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Characterization and possible astrophysics applications of UV sensitive SiPM devices

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Summary. — The National Institute of Nuclear Physics (INFN) is involved in the R&D of Silicon Photomultiplier (SiPM) sensors optimized to detect near-UV (NUV) photon radiation in low-intensity photons and high-precision time mesaurements, in collaboration with the Bruno Kessler Foundation (FBK). The performances of $6\times6\,\text{mm}^2$ NUV-HD SiPMs with $30\times30\,\mu\text{m}^2$ microcell area and the possible prospects for production and packaging of multi-sensor modules for astrophysical applications are discussed in this paper.

SiPM sensors are high performance, solid state photomultipliers with high signal amplification ($\sim10^6$) and short rise time o(ns), widely used in low-intensity photon detection applications. The $6 \times 6\,\text{mm}^2$ NUV-HD (Near UltraViolet - High Density) SiPMs, produced by FBK [1], are made of 40394 $30 \times 30\,\mu\text{m}^2$ microcells with a fill factor of $\sim$76%. They were tested in the laboratories of INFN to verify their performances for possible applications as Cherenkov light detectors.

The electrical characterization was made in a temperature controlled environment. The devices were characterized in current and in pulse mode. Their breakdown voltage (about 28 V) was evaluated from the dark current response as a function of the inverse bias, as reported in fig. 1(a). The current signal from the device was converted to a voltage pulse using an AdvanSiD Transimpedance Amplifier (TIA) [2] front end electronics board and read with an oscilloscope. To maximize the suppression of pile up, the dark count rate measurement was performed using the Differential Leading Edge Discrimination (DLED) [3] technique.

The devices show a low breakdown drift in temperature ($<30\,\text{mV}/^\circ\text{C}$, fig. 1(a)) and the maximum of the PDE in Near-UV region ($\sim$50% at $\sim$350 nm, fig. 1(b)). Furthermore, the SiPMs perform a low dark count rate ($<100\,\text{kHz}/\text{mm}^2$ at a temperature lower than $25\,^\circ\text{C}$, fig. 1(c)) and high gain ($\sim2\times10^6$ at $20\,^\circ\text{C}$, fig. 1(d)). These features confirm that these devices may be excellent light detectors to equip the focal planes of telescopes for ground based Imaging Air Cherenkov Telescopes (IACT) arrays.

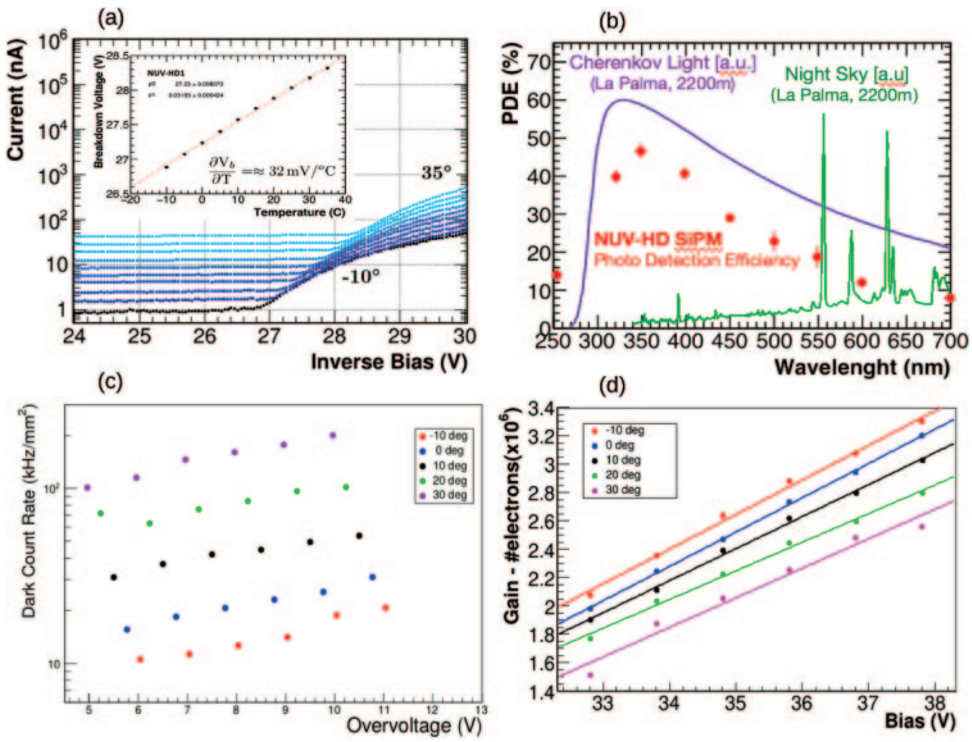

Fig. 1. – (a)Dark current measured at different temperatures as a function of applied bias; in the inset: temperature dependence for the breakdown voltage; (b) Photon Detection Efficency (red) as a function of wavelength, estimated Cherenkov signal spectra (purple) and background spectra (green) in La Palma site [4]; (c) dark count rate at different values of overvoltages and temperatures; (d) bias voltage dependence for the SiPM gain for several temperatures.

INFN is currently developing the concept, mechanics and electronics for the focal plane camera to equip a Schwarschild-Couder Telescope prototype. The procedures for packaging multiple SiPMs on modules are being developed for the assembling, test and commissioning of the prototype. Further details are available in [5] and [6].

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REFERENCES

[1] www.fbk.eu.
[2] http://advansid.com/.
[3] Gola A. *et al.*, *IEEE Trans. Nucl. Sci.*, **59** (2012) 358.
[4] Benn R. C. *et al.*, *New Astron. Rev.*, **12** (1998) 503.
[5] Vagelli V., these proceedings.
[6] Tosti L., *Disegno e caratterizzazione di un dimostratore di camera a SiPM per il piano focale dei telescopi dellosservatorio Cherenkov Telescope Array* (Master Thesis) 2016.