The Svedberg Laboratory

A THE FACILITY

A.1 Quality of the TSL infrastructure

The Svedberg Laboratory (TSL) in Uppsala is a cyclotron facility with a reputed mission in proton radiotherapy, interdisciplinary research and commercial irradiations.

The Gustaf Werner cyclotron is providing a wide range of ion beams of various energies up to 180 MeV for protons and 8 MeV/nucleon for xenon ions. The cyclotron has an internal PIG ion source for the production of light ions and an external ECR ion source for multiply-charged heavy ions. The neutron-beam facility giving quasi-monoenergetic neutrons in the range 20 to 175 MeV is of course of special importance for the present I3-TA application.

Uppsala has a long tradition in biomedical research and radiotherapy. High-intensity proton beams are used for radionuclide production for medical applications, whereas light ions with energies up to 45 MeV/nucleon are used by several groups studying the effects of high-LET irradiation on the induction of cell death and DNA fragmentation. A main fraction of the beam time at TSL is devoted to 180 MeV proton radiotherapy treatments of cancer patients. Since the treatment time for each patient normally is very short, more than 80% of the beam time may be used for other projects during the radiotherapy weeks.

The materials-physics experiments at TSL are mainly using the heavy-ion beams from the cyclotron. A remotely controlled irradiation facility has been installed, giving homogeneous irradiations of 40x40 mm^2 samples by beam scanning. Several projects within ion-track-based nano- and micro-technology profit from this installation.

There is a long-term experience in high-energy neutron production at TSL. A neutron facility was built first in the late 1980's and remained in operation until 2003. In 2003-2004, a new facility was constructed where emphasis was put on high neutron-beam intensity in combination with flexibility in energy and neutron field shape.

The facility uses the $^{7}Li(p,n)^{7}Be$ reaction to produce the quasi-monoenergetic neutron beams. The cyclotron provides proton beams in the energy range 25 – 180 MeV resulting in neutrons with peak energies controllable in the 20 – 175 MeV range.

A general view of the neutron-beam facility is given in Fig. 1. The neutron beam is formed geometrically by iron collimators with holes of variable sizes and shapes. The user area extends from 3 to 15 m downstream of the lithium target. Neutron-beam intensities up to $5*10^{5}$ $cm^{-2}s^{-1}$ are obtained.

Commercial neutron and proton irradiations for industrial users studying single-event effects in electronic components represent a large and growing activity at TSL. In addition, two experimental stations, MEDLEY and SCANDAL, are available for research projects with neutron-induced reactions.

The MEDLEY facility consists of eight detector telescopes for the detection of light ions with an almost complete coverage both in energy and angle. It is being used mainly for cross-section measurements related to fast-neutron cancer therapy and basic studies on neutron single-event effects.

The SCANDAL facility is a two-arm detector telescope of plastic scintillators, drift chambers and CsI crystals for detection of neutrons and light ions. The system is used in basic neutron-scattering experiments and for cross-section measurements of relevance for transmutation technologies and accelerator-driven energy systems.

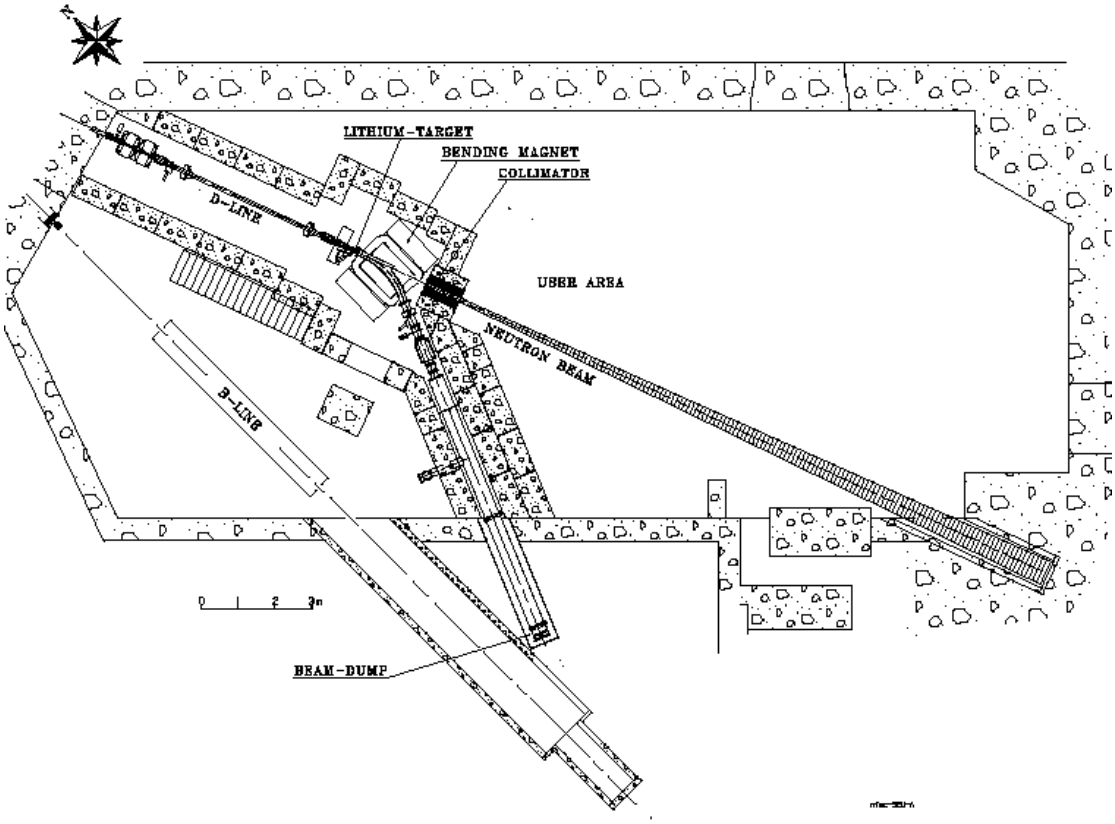

Fig. 1. General layout of the new neutron-beam facility at TSL.

Neutron-induced fission cross-section measurements of heavy elements and angular distribution measurements of fission fragments, both experiments connected to accelerator-driven energy systems, are being made using different counter techniques. The latter experiments are also performed using proton-induced fission in a separate beam line, at which also a broad-beam proton facility for irradiation purposes is installed.

A.2 Quality of research

The experimental facilities at The Svedberg Laboratory have attracted a wide international interest. Of particular importance to the current application is the new neutron-beam facility, which is unique in the world giving well-collimated and energetically well-defined high-energy neutron beams of sufficient intensity for a large number of investigations of fundamental as well as applied character. Interesting basic research is related to the fundamental pion-nucleon coupling constant and to nuclear three-body forces.

The high-quality neutron beams are also used for application-oriented projects within transmutation of nuclear waste, accelerator-driven energy systems, neutron cancer therapy, single-event effects and dosimetry. These important applications have a large impact on society.

A.3 New opportunities for access

The unique research capabilities offered at the new neutron-beam facility at TSL provide an excellent opportunity for extended transnational collaborations in the field of transmutation research and innovative nuclear energy systems. The EC has funded the FP6 Transnational Access proposal Hadron Physics for 4 years (Jan 2004 – Jan 2007). The access offered to TSL within EFNUDAT will be complementary to the access offered within Hadron Physics.

B MANAGEMENT OF THE ACCESS PROVIDED

B.1 User access to the infrastructure

The laboratory currently allocates 35 weeks per year to proton radiotherapy treatments of cancer patients according to an agreement between Uppsala University and the Uppsala University Hospital. During the treatment weeks there are possibilities for parallel experiments during daytime with more than 80% of the beam time, whereas the nights in principle are free for other experiments, though still only with 180 MeV protons/neutrons.

The remaining weeks of the year are allocated to industrial users for commercial irradiations and for limited research programmes in biomedicine and application-oriented projects. An approval of the present I3-TA application would certainly have a strong positive effect on the field of nuclear data measurements.

Experimental proposals submitted to TSL are approved by the TSL management following a review procedure. In the present case of nuclear data measurements, the allocation of beam time will be based on the evaluation by the EFNUDAT PAC, ensuring high standards of scientific or technological quality and originality.

Typical experiments at TSL involve data taking for periods between 3 and 15 eight-hour shifts, the data processing and analysis mainly being made later at the home institutes.

Users of the TSL facilities who are supported by the present I3-TA programme should disseminate the results of their work through publications, seminars and other public presentations. Publications should preferentially be in peer-reviewed international scientific journals.

B.2 Scientific, technical and logistic support

When a proposed experiment is approved, the proposing research group gets access to various resources of the laboratory, such as beam time at the cyclotron, computing facilities, experimental equipment, data acquisition systems, electronics from the electronics pool, technical assistance from the employed engineers and technicians, office space, help to arrange housing, etc. Of particular importance for a smooth running of the experiments at TSL are the employed scientists serving as contact persons between the users and TSL.

The scientific environment is provided by the laboratory scientists, and by the close connection to the researchers at the neighbouring Department of Neutron Research, Department of Radiation Sciences, Department of Materials Physics, Department of Biomedical Radiation Sciences and the Uppsala University Hospital. Many international experimental projects at TSL have started through initiatives and by collaborations with the neighbouring institutes at Uppsala University.

First-time users will be given a detailed facility-specific training, including detailed instructions on safety rules and, if needed, the use of the measurement techniques applied at TSL.

The laboratory is located close to the center of the old university town of Uppsala, 70 km north of Stockholm. It is easy to reach Uppsala by train or air. Arlanda, the Stockholm international airport, to which there are direct flights from most major cities in Europe, is located only 35 km from Uppsala, and there are frequent direct bus connections between Arlanda and Uppsala.

B.3 Peer review procedure

The peer review procedure, common for all Transnational Access Activities, is described under Activity NA1-Management of the I3, part B.3.2.4.

C EUROPEAN ADDED VALUE: European interest in the infrastructure

C.1 Community interest in the infrastructure

TSL has previously been supported by the European Commission as Large Scale Facility and as Research Infrastructure, allowing a strong increase in transnational access and networking. Currently TSL is offered transnational access through the I3 Hadron Physics contract. A contract within EFNUDAT would certainly have a strong impact on the application-oriented projects and also be a natural complement to the hadron-physics support.

Moreover, the infrastructure at TSL has been of utmost importance for attracting support from the EC in research projects, like the FP5 project HINDAS (High and Intermediate Nuclear Data for Accelerator-driven Systems), in which five research groups from several European countries conducted their experiments at TSL.

Presently, TSL is the prime European facility for studies of neutron-induced effects in electronics. These activities, which have a significant commercial relevance, involve about 100 scientists and corporate researchers from 12 countries. The proton radiotherapy for cancer treatments is at present a local activity, but negotiations to convert them to a national basis are in a close to final stage. Proton therapy is the largest use of the beam time, however with treatments only daytime for a moderate fraction of the time The parallel running of other activities together with the treatments and the possibility of using the night shifts allows a very efficient use of the total beam-time at TSL.

C.2 Expected impact

As evidenced by the access already offered on the use of the TSL infrastructure within the Large Scale Facility programme, the Research Infrastructure programme and the Integrated Infrastructure Initiative programme, a continued access support within EFNUDAT will play an important role in attracting a significant number of scientists from the European Union to the high-quality beams and experimental facilities of The Svedberg Laboratory. The access support together with the networking activities and joint research projects will certainly strengthen the European cooperation in the field of accelerator-based research, in this particular case in the nuclear-data research.

C.3 Attracting potential new users

The Svedberg Laboratory is active in attracting new users to its experimental facilities. Workshops are regularly being arranged to cover and promote different research areas at the laboratory. In these activities we have a close contact and collaboration with our sister institutes at Uppsala University.

The homepage of the laboratory is regularly updated to include information on the cyclotron operation, experimental programmes, schedules, publications, new positions, conferences and call for proposals. The homepage also contains information on the current I3 Hadron Physics programme at TSL. A similar web site will be created for EFNUDAT.

As for the I3 Hadron Physics programme, common advertisements and call for proposals are envisaged within EFNUDAT.

D Access offered by the infrastructure

D.1 Annual implementation plan

The implementation plan covers a contract duration of 4 years with one week of data-taking per year, i.e. 100 h/y or 400 h for the full period. Five researchers from two groups will spend on average 14 days at the laboratory resulting in 280 person-days for the full period.

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. Most if this is described in Section B2. Also costs for travel and subsistence related to visits of users will be supported through the contract.