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QUANTUM DRAGON

How China is Exploiting Western Government Funding and Research Institutes to Leapfrog in Dual-Use Quantum Technologies

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FOREWORD

In this report, Strider's Global Intelligence Team connects the dots to show how China has gone from a relative laggard in quantum science and technology to a global leader in quantum military applications in roughly a decade. Strider is not suggesting any illegal activities were conducted by any individual, university, professor, or research institute named in this report. Strider has not uncovered information that any foreign scientists or their respective research institutions are aware USTC scientists are collaborating with China's defense industry or that their research is being used to advance China's military capabilities.

INTRO

This report leverages Strider's technology platform and proprietary datasets to detail how China has exploited quantum science resources in the West to rapidly achieve global leadership in certain quantum technologies with military applications. China's advances in dual-use quantum technologies stem from a multi-decade strategy to exploit Western research institutes. This strategy includes sending Chinese scientists to top quantum research labs around the world for training and then recruiting those Chinese scientists, who made "unwritten agreements" to return before they were sent out, back to China through PRC government talent programs and funding schemes to support the development of China's quantum research programs. This activity is done in the name of "international scientific cooperation", however, the same Western-trained Chinese scientists simultaneously collaborate with Chinese state-owned defense companies to develop military applications for quantum technologies. The tactics, techniques, and procedures (TTPs) China has deployed to leapfrog competitors in quantum technologies uncovered by Strider's Global Intelligence Team are fueling a new global competition for dominance across strategically significant scientific fields and emerging technology industries.

The Bottom Line

- For more than a decade, China has implemented an intentional strategy to "assign" Chinese quantum scientists to leading research institutes around the world, including in the United States, UK, Germany, and Switzerland, to "master cutting-edge research" with the support of Western government funding after making "unwritten agreements that they must return to China after their studies are complete" to support PRC government dual-use quantum research programs. China's strategy has succeeded in building a competitive advantage over the U.S. and other nations in certain quantum technologies with military applications.
- Pan Jianwei [潘建伟] developed and leads this strategy. Pan, known as China's "father of quantum," is Head of the Division of Quantum Physics and Quantum Information at the University of Science and Technology of China (USTC), which drives China's quantum science collaboration with Western research institutes alongside parallel collaboration with China's major state-owned defense companies. Pan is also a concurrent part-time professor at Germany's Heidelberg University.
- Western Universities and research labs have been compromised at the highest levels. Pan and PRC government agencies have recruited a number of Western scientists with monetary incentives through government talent programs. Western quantum scientists inducted into PRC talent programs include Matthias Weidemuller, Dean of the Department of Physics and Astronomy at Heidelberg University, and Barry Sanders, a theoretical physicist at the University of Calgary in Canada.
- Heidelberg University is arguably the most important foreign partner behind China's rapid progress in dual-use quantum technologies. Over the past decade, Heidelberg University has provided physical equipment to USTC's quantum lab, trained, and continues to train, a generation of USTC quantum scientists, and engages in cutting-edge joint research with USTC.
- Pan and his team of quantum scientists at USTC directly collaborate with China's major state-owned defense companies and are behind numerous recent breakthroughs in quantum military applications. This includes quantum radar to detect stealth aircraft, quantum magnetometers to detect submarines, and quantum key distribution (QKD) to enable encrypted communications for the Chinese military, including on Chinese naval vessels in the "far seas."

Section 1

GO WEST

China's Strategy to Send Quantum Scientists Abroad & Bring them Home Using Government Talent Programs

China's position as a global leader in quantum technology was far from predictable a decade ago, when, as Pan Jianwei told the *Washington Post,* China's work on quantum technology was "relatively backward."[1] The story of how China went from "relatively backward" to a global leader in quantum science and technology in under a decade starts and ends with Pan Jianwei, a world-renowned expert in the field of quantum communications and the youngest Academician ever inducted into the Chinese Academy of Sciences (CAS) in 2011 at age 41. Pan acknowledged to the *Washington Post* that he "took the initiative to send students to top research groups abroad to learn related technologies." "Fortunately, they later returned back to work in China," he said.[2] In fact, fortune didn't have much to do with it.

> "We've taken all the good technology from labs around the world, absorbed it and brought it back."[4]
>
> — PAN JIANWEI

For over a decade, Pan, in collaboration with PRC government stakeholders, has executed an intentional strategy to exploit Western government funding to train Chinese quantum scientists at Western research institutes and relied on both "unwritten agreements" and monetary incentives through PRC government talent programs to then bring those Western-trained quantum scientists back to China. According to Lu Chaoyang, who is considered to be a "backbone" of Pan's team at the University of Science and Technology of China (USTC), young scientists are "assigned," based on their research interests, to study at leading quantum labs around the world, including in the United States, UK, Germany, and Switzerland, to "master cutting-edge research" and then return to China.[3] Pan sends these young scientists abroad for training with an "unwritten agreement that they must return to China after their studies are complete" and accomplishes this "under the support of China's system of talent programs."[3]

The strategy has been remarkably successful. In a 2016 interview, when he was asked how China was able to make such rapid strides in quantum communications, Pan replied, "we've taken all the good technology from labs around the world, absorbed it and brought it back."[4]

Pan's strategy depends on open collaboration with foreign quantum research labs and none has been more important than Germany's Heidelberg University. Pan's collaboration with Heidelberg University began with Pan's own European Commission funded training there from 2003 – 2008 as a Marie Curie fellow, concurrent to his position as a professor at the University of Science and Technology of China (USTC). During the last three years of Pan's European Commission funded training at Heidelberg University, from 2006 – 2008, he also received $400,000 in Project 973 funding from China's Ministry of Science and Technology (MOST) for "secure quantum key distribution research," a technology with military applications (see ***Section 3, Quantum Key Distribution***). China's Project 973 funds basic research to "mobilize China's scientific talent" and "meet national strategic needs."[5] Pan later tapped funding from the European Commission (via Marie Curie fellowships[6]) and German government (via Humboldt fellowships[7] and CAS-DAAD fellowships[8]) to finance his strategy of sending out young Chinese scientists for training at Heidelberg University. In Pan's own words:

> "From 2003 – 2008 I was back and forth between China and [Germany]. On the one hand, I vigorously developed optical quantum information technology in the lab at USTC; on the other hand, **leveraging Heidelberg University Institute of Physics' research strength in cold atoms and atomic chips as well as my status as a Marie Curie Professor, I applied for funding support in Europe through various channels to recruit graduate students and postdocs from China to cultivate China's cold atom quantum storage research capability.** In a few years, we formed a wealth of talent and technological accumulation in the cold atom quantum storage area and achieved a series of leading international research results...**In 2008, after accumulating a sufficient amount of technology and talent reserves, I gave up my position at Heidelberg University, moved Heidelberg University's experimental lab equipment to USTC, and recruited a group of outstanding young talents from Heidelberg University to USTC via talent programs such as the national 'Young Thousand Talents Program' and the Chinese Academy of Sciences' 'Hundred Talents Program'."**[9]

Strider has identified significant risks of intellectual property theft and economic espionage to companies with employees connected to talent programs. Association with a talent program is not illegal, but does create incentives to steal, violate export controls, and conflicts of interest.

Pan has elsewhere emphasized the pre-meditated and PRC government-coordinated nature of his exploitation of European and German government funding. In a January 2018 interview with China's *Southern People Weekly*, Pan explained that he secured PRC government permission before he accessed foreign government funding to support his time at Heidelberg University and to train his team:

> "I had discussions with the Chinese Academy of Sciences and USTC, who then had relevant communication with the [PRC] Ministry of Education, and they allowed me to work in this form, but we had a basic promise to bring this technology back to China when the moment comes. If not, how would you explain this team of more than ten people all returning back to China at about the same time in 2008? We had a very serious agreement, or say a promise, that we were going to return, that we were doing this for the ultimate objective… We built up the lab in Germany and finally spent money to bring the instruments back, buying it at a very cheap discount."[10]

Today, a disproportionate number of the University of Science and Technology of China (USTC) scientists have received some form of training at Heidelberg University. Including Pan, 13 of 29 quantum scientists listed as faculty by the USTC Department of Quantum Physics and Quantum Information have been trained at Heidelberg University (***See Figure 2***). Six of these scientists received European Commission or German government funding to finance their training at Heidelberg University (***See Figure 3***). All 13 of these Heidelberg University trained scientists were recruited back to China via PRC government talent programs, including the "Thousand Talents" and "Hundred Talents" programs (***See Figure 3***).

USTC quantum scientists, especially those trained at Heidelberg University, are elite scientists at the cutting edge of global quantum science research. For example, of the 27 members on the "Expert Committee" of the Quantum Information Association of China (QAIC), 14 are

Pan Jianwei (standing fourth from the left on the second row, between Chairman Xi and Premier Li, both seated on the first row) in the group photo for the 2015 National Science and Technology Award ceremony on January 8, 2016. Chinese media noted that the most important prize winners stood behind Chairman Xi and Premier Li in the group photo.

current or former USTC professors and 9 of those have received some form of training at Heidelberg University. Of the remaining 13 non-USTC affiliated experts, 2 hold positions at PLA research institutes.

In addition, a team led by Pan Jianwei won the 2015 National Natural Science Award First Class Prize, China's highest award in the field of natural science, for work on "Multiphoton Entanglement and Interferometry." Of the 15 members of Pan's award-winning team, including Pan, 12 had received training at a Western research institute and 10 of those had been trained at Heidelberg University. Pan Jianwei was the only award winner to speak at the award ceremony on January 8, 2016, which was attended by Chairman Xi Jinping and Premier Li Keqiang. The People's Liberation Army (PLA) was heavily represented at the ceremony.

> …We had a very serious agreement, or say a promise, that we were going to return, that we were doing this for the ultimate objective… We built up the lab in Germany and finally spent money to bring the instruments back, buying it at a very cheap discount."[10]

PRC government talent programs are also used to recruit non-ethnic Chinese quantum scientists to support the University of Science and Technology of China (USTC) research and further international collaboration. In 2013, Dr. Matthias Weidemuller, Dean of the Department of Physics and Astronomy at Heidelberg University and Founding Director at the Heidelberg Center for Quantum Dynamics, was recruited to USTC through the "Thousand Talents Program," which entails a one-time $150,000 payment and up to $750,000 for research, along with University of Calgary theoretical physicist Barry Sanders. Both Weidemuller and Sanders are now concurrent part-time Thousand Talent Chair Professors at USTC.

Matthias Weidemuller (left photo) and Barry Sanders (right photo) receive the Thousand Talents award from Hou Jianguo [侯建国], President of USTC, on August 27, 2013.

Strider Connects the Dots

Strider combines proprietary algorithms, machine learning, and subject matter expertise to provide customers actionable insights into the tactics, techniques, and procedures (TTPs) foreign governments utilize to acquire foreign technology and know-how.

This report shines a light on the TTPs used by China to leapfrog in quantum technologies by connecting the dots between PRC government strategies, funding schemes, quantum scientists, and defense industry stakeholders driving breakthroughs in military applications of quantum technologies.

FIGURE 1

Strider Data Engine

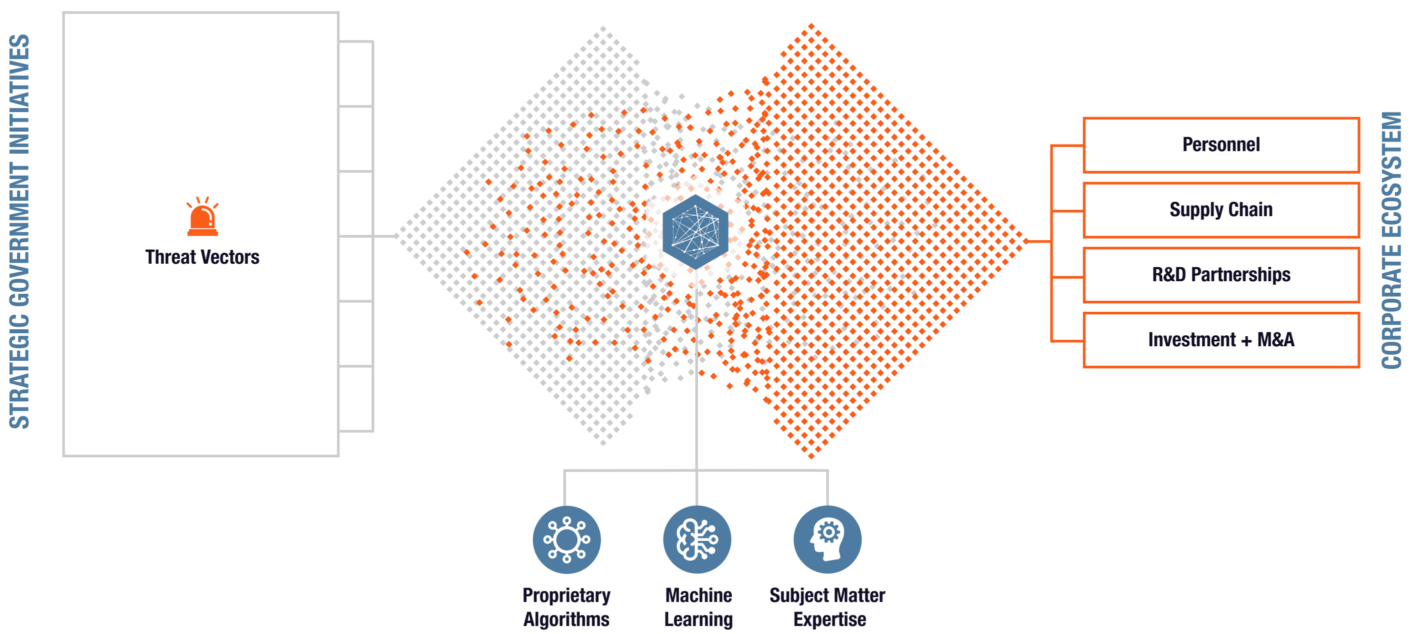

FIGURE 2

Leveraging Foreign Research Institutes to Build the USTC Department of Quantum Physics and Quantum Information

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This figure visualizes the foreign training of 24 USTC quantum scientists. Of these, 21 are listed as current faculty at the USTC Department of Physics and Quantum Information (excluding Jun Rui and Shen Qi, who are Senior Researchers, and Sun Hui, a PhD student), accounting for the vast majority of the total 29 member faculty.

16 scientists trained at Heidelberg University

1. Pan Jianwei (潘建伟)
2. Zhao Bo (赵博)
3. Bao Xiaohui (包小辉)
4. Chen Kai (陈凯)
5. Chen Shuai (陈帅)
6. Chen Yuao (陈宇翱)
7. Dai Hanning (戴汉宁)
8. Deng Youjin (邓友金)
9. Jiang Yuhai (江玉海)
10. Zhang Qiang (张强)
11. Yuan Zhensheng (苑震生)
12. Jun Rui (芮俊)
13. Shen Qi (沈奇)
14. Sun Hui (孙辉)
15. Yao Xingcan (姚星灿)
16. Matthias Weidemuller

8 scientists with training at other foreign research institutes

17. Xu Feihu (徐飞虎)
18. Lu Chaoyang (陆朝阳)
19. Huo Yongheng (霍永恒)
20. Zhu Xiaobo (朱晓波)
21. Zhang Jun (张军)
22. Yu Sixia (郁司夏)
23. Barry Sanders
24. Jonathan Dowling

University of Science and Technology of China and other open source material

FIGURE 3

Heidelberg University Trains a Generation of USTC Quantum Scientists

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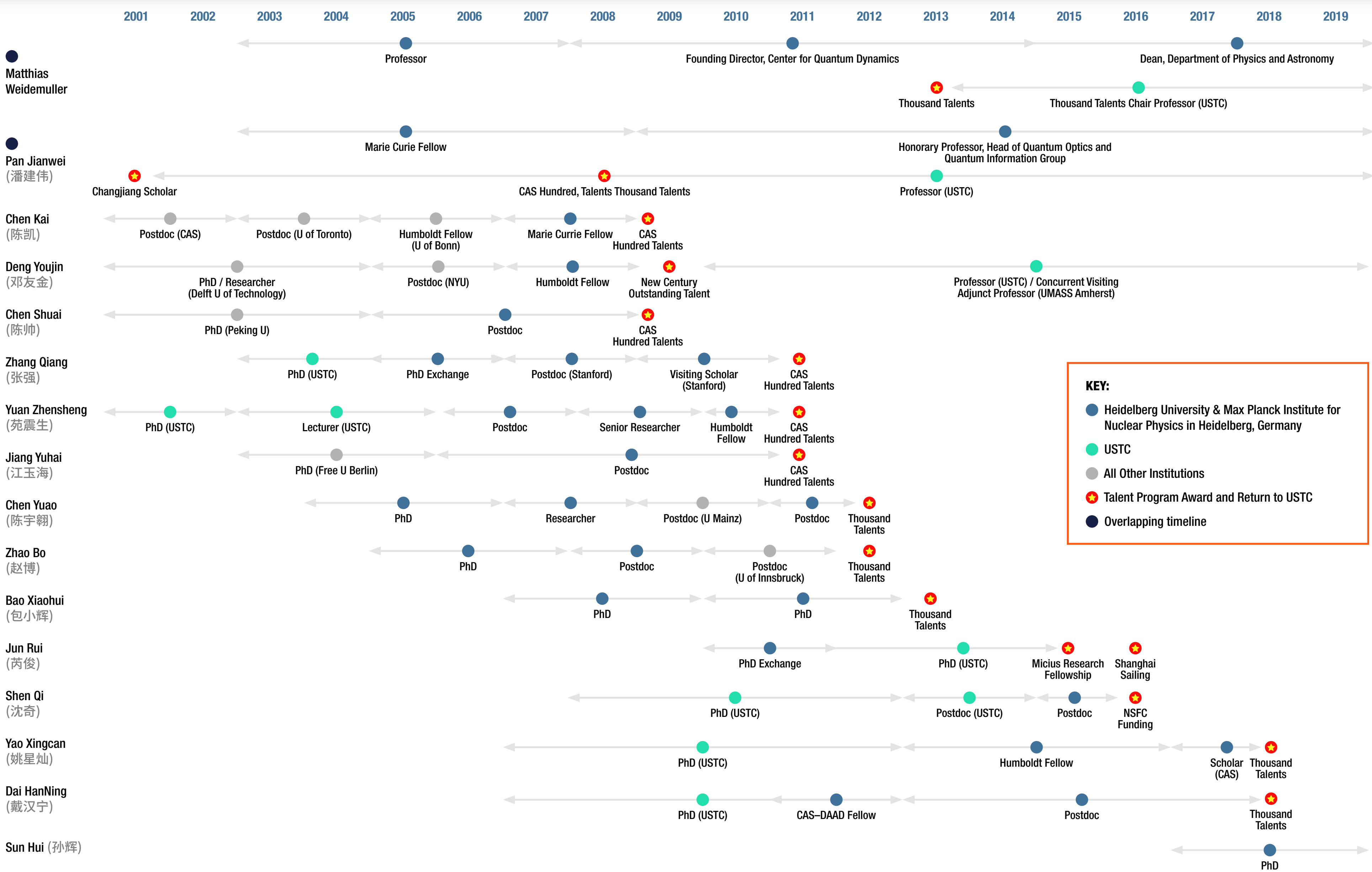

University of Science and Technology of China and other open source material

Marie Curie Fellow[6] indicates European Commission funding. Humboldt Fellow[7] and CAS-DAAD Fellow[8] both indicate German government funding.

Section 2

ENTANGLEMENT

USTC Collaboration with Heidelberg University and Other Western Research Institutes

With talent trained and back at the University of Science and Technology of China (USTC), ongoing close collaboration with Western quantum research labs has been vital to USTC and China's advances in quantum research and dual-use technology. These relationships provide access to Western innovation ecosystems, talent, and Western government research funding. According to USTC, it has or had collaborative research relationships with quantum scientists at the following institutions:[11]:

- **Heidelberg University – Heidelberg, Baden-Württemberg, Germany**
- **Louisiana State University – Baton Rouge, LA, USA**
- **University of Calgary – Calgary, Alberta, Canada**
- **Trento University – Trento, Italy**
- **Max Planck Institute of Optics – Munich, Germany**
- **Cambridge University – Cambridge, England, UK**
- **University of New South Wales – Kensington, Sydney, Australia**

The most important of these relationships is Matthias Weidemuller at Heidelberg University, who has been instrumental in China's short march to becoming a global quantum leader. Over the past decade, Heidelberg University has provided physical equipment to USTC's quantum lab, trained, and continues to train, a generation of USTC quantum scientists, and engages in cutting-edge joint research.

USTC's close ties to Heidelberg University are not a coincidence. As previously noted, Pan, while at Heidelberg University, initiated a long-term collaborative relationship with Matthias Weidemuller that continues to this day. Weidemuller is the Dean of the Department of Physics and Astronomy at Heidelberg University and is concurrently a part-time Thousand Talent Program Chair Professor at USTC. Pan remains a part-time concurrent professor at Heidelberg University where he leads the Quantum Optics and Quantum Information Group alongside fellow USTC scientists, including Yan Zhensheng [苑震生] (Senior Scientist), Dai Hanning [戴汉宁] (Postdoc Researcher), Bing Yang (Postdoc Researcher), and Sun Hui [孙辉] (PhD Student). In fact, according to the Group website, only one Group researcher, a master's student, is not affiliated with USTC.

Representatives from the Anhui Provincial government, Baden-Wurttemberg State government, USTC, and Heidelberg University at the signing ceremony for the Memorandum of Cooperation for the Joint Establishment of the Sino-German Joint Research Center for Quantum Science.

In many respects, Heidelberg University, and especially the Quantum Optics and Quantum Information Group, has become a platform for the University of Science and Technology of China (USTC)'s quantum scientists to tap into Europe's basic research ecosystem and access European government funding. For example, though led by Pan Jianwei and composed almost entirely of USTC scientists, the Group currently lists the following European and German government sponsors:

- **European Research Council**
- **European Union**
- **Seventh Framework Programme**
- **Deutsche Forschungsgemeinschaft**
- **Marie Curie Actions**
- **Landesstifung (Note: probably the Baden-Wurttemberg State government endowment)**
- **Alexander Von Humbolt – Stiftung Foundation**
- **Konrad-Adenauer Stiftung (Note: a political party foundation associated with the Christian Democratic Union)**

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Notwithstanding this European and German government support, the Heidelberg University Quantum Optics and Quantum Information Group, led by Pan Jianwei, has transferred a series of quantum research projects to USTC. These include

According to the Memorandum, in addition to promoting the construction of the Sino-German Joint Research Center for Quantum Science, the two sides agreed to establish joint training of doctoral students, jointly plan and collaborate on research projects, and employ joint-researchers to strengthen cooperation on frontier quantum science.

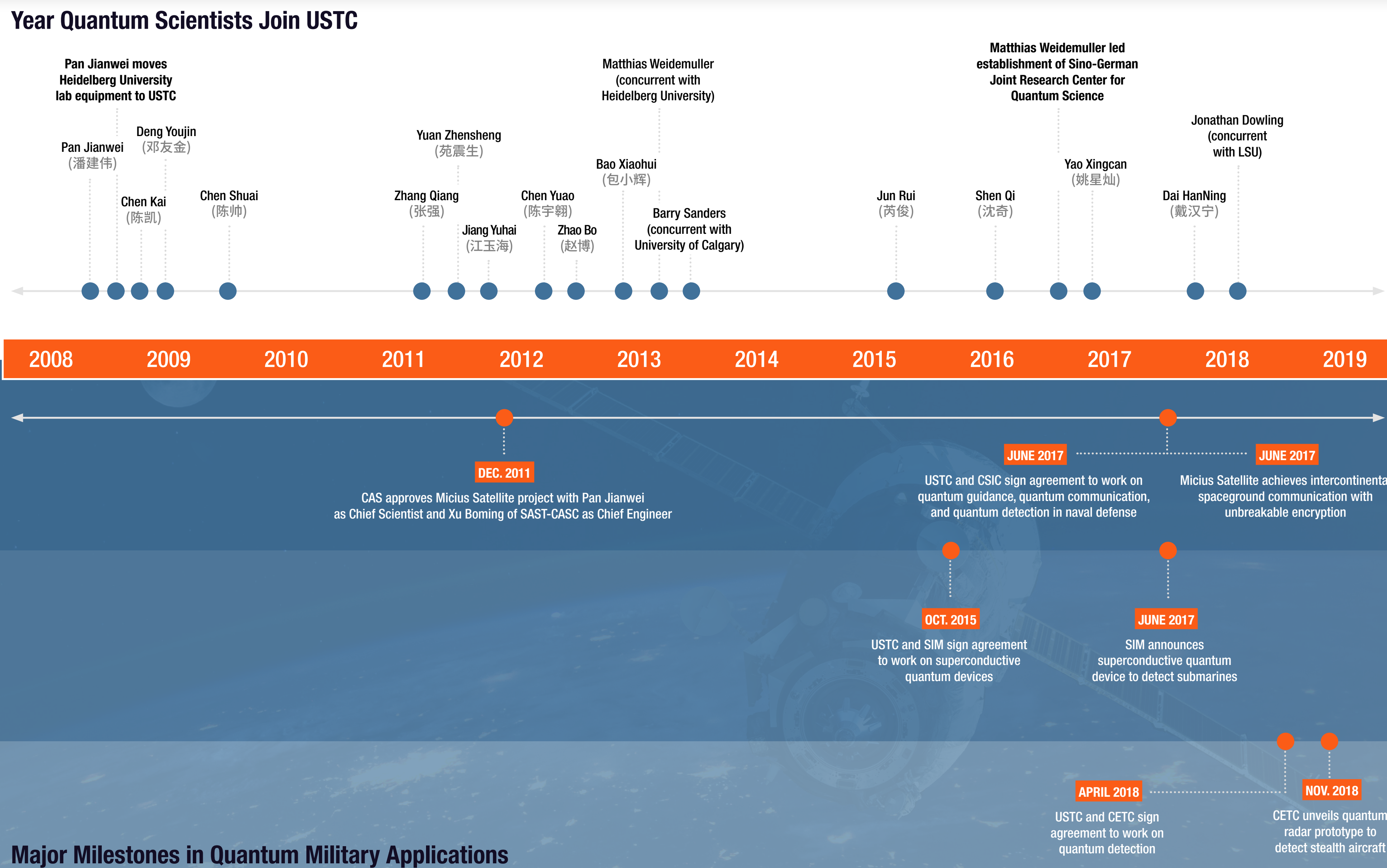
research projects on Photonic Entanglement, Quantum Memory and Quantum Repeater, and Quantum Information Theory. The only project listed on the group website that has not been transferred to the University of Science and Technology of China (USTC) is an Optical Lattices Experiment. Other groups at the Heidelberg University Physics Department conduct research at USTC in China as well. For example, the Quantum Dynamics of Atomic and Molecular Systems Group is conducting an experiment to study Rydberg physics with ultracold two-electron systems at the USTC Shanghai Institute for Advanced Studies.

In recent years, as Pan and USTC formalized collaboration with China's major state-owned defense companies on the development of military applications for quantum technologies, Pan and Weidemuller have expanded collaboration between USTC and Heidelberg University in quantum science.

In September 2016, Weidemuller led the signing of the Memorandum of Cooperation for the Joint Establishment of the Sino-German Joint Research Center for Quantum Science [中德量子科学联合研究中心] between USTC and Heidelberg University. According to the Memorandum, in addition to promoting the construction of the Sino-German Joint Research Center for Quantum Science, the two sides agreed to establish joint training of doctoral students, jointly plan and collaborate on research projects, and employ joint-researchers to strengthen cooperation on frontier quantum science. The signing ceremony was attended by Heidelberg University administrators and representatives from the Baden-Wurttemberg State government alongside representatives from USTC and Chinese government officials from the Anhui Development and Reform Commission, the Ministry of Finance, the Ministry of Foreign Affairs, and the PRC consulate in Frankfurt, highlighting high-level PRC government support of USTC and Heidelberg University collaboration.

FIGURE 4

Foreign-Trained USTC Quantum Scientists Develop Military Applications for New Quantum Technology



Source: University of Science and Technology of China and other open source material

Section 3

SPOOKY WEAPONS

USTC Scientists Drive Chinese Defense Industry & PLA Advances in Quantum

While leveraging international cooperation to make breakthroughs on the cutting edge of quantum science research, Pan's team at the University of Science and Technology of China (USTC) has cultivated direct ties with China's defense industry to develop military applications for new quantum technologies. These ties conflict with Pan's own public statements. When asked by the *Washington Post* in August 2019 whether his team contributes to research for the Chinese military, Pan said his university and team are "by nature, for fundamental scientific research and education."[12] He continued, "we publish our fundamental research results in international journals which are available to read from all around the world. From reading our papers, other people, who can be from the United States, Europe, Japan, or China, might be inspired and further develop 'immediately useful' technology or products for industry or commercial or military use," he said, adding this was "out of our control."[12]

> Strider's proprietary dataset and Global Intelligence Team are able to directly link Pan and his team at USTC to PRC state-owned defense enterprises and three recently announced military applications of quantum technology that have received international attention – stealth aircraft detection with quantum radar, submarine detection with a quantum magnetometer, and unbreakable encryption with satellite-earth quantum key distribution.

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– stealth aircraft detection with quantum radar, submarine detection with a quantum magnetometer, and unbreakable encryption with satellite-earth quantum key distribution.

Quantum Radar: Stealth Aircraft Detection

In November 2018, Research Institute #14 of China Electronics Technology Group Corporation [中国电子科技集团公司] (CETC), China's leading state-owned defense technology company and the cradle of China's radar industry, unveiled a new prototype quantum radar that PRC state-media claims can detect stealth aircraft. Seven months earlier, in April 2018, the University of Science and Technology of China (USTC) and CETC signed a Strategic Cooperation Agreement to "jointly establish a lab to work on quantum detection and quantum communication devices" as well as jointly create a "Wang Xiaomo Cyberspace Scientific Talent Class [王小谟网络空间科学英才班]" to train future talent. Wang Xiaomo, an Academician at the Chinese Academy of Engineers (CAE) known as the "Father of China's Airborne Early Warning System," was in attendance. Pan Jianwei signed the April 2018 strategic agreement with CETC on behalf of USTC, strengthening support that USTC has been providing CETC for years.[13]

Pan has worked with CETC Research Institute #14 and the PLA on other initiatives as well. Pan is providing "expert guidance" on developing the Chongqing Information Security Industrial Base [重庆信息安全产业基地], which aims to commercialize research achievements from "Project 211," a Ministry of Education initiative focused on improving research capacity at Chinese universities like USTC, and will focus on developing mobile internet, cloud, internet of things, big data, and industrial software industries in a "new security situation." CETC Research Institute #14, Jiangnan Research Institute [江南研究所] (also known as The 56th Research Institute of the Network Support System of the Strategic Support Force of the Chinese People's Liberation Army [中国人民解放军战略支援部队网络系统部第五十六研究所]), and Tsinghua University are providing "technology support" to further develop the base. The Strategic Support Force of the PLA is responsible for network systems and space systems.

Pan Jianwei (left) and Wu Manqing (right), Deputy General Manager and Party Committee Member of CETC, sign the Strategic Cooperation Agreement between USTC and CETC on April 26, 2018. Wang Xiaomo, the "Father of China's Early Warning Aircraft System," is standing second from the right.

Pan Jianwei (right) and Wang Wei (left), then Director of CAS Shanghai Institute of Microsystems and CENSE, sign an agreement between USTC and SIM on October 9, 2015 to jointly build a Superconductive Quantum Device and Quantum Information Joint Laboratory.

Quantum Magnetometer: Submarine Detection

On June 21, 2017 the Chinese Academy of Sciences announced a major breakthrough in a quantum device that measures magnetic fields and could be used to detect submarines. The device – a superconductive magnetic anomaly detector (MAD) array – was developed over four years by a research team led by Professor Xie Xiaoming [谢晓明], then Deputy Director of the CAS Shanghai Institute of Microsystem and Information Technology (SIM) [中科院上海微系统与信息技术研究所] and Executive Director of its subsidiary institution, the Center for Excellence in Superconducting Electronics (CENSE) [中科院超导电子学卓越创新中心].

Almost two years prior, on October 9, 2015, SIM signed an agreement with the University of Science and Technology of China (USTC) to jointly build a "Superconductive Quantum Device and Quantum Information Joint Laboratory." Pan Jianwei, in his capacity as Executive Vice President of USTC and Director of the CAS Center for Excellence and Innovation in Quantum Information and Quantum Physics, represented USTC in signing the agreement. Xie Xiaoming attended the signing ceremony. At the ceremony, USTC quantum researcher Zhang Qiang [张强] gave a presentation on "Research Progress on Quantum Information" and SIM researcher and "Thousand Talents" inductee Wang Zhen [王镇] gave a presentation on "Research Progress on Superconductive Single Photon Detectors."

Magnetometers have been used since World War II to detect submarines because they can measure an anomaly in the Earth's magnetic field like the one caused by a submarine, but traditional magnetometers can only detect a submarine at a very short range. The range of a magnetometer can be widened if it is based on a superconducting quantum interference device, or SQUID. But outside of the lab SQUID magnetometers are too sensitive and so are overwhelmed by the many small magnetic anomalies in nature.

The new magnetometer built by Xie Xiaoming and his team at SIM uses an array of SQUID and compares their readings to cancel out some of the background magnetic noise. According to an article in the New Scientist, "the achievement points to an airborne device that can detect submarines from several kilometres away rather than just a few hundred meters. This would be catastrophic for NATO submarines, which have been honed to run ever more quietly, using clever technology that prevents them from being heard or detected on sonar. Their magnetic signature is much harder to eliminate."[14]

Quantum Key Distribution: Unbreakable Encryption

One of China's most notable quantum achievements to date occurred on August 10, 2017, when the Micius Satellite achieved quantum key distribution (QKD), encryption deemed "unbreakable," between space and a ground station. Just over a month later, on September 29, 2017, the first "quantum-safe" video conference was held between President Bai Chunli of the Chinese Academy of Sciences in Beijing and President Anton Zeilinger of the Austria Academy of Sciences in Vienna, as the first real-world demonstration of intercontinental quantum communication. The Pentagon called these achievements a "notable advance" in quantum communications.

Though presented as a scientific initiative, the Micius Quantum Science Satellite Project was integrated with China's defense industry from the start. While Pan served as Chief Scientist of the Micius project, Xu Boming [徐博明] of the Shanghai Academy of Spaceflight Technology [上海航天技术研究院（又称中国航天科技集团有限公司第八研究院）] (SAST), a "backbone of China's national defense science and technology industry" and a subsidiary of state-owned defense enterprise China Aerospace Science and Technology Corporation [中国航天科技集团有限公司] (CASC), served as the Chief Engineer.

On September 7, 2017, four weeks after the Micius Satellite achieved QKD and three weeks before the first "quantum-safe" video conference, China Shipbuilding Industry Corporation (CSIC) [中船重工集团], a state-owned defense enterprise, and the University of Science and Technology of China (USTC) signed a Quantum Information Technology Cooperation Research Agreement to jointly establish three labs in "quantum guidance, quantum communication, and quantum detection." CSIC plans to plough $42 million across the three research entities to "seize the

Pan Jianwei (right) and the CSIC team (left) meet at CSIC headquarters to discuss research cooperation between USTC and CSIC on August 30, 2017. USTC and CSIC signed a Quantum Information Technology Cooperation Research Agreement on September 7, 2017.

commanding heights of naval defense applications." On top of that, CSIC appointed Pan Jianwei as Deputy Director of its Science and Technology Commission, an S&T advisory body. In October 2017, CSIC subsidiary CEC CoreCast Corporation Limited [中国船舶重工集团海洋防务与信息对抗股份有限公司] hired Guo Guangcan [郭光灿], Pan's colleague at USTC, as Chief Scientist. In November 2017, the CSIC-USTC Joint Quantum Lab [中船重工—中国科大量子联合实验室] officially opened.

In February 2018, Fan Guoping [范国平], Head of CSIC's Electronic Information Department [中国船舶重工集团公司电子信息部] and Chairman of CEC CoreCast Corporation Limited noted in an interview

> Though presented as a scientific initiative, the Micius Quantum Science Satellite Project was integrated with China's defense industry from the start.

Bao Xinhe (sitting left), CAS Academician and President of USTC, and Sun Bo (sitting right), General Manager and Deputy Secretary of the Party Committee of CSIC, signed the USTC - CSIC Quantum Information Technology Cooperation Research Agreement on September 7, 2017. Pan Jianwei is standing second from the left and Hu Wenming is standing fourth from the right.

with Chinese state media that they had "already been cooperating with Pan Jianwei's team on quantum guidance, quantum communication, and quantum detection to strive to seize the commanding heights of quantum information technology in the application area of naval defense." Fan continued, "the next step is to advance a cooperation pilot with Pan Jianwei to achieve key distribution between a ship on the sea and the Micius quantum communication satellite." "As a defense industry company," Fan said, "national defense applications are given priority for the best technology. First, it should meet the requirements of the navy's strategic transformation toward far seas and supply first-class equipment to build a first-class navy."[15] The breadth of agreements between CSIC and the University of Science and Technology of China (USTC) – covering quantum guidance, quantum communication and quantum detection – points to military applications beyond secure communications. In fact, in the same February 2018 interview Fan Guoping emphasized the opportunity to enhance the combat capabilities of China's strategic nuclear submarines:

Pan Jianwei (right) and Hu Wenming (left), Chairman and Party Committee Secretary of CSIC, shake hands after a meeting to discuss research cooperation between USTC and CSIC on August 30, 2017.

> "A missile can be positioned with the help of satellite navigation; but what if it is subject to interference? A nuclear submarine is hidden under water, but after a period of time it needs to ascend into a calibration position; what to do about it being detected? Quantum navigation technology essentially solves these problems. Depending upon its own inertial navigation; without requiring satellite navigation, it can achieve long-term navigation time, high-precision, fully-autonomous navigation, and concealed operation for strategic nuclear submarines' missions, for continuous execution of missions extending for over a hundred days, significantly increasing the concealed combat capabilities of these strategic submarines."

CONCLUSION

Foreign governments are increasingly active in the commercial domain as they seek to achieve dominance in emerging scientific fields and technologies deemed strategic, including quantum. These activities present new challenges to companies and research institutes leading the way in researching and developing future technologies.

Leveraging data uncovered by Strider's technology platform and Global Intelligence Team, this report delivers new insight into the tactics, techniques, and procedures (TTP) used by the PRC government and quantum scientists at the University of Science and Technology of China to leapfrog competitors in quantum technologies. These activities are fueling a new global race for science and technology dominance and generating new risks for foreign scientists and companies. Strider's proprietary datasets and technology platform provide customers direct visibility into these TTPs, enabling them to safeguard their people, protect their IP, and secure their bottom line.

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Contact Strider

For more information, please contact Strider at:

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Sources

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3. Ni Sijie, CHINA SCIENCE DAILY, *Pan Jianwei: Chinese can do good science too* [Chinese], January 8, 2019 at http://news.sciencenet.cn/sbhtmlnews/2019/1/342450.shtm

4. Josh Chin, *China's Latest Leap Forward Isn't Just Great—It's Quantum*, WALL STREET JOURNAL, August 20, 2016 at http://www.wsj.com/articles/chinas-latest-leap-forward-isnt-just-greatits-quantum-1471269555

5. Ministry of Science and Technology website, S&T Programmes at http://www.most.gov.cn/eng/programmes1/200610/t20061009_36223.htm

6. According to the European Commission website, "[g]rants provided by Marie Skłodowska-Curie Actions… encourage collaboration and sharing of ideas between different industrial sectors and research disciplines – all to the benefit of the wider European economy… the EU has set aside EUR 6.16 billion ($6.87 billion) to be spent by 2020 on researcher training and career development." See the European Commission website, Marie Skłodowska-Curie Actions webpage, accessible at https://ec.europa.eu/research/mariecurieactions/msca-actions_en

7. According to the Humboldt Foundation website, Humboldt fellowships "promote academic cooperation between excellent scientists and scholars from abroad and from Germany." See the Humboldt Foundation website, About Us webpage, accessible at https://www.humboldt-foundation.de/web/about-us.html. Furthermore, "[t]he Humboldt Foundation is funded by the Federal Foreign Office, the Federal Ministry of Education and Research, the Federal Ministry for Economic Cooperation and Development, the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety as well as other national and international partners with whom it cooperates... In 2017, the expenditure for the purpose of fulfilling the Foundation's mission was approximately EUR 127.3 million ($141.8 million) of which approximately 96 percent derived from Federal Government grants and the European Union." See the Humboldt Foundation website, Partners webpage, accessible at http://www.humboldt-foundation.de/web/partners.html

8. According to the German Academic Exchange Service website, "a cooperation agreement on the joint training and education of PhD students has existed between the Chinese Academy of Sciences (CAS) and the German Academic Exchange Service (DAAD) since 2007. Under this CAS-DAAD joint programme up and coming young Chinese scientists from the University of Chinese Academy of Sciences (UCAS) and CAS research institutes are provided with the opportunity of a research stay of 12 to 22 months in Germany. The programme is only for candidates aiming to gain a doctorate in China." See the German Academic Exchange Service website, CAS-DAAD Programme / Joint Fellowship Programme for Doctoral Students of CAS webpage, accessible at https://www.daad.de/deutschland/stipendium/datenbank/en/21148-scholarship-database/?daad=1&detail=50094047&origin=&page=20&q=&status=&subjectGrps=

9. Pan Jianwei, SHENZHOU SCHOLAR, *Pan Jianwei: My Quantum Research Road* [Chinese], April 19, 2019 at http://www.chisa.edu.cn/rmtnews1/subject/201970zn/70znfhzy/201904/t20190419_227052.html

10. Chen Zhuqin, SOUTHERN PEOPLE WEEKLY, *The most wonderful place in Quantum physics is inclusivity – dialogue with Pan Jianwei* [Chinese], January 30, 2018 at http://www.nfpeople.com/article/7922

11. At this time, Strider does not have any information indicating that these scientists or organizations knowingly or directly contributed to the development of military applications of quantum technologies for PRC defense enterprises or the People's Liberation Army.

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13. For example, an announcement of CETC Research Institute #14's first successful quantum radar prototype in 2016 noted the support of USTC, CETC Research Institute #27, and Nanjing University.

14. David Hambling, NEW SCIENTIST, *China's quantum submarine detector could seal South China Sea*, August 22, 2017

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