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Characterization and development of a new SiPM with high VUV sensitivity for the nEXO Experiment

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Silicon Photo-Multipliers (SiPMs) have emerged as a compelling photo-sensor solution over the course of the last decade. In contrast to the widely used Photo-Multipliers Tubes (PMTs), SiPMs have high single Photon Detection Efficiency (PDE) with negligible gain fluctuations, are low-voltage powered, optimal for operation at cryogenic temperatures, and have low radioactivity levels. For these reasons, large-scale low-background cryogenic experiments, such as the next-generation Enriched Xenon Observatory experiment (nEXO), are migrating to a SiPM-based light detection system. The current generation of Vacuum UltraViolet (VUV) SiPMs achieve at best 25% PDE below 300 nm compared to more than 50% at 420 nm, being limited by reflections and charge carrier collection close to the surface. The aim of this talk is to show a quantitative understanding of the processes that affect the SiPM performances. In particular we will show how we can describe, for different wavelengths, the SiPM PDE as a function of the bias voltage using a minimum set of parameters extracting: (i) the relative contribution of electrons vs holes, (ii) the length of an effective photon collection region. We will then use this parametrization to describe the SiPM dark noise, after-pulsing and cross-talk. This characterization is part of the development of a new generation of VUV SiPMs with very high efficiency in VUV (>50%) for operation in Liquid Argon and Liquid Xenon.

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