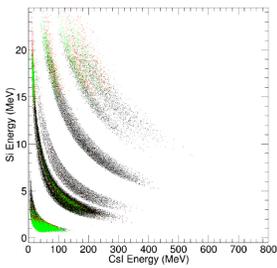
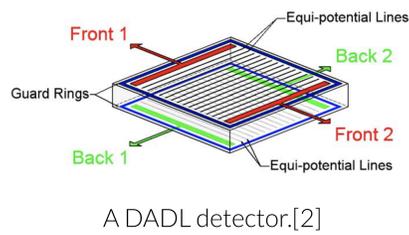


Motivation

Dual-axis duo-lateral detectors (DADLs), used in the Forward Array Using Silicon Technology (FAUST), are known to display particularly good position resolution for incident particles. We seek to further characterize position resolution on the detector and analyze the impact of position on the shape of the wave form recorded.

Dual-Axis Duo-Lateral Silicon Detectors

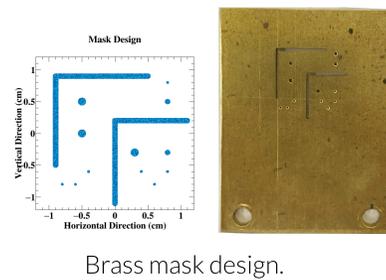
- 300 um thick silicon detector
- Two parallel contacts on front (F1, F2) and two on back (B1, B2), oriented orthogonally, measure signals from each side
- Equipotential aluminum channels allow charges to move linearly rather than through surface recombination
- Resistivity from detector corresponds with position



- Contacts far away from the position of an incident particle may not pick up a signal
- Current analysis techniques cannot plot data points with signals from only three contacts
- Data points with only three signals must be recreated

Experimental Setup

- A brass mask, designed to isolate selected extrema such as edges and corners, as well as center locations, was placed in front of a DADL detector
- Beams of 7.22 MeV/u alpha particles, 20 MeV protons, and 30 MeV protons from the K150 Cyclotron were impinged on the masked DADL



Wave Form Analysis

In examining the wave forms, we noted previously unseen shaped wave forms. Integrating over different ranges of the wave form, we calculated different X and Y position plots:

$$Y = (F1 - F2)/(F1 + F2)$$

$$X = (B2 - B1)/(B2 + B1),$$

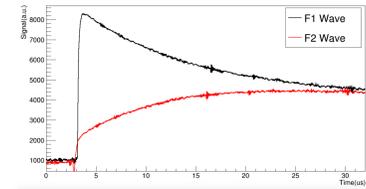
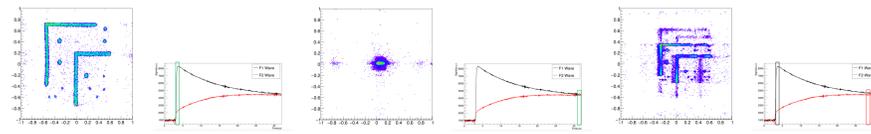
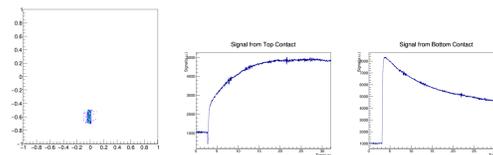


Figure 1. Wave forms from the same incident alpha particle, taken from opposite sides of the detector.

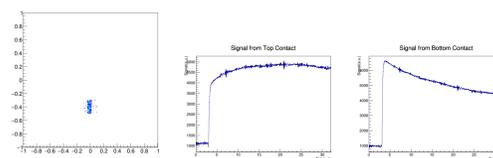


X and Y position calculated from initial rise; area of integration shown X and Y position calculated from end value; area of integration shown X and Y position calculated from maximum; area of integration shown

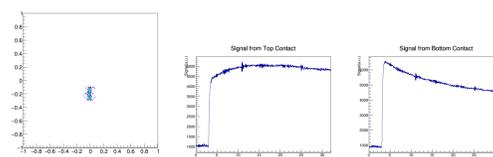
The anomalous pulse shapes occur consistently near the edge of the detector. We can see this by taking data points scanning in from an edge toward the center of the DADL.



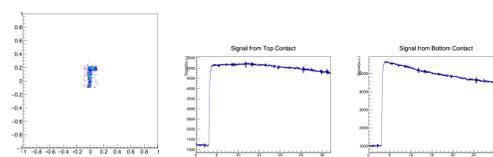
Position plot and wave forms at bottom of detector.



Position plot and wave forms scanning up detector.



Position plot and wave forms approaching center of detector.



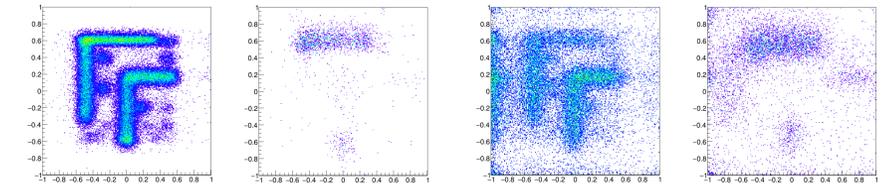
Position plot and wave forms at center of detector.

Signal Recreation

We are able to algebraically recreate the signals that are only picked up by three of the four contacts. In recreating three signal events, we find that the majority of events that only see three signals are those on the edges or corners of the detector. In order to recreate position values, we assume:

$$(F1 + F2) = slope * (B1 + B2) + intercept$$

where the slope equals $(F1 + F2)/(B1 + B2)$.



Position plot for 20 MeV protons; plot of recreated signals Position plot for 30 MeV protons; plot of recreated signals

Future Work

We began this work looking at the DADL detectors to further characterize the circumstances under which 3-signal events occur. However, while analyzing the wave forms from these events, we noted an anomalous pulse shape for events on the edges of the detector that had been previously unseen. We plan on further examining these anomalous pulse shapes in the future.

References

- Lauren A. Heilborn. *Proton-Proton Correlation Functions Measured Using Position-Sensitive FAUST*. PhD thesis, Texas A&M University, 2018.
- S.N.Soisson. A dual-axis dual-lateral position-sensitive detector for charged particle detection. *Nuclear Instruments and Methods in Physics Research*, page 241, 2009.

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