The ATLAS Hadronic Tile Calorimeter (TileCal)

The ATLAS Hadronic Tile Calorimeter (TileCal) is a component of the ATLAS detector system. The TileCal is designed to measure hadronic energy deposition in the ATLAS detector. It consists of highly segmented lead tungstate (PbWO4) crystals that are read out by photomultiplier tubes (PMTs). The TileCal provides a high granularity measurement of the energy deposited by hadrons in the ATLAS detector, which is crucial for physics analysis and trigger decisions.

The Phase-II Upgrade read-out system.

The Phase-II Upgrade of the ATLAS Tile Calorimeter has been developed to support the High-Luminosity LHC (HL-LHC) phase of the ATLAS experiment. The upgrade includes a new read-out system that will improve the performance of the TileCal in terms of read-out speed, hardware latency, and energy resolution.

The design of the Phase-II Upgrade read-out system is modularized in Superdrawers (SDs), each SD is divided into 4 Minidrawers (MDs), and each MD serves up to 12 channels by means of:

- 12 Photomultiplier (PMTs) to turn light pulses to electric signals.
- 12 Front-End Boards (FEBs) to shape and condition the PMT signals.
- A Mainboard (MB) to continuously sample and digitize two gains of each shaped PMT signal.
- A Daughterboard (DB) to distribute LHC synchronized timing, configuration and control to the front-end, and continuous readout of the digital data from all the MB channels to the off-detector systems via multi-Gbps optical links.

The Tile Calorimeter Link Daughterboard.

The Tile Calorimeter Link Daughterboard (TileCal Link DB) is a component of the Phase-II Upgrade read-out system. It is responsible for providing the necessary control and configuration signals to the Front-End Boards (FEBs) and transferring the data from the MB channels to the off-detector systems via multi-Gbps optical links.

Results from TID radiation tests.

A DB with functional firmware interfaced with a TilePPr exposed to a total of 20 krad delivered by a 5 MeV electron beam in six doses over ~1 hr with the system being power cycled and PMGs reconfigurable from the PROMs in between doses.

- Monitored currents were constant over the full dose, one DB had a small but measurable current decrease over the 20 krad exposure.
- Temperature and current monitoring showed no evidence of latch-up.
- No component failures (PFGAs, GBTx, PROMs, two types of SFP+) were observed.
- Double Gaussian strategy with 14.5 cm separation between peaks, ~10x20 cm fluence.

Outlook.

The DB was designed to meet all the requirements for the Phase-II Upgrade. Good preliminary results on TID radiation tests were seen, although adjustments are expected given new ATLAS simulation values and according to the ATLAS protocol and safety factors. Results on NIEL tests are expected after the board under test radiactively cools down. Meanwhile, firmware development and improvement and integration into the minidrawers is taking place. Near future plans include SEU tests, high-B field tests and integration in the Demonstrator for the testbeam campaign that will take place in October 2018.

Relevant references.