experiment's on-line computer and written to tape, the incoming data will be sifted by a final trigger using emulators to carry out such jobs as track finding and coordinate calculations.

While the L3 design leans heavily on past experience, the same experience also shows that physics isn't always predictable. Thus a flexible design, permitting rapid modification and evolution, as well as precision measurements, could pay dividends in this unexplored area of physics.

First neutrons from new machine

It was the culmination of an intense year of construction and commissioning when on 16 December the first neutron beams were obtained from the UK Rutherford Appleton Laboratory's new Spallation Neutron Source (SNS), and for the first time since 6 June 1978, when the Nimrod proton synchrotron was closed down, the Laboratory was back in the business of providing particle beams from an accelerator.

In 1976, with the decision to close down all home-based high energy physics research in the UK in favour of an increased commitment to CERN and other large Laboratories overseas, an ambitious plan was put forward to convert the Nimrod complex into a neutron source for other kinds of physics.

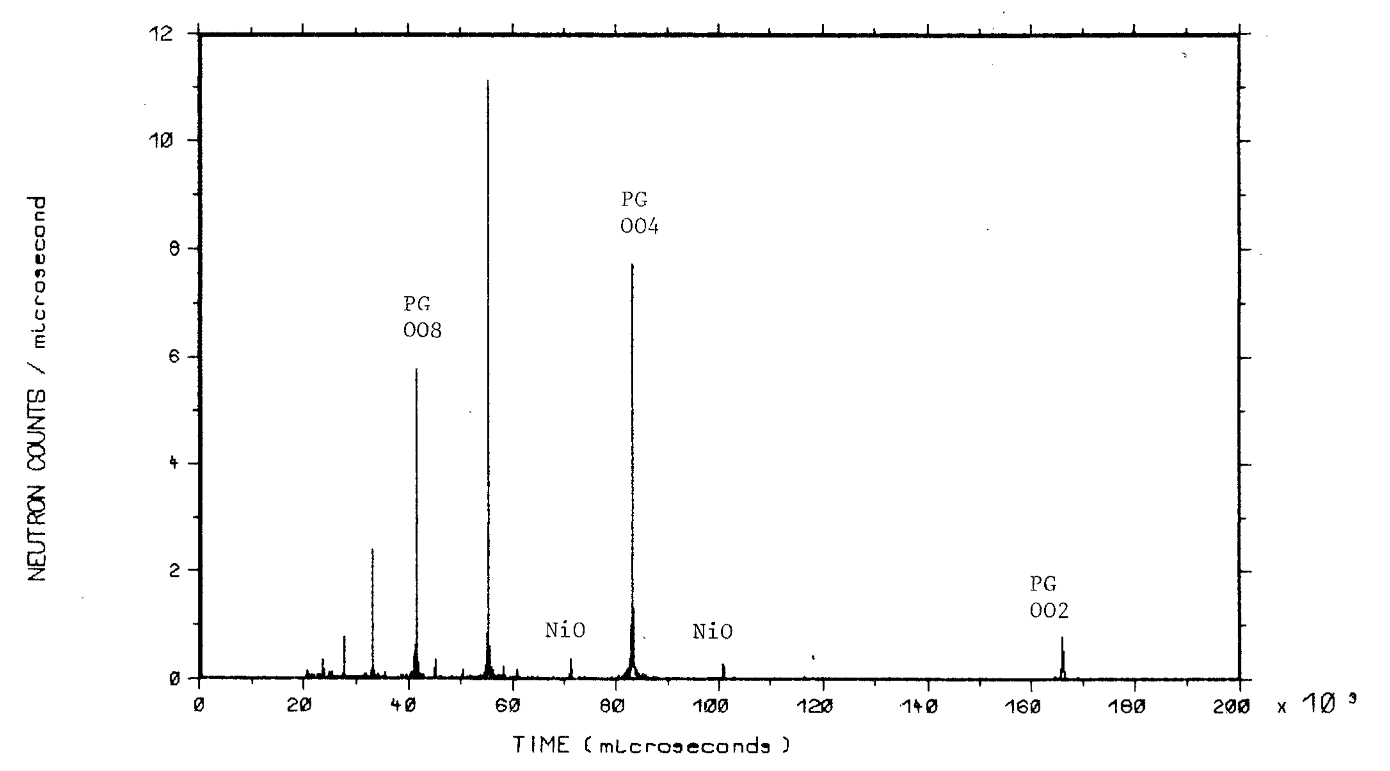
Nimrod, the last weak focusing proton machine to be built, provided its first 7 GeV proton beam in 1963 and provided the research fuel for several generations of UK particle physicists. With the decision to build the SNS, the task was to transform the existing facility into a high repetition rate, high intensity machine furnishing the protons to bombard a neutron production target. As well as equipment from Nimrod, the SNS synchrotron also makes use of components from the old NINA electron machine at Daresbury, closed down in 1977.

The SNS synchrotron reached 550 MeV last June using four of the eventual six radiofrequency cavities which will take the proton energy to 800 MeV (see September 1984 issue, page 289). During commissioning time, limited to a few days because construction is still proceeding, close to ten per cent of the final design performance of 2.5×10^{13} protons per pulse (ppp) has been accelerated

Goal! Rejoicing in the control room as the first protons hit the neutron production target of the UK Rutherford Appleton Laboratory's new Spallation Neutron Source — SNS.

(Photo Rutherford Appleton)

The shape of things to come. The neutron diffraction patterns of a pyrolytic single crystal and nickel oxide powder simultaneously measured on one of the 40 detector rings of the 96 m High Resolution Powder Diffractometer at the SNS, displaying the high resolution and low background given by this instrument.



to 550 MeV. 20 per cent of the design performance has been injected and circulated at 70 MeV. This should be sufficient to give a greater percentage of the design accelerated intensity.

At the end of September a further milestone was reached. Protons were extracted at the 10^{12} ppp level upwards into a beam dump in the synchrotron room. The extraction system uses three kicker magnets, all slightly different, but approximately 0.6 m long and having an aperture 170 mm square and giving a total vertical deflection of 14 mrad. The rise time is 200 ns, this being the time between the two bunches in the SNS. In the same straight section is a 1.8 m magnet with 10 mm septum giving 21° upward deflection. During the September run the beam also passed through the magnet which turns the beam horizontal above the synchrotron and through two horizontal bending magnets to a 2 m graphite beam stop. No beam loss was detected during this extraction process.

All commissioning work so far has been done at one pulse per second rather than the design figure of 50 Hz to minimize activation of components. The design performance of 800 MeV, 200 microamp mean current (160 kW of power in the beam) leads to the requirement for good diagnostics in the synchrotron to minimize beam loss to at most the one per cent level calculated to allow conventional maintenance techniques. A start has been made on commissioning the diagnostics. Beam intensity, beam profile, transversely and longitudinally, and closed orbit have been measured. It is noticeable that the 'raw' betatron Q-values coming from the main quadrupoles and dipoles being in series have given good injection and acceleration intensities at this early stage. Q-values have not been tuned using the trim quadrupoles — indeed they have not even been measured.

After commissioning the beam extraction system, the next task was installation of the extracted proton beam, the target station and the neutron beamlines. The extracted proton beam is about 150 m long and contains some 65 magnets — all except one, including their power supplies, being salvaged from the Nimrod and NINA installations, but requiring refurbishing. The extracted beam caters also for an intermediate transmission target 20 m upstream of the neutron target for producing muons for the first stage of the muon spin rotation and resonance project which will be funded by the

EEC, France and West Germany.

Early on Sunday 16 December, protons were taken to this intermediate target position into a 2 m graphite beam dump, and the very first pulse was seen on a scintillator on the target. Meanwhile the target station shielding had been completed to the stage where protons at low intensity could be focussed by the last six extraction line quadrupoles onto the neutron production target. This was the first of the full specification targets, with its uranium plates encased in zircaloy, together with all its cooling manifolds and connections and temperature monitoring. For the run the heavy water coolant was static, not circulating. The two ambient temperature moderators were installed and filled. In addition, the methane moderator was working with methane circulating at 100 K from its refrigerator through its 16 m-long transfer line, and the hydrogen moderator system, which previously had been successfully tested off-line, had been stripped and reinstalled in its final position. The moderator was filled and working at 25 K. This fed neutrons to the spectrometer built and installed by the Bhabha Institute of Trombay, India. The reflector vessels containing beryllium rods were filled with static heavy water. The 90-ton steel door, which completes the target shielding and is part of the train which carries all of the maze of room temperature and cryogenic cooling systems, was pushed into position. Six neutron holes in the 4.3 m thick shielding enclosure were open.

That evening, the beam dump at the intermediate target position was lowered and Laboratory Director Geoff Manning counted down to 'beam on'. Resounding cheers told that the operation was a success.

There was some checking and setting up of the equipment on the six neutron holes followed by a three-hour run. Neutron spectra and intensities were measured for each of the moderators. All were found to confirm the design performance. One of the spectrometers was 100 m away from the target, its particles coming through a neutron guide which also worked according to expectation. The time-of-flight and data collection electronics worked well together with the software, and a powder spectrum was taken as a demonstration that all was well.

Following this initial success, a scientific programme of neutron scattering at about ten per cent of the machine's ultimate performance level is scheduled for April. The Laboratory looks forward with pleasure to being once more the home of an accelerator-based research programme.

(From David A. Gray)

Around the Laboratories

FERMILAB
Accelerator back on

Throughout the end of last summer and the fall the Fermilab accelerator was down for improvement and maintenance. An enormous number of elements were installed and the accelerator has now operated once again at 800 GeV.

The most spectacular change involved the old Main Ring (conventional magnets) rather than the superconducting Doubler ring. There an overpass was installed at the DO straight section, raising the accelerator six feet above the median plane of the Tevatron and slightly inside the normal radius. This striking deformation to a conventional circular accelerator takes the main ring by the DO detector. Beam has now been accelerated to 150 GeV through the bypass. This success as part of the Tevatron project is reassuring, particularly in light of the large bypass that will be installed later near the BO Collider Detector. (The decision to go ahead with the DO detector was taken last year — see May 1984 issue, page 147. This will complement the big BO colliding beams detector — see January/February 1984 issue, page 11.)

Almost as spectacular was the operation to improve the lead restraints on a fair fraction of the Doubler magnets. A quarter of these magnets had to be moved into the tunnel aisle to carry out the operation. The smooth turn-on to 800 GeV attests to the effi-