



Contribution ID: 155

Type: **Oral Presentations**

Module development for the ATLAS ITk Pixel Detector

Wednesday, 6 September 2023 16:40 (20 minutes)

Abstract:

In HL-LHC operation the instantaneous luminosity will reach unprecedented values, resulting in about 200 proton-proton interactions in a typical bunch crossing. The current ATLAS Inner Detector will be replaced by an all-silicon system, the Inner Tracker (ITk). The innermost part of ITk will consist of a state-of-the-art pixel detector.

Several different silicon sensor technologies will be employed in the five barrel and endcap layers.

Based on first modules assembled using the RD53A prototype readout chip, numerous issues are studied, and solutions found. These included production issues like bump bonding of large area, thin modules, as well as layout issues like optimization of the bandwidth and sharing of links between multiple chips and modules. The talk will present results of many of these studies, which directly impacted the construction and assembly of pre-production modules using the first production version of the readout chip ITkPixV1. The status of the ITk preproduction pixel module will be presented.

Summary:

In this work the latest results with the latest pre-production ITkpix pixel module will be presented. In the ITk pixel system there are 5 pixel layers and there will be different module flavours depending on their distance with respect to the interaction point:

- In L2-4 there will be quad modules with 150 μm thick planar sensors.
- In L1 there will be quad modules with 100 μm thick planar sensors.
- In L0 (the innermost layer) three different flavours of triplet modules will be used with different pixel sizes and hybrid shapes all on 150 μm active thick substrates but:
 - 50 x 50 μm^2 pixel size in the endcaps (rings)
 - 25 x 100 μm^2 pixel sizes in the barrel (staves)

The reasons for the election of the different technologies will be justified. The different assembly procedures and challenges found on the module prototyping phase will be described.

About 15,000-pixel modules will be built for the Inner Tracker. The module assembly requires very high precision and custom designed tooling that can provide extreme accuracy. Design aspects of the components and tooling will be discussed.

The module design is validated for bump delamination caused by thermal stress due to the wide operational temperature range of -45 and +40°C. Results from the design validation will be presented.

All the modules have to undergo an exhaustive quality control protocol based on metrology and electrical functionality. These tests ensure that the whole detector will fit without problems within the tight ATLAS volume available, perform electrically within a serial power chain within the tight powering envelope and with the required pixel analogue and digital performance.

Final QC test of each module will include a thermal cycling in a wide range of temperatures between -45 and +40°C in order to estimate reliability of the modules. All electrical parts of the pixel modules need to be carefully tested and the modules which did not meet the required specifications will be rejected during production. A description of the QC procedure and the most recent test results will be presented, including the results of basic and advanced pixel module tests.

Primary author: Dr BATES, Richard (University of Glasgow)

Presenter: Dr SAIMPERT, Matthias (CEA Saclay IRFU/DPhP)

Session Classification: E1