation and characterization of ZnO nanostructures, nanomaterials and devices, and smart materials.
    - Was a short-term visiting scholar in 2006 at the ITL Space Technology Company in Canada. Grad students he has advised have studied at U.S. institutions, including the University of Washington, U.S. Department of Energy National Laboratory, and Dartmouth University, between 2011-2014.
- Qin Wei [秦伟][1230]
    - Researches energy conversion materials and devices, composite materials, and space environment damage effects.
- Li Xingji [李兴冀][1231]
    - Researches space environmental effects, radiation physics, semiconductor materials and defects, space environmental physics, and material irradiation damage.
    - Has worked on projects for the European Space Agency, including Astrium, TRAD, and Space Environment and Effects Simulation.
    - From 2012-2013 studied at Freiberg University of Mining and Technology in Germany.

Notable Collaborations:

Domestic

- HIT signed a strategic cooperation framework agreement with CASIC's Hunan Aerospace [湖南航天] in 2017, which included this lab as an interested party. The agreement mentioned promoting the role of new materials in military-civil fusion [军民融合], developing new materials for the equipment, technology, and product fields, strengthening exchange and cooperation with Hunan Aerospace in the fields of new space materials, space material genomes, and testing materials in a space environment. Hunan Aerospace subsidiaries involved in this agreement included the New Materials Research Academy [新材料研究院], Wuhan Magnetism-electron Co. [武汉磁电公司], Sanfeng Co. [三丰公司], and Tianlu Testing Co. [天麓检测公司].[1232]
- In 2019, this lab co-hosted with several other research institutions the 3rd National Academic Conference on Hypersonic Collisions [第三届全国超高速碰撞学术会议].

This included 57 work units, including an unspecified number of military work units. A speaker from Manchester University in England, Li Qingming [李庆明], also spoke.[1233]

International

- None Found

Lab Equipment:

- This lab utilizes multiple types of equipment for simulating the effects of a space environment, including:
    - Space materials positive ion irradiation simulation system
    - Vacuum thermal cycle simulation system for space
    - Vacuum low-temperature friction wear system for space materials
    - Space atomic oxygen effects simulation system
    - Space debris high-speed impact simulation system
    - Space dust high-speed impact simulation system
    - Space material vacuum gas precipitation test device
    - Material vacuum/low temperature hydraulic servo MTS tester
    - Precision multi-functional low-temperature static load material testing machine
    - Material vacuum/low-temperature tensile-compression fatigue testing machine
    - Material low-temperature thermal expansion coefficient testing device[1234]
    - Comprehensive irradiation simulation system for space materials
        - Final vacuum: 10-7torr; temperature range of thermal cycling: 77 ~ 400; wavelength of solar electromagnetic radiation: 200 ~ 2500nm; Wavelength of vacuum ultraviolet radiation: 1 ~ 200nm; electron-beam irradiation intensity: 1 ~ 50μa; proton-beam irradiation intensity: 1 ~ 50μa[1235]

Address:

Building #9, Harbin Institute of Technology, No. 92 West Xizhi Road, Nangang District, Harbin, Heilongjiang Province [哈尔滨市南岗区西大直街 92 号 哈尔滨工业大学 9 号楼][1236]

Website:

http://mse.hit.edu.cn/2015/0708/c3817a99883/page.htm

Known Aliases:

- National Key Laboratory of Materials Behavior and Evaluation Technology in Space Environment [空间环境材料行为及评价技术国家级重点实验室]
  - Most common English translation
- National Key Laboratory of Materials Behavior and Evaluation Technology in Space Environment [空间环境材料行为与评价技术国家级重点实验室]
  - Same name in English, but uses a different character for "and" (与 rather than 及)

47. Defense S&T Key Laboratory of Space Flight Dynamics Technology

Official English Name: State Key Laboratory of Space Flight Dynamics[1237]

Chinese Name: 航天飞行动力学技术国防科技重点实验室

Research Field: Aerospace – Space Vehicles (*Also: Non-ballistic Missiles*) – Space Operations (*Also: GNC, Hypersonic Technologies, Simulation & Modeling*)

Affiliations:

- Northwestern Polytechnical University (NWPU) [西北工业大学]
  - School of Astronautics [航天学院]
- PLA Strategic Support Force
  - Beijing Aerospace Control Center (BACC) [北京航天飞行控制中心]
    - *(a.k.a. PLA Unit 63920 [63920 部队])*

Key Data:

- Established: 2010
- Total Funding: Unknown
- Personnel: approx. 45[1238] [1239] [1240]
- Official start of operations: 2010
- Floor Space: over 4,000 sqm

Lab Overview:

The Defense S&T Key Laboratory of Space Flight Dynamics Technology is focused on various aspects of spaceflight, including orbital mechanics, manned spaceflight, deep space exploration, flight planning and control, and ground experimentation and verification.[1241]

The lab is jointly managed by Northwestern Polytechnical University (NWPU) and the Beijing Aerospace Control Center (BACC), itself subordinate to the PLA Strategic Support Force, meaning this lab is directly subordinate to the Chinese military. The BACC, established in 1996, is the primary command center for PRC space missions, as well as TT&C of satellites and spacecraft via both ground-based stations and the sea-based Yuanwang support ships.[1242]

Research Direction:

1. Orbital dynamics, planning and control [轨道力学、规划与控制]
    - Satellite formation flight
    - Large, flexible spacecraft
    - Deep space exploration
    - Trajectory optimization
    - Non-Keplerian orbit control
    - Attitude-orbit-multi-body coupling
    - Rigid-flexible coupling
2. Space operations and applications [空间操作与应用]
    - Orbit avoidance
    - Orbit transfer/lifting
    - Close observation and inspection
    - Rendezvous and docking
    - In-orbit payload release
    - In-orbit maintenance
    - Module replacement
    - Fuel replenishment
    - Orbit and attitude reset
    - In-orbit assembly and reconstruction
    - End-of-life and destruction maneuvers
    - Orbit transfer/lifting
    - Close observation and inspection
    - Rendezvous and docking
    - In-orbit payload release
    - In-orbit maintenance
    - Module replacement
    - Fuel replenishment
    - Orbit and attitude reset
    - In-orbit assembly and reconstruction
    - End-of-life and destruction maneuvers
3. Flight ground experimentation and verification [飞行地面试验与验证]
    - Similarity theory of space operation ground experiments
    - Liquid buoyancy/electromagnetic force hybrid levitation systems
    - Bonding diagram theory-based ground experiment similarity analysis
    - Hybrid levitation experiment test methods
    - Cyber space-assisted simulation experiment methods

Other Notable Research areas:

- Rocket malfunction simulation and semi-physical simulation systems
- Space non-cooperative target grasping dynamics and control
- Ground-based microgravity environment construction and applications
- Small UAV target detection
- Hypersonic vehicle surface control[1243] [1244] [1245]

Notable Applications:

- This lab was involved in the launch of the Tiangong-1 space station. A team from this lab, led by then-Director Tang Geshi, was present at launch monitoring "their" flight control software to ensure the craft was in correct orbit. Tang's team also played a key role in the rendezvous and docking of the Shenzhou-8, 9, and 10 with the Tiangong-1.[1246] [1247]

- This lab was involved in development of the Tianji Small Satellite Constellation.[1248]
- In 2008, researcher Yan Jie [闫杰] was awarded a 2nd Class Military S&T Progress Award for the project, "(REDACTED) Missile Research and Development" [XXX 导弹研制]. While unconfirmed, the redacted part could be referring to Air-to-air missiles and/or perhaps infrared missiles, as Yan was engaged in such research in 2008.[1249] [1250]

Leadership and Key Personnel:

- Director: Luo Jianjun [罗建军][1251]
- Former Director: Yuan Jianping [袁建平][1252]
- Former Director: Tang Geshi [唐歌实][1253]

Notable Collaborations:

Domestic

- This lab is asociated with the Collaborative Innovation Center of Future Aerospace Vehicle (*sic*) [未来飞行区协同创新中心] at NWPU, a consortium which includes several universities, defense SOEs (CASC, CASIC), and CARDC (PLASSF Base 29).[1254]
- This lab has a cooperative relationship with the Shanghai Aerospace Technology Research Institute [上海航天技术研究院].[1255]
- In 2011, this lab created the Joint Research Center for Remote Operation of Deep Space Exploration [深空探测遥操作联合研究中心] with the CAS Institute of Remote Sensing Digital Earth National Engineering Laboratory of Remote Sensing Satellite Applications [中科院遥感与数字地球研究所遥感卫星应用国家工程实验室].[1256]
- In 2018, this lab hosted the 6th National Symposium on Space Flight Dynamics. Participants included SASTIND, CAST (CASC 5th Academy), SAST (CASC 8th Academy), at least three major PLASSF institutions (Xi'an Satellite Measurement and Control Center [西安卫星测控中心], Space Engineering Research Institute [航天工程研究所], and Astronaut Research and Training Center [航天员科研训练中心]), the National University of Defense Technology, and several other universities. Topics included space robotic and robotic arm tele-operations, space tele-operation technology in the context of AI, space operation dynamics, refined lunar surface operations, intelligent image recognition, and microgravity ground simulation environments.[1257]
- Per searches of two scientific databases, this lab has collaborated with PLA Units 63921, 63999, 91206, 94647, 95854, 96271, 96363, and PLASSF Base 26.

International

- This lab claims to have signed cooperation agreements with U.S. Stevens Institute of Technology, Delft University of Technology in the Netherlands, and Technical University of Munich in Germany.[1258]
- An extensive list of foreign collaborations between 2013-2017 on the lab's website claims collaborations with the Stevens Institute of Technology and Utah State University in the U.S., as well as universities from France, Germany, U.K., and Canada.[1259]
- From 2013-2017, the lab's website claims that over 95% of its PhD students were able to study abroad, including at MIT, Stevens Institute of Technology, Utah State University, and Texas Tech in the U.S., as well as Canadian and European Universities.[1260]
- This lab collaborated with the COSMIC Program Office of the University Corporation for Atmospheric Research in Boulder, Colorado (a nonprofit consortium of over 100 U.S. academic institutions) on ionospheric research.[1261]
- This lab collaborated with the German Research Center for Geosciences on thrust maneuvers for uncooperative space objects.[1262]
- Researcher Wang Mingming [王明明] has allegedly collaborated on projects with the German Space Center [德国宇航中心].[1263]

Lab Equipment:

- Virtual prototype integrated design and test system for air and space vehicles
- Multidisciplinary integrated design system for aircraft
- Hybrid buoyancy microgravity simulation experimental system
- Space proximity manipulation and remote operation experimental system
- Electromagnetic system console
- Six-degree-of-freedom rotary table
- Liquid magnetic pool circulation treatment system[1264]

Address:

Appears to have facilities at both of NWPU's campuses at No. 127 Youyi West Road, Xi'an, Shaanxi Province [西安市友谊西路 127 号] and No. 1 Dongxiang Road, Chang'an District, Xi'an, Shaanxi Province [陕西省西安市长安区东祥路 1 号].[1265] [1266]

Website:

http://kypt.nwpu.edu.cn/index.php?c=content&a=show&id=315

Known Aliases:

- National Key Laboratory of Aerospace Flight Dynamics [航天飞行动力学技术国家重点实验室]
- Key Laboratory of Aerospace Flight Dynamics [航天飞行动力学技术重点实验室]
- Flight Dynamics Laboratory, Beijing Aerospace Control Center
- Science and Technology on Aerospace Flight Dynamics Laboratory
- National Key Laboratory of Science and Technology on Aerospace Flight Dynamics
- Key Laboratory of Aerospace Flight Dynamics Technology

48. Defense S&T Key Laboratory of Space Flight Intelligent Control Technology

Official English Name: Unknown

Chinese Name: 宇航智能控制技术国防科技重点实验室

Research Field: Aerospace – Multiple (*Also: Air/Missile Defense, Ballistic Missiles, Non-ballistic Missiles, Space Vehicles, UAVs)* – GNC (*Hypersonic Technologies, Intelligent Technologies, Measurement Technologies, Simulation & Modeling*)

Affiliations:

- China Aerospace Science and Technology Corporation (CASC) [中国航天科技集团]
  - Chinese Academy of Launch Technology (CALT) Beijing Aerospace Automatic Control Institute [中国运载火箭技术研究院北京航天自动控制研究所]
    - *(a.k.a. CASC 12th Research Institute [12 研究所])*

Key Data:

- Established: 2003
- Total Funding: Unknown
- Personnel: Unknown[1267] [1268]
- Official start of operations: 2006
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Space Flight Intelligent Control Technology conducts research into guidance and control technology, with a particular focus on utilizing intelligent technologies to improve flight vehicle (including space vehicle, UAV, and missile) GNC. It is dedicated to improving the PRC's indigenous capabilities in high-tech guided weaponry. It was the first Defense S&T Key Lab approved jointly by COSTIND and the PLA GAD following the reform of the PRC's defense scientific research system.[1269]

This lab may have originally been called the "Defense S&T Key Laboratory of Missile Guidance and Control Technology [导弹制导与控制技术国防科技重点实验室] when it was first established, but that name seems to no longer be used.

The lab's parent institution, the CALT Beijing Aerospace Automatic Control Institute (a.k.a. the CASC 12th RI), was established in 1958 as the PRC's first institution for research of launch vehicle control systems. It is mainly engaged in research of launch vehicle control systems, aerospace control and information, and launch vehicle software testing/evaluation.[1270]

Further Information:

- This lab oversees the Aerospace Intelligent Technology Innovation Center [航天智能技术创新中心]. The Center is divided into four smaller centers focused on intelligent systems technology, intelligent sensing technology, intelligent computing technology, and intelligent systems integration. The Center is aimed at open collaboration with universities and industry to accelerate intelligent technologies for the aerospace field. It was born from the State Council's 2017 Development Plan for a New Generation of Artificial Intelligence [新一代人工智能发展规划] and the 19th Party Congress.[1271]
- This lab co-hosted the BAACI Cup for innovation and creativity in AI.[1272]
- In 2019 and 2020, this lab twice won first place in a CASC competition of 16 of its key labs, 6 of which were under CALT. No mention of what this competition entailed.[1273]
- This lab designed a reusable test and validation platform for its technologies called the "Peacock Platform" [孔雀平台].[1274]
- This lab has published a large number of books on a variety of topics, including on vertical landings for reusable launch vehicles, missile simulations, and other topics related to rocketry. Notably, at least one title refers to navigation and control of both rockets *and* missiles, making clear the dual nature of this lab's work.[1275]

Research Direction:

1. Guidance and control technology [制导与控制技术]
2. Precision guidance technology [精确制导技术]
3. Systems integration technology [系统集成技术]
4. Rapid measurement and control technology [快速测控技术][1276]

Other Notable Research areas:

- Missile guidance and control technology
- Launch vehicle and hypersonic vehicle GNC
- Simulation of anti-missile defense penetration systems
- Electrical systems for manned launch vehicles

- Thermal radiation effects on hypersonic flying vehicles
- Much of the lab's research is focused on incorporating intelligent/AI technology into rockets, missiles, UAVs, etc.[1277]

Notable Applications:

- This lab appears to be a key research lab for the PLA's ballistic missile program. It and its parent 12th RI were involved in the PLA's ASBM program which eventually led to the development of the DF-21D. The Director of the PLASAF Equipment Research Academy was present at the lab's official opening.[1278] [1279]
- This lab, along with the subordinate Aerospace Intelligent Technology Innovation Center [航天智能技术创新中心], created a small reusable launch vehicle that could land vertically, a major breakthrough toward the goal of an eventual full-sized reusable launch vehicle. This smaller rocket tested concepts of precision guidance necessary for reusable vertical landings.[lii] [1280]
- As part of its efforts in intelligent aerospace technologies, this lab took part in work on an intelligent space launch vehicle, developing a "non-programmed guided intelligent control technology" [非程序制导智能控制技术] for a rocket control system. This technology makes the rocket "smarter" by determining and assessing faults mid-flight, and giving the optimal solution, such as adjusting the flight attitude or re-routing the flight path. It will also allow rockets to optimize their flight control plan mid-flight, making autonomous decisions based on the external environment and mission. It enhances the rocket's attitude control, trajectory planning, center-of-mass motion, and environmental awareness, allowing it to better respond to unexpected situations in flight. Yu Chunmei of this lab has also worked on incorporating AI into launch vehicle GNC, mitigating launch failures as it makes adjustments while in flight. This tech was successfully tested using the lab's "Peacock" testing platform.[1281] [1282]
- This lab developed an "Intelligent Target Recognition and Perception Integrated System Platform based on Neuro-Electrophysiology" [基于神经电生理的智能目标识别与感知集成系统平台] which can be used to improve UAV target recognition capabilities by 20%. It can be used as an EEG system, connecting sensors to a human user's head. It senses the user's brain waves to recognize a target without the user having to issue any commands. This technology is useful in situations where weather or obstacles may partially obscure a target and a human user would be better able to recognize a partial target than an AI. The public source advertises only civilian uses like SAR, but the military uses are obvious.[1283]
- Qi Zhenqiang of this lab was involved with developing the Long March-3A launch vehicles and the GNC systems for the Chang'e-1 and Chang'e-2 lunar missions.[1284]
- This lab has researched facial recognition and maritime smart port technology.[1285]

[lii] The video can be found here: https://www.bilibili.com/video/BV1sb411A7oi?from=search&seid=8399245110383015729

Leadership and Key Personnel:

- Director: Unknown
- Dep Directors: Liu Jiarun [柳嘉润]; Yu Chunmei [禹春梅]; Ren Zhang [任章][1286] [1287] [1288]
- Management Office Director: Qi Zhenqiang [祁振强][1289]
- Senior Engineer: Zheng Zhihui [郑智辉][1290]
- Chief Software Engineer: Wang Xiaoling [王晓玲][1291]

Notable Collaborations:

Domestic

- This lab has cooperated with Peng Cheng Laboratory [鹏城实验室], including creation of an Intelligent UAV Swarm Cooperative Control Technology Exchange [智能无人机集群协同控制技术交流会] which conducts research into UAV swarms.[1292] [1293]
- The lab presumably collaborates with the PLARF (former PLASAF). The lab's official founding ceremony was attended by the Director of the PLASAF Equipment Research Academy [二炮兵装备研究院].[1294]
- This lab is a part of the Aviation Control Forum, which was formed in 2001 and holds gatherings every two years. In 2017, this lab hosted the 9th Aviation Control Forum [航控论坛]. Participants included the Ministry of Industry and Information Technology, SASTIND, and the PLA CMC Equipment Development Department. Topics included intelligent and autonomous systems technology, future control and information technology, and intelligent development of aerospace equipment.[1295]
- In 2020, this lab participated in the 2nd Intelligent Precision Strike Systems Frontier Forum [第二届智能精打体系前沿论坛], a conference focused on using intelligent systems and AI for improved precision strike and "intelligentized" operations. Topics included using intelligent systems to improve situational awareness, target identification, more rapid and timely decisionmaking, and intelligent weapons development. Other participants included Xidian University's Defense S&T Key Lab of Radar Signal Processing, the Space Defense Innovation Center [空天防御创新中心], the Shanghai Institute of Electromechanical Engineering, the Beijing Remote Sensing Institute [北京遥感设备研究所], CETC 12th, 29th, and 54th RIs, the Key Lab of Complex Aviation Systems Simulations, the Key Lab of Aerospace Systems Simulations, the Key Lab of Millimeter Wave Remote Sensing Technology, the Key Lab of Satellite Navigation Systems and Equipment Technology, CAS Optoelectrics Signal Processing, the Jiangsu Engineering Research Center for Intelligent Navigation and Control Engineering for Complex Moving Bodies, the Key Lab of Complex Systems Control and Intelligent Cooperation Technology, and others.[1296] [liii]

[liii] Further detailed info on this conference (participants, reports, detailed topics, etc.) is available upon request.

International

- Personnel of this lab are associated with a joint lab with the U.K., the Sino-British Joint Laboratory of Advanced Control System Technology [中英先进控制系统技术联合实验室]. Qi Zhenqiang of this lab is the Director of the Chinese portion of this lab.[1297]

Lab Equipment:

No Information

Address:

None Found, may be co-located with parent institution in the Beijing 1000854 postal code.

Website:

None Found

Known Aliases:

- Defense S&T Key Laboratory of Missile Guidance and Control [导弹制导与控制技术国防科技重点实验室]
    - Name used on the "official" online list of DSTKLs, but less commonly used.
- State Key Laboratory of Space Flight Intelligent Control Technology [宇航智能控制技术国家重点实验室]
- National Key Laboratory of Space Flight Intelligent Control Technology [宇航智能控制技术国家级重点实验]
- Beijing Space Automatic Control Research Key Laboratory [北京航天自动控制研究所重点实验室]
- National Key Laboratory of Science and Technology on Aerospace Intelligent Control
- State Key Laboratory of National Defense for Aerospace Intelligence Control

49. Defense S&T Key Laboratory of Space Microwave Technology

Official English Name: Unknown

Chinese Name: 空间微波技术国防科技重点实验室

Research Field: Aerospace – Space Vehicles (*Also: Communications Equipment*) – Electromagnetics (*Also: Communications Technologies, Countermeasures, Measurement Technologies, Microwave Technologies, Sensing, Terahertz Technologies*)

Affiliations:

- China Aerospace Science and Technology Corporation (CASC) [中国航天科技集团]
  - China Academy of Space Technology (CAST) Academy of Space Information Systems [空间电子信息技术研究院]
    - *(a.k.a. CAST Xi'an Branch [中国空间技术研究院西安分院])*

Key Data:

- Established: 1995
- Total Funding: Unknown
- Personnel: Unknown[1298]
- Official start of operations: 1997
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Space Microwave Technology conducts research into microwave technology for satellite remote sensing, communications, and data transmission in line with the needs of the PRC's space strategy. Secondary areas of research may include precision measurement, space electronic countermeasures, and space debris.[1299]

The lab's parent institution, the CAST (a.k.a. CASC 5th Academy) Academy of Space Information Systems (a.k.a. CAST Xi'an Branch), was formerly known as the Xi'an Institute of Space Radio Technology [西安空间无线电技术研究所/中国空间院西安空间无线所] and the 504th Research Institute. It is mainly engaged in the development and production of space vehicle payloads and electronic systems, aircraft measurement and control systems, and weapons and satellite electronics. It is involved in satellite communications, data transmission, and navigation technology, develops satellite antennas, and is a pioneer in the field of ground, sea, and space-based measurement and control technology. It has provided thousands of pieces of equipment for China's domestically produced communications, broadcasting navigation, remote sensing, meteorological, and scientific satellites, the Shenzhou spacecraft, and ground-based measurement and control equipment.[1300]

Further Information:

- The lab translated the book "Principles of Terahertz Science and Technology" [太赫兹科学与技术原理] (originally published by Springer), and re-published it under the National Defense Industry Press [国防工业出版社].[1301]

Research Direction:

1. Space microwave communications and relays [微波通信转发]

2. Space microwave remote sensing [空间微波遥感]
3. Space microwave real-time high-speed data transmission [空间微波实时高速数传][1302]

Other notable research areas:

- Terahertz spectrum technologies
- Space electronic countermeasures
- Space debris situational awareness[1303] [1304] [1305]

Notable Applications:

- The lab's research has been successfully applied to major space projects such as manned spaceflight, the lunar exploration project, and high-definition earth observations, including:
  - Providing high-precision measurement technology used in the moon landing of the Chang'e 3
  - Significant technical support for deep space exploration
  - Payloads for civil and military communications and remote sensing satellites such as the Zhongxing and Beidou series[1306]

Leadership and Key Personnel:

- Director: Shi Pingyan [史平彦][1307]
- Deputy Directors: Cui Wanzhao [崔万照]; Li Xiaojun [李小军][1308] [1309]

Notable Collaborations:

Domestic

- This lab co-hosted the CAE 4th Space Information Technology and Applications Prospect Academician Forum and the 2017 Annual Conference on Satellite Payload Technology [中国工程院第四届"空间信息技术与应用展望院士论坛"暨2017年卫星有效载荷技术学术年会] with various universities, CASC entities and scholarly associations. It included reports and presentations on military-civil fusion [军民融合] in space, and presenters included the Chinese Academy of Military Science and the 55th Institute [55所] of the PLA Joint Staff Department.[1310]
- This lab co-hosed the 2020 Commercial Aerospace Advanced Communications Technology Forum [商业航天先进通信技术论坛] with the Key Laboratory of Millimeter Wave Remote Sensing Technology [毫米波遥感技术重点实验室], the Ministry of Education Key Laboratory of Equipment Efficiency in Extreme Environments [极端环境

下装备效能教育部重点实验室], and several universities. The director of a PLASSF space organization (Beijing Institute of Tracking and Telecommunications Technology [北京跟踪与通信研究所]) spoke at the event.[1311]

- This lab co-hosed the 2020 Space Electronic Information Academic Exchange Conference [2020 空间电子信息学术交流大会] with the Defense S&T Key Laboratory of Communication Anti-Jamming Technology, the State Key Laboratory of Experimental Physics and Computational Mathematics [试验物理与计算数学国家重点实验室], and other academic organizations. There were numerous reports/presentations by researchers from PLA and defense industry organizations, including PLA Unit 63921, the National University of Defense Technology, and CETC 22nd and 54th RIs.[1312]

International

None found

Lab Equipment:

No information

Address:

None found, possibly co-located with parent institution at No. 504 Chang'an Eastern Street, National Civil Aerospace Industrial Base, Xi'an, Shaanxi Province [陕西省西安市航天产业基地东长安街 504 号][1313]

Website:

None found

Known Aliases:

- National Key Laboratory of Science and Technology on Space Microwave [空间微波技术国家级重点实验室]
- Key Laboratory of Science and Technology on Space Microwave [空间微波技术重点实验室]
- Key Laboratory on Space Microwave [空间微波重点实验室]
- Defense S&T Key Laboratory of Space Microwave [空间微波基础国防科技重点实验室]
- Fundamental Defense Key Laboratory of Space Microwave [空间微波基础国防重点实验室]

- Space Microwave Technology National Defense Key Laboratory

50. Defense S&T Key Laboratory of Specialized Integrated Circuits

Official English Name: Unknown

Chinese Name: 专用集成电路国防科技重点实验室

Research Field: Multi-domain (likely Aerospace, Ground, Maritime) – Multiple (likely Radar, Communications Equipment) – Semiconductors (*Also: Communications Technologies, Materials, Terahertz Technologies*)

Affiliations:

- China Electronics Technology Group Corporation (CETC) [中国电子科技集团]
  - Hebei Semiconductor Institute [河北半导体研究所]
    - *(a.k.a. CETC 13th Research Institute [13 研究所])*

Key Data:

- Established: Unknown
- Total Funding: Unknown
- Personnel: Unknown
- Official start of operations: Unknown
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Specialized Integrated Circuits conducts research into semiconductor technology, including semiconductor materials like gallium nitride, gallium arsenide, and silicon carbide.

This lab is also one of several key labs conducting research into the terahertz spectrum, which it is applying to advanced communications and radar. Lab researcher Feng Zhihong has been involved in efforts to develop indigenous terahertz technology in order to break the embargo of this technology into China.[liv] It is also researching high-speed mobile communications networks.[1314] [1315] [1316]

The lab's parent institution, the CETC Hebei Semiconductor Institute (a.k.a. the CETC 13th RI), was established in 1956. It is one of the PRC's most important research institutes for semiconductors, conducting research related to semiconductors in microelectronics, photoelectronics, microelectronic machinery systems (MEMS), high-tech sensors, and optoelectromechanical integrated microsystems.[1317]

[liv] For further information on labs researching the terahertz spectrum, see Marcus Clay, "The PLA's Pursuit of Terahertz: Facts and Fallacies", *Jamestown Foundation*, 12 November 2020. https://jamestown.org/program/pla-pursuit-terahertz-facts-and-fallacies/

Further Information:

- There is a lab with a very similar name at Fudan University in Shanghai, with one fewer character (国家 vs 国家级, "national" vs "national-level) and known as the "National Key Laboratory of Application Specific Integrated Circuit and System" in English. There is no evidence that these labs are affiliated with one another.

Research Direction:

No formal research direction found.

Other Notable Research areas:

- High Power Terahertz Frequency Multiplier and Synthetic Frequency Multiplier Sources
- Graphene, diamond, and solid-state terahertz
- Gallium nitride and silicon carbide semiconductors
- Diamond material applications in microwave power devices[1318] [1319] [1320] [1321]

Notable Applications:

- This lab's research has been applied to improved semiconductors and semiconductor materials, advanced communications, and radar.
- This lab teamed up with the CAS Suzhou Nano Institute's Key Lab of Nano Devices and Applications [中科院苏州纳米所纳米器件与应用重点实验室] in 2017, successfully improving the frequency of its graphene terahertz detector [石墨烯太赫兹探测器] to 650 GHz, creating the world's first graphene heterodyne mixed frequency detection [石墨烯外差混频探测]. This detector, using graphene, will open a new frontier for terahertz imaging.[1322]

Leadership and Key Personnel:

- Director: Fang Yulong [房玉龙][1323] [1324]
  - Also heads the lab's Epitaxy Department [外延部].
  - Researches Gallium nitride and silicon carbide semiconductors.
- Standing Deputy Director: Feng Zhihong [冯志红][1325]
  - Expert in graphene, diamond, and solid-state terahertz.

Key Personnel:

- Lu Yuanjie [吕元杰][1326]
  - Leads a team focused on InAlN/GaN HEMT devices for semiconductors.

Notable Collaborations:

Domestic

- This lab has collaborated with CAS Suzhou Nano Institute's Key Lab of Nano Devices and Applications [中科院苏州纳米所纳米器件与应用重点实验室], improving the frequency of its graphene terahertz detector (see Notable Applications above).
- This lab co-hosted the 2016 2nd Annual Terahertz Science and Technology Conference [第二届全国太赫兹科学技术学术年会] along with several other institutes and key labs, including the CAS Key Laboratory of Electromagnetic Radiation and Detection Technology [中国科学院电磁辐射与探测技术重点实验室], CAS Key Laboratory of High Power Microwave Source and Technology [中国科学院高功率微波源与技术重点实验室], and CETC 12th RI State Key Laboratory of Microwave Electric Vacuum Devices [微波电真空器件国家重点实验室].[1327]
- This lab co-hosted the 2016 10th National Conference on Composite Semiconductor Materials, Microwave Devices and Photo-Electric Devices [十八届全国化合物半导体材料、微波器件和光电器件学术会议] along with the CAS Semiconductor Research Institute [中国科学院半导体研究所], CETC 55th RI [中国电科 55 所], the CAS Microwave Electronics Institute [中国科学院微电子研究所], and Xiamen University.[1328]

International

- A researcher from U.S. company Plasma-Therm spoke at a semiconductor conference at which personnel of this lab also spoke.[1329]
- This lab cooperated to organize the 10th Sino-International Forum on Semiconductor Lighting [第十四届中国国际半导体照明论坛] and 2017 International Forum for 3rd Generation Semiconductors [国际第三代半导体论坛] (IFWS 2017). These events also included a scholar from the U.K.'s Bristol University. It covered Gallium Nitride microwave devices and monolithic integrated circuit material epitaxy, modeling, design, and manufacturing, reliability technology, and applications in mobile communications.[1330]

Lab Equipment:

No Information

Address:

None found. Its parent institution is in Shijiazhuang, Hebei Province [河北省石家庄市].[1331]

Website:

None Found

Known Aliases:

- Defense S&T Key Laboratory of Gallium Arsenide Super High-speed Integrated Circuits and Power Devices [砷化镓超高速集成电路和功率器件国防科技重点实验室]
    - Name in the "official" online list of DSTKLs, but almost never used.
- National Key Laboratory of ASIC [专用集成电路国家级重点实验室]
- National Key Laboratory of Application Specific Integrated Circuit (ASIC)
    - This name is frequently used and may be the official English name.

51. Defense S&T Key Laboratory of Super High-Temperature Structural Composites

Official English Name: State Key Laboratory of Science and Technology on Thermostructural Composite Materials[1332]

Chinese Name: 超高温结构复合材料国防科技重点实验室

Research Field: Aerospace – Aircraft (*Also: Non-ballistic Missiles, Space Vehicles*) – Materials (*Also: Hypersonic Technologies, Nuclear Technologies, Propulsion, Simulation & Modeling*)

Affiliations:

- Northwestern Polytechnical University (NWPU) [西北工业大学]
    - School of Materials Science and Engineering [材料科学与工程学院]

Key Data:

- Established: 2000
- Total Funding: nearly 300m RMB
- Personnel: 40[1333] [1334]
- Official start of operations: 2004
- Floor Space: approx. 10,000 sqm

Lab Overview:

The Defense S&T Key Laboratory of Super High Temperature Structural Composites conducts research into ceramic matrix composite (CMC) materials, carbon and carbon composites, and high-temp mechanical properties for aerospace propulsion, hypersonic vehicles, aircraft and vehicle braking technology, and materials for use in space and irradiated environments.[1335] [1336]

The lab was the brainchild of CAE Academician Zhang Litong and Professor Yang Jing, and sprung from their research on CMCs and carbon/carbon composites in the early 1990s. Due to the research efforts of this lab, in 2004 China became the second country (after France) to independently master the preparation technology for CMCs.[1337]

Further Information:

- This lab was associated with the 2006 establishment of the Shaanxi Ceramic Matrix Composites Engineering Technology Research Center [陕西省陶瓷基复合材料工程技术研究中心] (later possibly upgraded to the National Engineering Research Center for Ceramic Matrix Composites Manufacturing Technology [陶瓷基复合材料制造技术国家工程研究中心] in 2013) and Shaanxi Carbon/Carbon Composite Engineering Technology Research Center [陕西省碳/碳复合材料工程技术研究中心].[1338]

Research Direction:

1. Ceramic matrix composites (CMC)
2. Carbon/carbon composites
3. High temperature mechanical properties[1339]

Other Notable Research areas:

- Material design
- Efficient and precision forming and processing technology
- Material surface and interface design and preparation technology
- Simulation and characterization of material performance under high-temperature and long-time oxidation/complex stress environments
- Component preparation and application technology development[1340]

Notable Applications:

- This lab's award-winning study, "Development and Application of Functional Composite Materials for Carbon Ceramic Aircraft Brakes"[lv] [碳陶飞机刹车功能复合材料的研制与应用], which included participation from Zhang Litong and Cheng Laifei, resulted in a new carbon composite material for aircraft brakes which was first tested in the J-10 combat aircraft in 2008, and is now utilized by over ten types of fighter (J-10, J-15) and transport (Y-12, Y-20) aircraft, as well as being exported for use in certain Boeing and Airbus airliners. This tech can also be used in tanks and other heavy and high-speed vehicles. It greatly increased aircraft safety and combat effectiveness. This was a joint effort with AVIC's Xi'an Aviation Brake Technology Co. [中航工业西安航空制动科技有限公司].[1341] [1342] [1343]

[lv] "Carbon Ceramic Aircraft Brakes" was redacted in most announcements.

- This lab produced an ultra high-temp ceramic nozzle for the ramjet engine of an unidentified missile [XX 导弹冲压发动机用超高温陶瓷喷管已定型批产].[1344]
- This lab produced a ceramic composite thermal protection system and control rudder for a hypersonic flight vehicle [高超飞行器陶瓷复材热防护系统和控制舵] which has already undergone five flight verifications.[1345]
- This lab developed the "Gaofen special project" remote sensing satellite camera nozzle [“高分专项”遥感卫星相机镜筒].[1346]
- This lab developed the throat lining and thermal protection sleeves [喉衬和热防护套] used in two missile types which were paraded at both the 60th National Day and 70th Victory Day parades.[1347]
- Cheng Laifei's team has designed fiber-toughened ceramic matrix composites which have been used in aircraft engines, high-performance rockets, space vehicle thermal protection systems, aircraft brakes, nuclear and other power stations, and deep space probes.[1348]

Leadership and Key Personnel:

- Director: Cheng Laifei [成来飞][1349]
- Academic Committee Director: Cai Hongnian [才鸿年][1350]
- Deputy Director: Li Hejun [李贺军][1351]
- Founder: Zhang Litong [张立同][1352] [1353]
    - CAE Academician and expert in aerospace materials
    - Worked as a researcher at the NASA Space Structure Materials Commercial Development Center [空间结构材料商业发展中心] from April 1989 to January 1991, where she was responsible for the fiber toughened ceramic matrix composites of a NASA space station.

Notable Collaborations:

Domestic

- This lab developed military and civilian aircraft brakes with AVIC Xi'an Aviation Brake Technology Co. (see Notable Applications above)
- This lab is closely associated with Xi'an Xin Yao Ceramic Composite Material Co. [西安鑫垚陶瓷复合材料有限公司] primarily for military use, which was established with lab Director Cheng Laifei. It claims to be the PRC's only ceramic matrix composites company [陶瓷基复合材料产业化公司].[1354]

International

- This lab hosted the 8th International Ceramic Matrix Composites Conference [国际陶瓷基复合材料会议] in Xi'an in 2013.[1355]

Lab Equipment:

- Despite NWPU being on the U.S. Commerce Department export control list since 2001, this lab advertises its use of several pieces of foreign equipment, including:
    - Instron8801 hydraulic servo universal testing machine [液压伺服万能试验机] from American company Instron
    - S-4700 cold field emission scanning electron microscope from Japanese company Hitachi
    - STA429CD/3/7 high temperature synchronous thermal analyzer from German company NETZSCH
    - EMGA-620W oxygen-nitrogen co-meter from Japanese company Horiba
- Other domestically produced equipment includes:
    - Material electromagnetic parameter testing system
    - Chemical vapor permeation silicon carbide substrate preparation furnace
    - Vacuum and atmosphere tube furnace
    - Large vacuum induction hot pressing furnace[1356]

Address:

No. 127 Youyi West Road, Xian, Shaanxi Province [陕西省西安市友谊西路 127 号][1357]

Website:

http://kypt.nwpu.edu.cn/index.php?c=content&a=show&id=301

Known Aliases:

- National Key Laboratory of Thermostructure Composite Materials [超高温结构复合材料国家级重点实验室]
- Key Laboratory of Thermostructure Composite Materials [超高温结构复合材料重点实验室]
- Defense S&T Key Laboratory of Superhigh Temperature Composites [超高温复合材料国防科技重点实验室]

- National Key Laboratory of Superhigh Temperature Composites [超高温复合材料国家级重点实验室]
- Science and Technology on Thermostructural Composite Materials Laboratory (TSCM)
- State Key Laboratory of Superhigh Temperature Composites
- Science and Technology on Thermostructural Composite Materials Laboratory
- Key Laboratory of Ultrahigh Composites
- Ultra-High-Temperature Structural Composites Laboratory
- Science and Technology on Thermostructure Composite Materials Laboratory
- Key Laboratory of Superhigh Temperature Composites

52. Defense S&T Key Laboratory of Tunable Gas Lasers

Official English Name: National Key Laboratory of Science and Technology on Tunable Laser[1358]

Chinese Name: 可调谐气体激光国防科技重点实验室

Research Field: Aerospace – Space Vehicles (*Also: Communications Equipment*) – Communications Technologies (*Also: Laser Technologies, Measurement Technologies, Optoelectronics, Sensing, Terahertz Technologies*)

Affiliations:

- Harbin Institute of Technology (HIT) [哈尔滨工业大学]
  - School of Astronautics Institute of Optoelectronics [哈尔滨工业大学航天学院光电子技术研究所]

Key Data:

- Established: 1994
- Total Funding: Unknown
- Personnel: 42[1359] [1360] [1361]
- Official start of operations: 1997
- Floor Space: approx. 8,500 sqm

Lab Overview:

The Defense S&T Key Laboratory of Tunable Gas Lasers, regarded as a top Chinese institution for research and indigenous innovation, is dedicated to narrowing the gap internationally in the field of opto-electric technology. It researches tunable laser technology, nonlinear optical technology, and laser communications in space, with the goal of creating superior space-based communications and data transmission, remote sensing, and "control of the information initiative in space."[1362]

Further Information:

- The lab has five subordinate labs, three offices, and numerous research teams, including:
  - *Mid- and Far-Infrared Tunable Laser Technology Research Team* [中远红外可调谐激光技术研究团队], led by Professor Yao Baoquan [姚宝权], which conducts research on long-wave infrared solid-state lasers.
  - *Satellite Laser Communications Team* [卫星激光通信团队], established in 1991 and later attached to this lab. In 2011, it successfully completed China's first low-orbit satellite-ground laser communication test. Between May and August 2017, it successfully completed the world's first synchronous satellite and ground two-way high-speed laser communications with a data rate of 5 GB per second.
  - *Laser Space Information Technology and Applications Team* [激光空间信息技术与应用团队].[1363 1364]
- This lab utilizes a laser damage dynamics experimental station [激光损伤动力学实验站] specializing in research on high-power laser-material interactions and damage mechanisms of optical components for laser-driven inertial confinement fusion engineering (ICF). It claims to be the only lab in China to conduct research on the interactions between high-power pulsed lasers and various materials. Currently, it is the only laser device in domestic universities that adopts the "Shen Guang-III" [神光-III] structure and realizes a highly integrated optical path.[1365]
- In 2020, HIT began construction of a Key Lab Cluster [重点实验室集群] in Shenzhen featuring research space for several of its key labs, including this one. The cluster will focus on automated products, high-end equipment design and distribution, technical transformation and improvements, and guiding production applications and industrialization. It is set to open in December 2023.[1366]
- This lab provides detailed information on its role in every recent FIve Year Plan:
  - During the 9th Five Year Plan (1996-2000), this lab was tasked with developing long-wave infrared CO2 pulsed external differential coherent detection laser imaging technology [长波红外 CO2 脉冲外差相干探测激光成像技术] with stronger cloud and fog penetration abilities, 3 km target laser intensity and range imaging [3 km 目标激光强度像和距离像].
  - During the 10th Five Year Plan (2001-2005), this lab was responsible for a major project on developing domestic flashing streak tub laser imaging radars [闪光式条纹管激光成像雷达技术] and made breakthroughs in high-sensitivity four-dimensional image detection, information reconstruction, and other technologies. A principle prototype was integrated and a 6 km target laser image obtained. Subsequently, the stripe tube LIDAR was promoted to work units, and two system LIDAR prototypes were developed.
  - During the 11th FIve Year Plan (2006-2010), this lab was responsible for a major engineering project, integrating a distance-selective LIDAR prototype,

completing airborne flight tests, and obtaining air-to-ground high-resolution laser images.

- During the 12th FIve Year Plan (2011-2015), this lab studied laser and infrared composite imaging technology, making breakthroughs in common aperture spectroscopy and system integration technology [共口径分光及系统集成等技术], and integrating the composite image principle prototype.
- During the 13th Five Year Plan (2016-2020), this lab developed a Gm-APD focal plane detector, with single photon detection being used to study miniaturized high-power lasers, multi-frame statistical signal processing, and far-field 3D automatic target recognition technology. At present, a 32×32 pixel Gm-APD short-wave infrared laser imaging radar far-field target 3D distance image has been obtained.[1367]

Research Direction:

1. Tunable laser technology [可调谐激光技术]
2. Nonlinear optical technology [非线性光学技术]
3. Laser space communications [激光空间通信][1368]

Other Notable Research areas:

- Capillary (or thin pipe) electrical discharge and soft X-ray laser amplification
- Mid- and far-infrared tunable laser technology
- Terahertz imaging and holographic technology
- Laser space information technology
- X-ray/XUV band and short wavelength laser research
- Nonlinear optics technology and applications
- Infrared laser technology
- New types of laser spectroscopy
- Space laser communications technology
- High-power light source and high-code rate modulation technology
- High-sensitivity anti-jamming optical signal reception technology
- Precision, reliable, high-gain transceiver and transmitter antennas
- Fast and precise capture, tracking, and targeting technology
- Atmospheric channel research
- Harmonic lasers
- Laws and mechanisms of stimulated Brillouin scattering (SBS)
- SBS optical phase conjugation
- SBS in optical fibers
- Laser spatio-temporal characteristics control
- Laser power synthesis
- Optical pulse controllers
- Optical limiters
- Fiberoptic SBS devices
- New concept lasers
- Dimer molecular spectroscopy
- Laser oscillations and dynamical processes

- Capillary (or thin pipe) electrical discharge
- Soft X-ray laser amplification
- Mid- and far-infrared tunable laser technology
- Terahertz imaging
- Two-dimensional scanning and digital holographic imaging
- Terahertz 2-D point-scan transmission imaging
- Two-dimensional surface-array transmission scanning imaging
- Two-dimensional confocal scanning imaging
- Digital holographic imaging
- Research on terahertz determination of object transmittance
- Backward scattering properties
- Holographic imaging and reverse reconstruction of holographic imaging using mathematical models
- High-power laser-material interactions
- Damage mechanisms of optical components for laser-driven inertial confinement fusion engineering (ICF)
- Distributed fiberoptic sensors
- Laser and infrared composite imaging technology[1369] [1370] [1371]

Notable Applications:

- Applications include the creation of a space-based satellite laser high-speed information network and a space-ground integrated information network. In 2007, this lab successfully completed China's first low-orbit satellite-ground laser communications test. In 2011, the lab’s Satellite Laser Communications Team successfully completed China's first low-orbit satellite-ground laser communications test. Between May and August 2017, it successfully completed the world's first synchronous satellite and ground two-way high-speed laser communications with a data rate of 5 GB per second.[1372]
- In 2015, the lab completed the "Satellite-Earth Laser Link Communication Test," an important milestone in the history of China's satellite communication technology development and high-speed information transmission from space.[1373]
- This lab is developing technology for distributed fiberoptic sensors and distributed fiberoptic strain monitoring [分布式光纤应变监测仪] targeted at safety monitoring of major infrastructure (e.g. energy pipelines, high-voltage cables, bridges, dams, and tunnels), aircraft monitoring, and natural disasters. This project was approved by the Ministry of Science and Technology [科技部] with funding of 41 million RMB. These sensors allow for continuous measurement in space, featuring long-range, high positioning accuracy, and the ability to measure temperature, strain, and vibration. They are lightweight, resistant to harsh environments, immune to electromagnetic interference/jamming, require no electricity at the sensing point, and can be used for long-distance distributed measurements with hundreds of thousands of points.[1374]
- Other projects include:
    - Development of long-wave infrared CO2 pulsed external differential coherent detection laser imaging technology.

- Development of domestic flashing streak tub laser imaging radar technology.
- Integrating a distance-selective LIDAR prototype leading to airborne flight tests and obtaining flight-to-ground high-resolution laser images.
- m-APD focal plane detector with single photon detection, used to study miniaturized high-power lasers, multi-frame statistical signal processing, and far-field 3D automatic target recognition. At present, the labs has a 32×32 pixel Gm-APD short-wave infrared laser imaging radar far-field target 3D distance image.[1375]

Leadership and Key Personnel:

- Director: possibly Lu Zhiwei [吕志伟],[1376] although this may be dated
- Deputy Director: Chen Deying [陈德应][1377]
- Founder: Ma Zuguang [马祖光][1378]
  - Influential academic and pioneer in China's laser technology field who died in 2003.

Key Personnel:

- Ma Jing [马晶] and Tan Liying [谭立英][1379]
  - Ma and Tan are experts on high-speed information transmission from space. They led this lab's efforts on technologies related to satellite laser communications, satellite laser link systems, and satellite high-speed laser communications networks. They took part in the 2015 "Satellite-Earth Laser Link Communication Test," a major milestone in the history of China's satellite communications technology development (see Notable Applications above).

Notable Collaborations:

Domestic

- Leaders from this lab took part in the opening ceremony for a CASC-HIT Joint Technology Innovation Center [中国航天科技集团公司-哈尔滨工业大学联合技术创新中心] with 10 million RMB in funding, implying this lab is an interested party in this agreement.[1380]
- Via a search of two scientific databases, this lab has worked with AVIC's China Air-to-air Missile Research Institute [中国空空导弹研究院] on GM-APD LIDAR distance-image neighborhood KDE reconstruction [GM-APD 激光雷达距离像邻域 KDE 重构]).

International

- In late 2020 this lab received a visit from the Dutch company Avantes, which specializes in fiberoptic spectroscopy instruments. Avantes personnel gave a talk outlining their spectrometer design and received a tour of the lab.[1381]

Lab Equipment:

- The lab's Mid- and Far-Infrared Tunable Laser Technology Team possesses a 3-5 μm mid-infrared optical parametric oscillator laser with output power over 40W (the highest international power level).[1382]

Address:

Possibly co-located with HIT at Harbin Institute of Technology, No. 92 West Xizhi Road, Nangang District, Harbin, Heilongjiang Province [哈尔滨市南岗区西大直街 92 号 哈尔滨工业大学]

Website:

http://www.opticsjournal.net/Lab/STTL.htm?action=index

Known Aliases:

- Defense S&T Key Laboratory on Tunable Laser [可调谐激光国防科技重点实验室]
    - Same name in English, but removes the characters "气体" (gas) in Chinese
- National Key Laboratory on Tunable Laser [可调谐激光国家级重点实验室]
- National S&T Key Laboratory on Tunable Laser [可调谐激光国家级重点实验室]
- Key Laboratory on Tunable Laser

53. Defense S&T Key Laboratory of UAV Special Technology

Official English Name: State Key Laboratory of UAV Special Technology[1383]

Chinese Name: 无人机特种技术国防科技重点实验室

Research Field: Aerospace – UAVs (*Also: Electronic Warfare*) – Multiple (GNC, Propulsion, Positioning, Simulation & Modeling, Stealth Technologies)

Affiliations:

- Northwestern Polytechnical University (NWPU) [西北工业大学]
    - School of Aeronautics [航空学院]

Key Data:

- Established: 2001
- Total Funding: 300-420m RMB
- Personnel: 46[1384] [1385] [1386]
- Official start of operations: 2003
- Floor Space: approx. 10,000 sqm

Lab Overview:

The Defense S&T Key Laboratory of UAV Special Technology claims to be the PRC's only national key lab dedicated to UAVs, with the stated goal of becoming a national leader and internationally advanced platform for UAV technologies. It focuses on UAV integrated control systems, takeoff and landing technology, performance testing and verification, wing layout, RF simulation, and other research related to UAVs. It has eight subordinate labs.[1387]

NWPU's Xi'an ASN Technology Group Co. [西安爱生技术集团公司],[lvi] a major UAV manufacturing company which produces the ASN series of military and civilian UAVs, relies on the expertise of this lab for its UAV research (see Notable Applications for more).[1388] [1389]

Further Information:

- In 2013, this lab established a National Engineering Research Center for UAV Systems [无人机系统国家工程研究中心] which is dedicated to accelerating the development of China's UAVs for industry, academia, and research.[1390]
- In 2016, NWPU announced plans to create the PRC's largest UAV production base for small to midsized UAVs, called the "Aviation Science City - UAV Industrial Base" [航空科学城——无人机产业化基地]. The base will include product testing and manufacturing areas. It will utilize NWPU's two primary UAV institutions, namely this lab as well as the National Engineering Research Center for UAV Systems.[1391]

Research Direction:

1. UAV optimization technology
2. Integrated control technology for UAV systems
3. UAV takeoff and landing technology
4. UAV integrated performance testing and verification technology[1392]

Other Notable Research areas:

- UAV wing layout
- RF simulation technology
- UAV virtual simulation software and hardware
- Special UAV pneumatic experimental research
- Jet engine control and semi-physical simulation
- Testing and evaluation of deformation, damage, and destruction of UAV materials and structures under special service conditions
- UAV control and whole-system semi-physical simulation verification
- UAV navigation verification

[lvi] a.k.a. the 365th Research Institute [365 研究所], a.k.a. the NWPU Drone Institute [西工大无人机所]

- UAV full-spectrum and all-frequency band terminal guidance simulation and verification
- UAV flight control system component testing
- UAV precision positioning (DGPS, pseudo-GPS) takeoff/landing simulation and verification
- UAV beam-guided takeoff and landing simulation and verification
- UAV visual takeoff/landing simulation and verification
- Wide Band High-power RF Simulation
- High-precision ultra-wideband antenna and stealth testing
- Data chain simulation testing in a complex electronic warfare environment[1393]

Notable Applications:

- This lab is responsible for much of the research for the ASN-series of military and civilian UAVs. The anti-radiation ASN-301[lvii] (a possible copy of the Israeli Harpy) was designed by husband and wife duo Zhou Zhou and Zhu Xiaoping of this lab. At the 2009 National Day parade, all of the military UAVs on display were ASN products. Three UAVs at the 2017 PLA Founding Day parade were also ASN products: the ASN-301 anti-radiation UAV, as well as a communications jamming UAV and a radar jamming UAV.[1394] [1395]
- Other public projects include the Phantom-6 Solar Powered, High-Endurance UAV, which set a record of 19 hours and 34 seconds of flight time, and the PRC's first solar powered 5G-enabled Fixed-Wing UAV [固定翼无人机], also developed by the NWPU Phantom Team. These can be used for civilian or military (remote comms, border patrol, stability maintenance, and anti-terrorism) purposes.[1396] [1397]

Leadership and Key Personnel:

- Director: Zhou Zhou [周洲][1398]
- Academic Committee Director: Chen Yijian [陈一坚][1399]

[lvii] The source also states that the anti-radiation UAV project was first test flown in 2001, but had propulsion problems due to international sanctions. The plan was to use an imported engine, but the exporting country did not allow for the engines to be exported. This forced the team to develop indigenous engines. The UAV also experienced control system problems, but a successful test was conducted on 24 December 2004. Through several years of work the team was able to overcome the international sanctions via indigenous innovation. The source states that the model carried missiles, and may target THAAD.

Key Personnel:

- Zhu Xiaoping [祝小平][1400] [1401]
    - Awarded a 2nd Class National Defense S&T Progress Award in 2010 for his project "(REDACTED) System General Requirements Series of National Military Standards."
    - Oversees the NWPU Unmanned Navigation Technology Research Center [无人航行技术研究中心] in Ningbo.
    - Husband of lab Director Zhou Zhou.

Notable Collaborations:

Domestic

- Collaborates with CASC, AVIC, COMAC, and other prominent aerospace SOEs, as well as CARDC (PLASSF Base 29) as part of the Collaborative Innovation Center of Future Aerospace Vehicle (*sic*).[1402]
- This lab co-sponsors the NWPU Special UAV Technology Research Institute [特种无人机技术研究所], along with the First Class State Key Discipline of Aeronautics and Astronautics [航空宇航学科与技术一级国家重点学科]. This Institute conducts research on new concepts for clean energy UAVs, bionic UAVs, and new concepts for VTOL UAVs. It has been responsible for projects related to the 9th, 10th, and 11th Five Year Plans.[1403]
- In 2019, this lab signed a three-way strategic cooperation agreement with CASIC Hubei Sanjiang Astronautics Hongfeng Control Co., Ltd.[湖北三江航天红峰控制有限公司] and Xi'an Lyncon Co. [西安羚控电子科技有限公司]. The three parties will leverage their respective strengths to cooperate in the development of flight control systems, server systems, and fiberoptic inertial navigation systems.[1404]
- This lab has taken part in the China Aero Weaponry Conference, along with AVIC. Conference topics included UAV reconnaissance, strike, air combat, anti-sub, and anti-carrier operations, as well as drone swarms and manned-unmanned aircraft cooperation.[1405]
- Per searches of two scientific databases, this lab has cooperated with PLA units 63961 (multiple projects), 93975, 91503, 93861, 91599, and 69296.

International

- The lab claims to have a "long-term cooperative relationship" with Kingston University in the U.K., and possibly other unnamed institutions.[1406]
- The 2016 China-International UAV System Conference and Exhibition [中国国际无人驾驶航空器系统大会暨展览] featured this lab as a cooperating party, and also featured support from the American Institute of Aeronautics and Astronautics (AIAA) and U.K. Royal Aeronautical Society.[1407]

Lab Equipment:

- UWM4000 Doppler velocimeter docking array from American company Linguest
    - Despite NWPU being on the U.S. Department of Commerce Entity List for export control since 2001, the lab received this equipment in 2014.
- Delmia&3DVIA virtual prototype assembly software from French company Dassault.[1408]

Address:

Building #2, No. 127 Youyi West Road, Xi'an, Shaanxi Province [陕西省西安市友谊西路 127 号][1409]

Website:

http://kypt.nwpu.edu.cn/index.php?c=content&a=show&id=360

Known Aliases:

- Key Lab of UAV Special Technology [无人机特种技术重点实验室]
- National Key Lab of UAV Special Technology [无人机特种技术国家重点实验室]
- National Laboratory of UAV Special Technology
    - More common translation.
- National Key Laboratory of Science and Technology on UAV
- State Key Laboratory of UAV Special Technology
- Science and Technology of UAV Laboratory
- National Key Laboratory of Unmanned Aerial Vehicle Technology
- National Key Lab of Special Technology on UAV
- National Key Laboratory of Special Technology on UAV
- Laboratory of Science and Technology on UAV

54. Defense S&T Key Laboratory of Underwater Information and Control

Official English Name: State Key Laboratory for Underwater Information and Control[1410]

Chinese Name: 水下信息与控制国防科技重点实验室

Research Field: Maritime – Underwater Vehicles (*Also: Communications Equipment*) – GNC (*Also: Communications Technologies, Information Processing*)

Affiliations:

- Northwestern Polytechnical University (NWPU) [西北工业大学]
    - School of Marine Science and Technology [航海学院]
- China State Shipbuilding Corporation (CSSC) [中国船舶集团]
    - 705th Research Institute [705 研究所]

Key Data:

- Established: 1993
- Total Funding: Unknown
- Personnel: 20 researchers[1411] [1412]
- Official start of operations: 1997
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Underwater Information and Control, a collaboration between NWPU and CSSC's 705th Research Institute, conducts research into various aspects of underwater information technology, including autonomous control and processing technology, navigation, identification, positioning, and communications.

This lab may also play a key role in the PRC's torpedo R&D, being subordinate to the 705th RI, which is the primary designer of all of the PRC's torpedoes. The lab may be known internally as the Defense Key Laboratory of Torpedo Guidance Technology [鱼雷制导技术国防科技重点实验室] and/or the Key Laboratory of Underwater Guidance Technology [水下制导技术重点实验] (see below). It is possible that these are internal names for this lab which are intentionally no longer used publicly, given their more explicitly military ring.[1413] [1414]

Despite the fact that NWPU has been on the U.S. Commerce Department Entity List for export control since 2001, this lab publicly advertises its use of imported high-tech equipment from the United States, European, and Japanese sources, much of which was acquired after 2001 (see lab Equipment section below). This lab has also been implicated in industrial espionage: Qin Shuren, who pleaded guilty in 2021 to illegal export of controlled technology related to underwater warfare from the U.S., was likely working at the direction of this lab. [1415] [lviii]

The CSIC (now CSSC, following a 2019 merger) 705th Research Institute was established in 1958 and today is cited as one of the 54 National Key Military Support Work Units [全国 54 个重点保军单位]. This RI conducts R&D of naval weaponry and equipment. Research areas include mechanical power, fluid transmission and control, computers, automatic control, power electronics, hydroacoustic engineering, and communications technology. It is heavily involved in the development of underwater weaponry and torpedo research and manufacture, including of the Yu-

[lviii] For more information on how the Qin Shuren case related to this lab, see the author's piece in Defense One: Ma Xiu, Peter W. Singer, "How China Steals US Tech to Catch Up in Underwater Warfare," *Defense One*, 8 June 2021. https://www.defenseone.com/ideas/2021/06/how-china-steals-us-tech-catch-underwater-warfare/174558/

6 torpedo. It was placed on the U.S. Commerce Department's Entity List for export control in 2020.[1416] [1417] [1418] [1419]

Further Information:

- This lab is broken up into 3 subordinate entities:
  - New Underwater Vehicle Control Technology Lab [水下航行器控制新技术实验室]
  - New Underwater Information Processing Technology Lab [水下信息处理新技术实验室]
  - Visualization and Data Processing Center [可视化数据处理中心].[1420]
- Director Yang Yixin is associated with the 111 Plan [111 计划] "Ocean Information Sensing" Academic Innovation and Intelligence Base [“海洋信息感知”学科创新引智基地]. The 111 Plan, which aims to attract foreign talent to establish joint Sino-Foreign research bases in China, has been associated with tech transfer.[1421]
- Evidence of different names: The Key Laboratory of Torpedo Guidance Technology (TGT) is rarely referred to publicly, but in one 2009 article it is revealed that it is also subordinate to the NWPU School of Marine Science and Technology, is also a collaboration with the 705th RI, and Xu Demin serves as the Academic Committee Director, just as he does with this lab. Professor Song Baowei is also affiliated with both labs. Further, searching an academic journal database brings up two articles ascribed to the TGT Lab and of the six authors cited, five are also affiliated with the DSTKL of Underwater Information and Control. The DSTKL of Underwater Information and Control also seems to be involved in torpedo technology research. The TGT lab is almost never referred to after around 2010, although a single unofficial source from 2019 lists it among NWPU's Key Labs, seemingly in lieu of the UIC Lab. In yet another instance, a single reference in 2009 was made to an Key Lab of Underwater Guidance Technology [水下制导技术重点实验], also a collaboration with the 705th RI and established and approved at the exact same time as the DSTKL of Underwater Information and Control. Given all these coincidences, it is probable that the Underwater Information and Control, Torpedo Guidance Technology, and Underwater Guidance Technology are three names for the same lab. Interestingly, in the latter article a banner can be seen in the background which is censored to obscure the name of the lab.[1422] [1423] [1424]

Research Direction:

Underwater information control and processing technology [水下信息控制与处理技术][1425]

Other Notable Research areas:

- High-speed underwater wireless laser communications

- Underwater vehicle navigation and control
- Underwater vehicle path planning, tracking, and guidance
- Underwater information processing and identification
- Hydroacoustic communications and multi-vehicle coordination
- Underwater precision control, navigation, and positioning technology
- Underwater information processing and identification technology
- Underwater vehicle ballistic optimization technology
- Research and development of underwater equipment
- Basic research into underwater information processing and control under complex interference/jamming conditions[1426] [1427] [1428]

Notable Applications:

- While no specific programs could be found, this lab is involved in the PRC's development of underwater warfare technologies related to submarines, UUVs and AUVs, and torpedoes.

Leadership and Key Personnel:

- Director: Yang Yixin [杨益新][1429]
- Academic Committee Director: Yang Huizhen [杨慧珍][1430]
- Deputy Directors: Yan Weisheng [严卫生]; Zhang Qunfei [张群飞]; Cui Songxin [崔荣鑫][1431]
- Former Director: Song Baowei [宋保维][1432]
- Former Academic Committee Director: Xu Demin [徐德民][1433]

Notable Collaborations:

Domestic

- NWPU has a Research Academy in the city of Ningbo, just called the Ningbo Research Academy [宁波研究院], which controls five innovation centers, One of which is the Unmanned Navigation Technology Research Center [无人航行技术研究中心]. This Center is run jointly by this lab and another NWPU lab, the National Specialist Lab of Acoustic Engineering and Testing Technology [声学工程与检测技术国家专业实验室]. It is focused on unmanned aircraft, boats, and underwater vehicles, and is described as an "integrated air-land-sea unmanned navigation innovation research center." It is run by Zhu Xiaoping [祝小平] of the Defense S&T Key Lab of UAV Special Technology. Lab facilities include a high-speed water cavity/cave [高速水洞], large anechoic pool [大型消声水池], underwater physical field simulation [水下物理场仿真], underwater power propulsion [水下动力推进], sound and vibration control [声与振动控制], and a navigation and control simulation center [导航与控制仿真中心].[1434]

- This lab works closely with the NWPU Autonomous Underwater Vehicle Team [自主水下航行器团队].[1435]

International

- This lab claims to have hosted academics from the University of North Carolina and George Mason University.[1436]
- This lab hosted the 2018 IEEE International Conference on Signal Processing, Communications, and Computing.[1437]

Lab Equipment:

- NWPU has been on the U.S. Commerce Department Entity List for export control of sensitive technologies since 2001. Nevertheless, a list of high-tech equipment utilized by this lab includes multiple items sourced from American, European, and Japanese companies. U.S. technology used by this lab includes:
    - AD RTS/6205 Real-time simulation system from Applied Dynamics International (ADI)
    - IVER2-580-EP Small Unmanned Underwater Vehicle from L3 OceanServer (also utilized for research by the U.S. military[1438])
    - TLA7012 Logic Analyzer from Tektronics
    - X2-8 Server from Sun Microsystems
    - AquaTrans underwater acoustics communications modem from Aquatic Sensor Network
    - 1160A pulse 500MHz waveform arbitrary waveform generator from Agilent Technologies
    - E4980A20MHz Precision LCR Tester from Agilent Technologies
    - 16823A500MHZ Logic Analyzer from Agilent Technologies
    - NovaTM Nano SEM450 Field Emission Scanning Electron Microscope from FEI
    - IConn Automatic metal wire ball welding machine from KNS
    - KNS 4522 Manual Ball Welder from KNS
    - EPS150COAX and Summit-11000B-M Probe table from CASCADE
- Other foreign-manufactured equipment includes:
    - Track Link 1500 hydroacoustic positioning system from U.K. company LinkQuest
    - DS1005 real-time simulation processing system from German company Dspace
    - OCEANO 2500 acoustic translator from French company iXblue
    - 8860 High Speed Data Logger from Japanese company Hioki
    - MR304 infrared spectrometer from Canadian company ABB
    - Oqus300 non-contact 3D motion analysis system from Swedish company Qualisys

- Equipment coming from PLA sources includes:
  - Doppler simulator manufactured by the Naval Engineering University
  - Short-cycle high-speed gas film cooling heat transfer wind tunnel from PLA Unit 63837
- Other domestically-manufactured equipment includes:
  - Data processing system with visualization software and database processing software, capable of complex fluid dynamics calculation and visualization simulation
  - Multi-channel programmable filters: 32 channels, high pass, low pass, and band pass filtering of signals as needed
  - Flight simulation turntable: three degrees of freedom, CNC continuous rotation. Can carry out motion body space and motion attitude simulations
  - 3KTD-630 inertial guidance system test turntable
  - Torpedo body scaling model
  - Angular motion simulator
  - Laser inertial navigation system
  - Servo control loop performance test stand
  - Servo based simulator
  - Depth simulator system
  - G2+RT2 differential GPS receiver system
  - TD1250C frequency response analyzer
  - CWT-00 blade wind tunnel unit
  - W780-G20E5*2/128G/2T+1.2TSSD GPU server
  - TAS-25091.8/147Kpa roots-type supercharger
  - Short-cycle heat transfer wind tunnel measurement system
  - Front-end microelectronic chip test purification studio
  - Fully automatic solder paste printing machine
  - Medium speed automatic vision mounter
- Anechoic pool
  - This pool is mainly used for torpedo acoustic self-guided systems and hydroacoustic transducer performance research. It is 20 meters long, 8 meters wide, and 7 meters deep. It includes a six-sided installation of sound-absorbing tip split, sound absorption frequency of 2KHz-80KHz, and two traveling cranes which can make horizontal movements in the pool. Test devices installed on the traveling crane can carry out vertical movement and rotational movement.
- The total value of equipment at this lab is 23.78 million RMB.[1439] [1440]

Address:

Likely co-located with NWPU Chang'an Campus and spread across several buildings on Dongxiang Road, Chang'an District, Xi'an, Shaanxi Province [西安市长安区东祥路 1 号][1441]

Website:

http://kypt.nwpu.edu.cn/index.php?c=content&a=show&id=261

Known Aliases:

- Defense S&T Key Laboratory of Torpedo Guidance Technology [鱼雷制导技术国防科技重点实验室]
- Key Laboratory of Underwater Guidance Technology [水下制导技术重点实验]
- Key Laboratory for Underwater Information and Control [水下信息与控制重点实验室]
- National Key Laboratory for Underwater Information Processing and Control [水下信息处理与控制国家级重点实验室]
- Defense S&T Key Laboratory of Maritime Weaponry [水中兵器国防科技重点实验室]
- Key Laboratory of Maritime Weaponry [水中兵器重点实验室]

55. Defense S&T Key Laboratory of Vehicle Transmission

Official English Name: Unknown

Chinese Name: 车辆传动国防科技重点实验室

Research Field: Ground – Ground Vehicles – Vehicle Parts & Technology

Affiliations:

- Beijing Institute of Technology (BIT) [北京理工大学]
  - School of Mechanical Engineering [机械与车辆学院]
- China Ordnance Industries Group Corporation (Norinco) [中国兵器工业集团]
  - China North Vehicle Research Institute [中国北方车辆研究所]
    - *(a.k.a. Norinco 201st Research Institute [201 研究所])*

Key Data:

- Established: 1992
- Total Funding: 20m RMB/year
- Personnel: 27[1442] [1443] [1444]
- Official start of operations: 1999
- Floor Space: 2,329-4,500 sqm

Lab Overview:

The Defense S&T Key Laboratory of Vehicle Transmission conducts research into tank and other vehicle transmission systems. It is considered one of the top work units in the PRC for transmission design for fourth-generation tanks.[1445]

The lab's parent institution, the Norinco China North Vehicle Research Institute (a.k.a the Norinco 201st RI), claims to be the PRC's only institution dedicated to the research and design of tanks and armored vehicles. It is also engaged in diverse areas such as high-speed rail, riot control vehicles, roadblock vehicles, and various civilian endeavors.[1446]

Further Information:

- This lab is sometimes referred as the "Defense S&T Key Lab of Tank Transmission" [坦克传动国防科技重点实验室]. This more military name can be found in multiple scattered sources. These two labs are confirmed to be one and the same, as lab Director Xiang Changle and others have been confirmed to be associated with both.[1447] [1448]
- The lab has several subordinate research labs, including:
    - Dynamic Design Research Laboratory [动态设计研究室]
    - Multi-stream Stepless Transmission Laboratory [多流无级传动研究室]
    - Automatic Operation Laboratory [自动操作研究室]
    - New transmission Research Laboratory [新型传动研究室]
    - Dynamic-Hydraulic Transmission Research Laboratory [动液传动研究室][1449]
- This lab also has a subordinate Multi-Stream Transmission Team [多流传动课题组] which has around 12 research personnel and around 40 PhD and Master's students. It is focused on five main areas:[lix]
    1. Unmanned vehicle dynamics and overall design [无人车辆动力学与总体设计]
    2. Fluid drive and control [流体传动与控制]
    3. Electromechanical composite transmission theory and technology [机电复合传动理论与技术]
    4. Transmission system design and topology synthesis [传动系统方案设计与拓扑综合]
    5. Transmission system friction and lubrication [传动系统摩擦磨损与润滑][1450]
- This lab takes on an average of 28 projects each year. There is evidence this lab's resources have grown significantly. An older source from 2012 states it has an average of only 5 million RMB in funding and takes on 10-15 projects annually.[1451] [1452]

Research Direction:

1. Transmission system dynamic design theory [传动系统动态设计理论]
2. Multi-stream stepless transmission and steering [多流无级传动与转向]
3. Transmission system automatic operations and adaptive control [传动系统自动操纵与自适应控制]

[lix] More information is available on the Team's website (see below)

4. Current change, viscous liquid transmission, and other new theories [电流变、粘液传动等新理论]
5. New dynamic liquid transmission and liquid machine joint braking [新型动液传动与液机联合制动][1453]

Notable Applications:

- This lab was involved in the design of parts of the Type-99A tank, including the integrated hydro-mechanical transmission with automatic gear shifting, steering wheel steering system, and joint braking. The 99A transmission designed by this lab is known as the CH-1000.[1454] [1455] [1456]
- This lab also designed the CH-400 tank transmission.[1457]
- This lab was involved in the design of the VT-4 and VT-5 export tanks.[1458]
- The Special Vehicle Research lab under this lab appears to have been involved in the development of several tanks and armored vehicles in the PLA's inventory, as evidenced by photos on their webpage. Another series of photos showing armored vehicles related to the research of the Special Vehicle Research Lab shows several types of armored vehicles this lab presumably had a hand in, including the ZBL-08 IFV.[1459]
- A video celebrating the 201st RI's 60th anniversary shows a variety of armored vehicles, including the Type 99 main battle tank and ZBD-04 IFV. A four wheeled armored vehicle and an unmanned vehicle with mounted machine gun are also shown. This lab would presumably be involved in aspects of these projects.[1460]
- One source states that BIT has been instrumental in the development of several armored vehicles, including the Type-15 light tank, PCL-181 vehicle-mounted howitzer, and the 3rd-generation Dongfeng Mengshi MRAP. Although a connection to these systems is not explicitly drawn, the source does specifically mention this lab, and it is probable that it was involved in some or all of these projects.[1461]

Leadership and Key Personnel:

- Director (BIT Branch): Xiang Changle [项昌乐][1462] [1463]
  - CAE Academician.

Notable Collaborations:

Domestic

- This lab manages the BIT New Energy Intelligent Vehicle Technology Innovation Center [新能源智能车辆技术创新中心] along with the MIIT Key Lab of Unmanned Vehicles

[无人车技术工业和信息化部重点实验室] and the Future 3-D Infrastructure Research Academy [未来立体交通研究院].[1464]

- This lab (under its more military "Tank Transmission" name), jointly oversees the Special Vehicle Research Laboratory [特种车辆研究所实验室], along with the Shanxi Transmission Lab [西山传动实验室], the Oil Fluid Analysis Lab [油液分析实验室], the Armored Vehicle Engineering Practice and Teaching Center [装甲车辆工程实践教学中心], and the Modern Design and Analysis Center [现代设计分析中心]. This lab is focused on armored vehicle engineering and on military vehicle transmission technology in particular. It has 29 researchers on staff. It has apparently (per photos on its website) been responsible for several current armored vehicles in the PLA inventory.[lx] [1465]

International

- This lab co-sponsored the 2019 International Conference on Rotating Machinery Transmission and Control (RMTC2019) [2019 年旋转机械传动与控制国际会议]. The conference included American participants from University of Virginia and Texas Tech, and private companies BRG, Pratt & Whitney, Siemens, Mistubishi, ANSYS, MSC Software, and Dassault. The article also states that BIT and the University of Virginia have a Joint Laboratory for Rotating Machinery [京理工大学-弗吉尼亚大学旋转机械联合实验室].[1466]
- International experts have allegedly come as guests to this lab, including U.S. professors from Wayne State and University of Wisconsin.[lxi] [1467]
- The lab claims to have sent students to study in the U.S., Germany, and Russia.[1468]

Lab Equipment:

- The lab has 28 major pieces of equipment worth over 100,000 RMB each, with a total equipment value of approximately 23.22m RMB.[1469]
- Equipment utilized by this lab that is imported from U.S. and other foreign sources includes:
  - Virtual test system for vehicle electronic control (from U.S.)
  - HP3565S data acquisition system (U.S.)
  - HP715 workstation (U.S.)
  - Oil spectrometer (U.S.)
  - Dynamic simulation test bench (Germany)
  - Current variable rotation viscometer (Germany)
  - Modal analysis software 10 (Belgium)
  - XR-5000 tape recorder and acceleration sensor (Japan)
- Other equipment utilized by this lab includes:
  - Current variable rotational viscometer

[lx] Further data on this Lab is available upon request.
[lxi] A more detailed list is available upon request.

- Spectral oil analysis system
- Data acquisition and modal analysis system
- Constant speed and torque adaptive power system
- Power measurement control and torque and flow measurement systems
- Transmission test bench
- Comprehensive transmission test bench
- Computer-aided design means
- 50kW transmission test bench
- Hydraulic transmission test bench
- Automatic variable speed manipulation test bench
- Iron spectrum analyzer[1470] [1471]

Address:

No. 5 Zhongguancun S. Street, Haidian District, Beijing [北京市海淀区中关村南大街五号][1472]

Website:

https://web.archive.org/web/20121026082800/http://www.bit.edu.cn/kyxs1/zdsys/27325.htm

Multi-stream Transmission Team: http://www.bitmpft.com/

Known Aliases:

- Defense S&T Key Lab of Tank Transmission [坦克传动国防重点实验室]
- State Key Laboratory of Vehicular Transmission [车辆传动国家重点实验室]
- Key Laboratory of Vehicle Transmission [车辆传动重点实验室]
- National Key Laboratory of Vehicle Transmission
- Science and Technology on Vehicular Transmission Laboratory

56. Defense S&T Key Laboratory of Vessel Integrated Power Technology

Official English Name: National Key Laboratory for Vessel Integrated Power System Technology[1473]

Chinese Name: 舰船综合电力技术国防科技重点实验

Research Field: Maritime – Surface Vessels (*Also: High-energy Weapons*) – Electrical Power (*Also: Propulsion*)

Affiliations:

- PLA Naval Engineering University (NEU) [海军工程大学]

- China State Shipbuilding Corporation (CSSC) [中国船舶集团]
    - Wuhan Institute of Marine Electric Propulsion [武汉船用电力推进装置研究所][lxii]
        - *(a.k.a. CSSC 712th Research Institute [712 研究所])*

Key Data:

- Established: 2007
- Total Funding: Unknown
- Personnel: 73 researchers[1474] [1475]
- Official start of operations: Unknown
- Floor Space: over 20,000 sqm

Lab Overview:

The Defense S&T Key Laboratory of Vessel Integrated Power Technology conducts research into vessel electrical generation for propulsion, high-energy weapons, high-power sensors, and day-to-day use. It is focused on integrated power generation, new forms of electrical power propulsion, and high-capacity electric power conversion technology. In addition to new propulsion systems, it is also pursuing development of electromagnetic launchers for large surface ships.[1476]

Integrated electrical power systems are considered a major element of 21st century naval power, with their ability to simplify power system architectures, optimize vessel design, more effectively utilize ship-based weapons systems, reduce vessel acoustic signatures, and improve vessel viability and integrated operations. At the time of this lab's founding in 2007, integrated power was considered a major bottleneck for PRC naval vessel development, and this lab was seen as filling a major area of need. This lab is especially focused on breaking the PRC's reliance on foreign imports and the foreign blockade on ship electrical power systems (oftentimes referred to as the ship's "heart" [心脏]). Since 2007, this lab has been a key player in establishing the PRC's international leading position in the field of integrated generator systems. It was the first to propose using medium voltage DC power systems, and the first to successfully develop medium voltage DC integrated power systems for ships, making China the first country in the world to fully master this second-generation of integrated power technology and allegedly putting it at a more advanced level than the United States.[1477] [1478] [1479] [1480]

Further Information:

- The lab utilizes military-civil fusion [军民融合] in patent and IP transfer to private enterprises. Its naval variable current device technology has been utilized in new energy access and intelligent micro-grids. It has also developed a direct-drive wind power inverter, breaking a foreign monopoly and forcing companies to reduce their prices by 60%. This lab is also the first new-energy development center in the PLA. Its multi-energy intelligent power station [多能源智能电站] was built in the South China Sea based on its IP.[1481]

[lxii] This Institute was previously subordinate to CSIC, but has presumably been absorbed by CSSC following the 2019 merger.

- The lab has a subordinate Systems Network Architecture and Intelligent Monitoring and Management Technology Research Lab [系统网络结构与智能化监控管理技术研究室] which studies grid architecture theory, systems operations, and energy dispatch of ship integrated power systems. It has worked on a grid architecture form of distributed medium-voltage DC transmission, DC regional substations, and distribution of naval integrated power systems, as well as new principles and methods of systems modeling and electromagnetic transient calculation, stability analysis and control, integrated and coordinated systems protection, network reconfiguration and self-healing, and intelligent energy management.[1482]
- This lab oversees the Integrated Power Innovation Team [电力集成创新团队].[1483]
- One article, about lab researcher Xiao Fei, states that foreign countries deliberately publish incorrect information to hurt the naval shipbuilding capabilities of other countries, forcing Xiao Fei to create his own calculations.[1484]

Research Direction:

1. High power density integrated power generation technology [高功率密度集成化发电技术]
2. New electric power propulsion technology [新型电力推进技术]
3. High-capacity electric power conversion technology [大容量电能变换技术]
4. Systems network structures and intelligent monitoring and management technology [系统网络结构及智能化监控管理技术]

Sources also list an additional three main fields:

1. Ship energy and power [舰船能源与动力]
2. Electromagnetic emissions [电磁发射]
3. New energy access [和新能源][1485] [1486]

Other Notable Research areas:

- Electromagnetic compatibility[1487]

Notable Applications:

- This lab is a major source of research into naval electromagnetic launch applications, including electromagnetic catapults for aircraft carrier launch and electromagnetic energy weapons. This research is led by Ma Weiming and his "Inegrated Electric Power Innovation Team" [电力集成创新团队]. NEU also added a new major for electromagnetic launch engineering beginning in 2017. The new Type 003 Carrier will allegedly include electromagnetic launch capabilities.[1488]

- The lab's development of medium voltage DC integrated power systems (also known as medium-voltage direct current full electric propulsion (FEP)) for naval vessels was awarded a 1st Class National S&T Progress Award in 2017. This technology may be included in the power systems for the new Type 076 Landing Helicopter Dock warships, the second batch of Type 055 Destroyers, the Type 003 Aircraft Carrier, and a new generation of frigates and destroyers, which will be able to carry electromagnetic rail guns, laser weapons, and integrated RF systems. According to one source, this technology represents the second generation of integrated power systems, whereas U.S. ships such as the Zumwalt-class Destroyers are still using the first generation, thus putting the PRC's technology 15 years ahead of the U.S.[1489] [1490] [1491] [1492]
- The DC area power distribution subsystem developed by Xiao Fei of this lab was used to power the Type 054A Frigate, as well as an unidentified new type of frigate.[1493]
- Ma Weiming was the first to develop a motor which could simultaneously send both AC and DC electricity, with superior density, reliability, and size. Ma followed this up with a high-speed induction rectifier generator power supply system with smaller volume and weight and larger power generation capacity, meeting large warships' need for more shipboard power. This design was then used on subsequent PRC submarines.[1494] [1495]
- This lab is a leading institution for research into electromagnetic railgun technology.[1496]
- This lab conducts research on island-based wind, solar, and multi-energy intelligent micro-grids, improving island power supply problems for military personnel stationed on small islands (presumably including in the South China Sea).[1497]
- This lab created a 2 MW permanent magnet direct-drive wind power converter which broke a foreign blockade on this technology.[1498]
- Ma Weiming developed a new immersion evaporative cooling technology which solves problems with efficient cooling during power integration. A double-winding structure and static excitation control technology solves problems of traditional induction generators, including low power factor and efficiency and inflexible voltage regulation. This also solved problems of electromagnetic incompatibility in many national defense projects.[1499]
- The 712th RI was involved in creating the PRC's first permanent magnetic-propulsion electric engine for the Kilo-Class submarine. This lab may have been involved in this project, as it has conducted related research, although it is not explicitly stated.[1500]
- In the 1990s (thus predating the lab), the PRC purchased a 12-phase rectifier generator system for its new submarines which had a problem with inherent oscillation. Ma Weiming solved this issue by developing a multi-phase synchronous motor stabilizer with rectifier load and inventing a multi-phase rectifier generator with stable winding which solved the problem. Foreign companies had to purchase the patent. Further, these companies gave Ma Weiming the design drawings of their motors, which were regarded as a core secret and had previously been tightly blocked by the foreign country.[1501] [1502] [1503]

Leadership and Key Personnel:

- Director/Founder: Ma Weiming [马伟明][1504] [1505]
    - Corps Leader Grade Rear Admiral, NPC Representative, and youngest ever CAE Academician.

Key Personnel

- Fu Lijun [付立军][1506]
    - Director of subordinate Systems Network Architecture and Intelligent Monitoring and Management Technology Research Lab.
- Xiao Fei [肖飞][1507] [1508]
    - PLAN Regiment Deputy Leader Grade Captain (possibly promoted to Senior Captain by 2017).
    - Based on fawning media coverage, heir apparent to Ma Weiming's intellectual throne.
    - Research into submarine electrical power short-circuits.

Notable Collaborations:

Domestic

- This lab has a military-civil fusion [军民融合] agreement with Hunan Province to build a joint technology innovation center for MCF equipment.[1509]
- This lab is associated with the Institute of Power Electronics Technology [电力电子技术研究所] at NEU. Ma Weiming also serves as Director of this Institute.[1510]
- This lab (or specifically Ma Weiming) has cooperated with CEP Hwaray [中电华瑞] on various unnamed projects related to naval electronics. CEP Hwaray supplies marine electronics to both military and civilian customers, including semiconductors, multi-functional display consoles, vibration isolators, and radar parts. Shenzhen Prince New Materials [王子新材] owns a majority stake in this company.[1511]

International

- Personnel of the 712th RI visited U.S. university UC Merced in 2015 to discuss possible cooperation.[1512]

Lab Equipment:

- The lab has 9 test platforms and 2 simulation centers, 700m RMB in fixed assets, and over 700 pieces of equipment.[1513] [1514]

Address:

Based on photos, appears to be co-located with NEU at No. 717 Jiefang Avenue, Qiaokou District, Wuhan, Hubei Province [湖北省武汉硚口区解放大道 717 号]

Website:

None Found

Known Aliases:

- National Key Laboratory of Science and Technology on Vessel Integrated Power System [舰船综合电力技术国家重点实验室]
- National Key Laboratory of Science and Technology on Vessel Integrated Power System Technology
- National Key Laboratory of Vessel Integrated Power System Technology
- National Key Laboratory for Vessel Integrated Power System Technology

Former Defense S&T Key Laboratories

Beside the 56 labs profiled above, the online list used for this report included three other labs which are no longer classified as Defense S&T Key Labs. Two of these labs were either downgraded or reorganized around 2006, having failed a COSTIND inspection. The third may have also been culled in this way, although no information was found to confirm this. They are presented below for informational purposes. Other than founding date, these three labs are not included in the statistics found in Part One of this report.

Defense S&T Key Laboratory of Flexible Manufacturing Systems Technology

Official English Name: Unknown

Chinese Name: 柔性制造系统技术国防科技重点实验室

Research Field: Unknown – Unknown – Manufacturing

Affiliations:

- China Ordnance Industries Group Corporation (Norinco) [中国兵器工业集团]
    - Changchun Equipment & Technology Institute [长春设备工艺研究所]
        - *(a.k.a. Norinco 55th Research Institute [55 研究所])*

Key Data:

- Established: Unknown, early 1990s
- Total Funding: Unknown
- Personnel: Unknown[1515]
- Official start of operations: Unknown
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Flexible Manufacturing Systems Technology may no longer exist. A source from around 2006 states that this lab was one of three which failed to pass a regular evaluation and had its credentials revoked by COSTIND, and the last academic papers attributed to this lab appeared soon after in 2007. Since then, there is no indication of this lab's fate or current status. The lab's parent institution, the Norinco Changchun Equipment & Technology Institute (a.k.a. Norinco 55th Research Institute) does today have a Digital Manufacturing Technology Research Office [数字化制造技术研究室] whose available research is similar to this lab's, indicating this could be the successor to the lab.[1516] [1517] [1518] [1519]

The Norinco 55th RI is mainly engaged in research of advanced manufacturing technology, providing capabilities in the areas of digital and intelligent manufacturing, safety automation engineering, metal spinning and forming, precision and ultra-precision processing, automation and experimental testing, and non-standard equipment and production lines. It has cooperated extensively with the weaponry, aerospace, aviation, ship, and civilian transport industries.[1520]

Further Information:

- The lab had a Nanjing branch [南京分部] in the early 1990s.[1521]

Research Direction:

- No explicit research direction was found. A survey of studies produced by this lab between 1999 and 2007 included a range of topics, including the internet and networked databases, CAD/CAM, human-machine collaboration, and advanced manufacturing.

Notable Applications:

None found

Leadership and Key Personnel:

Unknown

Notable Collaborations:

None found

Lab Equipment:

- The Lab has/had a CH-85FMS (flexible manufacturing) main experiment system [主实验系统(CH-85FMS)].[1522]

Address:

No address found, possibly co-located with 55th RI at No. 738 Huguang Road, Chaoyang District, Changchun, Jilin Province [长春市朝阳区湖光路 738 号][1523]

Website:

None Found

Known Aliases:

None found

Defense S&T Key Laboratory of Pulsed Power Technology

Official English Name: Unknown

Chinese Name: 脉冲功率技术国防科技重点实验室

Research Field: Unknown – Unknown – Pulsed Power (*Also: Electromagnetics*, *Laser Technologies*, *Nuclear Technologies*, *Plasma Technologies*, *Semiconductors*)

Affiliations:

- Huazhong University of Science and Technology (HUST) [华中科技大学]
    - School of Electrical and Electronic Engineering (SEEE) Department of High Voltage Engineering [华中科技大学电气与电子工程学院高电压工程系]

Key Data:

- Established: 1999
- Total Funding: Unknown
- Personnel: Unknown[1524]
- Official start of operations: Unknown
- Floor Space: Unknown

Lab Overview:

The Defense S&T Key Laboratory of Pulsed Power Technology conducts research into high-powered energy in support of projects involving laser technologies, electromagnetics (including electromagnetic launch and railgun technologies), and advanced energy.

Today, it is identified as a Provincial-level Ministry of Education Key Lab, or Ministry of Education National Defense Key Lab, indicating it was downgraded in status at some point. It may have been one of the three labs which failed a 2006 COSTIND inspection.[1525] [1526]

Further Information:

- SEEE also has two other research organizations that deal with similar fields – the Wuhan National High Magnetic Field Center (WHMFC) [国家脉冲强磁场中心] (which has a pulsed power field facility) and the State Key Laboratory of Advanced Electromagnetic Engineering and Technology [强电磁工程与新技术国家重点实验室].
- There are two similarly named labs: one at the National University of Defense Technology called the State Key Laboratory of Pulsed Power Laser Technology [脉冲功率激光技术国家重点实验室], which is sometimes be referred to (possibly incorrectly) as the State Key Laboratory of Pulsed Power Technology [脉冲功率技术国家重点实验室], and one at CAEP called the Key Laboratory of Pulsed Power [脉冲功率科学与技术重点实验室].

Research Direction:

1. High-energy storage density pulse forming network technology [高储能密度脉冲成形网络技术]
    - Energy storage devices [储能器件]
    - Network structure electrical, magnetic, and thermal stress simulation analysis and optimization [网络结构的电、磁、热应力仿真分析和优化]
    - High-precision charging and intelligent control and testing technology [高精度充电和智能化控制、测试技术]

2. High-current switching technology [大电流开关技术]
    - Nanosecond-level high-repetition frequency field distortion switches [纳秒级高重复频率场畸变开关]
    - Gas gap switches [气体间隙开关]
    - Triggered vacuum switches [触发真空开关]
    - Semiconductor switches and switch trigger control technology [半导体开关和开关的触发控制技术等]
3. Gas discharge laws and special discharge technology [气体放电规律及特种放电技术]
    - The influence of discharge products on discharge, the influence of ion background on the discharge path, and the laws of multi-phase body discharge [放电生成物对放电的影响、离子背景对放电路径的影响、多相体放电规律]
    - Pulse discharge, glow discharge, and dielectric barrier discharge and other special discharge technologies and applications [脉冲放电、辉光放电及介质阻挡放电等特种放电技术及应用]
4. Discharge plasma environmental pollution control [放电等离子体环境污染治理]
    - Pulse discharge plasma catalytic reduction, desulfurization, and denitrification [脉冲放电等离子体催化还原脱硫脱硝]
    - Wastewater and waste gas treatment [废水废气处理]
    - Other environmental pollution controls and treatment technologies [环境污染控制与治理技术]
5. Discharge plasma medical applications [放电等离子体医疗应用][1527]

Notable Applications:

- This lab (now Center) has been involved with the CAEP Shenguang high-power laser nuclear fusion energy project, conducting research on the Shenguang-III energy module [神光三能源模块]. The Department the lab belongs to at HUST's SEEE served as a core work unit for carrying out research & development and construction for Shenguang-III's device energy components. The lab has also published research on electromagnetic-launch weapons, specifically electromagnetic railguns.
- The lab has researched high-power pulse power systems and pulse power applications, including for major national scientific projects, and carried out projects on high-power lasers, microwaves, and electromagnetic emissions.[1528]

Leadership and Key Personnel:

- Director: Unknown
- Academic Committee Director: Pan Yuan [潘垣][1529]

Notable Collaborations:

Domestic

- Most of the lab's publicly available research has been with the State Key Laboratory of Advanced Electromagnetic Engineering and Technology (AEET) [强电磁工程与新技术国家重点实验室], which is part of the same School at HUST, has a tokamak nuclear fusion reactor [托卡马克实验装置], and does some national defense work. The two labs worked together for a study on electromagnetic railguns.[1530] [1531] [1532] [1533]
- The lab has worked with the CAEP on electrodes.[1534]

International

None Found

Lab Equipment:

None Found

Address:

Possibly co-located with SEEE at HUST Electrical Building Block A, No. 1037 Luoyu Road, Hongshan District, Wuhan, Hubei Province [湖北省武汉市洪山区珞瑜路 1037 号华中科技大学电气大楼 A 座][1535]

Website:

http://ceee.hust.edu.cn/info/1068/1866.htm

Known Aliases:

- Pulsed Power Technology Research and Development Center [脉冲功率技术研究与发展中心]
- Pulsed Power Center [脉冲功率中心]

Defense S&T Key Laboratory of Ultra-precision Machining Technology

Official English Name: Aviation Key Laboratory of Science and Technology on Precision Manufacturing[1536]

Chinese Name: 超精密加工技术国防科技重点实验室

Research Field: Aerospace – Aircraft (*Also: Helicopters, UAVs*) – Manufacturing (*Also: GNC, Intelligent Technologies, Measurement Technologies, Propulsion, Semiconductors*)

Affiliations:

- Aviation Industry Corporation of China (AVIC) [中国航空工业集团]
  - Beijing Precision Engineering Institute for Aircraft Industry (BPEI) [北京航空精密机械研究所]
    - *(a.k.a. AVIC 303rd Research Institute [303 研究所])*
    - *(a.k.a. AVIC Precision Institute [中航工业精密所])*

Key Data:

- Established: 1992
- Total Funding: Unknown
- Personnel: over 30[1537] [1538] [1539]
- Official start of operations: 1995
- Floor Space: 4,650 sqm

Lab Overview:

The Defense S&T Key Laboratory of Ultra-precision Machining Technology may no longer be a Defense S&T Key Lab, as it was apparently downgraded around 2006 when it failed a regular evaluation and had its credentials revoked by COSTIND. It has not published new research since 2006. Soon after, a new lab with a similar name, mission, and personnel, the Aviation Key Laboratory of Science and Technology on Precision Manufacturing [精密制造技术航空科技重点实验室], appears to have taken its place.[1540] [1541] [1542]

The original lab conducted research into ultra-precision processing technology, targeting key aerospace parts like aspherical components. It was also able to process components related to inertial navigation and semiconductors. The new lab conducts similar research into ultra-precision, anti-fatigue, and intelligent manufacturing, geared toward the needs of the military aviation industry.[1543] [1544] [1545]

The lab's parent institution, the AVIC Beijing Precision Engineering Institute for Aircraft Industry (BPEI) (a.k.a. the AVIC 303rd Research Institute or AVIC Precision Institute, and formerly the China Precision Engineering Institute for Aircraft Industry (CPEI) [中国航空精密机械研究所] or AVIC-I Precision Institute [一航精密所]), researches aviation precision/ultra-precision manufacturing, measurement, and testing technology. It produces military and civilian inertial navigation and motion test/simulation equipment, ultra-precision processing equipment, special equipment for mechatronics, aero-engine test equipment, and special parts for flight control systems, airborne detection systems, airborne surveillance/reconnaissance systems, aviation hydraulic systems, and aero-engines.[1546] [1547] [1548] [1549]

Further Information:

- There are several other labs with similar names: Hunan Province Key Laboratory of Ultra-precision Machining Technology [超精密加工技术湖南省重点实验室/湖南省超精密加工技术重点实验室], which is affiliated with NUDT, the State Key Laboratory of Ultra-precision Machining Technology [香港理工大学超精密加工技术国家重点实验室] at the Hong Kong Polytechnic University, and the Ultra-precision Machining Technology Key Laboratory at CAEP [中国工程物理研究院超精密加工技术重点实验室].

Research Direction:

2. Precision manufacturing technology theory, methods, and mechanisms [精密制造技术理论、方法及机理]
3. Precision measurement, testing, and control technology [精密测量、测试及控制技术]
4. Aeronautical micro-mechanical and micro-optical component manufacturing technology [航空微机械、微光学元件制造技术]
5. Aviation precision manufacturing, measurement, and testing equipment technology [航空精密制造及测量、测试装备技术]
6. Technologies for manufacturing of typical precision parts for aviation products [航空产品典型精密零件制造的适用(技术)][1550]

Notable Applications:

- The lab has also made achievements in precision and ultra-precision basic components and integration technology, precision inspection technology for key components of aero-engines, and anti-fatigue manufacturing technology. This includes for air and liquid hydrostatic spindles and guide rails, flight control systems, UAVs, and aero-engines.[1551]
- The lab may have developed its own version of a Nanosys-1000 ultra-precision machining tool, with a processing diameter of Φ1000mm.[1552]

Leadership and Key Personnel:

- Director: Unknown
- Deputy Director: Yang Hui [杨辉][1553]

Notable Collaborations:

Domestic

Little collaboration. Two notable recent research collaborations include:

- The 2017 study "Modeling and Simulation of Helicopter Cable Position System" [直升机缆位系统建模与仿真] with the Naval Delegate Group of Equipment for the Missile (*sic*) [海军驻北京地区导弹配套设备军事代表室].[1554]
- The 2019 study "Experimental Research on the Focus Evaluation Function of Air Film Hole Image" [气膜孔图像对焦评价函数的实验研究] with the AECC South Industry Company Limited [中国航发南方工业有限公司] (a subsidiary of Aero Engine Corporation of China (AECC)).[1555]

International

None Found

Lab Equipment:

- This lab has developed at least 11 pieces of ultra-precision machining equipment, 9 of which are used in the lab. Some of this technology was developed indigenously by the lab in the face of "foreign technological blockades." Ultra-precision processing equipment used in the lab has included:
  - Ultra-precision lathes
  - Ultra-precision boring machines
  - Diamond tool grinding machines
  - Ultra-precision surface grinder
  - Ultra-precision cylindrical grinder
  - Precision end gear disc grinding machine
  - High-precision coordinate measuring machines
  - Aspherical ultra-precision machining system
  - Coupling ultra-precision machining system
  - Form and position tolerance measuring instrument
  - Roughness measuring instrument
  - Laser interferometry system[1556] [1557]
- The lab has numerous pieces of equipment from U.S. company Nanosys, including a Nanosys-300 aspheric surface ultra-precision composite/compound machining system/tool and Nanosys-1000 LODTM CNC Optical Processing Machine.[1558] [1559]
- The new lab (as of around 2013) has 1,080 square meters of experimental space with constant temperature and humidity, which are 100- and 1,000-class [100 级和 10000 级]. It also has a 2,000 sqm temperature-controlled CNC workshop.[1560] [1561]

Address:

None found, possibly co-located with the parent institution at No. 5 Nanyuan East Road, Fengtai District, Beijing [北京市丰台区南苑东路 5 号][1562]

Website:

https://web.archive.org/web/20130821012445/http:/www.bj303.com/1s/1s_index.html

Known Aliases:

- National Ultra-precision Machining Defense S&T Key Laboratory [国家级超精密加工技术国防科技重点实验室]
- National Ultra-precision Machining Laboratory [国家级超精密加工技术实验室] (national-level lab)
- Aviation Key Laboratory of Science and Technology on Precision Manufacturing [精密制造技术航空科技重点实验室]
- Key Laboratory of Ultra-precision Machining for Defense Science & Technology

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