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The Noise Performance of the CMS Detector

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The design of the CMS power distribution system plays a major role in the ultimate noise performance of detector, both from the perspective of internally generated noise and of noise coupling between subdetectors. Noise considerations in a detector power system depend strongly on the mechanical configuration of the detector and the cabling and grounding conventions used.

This talk will review the commissioning history of CMS from the point of view of noise performance and interactions between detector subsystems. Particular emphasis is placed on the influence of the global mechanical design of CMS, as well as that of its subdetectors.

Summary

The design of the CMS power distribution system plays a major role in the ultimate noise performance of detector, both from the perspective of internally generated noise and of noise coupling between subdetectors. Noise considerations in a detector power system depend strongly on the mechanical configuration of the detector and the cabling and grounding conventions used.

The CMS detector is mechanically complex. It is segmented into 13 longitudinal sections, of which the central section is stationary, while the others can move up to 10m in the longitudinal direction. The cables in these sections pass through flexible cable chains in trenches beneath the detector. These cable paths are typically 100m-140m long.

The power system for the on-detector electronics of the CMS Experiment comprises approximately 12000 low voltage channels, requiring a total power of 1.1 MVA. Typical current requirements at the CMS detector front end range from 1A-30A per channel at voltages ranging between 1.25V and 8V. This requires in turn that the final stage of the low voltage power supply be located within ˜10m of the front-end electronics, that is, on the detector periphery.

In addition, the detector periphery holds crates containing first-level data acquisition and trigger electronics, many of which are laterally interconnected by control and readout buses.

In the process of commissioning the CMS detector we have observed multiple instances of interactions between the electronics of different subsystems. We have studied the behavior of noise currents in the CMS power system in an effort to understand the noise susceptibilities of the subdetectors. We have observed instabilities in detector electronics brought about by effects of the CMS magnetic field on cavern electrical infrastructure.

We have also observed significant high-frequency common-mode currents in the power cabling of a subset of the on-detector power supplies. These currents are present in the earthing conductors as well. Understanding the subsequent propagation of these currents through the mechanical structure of the detector, and understanding their effect on detector electronics is essential to optimizing the noise performance of CMS.

This talk will review the commissioning history of CMS from the point of view of noise performance and interactions between detector subsystems. Particular emphasis is placed on the influence of the global mechanical design of CMS, as well as that of its subdetectors.

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