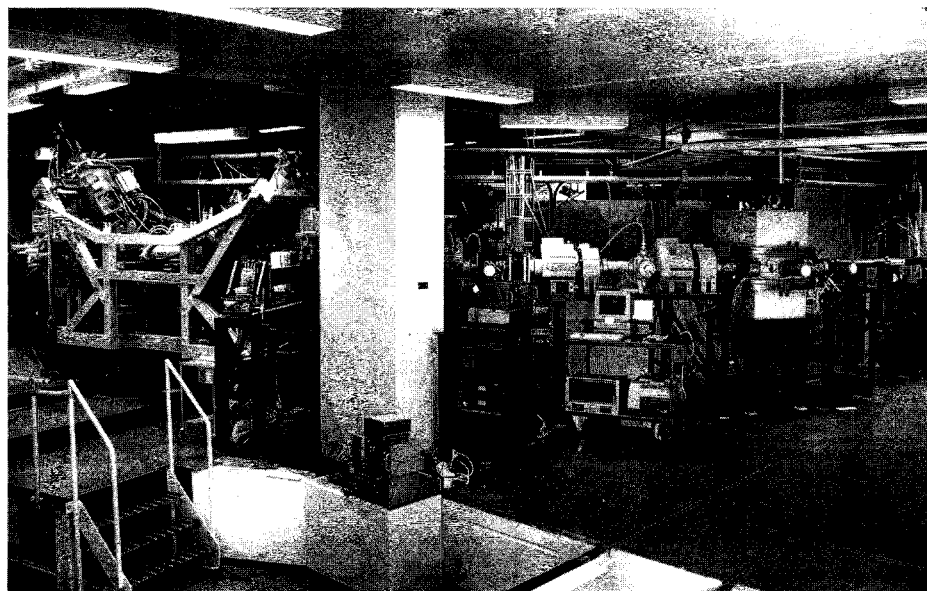


system (which will be complete in 1994); construction of the SINQ neutron source (to be completed in 1995; see November 1989, page 6).

The dismantling of the old target station 2 and the beam dump after two decades of operation was a very challenging task. Some 500 tons of activated material had to be removed. While 300 tons of this material could be reused, the remainder was enclosed in concrete and reinstalled as shielding. While 12,000 tons of slightly activated concrete and iron shielding were rearranged, no body contamination was monitored. The highest dose to any person was 30 mSv.

Up to the end of 1989, the accelerator complex was operated at currents up to 250 microamperes at 590 MeV. Towards the end of 1991, 590 MeV beam currents of up to 0.5 mA, representing a world record for cyclotron beam power, were routinely delivered to the two targets. Losses in the Main Ring were of the order of 0.5 microamperes, mainly in the extraction region, still an order of magnitude below the limit set by the requirements of safe operation and maintenance. The 590 MeV beam current is scheduled to increase to about 1.5 mA by the mid 90s.

Experiments using the Main Ring have mainly concentrated on particle properties and decays, hadron-hadron and hadron-nucleus reactions, pionic and muonic atoms, all of which are still active areas of study. Partly because of the higher beam intensity, increased emphasis is now being placed on other applications: solid state physics using muon spin rotation; defect physics and materials testing using 72 MeV protons from Injector 1 or 590 MeV proton beams from the Main Ring; radioisotope production for positron emission tomography experiments in-



The CRYRING ion ring at the Manne Siegbahn Institute in Stockholm. On the left is the electron cooling device which came into action in May.

house and for radiopharmaceutical products; cancer therapy with pions and protons.

In the near future, protons degraded to 200 MeV will be used for the irradiation of large cancers, and 72 MeV protons will be used to produce neutrons for Boron Neutron Capture Therapy. A new low energy beamline at 1 mA proton current will provide over 10^{10} positive pions per second at 120 MeV/c, or over 10^8 surface positive muons per second at 28 MeV/c.

STOCKHOLM CRYRING

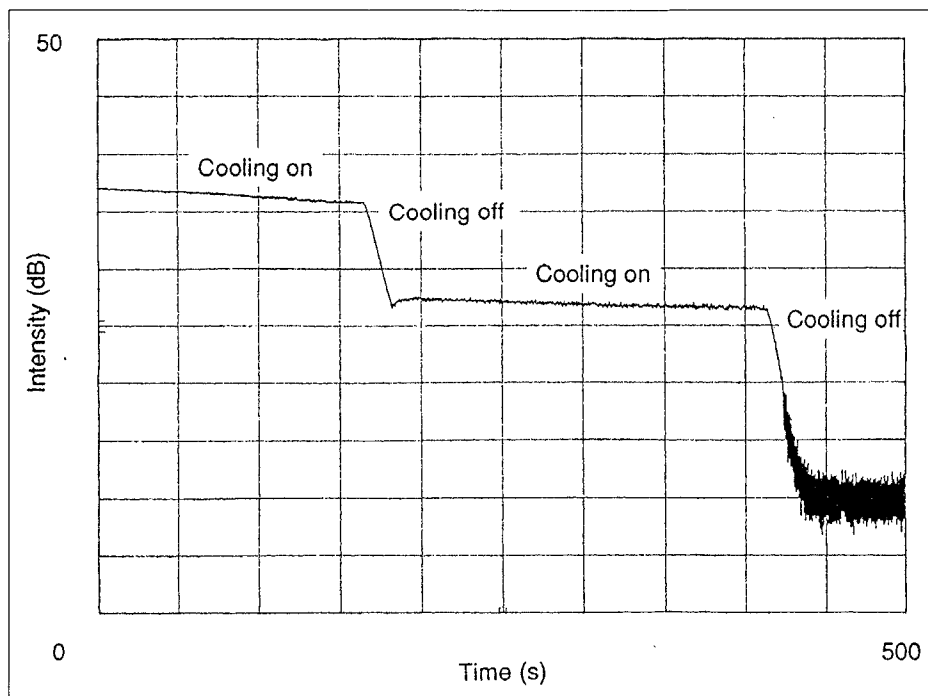
The CRYRING accelerator facility for atomic, molecular and nuclear physics at the Manne Siegbahn Institute of Physics in Stockholm is now in full operation, including an electron cooling device for precision beam control.

Main CRYRING components are an electron-beam ion source (EBIS) for the production of very highly charged

ions, an radiofrequency quadrupole (RFQ) linear accelerator and a synchrotron to accelerate, store and cool heavy ions with energies up to 24 MeV per nucleon (charge-to-mass-ratio 0.5).

The EBIS source has been in operation for several years, delivering low-energy beams to atomic physics experiments. It has produced ions such as argon and xenon in charge states up to argon 18+ and xenon 48+. A small plasmatron ion source delivers light ions for accelerator tests. The RFQ accelerates the ions to 300 keV per nucleon for injection into the ring. Since this energy is so low, the injection is made completely electrostatically. The acceleration system - a drift tube connected to a relatively simple high-bandwidth power amplifier - is unconventional in being non-resonant.

A first beam of hydrogen 2^+ ions circulated around the ring in December 1990, and full energy was reached with deuterons in October 1991. The ring's electron cooler came into operation this May, enabling beam lifetimes to be



▲ Typical initial performance of the electron cooling device on the Stockholm CRYRING.

▼ The AmPS (Amsterdam Pulse Stretcher) at the NIKHEF-K Laboratory, fed by a 200-metre electron linac, is now operational.

NIKHEF AmPS of electron beam

Now operational at the Dutch National Institute for Nuclear Physics and High Energy Physics (NIKHEF), Amsterdam, is a new tool for studying the electromagnetic properties of nuclei. Called AmPS - Amsterdam pulse stretcher - this ring provides experiments with a smoother, almost continuous supply of electrons.

The electrons emerge from the 200-metre electron linac with an energy of almost 1 GeV, and the AmPS ring, with a circumference of slightly more than 200 metres, evens out the spiked duty cycle of the linac, opening up experiments looking for particles produced in coincidence.

In addition, polarization experiments could use stored electron beams with

increased from about 10-20 seconds without cooling to longer than an hour.

Initial experiments include studies of restgas ionization with a beam-profile monitor and dissociative recombination of molecular ions in the electron cooler. Storage rings provide a unique possibility for molecular experiments since it is possible to store the molecules long enough for electronic and vibrational excitations to die away. Thus reaction rates can be measured for processes where the initial state is well defined.

During the autumn, further recombination experiments will use molecular and atomic ions. Then the CRYRING experimental programme will switch to heavy ions.

