

SiPM-Based Photon Detection Units for DarkSide-20k

The DarkSide-20k experiment, under construction at LNGS, employs innovative Photo Detection Units (PDUs) based on cryogenic Silicon Photomultipliers (SiPMs) for its light detection system. Each PDU integrates 16 tiles containing 24 FBK NUV-HD Cryo SiPMs, creating a $20 \times 20 \text{ cm}^2$ photosensor with 100 cm^2 active surface per channel. The production process, conducted in the new Nuova Officina Assergi (NOA) ISO-6 clean room, involves rigorous Quality Assurance testing at wafer level, showing a cumulative SiPM yield of 94%. The manufacturing workflow encompasses die extraction, packaging, and bonding, managed through an integrated software framework. Initial characterization in cryogenic conditions demonstrates excellent single-photon detection capabilities, crucial for achieving DarkSide-20k's sensitivity goal of $\sim 10^{-48} \text{ cm}^2$ at 100 GeV WIMP mass. Over 600 PDUs will instrument both the dual-phase liquid argon TPC's optical planes and the detector's veto system, marking a significant advancement in dark matter detection by means of large area SiPM technology. This contribution will detail the packaging workflow, from wafer testing to final assembly, and highlight the preliminary results from the characterization of the first PDUs.

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