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Time dependence of the behaviour of silicon detectors

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Semiconductor detectors are widely used in modern high energy physics experiments. They are elements of the high resolution vertex and tracking system, as well as of calorimeters
The bulk displacement damage in the detector, consequence of irradiation, produces effects at the device level: increases the leakage current, decreasing the satisfactory Signal/Noise ratio, produces carrier trapping, modifying the build-up space charge, changing the required operating voltage. These effects limit the utilisation of the detector as a position sensitive device. In silicon p-n junction detectors, after large irradiation fluences, the negative space charge dominates and the required operating voltage increases. The safe operating value of the depletion voltage limits the detector lifetime and thus the lifetime of detector systems. So, the prediction of time behaviour of detectors in hostile radiation environments, as those expected in the next generation of colliders, represents a very useful tool.
In some recent papers [1,2,3], the authors argued that the main source of discrepancies between data and previous models for degradation of device characteristics (leakage current and effective carrier concentration), especially after hadron irradiation, could be explained considering the contributions to these effects of the "usual"vacancy and the existence of a pseudo vacancy –the SiFFCD defect (fourfold coordinated vacancy defect).
In this contribution we predict the time degradation of silicon detectors –leakage current and concentration of effective carriers, in the radiation environments expected in the LHC machine upgrade in luminosity and energy as SLHC and VLHC respectively, for detectors fabricated using different silicon growth technologies. If these hypotheses are correct, thus, in conditions of continuous long time irradiation, as e.g. LHC and its upgrades, the contribution of primary defects will represent a major problem and must be considered. Also, this study permits to predict which materials are more adequate to obtain harder radiation devices, but experimental confirmations are needed.

References

[1] S. Lazanu, I. Lazanu, hep-ph/0410172
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[3] I. Lazanu, S. Lazanu, The role of primary point defects in silicon detector degradation due to irradiation, submitted to NIM B

Primary author: Dr LAZANU, Sorina (National Institute for Materials Physics, Romania)

Presenter: Dr LAZANU, Sorina (National Institute for Materials Physics, Romania)

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