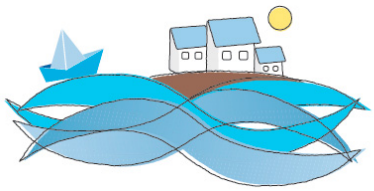

Mediterranean Thematic Workshops in Advanced Molecular Imaging

Contribution ID: **69** Type: **Oral**

Leave no photon behind: Photon classification, modeling and reconstruction for ultra-fast time resolution detectors

Monday 5 September 2022 15:30 (20 minutes)

Identifying the photon origin and track on an event-to-event basis is of utmost importance to understand the underlying nature of light based fast timing detectors and to push the boundaries toward the ambitious goal of 10 ps coincidence time resolution (CTR). The photon history can be manifold: different production mechanism (Cherenkov/Scintillation), different materials in a composite structure, variable production point (DOI) in high aspect ratio crystal geometries, photon directionality, or just fluctuations due to the amount of deposited energy. This phenomena shows different classes, timing-wise, of photons, and segregation continues to exist.

This comprehensive study combines three key aspects of exploring the nature of timing with mixed photon origins: experimental work, analytical modeling and image reconstruction.

First, we demonstrate how event classification can be experimentally carried out on the particular case of Cherenkov/Scintillation light with BGO. Timing can be improved by selecting only the fastest 4% of events (CTR: 169 ps → 117 ps FWHM) or "switching off"slow scintillating light and harvesting solely prompt photons, as for instance in PbF2 (142 ps FWHM). Next, an analytical model is developed to estimate/predict the timing performance of either knowing or not knowing the history of the detected photons and to reproduce our laboratory results. Last, measured data on BGO is classified into 25 timing kernels based on the Cherenkov photon yield of each category and used to reconstruct an image of the NEMA IQ phantom, proving from an application point of view the benefits of advanced information.
Although emphasis is given on Cherenkov/Scintillation photons for TOF-PET, this work can be generalized for various types of mixed photon populations and applications, ranging from TOF-CT, TOF-PET, range verification in hadron therapy and high energy physics.

Topic Selection

Technical Advances in brain imaging

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