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Trapping in p-on-n silicon sensors at fluences relevant for the HL-LHC

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Effective trapping rates in 200 um thick n-type silicon sensors are determined after irradiation of up to 3 x 10¹⁵ neq/cm2 for electrons and holes.

For this pulsed red laser light with a wavelength of 672 nm is used to generate electron-hole pairs close the the electrodes of single-pad sensors (diodes).
The charge-collection efficiencies were determined separately for electrons and for holes drifting through the sensor, and they were used to extract the effective trapping rates by comparing the results to simulations.

The electric field was simulated in Synopsys TCAD device simulations assuming two effective defects. Different literature values for the defect concentrations and the cross sections were used for low-energy protons (23 MeV) and high-energy protons (23 GeV). The generation and the drift of charge carriers were simulated in an independent simulation based on PixelAV.

The effective trapping rates which describe the measured charge-collection efficiencies were determined and simulated and measured time-resolved current pulses have been compared.

The trapping rates determined for both electrons and holes are about 50% lower compared to often-used extrapolations of earlier studies which were done at lower fluences. Hence an improved tracker performance is predicted.

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