



China's Arctic Ambitions

Technological Developments and Strategic Interests

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/ Executive Summary

The study of the Arctic region holds relevance not only for Arctic nations (Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, and the United States), but also for non-Arctic countries such as China. This interest stems from multiple factors, including the region's geographic position connecting Europe, Asia, and North America, the potential emergence of new maritime corridors due to climate change, the abundance of natural resources and minerals, and the scientific research that can be conducted there.

However, operating in the Arctic region poses considerable challenges, as harsh weather conditions complicate **Arctic scientific exploration and monitoring**. Monitoring the Arctic landscape is fundamental for many countries and organizations, including NATO. Recognizing this, the 11th NATO Innovation Challenge, held in June 2023, focused on the theme "Monitoring the Arctic from Space to Seabed." The Challenge addressed issues related to the High North and the Arctic region, with an emphasis on communications, search and rescue, situational awareness, preservation, and sub-surface navigation.¹

China has also shown interest in Arctic exploration. In June 2023, it completed the field testing and evaluation of an underwater listening device that it plans to deploy on a large scale in the Arctic Ocean.² This marks the first time China has operated such a listening device in the Arctic, overcoming significant technical challenges involved in the automatic monitoring of Arctic waters.

This report provides an analysis of **technologies used for Arctic exploration**, with the goal of assessing whether and to what extent China is developing such capabilities. The objective here is to assess China's advancements and identify potential capability gaps. To do so, Datenna first investigated China's strategy and diplomacy in the region, assessing the associated security, political, economic, and social risks. This analysis informed our investigation into the technologies China is developing to explore such a complex environment, including an examination of the main actors involved.

The first part of the research draws on primary sources in both Mandarin and English to analyze recent policies and developments. A subsequent quantitative analysis utilized the Datenna platform to identify the levels of funding, and the main actors involved in these activities. Our data-driven methodology, which leverages a great number of data points, enables us to validate potential connections with source materials and provide a comprehensive understanding of China's Arctic activities.



Figure 1: Source - Mineral Sources in the Arctic, An Introduction

¹ "Join the NATO Innovation Challenge 2023: Monitoring the Arctic from Space to Seabed," NATO Information and Communication Agency, October 5, 2023 [last accessed August 19, 2024], <https://www.ncia.nato.int/about-us/newsroom/join-the-nato-innovation-challenge-2023-monitoring-the-arctic-from-space-to-seabed.html>.

² "China plans massive listening programme at the North Pole after declaring success in Arctic test of underwater device," South China Morning Post, July 9, 2023 [last accessed August 19, 2024], <https://www.scmp.com/news/china/science/article/3226755/china-plans-massive-listening-programme-north-pole-after-declaring-success-arctic-test-underwater>.

/ 1. Relevance of the Arctic Region

According to the Arctic Council, an intergovernmental forum for addressing issues related to the Arctic region, the eight countries that can be considered “**Arctic States**” are **Canada, Denmark, Finland, Iceland, Norway, Sweden, the Russian Federation, and the United States**.³

Unlike Antarctica, there are no overarching treaties governing the Arctic and no single comprehensive treaty for all Arctic affairs. Instead, the region is subject to a patchwork of international laws, including the Charter of the United Nations, the United Nations Convention on the Law of the Sea (UNCLOS), and the Spitsbergen Treaty.

The Arctic is considered strategically important for several reasons, among the most important are:

- Its **strategic location**: The Arctic region is situated amid the three continents (North America, Europe and Asia). Global warming is accelerating the process of glacial melting, and the region is warming three to four times faster than the rest of the world.⁴ The melting will open new sea routes and will make shipping distances from East Asia to Europe shorter, attracting interest not only from regional countries but from the international community as well.
- The abundance of **natural resources and minerals**: The Arctic is one of the last untapped frontiers for large deposits of strategic natural resources. The melting of the Arctic ice cap makes these resources more accessible, including vast reserves of phosphate, bauxite, diamonds, iron ore, gold, silver, copper, and zinc. Additionally, the Arctic holds an estimated 22 percent of the world’s untapped oil and gas reserves, according to the United States Geological Survey (USGS).⁵

These factors make the Arctic strategically attractive even to nations outside the geographical Arctic area.

However, scientific research and operations in the region remain highly difficult given its remoteness and extreme weather conditions. Accessing and operating in difficult locations, such as under water and ice, requires advanced technology. Vast ice sheets often prevent underwater vehicles from surfacing to establish links with other air, space, or offshore platforms. These challenges make **underwater acoustic technology** essential for acquiring and transmitting information beneath the Arctic ice cap.⁶ The adaptation of sonar equipment to ice-covered environments faces unique challenges. The presence of an ice interface introduces new scientific problems related to the physical modeling of sound propagation, which complicates the efficiency and application of sonar technology in these conditions.⁷

³ Organization: Arctic States”, Arctic Council, [last accessed August 19, 2024] <https://arctic-council.org/about/states/>

⁴ Mika Rantanen, Alexey Yu. Karpechko, Antti Lipponen, Kalle Nordling, Otto Hyvarinen, Immo Ruosteenoja, Timo Vihma, and Ari Laaksonen, “The Arctic Has Warmed Nearly Four Times Faster than the Globe Since 1979,” *Communications Earth & Environment* 3, Article number: 168 (2022), <https://www.nature.com/articles/s43247-022-00498-3>; and Chelsea Harvey, “The Arctic is Warming Four Times Faster Than the Rest of the Planet,” August 12, 2022, <https://www.scientificamerican.com/article/the-arctic-is-warming-four-times-faster-than-the-rest-of-the-planet/>.

⁵ Philip Budzik, “Arctic Oil and Natural Gas Potential,” EIA, October 2009 [last accessed August 19, 2024] https://www.eia.org/docs/vol1/AlaskaGas/Paper/Paper_EIA_2009_ArcticOilGasPotential.pdf

⁶ 14th International Conference on Theoretical and Computational Acoustics, Beijing

⁷ 14th International Conference on Theoretical and Computational Acoustics, Beijing

/ 2. China in the Arctic: Research, Policy, and Subsidies

Over the last decade, China, despite being a non-Arctic state, has taken great interest in Arctic exploration, deeming the region relevant for strategic, economic, and environmental reasons.

China has developed a series of initiatives to position itself in the Arctic, not necessarily with specific articulated goals, but to more broadly legitimize its presence in the region. The Arctic is mentioned in multiple Chinese policy documents, such as the 13th and 14th Five Year Plans that were published, respectively, in 2016 and 2021.

As for other national strategies:

- In 2013, China developed the **Polar Silk Road** (冰上丝绸之路) as part of the Belt and Road initiative. This specific project aims to connect China to Europe via the Arctic.
- In 2018, the State Council Information Office published **China's Arctic Policy** (中国的北极政策), in which China declared itself a "near-Arctic state."

Historically, China joined the Spitsbergen Treaty in 1925. As a contractual party to the treaty, China has access to certain areas of the Arctic and the right, under certain conditions, to conduct scientific research and commercial activities such as fishing and mining. UNCLOS also provides China with rights to conduct scientific research and maintain freedom of navigation in the Arctic. Moreover, in 2013, China became an accredited observer of the Arctic Council, a high-level intergovernmental forum comprising the eight states that have territories within the Arctic: Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden and the United States.

Civilian scientific exploration can, however, also support a country's military presence in the region. The U.S. Department of Defense, in its annual report to Congress on China's armed forces, noted that "civilian research could support a strengthened Chinese military presence in the Arctic Ocean, which could include deploying submarines to the region as a deterrent against nuclear attacks."⁸ The integration of the civil and military realms forms the foundation of **China's Military Civil Fusion (MCF) policy strategy**. MCF emphasizes the complementarity, integration, and transfer of resources, capabilities, and technologies between military and civilian actors to achieve "fusion." It facilitates the adaptation of civilian technologies for military use while also driving the commercialization and widespread adoption of military technologies for civilian consumption. Diversifying technology use cases is considered beneficial for enhancing high-tech production and expanding the applications and consumer base for dual-use technologies.

It has also been suggested that China leverages scientific collaboration to establish a foothold in the Arctic, thereby enhancing its strategic influence in the region.⁹

⁸ U.S. Department of Defense, "Annual Report to Congress: Military and Security Developments Involving the People's Republic of China, 2019," May 2, 2019 [last accessed August 19, 2024], https://media.defense.gov/2019/may/02/2002127082/-1/-1/1/2019_china_military_power_report.pdf.

⁹ Jana Robinson, "Arctic Space Challenge for NATO Emerging from China's Economic and Financial Assertiveness," *The Journal of the JAPCC*, Spring/Summer 2020, pp. 35-42.

2.1 Datenna's Quantitative Analysis on China's Arctic Research

To better understand the state of China's Arctic research, Datenna analyzed **Chinese government funding for Arctic research and development (R&D)** and tracked how funding and research projects have evolved over time. This report provides a general overview of the distribution of funding into Arctic R&D, followed by a closer examination of the academic institutions that received the most government funding in the field of underwater acoustic technology. Understanding the distribution of research funding provides insight into the level of commitment and effort placed on the Arctic region by the Chinese government and individual research institutions.

From 2005 to 2020, the National Natural Science Foundation (NSFC) of China and its provincial counterparts invested a total of CNY 473.5 million across 569 Arctic-related research projects. As shown in Figure 2, the number of Arctic-related research projects grew steadily from 2012 until 2017, coinciding with the release of China's Arctic policies.

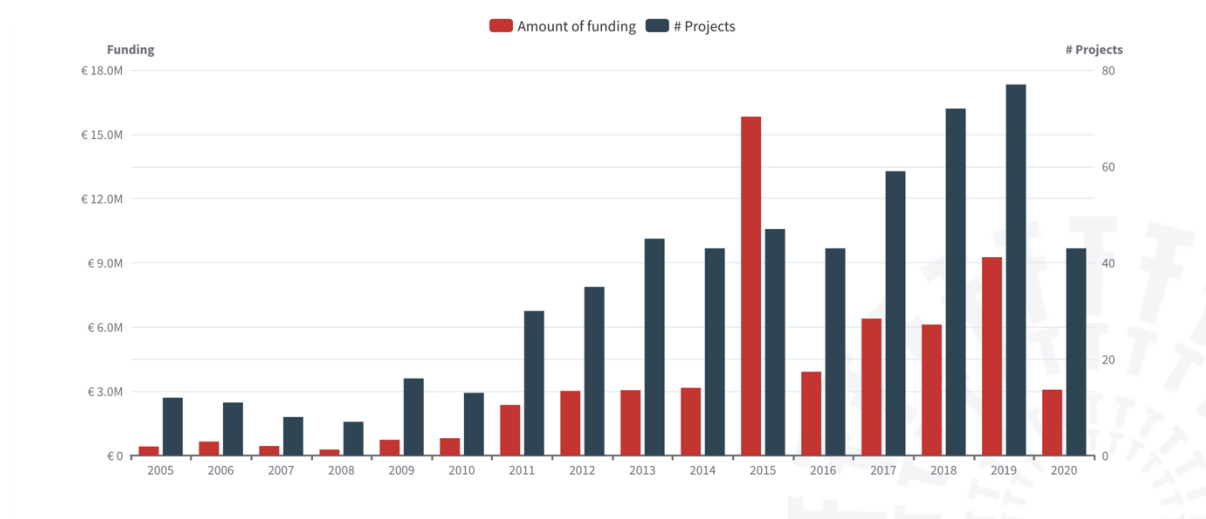


Figure 2: Funding for projects related to Arctic Research (2005-2020) | Query: "arctic" | "北极"

China is actively conducting scientific exploration in the Arctic, with one of its main methods being the use of manned and unmanned underwater submarines. As mentioned before, due to the presence of large ice sheets, underwater vehicles cannot surface to communicate with other air-space or offshore platforms. As a result, underwater acoustic technology becomes a critical—and often the only—means of acquiring and transmitting information beneath the Arctic ice.¹⁰ Furthermore, the presence of ice interfaces introduces unique scientific challenges, such as refining the physical model of sound propagation and improving the efficiency of sonar technology.¹¹ These factors underscore the importance of developing specialized tools for scientific exploration in such extreme conditions.

¹⁰ 14th International Conference on Theoretical and Computational Acoustics, Beijing

¹¹ 14th International Conference on Theoretical and Computational Acoustics, Beijing

While China's polar acoustic research is still in its early stages, the country's strategic interests in the Arctic region make tracking its developments worthwhile. Using the Datenna platform, Datenna analysts have identified the key universities and academic institutes involved in Arctic exploration, specifically in the subfield of underwater acoustics. By looking at the institutes that received the largest amount of research funding on underwater and ocean acoustic technologies in the Arctic, it becomes clear that the Institute of Acoustics of the Chinese Academy of Sciences (CAS) is the main recipient of government funding in this field, receiving almost half of the total funding. Northwestern Polytechnical University and Harbin Engineering University rank second and third respectively. Other institutions receiving significant funding for underwater and ocean acoustic research are Ocean University of China, Southeast University, and Shanghai Jiao Tong University.

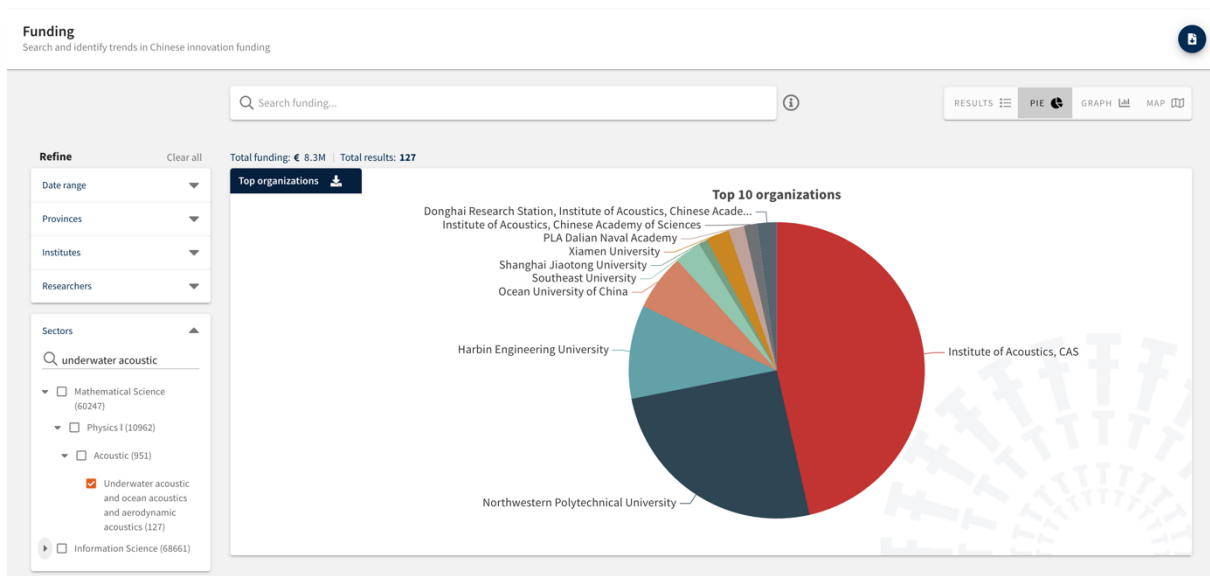


Figure 3: Most active institutes within the subfield of "Underwater acoustics and ocean acoustics and aerodynamic acoustics"

/ 3. Key Academic Players

This section analyzes two key Chinese academic institutions in the field of underwater acoustics. These were selected based on the amount of research funding received, the number of published patents, and qualitative data from external public sources.

The institutions analyzed are:

- Institute of Acoustics (IOA), Chinese Academy of Sciences (CAS)
- Harbin Engineering University (HEU)

For each institution, we assess the amount of research funding they received, associated research projects, key researchers, patents, procurements, and investments, as applicable.

3.1 Institute of Acoustics (IOA)

The Institute of Acoustics (IOA) of the Chinese Academy of Sciences (CAS) (中国科学院声学研究所) was established in 1964 to meet China's strategic needs in acoustics research. IOA focuses on underwater acoustics, acoustical detection, environmental acoustics, and noise control technologies. It is directly involved in Arctic research, and participated in the 2018 9th Arctic Research Expedition, where Dr. Wu Yuquan from the IOA led the acoustic observation group.¹² The institute also carried out a project titled "Progresses and Advances in Arctic Underwater Acoustics Study." This will be further analyzed in the "Research Projects" section.

Under the Belt and Road Initiative, IOA has launched eight international cooperation projects with countries including Russia, Portugal, and Norway, to explore acoustical environment features in the Arctic, the Atlantic, and other regions.¹³

Research Projects

The following table highlights IOA's key research projects in underwater acoustics.

¹² "IACAS Participated in China's 9th Arctic Research Expedition", IOA CAS, October 28, 2018 [last accessed August 19, 2024], http://english.ioa.cas.cn/es/201810/t20181028_200531.html

¹³ "Institute of Acoustics", IOA CAS, [last accessed August 19, 2024], <http://english.ioa.cas.cn/au/bi/>

Title	Institute	Researcher	Funding	Date
Study on Acoustic Scattering Characteristics and Acoustic Vibration Mechanism of Bending Elastic Shell with Covering Layer	Institute of Acoustics, Chinese Academy of Sciences	Jin ZhongKun, Jin Zhongkun	€ 30.0K	2020
Parameter Inversion of Seafloor Rough Interface Based on Shallow Sea Low Frequency Reverberation Data	Institute of Acoustics, Chinese Academy of Sciences	Hou QianNan, Hou Qiannan	€ 32.4K	2020
Study on Sound Propagation Characteristics in High Sea Conditions	Institute of Acoustics, Chinese Academy of Sciences	Yao MeiJuan, Yao Meijuan	€ 30.0K	2020
Research on multi-UUV cooperative target perception technology under communication constraints	Institute of Acoustics, Chinese Academy of Sciences	Sun FeiHu, Sun Feihu	€ 32.4K	2020
Vibration characteristics and rupture mechanism of enveloped bubbles in non-Newtonian fluids under ultrasonic action	Institute of Acoustics, Chinese Academy of Sciences	Wu PengFei, Wu Pengfei	€ 32.4K	2020
Research on Joint Recognition Technology of Multilingual Speech Content and Language Type Based on End-to-End	Institute of Acoustics, Chinese Academy of Sciences	Xu Ji, Xu Ji	€ 30.0K	2020
Research on efficient distributed detection technology for underwater wireless sensor network based on multi-bit quantization	Institute of Acoustics, Chinese Academy of Sciences			
Research on identification technology of cobalt-rich crusts based on deep learning network under acoustic in situ measurement	Donghai Research Institute of Acoustics, Chinese Academy of Sciences			
Design and verification of an impedance-matched metamaterial device for controlling underwater acoustic propagation	Institute of Acoustics, Chinese Academy of Sciences			
Acoustic-fluid coupled cavitation research	Institute of Acoustics, Chinese Academy of Sciences			

Figure 4: Research projects conducted by IOA

One notable project, “Design and Verification of an Impedance-Matched Metamaterial Device for Controlling Underwater Acoustic Propagation (阻抗匹配型水下声传播调控超材料器件的设计与验证),” has defense applications as identified by the Datenna platform, particularly in underwater communication and detection. Another defense-related research project, the “Research on Detection Technology of Underwater Acoustic Cognition Network (水声认知网络探测技术研究),” focuses on active sonar signal design, communication protocols, and collaborative strategies for distributed underwater acoustic networks.

Together with other projects, the project team conducted several field tests from November to December 2010 in the Bohai Sea in Huanghua, Hebei province, and in June 2012 in the South China Sea. China’s research expeditions in the Arctic often involve extensive oceanographic surveys and acoustic modeling, which mirror some of its activities in the South China Sea, where a thorough understanding of the region’s waters is also essential for the People’s Liberation Army Navy (PLAN) to operate effectively.¹⁴ Notably, China’s polar programs and South China Sea research activities are all organized under the Ministry of Natural Resources.

Patents

We conducted an in-depth analysis on IOA’s patents. IOA has filed almost 5000 patents, many of which involve technologies related to submarines and underwater robots designed to resist extremely low temperatures, making them suitable for Arctic exploration.

¹⁴ “Hidden Reach,” CSIS [last accessed August 19, 2024], <https://www.csis.org/programs/hidden-reach>.

▼ A kind of vertical array 1 system suitable for the extremely cold marine site acoustics hydrographic survey of high latitude STR		2017
Title:	A kind of vertical array 1 system suitable for the extremely cold marine site acoustics hydrographic survey of high latitude	
Assignee:	中国科学院声学研究所	
Inventors:	-	
IPC codes:	G01C13/00, G01H3/00	
Abstract:	<p>The invention discloses a kind of vertical array 1 system suitable for the extremely cold marine site acoustics hydrographic survey of high latitude, the vertical array 1 system includes several hydrophones connected by high intensity cable, and the hydrophone includes: High sensitivity hydrophone head, for receiving ambient sea noise and water sound communication signal; Signal acquisition and modulate circuit, for high sensitivity hydrophone head to be acquired and nursed ones health; Sensor assembly, for gathering pressure, temperature, inclination angle, acceleration and azimuth information; Including: Pressure sensor, obliquity sensor, acceleration transducer, temperature sensor and aspect sensor; Master controller, for controlling the data transfer between each module; And real-time clock, for realizing that the rough grade of each hydrophone node is synchronous. System provided by the invention is not constrained by cable, and charging equipment is all designed with the target of resistance to extremely low temperature in vertical array so that whole system is particularly suitable in the arctic and adjoined to use in the deep-sea acoustic measurement in marine site.</p>	
Citations:	CN-101561313-A, CN-102023050-A, CN-102353515-A, CN-103364067-A	
Publication number:	CN-107356233-A	

Figure 5: Example of an IOA Patent

▼ Vertical array system suitable for acoustic hydrological measurement in high-latitude extremely cold sea area STR		2020
Title:	Vertical array system suitable for acoustic hydrological measurement in high-latitude extremely cold sea area	
Assignee:	中国科学院声学研究所	
Inventors:	-	
IPC codes:	G01C13/00, G01H3/00	
Abstract:	<p>The invention discloses a vertical array system suitable for acoustic hydrological measurement in a high-latitude extremely cold sea area, which comprises a plurality of hydrophones connected in series through high-strength cables, wherein each hydrophone comprises: the high-sensitivity hydrophone head is used for receiving marine environmental noise and underwater acoustic communication signals; the signal acquisition and conditioning circuit is used for acquiring and conditioning the high-sensitivity hydrophone head; the sensor module is used for acquiring pressure, temperature, inclination angle, acceleration and azimuth information; the method comprises the following steps: the device comprises a pressure sensor, an inclination angle sensor, an acceleration sensor, a temperature sensor and an orientation sensor; the main controller is used for controlling data transmission among the modules; and the high-precision real-time clock is used for realizing coarse precision synchronization of each hydrophone node. The system provided by the invention is not restricted by cables, and the live equipment in the vertical array is designed with the aim of resisting extremely low temperature, so that the whole system is particularly suitable for being used in the deep sea acoustic measurement of the north pole and the adjacent sea area.</p>	
Citations:	-	
Publication number:	CN-107356233-B	

Figure 6: Example of an IOA Patent

Procurement Activities

Procurement records show how IOA activities support the R&D of ocean and underwater acoustics. Participation in defense procurement bids, regardless of the results, offers a strong signal of both the intent and capability of the IOA to supply the Chinese military.

In 2021, IOA won a bid to support the Chinese People's Liberation Army (PLA) in underwater acoustics research.

▼ Chinese People's Liberation Army DEF		2021
Project name:	Ocean Acoustics Survey Project Transaction Announcement	
Publicity time:	13 December 2021 - 16 December 2021	
Budget:	€ -	
Bid status:	Won	
Procurement ID:	4346C7B1E261447E9BE43C9ACD0111F4	

Figure 7: Example of a defense procurement involving IOA

▼ Chinese People's Liberation Army DEF		2022
Project name:	Announcement of winning the bid for the underwater acoustic releaser beacon project	
Publicity time:	20 May 2022 -	
Budget:	€ 61.9K	
Bid status:	Won	
Procurement ID:	85C58877F10343F7A0F8F1C33D044144	

Figure 8: Example of a defense procurement involving IOA

As for the PLA's activities in the Arctic, academics have pointed to the potentially serious strategic implications of a PLAN missile or attack submarines roaming the Arctic Ocean.¹⁵

Moreover, in 2021, IOA won a bid to conduct research on noise acoustic characteristics prediction for the PLAN.

navy DEF 2021	
Project name:	Announcement of bid evaluation results for research on noise acoustic characteristics prediction and analysis principle
Publicity time:	8 October 2021 - 11 October 2021
Budget:	€ 28.7K
Bid status:	Won
Procurement ID:	HLJDGG20211008062

Figure 9: Example of a defense procurement involving IOA

Investments

IOA has made several investments, the majority of which are related to technology and acoustics, demonstrating IOA's intent to further advance its technology capabilities. This is especially notable given that research efforts often extend beyond the R&D phase and can result in commercial spin-offs.

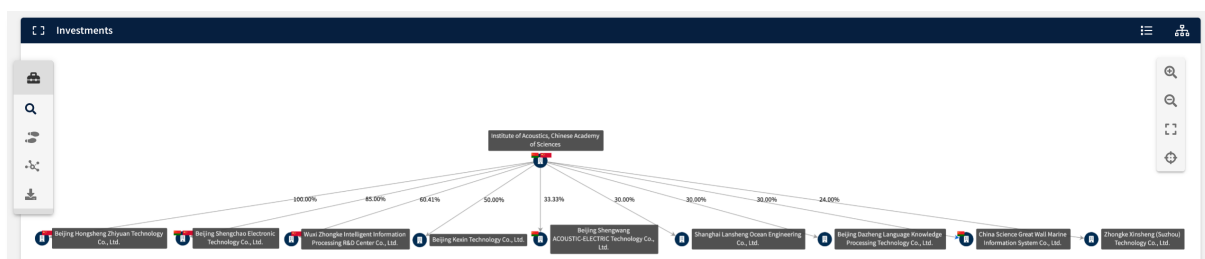


Figure 10: Investments and subsidiaries of IOA

Most of IOA's corporate investments are in the same field in which the institute operates. The sheer number and nature of IOA's investments demonstrate that it is a leader in this field and is deeply intertwined with China's defense industry. On the Datenna platform, companies are assigned a green defense label if they show one or more indicators of connections to the Chinese defense industry.

3.2 Harbin Engineering University (HEU)

Harbin Engineering University (HEU, 哈尔滨工程大学) is part of the "Seven Sons of National Defense," a group of seven universities closely tied to the Chinese PLA for developing technologies with military applications. The critical function of these universities in the defense ecosystem is evident from the fact that in 2019, three-quarters of university graduates recruited by Chinese defense state-owned enterprises came from the *Seven Sons*. Additionally, at least half of their research budgets are allocated to developing military products.

¹⁵ "Mahan and Understanding the Future of Naval Competition in the Arctic Ocean," Canadian Naval Review 14:3 (Winter, 2019) and Anne-Marie Brady, "China as a Rising Polar Power: What it means for Canada," Macdonald Laurier Institute (December 2019).

HEU has been blacklisted by Japan’s Ministry of Economy, Trade and Industry (METI) for its potential involvement in the development of weapons of mass destruction.

HEU is also active in Arctic-related initiatives. In 2018, in partnership with the Russian Northern (Arctic) Federal University, it established the Arctic Blue Economy Research Center (ABERC). The center’s mission is to provide a full range of the most current policy-relevant economic information available on international collaboration, economic development, and sustainability in the Arctic. It also looks at changes in China’s Arctic policy and implications on major stakeholders in the North, as well as the current situation and trends along the Russian Arctic coastline and surrounding coastal waters.¹⁶

Research Projects

The table below provides examples of research projects led by HEU.

Harbin Engineering University
哈尔滨工程大学

OVERVIEWPROJECTSRESEARCHERSFUNDINGPATENTSPROCUREMENTSTOP SECTORS LATEST NEWSCOMPANY PROFILE

Projects

underwater vehicle

Research project title	Year	Funding
Research on new navigation filtering method for underwater AUV based on thick-tailed non-Gaussian noise modeling	2018	€ 78.0K
Research on the dynamic control method of formation of multiple unmanned submersibles operating near the seabed	2018	€ 30.0K
Research on autonomous tracking and docking method of acoustically guided UUV to underwater mobile platform	2018	€ 27.6K
Research on bionic directional detection method and mechanism of small underwater targets under the mechanism of multiple transmission and multiple reception	2018	€ 74.4K
Research on Adaptive Fault-Tolerant Control Method for Area Tracking of Autonomous Underwater Robot	2018	€ 72.0K
Research on drag reduction and noise reduction characteristics of microfloating raft array skin fluid	2018	€ 72.0K
Research on Cooperative Positioning Technology of Multi-Underwater Vehicles in Polar Region	2017	€ 74.4K
Research on Environmental Homomorphic Prediction and Task Reconfiguration of UUVs for Covert Operations in the Coastal Sea	2017	€ 74.4K
Theories and key technologies of autonomous safety navigation of polar deep-sea space stations	2017	€ 318.0K
Research on Weak Fault Diagnosis Method of Autonomous Underwater Robot Thruster	2017	€ 74.4K

Figure 11: Overview of research projects within the field of underwater acoustics led by HEU

One research project worth investigating is titled “Research on Cooperative Positioning Technology of Multi-Underwater Vehicles in Polar Region (极区多水下航行器协同定位技术研究).” The NSFC granted a substantial amount of CNY 608,773 to Yu Fei (于飞) to lead this project.¹⁷ According to the research project abstract, the polar region is very important to the future development of China, particularly in polar underwater topography survey, naval mine detection, coastal anti-submarine, and relay communication technology. To complete these tasks, unmanned underwater vehicles are the optimal choice. The abstract further states that the project not only has important theoretical value for the development of the technology, but also has important significance for the PLAN’s military development.

16 “Arctic Blue Economy Research Center has been established at Harbin Engineering University”, UArctic, November 26, 2018 [last accessed August 19, 2024], <https://www.uarctic.org/news/2018/11/arctic-blue-economy-research-center-has-been-established-at-harbin-engineering-university/#>.

17 NSFC, the National Natural Science Foundation of China, in accordance with the Chinese government’s plans for the development of Science and Technology, is responsible for directing and coordinating funding to support research.

Patents

We conducted a review of HEU's patents to determine if specific patent inventions pertain to underwater acoustics. This analysis revealed that a number of HEU's patents are related to these technologies.

The patents illustrated below are good examples illustrating how different inventions relate to unmanned subglacial devices, multi-underwater unmanned vehicles, and underwater communication, especially in Arctic conditions.

▼ Ice-crossing sound communication system and method DEF		2023
Title:	Ice-crossing sound communication system and method	
Assignee:	哈尔滨工程大学	
Inventors:	-	
IPC codes:	H04B11/00, H04B7/185, H04B13/02	
Abstract:	<p>The invention aims to provide a system and a method for ice-crossing communication, comprising an ice communication device and an underwater communication device. Based on the floating ice sound propagation characteristic, the invention simultaneously uses the ice layer sound propagation channel and the water sound propagation channel, and carries out information transmission from ice surface to water by exciting longitudinal waves between ice plates, thereby solving the problem that downlink long-distance communication cannot be realized because the attenuation of direct waves in water is faster when an ice surface seismic source is excited, and realizing the effective transmission and reception of the ice medium-crossing sound signals, and further completing the ice medium-crossing sound communication. The uplink communication and the downlink communication use different frequency bands for communication, namely, the ice communication device can simultaneously transmit signals of the ice layer acoustic propagation channel and receive signals of the underwater acoustic propagation channel, so that full duplex communication is realized, and the communication efficiency is improved. Meanwhile, three-component data received on the ice surface are analyzed and processed, and the receiving module in water can receive the three-component data in a directional manner, so that interference of a transmitting signal and noise can be effectively reduced, and the quality of a receiving signal is improved.</p>	
Citations:	-	
Publication number:	CN-116800350-A	

Figure 12: Example of a HEU patent

Title:	Method for designing acoustic communication waveform of ice-crossing medium	
Assignee:	哈尔滨工程大学	
Inventors:	-	
IPC codes:	H04B10/299, H04B10/508, H04B10/516, H04B10/564, H04B13/02	
Abstract:	<p>The invention discloses a method for designing acoustic communication waveforms across ice media, which comprises the steps of obtaining sea ice acoustic parameters, establishing a dispersion equation describing the characteristics of an ice layer elastic waveguide according to an elastic fluctuation theory, and solving the dispersion equation to obtain a phase velocity dispersion function c_p. According to c_p Obtaining a group velocity dispersion function, and further obtaining a group velocity dispersion curve; determining sound source excitation parameters serving as a signal source, wherein the sound source excitation parameters comprise an excitation frequency range and an acoustic energy incidence angle range, and selecting a corresponding group velocity dispersion function in a dispersion curve according to the sound source excitation parameters; calculating a system transfer function according to the distance between the receiving end and the transmitting end based on the obtained frequency dispersion function; obtaining a system frequency domain response function based on the system transfer function and the expected pulse signal frequency domain waveform; and converting the frequency domain response function into a time domain, and inverting the time domain waveform to obtain a transmitting end waveform. The invention greatly increases the communication concealment while improving the communication distance and the communication reliability, and realizes the high-efficiency, stable and concealed ice-crossing fixed-point acoustic communication.</p>	
Citations:	JP-2004015762-A, CN-106019288-A, CN-108777598-A, CN-111077532-A	
Publication number:	CN-114070408-B	

Figure 13: Example of a HEU patent

▼ Polar region cross-ice layer wireless network communication system and method DEF		2022
Title:	Polar region cross-ice layer wireless network communication system and method	
Assignee:	哈尔滨工程大学	
Inventors:	-	
IPC codes:	H04B13/02, H04B11/00, H04W16/18, H04W40/22, H04W84/06, H04W72/08, H04W4/40	
Abstract:	<p>The invention provides a polar region cross-ice layer wireless network communication system and a method, comprising an under-ice communication network system and an on-ice communication network system; the under-ice communication network system is characterized in that an underwater acoustic sensor node array, a UUV mobile node and a high-power relay communicator node array are distributed below an ice layer from bottom to top, the underwater acoustic sensor node array and the UUV mobile node are responsible for detecting and analyzing environmental signals, the high-power relay communicator array is responsible for relay forwarding and cross-domain communication, the on-ice network communication system comprises an ice layer detector array, a satellite and a water surface control center, the ice layer detector array is closely coupled with an ice surface, communication signals from the high-power relay communicator node array below the ice layer are detected, and then a communication network is established by using electromagnetic waves and the satellite and forwarded to the control center; the invention can construct an underwater-on-ice-satellite integrated cross-domain information transmission network without drilling through the ice surface, thereby realizing cross-domain information transmission.</p>	
Citations:	CN-201966959-U, CN-108777598-A, CN-110958591-A, CN-111132064-A, CN-111181627-A, CN-111416669-A	
Publication number:	CN-115529567-A	

Figure 14: Example of a HEU patent

Procurement Activities

HEU has participated in more than 50 tenders to supply China's defense industry. We examined all tenders in which the university has participated (both won and lost) to determine whether some of the relevant projects relate to the technologies in question. The following examples show how HEU's research efforts are linked to China's defense industry through procurements.

▼ Academy of Military Sciences DEF		2020
Project name:	Underwater detection and warning system winning bid announcement	
Publicity time:	3 July 2020 - 7 July 2020	
Budget:	€ -	
Bid status:	Won	
Procurement ID:	SLJDGG20200703060	

Figure 15: Defense procurement won by HEU

▼ China Ship Research and Design Center DEF		2021
Project name:	Prototype manufacturing and testing of QT DW buoy acoustic communication and processing equipment	
Publicity time:	16 December 2021 - 24 December 2021	
Budget:	€ 64.8K	
Bid status:	Won	
Procurement ID:	HLJGGG20211216252	

Figure 16: Defense procurement won by HEU

▼ Academy of Military Sciences DEF		2022
Project name:	Announcement of the review results of the underwater acoustic communication module	
Publicity time:	7 January 2022 - 12 January 2022	
Budget:	€ -	
Bid status:	Lost	
Procurement ID:	HLJDGG20220107082	

Figure 17: Defense procurement in which HEU participated, but lost

Investments

HEU has made several investments of interest, including companies involved in military or defense industry procurements, companies placed on blacklists, and officially registered State-Owned Enterprises.

Most of the investments are in underwater technology and shipbuilding. The number and nature of these investments demonstrate that HEU occupies a prominent position in this field and is deeply intertwined in China's defense industry.

By examining all its investments with a defense link, Datenna analysts discovered that HEU has a direct asset management holding company operating independently and making additional investments. The company, Harbin Chuanda Engineering Technology Design Research Institute (哈尔滨工程大学资产经营有限公司), owns multiple companies that are registered as military suppliers or involved in military procurements. For example, in 2022, Harbin Ship Marine Information Technology won a procurement to supply the Chinese PLA with an underwater acoustic navigation and positioning module.

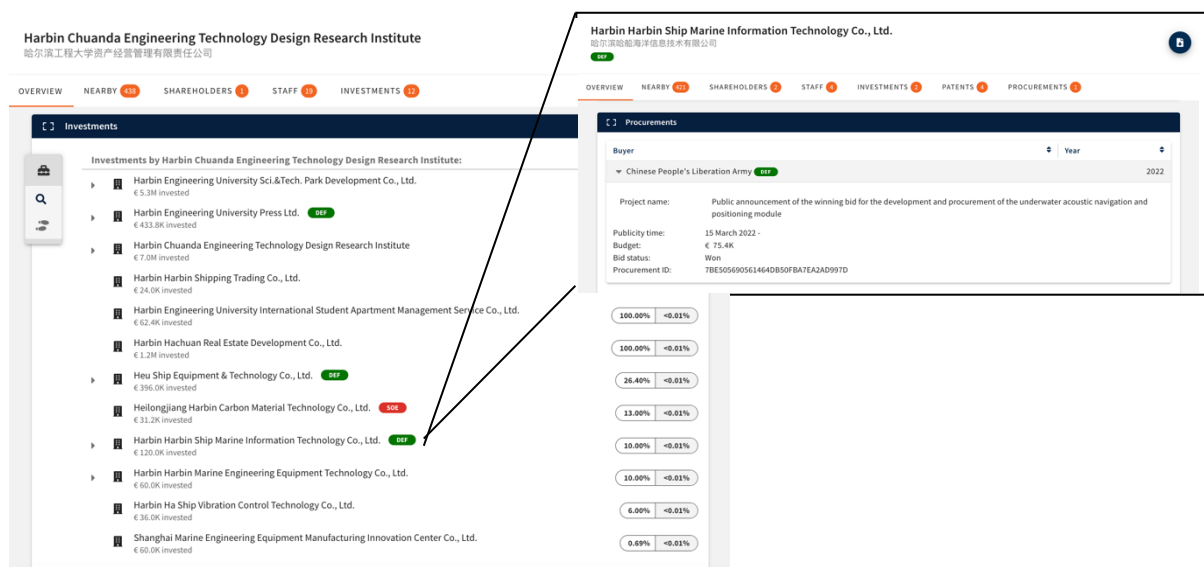


Figure 18: Defense procurement won by Harbin Ship Marine Information Technology

/ 4. Conclusion

Datenna's report provides a comprehensive analysis of **China's presence in the Arctic** and its development of technologies for scientific exploration in the region.

The report begins by highlighting the Arctic's strategic importance, focusing on its geographic position and abundant natural resources. These factors make the region highly significant, yet its extreme weather conditions present considerable challenges for exploration. These challenges have driven the development of specialized instruments, such as underwater acoustic technology, for Arctic exploration. Although polar acoustic research in China is still in its early stages, the increasing amount of funding dedicated to this field underscores China's strategic interest in the region.

To provide a concrete overview of the state of underwater acoustic research in China, Datenna selected two key academic players for an in-depth discussion. The analysis of the two institutes focused on their research projects, patents, procurements, and investment activities. All these datapoints give an image of the process that starts with R&D and continues to the actual implementation by means of patent filings or procurement activities. This research not only shows the high level of activity by these key institutions but also reveals their close ties to **China's defense industry**.

Both the **Institute of Acoustics of the Chinese Academy of Sciences** and **Harbin Engineering University** are notable for their government-funded research projects, which align with China's goal of achieving technological self-sufficiency. The Chinese government's support, both through policy and funding, has fueled advancements in this field to meet the growing demand across various industries. These efforts extend beyond R&D, as evidenced by both institutes' patents, procurements, and investments, showcasing a full-spectrum approach to technological development.

Given the rapid evolution of scientific research in China, regular updates to this analysis are essential to maintain an accurate and up-to-date understanding of the situation. Using the Datenna platform, analysts have the tools to track and evaluate China's ongoing activities in the Arctic, including its technological development and the roles of key players, to glean a comprehensive and current picture of China's footprint in this region.