JP0150501

JAERI-Conf 2001-002

ICANS-XV
15th Meeting of the International Collaboration on Advanced
Neutron Sources
November 6-9, 2000
Tsukuba, Japan

2.5 Current Status of the AUSTRON Project

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Abstract

The current status of the AUSTRON spallation source project is described with reference to the need for neutrons in Europe and – due to a certain West-East imbalance of large research facilities - especially in Central Europe. A short overview about technical aspects of proton accelerator, rapid cycling synchrotron, storage ring, target and instrumentation is presented.

1. Introduction

End of August 1998 the Federal Government of Austria has decided to promote the project AUSTRON, a pulsed neutron spallation source, to establish a medium to large scale research facility in the eastern part of Austria. The promotion of AUSTRON also includes the decision to raise a third of the funds necessary to construct the facility which is considered to be a generous offer of a small country like Austria. As a consequence Austria seeks international partners to co-finance the project, a mission which Ambassador Jankowitsch was entrusted by the Federal Government of Austria. As a juridical means an International Organisation is suggested to allow for an optimum adaption to the needs of the organisation and the wishes of the partners.

The need for neutrons in Europe is unquestioned since many of the existing 16 sources will have to be closed due to the expiration of their natural life time. Until 2015 it is envisaged that only 4 reactors will be in service. The leading role of Europe in neutron research should be maintained, first intentions to build a neutron source in Central Europe have been expressed already 1991 in the framework of the Pentagonale (now the Central European Initiative).

Looking at the European scientific map geographically, a West-East imbalance of large research facilities can be observed. By including all the direct and indirect neighbour countries of Austria into a partnership for the establishment of such a scientific facility, a site in East – Austria is suggested as a Central European location. Also, on forefront scientific grounds, the envisaged enlargement of the European Union could take place by creating such a centre of excellence in the region which is in line with the recommendations of the 5th framework programme suggesting the integration of scientists of member candidates. A recent visit in Brussels has reconfirmed this opinion. Moreover, the intentions to create a

"European Research Area" are signalling that the need of support for research infrastructure on a European level is fully recognised.

On an international scale the project AUSTRON was incorporated in the global plans to counteract the occurring "neutron gap" by the OECD – Megascience Forum. The major projects of neutron sources of the next generation are the ESS in Europe, the SNS in USA and JJP in Japan. New sources in Europe are the projects FRM II (under construction) in Munich and AUSTRON. Also, the upgrade of ISIS, ILL, NIST etc. are necessary measures to maintain a network of neutron research facilities satisfying the demand for neutrons. As it exists since some 20 years with ILL and ISIS at their scale, FRM II and AUSTRON could build up such a new pair of a continuous and a pulsed source in Europe.

AUSTRON is not considered to be in competition with the European Spallation Source ESS, which will be in service not before 2015. ESS is planned with a beam power one order of magnitude higher than AUSTRON (5 MW versus 500 kW). However, the 10 Hz version of AUSTRON, as described below, gives rise to ½ the energy per pulse planned for ESS. It is one of the most important future research projects for which the technology of the accelerator and the target have yet to be defined within several research projects to be launched. AUSTRON is based on known technology and could also serve as an experimental field for ESS. As an earliest date AUSTRON could be in service by 2006. The recent suggestions to incorporate the ESS project into an even more powerful multipurpose machine will now be analysed in the next couple of years.

The technical concept of AUSTRON comprises a linear proton accelerator (130 MeV H^-) with a repetition rate of 50 Hz and a rapid cycling synchrotron accelerating to an energy at extraction of 1,6 GeV and 500 kW beam power. 4 pulses are stored and confined to a bunch in a storage ring, the 5^{th} pulse is sent directly together with the bunch of 4 pulses to the target giving rise to 5 times the energy per bunch deposited on the target at a rate of 10 Hz. This unique type of construction allows for a 15 – 20 times higher peak flux ($\sim 3.7 \cdot 10^{16}$ n/cm^{2}s) than obtained today at the only existing neutron spallation source in Europe, ISIS in UK. Together with optimised moderators ideal conditions for cold neutron experiments are foreseen. Special sample environment, like ultra-low vibration, clean room and extreme temperature conditions are planned. When taking up service, 6 – 8 instruments will be installed. In a final stage 21 instruments have been suggested including some unique experiments so far nowhere installed. The financing of the additional instruments is planned for within the operational cost of the facility and by EU-projects.

The investment cost of AUSTRON was carefully estimated to be 340 Mill EUR of which Austria has envisaged to contribute a third or 113 Mill EUR. The operative cost will be some 37 Mill EUR (roughly 10% of the investment cost and in line with a rule of thumb for large scale facilities). The creation of this international research centre will need a workforce of about 280 newly employed on a site of about 20 ha. The cost estimates are based on the condition that AUSTRON will be built "on the green field". Good infrastructure is found in the region of East Austria with the nearby universities of Vienna, Graz and Linz and those of Bratislava, Ljubliana and Budapest, all of them within a circle of a 3 hours drive. The existing infrastructure also provides for schools, hotels, hospitals and recreation areas nearby.

It is important to outline as well the project of Med – AUSTRON which is a cancer research and therapy centre with the unique possibility to apply proton and ion beams at the same unit to treat malign tumors. The accelerator is designed to produce an optimised beam for medical treatment. Proton and ion gantries are planned and a research institute for radiation planning.

The cost has been estimated to 90 Mill EUR and once in service the operative cost will be some 14 Mill EUR. In case AUSTRON and Med – AUSTRON are built at the same time, major effects of synergy can be foreseen as well for the investment as for the operation.

In course of the efforts to win partners for the project, in all the capitals visited a warm welcome of the scientific community was sensed. Countries from the EU like Italy, France and Germany, Central European countries like the Czech Republic, Hungary, Poland, Romania, Slovak Republic and Slovenia and non-EU countries like Switzerland and Turkey have been approached, with other contacts like Bulgaria, and Spain under way. For some internal reasons, France and Germany have declared that they are not able to participate for the moment being, however, in July 1999, all other countries were convoked to a meeting on ministerial level by the Austrian Minister of Science. At the meeting, two working groups have been installed to investigate financial and legal matters best suited to the project needs of AUSTRON. A broad field of topics has been tackled and a common report by the two working groups was delivered to the coordinator of the mission, Ambassador Jankowitsch. Further decisions will now have to be made at a minister's meeting to be called for.

As a summary AUSTRON is planned timely to counteract the foreseeable neutron gap. The impact on education, the possibility to train PhD's and post doctoral students will also contribute to avert the existing brain-drain in the region. It is aimed to create an international organisation using a well tried model of an organisational chart thereby allowing for the efficient control of scientific and financial goals. With the envisaged location of AUSTRON this centre of excellence will play an important regional role in the scientific landscape of Central Europe stimulating new basic and applied research in a multidisciplinary way in many fields of science and life science.

2. The proposed AUSTRON instrumentation

Some striking features of the proposed AUSTRON instrument suite comprise the emphasis on instruments which gain from the 10 Hz operation of the neutron source, the emphasis on instruments which use cold neutrons (3 out of the planned 4 moderators are cold neutron moderators), the recognition of the importance to develop new instruments and experimental methods in relation to optimal exploitation of the given neutron flux, the tremendous potential of polarised neutrons, the availability of extreme sample environment and the special environmental conditions provided by a clean-room area which covers about one quarter of the AUSTRON instrument hall (clean-room type environment, temperature stabilisation, ultra-low vibration levels, ultra-low temperature experiments, high sensitivity quantum optics experiments). In total, 21 instruments were proposed to be installed at the AUSTRON facility (see Table and Figure).

Table. **Proposed AUSTRON instruments and their characterisation; see Figure for details**

Instrument	Characteristics	10 Hz type	Scientific Highlights
Powder diffractometers			
High resolution diffractometer	Very high resolution, covers a very large detector solid angle	x	Analysis of materials of extreme complexity
General purpose diffractometer	Recommended in the Autrans-Report, wide Q-range, low- and small-angle detectors, polarised neutrons	x	Long range order phenomena in condesed matter
Single crystal diffractometers			
Single crystal diffractometer	High resolution, large area position sensitive detector, Special environment	x	Protein crystallography In-situ crystal growth studies
Diffractometer for polarised nuclei	Polarised neutrons, Special environment	x	Neutron scattering from highly oriented nuclei at ultra-low temperatures
Diffractometer for liquids and amorphous materials	Very large Q-range, emphasis on low- and small-angle scattering		
Engineering diffractometers			
Strain measurement instrument	Dedicated instrument, large sample space, various supporting equipment, industrial users	x	Study of deformation processes in real components under real conditions
Texture instrument	Dedicated instrument, industrial users	x	Geophysical materials under extreme conditions
SANS instruments			
3D-SANS instrument	Combined small- and wide-angle scattering, oriented samples	x	Long and short range correlations in single-crystalline specimens
Spin echo small-angle scattering instrument	New development, direct measurement of the real space correlation function	x	
Reflectometers			
General purpose reflectometer	Flexible instrument set-up, large Q-range Special environment	x	In-situ formation of surface structures under ultra-clean and ultra-low vibration environment conditions
Phase reflectometer	Polarised neutrons :3-dim. polarisation control and analysis Special environment	x	Model-independent and unique reconstruction of surface profiles

TOF-spectrometers	Direct geometry instruments		
Single-chopper spectrometer	Recommended in the Autrans-Report, large detector area, emphasis on small- and low-angle detectors		Magnetic excitations and vibrational spectroscopy
Multi-disk chopper spectrometer	Continuously variable energy resolution (4 orders of magnitude) , large diversity of application areas	x	Dynamics of high-T_C superconductors, protonic conductors, glasses, gels, biological macro-molecules and membranes
Phase space transformation spectrometer	High resolution spectroscopy studies, selective increase of used neutron intensity		Excitations in complex materials
TOF-spectrometers	Crystal analyser spectrometers		
Molecular spectrometer	Recommended in the Autrans-Report, multiple analyser crystals for molecular spectroscopy		Dynamics of non-hydrogenous systems, coherent scattering in vibrational dynamics
High resolution spectrometer	μeV-resolution, includes diffraction option at backscattering and low-/small-angle positions, polarised neutrons	x	Local structure and long range order studies in solid state reactions, dynamics of complex soft solid systems, macromolecular dynamics
Neutron spin echo instruments			
SANS+MIEZE instrument	High resolution spectroscopy at small angles; operation mode as standard high resolution SANS instrument possible	x	Structure and dynamics of proteins
Multi-purpose NRSE instrument	New development with special operation modes for a pulsed source by using the full neutron bandwidth	x	
Neutron optics instruments			
Neutron optics research station	Flexible instrument set-up for various neutron optics configurations, polarised neutrons Special environment	(x)	Study of the neutron as a quantum optical object, phase- and micro-tomography
Neutron optics development beam line	Developments for phase space manipulations and advanced beam tailoring (optically active elements)	x	Neutron beam monochromatisation by energy focusing
Radiography/Tomography facility	Element identification via resonances and Bragg-edges in TOF mode possible		Element-sensitive real-time radiography
General development beam line	Flexible beam line for development of methods, components, detectors and ancillary equipment, polarised neutrons	x	Development of the spin echo SANS and the NRSE instruments for use at high peak flux neutron sources

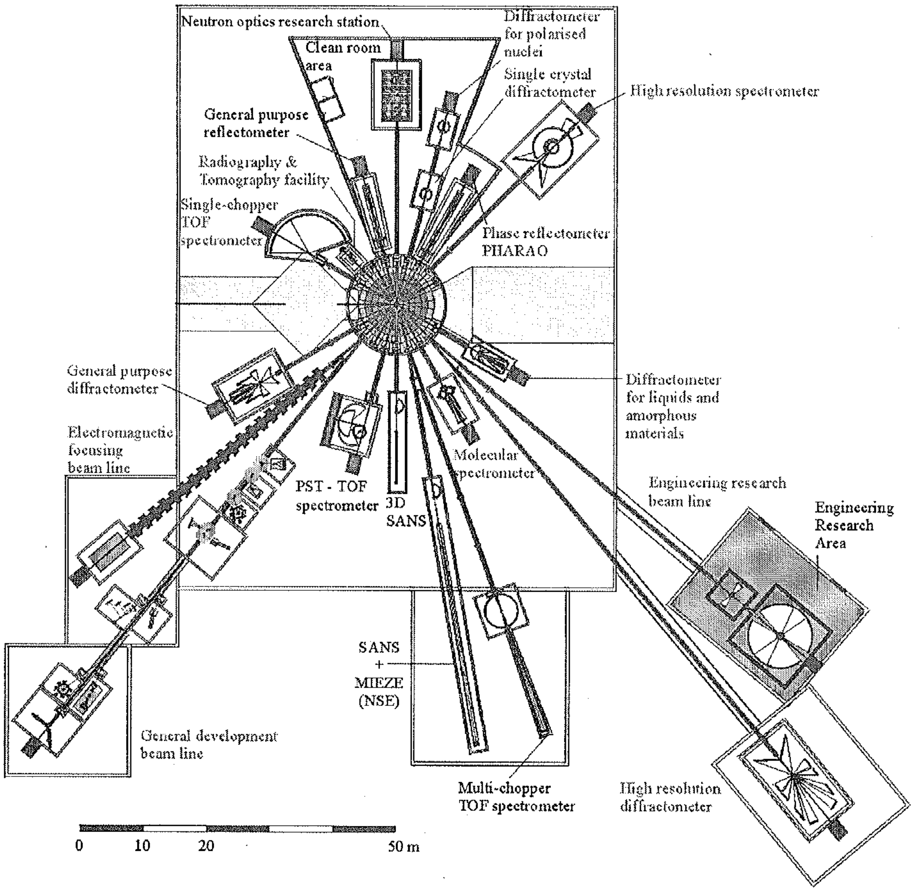

Figure : Proposed Layout of AUSTRON instruments; see Table for details