ATLAS electroweak precision physics & trigger software

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Science and Technology Facilities Council

UCL

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CERN
JINR

ATLAS Collaboration

183 institutions (253 institutes) from 42 countries

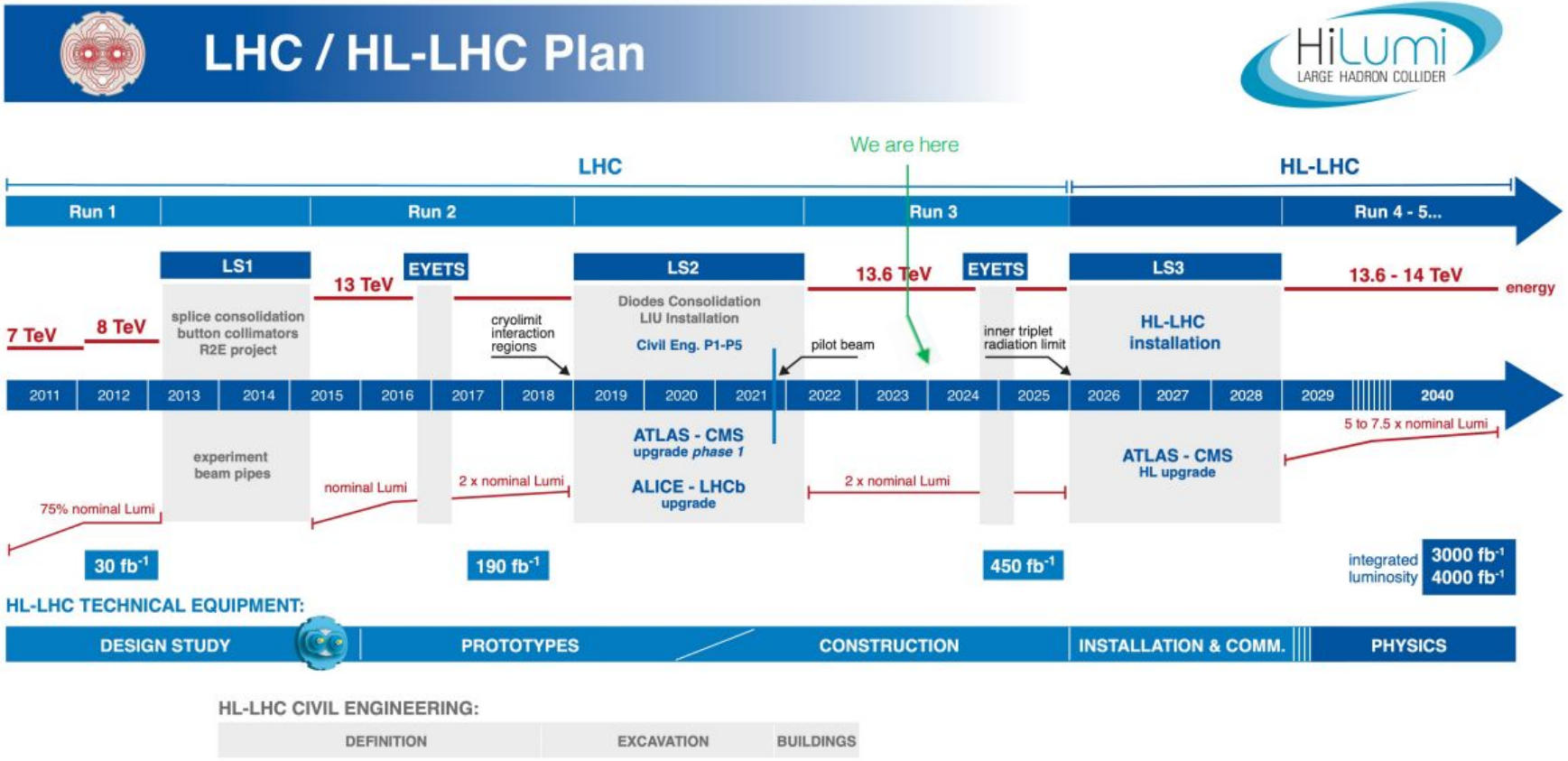
183 Institutions (252 Institutes) from 42 countries
(103 nationalities) + 14 Technical Associate Institutes

- 2881 scientific authors
- 1936 with PhD contributing to M&O share
- 1190 physics PhD students
- 1304 engineers and technicians

Status: October 2023

Try the intereactive ATLAS map: http://atlas.web.cern.ch/Atlas/Management/Map.html

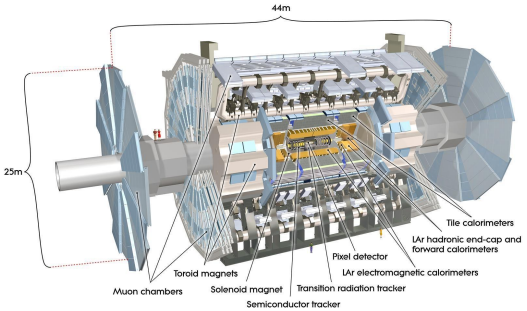
Preparing the future — the grand plan

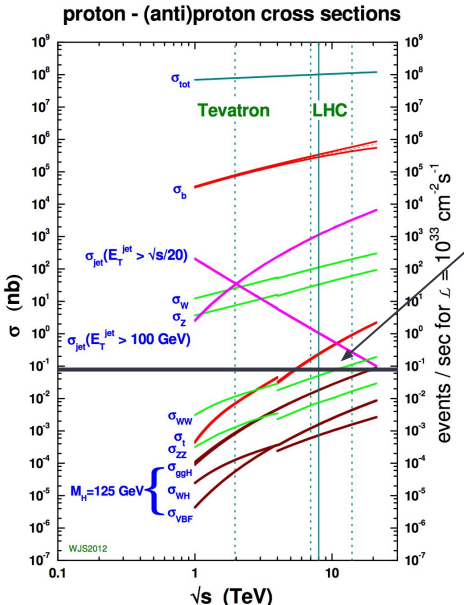



NSW-A in July 12, 2021

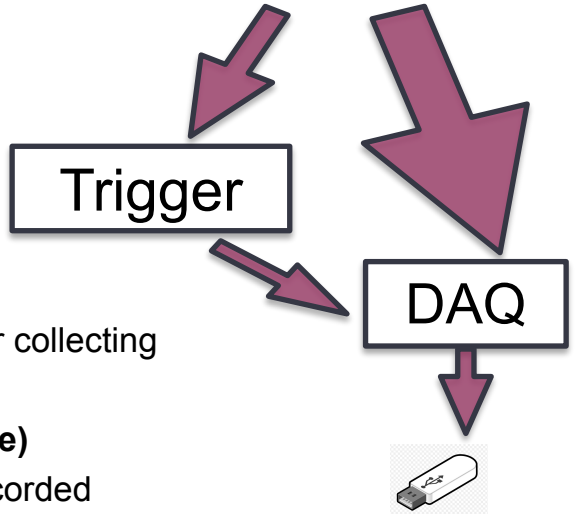
Trigger & Data Acquisition (TDAQ) System

- Recording the interesting physics is a challenge
  - **ATLAS detector is BIG**
    - ~1 MB of RAW data per event
  - **Rate of delivered collisions is high**
    - 40 MHz measurement rate (every 25 ns)





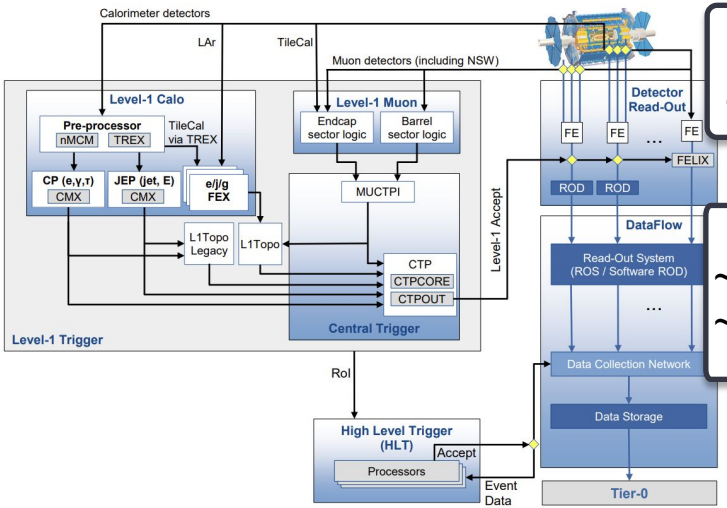
One interaction per second (on average) at $L = 2x10^{34}\ cm^{-2}s^{-1}$, typical for 2022-2025. Rising to $7.5x10^{34}\ cm^{-2}s^{-1}$ after 2029.

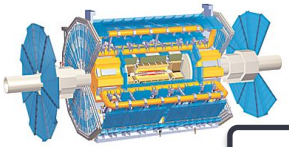


- **Data Acquisition (DAQ)** is responsible for collecting & recording data from detector systems
- **Trigger** is responsible for **real-time (online) selection** of the subset of events to be recorded

Preparing For a Major DAQ Upgrade

Current architecture (to Dec 2025)





40 MHz

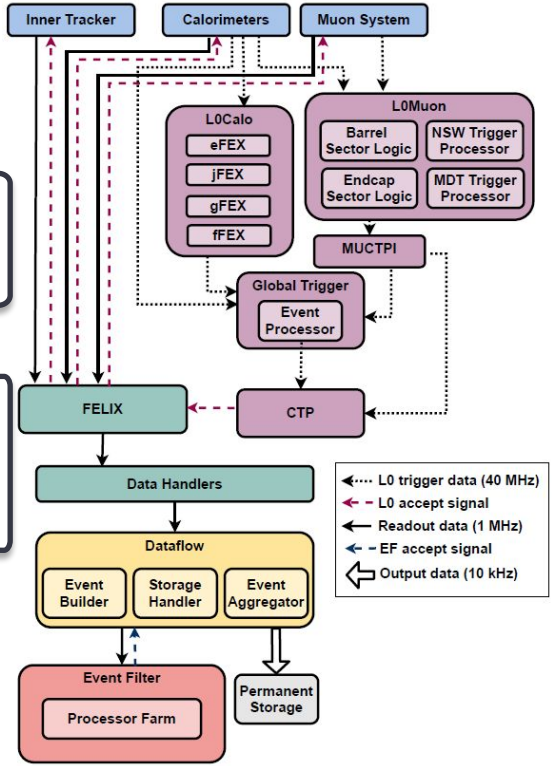
100 kHz, ~ 2.5 µs

1 MHz, ~ 6.9 µs

~3 kHz, ~ 500 ms

~10 kHz, ~ 500 ms

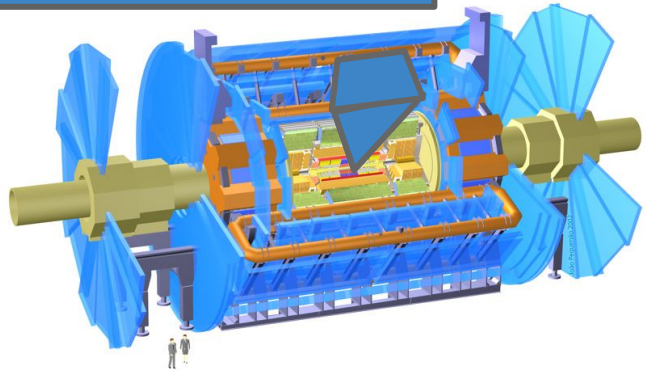
New architecture (from 2029)



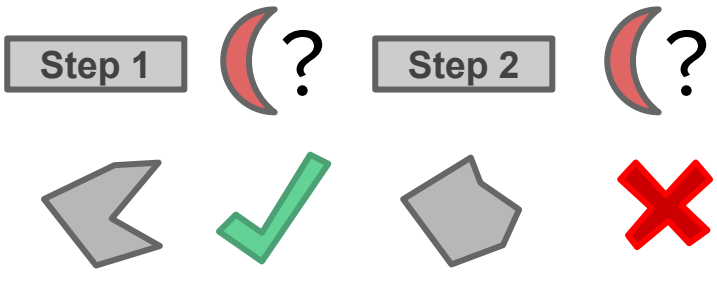
High Level Trigger, Rewritten for 2022

- **Regional Reconstruction**
  - We **cannot** look at all **1.6 MB** of every event.
  - Restrict to running **reconstruction algorithms** within **Regions of Interest**, identified in the 1st level hardware trigger.
- **Early Rejection**
  - Split reconstruction up into multiple **Steps**.
  - **Filtering** occurs after each **Step** via **Hypothesis Algorithms**
  - **Early** steps are **fast**, but **coarse**.
  - **Later** steps **take more time**, but are **detailed**.
  - **Stop** reconstructing an **object** as soon as it fails a selection at the end of a **Step**.
  - **Stop** reconstructing the **event** when all objects are **rejected**.

Region of Interest



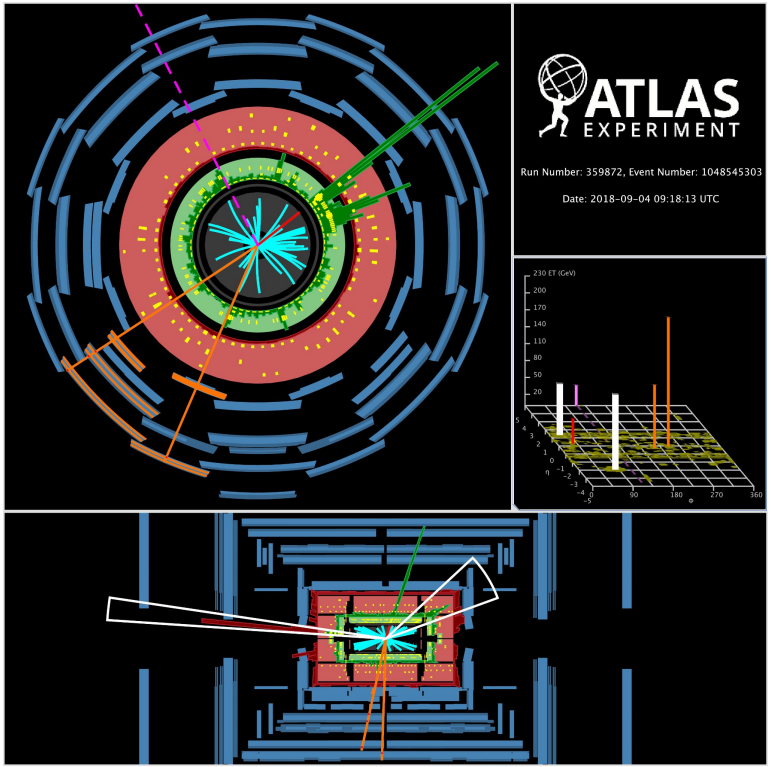
Hypothesis Algorithms



Analysing Existing Data.

- Make a new measurement of kinematic spectra of **three-lepton events** using ATLAS data from Run-2 and Run-3.
- Known Standard Model production modes: **WZ** or **tZ** as two examples, with contributions arising from from both *on-mass-shell* and *off-mass-shell* components.
- Correct the data for experimental effects in a *model independent* way - ***"unfolding"***.
- Publish differential spectra at the ***particle level***, corresponding to the long-lived states which we actually measure in the detector.
- Then... **interpretations**! E.g. Effective Field Theories - investigate Triplet & Quartic Gauge couplings.

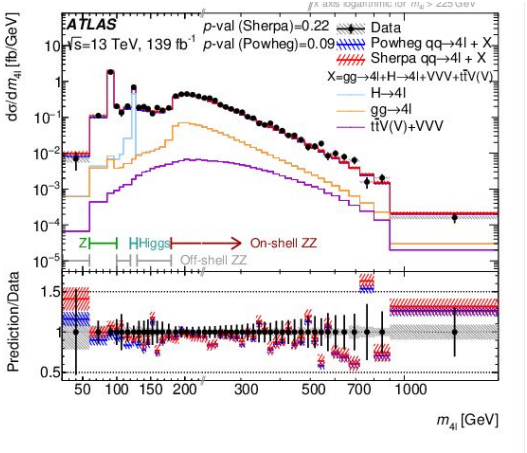
Candidate WZ→evμμ Event



PhD on ATLAS

- This style of precision physics measurement already demonstrated for the four-lepton final state, see [JHEP 07 (2021) 005] and [Contur] for more information.
- Opportunities to leverage **modern machine learning techniques** in **physics analysis** and in the **high level trigger**. Expertise with GPU-based track-finding at RAL.
- Come join a massively international collaboration of over 5,500 members.

Measure, carefully



... and then interpret