Contribution ID: **41** Type: **Oral**

High-Precision Luminosity Instrumentation for the CMS Experiment at the HL-LHC

Thursday, 5 September 2019 11:05 (25 minutes)

The High Luminosity upgrade of the LHC (HL-LHC) is foreseen to increase the instantaneous luminosity by a factor of five over the present LHC nominal value. The resulting, unprecedented requirements for background monitoring and luminosity measurement create the need for new high-precision instrumentation at CMS, using radiation hard detector technologies. This contribution presents a system using the Tracker Endcap Pixel Detector (TEPX) with an additional 75 kHz of dedicated triggers for online measurement of luminosity and beam-induced background. Real-time implementations of algorithms such as pixel cluster counting on an FPGA are explored for online processing of the resulting data.

Summary

The expected high level of pile-up events at the HL-LHC imposes challenging requirements for the online measurement of luminosity and beam-induced background at the CMS experiment. A new instrumentation system is necessary given the extreme radiation and increased precision goals. Additionally, the space presently used for luminosity instrumentation and background monitors will be occupied by the extension of the Inner Tracker. Thus, in order to provide high precision luminosity and background measurement, the Tracker Endcap Pixel Detector (TEPX) will be employed with 10% of dedicated luminosity triggers in addition to the Level-1 trigger. In particular, the innermost ring of the outermost TEPX disk will have a central role in beam monitoring, as it will be operated as a standalone instrument, independent from the rest of the CMS tracker. Studies have been conducted to simulate the expected luminosity data rates for TEPX, based on a model of the RD53B data encoding and stream building. The results are presented for different readout modes, trigger rates and pileup to account for various operational scenarios. The data corresponding to luminosity triggers will be forwarded from the Inner Tracker Data, Trigger & Control boards (DTCs) to a dedicated luminosity back end. The envisaged system architecture and its implications for the CMS DAQ system are explained. Since luminosity and beam background information are crucial for CMS as well as LHC operations, a prompt and reliable measurement must be provided. This not only implies special demands on the TEPX servicing, but also requires real-time processing of the corresponding data. Therefore, an online implementation of a pixel cluster counting algorithm on an FPGA or System-on-Chip is under investigation, as this algorithm has been proven to give a reliable offline luminosity measurement throughout previous LHC runs.

Primary author: RUEDE, Alexander (CERN/KIT-IPE)

Co-authors: AUZINGER, Georg (CERN); DABROWSKI, Anne (CERN); STICKLAND, David (Princeton University (US))

Presenter: RUEDE, Alexander (CERN/KIT-IPE)

Session Classification: Systems, Planning, Installation, Commissioning and Running Experience

Track Classification: Systems, Planning, Installation, Commissioning and Running Experience