

FELIX and the SW ROD: the ATLAS readout system for the next decade

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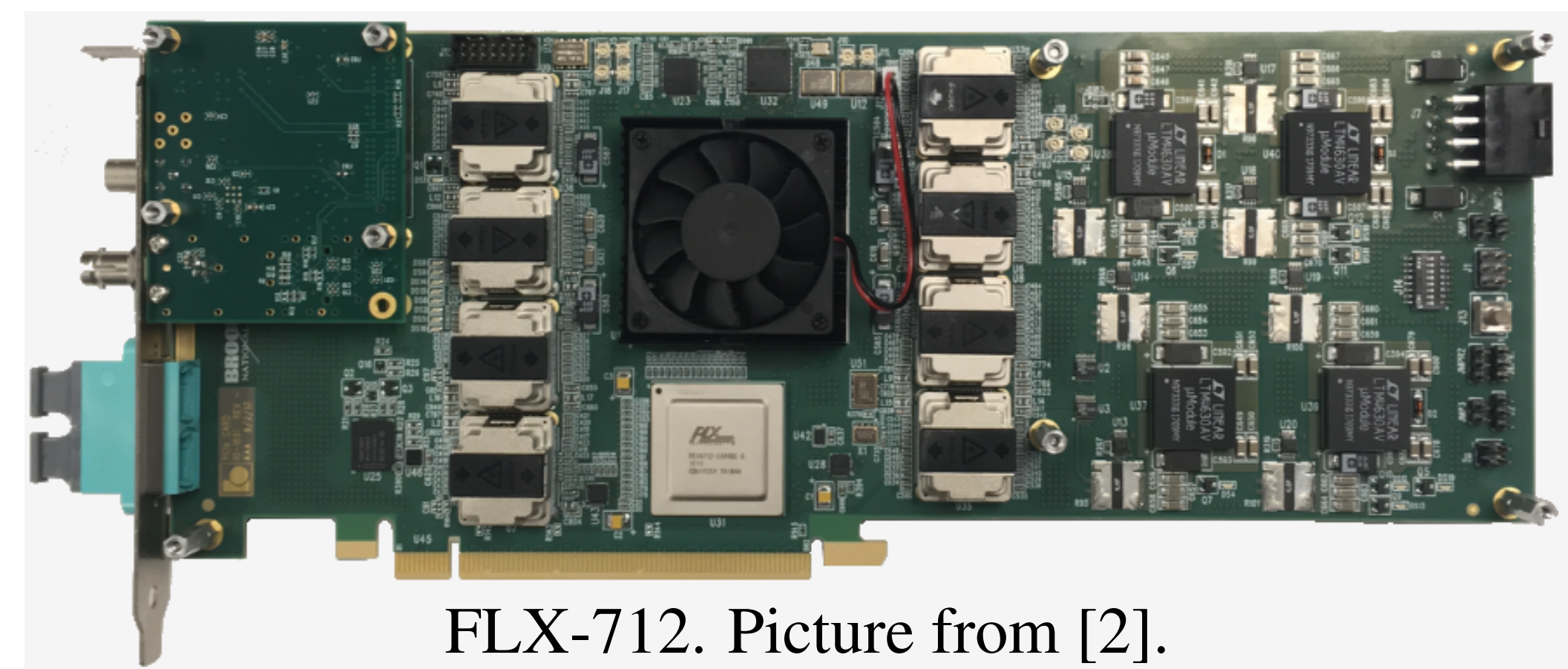
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Motivation

- The Large Hadron Collider (LHC) will undergo a series of upgrades that will increase the average collision luminosity by up to 7 times the original design value. These will culminate with the start of LHC Run 4 in 2027.
- To cope with the higher data volumes and event processing complexity, the ATLAS experiment's [1] trigger and data acquisition (TDAQ) systems are being redesigned, along with some detector upgrades.
- The Front End Link eXchange (FELIX) and the Software Readout Driver (SW ROD) are part of the upgrade effort.

FELIX

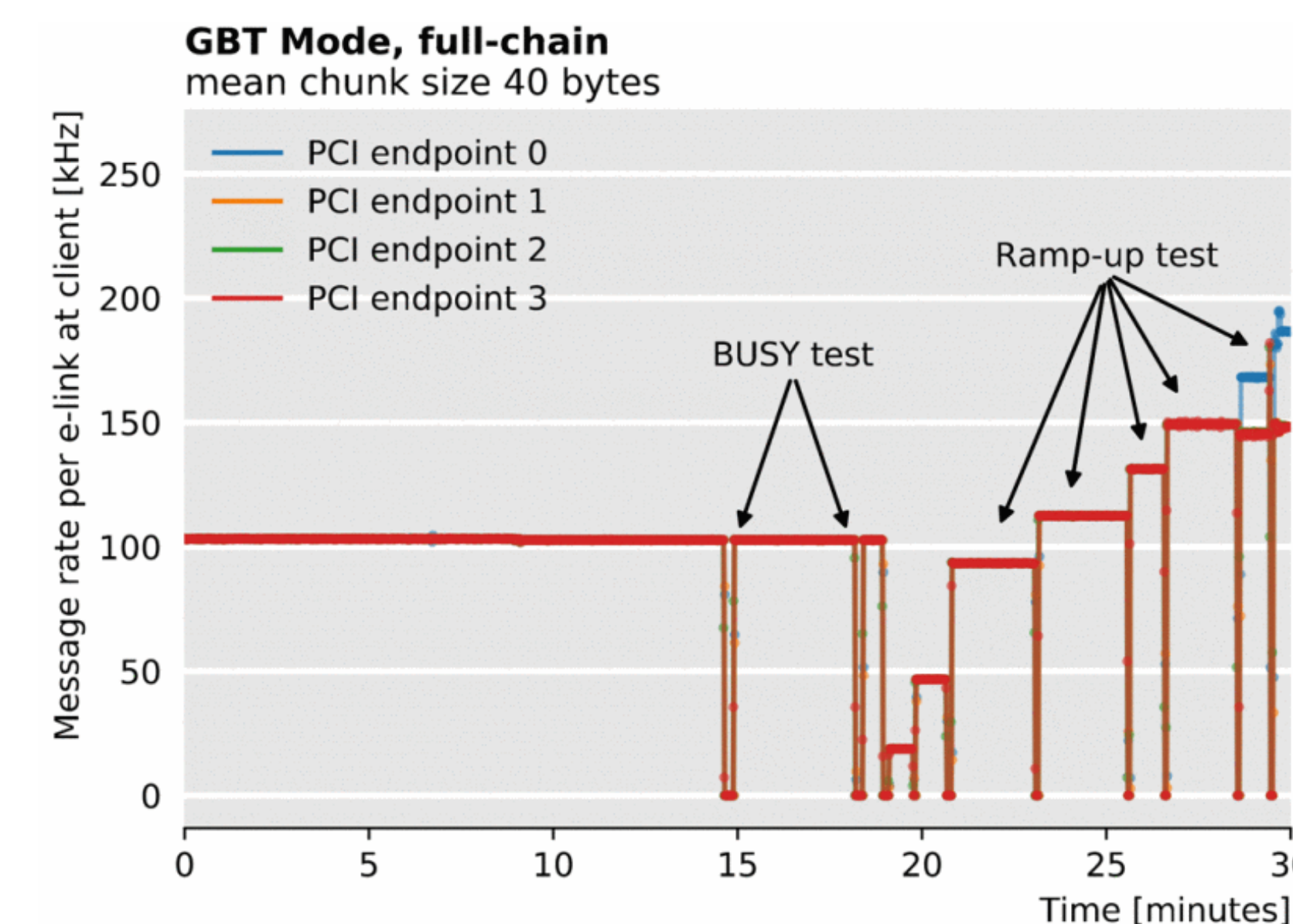


- FELIX is a data router that works as an interface between on-detector systems and commodity computing. The data being routed includes readout, configuration, trigger, clock distribution, monitoring and BUSY.
- The FELIX system consists of commodity servers with PCIe cards (FLX-712). The card is based on a Xilinx Kintex Ultrascale FPGA with up to 48 high-speed optical links to interface with the on-detector systems.
- The firmware is modular and flexible with a routing module between the custom serial links and PCIe interface.
- The software includes drivers, low-level tools, test software and routing software. The software portion of the routing platform, felix-star, distributes data between the card and subscribed applications via the network.

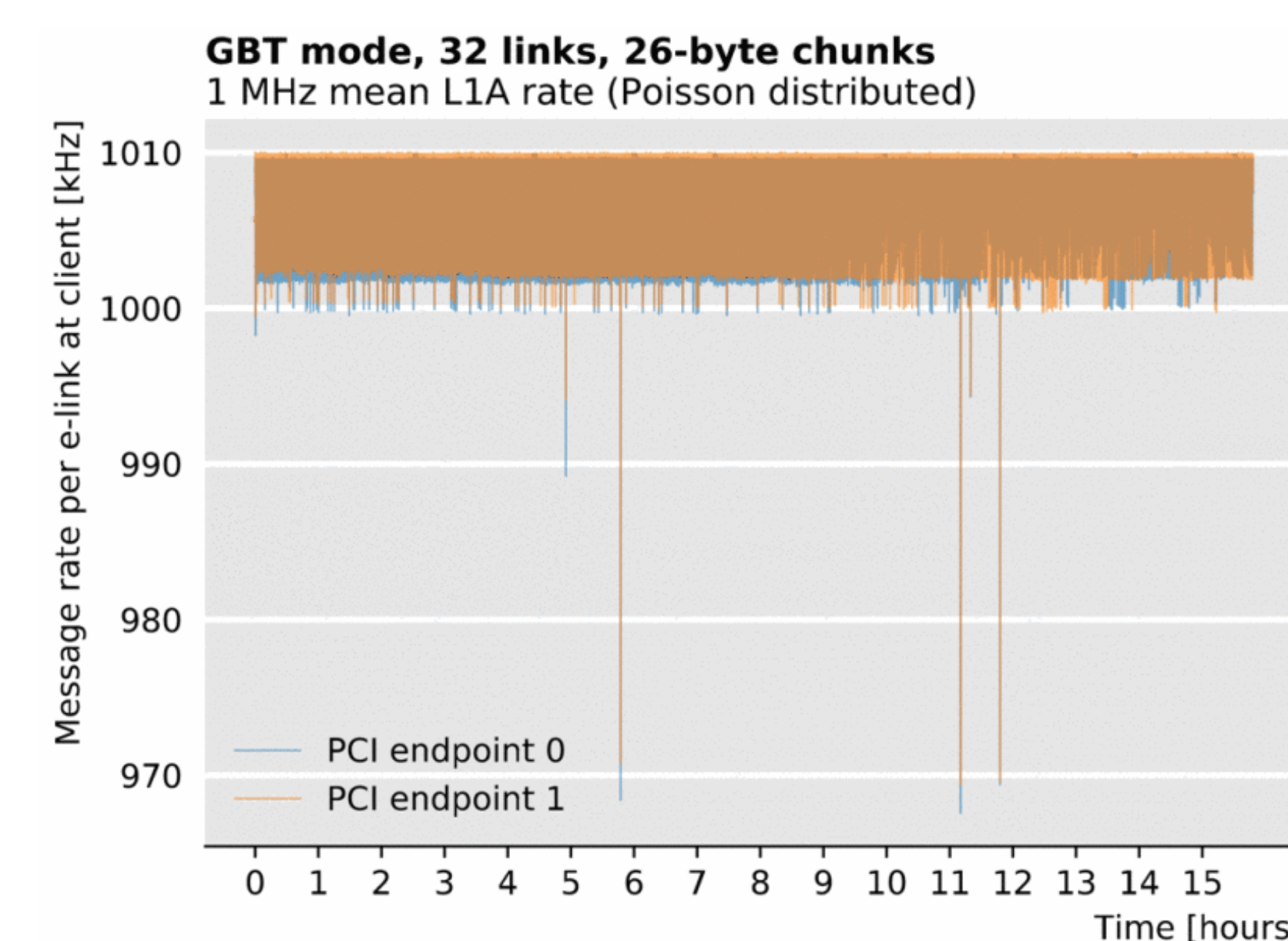
SW ROD

- The SW ROD is a commodity server farm responsible for all the data processing, formatting and monitoring tasks that used to be performed with custom electronic boards.
- The primary function is to receive data from FELIX and serve it to High Level Trigger (HLT) nodes on demand.
- Can process particle collision data as well as those produced during calibration runs and other tests.
- The SW ROD was built to support detector-specific algorithms for event building and processing.

Selected results



System performance at 100 kHz trigger rate (LHC Run 3).



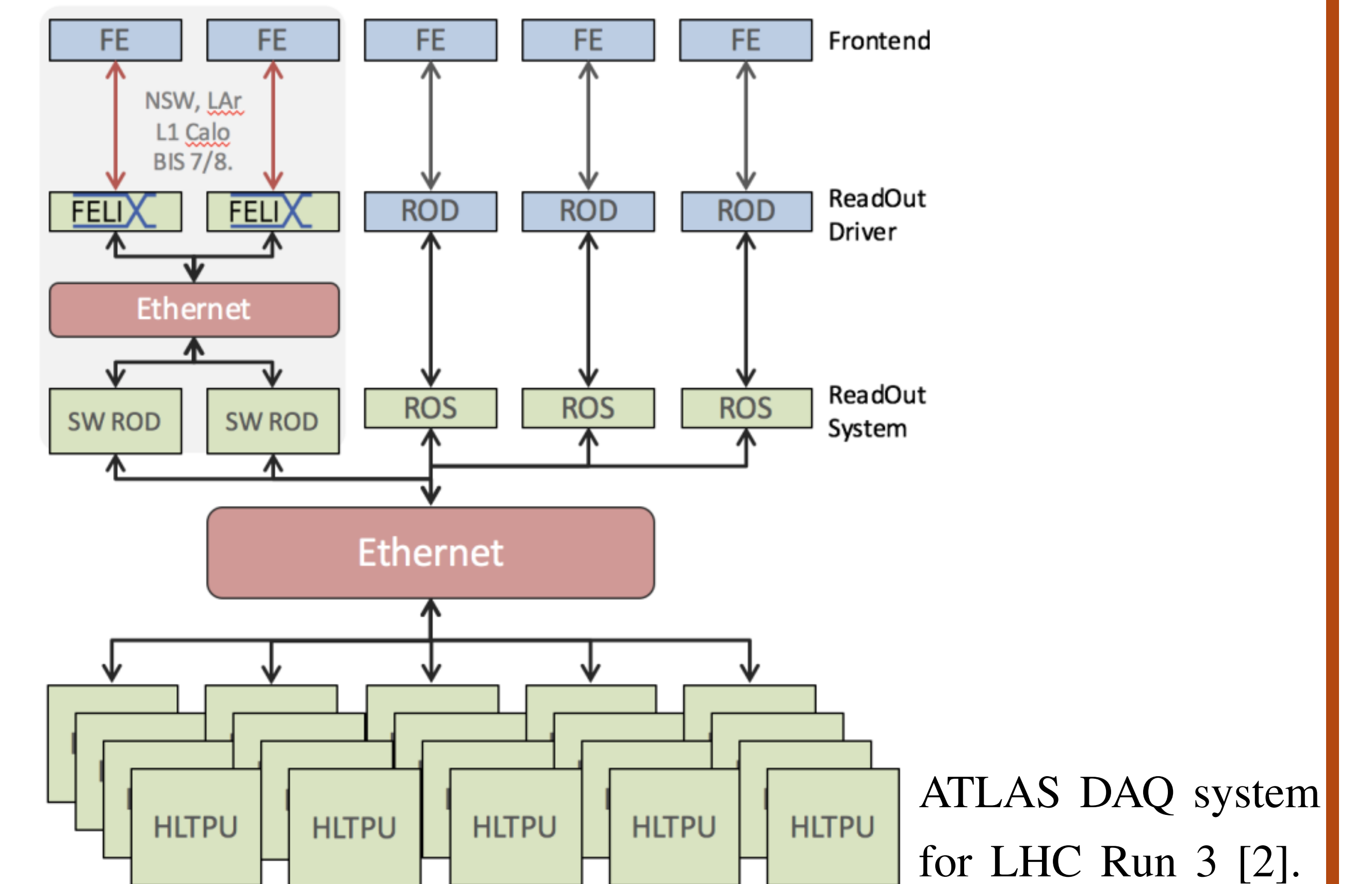
Stress test to evaluate performance for rates up to 1 MHz (LHC Run 4).

Both plots from [3]

References

- [1] ATLAS Collaboration, *The ATLAS Experiment at the CERN Large Hadron Collider*, 2008
- [2] ATLAS TDAQ, *FELIX: the New Detector Interface for the ATLAS Experiment*, 2019
- [3] C. A. Gottardo, *FELIX and SW ROD Commissioning of the New ATLAS Readout System*, 2020

Integration and commissioning



- FELIX and SW ROD will be used in all new readout paths for LHC Run 3. These include the muon systems New Small Wheel (NSW) and Inner Barrel RPCs (BIS 7/8), as well as Liquid Argon (LAr) calorimeter and Level-1 calorimeter trigger (L1Calo).
- NSW: FELIX tested at scale on the surface, integration with systems in cavern ongoing.
- BIS 7/8: Electronics updates, installed and connected to FELIX and SW ROD. Low level communication tested.
- LAr: Systems successfully integrated as part of collision data taking (LHC pilot run).
- L1Calo: successful surface tests, installation of FELIX and SW ROD in the cavern complete.
- FELIX and SW ROD will become the sole readout system for LHC Run 4.

Summary

- FELIX and SW ROD developed for the upcoming LHC Run 3, final commissioning now ongoing.
- This system will have an expanded role in the High Luminosity LHC. Development for LHC Run 4 is ongoing.