SSC underground

By late April, 12 shafts for the SSC Superconducting Supercollider had been sunk to tunnel depth, with four more under construction. Completed shafts include two for magnet delivery, three utility shafts, three for personnel, and four for ventilation, all in the ring's north arc.

Approximately 21,000 ft (6.4 km or 4.0 miles) of tunnel had been bored. Best daily rate of tunneling was 384 ft. Approximately 70% of the 87-kilometre Collider tunnel is so far under contract, and favourable bids for remaining portions have been received.

extent of hadronic showers, because the energy flow direction, rather than the magnitude, is the limiting measurement.

Inside the electromagnetic calorimeter is a compact tracker, 1.8 m in diameter by 3.5 m long, to distinguish different "pileup" events in the same beam crossing by finding the primary vertex; to help identify electrons, gammas, muons, and hadrons; to help reject background; and to determine the electron sign up to 600 GeV/c. The inner section has silicon microstrip ladders and discs (3.5 million strips covering seven sq m). The outer part employs interpolating pad chambers (IPCs). The silicon is designed to operate for 10 years at a luminosity of 10^{33}; the IPCs, for 10 years at 10^{34}. The pad tracker provides space points to help tracking capability at very high collision rates. Relatively few tracks curl up inside the relatively small tracker, simplifying pattern recognition .

Muon momentum resolution requirements fixed the parameters of the superconducting magnet - an 0.8-tesla solenoid, 31 m long with a free bore of 18 m. Too large to install in one piece, the magnet will be assembled in situ from two halves, which can be moved apart for access to other components. Support structures, cables, and services go in a 1.5-m gap. On the axis, cone-shaped iron field shapers bend the field lines to improve forward muon momentum resolution. No flux return is provided; components operating in the fringe field will be shielded as necessary. The operating current, 50 kA, is less than a quarter of the critical current, and the temperature margin is 3.4K; thus quenches should be rare.

A magnet with iron only at the ends of the solenoid is relatively light, saving installation time and cost. Omitting a flux return also leaves a useful region outside the coil for future additional tracking.

Data acquisition uses a multi-level trigger with buffering between levels. The first level selects interesting events using simple requirements on calorimeter energy and muon chamber hits. During this 2-microsecond delay, data from each subsystem are stored in digital or analog pipelines. After an event is accepted, the data from all systems are digitized/processed for the second and third level trigger algorithms. Higher level trigger processing has access to all data from the detector, with full granularity, in a microprocessor "ranch" (this being Texas).

The collaboration includes 1010 physicists from 114 institutions in 17 countries. The technical design report was submitted on April 30, and will be reviewed in depth by the SSC Laboratory and the US Department of Energy. If approved, the detector will be located at the IR-5 site on the east side of the ring; site preparations are underway and the underground hall design is progressing rapidly. Because magnet installation paces the GEM schedule, the magnet design, cost, and schedule have received early review, and the prime contractor will soon be selected.

DUBNA Nuclotron

The Nuclotron, the first superconducting accelerator for high energy nuclei, now in operation at the High Energy Laboratory of the Joint Institute for Nuclear Research, Dubna, near Moscow, will provide beams of relativistic nuclei and heavy ions with energies up to 6 GeV per nucleon.

The planned wide research programme will have a major impact on the study of the features of atomic nuclei beyond the proton-neutron nuclear model and the development of the understanding of nuclear matter in terms of quarks and gluons. This work began back in 1971 when beams of relativistic deuterons were provided by the Dubna Synchrophasotron.

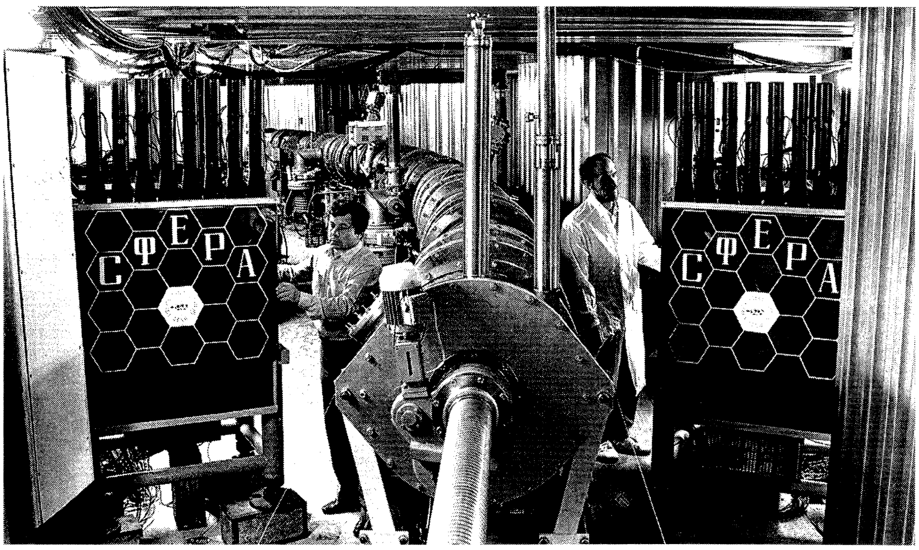
The 251-metre, 80-ton Nuclotron ring contains 96 dipoles and 64 quadrupoles cooled by two-phase helium. The cryogenic complex includes three KGU-1600/4,5 liquifiers producing 500 litres per hour. At the end of last year, the ring, assembled in the Synchrophasotron technological tunnel, passed vacuum tests. Cooling began on 17 March and took 100 hours to reach 4.5K in all elements, with vacuum in the beam pipe at 10^{-9}-10^{-10} torr. Cryogenic reliability was more than 98%, and it is hoped that cooling time will eventually be halved.

Magnets were fed by a 90A direct current. A 5 MeV/nucleon deuteron beam was injected and first full turns were achieved on 26 March. The high frequency accelerating system was tested for 12 hours under 8kV at 0.6 MHz.

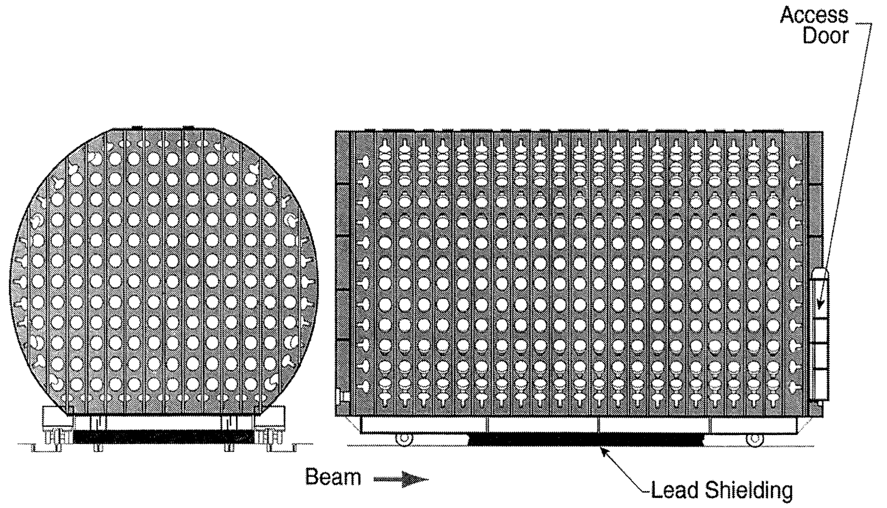
The next stage is a run at 1.5kA with limited beam acceleration and irradiation of internal targets. 2000 hours are scheduled this year for Nuclotron commissioning. Meanwhile slow extraction system assembly continues, en route to installation in the ring next year.

The commissioning of this pioneer machine is a major scientific and technological achievement for the Laboratory and carries an important message for the development of research capabilities in JINR countries.

(Below) At Dubna's superconducting Nuclotron heavy ion machine, the SPHERE electromagnetic calorimeter is prepared for studies on internal targets.



Liquid Scintillator Neutrino Detector (LSND)



(Above) Schematic of the LSND detector at LAMPF, Los Alamos, designed to search for neutrino oscillations with high sensitivity and to measure the strange quark contribution to the proton spin in neutrino-proton elastic scattering. The tank, approximately 6m in diameter and 9m long, is covered by 1220 8" phototubes and will be filled with 200 t of dilute liquid scintillator (see front cover).

LOS ALAMOS New neutrino experiment

The Liquid Scintillator Neutrino Detector (LSND) experiment at Los Alamos' Meson Physics Facility (LAMPF) has been designed for a high sensitivity search for oscillations between muon- and electron-type neutrinos and, concurrently, between the corresponding antineutrinos. In addition, the experiment will measure neutrino-proton elastic scattering, thereby determining the strange quark contribution to the proton spin. At low momentum transfer, neutrino-proton elastic scattering is a direct probe of this contribution.

The detector tank, filled with 200 tons of dilute liquid scintillator, has 1220 8" Hamamatsu photomultiplier tubes mounted on the inside, cover-