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System level tests of large-scale multi-module prototype structures of the ATLAS ITk pixel detector

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The ATLAS collaboration will replace its inner detector by an all-silicon tracker (ITk) for the HL-LHC. The new pixel detector will cover a sensitive area of 13m^2. The pixel modules are loaded on light-weight carbon structures in the form of (half)rings and staves. Electrically functional prototypes of these local supports based on the RD53A readout chip were built and extensive system-level tests of these structures were carried out evaluating serial powering, grounding and shielding, system monitoring, and the overall performance of the multi-module detector systems.
In this contribution, the results of these system tests will be presented.

Summary (500 words)

The ATLAS collaboration is going to replace its entire inner detector by an all-silicon inner tracker (ITk) in order to be able to cope with the harsh conditions of the HL-LHC in terms of data rate and radiation damage and to extend the tracking to a pseudo rapidity of 4.0. One part of ITk is a new pixel detector made of planar and 3D silicon sensors with an overall sensitive area of 13m^2. The readout chip is developed by the RD53 collaboration and features serial powering in order to save material in the required power cables. For further material reduction, the detector is going to use 2-phase CO2 cooling. The detector modules are loaded on light-weight carbon structures in the form of (half)rings and staves which represent feature-complete building blocks of the final pixel detector. Electrically and thermally functional prototypes of these local support structures have been built based on a close-to-final detector design. Extensive tests of these structures on system level have been carried out evaluating aspects like serial powering, grounding and shielding, monitoring, and the overall module performance after the integration into a multi-module detector system. The completion of these tests mark a very important milestone in the prototyping phase of the ITk pixel detector design and allows to transition to pre-production of these detector parts. Valuable experience was gained during the electrical testing of the components (and their interplay) which for the first time work together on the level of local supports. This integration aspect of many different electronics components makes the results very interesting for the audience at TWEPP.

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