Overview of ATLAS Phase 1 Upgrade

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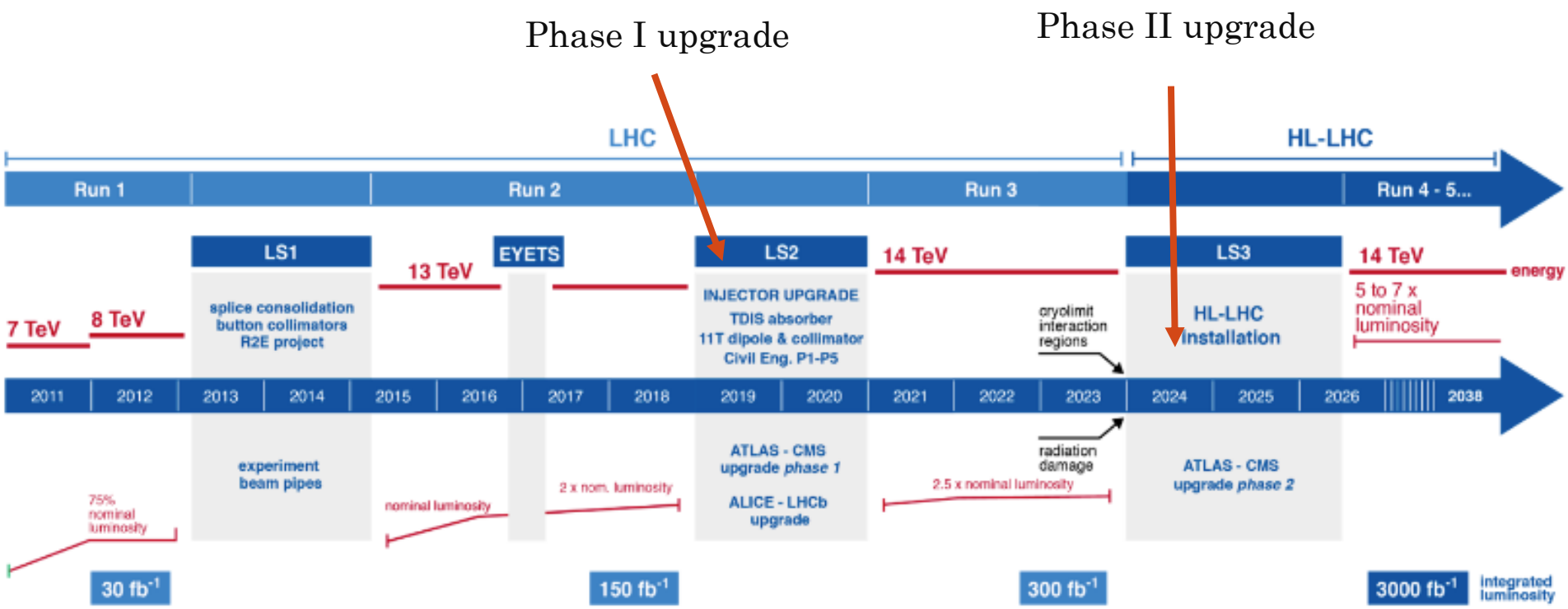
CPPM ATLAS Prospect Meeting - 2019-05-06

Reminder: Upgrade Schedule



$L\sim=2.10^{34}\ cm^{-2}.s^{-1}$
$Int(L)\sim=100fb^{-1}$
$<mu>\sim=40$

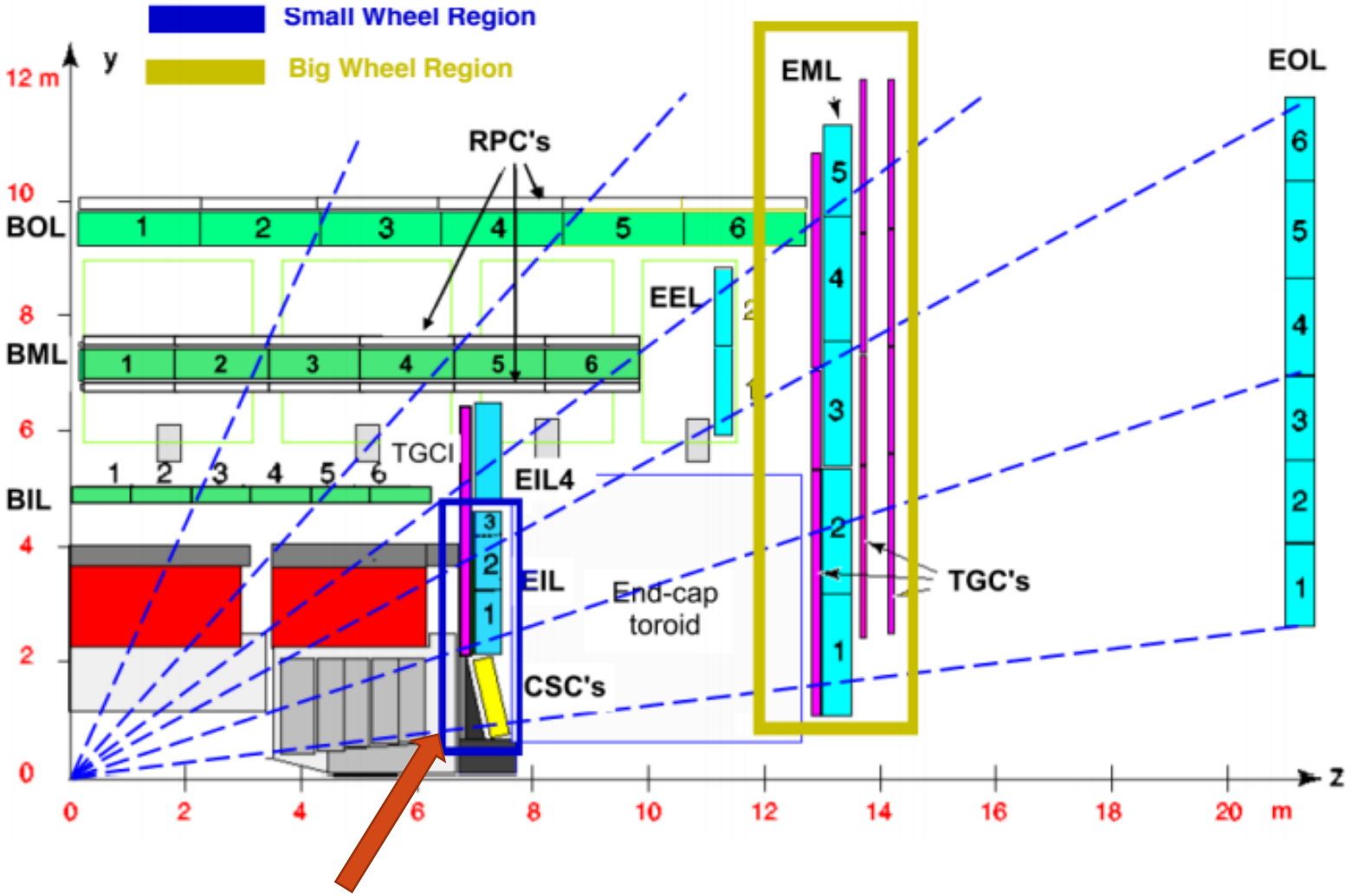
$L\sim=3.10^{34}\ cm^{-2}.s^{-1}$
$Int(L)\sim=300fb^{-1}$
$<mu>\sim=80$

$L\sim=5.10^{34}\ cm^{-2}.s^{-1}$
$Int(L)\sim=3000fb^{-1}$
$<mu>\sim=140$

Why the Phase 1 Upgrade

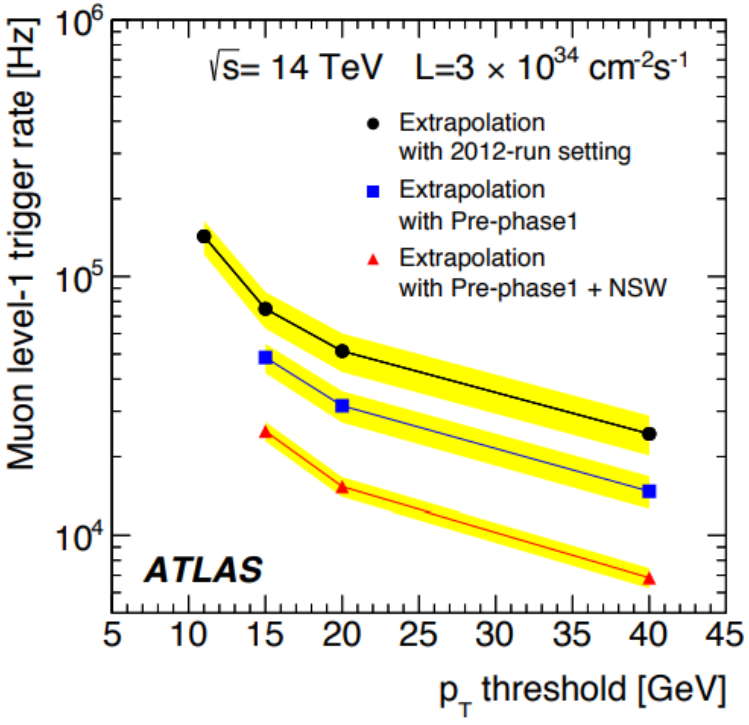
- Increase granularity of the readout of Liquid Argon (Lar) calorimeter at trigger level
  - Maintain performance at high pileup
  - Improve signal/background separation
  - Maintain low trigger rates and low thresholds for physics objects
- Exchange the first endcap layer of the muon spectrometer
  - Aging current later with reduced performance
  - Higher granularity and faster electronics to sustain the higher pileup
  - Improve signal/background separation
  - Maintain low trigger rates and low thresholds for physics objects
- New TDAQ system allowing in particular to take advantage of the higher granularity in the Lar calorimeter
- Exploit better the fast tracker system (FTK) at HLT
  - Partially already installed during run 2

Muon Spectrometer Upgrade



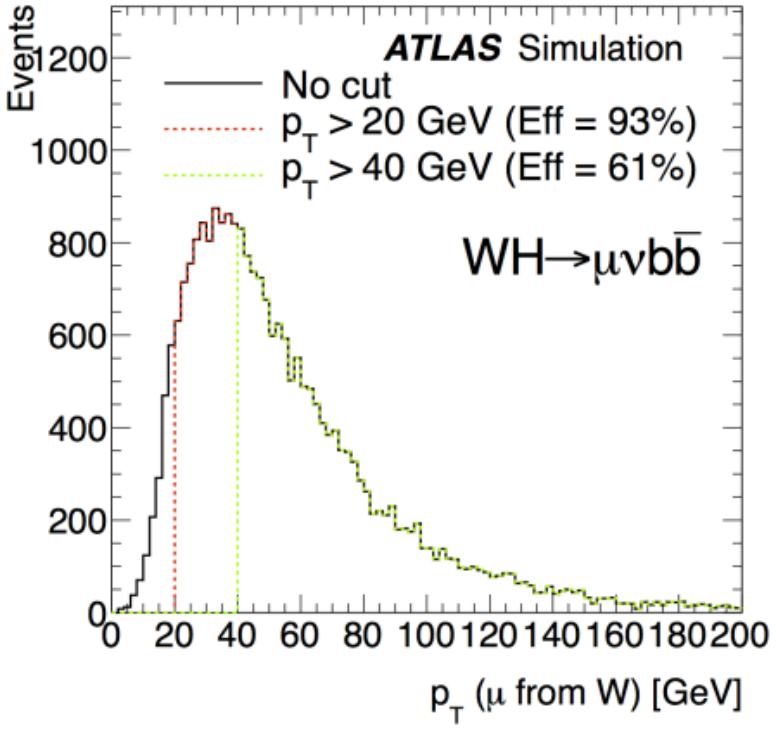
Changing the first layer in the forward region
Region with high particle rate

L1 Trigger Performance



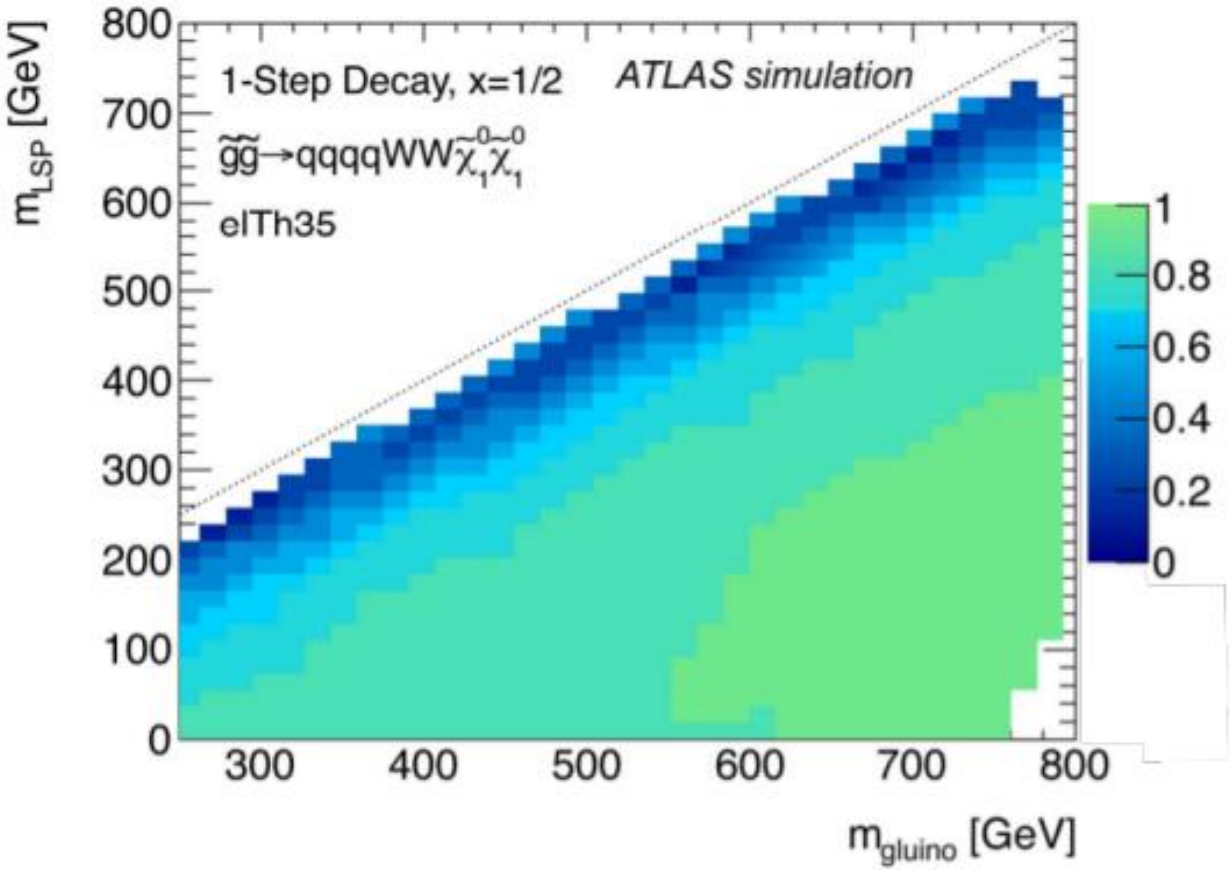
Muon allocated L1 rate is about 20 KHz

- Forward region responsible for most of the fake muons
- Cut it or increase dramatically the threshold
- NSW upgrade to help maintaining the trigger rates at a reasonable level and thus not cut into interesting processes phase space

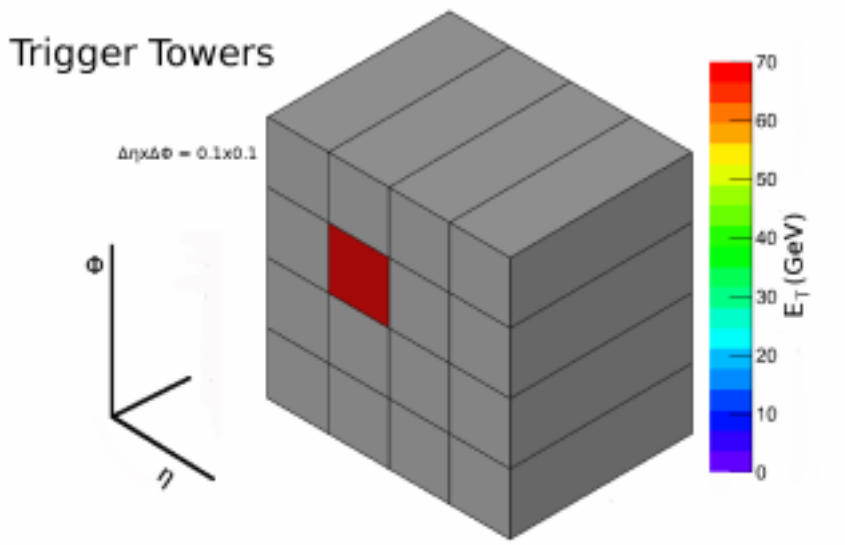


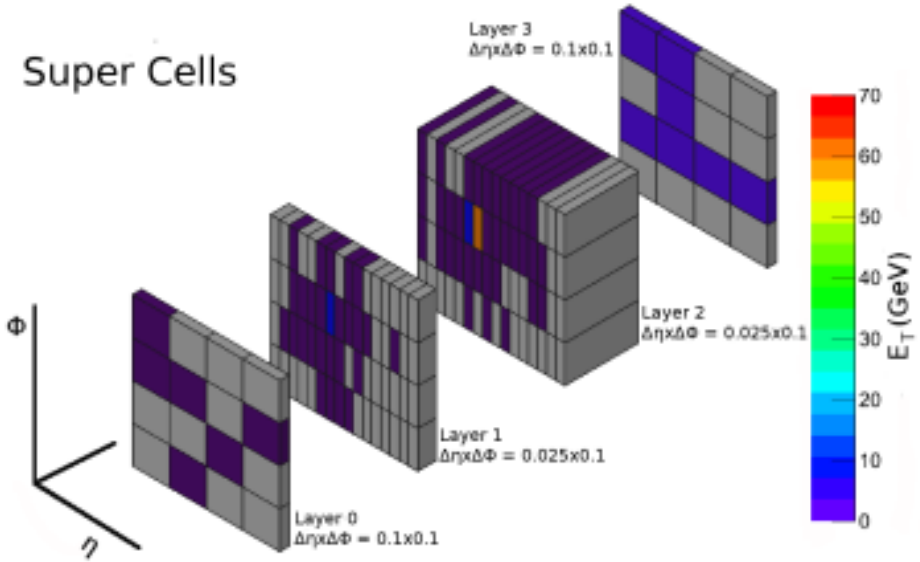
L1 Trigger Performance

Example of reduction of sensitivity for models with long cascades when increasing the threshold from 25 GeV to 35 GeV.



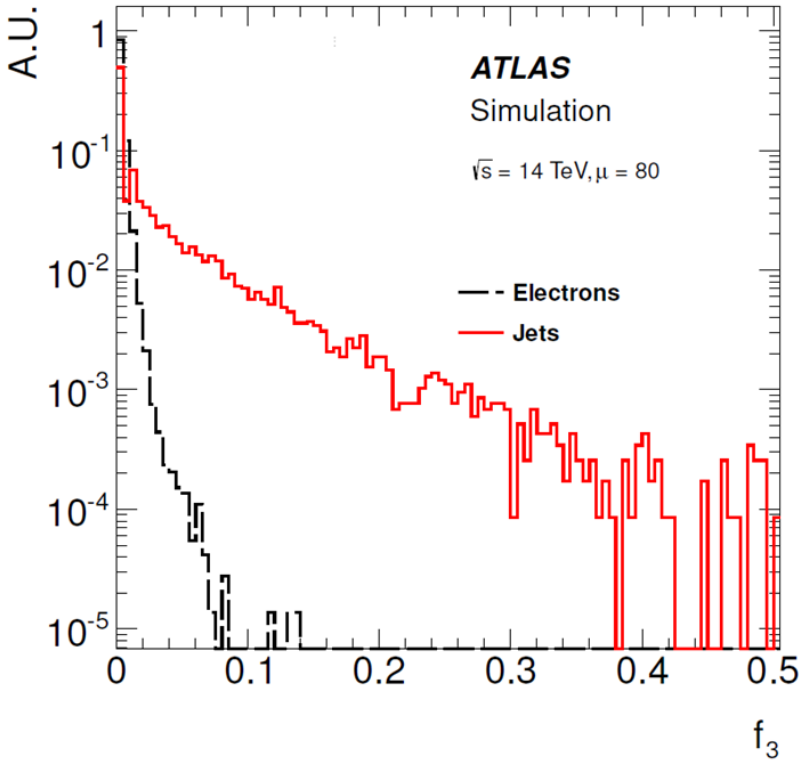
Lar Phase I Upgrade

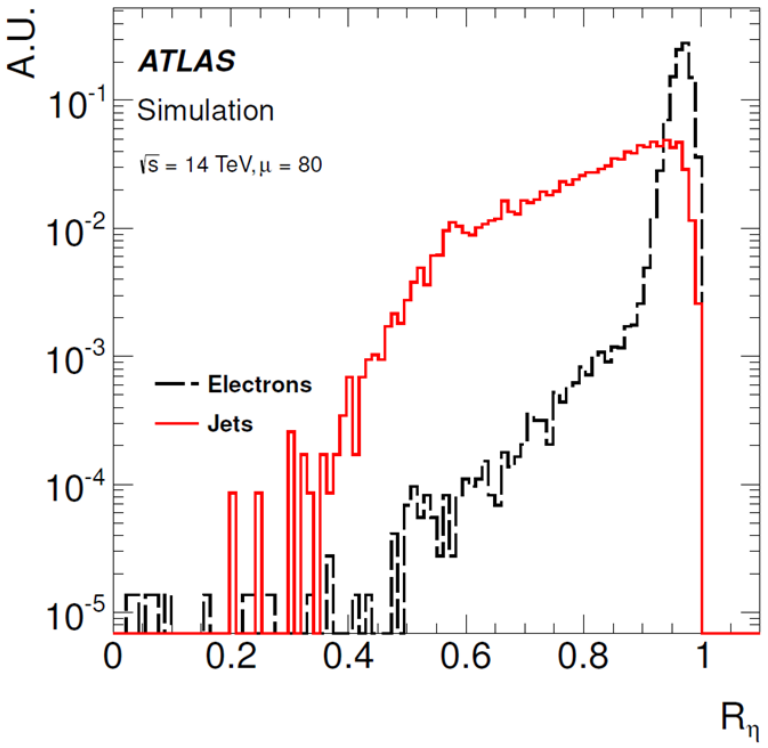




Coarse granularity at trigger level (high processing rate needed)
Increase the granularity by a factor of 10 in phase 1
Profit from shower shape variables for better background rejection

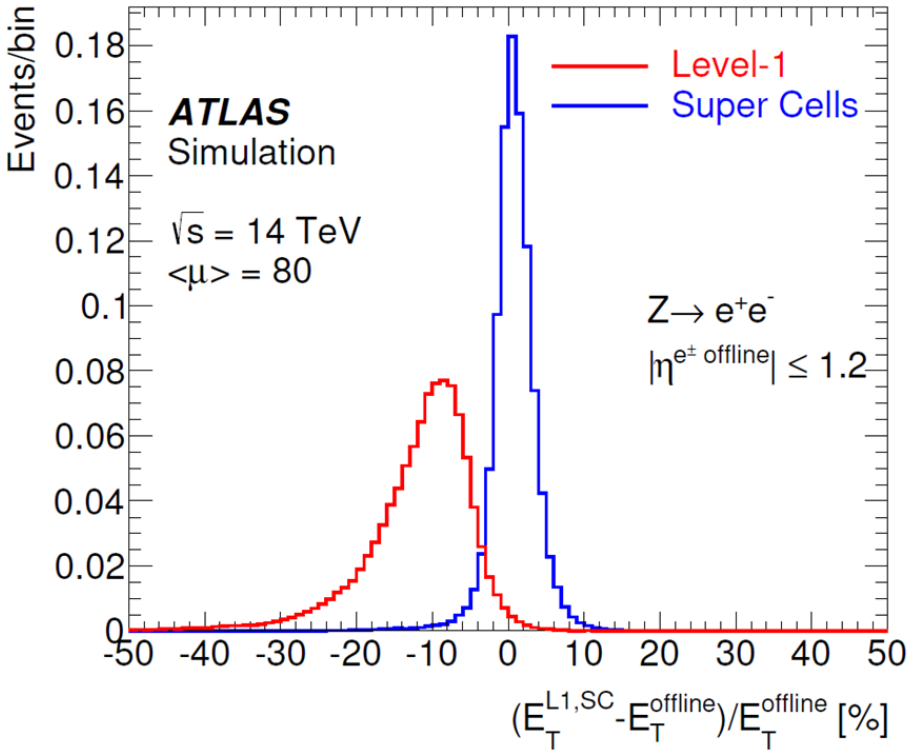
Shower Shape at Trigger Level

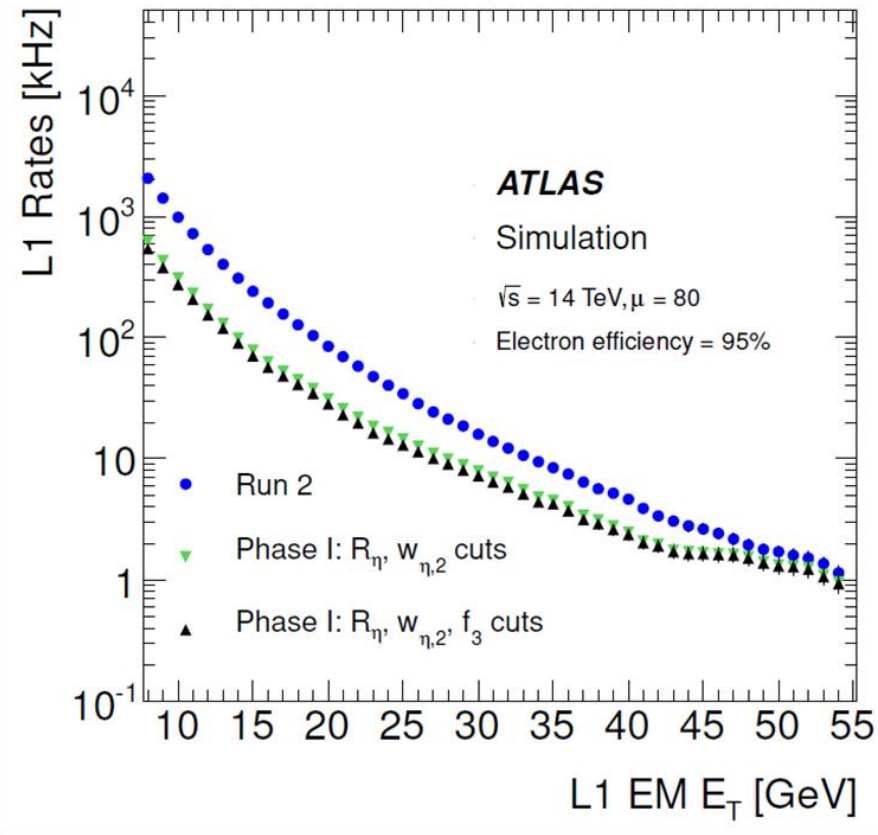




Able to use transverse and longitudinal shower shape variables and isolation variables to identify EM clusters
Closer to offline identification techniques

Calo L1 Trigger Performance (EM)

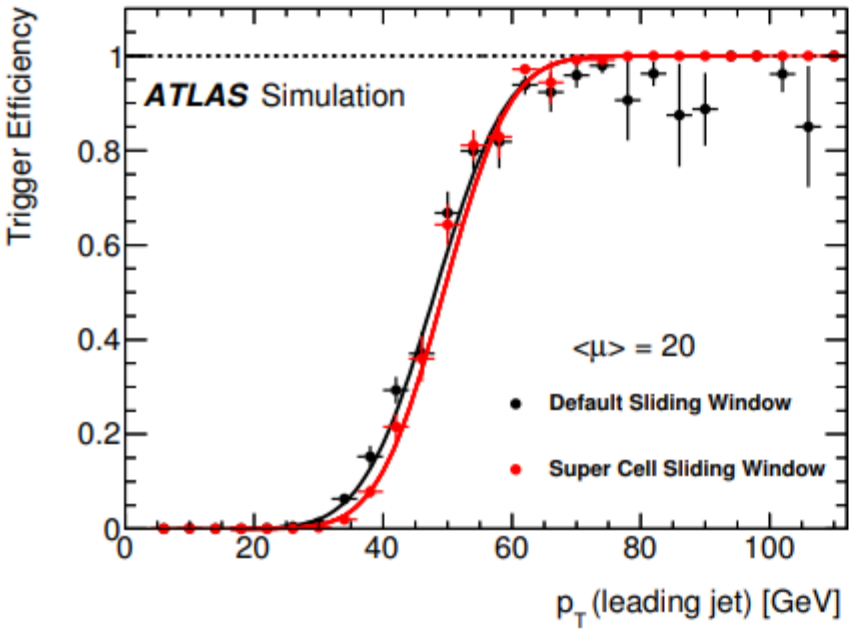


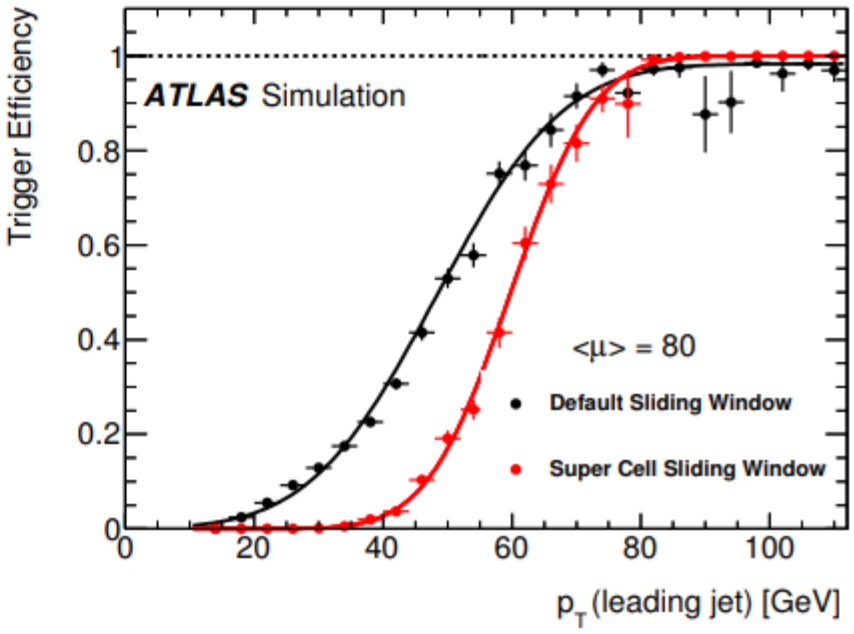


Better resolution on EM clusters → Better turn on curves for the efficiency

Better rejection of backgrounds → Improve trigger rates and maintain thresholds

Calo L1 Trigger Performance (jets)

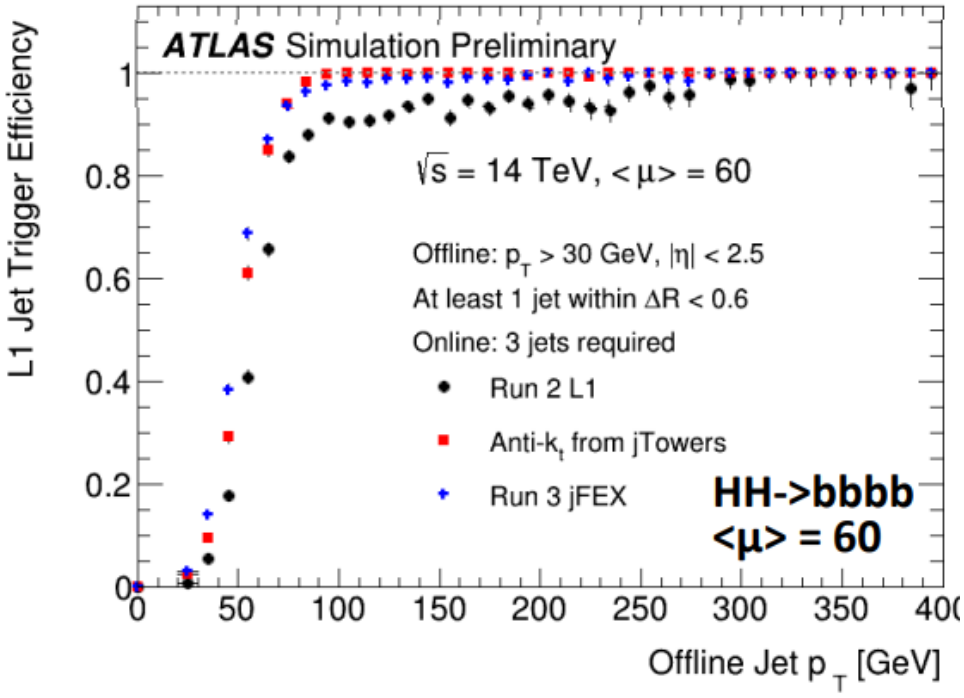


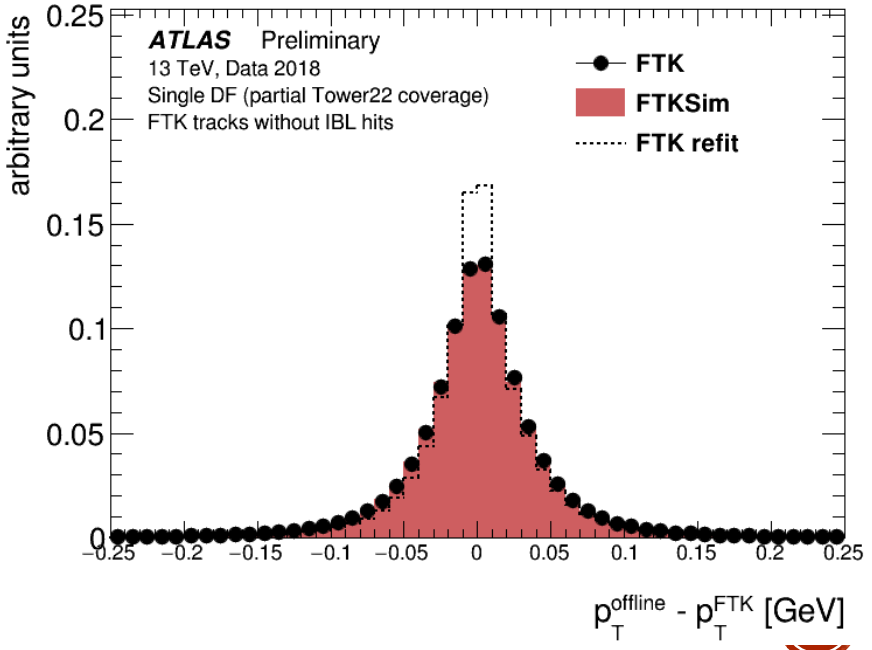


Better resolution for jet energy → Better turn on curves at high pileup
Maintain jet pT thresholds

TDAQ Upgrade

- TDAQ Level 1 upgrade allowing to better explore the higher granularity of data in LAr
  - New L1 trigger hardware to implement better trigger algorithms
- Better usage of the Fast Tracker at HLT
  - Obvious benefit for btagging but also for missing energy resolution
- However no fundamental change for algorithms with respect to run2
  - The usual focus on improving resolution and rejection
  - More focus on VBF topologies, boosted topologies, displaced objects, …





Conclusion

- Phase 1 upgrade focuses on maintaining the trigger rates at a reasonable values with the increase of the pileup expected in run 3
  - Improving background rejection allows to maintain similar thresholds for physics objects
  - Mandatory for relatively low pT topologies or topologies with large cascades
  - Improved resolution will benefit also missing energy triggers

- Topological trigger for dedicated topologies already exists in run 2
  - Ideas to improve are under study
  - High pT objects will profit from the increased focus on boosted topologies
  - Also more focus on VBF, displaced vertices and covering corners of the phase space by combining more objects in the triggers

- Fast tracker will allow to better exploit tracking at HLT
  - Improvement in btagging and missing energy resolution
  - Can also be used to find displaced vertices