ELECTRON COOLING ACHIEVED

Electron cooling of a proton beam was demonstrated at Fermilab early in the morning of October 17. Both longitudinal and transverse cooling have been observed.

This was the culmination of several years of building the electron-cooling gun system and storage ring. The first proposal for this work was made in 1976 by Cline, McIntyre, Mills, and Rubbia.[1] This work is being done as a collaboration of Fermilab with Argonne National Laboratory, Lawrence Berkeley Laboratory, University of Wisconsin, and the Institute of Nuclear Physics in Novosibirsk. The storage ring has previously been used to test stochastic cooling by Argonne and LBL. Electron cooling had previously been observed at Novosibirsk and at CERN.

Electron cooling is an important part of the plan to produce proton-antiproton collisions at 2 TeV in the center of mass in the Fermilab superconducting accelerator. Electron cooling reduces the transverse and longitudinal size of a heavy-particle beam by Coulomb scattering by a parallel electron beam, which carries oscillation energy away from the heavy particles.

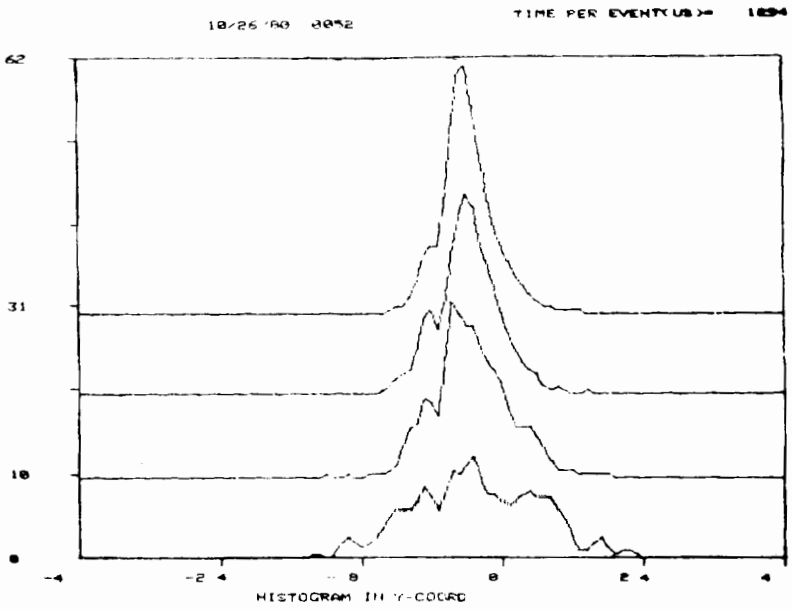
The cooling experiments recently accomplished were carried out with a circulating proton beam injected from the Linac at 115 MeV. Longitudinal cooling was first detected by cooling the proton beam into a very small rf bucket and observing the bunched signal. In later experiments, the drag of the electron beam moved the entire proton beam to the energy corresponding to the rf bucket frequency. The drag force calculated from the electron-beam parameters is in reasonably good quantitative agreement with that observed in these experiments. The momentum spread of the proton beam appears to be reduced by a factor 50.

With the given beam properties, the calculated transverse cooling time is approximately 20 sec, but the observed cooling rate is faster than this, 10 to 12 sec. The best beam lifetime achieved in a series of experiments before the run ended was approximately 1000 sec, consistent with single scattering from the residual gas. Vertical profiles at different times are shown in the figures on the next page.

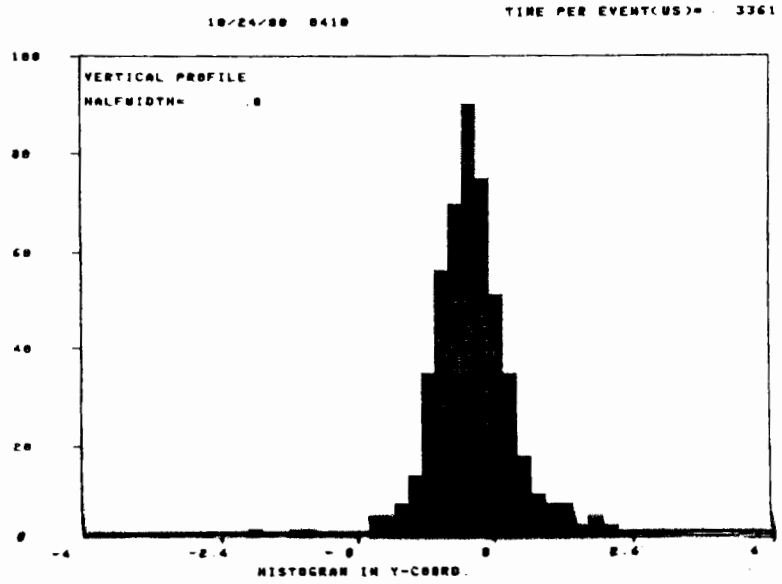
Work is now going on to improve the electron-beam system for another series of experiments.

Reference

[1] D. Cline, P. McIntyre, F. Mills, and C. Rubbia, Collecting Antiprotons in the Fermilab Booster and Very High Energy Proton-Antiproton Interactions, Fermilab Internal Report TM-689, October 1976.



Vertical cooling of a beam.



Histogram of the vertical distribution of a cooled beam.