

AIFIRA

(Applications Interdisciplinaires de Faisceaux d'Ions en Région Aquitaine)

A. The Facility

The Centre d'Etudes Nucléaires de Bordeaux-Gradignan (CENBG) is operated jointly by the University of Bordeaux I and CNRS/IN2P3. The laboratory permanent staff is composed of about 100 persons. Half of them are physicists belonging to University, the other half to CNRS. The major research programmes cover a wide range of basic and applied activities including nuclear physics (theory and exotic nuclei studies), laser physics, neutrino mass measurements as well as applied research activities (biology, material science and nuclear waste management). The CENBG hosts the AIFIRA platform. This recently developed ion beam facility is equipped with 3.5 MV singletron DC positive ion accelerator. This accelerator has been designed by the HVE Europe company, it offer high intensity (up to $50 \mu\text{Ae}$) beam of light ions (H^+ , D^+ , He^+) with excellent beam brightness ($>15 \text{ A/rd}^2 \cdot \text{m}^2 \cdot \text{eV}$) and energy stability ($\Delta E/E \approx 10^{-5}$). These characteristics make AIFIRA a very valuable tool for neutron induced reaction measurements. The facility was commissioned in January 2006. The accelerated beams are distributed to 5 beam lines, one of which (fig. 1) is devoted to the production of fast neutrons. The energy of the neutrons (0.1-6.5 MeV) is defined by the incoming charged projectile (proton or deuteron), the target (Lithium-7, deuterium (solid or gaseous) or tritium) and their emission angle (the 0° direction is the more often used option). A neutron hole (2 meters deep) has been built under the neutron production head in order to reduce backscattered neutrons. The neutron beam line is equipped with a wide variety of detectors for neutron (^3He counters), for light charged particles (silicon detectors), fission fragments (solar cells and silicon detectors) and γ -ray detectors (C6D6 and HPGe detectors).



Figure 1. A view of the neutron beam line

A.2 Quality of research

The CENBG is the key CNRS/IN2P3 laboratory for neutron cross section measurements. The neutron beam line is operated by the research group ACEN (Aval du Cycle et Energie Nucléaire). The permanent staff is composed of six physicists (four from CNRS/IN2P3 and two from the University of Bordeaux I). It is strongly supported by CNRS/IN2P3 and the GEDEPEON/PACE consortium which coordinates, at the French level, the whole research programme on nuclear

waste management (transmutation and geological disposal) and advanced innovative nuclear systems (ADS, Molten salt reactors and GEN IV reactors). The ACEN group has an acknowledged expertise in nuclear fission, neutron induced reaction mechanism and neutron and γ detection techniques.

Several measurements have been carried out in order to improve the quality of the neutronic nuclear data as requested by the HPRL edited by the Working Party of Evaluation Co-operation (WPEC) of the OECD/NEA Nuclear Science Committee. The highlights of these measurements are:

Measurements dealing with the improvement of nuclear data for some key nuclei of the innovative Thorium cycle :

- The cross section determination of the reactions $^{232}\text{Th}(n,\gamma)$, $^{232}\text{Th}(n,f)$ and $^{233}\text{U}(n,f)$ induced by fast neutrons.
- The full preparation and analysis of the reactions $^{233}\text{Pa}(n,f)$ and $^{233}\text{Pa}(n,\gamma)$ using the surrogate method.
- Total cross section determination of the light nuclei (^{12}C and ^{19}F) involved in the molten salt reactor concept.

Measurements closely related to minor actinide transmutation.

- The neutron induced fission of ^{243}Am . These activities are supported by the EC through the FP6/EUROTRANS/NUDATRA programme.

These activities have stimulated a continuous flow of PhD students from French universities and of post-doc fellow from European universities. Most of them have been published in peer-reviewed publications and presented at several international meetings.

A.3 New opportunities for access

The AIFIRA facility of CENBG is ideally suited for experiments with fast neutrons in the energy range from 0.1 to 6.5 MeV. Measurements related to transmutation research and innovative nuclear systems will benefit of a highly performing accelerator as of an efficient support from a well qualified staff. In the framework of EFNUDAT, the CENBG can offer a maximum of 360 data taking hours per year.

B. MANAGEMENT OF THE ACCESS PROVIDED

B.1 User access to the infrastructure

The CENBG is located in the south-west of France and easy to reach by car, train (TGV) or airplane. Single scientist or research group can apply to the accelerator by submitting a proposal at our local PAC. There are two calls per year. The spoke person of the proposal presents orally the experiment (scientific motivations, technical details and specific features related to the experiment). There is no restriction on the project research except that the needs must fit the possibilities of the accelerator. As the neutron beam line is mainly used for nuclear waste management and related nuclear technology, beam time allocation will follow closely the recommendation of the EFNUDAT PAC. It is expected that external users follow the safety regulations for experimental set up with potential hazards (use of gases and/or radioactive products). Beam time is provided generally on the basis of one week. The accelerator can be used all around the clock including Saturday and Sunday. The participation of the local staff (scientists, engineers and technicians) has to be defined in a collaboration agreement with the users. This includes the manpower needs for preparing the experimental area and running the experiment. The whole equipment of the neutron beam line is normally provided to external users. Upon their request, external users can bring their own equipment. In any case external user's autonomy will be guaranteed. Users of the accelerator making part of the TAA have to disseminate their results through peer-reviewed publications, seminars and other public presentation.

B.2 Scientific, technical and logistic support

A team of 2 engineers and 1 technician maintain and operate the accelerator. The staff on duty will provide support to the external research group in setting up and preparing the charge particle beam and the neutron target. The in-house waste management group will also participate in assisting external users during the preparation and duration of the experiment for the handling of the equipment on the neutron beam line. Support from target laboratory and workshop are available for small mechanical work and for special non radioactive sample handling and mounting.

External users will benefit from developing strong links with CENBG scientists and engineers from CNRS and University of Bordeaux I . They will have access to the same services as the local staff (telephone, fax, internet server, library and meeting rooms). The external users can be accommodated on site in the laboratory (2 rooms) or in hotels close to the CENBG. Transport arrangements can be provided for foreign guests.

C EUROPEAN ADDED VALUE.

C.1 Community interest in the infrastructure

Over the last 10 years, the old accelerator ran annually at an average of 3600 hours. About 400 hours were used for producing fast neutron beams. They were used by international users for different purposes:

- Investigation of the energy response functions of neutron detectors for the TARC and FEAT experiments driven by C. Rubbia from CERN. The different measuring teams involved physicists and technical staff from CERN, Greece, Italy and Spain.
- Preliminary tests of the neutron beam profiler Micromégas now currently used on n_Tof at CERN.

There is no doubt that the new facility AIFIRA will attract new users. There is locally a strong will to open this new facility to European users. A recent workshop on the future use of the AIFIRA beams (microprobe and nanoprobe for biology, medicine, material science and neutron) has attracted more than 50 scientists from Europe and USA. Two European programmes (NANODERM and CELLION) have included the AIFIRA machine in their network of facilities. Thus, EFNUDAT will provide an opportunity to reach European research groups who wish to take advantage of the CENBG neutron measurement capabilities coupled to a modern accelerator such as AIFIRA.

C.2 Expected impact

Additional 360 data-taking hours per year will be available for external users. As a consequence, the workload of the local staff will be increased. Nevertheless, the integration of our accelerator to the transnational access programme is for the CENBG a unique opportunity to increase and strengthen our scientific knowledge and technical capabilities. New ideas, new contacts and a diversification of the scientific domain and techniques will create around the AIFIRA accelerator a fertile and innovative environment.

Nuclear research has always been a subject with a large European dimension. Key theoretical and experimental elements have originated in Europe. In the neutron physics domain AIFIRA will be a unique instrument, of the highest quality and performance in Europe. Integration of AIFIRA into the consortium of EFNUDAT and securing open non-restricted transnational access to the facility will:

- Improve significantly the availability of resources for nuclear data research in Europe. AIFIRA is an essential instrument for the nuclear data community working in the areas of radioactive waste management and other activities in the field of nuclear technologies.
- Help integrating European research efforts in a lasting way by fostering long-term collaborations and co-ordinating European nuclear data research laboratories by planning of joint experiments and setting research priorities.
- Support the New Member States and Candidate Countries in their integration into an enlarged area by creating effective links.
- Provide unique training and mobility opportunities to young visiting researchers and technicians, an important aspect in view of the declining number of nuclear science specialists in Europe.

C.3 Attracting potential new users

The research possibilities at all EFNUDAT facilities together, will be advertised internationally in a common and systematic way, using different modern methods and media. A special web-page is available for EFNUDAT. It is linked to the home-page of the CENBG.

D. ACCESS OFFERED BY THE INFRASTRUCTURE

D.1 Annual implementation plan

The implementation plan covers project duration of 48 months. If the proposal can be accepted a reasonable estimate is that we can offer each year three experiment-weeks. Because the accelerator is operating continuously, this corresponds to 360 supplementary data-taking hours per year (120 hours per week). The average duration of an experiment is estimated to be two weeks, so that researchers will spend 14 days at the infrastructure. For a visiting experimental group, access will be financed for 2 users.

D.2 Activities connected with access

Access offered to the external users will include user training, scientific and technical support during the experiment, office services, computers and administrative and logistic backing.

D.2.1 Training

All starting projects at CENBG are submitted to a specific procedure for hazard identification and risk assessment. Special training sessions are organised for newcomers on health and safety at work, including radiation protection issues for activities in controlled areas. In addition, new users will be given a detailed facility-specific newcomers training. If needed, first-time users will get all training they need to get acquainted with the novel measurement techniques applied at our facility.

D.2.2 Scientific and technical support

A local senior scientific officer will be designated by the PAC as local scientific contact. He will be in charge of the external users during their whole measurement period. He will introduce the users to all facility aspects. He functions as a liaison with the machine operators and with the administration and technical service of the CENBG.

Technical support laboratories and workshops are available on site for small mechanical and electronic work (preparing, setting up and dismantling measurement equipment, special sample handling and mounting). The PAC defines the level of technical support charged to the contract. The user groups may use consumables charged to the project up to the maximum level, defined by the PAC. If there is a real need, the CENBG director can approve adjustment of this level.

D.2.3 Administrative and logistic support

Users will get access to the same services as the CENBG staff e.g. office space, standard office services (telephone, fax, internet services) and meeting rooms, library and canteen. The Administration Service of the CENBG can be contacted for administrative or personal problems, such as lodging, contacts with local administration and hospitals.