Secondary track finder update

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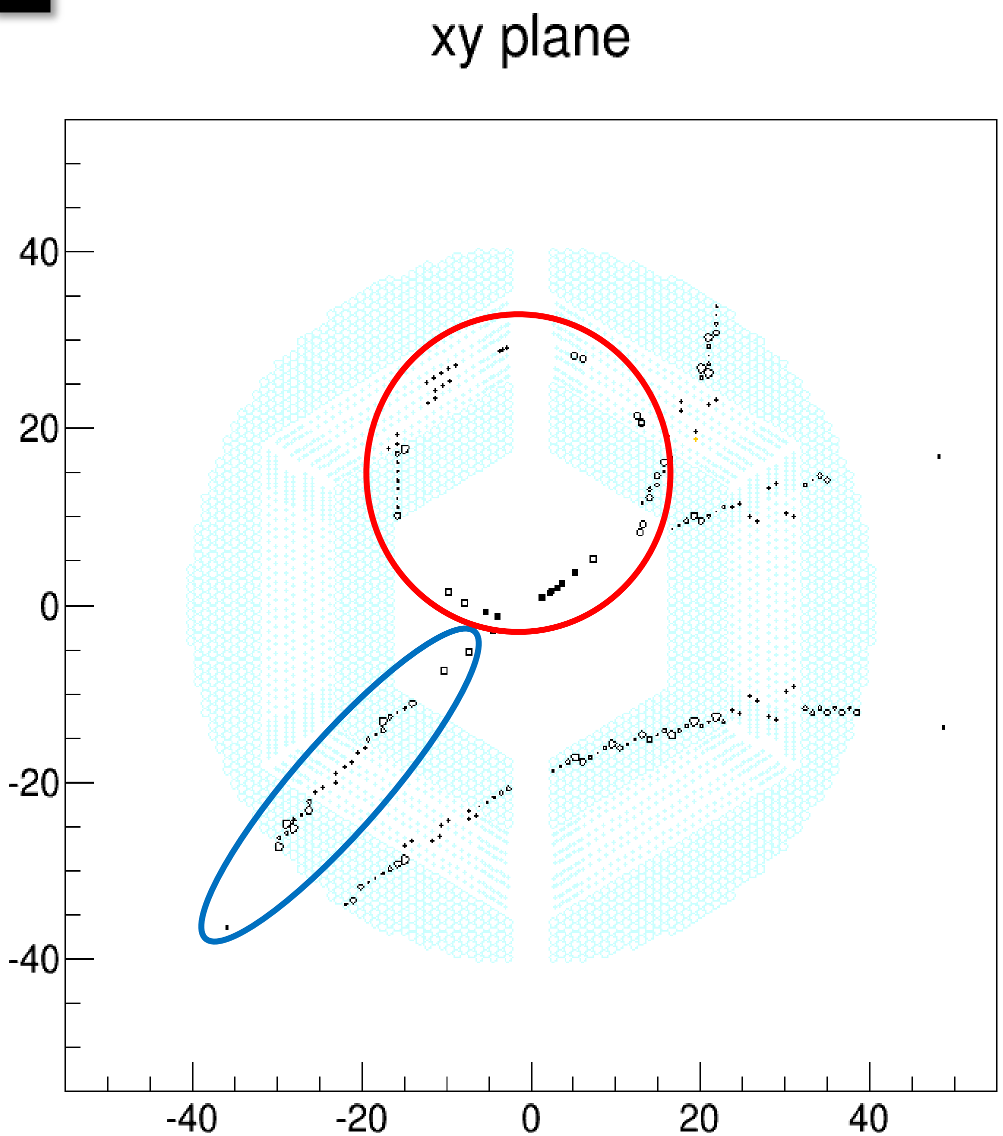
LIII PANDA Collaboration Meeting – Pattern Recognition Session
Uppsala, 8 – 12 June 2015

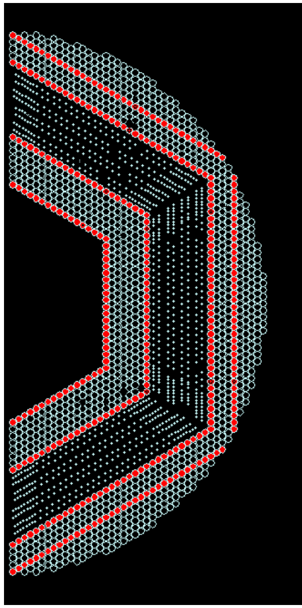
Summary

- The problem of the peak @ 1 in (MC – RECO)/MC momentum distributions
- Combinatorial suppression in the GEM chambers
- Results of the updated version of the code w.r.t. the previous one:
  - Long tracks
  - Forward tracks
- How to proceed with the looping particles

Won't repeat the procedure



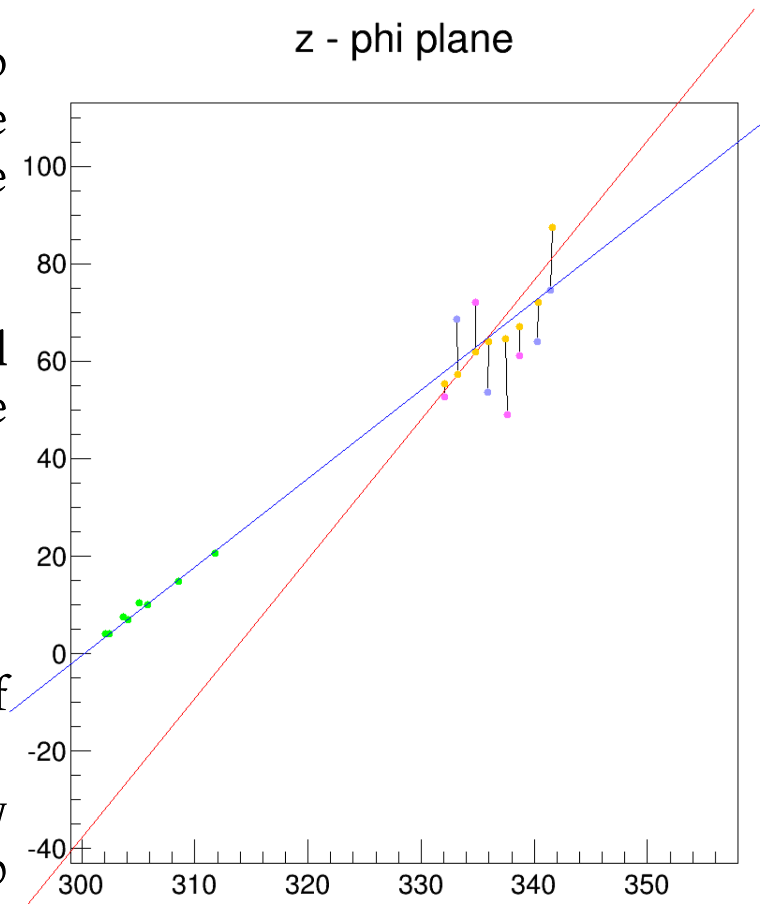
- LONG tracks, where it all starts from the 4 pivotal layers in the STT
- FORWARD tracks, where it all starts from the 3 GEM stations



- Key factors:
  - Conformal transformation
  - Legendre/Hough transformation
  - Z finding with the skewed tubes
  - Analytical fit

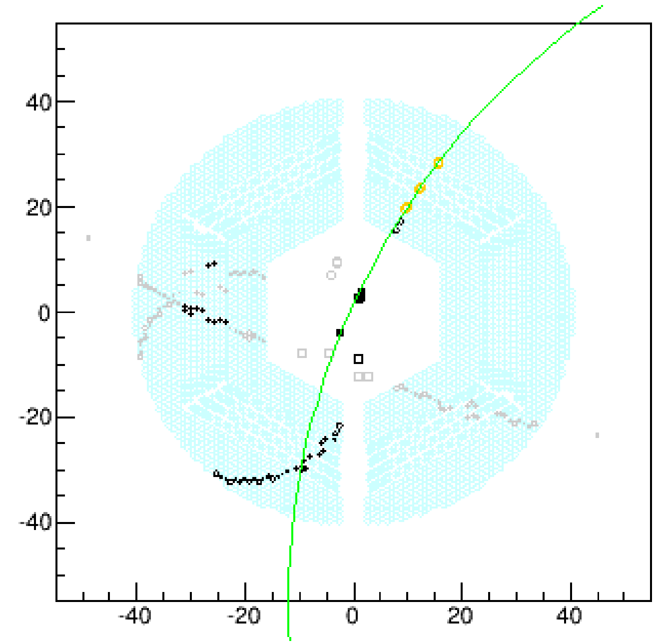
The changes/fixes

- For **LONG** tracks:
  - The hit on which the (0, 0) position is translated to apply the conformal transformation is kept on the **outer indivisible hit** instead of moving it to the SciTil: it showed better resolution.
  - For the fit in zϕ plane, first hypothesis, the **full combinatorial** of the intersection1 and 2 of the skewed tubes is used
  - The final fit in the zϕ plane is performed both with:
    - the Hough transformation
    - an analytical fit (of the mean points of intersections 1 and 2 for the skewed tubes).
  - Empirically the fit shows better results for low slopes, w.r.t the Hough results → temporarily keep this for small slopes and Hough's for higher ones



The changes/fixes

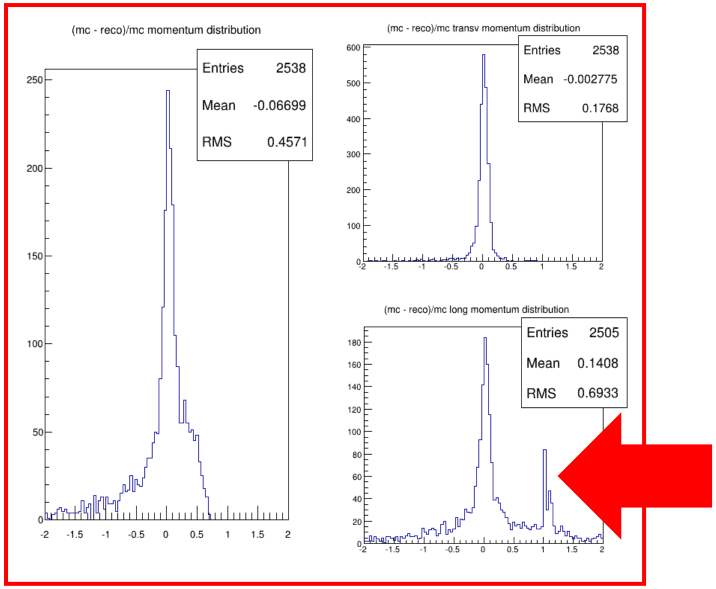
- For **FORWARD** tracks:
  - The very first fit in *xy* is done with the 6 GEM hits *analytically* and not with the mean values on each station anymore
  - The first hypothesis in the zϕ plane is computed with the GEM alone
- In **BOTH** cases:
  - Combinatorial suppression before filling the *gemhitlist* is performed
  - A flag for tracks where the fit in zϕ fails is set
  - Bug fixing, e.g. the ϕ calculation

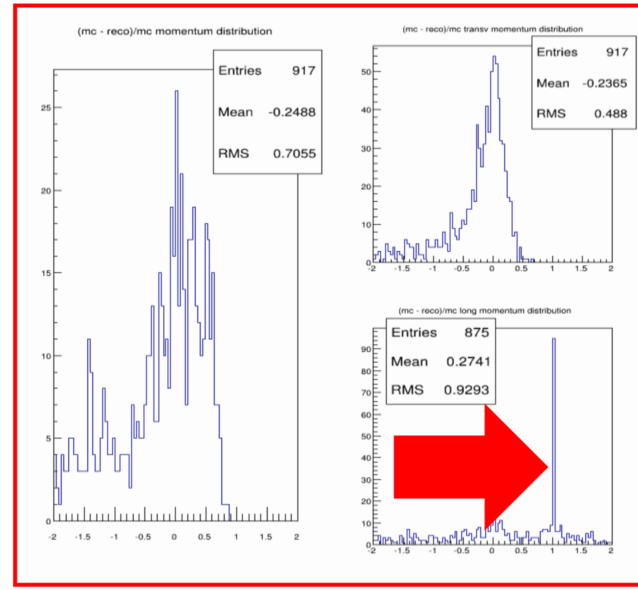


Open point: the peak@1

X = 5 CM, Z = 0

X = 25 CM, Z = 0





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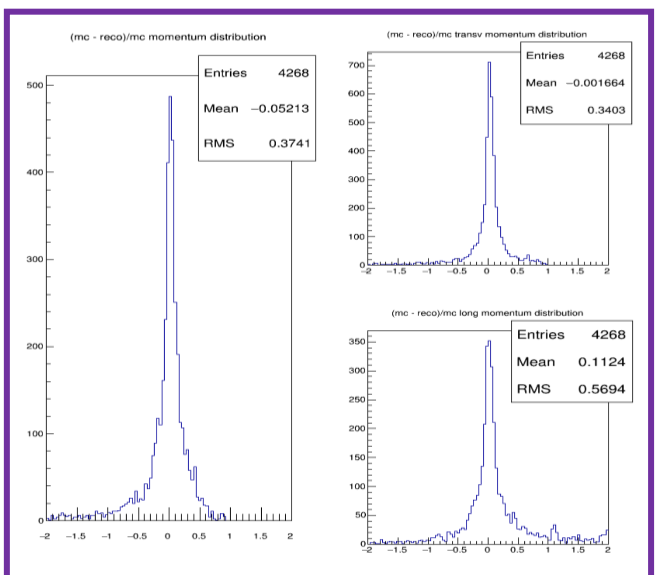
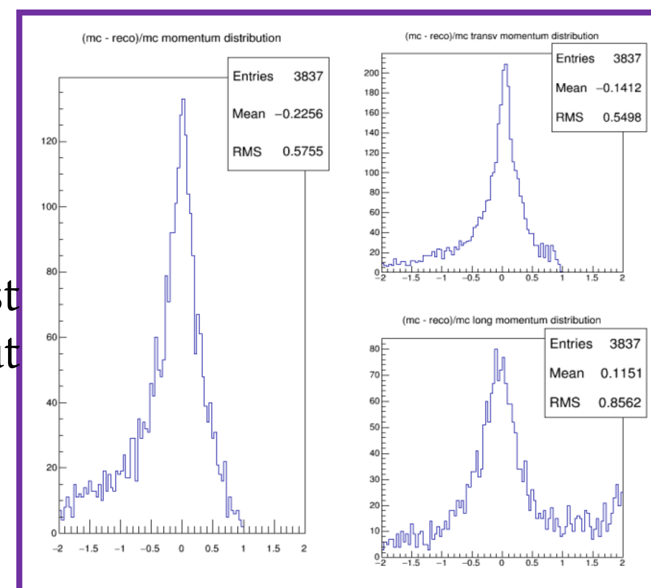


NEW

The numbers must be rechecked but the shape is fine



Open point: the peak@1

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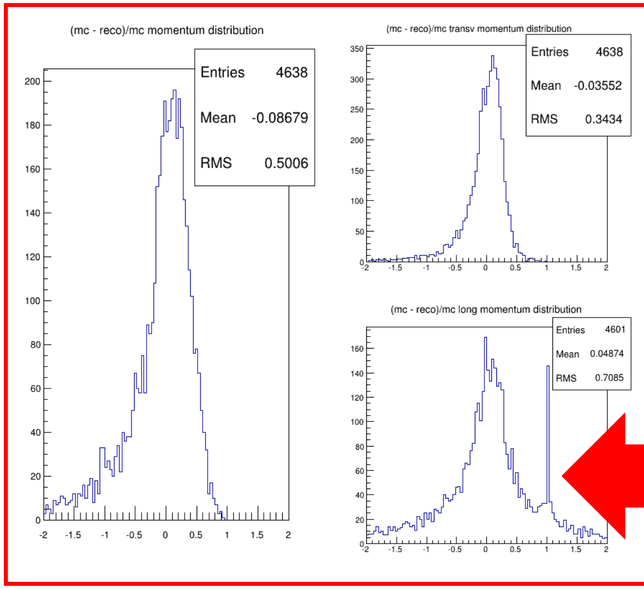

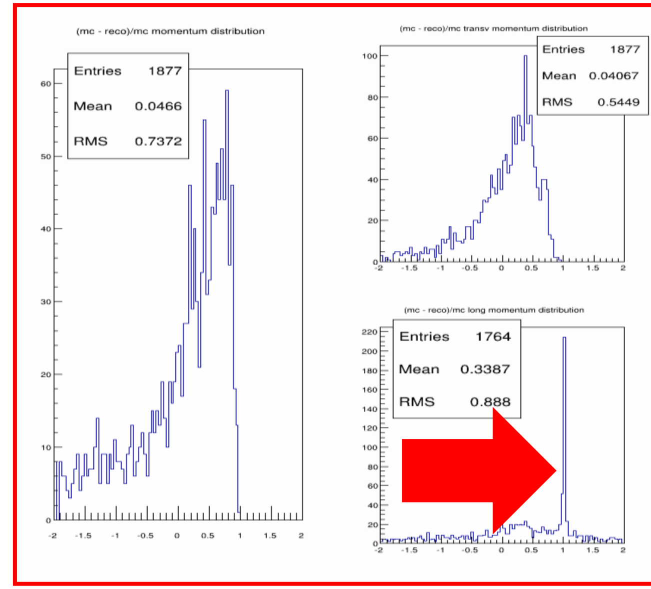

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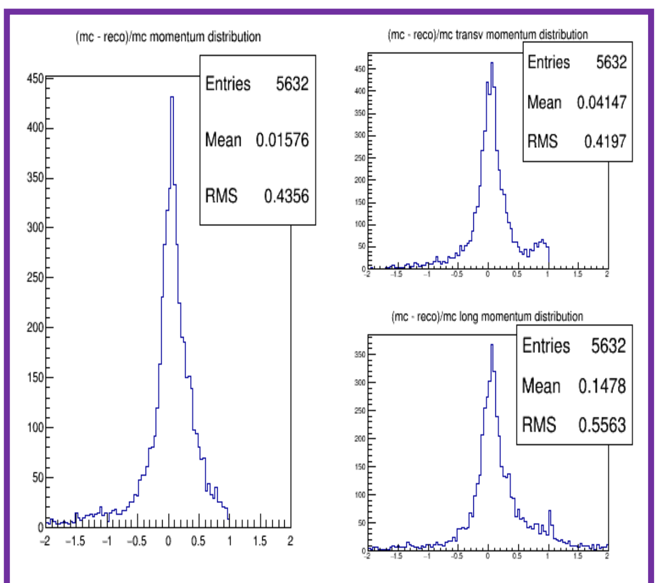

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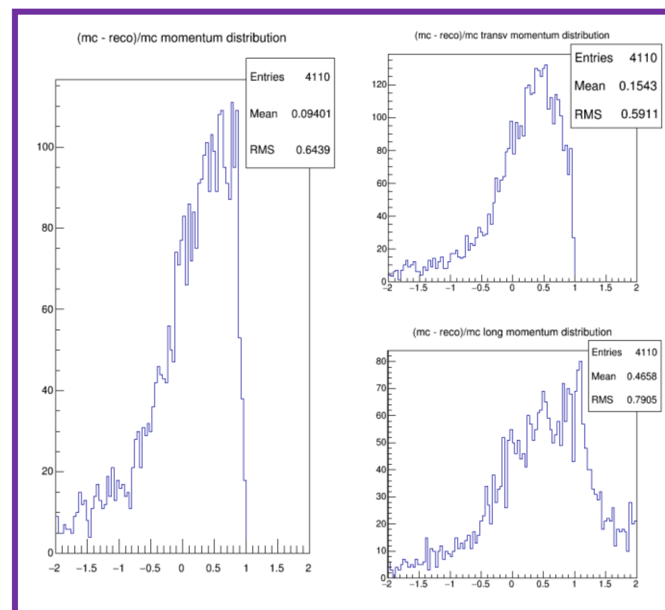
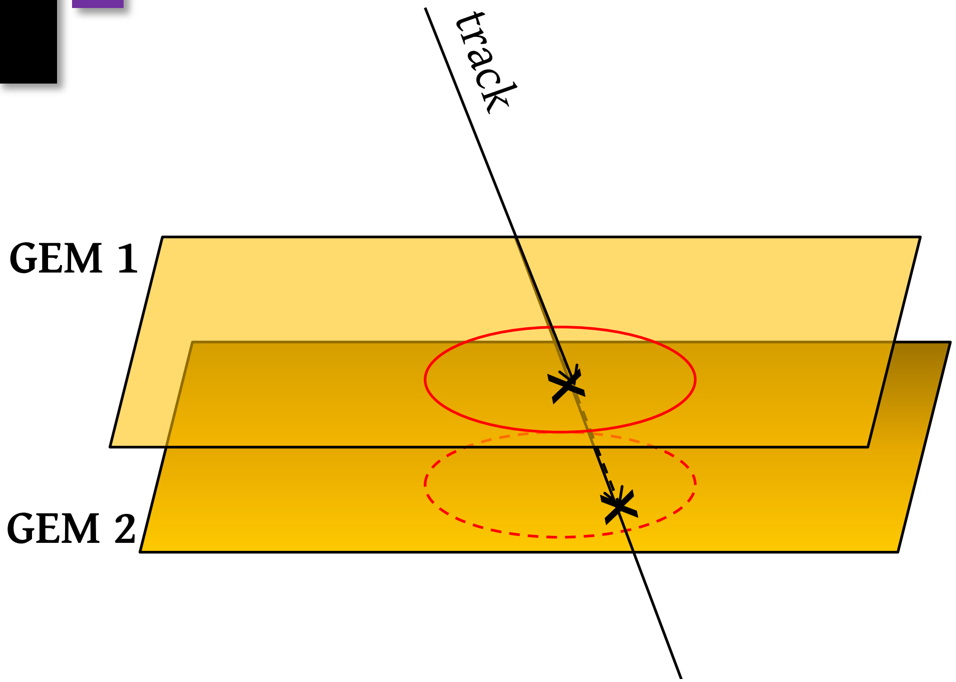


The combinatorial in GEM



source: pandaroot / trunk / tracking / TrkAlgo @ 27823

Name ▲
../
PndTrkClean.cxx
PndTrkClean.h
PndTrkCombiLegendreTransform.cxx
PndTrkCombiLegendreTransform.h
PndTrkConformalTransform.cxx
PndTrkConformalTransform.h
PndTrkFitter.cxx
PndTrkFitter.h
PndTrkGemCombinatorial.cxx
PndTrkGemCombinatorial.h
PndTrkLegendreTransform.cxx
PndTrkLegendreTransform.h
PndTrkTools.cxx
PndTrkTools.h

- added a suppression of the combinatorial in the GEM stations
- It is the same procedure used in the *GEM extension* of the standard pattern reco
- It considers *true* GEM hits only the ones with a counterpart in the other sensor inside the same station within a certain range in the *xy* projection

The combinatorial in GEM

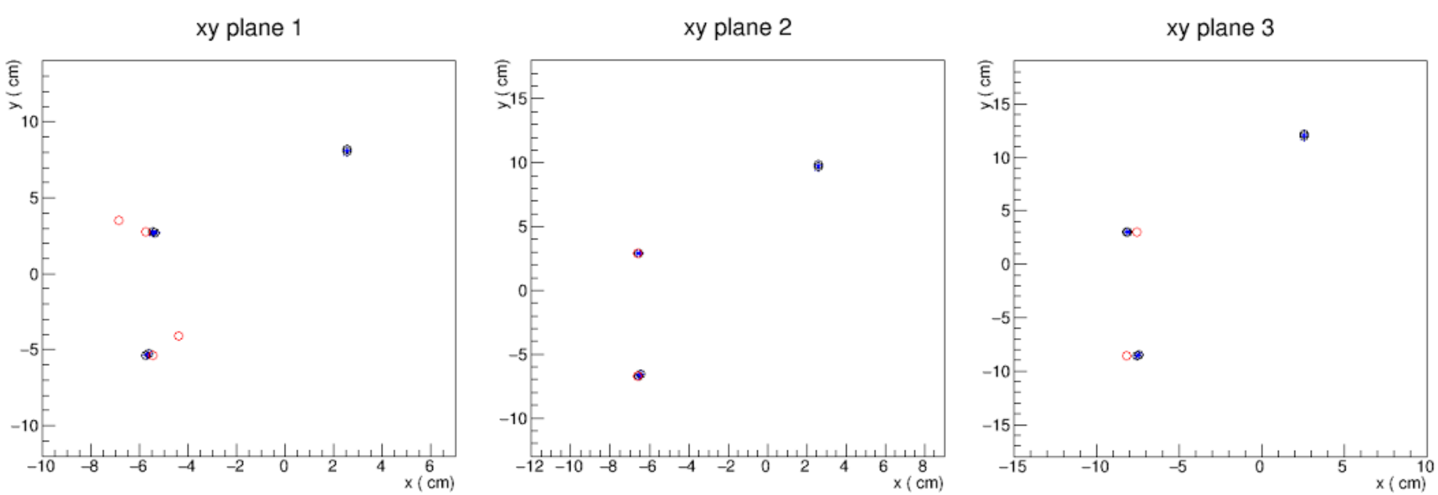
Example of results

Simulation
100 events
3 muons/event
$\theta \in [0.1, 5]°$
$\phi \in [0, 360]°$

TOTAL #hits = 1229
77.5% true
22.5% fake

From the combinatorial suppression:
#correct *true* hits/#real *true* hits : 98.8%
#wrong *true* hits/#hits : 3.2%

#correct *combi* hits/#true *combi* hits: 88.8%
#wrong *combi* hits/#hits : 4.3%



STAT I STAT II STAT III

* MC point
O hit
O found combinatorial

Present results

RECALL

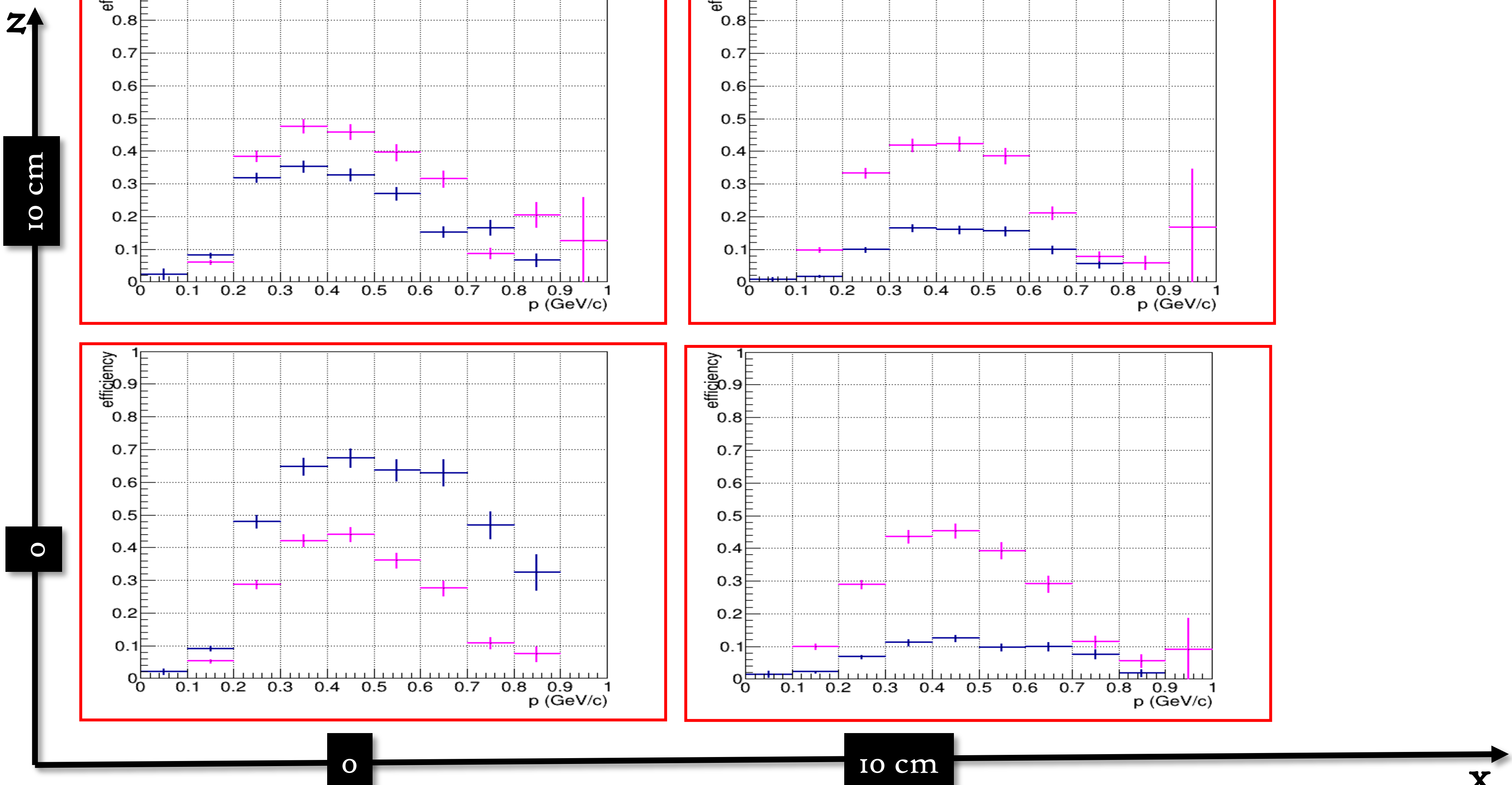
- Study of the performances of the secondary *vs* primary track finder
- 5000 events of $\bar{p}p \rightarrow \bar{\Lambda}\Lambda$ @ beam mom = 4 GeV/c
- Decay with cτ = 0 → decay in the formation vertex @:
  - x = 0, z = 0
  - x = 0, z = 10 cm
  - x = 10 cm, z = 0
  - x = 10 cm, z = 10 cm
- Secondary track finder with *long* and *forward* track finders *on*
- Primary track finder in its standard layout
- Selection of the *reconstructable* tracks:
  - 3 hits for *xy* (MVD, STT paral, GEM, SciTil)
  - 2 hits for $z\phi$ (MVD, STT skew, GEM, SciTil)
- Association to MC with PndMCTrackAssociator BUT, afterwards, only one reco track for each MC track is considered *true*. Further reco tracks associated to the same MC track are *clones*.

Efficiency - pions

- Primary TF
- Secondary TF

EFFICIENCY = # TRACKS WITH SINGLE TRACK EFF > 80% / # MC RECONSTRUCTABLE * TRACKS

OLD



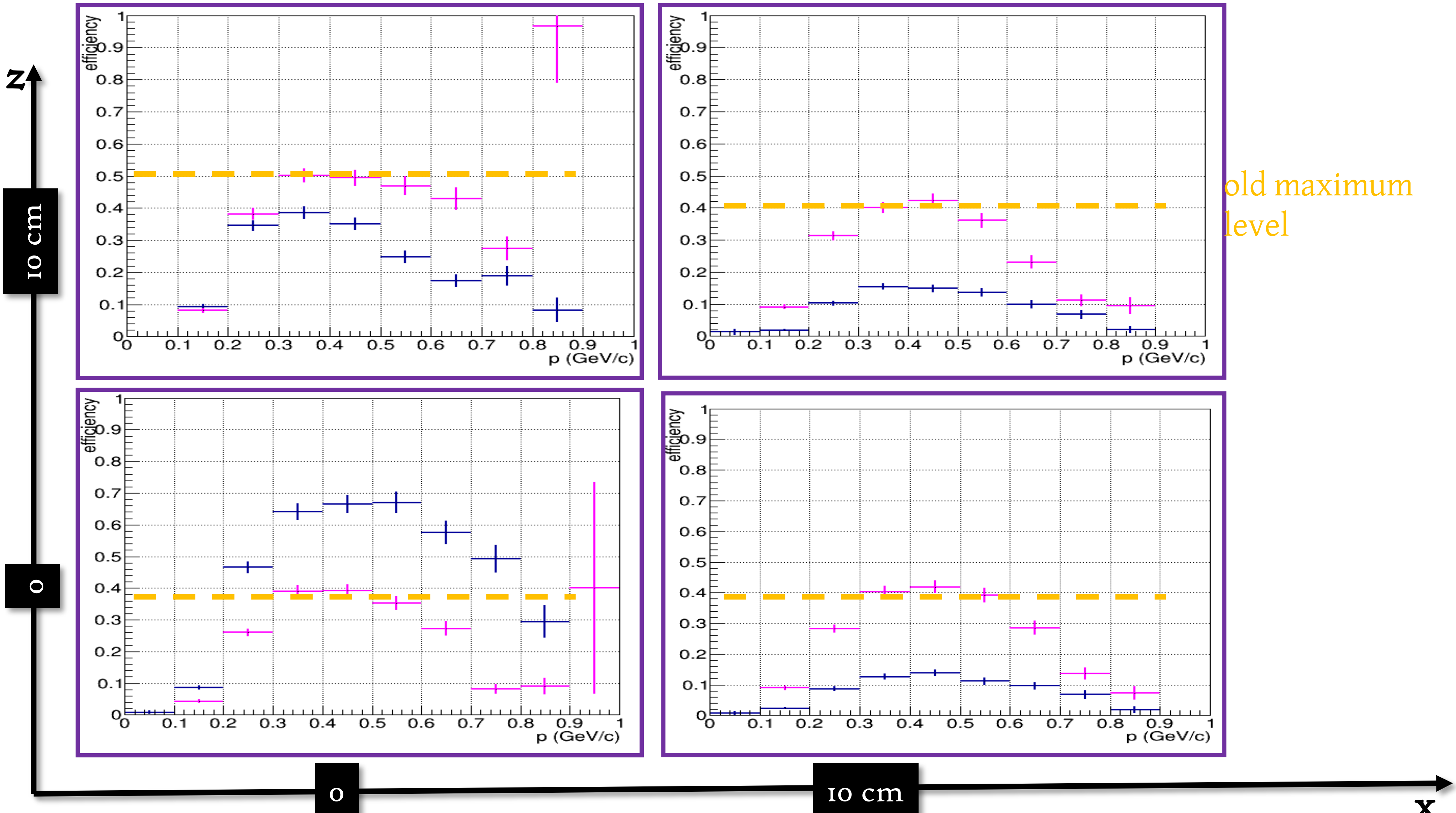
Sec Trk Fin

Efficiency - pions

- Primary TF
- Secondary TF

EFFICIENCY = $\frac{\text{\# TRACKS WITH SINGLE TRACK EFF > 80\%}}{\text{\# MC RECONSTRUCTABLE * TRACKS}}$

NEW



Sec Trk Fin

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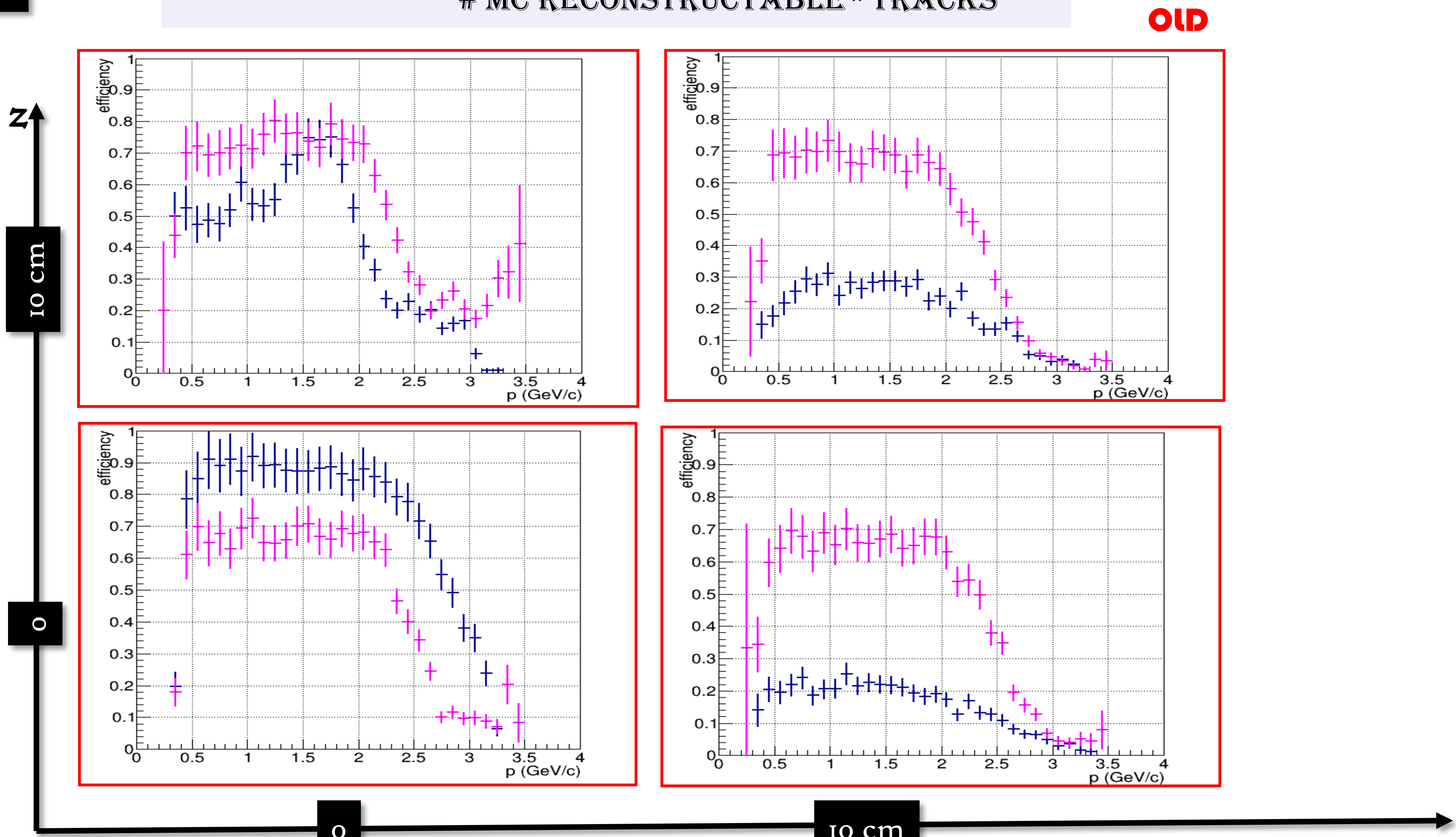
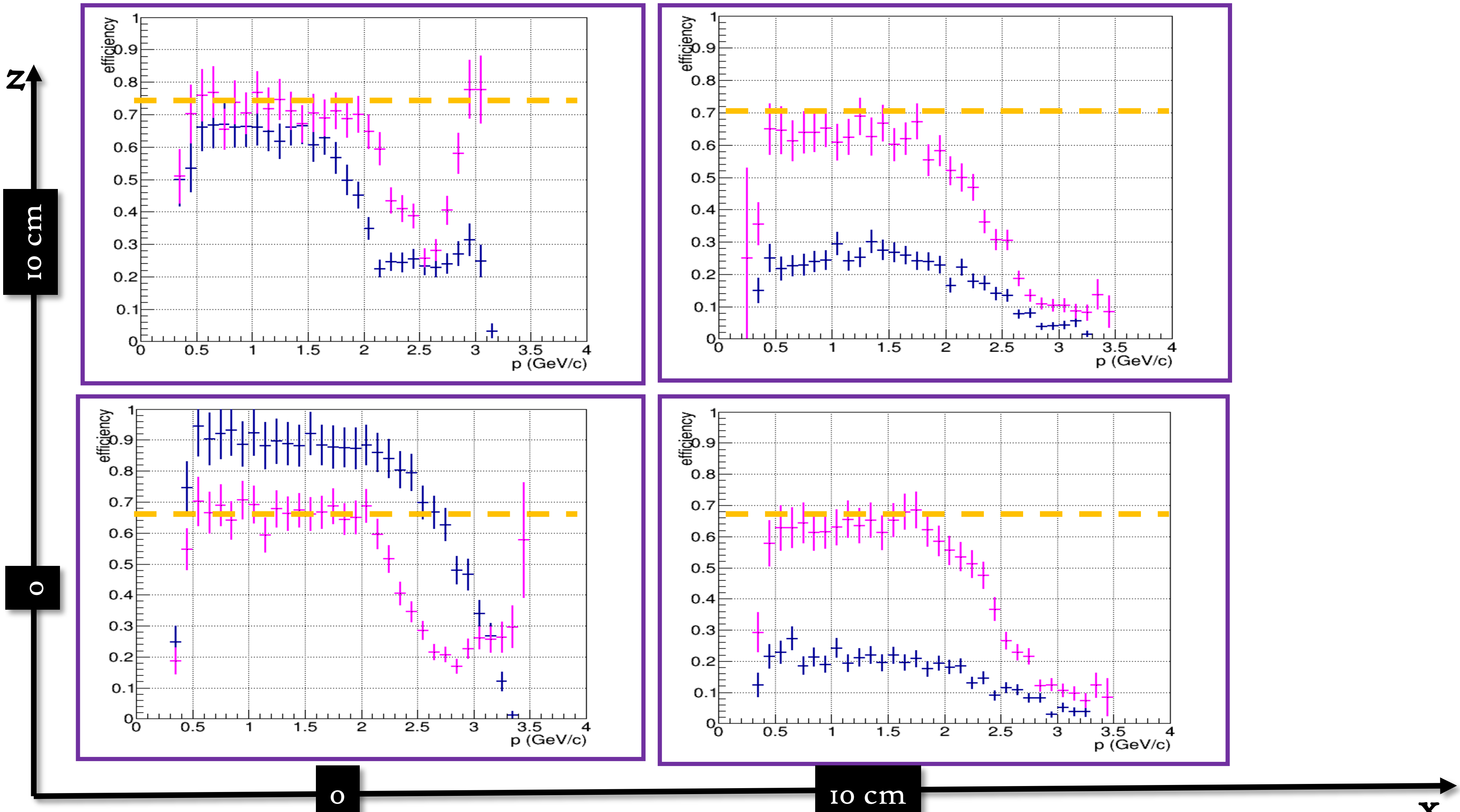


Efficiency - protons

¤ **Primary TF**
¤ **Secondary TF**

$$\text{EFFICIENCY} = \frac{\text{\# TRACKS WITH SINGLE TRACK EFF} > 80\%}{\text{\# MC RECONSTRUCTABLE * TRACKS}}$$

NEW



Sec Trk Fin

Efficiency - protons

¤ **Primary TF**
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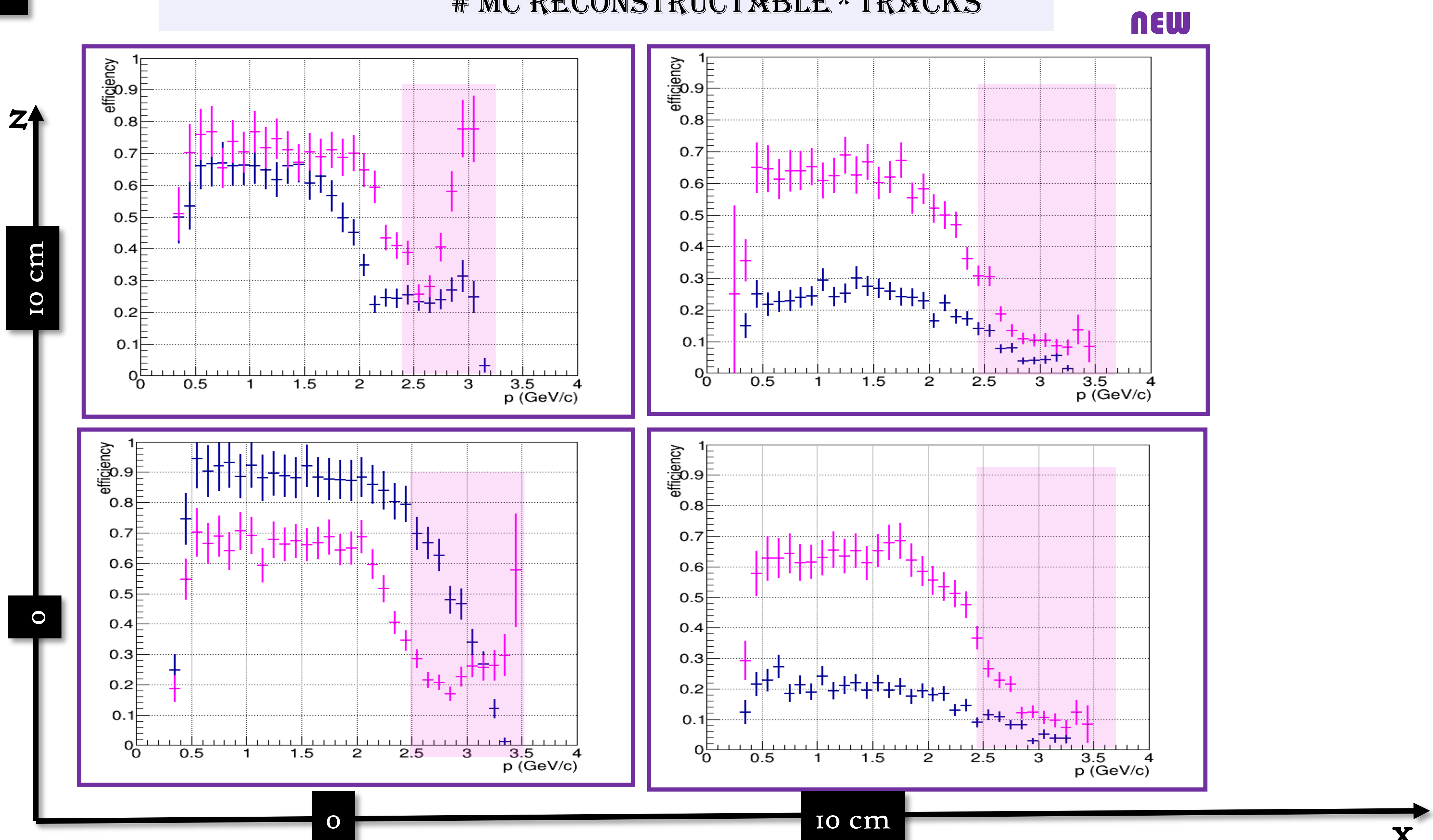
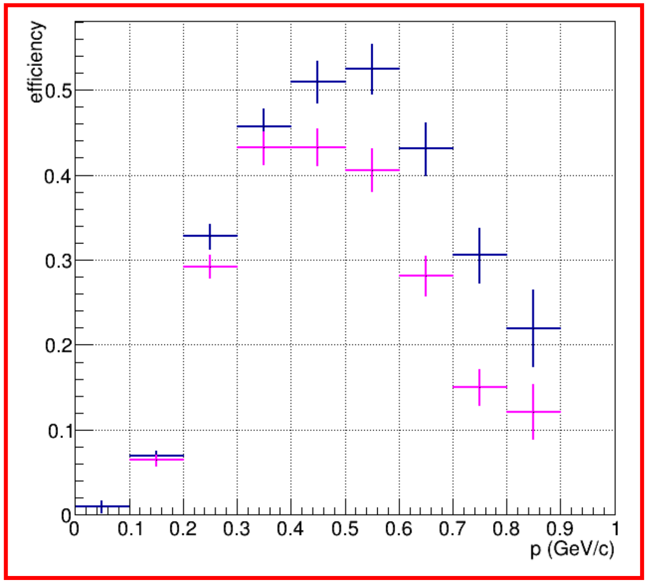


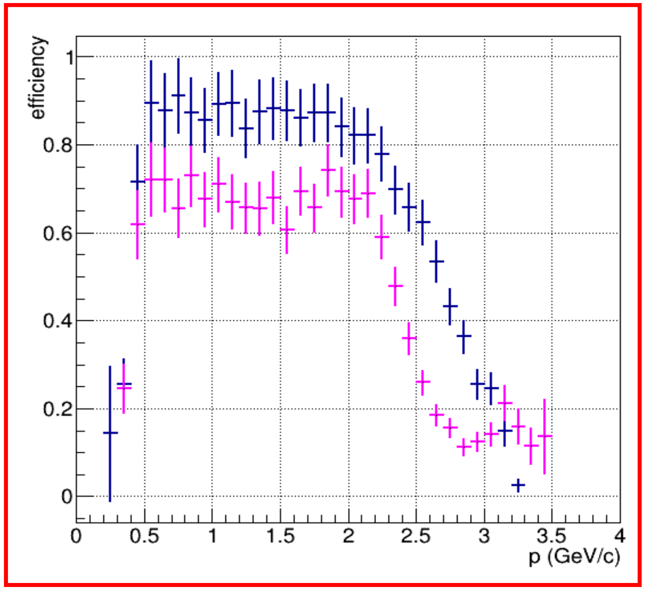
Sec Trk Fin

$p\bar{p}_{bar} \rightarrow \Lambda\Lambda_{bar}$ – Phase Space

- Primary TF
- Secondary TF

OLD





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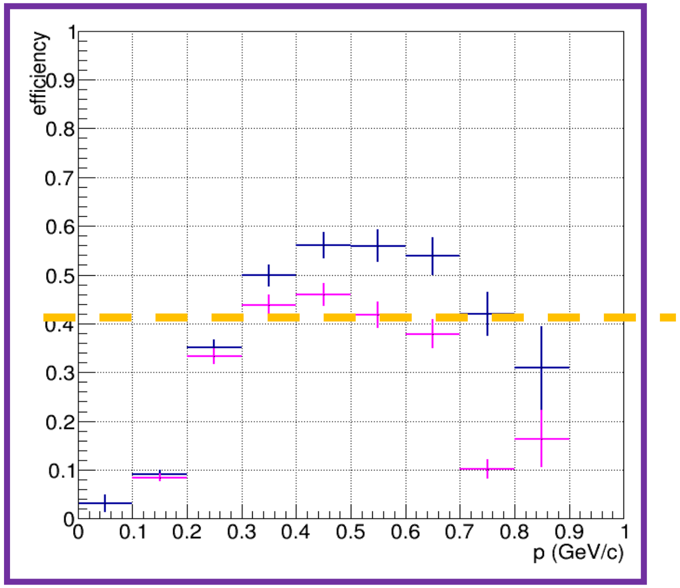
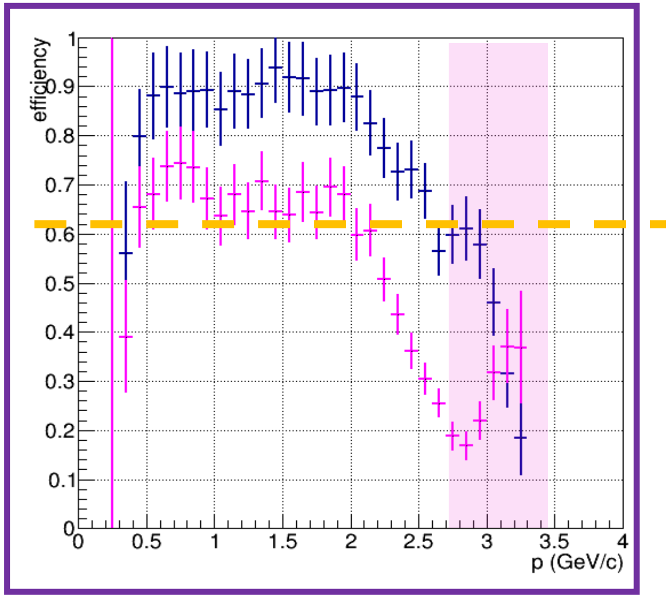
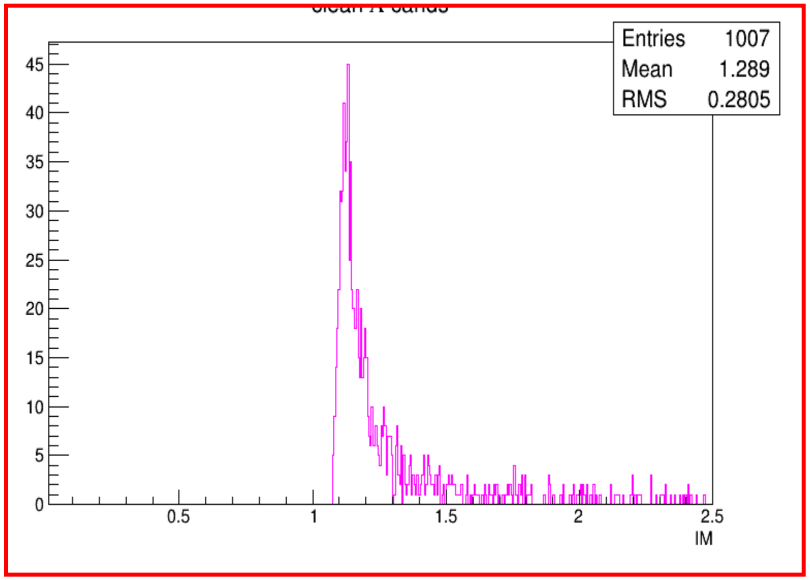




$p\bar{p}_{bar} \rightarrow \Lambda\Lambda_{bar}$ – Phase Space



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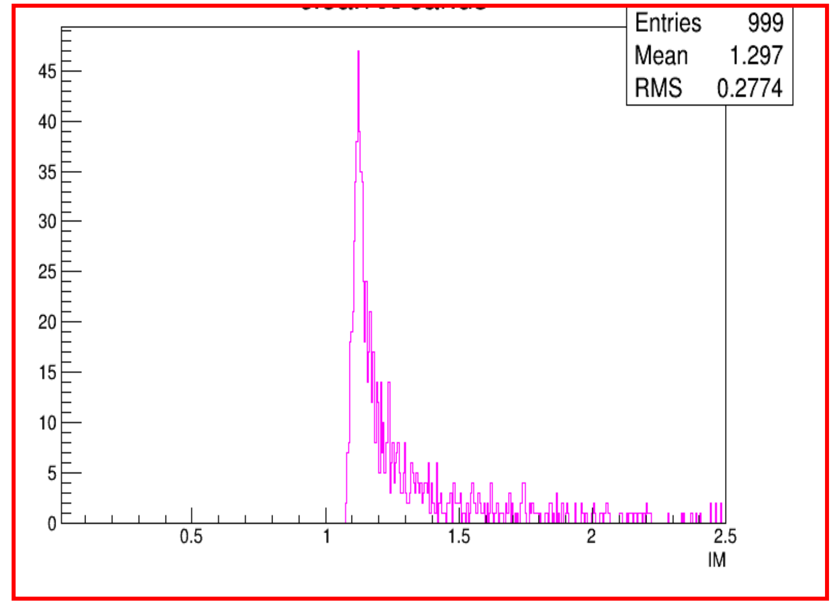

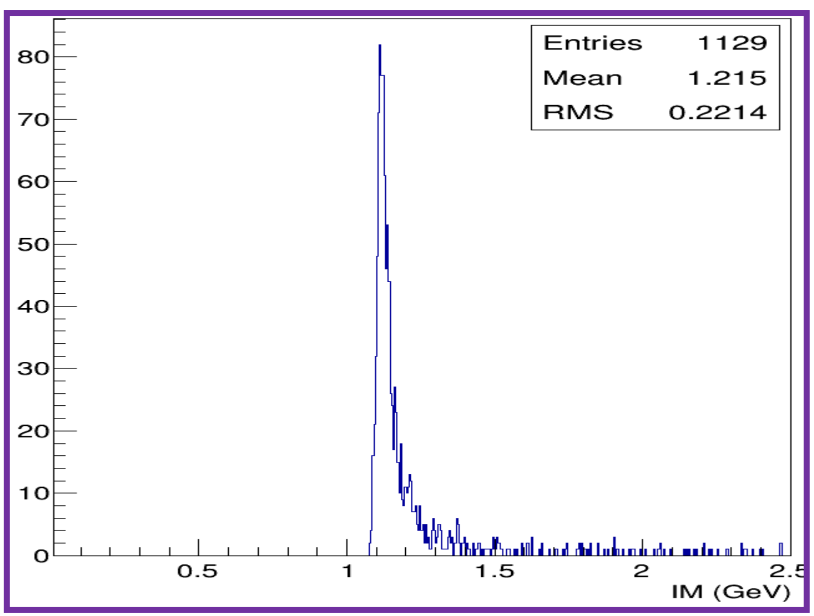

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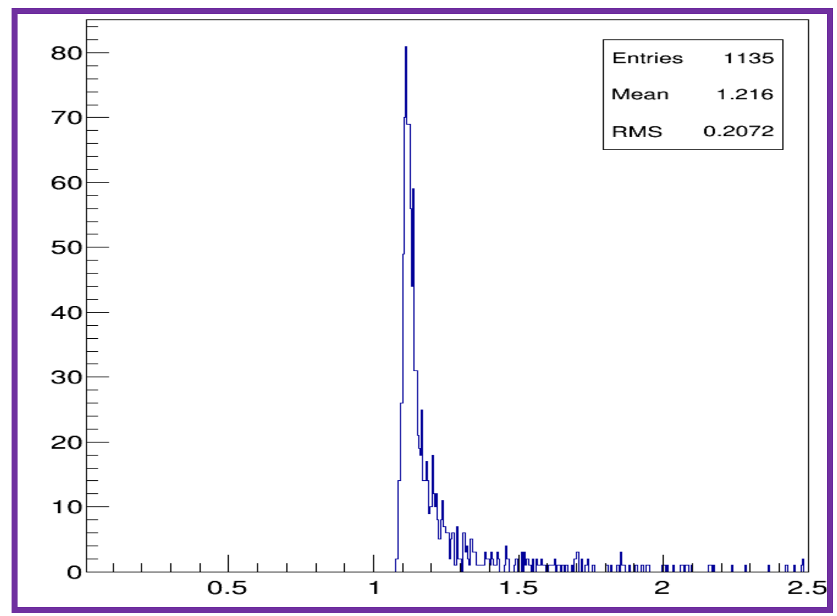
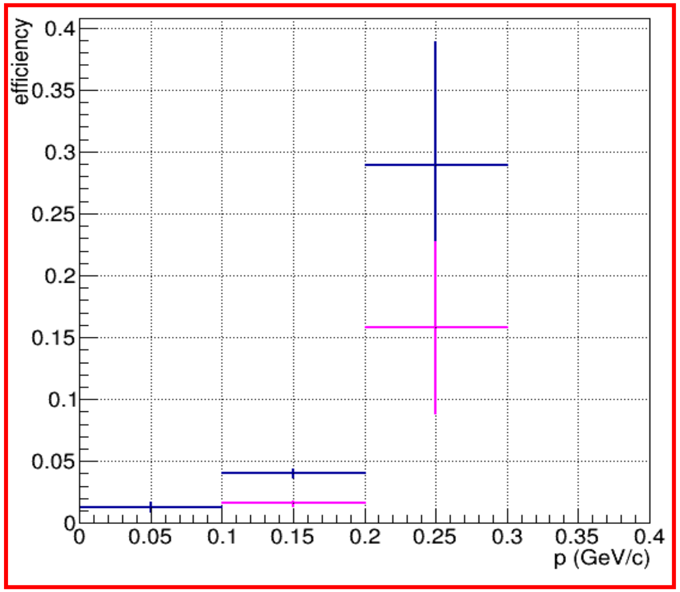
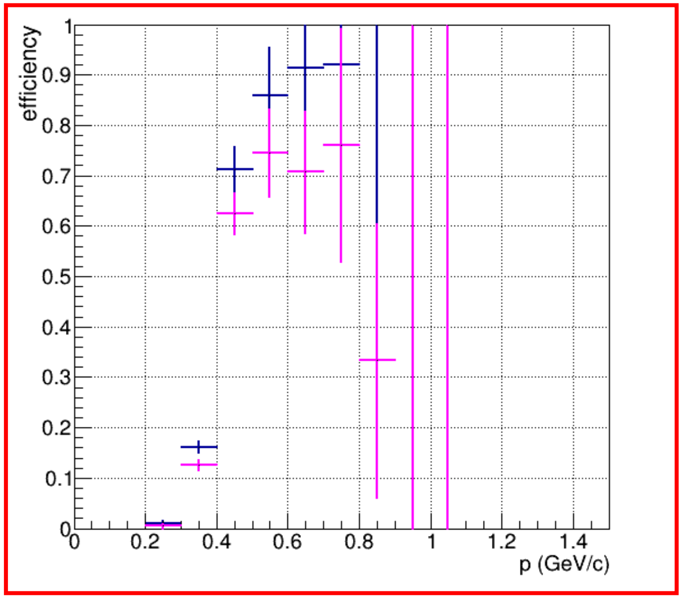


$pp_{bar} \rightarrow \Lambda\Lambda_{bar}$ – Boost

- **Primary TF**
- **Secondary TF**



NEGATIVE PIONS



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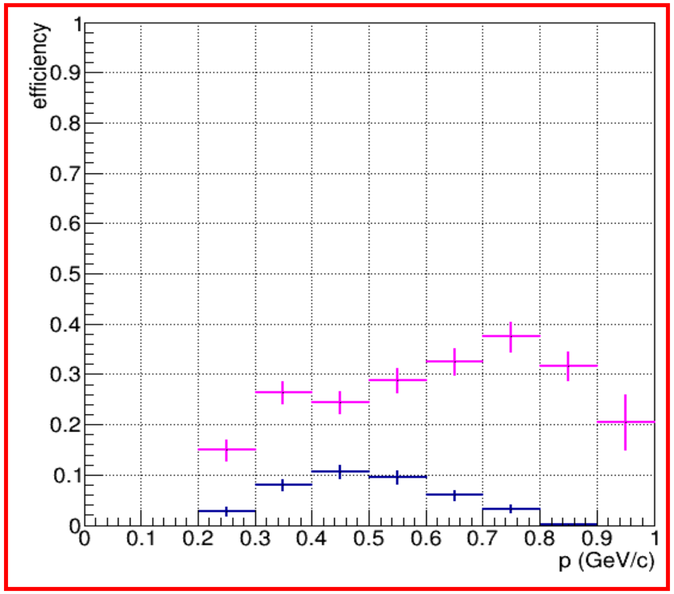
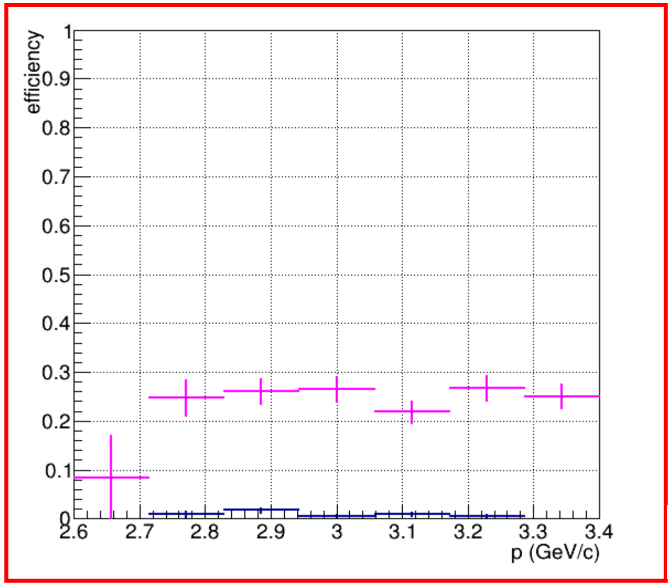
PROTON



POSITIVE PIONS

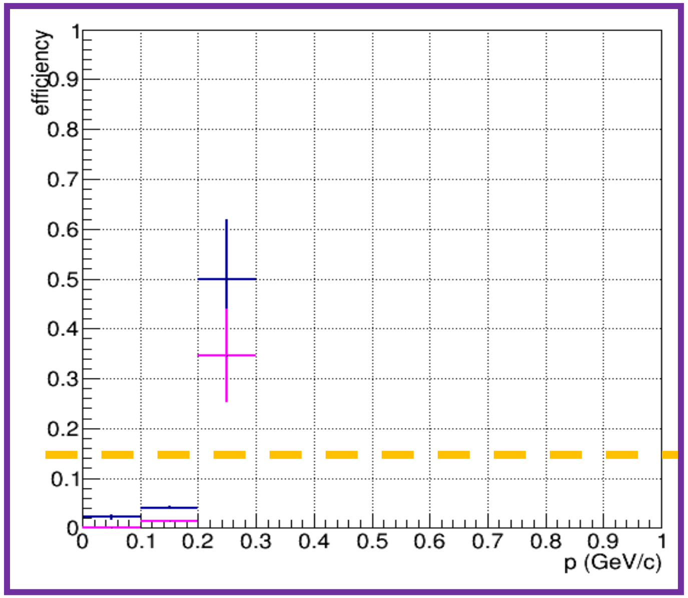


ANTIPROTON

$pp_{bar} \rightarrow \Lambda\Lambda_{bar}$ – Boost

- Primary TF
- Secondary TF

NEGATIVE PIONS



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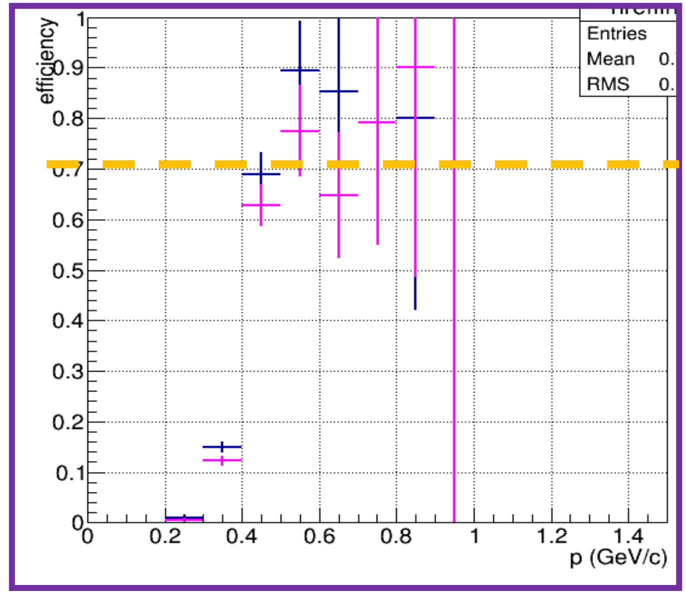
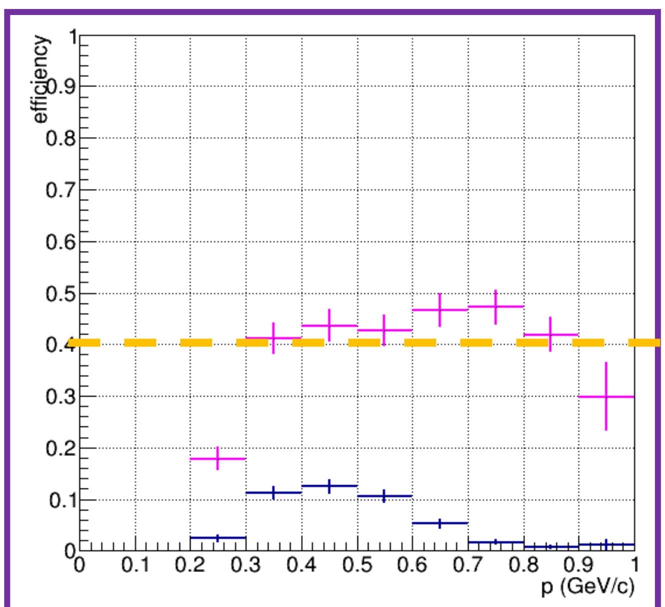
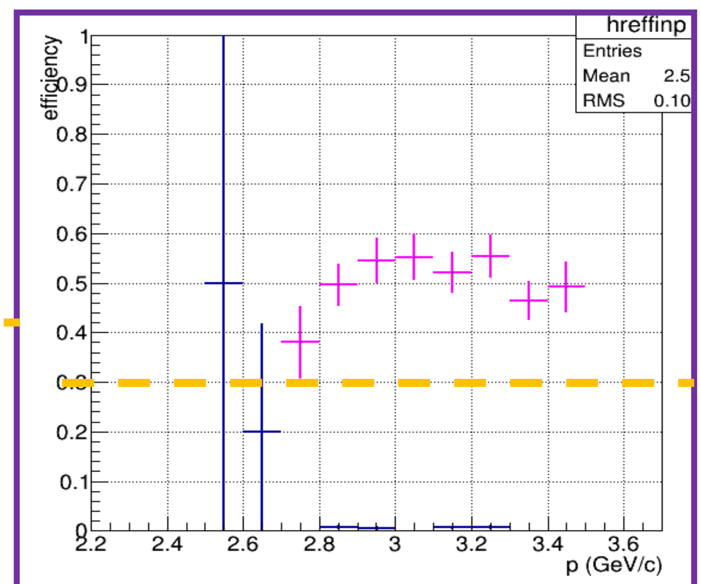


PROTON

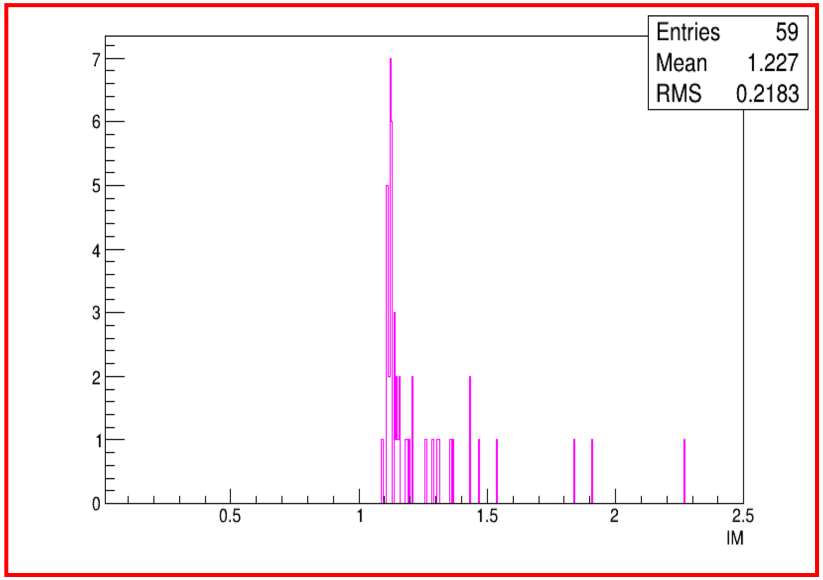
POSITIVE PIONS





ANTIPROTON

$p\bar{p}_{bar} \rightarrow \Lambda\Lambda_{bar}$ – Boost



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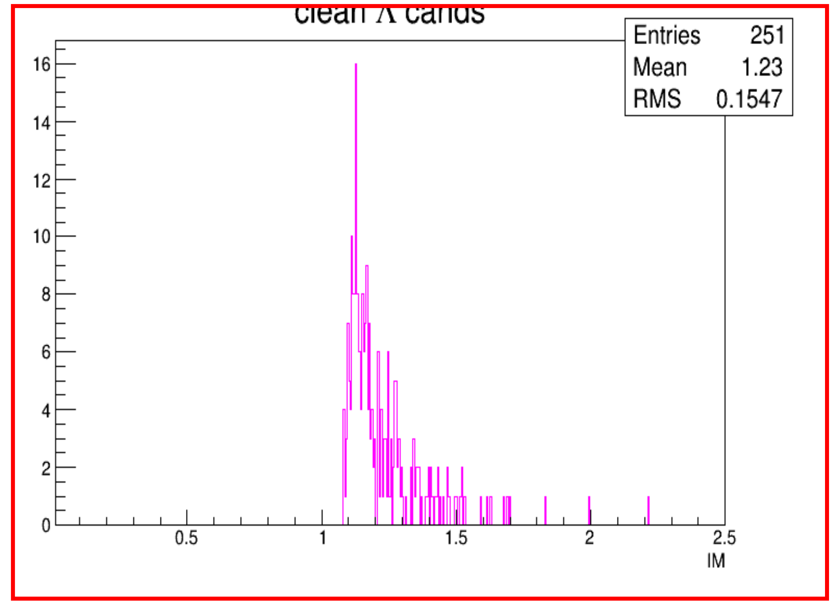

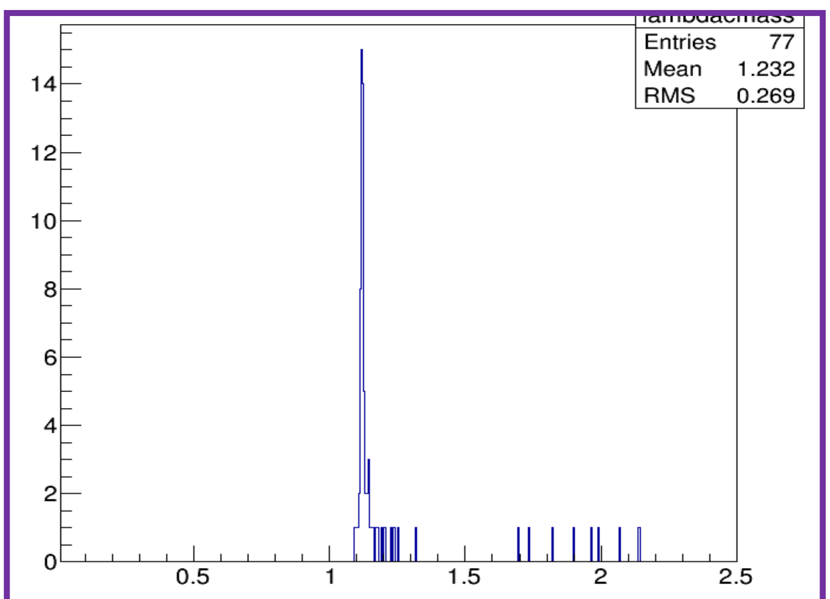

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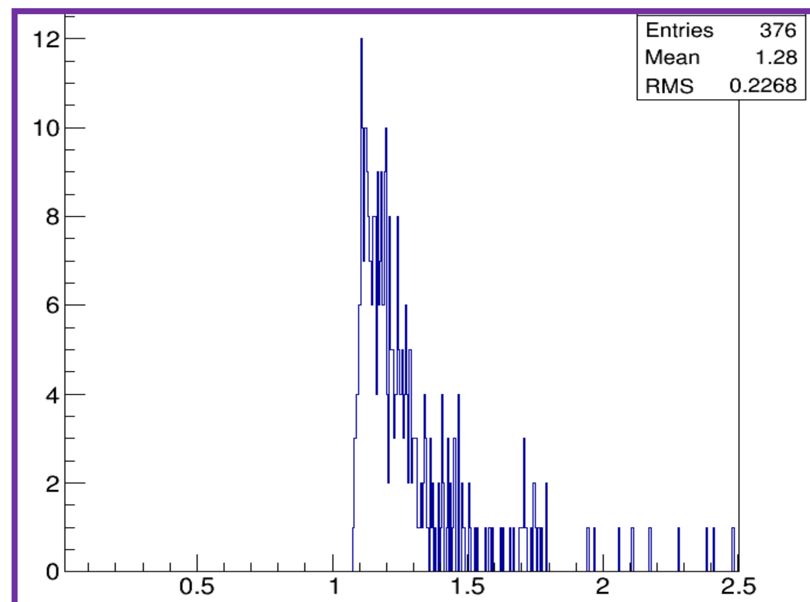

Conclusions

- The situation for LONG and FORWARD tracks is acceptable
- Still missing: the suppression of the clones, which are still many
- Possible improvement in the zϕ plane fit
- The looping particle problem:

Development of The Low Momentum Track Reconstruction Program and The Kinematic Fitter for The BELLE Experiment

JUN-ICHI TANAKA

Department of Physics, University of Tokyo

January 12, 1999

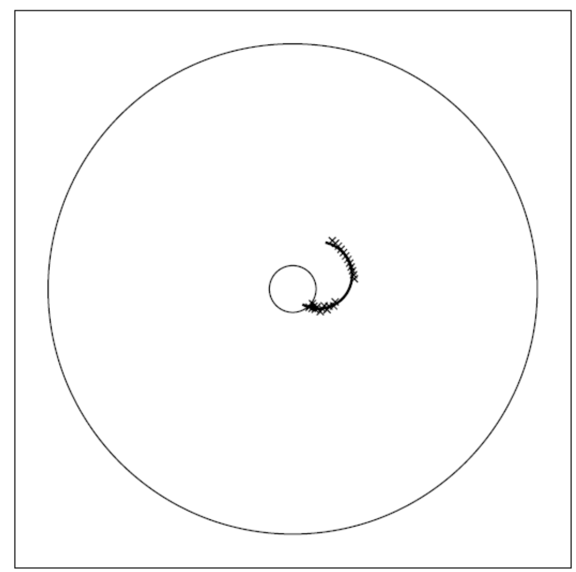

Figure 3.3: A Curling Track in The CDC

Considers the high number of hits in the same layer as indication of a curler

Thank you for your attention