

Installation, integration and first operating experiences of the ALICE ITS Upgraded Readout System

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The ALICE Inner Tracking System has gone through a significant upgrade for the upcoming third running period of the CERN LHC. The new detector consists of seven layers of high-granularity pixel sensors, while 192 custom FPGA-based readout units control the sensors and transmit the data upstream for analysis. This contribution describes the current system status and the expertise gained by moving from commissioning to the installation and throughout the data-taking preparation period, focusing on the intricate integration with other system components. Furthermore, we outline strategies applied to identify and handle various error conditions of the readout system.

Summary (500 words)

The new ALICE Inner Tracking System (ITS) is using a total of 24120 ALPIDE monolithic active pixel sensors arranged as staves in a seven-layer cylinder configuration. The upgraded system design specifications allow data taking of a minimum of 100 kHz Pb-Pb and 400 kHz pp events, but the final design can achieve even higher interaction rates. The sensors chips are fully controlled by 192 readout units (RU), one per staff. The RU's main component is a Xilinx UltraScale FPGA that is responsible for the four primary operations:

1. Configuration of the sensors.
2. Distribution and control of triggers from the Central Trigger Processor (CTP) to the sensors.
3. Aggregating and formatting the data sent from the sensors electrically and forwarding it upstream to the ALICE Common Readout Unit (CRU) on optical links.
4. The monitoring and control of the sensors' voltage and current supply, controlling the Power Boards.

The ALICE ITS detector and its readout electronics were installed in the ALICE cavern in early 2021. In this contribution, we will present the status of the ALICE ITS detector readout electronics. Furthermore, we will describe the first experiences made going from commissioning to the installation in the ALICE cavern. This transition period is demanding since many issues can be revealed and addressed. Especially when integrating the readout system with other components, like the CTP, the CRU, and the various software for detector control and data distribution, issues and obstacles can be exposed and addressed. The integration process is further complicated by the continuing development of both firmware and software. We will report some of the lessons learned while integrating all the components of the system.

During the installation and preparation for data taking, the focus has been to optimize the system and reduce the number of potential data-taking inefficiencies that can arise during a run. We expect that the readout electronics will need to handle several types of anomalous conditions brought about by external factors. For instance, issues with cooling, powering, or single-event effects might provoke transient functional errors that can cause problems with correctly sampling data from the sensor links. During a run, the ultimate goal is that data reading efficiency is maximized. This is the reason why significant efforts have been directed into analyzing the possible error conditions of the system that might inhibit our objective. We will present some of the methods applied to cope with prospective issues.

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