Austria wants to build a neutron spallation source

The Austron Proposal

The Austrian government is proposing a new neutron spallation source, the original design goal of which was to offer a source whose performance would be better than that of the present world leader, the ISIS facility at the Rutherford-Appleton Laboratory in the United Kingdom.

Austria has recently joined the consortium for the European Spallation Source (ESS), and Austron will be a step along the way towards the much bigger ESS facility, which will not be in operation before 2015. At the time of writing Austria's neighbours were expected to show an interest in the project.

The overall concept is based on an accelerator with a specially tailored design. The complex would consist of an ion source, a radio-frequency quadrupole, a drift-tube linac, and a rapid-cycling synchrotron. Construction would take five to six years.

In 1996 the feasibility study (which began in May 1993) was handed over by the Austrian Minister for Research to the European Science Foundation (ESF) for assessment, and in November 1997 the ESF panel recommended the Austron project as a potential candidate for a medium- to large-scale international research facility. The minister asked the Austron group to prepare an improved proposal to seek international partners.

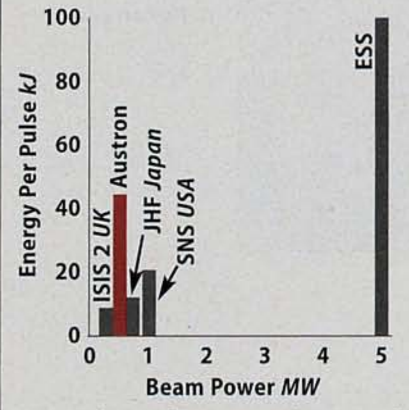
Based on an unanimous decision of the Austrian Government dated 20 August 1998, Austria is offering to contribute one-third of the total cost of the project.

Two teams contributed to the proposal: one at CERN working on accelerator design, and one based at the Atomic Institute of the Austrian university system, working on target and instrumentation design. The proposal is currently for a 0.5 MW source which will be operated with a 10 Hz repetition rate, with a deposit of 50 kJ per pulse on the spallation target. The peak flux for thermal neutrons is expected to be some 3.5×10^{16} (15 to 20 times more than ISIS).

The improvements to the proposal made after the feasibility study were the following: the original 50 Hz magnet cycle was modified to a dual frequency cycle (30 Hz rise, 100 Hz fall) providing a useful margin for the otherwise tight RF voltage requirements, and a storage ring was added which would hold four consecutive pulses from the 50 Hz synchrotron and send five pulses to the target at once (*see box below*).

The level of neutron flux will represent a challenge for the instruments. An important part, therefore, of the improved proposal was dedicated to the Austron instrumentation. The proposed instrument suite for the source comprises instruments which are particularly suited to a pulsed neutron source, with the majority taking advantage of the low source repetition rate. With this feature, a larger part of the neutron spectrum can be used and in many cases the overlapping of subsequent neutron pulses is avoided.

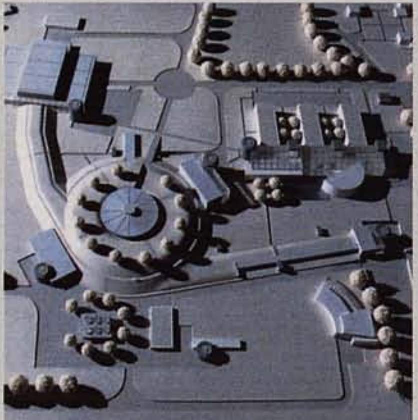
Among these instruments are various diffractometers for the investigation of general materials, single crystals, liquids and amorphous substances, instruments for the study of large scale structures for small-angle neutron scattering and reflectometry, inverted geometry spectrometers which employ analyser crystals and neutron spin echo instruments. A plethora of studies belonging to such diverse areas as structural physics and chemistry, superconductivity and magnetism, soft matter, biology, materials science or earth sciences could be tackled. The expected neutron flux not only guarantees reasonable measuring times for these problems but also offers, together with adequate neutron detectors, unprecedented resolution in neutron scattering results.



Comparison of current and proposed neutron spallation sources

The well-balanced set of advanced standard type instruments is to be accompanied by novel instrumental concepts and techniques to cover a wide area of neutron scattering applications and fundamental neutron physics. Among the new concepts are developments in neutron small-angle scattering, reflectometry, time-of-flight and spin-echo spectroscopy, and neutron quantum optics. New neutron optical techniques, based on electromagnetic phase space manipulations for example, will be essential parts of the instrument development programme and will use the available neutron flux efficiently.

A key feature of the facility will be a special clean room area where ideal conditions in a clean and ultra-low vibration environment can be provided, for surface investigations, single crystal studies at ultra-low temperatures, crystal growth processes or perfect crystal neutron optics like neutron interferometry or perfect crystal triple-axis spectroscopy, for example. Up to a quarter of the instruments will be installed in this clean room area. The instrument suite will be completed by installations of industrial relevance such as a neutron radiography/tomography facility and the proposed separate engineering research beam line where, for example, heavy industrial samples or rotating machinery would be examined without disturbing the experiments of the general facility.



Left a model of the facility. The rapid cycling synchrotron will have a cycling frequency of 50 Hz (energy 1.6 GeV). To cope with losses an asymmetric magnet cycle (75% rise, 25% fall fraction) has been proposed so the total loss will stay below 0.5%. However, acceleration of five times more protons per pulse at one fifth of the repetition rate will not be possible because of the space charge limit at low energies. A slow repetition rate of 10 Hz is achieved by the addition of a storage ring holding four consecutive (single bunch) pulses from the 50 Hz synchrotron until a fifth pulse is accelerated and transferred to the target with the four stored ones

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