The Physics Selection Strategy of the ATLAS High Level Trigger

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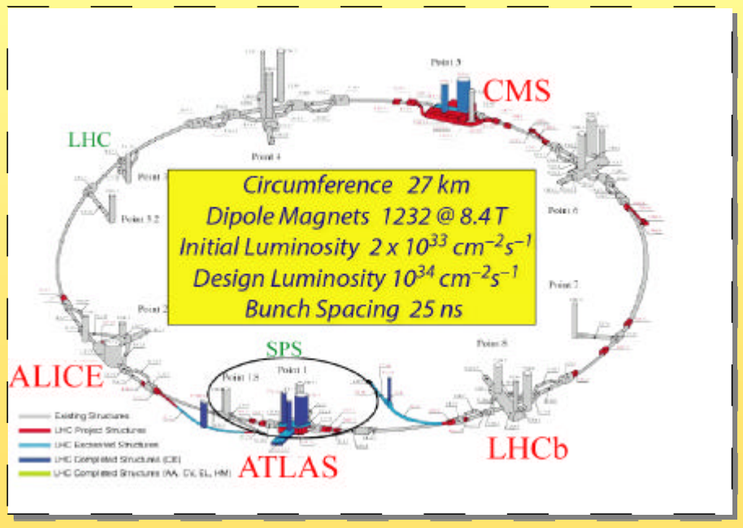
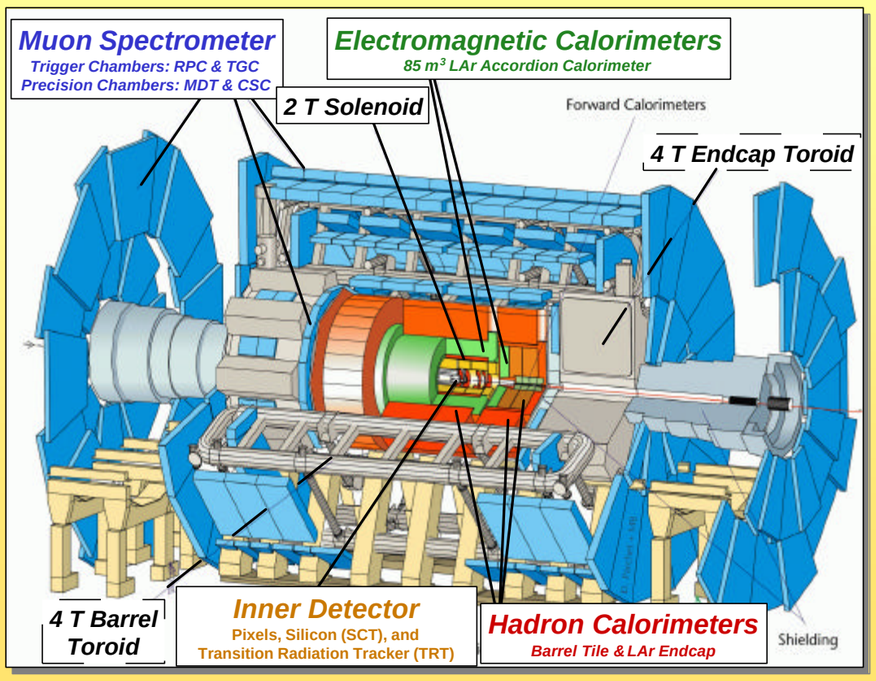
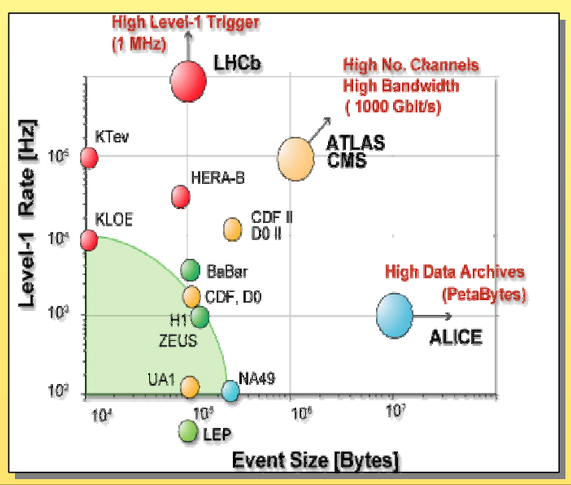
The Large Hadron Collider (LHC) and the ATLAS Detector

The LHC project at CERN presents unprecedented physics opportunities as well as challenges for the design and construction of detector, trigger, and data-acquisition systems.

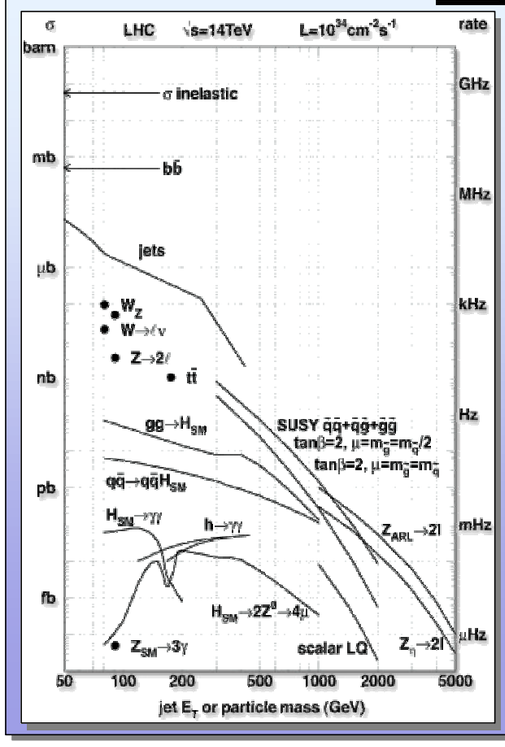




A highly hermetic and granular detector designed to cope with large particle multiplicity (~2100 particles per bunch crossing) leads to more than 140 million readout channels and a large 1.5 MByte event size. Coupled with the 40 MHz bunch-crossing rate, ATLAS lies on a new Trigger/DAQ performance frontier.



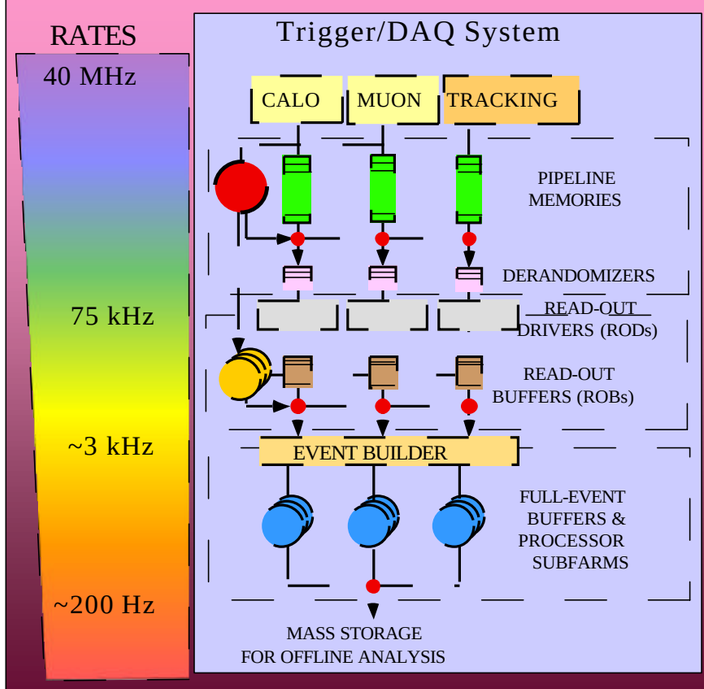
Physics Coverage



The High Level Trigger must support a broad and ambitious physics program. It is axiomatic that events which are not selected by the trigger will not be available for offline analysis. Hence, to maximize the discovery potential, selection schemes generally only use inclusive signatures. Although exclusive reconstruction of particle decays is possible, the present scheme concentrates on inclusive classes of final-states:

Physics Object	Examples of Physics Coverage	Trigger Element Nomenclature
Electrons	Higgs (SM, MSSM), new gauge bosons, extra dimensions, SUSY, W, top	e25i, 2e15i
Photons	Higgs (SM, MSSM), extra dimensions, SUSY	g60i, 2g20i
Muons	Higgs (SM, MSSM), new gauge bosons, extra dimensions, SUSY, W, top	m20, 2m10
Jets	SUSY, compositeness, resonances	j360, 3j150, 4j100
Jet+missing E_T	SUSY, leptoquarks	j60 + xE60
Tau+missing E_T	Extended Higgs models (e.g. MSSM), SUSY	t30 + xE40

Trigger/DAQ Architecture



ATLAS has a three-level Trigger design.

LEVEL 1 TRIGGER
- Hardware-Based (FPGAs ASICs)
- Coarse granularity from calorimeter & muon systems
- 2 ms latency (2.5 ms pipelines)

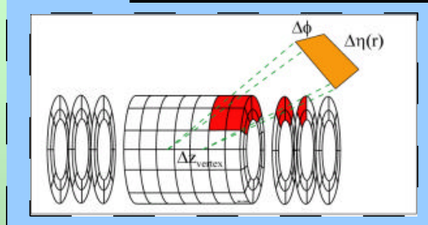
LEVEL 2 (LVL2) TRIGGER
- Regions-of-Interest "seeds"
- Full granularity for all subdetectors
- Fast Rejection "steering"
- O(10 ms) latency

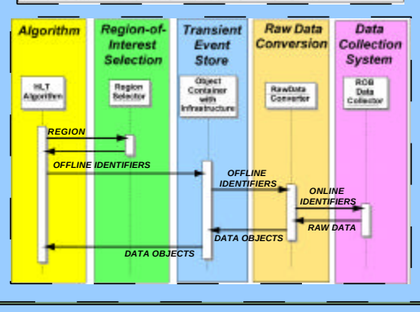
EVENT FILTER (EF)
- "Seeded" by Level 2 result
- Full event access
- Offline-like Algorithms
- O(1 s) latency

High Level Trigger (HLT) (software-based)

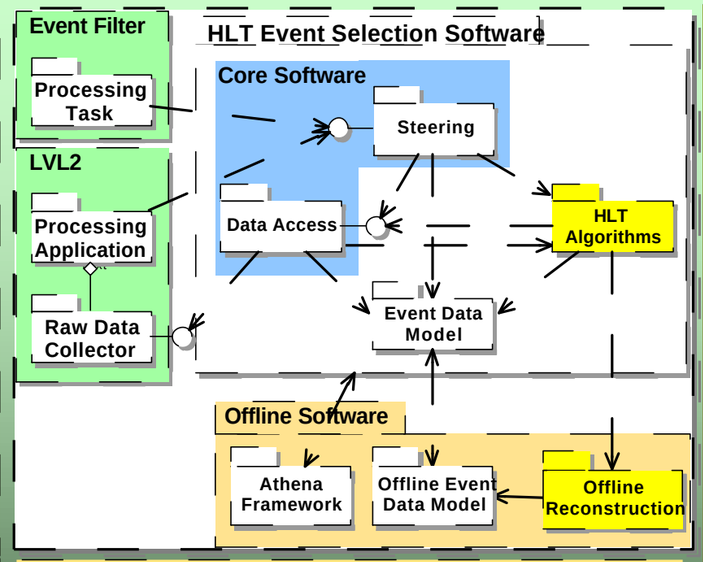
High Level Trigger Event Selection Software

Restricted and Realistic Data Access





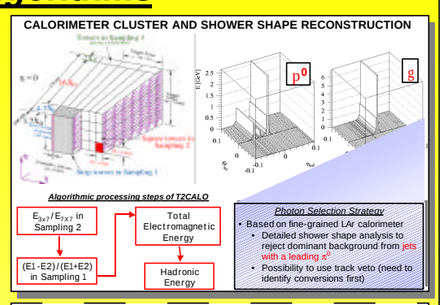
Region-of-Interest mechanism allows algorithms to request only relevant event data (typically 2% of total data volume) thus dramatically reducing required network and processing resources. In simulation, a ByteStream of raw data exactly as it would be received from front-end electronics is processed within the software framework.

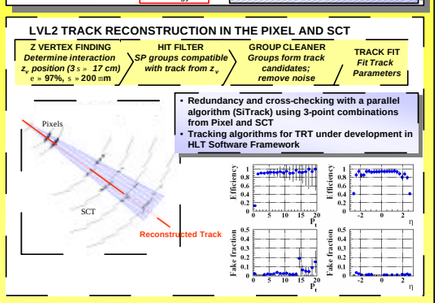


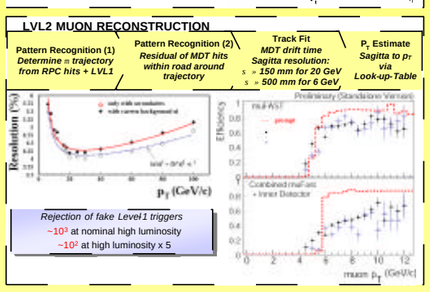
HLT Algorithms

HLT algorithms are the basic reconstruction software components that provide results from which the trigger decision is derived. Unlike typical Offline reconstruction, HLT algorithms must be
- **guided by HLT Steering**
- **support being called multiple times per event**
- **operate with seed from previous result in trigger**
- **validate only a specific trigger hypothesis**

LVL2 algorithms use data restricted to Regions-of-Interest and provide a fast *O*(10 ms) and rough result. EF algorithms have potential full data access and a more generous *O*(1 s) processing time.

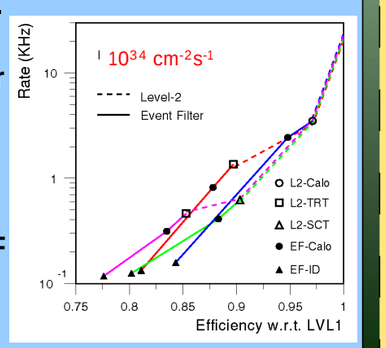






Steering

The Steering controls the HLT selection. It arranges algorithms for the event analysis in the correct order so that the required data are produced and the trigger decision obtained. It provides a flexible and dynamically-configurable LVL2 & EF boundary allowing tuning of rates and efficiencies.



Importation of Offline Software

Use of Offline Software in the Online Trigger environment serves two goals:

1. ***Same infrastructure and services*: HLT Software may be run Offline to facilitate development of algorithms, to study LVL2/EF boundary, and to permit physics performance studies.**
2. ***Consistent model for event data objects*: major parts of the trigger reconstruction may be based on offline reconstruction algorithms.**