THE INTERNAL TARGET AREA

E. T. Nash

The Internal Target Area was last discussed in these pages in an article by Drasko Jovanovic in June, 1975. At that time, the additional floor area of the spectrometer room was still being constructed and the spectrometer itself was still being designed. We have now completed successful experimental runs with the spectrometer. In addition, with the passage of time, warm jet targets have supplanted the traditional cold jets. It is therefore an appropriate time to report on progress in the Internal Target Area.

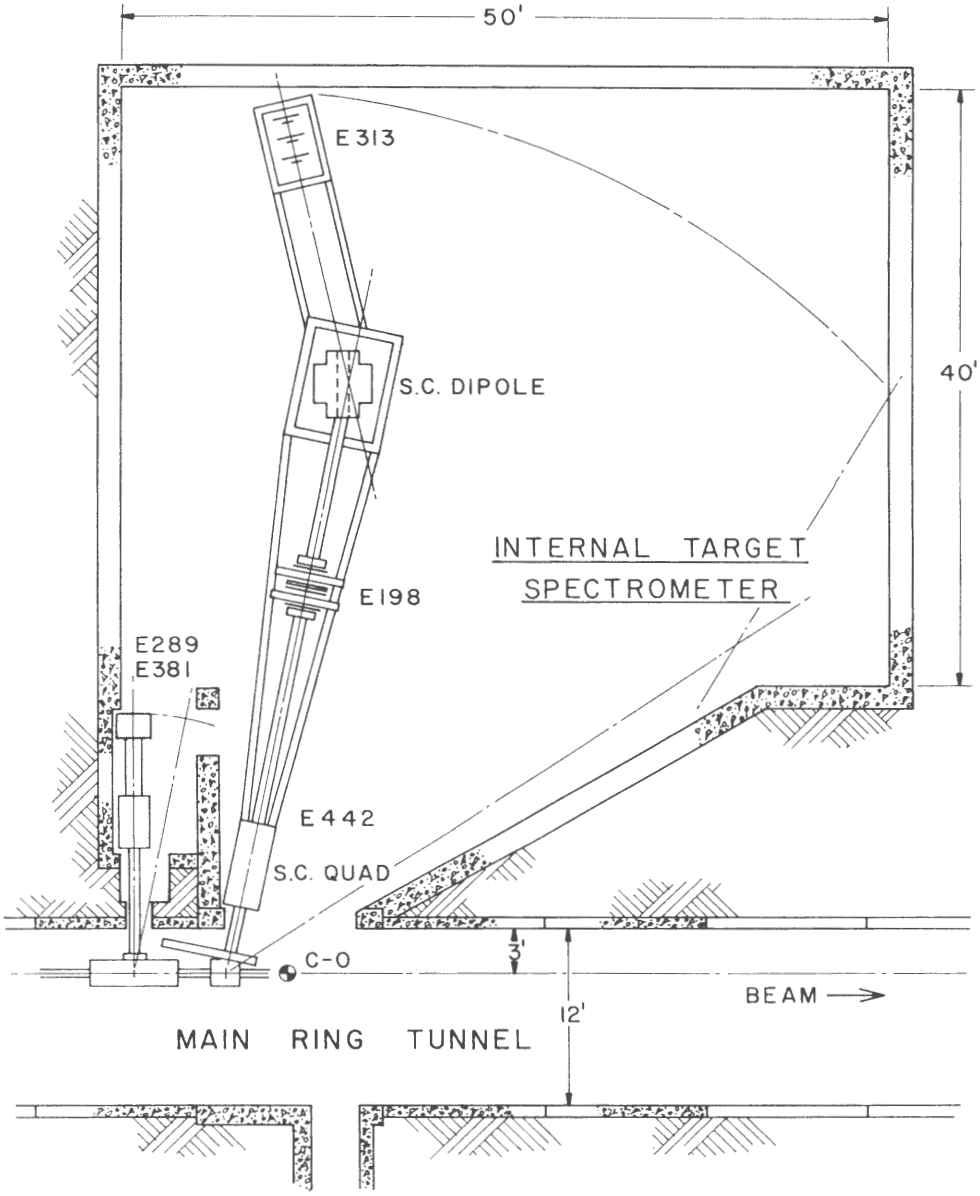
Through the end of 1975 and the first three quarters of calendar year 1976, the spectrometer was being installed and debugged and the only experimental operation was by experiment E321, which we shall discuss later in this report. The installation work on the spectrometer was made difficult by the limited access possible in C0. Now that the spectrometer is operating, the limited access is a continued, though much smaller problem, because everything on the spectrometer is remotely controlled.

The entire spectrometer is mounted on a rigid frame more than 18 m long, which pivots on tracks about the end closest to the Main Ring. Particles scattered into the spectrometer are initially focused by a superconducting quadrupole doublet built at the Lawrence Berkeley Laboratory. The doublet is followed by a series of proportional chambers built at the University of Rochester. After the first series of chambers, there is a superconducting dipole capable of up to 40 kG magnetic field that is the heart of the

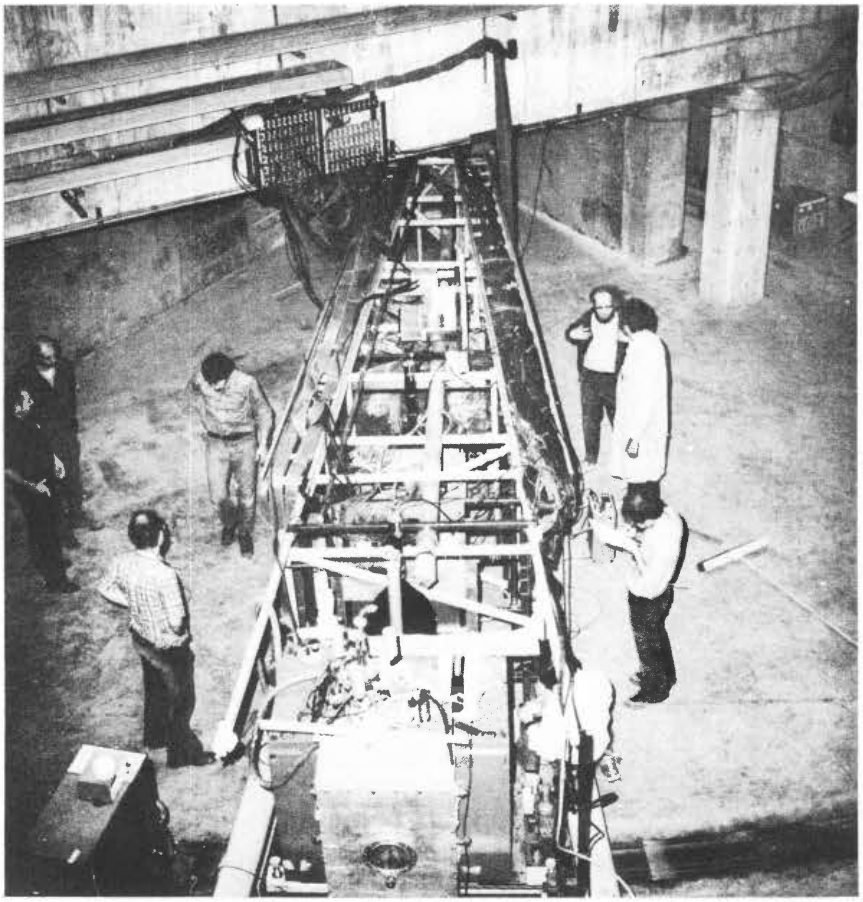
spectrometer, followed by more proportional chambers. Appended at the end and moving with the whole assembly is the Indiana University polarimeter.

This spectrometer, whose mechanical design was done by Chuck Nila and Joel Misek, is a large remotely controlled movable superconducting system. It requires a full-time cryogenic support system. It is located in a radiation area near the Main Ring, so access is rare and it is to some degree a forerunner of the Energy Doubler/Saver, which will have similar problems, although on a far larger scale. During this winter, the spectrometer and the Internal Target Area were ready to take data for more than 95% of the available beam time. The magnets were in a continuous cryogenic state essentially from January until the shutdown in April. This fine record was due to the hard work of Don Mizicko, Joel Misek, Les Oleksiuk, and the technicians of our group. The spectrometer requires 44 liters per hour of liquid helium and the two helium liquefiers were capable of producing up to 60 liters per hour. Operation was difficult in the fall because we had only one liquefier producing less than 35 liters and as a result we were always trying to catch up. But with two liquefiers, we have been able to continue operation even when we had to shut one down for several days for maintenance. When both liquefiers were up there was often sufficient extra liquid to operate the E381 cold jet simultaneously. A layout of the spectrometer is shown on the next page and a photograph appears on page 4.

While the spectrometer was being built, E321, a Columbia-Stony Brook collaboration, ran for p-p inclusive scattering. This experiment also used a warm-jet target, designed and built by the experimenters. This jet used

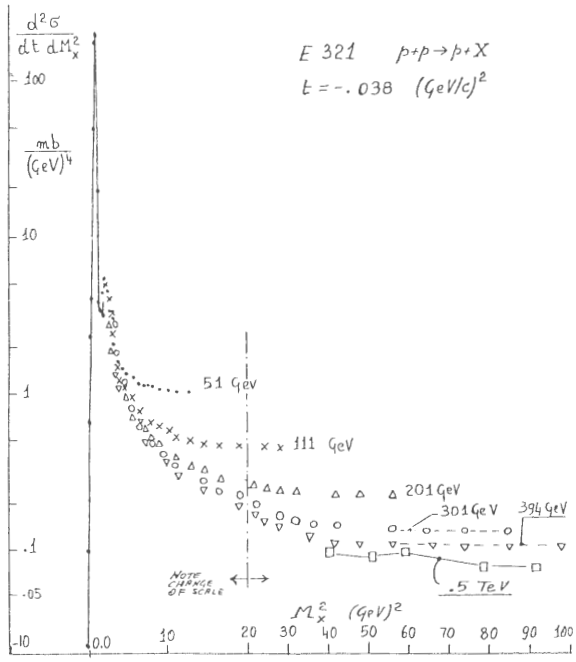


p-p inclusive scattering cross section as a function of energy (E321).



A recent photograph of the spectrometer.

large pumps to pump away the jet particles so that they do not contaminate the accelerator vacuum. Other, more recent warm jets use a very large pumped buffer volume to keep jet particles from scattering back into the accelerator vacuum. The preliminary results of E321, some of which are shown below, show a clear separation into an energy-dependent continuum and a scaling contribution.



p-p inclusive scattering cross section as a function of energy (E321).

Since spectrometer operation began, two experiments, E198 and E313, have completed substantial data-taking with it. Experiment #198 is a series of measurements of p-p elastic scattering in the diffraction-dip region near $|t| = 1.4\ (GeV/c)^2$ as a function of energy. This experiment,

a Rochester-Rutgers-Imperial College of London collaboration, has given a clean measurement of the cross section in the dip. The same collaborators have proposed to carry on their measurements at higher $|t|$ and in p-D scattering.

Experiment #313, an Indiana University experiment, is a measurement of the polarization of the scattered proton in p-p elastic scattering in the region $0.3 < |t| < 1\ (\mathrm{GeV}/c)^2$. Polarization is measured by rescattering from a carbon target. Preliminary results indicate that there are definite polarization effects in elastic scattering. The group has proposed to continue by studying inclusive polarization, where in preliminary testing they have seen significant polarization consistent with and perhaps equally surprising as that seen in Λ^0 inclusives in the Meson Laboratory.

Both these experiments ran with a warm-jet target. This target was built by Dan Gross; a prototype had been built by Paul Mantsch and Frank Turkot.[1] The last of the cold-jet targets has been phased out with the completion of E381, a Dubna-Fermilab-Arizona-Rochester collaboration to measure p-p and p-D elastic scattering at very low t. This target was built at Dubna and was the third cold-jet target of the Soviet-American collaboration. It used 12 liters per hour of liquid helium. E381 ran while debugging of the spectrometer was being completed in the fall of 1976 and parasitically during the ensuing spectrometer run.

Experiment #381 and E289, now in progress, are follow-ons to E36, E186, and E317. They share a common apparatus located as shown in Fig. 1. The new experiments have higher mass resolution because the ion guide is longer and, in addition, is built to allow more precise surveying.

During the April accelerator shutdown, E289 and other experiments have been set up in the spectrometer are to run until the end of June. We should note that these are purely noncryogenic efforts, which will leave the Internal Target group somewhat free to devote effort to the support of other activities, such as the antiproton cooling ring, the Colliding Beams Department, and the Energy Doubler.

Of these new experiments, E442, a Fermilab-Purdue collaboration, is not a spectrometer experiment, but has detectors set up in the first quadrupole of the spectrometer. The objective of the experiment is to look for fragments of heavy nuclei from proton-heavy nuclei interactions. The experiment uses the spectrometer warm jet to blow heavy gasses such as Xenon into the beam. Preliminary results, such as those shown in the scatter plot on the cover, are very interesting.

Experiment #289 is a Soviet-American collaboration to investigate p-He scattering. A new Soviet built warm helium jet has been installed and is being tested. There are special problems with helium leaked into the accelerator because it is difficult to pump and interferes with leak detection. For this reason, there is not only a buffer volume, but extensive differential pumping in the straight section and permanent leak-detector mass spectrometers installed at each end of C0.

The advent of the spectrometer has given new impetus to the Internal Target Area, with greatly increased competition for beam time. We expect this vigorous experimentation with internal targets to continue.

Reference

[1] P. Mantsch and F. Turkot, Fermilab Internal Reports TM-582 and TM-586, June 6, 1975, and June 18, 1976.