TRACKING DETECTOR DEVELOPMENT

J. Yurkon, T. Glasmacher, B.M. Sherrill

Future experiments and the A1900 analysis line will require tracking detectors capable of $>10^6$ cps rates and resolutions $<500\mu$m.

A suitable choice for lightly ionizing beams would be a multi-wire drift detector running at atmospheric pressure. We have designed a prototype detector based on a detector developed at Los Alamos. A photograph of this detector may be seen in Fig. 1.

Figure 1:

The detector consists of 14 anode wires of 25 μm gold plated tungsten spaced 0.8 cm apart. Between these anode wires are 15 field/sense wires 75 μm in diameter. Aluminized foils, acting as cathodes, are spaced 0.48 cm of each side of the wire plane. The anode wires are connected to a microstrip delay line seen in Fig. 2.

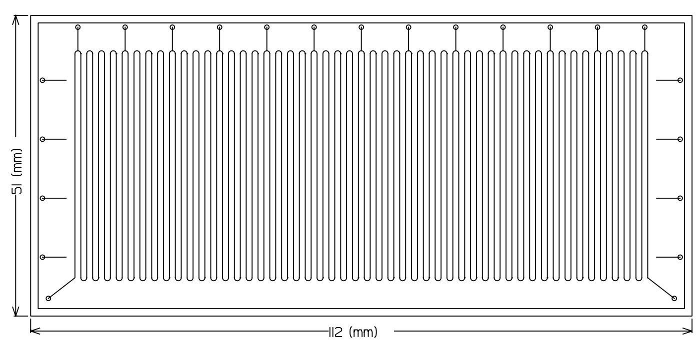

Figure 2: Micro Strip Delay Line.

The ends of the delay line are read out and timed relative to a scintillator. The time difference from the two ends yield the anode wire number and the time sum yields the drift time to the anode wire.

In order to resolve the ambiguity of which side of the anode wire the electron cluster is drifting, alternate field wires are connected together. The difference between these two signals yield the side of the wire since the anode wire partially shields the field wire from the electron cloud.

The electric field contours of the counter can be seen in Fig. 3.

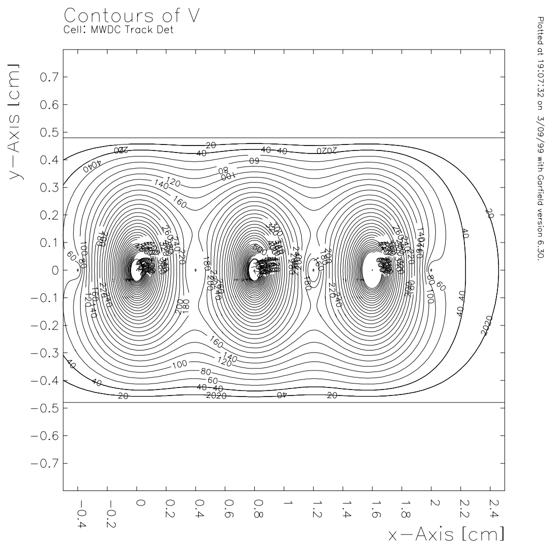

Figure 3: MWDC field contour.

We have tested the counter with a heavy ion beam, getting better than 0.5 mm FWHM resolution at rates up to 300Kcps. The gas fill was P30 and was run at 700 Torr. The limitation at 300Kcps is mainly due to pileup of the linear signal from the field wires. In order to achieve a higher counting rate we will separate the readout of both the anode wires and the field wires. This should improve the rate capability to near 10^6cps. The maximum drift time to the anode wire is around 90nsecs and should not be a limiting factor. The positive ion space charge though will be a consideration and needs to be looked at. Operation of the counter at the lowest usable gain should help reduce the space charge limitation.

We have modeled the detector with a CERN program called Garfield. The X/T (position vs. time) correlation can be seen in Fig. 4. The two curves show the X/T correlation for the arrival of the first five electrons and for all of the electrons. Garfield produces the arrival times by generating the drift and diffusion properties of P30 through an interface to the program Magboltz. It then generates a track normal to the detector and uses the program Heed to generate the distribution of electrons around the track. Heed uses the concept of "virtual gammas" to generate the electrons and produces both primary and delta electrons. The electrons are then drifted to the anode wire and the mean arrival time computed for the selected electrons and for all of the electrons. The variance in the arrival times is also computed. The track is then stepped along the counter, and a histogram is generated. As demonstrated by the curves it can be seen that in order to achieve reasonable linearity the threshold must be set for the arrival of the first few electrons. This makes the threshold setting critical since a low threshold makes the detector sensitive to the effects of delta electrons from heavier beams.

Figure 5 are plots of the time spread of the arrival of the first five electrons and when 50% of the electrons have arrived. The time spread is much smaller for the first five electrons yet the total drift time is similar. Thus, the position resolution is better for the lower threshold. A comparison of the spread and

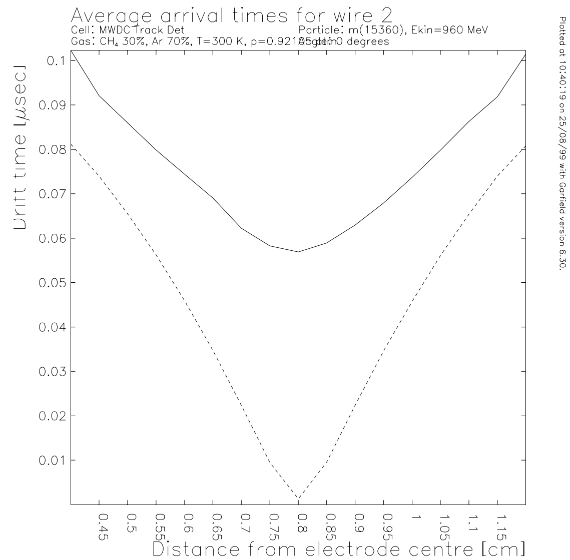

Figure 4: Average Arrival Times. The top curve is for all the electrons, and the bottom curve is for the first five electrons.

drift velocity suggest a resolution similar to the measured resolution.

Future development of the MWDC will concentrate on improving the count rate capability and aging characteristics. Other counting gases such as 80-CF_4-20-C_4H_{10} will be evaluated.

Reference

1. Garfield, a drift-chamber simulation program, Rob Veenhof, CERN.

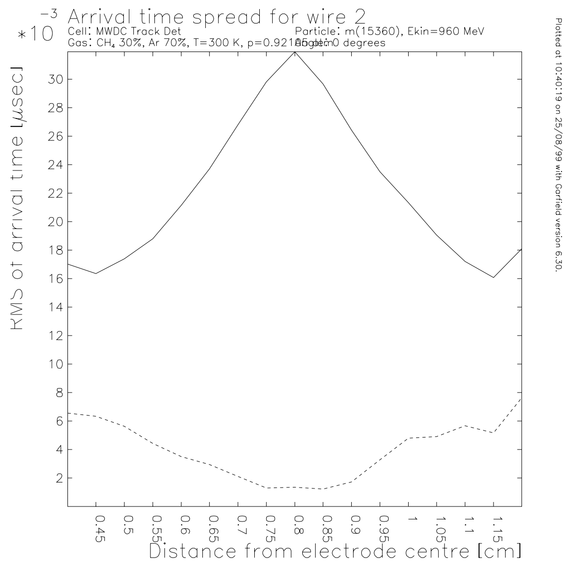

Figure 5: Arrival Time Spread. The top curve is for all the electrons, and the bottom curve is for the first five electrons.