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Powering of the CMS Phase-2 Upgraded Tracker

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The LHC machine will be upgraded to increase its peak luminosity and possibly reach an integrated luminosity of $3000 - 4500$ fb^{-1}. The CMS experiment is called for an upgrade to keep up with the new challenges such as unprecedented radiation environment, requiring high resilience, and increased number of events per bunch crossing, requiring higher detector granularity. Consequently, both Outer Tracker (OT) and Inner (IT) Tracker have to fulfill very stringent requirements: OT (> 13000 independent modules) uses in situ DC/DC converters to parallel distribute 100 kW of power, IT a serial powering scheme to provide about 60 kW among thousands of modular units.

Summary

Within 2028 the Large Hadron Collider is going to be upgraded, targeting a peak luminosity of $5 - 7.5 \times 10^{34}$cm^{-2}s^{-1} and aiming to collect an integrated luminosity of $3000 - 4500$ fb^{-1} by the end of 2039. In order to operate at these unprecedented conditions the CMS experiment needs to upgrade its own apparatus, increasing both the radiation resiliance and the granularity of the detectors. A completely new system of central tracking silicon detectors is being designed, composed of innovative pixel detectors in the inner region (Inner Tracker) and silicon strip and macro-pixel detectors in the outer region (Outer Tracker). Two different powering schemes are used to provide bias (down to -1000 V) to the sensors and low Voltage power (in the range 2.5 - 0.8 V) to the front end electronics, for a total power consumption exceeding 100 W for Outer Tracker and 50 W for Inner Tracker. A common requirement is to keep the material budget as low as possible, in order not to compromise the detector performance, which includes minimizing the cross section and/or the number of the cables which bring power to the detectors.

For the Outer Tracker, composed of more than 13 thousand independent detector modules, a parallel power supply scheme is adopted, where one bias voltage and one low voltage line (10-11 V) is provided to each detector module. On detector DC/DC converters are used to transform and distribute the low voltage power to the rest of the front end electronics. The back-end power supply system is modular and has high-granularity; it must operate in the proximity of the detector, inside the experimental cavern, in the presence of ionising radiation and magnetic fields, in order to reduce the voltage drop on the cables.

For the Inner Tracker an innovative serial power distribution scheme is adopted, where series of $8 - 12$ detector modules are connected to one current source, thereby reducing the number of cables required to distribute the power. This powering scheme is supported by the readout chip, which provides the needed shunt and local voltage regulation capabilities. One voltage source distributes the bias voltage to the sensors within each serial chain, following a parallel scheme.

The two powering schemes and the status of their development are reported.

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