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TCAD and Monte Carlo simulations of 3D pixel sensors

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Unlike traditional planar sensors in which different types of electrodes reside on the surfaces of the wafer, 3D sensors have both types of electrodes penetrating deep into the silicon bulk. This special configuration allows for the separation of the charge drift distance from the wafer's thickness, enabling 3D sensors to provide high temporal resolution and strong radiation hardness through adjustment of the inter electrode spacing.
Decades of R&D of 3D sensors have yielded excellent results, including the the 3D Double-side Double-column sensors (3D-DDTC) installed in the ATLAS Inner B-Layer (IBL). However, the double-sided technology necessitates thick wafers to alleviate wafer bowing issues, limiting the achievable minimum pixel size. Consequently, extensive studies have been conducted on 3D sensors based on single-sided technology, resulting in promising outcomes and paving the way for a new generation of 3D sensors known as small-pitch 3D pixel sensors, chosen for integration into the ATLAS Inner Tracker (ITk).
In addition to cylindrical electrodes, trench-shaped electrodes are also feasible. The unique shape of these electrodes ensures a uniform distribution of the electric field, thereby promises even better temporal resolution and radiation hardness. Preliminary test results have demonstrated a temporal resolution of approximately 10 ps, with no degradation observed after exposure to radiation damage levels up to $3.5*10^{16}$ n_{eq}/cm^2.
This presentation provides an overview of the development of 3D sensors with various designs. Furthermore, TCAD simulations and Monte Carlo simulations based on Allpix^2 to evaluate the intrinsic performance of 3D pixel silicon sensors will be discussed.

Will the talk be given in person or remotely?

In person

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