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P1.51: Design and TCAD simulation of modified 3D-trench electrode sensors

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Future experiments at high-luminosity hadron colliders will involve unprecedent levels of pile up, calling for ultrafast detectors in order to add time information to distinguish between particle tracks. The unique geometry of 3D sensors enables to achieve very good timing performance, with the additional benefit of high radiation hardness. Remarkable results in terms of timing resolution have been reported for 3D sensors with columnar electrodes (˜30 ps) [1] and even better with trenched electrodes (˜10 ps) [2], because of a more uniform distribution of the electric field and weighting field. However, 3D-trench technology is more complex, and has still to be optimized in terms of both fabrication process and pixel layout. To this purpose, as an alternative to the existing design which features continuous (p+) ohmic trenches, we propose a new variant with dashed p+ trenches. This modification is aimed at reducing the lithographical defects that were observed in mm's long ohmic trenches, thus improving the fabrication yield. The performance of the two designs has been compared by TCAD simulations. The gaps between the p+ trenches can be made small (˜10 μm) and placed offset with respect to the readout (n+) trenches, so that the impact on the uniformity of the electric and weighting field is minimum, and good timing performance is preserved. This is confirmed from the analysis of 2d maps of the instantaneous current, *i*, induced at the electrodes according to Ramo's theorem: $i = qEw \cdot vd$, where q is the elementary charge, Ew is the weighting field and vd is the carrier drift velocity, as obtained from TCAD simulations. As an example, Figure 1 shows the Ramo's maps for electrons for the existing and modified designs, that are indeed very similar. The considered designs have been implemented in a fabrication batch currently under way at FBK in the framework of the AIDA-Innova Project. A comprehensive TCAD study, including post irradiation performance based on advanced radiation damage models, will be presented at the Conference.

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