The MAP tracking detector: lessons learned

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Workshop on Detector and Physics Simulation at a Muon Collider
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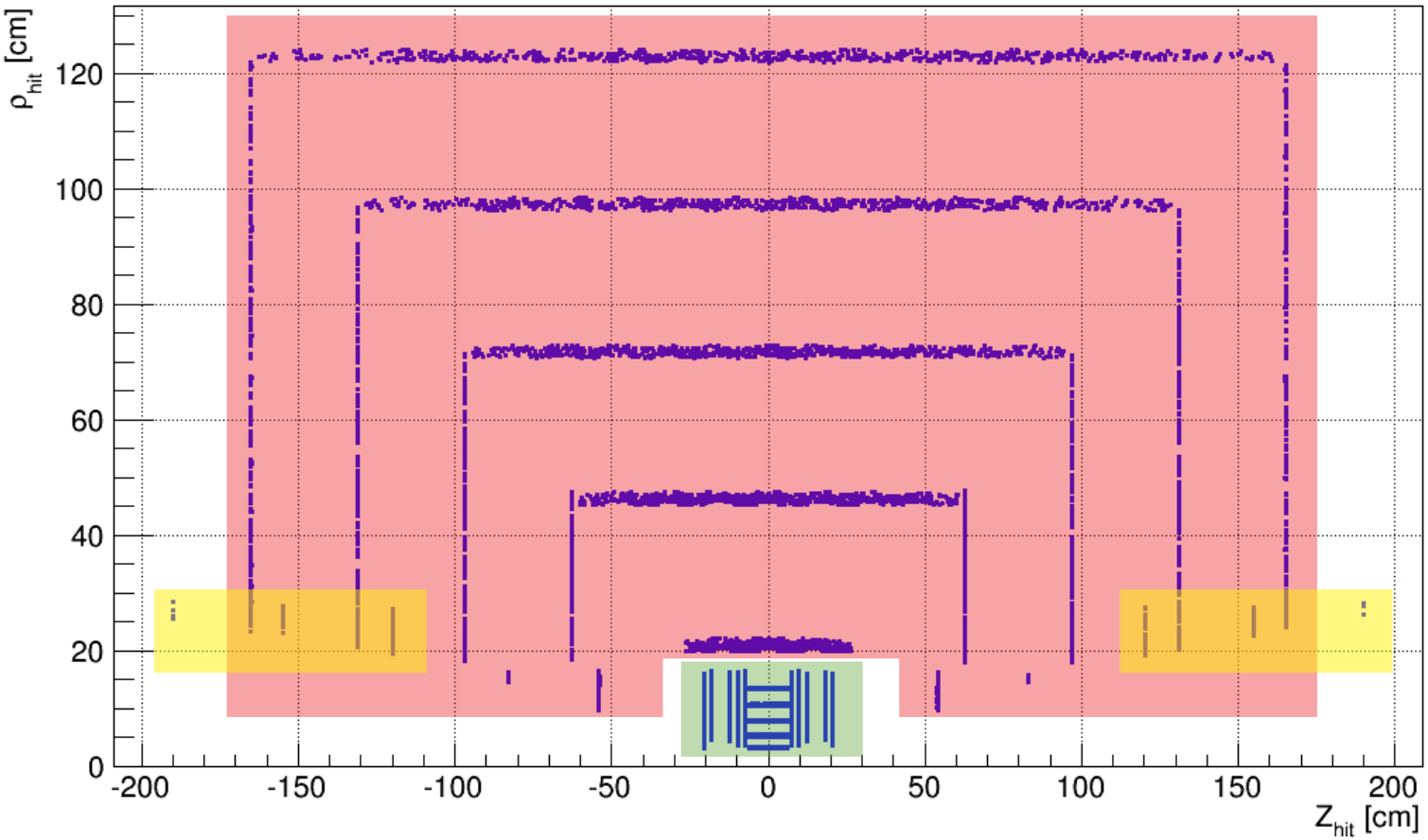
Introduction

- The MAP tracking detector and its performance have already been presented in:
  - N. Bartosik, "*Tracking performance studies*", Muon Collider Workshop, CERN, October 9-11, 2019 (link);
  - N. Bartosik *et al.*, "*Detector and Physics Performance at a Muon Collider*", arXiv:2001.04431, 2020 (link).
- This talk will focus on the process that led to those results and the lessons learned along the way.

Tracker overview



Vertex detector (VTD):

- 20x20 μm² pixels;
- 75/100 μm thick.

Silicon Tracker (SiT):

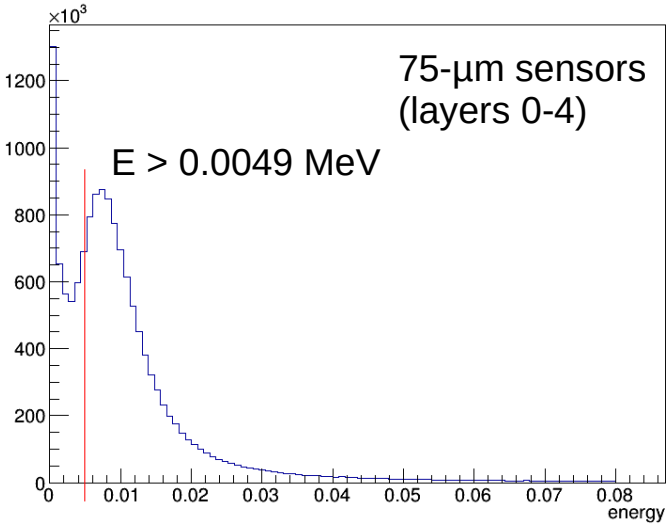
- 50x50 μm² pixels
- 200 μm thick

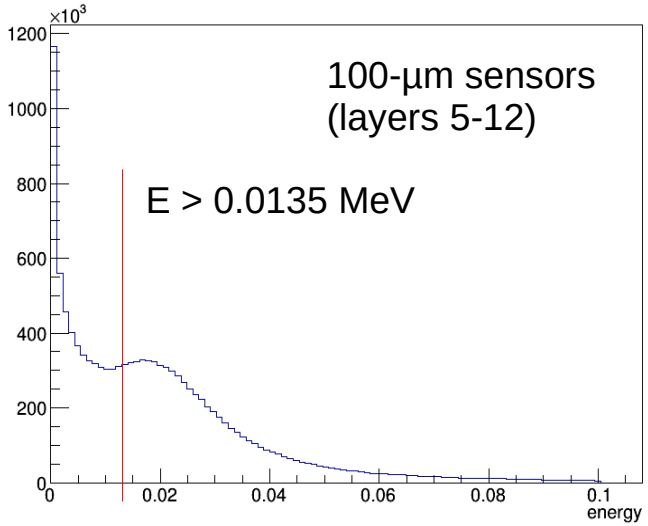
Forward Tracker Disks (FTD):

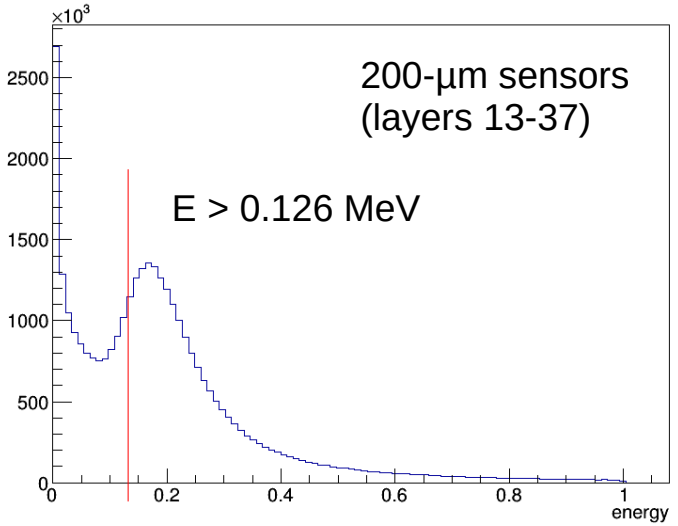
- 50x50 μm² pixels
- 200 μm thick

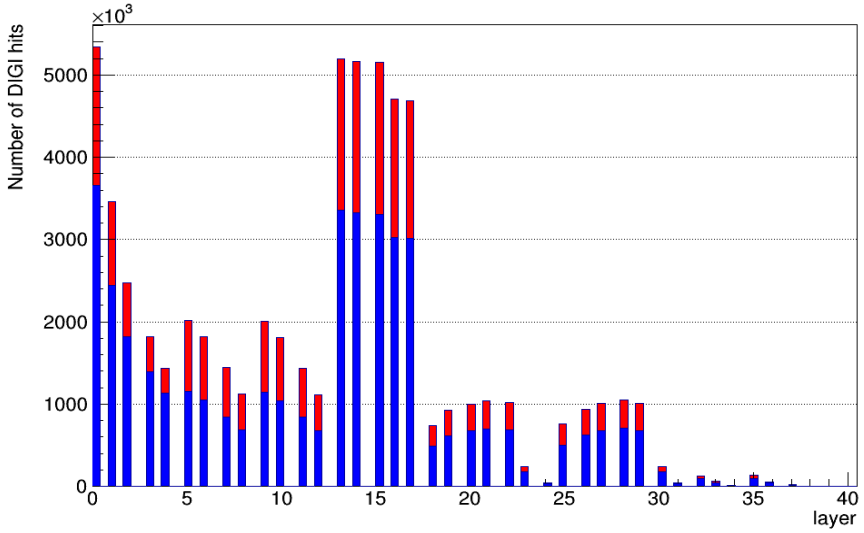
Cut on DIGI's amplitude

- 100K muon sample with $0.5 < p_T < 100$ GeV/c.





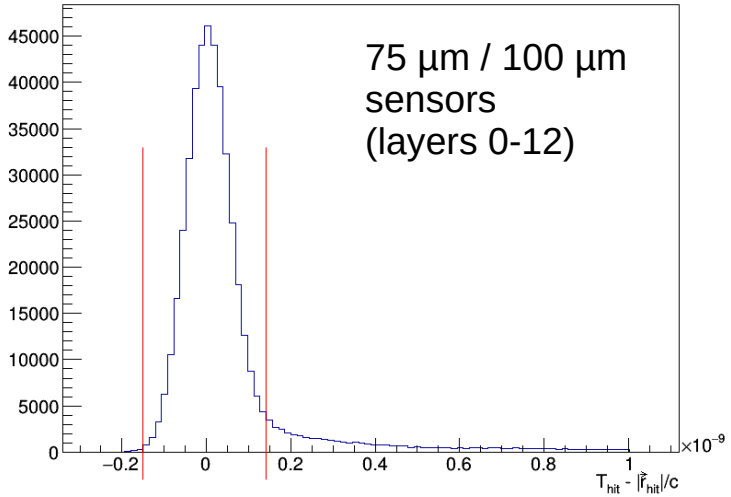




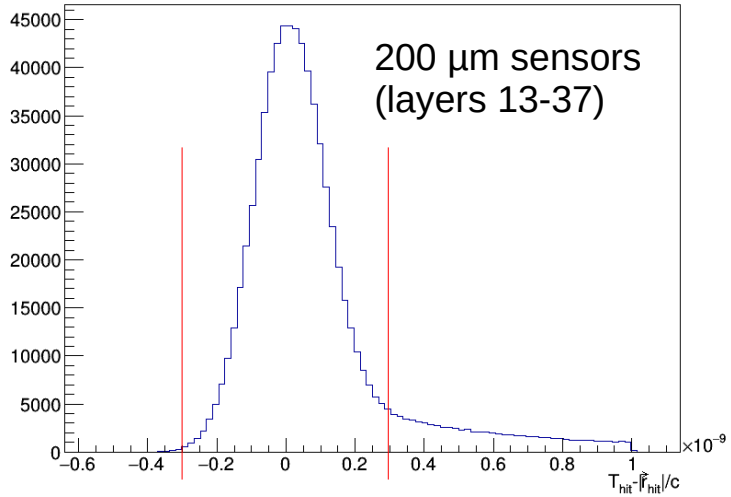
layers 0-4	⇒ VTD barrel
layers 5-12	⇒ VTD disks
layers 13-17	⇒ SiT barrel
layers 18-31	⇒ SiT disks
layers 32-37	⇒ FTD

Cut on hit's time (I)

- Assumed time resolutions (W. Riegler and G. Aglieri Rinella, 2017 JINST 12 P11017):
  - 50 ps for 75-μm and 100-μm thick sensors;
  - 100 ps for 200-μm thick sensors.
- Time window width tuned in a sample of 100K muons with $0.5 < p_T < 100$ GeV/c:



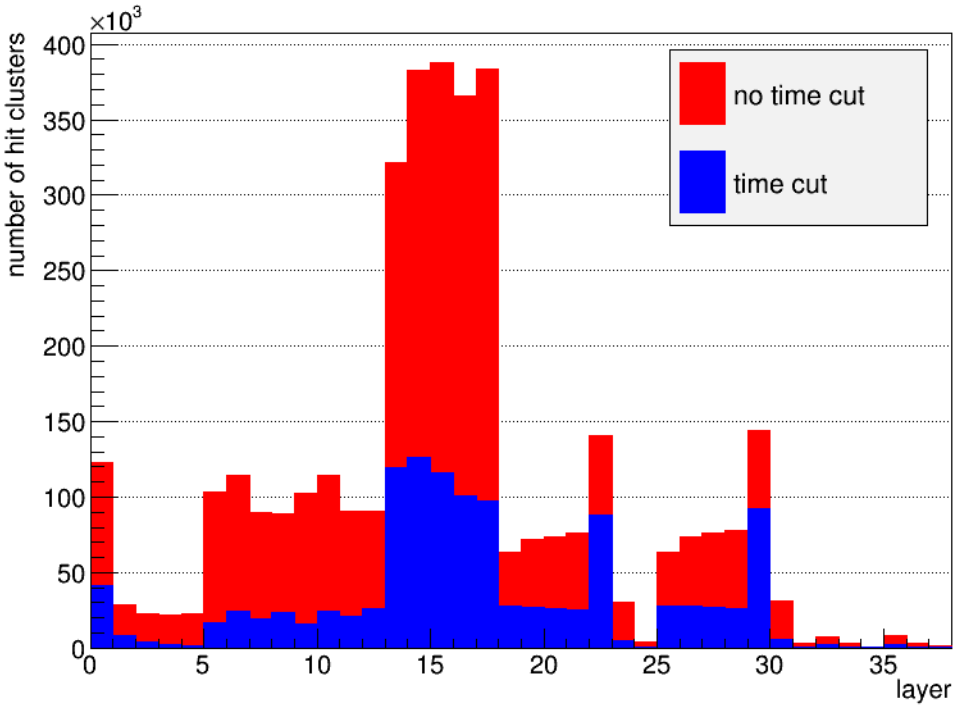
-3 σ +3 σ



-3 σ +3 σ

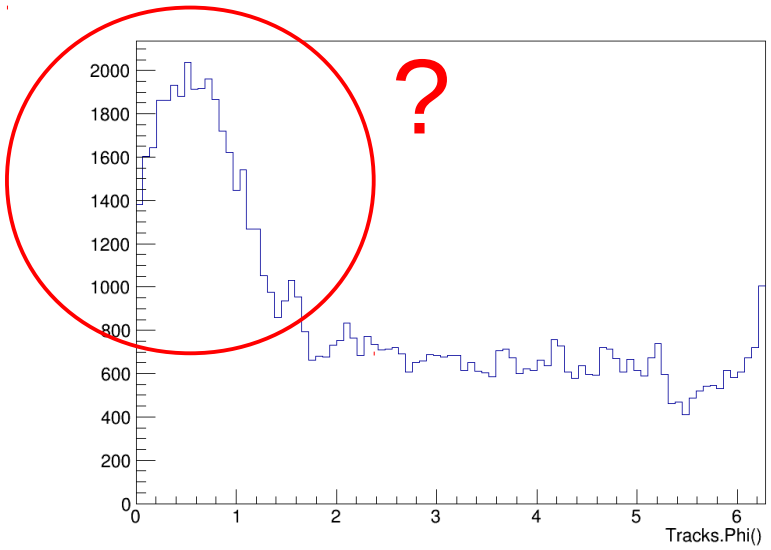
Cut on hit's time (II)

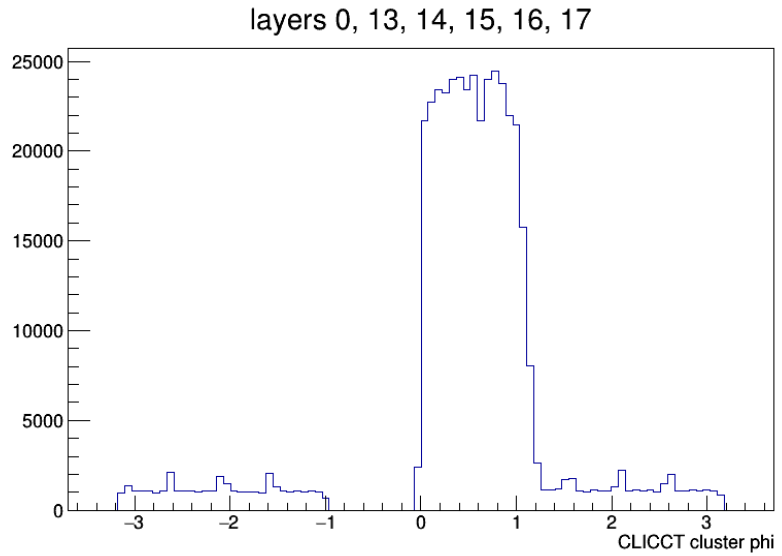
- Number of hit clusters per tracker layer:



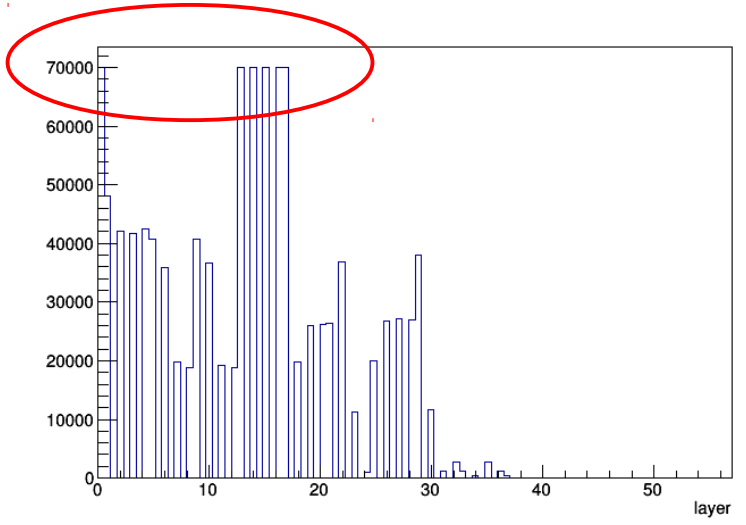
Nuisances on the way

- Some nuisances due to a detector not designed for a muon collider.





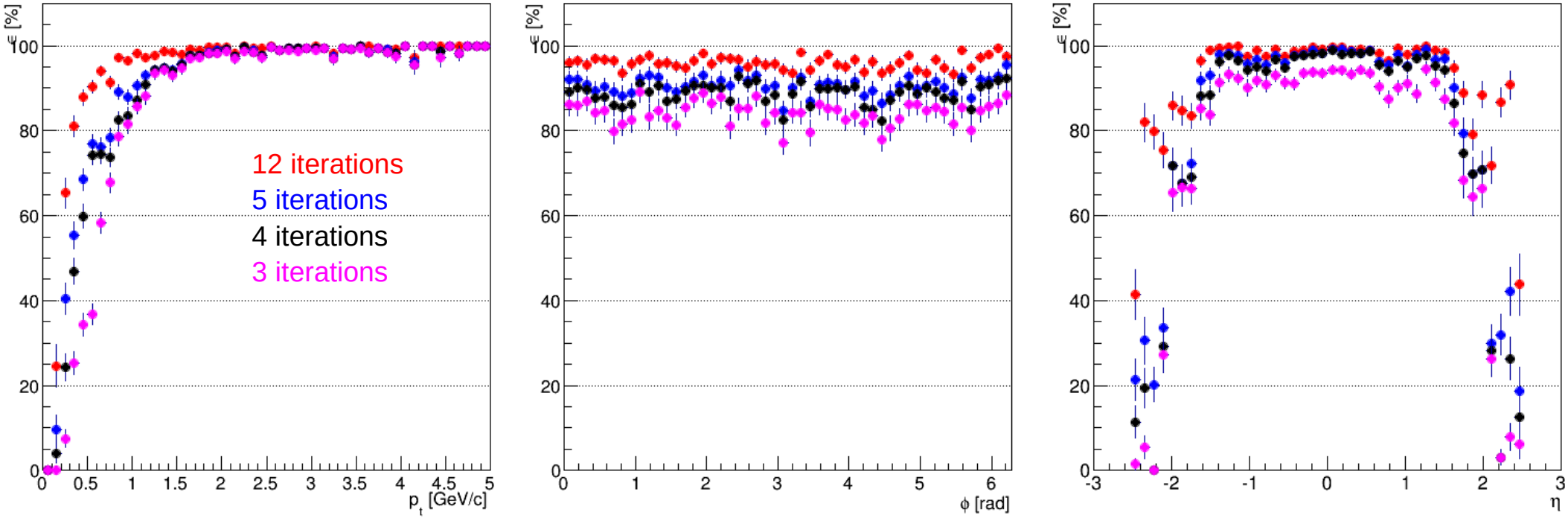

```
//namespace IlcCLICCTreco {
    const Int_t kMaxClusterPerLayer=7000*10;
    const Int_t kMaxClusterPerLayer5=7000*10*2/5;
    const Int_t kMaxClusterPerLayer10=7000*10*2/10;
    const Int_t kMaxClusterPerLayer20=7000*10*2/20;
    const Int_t kMaxDetectorPerLayer=1000;
```



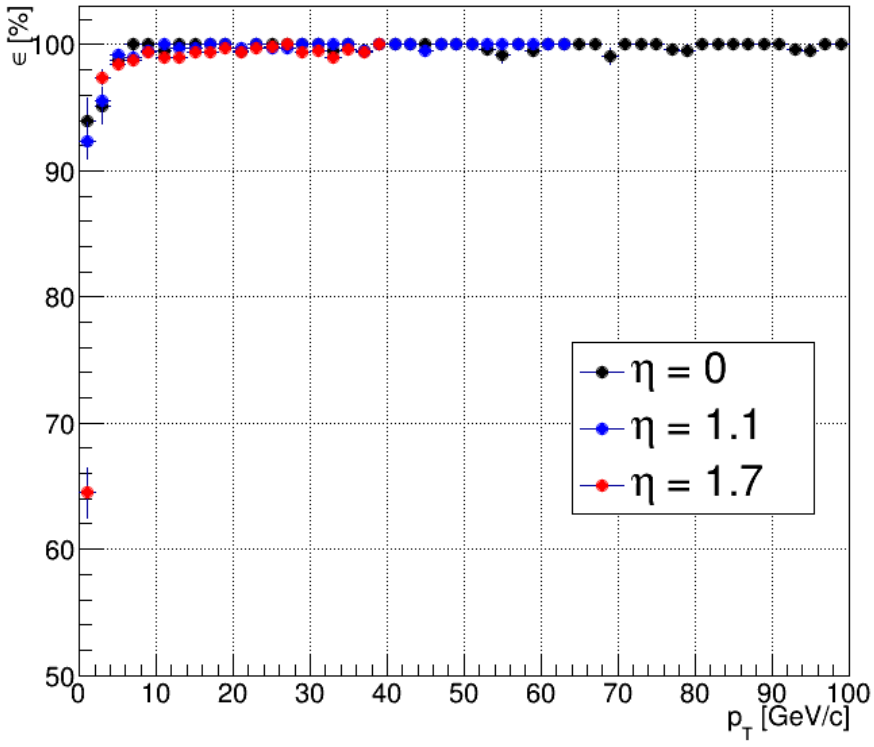
Tracking code

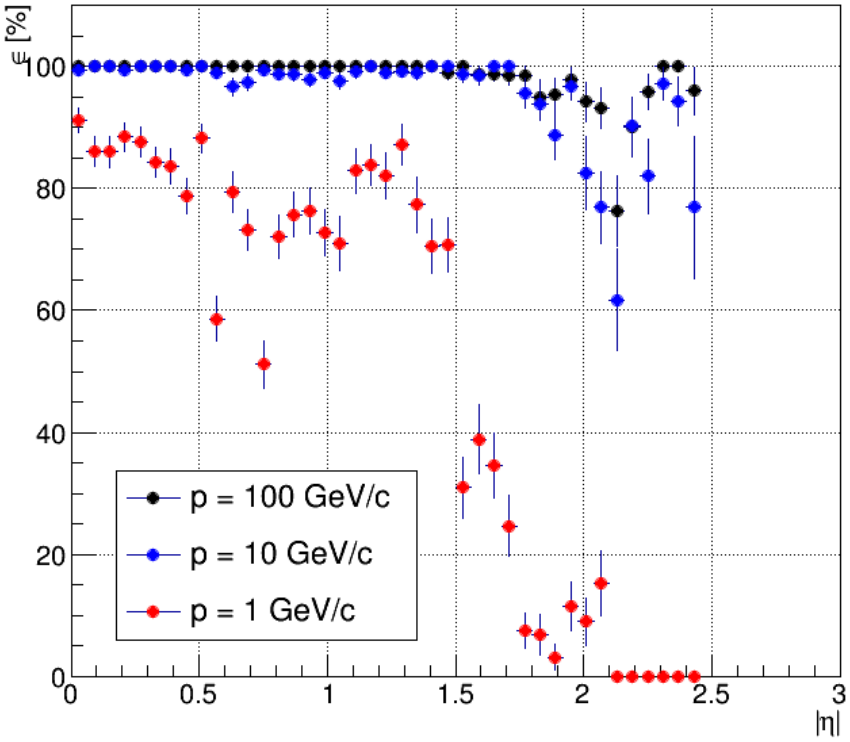
- 12-iteration tracking code not-optimal for a muon collider.

10K pions with $0.5 < p_T < 5$ GeV/c

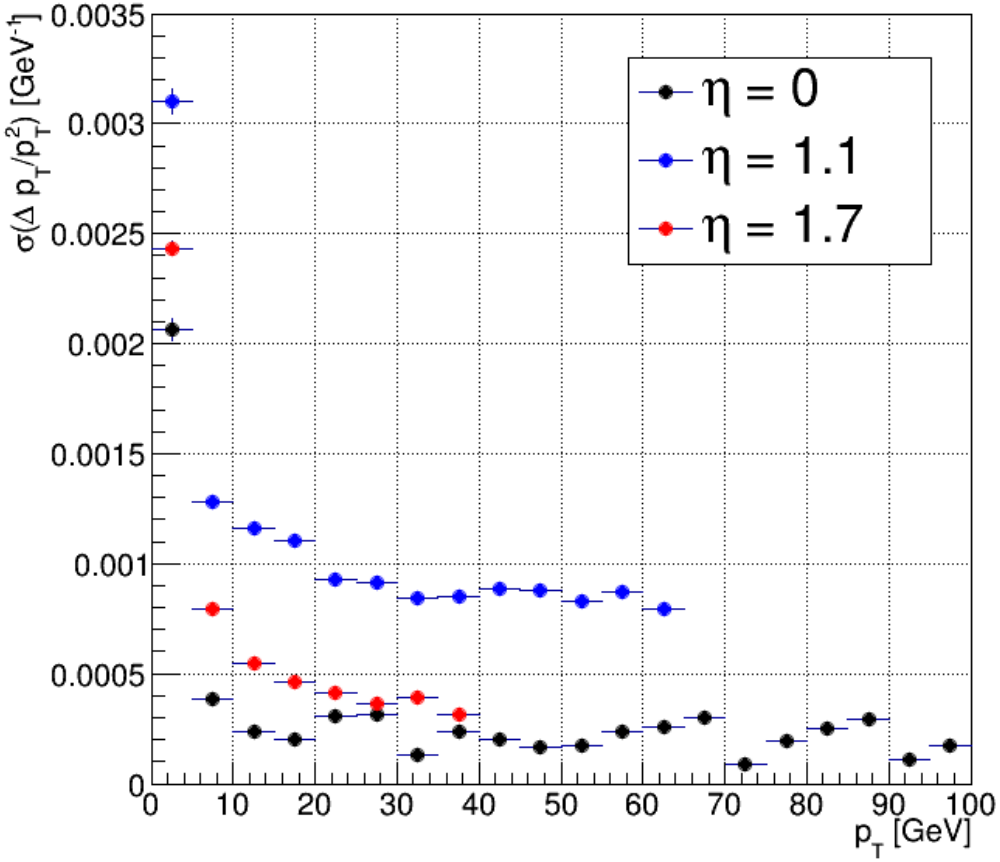


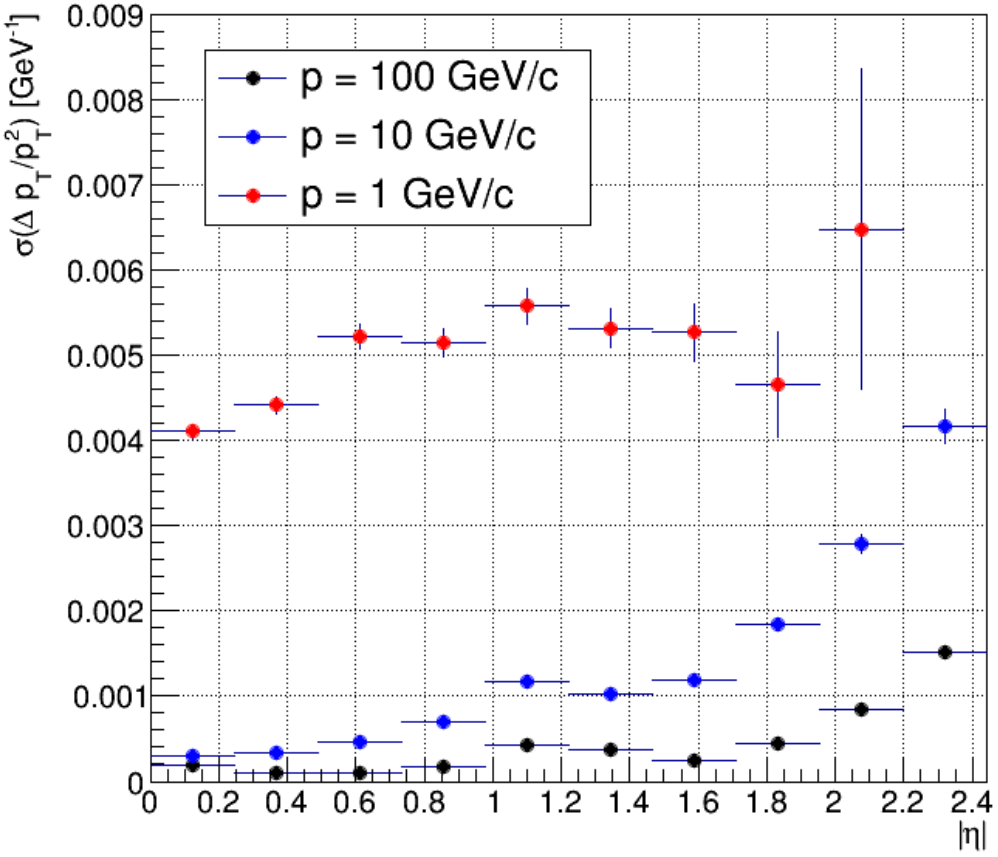
Tracking efficiency for $\mu^{\pm}$





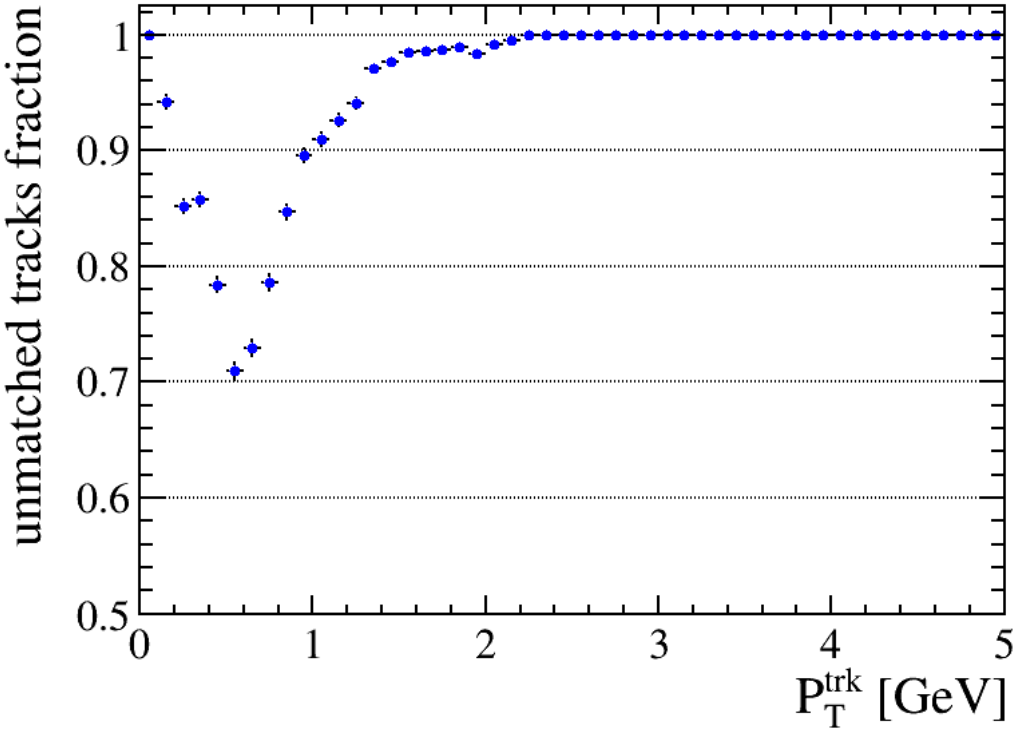
Track p_T resolution for $\mu^{\pm}$

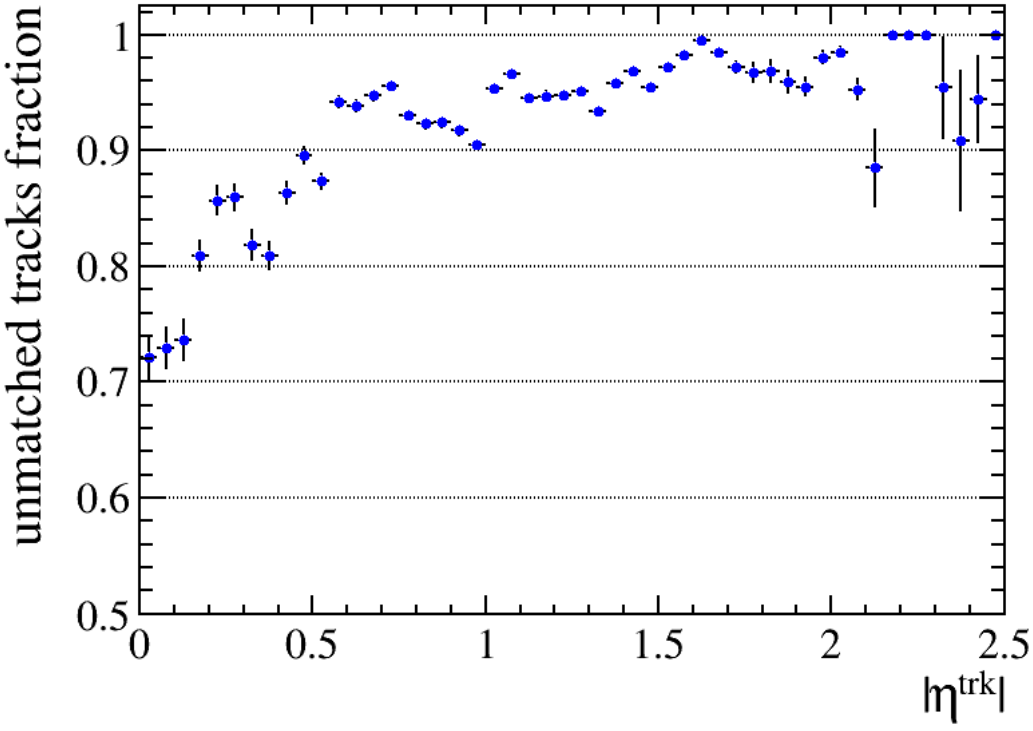




Beam-induced bkg tracks

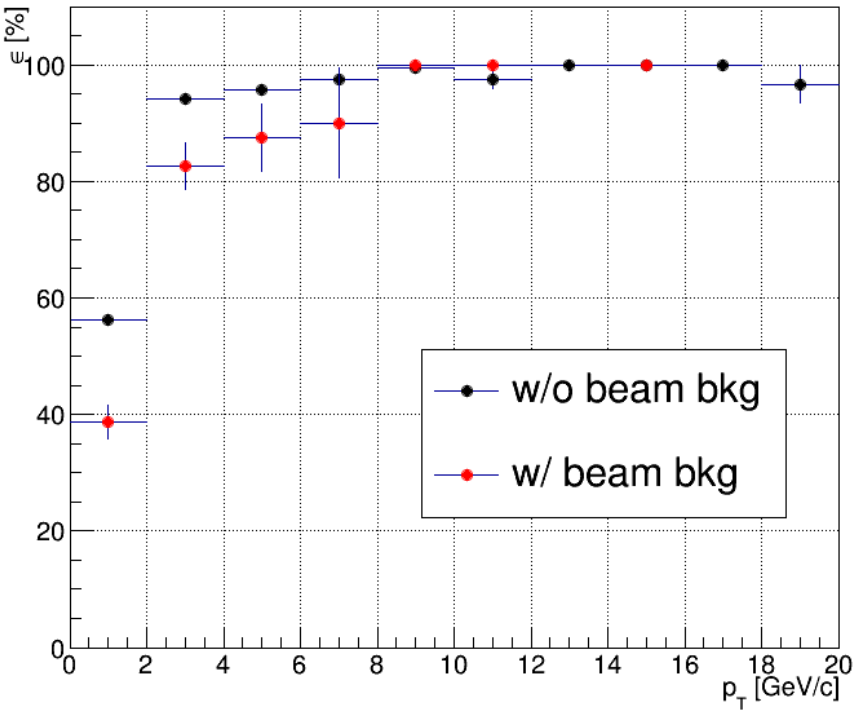
- Background generated particles propagated analytically to the IP and matched to reconstructed tracks in $\Delta\varphi$, $\Delta\vartheta$, $\Delta p_T/p_T$.

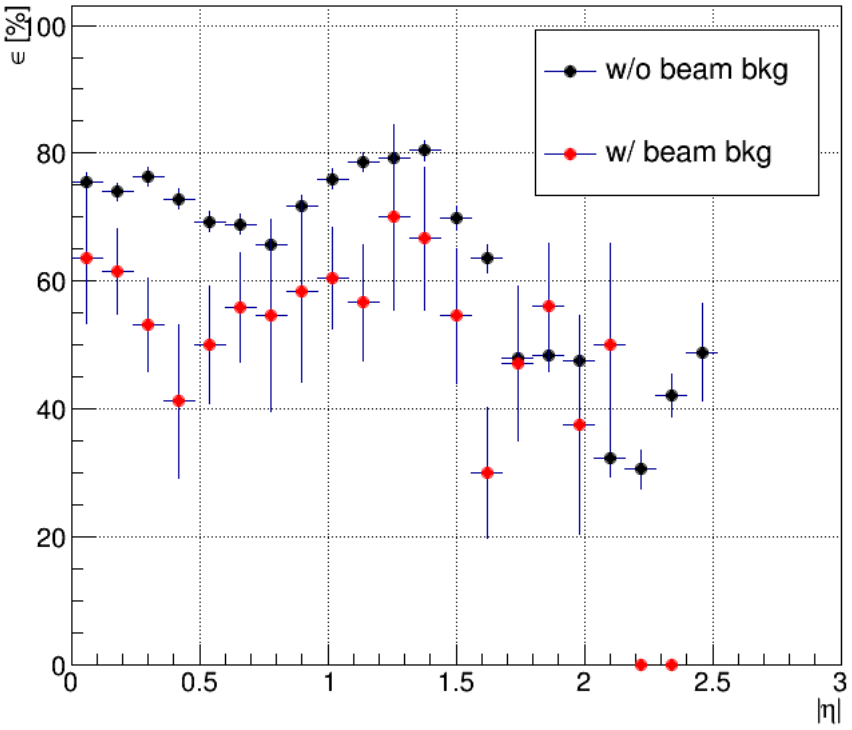




Tracking performance w/ bkg

- $\mu\mu \rightarrow H\nu\bar{\nu} \rightarrow b\bar{b}\nu\bar{\nu}$ events w/ and w/o beam-induced bkg:





Conclusions

- The MAP tracker is borrowed from one of the detector concepts developed for CLIC.
- It's basically a good detector with high granularity, high hit efficiency, high resolution on track parameters and good acceptance (modulo the shielding nozzles), but was conceived and designed for a conventional collider.