

# Silicon photomultipliers for future HEP experiments

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For the particle identification systems of the future high energy physics detectors, single photon sensors with sub-mm granularity and high sensitivity are needed. Due to harsh radiation environments and high track densities, they must be resilient to neutrons and have excellent timing resolution. For example, in the LHCb RICH after Upgrade 2, the expected fluence will be  $3 \times 10^{12}$  neq/cm<sup>2</sup>. A timing resolution for single photons below 100 ps is needed to associate photons to the tracks coming from different vertices. Silicon photomultipliers are considered a baseline technology for the application due to their high photon detection efficiency, good timing resolution, and low operating voltage compared to vacuum-based photosensors. Unfortunately, they are sensitive to neutron irradiation. The dark counts increase with the neutron fluence and distort the signal baseline, making the single photons undistinguishable. Although the DCR of different unirradiated SiPMs varies, the devices show very similar rates when irradiated to high doses. The operation can be recovered by lowering the operation temperature. In this work, we investigated the performance parameters of FBK NUV-HD-RH 1 mm<sup>2</sup> device and determined the temperature below the operation possible. The cryogenic container was used to cool the silicon photomultipliers contained in an RF-shielded box with the cryogenic preamplifier to the liquid nitrogen temperature. With two resistor heaters, the temperature was increased by 40 degrees, and different performance parameters were measured before and after irradiation. In the presentation, we will show the results of the I-V characteristic, DCR, timing and pulse height distribution, and the determination of the working temperature. We will show that the sensor can be used as a single photon detector by operating silicon photomultipliers at very low temperatures.

## Collaboration

## Role of Submitter

I am the presenter

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