

Forschungszentrum Karlsruhe

A THE FACILITY

A.1 The nuclear data research infrastructure of FZK

The Institute for Nuclear Physics at FZK in Karlsruhe (Germany), operates a Van de Graaff facility for the measurement of highly accurate cross-section data. A pulsed, high current 3.7 MV Van de Graaff (VdG) is dedicated to neutron cross section studies, mostly in the field of (n,γ) reactions, where optimised state-of-the-art equipment has been developed and used for three decades. A second 2 MV VdG is used for charged particle reactions in materials research.

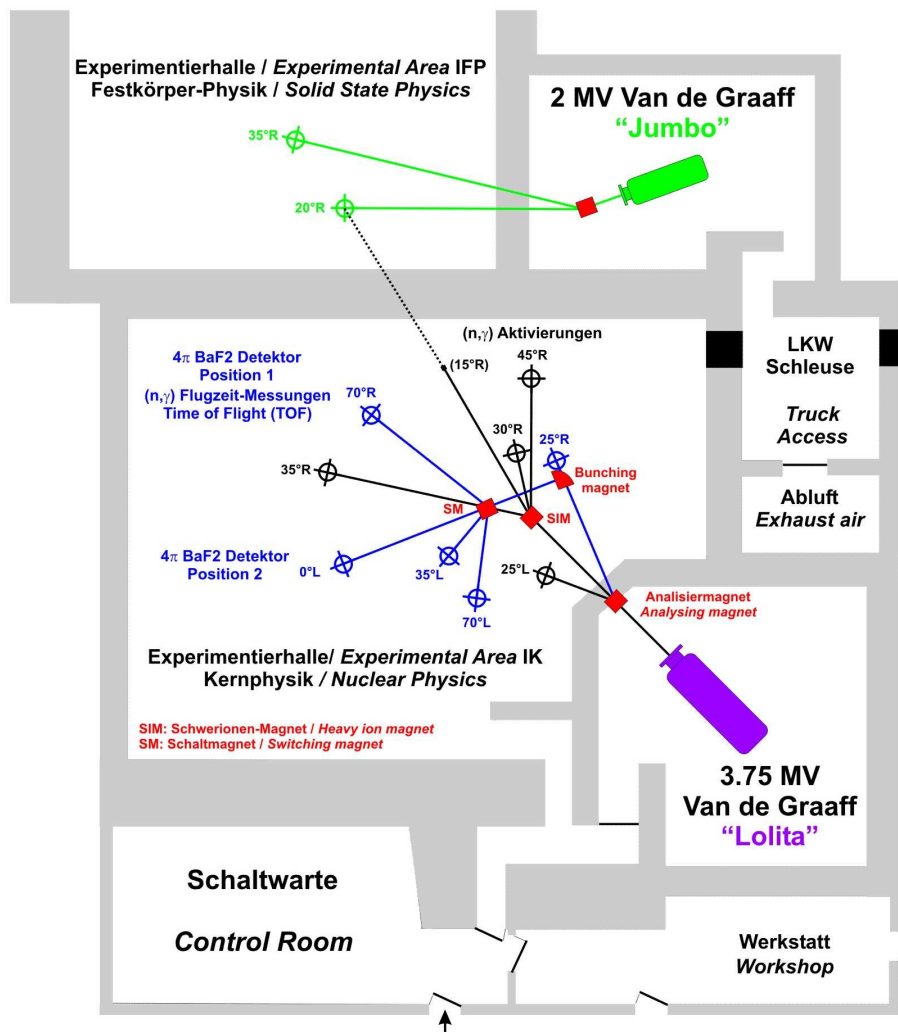


Fig. 1 Accelerator facilities and experimental areas at FZK

The **3.7 MV Van de Graaff** facility is mostly used for the production of continuous and pulsed neutron beams in the energy range up to 1.5 MeV. In DC mode proton intensities of up to 150 μA can be handled, yielding neutron intensities of up to $5 \cdot 10^9$ neutrons/s. In pulsed mode repetition rates can be chosen between 1 MHz and 125 kHz and pulse widths between 700 ps and 15 ns. Maximal peak currents of 1 A are reached in the best case, typical average currents are 6 μA at 1 MHz. The facility is operated continuously 24 per day and 7 days a week. On average, the availability is 5000 h of beam on target per year. Long-term stability is guaranteed by a computer assisted semi-automatic operation of the accelerator. A variety of experimental setups can be served at seven different beam lines, thus facilitating a most flexible access by external users. Advanced detection techniques and data

acquisition systems are available. These include a 4π BaF₂ array operating as a total absorption γ calorimeter, two HPGe Clover detectors, BGO scintillators, and electron spectrometers.

The present research activities in nuclear technology are focused on high-quality nuclear data for

- improved waste transmutation concepts
- accelerator-driven systems
- improved reactor operation and fuel management.

A.2 Quality of research

The Van de Graaff group at FZK is one of the most influential European groups in the field of neutron cross-section measurements with more than two papers per scientist per year. It takes a leading role in measurements on radioactive samples such as ¹⁴C, ¹³⁵Cs, ¹⁴⁷Pm, ¹⁵¹Sm, and ¹⁵⁵Eu as well as in precision measurements with the 4π BaF₂ array. The present work is focused on nuclear data for astrophysics and waste transmutation. The group takes also a leading role in the n_TOF collaboration at CERN.

Some highlights are:

- high-resolution capture measurements at CERN with an optimised set of C6D6 liquid scintillators of extremely low neutron sensitivity for the long-lived fission products ⁹³Zr and ¹⁵¹Sm. In addition, corresponding measurements have been performed on ^{204,206,207,208}Pb and ²⁰⁹Bi to assess the role of these potential liquid metal coolant materials as well as on the stable isotopes of the structure materials Zr and Mg
- keV capture cross-section measurements at FZK on sub- μ g samples of the relatively short-lived isotopes ¹³⁵Cs, ¹⁴⁷Pm, and ¹⁵⁵Eu via the activation technique
- precision activation measurement at FZK of the absolute capture cross section of ¹⁹⁷Au, which is considered a cross section standard
- precision time-of-flight measurements with the 4π BaF₂ array at FZK on a variety of fission product nuclei with uncertainties between 1% and 2% accuracy (i.e. the stable isotopes of Te, Xe, Ba, and Nd)

The Karlsruhe group is pursuing long standing collaborations with leading research groups in Europe, Japan, and the US with a continuous exchange of graduate students, postdoctoral fellows, and visiting scientists. The highly international character of the activities is documented by a very intense publication policy.

A.3 New opportunities for access

The facility at Karlsruhe is unique for the availability of highly sensitive and very precise experimental techniques. Within the framework of this proposal these options will be offered to outside users during a maximum of 500 data-taking hours per year corresponding to 10% of the available beam time.

B Management of the access provided

B.1 User access to the infrastructure

Typically, at the Van de Graaff accelerator beam time can only be provided for one experiment at a time. Therefore, visiting scientists or research groups can rely on the support of the local group throughout their allotted beam time. Access to the facilities will be decided on the basis of a proposal describing the research project. Only projects related (i) to the management of radioactive wastes or (ii) to other activities in the field of nuclear technologies and safety will be considered in this context. Allocation of beam time will be based on the evaluation by the EFNUDAT PAC to ensure high standards of scientific or technological quality and originality. Young scientists and users from the new member states are particularly encouraged to submit proposals.

In order to guarantee an optimal efficiency, early planning of the approved experiments including detailed simulations will be suggested and actively supported by FZK. This kind of support may be

particularly important for small groups or individual scientists. Proposals of individual researchers may also be possible, but should preferentially be in line with existing activities so that their experiments can be performed in close collaboration with internal research groups. Access to the facility will be granted at any time before and during the measurements. The involvement of this FZK contact will be defined in a collaboration agreement with the users. Where appropriate, the PAC may propose to merge experimental complementary measurement capabilities and expertise.

A typical experiment involves two weeks for preparation of the experimental set-up, performing the experiments, and dismantling the equipment. The major part of the data processing and analysis shall be performed at the home institute.

Users supported by the Euratom Transnational Access 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. The experimental data should be submitted to the EXFOR database at the NEA databank.

B.2 Scientific, technical and logistic support

B.2.1 Scientific environment

As part of FZK, the Institute for Nuclear Physics is embedded in the largest multi-disciplinary research institute in Germany, an internationally recognised centre of scientific excellence. The centre covers a great variety of scientific disciplines (including basic research, nuclear technology, climate research, micro- and nano-techniques, material studies, fusion technology, and environmental research). Thanks to the strong collaboration with the surrounding universities of Karlsruhe, Heidelberg, and Tübingen, the research groups of FZK are hosting a fair number of undergraduate students, PhD students, and postdoctoral fellows. In case of the Institute for Nuclear Physics a very close connection is granted by the fact that its director holds the chair for experimental physics at the University of Karlsruhe. This provides the stimulating and lively atmosphere that is particularly important and attractive for students and young researchers.

Scientifically, users will benefit from the world-class quality of the ongoing research activities, the excellent performance of the accelerator, the state-of-the-art equipment, and the outstanding expertise of the staff members. In addition, they will have access to the excellent infrastructure of FZK, which opens a multitude of complementary investigations. For example, radioactive samples can be very accurately defined by decay heat measurements or extremely high-efficiency, low-level radioactivity counting techniques.

B.2.2 Technical and logistic support

FZK operates an excellent, dedicated office for supporting foreign visitors in all practical questions, from housing to contacts with local administration, schools and hospitals. Housing facilities for visiting scientists are available either on site or in the guest house of FZK in down town Karlsruhe. External visitors will be assigned office space and receive all administrative and computing support that is adequate for their needs. They have access to the same services as the FZK staff (e.g., telephone, fax, internet access, library, meeting rooms and restaurant). The Social Service of the institute can be contacted for administrative or personal problems, such as lodging.

Support laboratories and workshops are available on site for small mechanical work, and for special sample handling and mounting.

B.2.3 Training

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 our facility. They may also participate in seminars and lectures organised on site. Especially young researchers can benefit from numerous lectures organised within FZK.

C EUROPEAN ADDED VALUE: European interest in the infrastructure

C.1 Community interest in the infrastructure

C.1.1 International users in the past

From 2000 to 2004 the Van de Graaff accelerator produced neutron beams for experiments during 4700 hours per year on average. The machine was running continuously 24 hours a day and 7 days a week. During this period the facility hosted 25 external scientists for experimental nuclear data work.

C.1.2 Future demand

In view of the continuous demand for beam time at FZK we expect to host 4 scientists per year who will use about 10% of the beam time corresponding to 500 hours per year.

C.2 Expected impact

C.2.1 Impact on use of infrastructure

The access offered to new external users will have a twofold impact on the present working conditions:

- Since the beam time is already at a constant annual maximum close to 5000 hours additional beam time requires that the efficiency of operation and use has to be further optimized. This can be achieved by careful preparation of the experiments on the basis of detailed simulations and extensive testing of equipment.
- The workload of local staff will inevitably increase. Therefore, efforts will be directed to closer collaboration of the visiting groups by harmonizing the mutual research programs. Additional technical and logistic support may be provided by the infrastructure of FZK.

In effect, the integration of the facilities in a wider-ranging transnational access programme and the scientific input of new users are expected to result in an improved exploitation of the scientific potential of our facilities and in a substantial strengthening of the experimental programme. The NP Unit will benefit from new ideas, useful contacts and a diversification of the scientific scope. Merging new initiatives with present know-how will create a fertile and innovative environment.

C.2.2 Impact on Europe's scientific community in general

Nuclear research has in essence always been a subject with a large European dimension. Key theoretical and experimental elements have originated in Europe. In the neutron physics domain, research at the Karlsruhe Van de Graaff has always aimed at highest quality and performance in Europe and has always maintained intense transnational collaborations.

Integration of the Karlsruhe Van de Graaff into the consortium of EFNUDAT and securing open non-restricted transnational access will

- improve the possibilities for nuclear data research in Europe substantially since it has proven expertise in advanced measurements in the areas of radioactive waste management and other activities in the field of nuclear technologies and safety,
- provide important contacts for the New Member States and Candidate Countries in their integration into an enlarged European context, and
- creates unique training and mobility opportunities to young researchers, a most important aspect in view of the declining number of nuclear science specialists in Europe.

Special actions will be taken with respect to young researchers from the Candidate Countries, deprived from similar 'on-the-job' training opportunities. The multi-disciplinary training component will also receive particular attention.

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. In addition the publicity within the framework of NUDAME will also refer to the EFNUDAT Transnational Access programme.

C.3.1 Web-page

A special web-page will be created for EFNUDAT with a description of the consortium of facilities and their research opportunities. This web-page will be linked to the web-page of NUDAME, to the home-pages of the participating partners and, if possible, to the CORDIS server.

C.3.2 Other forms of publicity

In order to increase the visibility and to attract new users, several measures will be taken. An active scheme will be established of seminars, folders and posters that will be presented at all possible occasions (universities, conferences, meetings...). To increase the efficiency for contacting potential new users and presenting our facilities, the extent of our electronic mailing list will be gradually increased via an effective search of potential users through the new groups who work at the facilities and through our links with the universities.

All users performing experiments at our facilities in the framework of the EFNUDAT Transnational Access program will be asked to describe shortly their access to our facilities in all presentations (at seminars, conferences, workshops, summer schools, etc...) or institute reports, related to measurements at our research infrastructure. Their scientific publications must acknowledge the financial support of the EFNUDAT programme.

D ACCESS OFFERED BY THE INFRASTRUCTURE

D.1 Annual implementation plan.

The implementation plan covers a project duration of 18 months since the FZK activities will be shifted by the end of 2007 to a new accelerator laboratory in Frankfurt/Main (Germany). Therefore, FZK can offer an annual amount 500 hours of beam time up to the end of 2007 or a total of 750 hours if the contract starts by mid 2006. Because the accelerator is operating continuously for 150 hours per week, and because the average duration of an experiment is estimated to be two weeks, the visiting researchers will spend 35 days at the infrastructure. For a visiting experimental group access will be financed for an average of 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. Also costs for travel and subsistence related to visits of users will be supported at charge of the contract.

D.2.1 Training

All starting projects at FZK 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. Young researchers can also benefit from a variety of lectures organised within FZK.

D.2.2 Scientific and technical support

A local senior scientist will be designated by the PAC as local contact. While in charge of the external users during their whole measurement he will introduce them to all facility aspects. He functions as a liaison with the machine operators, with the other scientific staff of the NP unit and with the administration and technical service of FZK.

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 NP Unit Head can approve adjustment of this level. Computers and data storage facilities will be available for the user groups during their entire stay.

D.2.3 Administrative and logistic support

Users will get access to the same services as the FZK staff, e.g. office space, standard office services (telephone, fax, internet services), meeting rooms, library access, and restaurant. The international service of FZK provides assistance for administrative or personal problems, such as lodging, contacts with local administration, schools, and hospitals.

D.2.4 Travel and subsistence costs

Justified and approved travel costs for users travelling to the infrastructure and to user meetings will be reimbursed, together with their subsistence costs.