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Power electronics in HEP experimental caverns

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Next generation high energy physics experiment will be more granular than current ones, this means more demanding electronics to power the detectors and to process all collected data. Space constrains, cabling, cooling and, last but not least, efficiency are all parameters that need to be optimized during experiment design to have the best performance for data taking.
We will present some result from an R&D lunched by CAEN in 2020 to develop the next generation of power supplies for the experimental caverns of HL-LHC, in this hostile environment the electronics needs to survive to magnetic fields and a mixed radiation field (composed by gamma, neutral and charge hadrons). The composition of the radiation field, as well as the intensity and direction of the magnetic field, can vary by orders of magnitude between experiments but also within the same cavern. To cover all needs, CAEN started an irradiation campaign in various steps and at various irradiation facilities, we wanted to investigate COTS electronics behavior using one radiation per time: neutron, gamma, protons, and then validate the final board design with mixed field. Plus, we performed efficiency tests in magnetic fields up to 1 T using various orientation to exploit different symmetry in the boards design.
During this talk we will focus on last year test campaigns, some undertaken within the RADNEXT EU project and in collaboration in INFN and CERN, that include tests with proton, neutron, and gamma sources, of various components: ADCs, DACs, RAMs, FPGAs, µControllers, Power Transistors and FETs, temperature and humidity sensors, etc. All the necessary pieces to the design and build circuits and boards capable to survive in the experiments; these components alone cannot ensure the reliability to run an experiment in such conditions so also the circuits and control loops must be tested. The results of the test campaigns will be discussed together with some mitigation techniques used to achieve the wanted reliability.
First developments of power supply circuits and devices based on these blocks will be also presented, as well as the performances achieved so far in terms of reliability, power density, energy efficiency, noise figure, etc.

In-person participation

Yes

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