VXD-CDC Track Merging

Status Update

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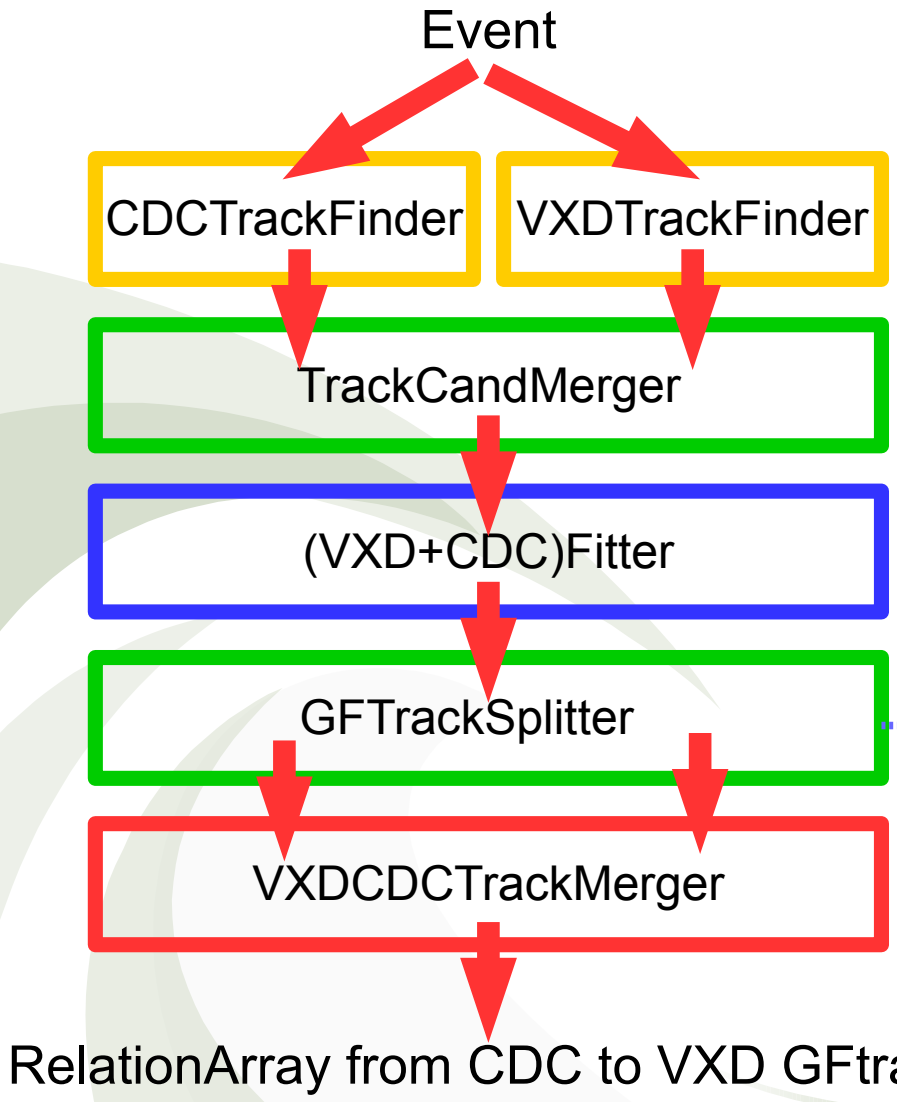
On behalf of the Belle2 group at Univeristy of Tabuk, Saudi Arabia

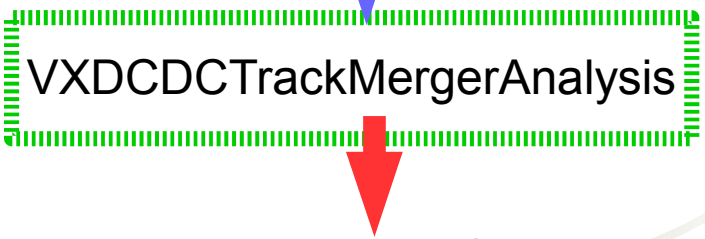
Belle2 F2F Tracking Meeting, 19-20th January 2015,
Prague, Czech Republic

Reminder: code flow



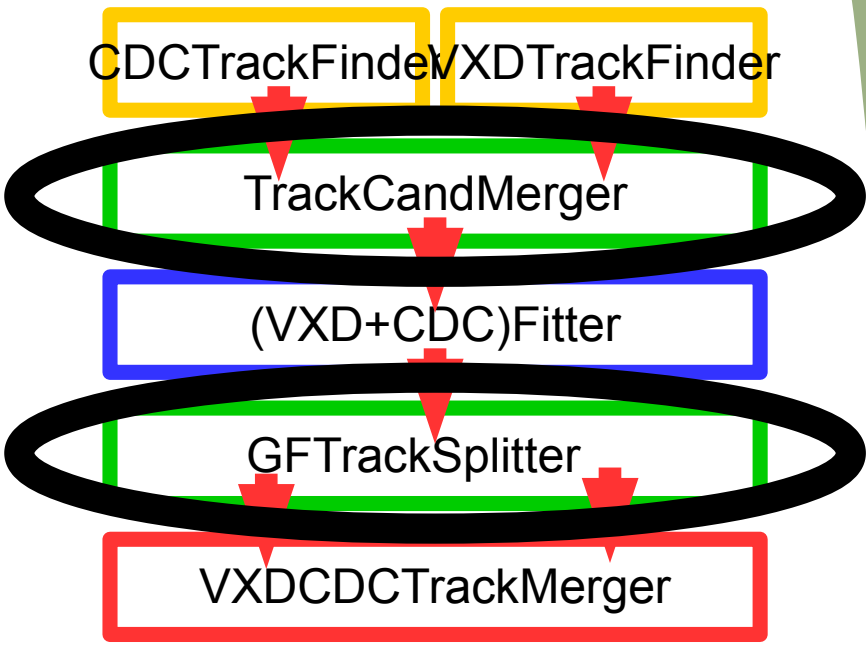
example script:
tracking/examples/
vxdCDCTrackMerger.py

Analysis module is fully parallel to VXDCDCTrackMerger



General remarks & ToDo List

- *TrackCandMerger & GFTracksplitter were introduced due to a bug in Genfitter (no multiple calls allowed in .py path): are they still necessary?*



- *The output of the module are relation arrays linking merged tracks: is this the correct output content and format?*

- *Analysis module repeats the merging as done VXDCDCTrackMerger module and makes some additional analysis job: it has to be adapted and generalized to take directly RelationArray from Merger for analysis*

- *I think it would be useful to introduce some validation scripts for the merger (which TrackFinders? which type of events?)*

Merging algorithm

- *Tracks, separately fitted, are extrapolated to CDC wall:*
  genfit::MeasuredStateOnPlane cdc_SoP=cdc_Track[i]->GetFittedState();
  genfit::MeasuredStateOnPlane vxd_SoP=vxd_Track[j]->GetFittedState();

- *Pre-filter: tracks have to be "near enough", $d<d_{max}$ (module parameter)*

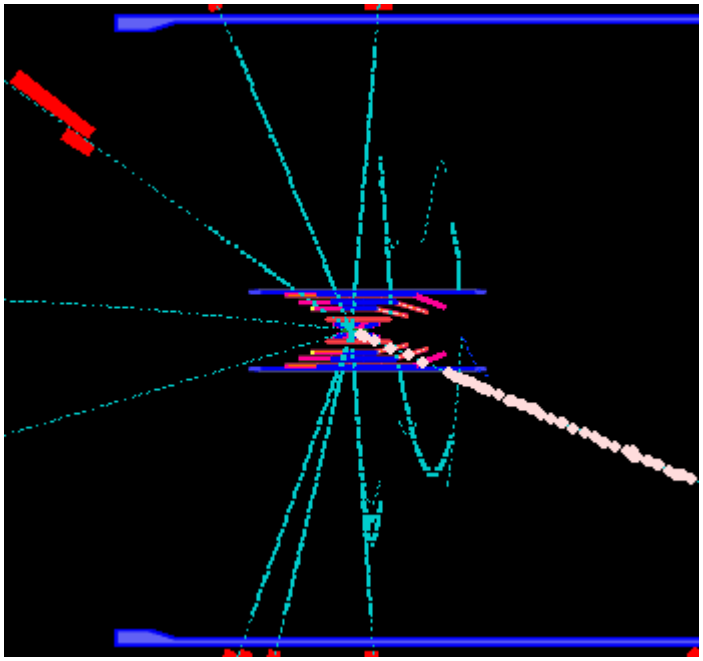
- *Take the projection of the VXD track on the plane defined by the CDC track:*
  cdc_SoP.extrapolateToCylinder(CDC_wall_radius, cyl_pos, cyl_mom);
  vxd_Sop.extrapoateToPlane(cdc_Sop.getPlane());

- *Then we calculate in 5D:*
  $X^2 = (cdc\_state - vxd\_state)\ (vxd\_cov + cdc\_cov)^{-1}\ (cdc\_state - vxd\_state)$

- *For every CDC track we loop over all VDX tracks and we calculate X^2*
- *We match the two tracks with lowest X^2 if $X^2 < X^2_{max}$ (module parameter)*

Merging remarks

- *For "good tracks" (e.g. high pT muons, 40 < ϑ < 120) merging fails mainly for 2 reasons:*
- *ExtrapolationToCylinder fails*
- *The track has a kink → X^2 explodes*



- *Current code does not handle this cases → tracks are not merged*
- *Even for "good tracks" this loss is non-negligible*
- *I think we should introduce some "recovery mode" e.g. by requiring the tracks just to be close enough if they fail one of the above*
- *To distinguish such tracks (now merged) we could introduce some additional index*

What's new

- *Until last B2GM I used MCTruthTrackFinder for track candidates*

- *First studies with Trasan & VXDTF, 4 combinations tested:*
- *MC-MC*
- *MC-Trasan*
- *VXDTF-MC*
- *VXDTF-Trasan*

- *Muons from pGun :*
- *10, 2 GeV muons with uniform angular distribution, 200 evt*
- *10, [0, 5] GeV muons with flat p and angular distribution, 1000 evt*

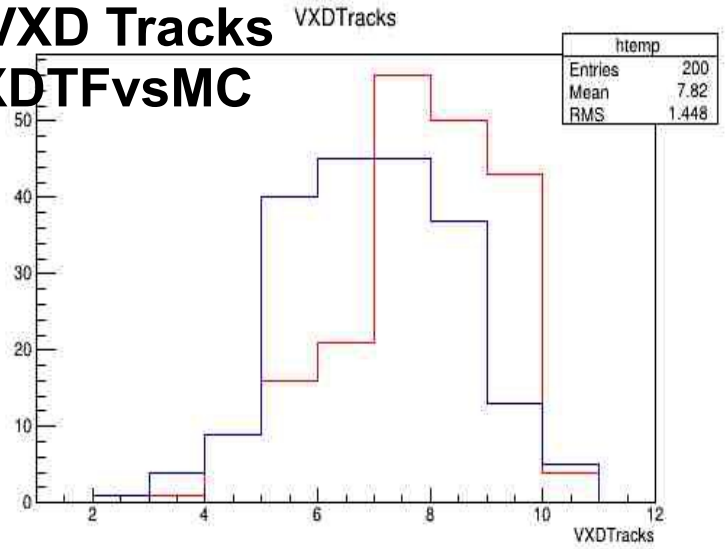
- *200 EvtGen events*

- *build2015-01-03* (*without latest VXDTF fix by Jacob)*

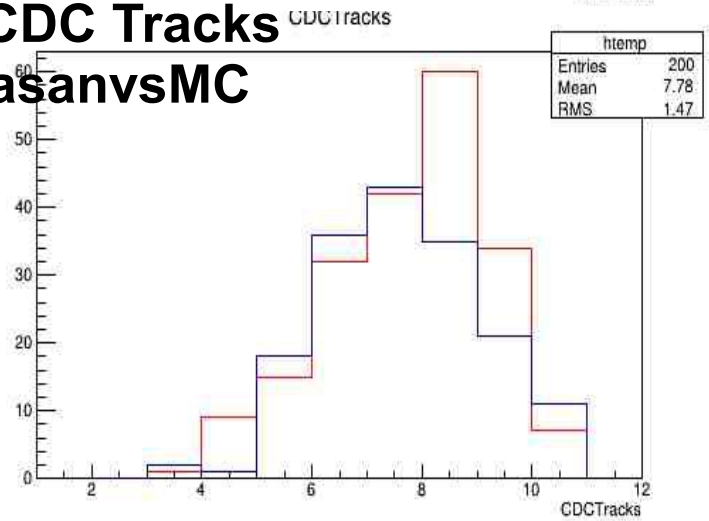
Monochromatic muons

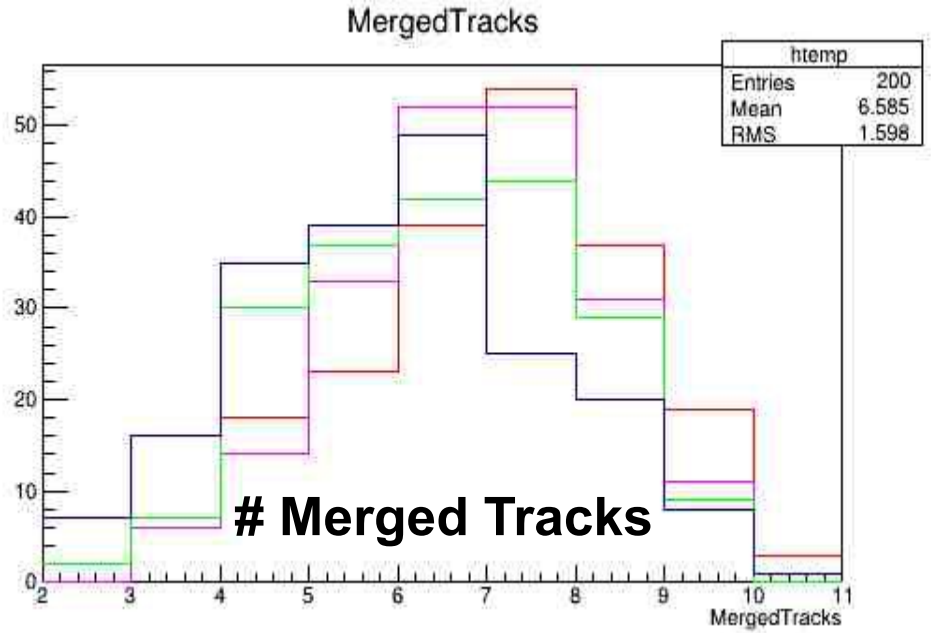
- *10 muons/evt from pGun with 2GeV each, full solid angle, 200 evt*

 # VXD Tracks
VXDTFvsMC



 # CDC Tracks
TrasanvsMC





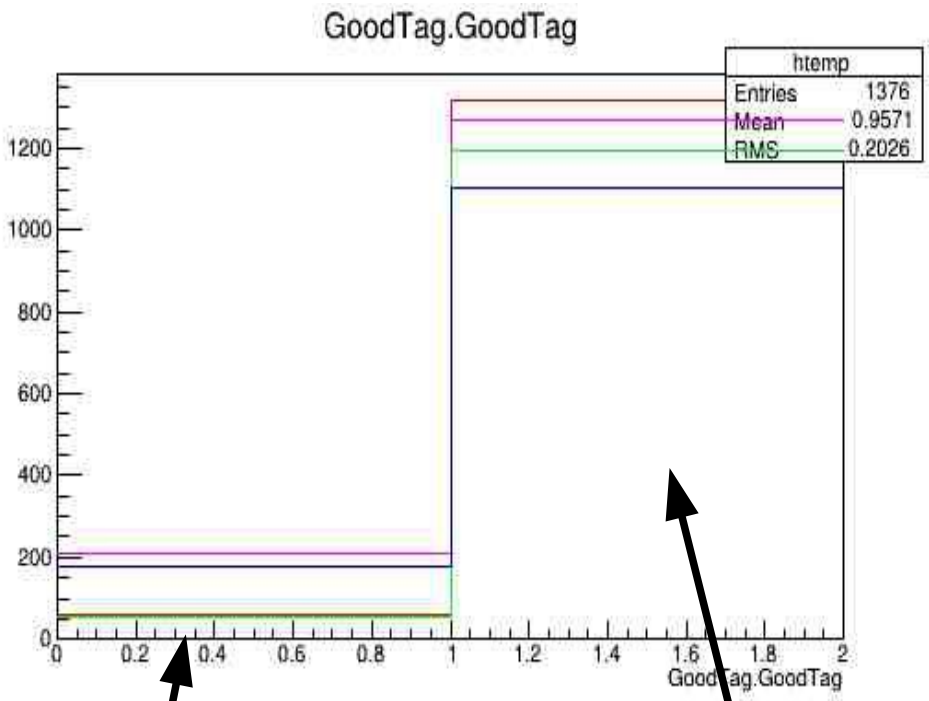
VXDTF + Trasan

VXDTF + MC

MC + Trasan

MC + MC

Monochromatic muons (2)

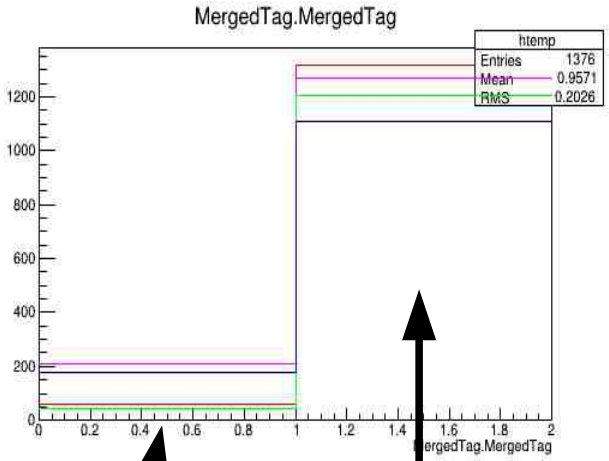


VXDTF + Trasan

VXDTF + MC

MC + Trasan

MC + MC



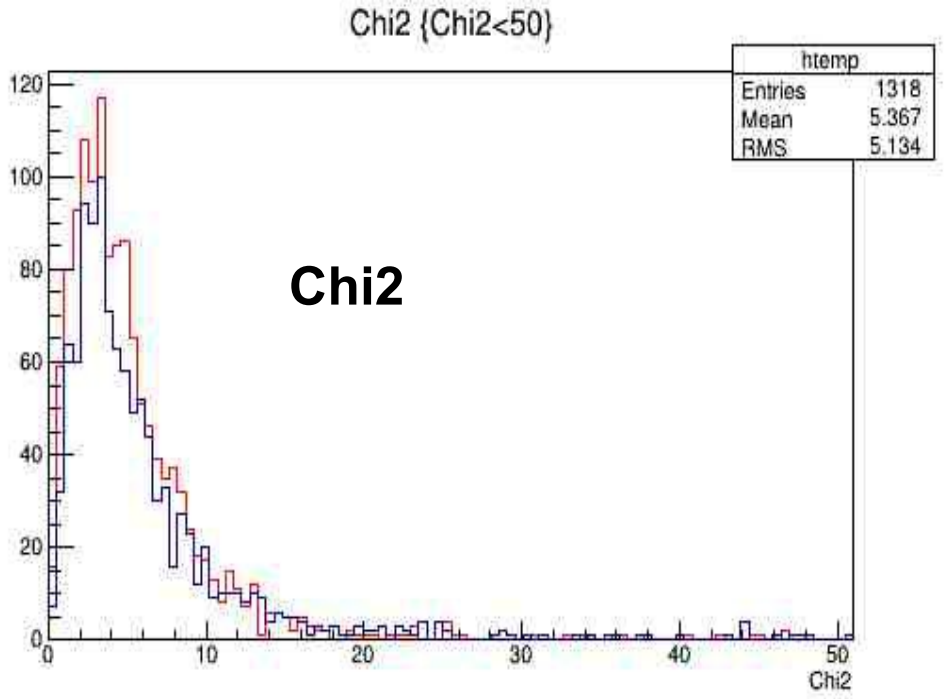
Not corr. Merged, i.e.
(!(Merged)&&TruthMatched)||
(Merged&&!(TruthMatched))

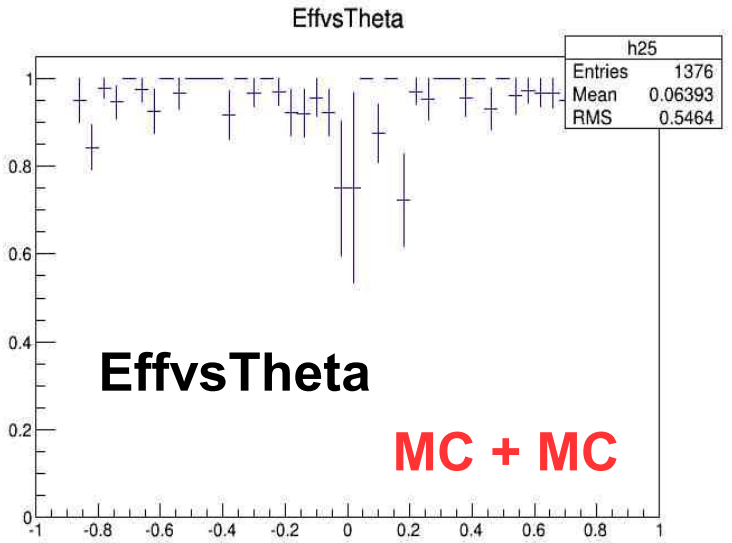
Correctly Merged
i.e.
Merged&&TruthMatched

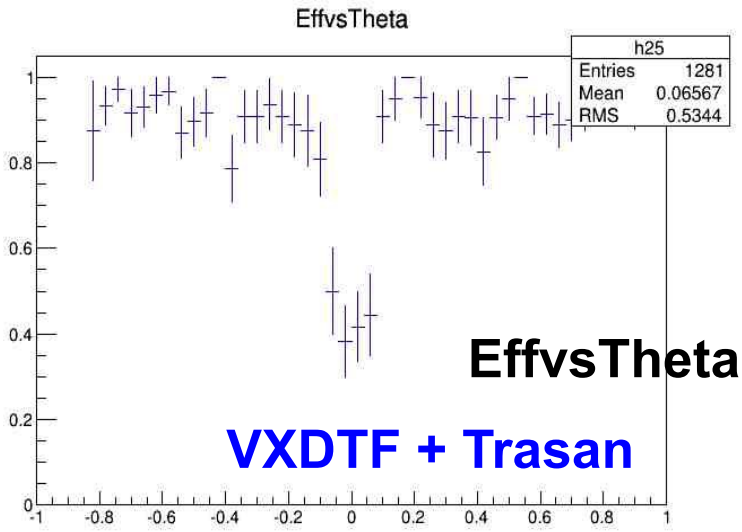
Not Merged

Merged

Monochromatic muons (3)





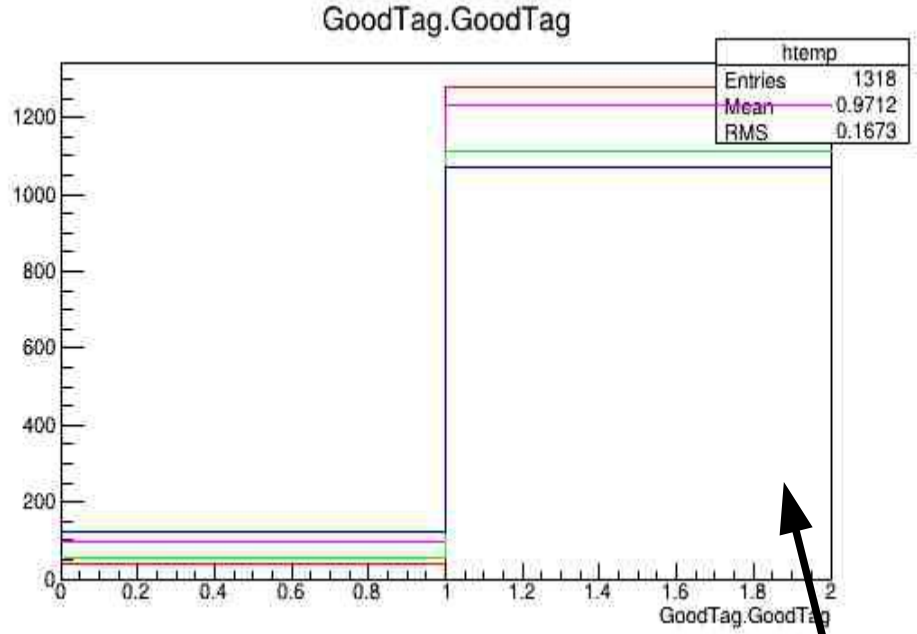


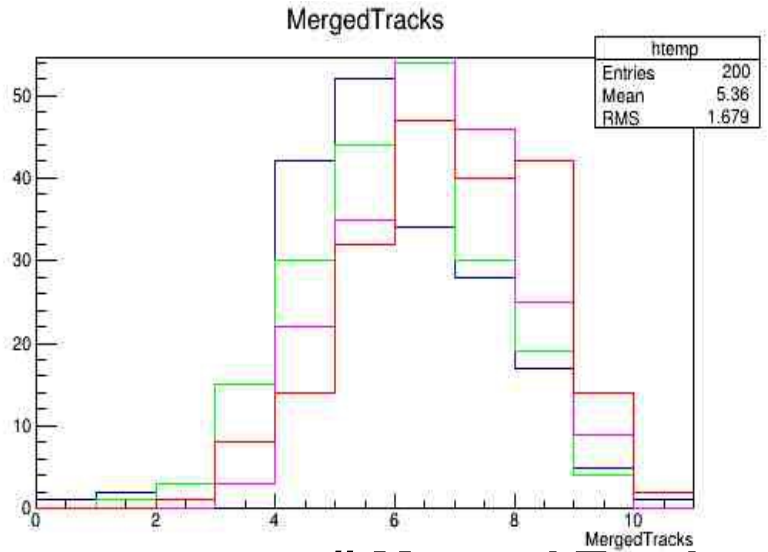
VXDTF + Trasan

MC + MC

Flat muons [0, 5] GeV

- *10 muons from pGun, flat [0, 5] GeV, full solid angle, 1000 evt ***





 # Merged Tracks

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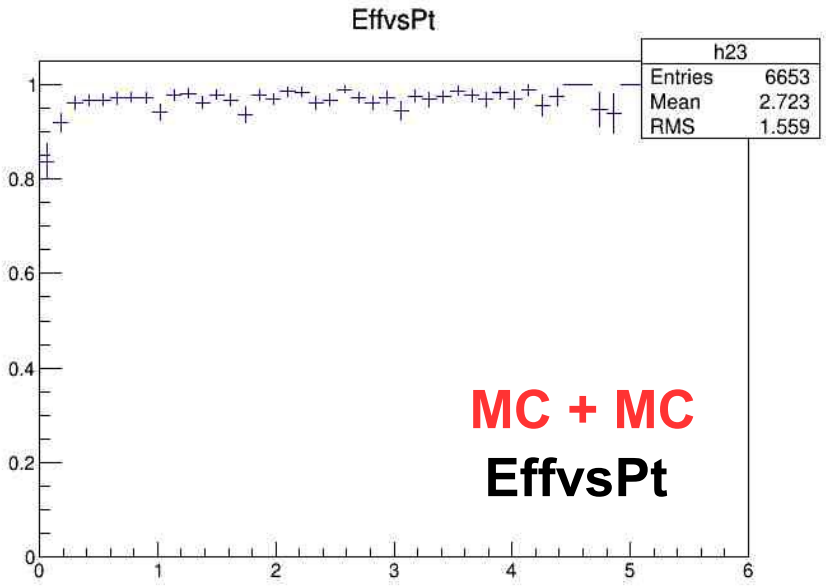
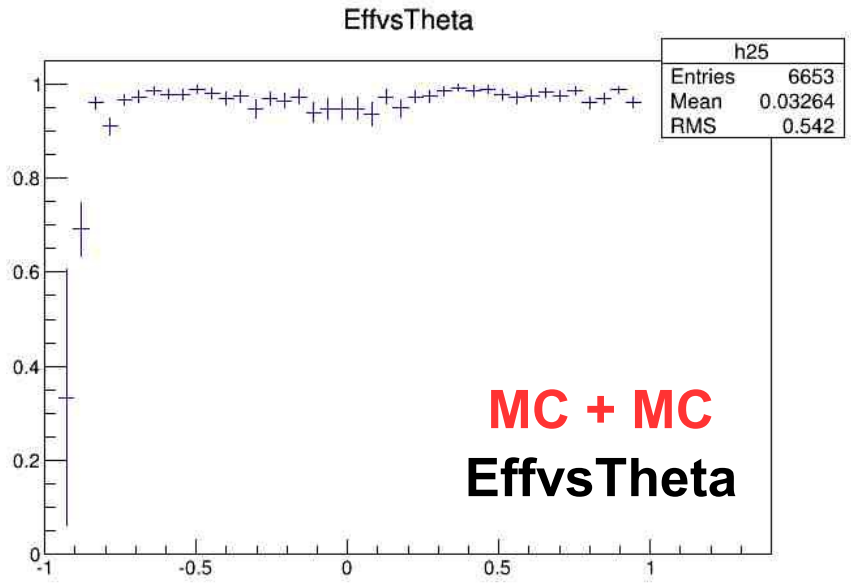
i.e.
Merged&&TruthMatched

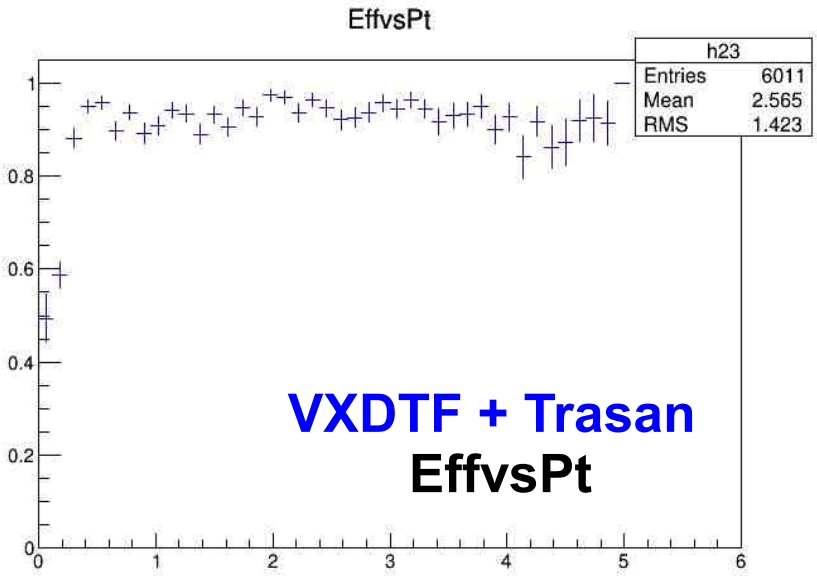
VXDTF + Trasan
VXDTF + MC
MC + Trasan
MC + MC

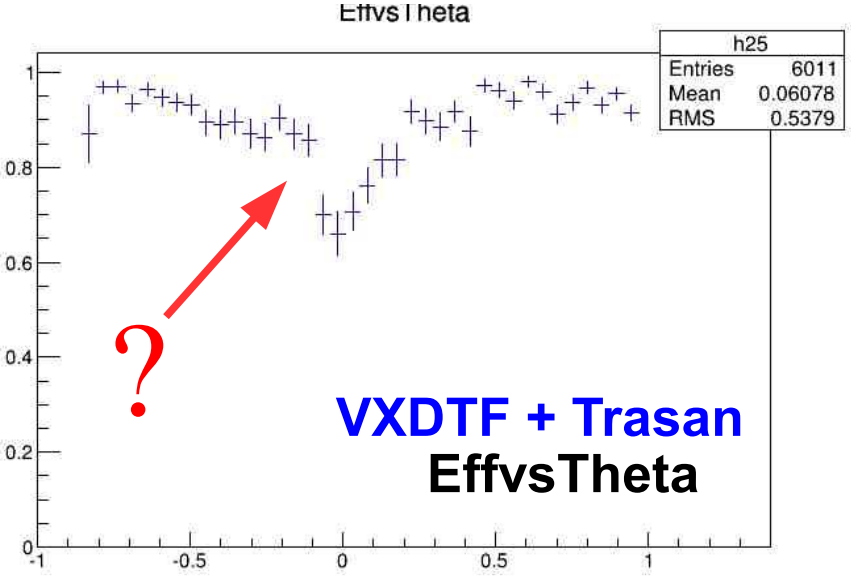
***some plots are mad with just 200 evt*

Flat muons [0, 5] GeV, scan



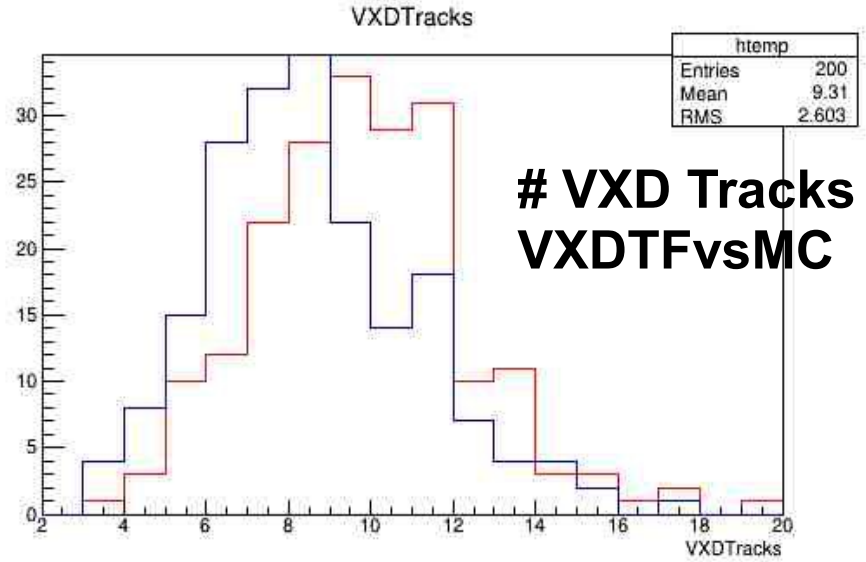




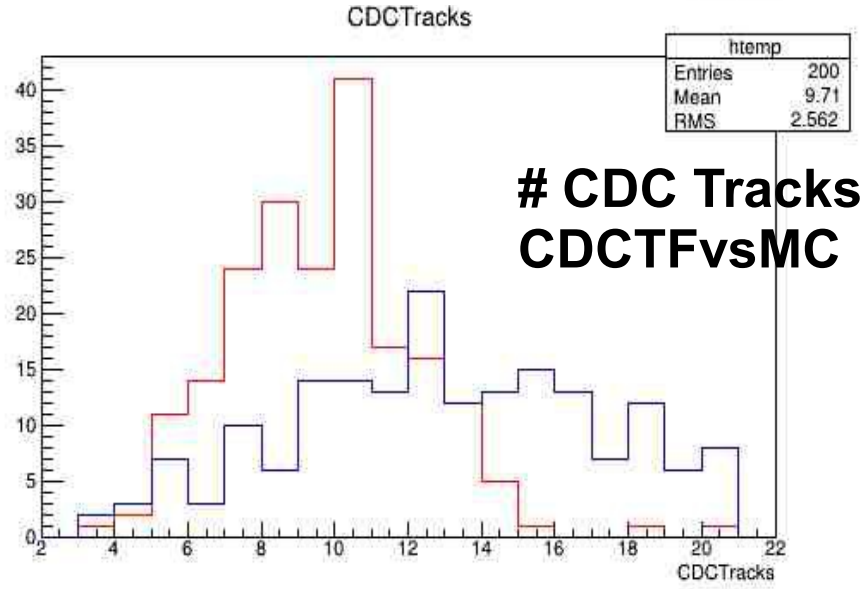


EvtGen

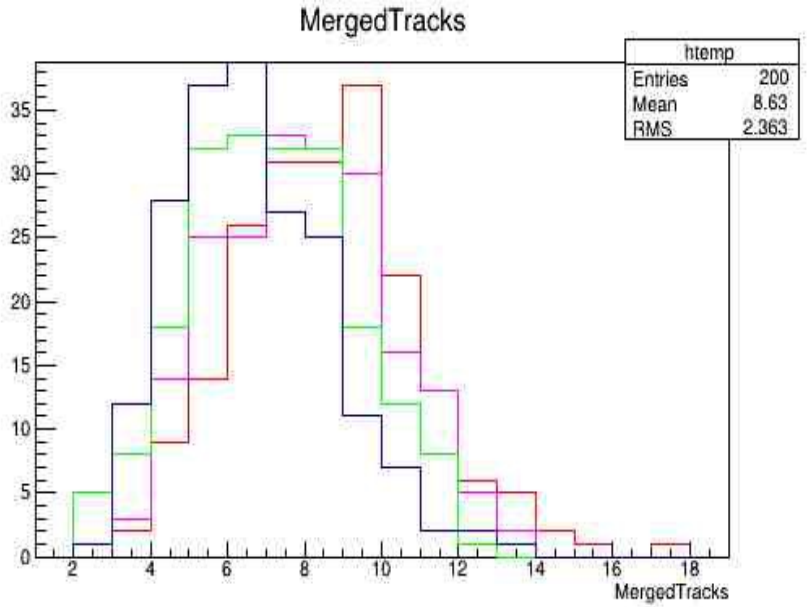
- *EvtGen, default settings, 200 evt*



 # VXD Tracks
VXDTFvsMC



 # CDC Tracks
CDCTFvsMC

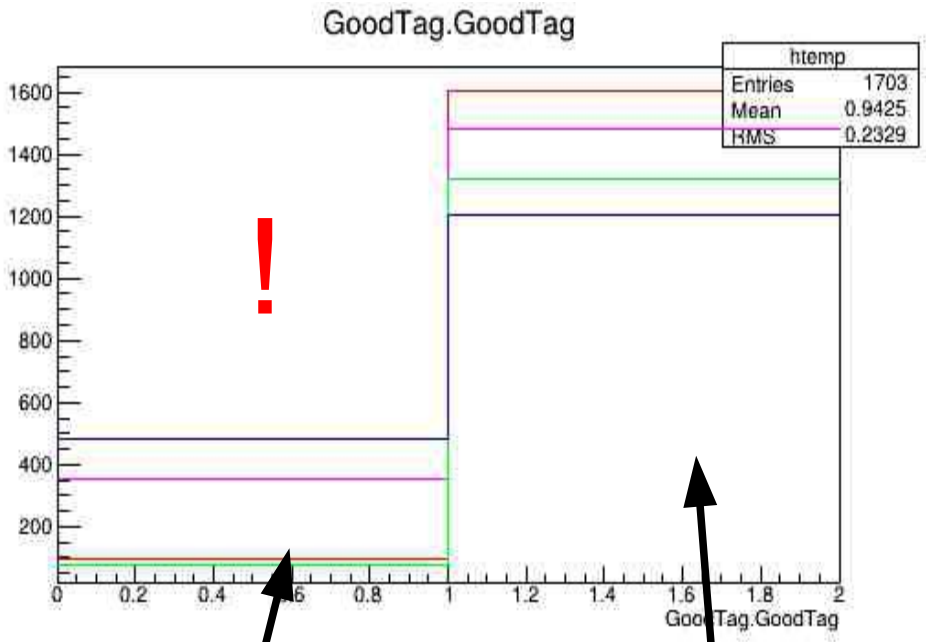


 # Merged Tracks

VXDTF + Trasan
VXDTF + MC
MC + Trasan
MC + MC

EvtGen (2)

VXDTF + Trasan
VXDTF + MC
MC + Trasan
MC + MC



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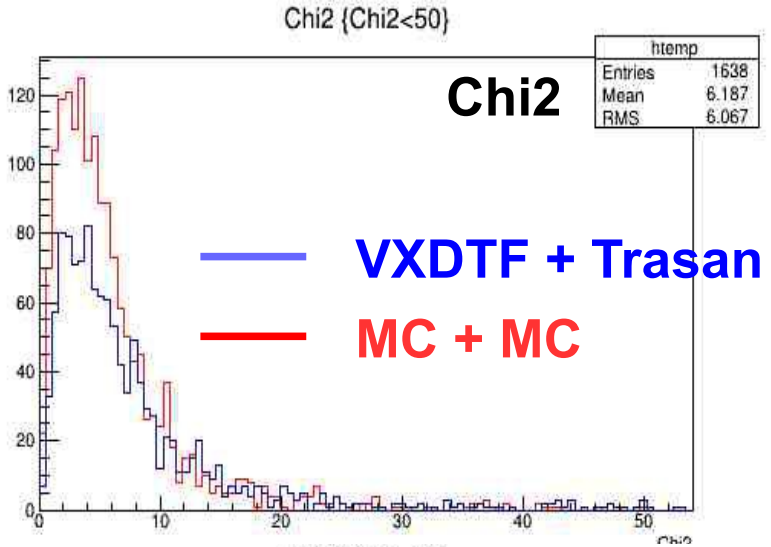
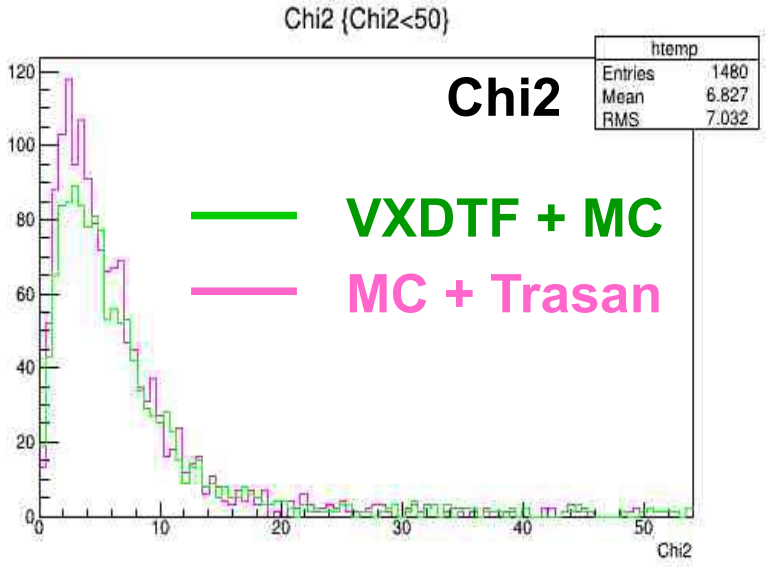
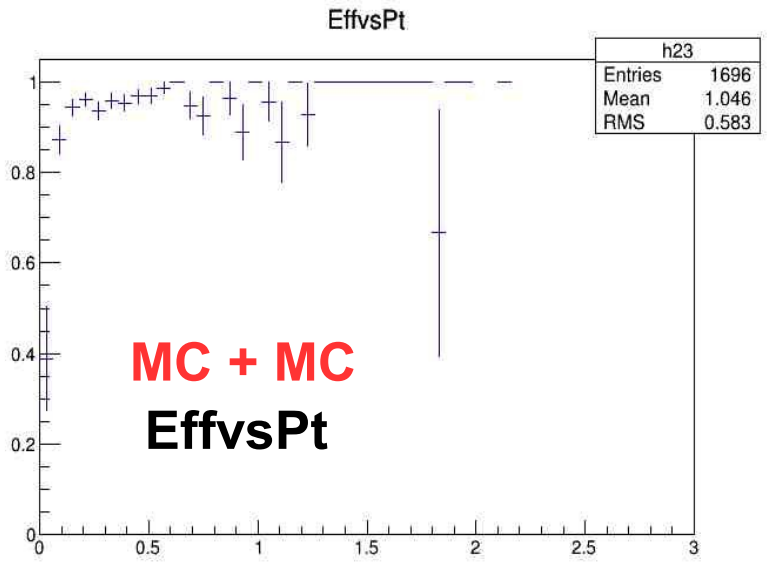
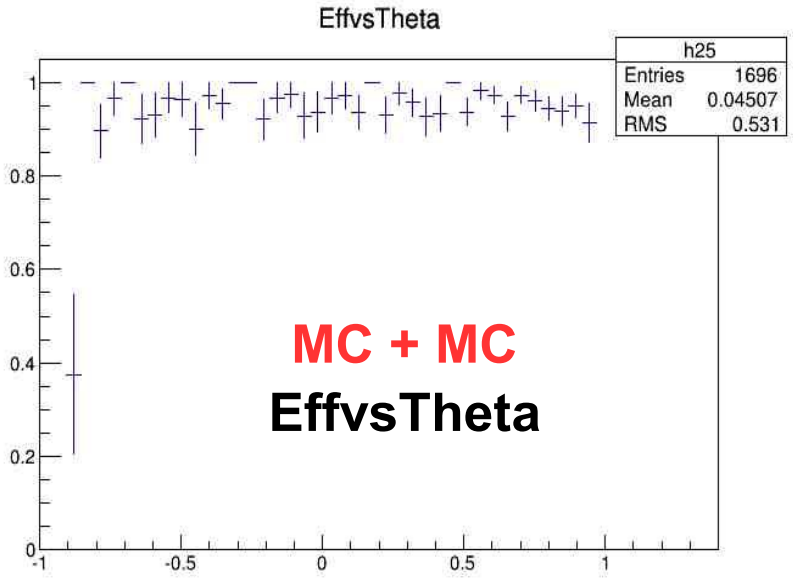
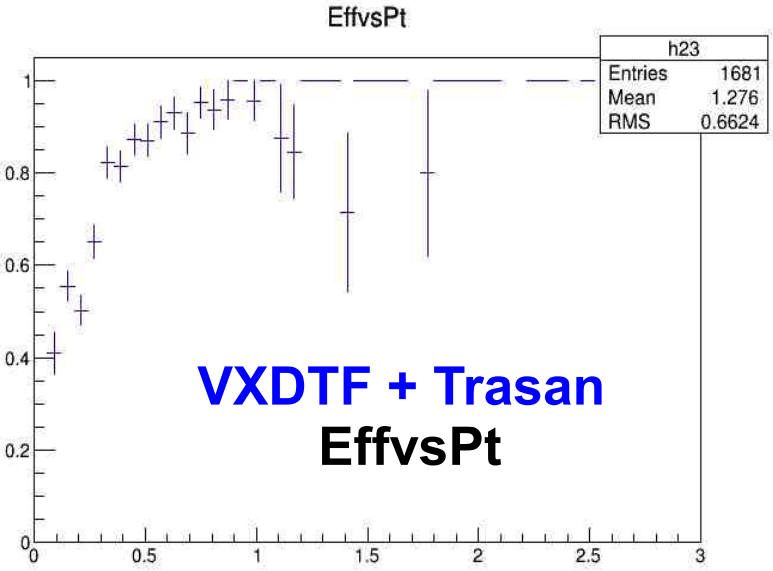


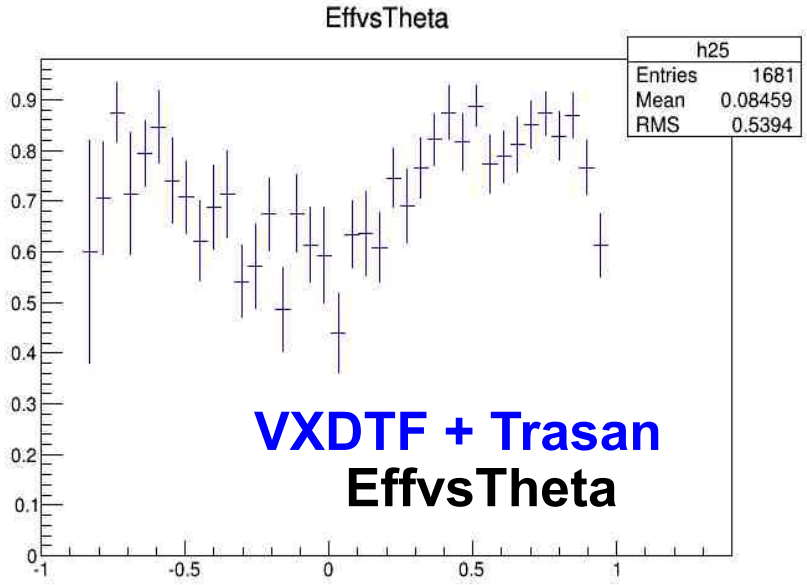


EvtGen (3), scan









Summary & Outlook

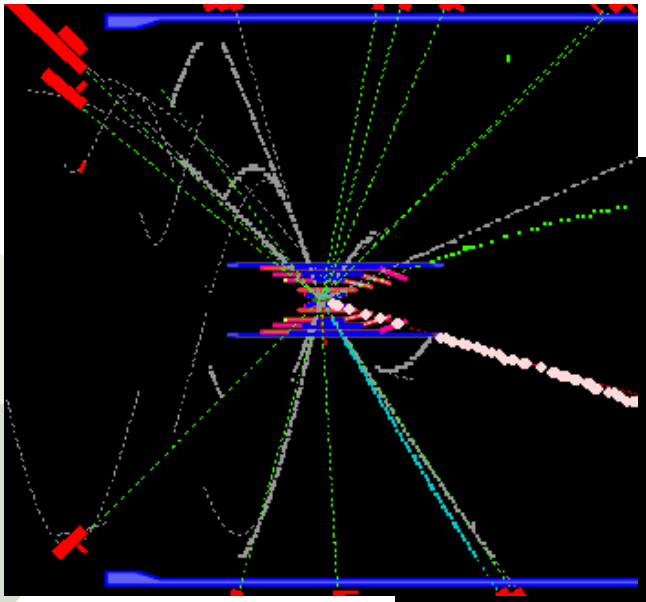
- *Efficiency loss with actual track-finders w.r.t. MCTruthTF is big, especially for typical for EvtGen*
- *High efficiency loss MCFinder → VXDTF*
- *Further study is needed to understand how to improve the merger*

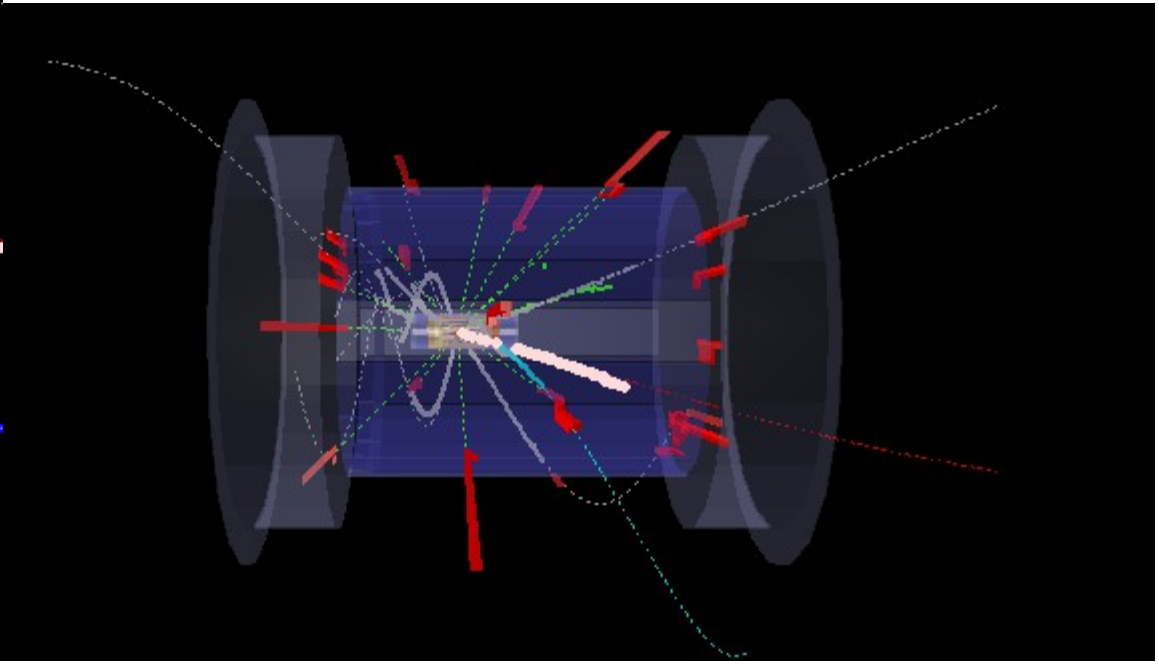
- *There is a bug in the last code version, run time-crash <every> 4-500 events, I have to find out why*
- *Can we remove CandMerger & GFTrackSplitter modules??*
- *I think we have to implement some "recovery mode" for tracks which fail merging, and introduce an index to label them*
- *Partial rewriting of VXDCDCTrackMergerAnalysis is necessary*
- *Validation scripts will be added after B2GM (need feedback from the tracking group for TrackFinders and event type to be used)*

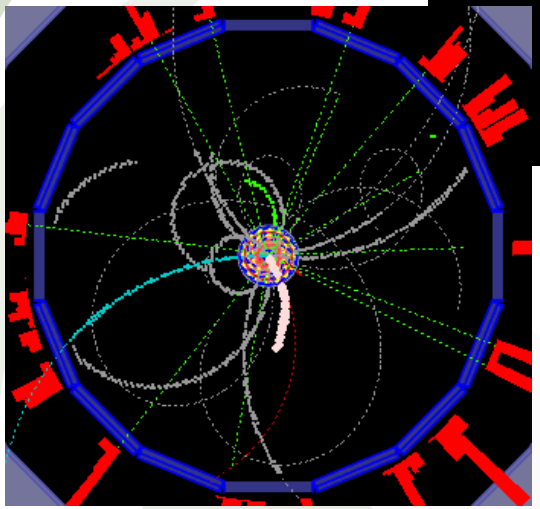
Thanks!

Backups

EvtGen: why merging fails? (K)







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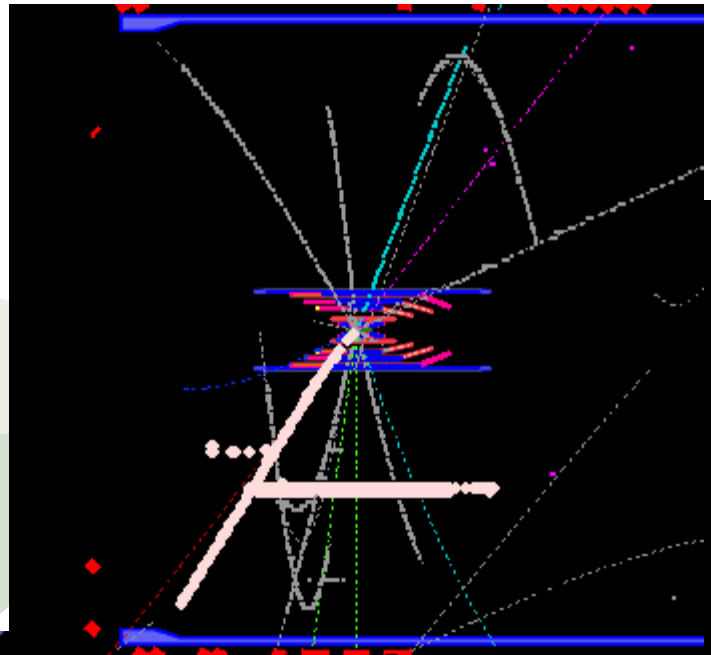
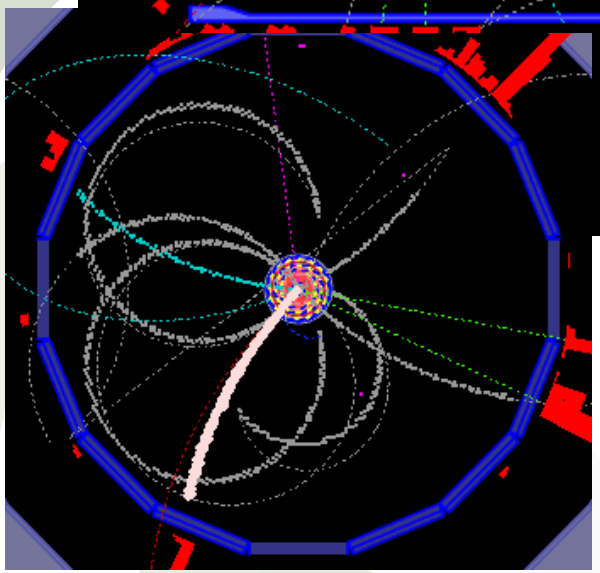
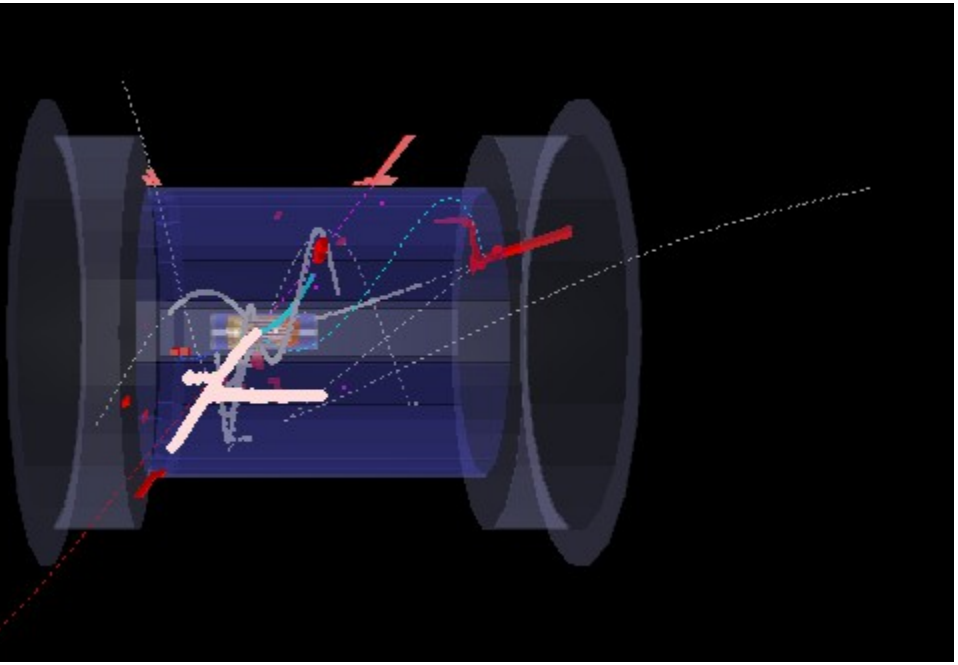
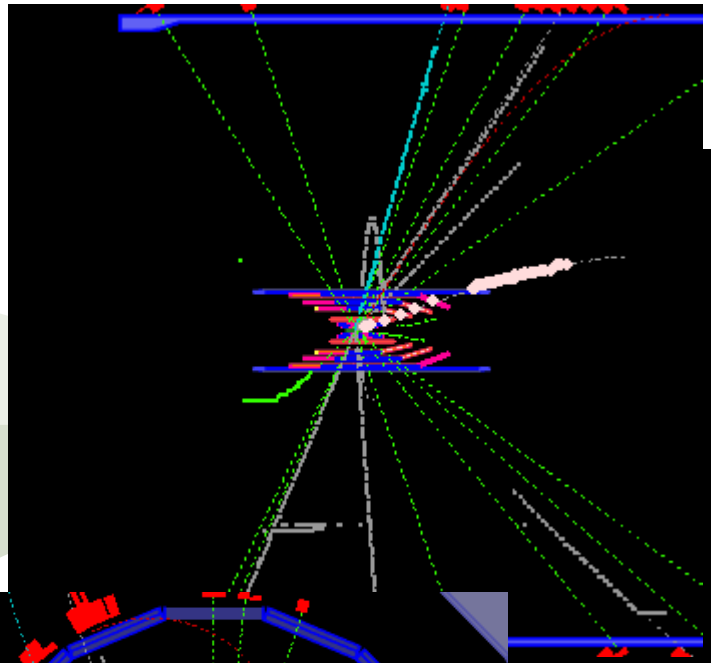
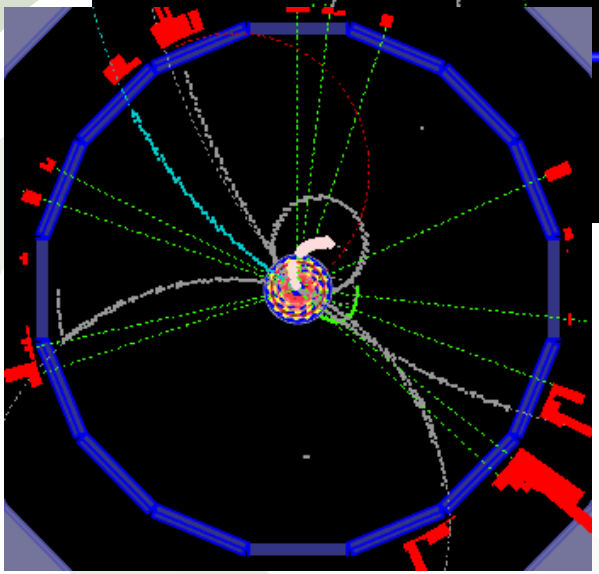


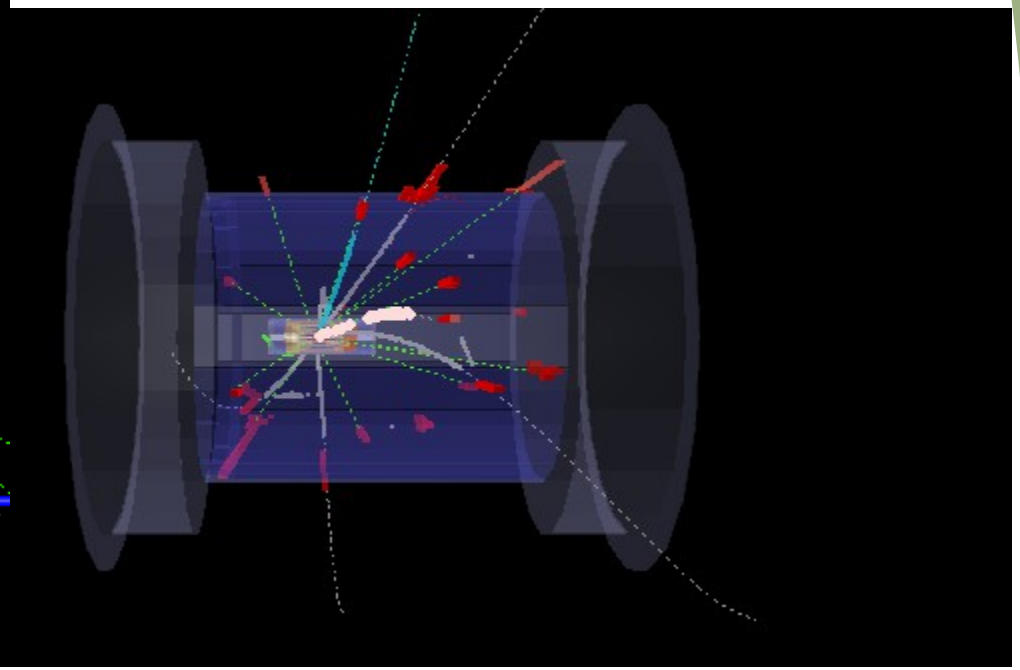




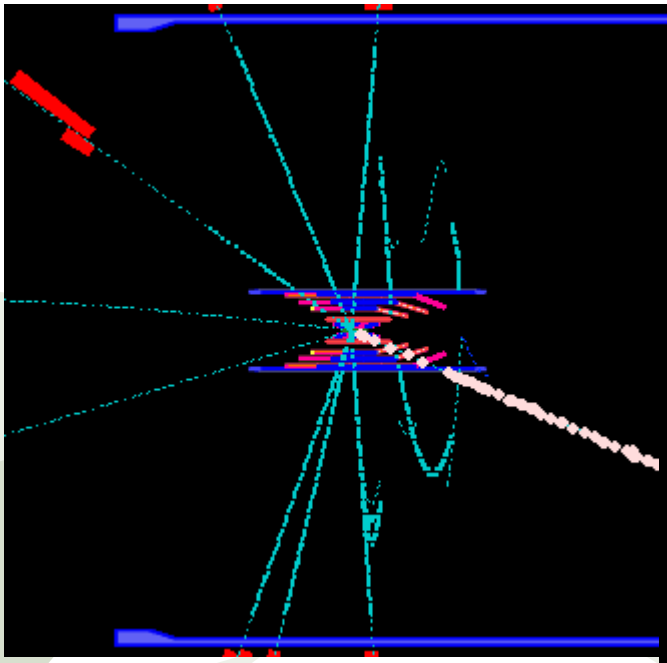
EvtGen: why merging fails? (pi)

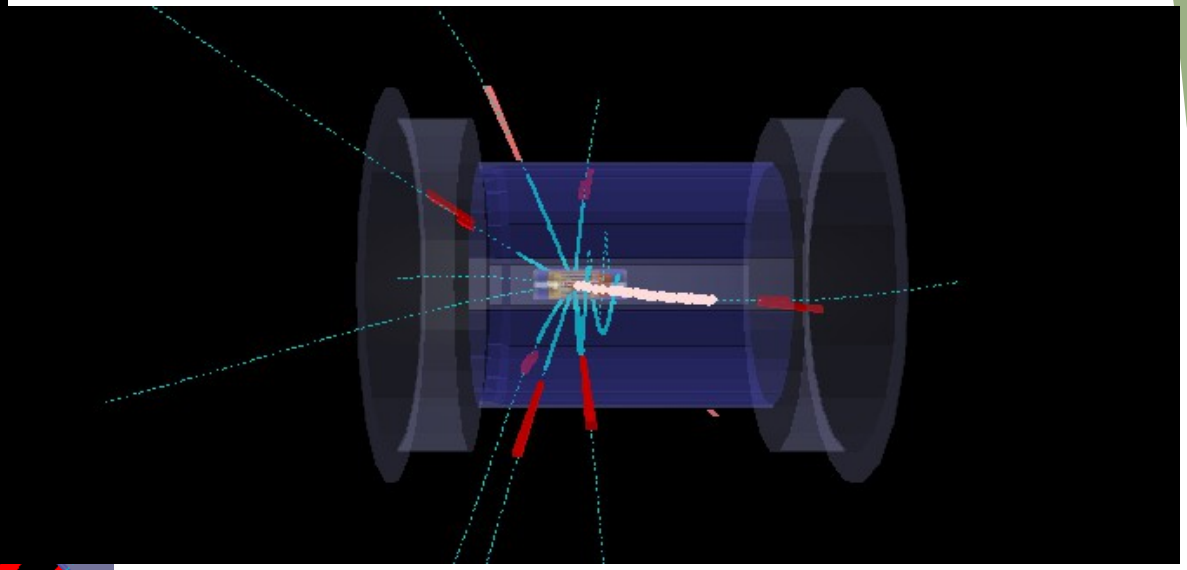


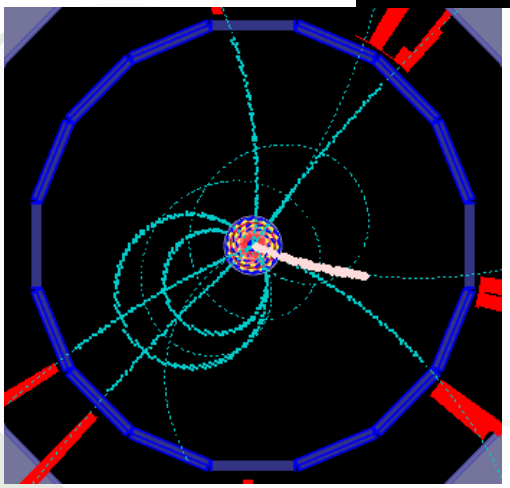




Muons: why merging fails?







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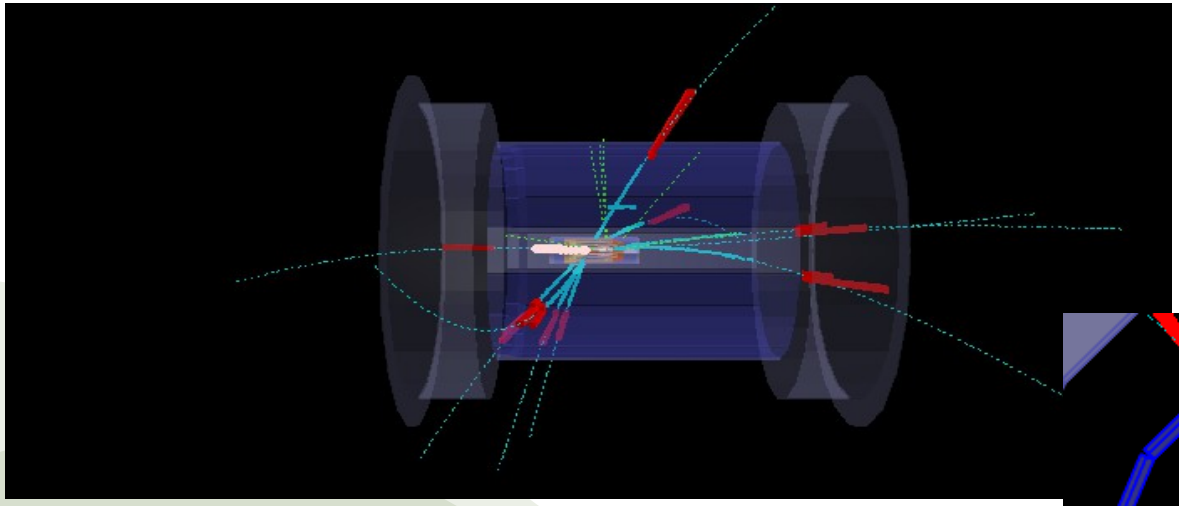

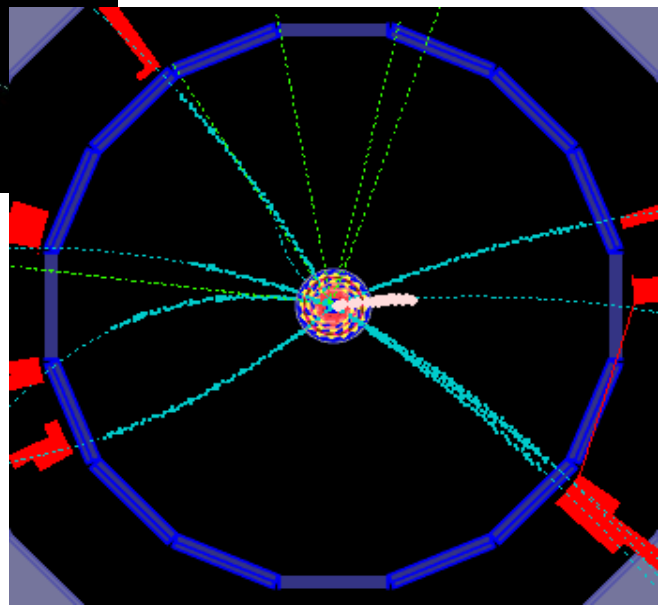

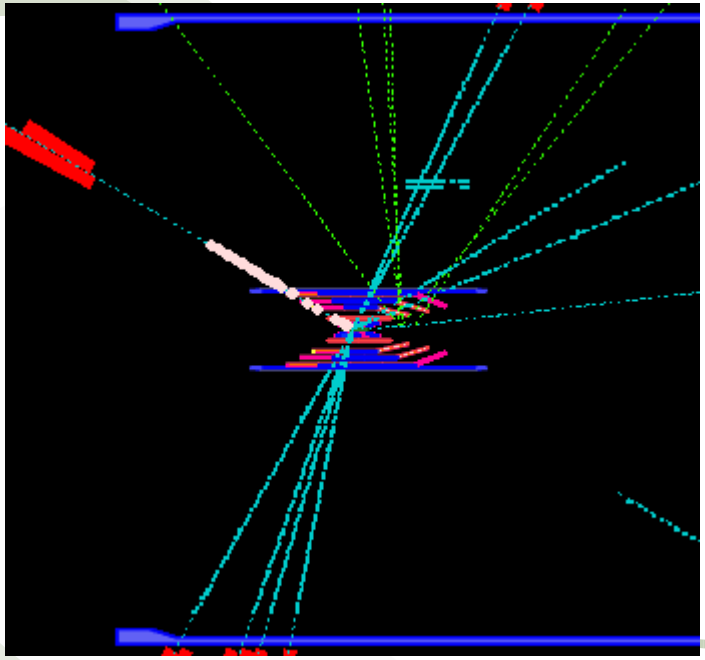

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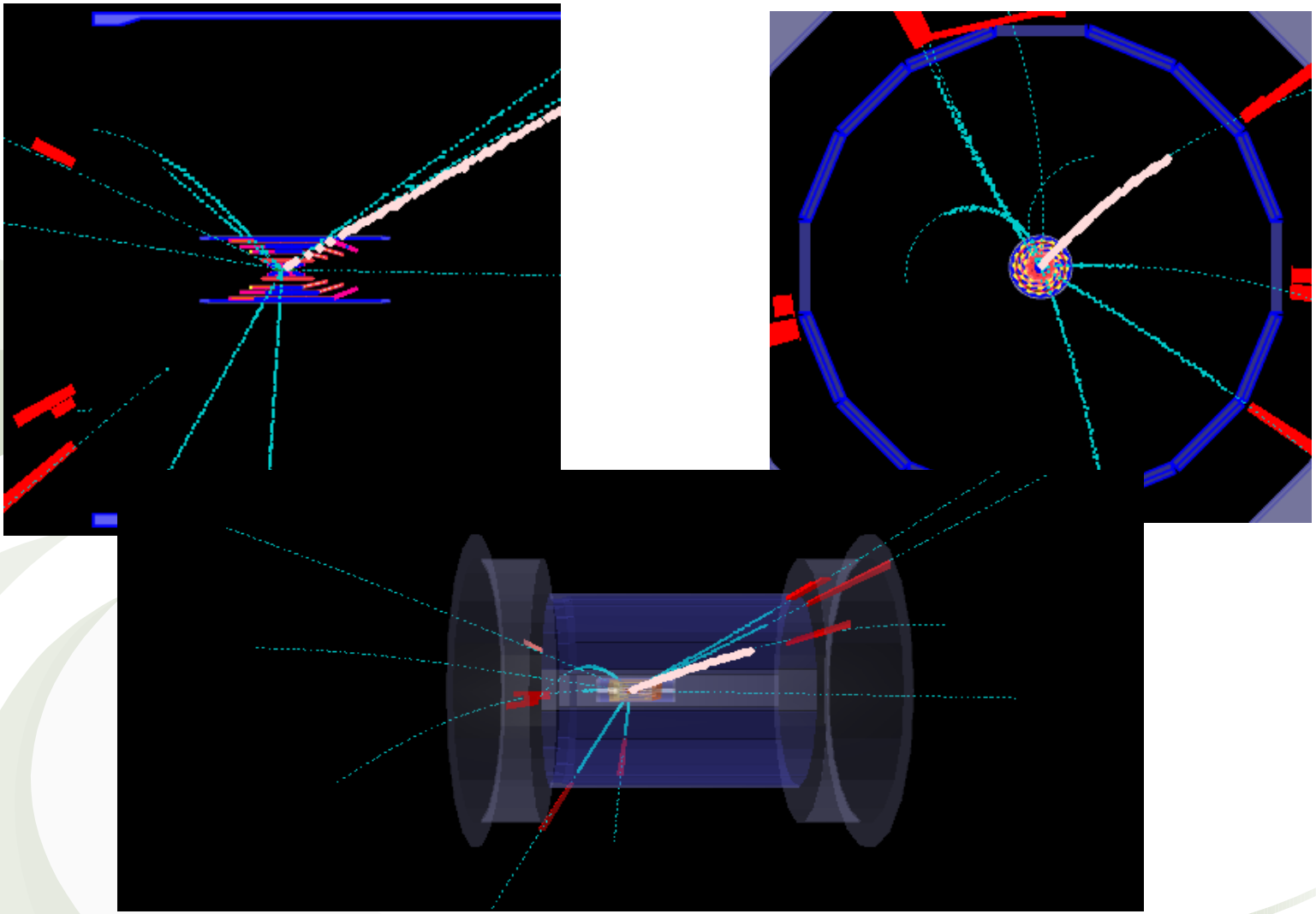

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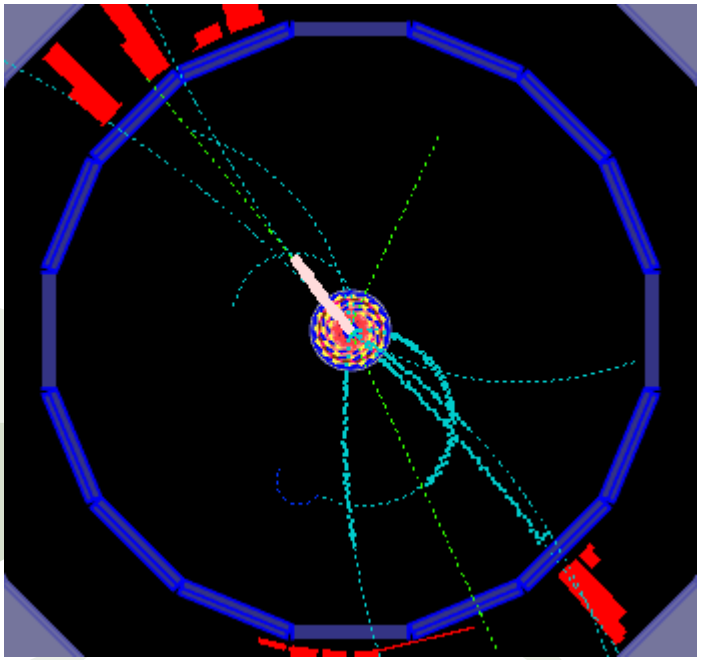
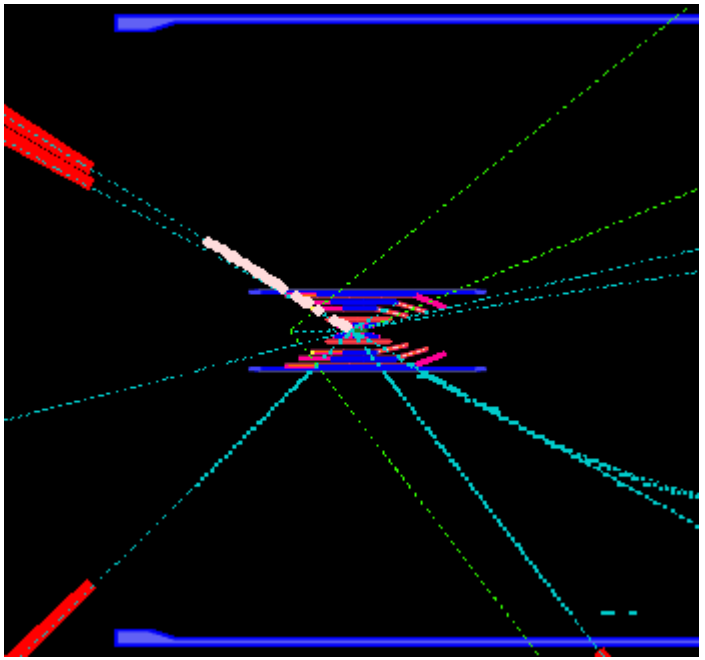
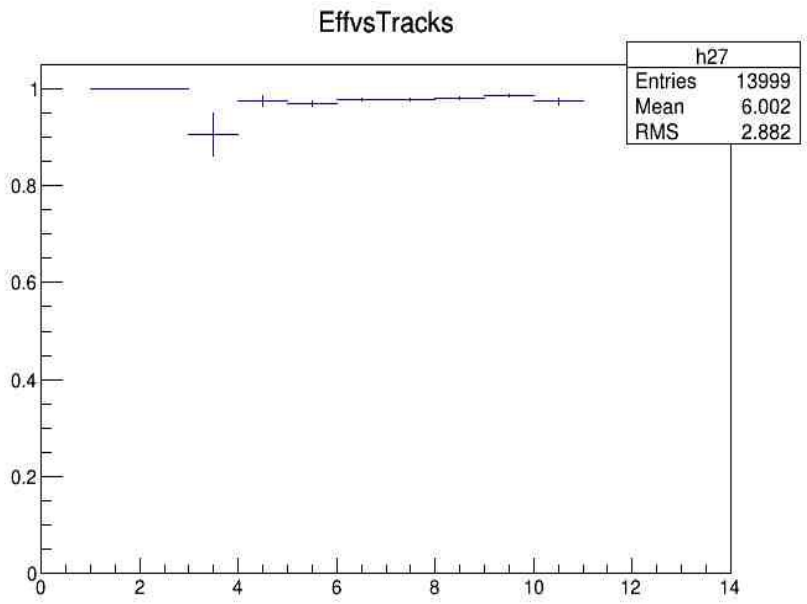


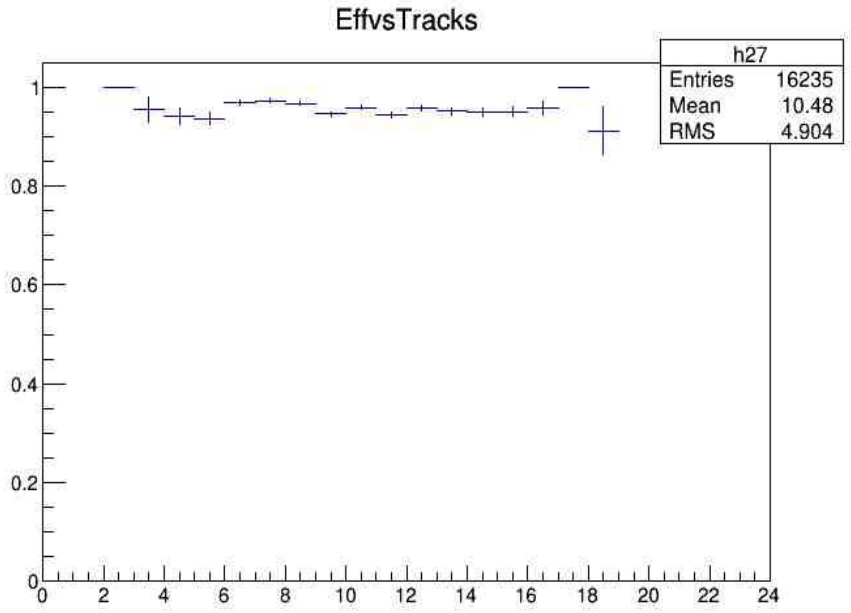


- *Tracks fail mainly when CDC track is "short" i.e. near the SVD border or it passes in the region of the SVD angle*
- *No events with unmerged curlers observed*
- *$X^{2\ is}$ is big because difference in momenta, in the above regions it would be worth to test a position only based selection*

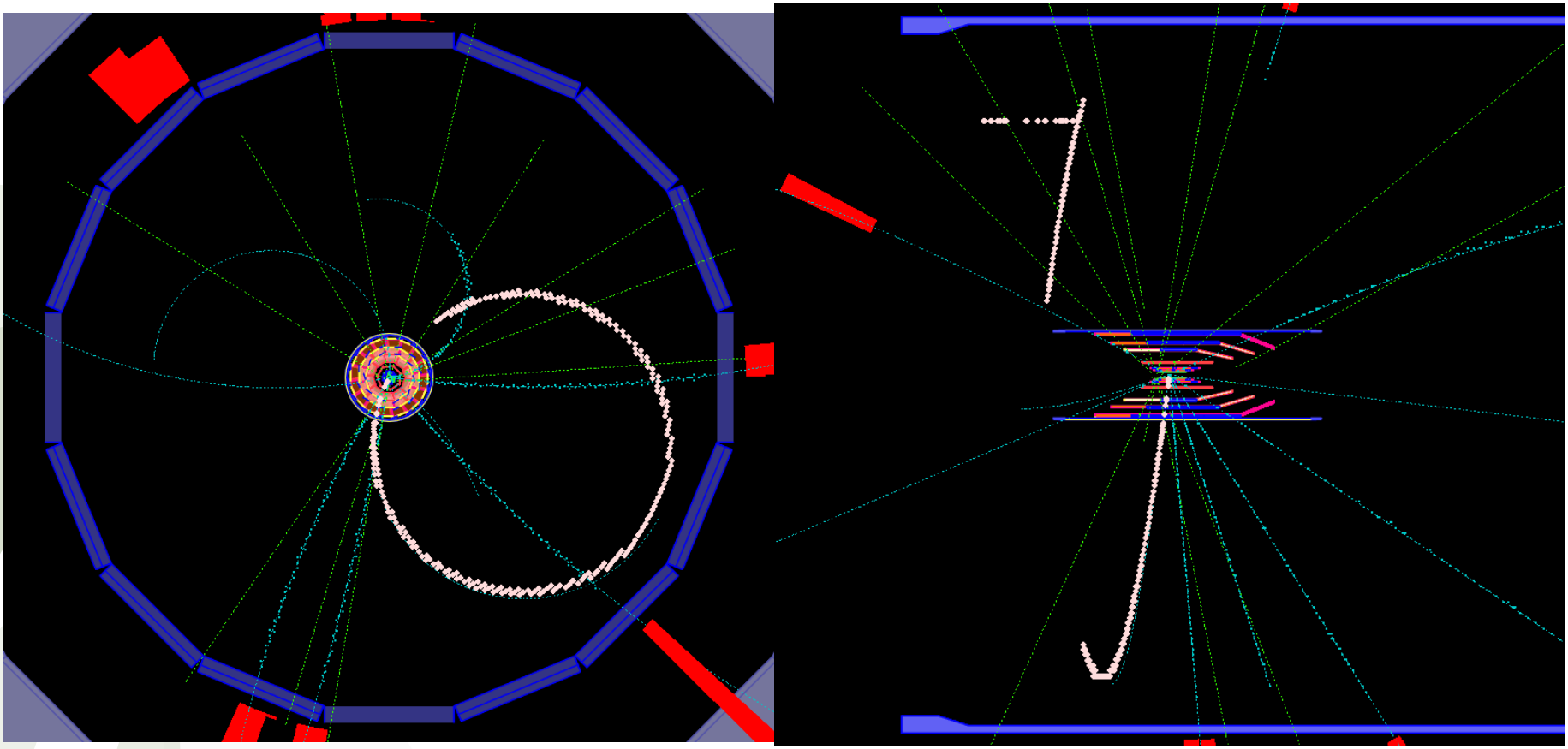
Efficiency vs # tracks

- *Efficiency vs. # of tracks for muons (left) and EvtGen (right)*
- *No particular pattern is observed*





Pi, p_T=270 MeV, P_z=-0.023



Analysis module

- *Doesn't need VXDCDCTrackMerger module output, runs in parallel*
- *Same algorithm, same path, but more info is stored*
- *Same parameters as VXDCDCTrackMerger + output_file_name*
- *Loops on CDC tracks, for every track there's a bit if merged, truth_merged etc...*
- *Most quantities directly available in TTree, e.g. Chi2, residuals, etc..*