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Electromagnetic Compatibility of CMS Infrastructure and Detector Electronics

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The electronic systems of modern high-energy physics detectors are often built with electromagnetic compatibilty issues as an important part of the requirements driving the design of the detector. The CMS experiment at CERN has an appreciable amount of electronic infrastructure not usually found in previous generations of high-energy physics detectors.

Over more than a year of CMS running, we have had the opportunity to observe several instances of unexpected interactions with infrastrucutre electronics. This presentation will examine the mechanisms and consequences of these interactions, as well as considering the coordination of infrastructure and detector electronics design.

Summary 500 words

The electronic systems of modern high-energy physics detectors are often built with electromagnetic compatibilty issues as an important part of the requirements driving the design of the detector. Cable routing, grounding design and mechanical layout of subdetector systems all form part of the design criteria intended to optimize the subdetector electronic performance, and by extension, the physics performance of the detector as a whole.

But along with the individual subdetectors there exist additional systems intended to provide cooling, ventilation, power, lighting, safety and industrial controls and monitoring: services that are not part of the detector design process and which are often added late in the construction phases of an experiment. These systems can have as much EMC impact on overall detector performance as subdetector systems do.

Added to this is the fact that these services are often provided by laboratory support organizations that are not part of the formal detector design process, and which provide these services using available solutions designed for earlier generations of experiments or simply carried over from an industrial context.

These organizations are typically expected to provide services for several experiments at the same time, so it is not unexpected that they should seek common solutions that are already part of the existing repetoire. The design personnel for these systems are typically oriented towards industrial systems and are usually unfamiliar with the special sensitivities of high-energy physics detectors. The resulting systems are designed for a contemporary industrial environment, most often independently from the design process of the detector.

The CMS experiment at CERN has an appreciable amount of electronic infrastructure not usually found in previous generations of high-energy physics detectors. Many new developments from the industrial sector have been incorporated into the service systems of the detector, not all of which are fully evaluated with regard to electromagnetic compatibilty concerns.

Over more than a year of CMS running, we have had the opportunity to observe several instances of unexpected interactions with infrastrucutre service electronics. We have observed electrical disturbances from variable-frequency drives (VFDs) for pump motors, electrical heaters, lights, power converters and several sources that are still unknown. The replacement of hard-wired logic with programmable-logic controllers (PLCs) has introduced new considerations in the procedures of recovery from power failures.

This presentation will examine the mechanisms and consequences of these interactions, as well as considering the origins of this two-level design process and methods of design coordination.

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