

The Phase-2 ATLAS ITk Pixel Upgrade

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The entire tracking system of the ATLAS experiment will be replaced during the LHC Phase II shutdown (foreseen to take place around 2025) by an all-silicon detector called the “ITk” (Inner Tracker).

The innermost portion of the ITk will consist of a pixel detector with stave-like support structures in the most central region and ring-shaped supports in the endcap regions; there may also be novel inclined support structures in the barrel-endcap overlap regions. The new detector could have as much as 14 m² of sensitive silicon. Support structures will be based on low mass, highly stable and highly thermally conductive carbon-based materials cooled by evaporative carbon dioxide.

The ITk will be instrumented with new sensors and readout electronics to provide improved tracking performance compared to the current detector. All the module components must be performant enough and robust enough to cope with the expected high particle multiplicity and severe radiation background of the High-Luminosity LHC.

Readout will be based on the new front-end ASIC being developed by the RD53 Collaboration. Ideally the readout chips will be thinned to as little as 100 μm to save material; this presents a challenge for sensor-chip interconnection and options are being evaluated in collaboration with industrial partners to develop reliable processing techniques.

Servicing the detector reliably without introducing excessive amounts of material and dead space is another significant challenge. Data cables must be capable of handling up to 5 Gb/s and must be electrical in nature, with optical conversion at larger radii where the radiation background is less intense. Serial powering has been chosen as the baseline for the ITk pixel system as it minimises service cable mass; extensive testing has been carried out to prove its feasibility.

Attention must also be paid to grounding and shielding in the detector to mitigate cross-talk and common mode noise.

Most of the baseline technological decisions will be taken this year in view of the ITk Pixel TDR to be completed by the end of 2017.

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