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## Qualification of the CMS Phase 1 Upgrade HF Front-end Electronics

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The Phase 1 Upgrade of the CMS Forward Calorimeter requires the installation of custom and commercial electronics components into the CMS cavern where they are exposed to ionizing and hadronic radiation. We present the results of qualification tests on the most recent FPGAs from Microsemi (modified Igloo2 devices) and the QIE10 ASIC. The operation of the Igloo2 optical data link is demonstrated for both asynchronous transmission at 5 Gbps and LHC-synchronous operation as a control link following the CERN GBT protocol.

### Summary

The upgrade of the forward hadron calorimeter (HF) frontend electronics is an important part of the phase 1 upgrade plans of CMS. The HF plays an important role in missing energy measurements and object reconstruction at high pseudorapidity. Run I operations have motivated the upgrade to dual-anode PMTs and the inclusion of a TDC for measuring the arrival time of pulses, both of which will reduce sources of noise expected to become more prominent during 25 ns collisions. The frontend electronics will be installed in the CMS experimental cavern where they will be exposed to ionizing and hadronic radiation. To achieve the design requirements and survive the expected radiation doses, the CERN developed, radiation tolerant VTTx and VTRx optical transceivers paired with radiation tolerant Microsemi Igloo2 FPGAs are used for both the communication link and the data transmission link. The improved digitizing ASICs, the QIE10, employ a large dynamic range ADC and a 500 ps resolution TDC. Qualification testing and calibration of the frontend readout and the QIE10 using both DC charge injection and fast analog signals will be presented. The operation of the Igloo2 optical data link is demonstrated for both asynchronous transmission at 5 Gbps and LHC-synchronous operation as a control link following the CERN GBT protocol.

**Primary author:** WHITBECK, Andrew James (Fermi National Accelerator Lab. (US))

**Co-author:** MANS, Jeremy (University of Minnesota (US))

**Presenter:** WHITBECK, Andrew James (Fermi National Accelerator Lab. (US))

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