STATUS REPORT ON THE SIN NEUTRON SOURCE

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1. OVERALL EXPERIMENTAL FACILITY LAYOUT

Figure 1 shows the proposed layout of the SIN accelerator system and experimental facilities following the installation of the Injector II. At present Injector I feeds the Ring Cyclotron with a 100 to 150 μA proton beam for routine operation. Injector II is designed to deliver a beam current of at least 1 mA. Ultimately the current should be further increased by a factor which at the present time is only vaguely known: Operational experience will in fact set the final limit.

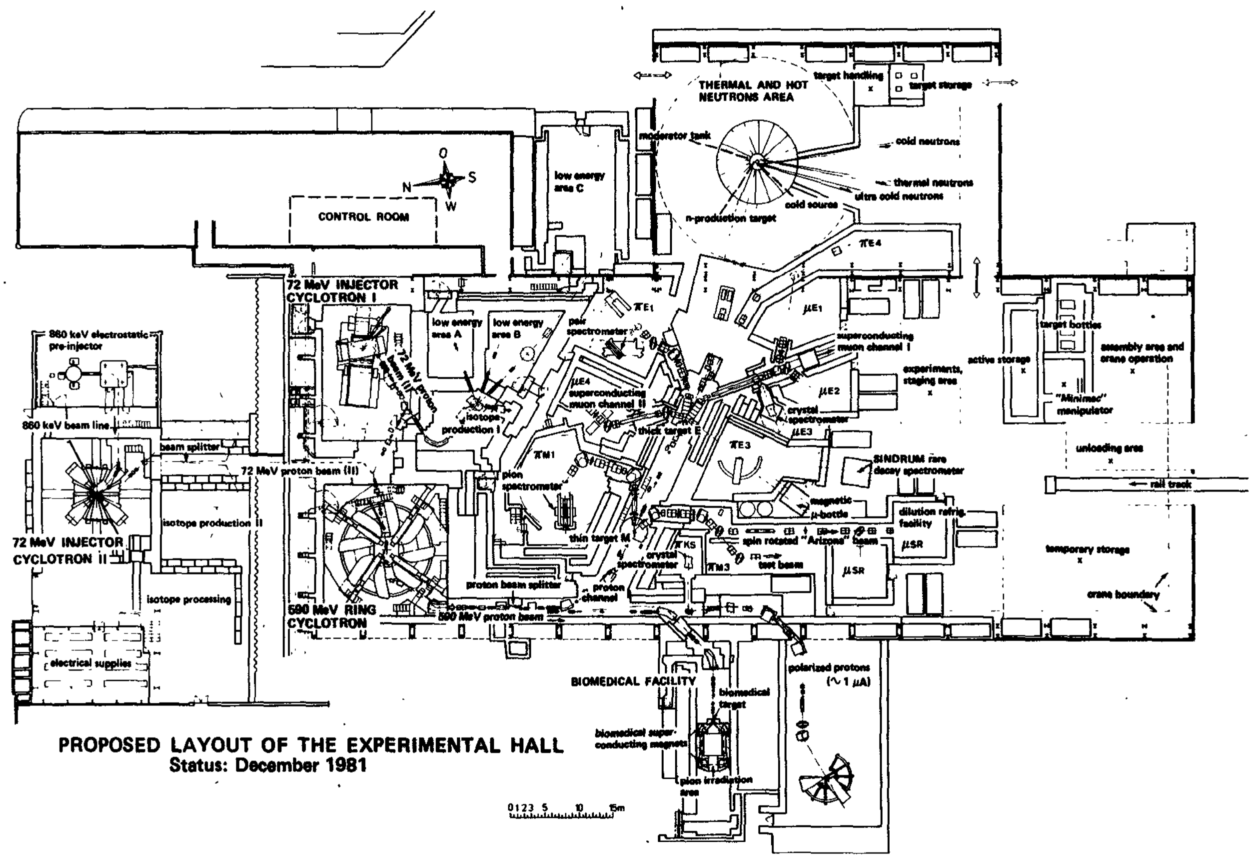

Fig. 1

The present status is as follows:

Injector II is under construction.

Improvement of the proton channel for high current operation is in the design stage.

The spallation neutron source design is progressing.

2. TIME SCHEDULE

First beam from Injector II is expected towards the end of 1983. During 1984 and 1985 the intensity limits will be explored. In order to accelerate a 1 mA beam in the Ring Cyclotron to 590 MeV; the RF-power has to be increased. The proton channel, including the meson target stations, need considerable improvement to allow full exploitation of this higher current. This task will now be accomplished during two long shutdown-periods, presumably those in 1984/85 and 1986/87.

The spallation neutron source, recommended by the Federal Science Council, and now approved by the Federal Schools Council, is scheduled for funding as from 1985.

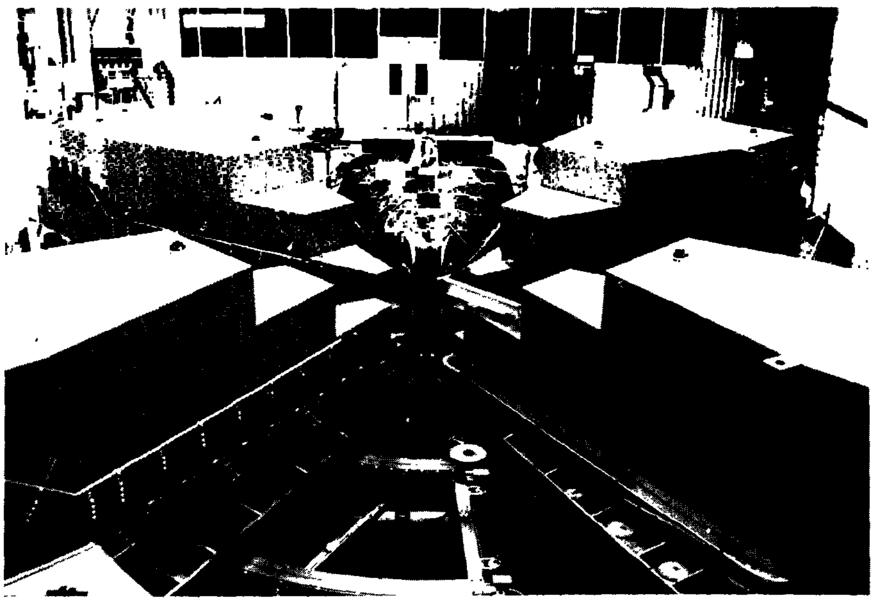

Fig. 2
The 72 MeV Injector II under construction in May 1981. The prototype of the 50 MHz-resonators is installed between two sector magnets.

3. INJECTOR II

This is a 72 MeV Isochronous Cyclotron, and is, in its principles, very similar to the 590 MeV Ring Machine. Figure 2 gives an impression during the state of construction. It will be fed by a 860 kV Cockcroft-Walton generator as a pre-accelerator.

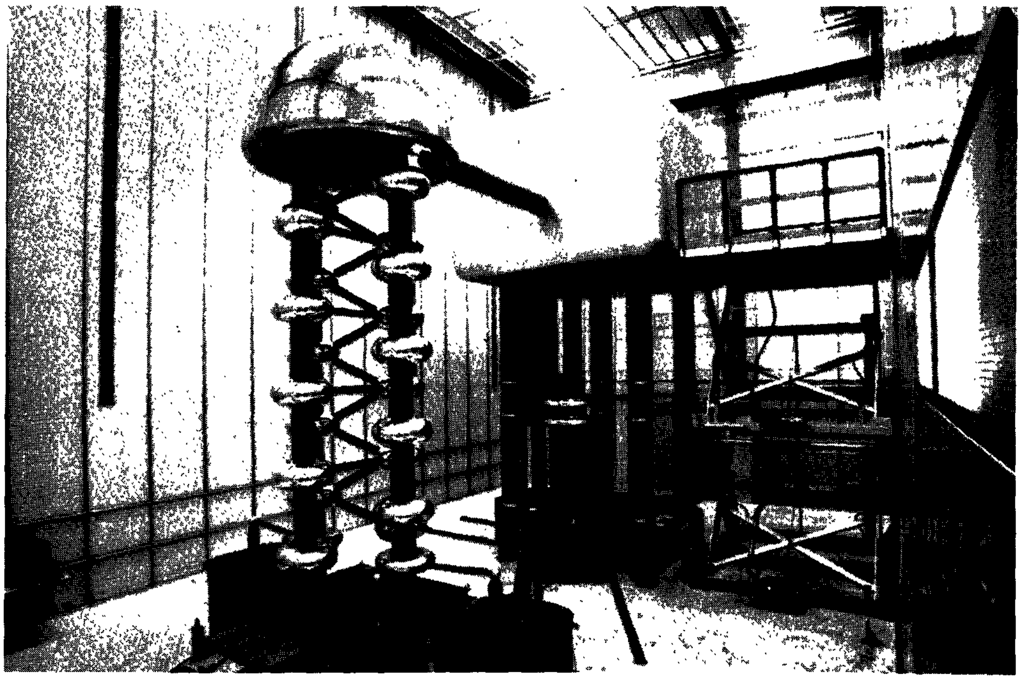

Fig. 3
View showing the main components of the 860 keV pre-accelerator: The Cockcroft-Walton generator designed for 900 kV (left) and the high voltage dome (right) which will house the ion source and the 60 keV beam line.

An artist's impression of the beam transport from the Cockcroft-Walton generator and the vertical injection system are shown in Fig. 4.

4. NEUTRON SOURCE

Among the different versions discussed at the last ICANS-meetings, we now prefer the arrangement with a vertical liquid metal target (beam injected from below) using natural convection as cooling mechanism. A cross section, showing the principle of this source type, is given in Fig. 5.

The design of a vertical Pb/Bi-target needs a rather careful investigation of the thermo-fluid dynamics which is driven by the

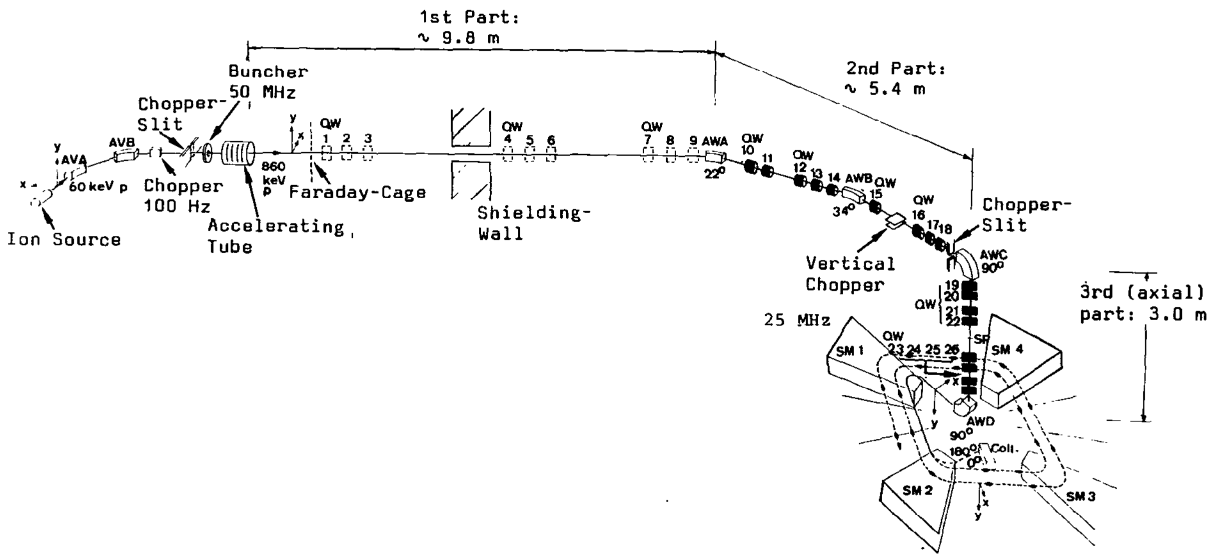

Fig. 4
Schematic presentation of the 860 keV beam transport system between pre-accelerator (left) and 72 MeV Injector II. The length of the horizontal section is 14.2 m (measured from the Faraday cage wall) whereas the length of the vertical section is 3.0 m.

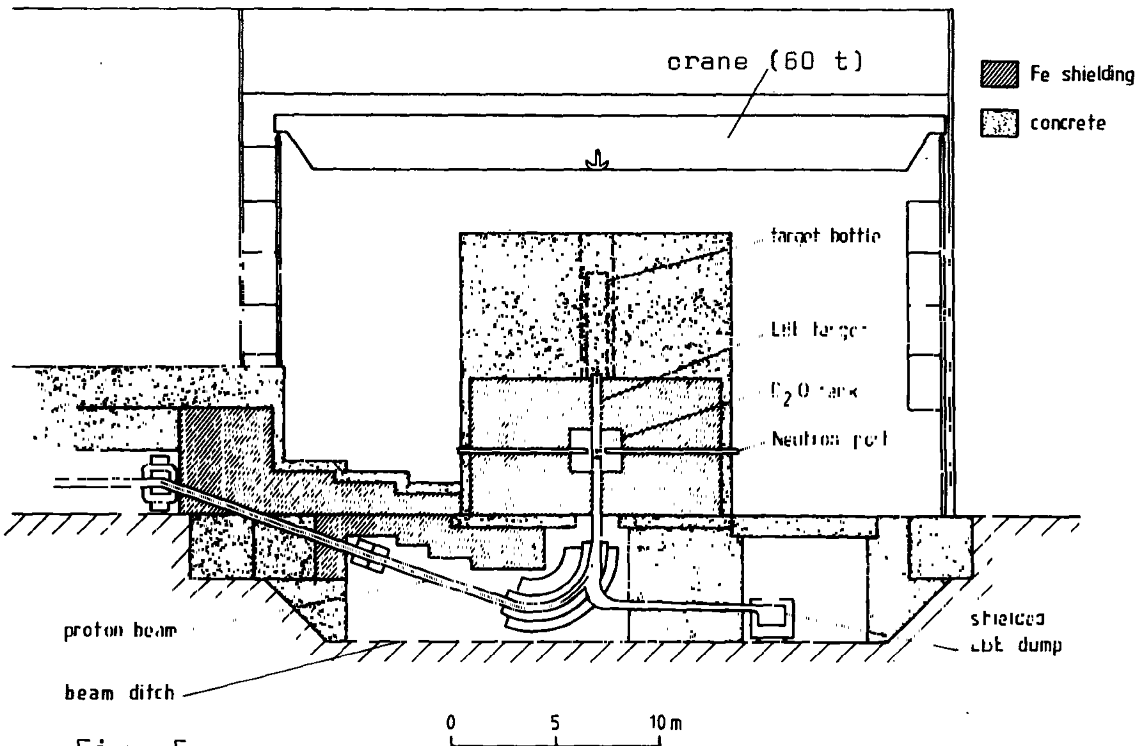

Fig. 5
Schematic view of the vertical version of the spallation neutron source. LBE = lead-bismuth eutectics.

buoyancy force caused by the heating of the lower part of the target by the proton beam. A program of work to study the behaviour of such systems theoretically and experimentally is under way. In Fig. 6 we show a typical set of flow-patterns and temperature distributions for some time sequence after switching on a beam. This subject will be treated in a special paper to this Conference [1]. Some effort is still needed to find the optimal configuration of the target for most effective cooling.

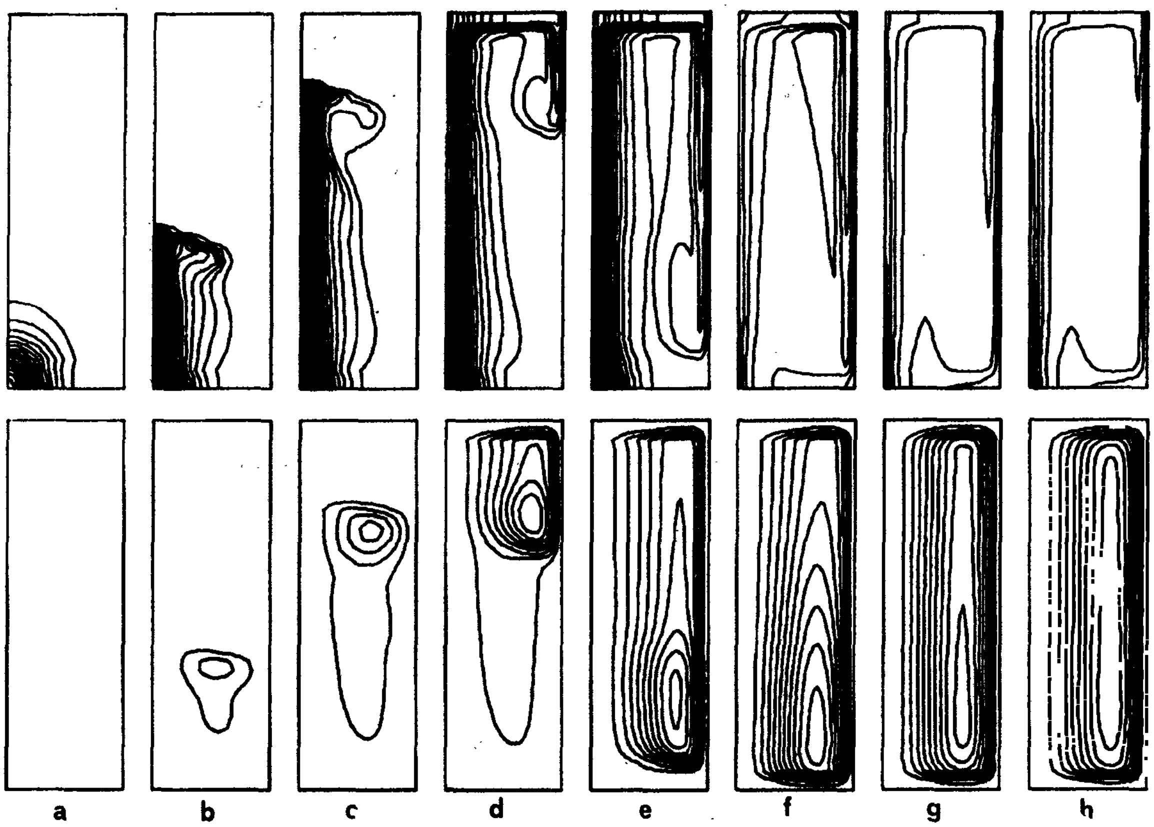

Fig. 6
Transient behaviour for 3 m target of 15 cm radius. Beam current is 100 μA. Contour-maps are for temperature (above) and stream function (below). For temperature contours, the lowest line is 3.1 ^{0}C above melting point, and line interval is also 3.1 ^{0}C. "a" is at 2.55 sec, and interval between two figures is 5.10 sec.

On the neutronics side, further measurements of flux distributions in moderators have been made by the Jülich-Karlsruhe-SIN collaboration. One of the flux maps, relevant to the planned SIN-source, is shown together with its comparison with a Monte-Carlo simulation (Fig. 7). This setup had an annular void gap between target and moderator. Other configurations and their comparisons are presented in another paper to this Conference [2]. By means of these flux distributions for thermal neutrons in the D_2O moderator, we may find the optimal position of the cold source as well as the position and size of the beam tubes.

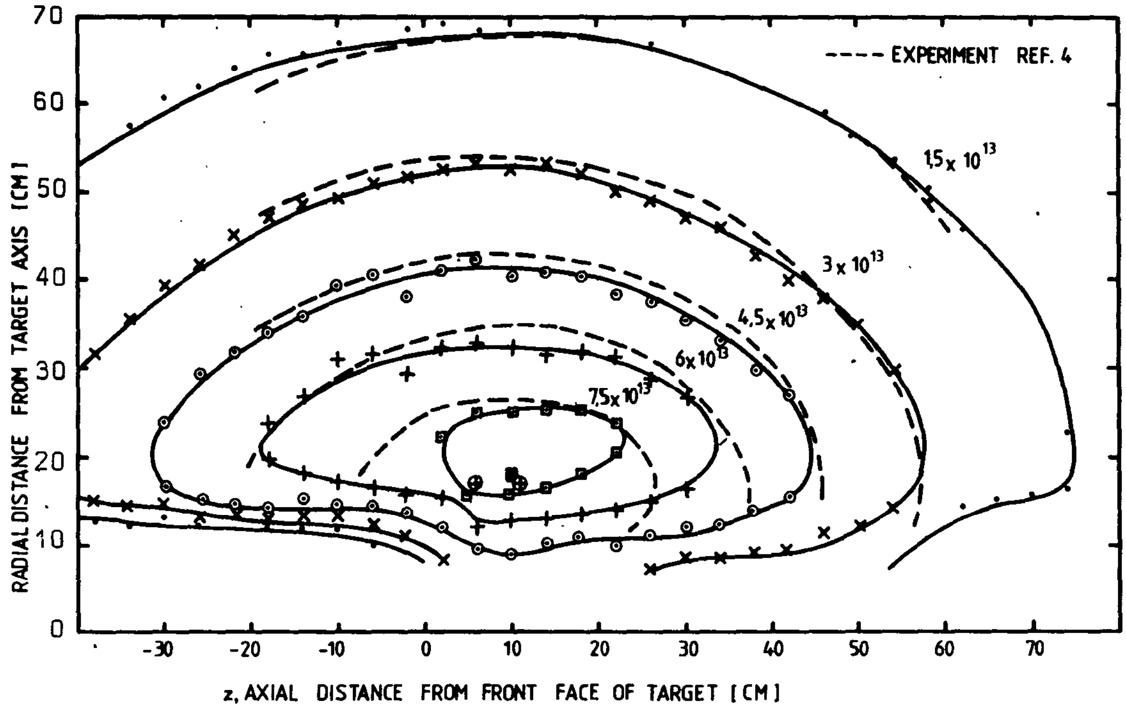

Fig. 7
Comparison of calculation and experiment for the thermal neutron flux in a D_2O moderator. 590 MeV protons incident on a 15 cm diameter Pb/Bi-target. Intensities in units of neutrons $cm^{-2}sec^{-1}mA^{-1}$. Measured ⊕ and calculated ■ peak flux = $8.6 \cdot 10^{13}$ neutrons $cm^{-2}sec^{-1}mA^{-1}$.

Further activity is concerned with the heat dissipation in the vicinity of the spallation target - a topic particularly important for the design of the cold source. Model calculations for an experimental setup at the TRIUMF-source have been done for several sample materials. The results are presented in a third paper to this Conference [3]. The experimental run is scheduled at TRIUMF for November 1982.

5. ACTIVITIES FOR THE NEAR FUTURE

Below we give a list of experimental activities planned to be realized during the second part of 1982 and in 1983:

(i) Irradiation tests of window materials at LAMPF.

(ii) Heat dissipation measurements in the vicinity of a spallation target. This experiment will be done at TRIUMF in collaboration with KFA-Jülich.

(iii) Model experiments for thermo-fluid dynamics of the liquid metal target
a) water model
b) Pb/Bi model

(iv) Mock-up experiment at the SIN proton beam for tests of several configurations of cold sources; in collaboration with KFA-Jülich and TU-Munich.

6. INSTRUMENTATION

A list of spectrometers to be installed at the source has been given at ICANS-V. A recent reinvestigation among the present users in Switzerland of neutron scattering facilities has not changed this situation.

Presently there are five neutron spectrometers at the reactor "Saphir" fully booked up. Furthermore, spectrometer time abroad - mainly in Grenoble and Risø - is used by Swiss groups. According to the investigations there will be requirement for about twice the present number of spectrometers in future. In this sense, the SIN spallation source may be exploited by experiments of our own research groups.

International participation in the experimental program, especially at the guides for cold neutrons, where some spare time is likely to be available, is however strongly urged.

REFERENCES

[1] Y. Takeda, Thermofluid Dynamics of the Liquid Lead-Bismuth Target for the Spallation Neutron Source at SIN, These proceedings

[2] F. Atchison, W.E. Fischer and B. Sigg, Some Aspects of the Neutronics of the SIN Neutron Source, These proceedings

[3] Monte Carlo Study of the Energy Deposition of a Flux of Spallation Neutrons in Various Samples, These proceedings

SIN - W. Fischer

D. A. Gray	Q	Will you have space charge problems in the 860 kV beam in injector??
W. Fischer	A	Yes we probably will. That's why we've allowed 1-2 years to work up. The 40 eV beam from the source has been operated at full intensity space charge neutralisation occurs when argon at 10^{-5} Torr is the background gas.
A. Carne	Q	Have you integrated the flux to get the neutron yields?
W. Fischer	A	Yes and we also have other estimates at yields. We think there will be 10n/proton at 590 MeV.
H. Wroe	Q	How many hours a year will you run?
W. Fischer	A	We haven't got an exact figure yet, but the neutron source parasites on the main machine which has only one long shutdown of 1 month in a year.