STATUS OF THE ELECTRON COOLING EXPERIMENT

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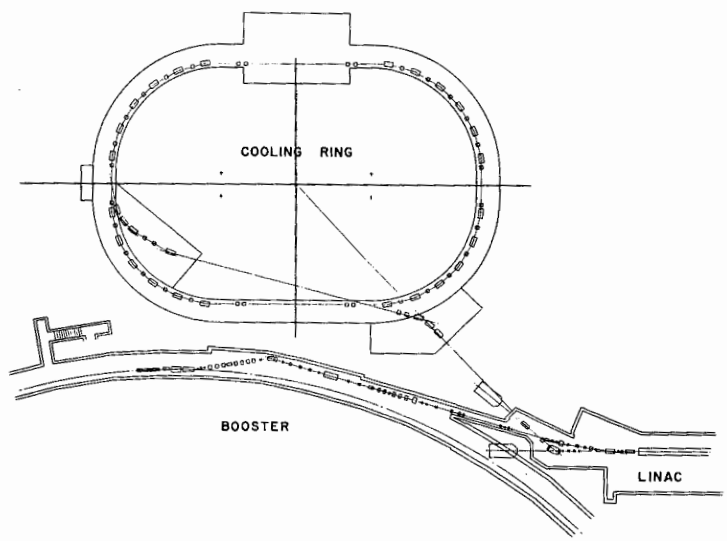
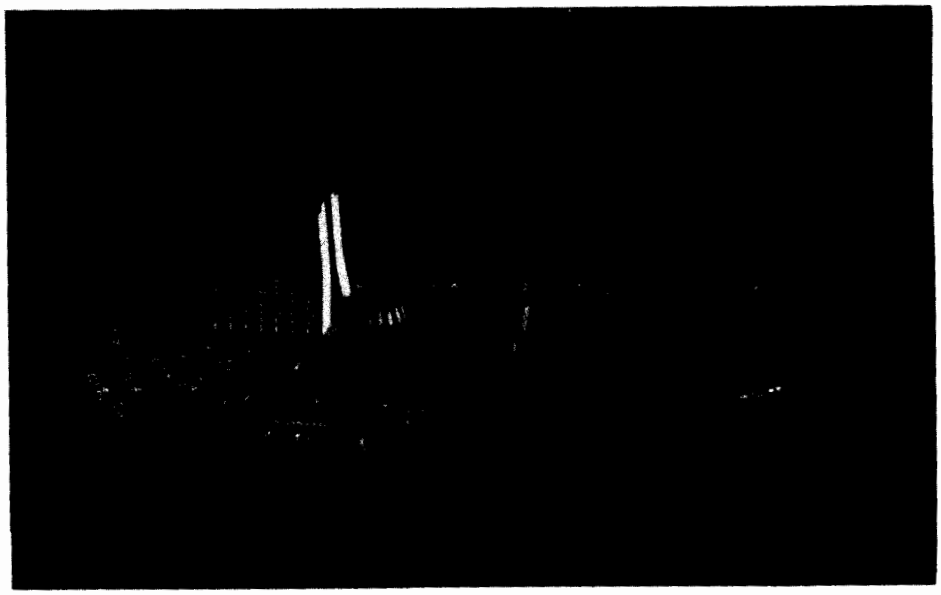
Electron cooling, the damping of the oscillations of a proton beam by the interaction with an electron beam, was described in the December 1976 issue of NALREP. An experiment is being constructed at Fermilab to verify the data obtained on electron cooling at the Institute of Nuclear Physics, Novosibirsk, USSR, and to demonstrate the accumulation of cooled protons. It will consist of a storage ring located at ground level just west of the Booster (see diagram below), which will be equipped with a high-current electron gun in the cooling straight section to cool a beam of 200-MeV protons



Cooling-ring experiment located above ground near the Booster at the 200-MeV end of the Linac (see aerial view on next page).



Aerial view of the Injector Area with the cooling ring in the foreground to the right. (Photo by Fermilab Photo Unit)

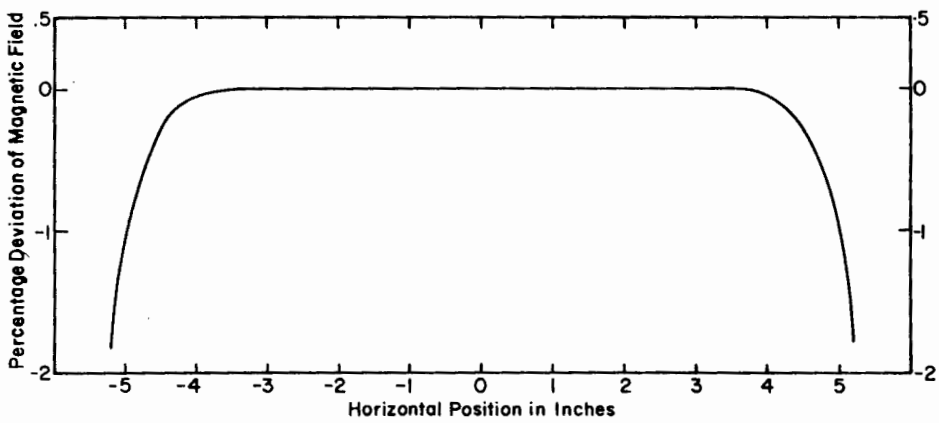
extracted from the Linac. The purpose of this report is to summarize the progress being made toward construction of this experiment.

The temporary building that will house the ring has been completed and occupied. Power and water are installed. Power supplies for the dipole magnets are installed along with the dc distribution system and cable trays. Preliminary survey monuments have been installed. A control room is being installed in the adjacent Booster West Gallery fan room.

The high-intensity electron beam and the magnets to contain and transport it have a powerful influence on the orbits of protons in the storage ring. We now have a lattice (with sextupoles) that corrects all electron-beam effects

and will contain a total momentum spread of 2%. This large momentum aperture is necessary both to cool and accumulate protons.

The magnets for this lattice are also progressing. All 68 half-cores of the ring and beam-transport dipoles have been fabricated and all coils have been wound and insulated. Field measurements on a dipole were made to determine the necessary modifications in the magnet-core end-pack to correct the field. The graph below shows the measured field after these corrections were made. The dipole field is flat to within 0.02% over the full 7-in. width.



Integrated field profile in cooling-ring dipole magnet.

All quadrupole coils have been completed. A complete quadrupole has been assembled for measurements, with two different end-packs for interpolation to reach the final design. All quadrupole iron half-cores should be completed this month.

Vacuum tests on prototype chambers have been completed. These tests were essential in order to achieve the desired pressure of 10^{-10} Torr.

Vacuum parts (chambers, bellows, pump elements) are beginning to arrive. We are planning to install pickup-electrode beam-position detectors at every quadrupole location. We are also planning to use the Schottky-scan technique that was used in the Booster to measure beam-momentum spread. With these techniques we should be able to measure beam positions with only 10^7 protons circulating. A magnesium-jet beam-profile monitor is also being built.

The electron-beam equipment is progressing on schedule. The electron gun, which was built for us by SLAC, is on hand. The electron collector is also being fabricated at SLAC and will be finished by February. This collector should allow recovery of 95% of the 2 MW electron beam power. The solenoidal and toroidal coils are being wound here. The precise high-voltage supply has been delivered and is under test. Several diagnostic devices for the electron beam have been designed, and are being built--microwave cyclotron radiation, light scattering, and beam-profile detectors.

An injection line to the ring has been designed and is under construction. Unused protons in the Linac momentum analysis line will be used as a source of protons for the cooling ring. These protons (or H^- ions) would normally end up in the beam dump. A vertical switching magnet and horizontal bending magnet direct the beam through a collimator system which attenuates the beam to the desired intensity and determines the beam momentum spread and emittance. The switching magnet has been fabricated and was scheduled for installation during January; the horizontal bending magnet was installed last September. The above-ground section of the beam line to the South

straight section of the cooling ring utilizes dipole and quadrupole magnets which are the same as those used in the cooling ring. The injection beam line from the Linac and cutting across the inside of the cooling ring is shown in the diagram on page 1.

The controls for the cooling ring will be integrated with the existing control system for the accelerator and will incorporate the same control and diagnostic techniques.

With construction activities moving at this pace, we expect to inject protons into the ring in the spring and to begin cooling experiments in the summer.

Clarence Black of Aurora (left) and Merrit Nicholls of Wheaton (right) clean seeds of big bluestem grass (Andropogon gerardi) for the Fermilab Prairie Project. The event was held in the Village Barn.

(Photo by Anthony R. Donaldson)