Poster Introduction

Software Performance of the ATLAS Track Reconstruction for LHC Run 3

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On behalf of the ATLAS collaboration

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ATLAS EXPERIMENT

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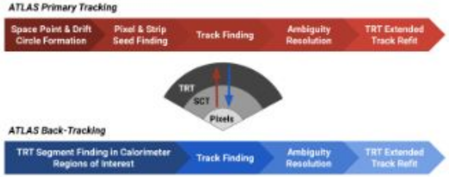
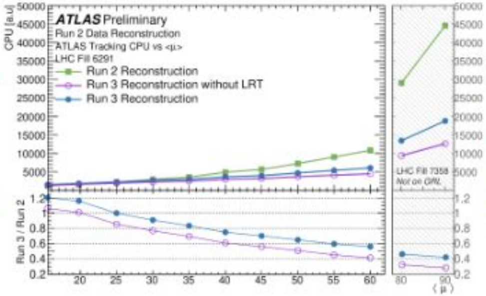
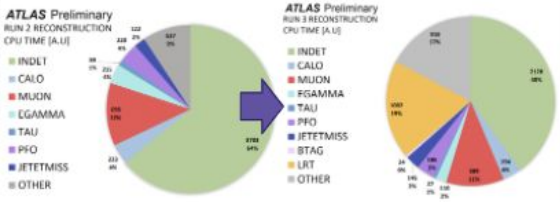
Introduction

- Reconstructing tracks in the ATLAS Inner Detector is the **most resource-intensive portion** of the ATLAS reconstruction chain during the LHC Run 2 and **expected to scale exponentially** with an increasing number of simultaneous p-p collisions (pile-up,μ)
- Large scale effort undertaken in ATLAS during the Long Shutdown 2 to speed up tracking while preserving physics performance, **now scales near-linearly with increasing pile-up**.







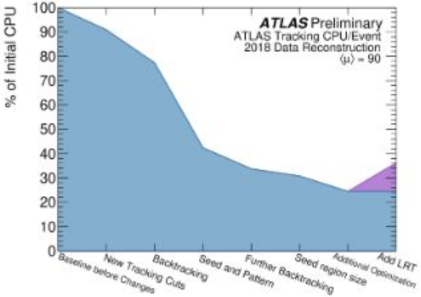
General Improvements and Optimizations

Stricter cuts for track candidates:

- Require at least **8 silicon clusters** (from 7 in Run 2)
- Permitted **$|d_0|$ range restricted to <5 mm** (from <10 mm in Run 2)

Backtracking seeding optimization:

- Only perform backtracking within ROI seeded by **deposits in EM calorimeter** with **E_T > 6 GeV**
  - Execution speed for backtracking improved by **factor of 20** with minimal efficiency loss

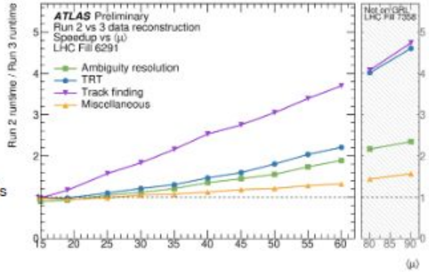


Primary seeding optimization:

- **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

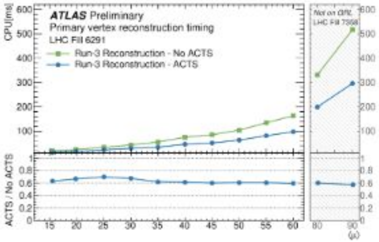
Additional Optimizations:

- **Abort iterative track fit procedure in TRT extension** early for candidates with an incompatible number of hits
- General software improvements such as exploiting **vectorized instructions** for Runge-Kutta propagator implementation



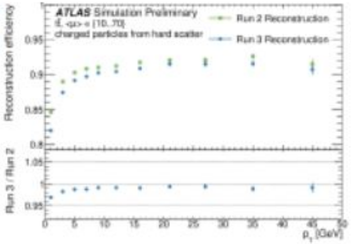
Adaptive Multi Vertex Fitter (AVMF) and ACTS Integration

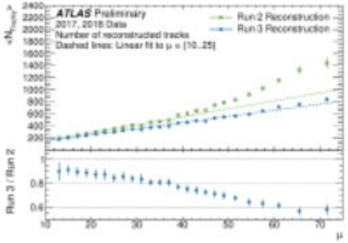
- **Adaptive multi vertex fitter** (AVMF) algorithm commissioned for Run 3 to replace an iterative procedure
  - Each track assigned a weight to multiple vertices, **pile-up dependency reduced**
  - By default is slower compared to iterative, solved through deploying **highly optimized** ACTS implementation[1] of vertexing routine



Physics Performance

- **Excellent physics performance** maintained with Run 3 reconstruction
  - Maximum efficiency loss of **only 4% at lowest p_T values**
  - Up to **2-4x improvement in execution speed**
- **Near-linear behavior** of Run 3 reconstruction shows **dramatic improvement in track purity**





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1: *A Common Tracking Software*, arxiv.org/abs/2106.13593