The Large Hadron Collider (LHC) has envisaged a series of upgrades towards a High Luminosity LHC (HL-LHC) delivering five times the LHC nominal instantaneous luminosity, which will take place throughout 2026-2028, corresponding to the Long Shutdown 3. During this upgrade, the ATLAS Tile Hadronic Calorimeter (TileCal) will replace completely on- and off-detector electronics adopting a new read-out architecture. Signals captured from TileCal are digitized by the on-detector electronics and transmitted to the TileCal PreProcessor (TilePPr) located off-detector, which provides the interface with the ATLAS trigger and data acquisition systems. TilePPr receives, process and transmits the data from the on-detector and transmits it to the Front-End Link eXchange (FELIX) system. FELIX is the ATLAS common hardware in all the subdetectors designed to act as a data router, receiving and forwarding data to the Software Read-Out Driver (SWROD) computers. FELIX also distributes the Timing, Trigger and Control (TTC) signals to the TilePPr to be propagated to the on-detector electronics. The SWROD is an ATLAS common software solution to perform detector specific data processing, including configuration, calibration, control and monitoring of the partition.

In this contribution we will introduce the new read-out elements for TileCal at the HL-LHC, the interconnection between the off-detector electronics and the FELIX system configuration and implementation for the test beam campaigns, as well as future developments of the preprocessing and monitoring status of the calorimeter modules through the SWROD infrastructure.

**DATA TRANSFER SCHEME IN THE TILE CALORIMETER FOR PHASE-II**

TilePPr is the core element of the back-end electronics. Provides the interface between the front-end electronics and the ATLAS global data acquisition as well as the trigger systems. It is capable to read up to 8 Tile super drawers. It is composed by an ATCA Carrier board that is equipped with four Compact Processing Modules (CPM) and one Trigger and Data Acquisition Interface (TDAQi). Along with these components, a Tile Computer-on-Module (TileCom) is connected into the ATCA carrier board. 32 TilePPr modules are needed to operate the complete TileCal detector. The CPMs are responsible for the distribution of the LHC clock and the TTC command towards the on-detector electronics, control and read-out of the Tile modules, as well as the cell energy reconstruction and transmission of data to TDAQi and FELIX. TileCom provides remote configuration of on-detector electronics, interface the TilePPr with the ATLAS Trigger and Data Acquisition (TDAQ) system and with the ATLAS Detector Control System (DCS). TDAQi receives reconstructed energy from the CPMs and creates the trigger primitives for L0Calo, L0muon and the global systems.

FELIX system has been developed to be the primary interface between the front-end electronics and the DAQ system of the detector, acting as a router for the transfer of the data packets from the front-end electronics. This is the uplink path which reaches up to 9.6 Gbps in Full Mode configuration. This path demands high data bandwidth due to the amount of data coming from the detector. FELIX will also serve as a provider of the trigger acceptance signal and clock information from the TTC system to the drawers in the detector. This is the downlink, which reaches data rates up to 4.8 Gbps in GBT latency optimized protocol given that in opposition of the downlink case, we need deterministic latency in this path to properly recover the LHC clock.

TileCal complete readout system will be composed of 181 bi-directional links with FELIX, where 128 of them will be used for data readout. 32 for trigger primitives monitoring and 1 for TTC information, data integrity and small data processing, as well as to provide for online monitoring to the Data Quality Monitoring Display (DQMD).

**TESTBEAM PERIODS AND POINT 1 FUTURE ACTIVITIES**

Data acquired by the electronics of the upgrade module located in the TestBeam area is sent to the PPr demonstrator. This data is then formatted into a new data packet that is forwarded to FELIX. FELIX captures this packet and publish it via network at which point SWROD subscribes and captures the data packets to be saved into the system in the ATLAS event format for offline processing.

For further verification of the data received, same data that is captured from the front-end electronics and received in the PPr demonstrator is sent to one of the ROD inputs from the legacy system to be analyzed and compared.

Future test beam periods will be followed by a numerous amount of upgrades for the readout. Tile PPr demonstrator will be replaced by the final prototype design composed by an ATCA crate with an ATCA carrier, TDAQi and CPM. CPM will provide the data output received by FELIX, at the same time FELIX will provide the TTC signals to the CPM to be propagated into the front-end electronics. Monitoring systems of the acquired data will be implemented into the DQM system in TDAQ with the help of ATLAS event format. Further test of the electronics and the readout path will validate the design and provide access to the installation of FELIX and SWROD into P1 to capture data from the Tile demonstrator located in the ATLAS Experiment for the Run 3.