



ATLAS Upgrades for the SLHC and the Physics Case

DIS-2011

Sarah Demers, Yale University
On behalf of the ATLAS Collaboration



HL-LHC

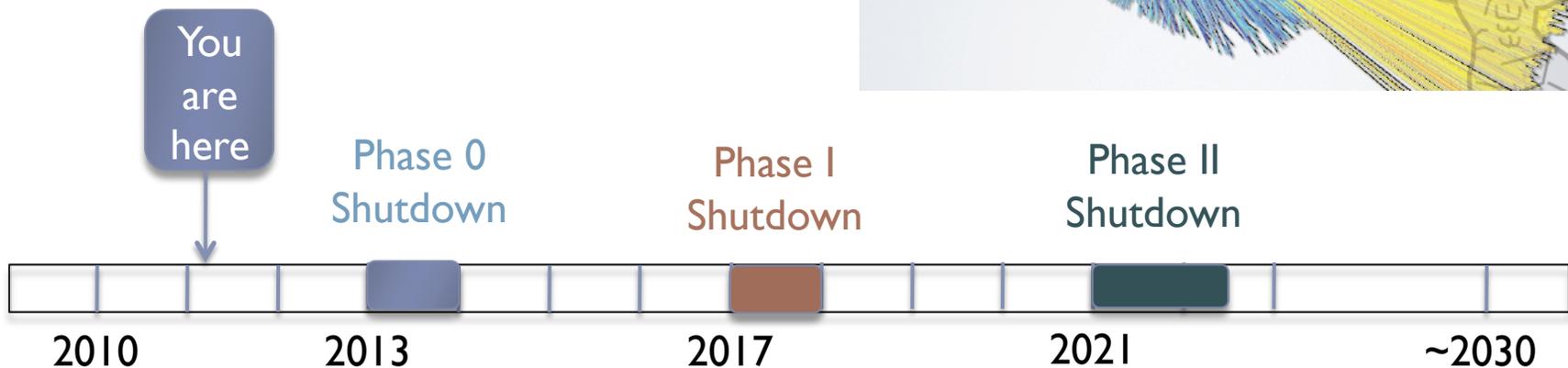
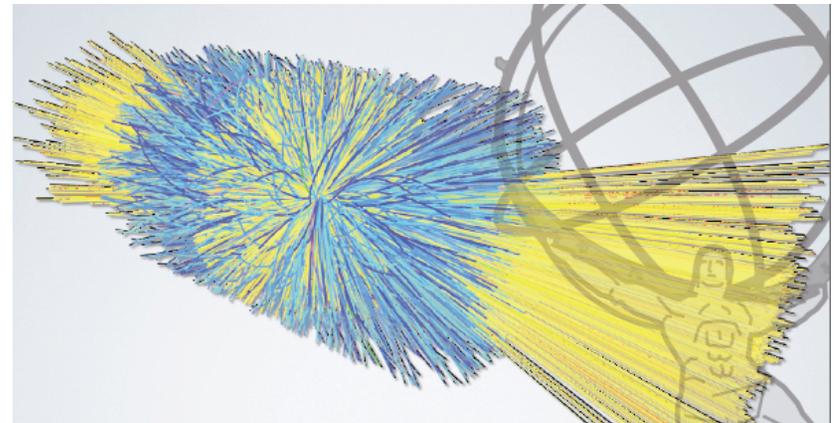
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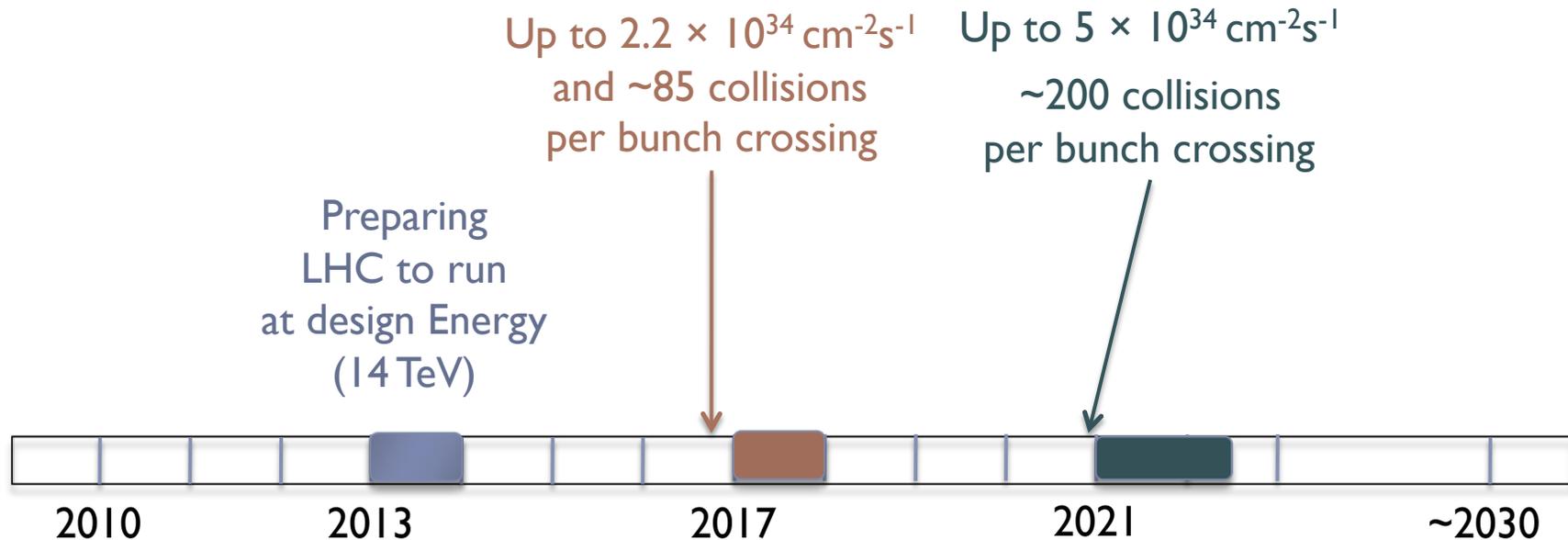
Schedule

- ▶ **Caveat:** This schedule spans decades. Changes to the schedule could be prompted by
 - ▶ physics landscape
 - ▶ machine (LHC) needs
 - ▶ detector needs



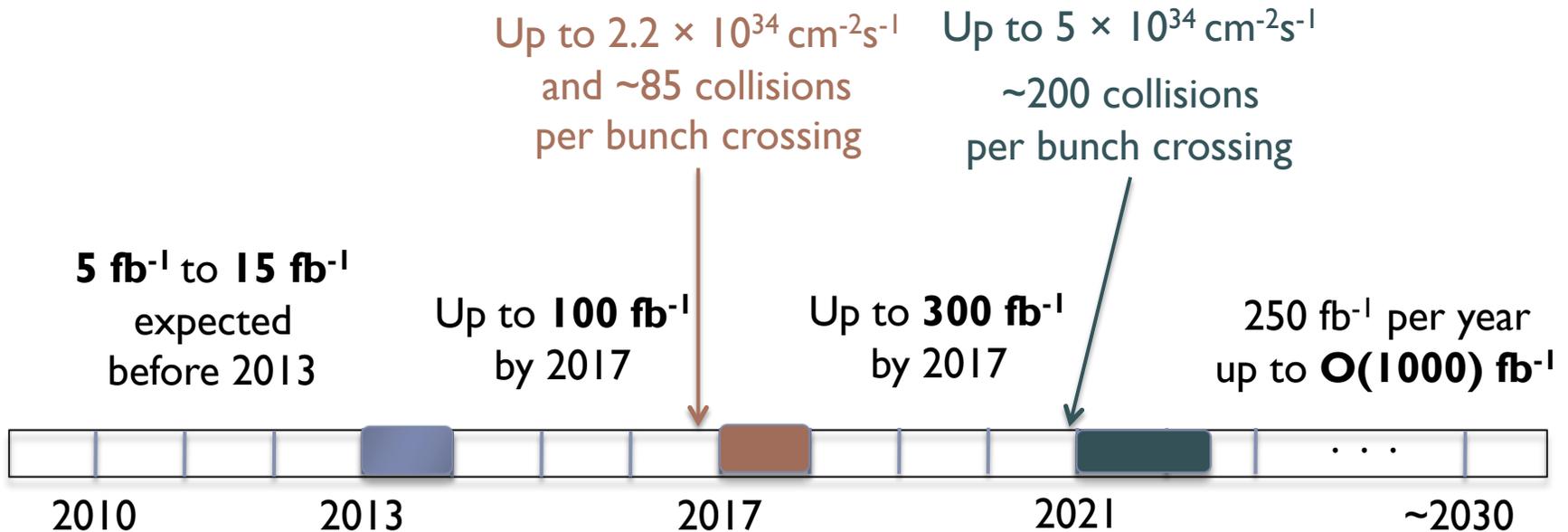
Maximum Expected Instantaneous Luminosity

- ▶ The maximum number of overlapping collisions depends on how the machine delivers the luminosity
 - ▶ Time between colliding bunches of 25 or 50 ns?
 - ▶ Luminosity Leveling?
- ▶ Estimates are shown based on current machine planning

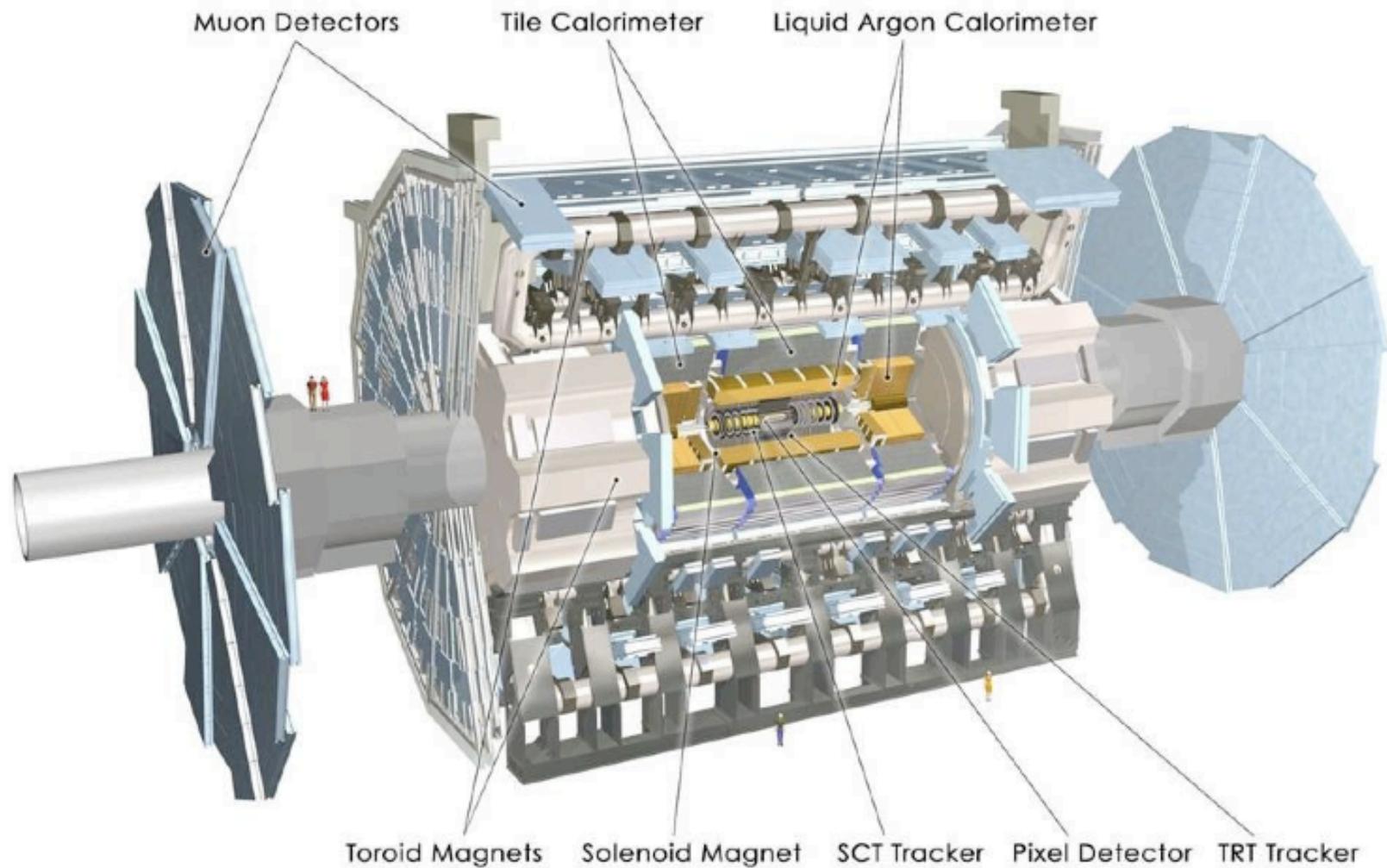


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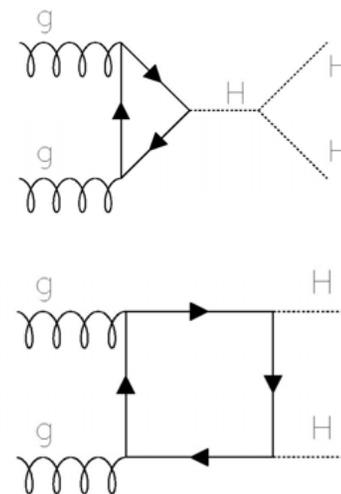
ATLAS Overview



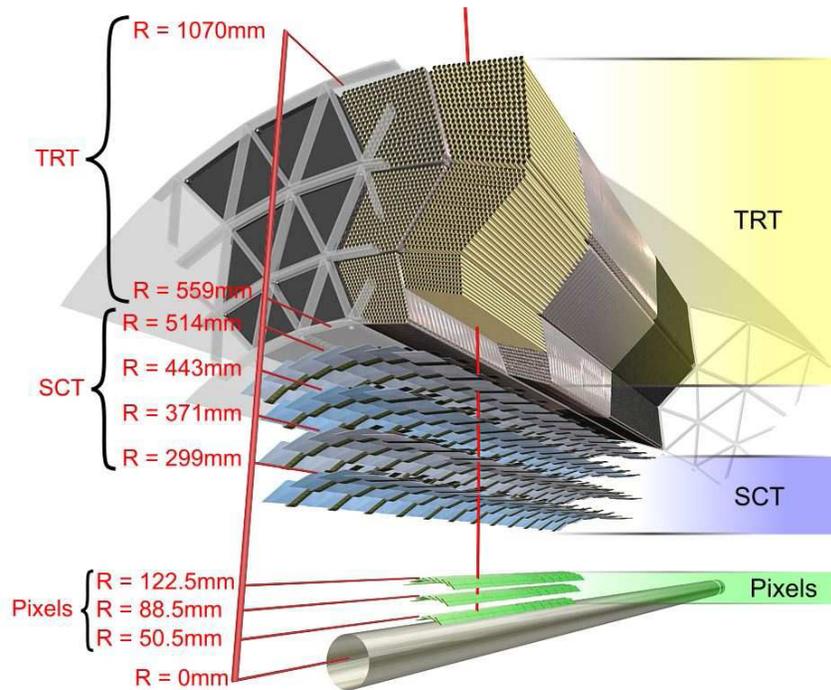
The Physics Case for the HL-LHC

- ▶ **General ATLAS Goals**
 - ▶ Understanding Mass and Electroweak Symmetry Breaking
 - ▶ Progress toward
 - ▶ Unification of forces
 - ▶ Understanding Dark Matter
 - ▶ Search for
 - ▶ New forces (W' and Z' ?)
 - ▶ Extra dimensions
 - ▶ Black holes
 - ▶ Understanding Flavor
 - ▶ Three Generations?
 - ▶ Neutrino Mass?
- ▶ **Large Datasets required for**
 - ▶ Measuring Higgs Couplings
 - ▶ Triple gauge boson couplings
 - ▶ Vector boson fusion at ~ 1 TeV
 - ▶ SUSY discovery or spectroscopy
 - ▶ Extending searches to higher limits (W' , Z')

Example Higgs Self-Coupling



Tracking



▶ Challenges:

- ▶ Radiation damage to inner layers
- ▶ Occupancy, particularly in Transition Radiation Tracker
- ▶ Providing trigger information for high luminosity running

▶ Phase 0

- ▶ Insert-able B-Layer on beam pipe

▶ Phase I

- ▶ New pixel detector considered

▶ Phase II

- ▶ New inner detector

Calorimeters

▶ Challenges

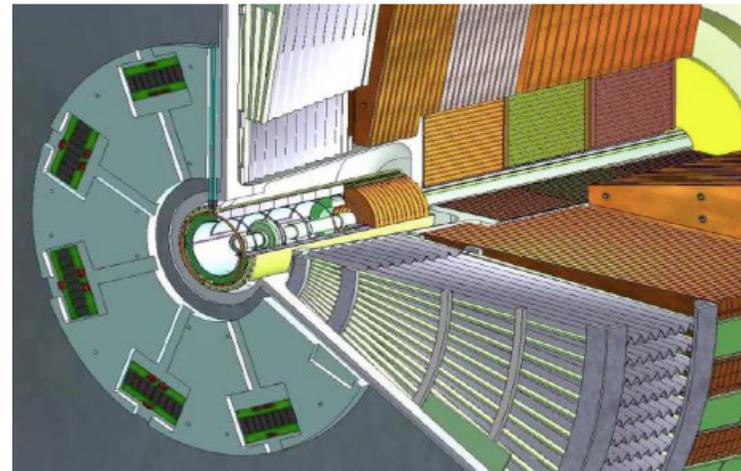
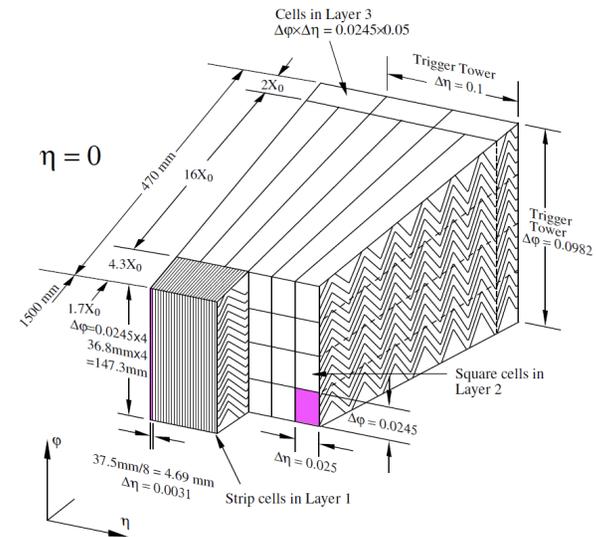
- ▶ High flux of particles in forward region
- ▶ Course granularity of Level I Trigger information
- ▶ Age of electronics by mid-2020s

▶ Phase I

- ▶ New Warm Forward Calorimeter

▶ Phase II

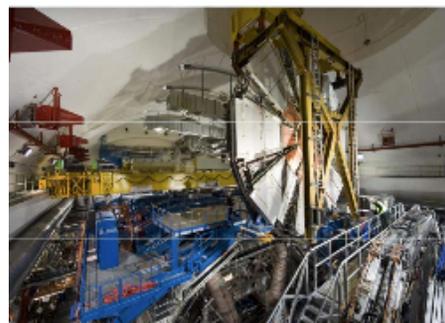
- ▶ New Calorimeter readout, providing full granularity to the L1 Trigger



Muons

Challenges

- ▶ High hit rate from Cavern Background
- ▶ Trigger Challenge to achieve sharp turn-on at high (40 GeV) thresholds

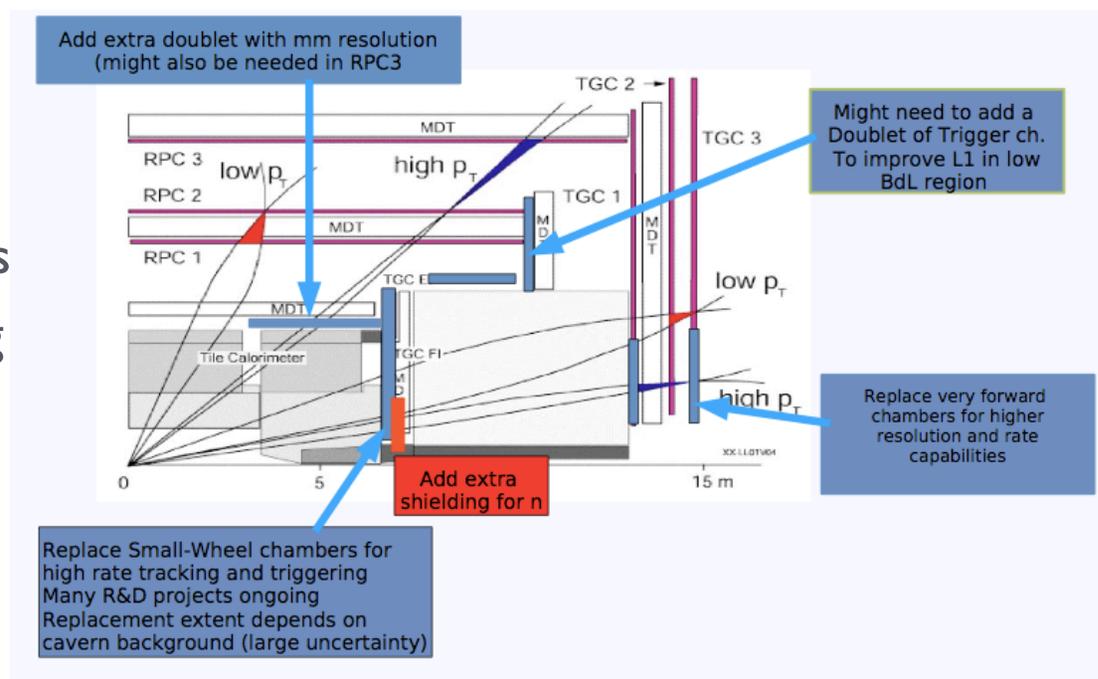


Phase I

- ▶ Replace Muon Small Wheels
- ▶ provide improved triggering capability

Phase II

- ▶ New muon chambers



Trigger

▶ Challenges

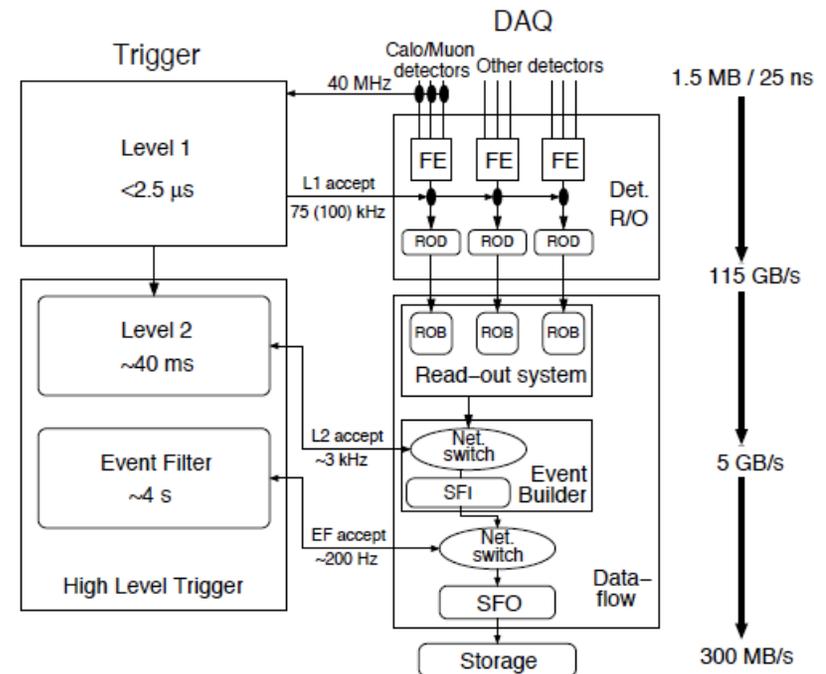
- ▶ Growing rates and event sizes with luminosity
- ▶ Physics needs to keep thresholds low
- ▶ Managing latency budgets with changing detector

▶ Phase I

- ▶ Fast tracker (FTK) providing track information at Level 1.5
- ▶ Level 1 Topology Trigger
- ▶ Improved processors and data links

▶ Phase II

- ▶ Level 0/1 Track Trigger
- ▶ Changes to software trigger? (GPUs?)
- ▶ Full granularity of calorimeter at Level 1
- ▶ Improved muon trigger coverage and sharper turn-on curve for high thresholds



Conclusions

- ▶ The physics we are pursuing at the LHC requires large datasets at high energy
- ▶ The LHC has an upgrade plan to provide these datasets
- ▶ The high luminosity environment, with up to 200 overlapping collisions, and the aging of the detector requires upgrades to ATLAS in order for the experiment to continue to support the physics program
- ▶ A general plan for ATLAS upgrades is in place
 - ▶ R&D on specific technologies is on-going
- ▶ Thanks to the organizers of DIS for the opportunity to tell you about ATLAS in the HL-LHC era. In a decade we may be discussing the HE-LHC!