5. International dimensions of the EU's FET Flagships: Large-scale strategic research investments as a site of de-facto science diplomacy

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List of Acronyms

CERN	European Organization for Nuclear Research
DG	Directorate-General
DG CONNECT	Directorate-General for Communications Networks, Content and Technology
DG RTD	Directorate-General for Research and Innovation
DG TRADE	Directorate-General for Trade
EC	European Commission
EEAS	European Union External Action
EPFL	École Polytechnique Fédérale de Lausanne
ERA-Net	European Research Area networks (a project type in the Framework Programme)
ESA	European Space Agency
EU	European Union
FET	Future and Emerging Technology
FLAG-ERA	"The Flagship ERA-NET" (FP7 / Horizon 2020 ERA-Net projects)
FP	Framework Programme
HBP	Human Brain Project
IBM	International Business Machines Corporation (American multinational technology company)
ICT	Information and Communication Technologies
IP	Intellectual Property
QFlag	"Quantum Technology Flagship Coordination and Support Action" (Horizon 2020 project)
QuantERA	"ERA-NET Cofund in Quantum Technologies" (Horizon 2020 ERA-Net project)
SDGs	Sustainable Development Goals
SESAME	Synchrotron-light for Experimental Science and Applications in the Middle East
SWD	Staff Working Document
TAIPI	"Tools and Actions for Impact Assessment and Policy makers Information" (FP7 project)
US	United States
ZSI	Zentrum für Soziale Innovation (Centre for Social Innovation)

1. Introduction

The European Union's Future and Emerging Technology (FET) Flagship projects are among the largest and most ambitious cooperative research endeavours on the globe. The European Commission launched the Flagship programme as part of its 7th Research and Innovation Framework Programme. The first two (Graphene, Human Brain Project) of three Flagship projects started in 2013, the third (Quantum Flagship) kicked off in 2018 (already under a Horizon 2020 regime). Each of the three is expected to absorb around € 1bn of public and private funding over a potential 10-year runtime to transform outstanding European research in areas of strategic relevant into technological innovation as well as economic and societal benefit.

In looking at the Flagship projects from a science diplomacy perspective, we ask the question of the international reverberations of large-scale research investments. The hypothesis is that these initiatives cannot and do not take place in a purely European space. They constitute interventions that potentially cross European boundaries. Research on topics such as graphene or the human brain is taking place around the globe, much of it in collaborative settings. Europe is not the only region trying to exploit research in these areas for economic and societal benefit. This poses a number of questions:

- How did/do the FET Flagships affect EU foreign relations and vice versa?
- How are they perceived in the EU and non-EU foreign and science policy community?
- To what extent is international cooperation relevant in/for the Flagships? How is it organised? How did the international cooperation dynamics change over time?
- How could they be relevant in future EU foreign relations?

We consider this case as being driven by science opportunities while at the same time, the European instruments available are also driving many aspects.

We have approached these questions with a qualitative research methodology consisting of a mix of desk-based document analysis, semi-structured interviews and participant observation completed between June 2018 and February 2019. Document analysis focused on official EU documents as well as policy and scholarly discussion of the FET Flagship instruments. This research was guided by insights gathered through interviews and observations and partly guided by ZSI's experience in the TAIPI project (2015-2018), a Framework Programme 7-funded project developing a monitoring framework for the first two FET Flagships. A set of eight semi-structured interviews were carried out face-to-face or via telephone. In addition, the main author of the report attended the first conference of the Quantum Flagship.

2. Governance arrangements and background of the case

The format of the FET Flagships goes back to a European Commission Communication in the year 2009[1]. Launching FET Flagships was proposed as one line of action to 'moving the ICT frontier' and to ensuring European leadership in FETs. The document shows that the idea of FET comes out of ICT-related research and innovation policy. This is still reflected in FET Flagship governance, which is institutionally located at DG CONNECT (while the Research Framework Programme governance is of course driven by DG Research and Innovation).

The 2009 Commission Communication asks to "prepare ambitious Europe-wide, goal-driven FET flagship initiatives that can combine large, sustained European research efforts on clearly defined foundational challenges, on a scale too large to be addressed by current FET initiatives"[2]. Essentially, the rationale behind the Flagships is a perceived mismatch between ICT-related foundational challenges and available funding instruments. The example given in the document is 'understanding how nature processes information' and building biocomputers on the basis of this new understanding.

The 2009 document was explicit about the global nature of these endeavours: "They should foster extensive and ambitious European and global collaboration and pool resources going beyond the existing fragmented initiatives and programmes"[3]. It was not specified how the inner-EU cooperation would compare to the global cooperation. As we shall see, in practical terms, the Flagships defined quite clear boundaries between European (meaning among EU Member States and countries associated to the Framework Programme) and global cooperation.

While the programmatic background of the Flagships was already defined by the 2009 Communication, the governance model for the first generation Flagships was published in the form of a European Commission Staff Working Document in 2014[4]. The model essentially describes a combination of an EC-funded (via the Framework Programmes) core project that is linked to a series of so-called partnering projects at different geographical levels. The main idea is that the substantial funding for the core project motivates other stakeholders to align their research agendas, leading to more funding for coordinated thematically defined research efforts. The figure shows the relation between the core and the partnering projects as well as the respective funding institutions.

[1] European Commission (2009): Moving the ICT frontiers - a strategy for research on future and emerging technologies in Europe. Communication COM (2009) 184 final.

[2] Ibid. p. 9.

[3] Ibid.

[4] European Commission (2014): FET Flagships: A novel partnering approach to address grand scientific challenges and to boost innovation in Europe. Commission Staff Working Document, SWD (2014) 283 final.

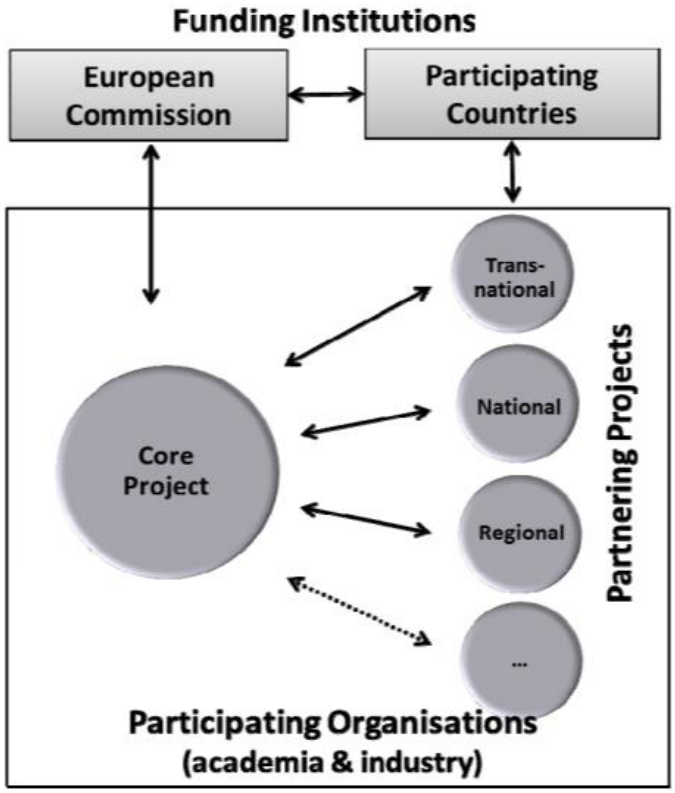

Figure 1: The Model of FET Flagships[5]

Three governance bodies link these stakeholders.

- The Framework Partnership Board brings together the Flagship core project consortium and the European Commission.
- The Board of Funders brings together the European Commission and the participating countries.
- The Flagship Governance Forum is the broadest governance body bringing together the funders, the core project as well as the partnering projects.

This governance model is the blueprint for the two first-generation Flagships.

2.1. First-generation flagships – Graphene and the Human Brain Project

Besides laying out the main idea and expectations behind the Flagships, the 2009 Commission Communication also specified the goal of launching at least two of them until 2013 – a goal that was achieved with the start of Graphene and the Human Brain Project (HBP) in 2013. The selection process of these two Flagships started in 2010[6]. A preparatory study concluded that research communities would have to be involved in order to make the Flagships a success. What followed was an open-ended, bottom-up selection process (starting with an open consultation in 2010).

In July 2010, a Call for pilots was published. Out of 21 eligible proposals, six pilots were launched in 2011. In 2012, through a second call, out of the six pilots, two – Graphene and HBP – were selected to be launched as full Flagships. The selection was based on an

[5] Source: European Commission (2014): FET Flagships: A novel partnering approach to address grand scientific challenges and to boost innovation in Europe. Commission Staff Working Document, SWD(2014) 283 final. Retrieved from http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?doc_id=6812 p. 8.
[6] cf. Ibid.

evaluation involving experts from academia, industry and policy. The selected flagships received funding for a 30-month ramp up phase (2013-2016) under an FP7 regime (funded with € 54 million) and are in the operational phase projected for 2016-2023 (funded with € 50 million per year) funded by Horizon 2020. In total, each of the Flagships receives EU funding of € 500 million over a ten-year time span. An additional € 500 million is expected to be funded through the so-called partnering projects (funded by EU Member States and other sources).

The two first-generation Flagship projects' partner structure is as follows:

- The Graphene project is coordinated by Chalmers University (Sweden) and brings together over 150 academic and industrial research groups in 23 countries plus an additional 60 associate members. Full partners are from EU countries or countries associated to the Framework Programmes (like Israel, Norway or Switzerland). Associate members include institutions in non-EU countries like Armenia, Ukraine (which are associated to the FP) or Belarus. Around a third of partners are companies.
- The Human Brain project is coordinated by the École Polytechnique Federale de Lausanne (EPFL) in Switzerland and brings together a total of 131 partner institutions from EU Member States and countries associated to the Framework Programmes. In the case of HBP, there are only a few private sector partners.

In order to support partnering projects, a European Research Area Network (ERA-Net) multi-national funding scheme was established in parallel to the two core projects. This ERA-Net 'FLAG-ERA' brought together funding partners from 26 EU Member States to coordinate national-level efforts and mobilise additional support for the selected topics. In four Calls for Proposals (2015, 2016, 2017 and 2019), a total indicative budget of around € 69 million was mobilised (for both Flagships). Although case contributions to joint calls are not the only support from EU Member States to the Flagships and their topics, these numbers still fall short of expectations projecting € 500m partnering project funding over the year runtime[7].

With the two Flagships running operational phase starting in 2016, the European Commission invited a panel of experts to conduct an interim evaluation of the Flagships. The evaluation asked the question of the relevance, effectiveness and efficiency of the Flagships so far as well as of their added value. Among the results, it was pointed out that "[w]hile the Flagships demonstrate their effectiveness in delivering excellent science, their future effectiveness in supporting innovation still needs to be demonstrated"[8]. The evaluation is also explicit about the need to consider whether two very different objectives – excellent science and excellent innovation – can indeed be covered with one and the same instrument. The evaluation panel also notes that linking research investments from public and private sources at both European and national level is proving more difficult than expected.[9] In the eyes of the evaluators, this has implications for the selection process of future flagships.

[7] cf. European Research Area and Innovation Committee (2018): Final Report by the ERAC Ad-hoc Working Group on Partnerships on the 'Recommendations on increasing the efficiency of implementation of partnerships'. ERAC 1211 / 18, p.7, Retrieved from: http://data.consilium.europa.eu/doc/document/ST-1211-2018-INIT/en/pdf

[8] Carrozza, M. C., C. Brogren, M. Kleiber, M. Kleiner, R. McKernan, P. T. Kidd, J. Lindberg, C.A. Lodemann, M. Sivasegaram, C. M. Oddo (2017): FET Flagships Interim Evaluation [Final Report]. p.7, Retrieved from: https://ec.europa.eu/newsroom/document.cfm?doc_id=42760

[9] ibid., p. 8

2.2. A third Flagship

The formation of the third Flagship project, the Quantum Flagship, was already announced during the work of the interim evaluation panel of the first two Flagships. As is also noted by the panel[10], the selection process for this third Flagship was different from the first two: the Quantum topic has not been selected following a bottom-up process, but a top-down approach. The topic selection was, of course, done in close coordination with the scientific community, industry and, importantly, EU Member States. The scientific community followed an invitation by Günther Oettinger, the Commissioner for the Digital Economy, to formulate a strategy for Europe to stay at the front of the second Quantum Revolution. The so-called Quantum Manifesto[11] was handed over in May 2016 at the Quantum Europe Conference in Amsterdam. Following this, a High-Level Steering Committee was set up to advise the Commission on the design, implementation and governance of the Flagship.

The mechanism and governance model of the Quantum Flagship are different from Graphene and HBP. There is no core project and partnering projects, but a set of research and innovation projects that are aligned by a framework structure (basically a Coordination and Support Action and a stakeholder network). They are selected by peer review following Call for Proposals oriented along a strategic research agenda. In the ramp-up phase of the Quantum Flagship (2018-2021), 20 projects have been awarded a total of € 132 million in four application areas (quantum communication, quantum simulation, quantum computing and quantum metrology and sensing).

Similar to FLAG-ERA for the first two Flagships, there is also an ERA-Net project ('QuantERA') bringing together European Member States (and countries associated to Horizon 2020) for additional funding. It is seen as a success of the setup and implementation of the Quantum Flagship that QuantERA indeed managed to coordinate national-level efforts to a stronger degree than FLAG-ERA. The first QuantERA call in 2017 already mobilised a total funding of € 36 million, the 2019 Call an additional € 20 million. As stated above, EU Member States invested a total of € 69 million in four FLAG-ERA Calls (covering both of the former Flagships).

2.3. The future of the Flagships

At the time of writing this report (2019), it is understood that the continuation of the FET Flagship instrument in Horizon Europe is not foreseen. Before this became clear, a discussion about selection processes was implemented. In spring 2016, the European Commission launched an online consultation that resulted in 24 proposals for future Flagships. At the end of 2016, Commissioner Oettinger organised a round-table conference with Member States and representatives from the scientific and industrial communities. The idea was to discuss the selection of the four to six most promising topics for future Flagships. In March 2019, six 'Preparatory Actions' for future Flagships were selected for funding.

- "Time Machine" on the access of historical information
- "Humane AI Flagship" on artificial intelligence
- "Energy-X" on chemical energy conversion technologies
- "LifeTime" on genomics research
- "Sunrise" on renewable energies
- "Restore" on "living drugs" and regenerative medicine

Each of these initiatives received € 1 million to develop a research agenda and an implementation plan. Ultimately, two new Flagships were to be selected to start in 2020.

[10] ibid., p. 20

[11] QUROPE (2016): Quantum Manifesto. A New Era of Technology. Retrieved from: http://qurope.eu/manifesto

However, the latest plans for the upcoming 'Horizon Europe' Framework Programme abandon the concept of Flagship projects – none of the preparatory actions will be funded as such.[12]

In conclusion, FET Flagship governance is rooted at the EU-level, involving DG CONNECT and DG RTD as the relevant European Commission bodies. The national level of EU Member States is involved to varying degrees. The idea is that the large Flagship initiatives offer an incentive to Member States to coordinate national-level funding in the respective thematic areas. As we have seen, this objective was reached to varying degrees.

The main policy hypothesis behind the Flagships is that an instrument of the size and type of the Flagships is necessary to advance European science in strategically relevant areas where it is possible to transform research excellence into technological development and socio-economic benefits. There is a fundamental paradox linked to this expectation, which affects the way the Flagships relate to European Union foreign (science) policy: the Flagships support transnational collaborative research at an unprecedented scale. At the same time, they have the mandate to generate innovation leading to economic benefits for the European Union. The way this is operationalised is that the Flagships have only EU research institutions (and institutions from countries associated to the Framework Programmes) as full partners. Technically, the openness principle of the Framework Programmes does not allow to exclude non-European partners. Hence, other softer approaches were necessary to construct the Flagships the way it was done (highlighting the objective of triggering EU economic impact, adjusting IP rules, informally communicating expectations). Having only EU partners in the Flagships is, however, not sufficient to dissolve the paradox of cooperation and competition. The Flagships cannot and do not operate in a void. The European Commission relies on non-European reviewers for selecting Flagship projects. Scientists involved in the Flagships travel, speak about their work, have prior and ongoing collaborations with non-European partners. They move from one country to the next. Participating companies might have multinational geometries going well beyond Europe. The question how this tension is resolved (or not) is what makes the Flagships an interesting case from a science diplomacy perspective.

3. Stakeholder landscape

As indicated above, the following stakeholders are involved in the FET Flagships:

- The European Commission programme owners and funding bodies. This concerns DG Research and Innovation as the responsible body for the Research Framework Programmes. Most importantly, however, it concerns DG CONNECT as the one responsible for the ICT-related parts in the Framework Programme.
- National-level research and innovation Ministries and funding bodies that are represented in ERA-Nets 'FLAG-ERA' and 'QuantERA' as well as in the relevant governance bodies (the Board of Funders).
- Research institutions participating in the Flagships (the coordinators at Chalmers and EPFL as well as the QFlag consortium servicing the Quantum Flagship; the partners of Graphene and HPB as well as the Quantum Flagship projects).
- Individuals involved in a number of advisory bodies like the Quantum Flagship Strategic Advisory Board.
- The European Parliament is, of course, involved in the design of the Framework Programmes and, thus, its support to FET Flagships. During their implementation,

[12] ScienceMag (2019): Europe abandonds plans for 'flagship' billion-euro research projects. Retrieved from: https://www.sciencemag.org/news/2019/05/europe-abandons-plans-flagship-billion-euro-research-projects

the Parliament is also informed about the development of the Flagship initiatives (through periodic hearings[13]).

- The Council configuration responsible for research and innovation, the European Research Area and Innovation Committee, is also conducting oversight work of the instrument[14].

What is interesting from the perspective of our case, is the absence of certain actors. Neither the document analysis nor the interview work or the participant observation produced any evidence of structured interactions with EU or national-level foreign policy institutions. Most notably, the European External Action Service has not been involved in FET Flagship-related discourse or policy-making in any substantive way. As to EEAS headquarters and the staff of Federica Mogherini, High Representative of the Union for Foreign Affairs and Security Policy and Vice-President of the European Commission, there was no evidence of involvement. As to the European Union Delegations, the Counsellors assigned to DG Research and Innovation or DG CONNECT have been aware of the instrument and of the discussions in the EU's partner regions. However, their role in FET Flagship governance was described as limited, and, according to our research, their institutional linkage with the Commission bodies they report to (DG CONNECT and DG Research and Innovation respectively) is stronger than their embedding in EEAS hierarchy.

The FET Flagships are instruments of EU research policy. Their relevance beyond Europe is dealt with, if at all, in EU foreign research policy, rather than foreign policy in general. In practical terms, this means that the topic is considered when the European Commissioners responsible for research or ICT travel abroad or meet with foreign delegations. The topic might also be touched upon in one of the sectoral policy dialogues in ICT or research and innovation. However, the policy dialogues are mostly used to discuss opportunities for collaboration and possible joint undertakings. As the FET Flagships were not actively seeking third country participation, the topic was not high on the agenda of these dialogue meetings.

What our research shows, thus, is that the FET Flagships have not found their way into formalised EU-level foreign policy-making. However, as we shall see, FET Flagships as an intervention cause substantial interactions with non-EU stakeholders. They developed their own foreign policy and science diplomacy dynamics.

4. De-facto governance practices

We have seen that, on a formalised level, the role of non-EU stakeholders in the FET Flagships is limited. Although not ruled out in principle, participation in the Flagships is de facto restricted to EU and associate countries (with a few exceptions like a Belarusian partner in the Quantum flagship[15]). The work of scientists around the globe in evaluating Flagships and partnering project proposals is hidden behind the walls of blind peer review. The recommendation of the Interim Evaluation to establish an international strategic advisory board (to „[i]mprove strategic management to enhance openness of the Flagships

[13] One of which the authors was able to attend.

[14] cf. for instance European Research Area and Innovation Committee (2018): Final Report by the ERAC Ad-hoc Working Group on Partnerships on the 'Recommendations on increasing the efficiency of implementation of partnerships'. ERAC 1211 / 18. Retrieved from: http://data.consilium.europa.eu/doc/document/ST-1211-2018-INIT/en/pdf

[15] EaP-PLUS (2018): A Belarusian team joined the FET Flagship on Quantum Technologies. Retrieved from: https://www.eap-plus.eu/object/news/230

towards adopting new directions [by being] more open to external inputs that can challenge assumptions and direction"[16]) is not yet implemented at the time of our research.

However, there are a number of interactions with non-EU regions, creating a Flagship-specific foreign research policy that is linked to the broader questions of Framework Programmes governance and that has an impact on the EU's soft power and image in the world. These interactions also raise the question of unintended side effects of sectoral foreign policy and implicit science diplomacy.

4.1. Non-EU research policies as a trigger of Flagship governance

The FET Flagship programme was set up in an EU policy environment, but its thematic orientation was reacting to global developments in research and research policy. Barack Obama launched the ten-year US Brain Initiative in February 2013, at a time when the selection process of the first two Flagships was under way. Evidence from our interviews suggests that developments like these might have affected the EU's selection of Flagship topics. Similarly, in the case of the Quantum Flagship, the very visibly promoted activities of the Chinese government have strengthened proponents for a European flagship in this arena. Part of this was also the collaboration of the Austrian quantum physicist Anton Zeilinger with his Chinese colleague and former Post-Doc Jian Wei-Pan, which resulted in the first "Quantum Call" between China and Austria[17]. The prospect of China pulling ahead of Europe by combining large-scale public investment with access to European quantum science strengthened arguments in favour of a European Quantum Flagship. The interactions between the Flagships and similar large-scale initiatives in other world regions go both ways, however.

4.2. Flagships as a trigger of non-EU research policies

As the Flagship Interim Evaluation states (and our interviews confirm), the Flagships "have created an international profile for Europe's researchers at the forefront of science and technology developments, and arguably triggered significant investment internationally in these domains"[18]. The Flagships are perceived by partner regions as relevant research policy interventions. Non-EU stakeholders, again mostly in research policy, react and relate to these interventions. In the case of brain research, as we have seen, the US announced its Brain Initiative in early 2013, before the start of the Human Brain Project. China launched its 15-year Brain Project in 2016. In the case of quantum science, the European Flagship has intensified discussions around a national approach in the US, which resulted in the signing of a National Quantum Initiative Act end of 2018.

These examples show that the decision to fund a Flagship and a specific area reverberates in the international research policy sphere. Partner regions might react with their own programmes. They might also try to establish specific cooperation linkages with the European Flagships. If the cooperation options are too limited and rules to restrictive, this might lead to the protest of potential partners or shed a strange light on the Framework Programme's 'open to the world' principle. If cooperation rules are too open, the fear is that results of EU-funded research will be exploited elsewhere. This is where the Flagships

[16] Carrozza, M. C., C. Brogren, M. Kleiber, M. Kleiner, R. McKernan, P. T. Kidd, J. Lindberg, C.A. Lodemann, M. Sivasegaram, C. M. Oddo (2017): FET Flagships Interim Evaluation [Final Report]. p. 10, Retrieved from: https://ec.europa.eu/newsroom/document.cfm?doc_id=42760.

[17] cf. Liao, Sheng-Kai, et al. (2018): Satellite-Relayed Intercontinental Quantum Network. In: Phys. Rev. Lett., 120, 030501.

[18] Carrozza, M. C., C. Brogren, M. Kleiber, M. Kleiner, R. McKernan, P. T. Kidd, J. Lindberg, C.A. Lodemann, M. Sivasegaram, C. M. Oddo (2017): FET Flagships Interim Evaluation [Final Report]. p.14, Retrieved from: https://ec.europa.eu/newsroom/document.cfm?doc_id=42760

have to consolidate a culture of open cooperation deeply embedded in the practices and careers of Flagship researchers with the competitiveness principles behind innovation diplomacy.

4.3. Establishing cooperation regimes

As indicated above, the Flagships have no full partners from outside the EU (and the countries associated to the framework programmes). However, cooperation is practised at a less formalised level in all of the three running flagships. The way these collaboration dynamics play out in detail is very different between the Flagships. Interviewees explain the type and causality of these interactions with the state of the research field and the (perceived) relevance of the EU in global research in the respective area. Reflecting on the ways the Flagships engage with non-EU partners sheds light on the practical difficulties of, first, integrating science diplomacy considerations into research policy and, second, consolidating cooperation and competition.

4.3.1. Graphene

The area of graphene research closely links areas like physics with promising applications in areas where Europe's industry is strong or has strong stakes. Graphene is the Flagship with the highest probability of triggering economic impact through graphene-based products and processes reaching the market. It also has the highest share of industry partners among the Flagships. The assessment of the role of the industrial partners in the Graphene Flagship varies: they play an important role, not only in professional management of Graphene IP, but their personnel resources are limited compared to academia partners, which means the project is still very much research oriented. There are no comparable large-scale funding schemes for graphene research around the world. The Graphene Flagship held joint workshops with researchers from Australia, China, Japan, South Korea and the US. These workshops focused on the basic research aspects, however. There is also a mobility scheme for Graphene researchers to attend international meetings. Although staff fluctuation and researcher mobility are of course commonplace, there is concern with regard to the specific efforts of some regions (especially China) to recruit Graphene researchers. Although there is agreement that international cooperation is important research-wise, there is also an increased consciousness about the limits of open cooperation.

4.3.2. Human Brain Project

Compared to the Graphene Flagship, the research conducted in the human brain project has been characterised as less applied and further away from industry. A lot of HBP is about establishing the infrastructures necessary for brain research. The consortium also has less industry partners than Graphene. According to our data, international cooperation was high on the agenda of HBP at the outset, especially with the US and its Brain Initiative. With some early troubles around HBP[19], however, the stakeholders were then focused on getting the project on track and attention was taken away from the issue of international cooperation. Joint workshops were organised back-to-back with other events, e.g. in the frame of scientific conferences. There was also an exchange workshop with NIH in the US as well as with Canadian brain research consortia. There were political level discussions

[19] The neuroscience community criticised the scope of the Flagship project, cf. The Lancet Neurology (2017): Editorial. Retrieved from: https://www.thelancet.com/pdfs/journals/laneur/PIIS1474-4422(17)30013-3.pdf

with China and Japan and early discussions around possible joint funding schemes with the US and Australia. HBP provided support to set up the Australian brain initiative.

4.3.3. Quantum Flagship

The specificity of the Quantum Flagship, apart from being the third flagship with a different setup and governance (see above), is the role the EU plays in the research field. In quantum research, Europe has been presented (and was perceived) as a global leader[20]. The Flagship investment is motivated by the idea of not losing scientific leadership and of turning research excellence into economic value – not least in light of the large private sector investments in the area by US-based multinationals (like IBM) or the defence sector investments in China and the US. International cooperation has been a topic in the Quantum Flagship right from the start. Unlike the other flagships, however, in this case it was partner regions actively seeking to collaborate. The wish to engage with the Quantum Flagship has been communicated at the political level (of research ministers) as well as vis-à-vis the Flagship researchers. The explicit interest put pressure on Quantum Flagship stakeholders, which were, at the time of the research, busy with setting up the Flagship operations.

Discussing ways to engage with non-EU partners was high on the agenda right from the start of the Quantum Flagship. These discussions, however, could not be conducted openly (at least some internal coordination was necessary in advance), which contrasted with the overall design of the first Flagship events (the kick-off event in 2018 and the Grenoble event in early 2019). For instance, a session on international cooperation was foreseen at the kick-off event, but was then postponed. Some stakeholders fear that an open cooperation regime (with in-depth scientific exchange, joint funding or even participation in the flagship) might be detrimental to the EU's interests. Worries especially at the European Commission are that other regions might be better able to exploit the knowledge generated by the Flagship (e.g. building on private sector investments at a scale not available in Europe) or to put technology to military use without the EU having a say in it. Other Flagship stakeholders consider cooperation essential, not least as an opportunity for EU science diplomacy. These discussions illustrate the challenges for research policy instruments of the scale of the flagships to define a balance between openness and restriction, cooperation and competition.

4.3.4. Cooperation regimes between openness and competition rationales

We can summarise the international cooperation approach of the Flagships as follows: There is no full partner participation from third countries. There are discussion events and joint conferences/workshops at both political and research level. There is no joint funding with third country partners yet, although some bilateral (EU-partner country) programmes are reportedly under preparation. There are only some unilaterally funded mobility schemes. Independent of these programmes, there is academic mobility of Flagship researchers.

In terms of protecting intellectual property, Flagship partners are required (by law through the grant agreement) to request permission from the European Commission for any IP protection or exploitation outside of the EU. While patents are, of course, a key

[20] In the words of the community behind the Quantum Manifesto: "Quantum physics was created in Europe in the first decades of the twentieth century […]. One hundred years on, Europe still plays a leading role in quantum research. Compared to the rest of the world, Europe has more researchers and a broader research scope, linking fundamental and applied science and engineering. Top institutions can be found across Europe, covering all aspects of quantum technologies from basic physics to electronics and computer science" - QUROPE (2016): Quantum Manifesto. A New Era of Technology. p.9, Retrieved from: http://qurope.eu/manifesto

performance indicator, they have to be filed and commercialised in the EU first. We have already alluded to the fact that this raised concerns among some of the industrial partners, especially some multinational companies (interested in) participating in the Quantum Flagship. As long as they had legal entities established in the eligible countries, participation was possible, but they are also required to comply with the specific IP regulations.

The European Commission is aware that the research taking place in the Flagships cannot be isolated (researchers move, they meet at conferences, they collaborate elsewhere). Therefore, the approach is to provide the necessary regulatory environment to make sure the economic value created by the EU-funded research actually benefits the EU's economy. This regulatory environment focuses on the exploitation side more than it does on the knowledge generation side.

Events like the Kick-off conference and the European Quantum Technology Conference 2019 in Grenoble[21] illustrate that a concurrent focus on exploitation can be tricky: On the one hand, Flagship stakeholders have an interest in presenting the Flagship and the work that they will engage in. At the same time, there are issues of competition and IP: presenting future research activities can lead to others adapting the same approach and, potentially, reaching the targets before the Flagship researchers do. Properly managing the information flows within the Flagship and between the Flagship and its environment is challenging, especially during a ramp-up phase.

Some stakeholders pushed for this competitive rationale more than others: DG TRADE and DG CONNECT more than DG RTD; the European industrial partners more than the researchers in universities and public sector research. What our findings show is that concerns about competitiveness took up resources that might otherwise have been used to define a niche for science diplomacy. The following three aspects could have been systematically reflected upon at European Commission level, but were not:

- The Flagships' lack of an explicit (not necessarily public!) science diplomacy strategy can lead to unintended consequences. In particular, the balancing act of consolidating cooperation needs (and demands) with competitiveness considerations can lead to unintended side effects in research, trade and, potentially, broader foreign policy.
- Even if Flagships are considered instruments targeting EU economic benefits, strategically inviting/including third country partners (e.g. from emerging economies) could have triggered positive effects for Europe's relations with these regions.
- Likewise, especially with regard to Human Brain Research and the Quantum Flagship, the link between large-scale European investment and global challenges/SDGs could have been more explicitly designed and used.

Our results suggest that the obstacles for considering science diplomacy more explicitly were: the lack of resources on the side of Flagship stakeholders; the novelty of the topic/discourse; limited interfaces and a lack of foreign policy stakeholders. The latter two have to do with the way how the governance interfaces around science diplomacy are constituted at EU-level.

4.4. Interfaces

As indicated above, our research did not uncover any formal interactions between EU research policy around the Flagships and the Common Foreign and Security Policy as operationalised through High Representative Mogherini, her cabinet and the EEAS

[21] EQTC 2019: European Quantum Technology Conference (EQTC19). Retrieved from: https://eqtc19.sciencesconf.org/

hierarchy. Interactions took place at the level of DG RTD and DG CONNECT staff in European Delegations.

As to the European Commission Headquarters in Brussels, it is important to keep in mind that the Framework Programme governance itself already involves several DGs (EEAS is not among them). In the case of the Flagships these are DG RTD and DG CONNECT. DG Research and Innovation is responsible for the Framework Programme in general, including the issue of international cooperation. DG CONNECT is responsible for the ICT-related parts of the Programme including the governance of the FET Flagships. As our research suggests, this constellation is not without disagreements. Complexity is increased when it comes to defining the relationship with partners like China, where other DGs (e.g. DG TRADE) have very specific and articulate positions.

In this context, it is also important to remember the genesis of the science diplomacy discourse at EU-level. The discussion was launched and promoted by Commissioner Carlos Moedas, responsible for Research and Innovation. The way the concept was used is twofold:

- The Commissioner and other stakeholders presented some EU research policy initiatives as science diplomacy-relevant, particularly international research infrastructures (e.g. the SESAME synchrotron) and joint funding initiatives (like PRIMA).
- In addition, science diplomacy found its way into Horizon 2020 funding, but not as an element of project evaluation and selection, but as a topic of research (the S4D4C project itself being an example).

The EC-level discussions around science diplomacy were not expanded to systematically include other DGs. This specific set of interfaces (and the lack thereof) leads to or at least reinforces a framing of Flagships that does not include science diplomacy considerations. For instance, Flagships are not seen as global challenge-related big science initiatives or research infrastructures, but as competitiveness instruments. International cooperation regimes are defined on the go instead of following a comprehensive strategy that is defined in advance.

The assessment of the outcomes of this approach is beyond the scope of this case study. It might as well be that the combination of a general cautious approach to cooperation with the punctual initiatives of motivated stakeholders (engaging with non-EU stakeholders) triggers suitable outcomes. A systematic evaluation might also show, however, that the de facto research foreign policy-making combined with uncoordinated initiatives of individual stakeholders (Flagship researchers acting as science diplomats in ways that are not coordinated with EU or national level foreign policy) might lead to missed opportunities or unintended negative side effects.

5. Relevance and use of knowledge

As indicated above, there are no explicit links between the FET Flagships and their governance with official EU-level foreign policy. When it comes to the sectoral international relations in research and innovation policy, for example domain knowledge can be considered. This includes knowledge of technologies and technical assemblies: When actors compare the state-of-the-art in areas such as graphene or quantum research, they build their judgement on questions like who was able to put a graphene-based product on the market, who could showcase quantum communication or who had the most promising approaches for quantum computers. In that sense, knowledge (or experiments) in niches that become highly visible are important to claim leadership and, subsequently, mobilise funding, trigger cooperation requests, etc. Knowledge of models can also be considered, e.g. of the human brain or animal brains.

Apart from knowledge per se, several 'input' factors to scientific knowledge production were relevant in the discussions around the FET Flagships:

- Data: Data was an argument both in favour and against international cooperation in the Flagships. For instance, it is known (and has been communicated) that China has large data sets that could be relevant for the area of neuroscience and brain research.
- Research infrastructure: The HBP Flagship as a whole is, to a large extent, conceived of as a research infrastructure allowing participating researchers to access data (and processing power) necessary for the kind of complex modelling necessary to research the human brain. In the area of quantum research, the question of quantum satellites has become important (for instance, ESA has not launched a satellite for quantum communication yet, but the Chinese have).
- Standards: The question who could and would define standards in the respective fields is also relevant for Flagship governance (standard models of the brain, communication standards, etc.).

There is no evidence (yet) that the Flagship projects produce scientific knowledge that is used in foreign policy (in the spirit of 'sd'). This might change with applications in Quantum Communication (secure communication for foreign policy).

6. Issues of multi-level policy-making

Given the nature of its funding, the Flagship-related policy-making is multi-level by definition: It involves various European Commission DGs as pointed out above as well as EU Member States and associated countries co-funding partnering projects. The dynamics around this involve significant 'diplomacy for science' work that could potentially expand to non-EU stakeholders (in preparing co-funding schemes with third country partners). Importantly, however, there are no formal links to foreign policy, not at EU-level and not at Member State-level. The stakeholders involved in the multi-level governance of the Flagships are research policy-makers. When it comes to the Member States, this includes research and/or innovation ministries. On occasions, there are national-level coordination mechanisms, but again, they do not involve the EU science diplomacy or foreign policy (instead, the Swiss coordinators of HBP might coordinate with their bodies responsible for defining the relations between the EU and Switzerland). The Flagships are rooted in the broader research policy discussions at EU-level.

As such, the future development of the case also depends on the design of the next Framework Programme, Horizon Europe. As discussed above, the instrument of the Flagships is likely to be discontinued, which also raises questions for the importance of the present Flagships – in general and for the EU's international relations in particular.

7. Conclusions: How is the case changing our understanding of Science Diplomacy?

The FET Flagships are not conceived of as science diplomacy instruments by the European Commission. To what extent, then, are they more than research policy? The foreign research policy dynamics that we have depicted above suggest to consider them as an instance of sectoral foreign policy and an example of unintended science diplomacy. The case draws our attention to the possible unintended consequences of sectoral foreign policy in the areas of research and innovation. Although hardly any research policy and funding instruments are specifically designed for a science diplomacy use (the exception might be certain co-funding schemes or participation rules), an EU science diplomacy strategy should consider these broader instruments, for two reasons:

- To monitor unintended consequences (of the research policy intervention as such, but also of the science diplomacy-related activities of its stakeholders, including non-traditional actors in diplomacy),
- To reflect on windows of opportunity for science diplomacy.

Even though the FET Flagships are targeted at advancing EU research and innovation, with a corresponding focus on competitiveness (commonplace in innovation diplomacy, but more alien to science diplomacy), science diplomacy could be built into the scheme (e.g. by strategically allowing participation from – or infrastructure access for – certain third countries while restricting it from others). In addition, the case suggests that monitoring intended and unintended effects of research policy instruments (at least of a certain scale) on international relations should be part of a science diplomacy strategy.

Science diplomacy related to initiatives such as the Flagships will, of course, always be different from the well-publicised science diplomacy aspects of big science collaborations or infrastructures (CERN, SESAME, etc.). It will also be difficult to argue for innovation as a public good.[22] However, the European research community is used to openness and collaboration. If instruments like the Flagships end up connecting it to a form of innovation diplomacy that is about claiming stakes in the global knowledge economy (similar to other forms of diplomacy being about stakes in land or other resources), we should at least have the consequences of this process in mind. Disguising realist international relations in an idealist framework of international science relations without reflecting on the effects of sizeable research policy interventions on the EU's international relations can ultimately be detrimental to both research and international relations goals.

[22] cf. Leijten, J. (2019): Innovation policy and international relations: Directions for EU diplomacy. In: European Journal of Futures Research. 7(1), p.4. https://doi.org/10.1186/s40309-019-0156-1

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