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Overview of radiation hardness assurance studies for FCC

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Radiation effects on electronics pose a serious threat to the operation of a high-energy hadron accelerator such as the present LHC and future FCC-hh machines. In particular, Single Event Effects (SEEs) are the result of the interaction of a single particle with the sensitive volume of a component that compromise its operation and can even result in its permanent destruction in the case of hard errors. In addition, soft errors such as Single Event Upsets (SEUs) or Single Event Functional Interrupts (SEFIs) can typically be recovered from through a correction scheme or power reset, but depending on their criticality at a sub-system level, can also lead to equipment failure.

This work reviews the existing radiation tests standards for SEEs, mainly focused on the space environment and applications, and their adaptation to the high-energy accelerator mixed-field environment. It explores possible means of optimizing the qualification approaches for the future FCC-hh radiation field and component reliability constraints. Whereas present methods rely on proton and mixed-field testing, this work investigates the possible use of ultra-high energy (UHE, > 1 AGeV) heavy ions for the qualification at component and board level of accelerator equipment constituents. Such beams offer potential advantages with respect to proton and mixed-field testing, notably the reduced beam time, reduced total ionizing dose deposition in the components, as well as reduced activation. In addition, they do not suffer from the drawbacks of traditional heavy ion testing (~10 AMeV) mainly related to the limited penetration and possible inaccessibility to the component's sensitive volume.

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