Electronics System for CMS BRIL Group

Project code	58
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Department	EP (funding only for 2 EP projects)

Title

Electronics System for CMS BRIL Group

Description

CMS is one of the two experiments at CERN's Large Hadron Collider (LHC) that, in 2012, announced the discovery of the Higgs boson. It is one of the largest, most complex and highly performant experiments in history and has so far taken <5% of the total expected data. It will continue operation until around 2040.
The CMS Beam Radiation Instrumentation and Luminosity (BRIL) project is responsible for the instrumentation in the CMS experiment to measure the delivered luminosity (~number of collisions per second) with high precision, an essential parameter for all physics analysis, and give feedback on the LHC beam conditions. In particular, the measurement of the online (real-time) luminosity and beam-induced background is needed for the tuning of the LHC to optimise data taking conditions for CMS.
For this purpose, the BRIL group operates several independent luminosity measurement devices (luminometers), some of which will undergo upgrades during the ongoing LHC Long Shutdown 2 (2019/2020) and Long Shutdown 3 (2024-2026) to ensure efficient luminosity measurements throughout the lifetime of CMS. The proposed project intends involvement in several of the major BRIL Upgrade activities, including research and development, re-commissioning of existing detector systems and design of new systems.
In contrast to many subsystems of CMS, BRIL detectors are relatively small, but necessarily incorporate cutting-edge hardware, firmware and software. The upgrades being developed now need to be ready for commissioning in 2021.
You will have the opportunity to contribute significantly to several BRIL upgrade projects, making a major impact on the system design of present and future luminosity measurements, and will be actively involved in the commissioning phase.

Functions and Training Value

You will be deeply involved in the re-commissioning of existing BRIL detector systems (known as BCM1F and BHM), allowing you to become familiar with the different technologies employed and the stringent requirements for luminosity measurements in CMS. You will have the opportunity to learn and develop advanced real-time data acquisition systems for detectors placed in high-radiation environments, and then apply this knowledge in new (upgrade) BRIL systems.
The work will involve firmware programming of latest-generationl FPGAs, embedded systems and high-performance data acquisition systems for large-scale particle physics experiments.
More specifically, the job will involve:
The design, design verification, upgrade and maintenance of digital acquisition electronics based on field programmable logic-based devices (FPGA), including maintenance of low-level SW driver libraries for the BCM1F and BHM detectors in Run 3

The design, implementation, verification and commissioning of an FPGA-based solution for muon scouting data for the purpose of real-time luminosity measurement in Run 3 using current-generation high-speed FPGAs
The research and development to design a control- and read-out system for an independent luminosity detector for the Phase 2 Upgrade of the CMS detector
Simulation and modifications of printed circuit board schematics.
The knowledge gained is applicable in many areas outside of particle physics where real-time processing of large amounts of data are appropriate (e.g. medical applications, security systems, autonomous vehicles etc.)

Qualifications/Skills

Master / PhD degree or equivalent relevant experience in the field of digital electronics design, electronics engineering or a related field.
Demonstrated hands-on experience in the field of digital electronics design and simulation, in particular with FPGAs, including the appropriate design tools (e.g. Vivado).
Experience in electronics PCB design, construction and testing is desirable.