Status report of SINQ: A continuous spallation neutron source

W. E. Fischer
Paul Scherrer Institute (PSI)
CH-5232 Villigen
SWITZERLAND

1 Introductionary Remarks

A most significant development at SIN the past year has been the merging of several research institutes to what is today called the "Paul Scherrer Institute" (PSI). Good old SIN fell prey to this undertaking. The new institute contains the former

Swiss Institute for Nucelear Research (SIN)
Federal Institute for Reactor Research (EIR)
Radio Corporation of America Laboratory in Zurich (RCA)

Since, within the new organisation, the research domains "physics of condensed matter" and "material science" are supposed to gain considerable significance, I would like to present this PSI here as an introductionary remark.

PSI contains four research departments, namely (Fig. 1)

Nuclear- and Particle Physics
Biological- and Medical Science
Physics of Condensed Matter, Material Science
Energy Research and Engineering Sciences

One of the tasks of the institute is the development and operation of complex research facilities, which are beyond the scope of universities. The relationship between PSI and the federal and cantonal schools are based on the principles of complementarity and close collaboration. International scientific collaboration, in particular through common research- and development programs, is strongly anticipated.

With Fig. 2 we try to demonstrate the significance of the institute's accelerator system (formerly SIN) for the research activities of the various research departments. It shows that this facility is still the backbone (the central hardware unit) for the present and future research program.
A layout of the accelerator – and the meson facilities is presented in Fig. 3. The location of the neutron hall, containing SINQ-station and the guide hall is at the upper right of the picture.

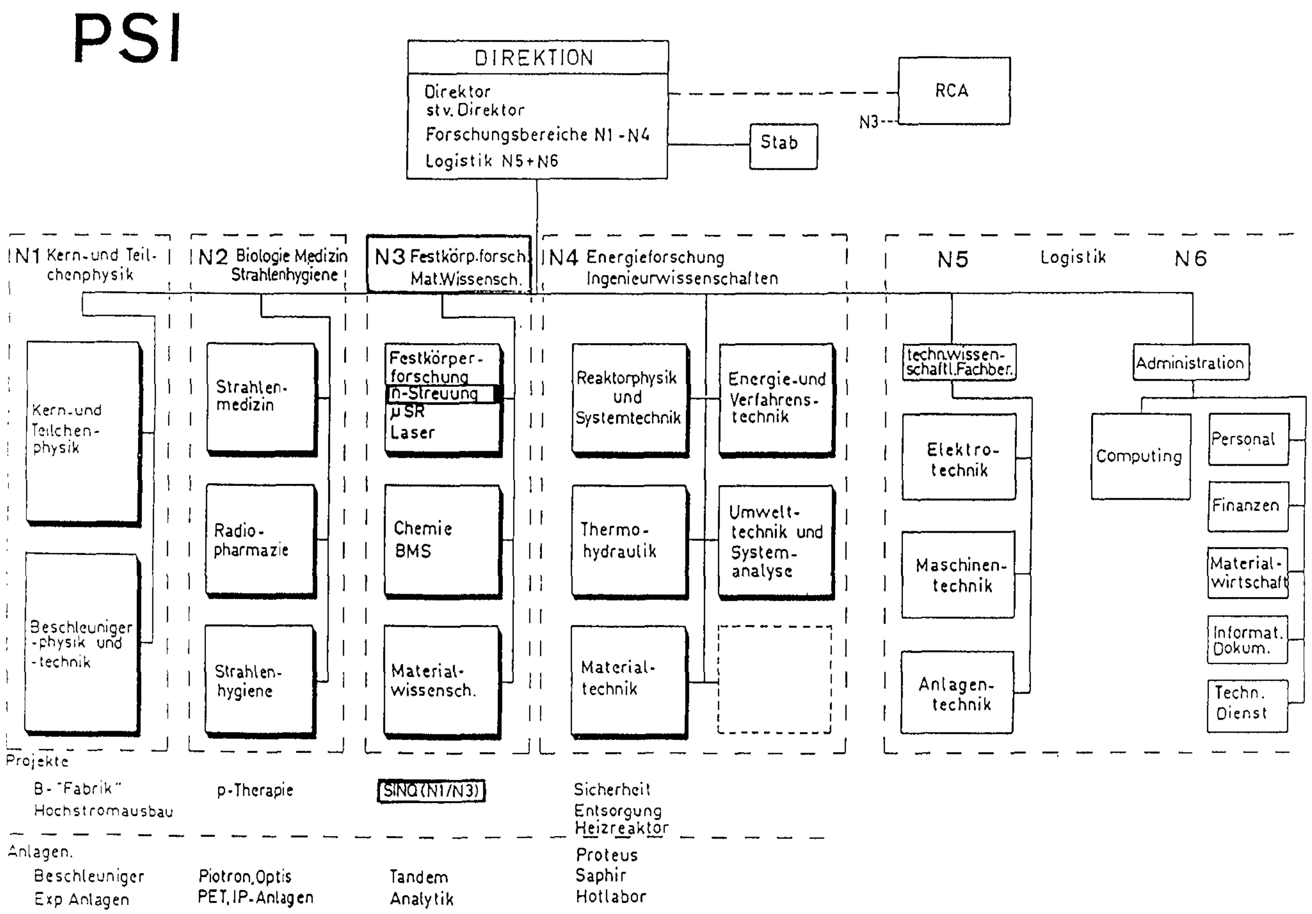

Fig. 1 Organigram of the "Paul Sherrer Institute", PSI.

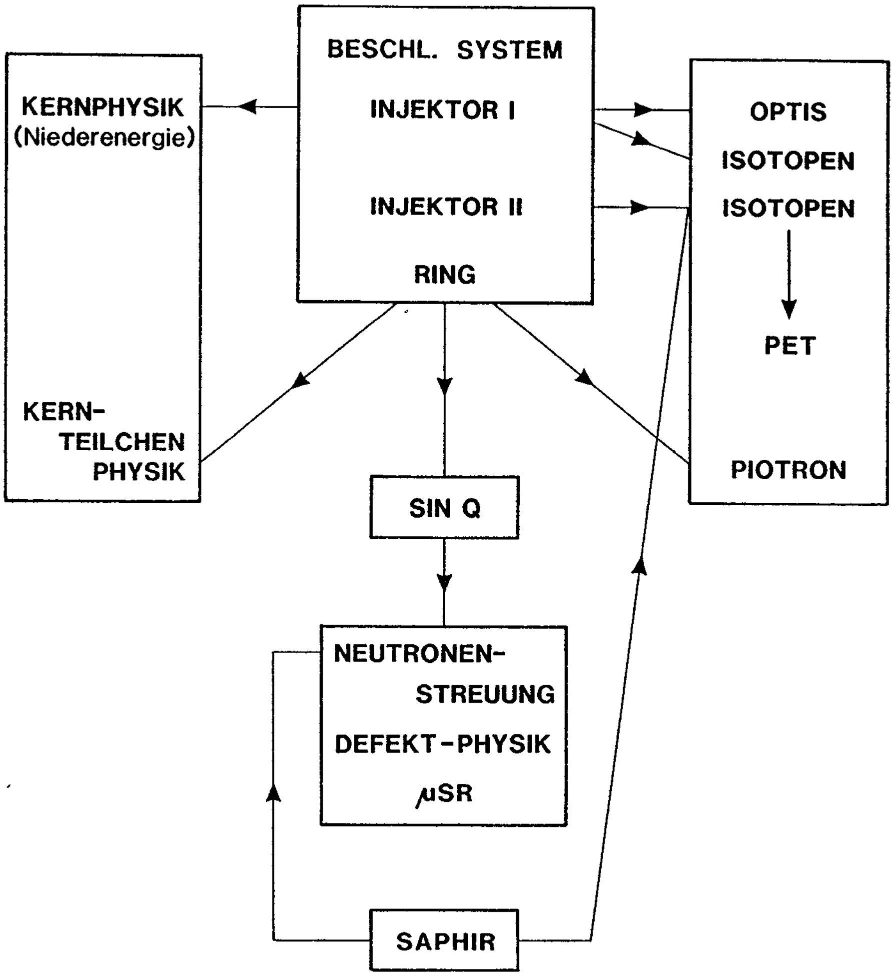

Fig. 2 Research domains at PSI, which make use of the accelerator facility.

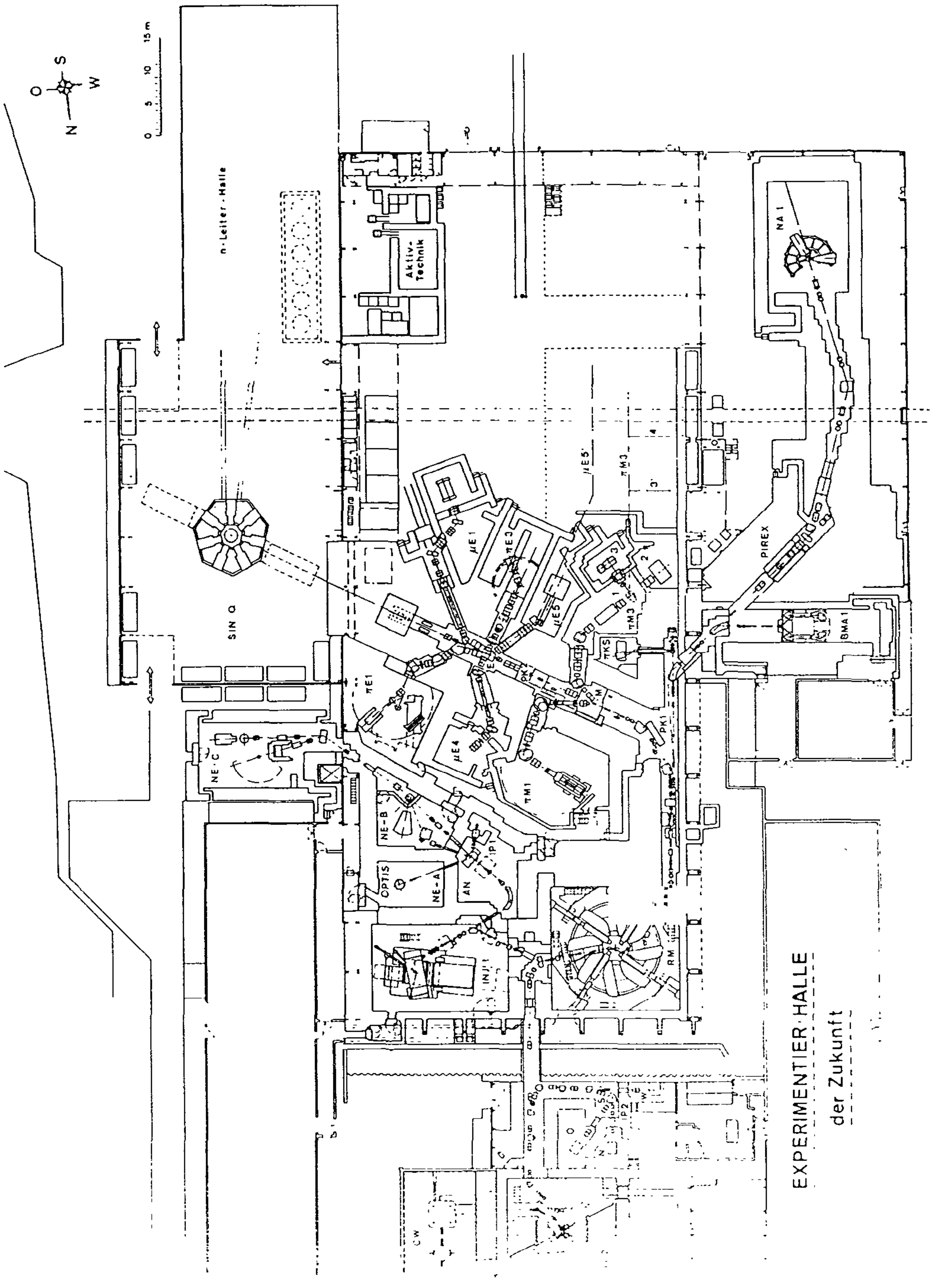

Fig. 3 Layout of the accelerator system and the various experimental facilities at PSI (West.)

The accelerator system delivers today a proton beam of 200 - 250 μA at 590 MeV onto the meson targets. While the accelerator could run currents of 500 μA, the operation is restricted today by the second target station which has still to be improved for the higher currents. For currents above 1 mA the rf-system of the ring-cyclotron will be upgraded by doubling the rf-power of the main amplifiers. The time schedule for these tasks is given in Fig. 9.

2 The Spallation-Neutronsource

A vertical cut of the central part of SINQ is shown in Fig. 4. Proton beam injection into a molten lead-bismuth target (eutectic mixture) through a solid window is from below. Natural convection of the target material driven by the power deposition of the proton beam is used as cooling mechanism for the target. The heat exchanger is located in the upper part of the slim target cylinder.

The D_2O moderator is in a double walled Al-tank. The gap between the two walls is filled with light water, which acts as a shield for thermal neutrons. They are hence captured mainly in the water and do not contribute anymore via (n,γ)-reactions to the heating of the surrounding iron shield. The heating of this shield is therefore dominated by the energy deposition of high energy neutrons. While the upper shield part and the ring around the moderator tank have still to be actively cooled, the lower part does not need active water cooling under these conditions.

The whole source is surrounded by a contained helium atmosphere. An additional safety barrier is defined by a controlled nitrogen containement. Beam extraction systems – beam tubes and guides – are installed in a similar way, as in a beam tube reactor. Remember that SINQ – due to the absence of macro-timestructure in the beam – is a continuous source.

Before entering into the spallation target, the proton beam is forced through a collimator system to prevent – given the emittance – any focus on the target window.

The proton beamline over the distance of 54 m between the second meson target and the spallation target is given in Fig. 5. The halo produced by scattering in the meson target is scrapped off in a four stage collimator system just behind this target. After this clean up a virtually lossless transport of the beam up to the spallation target appears to be possible. Hand-on maintenance of the transport system in the channel ditch is the aim.
The beam envelope in Fig. 5 is of 4σ-width and in second order.

The layout of the inserted plugs for the neutron extraction channels is shown in Fig. 6. We plan to install two cold sources into this facility – a light hydrogen – and a deuterium-source. The neutronics and hydraulics of the 20 l deuterium source will be discussed in detail by F. Atchison at this workshop.

SINQ will provide thermal neutrons at four beam tubes viewing the D_2O-moderator. Another four beam tubes view the light hydrogen source which appears to provide

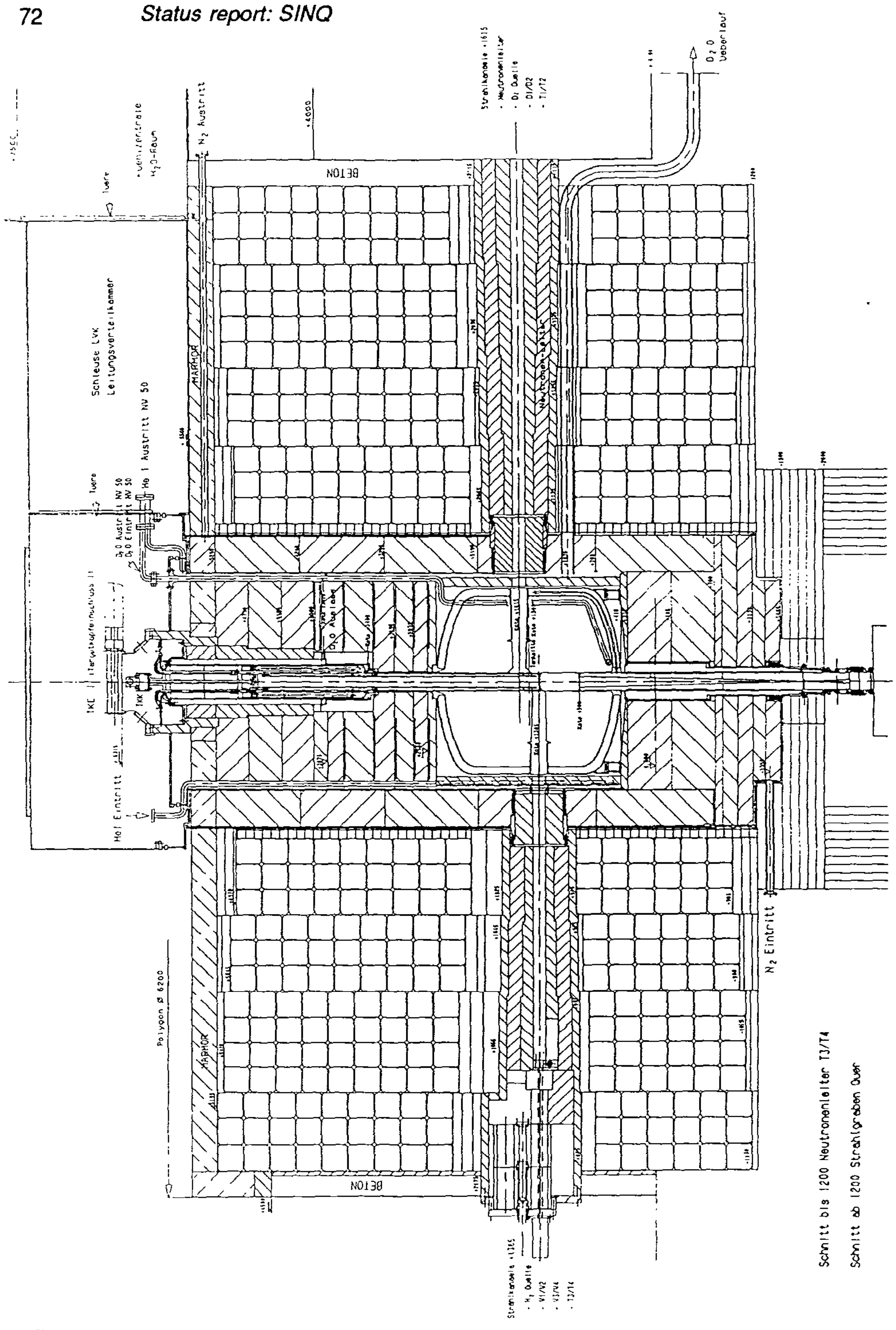

Fig. 4 Cross section through the central part of the spallation neutron source (SINQ).

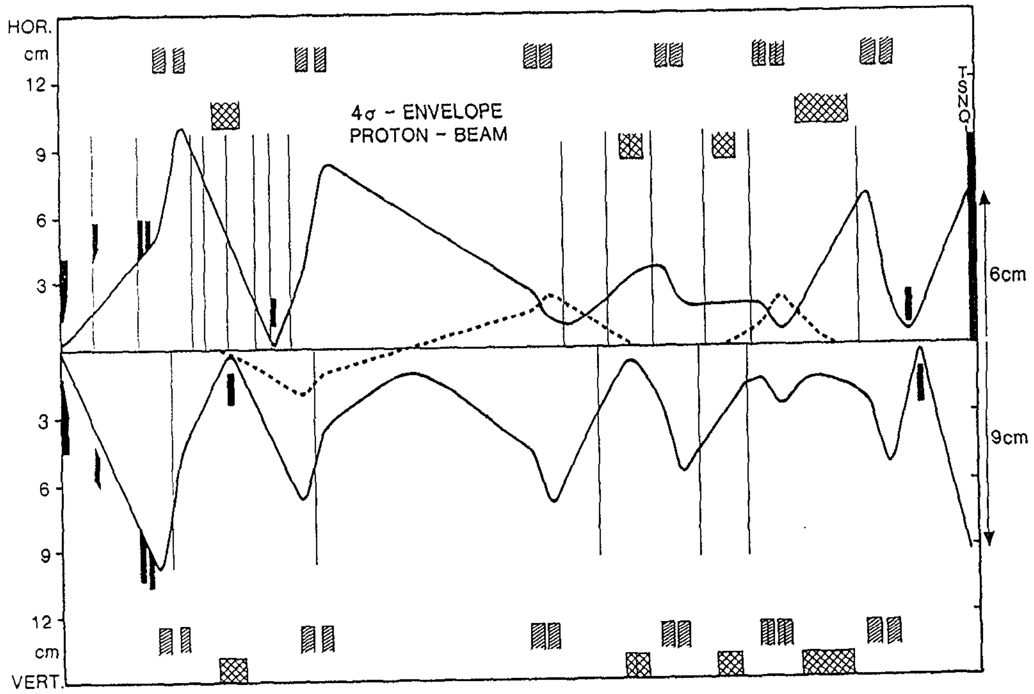

Fig. 5 Envelope (4σ) of the proton beam injected into the spallation source.

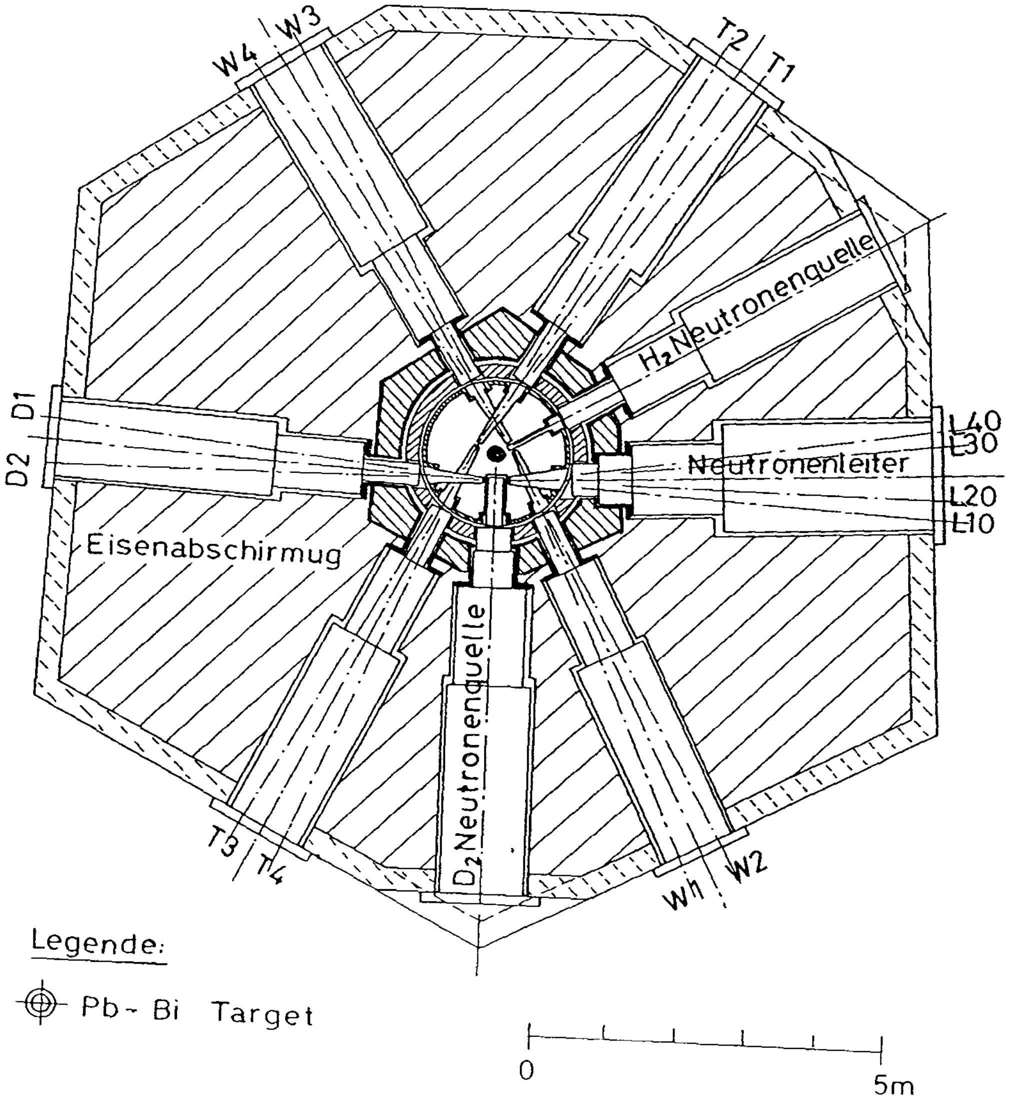

Fig. 6 Layout of the neutron channels.

the highest flux in the wave length region between 2 - 4Å (Fig. 7). To the D_2-source we shall attach a beam tube pair and the guide system. This guide system was presented as a poster at this workshop by I. Anderson and F. Atchison.

In view of the favorable performance of pulsed neutron sources for hot and epithermal neutrons we refrained from installing a hot source into our system.

In Fig. 7 we present the expected spectral fluxes for a nominal primary proton current of 1.5 mA. These fluxes are given at the positions of the monochromators for beam tubes and at the exit of neutron guides at possible end-standing instruments. The option to install short supermirror guides in (and at) beam tubes viewing the light hydrogen source has been kept open.

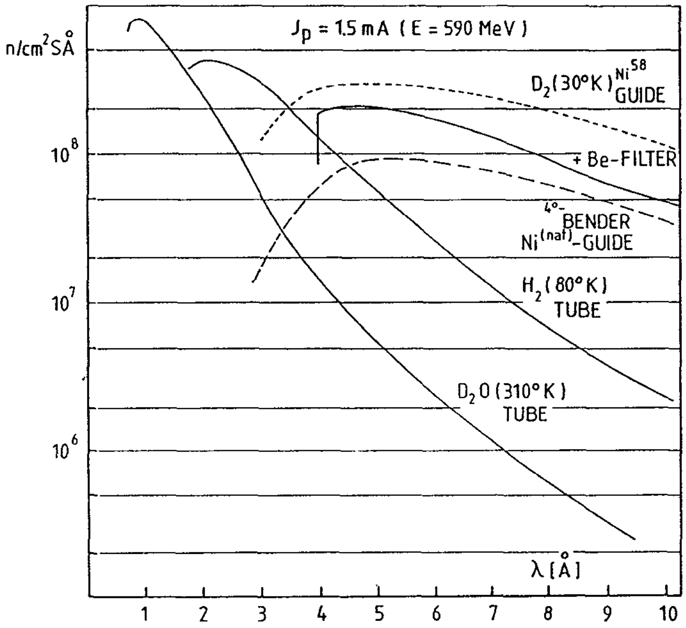

Fig. 7 Spectral fluxes at the position of the monochromators or neutron guide exits.

3 Instrumentation

In table I we list the spectrometers planned to be installed at the spallation source. Two priorities are distinguished – the highest priority being given to the instruments at the guide system (3.3 - 5.2, 6.1, 6.3). Instruments already in operation now at the reactor "Saphir" (formerly EIR) planned to be rebuild or possibly transferred have second priority.

Generally speaking the instrumental set corresponds to the experimental installations realized today at a modern beam tube reactor.

Fig. 8 presents the layout of the instruments in the Target Hall and the Neutron Guide Hall.

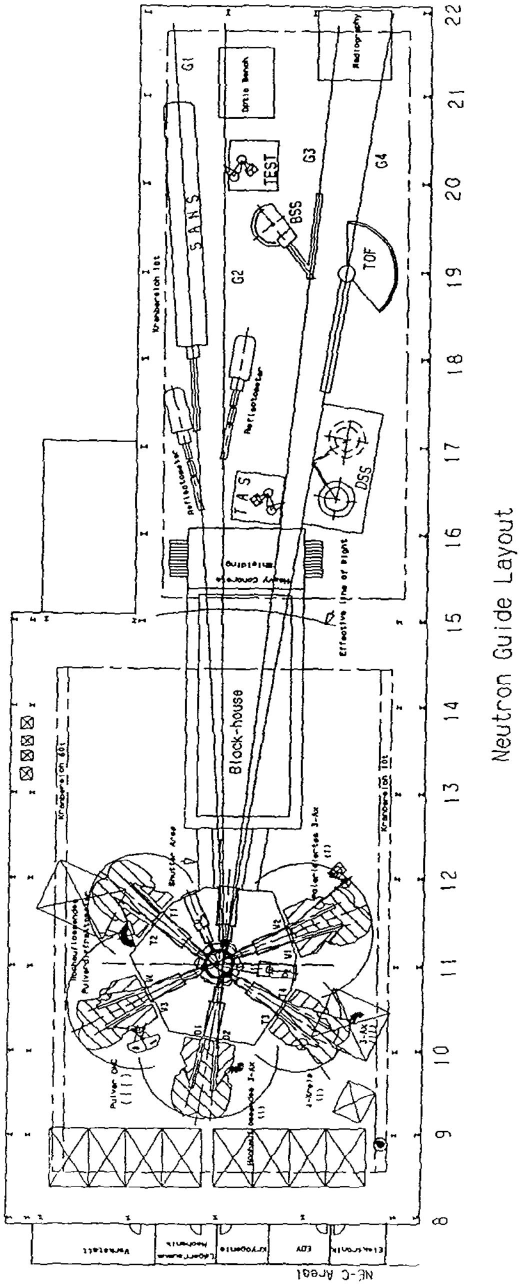

Fig. 8 Layout of the instruments in the target hall and the guide hall.

4 Time Schedule

Construction work has been started this summer 1988. We plan to begin with the installation of the actual target station towards the end of 1990. This phase is supposed to last for about $2\frac{1}{2}$ years – first trial operation to be expected towards the end of 1993.

As can be recognized from Fig. 9 this schedule is strongly coupled with the activities for upgrading the second meson-target station (Target E). A general shutdown lasting at least one year (1990) is foreseen for this task. During the same shutdown preparatory work for the improvement program at the accelerators will be done. The short shutdowns during the years 1991/92 are inserted in order to install – one by one – the rf-amplifiers delivering higher power to the accelerator cavities of the ring-cyclotron. As a consequence a gradual increase of the operational beam current can be achieved.

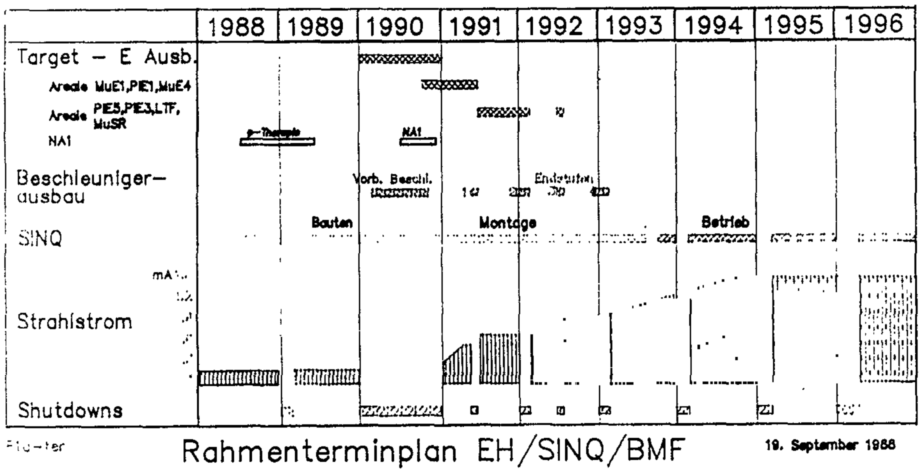

Fig. 9 Time schedule of the major tasks at PSI from 1988-1994.

SINQ-Spektrometerplanung (Stand: 9.1.87)

Nr.	Spektrometertyp	SINQ		Saphir
		1. Priorität	2. Priorität	
1.1	Pulver (höchstauflösend)	○		
1.2	Pulver (Lineardetektor)		◌ ←	○
2.1	4-Kreis (Flächendetektor)	○		
2.2	4-Kreis (grosse Q)		○	
2.3	2-Achsen		◌ ←	○
3.1	3-Achsen (kleine ω)	○		
3.2	3-Achsen (grosse ω)		○	○○
3.3	Diffuse Streuung	◌ CH01 ←	○	
4.1	3-Achsen (Monochr.-Turbine)	○	○	
4.2	Rückstreuung			
4.3	Flugzeit			
5.1	Kleinwinkelstreuung	○		
5.2	Reflektometer		○	
6.1	3-Achsen (polarisiert)	○		
6.2	2-Achsen (polarisiert)	◌ →	◌	
6.3	Neutronenoptik-Bank	○ A01		

Legende: ○ Planung ◌ Option