First glance on ATLAS data with run-3

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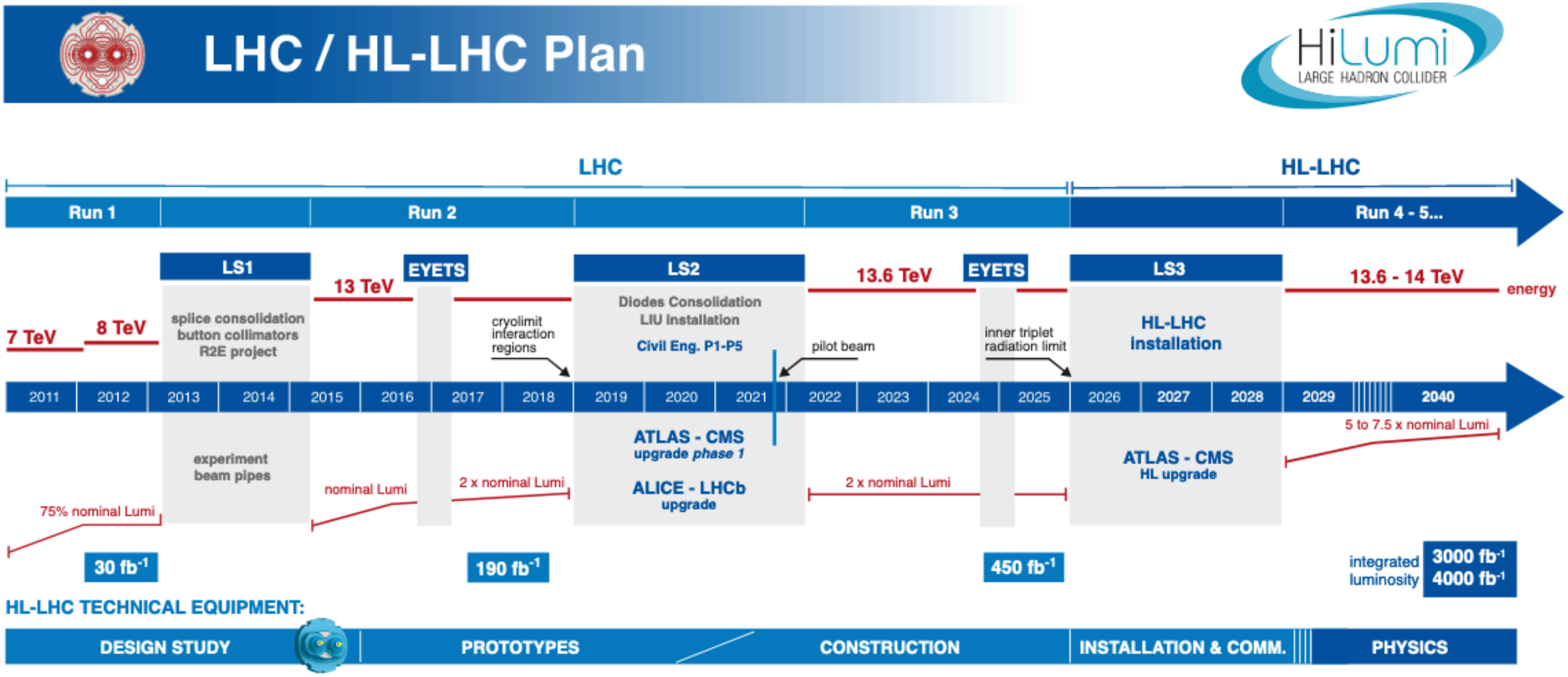
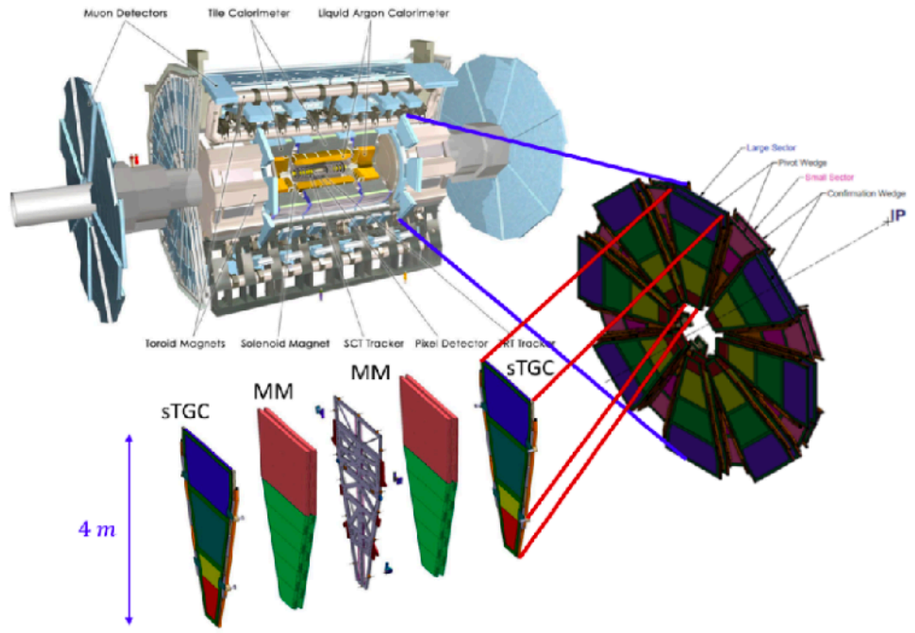
Introduction: LHC run plans

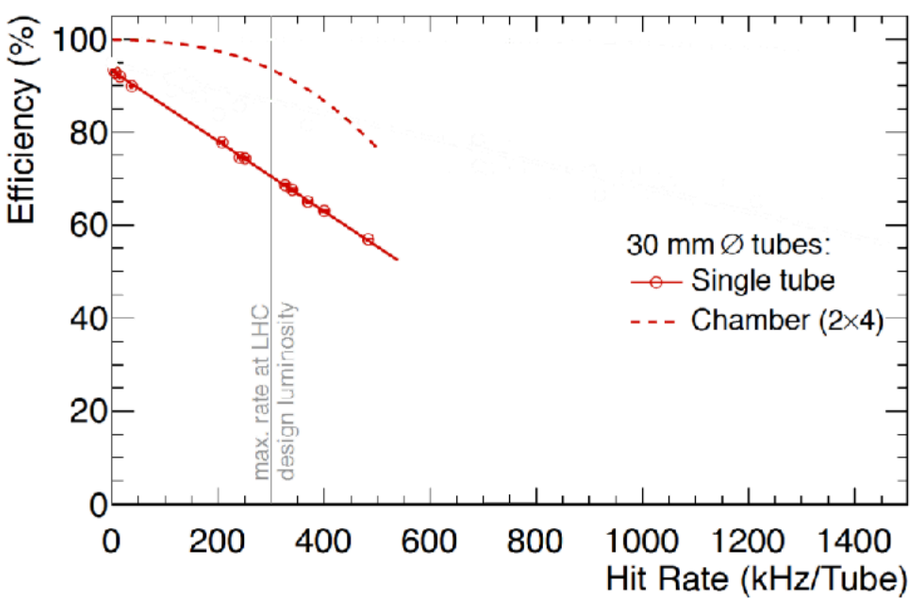


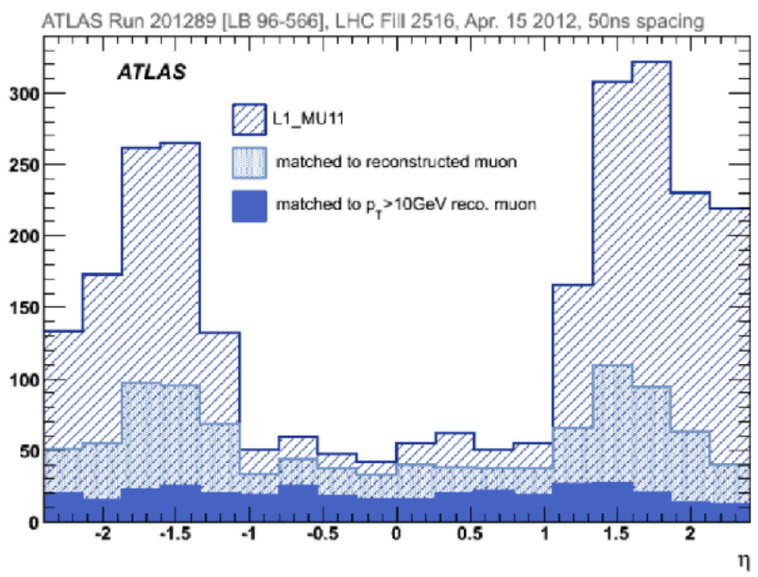
- Recent update (Feb 2022): run-3 and LS3 extended by 1 year
- Run3: 2 x 10^{34} $cm^{-2}s^{-1}$@ 13.6 TeV, integrated luminosity 450 fb-1 <μ> up to ~80
- Run4-Run5: up to 7.5 x 10^{34} $cm^{-2}s^{-1}$@ 14 TeV, integrated luminosity 4000 fb^{-1} , reaching <μ> up to ~200

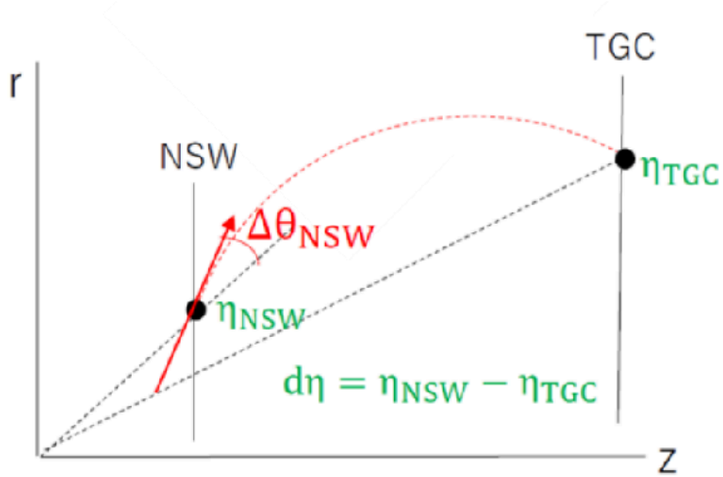
ATLAS upgrades for run 3

- New Muon detectors in the endcap innermost station
  - The New Small Wheel (NSW): two new detector technologies (MicroMegas -MM and Small Thin Gap Chambers- STGC) to replace the detectors used in run-1 and run-2
  - MM and STGC for both tracking and trigger
- Keep high tracking efficiency in run-3 and up to <μ>=200 at Hi-Lumi LHC
- Improve background rejection at L1 trigger exploiting the segment direction measurement in the innermost MS station
  - Keeping low-pT trigger signatures unprescaled is fundamental for many physics studies

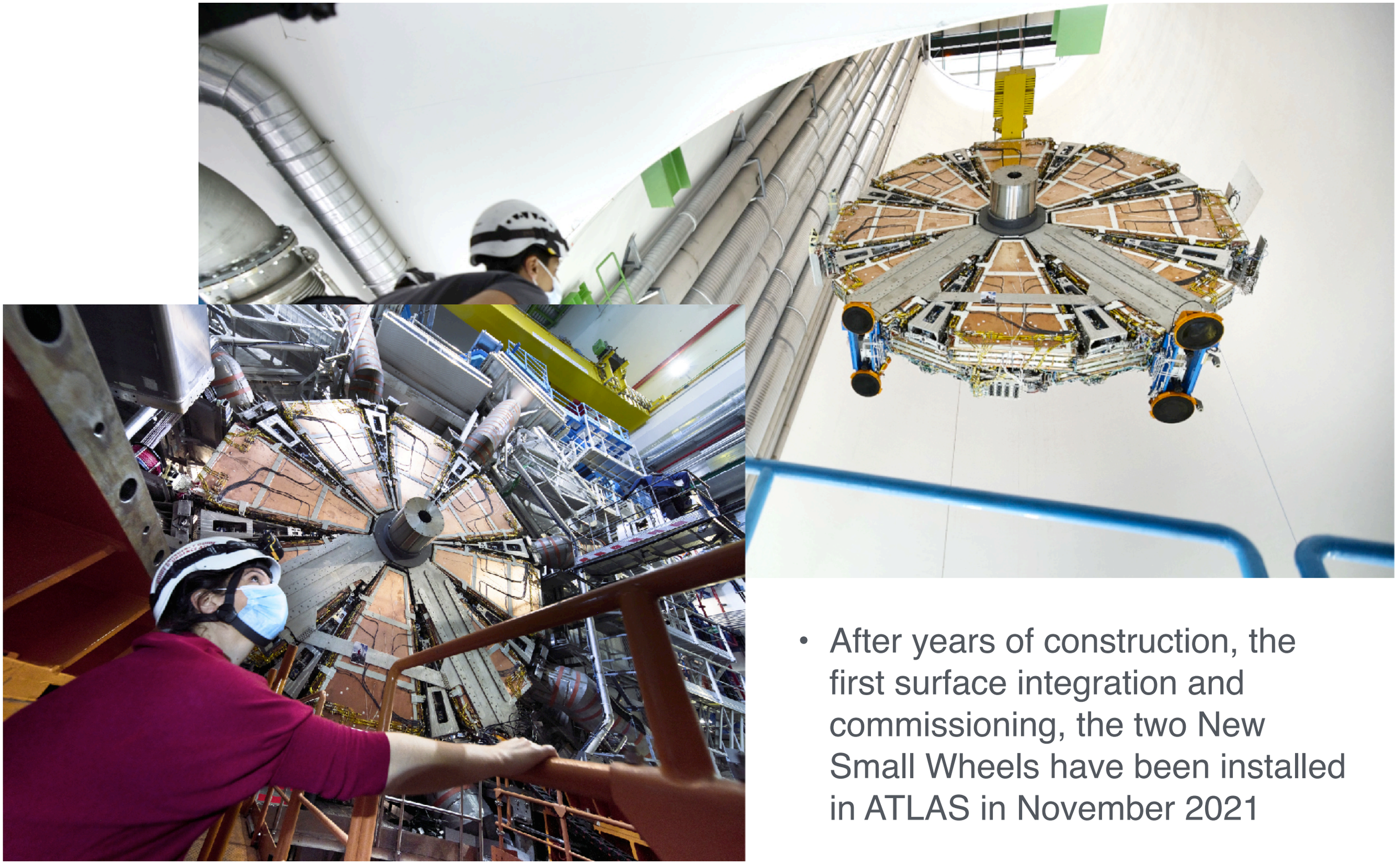








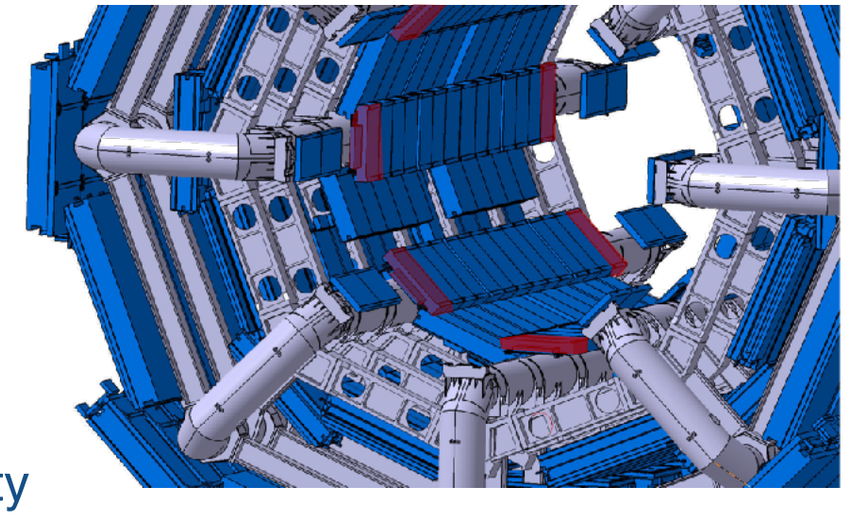
New Small Wheels in ATLAS



- After years of construction, the first surface integration and commissioning, the two New Small Wheels have been installed in ATLAS in November 2021

ATLAS upgrades for run-3

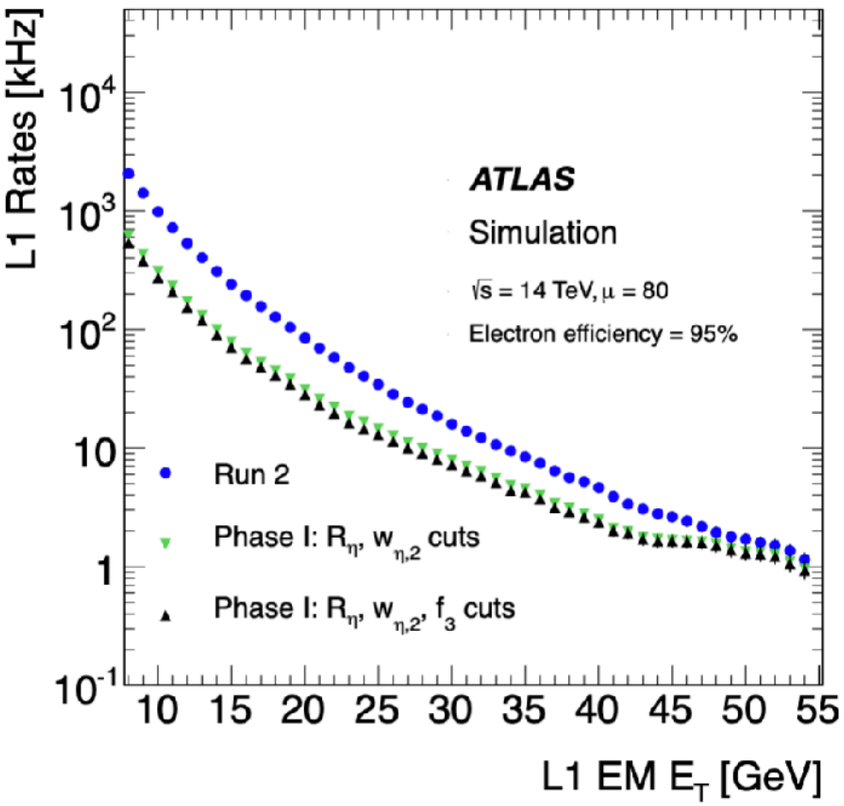
- Other upgrades of the muon system
  - New 3-gaps RPC chambers to improve L1 acceptance and background rejection in the barrel/endcap transition region



- LAr upgrade:
  - New front-end and back-end electronics with increased granularity
- L1 calo trigger:
  - New boards for the feature extraction (eFEX,gFEX,jFEX)
- These upgrades will allow to keep same thresholds, rates and efficiencies, at the larger pileup of run-3 and Hi-Lumi LHC

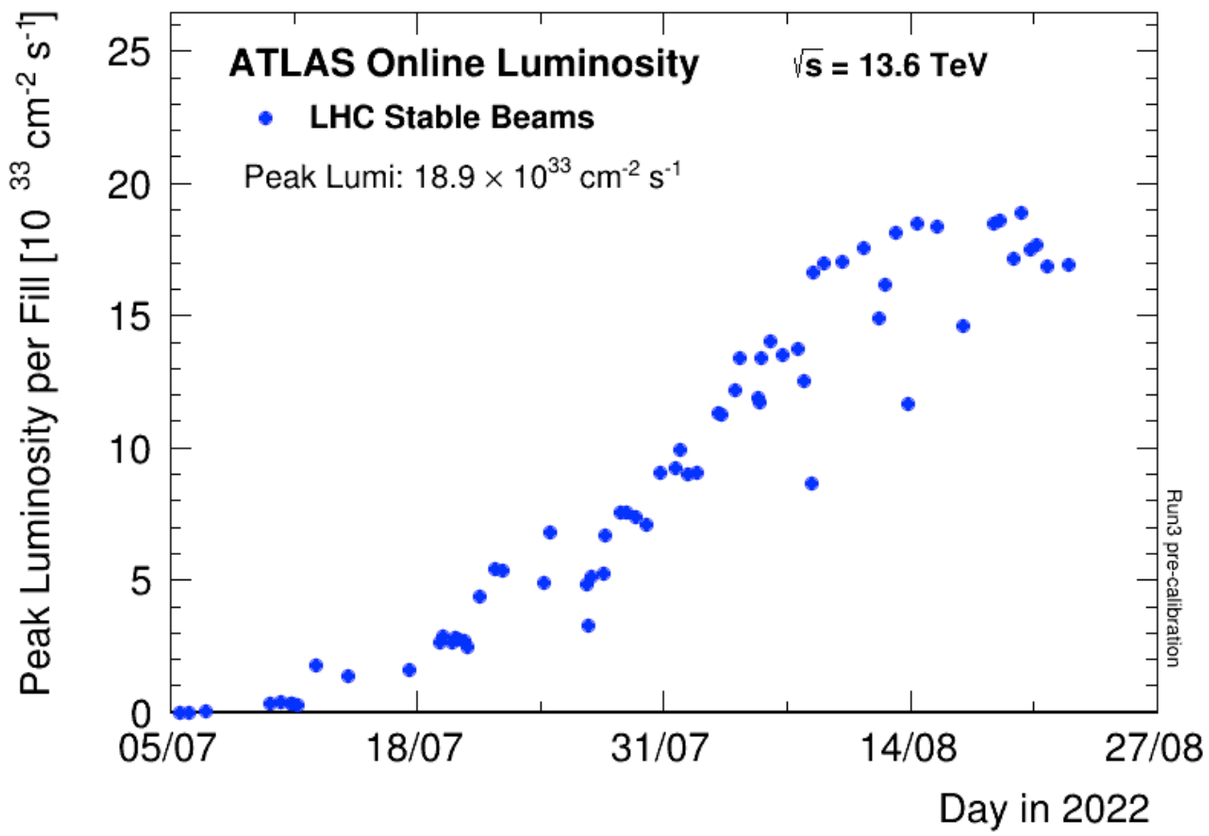
- Upgrades in the TDAQ off-detector electronics
  - L1 hardware: new electronics for Calo, NSW, MuCTPi
  - High Level Trigger
    - New processor farm, improved algorithms, the output rate will go up to 1.5 kHz

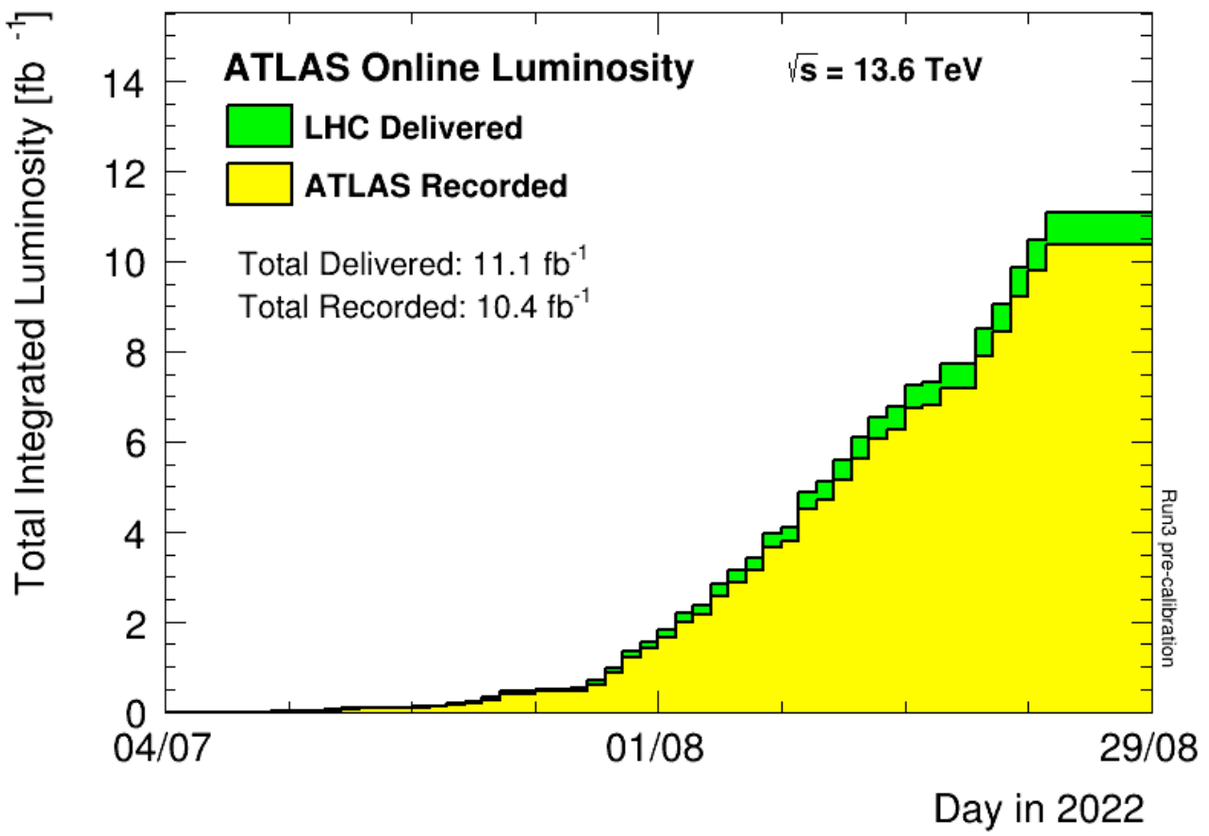
ATLAS LAr upgrade TDR



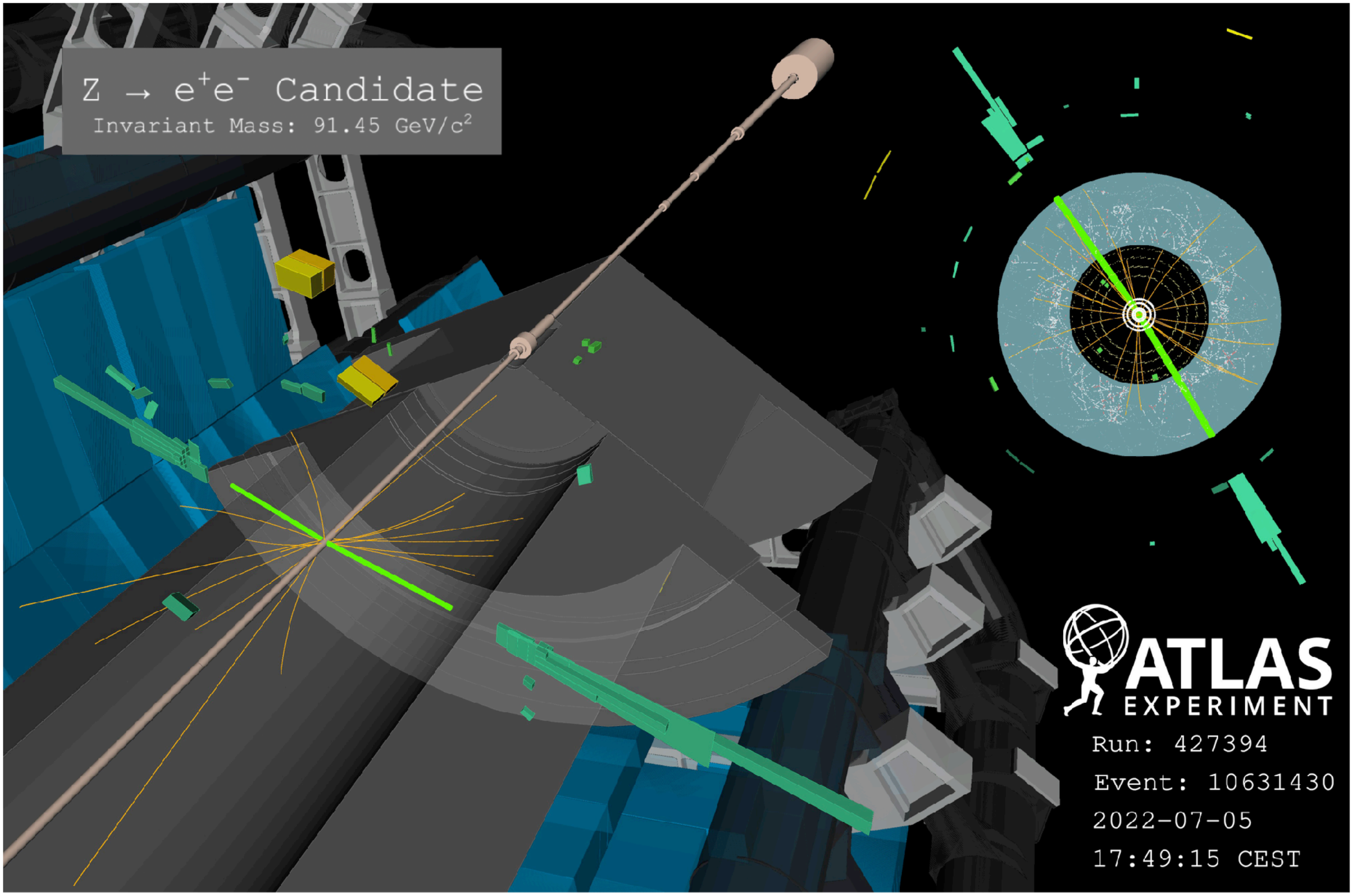
The run-3 dataset up to now

- First collisions in June 2022, at 900 GeV center of mass energy
  - First checks on timing, calibrations, data quality and in general detector readiness
- The 13.6 TeV data taking started on July 5, 2022
  - First crucial data for the commissioning, in particular of the new detectors
- Since then, LHC increased the number of bunches to 2400 and we could collect ~10 fb-1 during the first weeks of operation
  - Peak lumi reached 1.9 x 10^{34}
- Now a ~4-weeks LHC stop, started on August 25, due to a cooling tower fault

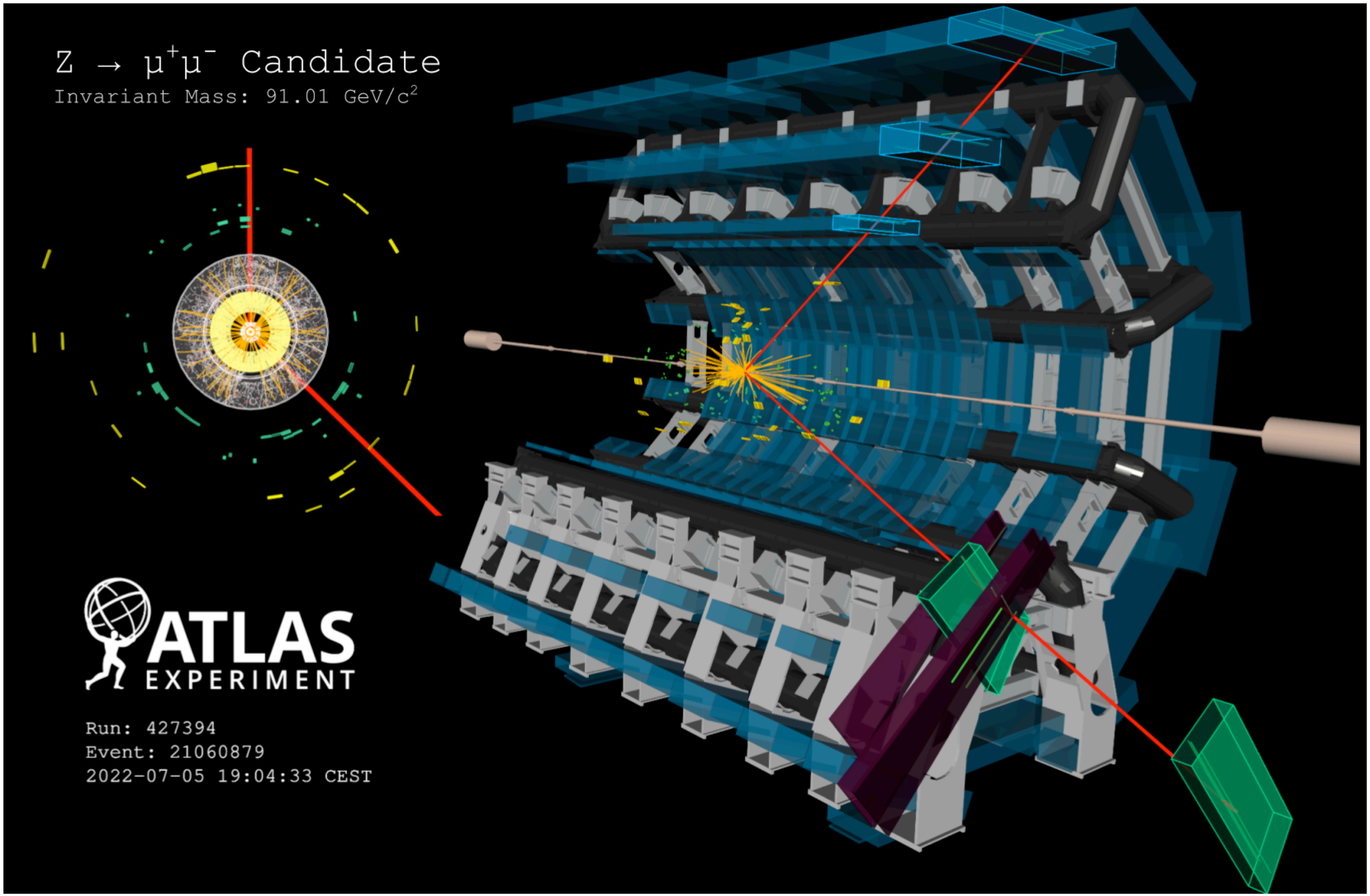




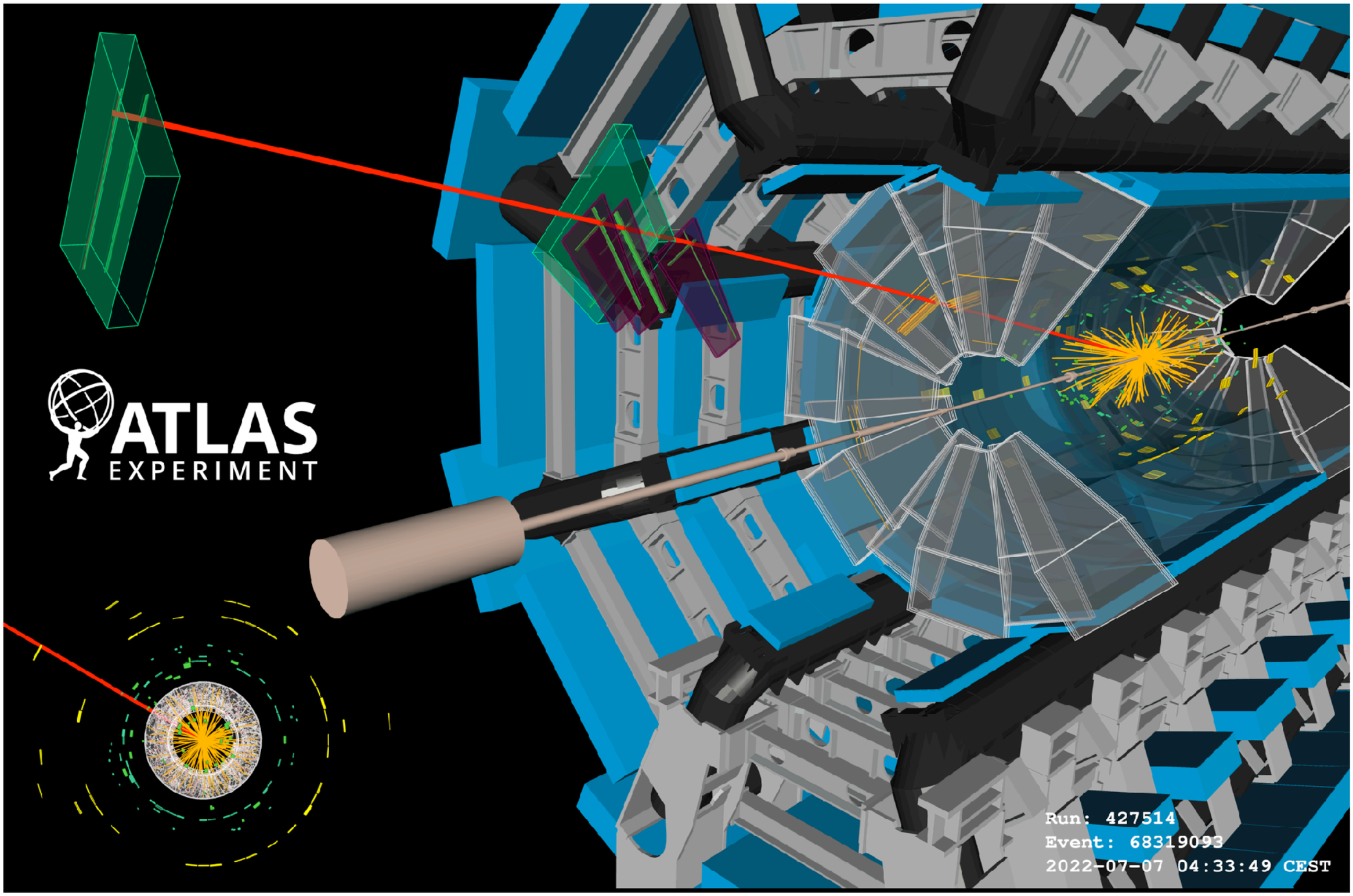
$Z \rightarrow e^+e^-$ candidate at 13.6 TeV



$Z \rightarrow \mu^+\mu^-$ candidate at 13.6 TeV

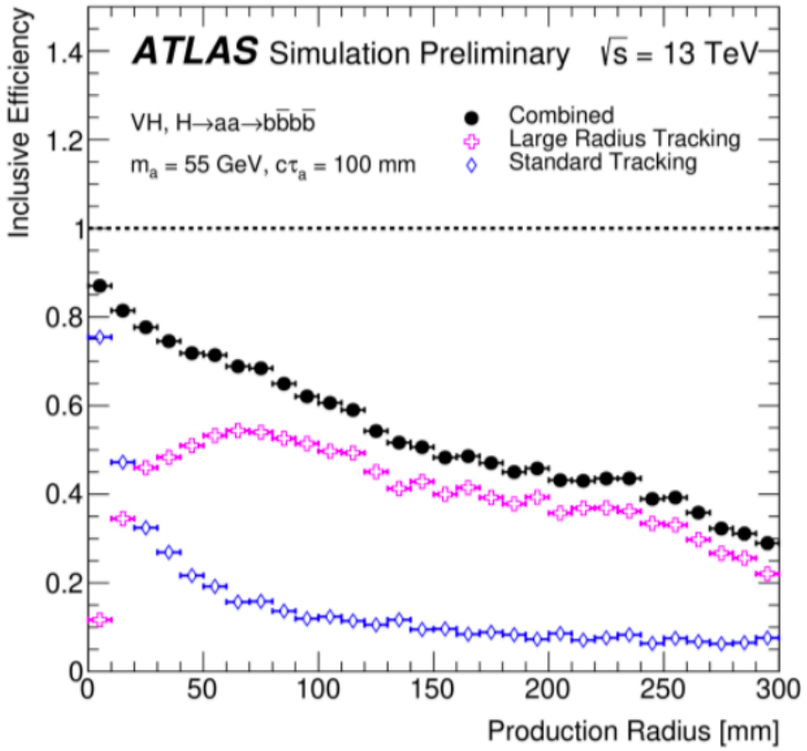


The first collisions seen by the NSW



Inner detector track reconstruction

- Tracking has been re-tuned for run-3 higher pileup conditions
  - Yielding a factor ~2 speedup
  - Efficiency very close to run-2, but large improvement in fake rejection at high μ
- Large d0 tracks reconstruction retuned, fake rate reduced by a factor ~10, minimal efficiency loss
  - Now available in all events -> expand run-3 search capabilities



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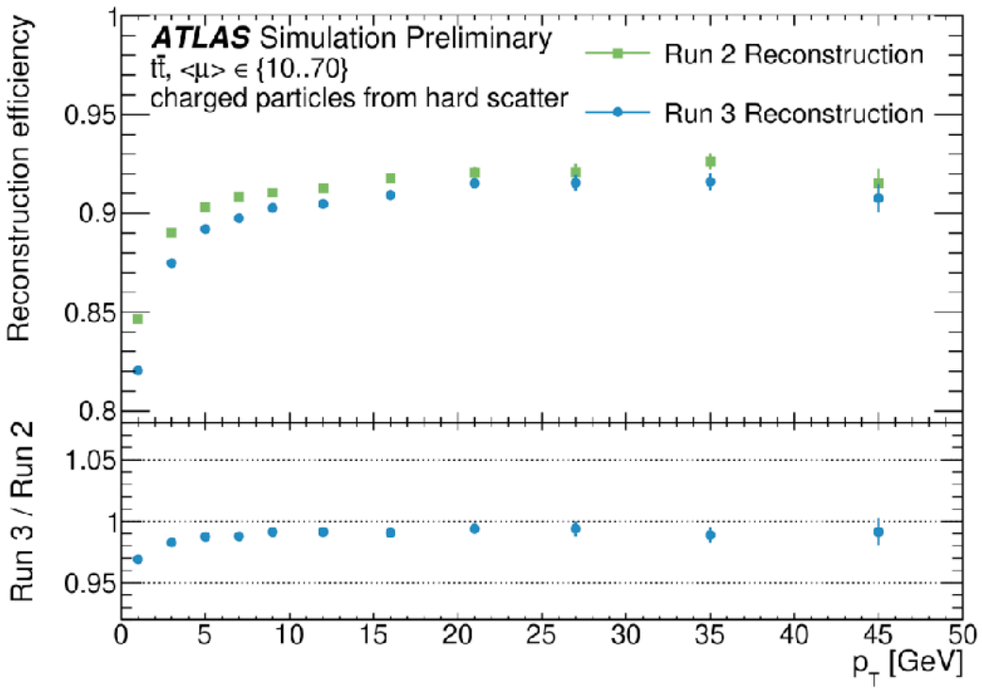
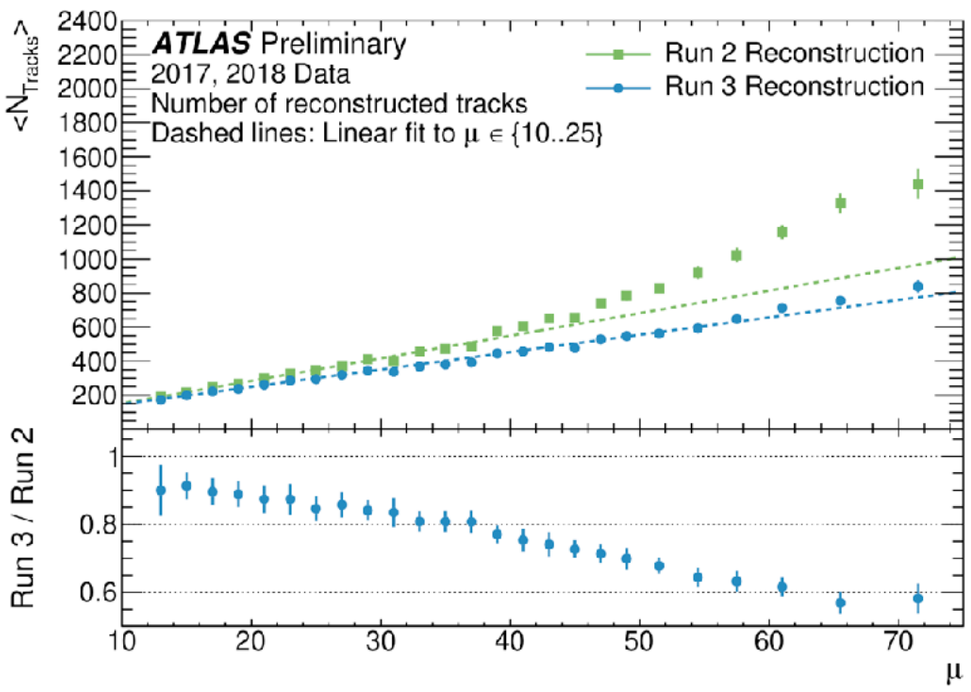
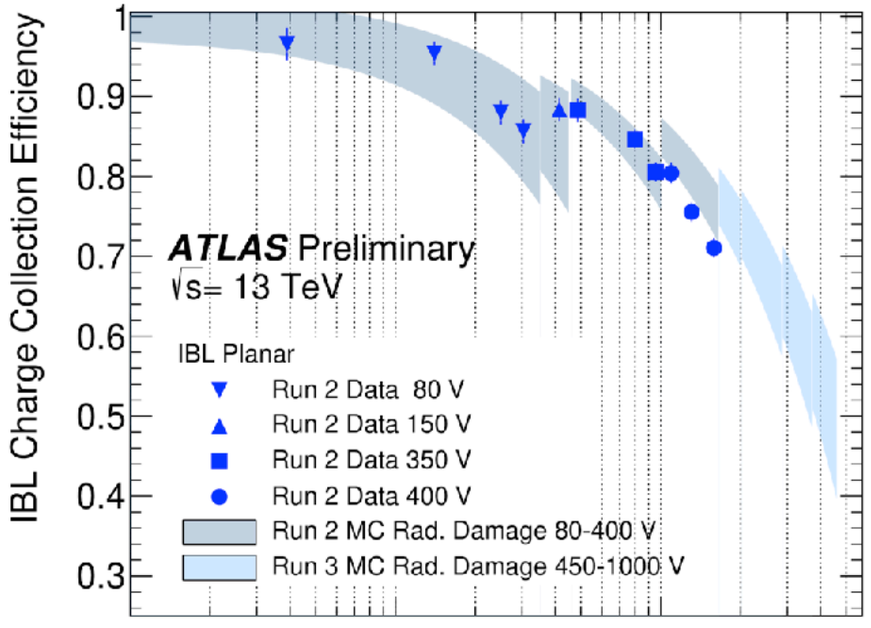




Inner detector tracking with first data

- Data/MC agreement with radiation damage modeled in the simulation
  - Raise bias voltage vs integrated lumi to compensate for efficiency losses
- Updated ID alignment, with first pass on 13.6 TeV data
- Adaptive multi vertex fitter for primary vertex finding, optimized for performance and CPU time
  - Particularly elevant for the high pileup conditions of run-3



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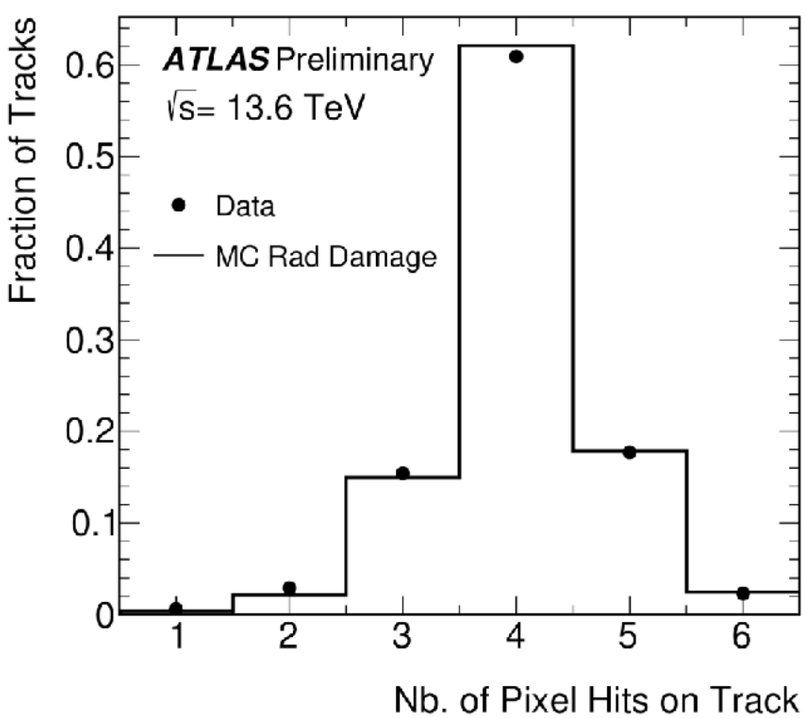
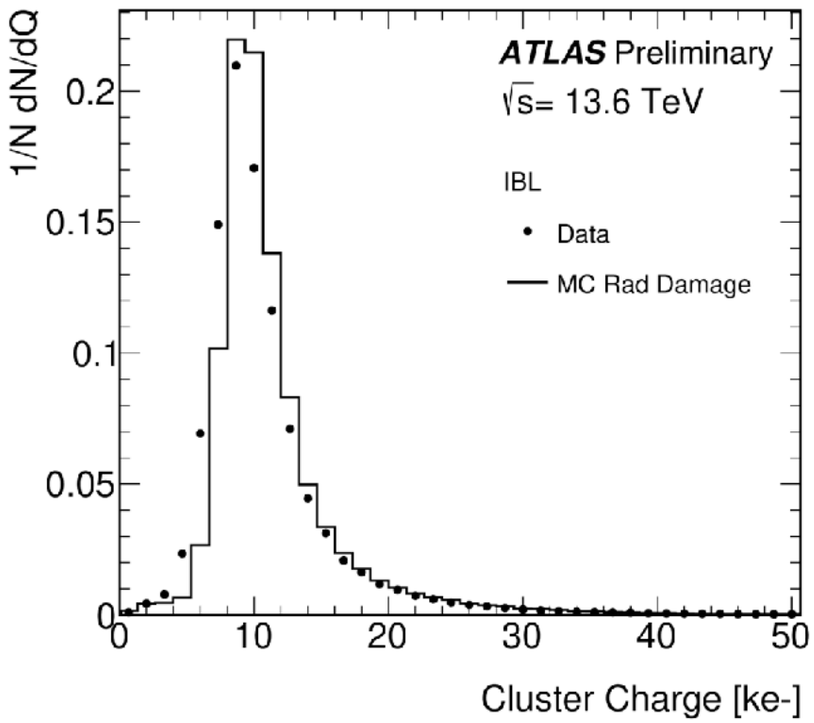
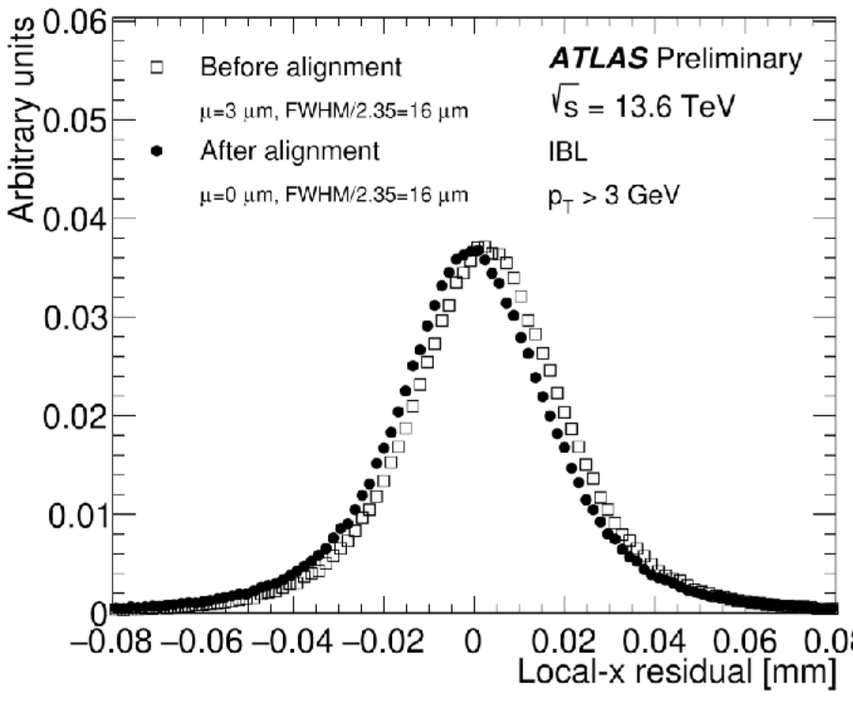
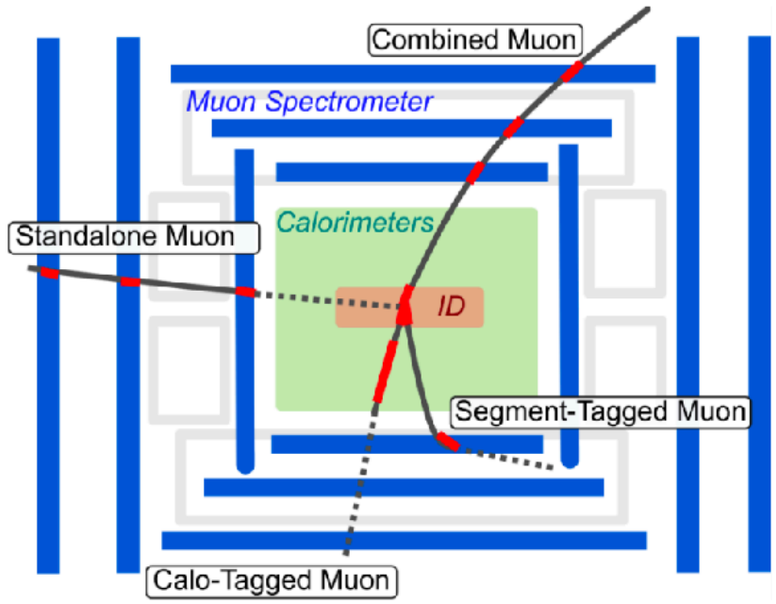






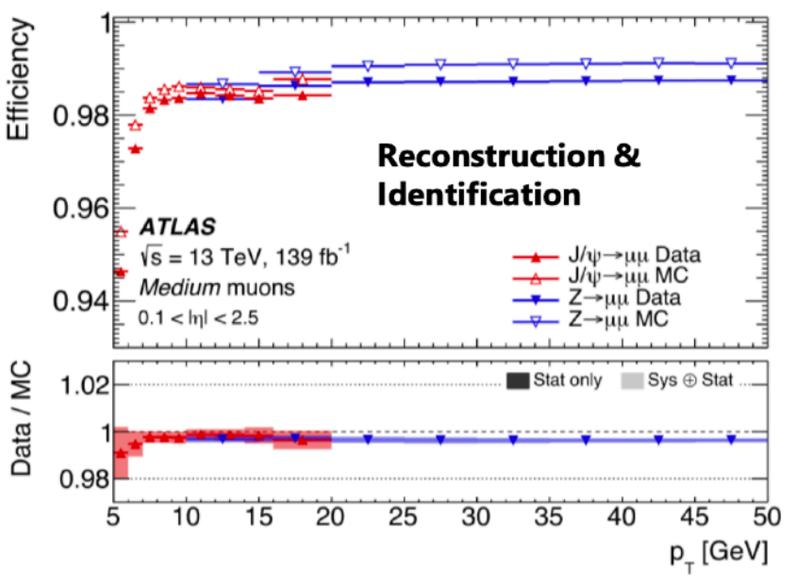
Muon reconstruction

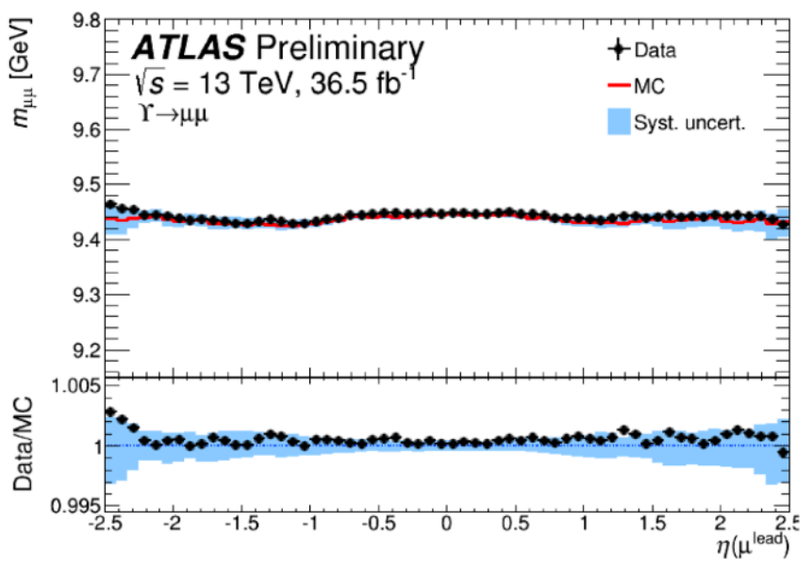
- Muon reconstruction is relying on the combination of all ATLAS subdetectors
  - Combined muons by back extrapolating muon tracks to the inner detector
  - Tagged muons via MS hits or calo patterns
    - Low-pT muons and acceptance optmization
  - Standalone muons up to $|\eta|<2.7$
- The new detectors from the NSW have been integrated in the ATLAS simulation and reconstruction software framework, for run-3 samples production and for the analysis of the first real data

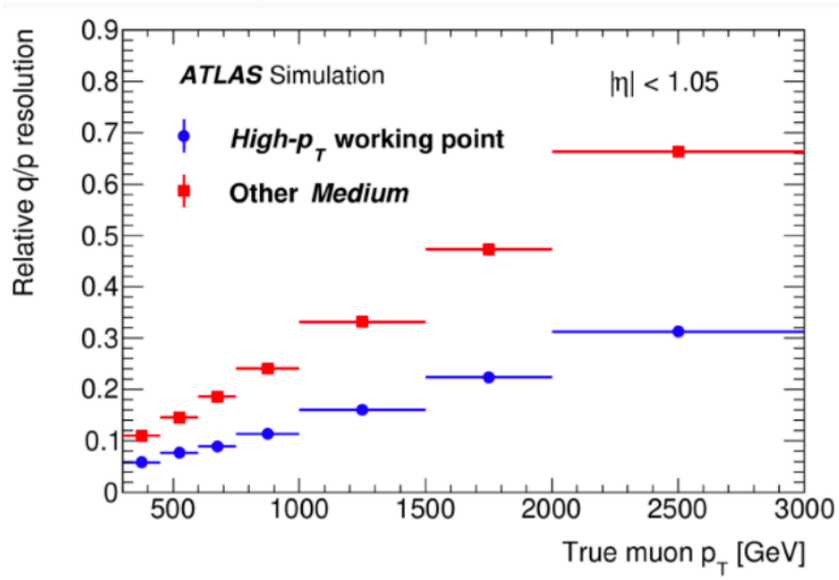


- Efficiencies, scales and resolutions fully data-driven
  - Run 2 results: systematics at the per-mille level from tag&probe and resonances fits
  - Alignment from optical system -> impact on high-pT momentum resolution

[Eur. Phys. J. C 81 (2021) 578]

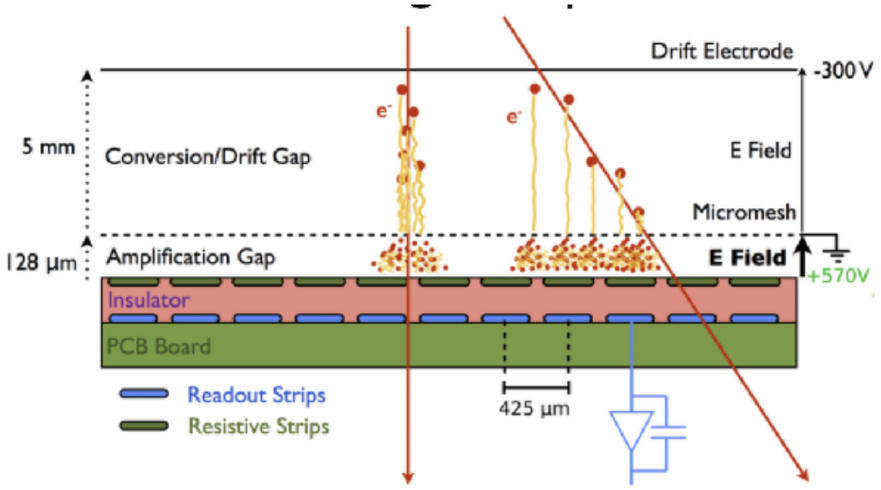


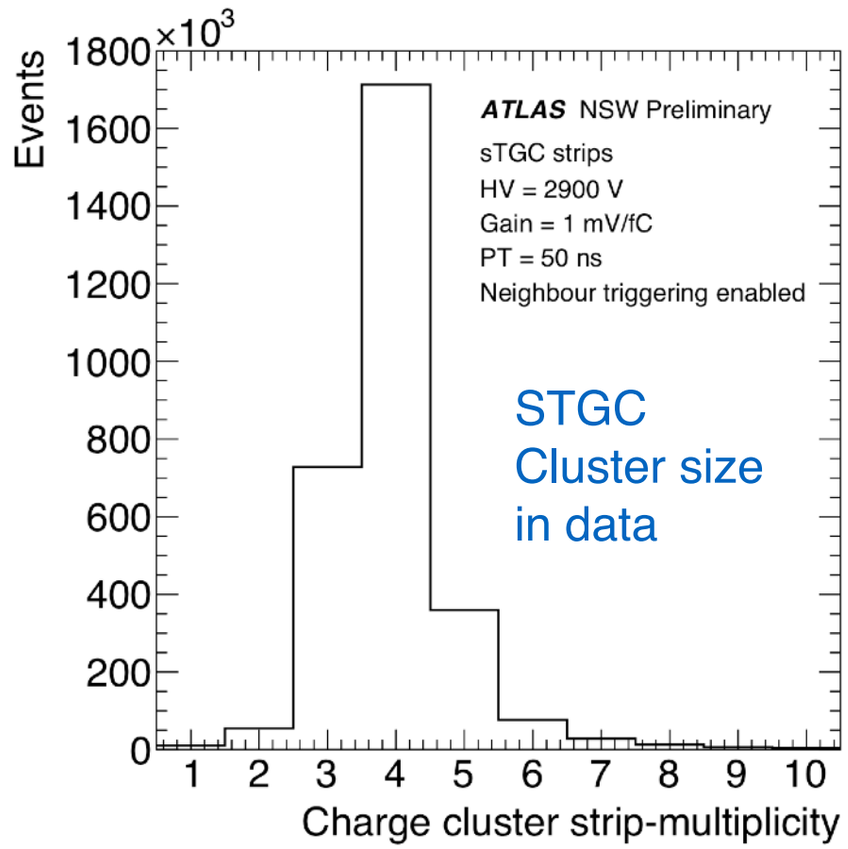


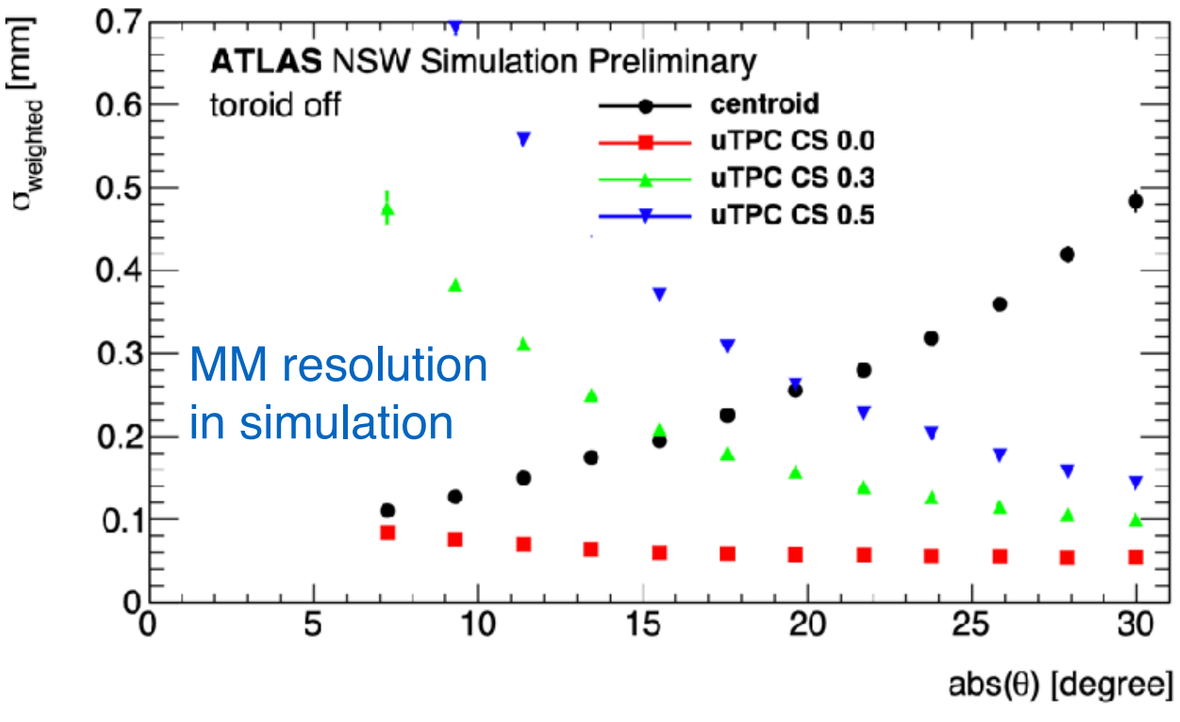


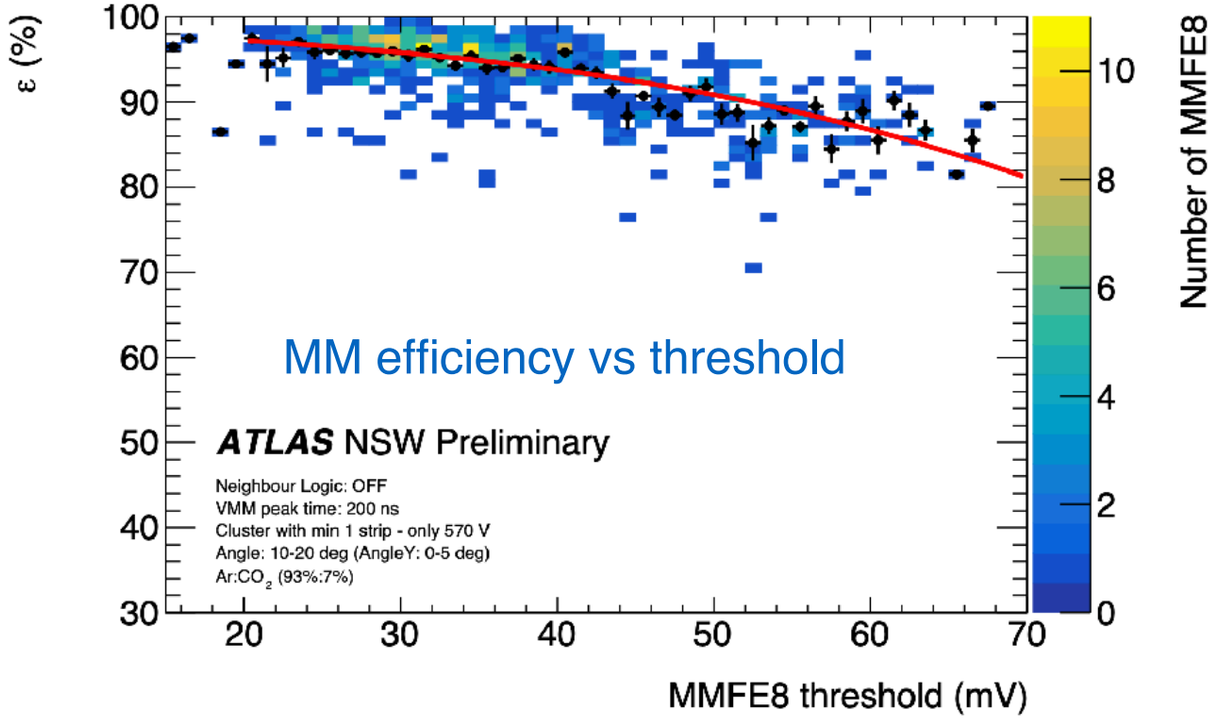
NSW performance studies

- Various checks already performed with data from cosmics test-stands, and compared to modeling in the simulation





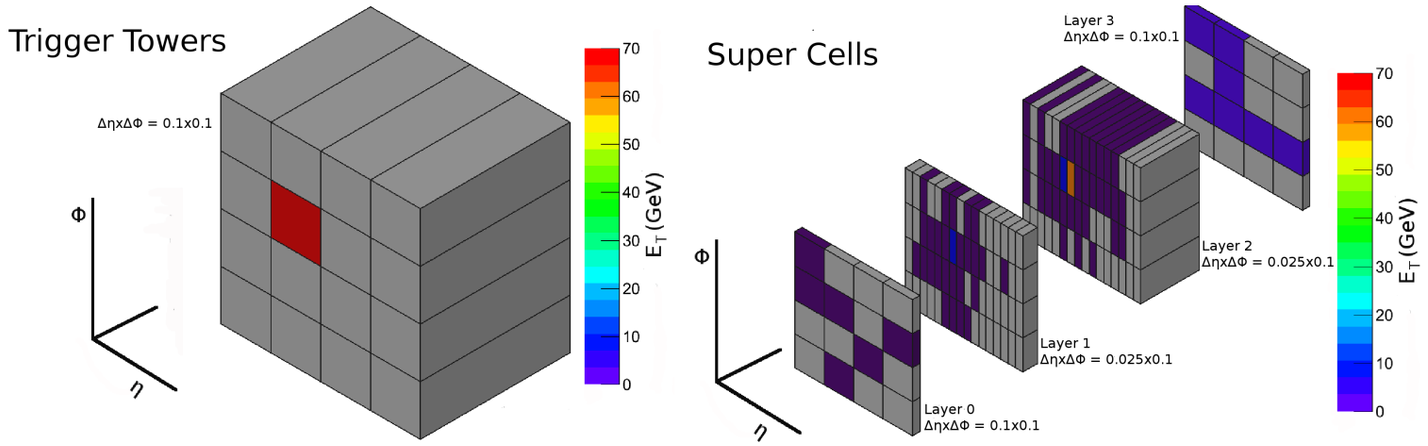




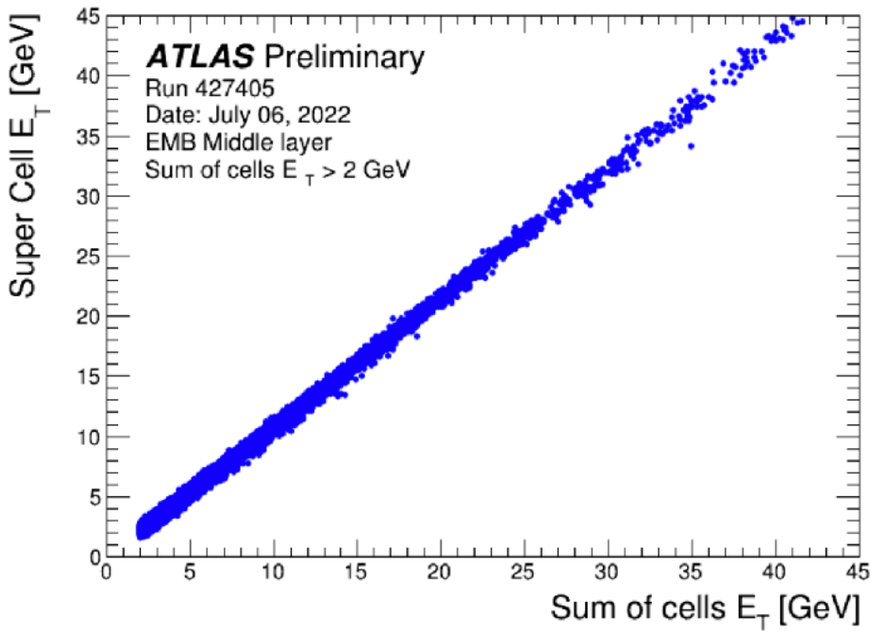
Performance of the new LAr digital trigger

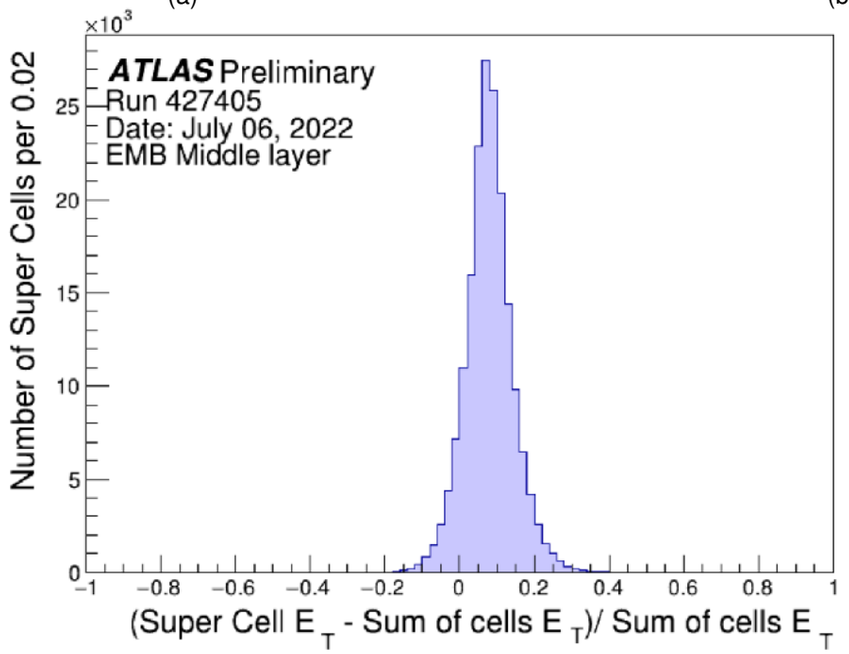
- The new trigger signals are arranged in 34K Super-Cells with much larger granularity than the run1-run2 trigger towers
  - 1 TT becomes: 1 PS + 4 strips + 4 middle + 1 back
- Improve EM trigger electron and photon discrimination
- First data collected at 13.6 TeV show a good correlation between the energy in the new supercells and the corresponding calo cells sum

[ATLAS LAr public plots]



(a) (b)

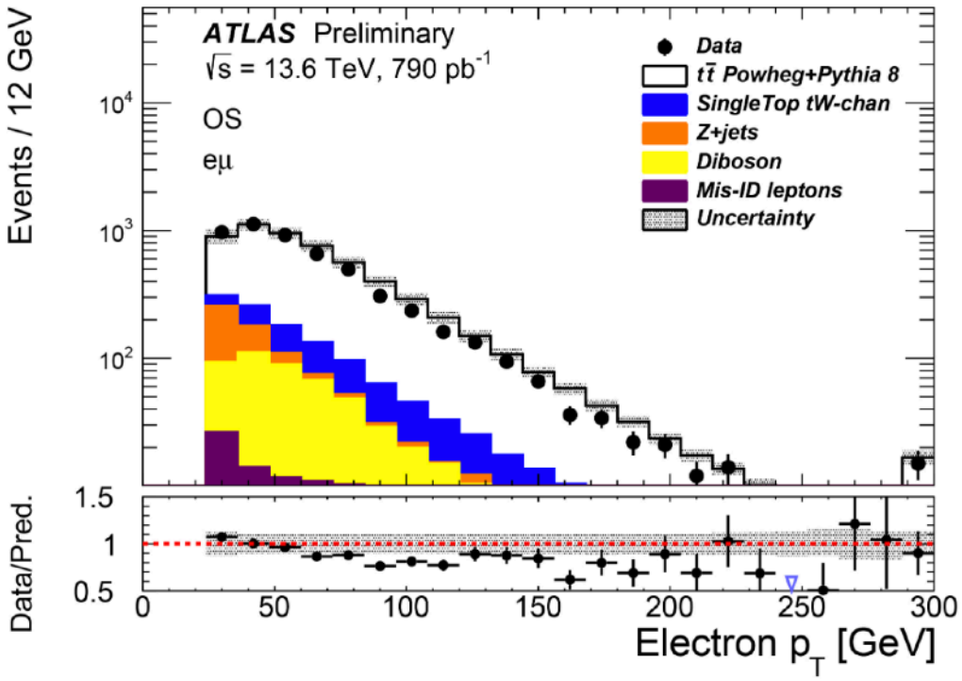


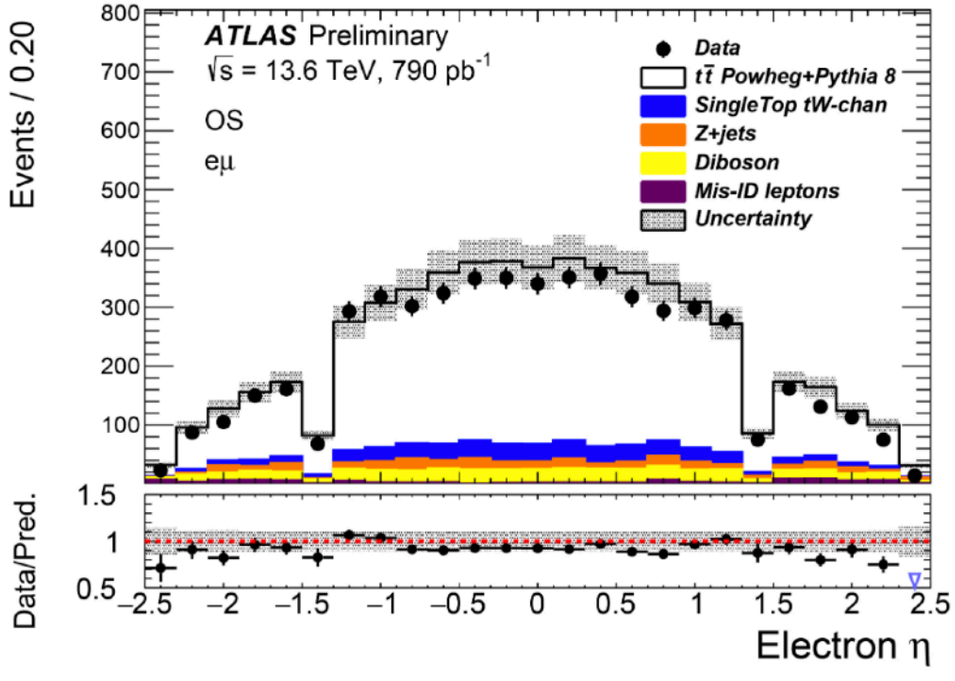


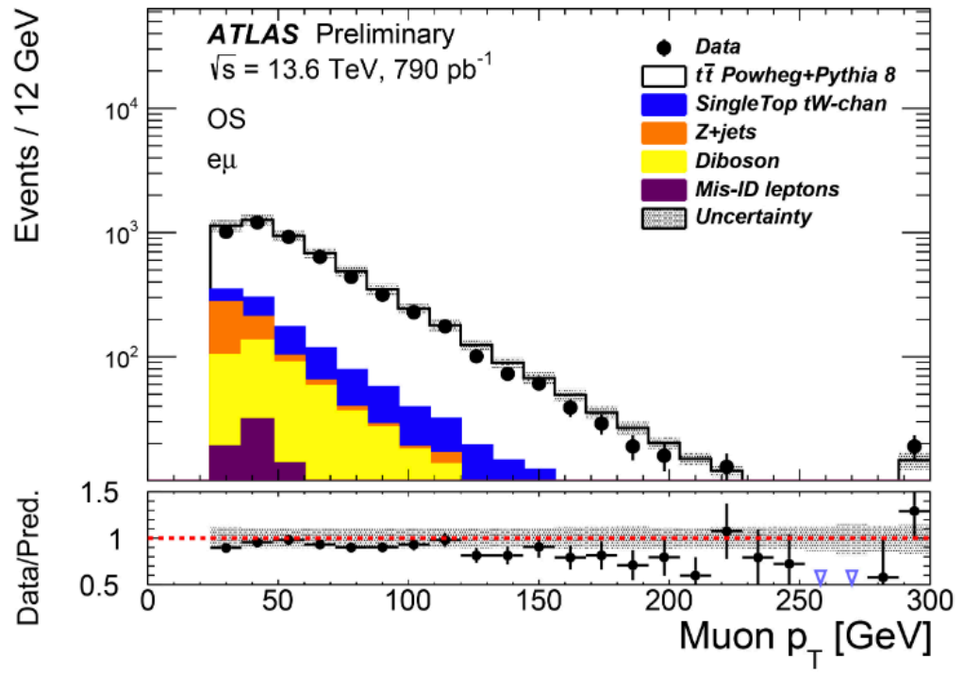
Electrons and muons in first run-3 data

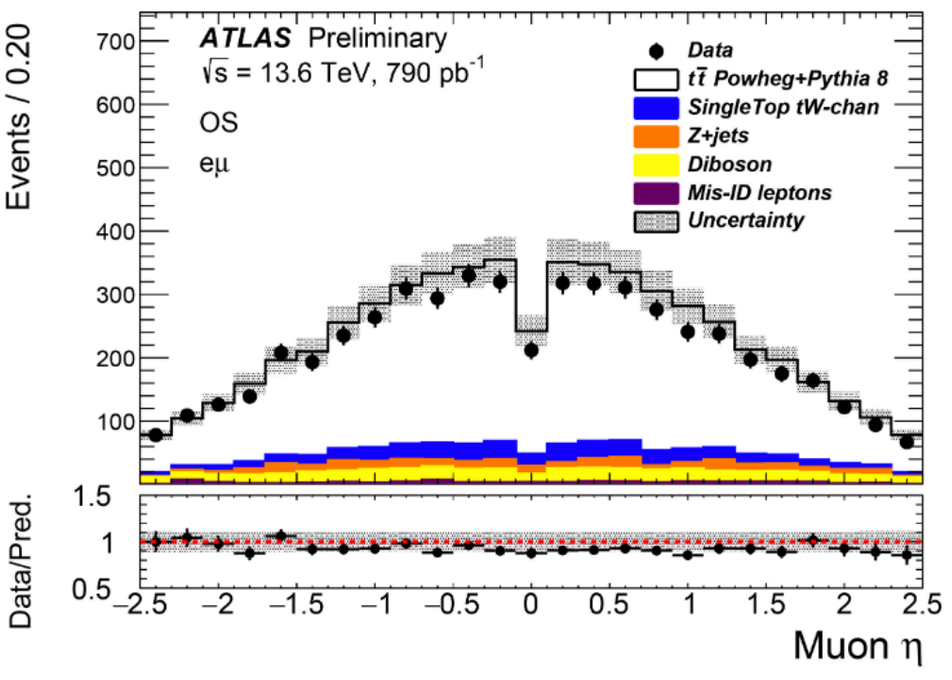
- Data/MC comparison for events passing an opposite-sign eμ selection
- Dominated by ttbar events

[ATLAS-COM-PHYS-2022-820]





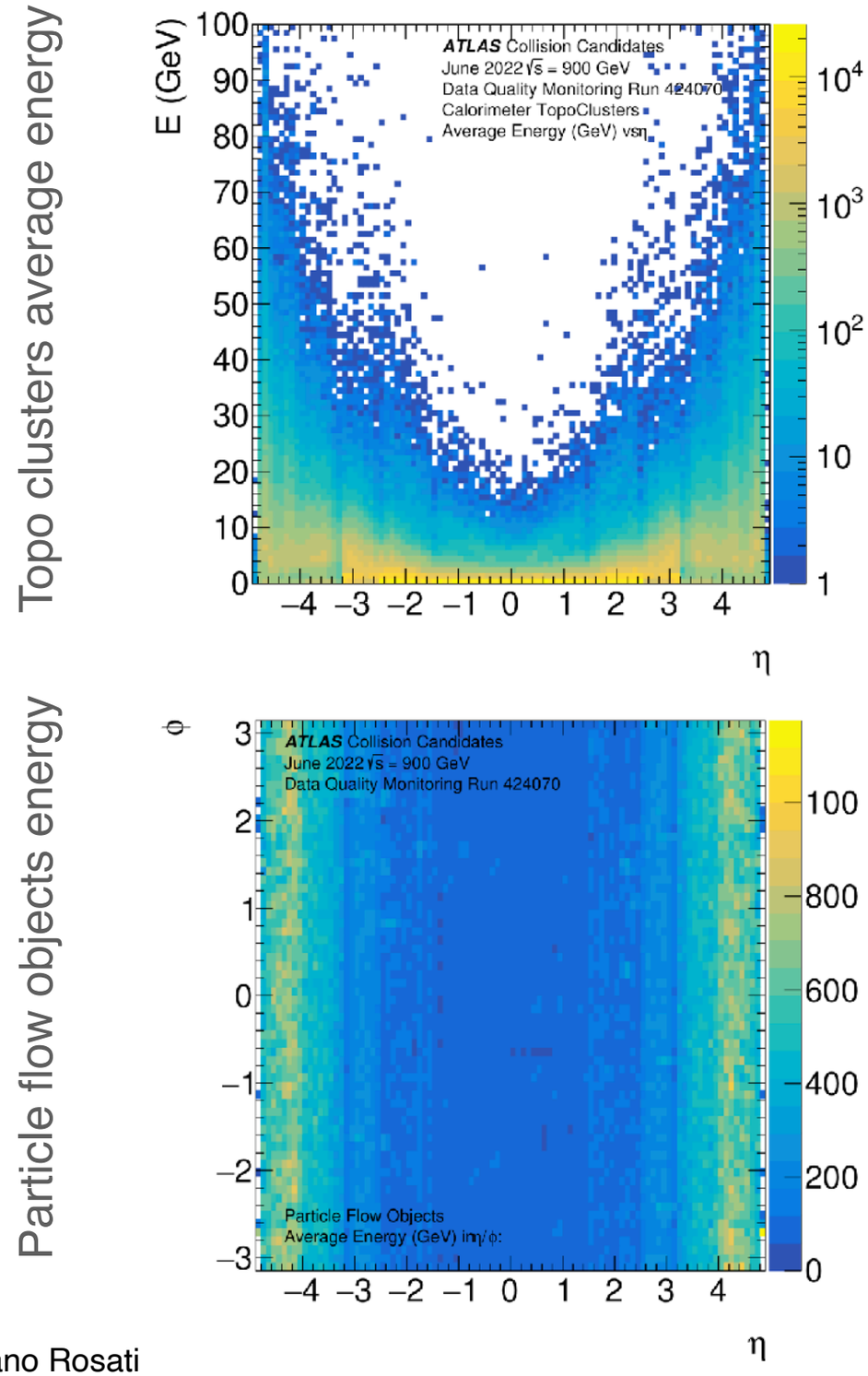


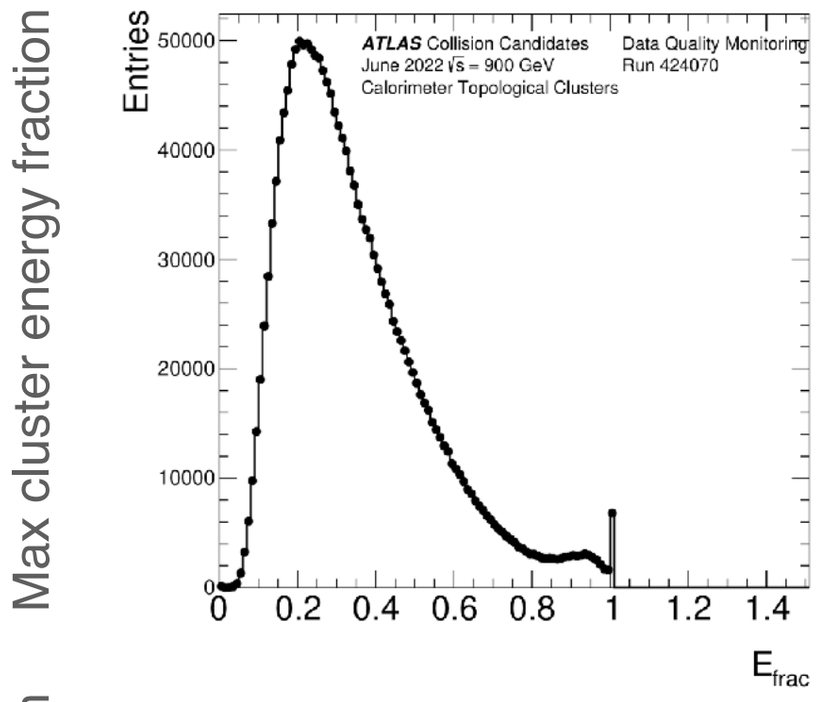


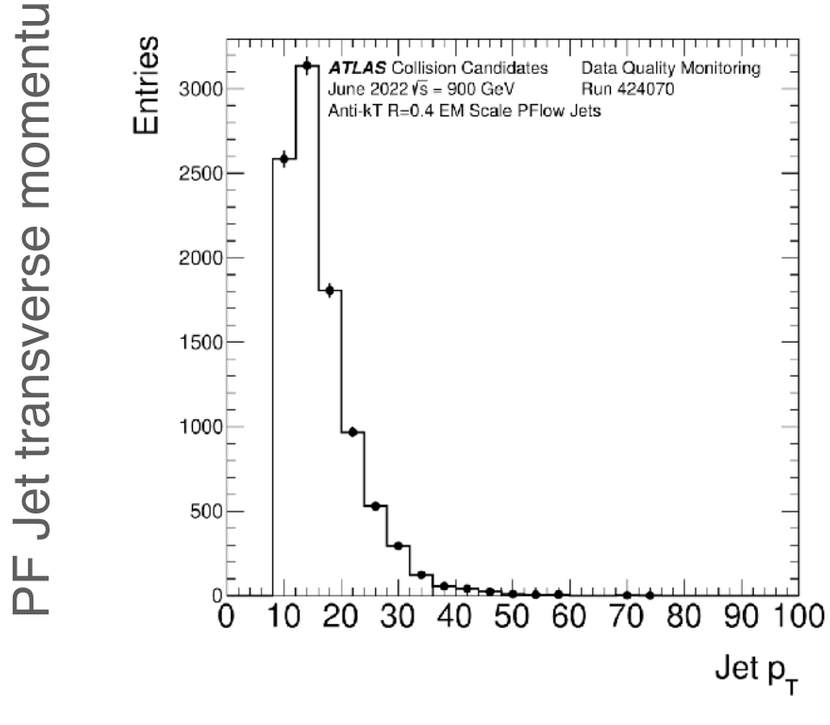
Jet reconstruction

- First jets reconstructed during the June 2022 commissioning run at 900 GeV center of mass energy

JETM-2022-003







b-tagged jets in first run-3 data

- Multiplicity of b-tagged jets for the DL1d tagger
  - Combining impact parameter information of displaced vertices and topological information of secondary and tertiary vertices in a NN discriminant
- Same flavour eμ selection, dominated by ttbar events
  - Main uncertainties from integrated luminosity (10%), b- c- and light-jets efficiency, ttbar and backgrounds modeling

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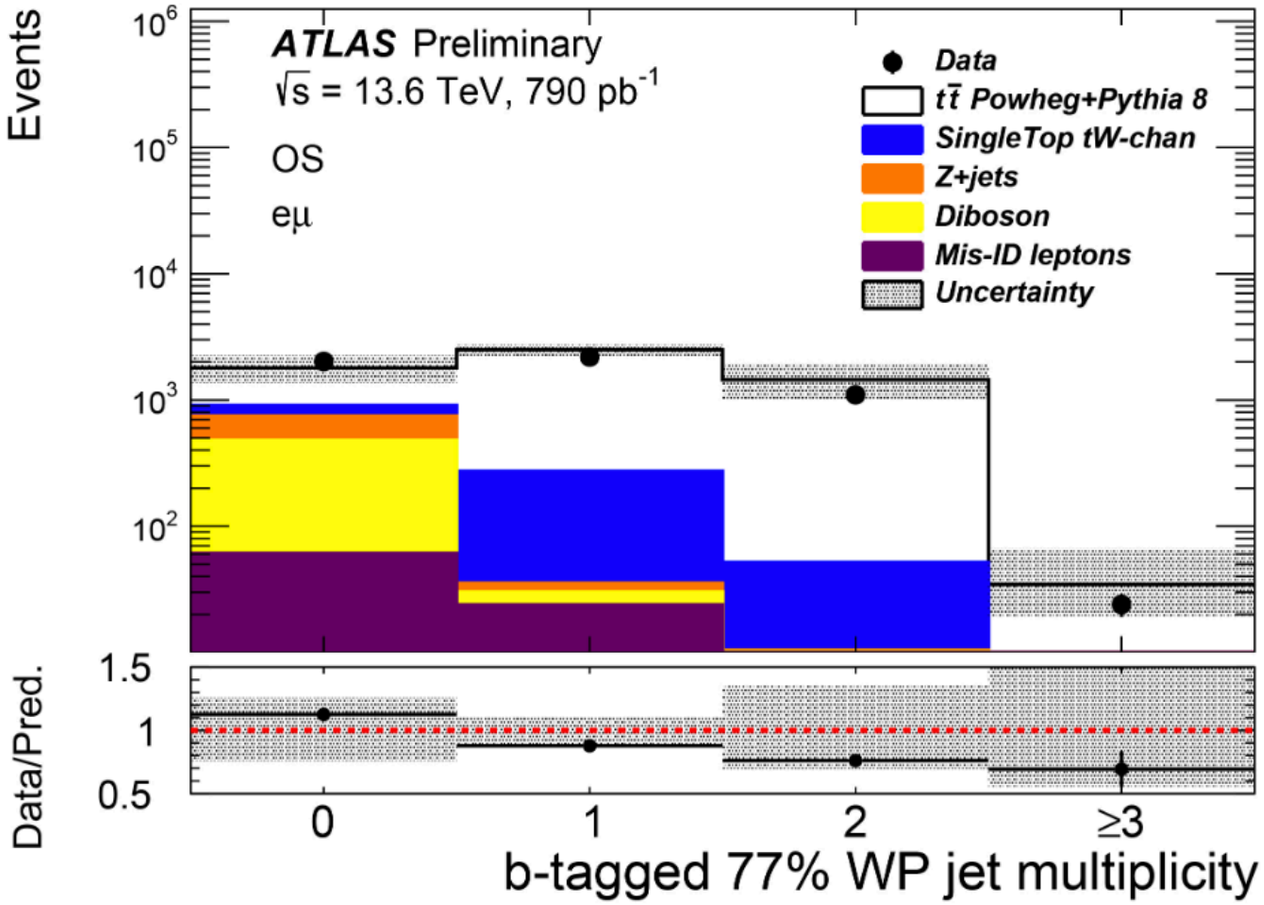

Conclusions

- LHC Run-3 has started in July, with collisions at the unprecedented center of mass energy of 13.6 TeV

- The ATLAS experiment is collecting data with an upgraded detector
  - New Small Wheel for forward muons trigger and tracking
  - New LAr digital trigger for electrons and photons discrimination
  - More readout electronics and TDAQ system upgrades

- Already ~10 fb-1 of data have been collected, with the instantaneous luminosity reaching ~1.9 x 10^{34} as planned for run-3

- The commissioning phase for the new detectors is ongoing, but the first performance results have been presented

- The quality of the data is already good for the first physics analyses and results at 13.6 TeV center of mass energy

- This is only the beginning of the exciting run-3 LHC physics program with the ATLAS experiment