Current status of the TPC simulation and reconstruction

A.Zinchenko

for the MPD collaboration

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Outline

1. The "realistic" TPC simulation ("microsimulation") procedure
2. Cluster / hit reconstruction method and results
3. Track reconstruction method and results
4. Secondary vertex reconstruction method
5. Results: hyperon reconstruction

Simulation procedure (digitization)

1. Primary ionization (ionization clusters)
2. Drift and diffusion of ionization electrons
3. Gas gain fluctuations (Polya distribution)
4. Pad response (charge distribution on pad plane)
5. Electronics shaping
6. Signal digitization (ADC overflow)

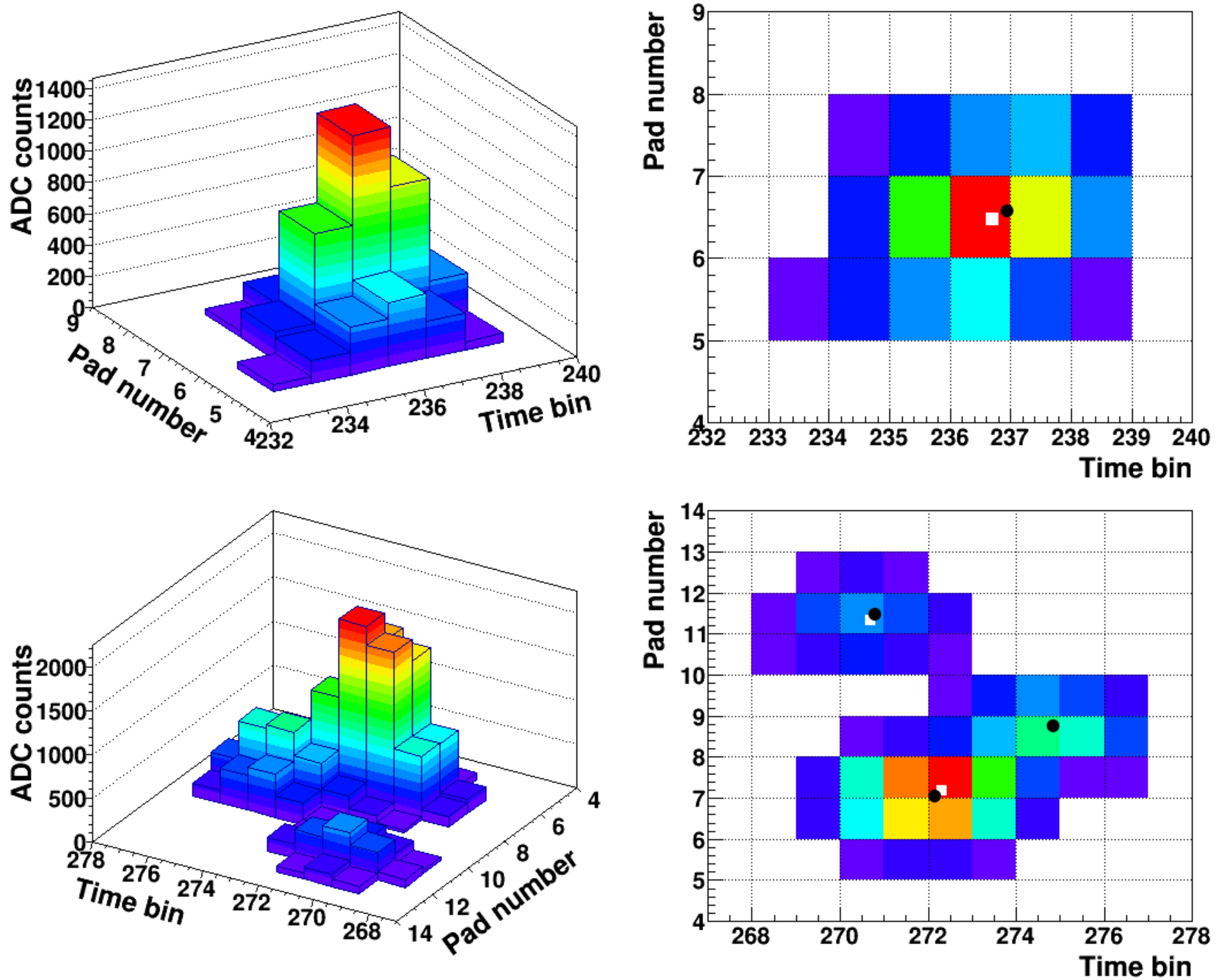
TPC parameters

Parameter	Value
Magnetic field	0.5 T
Drift gas	P10 (90% Ar + 10% CH_4)
Drift velocity	5.45 cm/μs
Transverse diffusion at 0.5 T	185 μm/√cm
Longitudinal diffusion	320 μm/√cm
Pad size	5x12 mm^2 (27 rows) + 5x18 mm^2 (26 rows)
Charge spread σ	0.196 mm
Electronics shaping time	180 ns (FWHM)
ADC dynamic range	12 bits
ADC sampling frequency	10 MHz

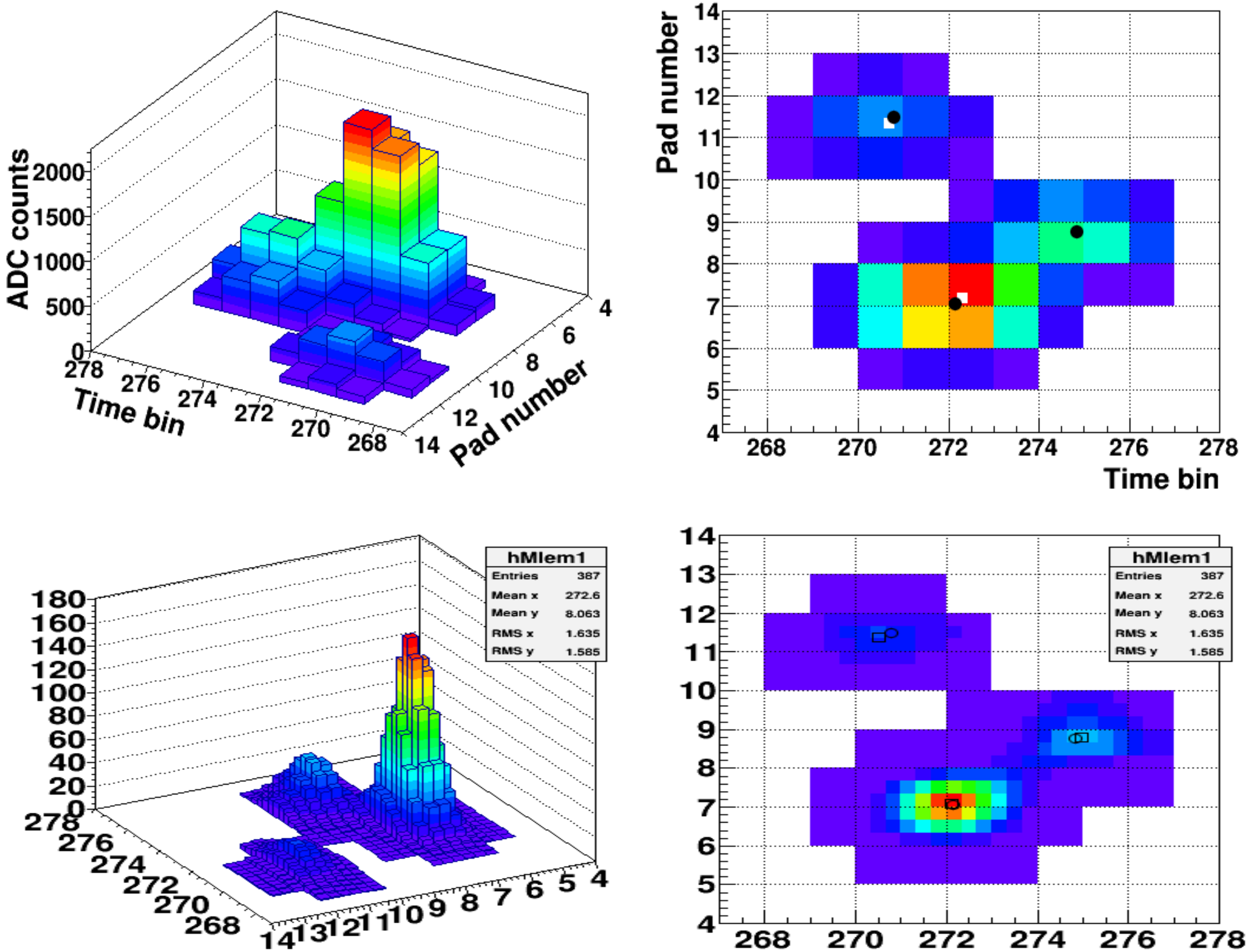
Cluster / hit reconstruction

1. Precluster finder (group of adjacent pixels in time bin – pad space)
2. Hit finder ("peak-and-valley" algorithm either in time bin – pad space (for simple topologies) or in time-transverse coordinate pixel space after Bayesian unfolding (for more complicated topologies)) → COG around local maxima

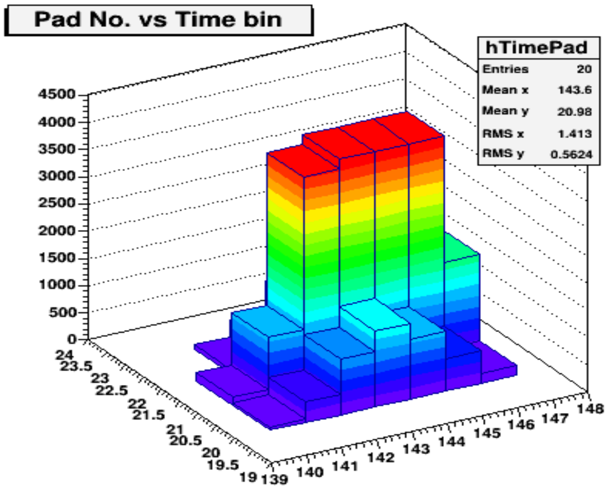
Cluster topologies

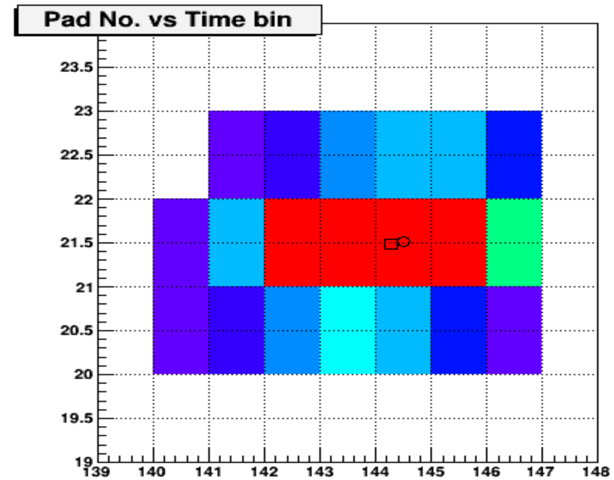


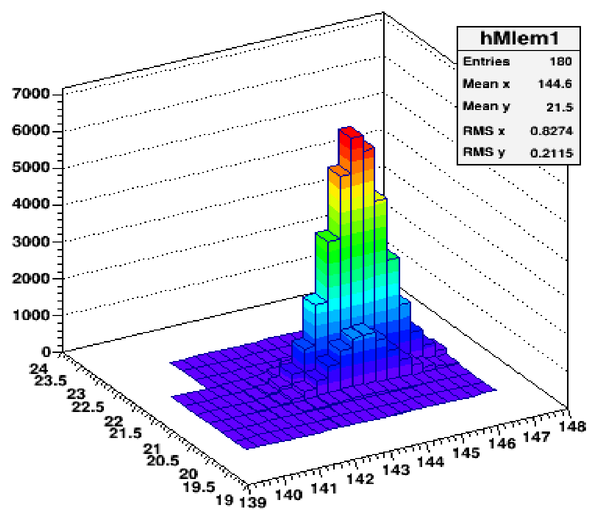
MLEM procedure (Bayesian unfolding)

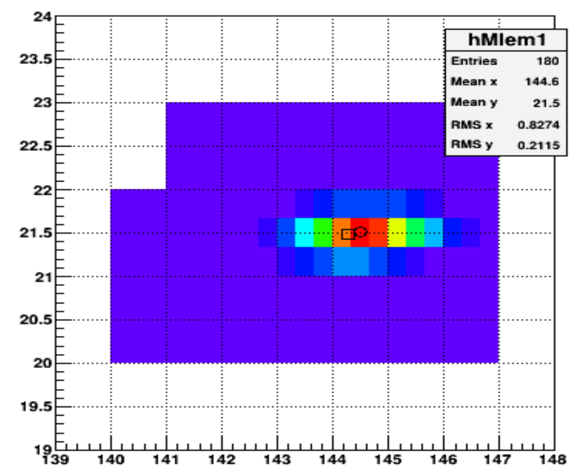


MLEM procedure - information recovery





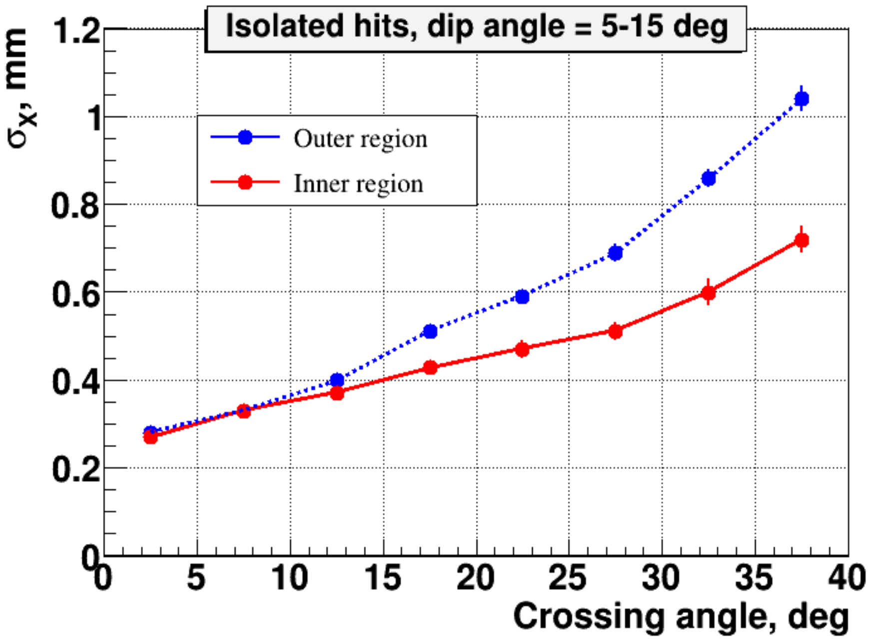


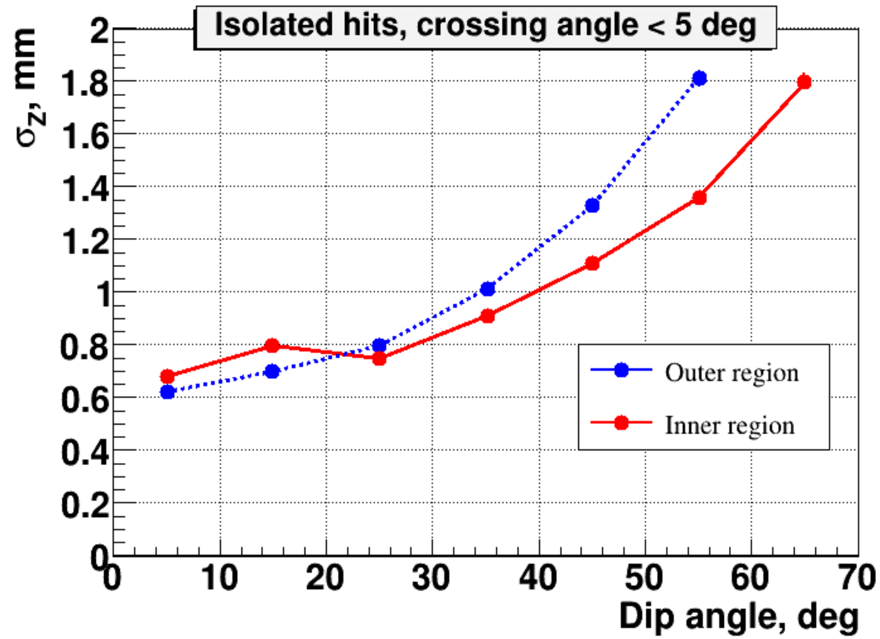


Event sample

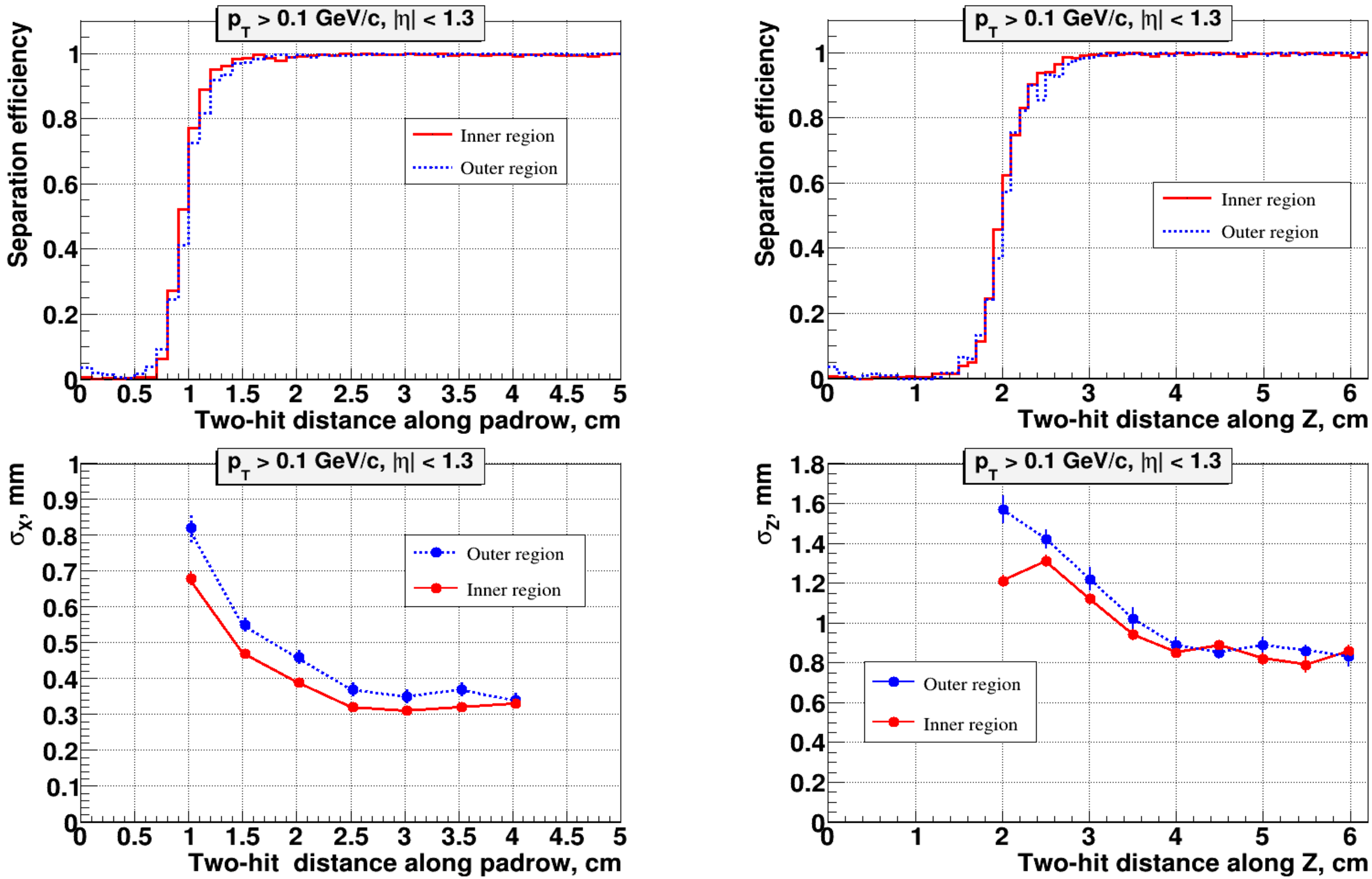
1. UrQMD, central (0-3 fm), Au+Au at 9 GeV

Coordinate resolution





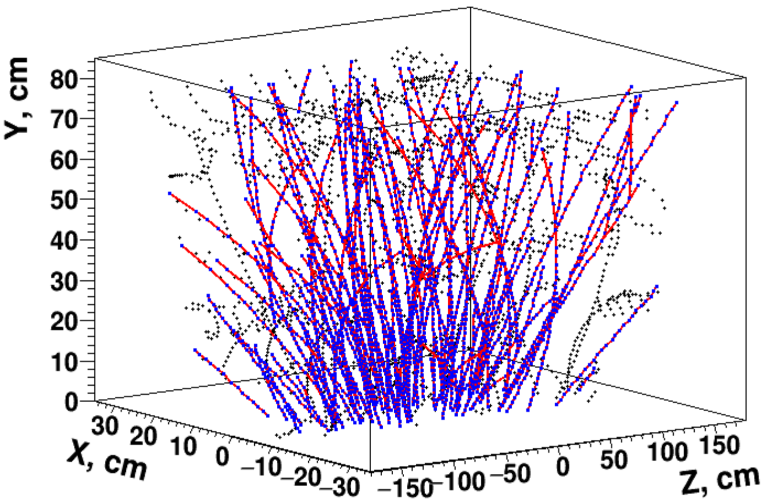
Double-hit resolution

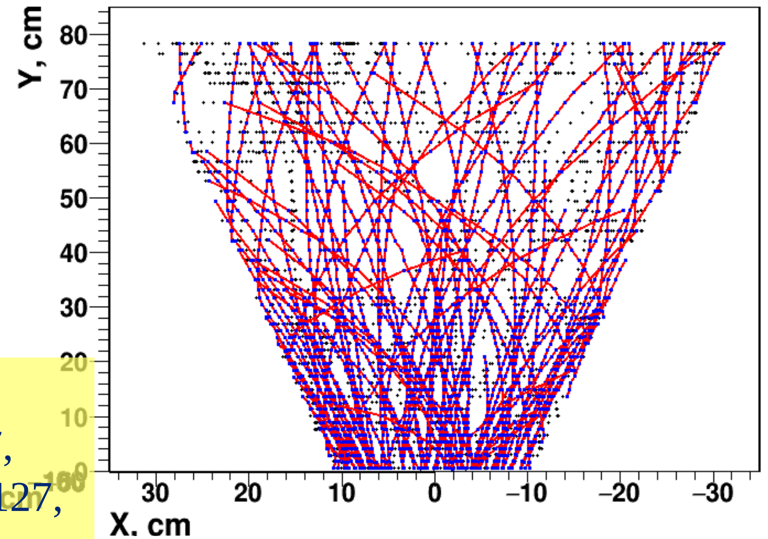


Track reconstruction

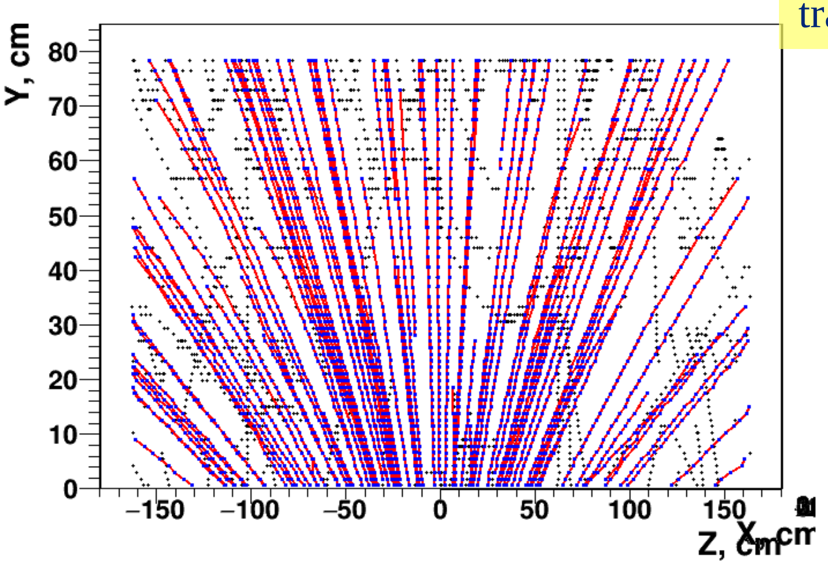
Two-pass Kalman filter with track seeding using outer hits (1st pass) or leftover inner hits (2nd pass)

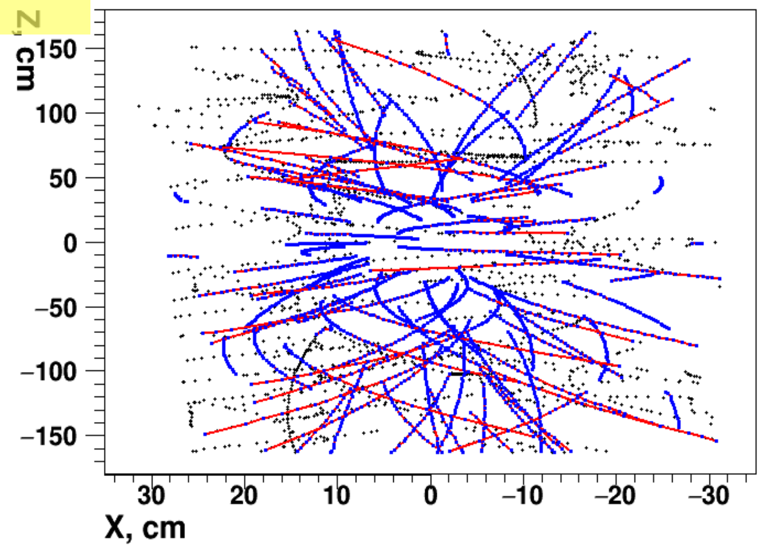
Track reconstruction





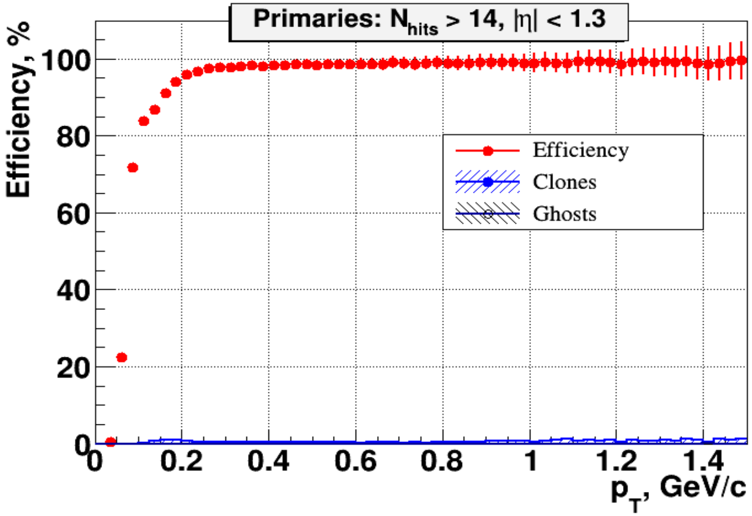
Some stats:
rec. points = 4867,
hits on tracks = 3127,
tracks = 102

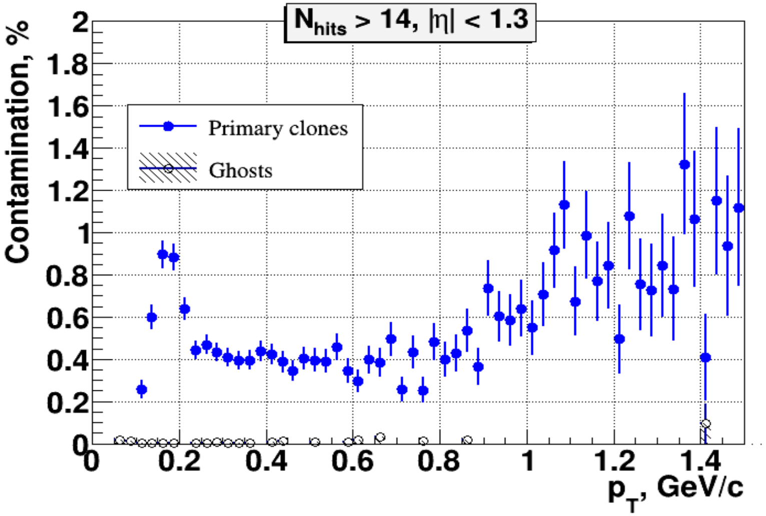




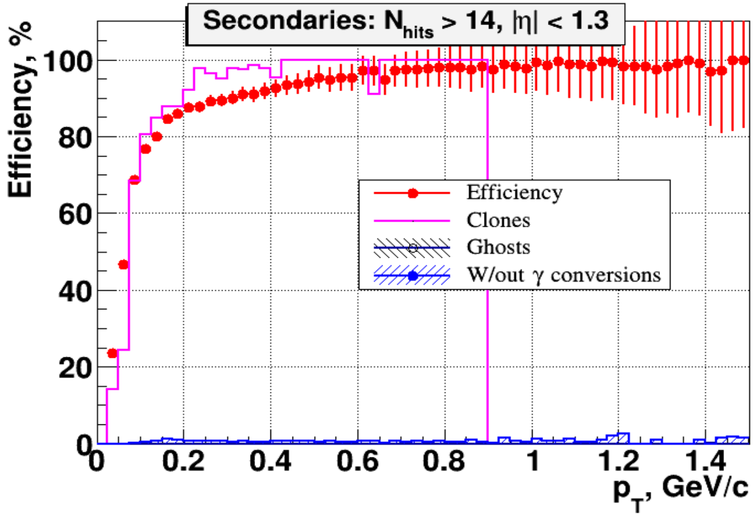
Track reconstruction efficiency

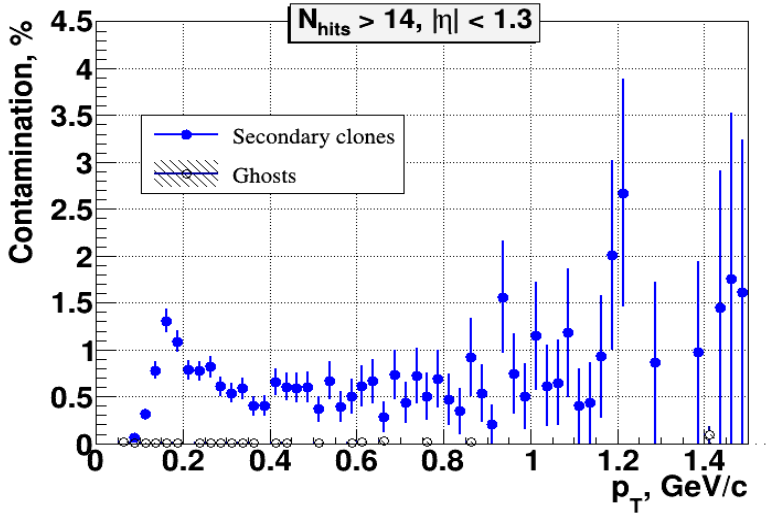
Primary





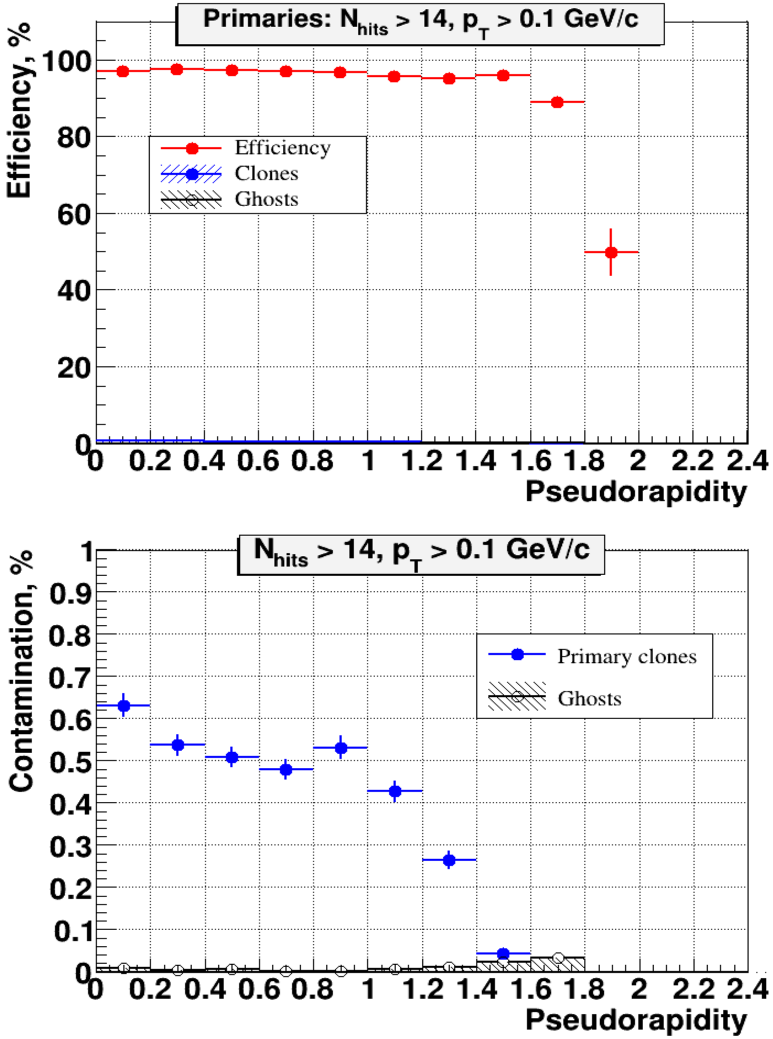
Secondary



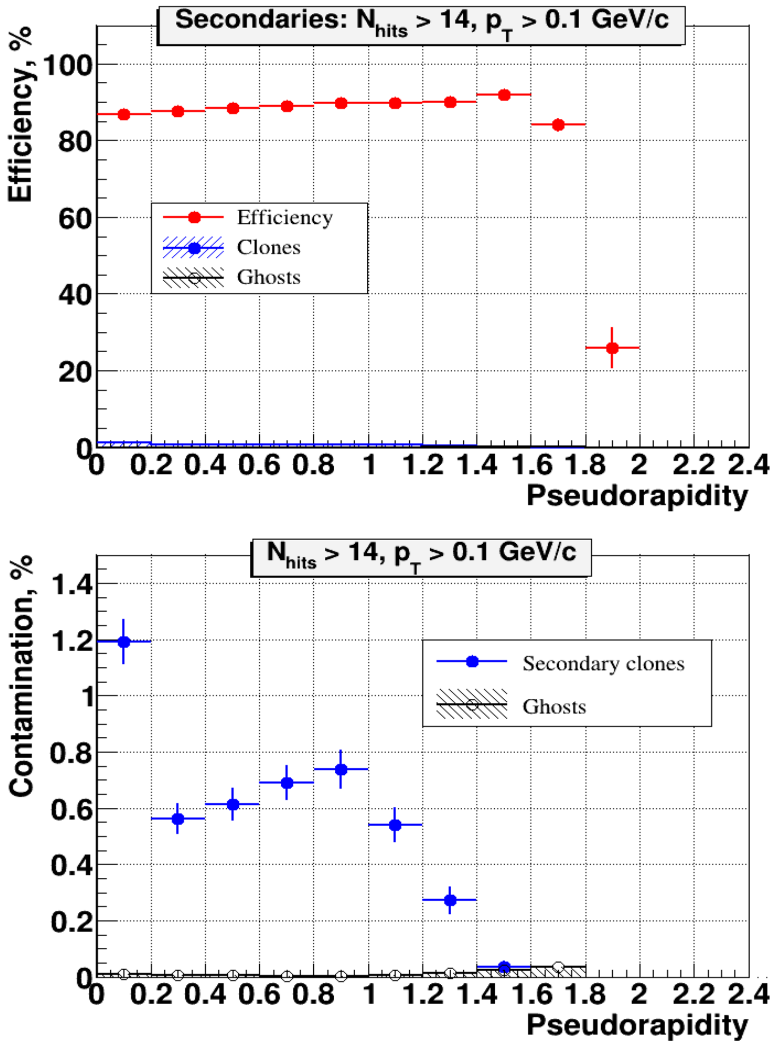


Track reconstruction efficiency

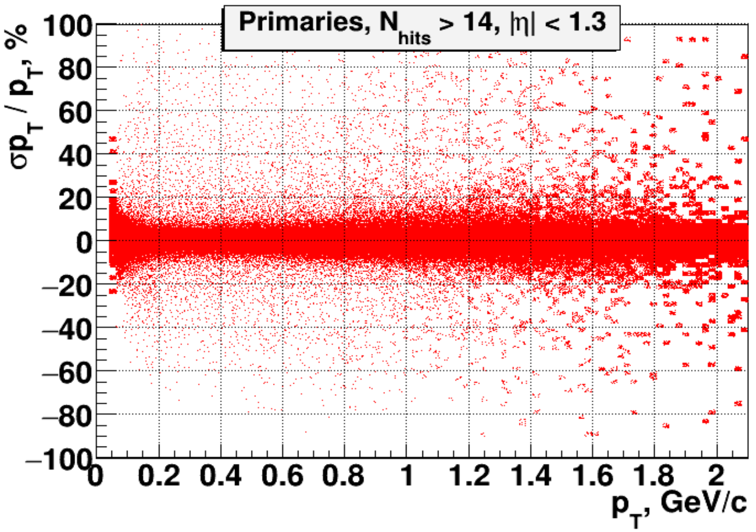
Primary

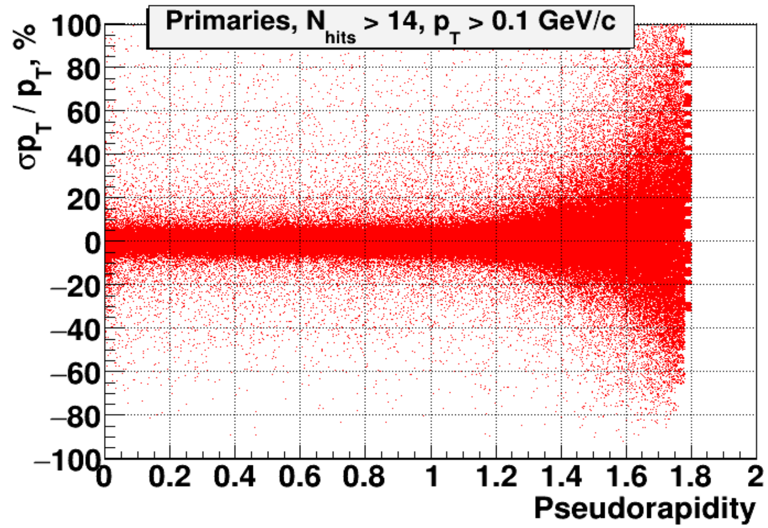


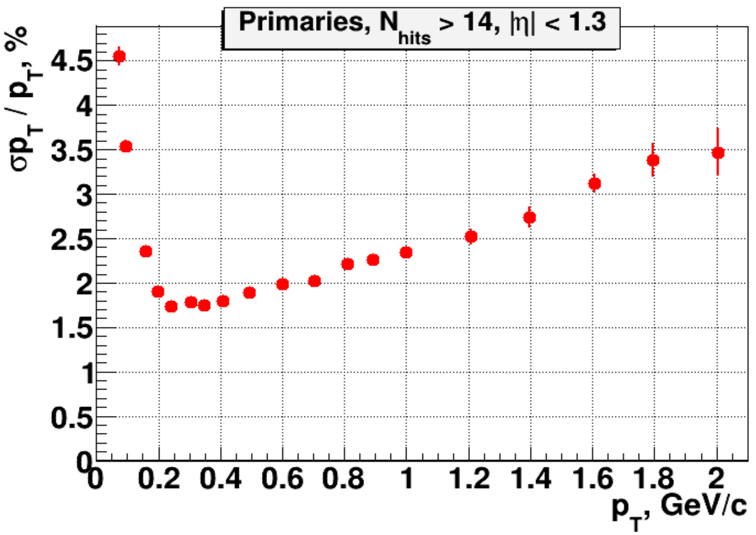
Secondary

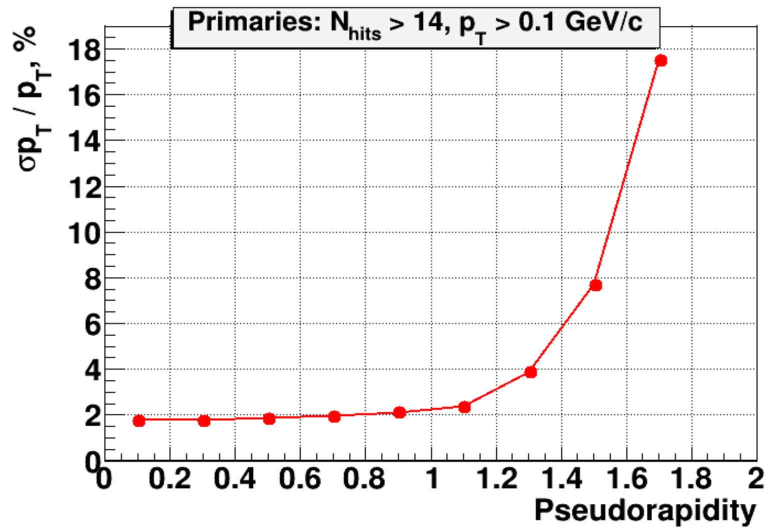


Momentum resolution

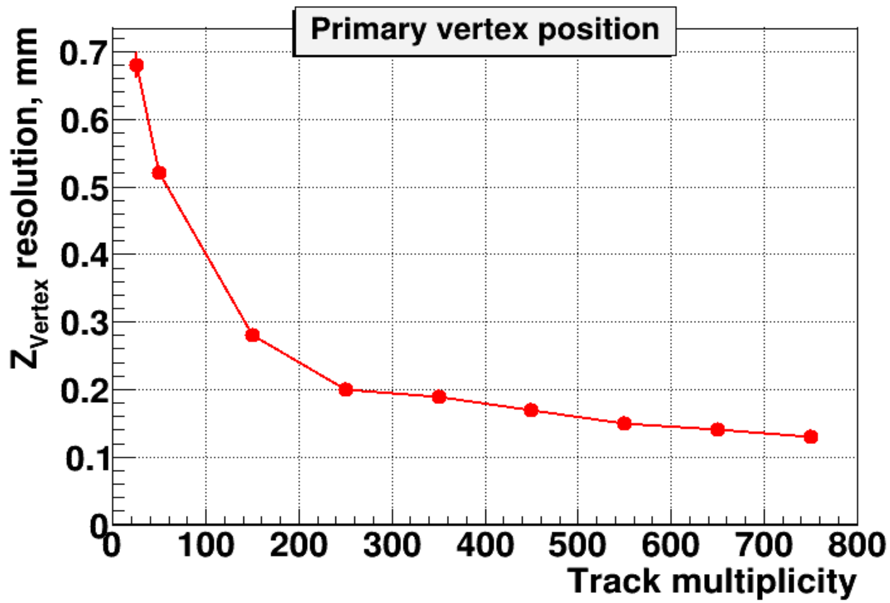


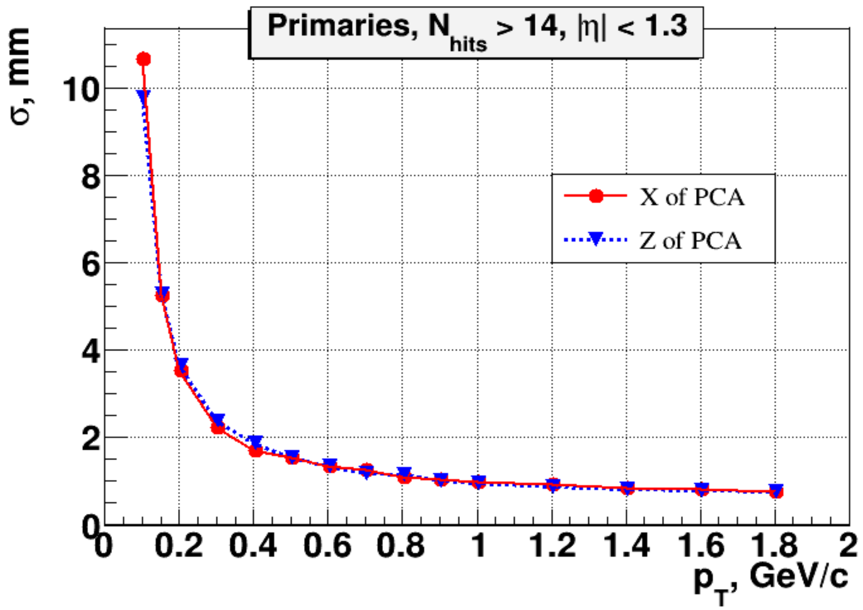




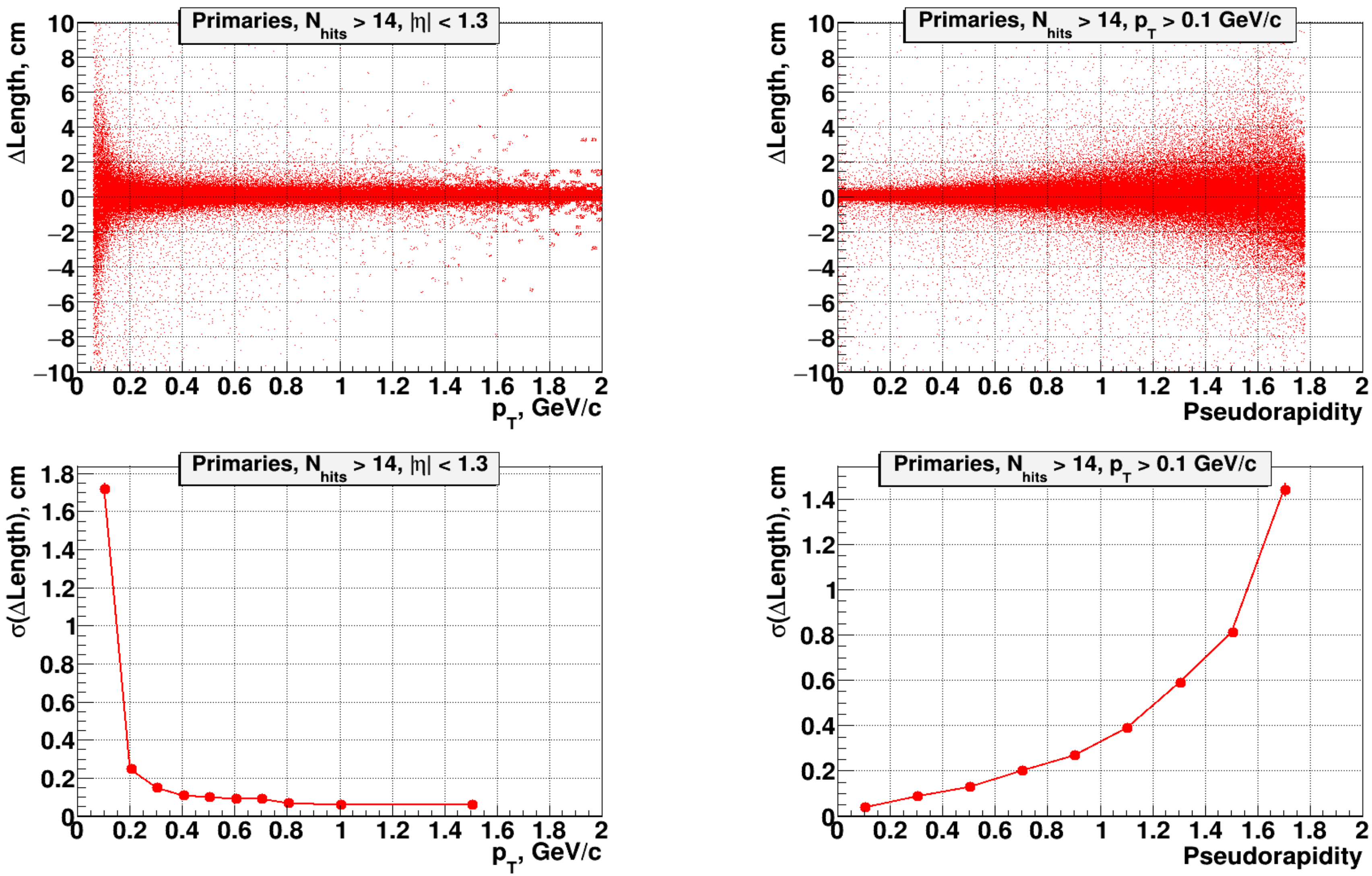


Track pointing accuracy

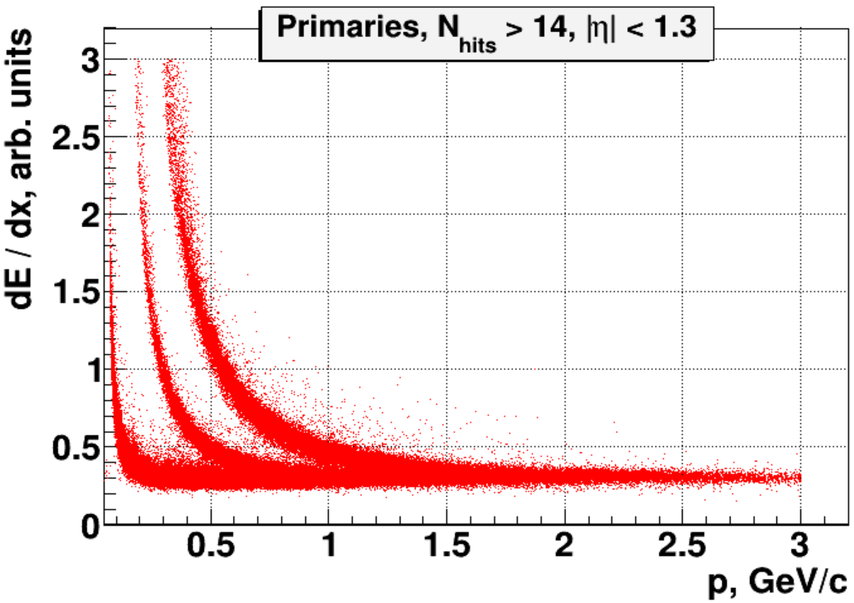


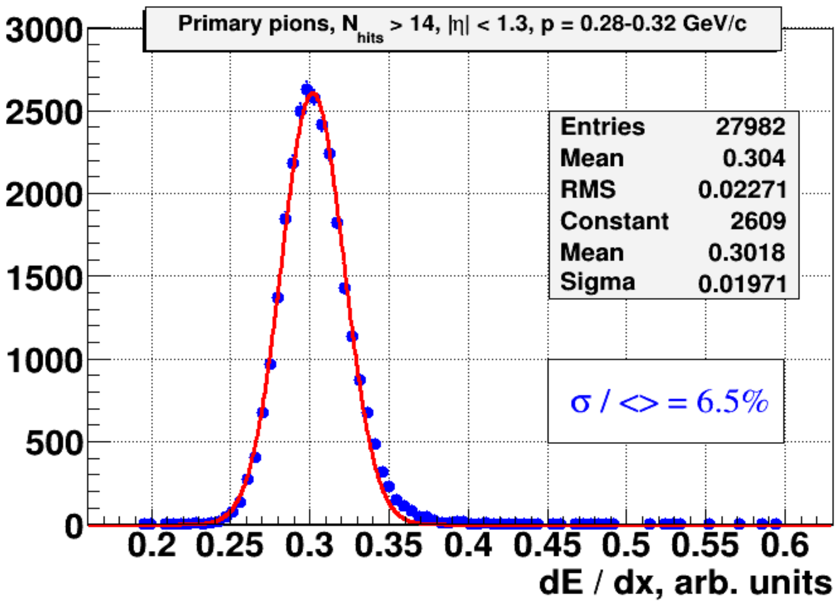


Track length resolution



dE / dx measurement





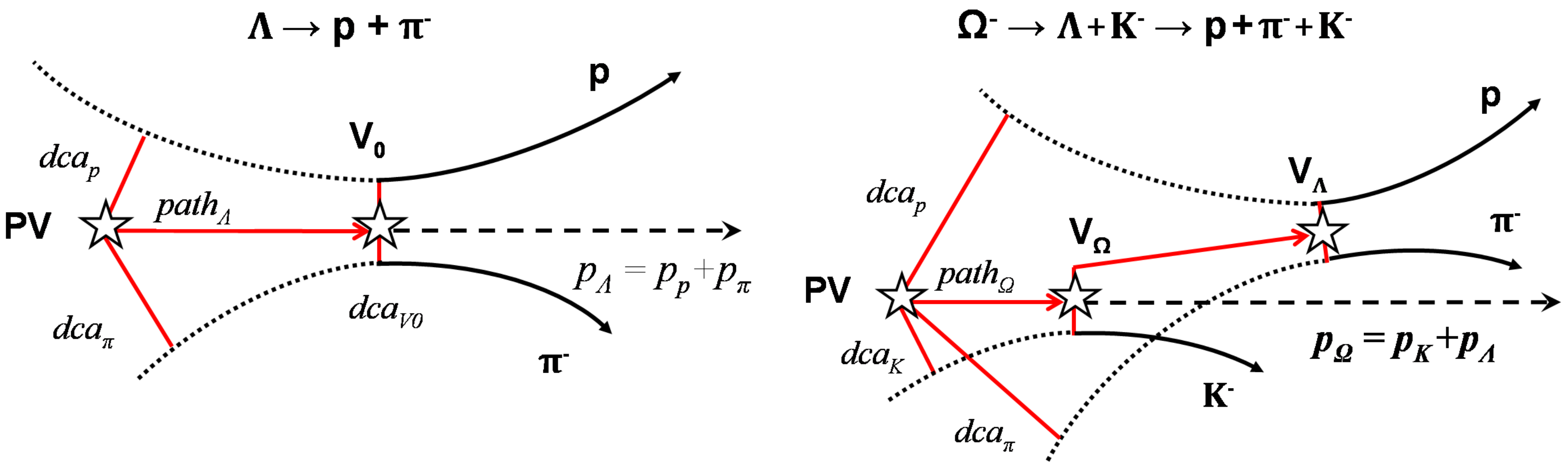
Secondary vertex reconstruction

MpdParticle (inspired by CbmKFParticle approach (which was inspired by BaBar software))

Main idea: decouple secondary vertex reconstruction / decay product fitting from the tracking task – work with particle parameters – the approach makes it possible to treat charged and neutral objects on the same footing.

Method implementation is based on the Kalman filter formalism described in R.Luchsinger, Ch.Grab "Vertex reconstruction by means of the method of Kalman filter", Comp. Phys. Comm., 76 (1993) 263.

Analysis Method:
Secondary Vertex Finding Technique



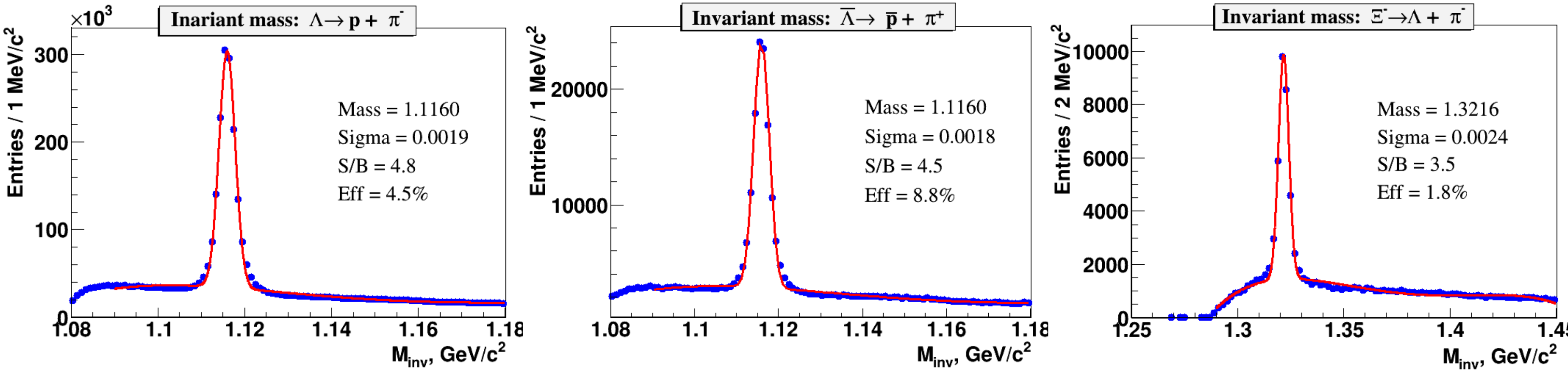
Event topology:

- PV – primary vertex
- V_0 – vertex of hyperon decay
- dca – distance of the closest approach
- path – decay length

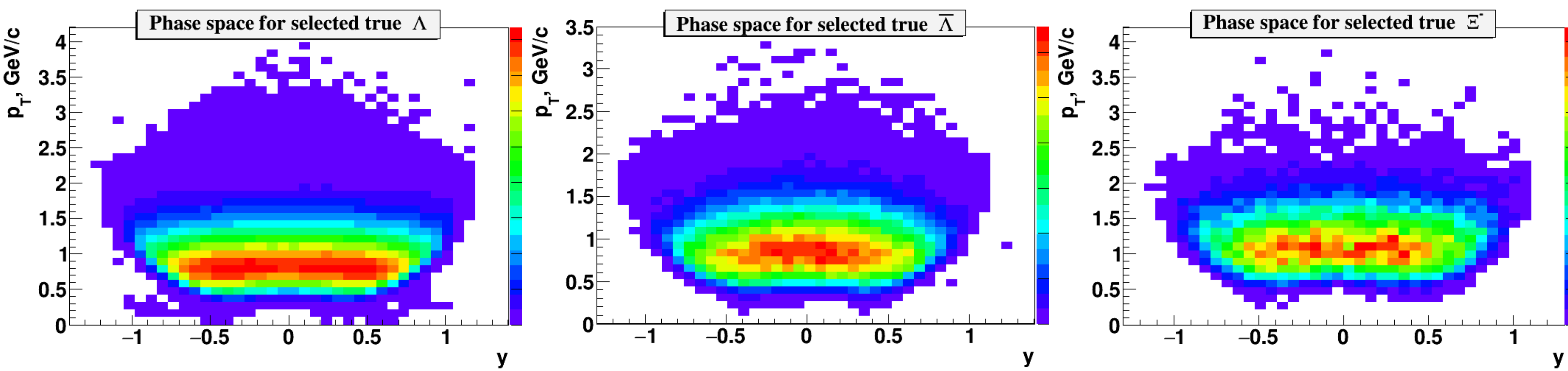
Hyperon reconstruction: data set

- **Generator:** PHSD, Au+Au @ 11 GeV, minbias, 2M events $\rightarrow$ 4M
- **Detectors:** start version of MPD with up-to-date TPC & TOF
- **Track acceptance criterion:** $|\eta| < 1.3$, $N_{hits} \geq 10$
- Realistic track reconstruction
- Realistic PID in TPC & TOF

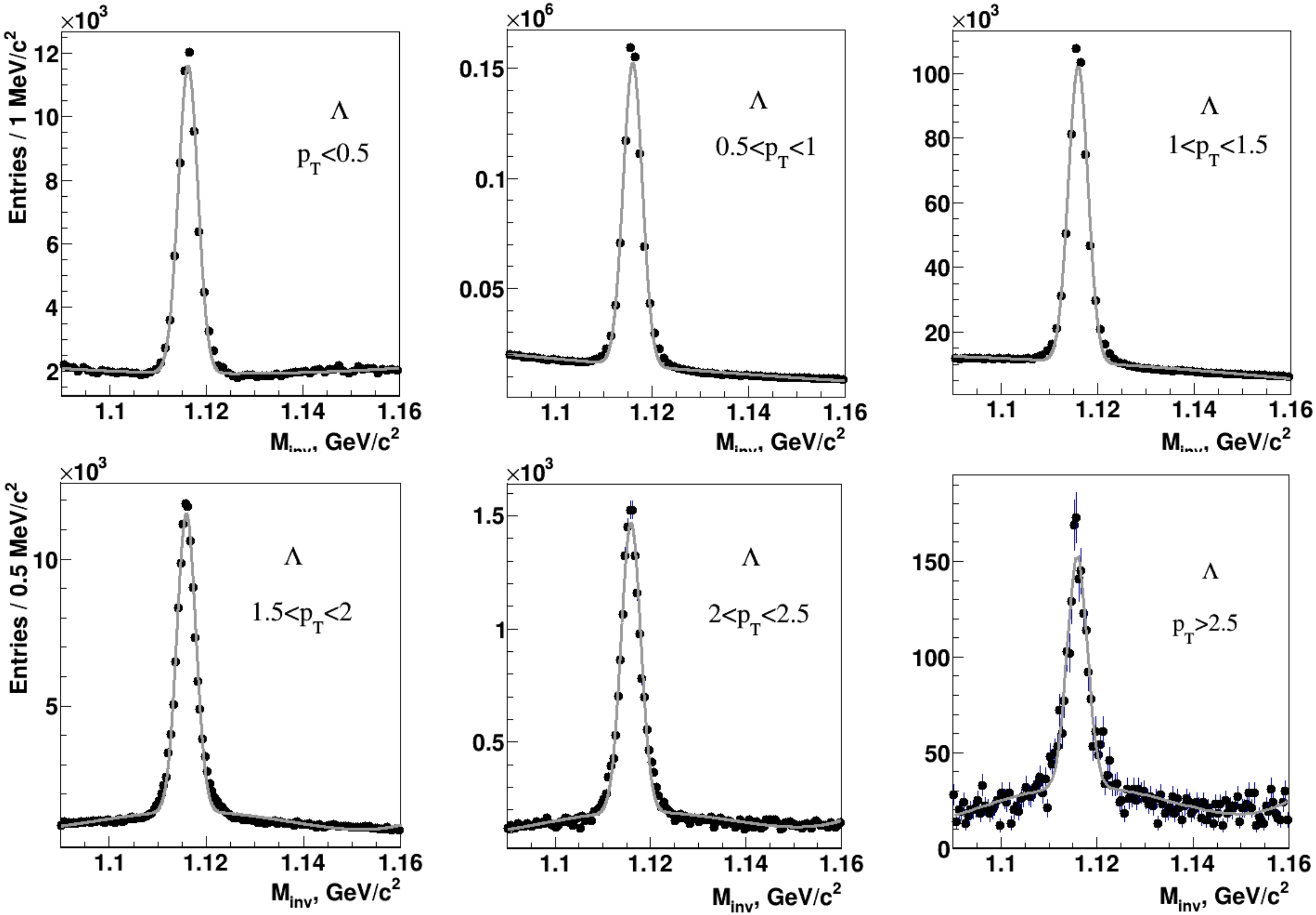
Hyperon reconstruction



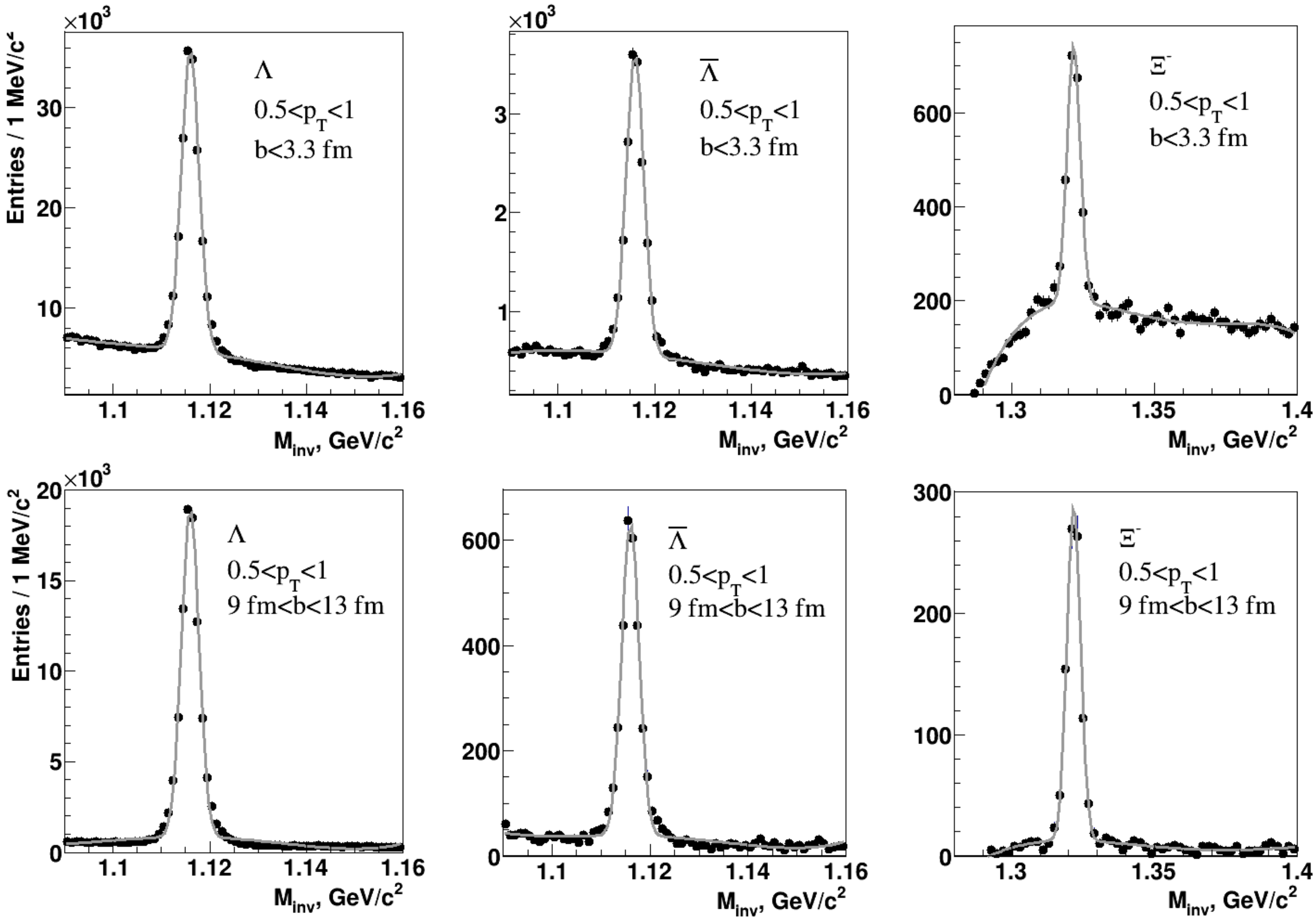
Phase space for reconstructed and selected true hyperons



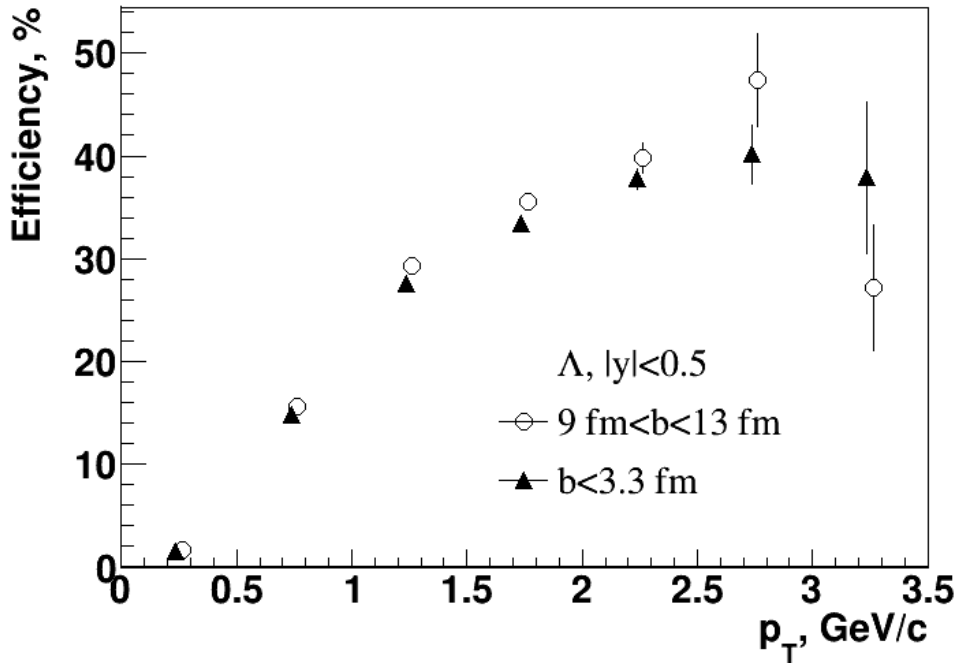
Λ reconstruction: p_T dependence



Hyperons @ different b

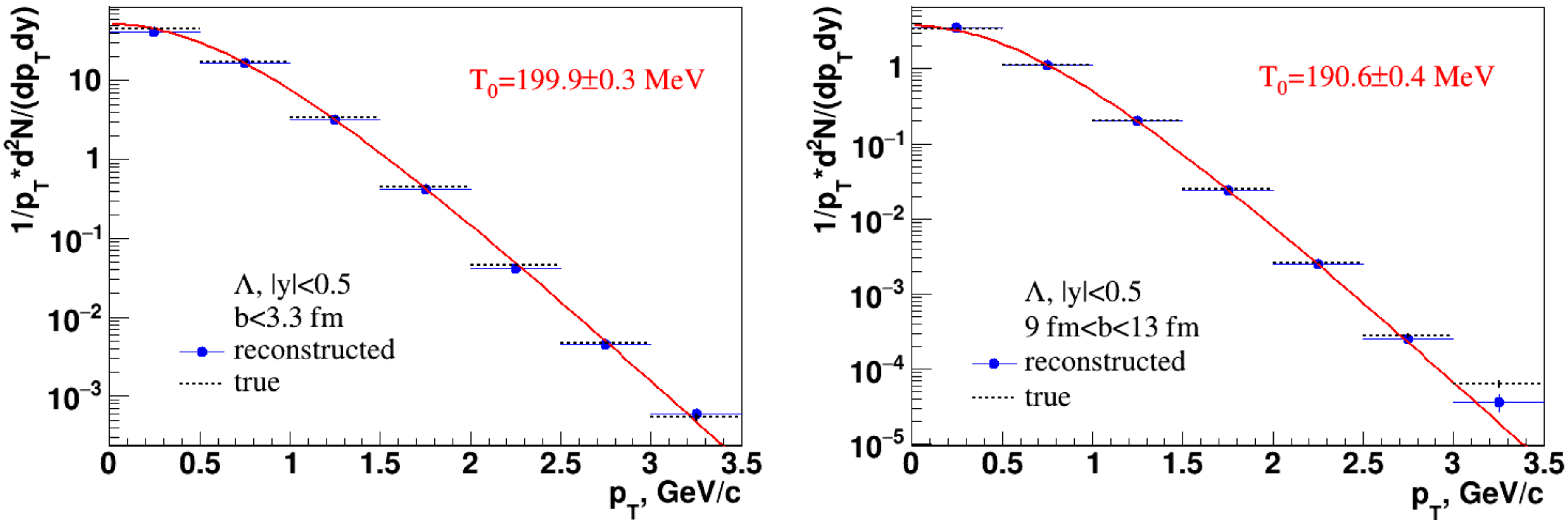


Efficiency of Λ reconstruction



Efficiency of true Λ in p_T&b bins for |y|<0.5: (reco & select Λ) / (all gen Λ)

p_T spectrum of Λ



Reconstructed spectrum: fit of selected Λ in each bin (Gauss ± 3σ) / Eff.

Summary

- The MPD TPC "realistic" simulation is in operation
- Reconstruction results look reasonable
- Simulation / reconstruction chain can be used for physics analyses