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Low Voltage Power for the ATLAS New Small Wheel Muon Detector

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The New Small Wheel (NSW) is an upgrade for enhanced triggering and reconstruction of muons in the forward region of the ATLAS detector. The large Low Voltage power demands necessitate a point-of-load architecture with on-detector power conversion. We present final results from an extensive campaign to test commercial power devices in radiation and magnetic fields, and describe an alternate solution based on a radiation-hard power conversion ASIC produced by CERN. We detail the challenges and solutions in integrating this device into the New Small Wheel, and outline the full resulting power system.

Summary

The New Small Wheel will comprise two detector technologies, Micro-Megas (MM) and Small Thin Gap Chambers (sTGC), totaling over 2.5 million channels and over 7400 Front End (FE) boards. The on-detector electronics are expected to require in excess of 50kW delivered at voltages ranging from 1.2V to 2.5V. Over its design lifetime, the NSW will accumulate as much as 1700 Gy total ionizing dose and be subject to a non-ionizing fluence which can approach 3*10ˆ14 1-MeV equivalent neutrons/cm2. It must operate in a magnetic field that can exceed 5 kiloGauss.

We summarize the final results of a campaign to evaluate commercial power devices for their suitability for this environment, with particular attention to studies of transient single-event effects induced by 220MeV protons. These data were collected with a purpose-built fast triggered data acquisition system, able to capture microsecond-length transients with all active components 30 meters from the device under test. The results include a comparison of the different failure modes in gamma rays and protons of the Linear Technologies LTM4619, a commercial part that has been considered a strong contender for use in other ATLAS subsystems as well.

The ultimate power scheme for the New Small Wheel is constructed around the FEAST, a radiation-hard buck converter ASIC produced by CERN microelectronics. This application is highly space-constrained, with an envelope for power that is in places as little as 3mm in height. We describe tests of commercial low-profile ferrite inductors that are able to meet these envelope requirements while tolerating magnetic fields above 5 kilogauss. Even more stringent are the noise requirements imposed by sensitive analog front-end electronics, and we report studies on the feasibility of directly powering these analog components from the FEAST. Finally, we also discuss issues of cooling and of providing the supply voltage - at most 12V - required by the FEAST.

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