

The ATLAS Trigger System

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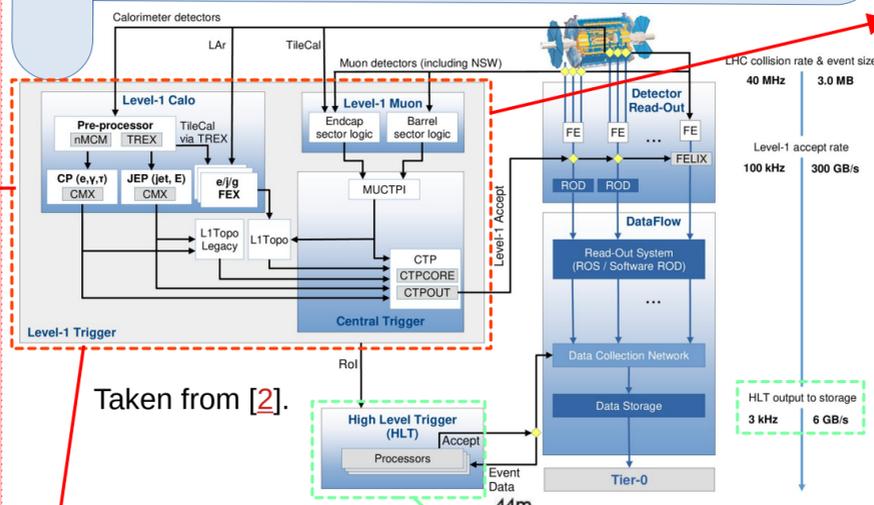
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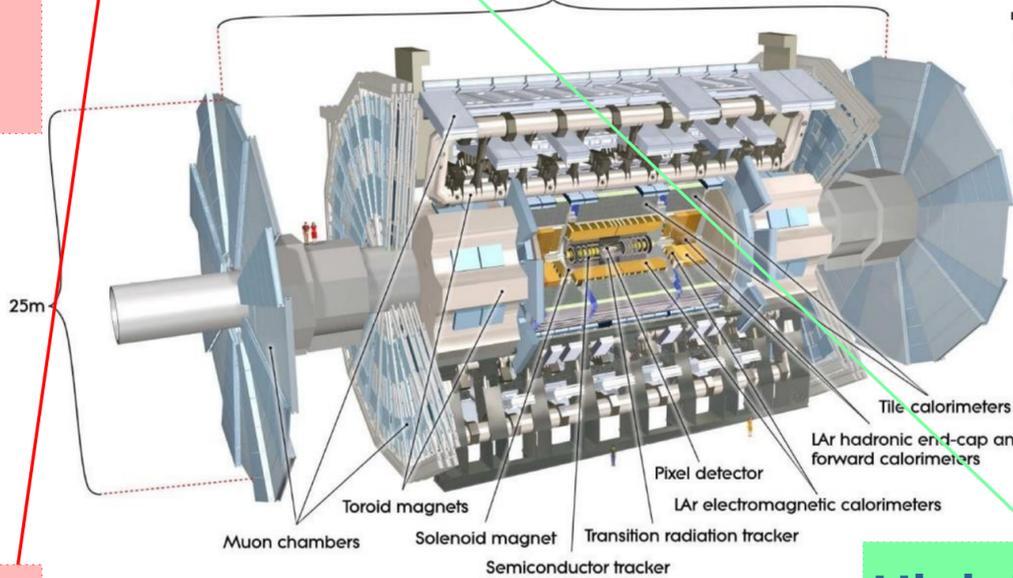
³ CERN

ATLAS Trigger System

- multi-level event selection with inputs from subdetectors of the **ATLAS Experiment** [1]
 - hardware-based **Level-1 Trigger (L1)**
 - provides Regions-of-Interest (Rois) to the HLT
 - software-based **High Level Trigger (HLT)**
 - exploitation of the RoIs + reduction of the L1 rate for disk storage + needs from physics analysis

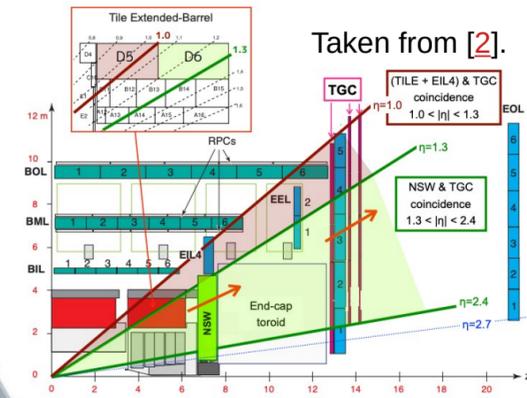


Taken from [2].



L1 Muon

- definition of different threshold and multiplicities
- inputs from the muon trigger detectors
 - RPCs**
 - TGCs**
 - NSW** ← new detector installed in Run-3 (2022-): $1.3 < |\eta| < 2.7$
 - designed to improve fake muons rejection
 - Micro-Megas (MMGs)
 - small-strip Thin Gap Chambers (**sTGCs**): $1.0 < |\eta| < 1.3$
 - around 14 kHz reduction L1 rate with new TGC/NSW coincidence

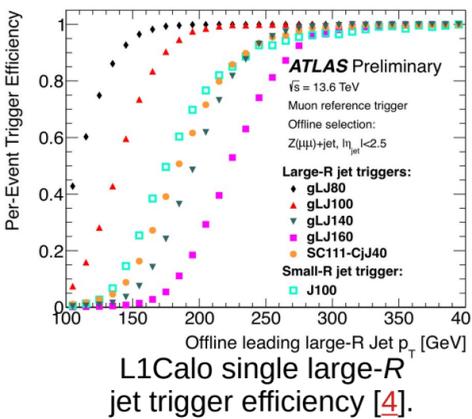


Taken from [2].

L1 muon trigger efficiency [3].

L1 Calo

- threshold definition:
 - jet & forward jet thresholds
 - EM, tau thresholds
- input from **LAr** and **Tile** calorimeters
- Run-3 improvements
 - finer granularity LAr calorimeter input
 - ATCA-based **Feature EXtractors (FEX)**
 - eFEX (Electron FEX)**
 - electrons, photons, taus identification
 - sophisticated clustering algorithms and isolation
 - jFEX (Jet FEX)**
 - identification of jets, E_T^{miss} , hadronically-decaying taus
 - jet reconstruction algorithms
 - gFEX (Global FEX)**
 - full-scan algorithms to compute global event quantities

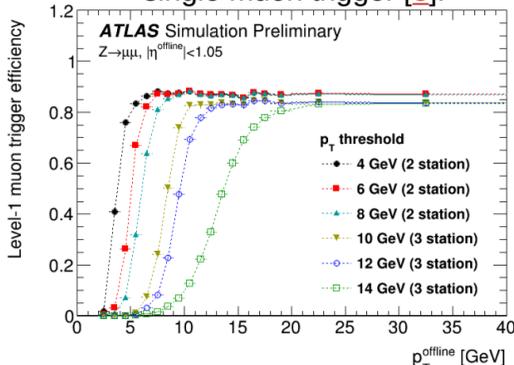


L1Calo single large-R jet trigger efficiency [4].

CTP & L1Topo

- Central Trigger Processor** → input from all L1 systems
- applies prescales, bunch groups, deadtime veto, L1 items monitoring
- muon-to-CTP Interface (**MuCTPI**)
- L1Topo** – input from **L1Calo** and **L1Muon**
 - topological selections between L1 trigger objects (e.g. dR)

Run-3 efficiency of L1 single muon trigger [3].



under development

Data streams

- Stream: collection of events or event fragments in the same dataset
 - Main stream** – for most data analysis, also for Data Quality assessment
 - Express stream** – events for prompt reconstruction
 - Delayed streams** (Bphys, VBF) – events not automatically processed offline
 - Calibration streams** – events with minimum amount of information for detector calibration at high rate → also used during VdM scans
 - TLA stream** – data written out with reduced event content for trigger level analysis
 - Debug stream** – events with no full trigger decision, due to failures in a part of the online system → automatic offline recovery at CERN Tier-0, **Recovery Web App** for monitoring

High Level Trigger (HLT)

- Rate from **100 kHz (L1)** to **3 kHz (HLT, target for Main stream)**
- offline algorithms using full granularity detector information in either RoIs or the whole event
- Run-3 improvements:
 - migration to **multi-threaded** software
 - track reconstruction speed up, now able to run in full scan mode
 - benefit to pile-up sensitive algorithms
 - triggers for unconventional signatures
- Trigger Menu**: collection of triggers and corresponding prescales
 - fit within hardware, rate and CPU constraints
 - kept as inclusive as possible in term of signatures → input from physics analyses groups

References:

- ATLAS Collaboration, *The ATLAS Experiment at the CERN Large Hadron Collider*. JINST 3 (2008) S08003, 1-407.
- ATLAS Collaboration, *The ATLAS trigger system for LHC Run 3 and trigger performance in 2022*, JINST 19 (2024) P06029.
- ATLAS Collaboration, *L1 muon trigger public results*, <https://twiki.cern.ch/twiki/bin/view/AtlasPublic/L1MuonTriggerPublicResults>.
- ATLAS Collaboration, *L1Calo trigger public results*, <https://twiki.cern.ch/twiki/bin/view/AtlasPublic/L1CaloTriggerPublicResults>.

