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Coincident Detection of Cherenkov Photons from Compton Scattered Electrons for Medical Applications

Throughout the last decade there has been an increasing interest in an efficient gamma ray detector for medical applications. Especially proton beam therapy and nuclear medicine could benefit from the ability to detect higher energetic gamma-radiation above 1 MeV. One possible detector would be a dual-plane Compton Camera.
Coincident detection of energy and position of both the electron and the scattered gamma allows for a reconstruction of the incoming gamma momentum to lie on the surface of a cone.Intersection of many cones yields information on the gamma source location.
A novel concept for the detection of the high energetic Compton-Scattered electron is proposed. Using coincident detection of Cherenkov photons generated by the electron in an optically transparent radiator material an estimation of the scattering vertex, the electron energy and momentum is possible. A proof of principle is presented showing the coincident detection of Cherenkov photons created by electrons in PMMA on a 8-by-8 Silicon-Photomultiplier array. A coincidence timing resolution in the order of 250 ps is achieved. Spatial sensitivity for the electron source location from accumulated events will be demonstrated as well as the ability to reconstruction information on the electron from single coincident events. The influence of radiator material and thickness has been investigated and will be presented together with a comparison of obtained results with theoretical estimations and simulations.

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