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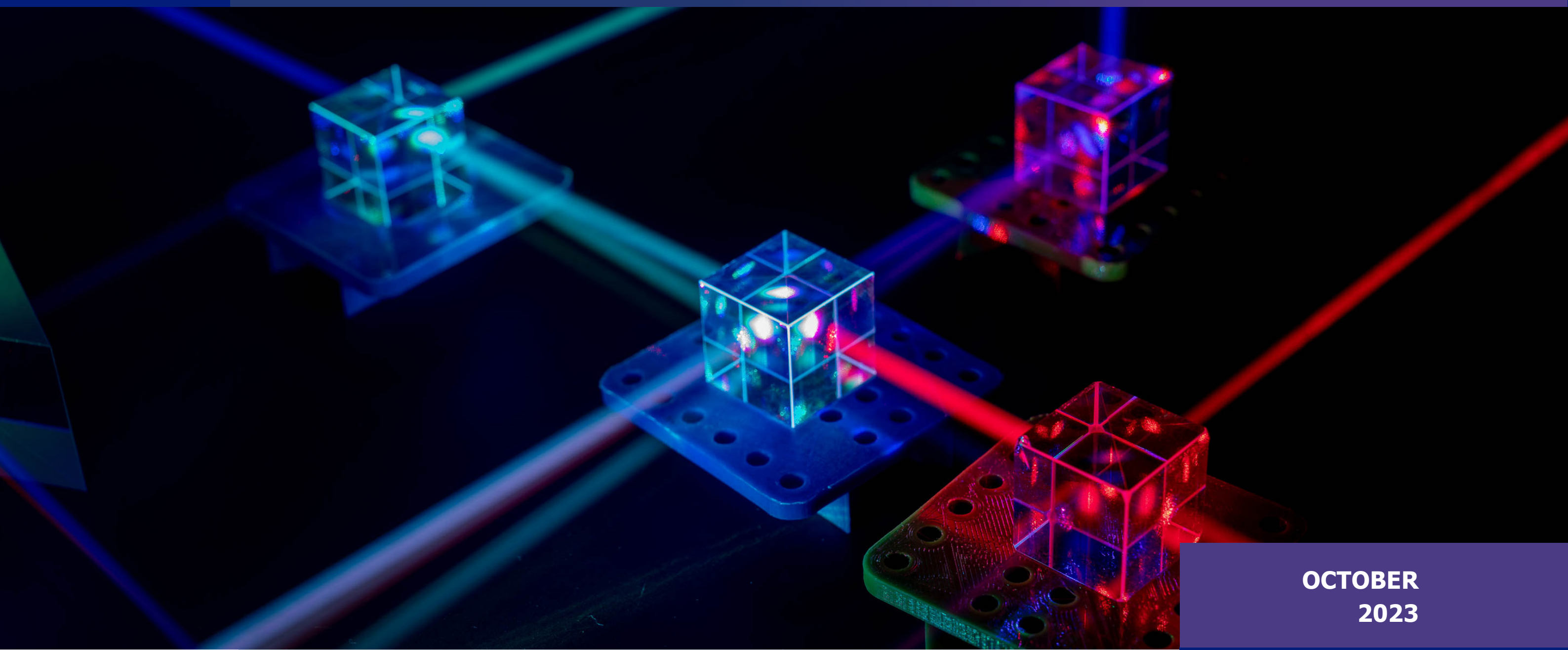

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# Balancing Security and Openness for Critical Technologies

## Challenges for French and European Research

Alice PANNIER

The French Institute of International Relations (Ifri) is a research center and a forum for debate on major international political and economic issues. Headed by Thierry de Montbrial since its founding in 1979, Ifri is a non-governmental, non-profit foundation according to the decree of November 16, 2022. As an independent think tank, Ifri sets its own research agenda, publishing its findings regularly for a global audience.

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# Executive Summary

While matters related to research security and international partnerships in critical domains are certainly not new, they have become increasingly central to governments, research institutions and industry since the turn of the 2020s. Two recent geopolitical factors have contributed to this focus. On the one hand, concerns about China have led to a re-examination of existing research security mechanisms. On the other hand, Russia's invasion of Ukraine in 2022 has led to unprecedented sanctions on scientific cooperation by the European Union (EU).

In Europe, governments and companies are adapting their instruments for protecting research in the face of the risk of knowledge drain and the new geopolitical situation. The French model, with its policy for "Protecting the Nation's Scientific and Technical Potential", is notable for its scope and centralized control mechanisms. At the same time, within the EU, the European Commission has undergone a paradigm shift, abandoning an attitude of openness by default, taking up the issue of foreign interference in research, and linking its research policy more closely to its ambitions for technological sovereignty.

Science and technology diplomacy is also being rethought, both at the level of the EU and its Member States. International cooperation in research is increasingly seen as a means of strengthening political ties as part of a strategy of influence and strategic partnerships with like-minded countries. Critical and emerging technologies, such as artificial intelligence and quantum technologies, are at the heart of these new partnerships. They are also characterized by greater European vigilance over the reciprocity of exchanges and the intellectual property implications for Europe.

These political developments are taking place in a context of changing research ecosystems, particularly in the digital sector, where industry is playing an increasingly important role. This situation limits the scope for government action in terms of both research security and international partnerships.

# Résumé

Si la sécurité de la recherche et l'enjeu des partenariats internationaux dans les domaines critiques sont loin d'être des questions nouvelles, celles-ci apparaissent depuis le tournant de la décennie 2020 comme de plus en plus centrales aux yeux des gouvernements, des institutions de recherche et de l'industrie. Deux facteurs géopolitiques récents ont contribué à cette mise à l'agenda. D'une part, les inquiétudes envers la Chine ont entraîné un réexamen des mécanismes existants en matière de sécurité de la recherche. D'autre part, l'invasion de l'Ukraine par la Russie en 2022 a entraîné de la part de l'Union européenne (UE) des sanctions sans précédent dans la coopération scientifique.

En Europe, les États et entreprises adaptent leurs outils de protection de la recherche face aux risques de fuite de connaissances et à la nouvelle donne géopolitique. Le modèle français, avec sa politique de Protection du potentiel scientifique et technique de la Nation, est notable par sa portée et la centralisation des mécanismes de contrôle. En parallèle, au sein de l'UE, la Commission européenne a effectué un changement de paradigme, rompant avec une posture d'ouverture par défaut, se saisissant des problématiques d'ingérence étrangère dans la recherche et liant davantage sa politique de recherche avec ses ambitions de souveraineté technologique.

La diplomatie scientifique et technologique est également repensée, tant au niveau de l'UE que de ses États membres. Les coopérations internationales dans la recherche sont de plus en plus perçues comme participant au renforcement de liens politiques dans une logique d'influence et de partenariats stratégiques avec des pays affinitaires. Les technologies critiques et émergentes, au premier rang desquelles l'intelligence artificielle et le quantique, sont au cœur de ces nouveaux partenariats. Ceux-ci sont également caractérisés par une plus grande vigilance européenne quant à la réciprocité dans les échanges, et les retombées pour l'Europe en matière de propriété intellectuelle.

Ces évolutions politiques se jouent sur fond de transformation des écosystèmes de recherche, notamment dans le numérique, où l'industrie joue un rôle de plus en plus important. Cet état de fait limite la portée de l'action de l'État en matière de sécurité de la recherche, comme dans les choix de partenariats internationaux.

# List of acronyms

**BPI** – Public Investment Bank (France)

**CERN** – European Organization for Nuclear Research

**CNRS** – National Center for Scientific Research (France)

**DGSI** – General Directorate for Internal Security (France)

**EUIPO** – European Union Intellectual Property Office

**GPAI** – Global Partnership for Artificial Intelligence

**HFDS** – Senior Defense and Security Official (France)

**Inria** – National Institute for Research in Digital Science and Technology (France)

**ITER** – International Thermonuclear Experimental Reactor

**MEAE** – Ministry of Europe and Foreign Affairs (France)

**MESR** – Ministry of Higher Education and Research (France)

**NUDT** – National University of Defense Technology (China)

**IP** – Intellectual Property

**PPST** – Protecting the Nation's Scientific and Technical Potential (France)

**R&D** – Research and Development

**R&I** – Research and Innovation

**SGDSN** – General Secretariat for Defense and National Security (France)

**SGPI** – General Secretariat for Investment (France)

**Sissé** – Department of Strategic Intelligence and Economic Security (France)

**S&T** – Science and Technology

**TRL** – Technology Readiness Level

**ZRR** – Restricted area (Zone à régime restrictif)

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# Introduction

Research requires international collaboration to produce knowledge, tackle global challenges and drive innovation. While research communities are inherently open, certain risks threaten such collaboration, particularly for research in so-called critical technologies. Critical technologies – a term in use in the United States since the 1980s, the scope of which can vary – are technologies whose properties are of special importance to national interests, key to economic growth, and subject to international competition and espionage risks.[1]

Critical technologies include emerging technologies, which "have not yet attained a sufficient level of maturity to enter the market", or which are aimed at a market that is not yet sufficiently developed.[2] The term "disruptive technologies" is also used to refer to innovations designed to replace the dominant technology in a given market, resulting in the introduction of a new category of product or service. They give first movers the opportunity to benefit from "discovery primacy".[3] States thus enter the emerging technology arms race to "capitalize on the potential industrial and military advantages" that will result from this research.[4]

The disruptive potential of emerging technologies like artificial intelligence (AI) and quantum technologies makes them central to international technological competition. This raises however the question of how far the scope of sciences and technologies to be protected should be extended. For military or dual-use technologies listed under international control regimes, states have obligations, and therefore tools, to prevent their dissemination or proliferation: government-funded research, classified research, secure premises, export controls, etc. For many emerging technologies, however, one challenge lies in identifying those areas where the risk of proliferation and/or opportunities for economic gain are likely to arise in the future.[5]

Critical and emerging technologies also bring into question the role, nature and geographical location of those producing research. Emerging technologies are the product of long-term research, which, in an academic context, depends on publishing results, reproducing experiments, peer review, circulating researchers and international collaboration. Research in critical technologies is an extremely international field. Quantum technology

1. B. Bimber and S. W. Popper, "What Is a Critical Technology?", RAND, DRU-605-CTI, February 1994.
2. P. Marlier and J.-F. Mathieu, "Technologies clés émergentes : outil de politique publique pour la recherche", BIPE report for the Senate, February 2008, p. 6.
3. C. A. Grubbs, "Optimization of U.S. Government Research and Development Framework with Emphasis on Discovery Primacy and Resource Efficiency", PhD thesis, Georgetown University, 2022, p. 3.
4. *Ibid.*
5. Interviews with senior public administration officials.

is a case in point: in the United States, half of all graduates in fields related to quantum technologies are foreign nationals.[6] International co-publications are also statistically more common than in most fields of technological research[7]: around half of all U.S. quantum science publications have a co-author working in a foreign institution.[8] This international reach attracts top talent[9] and tends to increase the impact of research.[10]

Yet the industry is also involved in the development of critical technologies, including what is known as fundamental research. This is particularly true in the digital, quantum, transport, energy, and healthcare sectors. The quantum industry has developed over the last 5 to 10 years to the point that "the center of gravity has shifted to the private sector".[11] This trend is even more apparent in fundamental AI research. The authors of the most "significant" academic articles globally are now almost all affiliated with the industry or are part of joint teams, with ratios flipping around 2018 (see Figure 1, next page).[12]

The industry attracts leading scientists with attractive working conditions and access to data and computing power.[13] Indeed, the computational power required to run "large-scale experiments" in AI have increased more than 300,000-fold over the past decade, and this surge in resource requirements has resulted in a decline in purely academic contributions to such experiments, dropping from 60% to nearly zero.[14] The privatization of research in critical sectors raises the question of where these ecosystems are located, how their inventions are protected, and where the capital funding them comes from. This state of affairs means that this study must also take into account the private sector's particular dynamics.

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6. *The Role of International Talent in Quantum Information Science,* National Science and Technology Council, October 2021, p. 4. The relevant fields of study are: physics, computer science, mathematics and electrical engineering.

7. E. Parker, interviewed by Y. Boger on "The Qubit Guy's Podcast", August 3, 2022, available at: www.youtube.com.

8. E. Parker, "Promoting Strong International Collaboration in Quantum Technology Research and Development", Perspectives, RAND Corporation, February 2023, p. 9.

9. The majority of the "most promising" AI start-ups in the United States were founded by people from outside the U.S., including immigrants from India, Israel, the United Kingdom and China. See T. Huang, Z. Arnold and R. Zwetsloot, "Most of America's 'Most Promising' AI Startups Have Immigrant Founders", *CSET Data Brief*, Center for Security and Emerging Technology, October 2020, p. 4.

10. Articles stemming from international collaborations tend to be cited more often, and therefore have greater impact. See E. S. Vieira, "The Influence of Research Collaboration on Citation Impact: The Countries in the European Innovation Scoreboard", *Scientometrics*, No. 128, 2023, p. 3555-3579.

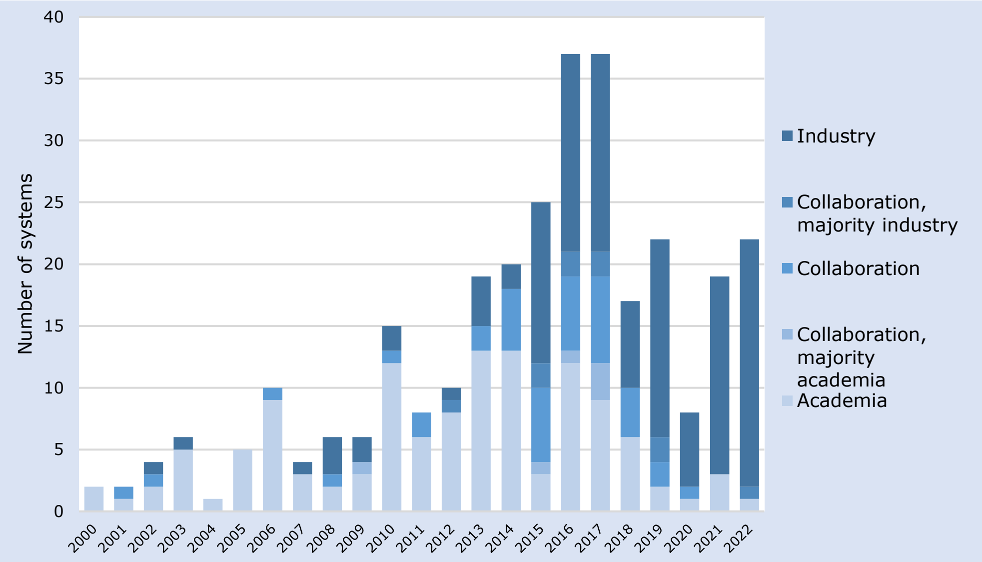
11. E. Parker on "The Qubit Guy's Podcast", *op. cit.*

12. *Ibid.,* p. 32.

13. P. Hartmann and J. Henkel, "The Rise of Corporate Science in AI: Data as a Strategic Resource", *Academy of Management Discoveries*, vol. 6, No. 3, 2020, p. 359-381; I. Sample, "'We Can't Compete': Why Universities Are Losing their Best AI Scientists", *The Guardian,* November 1, 2017, available at: www.theguardian.com.

14. D. Ganguli, "Predictability and Surprise in Large Generative Models", FAccT '22: Proceedings of the 2022 ACM Conference on Fairness, Accountability, June 2022, p. 12, available at: https://dl.acm.org.

**Figure 1. Affiliation of researchers involved in the largest machine learning systems (2000-2022)**




*Sources: J. Sevilla* et al., *"Compute Trends Across Three Eras of Machine Learning", 2022, available at https://arxiv.org/abs/2202.05924; data available at https://docs.google.com. Adapted from Institut Montaigne, "Investir l'IA sûre et digne de confiance : un impératif européen, une opportunité française",* Action Note, *April 2023.*

Because they are the product of research (whether private or academic), and because of their strategic importance, emerging technologies challenge the balance between the desire of states like France, and the European Union (EU), to assert "sovereign" control over certain technologies, and the open nature of scientific research. This dilemma is all the more pressing in the current international context. This period is characterized by the technological ascendancy and political hardening of China on the one hand, and the Russian invasion of Ukraine on the other. These two factors threaten the existing balance between open and closed research ecosystems for emerging and disruptive technologies.

Geopolitical and technological developments are making the protection of research and collaboration strategies a central concern for governments and corporations alike. How are these concerns reflected in the tools private and public-sector actors choose to safeguard research, and in their partnership strategies? Many studies have examined the situation in the United States. But Europe is also a key region for research and development in critical and emerging technologies. It is therefore also a target for technology and knowledge acquisition strategies. Europe is also keen to establish itself as a model for the management of tensions between open and closed research ecosystems. Within Europe, France is in many respects a forerunner, with other countries following its lead. This analysis will therefore focus on France and the EU.

This study examines how French and European public and private actors are tackling these dilemmas, drawing extensively on interviews conducted in spring-summer 2023 with, in particular, the French Ministries of Europe and Foreign Affairs, the Economy, Finance and Industrial and Digital Sovereignty, and Higher Education and Research; the Prime Minister's office; Inria (the French National Institute for Research in Digital Science and Technology); the European Commission; the U.S. State Department; and several companies (French industrial groups, a French start-up, and an American technology company operating in Europe). This study also draws on several closed seminars.

The study first examines the evolution of the international context, causing certain international research cooperations to be reconsidered, in particular due to risks associated with practices adopted by the Chinese government, and the Russian invasion of Ukraine. We then look at the tools implemented by France and the EU to secure research and protect innovation, and their adaptation to new developments. This study shows that, over the last three years or so, France and Europe have introduced stricter measures to protect research against foreign interference and unwanted transfers of knowledge in areas deemed critical. Finally, we examine how international research and R&D partnerships are evolving, in order to ensure strategically sound cooperation, which remains essential for the advancement of knowledge and innovation. Science and technological diplomacy is increasingly seen as a means of strengthening political ties, as part of a strategy of influence and strategic partnerships with like-minded countries.

# Openness as a risk: geopolitical challenges to cooperation in research

While the security of research and the importance of international partnerships in critical fields are by no means novel concerns, they have taken on an increasingly central role since the start of the 2020s, in the eyes of governments, research institutions and industry alike. Two recent geopolitical factors have contributed to this shift in focus.

On the one hand, concerns about China have led to a re-examination of existing research protection mechanisms. China's impressive technological ascent over the past decade is underpinned by a strong commitment to international research collaborations, backed by the government in Beijing. Knowledge acquisition strategies, "military-civil fusion" and infringements of academic freedoms have led to a growing awareness in Europe, especially from 2021 onwards, of the need to reassess the security of research and certain partnerships in critical sectors.

On the other hand, Russia's invasion of Ukraine in 2022 has led to unprecedented EU sanctions on scientific cooperation. Scientific diplomacy has traditionally been seen as a means of maintaining ties despite political tensions, but Russia's case seems to have introduced a new paradigm: profound conflicts in values, such as those revealed by the illegal invasion of Ukraine, can lead to withdrawal from bilateral institutional ties in research, and the suspension or delay of multilateral scientific cooperation.

## Openness to China in technological research entails greater risks

### *Rising technological power driven by government-backed international integration*

China has become a leading technological power, fully integrated into international research networks. Since 2016, it produces more scientific publications than any other nation.[15] Its achievements are especially striking in the fields of life sciences, agronomy, chemistry, materials science, mathematics and information sciences.[16] Funding from the Chinese government has contributed significantly to this growth. In 2018, China

15. T. Shih and E. Forsberg, "Origins, Motives, and Challenges in Western-Chinese Research Collaborations amid Recent Geopolitical Tensions: Findings from Swedish-Chinese Research Collaborations", *Higher Education,* No. 85, 2023, pp. 651-667.

16. *Research Fronts 2021,* CAS & Clarivate, December 2021, cited in T. Shih and E. Forsberg, 2023.

invested more in R&D than the EU as a whole.[17] Building on this momentum, Beijing plans to increase R&D spending by 7% annually between 2021 and 2025, and fundamental research spending by 10%.[18]

China's success is not simply due to budgetary support for research, but above all to its integration into global research networks. In recent years, this integration has been the subject of numerous reports (from members of parliament, the media, think tanks) underscoring the relationship between international cooperation programs and China's strategy for knowledge acquisition and technological development, including through intellectual property theft.[19] With regard to academic research, China's strategy relies on:

- **Study and research grants:** the Chinese government encourages international mobility for Chinese students and researchers, through grants such as those awarded by the China Scholarship Council, which Europe and the United States monitor closely.[20]
- **Research collaborations:** recent studies show that collaborations with European researchers are mainly initiated by Chinese researchers, in particular in fields of strategic importance to China and which are nearing commercialization, e.g., robotics, AI, aeronautics and 5G technologies.[21] European academics' lack of awareness and caution concerning these risks facilitates Chinese efforts. In one example documented by the Dutch platform Follow the Money, one PhD student from the University of Aalborg (Denmark) collaborated with a Chinese engineer who claimed to come from a nonexistent university.[22]
- **Recruitment:** in 2008, China launched its "1,000 Talents" program to recruit international experts (Chinese diaspora and foreign researchers) in key technology sectors. The U.S. intelligence community revealed in 2018 that this program was aimed at transferring sensitive technologies,

17. J. Tollefson, "China Declared World's Largest Producer of Scientific Articles", *Nature.com*, January 18, 2018, available at: www.nature.com. Cited in T. Shih and E. Forsberg, 2023. Chinese investment is higher in absolute terms, but significantly lower than that of European countries as a share of GDP.Cited in T. Shih and E. Forsberg, 2023. Chinese investment is higher in absolute terms, but significantly lower than that of European countries as a share of GDP.

18. A. De Bruijn, D. Booij, H. Emanuel, M. Sys and S. Eikelenboom, "European Universities Are Helping China to Build the World's Most Modern Army", *Follow the Money,* May 19, 2022, available at: www.ftm.eu.

19. A. Gattolin (rapporteur), *Rapport d'information fait au nom de la mission d'information sur les influences étatiques extra-européennes dans le monde universitaire et académique français et leurs incidences,* Report No. 873, Paris, Senate, September 2021. See also NCSC, "Fact Sheet – Protecting Critical and Emerging U.S. Technologies from Foreign Threats", October 21, 2021.

20. E. Felden, "How China Controls Its Top Students in Germany", *Deutsche Welle*, July 3, 2023, available at: www.dw.com.

21. I. d'Hooghe, A. Montulet, M. de Wolff and F. Pieke, "Assessing Europe-China Collaboration in Higher Education and Research", LeidenAsiaCentre, 2018.

22. A. De Bruijn *et al.*, "European Universities Are Helping China to Build the World's Most Modern Army", *op. cit.*

including through intellectual property infringement.[23]

Chinese espionage practices – cyber-espionage in particular – are also well documented. Germany's recent strategy towards China reveals that Chinese cyber-actors engage in economic and academic espionage to gain access to the commercial and research secrets of German high-tech companies.[24] According to the Dutch government, these unauthorized leaks of sensitive knowledge and technology have stymied Europe's potential for innovation, thereby undermining its competitiveness.[25] In its 2021 annual report, Dutch intelligence called China "the greatest threat to the economic security of the Netherlands".[26]

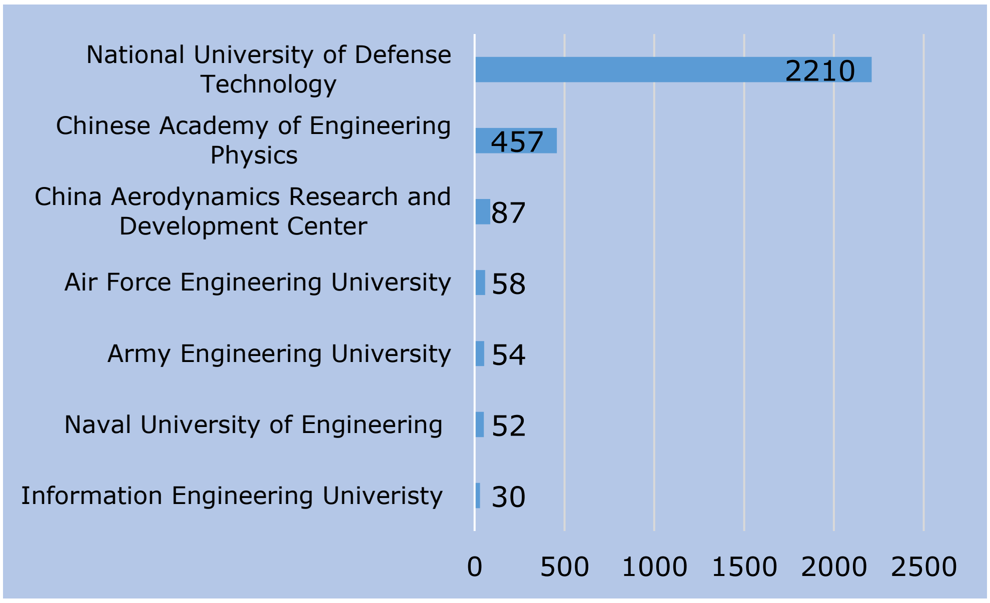
## *The issue of military-civil fusion*

These unwanted leaks of knowledge to China are of even greater concern since the implementation of the "military-civil fusion" law in 2015. Civil-military integration is "a process that aims to combine defense and civilian industrial and technological bases so that technologies, manufacturing processes and equipment, but also personnel and facilities, can be shared".[27]

Scientific cooperation channels have thus led to (indirect) participation from Europe and the United States in the development of Chinese military technologies. Democracies run the risk of unintentionally violating their international non-proliferation obligations and/or having shared knowledge used against them at a later stage.[28] An investigation backed by Follow the Money and carried out by thirty investigative journalists, published in May 2022, revealed the extent of the connections between European universities and the Chinese military ecosystem. It examines 2,994 publications resulting from these cooperations, which have expanded since 2012.[29] Of these, over 2,000 involved the National University of Defense Technology (NUDT), the Chinese army's main engineering school. The areas of research cooperation tied to the Chinese army (in descending order of the number of publications) are: computer science, physics, engineering, novel materials, mathematics, photonics and AI.

23. A. Gattolin, *Rapport d'information fait au nom de la mission d'information sur les influences étatiques extra-européennes*, *op. cit.*, p. 82.
24. Government of the Federal Republic of Germany, *Strategy on China,* July 2023, p. 45.
25. Dutch Ministry of Education, Culture and Science, *Knowledge Security in Higher Education and Research,* November 2020, p. 3, available at: www.government.nl.
26. A. De Bruijn *et al.*, "European Universities Are Helping China to Build the World's Most Modern Army", *op. cit.*
27. "La Chine : première puissance mondiale du XXIe siècle ?", Report No. 24, Committee on National Defense and Armed Forces, National Assembly, December 2019.
28. Dutch Ministry of Education, Culture and Science, *Knowledge security*, *op. cit.*
29. A. De Bruijn *et al.*, "European Universities Are Helping China", *op. cit.* Co-publications are however in decline after 2019, presumably due to Covid.

**Figure 2. European collaborations with Chinese military institutions**




*Source: Adapted from A. De Bruijn, D. Booij, H. Emanuel, M. Sys and S. Eikelenboom, "European Universities Are Helping China to Build the World's Most Modern Army",* op. cit.

The case of quantum technologies offers an example of how seemingly innocuous academic ties between Europe and China have helped consolidate Beijing's lead in this strategic field. Leading Chinese researchers have benefited from EU research grants (Marie Curie program) and numerous, far-reaching and institutionalized collaborations with organizations such as the Austrian Academy of Sciences and the University of Heidelberg (Germany).[30] In 2016, Pan Jianwei, a researcher behind many of China's advances in quantum communications, on being asked about Chinese advances in quantum technology, said, "We've taken all the good technology from labs around the world, absorbed it, and brought it back [to China]."[31]

These revelations are also taking place at a time when civil and political rights are being eroded, which impacts universities. Fudan University in Shanghai, for example, has removed references to "academic independence and freedom of thought" from its charter, replacing them with "Xi Jinping's thoughts on Chinese socialism in the new era" and postulates adherence to

30. M. Julienne, "Le rêve quantique chinois : les aspirations d'un géant dans l'infiniment petit", *Études de l'Ifri*, February 2022, p. 15-16 ; S. Petersmann and E. Felden, "China's Quantum Leap – Made in Germany", *Deutsche Welle*, June 13, 2023, available at: www.dw.com; *Quantum Dragon: How China is Exploiting Western Government Funding and Research Institutes to Leapfrog in Dual-Use Quantum Technologies,* Strider, November 2019, p. 13.*Quantum Dragon: How China is Exploiting Western Government Funding and Research Institutes to Leapfrog in Dual-Use Quantum Technologies,* Strider, November 2019, p. 13.

31. G. Chang, "Despite 'Quantum Leap,' China's Innovation Sector in Distress", *Forbes*, August 21, 2016, available at: www.forbes.com.

the role of the leader of the Chinese Communist Party.[32] Germany's China strategy, published in July 2023, stresses that increasing restrictions on civil society, the media, research institutions and government agencies have resulted in "a growing asymmetry" in relations with China.[33]

While unfair academic practices, espionage and interference in research are far from being China's exclusive purview, the systemic nature of its strategy, coupled with its military-civil fusion, makes it one of the main causes of concern for European policy-makers and private actors, and one of the main factors driving the adaptation of security tools for research, which we will examine in the next section.

# Scientific and technological sanctions against Russia: a test?

> "Scientific diplomacy is being reinvented today in the heat of the war in Ukraine."[34]

## *After the invasion of Ukraine: unprecedented academic sanctions against Russia*

In 2015, shortly after Russia's annexation of Crimea and destabilization of eastern Ukraine, Carlos Moedas, then European Commissioner for Research and Innovation, declared, "We are working to maintain this important bridge to Russia, maintaining precious ties through the common language and ideals of science."[35] In 2021, the CNRS wrote of the Poncelet center in Moscow: "Russia is one of the CNRS's leading scientific partners […]. A partnership dating back to the Joliot-Curies, before the CNRS was even founded, with collaborations in the field of nuclear physics that are still very much alive today."[36]

Russia's invasion of Ukraine in late February 2022 resulted in a very different reaction than in 2014. By spring, scientific and technological ties between Russia and Europe were sanctioned in an unprecedented way.[37] According to the socialist member of the German parliament Ruppert Stüwe,

32. P. Buhler, "'L'offensive de Pékin contre les libertés académiques appelle des mesures défensives'", *LeMonde.fr,* June 8, 2021, available at: www.lemonde.fr.

33. *Strategy on China,* Government of the Federal Republic of Germany, July 2023, p. 20.

34. S. Balme, "Ukraine-Russie, la diplomatie scientifique à l'épreuve de la guerre", *Les dossiers du CERI,* April 2022, available at: www.sciencespo.fr.

35. P. Ruffini, "Guerre en Ukraine, sanctions académiques et diplomatie scientifique", working paper, May 2023, p. 17, available at: www.hal.science.

36. "Au centre Poncelet à Moscou, 20 ans de recherches collaboratives", CNRS Info, March 29, 2021, available at: www.cnrs.fr; P. Roppert, "'On risque une dégradation rapide et totale de la science en Russie'", France Culture, April 19, 2022, available at: www.radiofrance.fr.

37. Precedents include Iran, North Korea, Libya and Syria. Boycotts also took place during the 20th century against Germany, the Soviet Union and South Africa. See M. D. Gordin, "A Century of Science Boycotts", *Nature*, May 25, 2022. Today, according to Pierre-Bruno Ruffini, the range of scientific sanctions against Russia is unprecedented and historic in its scope. See P.-B. Ruffini, "Guerre en Ukraine", *op. cit.*

the war on Ukraine and hybrid threats to democracies have "called into question the validity and effectiveness of soft power exerted through education and science" – principles of scientific diplomacy expressed in slogans like "change through exchange", or "science for diplomacy".[38]

As for France, in its decision to suspend cooperation with Russia, the CNRS declared that "the shared values of all scientific communities cannot tolerate this war", while the Académie des Sciences stated that "international cooperation, in science as in many other fields, demands the protection of freedom, the freedom of peoples to determine their own fate, and their freedom of thought and expression".[39] Thus, in the spring of 2022, one of the primary justifications for sanctioning scientific cooperation was the threat to academic freedom in Russia, in the context of the war. Shortly after the invasion began, the Russian Union of Rectors, composed of 140 public figures, published a letter in support of Vladimir Putin, institutions expelled students who opposed the war, and public statements denouncing the war were removed from the websites of several universities.[40]

Many members of the Russian Academy of Sciences, Russian researchers and scientific journalists also signed an open letter denouncing Ukraine's aggression, calling for its immediate cessation. Despite these conflicting voices, the idea that scientific relations with Russia should, in some shape or form, be subject to sanctions, was supported by around 70% of European researchers responding to a survey conducted by *Science Business*.[41] Following the same rationale, the EU decided to sanction research in Russia as of March 4, 2022. Russia has been suspended from the Horizon (research funding) and Erasmus (student mobility) programs, and the EU has decided not to commit to any further cooperation projects and to suspend all payments to Russian entities under ongoing contracts.[42] At the same time, many efforts (which we will not cover here in detail) have been made to support Ukrainian researchers. The EU has committed to fast-tracking Ukraine's inclusion in the Horizon program in 2022, with no participation fees.[43] Similar measures were taken by the governments of many member states. In a memorandum dated February 28, 2022, the French National Center for Scientific Research (CNRS) instructed French laboratories to "suspend all new bilateral cooperations, except in duly

38. R. Stuwe and T. Flink, "Viewpoint: How a Year of War Has Changed German Science and Higher Education Policy", *Science Business*, February 21, 2023, available at: www.sciencebusiness.net.

39. Cited in P. Ruffini, "Guerre en Ukraine", *op. cit*.

40. H. Richard, "Le Kremlin verrouille la liberté d'expression", *Le Monde Diplomatique*, April 2022, p. 10, available at: www.monde-diplomatique.fr.

41. "Most European Researchers Support Science Sanctions on Russia", *Science Business*, October 27, 2022, available at: www.sciencebusiness.net.

42. Pierre-Bruno Ruffini points out that, "unlike the economic sanctions imposed by the Union, nothing has been said about the expected impact of such decisions [and] these provisions are not systematically supervised, nor is their enforcement". See P. Ruffini, "Guerre en Ukraine", *op. cit.*, p. 1.

43. Interview with a representative of the French Ministry of Higher Education and Research.

substantiated and validated cases”.[44] Certain academic journals also individually decided to reject all manuscripts from researchers affiliated with Russian institutions. Some countries, such as Hungary, however, are not imposing academic sanctions on Russia.[45]

In the United States, the White House Office of Science and Technology Policy issued a statement on June 11, 2022, affirming its intention to “wind down” government-to-government research cooperation with Russia, though ongoing collaborations would not be called into question.[46] The U.S. government also urged federal agencies and government labs to “curtail interactions” with the heads of universities and institutions affiliated with the Russian government, as well as those that have publicly expressed support for the war.[47] The administration remained silent for more than three months before adopting this stance, engaged in a lengthy internal debate on how to respond. In the meantime, some American research institutions took their own measures, such as MIT with Skoltech (the science and technology institute at the Skolkovo innovation center in St. Petersburg). This institute had been established in 2011 as part of a partnership with MIT, focusing on topics such as AI, telecommunications, novel materials, photonics, etc.[48]. On February 25, 2022, MIT announced the end of the MIT Skoltech program, while expressing its deep regret for the Russian scientific community.[49]

In addition, some Russian research institutions were also directly targeted by the formal sanctions put in place by the EU and the United States against the Russian military-industrial complex. Entities sanctioned in the field of science and technology research include the Skolkovo Foundation; the Skolkovo Institute of Science and Technology; the International Center for Quantum Optics and Quantum Technologies (an independent Russian quantum technology center in Skolkovo[50]); the Moscow Institute of Physics and Technology; and the Scientific Research Institute of Applied Chemistry. Due to their collaboration with the Russian Ministry of Defense and/or the arms industry, any academic collaboration and/or co-publication with these institutions is forbidden.

Technological sanctions have also indirectly impacted the Russian research sector: export restrictions target dual-use goods and technologies that may contribute to the technological development of the Russian defense

44. Ministry of Education, Youth and Sports; Ministry of Higher Education and Research, circular of February 28, 2022; P. Ruffini, “Guerre en Ukraine”, *op. cit*.
45. *Ibid*.
46. R. L. Hudson, “US to ‘Wind Down’ Research Collaboration with Russia”, *Science Business*, June 13, 2022, available at: www.sciencebusiness.net.
47. *Ibid*.
48. Complete history of the institute available at: www.skoltech.ru; P. Ruffini, “Guerre en Ukraine, sanctions académiques et diplomatie scientifique”, *op. cit*.
49. Press release available at: www.skoltech.ru.
50. More information on the center's activities available at: www.rqc.ru.

and security sector (such as semiconductors and advanced technologies[51]), but may also be necessary to the operations of civilian research laboratories. Russian researchers have therefore had difficulties since 2022 in obtaining computer equipment, chemicals, processors and industrial software, as well as office software and operating systems like those from Microsoft, which has suspended sales of products and services in Russia.[52]

In Russia, the government has banned researchers from taking part in international conferences and ceased indexing publications by Russian scientists in international databases.[53] According to a March 2022 survey of some 350 researchers – mainly biologists working in Moscow (only two of whom declared their support for the war in Ukraine) – Russian scientists feel "trapped" and believe that scientific sanctions will be counter-productive in the long term, forcing Russia to turn increasingly towards India or China, instead of Europe and the United States.[54]

### *Multilateral cooperation involving Russia: sanctions and exceptions*

Russia and Russian researchers have participated in many large international research projects, including CERN (the European Organization for Nuclear Research), the International Space Station (ISS) and ITER (the International Thermonuclear Experimental Reactor). These projects were affected in different ways by the invasion of Ukraine.

In the case of ITER, a project launched in 2006 by the EU, Russia, the United States, China, India, Japan and Korea, and located in France, Russia has not been suspended and remains a member of the Council. ITER's objective is to build a prototype nuclear fusion reactor, with the intent to develop a clean, limitless source of energy. Russia supplies this project with materials for the superconducting magnets, an essential component of the fusion reactor. As a result, EU sanctions against Russia include an explicit derogation for the ITER project.[55] Initially, it was feared that the sanctions – particularly on Russian shipping – would interfere with the delivery of components and lead to delays.[56] According to a project spokesman, the conflict has ultimately had very little impact and caused no delays, and the

51. Council of the EU, "Russia's military aggression against Ukraine: EU imposes sanctions against President Putin and Foreign Minister Lavrov and adopts wide-ranging individual and economic sanctions", Press Release, February 25, 2022, available at: www. consilium.europa.eu.
52. B. Smith, "Microsoft Suspends New Sales in Russia", *Microsoft on the issues,* March 4, 2022, available at: www.blogs.microsoft.com; D. Matthews, "Russian Labs Out of Equipment as Sanctions Begin to Bite", *Science Business,* March 17, 2022, available at: www.sciencebusiness.net.
53. P. Lem, "Russia Bars Academics from International Conferences", *Times Higher Education*, March 22, 2022, available at: www.timeshighereducation.com.
54. M. Rentetzi, "Scientific Sanctions Do Not Work", *Diplomatic Courier,* May 31, 2022, available at: www.diplomaticourier.com.
55. D. Matthews, "ITER Faces Further Delays if Key Parts Stuck in Russia", *Science Business*, July 14, 2022, available at: www.sciencebusiness.net.
56. *Ibid.*

giant magnet was able to be shipped from St. Petersburg to Cadarache (Bouches-du-Rhône, France) in February 2023.

Things have not been so simple for Europe in the aerospace sector, as ties have been severed between the European and Russian space agencies. The 87 Roscosmos agency staff working at the Kourou base in French Guiana were repatriated to Russia in March 2022. Russia has also imposed counter-sanctions, which have had a lasting impact on European space research programs. This concerns in particular the Exomars program, developed in partnership between the European Space Agency and Roscosmos. The Exomars rover, originally scheduled to be sent to Mars in 2022, included Russian components, which had to be removed and will be replaced with European components.[57] Its launch is now scheduled for 2028.[58] In the meantime, Europe still needs to find long-term solutions for the launch of its different space missions and satellites (including Galileo), which until now relied on Russian Soyuz and Proton rockets.[59] Because of these disruptions and delays to the Ariane 6 rocket, the European Space Agency plans to collaborate with the American company SpaceX. With regard to multilateral cooperation, Russia initially stated its intention to withdraw from the International Space Station in 2024, before agreeing to extend its collaboration until 2028. In August 2023, a new crew of four astronauts, one of which is Russian, was sent to the ISS.

The situation is different once more for CERN. Since its launch in 1954, CERN has attracted some 10,000 scientists from one hundred different countries. Initially intended to bolster science in Europe, it is now a "model of global scientific and technological collaboration" and demonstrates how "science can unite nations".[60] CERN's very infrastructure is global, since the organization's computer network is decentralized and relies on one million processors, spread across 170 data centers in 42 countries.[61] At the start of 2022, Russia and the Russian Institute for Nuclear Research were observer members of CERN. More than 1,000 Russians worked at CERN in 2022, accounting for 8% of the 12,000 scientists on staff.[62] Russia's observer status was suspended immediately after the outbreak of the war. For researchers affiliated with Russian institutions, the process was more complex, and a decision was reached only one year later. Many CERN collaborators, Ukrainians in particular, refused to appear in author lists alongside Russian scientific institutions whose leaders supported the invasion of Ukraine. For one year, some one hundred articles could not be published, until a solution

57. J. Lausson, "Le rover ExoMars va se débarrasser des composants russes", *Numerama,* March 20, 2023, available at: www.numerama.com.

58. *Ibid.*

59. O. James, "Après l'arrêt de la mission ExoMars, l'ESA en quête d'alternatives aux technologies spatiales russes", *L'Usine Nouvelle,* March 18, 2022, available at: www.usinenouvelle.com.

60. CERN tour, May 2023.

61. *Ibid.*

62. A. Cho, "World's Largest Particle Physics Lab Suspends Political Ties with Russia", *Science*, March 8, 2022, available at: www.science.org.

that was acceptable to the entire CERN community could be found. In the end, it was decided that authors would be identified by name and personal ORCID number, but not by institutional affiliation. As for institutional funding received by contributing authors, the entities are named, with the exception of those based in Russia and Belarus.

The cases of China and Russia illustrate a paradigm shift at work in Europe's political approach to research cooperation. Looking ahead, the scientific sanctions against Russia – like the joint economic sanctions – can be seen as setting a precedent: at a time when a Chinese military action over Taiwan is a plausible scenario for Western defense, it is worth considering the consequences such a crisis would have on research relations between Europe and China. At present, these developments challenge current practices, both in terms of knowledge protection and research collaboration.

# Technological research in France and Europe: A reinforcement of security mechanisms

How are governments and firms adapting their research protection tools to cope with the risks of knowledge leaks and the changing geopolitical landscape?

Many reports have focused on the U.S. and its relationship with China – due to their dense bilateral ties in research and the political context of their relationship. Indeed, the United States, under President Trump, pursued a research protection strategy aimed specifically at China. The "China initiative" was launched in 2018 by the Department of Justice with the aim of combating Chinese espionage in U.S. research, by identifying ties between American researchers and China. This initiative, which caused controversy for its discriminatory nature, ultimately proved ineffective. Numerous investigations were carried out, often without any evidence, and never led to any convictions for espionage.[63] At the same time, the U.S. government began more aggressively enforcing a measure dating back to 1938, the Foreign Agents Registration Act, which requires the "disclosure of foreign power interests in a public registry".[64] In addition, the Biden administration, building on the Trump administration, has made it mandatory for research organizations receiving federal funding to implement research security measures (including cybersecurity).[65] The White House wants to encourage all research organizations to implement security measures, but the decentralized nature of the academic sphere and the absence of any lists of protected areas in fundamental research make it difficult to carry out such recommendations.[66]

And in Europe? National research security policies vary significantly. The French model, with its policy to Protect the Nation's Scientific and Technical Potential (PPST), stands out in terms of its scope and centralized

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63. S. Prasso, "DOJ China Initiative to Catch Spies Prompts FBI Misconduct, Racism Claims", *Bloomberg*, December 14, 2021, available at:www.bloomberg.com.

64. A. Gattolin, *Rapport d'information fait au nom de la mission d'information sur les influences étatiques extra-européennes*, *op. cit.*, p. 58.

65. Executive office of the President of the United States, "Guidance for Implementing National Security Presidential Memorandum 33 (NSPM-33) on National Security Strategy for United States Government-Supported Research and Development", January 2022, available at: https://whitehouse.gov.

66. Interview with representatives of the U.S. State Department.

control mechanisms.[67] This mechanism, established in 2012, is currently being updated to meet changing technological, geopolitical and economic challenges. The European Commission, meanwhile, has undergone a paradigm shift, moving away from a posture of openness by default and addressing issues of interference in research, with the intention of better aligning its research policy with its ambitions for technological sovereignty.

# The French model: a centralized mechanism which requires participants' commitment

In France, a number of public policy tools, involving several governmental departments, work in tandem to protect research and technologies developed in university labs and by businesses. The mechanism to Protect the Nation's Scientific and Technical Potential (PPST) – which we will examine here – includes research and technologies at all stages of development. Systems are also in place for the control of dual-use and military equipment; the control of foreign investments in France; and the protection of certain public and industrial entities designated as "Critical Assets" (Opérateurs d'Importance Vitale).[68]

## *Protecting the Nation's Scientific and Technical Potential*

### Scope of the mechanism

The PPST is an interministerial policy steered by the General Secretariat for Defense and National Security (SGDSN), which is part of the Prime Minister's Office. The PPST aims to protect against a range of risks related to "the misappropriation of sensitive scientific or technical information for the purposes of terrorism, the proliferation of weapons of mass destruction and their means of delivery, or to prevent the growth of military arsenals".[69] Another category of risk covers "the nation's economic interests".

The decree of July 3, 2012 establishes the list of protected scientific and technical sectors and introduces the mechanism. This list includes: biology, medicine, health, chemistry, mathematics, physics, agronomic and ecological sciences, earth, universal and space sciences, information and communication sciences and technologies, and engineering sciences.[70] The objective is to "protect access to strategic knowledge and know-how, as well

67. C. Villani and G. Longuet, "Rapport sur les zones à régime restrictif (ZRR) dans le cadre de la protection du potentiel scientifique et technique de la nation", Full report, French Parliamentary Office for the Evaluation of Scientific and Technological Options, National Assembly, March 2019, p. 14.
68. Interview with a senior public administration official.
69. A. Gattolin, *Rapport d'information fait au nom de la mission d'information sur les influences étatiques extra-européennes*, *op. cit.*, p. 103.
70. *Ibid.*

as sensitive technologies, within public and private organizations"[71] in the targeted sectors. The mechanism relies in particular on the deployment of restricted areas, known as "zones à régime restrictif" (ZRR), on premises where strategic research or production activities are carried out. They feature controlled physical and IT access.

The PPST is enforced by the Ministries of Agriculture, Defense, Sustainable Development, Economy and Finance, Health, and Research. Each ministry appoints a Senior Defense and Security Official (HFDS) who "liaises with the SGDSN and coordinates the protection strategy within the scope of their ministry".[72] The HFDS acts as a liaison for the heads of units, institutions or companies reporting to their respective ministries, whose activities fall within the scope of the protected scientific and technical sectors.[73] As of 2021, 52 higher education and research establishments participated in the PPST, with 573 ZRRs protecting over 150 research units.[74] The introduction of a ZRR in a research laboratory is most often imposed by decision of the French Ministry of Higher Education and Research (MESR), based on the subjects under study in the laboratory.[75] For institutions that do not come under the authority of a ministry, the PPST mechanism (and the establishment of a ZRR) can be implemented voluntarily.

### A mechanism based on the commitment of research partners

The PPST mechanism depends on the support of the actors involved. According to a government representative who wished to remain anonymous, "the PPST is aimed at two categories of actors: outsiders, meaning foreigners in France, and insiders, meaning French researchers engaged in open research – how can we prevent them from releasing sensitive information?".[76] The mechanism must ensure that the researchers themselves have a clear understanding of the risks they are exposed to, and of the mechanism's value.[77] In fundamental, theoretical and experimental research, ensuring actor's commitment to the protection mechanism can be particularly challenging, as the strategic implications are sometimes difficult to assess. The PPST can be met with reluctance from researchers themselves, who value academic freedom, open research and international collaboration. Yet, as mentioned above, foreign interference in university research laboratories has been observed. These are identified as "weak links" with regard to security, as they do not see themselves as competing with foreign

71. A. Gattolin, *Rapport d'information fait au nom de la mission d'information sur les influences étatiques extra-européennes*, *op. cit.*, p. 103.
72. *Ibid.*, p. 104.
73. Decree of July 3, 2012, "relatif à la protection du potentiel scientifique et technique de la nation".
74. A. Gattolin, *Rapport d'information fait au nom de la mission d'information sur les influences étatiques extra-européennes*, *op. cit.*, p. 106.
75. Interview with a senior public administration official.
76. Interview with senior public administration officials.
77. *Ibid.*

actors, while still playing a role in the industrial value chain.[78] The government's vigilance towards economic security risks therefore takes a "360-degree" approach, and applies to France's partner countries as well[79] (see below).

As explained previously, the PPST applies to both the private and public sectors. While it is not as "visible" as in public research, safety standards in the private sector are "draconian"[80], due to the challenges of protecting the living (e.g., protecting staff and clean rooms in the pharmaceutical industry), research falling within the scope of dual-use goods lists, data protection (e.g., medical data), as well as financial and intellectual property concerns.[81] In joint research units, for example, it is often the private party that requests that sites be secured.

In an effort to raise awareness, the French General Directorate for Internal Security (DGSI) has published a series of memoranda on economic interference. One of these deals specifically with the risks associated with the extraction of expertise in fundamental research. Such collection efforts are often carried out "without consent",[82] through theft, which is why the physical and cyber security of these sites is so important. But these operations can also be more explicit. Foreign universities may offer partnerships in fundamental, rather than applied, research, in order to "conceal their intended uses" or to acquire the knowledge base needed to develop technological applications in growth sectors.[83] The DGSI gives the example of a foreign researcher working in a laboratory in France, who made proposals to obtain equipment installation plans. When rejected, he approached a retired researcher to transfer his expertise in exchange for payment. Finally, he proposed establishing a formal partnership with the university to duplicate the equipment abroad. Given the potential negative impact on the French laboratory's competitive advantage, and the dual nature of its research activities, the MESR issued an unfavorable opinion on this duplication.[84]

## Challenges and limits of the PPST

How can protection be balanced, ensuring that what needs to be secured is secured, without hindering the sharing of knowledge that is essential to scientific progress? Reaching a consensus among all the parties involved on risk assessment and the appropriate levels of protection is not an easy task. While one senior official insists that "we aren't talking about building

78. Interview with a representative of the European Commission.
79. Interview with a senior public administration official.
80. *Ibid.*
81. *Ibid.*, and interview with representatives of a major French industrial group.
82. Deputy Director of the DGSI, as cited in C. Villani and G. Longuet, "Rapport sur les zones à régime restrictif", *op. cit.*, p. 21.
83. "Ingérence économique. Les risques associés aux captations de savoir-faire dans la recherche fondamentale", DGSI, June 2023, available at: www.dgsi.interieur.gouv.fr.
84. *Ibid.*

bunkers",[85] ZRRs, and the role of the Senior Defense and Security Official, are not without their critics in the research community.[86] One of the main criticisms of the PPST is that it is a two-tier system: the controls imposed by a ZRR may seem excessive to university laboratories and companies, while entities without a ZRR are subject to few, if any, controls.[87] ZRRs also entail practical constraints, such as the time required to approve candidates for recruitment. This can represent "a significant disadvantage compared to laboratories in other countries, given the intense competition to recruit the best researchers".[88] On top of delays, recruiting foreign candidates is not always possible – our interviews revealed cases of Japanese and Vietnamese candidates being turned down.[89]

An industry representative also points out that while the PPST is enforced in France, it does not cover research carried out abroad or as part of transnational teams.[90] In such cases, all the government can do is raise awareness or impose a ZRR. Finally, and despite the emphasis on awareness-building, there is no systematic research safety training built into the programs of students and researchers at universities and laboratories.[91]

## *Building on the PPST: technological anticipation and economic security*

### The need for technological anticipation

In early 2021, a report submitted to the Élysée by the French Inspectorate General of Finances found an increase in foreign interference in research, as well as "some shortcomings such as the inconsistent deployment of [ZRRs]".[92] In July 2021, the MESR resolved to tackle this issue, citing over 200 reported cases of "breaches or vulnerabilities".[93] An update to the mechanism appeared necessary.

As explained above, the protected fields of science in France are listed in an order issued in July 2012. This order stipulates that the list of protected scientific areas be updated annually. In practice, the list has been kept unchanged since 2012, as it was deemed "sufficiently broad to encompass"

85. Interview with senior public administration officials.
86. Interview with a senior public administration official. See N. Duclos, "Le Fonctionnaire de sécurité et de défense, ou la recherche percutée par la problématique sécuritaire", *Critique international*, No. 100, vol. 3, 2023, pp. 93-100.
87. C. Villani and G. Longuet, "Rapport sur les zones à régime restrictif", *op. cit.*, p. 13.
88. *Ibid.*, p. 19.
89. Interviews with representatives of a major French industrial group and a representative of the French Ministry of Higher Education and Research.
90. Interview with representatives of a major French industrial group.
91. Exchange with a representative of a higher education and research establishment.
92. A. Izambard and D. Bensoussan, "Ingérences étrangères dans la recherche : l'Élysée à la manœuvre, la Chine visée", *Challenges*, February 15, 2022, available at: www.challenges.fr.
93. A. Izambard, "Ingérences étrangères dans la recherche : pourquoi la DGSI monte au front", *Challenges*, October 25, 2021, available at: www.challenges.fr.

the relevant topics.[94] The French government has, however, taken steps to update the list of protected scientific sectors. The SGDSN and MESR are working together to produce an update to the list, due by the end of 2023 and announced as being "substantial".[95]

One of the challenges for the administration lies in appreciating the sensitivity of a field of science or academic research. This is partly a question of anticipating potential applications, or an area of fundamental research's "sensitivity in the making".[96] While from the point of view of the CNRS, research is not sensitive in and of itself (including in mathematics, nuclear or quantum physics), from the perspective of French economic security experts, science and technology must be subject to a "precautionary principle", granting the State the right to exercise oversight. One contact mentioned, for example, the use of algorithms to interpret emotions as an emerging subject.[97]

## Beyond the PPST: research in the economic security agenda

While a technology's "sensitivity" may depend on its application (whether for military, terrorist, or population surveillance or manipulation purposes), the economic security agenda takes a much broader view. The PPST's presentation brochure explains that it covers any person or business that develops knowledge, know-how or technologies whose "undue capture or misappropriation" could "significantly harm" its "competitiveness", that of its industrial partners "or that of the country".[98]

The State's mandate in terms of economic security extends beyond the PPST to include the protection of France's innovation ecosystem.[99] For instance, the control of foreign investments in France covers some twenty technological sectors deemed to be critical,[100] the objective being to protect assets, in particular against hostile takeovers. The aim is also to prevent cutting-edge researchers and innovative start-ups from moving abroad, and to leverage the full range of financing and support tools at its disposal to incubate technologies domestically. The Ministry of the Economy, Finance and Industrial and Digital Sovereignty plays an important role in this mission of economic security for research, namely through its Department of Strategic Intelligence and Economic Security (Sissé) created in 2016.

94. Interviews with senior public administration officials.
95. *Ibid.*
96. Interview with a senior public administration official.
97. *Ibid.*
98. Brochure available at: www.sgdsn.gouv.fr.
99. Interview with a senior public administration official.
100. This targets critical technologies in the following fields: cybersecurity, artificial intelligence, robotics, additive manufacturing, semiconductors, quantum technologies, energy storage and biotechnologies, and technologies involved in renewable energy production. See "Les secteurs d'activité dans lesquels les investissements sont soumis à autorisation préalable", Ministry of the Economy, Finance and Industrial and Digital Sovereignty, May 23, 2023, available at: www.tresor.economie.gouv.fr.

As part of its mission to protect France's scientific and technological ecosystem, the ministry receives alerts (several hundred every year) concerning foreign direct investments, and coordinates the different departments involved in security and economic intelligence. These alerts may cover proposed stake acquisitions in strategic French companies. They can also involve predatory attacks on a research laboratory's intellectual property. Since "there are no allies in economic security", France adopts an "agnostic" or "erga omnes" approach.[101] Through due diligence, these alerts can therefore target actors from all non-European countries (the United States, Israel, Switzerland, Turkey, India and China were mentioned during interviews) as well as from within the EU.[102] In addition to investment controls, in 2022 the government reinforced the so-called "blocking statute", which dates back to 1968.[103] This statute requires foreign authorities to use international judicial or administrative cooperation channels when conducting investigations calling for the disclosure of information that could compromise national interests (including "essential economic interests").[104] Since 2022, companies can contact Sissé to share concerns and receive advice in the event of a request to disclose sensitive information.[105]

## In Brussels, the desire for strategic autonomy extends to research in critical areas

The EU's many scientific programs make it a major player in European research. It accounts for 10% of public spending on research, with Member States providing the remaining 90%.[106] The Horizon program is an increasingly powerful instrument, its budget growing from €79 billion for Horizon 2020 (2014-2020) to €95.5 billion for Horizon Europe (2021-2027). This increase has enabled the EU to further strengthen its joint research activities in digital and telecommunications technologies and networks.[107] While it has always adopted an "open by default"[108] stance, the EU is increasingly concerned about the risks of foreign interference, and over the past four years has introduced new restrictions on international research collaborations.

101. Interview with senior public administration officials.
102. *Ibid.*
103. "Protection économique des entreprises : réforme de la loi dite de 'blocage' de 1968", *economie.gouv.fr*, available at: www.economie.gouv.fr.
104. *Ibid.*
105. Décideurs Magazine, "Joffrey Célestin-Urbain (Sisse) : 'Bercy n'est pas dans une démarche punitive : nous sommes là pour aider les entreprises'", June 27, 2022, available at: www.decideurs-magazine.com.
106. C. Evroux, "The EU's Global Approach to Research and Innovation", European Parliamentary Research Service, March 28, 2023, p. 7, available at: www.europarl.europa.eu.
107. *First biennial report on the implementation of the Global Approach to research and innovation,* European Commission, June 2023, p. 10.
108. Interview with senior public administration officials.

## *New measures to secure research and protect EU interests*

The EU marked a real shift at the start of the decade in its approach to European strategic autonomy, and how it should be reflected in research and innovation. This contrasts with Europe's traditionally open stance.[109] Led by its Secretariat General and Vice-President Margrethe Vestager, the European Commission has also begun to address issues concerning defense and security, with a particular focus on emerging and dual-use technologies. Deteriorating relations with China have heightened awareness of the risks posed by openness to the EU's strategic and economic assets, and to the freedom and security of researchers themselves. The Commission has thus pronounced an "end to naivety".[110]

These considerations were developed in a communication adopted by the Commission in May 2021: The "Global approach to research and innovation", coinciding with the launch of the Horizon Europe program. This document presents an updated vision of Europe's openness in research, which takes into account geopolitical issues and the relationship between research and Europe's strategic autonomy. In this document, the Commission denounces the political tensions, restrictive or discriminatory measures adopted by certain countries, and foreign interference that undermine its policy of openness. The Commission also intends to promote the protection of intellectual property resulting from research collaborations, and to prevent European dependency in the field of security.[111]

The major concrete implementation of this new policy was the adaptation of the Horizon Europe program. Firstly, candidates (individuals or entities) must now declare their foreign affiliations and funding. In addition, the EU may exclude from certain bids applicants located outside the EU, or those within the EU if they are directly or indirectly controlled by an ineligible third country.[112] According to Article 22(5), these limits must apply "when there is a justified need to safeguard the EU's strategic assets, interests, autonomy or security".[113]

These exclusions can be defined on a case-by-case basis, for specific projects, or can apply to an entire field. Article 22(5) was invoked for 49 items in the 2021-2022 work program and 31 in the 2023-2024 work program, representing respectively 4% and 3.5% of these work program' budgets.[114] These restrictions have been applied to projects in the fields of quantum

109. Interview with a representative of the French Ministry of Higher Education and Research.
110. *Ibid.*
111. *Global approach to research and innovation*, European Commission, May 2021, p. 1.
112. *Ibid.*, p. 6.
113. *Ibid.*
114. *First biennial report on the implementation of the Global Approach, op. cit.*, p. 6.

research, space and critical raw materials.[115] In the previous program (Horizon 2020), only the space sector was concerned.[116]

Europe has thus already begun to enact an "end to naivety" in critical areas of research. And this trend should continue to grow. According to a French representative in Brussels, the next negotiation of the multi-annual financial framework, and therefore of the European research program (which will begin in mid-2025), will take a different, more holistic approach, taking the EU's strategic autonomy into account, for instance by integrating value chain considerations.[117] This is reflected in the Commission's progress report on the implementation of the Global Approach to Research and Innovation, published in June 2023, two years after its launch:

> "Technological sovereignty requires both the scientific knowledge necessary to build, operate and understand critical technologies, and access to the components and materials needed to transfer the technologies from the laboratory to the market."[118]

Along the same lines, the European Economic Security Strategy, published in June 2023, indicates a more direct inclusion of research in this agenda. In this document, the Commission is committed to "promoting the EU's competitiveness and growth [by] fostering the EU's research, technological and industrial base".[119] The Commission also adds that, while "openness and international cooperation are at the heart of European research and innovation [...] for technologies deemed to be critical for economic security [...], the Commission will, after assessment, propose measures to improve research security".[120] It should be noted that the term "research security" is new to the Commission's vocabulary, which until now only spoke of protection against the risk of interference.

## *Building coherence across Member States*

### Diversity and evolution of policy instruments

Research is one of the EU's shared competences, giving member states the freedom to legislate in this area if the EU itself fails to do so. The EU cannot enact regulations that would infringe on the freedom of universities, and joint

115. *Ibid.*

116. C. Evroux, "The EU's Global Approach to Research and Innovation", *op. cit.*

117. Interview with a French diplomat.

118. *First biennial report on the implementation of the Global Approach, op. cit.*, p. 6.

119. *Joint Communication to the European Parliament and the Council on the "European Economic Security Strategy"*, European Commission, June 2023, available at: www.eur-lex.europa.eu.

120. *Economic Security Strategy*, European Union, June 20, 2023, p. 10, available at: https://eur-lex.europa.eu. The Commission has proposed that technology security and leakage risks be assessed "on the basis of a list of strategic [dual-use] technologies critical for economic security", based on "narrowly defined and forward-looking criteria such as the enabling and transformative nature of a technology, the risk of civil military fusion, and the risk of their misuse for human rights violations" (p. 6). An initial list was published in early October 2023 and is available at: https://ec.europa.eu.

decision-making (EU-Member States) is necessary to the development of the Horizon program. Subjects which affect Member States, such as foreign interference, also require dialogue and co-development, with the participation of stakeholders (universities, research centers, expert groups…).[121] In its September 2021 conclusions, the Council of the EU invited the Commission and Member States to "engage in a co-design process […] to further develop the Union's key principles and values for international R&I cooperation".[122] Thus, if authorized by Member States, the EU could develop its own legal tools for research security, applicable beyond the Horizon program.

In the meantime, the EU's main challenge lies in establishing coherence between the EU and Member States. Margrethe Vestager says that reducing risk in research requires a mix of tools implemented by the EU and by Member States: "This is not about changing competences, but about having an approach to act in common".[123] The aim is to avoid unnecessary overlap of EU and Member State efforts, but also to prevent the emergence of contradictory policies. For instance, if the EU chooses not to cooperate with China on AI, but a Member State sets up a bilateral project with China.[124]

## Sharing best practices

National public policy varies widely from one Member State to another, and is constantly evolving. As seen in the previous section, France has adopted a rather "conservative" stance on strategic and technological independence, and its implications for research, compared to its EU neighbors.[125] According to one representative of the French Ministry of Higher Education and Research, there has however been "a real awakening at the European level […] even from countries that have always advocated for unrestricted openness, like the Netherlands, Ireland and Austria".[126] A representative of the Ministry of the Economy explains that other European ministries, as well as certain Asian countries, have contacted the French administration, looking to learn from its "groundbreaking" experience in economic security and the protection of sensitive information.[127] Indeed, no other country has adopted a similar framework, as governments tend to rely more on universities to regulate themselves.[128]

The Netherlands has thus begun adapting its research safety policy, along similar lines to France's existing mechanisms. In November 2020, the Dutch Ministry of Higher Education, Culture and Research submitted a letter to Parliament. It stated that recent developments in "knowledge security"

121. Interview with a representative of the European Commission.
122. Council conclusions of September 28, 2021, available at: www.data.consilium.europa.eu.
123. Speech to the press delivered on June 20, 2023, available at: www.ec.europa.eu.
124. Interview with a representative of the French Ministry of Higher Education and Research.
125. Interview with a French diplomat.
126. Interview with a representative of the French Ministry of Higher Education and Research.
127. Interviews with a senior public administration official and a French diplomat.
128. Interview with a French diplomat.

risks compelled the government to urgently review existing policies and their implementation.[129] Indeed, existing instruments for research control only covered countries subject to sanctions and scheduled military or dual-use technologies. The government has therefore undertaken an inventory of fields and disciplines requiring protection. It plans to require prior notification or authorization when transfers of sensitive knowledge or technologies are being considered. It is also considering imposing bans to block research partnerships organized with non-EU countries. The Netherlands has since published recommendations on research security and created a national point of contact, which handles an ever-growing number of requests.[130] Finally, legislation is currently being drafted to screen students and researchers from non-European countries before they are allowed to carry out research in fields deemed to be sensitive. This draft legislation has sparked debate in the research community.[131]

Aside from the Netherlands, the EU and Member States have undertaken a number of collective actions to structure the sharing of best practices. The Commission has produced guidelines to counter foreign interference, as well as guiding principles for knowledge valorization and intellectual property management.[132] At France's behest, during its Council presidency in the first half of 2022, Member States also agreed to work together on the challenges of cooperation with China.[133] A mutual learning exercise was also launched in April 2023 and will run until 2024, to build on these exchanges of best practices.[134]

Some blind spots remain in intra-European cooperation, however. It is in particular difficult for European states to share sensitive information pertaining to economic security (beyond existing tools for screening foreign direct investments, and the anti-coercion instrument, developed at the EU level), given that European partners are also economic competitors.[135] When a Member State identifies an individual or entity as being at risk, there appears to be no sharing of such profiles. Yet a Schengen visa gives foreign researchers access to the entire Schengen area, which is problematic given the disparity in control standards across the EU. This problem was highlighted by the Dutch Minister of Education, Culture and Science, Robbert Dijkgraaf, who, in a public Council meeting in May 2023, suggested the creation of a European center of expertise on knowledge security, which

129. *Knowledge Security in Education and Research,* Dutch Ministry of Education, Culture and Science, *op. cit.*

130. B. Upton, "Dutch Research Security Hotline Sees 'Big Increase' in Queries", *Times Higher Education,* April 12, 2023, available at: www.timeshighereducation.com.

131. S. Slegers, "How to Keep Out Foreign Researchers", *Argos,* April 15, 2023, available at: www.vpro.nl.

132. *European strategy for universities,* European Commission, January 2022; *Tackling R&I Foreign Interference. Staff Working Document,* European Commission, January 2022; T. Shih, "EU Recommendations on Tackling Foreign Interference in Research and Innovation: Implications for European Research Collaboration with China", *Brief,* Swedish National China Centre, February, 2023.

133. Marseille declaration available at: www.enseignementsup-recherche.gouv.fr.

134. Interview with a representative of the French Ministry of Higher Education and Research.

135. Interview with a senior public administration official.

could facilitate the exchange of information on cooperations with third countries.[136] This proposal was favorably received by many of the participating ministers.[137]

# Protecting innovation: more patents, fewer publications?

> "If our workers and intellectual property are protected, then there's no country on earth – not China or any other country on earth – that can match us."
>
> Joe Biden, President of the United States, February 4, 2021[138]

As U.S. President Joe Biden has suggested in this emphatic statement, sustaining national performance in critical technologies also means protecting the knowledge generated by research, which is essential to the competitiveness and capacity for innovation of nations and businesses alike. Filing patents is one of the means used to achieve this, as is, increasingly, withholding research results from publication. In excess, both of these methods can have a detrimental effect on scientific and technological progress globally.

## *Intellectual property and patents: Europe lagging behind*

The protection of inventions developed through R&D and innovation is a key factor in the competitiveness of businesses: they must guard against competitors trying to appropriate their intellectual property (IP).[139] IP protection can be achieved through secrecy or patenting, which is not without its difficulties in the case of digital technologies (see insert below).

### Intellectual property protection challenges

Secrecy, through the protection of premises and IT systems, is one means of protecting intellectual property. But it only functions if the manufacturing processes and/or components and materials used cannot be subsequently identified. Yet technical advances are making reverse engineering more and more effective.[140] Patents may then be preferred to combat technology theft and copying, as well as to generate income if the

136. "Competitiveness Council", Council of the EU, public session, May 23, 2023, available at: https://video.consilium.europa.eu.
137. G. Naujokaitytė, "Research ministers want an EU knowledge exchange to help in curbing foreign interference", *Science Business,* May 25, 2023, available at: www.sciencebusiness.net.
138. Speech delivered by U.S. President Joe Biden on February 4, 2021, available at: www.whitehouse.gov.
139. V. Cui, R. Narula, D. Minbaeva *et al.,* "Towards Integrating Country- and Firm-Level Perspectives on Intellectual Property Rights", *Journal of International Business Studies,* vol. 53, No. 9, 2022, p. 1883.
140. Interview with a representative of the French National Institute of Industrial Property.

patents become "standards-essential", i.e., if they impact the technical standards of other technologies developed on the basis of these patents. This is the case, for example, for communication protocols used by connected objects (Wifi, Bluetooth, 5G…).[141]

Patents are however difficult to obtain in the digital sector. A computer-implemented invention (i.e., software) can be patented by demonstrating a sequence of logical operations (protocols, computation routines) which produce a technical result, even if that result is digital.[142] That which can be patented is the design of an algorithm which provides an inventive solution to a problem. For example, automotive supplier Valeo has patented an artificial vision algorithm to park vehicles automatically.[143] The work required to reformulate the technical aspects for a patent application is often an impediment, however, as is the need for translation into multiple languages for international filing.

Research partnerships require the signing of collaboration contracts to structure the management of intellectual property, covering the background (knowledge, expertise, clients and patents contributed by each party), foreground (results, future patents and operating licenses resulting from the research collaboration) and *sideground* (unanticipated results and discoveries).

Certain countries, like Korea, Japan, China and the United States, have made intellectual property a political priority. Japan has an IP strategy, overseen by the Prime Minister's Office, and the U.S. has, since President G. W. Bush, an IP Enforcement Coordinator Office at the White House, which reports to Congress.[144] In China, IP is a central theme of Xi Jinping's speeches. In 2022, China filed more than 70,000 international patent applications, the United States more than 59,000, and Japan more than 50,000. Germany, Europe's leading issuer of patents, filed 17,500, nearly three times less than Japan. IT made up the largest share of filings, accounting for 10.4% of the total, followed by digital communications (9.4%), electrical machinery (7.1%) and medical technologies (7%).[145] Digital communications and technologies are growing fastest, followed by semiconductors and biotechnologies.[146] These fluctuations in IP's consideration and patent filings can also be seen in the field of quantum science and technology, where there has been an "avalanche" of patents from the USA and China.[147] Patents are being filed even for technologies at the

141. *Ibid.*

142. *Ibid.* and interview with a representative of a quantum start-up.

143. Interview with a Valeo representative.

144. Interview with a representative of the French National Institute of Industrial Property.

145. "Les dépôts de brevets internationaux en légère hausse en 2022", *Le Figaro*, February 28, 2023, available at: www.lefigaro.fr.

146. *Ibid.*

147. Interview with a representative of the French National Institute of Industrial Property.

experimental and prototype stages, a trend that could stall technological development.[148]

The subject attracts less political attention in Europe.[149] Best practices (such as collaboration contracts) are not universally implemented. Some actors, large corporations in particular, pay close attention to this subject, but this is less the case in small and medium-sized companies, and even less so in university laboratories[150]. Researchers have studied Swedish-Chinese research collaborations and have found that "overall, intellectual property rights (IPR) were an overlooked aspect of the projects and often at best treated as an afterthought".[151] This is especially the case on the Swedish side, they say: in the projects they examined, the Chinese participants had "in general more incentives from the academic system in securing IPR for work developed in the projects".[152]

In light of these imbalances, some in Europe have called for a more proactive response from laboratories and businesses, to promote the filing of patents, and to factor intellectual property considerations into research collaborations and encourage commercial applications within the EU. Under the Horizon program, the EU must be notified of any proposed commercial exploitation of intellectual property outside the EU. Article 40 of the Horizon program empowers the Commission to object to transfers of ownership of research results, or to grants of an exclusive license regarding such results, if their transfer to a non-associated third country is not in line with the EU's interests.[153] In addition, in 2022, the European Innovation Council and the European Union Intellectual Property Office (EUIPO) have committed to strengthening their cooperation and developing an IP management support service for innovative European companies, to help them identify, protect and capitalize on their intangible assets. The project will specifically target beneficiaries of Horizon funding (Pillar 3) to bring high-risk, high-impact technologies to market.[154]

148. Interview with a representative of the French National Institute of Industrial Property. According to a representative of a French start-up, the quantum computers currently being developed, for which patents have been filed, are sufficiently different from each other that this is not yet the case.
149. Interview with a representative of the French National Institute of Industrial Property.
150. *Ibid.*
151. T. Shih and E. Forsberg, "Origins, Motives, and Challenges in Western-Chinese Research Collaborations amid Recent Geopolitical Tensions", *op. cit.,* p. 662.
152. *Ibid.*
153. C. Evroux, "The EU's Global Approach to Research and Innovation", *op. cit*. In practice, according to a European Commission representative, such rejections are rare, as industry can circumvent this process, e.g., by not declaring the IP as resulting from a Horizon-funded project.
154. "Intellectual Property: EISMEA and EUIPO Join Forces to Assist SMEs and Start-Ups", European Commission, October 28, 2022, available at: [www.eismea.ec.europa.eu](www.eismea.ec.europa.eu).

### *Reducing research dissemination to protect knowledge?*

France, the EU and the United States have implemented "open science" policies aimed at encouraging the dissemination of research results. These policies not only make it compulsory to share publicly-funded research data – with certain exceptions for reasons of sensitivity or commercial significance – but also seek to extend this practice beyond the realm of public research.[155] By 2021, 83% of scientific publications generated by Horizon 2020 activities were already available in open access.[156] By contrast, in a drastic move towards closure, the Chinese authorities decided in April 2023 to block foreign researchers from accessing certain databases on its CNKI scientific publications portal, in an effort to protect national knowledge.[157]

While China's approach here is exceptional, European governments and research actors – in the private sector in particular – are beginning to question whether research results should be published if they could benefit economic competitors or strategic rivals. In fields that involve military technologies, governments can require research results to be classified, but this is not the case elsewhere. A biology researcher, for instance, is in principle entitled to publish his or her research on a virus, even if said research could be used to develop a biological weapon.[158] In areas such as nuclear physics and virology, efforts to raise awareness do seem to have yielded results.[159] Additional restrictive measures on publications may also be imposed within research laboratories as part of the PPST. A 2019 report on behalf of the Parliamentary Office for the Evaluation of Scientific and Technological Options revealed some examples of overreach in implementation, such as the need to obtain prior authorization for publication, often stipulated in the internal regulations of ZRRs, when official texts provide for no such obligation in the PPST's implementation.[160]

As explained in the introduction, in fundamental research in artificial intelligence, as in other emerging fields, the academic and industrial worlds are highly intertwined and porous.[161] Large tech companies operate

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155. *Le Plan national pour la science ouverte 2021-2024 : vers une généralisation de la science ouverte en France,* Ministry of Higher Education and Research, July 2021 ; "Open Science", European Commission, available at: www.research-and-innovation.ec.europa.eu; Office of Science and Technology Policy, "Ensuring Free, Immediate, and Equitable Access to Federally Funded Research", August 25, 2022, available at: www.whitehouse.gov.

156. C. Evroux, "The EU's Global Approach to Research and Innovation", *op. cit.,* p. 4.

157. D. Matthews, "US Extends Science and Technology Agreement with China, Buying Time to Renegotiate the Deal", *Science Business*, August 29, 2023, available at: www.sciencebusiness.net.

158. Interviews with senior public administration officials.

159. Interview with a senior public administration official.

160. C. Villani and G. Longuet, "Rapport sur les zones à régime restrictif", *op. cit.,* p. 11.

161. Interview with a Valeo representative; R. Heston and R. Zwetsloot, "Mapping U.S. Multinationals' Global AI R&D Activity", *CSET Data Brief*, Center for Security and Emerging Technology, December 2020.

their own research labs, leading to "highly academic" environments where researchers are able to pursue fundamental research.[162] The reasoning behind Google's Project Brain is that "we don't know where the next breakthrough will come from"[163] and "science moves faster when we publish".[164] Part of the research conducted at Google is integrated into product teams, for example with work on image generation and identification of AI-generated images (like SynthID), quantum technology, or immersive view. Other researchers, whose work focuses on ethics and responsibility in large language models, for example, work separately from product teams.

Companies face a number of dilemmas when it comes to disseminating research results. A growing number of researchers, particularly in Anglo-Saxon countries, but also in major corporations in France and Europe, have dual affiliations and split their time between industry and academia.[165] These researchers have an incentive to disseminate the results of their research – be it through conference presentations, academic publications, posting code online, etc. And in the case of fundamental quantum or AI research carried out in the private sector, there are also incentives to publish technological breakthroughs, if only to attract investors.[166] For established businesses, publishing provides visibility, credibility, enhances the company's image, helps with marketing, and helps retain researchers.[167] The aim may also be to gain recognition in a new market.[168] A major American tech company like Google, for example, publishes several hundred articles a year, while the AI branch of the French group Valeo publishes around thirty.[169]

On the other hand, the race for commercialization and patenting, including at very early stages of technological development, is in contradiction with the practice of publishing research results.[170] Publishing research results (as well as releasing code as open source) can also help the competition.[171] The meteoric rise of OpenAI, the start-up behind the generative AI platform ChatGPT, relied on a study of a deep learning architecture, known as Transformer, published by Google researchers

162. Interview with a Google Research representative.
163. *Ibid.*
164. *Ibid.*
165. Interviews with senior public administration officials.
166. E. Parker on "The Qubit Guy's Podcast", *op. cit.*
167. Interviews with representatives of major industrial groups and a quantum start-up.
168. Interview with representatives of a major French industrial group.
169. Google Research, "Publication database ", available at: https://research.google; interview with a Valeo representative. There are significant international variations in the role played by the private sector in fundamental research, but the feature they all share is the concentration of publications around a small number of companies. See B. Krieger, M. Pellens, K. Blind *et al.,* "Are Firms Withdrawing from Basic Research? An Analysis of Firm-level Publication Behaviour in Germany", *Scientometrics,* vol. 126, No. 12, 2021, pp. 9677–9698.
170. Interview with a representative of the French National Institute of Industrial Property.
171. A. Pannier, "Software Power: The Economic and Geopolitical Implications of Open Source Software", *Études de l'Ifri*, Ifri, December 2022.

in 2017.[172] This prompted the company to change its policy regarding the publication of research results. In February 2023, three months after the release of ChatGPT, Google's Director of Artificial Intelligence decided that from now on, "Google would take advantage of its own AI discoveries, sharing papers only after the lab work had been turned into products".[173]

According to a representative for Google Research, the goal of every publication at Google is to ensure the quality of the research through peer review, but there needs to be a balance between the research's reproducibility (e.g., by making datasets available) and the resulting opportunity costs for the company: the priority is to implement new advances in products. Publication is therefore decided on a case-by-case basis.[174] This change also affected the company's structure, Google Brain (which focuses on research) merging with DeepMind, a unit tasked with accelerating AI development at Alphabet.[175] These changes – restructuring and publication restrictions – have raised concerns among some of the firm's researchers, who already had difficulties bridging the gap between science and product development.[176]

172. N. Tiku and G. De Vynck, "Google Shared AI Knowledge with the World — until ChatGPT Caught Up", *Washington Post,* May 5, 2023, available at: www.washingtonpost.com.
173. *Ibid.*
174. Interview with a Google Research representative.
175. N. Tiku and G. De Vynck, "Google Shared AI Knowledge with the World — until ChatGPT Caught Up", *op. cit.*
176. *Ibid.*

# Rethinking international partnerships in technological research

Research partnerships (at the government, industrial or individual level) are a means of attracting talent and facilitating mobility, raising financial resources, gaining access to specific knowledge and equipment, and building long-term ties. This being said, how can research security, and the attendant need for a relatively closed environment, be reconciled with a non-discriminatory strategy for international cooperation? And at the same time, how can specific concerns posed by certain foreign nations or businesses, and competition in research and innovation from France's and Europe's strategic partners, be taken into account?

Here too, China is a central concern. In the United States, discussions are underway concerning the renewal of the Science and Technology Cooperation Agreement (STA) signed with China in 1979 as part of the normalization of bilateral relations, at a time when the United States largely dominated China from a scientific and technological standpoint. Today, the U.S. strategy seeks to slow China's advances, amid worsening bilateral relations. The agreement, which expires in 2023, is the subject of much debate. Certain Republican lawmakers argue that "the United States must stop fueling its own destruction. Letting the STA expire is a good first step".[177] Instead of renewing the agreement for five years, it has been extended for six months, and negotiations are underway to ensure that this arrangement remains mutually beneficial, in particular through the inclusion of provisions concerning IP.

In Europe, research partnerships are a cross-cutting issue, and the focus of this debate is not limited to China. There is a clear desire to remain open to cooperation. In a speech in July 2023, French Minister of Higher Education and Research Sylvie Retailleau declared:

> "Science diplomacy [...] facilitates progress by disseminating scientific discoveries and combating misinformation, and contributes to solving global challenges. Science is a universal language that transcends cultural differences. I believe that by working together on shared scientific endeavors, nations can overcome their divisions and strengthen their bonds of trust. [...] Scientific diplomacy is not limited to the activities of research organizations, universities and their laboratories. It also extends

177. C. Lu and C. Gutman-Argemí, "Biden Puts U.S.-China Science Partnership on Life Support", *Foreign Policy*, August 24, 2023, available at: www.foreignpolicy.com; E. Chen, "The Science Split?", *The Wire China*, August 20, 2023, available at: www.thewirechina.com.

> to the economic sphere, where innovation is a key driver for appeal, growth and competitivity."[178]

The German government's China strategy, for its part, affirmed its intention to intensify and diversify international cooperation in technological innovation, with like-minded partners and in support of EU policies.[179]

Cooperation is encouraged, then, but with whom, and in what areas? How best to regulate research cooperation with China, as well as with countries which are both political partners and economic competitors?

# France's partnership policy: an updated strategic approach

France is the 6th-largest host country for international students (half of whom come from Africa and the Middle East, and one quarter from Europe), and more than two-thirds of French academic publications are the result of collaborations with partner countries.[180] Attractiveness and international mobility are therefore priorities for the MESR, but they must work alongside a geopolitical approach to partnerships, which is increasingly led by the Ministry of Europe and Foreign Affairs.

## *Research partnerships: preserving academic freedom while increasing vigilance*

French higher education and research establishments, like those in other European countries, are free to develop their partnership strategies, in line with the broader principles of academic freedom and institutional autonomy. According to article L.123-7-1 of the French Education Code, this means that institutions are free to enter into contracts with "foreign or international, academic or non-academic" institutions. Draft partnership agreements must, however, be submitted to the MESR for approval, and, for sensitive matters, to the Senior Defense and Security Official. In 2021, according to a Senate fact-finding mission, an average of 32 proposals were submitted to the MESR each month, with negative opinions accounting for 6.5% of the total.[181] However, the one-month deadline is too short to process all proposals.[182]

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178. Speech delivered by Sylvie Retailleau at the Journées du Réseau du Ministère de l'Europe et des Affaires étrangères, July 19, 2023, available at: www.enseignementsup-recherche.gouv.fr.

179. Government of the Federal Republic of Germany, *Strategy on China,* July 2023, p. 52.

180. Speech delivered by Sylvie Retailleau, *op. cit.*; Ministry of Europe and Foreign Affairs, *Feuille de route de l'influence*, December 2021, p. 15.

181. A. Gattolin, *Rapport d'information fait au nom de la mission d'information sur les influences étatiques extra-européennes, op. cit.*, p. 115.

182. *Ibid.*, p.116.

Reflecting the growing awareness of this issue, as explained above, research institutions are increasingly asking for guidance on the scope of cooperation to be developed with China, which, unlike Russia, is still considered a "partner" (as well as a competitor and rival) in French and European diplomacy.[183] There are some models of best practices, such as those endorsed by the CNRS, which pays particular attention, and consults the Ministry, regarding certain aspects of its partnerships, such as foreign researchers receiving funding from China Scholarships, the 1,000 Talents program, and other forms of Chinese public funding, including stays or missions in China.[184]

There is a similar dynamic in Germany. The federal government has limited control over universities and the management of their partnerships.[185] But Germany's Future Research and Innovation Strategy of February 2023 calls for more horizontality in cooperation with Chinese researchers, and for risk assessments to be carried out to prevent technology transfers to the Chinese military.[186] Likewise, in the July 2023 China Strategy, the Federal Government announced that it will introduce measures to prevent projects involving China likely to result in knowledge leaks from being backed, or only if suitable conditions are imposed.[187]

## *Scientific diplomacy integrated into the Foreign Ministry's policy of influence*

For French diplomacy, cooperation in research requires priority areas to be defined – based on shared values – and a long-term vision.[188] Within the Ministry of Europe and Foreign Affairs (MEAE), the Sub-Directorate for Higher Education and Research is part of the Directorate for Diplomacy of Influence, whose mission is defined in a roadmap dated January 1, 2022. According to this roadmap:

> "Scientific and academic cooperation has become a key element in France's policy of influence: the network of diplomacy and influence helps to integrate French research into international cutting-edge networks, contributes to the promotion of French higher education abroad, and strengthens the appeal of its research centers and doctoral schools".[189]

183. Interview with French diplomats.
184. A. Gattolin, *Rapport d'information fait au nom de la mission d'information sur les influences étatiques extra-européennes, op. cit.,* p. 115. It should be noted that programs run by foreign state agencies, such as the U.S. Defense Advanced Research Projects Agency (DARPA), are also monitored.
185. M. Stepan, "What Future for the Cooperation with Chinese Higher Education Institutions? The German Case", China Research Seminar, Sciences Po, March 1, 2023.
186. *Future Research and Innovation Strategy,* Government of the Federal Republic of Germany, February 2023, available at: www.bmbf.de.
187. *Strategy on China,* Government of the Federal Republic of Germany, *op. cit.*
188. Interview with French diplomats. Cf. text of the Marseille Declaration.
189. *Feuille de route de l'influence*, *op. cit.*, p. 16.

International research cooperation should also benefit French scientific diplomacy in the service of the "three great technological revolutions": 1) digital – e.g., AI – and quantum, 2) healthcare and life sciences, and 3) energy and sustainable development.[190]

To this end, the MEAE is currently working on cooperation instruments, based on research grants and funds, and joint committees.[191] These cooperation instruments fit within an evolving vision for scientific diplomacy: "We've shifted from cooperation as a means of soft power – research cooperation when all other ties have been severed – to an approach centered on security, defense and the economy – a hard power or sharp power model",[192] says one MEAE representative. The goal is to establish new "strategic" joint committees: targeted, structured partnerships which are balanced and complementary, with jointly-funded research projects designed to serve France's interests (e.g., attracting talent) and incorporate France's vision for economic security, diplomacy and defense.[193]

These new strategic partnerships require France to define its priority partners, who will need to be "major science-producing countries", "like-minded", and priority countries for French diplomacy. This list of countries, as part of the new strategy, was prepared jointly by the MESR and the MEAE.[194] In a speech delivered in July 2023, the French Minister for Higher Education and Research, Sylvie Retailleau, listed the "12 priority science-producing countries" with which France wishes to strengthen its strategic partnership: Canada, the United States, Brazil, Australia, South Korea, India, Singapore, Japan, South Africa, Israel, Germany and the United Kingdom.[195] The first two joint strategic committees were formed with Canada and South Korea.

India is a clear example of a partnership built on a policy of influence: research cooperation with this country, in addition to improving student mobility, is "a tool for broader geopolitical cooperation, supporting France's Indo-Pacific policy".[196] Conversely, politics can also stand in the way of new partnerships, as with the UK. The latest bilateral summit, in March 2023, demonstrated a desire to revitalize partnerships, including in research, and a strategic committee is set to be formed. But Brexit has complicated cooperation, the question of the UK's involvement in the Horizon program having only just been settled in September 2023.[197] With Australia, too, political disagreements over the AUKUS affair (the industrial and defense

190. *Ibid.*, p. 57; Interview with French diplomats.
191. Interview with French diplomats. These are high-level dialogues, chaired either by the Minister of Higher Education and Research, or by the Minister of Foreign Affairs, with the MESR now taking a more active role in this area.
192. Interview with French diplomats.
193. *Ibid.*
194. *Ibid.*
195. Speech delivered by Sylvie Retailleau at the Journées du Réseau du Ministère de l'Europe et des Affaires étrangères, *op.cit.*
196. Interview with French diplomats.
197. *Ibid.*

cooperation agreement between the United States, the United Kingdom and Australia, which cost France a substantial submarine construction contract) have affected bilateral research cooperation on strategic technologies, in particular quantum.

### *Digital and quantum technology at the core of new strategic partnerships*

As seen in the case of Australia, digital and quantum technologies are central to France's strategic partnership priorities, with significant political implications. According to the MEAE, these technologies are at the intersection of economics, security and fundamental research.[198] The Ministry is therefore closely involved in the development of France's quantum strategy. For Inria, the French National Institute for Research in Digital Science and Technology, which also conducted a study on the choice of strategic partners, these depend on existing scientific collaborations, the presence of French industries conducting R&D locally, and the geopolitical profile of partner countries.[199] Inria has over a hundred "associate" teams, which carry out three-year projects with international partners.[200] Inria's geographic priorities coincide with those of the MESR and MEAE.

Ties with research ecosystems in the United States are strong. There are for instance agreements to share computational equipment, based on a history of cooperation between the French Atomic Energy and Renewable Energies Commission (CEA) and the US Department of Energy. The purpose is to take advantage of this equipment, but also, for France, to show the United States that it too "has interesting machines".[201] These updated partnerships also seek, however, to establish more "balanced" cooperation with the United States.[202]

Canada, for its part, presents opportunities for France to cooperate in cyber, AI and quantum technologies. One goal is to leverage the convergences that exist between the two countries regarding the ethics of AI. Indeed, France and Canada are behind the Global Partnership for Artificial Intelligence (GPAI), which promotes the responsible development of artificial intelligence, founded on human rights, inclusion, diversity, innovation and economic growth.[203] Quantum and AI were thus defined as

198. Interview with French diplomats.
199. Interview with Cécile Vigouroux, Director of International Relations at Inria.
200d. "Programme 'équipes associées' : Appel à projet 2023", PDF available at: www.inria.fr.
201. Interview with a representative of the public administration.
202. Interview with French diplomats.
203. Interview with Cécile Vigouroux, Director of International Relations at Inria; Joint statement by the founding members of the Global Partnership on Artificial Intelligence, June 15, 2020, available at: www.diplomatie.gouv.fr.

the first priority research areas when the Joint Committee on Science, Technology and Innovation was established on April 24, 2023.[204]

South Korea and Japan's research capabilities are a priority, for instance in high-performance computing[205] – Japan's RIKEN institute is home to the world's most powerful supercomputer. India's priorities are computer science and applied mathematics. Large French corporations are also keen to pursue opportunities for innovation and technology transfer in India.[206] Singapore, as is the case with India, straddles geopolitics and research: it is a very open and prominent hub in the fields of quantum technology and digital health, while also ranking among France's diplomatic priorities in its Indo-Pacific strategy. Several major French corporations have established R&D centers there (Naval Group, Atos and EDF). Finally, Brazil, whose economic ties with France are growing, offers opportunities for French manufacturers in the fields of AI and data science.

# Within the EU: working towards "reciprocal" and "modulated" partnerships

## *Objectives and modalities of EU research partnerships*

The EU's Horizon program and excellence grants are an important means of attracting partners from outside Europe, whether individual researchers, labs, industrial actors or states. The EU structures research cooperation with non-member states using three categories:

- **Associated countries:** "Legal entities from associated countries can participate under equivalent conditions as legal entities from the EU Member States, unless specific limitations or conditions are laid down in the work programme and/or call/topic text".[207] These countries contribute to the Horizon budget to obtain the right to apply and receive funding if they are selected. As of August 2023, the 17 associated countries include the Balkan states, Norway, Israel, Iceland, Tunisia, Turkey, Ukraine and New Zealand. On January 1, 2024, the United

204. "La France et le Canada lancent le Comité mixte sur la science, la technologie et l'innovation", Ministry of Higher Education and Research, April 25, 2023, available at: www.enseignementsup-recherche.gouv.fr; "Création par les gouvernements du Canada et de la France d'un nouveau comité mixte sur la science, la technologie et la recherche", Government of Canada, April 24, 2023, available at: www.canada.ca.

205. "La France et la Corée du Sud organisent la 8$^{e}$ réunion du comité mixte stratégique sciences et technologies (COMIX)", Ministry of Higher Education and Research, June 20, 2023, available at: www.enseignementsup-recherche.gouv.fr.

206. Interview with Cécile Vigouroux, Director of International Relations at Inria.

207. "List of Participating Countries in Horizon Europe", European Commission, August 2023, available at: www.ec.europa.eu.

Kingdom will be added to this list.

- **Countries due to be associated, with transitional arrangements:** Morocco, and the United Kingdom until January 1, 2024.
- **Non-associated countries:** "Most Horizon Europe calls are also open to participants from non-associated countries and international organizations, unless specific limitations or conditions are laid down [...] Participants from non-associated non-EU countries can take part in Horizon Europe actions – but not always with funding".[208] Only countries and entities from low- and middle-income countries are automatically eligible for funding; other countries are only eligible in exceptional cases. The EU may also negotiate bilateral roadmaps with non-associated countries, and launch specific calls for tender, particularly for countries in the Global South.

The Horizon program is divided into three Pillars: 1) support for fundamental research, or "science for science's sake" (25 billion euros); 2) support for applied research aimed at "addressing societal challenges that are by definition global", e.g., green and digital technologies, biotechnologies and space (53.5 billion euros); and 3) the most recent, the European Innovation Council, with a particular focus on start-ups and industry (13.6 billion euros).[209] The Association agreements contribute significantly to the Horizon program's funding – one Commission representative even likened it to "striking gold" for the EU, in that the additional funding arrives after the initial arbitrations and relieves some of the constraints on Horizon's programming[210]. For example, from 2024 onwards, the UK will contribute 2.6 billion euros a year to the Horizon program.[211]

As previously noted, the EU has introduced restrictions to protect research in strategic sectors from unfair or intrusive practices. It has also revised its research partnership policies to pursue "reciprocal openness"[212] and "modulated" partnerships.[213] With this approach:

> "The EU should engage with non-EU countries in a nuanced and modulated approach, based on levels of reciprocity, a level playing field, and respect for fundamental rights and shared values. The EU should remain a strong and open partner, while seeking to enhance, through well-targeted cooperation, its own expertise in key emerging areas."[214]

208. *Ibid.*
209. Interview with a representative of the European Commission; "Le programme Horizon Europe", *entreprises.gouv.fr,* May 9, 2023, available at: www.entreprises.gouv.fr.
210. Interview with a representative of the European Commission.
211. D. Matthews, "It's Official: UK to Associate to Horizon Europe", *Science Business,* September 7, 2023, available at: www.sciencebusiness.net.
212. *Global approach to research and innovation, op. cit.*, p. 1.
213. *Ibid.*
214. *Ibid.*, p. 14.

According to one French diplomat, the EU's policy of openness is not new; the innovation is its approach based on agreements and reciprocity.[215] Redefining partner selection and establishing bilateral roadmaps which align with European interests is all the more necessary in light of the European Commission's intention, in its Global Approach to Research and Innovation, to promote cooperation in critical areas: digital technology, specifically "artificial intelligence, blockchain, internet of things, big data, spatial data, applications of digital technologies to green transition, health, and education".[216]

### *Association agreements: a shift towards "like-minded countries"*

Association agreements have traditionally been reserved for non-member European countries (Norway, Switzerland), Israel, and those in the process of accession (Turkey, Balkans). In 2008-2009, the EU even considered Russia's association.[217] More recently, the EU has shifted its focus towards so-called like-minded countries. The agreement with New Zealand, signed in the summer of 2023, is one example of this new direction for the Commission, which is also negotiating with Canada, Japan and South Korea.[218] Regarding the agreement with New Zealand, the Commission declared:

> "This marks the first association with a close partner that is not geographically close to Europe. It marks a completely new approach whereby the EU is strengthening even more its ties with trusted partners that have a solid scientific base and a robust research track record."[219]

When negotiating association agreements and bilateral roadmaps, the Commission may choose to only include Pillars 1 and 2 in the scope of the cooperation, or the associated country may choose to limit its participation, for budgetary reasons for example. New Zealand for example will only take part in Pillar 2 (applied research),[220] while the UK is excluded from Pillar 3 (European Innovation Council) until January 2024.[221]

215. Interview with a French diplomat.
216. *Global approach to research and innovation*, *op. cit.,* p. 12.
217. Interview with a representative of the European Commission.
218. Interview with a French diplomat.
219."New Zealand Joins Horizon Europe Research and Innovation Programme", European Commission, July 9, 2023, available at: www.ec.europa.eu.
220. According to the Council of the EU, "Pillar II was deemed to be the most appropriate to facilitate the association of highly industrialized countries outside the Union's geographical vicinity". Council of the European Union, "Proposal for a Council Decision on the conclusion of the Agreement between the European Union, of the one part, and the Government of New Zealand, of the other part, on the participation of New Zealand in Union programmes", March 9, 2023, p. 3, available at: www.senat.fr.
221. Interview with a French diplomat.

This new approach is not without its critiques, even inside the Commission. According to one of its representatives, while these countries are indeed aligned with the EU with regard to their values, they are also "fierce" economic competitors, especially in the case of Korea and Japan.[222] Yet it is difficult to isolate cooperation on the applied research program (Pillar 2) from industrial interests – indeed, industry accounts for over 30% of Pillar 2 (both in terms of participation and funding).[223] The worst-case scenario for the EU would be for applied research co-funded by Horizon to lead to the development of commercial applications in non-EU partner countries. One French diplomat also thinks the Commission fails to adequately convey the political goals of these partnerships.[224]

Lastly, while international cooperation in research is largely fueled by the mobility of researchers, partnerships with geographically distant countries can create difficulties in fields like quantum technology, which requires both hardware and software resources. For Ulrich Mans, Director of Strategic Partnerships at Quantum Delta, the umbrella organization for the Dutch quantum ecosystem, European partnerships are the way forward. In his view, geography matters in this developing technological field: building technology clusters requires a proximity that makes cooperation with Japan, South Korea or Canada more difficult than with neighbors like Switzerland or the UK.[225]

## *Cooperation with the United States and China*

### Cooperation with the United States is still a key factor

The United States and China, two research giants, are third countries which are not associated with the Horizon program. A bilateral scientific and technological cooperation agreement with the United States has been in place since 1998. Among non-associated third countries, the United States was "by far the most active country participating in Horizon 2020", whether in terms of co-investment sums, flows of researchers, or the number of co-publications and co-signed patents.[226]

The United States and the EU intend to further develop their research cooperation, in particular in the fields of climate and digital technologies. A bilateral administrative agreement signed in January 2023 focuses on

222. Interview with a representative of the European Commission.

223. *Ibid.*

224. Interview with a French diplomat.

225. Presentation by Ulrich Mans at the Journée nationale de la Stratégie quantique, March 30, 2023, Paris.

226. *Proposal for a Council Decision concerning the renewal of the Agreement for scientific and technological cooperation between the European Community and the Government of the United States of America*, Brussels, March 2023, available at: www.eur-lex.europa.eu.

research in AI, computer science and data protection methods.[227] The partnership will focus in particular on advanced AI research to address and anticipate global challenges (climate forecasting, electrical grid optimization, healthcare, etc.).[228] The objective is to benefit the general interest and the Global South, and demonstrate that the United States and the EU are responsible stewards in the field of AI.[229] The partnership also intends to work with industry on research into next generation networks (6G) and quantum technologies.

There are some obstacles, however, to bilateral cooperation involving critical technologies, such as the growing number of export controls imposed by the United States on an ever-increasing number of technologies, countries and entities. As an example, in 2017, the German Fraunhofer Institute decided to pull out of a transatlantic collaboration project on diamond technologies due to U.S. export and security controls.[230] Today, EU-U.S. cooperation in quantum technology aims to develop a common vision on the risks to quantum research, export controls (and how they can affect quantum science and technology development), and intellectual property protection.[231] Given the power of the U.S. private sector and the tendency of U.S. labs to patent as many inventions as possible, Brussels' goal of promoting commercial exploitation within the EU through the Horizon program is partly intended as a means of countering the United States.[232]

### EU-China cooperation: slowing down, new restrictions

With China, the dynamic is different. The 2021 Global Approach declared: "China's position as an economic competitor and a systemic rival to the EU calls for a rebalancing of research and innovation cooperation".[233] The EU now wants to adopt a "nuanced" approach to China, one that reflects the "necessary" cooperation with the country in research and innovation, while aiming to establish "suitable conditions".[234]

227. "Statement by National Security Advisor Jake Sullivan on the New U.S.-EU Artificial Intelligence Collaboration", January 27, 2023, available at: www.whitehouse.gov.
228. "Joint Statement EU-US Trade and Technology Council of 31 May 2023 in Lulea, Sweden", European Commission, May 31, 2023, available at: www.ec.europa.eu; "The European Union and the United States of America Strengthen Cooperation on Research in Artificial Intelligence and Computing for the Public Good", European Commission, January 27, 2023, available at: www.digital-strategy.ec.europa.eu.
229. Interview with representatives of the U.S. State Department.
230. R. Hudson, "How to Keep Science Open – but also Secure? G7 Nations Work on an Answer", *Science Business,* July, 2022, available at: www.sciencebusiness.net.
231. Presentation by a representative of the European Commission at a closed seminar.
232. Interview with a representative of the European Commission.
233. *Global approach to research and innovation*, *op. cit.*, p. 17.
234. Presentation by Maria Christina Russo, Director for Global Approach and International Cooperation in R&I at the European Commission, during the "Rewriting the rulebook on EU-China scientific cooperation" conference, Friends of Europe, June 29, 2023.

Since 2019, the European Commission has engaged in discussions with Beijing in order to establish a bilateral roadmap that would create a mutually beneficial framework for cooperation. Negotiations are still ongoing – reflecting the evolution of EU-China bilateral relations over this period. The Commission wanted the roadmap to include provisions relating to intellectual property, open science, scientific ethics and integrity, IT systems, and small and medium-sized businesses. The roadmap has now come to a standstill. Joint research projects have been successful during this time, however, in a number of areas of common interest: food, agriculture and biotechnology, and climate and biodiversity. In 2023, two Horizon research actions targeting these subjects were launched, with 15 million euros of funding for the EU and 18 million euros for China.[235]

Beyond the political framework of this bilateral relationship, scientific cooperation with China has declined since 2020, due to decisions by individual researchers related to Covid and political developments in China. According to a Euraxess study published in January 2022, the number of European researchers in China has fallen by 50% in two years. Departures are especially high in the fields of physics and engineering: the share of European researchers in China in these fields has fallen from 36% to 20% between 2019 and 2022.[236] More than half of researchers who left China cited the changing political situation as a factor in their decision.[237] Restrictions on the use of certain software in China are another concern cited by researchers, according to *Science Business*.[238] There is a downward trend in the number of young researchers moving to China, and a general perception, including among researchers having already returned to Europe, of a decline in research collaborations with China.[239] This trend also holds true in the opposite direction. In the case of the United States and Australia, analyses show that a growing number of Chinese researchers are leaving these countries as security measures make them less and less attractive to Chinese students and researchers.[240]

This trend is unlikely to reverse in the foreseeable future. In early 2023, the EU decided to ban Chinese entities from participating in any Innovation Action under Horizon Pillar 2 – projects nearing market maturity (prototypes, demonstrators…) and intended to contribute to the Union's competitive advantage.[241] In the summer of 2023, the Commission also decided to impose restrictions on Chinese telecom and software companies Huawei and ZTE,

235. D. Matthews and R. Guerini, "Bans, Flagships, and a Green Pivot: The State of EU-China Research Relations", *Science Business,* August 1, 2023, available at: www.sciencebusiness.net.
236. "Survey for European Researchers in China 2022", Euraxess, July 2022, available at: www.euraxess.ec.europa.eu.
237. *Ibid.*
238. D. Matthews and R. Guerini, "Bans, Flagships, and a Green Pivot", *op. cit.*
239. Euraxess, "Survey for European Researchers in China 2022", *op. cit.*
240. W. Kuang, "Australia and the US Are Cracking Down on 'Chinese Spies' in STEM, and Beijing Is Taking Advantage", *ABC,* February 9, 2023, available at: www.abc.net.au.
241. D. Matthews and R. Guerini, "Bans, Flagships, and a Green Pivot", *op. cit.*

to reflect their status as "high-risk" suppliers.[242] Until then, both companies had been able to participate in Horizon research projects: Huawei had received 4 million euros in European funding for 13 research projects, including one on machine-to-machine communications in 6G, via its German subsidiary in Düsseldorf. Commission Vice-President Margrethe Vestager acknowledged that these projects had not, at the time of the 2021-2022 work program's adoption, been identified as representing a risk for the Union's strategic assets, interests, autonomy or security.[243] However, as mentioned in the first section, these European projects represent only a small fraction of collaborations between European researchers, universities or companies, and companies like Huawei and others, with ties to the Chinese military.

# International R&D in the private sector: what coordination with government action?

## *International R&D drivers*

How do private-sector decisions concerning research partnerships interact with public policy in the field? While industry is regarded as a source of strong research security practices (in contrast with academia),[244] their partnership choices are made independently of the bilateral agreements drawn up by national governments or the EU, which mostly focus on fundamental rather than commercial research.[245] Public authorities also have no control over industrial partnerships in the private sector, aside from regulated sectors, e.g., dual-use goods and military technologies.[246]

Thus, while the French authorities in charge of economic security are generally not favorable to semiconductor, aeronautics or automotive companies deploying in China, the French government can do "nothing but talk" with these companies.[247] They are also often better informed than the government about the local political and economic context.[248] In the case of private research funded by the French public sector, such as for quantum technology, through programs run by the BPI or the Directorate General of Armament, the French government may prohibit certain foreign investments, according to a list of countries (e.g., Russia, Iraq, Pakistan, Israel and China) or entities (including those based in allied countries, but whose financial ties

242. D. Matthews, "Commission Confirms it Is Planning Restrictions on Huawei in Horizon Europe", *Science Business,* August 22, 2023, available at: [www.sciencebusiness.net](www.sciencebusiness.net).
243. *Ibid.*
244. Interview with a representative of the European Commission.
245. Interviews with representatives of the U.S. State Department and French diplomats.
246. Interview with a senior public administration official.
247. *Ibid.*
248. *Ibid.*

or political affiliations are deemed problematic).[249] When it comes to R&D partnerships or commercial ties, however, the State may not prohibit them, but it does warn of the risks and encourage due diligence.

Despite geopolitical challenges and research security issues, one representative of a major global industrial group headquartered in France maintains: "We will continue to conduct R&D in multiple countries because we rely on local expertise and ecosystems to grow our markets and develop our products."[250] For this group in particular, coordinating R&D through international teams present in a variety of markets makes it possible to develop specific products that better meet the needs of local customers, and are better integrated into their manufacturing processes, in very diverse and geographically specialized sectors. R&D activities thus need to be localized in certain countries to be in direct contact with these countries' customers and researchers.[251] This company therefore operates several research centers, in Europe, America and Asia, working closely with its subsidiaries and customers, and develops its products drawing on its international teams and their wide range of expertise. This group also collaborates with local universities and labs, gaining direct access to expertise and technologies.

Many other companies share this approach, including Google, as one representative for Google Research, which opened one of its main research centers in Paris, explains:

> "For fundamental research in AI, Google goes where the talent is, and that talent is scarce: it's located disproportionately in Europe (particularly in the UK, France for mathematics, Switzerland, where Google has a big engineering hub), the United States and Canada. We set up where that talent is."[252]

As Google has shown, Europe is also home to international R&D facilities for major foreign groups. This is also true for Chinese companies like Huawei, which has six R&D centers in France, including one dedicated to fundamental research in mathematics and computing, in Paris. While the state welcomes France's appeal as a location for international research labs, authorities are keeping a close eye on the activities of these "digital giants" in France, given their potential ties with their home countries and the risk of French talent being poached.[253]

Another factor driving international R&D activities in critical technologies lies in local legal or technical constraints. Artificial intelligence involves the issue of training data, which is country-specific, especially for language models and computer vision applications (road signs in the case of autonomous driving, for example). Local laws may restrict information

249. Interview with a representative of a quantum start-up.
250. Interview with representatives of a major French industrial group.
251. *Ibid.*
252. Interview with a Google Research representative.
253. Interviews with senior public administration officials.

transfers in the context of international R&D activities. In China, for example, laws prevent the circulation of training data outside the country[254]. Algorithms therefore need to be developed locally, in order to cater to the Chinese market.

According to a December 2020 Georgetown University study on the location and activity of 62 AI research labs operated by major U.S. companies (Facebook, Google, IBM and Microsoft), Europe (primarily France and the UK) is home to 19% of these labs, China and Israel each account for 10%, and India 8%[255]. Among the leading U.S. corporations, Microsoft has by far the strongest foothold in China: Microsoft Research Asia has some 9,000 employees in China, over 80% of whom are software engineers or R&D staff.[256] In the United States, some critics deplore the fact that labs run by American companies, most notably Microsoft's at Tsinghua, regarded as a leader in machine learning as far back as the 2000s, have trained the future leaders of China's AI ecosystem.[257]

## *Risks and challenges of international R&D*

We have already outlined the risks of openness in research on critical technologies. The same applies to international R&D. Given the Chinese political context described at the start of this paper, corporations have limited the scope of technologies they are willing to develop in China or elsewhere, and taken steps to protect the intellectual property developed as part of these research partnerships. Some of the key technologies belonging to the previously mentioned major French industrial group have historically been developed in France, and intellectual property is centralized at the Group's headquarters in France.[258] The Dutch firm ASML takes a similar approach: R&D is mainly carried out in the Netherlands and the United States; only 3% takes place in China, and patents are mainly held in the Netherlands, with none in China.[259]

As with researchers in academia, the changing political context in China has led the private sector to adopt new strategies. In late 2017, Google announced the launch of the Google AI China research center in Beijing,[260] staffed by several hundred engineers.[261] Two years later, this research center

254. Interview with a Valeo representative.

255. R. Heston and R. Zwetsloot, "Mapping U.S. Multinationals' Global AI R&D Activity", *op. cit.*, p. 2.

256. "Microsoft Research Asia Refutes Rumors of Relocating from China to Canada", *Pandaily*, June 19, 2023, available at: www.pandaily.com.

257. M. Sheehan, "Who Benefits from American AI research in China?", *Macropolo,* October 19, 2019, available at: www.macropolo.org.

258. Interview with representatives of a major French industrial group.

259. T. Dams and X. Martin, "Investors Beware: Europe's Top Firms Are Highly Exposed to China", *Clingendael Report*, Clingendael, April 2022, p. 20.

260. F. Li, "Opening the Google AI China Center", *Google Blog,* December 13, 2017, available at: www.blog.google.com.

261. J. Vincent, "Google Opens Chinese AI Lab, Says 'science Has No Borders'", *The Verge,* December 13, 2017, available at: www.theverge.com.

was disbanded: "we do not conduct AI research in China", reads the updated announcement page.[262] Microsoft, for its part, recently refuted rumors suggesting a relocation of its R&D activity from China to Canada.[263]

Finally, technology sanctions and trade restrictions can also complicate international R&D activities. As a representative of an international group headquartered in France explains:

> "Depending on national regulations, certain products may be subject to different export authorizations or restrictions. The decoupling of the semiconductor industry between China and the United States, for example, will impact where R&D work in this sector will be carried out in the future, for all actors in the industry."[264]

The restrictions imposed by both sides do not only affect R&D activities with China. As mentioned above, cooperation between Europe and the United States is also affected by U.S. export controls. For quantum technology, new export controls could jeopardize the (potential) international revenues of companies that are, for the most part, very young.[265] Additionally, labs and start-ups developing quantum technologies rely on international supply chains for enabling technologies, components and materials, themselves exposed to the risk of new trade restrictions and bottlenecks as this new industry grows.[266]

262. F. Li, "Opening the Google AI China Center", *op. cit.*
263. "Microsoft Research Asia Refutes Rumors of Relocating from China to Canada", *Pandaily, op. cit.*
264. Interview with representatives of a major French industrial group.
265. Parker on "The Qubit Guy's Podcast", *op. cit.*
266. E. Parker, "Promoting Strong International Collaboration in Quantum Technology Research and Development", *op. cit.*; G. E. Riekeles, "Quantum Technologies and Value Chains: Why and How Europe Must Act Now: A Test Case for the EU's Technological Competitiveness and Industrial Policies", *Discussion Paper,* European Policy Centre, March 2023.

# Conclusion

Critical technologies combine security and economic competitiveness concerns, and cover by definition constantly evolving fields of science and technology. They raise questions, for governments and industry alike, as to their ability to anticipate and manage the potential repercussions arising from the exploitation of research results. Research into critical technologies thus exists in a state of tension, between the field of research, inherently open and characterized by internationalization and cooperation, and a national security agenda and competitive interests, which demand that limits be placed on this openness.

Research security and international partnership choices have been pushed up the agenda in the EU, in France and in other Member States, as well as in the United States, following the emergence of heightened economic and geopolitical risks. These risks relate in particular to research connections with China and Russia. As a result, the last three years or so have seen a tightening of security measures for research, to combat foreign interference and unwanted knowledge transfers, in areas deemed to be critical: restricted foreign participation in research programs, enhanced site security, etc. The French model is centralized and extensive in scope, when compared to other EU Member States. France' example also shows that regular adjustments are necessary in order to find a good balance, in terms of protection measures, in the list of fields requiring protection, and in the responsibilities to be assigned between the central administration and research entities.

Science and technology diplomacy is also being rethought, at both EU and Member State levels. International cooperation in research is increasingly seen as a means of strengthening political ties and gaining influence through strategic partnerships with like-minded countries. Critical and emerging technologies, foremost among them artificial intelligence and quantum technologies, are central to these new partnerships. They are also characterized by greater vigilance from Europe to ensure reciprocity in these exchanges, and their resulting benefits for Europe with regard to intellectual property.

Finally, critical technology research ecosystems are themselves evolving. This study has shown that corporations are playing an increasingly central role in AI and quantum technology research. This limits what governments can do to ensure research security. It also restricts the range of options for international research partnerships in critical fields.

This study has also identified a number of issues that would merit further examination. On the one hand, the privatization of research in critical fields, and the extension of security policy tools, raise questions surrounding public access to research results, as well as the relationship between protective policies and those promoting open science. On the other hand, it will be useful to examine the effects of scientific and technological sanctions against Russia on the Russian research ecosystem, and on the ties that have been maintained or that may be (re)established in the long term, and to draw lessons from the precedent set by these sanctions.

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