Updates on electron reconstruction

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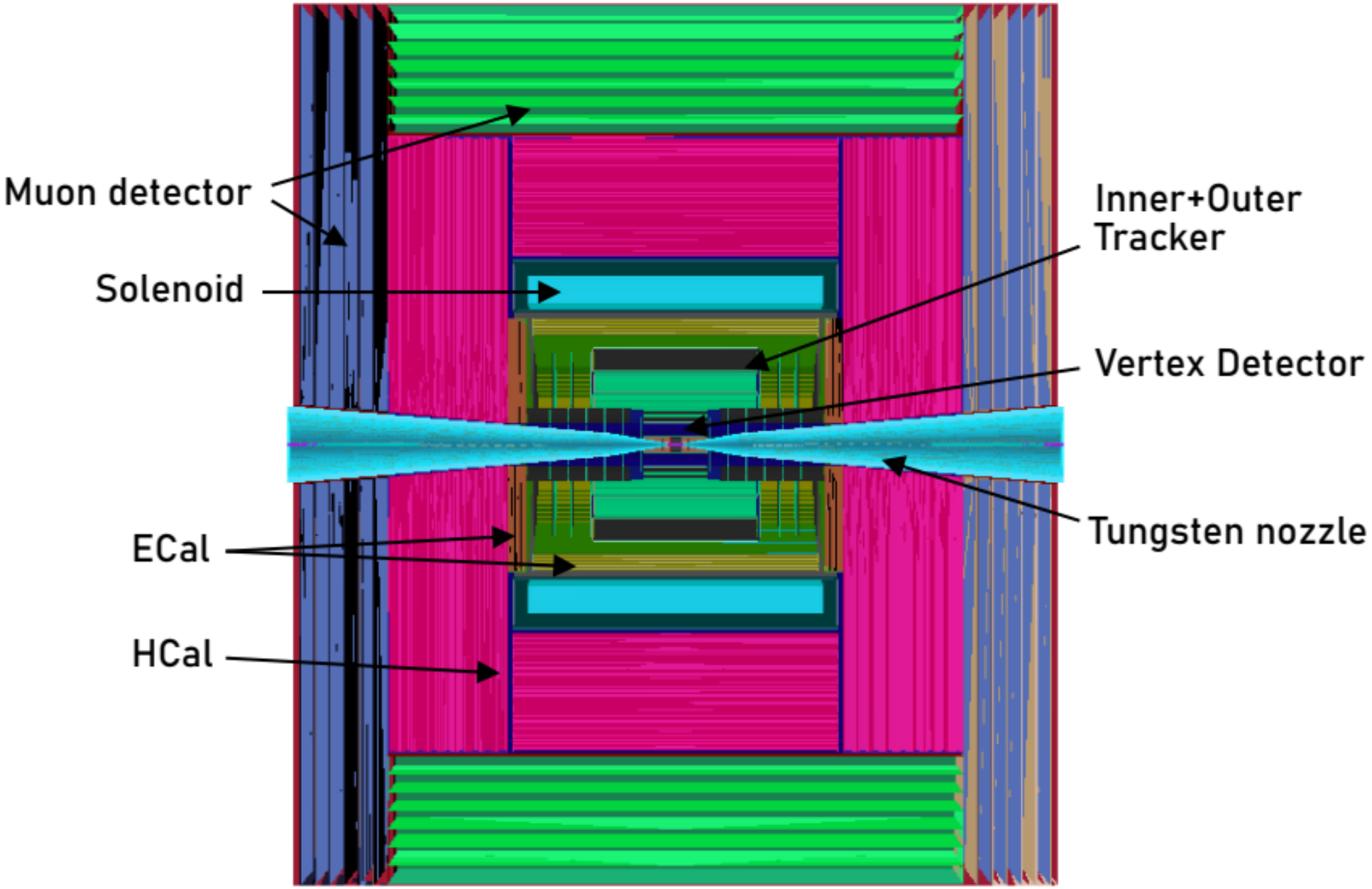
Outline

- Detector geometry updates
- Software updates
  - PandoraPFA
  - DDMarlinPandora digitizer
- First reconstructions with 10 TeV BIB

Hybrid geometry: MUSIC v0

- In view of the major updates for ESPP, make the detector geometry as close as possible as the design goal for the 10 TeV proposal.
- Since some updates are still in progress it is a “3/10 TeV hybrid”:
  - Old (MAP) tracking detectors
  - Updated CRILIN Ecal: 6 layers
  - Updated solenoid position: between Ecal and Hcal
  - Usual Hcal
  - Usual Muon detectors
  - **Old nozzle design**


Muon detector
Solenoid
ECal
HCal
Inner+Outer Tracker
Vertex Detector
Tungsten nozzle

Software updates: PandoraPFA refinements

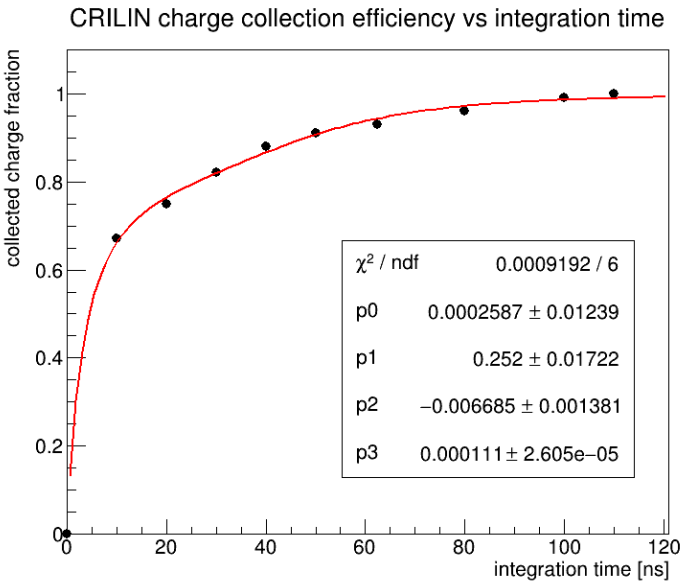
- Last PandoraPFA minor changes:
  - Possibility to set different PID cuts for different energies and polar directions for max flexibility
  - Possibility to set an input momentum threshold for tracks: especially when performing isolated leptons studies, it allows to further exclude BIB tracks before they are used for cluster seeding → less fakes, shorter execution times.

No major performance increase without BIB, electron PID efficiency was already >90% after last update.

Re-optimization needed when adding BIB.

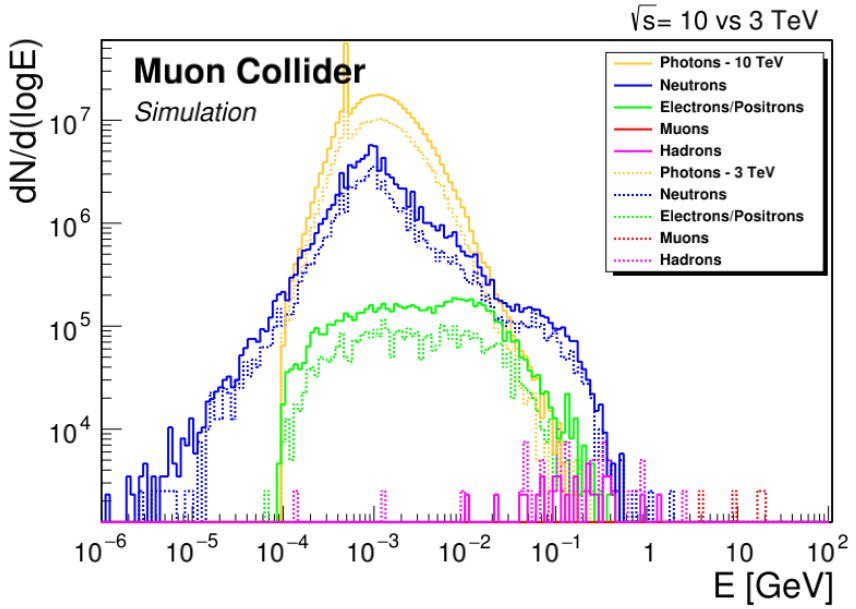
Software updates: digitizer modifications

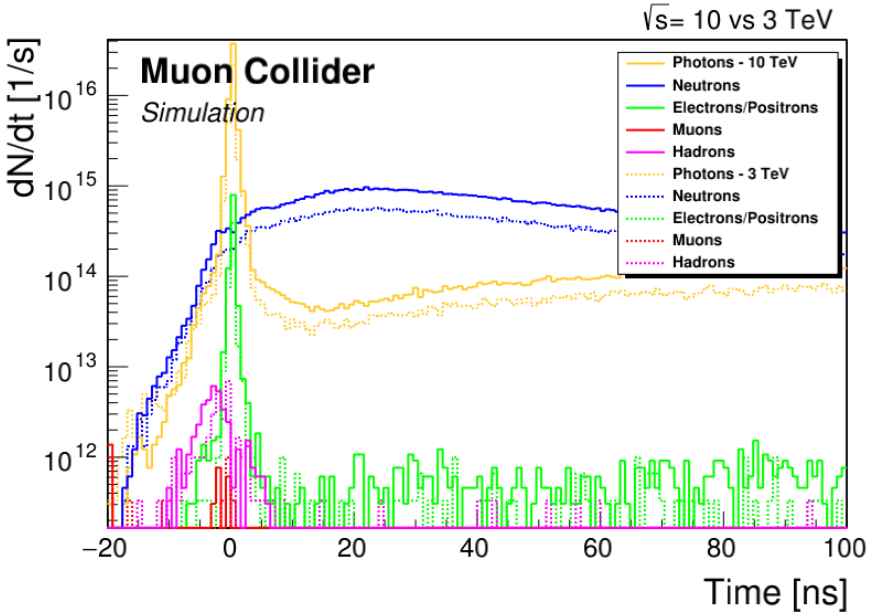
- DDCaloDigi_BIB from /DDMarlinPandora
  - To exploit CRILIN timing, original DDCaloDigi_BIB is not enough
  - Already an unofficial “Calo_Crilin” version around (L. Sestini)
  - Only for barrel
- New version:
  - More realistic charge integration efficiency: polynomial function reproducing testbeam-sampled signal efficiency
  - Added 6-layered barrel+endcap
  - Configurable time-energy cuts for each layer and arbitrary Ecal region, as suggested by 1.5 TeV BIB studies (C. Giraldin).



First studies with BIB overlay

- First reconstructions with 10 TeV BIB
  - Old nozzles → old BIB
  - Expected worse than updated nozzle design (D. Calzolari)
- Realistic overlay: [-1, 25] ns == 80% charge integration efficiency
- Quite long execution time → now low statistics test runs (1/10)
- Indicatively x2 total raw hits (10M barrel+endcap) wrt 1.5 TeV



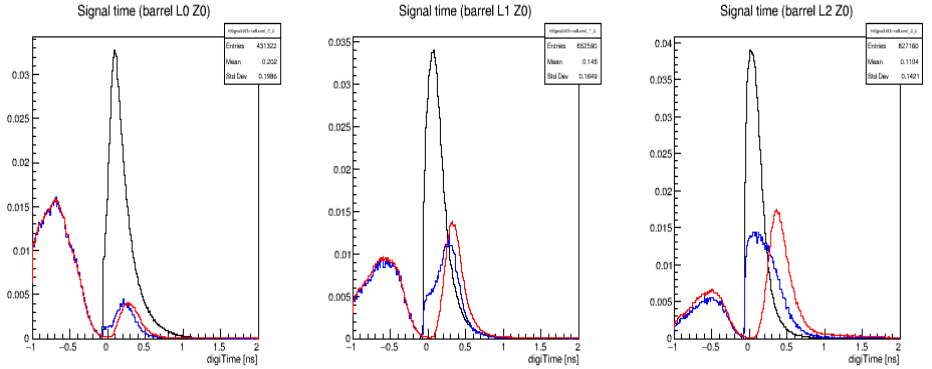


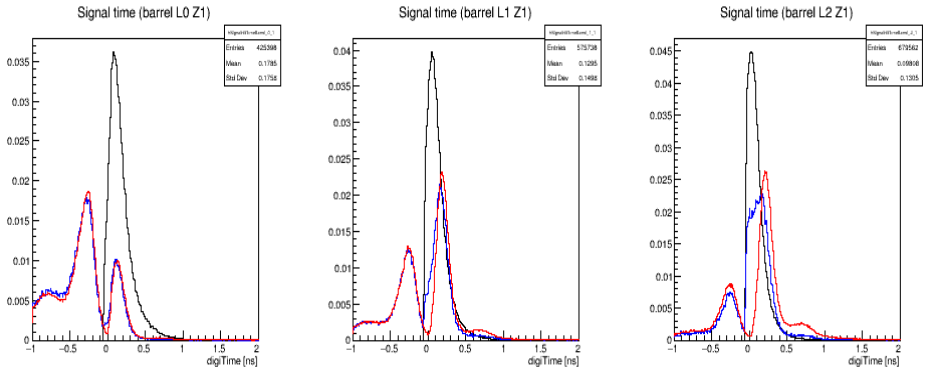
From *Towards Muon Collider*

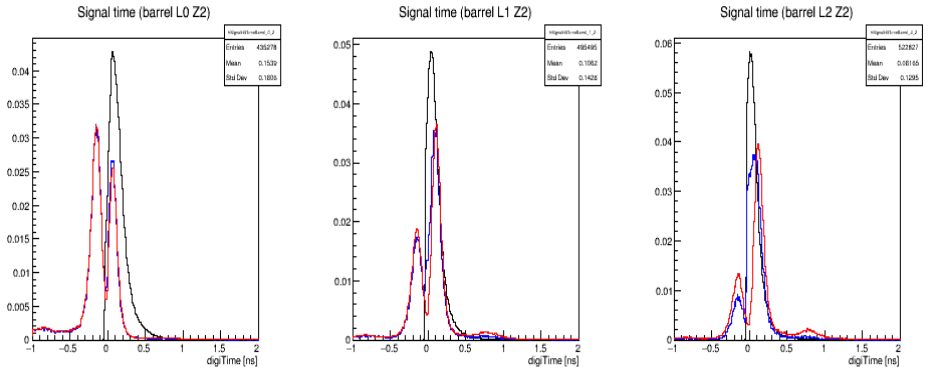
10 TeV BIB: time-energy cuts with CRILIN

- CRILIN allows strong BIB rejection using its <100ps timing
- Very different time spectra in different regions
  - BIB can be a late component (barrel) or an early one (endcap)
  - Energy spectra vary within the different regions
- Our division:
  - Barrel: 3 z-zones per side, of equal size
  - Endcap: 3 radial zones, of equal “thickness”
- Resolution study as soon as high statistics samples are ready

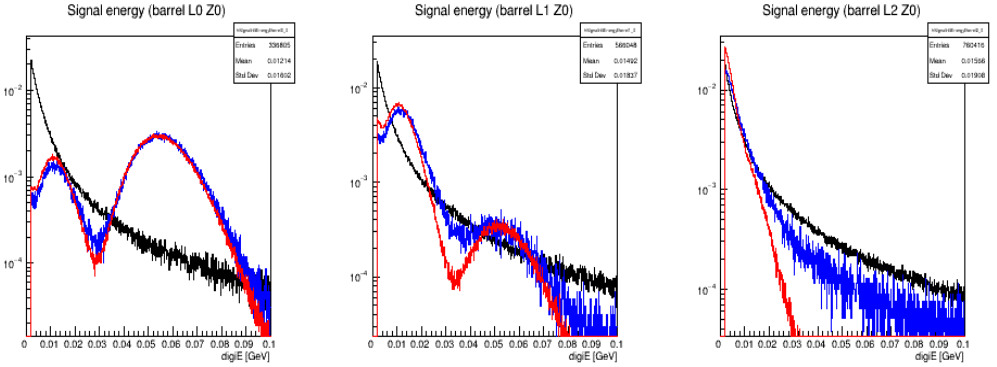
Time barrel (first 3 layers x 3 zones)

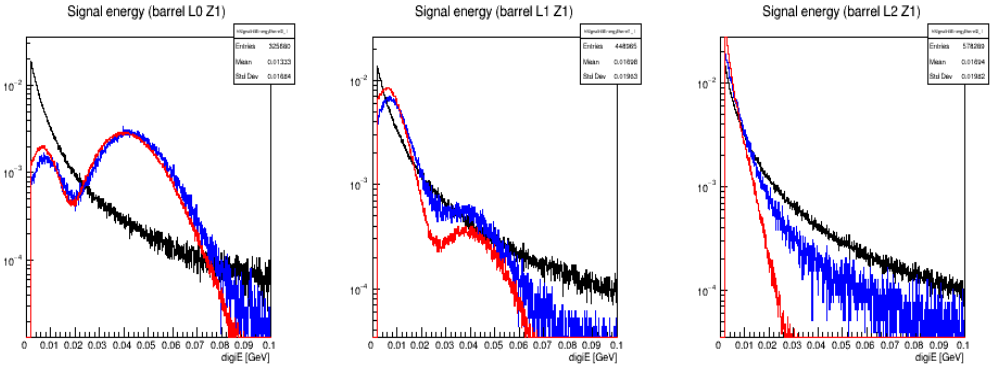


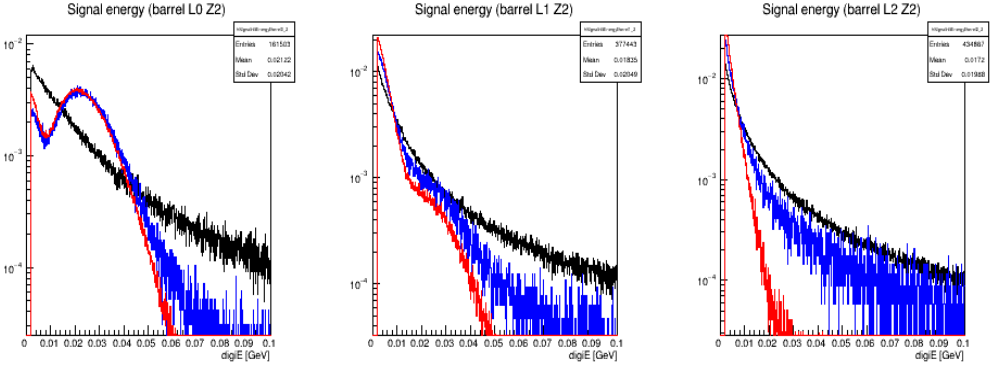




Energy barrel (same)



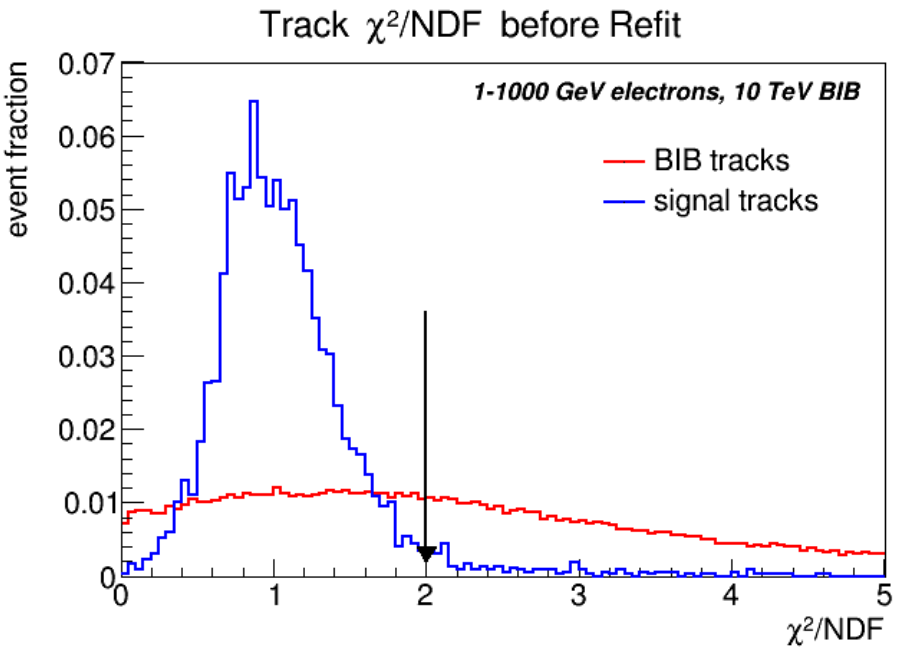


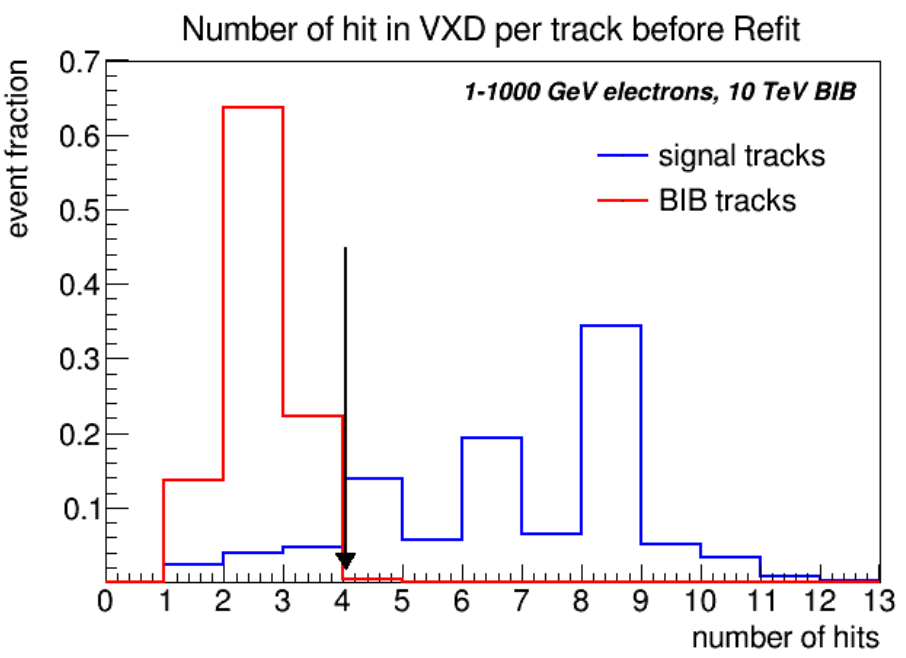


SIGNAL **BIB** **SIGNAL+BIB**

10 TeV BIB: track refit cuts

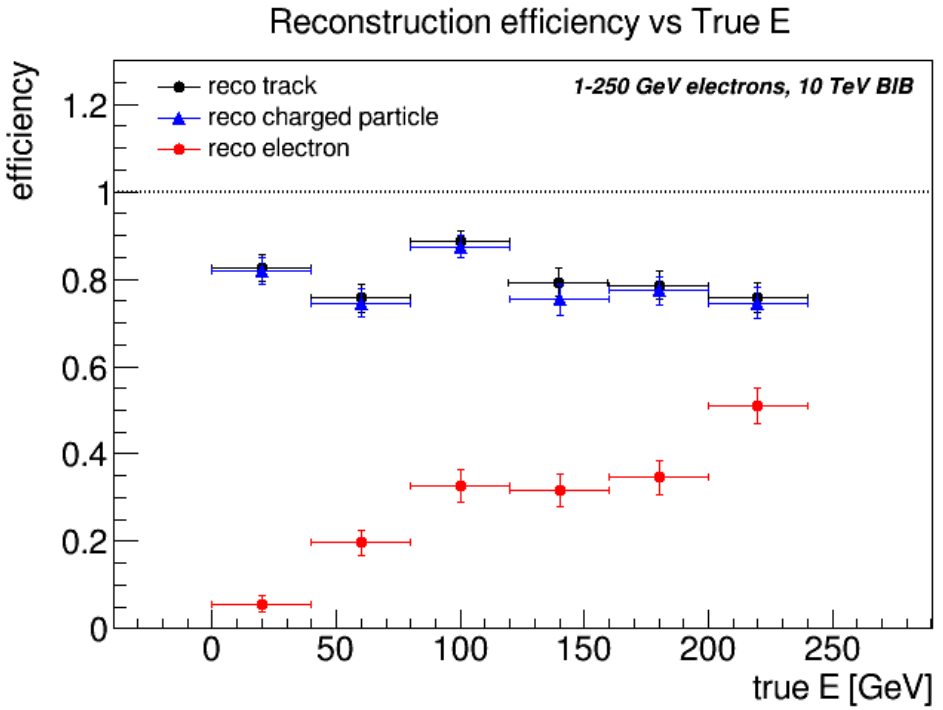
- The “Refit” processor allows some simple quality cuts before track refitting (L. Buonincontri), like:
  - Number of hits in arbitrary detector subsets
  - Track χ^2/NDF
- Chosen: VXD(barrel+endcap) hits > 3, χ^2/NDF < 2
  - In this way: > 100k → < 200 BIB tracks, 80% signal efficiency

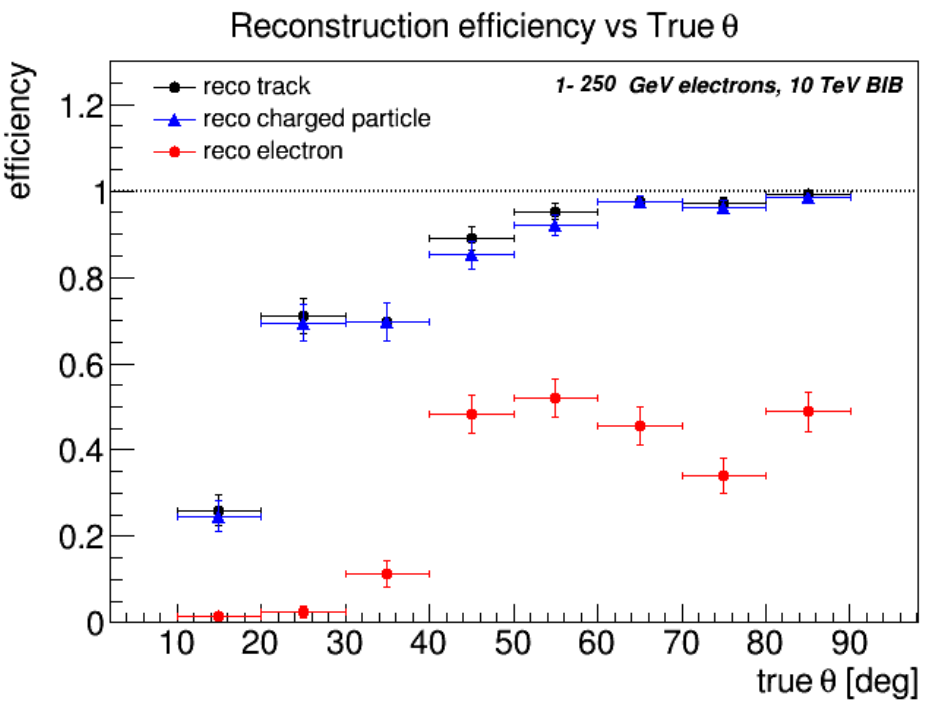




10 TeV BIB: preliminary efficiencies

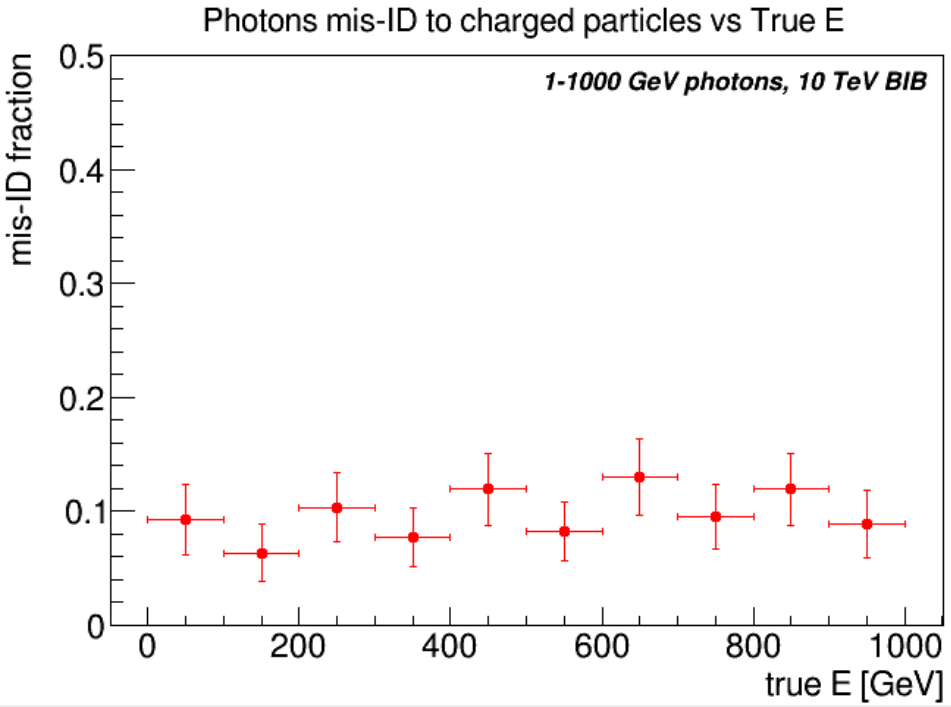
- Compare efficiencies, asking for a track, a charged particle (PFO with track+cluster) or an electron (correctly-IDed charged particle) in the proximity (R=0.05) from an MCParticle.
- Tracking efficiency as expected, usual forward issue from old tracker and ACTS configuration.
- Charged PFO reconstruction has efficiency ~ 1.
- Electron PID loses everything → needs re-tune of parameters

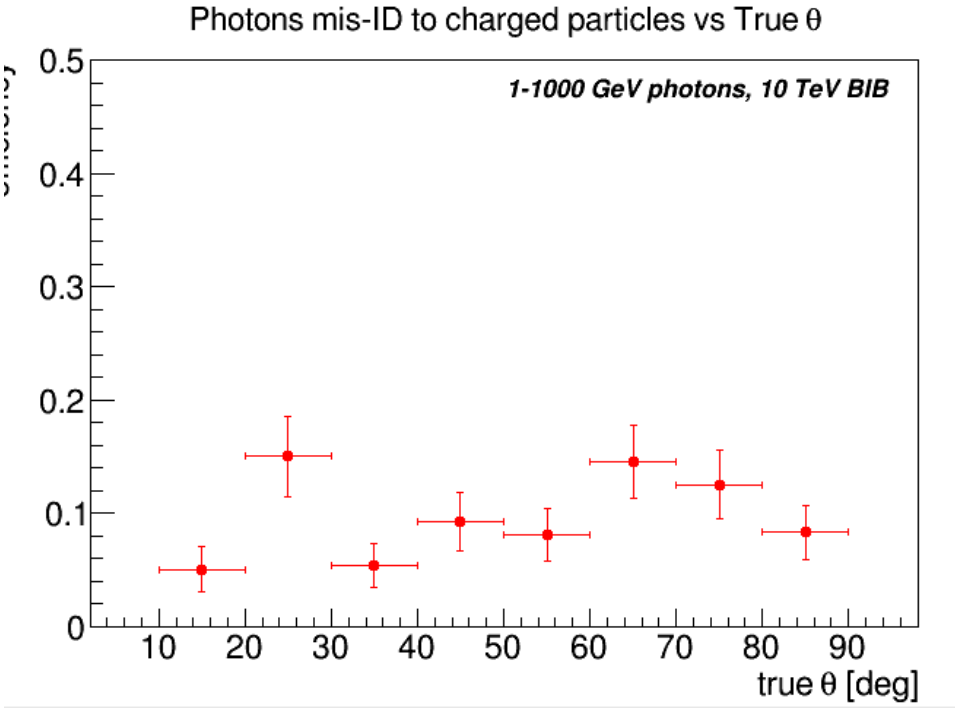




10 TeV BIB: preliminary fake rate from photons

- In view of the h→4e study, some studies on fake reco electrons are useful to make informed assumptions on some reducible backgrounds:
  - With ~200 BIB tracks, a photon cluster may be wrongly associated to a track → check with 1-1000 GeV photons
  - Even with lower momentum threshold than actual physics study, fake rate is < 10% → high multiplicity photon bkgs can be excluded





Conclusions and next steps

- First steps towards full 10 TeV design studies
- Software is ready for full CRILIN exploitation
- Usual limits of old tracker + ACTS
  - Excellent in central region → ok for high energy BSM searches
  - Insufficient in forward region → at 10 TeV all SM VV processes are forward-boosted
- Next: re-tune of electron PID parameters to re-gain efficiency
- Next: increase statistics → energy resolution study
- Suggestions are welcome, thank you!