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Monte Carlo Simulation of the PoWER: Proof of Concept

The PoWER system is a novel, cost-effective photon detection proposal designed for large-scale Liquid Argon Time Projection Chambers (LArTPCs). A proof-of-concept prototype was developed at Unicamp to validate its light yield and veto capabilities, consisting of two concentric volumes: an outer Teflon cube internally lined with Vikuiti and an inner acrylic cube coated with PEN foils. Detection is handled by four SiPM arrays (two VUV-sensitive and two visible-light-only sensitive). Experimental tests utilized two alpha sources, an internal U-Al source and an intermediate Am source, alongside an external gamma source to evaluate detection performance and veto capabilities.

This work presents a Geant4-based Monte Carlo (MC) simulation of the proof of concept for the PoWER system, encompassing geometry and optical modeling. By analyzing event discrimination between different regions and calculating light yields for both alpha and gamma sources, the simulation results were validated against the experimental data.

The developed MC model demonstrates agreement with the experimental results, confirming both the event discrimination and the high light yield capabilities of the PoWER system. Furthermore, this agreement validates the accurate modeling and thorough understanding of the system's optical properties.

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