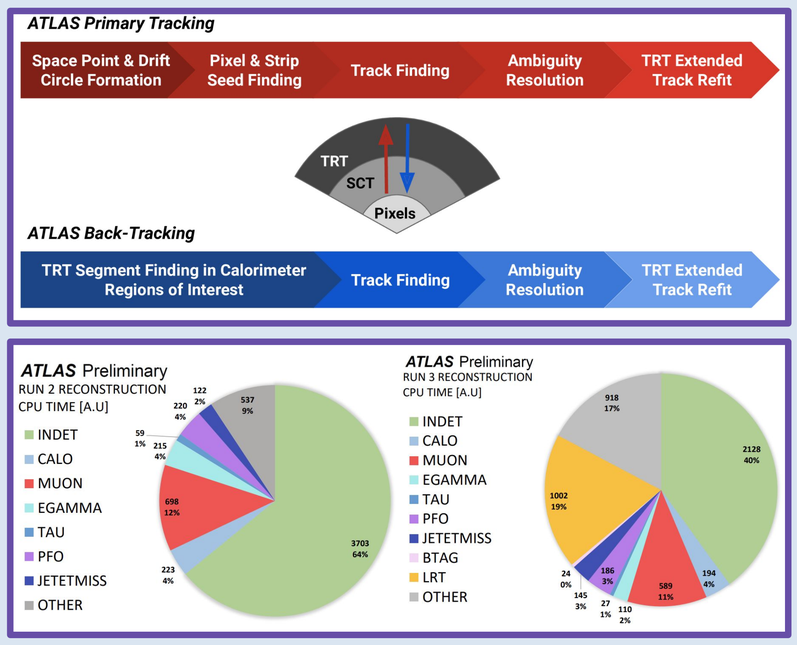
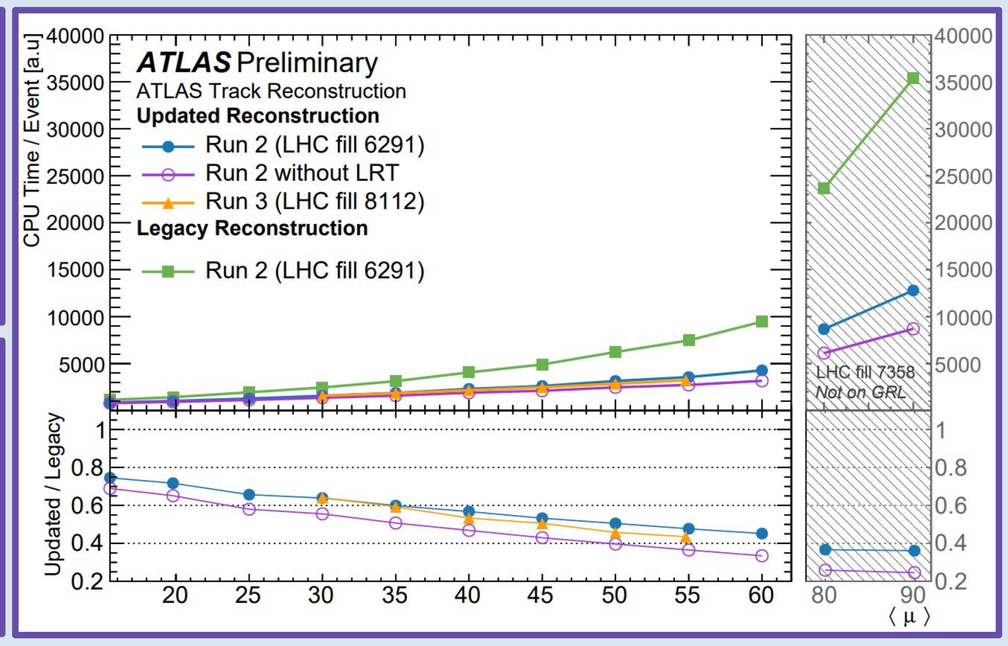
LHCC Poster Session - CERN, 29 November 2022

Software Performance of the ATLAS Track Reconstruction in LHC Run 3

Introduction

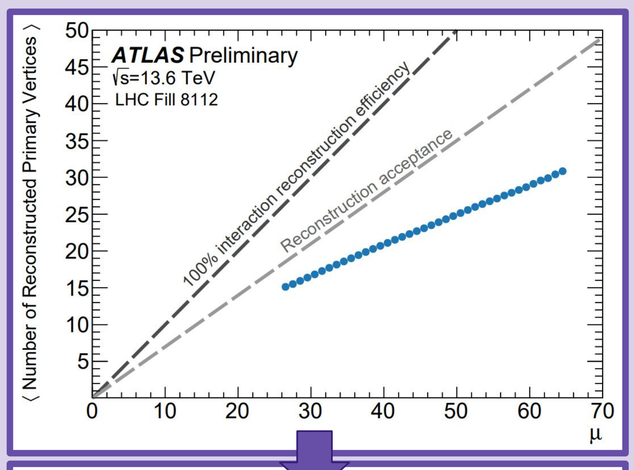
- **In Run 2,** charged particle reconstruction in the ATLAS Inner Detector is the **most resource-intensive portion** of the reconstruction chain and **scales exponentially** with an increasing number of simultaneous p-p collisions (pile-up, μ)
- **In Run 3**, now **scales near-linearly** with increasing pile-up, with **2-4x improvement in execution speed** and **20-50% reduction in output size** while **maintaining minimal efficiency loss** and **reducing fake rate**

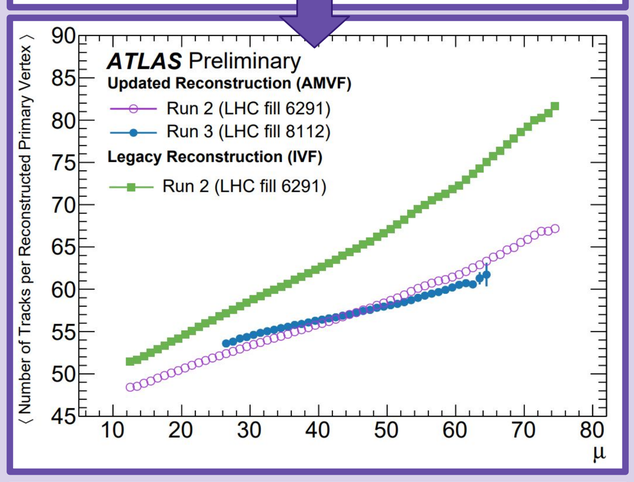


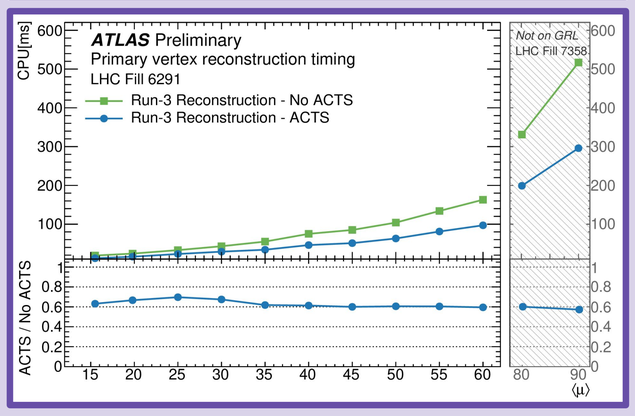


Adaptive Multi Vertex Fitter (AMVF) and ACTS Integration

- **Adaptive Multi Vertex Fitter** (AMVF) algorithm commissioned for Run 3 to replace an iterative procedure
  - Each track assigned a weight to multiple vertices, **pile-up dependency reduced**
  - By default AMVF is slower compared to iterative, solved through deploying **highly optimized** ACTS implementation of vertexing routine







General Improvements and Optimizations

Stricter cuts for track candidates:

- Require at least **8 silicon (Pixels+SCT) clusters**
  - From 7 in legacy reconstruction
- **$|d_0|$ range restricted to <5 mm**
  - From <10 mm in legacy reconstruction

Backtracking seeding optimization:

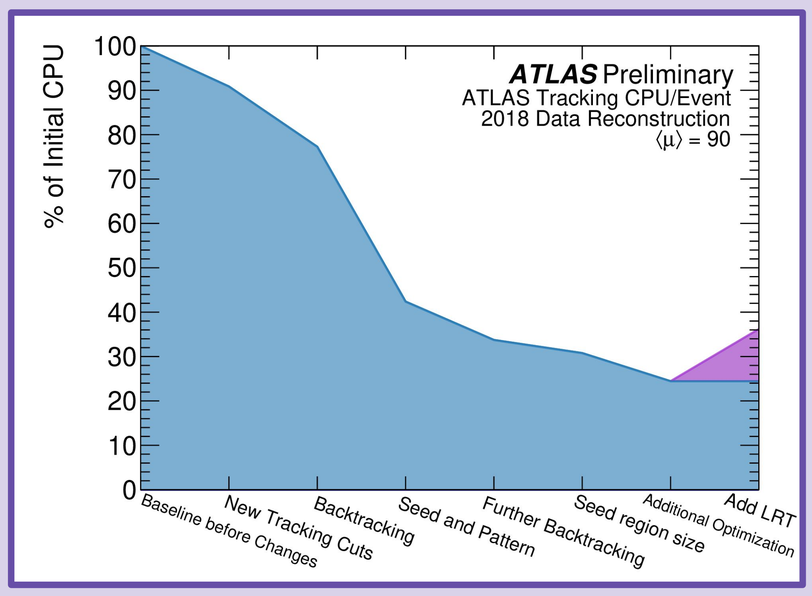
- Perform backtracking within regions of interest seeded by **deposits in EM calorimeter** with **E_T > 6 GeV**
  - **20x speed up** with **minimal efficiency loss**

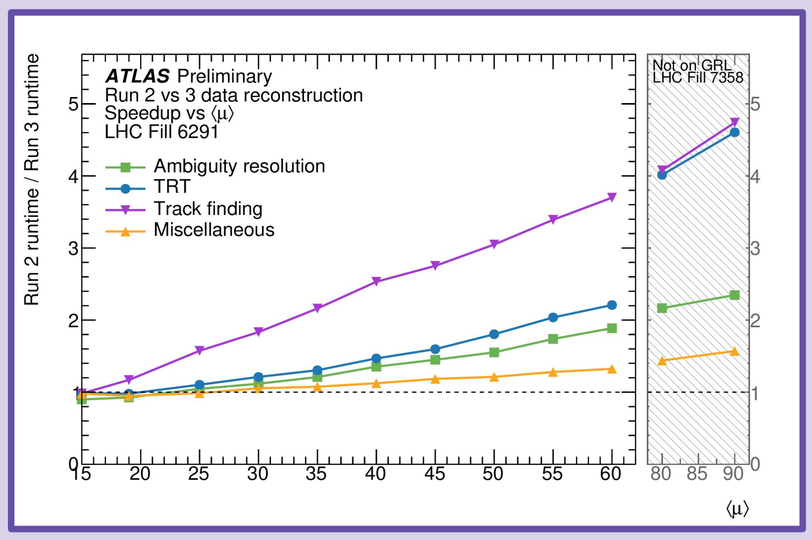
Primary seeding optimization:

- **Removed seeds unlikely to result in high-quality tracks** with:
  - Stricter requirements on impact parameters
  - Narrower search roads
  - Restrictions on number of overlapping seeds
  - Confirmation space points
  - Reduced angular region size for seed formation

Additional Optimizations:

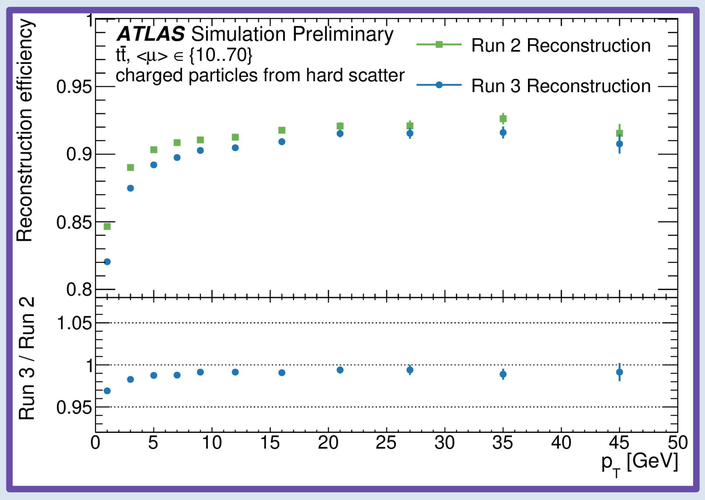
- **Early exit in TRT extension** for candidates with insufficient TRT hits
- **Software improvements** such as **vectorized instructions** for Runge-Kutta propagator

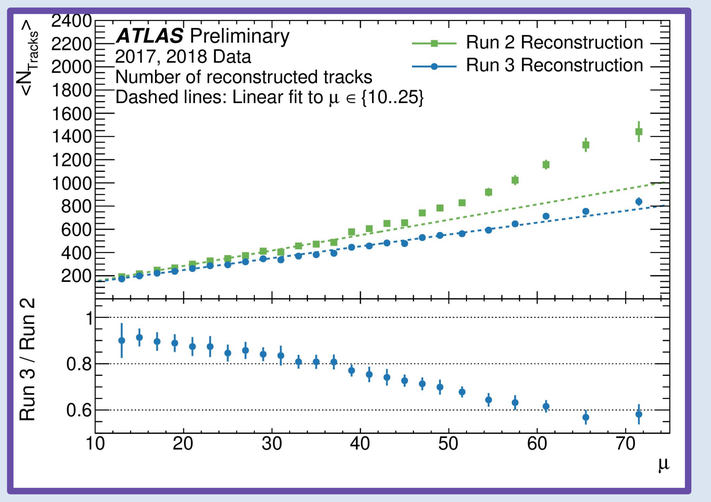




Physics Performance

- **Excellent physics performance** maintained with updated reconstruction
  - Maximum efficiency loss of **only 4% at lowest p_T values**
  - Up to **2-4x improvement in execution speed**
- **Near-linear behavior** of updated reconstruction shows **dramatic improvement in track purity**





Makayla Vessella (University of Massachusetts Amherst)
On behalf of the ATLAS Collaboration

Refs: ATL-PHYS-PUB-2021-012, ATL-PLOT-IDTR-2022-08

University of Massachusetts Amherst

ATLAS EXPERIMENT