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Detailed Studies of Full-Size ATLAS12 Sensors

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The "ATLAS ITk Strip Sensor Collaboration" R&D group has developed a second iteration of single-sided n -in- p type micro-strip sensors for use in the tracker upgrade of the ATLAS experiment at the High-Luminosity (HL) LHC.

The full size sensors measure approximately $97 \times 97 \text{ mm}^2$ and are designed and engineered for tolerance against the $10^{15} \text{ 1 MeV n}_{eq}/\text{cm}^2$ fluence expected at the HL-LHC. Each sensor has 4 columns of 1280 individual channels arranged at $74.5 \mu\text{m}$ horizontal pitch.

Three batches comprising of 100 unirradiated sensors, all produced by Hamamatsu Photonics, were evaluated for their mechanical, bulk and strip characteristics.

Non-contact optical microscopy measurements were performed to obtain the sensor surface profile and sensor thickness. The leakage current and bulk capacitance properties were measured for each individual sensor. For sample strips across the sensor batches, the inter-strip capacitance and resistance as well as properties of the punch-through protection structure were measured. A custom-built multi-channel probecard was used to measure leakage current, coupling capacitance and bias resistance for each individual strip on every sensor.

The compiled results for 100 non-irradiated sensors are presented in this paper, including summary results for over 500'000 strips probed. Results on the reverse bias voltage dependence of various parameters and frequency dependence of tested capacitances are included for validation of the experimental methods used. Where possible, results are compared with the result data delivered by Hamamatsu Photonics.

It was verified that the sensors satisfy the specifications for unirradiated sensors, with almost all sensors falling well within specification.

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