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# Design and performance of CMS Muon Triple-GEM Detector Control System

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We present the Detector Control System (DCS) system being designed for triple-GEM detectors to be installed in 2019-2020 in the CMS muon endcaps for HL-LHC. Beginning of 2017, 10 triple-GEMs, called slice-test, have been installed for the very first time in CMS. Therefore the GEM DCS had basically to be designed from scratch. We will describe its key features (hardware and software), the main developments and the important commissioning steps which were required to allow its integration within the central CMS DCS to enable the data acquisition of the slice-test GEM data by the central DAQ system of CMS.

## Summary

In this contribution, we present the Detector Control System (DCS) system being designed for triple-GEM detectors to be installed in 2019-2020 in the CMS muon endcaps for HL-LHC. Beginning of 2017, 10 triple-GEMs, called slice-test, have been installed for the very first time in CMS.

The GEM DCS is responsible of ensuring the safe and optimal operation of the new GEM detectors so that high quality data can be recorded. The GEM DCS controls the detector HV, the electronics LV, the gas and cooling systems. In addition some triple-GEM detectors are equipped with radiation monitoring sensors (RADMON) or Fiber Bragg Grating (FBG) sensors to monitor the temperature; they are also controlled by DCS.

For the slice-test, the GEM DCS had basically to be designed from scratch, as it is the first time triple-GEM detectors are used in CMS. We will describe the key features of the GEM DCS, the main developments and the important steps which were required to allow its integration within the central CMS DCS to enable the data acquisition of the slice-test GEM data by the central DAQ system of CMS.

Among the main features, two slice-test detectors are equipped with a "multi-channel"HV power supply system which uses new and dedicated commercial boards able to individually power the 7 electrodes (6 GEM electrodes and the drift cathode) of the detector, instead of the usual "single-channel"option using an on-detector resistor divider to power the 7 electrodes. The advantages of the new powering scheme is the possibility to monitor with higher accuracy the current drawn by each electrode, looking for possible discharges, and to adjust the various electric fields to enhance the performance of each detector.

It is important to note also, that the GEM detectors which will be installed during 2019-2020 will be read-out by the new FE VFAT3 chip, while the slice-test detectors use its predecessor, the VFAT2. In February 2018, two slice-test detectors have been replaced with newer ones equipped with the VFAT3. This is a unique opportunity to develop and commission the GEM DCS in-situ for the final electronics.The CMS GEM DCS hardware architecture and software solutions adopted will be presented along with results from the commissioning phase and the operation of this new CMS subsystem during the LHC runs of 2017 and 2018. In particular the results from a study on the stability of the currents with the multichannel power supply.

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