

Charged Particle Reconstruction at the Muon Collider

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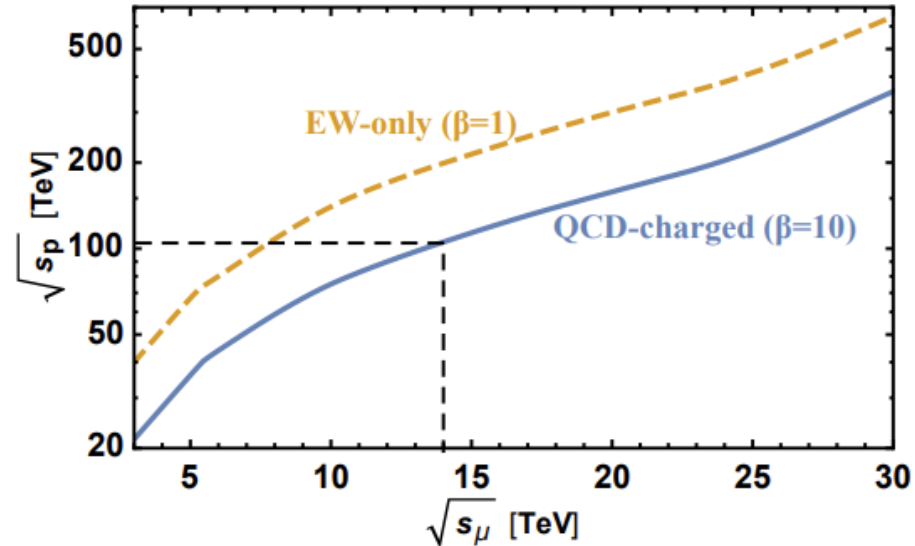
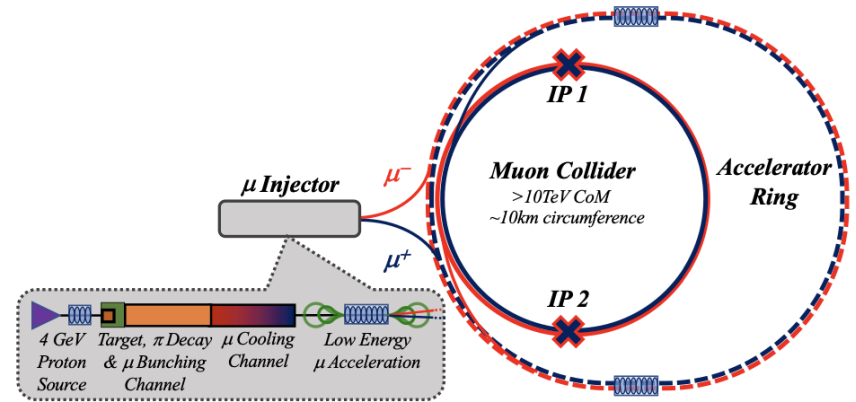
Advisor: Simone Pagan Griso



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Why a Muon Collider?

- In 2023, the P5 report suggested a Muon Collider as one of the best options to push the energy frontier
- Elementary Particles – All energy goes into collision
- Higher mass than electrons – Less synchrotron radiation
- High energy muon collisions create an abundance of effective vector bosons – sensitive to Higgs



Project 1:

Testing and Validation
of the New ACTS Version

A Common Tracking Software (ACTS)

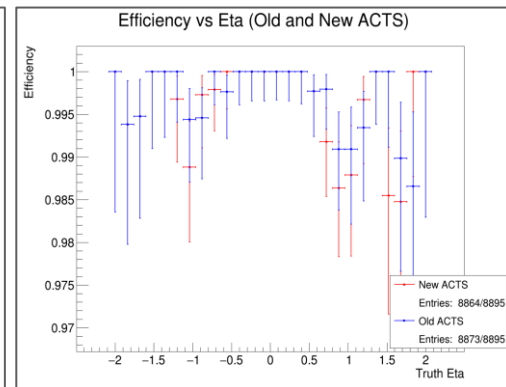
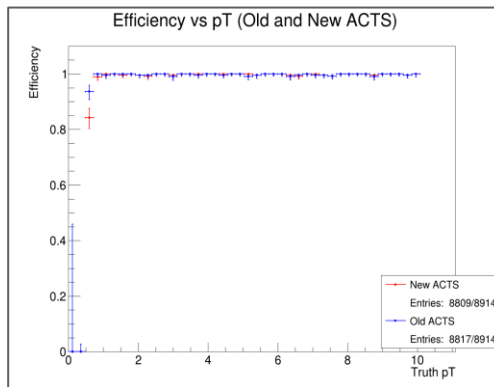
- The Tracking Library used for the muon collider.
- Transitioned from version 13 to version 32.
- Additionally, the algorithms were improved as well as the interface.



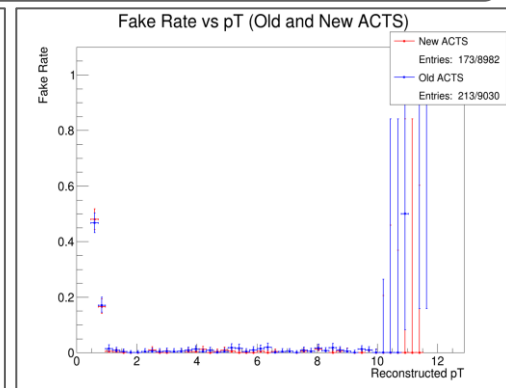
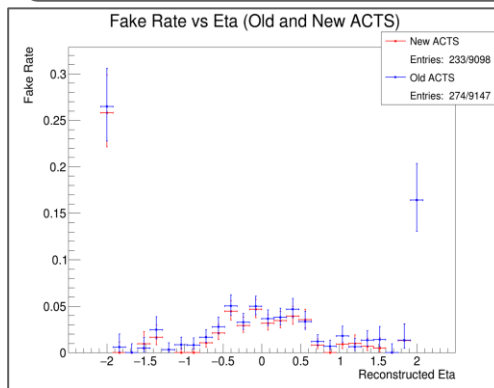
Moving to a Newer ACTS

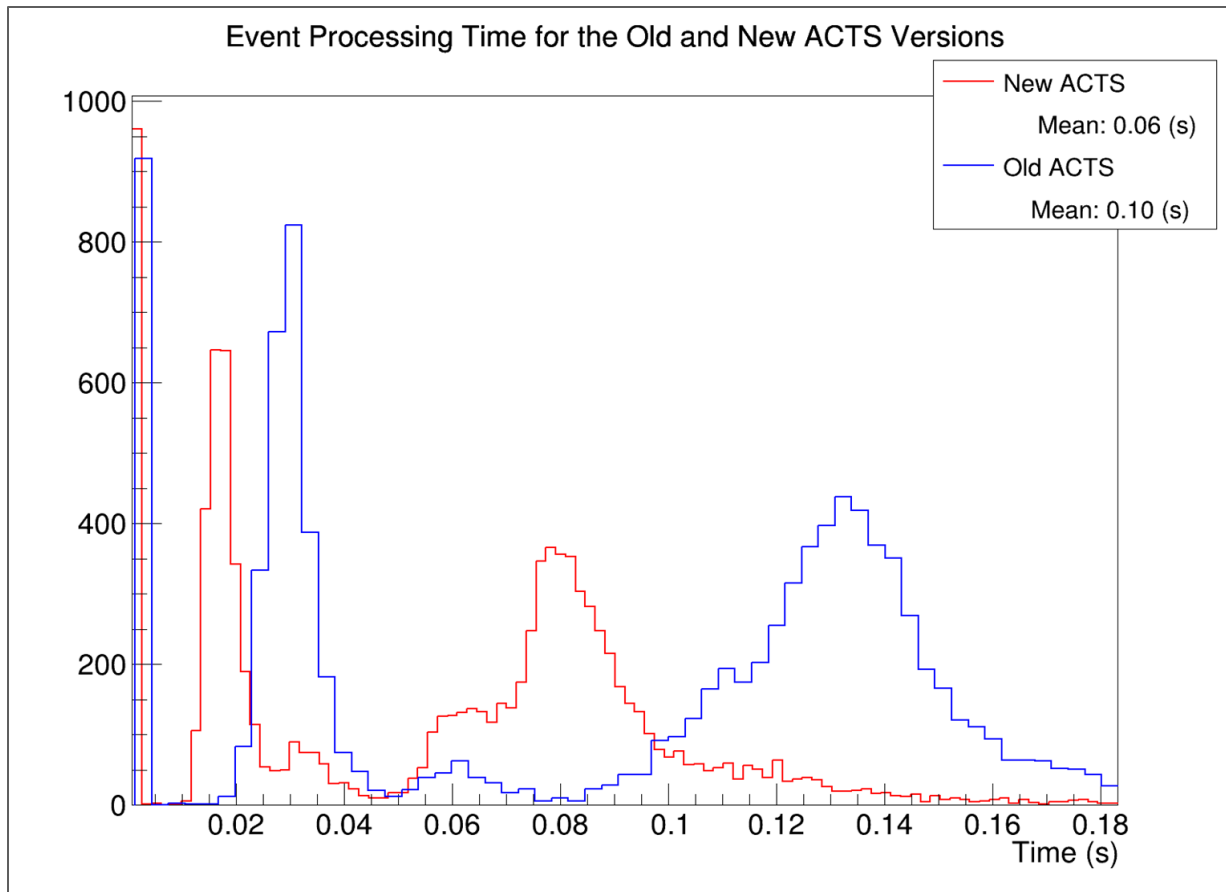
- Reconstruction efficiency remained consistent.
- Additionally, the rate at which fake tracks were generated did not increase.
- The main improvement between versions shows in the dramatic speed increase. (*See next slide*)

Tracking efficiency for 10,000 muon particle gun events for old ACTSTracking (blue) and new ACTSTracking (red). Binned by p_T (left) and η (right).



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





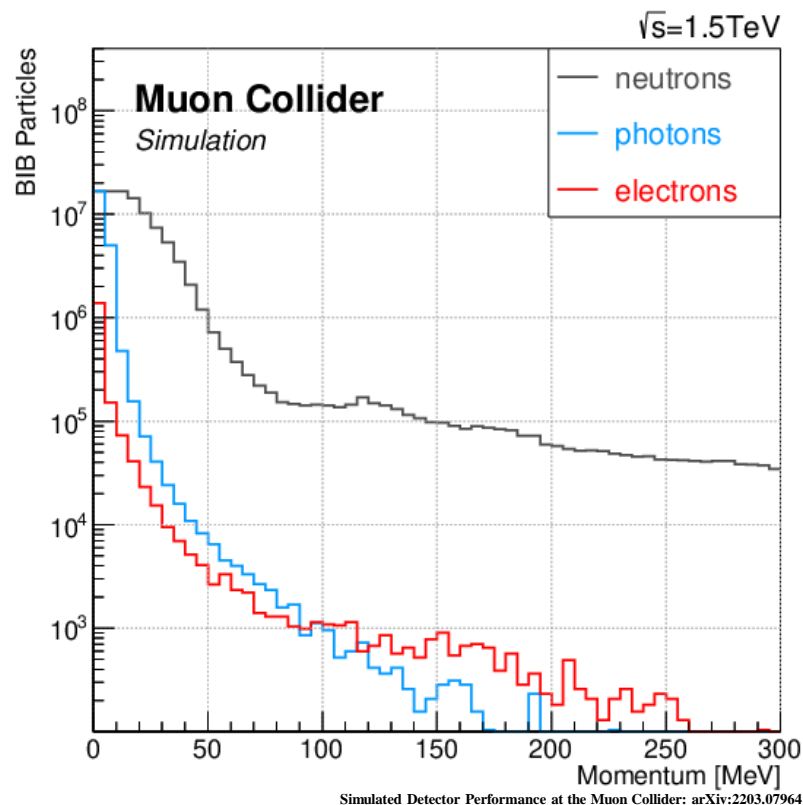
Tracking runtime for 10,000 muon particle gun events for old ACTSTracking (blue) and new ACTSTracking (red).

Project 2:

Conversion of Tracking
Processors to Key4HEP

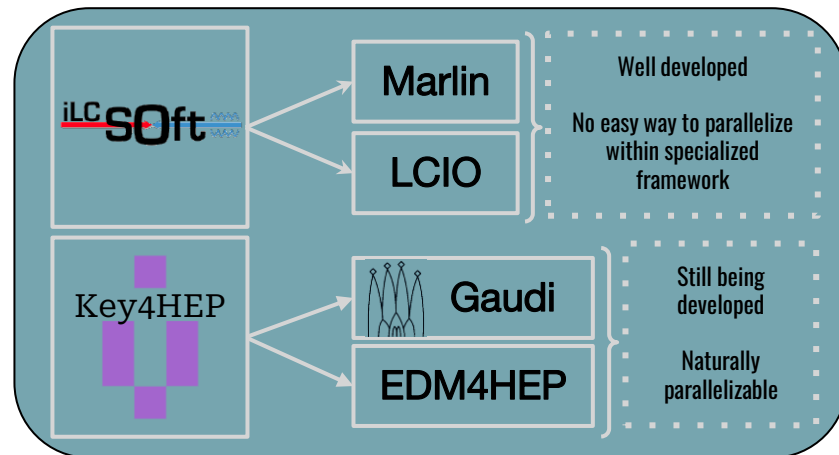
The Problem Statement

- The BIB at the Muon Collider presents a unique difficulty for track reconstruction
- We need faster reconstruction.
Solution: Multithreading
- The current Marlin framework does not allow for multithreading



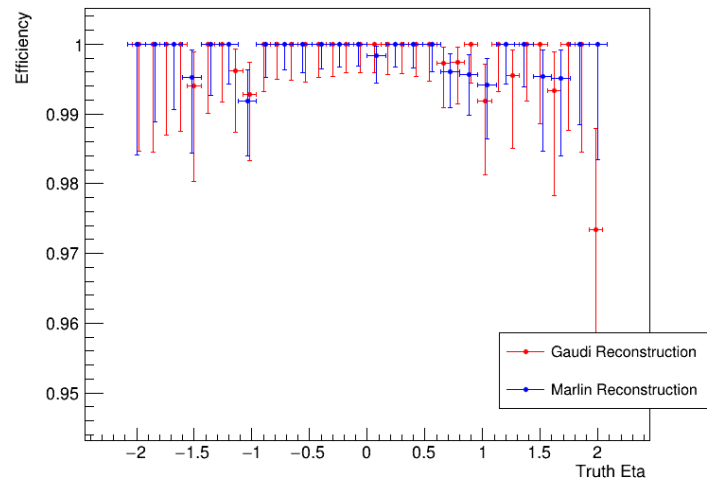
The Conversion Plan

- Every Marlin Processor had to be converted into a Gaudi Functional.
- All LCIO tasks had to be performed by the equivalent EDM4HEP objects.
- Marlin steering files are converted to Gaudi steering files.

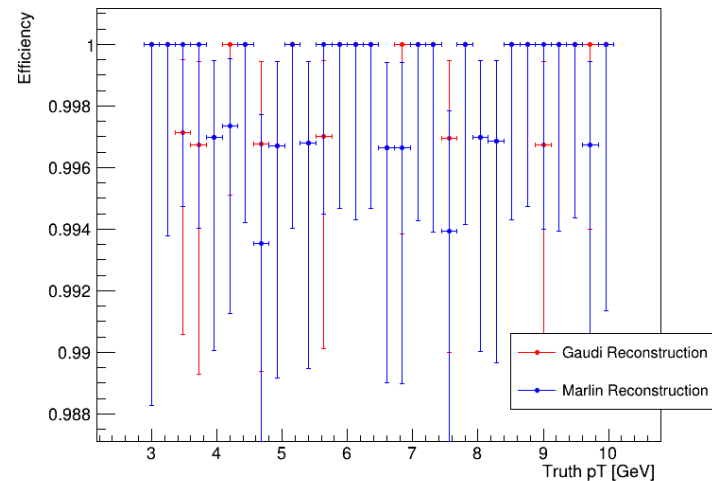


The Results

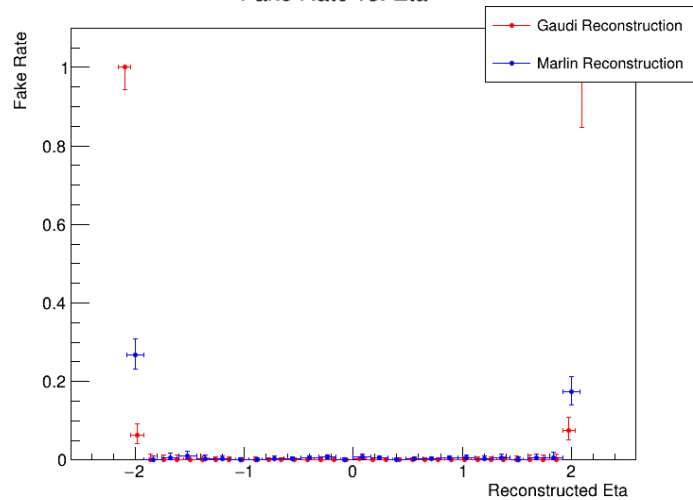
Reconstruction Efficiency vs. Eta



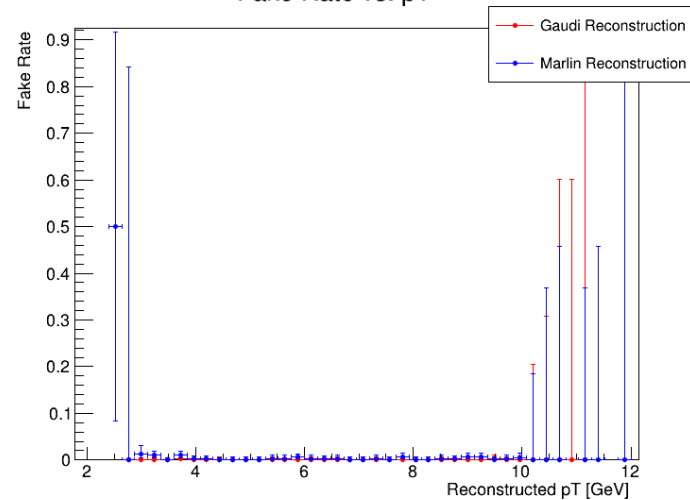
Reconstruction Efficiency vs. pT



Fake Rate vs. Eta



Fake Rate vs. pT



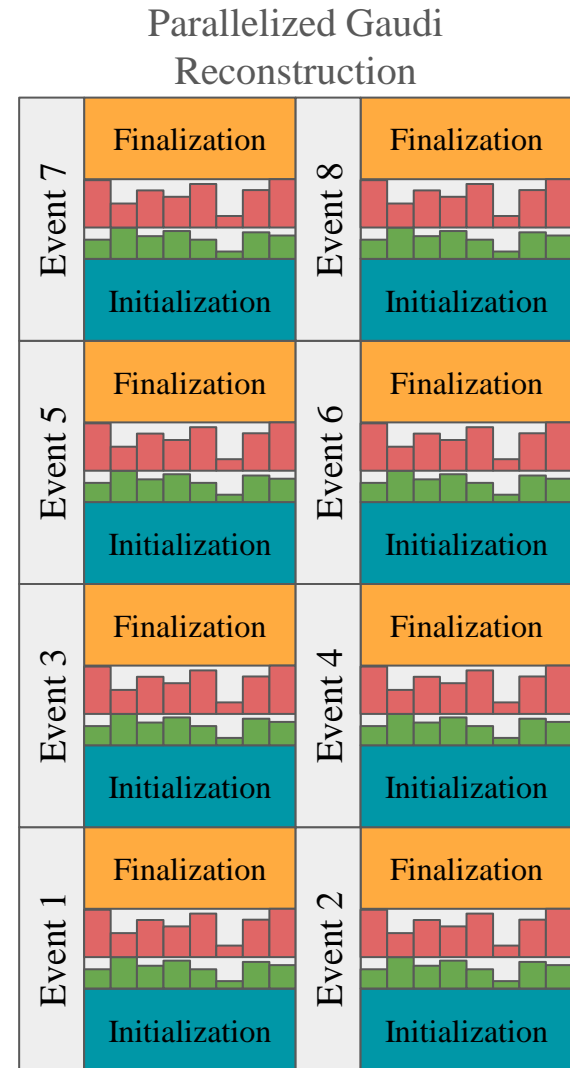
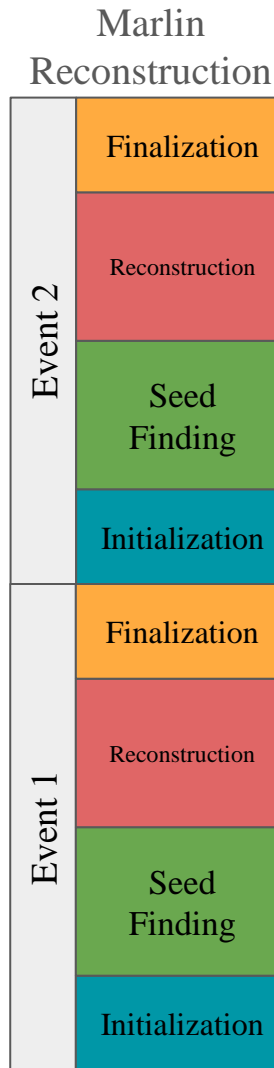
The Remaining Issues

Key4HEP and EDM4HEP are still in development. There are aspects of them that will change.

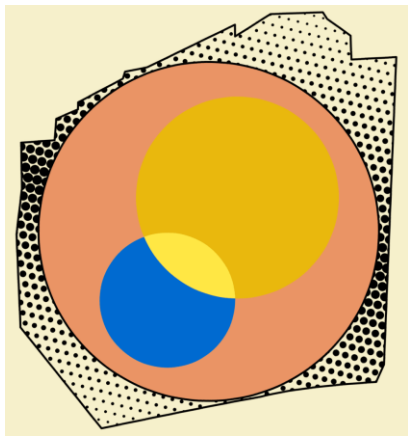
- A few workarounds had to be implemented to get around EDM4HEP bugs.
 - The code is set up to be easy to change once the bugs are solved
- As the framework changes, the code will have to be updated to reflect that.
- These changes will be minor compared to the conversion process.

The Next Steps

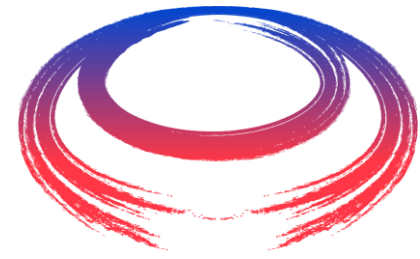
- Parallelization!
- Starting with multithreading the track reconstruction process.
 - A few minor changes to the algorithm will have to be implemented.
- As Key4HEP develops, it should become possible to also multithread events giving another avenue for improvement.



Sharing My Work



USMCC Workshop



International
UON Collider
Collaboration



M u C o l



Thank You,
Questions?