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A MINI-PAD CHAMBER

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SUMMARY

A miniature pad chamber is described that may be capable of counting at high rates and a large number of simultaneous tracks. It provides unambiguous space points with high spatial resolution in two dimensions. The chamber is designed to use the maximum rate capability that a chamber wire can provide.

WHY A PAD CHAMBER?

Fermilab is constructing a $\bar{p}p$ colliding beam facility[1] at a center of mass energy of 2 TeV. At this energy, an average number of 12 charged particles are expected between 2^o and 10^o cone angles. Fig. 1 shows a computer simulated event[2]. Conventional proportional and drift chamber with x, y, u projected coordinate readout would have a large number of multiple ambiguities for 12 tracks. Unambiguous space point determination of every track is needed for pattern recognition.

Rate capability of an anode wire is about 5×10^5 per centimeter per second along its length with a gap of 4 mm between the anode and the cathode of a proportional chamber. This number mainly depends on the gap and the total avalanche size at which the chamber is operated. Space charge due to a positive ion cloud limits the rate capability. When the total count rate per wire approaches 10^6 per second, charge pile up may saturate the amplifier front end. Small cathode pads as independent observation windows for detecting induced pulses remove the electronics limit thus utilizing the maximum rate capability the anode wires can provide.

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The chamber is illustrated in Fig. 2. The centroids of the charge distribution from the pads determine the hit wire and the avalanche position along the wire. The chamber is built asymmetrically for optimizing spatial resolution together with maximizing rate capability and multitrack resolution (smaller space charge builds up due to the small gap which controls the gas electron gain). Construction is such that three x and three y pads would have appreciable charge for determining the centroids in x and y directions to a high accuracy. A practical rule[3] for obtaining an optimum resolution is:

2 times narrow gap = pad size

In this case the narrow gap is 2 mm, and the pad size is 4 x 4 mm^2. The other gap is made to be 4 mm for obtaining good efficiency for detecting minimum ionizing tracks. The cathode which contains the pads is kept at ground potential, the anode wires are at positive high voltage, and the other cathode is at an appropriate negative potential. The chamber gain is controlled mainly by the anode potential.

A beam view of the chamber is shown in Fig. 3. The induced signals are read out indirectly from the pads outside using the resistive cathode technique[4,5,6]. The rigid Roha-foam improves flatness of the cathode. An approximately 200 A^o thick layer of In-Sn oxide on Mylar film (commercially produced by Sierracin Co., California) provides an excellent cathode material. The benefits in using a resistive cathode are that it limits the current locally, preventing possible damage by sparks, it may self quench corona discharge, and it provides convenience in connecting the pads to the amplifiers. An important consequence of the small pads is that each pad has a capacitance of less than 1 pf resulting in very small noise relative to the anode wires. Common mode noise picked up by the bifilar wires is cancelled out by the differential amplifier. This allows running the proportional chamber at a low gain thus increasing the rate capability.

The expected rate capability of a 10 x 10 cm^2 area chamber is about 10^8 tracks per second from a uniformly distributed beam. Earlier results[7] showed that the charge centroid method using In-Sn oxide resistive film can produce better than 125 μm resolution in one dimension. The resolution in the other dimension is limited by the wire spacing, parallel to the wires. For a 0.5 mm anode wire spacing, it is $0.5/\sqrt{12}$ = 144 μm. A total of 625 pad readout channels is not a large number of today's standards. Such a chamber providing unambiguous x, y, and z coordinates for large number of simultaneous tracks can be an excellent detector for pattern recognition.

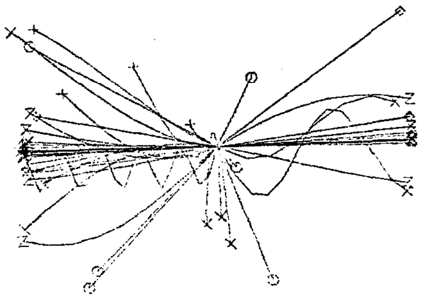

Fig. 1a. A side view of a simulation $\bar{p}p$ event at 2 TeV center of mass energy.

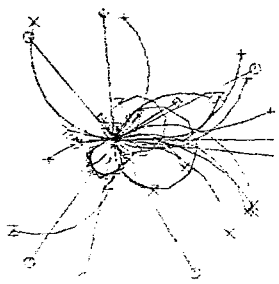

Fig. 1b. Beam view of the same event.

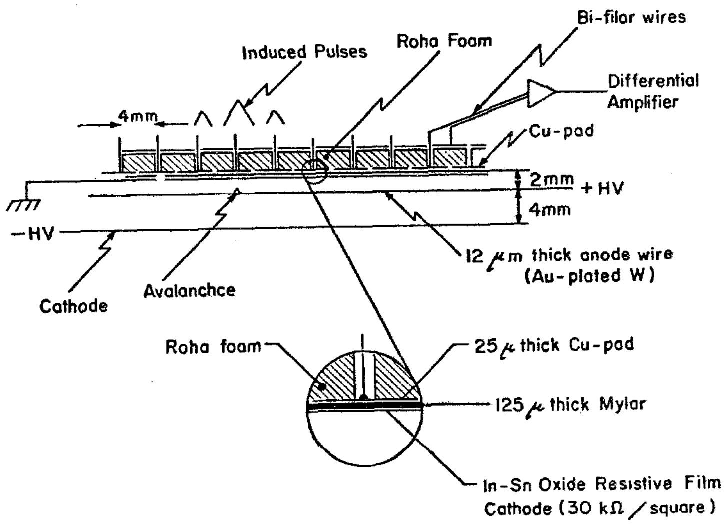

Fig. 2. A cross section view of the mini-pad chamber.

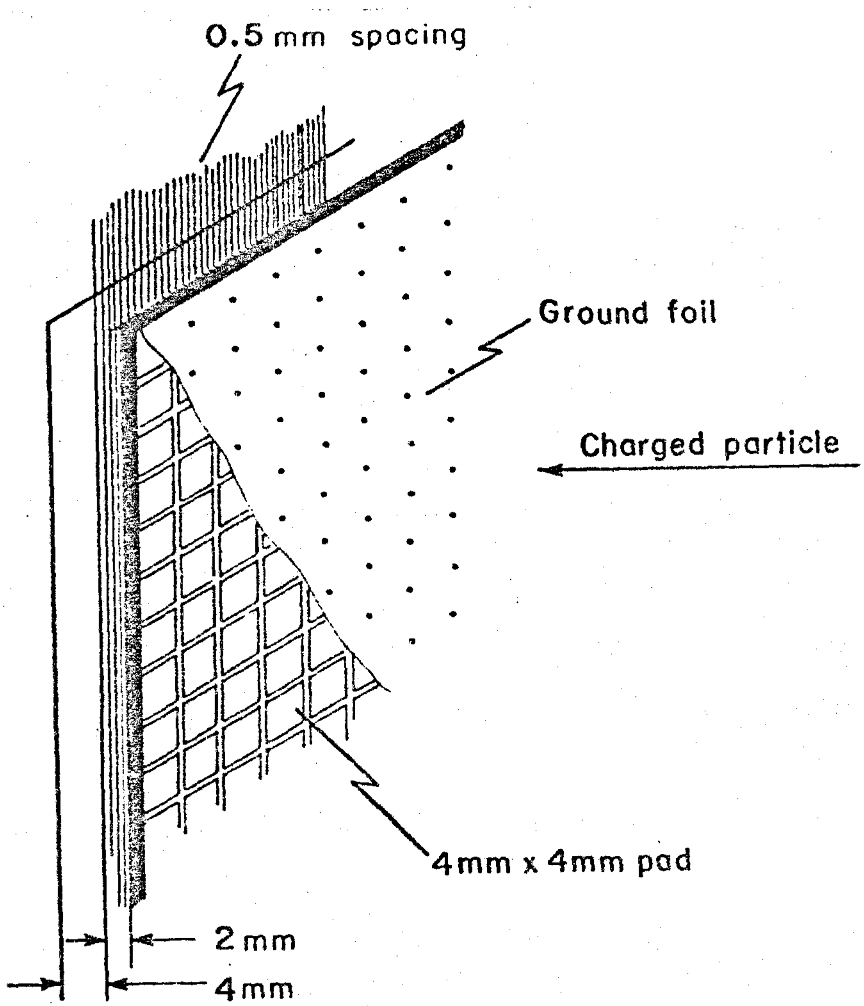

Fig. 3. A beam view of the pad chamber

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