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RD53A pixel module assembly and testing experience

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The entire tracking system of the ATLAS experiment will be replaced during the LHC Phase II shutdown. A new silicon Inner Tracker (ITk) will contain five innermost pixel layers equipped with new sensors and readout electronics capable to improve the tracking performance, cope with the high particle multiplicity and work in a high luminosity environment. In order to standardize modules of the ITk, the idea of a common hybrid module was introduced. The common hybrid module assembly and testing techniques will be presented. The module construction, metrology and electrical testing results will be discussed.

Summary (500 words)

The entire tracking system of the ATLAS experiment will be replaced during the LHC Phase II shutdown. A new silicon Inner Tracker will contain five innermost pixel layers equipped with new sensors and readout electronics capable to improve the tracking performance, cope with the high particle multiplicity and work in a high luminosity environment provided by the LHC. The total surface area of silicon covered by the new pixel detector will be up to 14 m2.

About 10 000 pixel modules will be built for the Inner Tracker. Serial powering has been chosen for the Inner Tracker pixel detector in order to minimize the amount of service cables. A low-mass support structure of the system will consist of long barrel staves and inclined sections. In order to standardize modules of the Inner Tracker, the idea of a common hybrid module was introduced to be used in all regions of the detector. The common hybrid module assembly procedure, methods and challenges during the module production will be presented. The module construction, metrology and electrical testing results will be discussed. In this talk we will describe the steps of the pixel module production starting from the reception of the bare components and until the final electrical testing of the modules. Design aspects of the components and tooling will be discussed as well. One of the main challenges during the production was the gluing precision of hybrid modules required to be at the level of 40 ± 25 µm. That precision level requires a very accurate tooling which will be described. Also all otherdimensions of the modules were measured with a micrometre precision since they are very important parameters in the tight volume of the new ATALS pixel detector. After the module assembly the detailed electrical test of each of them was done in different conditions. All electrical parts of the pixel modules were carefully tested and the modules which did not meet the required specifications were rejected. The final test of each module was a thermal cycling in a wide range of temperatures between -45 and +40℃ in order to estimate reliability of the modules. We will present methods to avoid humidity at low temperatures, which is of critical importance for module testing. The results of basic and advanced pixel module tests will be discussed. Since the final destination of the assembled modules will be a new Outer Barrel demonstrator at CERN, the logistics points will be discussed as well.

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