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Measurements and TCAD simulations of guard-ring structures of thin silicon sensors before and after irradiation

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The next generation of HEP experiments at future hadronic colliders (e.g., FCC-hh) will require tracking detectors to operate efficiently up to very high fluences (~ 1×10^{17} 1 MeV n_{eq}/cm^2). The design of the peripheral region, i.e., the guard-ring (GR) structure, is crucial to obtain high performing silicon detectors able to sustain high voltage values with minimum leakage current injection into the core region, especially when small substrate thicknesses are used.
In a recent R&D batch produced at FBK in the framework of the eXFlu project, different optimisation studies of the GR structures for thin substrates (ranging from 15 to 45 μm) up to high fluences have been addressed. These studies have been enabled thanks to Technology CAD simulations of GR structures, accounting for both different design strategies, e.g. zero-guard and multi-guard structures, extension of the periphery region, as well as the comprehensive bulk and surface damage effects induced by radiation on silicon sensors. Furthermore, an extensive test campaign has been performed on these GR structures, both before and after irradiation (up to 2.5×10^{15} 1 MeV n_{eq}/cm^2), to validate the development framework. This involves an analysis of the agreement between simulated and experimental data obtained from the sensors, and the impact of the various design options on their performance.
This contribution outlines the recent advances in this R&D activity, aiming to guide the design and optimisation of the GR structures for the future productions of thin silicon sensors for high fluence applications.

Collaboration

Role of Submitter

I am the presenter

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