ATLAS Trigger and Data Acquisition Upgrades for the High Luminosity LHC

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High-Luminosity LHC


The HL-LHC is expected to start operations in the middle of 2026, and to reach up to as much as a peak instantaneous luminosity of $L = 7.5 \times 10^{34}$ cm$^{-2}$s$^{-1}$, corresponding to approximately 200 million proton-proton collisions per bunch crossing (pileup). In this configuration, more than ten times the integrated luminosity of the LHC Runs 3-3 combined will be delivered (up to 4000 fb$^{-1}$).

**Physics Motivation**

The LHC and ATLAS detector upgrades are designed to enable a broad physics program, including the study of the properties of the Higgs boson, precision Standard Model measurements, searches beyond the Standard Model and Flavor and Heavy ion physics. The initial goals are described in [3] and [4].

**Readout**

The Readout system receives data from the ATLAS detector Front-end Electronics (FE) at the L0 trigger rate (3 MHz) and performs basic event processing before sending them to the Dataflow system. It forwards the TTC information to the FE. It is responsible for handling the TTC information with the correct latency.

**Dataflow**

The Dataflow system buffers, transports, aggregates and compresses event data, exposing a simple interface to Readout and Event Filter systems. The main functional components are:

- Event builder
- Storage Handler
- Event Aggregator
- Data Network
- Processor Farm
- Hardware Track Trigger
- References

6 TeraByte/s (Raw)

Level-0 Trigger System

The Level-0 Trigger System uses Calorimeter and Muon system information at 40 MHz to perform an initial event selection and to identify features to be examined in the subsequent trigger level. The maximum average Level-0 trigger rate is estimated at 1 MHz. The system makes extensive use of FGPA and ATCA technology.

40 MHz

6 TeraByte/s (Processed)

Event Filter

The Event Filter (EF) system takes as input the detector data from events accepted by the preceding hardware trigger at 3 MHz. It must select the most useful events according to the trigger menu with 10 bits and reject the rest.

1 MHz

36 GB/s

Tier-0 Permanent Storage

Selected physics events are submitted to the Worldwide LHC Computing Grid (WLCG) for further analysis. The WLCG is a multi-tier computing infrastructure distributed around the world. The Tier-0 facilities are hosted at GSI and provide permanent storage capacities for the LHC experiments.

For the ATLAS, the total available space for the LHC experiments are estimated to 500 PB/year. Several R&D programs are ongoing to study how to better use the available technologies and opportunistic computing resources (Grid, ICP, Cloud, volunteer, etc.).