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Characterization of first prototype of high-density NUV-HD SiPMs for near-UV light detection

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New high-density (HD) cell silicon photomultipliers (SiPM) for near-ultraviolet light detection have been recently produced at Fondazione Bruno Kessler. The NUV-HD SiPMs are an evolution of the standard NUV technology, based on a p-on-n junction and featuring peak detection efficiency in the region between 380 and 480 nm. With respect to the standard NUV SiPMs, the HD technology implements a new border structure, based on trenches, which provide both electrical and optical isolation of the single-photon avalanche diodes. This technology has been exploited to produce devices with small cells (from $30 \times 30 \mu\text{m}^2$ down to $12 \times 12 \mu\text{m}^2$) increasing at the same time the fill factor (FF), equal to 77% for the bigger cell and higher than 50% for the smallest one.

Thanks to the high FF, a photo-detection efficiency approaching 55% has been measured at 400 nm for the SiPM with $25 \times 25 \mu\text{m}^2$ cell size with a dark count rate of less than 150 kHz/mm² at maximum efficiency and 20°C. At the same time, the ability to reduce the cell size preserving FF leads to a proportional reduction of the gain and hence of after-pulsing and optical Cross-talk phenomena, mainly due to an effective reduction of the carriers trapped as well as the photons produced during the avalanche. The direct cross-talk and the after-pulse probabilities measured at maximum efficiency are equal to 25% and 2% respectively, halved with respect to the standard NUV devices.

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