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Infrastructure and international cooperation in research and knowledge transfer: supporting access to key infrastructures and pan-European research – lessons learned

Concetta Fazio[1,*], Karl-Fredrik Nilsson[1], Dario Manara[1], Arjan Plompen[1], Andrea Bucalossi[1], Stéphane Bourg[2], Rik-Wouter Bosch[3], Jean-Claude Bouchter[4], Walter Ambrosini[5], Rosa Lo Frano[5], Leon Cizelj[6], and Pedro Dieguez[6]

[1] European Commission, Joint Research Centre
[2] Commissariat à l'énergie atomique et aux énergies alternatives, CEA/DEN/MAR/DRCP, Bat 400. CEA, Marcoule, BP 17171, 30207 Bagnols sur Cèze, France
[3] Belgian Nuclear Research Centre, SCK-CEN, Boeretang 200, 2400 Mol, Belgium
[4] Commissariat à l'énergie atomique et aux énergies alternatives, CEA Saclay, France
[5] CIRTEN - Università di Pisa, Largo Lucio Lazzarino 2, 56122 Pisa, Italy
[6] European Nuclear Education Network, Rue d'Egmont 11, 1000 Brussels, Belgium

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Abstract. Access to research infrastructures has been supported by the European Commission under different financial schemes. During the 6th EURATOM Framework Programme the instrument introduced by the European Commission were the Integrated Infrastructure Initiatives (I-3). Moreover, funding schemes to support Education and Training for students and professional developments were defined also. The main difference between these two funding schemes is that I-3 are topic-driven projects with access to infrastructure components, while the Education and Training related projects have a mobility component that is applied for the different research topics. The outcome of projects as TALISMAN (I-3), EFNUDAT/NUDAME (I-3), GENTLE (mobility), ENEN-plus (mobility), NUGENIA-plus (mobility within TA of NUGENIA) and ESNII-plus (I-3 similar) will be shortly presented as well as the future European Commission plans in the field of access to research infrastructure.

1 Introduction

Pooling and integration of research infrastructures as well as their access had the objective to promote in Europe the development of networks with high quality research infrastructures and their optimum use on a European scale based on the needs expressed by the research community. The infrastructure access scheme called integrated infrastructure initiative (I-3) has the objective to promote access to infrastructure for European researchers or research teams for their research needs, irrespective of the location of the infrastructure. I-3 projects have in general three components, which are (i) networking, (ii) transnational access to infrastructure and (iii) joint research initiatives. Past I-3 projects have been conducted around specific topics as e.g. the FP6 EURATOM supported projects VELLA (Virtual European Lead Laboratory), EFNUDAT (European Facilities for Nuclear Data Measurements) and NUDAME (Neutron data measurements at IRMM) and ACTINET-I3 (Actinide Network) as well as the FP7 EURATOM project TALISMAN. These five projects as indicated by their acronyms were focused on three major topics: liquid lead technology to support the development of lead-cooled reactor systems (VELLA); nuclear data measurement for nuclear reactor physics and basic science applications (EFNUDAT and NUDAME) and actinides science (ACTINET-I3 and TALISMAN). Furthermore, the European Commission has supported along the past EURATOM framework programs several projects and initiatives related to Education and Training, aimed at attracting young talented students and professionals to the nuclear field. These projects and initiatives were more people centred and crosscutting different nuclear topics. The components of the Education and Training projects are the development and execution of specific classroom or (i) online courses for students, (ii) training for professional development and (iii) mobility schemes. Examples of projects with such type of scheme that are completed or

* e-mail: concetta.fazio@ec.europa.eu

ongoing are GENTLE, ANNETTE (without mobility grants) and ENEN-plus (more focussed on mobility and dissemination). Finally, mobility grants are also part of projects that are built around specific topics as for instance NUGENIA-plus and ENSII-plus. In the following chapters, an overview of the above listed projects will be given and more in particular the outcome of the mobility grants implemented in the projects TALISMAN, GENTLE and NUGENIA-plus will be discussed in terms of organisation of the access to the infrastructures and achievements. Finally, this manuscript includes also the recent initiative of the Joint Research Centre to grant access to its research infrastructures.

2 Transnational access to research infrastructure

As already mentioned in the introduction, the access to research infrastructure has been organised in Europe along three different schemes:
– integrated infrastructure initiatives;
– mobility grants within topical projects;
– mobility grants within education and training projects.

In all three cases, access to research infrastructure is granted to researcher, research teams or students. However, the Integrated Infrastructure Initiative had the aim to pool specialised infrastructures around specific topical areas (e.g. liquid metal technology, nuclear data, actinide science), while the mobility grants were more people centred and focussed on promoting mobility into different research infrastructures. Hereafter, a brief overview is given for TALISMAN, NUGENIA+ and GENTLE corresponding to the three different schemes, respectively, and where appropriate extension and examples from the other projects are included.

2.1 TALISMAN

The TALISMAN project was established as a follow-up of the previously successfully concluded Network of Excellence ACTINET-6 and Integrated Infrastructure Initiative ACTINET-I3. The importance to establish a network of competences and infrastructure for actinide science is due to the fact that, actinides of interest for nuclear energy are radioactive elements and their study requires specific tools, facilities and licences that are available only to few European academia and research organisations. Therefore, it is strategic to coordinate the European actinide infrastructures and to strengthen its scientific community in view of performing excellence research and developing excellent professionals in the field. In this context, TALISMAN had the objective to establish a network of Actinide facilities and infrastructures across the EU to structure and foster their joint development in terms of capacity and performance. TALISMAN supported Transnational Access to these facilities through the organization of periodic calls for Joint Research Projects (JRP) and conducted a set of Joint Research Activities (JRA) involving member organisations, with the objective to improve the performance of infrastructures by developing new relevant instrumentations and/or data of common interest.

Fig. 1. Infrastructures pooled within the TALISMAN project. *Courtesy S. Bourg, CEA*. Details on the facilities can be gathered at the link: https://cordis.europa.eu/project/rcn/93856/factsheet/en

TALISMAN has also promoted training and education actions through the organisation of summer schools, networking meetings for trained young scientists, attributing travel grants to students attending international conferences on actinides sciences.

The facilities pooled in TALISMAN were hot laboratories belonging to CEA, JRC, KIT, NNL, Chalmers University and HZDR; as well as beam lines belonging to KIT, PSI and HZDR (see Fig. 1).

The selection of the transnational access to be funded was organized through calls for proposals (two times per year over three years). At the end of each call, the proposals were sent to the Project Scientific Advisory Committee that received a list of ranking criteria, established by the Executive Committee of the project. These criteria were related to (i) the originality of the subject and its compatibility to the TALISMAN portfolio, (ii) the skills of the teams (both visitor and pooled facility), (iii) the relevance of the choice of the pooled facility and that all results had to be publishable.

Within the TALISMAN project, 6 calls were published and in total 107 proposals for infrastructure access were received. From the 107 proposals 96 were granted and 91 were concluded (5 proposals were cancelled due to issues encountered by the visiting teams).

The distribution of the access over the seven involved infrastructure is shown in Figures 2 and 3 summarises the access over the three broad scopes defined within the TALISMAN project, i.e. scope 1 = separations, scope 2 = environmental actinide chemistry and scope 3 = irradiated materials.

The teams hosted at the pooled infrastructures through the TALISMAN grants were either researchers/scientists and/or students.

In Figure 4, the countries of origin of the different research teams asking for accessing the pooled infrastructures are reported. As shown in this figure, TALISMAN was not restricted to only European research teams but research teams from France, Germany and UK were the most numerous.

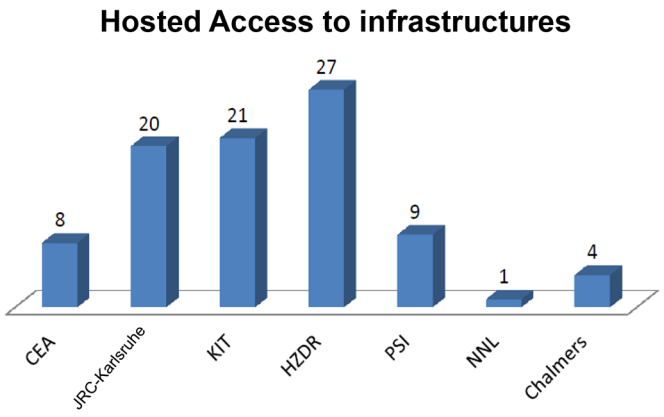

Fig. 2. Frequency access to the infrastructures pooled within the TALISMAN project. *Courtesy S. Bourg, CEA.*

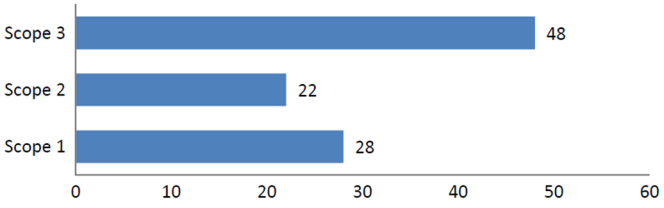

Fig. 3. Access to infrastructure distribution over the three broad TALISMAN scopes: scope 1 = separations, scope 2 = environmental actinide chemistry and scope 3 = irradiated materials. *Courtesy S. Bourg, CEA.*

2.2 NUGENIA-PLUS

The objective of the FP7 EURATOM NUGENIA-PLUS project was to support the NUGENIA Association in its role to coordinate and integrate European research on safety of the Gen II and III nuclear installations in order to better ensure their safe long-term operation, integrating private and public efforts, and initiating international collaboration that will create benefit in its activity fields.[1]

The project was a combination of Coordination and Support Action and a Collaborative Project. The Coordination and Support Action was aimed at establishing a management structure to carry out the planning and management of R&D including project calls, proposal evaluation, project follow-up dissemination and valorisation of R&D results in the area of safety of existing Gen II and future Gen III nuclear installations. The part dedicated to collaborative project was based on thematic calls for research proposals organized among the NUGENIA technical areas, i.e. plant safety and risk assessment, severe accident prevention and management, core and reactor performance, integrity assessment of systems, structures and components, innovative Generation III design and harmonisation of procedures and methods.

[1] https://cordis.europa.eu/project/rcn/110017/factsheet/en

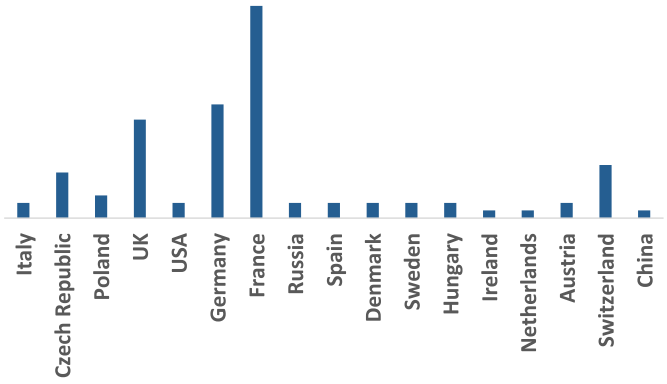

Fig. 4. Countries of origin of the research teams asking for access to infrastructures. Data taken from [1].

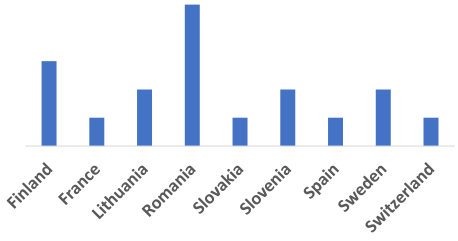

Fig. 5. Countries of origin of applicants. Data taken from [2].

Within NUGENIA-PLUS also mobility grants were offered with the scope to allow young and senior professionals to visit selected key NUGENIA infrastructures (including experimental facilities and modelling and simulation platforms). The overall objective of this action was to enhance the relationships between European R&D facilities and NUGENIA end users. Two type of mobility grants were defined, namely, short training periods for post-doc students and researchers (typically less than 1 month) and long training visits for more experienced staff (from 1 to 3 months). As far as the rules for application were concerned, it was established that the grants were limited to members of NUGENIA-PLUS consortium in terms of hosting organisation and in terms of applicants, but exemptions from this rule were also foreseen.

Within NUGENIA a "Resource Map" which included a database of infrastructures (experimental facilities and modelling platforms) was established that allowed the applicants to select the most suitable infrastructure and related contact person for its grant application. A team established within the work package addressing the mobility grants evaluated the proposals. The criteria for evaluating the proposals were: (i) topic within the NUGENIA roadmap; (ii) training related to infrastructures; (iii) quality of application and requested funding within the budgetary framework.

During the one year of continuous call (there were no deadline for applications), 18 mobility grants have been assigned. As shown in Figure 5, the applicants were from 9 different EU countries with the majority belonging to research organisations and universities. The organisations

hosting the grant holders were belonging to 8 different EU countries as shown in Figure 6. The geographical distribution of applicants and hosting organisation is quite interesting since one can identify a rough pattern from Central and Eastern Europe towards Western Europe. This pattern might be due to the communication effort performed for the NUGENIA grants. A further explanation could be that some infrastructures are not available in these European regions.

Among the 18 grants three were long-term visits and fifteen short term visits. The topical distribution of the grants was quite diversified, although the majorities of the topics were within the areas of (i) severe accidents and (ii) integrity assessment of system and structures. The distribution is shown in Figure 7.

The NUGENA-PLUS responsible for the grant assignment did also a critical review of the process and defined the following conclusions and recommendations:

- a more efficient communication of the availability of the grants and its open call without deadline would have improved the number of applications (indeed, the budget allocated to the grants were not fully exploited);
- the administrative part concerning the coordination and transfer of the grants can be simplified. The coordination (organisation and payment of the grants) should be with one organisation, whereas in NUGENIA it was split over two different project partners. Also, the payment can be simplified moving from real costs to lump sum;
- the distribution over the technical areas was not even. Indeed, two topical areas get more interest with respect to the others, but no further assessment was done with this respect;
- a further recommendation that was formulated on the basis of the experience gathered during the calls for access to infrastructure was that the members of the evaluation committee should be well defined and the number of participants to this committee should be in the order of 4–5.

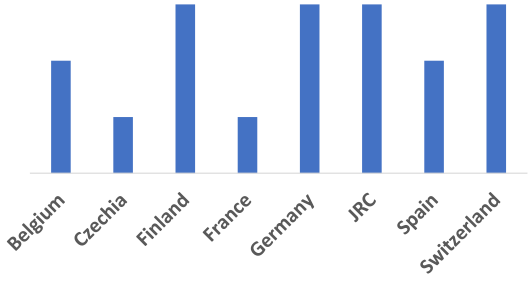

Fig. 6. Countries of origin of hosting organisations. Data taken from [2].

Within the ESNII-PLUS project a similar approach as for NUGENIA-PLUS was adopted. The first step of ESNII-PLUS was the identification of available research facilities associated with the research needs for the different reactor concepts [3]. A "Research Facility map" resulted from this analysis and within ESFR-SMART a mobility grant program for SFR was launched. The call for the grants were organized similar to the I-3 approach, however, results of the outcome of the grant assignment were not made available at the time of writing this manuscript since the project is still ongoing.

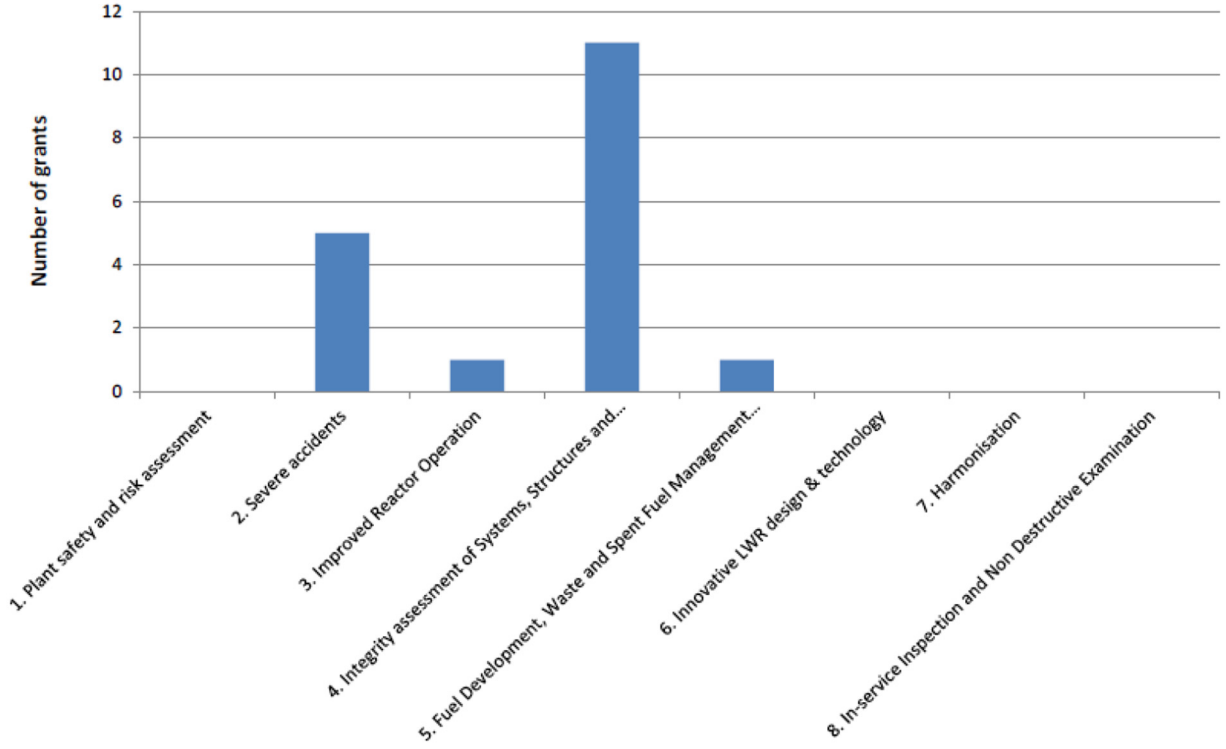

Fig. 7. Number of Nugenia grants per technical area. Graph taken from [2].

2.3 GENTLE

GENTLE (Graduate and Executive Nuclear Training and Lifelong Education) was a joint effort by leading academic and research institutions in Europe to coordinate an education and training programme in the field of nuclear fission technology. The members of the consortium contributed to the common objective of creating a sustainable lifelong education and training programme in the field of Nuclear Fission Technology meeting the needs of European stakeholders from industry, research and technical safety organisations.

Specifically, GENTLE implemented the following education and training tools:

- student research experiences (SREs) to facilitate access of European students to Europe's unique and specialised laboratories and work hands-on on cutting-edge research;
- inter-semester courses for graduate and post-graduate students on topics related to nuclear fuel, nuclear safeguard and security, nuclear waste management, nuclear data, etc;
- a professional course (resulting in a Massive Open Online Course, MOOC) for young professionals working in, among others, industry, consultancy companies or regulatory bodies, to enhance their knowledge of nuclear reactors and fuel cycles.

An essential tool to achieve the training objective of GENTLE was the SREs. The SREs could last between 1 and 24 months at the participating research establishments of the GENTLE consortia and applicants could come from any European academic institutions. The SRE proposals were defined as common research between the applicant and the hosting research institution and were focused on the understanding of basic phenomena related to material behaviour or process technology, the development of analytical methods, or measurement and modelling of fundamental properties.

The selection was based on a written proposal, directly submitted by the student, which was then examined by the GENTLE SRE evaluation committee. Scientific quality, availability of equipment, staff and materials at the hosting institution, training benefit to the applicant, and impact on the field were the main selection criteria.

Within the GENTLE project particular attention was devoted to the rules that are summarised hereafter [4]:

- applicants had to fill in a dedicated form stating the main objectives of the research proposal, as well as a reasonably detailed work description, indicating a suitable host institution (beneficiary) and local supervisors for their SREs;
- the minimum stay of students within GENTLE SREs shall be 1 month, maximum 24 months, but can be subject to local rules at the hosting organization;
- candidates belonging to partner as well as non-partner European academic or research institutions can apply;
- students must be enrolled in an EU academic or research institution but must not necessarily have a European citizenship;
- agreement on local grant rules (€/month) of the hosting institution shall be applied. The recommended grant is on the order of 1000 €/month;
- the grant could not be used to extend PhD studies at the institution where the PhD is performed. Only one application plus one extension were allowed (with a maximum total duration of 24 months);
- during the complete SRE, the students had to be enrolled at the university;
- SREs within the same town/region were allowed, but will not be supported financially.

Moreover it was established that all members of the GENTLE consortium could recruit students within SRE projects approved by the evaluation committee and the costs had to be claimed by the beneficiaries (either host or sending institution, provided the latter is also a GENTLE partner) who will recruit the student. A suitable administrative and financial framework for the reimbursement of SRE costs was defined by each partner separately, due to the different legal conditions to which each GENTLE participant was bound. Some of the partners had already defined such framework, while others had to define and implement it.

At the end of the GENTLE project, a final report on SRE was published, where statistical analysis of this training tool was done [5]. What follows is a summary of this analysis.

A total of 84 SREs were granted during the GENTLE project duration (2013–2016), corresponding to 10–20 SREs per year (depending on the single SRE duration). Forty-seven SRE applications were received for 2016, while during the two years 2014 and 2015 in total thirty seven applications were received. This, more than double number of applications for 2016, was the result of important efforts done to advertise GENTLE to EU students and most probably also due to a sort of "word-of-mouth chain reaction", which has increased the popularity of the GENTLE SRE initiative among EU students in nuclear-related subjects.

In the next figures, statistics about the accepted SRE projects over the whole duration of the project (2013–2016) are shown. Figure 8 shows the origin of the academic institutions at which the students were enrolled. Sixteen EU countries and most of the main countries having nuclear education and training programs were represented and most students were from universities located in Spain, France and Italy.

Figure 9 shows the number of SREs per GENTLE beneficiary. It can be noticed here that the majority of GENTLE partners hosted SREs. It is worth pointing out that the main experimental facilities available at GENTLE partners (namely at SCK-CEN, KIT, PSI and JRC) have been largely used for SREs and JRC infrastructures hosted more SREs with respect to the other partners.

Figure 10 schematically shows a rather well-balanced distribution of the accepted SREs among various research and engineering topics. In Figure 11, one can see that more student-months were devoted to experimental work rather than computational modelling activities. This is rather understandable, considering that experimental work in

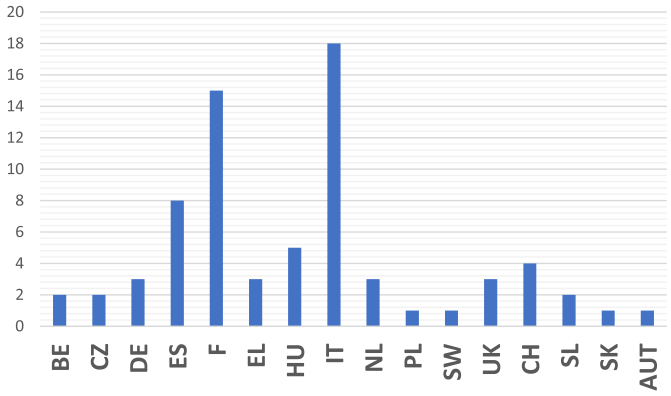

Fig. 8. Distribution of the GENTLE SRE students per country of the academic institution in which the students are enrolled. AUT = Austria; BE = Belgium; CH = Switzerland; CZ = Czech Republic; DE = Germany; ES = Spain; F = France; FIN = Finland; EL = Greece; HU = Hungary; I = Italy; NL = The Netherlands; PL = Poland; SL = Slovenia; SK= Slovakia; SW = Sweden; UK = United Kingdom.

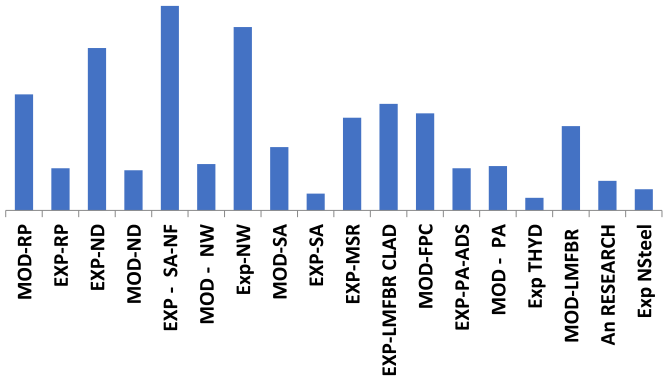

Fig. 10. Distribution of SRE over the different topics. Legend of the Graph: RP = Reactor physics; ND = Nuclear data; SA = Severe accidents; NF = Nuclear fuel; NW = Nuclear waste; PA = Particle accelerators; MSR = Molten salts reactor; CLAD = Cladding; FPC = Fuel performance code; THYD = Thermal hydraulics; An = Actinides; NSteel = Nuclear steels; EXP = Experimental; MOD = Modelling.

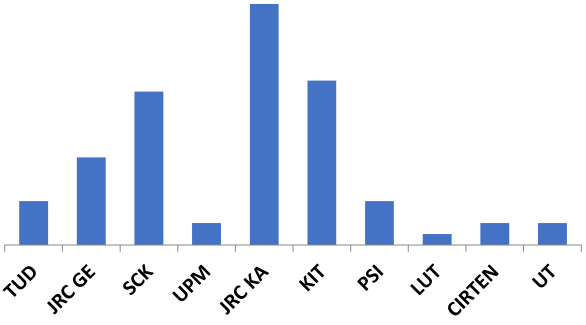

Fig. 9. Distribution of SREs over the beneficiaries.

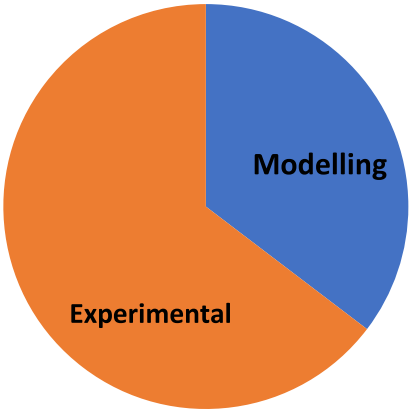

Fig. 11. Share between experimental and modelling SREs.

nuclear-related topics often require complex facilities that are not available at universities. Therefore, students willing to perform experimental work in these fields are more easily motivated to seek external internships in research centres offering access to such facilities.

In summary, the GENTLE SRE program was highly successful and very popular. This large popularity increase of the project GENTLE over the years shows the success of the initiative as a whole, and specifically of an intense advertisement activity, including the regularly updated website, https://ec.europa.eu/jrc/en/page/gentle-project-graduate-and-executive-nuclear-training-lifelong-education. Many students and supervisors have shared their disappointment about the fact that this project was ending, which should be encouraging about the launch of further similar international projects supporting the mobility of students.

The quantitative statistics and qualitative feedback from students and hosts paint a very positive picture of this activity: a large number (seventeen) of EU countries sending students for GENTLE SREs and a very broad spectrum of nuclear-related subjects were covered by the SREs. In conclusion, GENTLE Student Research Experiences have been an effective and highly successful tool for supporting student mobility across EU nuclear-related facilities.

The ENEN+ project (Attract, Retain and Develop New Nuclear Talents Beyond Academic Curricula) can be considered as a follow-up of the GENTLE SRE experience. Indeed, ENEN+ proposes cost-effective actions to attract, develop and retain new talents in nuclear professions with the objective to preserve, maintain and further develop the valuable nuclear knowledge for todays and future generations. The ENEN+ project focuses on learners and careers in nuclear reactor engineering and safety, waste management and geological disposal, radiation protection and medical applications. The most notable action of the ENEN+ project is mobility funding for learners at different stages of the early career. The mobility grants are accessible through the web application and selection system (http://plus.enen.eu) to the individuals aiming at starting or improving their careers in nuclear.

3 Conclusion and further/future initiatives

In the above paragraphs the experience gathered during the implementation of different transnational access to infrastructure funding schemes have been summarised. As described before, over the past years there have been different approaches to grant access to the infrastructures. The approaches have been either infrastructure and topic oriented or people oriented. In all cases, successful accomplishments of the projects have been reported. The important lessons learned within the different projects are related to the definition of rules (administrative, financial and scientific) to grant access and to the advertisement of the mobility opportunity and reaching out to the European nuclear community.

Moreover, it could be relevant to elaborate a blended approach for the transnational access to infrastructures through mobility grants at pooled facilities within the different topical areas as done within ACTINET, NUGENIA, ESNII, VELLA etc. and also people oriented as done within GENTLE and ENEN+. Ideal would be if such type of initiative would be coordinated centrally taking care of all organisational and administrative issues in order to aim at a harmonised access scheme as well as coordinating the different topical/pooled facilities. This centralised entity could be for instance ENEN. In support to this approach, ENEN has already started to create a database of infrastructure as documented in the report [6].

Within the European Commission there is a further initiative initiated over the last year and that concerns the access to all Joint Research Centres Infrastructures including the nuclear one, with the objective to exploit their full potential. The JRC open access has the aim to promote innovative research and development; dissemination of knowledge; improvement related methods and skills; training of researchers and technicians and collaboration at European level. More information on open access opportunity can be found at the JRC science hub link https://ec.europa.eu/jrc/en/research-facility/open-access. In combination of this JRC initiative there will be within the Horizon 2020 framework a further action in collaboration with RTD in order to make available mobility funds to the European Community dedicated to European research teams, students and SMEs to support their access to the nuclear JRC infrastructures.

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