# Updating the MC Simulation for PANDA GEM-Tracking Detector

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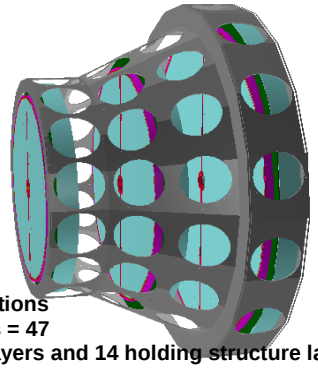
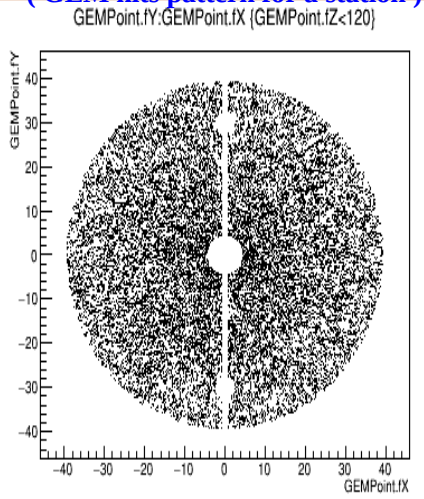
# Summary of the previous presentation at PANDA LV. Meeting - Vienna

**( realistic GEM geometry on the ROOT )**

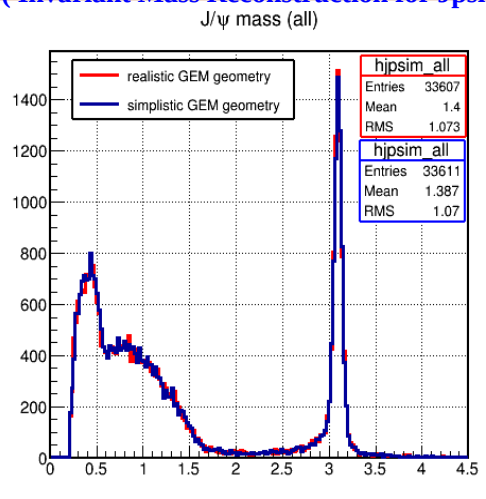


With 3 stations
NofLayers = 47
33 main layers and 14 holding structure layers
DiskInnerRadius= { 4.50, 4.50, 4.50 }cm
DiskOuterRadius= { 45.00, 56.00, 74.0 }cm
DiskZPosition= { 119.40, 155.40, 188.50 }cm

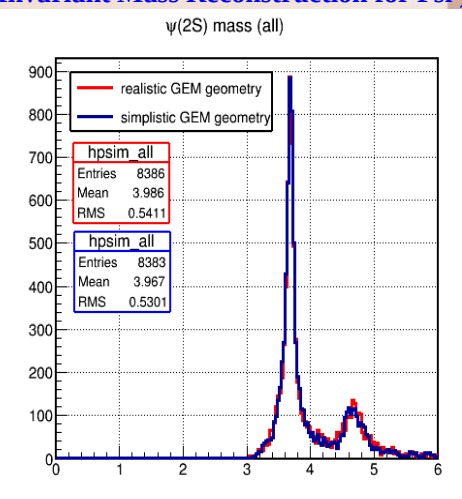
**( GEM hits pattern for a station )**



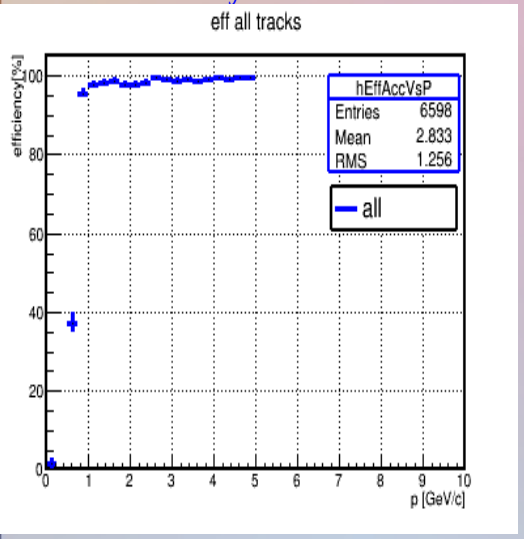

**( Invariant Mass Reconstruction for Jpsi )**



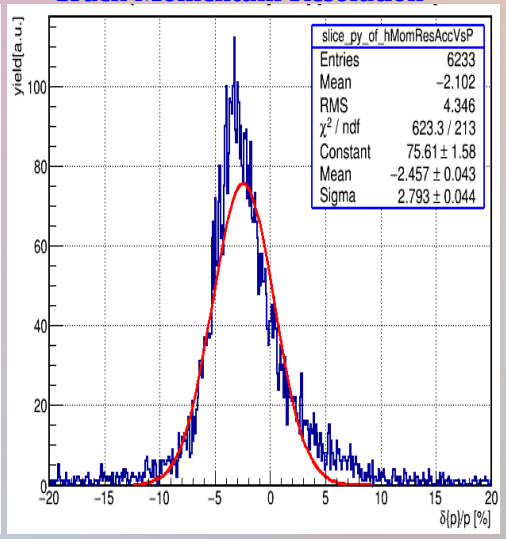

**( Invariant Mass Reconstruction for Psi )**



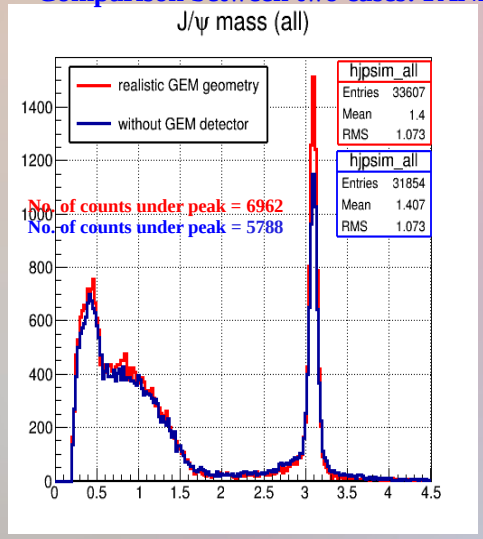

**Track Efficiency vs Momentum**

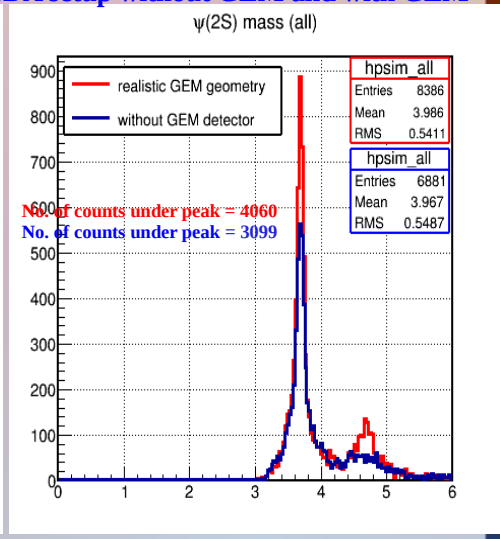



**Track Momentum Resolution**

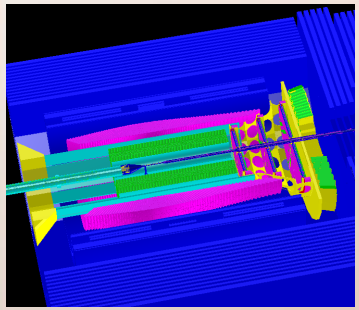


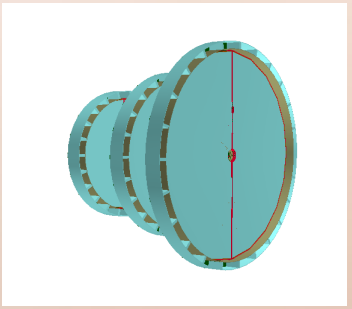

**Comparison between two cases: PANDA setup without GEM and with GEM**

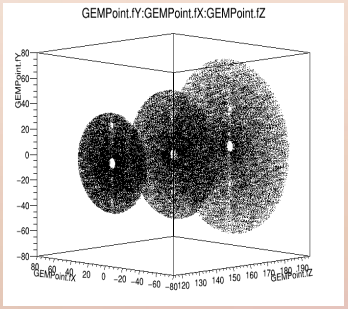


# Summary of the previous presentation ( conclusion and outlook )





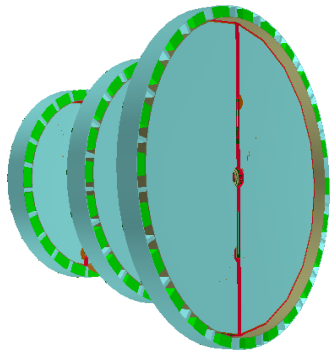



- **As the Conclusion :**
- **The realistic geometry of GEM for PANDARoot was almost ready**
- **Materials for supporting structures and cooling devices didn't increase background in the invariant mass reconstruction histograms**
- **With realistic GEM geometry, mass resolution and tracking acceptance were improved**
- **To emphasize of the GEM role on the PANDA setup, in the current tracking class PndSttMvdGemTracking, improvement by adding GEM should be separated from the other contributions**

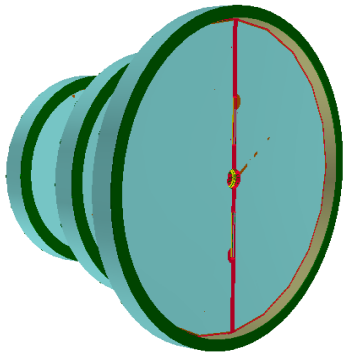
- **As the Future Tasks :**
- **Implement more realistic geometries such as electronics modules, cables and connectors**
- **Check extrusions and overlaps for inner GEM parts and between GEM and its neighbors**
- **Upload the realistic GEM geometry to the repository of the PandaROOT framework**
- **Separate contributions by GEM from the other contributions and implement MVD+GEM tracking**
- **Investigate the invariant mass reconstruction for the other physics benchmark channels**

# More completion of GEM geometry : Adding some parts as the electronic devices

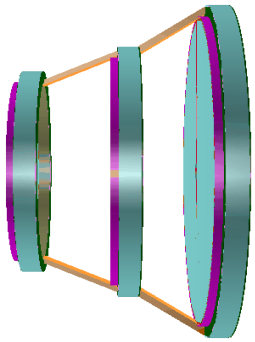
## Adding electronic modules in copper



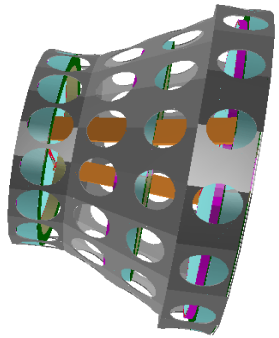
## Covering ring in glass fiber



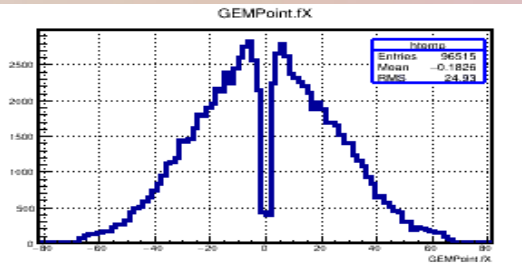
## Adding cables in copper as big as possible



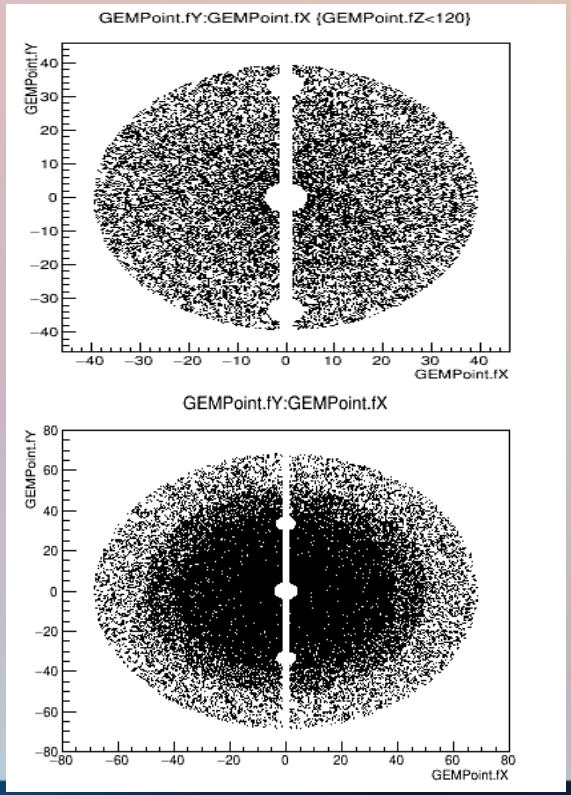
## Fitting the Riddle shell without any contact

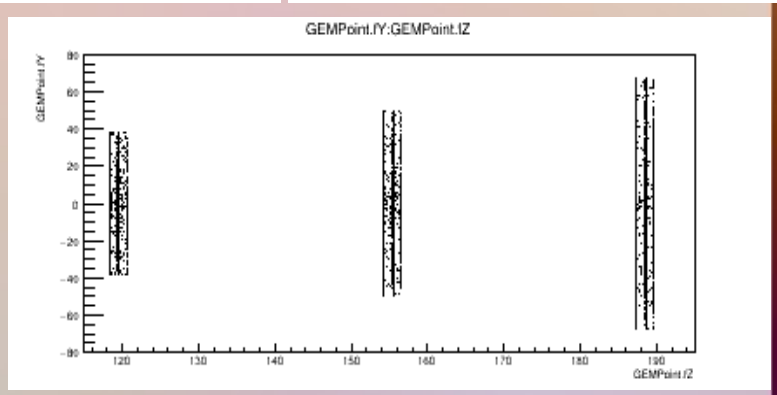


## GEM Points (X,Y,Z)

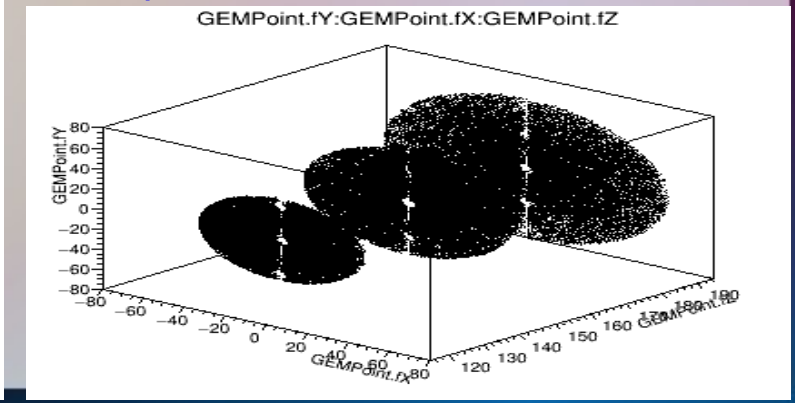



## GEM hits pattern for a station and all stations



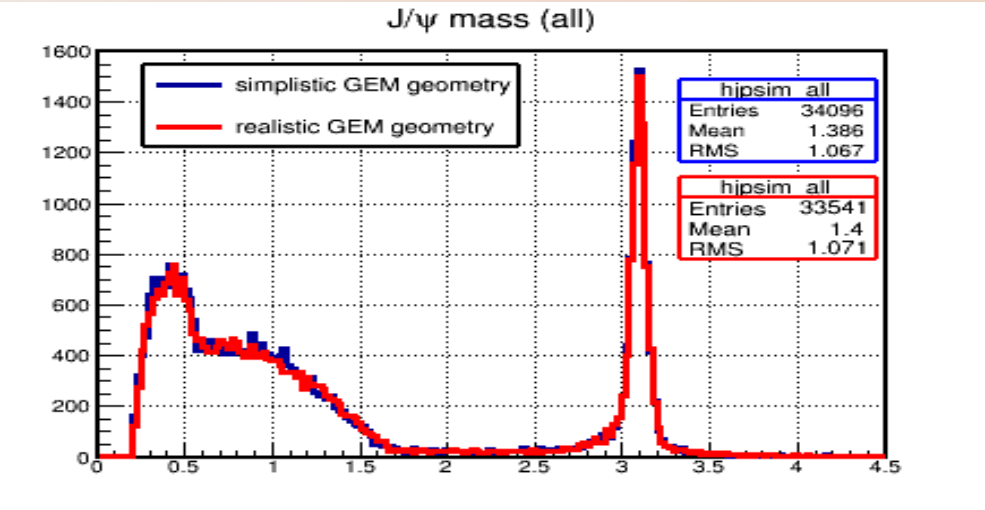



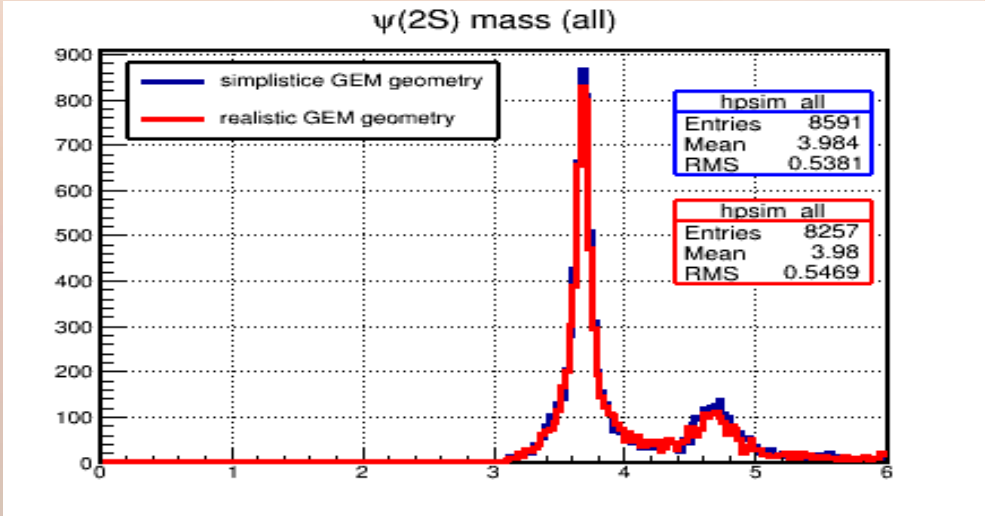

## GEM hits pattern for three stations Z=119.4 , 155.4 , 188.5 cm

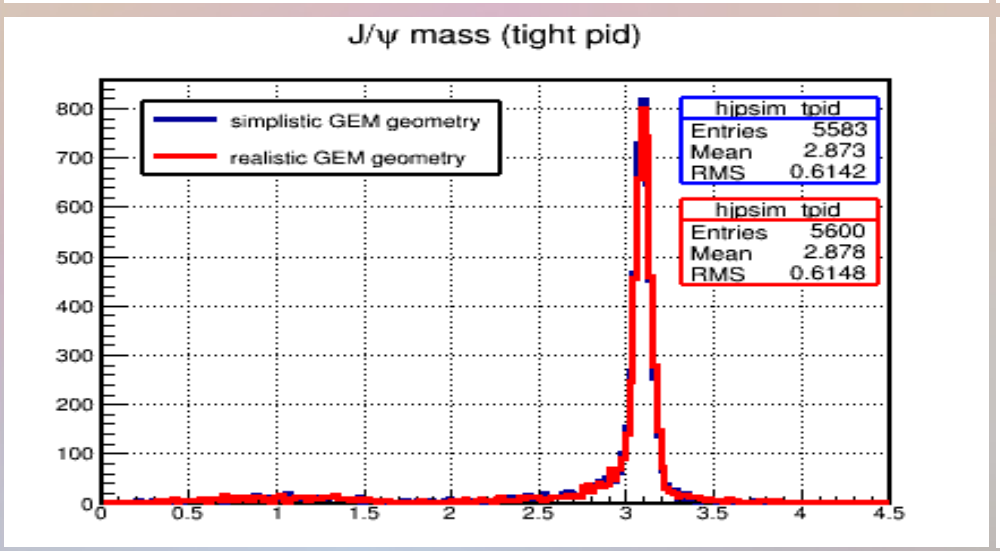


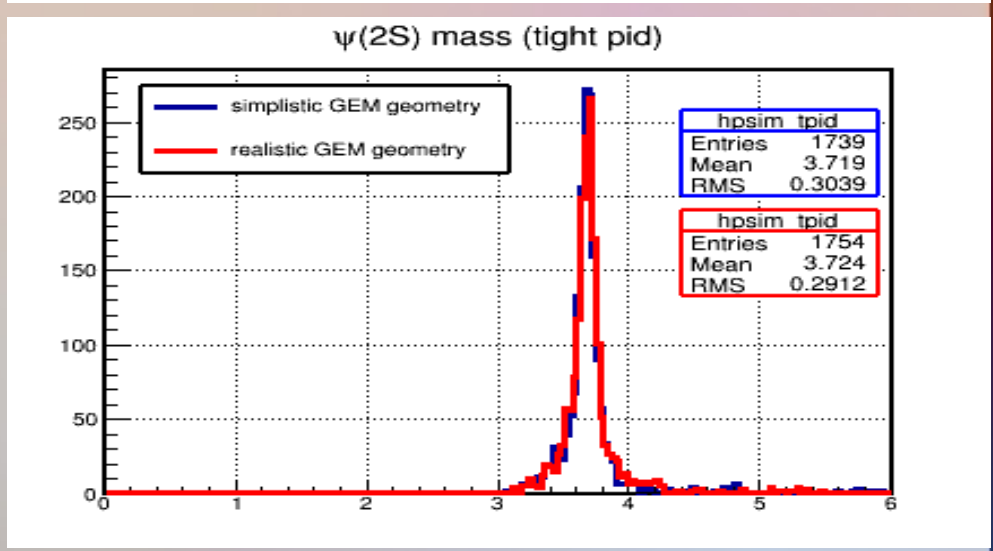
# Investigation of Invariant Mass Reconstruction

Benchmark channel including antip+p→ψ(2S)→J/ψ(1S)π+π–, then J/ψ into $\mu$+ and $\mu$- (muonic decay) mass of the ψ(2S) and J/ψ(1S) are respectively 3686.109±0.012MeV/c² , 3096.916±0.011MeV/c²



# Geometry Completing – Overlap Checking – Repository Updating

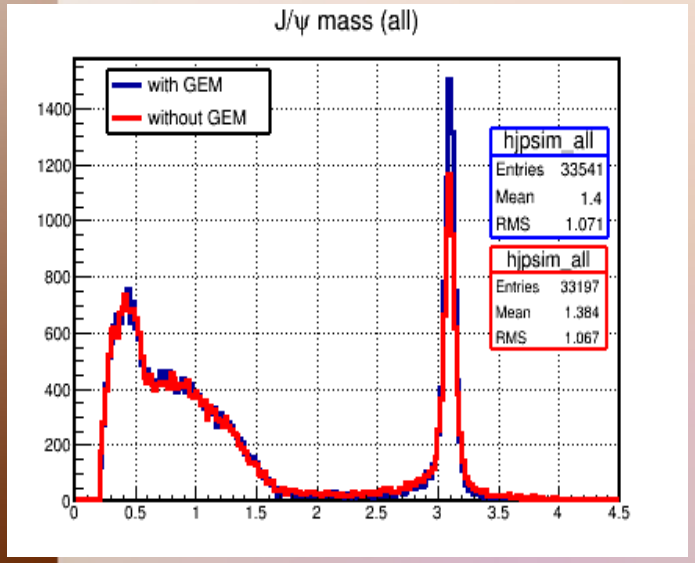
- Therefor, we could do these steps up to now :
- Implemented more realistic geometries such as electronics modules, cables and connectors ------> The geometry could be changed

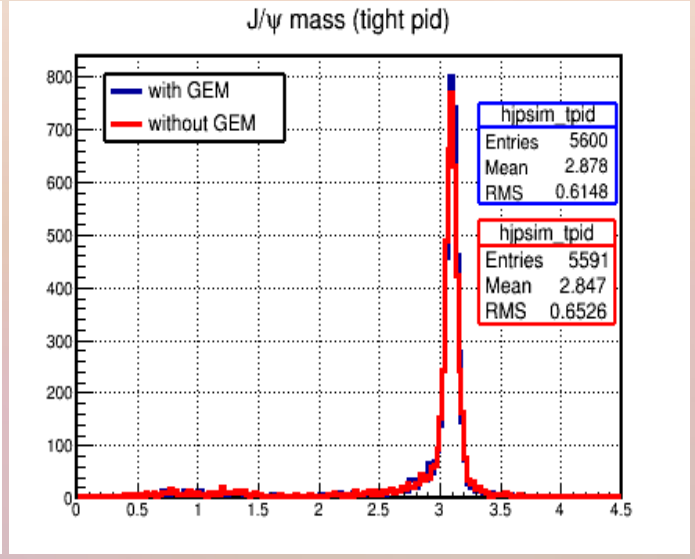
  The result are acceptable

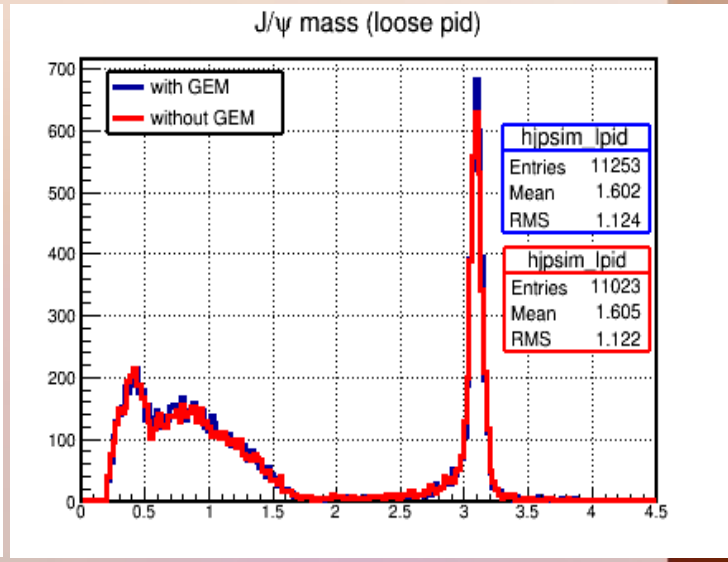
  Realistic GEM geometry and extra materials do not disturb reconstructing
- Checked extrusions and overlaps once again for inner GEM parts and between GEM and its neighbors ------> It seems there is no overlap
- Uploaded the realistic GEM geometry to the repository of the PandaROOT framework ------> trunk/macro/gem@revision28834 , (27/01/2016)
  create3stationsGem.C: gem_3Stations_realistic_v1.root
  gem_3Stations_realistic_v1.digi.par

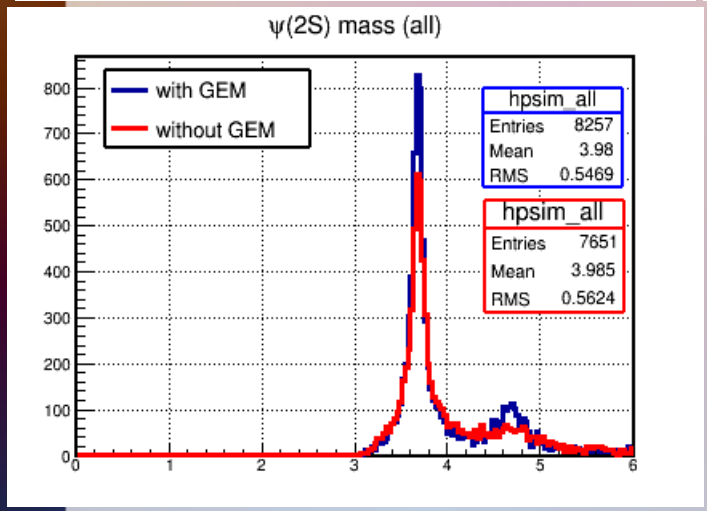
# Comparison between two cases: PANDA setup with and without GEM

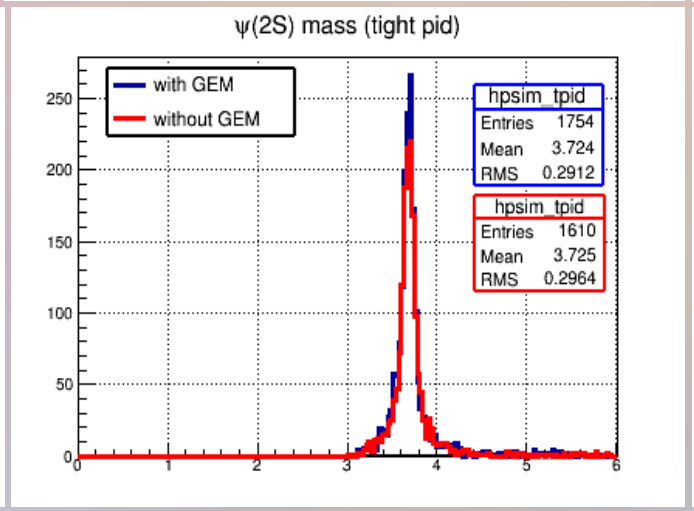
**using PndSttMvdGemTracking current class for track reconstruction.**

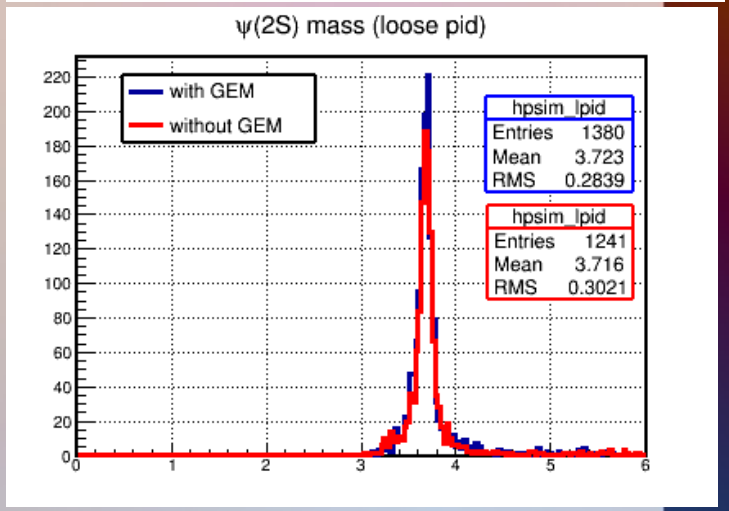


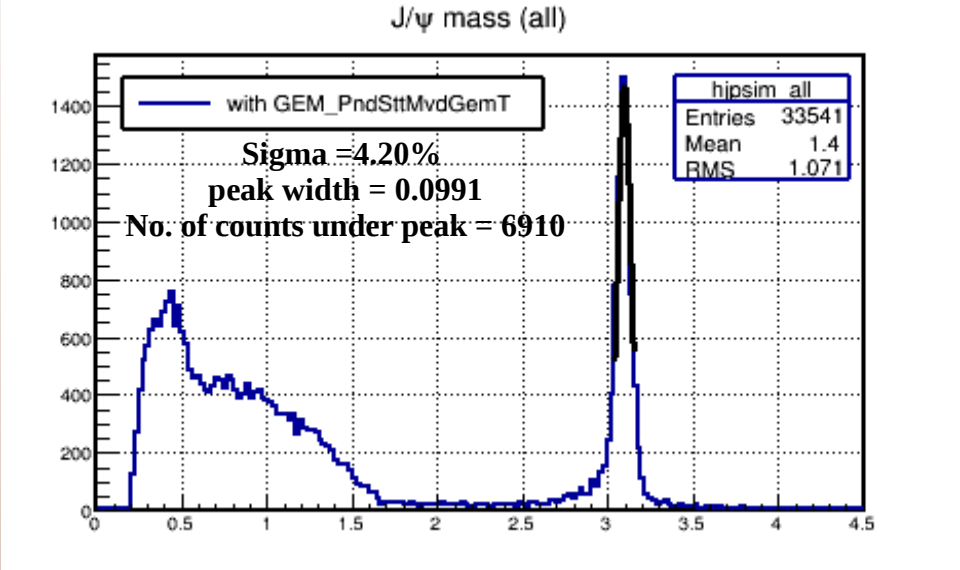



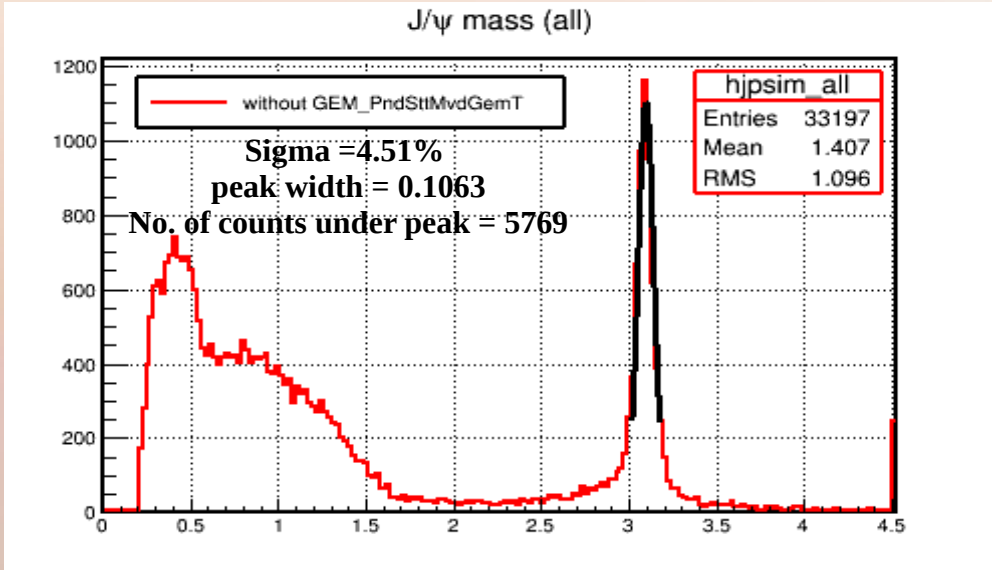



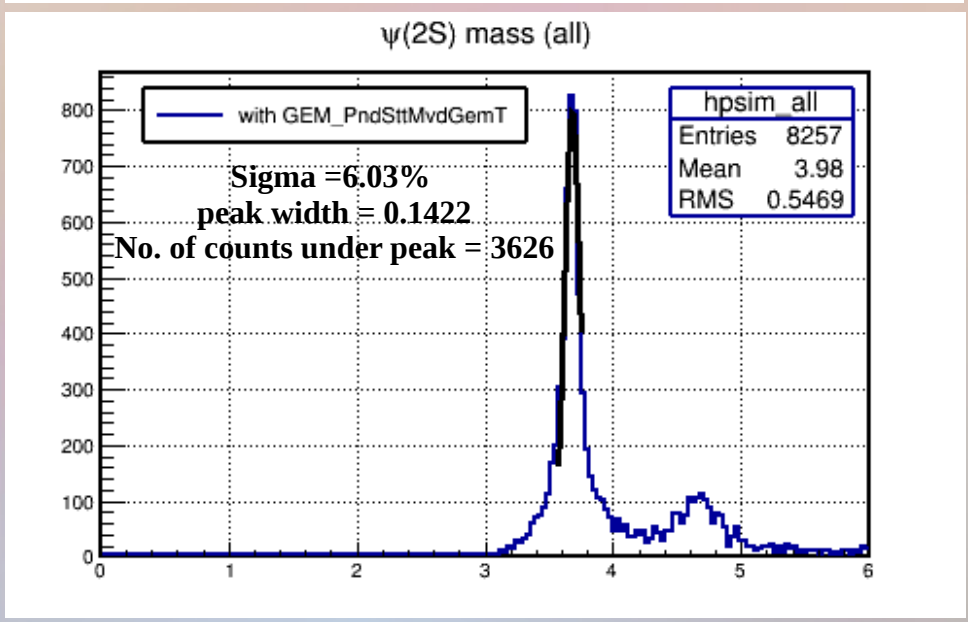



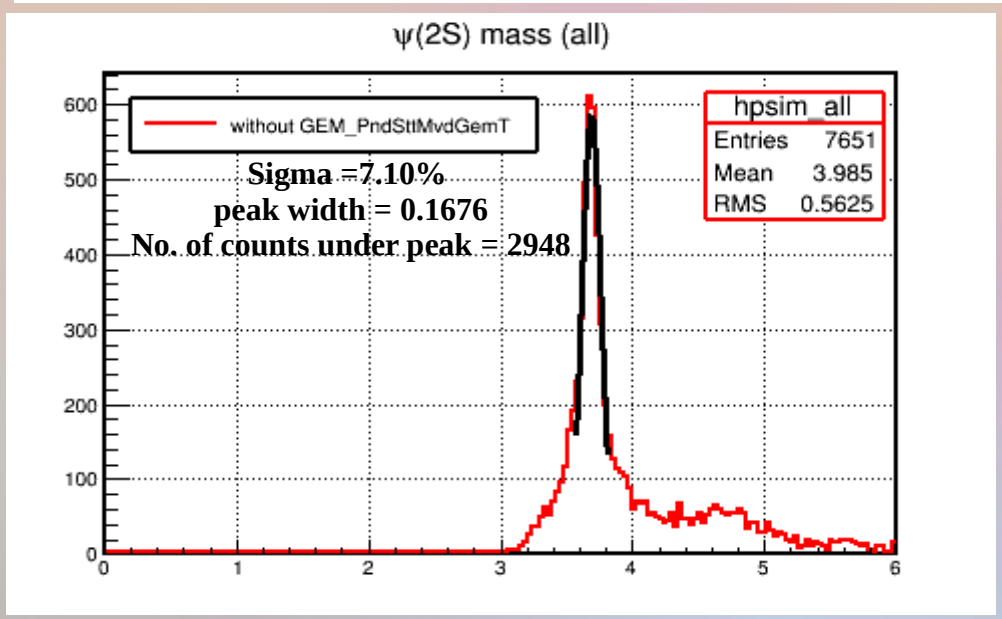



# Results for PANDA setup with and without GEM using PndSttMvdGemTracking



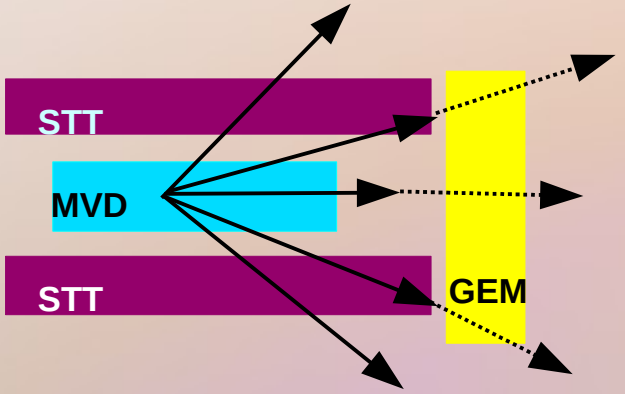



# Study about changing track reconstruction class

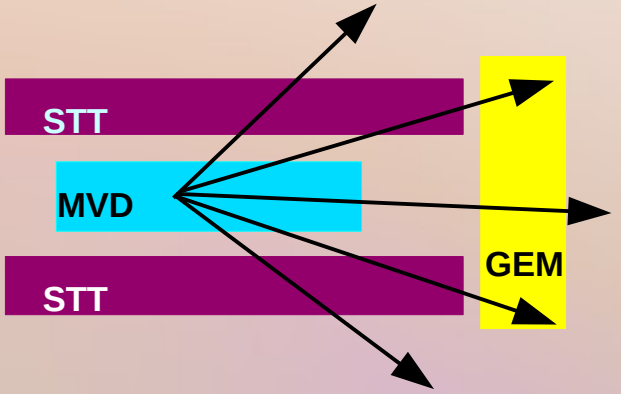
Benchmark channel including antip+p→ψ(2S)→J/ψ(1S)π+π–, then J/ψ into $\mu$+ and $\mu$- (muonic decay)

## Comparison between two track reconstruction classes :




### PndSttMvdGemTracking

- Current tracking class in the framework is PndSttMvdGemTracking
  - Tracking procedure always uses hits in STT and MVD
  - GEM hits are used for track improving when they exist
  - Contributions with STT+MVD & GEM coincidence is not large

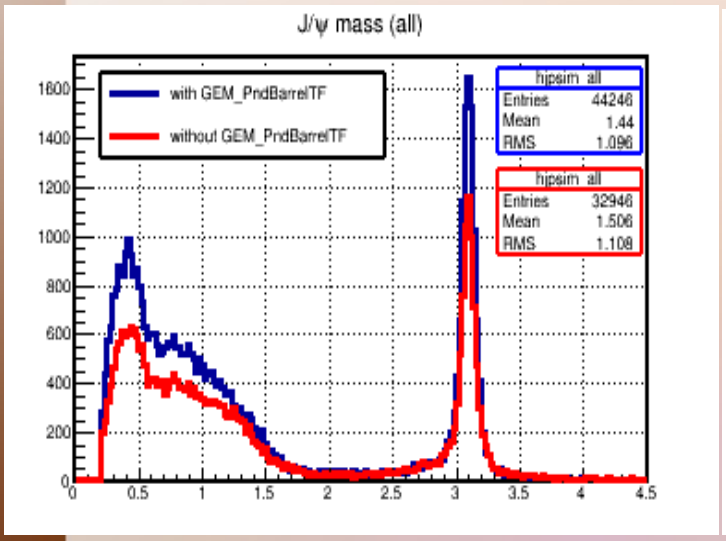


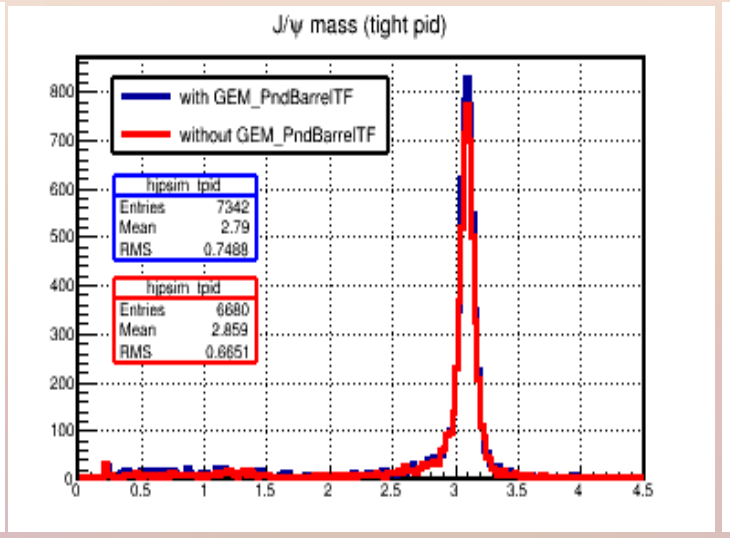

### PndBarrelTrackFinder

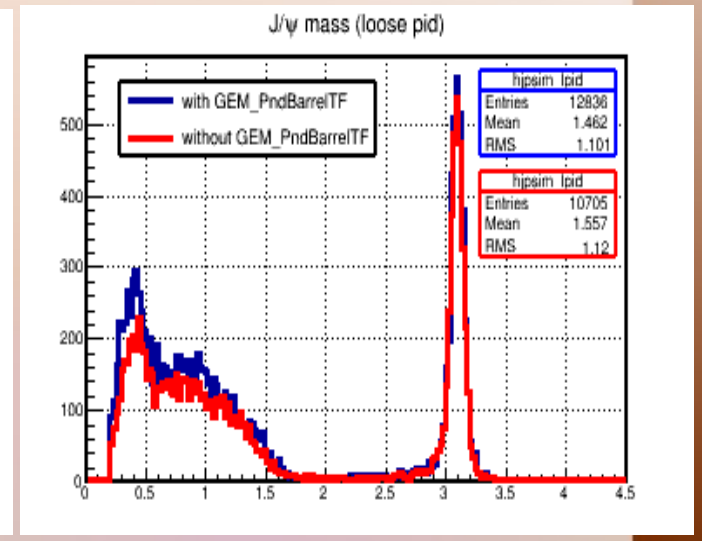
- Another tracking class in the framework is PndBarrelTrackFinder
  - Tracking procedure always uses any hits in STT and MVD and GEM
  - GEM hits are counted for track finding simultaneously
  - Contributions with STT+MVD & GEM coincidence is good

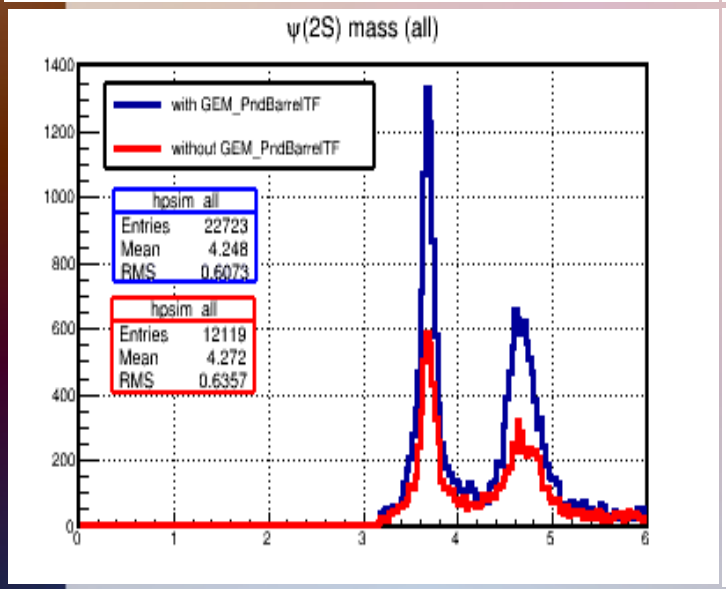
# Comparison between two cases: PANDA setup with and without GEM

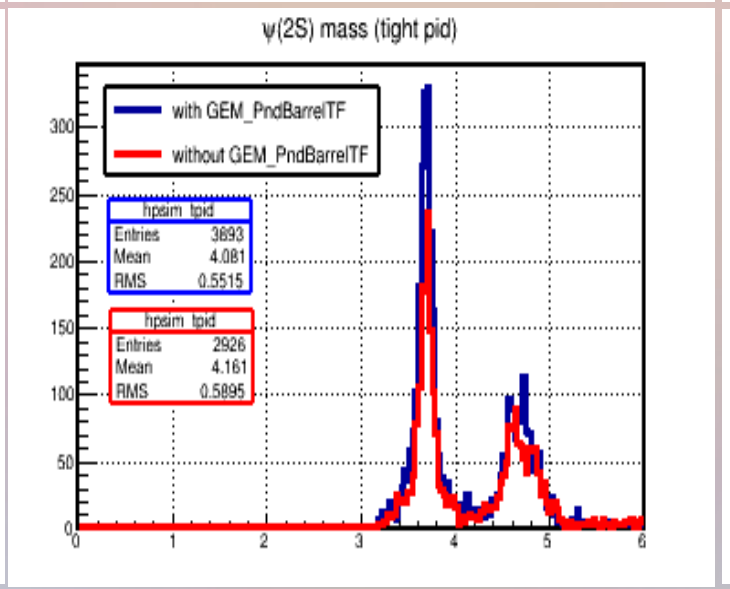
**using PndBarrelTrackFinder class for good track reconstruction**

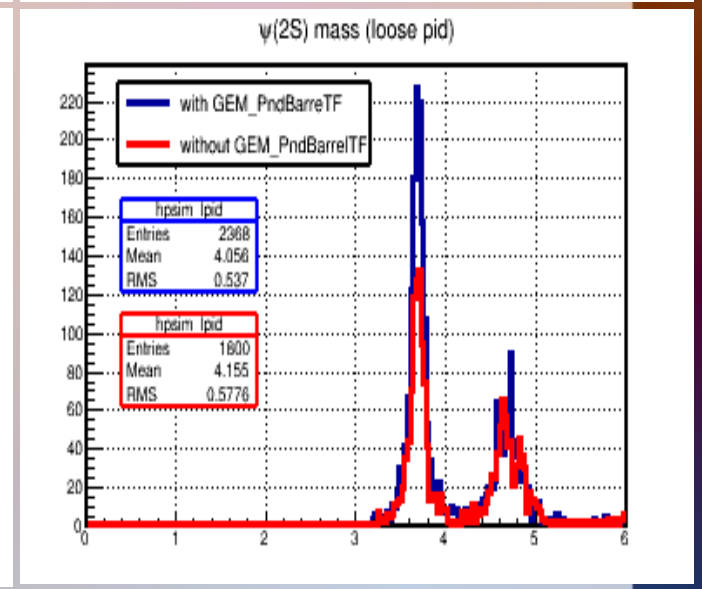


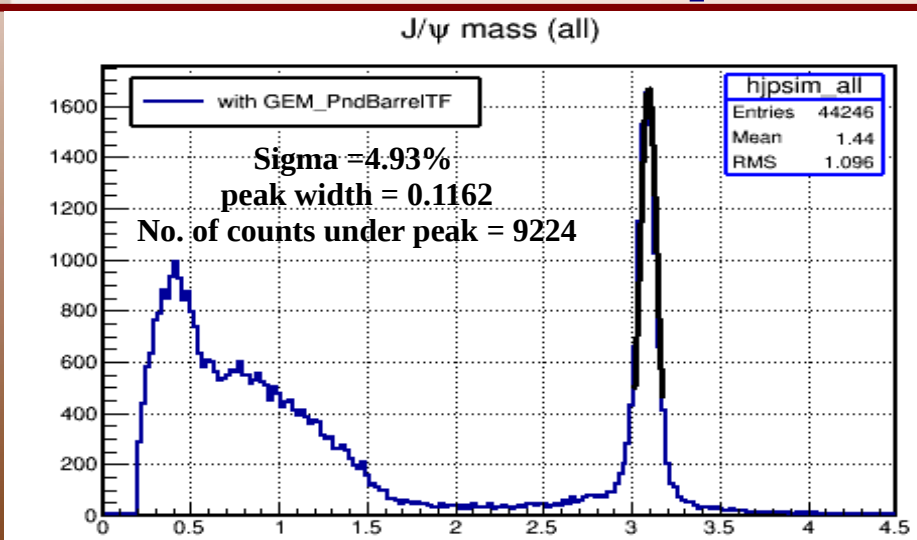



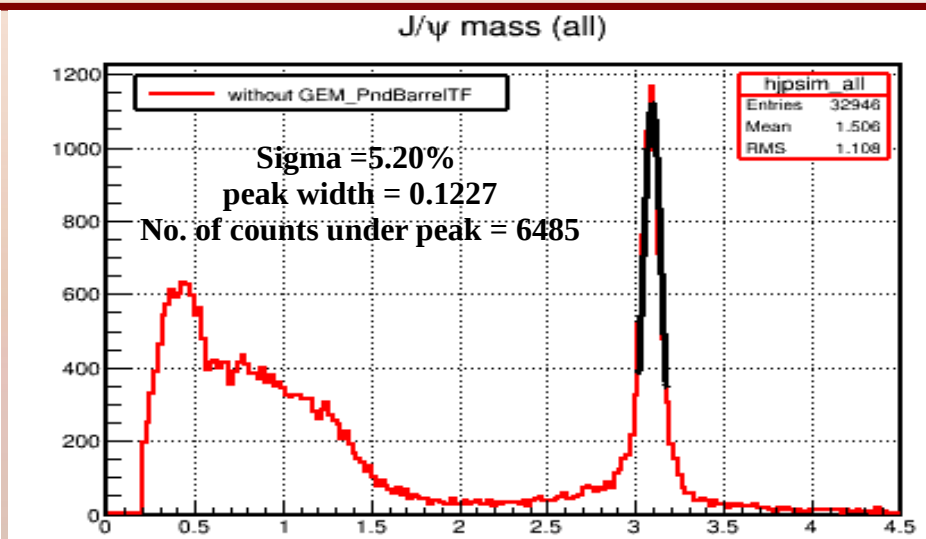



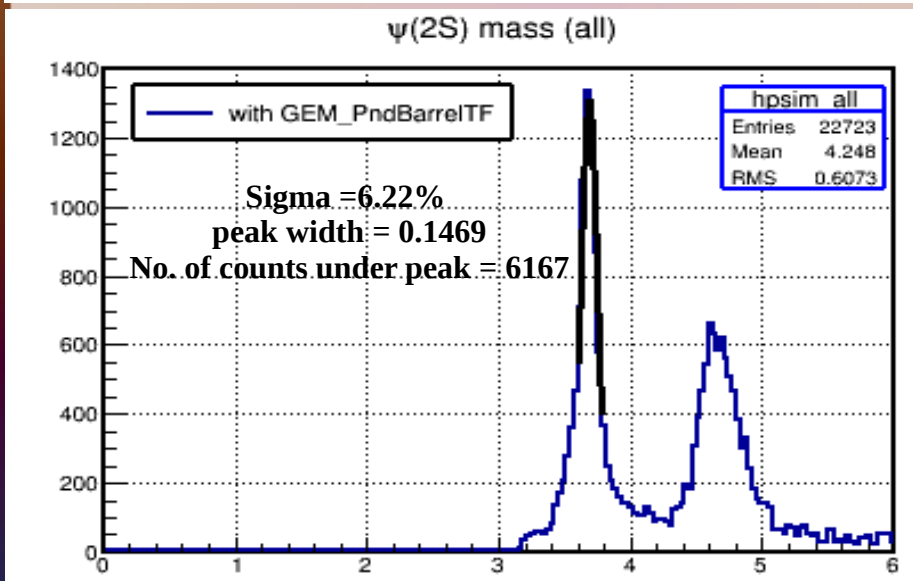



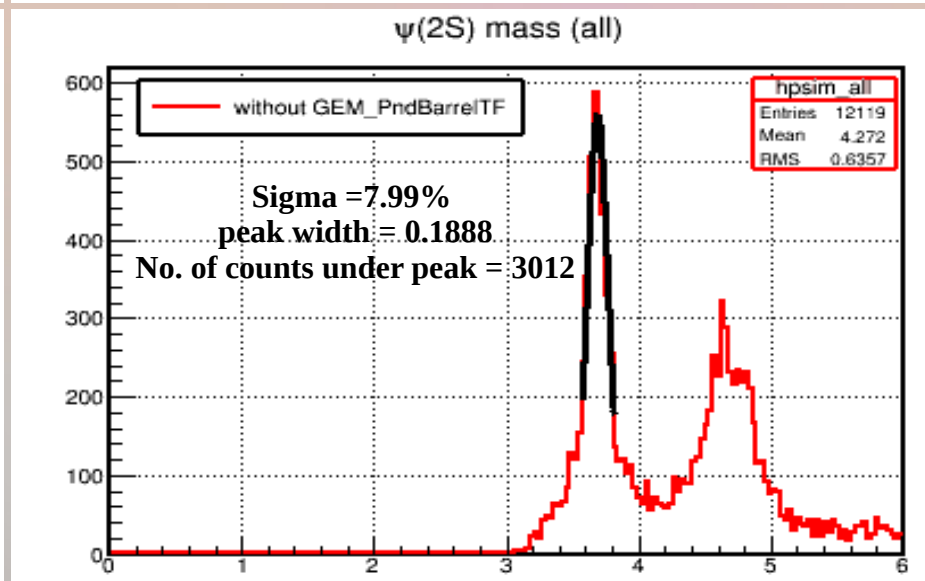



# Results for PANDA setup with and without GEM using PndBarrelTrackFinder



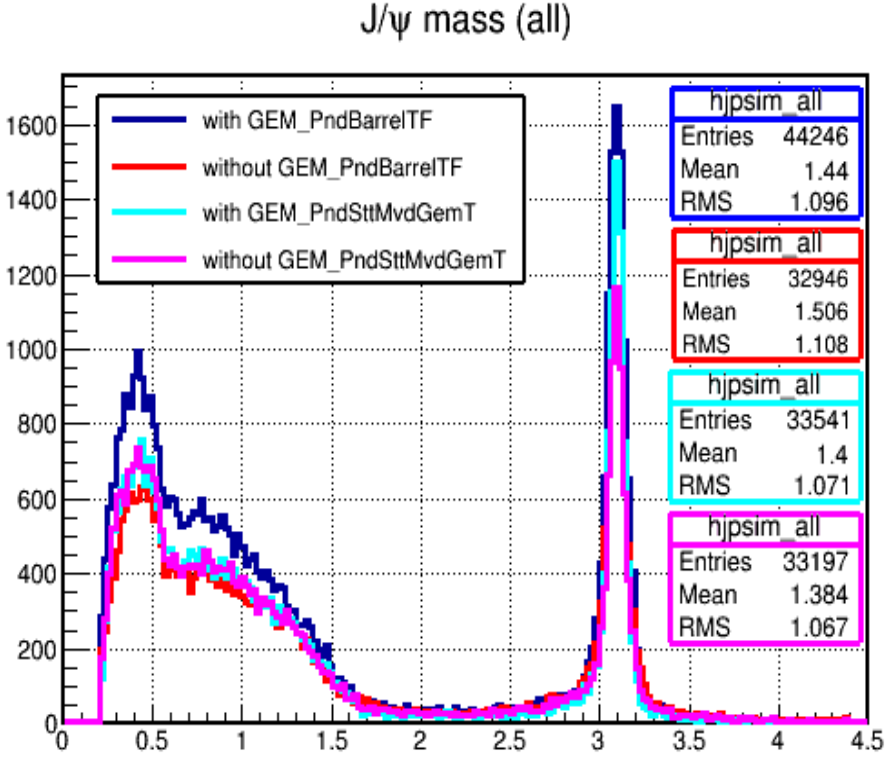



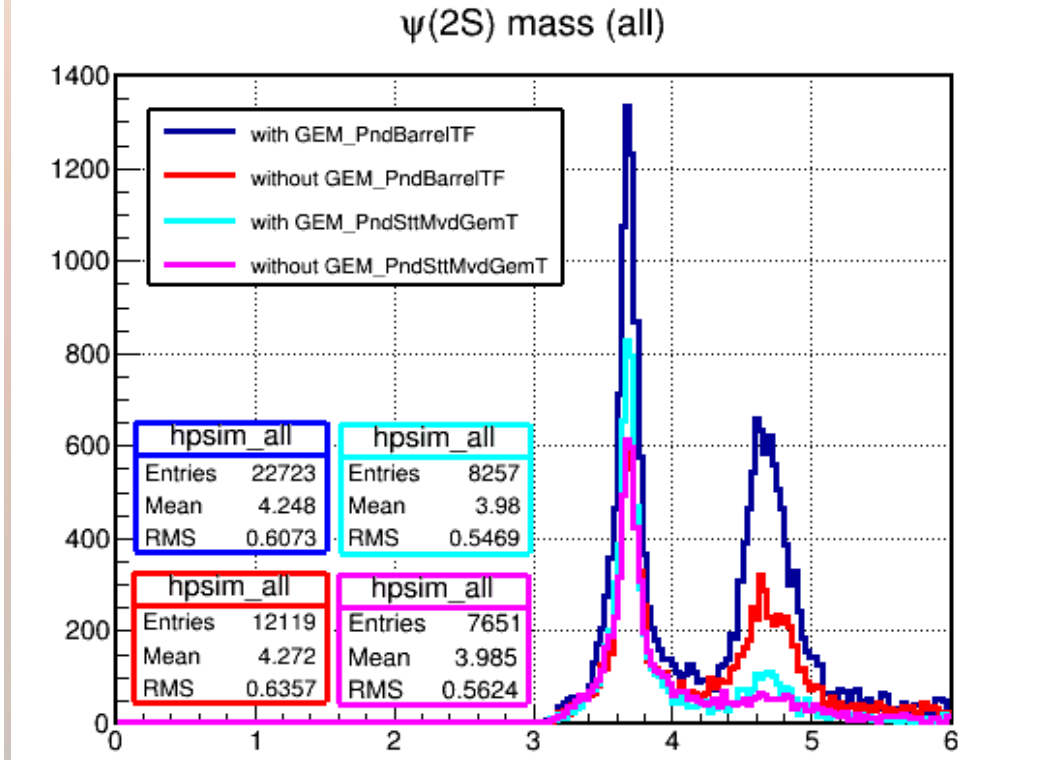



# Comparison between two cases: PANDA setup with and without GEM

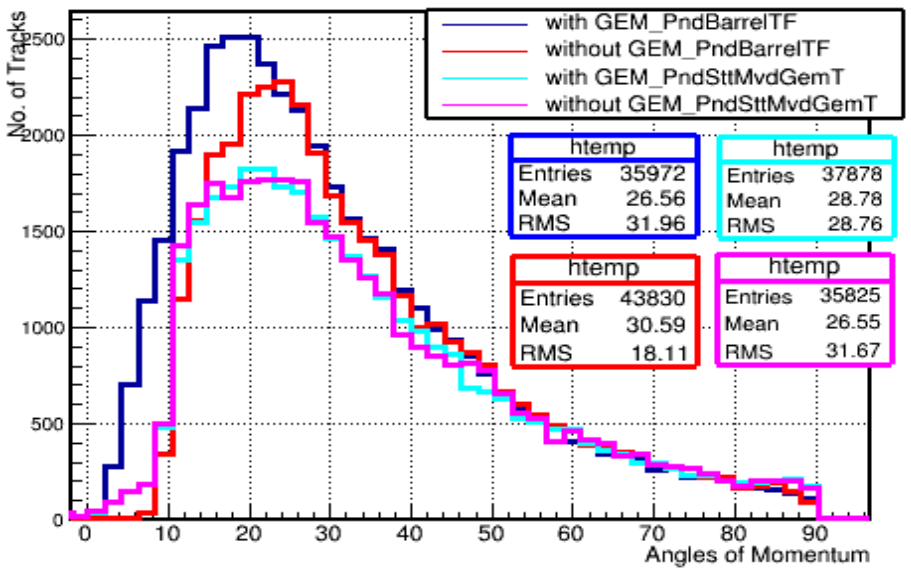
**Comparison between two track reconstruction class : PndSttMvdGemTracking with PndBarrelTrackFinder**

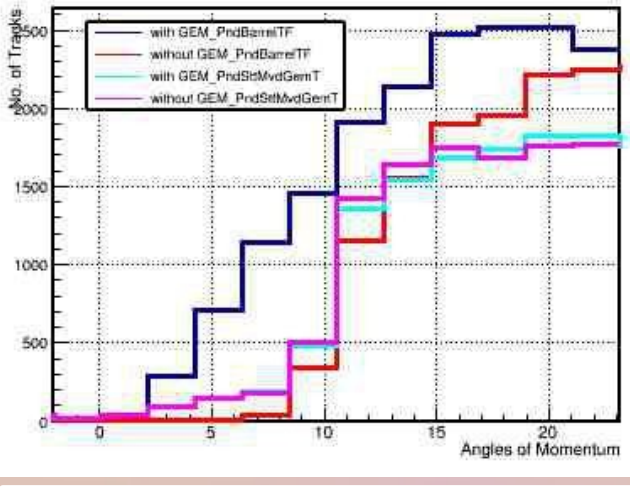


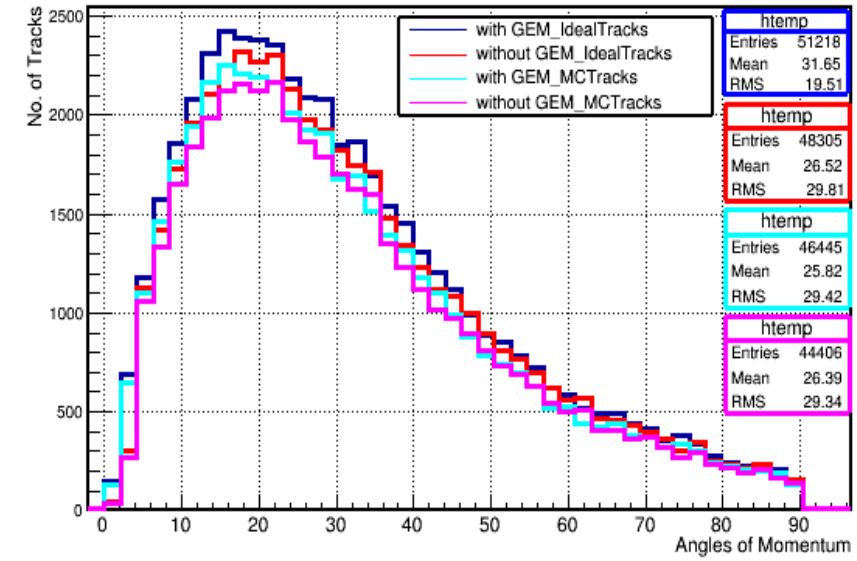

We have difference between using PndBarrelTrackFinder and PndSttMvdGemTracking.
It seems using PndBarrelTrackFinder can be beneficial and the results look quite reasonable.
With the PndBarrelTrackFinder there is much more entries than in the PndSttMvdGemTracking.
There is a big peak at the background region that maybe comes from low momentum particles.

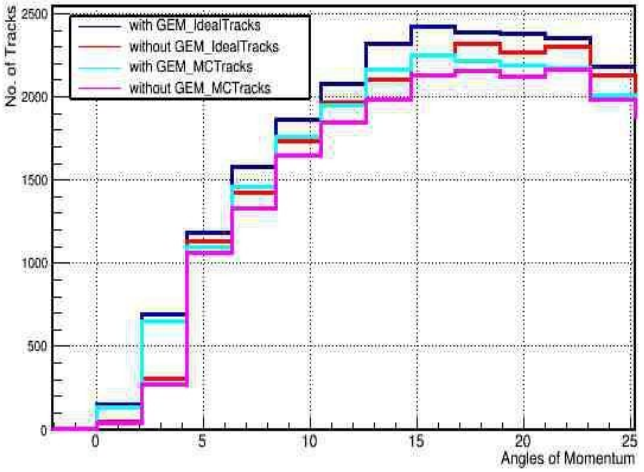
# Comparison between two track reconstruction class : PndSttMvdGemTracking with PndBarrelTrackFinder



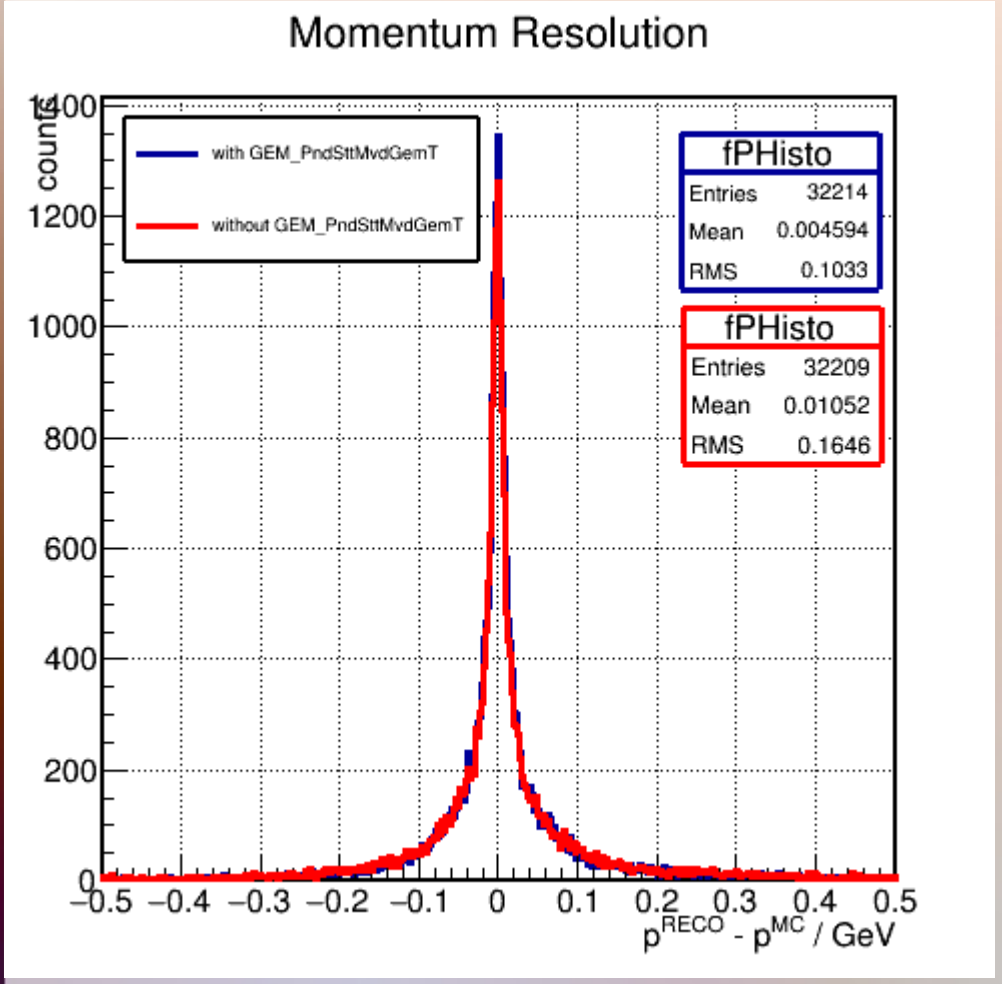



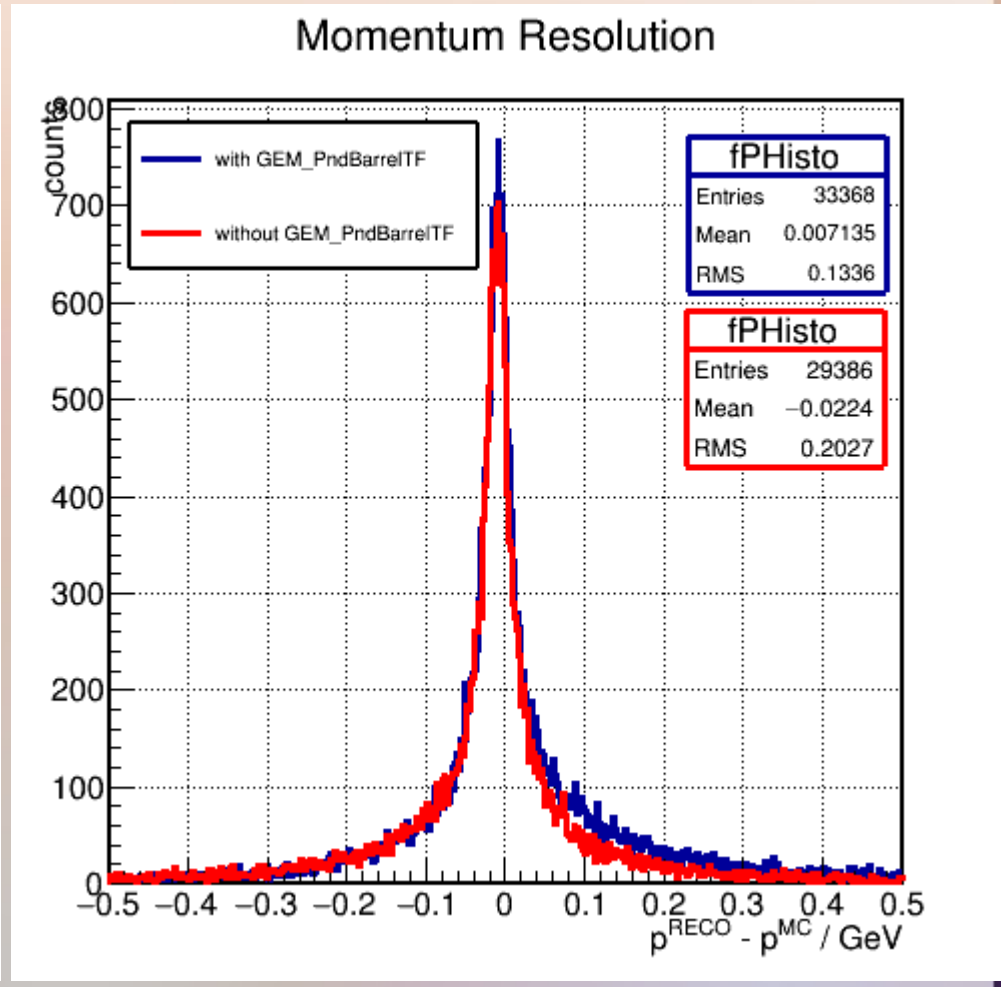

**The important thing seen from this plot is that using PndBarrelTrackFinder can help to show GEM covers the small angles region, below 20 degrees better than the another cases.**



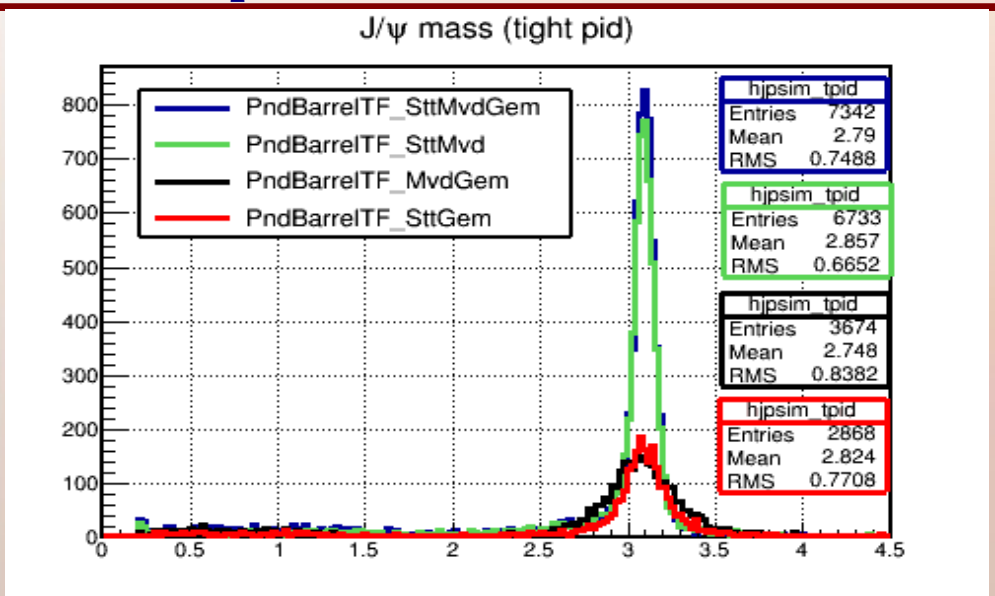
## Comparison between two track reconstruction class : PndSttMvdGemTracking with PndBarrelTrackFinder

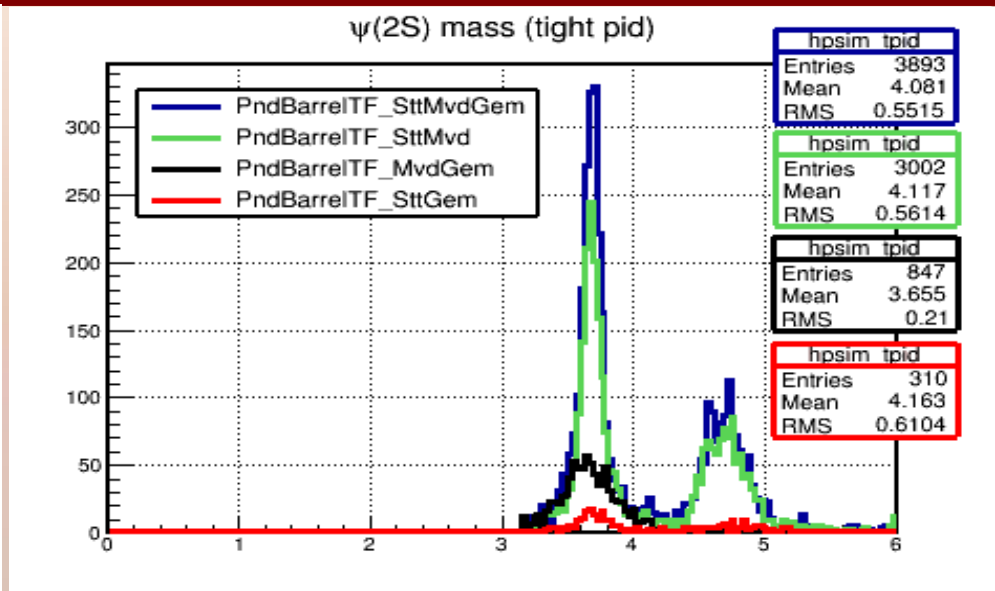


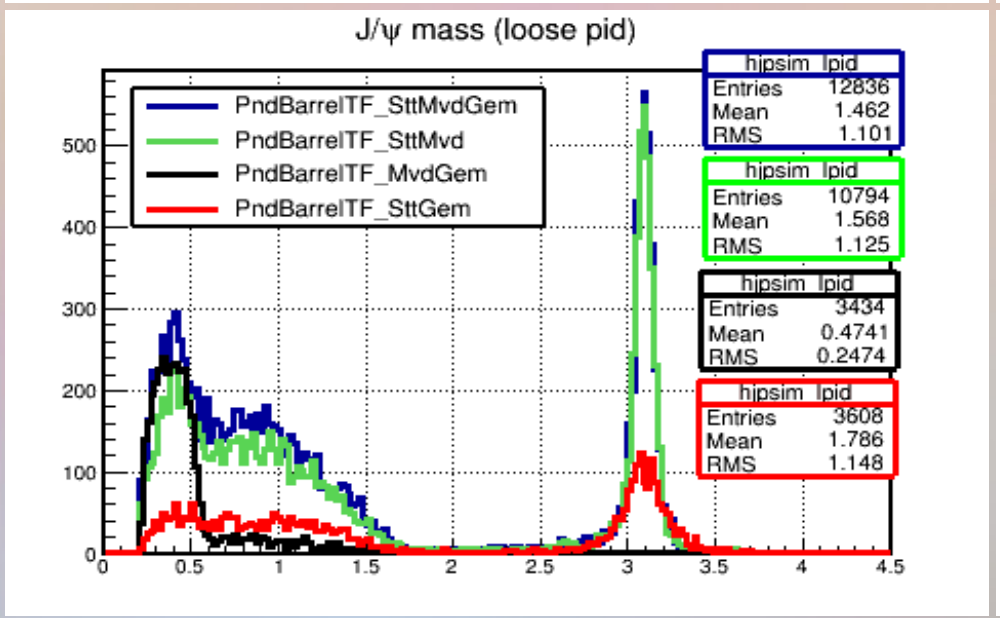



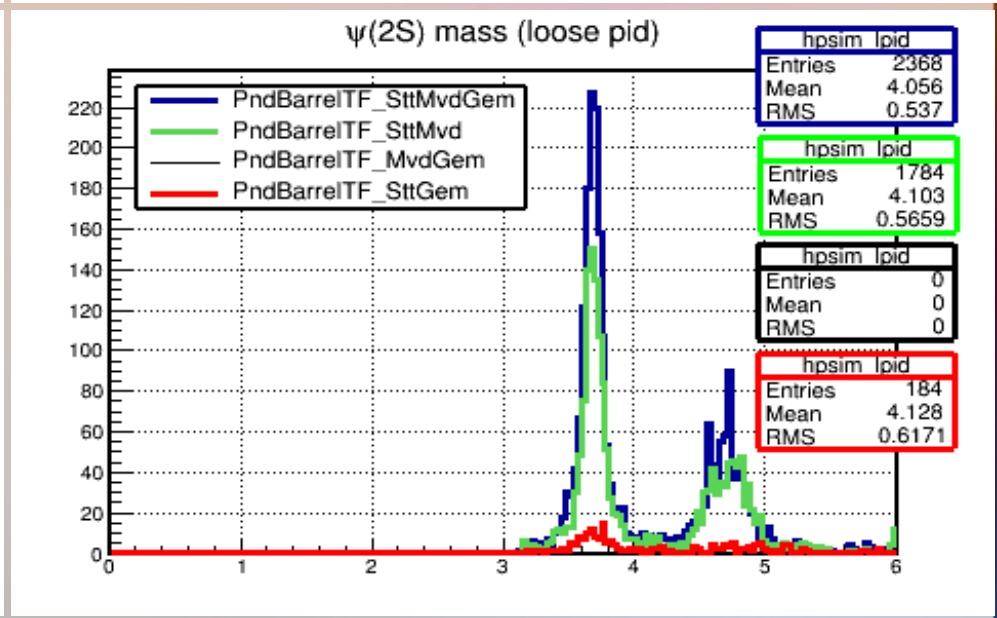

**Although momentum resolution doesn't improve by using PndBarrelTrackFinder class, it could be useful to reconstruct tracks in forward directions.**

# Comparison between all of the contributions using PndBarrelTrackFinder

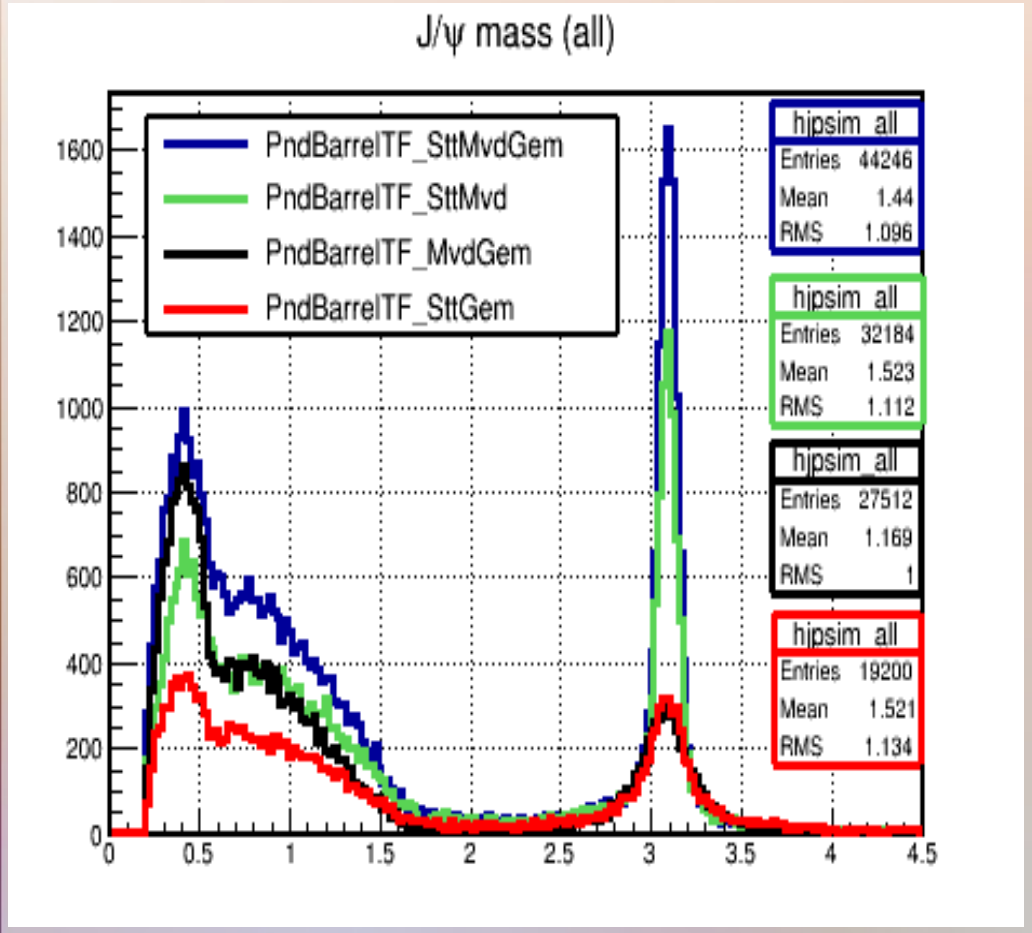


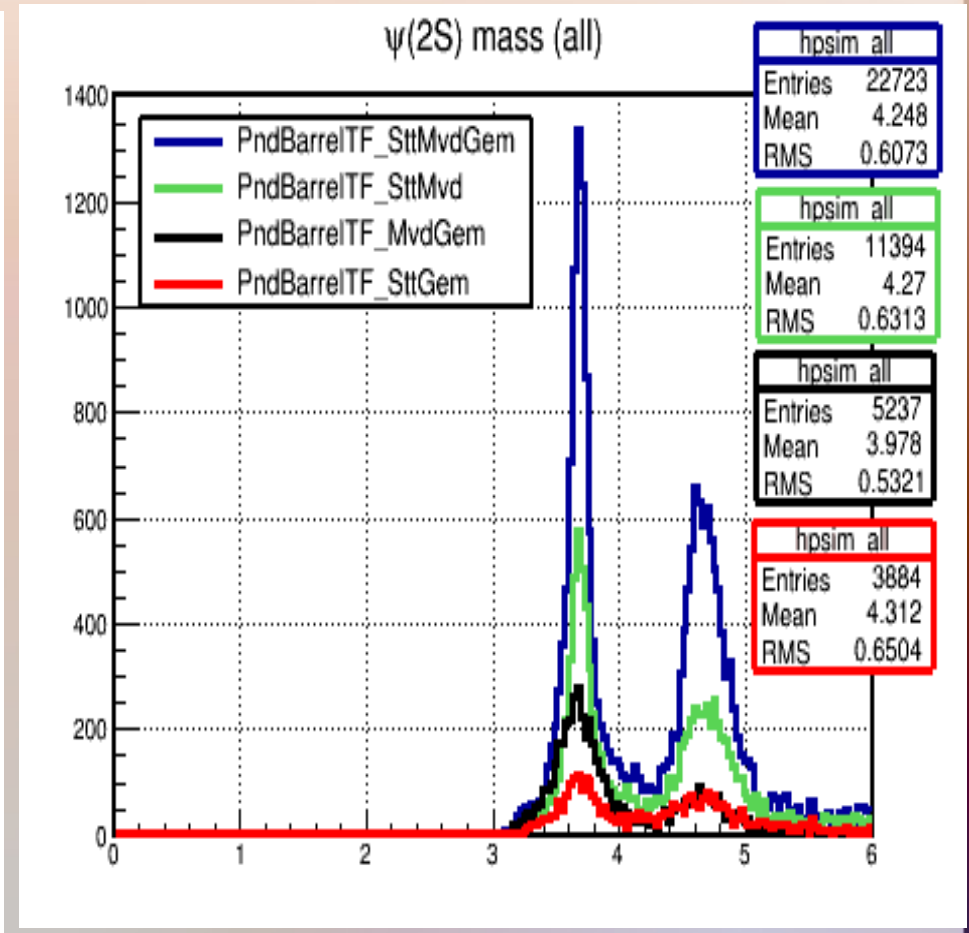



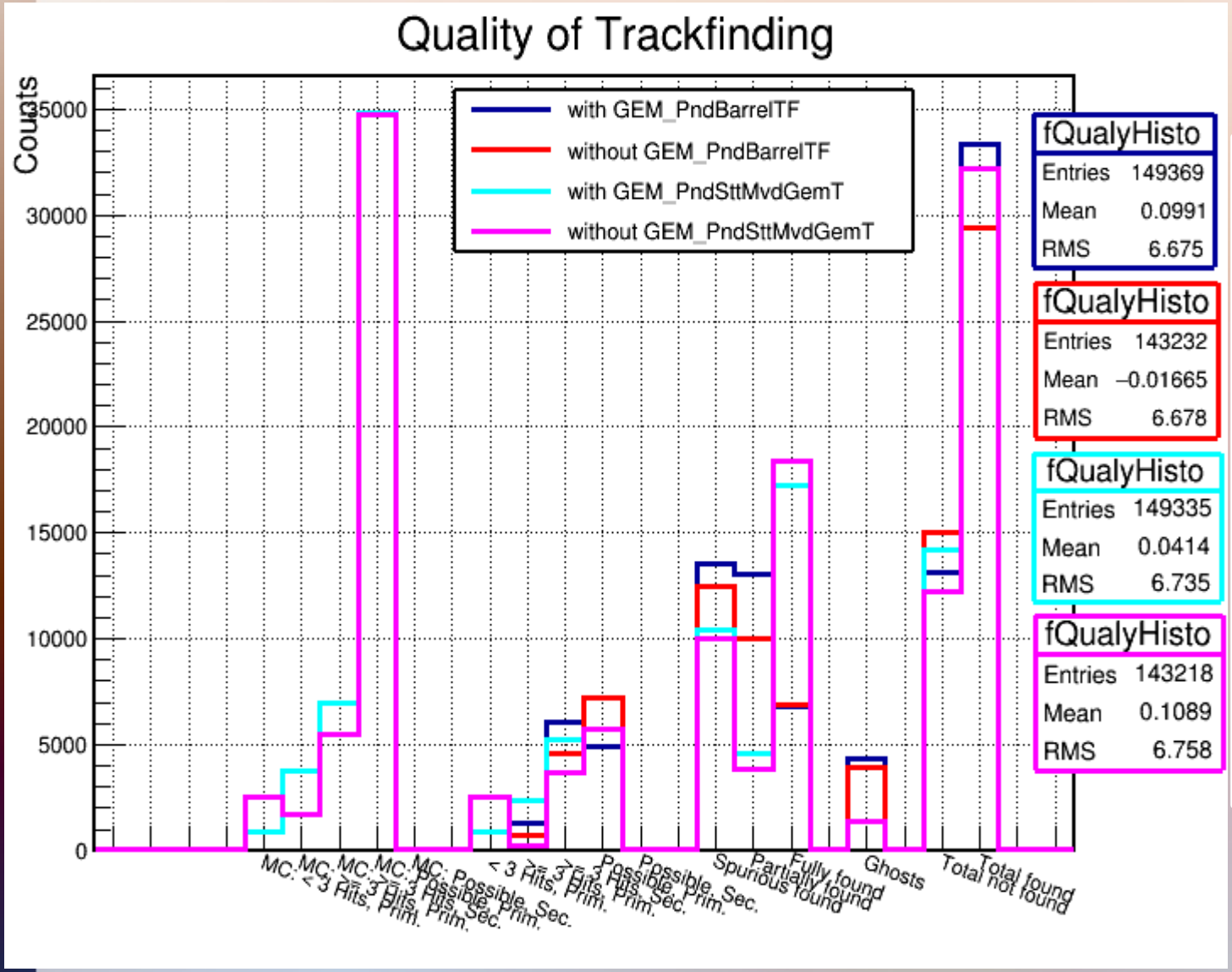
# Comparison between all of the contributions using PndBarrelTrackFinder




**By using the PndBarrelTrackFinder class , separation between contributions have been done.**

## Comparison between two track reconstruction class : PndSttMvdGemTracking with PndBarrelTrackFinder




Even though current track reconstruction class PndSttMvdGemTracking has a better quality of track finding than the another one, using PndBarrelTrackFinder class has been more beneficial in order to prove our discussion about the influence of GEM on the PANDA setup.

# Conclusion

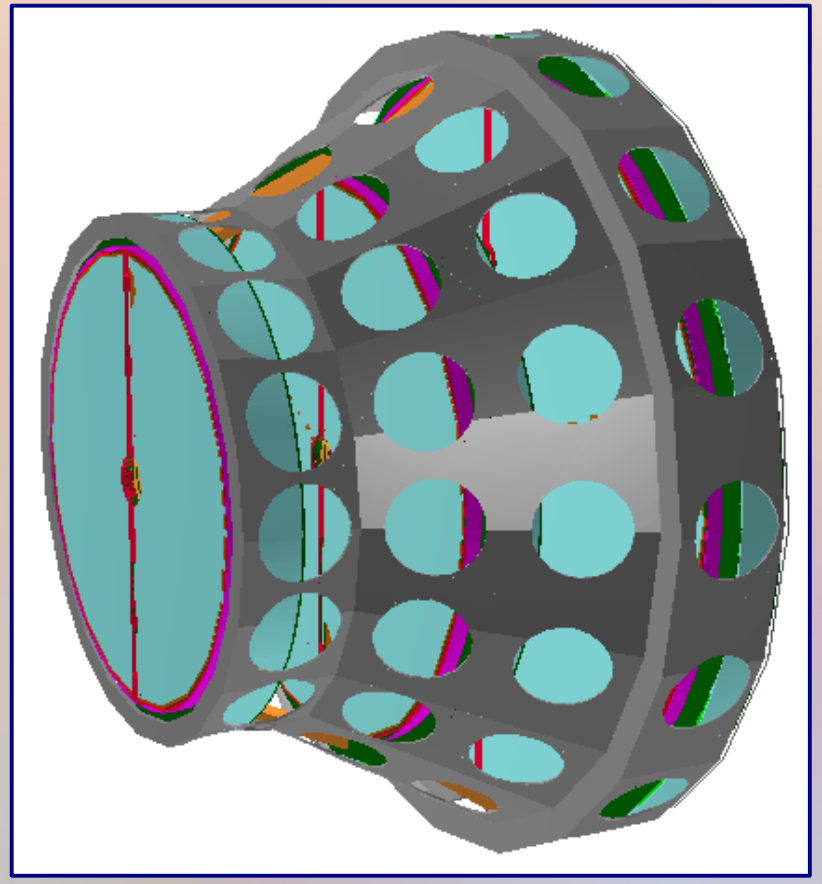
- **The geometry in the MC simulation has been updated**
- **Additional materials in the realistic GEM geometry with 3 stations do not disturb the invariant mass reconstruction**
- **With realistic GEM geometry, mass resolution and tracking acceptance are better than those without GEM**
- **Using PndBarrelTrackFinder class can show :**

  **- the differences between the results better than using PndSttMvdGemTracking current class in case of PANDA setup with and without GEM**

  **- the GEM can cover the angles below 20 degrees better than those without GEM**
- **With realistic GEM geometry total momentum resolution will improve**

# Future Tasks

- Overall look to check and fix all of the details at the GEM geometry
- Implement GEM geometry only for one station (next talk)
- Investigate the invariant mass reconstruction for the other physics benchmark channels
- Wait for GEM prototype



**Many Thanks For Your Attention**

# Back up slide

using the trunk release of PANDARoot Package
Path: .
URL: https://subversion.gsi.de/fairroot/pandaroot/trunk
Repository Root: https://subversion.gsi.de/fairroot
Repository UUID: 0381ead4-6506-0410-b988-94b70fbc4730
Revision: 28835
Node Kind: directory
Schedule: normal
Last Changed Author: NazilaDivani
Last Changed Rev: 28835
Last Changed Date: 2016-01-27 10:24:36 +0100 (Wed, 27 Jan 2016)

## GEM stations materials:

- The stations are in form of circular planes ( Disk shape ) → HalfStationThickness = 7.4 cm
- The stations are full of $ArCO_2$ gas
- Separately , each station has 2 Gem_Sensor_GEMmixture ($ArCO_2$ gas) that each one has 1.0020 cm thickness
- The total thickness of each station only for layers is 5.8864 cm
- Totally , each station includes: 0.0338 cm of kapton, 0.0006 cm of aluminium & 0.008 cm of copper ( for main layers ), 1.84 cm of glass fiber & 2 cm of carbon ( for holding structure layers ) , ...

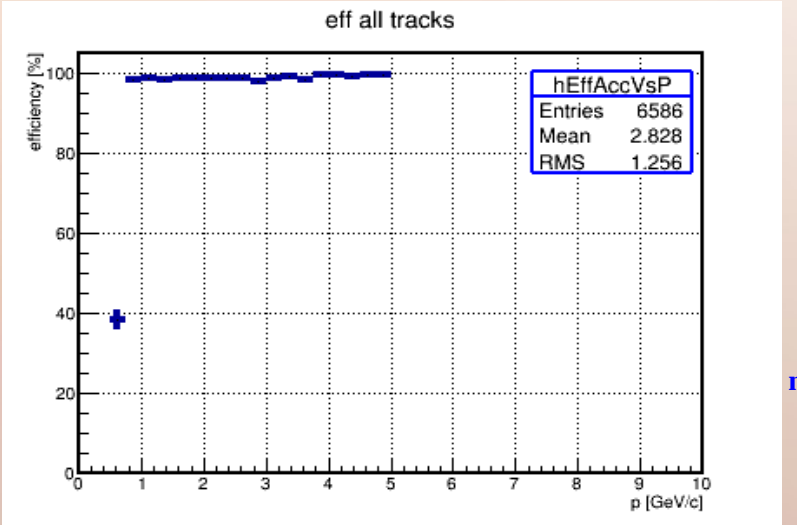
# GEM Track Efficiency and Track Momentum Resolution

---------- GEM Digitizer : Summary----------
Events: 10000
MC Points: 44400 ( 4.44 per event )
Digis: 88703 ( 8.8703 per event )
--> ( 1.47838 per sensor )
--> ( 0.0182498% occupancy )
--> ( 2 x 0.998908 per point )

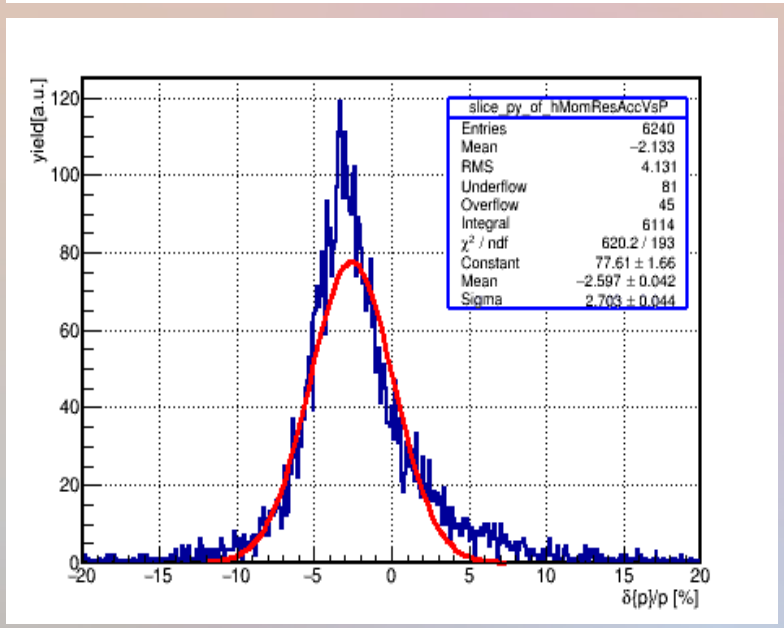
---------- GEM Hit Finder : Summary ----------
Events: 10000
Digis: 88703 ( 8.8703 per event )
HitsTemp: 47700 ( 4.77 per event )
Hits: 46386 ( 4.6386 per event )
--> ( 0.7731 per sensor )
--> ( 0.522936 per digi )

---------- PndGemFindTracks : Summary ----------
Events: 10000
Tracks: 6237 ( 0.6237 per event )
Time: 0.812166 ( 8.12166e-05 per event )
( 0.000130217 per track )

---------- PndGemTrackFinderQA : Summary ---------
Events: 10000
MC Tracks: 8511
reconstruable: 6598 reconstructed: 6230 >>>> 94.4226%
primaries : 6513 reconstructed: 6227 >>>> 95.6088%
reference : 5413 reconstructed: 5183 >>>> 95.751%
secondaries : 85 reconstructed: 3 >>>> 3.52941%
ghosts : 0 >>> 0 per event >>> 0 per MC Track
clones : 10 >>> 0.001 per event >>> 0.00117495 per MC Track
---




track efficiency vs momentum




track momentum resolution