A dual-axis dual-lateral position sensitive detector for the FAUST array

S. N. Soisson, B. C. Stein, L. W. May, and S. J. Yennello

In the last several years advances in silicon strip technology and continuous position sensitive detectors have allowed for more precise measurement of the emission angle of fragments from heavy-ion reactions. By achieving a greater understanding of the emission pattern of fragments from heavy-ion collisions, it is possible that the modes of disassembly of excited nuclei can be differentiated [1]. Because of the success of FAUST due to its reconstruction capabilities it is a prime candidate for a move towards greater position sensitivity to allow for a greater understanding of multifragmentation processes.

We have continued work with a dual-axis dual-lateral position sensitive detector (DADL PSD) in conjunction with Micron Semiconductor. The second prototype experienced charge leakage issues between the back guard ring and the back side [2]. This issue in manufacturing was corrected by Micron Semiconductor and a third prototype was delivered.

The third prototype of a DADL PSD delivered has been shown to function as designed. A DADL PSD is a highly uniform p-on-n silicon structure with highly uniform resistive junction and ohmic layers and equipotential channels. The readout between the two anodes is orthogonal with respect to the readout between the two cathodes. The total energy of an incident particle is determined by either the summation of the charge collected on the front contacts or the back contacts. The position of the incident particle on each axis can be easily determined using a conventional formula such as $X \propto (Q_1-Q_2) / (Q_1+Q_2)$, where Q is the charge collected from one contact.

An experiment was performed in the SEE Line to determine how a DADL PSD would perform under experimental conditions. Data was taken with ^{20}Ne + ^{nat}Au at 45 MeV/nucleon. A detector telescope comprised of a DADL PSD and a CsI(Tl) was placed at $30°_{lab}$ with beam on target, as well as $0°_{lab}$ with a direct dispersed beam. It has been determined that the optimal running conditions for this detector is to apply voltage to the front side to completely reverse bias the detector. The front and back guard rings receive -15 V and +5 V respectively. A 260 ohm resistor is placed between the detector and pre-amplifier to insure that complete charge splitting occurs when an incident particle hits near the charge collection strip. An amplifier shaping time of 3 μs is chosen to allow for maximum position and energy resolution.

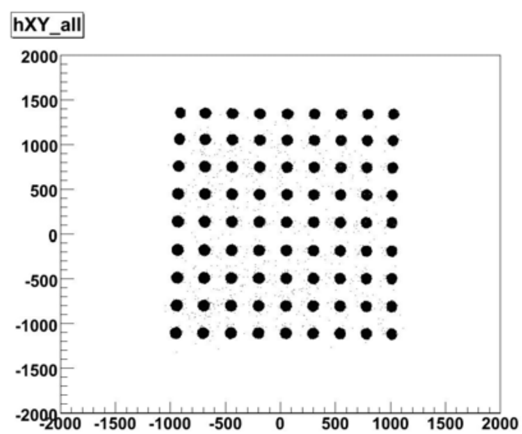

Figure 1. Reconstruced position for a 9 by 9 gridded mask.

With the detector placed at $0°_{lab}$, position measurements were taken. In Fig. 1, we see the position reconstruction of a 9 by 9 gridded mask. Each hole is 1/32 in. or ~800 μm in diameter. It is clearly seen that each hole is uniform in shape and the grid appears square. Calculations have been performed to show that the position resolution is 200 µm. With the detector placed at $30°_{lab}$, the ^{20}Ne beam was placed on a Au target. This set up allowed for the measurement of fragments produced in the heavy-ion reaction. In Fig. 2 it is shown that clear isotopic separation can be obtained. The DADL PSD shows particle identification on par with the current FAUST set up. A ^{228}Th source was used to determine the energy resolution of this detector at the end of the experiment. It was found that the energy resolution is 80 keV [3].

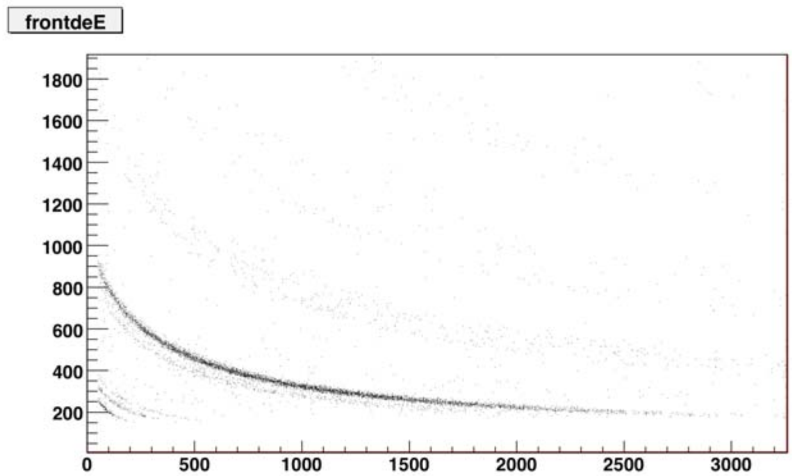

Figure 2. ΔE – E spectra showing clear particle identification.

The development of the DADL PSD has been completed. It has an energy resolution of 80 keV and a position sensitivity of 200 µm under experimental conditions.

[1] R. J. Charity *et al.,* Phys. Rev. C **46**, 1951 (1992).

[2] S. N. Soisson *et al., Progress in Research,* Cyclotron Institute, Texas A&M University (2006-2007) p. II-23.

[3] IEEE Std 300™ -1988(R2006)