A PHOTODIODE/CsI PHOSWICH DETECTOR

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A photodiode phoswich (PD-phoswich) ΔE-E detector,[1] which simplifies conventional phoswich design by placing a photodiode on the front face of a slow scintillator, has been developed. In this configuration (Fig. 1) the photodiode replaces the thin fast scintillator as the ΔE detector and is also used in place of a PMT for scintillator readout. The result is a reduced-cost, compact light-charged-particle detector that is well suited for large solid angle coverage. Another unique design feature which was used in this experiment is that the photodiode is permanently bonded directly to the face of the crystal. The photodiode phoswich detector[2] was made by bonding a 1 cm $\times$ 1 cm $\times$ 8 cm CsI(Tl) crystal (0.01% Tl) to the p^+ face of a 1 cm $\times$ 1 cm fully-depleted transmission photodiode of thickness 307 μm.[3] The CsI(Tl) crystal was wrapped in a layer of Teflon tape followed by a layer of black tape. In order to increase the ΔE signal, an ion-implanted passivated-silicon detector was placed in front of the PD-phoswich. Both detectors were wired in parallel, keeping the electronics to a minimum. The ion-implanted passivated-silicon detector had an active area of 450 mm^2 and thickness of 305 μm, giving a total ΔE thickness of 612 μm.

A brass collimator with an outer diameter of 60 mm, thickness 80 mm and an inner hole of diameter 2 mm was placed in front of the detectors to stop any uncollimated charged particles from reaching the detector elements. The particle identification telescope

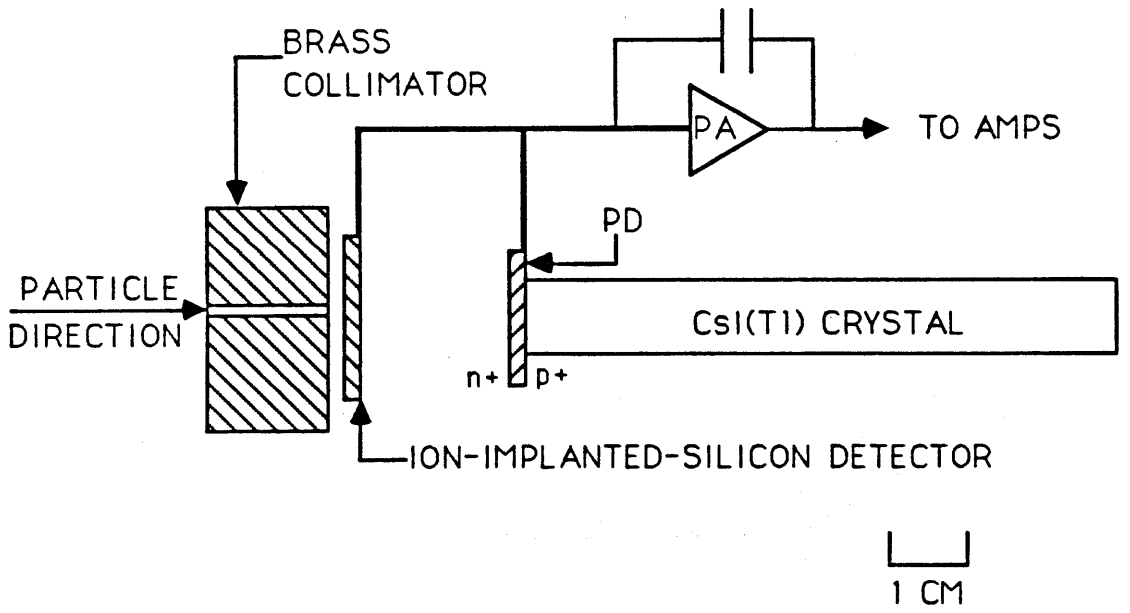

Figure 1. Full scale diagram of PD-phoswich.

and collimator were enclosed in a Faraday cage made of conducting aluminum tape. The detector system was tested in the 162 cm scattering chamber at IUCF with a ^{59}Co target of thickness 701 ug/cm^2 bombarded by a 200 MeV ^{3}He beam. The signals were amplified by an Ortec H242A pre-amplifier and distributed to two amplifiers. The fast signal was amplified using an Ortec 472 spectroscopy amplifier and the slow signal was amplified using an Ortec 572 amplifier.

Figure 2 presents a density plot of ΔE versus $E_{total} - \Delta E$. This spectrum clearly shows the isotope lines of from bottom to top: protons, deuterons and tritons with ^{3}He and ^{4}He above. These results are equivalent to conventional silicon-CsI(Tl), ΔE-E, particle identification telescopes.

The PD phoswich in parallel with a silicon ΔE detector performed well, giving excellent resolution for H and He ions. Charged particles with higher mass were stopped in the ΔE segment of the detector and could not be identified in this experiment.

1. K. Kwiatkowski, *et al.*, Nucl. Instr. and Meth. **A299** (1990) 166.
2. Custom order from Micron Semiconductor.

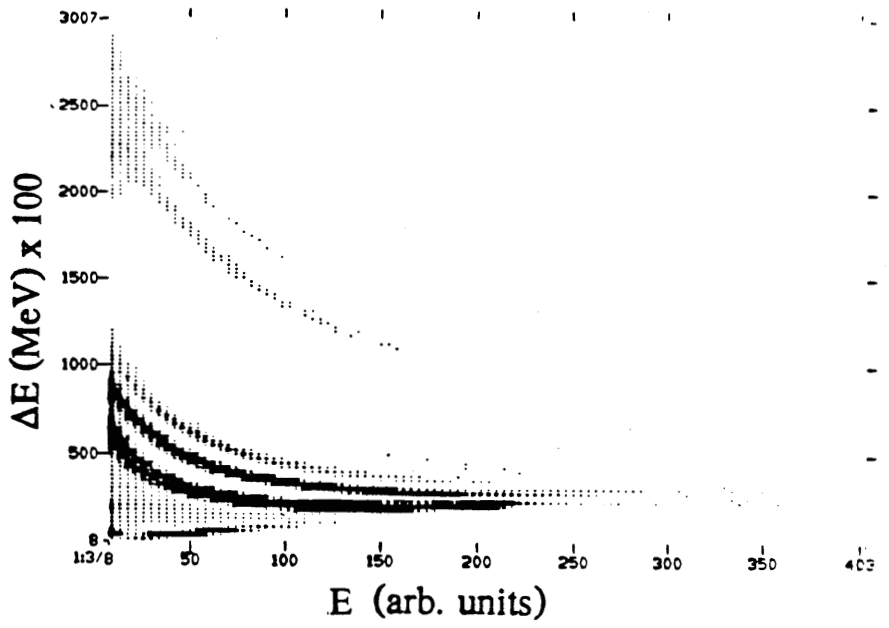

Figure 2. Density plot of ΔE vs. E (total) - ΔE.