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Characterization of VUV-Sensitive SiPMs for LXe Scintillation Light Detection in nEXO

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The nEXO experiment will operate an ultra-low background TPC filled with 5\,tons of isotopically enriched liquid Xenon~(LXe) to search for the neutrinoless double beta ($0\nu\beta\beta$) decay of Xe-136. The detector will use $4\,\mathrm{m}^2$~of SiPM tiles operated at~-104°C to collect the scintillation light from any events in the xenon. There are strong requirements on the SiPM performance, light collection efficiency and background levels to achieve an excellent energy resolution. Detecting the $0\nu\beta\beta$-decay would have wide-spread implications for particle physics.

The SiPMs have to be sensitive to the vacuum-ultraviolet (VUV) scintillation light of LXe at 178 nm which is not given for off-the shelf SiPMs. The development and characterization of such VUV-sensitive SiPMs for nEXO has already produced promising results: (1) measured limits for the radio-isotope content of SiPMs (manufactured by Foundation Bruno Kessler, FBK) are consistent with requirements, (2) the photo-detection efficiency exceeds 15 % for FBK and Hamamatsu Photonics SiPMs at 178 nm, (3) dark noise and correlated avalanche rates are better than the upper limits adopted by nEXO of $50\,\mathrm{Hz/mm}^2$ and 20 %, respectively. The nEXO collaboration is continuing to work with SiPM manufacturers to further improve performances.

nEXO also examines the VUV-reflectance of SiPM. Detector samples are immersed in a LXe cell and irradiated with photons at a wavelength of 178 nm at the LXe laboratory at M{\"u}nster University. The reflectance for given incident angles can be derived as the ratio of the reflection rate off of the SiPM surface and the reference rate without sample – both measured with a secondary detector for a wide reflectance angle range. Other investigations focus on possibly different behaviours of SiPMs in high electrostatic fields as present in the final TPC by nuisance measurements at various electric field strengths.

In this talk, we give an overview of the current VUV-sensitive SiPM characterisation efforts within the nEXO collaboration focussing on PDE and surface reflectance studies.

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