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Next-Generation Tracking System for Future Hadron Colliders

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The design of future high-energy and high-intensity hadronic machines, such as FCC-hh, relies on the ability of detectors to sustain harsh radiation environments while keeping excellent performances on tracking and tagging all the interaction products. In order to face the challenge, a vast R&D effort is required.

In this contribution, we propose a novel concept of tracking system, that combines the possibility to track particles up to fluences of the order of 5-10·10^{16} n_{eq}/cm^2 together with a precise time information, σ_t ˜ 10 ps. For this purpose, Low-Gain Avalanche Diodes (LGAD) are the suited technology.

For the innermost, most irradiated portion of the detector, very thin sensors (20-40 μm) with moderate gain (˜5-10) can provide the required tolerance to the radiation. For such detectors, the internal gain mechanism of LGAD allows to provide the same amount of charge released by a particle passing 100-200 μm of standard PiN diodes up to ϕ ˜ 0.5·10^{16} n_{eq}/cm^2. Above those fluences, the thin doped layer responsible for the signal multiplication gets deactivated, but if operated at the proper bias voltage (˜500 V) the signal multiplication happens inside the whole irradiated bulk volume.

Moreover, in the region of the tracker detector where the level of overall fluence keeps ≤ 0.5-1·10^{16} n_{eq}/cm^2, LGAD with a geometry optimised for timing measurement can be used to provide precise position and timing information at the same time. Considering the current timing performances of LGAD under irradiation and assuming a σ_t ˜ 40 ps from sensor + ASIC, the usage of track-timing layers alternated to tracking only layers can provide an ultimate σ_t ˜ 10 ps per single track.

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