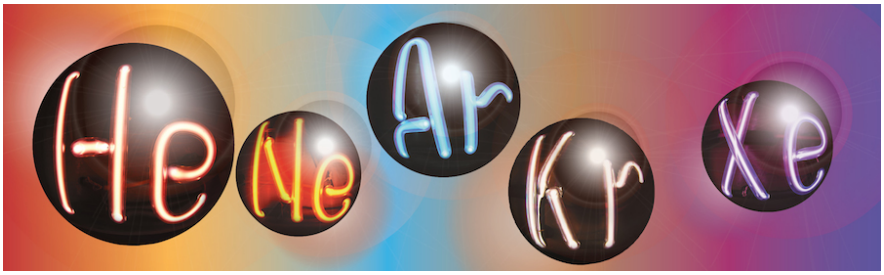

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Design and Characterization of a Readout System for Large-Area SiPM Arrays in the DarkSide-20k Neutron Veto

DarkSide-20k is a global direct dark matter search experiment in the construction phase at LNGS (Italy). The core of the detector is a dual-phase Time Projection Chamber (TPC) filled with 50 tonnes of low-radioactivity liquid argon. The entire TPC wall is surrounded by polymethylmethacrylate (PMMA), which acts as a neutron veto, immersed in a second low-radioactivity liquid argon bath enclosed in a stainless-steel vessel. The TPC and the neutron veto are enclosed within the cryostat volume, which is filled with 650 tonnes of atmospheric argon comprising the outer veto volume. DarkSide-20k aims to reach a world-leading high WIMP mass 7.4 x 10-48 cm2 for a 1 TeV/c2 WIMP in a background-free instrumental background in 200 tonne x years. A key role is played by the neutron veto, which is instrumented with large-area light detectors utilising a custom Silicon Photo-Multiplier (SiPM) technology optimised for high optical photon detection efficiency and low noise at liquid argon temperatures. SiPMs are arranged in a compact design meant to minimise the material (and hence the radioactive budget) used for the active electronics, cables and connectors: the veto PhotoDetection Units (vPDUs). A vPDU comprises 16 “Tiles”, each containing 24 SIPMs, together with front-end electronics, and a motherboard (which distributes voltage and control signals, sums Tiles channels, and drives the electrical signal transmission), providing a single readout area of 10x10 cm2.
This talk presents the characterisation of the vPDUs operated in cryogenic conditions using liquid nitrogen, with measurements conducted across international laboratories in the UK and Poland. The study includes tests of the readout performance, stability, and noise behaviour, together with radiopurity-driven material selection and background modelling to assess the impact of the veto readout system on the overall background budget of the DarkSide-20k experiment.

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