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Simulation of Low Gain Avalanche Detector characteristics based on the concept of negative feedback in irradiated silicon detectors with carrier impact ionization (Part II)

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The dependencies of the collected charge versus bias voltage and fluence for LGADs are calculated to fit experimental data. The calculations are based on two models of radiation degradation in Si detectors previously developed at the Ioffe Institute and adapted to the LGAD structure: 1) a model of two effective energy levels of radiation-induced defects responsible for the electric field profile, and 2) a mechanism of internal negative feedback responsible for the gain degradation in irradiated Si detectors with avalanche multiplication. It is shown that the developed models give adequate quantitative description of the experimental results for the LGADs including the detector pulse response. In irradiated LGADs negative feedback leads to the transfer of a significant fraction of the potential drop from the built-in layer toward the p+ contact. It initiates two negative effects, which both cause the gain degradation with irradiation: the lowering of the electric field in the n+-pbi region that reduces the multiplication probability, and the increase of the collection time and trapping-related charge losses.

Author: Dr VERBITSKAYA, Elena (Ioffe Institute)

Presenter: Dr VERBITSKAYA, Elena (Ioffe Institute)

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