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## TCAD simulations of pixel sensors for the ATLAS ITk upgrade and performance of annealed planar pixel modules

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In view of the high luminosity phase of the LHC (HL-LHC) to start operation around 2026, a major upgrade of the ATLAS inner tracker system is in preparation. Thanks to their reduced power dissipation and high charge collection efficiency after irradiation, thin planar pixel modules are the baseline option to instrument all, but the innermost layer of the pixel system.

To optimise the sensor layout for a pixel cell size of  $50 \times 50 \mu\text{m}^2$ , TCAD simulations are being performed. Charge collection efficiency, electronic noise and electrical field properties are investigated. Two radiation damage models are employed to estimate the performance before and after irradiation.

The effects of storage time at room temperature for the ITk pixel detector during maintenance periods are reproduced using sensors irradiated up to a fluence of  $1 \times 10^{16} \text{ n}_{\text{eq}}/\text{cm}^2$ . Pixel sensors of 100-150  $\mu\text{m}$  thickness, interconnected to FE-I4 read-out chips with pixel dimensions of  $50 \times 250 \mu\text{m}^2$ , are characterised using the test-beam facilities at the CERN-SPS and DESY. The charge collection and hit efficiencies are compared before and after annealing at room temperature up to one year.

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