Development of a Distributed Drift Chamber for BNL E896

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Experiment 896 (E896) is a search for the H_o (a six quark, neutral charged, short-lived strange dibaryon state) in nucleus-nucleus (AA) collisions at the AGS. The primary detector in this experiment is a large volume tracking detector located in a 1.5T field. A superconducting magnet will be utilized to sweep the beam and charged secondaries away from the area occupied by neutral particles. The tracking detector has been designed to unambiguously identify the topological signature of particle decays and provide enough track information to reconstruct the rigidity of each charged particle produced. A Distributed Drift Chamber (DDC) was determined to be the optimum tracking detector for this application, capable of higher event rates than a TPC and better spatial resolution than an MWPC.

The design of the 144 plane DDC relies heavily on GEANT-based simulations[1]. A 2mm wire spacing was determined to be sufficiently large to avoid electrostatic breakdown and still achieve the double track resolution required to resolve the $\Sigma + p$ decay channel of the H_o. A granularity of 0.6 cm along the beam direction allows for multiple measurements along the short lived sigma track while maintaining a reasonable total depth of the detector to increase momentum resolution. Conductive kapton foil High Voltage planes were used because the low Z material reduces the delta ray background and foils facilitate transitions between different sense wire orientations. A 3cm diameter hole was cut in the foils to reduce background from passage of beam through a non-active region of the chamber. A Helium-based gas, He:C_2H_6 (50:50), was chosen to reduce the amount of δ-rays and secondary interactions produced in the gas by the uninteracted beam and projectile fragments. It is expected that the effect of the magnetic field on the drift velocity of this "cooler" helium-based gas will be less than that experienced in the "hotter" Argon-based gases. However, the effect of the magnetic field will reduce the pulse height and distort the drift paths which has been a concern[2].

In June 1996 a Prototype Drift Chamber (PDC) using He:C2H6 was tested in a 1.65T field at the AGS. The PDC consisted of 3 full size DDC planes. The PDC resolution was measured to be 2.8ns, corresponding to a spatial resolution of ~100 μm (the effective drift velocity being ~35μm/ns). The efficiency for most of the volume of the drift cell was determined to be ~99%. The distortion of the drift region by the magnetic field caused the efficiency at the edges of the cell to be reduced to ~75%.

It is important for the analysis to be able to simulate these effects. Using the CERN packages GEANT and GARFIELD, along with a time to TDC interpolation code[3], we are able to reproduce the data quite well, as shown below. The simulations clearly reproduce all the major features of the measured data.

The results of the testbeam show 1) that the response of the He:C_2H_6 gas in the presence of the magnetic field is more that sufficient for our application 2) the distortion of the drift lines is consistent with the GEANT/GARFIELD simulations 3) the resolution is within the tolerances set by the GEANT simulations and track reconstruction algorithms developed for this experiment.

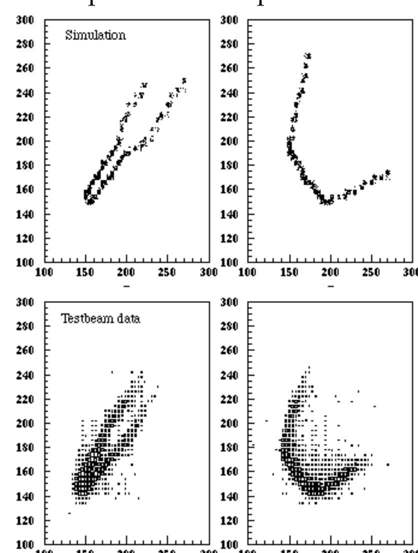

Figure 1. TDC distributions of neighboring wires from X and X′ planes for simulated and testbeam data. Testbeam data was produced by 10GeV/c, Z=+1 particles at normal incidence to the PDC.

Footnotes and References

1 I.Sakrejda, LBL-37384 UC-413, 125 (1995).
2 Becker, NIM A335, 439 (1993).
3 http://centauri.lbl.gov/~mats/e896/digit.html