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Component Qualification for the Mu2E Calorimeter Wafeform Digitizer

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The Mu2e experiment at Fermilab searches for the muon conversion to electron in the Coulomb field of a nucleus. The detector is composed of a straw tube tracker and an CsI crystals electromagnetic calorimeter housed in a superconducting solenoid.
The digitizing electronics will be located inside the magnet cryostat and will be operated in vacuum.
The harsh experimental conditions, with the presence of a high neutron flux, ionizing dose and magnetic field, make the design challenging and all the components must be individually tested and qualified.
The experimental results of the qualification tests are described.

Summary

The Mu2e experiment at Fermilab searches for the coherent muon conversion to electron
in the Coulomb field of an Al nucleus, with the goal to improve the current experimental
limit by 4 orders of magnitude. The Mu2e detector is composed of a straw tube tracker and an
undoped CsI crystals electromagnetic calorimeter housed in a superconducting solenoid.
In order to achieve the needed background suppression, the calorimeter provides a time resolution
better than 500 ps and an energy resolution of O(5%) @ 100 MeV. To fulfill these requirements a digitizing system,
composed of around 150 cards sampling a total of around 2700 channels at a frequency of 200 MHz, is currently being designed.
The electronics will be located close to the calorimeter, inside the magnet cryostat and will be operated in vacuum.
The harsh experimental conditions, with the presence of a high neutron flux, ionizing dose and magnetic field, make the design
challenging.
All the components and materials must be individually tested and qualified. The main components are the DCDC converter, the ADC
and the FPGA and we started selecting and qualifying these parts.
DCDC converter
The more critical part is the DCDC converter because of the presence of a strong magnetic field. Following some studies
described in literature we evaluated several parts from Linear Technologies and finally the LTM8033 survived the selection.
After some operational tests we defined a qualification procedure and then we started the test campaign.
The setup was composed of an automated system capable of measuring and storing input and output voltages and currents with a good
degree of precision. The important parameters to check in these kind of tests are the stability of the output voltage and of the
conversion efficiency. The DCDC behaviour in magnetic field was tested at the LASA INFN laboratory of Milan Italy, while the

performance when irradiated with neutrons was tested at the ENEA FNG facility in Frascati Italy. The test under ionizing dose was performed
at the ENEA Calliope facility in Bracciano Italy.
ADC
The digitizer is specified to sample at least with 200 Msamples 12 bits of resolution and operating in vacuum the absolute low power is a fundamental requirement. Also the cost is an important parameter just to the fact that
more then 3000 channels will be digitized. At the end we selected the Texas Instrument ADS4229.
Also in this case a portable test setup was developed. A standard sinusoidal signal was sent in input to one ASS4229
demo board and the ADC output was stored on disk. We performed the test in the same facilities as the DCDC converter
FPGA
The selected FPGA is a Microsemi SMartFusionII, model SM2150T. This part is already qualified by the producer so our
current idea is not to qualify this part individually but only at the board prototype level
The experimental results of all these qualification tests are described.

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