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Serial Powering Pixel Stave Prototype for the ATLAS ITk upgrade

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A Serial Powering Stave Prototype has been developed using FE-I4 Quad Pixel Modules in order to investigate a Serial Powering scheme for ATLAS ITk Phase II Pixel upgrade.

The talk will explain the need for a new powering scheme which is different from the currently used parallel (direct) powering in order to power detector modules for the ATLAS ITk Phase II Pixel upgrade. The Serial Powering building blocks will be introduced and the full scale prototype will be described. Detailed investigations of the electrical performance including robustness against noise and power failures will be shown.

Summary

ATLAS ITk is a new inner tracker that will be built for the Phase II upgrade in order to meet the requirements of increased Luminosity.

Current pixel detector modules are powered according to the parallel (direct) powering scheme: each detector module is powered with an independent power supply and a set of cables. With this powering scheme modules can be operated individually, which is a big advantage. However, due to increased granularity of the detector more cables are needed for powering. Increased FE current consumption leads to increase in cable cross section. All these increases power losses in the cables as well as the amount of passive material in the active detector volume. Finally, it results into unwanted interactions of particles with the inactive part of the detector and degradation of the detection performance.

The solution is to use a new powering scheme, different from direct powering. Proposed options are Serial Powering and DC-DC converters scheme. Serial Powering scheme is the main focus here.

A Serial Powering Pixel Stave Prototype has been developed using FE-I4 Quad Modules in order to investigate a Serial Powering scheme for ATLAS ITk Phase II upgrade. The Stave Prototype holds 6 Quad Pixel Modules that are connected in series and powered with a constant current source. Shunt-LDO regulators, that are a combination of shunt and linear regulator, are used at the module level to generate the supply voltage out of the constant current. Some of the modules have on-flex PSPP chip, which allows bypassing a particular module to avoid loosing a complete Serial Powering chain if only one module is failing. PSPP chips are controlled via an additional control and power lines. AC-coupled data transmission is used because modules are on different ground potentials. End of Stave connections provide power for the modules, high voltage for the sensors, cooling and readout lines. The Readout is implemented with the help of the USBpix3 readout system that was developed in Bonn.

Various characterization measurements have been performed with the Stave Prototype. 6 modules were tuned successfully to ATLAS IBL target values. Performance studies with noisy and bypassed modules were made. Both static and dynamic bypassing effects were investigated. The minimum operational threshold of the Serial Powering system was determined with two different methods. 2-trigger threshold and noise occupancy scans with different Trigger lengths were performed with modules tuned to IBL target values and to the minimum threshold.

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