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DEVELOPMENT AND TESTS OF AN ANODE READOUT TPC WITH HIGH TRACK SEPARABILITY FOR LARGE SOLID ANGLE RELATIVISTIC ION EXPERIMENTS*

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ABSTRACT

We have developed, constructed and tested an anode readout TPC with high track separability which is suitable for large solid angle relativistic ion experiments. The readout via rows of short anode wires parallel to the beam has been found in tests to allow two-track separability of ≈ 2-3 mm. The efficiency of track reconstruction for events from a target, detected inside the MPS 5 KG magnet, is estimated to be > 90% for events made by incident protons and pions.

15 GeV/c × A Si ion beams at a rate of ≈ 25 K per AGS pulse were permitted to course through the chamber and did not lead to any problems. When the gain was reduced to simulate the total output of a minimum ionizing particle, many Si ion tracks were also detected simultaneously with high efficiency.

The resolution along the drift direction (parallel to the MPS magnetic field and perpendicular to the beam direction) was < 1 mm and the resolution along the other direction ⊥ to the beam direction was < 1 mm also.

The gas used was a stable high gain gas mixture of Argon-Isobutane and Methylal similar to MPS II drift chamber gas with which we have considerable experience. From minimum ionizing tracks we obtained clean pulses with an average pulse height of 8 μamps. The peak pulses were greater than 20 μ amps. This allowed us to set a threshold of 2-3 μ amps and obtain high efficiency track reconstruction of > 10 track events in a single module (one of four in AGS 810). Tests on modified electronics of which we have working and tested in one row indicate that the noise is ≤ 1/2 μ amp during AGS 810 running. Tests have been made with Oxygen and Si ion beams including detecting interactions in targets with the TPC in the MPS magnet. We hope to present some of these results at the conference. We believe this system will allow a sensitive search for QGP at AGS. A larger TPC system of this type accompanied by a cathode pad readout system for dE/dx capability in the central region has also been proposed for RHIC.

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REQUIREMENTS ON THE DETECTOR SYSTEM

From previous works[1] it is clear that a tracking detector system capable of working in this high particle density environment with sufficient space, angular and momentum resolution is essential. A TPC is a three dimensional point detector and thus can track in much higher multiplicity enviroments than projective geometry detectors. We have built a specially designed TPC to maximize two-track separability and also minimize costs. As a result dE/dx information for the TPC is not available. However it is supplemented with a time-of-flight hodoscope (TOF) which will identify ≈ half of the $\bar{p}$ particles of interest. Secondly negative particles are expected to be > 90% pions so that pion identification can be made to a good approximation. Figure 1 shows the experimental arrangement for the first phase of AGS E-810. The TOF $\bar{p}$ and K^- identifier is 50' downstream of target and is not shown.

Four modules comprise the TPC system. They are placed along the beam in the MPS 5KG magnet (Fig. 1) with the S (or Si) and O ion beams passing through the TPC to provide large solid angle coverage. From ion beam tests we conclude that this will be satisfactory for these runs. However it should be noted that one can deaden the beam area if necessary. When the booster becomes available at AGS to accelerate Au ions; this will likely become necessary. The anode readout wires are 25 μ gold-plated tungsten 1 cm long rows parallel to the beam direction. There are 10 wires to the inch between cathode structures. A gate which opens only when events of interest occur is included for operation at high ion beam rates (~ 1/2 10^4/pulse). See Figs. 2a and 2b for details.

A TPC module was tested in > 25K Si ions per pulse beam without magnetic field. The hits can clearly be associated with several tracks consistent with beam particles dispersed in y because of late arrival. When we reduced the anode structure gain to correspond to detecting minimum ionizing particles the silicon ions were detected with high efficiency > 90%. The next tests were in an 18 GeV/c proton beam. Figure 3a shows accidental tracks from several million per pulse incident 18 GeV/c protons. Figure 3b shows detected events from a target. Our pattern recognition program led to fits with efficiencies of > 90%. Figure 3c shows the TPC module inside the MPS magnet with a 5 KG field. A 3 GeV π^- beam is incident and low momentum tracks from a target are clearly reconstructed with high efficiency (> 90%). The resolutions in x (transverse to the beam and magnetic field) and y (along the drift and magnetic field direction but perpendicular to the beam) were both measured to be < 1 mm. The two track separability was measured to be ≈ 1-3 mm. The gas is a stable high gain, low difusion mixture of Argon, Isobutane and Methylal which is a slightly modified mixture of the standard MPS II drift chamber gas. Minimum ionizing particles gave clear well-shaped pulses averaging 8 μamps with peaks of > 20 μamps. Setting a threshold of 2-3 μamps ensured clean pulse operation with very high efficiency. The readout electronics was vintage 86 LeCroy hybrids we designed for TPC readout. An improved version has in recent tests in

AGS Oxygen ion runs shown that even lower thresholds (i.e. $< 1/2$ microamp) are useable with the new readout system.

Thin targets will be used to minimize secondary interactions. The triggering system includes beam halo counters in veto, counters to detect interactions in the target and a $\sum Z^2$ counter to select candidates for events varying from central to peripheral depending on the setting (see Fig. 2). We prefer minimal triggering in the early stages since according to our Monte Carlo's and plasma model one can get surprises if one triggers tightly. For example our plasma model calculations predict that plasma events have a smaller multiplicity distribution than cascade events at AGS energies. The pattern recognition program previously developed by BNL/CCNY was described in Ref. 1. It has been modified somewhat. A local pattern recognition forms a single hit from adjacent and nearby readout wires. A subroutine corrects $\vec{E} \times \vec{B}$ effects which varies from less than 2 mm to a fraction of a mm. Track recognition and reconstruction starts downstream. The PR forms and fits > 3 consecutive hit chains. Finally the chains are joined to form tracks. The existing MPS vertex finding and fitting program has been adapted to the TPC analysis. High efficiency track reconstruction $> 95\%$ has been attained in Monte Carlo's and actual MPS and beam tests which were monitored on-line.

We have just obtained preliminary results on an Oxygen ion beam incident on a thin Pb target. Figures 4 and 5 show the preliminary reconstruction of these events via our pattern recognition. The pattern recognition efficiency is nominally estimated to be roughly 75%. The TPC obviously can stand high track density events caused by the several thousand Oxygen ions epr second which course through the chamber. The target is just upstream of the chamber.

Reference 1, attached, gives the physics connected with this project.

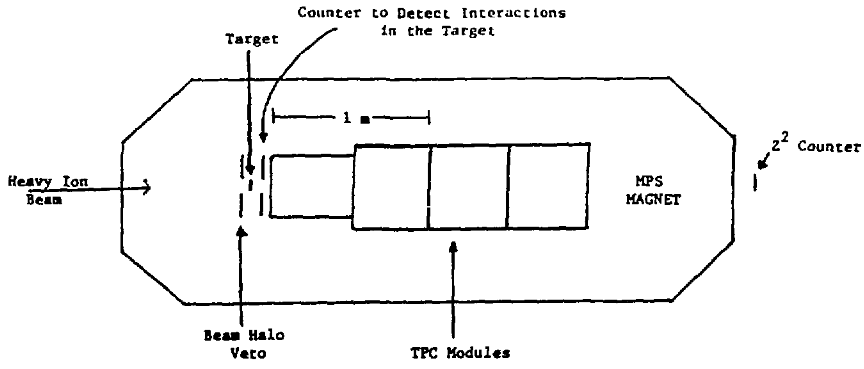
We have proposed a large TPC spectrometer for RHIC.[3]

REFERENCES

1. S.J. Lindenbaum <u>et al.</u>, Search for QGP Signals at AGS with a TPC Spectrometer, and Comparison of our Event Generator Predictions for Plasma Model and Cascade Interactions. Paper presented by S.J. Lindenbaum at the 3rd Conference on the Intersections Between Particle and Nuclear Physics, May 14-19, 1988, Rockport, Maine (to be published).

2. S.J. Linenbaum <u>et al.</u>, Nucl. Phys. <u>A461</u>, 431 (1987).

3. S.J. Lindenbaum. An Approximately 4π Tracking Spectrometer for RHIC, <u>Proc. of Second Workshop on Exeriments and Detectors for RHIC, LBL, Berkeley, California, May 25-29, 1987)</u> (to be published).



NOTE: Counters and target are not to scale

Figure 1: AGS E-810 Setup

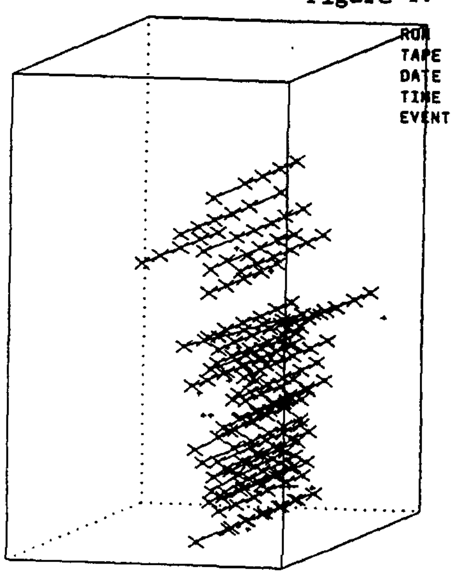


Fig. 3a: High Rate 18 GeV/c Protons

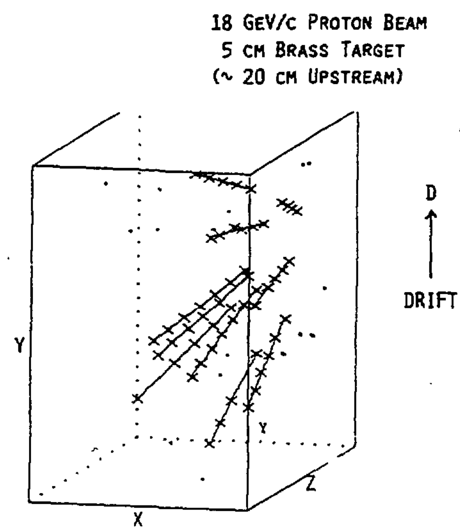


Fig. 3b: Interaction Detected

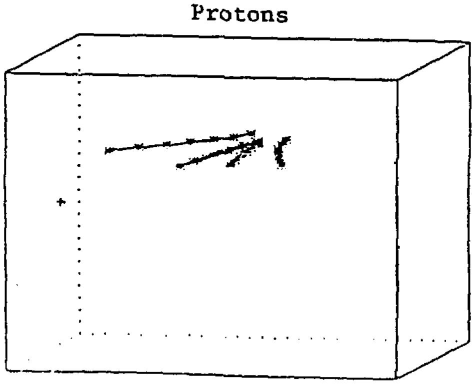


Fig. 3c: TPC in MPS Magnet

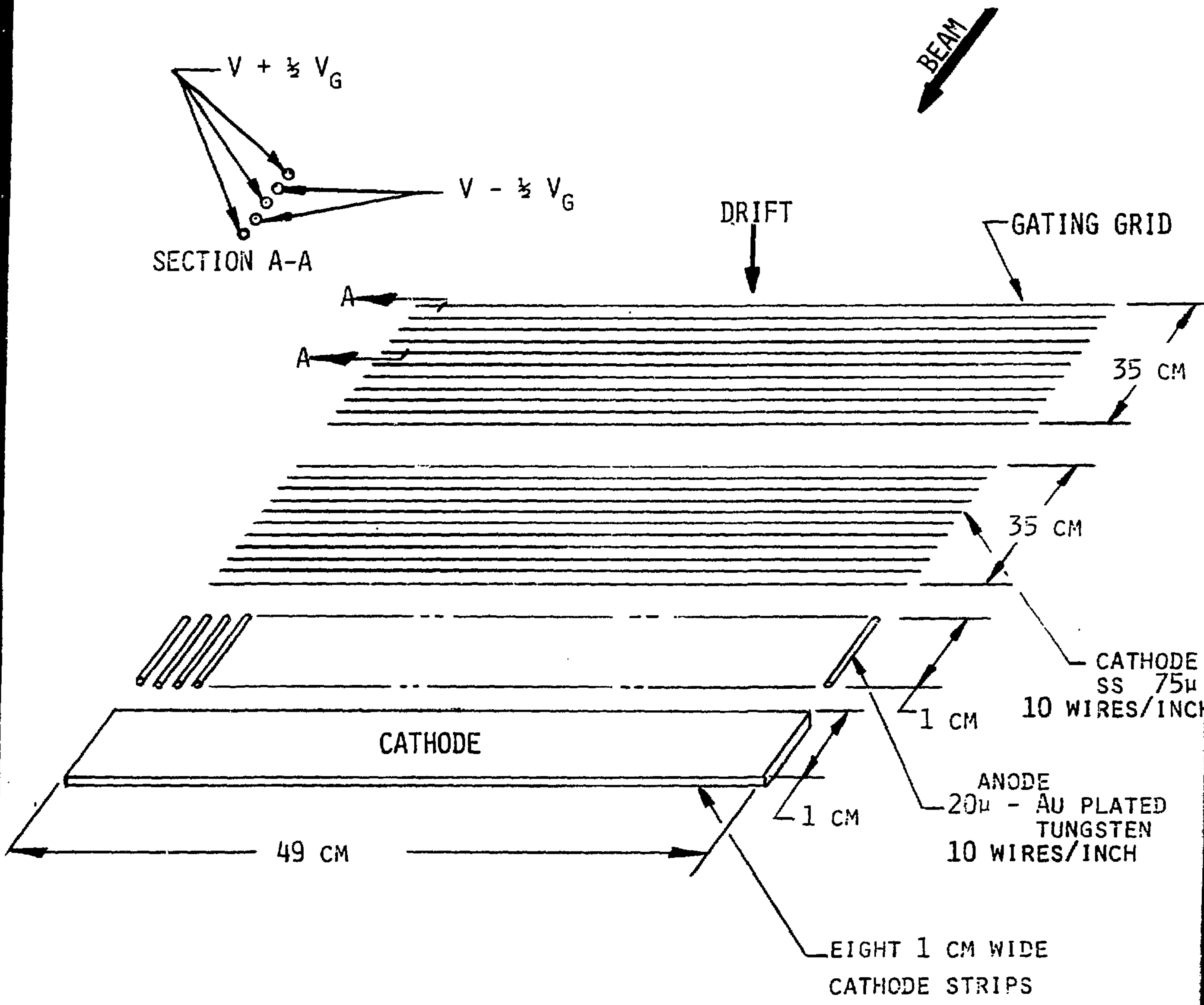


Fig. 2a: Anode Readout Structure. Each section lies above the other physically with gating grid at top.

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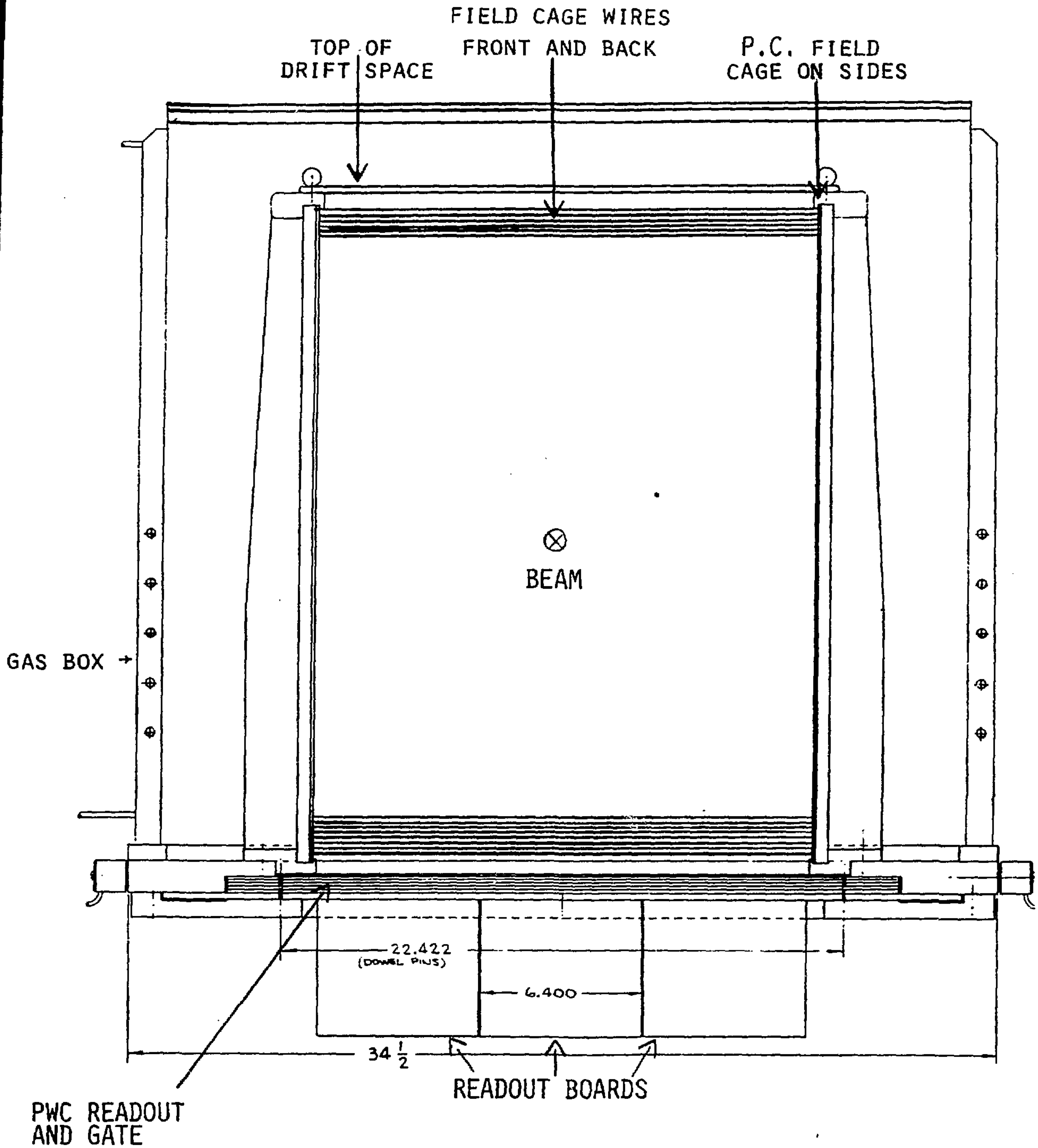
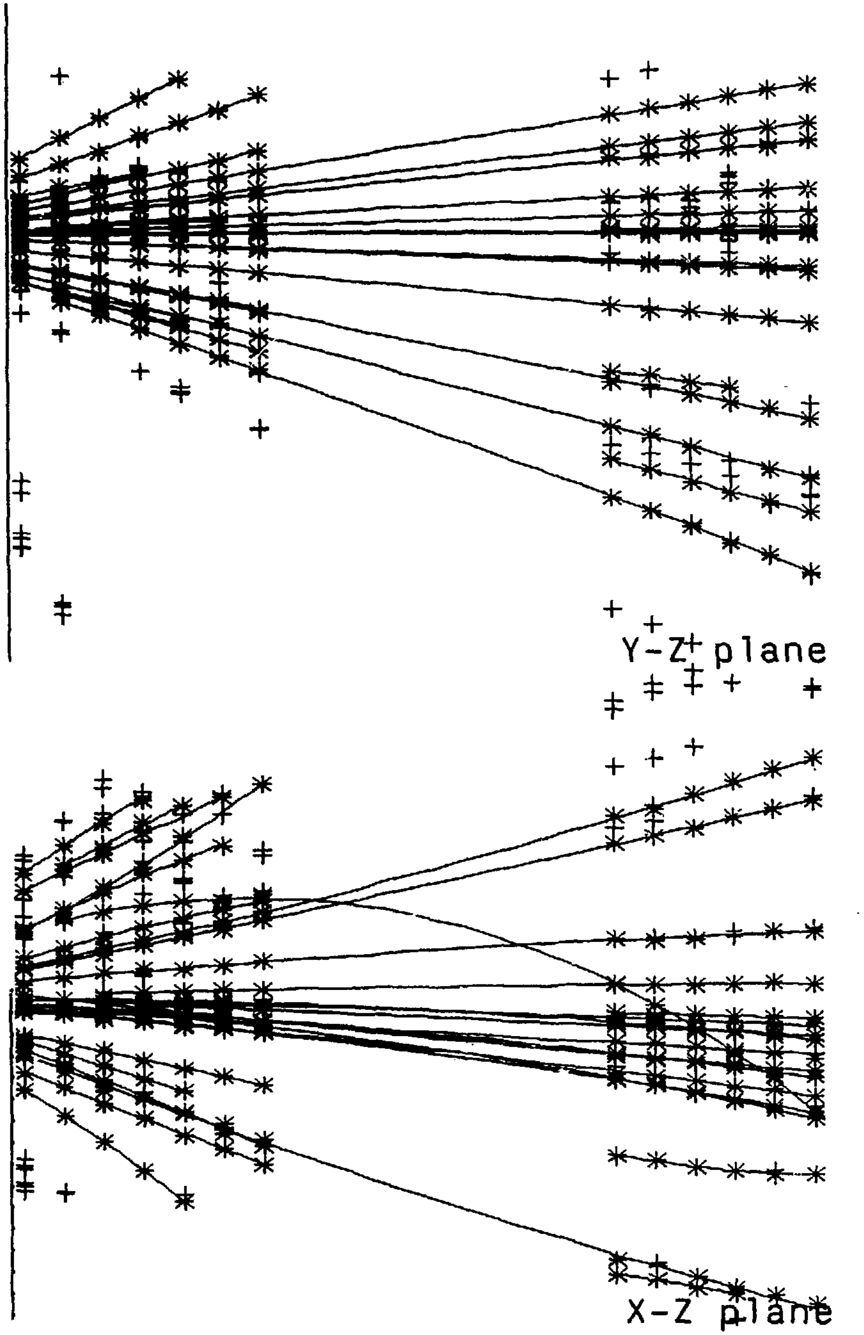


EVENTUAL ACTIVE VOLUME 19.2" W x 25" H x 13" L

FOR DEC.+JAN. RUN: 6 ROWS WITH 6.4" INSTRUMENTED
1 ROW WITH 1.6" INSTRUMENTED
(WITH ANALOG OUTPUT ON NARROW BOARD)

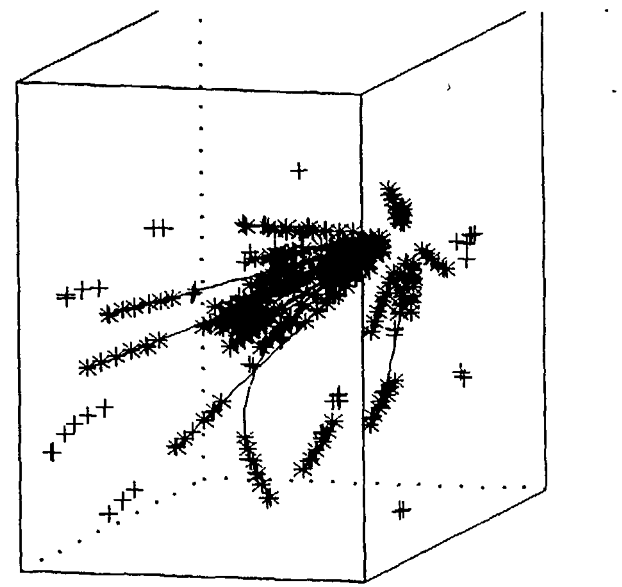
Fig. 2b: Construction details of TPC Module



RUN 22
TAPE 14256
DATE 25 JUN 88
TIME 22:25:50
EVENT 440

O + Pb

Figure 4: 29-prong event produced by 14.5 GeV/c Oxygen Ions incident on a Pb target



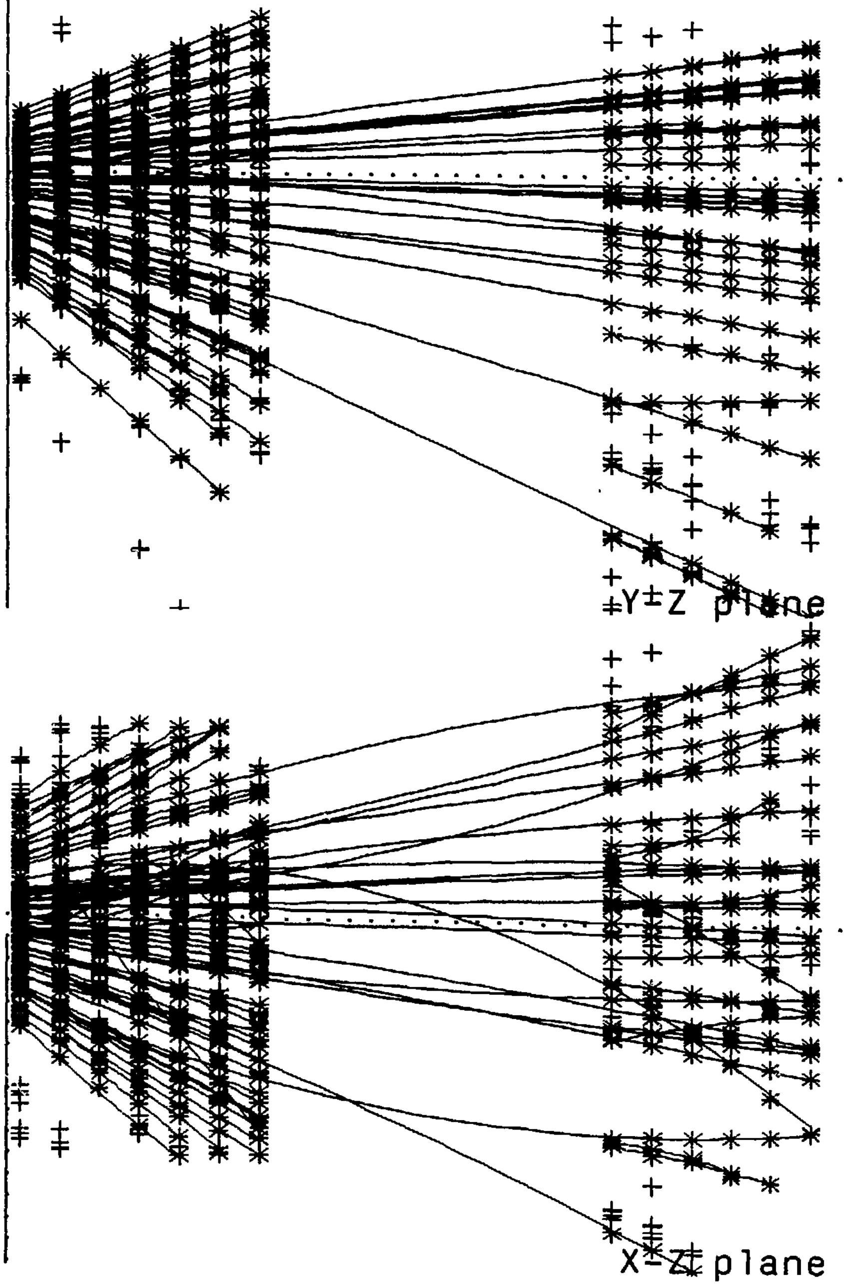


Figure 5: 80-prong event produced by 14.5 GeV/c Oxygen ions incident on a Pb target