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Silicon Sensor and Detector Developments for the CMS Tracker Upgrade

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CMS started a campaign to identify the future silicon sensor technology baseline for a new Tracker for the high-luminosity phase of LHC, coupled to a new effective way of providing tracking information to the experiment trigger. To this end a large variety of 6"wafers was acquired in different thickness's and technologies at HPK and new detector module designs were investigated. Detector thickness's ranging from 50μm to 300μm are under investigation on float zone, magnetic Czochralski and epitaxial material both in n-in-p and p-in-n versions. P-stop and p-spray are explored as isolation technology for the n-in-p type sensors as well as the feasibility of double metal routing on 6"wafers. Each wafer contains different structures to answer different questions, e.g. influence of geometry, Lorentz angle, radiation tolerance, annealing behaviour, validation of read-out schemes. Dedicated process test-structures, as well as diodes, mini-sensors, long and very short strip sensors and real pixel sensors have been designed for this evaluation. The structures will be exposed to fluences composed of protons and neutrons representing the mixture of charged hadrons and neutrons as expected in the CMS Tracker after an integrated luminosity of 3000/fb at several radii. At the same time simulation studies were performed on how identification of high-momentum particle tracks, as a part of the Level 1 Trigger, can be achieved by correlating hits on two closely spaced sensors (stacked modules), making use of their strip or pixel cluster widths and positions to estimate the track bending in the high CMS magnetic field. This contribution provides an overview of the individual sensor structures and their characteristics and of the construction of different types of stacked modules for trigger studies, and summarizes interesting measurements performed so far.

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