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Planar slim edge ATLAS pixel sensors for the IBL and high-lumi-LHC upgrades

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The pixel detector is the innermost tracking detector of ATLAS which requires hermeticity to achieve superb track reconstruction performance. The current planar n-type sensors feature an active pixel matrix of n+ implantation and, so called, guard rings on the opposite p-side to reduce the high voltage stepwise. Because of the inactive safety margin around the active area, the sensor modules have been shingled on top of each other's edge which limits the thermal performance and adds complexity in the present detector.
For the insertable b-layer (IBL) and the high-lumi-LHC upgrade of ATLAS, a flat arrangement of sensors is foreseen. If the inactive edge is reduced from 1100 um down to about 250um (slim edge) the required level of hermeticity can be achieved.

In this presentation it will be shown that the essential reduction of the inactive edge is feasible by still fulfilling the IBL quality criteria concerning electrical specifications and breakdown behaviour. This is firstly achieved by monitored dicing into the safety margin, secondly by the reduction of number of guard rings and thirdly by shifting them beneath the active pixel area.

Dedicated designed and produced pixel sensors were studied in test beams to investigate the efficiency performance in the edge region of unirradiated sensors and those ones irradiated up to IBL fluences.

On the basis of these results we designed and produced planar n-type sensors adapted to the new read-out chip (FE-I4) with different bulk thicknesses. These sensors are designated candidates for IBL as well as one option for high-lumi-LHC. First unirradiated and irradiated sensor-chip-assemblies have already proven their performance during test beams.

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Author: Mr WITTIG, Tobias (TU Dortmund)

Co-authors: Mr RUMMLER, Andre (TU Dortmund); Prof. GOESSLING, Claus (TU Dortmund); Dr MUENSTERMANN, Daniel (CERN); Mr TROSKA, Georg (TU Dortmund); Mrs JENTZSCH, Jennifer (TU Dortmund); Dr KLINGENBERG, Reiner (TU Dortmund); Mrs ALTENHEINER, Silke (TU Dortmund); Mr LAPSIEN, Tobias (TU Dortmund)

Presenter: Mr WITTIG, Tobias (TU Dortmund)

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