Notes and updates on tracking

Federico Meloni (DESY)

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Motivation

Triggered by <u>Mark's talk</u> at our meeting and the discussion that followed, I had a look at the RefitFinal processor (and in general the tracking workflow outside of ACTS).

- Update of ACTS to fix seeding considered outside of scope of paper

Findings:

- In RefFinal
    - Max_Chi2_Incr   argument ignored
    - _ReducedChi2Cut   argument ignored
    - Suspicious re-initialisation of fit (<u>L157</u>) and finalisation of LCIO track with older interface
    - Number of fit outliers only available here

- In TrackSelector
    - Refit Tracks lose track of holes, so can't cut on these if not right out of actstracking
    - Unsure if number of hits per subsystem properly counted

MarlinTrkProcessors 2.18.2

Updated the processor to take care of all points on previous slide
https://github.com/MuonColliderSoft/MarlinTrkProcessors/tree/v02-18-02-MC

- Exception: propagation of the number of holes and fit outliers
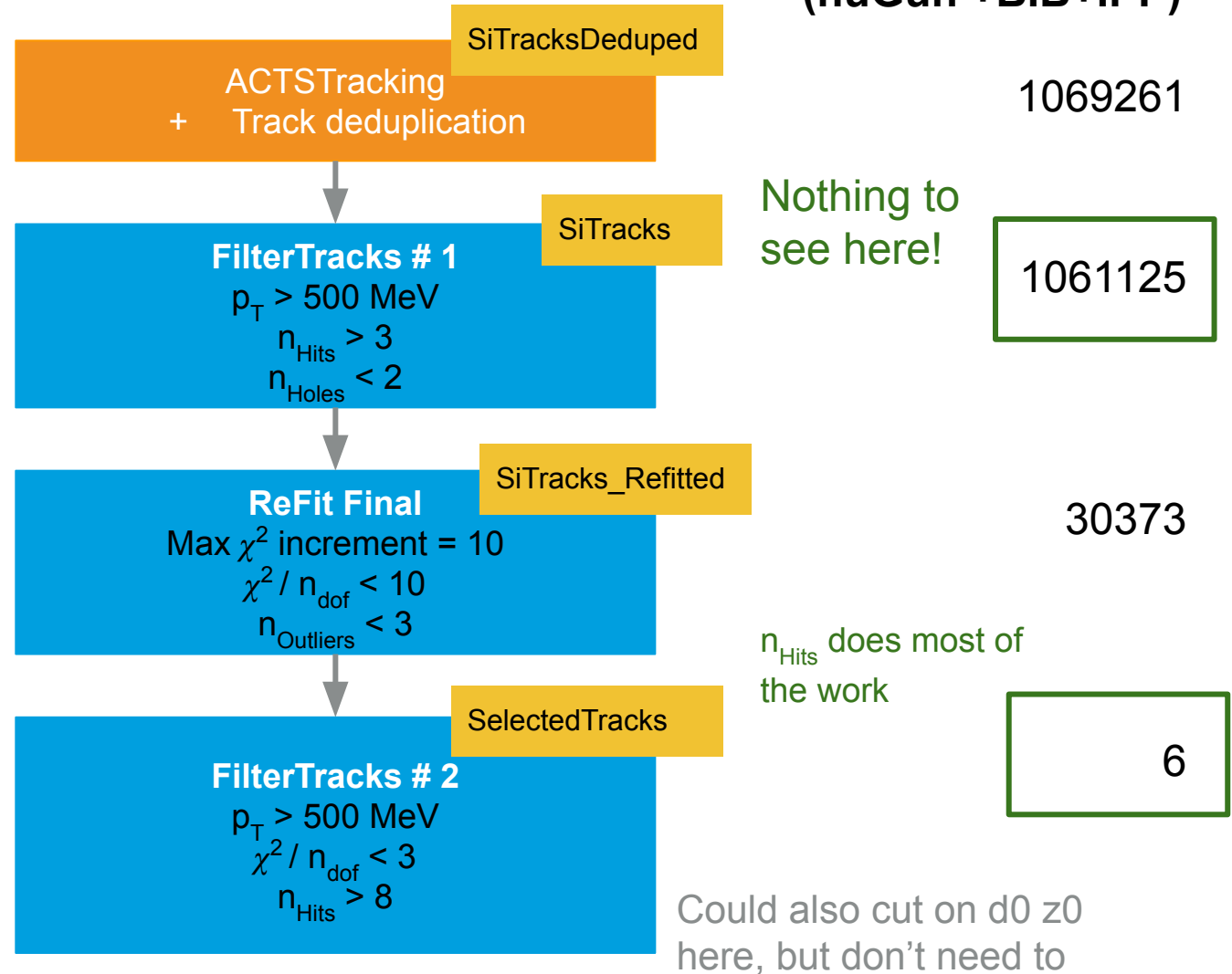 (would require major re-architecting of EDM and processors)

Furthermore:

- RefitFinal

  - allows to add a cut on the maximum number of outliers in a track fit

- TrackSelector

  - Added option to cut on maximum d0
  - Added option to cut on maximum z0
  - Fixed implementation of chi2 cut, cuts implemented as > instead of >=

# A (somewhat) convoluted workflow

Jumping through some hoops to use information where it is available

**CUTFLOW
(nuGun +BIB+IPP)**

SiTracksDeduped

**ACTSTracking
+   Track deduplication**

1069261

SiTracks

Nothing to see here!

FilterTracks # 1
$p_T > 500$ MeV
$n_{Hits} > 3$
$n_{Holes} < 2$

1061125

SiTracks_Refitted

ReFit Final
Max χ^2 increment = 10
$\chi^2 / n_{dof} < 10$
$n_{Outliers} < 3$

30373

n_{Hits} does most of the work

SelectedTracks

FilterTracks # 2
$p_T > 500$ MeV
$\chi^2 / n_{dof} < 3$
$n_{Hits} > 8$

6

Could also cut on d0 z0 here, but don't need to

# Tracks after deduplication

Distributions don't seem to justify
a 50% efficiency of
FilterTracks#1 on BIB
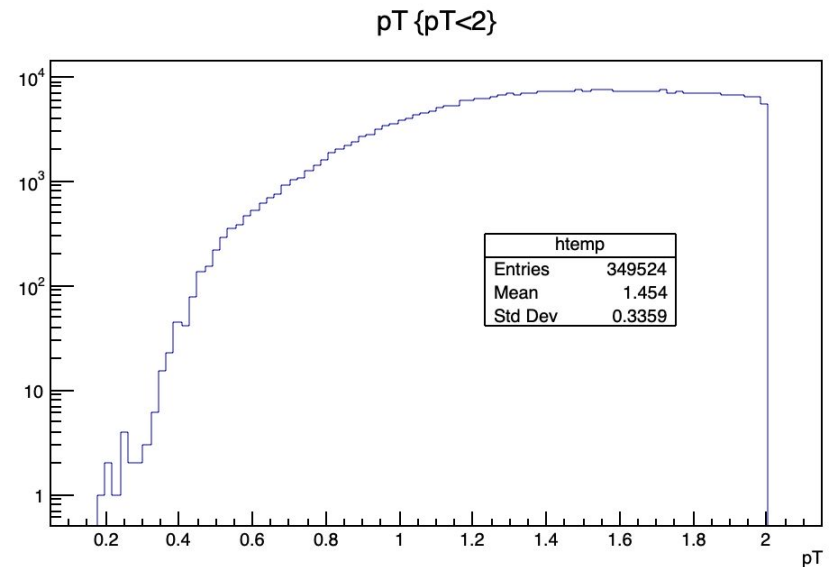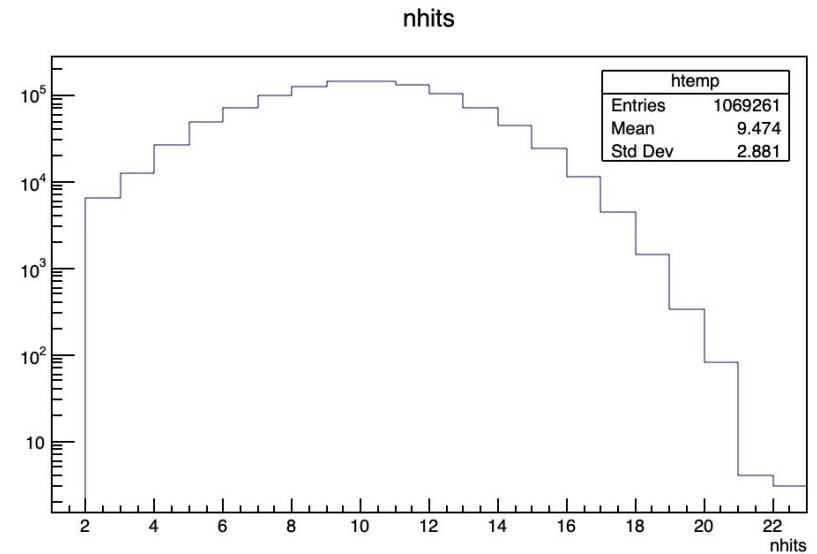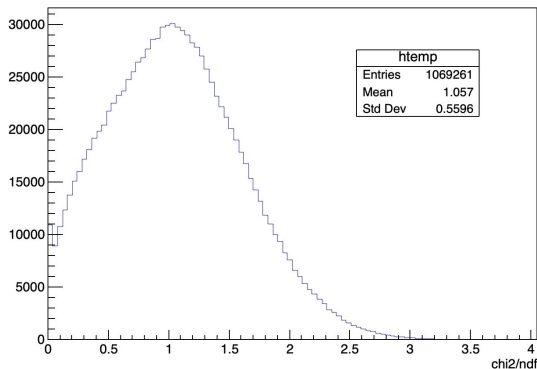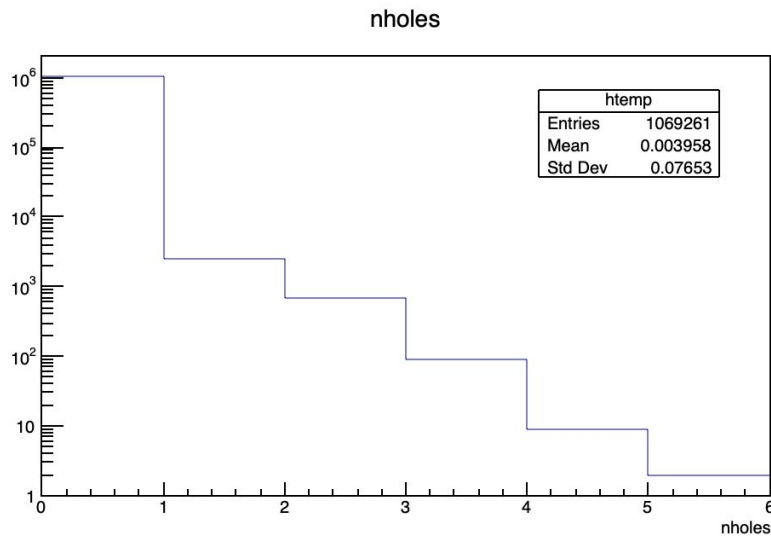
Tracks after RefitFinal

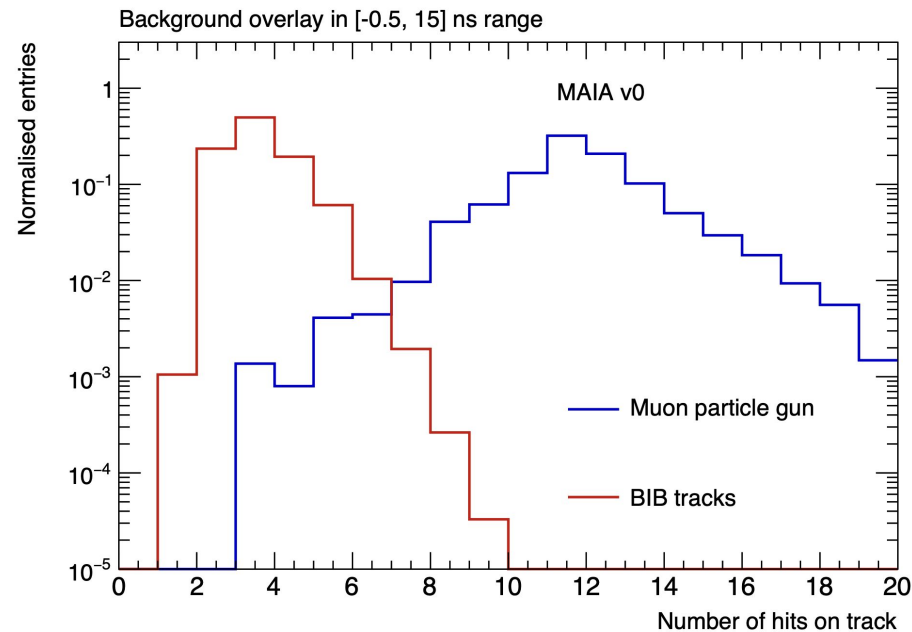Nhits on track and χ^2 / n_{dof} are the quantities that changes the most
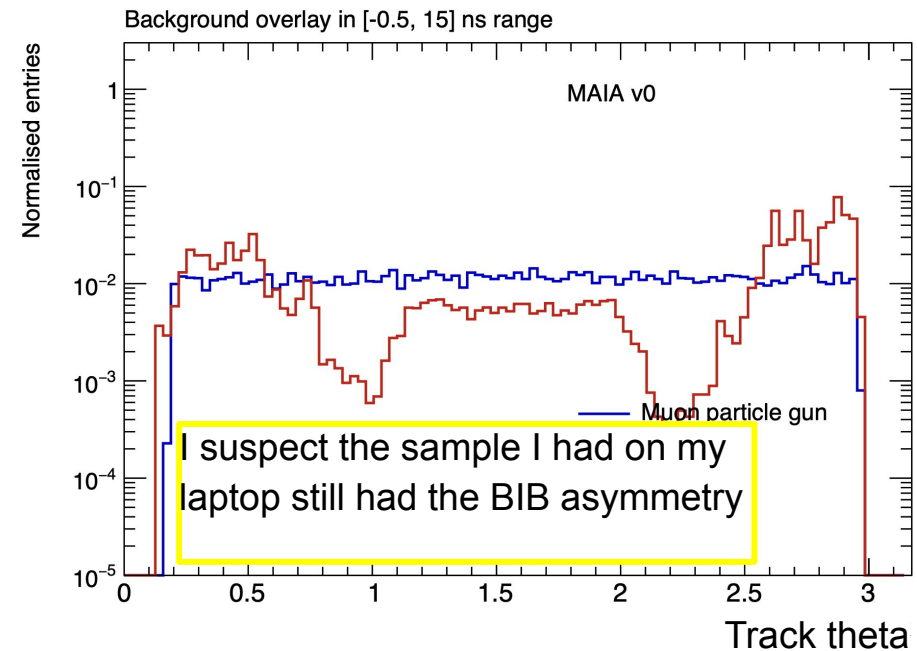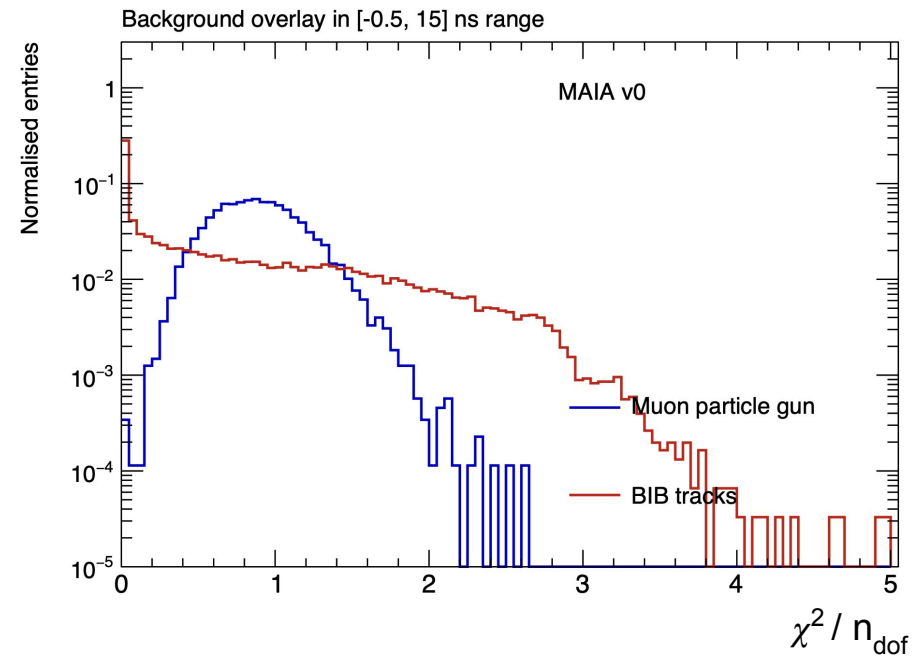
- ACTS fitter and MarlinTrkFitter use different spacepoint uncertainties
  - MarlinTrk gets it from dd4hep
  - ACTS ??
  - Which one is more correct - unclear
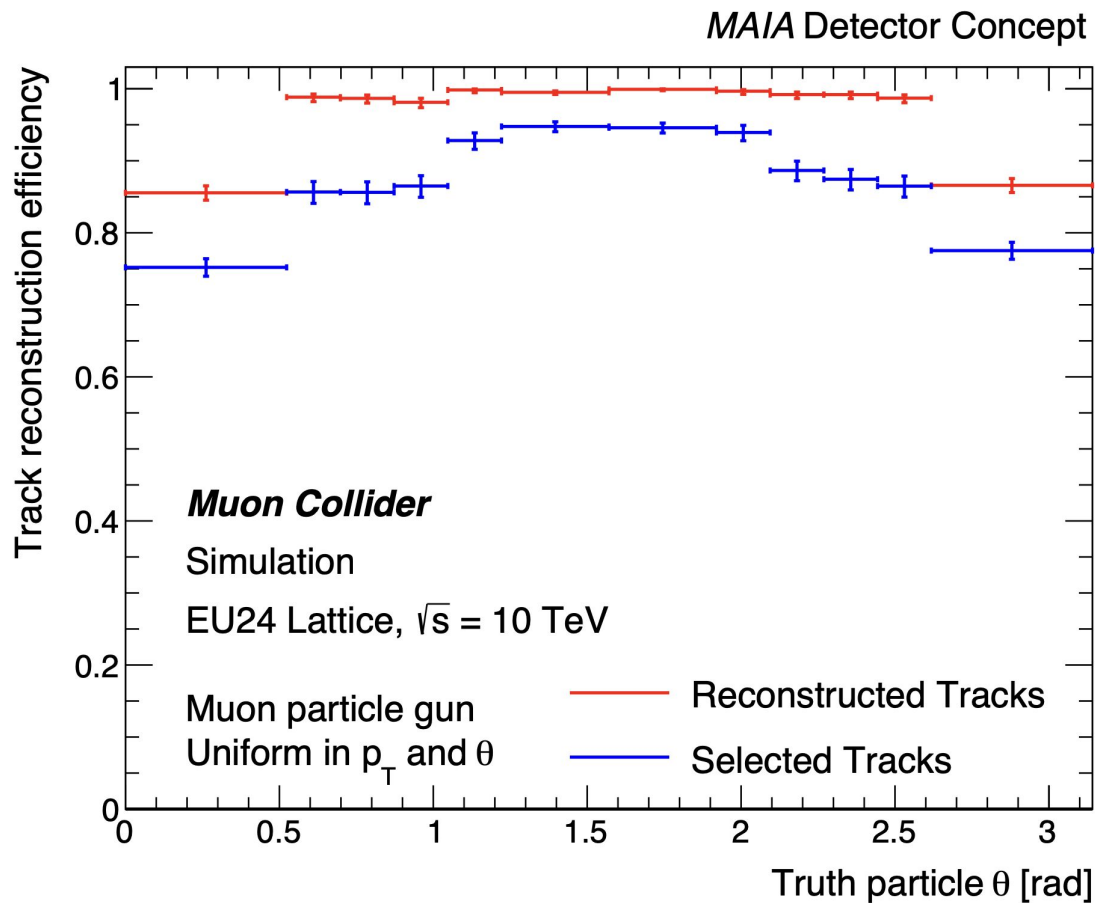- (Guess) max χ^2 cut has large effect on what is included
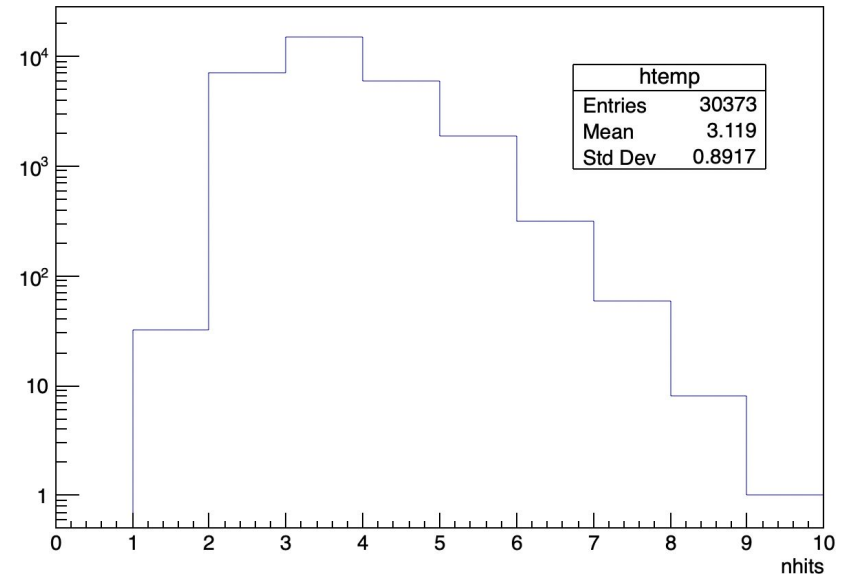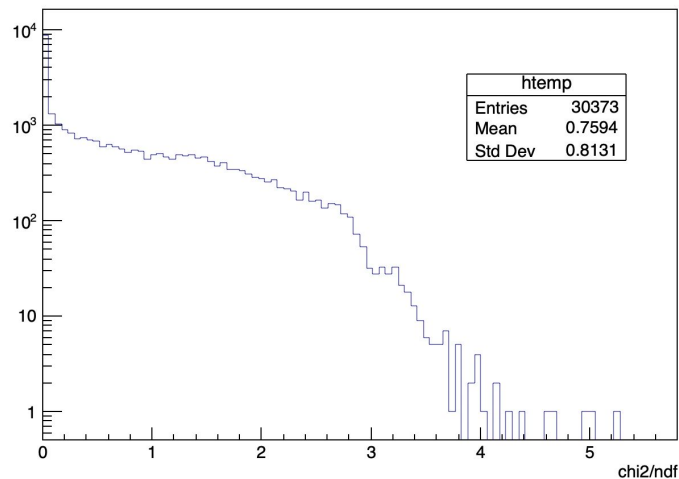
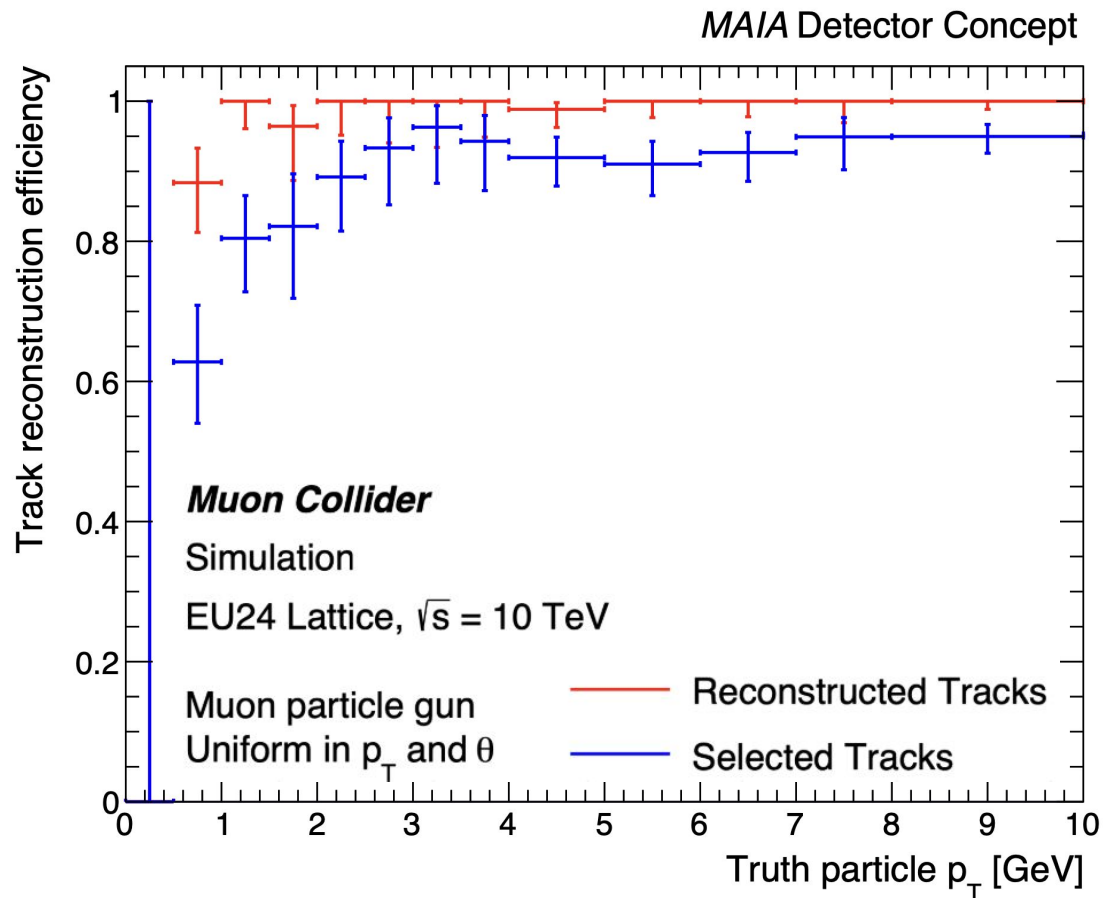# More distributions

Plots after ReFit final step

Everything is normalised to unit area

Efficiency vs theta (no BIB+IPP)

Efficiency vs p$_T$ (no BIB+IPP)

Check my results?

Software available in ghcr.io/muoncollidersoft/mucoll-sim-ubuntu24:main

- Ready to go in 2.x numbered release

BIB-only SLCIO files with tracks available at:
/ospool/uc-shared/project/futurecollide_____MuC_MAIA_v0/v7_track_special

- Had to split in t_____30,180) to circumvent failure of writer (too many_____pression)

Updated files being copied

Also available in ntuple format:

- Signal   ntup_SiTracks.root, ntup_SelectedTracks.root
- Background   ntup_BIB_SiTracksDeduped.root, ntup_BIB_SiTracks.root, ntup_BIB_SiTracks_Refitted.root

Todo / ongoing

- Evaluating efficiencies on signal with BIB+IPP overlay

- Extract p_T and d_0/z_0 resolutions

Conclusions

If the results turn out to be correct, I see two main implications:

1. We don't need to apply such stringent impact parameter cuts in our track selection for the paper (eases concerns about impact on flavour tagging)

2. Could skip BIB overlay in tracker when reconstructing photon and neutron particle gun events (speed up track-based pandora seeds)

3. (longer term?) If track selection efficiency on signal tracks independent of BIB, we could skip BIB overlay in tracker entirely

Thank you!