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Fostering European Collaborations: EUFRAT and work done at the accelerator facilities of JRC-IRMM

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Summary. — The European Commission via the General Directorate RTD in its different Framework Programs supported collaborations of member state institutions dealing with nuclear data. The projects EFNUDAT, ERINDA, CHANDA and EUFRAT all have in common Transnational Access Activities (TAA) to partner institutions. Within the past 10 years the collaborations have grown and in CHANDA now 35 partners are involved of which 16 offer TAA to their facilities. Since June 2014 JRC-IRMM, one of the driving forces behind the TAA, launched its own TAA project EUFRAT to foster collaborations with member states institutions. The calls for proposals are open ended with a deadline twice a year. A Project Advisory Committee discusses the proposals and decides on about approval. Financial support is given to approved proposals for two scientists. So far two calls have been evaluated with a request for access totalling more than 5000 h. Examples of proposals at the accelerator facilities at the JRC-IRMM are presented showing the multitude of possibilities using the nuclear facilities at the JRC-IRMM.

PACS `29.20.-c` – Accelerators.
PACS `28.20.Fc` – Neutron absorption.
PACS `29.25.Dz` – Neutron sources.
PACS `29.30.Hs` – Neutron spectroscopy.

1. – Introduction

The Strategic Research Agenda of the Sustanaible Nuclear Energy Technology Platform (SNETP) [1] clearly states: "*Availability of accurate nuclear data ... is the basis for precise reactor calculations both for current and new generation reactors ...*"

The Joint Research Centre - Institute for Reference Materials and Measurements (JRC-IRMM) at Geel (B) offers since 2005 access to its nuclear research facilities for external users. The selection process of the proposals is quality-based using a peer review by a Programme Advisory Committee (PAC) with external experts. In the period 2005–2012 this programme was running with support from General Directorate RTD of the European Commission (indirect actions NUDAME and EUFRAT). To transform it into a sustainable programme, the transnational access activities (TAA) within EUFRAT [2] run now as an institutional project within the EURATOM Work Programme of the JRC. The concept, that has been developed 10 years ago by the JRC-IRMM, has also been copied for the three other Europe-wide TAA projects in the nuclear data field, *i.e.* EFNUDAT [3], ERINDA [4] and CHANDA [5]. These projects use(d) the same model, rules and procedures. Recently, the nuclear research facilities at JRC-IRMM have also become a pilot project in the framework of the JRC-ESFRI (European Strategy Forum on Research Infrastructures) collaboration.

The JRC-IRMM operates a nuclear research infrastructure which is unique in Europe. The nuclear facilities of JRC-IRMM encompass:

- a *150 MeV linear electron accelerator (GELINA)* with a high-resolution neutron time-of-flight facility [6];
- a *7 MV Van de Graaff (VdG) facility* for the production of continuous and pulsed proton-, deuteron- and helium-ion beams serving as a source of well characterised quasi-monoenergetic neutron beams. This facility will be replaced by a tandem accelerator in 2016;
- a *broad set of experimental instruments* used for nuclear decay measurements and primary standardisation;
- a *low-level radioactivity laboratory* in the 225 m deep underground facility HADES; and
- laboratories for the *preparation and characterisation of actinide and stable samples* needed for nuclear data measurements.

These laboratories are specially designed for measurements of highly accurate cross section and nuclear decay data. Measurements at these facilities provide data that form the basis for a wide range of evaluated nuclear data files which are crucial for studies towards an improved safety and sustainability of nuclear energy produced by fission.

2. – Organisation of the transnational access programme at JRC-IRMM

Via the EUFRAT programme, JRC-IRMM offers external researches from the EU member states and 3rd countries possibilities for experimental research at its nuclear facilities. This TAA project is the single entry point for all experiments at the JRC-IRMM nuclear facilities performed by external users. There is a permanent call for proposals with two deadlines per year (15 June and 1 December). A "typical experiment" is defined as an experiment of one week at one of the JRC-IRMM facilities. This includes: preparation of the experimental set-up, performing the measurements, and dismantling the equipment. The major part of the data processing and analysis after the experiment is performed at the home institute of the external groups that perform the experiment.

External users of the JRC-IRMM facilities that submit a proposal must agree to disseminate the results of their work through publications, seminars and other public presentations. Publications should preferentially be in peer-reviewed international scientific journals.

Selection of experiments is based on peer review by a PAC composed of international experts representing the stakeholder community. The PAC must ensure the best scientific quality combined with the most efficient expenditure of the resources and to guarantee an equal treatment of all users. The PAC assesses the proposals from external users on the basis of criteria as scientific and/or policy importance, use of the uniqueness of JRC-IRMM facilities, feasibility and quality of data that can be obtained. This approval process is fully in line with the seven criteria for "quality-based access" defined in the draft European charter for access to research infrastructures of ESFRI. So far the PAC has approved 13 experimental projects with a total measurement time of 5340 hours: 3360 hours at GELINA, 100 hours at the Van de Graaff and 1880 hours at the radionuclide metrology cluster, including the underground laboratory at HADES.

3. – Examples

In the following examples of experiments performed at the GELINA and VdG accelerator facilities operated at JRC-IRMM in the frame of the EUFRAT project are given. These neutron producing facilities are used for cross section measurements of neutron induced reactions and for calibration and performance assessment of innovative detectors, methods and systems.

3˙1. *Test of a XY-MICROMEGAS detector for n_TOF.* – The proposal for this measurement was forwarded by CEA Saclay. The goal of this work is to develop a transparent and standalone neutron beam profiler in order to use this detector as a permanent standard neutron beam monitor at the n_TOF facility of CERN. Since it is the first time that a segmented mesh MICROMEGAS has been constructed, the objective for this experiment is to validate the detector and acquisition system in an experimental environment. A ^{10}B neutron converter, produced at JRC-IRMM, is used to generate alpha particles which are then detected by the MICROMEGAS detector. The tests at the GELINA facility have been used to verify the operation in a neutron beam close to an operating accelerator, to test the amplitude signal and the position reconstruction algorithms.

3˙2. *Neutron inelastic scattering cross section measurements on actinides.* – The proposal for this measurement was forwarded by CNRS/IPHC Strasbourg. Recent reactor sensitivity studies have shown that tight target uncertainties on inelastic scattering are necessary to achieve the high requirements (safety, fuel consumption optimization, waste production minimization) for future nuclear reactors. The GRAPhEME set-up is installed at the GELINA facility and is dedicated to inelastic scattering measurements on actinides by the prompt γ-spectroscopy method [7]. Several experiments have been already done at GELINA. The set-up is currently composed of 4 HPGe detectors shielded by a lead castle to prevent the counters from the ambient gamma background.

3˙3. *Fission cross sections measurements for advanced reactor systems.* – A proposal for fission cross section measurements at the VdG facility was forwarded by NPL Teddington. Recent studies [8] have shown the importance of neutron induced fission cross section of transuranics in the fast-neutron energy region. These data are crucial for the design of the next generation of nuclear power plants, specifically for the fast neutron reactors. Among the most relevant nuclides there are ^{240}Pu and ^{242}Pu.

Results of recent ^{240,242}Pu(n,f) cross section measurements were in disagreement with previous data. To address the discrepancies, measurements have been carried out at the VdG. In addition, experiments using the cross sections for ^{238}U(n,f) and ^{237}Np(n,f) as secondary standards were performed. Therefore, new electrodeposited ^{238}U and ^{237}Np samples have been produced at JRC-IRMM.

3˙4. *Calibration of detectors at the mono-energetic neutron beams.* – The VdG has been used extensively for the characterization of neutron detectors, *e.g.* response function for diamond detectors [9]. The last experiment was carried out in August 2015. The proposal was submitted by University of Tartu. Response functions of plastic scintillators were determined using mono-energetic neutron beams. These measurements were part of a project to reduce the impact of cosmic ray background on detection systems that use neutron multiplicity counting techniques, in an attempt to lower the detection limit.

4. – Conclusions

Ten years of TAA activities at the JRC-IRMM nuclear facilities and the positive response from researchers from the Member States show the importance of opening up these facilities for external users. The procedures developed at JRC-IRMM substantially lowered the access threshold for external researchers, allowed an impartial selection of high-quality proposals and a smooth organisation of the experiments. These procedures found their way also in TAA organised within European research consortia.

The TAA projects created visibility for the JRC activities, offered new experimental opportunities for researchers from the Member States and attracted external expertise valuable for research performed within JRC. They created a fertile ground for merging and exchanging know-how and they helped to focus European-wide efforts towards the priorities of the Euratom work programme. The TAA project of JRC-IRMM contributed to structuring the nuclear data community in Europe and played a key role in the construction of an efficient European infrastructure environment for nuclear data research.

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REFERENCES

[1] Sustainable Nuclear Energy Technology Platform (SNETP), `http://www.snetp.eu/`.
[2] EUFRAT, `https://ec.europa.eu/jrc/en/eufrat`.
[3] EFNUDAT, `http:://www.2020-horizon.com/EFNUDAT-European-Facilities-for-Nuclear-Data-Measurements%28EFNUDAT%29-s27641.html`.
[4] ERINDA, `http://www.erinda.org`.
[5] CHANDA, `http:://www.chanda-nd.eu`.
[6] Mondelaers W. and Schillebeeckx P., *Notiziario Neutroni e Luce di Sincrotrone*, **11** (2006) 19.
[7] Kerveno M., Thiry J. C., Bacquias A., Borcea C., Dessagne P., Drohe J. C., Goriely S., Hilaire S., Jericha E., Karam H., Negret A., Pavlik A., Plompen A. J. M., Romain P., Rouki C., Rudolf G. and Stanoiu M., *Phys. Rev. C*, **87** (2013) 024609.
[8] Salvatores M., *Uncertainty and Target Accuracy Assessment for Innovative Systems Using Recent Covariance Data Evaluations* NEA/WPEC-26, Nuclear Energy Agency (OECD), Paris 2008.
[9] Pillon M., Angelone M., Krasa A., Plompen A. J. M., Schillebeeckx P. and Sergi M. L., *Nucl. Instrum. Methods A*, **640** (2011) 185.