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#11-60 Pulse shape simulation for organic scintillation detectors using GEANT4

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Plastic scintillators exhibiting pulse shape discrimination properties represent a promising, solid-state alternative to the use of organic liquids and crystals for the detection of neutron and gamma radiation. They are robust, inexpensive and can be fabricated in a variety of shapes and sizes. The time-dependent pulse shapes derived from plastic scintillation detectors can be characterised by a rising edge and multiple decay time constants. These time constants relate to the scintillation mechanism following particle interaction and differ depending on the type of interacting particle. The technique of pulse shape discrimination (PSD) enables the separation of neutron and gamma ray induced signals based on subtle differences in their pulse shape. The objective of this research is the development of accurate pulse shape simulations that are capable of reproducing the pulses measured experimentally for organic scintillation detectors. The ability to accurately simulate pulse shapes presents the opportunity to assess the PSD performance of scintillation detectors prior to fabrication, enabling this to be optimised in the initial stages of detector design. This is particularly important for detectors which utilise plastic scintillators as the PSD performance of these materials varies as a result of numerous factors affecting the shape of the pulses. This includes the scintillator geometry, where the ability to separate out neutron and gamma ray induced signals becomes degraded as the size of the scintillator is increased. Work presented demonstrates the use of the Monte Carlo toolkit GEANT4 to simulate the time-dependent pulse shapes from EJ-276, a pulse shape discriminating plastic scintillator developed by Eljen Technologies, coupled to an ET-Enterprises 9214 photomultiplier tube (PMT). GEANT4 has been used to simulate the generation and transportation of scintillation photons up to their detection at the photocathode for commonly used scintillator geometries. These represent the scintillation detector pulse shapes when the response of the PMT is excluded. Since the temporal response of the photodetector impacts on the overall shape of the pulses, future work will focus on experimental work to precisely measure the response of the PMT and integrate this with existing simulations.

Primary author: HOLROYD, Caroline (Lancaster University)

Co-authors: Dr ASPINALL, Michael (Lancaster University); Dr DEAKIN, Tom (LabLogic Systems Ltd)

Presenter: HOLROYD, Caroline (Lancaster University)

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