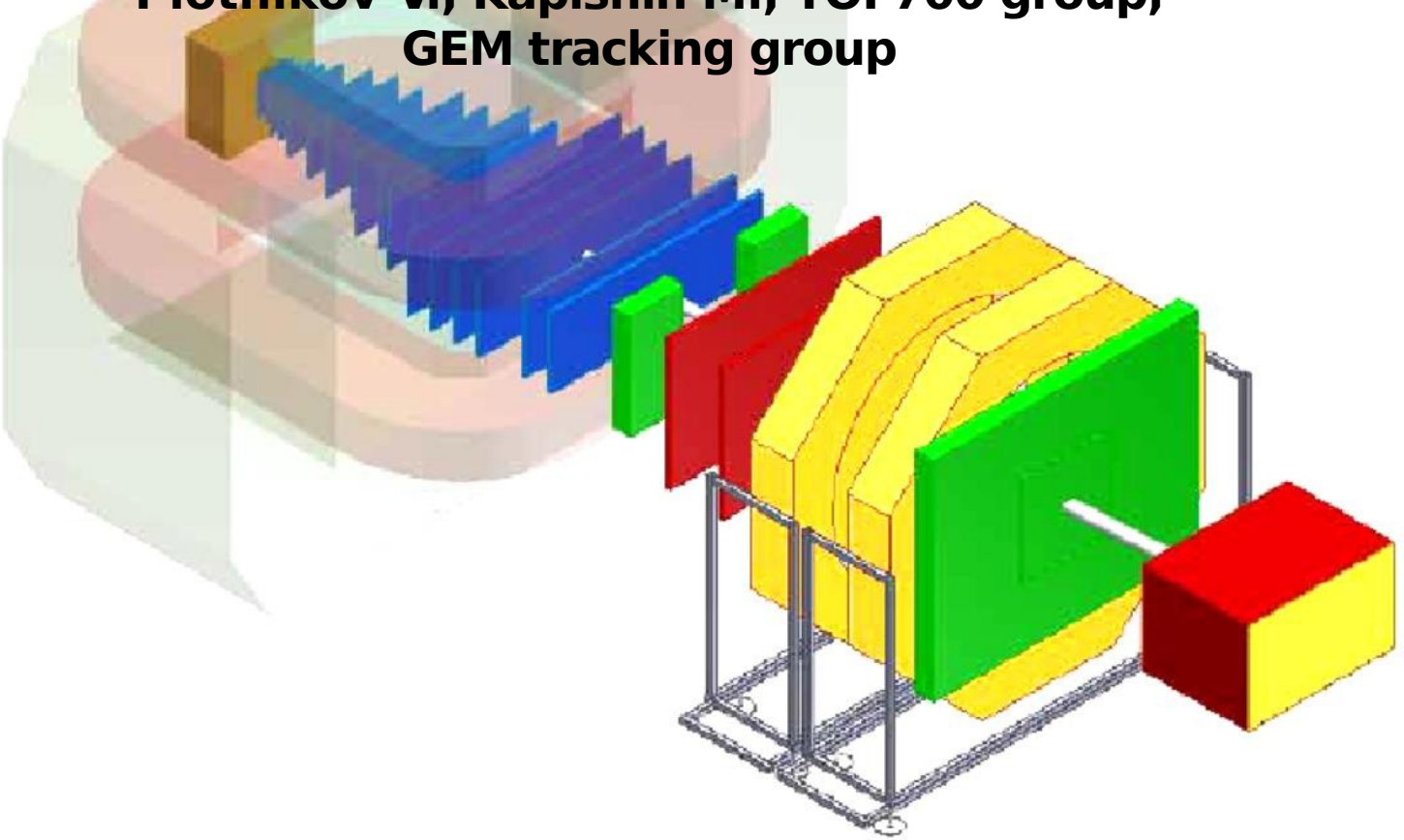
The Status of Identification in Argon Run, TOF400

Plotnikov V., Kapishin M., TOF700 group,
GEM tracking group



7th Collaboration Meeting of the BM@N Experiment at the NICA Facility
19.04.2021

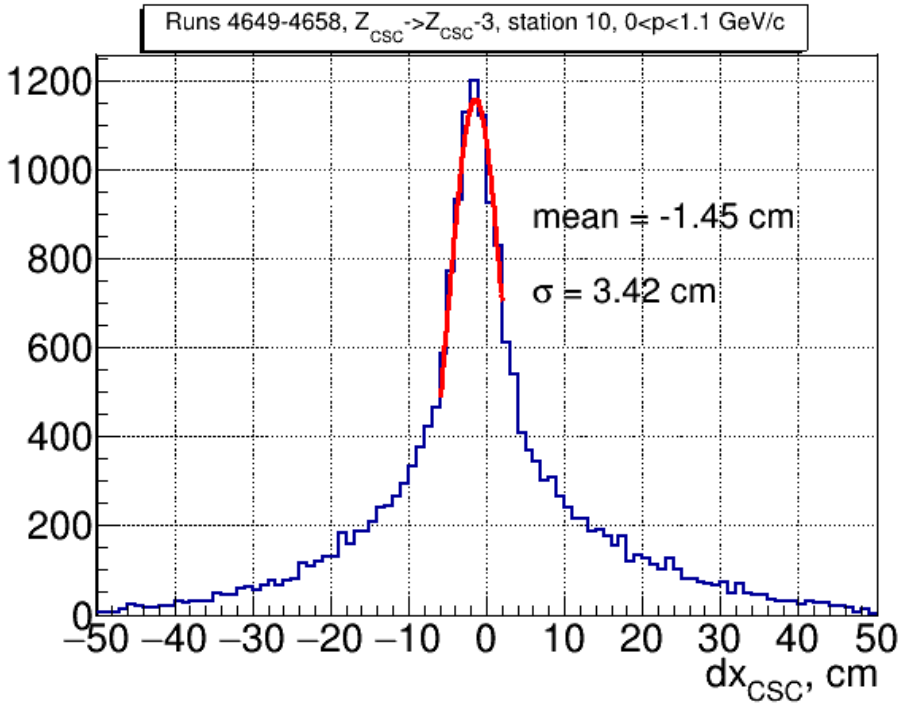
Content

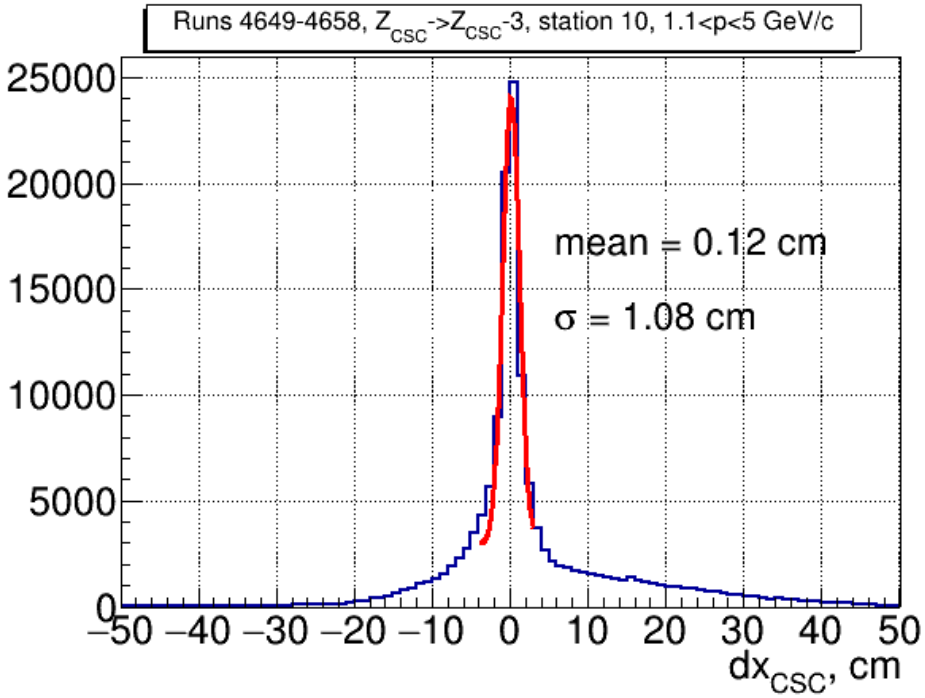
- Wide CSC residuals for Data at p<1 GeV/c
- Dependence of CSC/TOF400 residuals on P
- Taking into account the dependence of CSC/TOF400 residuals on p
- New TOF400 efficiency results
- Detailed GEM geometry
- $<dx_{GEM}>(p)$ compensation for Data and MC and $\sigma_{GEM}(p)$ smearing for MC

Content

- GEM efficiency
- CSC residuals in MC
- TODO

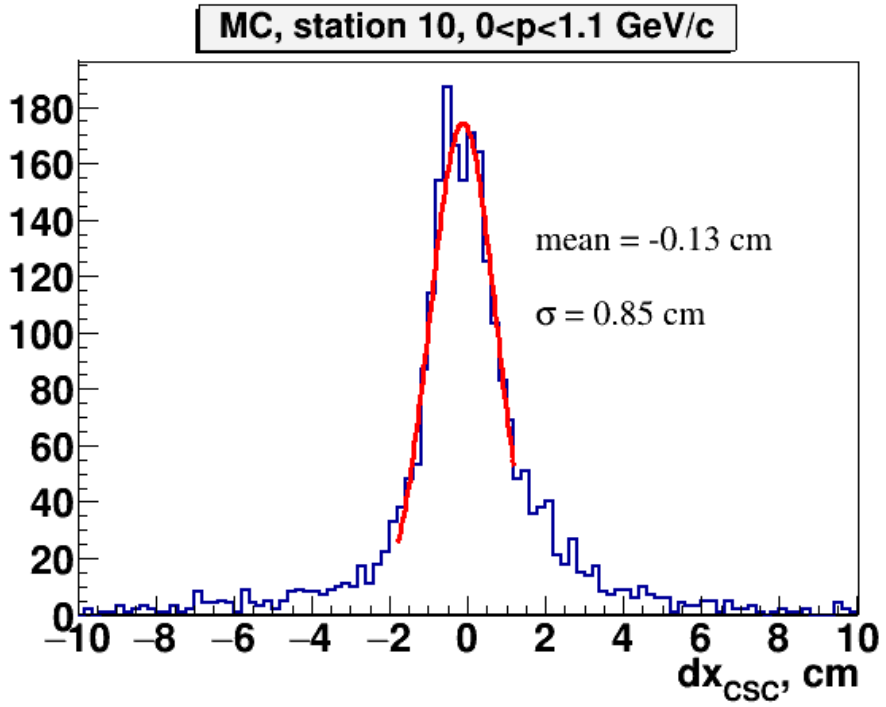
CSC residuals for Data

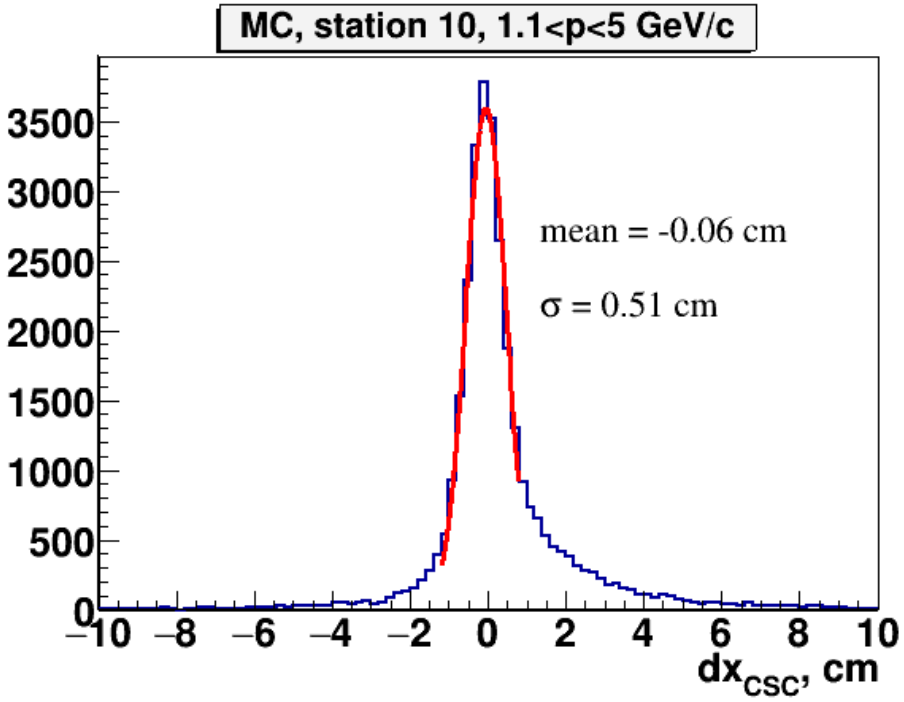




- The CSC residuals not Gaussian. The tails are very wide. Especially for 0<p<1.1 GeV/c
- $|mean_{0<p<1.1}-mean_{1.1<p<5}|$~1.5 cm
- $\sigma_{0<p<1.1}$~$3\sigma_{1.1<p<5}$
- The number of low momentum tracks (0<p<1.1 GeV/c) <10% of all tracks (0<p<5 GeV/c)

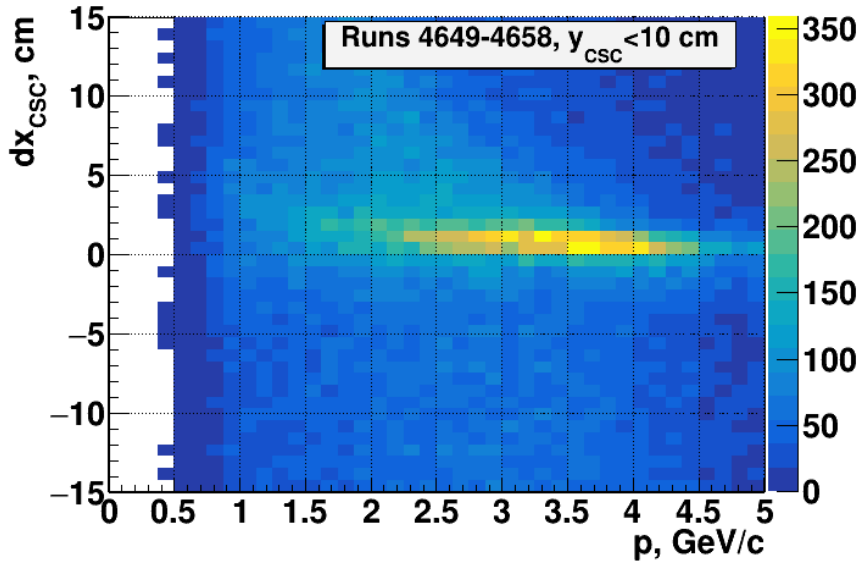
CSC residuals for MC

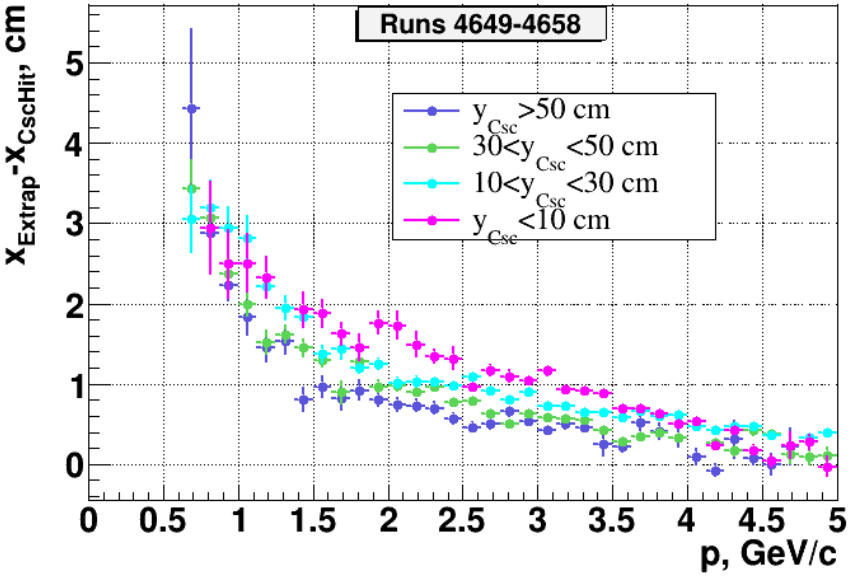


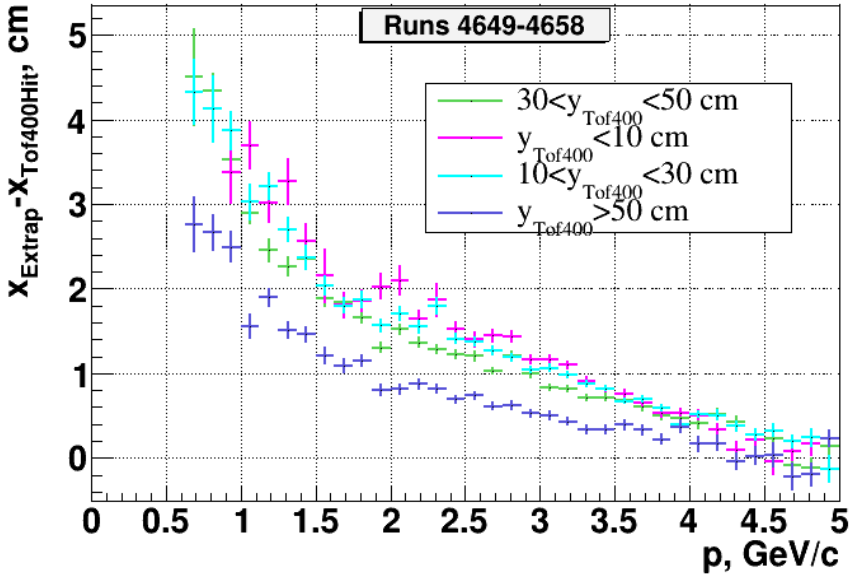


- The CSC residuals close to Gaussian
- Peaks for 0<p<1.1 GeV/c and for 0<p<5 GeV/c are aligned
- $\sigma_{0<p<1.1} \sim 1.5\sigma_{1.1<p<5}$
- The Kalman Filter works well to extrapolate traks from thr GEMs to CSC
- Something wrong with CSC residuals for the Data!

<dx> vs p for CSC and TOF400 at Y intervals

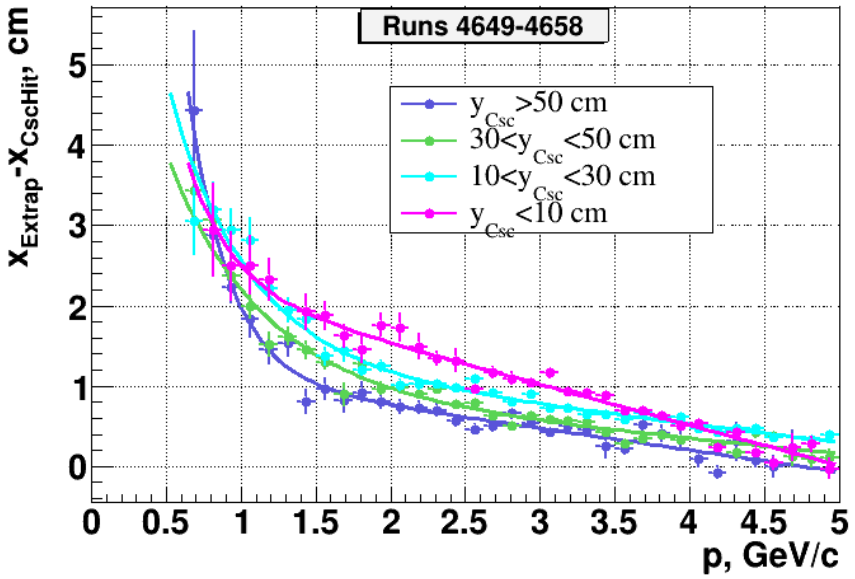


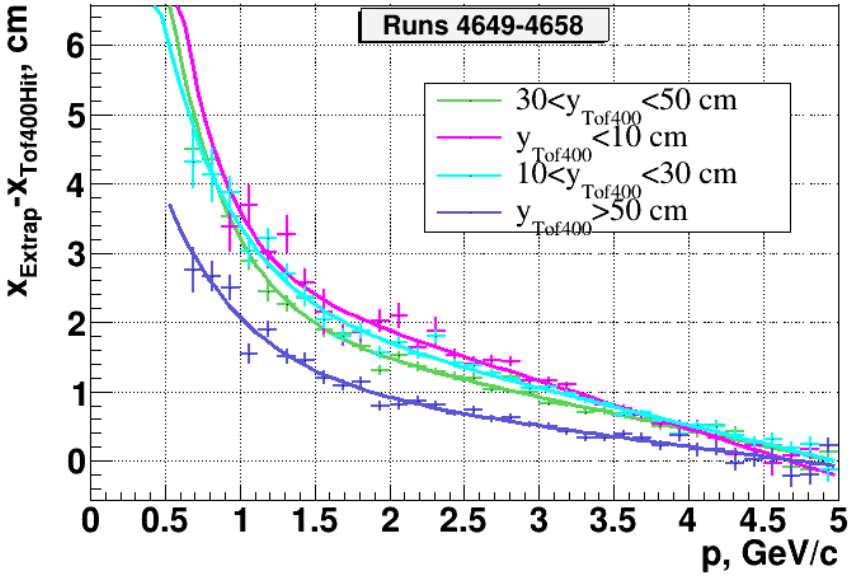




- Strong dependence residuals on P obtained for CSC and TOF400

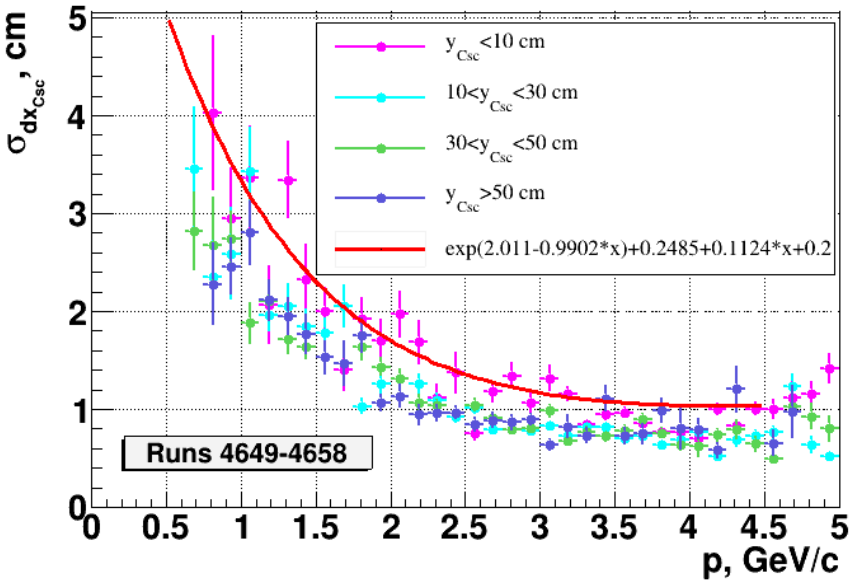
<dx> vs p at Y intervals (fit)

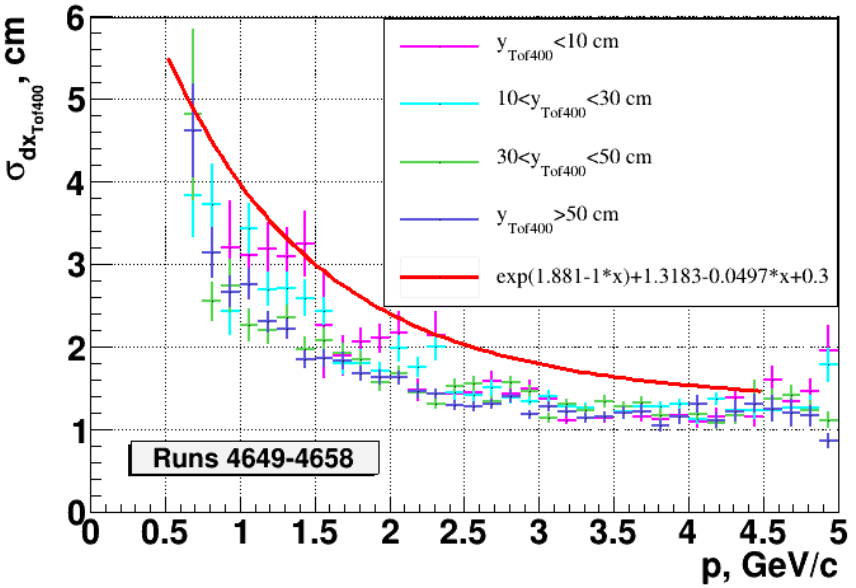




	Constant	Slope	p0	p1
CSC, y<10 cm	2.647	-3.398	2.536	-0.505
10<y<30 cm	2.193	-1.894	1.434	-0.227
30<y<50 cm	1.859	-1.591	1.078	-0.184
y>50 cm	3.655	-3.686	1.284	-0.270
TOF, y<10 cm	3.255	-3.196	3.222	-0.688
10<y<30 cm	2.430	-2.162	2.602	-0.521
30<y<50 cm	2.871	-2.556	2.307	-0.464
y>50 cm	1.912	-1.881	1.325	-0.280

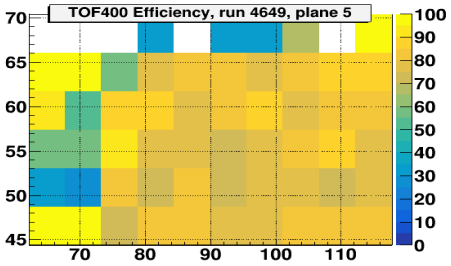
σ_{dx} vs p for CSC and TOF400 at Y intervals

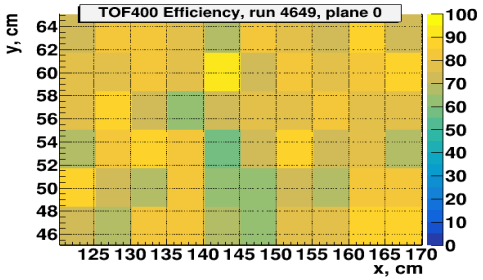




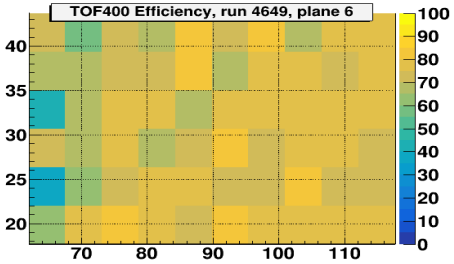
- During matching, we need to dynamically select the matching window according to the red lines
- To implement closest hit approach, we need to weigh the track-hit distances using red lines

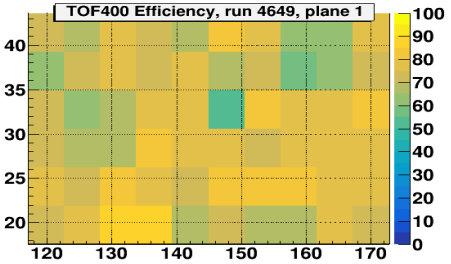
New TOF400 efficiency results (run 4649)

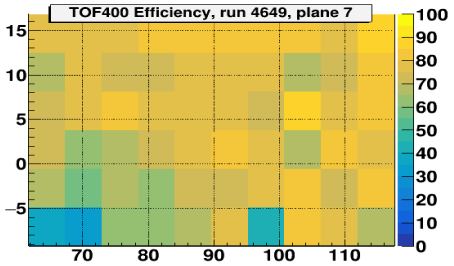


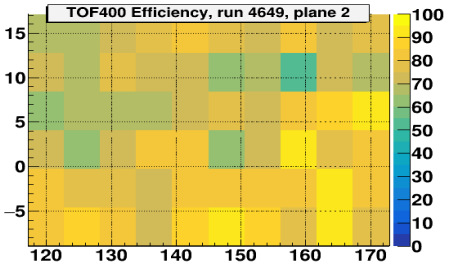


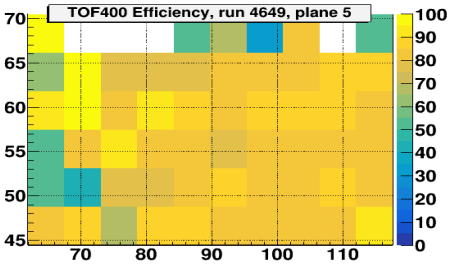
Before compensation

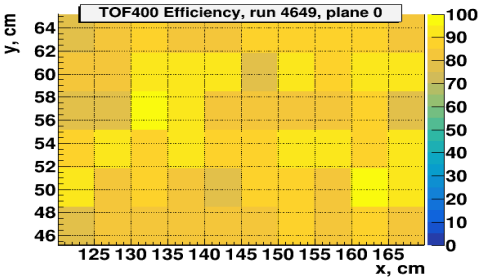




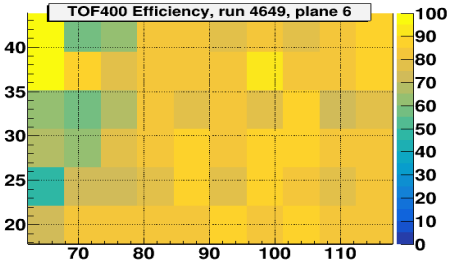


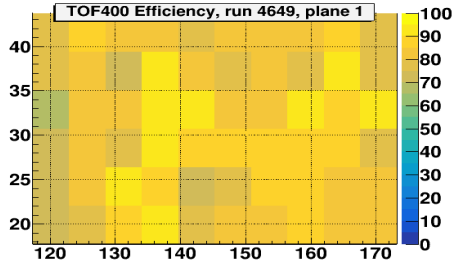


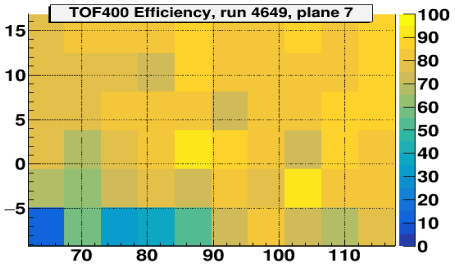


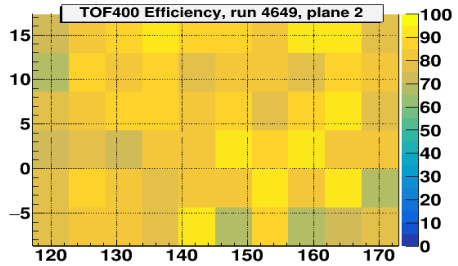


After compensation



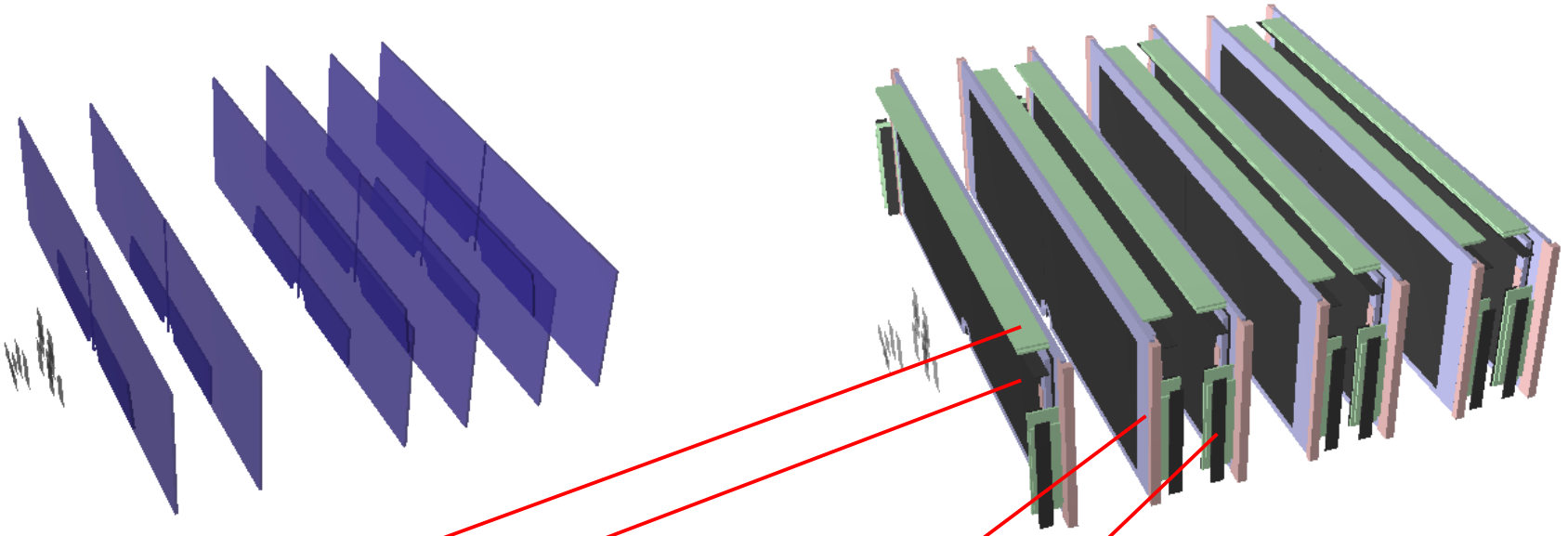






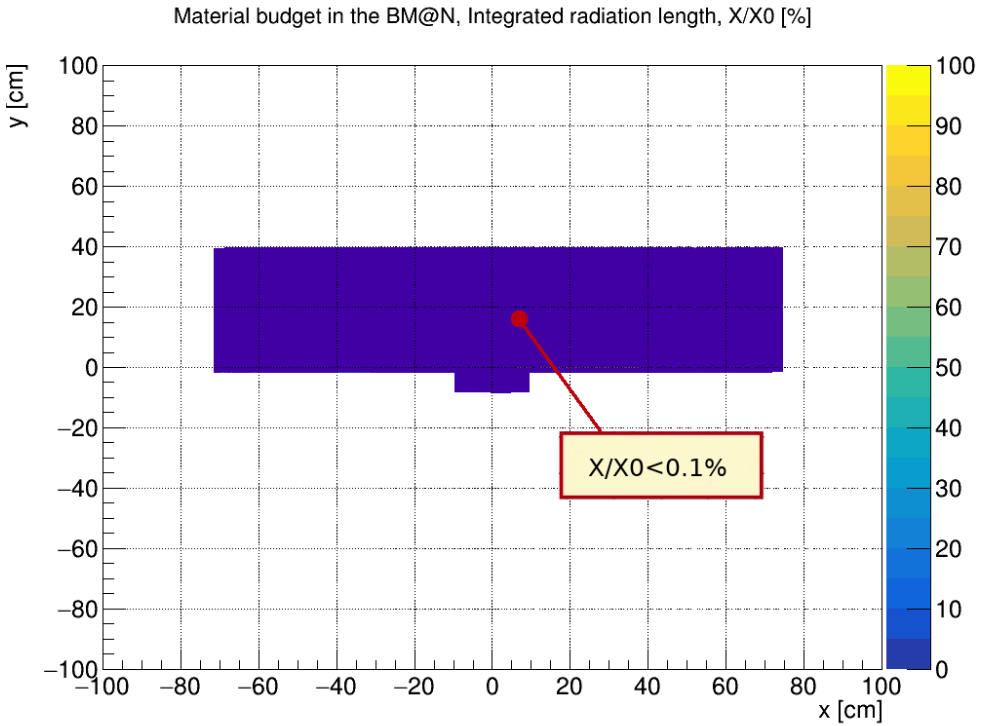
- After field compensation, the TOF400 efficiency increases by at least ~10-15%

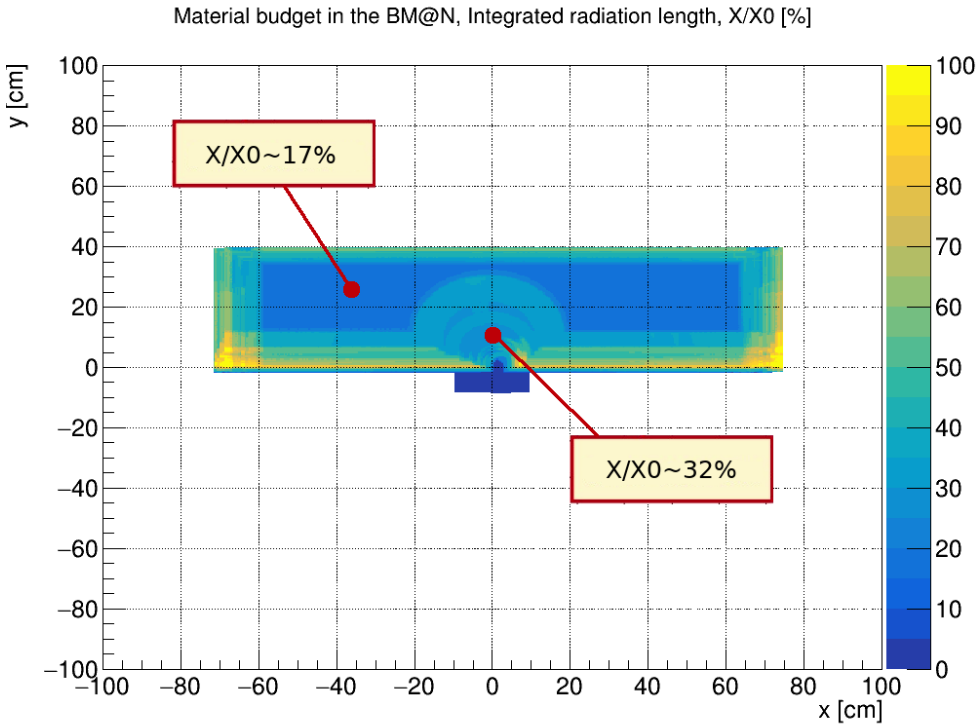
Detailed vs simple GEM geometry



- New layers (**black**), frames (indigo), electronics (green) were added for each GEM sensitive volume
- Broken station was added
- Detailed geometry from D. Baranov

Taking into account detailed GEM geometry

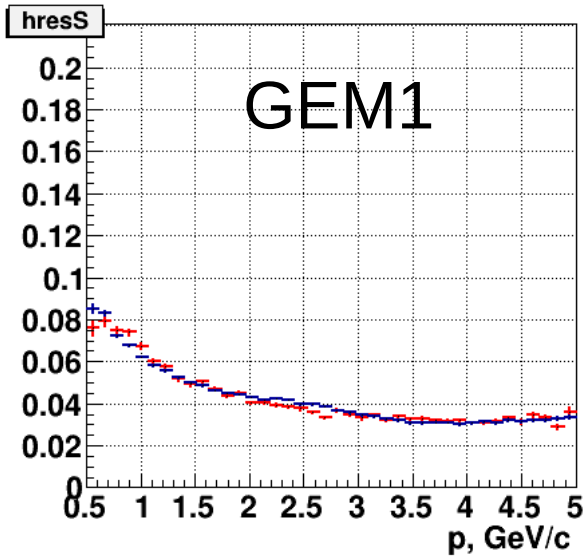


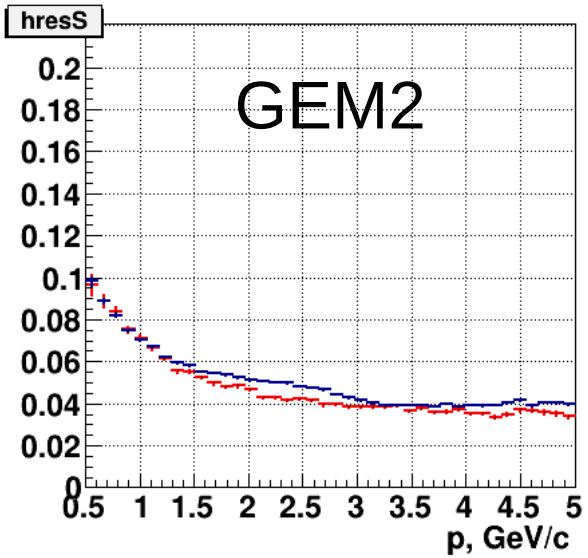


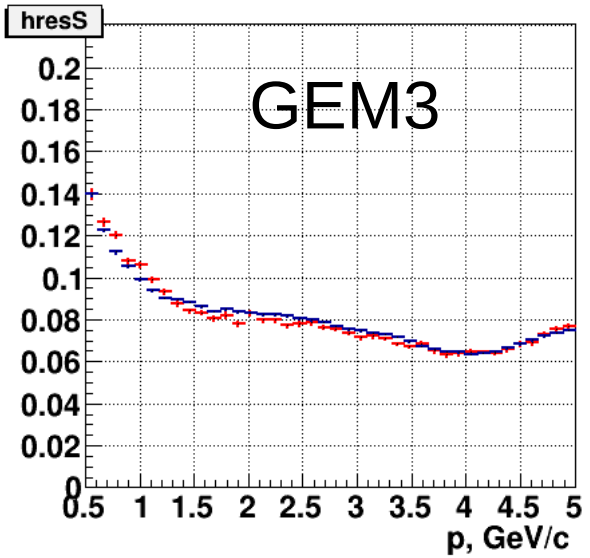
- Material budget is calculated using straight tracks from the target
- Material budget has been significantly increased in GEM detailed geometry
- Much of the material budget comes from frames around the beam hole

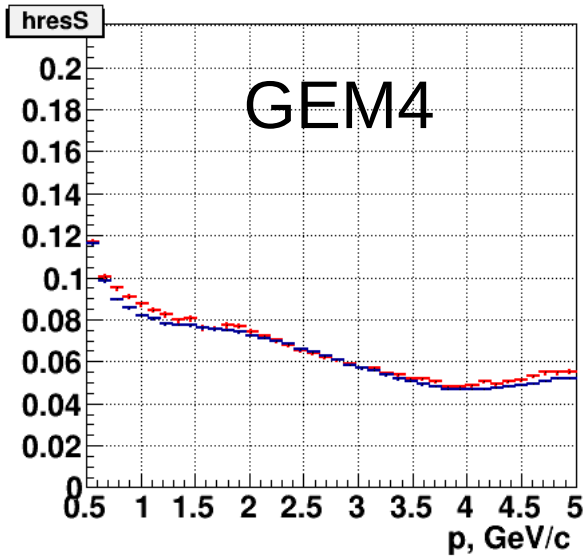
GEM residuals compensation and smearing for Data and MC. $\sigma_{dx}(p)$

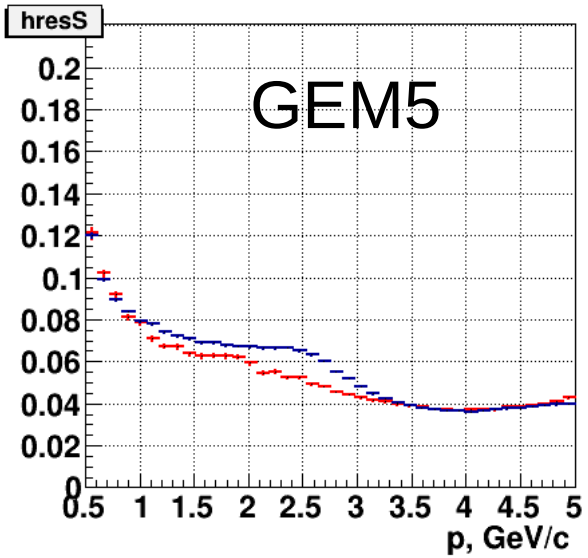
— Data — MC

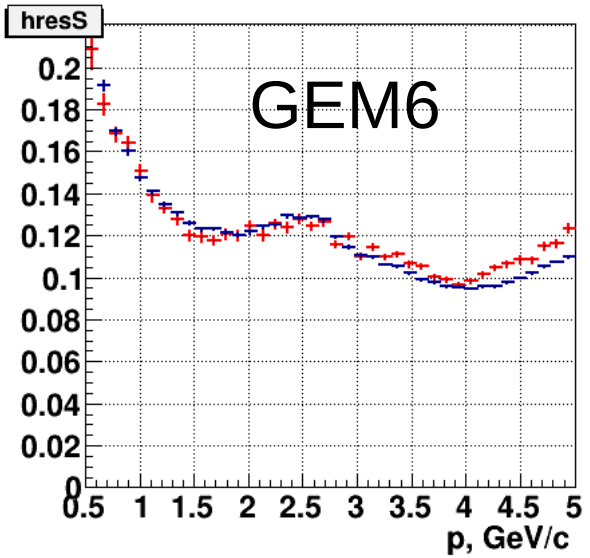






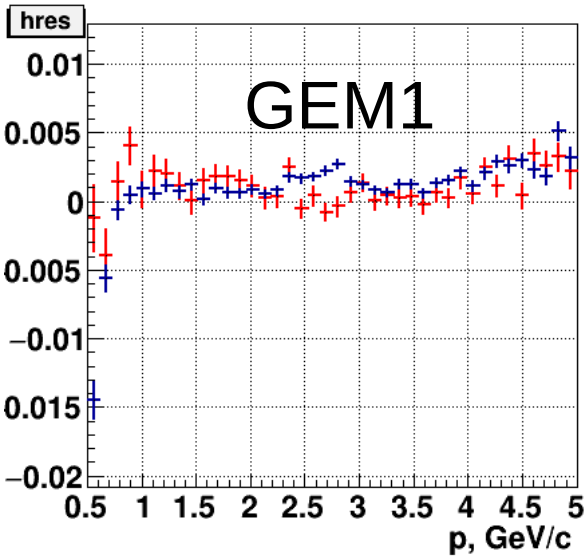


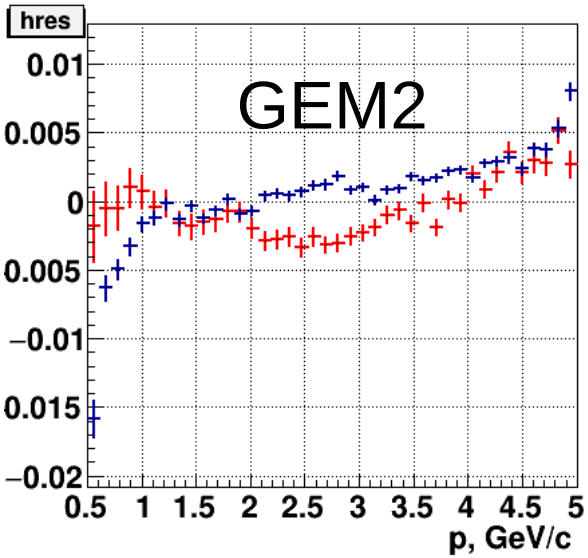


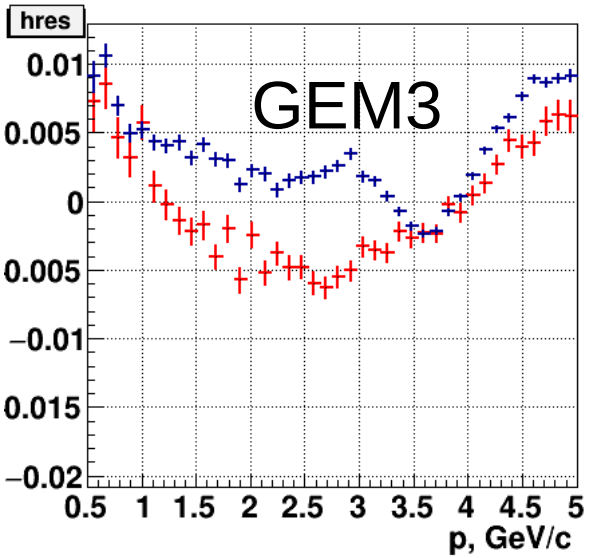


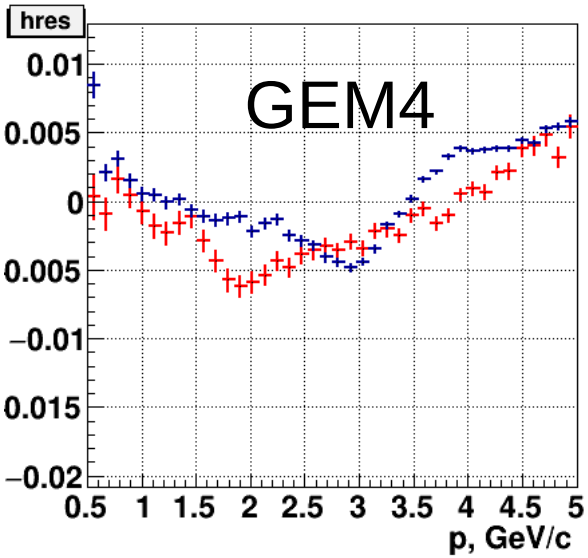
GEM residuals compensation and smearing for Data and MC. <dx>(p)

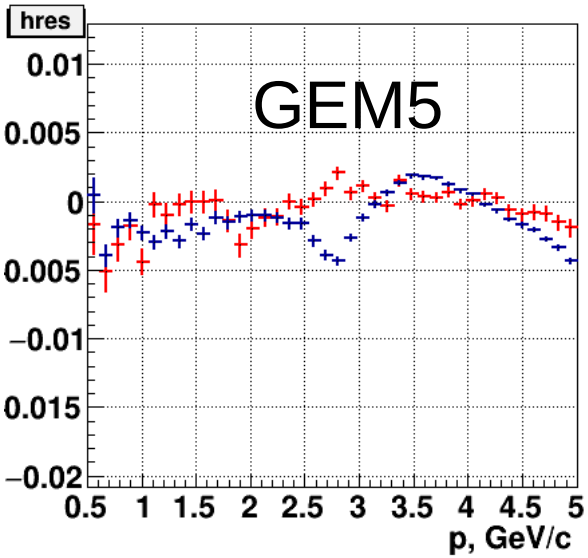
— Data — MC

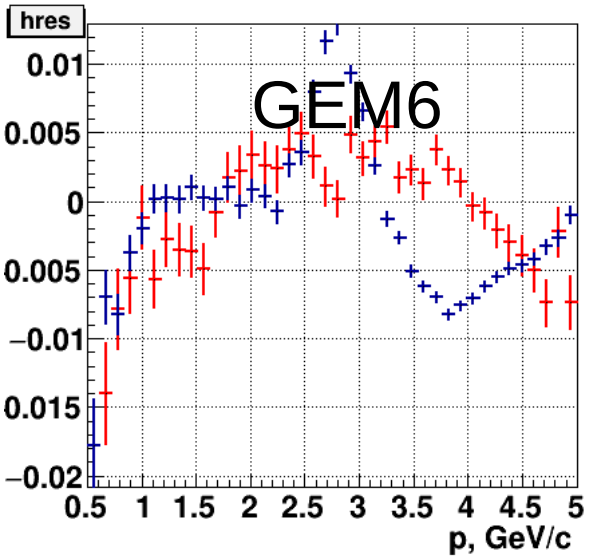












GEM residuals compensation and smearing for Data and MC

- $\sigma_{dx}(p)$ for MC matches $\sigma_{dx}(p)$ for Data
- Mean shift well compensated
- The mean shift is much less than σ_{dx} for all p

Cuts for calculating/applying GEM efficiency

Cuts for choosing events

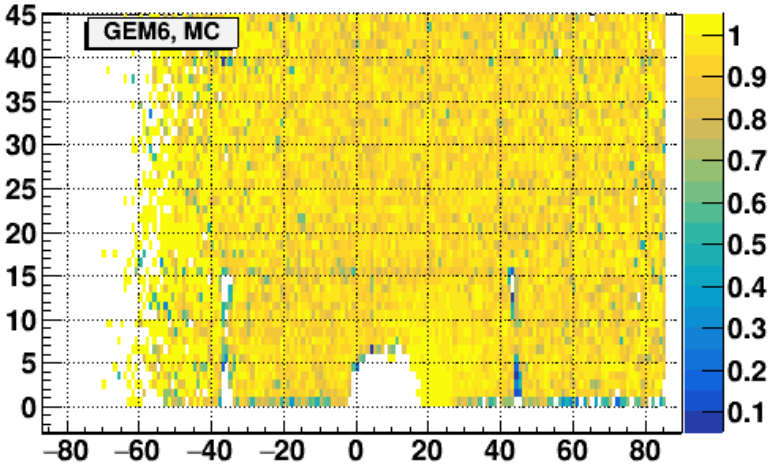
- |PV-TargetCenter|<6 cm
- $N_{3hitTracks}$>2

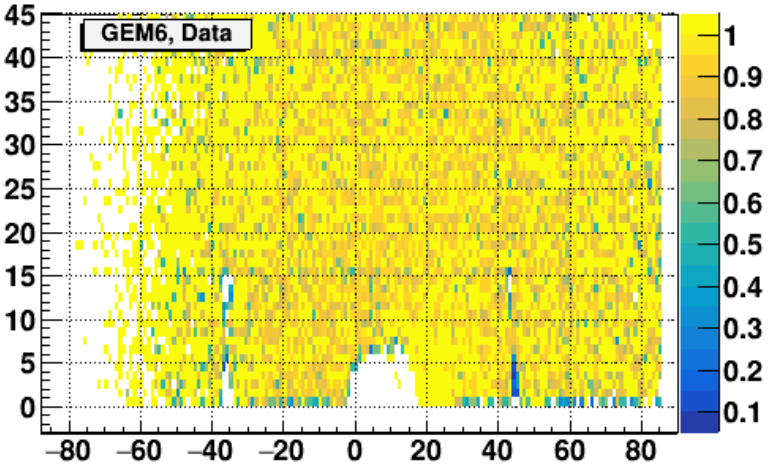
- **Cuts for choosing tracks**
- |Track-PV|<2 cm
- N_{SiHits}≥2 and $N_{GemHits}$≥4
- 0.5<p<2 GeV/c

Applying Eff_{Norm} in MC

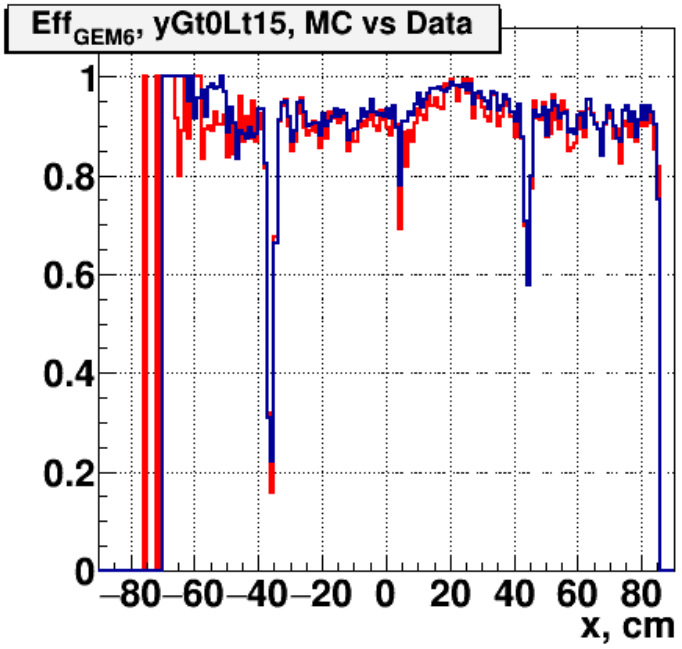
- Eff_{Norm} disabled for GEM6 at x<-50 cm

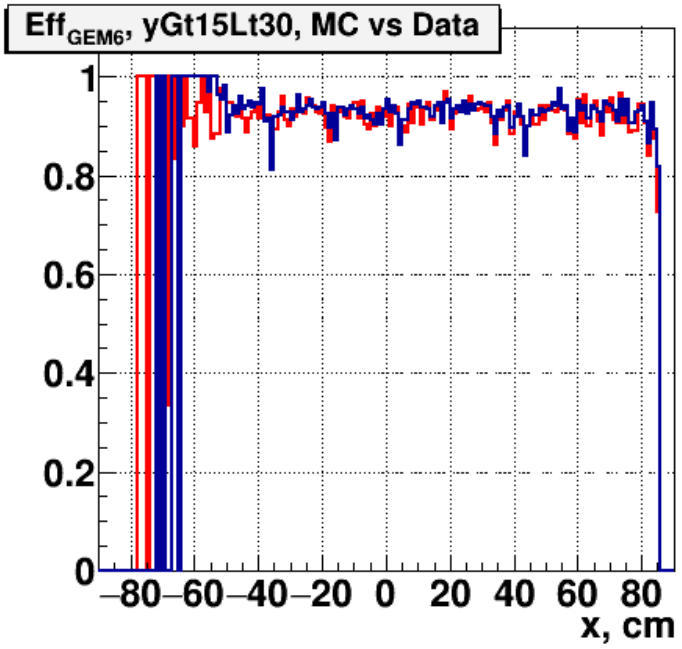
GEM6 efficiency, 0.5<p<2 GeV/c

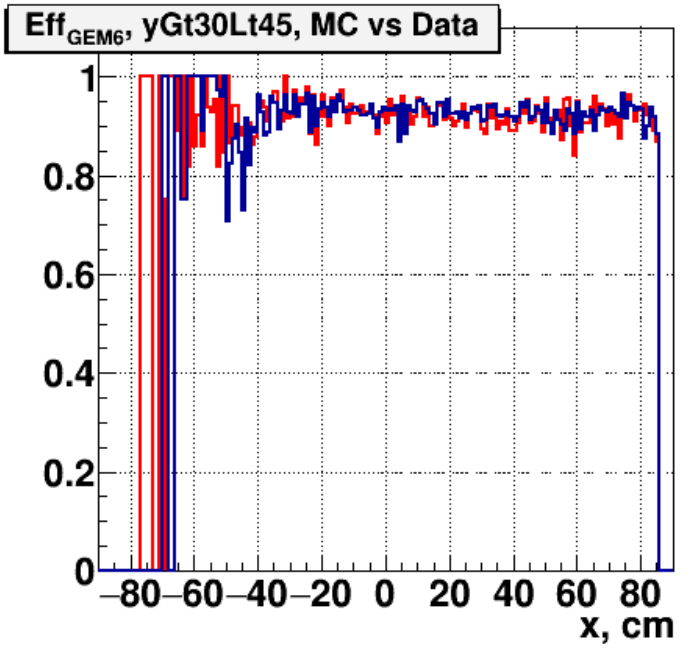




— MC — Data



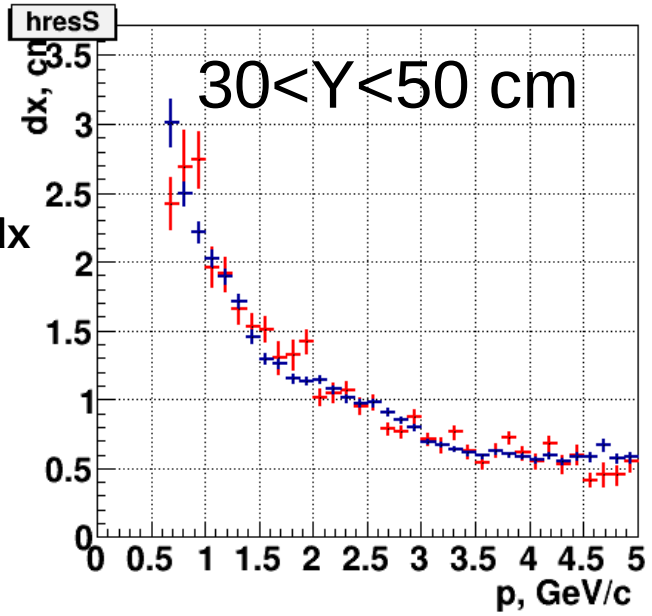




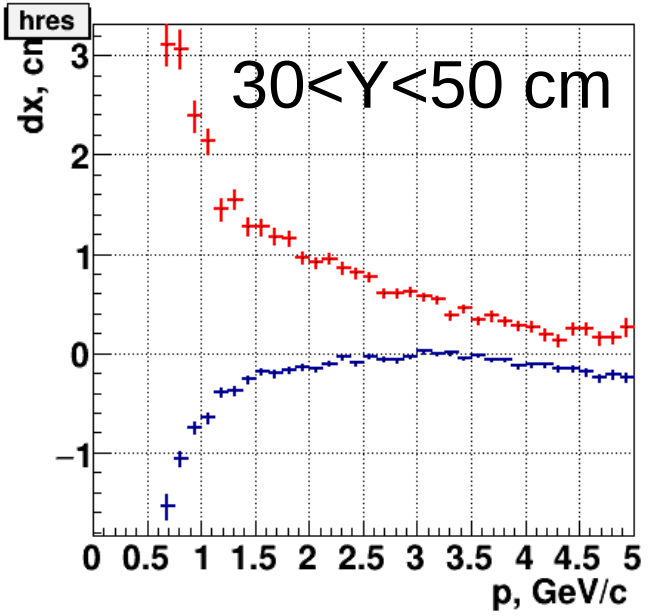
Comparison of GEM efficiencies for Data and MC

- For the Data, the fluctuation of efficiency from bin to bin is larger than for the MC
- MC and Data efficiencies are close to each other in Y-slices
- The largest discrepancy is obtained for low-X edges in Y-slices because of **low statistics**

CSC residuals in MC



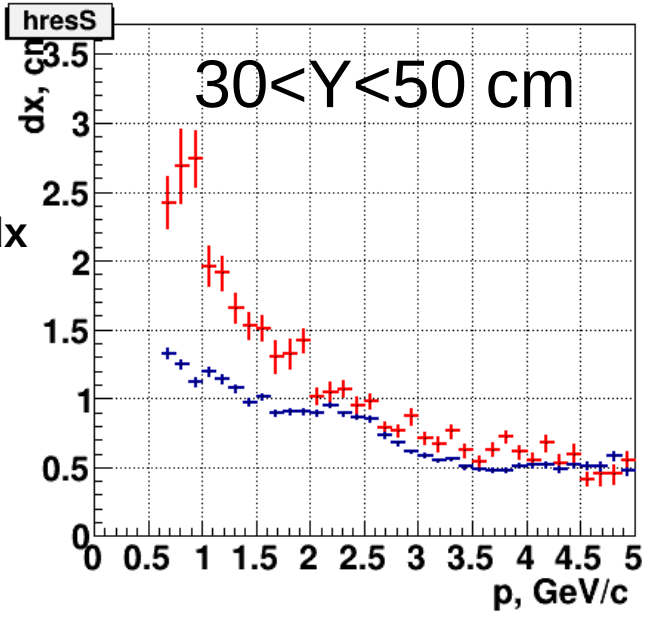
σ_{dx}



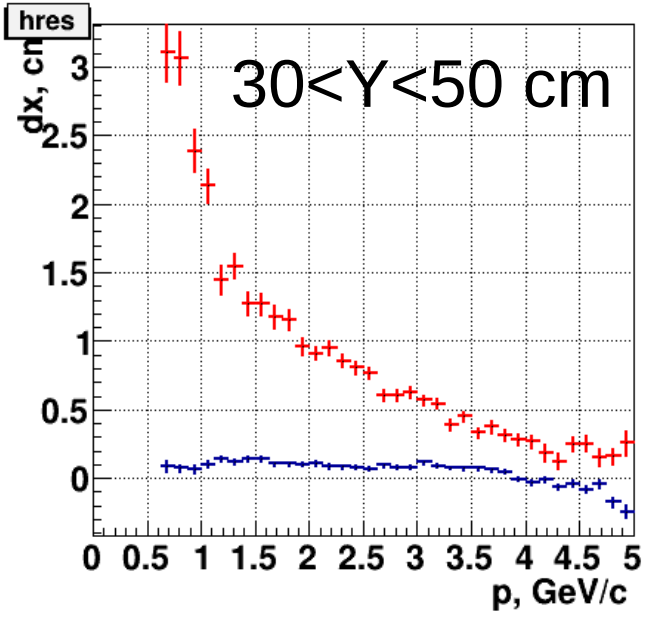
— Data
— MC

<dx>

Detailed GEM geometry



σ_{dx}



<dx>

Simple GEM geometry

CSC residuals in MC

- $\sigma_{dx}(p)$ for MC in case of detailed GEM geometry matches $\sigma_{dx}(p)$ for Data
- <dx>(p) for MC in case of detailed GEM geometry shows strong dependence, especially for low p, because of multiple scattering

TODO

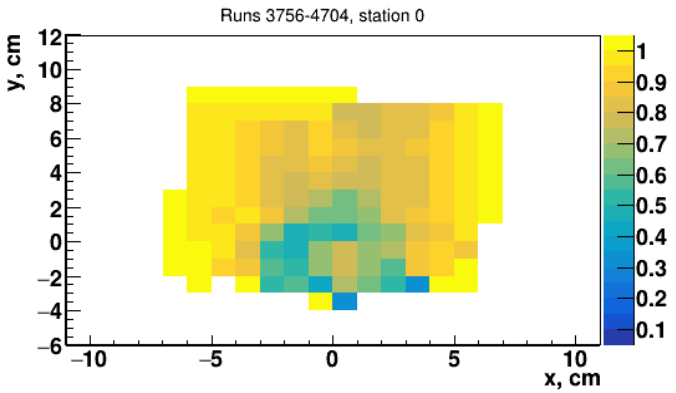
- Take into account strong $\langle dx \rangle_{csc}(p)$ dependency
- Look at the TOF400 residuals
- Examine the trigger efficiency

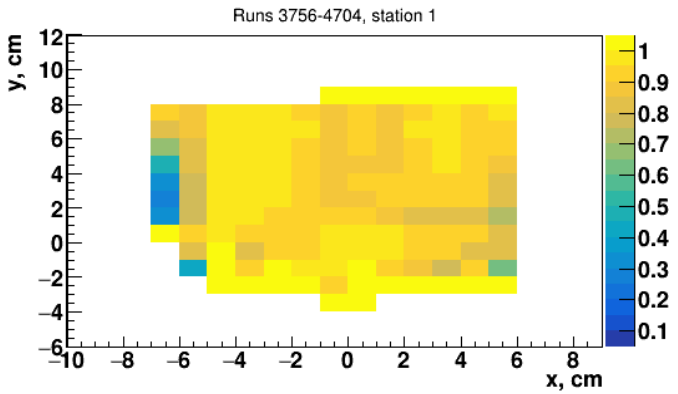
Thank you!

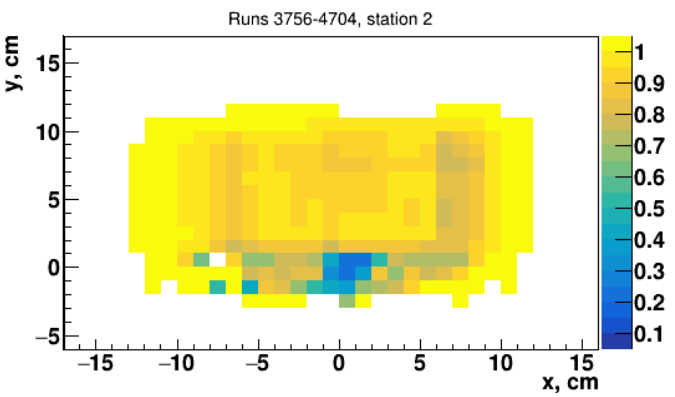
Backup

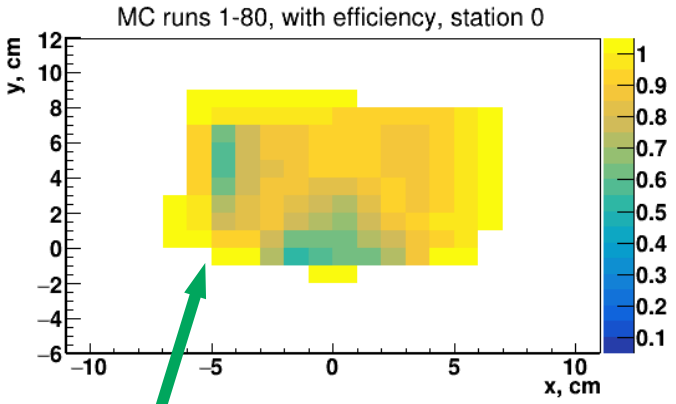
Data and MC Si/GEM efficiencies comparison

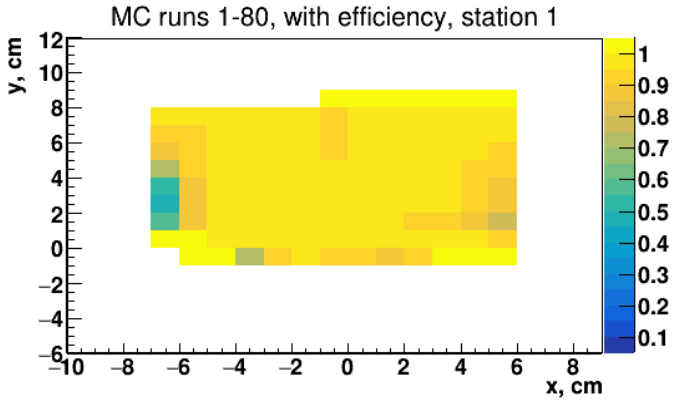
Data

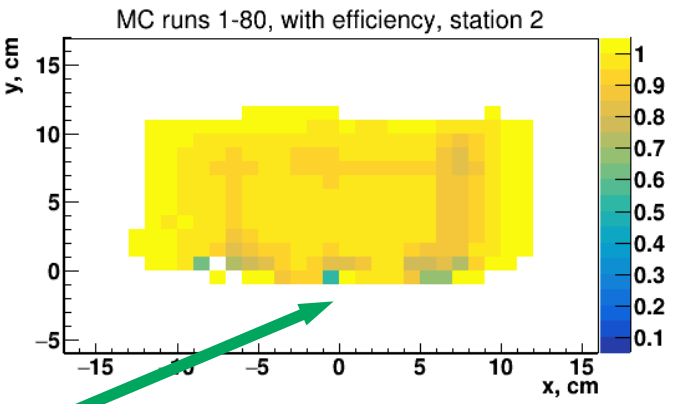






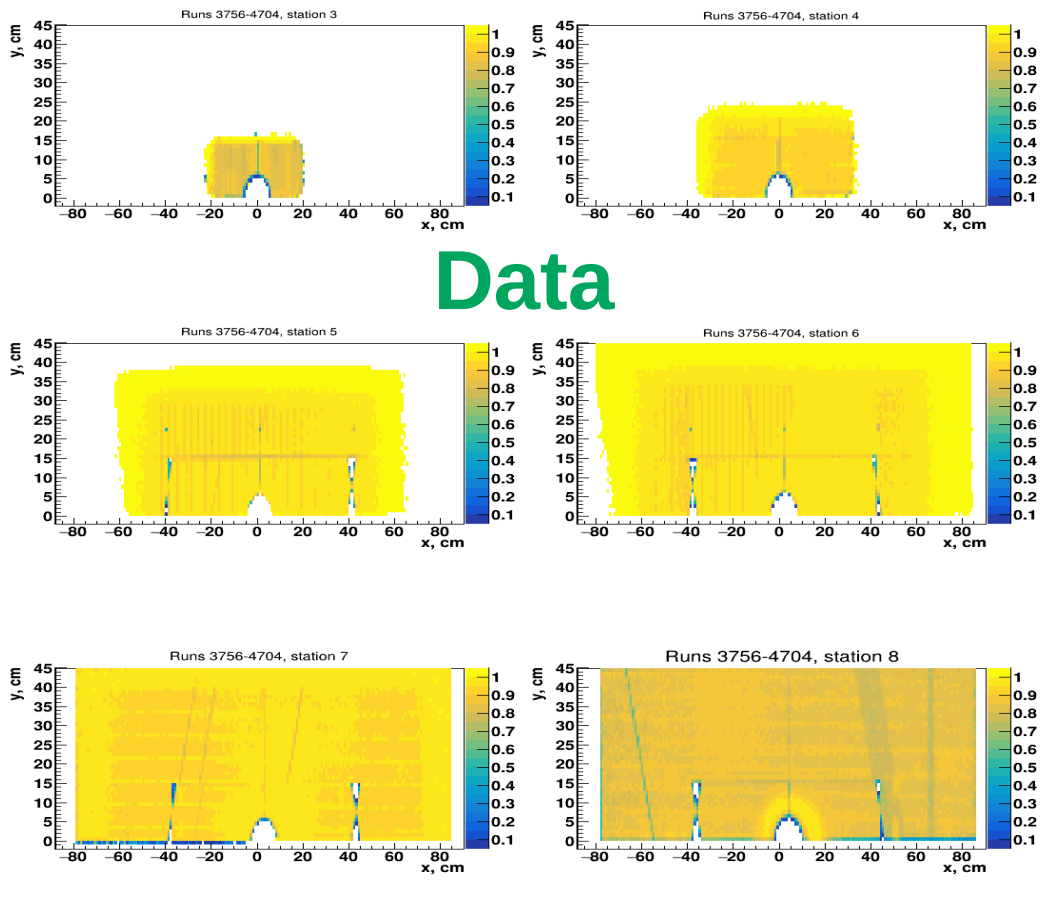




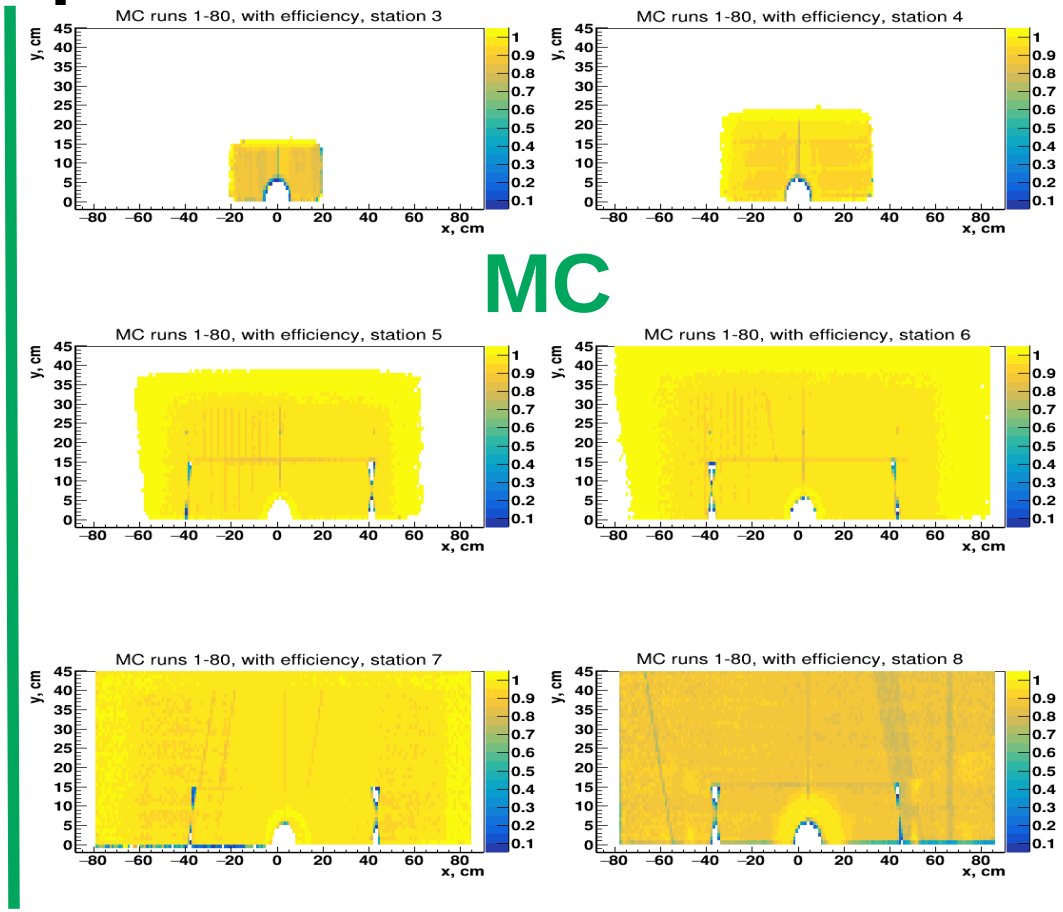


- MC efficiency higher than Data efficiency on 3-5% in average **MC** for all Si
- Low MC efficiency for Si1 at X~-5 cm
- High MC efficiency for Si3 at X~0 cm

Data and MC Si/GEM efficiencies comparison



Data

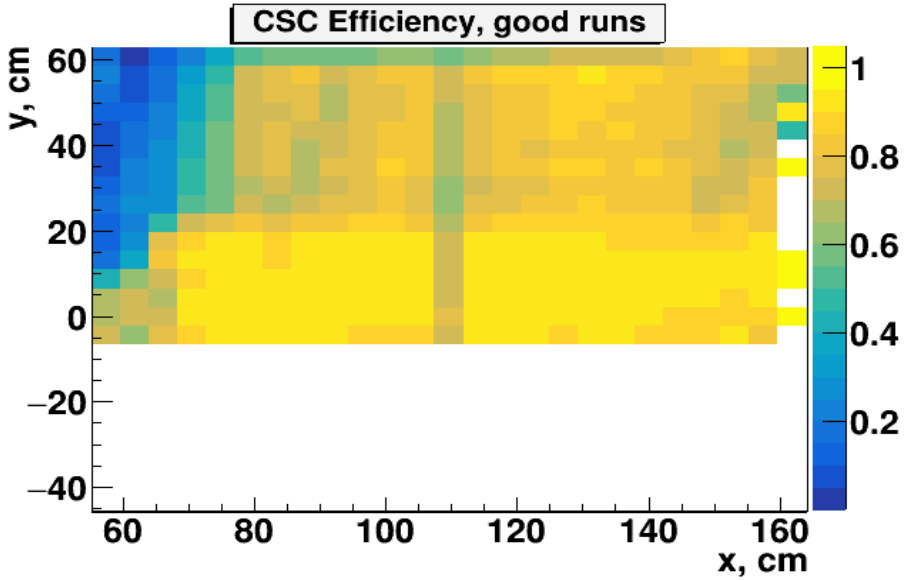


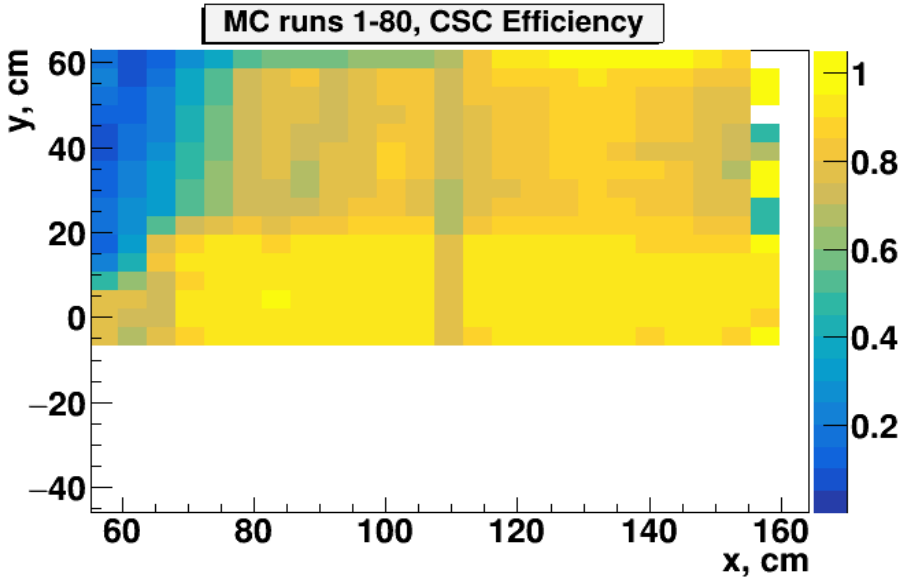
MC

- MC efficiency higher than Data efficiency on 3-5% in average for all GEM

Data and MC CSC efficiencies comparison

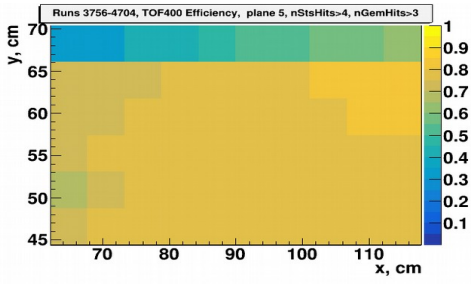
Data, good runs **MC**

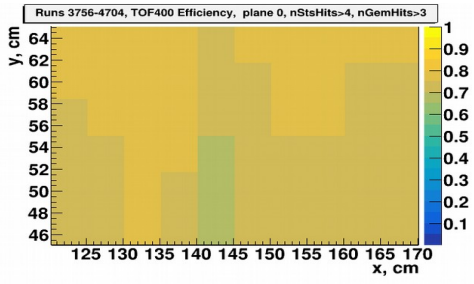


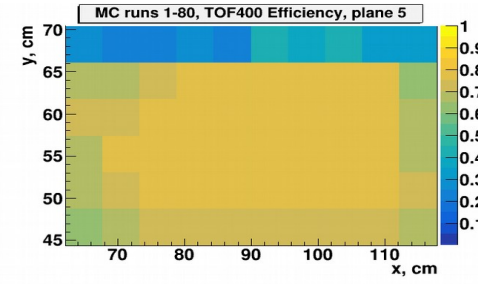


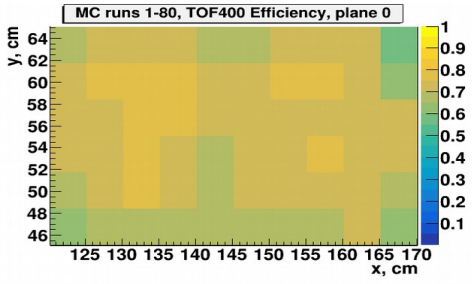
- Good runs - runs with Eff_{CSC}>40% in the Main zone
- MC and Data efficiencies are close to each other

Data and MC TOF400 efficiencies comparison

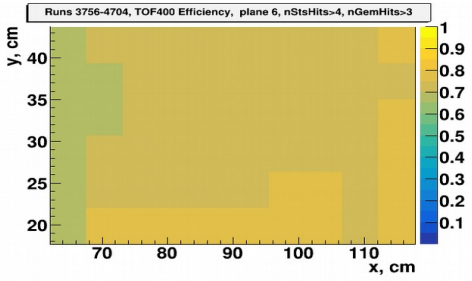


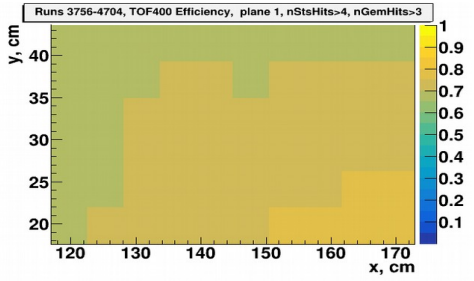


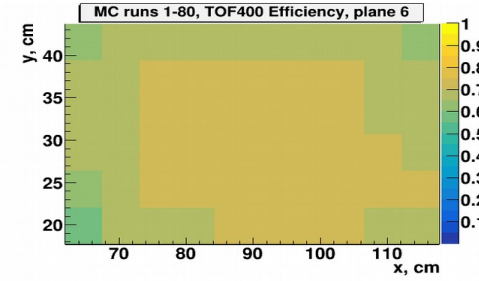


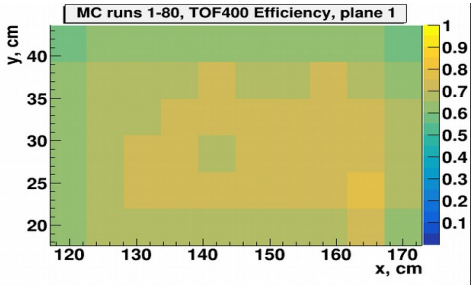


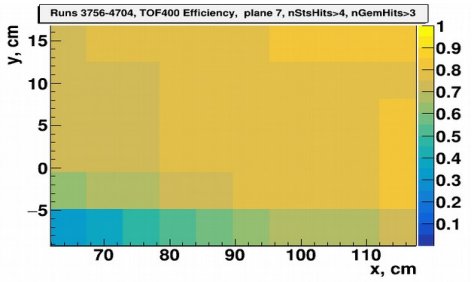
Data **MC**

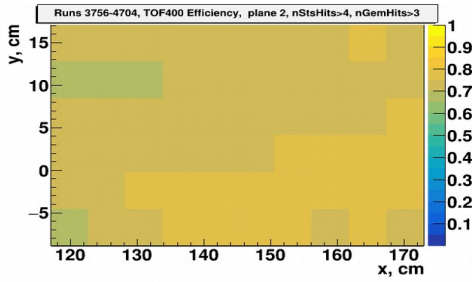


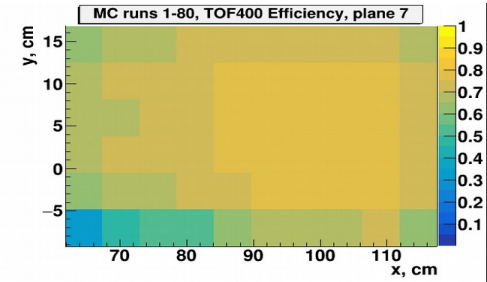


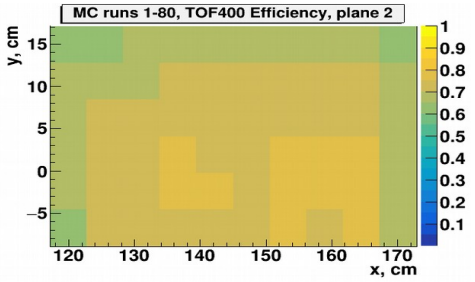






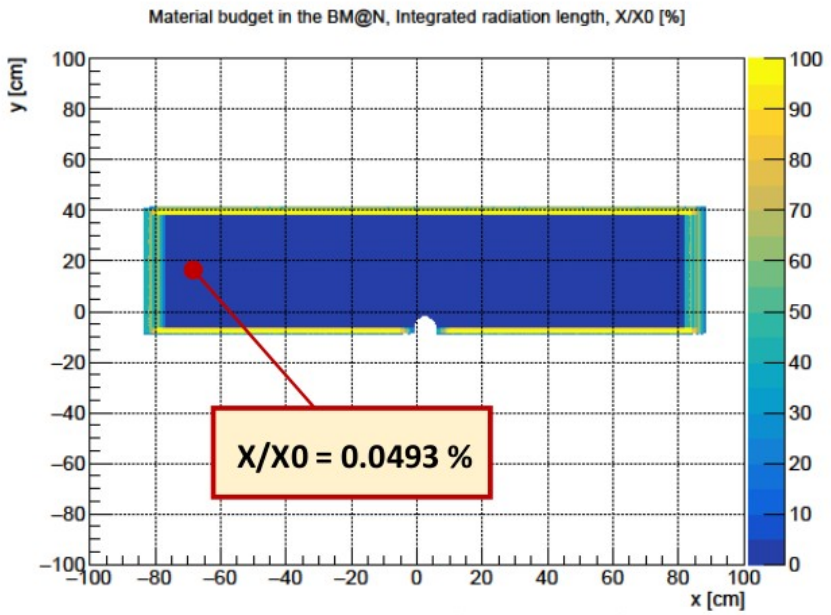




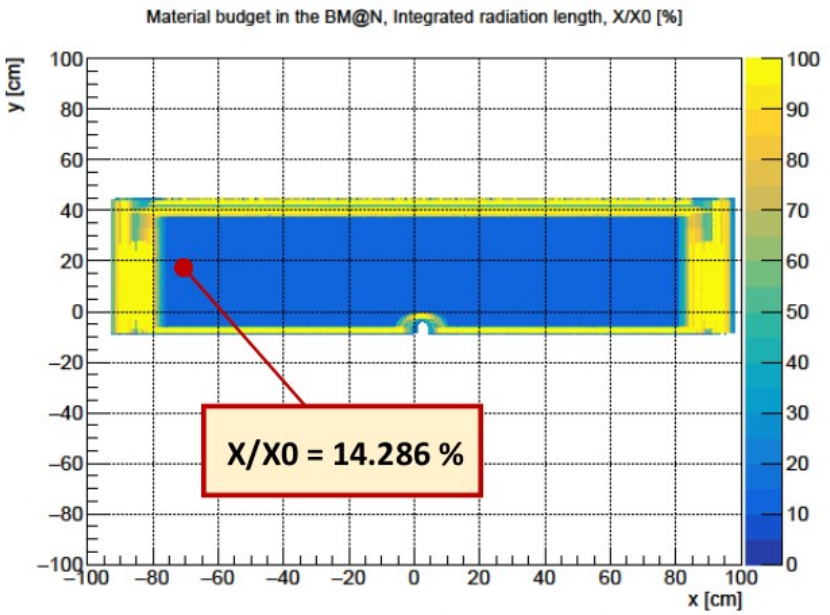


- MC efficiency lower than Data efficiency on ~5% in average for all TOF400 planes

Detailed Si/GEM geometry



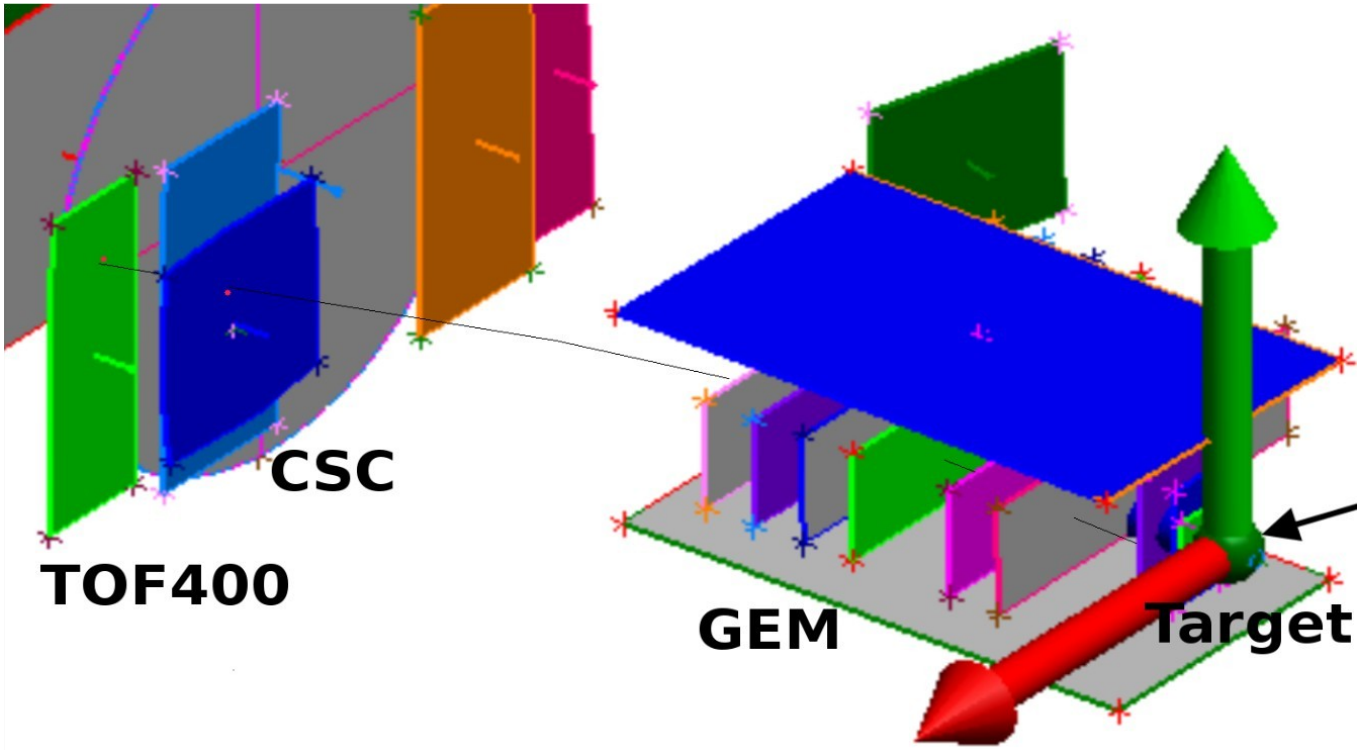
Material budget of six stations for tracks parallel to Z axis (simplified geometry)



Material budget of six stations for tracks parallel to Z axis (detailed geometry)

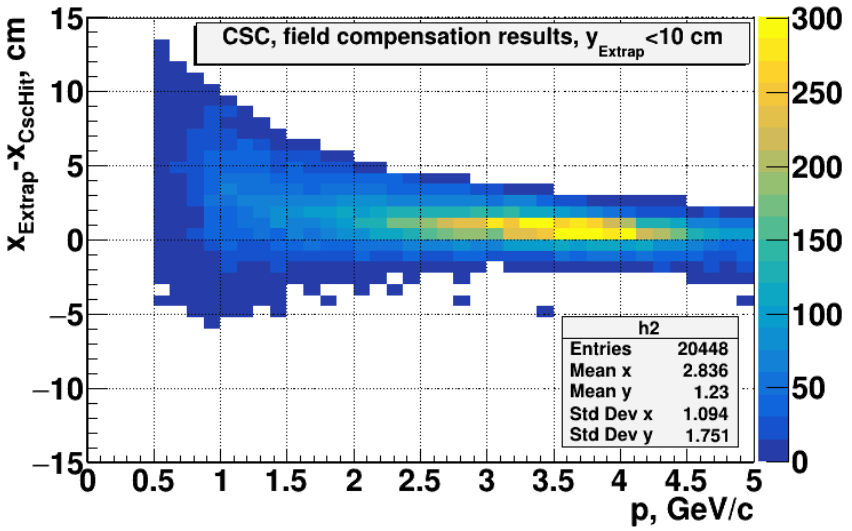
- Made by Dmitriy Baranov
- Left plot – current geometry, right plot – new geometry
- New geometry gives additional background (embedding is aimed to solve it) and prevents π^+ from passing through identification detectors

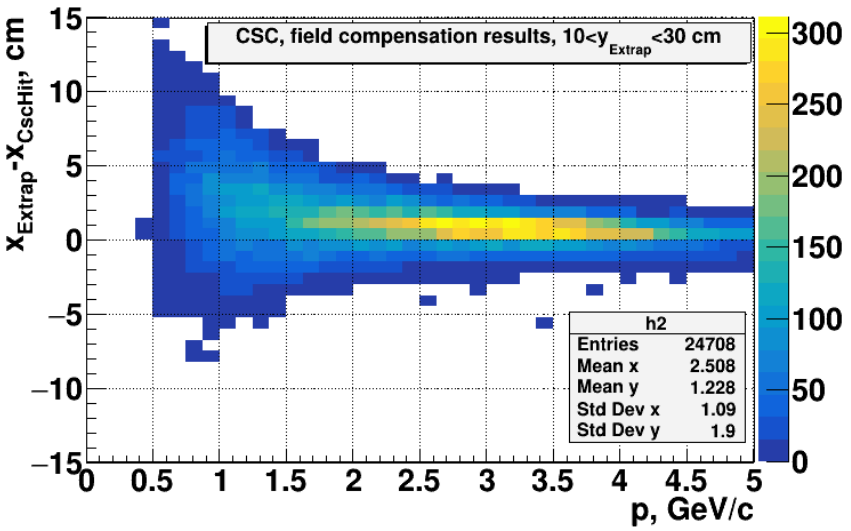
Si+GEM+CSC+Extend features



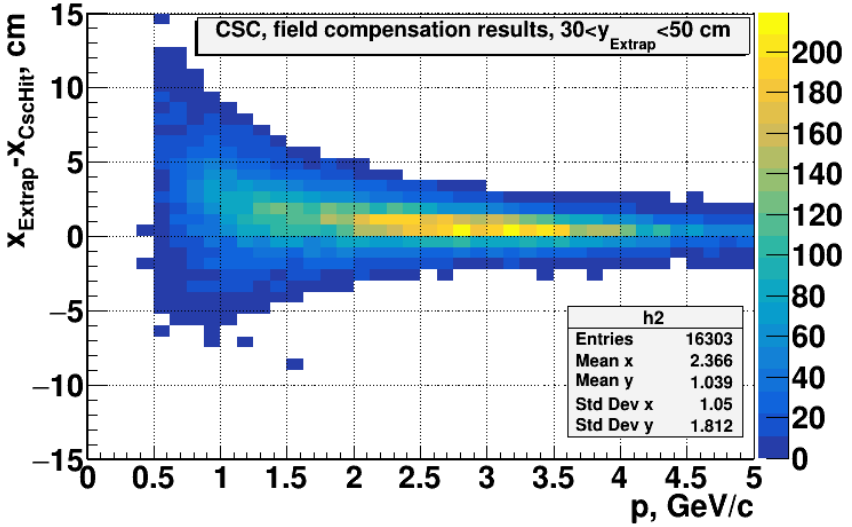
- Short tracks are reconstructed using hits from last four GEMs
- Short tracks are extrapolated upstream and refitted with matched hits from first two GEMs and Silicones
- Tracks are extrapolated downstream and refitted with matched hits from CSC

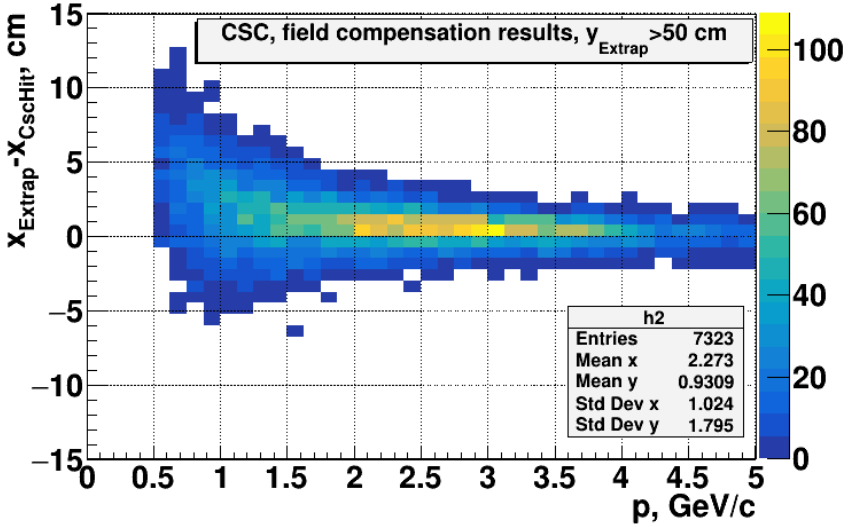
Matching CSC hits at Y intervals



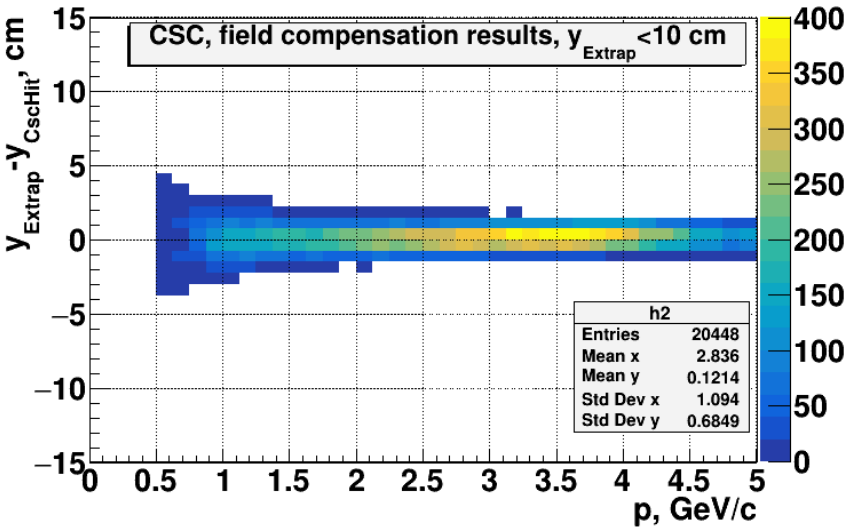


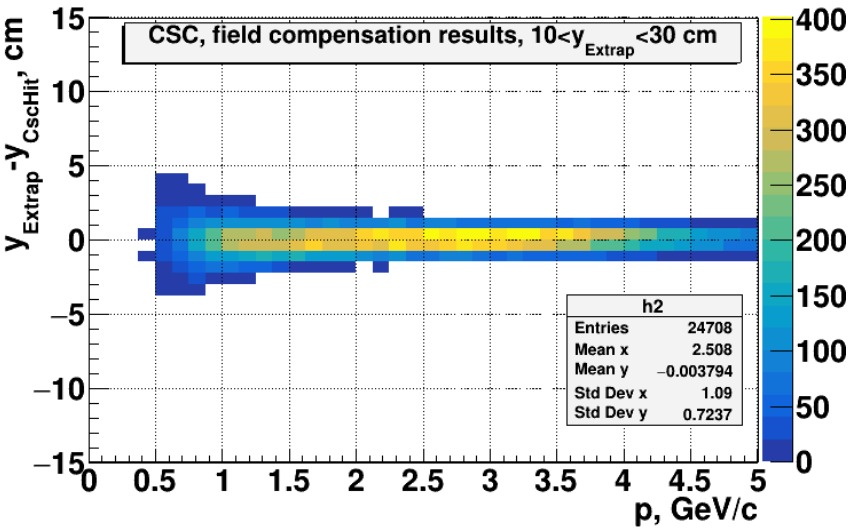
dx



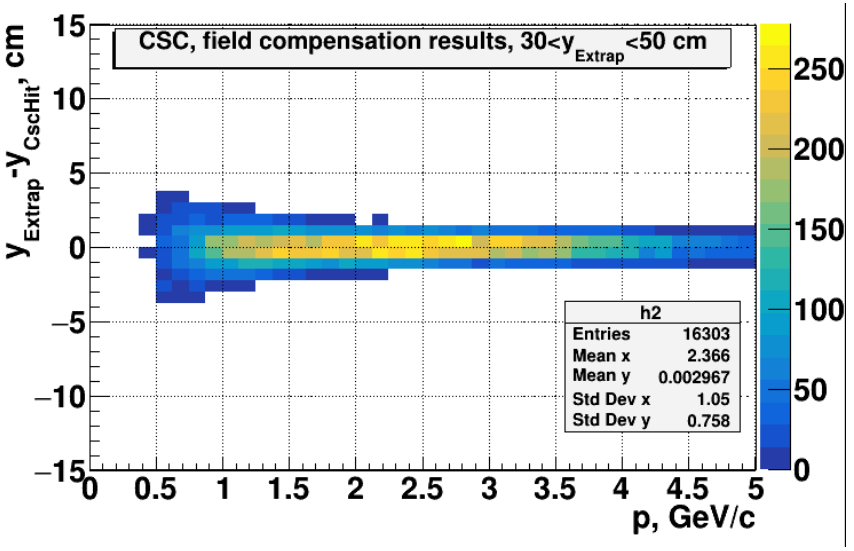


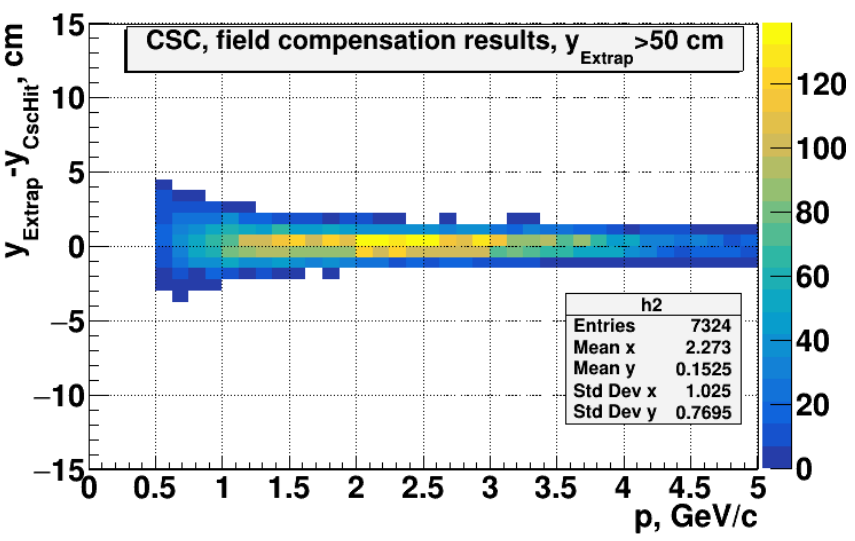
Matching CSC hits at Y intervals



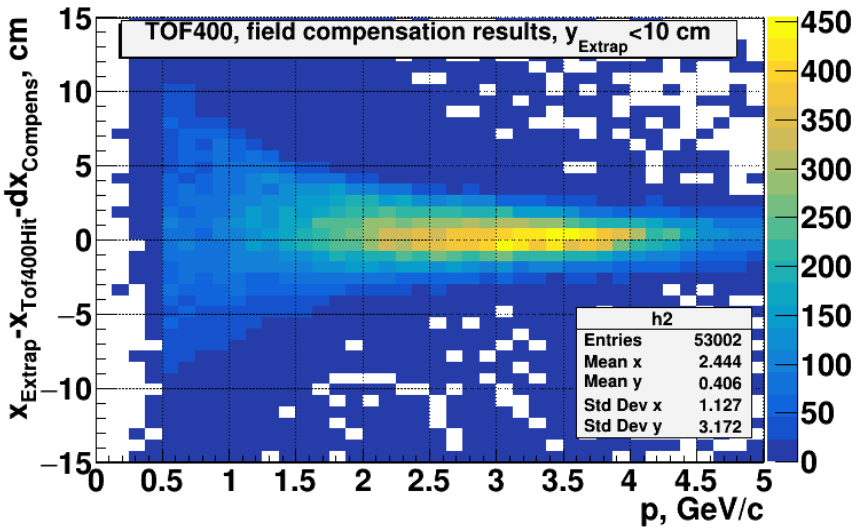


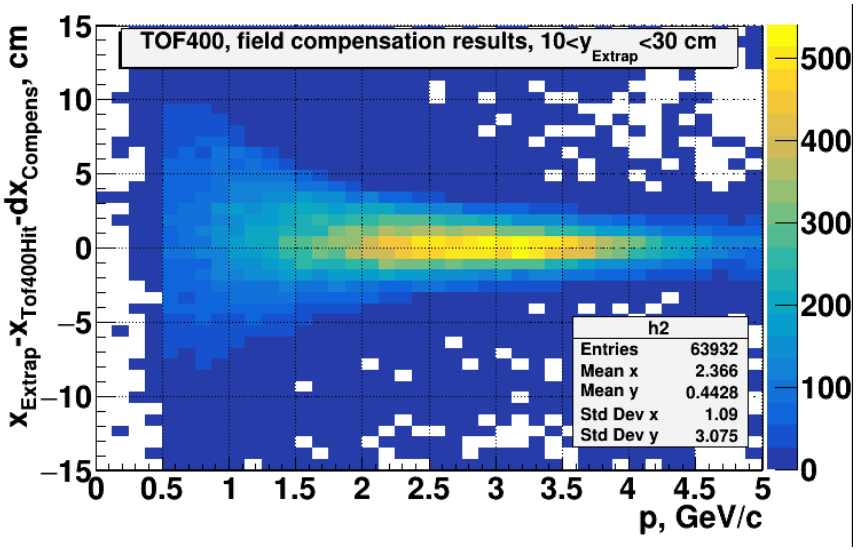
dy



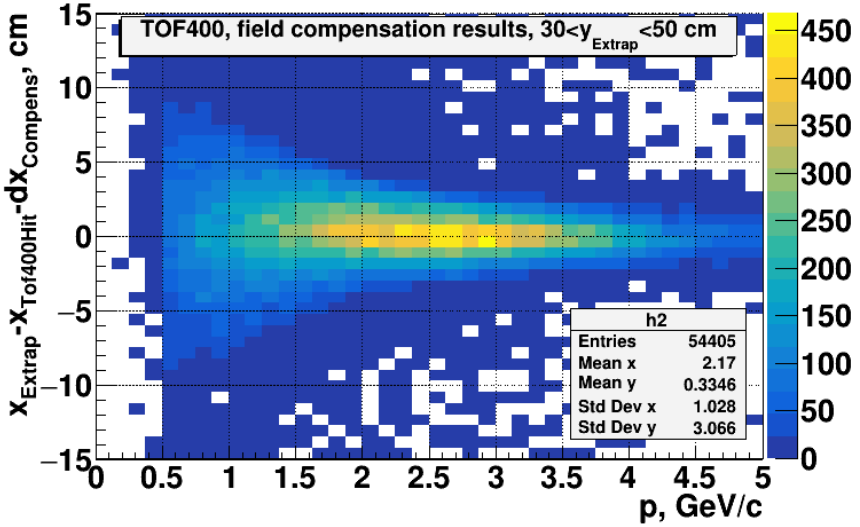


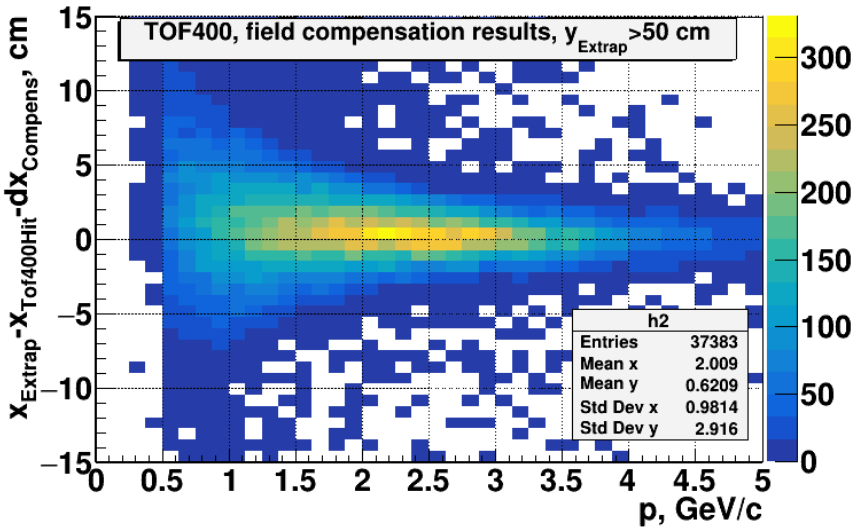
Matching TOF400 hits at Y intervals



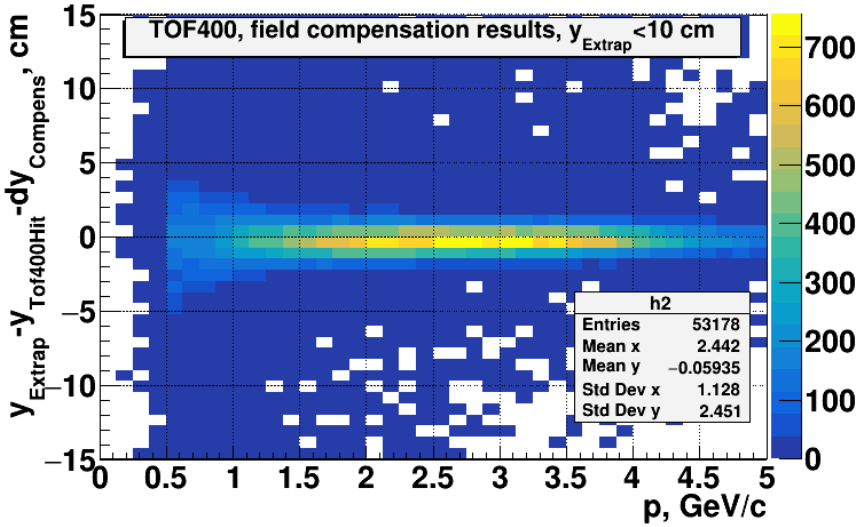


dx

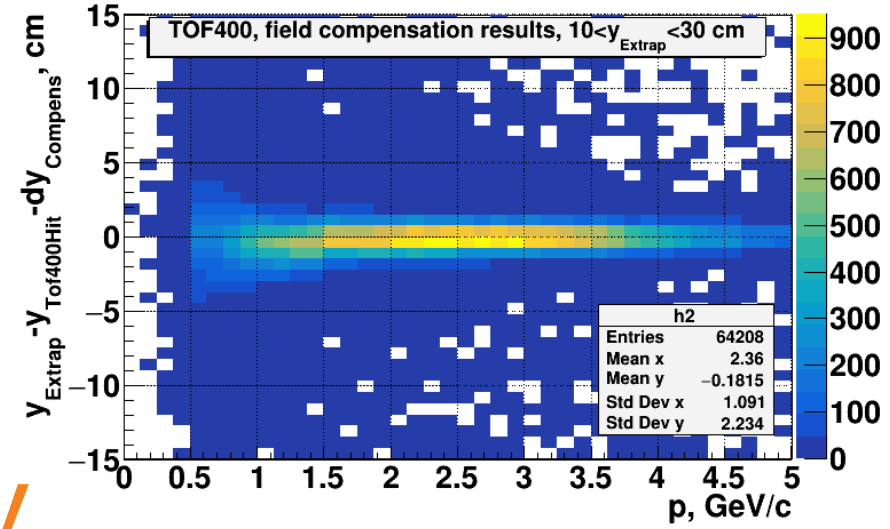


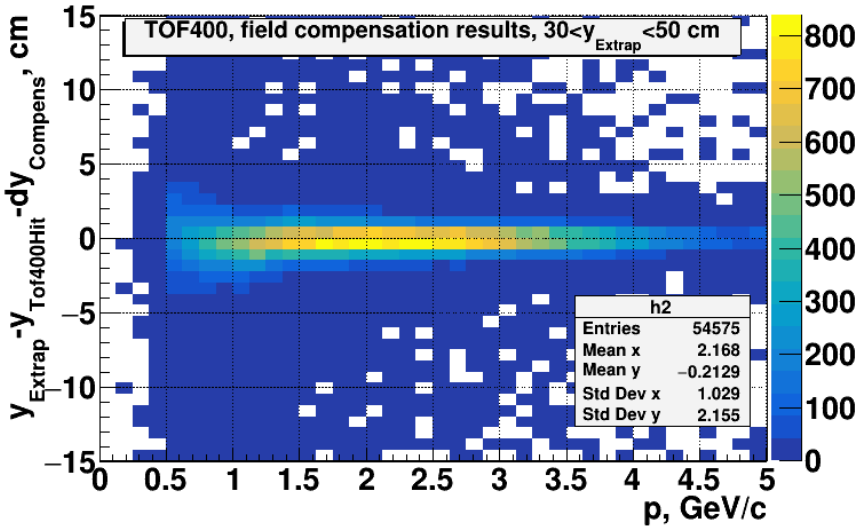


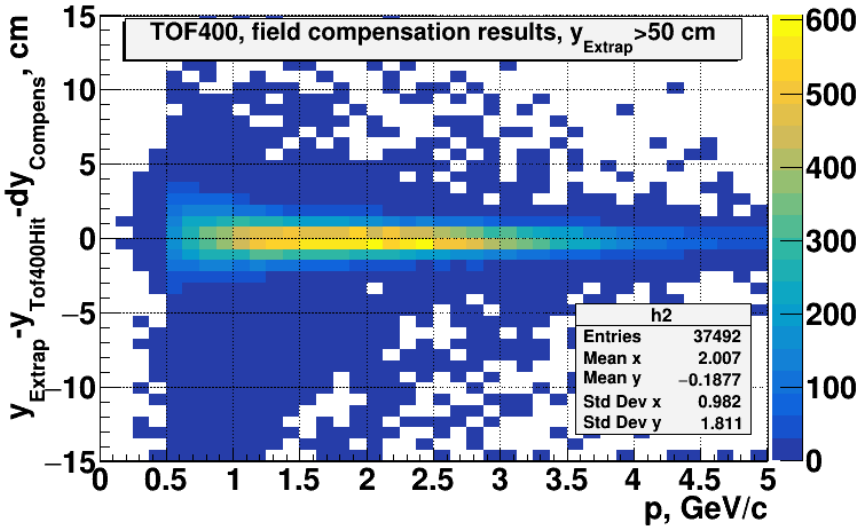
Matching TOF400 hits at Y intervals



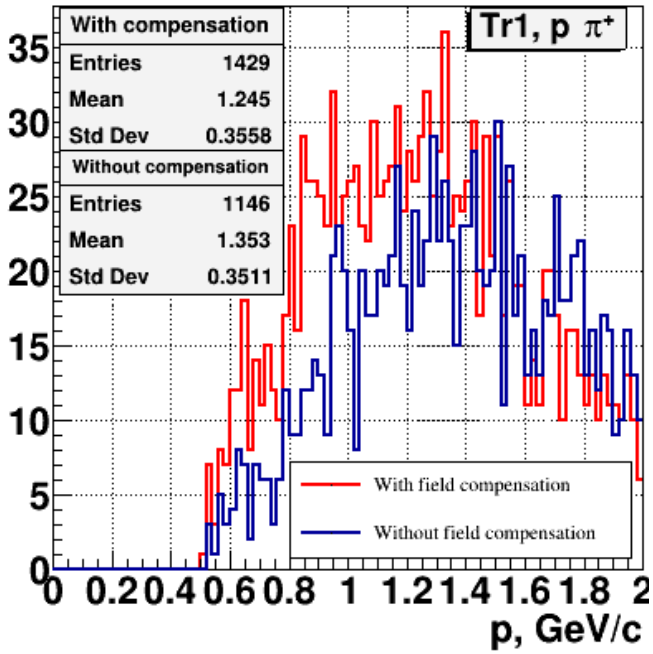
dy

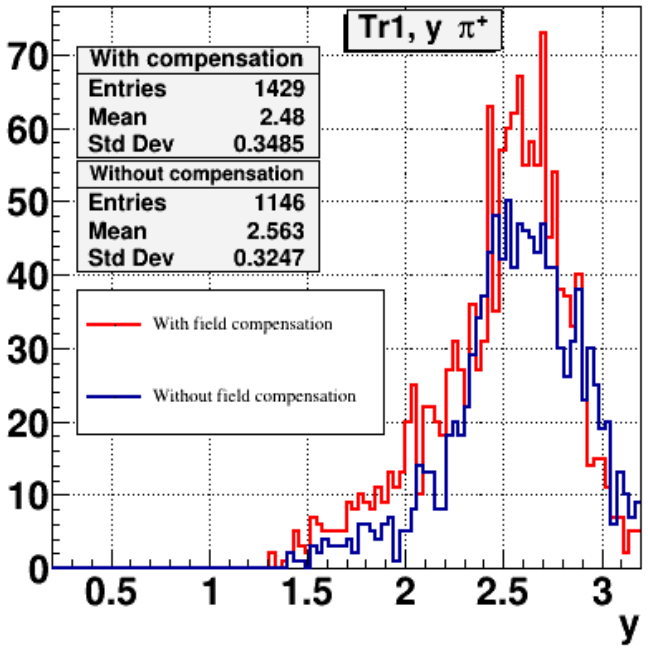


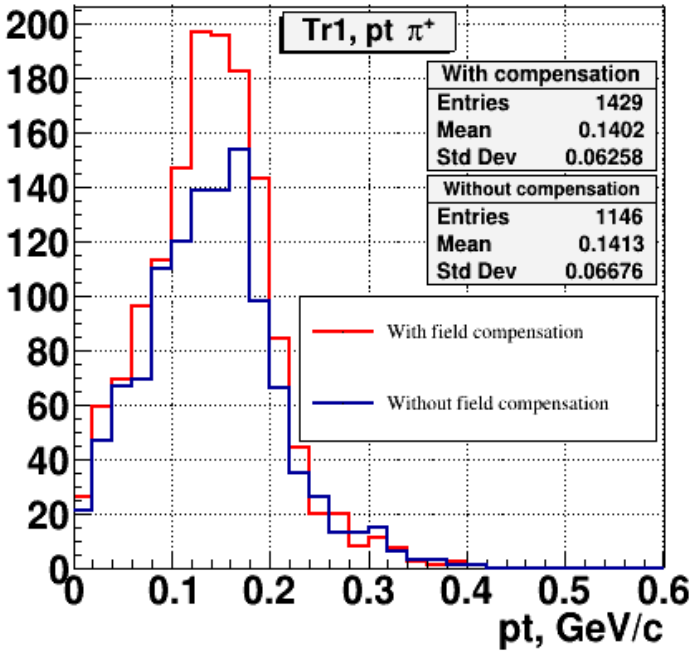




Control plots. Data after field compensation **vs** data before it

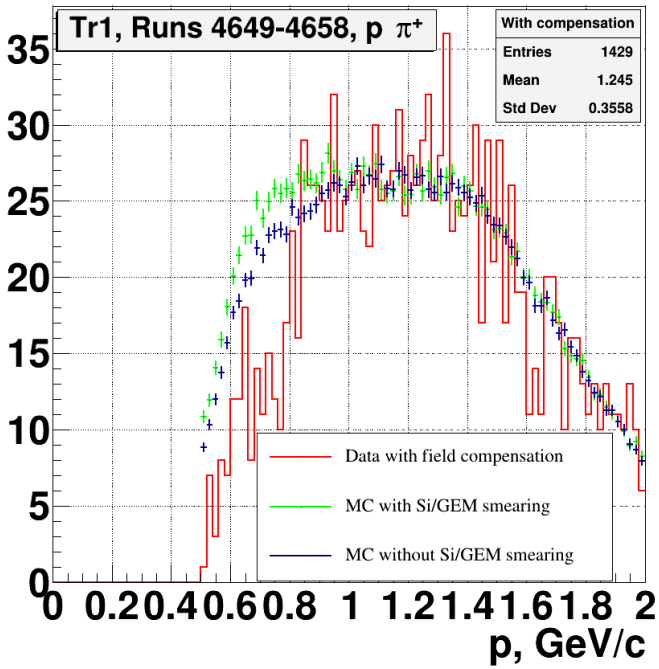


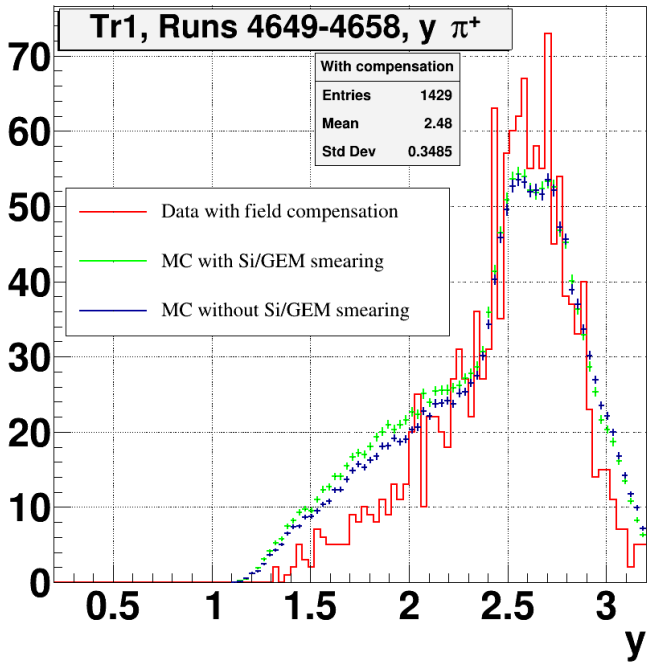


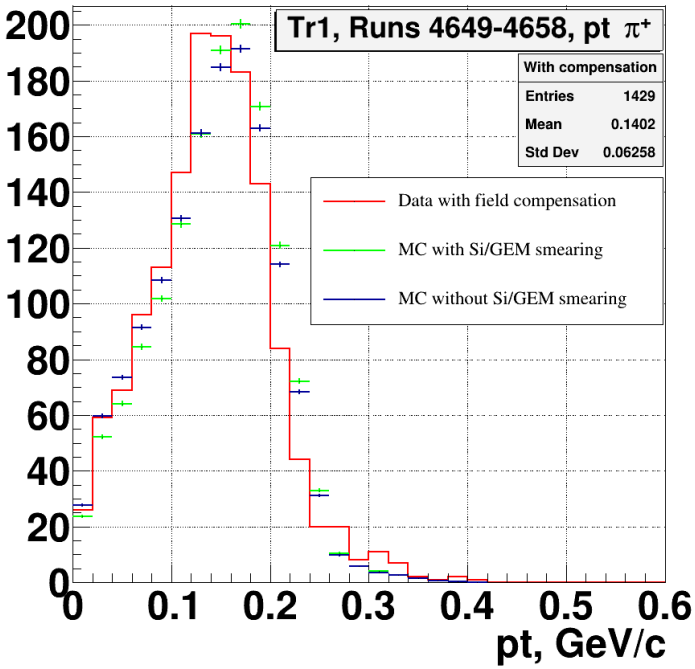


- The number of found π^+ increased by ~20%
- p_{full} spectrum became softer as expected

Control plots. Data **vs** MC

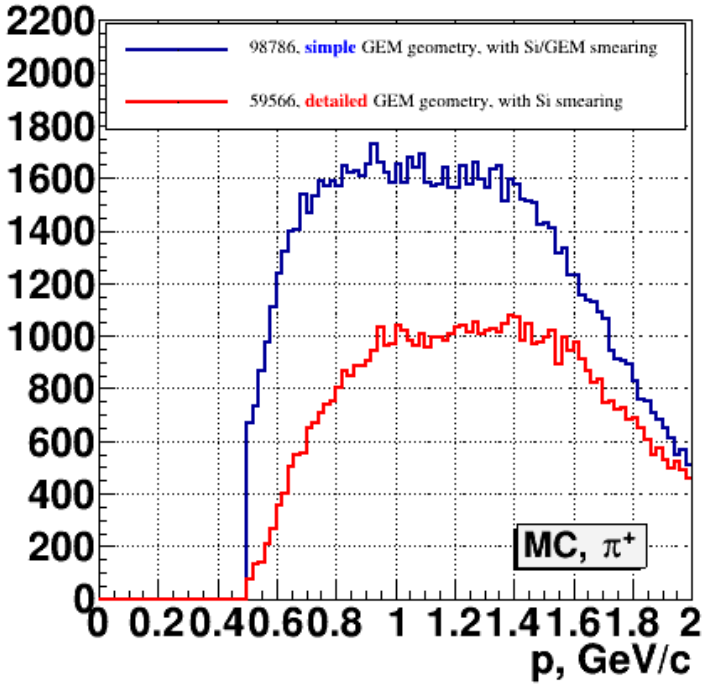


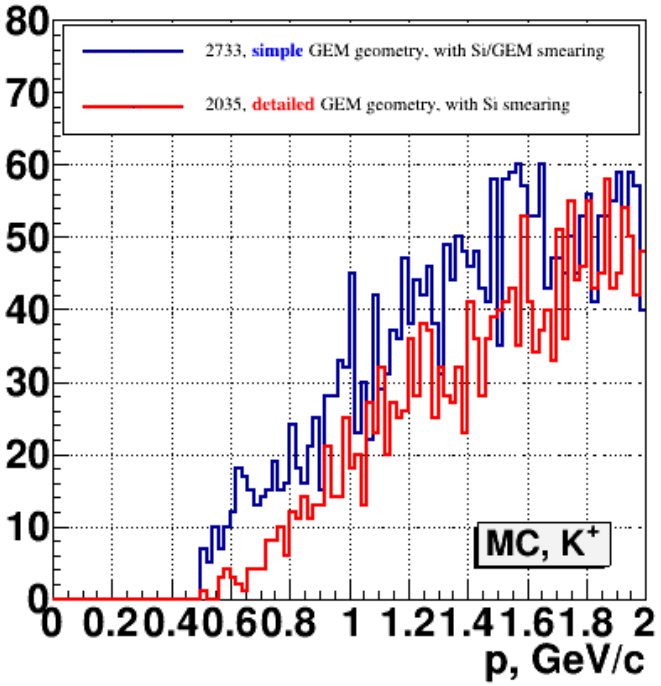




- P-spectrum of the data corresponds to the MC spectrum from 2 to ~0.8 GeV/c
- Y-spectrum of data is consistent with MC spectrum from 2 to 3.2
- Pt-spectrum of data is in a good agreement with MC spectrum

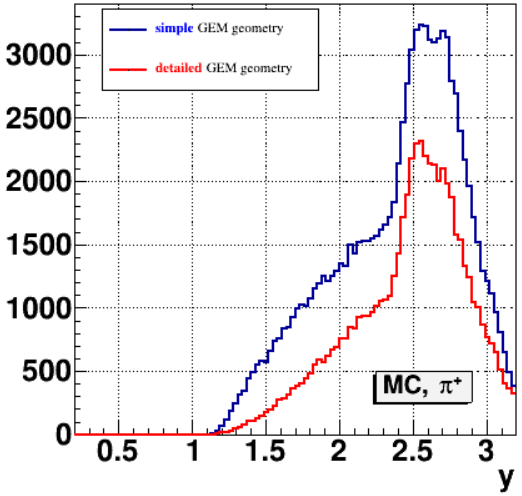
Control plots. Detailed vs simple GEM geometry

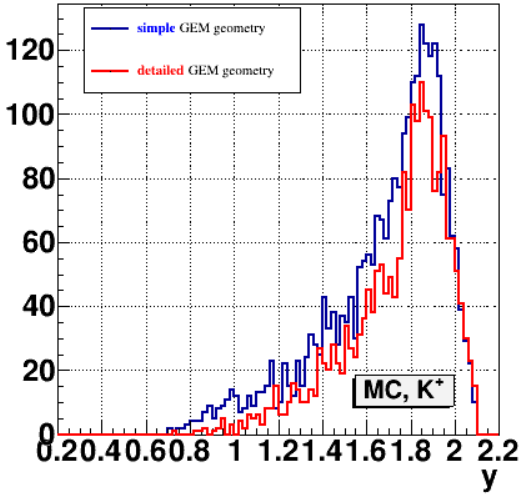


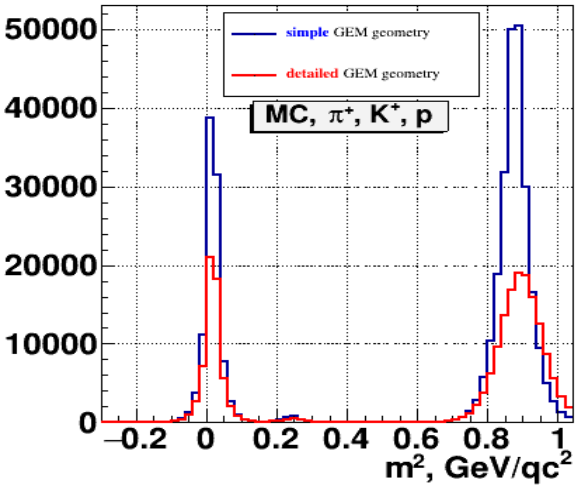


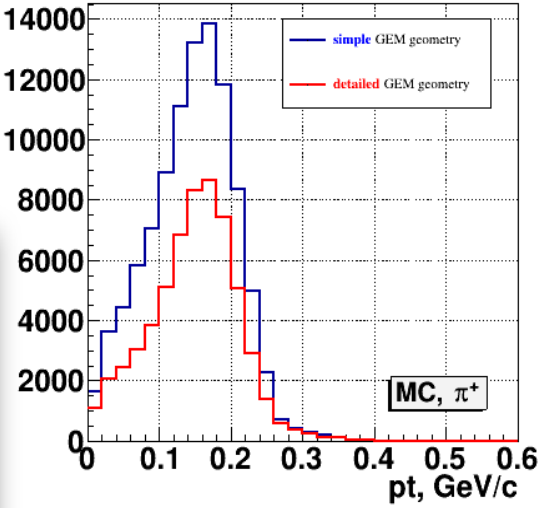
- $N_{\pi+,detailed}(p)/N_{\pi+,simple}(p)$ increases with p
- $N_{K+,detailed}(p)/N_{K+,simple}(p)$ almost independent of p
- $N_{\pi+,detailed}/N_{\pi+,simple} \sim 0.6$, $N_{K+,detailed}/N_{K+,simple} \sim 0.74$

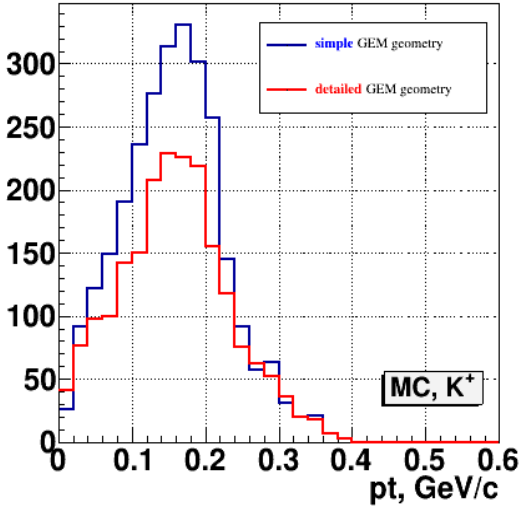
Control plots. Detailed vs simple GEM geometry

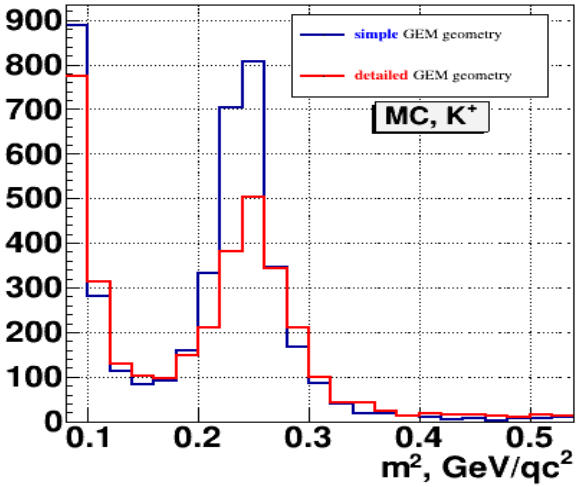




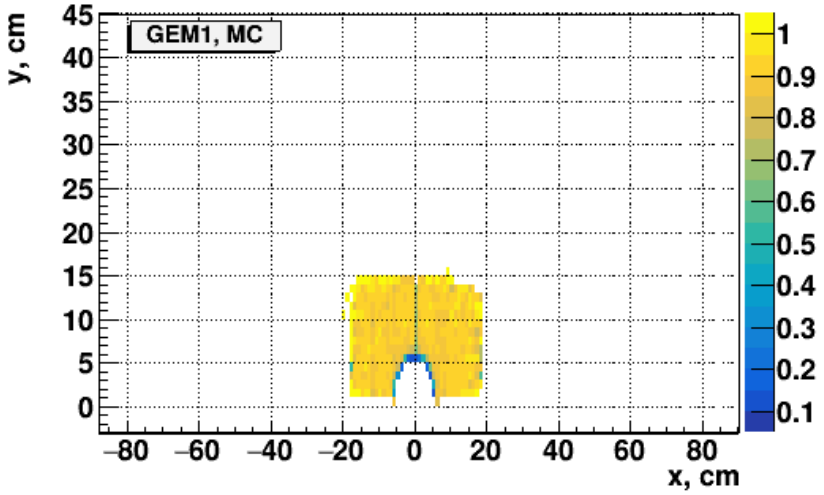


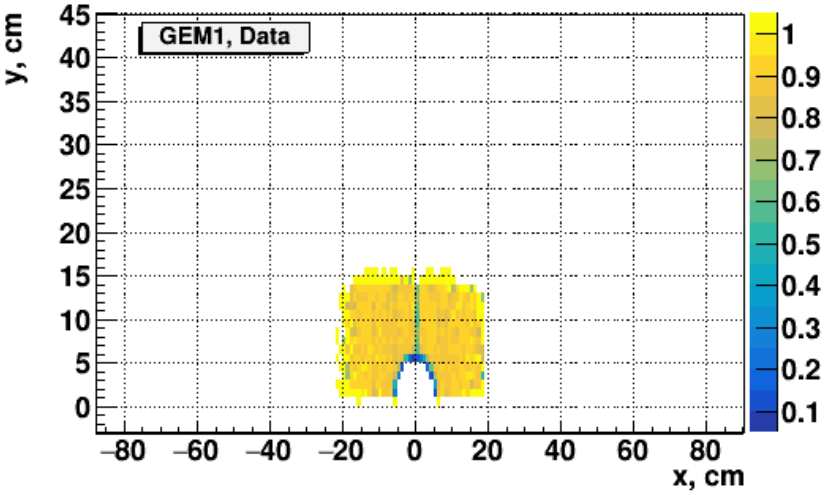




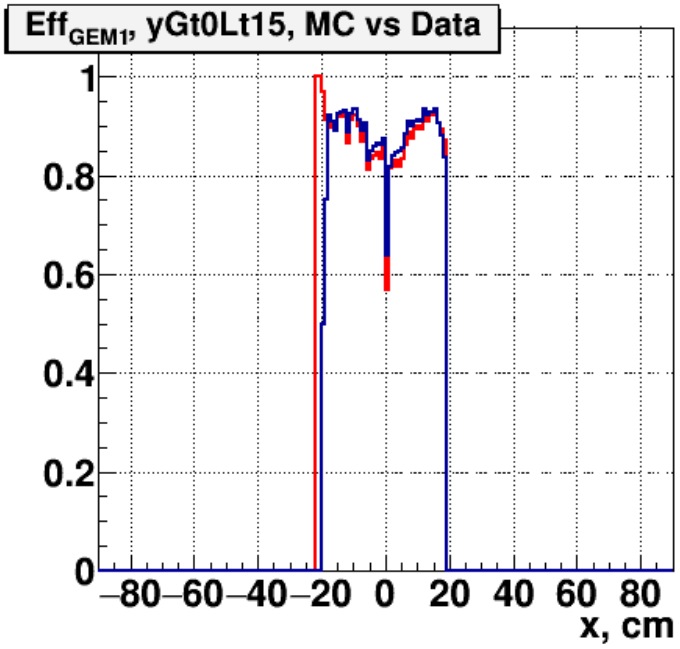


GEM1 efficiency, 0.5<p<2 GeV/c

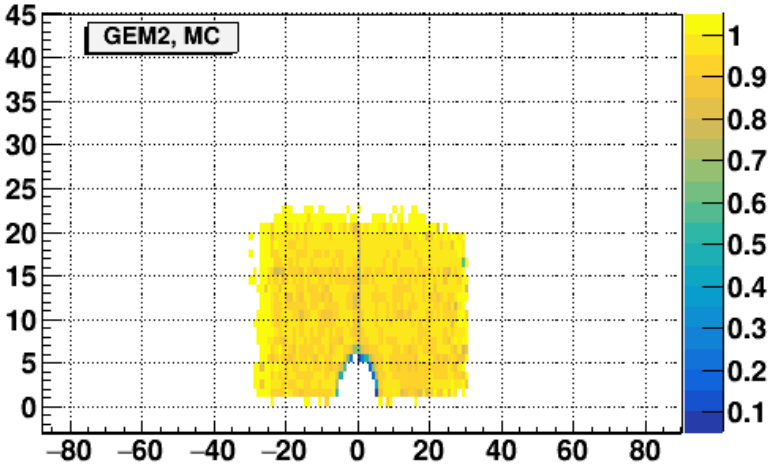


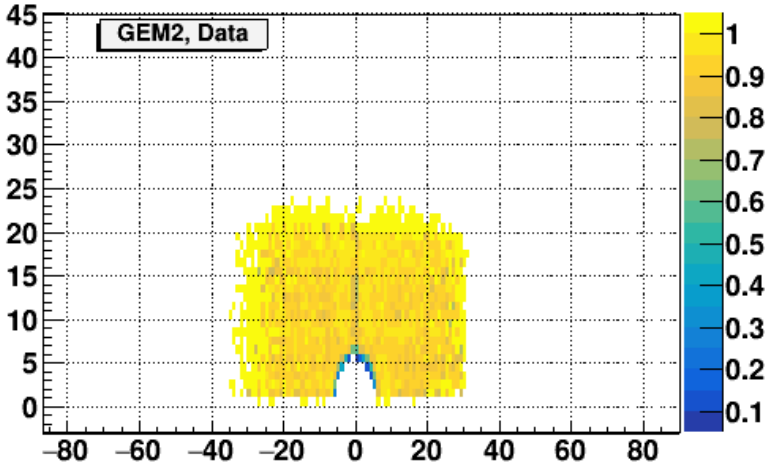


— MC — Data

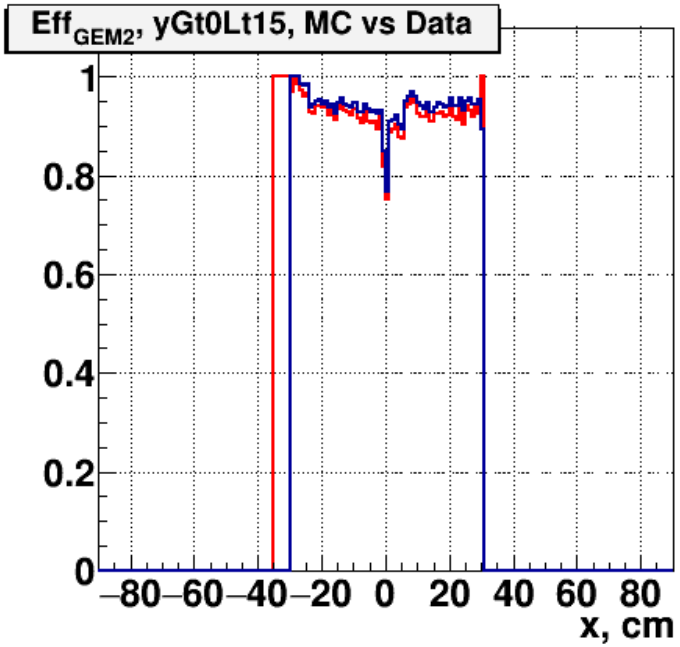


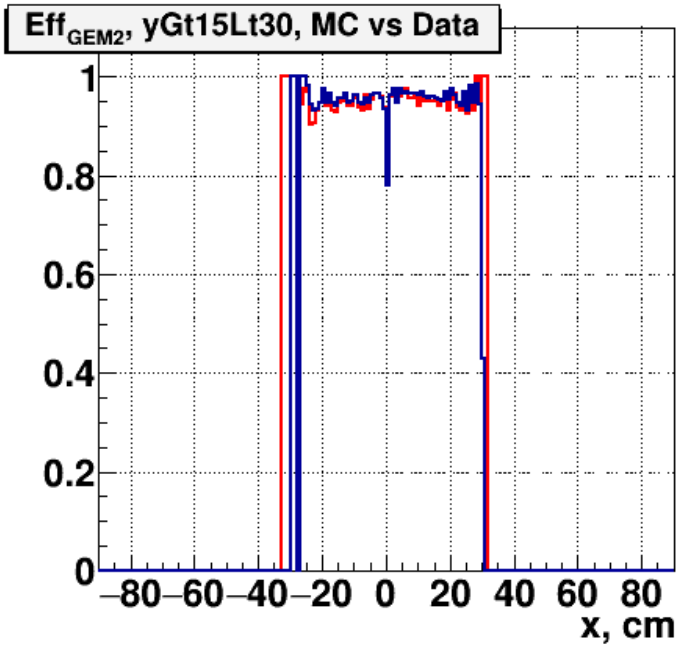
GEM2 efficiency, 0.5<p<2 GeV/c



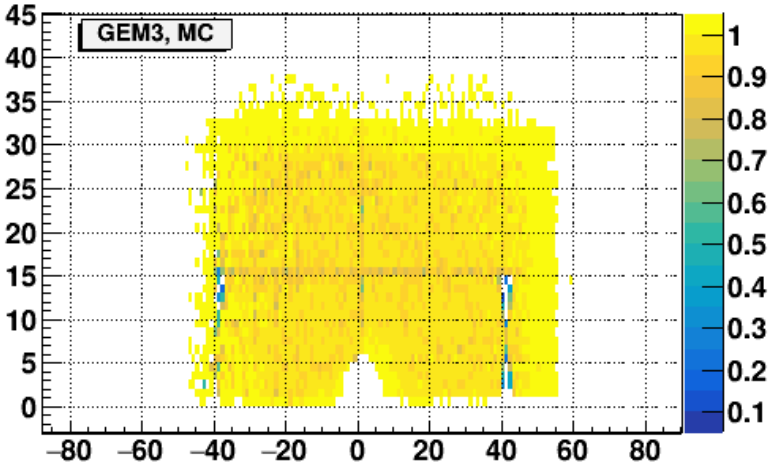


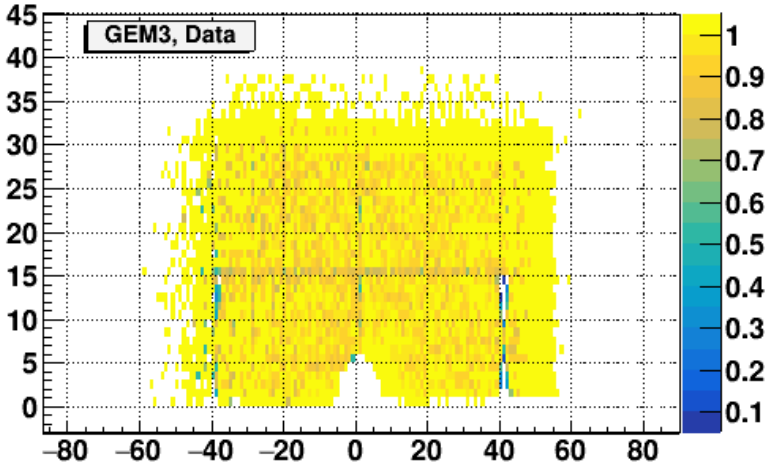
— MC — Data



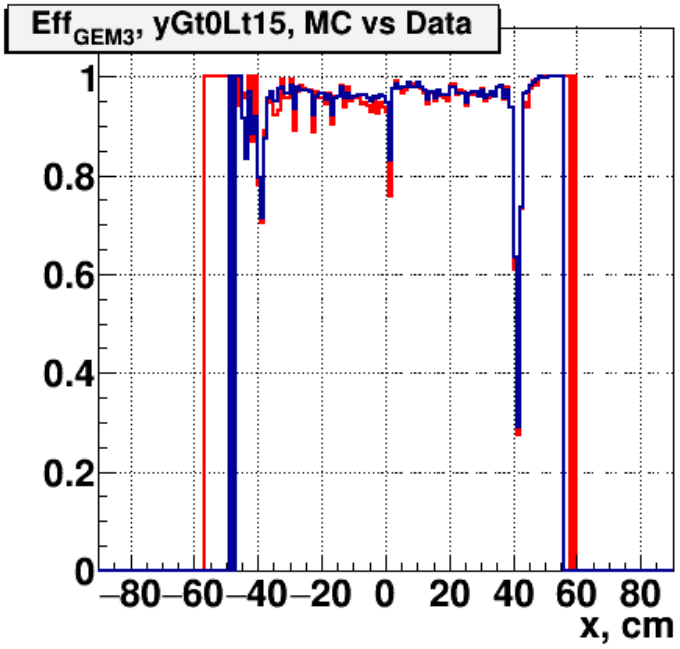


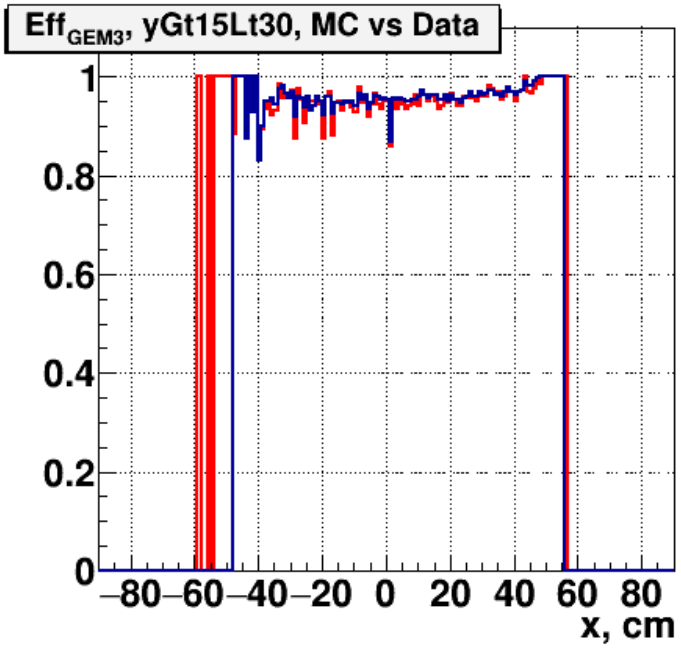
GEM3 efficiency, 0.5<p<2 GeV/c



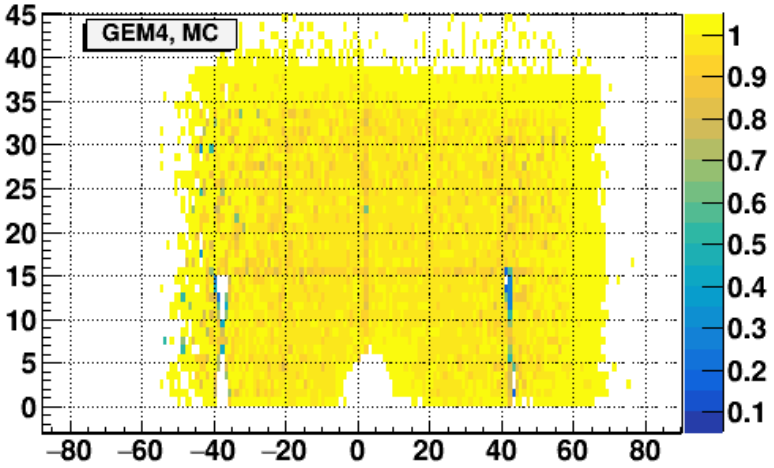


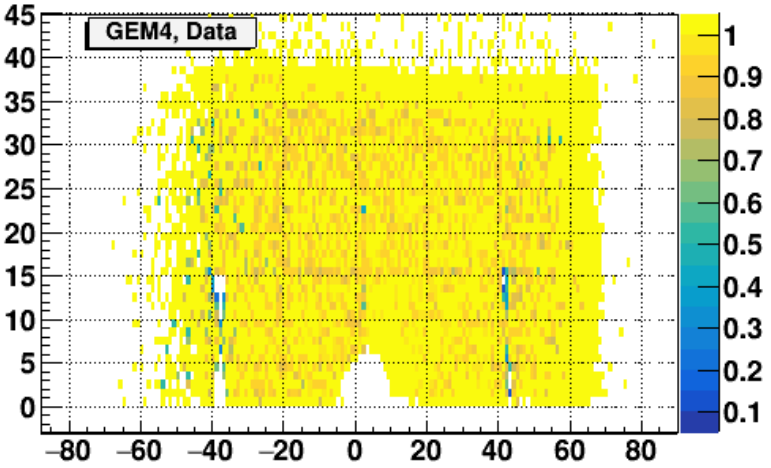
— MC — Data





GEM4 efficiency, 0.5<p<2 GeV/c





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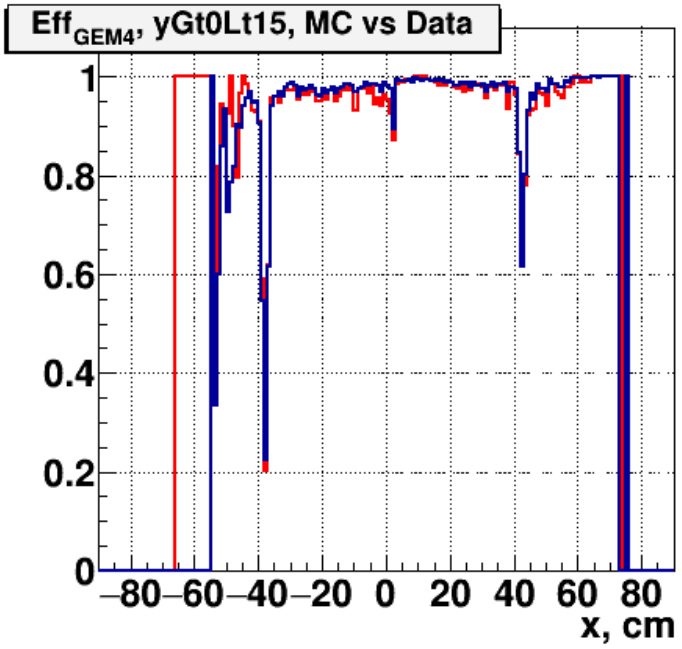
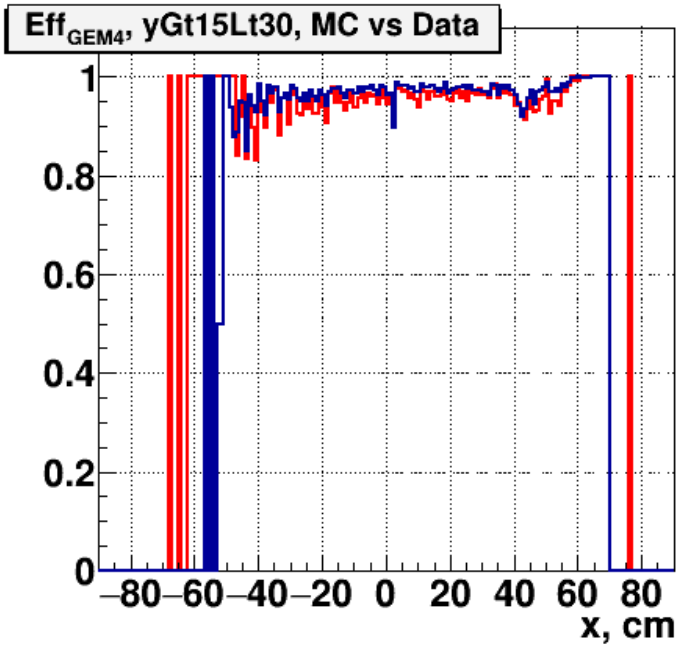
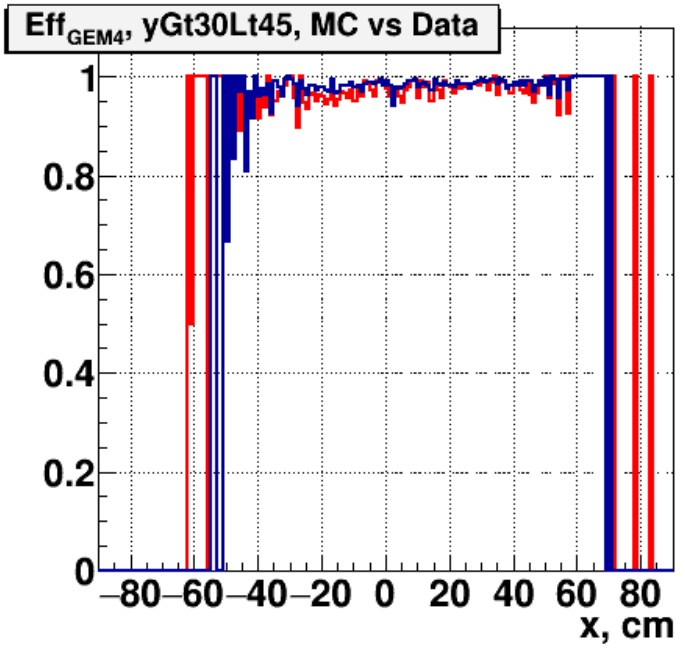
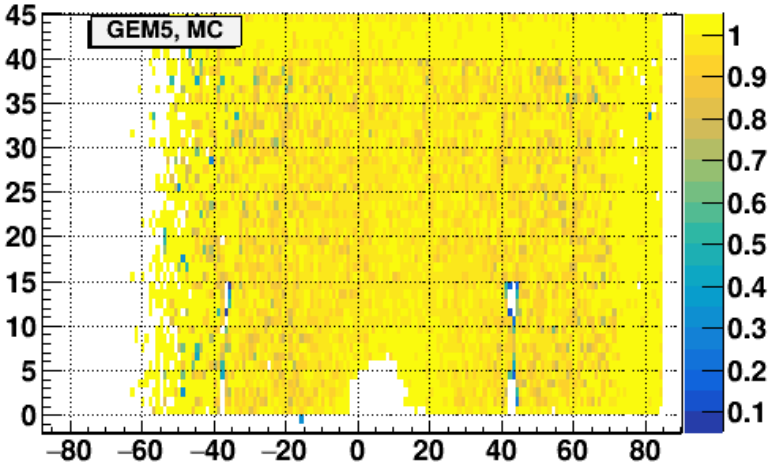
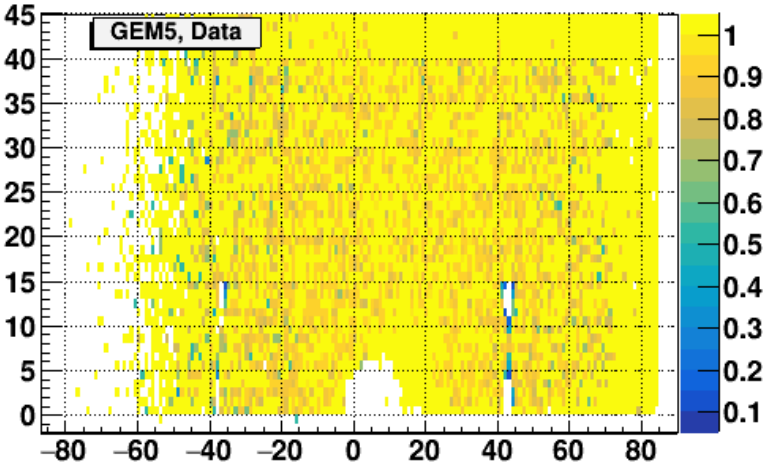




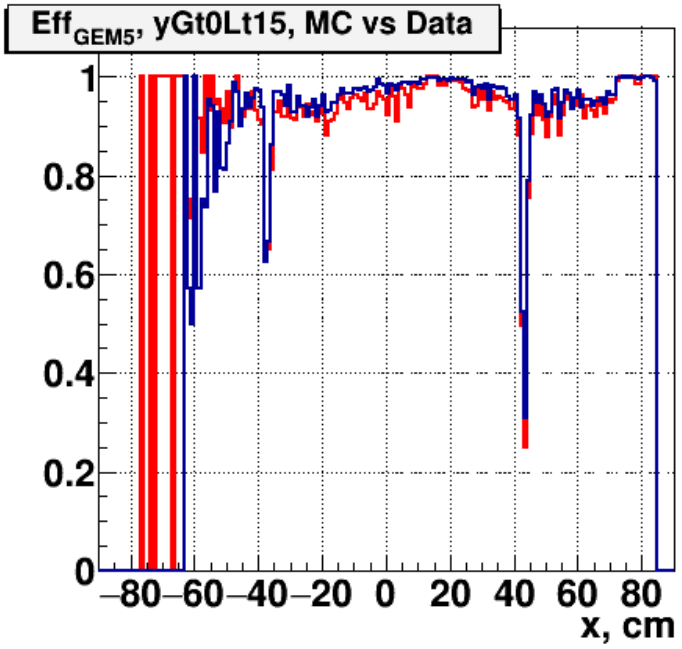


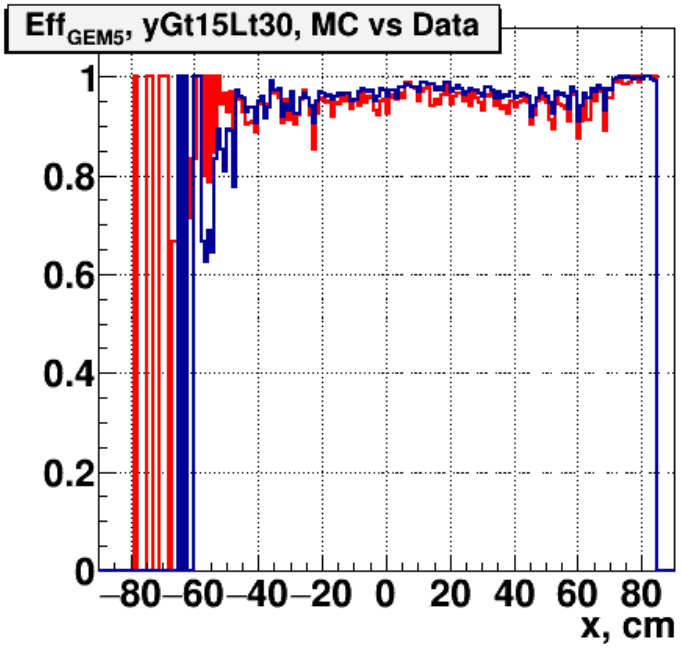
GEM5 efficiency, 0.5<p<2 GeV/c

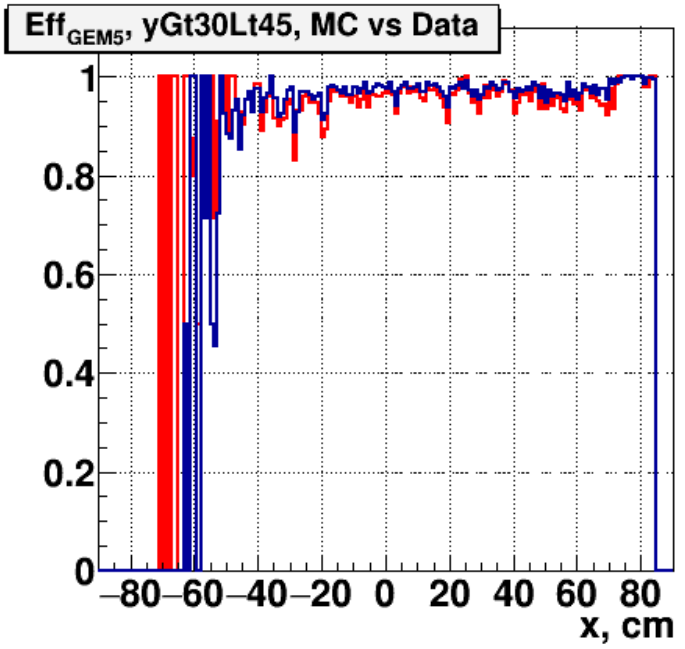




— MC — Data







Cuts for calculating/applying GEM efficiency

Cuts for choosing events

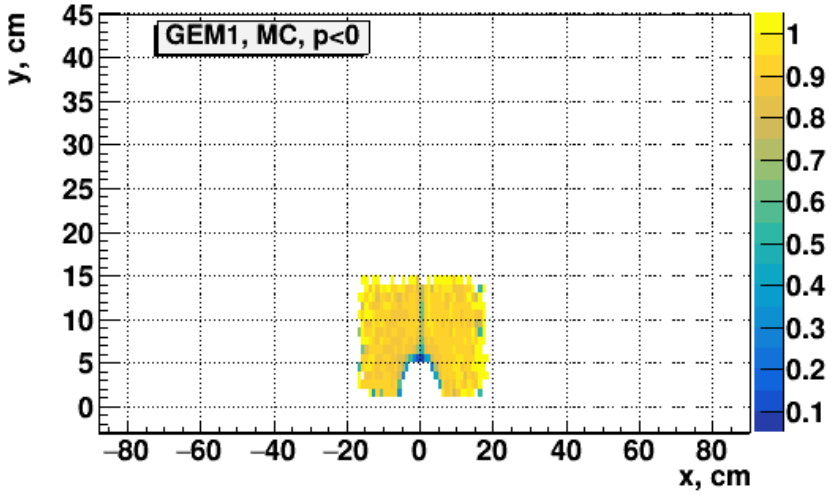
- |PV-TargetCenter|<6 cm
- $N_{3hitTracks}$>2

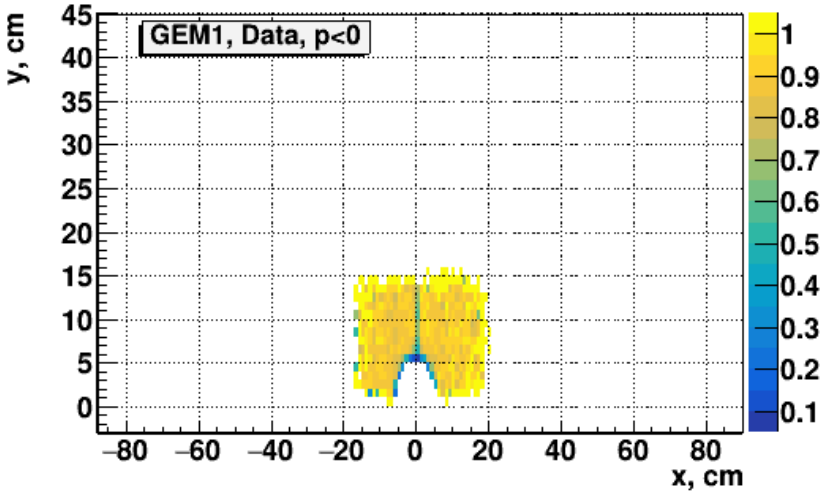
- **Cuts for choosing tracks**
- |Track-PV|<2 cm
- N_{SiHits}≥2 and $N_{GemHits}$≥4
- p<0 GeV/c

Applying Eff_{Norm} in MC

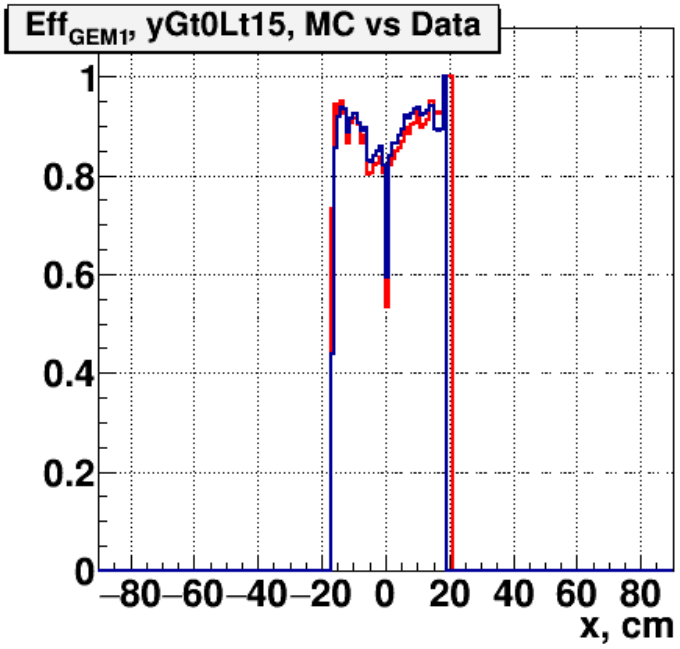
- Eff_{Norm} disabled for GEM6 and GEM5 at x>30 cm

GEM1 efficiency, p<0

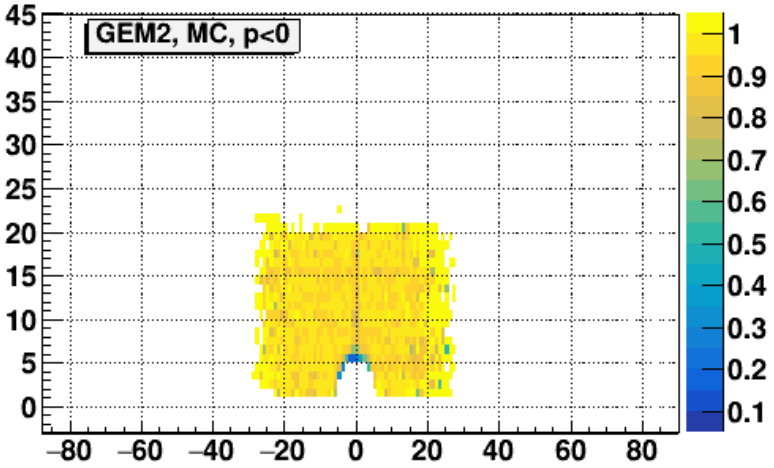


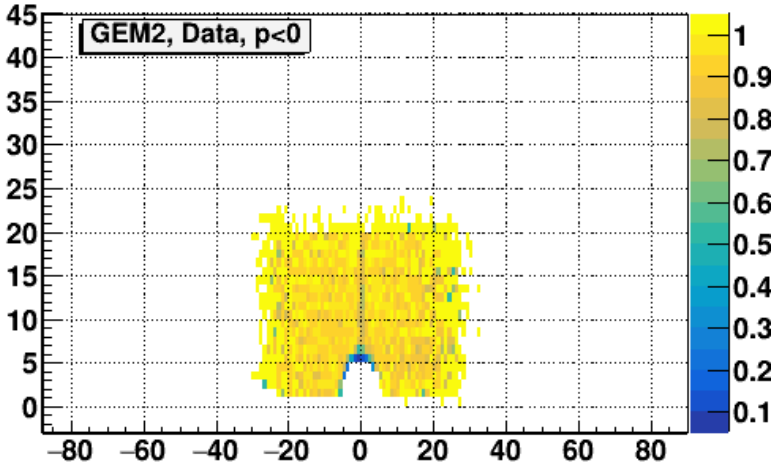


— MC — Data

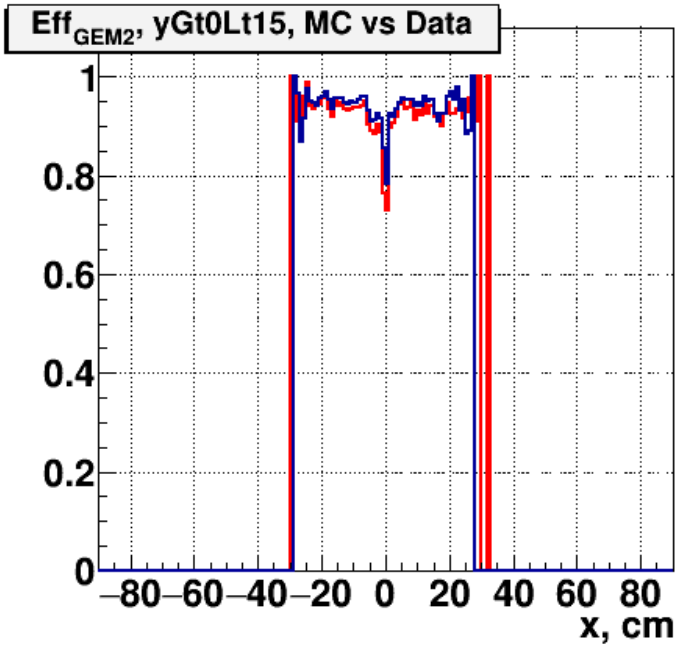


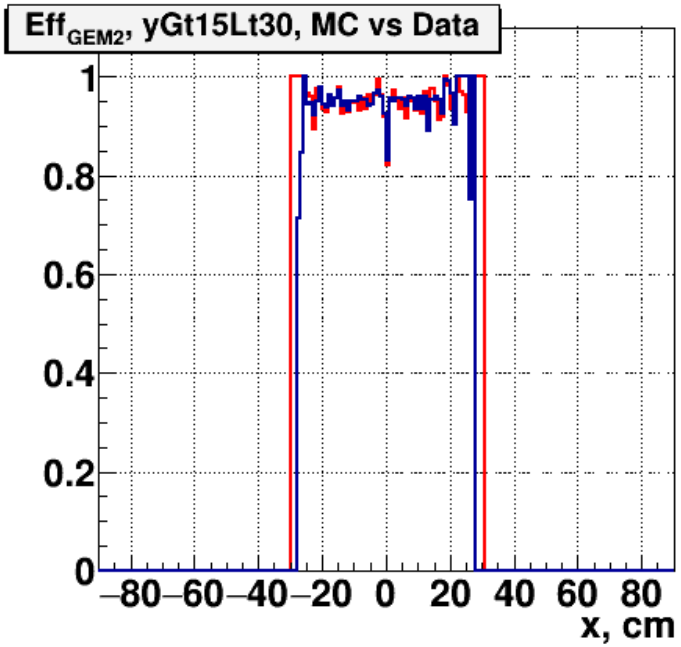
GEM2 efficiency, p<0



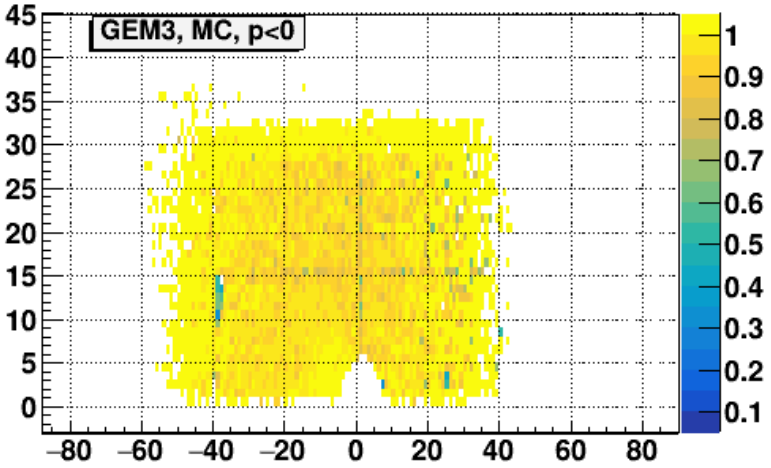


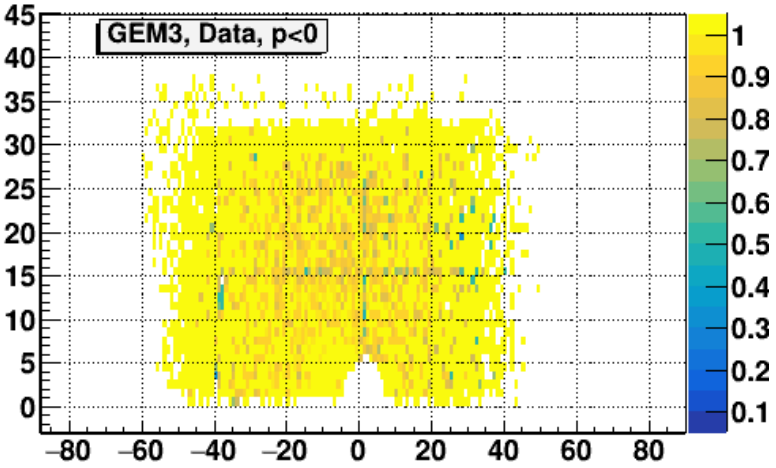
— MC — Data



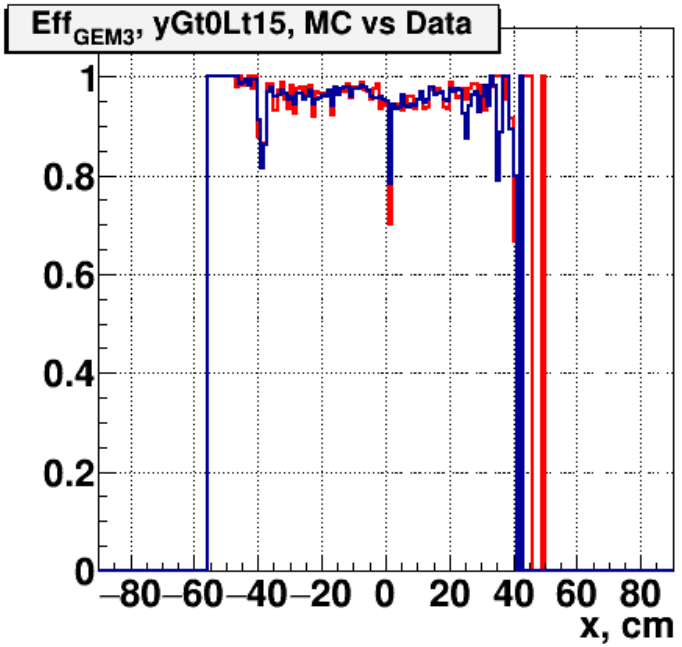


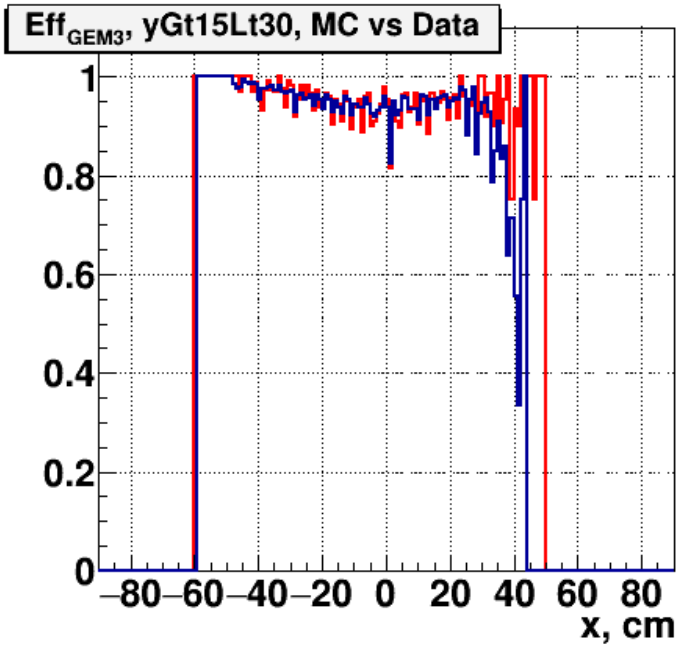
GEM3 efficiency, p<0



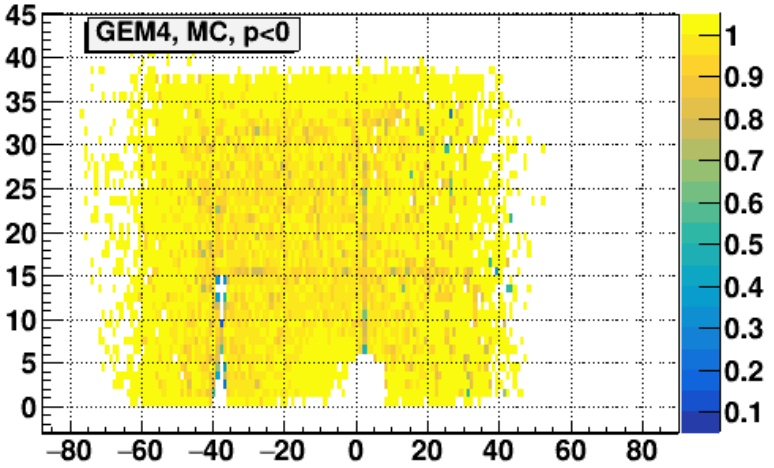


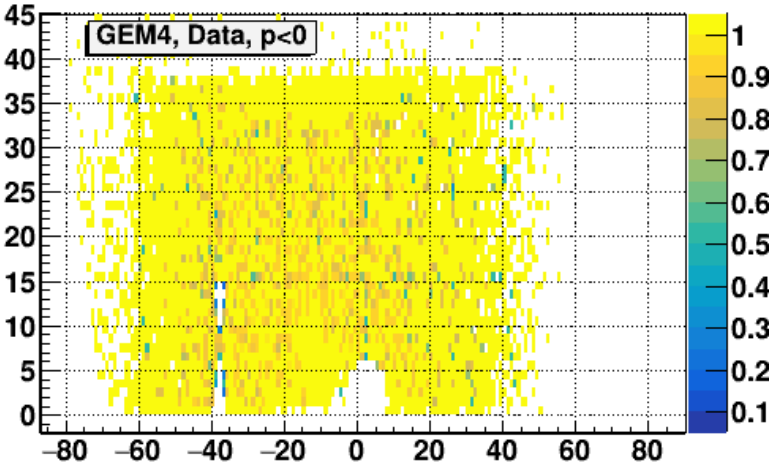
— MC — Data



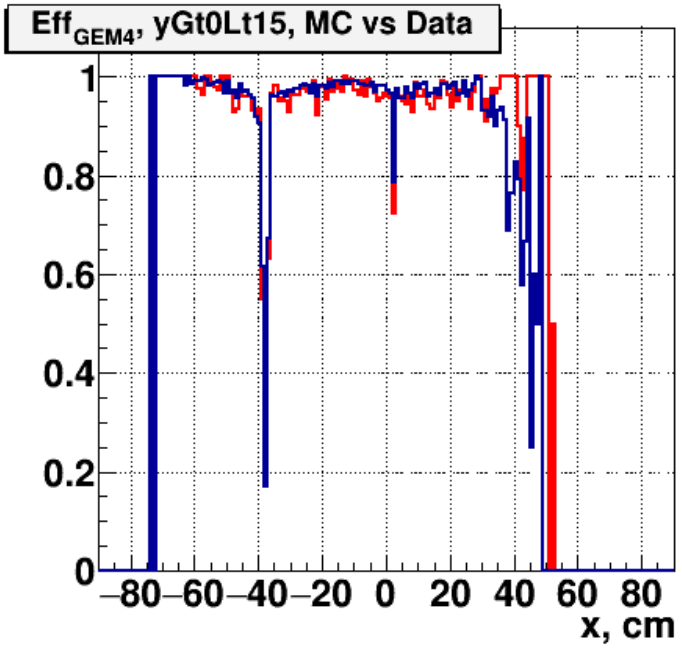


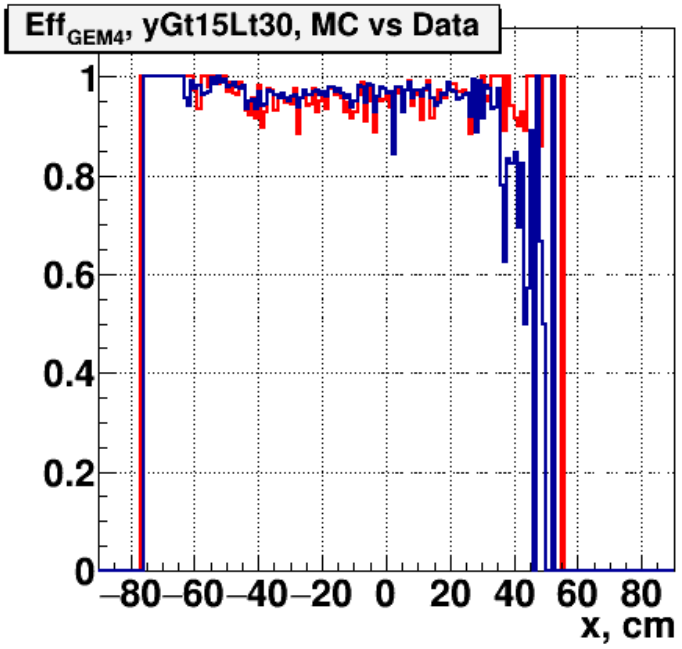
GEM4 efficiency, p<0

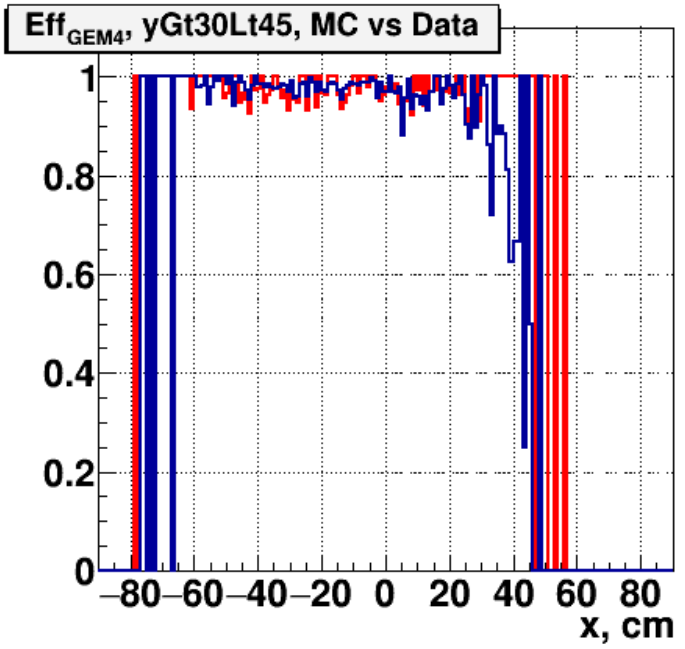




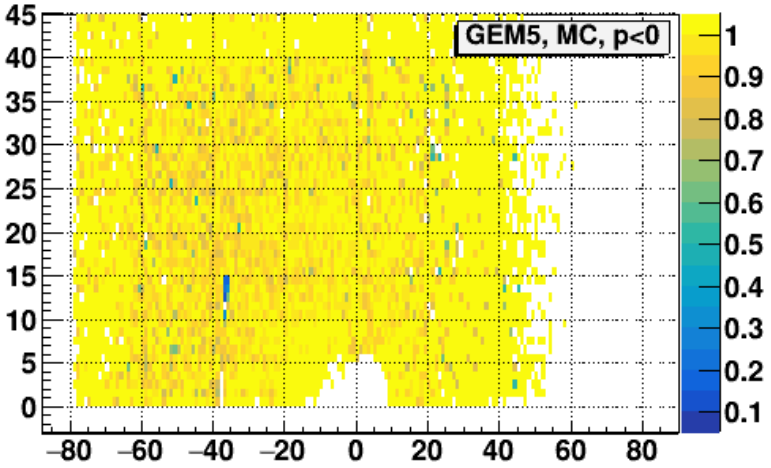
— MC — Data

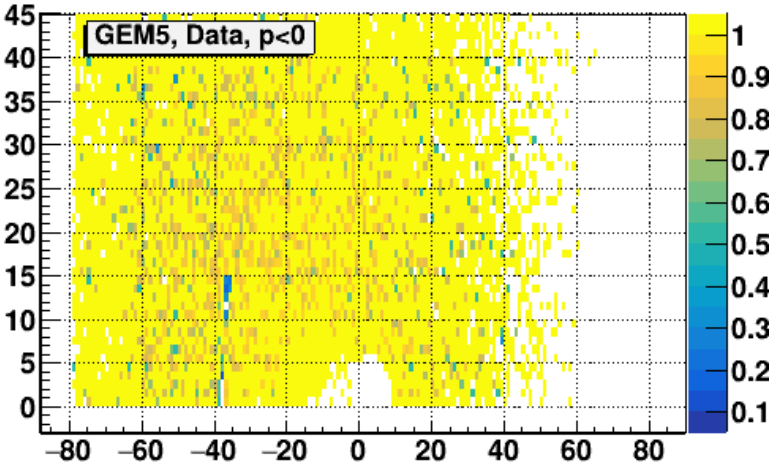




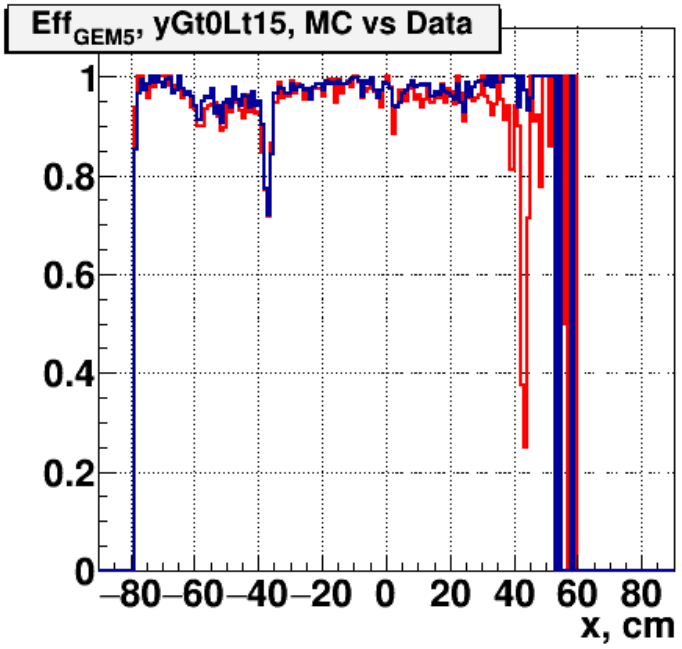


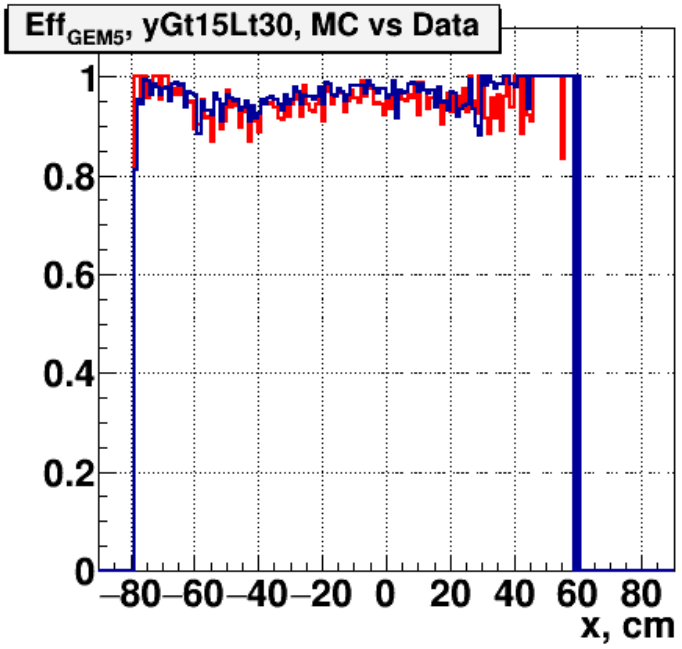
GEM5 efficiency, p<0

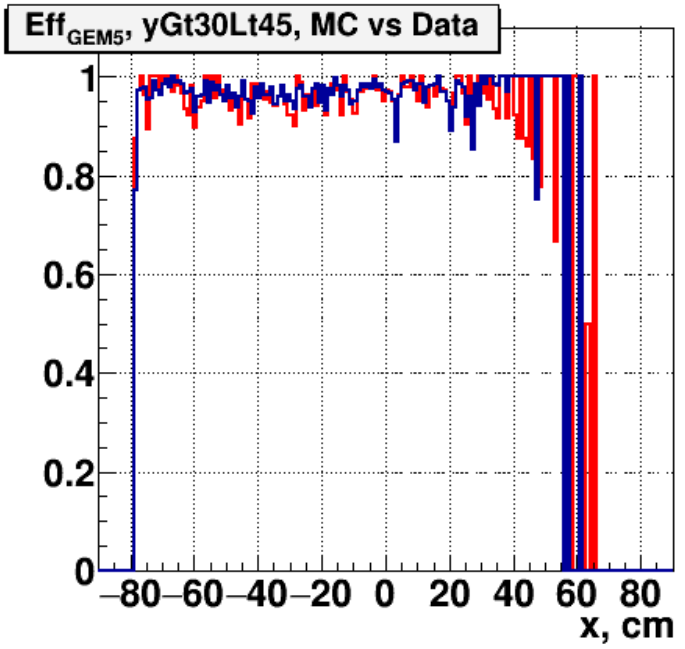




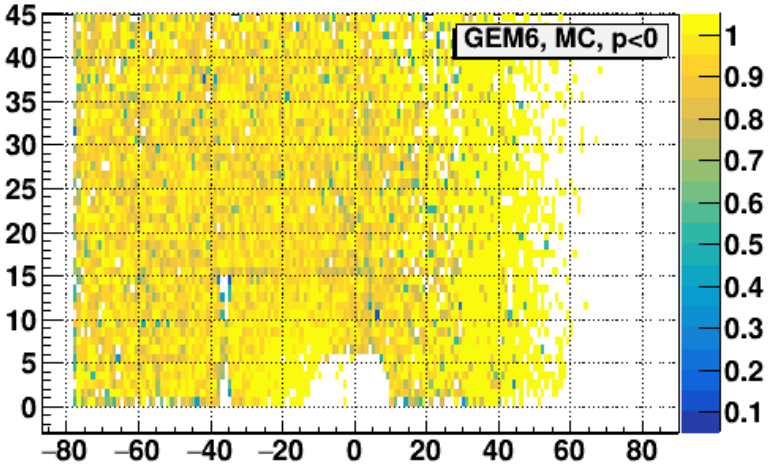
— MC — Data

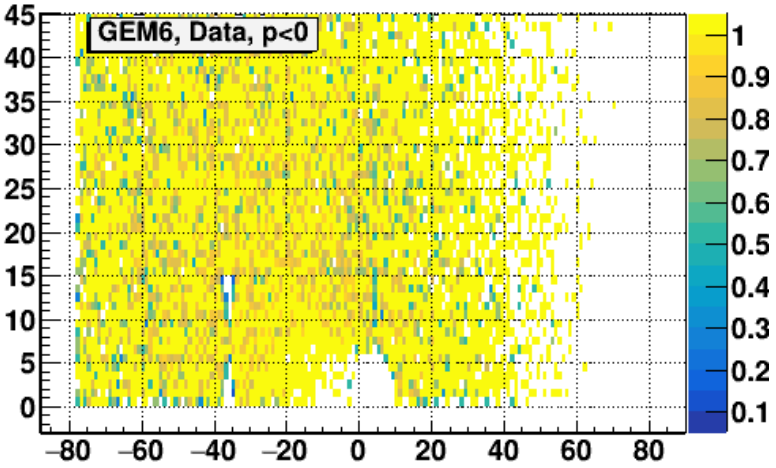






GEM6 efficiency, p<0





— MC — Data