Contribution ID: **556**   Type: **Talk**

Analysis methods for highly radiation-damaged SiPMs

Thursday 21 February 2019 16:55 (20 minutes)

Measurements and analysis methods are presented with the aim to determine the SiPM performance after irradiation by neutrons to fluences between 10^9 and 5×10^{14} neq/cm^2. SiPMs with 4384 pixels of 15x15 µm2 produced by KETEK are used.

Following measurements and analyses will be presented to determine the fluence dependence of the SiPM parameters given in the list.

1. Y–f from which the pixel capacitance, quenching capacitance and quenching resistance are determined.
2. C–Vreverse for determining the doping profile and the electric field.
3. Idark–Vforward for determining the quenching resistance.
4. Idark–Vreverse for determining the breakdown voltage and estimating the dark-count rate (DCR), the pixel occupancy and saturation effects at high DCR values.
5. Iphoto-Vreverse for determining the breakdown voltage and the reduction of the photo-detection-efficiency (pde).
6. Transient_dark–Vreverse from the rms-spread of the Transient_dark integrrated over different time intervals the SiPM pulse decay time, the DCR and saturation effects due to high DCR are determined.
7. Transient_light–Vreverse from the mean and rms-spread of the Transient_light integrated over different time intervals, the SiPM gain and the pde are determined.

The assumptions and limitations of the analyses and ways how to minimise the loss of pde for a given radiation fluence, will be presented. If a parameter can be determined in several ways, the differences will be discussed.

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Session Classification: SiPM

Track Classification: SiPM