Contribution ID: **340** Type: **Poster**

Timing performance of FBK SiPM NUV-HD-MT technology

Monday, 27 May 2024 09:54 (1 minute)

The improvement of the timing performance is one of the main focus for several fields from high energy physics to biomedical applications such as Time of Flight Positron Emission Tomography (ToF-PET). In the last years, excellent results in terms of Single Photon Time Resolution (SPTR) and Coincidence Time Resolution (CTR) have been achieved thanks to the improvement of the scintillator crystal materials, the electronics readout and the detector development. In this study we will present SPTR and CTR measurements of the recently introduced FBK NUV-HD Metal in Trench (MT) SiPM technology. Thanks to the addition of the optically insulating material inside the trenches, FBK NUV-HD-MT devices show an extremely low CrossTalk (CT) of about $\simeq 5\%$ at $47.5V$ ($\simeq 15V$ excess bias). The Photon Detection Efficiency (PDE) reaches the $\simeq 65\%$ at the same excess bias at $420nm$.
By using a femto-second laser with a wavelength of $390nm$, we have measured the SPTR for SPADs with different microcell sizes and different versions with a metal mask outside the active area (capacitive coupling). Moreover, a $1mm \times 1mm$ and a $3mm \times 3mm$ SiPM with $40\mu m$ cell size and M0 masking version have been tested. The CTR has been measured using a $4mm \times 4mm$ SiPM to match the $3mm \times 3mm \times 5mm$ LYSO:Ce:Ca crystal. By using a high frequency readout electronics, we achieved a CTR of about $\simeq 80ps$ FWHM and an outstanding SPTR of about $\simeq 19ps$ and $\simeq 30ps$ FWHM for the SPAD and $1mm \times 1mm$ SiPM with $40\mu m$ M0 masking respectively.
This work opens the door to further investigations in order to study the worsening of the SPTR as the SPAD size increases but also to understand the role of the metal masking in the timing performance and to discuss about limitations and further improvements.

Collaboration

Role of Submitter

I am the presenter

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Session Classification: Photo Detectors and Particle ID - Poster session

Track Classification: T2 - Photo Detectors and Particle ID