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Single Photon Timing Resolution study on Silicon Photomultipliers at cryogenic temperatures

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Silicon Photo-Multipliers (SiPMs) have emerged as a compelling photo-sensor solution over the course of the last decade and due to their optimal operation at cryogenic temperatures and low radioactivity levels are the baseline photo-sensor solution for several next generation dark matter detectors.

SiPMs are the baseline photo-sensor solution for the Darkside-20k detector and thanks to their high timing resolution and photon detection efficiency will allow to achieve an excellent pulse shape discrimination discriminating electron recoil from nuclear recoil events.

To establish experimentally the effect of the timing resolution in the pulse shape discrimination for DarkSide-20k, a detailed characterisation study of the SiPM Single Photon Timing Resolution (SPTR) was carried out at Laboratori Nazionali del Gran Sasso (LNGS). More precisely we studied from room temperature down to 40 K the SiPM SPTR as a function of the over-voltage and for different wavelengths. The factors affecting the SPTR electronically are bandwidth and rise time which were also investigated to identify the quantities that can potentially improve the detector timing resolution. The SPTR was studied at different scales of integration of SiPMs in order to identify the key quantity that reduces the final detector SPTR with increasing photodetector readout area.

Collaboration

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