Contribution ID: **232** Type: **Recorded Presentation**

Radiation hardness study using SiPMs with single-cell readout

Radiation hardness is one of the key properties of silicon photomultipliers (SiPMs) for their application in experiments with harsh radiation environments. After a certain level of irradiation it becomes impossible to resolve signals generated by a single photon from the noise and the main SiPM parameters cannot be determined from a single photo-electron distribution.

The possibility to readout a single cell enables the study of highly irradiated SiPMs, retaining the single-photon counting capability, which was not presented so far. A dedicated single-cell SiPM structure was designed and produced by Hamamatsu.

Measurements of such a structure were carried out to investigate the radiation damage effects on the parameters of SiPMs exposed to a reactor neutron fluence up to $\Phi = 5e13cm^{-2}$. A method for the data analysis is developed, which includes initial waveform processing, SiPM pulse recognition, validation and pulse parameters calculation. From the acquired data, the main SiPM parameters are extracted.
From the analysis of the data we observed a reduction of the gain by 17% and an increase of V_{off} by about $0.5\ V$ after $\Phi = 5e13cm^{-2}$.

The talk will present the novel studies on a single SiPM cell and the results on radiation damage effect on gain, breakdown voltage, dark count rate and photon detection efficiency.

Primary experiment

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Track Classification: SiPM