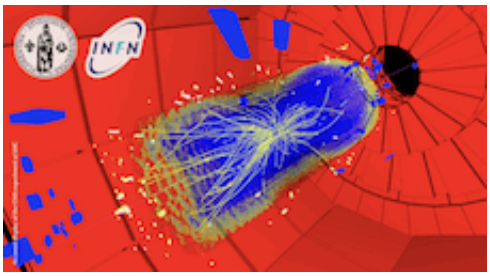

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Calculation of effective doping concentration alternation due to displacement damage in the n-type silicon detectors irradiated by protons of cosmic radiation

Cosmic radiation consist of Galactic Cosmic Ray (GCR) and Solar Particle Events (SPE), affect on electronic devices. Because of their high energy and fluence, space radiation can induced a kind of long term radiation damage mechanism, so called “displacement damage”. Therefore the silicon detectors exhibit macroscopic changes in their electrical characteristics which lead to a degradation in performance. This research has been focused on effective doping concentration (Neff) alternation in n-type silicon detectors in three consecutive stages. First is the estimation of 1-MeV neutron equivalent fluence using FLUKA code and second is numerical calculation for investigating of complex defects formed during irradiation via kinetic model. Eventually electric field profiles have been computed for every significant defect concentration. The results indicated that effective doping concentration alternation due to protons of SPE spectra is more significant than protons of GCR spectra and also n-type silicon is inverted to p-type in the amount of approximately10^12 [1/cm^2]of 1-MeV neutron equivalent fluence and after inversion, trend of Neff has increased linearly with 1-MeV neutron equivalent fluence. This value is generated when the actual amount of SPE fluence might reach up to 10^15 [1/cm^2] in several days during of solar events. It should be mention that maximum neutron equivalent fluence written in available valuable literature in CERN and other related research centers are up to 10^14 [1/cm^2].

Summary

In order to estimate the probable consequences of the long term exposure and to evaluate the displacement damage effects on electrical characteristics of silicon devices, the following steps have been followed:
•Determination of space radiation environment at 1AU using proportional models.
•Simulation of space environment (Source, target material and geometry) with FLUKA and processing of given estimators.
•Calculation of molecular dynamics and prediction of complex defect concentration via Davies model.
•Replacement of complex defect concentration value in the Poisson’s equations via applying finite element and then preparing electrical field profiles.
•Calculating effective doping concentration (Neff) by means of relevant governing equations.

In this work, it has been tried to simulate and follow-up time and spatial conditions as in Extra Vehicular Activity (EVA). In what follows assessment of displacement damage on n-type Float-zone silicon detector 300 µm thick, caused by protons of GCR and SPE spectra in deep space has been investigated.
It should be mentioned that all the proporthinal formula and resulted curves are available.

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