Contribution ID: **130** Type: **Poster**

An FPGA-based Data Aggregator for the New ATLAS DCS System

Thursday 3 October 2024 17:40 (20 minutes)

The upcoming ATLAS Phase II upgrade mandates replacing the tracking system with the all-silicon Inner Tracker (ITK), featuring a pixel detector as its core element. The monitoring data of the new system will be aggregated from an on-detector ASIC, Monitoring Of Pixel System (MOPS), and channeled to the Detector Control System (DCS) via a newly developed FPGA-based interface known as MOPS-Hub.

The implementation details and experimental outcomes of the MOPS-Hub will be presented. Additionally, mitigation strategies for addressing potential Single-Event Upset (SEU) issues in the new system along with the irradiation results is presented.

Summary (500 words)

The ATLAS experiment is set to undergo a significant upgrade with the introduction of the Inner Tracker (ITk), featuring a pixel detector as its central component. This upgraded pixel detector will boast five times more modules than its predecessor. To support the new system, a novel Detector Control System (DCS) is under development at the University of Wuppertal, incorporating an on-detector ASIC known as the Monitoring Of Pixel System (MOPS).\newline

The integration plan for the MOPS chip, encompassing power and communication aspects, is anchored around the MOPS-Hub as a central unit. This FPGA-based interface serves as the nexus for aggregating monitoring data between the MOPS chips, situated near the detector modules, and the DCS computer. The MOPS-Hub not only facilitates the transmission of monitoring data but also monitors information per Controller Area Network (CAN) bus and exercises full power control over the connected CAN.\newline

At the heart of the MOPS-Hub lies the FPGA core unit, tasked with facilitating communication with the MOPS chips via CAN bus using an integrated CAN controller and physical layer. The data flow between the MOPS-Hub FPGA and the DCS traverses multiple stages. Initially, the FPGA communicates with an Embedded Monitoring and Control Interface (EMCI) via low-power differential signals known as elinks. Subsequently, the EMCI acts as a bidirectional channel interface, transmitting data through a high-speed optical link to an Embedded Monitoring Processor (EMP), located in a non-radiation environment. Finally, the EMP forwards the data to the DCS via an Ethernet connection.\newline

The MOPS-Hub will operate in a radiation-hard environment, necessitating specialized considerations for its firmware design. This presentation will focus on the hardware implementation and experimental outcomes of the MOPS-Hub. Additionally, it will introduce mitigation techniques for Single-Event Upset (SEU) and present irradiation results to ensure robust performance in the face of radiation challenges.

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Session Classification: Thursday posters session

Track Classification: Module, PCB and Component Design