



iWoRiD 2022

## 23rd International Workshop on Radiation Imaging Detectors

26 – 30 June 2022

Riva del Garda, Italy

Contribution ID: 47

Type: Poster

# Specifications and Pre-production Experience of $n^+$ -in-p Large-format Strip Sensors fabricated in 6-inch Silicon Wafers, ATLAS18, for Inner Tracker of ATLAS Detector for High-Luminosity Large Hadron Collider

Monday 27 June 2022 16:20 (1 minute)

The full volume of the inner tracker of the ATLAS experiment will be replaced with new all-Silicon detectors for HL-LHC. The strip detectors, in the radial extent of 40 to 100 cm, are made of four layers of cylindrical-structures in the barrel and six layers of disk-structures in the endcap section with 2 layers of strip sensors for stereo-viewing in each layer-structure. The corresponding area of strip sensors, at 165 m<sup>2</sup>, will be covered with 10976 barrel and 6912 endcap sensors. A new approach is adopted to use p-type material to be more radiation-tolerant, making the readout in n-strips, so-called  $n^+$ -in-p sensors, to cope with the fluence and ionizing dose of  $9.7 \times 10^{14}$  ( $1.6 \times 10^{15}$ ) 1-MeV neutron-equivalent ( $n_{eq}$ )/cm<sup>2</sup> and 44 (66) Mrad at the maximum in the barrel (endcap in the parenthesis) section, for its lifetime including a safety factor of 1.5. In the barrel sensors, the geometry is square,  $9.8 \times 9.8$  cm<sup>2</sup>, to have the largest area of sensor possible from a 6-inch wafer. The strips are laid out in parallel with a strip pitch of 75.5  $\mu$ m and 4 or 2 rows of strip segments in two types of sensors, “short strips (SS)” for the inner 2 layers and “long strips (LS)” for the outer 2, respectively. In the endcap, we have designed roughly trapezoidal sensors with built-in stereo angle, curved edges along the circumference, and in 6 different shapes in each radial extent, R0 to R5. The strips are in fan geometry, with a mean pitch of approximately 75  $\mu$ m and 4 or 2 rows of strip segments. The readout is AC-coupled and the strips are biased via Polysilicon resistors for all sensors. The sensors of this specification are labelled as “ATLAS18xx” where xx stands for SS, LS, Rx (x=0 to 5). With the specifications of mechanical features and electrical performance, CAD files for processing were laid out by succeeding from a sequence of successful designs of ATLAS12 and ATLAS17LS of the barrel sensors, and ATLAS12EC/R0 of the R0 endcap sensors, together with a number of optimizations. In the open space of the wafer outside the main sensor, called “halfmoons”, we laid test structures, miniature sensors, monitor diodes, etc. for monitoring the processing and wafer characteristics. “Pre-Production” amount of 1041 wafers were fabricated and delivered with the tests carried out by vendor. The quality of the sensors was reviewed through the data as provided by the vendor. These sensors were used for establishing and exercising acceptance procedures, and subsequently to be used for pre-production of strip modules and layer structures.

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**Session Classification:** Poster