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Silicon Photomultipliers for the decay tunnel instrumentation of the ENUBET neutrino beam

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The ERC funded ENUBET project is developing detectors suitable for positron reconstruction in the decay tunnel of a narrow band beam to monitor at 1% level the neutrino flux from the three-body semileptonic decays of kaons. The baseline option for the tunnel instrumentation employs a fine-grained shashlik calorimeter with a 4.3 X_0 longitudinal segmentation to separate positrons and pions coming from other decay modes of kaons. The iron-plastic scintillator stack composing each basic unit (UCM) is crossed by 9 WLS fibers with a density of 1 fiber/cm^2. These fibers are directly coupled to small-area SiPMs hosted on a PCB on the back of each module, hence avoiding dead zones from fiber bundling. The instrumentation is complemented by rings of plastic scintillator doublets below the calorimeter, acting as a photon veto to suppress the π^0 background and providing timing informations. Each tile is readout by a WLS fiber optically linked to a SiPM.
Since march 2019, ENUBET is also a CERN Neutrino Platform experiment (NP06/ENUBET) and collaborates both with CERN accelerator physicists on the development of the beamline and with Research Centers in Italy and Croatia (Fondazione Bruno Kessler and the Photonics and Quantum Optics Lab. of the Institut Ruđer Bošković) for the photosensors. In this context, we are also developing the required triggerless front-end electronics for SiPM readout to cope with the needs of a monitored/time-tagged neutrino beam.
SiPMs instrumenting the calorimeter will be exposed to sizeble amounts of neutrons arising in hadronic showers. In order to reproduce such a working environment, SiPMs with different cell size (from 12 to 20 μm) produced by FBK employing the RGB-HD technology were irradiated at the INFN-LNL Irradiation Test facility with neutron fluences up to 2×10^{11} n/cm^2 (1 MeV-eq.). The exposed light sensors were characterized in situ in terms of I-V curves at different irradiation levels, and their response in the ENUBET UCMs was tested at CERN with electrons, muons and pions.
In this contribution we will report the results of the described tests on SiPMs, together with the advances in their integration with the ENUBET detectors and in the dedicated readout electronics.

References:

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