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Light detection in liquid Xenon for nEXO and beyond

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The nEXO experiment is being designed for neutrinoless double beta decay in liquid Xenon. To meet its target sensitivity, the energy resolution must be 1%, in order to reject gamma and two-neutrino double beta decay backgrounds. This requirement translates into the requirement of detecting at least 3% of the scintillation photons produced with minimum added fluctuations. In addition, the scintillation light detection system must contribute minimally to the radioactive material budget, i.e. less than a few percent of the gamma background detected can stem from the light detection system. This latter requirement rules out the use of photo-multiplier tubes. Single Photon Avalanche Diode (SPAD) arrays have been selected for nEXO because they fulfill the radiopurity requirement and because they minimize electronics noise, thanks to their high gain. The baseline solution for nEXO is analog SPAD arrays, called Silicon Photo-multipliers (SiPMs) [1]. We will show detail performance characterization in vacuum and liquid Xenon assessing their performance for the detection of 175nm scintillation photons and the processes that may distort the energy estimator, so called dark noise, after-pulsing and crosstalk. This later process stems from light emission during the avalanche responsible for the SPAD high gain, and it can create additional spurious avalanches within the same chip (internal crosstalk) but also within other SiPM channels (external crosstalk)[2]. We will show detail characterization of this process imaging the light produced and reconstructing external crosstalk events in the Light only Liquid Xenon experiment. Finally, we will discuss the use of digital SPAD arrays, called Photon to Digital Converter for applications beyond nEXO outlining their key advantages.

Auteur principal: FABRICE, Retiere (TRIUMF)

Orateur: FABRICE, Retiere (TRIUMF)

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