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The Phase-1 Upgrade of the CMS Pixel Detector

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Content

The CMS experiment features as its innermost component a silicon pixel detector which provides high precision space point measurements of charged particle trajectories. The original detector was designed for an instantaneous luminosity of $1.0 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$. Due to improvements of the LHC this luminosity was already exceeded in 2016 and it is foreseen that it will be further increased up to two times the design value before 2018. This will lead to more interactions per bunch crossing and also the inefficiencies caused by the readout electronics will rise.

To maintain the excellent tracking efficiency, the CMS collaboration has built a new pixel detector with the plan to install it in an extended technical shutdown at the beginning of 2017. The Phase I pixel detector features an additional fourth layer in the barrel part and an additional third layer in the endcaps. The material budget could still be reduced by a lightweight carbon fiber support structure and a new cooling system using a two-phase CO₂ cooling. To reduce data losses, new readout chips with larger buffers and a digital readout have been developed and the readout electronics was upgraded. Furthermore the new detector features a novel powering scheme using DC-DC converters. This contribution will motivate the design choices for the new pixel detector and their impact on the tracking performance. With a special focus on the barrel detector, the production and qualification of pixel modules and the power system components will be discussed and final results will be presented. The results of system tests that were carried out with the DC-DC power system will be shown. The status of the mounting of components onto the support structures, the associated test procedures including results, and the status of the installation of the whole detector into CMS will be discussed.

Summary

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