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Inadvertently Arming China?
One Year On

The Chinese military complex and its exploitation of scientific research at UK universities

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"Technological innovation has become the main battleground of the global playing field, and competition for tech dominance will grow unprecedentedly fierce."

President Xi Jinping, 2021

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Robert has also recently published for the NATO Defence College, published a peer reviewed paper in *Democracy and Security*, highlighting the Chinese genocide in Xinjiang, and written about the British military response to the COVID-19 pandemic.

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Summary

This report picks up one year on from '*Inadvertently Arming China: The Chinese military complex and its potential exploitation of scientific research'* (hereon known as '*IAC'*). Researched in 2020 and published in February 2021, *IAC* documented and analysed the extent to which some of the UK's leading universities, research institutions, academics, scientists and researchers, collaborated with Peoples Republic of China (PRC) entities directly linked to either the Chinese military or to Chinese military-funded and supported universities, for sensitive dual-use technology research.

This research has uncovered at least 60 Chinese nationals working at UK universities and research institutions, in the last 18 months, who are either employed directly by UK universities as researchers, academics, engineers, and scientists, or are directly cited as either visiting or associated fellows, in a professional capacity. These individuals have all come either directly from one of China's defence conglomerates, such as the Aviation Industry Corporation of China (AVIC), or from one of the High Risk or Very High Risk People's Liberation Army (PLA)-linked universities, are still listed at such institutions, or have only recently left.

This figure includes:

- Two individuals who were concurrently listed within a serving branch of the People's Liberation Army (PLA) whilst working for a UK university on potential dual-use technology, including the PLA's Air Force Engineering University, and the PLA's Strategic Support Force;

- One individual who was previously listed at the PLA's Rocket Force University of Engineering prior to their professional affiliation at a UK university;

- Eight individuals who worked at various PLA institutions *during* their collaborations with UK universities and academics, and three individuals who had previously worked at PLA institutions *prior* to collaboration with UK universities and academics.

These figures likely represent only the tip of the iceberg. Due to methodological limitations, a more complete and exhaustive review would likely take far longer.

Moreover, of the 16 official Sino-British joint labs first identified in *IAC* in 2021, this report determines that at least six remain fully operational, across four separate UK universities, having produced multiple potential dual-use collaborative research projects in the last 18 months since *IAC*. This is despite the majority of the UK universities maintaining in their responses from 2021 that formal collaborations had ceased.

Of the remaining ten joint labs, eight others have since retained close research collaborations together with the original Chinese defence university or company, continuing joint research outputs, but in a less formal manner (i.e. often at the individual rather than at the institutional level).

For methodological rigour this report keeps the same analytical and methodological frameworks as *IAC*, in order to determine what changes have occurred, if any, in the 18 months since *IAC* was released in February 2021. To that end, there are similar themes discussed throughout with the original research from *IAC,* allowing research continuity.

However, this text is also designed to act as a standalone research and policy document, designed to inform the general reader, practitioner, and policy maker alike, of the various themes and issues unpacked throughout.

This follow-up study draws attention to the continued pervasive presence of Chinese military-linked conglomerates and PLA-linked universities in the sponsorship of high-technology research centres in several leading UK universities, and their continued research relationships at both an institutional and intra-personal level.

In many cases, these UK universities continue to unintentionally generate research that is sponsored by and/or may be of use to China's military conglomerates, including those with activities in the production of Weapons of Mass Destruction (WMDs), including intercontinental ballistic missiles (ICBMs) as well as hypersonic missiles, in which China is involved in a new arms race and seeks 'massively destabilising' weaponry. Often this dual-use technology is in military fields which China seeks to use to equal the US militarily by the end of this decade. The geopolitical ramifications of which are of the most serious consequences for British national security.

The majority of this potential dual-use research takes places at these UK universities, with some occasionally occurring in China, such as workshops and seminars hosted by high risk and very high risk PLA-linked universities, in addition to research occurring at the labs of Chinese defence conglomerates.

The vast majority of these research projects have a civilian use, and UK-based researchers will be unaware of a possible dual-use that might lead to a contribution to China's military industries. Some of these projects however have explicitly defined purposes, such as researching swarming technology for Unmanned Aerial Vehicles (UAVs), which clearly have a military application.

Much of the research at the university centres and laboratories is also being sponsored by the UK taxpayer through research councils, UK Research Innovation, Innovate UK, and the Royal Society.

The majority of the research referenced throughout this paper has Chinese funding supporting it. The majority of these Chinese funding bodies are either state-sponsored

defence conglomerates, such as Beijing Institute for Aeronautical Materials (BIAM) and China Aerospace Science and Technology Corporation (CASC), People's Liberation Army (PLA)-linked research institutions and defence universities such as National University of Defence Technology (NUDT), or government-linked research bodies like the National Natural Science Foundation of China (NSFC); the latter actively promoting and supporting the military integration of civilian technology in to the PLA.

This research paper should be viewed in the context of China's stated aim to equal the US military by 2027; and to use advanced military technology to leapfrog the US by 2049, the centenary of the founding of the People's Republic of China (PRC).

This report should also be viewed in the geopolitical context of the PRC's stated aim to incorporate the Republic of China (Taiwan) into the mainland, by force if necessary. Beijing's ability to do so rests on its military capability – civil-military integration of dual-use technologies is central to achieving this strategic aim.

One of Beijing's strategies for achieving military hegemony is through 'civil-military fusion'; the integration of civilian technology for military applications, intended to give the PLA a leading edge in adapting emerging technologies. The existence of this strategy makes any claim to be able to reliably cooperate only with the civil branches of Chinese military-linked companies and universities wholly incompatible with British national security interests.

This report includes statements from the UK institutions analysed: we are determined to be as fair to them as possible, and, provided they responded to our enquiries, the position of each is represented to the fullest extent possible. We have also told those institutions we did not hear from that we will update the online version of this report to the fullest extent possible, if and when they contact us.

Again, in the interests of accuracy and fairness, we state here that a number of UK institutions took issue with our analyses. We have duly included their comments and reiterate that even so, in our view there remains the danger that research, which is carried out in good faith, may be co-opted and exploited by the Chinese military. Whilst the UK government have begun to understand the threat and risks deep scientific-based collaboration with the Chinese government have, British academia are still significantly far behind.

We also wish to make clear that none of the academics, researchers, or other staff whose research at UK universities or centres is discussed in this report are accused of knowingly assisting the development of the Chinese military, of knowingly transferring information to that end, or of committing any breach of their university regulations. Nor are they accused of any other wrongdoing, or breach of national security, or any criminal offence.

The sponsorship of high-technology research in UK universities which have potential military applications discussed in this report covers areas such as:

- Aerospace physics and hypersonic technology;
- Metals and alloys;
- Drones and radars;
- Shipbuilding;
- Data science, artificial intelligence (AI), facial recognition, and internet of things (IoT);
- Ceramics, piezoelectrics and rare earths;
- Robotics (land, sea and space).

Conclusions

China continues to militarise in order to achieve equal military power with the US in only five years' time. This is crucial to achieving unification by either coercion or force of Taiwan – a stated CCP strategic aim. In addition, China has a long history of weapons sales to regimes that carry out grievous human rights abuses including Iran, Syria, Burma and North Korea. More recently, Beijing have also supplied Russia with arms, intelligence, and cyber capabilities during Moscow's unprovoked and illegal war in Ukraine. Furthermore, China's development of a surveillance state is already leading to systematic human rights abuses, with its treatment of the Uighur minority described as genocide.

The methods by which the UK monitors and controls Chinese involvement in UK university research are, we suggest, fundamentally still woefully inadequate. The companies sponsoring UK-based research centres include China's largest weapons manufacturers, including producers of strike fighter engines, ICBMs, nuclear warheads, stealth aircraft, military drones, tanks, military-use metals and materials, and naval warships.

At its simplest, for the UK government and taxpayer to continually fund and assist the technological development and the force-projection capabilities of the Chinese military is not in the British national interest. This is a picture of deep 'strategic incoherence'. China is demonstrating rapid technological military development and growing force-projection capabilities. To risk financing and enabling these developments suggests a lack of strategic coordination which it was hoped would end after the government correctly identified China as a systemic challenge in the 2021 integrated review of defence.

This points to the need for an urgent strategic reassessment by the new British government in Westminster, for new rules for scientific research with PRC universities and companies, some of which should be applied directly to the UK's research councils and universities, while some may require legislation. Other rules are needed for scientific research in wider potentially sensitive scientific fields generally and in universities in particular.

Recommendations

The UK government should:

- List all those Chinese military-linked companies and institutions that it wants to bar from sponsoring science research in UK universities and from research cooperation

in general. At an absolute **minimum** this ought to include the National University of Defence Technology (NUDT), the Seven Sons of National Defence, and all Chinese defence conglomerates. Serious consideration should be applied to adding all universities rated as *High Risk* and *Very High Risk* by the Australian Strategic Policy Institute (ASPI) on their universities tracking data.

- List those entities it wishes to prevent making inward investments generally into the UK. This has been the practice of the US government and looks set to continue under the Biden administration.
- Introduce much more thorough oversight mechanisms for UK universities and research centres accepting funding and other support from entities linked to hostile military powers. This is not happening with Chinese sponsorship to the same degree as say Iran or North Korea, yet undermines national security potentially even further.
- Initiate a public audit of UK universities' sponsorship policies to establish the total Chinese funding of UK technology research and establish new rules for universities themselves, as well as for United Kingdom Research and Innovation (UKRI), Innovate UK, the Royal Society, and research councils. Combined with an 'entities list', this may be best placed in new legislation dealing with research and Chinese military-linked organisations specifically, or authoritarian states generally.
- Set up a new government organisation similar to the Committee on Foreign Investment in the United States (CFIUS), whose role would include monitoring and assessment of university sponsorship.
- While it is important to preserve academic freedom, the government should more deeply assess whether some of what is currently deemed 'basic scientific research', or research with findings in the public domain, may have possible dual-uses in sanctioned countries including China, and where approval for research centres may have allowed projects which are exposed to this risk to take place.
- Further review the Academic Technology Approval Scheme (ATAS), to better control visa (re)applications for international students and researchers (apart from exempt nationalities) whose research may create risks in certain sensitive subjects – particularly those with military links to hostile foreign powers. There are specific cases of PLA personnel studying dual-use technology at UK universities who have seemingly had their ATAS applications approved. Not only is this an incredibly alarming oversight by the Home Office, but those individuals found to be from a hostile foreign military studying sensitive technology subjects which have a potential dual-use military application should have their visas revoked and removed from the UK.
- Reassess the areas of scientific research that can be carried out by public research institutions and/or in which research findings can be publicly released. These measures should form part of an urgent reassessment of the security implications of the so-called 'Golden Era' policies towards China and the strategic assumptions that underpinned them.

- An absolute ban on visa and ATAS applications for Chinese individuals who have worked for the PLA, either in one of the five strategic arms of the PLA, or any officially affiliated research institution (i.e. the PLA's Air Force Engineering University), or for anyone who holds current CCP membership.

Glossary

AECC Aero Engine Corporation of China

ASPI Australian Strategic Policy Institute

ATAS Academic Technology Approval Scheme

AVIC Aviation Industry Corporation of China

BAMTRI Beijing Aeronautical Manufacturing Technology Research Institute

BIAM Beijing Institute for Aeronautical Materials

BIT Beijing Institute of Technology

BUAA Beihang University

CAF Creep Age Forming

CALT China Academy of Launch Vehicle Technology

CASC China Aerospace Science and Technology Corporation

CAST China Academy of Space Technology

CCP Chinese Communist Party

CETC China Electrical Technology Group Corporation

COMAC Commercial Aircraft Corporation of China

CRG Communications Research Group

CSU Central South University

DOD Department of Defense

FML Fibre Metal Laminates

GAN Generative Adversarial Network

HEU Harbin Engineering University

HIT Harbin Institute of Technology

HUST Huazhong University of Science and Technology

IAC Inadvertently Arming China

ICBM Intercontinental Ballistic Missile

MOD Ministry of Defence

MOI Memoradum of Understanding

NJUST Nanjing University of Science and Technology

NPU Northwestern Polytechnical University

NSFC National Natural Science Foundation of China

NUAA Nanjing University of Aeronautics and Astronautics

NUDT National University of Defence Technology

PLA People's Liberation Army

PLAAF People's Liberation Army Air Force

PLAN People's Liberation Army Navy

PRC People's Republic of China

QMUL Queen Mary University London

SASTIND State Administration for Science, Technology and Industry for National Defense

SIPRA Signal Imaging Process Research Institute

SJTU Shanghai Jiao tong University

UAV Unmanned Aerial Vehicle

UESTC University of Electronic Science and Technology of China

UKRI United Kingdom Research and Innovation

WAAM Wire-arc additive manufacturing

WMD Weapons of Mass Destruction

WOS Web of Science

WUT Wuhan University of Technology

Introduction

The context of Chinese military expansionism and civil-military fusion

Both domestic and global events have greatly altered the security and geopolitical landscape since *Inadvertently Arming China* (*IAC*) was published in February 2021.

Only four weeks after *IAC* was released, the UK government released their most comprehensive foreign policy strategy in a generation. The Integrated Review identified the PRC as a systemic challenge,[1] whilst also listing the People's Liberation Army's (PLA) modernisation as a risk to UK national security.[2] Only four months later in July 2021 President Xi Jinping publicly reaffirmed his intention to modernise the PLA to be on a par with the US military by 2027.[3] This would have deep and far-reaching consequences for not only the UK's national security (as previously stated in the Integrated Review), but for the UK's democratic allies and partners across the globe.

The PLA's modernisation and the threat that this poses to Britain's allies democracies around the globe can be readily evidenced from what can accurately be described as the Fourth Taiwan Strait crisis in August 2022. The air and sea around Taiwan – including its own exclusive economic zone – were subjected to multiple Chinese missile barrages and PLA Air Force fighter jet exercises. This significant military escalation included up to 11 Chinese Dongfeng ballistic missiles (manufactured by China Aerospace Science and Technology Corporation (CASC)), firing into waters just off Taiwan. In addition, contingents of the PLA Air Force's fifth generation stealth fighter jet, the J-20 (manufactured by the Chengdu Aircraft Industry Group (CAIG), a subsidiary of the Aviation Industry Corporation of China (AVIC)), will now almost certainly be deployed to Longtian airbase, roughly 100 miles from Taipei. Both CASC and AVIC and their subsidiaries have retained active research collaboration links with at least three separate UK universities each since *IAC*, including a jointly run laboratory between Imperial College London and AVIC.

Of more immediate impact to British national security of the PLA's modernisation is the unprovoked and illegal Russian war in Ukraine. Chinese microchip exports which have a military application have almost doubled to Russia since the invasion, whilst exports of aluminium oxide, a crucial raw material for weapons production, have risen by 400 times.[4] Beijing is also widely suspected of conducting a series of cyber-attacks against Ukraine's military and nuclear facilities, in the run up to the Russian invasion.[5]

There is also widespread collaborative defence research and development between Beijing and Moscow. Recently this has included between the Chernyshev Moscow Machine-Building Enterprise and the China National Aero-Technology Import and Export Corporation (a

[1] Global Britain in a competitive age (publishing.service.gov.uk) p.22.
[2] *Ibid.* p.28.
[3] Xi Jinping commands Chinese military to become world's best army on par with USA by 2027 (freepressjournal.in)
[4] Brian Spegele, 2022.
[5] China accused of hacking Ukraine days before Russian invasion | News | The Times

subsidiary of AVIC), leading to jointly modernising the Russian Klimov RD-33 turbofan engine for use in lightweight fighter jets.[6]

Described in a joint statement by both President's Xi and Putin in the immediate days prior to the invasion of Ukraine as a relationship without limits, Sino-Russia relations can more accurately be described as the co-option of Moscow by Beijing. No longer is China the arms export market for Russia it once was, in fact the reversal, as Beijing seeks greater Russian dependence on China – particularly as Moscow has now, for all intents and purposes, achieved global pariah status, similar to North Korea and Iran. This increasing dependence away from western markets and knowledge transfers will lead the Russian bear even closer to the arms of the Chinese dragon; Beijing will use this market to its advantage with arms exports and military knowledge exchange to greater benefit once western sanctions against Russia predictably begin to ease in the years ahead.

This rapid technological development of the PLA should also be set against the wider background of the increasingly hawkish strategy of and strategic thinkers around President Xi Jinping, as well as the authoritarian entrenchment of the state in China. Xi's adherence to the concept of the '100-year marathon', a strategic attempt to become the global hegemon by 2049, the centenary of the founding of the PRC is shared by the CCP's elite, the so-called Wolf Warriors. This aggressive geostrategic outlook for China's foreign policy will likely solidify before the end of 2022, as Xi looks to replace Beijing's two most senior diplomats with even more hawkish and extreme alternatives.[7] Research and development in next-generation military technology should be understood in this broader strategic context.

Militarily speaking, Beijing is attempting to harness new civilian technologies for defence applications, as part of the state-mandated policy of 'civil-military fusion'. The aim, discussed by senior Chinese military figures, is to use advanced technologies to overtake the United States in particular. This includes the capacity to launch devastating pre-emptive strikes or counter-attacks, aimed at destabilising enemy forces' radar systems, orbital satellites, and command and control systems, including through the possible use of unconventional weapons and electronic warfare.

This is underway amidst ongoing confusion in British and wider western strategic thinking. While UK taxpayers fund research at universities that risks contributing to the development of China's military, the UK's R&D spending on its own defence is anaemic: Volkswagen alone continues to spend more on R&D than the entire UK defence sector. Beijing utilises civil-military fusion with the aim of giving the PLA a leading edge in adapting emerging technologies in order to utilise them for military purposes, across technological fields. Therefore, it can be especially difficult to know for certain that civilian research for an apparently civilian business unit of a military-linked Chinese conglomerate, or for an

[6] How China Supplies Russia's Military – The Diplomat
[7] The next wolf warriors: China readies new generation of tough diplomats - Nikkei Asia

apparently civilian-oriented department of a military-backed university, will not ultimately be put to military use.

Beijing's utilisation of civil-military fusion operates an all-of-systems approach – across every layer of Chinese government and society. Of particular salient relevance to this research is the Ministry of Education, which alongside the State Administration for Science, Technology and Industry for National Defense (SASTIND) governs higher education and university policy across China. The Military Industry Division of the Department of Science and Technology is a branch deep within the Ministry of Education,[8] demonstrating how the PRC's quest for incorporating civilian technology for defence purposes is not merely limited to China's infamous Seven Sons of National Defence, but across all Chinese universities to varying degrees.

This is not a new phenomenon. Reported by the BBC in 2018, the NUDT had collaborated with multiple leading UK universities, listed on an NUDT database as a series of academic papers. Much of the collaboration involved aerospace and aviation.[9] It was understood even then that collaboration between the UK and NUDT was highly concerning, whilst UK universities were already estimated to have trained hundreds of scientists from NUDT as part of the Chinese military's efforts to 'leverage foreign civilian expertise for military ends'.[10]

An integral part of the CCP's extensive toolkit for research theft and technology transfer from western institutions remains utilising the extensive number of Chinese national students studying abroad. The threat is particularly acute from CCP members, and those who are active members within the multi-layered PLA and their research institutions; several of which have been identified in this research, studying and working in UK universities. With approximately 150,000 Chinese students in UK universities,[11] the threat is significant. This was recently highlighted by the British intelligence services who announced that 50 Chinese students have left the UK since 2019 after visa violations regarding their role within the Chinese military.[12]

With slightly over double the number of Chinese students, the US appears to be increasingly proactive in mitigating against these threats. In 2020 under the Trump administration, the US revoked the visas of more than 1,000 Chinese students and researchers, said to have had ties to the Chinese military.[13] Then acting secretary for the Department of Homeland Security, Chad Wolf, stated that China had been "abusing student visas to exploit American academia", blocking visas for Chinese graduate students and researchers with ties to China's

[8] KDP Crystal Technology Research Center of the Ministry of Education was inaugurated at Shandong University-Shandong University News Network (archive.ph)
[9] Corera, 2018.
[10] Alex Joske, *Ibid.*
[11] 50 Chinese students leave UK in three years after spy chiefs' warning | Espionage | The Guardian
[12] *Ibid.*
[13] US cancels 1,000 China student visas, claiming ties to military | China | The Guardian

military fusion strategy, in order to safeguard against the CCP theft of American research and technology transfer.

Since 2018 China's military force-projection capacity has been growing, and its military committing even more resources to researching highly-destabilising materiel, such as directed-energy weapons, hypersonic technology, and continuing nuclear development. This occurs as Chinese entities and companies are continually believed to have been involved in nuclear proliferation to Pakistan, Iran and North Korea, whilst domestically, China's development of a surveillance state is causing systematic human rights abuses, and genocide in Xinjiang.

Given these changes over the last 18 months in the global order, the speed and pace of China's military modernisation, and the ongoing significant threats posed by Chinese research into emerging technologies and weapons proliferation, an updated account of any continued dual-use technology research collaboration between UK universities, and Chinese defence conglomerates as first identified in *IAC*, is not only necessary and prudent, but also timely given the recent changes in the British government.

The findings of this report do not detract from the value of the international scientific collaboration in which British universities participate and frequently lead, including with Chinese nationals, and should not be used to cast suspicion on Chinese researchers in the UK. However, that the Chinese military is liable to exploit some of the scientific research at UK universities that we describe, research which is often also sponsored by the UK taxpayer, demonstrates a lack of strategic coordination that is against the British national interest.

The threats posed by the CCP towards British national security culminated in July 2022 with an unprecedented joint address given in London by the chiefs of both MI5 and the FBI. At an audience with leading business and academic personalities, the head of MI5 described how the CCP is actively engaging in research theft and technology transfer.[14] To combat against this the US have stopped issuing visas to individuals from some PLA universities, whilst the Home Office ATAS policy has been strengthened. This research paper discernibly demonstrates however that not enough action is being taken by the universities themselves to reduce the mitigation of Chinese research theft and technology transfer, which inevitably and demonstrably ends up being pioneered by the Chinese military.

It is within this geopolitical context that the new British Prime Minister stated an intended reset in relations between London and Beijing in summer 2022. Advocating to reassess the Integrated Review on defence from 2021, and to potentially reclassify China as a 'threat', in similar language to how London views Russia, is to be welcomed. Only by a much clearer appraisal of the situation with which liberal democracies are facing down their relations with the CCP can any meaningful change occur.

[14] Joint address by MI5 and FBI Heads | MI5 - The Security Service

No longer can the globally renown UK higher education and research fields accept seemingly unconditionally Chinese research grants and collaborations with high risk individuals and institutions with proven links to the Chinese military apparatus; an organisation whose sole purpose is not the territorial integrity of a sovereign Chinese nation, but the security of the ruling Communist party – a party who has continually been seeking the replacement of not just the US as a global hegemonic power, but the liberal democratic model of global governance alongside it.

NB: None of the academics, researchers, or other staff whose research at UK universities or centres is discussed in this report are accused of knowingly assisting the development of the Chinese military, of knowingly transferring information to that end, or of committing any breach of their university regulations. Nor are they accused of any other wrongdoing, or breach of national security, or any criminal offence. In some cases, research may be used solely for non-military ends; the purpose of the examples mentioned in this report is not necessarily to demonstrate that they risk being used for military purposes, but in some cases that the research may simply help improve the business or academic position of a PRC military-linked conglomerate or institution; where research may be put to use by the military of the PRC or organisations which are linked to it, we assume that researchers in the UK will have carried out this research without intending this to happen.

Furthermore, none of the UK universities, institutes or funding bodies mentioned in this report are accused of knowingly contributing to the development of China's military or its military industries, as we believe that these universities have developed the sponsorship and research relationships we describe in good faith and in the belief that their scientific outputs will have purely civil ends. The purpose of this report is simply to draw attention to the risk that UK research may be exploited by the Chinese military in a way the researchers could never have envisaged. It is our belief that shedding light on this risk is unquestionably a matter of pressing and vital public interest. We have initially published this in online form only to provide more opportunity for possible corrections.

In addition, it is important to highlight the positive impact the notable Chinese diaspora in the UK have upon British life. Quite often fleeing persecution from the CCP, the Chinese nationals who have settled in the UK continue to make important contributions to wider civil-society. Knowing this, the Chinese regime routinely subvert, coerce, even threaten and blackmail, in an attempt to ultimately exploit, this often vulnerable demographic of British society. This is a critical area not discussed further in this report, however, remains fundamental for further future study in order to better comprehend wider CCP threats to liberal democracies.

Methodology

This volume follows on from where *IAC* left in February 2021. As such, this research used the same methodological framework. This provides the most credible and relevant research to highlight the extent of the ongoing research collaborations between UK universities and high -risk Chinese defence entities. This work can also be used as a standalone example of recent (2021-22) research collaborations, with case studies highlighting the troubling nature of this dual-use research.

This research uses a mixed methodology, utilising Web of Science's (WoS) vast index of scientific, engineering, and technology-based research publications to gain a quantitative sample of collaborations between the same 15 UK universities from *IAC*, and with high-risk Chinese partners. Due to the size and scale of the WoS index, it was not possible to gain a definitive number of research collaborations, rather, a reflective sample which highlights specific studies. For instance, when inputting 'University of Cambridge and National University Defence Technology' in to WoS search engine, it would produce 647 positive results. However, many of these contained neither university; it would take 'Cambridge' as an address for Harvard University, and 'technology' which is used in many science-based research institutions worldwide. Despite these anomalies, a clear quantitative picture emerged of these collaborations over the past 18 months.

The research itself is broken down further in to two sections: Chapter Two ascertains whether or not individual research centres jointly run between UK-Chinese entities, first identified in *IAC*, are still operational. This is established through multiple avenues: published research from WoS dated since February 2021; student exchange programs, workshops, or seminars hosted since February 2021; or any official website updates and research centre announcements. Often a combination of these events occurred in the jointly-run centres which this work verifies as still being operational.

The second section of research, in Chapter Three, provides detailed case studies of specific research collaborations; the nature of the work itself, the backgrounds of the individuals involved (i.e., from which Chinese institutions); the funding agencies; and how that research can be (and is) utilised for defence research and military applications.

To determine whether a UK university is undertaking risky research with a Chinese entity or not, this paper utilises the risk rating devised by the Australian Strategic Policy Institute (ASPI), whose analysis of cooperation between the Chinese military nexus and western universities first drew attention to some of the university centres discussed in *IAC*; in many respects both *IAC* and One Year On constitutes an extension of that work.

The database which ASPI designed in 2019 determined the risk that relationships with defence related entities in China could be leveraged for military or security purposes, including in ways that contribute to human rights abuses. The ASPI database provides overviews of Chinese entities defence and security links, records any known involvement in

espionage or cyberattacks, inclusion on end-user lists that restrict exports, and several measures of their involvement in defence research.[15] This research, in line with *IAC*, uses the ASPI risk-rating scale when determining the risk to UK universities dealing with Chinese institutions and entities. Graded from low, medium, high, and very high risk, this research is primarily concerned with those rated as high and very high risk. These entities all have very strong links and associations with the PLA, have large defence research budgets, and are often involved in joint research collaborations for the Chinese military industrial complex, including actively pioneering civil-military fusion for the benefit of the PLA.

This work therefore examines UK universities, academics and research staff, collaborating directly with the following different categories of Chinese entities:

- Any members of the Seven Sons of National Defence (all rated *Very High Risk* by ASPI);
- Any university rated as either *Very High Risk* or *High Risk* by ASPI;
- The National University of Defence Technology (rated *Very High Risk* by ASPI);
- Any Chinese defence conglomerate (All rated *Very High Risk* by ASPI);
- Any Chinese company with links to the PLA;
- PLA research institutions.

[15] The China Defence Universities Tracker | Australian Strategic Policy Institute | ASPI

Chapter One: Chinese military-linked and funded universities and companies

In keeping with as similar a methodology as possible with *IAC,* this paper again uses the Australian Strategic Policy Institute (ASPI's) risk ratings and background materials, to build a list of the relevant Chinese institutions and companies involved in scientific research with UK universities. This paper has added some universities and institutes that do not appear in the ASPI system, but are relevant to the wider discussion. This project once again regards ASPI's university tracking as the most comprehensive research carried out into China's universities' military links; no other institute has its reach.

This chapter first outlines the relevant Chinese universities and research institutions, then the defence companies. Where applicable, we provide ASPI's risk and security rating of each institution and the UK universities with which they are associated. It is notable that once again, these universities include many of the 'Seven Sons of National Defence', the group of leading Chinese universities with especially close ties to the military. While some of the Chinese universities below are officially under civilian administration, some are official military universities, and almost all have extensive military research activities. The paper also discusses some universities in China which are not considered military-linked or funded and which do not appear in this list.

Key for associations with UK universities

FP = Formal partnership or cooperation in other formal project since 2021

R = Research cooperation generally, co-authored papers, shared researchers or teachers including with constituent colleges of the relevant universities, staff or student visits, or joint training since 2021

Beijing Institute of Technology (BIT)

BIT is one of a cluster of elite defence universities known as the Seven Sons of National Defence, and one of just fourteen institutions allowed to grant PhDs in weapons science.[16] It has launched a programme to train elite high school students in intelligent weapons systems. BIT chairs the B8 Cooperation Innovation Alliance, a weapons research group of eight institutions. It has produced China's first light tank, two-stage solid sounding rocket and low-altitude altimetry radar. It states that it carries out 'world-class research on several areas of missile technology', including 'precision strikes, high damage efficiency, manoeuvre penetration, long-range suppression, and military communications systems and

[16] https://unitracker.aspi.org.au/universities/beijing-institute-of-technology/

countermeasures'.[17] No Chinese institution has produced more military patents; BIT's designated 'disciplines with defence characteristics' include artillery, communication and information systems, control engineering, and aircraft design.[18]

Selected defence laboratories:[19]

- State Key Laboratories of Vehicle Transmission; Science and Technology on Materials under Shock and Impact; Mechatronical Engineering and Control (with Norinco Group's 212 Research Institute, aka Xi'an Mechanical & Electric Institute); Explosion Science and Technology;
- Key Laboratory of Fundamental Science for Advanced Machining and of Electronic Information Technology in Satellite Navigation, Ministry of Education;
- Science and Technology on Electromechanical Dynamic Control Laboratory;
- Fundamental Science on Vehicular Power System Laboratory;
- Fundamental Science on Multiple Information Systems Laboratory; and
- Micro-structure Fabrication Technology Research and Application Center for Science Technology and Industry for National Defense.

Links or associations:

US ban on students.

ASPI rating: Very high risk. Top Secret security credentials.[20]

UK research connections or cooperation between staff: Manchester (**R**); Nottingham; Cranfield (**R)**; Warwick (**R**).

Beihang University (formerly Beijing University of Aeronautics and Astronautics (BUAA)

Another of the Seven Sons, Beihang is a leading institution for research on military aircraft, stealth technology, and nuclear science. It has a cooperation agreement with ballistic missiles manufacturer China Aerospace Science and Technology Corporation (CASC).[21] Designated defence research areas include navigation guidance and control, biomedical engineering, and nuclear energy science.[22]

Selected defence laboratories:[23]

- National Key Laboratory of Aero-thermodynamics of Aero-engines; Science and Technology on Aircraft Control; Reliability and Environmental Engineering Technology;
- National Laboratory for Computational Fluid Dynamics;

[17] https://web.archive.org/web/20180816213622/http:/www.bit.edu.cn/gbxxgk/gbxqzl/xxjj/index.htm
[18] https://web.archive.org/web/20190816013340/http:/www.bit.edu.cn/gbkxyj/gbxkjs/97886.htm
[19] Beijing Institute of Technology – Chinese Defence Universities Tracker — ASPI
[20] Security credentials are also based on ASPI's rating, which is derived from the level of access granted by the Chinese government itself
[21] https://unitracker.aspi.org.au/universities/beihang-university/
[22] https://web.archive.org/web/20190816021802/http:/physics.buaa.edu.cn/info/1097/1244.htm
[23] Beihang University – Chinese Defence Universities Tracker — ASPI

- Key Laboratory of Fundamental Science for National Defense-Novel Inertial Instrument & Navigation System Technology; and
- National Defence Key Discipline Laboratory of Trusted Network Computing Technology or Key Laboratory of National Defense Science and Technology for Trusted Network Computing Technology.

Links or associations:

US ban on students.

On US and Japan End User Lists.

ASPI rating: Very high risk. Top Secret security credentials.

UK research connections or cooperation between staff: Imperial (**R**); Cambridge (**R**); Nottingham (**R**); Cranfield (**R**); Swansea (**R**)**.**

Central South University (CSU)

CSU has a long history of strategic military research, including for China's first atomic bomb and intermediate-range ballistic missile.[24] More recently military research specialisms include aviation, metals, heat-resistant materials for aero and rocket engines, and guidance and control technology. The State Administration for Science, Technology and Industry for National Defense (SASTIND) has committed to developing CSU military research, including its Military Industry Technology Research Institute and School of Aeronautics and Astronautics.[25] It has a cooperation agreement with the China Academy of Launch Vehicle Technology (CALT). CSU was the first university to receive a weapons production license.[26]

Selected defence laboratories:[27]

- National Key Laboratory of Science and Technology for National Defence on Highstrength Structural Materials;
- State Key Laboratory for Powder Metallurgy; and
- National Defense Discipline Laboratory for Detection, Guidance and Control Technology.[28]

Links or associations:

ASPI rating: High Risk. Secret security credentials.

UK research connections or cooperation between staff: Imperial (**R**); Cambridge (**R**).

Harbin Engineering University (HEU)

[24] https://unitracker.aspi.org.au/universities/central-south-university/
[25] https://web.archive.org/web/20190606005331/http:/news.csu.edu.cn/info/1003/80531.htm
[26] https://web.archive.org/web/20190606005331/http:/news.csu.edu.cn/info/1003/80531.htm
[27] Central South University – Chinese Defence Universities Tracker — ASPI
[28] https://archive.fo/kjBmI

One of the Seven Sons and supervised by the PLA Navy, HEU pioneered China's first experimental submarine and focuses on navy ships and armaments. HEU states that it is involved in 'most' naval submarine, undersea weapon, and warship research programmes[29] and is a centre for aircraft carrier and 'high tech weapons' research, nuclear engineering, stealth technology, naval architecture, underwater acoustics, information security, and nuclear reactor engineering.[30] Since 2012, HEU employees have been implicated and convicted in espionage and illegal military exports cases in various countries, including for ballistic missile technology.

Selected defence laboratories:[31]

- National Key Laboratory of Underwater Acoustic Technology;
- National Defense Key Laboratory of Underwater Vehicles Technology;
- Multi-hull Ship Technology Key Laboratory of Fundamental Science for National Defense;
- Coatings Analysis and Detection Center (jointly with PLA Navy); and
- Energetic materials (such as explosives) (jointly with the Chinese Academy of Engineering Physics, a nuclear warhead research organisation).[32]

Links or associations:

US ban on students. On US Entity List.[33]

ASPI rating: Very high risk. Security credentials: Top Secret.

UK research connections or cooperation between staff: Southampton (**FP**).

Harbin Institute of Technology (HIT)

One of the Seven Sons of National Defence, HIT has a joint research centre with ballistic missile manufacturer China Aerospace Science and Technology Corporation (CASC).[34] Its specialisms include robotics, aviation, nuclear technology, electronic propulsion and thrusters, and biomedicine. A US-China Security and Economic Review Commission report named HIT as one of four universities focused on information warfare-applicable research.[35] Missile research deemed 'contrary to national security and foreign policy interests' led to US sanctions.[36]

Selected defence laboratories:[37]

[29] https://web.archive.org/web/20190520053551/http:/pnec.hrbeu.edu.cn/2016/1229/c3349a122303/page.htm
[30] https://web.archive.org/web/20190520053551/http:/pnec.hrbeu.edu.cn/2016/1229/c3349a122303/page.htm
[31] Harbin Engineering University – Chinese Defence Universities Tracker — ASPI
[32] https://www.federalregister.gov/documents/2020/06/05/2020-10869/addition-of-entities-to-the-entity-list-revision-of-certain-entries-on-the-entity-list
[33] These companies are the subjects of sanctions by either the US Dept. of Defense or Dept. of Commerce.
[34] https://web.archive.org/web/20190517054529/http:/news.hit.edu.cn/2008/1201/c1990a49048/page.htm
[35] https://nsarchive2.gwu.edu/NSAEBB/NSAEBB424/docs/Cyber-066.pdf?_ga=2.30462079.1319451064.1567722102-1036413872.1567722102
[36] https://www.latimes.com/archives/la-xpm-2009-jun-03-me-espionage-trial3-story.html
[37] Harbin Institute of Technology – Chinese Defence Universities Tracker — ASPI

- National Defence Key Laboratories of Micro and Small-Scale Spacecraft Technology;
- Satellite Laser Communications Technology; and Spaceflight Space Structure and Control Technology;
- National Key Laboratory of Science and Technology on Advanced Composites in Special Environments; and
- Information Countermeasures Technology Research Institute.[38]

Links or associations: US ban on students. On Japan's End User and US Entity Lists.

ASPI rating: Very high risk. Security credentials: Top Secret.

UK research connections or cooperation between staff: Manchester (**R**); Surrey (**R**); Nottingham (**R**); Strathclyde (**R**); Cambridge (**R**); Warwick (**R**).

Huazhong University of Science and Technology (HUST)

Supervised by SASTIND, HUST military research includes shipbuilding, image processing, navigation technology, engineering, electronics, materials, lasers and directed-energy weapons. Cooperation between HUST and China's military industries includes AI and imaging for weapon systems. Some research students are sponsored by China's nuclear warhead manufacturer.[39]

Selected defence laboratories:[40]

- State Key Lab of Multi-spectral Image Information Processing Technology (under HUST's Institute of Pattern Recognition and Artificial Intelligence);
- China Aerospace Pattern Recognition Technology Research Institute;
- Ministry of Education Key Laboratory of Functional Materials for Electronic Information;
- Key Laboratory of Gravity Navigation of Ministry of Education; and
- Research centre on vibration damping and isolation (jointly with the Academy of Aerospace Solid Propulsion Technology (AASPT) of CASC (AASPT develops ballistic missiles and carrier rockets).[41]

Links or associations:

ASPI rating: Very high risk. Security credentials: Secret.

UK research connections or cooperation between staff: Imperial (**R**); Birmingham (**R**); Cranfield (**R**).

Nanjing University of Aeronautics and Astronautics (NUAA)

[38] USA v. Dongfan "Greg" Chung: Memorandum of Decision (fas.org)
[39] https://archive.fo/QEVhF
[40] Huazhong University of Science and Technology – Chinese Defence Universities Tracker — ASPI
[41] *Ibid.*

One of the Seven Sons, NUAA is a specialist aerospace research institution with relationships with military aerospace manufacturers AVIC and AECC. It is home to China's national helicopter defence laboratory and is implicated in US aerospace technology theft.[42] Defence research fields include nuclear science, aeronautical propulsion, guidance and control technology, and microwave and millimetre wave systems and components.[43]

Selected defence laboratories:[44]

- State Key Laboratory of Helicopter Drive Technology;
- Ministerial Key Discipline Laboratory of Advanced Design Technology of Aircraft; and
- Ministry of Education Key Laboratory of Radar Imaging and Microwave Photonics.[45]

Links or associations:

US ban on students.

ASPI rating: Very high risk. Security credentials: Top Secret.

UK research connections or cooperation between staff: Cambridge (**R**), Strathclyde (**R**), Cranfield (**R**), Nottingham (**R**).

Nanjing University of Science and Technology (NJUST)

A member of the Seven Sons of National Defence, NJUST has a collaborative relationship with a PLA signals intelligence research institute, involving cooperation on unmanned combat platforms and information security.[46] Alongside BIT, NJUST is ranked as China's top university for armaments research.[47]

Selected defence laboratories:[48]

- National Key Laboratory of Transient Physics, also known as the National Defense Key Laboratory of Science and Technology on Trajectory;[49]
- Key Discipline Laboratory of Defense of Short-range and High-speed Target Detection Technology; and[50]
- National Defence Key Discipline Laboratory of Smart Munition Technology.[51]

Links or associations:

[42] https://www.bbc.co.uk/news/resources/idt-sh/Looking_for_Chinas_spies
[43] https://web.archive.org/web/20190819055420/http:/msc.nuaa.edu.cn/3297/list.htm
[44] Nanjing University of Aeronautics and Astronautics – Chinese Defence Universities Tracker — ASPI
[45] *Ibid.*
[46] Nanjing University of Science and Technology – Chinese Defence Universities Tracker — ASPI
[47] 全国第四轮学科评估结果出炉：兵器科学与技术学科高校排名-考研-中国教育在线 (archive.org)
[48] Nanjing University of Science and Technology – Chinese Defence Universities Tracker — ASPI
[49] 6个首批国家重点实验室转为国防科技重点实验室 - 大学排行 - 网大论坛 - Powered by Discuz! (archive.org)
[50] 近程高速目标探测技术国防重点学科实验室 (archive.org)
[51] 2016 Meeting of the Academic Committee of the National Defense Key Discipline Laboratory of Intelligent Ammunition Technology (archive.org)

Added to the US Entity List in December 2020 for acquiring and attempting to acquire US-origin items for the PLA.[52]

ASPI rating: Very high risk. Security credentials: Top secret.

UK research connections or cooperation between staff: Birmingham (**R**); Cranfield (**R**); Warwick (**R**); Surrey (**R**).

National University of Defense Technology (NUDT)

NUDT is China's leading military-affiliated research institution, under direct supervision by the powerful Central Military Commission.[53] Research specialisms include hypersonic missiles, drones and drone swarms, radars, navigation and quantum physics. NUDT developed the Tianhe-2A supercomputer. Defector testimony indicates that its 'Intelligence Center' is involved in political interference outside the PRC.[54]

Selected defence laboratories:[55]

- State Key Laboratories of New Ceramic Fibers and Ceramic Matrix Composites;
- Complex Electromagnetic Environment Effects on Electronics and Information System;
- National Laboratory of Science and Technology on Automatic Target Recognition;
- National 863 Plan Laser Gyroscope Key Laboratory; and
- Science and Technology on Scramjet Laboratory.[56]

Links or associations:

On Japan's End User List (for missile development) and US Entity List (for importing equipment from the US for potential nuclear weapons use).

ASPI rating: Very high risk. Security credentials: Top secret.

UK research connections or cooperation between staff: Strathclyde (**R**); Cambridge (**R**); Birmingham (**R**); Cranfield (**R**).

Northwestern Polytechnical University (NPU)

One of the Seven Sons and specialising in aviation, space and naval technology. Its UAV laboratory manufactures military drones though a subsidiary. NPU is implicated in the illegal export of anti-submarine warfare technology from the US.[57] It researches electromagnetic field and microwave technology, space biology, and detection, guidance and control technology.

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[52] Federal Register :: Addition of Entities to the Entity List, Revision of Entry on the Entity List, and Removal of Entities From the Entity List
[53] https://unitracker.aspi.org.au/universities/national-university-of-defense-technology/
[54] https://www.auliving.com.au/zh-tw/201911/132010.html
[55] National University of Defense Technology – Chinese Defence Universities Tracker — ASPI
[56] *Ibid.*
[57] https://web.archive.org/web/20181103131242/https:/www.justice.gov/usao-ma/pr/chinese-national-allegedly-exported-devices-military-applications-china

Selected defence laboratories:[58]

- Fundamental Science on Aircraft Structural Mechanics and Strength Laboratory;
- State Key Laboratories of UAV Special Technology; Underwater Information and Control (jointly with China Shipbuilding Industry Corporation's 705 Institute, which may be another name for the National Defense Key Laboratory of Torpedo Guidance Technology) ;and
- Science and Technology on Thermostructural Composite Materials Laboratory.[59]

Links or associations:

US ban on students. On Japan End User List and US Entity List.

ASPI rating: Very high risk. Security credentials: Top Secret.

UK research connections or cooperation between staff: Imperial (**R**); Manchester (**R**); Strathclyde (**R**); QMUL (**FP**); Nottingham (**R**); Cranfield (**R**); Surrey (**R**).

Peking University (PKU)

The PLA Navy and PKU signed a strategic cooperation framework agreement in 2013 at a ceremony attended by then-PLA Navy Commander,[60] whilst PKU has at least two joint-supervision agreements between the Ministry of Education and defence industry agency SASTIND, designed to deepen the university's involvement in defence research. PKU's Advanced Technology Institute, founded in 2006, oversees and develops the university's defence research, covering semiconductors, nuclear technology, quantum physics, advanced materials, underwater acoustics, satellite navigation and communications, flight propulsion, aerospace engineering and microprocessors.[61] PKU researchers often participate in expos and events related to military-civil fusion,[62] whilst the university is among the founders of the Beijing University Technology Transfer Alliance, promoting commercialising patents and researchers in dual-use and military-relevant sectors including 3D printing and robotics.[63]

Selected defence laboratories:

- PKU–CAEP New Structure Center for Applied Physics and Technology. The Chinese Academy of Engineering Physics (CAEP) is China's nuclear weapons program. The joint centre carries out research on materials, lasers for atomic physics applications, laser plasma physics, computer science and fluid dynamics. PKU's report on the centre states that it will serve China's national defence needs and that CAEP's

[58] Northwestern Polytechnical University – Chinese Defence Universities Tracker — ASPI
[59] https://archive.fo/uBnWI
[60] The Navy and Peking University signed a cooperation agreement on the innovative development of military-civilian integration| the Navy Channel of china's military network (archive.ph)
[61] Peking university (archive.org)
[62] Peking University's Outstanding Achievements Unveiled at the "Fourth Military-Civilian Integration Development High-Tech Equipment Achievements Exhibition" (archive.ph)
[63] Alliance seeks to commercialize universities' research triumphs - Chinadaily.com.cn (archive.ph)

deputy director emphasised it should 'take the path of military-civil fusion'.[64] The joint centre's honorary director and founding director, He Xiantu, is credited as the developer of China's first neutron bomb;[65]

- National Key Laboratory of Science and Technology on Micro/Nano Fabrication;[66]
- Fundamental Science on Radiochemistry and Radiation Chemistry Laboratory;[67]
- Nuclear Fuel Cycle and Nuclear Chemical Engineering National Defense Key Laboratory;[68]
- Key Laboratory of High Energy Density Physics Simulation, Ministry of Education;[69] and
- Key Laboratory of Microelectronic Devices and Circuits, Ministry of Education.[70]

Links or associations:

ASPI rating High risk.

UK research connections or cooperation between staff: Nottingham (**R**); Birmingham (**R**); Strathclyde (**FP**).

Shandong University (SDU)

Shandong University (SDU) is designated as *Very High Risk* for its high number of defence laboratories and links to China's nuclear weapons program.[71] This includes collaborations with the Chinese Academy of Engineering Physics, China's nuclear warheads development facility, including the study of nuclear explosions and research on fusion ignition.[72]

Selected defence laboratories:

- Key Laboratory of Functional Crystal Materials and Device.[73]
- Ministry of Education Key Laboratory of Special Aggregated Materials.[74]
- Key Laboratory of Laser and Infrared System Integration Technology of the Ministry of Education.[75]
- KDP Crystal Technology Ministry of Education Technology Research Centre (Linked to China's nuclear warheads development facility, the Chinese Academy of Engineering Physics).[76]

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[64] 北京大学应用物理与技术研究中心研究技术系列研究员招聘启事 - 学院公告 - 北京大学工学院 (archive.org)

[65] 贺贤土院士荣获世界聚变能源领域最高奖—新闻—科学网 (archive.org)

[66] 2010年北京大学信息科学技术学院简介_新浪教育_新浪网 (archive.org)

[67] Introduction – inst (archive.org)

[68] The Director of the Atomic Energy Department of the Bureau of Science, Technology and Industry for National Defense came to the State Key Laboratory for a discussion - State Key Laboratory of Nuclear Physics and Technology (archive.org)

[69] Provincial and Ministerial Key Laboratory - School of Engineering, Peking University (archive.org)

[70] Peking university (archive.org)

[71] Shandong University – Chinese Defence Universities Tracker — ASPI

[72] The Institute of Chemical Materials of the Chinese Academy of Engineering Physics visited the School of Materials Science and Engineering of Shandong University (archive.org)

[73] Two key laboratories of the Ministry of Education of Shandong University passed the acceptance - China Cement Network (archive.org)

[74] *Ibid.*

[75] Progress report on the construction of world-class universities (archive.ph)

[76] KDP Crystal Technology Research Center of the Ministry of Education was inaugurated at Shandong University-Shandong University News Network (archive.ph)

- Resin-based Composite Materials and Structures Manufacturing Technology Research Centre.[77]

Links or associations:

ASPI rating: Very High Risk. Security credentials: Secret.

UK research connections or cooperation between staff: Kent (**R**); Warwick (**R**); Surrey (**R**).

Shanghai Jiao tong University (SJTU)

SJTU is linked to Unit 61398, a PLA cyber-espionage unit implicated in cyber-warfare against the US.[78]

Selected defence laboratories:[79]

- Defense Key Disciplines Laboratory of Ship Equipment Noise and Vibration Control Technology.

Links or associations:

ASPI rating: High Risk. Security credentials: Secret.

UK research connections or cooperation between staff: Strathclyde (**R**); Cranfield (**R**); Surrey (**R**).

University of Electronic Science and Technology of China (UESTC)

Founded in 1961, UESTC is one of China's oldest military-linked universities. Under joint SASTIND-China Electronics Technology Group Corporation (CETC) supervision,[80] and with programmes in microwaves, anti-jamming, and military-use materials, its military electronic outputs are used in missiles, aircraft carriers and aircraft, such as the JF-17 fighter. Staff associated with UESTC have founded at least one AI firm involved in surveillance in Xinjiang.[81]

Selected defence laboratories:[82]

- National Anti-interference Communication Technology Laboratory;
- Fundamental Science on EHF [Extremely High Frequencies] Laboratory; and
- Strong Radiation Laboratory (jointly with the Chinese Academy of Engineering Physics, China's main nuclear warhead research institution, leading to the US government giving UESTC Entity listing as a 'proxy for China's nuclear weapons programme'; originally a National 863 Plan laboratory).[83]

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[77] 国防院简介 (archive.org)
[78] Shanghai Jiao Tong University – Chinese Defence Universities Tracker — ASPI
[79] *Ibid.*
[80] https://unitracker.aspi.org.au/universities/tianjin-university/
[81] https://unitracker.aspi.org.au/universities/university-of-electronic-science-and-technology-of-china/
[82] University of Electronic Science and Technology of China – Chinese Defence Universities Tracker — ASPI
[83] https://archive.fo/rVagW

Links or associations:

On Japan's End User List (for chemical weapons development) and US Entity List.

ASPI rating: High Risk. Security credentials: Secret.

UK research connections or cooperation between staff: Strathclyde (**R**).

Wuhan University of Technology (WHUT, WUT)

WUT researches military engineering and advanced composite materials for weapons in formal cooperation with the PLA Air Force,[84] as well as ship design.

Selected defence laboratories:[85]

- Key Laboratory of High-Performance Ship Technology; and
- PLA Air Force-WHUT Air Defence Engineering and Protective Technology Research Institute.[86]

Links or associations:

ASPI rating: High Risk. Security credentials: Secret.

UK research connections or cooperation between staff: Southampton (**R**); Birmingham (**R**).

Xidian University

Supervised by SASTIND and defence electronics manufacturer CETC and a partner of the PLA signals intelligence unit,[87] Xidian is a research base for radar, antennas, electronic countermeasures, pattern recognition and intelligent systems. It claims an 'unbreakable bond with secret intelligence work since its beginning'.[88] Xidian's Mobile Internet Security Talent Recruitment Base (also known as the National 111 Project for Mobile Security) has recruited foreign scholars and is directed by a PLA Navy Major General.[89]

Selected defence laboratories:[90]

- National Laboratory of Radar Signal Processing;
- National Key Laboratory of Antennas and Microwave Technology (jointly with China Electronics Technology Group Corporation's 14th Research Institute, a centre of anti-stealth research on the US Entity List);
- National Key Discipline Laboratory of Wide Band-gap Semiconductor; and

[84] https://archive.fo/u9Kgv
[85] Wuhan University of Technology – Chinese Defence Universities Tracker — ASPI
[86] https://web.archive.org/web/20190722043237/http:/www.wutnews.net/politics/news.aspx?id=61013
[87] https://web.archive.org/web/20190531021509/http:/leixieyuan.xidian.edu.cn/gywm/gsgk.htm
[88] https://unitracker.aspi.org.au/universities/xidian-university/
[89] https://mis.xidian.edu.cn/html/team/overseas/2017/0306/5.html
[90] Xidian University – Chinese Defence Universities Tracker — ASPI

- Key Laboratory of High-Speed Circuit Design and EMC [Electro-magnetic Compatibility].[91]

Links or associations:

ASPI rating: Very high risk. Security credentials: Secret.

UK research connections or cooperation between staff: Kent (**R**); Surrey (**R**).

Zhejiang University

Zhejiang University is an MSS-funded cyber research centre and a base for military-focused research into automation and manufacturing. The university participates in China's National Defense Technology Industry Nuclear Power Technology Innovation Center. Zhejiang University has been implicated in espionage charges in the US.[92]

Selected defence laboratories:[93]

- Key Laboratory of High-Performance Embedded Computing.[94]

Links or associations:

ASPI rating: High Risk. Security credentials: Secret.

UK research connections or cooperation between staff: Cambridge (**R**); Nottingham (**R**); Surrey (**R**).

Aero Engine Corporation of China (AECC)

The Aero Engine Corporation of China (AECC) was created from the Aviation Industry Corporation of China (AVIC, below) in 2016, with AVIC retaining a stake and Commercial Aircraft Corporation of China (COMAC, also below) another shareholder.[95] AECC is one of China's leading civilian and military aviation engine manufacturers, and it appears that this includes attack helicopters and ground attack aircraft.[96]

Links or associations:

Under US DOD sanctions as a 'Chinese military company' (specific sanctions also apply separately to subsidiaries and former subsidiaries such as Skyrizon).

UK research connections or cooperation between staff: Imperial (**R**); Cranfield (**R**).

Aviation Industry Corporation of China (AVIC)

[91] https://unitracker.aspi.org.au/universities/xidian-university/
[92] https://unitracker.aspi.org.au/universities/zhejiang-university/
[93] Zhejiang University – Chinese Defence Universities Tracker — ASPI
[94] College of Biomedical Engineering and Instrumental Science, Zhejiang University (archive.org)
[95] https://web.archive.org/web/20171127182732/http:/www.guancha.cn/Industry/2016_06_13_363868.shtml
[96] *Ibid.*

China's leading civilian and military aviation supplier, AVIC supplies the PLA Air Force with the J-20 fifth generation stealth fighter jet,[97] among many other military systems. AVIC has dozens of subsidiaries.

Research subsidiaries involved with UK universities include:

- AVIC First Aircraft Institute (FAI), responsible for designing the new PLA Air Force stealth strategic bomber;[98]
- AVIC Aircraft Strength Research Institute (ASRI); and
- AVIC Manufacturing Technology Institute (MTI). Formerly the Beijing Aeronautical Manufacturing Technology Research Institute (BAMTRI), MTI is reported to include laser weapons research.[99]

Links or associations:

Under US DOD sanctions as a 'Chinese military company'.

UK research connections or cooperation between staff: Imperial (**FP**); Nottingham (**R**).

Beijing Institute for Aeronautical Materials (BIAM)

An AECC subsidiary, the Beijing Institute for Aeronautical Materials (BIAM) develops and manufactures advanced materials for civilian and military use: BIAM researchers are reported as working on military helicopters, including graphene armour, and other military fields.[100]

Links or associations:

Under US DOD sanctions as a 'Military End User'.

UK research connections or cooperation between staff: Imperial (**FP**); Manchester (**R**); Birmingham (**R**).

China Aerospace Science and Technology Corporation (CASC)

China Aerospace Science and Technology Corporation (CASC) and some of its subsidiaries are leading suppliers of missiles, carrier rockets, military satellites and precision-guided weapons, and as leading players in China's nuclear weapons programme are involved in international nuclear proliferation. One subsidiary, China Great Wall Industry Corporation (CGWIC), has a history of proliferation to Iran.[101] In December 2020, CASC entered into an agreement with the China State Shipbuilding Corporation (CSSC) to integrate advanced weaponry into naval projects to 'jointly build a world-class military, aerospace power, maritime power, manufacturing power, and science and technology power.'[102] CASC

[97] https://thediplomat.com/2018/03/chief-engineer-of-chinas-alleged-stealth-fighter-vows-new-capabilities-for-aircraft/
[98] https://unitracker.aspi.org.au/universities/aviation-industry-corporation-of-china/
[99] https://nationalinterest.org/blog/buzz/china-developing-airborne-laser-weapon-113546
[100] News Co. (NASDAQ:NWS) Shares Sold by WINTON GROUP Ltd - Defense World
[101] https://www.nti.org/learn/facilities/50/
[102] https://www.janes.com/defence-news/news-detail/china-shipbuilding-casc-sign-deal-on-military-technologies

developed autonomous technology and unveiled the D3000 unmanned oceanic combat vessel in 2017 for anti-submarine and surface combat, expected to be deployed in the South China Sea.[103]

Links or associations:

Under US DOD sanctions as a 'Chinese military company'.

UK research connections or cooperation between staff: Manchester (**R**); Nottingham (**R**); Surrey (**R**).

China Academy of Space Technology (CAST)

The China Academy of Space Technology (also known as the 5th Academy of CASC)[104] is a CASC subsidiary.

Links or associations:

On Japan's End User List.

UK research connections or cooperation between staff: Nottingham (**R**); Birmingham (**R**); Surrey (**R**).

China Academy of Launch Vehicle Technology (CALT)

A CASC subsidiary, the China Academy of Launch Vehicle Technology (CALT) develops ICBMs[105] and produces the Long March series of rockets with dual civilian and military use. In October 2020, the Long March 2C rocket propelled three Yaogan 30 military signals intelligence satellites 370 miles into Earth's orbit. These test electronic eavesdropping equipment and help the Chinese military track US and other deployments.[106] As the leading manufacturer of China's ICBMs, through the 1990s CALT produced the Dongfeng 5 (DF5), a silo-based ICBM with an effective 7,456 mile-range and equipped with a 1-3 MT nuclear warhead, able to strike targets across western Europe and the mainland US. In 2015, CALT upgraded the Dongfeng to the DF5B, equipped with multiple independent re-entry vehicle (MIRV) warheads, allowing separate strikes from one missile. In 2017, CALT tested the DF5C, able to carry 10 MIRV warheads.[107]

Links or associations:

Under US DOD sanctions as a 'Chinese military company'.

UK research connections or cooperation between staff: Strathclyde (**FP**).

Commercial Aircraft Corporation of China (COMAC)

[103] China's great leap in unmanned warship development - Asian Military Review
[104] https://unitracker.aspi.org.au/universities/china-aerospace-science-and-technology-corporation/
[105] https://unitracker.aspi.org.au/universities/china-aerospace-science-and-technology-corporation/
[106] https://spacenews.com/china-launches-latest-trio-of-yaogan-30-remote-sensing-satellites/
[107] https://www.globalsecurity.org/wmd/world/china/calt.htm

Commercial Aircraft Corporation of China (COMAC) is a state-owned aircraft manufacturer. Focused on civilian airliners, China's Ministry of Industry and Information Technology nonetheless calls it a defence industry conglomerate,[108] and China's main military aircraft manufacturer AVIC (above) holds a 10 per cent stake. Senior staff at the Central Military Commission have described their interest in converting civilian planes to military uses during inspections of COMAC jets.[109]

Links or associations:

Under US DOD sanctions as a 'Chinese military company'.

ASPI rating: Very high risk.

UK research connections or cooperation between staff: Manchester (**R**).

Shougang Group

Shougang Group (formerly Shougang Corporation) is a state-owned steel and metals conglomerate based in Beijing. Shougang acquired thirteen military factories in 1988.[110] Subsidiaries such as Shougang Guiyang Special Steel Company describe a manufacturing role in the 'national defence and military industry'.[111]

UK research connections or cooperation between staff: Imperial (**FP**).

[108] http://archive.md/5MKh1
[109] *Ibid.*
[110] http://sro.sussex.ac.uk/id/eprint/118/1/Shougang.pdf
[111] https://www.shougang.com.cn/en/ehtml/IronSteelIndustry/20170329/829.html

Chapter Two: UK universities hosting collaborative Sino-British research centres

Of the 16 official Sino-British joint labs identified in *IAC*, at least six remain fully operational across four separate UK universities, having since produced multiple potential dual-use collaborative research projects. This is despite the majority of the UK universities maintaining in their right to replies that formal collaborations have ceased.

Of the remaining ten labs, nine others have since retained close research collaborations together with the original Chinese defence university or company, by continuing joint research outputs but in a less formal manner (i.e. often at the individual rather than at the institutional level).

This chapter details the six jointly funded and run labs still hosted at UK universities, and provides specific cases of potential dual-use technology pioneered and developed at these labs since *IAC*. The timeline for this is from January 2021, since most of the research for *IAC* was concluded, with the universities right to replies added in February prior to publication the same month. Therefore, all research during, and published since, has been used to substantiate this and the following chapter's findings.

NB: In the following, when we discuss some of the possible dual uses of technology types, we do not imply that any UK-based researcher working in a technological field is knowingly contributing to the potential military uses we outline here. We believe that all research carried out in the UK and/or by UK-based researchers is intended by parties within the UK for civil use only. The purpose is simply to discuss the potential risks that their research may be exploited for these types of ends. The aim is also not to show that any piece of research by a UK-based researcher is being put towards China's military development, but that some research may exist in a general area of potential dual use, and the way that universities are asked to assess the related risks may therefore need to change. None of the fields or projects discussed in this paper need directly contribute to a military programme, but they may improve the state of knowledge in general in a particular field in the PRC that may later help generate dual use outputs, or the business position of military-linked companies, or the capacities of military-linked universities.

Jointly financed and run Sino-British research laboratories hosted at UK universities which have remained fully operational since *IAC*

1. Imperial College London and the Beijing Institute for Aeronautical Materials (BIAM)

The Imperial Centre for Materials Characterisation, Processing and Modelling

Key words: aerospace; lithium-ion batteries; nickel-based superalloys.

The BIAM Centre carries out research for aerospace, including in aeronautical materials, lithium-ion batteries, and aircraft windshields. Overseen by a PRC researcher, the BIAM

Centre's research includes superalloy micromechanics, solid-state lithium batteries, and fatigue performance of nickel-based (Ni-based) single-crystal superalloys. In 2019, the Centre received as a visitor the Chairman of AECC itself.

It was noted in *IAC* how a central facet of the Centre's research was nickel-based single-crystal superalloys, and that this was a crucial aspect to the AECC (BIAM's owner) developing the PLA Air Force's ability to develop the J-20 stealth fighter jet. These jets are now almost certainly deployed at Longtian airbase – only 100 miles from Taipei.

This research into NI-based single-crystal superalloys has continued; in 2022 a paper was financed by BIAM and conducted at the Centre.[112]

The Centre produced research in 2020 leading to seven research papers published. In 2021 the figure rose to nine, which included a project that received financial support from BIAM,[113] researching Inconel 718 – a highly complex and strong super alloy, with 50% of all the alloy manufactured going towards the aerospace industry, in particular jet engines and turbines.[114]

2. Imperial College London and the Aviation Industry Corporation of China (AVIC)

The AVIC Centre for Structural Design and Manufacturing

Key words: additive manufacturing (3-D printing);[115] wire-arc additive manufacturing (WAAM); fibre-reinforced composites;[116] [117] aluminium alloys.

The Centre cooperates with the AVIC Aircraft Strength Research Institute (ASRI); Manufacturing Technology Institute (MTI); and First Aircraft Institute (FAI), the latter of which designed China's latest bombers;[118] the H-20 stealth bomber which is known to potentially evade radar technology.[119] Moreover, the FAI undertake research and development of several advanced military and civil aircrafts, and is strategically centred on six national tasks in both the 'military and civil' fields.[120]

The AVIC-sponsored Centre carries out research into materials science, manufacturing techniques and structural integrity, which Imperial states is for 'safer, lighter and more efficient air transportation facilities.' According to Imperial, the institutes' 'knowledge of

[112] On the detailed morphological and chemical evolution of phases during laser powder bed fusion and common post-processing heat treatments of IN718 - ScienceDirect
[113] On the constitutive relationship between solidification cells and the fatigue behaviour of IN718 fabricated by laser powder bed fusion- Web of Science Core Collection
[114] Inconel 718 for aerospace engine applications (super-metals.com)
[115] The effects of hot forging on the preform additive manufactured 316 stainless steel parts - ScienceDirect
[116] The influence of microstructural anisotropy on the hot deformation of wire arc additive manufactured (WAAM) Inconel 718 - ScienceDirect this research was conducted cooperatively at ICL and at BIAM, with support from AVIC (see paper's 'Acknowledgements').
[117] Additive and WAAM has military applications, see Pub72376.pdf (ornl.gov)
[118] Prison term, fine for defense firm executive 'deterrent to corruption' - Global Times
[119] China's H-20 Stealth Bomber: Why the US Military Is Worried - 19FortyFive
[120] 中国航空工业第一飞机设计研究院 - Cooperators - ICAS2020

metals, polymers and composites and experience with design, manufacture, testing and inspection combines well with Imperial's capabilities on fundamental research.'[121]

The Centre produced research in 2020 leading to 11 published papers, a further nine in 2021, and two in 2022. AVIC financially contributed to five of the nine research projects listed in 2021, and either directly funded or supported the two research papers in 2022. These two research papers included a paper researching fibre-reinforced composites, in collaboration with two researchers from AVIC and which was supported and funded by the FAI.[122] Fibre-reinforced composites and polymers have active military applications particularly in naval vessels and submarines,[123] and also in military aircraft.[124]

The second paper from 2022 researched aluminium alloys, in collaboration with a researcher from Beihang University (BUAA), and funded by Chinese entities including the National Natural Science Foundation of China (a subsidiary of the Ministry of Science and Technology), with support from AVIC.[125]

Imperial describes its AVIC Centre for Structural Design and Manufacturing as 'promoting world leading scientific research into aircraft design and manufacturing technologies.'[126] A report at King's College London found that research sponsored by AVIC at Imperial used high-velocity gun systems which are 'relevant for nuclear weapons development'.[127]

Imperial College London's AVIC Centre for Structural Design and Manufacturing currently lists 14 separate research projects on their website.[128] Of these 14, 11 have live links to the project's research aims, and who is involved on the projects. Of those 11 projects, two have Chinese AVIC-only researchers listed as working on the project, which includes research into aerospace applications for aluminium-lithium alloys.[129] Listed below are the 11 live research projects under the AVIC Centre for Structural Design and Manufacturing.

1. The *Vibration Absorption Systems and Energy Absorption Structures* project focuses on the development of energy absorbing materials that possess excellent mechanical properties such as high strength, low density and ideally high stiffness, while having the ability to reduce vibrations over a range of frequencies and absorb large quantities of energy.[130] The project lists a Chinese researcher, who was an academic visitor from the Beijing Aeronautical Manufacturing Technology Research Institute (BAMTRI) to Imperial

[121] AVIC Centre for Structural Design and Manufacture | Research groups | Imperial College London
[122] A Comparative Study on the Failure Criteria for Predicting the Damage Initiation in Fiber-Reinforced Composites | SpringerLink
[123] Military applications of fiber-reinforced polymers (FRP) structures to... | Download Scientific Diagram (researchgate.net)
[124] Practical Use of Composite Materials Used in Military Aircraft - PMC (nih.gov)
[125] A New Method to Characterize and Model Stress-Relaxation Aging Behavior of Aluminum Alloys Under Age Forming Conditions | SpringerLink
[126] AVIC Centre for Structural Design and Manufacture | Research groups | Imperial College London
[127] Scott, E. at al 2020.
[128] Improving the Mechanical Properties of Composite-Metal Joints by Surfi-Sculpt | Research groups | Imperial College London
[129] Post-weld Strength Prediction for Aluminium-Lithium Alloy | Research groups | Imperial College London
[130] Vibration Absorption Systems and Energy Absorption Structures | Research groups | Imperial College London

College London between August 2013 to March 2014.[131] The project also lists a Chinese AVIC employee, as a researcher.[132]

2. The *Creep Age Forming* project has two researchers. One is at the Beijing Aeronautical Manufacturing Technology Research Institute, AVIC.[133] Creep Age Forming has applications for military aircraft: 'Creep age forming (CAF) is an advanced metal forming method for manufacturing large integrally stiffened, lightweight structures of aluminum alloy. It synchronizes metal creep and age strengthening of aluminum alloy, thus greatly improving manufacturing efficiency. Examples of creep age forming application include the upper wing skins of Gulfstream IV/V, B-1B long-range combat aircraft'.[134]

3. *Residual Stress Control and Detecting Method for Large Aluminum-Alloy Parts* is a project that develops of the principle of fatigue and damage tolerance in the aircraft design.[135] The project lists two AVIC researchers.

4. *Impact testing of laminated glass and composites* investigate the behaviour of various composite structures against both low and high velocity impacts. A main material of interest in this project is laminated glass structures, specifically for aircraft windshields.[136] The project lists a sole researcher, cited on Research Gate as working at Imperial College London, with 18 publications since they have been there.[137] One major part of their research includes the impact performance of thermoplastic and thermoset composites.

5. *Structural Integrity of High Power Fibre Laser and Electron Beam Welded Lightweight Alloy Aircraft Structures* is a project that researches light-weight alloys for future aerospace applications. A Chinese Professor is listed on the project, an employee at BAMTRI.[138]

6. *Strength Assessment and Modelling for Thick CFRP Composite Laminates* focuses on the evaluation of thick CFRP (Carbon Fibre Reinforced Plastics) composite laminates used in wing or stabiliser structures of aircraft.[139]

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[131] Mr Qifeng Lu | Research groups | Imperial College London
[132] *Ibid.*
[133] Creep Age Forming | Research groups | Imperial College London Ms Xia Huang | Research groups | Imperial College London
[134] Zhang, Jin & Jiang, Zhen & Xu, Fushun & Chen, Mingan. (2019). Effects of Pre-Stretching on Creep Behavior, Mechanical Property and Microstructure in Creep Aging of Al-Cu-Li Alloy. Materials. 12. 333. 10.3390/ma12030333. p.2.
[135] https://www.imperial.ac.uk/avic-design/projects/mti-fai/residual-stress-control-and-detecting-method-for-large-aluminum-alloy-parts/
[136] Impact testing of laminated glass and composites | Research groups | Imperial College London
[137] Jun LIU | Doctor of Philosophy | Imperial College London, London | Imperial | Department of Mechanical Engineering (researchgate.net)
[138] Structural Integrity of High Power Fibre Laser and Electron Beam Welded Lightweight Alloy Aircraft Structures | Research groups | Imperial College London
[139] Strength Assessment and Modelling for Thick CFRP Composite Laminates | Research groups | Imperial College London

The project lists four AVIC researchers on the team, including a Chinese Professor who was an Academic Visitor at Imperial College London between January 2014 to January 2015.[140] Their LinkedIn profile lists the role at Imperial College London as current.[141] The project further lists a Chinese researcher, and that their position is still running;[142] in addition to an Academic Visitor from AVIC from February 2015.[143]

7. *Improving the Mechanical Properties of Composite-Metal Joints by Surfi-Sculpt* is a project which aims to investigate the influences of z-pins on the impact damage resistance and damage tolerance of composite structures.[144] The use of z-pins is intrinsic to several high performance composite structures: including in F/A-18 E/F aircraft.[145]

   An Academic Visitor to Imperial College London from BAMTRI between November 2013 – October 2014, and a PhD researcher from Huazhong University of Science and Technology (HUST) in China, is one of two research staff.[146] HUST is designated as 'very high risk' by ASPI for its high number of defence laboratories and close links to China's defence industry.[147] According to ASPI, HUST has worked closely with the PLA and China's defence industry, with the university's work on pulsed power is linked to China's nuclear and directed-energy weapons program.[148] Furthermore, China's state-owned defence conglomerates and China's nuclear warhead facility sponsor dozens of HUST postgraduate students each year, who are required to work at their sponsoring organisation for at least five years after graduating.[149]

8. *HFQ and SPF Forming on Al-Li Alloy Components* is a project researching medium and high strength aluminium lithium alloys.[150] The sole researcher listed on the project's website is a Chinese researcher, who has published twelve pieces of research whilst at Imperial College London.[151]

9. *The Structural Integrity Assessment of Additive Manufactured Product* is a project designed to assess BAMTRI's materials and for structural integrity.[152]

[140] Professor Yuming Jia | Research groups | Imperial College London
[141] Yuming Jia - researcher - Imperial College London | LinkedIn
[142] Mr Liyong Jia | Research groups | Imperial College London
[143] Ms Miao Li | Research groups | Imperial College London
[144] Improving the Mechanical Properties of Composite-Metal Joints by Surfi-Sculpt | Research groups | Imperial College London
[145] *Ibid.*
[146] Mr Xichang Wang | Research groups | Imperial College London
[147] Huazhong University of Science and Technology – Chinese Defence Universities Tracker — ASPI
[148] *Ibid.*
[149] notice on the selection of national defense science and technology scholarships for graduate students in 2018 - huazhong university of science and technology graduate funding network (archive.fo)
[150] HFQ Forming on Al-Li Alloy Components | Research groups | Imperial College London
[151] Haoxiang GAO | Imperial College London, London | Imperial | Department of Mechanical Engineering (researchgate.net)
[152] Structural Integrity Assessment of Additive Manufactured Products | Research groups | Imperial College London

10. *The Post-weld Strength Prediction for Aluminium-Lithium Alloy* project researchers post-weld strength for aluminium lithium alloy materials used in the aerospace industry.[153] The project lists a researcher from BAMTRI as the sole researcher, who has ten research publications whilst attached to Imperial College London, including two released in October and November 2021 regarding laser welding for aluminium lithium alloys.[154]

11. *Microstructure and mechanical properties of the brazing joint for Ti6Al4V alloy* is a research project which investigates the microstructure and tensile properties of the brazed joints for the most widely used aerospace alloys, namely as Ti6Al4V.[155] This alloy has significant potential use in combat aircraft technology.[156] The sole researcher on this project is a Chinese engineer from BAMTRI.[157]

3. Imperial College London and Shougang Group

Shougang-Imperial Lab for Lightweight Steel Based Systems for Impact Resistant Automotive Applications

Key words: fibre metal laminates (FML); steels; hot stamping

Imperial has maintained its established research centre with the major Chinese steel-making SOE Shougang. Shougang is a steel conglomerate, supplying large volumes of steel to the military, with some of this laboratory's research may risk having dual-use applications.

Research includes fibre metal laminates (FMLs), a class of lightweight structural materials that separately is of considerable interest to military industries. Defence-applicable research into FMLs elsewhere has included their capacity to improve the mechanical properties of CFRP, a material being researched by the centres above at Imperial and of increasing interest for stealth jets.

The Centre doubled its published research output from 2020 to 2021, and continued publishing research developed at the Centre in 2022.

A Chinese Doctor is the co-Director.[158] In 2022 they undertook three separate research projects all financed and supported by Chinese entities including AVIC[159] [160] and the Shougang Group[161], conducted at Imperial. One of the projects researched aluminium alloys

[153] Post-weld Strength Prediction for Aluminium-Lithium Alloy | Research groups | Imperial College London
[154] Enguang He's research works | Beijing Institute of Aeronautical Materials, Beijing (AVIC) and other places (researchgate.net)
[155] Microstructure and mechanical properties of the brazing joint for Ti6Al4V alloy | Research groups | Imperial College London
[156] Additively manufactured Ti-6Al-4V replacement parts for military aircraft - ScienceDirect
[157] Microstructure and mechanical properties of the brazing joint for Ti6Al4V alloy | Research groups | Imperial College London
[158] Home - Dr Zhusheng Shi (imperial.ac.uk)
[159] A New Method to Characterize and Model Stress-Relaxation Aging Behavior of Aluminum Alloys Under Age Forming Conditions | SpringerLink
[160] Tool path planning of consecutive free-form sheet metal stamping with deep learning - ScienceDirect
[161] Investigation of deformation behaviour with yield point phenomenon in cold-rolled medium-Mn steel under hot stamping conditions - ScienceDirect

with a researcher based at BUAA,[162] who has research expertise and interests in robotics and autonomous vehicles.[163] BUAA maintains at least five major defence laboratories for the PLA which all research the aerospace industry for the Chinese military.[164]

Shougang Group funded two research projects and papers at Imperial College London in 2021, both researching hot stamping process for steel manufacturing.[165] [166]

In the production of essential military components, like aviation gauges or segments of armoured vehicles, end users require parts reliability and high performance. Due to the extremely complex nature of engineering military and defence equipment and the involvement of high-level mathematics and calculations, component measurements and requirements are stringent with little to no room for deviation. Additionally, there are strict requirements manufacturers of these parts must adhere to—known as Mil-Spec. Production of these parts requires advanced technologies, precise processes, superior quality assurance tools, and reliable machinery to ensure product repeatability over high volumes. Precision metal stamping like the Chinese funded project at the joint Shougang-Imperial Lab is critical to many defence manufacturing process.[167]

Additional dual-use technology research developed between Imperial College London and Chinese military-linked entities since *IAC*

A Chinese researcher joined the Department of Mechanical Engineering at Imperial College London in October 2017 as a postgraduate researcher. After their graduation in June 2021, they were employed by Imperial College as a postdoctoral research associate (PDRA) to continue their research in the same group. They work on evaluating and modelling the formability of sheet metals, such as boron steels and aluminium alloys, under warm or hot stamping conditions.

Before joining Imperial College London, the same researcher completed their Bachelor's degree in Mechanical Design, Manufacture & Automation in 2014 and Master's degree in Mechanical Engineering in 2017 at Central South University (CSU) (China).[168] CSU is designated *High Risk* for its high level of defence research and close relationship with China's defence industry.[169] CSU's defence research appears to focus on metallurgy, materials science, and aviation technology, including the development of heat-resistant materials for aeroplane and rocket engines.[170] The researcher subsequently published throughout 2021 and 2022, including hot metal stamping for boron steel; a highly resilient and tough alloy which has significant anti-corroding capabilities and thus a high desired

[162] A New Method to Characterize and Model Stress-Relaxation Aging Behavior of Aluminum Alloys Under Age Forming Conditions | SpringerLink
[163] https://ieeexplore.ieee.org/author/37066648300
[164] Beihang University – Chinese Defence Universities Tracker — ASPI
[165] Rapid feasibility assessment of components to be formed through hot stamping: A deep learning approach - ScienceDirect
[166] Investigation of austenitising behaviour of medium-Mn steel in the hot-stamping heating process - ScienceDirect
[167] Metal Stamped Components for Military & Defense Industries | AIC (americanindust.com)
[168] Home - Dr Ruiqiang Zhang (imperial.ac.uk)
[169] Central South University – Chinese Defence Universities Tracker — ASPI
[170] 因为这两件技术，英国人关注中国中南大学和厦门大学_飞行器 (archive.org) (Chinese).

manufacturing process for many military applications,[171] including helicopter and tank armour, and bullet-proof vests.[172]

Since August 2018, they have been working as a Research Associate at Imperial College London's Faculty of Engineering, Department of Minerals, on the projects of multi-scale experiments and modelling crystalline materials' behaviour under multi-physics fields.[173] This includes two separate published pieces of research in 2022, including on nickel-based superalloys.[174]

A Chinese research associate at Imperial College London has a Bachelor's degree in Mechanical Engineering and a Master's degree in Tribology and Surface Engineering from China University of Geosciences (CUG). CUG is actively engaged in defence research and training on geology, hosting the defence-focused Ministry of Education Key Laboratory on Geological Exploration and Evaluation. The laboratory trains students in 'military geology'.[175]

They have worked in the UK as a researcher since 2013,[176] and have published multiple research throughout 2021 and 2022 in mechanochemistry.[177]

A PhD student at Imperial College London's AVIC Centre for Structural Design and Manufacture researches additive manufacturing and subsequent forging.[178] They are an associate member of BAMTRI.

A Chinese researcher completed their PhD in solar powered UAVs at Imperial College London's AVIC Centre for Structural Design and Manufacturing in 2021.[179] Prior to this they obtained a BEng in Mechanical Engineering and Automation at Zhejiang University, China. ZJU is designated *High Risk* for its number of defence laboratories, relationship with defence industry, and links to economic and cyber espionage. The university holds secret-level security credentials, allowing it to work on classified military projects.[180]

[171] Boron Demand In Military Conflict | Borates Today
[172] https://linkinghub.elsevier.com/retrieve/pii/S0924013621004416
[173] Home - Dr Yilun Xu (imperial.ac.uk)
[174] Twin boundary fatigue crack nucleation in a polycrystalline Nickel superalloy containing non-metallic inclusions - ScienceDirect
[175] China University of Geosciences (Wuhan) – Chinese Defence Universities Tracker — ASPI
[176] Home - Dr Jie Zhang (imperial.ac.uk)
[177] Oxidational wear in lubricated contacts – Or is it? - ScienceDirect
[178] Zinong Tan | Research groups | Imperial College London
[179] Mr Lei Zhu | Research groups | Imperial College London
[180] Zhejiang University – Chinese Defence Universities Tracker — ASPI

A Chinese Visiting Professor at Imperial College London is also a Professor with Manufacturing Technology Institute (MTI), AVIC, China. They graduated from NPU in 1986, joining AVIC the same year. They received their PhD degree from the University of Science and Technology, Beijing. They published a paper at Imperial College London in March 2021 concerning sheet metal forming;[181] this steel manufacturing process has military applications regarding manufacturing armoured vehicles.[182]

Imperial College London

An Imperial College London spokesperson said: "These projects are fundamental scientific research. Imperial's research is open and routinely published in leading international journals and we conduct no classified research. All partnerships and collaborations undergo thorough scrutiny and are regularly reviewed, working closely and regularly with the appropriate Government departments, and in line with our commitments to UK national security."

The AVIC Centre for Structural Design and Manufacture and the BIAM-Imperial Centre for Materials Characterisation, Processing and Modelling are both approaching their end dates and will be closing in the next couple of months.

4. University of Strathclyde and the China Academy of Launch Vehicle Technology (CALT)

The Space Mechatronic Systems Technology (SMeSTech) Laboratory

Key words: aerospace physics; drones and lithium-ion batteries.

The University of Strathclyde still maintains its SMeSTech laboratory on their website,[183] and published at least one research project undertaken in 2021. There were further non-CALT research projects since *IAC*, regarding artificial intelligence, autonomous vehicles and robotics, and UAV swarm technology,[184] confirming that the lab is still operational. The concern over CALT retaining IP ownership of research conducted at Strathclyde was raised as far back as 2013.[185]

One of the ongoing research projects being conducted at the SMeSTech lab resulted in a publication in 2022 concerning high-precision ultra-wideband (UWB) based UAVs for applications in extremely confined environments.[186] One of the researchers is currently a PhD student at SmeSTech. Prior to their PhD research into UAV technology, they were at the

[181] Deep Learning in Sheet Metal Bending With a Novel Theory-Guided Deep Neural Network | IEEE Journals & Magazine | IEEE Xplore
[182] Metal Fabrication for the Defense Industry | Stanron Steel Specialties
[183] The Space Mechatronic Systems Technology Laboratory | University of Strathclyde
[184] Research projects | University of Strathclyde
[185] Lauren, 2013.
[186] High-precision UWB based localisation for UAV in extremely confined environments — University of Strathclyde

National University of Defense Technology (NUDT), and before that North Western Polytechnic (NPU).[187]

Furthermore, collision friction research for the space domain was conducted in collaboration between a Chinese manufacturing engineer based at Strathclyde, with five Chinese-based researchers, all based either at CALT, or at members of the Seven Sons of Defence. This research project was financed by Chinese entities and Chinese research grants.[188] One of these grants was from the National Natural Science Foundation of China, which is heavily state-subsidised and promotes civil-military integration.[189]

The same Chinese engineer at Strathclyde also collaborated with six researchers from NPU (Seven Sons member and rated *Very High Risk* by ASPI) on laser additive repairing with superalloys in 2021, in a Chinese-funded project.[190] This research project was submitted for publishing in December 2020, accepted in March 2021, and published in May 2021.[191]

In a written letter to the Chair of the Foreign Affairs Select Committee dated March 2021, the Vice Chancellor of Strathclyde stated that all formal collaboration with CALT ceased in February 2017.[192] The fact that a Chinese researcher working at the (CALT-funded) SMeSTech lab at Strathclyde, collaborated with CALT and Seven Sons researchers throughout the first six months of 2021 on collision research, would suggest that there is still collaboration between the university and CALT.

[187] https://ieeexplore.ieee.org/author/37088954108
[188] Molecular Dynamics Simulation on Collision Frictional Properties of a Molybdenum Disulfide (MoS2) Film in Microgravity Environment | SpringerLink
[189] nsfc.pdf (s3-service-broker-live-19ea8b98-4d41-4cb4-be4c-d68f4963b7dd.s3.amazonaws.com)
[190] Compatibility research of laser additive repairing TA15 forgings with Ti6Al4V-xTA15 alloy | SpringerLink
[191] *Ibid.*
[192] Correspondence with the University of Strathclyde relating to Xinjiang (parliament.uk)

University of Strathclyde

"The university seeks to maintain an open international outlook while managing the recognised risks around international collaborative research.

All of our research collaborations are open and transparent and are subject to due diligence. Our research outputs are in the public domain and are published openly in leading journals and websites.

Our research is undertaken in accordance with our Research Code of Practice and its guidance on research integrity with the core elements of: honesty; rigour; transparency and open communication; and, care and respect. Any transfer of materials is subject to UK Government legislation on export control. All relationships with third parties are subject to well established policies and continued review. We remain committed to a process of continuous improvement in facilitating research endeavour and cooperation in a compliant and collaborative manner.

The University is, like other Universities, continuing to develop its processes around Trusted Research. The MOU with Peking is around collaboration in areas of management science and decarbonisation research which are not in sensitive areas, but do help us address key global challenges.

We stand by the statement made in the Strathclyde VC letter to the Chair of the Foreign Affairs Select Committee that formal collaboration with CALT ceased. The contract with CALT ended in February 2017 and CALT has no rights to prevent publication of work carried out at the University."

5. The University of Southampton and Harbin Engineering University (HEU)

Southampton Ocean Engineering Joint Institute at Harbin

Key words: shipbuilding; offshore energy; underwater engineering; marine engineering; marine equipment.

Southampton chooses not to publish much about the Joint Institute at Harbin (JEI), a joint educational institute for undergraduate students between Southampton and Harbin Engineering University (HEU),[193] one of the Seven Sons of National Defence. JEI describes itself as the first China-UK maritime school, which has placed Harbin in a 'world-class' position. JEI was launched in September 2020, and will develop the Chinese navy by offering 'undergraduate training in four undergraduate majors [including] Naval Architecture and

[193] Our international strategic partnerships | University of Southampton

Ocean Engineering', according to Harbin.[194] The program allows for much integration and collaboration between Chinese and British university staff, researchers, and students.[195]

HEU is rated *Very High Risk* by ASPI, and is a leading centre of research and training on shipbuilding, naval armaments, maritime technology and nuclear power for the PLA,[196] and the university itself became directly supervised by the PLA Navy from 2007,[197] highlighting the intrinsic relationship between HEU and the Chinese military.

Although Southampton says that there are no British students studying at the JEI, one hundred and fifty students were reportedly enrolled in September 2020, to study subjects including: naval architecture; ocean engineering; marine engineering; automation; and underwater acoustic engineering.[198] The Underwater Acoustic Engineering program is taught by personnel from the 'College of Underwater Acoustic Engineering' at HEU.[199] As part of HEU's extensive defence collaborations with the Chinese military, they maintain the National Key Laboratory of Science and Technology of Underwater Acoustic Technology, a PLA Navy-supported defence laboratory which counts amongst its staff one person of the '511 Talent Project' of the National Defense Science and Technology Industry, three people of the Chief of National Defense 973 Technology, and one person of National Defense Science.[200] This raises concerns that in fact Chinese military and Chinese military-supported scientists are teaching modules at the JEI, posing key concerns for Southampton students subjected to these modules.

In May 2021 a Chinese researcher at the JEI gave a presentation to the UK-China Joint Institutes Symposium "Evaluating the student experience at UK-China Joint Institutes",[201] firmly demonstrating that the jointly-run centre is still operational.

Further highlighting the nature of the relationship between HEU and the Chinese military, as depicted by the picture below all courses run at the JEI include three weeks of 'military training' in Semester One, and 'Military Theory' training in Semester Two. Whilst the JEI course programs state that these subjects are taught in Chinese, and delivered at HEU, it does raise significantly concerning questions concerning British students studying at the JEI or undertaking any of the JEI's courses being subjected to these alarming modules.

[194] Tylecote and Clark, 2021. p.70.
[195] About JEI (hrbeu.edu.cn)
[196] School Profile (archive.org)
[197] *Ibid.*
[198] Xiaoxiao Ren (HEU-UoS JEI) – Evaluating the Student Experience of Teaching Quality at HEU-UoS JEI - YouTube 1:14.
[199] Xiaoxiao Ren (HEU-UoS JEI) – Evaluating the Student Experience of Teaching Quality at HEU-UoS JEI - YouTube 3:44.
[200] Key Laboratory (archive.org)
[201] Schedule – Evaluating the student experience at UK-China Joint Institutes

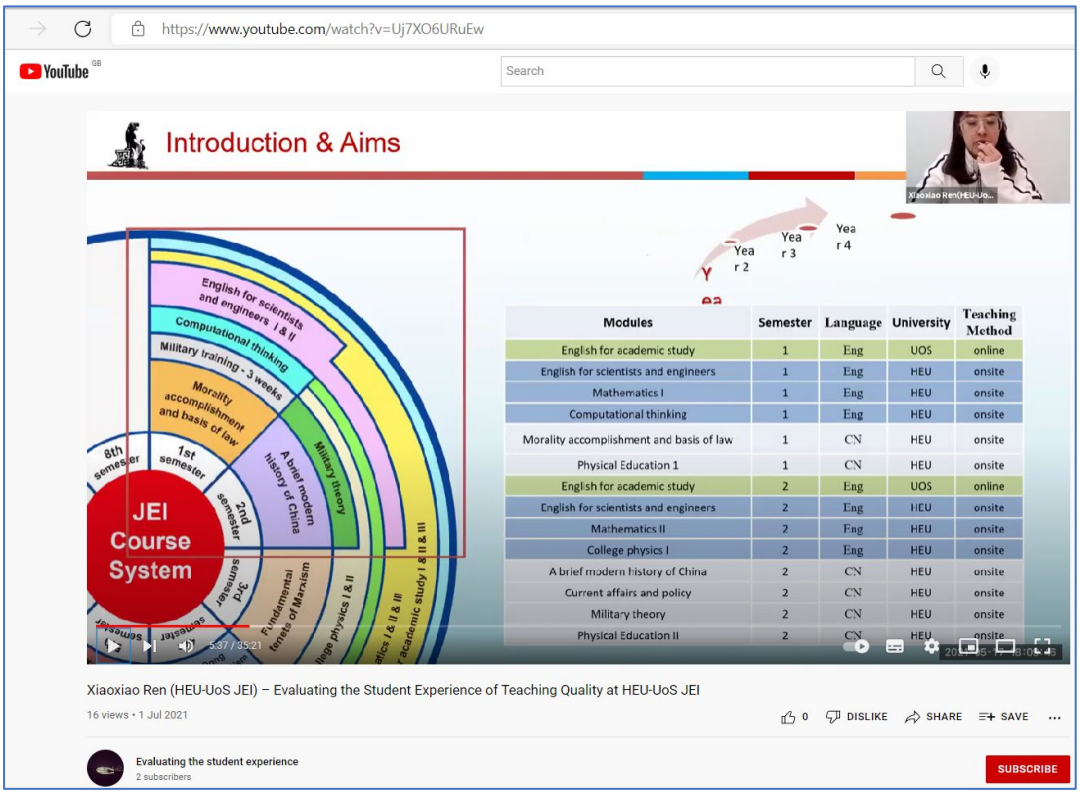

Image One: Introduction and Aims at the JEI. Copyright HEU.

In May 2022 the 2022 American College Mathematical Contest In Modelling (MCM/ICM) awarded multiple prizes to JEI students and researchers. This included for research projects in automation and underwater acoustic engineering.[202]

University of Southampton

The University of Southampton stated that; "The University of Southampton has strong governance processes in place to ensure that we comply with all relevant legislation and government guidance on these matters.

In common with most transnational education activities, worldwide, for the programme to be accredited, national governments often impose additional requirements on the programme, including courses on politics, religion or other topics deemed to be of national importance. A UK student would not need to take these modules to receive a degree accredited by the University of Southampton. There are no British students studying at the JEI, and if there were, they would not be permitted to take these modules."

[202] Southampton Ocean Engineering Joint Institute at HEU Won Prizes in the 2022 American College Mathematical Contest In Modeling (hrbeu.edu.cn)

6. Queen Mary University of London (QMUL) and Northwestern Polytechnic University (NPU)

Queen Mary University of London – NPU Joint Research Institute of Advanced Materials and Structures

Key words: Materials science; polymers.

The Queen Mary University of London (QMUL) School of Engineering and Materials Science (SEMS) still hosts the *NPU-QMUL Collaborative Partnership and Joint Research Centre*, as detailed in *IAC*.[203] The partnership includes the Queen Mary Engineering School (QMES) at NPU itself, which provides NPU students with Chinese-recognised degrees in materials science or polymers. NPU is rated *Very High Risk* by ASPI, is one of China's Seven Sons of National Defence, supplies 90% of the PLA's drones,[204] and is on the US Bureau of Industry and Security's Entity List.[205]

A Chinese Professor is a Dean of QMES; they are also its Party Branch Secretary and a guest professor of QMUL. They lead a province-level innovation team in polymers and is a national authority on space physics. Their research, which includes major national projects for aero engines and gas turbines, has been funded by the National Defense Technology Foundation for Scientific Research of China.[206] In addition they have used their academic platform to publicly emphasise socialist core values as the basis for developing personalities and moral characteristics.[207]

QMUL also hosts the *Queen Mary University of London - NPU Joint Research Institute of Advanced Materials and Structures* (JRI), with the five research centres all still fully functional,[208] having hosted a summer PhD workshop program in June 2021,[209] and again in June 2022. The five research centres hosted at the JRI are:

- **Research Centre of Advanced Ceramic Materials**
  The main research topics are design, fabrication, and properties of advanced ceramic materials, such as thermoelectric materials, piezoelectric materials, ferroelectric materials.

- **Research Centre of Nano Energy Materials**

[203] Welcome 欢迎 - QMUL School of Engineering and Materials Science
[204] Northwestern Polytechnical University – Chinese Defence Universities Tracker — ASPI
[205] United States Bureau of Industry and Security. p.159.
[206] Kong Jie-伦敦玛丽女王大学工程学院 (nwpu.edu.cn)
[207] Party Secretary Kong Jie of QMES Party Branch, Gave A Lecture in the Theme of "Remain True to Our Original Aspiration and Keep Our Mission Firmly in Mind"-伦敦玛丽女王大学工程学院 (nwpu.edu.cn)
[208] Research 科学研究: QMUL School of Engineering and Materials Science
[209] QMUL-NPU JRI PhD Summer School and Workshop 2021: QMUL School of Engineering and Materials Science

The main research topics are high-energy-density battery, supercapacitor, electroanalysis and photocatalysis nano-energy materials.

- **Research Centre of the Functional Polymers & Composites**
  The main research topics are electronic, magnetic, functional polymers and composites, advanced polymer composites, polymer synthesis and processing, sustainable and recycled materials and soft materials.

- **Research Centre of Biomaterials and Engineering**
  The main research topics are biomaterials, drug release and bioengineering.

- **Research Centre of Material Structure Design and Optimization**
  The main research topics are structure design and optimization methodology, composites structure design, and smart materials and structural design.

The 2021 PhD summer workshops were led by a Professor at QMUL SEMS,[210] who since *IAC* has co-authored 6 separate research papers, in collaboration with at least five separate PLA-linked universities, and with 22 separate Chinese academics based at these institutions.[211] These include a paper co-authored with five Chinese researchers investigating carbide compounds and ceramics, and funded in part by the National Natural Science Foundation of China (NSFC).[212] The NSFC promotes civil-military integration,[213] and is directly subservient to the Chinese Communist Party's Central Committee.[214]

The 2022 workshop for NPU PhD students hosted at QMUL included the following topics: High Entropy Ceramics and Alloys; Structural and Multidisciplinary Optimisation; Advanced Biomaterials and Theranostic Application; Smart Materials and 3D-Printing; Genomics and Genome Editing.[215]

[210] High Entropy Ceramics: QMUL School of Engineering and Materials Science
[211] Staff: Publications: Prof Michael Reece: QMUL School of Engineering and Materials Science
[212] Densifying (Hf0.2Zr0.2Ta0.2Nb0.2Ti0.2)C high-entropy ceramics by two-step pressureless sintering (wiley.com)
[213] nsfc.pdf (s3-service-broker-live-19ea8b98-4d41-4cb4-be4c-d68f4963b7dd.s3.amazonaws.com)
[214] osr-Senate-HSGAC-Subcommittee-Full-Report.pdf (unc.edu) p.22.
[215] QMUL-NPU JRI PhD Summer School and Workshop 2022 - QMUL School of Engineering and Materials Science

High entropy alloys have been identified for military applications, due to the increased strength and durability of the materials,[216] whilst China have been known to develop genome editing (also called gene editing) since at least 2016 to harness military capabilities. A Chinese paper described how genome editing was one of 'three primary technologies that might boost troops' combat effectiveness'.[217] China's application of genome editing for military applications has been heavily researched by scholars,[218] and substantiated by John Ratcliffe, former US Director of National Intelligence, in 2020 when still in post.[219]

Queen Mary University of London

A Queen Mary University of London spokesperson said that "All Queen Mary's partnership agreements are constructed in full alignment with UK government legislation and subject to rigorous procedures regarding security, ethics and other relevant policies. Our transnational educational partnership with Northwestern Polytechnical University is no exception."

[216] Characterization and Testing of High-Entropy Alloys from AlCrFeCoNi System for Military Applications | IntechOpen
[217] Is CRISPR in use to Create China Super Soldiers? | BioSpace
[218] China's Military Biotech Frontier: CRISPR, Military-Civil Fusion, and the New Revolution in Military Affairs - Jamestown
[219] China Is National Security Threat No. 1 - WSJ

Chapter Three: Additional Sino-British dual-use research collaborations

In addition to the six UK university centres discussed in Chapter Two which still actively maintain joint research programs with high risk Chinese military related organisations and institutions, there remain a further six universities (and eight partnerships) as identified in *IAC*, which still maintain close working research collaboration relationships with high risk Chinese defence-related entities.

Some of these relationships are still maintained through the official institution collaborations as per Chapter Two, but on an individual level. In some places, the official organisational collaborations, such as through the jointly funded laboratories, no new evidence could be obtained since *IAC* to indicate that those formal intra-institutional collaborations and laboratories were still operational. In instances where there has been no apparent research collaborations, events, or updates, since *IAC* was published, then those centres have been declared 'non-operational'. However, quite often, individuals from those same centres have produced co-authored research with individuals from the original partnered organisation, which suggests that there is still a strong and defined research link maintained in these instances.

Those research projects, collaborations, and links, have been catalogued and recorded in this chapter, in addition to any further examples of UK university collaborations not directly linked to the original centres or that centres' research, but which include potential dual-use research with high risk military linked entities. Thus this chapter further highlights specific cases of these potential dual-use research links still able to continue producing research which the UK universities have little to zero control over where the IP ends up – bearing in mind that their partnered Chinese entities have all subscribed to the CCP strategy of civil-military fusion.

What follows below is not an exhaustive list of these ongoing collaborations, due to the nature of the data collection (detailed in the Methodology section above), but rather a representative sample of the nature of these relationships, and how, given their potential (and often desired) military-applications, they are not in the UK's national interests to continue.

UK universities and their original Chinese military-linked partnerships which still maintain their research links and collaborations, as identified in IAC

1. University of Cambridge and National University of Defense Technology (NUDT)

Key words: Granular environment; theoretical physics; robotics; genome sequencing.

The Memorandum of Understanding (MOU) first identified in *IAC* between Cambridge and the NUDT expired in 2018. Whilst not providing any direct means of joint projects with NUDT, the MOU did however create the conditions for broader collaboration with visiting

academics from NUDT, as identified in *IAC.* Subsequent research has since identified links between the University of Cambridge and a visiting researcher at the Cavendish Laboratory.

In March 2021 a Cambridge Bye-Fellow in theoretical physics published a paper with four NUDT researchers, funded by the NUDT, looking at granular environments and robotics.[220] This work has a military application as research looks into granular objects being able to thwart missiles.[221] This individual has been at Cambridge since 1990, whilst not in full-time employment has been involved teaching undergraduates.[222] Between 2014-18 they were also at NUDT whilst still with Cambridge.[223] The Bye-Fellow has described themselves on their webpage 'nominated a High Level Foreign Talent' in China, and is listed as a Distinguished Visiting Professor in Hunan Central South University.[224]

Additional dual-use technology research developed between the University of Cambridge and Chinese military-linked entities since *IAC*

The Cavendish Laboratory lists a Visiting Researcher from 2018 – present on their website,[225] though the university stated that this expired some time in 2021, and to yet be updated. This individual is also listed on the Cavendish Laboratory website as a Principal Investigator (tenure-track professor), at the College of Optical Science and Engineering, Zhejiang University (ZJU), China. ZJU is designated by ASPI as a high risk for its high number of defence laboratories, relationship with defence industry, and links to economic and cyber espionage.[226] Their research at Cambridge is listed as: light-emitting diodes; photovoltaic solar cells; semiconductor device physics; excitonic and quantum-confined systems; spectroscopy; perovskite and organic semiconductors.[227] Many of these have military applications. For instance, photovoltaic cells are the US Department of Defense's choice of power for powering remote military bases.[228]

Despite this individual being listed at Cavendish Laboratory from 2018-2021, the University of Cambridge wrote in their 'right of reply' to *Inadvertently Arming China;* "The Cavendish Laboratory does not have, nor has ever had, any projects, research grants or contracts with NUDT or other military institutions in China". Whilst this may well be correct, it appears that the University allowed a partnership with at least one researcher from a Chinese university with extensive links to the PLA and highly secret defence research. The researcher was seemingly allowed to conduct research at Cambridge which, according to the researcher's own portfolio listed on Cambridge's website, has extensive military applications.

[220] Locomotion of Self-Excited Vibrating and Rotating Objects in Granular Environments-Web of Science Core Collection
[221] Granular Materials Could Thwart Missiles - Scientific American
[222] From University of Cambridge right to reply.
[223] Blumenfeld, Raphael - Web of Science Core Collection
[224] Rafi and statistical physics: A never-ending story (blumenfeld.co.uk)
[225] Dr Dawei Di | Optoelectronics (cam.ac.uk)
[226] Zhejiang University – Chinese Defence Universities Tracker — ASPI
[227] Dr Dawei Di | Optoelectronics (cam.ac.uk)
[228] Lightening Soldiers' Loads by Lifting PV Cells onto Flexible Surfaces | News | NREL

The above case, alongside Zhejiang University's apparent links with the University of Cambridge from 2018, highlights how 2021's strengthening of ATAS did not go far enough. An annual reapplication and renewal for instance would allow further due diligence into cases where there may be previously unknown and harmful collaborations which are allowed to continue, and are fundamentally detrimental to national security.

In 2019 University of Cambridge hosted a computer science and communications research paper at a conference, from a Chinese-based research team, including a member from NUDT.[229]

In November 2021 a paper researching genome sequencing by three researchers at Cambridge was conducted with three researchers from Harbin Institute of Technology. One of these individuals is listed at both institutions.[230]

In December 2021 a research project involving a then-Chinese postdoctoral research associate at Cambridge, previously at NUAA,[231] published Chinese-funded research (including from the Chinese government) regarding Lithium-Ion batteries and Thermodynamic technology, in collaboration with six researchers from BUAA.[232]

In May 2022, a machine intelligence and information engineering PhD student in the Department of Engineering[233] published a research paper on advanced satellite attitude manoeuvres.[234] Prior to starting their PhD they were based at BU, where they are dual-listed. This technology is being used in agile Earth observation satellite (AEOS). Highlighting the CCP's civil-military fusion, and the role that deception plays as part of this official strategy, in May 2021 CASC launched a Yaogan 34 earth observation satellite into space. This was to conduct in the words of China's state-run Xinhua news agency said technology which will be used for "the survey of land resources, urban planning, the confirmation of land rights, road network design, crop yield estimation, and disaster prevention and reduction."[235] However, the PRC uses the Yaogan name as a cover for military spy satellites; in the official post-launch statement, CASC in fact confirmed that the Yaogan 34 satellite will provide support 'for the implementation of major national strategies and the modernization of national defense.'[236]

[229] TabTree: A TSS-assisted Bit-selecting Tree Scheme for Packet Classification with Balanced Rule Mapping-Web of Science Core Collection
[230] Efficient iterative Hi-C scaffolder based on N-best neighbors-Web of Science Core Collection
[231] Lu, Ziheng - Web of Science Core Collection
[232] Identifying Hidden Li-Si-O Phases for Lithium-Ion Batteries via First-Principle Thermodynamic Calculations-Web of Science Core Collection
[233] Huijiang Wang | Department of Engineering (cam.ac.uk)
[234] A versatile method for target area coverage analysis with arbitrary satellite attitude maneuver paths-Web of Science Core Collection
[235] China launches military observation satellite – Spaceflight Now
[236] *Ibid.*

University of Cambridge

It is noted in the University of Cambridge's replies that they highlight their work managing risks in international engagement. It is further noted that part of the universities strategy for doing so involves: 'Protect the open flow of ideas, data and other forms of intellectual property – including a duty to protect it against wrongful exploitation or interference'.

Regarding the December 2021 Lithium-Ion battery research project, the University of Cambridge stated that the Chinese postdoctoral research associate is no longer at Cambridge at the time of writing (September 2022), and that the research for this project was not conducted at Cambridge, and that the paper was published after they had left. The paper was first published in December 2021, whilst the individual is listed at Cambridge into 2022 on Web of Science.

2. University of Manchester and the China Aerospace Science and Technology Corporation (CASC)

Key words: optical communications; aerospace physics; gas turbines; semiconductors; graphene.

Chinese individuals related to the original research output at the *Sino-British Joint Advanced Laboratory on Control System Technology* are still at the University's department, and collaborating with Chinese entities on ongoing related research, in addition to further collaboration between Manchester and CASC. The university stated in their right to reply in *IAC* that agreements with CASC were terminated in 2018.

However, as soon as 2019 there was a joint wireless and optical communications networks research project between a Chinese researcher at Manchester's Department of Electrical and Electronic Engineering, with three researchers from NPU.[237] CASC were one of the main funders for this research.[238] In 2021, this project, with further funds from CASC, generated further research with NPU staff.[239] The Chinese researcher at Manchester is also at the Hunan Institute of Traffic Engineering,[240] which states on its website that it is "deeply integrated" into China's military-civil fusion strategy.[241] All three of the NPU researchers on this project have worked on UAV networks and communication systems research at highly

[237] Latency Optimization for Multi-user NOMA-MEC Offloading Using Reinforcement Learning-Web of Science Core Collection
[238] *Ibid.*
[239] Resource Allocation for NOMA-MEC Systems in Ultra-Dense Networks: A Learning Aided Mean-Field Game Approach-Web of Science Core Collection
[240] Ding, Zhiguo - Web of Science Core Collection [last accessed 4 October 2022]
[241] Hunan Institute of Traffic Engineering | Higher Ed Jobs (isacteach.com)

sensitive military-linked entities, with one currently based at the Academy of Military Medical Sciences; a PLA medical research institution.[242] [243] [244]

The Chinese director of the joint lab with CASC[245] is still at Manchester's Department of Electrical and Electronic Engineering.[246] Whilst it appears that the lab itself may be closed (as the university itself stated it had done so in 2018 in its right to reply for *IAC*), recent research collaboration at the department between a Chinese PhD student and various Chinese entities, under the direction of the Chinese former director of the jointly run CASC lab, has continued.

The PhD student is at the department from Wuhan University of Technology (rated *High Risk* from ASPI due to its high level of defence research, particularly with the PLA Air Force[247]), and as recently as March 2022 published a paper researching autonomous vehicles with two other Chinese researchers at Chinese universities (both with defence ties[248]), on a project entirely funded by the same defence-linked universities and Chinese research grants.[249]

3. University of Manchester and the Beijing Institute for Aeronautical Materials (BIAM)

Key words*:* Graphene; alloys; aerospace; off-shore turbines.

The *BIAM-University of Manchester Graphene Aerospace Materials Centre*, and the *BIAM-University of Manchester Technology Centre* both appear no longer operational. However, much collaboration has remained between Manchester and BIAM.

In their right to reply for *IAC*, the University of Manchester stated that agreements with BIAM had been terminated in 2020. However, having only produced one joint research paper in 2020, Manchester and BIAM collaborated on 4 separate papers in 2021, and at least one in 2022, regarding silane-functionalized graphene nanoplatelets research. This collaborative project from 2022 was funded by BIAM, involved four BIAM researchers from China, and conducted at Manchester.[250]

[242] Li, Lixin - Web of Science Core Collection [last accessed 4 October 2022]
[243] Cheng, Qianqian - Web of Science Core Collection [last accessed 4 October 2022]
[244] Tang, Xiao - Web of Science Core Collection [last accessed 4 October 2022]
[245] Tylecote and Clark, 2021. p.54.
[246] Prof Zhengtao Ding | The University of Manchester
[247] Wuhan University of Technology – Chinese Defence Universities Tracker — ASPI
[248] Northeastern University – Chinese Defence Universities Tracker — ASPI South China University of Technology – Chinese Defence Universities Tracker — ASPI
[249] Scopus preview - Scopus - Document details - Velocity-Based Path Following Control for Autonomous Vehicles to Avoid Exceeding Road Friction Limits Using Sliding Mode Method
[250] Silane-functionalized graphene nanoplatelets for silicone rubber nanocomposites | SpringerLink

Three of the four research projects in 2021 were also funded by BIAM, one of which involved researchers from BIAM[251] and one from COMAC,[252] and took place at Manchester. A fourth had a researcher involved from AVIC.[253]

Manchester stated in their right to reply in *IAC* that agreements between CASC and BIAM were ended in 2018, and 2020, respectively. However, with five jointly funded and researched projects with BIAM since then, including one funded by BIAM published only in 2022, there appears to be growing collaboration between the University of Manchester and BIAM.

Additional dual-use technology research developed between the University of Manchester and Chinese military-linked entities since *IAC*

Whilst the University of Manchester's website claims that the Sino-British Joint Laboratory on Advanced Control Systems Technology closed in 2018,[254] its director, a Chinese Professor, is currently listed at the University's Department of Electrical and Electronic Engineering, as a Professor of Control Systems.[255] Under the University's website, the Professor is still accepting PhD candidates,[256] and has had research at the University published as recently as December 2021. This research, conducted at Manchester, involved artificial intelligence and autonomous vehicle swarm technology.[257] This project was supported by the Engineering and Physical Sciences Research Council.[258]

In addition, they published a volume in May 2021 with three other researchers; two of whom work at the BIT (one of the Seven Sons of Defence and rated as *Very High Risk* by ASPI).[259] The work concerns trajectory tracking for both aerial objects including UAV drone swarms, and for ground-based vehicles. This work certainly has a potential military application, and despite being published in the open domain, was still conducted in collaboration with entirely exclusive PLA-linked universities.

[251] Interfacial energy dissipation in bio-inspired graphene nanocomposites - ScienceDirect
[252] Heat-treatment induced microstructural evolution and enhanced mechanical property of selective laser melted near β Ti-5Al-5Mo-5 V-3Cr-1Zr alloy - ScienceDirect
[253] Aerospace | Free Full-Text | Towards a Circular Economy in the Aviation Sector Using Eco-Composites for Interior and Secondary Structures. Results and Recommendations from the EU/China Project ECO-COMPASS (mdpi.com)
[254] Sino-British Joint Laboratory on Advanced Control Systems Technology | The University of Manchester | University of Manchester Aerospace Research Institute (archive.org)
[255] Prof Zhengtao Ding - Contact details | The University of Manchester
[256] Prof Zhengtao Ding - Opportunities | The University of Manchester
[257] Songtao_ICAR.pdf (manchester.ac.uk)
[258] *Ibid.* p.7.
[259] Robust Cooperative Control of Multi-Agent Systems | A Prediction and O (taylorfrancis.com)

The University of Manchester stated in its 'right to reply' for *Inadvertently Arming China* that the website listing a Chinese Professor is out of date, and would be updated to reflect this.[260] No updates have since occurred, and in fact their recent research conducted throughout 2021 and 2022 would certainly suggest otherwise.

This Chinese professor is listed on the University of Manchester's Department of Materials as a Professor of Corrosion Science and Engineering.[261] Prior to this they were a research engineer at BIAM, and before that a graduate of Hunan University, a top nuclear weapons research intuition with extensive ties to the PLA.[262] They are listed on the Scopus website (an online academic citation and reference database) as still working at the University of Manchester, and has published many works while still there, including several in 2022.[263]

A further Chinese professor, who received his BEng in Telecommunication Engineering from Nanjing University, is listed as a Professor at both Department of Electrical and Electronic Engineering, and the National Graphene Centre (NGC).[264] Their recent research interests are in graphene/2D materials for RF, mmWave and THz communications and sensing applications, wearable electronics, RF, mmwave and Thz device, circuit and antenna design, realisation and characterisation. They have published more than 250 peer reviewed journal and conference papers, including research conducted throughout 2021.[265]

Also in Manchester's 'right to reply' from *IAC*, the University states that all collaboration between Manchester and BIAM ended in 2020.[266] However, as of February 2022, one year later, a professor of Materials Science is still listed on the University's website as currently holding the Rolls-Royce/Royal Academy of Engineering Research Chair in Advanced Coating Technology, at Manchester.[267] Their research includes thermal barrier and environmental barrier coatings for aeroengine applications, and ceramic coatings for nuclear applications.

This individual was listed as heading the BIAM-University of Manchester Graphene Aerospace Materials Centre, due to have been closed in 2020. They are still at Manchester, having recently published several graphene-based research papers, including one in December 2021 researching improved thermal conductivity of graphite and improved thermal conductivity and graphite wear resistance.[268]

This individual also heads the Ceramic Coating Research Group, a research group funded by both the Engineering and Physical Sciences Research Council, and by BIAM.[269] This group

[260] Tylecote and Clark, 2021. p.57.
[261] Prof Xiaorong Zhou | The University of Manchester (archive.org)
[262] Hunan University – Chinese Defence Universities Tracker — ASPI
[263] Scopus preview - Zhou, Xiaorong - Author details - Scopus
[264] Prof Zhirun Hu | The University of Manchester
[265] Prof Zhirun Hu - Publications | The University of Manchester
[266] Tylecote and Clark, 2021. p.57.
[267] Prof Ping Xiao | The University of Manchester
[268] Improved thermal conductivity of graphite though infiltration with SiC and Si3N4 inclusions | Research Explorer | The University of Manchester

[269] Prof Ping Xiao - Research interests | The University of Manchester

has developed both chemical vapour deposition and electrophoretic deposition to produce ceramic coatings for applications in aeroengines and nuclear reactors. The materials that have been studied covers Lanthium Zirconate, Yttria Stablized Zirconia and metallic coatings as thermal barrier coatings, SiC and carbon coatings for containment of nuclear fuels, and graphene for electrochemical and mechanical applications.[270]

That the professor of materials science is still chair of the Ceramic Coating Research Group, which is part-funded by BIAM, would suggest that in fact Manchester still maintains some form of direct collaboration with BIAM one year on.

A further professor, formerly of Nanjing University, is listed at the Department of Electrical and Electronic Engineering, in addition to the National Graphene Institute.[271] They have published research at Manchester throughout 2021, including papers on semiconductors and graphene.[272]

There is a further Chinese academic at Manchester's Department of Electrical and Electronic Engineering, specialising in machine learning and aerospace systems,[273] who comes from the Harbin Institute of Technology[274] (one of the Seven Sons of Defence, and rated *Very High Risk* by ASPI for its extremely close relationship with the Chinese military[275]). In 2021 this individual collaborated with four members of Beijing Jiao Tong University (itself involved in Chinese military research projects since 2005, and obtaining secret-level security credentials allowing it to participate in classified military research projects since 2007[276]) on a project researching turbines, which was funded entirely by a Chinese research grant.[277]

A paper in 2021 researching offshore wind turbines was in collaboration with a Chinese researcher dual-listed at both the University of Surrey and at the HIT.[278]

University of Manchester

A University of Manchester spokesperson said: "The University gives careful consideration to its research collaborations and follows all government legislation and guidance."

4. University of Southampton and Wuhan University of Technology (WUT)

The High Performance Ship Technology Joint Center

[270] *Ibid.*
[271] Prof Zhirun Hu | The University of Manchester
[272] Prof Zhirun Hu - Publications | The University of Manchester
[273] Dr Long Zhang | The University of Manchester
[274] Long Zhang - IEEE Xplore Author Profile
[275] Harbin Institute of Technology – Chinese Defence Universities Tracker — ASPI
[276] Beijing Jiaotong University – Chinese Defence Universities Tracker — ASPI
[277] Entropy | Free Full-Text | Misalignment Fault Diagnosis for Wind Turbines Based on Information Fusion | HTML (mdpi.com)
[278] JMSE | Free Full-Text | Physical Modelling of Offshore Wind Turbine Foundations for TRL (Technology Readiness Level) Studies | HTML (mdpi.com)

Key words: Shipbuilding

Whilst the 'High Performance Ship Technology Joint Center' in collaboration with WUT (rated *High Risk* by ASPI[279]) is no longer operational according to the University of Southampton's right to reply to this report, there remains much research collaboration still between academics at both institutions.

An academic listed on Southampton's website at the High Performance Ship Technology Joint Center has published marine research extensively in collaboration with Chinese academics and researchers based at PLA-linked universities. The most recent co-published research was in June 2021, with three co-authors at WUT who all are listed on the High Performance Ship Technology Joint Centre at WUT investigating machine learning to help predict ship resistance.[280]

Joint marine technology research has also been conducted by this individual at Southampton with a Chinese researcher based at Shenzhen University (rated *Medium Risk* by ASPI for its target recognition research conducted for the PLA)[281] since 1996, and has included 35 pieces of published joint research.[282]

WUT is directly supervised by SASTIND, which approved ship design and manufacturing as one of the university's six core disciplines,[283] in addition to military-use materials.[284] WUT's website claims to align with:

> "*national needs in terms of state major strategies*, with widening of knowledge as the basis, technological innovation as the focus, and *application of research findings* as the breakthroughs, *WUT has made great contributions to China's national defense development*"[285] (author's italics).

Furthermore, one of WUT's main objectives is researching "new materials and smart shipping serving Strategy of Maritime Power".[286] A core component of China's Strategy of Maritime Power is the ability to advance Chinese rights and interests, in both near and distant seas.[287] China's aggressive maritime behaviour can readily be witnessed across the South China Sea and the Straits of Taiwan, as it seeks to dominate its neighbours for control over the globally strategic waterways.

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[279] Wuhan University of Technology – Chinese Defence Universities Tracker — ASPI
[280] WHUT-UoS High Performance Ship Technology Joint Centre / University of Southampton (UoS) | SPE
[281] Shenzhen University – Chinese Defence Universities Tracker — ASPI
[282] Professor Geraint Price | Engineering | University of Southampton
[283] welcome to the school of transportation, wuhan university of technology (archive.org)
[284] welcome to the school of science of wuhan university of technology (archive.org)
[285] Wuhan University of Technology (whut.edu.cn)
[286] *Ibid.*
[287] China's Maritime Strategy | Indo-Pacific Defense Forum (ipdefenseforum.com)

5. University of Strathclyde and the China–Scotland Signal Image Processing Research Institute (SIPRA)

Key words: signal imagery; artificial intelligence.

There is no new evidence to suggest that the SIPRA is still operational, despite its website remaining live, the last recorded activity was from 2018. However, potential dual-use research collaborations between the university and Chinese defence entities from SIPRA remain.

SIPRA is a jointly funded and administrated Chinese-Scottish research entity, developing research techniques and leveraging combined expertise to further develop the field of signal imagery and processing. As an example of the types of joint research undertaken between the Chinese and Scottish partners, a workshop in 2013 (hosted by the University of Stirling, under the current SIPRA Scottish coordinator now based at Strathclyde) included such sessions as: 'Visual Computing for Enhanced Security' given by a Chinese scientist from the National Laboratory of Pattern Recognition (NLPR, see below); 'A Novel Method for Group Target Tracking' given by a Chinese scientist from Beihang University (one of China's Seven Sons of Defence); and 'Improved Sparce Representation for Effective Target Detection in Hyperspectral Imaging', given by a Chinese scientist based at Strathclyde.[288]

Of the ten official Chinese partners in SIPRA, three are rated *High Risk* by ASPI, whilst a further two are rated *Very High Risk*, including the University of Electronic Science and Technology of China (UESTC).[289] UESTC has very high levels of defence research, with as much as 32% of its research budget prioritised for defence,[290] links to AI companies with potential human rights abuses in Xinjiang,[291] inclusion on the US Government Entity List,[292] and relationships with China's nuclear weapons program.[293] Signal and information processing is cited as a key university defence discipline.[294]

Furthermore, one of SIPRA's other official Chinese partners is the National Laboratory of Pattern Recognition (NLPR). This state-controlled lab is part of the Chinese Academy of Sciences Institute of Automation (CASIA), China's main research institution on artificial intelligence, biometrics, and neuroscience.[295]

While some of CASIA's commercial partners undertake projects which advance scientific knowledge in areas including medicine, they also partner with Chinese police and security

[288] SIPRA-Workshop-Stirling-11-12-April-2013-final-programme
[289] Partners – CHINA – China-Scotland Signal Image Processing Research Academy (china-scotland-sipra.org)
[290] University of Electronic Science and Technology of China Chengdian News Network (archive.org)
[291] The company with Aussie roots that's helping build China's surveillance state | The Strategist (aspistrategist.org.au)
[292] Federal Register :: Addition of Certain Persons to the Entity List; Removal of Person From the Entity List Based on Removal Request; and Implementation of Entity List Annual Review Changes
[293] *Ibid.*
[294] University of Electronic Science and Technology of China – Chinese Defence Universities Tracker — ASPI
[295] stoff-tiffert_eyeswideopen_web_revised.pdf (hoover.org)

services on mass surveillance technologies, which are currently being used to conduct China's genocide against the Uyghur population in Xinjiang.[296]

Accordingly, a report by the Hoover Institution in 2021 recommended that the US Department of Commerce should place CASIA and the NLFR on the Entity List for export controls, in addition to ensuring that academic and private sector organisations review their partnerships with CASIA and its affiliates for risks to human rights.[297]

An additional Chinese partner of SIPRA is Jiangnan University. In 2021 the Scottish lead coordinator for SIPRA published Generative Adversarial Network (GAN) research with two Chinese scientists from Jiangnan.[298] GAN technology has military applications, particularly in ground-based target recognition, and has recently been researched extensively by the Chinese military, including by the PLA's Space Engineering University, and by the PLA's Army Engineering University.[299] This work follows previous Chinese-funded research conducted by SIPRA's lead Scottish coordinator based at Strathclyde, and Chinese scientists at Jiangnan the year before.[300]

The same professor at Strathclyde was awarded a three-year grant in 2017 under the 'Foreign Experts' and 'Thousand Talent' program by the Chinese government to collaborate with Tianjin Normal University, which maintains extensive links to the PLA – citing the Chinese military as the university's ninth largest domestic research collaborator.[301]

Additional dual-use technology research developed between the University of Strathclyde and Chinese military-linked entities since *IAC*

During written evidence to the chair of the Foreign Affairs Select Committee, the University of Strathclyde's Vice-Chancellor stated in March 2021 that formal collaboration between CALT and the university ended by February 2017.[302] Furthermore, in the university's right to reply for *IAC*, it was recorded that research collaboration was for agricultural projects.

However, as recently as August 2021, collision friction research for the space domain was conducted in collaboration between a Chinese manufacturing engineer based at Strathclyde, with five Chinese-based researchers, all based either at CALT, or at members of the Seven Sons of Defence. This research project was financed by Chinese entities and Chinese research grants.[303] One of these grants was from the National Natural Science Foundation of China, which is heavily state-subsidised and promotes civil-military

[296] Baker-Beall and Clark, 2021.
[297] *Ibid.* p.1.
[298] Image fusion based on generative adversarial network consistent with perception-Web of Science Core Collection
[299] Visual-simulation region proposal and generative adversarial network based ground military target recognition - ScienceDirect
[300] NestFuse: An Infrared and Visible Image Fusion Architecture Based on Nest Connection and Spatial/Channel Attention Models-Web of Science Core Collection
[301] Tianjin Normal University (TJNU) | Institution outputs | Nature Index
[302] Correspondence with the University of Strathclyde relating to Xinjiang (parliament.uk)
[303] Molecular Dynamics Simulation on Collision Frictional Properties of a Molybdenum Disulfide (MoS2) Film in Microgravity Environment | SpringerLink

integration.[304] The main research focus' of the Chinese researcher based at Strathclyde include space-based laser technology and 3-D printing.[305]

In addition, this individual was listed at Xi'an University of Technology in 2020, whilst also at Strathclyde.[306] In 2021 the individual collaborated with six Chinese researchers at NPU on a research project concerning laser additive repairing,[307] technology which is actively being incorporated into the Chinese military-industrial complex.[308]

In January 2022, a Chinese Visiting Professor still listed at both Strathclyde and Shanghai Jiao Tong University (SJTU) was involved in a Chinese-funded project researching advanced Gaussian laser pulses.[309] The project was part-funded by the NUDT, as well as having seven NUDT scientists amongst the research team. Gaussian laser technology has military laser applications, particularly amongst vehicle-mounted laser warning devices.[310]

In March 2022, a Memorandum of Understanding was signed between the University of Strathclyde and Peking University, to allow further student exchange and greater collaboration with management science and decarbonisation programs.[311] Peking is rated *High Risk* by ASPI for its links to China's nuclear weapons program.[312]

Furthermore in March 2022, the university's China-Scotland Signal Image Processing Research Academy (SIPRA) coordinator published a Chinese-funded research project regarding convolutional neural networks, a class of artificial neural network most commonly applied to analyse advanced visual imagery. This field has been researched for military applications since at least 2018.[313] [314] The research team included three Chinese scientists from Nanjing University of Aeronautics and Astronautics,[315] one of China's Seven Sons of Defence.

Strathclyde's' SIPRA coordinator appears to be the lead coordinator for all of Scotland's activities with its Chinese partners.[316] Despite listing his many professional honours,[317] Strathclyde fails to list on their SIPRA website his election in 2021 as a Foreign Member of the Chinese Academy of Sciences.[318] This award demonstrates the professor's long-term collaboration with Chinese entities. This includes the last six of the professor's published research papers exclusively being with Chinese academics and scientists, all six papers

[304] nsfc.pdf (s3-service-broker-live-19ea8b98-4d41-4cb4-be4c-d68f4963b7dd.s3.amazonaws.com)
[305] Quanren Zeng – Fingerprint — University of Strathclyde
[306] Zeng, Quanren - Web of Science Core Collection [last accessed 4 October 2022]
[307] Compatibility research of laser additive repairing TA15 forgings with Ti6Al4V-xTA15 alloy | SpringerLink
[308] Microsoft Word - 6JN6VNCSZL (iop.org)
[309] All-optical quasi-monoenergetic GeV positron bunch generation by twisted laser fields-Web of Science Core Collection
[310] Military Laser Technology For Defense.pdf (idu.ac.id) p.29.
[311] Strathclyde signs Memorandum of Understanding with Peking University | University of Strathclyde
[312] Peking University – Chinese Defence Universities Tracker — ASPI
[313] Military Surveillance with Deep Convolutional Neural Network | IEEE Conference Publication | IEEE Xplore
[314] A Fast Military Object Recognition using Extreme Learning Approach on CNN (thesai.org)
[315] A Spectral-Spatial Feature Extraction Method With Polydirectional CNN for Multispectral Image Compression | IEEE Journals & Magazine | IEEE Xplore
[316] China-Scotland Signal Image Processing Research Academy – 中国-苏格兰信号图像处理研究院 (china-scotland-sipra.org)
[317] Professor Tariq S DurraniUniversity of Strathclyde – China-Scotland Signal Image Processing Research Academy (china-scotland-sipra.org)
[318] Strathclyde engineering professor first in Scotland to receive Chinese honour | University of Strathclyde

involving potential dual-use technology.[319] A collaboration which, as recently as March 2022, has resulted in joint research of a dual-use nature undertaken with Chinese scientists at one of China's national defence institutions.

In August 2022 SIPRA's Scottish lead coordinator based at Strathclyde published Chinese-funded research with three Chinese scientists regarding Person Re-Identification, a mass-surveillance method.[320] It has been comprehensively established that China is using mass-surveillance techniques and artificial intelligence to discriminate against the Uyghur population in Xinjiang.[321]

In 2021 SIPRA's Scottish lead coordinator based at Strathclyde published a Chinese-funded communications project with two Chinese scientists from Harbin Institute of Technology, one of China's Seven Sons of Defence.[322] [323] A further Chinese research partner on this project is currently at the PLA Military Science Academy – China's leading military research centre – and before that at the Air Force Military Medical University (whilst on this research project).[324]

In 2021 a further research paper was produced examining 6G satellite communications data, with a Chinese scientist who had recently worked at both HIT and NUAA, two of China's Seven Sons of National Defence.[325]

6. University of Nottingham and the Commercial Aircraft Engine Company (ACAE)

Key words: 3-D printing.

The *University of Nottingham University Innovation Centre* (UIC) is sponsored by ACAE, a subsidiary of AVIC. The lab in Nottingham appears to have ended official collaboration with ACAE in-line with the university's assertion that it ended all research with the company in 2017.

However, despite formally ending the relationship between AVIC and the university in 2017, Nottingham still maintains extensive research collaborations and relationships with AVIC, both Chinese-funded research and with AVIC researchers, occurring at the UK and Ningbo campuses. Since *IAC* was published, there have been at least 12 collaborative research papers published between ACAE and AVIC and Nottingham researchers.

In 2022, a Chinese funded research project developing 3-D printing and polymer composites was conducted between a Chinese researcher at AVIC, and three academics at the

[319] Tariq Durrani – Research output — University of Strathclyde
[320] Integration graph attention network and multi-centre constrained loss for cross-modality person re-identification - He - IET Computer Vision - Wiley Online Library
[321] One Month, 500,000 Face Scans: How China Is Using A.I. to Profile a Minority - The New York Times (nytimes.com)
[322] Simultaneous Wireless Information and Power Transfer Based on Time-Frequency Block Allocation in OFDM Cooperative Communication System-Web of Science Core Collection
[323] Li, Feng - Web of Science Core Collection [last accessed 4 October 2022]
[324] Liu, Xueying - Web of Science Core Collection [last accessed 4 October 2022]
[325] Liu, Xin - Web of Science Core Collection [last accessed 4 October 2022]

University of Nottingham.[326] One of the authors is dual-listed at both the University of Nottingham and at the BIT,[327] one of the Seven Sons of Defence and rated as *Very High Risk* by ASPI for its extensive links to the PLA.[328] BIT was added to the US entity list in 2020 for supplying US-made items for the PLA.[329] Prior to Nottingham they were at BUAA.

In 2021 another example illustrates joint project researching 3-D printing for breathing materials was conducted between several researchers at the University of Nottingham's Ningbo campus, and an AVIC researcher.[330]

Additional dual-use technology research developed between the University of Nottingham and Chinese military-linked entities since *IAC*

A Chinese researcher is listed as an Assistant Professor at Nottingham's Composites Research Group (CRG).[331] Prior to this they studied at NPU[332] (rated *Very High Risk* by ASPI). The CRG aims to apply its research within a number of UK sectors, including automotive, aerospace, and power generation.[333] This researcher has co-authored numerous research projects in collaboration with Chinese academics and researchers, including one in August 2021 with a researcher from NPU.[334]

Also at the CRG is a professor of Aerospace Composites at the Faculty of Engineering.[335] With an academic background in aerospace in China, they are listed as a Visiting Professor at the College of Aerospace Engineering, NUAA, China.[336] The NUAA is one of the Seven Sons of Defence in China, and due to extensive collaborations with the PLA is rated as *Very High Risk* by ASPI.[337] In December 2020 it was added to the US Entity List for 'acquiring and attempting to acquire US-origin items in support of programs for the People's Liberation Army.'[338]

This individual is also listed as a Visiting Professor at the School of Materials Science and Engineering, Zhejiang University, China. Zhejiang is listed as *High Risk* by ASPI for, among other issues, its civil-military integration of research and technology in the aerospace industry.[339] Furthermore, the individual is listed as an expert at AVIC's Aircraft Strength Research Institute in Xi'an, China, and as a Technical Consultant at Sinoma Science &

[326] Continuous fibre composite 3D printing with pultruded carbon/PA6 commingled fibres: Processing and mechanical properties-Web of Science Core Collection
[327] Mao, Xuerui - Web of Science Core Collection [last accessed 4 October 2022]
[328] Beijing Institute of Technology – Chinese Defence Universities Tracker — ASPI
[329] *Ibid.*
[330] Development of hybrid breathing materials for sustainable composite manufacturing-Web of Science Core Collection
[331] People - The University of Nottingham Tao LIU | University of Nottingham, Nottingham | Notts (researchgate.net)
[332] (6) Tao Liu | LinkedIn
[333] Composites Research Group - The University of Nottingham
[334] Creep crack growth modelling of Grade 91 vessel weldments using a modified ductility based damage model - ScienceDirect
[335] People - The University of Nottingham
[336] Microsoft Word - CV_2018 - Brief (shellbuckling.com)
[337] Nanjing University of Aeronautics and Astronautics – Chinese Defence Universities Tracker — ASPI
[338] Federal Register :: Addition of Entities to the Entity List, Revision of Entry on the Entity List, and Removal of Entities From the Entity List
[339] Zhejiang University – Chinese Defence Universities Tracker — ASPI

Technology Co., Ltd., Nanjing, China,[340] a manufacturer and supplier of military-grade thermally conductive materials.[341]

The CRG currently has four ongoing research projects listed on its website. Two of these ('Impact damage in composites components', and 'Buckling analysis software of Stiffened panel structure') have their official sponsor's listed as AVIC.[342] This Chinese professor is the investigator for the second AVIC project.

Nottingham also hosts the Advanced Materials Research Group. A Chinese researcher is listed in this group as an Assistant Professor in Materials, Faculty of Engineering, with an academic background from the Chinese Academy of Sciences (CAS)[343] (a subservient agency of the Chinese Communist Party's Central Committee, who sets the CAS's research agenda[344]). They have collaborated on multiple co-authored research projects with Chinese researchers and academics, including one in January 2022 with individuals from both the Northwestern Polytechnical University and Beijing University of Technology (both rated *Very High Risk* by ASPI, both Seven Sons of National Defence, both on the US Entity List[345]).[346]

An individual listed at Nottingham's Ningbo campus is also listed at China's Air Force Engineering University,[347] one the PLA's five defence universities and rated as *Very High Risk* by ASPI for weapons and avionics research conducted for the PLA Air Force.[348] This individual has unsurprisingly conducted extensive defence related research, including on aerial combat manoeuvring.[349]

Nottingham continues to employ an individual at the Ningbo campus who is also a researcher at AVIC in Beijing,[350] in addition to employing a 3-D modelling researcher in 2020 who is still listed at the Harbin Institute of Technology while at Nottingham.[351]

A June 2022 research paper was published from a joint project conducted throughout 2021 between two academics at Nottingham, with four individuals from Harbin Institute of Technology (HIT) and one from Nanjing University of Aeronautics and Astronautics (another member of the Seven Sons of Defence). The Chinese-funded project researched interior

[340] Microsoft Word - CV_2018 - Brief (shellbuckling.com)
[341] SSA910-Sinoma Technology (Suzhou) Co., Ltd
[342] Mechanical and Failure Analysis - The University of Nottingham
[343] Meet the team - The University of Nottingham
[344] osr-Senate-HSGAC-Subcommittee-Full-Report.pdf (unc.edu) p.23.
[345] Beijing Institute of Technology – Chinese Defence Universities Tracker — ASPI
[346] A novel fatigue-oxidation-creep life prediction method under non-proportional loading - ScienceDirect
[347] Hu, Dongyuan - Web of Science Core Collection [last accessed 4 October 2022]
[348] Air Force Engineering University – Chinese Defence Universities Tracker — ASPI
[349] Aerial combat maneuvering policy learning based on confrontation demonstrations and dynamic quality replay-Web of Science Core Collection
[350] Yi, Xiaosu - Web of Science Core Collection [last accessed 4 October 2022]
[351] Ma, Conggan - Web of Science Core Collection [last accessed 4 October 2022]

permanent magnet synchronous motors (IPMSM),[352] which has extensive utility for military vehicles including UAVs.[353] The same research group including four scientists from HIT published an earlier paper in December 2021 researching IPMSMs.[354]

In September 2021 a Chinese-funded, joint research paper between the same Nottingham academic and six Chinese individuals from NUAA and HIT explored space vector pulse width modulation,[355] an algorithm for the control of *pulse-width modulation, research used in the development of military-use rail gun technology.*[356]

Nottingham employs an individual, listed at the university since 2020, who is concurrently at both BIT and CAST. In addition, they were at CASC in 2021 (whilst still at Nottingham) and Peking University. Furthermore, they were at the Beijing Institute of Spacecraft System Engineering immediately prior to starting at Nottingham. This is a front company for CASC, and is listed on the US Entity List as such.[357]

7. University of Birmingham and University of Science and Technology China (USTC)

Key words: Computational science

There is no new evidence that the joint *USTC-Birmingham Research Institute in Intelligent Computation and its Applications* lab is still operational. However, the same Chinese individual identified from *IAC* is still listed as the lab's leader on the University of Birmingham's website,[358] with an additional computational scientist at Birmingham also collaborating with Chinese scientists from both USTC and Seven Sons of Defence affiliates.

In August 2021 a Chinese-funded (including NSFC) evolutionary computation project was published, in collaboration with a Chinese scientist at the USTC.[359] In addition, a third researcher on this project has worked at several of China's Seven Sons of National Defence, including whilst working on this project, at the NJUST.[360]

In 2022 a collaborative project between individuals from Birmingham and USTC which researched mobile data traffic was published.[361]

8. University of Birmingham and Beijing Institute for Aeronautical Materials, Commercial Aircraft Corporation of China, and Huazhong University of Science and Technology

Key words: Super alloys; telecommunications; 3-D printing.

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[352] Calculation Model of Armature Reaction Magnetic Field of Interior Permanent Magnet Synchronous Motor With Segmented Skewed Poles | IEEE Journals & Magazine | IEEE Xplore
[353] applsci-11-04856-v3.pdf
[354] Open-Circuit Air-Gap Magnetic Field Calculation of Interior Permanent Magnet Synchronous Motor With V-Shaped Segmented Skewed Poles Using Hybrid Analytical Method | IEEE Journals & Magazine | IEEE Xplore
[355] Analysis and Performance of Five-Phase Piecewise-Random-Switching-Frequency Space Vector Pulse Width Modulation | IEEE Journals & Magazine | IEEE Xplore
[356] Microsoft Word - PN 292 Hebner.doc (utexas.edu) p.6.
[357] China Aerospace Science and Technology Corporation – Chinese Defence Universities Tracker — ASPI
[358] Professor Xin Yao - University of Birmingham
[359] Analysis of Evolutionary Algorithms on Fitness Function With Time-Linkage Property-Web of Science Core Collection
[360] Chen, Huanhuan - Web of Science Core Collection [last accessed 4 October 2022]
[361] A Survey on Technologies and Challenges of LTE-U-Web of Science Core Collection

Birmingham was the project-lead for the EU-funded *Efficient Manufacturing for Aerospace Components Using Additive Manufacturing, Net Shape HIP and Investment Casting* (EMUSIC), which ended in 2019.[362] Birmingham have since removed their EMUSIC posts from their website after *IAC* was published in February 2021. Despite this, their appears to be collaboration still between Birmingham and some of the original EMUSIC Chinese partners, in particular with BIAM.

In 2021 a joint project involving two Birmingham academics at the School of Metallurgy and Materials[363] was conducted, researching Inconel 718, a highly complex and strong super alloy. Half of all the alloy manufactured is used in the aerospace industry, and in particular in jet engines and turbines.[364] This research, as well as financially supported by BIAM,[365] was conducted at the joint BIAM-Imperial Centre for Materials Characterisation, Processing and Modelling (see Imperial section above).

In 2022 a Chinese researcher at Birmingham was involved in a Chinese-funded project, with individuals from both WUT and HUST; one of whom was previously at the PLA Information Engineering University.[366] Described as the sole military academy for the cyber and electronic warfare arms of China's network-electronic forces,[367] this military institution is subordinate to the PLA Strategic Support Force's Network Systems Department, which holds the military's signals intelligence capabilities.

In 2022 a Chinese scientist at Birmingham was involved in a Chinese-funded project researching 3-D printing for guided bone regeneration with several other Chinese scientists.[368] The individual at Birmingham had previously been employed at four *High Risk* and *Very High Risk* rated Chinese defence universities, including at Peking University (rated *High Risk* by ASPI for its work on China's nuclear program) immediately prior to starting at Birmingham, and also HUST (*Very High Risk)* whilst at Birmingham.[369] Furthermore there was a Chinese researcher who worked at Harbin Institute of Technology (one of the Seven Sons of Defence) and a further individual who whilst on this project at HUST was also listed at the Beijing Aerospace Command and Control Centre, and prior to that in the PLA itself.[370]

In 2021 a joint Birmingham-HUST-CALTECH project researched quantum optics, which has significant value in advanced telecommunications research and technology. One of the Chinese scientists on the project was previously at NJUST.[371]

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[362] EMUSIC | Innovation and Networks Executive Agency (europa.eu)
[363] On the constitutive relationship between solidification cells and the fatigue behaviour of IN718 fabricated by laser powder bed fusion - ScienceDirect
[364] Inconel 718 for aerospace engine applications (super-metals.com)
[365] On the constitutive relationship between solidification cells and the fatigue behaviour of IN718 fabricated by laser powder bed fusion-Web of Science Core Collection
[366] A method to improve position accuracy for the dual-drive feed machines by state-dependent friction compensation-Web of Science Core Collection
[367] Information Engineering University – Chinese Defence Universities Tracker — ASPI
[368] Electrophoretic deposition of novel semi-permeable coatings on 3D-printed Ti-Nb alloy meshes for guided alveolar bone regeneration-Web of Science Core Collection
[369] Zhang, Zhen - Web of Science Core Collection [last accessed 4 October 2022]
[370] Li, Ke - Web of Science Core Collection [last accessed 4 October 2022]
[371] Chen, Yanbei - Web of Science Core Collection [last accessed 4 October 2022]

Additional dual-use technology research developed between the University of Birmingham and Chinese military-linked entities since *IAC*

In 2021 an academic from Birmingham worked on a vast multi-billion dollar project called the TianQin project, a Chinese-led proposed space-borne gravitational-wave observatory (gravitational-wave detector) consisting of three spacecraft in Earth's orbit.[372] There are many Chinese scientists working on this project from some of the country's biggest defence companies and defence universities, including; NUDT;[373] the PLA Information Engineering University;[374] and multiple Chinese defence companies, including military satellite companies supplying the PLA and owned by CAST.[375]

A Chinese professor previously identified in *IAC* as the leader for the USTC-Birmingham Research Institute in Intelligent Computation and its Applications, is also the Chair Professor of Computer Science with the Southern University of Science and Technology (SUSTech), Shenzhen, China. SUSTech signed a Memorandum of Understanding with Birmingham in 2017 for the China-UK Joint Artificial Intelligence Research Institute (CUJAIRI). This is to enable academic research and training collaborations in areas such as computational intelligence, autonomous and cognitive systems, and intelligent 'internet of things' (IOT) systems.[376]

SUSTech is rated as *Medium Risk* by ASPI.[377] One area for concern with SUSTech is the deepening links to the PLA, including increasing contributions to Chinese defence research by establishing a new centre for civil-military fusion.[378]

Whilst still maintaining a Professorship at both SUSTech and at Birmingham, and since *IAC* was published in February 2021, this individual has published numerous research papers in collaboration with individuals from several PLA-linked universities in China.[379] These include with five individuals from Hefei University of Technology (rated *Medium Risk* by ASPI),[380] an institution which has undertaken over 200 secret-level military research projects.[381] The research also included three individuals from SUSTech, including a paper researching advanced computational science in which the individua's affiliation is listed as SUSTech.[382]

In 2021, this Chinese professor collaborated with four other Chinese researchers from the PLA Air Force Engineering University, and from NUDT, on an NUDT-funded project

[372] The TianQin project: Current progress on science and technology-Web of Science Core Collection
[373] Bao, Jiahui - Web of Science Core Collection [last accessed 4 October 2022]
[374] Cao, Bin - Web of Science Core Collection [last accessed 4 October 2022]
[375] Ding, Yan-wei - Web of Science Core Collection [last accessed 4 October 2022]
[376] University of Birmingham joins SUStech to plan new Artificial Intelligence centre
[377] University of Science and Technology of China – Chinese Defence Universities Tracker — ASPI
[378] institute of advanced technology, university of science and technology of china recruitment information of military-civilian integration innovation center recruitment information | professional recruitment-talent recruitment-institute of advanced technology, university of science and technology of china (archive.org)
[379] Find Research outputs — University of Birmingham
[380] Enhanced Constraint Handling for Reliability-Constrained Multiobjective Testing Resource Allocation | IEEE Journals & Magazine | IEEE Xplore
[381] Hefei University of Technology – Chinese Defence Universities Tracker — ASPI
[382] paper_final.pdf (bham.ac.uk)

researching state estimation in power systems,[383] technology which has military utility regarding AI and robotics,[384] and also in cyber warfare.[385] The scientist from NUDT in this project has researched extensively for the Chinese military on UAV drone swarm technology, including at NUDT and at the PLA Air Force Engineering University.[386]

In May 2022, a Senior Lecturer in Computer Science at Birmingham, along with a fellow Chinese colleague at the university, published a Chinese-funded paper researching bioinformatics and computer science.[387] This was conducted with three individuals from the School of the Internet of Things Engineering, Jiangnan Social University (JSU). JSU is designated *Very High Risk* by ASPI for its affiliation with the MSS, China's civilian intelligence agency.[388]

The first Chinese individual at Birmingham has been listed at the university continuously since 2007.[389] In the last ten years, they held positions at two *High Risk* Chinese universities (Xi'an Jaiotong University and Peking University), whilst concurrently working at Birmingham.[390]

The second Chinese researcher at Birmingham listed on this project has been cited at the university since 2019. In that time, they held positions at both the PLA's Strategic Support Force (the Chinese military's space, cyber, and electronic warfare force and the 5th branch of the PLA), and at the Academy of Military Medical Sciences .[391] In December 2021, the United States Department of Commerce added the Academy of Military Medical Sciences to the Entity List, for its role in aiding the Uyghur genocide.[392]

In 2021 a Chinese researcher at Birmingham – whilst also listed at SUSTech – collaborated with Chinese scientists, on a Chinese-funded project, researching Digital microfluidic biochips,[393] which has a military application.[394] The individual was also listed at BUAA whilst also at Birmingham.[395]

In 2021 two Birmingham academics collaborated with researchers at the BIAM-Imperial Centre for Materials Characterisation, Processing and Modelling at Imperial College London.

[383] Joint Adversarial Example and False Data Injection Attacks for State Estimation in Power Systems-Web of Science Core Collection
[384] Distributed Dynamic State Estimation of Power Systems | Request PDF (researchgate.net)
[385] Cyber security analysis of state estimators in electric power systems | IEEE Conference Publication | IEEE Xplore
[386] Cao, Kunrui - Web of Science Core Collection [last accessed 4 October 2022]
[387] Data-Driven Boolean Network Inference Using a Genetic Algorithm With Marker-Based Encoding-Web of Science Core Collection
[388] Jiangnan Social University – Chinese Defence Universities Tracker — ASPI
[389] Dr Shan He - School of Computer Science - University of Birmingham He, Shan - Web of Science Core Collection [last accessed 4 October 2022]
[390] He, Shan - Web of Science Core Collection [last accessed 4 October 2022]
[391] Shi, Ning - Web of Science Core Collection [last accessed 4 October 2022]
[392] U.S. sanctions Chinese tech companies over abuse of Uyghurs (axios.com)
[393] Placement of Digital Microfluidic Biochips via a New Evolutionary Algorithm-Web of Science Core Collection
[394] A Design of Digital Microfluidic Biochip along with Structural and Behavioural Features in Triangular Electrode Based Array - ScienceDirect
[395] Yao, Xin - Web of Science Core Collection [last accessed 4 October 2022]

This research was funded by BIAM, and tested IN718 alloy; a super strength alloy used primarily in jet engines.[396]

9. University of Kent Communications Research Group (CRG)

Key words: radars; antenna; telecommunications.

IAC uncovered multiple researchers at the Communications Research Group (CRG) who had prior affiliations with military-linked entities in China. Absent an official joint lab, the CRG nonetheless has continued to engage with multiple military-linked Chinese individuals and organisations.

Since February 2021 and the University of Kent's then assertion that in fact there was no collaboration with any PLA-linked Chinese institutions,[397] there have been no less than seven co-authored research papers, involving five academics and researchers at Kent, collaborating on research with individuals from five separate Chinese universities all of which share extensive links with the PLA.

The CRG researches 'advanced communications technologies and systems for high-frequency and/or high data-rate wireless systems operating from radio frequency (RF) to Terahertz (THz) frequencies', for use in; space antennas, smart antennas, space-borne radars, phased arrays, MIMO (multiple input multiple output), antenna and radio propagation for 4G/5G/6G mobile communications, base station antennas, antennas for satellite communications, RF/microwave/millimetre-wave circuits and RF front ends, mobile communication systems, satellite communications, inter-satellite links, wireless power transfer, ultra-wide band (UWB) radars, GNSS reflectometry, synthetic-aperture radars, electromagnetic modelling and small satellites.[398]

A Chinese academic is listed on the CRG's website as a Reader in Communications,[399] and has an academic background at both Xidian and Tsinghua Universities, which maintain extensive links to the PLA (both rated *Very High Risk* by ASPI).[400] They also chaired various aspects to IEEE conferences in China, which have partnerships with PLA-linked universities.

This included the 2013 IEEE wireless communications and networking conference in Shanghai, chaired by an academic from Southeast University[401] (designated *High Risk* by ASPI for defence research and PLA-links[402]) where the individual was a publication co-chair.[403] The conference itself was in partnership with Southeast University, which financially contributed to the event.[404] They published research undertaken at the

[396] On the constitutive relationship between solidification cells and the fatigue behaviour of IN718 fabricated by laser powder bed fusion - ScienceDirect
[397] Tylecote and Clark, 2021. p.65.
[398] Communications Research Group - Research at Kent
[399] Dr Huiling Zhu - School of Engineering - University of Kent
[400] Tsinghua University – Chinese Defence Universities Tracker — ASPI Xidian University – Chinese Defence Universities Tracker — ASPI
[401] Welcome to IEEE WCNC 2013 (ieee-wcnc.org)
[402] Southeast University – Chinese Defence Universities Tracker — ASPI
[403] *Ibid.*
[404] Welcome to IEEE WCNC 2013 (ieee-wcnc.org)

University of Kent in 2021 regarding wireless network communications intrinsic to developing 6G technology.[405]

In 2019 they visited Xidian University for a collaborative project between the *Very High Risk*-rated university, and Kent's Communications Research Group. The project entailed researching emergency communications networks, with the CRG professor giving a demonstration to Xidian of the Kent-based group's research. The project was funded by the Chinese government, with future research collaboration proposals and research student exchanges also discussed.[406] Xidian University maintains extensive links to the PLA, making important contributions to Chinese militarisation,[407] and is jointly supervised by CETC – one of China's official defence industry conglomerates which seeks to incorporate civil-military fusion.[408]

Despite the University of Kent's 2021 claim that there is no collaboration at the university with any universities linked to the Chinese military, in fact there appears to be British-funded sensitive communications research taking place at Kent's CRG. This researcher, in turn, has presented to a Chinese university in collaboration which an institution which maintains active research links to the PLA, and which is directly supervised by a Chinese defence company responsible for incorporating civilian research into military applications.

In addition, the head of the CRG has published multiple research papers whilst at the University of Kent, with researchers at Chinese institutions linked to the PLA. Since April 2021, after the University of Kent stated that no collaborations exist with PLA-linked Universities in China, this individual has published at least eleven separate research papers with a Chinese researcher and Assistant Professor at the National Laboratory of Science and Technology on Antennas and Microwaves at Xidian University (designated *Very High Risk* by ASPI, in particular for their PLA-linked research on antennas, radar, and electronic countermeasures[409]).[410]

This Chinese individual has also collaborated with multiple other Chinese academics and researchers based at Kent, including three papers in January 2022 and one in September 2021 with a Chinese post-graduate researcher at the CRG,[411] [412] and a paper in June 2021 with a Chinese Senior Lecturer in Electronic Systems at Kent also.[413]

[405] manuscript_main_final.pdf (kent.ac.uk)
[406] Dr Huiling Zhu, Reader in Communications, visits China for a collaborative project on emergency communication networks – School of Engineering News (kent.ac.uk)
[407] University – Chinese Defence Universities Tracker — ASPI
[408] A Model Company: CETC Celebrates 10 Years of Civil-Military Integration - Jamestown
[409] Xidian University – Chinese Defence Universities Tracker — ASPI
[410] Wei HU | Associate Professor | PhD | Xidian University, Xi'an | National Laboratory of Science and Technology on Antennas and Microwaves (researchgate.net)
[411] Le-Hu WEN | PhD Student | Doctor of Philosophy | University of Kent, Canterbury | KENT | School of Engineering and Digital Arts (researchgate.net)
[412] People - Communications Research Group - Research at Kent
[413] Compact and Wideband Crossed Dipole Antenna Using Coupling Stub for Circular Polarization | Request PDF (researchgate.net)

Since February 2021 and the University of Kent's assertion that in fact there was no collaboration with any PLA-linked Chinese institutions, there have been no less than seven co-authored research papers, involving five academics and researchers at Kent, collaborating on research with individuals from five separate Chinese universities – four of which are rated Very High Risk, and all share extensive links with the PLA.

These include: Xidian University (rated *Very High Risk* by ASPI); Northwestern Polytechnical University (rated *Very High Risk* by ASPI[414]); Shandong University (rated *Very High Risk* by ASPI for, among other issues, links to China's nuclear weapons program[415]); Shanghai University (rated *Medium Risk* by ASPI and supervised by SASTIND); and Wuhan University (rated *Very High Risk* by ASPI for, among other issues, extensive links to the PLA including carrying out cyber-attacks on behalf of the Chinese military[416]).

These co-authored research projects all have a dual-use military application to them. For instance, a research paper published in September 2021 detailed Wideband Dual-Polarized Filtering Antenna,[417] technology which is already being investigated more widely for military applications.[418]

These research and publication collaborations between individual academics at the University of Kent and PLA-linked universities have all been ongoing since after the university maintained that there was in fact no such collaboration with any PLA-linked Chinese universities.

10. Cranfield University

Key words: Wire Arc Additive Manufacturing (WAAM); Direct Energy Deposition (DED); 3-D printing; aerospace; blast-wave monitoring; target acquisition; machine learning; hypersonics.

Cranfield University at Shrivenham is home to Cranfield Defence and Security, a secure military site run in partnership with the UK Defence Academy, a body of the Ministry of Defence. Its strategic partners include BAE Systems, research councils, and the Atomic Weapons Establishment (AWE).

Despite being home to some of the UK Ministry of Defence's sensitive research collaborations, researchers and academics at Cranfield have some of the most potentially seriously harmful partnerships with the Seven Sons of Defence in particular; one quarter of Cranfield's Chinese affiliations since 2020 are with members of the Seven Sons of Defence.

[414] Northwestern Polytechnical University – Chinese Defence Universities Tracker — ASPI
[415] Shandong University – Chinese Defence Universities Tracker — ASPI
[416] Wuhan University – Chinese Defence Universities Tracker — ASPI
[417] A Wideband Dual-Polarized Filtering Antenna for Base Station Applications | Request PDF (researchgate.net)
[418] Low-profile, Ultra Wideband and Dual Polarized Antennas and Feeding Systems (archives-ouvertes.fr) p.7. p.18.

In August 2022 three Chinese researchers at Cranfield (alongside a Warwick Manufacturing Group (WMG) researcher) published a composites research project, funded by WMG and Chinese entities. Three of the research partners were from BUAA, including one of the Cranfield researchers.[419]

In July 2022 three researchers at Cranfield collaborated on wire arc additive manufacturing (WAAM) with a scientist from Beijing University of Technology (BUT).[420] BUT established the Beijing University Technology Transfer Alliance, which promotes commercialising patents and researchers, including in such dual-use and military-relevant sectors as 3D printing and robotics.[421] A 2019 report by the Negotiation Design and Strategy research development group highlighted how Cranfield have developed their WAAM technology that includes 3-axis and 5-axis machines, that are similar to directed energy deposition (DED) in terms of functions and capability.[422] DED has been successfully applied in aerospace, with defence manufacturers increasingly using the technology to produce structural parts for satellites and military aircraft. Lockheed Martin Space, for example, has recently used the technology to build titanium fuel tanks domes for satellites. By using the technology, the company reduced production time by 87% whilst cutting lead time from two years to three months.[423] French company Naval Group used the WAAM printing process to manufacture a 3D propeller. Composed of five 200 kg blades, the propeller was then fitted to the Andromeda, a mine-hunting ship. The team behind the project explained that WAAM technology drastically reduced the construction time and minimised the number of materials used.[424]

Other key examples at Cranfield include:

- In July 2022 a researcher from Cranfield published hydrogen-fuelled aero engine performance research with an engineer from AECC, and a scientist from NPU.[425]

- In July 2022 a Chinese researcher at Cranfield (also listed at HUST) published a Chinese-funded (majority NSFC grants) project investigating wireless technology for blast-wave monitoring.[426] The project made explicit mention that this research has utility for defence applications. One of the researchers was a scientist at NJUST.

[419] Li, Wenhao - Web of Science Core Collection [last accessed 4 October 2022]
[420] Optimal droplet transfer mode maintenance for wire plus arc additive manufacturing (WAAM) based on deep learning-Web of Science Core Collection
[421] Alliance seeks to commercialize universities' research triumphs - Chinadaily.com.cn (archive.ph)
[422] NDS_Report_1908_WMD_AM_2019.pdf (nonproliferation.org)
[423] Metal 3D Printing: What is Direct Energy Deposition? - FacFox Docs
[424] The Use of Additive Manufacturing in The Defense Sector - 3Dnatives
[425] A dynamic performance diagnostic method applied to hydrogen powered aero engines operating under transient conditions-Web of Science Core Collection
[426] PkCOs: Synchronization of Packet-Coupled Oscillators in Blast Wave Monitoring Networks-Web of Science Core Collection

- In April 2022 four researchers at Cranfield published an NSFC-funded project testing structural wing designs for aerospace application.[427] One of the researchers has been at Cranfield since 2006. In that time, they have worked at BIT in 2020.[428] Another has worked at NPU from 2014, before starting at Cranfield in 2019.[429] A third concurrently works at BUAA, also prior to starting at Cranfield.[430]

- In March 2022 two researchers from Cranfield collaborated with two scientists from Beihang University's Research Institute of Aeroengines, on a project improving gas-turbine aero engines.[431] In turn, BUAA maintain extensive links with AECC, including the Beihang-AECC Research Institute of Aero-Engine and International School of Aero-Engine.[432] AECC, a subsidiary of AVIC, is one of China's leading military aviation engine manufacturers, including attack helicopters and ground attack aircraft, and is rated *Very High Risk* by ASPI.[433]

- In September 2020 a Chinese researcher at Cranfield published a Chinese-funded project (cited as '2020 Science and Technology Plan of Shaanxi Province') investigating advanced target acquisition research based on Chinese copies of Soviet-era military vehicles, including T60 main battle tanks and armoured personnel carriers.[434] They are also concurrently listed working at the University of Electronic Science & Technology (rated *High Risk* by ASPI), whilst another researcher on the project is at NPU,[435] whilst another is at China Electronics Technology Group (CETC), in addition to NPU.[436]

- In June 2021 a researcher from Cranfield published a majority Chinese-funded project investigating hyperspectral image analysis with a scientist from BIT.[437]

- In March 2021 a researcher from Cranfield (in addition to one from QMUL) published a joint EU-Chinese-funded project investigating deep reinforcement learning (DRL – an advanced machine learning subfield).[438] One of the project's co-researchers was a scientist from NUDT, whilst another was from NUAA. In other contexts NATO have

[427] Structure health monitoring of a composite wing based on flight load and strain data using deep learning method-Web of Science Core Collection
[428] Guo, Shijun - Web of Science Core Collection [last accessed 4 October 2022]
[429] He, Shun - Web of Science Core Collection [last accessed 4 October 2022]
[430] Li, Wenhao - Web of Science Core Collection [last accessed 4 October 2022]
[431] Self-enhancing model-based control for active transient protection and thrust response improvement of gas turbine aero-engines-Web of Science Core Collection
[432] United Innovation Center for Aeroengine Acoustics Founded-BEIHANG UNIVERSITY (buaa.edu.cn) and Aero-engine System Collaborative Design Center Unveiled-BEIHANG UNIVERSITY (buaa.edu.cn)
[433] Aero Engine Corporation of China – Chinese Defence Universities Tracker — ASPI
[434] Learn to Recognize Unknown SAR Targets From Reflection Similarity-Web of Science Core Collection
[435] Wei, QianRu - Web of Science Core Collection [last accessed 4 October 2022]
[436] Zhao, Yuan - Web of Science Core Collection [last accessed 4 October 2022]
[437] Novel Gumbel-Softmax Trick Enabled Concrete Autoencoder With Entropy Constraints for Unsupervised Hyperspectral Band Selection-Web of Science Core Collection
[438] Green Deep Reinforcement Learning for Radio Resource Management: Architecture, Algorithm Compression, and Challenges-Web of Science Core Collection

researched DRL for use in military war-gaming and as a strategic headquarters planning tool.[439]

- In February 2022 two researchers from Cranfield published a hypersonics vehicle research project with two researchers from BUAA,[440] both of whom research hypersonic weapons technology and targeting systems. The research was solely funded by the National Natural Science Foundation of China (NSFC), who actively promotes and supports civil-military integration.[441]

- In November 2021 the same researchers from Cranfield and from BUAA published Chinese-funded guidance and targeting systems research.[442] One of the funders was the Beijing Advanced Discipline Center for Unmanned Aircraft Systems; they fund advanced Chinese military research into manned and unmanned military aviation systems.[443]

- In October 2021 three Chinese researchers from Cranfield researched electroencephalography (EEG) technology with a scientist from BUAA.[444] A further researcher listed at the University of Sheffield is also concurrently at the University of Electronic Science & Technology (rated *Very High Risk* by ASPI). EEG technology has been researched by the US Army since 2015 to try and improve soldiers' cognitive ability in war.[445]

- In September 2021 a researcher from Cranfield published with three BUAA scientists a paper investigating permanent magnet synchronous motor (PMSM) drive systems and alternative electrical power sources for the aviation industry.[446] PMSM has utility amongst fixed-wing aircraft including fighter jets.[447] UK Research and Innovation funded the project for £227,835.00 GBP. One of the Chinese researchers is concurrently at CAST; a further is at HIT; whilst the third has been listed at five separate PLA institutions, including the PLA itself, most recently in 2017, in addition to having previously worked at NUDT.[448]

[439] MP-IST-160-W4-1.pdf
[440] Incremental Twisting Fault Tolerant Control for Hypersonic Vehicles With Partial Model Knowledge-Web of Science Core Collection
[441] nsfc.pdf (s3-service-broker-live-19ea8b98-4d41-4cb4-be4c-d68f4963b7dd.s3.amazonaws.com)
[442] Sensor-Based Robust Incremental Three-Dimensional Guidance Law with Terminal Angle Constraint-Web of Science Core Collection
[443] An evaluative review of the VTOL technologies for unmanned and manned aerial vehicles - ScienceDirect
[444] Brain functional and effective connectivity based on electroencephalography recordings: A review-Web of Science Core Collection
[445] EEG may someday boost Soldiers' cognitive ability | Article | The United States Army
[446] A High-Precision and High-Efficiency PMSM Driver Based on Power Amplifiers and RTSPSs-Web of Science Core Collection
[447] Design and testing of PMSM for aerospace EMA applications (1).pdf
[448] A High-Precision and High-Efficiency PMSM Driver Based on Power Amplifiers and RTSPSs-Web of Science Core Collection

- In February 2021 two researchers from Cranfield published gas turbine engine technology research with two engineers from BUAA.[449] Although they have several uses, gas turbine engines are frequently used in military aviation (jet engines).

- In February 2021 three researchers at Cranfield published Chinese-funded research (NSFC and China Scholarship Council grants) developing a nonlinear backstepping slidingmode controller for trajectory tracking control of a stratospheric airship.[450] One of the Chinese researchers is dual-listed at NPU, whilst another at SJTU.

Cranfield University

A Cranfield University spokesperson said: "We operate at all times within the guidance and regulations issued by the UK Government on academic relations with international institutions."

Further UK universities which have maintained research links and collaborations with Chinese defence entities

1. Warwick Manufacturing Group

Key words: aviation; aerospace; artificial intelligence; automation; Lithium-Ion batteries.

The Warwick Manufacturing Group (WMG) still list their partnerships with Chinese institutions on their website. They cite the Beijing Academy of Science and Technology (BJAST).[451] In turn, BJAST's largest domestic research collaborations include three Chinese universities rated *Very High Risk* by ASPI,[452] including with Hunan University, who maintain deep research links with China's nuclear weapons program.[453] Worryingly, BJAST cites its largest international collaboration with Imperial College London.[454]

A Chinese physicist based at Warwick since 2016 is a graduate of the Harbin Institute of Technology, where they were dual-listed from 2010-2022.[455]

In 2022 a Chinese researcher at WMG collaborated with a Chinese scientist at the BIT on artificial intelligence development for long lifetime battery manufacturing,[456] with an

[449] Hybrid Wiener model: An on-board approach using post-flight data for gas turbine aero-engines modelling-Web of Science Core Collection
[450] Backstepping sliding-mode control of stratospheric airships using disturbance-observer-Web of Science Core Collection
[451] Homepage contents (warwick.ac.uk)
[452] Beijing Academy of Science and Technology (BJAST) | Institution outputs | Nature Index
[453] Hunan University – Chinese Defence Universities Tracker — ASPI
[454] Beijing Academy of Science and Technology (BJAST) | Institution outputs | Nature Index
[455] Li, Zhichao - Web of Science Core Collection [last accessed 4 October 2022]
[456] Towards Long Lifetime Battery: AI-Based Manufacturing and Management-Web of Science Core Collection

emphasis on electric vehicles. The Chinese scientist from BIT is based at the National Engineering Laboratory Electric Vehicles. BIT currently has at least two vehicle labs designated for defence research.[457] Long lifetime batteries are seen as essential for military operations, with much research geared towards the defence industry.[458]

In 2022 a Chinese researcher at WMG collaborated with several Chinese individuals from Seven Sons of National Defence institutions, on power supply development for electric hybrid vehicles.[459] There were three Chinese individuals listed at Birmingham University also. A further individual was at the University of Electronic Science & Technology of China and at the NPU immediately before this project began. Another individual is at the BIT.

In 2021 and 2022 a Chinese researcher, now a PhD student at WMG, collaborated with two Chinese scientists from the NJUST (a Seven Sons of National Defence member) regarding GAN (see Strathclyde and SIPRA).[460] Even more troublingly, the researcher from WMG had previously worked for at least three different Chinese military research institutions – most recently at the PLA's Rocket Force University of Engineering (RFUE), the year before they started at WMG.[461] Rated *Very High Risk* by ASPI, the RFUE is the PLA Strategic Missile Force's leading institution for training technicians and scientists. Students entering the university tend to be career members of the PLA Rocket Force.[462]

In March 2022 a collaborative research paper between an academic at the WMG and Chinese scientists, including an individual from Shandong University (rated *Very High Risk* by ASPI for its number of defence laboratories and links to China's nuclear weapons program[463]),[464] developed battery aging for Lithium-Ion battery packs.[465] Lithium-Ion batteries are essential to developing drone technology, as previously covered in *IAC*.[466]

A further Chinese scientist working on this project was listed at Xi'an UniIC Semiconductors Co., Ltd., a DRAM chip supply chain developer, whilst at the same time working on this project.[467] Xi'an UniIC Semiconductors is a subsidiary of Unigroup Guoxin, which is involved in semiconductor and microchip manufacturing for the domestic Chinese security market.[468] Xi'an UniIC Semiconductors themselves have links to the Chinese defence industry.[469] As of April 2022, the parent organisation of Unigroup Guoxin, Tsinghua Unigroup, now includes New H3C Technologies – an enterprise hardware company that was named as supporting

[457] Beijing Institute of Technology – Chinese Defence Universities Tracker — ASPI
[458] Energy storage for military applications faces demands for more power | Military Aerospace
[459] Electrothermal Dynamics-Conscious Many-Objective Modular Design for Power-Split Plug-in Hybrid Electric Vehicles-Web of Science Core Collection
[460] Distinguishing Between Natural and GAN-Generated Face Images by Combining Global and Local Features-Web of Science Core Collection
[461] Wang, Yiting - Web of Science Core Collection [last accessed 4 October 2022]
[462] Rocket Force University of Engineering – Chinese Defence Universities Tracker — ASPI
[463] Shandong University – Chinese Defence Universities Tracker — ASPI
[464] Tang, Xiaopeng - Web of Science Core Collection [last accessed 4 October 2022]
[465] A Balancing Current Ratio Based State-of-Health Estimation Solution for Lithium-Ion Battery Pack-Web of Science Core Collection
[466] Tylecote and Clark, 2021. p.91.
[467] Liu, Qi - Web of Science Core Collection [last accessed 4 October 2022]
[468] Creation of China chip supply chain key for Tsinghua Unigroup revival - Nikkei Asia
[469] Xi'an UniIC Semiconductors Co., Ltd. (unisemicon.com)

China's military and subject to US embargos.[470] The many links to the PLA, and China's wider defence manufacturing base by domestic semiconductor and chip manufactures, are well established.[471]

Warwick Manufacturing Group

WMG stated in their right to reply that they do not have any education business with Beijing Academy of Science. However, BJAST is still listed on WMG's website as an institution which WMG have successfully designed and delivered intensive courses for the senior managers for over 10 years.

Regarding the WMG's Chinese researcher collaborating with a Chinese scientist from BIT on AI development, WMG replied that; "While the researcher is employed by WMG, the researcher was working independently. It is common within UK universities for researchers to maintain links with colleagues and supervisors from other institutions".

The WMG had the same response for the 2022 project developing power supply development for electric hybrid vehicles, and for the March 2022 project regarding battery aging for Lithium-Ion battery packs.

Regarding the PhD student working on GAN technology with Chinese scientists from Seven Sons entity NJUST in 2021 and 2022, WMG stated that; "While the researcher is now a PhD student at WMG, she was working independently when this paper was published." The individual was officially listed at WMG when this project was undertaken, so if they were working 'independently', then it would suggest that more thorough due diligence is conducted by WMG in the future, should the university not like their staff working on such projects in an 'individual' capacity.

2. University of Surrey

Key words: aerospace; satellite communications

The University of Surrey's joint research agreement with the China Academy of Space Technology (CAST), drafted in 2016 and identified in *IAC*, subsequently led to a Memorandum of Intent. This formed the basis for a research collaboration between Surrey's Institute for Communications Systems (ICS) and CAST, established in July 2017. Initially to last two years, the partnership included "training and advanced radio and networking research" in the area of High Throughput (Capacity) Satellite and 5G mobile satellite systems. The MOI further stated that; "The joint lab will cement our relationship with CAST

[470] Beijing bails out bankrupt Tsinghua Unigroup • The Register
[471] SMIC Is One Of Many Semiconductor Fabs With Ties To China's Military (forbes.com)

and make it a **long-term cooperation between China and UK** on the strategically important area of satellite communication networks." (author's bold for emphasis).[472]

In November 2017 Surrey announced that the Future AI and Robotics for Space (FAIR-SPACE) Hub, a new space-focused artificial intelligence and robotics research hub, funded through a £6.9m grant from the Engineering and Physical Sciences Research Council (EPSRC) and the UK Space Agency (UKSA), along with a further £7.5m from the sector on the Hub's core research programme. The hub will be further boosted by £15m funding from a business development fund. The China Aerospace Science and Technology Corporation (CASC, the parent company of CAST) is an official partner.[473]

In 2017, the Engineering and Physical Sciences Research Council funded a five year project, culminating in March 2022, for £8,602,141 GBP, to be spent at Surrey's Space Centre. CASC was again listed as an official partner in this project, in alongside the UK Space Agency and the UK Atomic Energy Authority, whilst a Chinese engineer from SJTU (rated *High Risk* by ASPI) was involved.[474]

A Chinese researcher, originally from Shandong University (rated *Very High Risk* by ASPI for the university's work on China's nuclear weapons program) works at Surrey's Institute for Communications Systems (ICS).[475]

The Head of the ICS[476] has continued to produce research with Chinese defence universities and entities; in July 2022 publishing a co-researched paper on RIS technology and the Internet of Things (IoT).[477] This project was co-funded between the National Natural Science Foundation of China (NSFC) and the UK Research & Innovation (UKRI), and included a scientist from Zhejiang University, rated *High Risk* by ASPI.[478]

In June 2022 the same professor and a Chinese researcher at ICS published Chinese-funded 6G research in collaboration with four Chinese researchers at Xidian University,[479] rated *Very High Risk* by ASPI. One of Xidian's designated defence research areas is communication engineering.[480] The four researchers from Xidian all came from the PLA-linked university's School of Telecommunication Engineering.

In February 2022 the head of ICS published a Chinese-funded low-earth orbit satellite project, with three Chinese researchers all from SJTU. One of the Chinese researchers has been at the University of Electronic Science & Technology of China (rated *Very High Risk* by

[472] Research collaboration between CAST Xian and ICS at University of Surrey announced | University of Surrey
[473] Surrey to lead new AI and Robotics Space Hub | University of Surrey
[474] Future AI and Robotics Hub for Space (FAIR-SPACE) (ukri.org)
[475] Xiao, Pei - Web of Science Core Collection [last accessed 4 October 2022]
[476] Prof Rahim Tafazolli FREng | University of Surrey
[477] RIS Assisted Wireless Powered IoT Networks With Phase Shift Error and Transceiver Hardware Impairment | IEEE Journals & Magazine | IEEE Xplore
[478] Zhejiang University – Chinese Defence Universities Tracker — ASPI
[479] Multiobjective Resource Allocation for mmWave MEC Offloading Under Competition of Communication and Computing Tasks-Web of Science Core Collection
[480] Xidian University – Chinese Defence Universities Tracker — ASPI

ASPI for links to human rights abuses, inclusion on the US entity list, and relationship with China's defence industry and nuclear weapons program) since 2009, in addition to being at the PLA Air Force Engineering University in 2016.[481]

In February 2022, four researchers and academics at Surrey's ICS published satellite-based non-terrestrial networks and 5G technology research conducted with five Chinese scientists from China Electrical Technology Group Corporation (CETC).[482] In addition, one of the five is concurrently listed at HIT and NPU, in addition to previously being at HEU, NJUST, and BUAA, and having been at three separate PLA research institutions,[483] whilst another was recently listed at HIT also.

Established with the stated aim of leveraging civilian electronics for the benefit of the PLA, CETC manufactures parts and systems for radars, missiles, semiconductors, satellites, antennas for 5G networks, as well as autonomous driving technology. CETC has been described by the Jamestown Foundation as:

> 'the crux of China's effort to support the PLA with dual-use electronics and information technology. As a research organization, CETC has access to favorable government policies, science grants, and top technicians. As a business, it can actively attract partners in the private sector and leverage their technology. Finally, as a state-run organization, it uses these resources to openly support the PLA and its modernization program.'[484]

In August 2020, the US Bureau of Industry and Security placed four CETC subsidiaries on its Entity List for their work helping the PLA to militarise artificial islands in the South China Sea,[485] whilst in December 2020 the US placed CETC on its list of PLA-linked entities making it illegal for US citizens or companies to trade with.[486]

The ICS employ a 6G researcher[487] who is also listed at University of Electronic Science & Technology of China, in addition to the University of Science & Technology Beijing. Both universities are rated *Very High Risk,* and *High Risk,* by ASPI respectively.[488]

In April 2021 the President and Vice Chancellor of the University of Surrey gave a written response to the Foreign Affairs Select Committee (FASC), in relation to their inquiry into British involvement and links with Chinese entities involved in perpetuating the PRC's genocide of China's Uyghur population in Xinjiang.[489] The reply sent by Professor Max Lu

[481] Li, Rui - Web of Science Core Collection [last accessed 4 October 2022]
[482] Satellite-Based Non-Terrestrial Networks in 5G: Insights and Challenges-Web of Science Core Collection
[483] Zhang, Haipeng - Web of Science Core Collection [last accessed 4 October 2022]
[484] A Model Company: CETC Celebrates 10 Years of Civil-Military Integration - Jamestown
[485] U.S. Sanctions Chinese Firms and Executives Active in Contested South China Sea - WSJ
[486] Trump bans U.S. investments in companies linked to Chinese military | Reuters
[487] Fan Wang - IEEE Xplore Author Profile
[488] Wang, Fan - Web of Science Core Collection [last accessed 4 October 2022]
[489] Correspondence with the University of Surrey on Xinjiang (parliament.uk)

was almost identical to the university's right to reply to *IAC*, published in February 2021. Both replies to *IAC* and the FASC ended with the same identical paragraph:

> 'The University of Surrey is dedicated to world-class research and innovation. By advancing our work in multiple fields through collaboration and international partnership with universities, businesses, governments and communities, and in compliance with all relevant British Government guidance and legislation, we are playing our part in both advancing the sum of human knowledge and delivering a global Britain.'

A separate Chinese researcher dual-listed at both the University of Surrey and at the HIT was involved in a further project researching offshore wind turbines in 2021.[490]

University of Surrey

A spokesperson for the University of Surrey said that:

"The University of Surrey is dedicated to world-class research and innovation. By advancing our work in multiple fields through collaboration and international partnership with universities, businesses, governments and communities, and in compliance with all relevant British Government guidance and legislation, we are playing our part in both advancing the sum of human knowledge and delivering a global Britain."

3. University of Swansea

Key words: aviation.

The professor identified at Swansea in *IAC* has continued to produce research collaborations with Chinese scientists and members of Seven Sons of National Defence entities. Most recently a research project since at least August 2021 investigated resonant passive energy balancing (RPEB) – primarily in helicopter blades and unmanned aircrafts.[491] This EU-funded project has produced at least three research papers and a conference paper, ranging from August 2021 to July 2022. On the research team are a Chinese scientist from NJUAA, and another from BUAA.[492] This research concludes that the results from this work can be used in practical cases to improve the performance of aircraft.

[490] JMSE | Free Full-Text | Physical Modelling of Offshore Wind Turbine Foundations for TRL (Technology Readiness Level) Studies | HTML (mdpi.com)
[491] (PDF) Resonant Passive Energy Balancing of Morphing Helicopter Blades with Bend-Twist Coupling (researchgate.net)
[492] System-Level Optimization of Passive Energy Balancing | Request PDF (researchgate.net)

Swansea employ a Chinese engineer who is also listed at both NJUST (a Seven Sons of National Defence member) and USTC – both rated *Very High Risk* by ASPI.[493]

[493] Chen, Huanhuan - Web of Science Core Collection Zhang, Haipeng - Web of Science Core Collection [last accessed 4 October 2022]

Chapter Four: UK legislation and guidelines

Since *IAC* was released in February 2021 there have been several notable changes and amendments in UK legislation governing export controls. One reason for this was the UK's departure from the European Union, and existing arms control legislation requiring updating to reflect this. An additional reason for recent changes to UK legislation is a gradual and welcome shift in wider government strategy, realising the potential risk and harm from a continued reliance on Chinese funded research and dual-use technology collaboration. This is evident with the Integrated Review in March 2021 (as discussed in the Introduction), in addition to the government adding China to the list of destinations subject to military end-use controls in May 2022 (see below).

Much of the remaining frameworks and guidance governing UK export controls for dual-use technology (including research) was extensively covered in *IAC*. The following passages revisit these frameworks with any relevant developments in the past 18 months.

UK partial arms embargo to China

At the first instance it should be recognised that the UK has maintained a partial arms embargo on China since 1989, and the student protests culminating in the Tiananmen Square massacre. This has included Hong Kong since July 2020, in response to the National Security Law.[494]

The military items covered by the embargo include the following:

- lethal weapons, including machine guns, large-calibre weapons, bombs, torpedoes, rockets and missiles;
- specially designed components of the above and ammunition;
- military aircraft and helicopters, vessels of war, armoured fighting vehicles and other weapons platforms;
- any equipment which might be used for internal repression

It can be readily evidenced that from the above list there are growing concerns that the nature of the dual-use technology research between UK universities and Chinese defence entities covers the realms of military aircraft and helicopters, vessels of war, and equipment which might be used for internal repression. The partial arms embargo to China is controlled by the Export Control Order 2008.

The Export Control (Amendment) Order 2022

In December 2021 the Secretary of State for International Trade announced that the Export Control Order 2008 would be updated to reflect the UK's exit from the European Union, and to strengthen certain areas after an internal review of the UK's arms controls. The updates were to include adding China to the list of destinations subject to military end-use controls,

[494] UK arms embargo on mainland China and Hong Kong - GOV.UK (www.gov.uk)

in addition to reaffirming the UK's obligations and commitments to both the Missile Technology Control Regime (MTCR), and to the Wassenaar Arrangement.[495]

Furthermore, Criterion Two of the revised edition to The Strategic Export Licensing Criteria committed the UK to refuse an export license for dual-use and other sensitive goods and technologies should there be:

> "a clear risk that the items might be used to commit or facilitate internal repression; Internal repression includes, inter alia, torture and other cruel, inhuman and degrading treatment or punishment; summary or arbitrary executions; disappearances; arbitrary detentions"[496]

These changes and amendments to ongoing commitments came into effect on 19 May 2022 with the revised The Export Control (Amendment) Order 2022**.**[497]

Missile Technology Control Regime

The Missile Technology Control Regime (MTCR) is an informal arrangement between its 35 member states, limiting the proliferation of missiles and missile technology. It maintains vigilance over the transfer of missile equipment, material, and related technologies for systems capable of delivering weapons of mass destruction (WMD). The MTCR seeks to limit the risks of WMD proliferation by controlling exports of goods and technologies that could contribute to delivery systems (other than manned aircraft) for such weapons. Particular focus is on rockets capable of delivering a payload of at least 500kg over at least 300km, and equipment, software, and technology for these.

The MTCR does this with export controls applied to a common list of items (the MTCR Equipment, Software, and Technology Annex), a list of controlled items – including much of the equipment, materials, software, and technology needed for missile development, production, and operation controlled by MTCR members. The Annex has two parts: Category I and Category II items, which MTCR members require license authorisation requirements before listed items may be exported. Category I items include complete rocket and unmanned aerial vehicle systems, Category II items include dual-use missile-related parts and components.

Implementation of the MTCR is a matter for individual national sovereignty, as each member state implements the regime's guidelines in accordance with national legislation. UK compliance is maintained through The Export Control Order 2008.

The Wassenaar Arrangement (WA) on Export Controls for Conventional Arms and Dual-Use Goods and Technologies

The WA is a non-legally binding regime asking its 42 member states to be accountable for exports of conventional arms and dual-use goods and technologies to non-member states.

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[495] Written statements - Written questions, answers and statements - UK Parliament
[496] *Ibid.*
[497] NTE 2022/17: military end-use controls update - GOV.UK (www.gov.uk)

The UK is a signatory; the PRC is not. Volume 2 of the WA details the dual-use goods and technologies member states must consider when exporting or sharing such items. Dual-use goods and technologies to be controlled are **'major or key elements for the indigenous development, production, use or enhancement of military capabilities'**.

The WA's list of dual-use categories was updated in December 2021,[498] but there are three categories, if relevant, which will apply to most of the research centres above:

- Category 1 Special Materials and Related Equipment

  The Imperial Centre for Materials Characterisation, Processing and Modelling

  Shougang-Imperial Lab for Lightweight Steel Based Systems for Impact Resistant Automotive Applications

  The Space Mechatronic Systems Technology (SMeSTech) Laboratory

  The High Performance Ship Technology Joint Center

  The High Performance Ship Technology Joint Center

  The NPU-QMUL Collaborative Partnership and Joint Research Centre

- Category 2 Materials Processing

  The Imperial Centre for Materials Characterisation, Processing and Modelling

  The AVIC Centre for Structural Design and Manufacturing

  Shougang-Imperial Lab for Lightweight Steel Based Systems for Impact Resistant Automotive Applications

  The Space Mechatronic Systems Technology (SMeSTech) Laboratory

  The High Performance Ship Technology Joint Center

  The NPU-QMUL Collaborative Partnership and Joint Research Centre

- Category 9 Aerospace and Propulsion

  The Imperial Centre for Materials Characterisation, Processing and Modelling

  The AVIC Centre for Structural Design and Manufacturing

  The Space Mechatronic Systems Technology (SMeSTech) Laboratory

[498] Summary-of-Changes-to-the-2019-2020-Lists.pdf (wassenaar.org)

UK export controls including Military and Dual-Use Lists

The Military and Dual-Use Lists are drawn from the Export Control Order 2008 Schedule 3: The UK National Dual-Use Control List (including the explosive-related list); and Annexes 2 and 3 of Council Regulation (EC) No. 1236/2005 (as amended) (the EU Human Rights List).[499]

Controlled dual-use goods cover many thousands of items controlled, but not necessarily designed, for dual-use, having benign civil applications but retain significant utility for military application, including for WMD, and potential for human rights abuses. According to the Department for International Trade, the item of concern will have utility **'in a weapons manufacture programme'**. This can 'control key components, accessories, technology and software, in addition to actual goods'.

Crucially, under the lists, 'technology' means 'information' necessary for the 'development', 'production', or 'use' of goods or software (which are subject to controls). There remain exceptions for information in the public domain. Exports can take the form of physical or electronic transfers.

The dual use categories are as follows:[500]

0 Nuclear materials, facilities and equipment.

1 Special materials and related equipment.

2 Materials processing.

3 Electronics.

4 Computers.

5 Telecommunications and information security.

6 Sensors and lasers.

7 Navigation and avionics.

8 Marine.

9 Aerospace and propulsion.

Regarding WMD and End Use Controls, in its briefings DIT states that: 'WMD and End-Use Controls: The end-use control can be applied to ANYTHING (e.g. main equipment or components) or ANY activities (e.g. training or helplines), if potentially connected to a WMD programme.' According to DIT, 'Most of the goods or technology required for WMD or

[499] The Trade Controls are set out in Articles 20 to 25 of the Export Control Order 2008 (following the Export Control Act 2002) and Schedule 1 Part 1 – Category A goods; Schedule 2 (the Military list (items 'specifically designed or modified for military use')) Part 2 – Category B goods; Schedule 3 – the UK dual use list.

[500] 4 Dual-use lists are drawn from the Wassenaar Agreement and MTCR, as well as the Nuclear Suppliers Group, Australia Group, and Chemical Weapons Convention.

missile delivery systems may not be on any control list', meaning it is incumbent on the party supplying the technology to contact the authorities to check whether its activities may be proscribed.

This does not mean that any researchers have personally broken UK rules, because it is assumed that university centres and their research focuses have been approved internally. However, it may suggest that individual research projects which risk falling under dual use areas may need prior approval on a case by case basis, as the products manufactured by companies also would, heavily suggesting that continued and appropriate reforms are needed to university rules.

For WMD End-Use Controls in the UK, Article 6 of the Export Control Order 2008 contains 'additional controls on transfer of technology by any means and provision of technical assistance in relation to WMD.' The DIT states that: 'If you know or suspect an export will be used in connection with a WMD programme you have a legal obligation to contact [the authorities] and ask for a licence.' 'WMD purposes' mean 'use in connection with the development, production, handling, operation, maintenance, storage, detection, identification or dissemination of chemical, biological or nuclear weapons or other nuclear explosive devices, or the development, production, maintenance or missiles capable of delivering such weapons.' DIT also defines 'in connection with' as 'includ[ing] exports which may be used directly in a weapon or missile or indirectly in WMD development'. Indirect uses include 'infrastructure projects; research programmes at universities or government laboratories; un-safeguarded nuclear activities; civil space programmes'. A licence is required if the exporter 'knows', has been 'informed', or even 'suspects' that the goods software or technology are intended for 'any relevant use'. Parties are advised to consult the Consolidated list of strategic military and dual-use items that require export authorisation, only a few of whose categories are listed below.

Current UK control lists

The following are examples of goods and technologies on UK control lists, intended only to be indicative of some of the areas covered.[501]

The UK Military List

This includes:

• Electronic guidance and navigation equipment;

• Vessels (surface or underwater);

• 'Aircraft', 'lighter-than-air vehicles', 'Unmanned Aerial Vehicles' ('UAVs'), aeroengines and 'aircraft' equipment, related goods, and components as follows, specially designed or

[501] UK Strategic Export Control Lists - GOV.UK (www.gov.uk)

modified for military use: o ‘UAVs’, Remotely Piloted Air Vehicles (RPVs), autonomous programmable vehicles and unmanned ‘lighter-than-air vehicles’;

• Launchers, recovery equipment and ground support equipment;

• Equipment designed for command or control; Propulsion aero-engines and specially designed components therefor;

• Electronic equipment, ‘spacecraft’ and components, not specified elsewhere in [this]Schedule [including] Global Navigation Satellite Systems (GNSS) jamming equipment and specially designed components therefor. The list also ‘controls all electronic guidance and navigation equipment Goods and material, coated, treated or prepared to provide signature suppression, specially designed for military use’;

The UK Dual-Use List

This includes the products listed below and the ‘technology’ for many of these:

• Remotely operated vehicles;

•[Various] metal alloys, metal alloy powder and alloyed materials;

• Metals in particle sizes of less than 60 µm whether spherical, atomised, spheroidal, flaked or ground, manufactured from material consisting of 99 per cent or more of zirconium, magnesium and alloys thereof;

• Materials and devices for reduced observables, such as radar reflectivity, ultraviolet/infrared;

• [Various] signatures and acoustic signatures [usable] in 'missiles', ‘missile’ subsystems or unmanned aerial vehicles (specified; includes: a. Structural materials and coatings specially designed for reduced radar reflectivity; b. Coatings, including paints, specially designed for reduced or tailored reflectivity or emissivity in the microwave, infrared or ultraviolet regions of the electromagnetic spectrum);

• A range of graphite, ceramic, and ultra-high temperature ceramic materials – including Hafnium carbide (HfC) (including usable for missile components (such as nose-tips, re-entry vehicles, leading edges, jet vanes, control surfaces or rocket motor throat inserts) in ‘missiles’, [some] space launch vehicles, [some] sounding rockets [or] 'missiles');

• Hafnium metal and alloys (with certain properties);

• Maraging steels useable in 'missiles' (with certain properties);

• Certain single or complex oxides of zirconium and complex oxides of silicon or aluminium;

• Robots designed to comply with national safety standards applicable to potentially explosive munitions environments, to operate at high altitudes or withstand high radiation;

Under the Category of Telecommunications and Information Security:

• Mobile telecommunications interception or jamming equipment;

• Telemetry and telecontrol equipment (including ground equipment, designed or modified for ‘missiles’);

• ‘Information security’ systems and components for the control of ‘satellite navigation system’ receiving equipment containing or employing decryption;

• ‘Cryptography for data confidentiality’ having a ‘described security algorithm’ in some conditions;

• Certain systems, equipment and components for defeating, weakening or bypassing ‘information [W] security’ (including ‘functions designed to defeat cryptographic mechanisms in order to derive confidential variables or sensitive data, including clear text, passwords or cryptographic keys’).

The dual list also includes:

• Hydrophones (including ‘Flexible piezoelectric composites’);

• Gyros usable in missiles;

• Certain 'integrated navigation systems', designed or modified for 'missiles'.

Under the Marine category:

• Submersible vehicles and surface vessels;

• Unmanned submersible vehicles;

• ‘Robots’ specially designed for underwater use, controlled by using a dedicated computer;

• Propellers, power transmission systems, power generation systems and certain noise reduction systems.

Under Aerospace:

• Aero gas turbine engines with various technologies;

• Ramjet, scramjet or 'combined cycle engines', and specially designed components thereof;

• ‘Unmanned aerial vehicles’ (‘UAVs’), unmanned ‘airships’, related equipment [and] components [including] Air breathing reciprocating or rotary internal combustion type engines, specially designed or modified to propel ‘UAVs’ or unmanned ‘airships’, at altitudes above 15,240 metres (50,000 feet);

• Vehicles for transport, handling, control, activation or launching, designed or modified for space launch vehicles (specified elsewhere), sounding rockets (specified elsewhere) or ‘missiles’;

• Other ‘technology’ ‘required’ for the ‘development’ or ‘production’ of any of the following gas turbine blades, vanes or ‘tip shrouds’, made from directionally solidified (DS) or single crystal (SC) alloys;

• Components [manufactured] from organic ‘composite’ materials designed to operate above 588K (315°C).

Under stealth technology:

• Materials specially designed for absorbing electromagnetic radiations, or intrinsically conductive polymers (and some materials and devices for reduced observables, such as radar reflectivity, ultraviolet/infrared signatures and acoustic signatures, or usable in some 'missiles', ‘missile’ subsystems or unmanned aerial vehicles, unless formulated solely for civil applications);

• ‘Software’ for analysis of reduced observables, such as radar reflectivity, ultraviolet/infrared signatures and acoustic signatures;

• Some pulse radar cross-section measurement systems and components.

Academic Technology Approval Scheme

The Academic Technology Approval Scheme (ATAS) applies to all international students (apart from exempt nationalities) who are subject to UK immigration control and are intending to study at postgraduate level in certain sensitive subjects. Its subjects are those where students’ knowledge could be used in programmes to develop Advanced Conventional Military Technology (ACMT), WMDs, or their means of delivery.[502] These students must apply for an Academic Technology Approval Scheme (ATAS) certificate before they can study in the UK.

In this area, ministers at the National Security Committee in 2020 signed off plans for stricter controls over the ATAS for Chinese post-graduate students from research institutions with links to the PLA, including within cyber security and aviation.[503]

There have been several important developments with the ATAS policy since the research for *IAC* was produced at the end of 2020:

- ATAS requires all post-graduate students and researchers subjected to visa controls for their period of study in the UK to officially declare all and any military connections (i.e. previous or current military employment in their home nation).
- In January 2021 the FCDO announced that ATAS would equally apply to all researchers, in addition to post-graduate students, before applying for a visa to conduct activities on UK soil that could result in the Intangible Transfer of

[502] Academic Technology Approval Scheme (ATAS) - GOV.UK (www.gov.uk)
[503] Chinese students face ban amid security fears | News | The Times

Technology (ITT) to WMD and ACMT programmes of concern.[504] This came into force 19 May 2021.

Both of these developments are significant for several reasons. First, the ability to track Chinese researchers and post-graduate students who have explicit individual links to the PLA is now a legal requirement set by the Home Office in order to apply for ATAS. Therefore the ability to refuse individuals access on the grounds that they pose a risk of ITT towards either WMD or ACMT programs is, in theory, greatly enhanced by the UK government. However, as this report has highlighted, there are still individuals who have intrinsic links to the PLA who have been granted visas to work on dual-use technology.

Ethical research guidelines

There were significant UK Research and Innovation (UKRI) funded projects uncovered by this research, including computational science research with Chinese researchers from *High Risk* PLA-linked universities. UKRI is a non-departmental public body of the UK government, directing research and innovation funded through the science budget of the Department for Business, Energy and Industrial Strategy.

UKRI highlights a Framework for Research Ethics, alongside their principles for researchers and research teams involved in collaborating with other entities on research projects. These guidelines stipulate that:

> "Projects involving collaborators from more than one organisation can also create complications for ethics review procedures or create specific ethics considerations, for example due to differences in organisational culture, training, access to research resources and participant populations. Consideration should also be given to public attitudes towards the collaboration and conflicts of interest.
>
> A single review process should be agreed by all researchers, with standards which should at least satisfy the ESRC ethics review guidance. Research organisations (ROs) and other partners engaged in collaborative research may agree to use the research ethics committee (REC) of the RO where the principal investigator is based to review the project on behalf of all collaborating ROs."[505]

UKRI therefore acknowledges that issues of ethics are paramount when collaborating with other partners, and that consideration should be given to the public interest and conflicts of interest. Issues of national security could be argued are in the public interest, but quite clearly, this requires firmer guidance and regulation through UKRI funded projects when issues of national security are at risk; the potential theft of sensitive technology which can

[504] FCDO Letter (imperial.ac.uk)
[505] Our expectations for research collaboration – UKRI

have military application by a hostile state entity which has civil-military fusion as a central state policy is surely one such instance requiring firmer guidance and regulation.

Furthermore, the UKRI states that:

> "Where research is to be conducted outside the UK or involves international partners, ROs should require researchers to establish whether ethics review is required by the non-UK ROs, and how the principles of the framework can be followed in developing and undertaking the research. Legal and ethics requirements for all the partner countries must be followed.
>
> Co-funded research may involve the ESRC in partnership with other Research Councils, business, other public sector organisations, civil society sector or research funded under a European Union framework programme and involving research teams from different EU member states. For co-funded research there may be conflicting national or international review procedures. In each of these cases, co-funders will discuss and agree the ethics review expectations. There should be a commitment of mutual recognition of ethical consideration between funders, where possible, of common standards, and it should be made clear where researchers should go for advice."

The above stipulated guidance for UKRI-funded projects involving collaborations with foreign entities places the emphasis upon researchers and their organisations to ensure UKRI ethical guidelines are adhered to. However, as is demonstrated, the wording is ambiguous and vague, using terms such as 'should', 'may', and 'where possible', throughout. This ambiguity towards ethically responsibility evidently leaves British researchers and UK organisations in an uncertain position when it comes to ensuring that the wording of (in this instance) UKRI ethical guidance is followed. As a body within the UK government, drawing its research funding from the Department for Business, Energy and Industrial Strategy, the government must require UKRI to tighten its ethical frameworks to actually ensure compliance, particularly when taxpayer money is used to fund collaborations with high risk Chinese entities linked to the industrial military complex.

The US approach

There was a marked change in rhetoric regarding the nature of bilateral relations with the PRC, and the threats which these posed to national security, from the Obama administration to the Trump administration. The Trump National Security Strategy in 2017 stated that *"China wants to shape a world antithetical to U.S. values and interests"*,[506] whilst in 2020 Secretary of State Mike Pompeo stated that the "*The Chinese Communist Party(s) actions*

[506] NSS_BookLayout_FIN_121917.indd (archives.gov)

are the primary challenge today in the free world".[507] The rhetoric from Trump administration policy documents and officials translated into tougher restrictions for certain Chinese entities, investments, export controls and research collaborations.

Regarding export control, the Export Control Reform Act 2018[508] mandated emerging and foundational technology controls, which the US Congress passed in large part due to concerns about Chinese technological advancement[509] whilst the Military End User (MEU) List was created and MEU restrictions tightened,[510] in addition to an expansion of the Entity List.[511] The US Entity List is an end-user-based control targeting foreign companies involved in activities contrary to the national security or foreign policy interests of the US. Designated entities can be barred from importing any items "subject to the EAR" (including almost any US-origin product); the exporter must first obtain a license. China has been a growing focus of the Entity List, with the number of Chinese entries quadrupling since 2018, from 130 to 532. Four years ago, China comprised only 14 percent of the Entity List; today, it accounts for 29 percent, as almost half of the Entity List's overall growth during that period came from new Chinese entries.[512]

In addition, there were increased investment restrictions, to include; increased activity for the Committee on Foreign Investment in the United States (CFIUS), including a 40% annual rise in filings from 2021;[513] the Foreign Investment Risk Review Modernization Act[514] being passed; the Non-SDN Chinese Military-Industrial Complex Companies List[515] created; and the Holding Foreign Companies Accountable Act[516] passed.

Furthermore, visa bans were instituted for graduate students and researchers tied to civil-military fusion, in addition to a restriction on Chinese Communist Party members. One particularly effective tool is the INA's Section 212(f), which can be used to ban broad categories of foreigners. It allows the US President to exclude "all aliens or any class of aliens" whose entry would be detrimental to the interests of the United States.[517] In May 2020, Trump suspended entry of all foreign graduate students and researchers with past or present ties to "an entity in the PRC that implements or supports the PRC's 'military-civil fusion strategy."[518] The Biden administration have retained this policy tool, which the

[507] Secretary Michael R. Pompeo Remarks "Communist China and the Free World's Future" - U.S. Embassy in Chile (usembassy.gov)
[508] Text - H.R.5040 - 115th Congress (2017-2018): Export Control Reform Act of 2018 | Congress.gov | Library of Congress
[509] Ian F. Fergusson and Karen M. Sutter, "U.S. Export Control Reforms and China: Issues for Congress," Congressional Research Service, January 15, 2021, https://sgp.fas.org/crs/natsec/IF11627.pdf.
[510] Federal Register :: Addition of `Military End User' (MEU) List to the Export Administration Regulations and Addition of Entities to the MEU List
[511] Federal Register :: Addition of Certain Entities to the Entity List
[512] The Evolution of U.S. Thinking and Policy - U.S.-China Technological "Decoupling": A Strategy and Policy Framework - Carnegie Endowment for International Peace
[513] CFIUS continues its watchful eye on foreign investment | White & Case LLP (whitecase.com)
[514] Summary-of-FIRRMA.pdf (treasury.gov)
[515] Non-SDN Chinese Military-Industrial Complex Companies List (NS-CMIC List) | U.S. Department of the Treasury
[516] SEC.gov | Holding Foreign Companies Accountable Act ("HFCAA")
[517] 8 U.S. Code § 1182 - Inadmissible aliens | U.S. Code | US Law | LII / Legal Information Institute (cornell.edu)
[518] Proclamation 10043, "Suspension of Entry as Nonimmigrants of Certain Students and Researchers From the People's Republic of China," May 29, 2020, https://www.federalregister.gov/documents/2020/06/04/2020-12217/suspension-of-entry-as-nonimmigrants-of-certain-students-and-researchers-from-the-peoples-republic.

Georgetown's Center for Security and Emerging Technology estimates that 3,000 to 5,000 Chinese students and researchers in science, technology, engineering, and math (STEM) could be excluded annually.[519]

These changes highlight a keen awareness of the varied national security risks posed by allowing research collaborations with Chinese entities from particular backgrounds, including in dual-use technology research and with individuals holding party membership. This last point is especially subtle but important; all CCP members are expected to put party priorities before their own. This can readily be understood in the context of IP ownership and theft with Chinese researchers, and a complete lack in the UK of mutually enforcing ethical guidelines framing joint projects, with the end user for dual-use technology research wholly in the hands of the civil-military fusion-focussed CCP with researchers from PLA-linked universities, and individual backgrounds.

This is an approach which the new British government must incorporate, particularly regarding expanding visa requirements to deny entry for dual-use technology research requests from any individuals with prior or existing backgrounds in the PLA, in addition to CCP membership. Quite simply, the national security risks associated with those individuals far outweigh any benefits to British research.

[519] Remco Zwetsloot, Emily Weinstein, and Ryan Fedasiuk, "Assessing the Scope of U.S. Visa Restrictions on Chinese Students," Center for Security and Emerging Technology, February 2021, https://cset.georgetown.edu/publication/assessing-the-scope-of-u-s-visa-restrictions-on-chinese-students/.

Conclusions and Recommendations

Conclusions

China continues to militarise in order to achieve equal military power with the US in only five years' time. This is crucial to achieve unification by either coercion or force of Taiwan – a stated CCP strategic aim. In addition, China has a long history of weapons sales to regimes that carry out grievous human rights abuses including Iran, Syria, Burma and North Korea. More recently, Beijing have also supplied Russia with arms, intelligence, and cyber capabilities during Moscow's unprovoked and illegal war in Ukraine. Furthermore, China's development of a surveillance state is already leading to systematic human rights abuses, with its treatment of the Uighur minority repeatedly described as genocide.

The methods by which the UK monitors and regulates Chinese involvement in UK university research are, we suggest, fundamentally still woefully inadequate. The companies sponsoring UK-based research centres still include China's largest weapons manufacturers, including producers of strike fighter engines, ICBMs, nuclear warheads, stealth aircraft, military drones, tanks, military-use metals and materials, and naval warships.

Furthermore, the threats to UK national security via IP ownership and theft of dual-use technology, through high-risk end users including PLA-linked conglomerates by Chinese researchers based UK universities, often with former or even existing ties to the PLA, is the absolute height of strategic incoherence. This simply must not allow to be continued to go ahead as 'business as usual' by UK universities blindly accepting Chinese research funding and Chinese partners who clearly and demonstrably have tangible and direct links to the Chinese military industrial complex. A complex which at its heart has civil-military fusion embedded into its strategy to usurp the existing global order.

At its simplest, for the UK government and taxpayer to continually fund and assist the technological development and the force-projection capabilities of the military of the People's Republic of China is not in the British national interest. China is demonstrating rapid technological military development and growing force-projection capabilities. To risk financing and enabling these developments suggests a lack of strategic coordination which it was hoped would end after the government correctly identified China as a systemic challenge in 2021, and especially now after the new British Prime Minister has stated a desired review into upscaling the classification of China, to a similar view to which Britain classifies security threats from Russia.

This points to the need for an urgent strategic reassessment by the new British government in Westminster, for new rules for scientific research with PRC universities and companies, some of which should be applied directly to the UK's research councils and universities, while some may require legislation. Other rules are needed for scientific research in wider potentially sensitive scientific fields generally and in universities in particular, with a further strengthening to the Home Office for ATAS applications.

Recommendations

The UK government should:

- List all those Chinese military-linked companies and institutions that it wants to bar from sponsoring science research in UK universities and from research cooperation in general. At an absolute **minimum** this ought to include the National University of Defence Technology (NUDT), the Seven Sons of National Defence, and all Chinese defence conglomerates. Serious consideration should be applied to adding all universities rated as *High Risk* and *Very High Risk* by the Australian Strategic Policy Institute (ASPI) on their universities tracking data.
- List those entities it wishes to prevent making inward investments generally into the UK. This has been the practice of the US government and looks set to continue under the Biden administration.
- Introduce much tougher oversight mechanisms for UK universities and research centres accepting funding and other support from entities linked to hostile military powers. This is not happening with Chinese sponsorship to the same degree as say Iran or North Korea, yet has the ability to undermines national security to the same extent.
- Initiate a public audit of UK universities' sponsorship policies to establish the total Chinese funding of UK technology research and establish new rules for universities themselves, as well as for UKRI, Innovate UK, the Royal Society, and research councils. Combined with an 'entities list', this may be best placed in new legislation dealing with research and Chinese military-linked organisations specifically, or authoritarian states generally.
- Set up a new government organisation similar to the Committee on Foreign Investment in the United States (CFIUS), whose role would include monitoring and assessment of university sponsorship.
- While it is important to preserve academic freedom, the government should more deeply assess whether some of what is currently deemed 'basic scientific research', or research with findings in the public domain, may have possible dual-uses in sanctioned countries including China, and where approval for research centres may have allowed projects which are exposed to this risk to take place.
- At present research guidelines for UK universities are advisory/recommended at best, and are up to the institutions themselves to police/action and oversee. This internal audit capability therefore places no external ownership or oversight ability outside of the university. When universities are financially incentivised to pursue research collaboration with proven high risk entities, then it is no longer ad adequate system ensuring checks and balances are conducted. Here, research councils including UKRI should seek to place stringent conditions on any financial awards or grants for research which involves international collaborations with high risk entities – including their own checks and balances to ensure that their money, and UK

taxpayer money, is not going towards the inadvertent sponsorship of hostile nation's and their militarisation.

- Further review the Academic Technology Approval Scheme (ATAS), to better control visa (re)applications for international students and researchers (apart from exempt nationalities) whose research may create risks in certain sensitive subjects – particularly those with military links to hostile foreign powers. There are specific cases of PLA personnel studying dual-use technology at UK universities who have seemingly had their ATAS applications approved. Not only is this an incredibly alarming oversight by the Home Office, but those individuals found to be from a hostile foreign military studying sensitive technology subjects which have a defined military application should have their visas revoked and removed from the UK.
- Reassess the areas of scientific research that can be carried out by public research institutions and/or in which research findings can be publicly released. These measures should form part of an urgent reassessment of the security implications of the so-called 'Golden Era' policies towards China and the strategic assumptions that underpinned them.
- An absolute ban on visa and ATAS applications for Chinese individuals who have worked for the PLA, either in one of the five strategic arms of the PLA, or any officially affiliated research institution (i.e. the PLA's Air Force Engineering University), or for anyone who holds current CCP membership.

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