Characterization of VUV-sensitive SiPMs for nEXO

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Physic beyond Standard Model?
- The neutrinoless double beta decay opens window to physics beyond SM
- Are neutrinos Majorana particles?
- Current 0νββ searches are sensitive to a half life of about $10^{25}$ years
- nEXO plans to increase sensitivity by two orders of magnitude

The nEXO detector
- Time-projection-chamber (TPC) filled with ~ 5 tons of liquid Xenon (LXe) – enriched to 90% in $^{136}$Xe
- Cylindric barrel with a diameter and height of 1.3 m
- Detector set up in underground lab to shield from cosmic rays (likely SNOLAB, 6000 mwe.)
- Signal detection via charge readout tiles (end cap) and VUV-sensitive SiPMs (inner wall)
- Cathode set to -60 keV to produce axial drift field
- Extensive radiopurity screening to constrain BG
- Detector set up in underground lab to shield from cosmic rays (likely SNOLAB, 6000 mwe.)
- Homogeneous detector & multi-parameter analysis

Light detection
- nEXO sensitivity depends on light collection efficiency and photo detection efficiency
- Inside wall covered with 4 m$^2$ of VUV-sensitive SiPMs
- Detection of 178 nm scintillation light in the LXe
- Strong requirements on SiPM parameters

SiPM characterization test setups
- ECAP, Erlangen (Dark noise, PDE, collab. with U.Münster for VUV reflectance)
- IHEP, Beijing (HV behaviour, VUV reflectance)
- TRIUMF, Vancouver (Dark noise, PDE)
- UA, Alabama (VUV reflectance)
- Stanford (PDE, SiPM tiles)
- Umass (PDE, LXe)

Various SiPMs
- Hamamatsu VUV3, VUV4
- FBK NUV 2016 LF & STD

Measuring procedure @ ECAP
- Record SiPM pulses under dark & light conditions at -100°C
- Fit waveforms with pulse template
- Account for afterpulsing and crosstalk
- Use amplitude, timestamp, rise/fall time for further analysis

Afterpulsing
- Delayed avalanches correlated to the primary pulse
- Important nuisance charge contribution

PDE
- Efficiency to detect single photons
- Angle-, wavelength- and bias voltage-dependent

Energy resolution
- Depends on PDE and photon transport efficiency
- Example performance in the case of PTE = 0.2

VUV reflectance
- Knowing VUV reflectance of TPC surfaces important for photo collection efficiency
- Measured in collaboration with the Institut für Kernphysik, University of Münster

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