JOINT INSTITUTE FOR NUCLEAR RESEARCH

Analysis and Detector Meeting
of the BM@N Experiment at NICA
JINR, Dubna, Russia, March 4-5, 2025

BM@N

Status of data analysis on Λ and K^0_s production in Xe run

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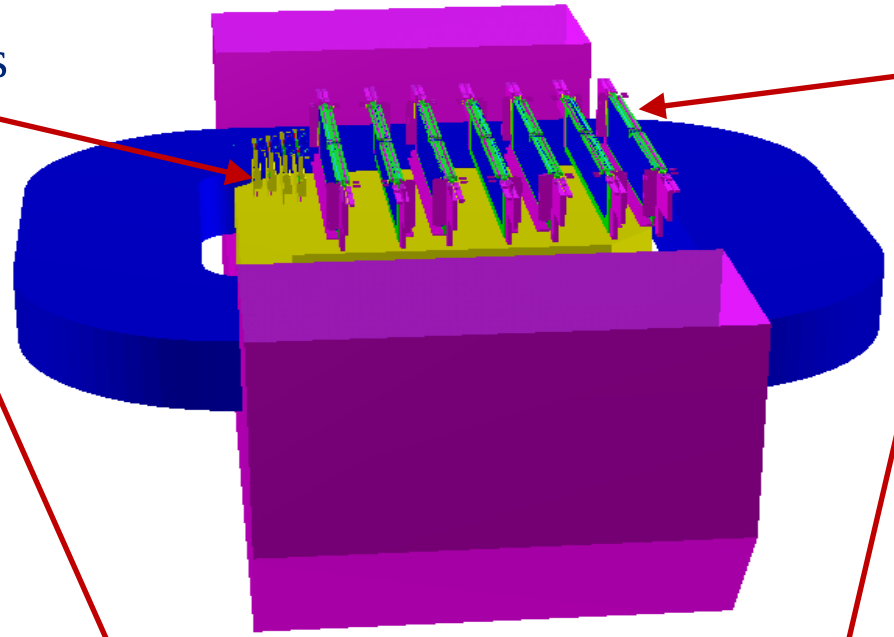
Outline

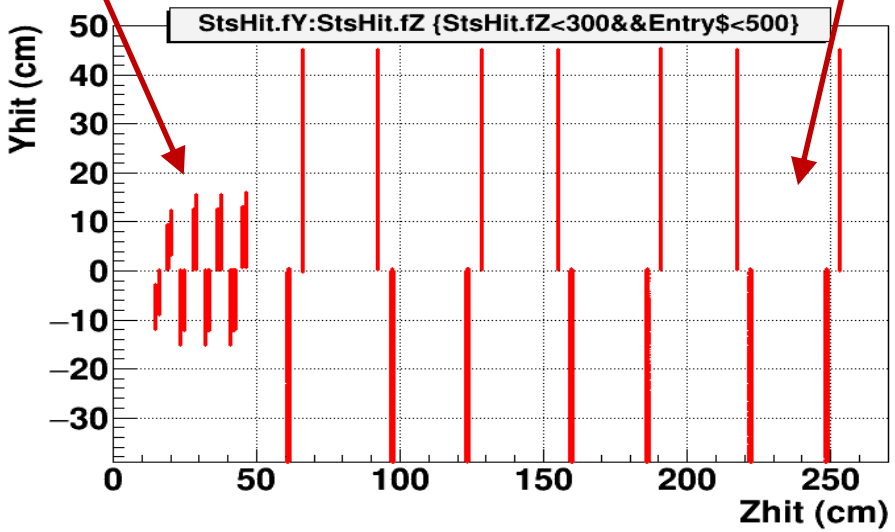
- ✓ BM@N configuration
- ✓ Reconstruction of strange particle decays
- ✓ Monte Carlo tuning – hit residuals
- ✓ Monte Carlo tuning – detector efficiency
- ✓ Steps toward physics analysis
- ✓ Summary and next steps

Detector geometry in Run 8

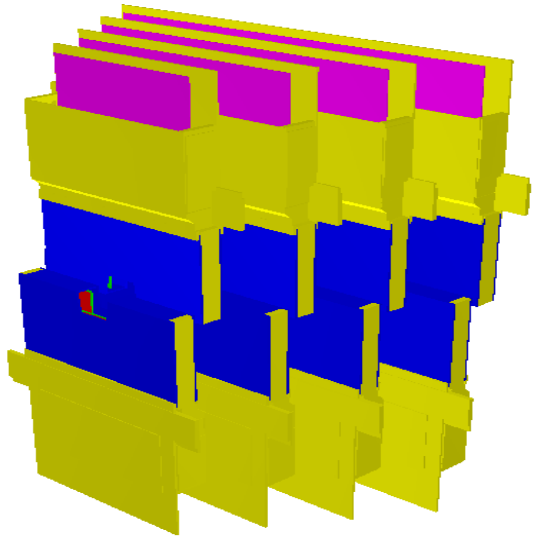
Si stations

GEMs

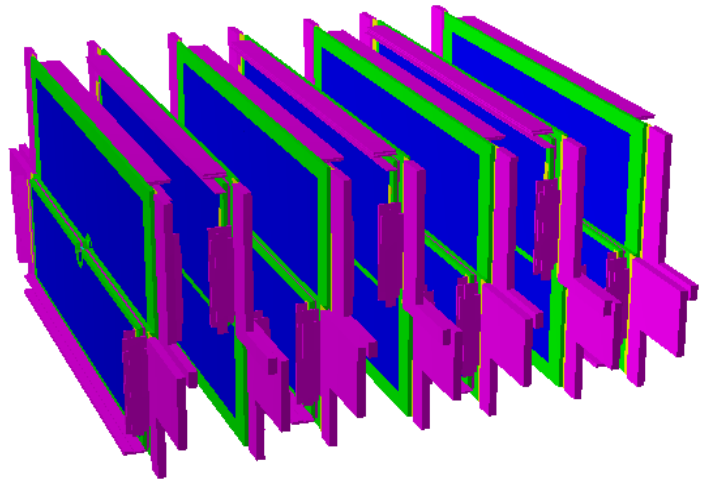




Si stations

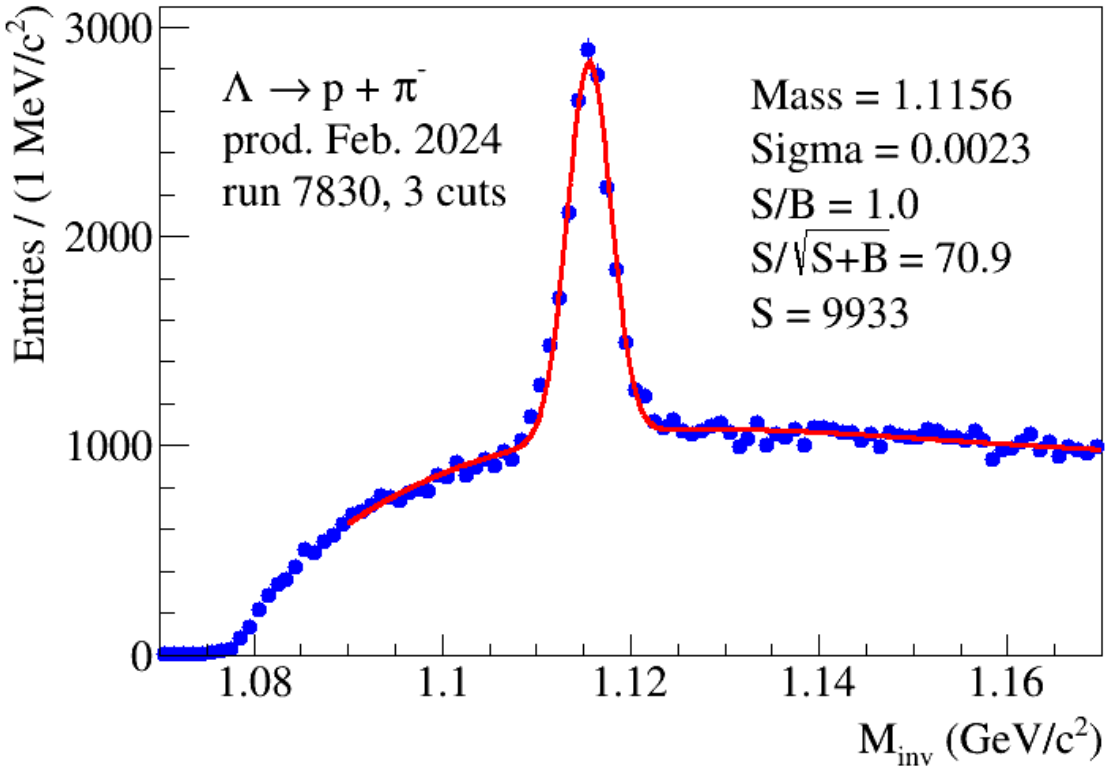


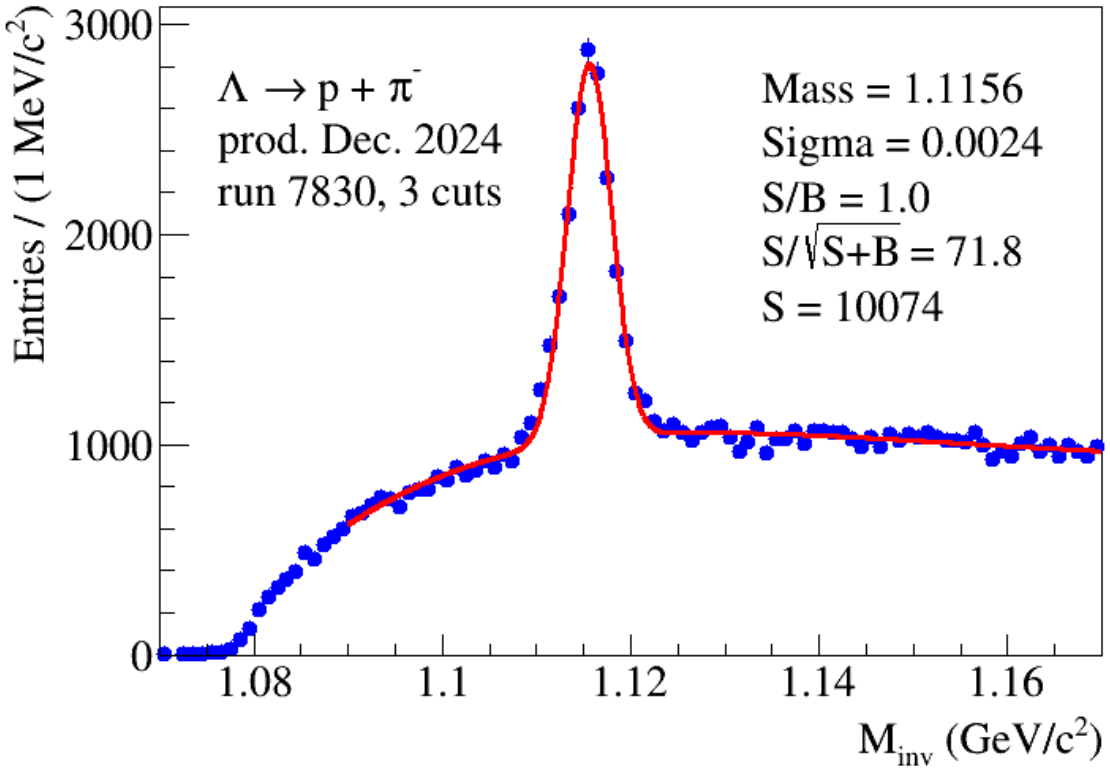
GEMs



Λ selection: time evolution

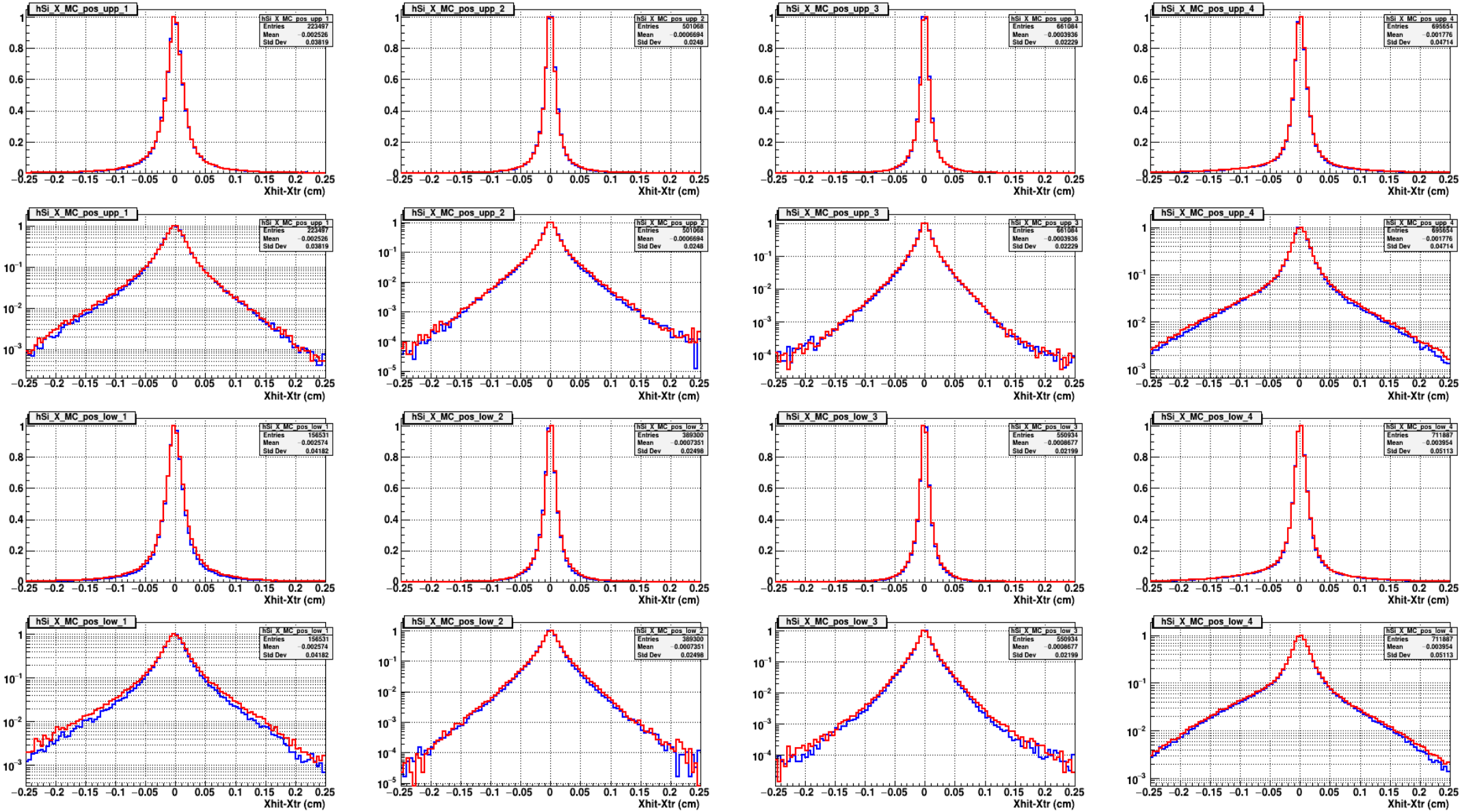
Production Feb. 2024 vs Production Dec. 2024



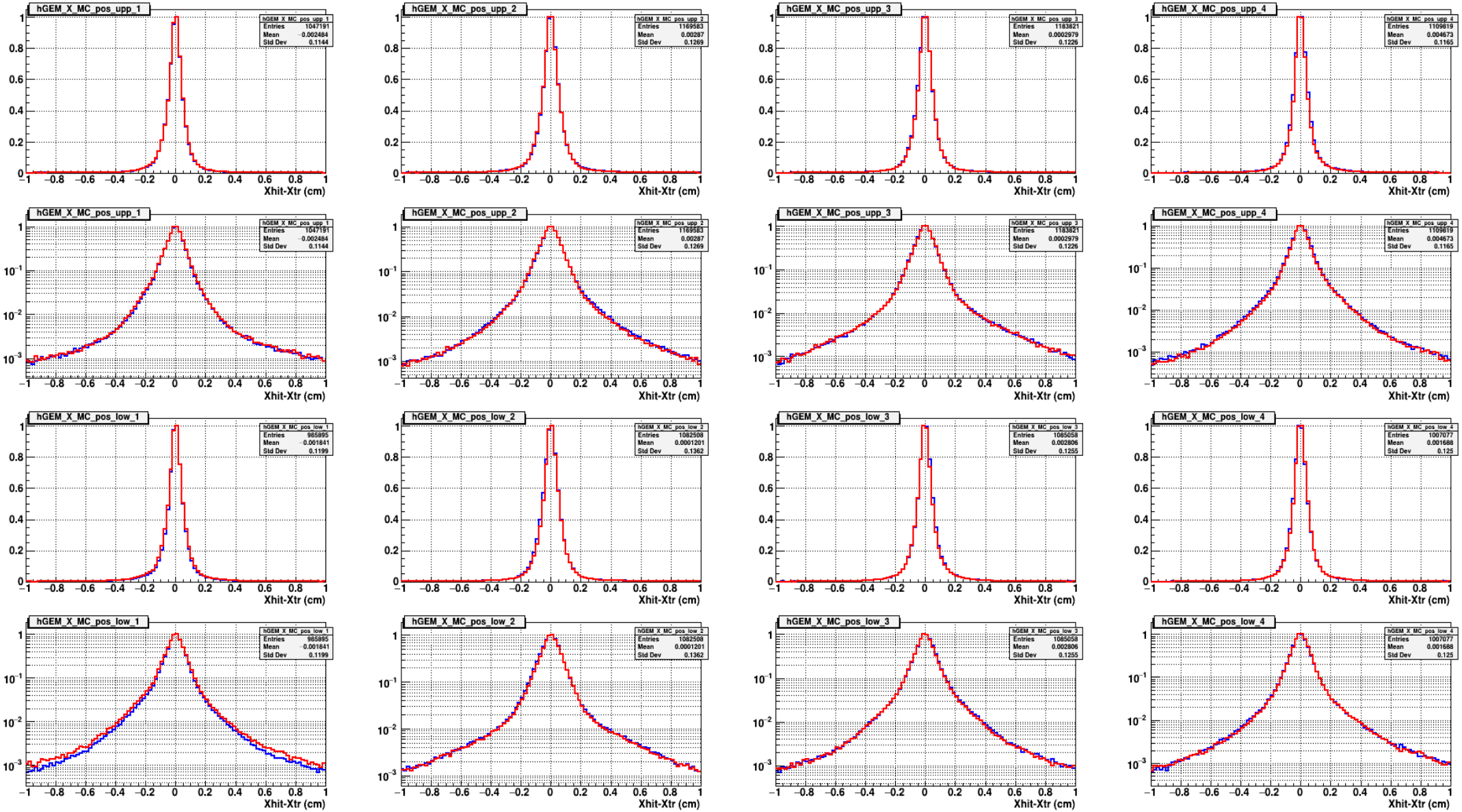


Monte Carlo tuning

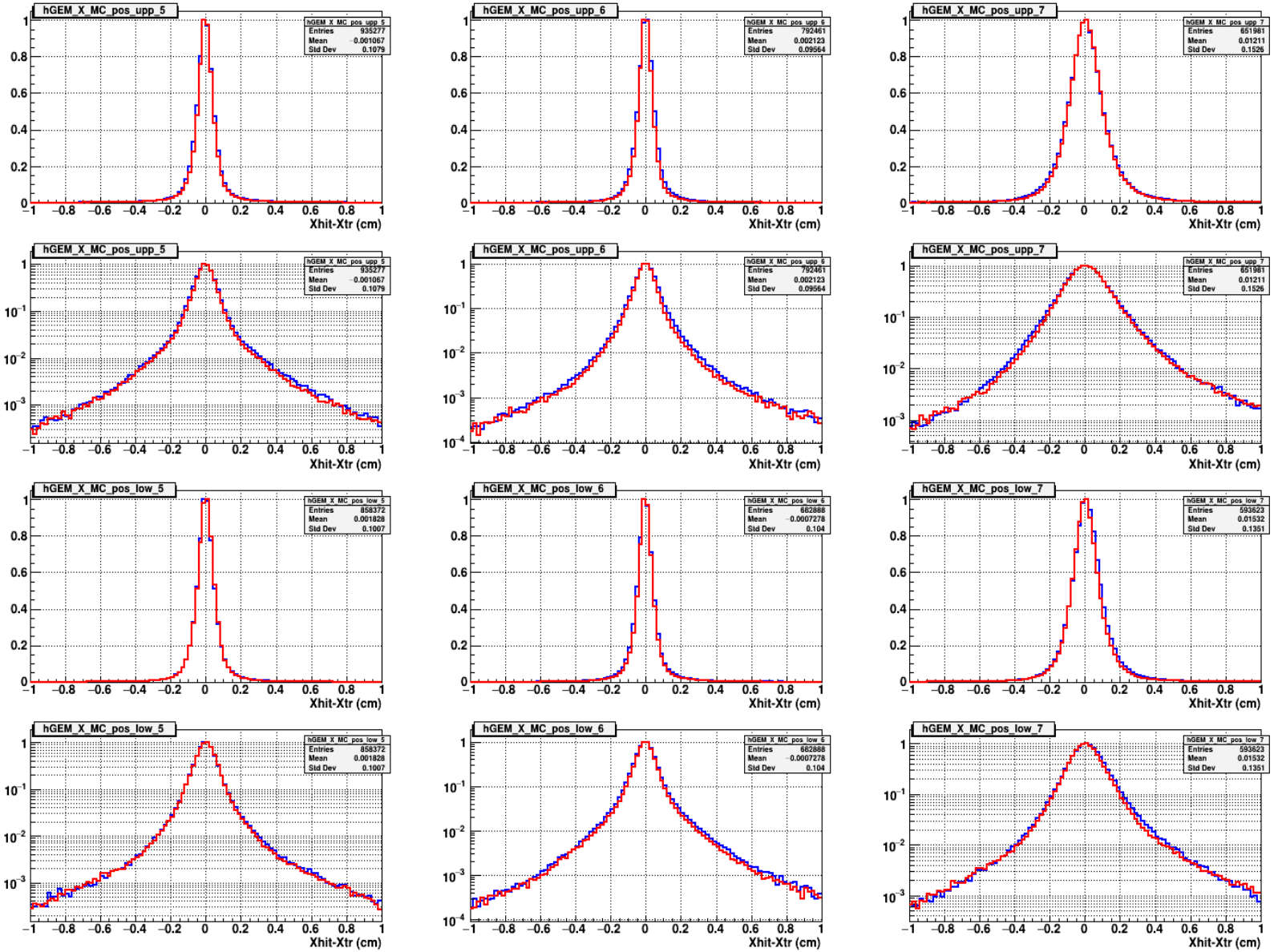
X-residuals in Silicon (q > 0)



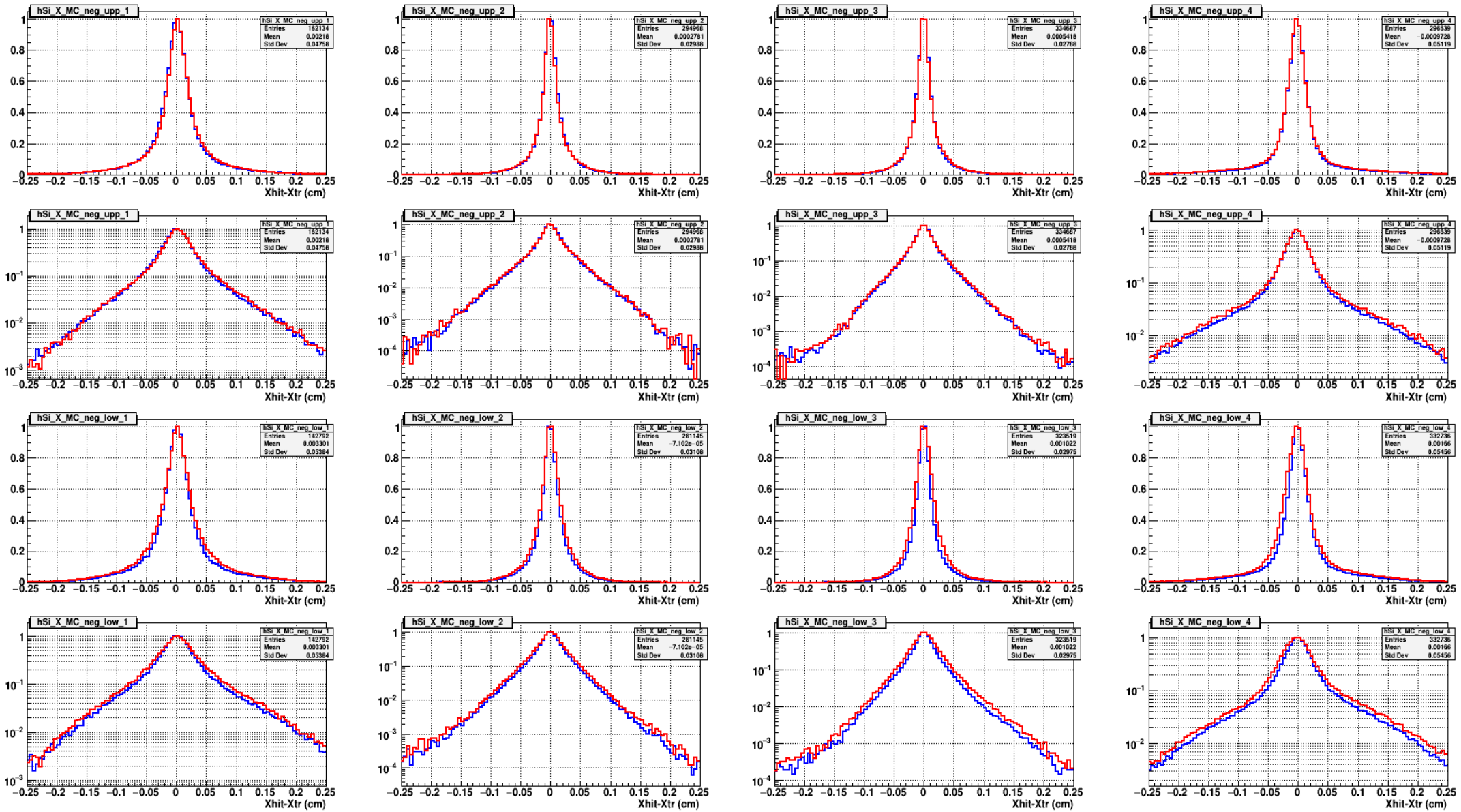
X-residuals in GEMs 1-4 (q > 0)



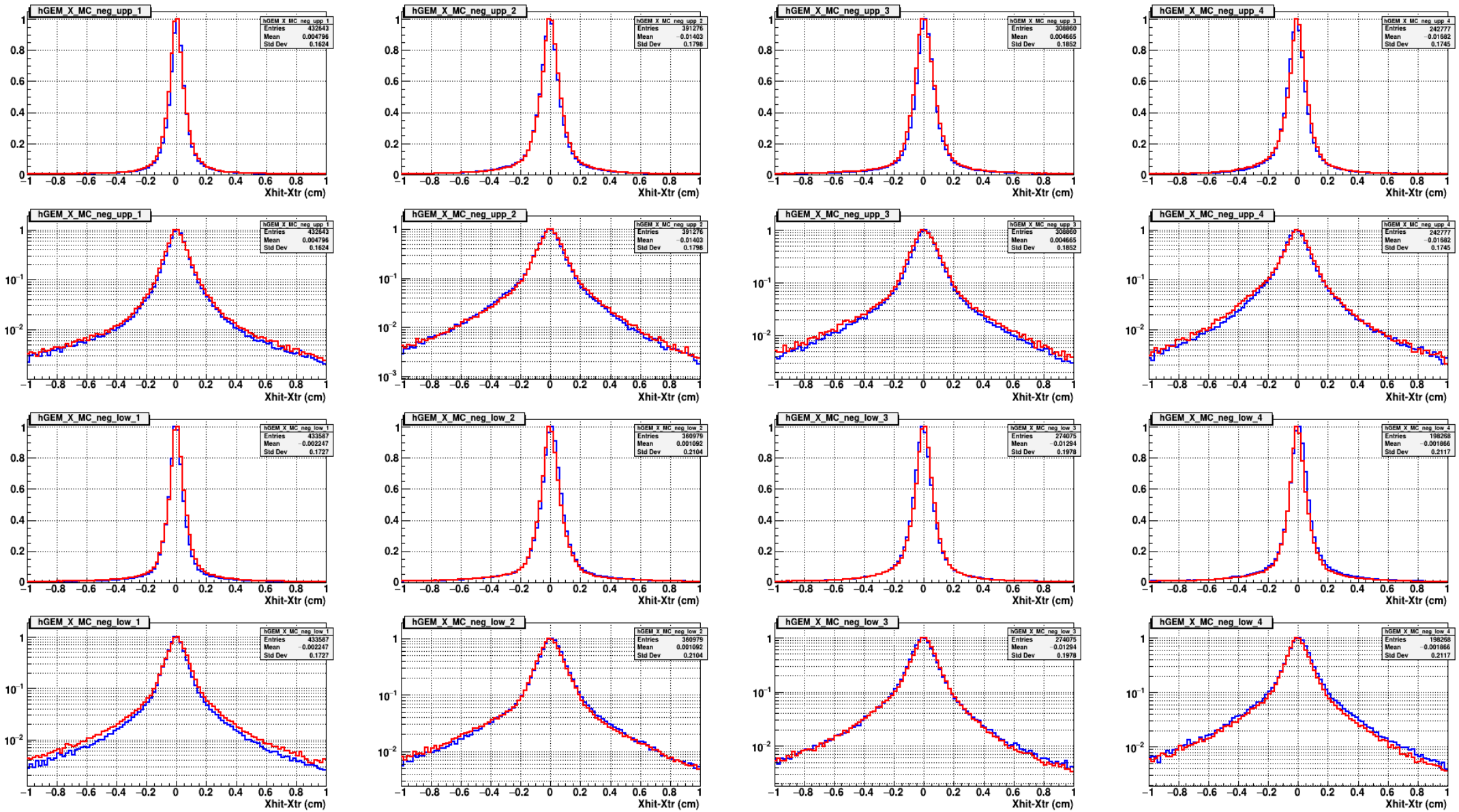
X-residuals in GEMs 5-7 (q > 0)



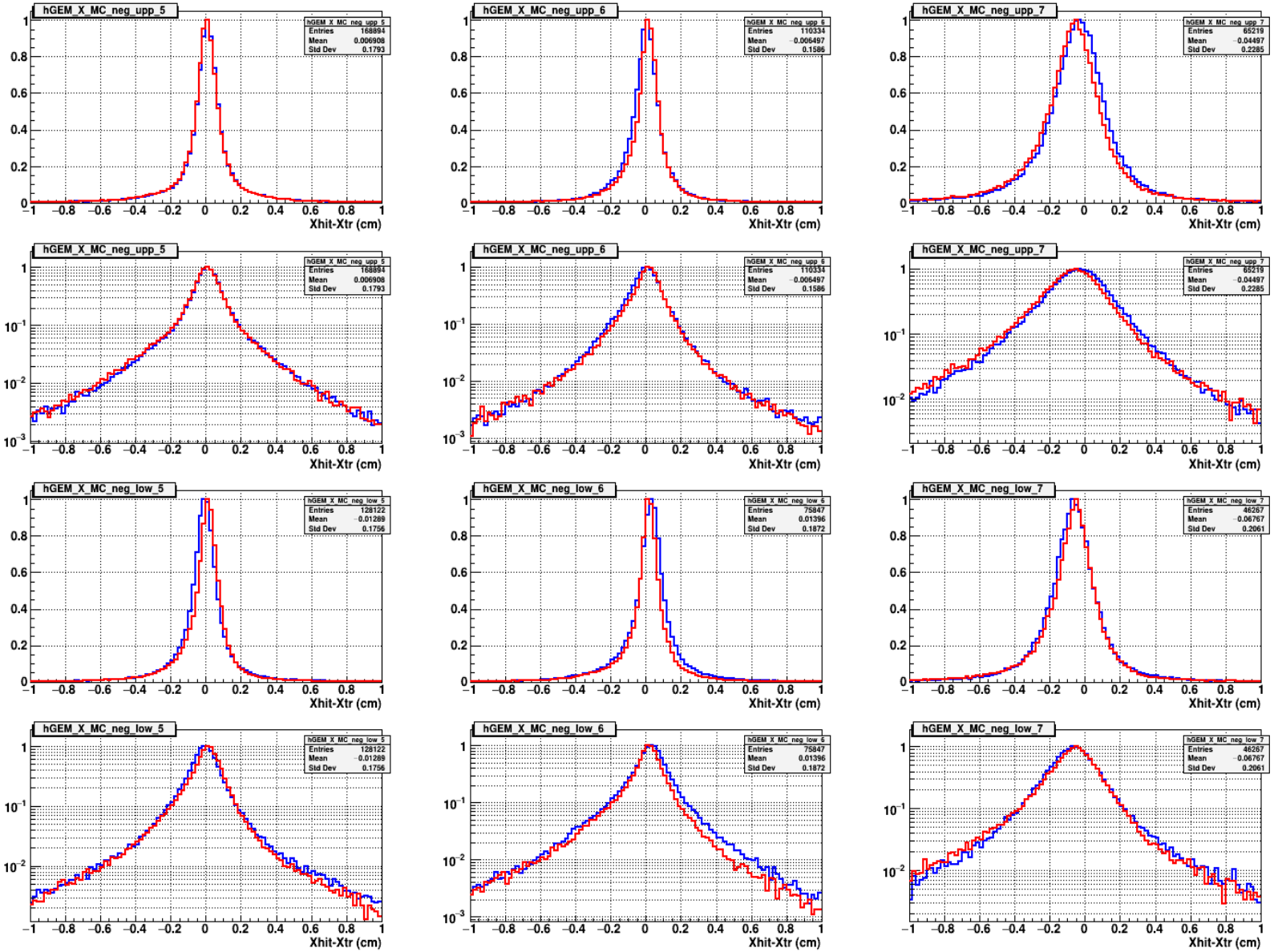
X-residuals in Silicon (q < 0)



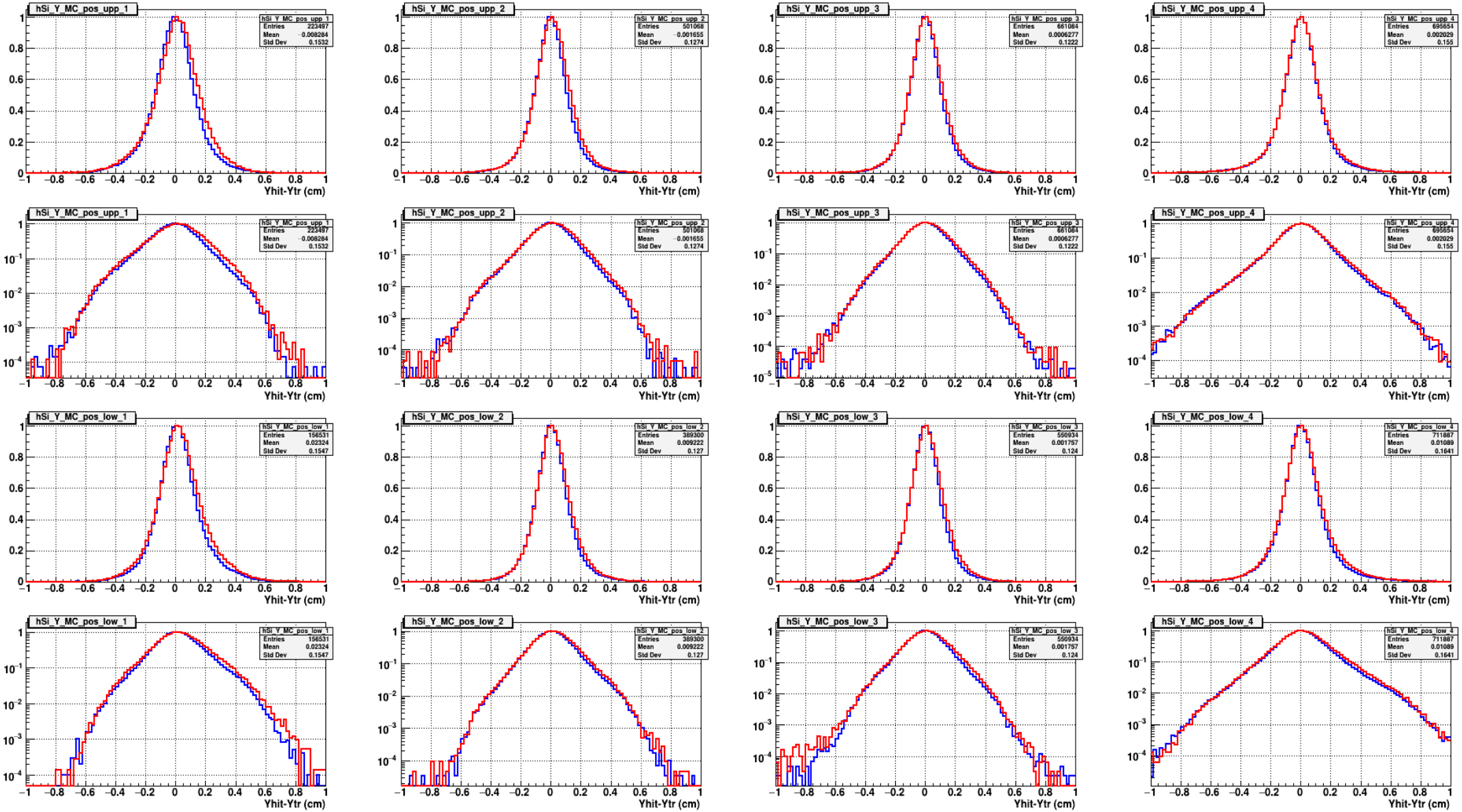
X-residuals in GEMs 1-4 (q < 0)



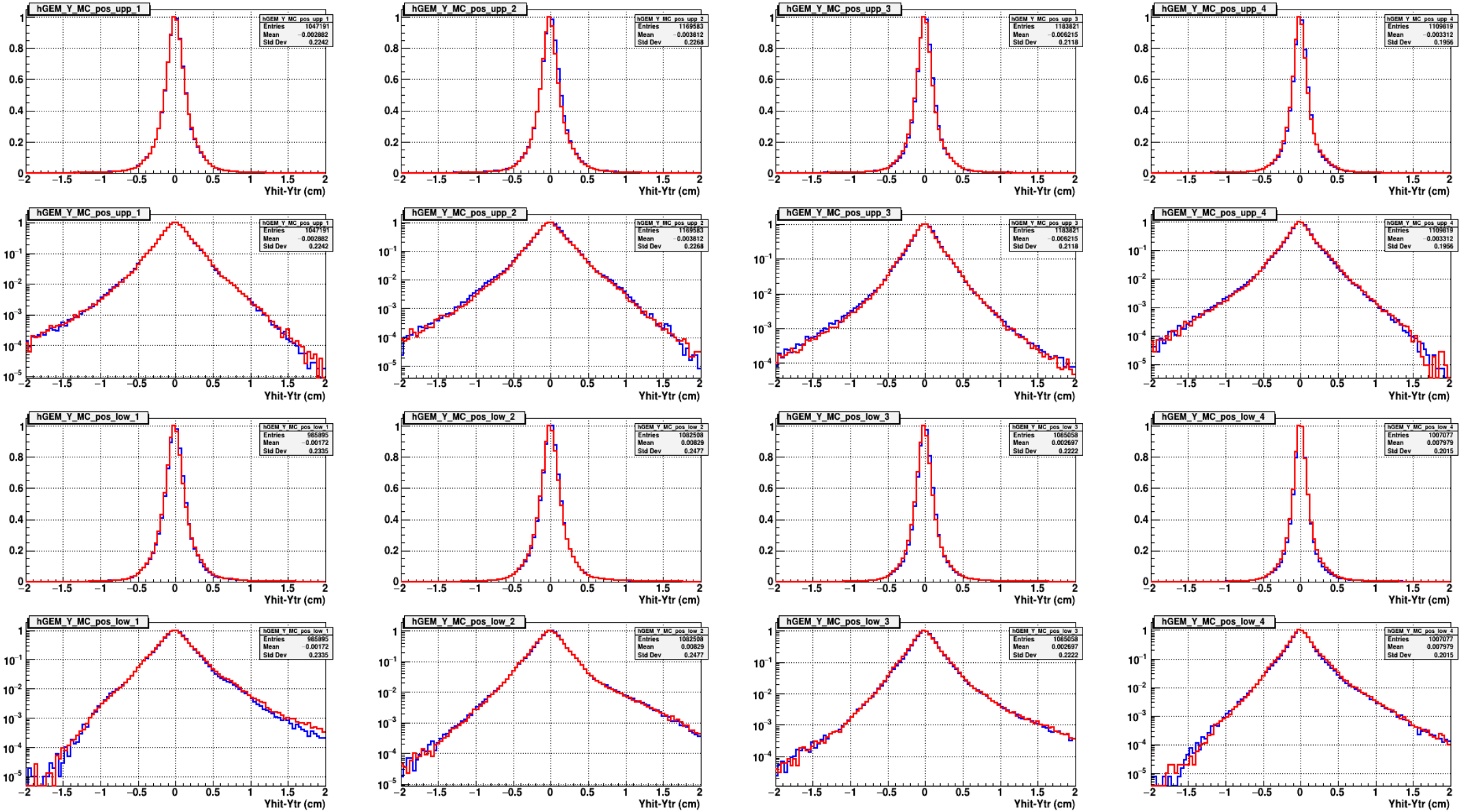
X-residuals in GEMs 5-7 (q < 0)



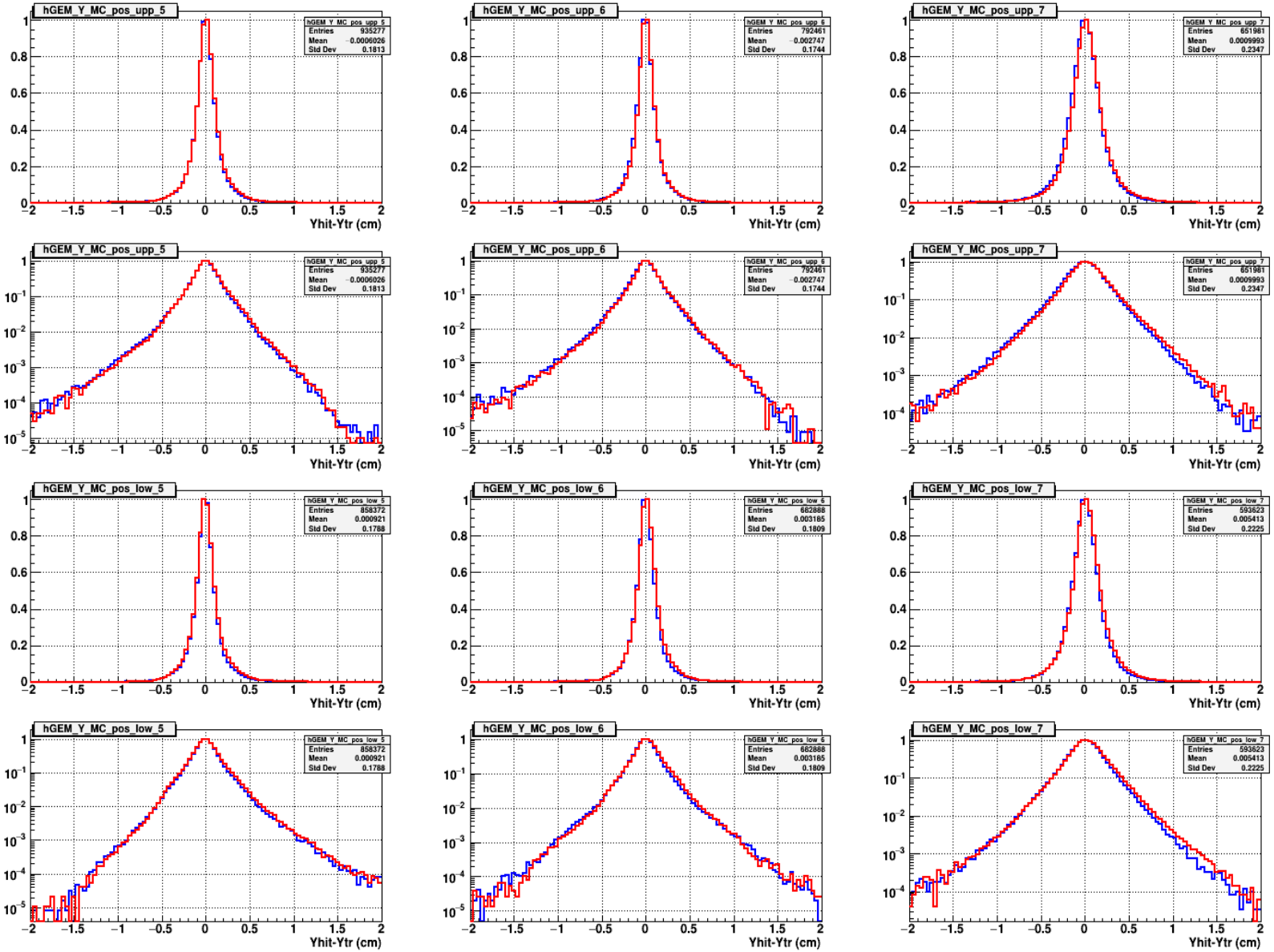
Y-residuals in Silicon (q > 0)



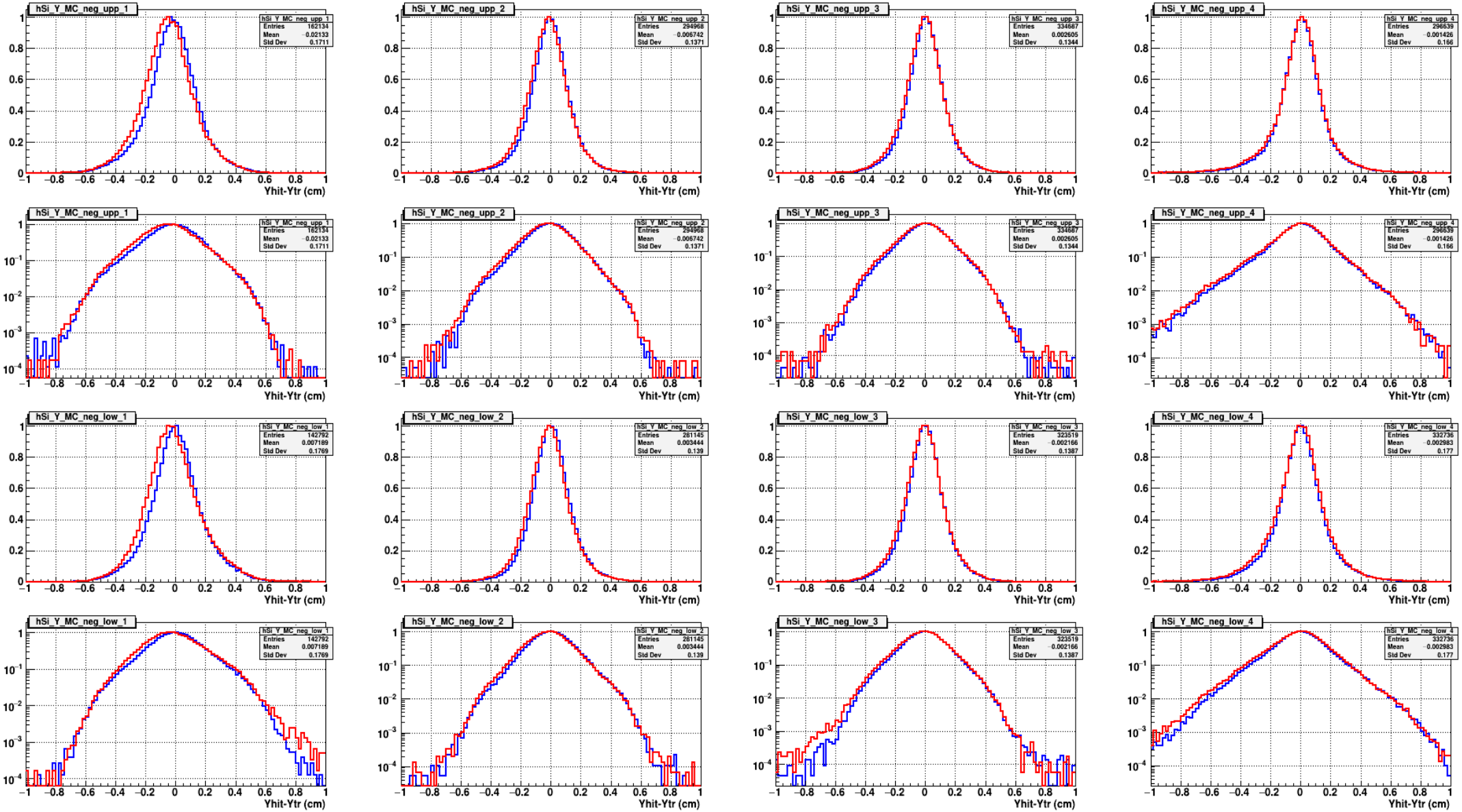
Y-residuals in GEMs 1-4 (q > 0)



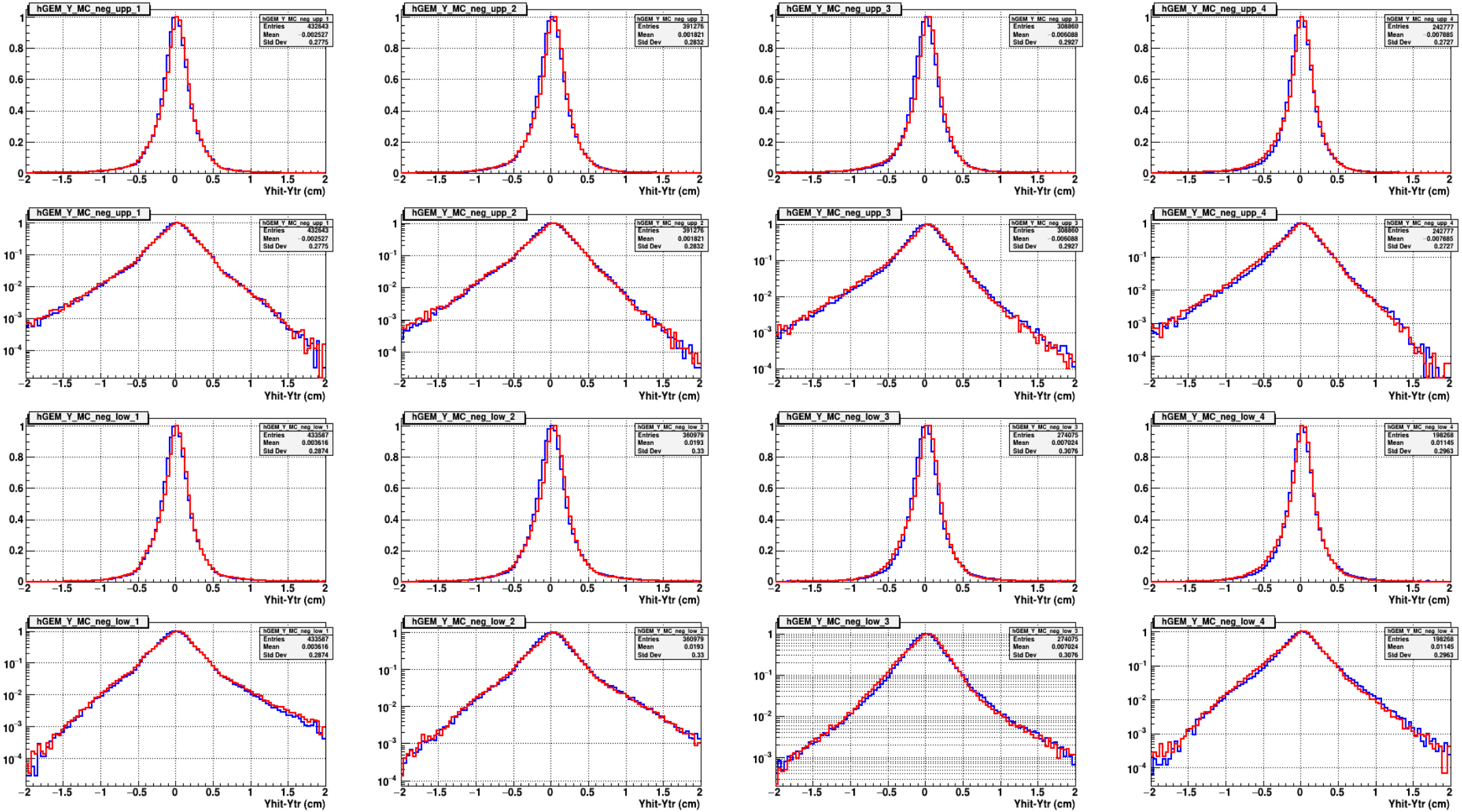
Y-residuals in GEMs 5-7 (q > 0)



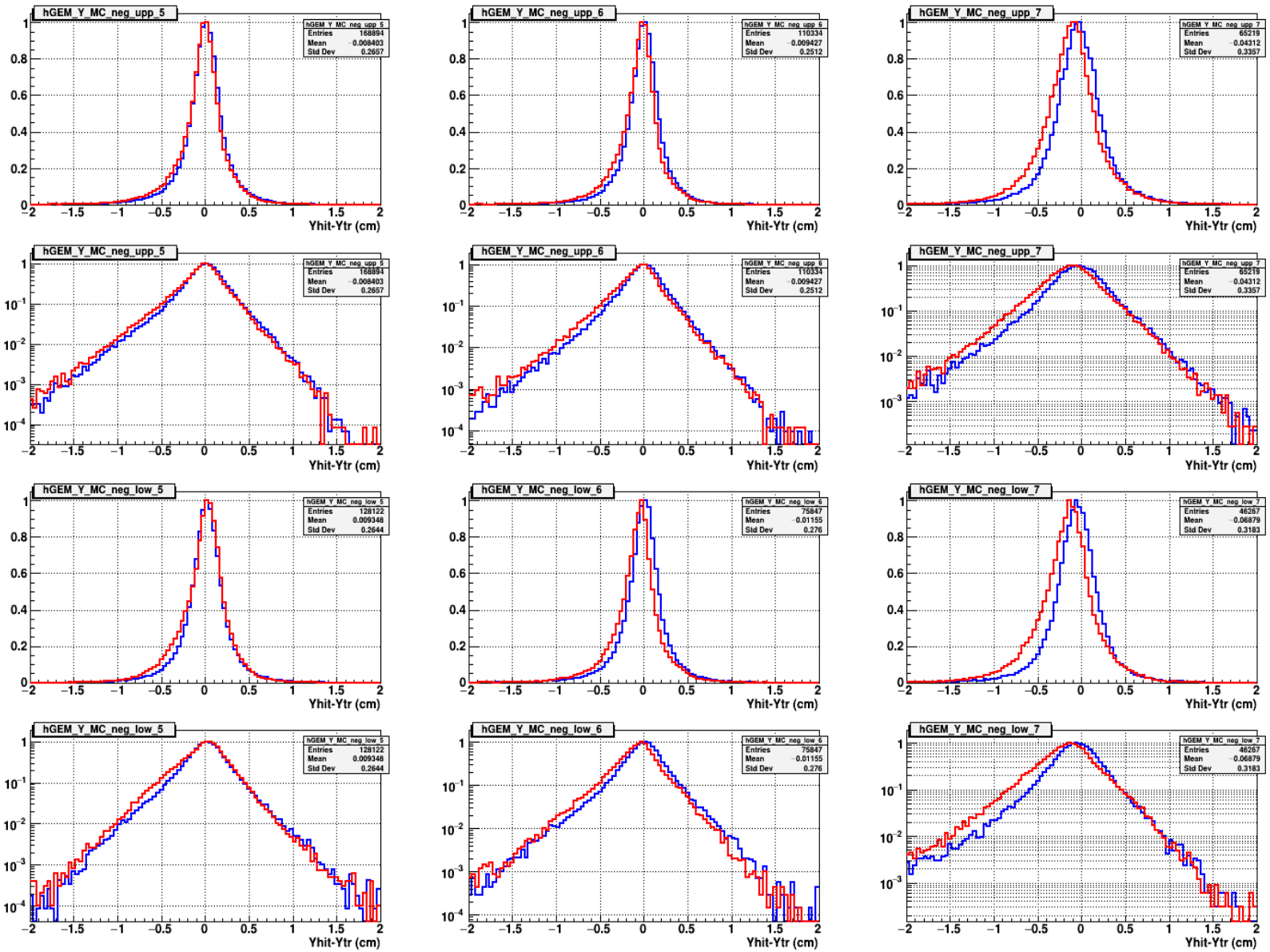
Y-residuals in Silicon (q < 0)



Y-residuals in GEMs 1-4 (q < 0)



Y-residuals in GEMs 5-7 (q < 0)



Detector (tracking) efficiency

JHEP

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Strangeness production in $\sqrt{s_{\rm NN}} = 3$ GeV Au+Au collisions at RHIC

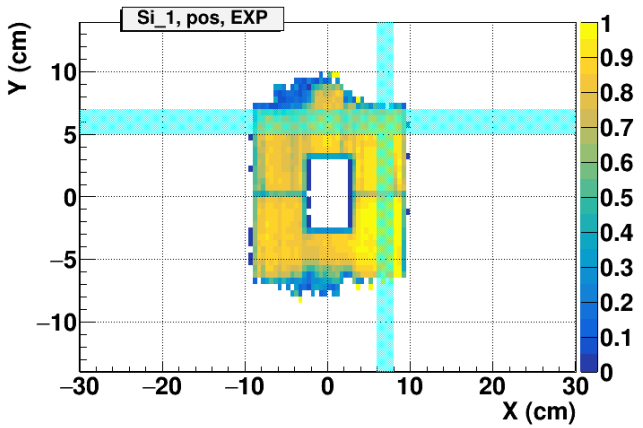
The STAR collaboration

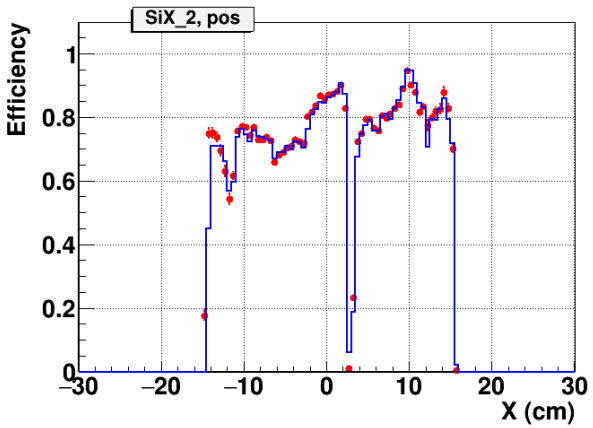
Source	Λ	K^0_S
Topological cuts	0.7 – 3.4%	1.1 – 3.1%
Track selection	0.1 – 0.5%	0.6 – 4.6%
Tracking efficiency	10%	10%
Signal extraction	0.4 – 0.8%	0.1 – 0.7%
Extrapolation	3.6 – 11%	0.2 – 1.6%
Feed-down correction	0.4 – 0.8%	N/A
Total	10.8 – 15.3%	10.2 – 11.6%

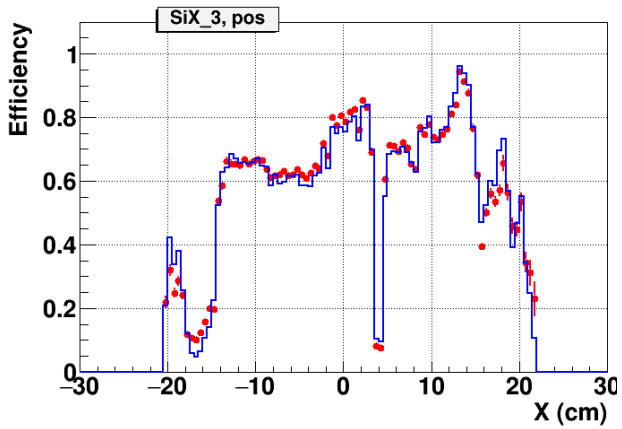
Table 1. Summary of systematic uncertainties for the Λ and K^0_S dN/dy measurements in 0-10% Au+Au collisions at $\sqrt{s_{\rm NN}} = 3.0$ GeV. The ranges indicate the variation of the systematic uncertainty among rapidity bins.

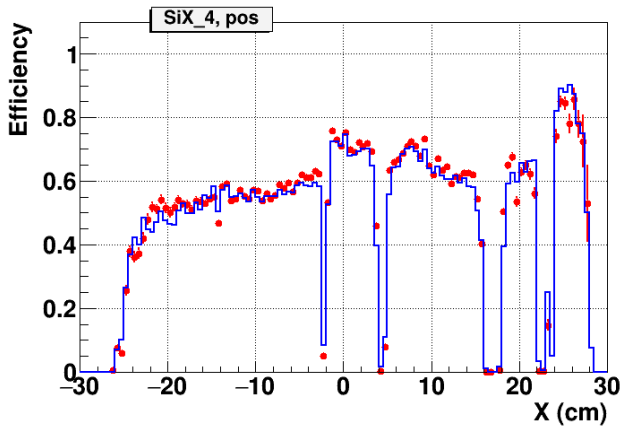
Silicon efficiency: hits on positive tracks

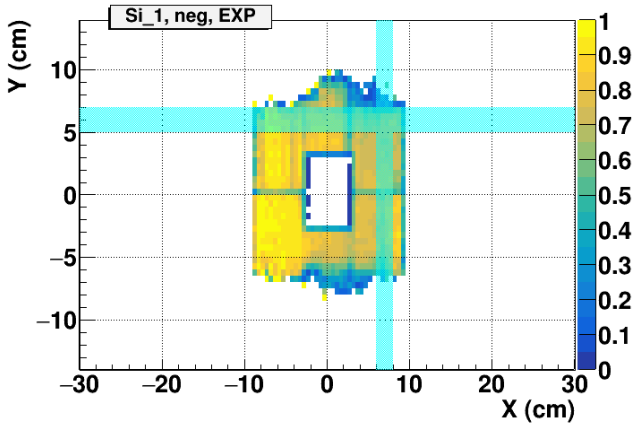
Data vs MC

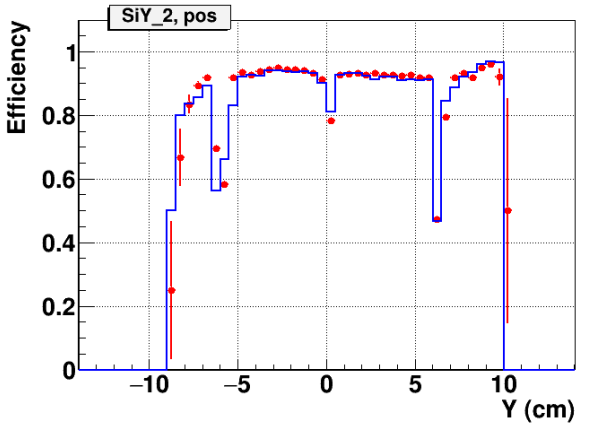


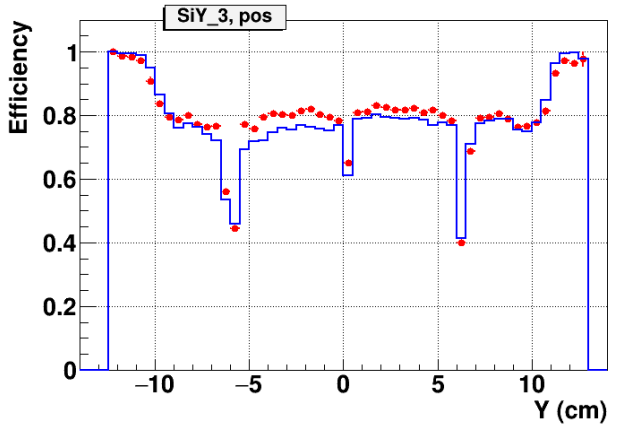


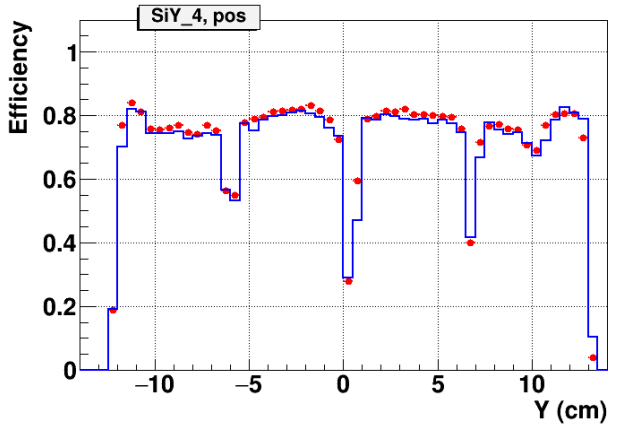






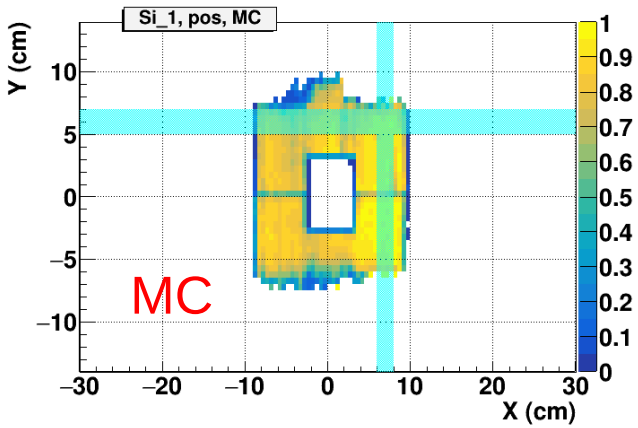


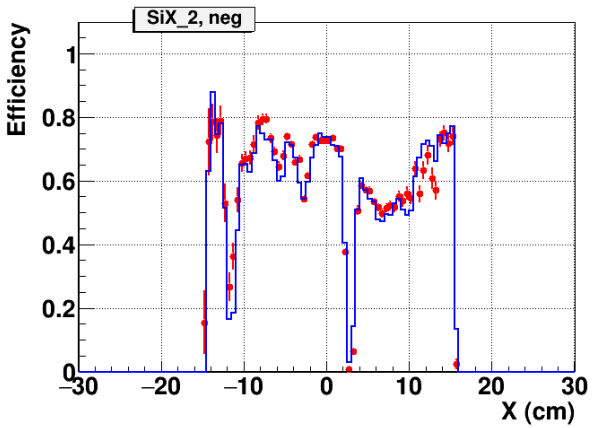


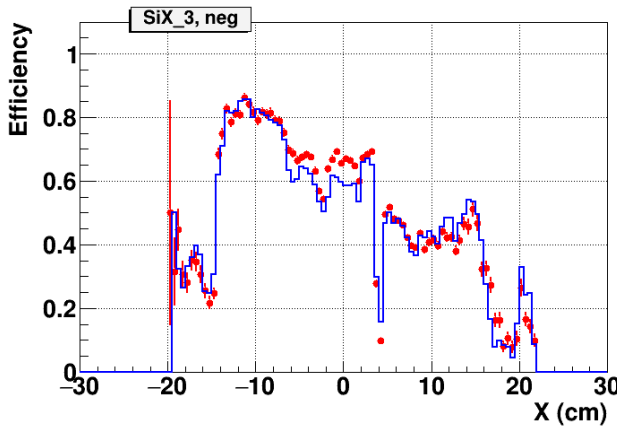


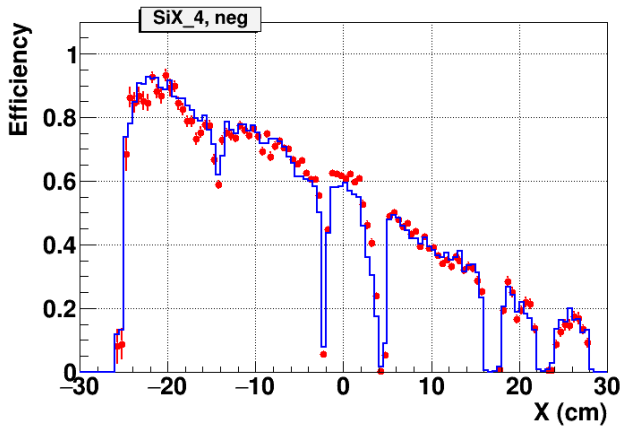
Silicon efficiency: hits on negative tracks

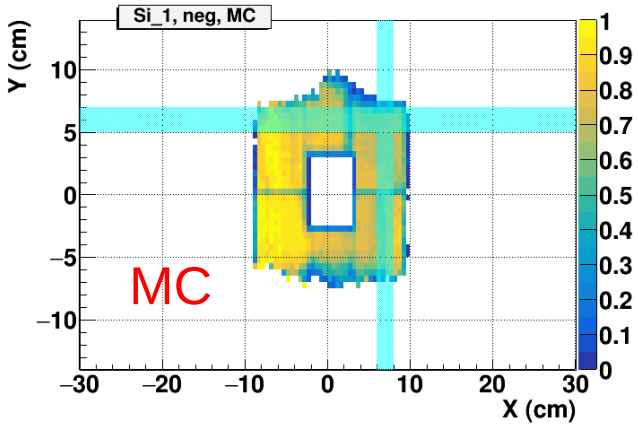
Data vs MC

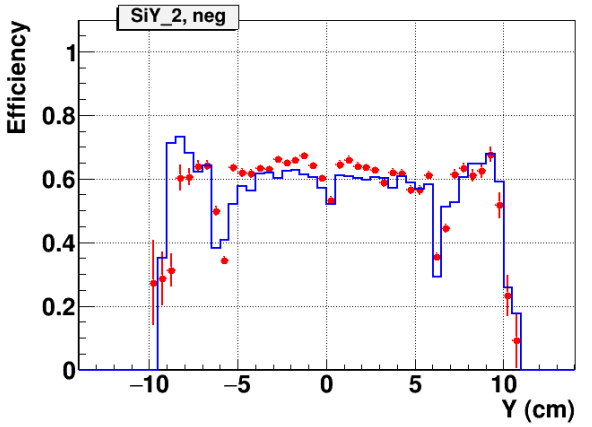


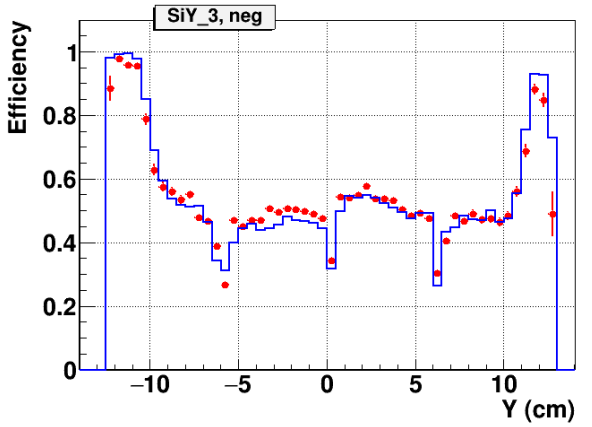


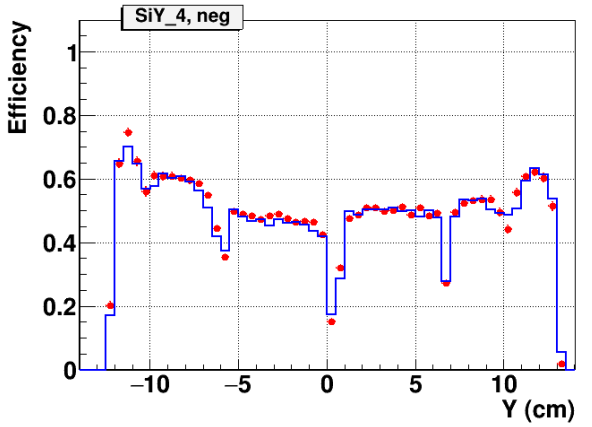






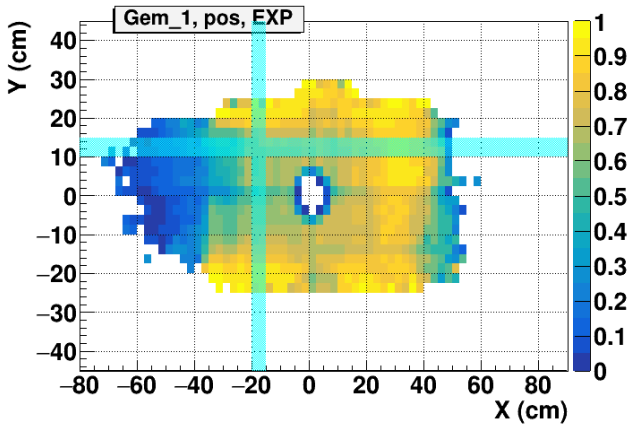


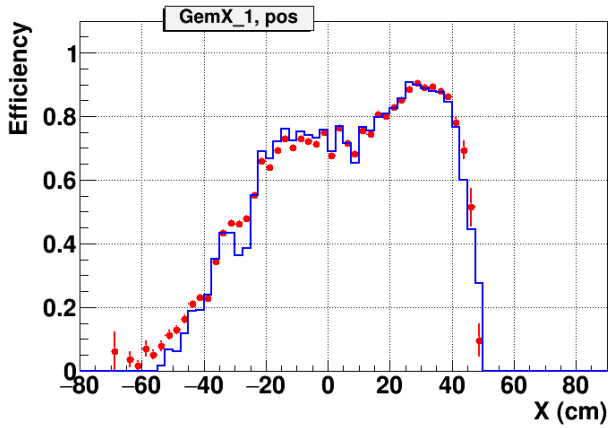


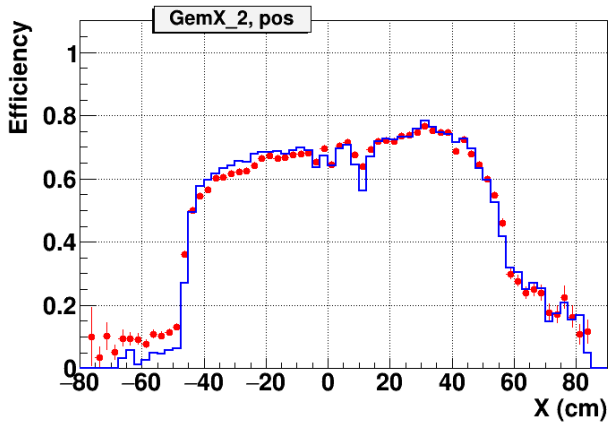


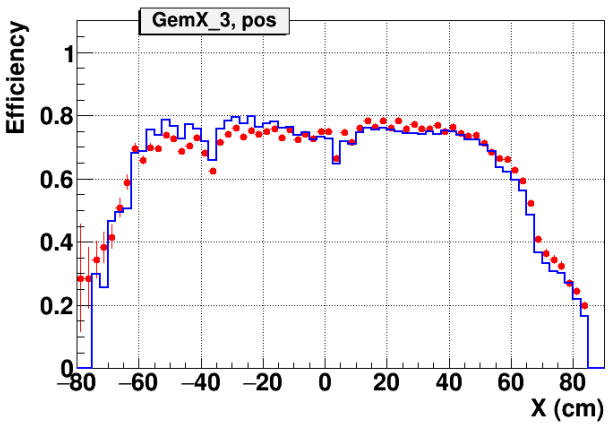
GEM efficiency: hits on positive tracks

Data vs MC

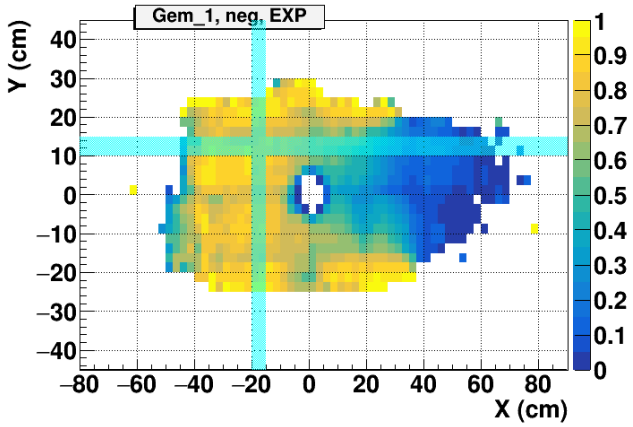


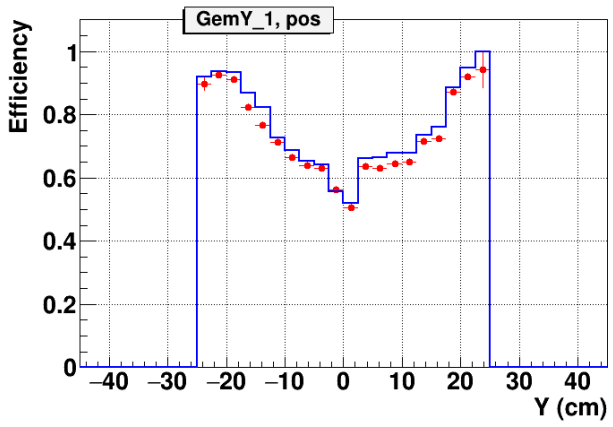


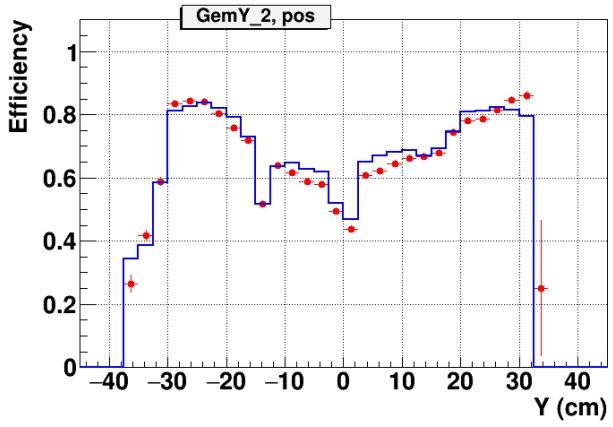


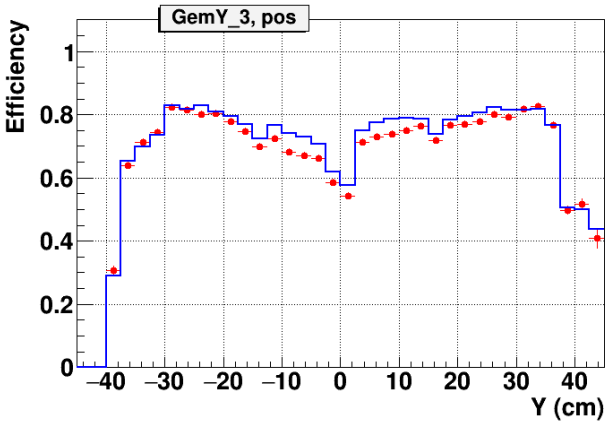


GEMs: 1-3



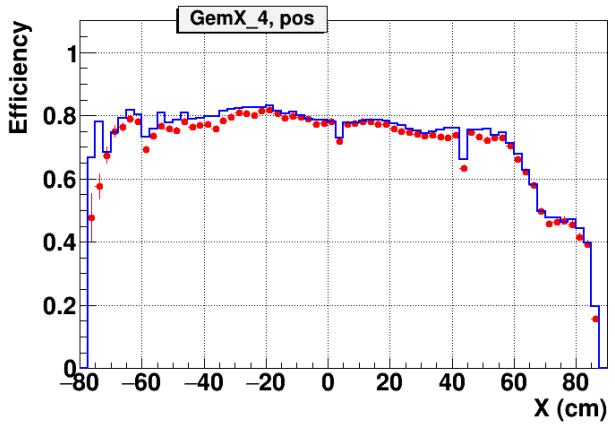


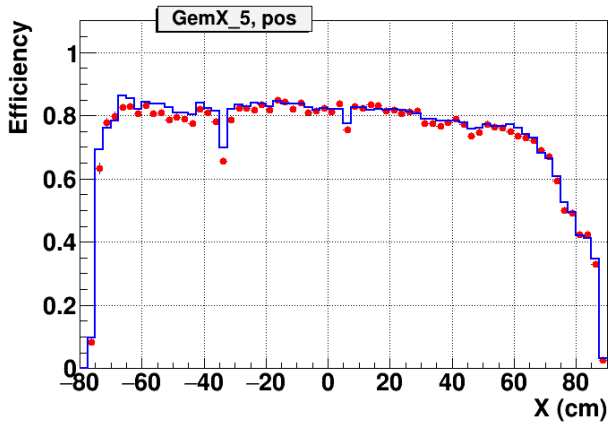


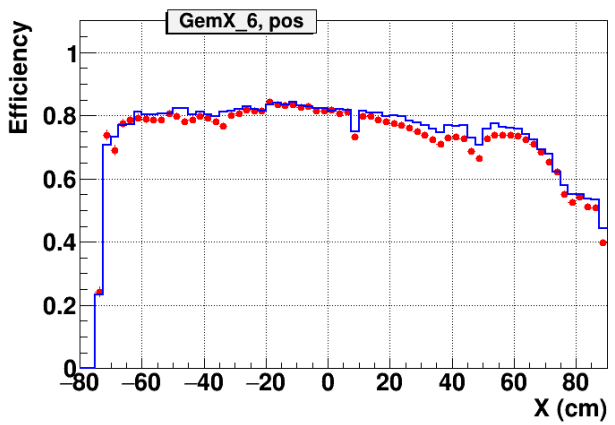


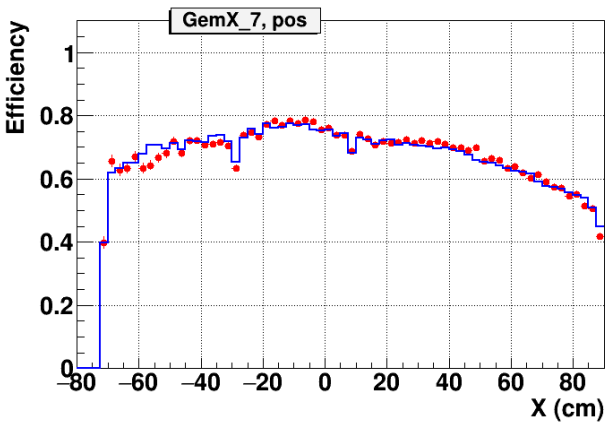
GEM efficiency: hits on positive tracks

Data vs MC

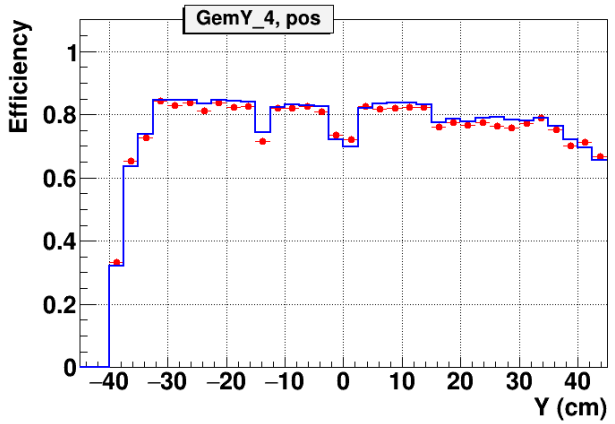


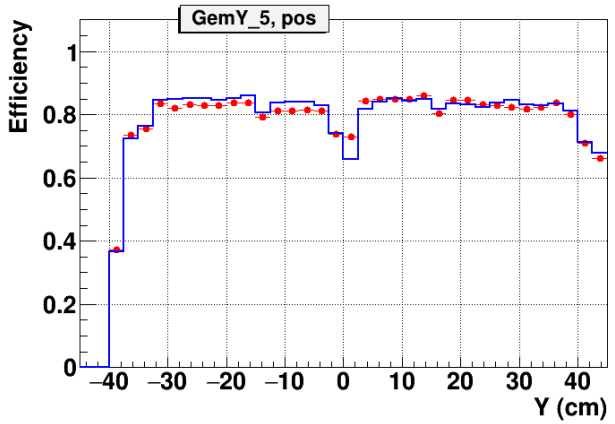


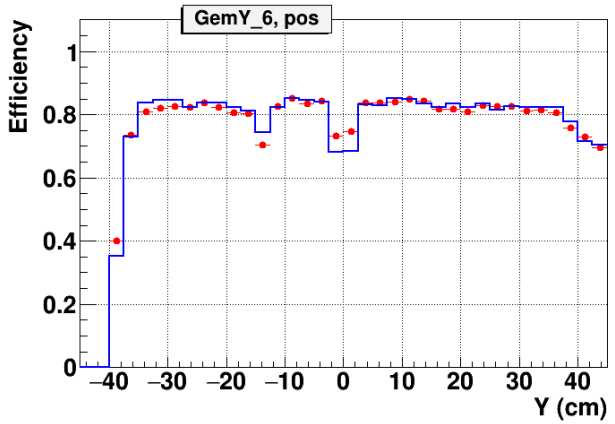


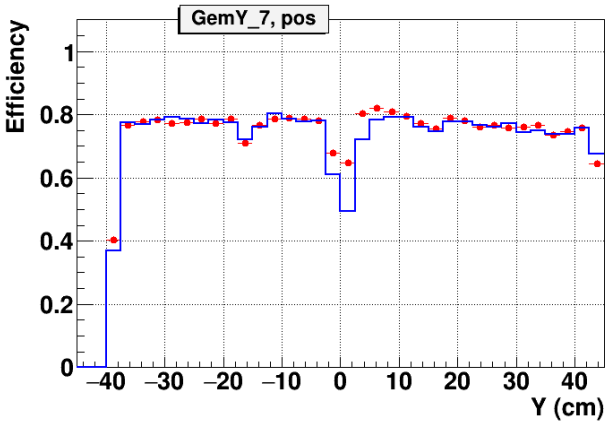


GEMs: 4-7



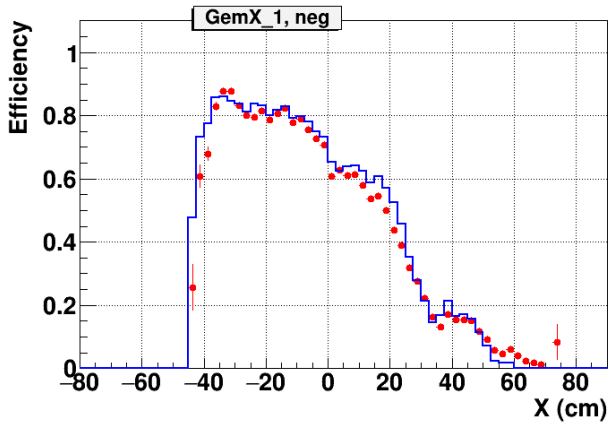


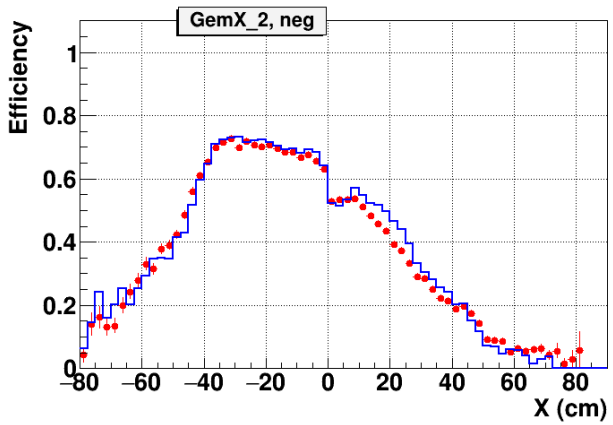


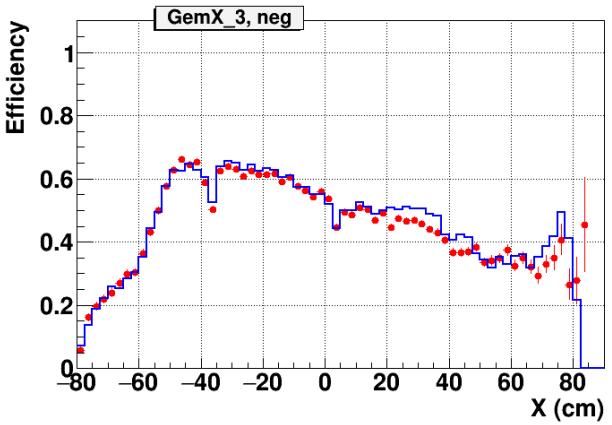


GEM efficiency: hits on negative tracks

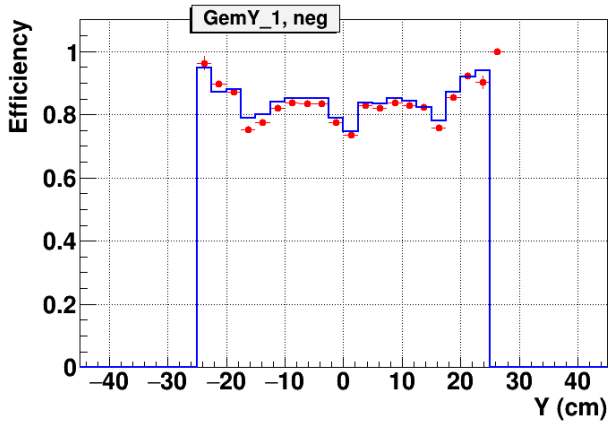
Data vs MC

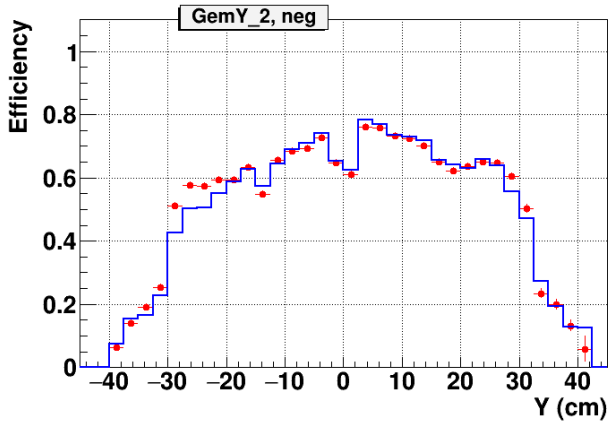


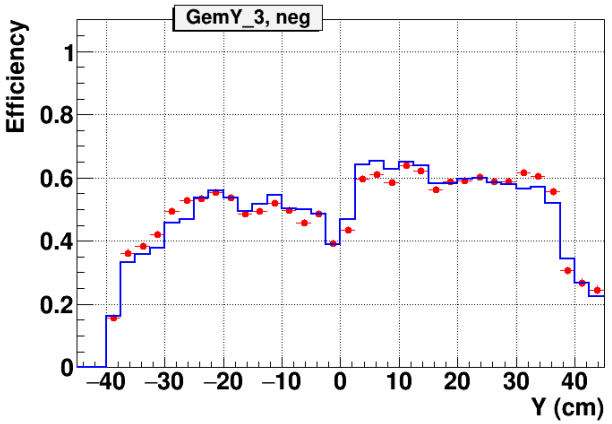




GEMs: 1-3

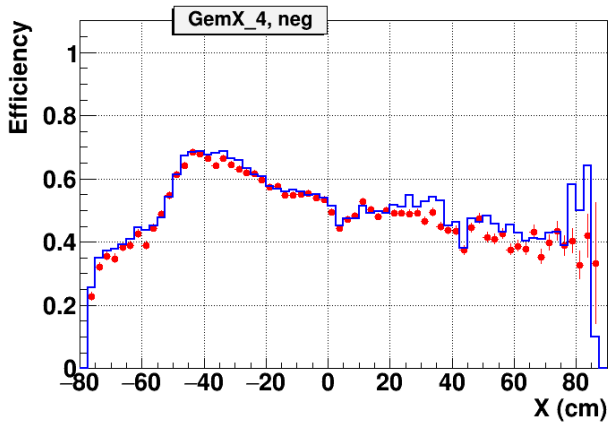


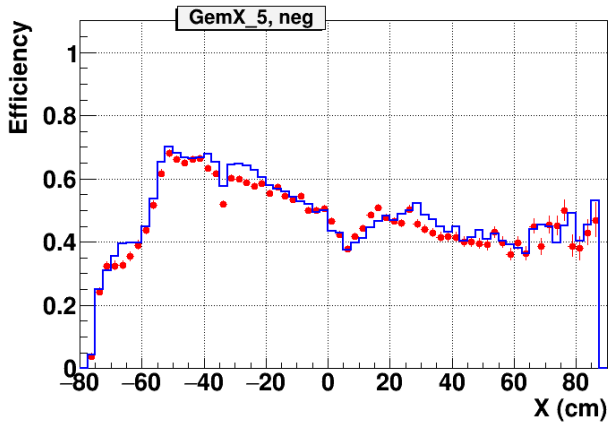


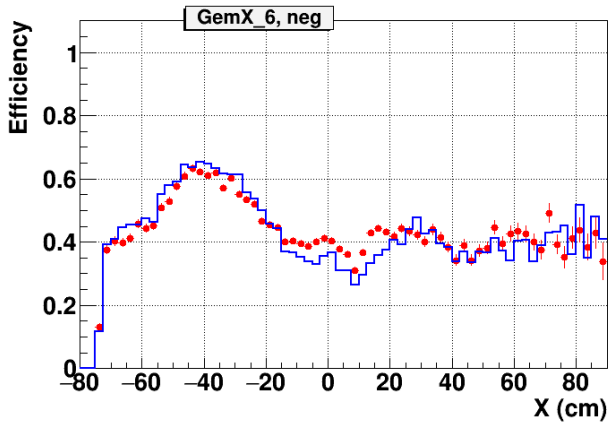


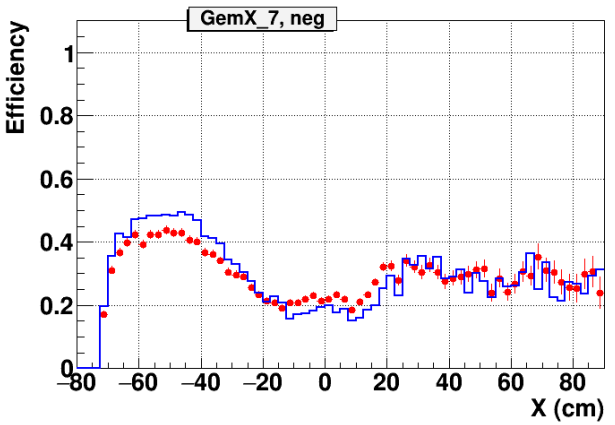
GEM efficiency: hits on negative tracks

Data vs MC

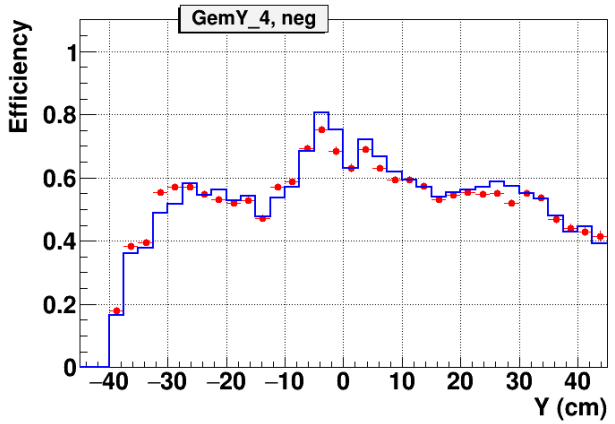


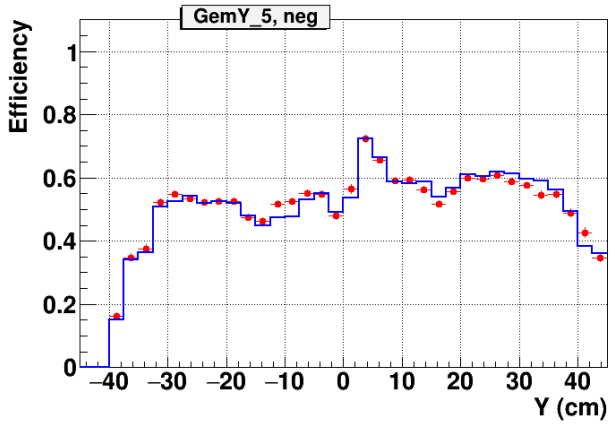


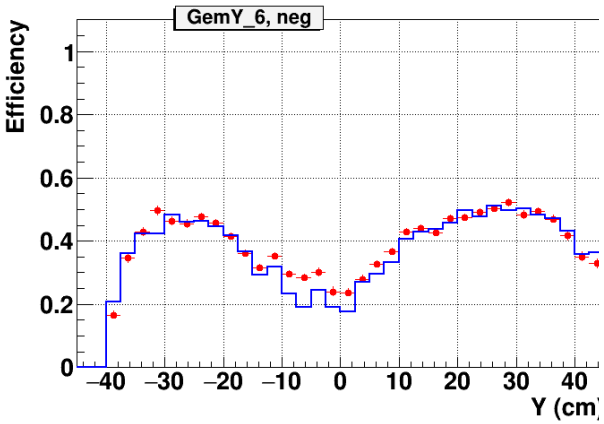


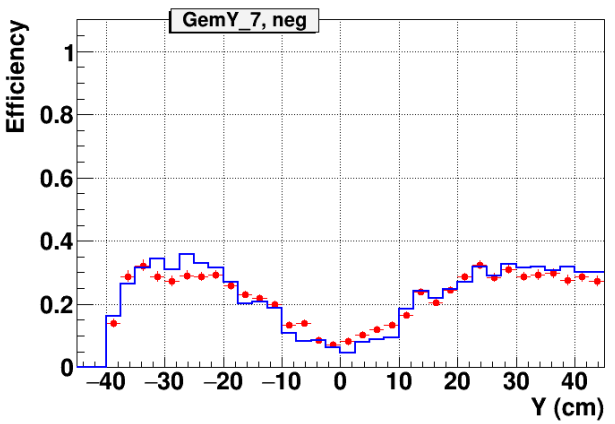


GEMs: 4-7









Towards physics analysis

Steps towards physics analysis

Statistics: 260 mln. events

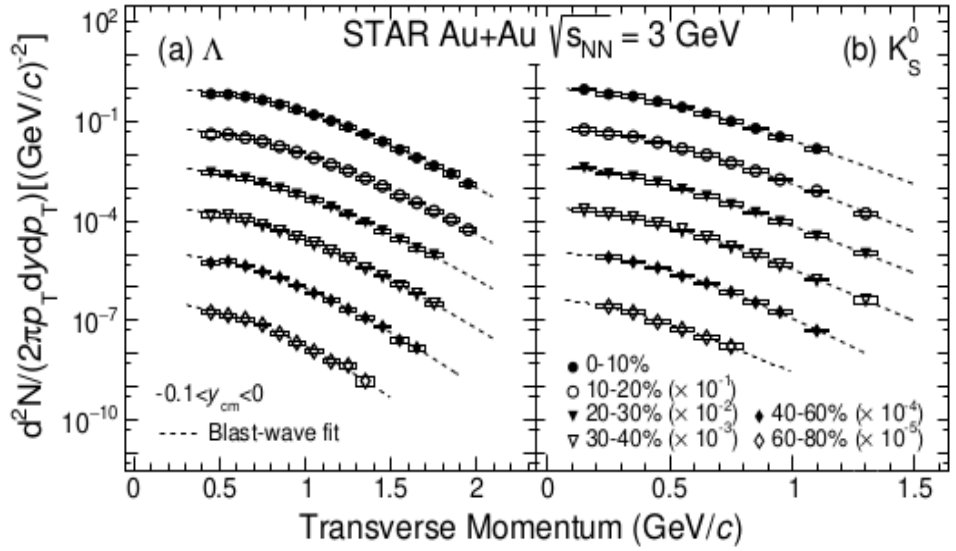


Figure 2. Transverse-momentum spectra of Λ (a) and K^0_S (b) at mid-rapidity from different centrality bins in Au + Au collisions at $\sqrt{s_{NN}} = 3$ GeV. The spectra are scaled by consecutive factors of 10^{-1} for each centrality bin as indicated in the legend. The vertical lines and boxes represent the statistical and systematic uncertainties, respectively. The dashed curves represent fits to the data using the blast-wave model.

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Strangeness production in $\sqrt{s_{NN}} = 3$ GeV Au+Au collisions at RHIC

The STAR collaboration

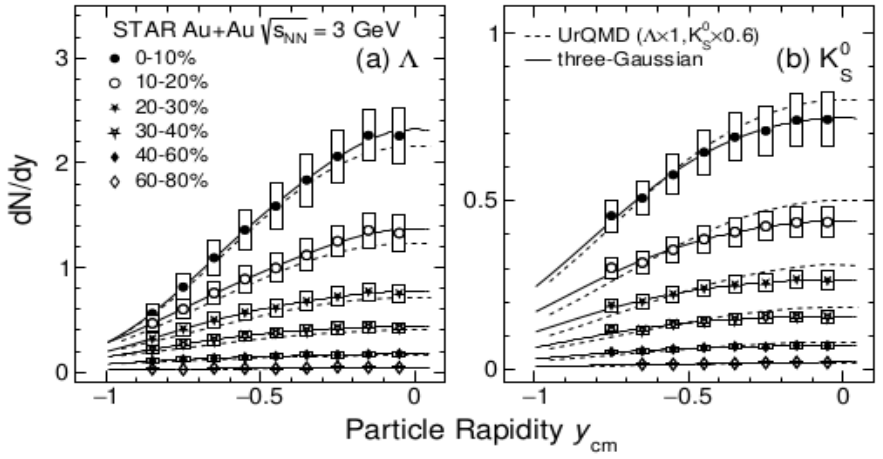

Figure 3. The rapidity dependence of dN/dy of particles for different centrality bins in Au+Au collisions at $\sqrt{s_{NN}} = 3$ GeV. The vertical lines and boxes represent the statistical and systematic uncertainties, respectively. The solid lines represent the three-Gaussian function that fit the data points. The dashed lines are the calculations from hadronic transport model UrQMD [42].

Steps towards physics analysis

BM@N Note
REC-2025-01, ANA-2025-01

Reconstruction of decays of strange particles produced in Xe+CsI interactions with the BM@N detector

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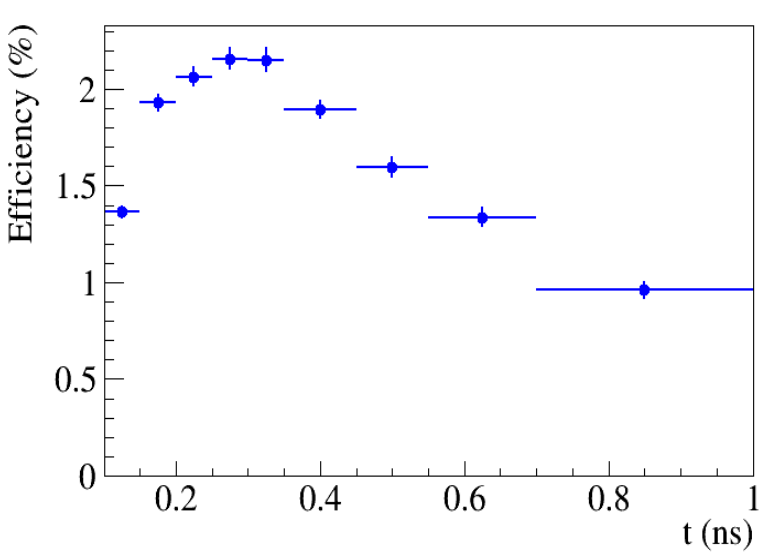
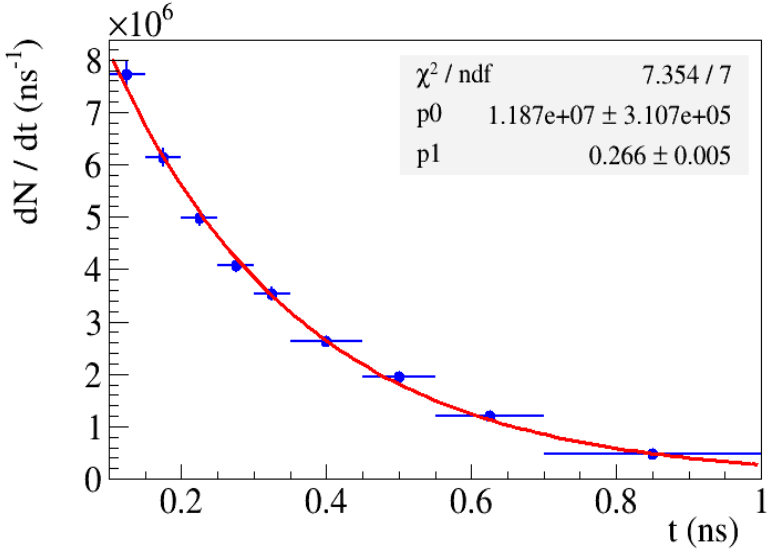
February 24, 2025

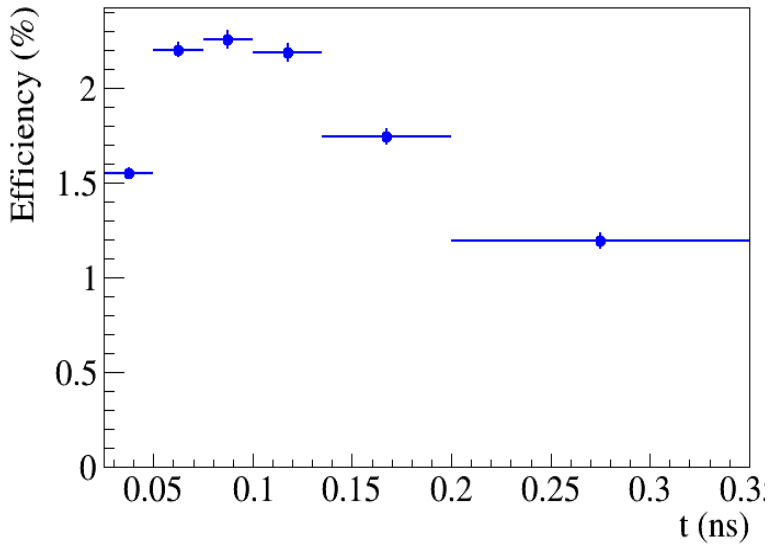
Abstract

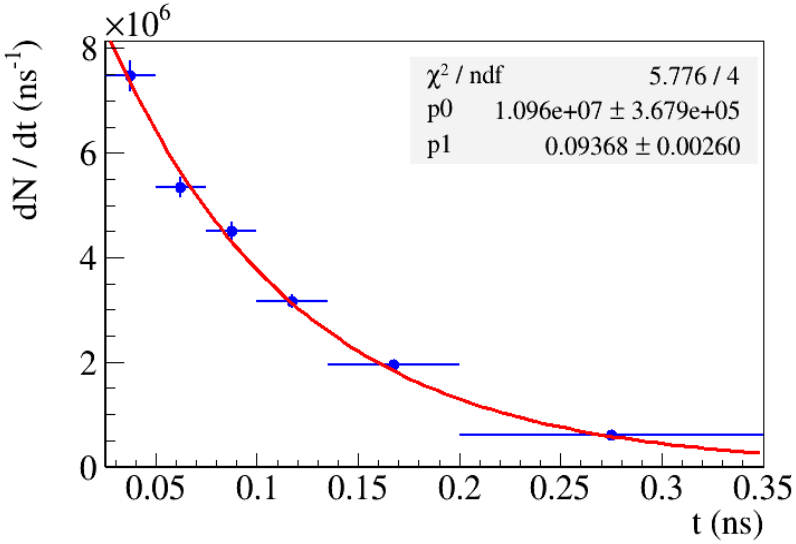
In December, 2022 - January, 2023 the BM@N experiment conducted its first physics run with full detector configuration. Over 500 million events of Xe beam interactions with CsI target with the beam kinetic energy of 3.8A GeV were collected.

Since then, strong efforts have been put to reconstruct the collected data and make preparations for physics analyses. The current status of such an activity related to reconstruction of strange particles weakly decayed to charged hadrons is presented in this paper. Main steps of the analysis procedure for a study of the strangeness production in nuclear collisions are outlined as well.

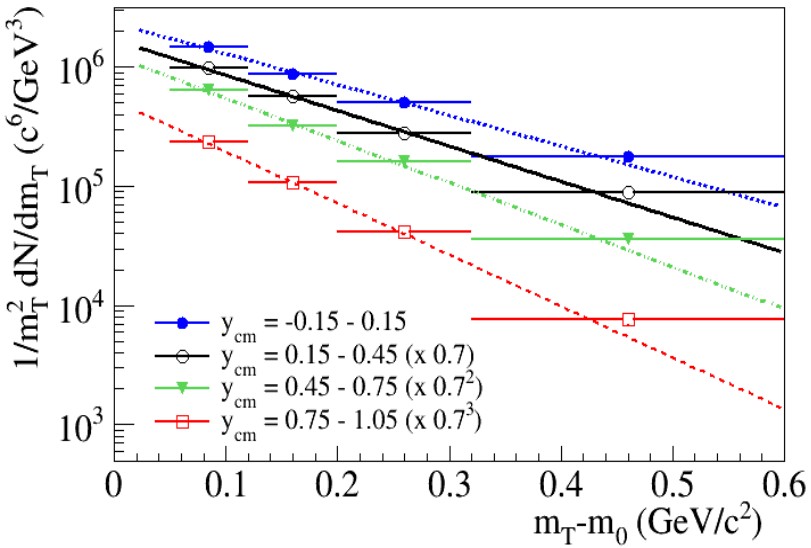


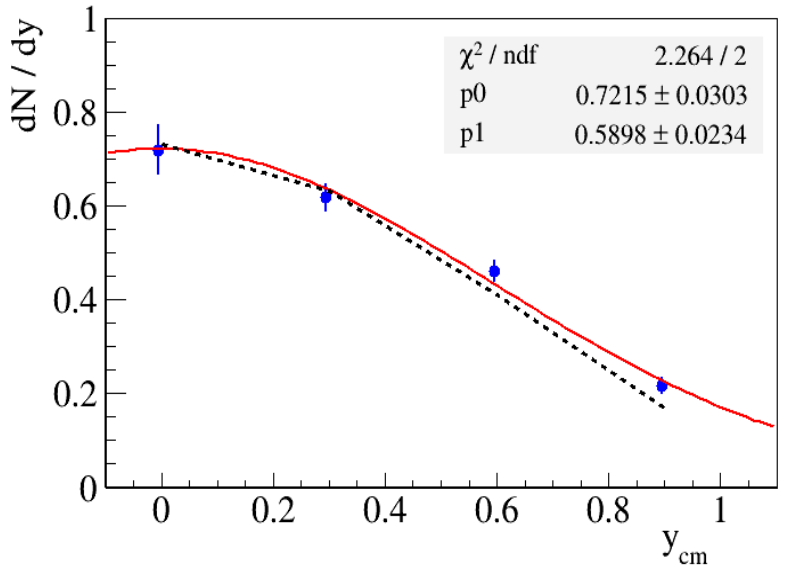


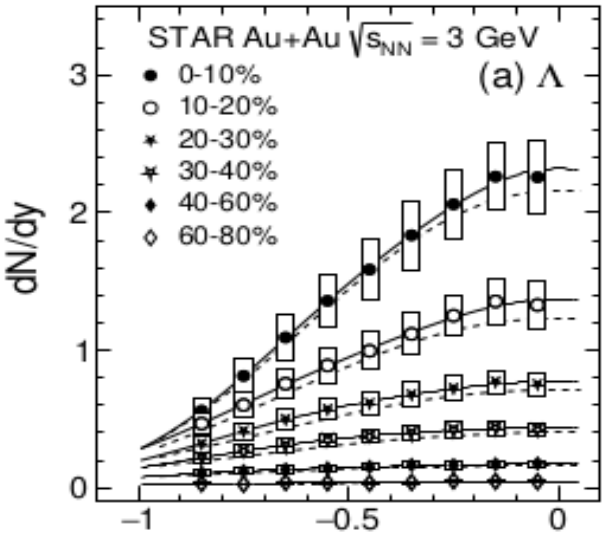


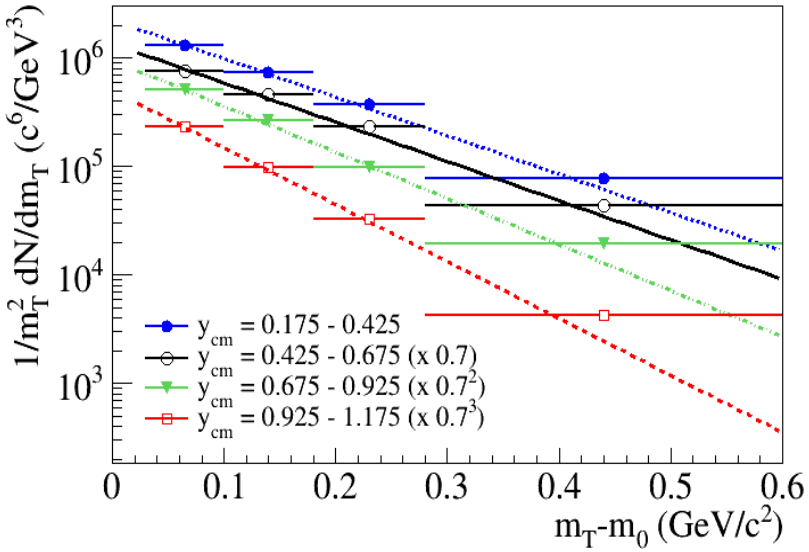


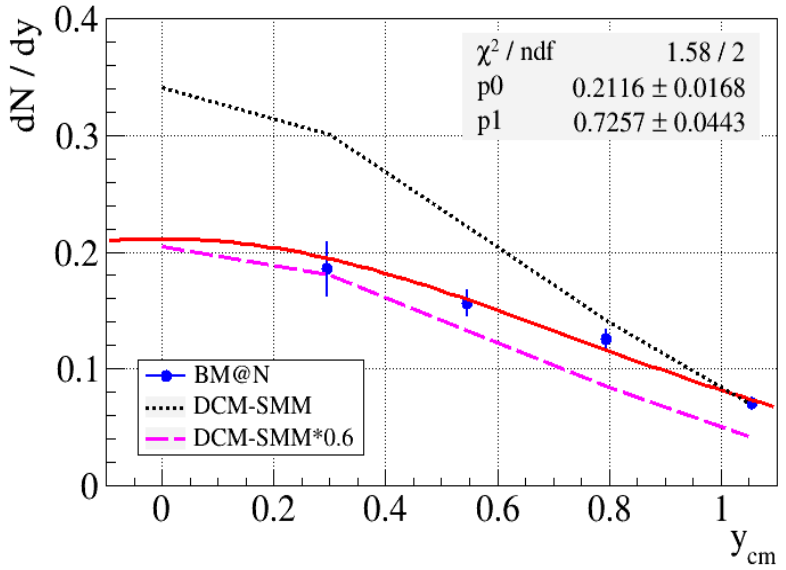
Steps towards physics analysis

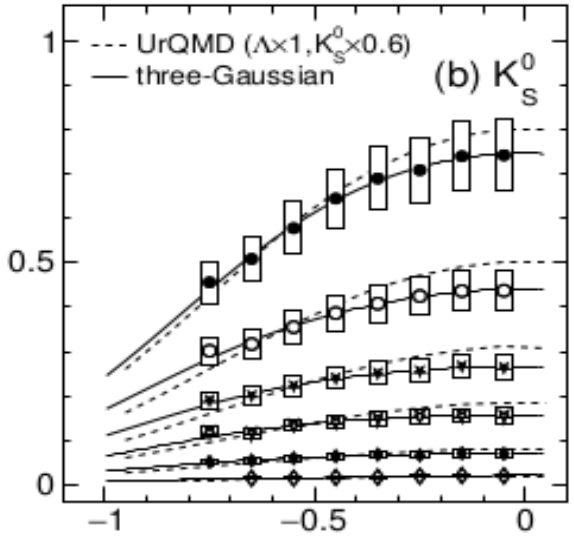




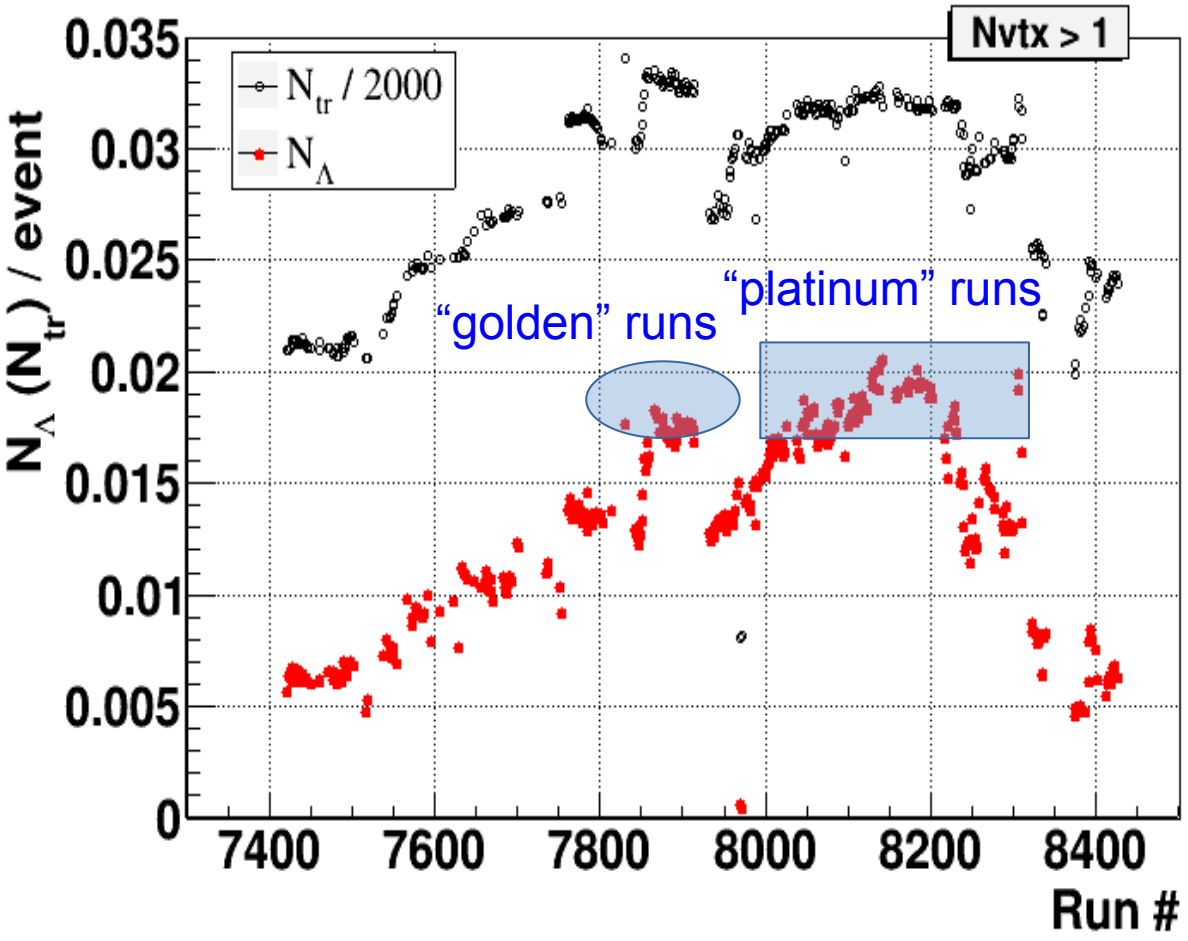








Steps towards physics analysis



100 runs with N_Λ/event > 0.017, ~60 mln. events with reconstructed vertex (N_{vtx} >1)

Next steps:

1. Estimate number of Λ and K^0_s in "golden" and "platinum" runs in centrality bins 0-10% and 40-60%
2. The other runs: evaluate the possibility to use a "simplified" Monte Carlo simulation (for signal particles only) to obtain the efficiency.

Summary and next steps

Summary

1. Monte Carlo tuning is done – no intention to make it better at this stage.
2. 10 mln. events of DCM-SMM have been produced.
3. 100 runs of experimental data with N_Λ/event > 0.017, ~60 mln. events with reconstructed vertex (N_{vtx} > 1).
4. Procedures to produce physics distributions are available and tested.
5. UrQMD can be used with fragment creator (from V.Kireyeu).
6. Resonances can be studied with UrQMD (also tested with DCM-SMM).

Next steps

1. Estimate number of Λ and K^0_s in “golden” and “platinum” runs in centrality bins 0-10% and 40-60% using centrality estimator with track multiplicity and Glauber fit.
2. Evaluate the possibility to use a “simplified” Monte Carlo simulation (for signal particles only) to obtain the efficiency for remaining runs.
3. Produce m_T (p_T) spectra, obtain rapidity spectra. Evaluate systematics.
4. Look at Ξ^- in Monte Carlo.