Samuel Ferraro
Rocky Bala Garg

Advancements in ACTS: Speed and Adaptability for the Muon Collider

Statement of Interest: This poster presents two projects aimed at evaluating and adapting A Common Tracking Software (ACTS) for the Muon Collider. In the first project, we analyze the performance of a newer version of ACTS for the Muon Collider Software. In the second project, we focused on transitioning ACTS processors from Marlin to Gaudi to address the need for scalable processing capabilities.

Part 1: An Analysis of the Old and New Versions of ACTSTracking

Introduction to ACTSTracking

- ACTS is a set of high-level track reconstruction modules that can be applied to any tracking detector **[1]**.
- ACTSTracking is a set of Marlin Processors that implement ACTS for a proposed Muon Collider geometry.
- As the development for a tracking algorithm for the Muon Collider continues, the team has begun migrating to a newer version of ACTS.

Remaining Issues

- It was noted in early versions of ACTSTracking that the reconstruction efficiency drops in the forward regions of the detector.
  - This issue persisted in the new version.
- Another issue that was left unresolved with the update is that high pT tracks (pT>250 GeV) tend to have fewer hits than expected.

Comparison of Versions

- The goal for the newest container of the Muon Collider software release was to have a functional implementation of an **updated ACTS** version.
- Reconstruction efficiency remained consistent.
- Additionally, the rate at which fake tracks were generated did not increase.
- The main improvement between versions shows in the **dramatic speed increase**. (Figure 1)

Figure 1. Tracking runtime for 10,000 muon particle gun events for old ACTSTracking (blue) and new ACTSTracking (red).

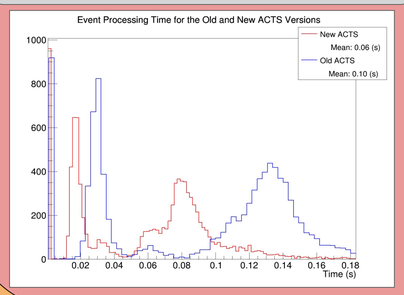


Figure 2. Tracking efficiency for 10,000 muon particle gun events for old ACTSTracking (blue) and new ACTSTracking (red). Binned by pT (left) and eta (right).

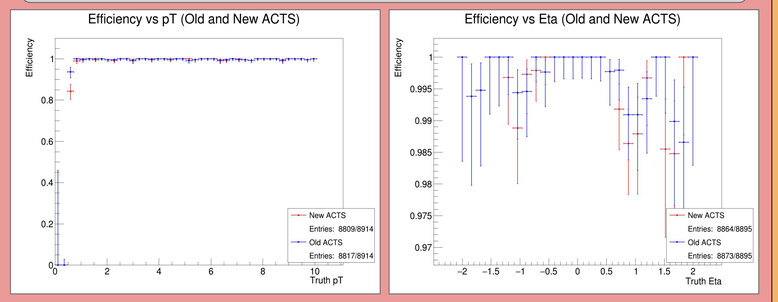
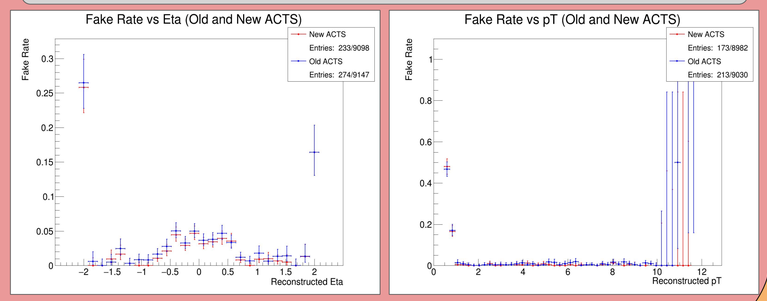


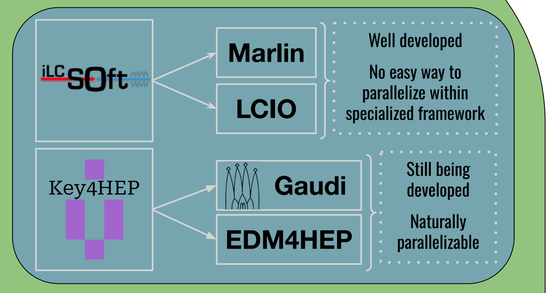
Figure 3. Tracking fake rate for 10,000 muon particle gun events for old ACTSTracking (blue) and new ACTSTracking (red). Binned by pT (left) and eta (right).



Part 2: Transitioning from ILCSoft to Key4HEP

ILCSoft → Key4HEP

- The Beam Induced Background at a Muon Collider poses a unique challenge. The number of background particles drastically increases the demand for an efficient and fast reconstruction algorithm **[2]**.
- As Key4HEP continues to develop, it has become clear that transitioning the older Marlin algorithms into native Gaudi will provide the necessary speed-up through parallelization



Completed Transition Tasks

- Every Marlin Processor had to be converted into a Gaudi Transformer, Multitransformer, or Consumer depending on its design.
- All LCIO tasks had to be performed by the equivalent EDM4HEP objects.
- Marlin steering files are converted to Gaudi steering files.
- This amounted to almost **4,000 lines of code** that required transitioning. (And led to **over 8,000 additions and deletions** to yield a correct result).

Figure 5. Number of hits per track (all tracks) for Gaudi Reconstruction (Red) and Marlin Reconstruction (Blue).

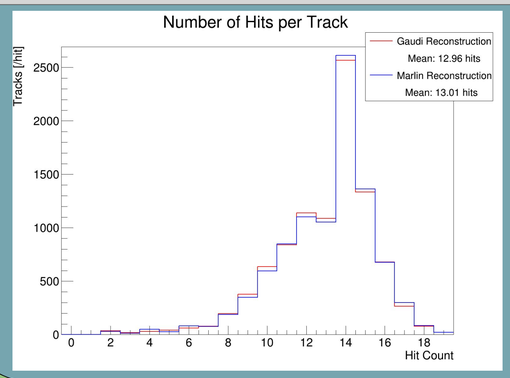
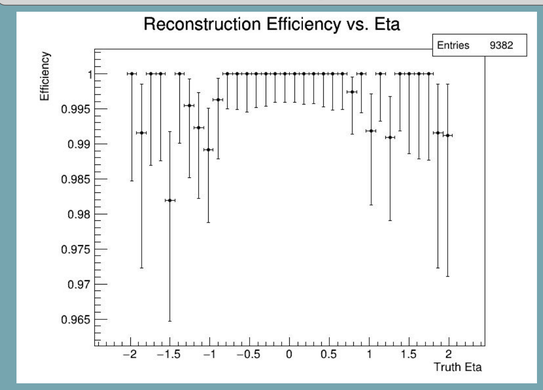


Figure 4. Tracking Efficiency for 10,000 muon particle gun events for the Gaudi reconstruction algorithm. Binned by eta.



Analysis

- The Gaudi Algorithms successfully match the performance of the Marlin Processors.

Next Steps

- Parallelization: The end goal will be to use the natural parallelization that exists with Gaudi to drastically increase the speed at which many events can be reconstructed.
- EDM4HEP Update: EDM4HEP is still being overhauled and thus parts will change (especially Links and Tracker Hits) We must update our algorithms to ensure compatibility.

Related Pages:
ACTS Home Page
ACTSTracking Repository
Muon Collider Wiki

References

Related Pages:
Key4HEP Home Page
Transitioned Code Repository
ILC Software Wiki