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STATUS OF THE SNS

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1. INTRODUCTION

Reports at past ICANS meetings have been on the state of construction of the SNS. It is a pleasure to report at this meeting preliminary experiences in producing neutrons. During June 1985 the SNS started on a routine schedule of operating 2 weeks for neutrons and 1 week for machine and target station development and maintenance. A description of commissioning highlights is given together with the general status of the neutron scattering instruments. Details of the state of machine and target station equipment as at May 1985 are given in ref (1).

2. COMMISSIONING

Highlights of commissioning are as follows:

Jan 84 - 1 μs long 70 MeV beam pulses injected into the main ring (with dc excitation of the magnets) and several hundred turns circulated at the first attempt.

Mar 84 - 0.8 μs, 70 MeV beam pulses successfully circulated with ac + dc excitation of the main ring magnets.

Apr 84 - 10 μs beam pulses successfully accelerated at the first attempt to 140 MeV using 2 rf cavities. With longer injected beam pulses the maximum accelerated beam intensity was 2.8×10^{12} protons per pulse (ppp) or about 10% of full intensity per pulse.

Jun 84 - 1.2×10^{12} ppp accelerated, at the first attempt using 4 rf cavities, to an energy of 550 MeV.

Sep 84 - 1.5×10^{12} ppp successfully extracted into a graphite beam dump, again at the first attempt.

Dec 84 First neutrons.

For all commissioning work repetition rates of about 1 per second have been used to minimise induced activity of components. The physics processes are independent of repetition rate.

3. THE DECEMBER 84 RUN

For the December run the following equipment was available for the first time:

- Extracted proton beam line, 150 m in length with 65 magnets
- Uranium target cooled by static D_2O
- The 2 ambient temperature moderators
- The 100K liquid methane moderator
- The 25K liquid hydrogen moderator
- Beryllium reflectors cooled by static D_2O
- Six neutron shutters open
- Six instrumental measuring stations
- 95 m neutron guide to High Resolution Powder Diffractometer
- 35 m neutron guide to Indian instrument, High Resolution Inelastic Spectrometer
- Data collection electronics and computer systems.

Neutrons were first produced at 19.16 hrs on Sunday 16 December 1984 (see Figures 1 - 4). Following this 2 to 5 x 10^{11} protons per pulse at 1 Hz were run into the target for a period of about 3 hours. The neutronic properties of the final target/moderator/reflector system were measured. These are reported fully in RAL Report RAL-85-030 (2) and together with reports on instruments are the subject of a number of papers at this meeting.

The basic design and performance of the system was as predicted.

4. PROGRESS DURING 1985

4.1 Installation and commissioning

The period until June was spent on the following installation and development work:

Target Station

- Completion of shielding
- Improvement to controls of cryogenic moderator systems
- Commissioning of cooling system for target and moderator
- Repair of small leak between circuits on the target module
- Commissioning of the Remote Handling Cell.

Machine

- Increasing repetition rate on injector
- Increasing repetition rate on injection kicker magnets
- Increasing repetition rate on extraction kickers
- Improvement on controls

Instruments

- Completion of installation to first stage for the 5 initial engineered instruments
- Preparation for installation of the 3 development instruments

The performance reached on various parts of the machine is as follows:

	Design			Performance		
	Energy	Rep rate Hz	Intensity per pulse	Energy	Rep rate Hz	Intensity per pulse
Ion source	18 keV	50	10^{14}	18 keV	50	2.5×10^{13}
Pre-injector	665 keV	50	10^{14}	665 keV	50/4	5×10^{12}
Linac RF system		50			50/4	
Injection kickers		50			50/2	
Synchrotron and magnet RF	800 MeV level	50		550 MeV level	50	
Synchrotron	800 MeV	50	2.5×10^{13}	550 Mev	50/16	2.5×10^{12}
Extraction kickers	800 MeV level	50		550 level	50	

The target/moderator/reflector system will take the full power. The policy on shielding is to make measurements as intensity is raised and to increase shielding to match personnel protection and backgrounds as required. Initial experience shows the shielding to perform as expected.

4.2 Scheduled running

Scheduled running started on 26 June 1985. Various items in the target station were brought on as follows:

June 26 Target and reflectors cooled with light water.
Two ambient temperature moderators.
550 MeV beam, 50/64 pps and 10^{12} ppp on to target.

June 30 Hydrogen moderator at 21K.

July 3 Methane moderator at 100K.
Target system was therefore all working.

July 5 550 MeV beam, 50/16 and 1.8×10^{12} ppp on to target.

At this stage typical intensities were:

Injection line	2.4×10^{12} ppp
Accelerated to 550 MeV	1.8×10^{12}
On target	1.8×10^{12}

The losses are consistent with what is expected and are such that the repetition rates can be increased without undue induced activity on accelerator components.

Target cooling will be changed to D_2O after a period of running with light water.

Commissioning of the installed spectrometers is under way, as is being reported at this meeting. The instruments are:

- High energy transfer spectrometer (HET) 0.1 - 1 eV
- High resolution powder diffractometer (HRPD) $\Delta d/d \sim 4 \times 10^{-4}$
- High resolution inelastic spectrometer (IRIS) 50 μeV resolution
- Liquids and amorphous diffractometer (LAD)
- Time focussed crystal analyser (TFXA) $\sim$ 1 eV

The small angle scattering instrument LOWQ is being installed as are the 3 development instruments:

- Polarised beams (POLARIS)
- Electron-volt spectrometer (eVS)
- Single crystal diffractometer (SXD)

5. OTHER USES OF THE SNS

KfK, Karlsruhe, are providing the main part of the funds for the neutrino physics facility, KARMEN, at SNS (3). The foundation for the 2.2 m thick, 5500 tonne, steel blockhouse and its walls and first part of the roof and its moveable shielding door have been installed.

The European Community, France and West Germany have provided funds for the installation of an intermediate target in the extracted proton beam some 20 m before the neutron target and a muon beam for tests on the technique of using pulsed muons for condensed matter research (4).

A test beam is being installed which will use a needle target which intercepts the edges of the beam in the synchrotron from which protons would normally be lost. The secondary particles will be used by particle physicists to test equipment destined to be used at other accelerator installations.

There has been some use of 70 MeV protons from the injector for irradiation of electronic components.

A pipe has been installed in the target station which allows irradiation of samples close to the neutron production target where the proportion of high energy neutrons is high.

6. INTERNATIONAL INVOLVEMENT IN THE SNS

The Bhahba Atomic Research Centre, India, has provided the IRIS instrument. The provision of the neutrino physics facility and the muon beam have already been mentioned. Italy has begun construction of the instrument PRISMA for studying single crystal excitations and it is planned to instal this in 1986. Sweden has provided funds for Swedish scientists to use the SNS.

Discussions are being held with France, Italy, West Germany, and others about a wider involvement of the European neutron scattering community in the SNS.

7. DEVELOPMENT OF THE SNS

We are clearly at the stage where our main priority is to get the SNS up to full performance and to equip it with a suitable range and number of spectrometers with appropriate support to provide efficient utilisation. Some thought has been given to uprating the present target by the use of enriched material in the target. Also it is feasible to multiplex the extracted proton beam to a second target station in a separate hall. These studies have been carried out in conjunction with KfA, Julich, and Birmingham University and are being reported at this meeting.

ACKNOWLEDGEMENT

The achievement of first neutrons and the start of scheduled operation on the SNS has been made possible by the enormous efforts of a large number of people at RAL. This is a further opportunity to record my appreciation of those efforts.

REFERENCES

(1) Initial operation of the SNS. D A Gray. 1985 Particle Accelerator Conference, Vancouver, May 1985.

(2) First neutron results from SNS. A J Leadbetter et al. RAL Report RAL-85-030, May 1985.

(3) Low energy neutrino physics at high intensity pulsed proton accelerators. B Zeitnitz, KfK, Germany. Progress in Particle and Nuclear Physics, Vol 13. Proc Intern School of Nuclear Physics, 445-78, 1985.

(4) A pulsed surface muon beam/pion beam for the RAL Spallation Neutron Source. G H Eaton et al. Nuclear Instr & Methods, 214(1983) 151-167.

FIG 1

Before 19.16 hrs
on 16.12.84

FIG 2

After 19.16 hrs
on 16.12.84

SNS Control Centre

FIG 3

FIG 4

SNS Target Station Control Room