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Characterization and Performance Evaluation of SiPM-Based Gamma and Neutron Detectors for Nuclear Science Applications

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The Portable African Neutron-Gamma Laboratory for Innovative Nuclear Science project has seen the characterization of a number of new detectors using reference radioactive gamma and neutron sources. These detectors will be used for two primary projects, namely as an upgrade to the existing mobile gamma-ray and neutron detection unit and as a two-stage Compton camera prototype for a position-sensitive detection of prompt gamma rays from proton-induced nuclear reactions.

Two compact 14x14x25.4 mm $LaBr_3$(Ce) SiPM-coupled scintillation detector assemblies were investigated and benchmarked against conventional 1"x1" $LaBr_3$(Ce) photomultiplier tube detectors where they have demonstrated excellent energy resolution ($\approx 3\%$ at 662 keV). Further, two epasolite Cs_2LiYCl_6 (CLYC) SiPM-coupled detector assemblies have been commissioned to maximise on their neutron detection capability using pulse shape discrimination to distinguish between neutron and gamma events for in situ neutron dose measurements.

The feasibility of building a position sensitive two-stage Compton camera using the fast-timing $LaBr_3$(Ce) crystal is investigated in terms of energy resolution, efficiency and optimum geometrical configuration to maximise on the strengths of the cutting edge SiPM technology.

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