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LGAD and 3D as timing detectors

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In view of the High Luminosity upgrade of the CERN Large Hadron Collider (HL-LHC), radiation tolerant silicon sensors are being developed in the framework of ATLAS, CMS, RD50 and other sensor R&D projects. The HL-LHC beam parameters and hardware configuration should enable the collider to reach a peak instantaneous luminosity of 5×10^{34} cm^{-2}s^{-1}, and an integrated luminosity (total collisions created) of 250 fb^{-1}/year with the goal of 3000 fb^{-1} after about 12 years of operation. This will imply a factor 5 increase in instantaneous luminosity, and 10 in integrated luminosity with respect to the LHC. This increase in luminosity will also imply a factor 4 rise in the expected pile-up with respect to that observed during Run 2 of the LHC in ATLAS and CMS. Lastly, at the end of the operation period, radiation levels are expected to reach values above 1.6×10^{16} fast hadrons/cm^2 at the innermost detectors.

To cope with the increase in pile-up, silicon sensors with timing capabilities of the order of $\sim$ 10 ps are being developed. Given the expected radiation levels, the radiation-tolerance of these devices is of the utmost importance. In order to tackle these issues, one line of research investigates the possibility of producing radiation tolerant silicon sensors with intrinsic charge gain: Low Gain Avalanche Detectors (LGADs). The aim is to improve the signal height after irradiation as well as the timing capabilities of silicon sensors. Another approach is the use of 3D sensors. The implementation of 3D devices would resolve some of the issues arising from using LGADs such as gain-loss, radiation hardness at fluences beyond 10^{15}cm^{-2}, or a reduced fill factor.

The aim of this presentation is to give an overview of both technologies, their performance, and their current development status for timing applications.

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