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Low Voltage Powering of On-Detector Electronics for HL-LHC Experiments Upgrades

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All LHC experiments will be upgraded during the next LHC long shutdowns (LS2 and LS3). The use of more advanced CMOS technology nodes typically implies higher current consumption of the on-detector electronics. In this context, and in view of limiting the cable voltage drop, point-of-load DC-DC converters will be used on detector. This will have a direct impact on the existing powering scheme, implying new AC-DC and/or DC-DC stages as well as changes in the power cabling infrastructure. This paper will present the first results obtained while evaluating different LV powering schemes and distribution layouts for HL-LHC trackers.

Summary

Currently, most LHC systems use relatively complex very low voltage power supplies to power their on-detector electronics directly or through radiation tolerant linear regulators. This existing infrastructure is based on radiation and magnetic field tolerant power converter systems generally consisting of remote bulk AC-DC converters and control systems linked to local DC-DC converters qualified for harsh environment. At HL-LHC, the use of POL (point-of-load) DC-DC converters and the expected overall power consumption increase will impose to change the existing powering chain and infrastructure.

POL DC-DC converters require higher input voltages than currently available. Besides reducing the voltage drop induced by the cabling, they present the advantage of potentially relaxing certain power supply requirements such as noise and ripple as well as the voltage regulation precision and stability.

Different solutions are being explored, simulated and qualified to supply POL DC-DC converters. The precise low voltage power source requirements are being assessed and understood using the CMS tracker upgrade as a use-case. In particular, the control granularity as well as the dynamic behaviour of the entire powering chain is being carefully evaluated and simulated. For this study, the power chain is subdivided in three parts, the power source, the monitoring and control and the cabling.

Once well qualified, the explored solutions will serve as a baseline for drafting a detailed technical specification towards the next generation of power supply systems to be proposed to experiments. The studied powering chain will hopefully also serve as conceptual baseline for the detector groups from various experiments to implement their own solutions.

This paper presents the results obtained from the different powering schemes evaluated so far. Focus is given on the first studied use-case consisting of the CMS tracker upgrade. However, some conclusions are surely common to other systems. A first set of key requirement parameters for the power source to be used with the POL DC-DC converter will also be drafted.

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