Frame Implementation and Physics Simulation

CBM-TRD Retreat, 7-9 November 2023

Omveer Singh

08.11.2023

CAD to RooT conversion

CAD → GDML → RooT → Existing Macro

(.step,.stp)

(tessellated object)

- FreeCAD GDML Workbench

  https://github.com/KeithSloan/GDML

- http://polar.psi.ch/cadmc/converter/index.php

  (max 5 MB)

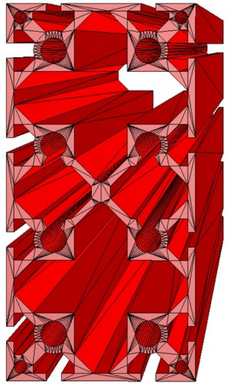
```
TGeoVolume *_vol_assembly = new TGeoVolumeAssembly(_volumename);

TGDMLParse parser;
TGeoVolume *_gdml_vol = parser.GDMLReadFile(_file);
TObjArray *_node = _gdml_vol->GetNodes();

 Int_t copy_number =0;
for (int iNode = 0; iNode < _node->GetEntriesFast(); iNode++) {
  TGeoNode *_fNode = (TGeoNode *)_node->At(iNode);

  TGeoVolume *_fVol = (TGeoVolume *)_fNode->GetVolume();

  _vol_assembly->AddNode(_fVol, copy_number, 0);
  copy_number++;
}
_vol_assembly->Export(_file_out);
```

```
TGeoVolume* trd_main_support = new TGeoVolumeAssembly("mainframe");

TFile* _file              = new TFile("mainframe_02.root");
TGeoVolume* mainframe_vol = (TGeoVolume*) _file->Get("mainframe_02");

TObjArray* nodesArr_mainframe = mainframe_vol->GetNodes();

for (int iNode = 0; iNode < nodesArr_mainframe->GetEntriesFast(); iNode++) {
  TGeoNode* fNode = (TGeoNode*) nodesArr_mainframe->At(iNode);

  TGeoVolume* fVol = (TGeoVolume*) fNode->GetVolume();
  fVol->SetMedium(aluminiumVolMed);
  fVol->SetLineColor(kRed);

  trd_main_support->AddNode(fVol, iNode, 0);
}
gGeoMan->GetVolume(geoVersion)->AddNode(trd_main_support, 0,  new TGeoTranslation(0, -313.48, 255.15));
```

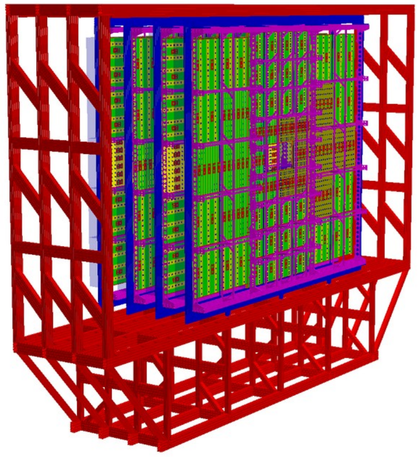
- The additional complexity in the GDML files comes with GEANT simulation processing time increase (upper limit: +110% for TRD).

- Committed in trd_support branch

  https://git.cbm.gsi.de/trd/cbmsoft/cbmroot_geometry



Tessellated Objects



trd_v23a_1h setup

Simulation Details

5M - Au+Au @ 8A GeV/c (central UrQMD)

Setup: sis100_electron

Simulation Engine: Geant3

Geometry Tags:

"magnet": "v22a",

"pipe": "v21d:v21i",

"mvd": "v20d_tr",

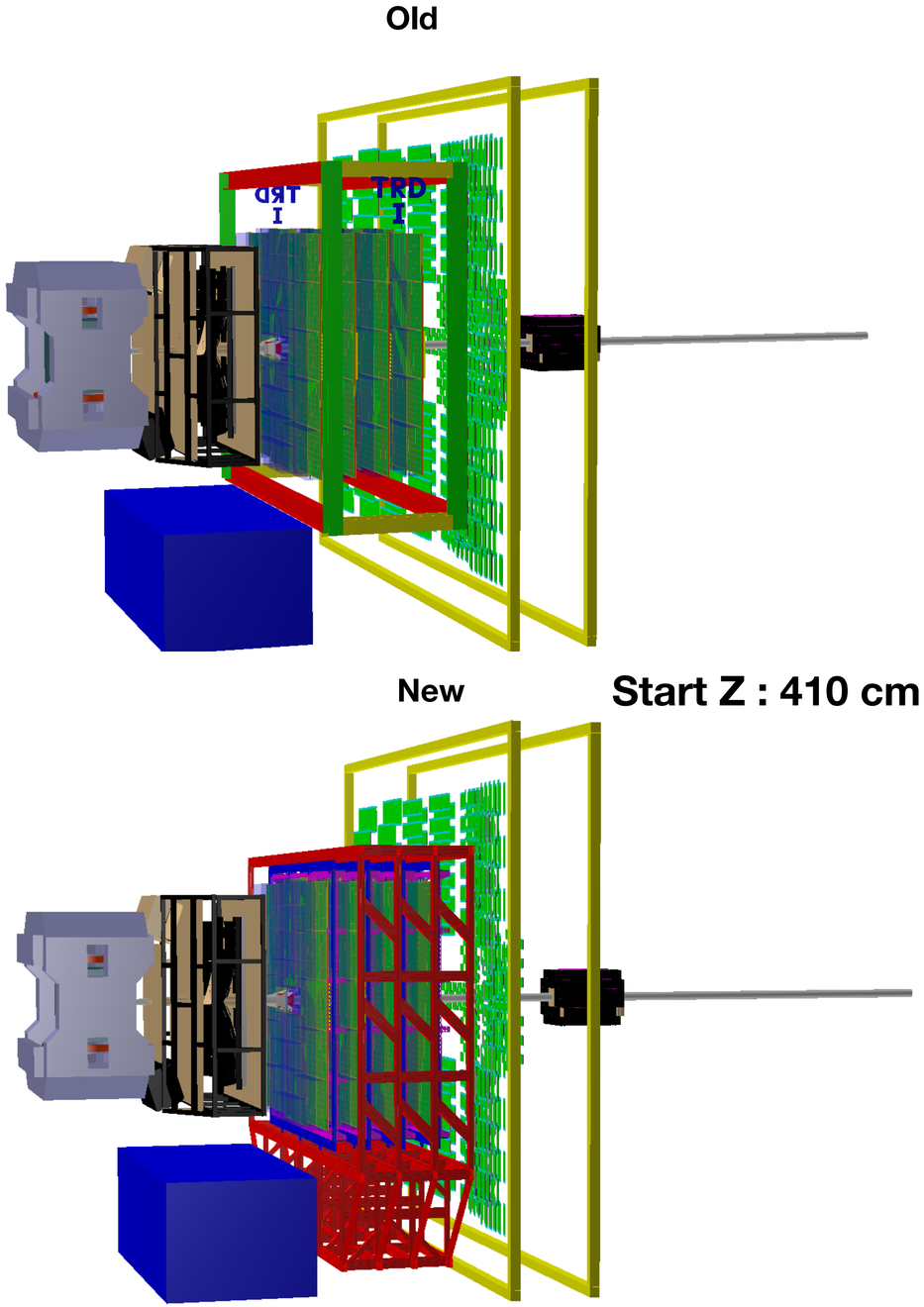
"sts": "v22c",

"rich": "v21a",

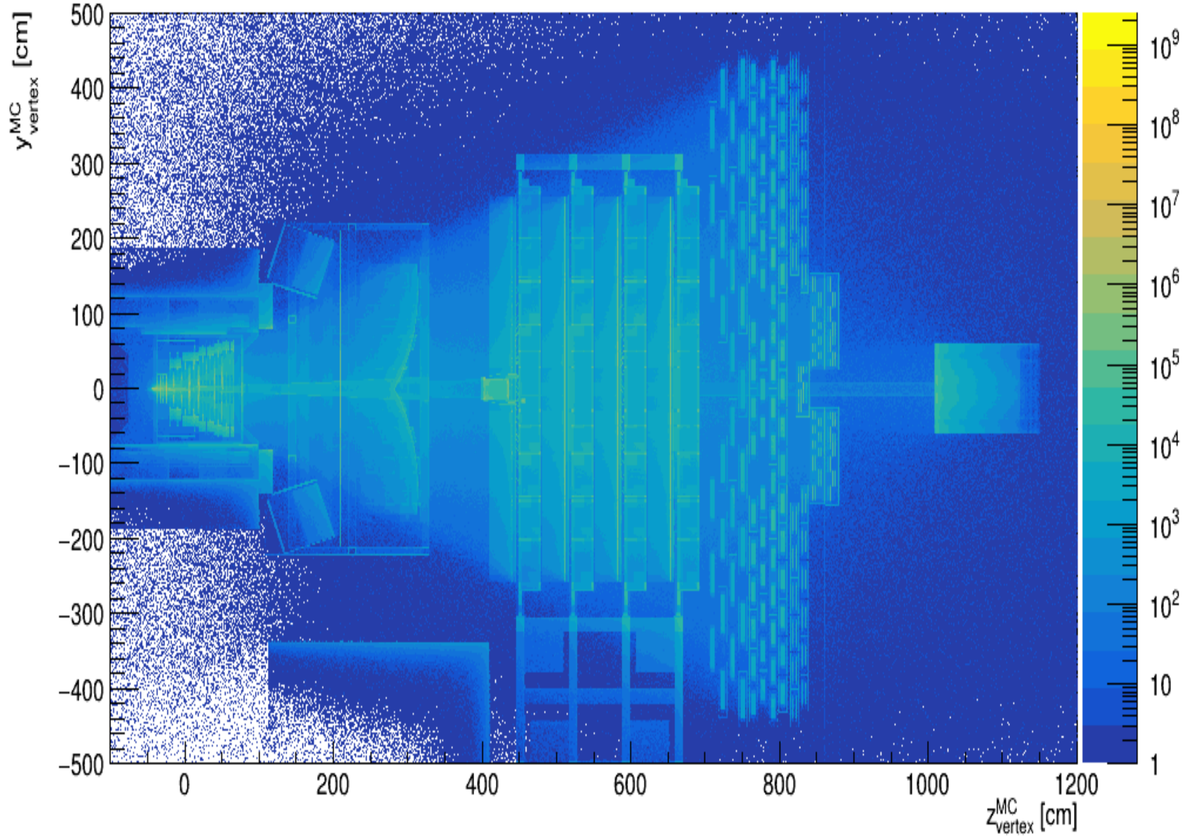
"tof": “v21a_1e",

"psd": "v22a",

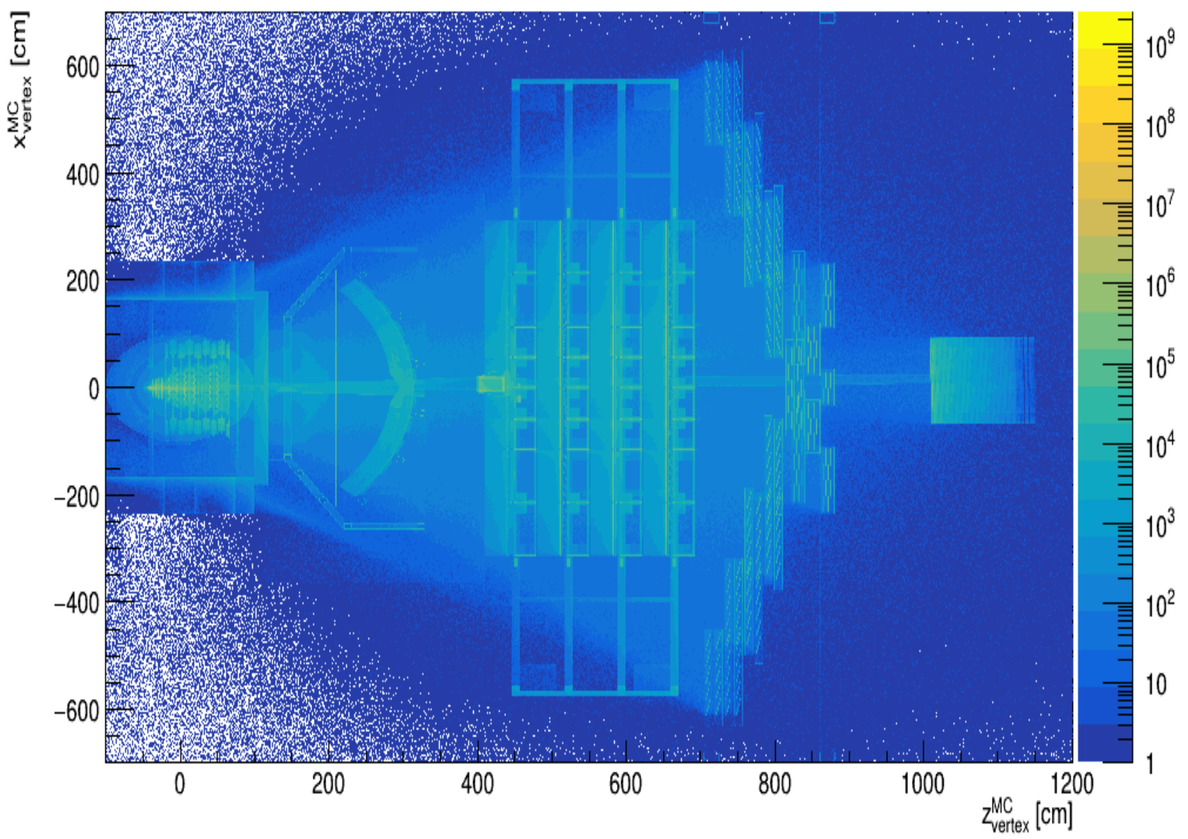
"platform": "v22b"



MC vertices of all particles in electron setup

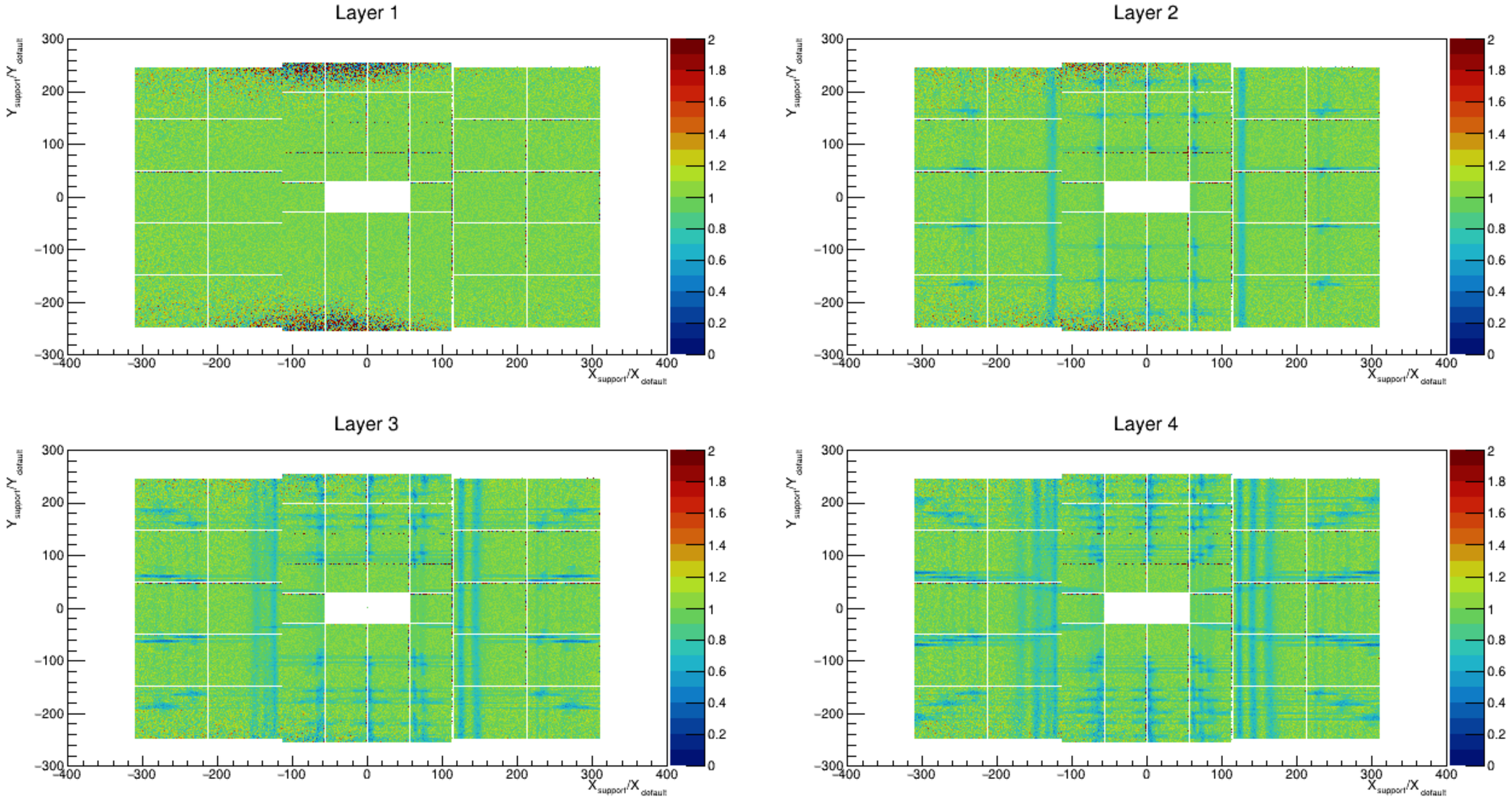


yz-plane



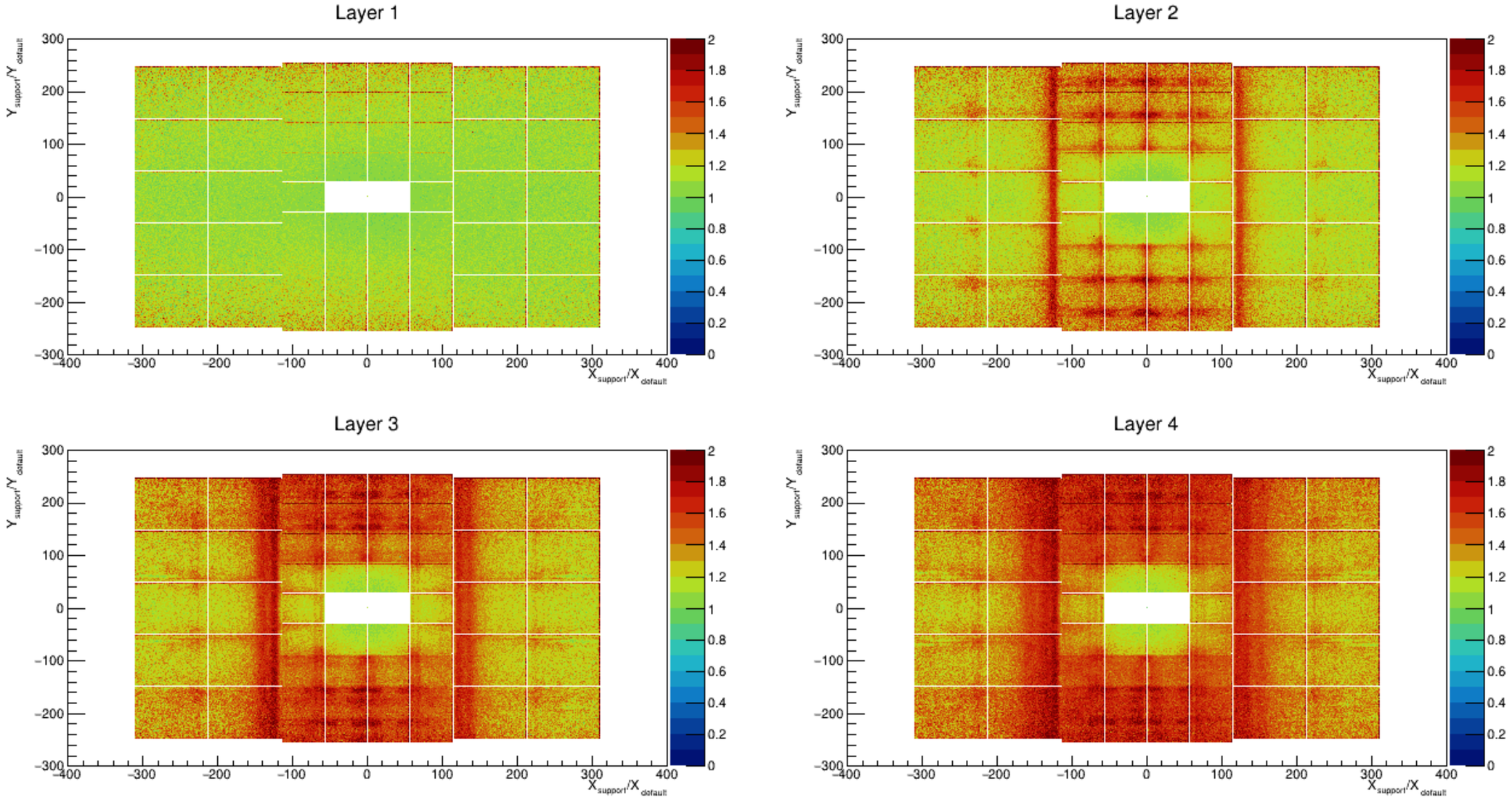
xz-plane

TRD MC points (primary)



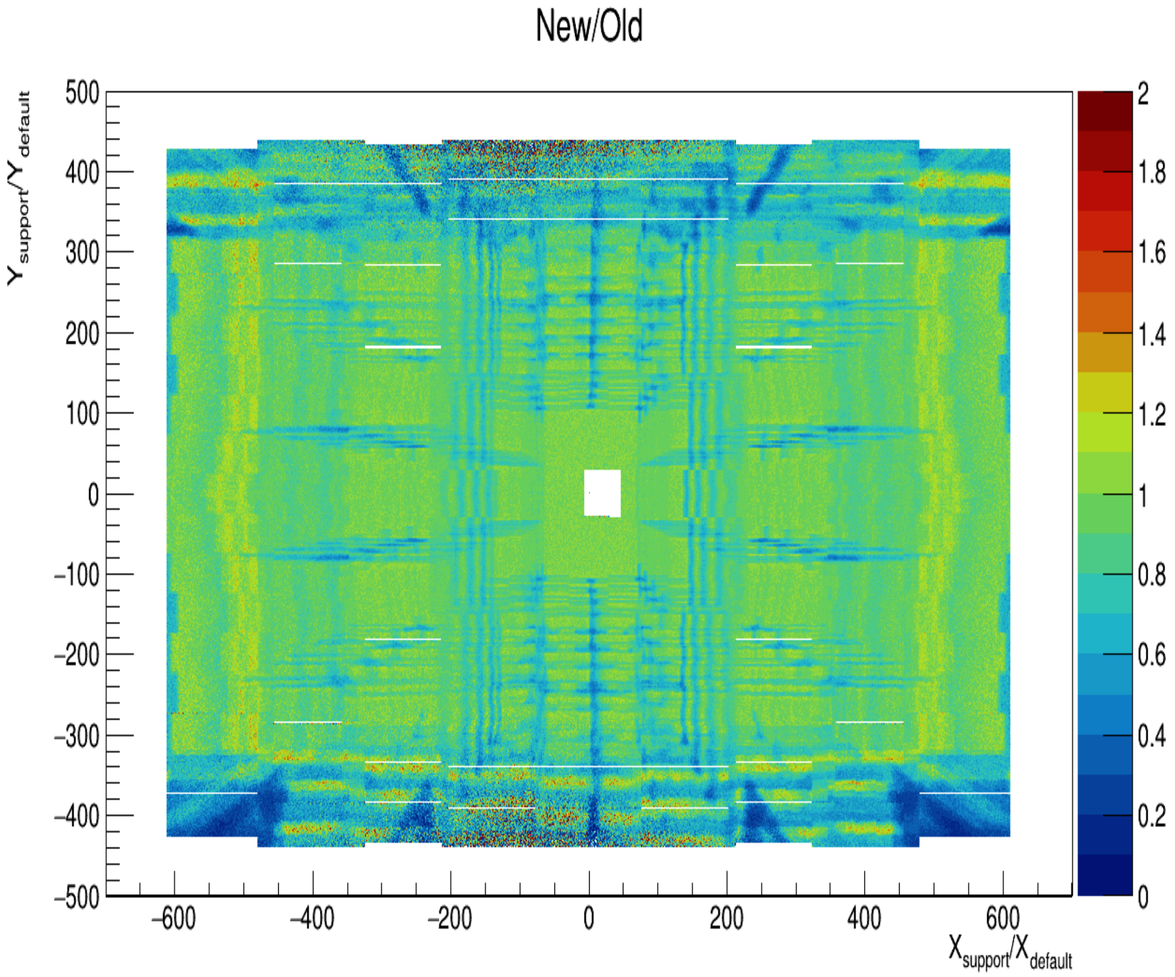
Reduction of MC points for primary MC tracks due to support frame

TRD MC points (secondary)

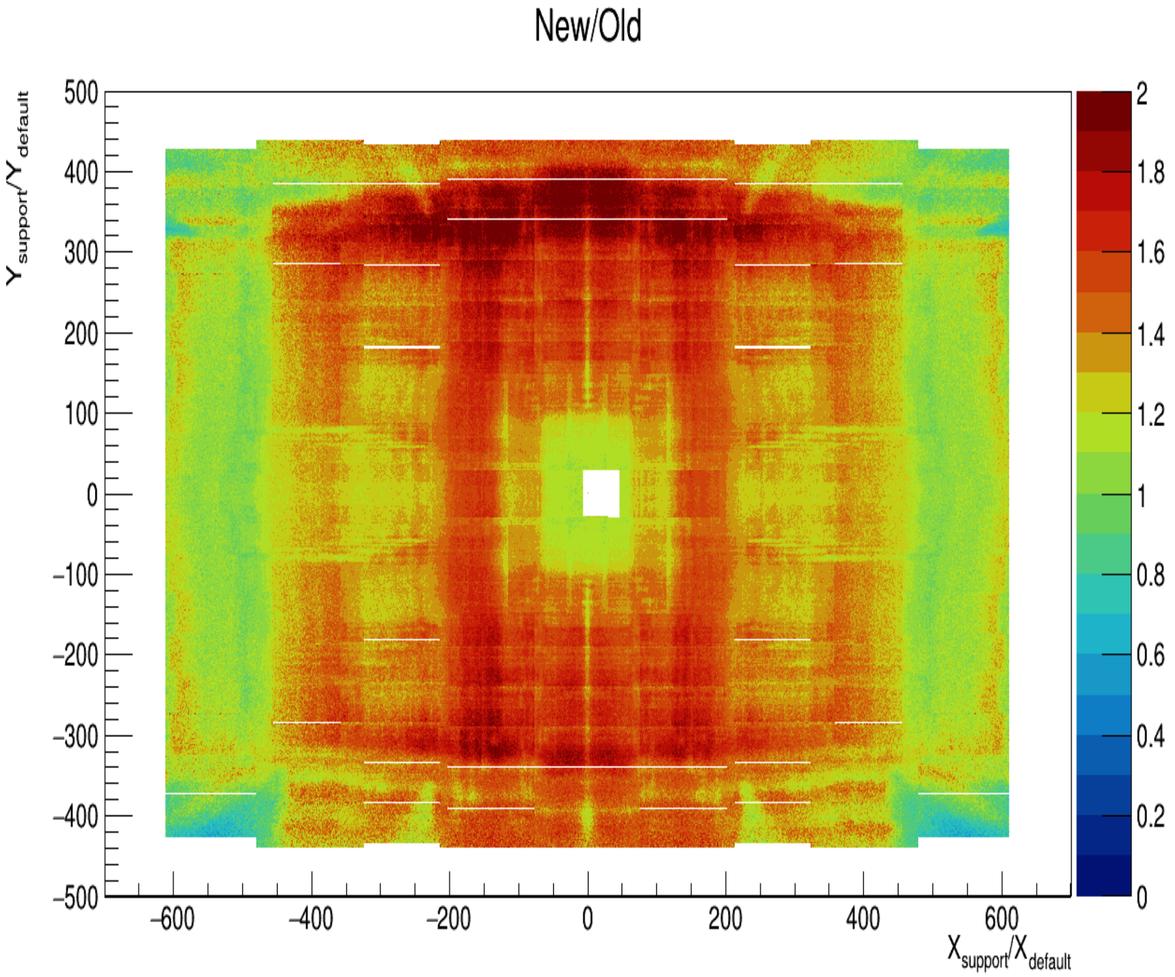


Additional MC points due to more secondary MC tracks generated through support frame

TOF MC points

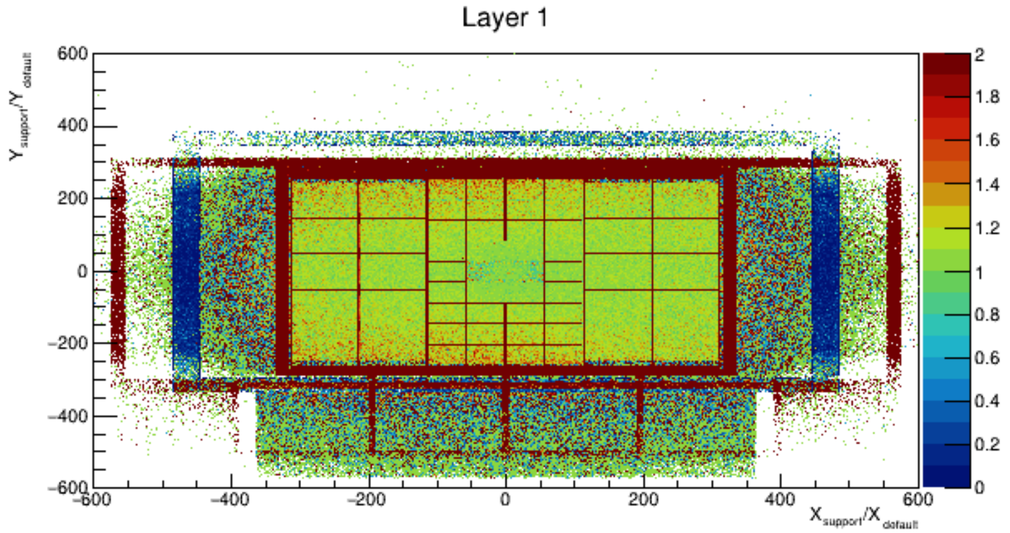


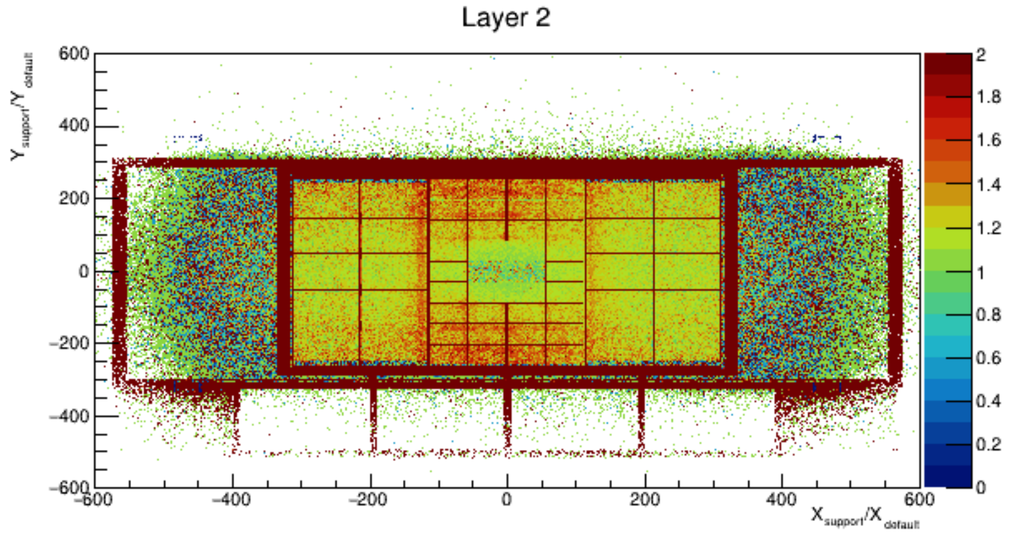
Primary

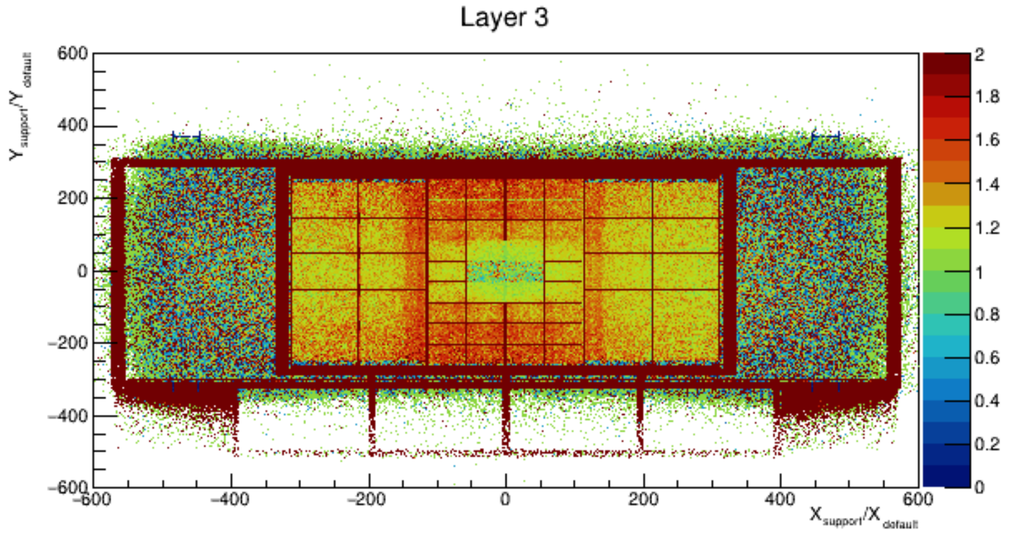


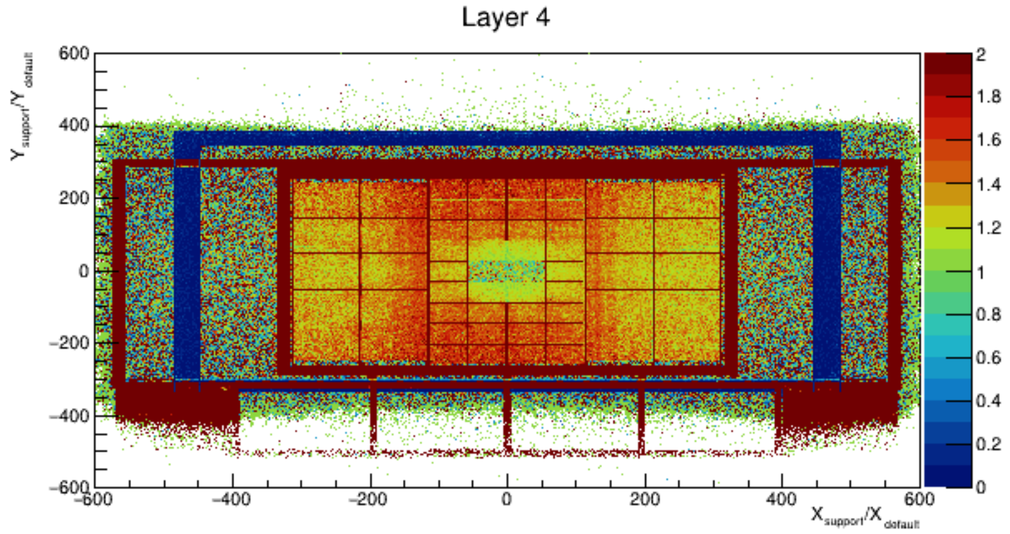
Secondary

Vertices of all secondaries @ TRD

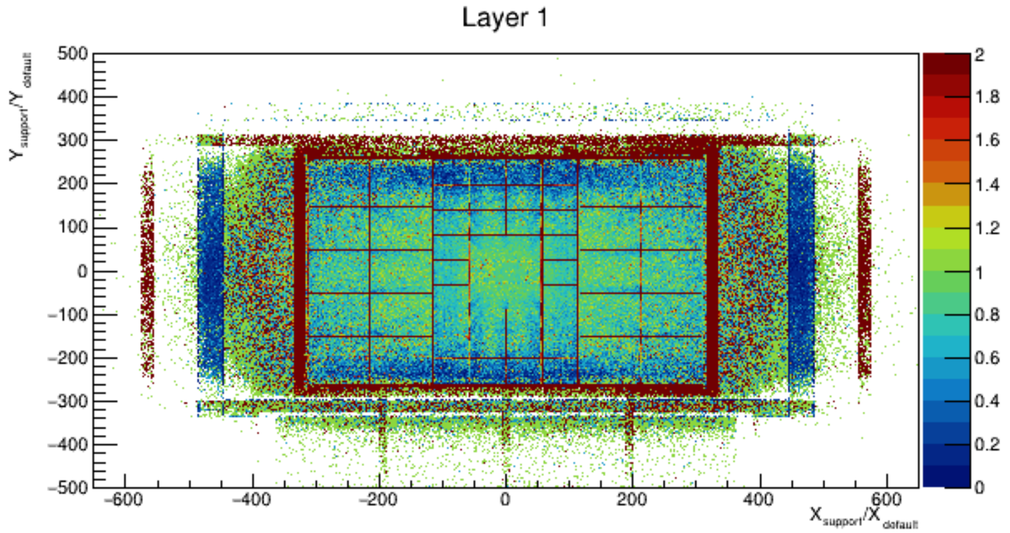


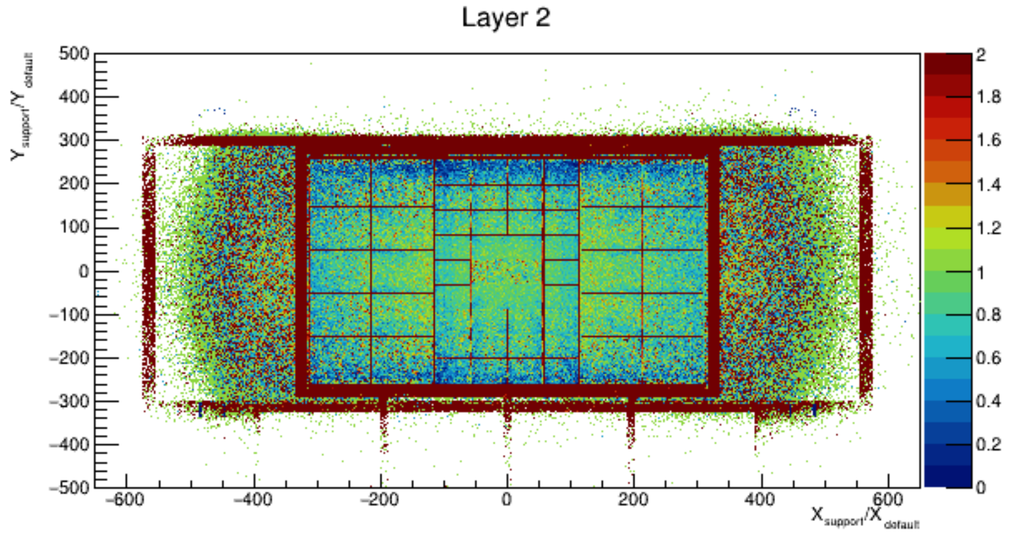


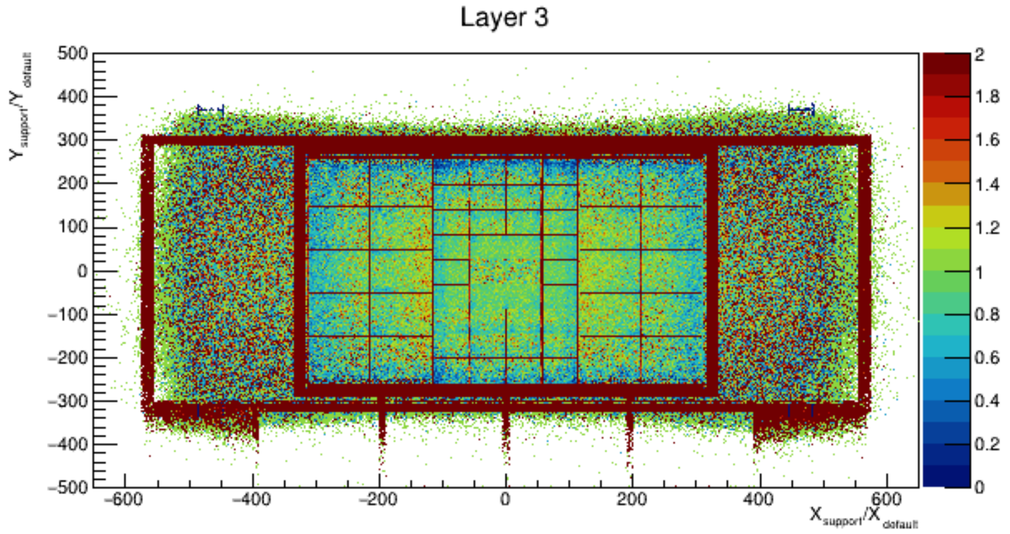


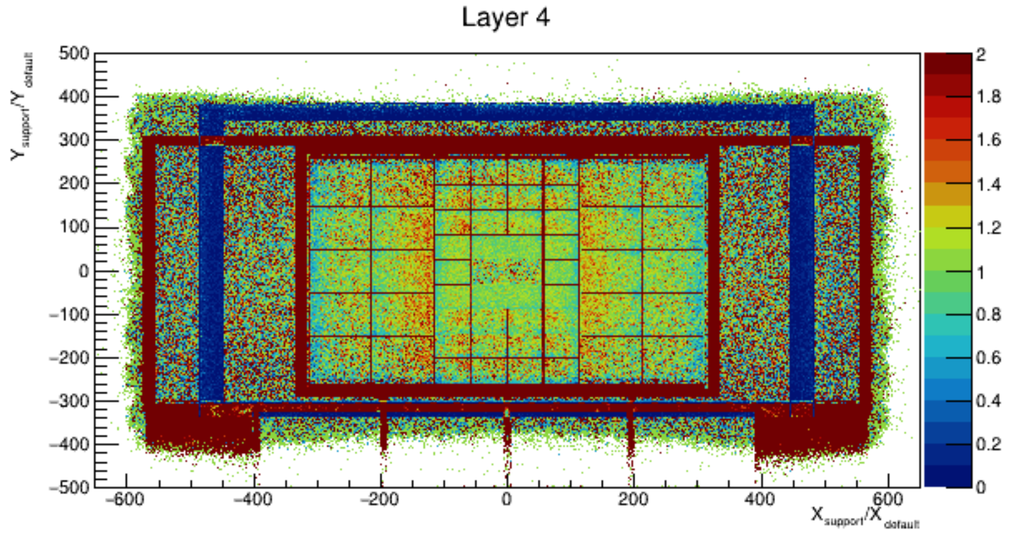


Vertices of secondaries @ TRD (TOF points)

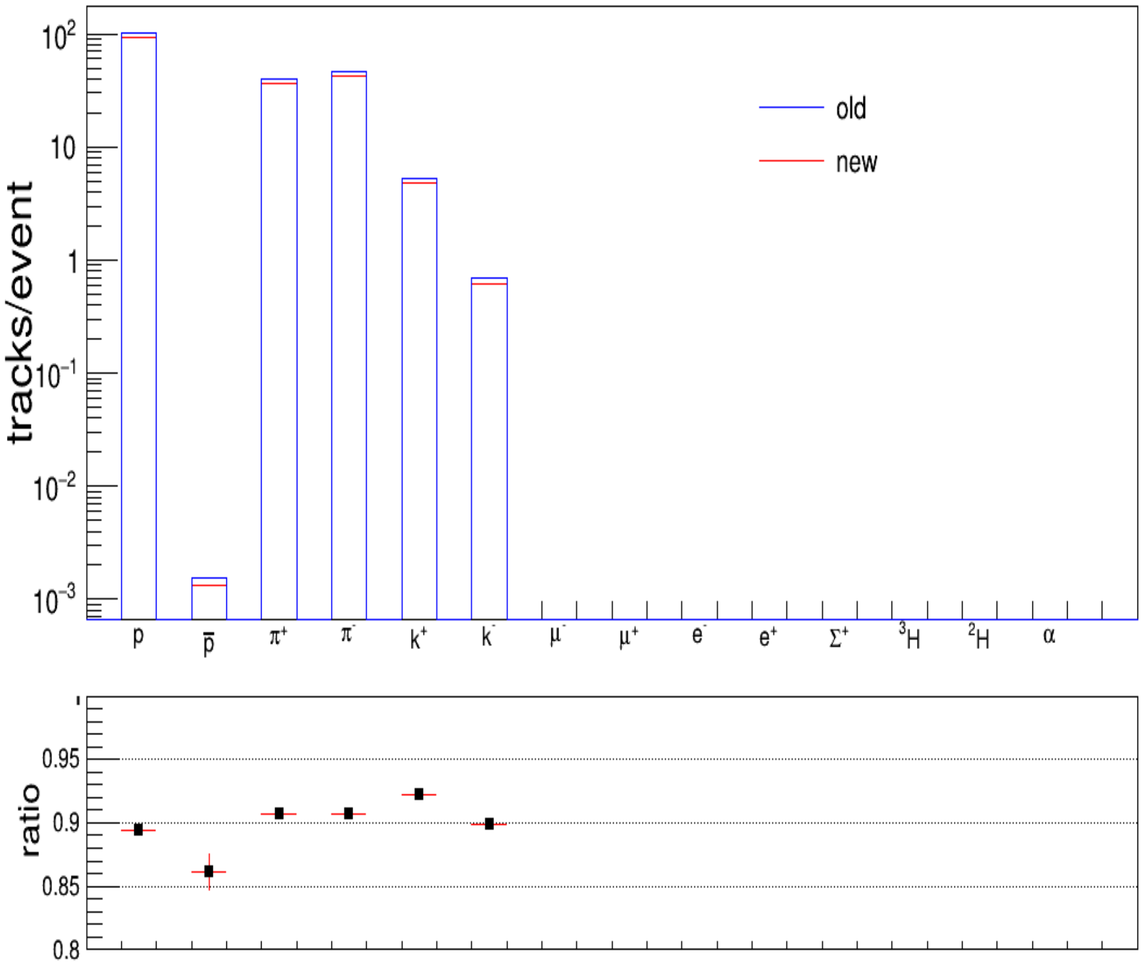




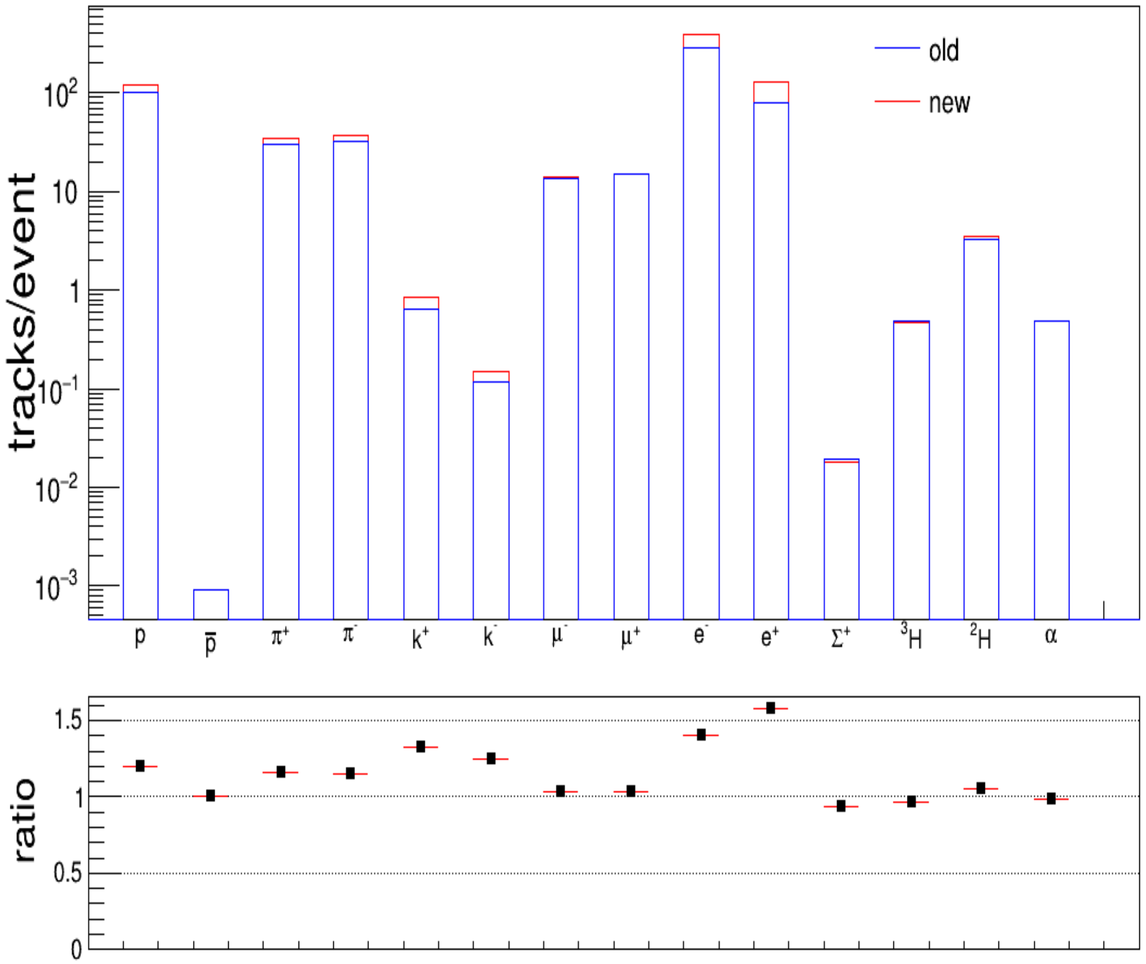




MC Particle composition @ TOF



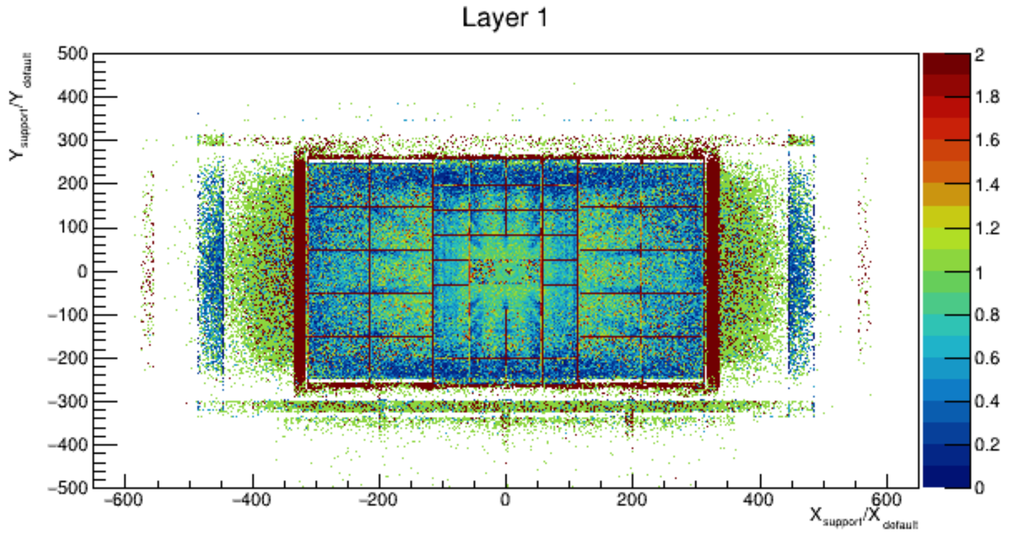
Primary

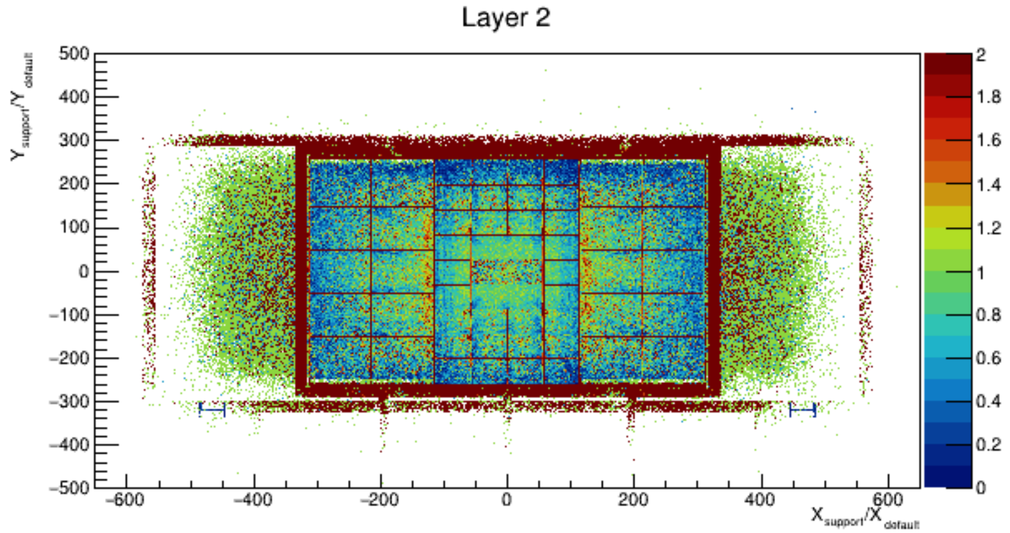


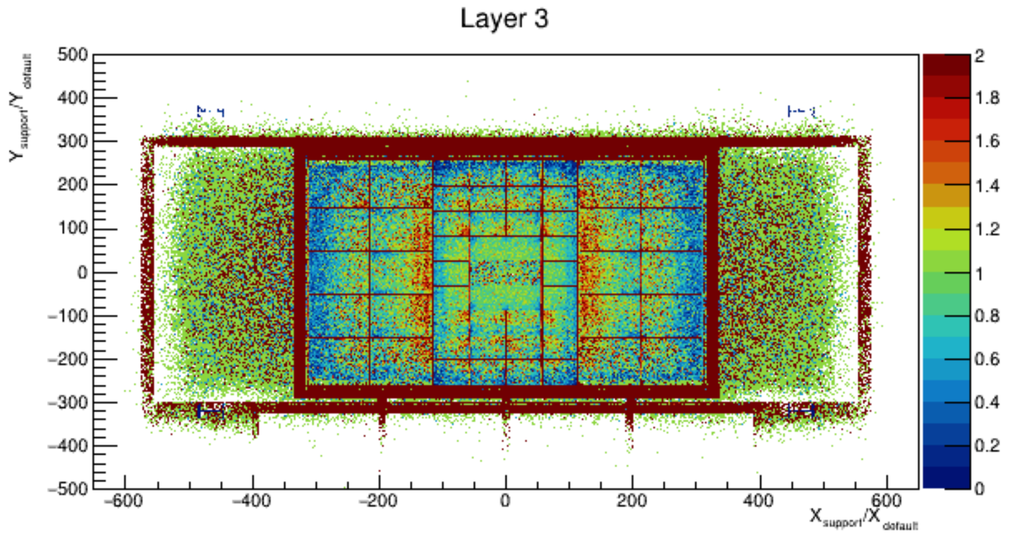
Secondary

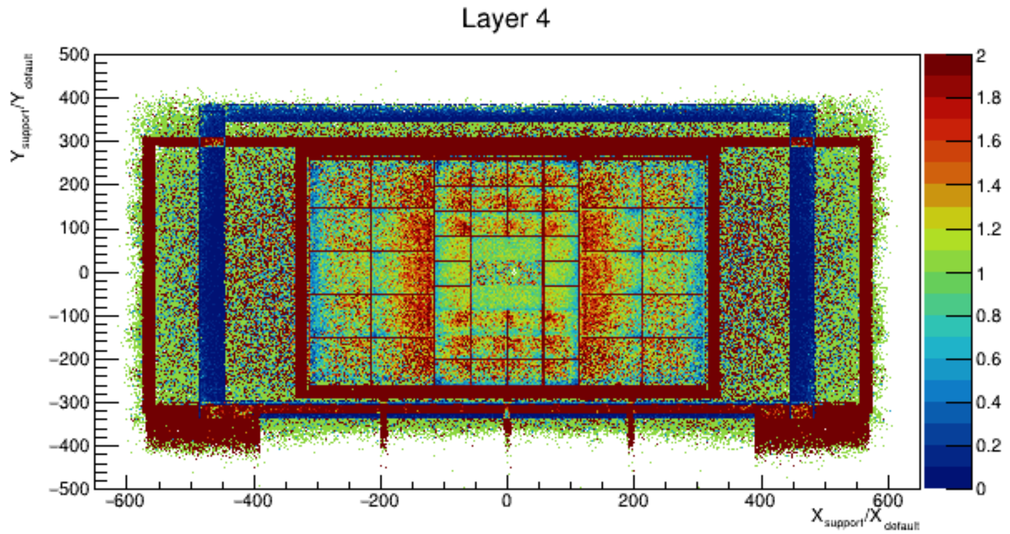
Primary particles reduced whereas secondaries are increased

Vertices of secondary e- @ TRD (TOF points)

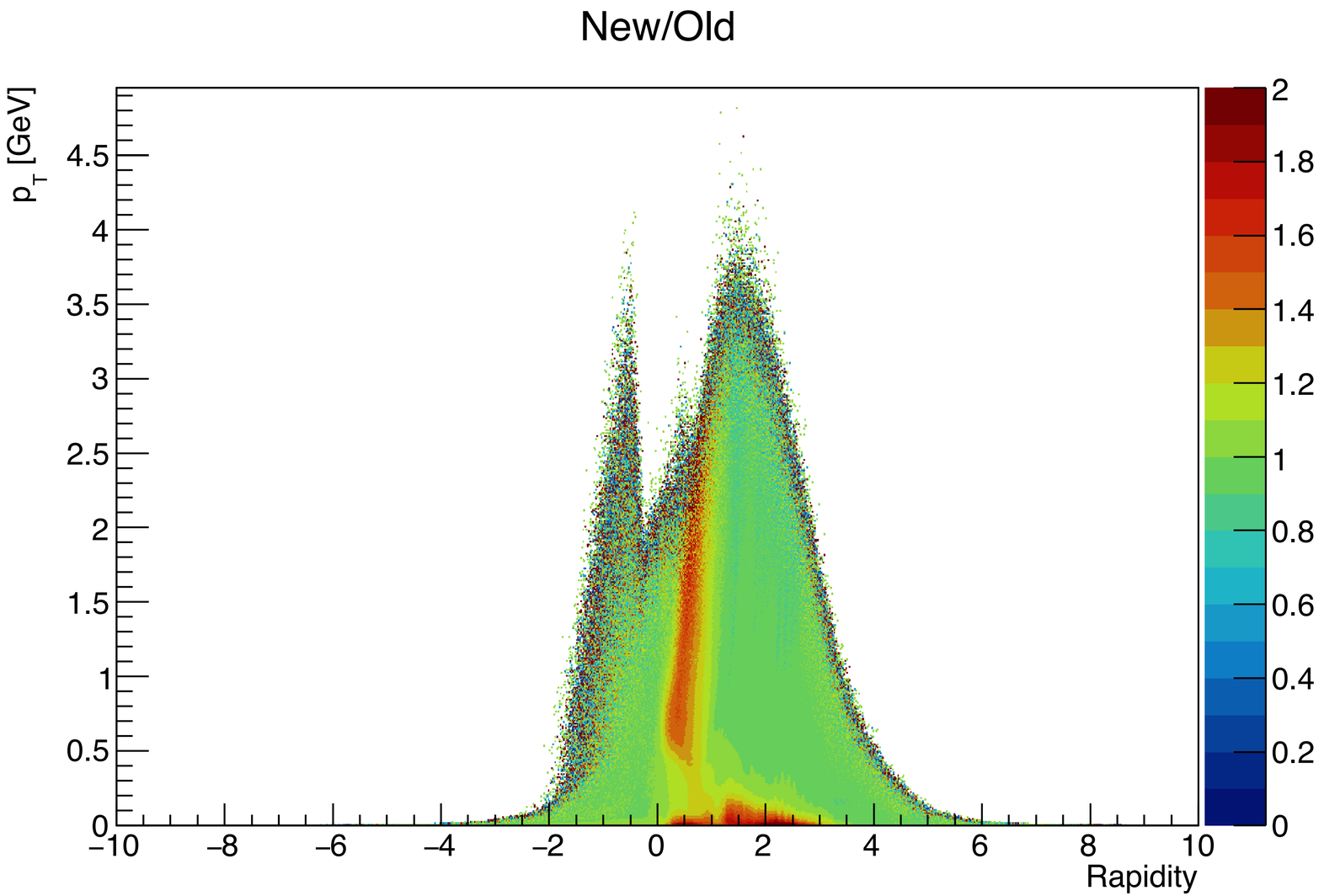








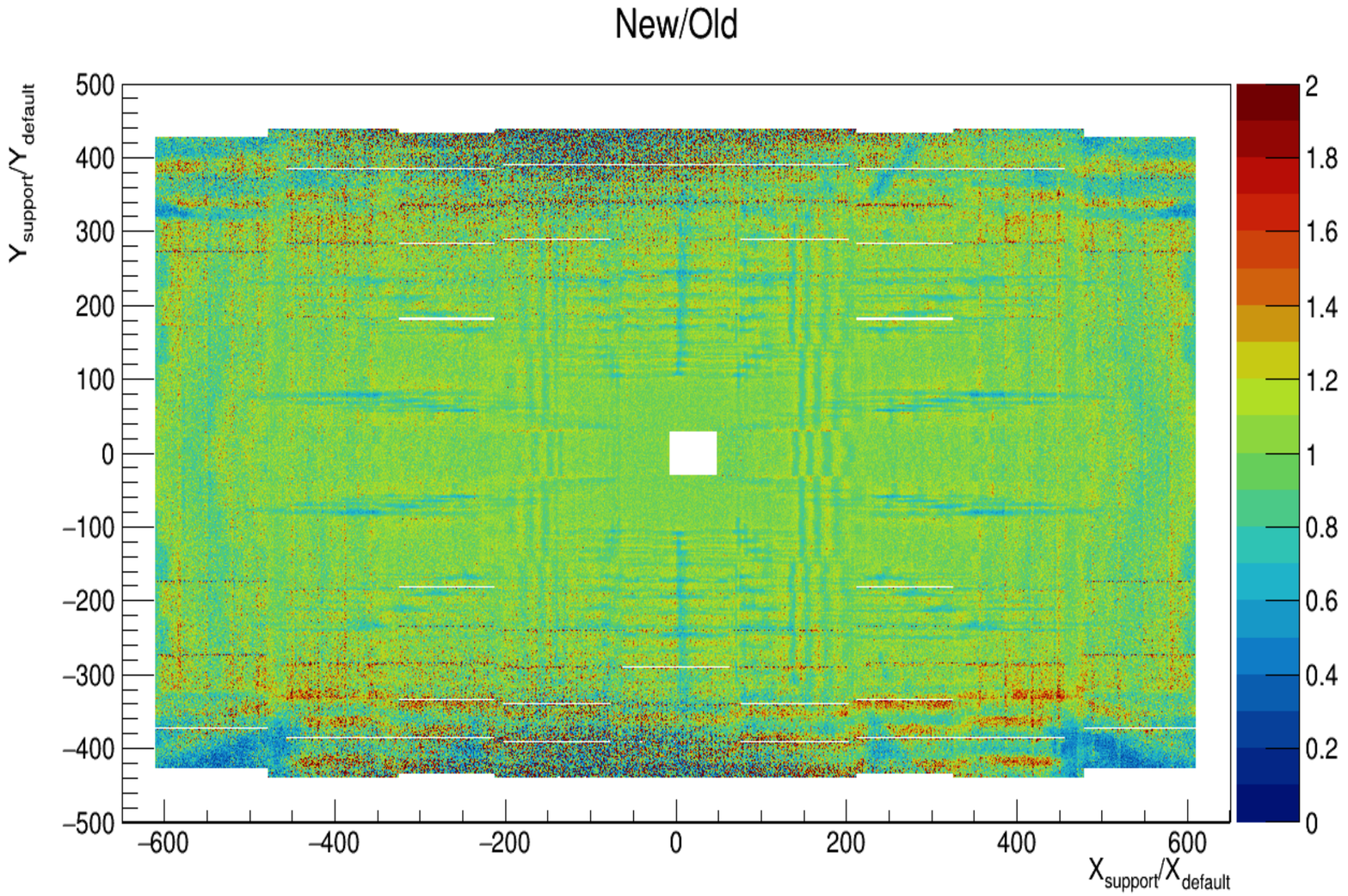
Y-pT distribution for all TOF MC tracks



Secondaries generation due to support

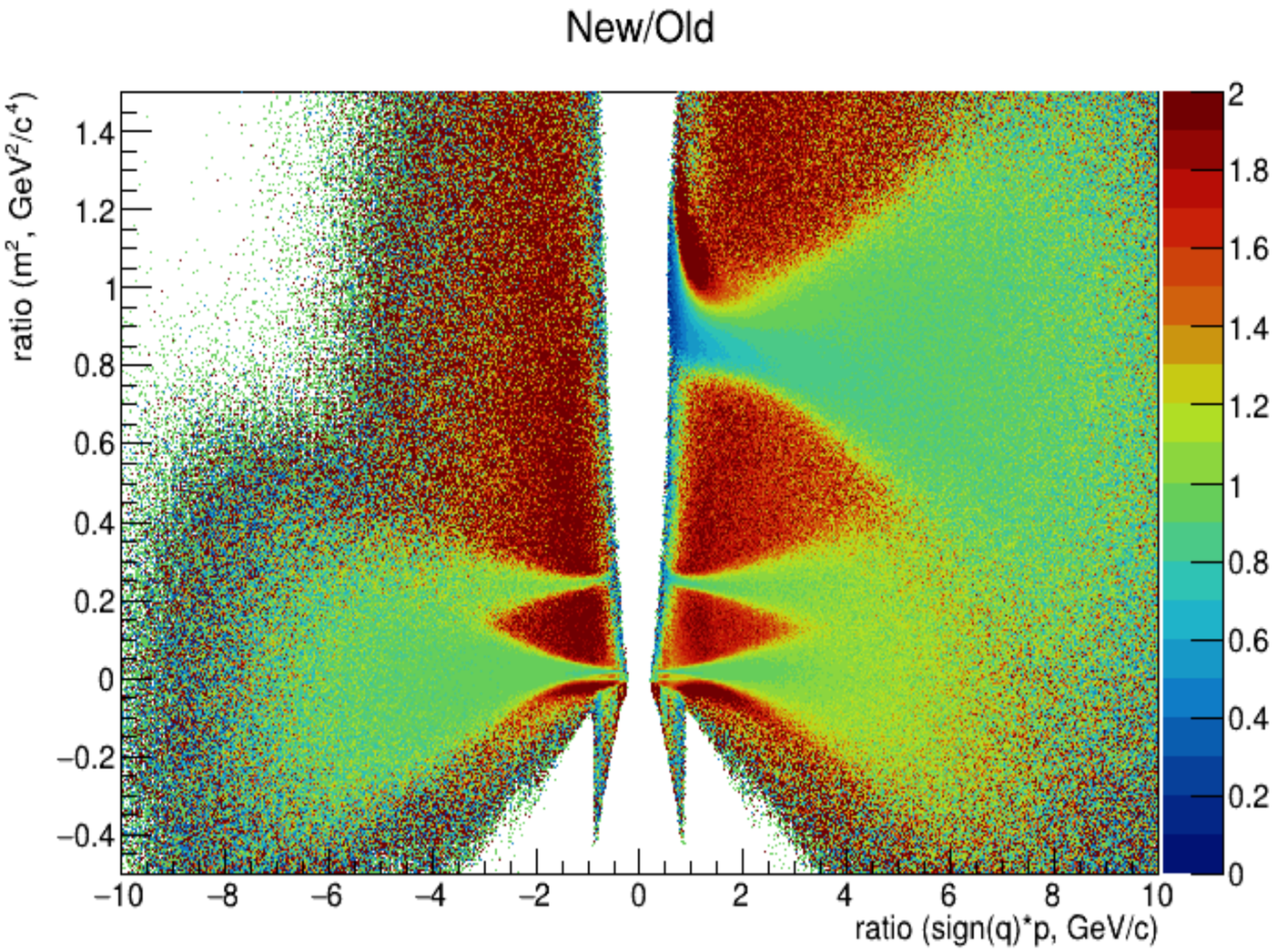
- low pT in mid rapidity
- high pT in rapidity range 0-1

TOF Hits



- Reduction in central region
- More hits created in top bottom region

Momentum Vs M²



- Momentum from STS track
- Reconstructed Track Selection :

STS Hits >= 7

TRD Hits >=3

TOF Hits >= 1

- **Low momentum protons are reduced**

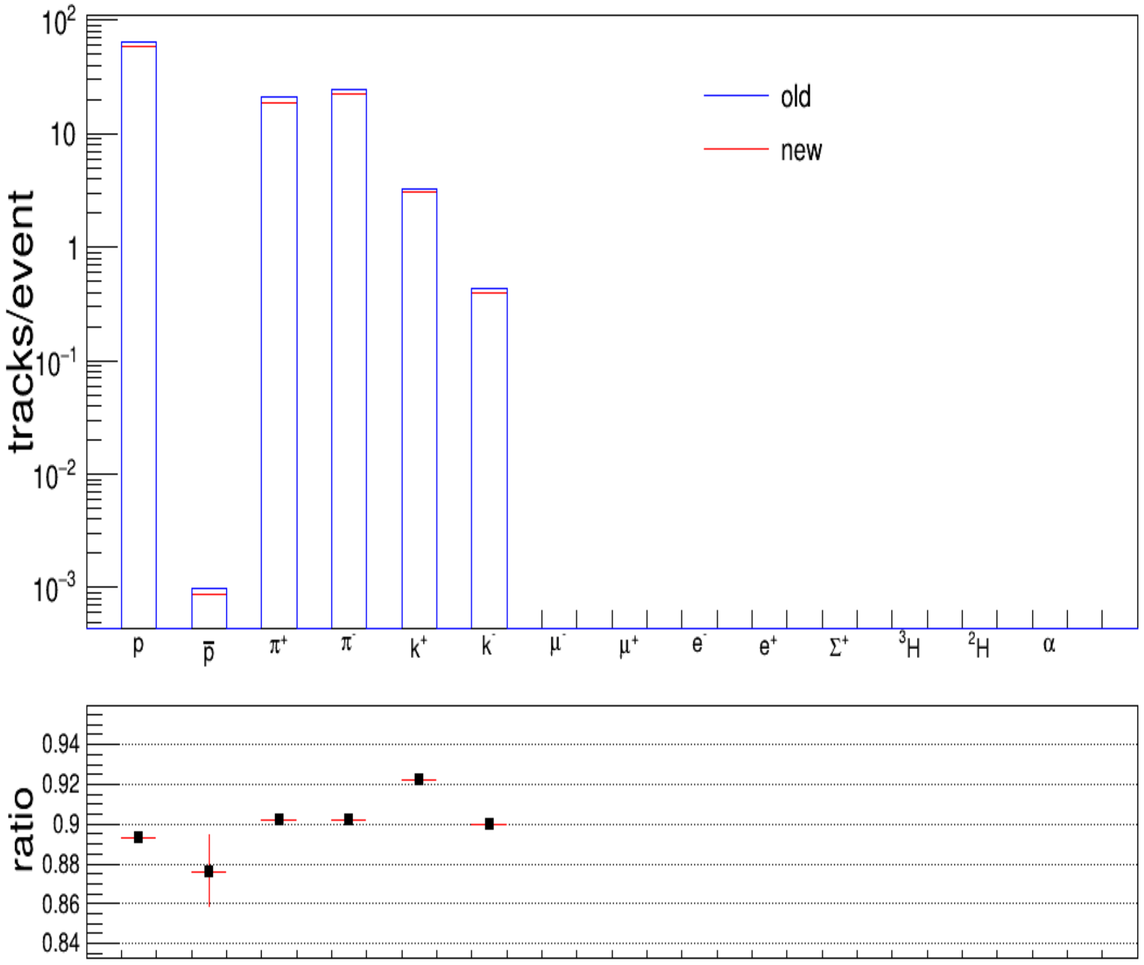
- **Reconstructed Track Selection :**

STS Hits >= 7

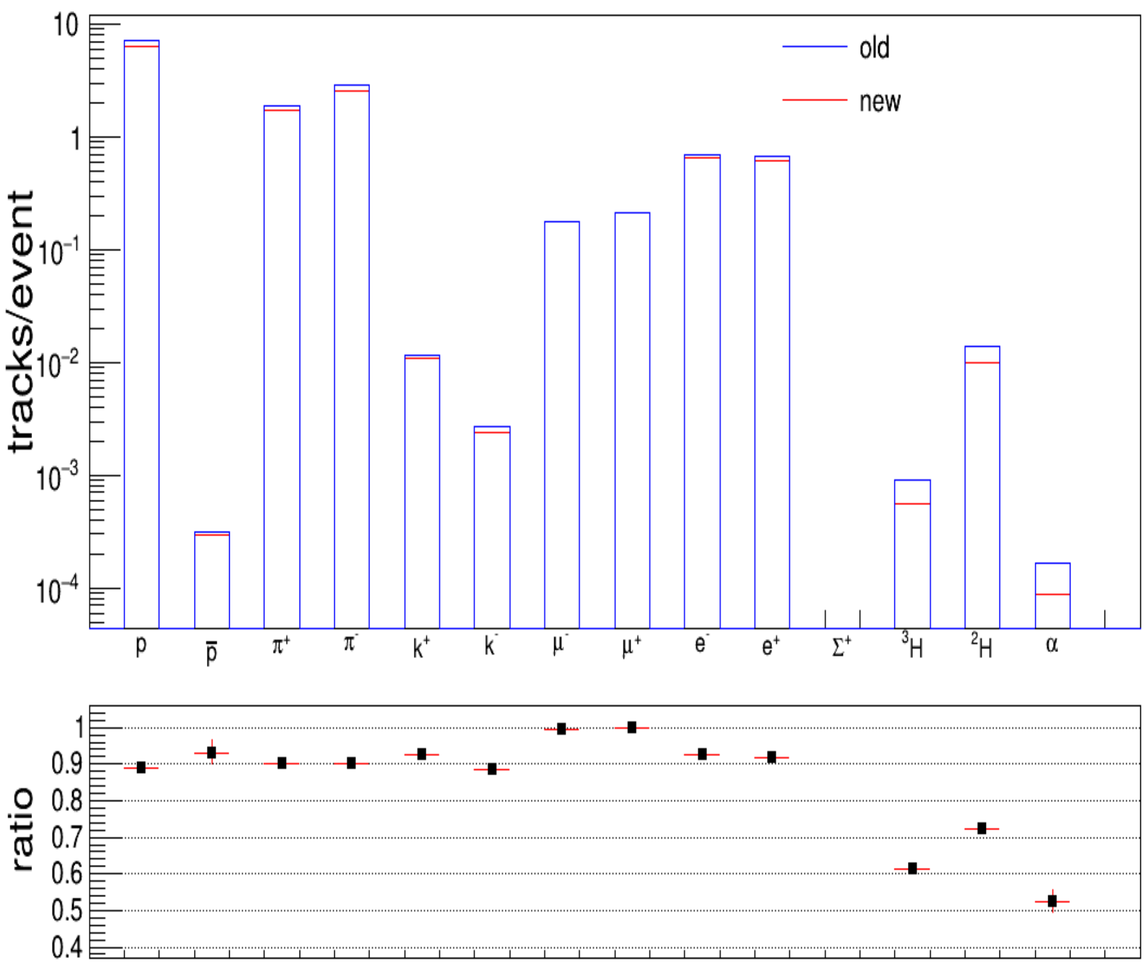
TRD Hits >=3

TOF Hits >= 1

RC Particle composition @ TOF



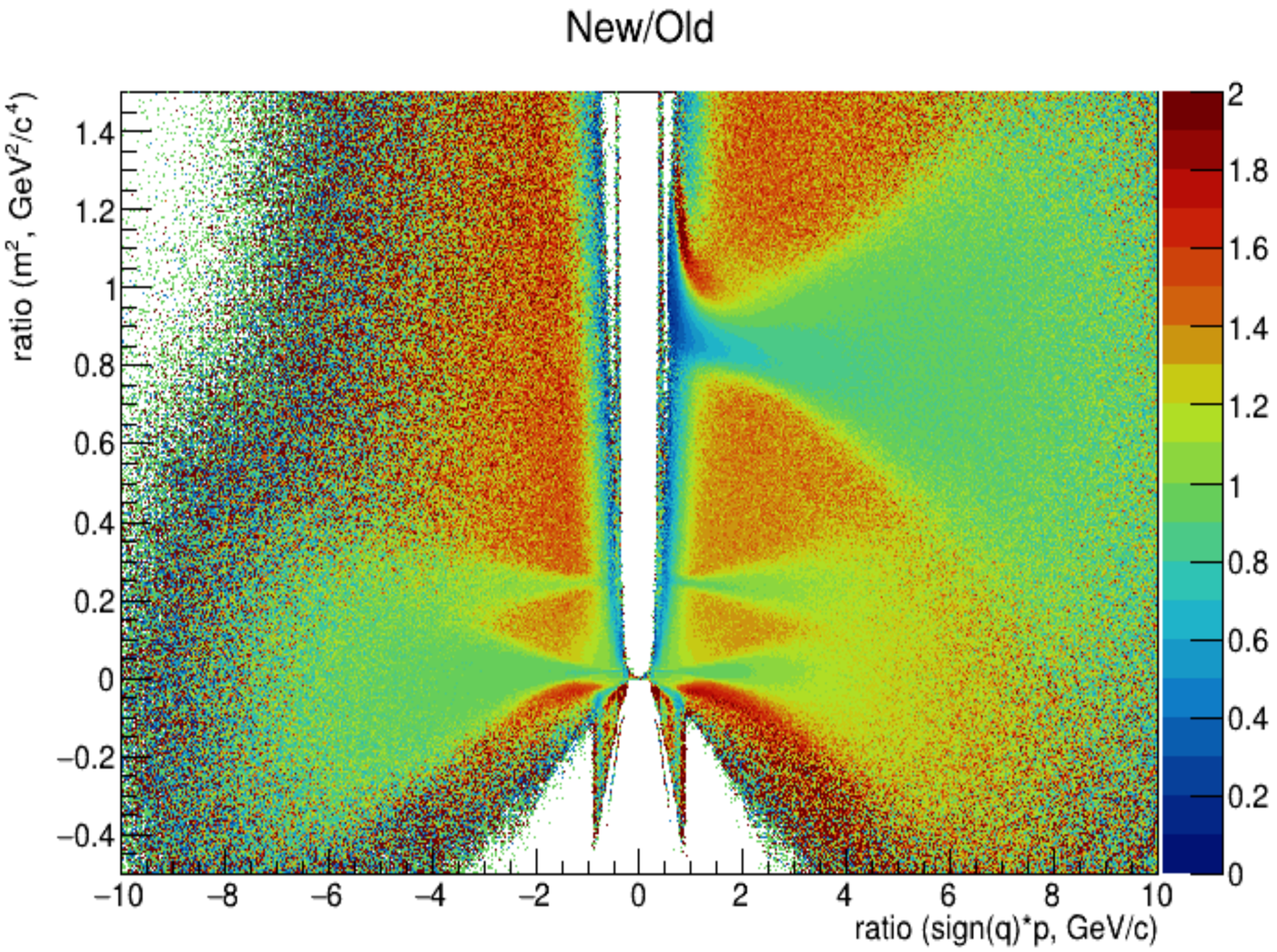
Primary



Secondary

Primary tracks reduced & Reduction of secondaries as well

Momentum Vs M²



- Momentum from STS track
- Reconstructed Track Selection :

STS Hits >= 7

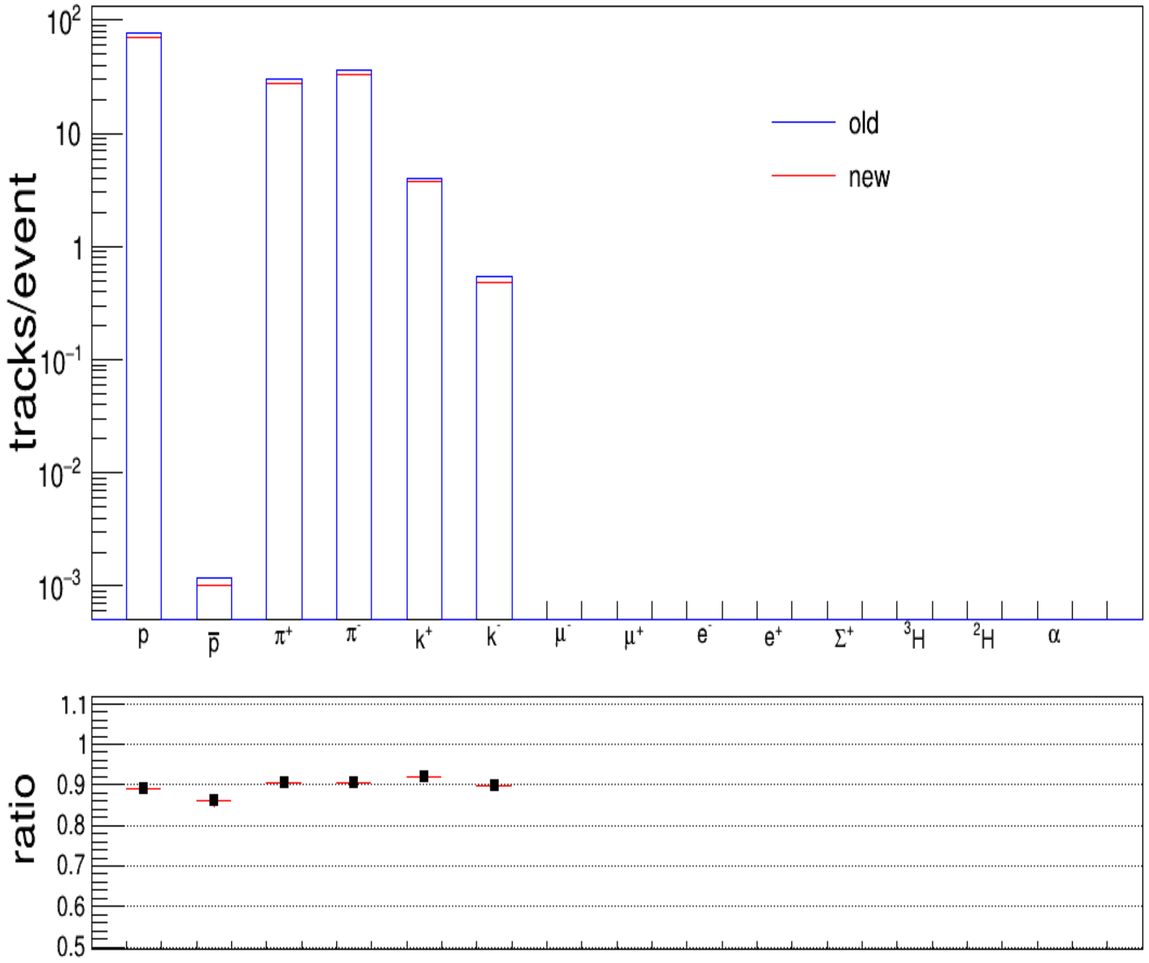
TOF Hits >= 1

RC Particle composition @ TOF

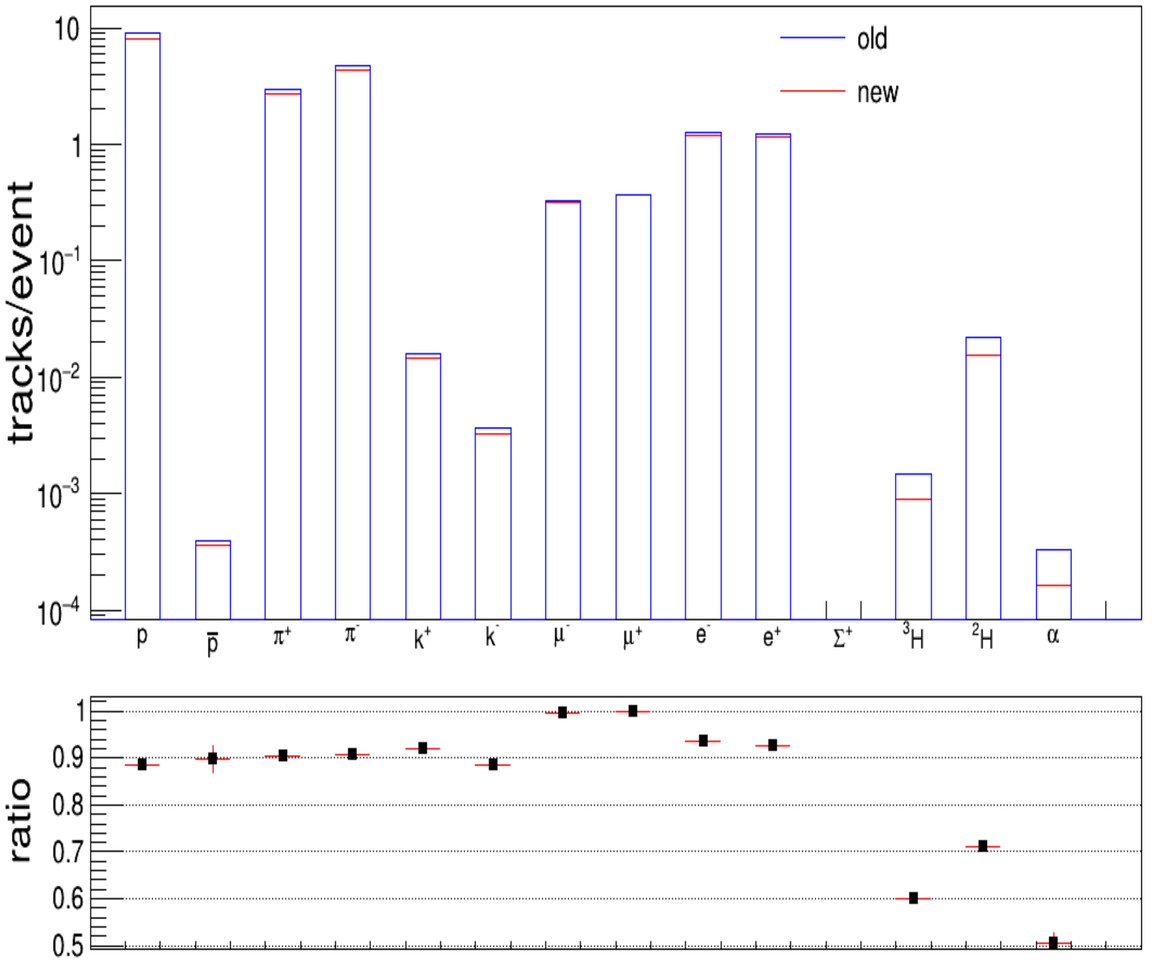
- Reconstructed Track Selection :

STS Hits >= 7

TOF Hits >= 1

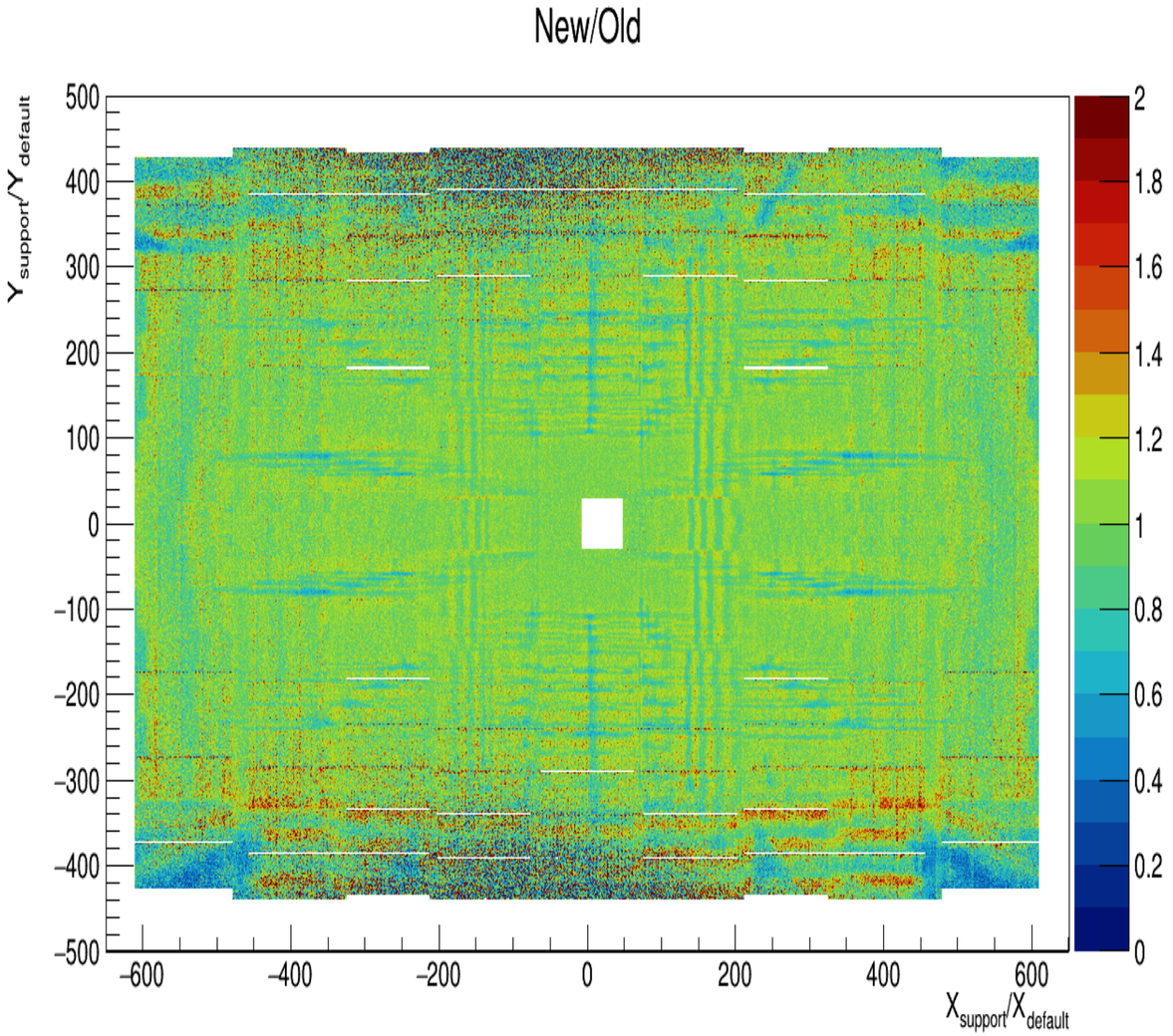


Primary

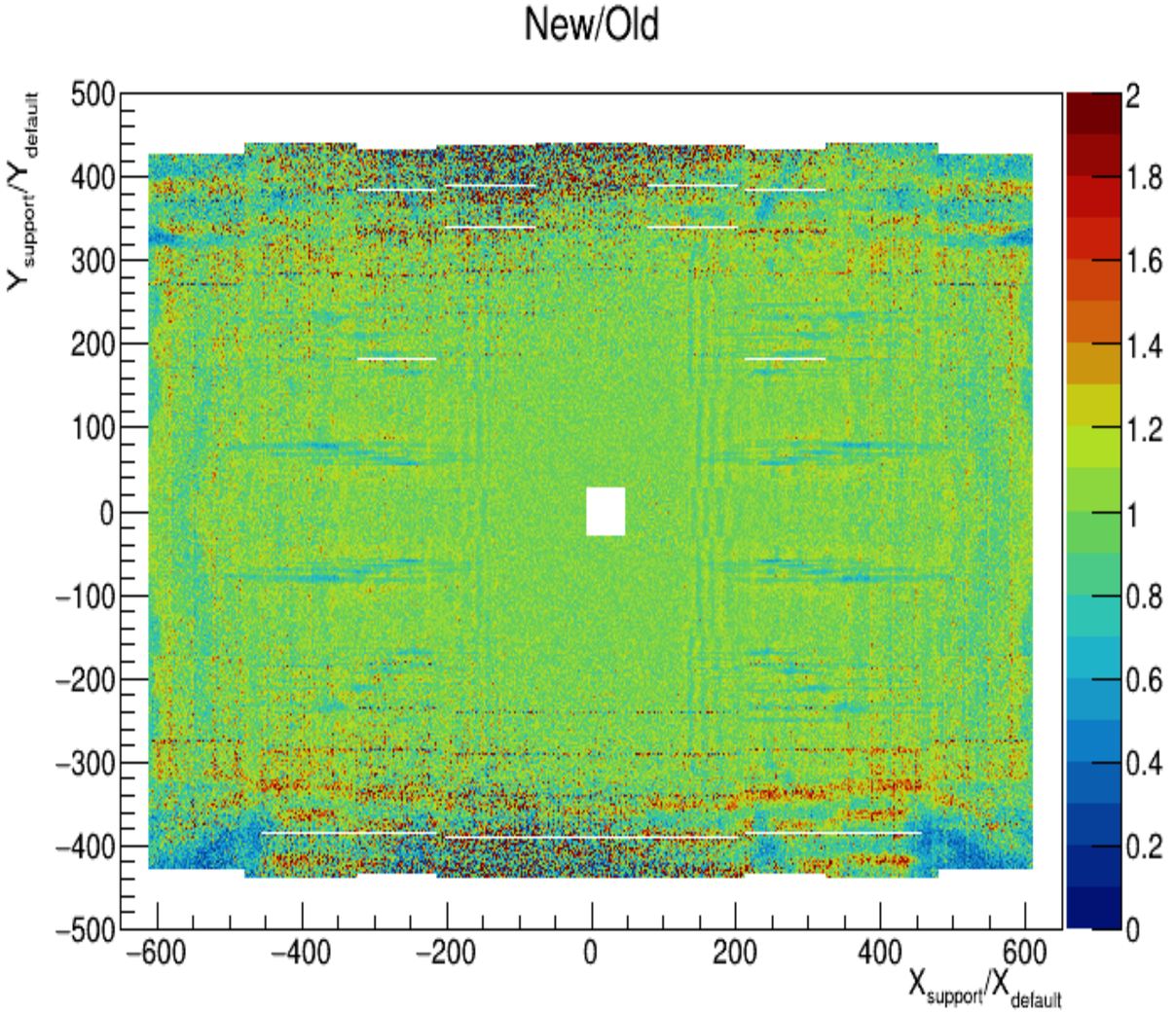


Secondary

TOF Hits (w/wo center support)



With center support



Without center support

Momentum Vs M²

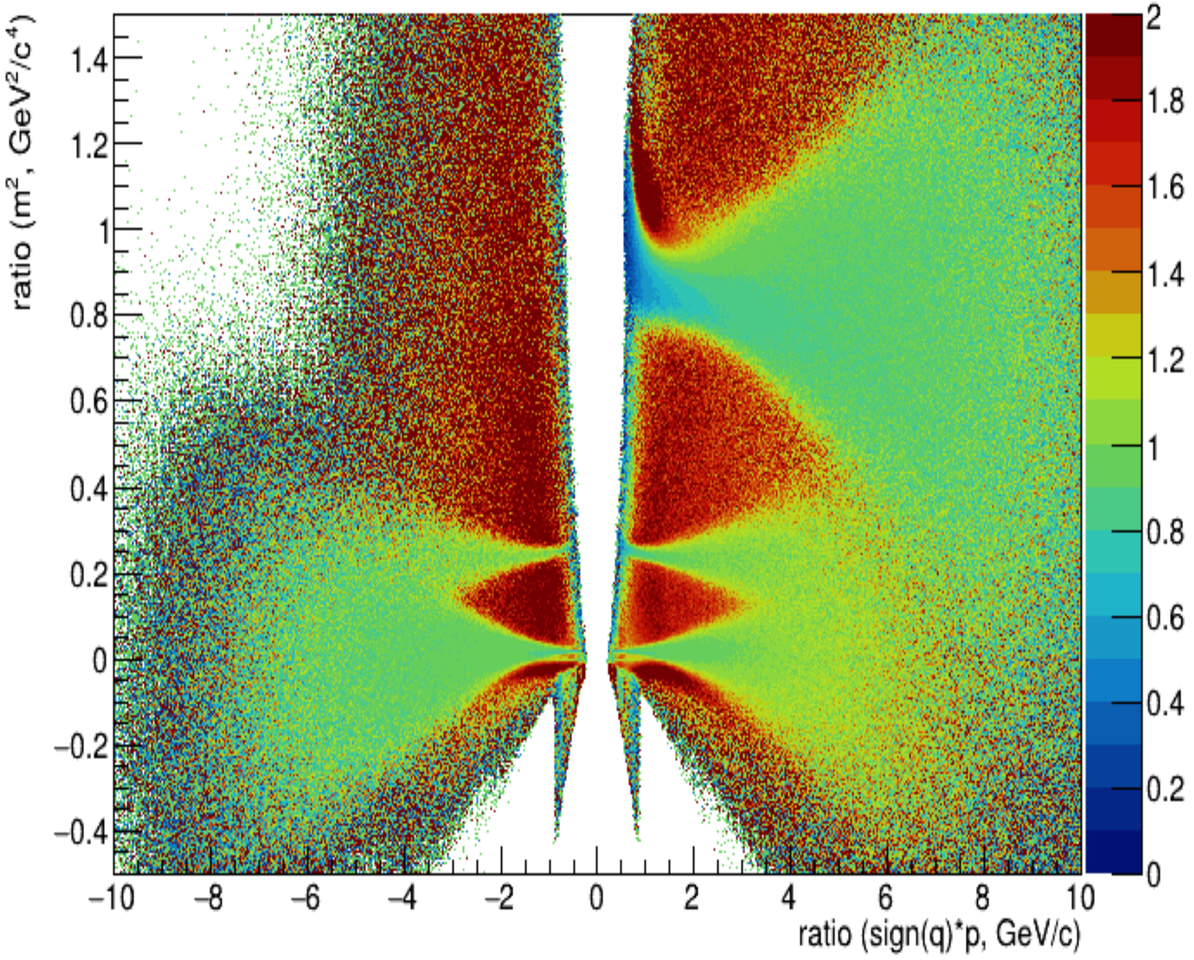
- **Reconstructed Track Selection :**

STS Hits >= 7

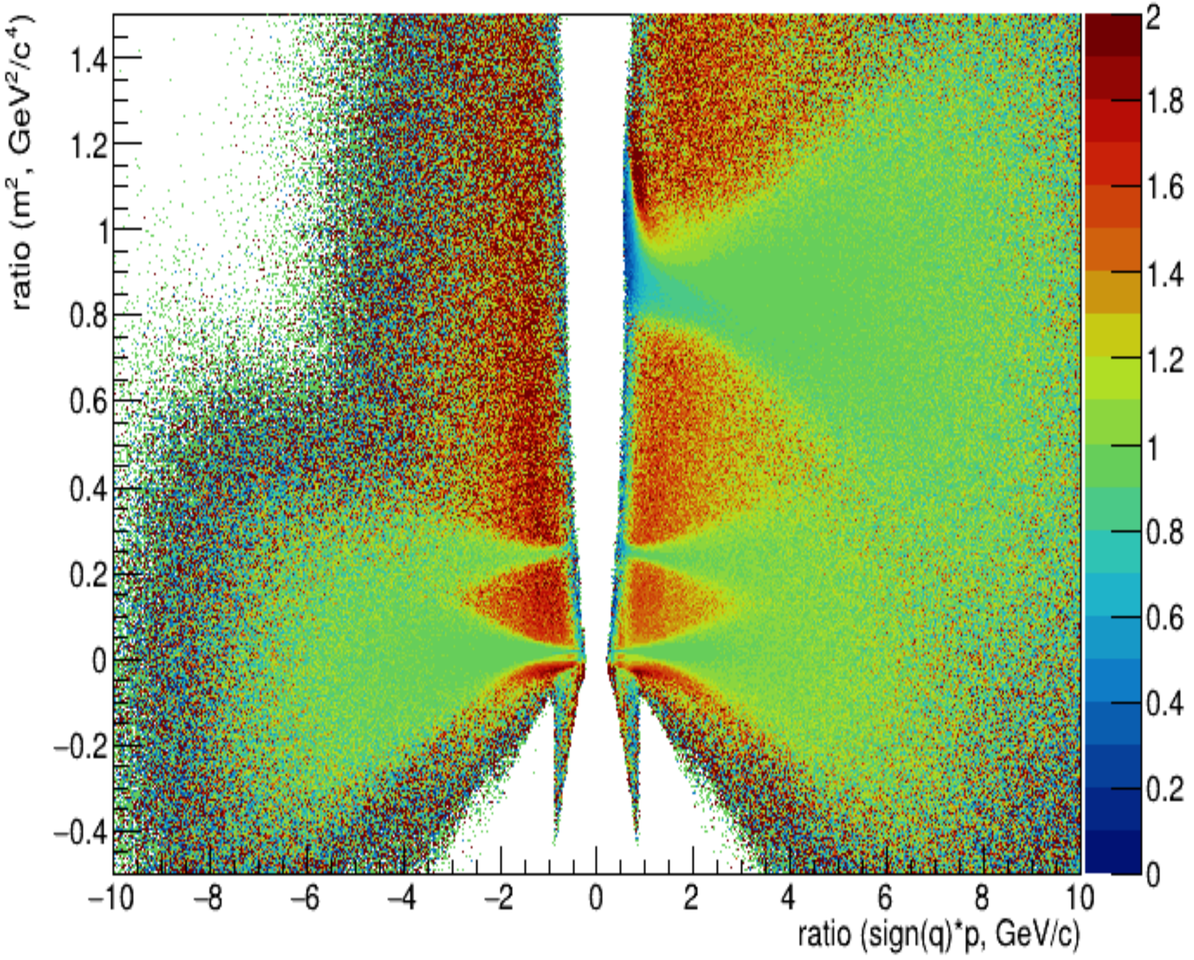
TRD Hits >=3

TOF Hits >= 1

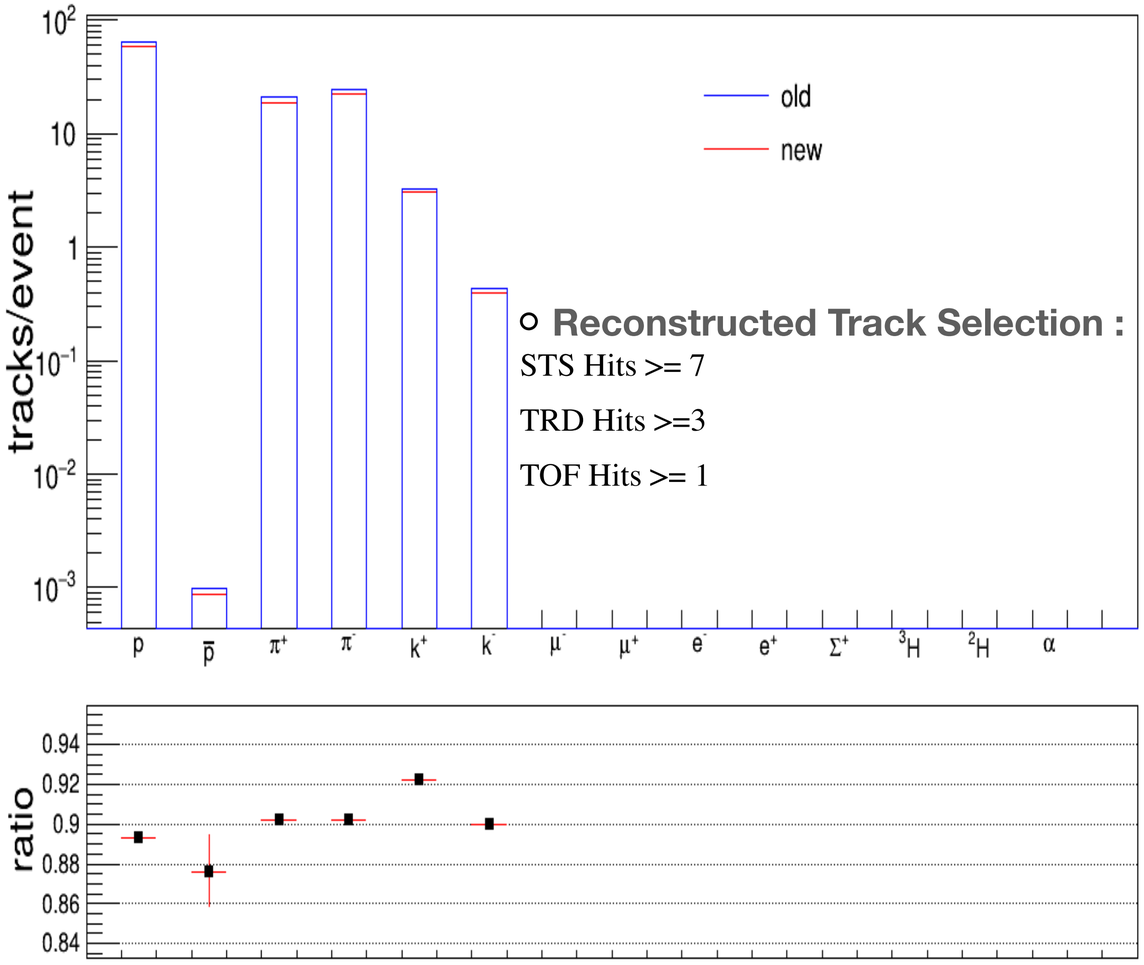
New/Old



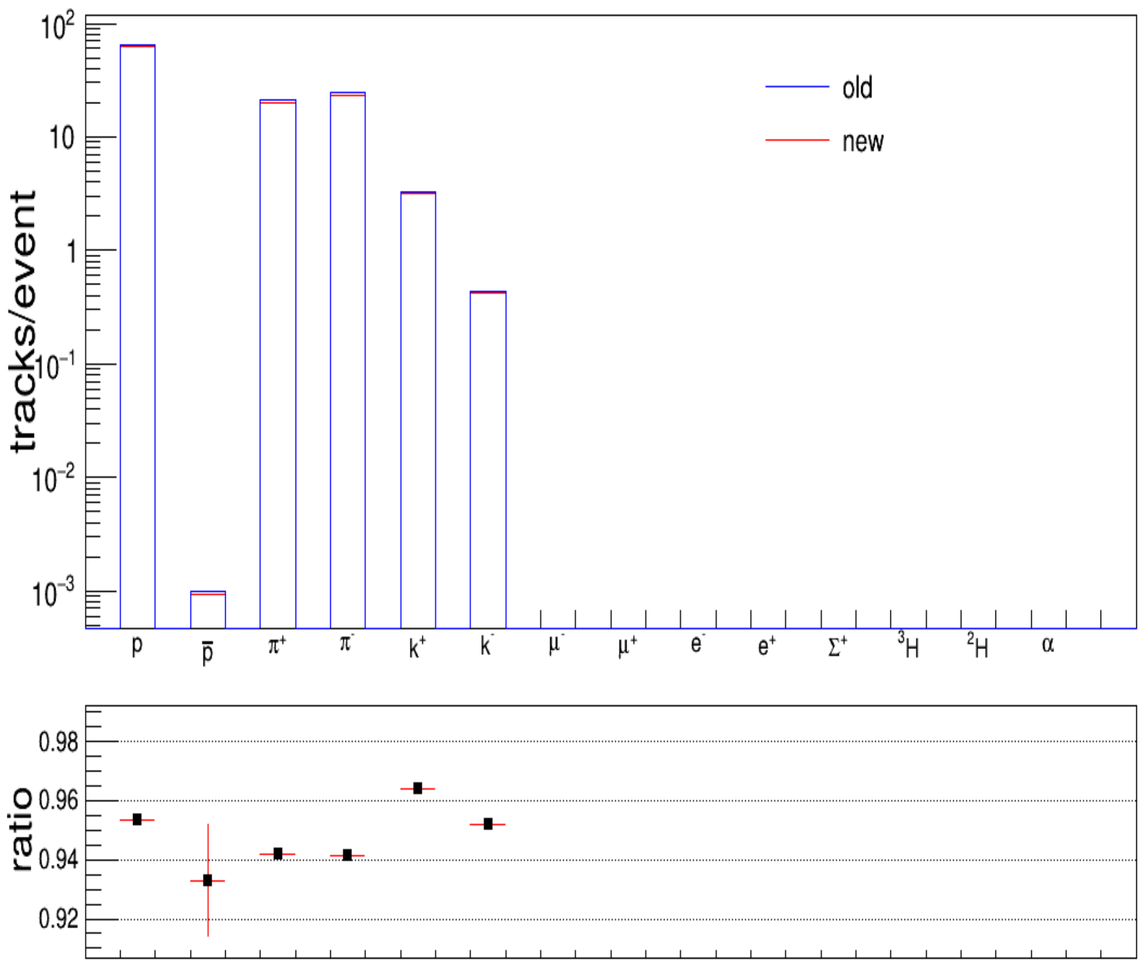
New (without center support)/Old



RC Particle composition @ TOF (primary)



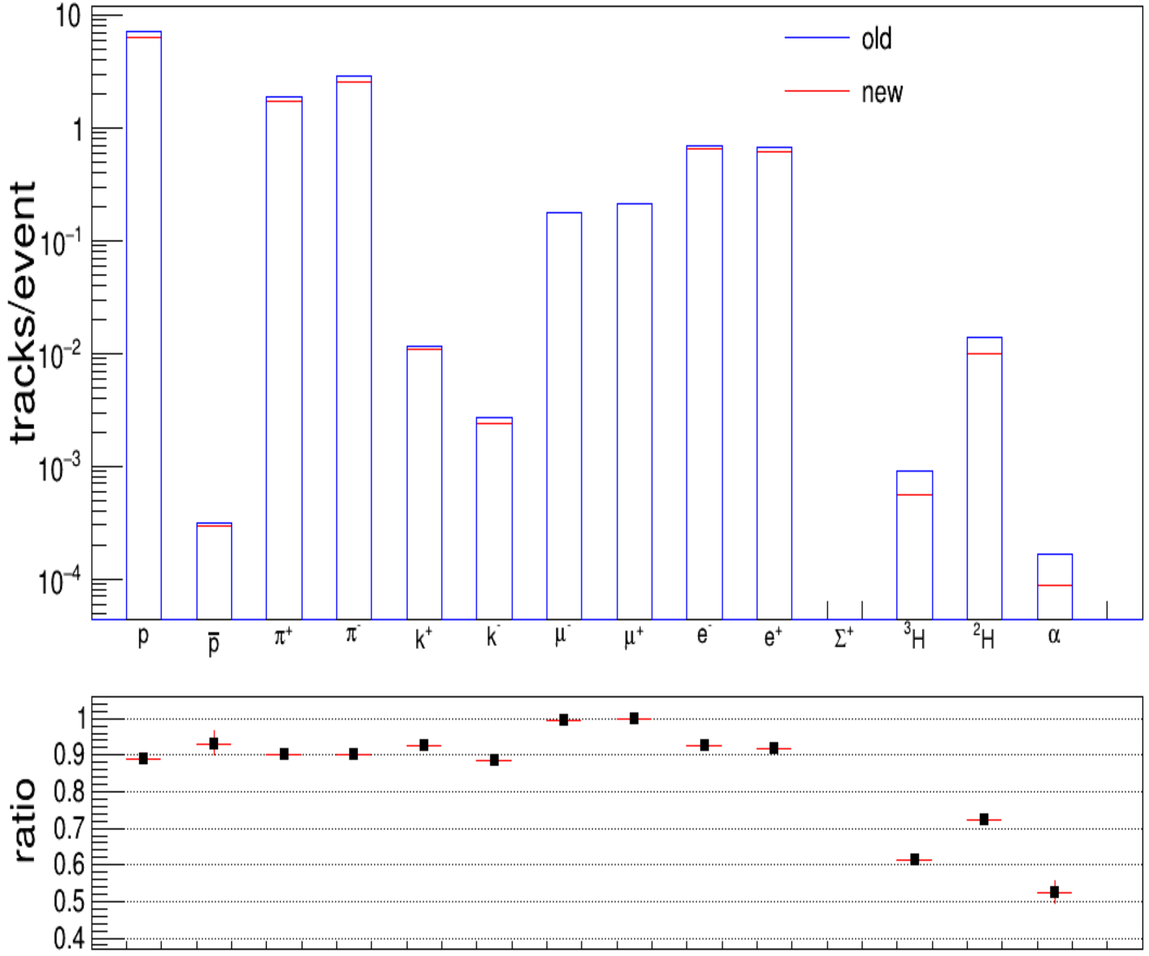
With center support



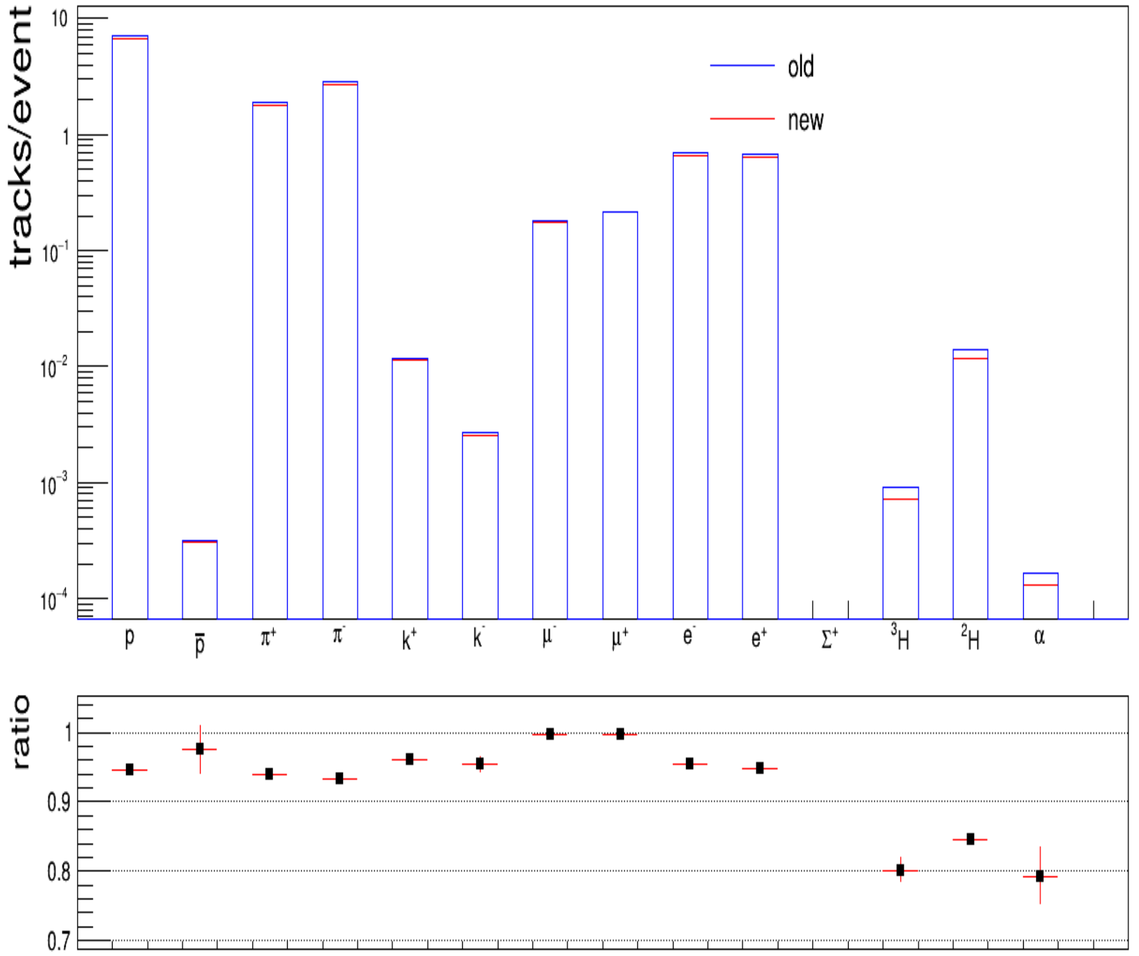
Without center support

Less reduction of primary particle after removing center support

RC Particle composition @ TOF (secondary)



With center support



Without center support

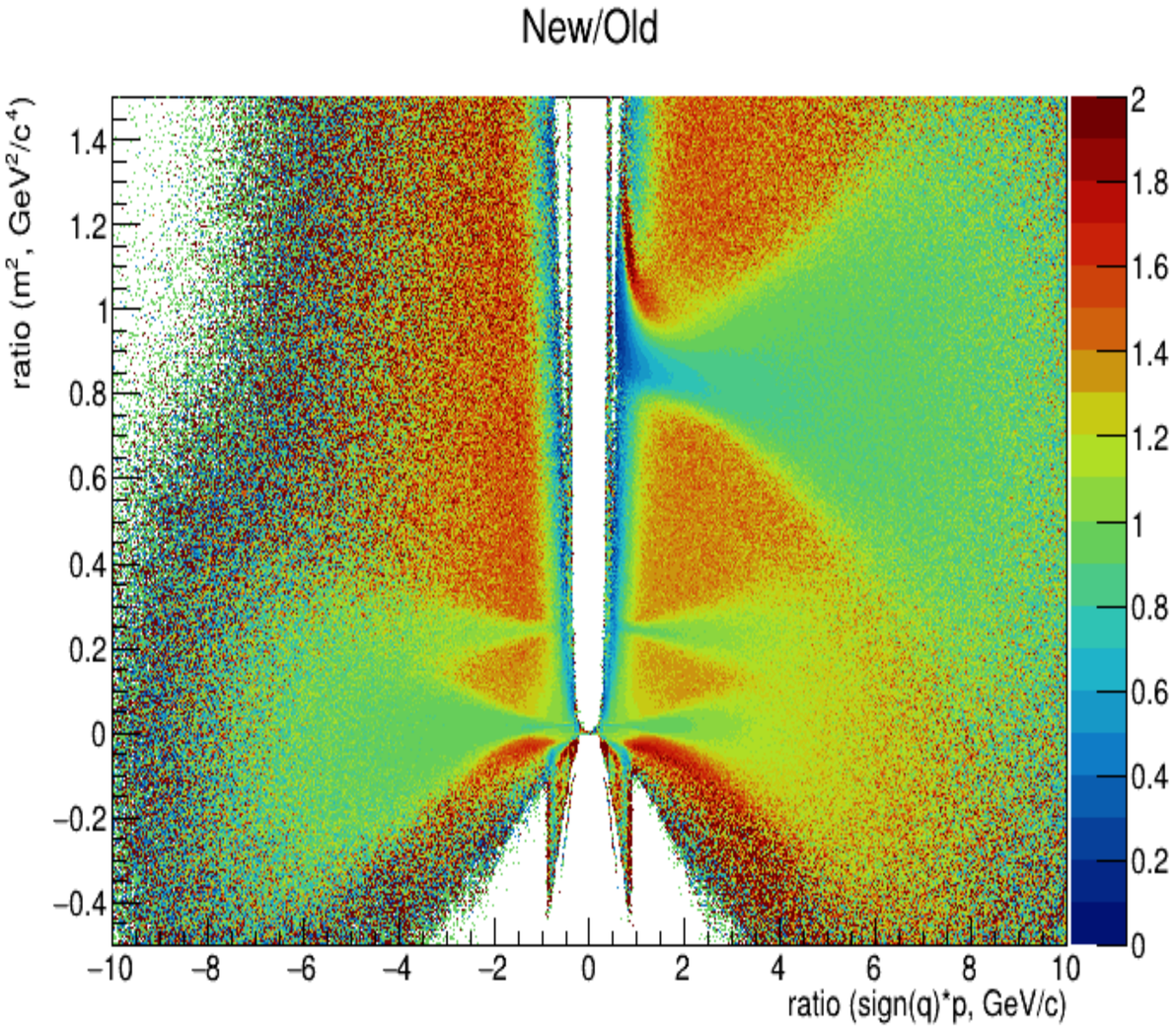
Less reduction of secondaries particle as well after removing center support

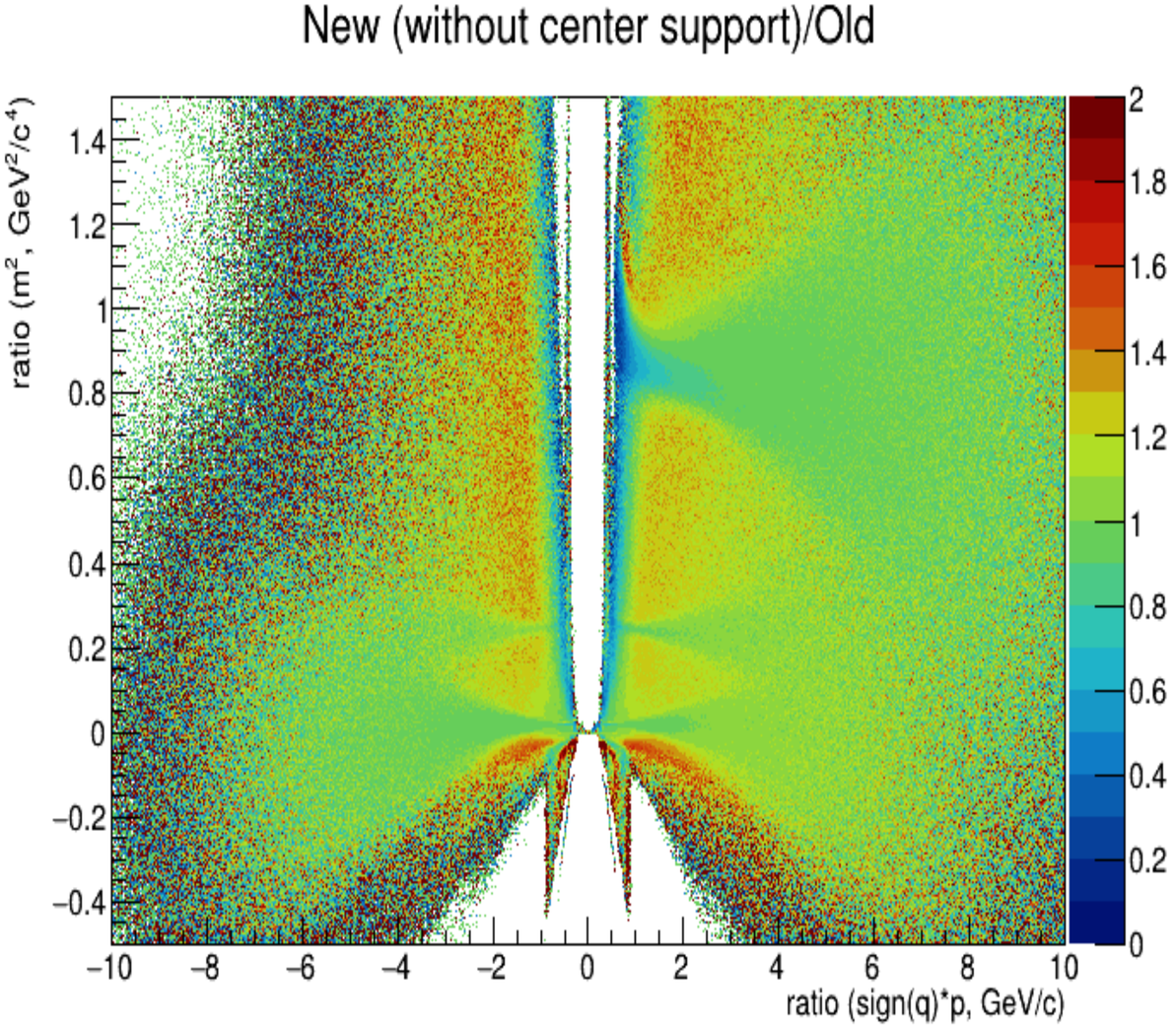
Momentum Vs M²

- **Reconstructed Track Selection :**

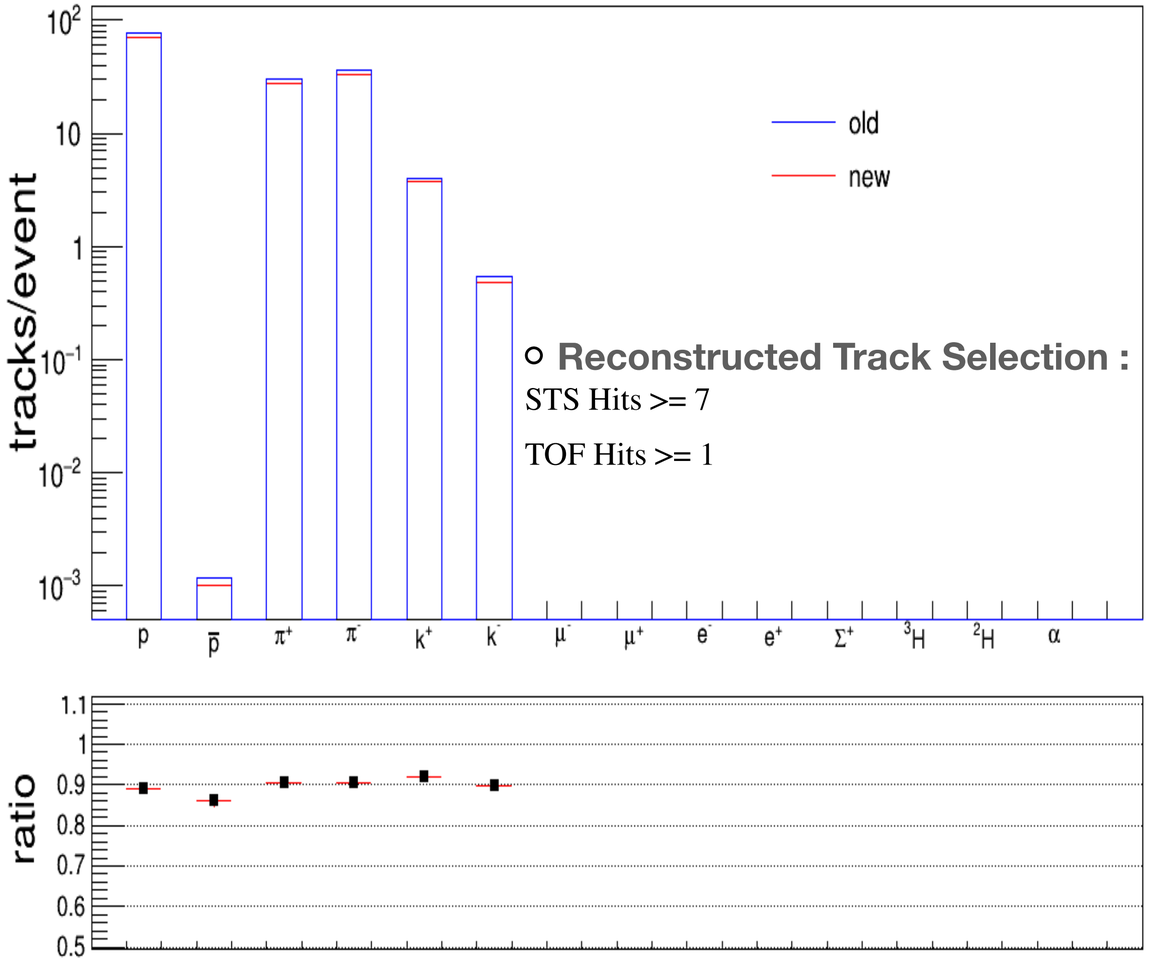
STS Hits >= 7

TOF Hits >= 1

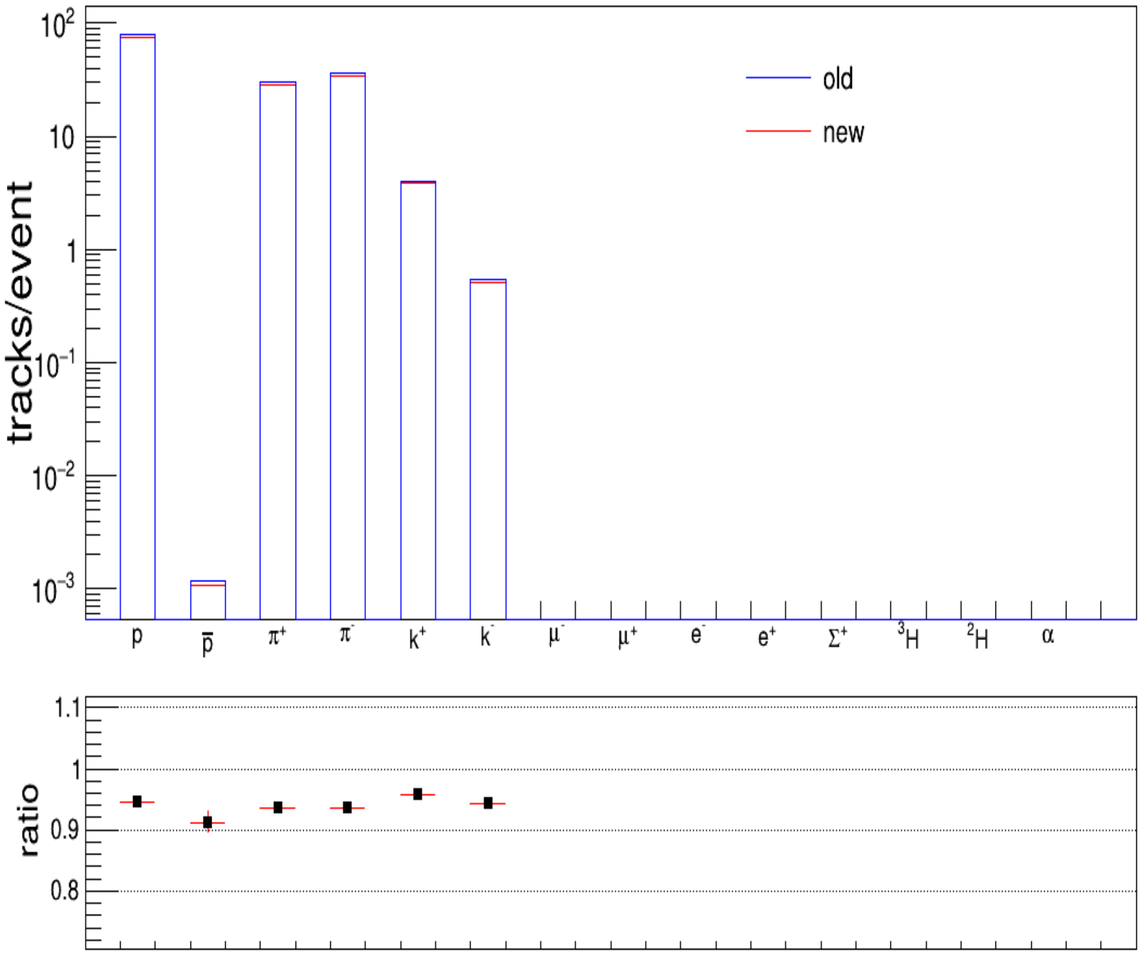




RC Particle composition @ TOF (primary)

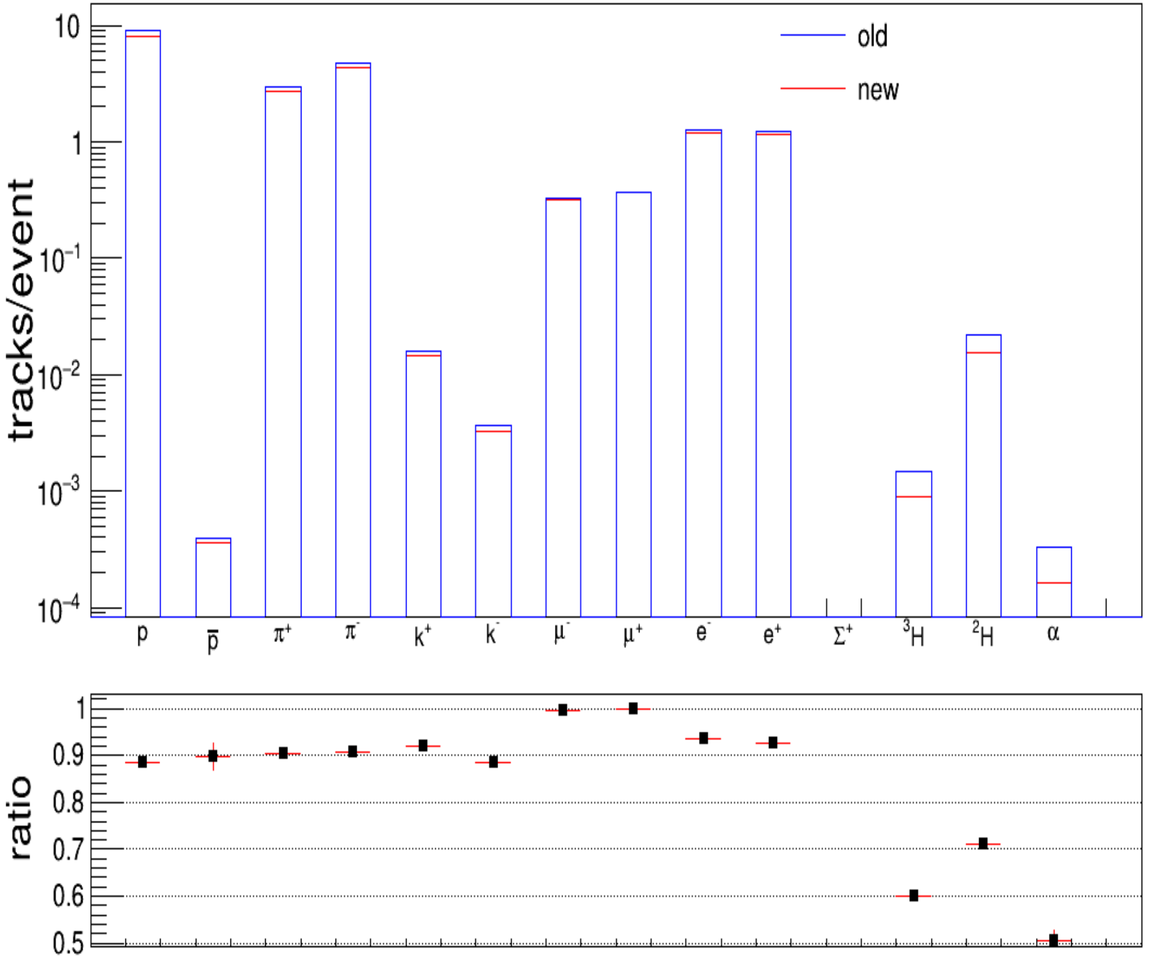


With center support

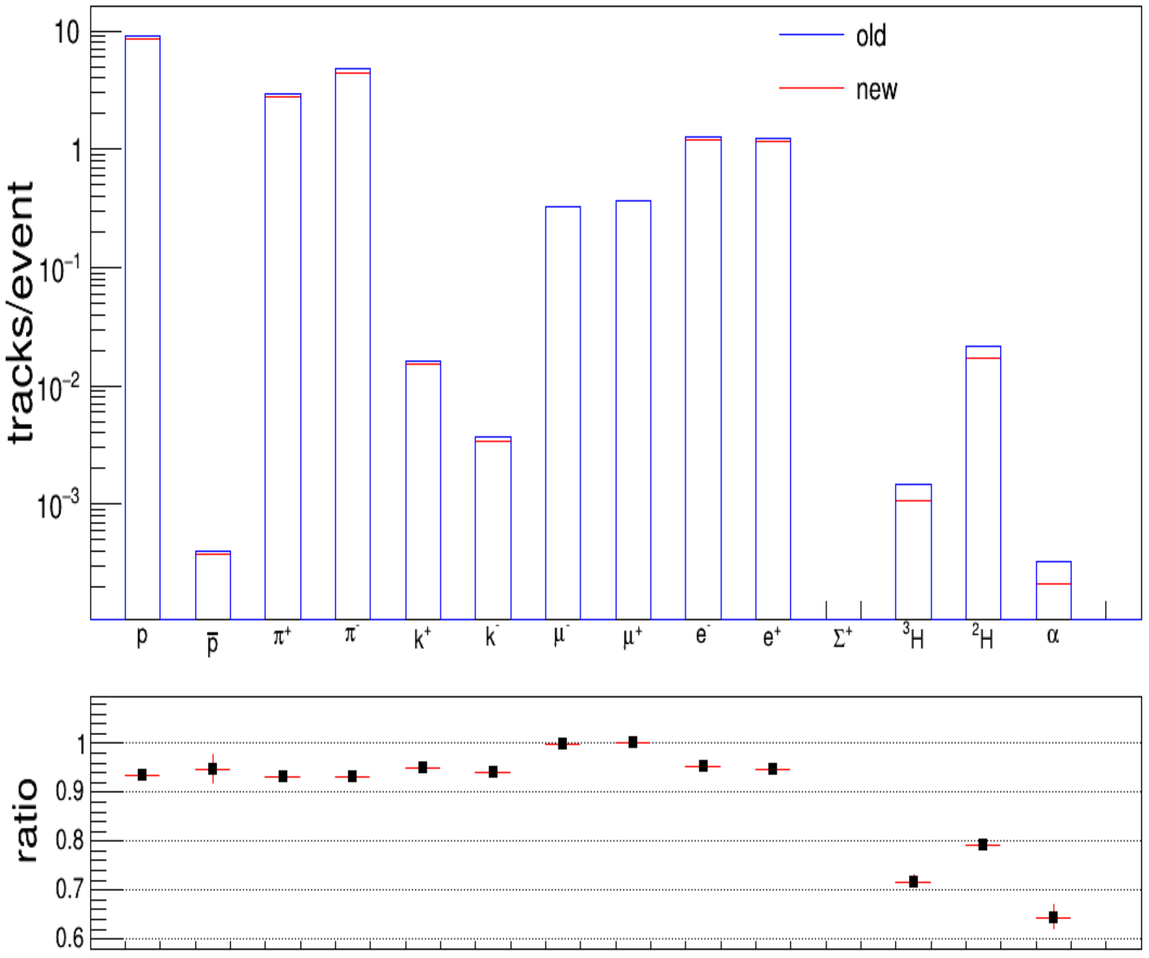


Without center support

RC Particle composition @ TOF (secondary)

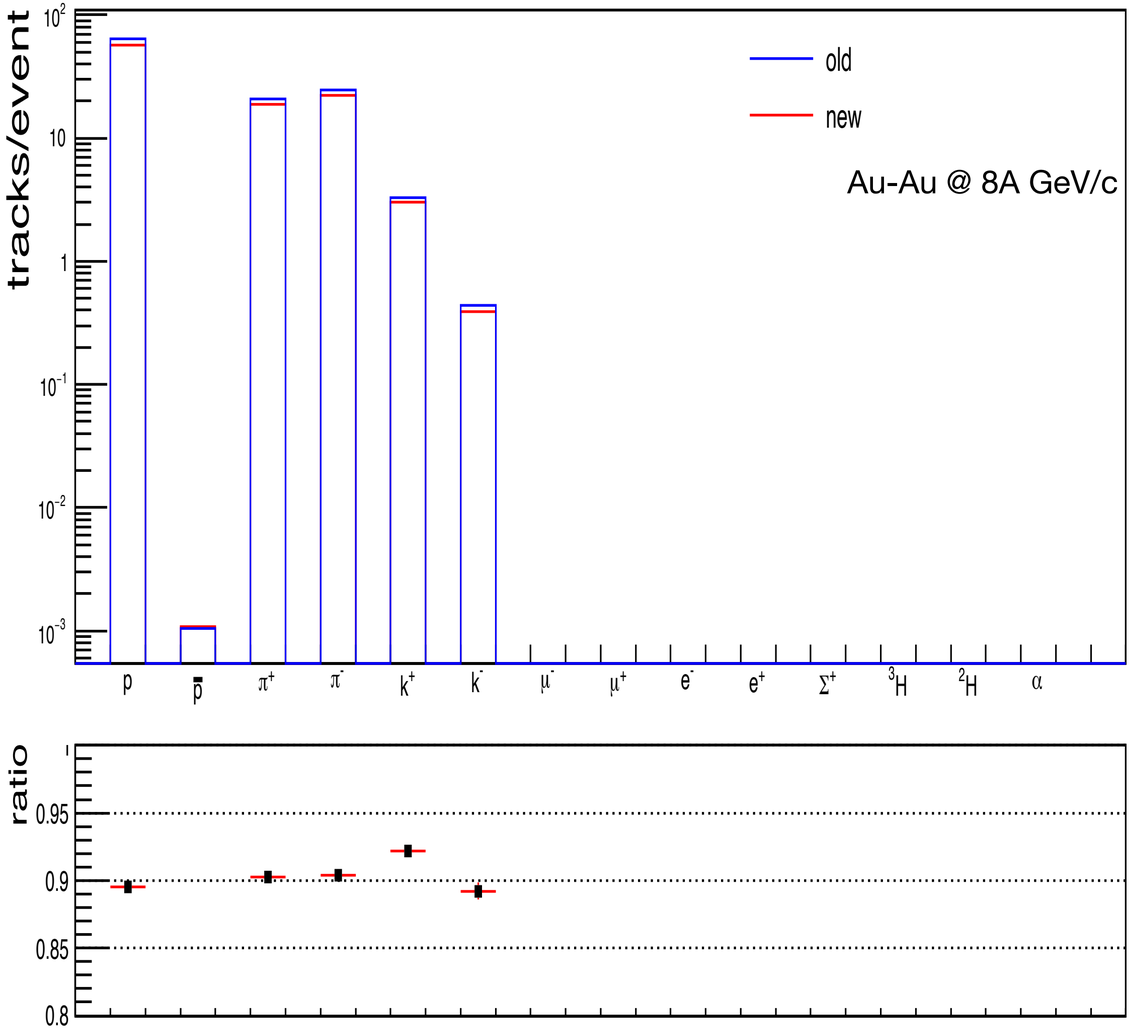


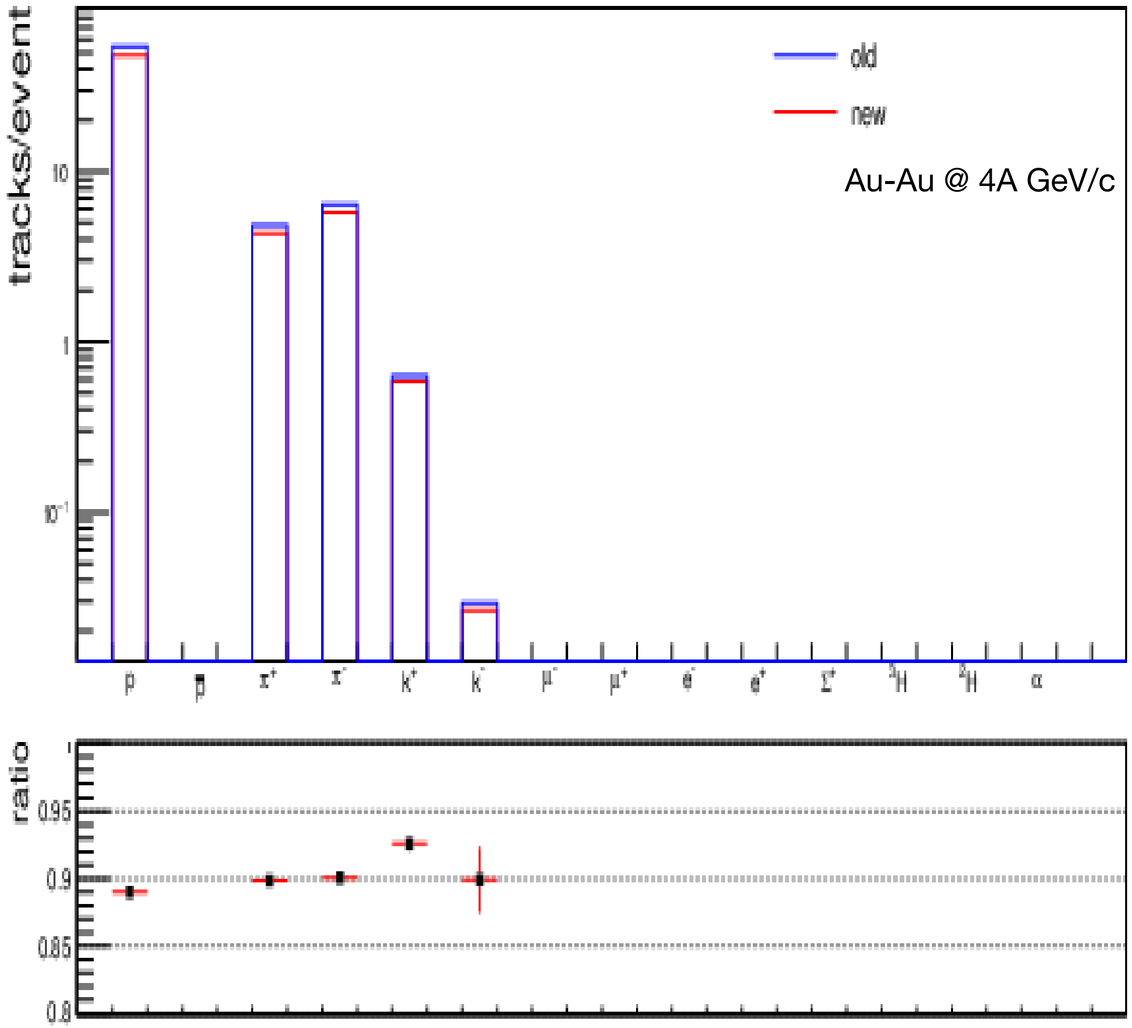
With center support



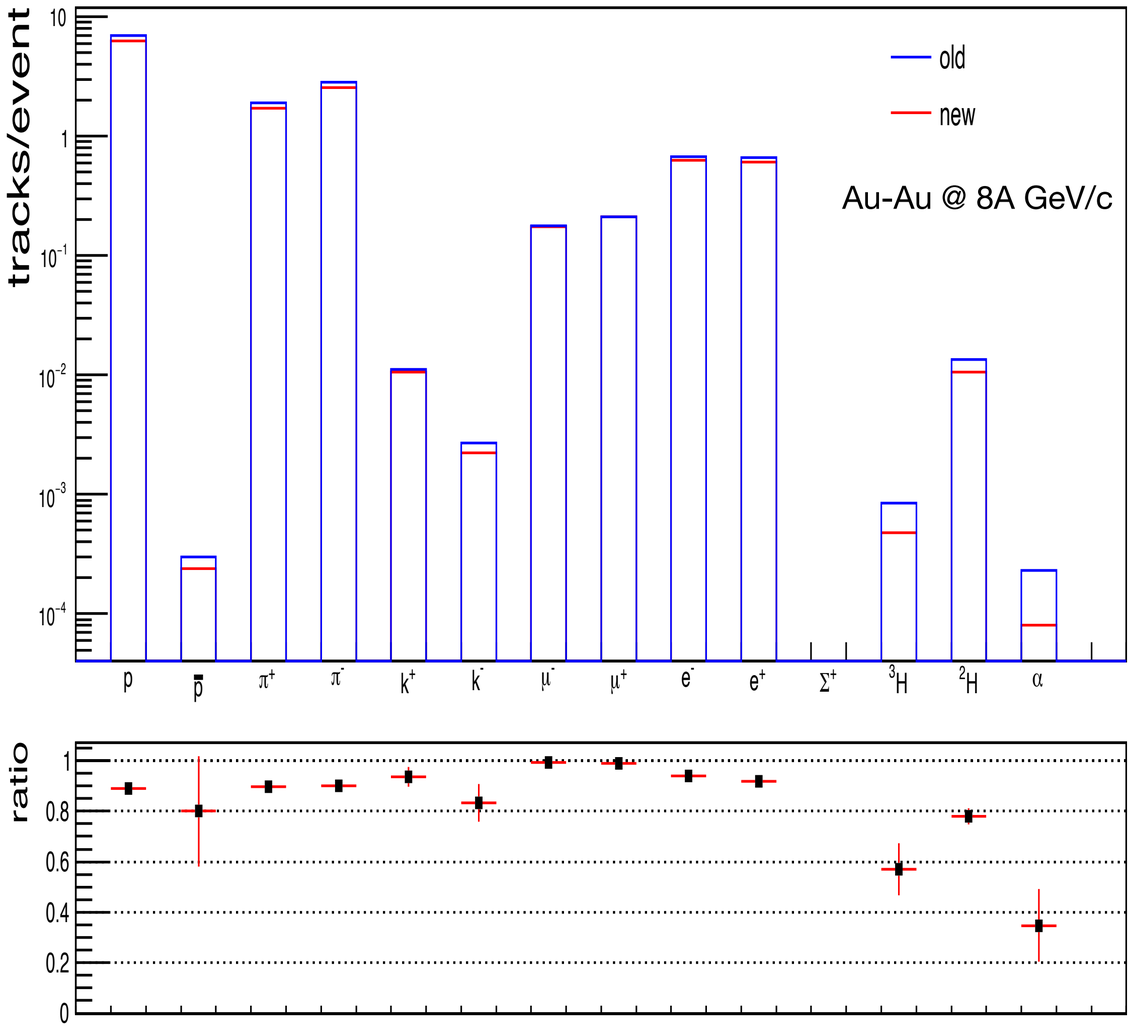
Without center support

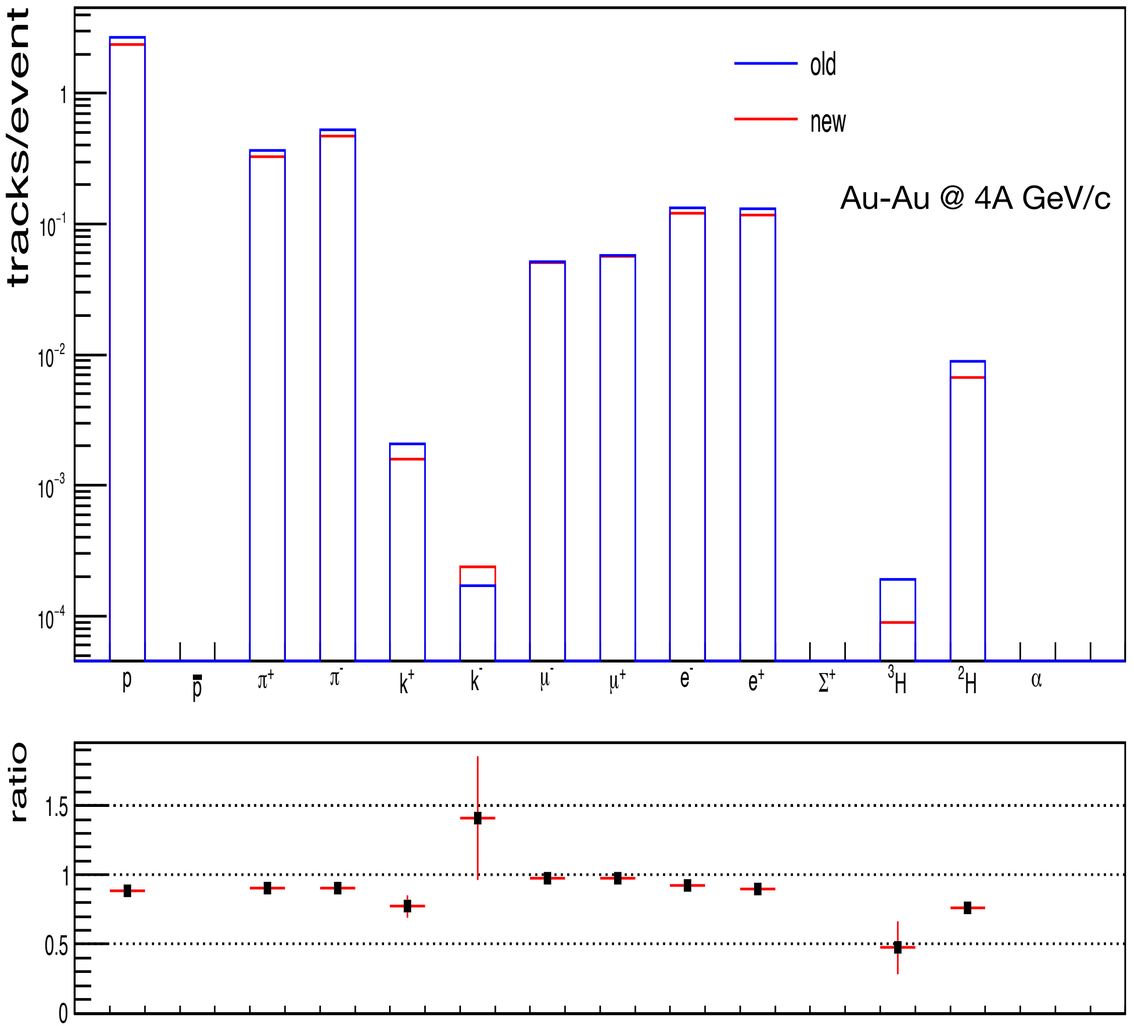
Particle composition (primaries: energy dependence)



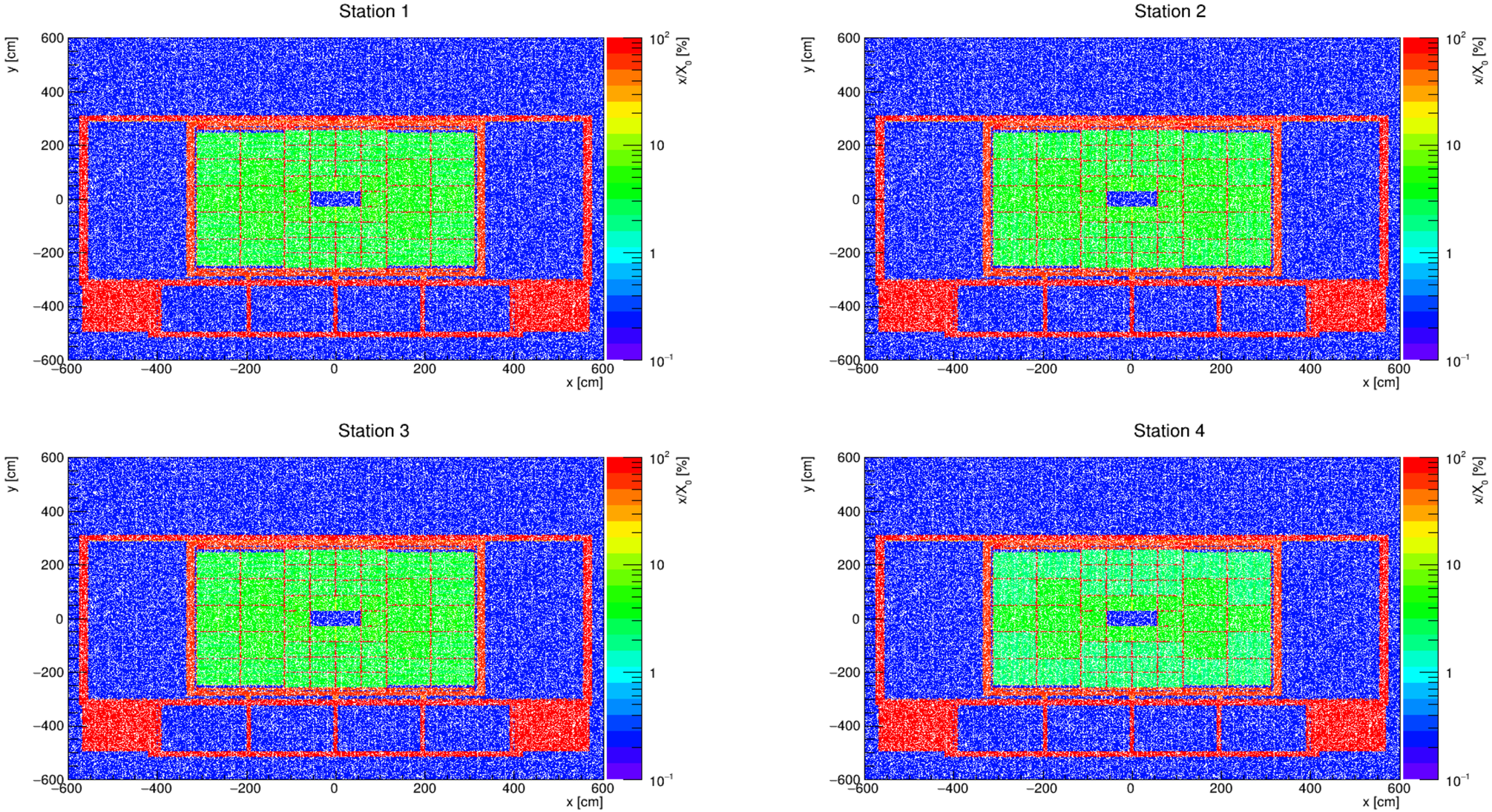


Particle composition (secondaries: energy dependence)





Open Issue: Material budget profile



Boxes instead of slanted bars at bottom are wrong, treated as volume. Could be the error in conversion or CAD geometry?

Open Issue: Momentum loss in RC tracks

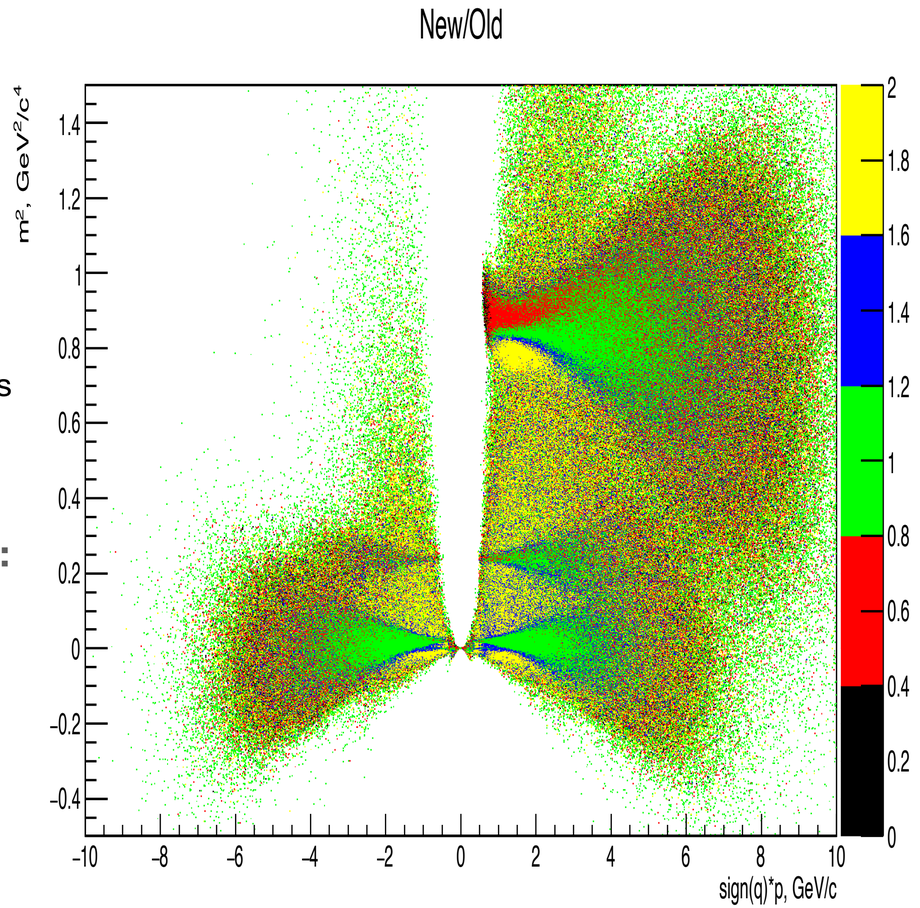
- Modification in particle mass due to momentum loss in reconstructed tracks

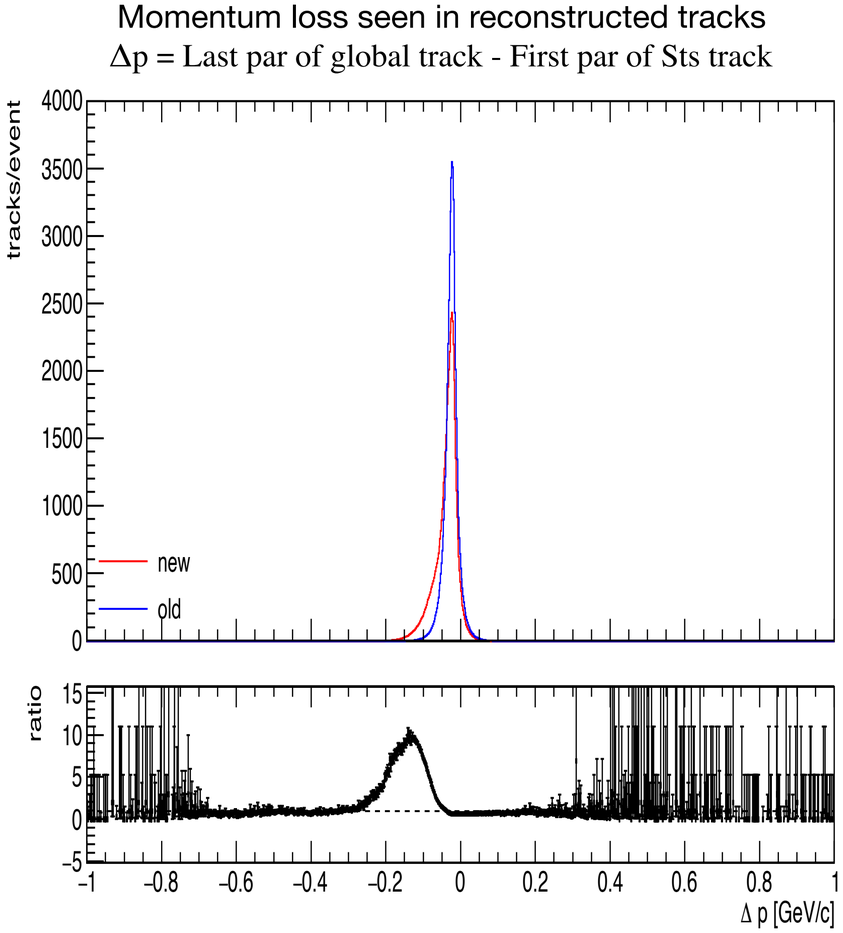
- **Reconstructed Track Selection :**

STS Hits >= 7

TRD Hits >=3

TOF Hits >= 1

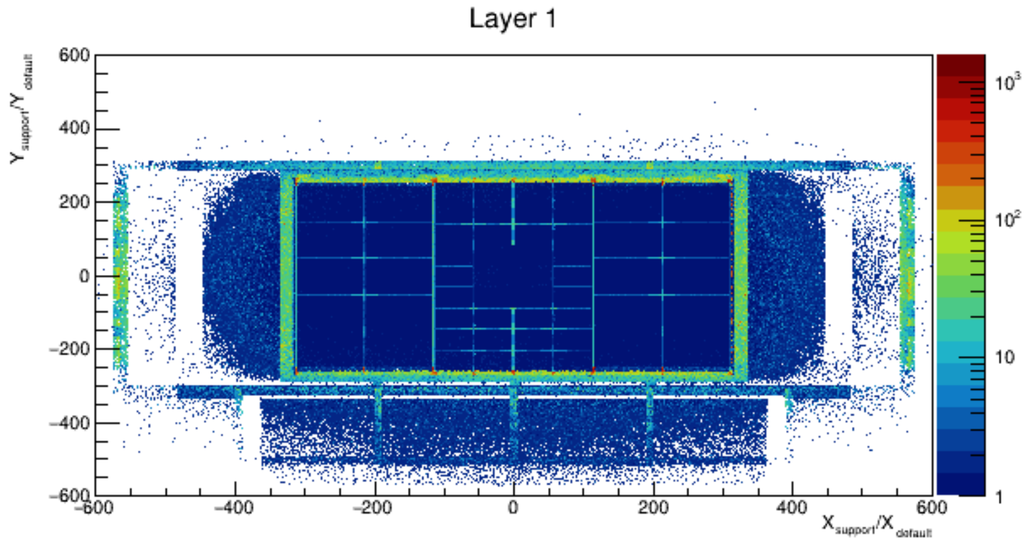


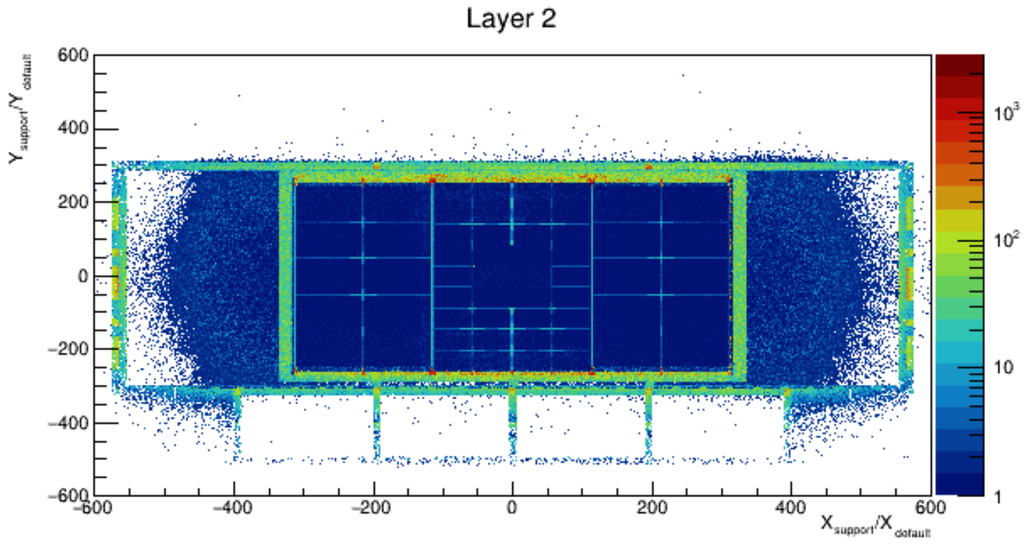


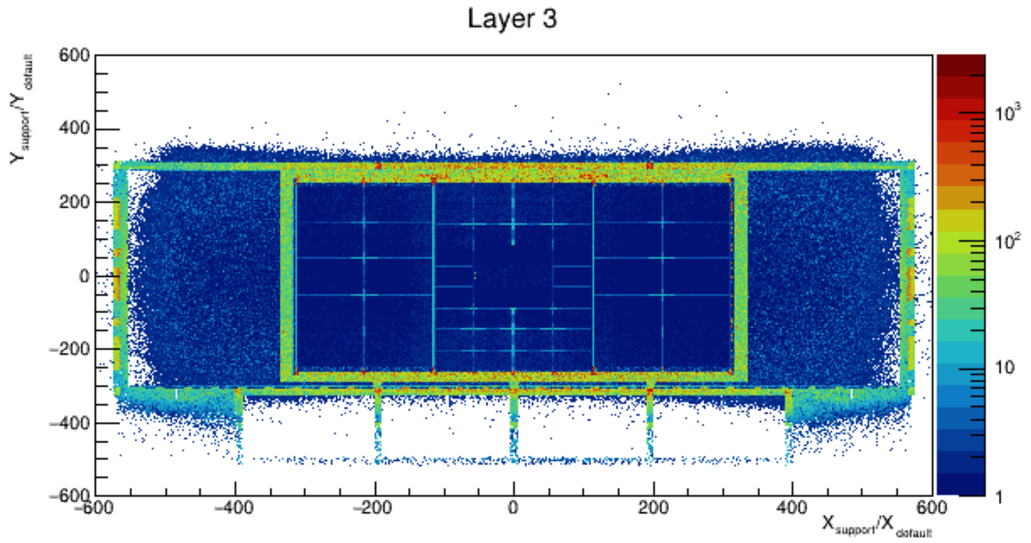
Summary

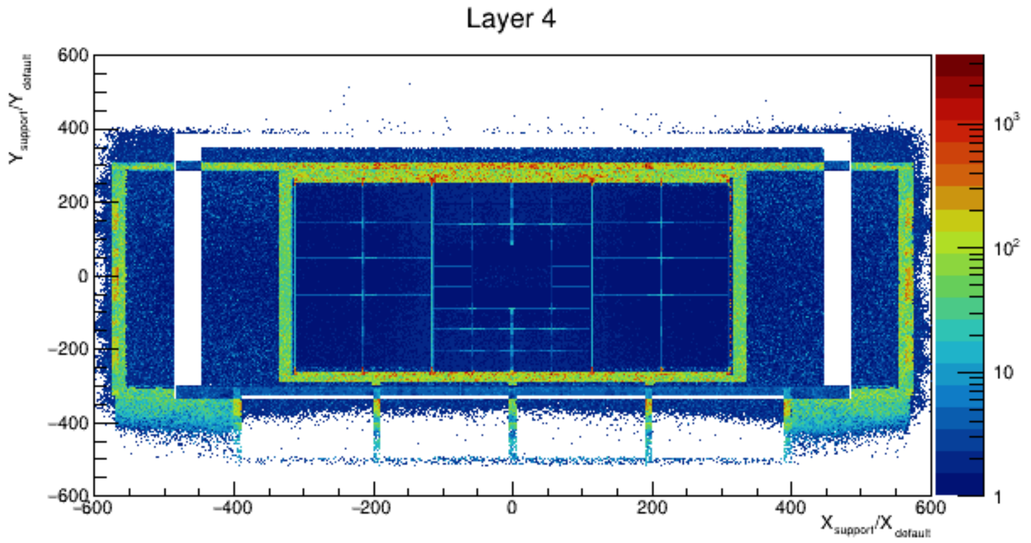
- Transfer process: STEP ⟶ GDML ⟶ RooT established
- MC tracks:
  - Primary tracks reduced
  - Generation of more secondaries due to support structure
- RC tracks:
  - Primary as well as secondaries reconstructed tracks reduced
  - After removing center support, reduction of protons are about 50% less as compared to center support
  - Reduction of primaries and secondaries are consistent with beam momentum (4A GeV/c & 8A GeV/c)
- Open issues:
  - Boxes appear instead of slanted bars in bottom corner of mainframe. Investigation on going (with Eoin). Need to check with GEANT4.
  - Momentum loss observed in reconstructed tracks. reported to software team

Backup: Vertices of all secondaries @ TRD









Vertices of secondaries @ TRD (TOF points)