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Development and Optimisation of a Two-Stage SiPM-Based Compton Camera

This work investigates the development of a two-stage Compton camera for environmental radiation monitoring, with a focus on energy resolution, detection efficiency, fast timing, and optimal geometrical configuration. While significant advances have been made in radiation imaging technologies, challenges remain in achieving high sensitivity and accurate source localisation in complex environments.

A prototype Compton camera is studied using compact, low-voltage 14 × 14 × 25.4 mm $LaBr_3$:Ce scintillation detectors coupled to SiPM readout, with the aim of leveraging the advantages of modern SiPM technology. These detectors, manufactured by CapeScint (MA, USA), demonstrate excellent energy resolution (3.4% at 662 keV) and fast timing performance. Scatter event tracking is modelled using the TOPAS Monte Carlo toolkit to determine optimal detector geometry and timing characteristics, complemented by experimental measurements with standard gamma-ray sources.

In addition, two Cs_2LiYCl_6 (CLYC-6) SiPM-readout detectors of the same geometry have been commissioned to exploit their neutron sensitivity. Pulse shape discrimination is used to distinguish neutron and gamma-ray interactions, enabling simultaneous gamma–neutron detection for comprehensive environmental radiation assessment.

The development of this system has the potential to improve radiation source localisation, contamination mapping, and situational awareness in environmental and nuclear safety applications. Its compact design and fast-timing capabilities make it well suited for field deployment in scenarios such as nuclear facility monitoring, waste management, and emergency response. Preliminary results from simulation and experimental studies will be presented.

Primary authors: HART, Shanyn (iThemba LABS); PELLEGRI, Luna (University of the Witwatersrand and iThemba LABS); Dr JONES, Pete (iThemba LABS); VAN TUBBERGH, Christo (iThemba Labs); PETERSON, Steve (University of Cape Town)

Presenter: HART, Shanyn (iThemba LABS)

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