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# Investigation on electron beam radiation defects induced in KETEK PM3350 silicon photomultipliers

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In this work, the impact of electron irradiation on crucial SiPM parameters like dark current, dark count rate and PDE are investigated. Controlled radiation dose studies are important in order to provide precise quantitative information about SiPM radiation hardness [1]. The damage in silicon devices depends on the flux, type and energy of the particle.

The photodetectors, subjected to radiation, were KETEK "PM3350"type consisting of an active area of 3X3 mm2 with 50 μm micro pixel size. The photo detection efficiency is usually up to 38% (for ˜406nm) for these devices. Experiments have been performed at the linear accelerator (LINAC) machine at the National Institute for Laser, Plasma and Radiation Physics, Romania while their characteristics were measured at KETEK GmbH laboratories, Munich.
The samples were exposed gradually to different doses, so that the accumulated dose was linear dependent from one SiPM to another. Tests on IV and DCR characteristics have been performed before and after exposure with a low light level CCD using a probe station (sample was contacted with probe needles) and "Andor, Clara" type camera with "Mitutoyo, FS70"optical microscope. The exposures parameters are 28V (1kGy) and 26.50V (10kGy). The exposure time was set to 10min.

The electron beam irradiation has shown that a large increase in dark count rate and a partial loss of gain uniformity occur at relatively low doses. Before breakdown the dark current increases by ˜1order of magnitude for the 1kGy sample with respect to the reference. Increasing the dose to 10kGy led to an additional increase of the dark current by 5 orders of magnitude (not a linear dependence). Currents before breakdown are attributed to the surface and Si/SiO2 interface. The dark current intensity after breakdown increases by ˜2-3 orders of magnitude. Dark currents after breakdown are attributed to a superposition of contributions from the surface and the bulk. In order to investigate parameters like the the breakdown voltage, recovery time and PDE a lower dose or a smaller sample (for example 6x6μcell test structure) is required. These experiments are planned for the next stages of our investigations.

[1] S. Sanchez Majos, et. al. Nucl. Instr. & Meth. Phys. Res. A 602(2009) 506-510.

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## Has accepted

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