The readiness of the ATLAS Trigger-DAQ system for the second LHC run

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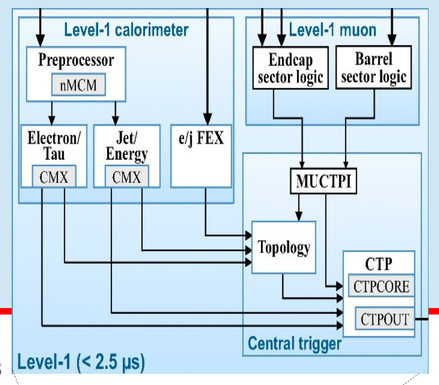
Upgrades to the Trigger-DAQ system for Run II

Data taking very successful with very high efficiency in Run I !
In Run 2 reduce rate and keep high efficiency.

Trigger Level-1 (L1)

- Custom Hardware with latency < 2.5 µs
- Defines ROI from Calorimeter /Muon info
- Rate Reduction 40 MHz -> 100 kHz
- Max. rate increased 70 kHz (run I) → 100 kHz

L1Calo
- New Multi-Chip Modules (nMCM)
- Improved handling of pile-up → reduction of E_T^{miss} rates
- CMX(New) additional trigger objects and propagation of these to L1Topo



L1Topo
- **Conceptually new**
- Input trigger objects from L1Calo and L1Muon
- **Real-time event kinematics and angular cuts at Level-1**
- Topological decisions on FPGAs
- Deal with increased rates of E_T^{miss}, b-jets, B-Physics, Taus

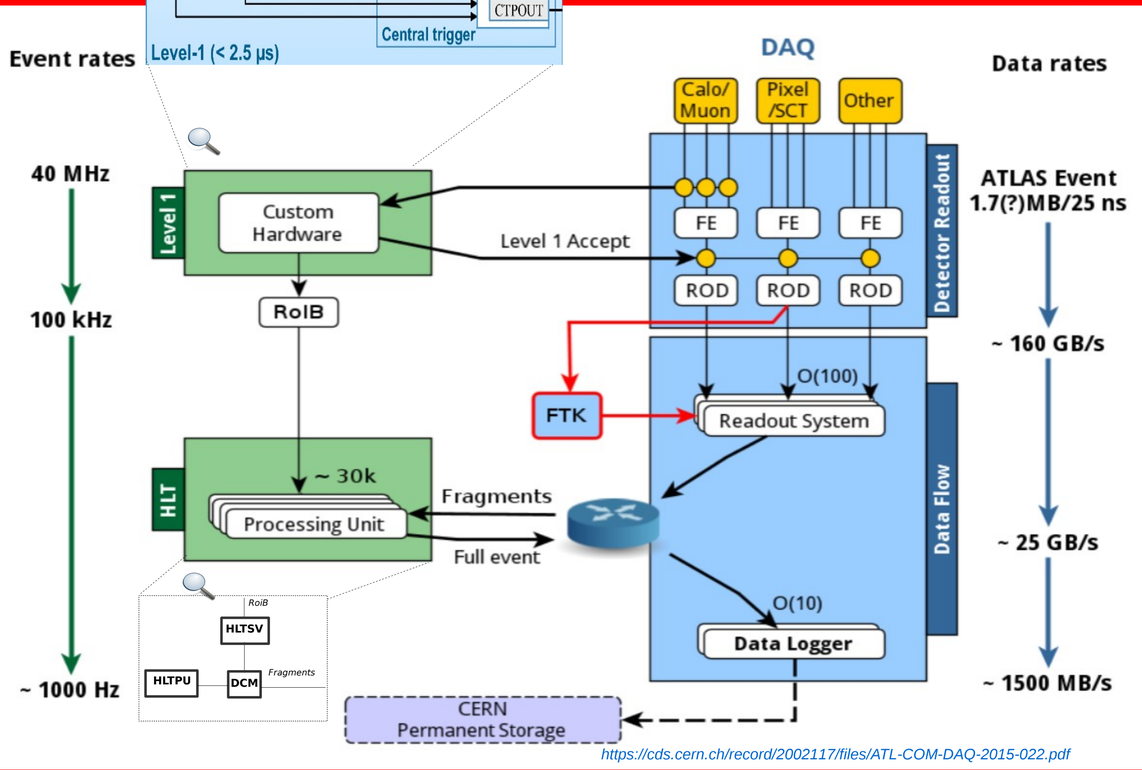
Region of Interest Builder(RoIB)

- Forwards L1 trigger decision and RoIs to the HLT
- VME based custom hardware from run 1
- Close to limit, replacement in the work

High Trigger Level (HLT)

- Software with average processing time ~ 0.2 s
- Rate Reduction 100 kHz -> ~1 kHz
- Max. Rate increased 600 Hz (run I) → 1.5 kHz
- Two Stage system (L2 and EF) merged to **single HLT farm** → large simplification
- **One event at a time** is processed
- Requests and reads only the **data needed** from ROS

HLT algorithms
- Major rework to be closer to offline
- Increased acceptance and higher rejection in physics analysis



https://cds.cern.ch/record/2002117/files/ATL-COM-DAQ-2015-022.pdf

- HLT supervisor (**HLTSV**) distributes events to HLT nodes; Several SVs merged; single application
- Data Collection Manager **(DCM)** handles partial data requests and full event building
- HLT Processing Unit **(HLTPU)** runs the HLT algorithms; Configuration in mother process, event processing with forked children to maximize memory sharing

Huge number of triggers defined
~500 @ L1
~1000 @ HLT

Conditions are changing !

	Run I	Run II
p-p collisions of up to [TeV]	**8**	**13**
Bunch spacing [ns]	**50**	**25**
Instant. Luminosity [$cm^{-2}s^{-1}$]	**~8e33**	**1-2e34**
Avg. Interactions per Bunch Crossing	**40**	**25-50**

L1Muon
- New coincidence measurements
  - with TGC & EIL4 &TileCal in η = 1 -1.3
  - with TGC & FI in η=1.3-1.9

  improve muon purity
  - 4 % larger acceptance in barrel region due to new chambers

CTP
- Increased resources
  - L1 items: 256(run I) → 512
  - Input bits: 160 (run I) → 320 +192
- Output increased to 100 kHz
- Software redesigned

Readout System (ROS)

- Buffers front-end (FE) data from the detectors
- New board (RobinNP) for S-link and buffer hardware
- Higher density of optical link connectors
- Increased data bandwidth to the HLT

Network

- Upgrade to 10 GBit/s
- Larger bandwidth of the backend switch
- Improved load balancing and link redundancy
- backup solutions for all components.

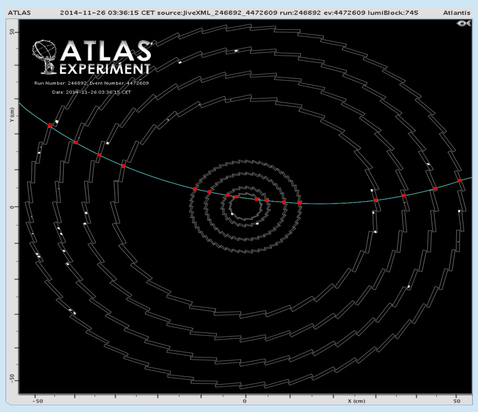
Data logger and permanent storage

- save accepted events to disk
- copy the files to permanent storage
- Upgraded system with multiple front-ends and redundant data paths
- increased fault tolerance

Commissioning and first data taking

Cosmic data

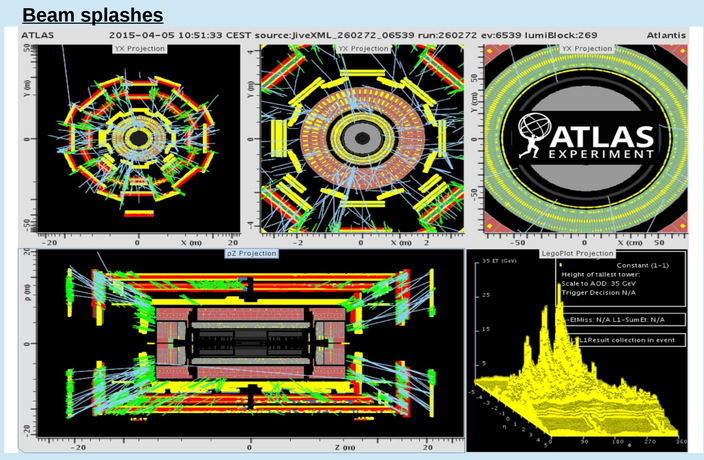
- Upgraded TDAQ system was tested continuously with cosmic data between run I and run II
- TDAQ system used to commission Sub-detectors and first timing of detectors
- Cosmic Muon triggers by combined TRT and MS trigger



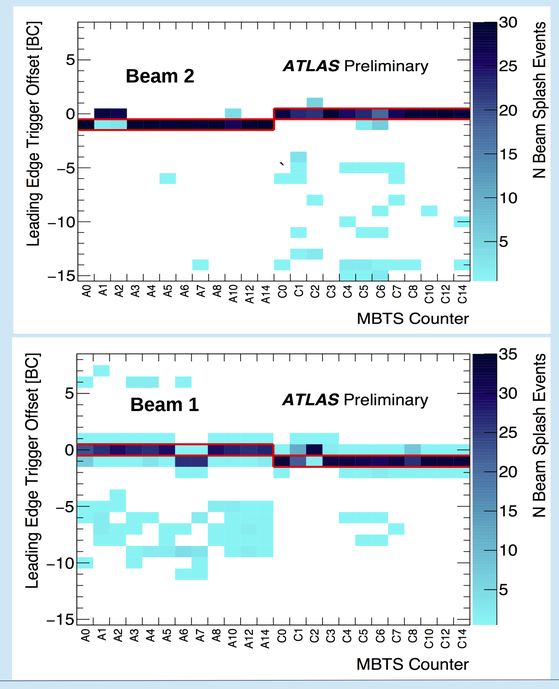
A cosmic ray hitting the new IBL of ATLAS, in the presence of a solenoidal magnetic field

First beams and collisions

Beam splashes



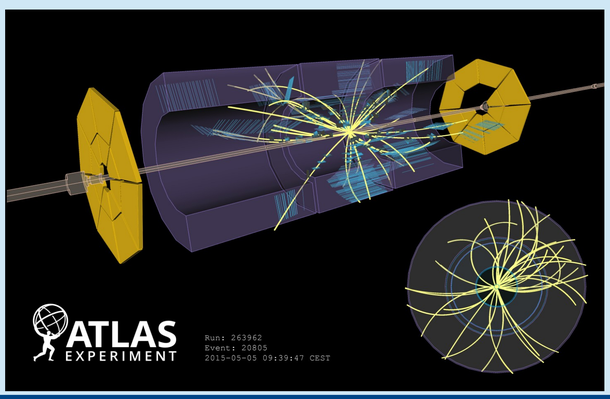
- Detector illuminated from single beams
- Trigger on ring of calorimeter cells
- Up and down stream
- Used for timing of detectors

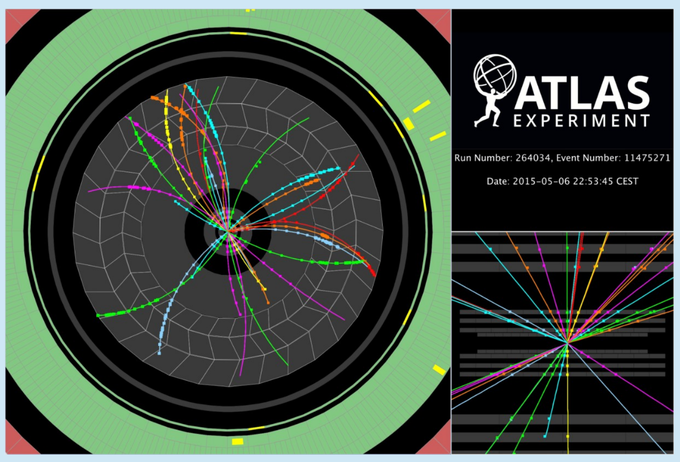


MBTS Beam Splash Timing

Relative timing of the trigger signal from different Minimum Bias Trigger Scintillator (MBTS) counters in beam splash events.

First Collisions at 900 GeV
- Timing in detectors
- Offline studies of detector performance
- Exercised event readout and triggering





Summary

- *The ATLAS Trigger-DAQ system has undergone a major upgrade between run I and run II to cope with changing conditions of the LHC.*
- *It has been continuously tested during the long shutdown with calibration, cosmic, first beams and first collisions runs.*
- *No bottleneck has been found and ATLAS Trigger-DAQ is ready to go and record collision data in run II.*

ATLAS TDAQ is ready for Run 2 !