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Development of GEM Electronics Board (GEB) for Triple-GEM Detectors

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Developed for use with triple GEM detectors; the GEM Electronics Board (GEB) forms a crucial part of the electronics readout system being developed as part of the CMS muon upgrade. The objective of the GEB is three-fold; to provide stable powering and ground for VFAT3 front ends, to enable high speed communication between 24 VFAT3 front ends and an Optohybrid, and to shield the GEM detector from electromagnetic interference. The paper will describe the concept and design of a large-size GEB in detail, highlighting the challenges in terms of design and feasibility of this deceptively difficult system component.

Summary

CMS is planning to use triple GEM detectors as part of it's Muon system upgrade. A complete electronics system is currently under design for this purpose. The on-detector part of this system is optimized for use with the GEM detectors and comprises a new front-end readout ASIC (VFAT3), a dedicated GEM Electronics Board (GEB) and an opto-hybrid with embedded GBT chip sets.

In this paper, we will introduce in detail one crucial part of the readout system, the GEM Electronics Board (GEB). The main objectives of the GEB are to provide stable powering and ground for 24 VFAT3 front end chips, to connect the 24 VFAT3 front ends to the GBTs of the Opto-hybrid using digital high speed signals and shield the GEM detector from electromagnetic interference.

In addition, the GEB enables a compact system design needed for installation within the limited space of the Muon stations GE1/1, GE2/1 and ME0. The design must be manufactured with relative ease and for reasonable cost. The GEB is designed to be manufactured from a single (over 1.2 meter long, 48 cm wide 6 layer and 1 mm thick) PCB. This unusual size makes it possible to provide a continuous shield to protect the noise sensitive strips of the GEM detector but at the same time introduces the challenges of design and manufacturing processes. The large size also introduces issues related to signal integrity of the 320Mbps clock and trigger signal distribution.

An initial version of the GEB board (GEBv1) has been manufactured. The goals were to verify the manufacturing process and the electrical characterization. The GEBv1 prototype measured slightly over 1 meter to be compatible with existing GEM detectors. Manufacturing with 6 layers was found to be feasible and cost efficient. Electrical measurements have been done to characterize the signal integrity and to assess the impact on the noise of the system.

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