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Radiation hard silicon sensors for the CMS tracker upgrade (Not Wednesday early morning)

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At an instantaneous luminosity of 5 × 1034 cm−2 s−1, the high-luminosity phase of the Large Hadron Collider (HL-LHC) is expected to deliver a total of 3000 fb−1 of collisions, hereby increasing the discovery potential of the LHC experiments significantly. However, the radiation dose of the tracking systems will be severe, requiring new radiation hard sensors for the CMS tracker. The CMS tracker collaboration has initiated a large material investigation and irradiation campaign to identify the silicon material and design that fulfills all requirements for detectors for the high-luminosity phase of the Large Hadron Collider (HL-LHC). Focusing on the upgrade of the outer tracker region, pad diodes as well as fully functional strip sensors have been implemented on silicon wafers with different material properties and thicknesses. The samples were irradiated with a mixture of neutrons (1 MeV) and protons (23 MeV, 800 MeV and 23 GeV) corresponding to fluences as expected for the positions of detector layers in the future tracker. Three different proton energies were used for irradiations to investigate the energy dependence of the defect generation in oxygen rich material. The measurements performed on the structures include electrical sensor characterization, measurement of the collected charge injected with a beta source or laser light and bulk defect characterization. In this talk, results and conclusions of the campaign are presented, with a focus on the recent decision to use p-bulk silicon strip sensors in the outer tracker of CMS.

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