



FELIX-based Data Acquisition System Integration with the NSW Micromegas Electronics and Detector Performance Validation

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Introduction - The New Small Wheel and the BB5 Commissioning Site

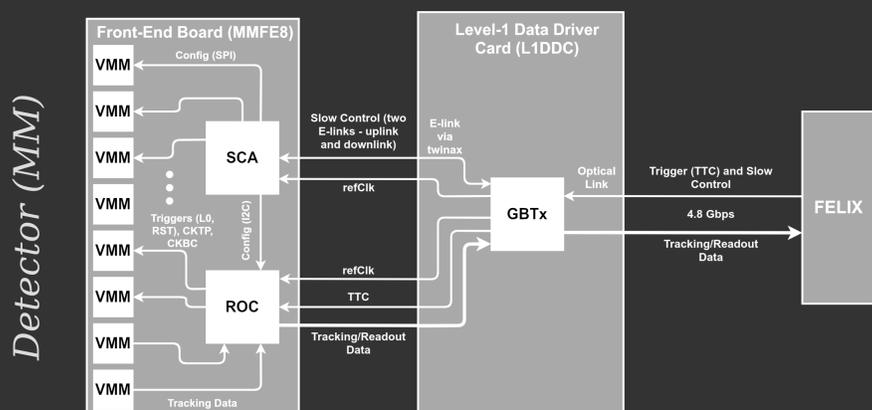
The foreseen upgrades of the Large Hadron Collider (LHC) are expected to increase the required throughput of the front-end and back-end electronics that support the readout of the LHC detectors. In some cases, new detector subsystems will have to be deployed, alongside next-generation data acquisition systems, both designed to cope with the luminosity increase. An example of this is the New Small Wheel (NSW) upgrade of the ATLAS detector [1]. The NSW will be comprised of two gaseous detector technologies, namely the Micromegas (MM), mainly used for track reconstruction, and the small strip Thin Gap Chambers (sTGC), mainly used for triggering. Prior to its integration with the sTGC wedges, each MM wedge is being fully-tested at the BB5 commissioning site. A series of tests are being run, from high-voltage stability to gas flow tests. But what will be studied in this work, are the application-specific tools that ensure proper flow of cosmic ray data, in order for them to be analyzed and confirm the detector's tracking capabilities before they are lowered into the ATLAS cavern.



Top-right: One of the NSW wheels, assembled. Bottom-Left: one MM wedge, in the cosmic test-stand of the BB5 commissioning site.

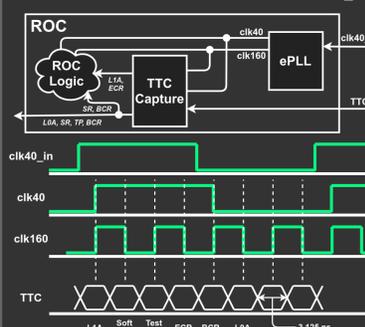
Electronics System

The NSW electronics scheme is a complex system comprised of several front-end and back-end electronics. The VMM [2] is where primordial muon pulses are digitized, the Read-Out Controller (ROC) aggregates data from several VMMs, the Gigabit Transceiver (GBTx) [3] aggregates data from several ROCs, and then these are forwarded to FELIX via optical fibers. FELIX is the keystone of the NSW readout scheme, and it will be used by more ATLAS subsystems in the future [4].

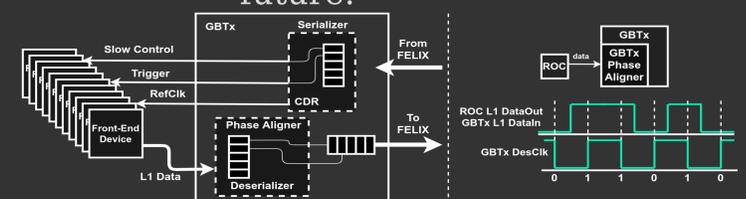


Trigger and Data Alignment

One of the critical DAQ paths that are validated is that of the trigger-bit output of the GBTx to the ROC. A misalignment of the bitstream may lead to unexpected behavior (bit misinterpretation and/or timing violations).

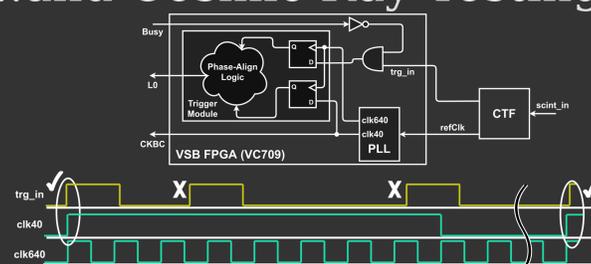


Another critical path is that of the L1 data (VMM's digitized data aggregated by the ROC). 500 paths (E-links) are utilized for the Phase-II readout. Netio Traffic Analyzer [5] is responsible for validating these paths. The said tool will be the base for a swROD-based DAQ validation software suite in the future.



In order to create a pseudo-synchronous system, an FPGA firmware was designed [6], that only permits muons aligned with the system clock to be read-out. This can allow for precision timing measurements in the future, as it emulates the LHC collision environment.

...and Cosmic Ray Testing



References

- [1] Technical Design Report - New Small Wheel. ATLAS Collaboration, CERN-LHCC-2013-006, ATLAS-TDR-020, <https://cds.cern.ch/record/1552862>
- [2] VMM1 - An ASIC for Micropattern Detectors. G. De Geronimo, J. Fried, L. Shaorui, et al., IEEE Transactions on Nuclear Science, Volume 60, June 2013, DOI: 10.1109/TNS.2013.2258683
- [3] The GBT Project. P. Moreira, et al., DOI: 10.5170/CERN-2009-006.342
- [4] FELIX: Developing a New Detector Interface for ATLAS Trigger and Readout. ATLAS TDAQ Collaboration, ATL-DAQ-PROC-2018-026
- [5] https://gitlab.cern.ch/cbakalis/netio_traffic_analyzer
- [6] https://gitlab.cern.ch/cbakalis/vsb_daq/-/tree/bb5_trg