Contribution ID: **146** Type: **Oral Presentations**

Novel pixel sensors for the Inner Tracker upgrade of the ATLAS experiment

Thursday, 7 September 2023 12:40 (20 minutes)

The High Luminosity upgrade of the Large Hadron Collider at CERN, the HL-LHC, is expected to provide up to 200 proton-proton interaction per bunch crossing delivering about 4000 fb^{-1} of data over 10 years.
To operate in such a harsh particle environment the present inner detector of ATLAS experiment will be replaced by a completely new Inner Tracker (ITk). The pixel detector, which is the innermost part of the ITk, will have to face an extremely large particle multiplicity and a consequent huge radiation fluence up to $2\times10^{16} n_{eq}/cm^2$. The pixel modules are therefore designed with a fine granularity employing pixel cells of 25×100 μm^2 in the innermost barrel layer and 50×50 μm^2 pixel cells in the remaining four layers and in the rings. Moreover, the pixel detector will be built with different sensor technologies depending on the distance from the proton interaction point and the consequent radiation levels expected.
Thin n-in-p planar sensors with 150 µm and 100 µm thick active substrates will instrument the outermost pixel layers and the second innermost layer, respectively; 3D silicon sensors produced with a single side process will instead instrument the innermost layer due to their superior radiation hardness.
The production of all sensor types for ITk is about to start, and the first pre-production sensors and modules have been already delivered and evaluated by the ATLAS Collaboration.
In this contribution we will present the performance of the different 3D and planar pre-production sensors as well as the result of the first modules assembled with the latest revision of the final readout chip, the ITkPix. Particular focus will be given to the evaluation of the radiation hardness of these sensors which have been irradiated up to the doses expected at the HL-LHC.

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Session Classification: F5