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A DC-DC converter based powering scheme for the upgrade of the CMS pixel detector

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Around 2016, the pixel detector of the CMS experiment will be upgraded. The amount of current that has to be provided to the front-end electronics is expected to increase by a factor of two. Since the space available for cables is limited, this would imply unacceptable power losses in the available supply cables. Therefore it is foreseen to place DC-DC converters close to the front-end electronics, allowing to provide the power at higher voltages and thereby to facilitate the supply of the required currents with the present cable plant.

This talk introduces the foreseen powering scheme of the pixel upgrade. For the first time, system tests have been conducted with pixel barrel sensor modules, radiation tolerant DC-DC converters and the full power supply chain of the pixel detector. In addition, studies of the stability of different powering schemes under various conditions are summarized. In particular the impact of large and fast load variations, which are related to the bunch structure of the LHC beam, has been studied.

Summary 500 words

For the upgrade of the CMS pixel detector it is foreseen to install DC-DC buck converters, based on radiation-tolerant ASICs from the CERN electronics group, on the so-called supply tube of the detector, approximately 2m away from the pixel sensors.

The implementation of DC-DC buck converters into CMS raises several challenges. Switching in the MHz range might inject conducted noise into the detector system while air-core inductors, needed due to the saturation of ferrite cores in the 3.8 T magnetic field of CMS, might radiate electromagnetic noise. In addition, buck converters can act as negative impedances, thereby implicating the risk of destabilizing the power supply chain. All of these potential problems have to be eliminated or excluded on system level before the new powering scheme can be installed.

To comply with the limited space available, a compact and low-mass scheme of implementation has been developed at Aachen. Based on this scheme a set-up, very similar to the intended detector system, was build, allowing system test measurements under realistic conditions. This set-up consists of the original power supply chain of the present pixel detector, a pixel sensor module, a mock-up structure of the supply tube and radiation tolerant buck converters. The effect of DC-DC buck converters on a pixel module was studied at room and cold temperatures. The influence of the expected load alternations was measured and different sensing scenarios were tested with the goal to provide a robust power plant that is compatible with the time schedule. This talk summarizes the results.

Author: Mr SAMMET, Jan (RWTH Aachen University)

Co-authors: Ms KLEIN, Katja (RWTH Aachen University); Prof. FELD, Lutz (RWTH Aachen University); Ms JENNIFER, Merz (RWTH Aachen University); Mr WLOCHAL, Michael (RWTH Aachen University); Mr KARPINSKI, Waclaw (RWTH Aachen University)

Presenter: Mr SAMMET, Jan (RWTH Aachen University)

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