Title: The ATLAS ITk Pixel Detector. The biggest challenges from design to construction.

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(the speaker to be selected by the ITk Speakers Committee after the contribution acceptance)

Abstract.

In the HL-LHC era, the radiation is expected to reach unprecedented values, with non-ionizing fluence of 1e16 n_{eq}/cm^2 and ionizing dose of 5 MGy. To cope with the resulting increase in occupancy, bandwidth, and radiation damage, the current ATLAS Inner Detector is replaced by an all-silicon system. The Pixel Detector will consist of five-barrel layers and a number of rings, resulting in about 13 m^2 of instrumented area. The ITk pixel system has been very carefully designed including three different flavours of silicon hybrid detectors equipped with novel ASICS and data transmission chains. A new serial powering scheme has also been developed to minimize the amount of material in the detector. Along the lifetime of this project from design to prototyping (current) stages many challenges have been encountered and unforeseen problems have to be solved.

In this contribution, an overview of the ITk pixel detector layout and the most challenging tasks resolved by now will be shown.

From the mechanical point of view, the detector's structure has to be robust and light providing support to the whole system, including local supports for modules and electronics, cables to power the detector and to drive the data in and out of the volume and cooling. All material and structures are designed to withstand all the possible conditions and cycles along the life of the detector. A customized cooling system will allow the operation of the detector at -35 C. Therefore, the detector will be exposed to a large number of temperature cycles that will stress it. Prototypes of mechanical supports systems at different stages of the project are tested and qualified. The environmental conditions at different locations within the pixel system will be monitored and linked to an interlock system that will protect the detector from major damages in case of any malfunction. Achieving that requires that the operation conditions of every pixel module are monitored by a Detector Control System (DCS).

Due to the HL-LHC collisions rate, the data needs to be driven form the front-end chip to the opto-electrical conversion system with high-speed transmission parallel lines (TwinAx cables) running at 1.28 Gb/s per data link. An Optosystem features custom designed radiation-hard electronics devoted to signal equalization, aggregation (to 10.24 Gb/s) and opto-electrical conversion.

Regarding the active part of the system, the pixel modules have gone through an extensive R&D program to identify what sensor technologies and thicknesses will be used in the final detector to achieve the best possible tracking performance. Prototypes have been already loaded on demonstrators and are going through exhaustive testing and qualification campaigns. The highlights of this effort together with the outcome can be expected within this contribution.

At the end of this contribution the audience will get a good understanding of the status of the ATLAS-ITk pixel project and what have been the biggest challenges faced up to the day of this presentation and what are the major ones that we still have to overcome.