Detector signatures of Ξ^- $\bar{\Xi}^+$ hyperons in the Forward Spectrometer at PANDA

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PANDA Collaboration meeting
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Overview

- Project description and goals
- Forward spectrometer (FS) layout
- Analysis strategy
- Results
- Conclusions

Project description

- Main focus on looking at characteristics of **reconstructed tracks** in the **FS** for the reaction

$$\bar{p}p \rightarrow \bar{\Xi}^{+}\Xi^{-} \rightarrow \bar{\Lambda}\pi^{+}\Lambda\pi^{-} \rightarrow \bar{p}\pi^{+}\,\pi^{+}p\pi^{-}\pi^{-}$$

at beam momenta **4.6 GeV** and **7 GeV**.

- Reconstruction in the **central tracker** (CT) was **not** taken into account for this study.

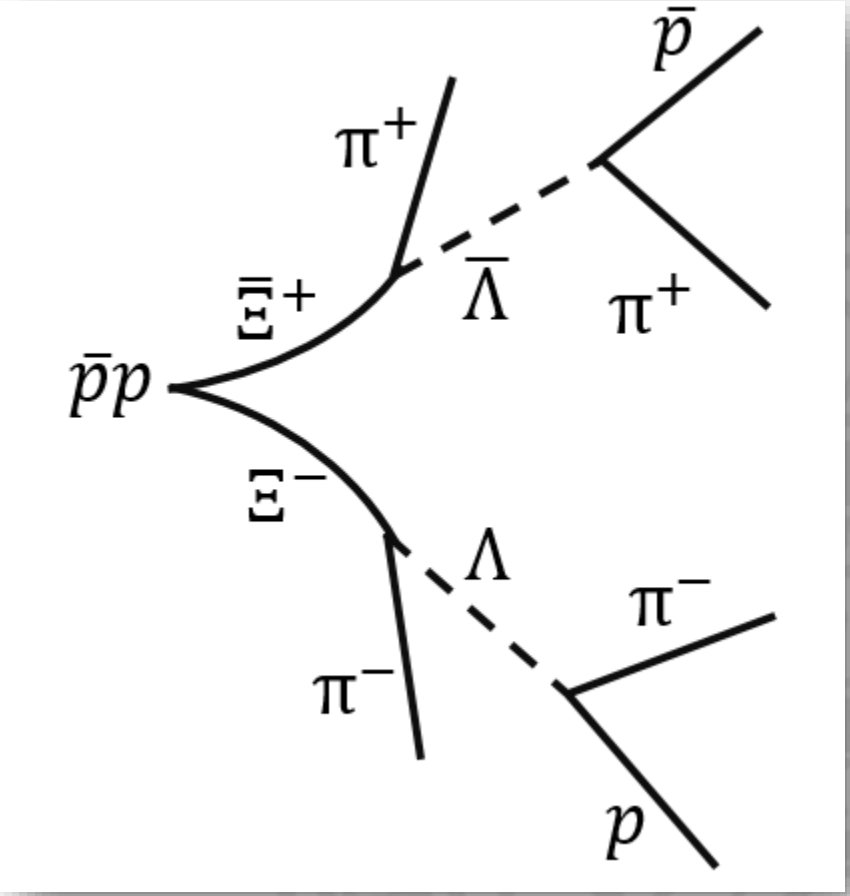


Image by Jenny Regina, 2017

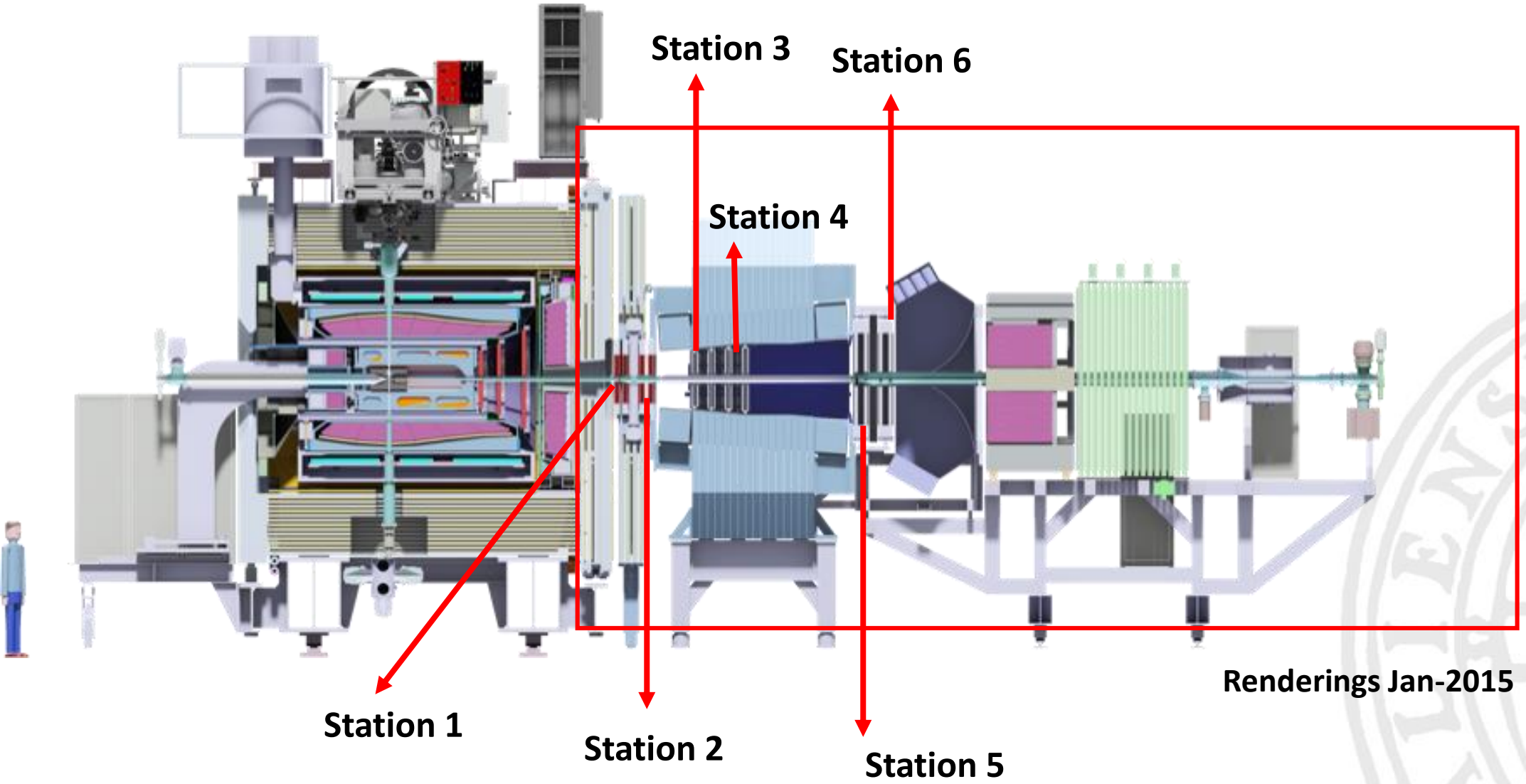
Goals

- To find **differences** and **similarities** between FS partial and full set ups.
  - Number of reconstructed tracks
  - Tracks per event
  - Hits per track

- To **describe** reaction **topology** in the FS.
  - Illumination plots
  - Acceptance

FS layout

Set Up	No. GEM	MVD	FS STATIONS
FTS1234	2	Strips	1,2,3,4
FTS1256	2	Strips	1,2,5,6
FTSFULL	3	Strips + pixels	1,2,3,4,5,6



Analysis strategy

PandaRoot Software was used to **simulate** the reaction:

$$\bar{p}p \rightarrow \bar{\Xi}^{+}\Xi^{-} \rightarrow \bar{\Lambda}\pi^{+}\Lambda\pi^{-} \rightarrow \bar{p}\pi^{+}\,\pi^{+}p\pi^{-}\pi^{-}$$

- ❑ Isotropic distribution
- ❑ 10,000 events
- ❑ Ideal track Finder
  - Track reconstructed if ≥ 6 FS hits
- ❑ Particle transport: Geant3
- ❑ Beam momenta: 4.6 GeV and 7 GeV

RESULTS

Number of reconstructed tracks, beam momentum 4.6 GeV						
Set up	FTS 1234	σ	FTS 1256	σ	FTS- Full	σ
π^-	1,409	38	1,419	38	1,336	37
π+	1,400	37	1,426	38	1,326	36
From Λ						
p	732	27	754	27	735	27
π^-	1,871	43	1,820	43	1,717	41
From $\bar{\Lambda}$						
$\bar{p}$	707	27	722	27	715	27
π+	1,833	43	1,864	43	1,694	41

Number of reconstructed tracks, beam momentum 7 GeV						
Set up	FTS 1234	σ	FTS 1256	σ	FTS- Full	σ
π^-	1,421	38	1,413	38	1,367	37
π+	1,452	38	1,471	38	1,403	37
From Λ						
p	817	29	847	29	829	29
π^-	1,515	39	1,466	38	1,438	38
From $\bar{\Lambda}$						
$\bar{p}$	780	28	824	29	790	28
π+	1,515	39	1,495	39	1,478	38

- Biggest difference between set ups in number of **pions**.
- Data generated using **different seeds**.
- Numbers very **similar** between set ups.

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- Data generated using **different seeds**.
- Numbers very **similar** between set ups.

Reconstructed tracks, beam momentum 4.6 GeV			
Set up	**FTS 1234**	**FTS 1256**	**FTS- Full**
No. Events	10,000	10,000	10,000
Reco. $\bar{\Xi}^-$	56	62	52
Reco. Ξ+	64	62	51
Reco. Λ	239	251	240
Reco. $\bar{\Lambda}$	251	252	225

Reconstructed tracks, beam momentum 7 GeV			
Set up	**FTS 1234**	**FTS 1256**	**FTS- Full**
No. Events	10,000	10,000	10,000
Reco. $\bar{\Xi}^-$	141	164	163
Reco. Ξ+	161	167	168
Reco. Λ	401	415	399
Reco. $\bar{\Lambda}$	394	416	399

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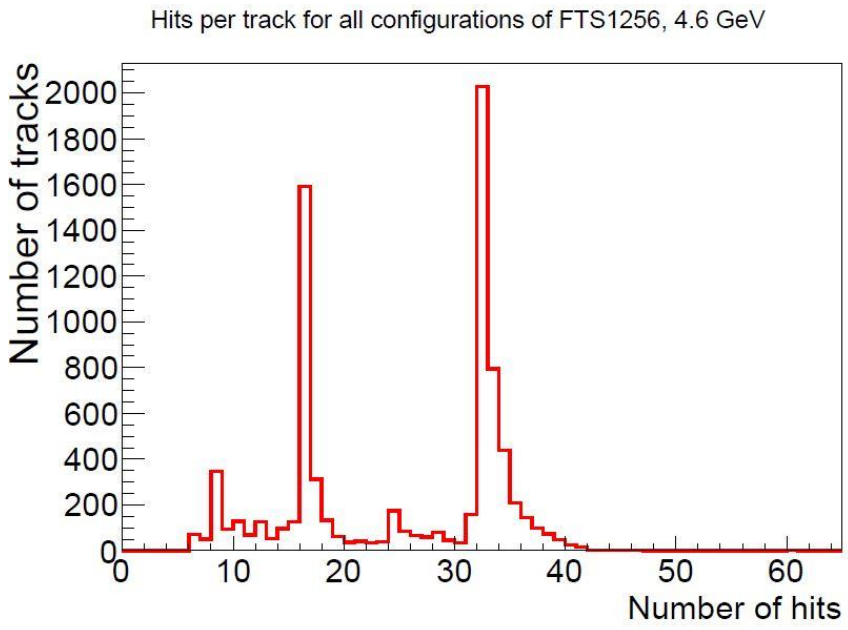
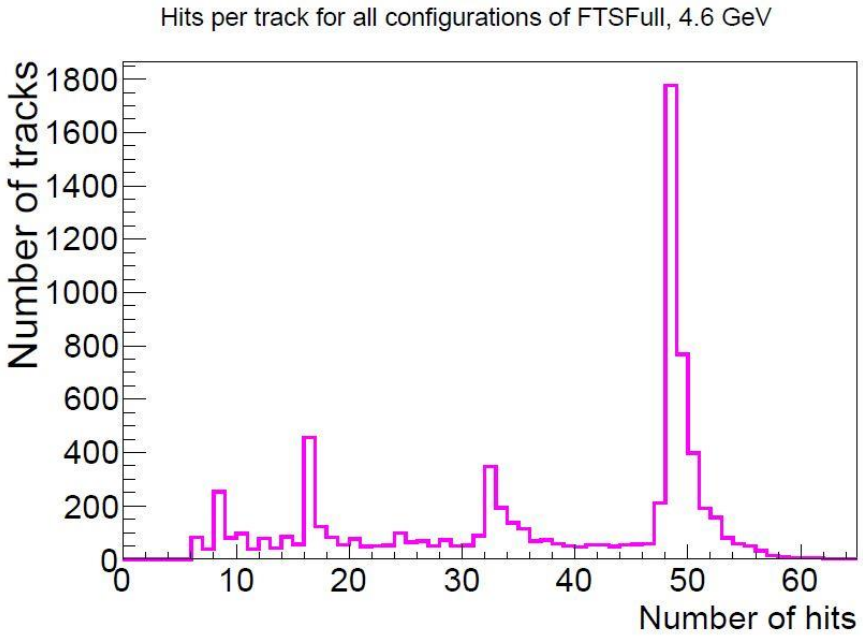
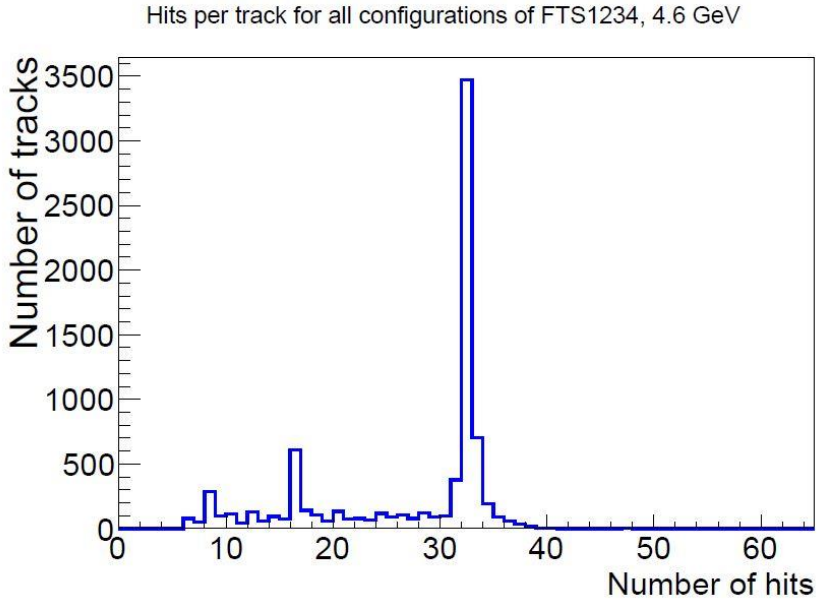
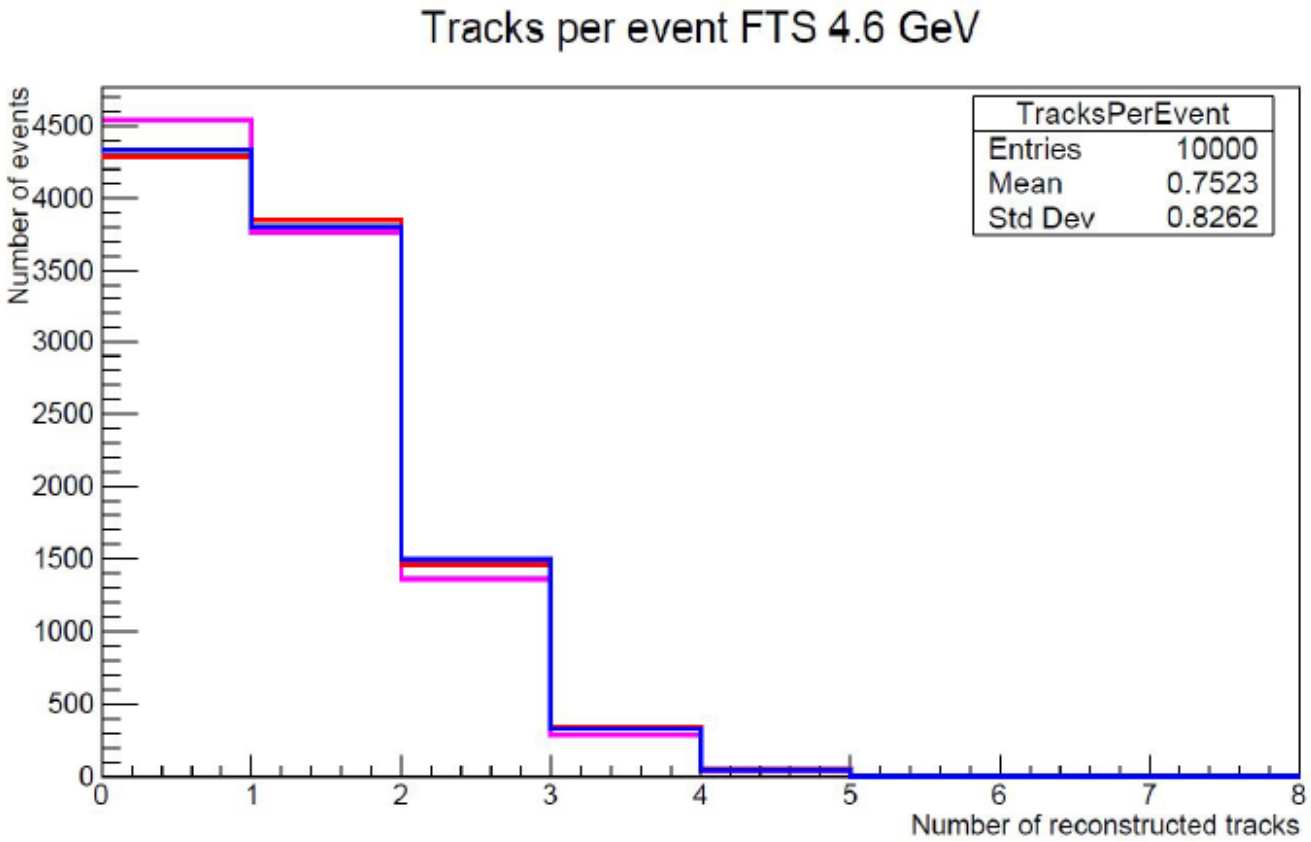






- FTS1234 Blue : Most of the tracks hit the 4 stations
- Red – FTS1256: Tracks get stuck or deflected after first station but still a big number go through the four stations.
- Magenta – FTSFull: Most tracks have hits in the 6 stations.
- The shape of this plot is the very similar in the 7 GeV beam momentum case.



Percentage of total events	Reconstructed tracks
~50%	0
> 33%	1
~17%	2
< 5%	3
< 1%	4
< 1%	5
0	6

- Blue – FTS1234
- Red – FTS1256
- Magenta – FTSFull

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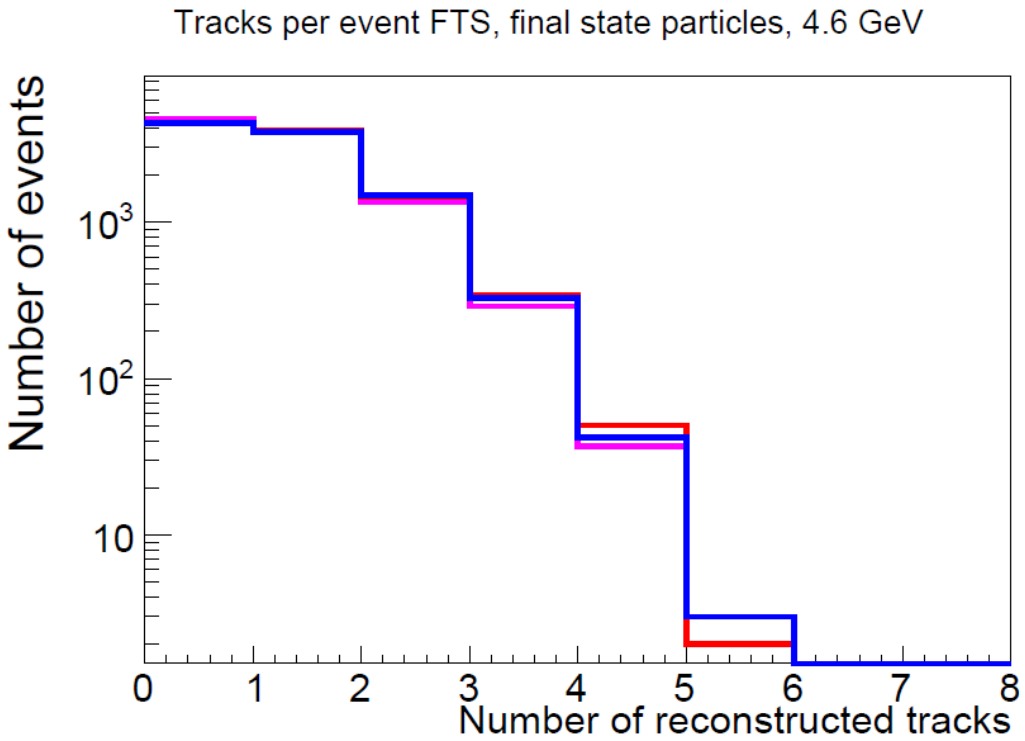

- Blue – FTS1234
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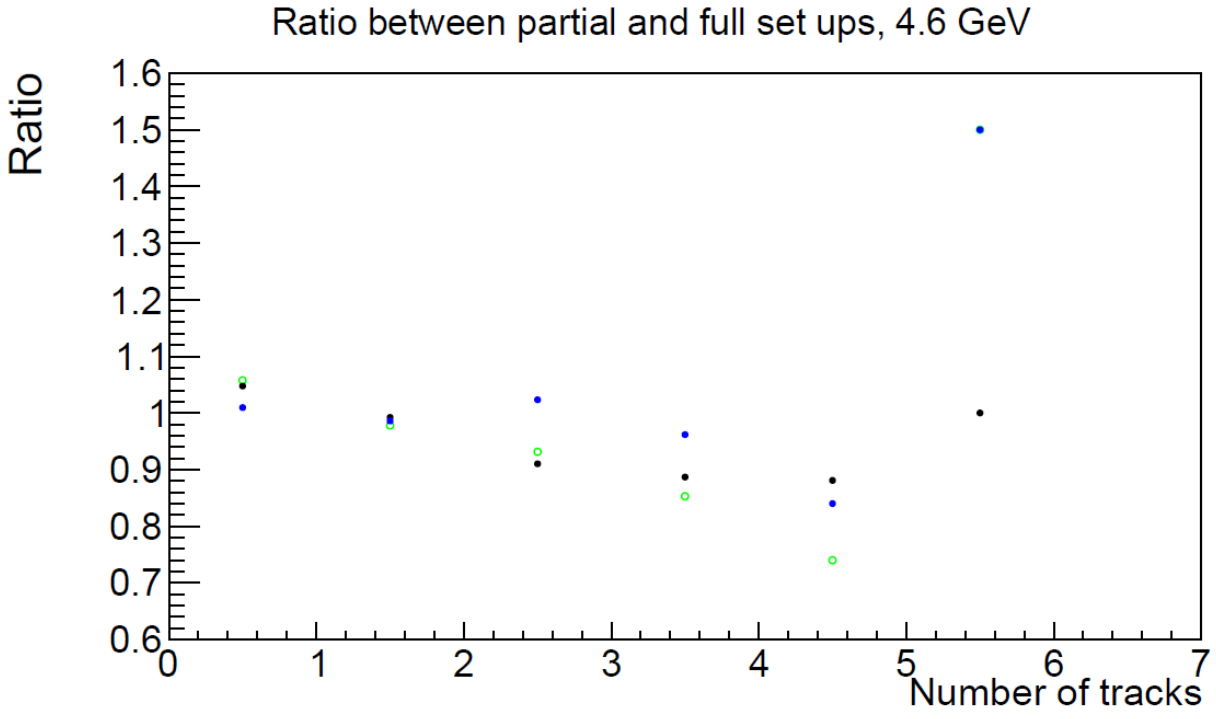

- No big difference between set ups.
- FTSFull/FTS1234
- FTSFull/FTS1256
- FTS1234/FTS1256C

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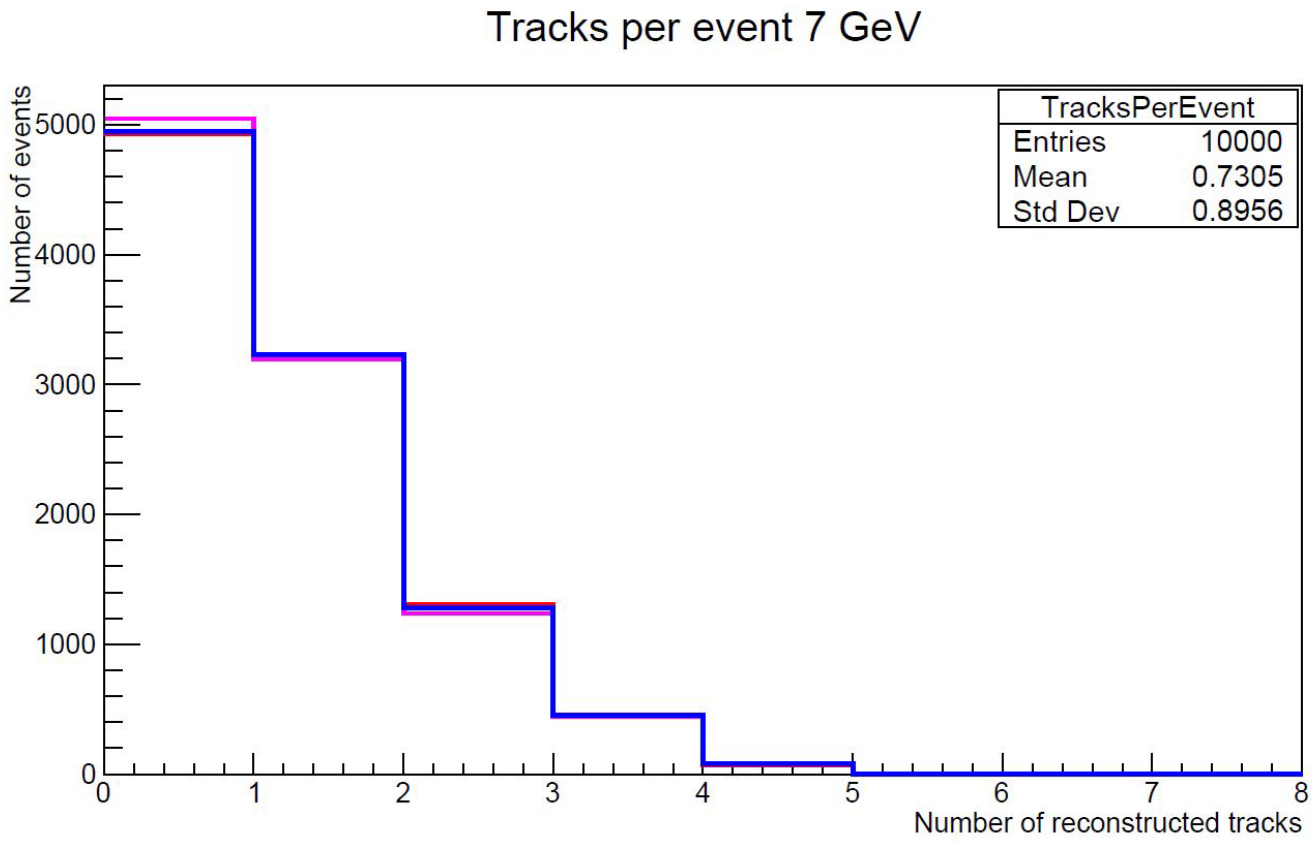
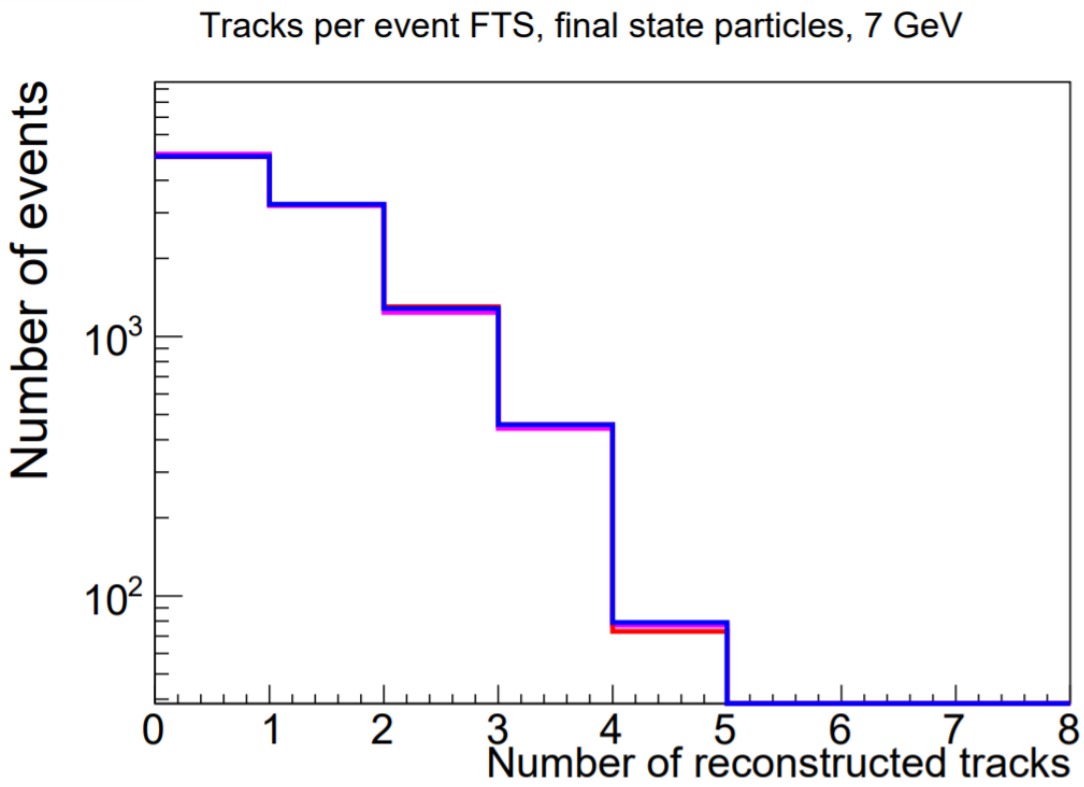


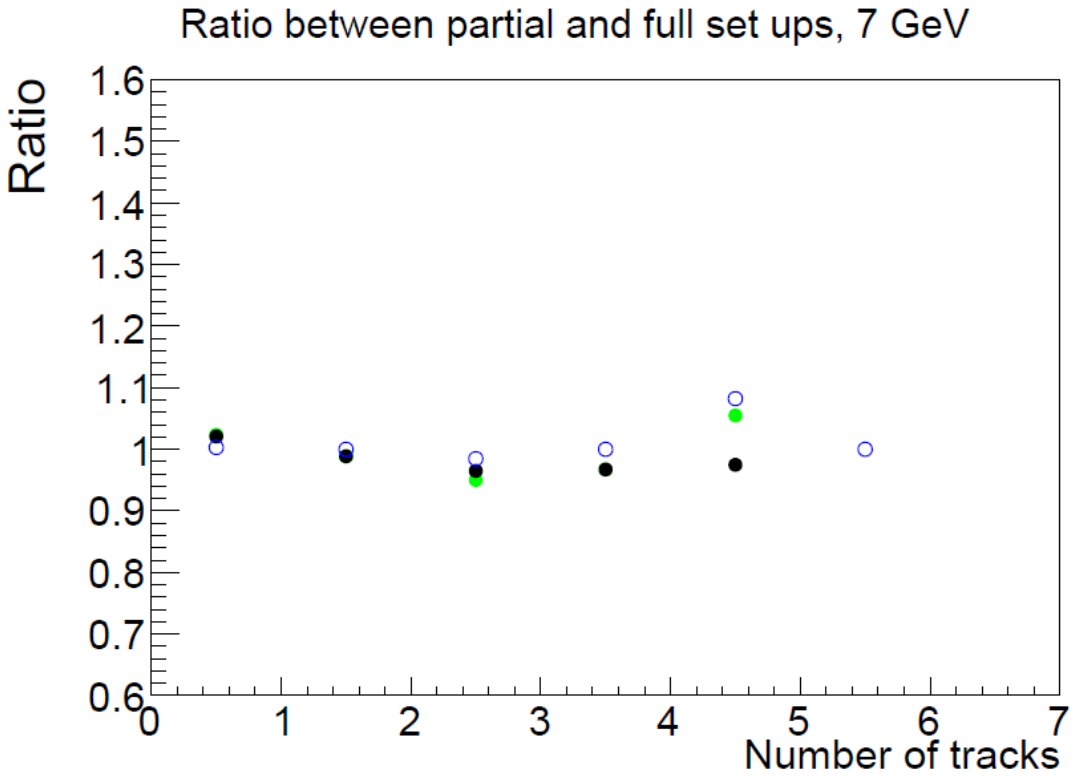
Fraction of total events	Reconstructed tracks
~50%	0
~33%	1
~10%	2
< 4%	3
< 1%	4
0	5
0	6

- Blue – FTS1234
- Red – FTS1256
- Magenta – FTSFull

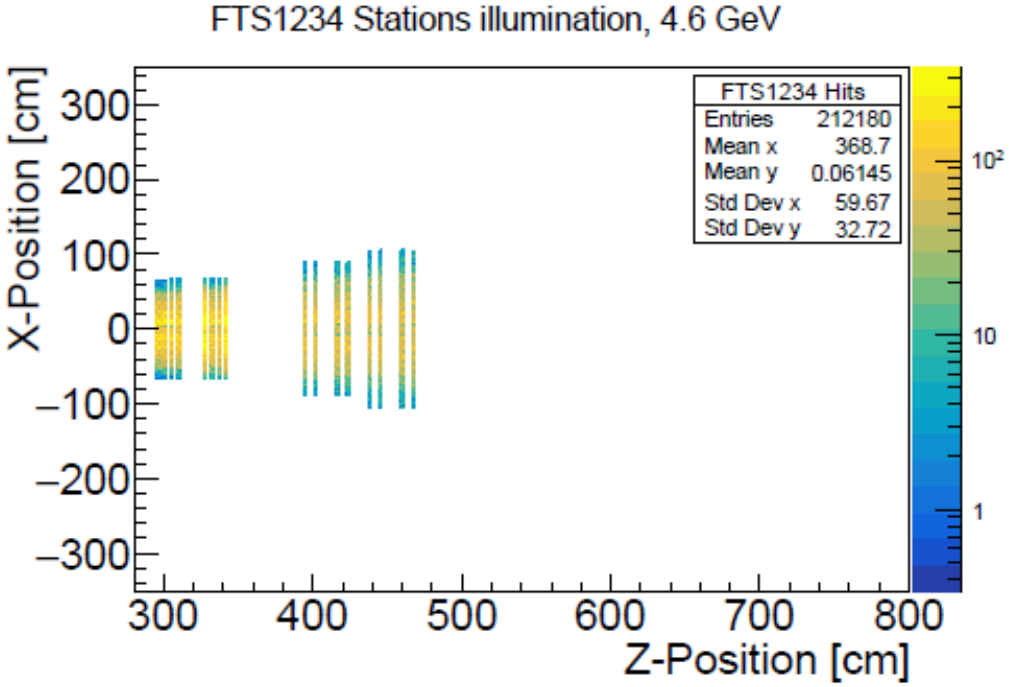
- No big difference between set ups.

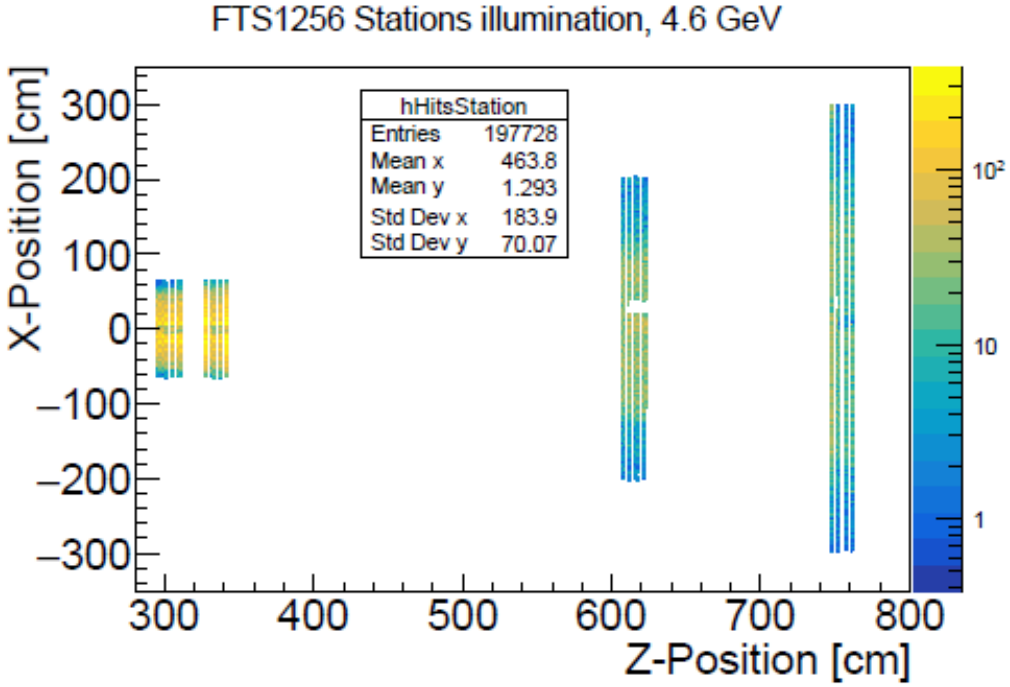


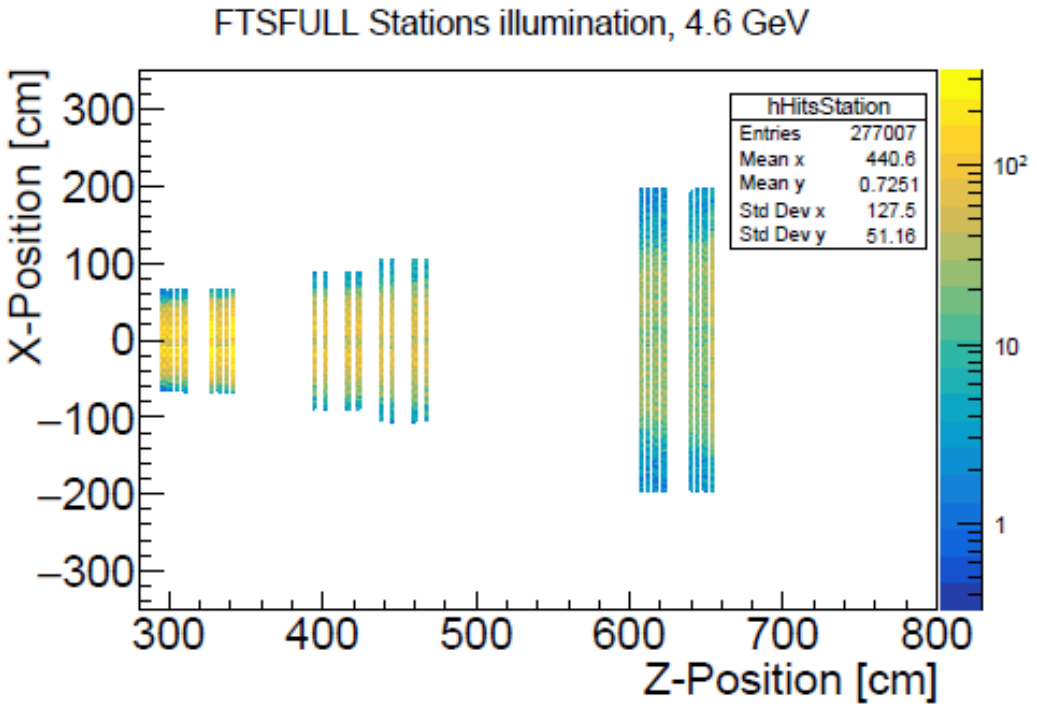
- Blue – FTS1234
- Red – FTS1256
- Magenta – FTSFull



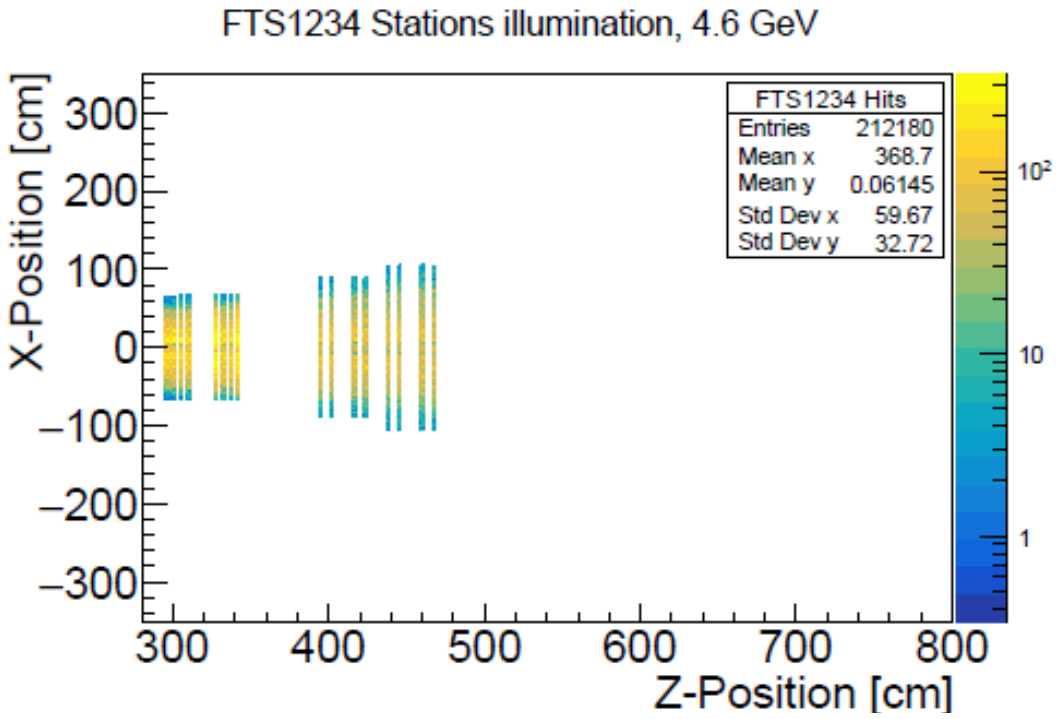
- No big difference between set ups.
- FTSFull/FTS1234
- FTSFull/FTS1256
- FTS1234/FTS1256

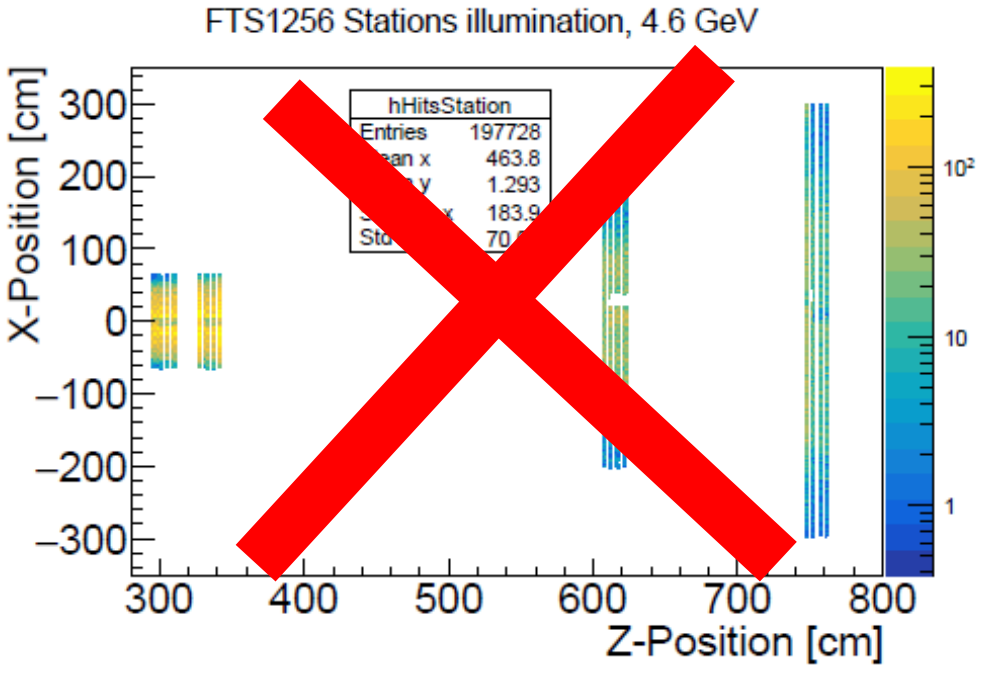


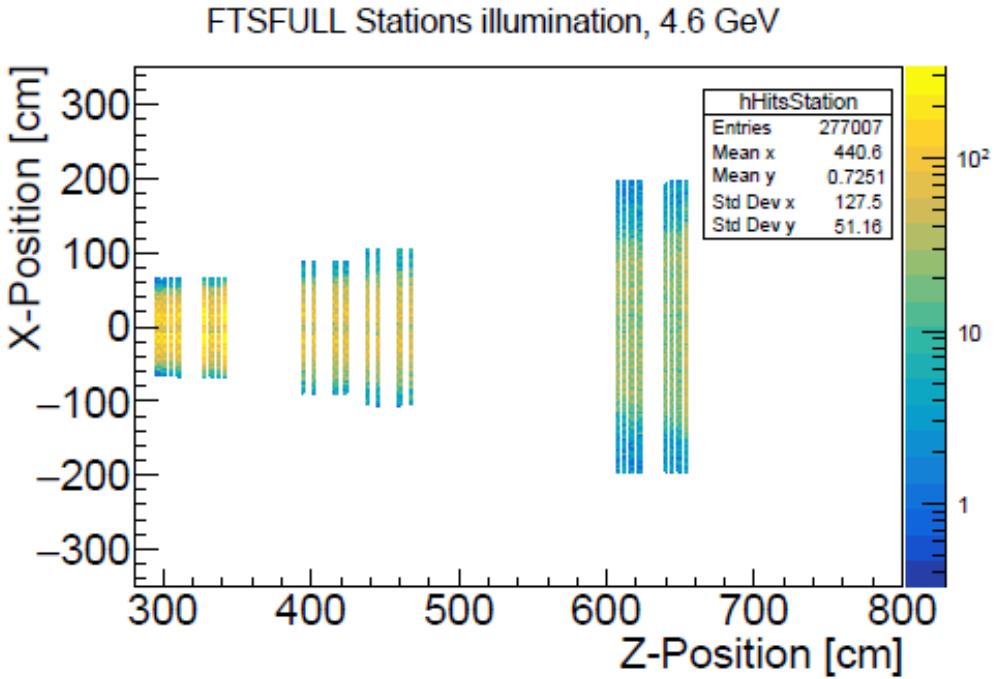




- Difference in **position** of station **6** between **FTS1256** and **FTSFull**
- Number of hits **decrease** with **distance** from the interaction point.







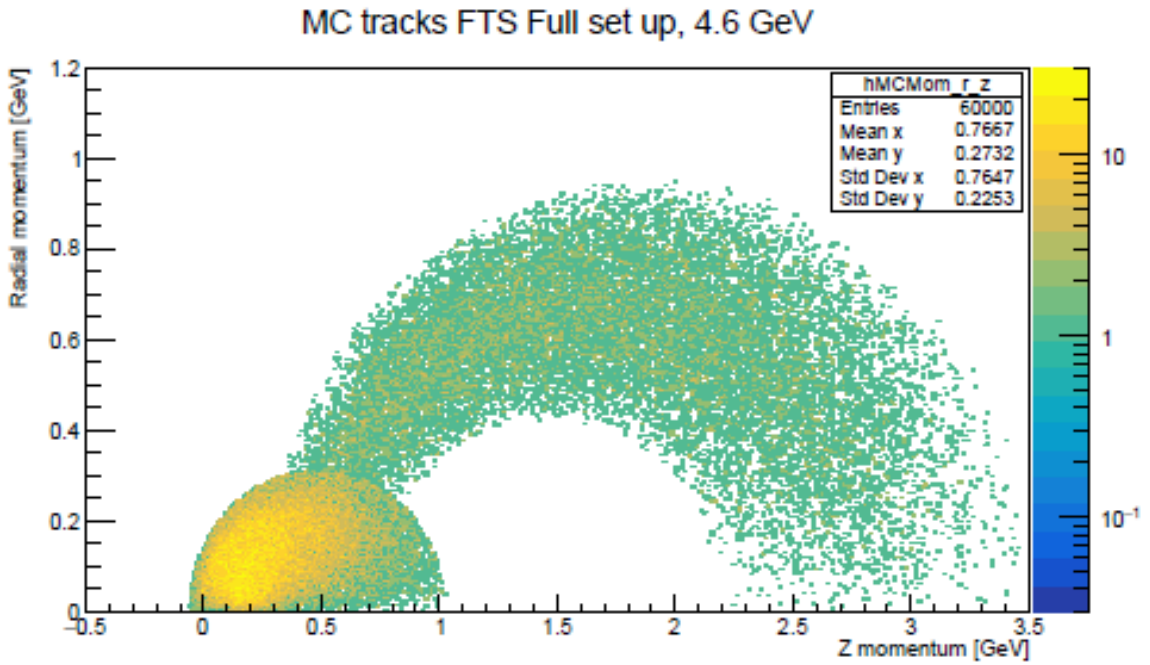
- Difference in **position** of station **6** between **FTS1256** and **FTSFull**

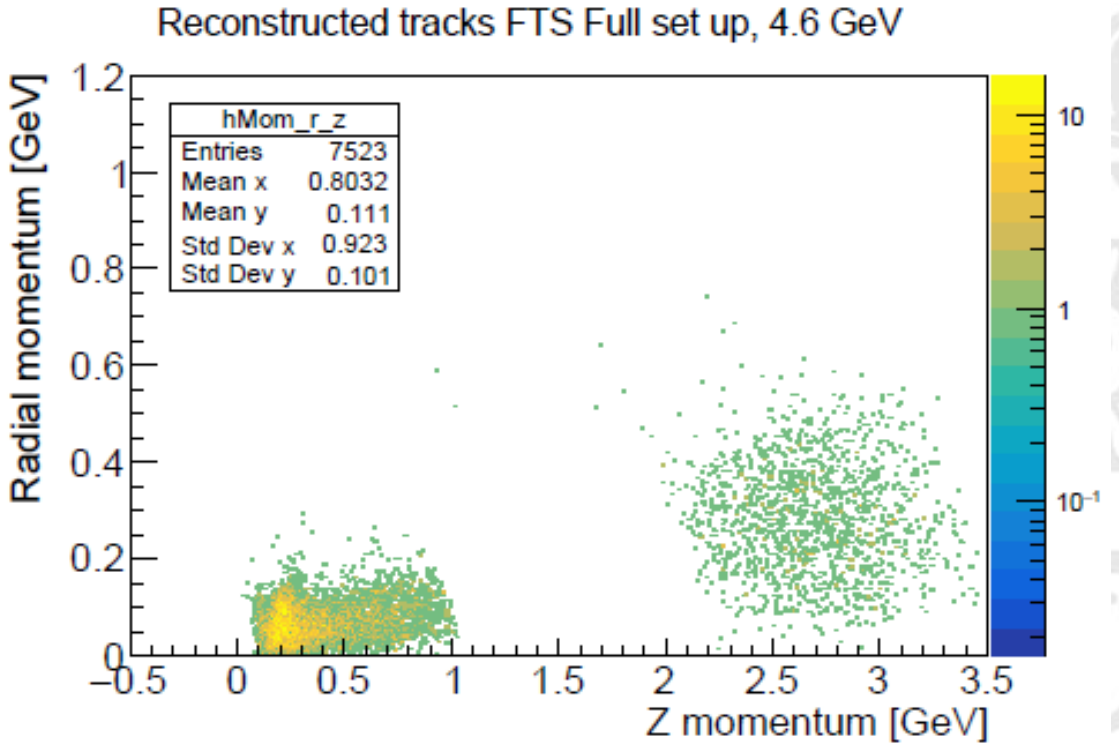
- Number of hits **decrease** with **distance** from the interaction point.

Longitudinal vs radial momentum

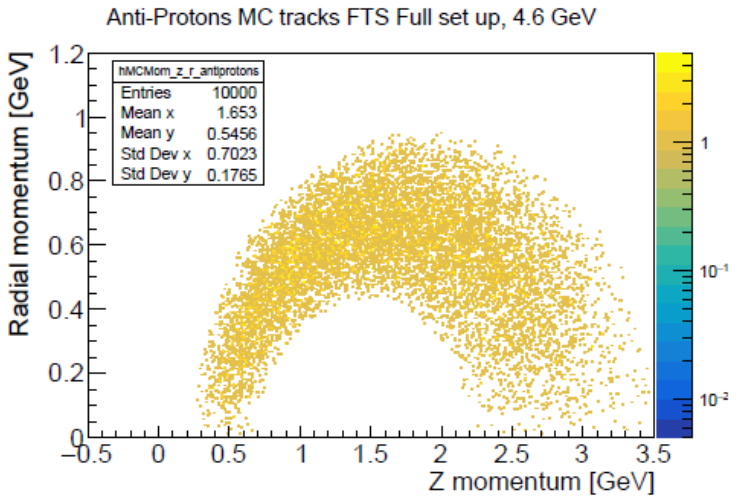
Comparison between **simulated** and **reconstructed tracks**, full set up:

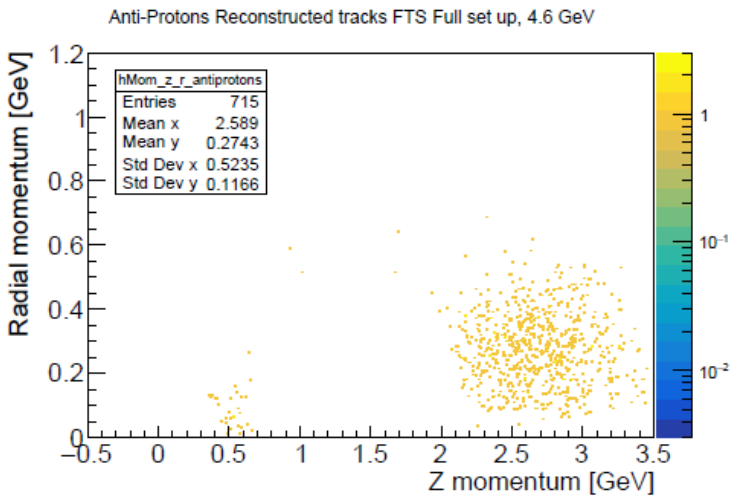
- No reconstructed tracks with Pt $>$ 0.6 GeV.
- Tracks reconstructed if:
  - **0 $<$ Pz $<$ 1 GeV** & **2 $<$ Pz $<$ 3.5 GeV**
  - **0 $<$ Pt $<$ 0.6 GeV**
- Same situation for partial set ups.
- Same situation at beam momentum 7GeV, only difference in range.

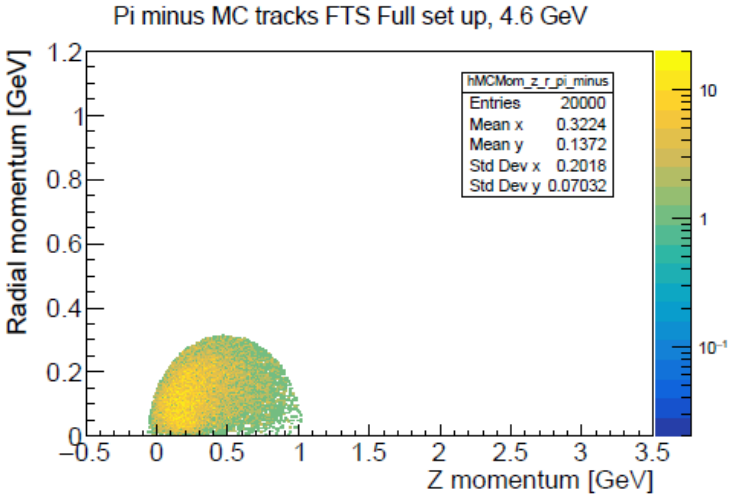


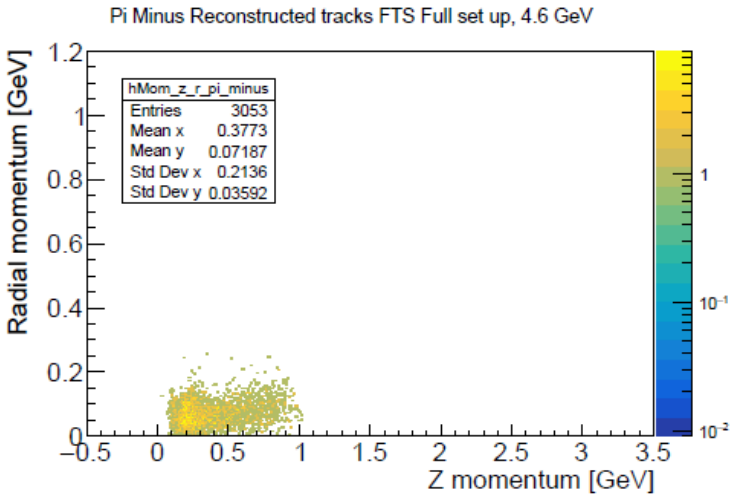


Longitudinal vs radial momentum







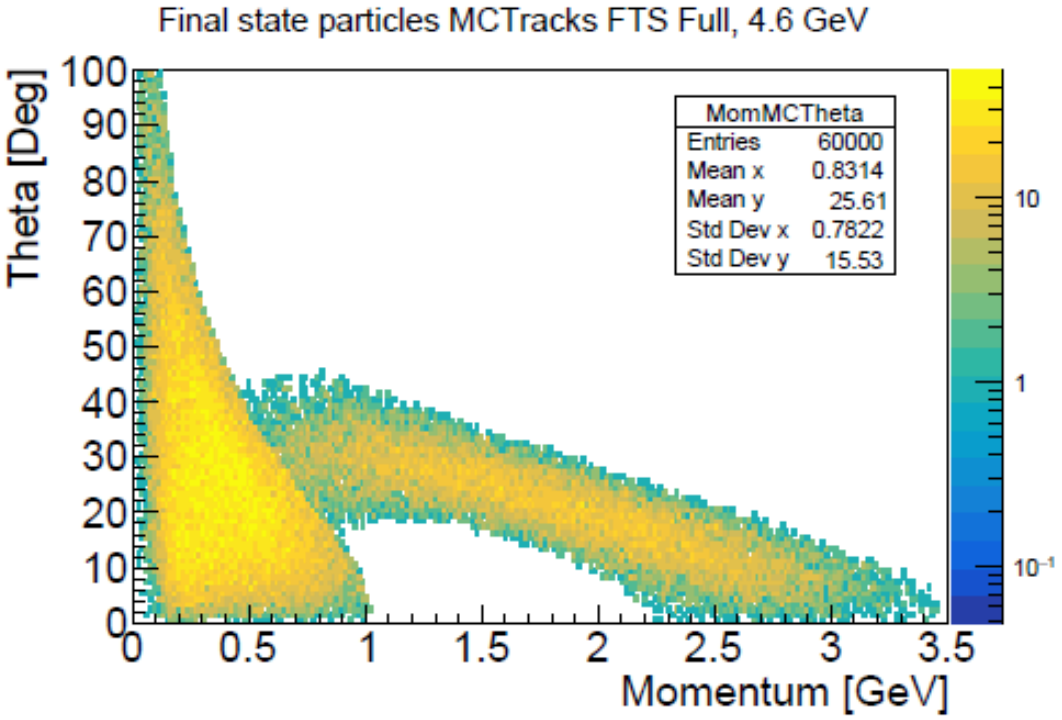


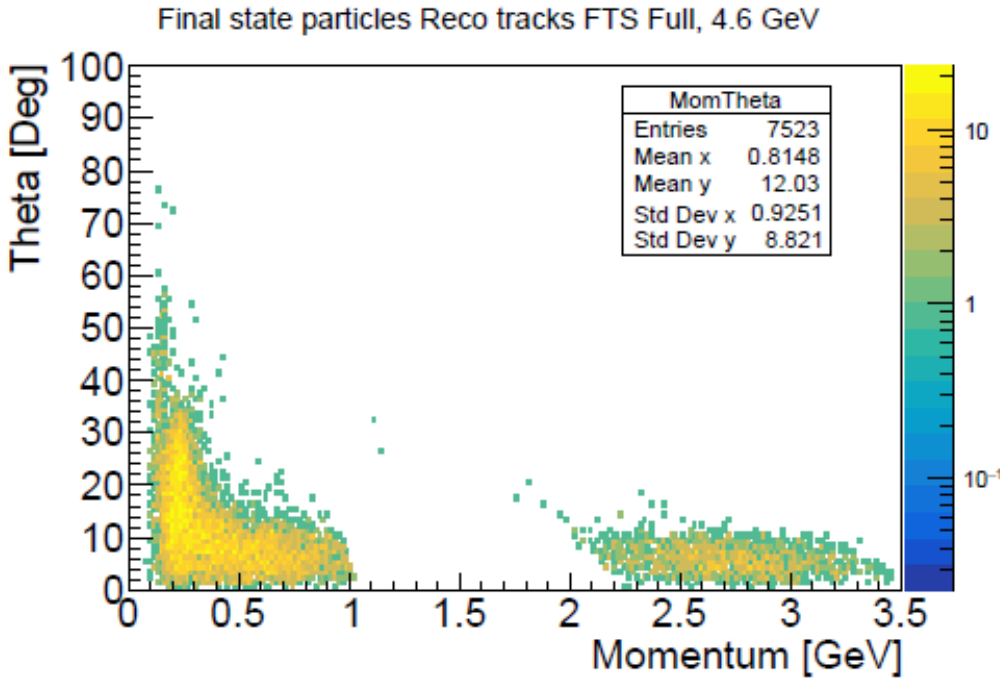
- **(Anti)protons** and **pions** **separated** in **momentum** region.
- **(Anti)protons** have **higher** momenta (Pt & Pz).
- **Pions** have **lower** momenta (Pt & Pz).

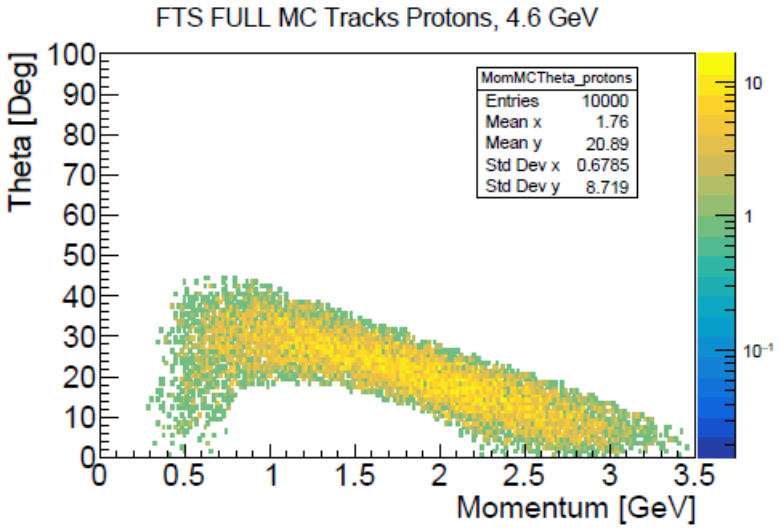
Momentum vs angle of emission

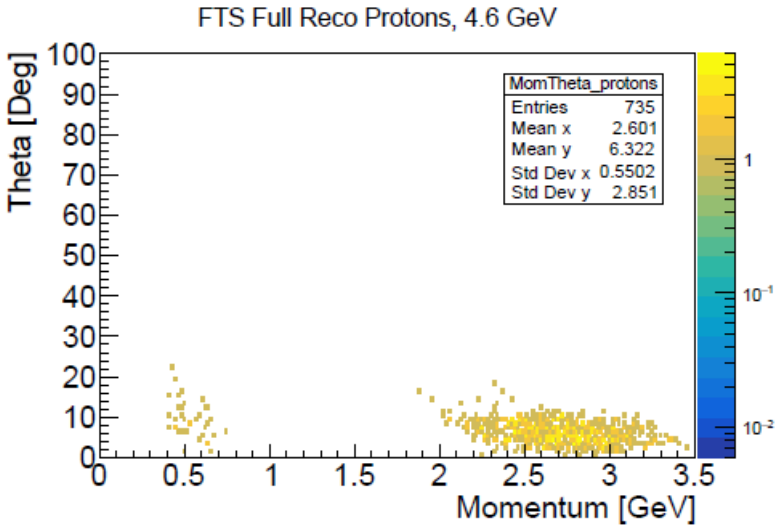
Comparisson between **simulated** and **reconstructed tracks**, full set up:

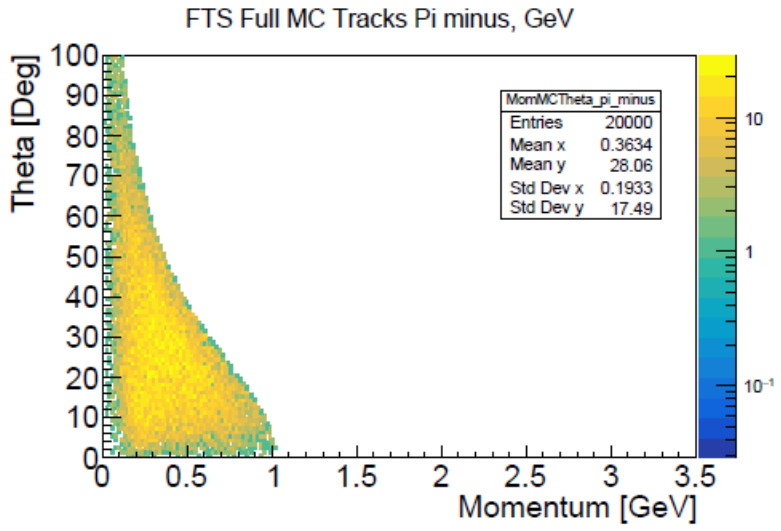
- Few tracks reconstructed at $\boldsymbol{\theta > 40°}$.
- Most tracks reconstructed at $\boldsymbol{\theta < 20°}$.
- **Same** situation in **partial** set ups.
- **Same** situation at beam momentum **7 GeV**, only difference in range.

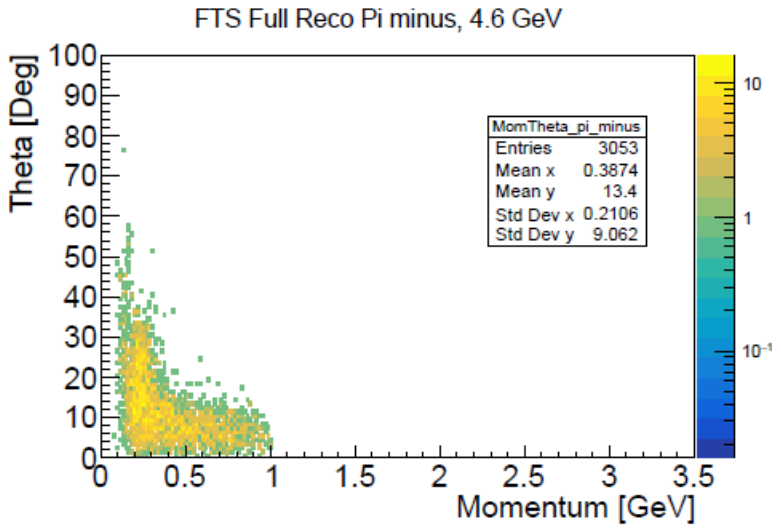












- (Anti)protons and pions **separated** in **momentum** region.
- Tracks from **(anti)protons** emmited at $\boldsymbol{\theta < 20}$ ° are reconstructed.
- Tracks from **pions** emmited at $\boldsymbol{\theta < 40}$° are reconstructed.

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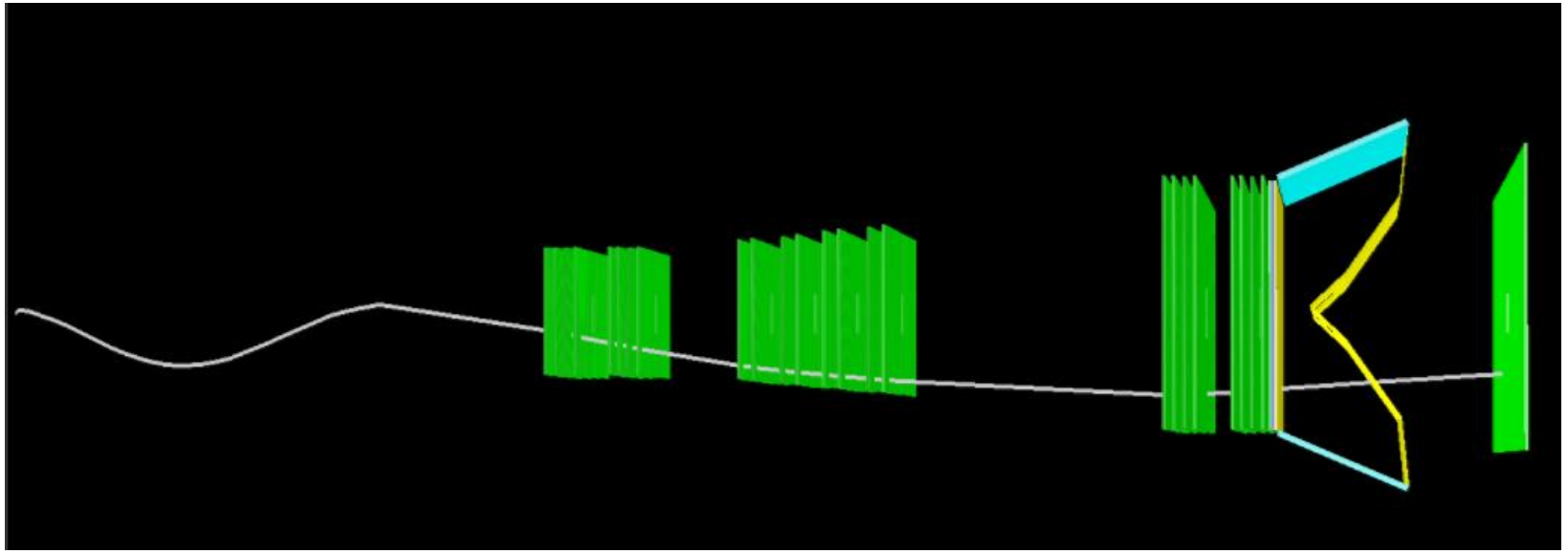
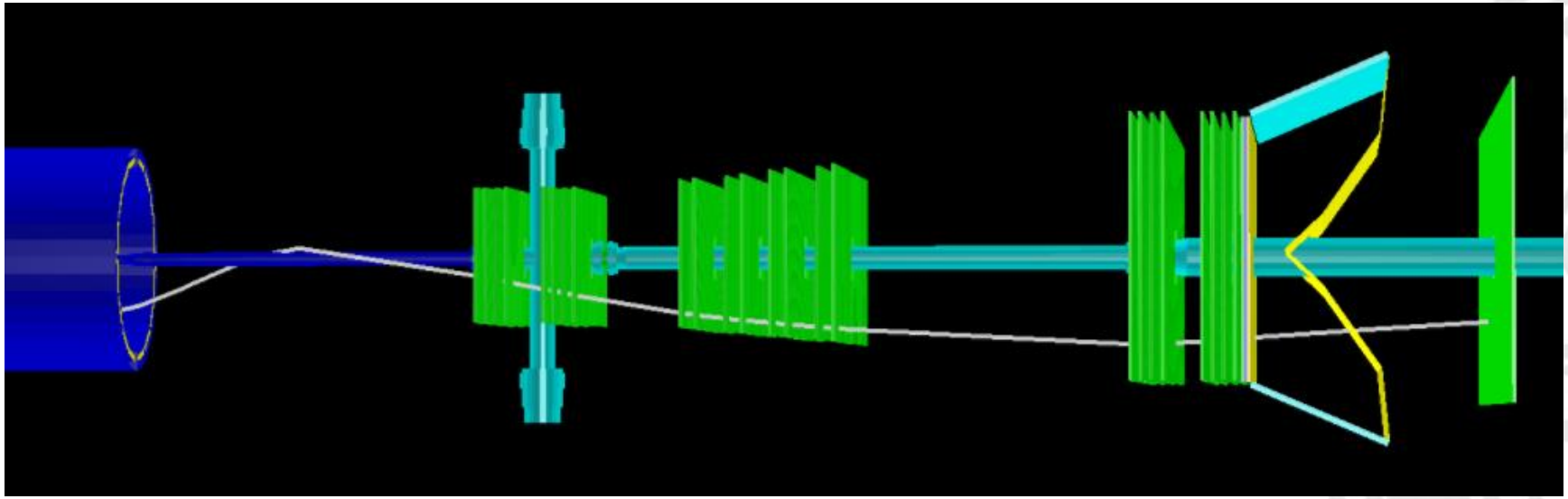
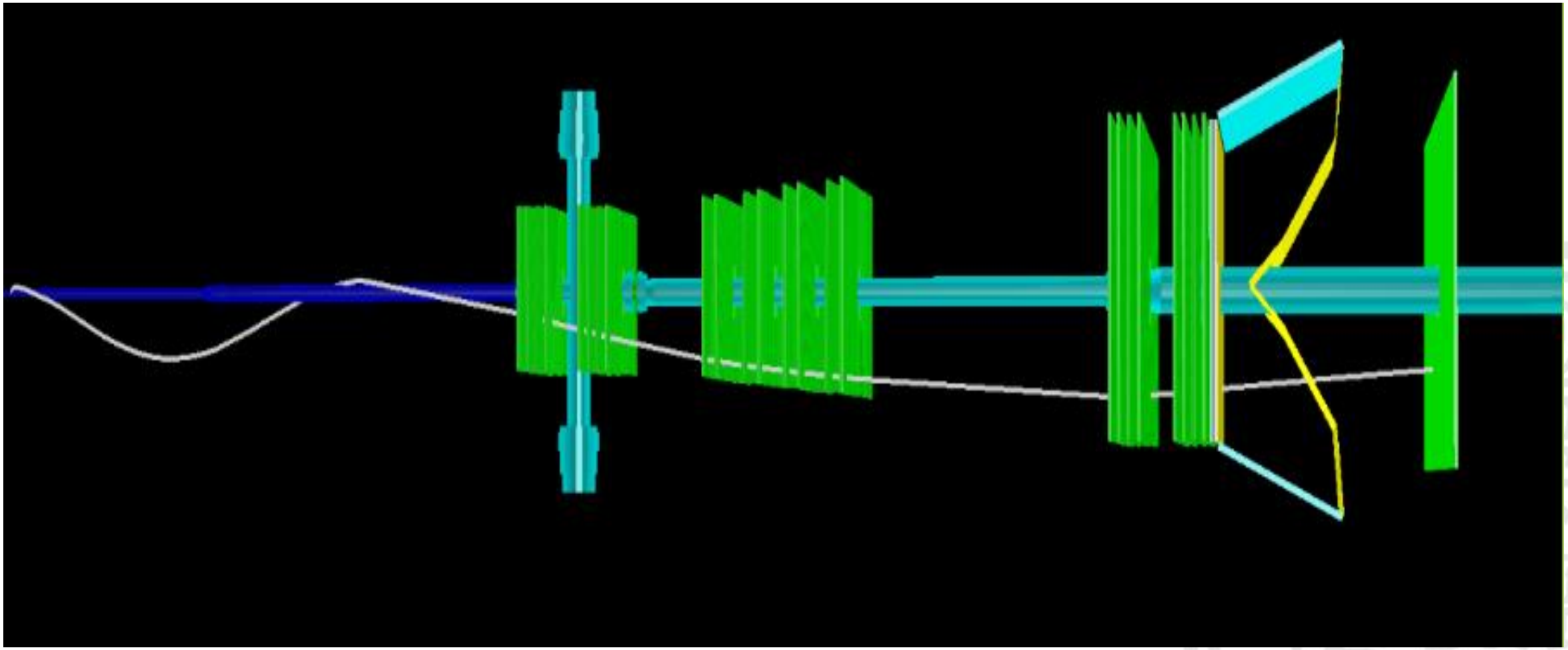
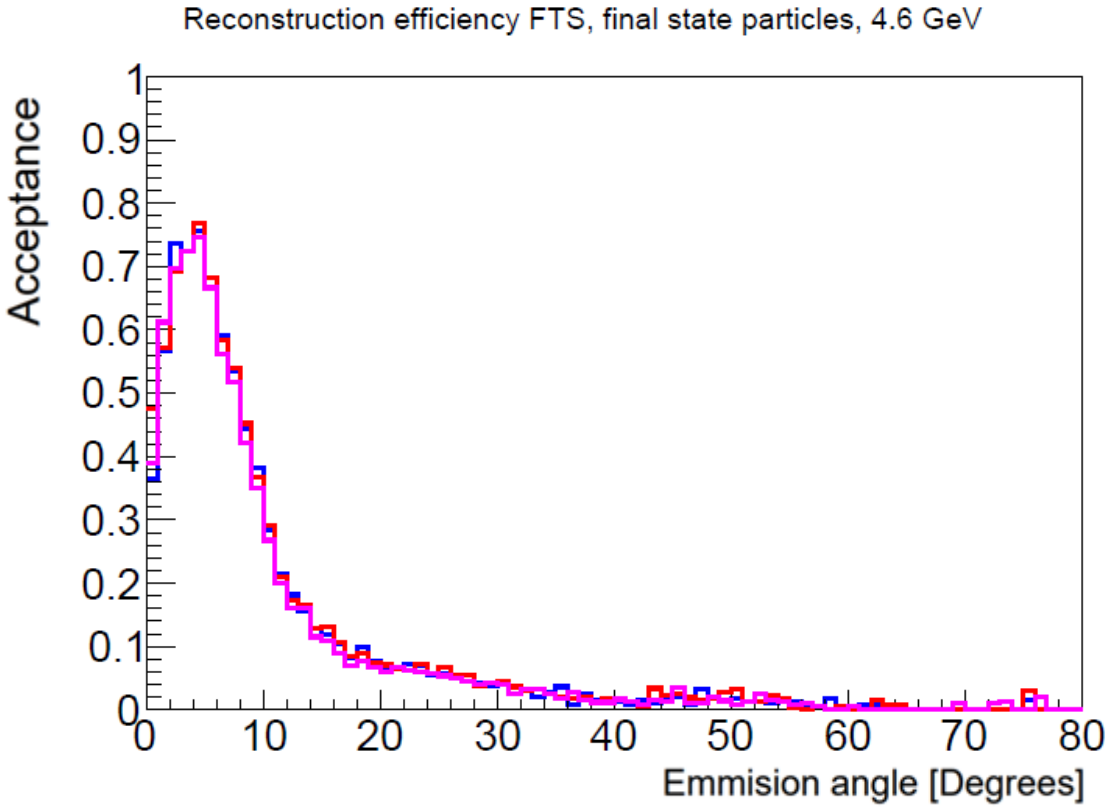






Reconstruction acceptance FS



- Blue – FTS1234
- Red – FTS1256
- Magenta – FTSFull

- Acceptance for particles **emitted** in $\boldsymbol{\theta < 10°}$.
- Acceptance **drops** after $\mathbf{10°}$.
- No reconstruction for particles **emitted** at angles $\boldsymbol{\theta > 40°}$.
- No evident difference between set ups.

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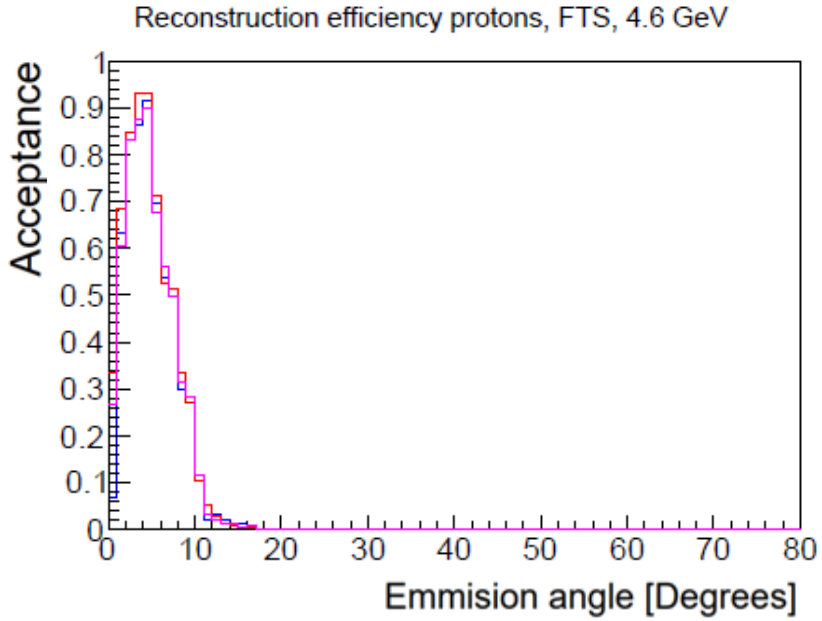
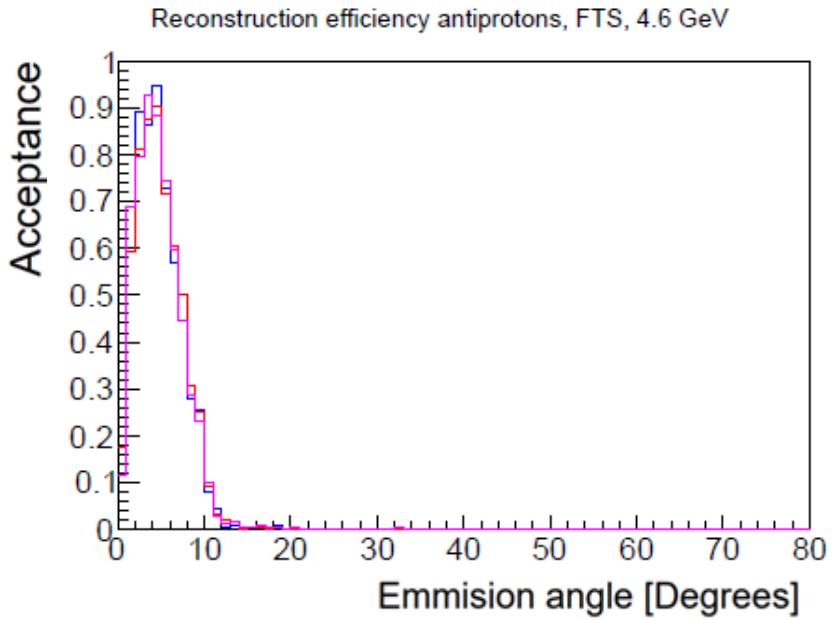
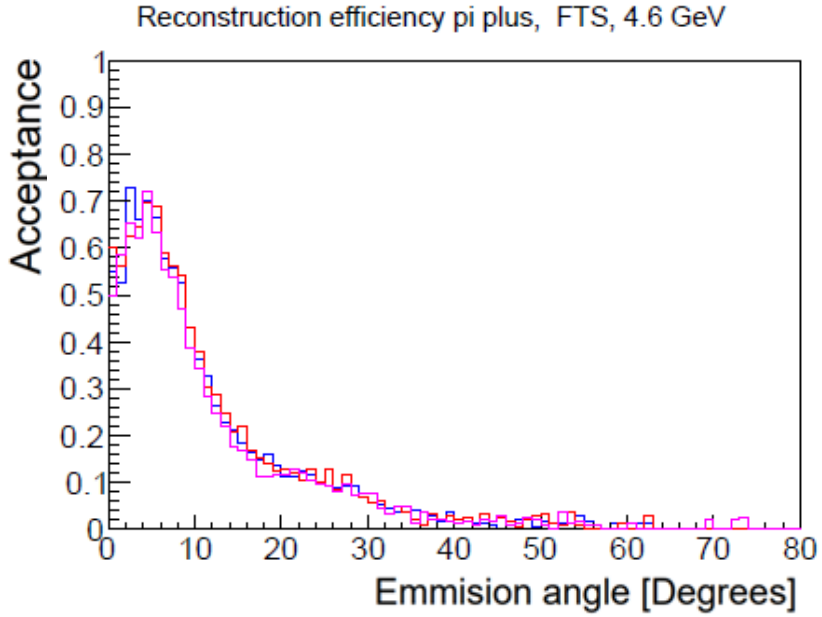
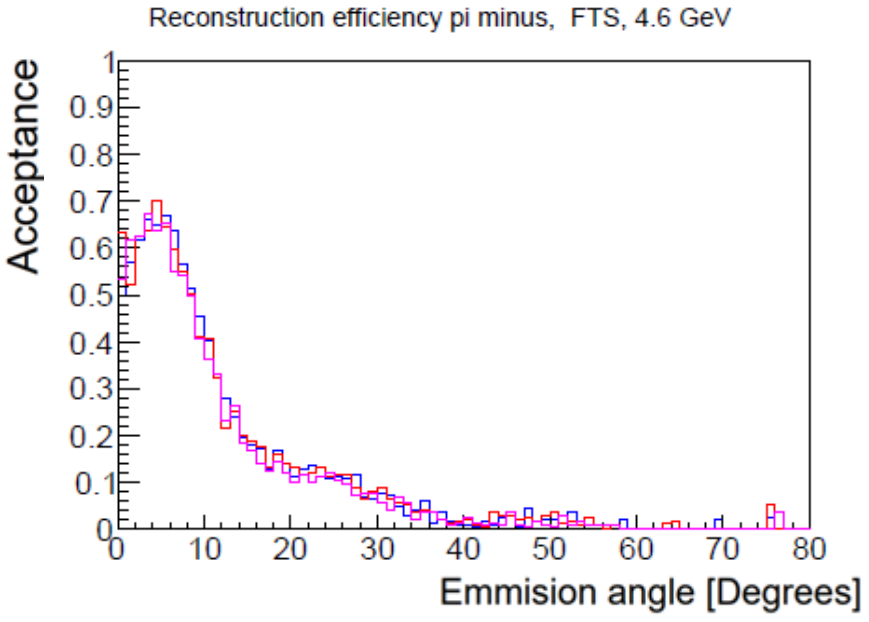


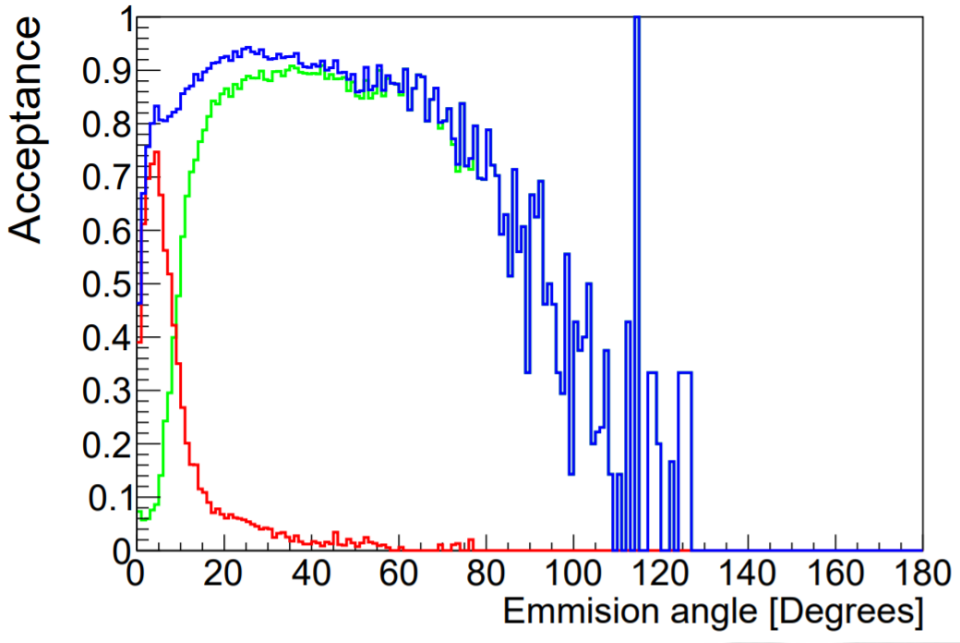


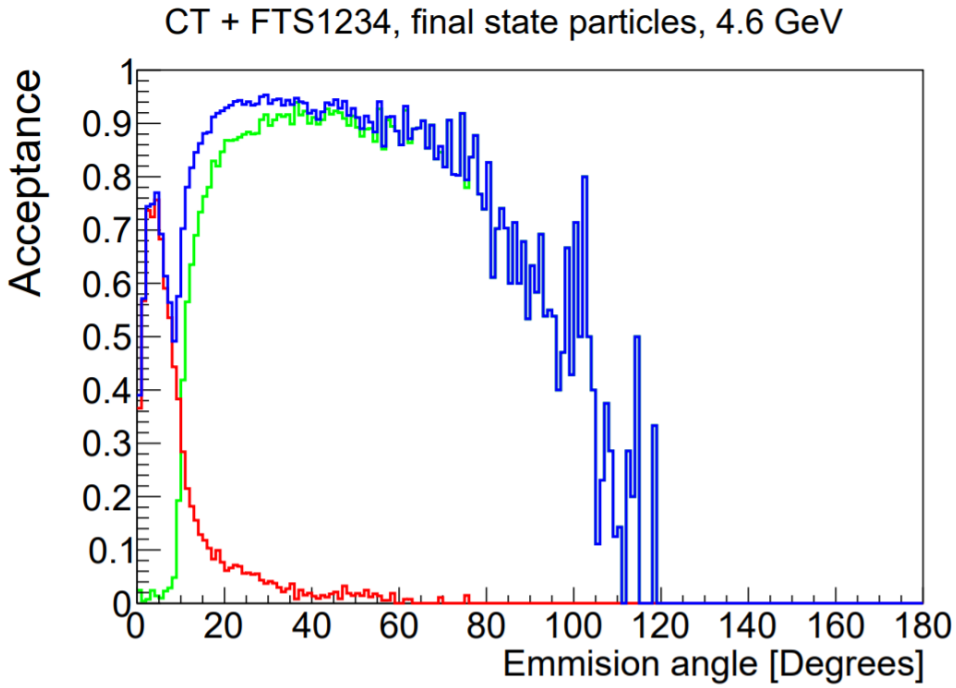


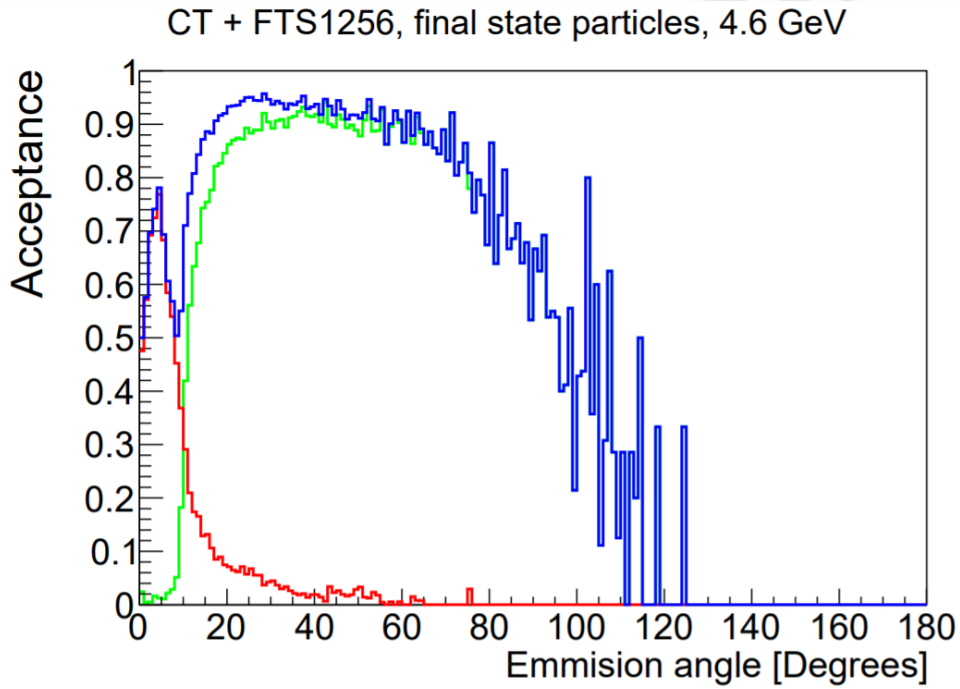


Acceptance Forward + Central Spectrometers

- **Partial** and **full** set ups **difference** due to other devices present in each case.
- **STT** shows **good** efficiency at emission angles $> 10°$.
- **STT** + **FS** system show **good** efficiency for the **whole** range of angles.







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Conclusions

- Number of **reconstructed tracks** is **independent** of the beam momentum.
- Most of the tracks are reconstructed using **hits in all the stations**.
- Position **difference** of the Station 6 between configurations **FTS1256** and **FTSFull**.
- Number of **hits** in the stations **decreases** as we move away from the interaction point.
- Area **surrounding** the beam line has **higher** hit densities and it is **lower** at the **edges** of the stations.
- Higher radial momentum tracks are **not** reconstructed. It is possible to **distinguish** between pions and (anti)protons in the reconstructed tracks.

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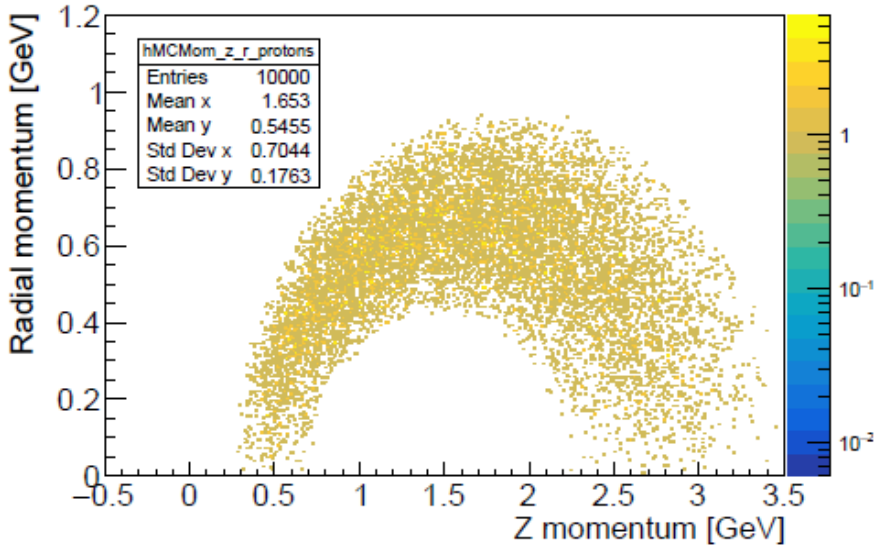
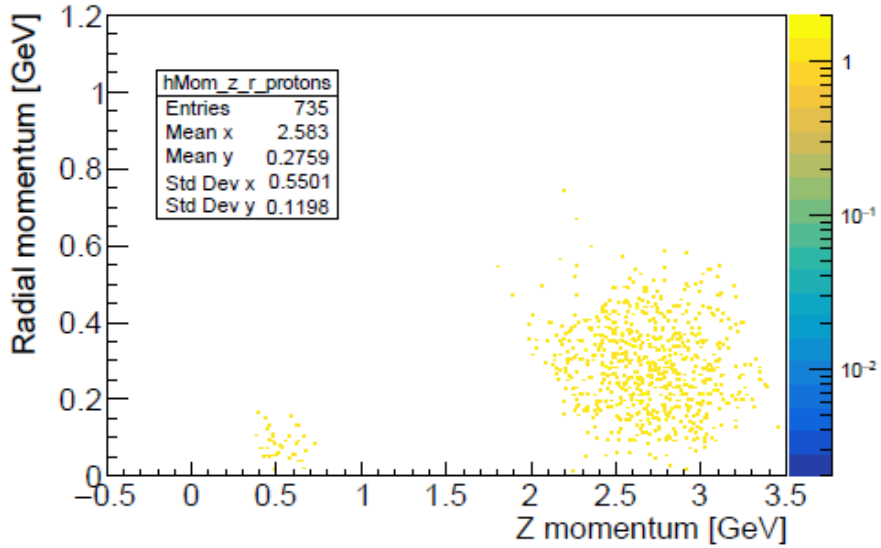
THANK YOU

OTHER PARTICLES (Full set ups)

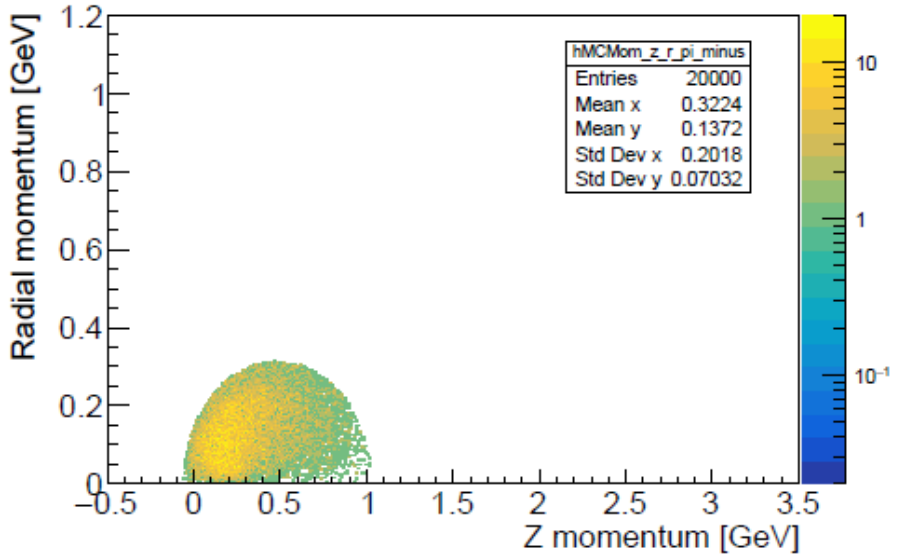
Protons MC tracks FTS Full set up, 4.6 GeV



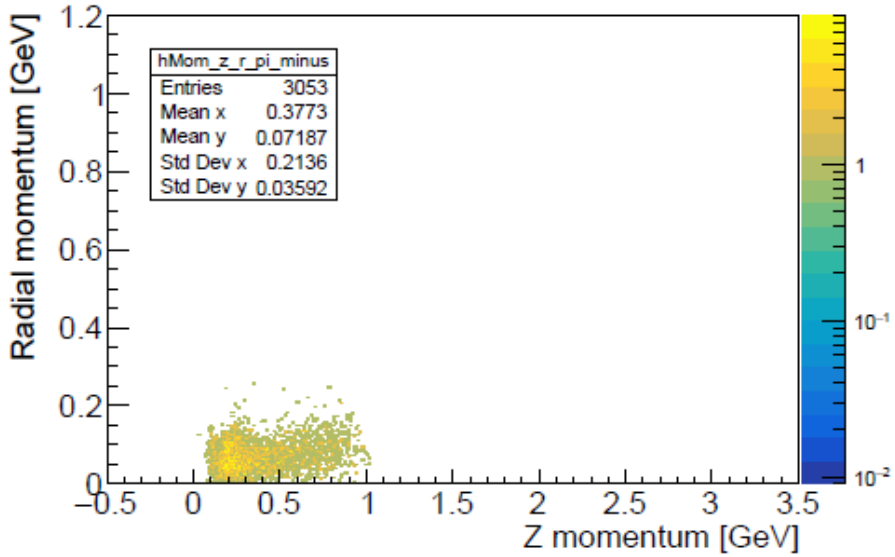
Protons Reconstructed tracks FTS Full set up, 4.6 GeV

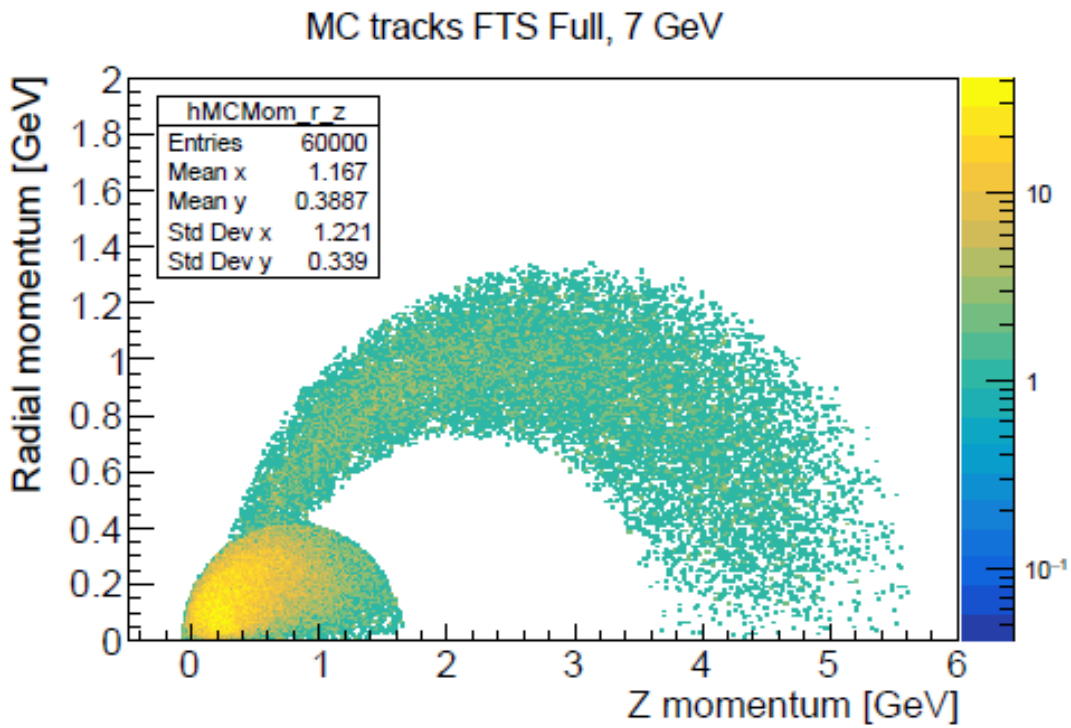


Pi minus MC tracks FTS Full set up, 4.6 GeV

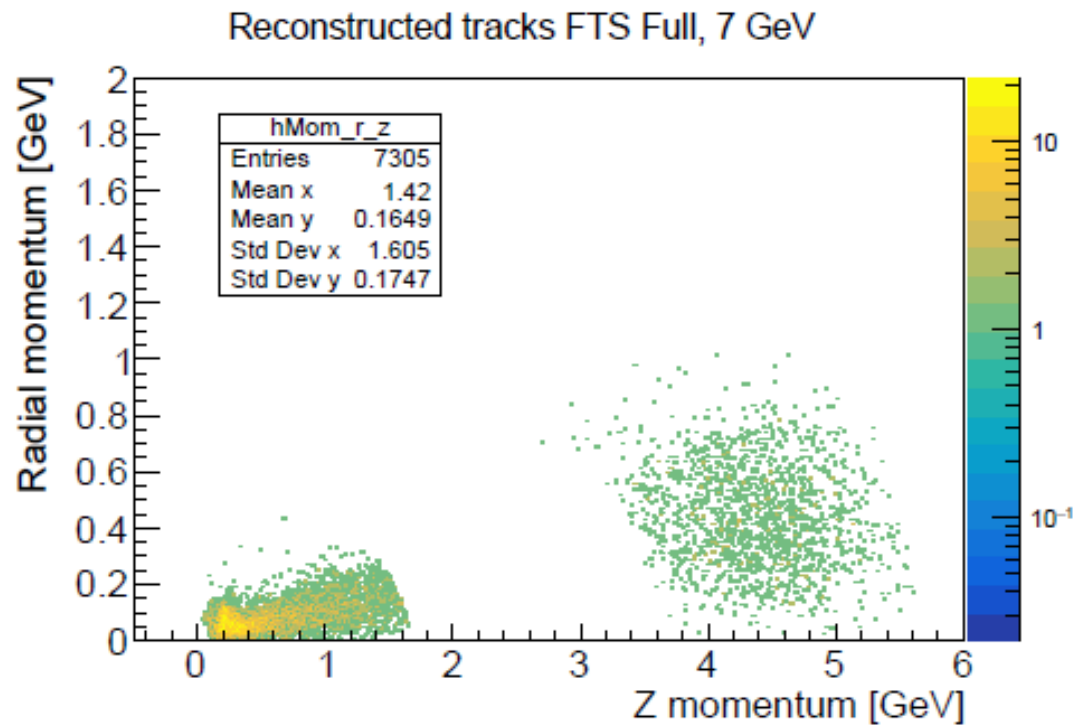


Pi Minus Reconstructed tracks FTS Full set up, 4.6 GeV

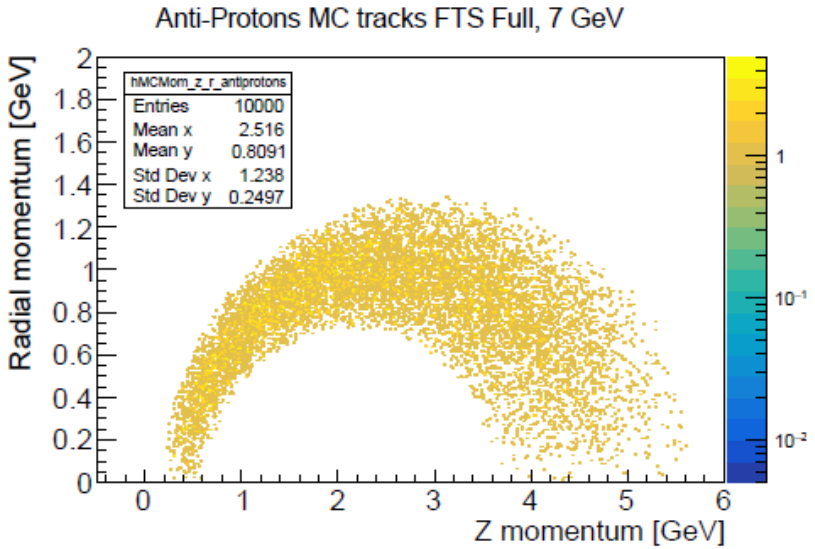


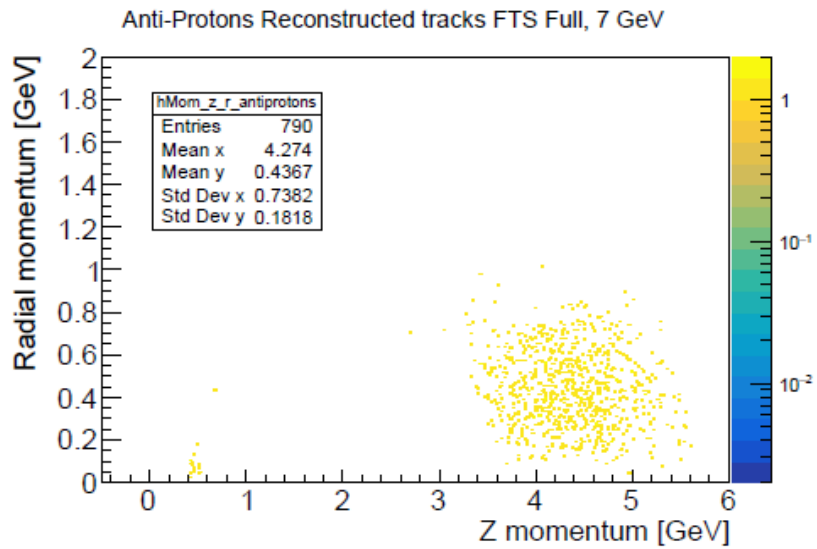

MC tracks FTS Full, 7 GeV
hMCMom_r_z
Entries 60000
Mean x 1.167
Mean y 0.3887
Std Dev x 1.221
Std Dev y 0.339
Radial momentum [GeV]
Z momentum [GeV]

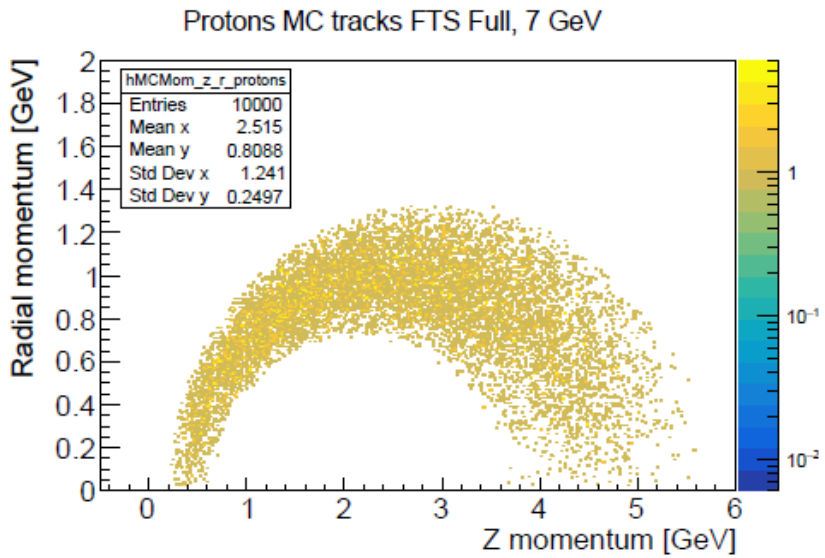
(a)

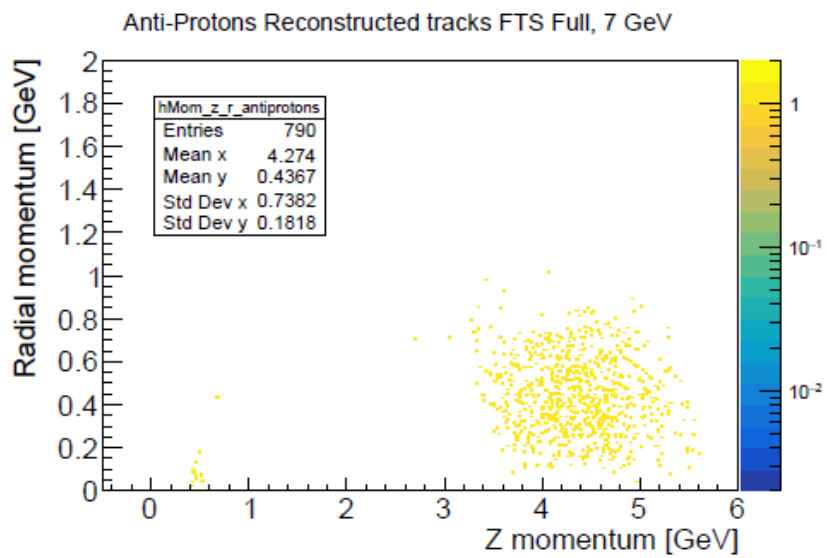

Reconstructed tracks FTS Full, 7 GeV
hMom_r_z
Entries 7305
Mean x 1.42
Mean y 0.1649
Std Dev x 1.605
Std Dev y 0.1747
Radial momentum [GeV]
Z momentum [GeV]

(b)

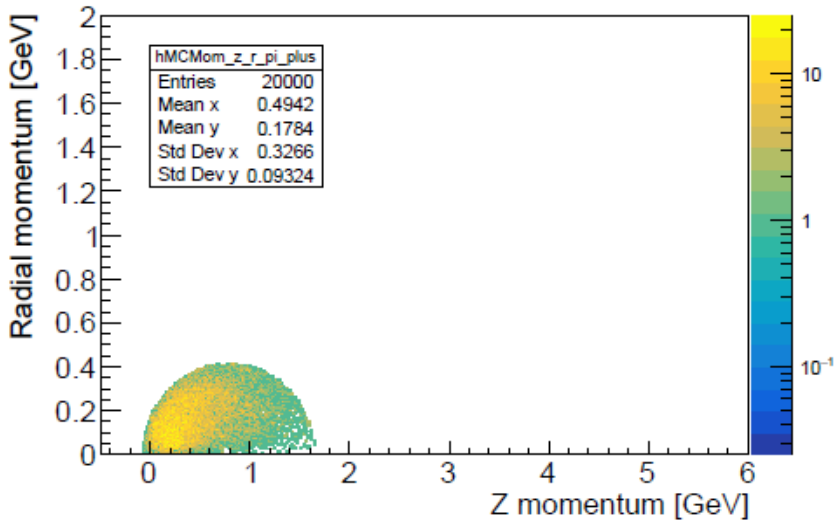

Anti-Protons MC tracks FTS Full, 7 GeV
hMCMom_z_r_antiprotons
Entries 10000
Mean x 2.516
Mean y 0.8091
Std Dev x 1.238
Std Dev y 0.2497
Radial momentum [GeV]
Z momentum [GeV]


Anti-Protons Reconstructed tracks FTS Full, 7 GeV
hMom_z_r_antiprotons
Entries 790
Mean x 4.274
Mean y 0.4367
Std Dev x 0.7382
Std Dev y 0.1818
Radial momentum [GeV]
Z momentum [GeV]

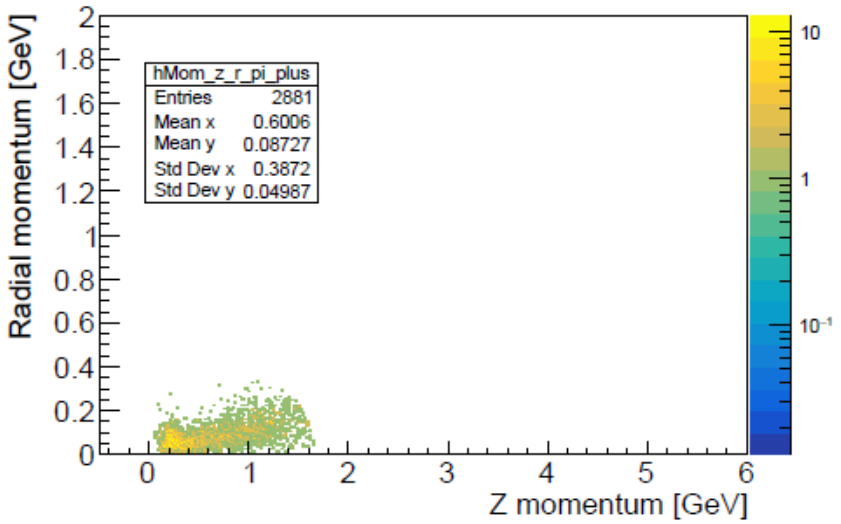

Protons MC tracks FTS Full, 7 GeV
hMCMom_z_r_protons
Entries 10000
Mean x 2.515
Mean y 0.8088
Std Dev x 1.241
Std Dev y 0.2497
Radial momentum [GeV]
Z momentum [GeV]


Anti-Protons Reconstructed tracks FTS Full, 7 GeV
hMom_z_r_antiprotons
Entries 790
Mean x 4.274
Mean y 0.4367
Std Dev x 0.7382
Std Dev y 0.1818
Radial momentum [GeV]
Z momentum [GeV]

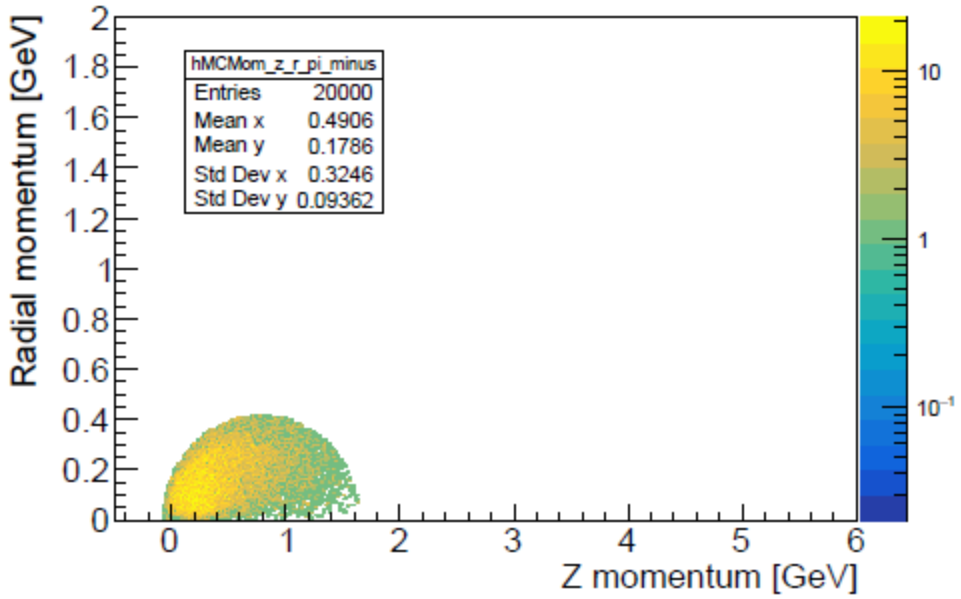
Pi Plus MC tracks FTS Full, 7 GeV



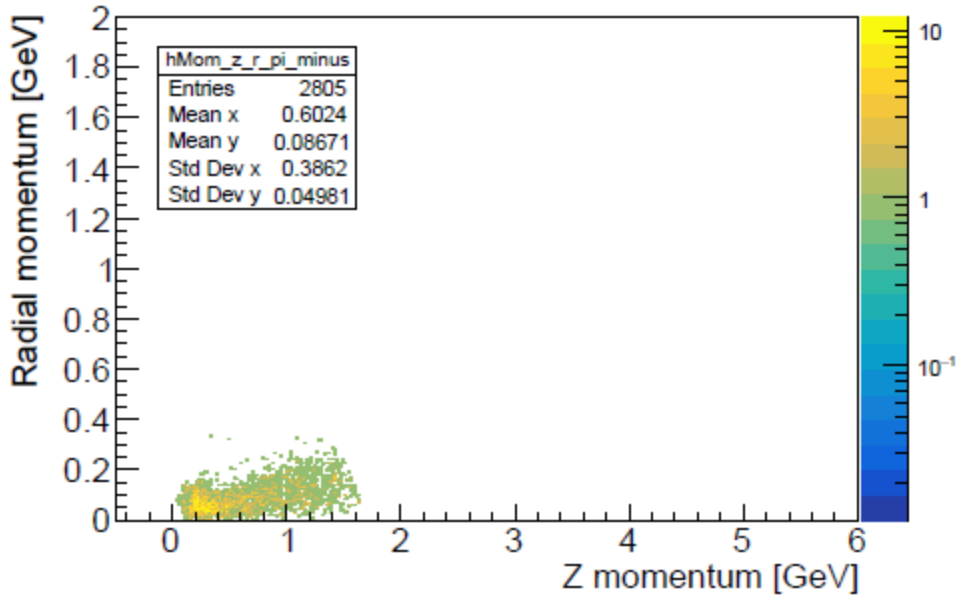
Pi Plus Reconstructed tracks FTS Full, 7 GeV

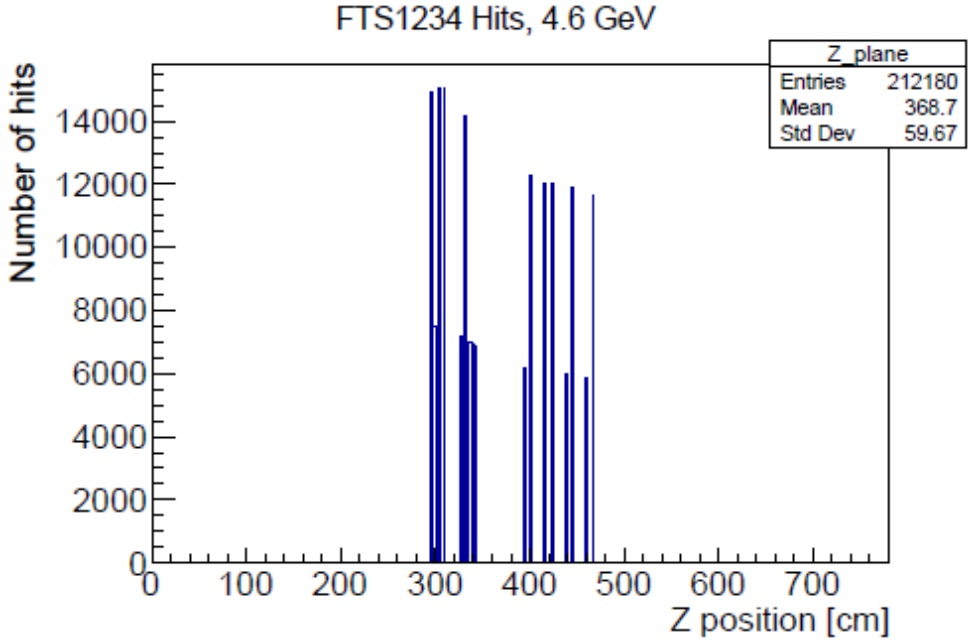


Pi minus MC tracks FTS Full, 7 GeV

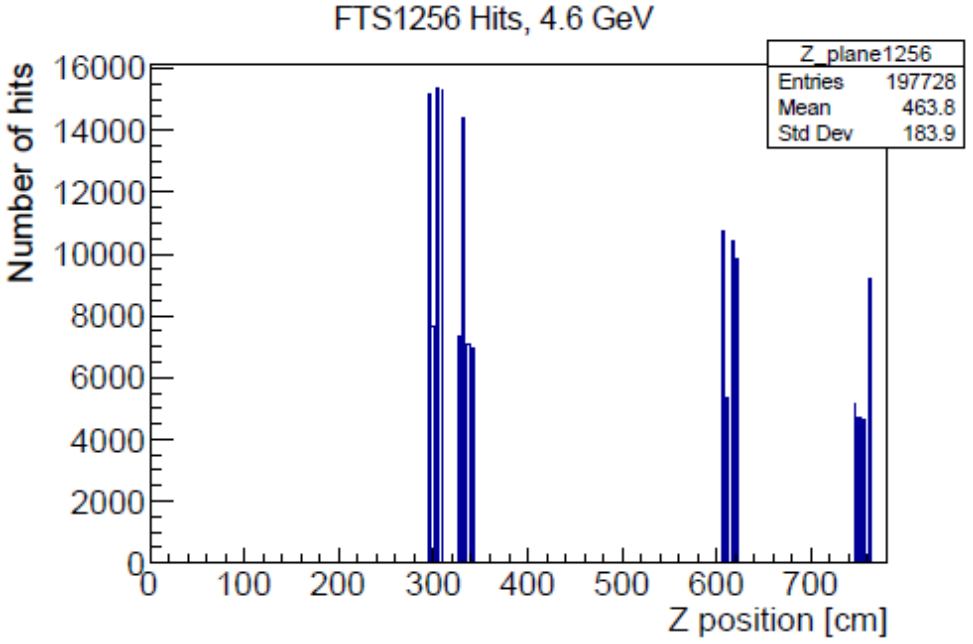


Pi minus Reconstructed tracks FTS Full, 7 GeV

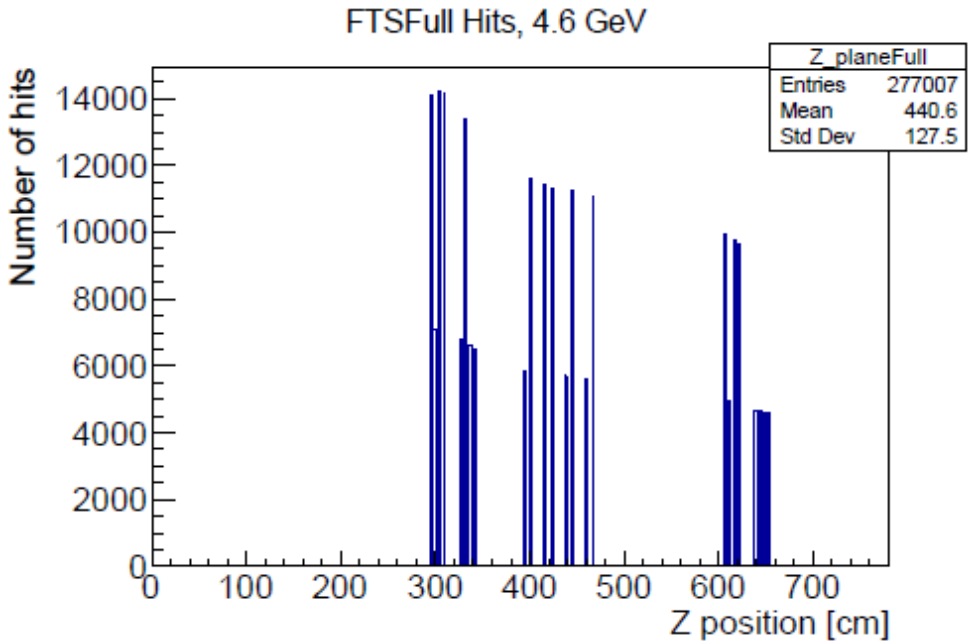


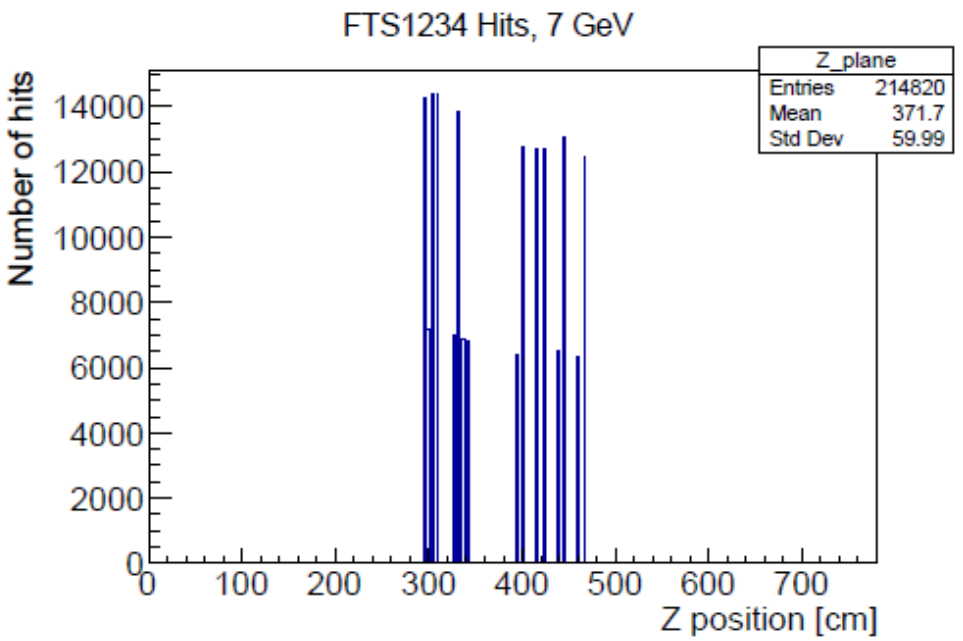

FTS1234 Hits, 4.6 GeV
Z_plane
Entries 212180
Mean 368.7
Std Dev 59.67
Number of hits
Z position [cm]

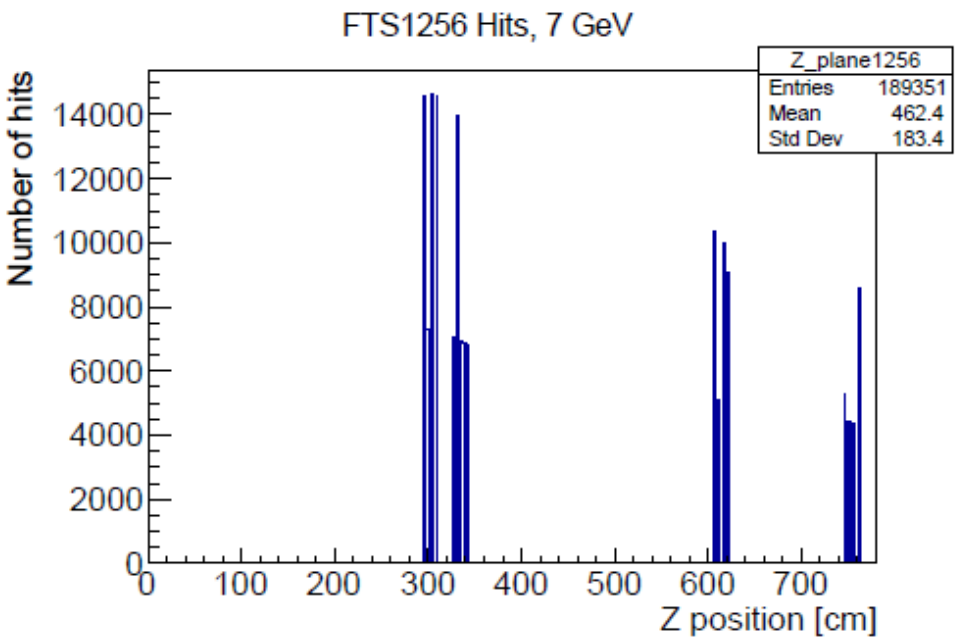
(a)


FTS1256 Hits, 4.6 GeV
Z_plane1256
Entries 197728
Mean 463.8
Std Dev 183.9
Number of hits
Z position [cm]

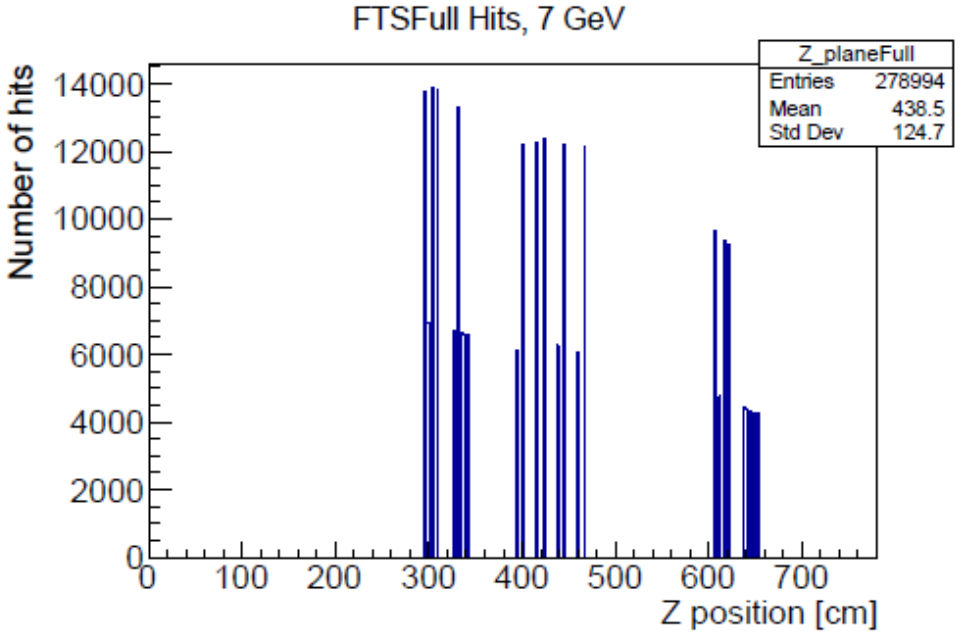
(b)


FTSFull Hits, 4.6 GeV
Z_planeFull
Entries 277007
Mean 440.6
Std Dev 127.5
Number of hits
Z position [cm]

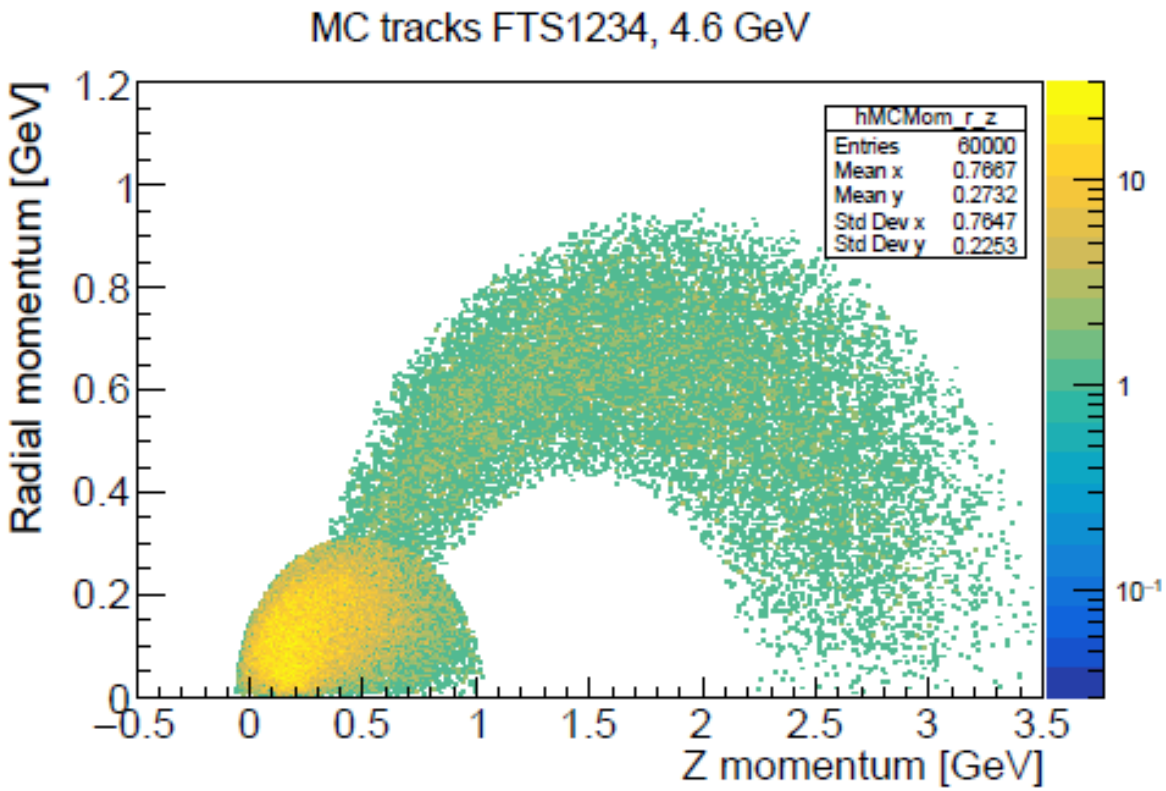

FTS1234 Hits, 7 GeV
Z_plane
Entries 214820
Mean 371.7
Std Dev 59.99
Number of hits
Z position [cm]

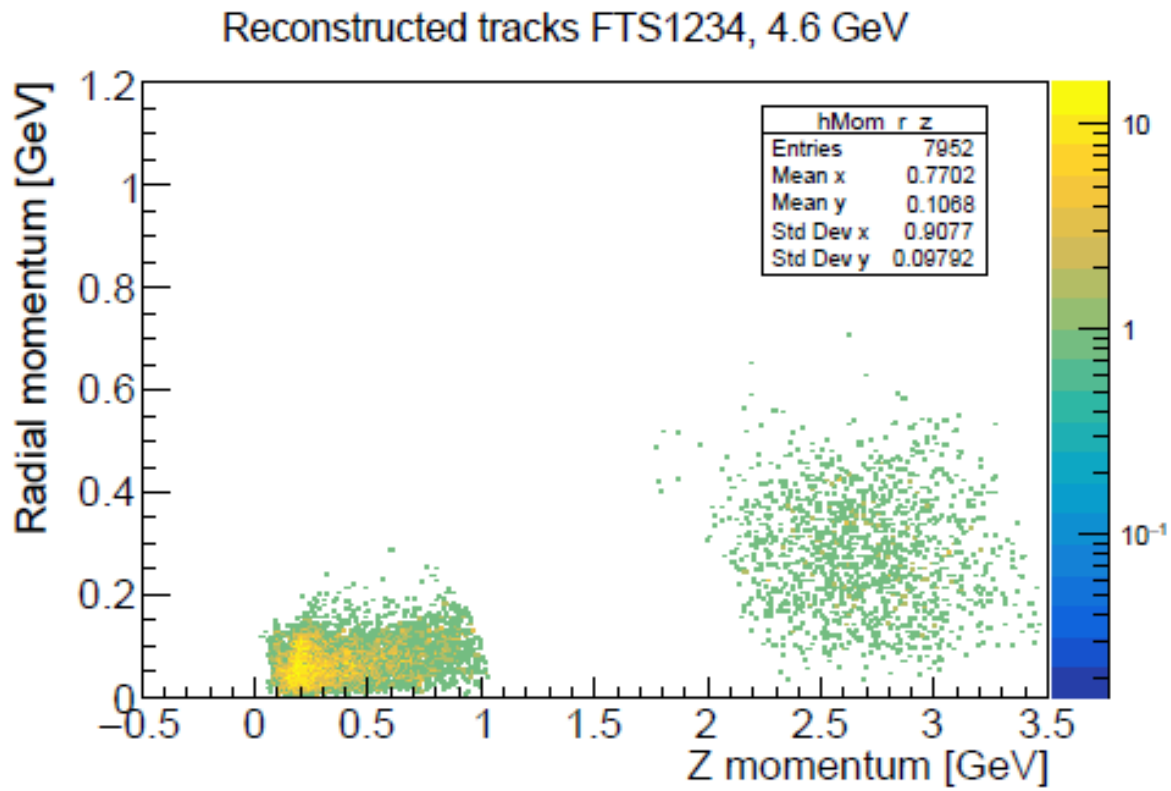

FTS1256 Hits, 7 GeV
Z_plane1256
Entries 189351
Mean 462.4
Std Dev 183.4
Number of hits
Z position [cm]

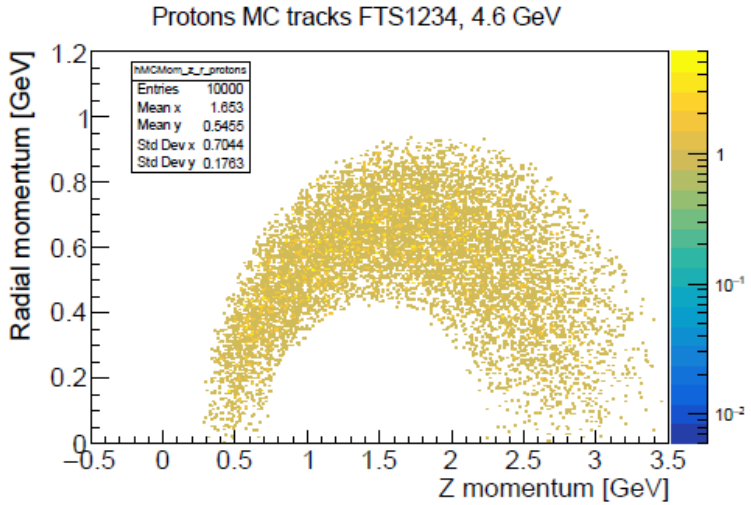
(c)

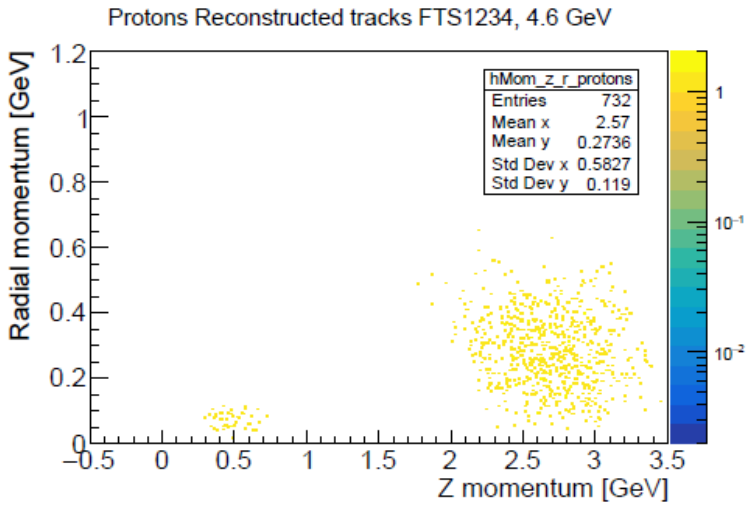

FTSFull Hits, 7 GeV
Z_planeFull
Entries 278994
Mean 438.5
Std Dev 124.7
Number of hits
Z position [cm]

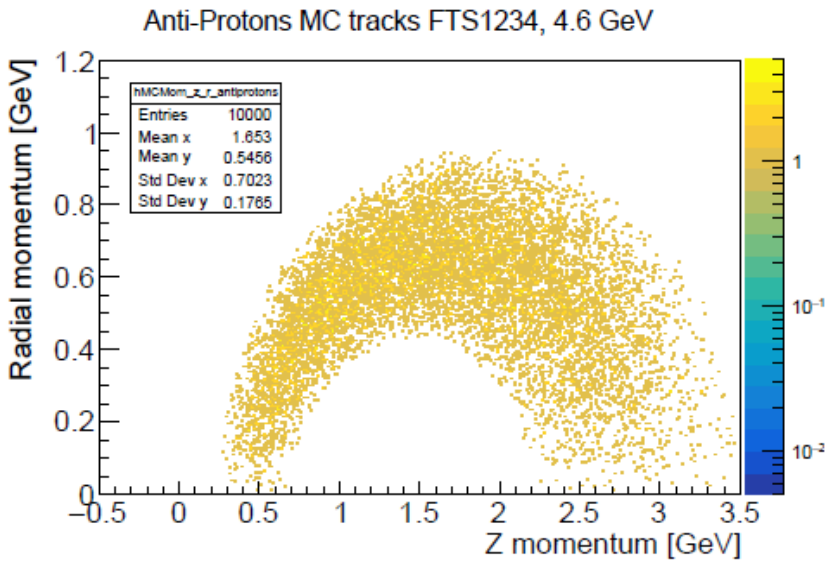
Partial set ups 4.6 GeV

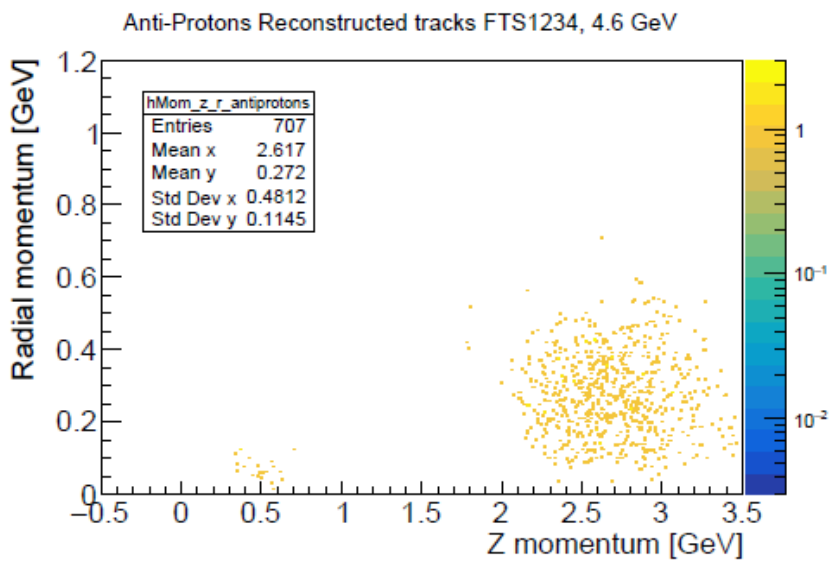

MC tracks FTS1234, 4.6 GeV
hMCMom_r_z
Entries 60000
Mean x 0.7667
Mean y 0.2732
Std Dev x 0.7647
Std Dev y 0.2253
Radial momentum [GeV]
Z momentum [GeV]

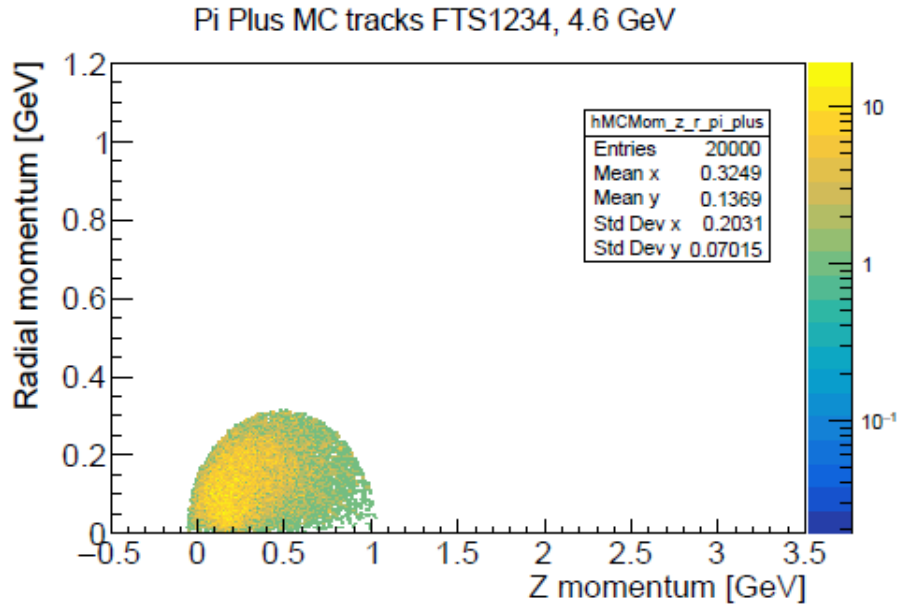

Reconstructed tracks FTS1234, 4.6 GeV
hMom_r_z
Entries 7952
Mean x 0.7702
Mean y 0.1068
Std Dev x 0.9077
Std Dev y 0.09792
Radial momentum [GeV]
Z momentum [GeV]


Protons MC tracks FTS1234, 4.6 GeV
hMCMom_z_r_protons
Entries 10000
Mean x 1.653
Mean y 0.5455
Std Dev x 0.7044
Std Dev y 0.1763
Radial momentum [GeV]
Z momentum [GeV]

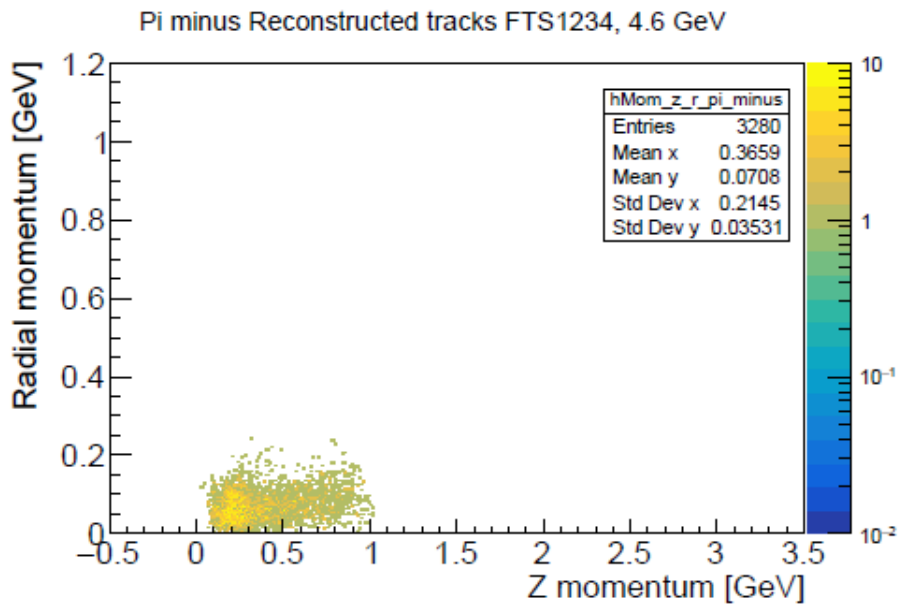

Protons Reconstructed tracks FTS1234, 4.6 GeV
hMom_z_r_protons
Entries 732
Mean x 2.57
Mean y 0.2736
Std Dev x 0.5827
Std Dev y 0.119
Radial momentum [GeV]
Z momentum [GeV]


Anti-Protons MC tracks FTS1234, 4.6 GeV
hMCMom_z_r_antiprotons
Entries 10000
Mean x 1.653
Mean y 0.5456
Std Dev x 0.7023
Std Dev y 0.1765
Radial momentum [GeV]
Z momentum [GeV]

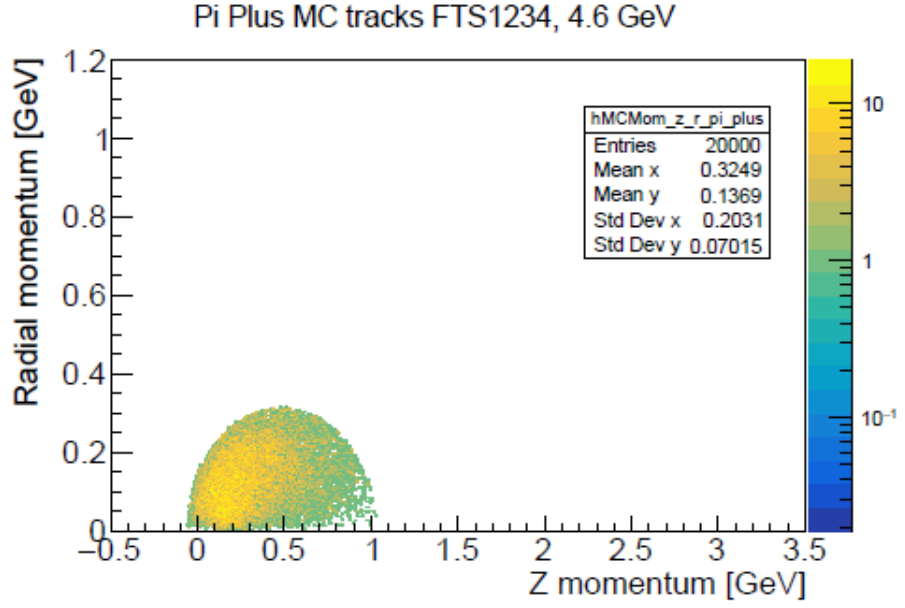

Anti-Protons Reconstructed tracks FTS1234, 4.6 GeV
hMom_z_r_antiprotons
Entries 707
Mean x 2.617
Mean y 0.272
Std Dev x 0.4812
Std Dev y 0.1145
Radial momentum [GeV]
Z momentum [GeV]

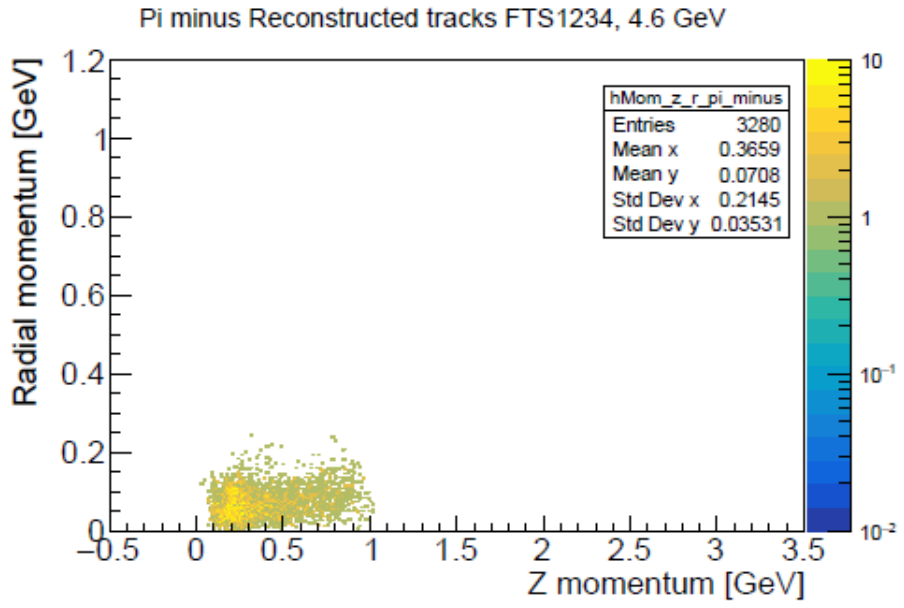

Pi Plus MC tracks FTS1234, 4.6 GeV
hMCMom_z_r_pi_plus
Entries 20000
Mean x 0.3249
Mean y 0.1369
Std Dev x 0.2031
Std Dev y 0.07015
Radial momentum [GeV]
Z momentum [GeV]

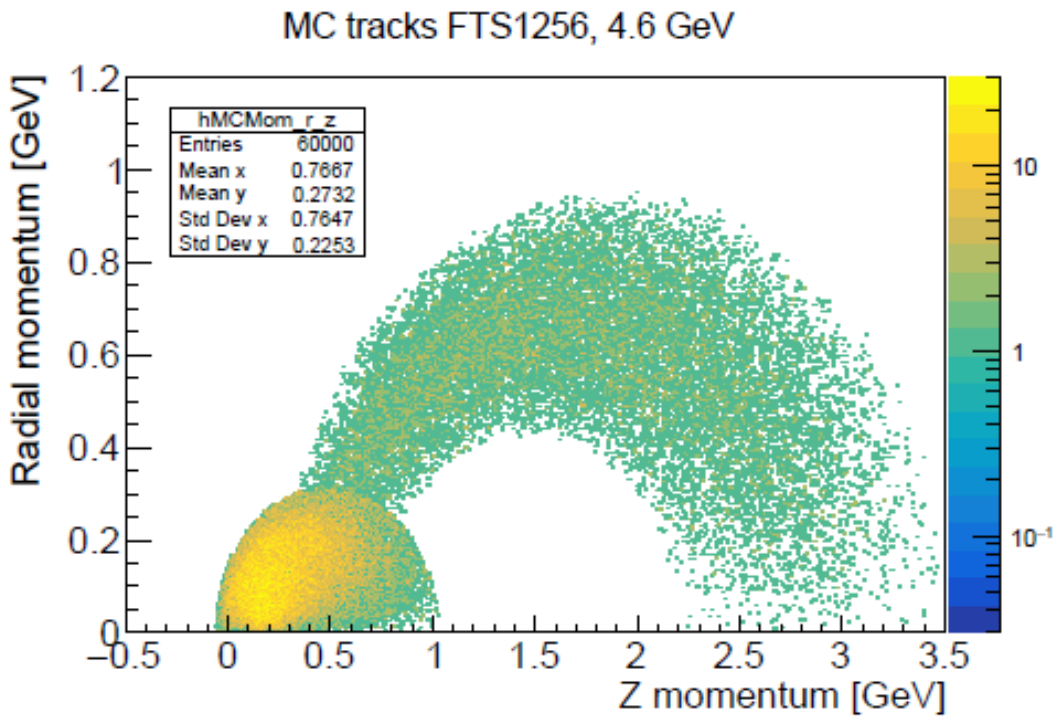
(g)

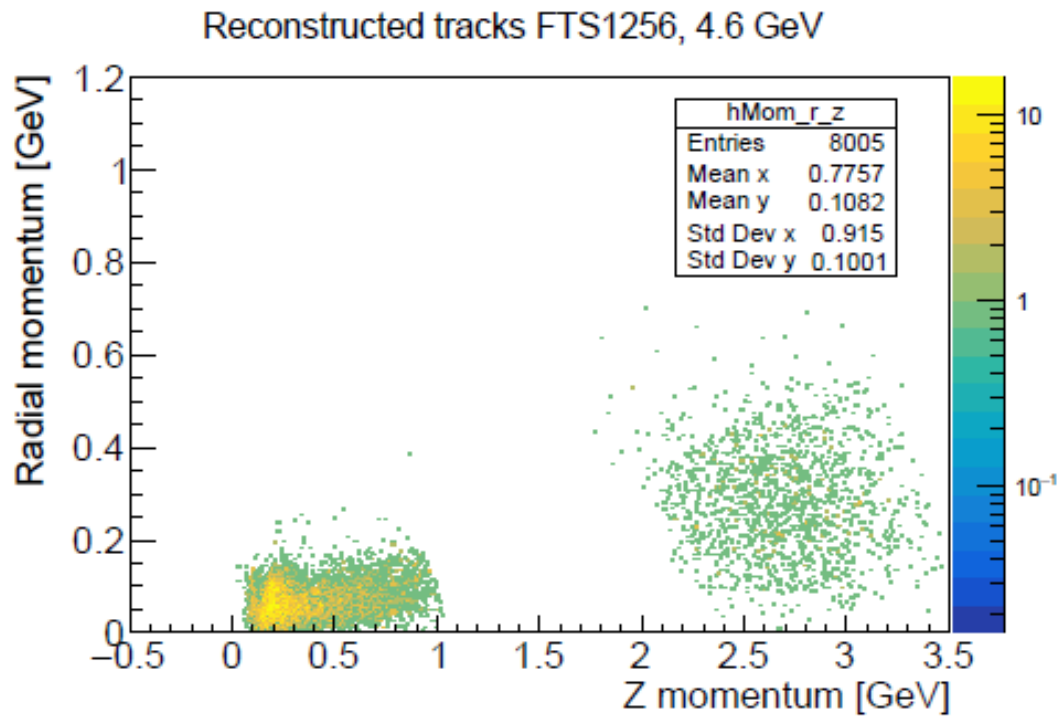

Pi minus Reconstructed tracks FTS1234, 4.6 GeV
hMom_z_r_pi_minus
Entries 3280
Mean x 0.3659
Mean y 0.0708
Std Dev x 0.2145
Std Dev y 0.03531
Radial momentum [GeV]
Z momentum [GeV]

(h)

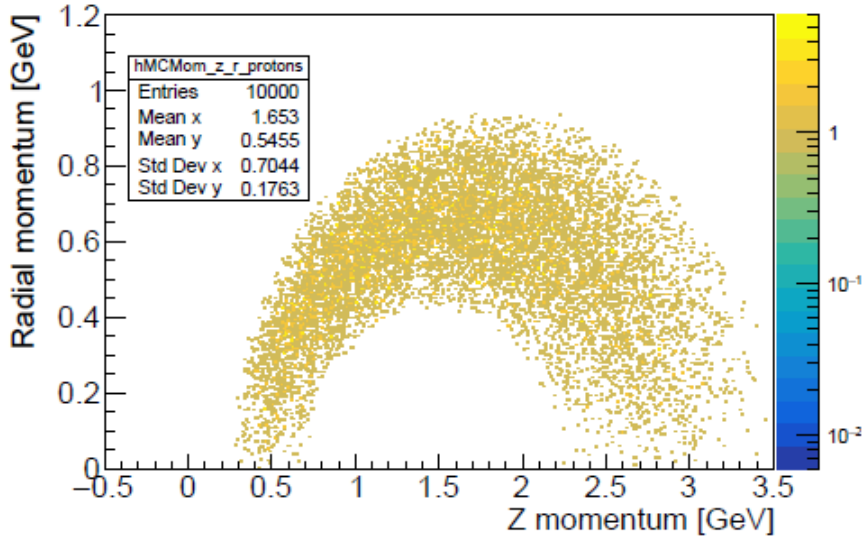

Pi Plus MC tracks FTS1234, 4.6 GeV
hMCMom_z_r_pi_plus
Entries 20000
Mean x 0.3249
Mean y 0.1369
Std Dev x 0.2031
Std Dev y 0.07015
Radial momentum [GeV]
Z momentum [GeV]


Pi minus Reconstructed tracks FTS1234, 4.6 GeV
hMom_z_r_pi_minus
Entries 3280
Mean x 0.3659
Mean y 0.0708
Std Dev x 0.2145
Std Dev y 0.03531
Radial momentum [GeV]
Z momentum [GeV]

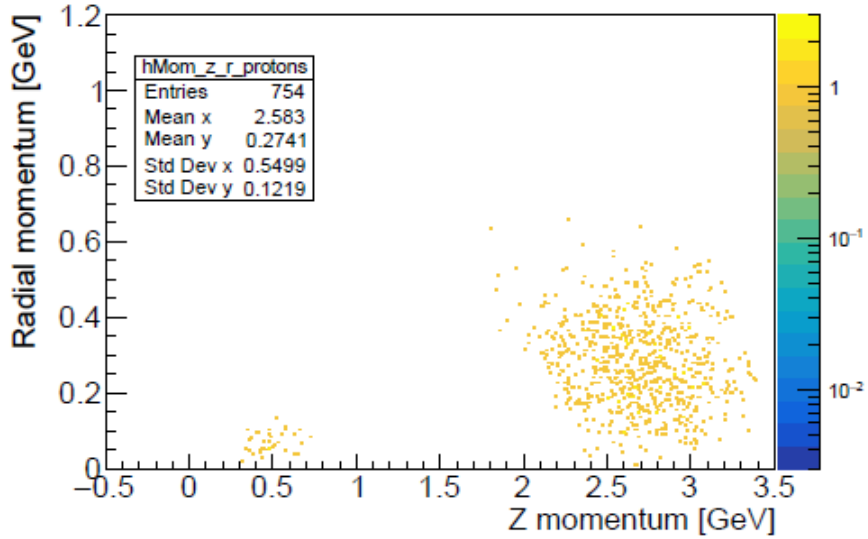

MC tracks FTS1256, 4.6 GeV
hMCMom_r_z
Entries 60000
Mean x 0.7667
Mean y 0.2732
Std Dev x 0.7647
Std Dev y 0.2253
Radial momentum [GeV]
Z momentum [GeV]


Reconstructed tracks FTS1256, 4.6 GeV
hMom_r_z
Entries 8005
Mean x 0.7757
Mean y 0.1082
Std Dev x 0.915
Std Dev y 0.1001
Radial momentum [GeV]
Z momentum [GeV]

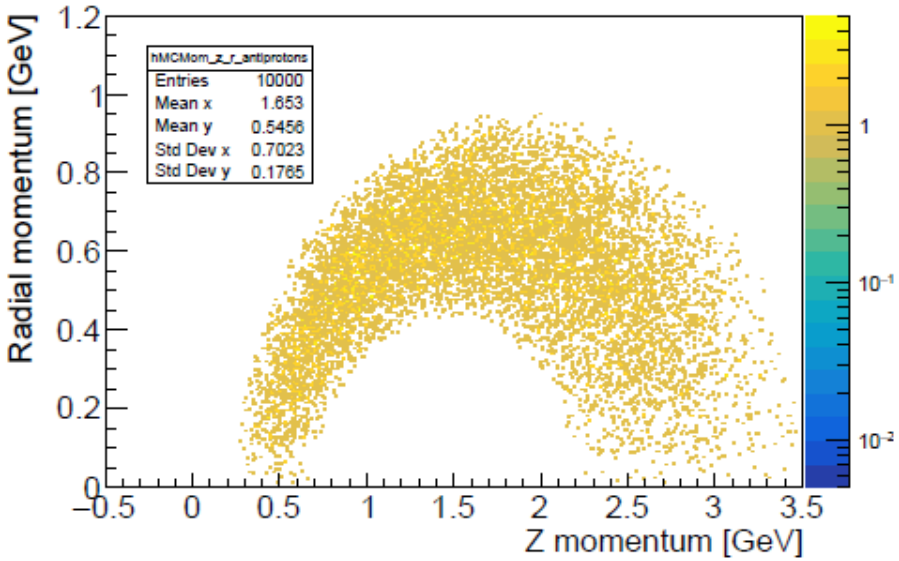
Protons MC tracks FTS1256, 4.6 GeV



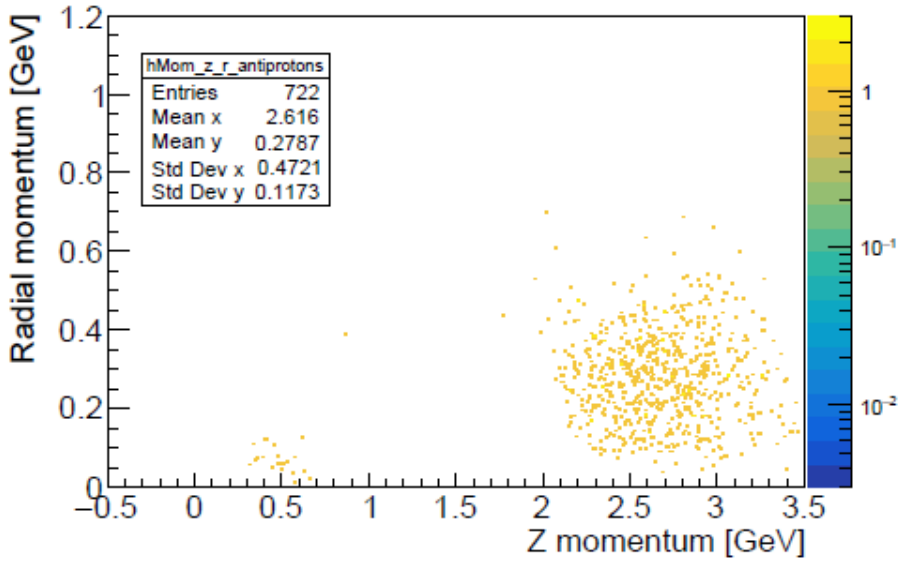
Protons Reconstructed tracks FTS1256, 4.6 GeV

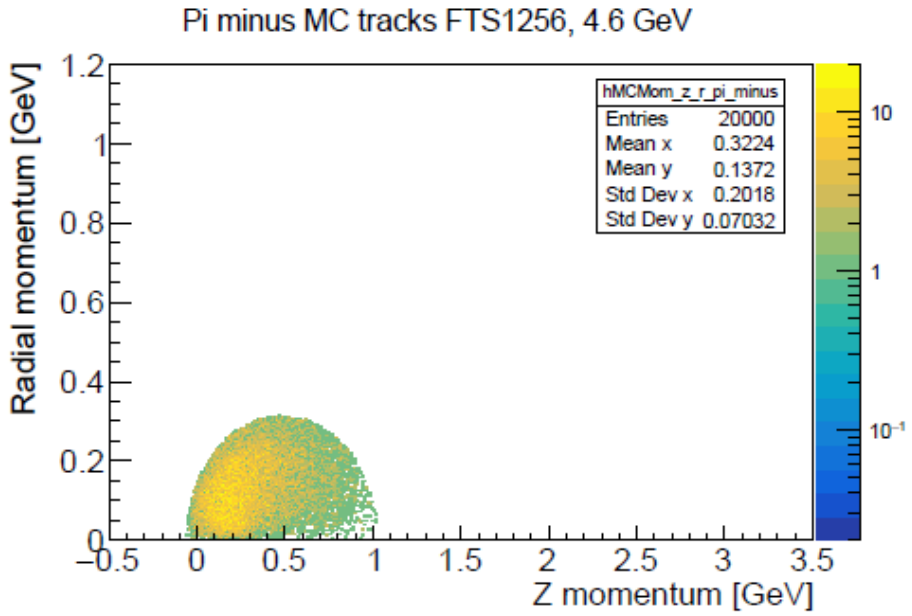


Anti-Protons MC tracks FTS1256, 4.6 GeV

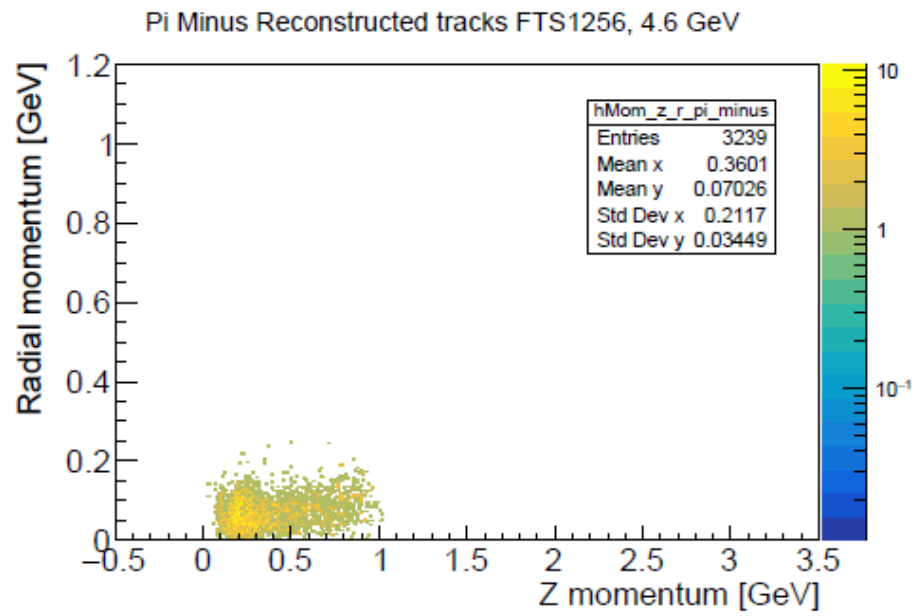


Anti-Protons Reconstructed tracks FTS1256, 4.6 GeV

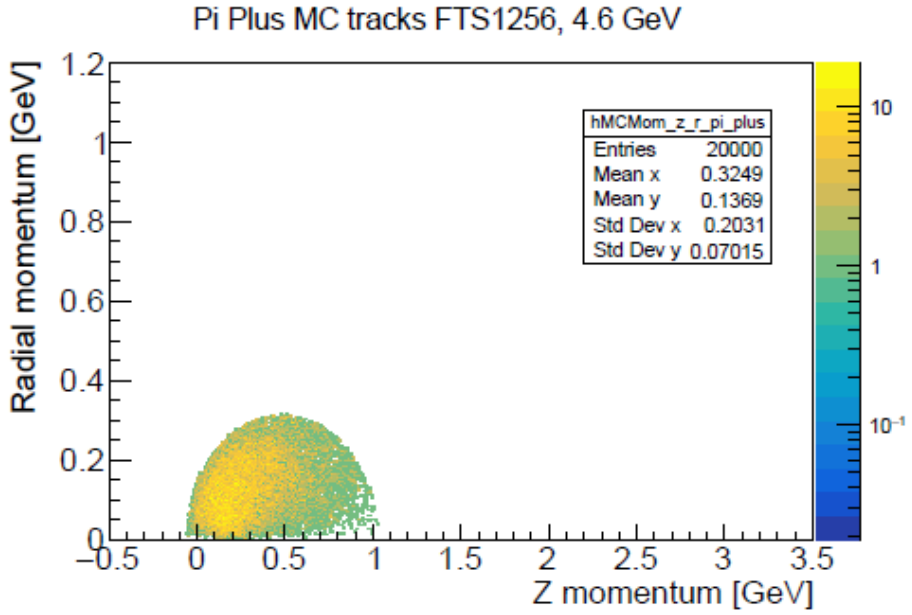


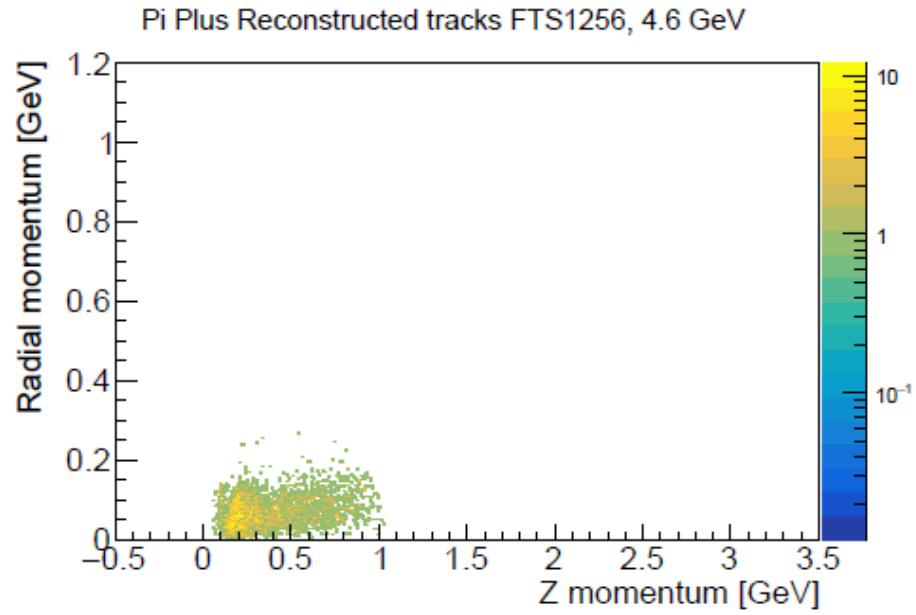

Pi minus MC tracks FTS1256, 4.6 GeV
hMCMom_z_r_pi_minus
Entries 20000
Mean x 0.3224
Mean y 0.1372
Std Dev x 0.2018
Std Dev y 0.07032
Radial momentum [GeV]
Z momentum [GeV]

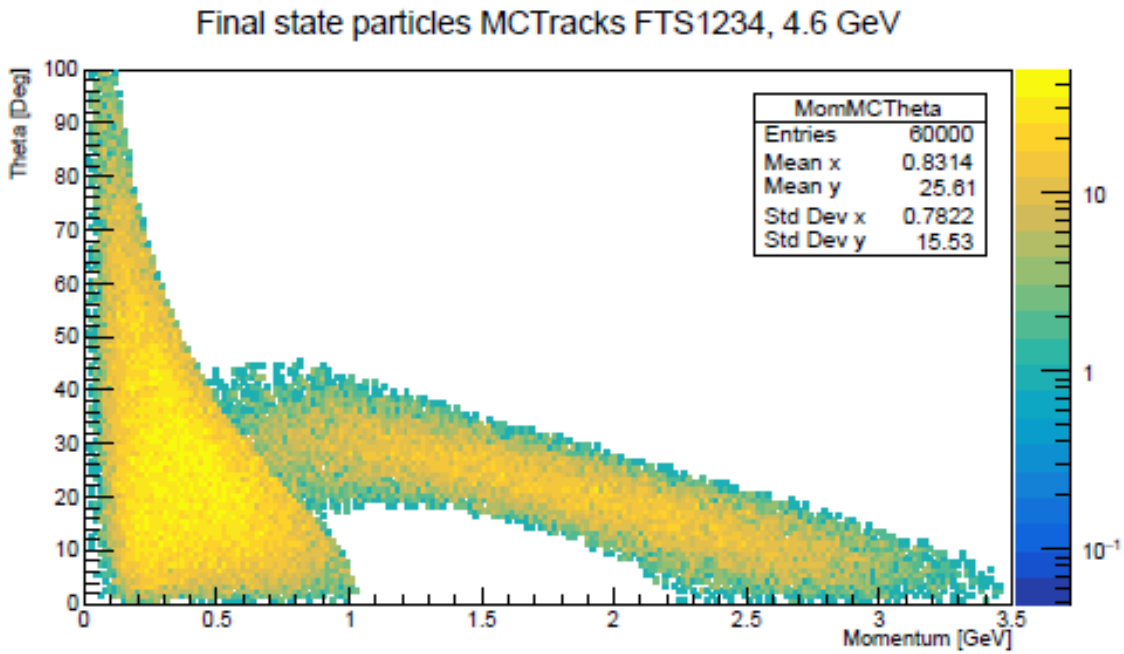
(g)

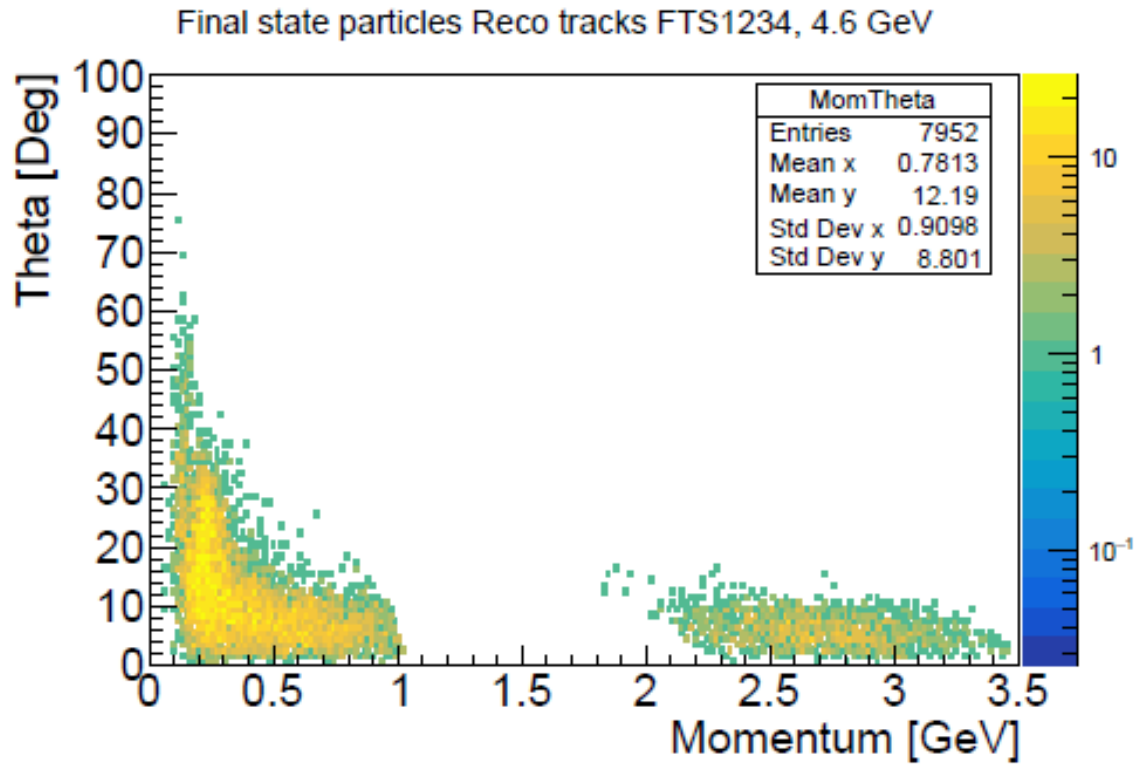

Pi Minus Reconstructed tracks FTS1256, 4.6 GeV
hMom_z_r_pi_minus
Entries 3239
Mean x 0.3601
Mean y 0.07026
Std Dev x 0.2117
Std Dev y 0.03449
Radial momentum [GeV]
Z momentum [GeV]

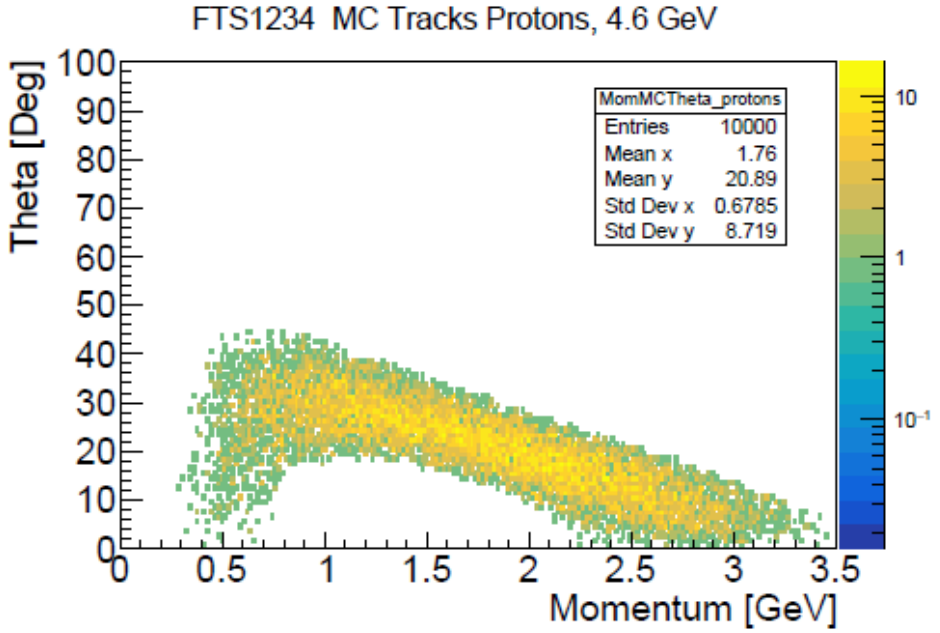
(h)

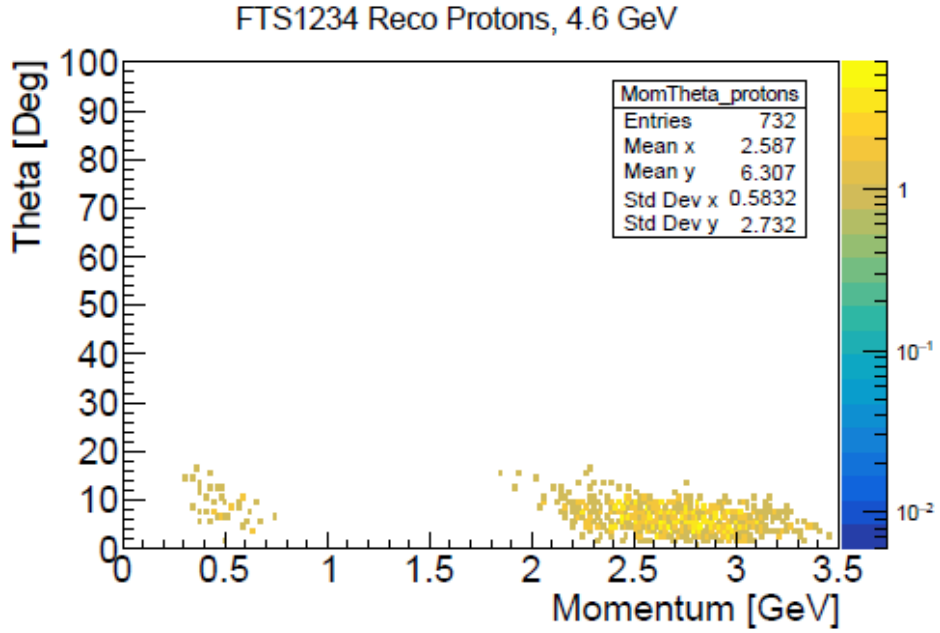

Pi Plus MC tracks FTS1256, 4.6 GeV
hMCMom_z_r_pi_plus
Entries 20000
Mean x 0.3249
Mean y 0.1369
Std Dev x 0.2031
Std Dev y 0.07015
Radial momentum [GeV]
Z momentum [GeV]

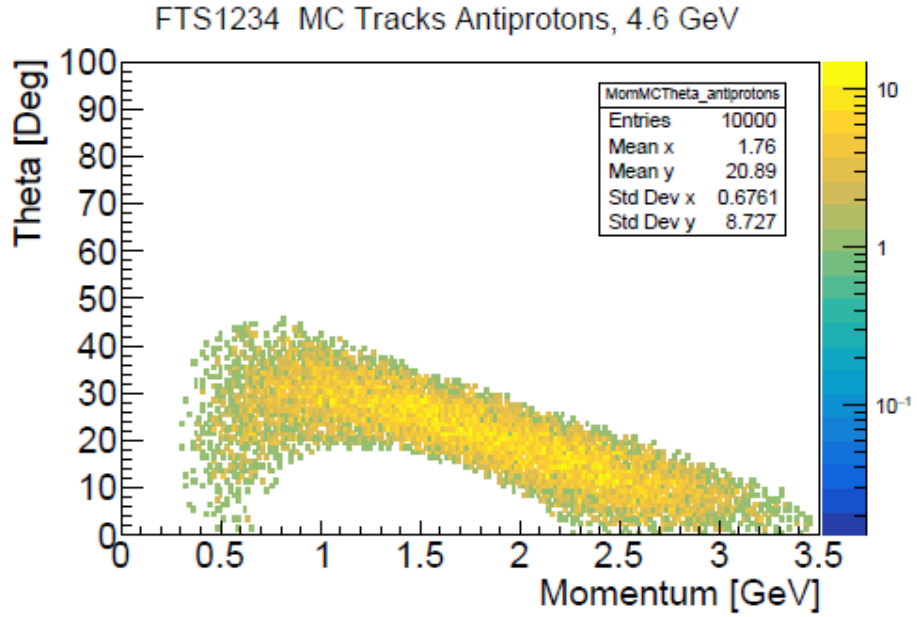

Pi Plus Reconstructed tracks FTS1256, 4.6 GeV
Radial momentum [GeV]
Z momentum [GeV]

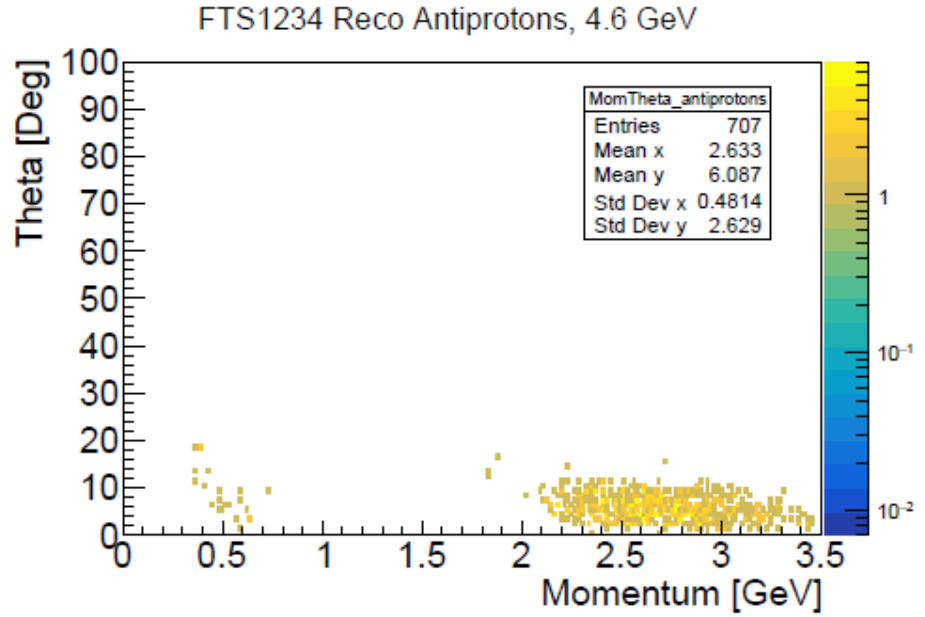

Final state particles MCTracks FTS1234, 4.6 GeV
MomMCTheta
Entries 60000
Mean x 0.8314
Mean y 25.61
Std Dev x 0.7822
Std Dev y 15.53
Theta [Deg]
Momentum [GeV]

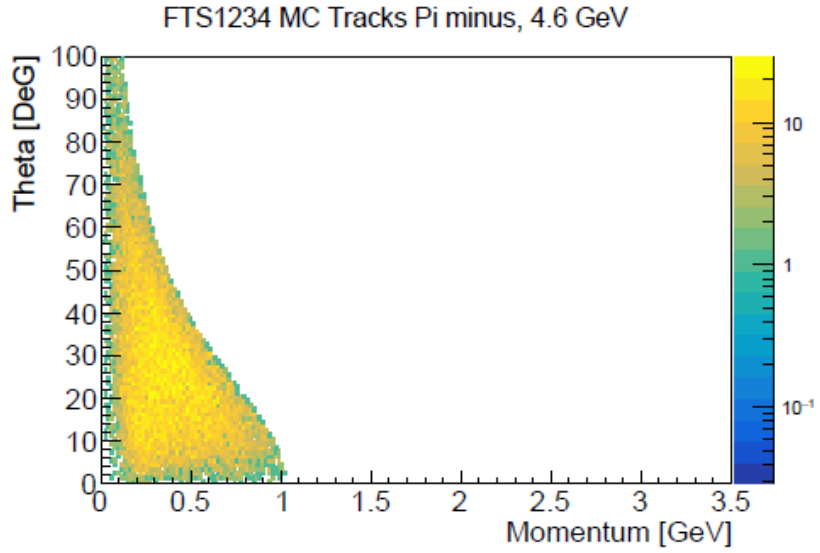

Final state particles Reco tracks FTS1234, 4.6 GeV
MomTheta
Entries 7952
Mean x 0.7813
Mean y 12.19
Std Dev x 0.9098
Std Dev y 8.801
Theta [Deg]
Momentum [GeV]


FTS1234 MC Tracks Protons, 4.6 GeV
MomMCTheta_protons
Entries 10000
Mean x 1.76
Mean y 20.89
Std Dev x 0.6785
Std Dev y 8.719
Theta [Deg]
Momentum [GeV]

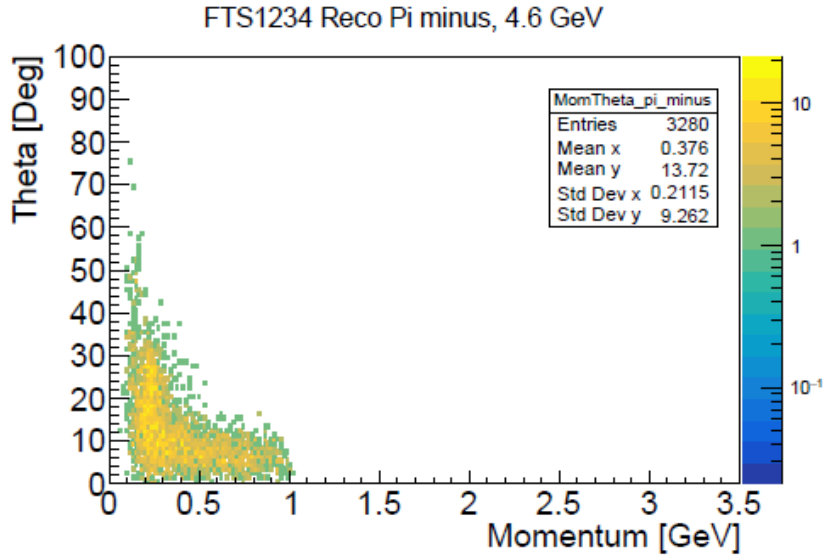

FTS1234 Reco Protons, 4.6 GeV
MomTheta_protons
Entries 732
Mean x 2.587
Mean y 6.307
Std Dev x 0.5832
Std Dev y 2.732
Theta [Deg]
Momentum [GeV]


FTS1234 MC Tracks Antiprotons, 4.6 GeV
MomMCTheta_antiprotons
Entries 10000
Mean x 1.76
Mean y 20.89
Std Dev x 0.6761
Std Dev y 8.727
Theta [Deg]
Momentum [GeV]

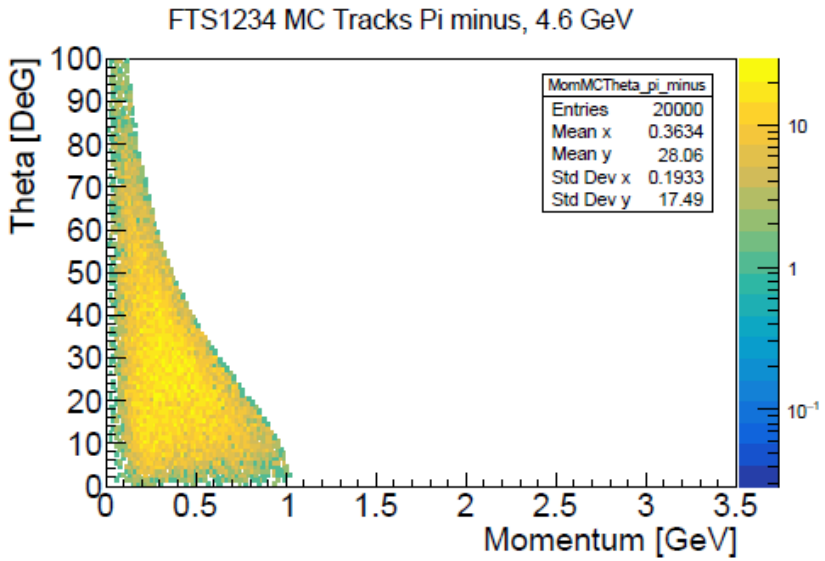

FTS1234 Reco Antiprotons, 4.6 GeV
MomTheta_antiprotons
Entries 707
Mean x 2.633
Mean y 6.087
Std Dev x 0.4814
Std Dev y 2.629
Theta [Deg]
Momentum [GeV]

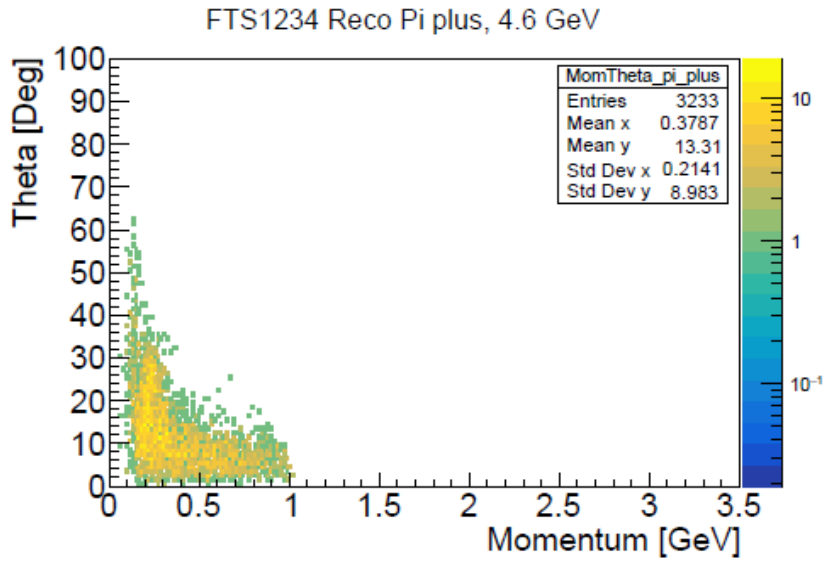

FTS1234 MC Tracks Pi minus, 4.6 GeV
Theta [DeG]
Momentum [GeV]

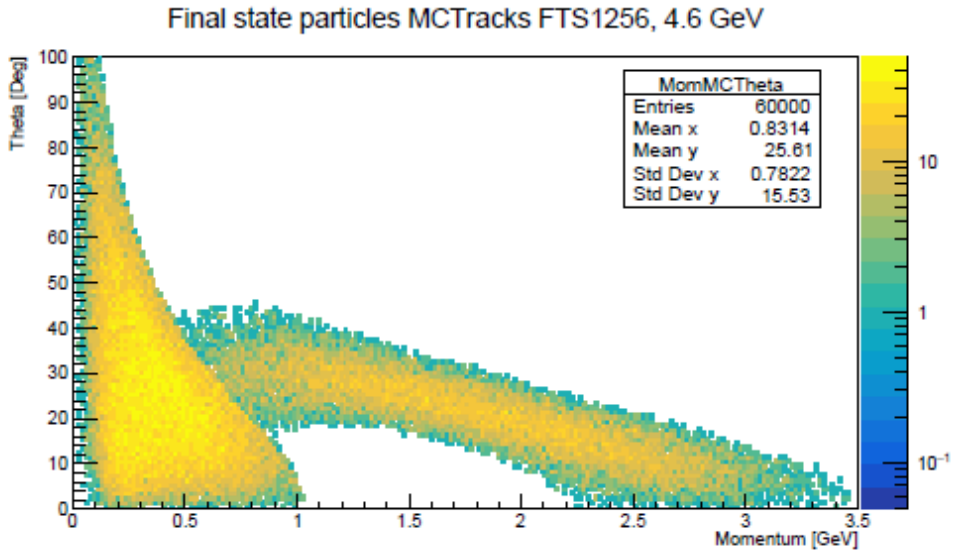
(g)


FTS1234 Reco Pi minus, 4.6 GeV
Theta [Deg]
Momentum [GeV]
MomTheta_pi_minus
Entries 3280
Mean x 0.376
Mean y 13.72
Std Dev x 0.2115
Std Dev y 9.262

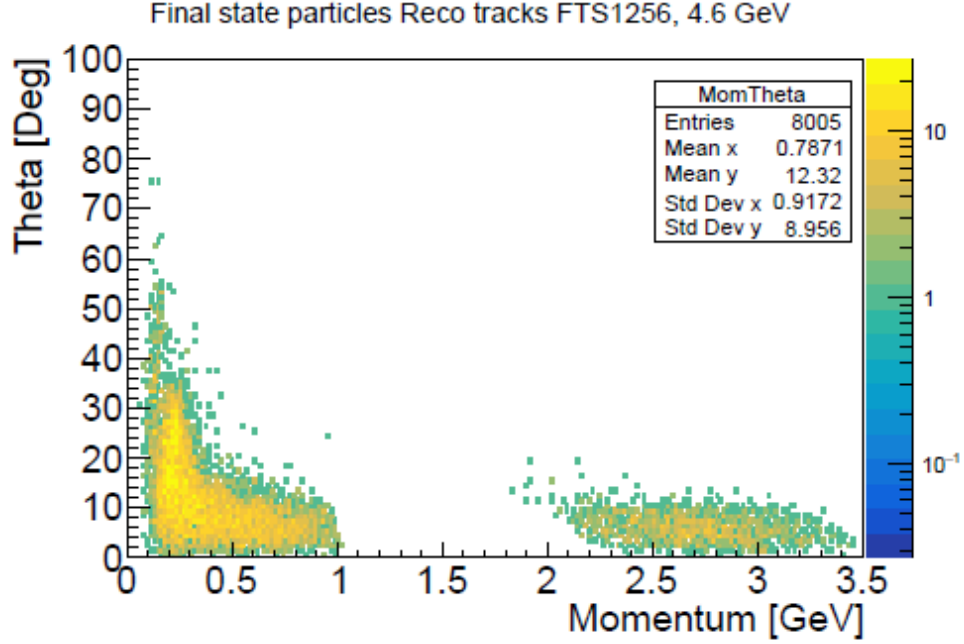
(h)


FTS1234 MC Tracks Pi minus, 4.6 GeV
Theta [DeG]
Momentum [GeV]
MomMCTheta_pi_minus
Entries 20000
Mean x 0.3634
Mean y 28.06
Std Dev x 0.1933
Std Dev y 17.49

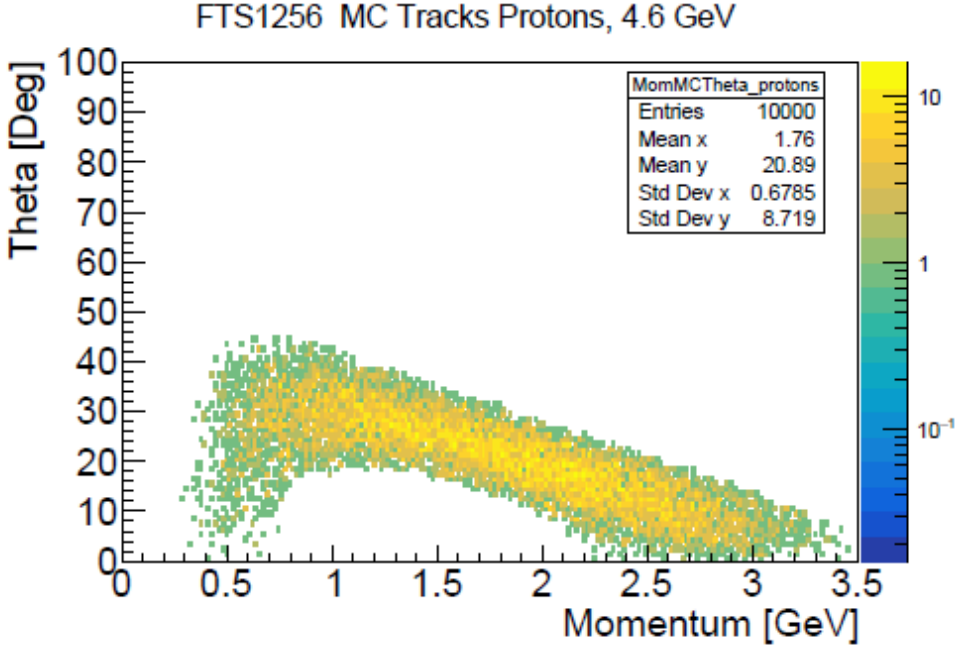

FTS1234 Reco Pi plus, 4.6 GeV
Theta [Deg]
Momentum [GeV]
MomTheta_pi_plus
Entries 3233
Mean x 0.3787
Mean y 13.31
Std Dev x 0.2141
Std Dev y 8.983

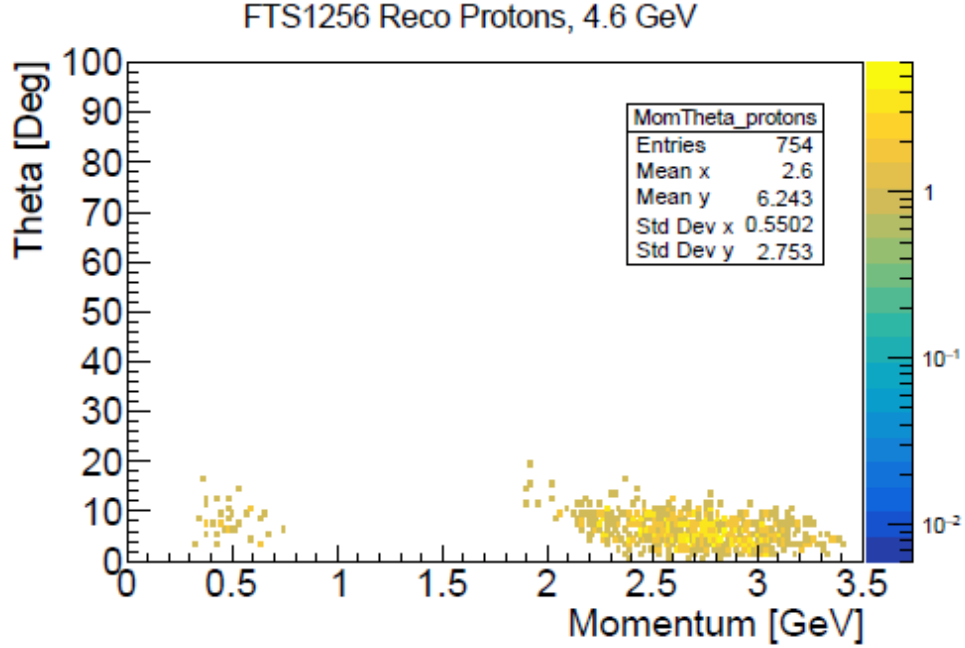

Final state particles MCTracks FTS1256, 4.6 GeV
MomMCTheta
Entries 60000
Mean x 0.8314
Mean y 25.61
Std Dev x 0.7822
Std Dev y 15.53
Theta [Deg]
Momentum [GeV]

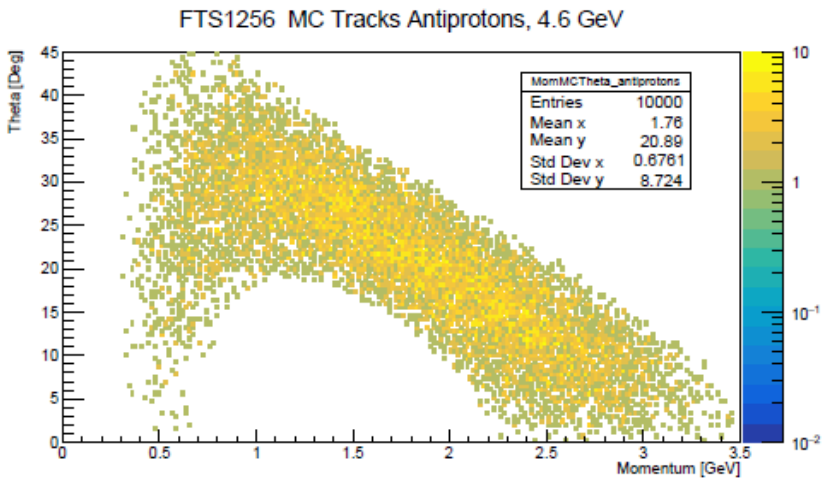
(a)


Final state particles Reco tracks FTS1256, 4.6 GeV
MomTheta
Entries 8005
Mean x 0.7871
Mean y 12.32
Std Dev x 0.9172
Std Dev y 8.956
Theta [Deg]
Momentum [GeV]

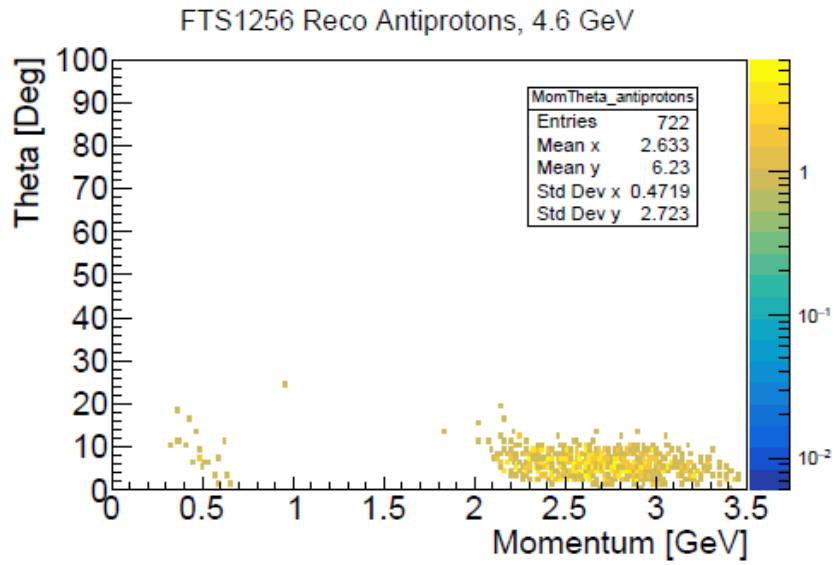
(b)


FTS1256 MC Tracks Protons, 4.6 GeV
MomMCTheta_protons
Entries 10000
Mean x 1.76
Mean y 20.89
Std Dev x 0.6785
Std Dev y 8.719
Theta [Deg]
Momentum [GeV]

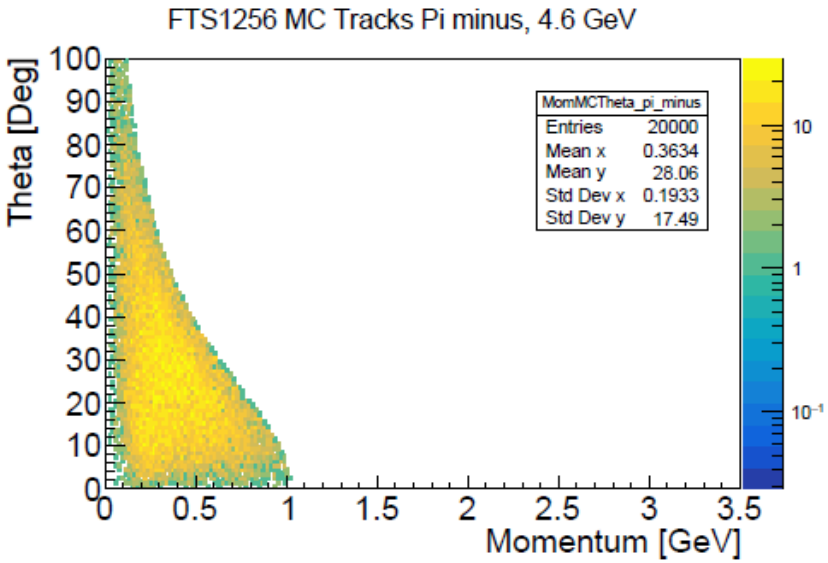

FTS1256 Reco Protons, 4.6 GeV
MomTheta_protons
Entries 754
Mean x 2.6
Mean y 6.243
Std Dev x 0.5502
Std Dev y 2.753
Theta [Deg]
Momentum [GeV]

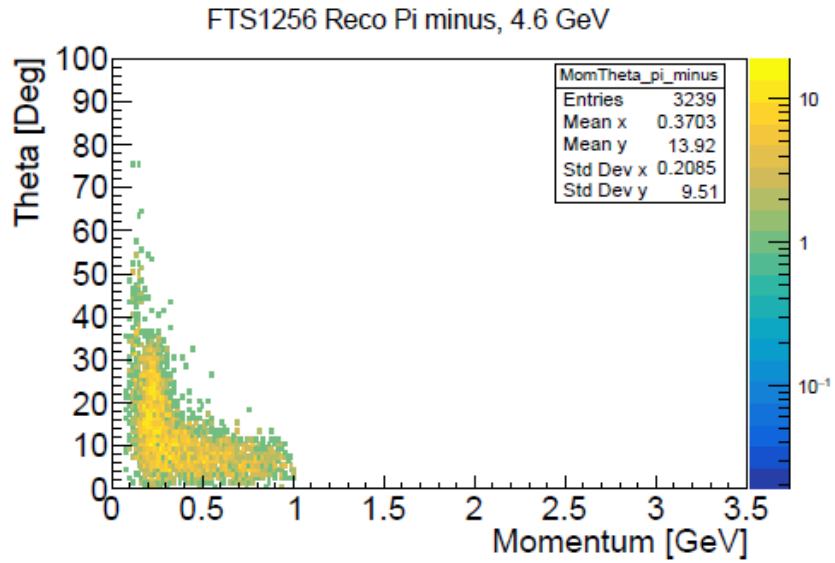

FTS1256 MC Tracks Antiprotons, 4.6 GeV
MomMCTheta_antiprotons
Entries 10000
Mean x 1.76
Mean y 20.89
Std Dev x 0.6761
Std Dev y 8.724
Theta [Deg]
Momentum [GeV]

(e)

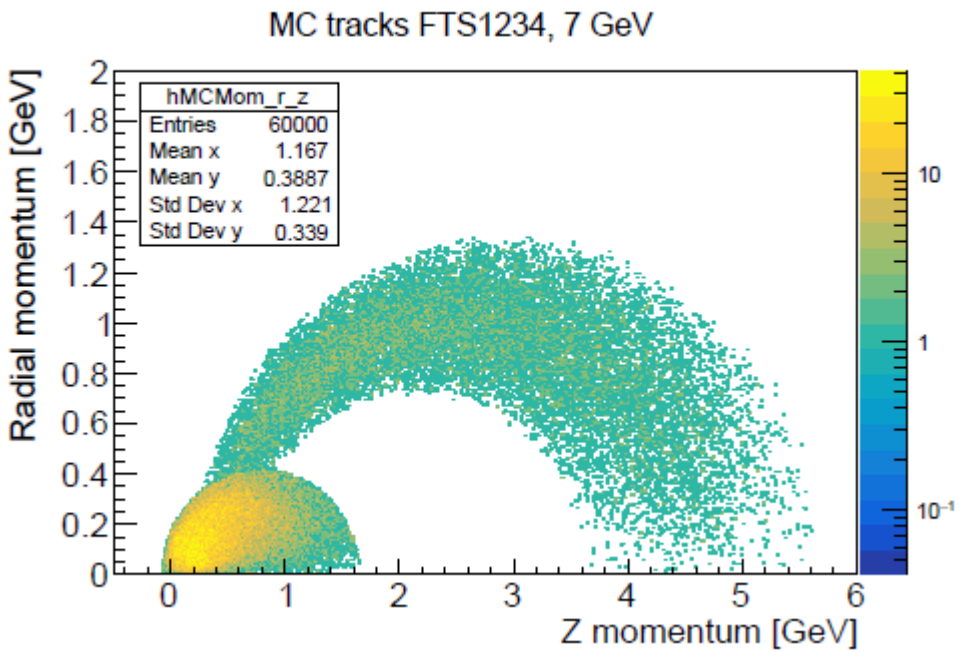

FTS1256 Reco Antiprotons, 4.6 GeV
MomTheta_antiprotons
Entries 722
Mean x 2.633
Mean y 6.23
Std Dev x 0.4719
Std Dev y 2.723
Theta [Deg]
Momentum [GeV]

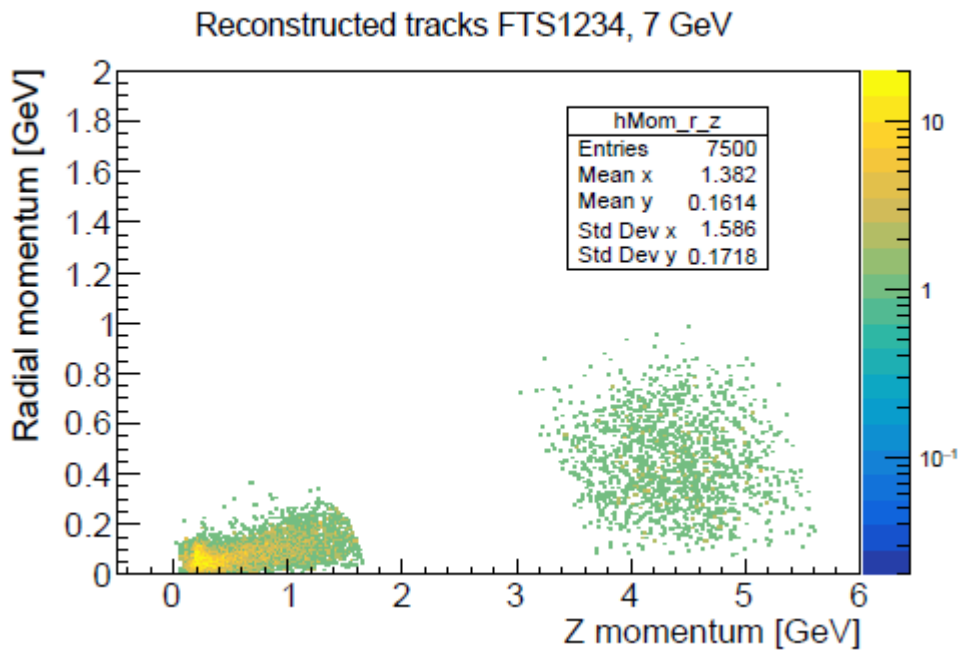
(f)

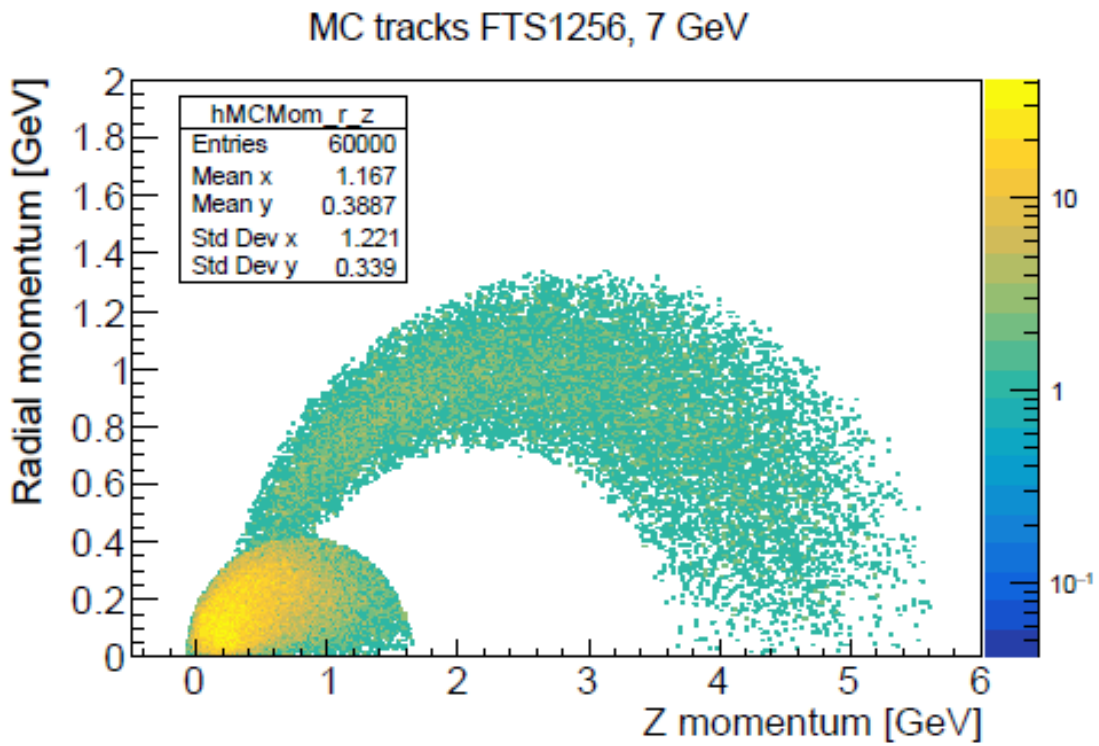

FTS1256 MC Tracks Pi minus, 4.6 GeV
MomMCTheta_pi_minus
Entries 20000
Mean x 0.3634
Mean y 28.06
Std Dev x 0.1933
Std Dev y 17.49
Theta [Deg]
Momentum [GeV]

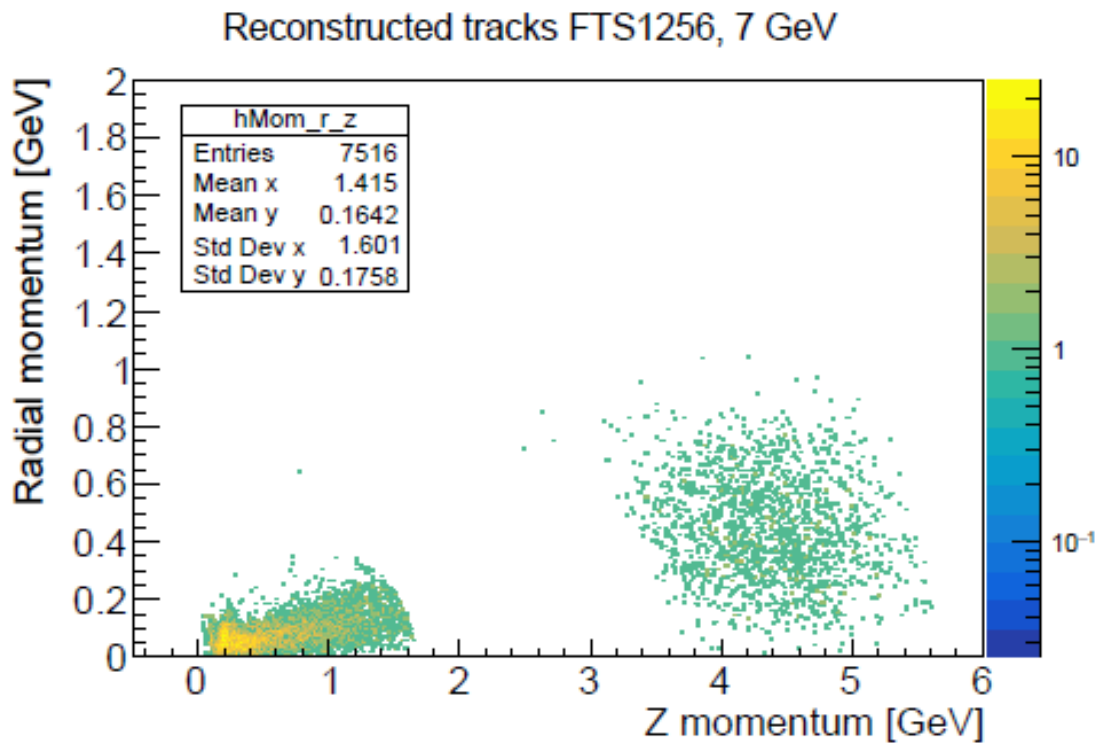

FTS1256 Reco Pi minus, 4.6 GeV
MomTheta_pi_minus
Entries 3239
Mean x 0.3703
Mean y 13.92
Std Dev x 0.2085
Std Dev y 9.51
Theta [Deg]
Momentum [GeV]

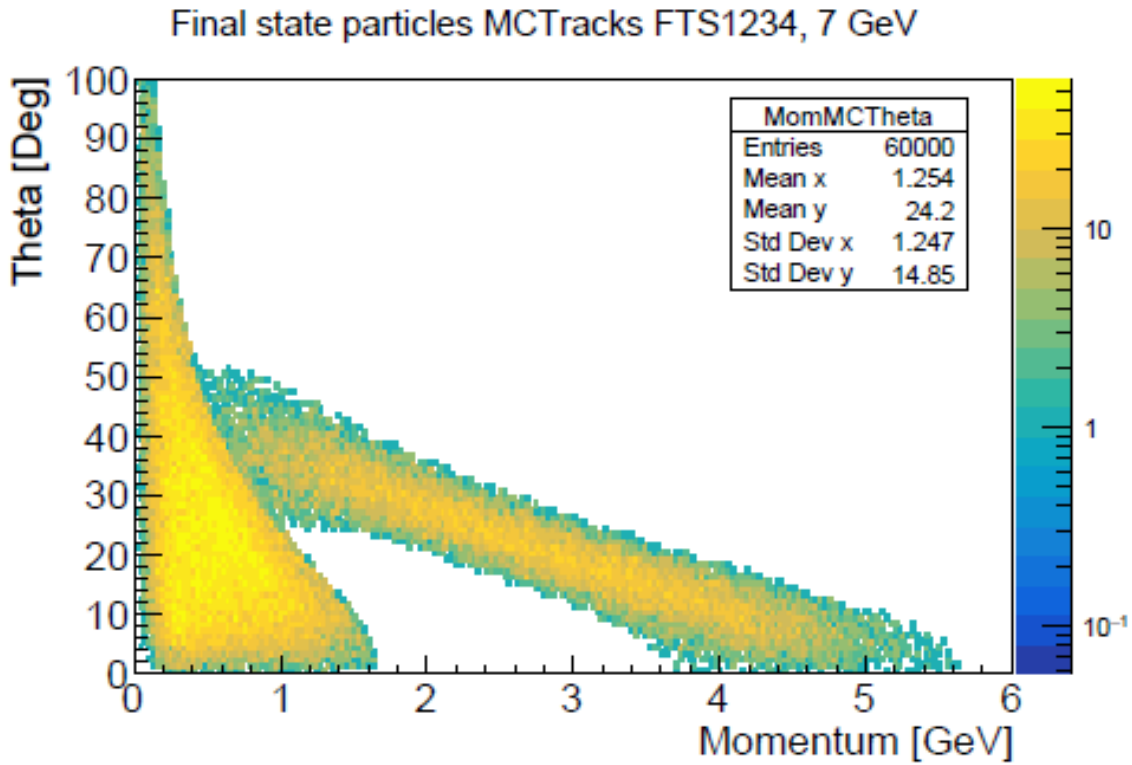
PARTIAL SET UPS 7 GeV

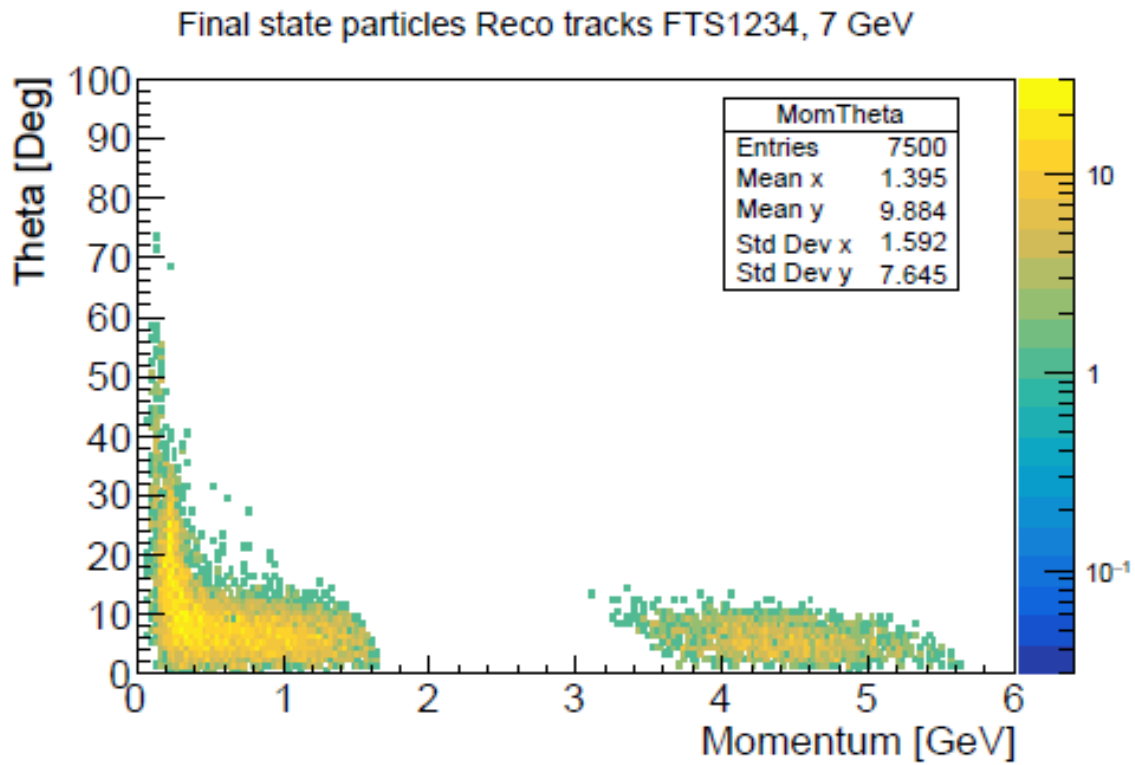

MC tracks FTS1234, 7 GeV
hMCMom_r_z
Entries 60000
Mean x 1.167
Mean y 0.3887
Std Dev x 1.221
Std Dev y 0.339
Radial momentum [GeV]
Z momentum [GeV]

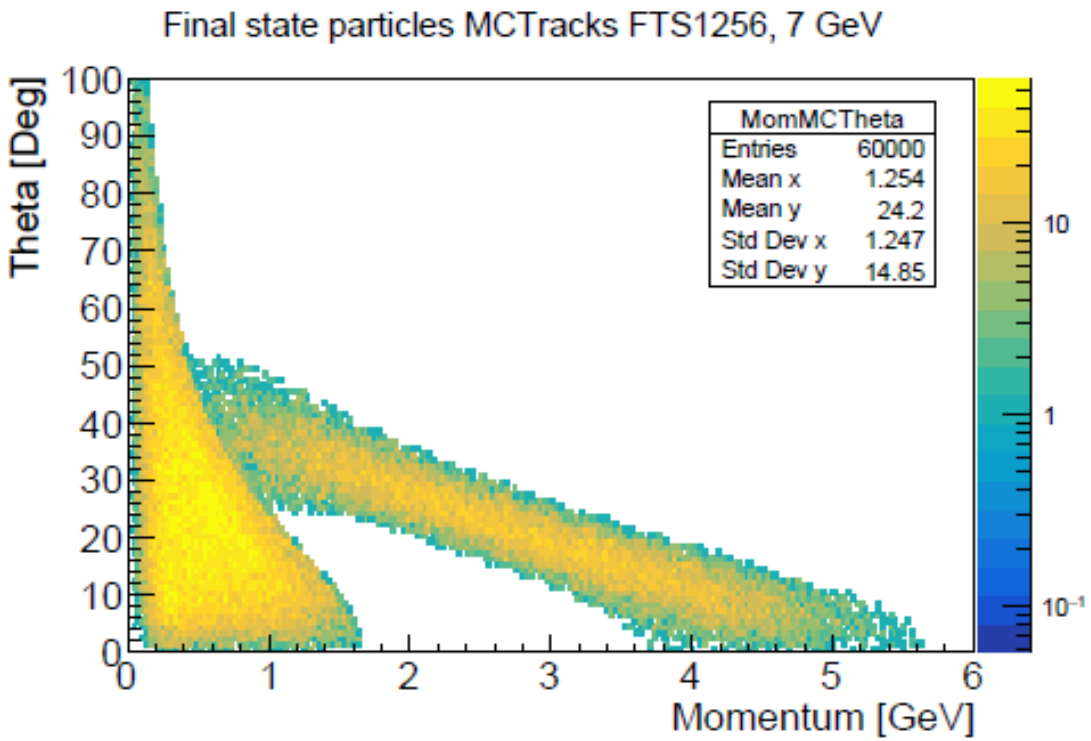

Reconstructed tracks FTS1234, 7 GeV
hMom_r_z
Entries 7500
Mean x 1.382
Mean y 0.1614
Std Dev x 1.586
Std Dev y 0.1718
Radial momentum [GeV]
Z momentum [GeV]

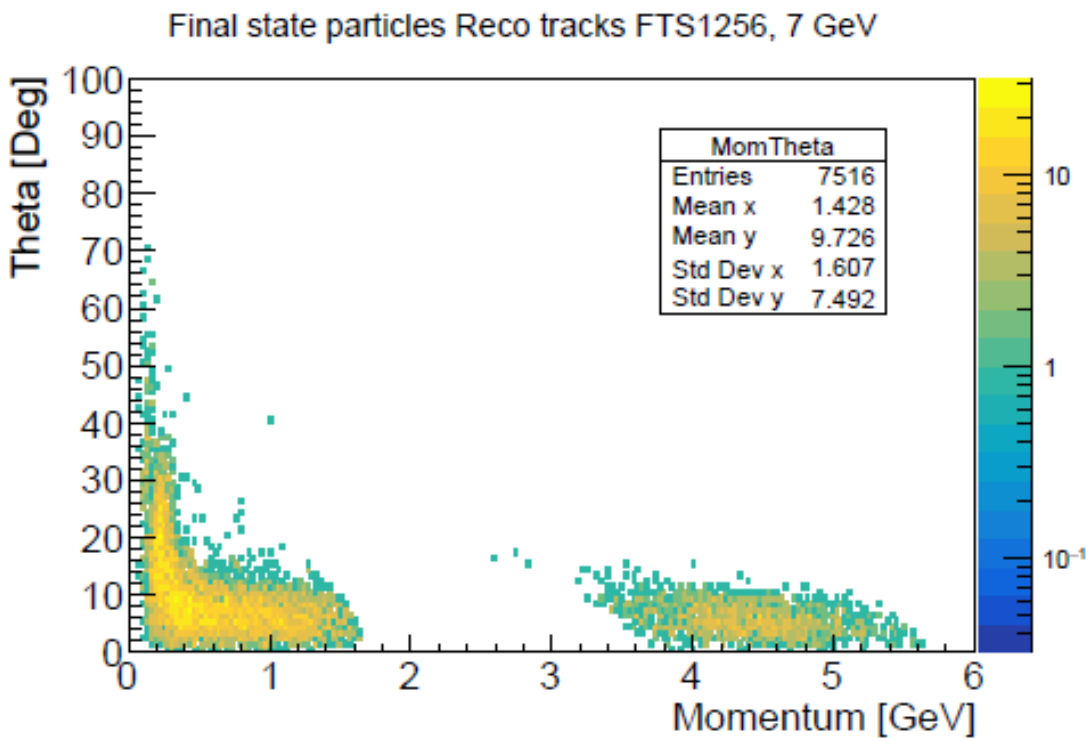

MC tracks FTS1256, 7 GeV
hMCMom_r_z
Entries 60000
Mean x 1.167
Mean y 0.3887
Std Dev x 1.221
Std Dev y 0.339
Radial momentum [GeV]
Z momentum [GeV]


Reconstructed tracks FTS1256, 7 GeV
hMom_r_z
Entries 7516
Mean x 1.415
Mean y 0.1642
Std Dev x 1.601
Std Dev y 0.1758
Radial momentum [GeV]
Z momentum [GeV]


Final state particles MCTracks FTS1234, 7 GeV
MomMCTheta
Entries 60000
Mean x 1.254
Mean y 24.2
Std Dev x 1.247
Std Dev y 14.85
Theta [Deg]
Momentum [GeV]


Final state particles Reco tracks FTS1234, 7 GeV
MomTheta
Entries 7500
Mean x 1.395
Mean y 9.884
Std Dev x 1.592
Std Dev y 7.645
Theta [Deg]
Momentum [GeV]


Final state particles MCTracks FTS1256, 7 GeV
MomMCTheta
Entries 60000
Mean x 1.254
Mean y 24.2
Std Dev x 1.247
Std Dev y 14.85
Theta [Deg]
Momentum [GeV]


Final state particles Reco tracks FTS1256, 7 GeV
MomTheta
Entries 7516
Mean x 1.428
Mean y 9.726
Std Dev x 1.607
Std Dev y 7.492
Theta [Deg]
Momentum [GeV]

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Total of reconstructed final state particles		
Set up	4.6 GeV	7 GeV
FTS1234	7,952	7,500
FTS1256	8,005	7,516
FTSFull	7,523	7,305

Tracks with at least 1 hit at GEM			
Beam mom	FTS1234	FTS1256	FTSFULL
4.6 GeV	7540	7583	7301
7 GeV	6951	6927	6974

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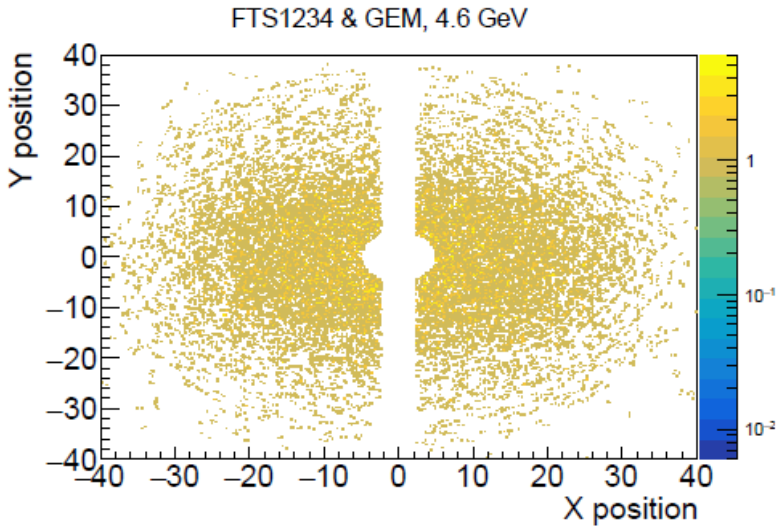
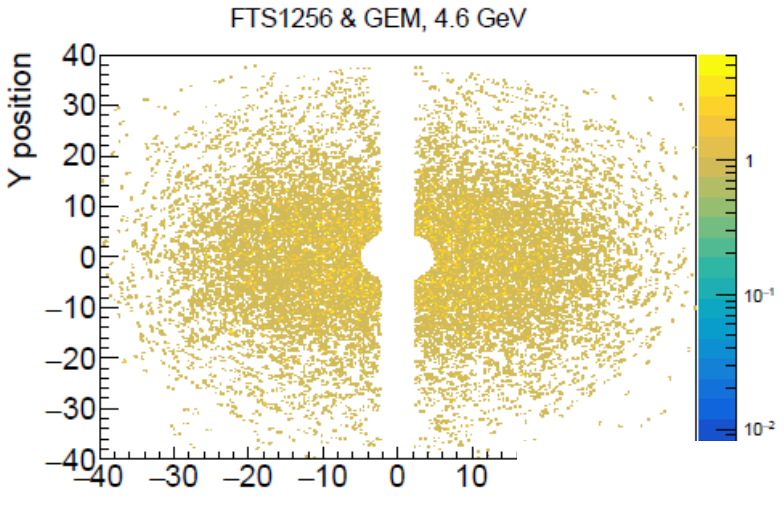
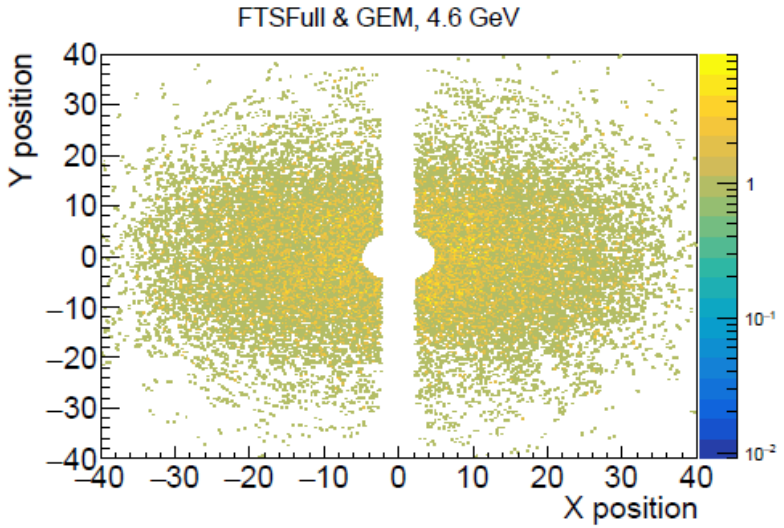


(a)

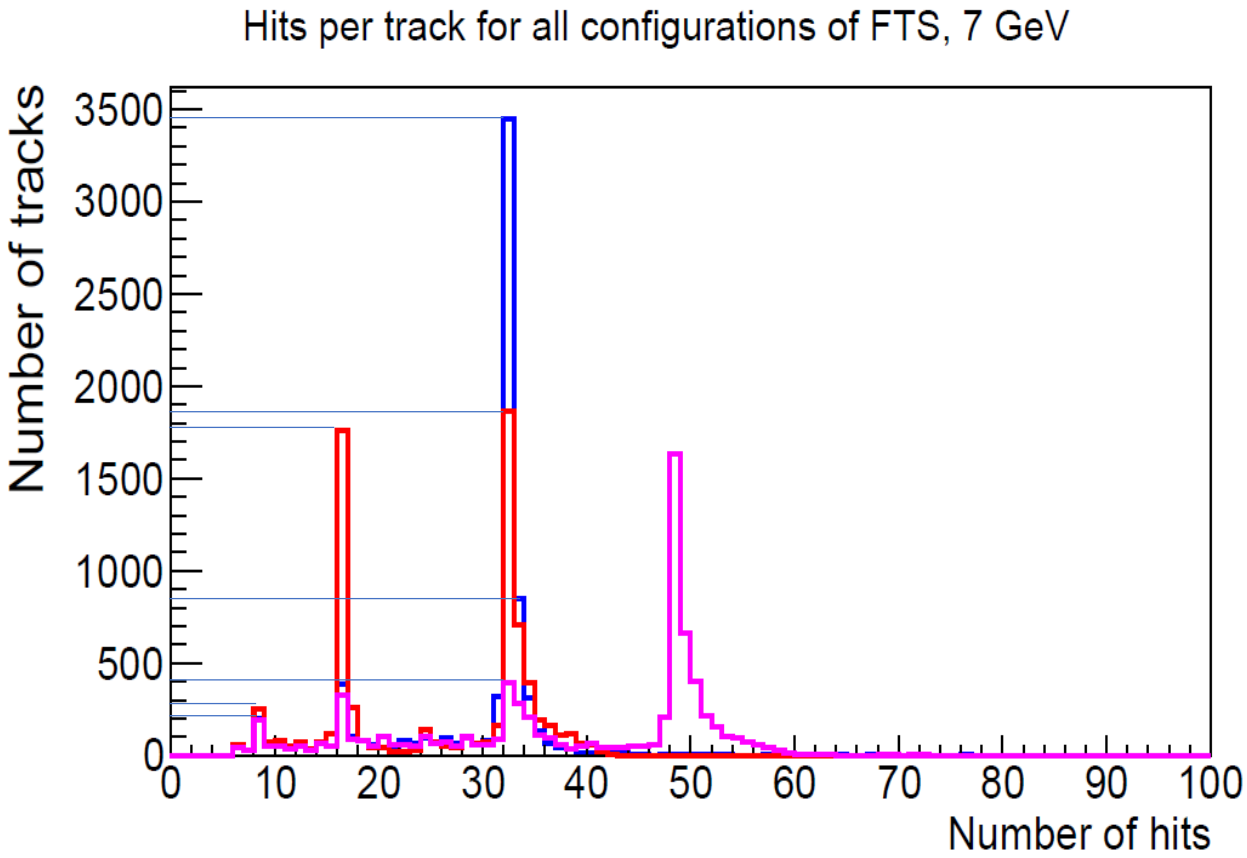


(b)



Tracks with at least 1 hit at GEM			
Beam mom	FTS1234	FTS1256	FTSFULL
4.6 GeV	7540	7583	7301
7 GeV	6951	6927	6974

BEAM MOMENTUM: 7 GeV

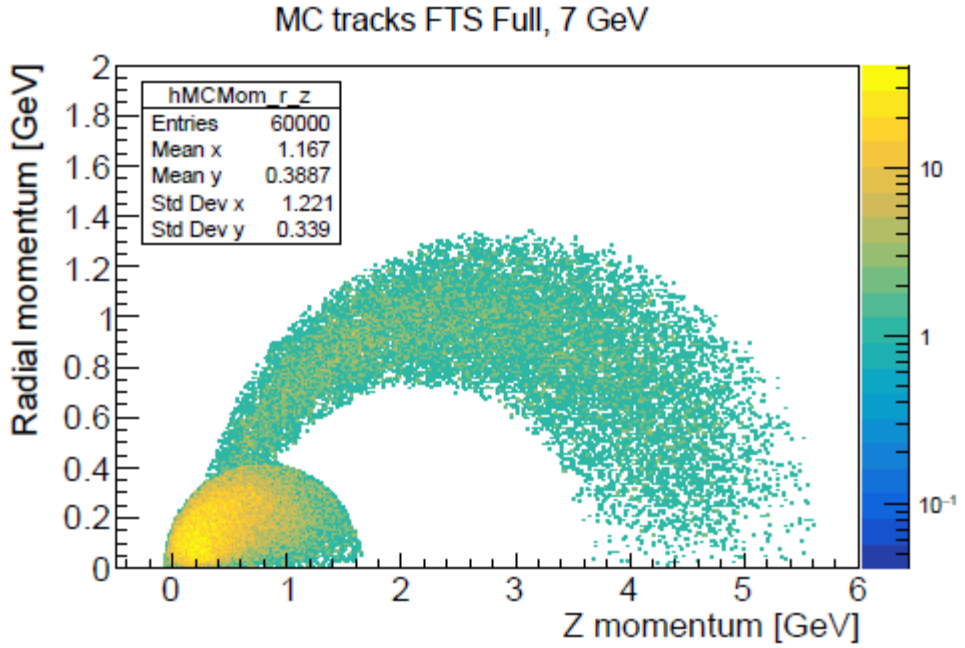


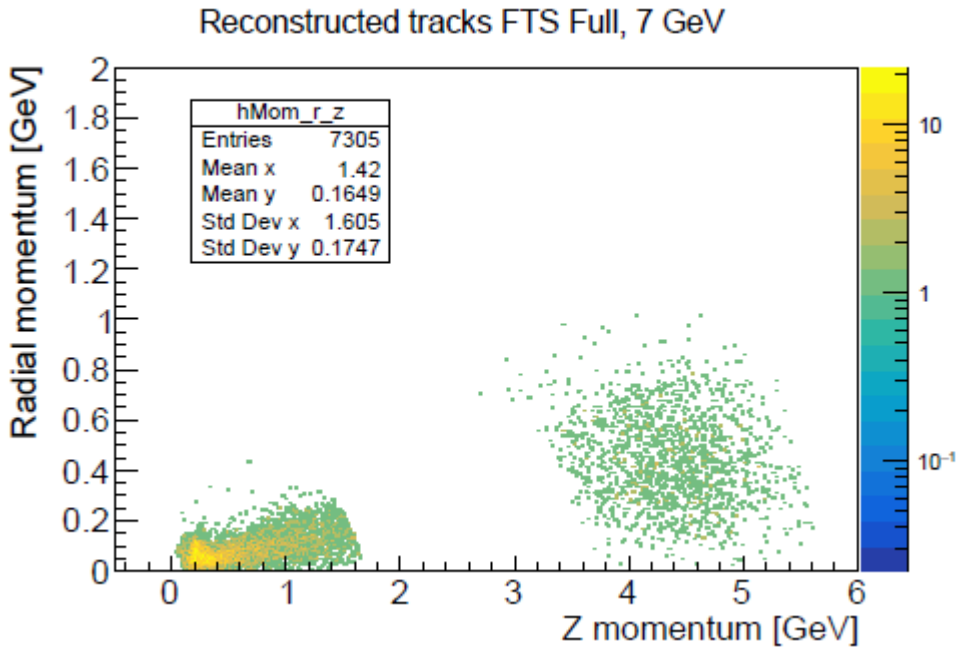
- Blue – FTS1234: Most of the tracks hit the 4 stations
- Red – FTS1256: Tracks get stuck after first station or they go through the four stations.
- Magenta – FTSFull: Most tracks have hits in the six stations.

Longitudinal vs radial momentum

Comparison between **simulated** and **reconstructed tracks**, full set up:

- No reconstructed tracks with Pt $>$ 1 GeV.
- Tracks reconstructed if:
  - **0 $<$ Pz $<$ 2 GeV** & **3 $<$ Pz $<$ 6 GeV**
  - **0 $<$ Pt $<$ 1 GeV**
- Same situation for partial set ups.





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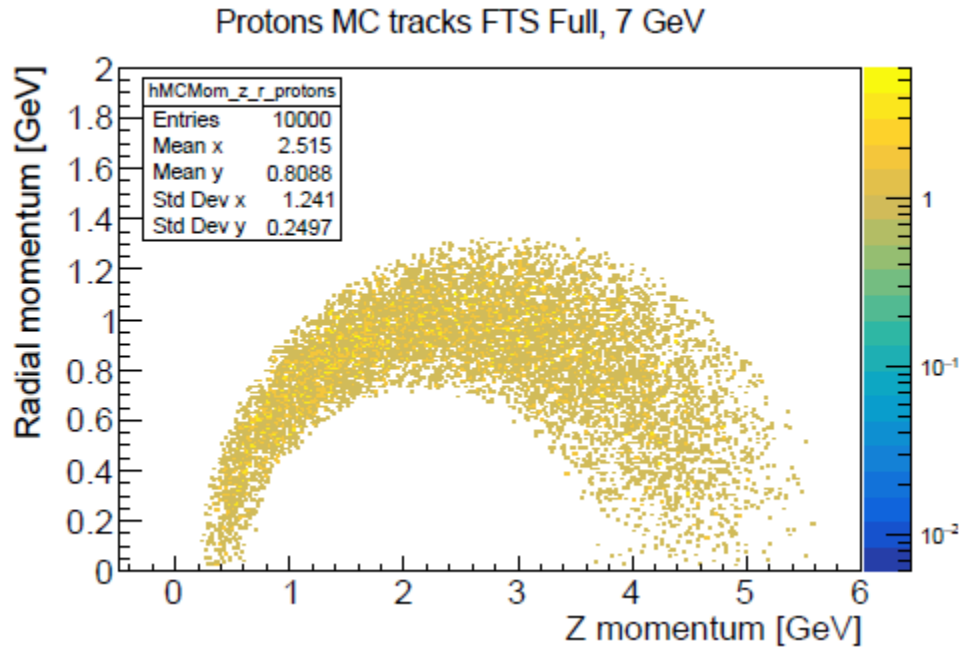
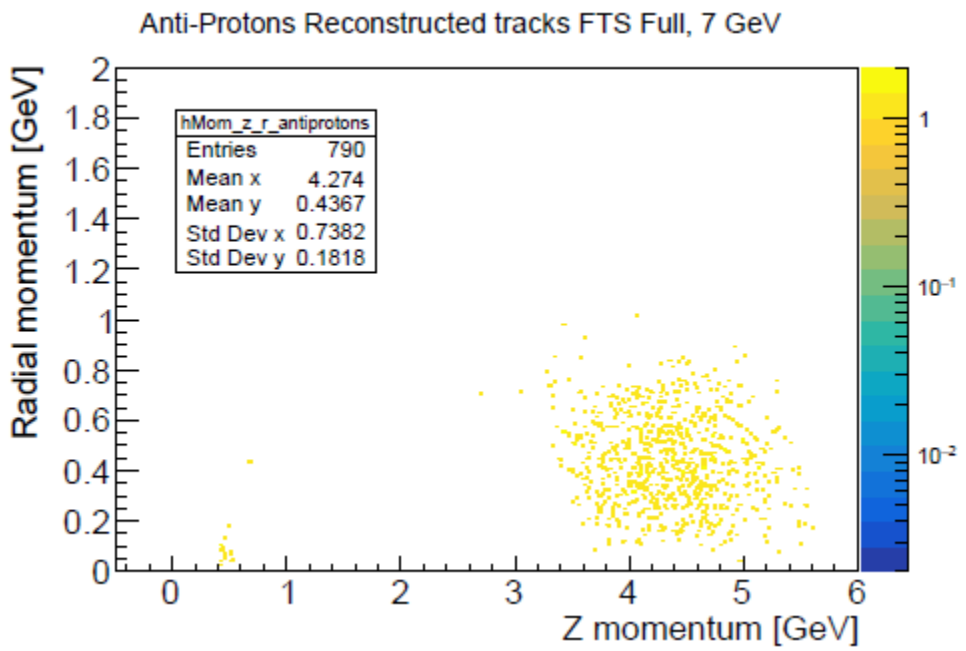
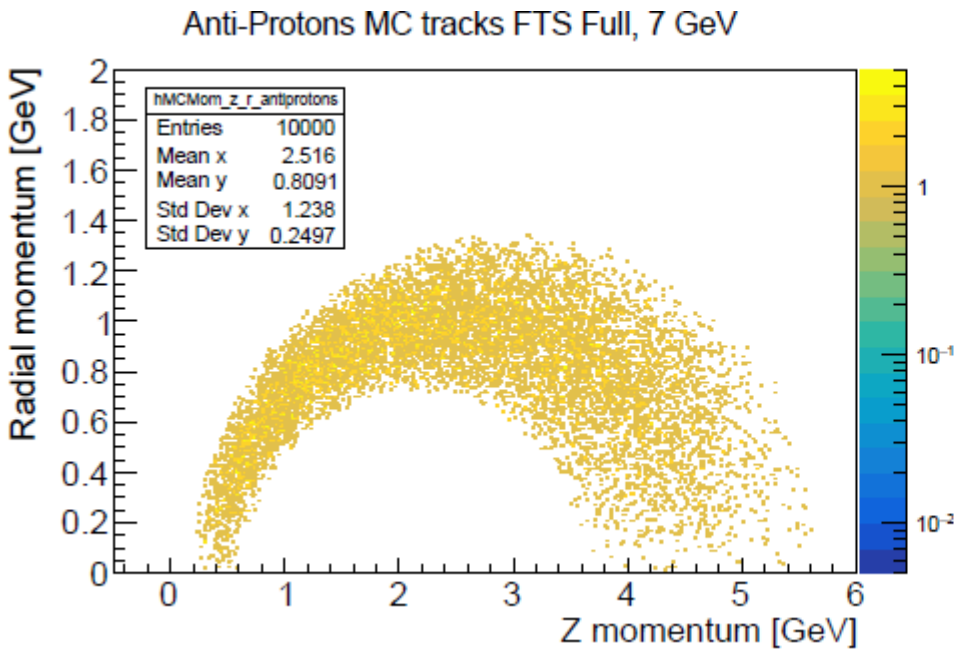
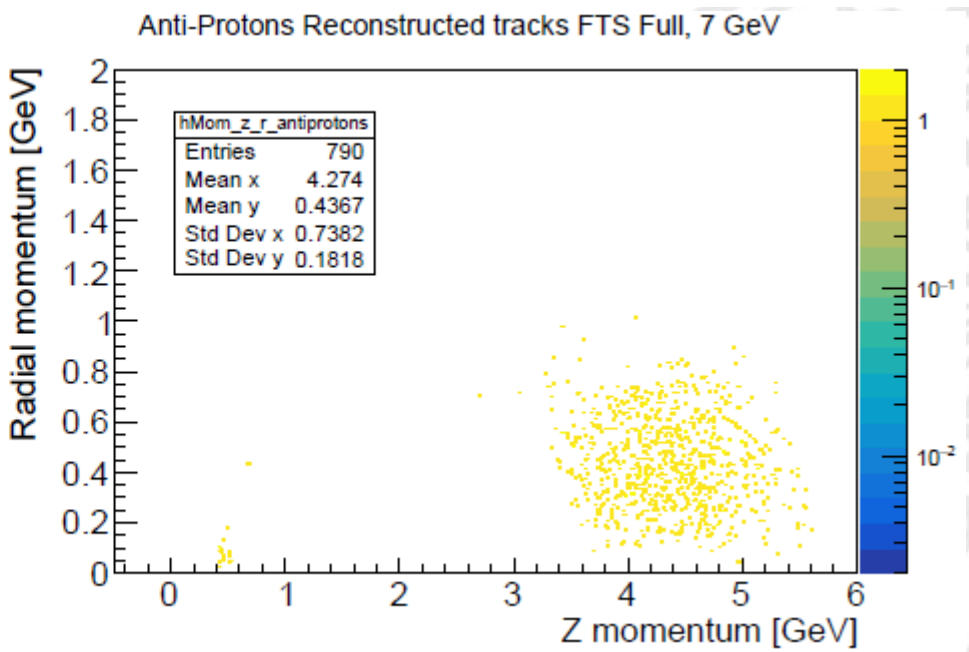
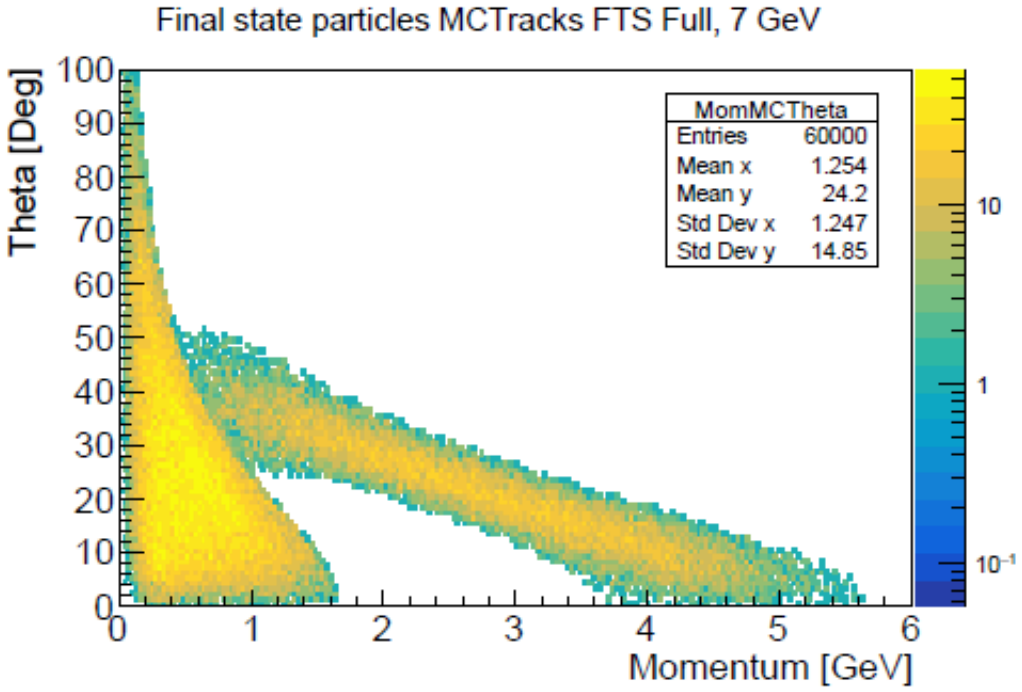
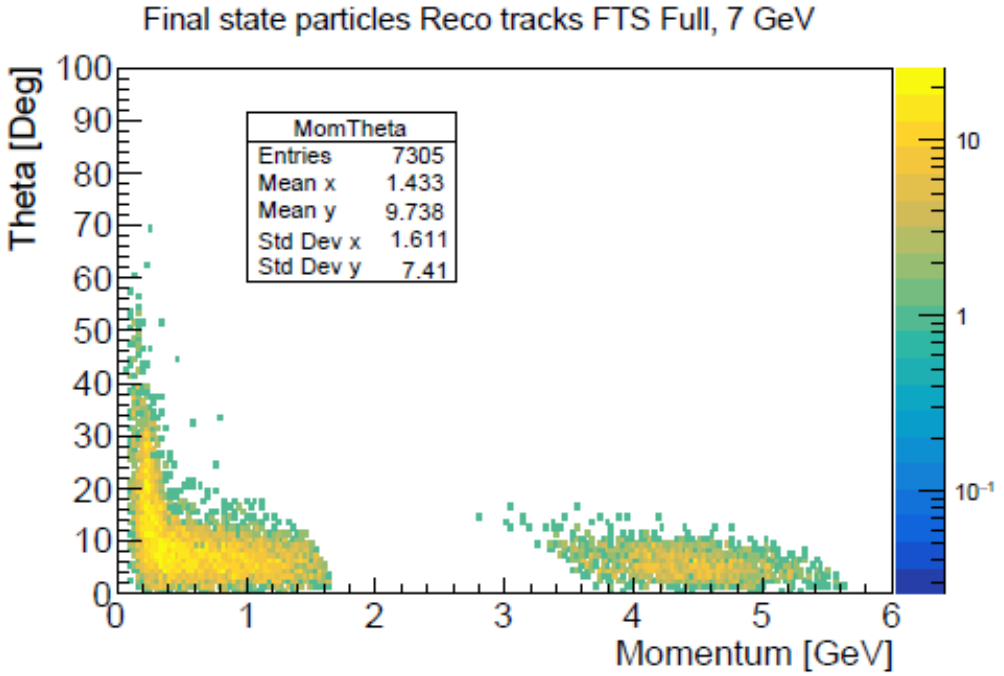






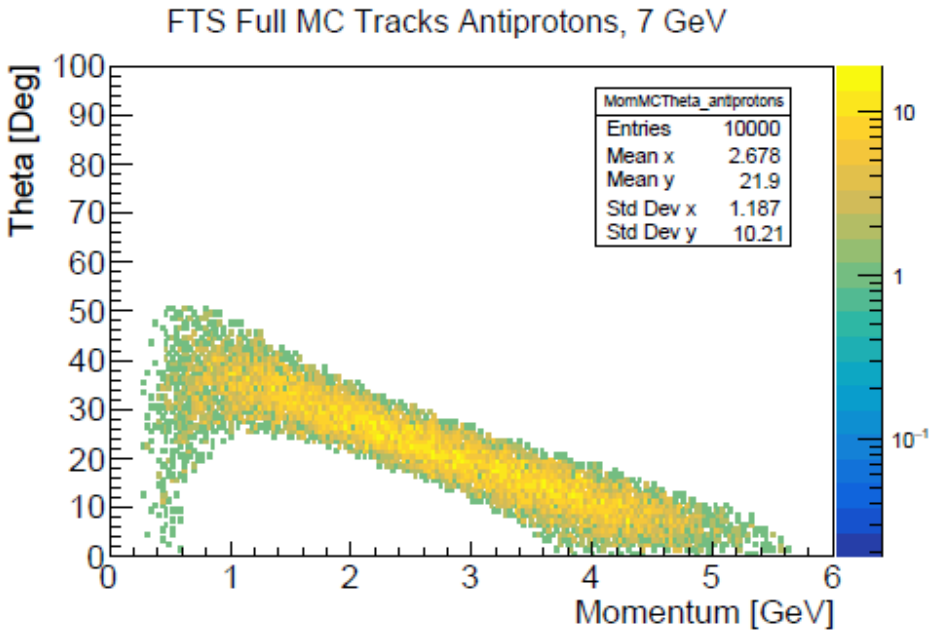




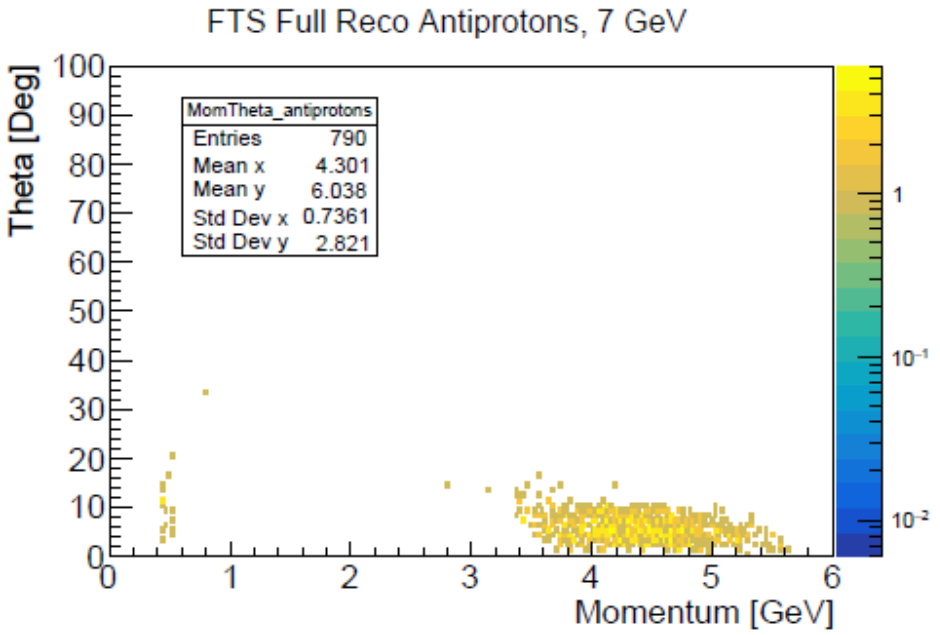


Comparisson between **simulated** and **reconstructed tracks**, full set up:

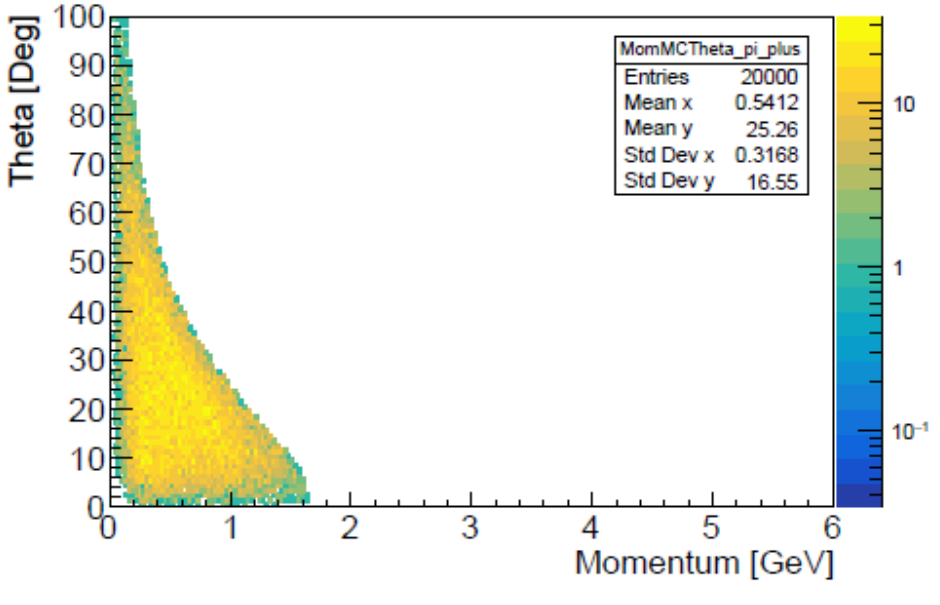
- Few tracks reconstructed at $\boldsymbol{\theta > 60°}$.
- Most tracks reconstructed at $\boldsymbol{\theta < 20°}$.
- **Same** situation in **partial** set ups.

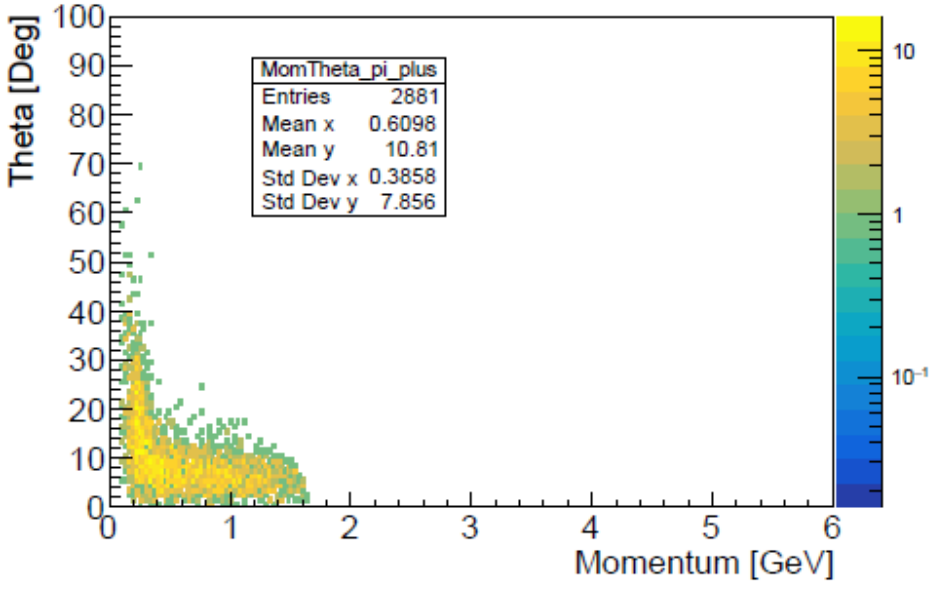

FTS Full MC Tracks Antiprotons, 7 GeV
MomMCTheta_antiprotons
Entries 10000
Mean x 2.678
Mean y 21.9
Std Dev x 1.187
Std Dev y 10.21
Theta [Deg]
Momentum [GeV]

(e)


FTS Full Reco Antiprotons, 7 GeV
MomTheta_antiprotons
Entries 790
Mean x 4.301
Mean y 6.038
Std Dev x 0.7361
Std Dev y 2.821
Theta [Deg]
Momentum [GeV]

(f)


FTS Full MC Tracks Pi plus, 7 GeV
MomMCTheta_pi_plus
Entries 20000
Mean x 0.5412
Mean y 25.26
Std Dev x 0.3168
Std Dev y 16.55
Theta [Deg]
Momentum [GeV]


FTS Full Reco Pi plus, 7 GeV
MomTheta_pi_plus
Entries 2881
Mean x 0.6098
Mean y 10.81
Std Dev x 0.3858
Std Dev y 7.856
Theta [Deg]
Momentum [GeV]

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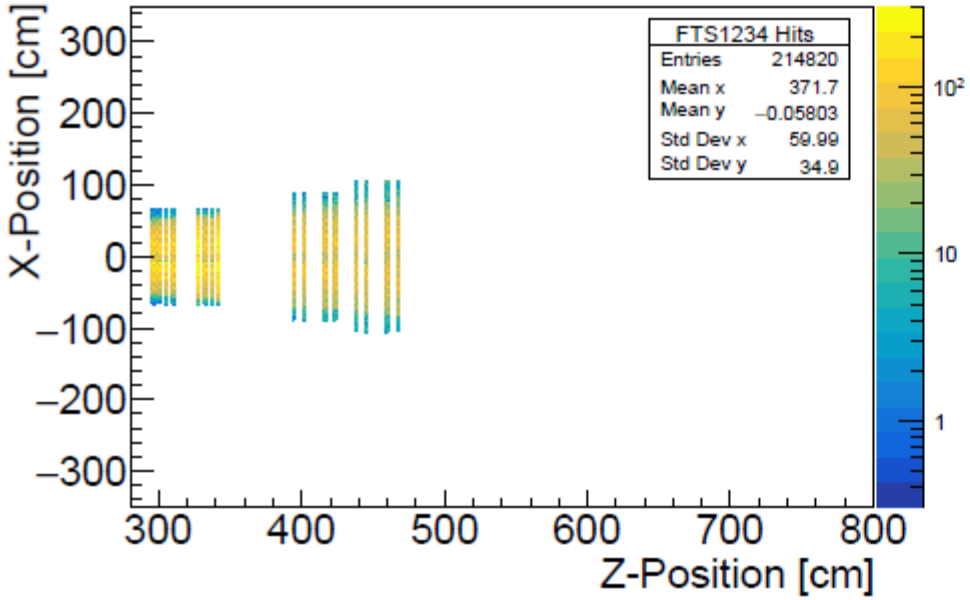
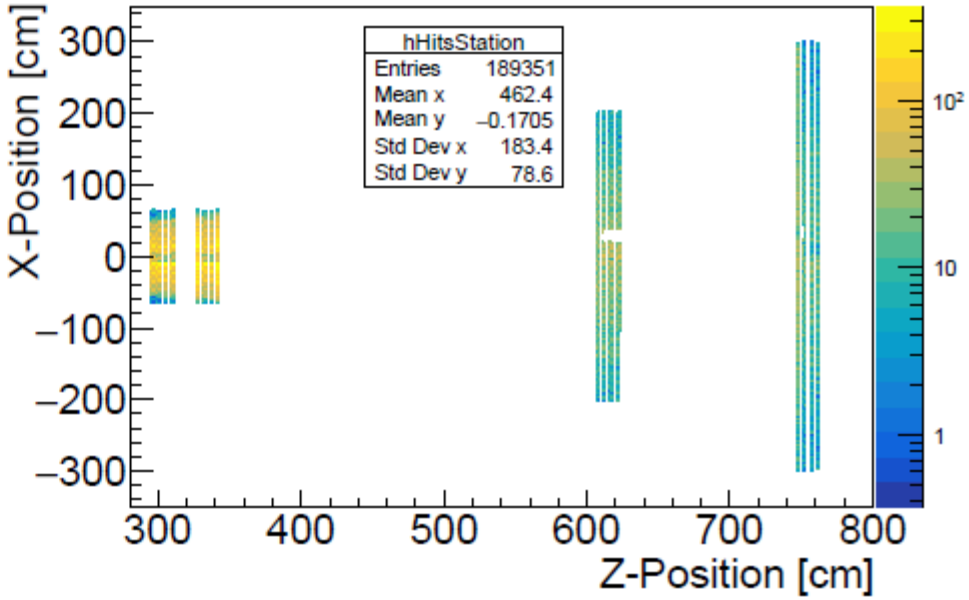
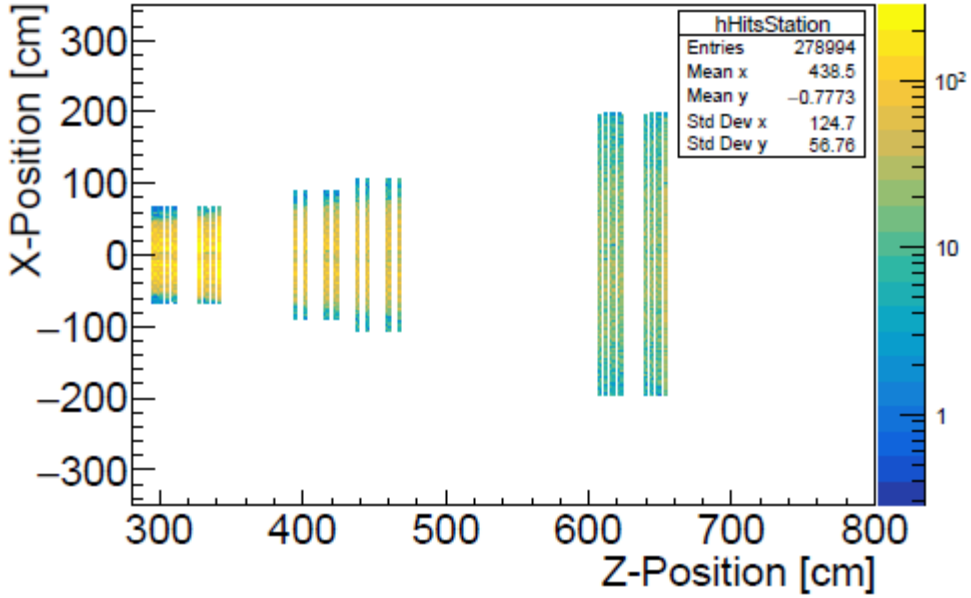
FTS1234 Stations illumination, 7 GeV

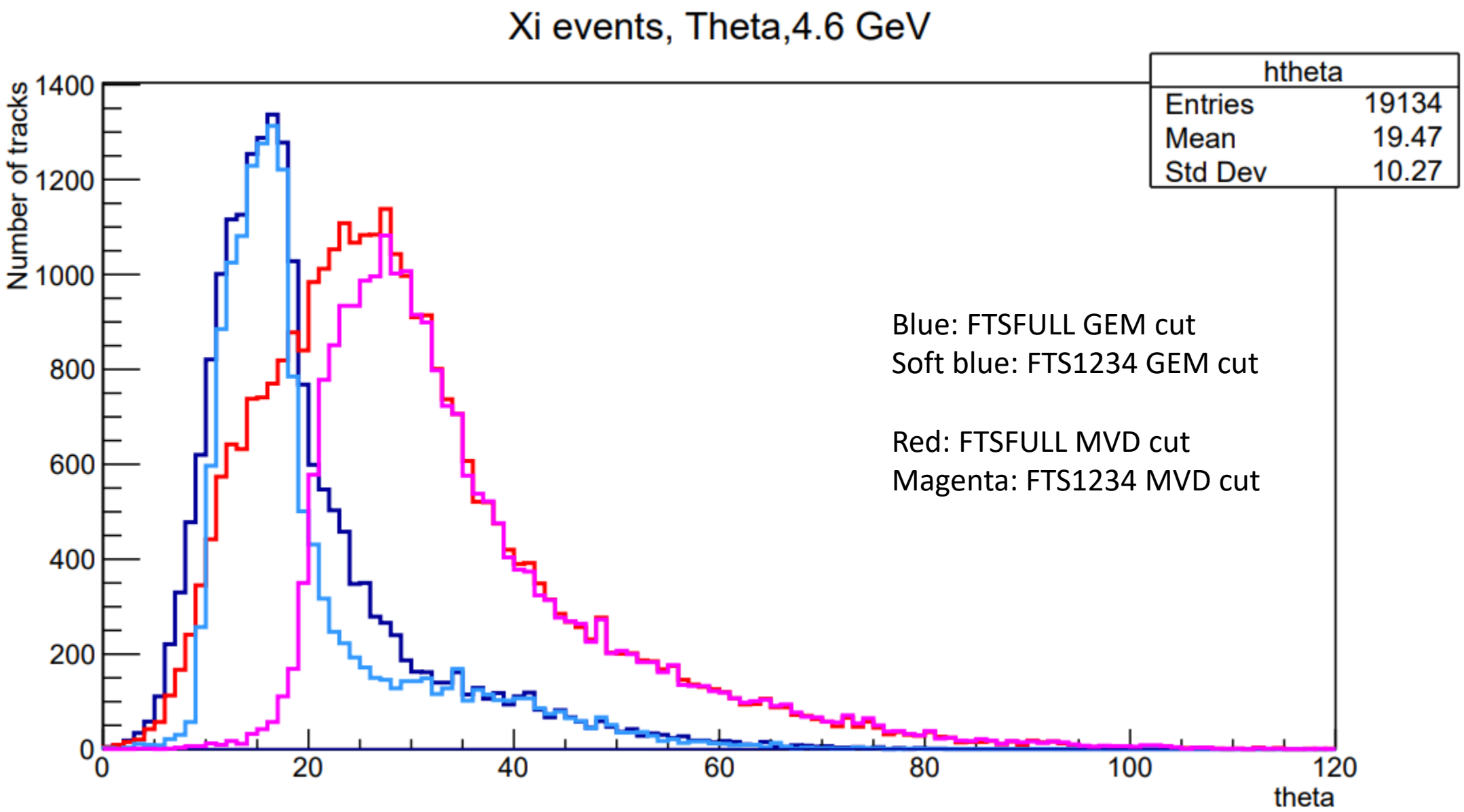


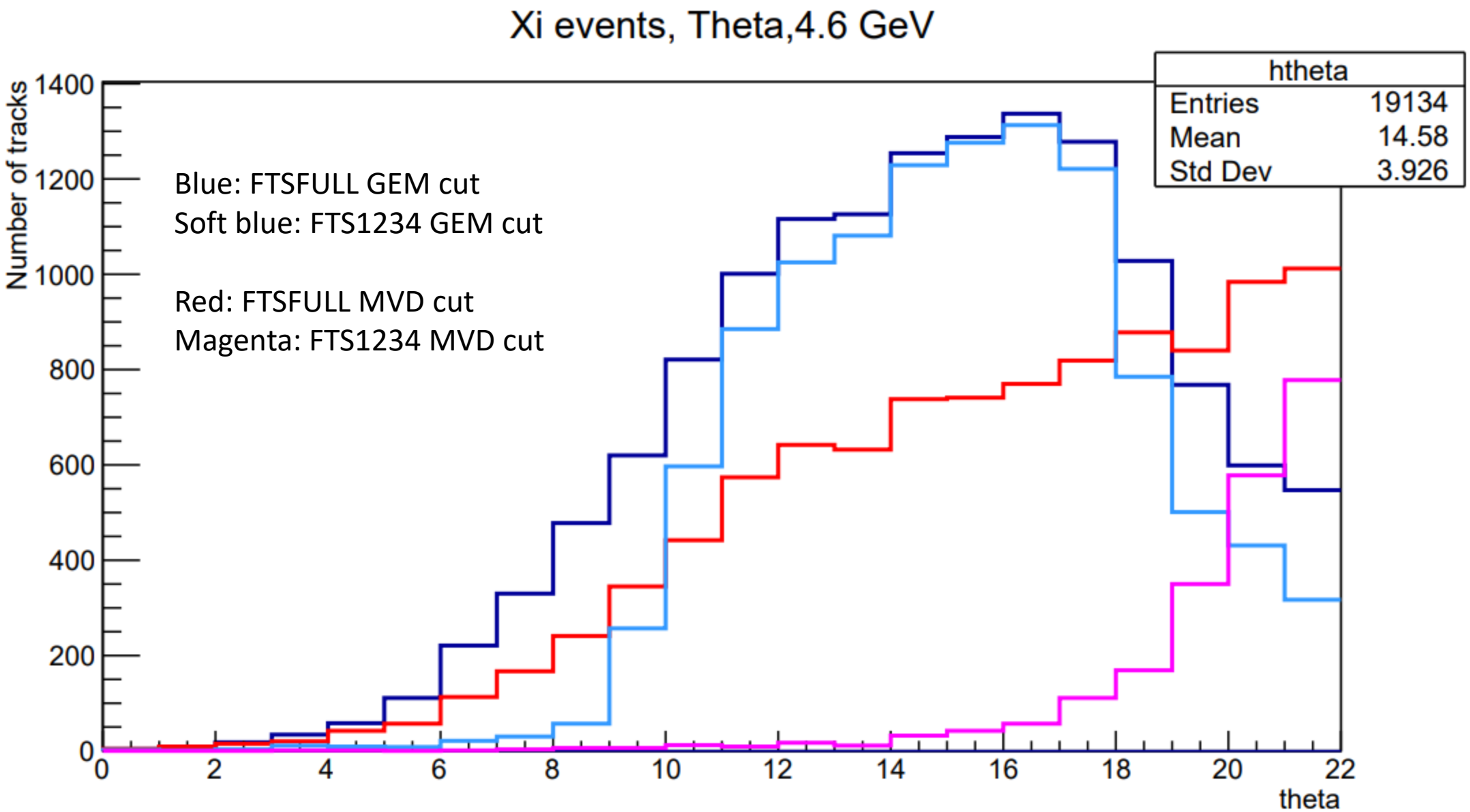
FTS1256 Stations illumination, 7 GeV

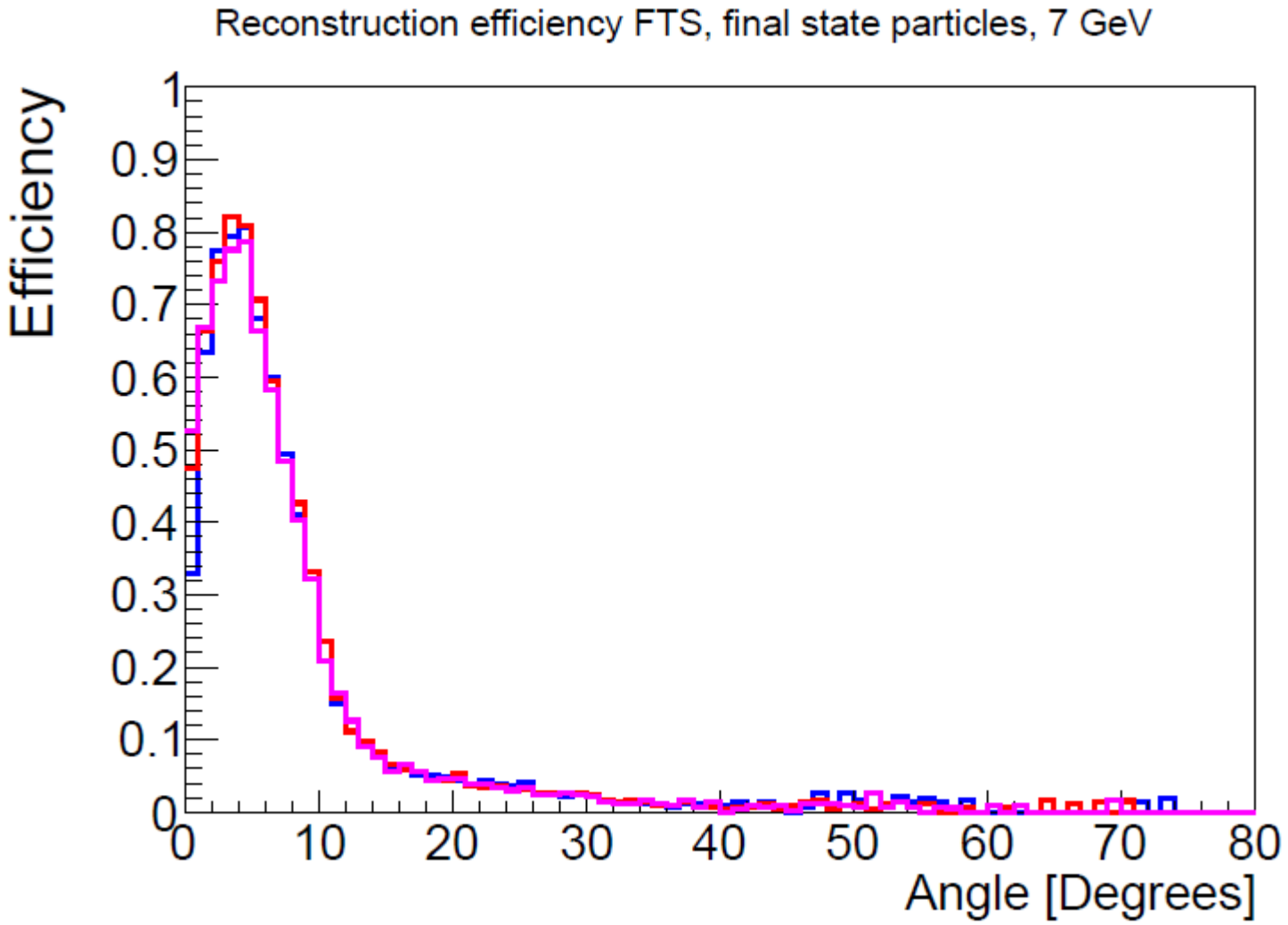


FTSFULL Stations illumination, 7 GeV




Xi events, Theta,4.6 GeV
htheta
Entries 19134
Mean 19.47
Std Dev 10.27
Number of tracks
1400
1200
1000
800
600
400
200
0
0
20
40
60
80
100
120
theta
Blue: FTSFULL GEM cut
Soft blue: FTS1234 GEM cut
Red: FTSFULL MVD cut
Magenta: FTS1234 MVD cut


Xi events, Theta,4.6 GeV
htheta
Entries 19134
Mean 14.58
Std Dev 3.926
Blue: FTSFULL GEM cut
Soft blue: FTS1234 GEM cut
Red: FTSFULL MVD cut
Magenta: FTS1234 MVD cut
Number of tracks
0
200
400
600
800
1000
1200
1400
0
2
4
6
8
10
12
14
16
18
20
22
theta


Reconstruction efficiency FTS, final state particles, 7 GeV
Efficiency
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
60
70
80
Angle [Degrees]

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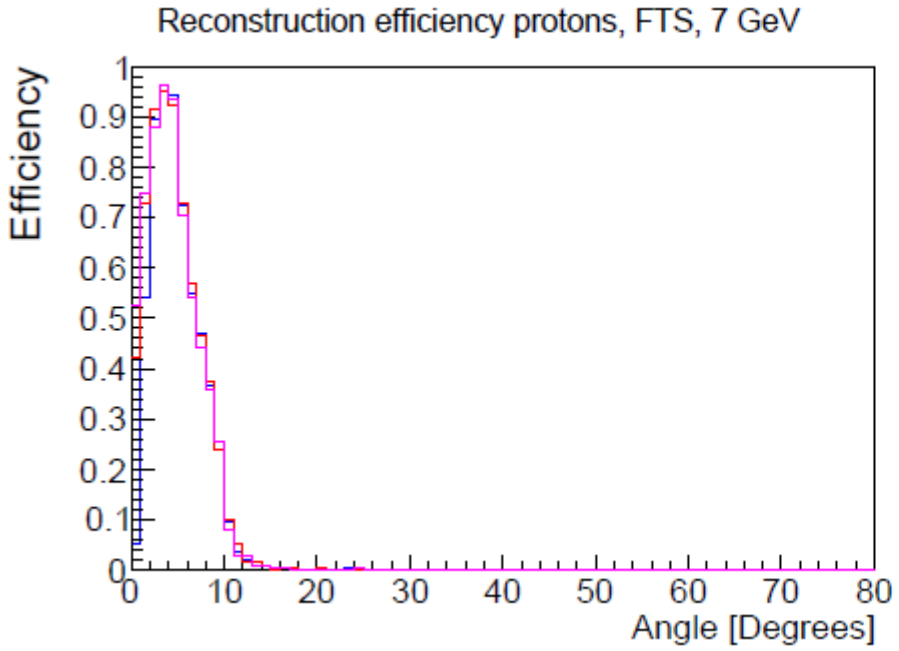

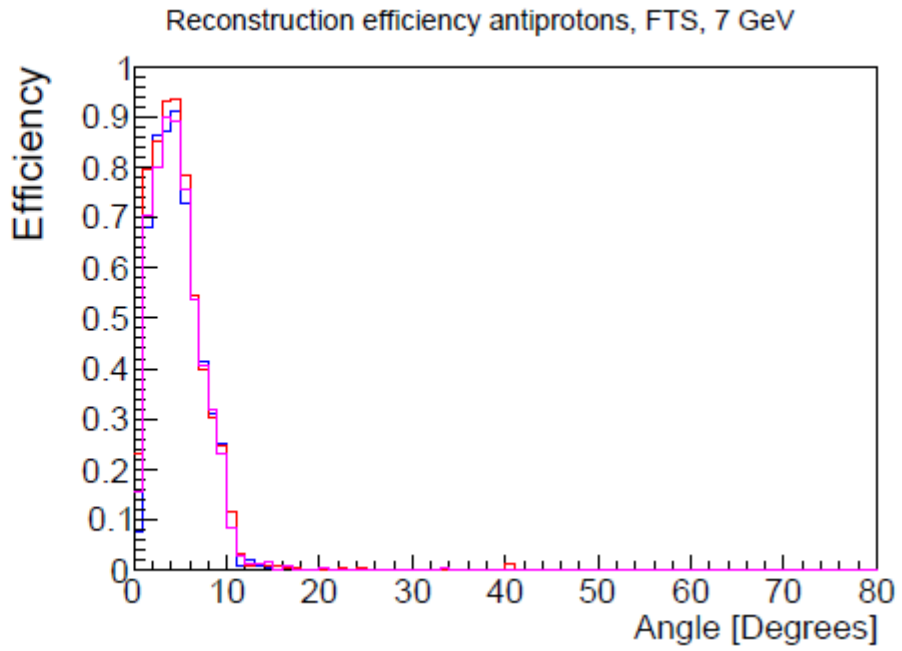

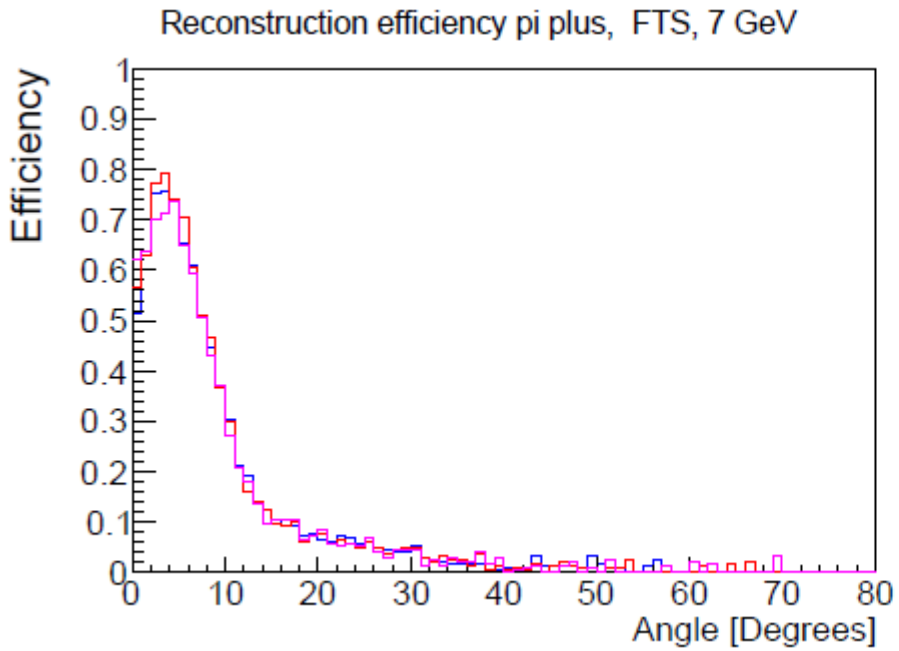

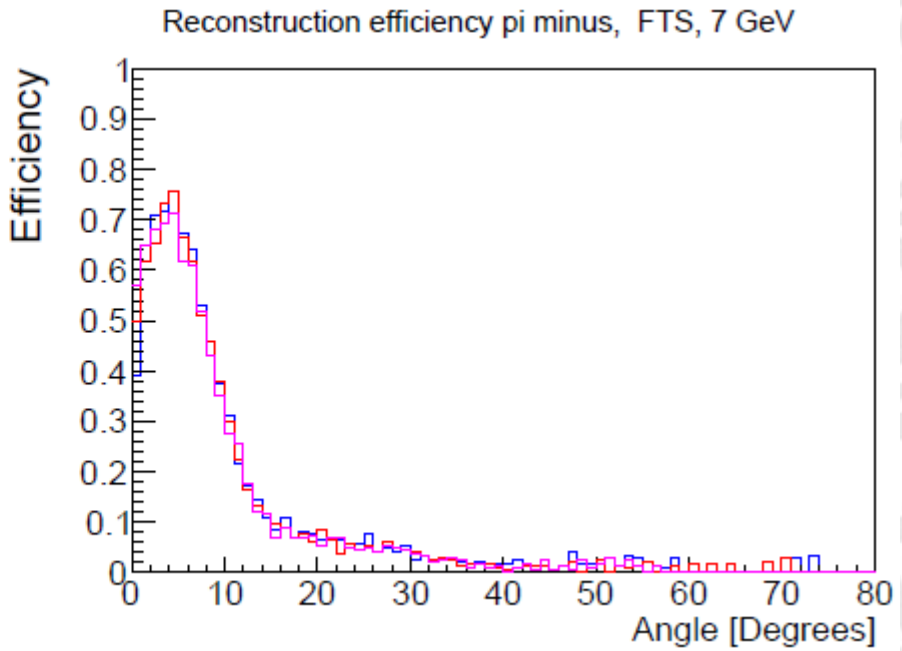

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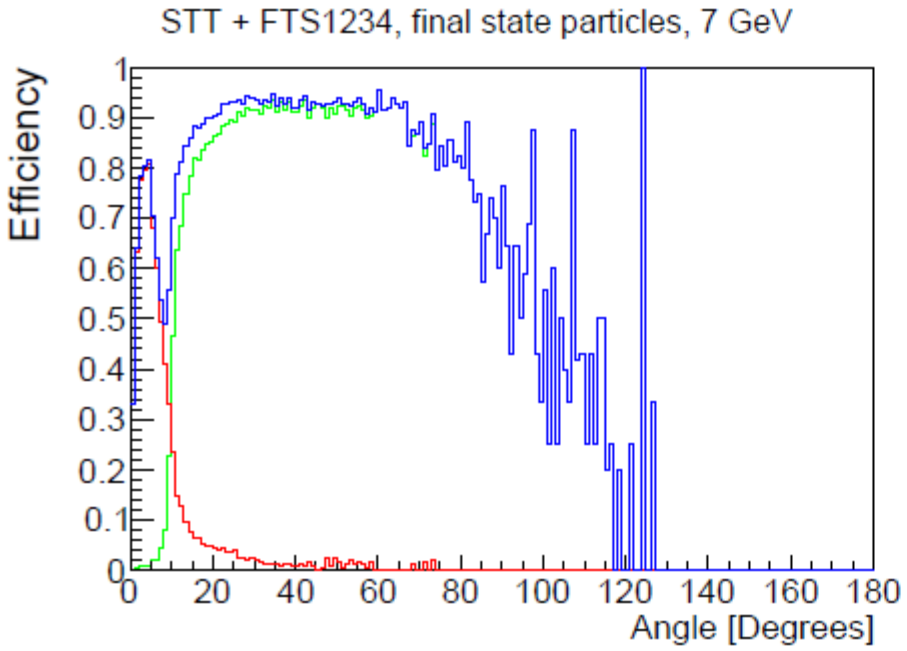

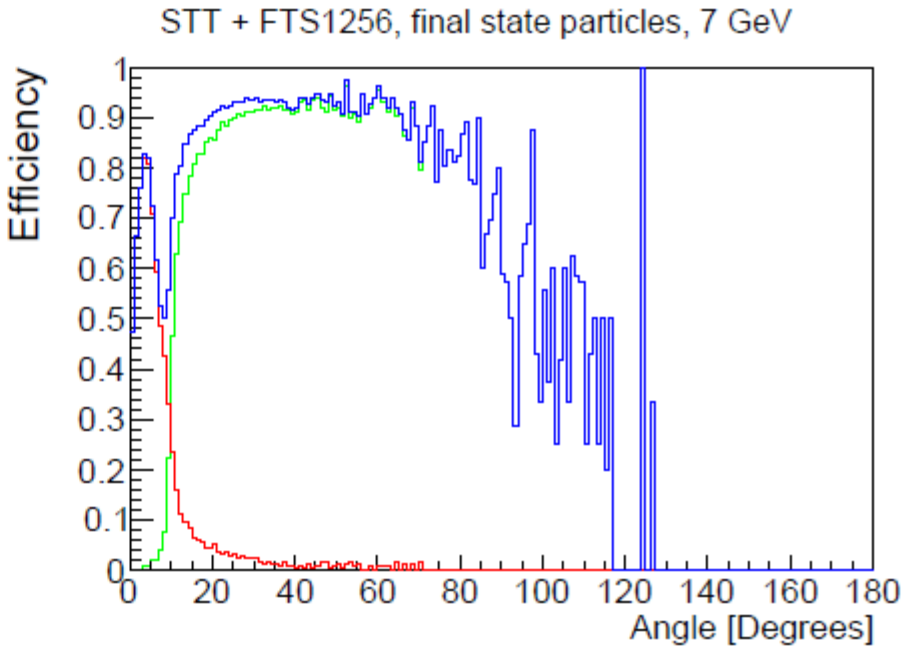

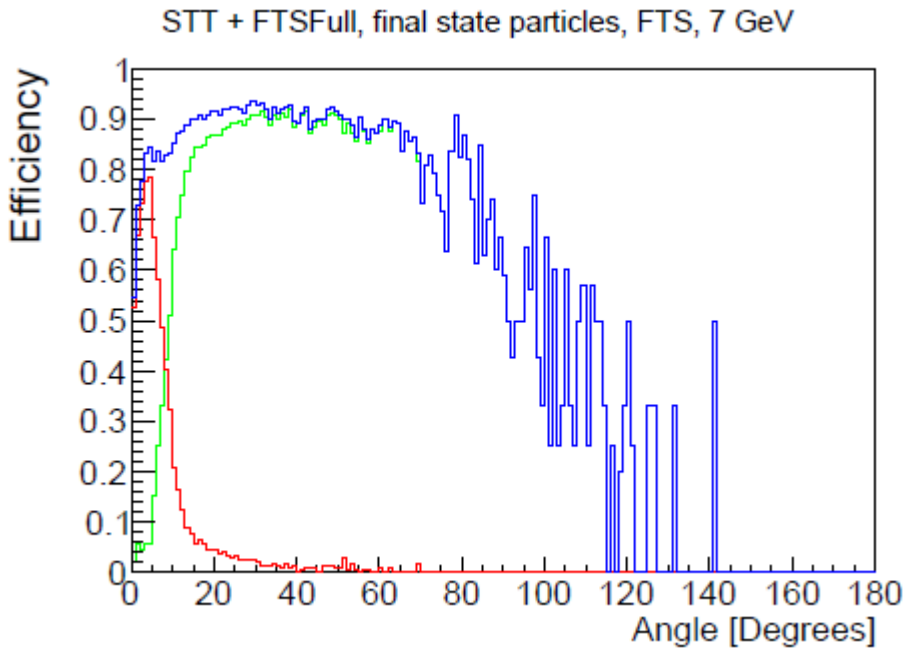

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Hits per station, at 7 GeV			
	FTS1234	FTS1256	FTSFull
Station 1	57,419	58,417	55,340
Station 2	55,161	55,556	53,179
Station 3	51,000	———	49,136
Station 4	51,240	———	48,993
Station 5	———	39,658	37,817
Station 6	———	35,720	34,529
TOTAL	214,820	189,351	278,994

Hits per station, at 4.6 GeV			
	FTS1234	FTS1256	FTSFull
Station 1	60,003	61,185	56,691
Station 2	56,282	57,072	53,153
Station 3	48,680	———	46,094
Station 4	47,215	———	44,917
Station 5	———	41,719	39,244
Station 6	———	37,752	36,908
TOTAL	212,180	197,728	277,007