



Contribution ID: 206

Type: Oral Presentation

Building a Hybrid Compton Camera System for Improving Proton Therapy Imaging

Wednesday, 5 July 2023 14:00 (20 minutes)

The UCT POLARIS system, a solid-state CZT detector for prompt gamma-ray imaging, has shown potential for improving range verification techniques in proton therapy [1]. However, its limitations in timing resolution and energy range impede its clinical applicability. In this project, we aim to overcome these limitations by combining the POLARIS detector with a fast-timing $2'' \times 2''$ LaBr₃(Ce) detector as a hybrid Compton camera [2] [3]. The LaBr₃(Ce) detectors have outstanding timing and energy resolution, and a higher maximum energy range, while the POLARIS detectors have high position sensitivity and excellent energy resolution. To investigate the feasibility of the hybrid setup, a pulse selected 66 MeV proton beam experiment was conducted at iThemba LABS.

The accurate tracking of double scatter gamma ray events from a POLARIS detector into a LaBr₃(Ce) detector requires careful coordination between the two systems. The onboard electronics of the POLARIS detector enable the selection of single scatter events within the CZT crystals. For background reduction, a cyclotron beam radiofrequency time of flight analysis is employed on the fast time data of the LaBr₃(Ce) detector [4]. This analysis allows for the identification and selection of gamma-ray events originating from interactions between the proton beam and the target. Implementation of these data reduction techniques, along with the intricate time synchronization of the two detector data acquisition systems, facilitates the precise tracking of gamma rays across the two detectors.

This Compton camera work offers the potential to enhance range verification techniques and facilitate the development of a clinical prompt gamma-ray imaging system. The successful deployment of such a system would improve treatment efficacy and bolster the role of proton therapy in cancer treatment.

References

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Apply to be considered for a student ; award (Yes / No)?

Yes

Level for award;(Hons, MSc, PhD, N/A)?

PhD

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Session Classification: Nuclear, Particle and Radiation Physics

Track Classification: Track B - Nuclear, Particle and Radiation Physics