Λ(1520), Σ(1385)$^{\pm}$ and K*(892)$^{\pm}$ resonance production in BiBi@9.2 GeV

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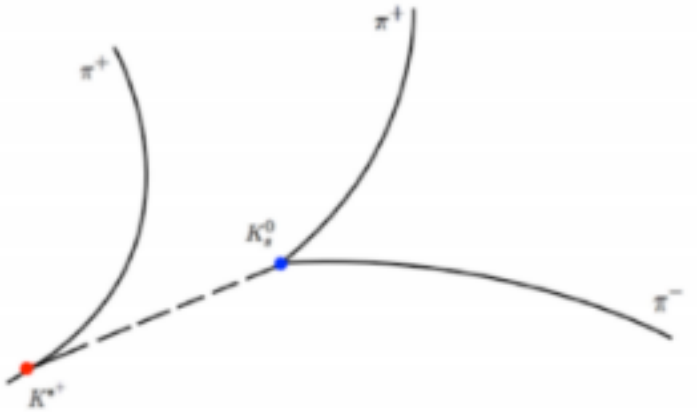
Analysis Details: Λ(1520)→p + K

- Data: Request 25, BiBi@9.2 GeV, UrQMD+Geant4
- Analysis train: Request 6 with resonance wagons
  - Event and track selection:

Event selection:
mZvtxCut 130 // cut on vertex z coordinate
event.getCentrTPC() // Centrality determination
# PID cuts:
mPIDsigTPC 2 // dEdx PID parameters
mPIDsigTOF 2 // dEdx PID parameters
mNofHitsCut 10 // minimal number of hits for a track
mEtaCut 1.0 // maximal pseudorapidity for a track
mPtminCut 0.1 // minimal pt for a track
mDCACut 2.0*σ // maximum DCA for a track (σ = σ(p_T, centrality))
Pair cuts:
mYCut 0.5 // pair rapidity cut

Analysis Details: $K^*(892)^{\pm} \rightarrow \pi^{\pm} + K_s$



Event selection:

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mPtminCut 0.1 // minimal pt for a track

mDCACut 2.0*σ // maximum DCA for a track ($\sigma = \sigma(p_T, \text{centrality})$)

Pair cuts:

mYCut 0.5 // pair rapidity cut

Ks cuts:

mChi2PionKs 7.0 // minimum Chi2-to-PV for pion from Ks

mKsEtaCut 1.2 // maximum pseudorapidity for Ks

mChi2Ks 3.0 // maximum Chi2 for Ks secondary vertex

mPAKs 0.1 // maximum pointing angle for Ks

mDecayKs 0.5 // minimum decay distance for Ks

mDistKs 1.0 // maximum distance between pi-pi in the secondary vertex from Ks

mNSigmaKs 2.0 // n-sigma selection for Ks candidates

mWidthKs 5e-3 // width of Ks peak

Analysis Details: $\Sigma(1385)^{\pm} \rightarrow \pi^{\pm} + \Lambda$

Event selection:

mZvtxCut 130 // cut on vertex z coordinate

PID cuts:

mPIDsigTPC 2 // dEdx PID parameters

mPIDsigTOF 2 // dEdx PID parameters

mNofHitsCut 10 // minimal number of hits for a track

mEtaCut 1.0 // maximal pseudorapidity for a track

mPtminCut 0.1 // minimal pt for a track

mDCACut 2.0*σ // maximum DCA for a track ($\sigma = \sigma(p_T, \text{centrality})$)

Pair cuts:

mYCut 0.5 // pair rapidity cut

Lambda cuts:

mChi2PionLam 7.0 // minimum Chi2-to-PV for pion from Lambda

mChi2ProtLam 3.0 // minimum Chi2-to-PV for proton from Lambda

mLamEtaCut 1.2 // maximum pseudorapidity for Lambda

mChi2Lam 3.0 // maximum Chi2 for Lambda secondary vertex

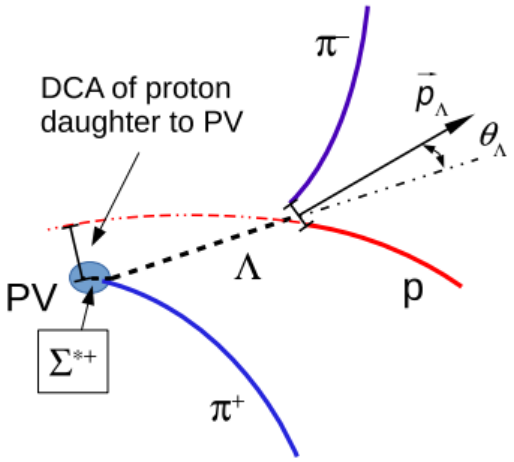
mPALam 0.1 // maximum pointing angle for Lambda

mDecayLam 0.5 // minimum decay distance for Lambda

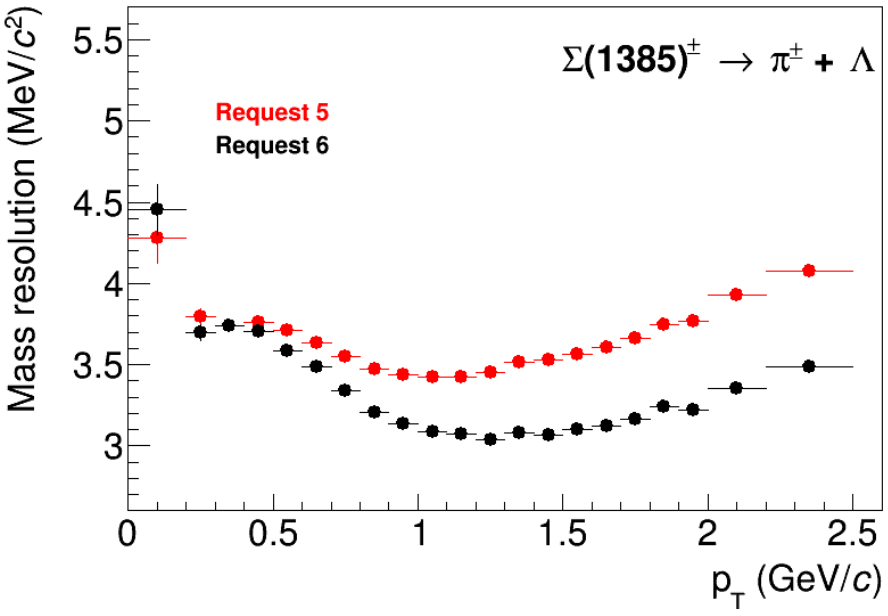
mDistLam 1.0 // maximum distance between p-pi in the secondary vertex from Lambda

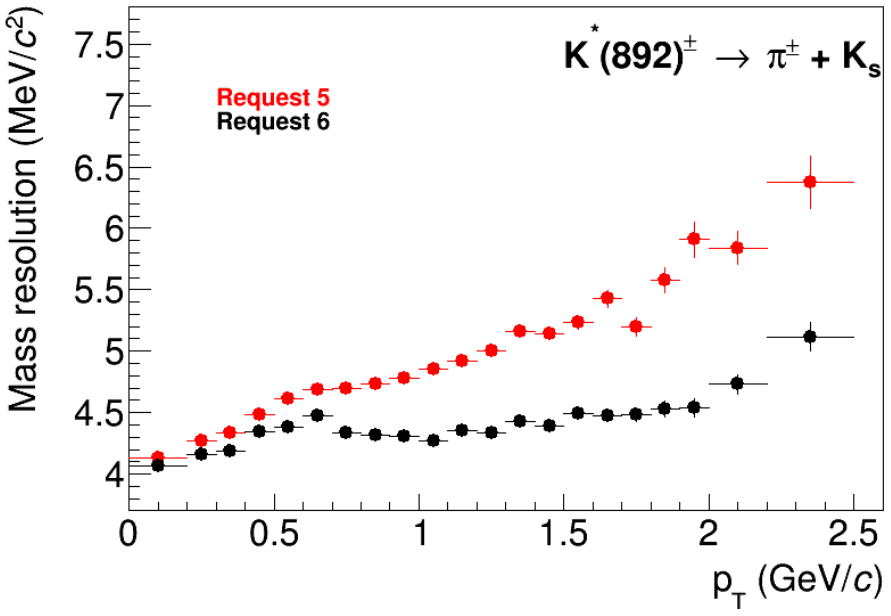
mNSigmaLam 2.0 // n-sigma selection for Lambda candidates

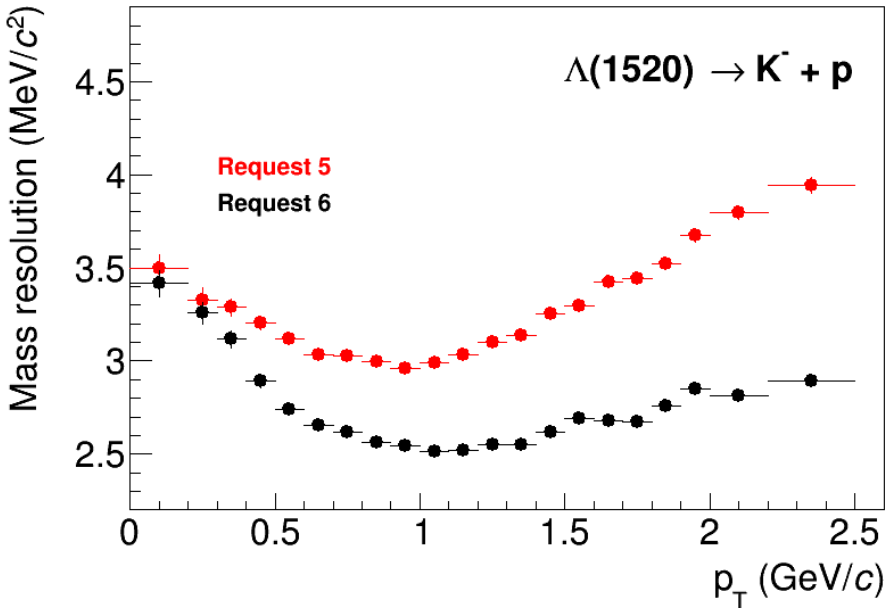
mWidthLam 2e-3 // width of Lambda peak



Mass Resolution for resonances

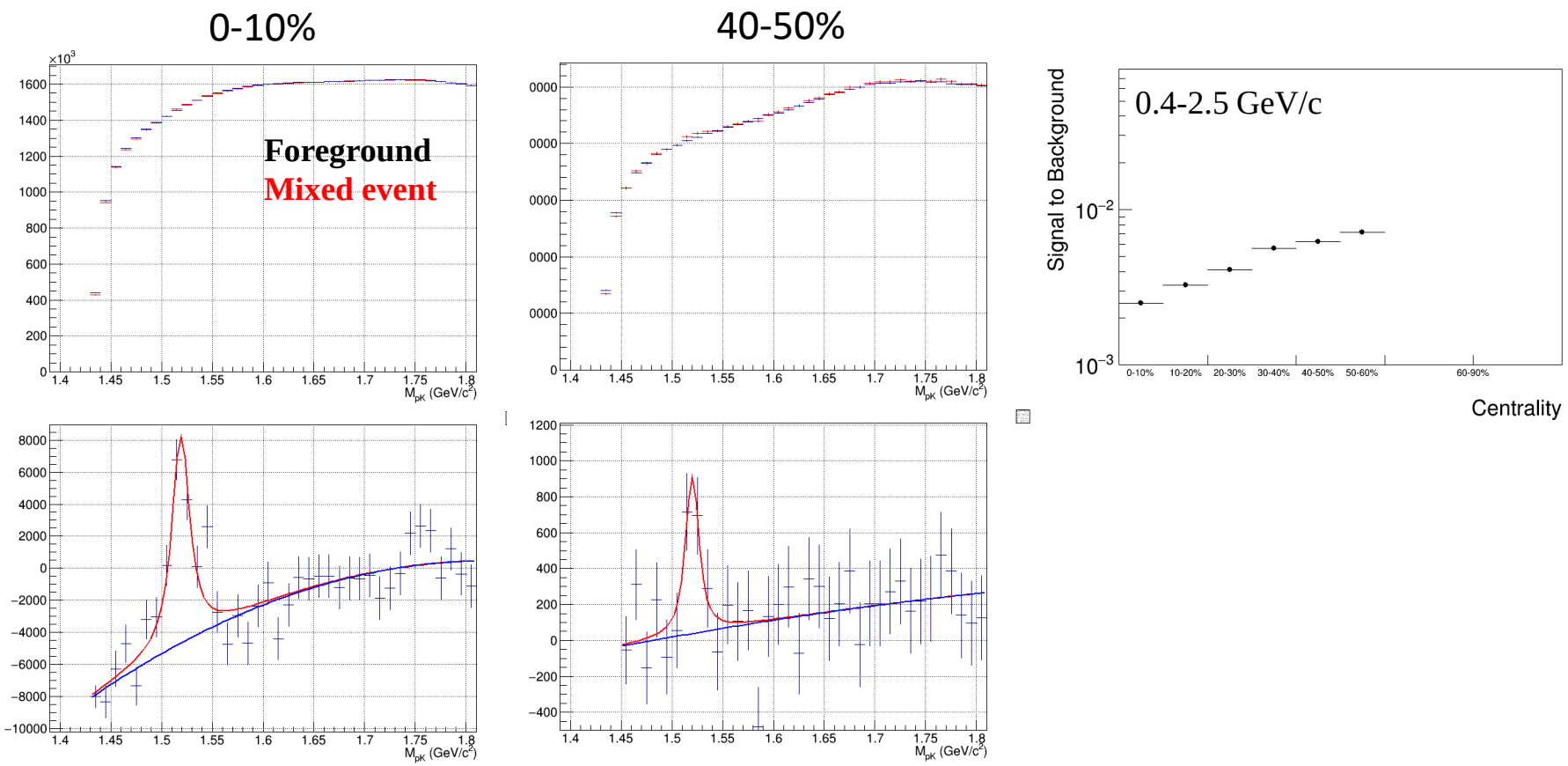






Λ(1520), reconstructed peaks

- Full chain simulation and reconstruction, p_T = 0.6-0.8 GeV/c, Λ(1520)→p + K^-, |y| < 0.5

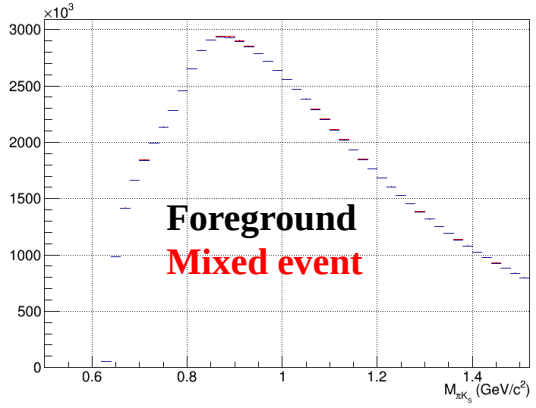


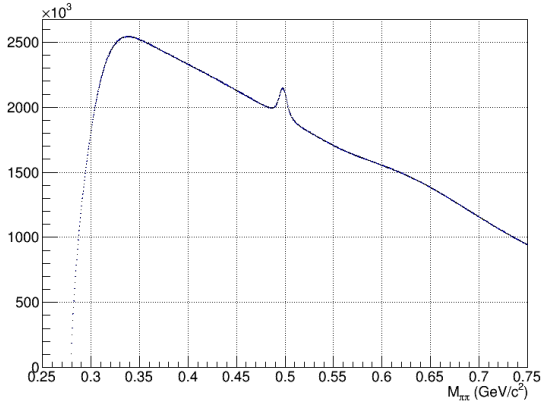
- Mixed-event combinatorial background is scaled to foreground at high mass and subtracted
- Distributions are fit to Voigtian function + polynomial (mass resolution fixed to estimated value, Γ - free parameter)
- Signal can be reconstructed at p_T > 0.4 GeV/c in central and semi-central collisions, high-p_T reach is limited by available statistics

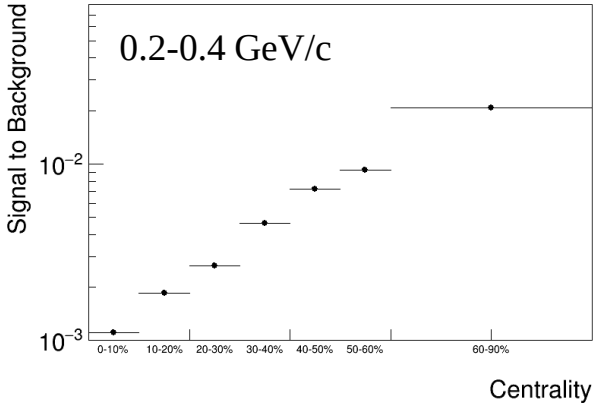
$K^*(892)^{\pm}$, reconstructed peaks

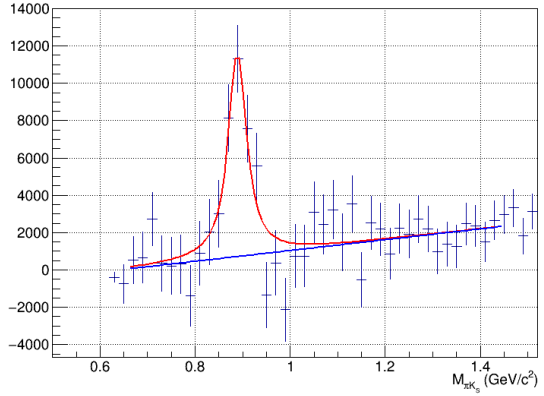
- Full chain simulation and reconstruction, p_T = 0.2-0.4 GeV/c, $K^*(892)^{\pm} \rightarrow K_s + \pi^-$,($K_s \rightarrow \pi^- + \pi^+$) |y| < 0.5

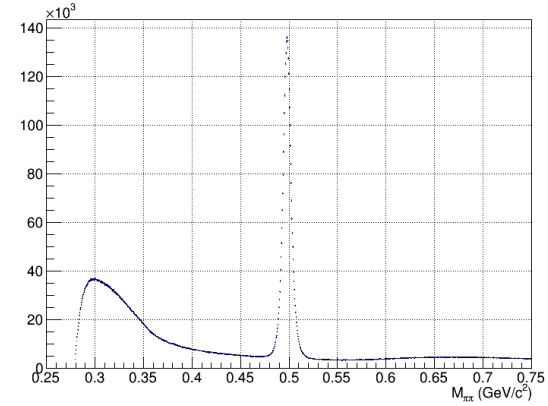
$K^*(892)^{\pm} \rightarrow K_s + \pi^-$ $K_s \rightarrow \pi^- + \pi^+$

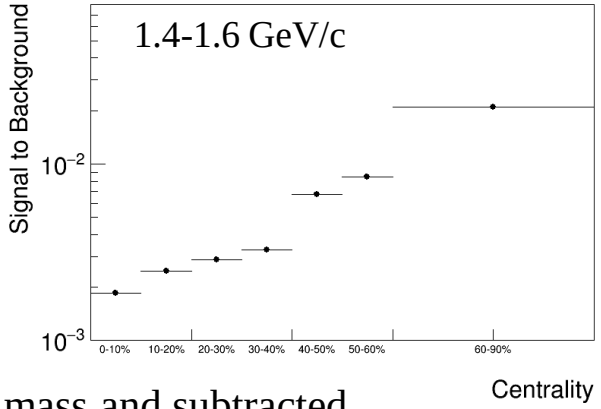








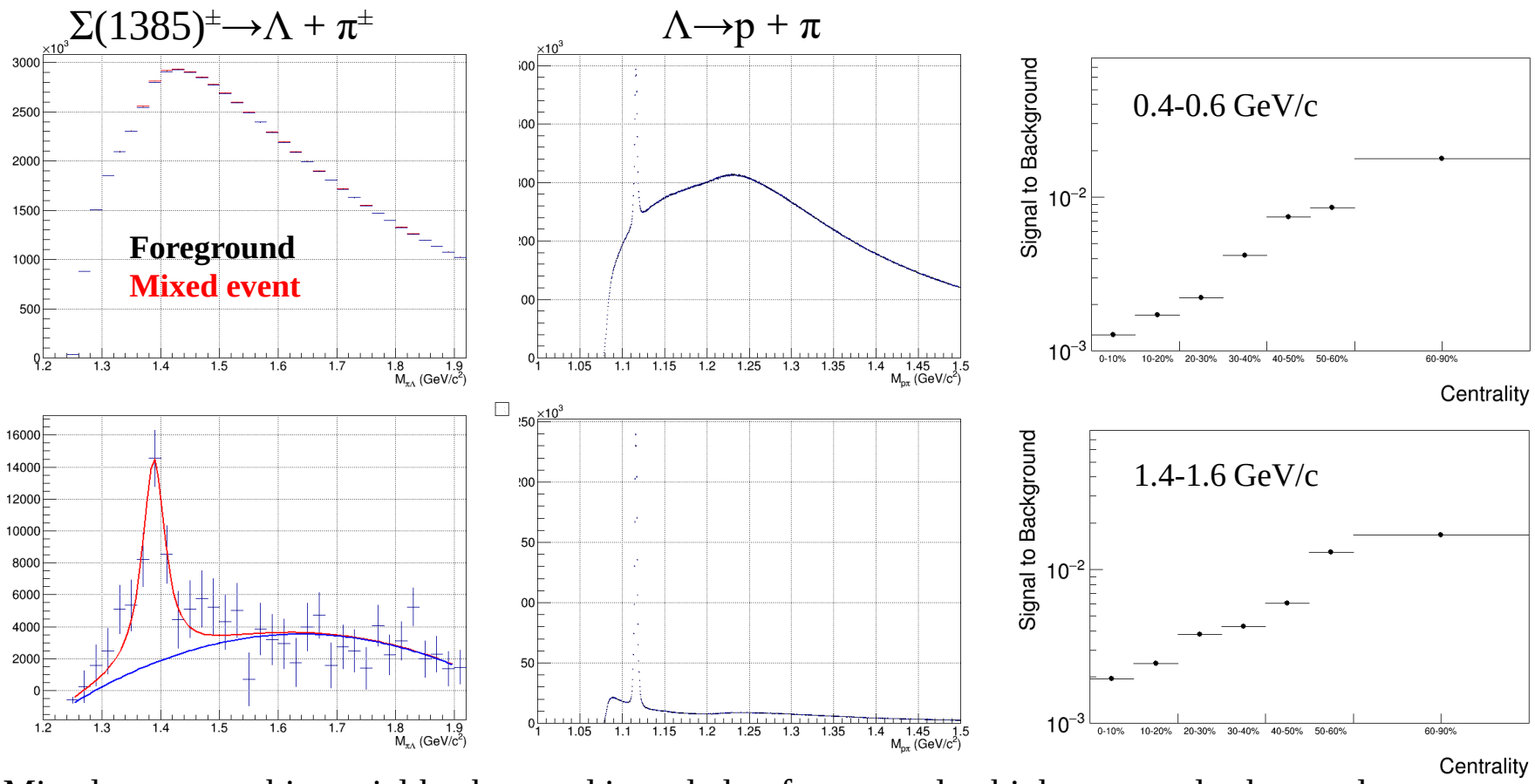




- Mixed-event combinatorial background is scaled to foreground at high mass and subtracted
- Distributions are fit to Voigtian function + polynomial (mass resolution fixed to estimated value, Γ - free parameter)
- Signal can be reconstructed at $p_T > 0$, high-p_T reach is limited by available statistics
- S/B ratios deteriorates with increasing centrality

$\Sigma^*(1385)^{\pm}$, reconstructed peaks

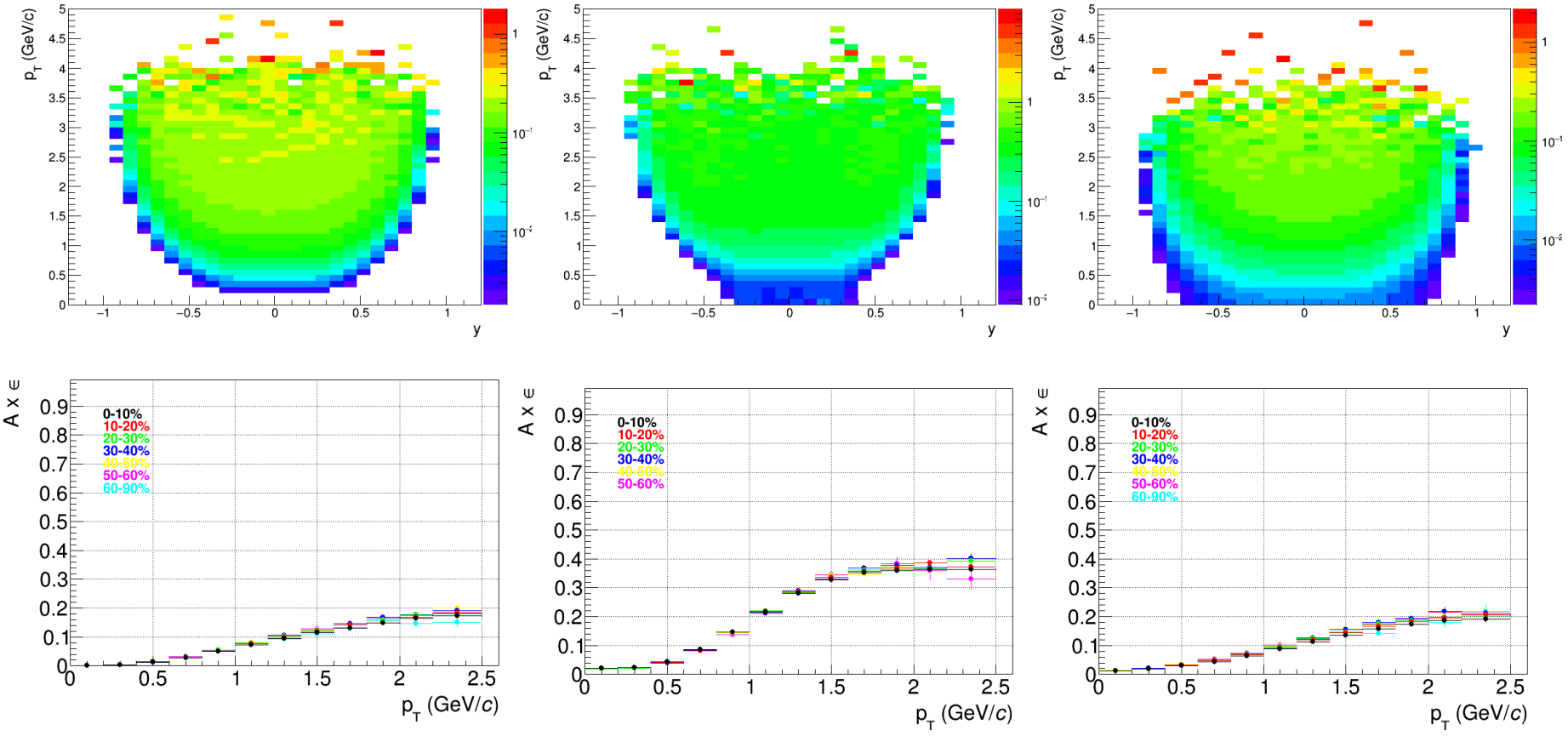
- Full chain simulation and reconstruction, p_T = 0.6-0.8 GeV/c, $\Sigma(1385)^{\pm} \rightarrow \Lambda + \pi^{\pm}$,($\Lambda \rightarrow p + \pi$) $|y| < 0.5$



- Mixed-event combinatorial background is scaled to foreground at high mass and subtracted
- Distributions are fit to Voigtian function + polynomial (mass resolution fixed to estimated value, Γ - free parameter)
- Signal can be reconstructed at $p_T > 0.2$ GeV/c in semi-central and at $p_T > 0.4$ GeV/c in central and peripheral collisions, high-p_T reach is limited by available statistics

Reconstruction efficiencies

Σ(1385)$^{\pm}$ Λ(1520) K*(892)$^{\pm}$

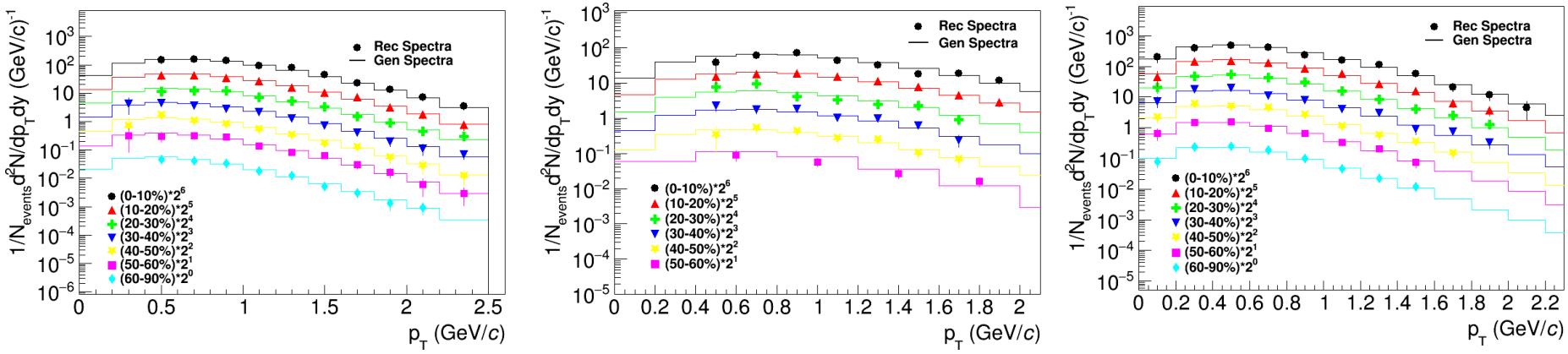


- Reasonable efficiencies in the wide p_T range, $|y| < 0.5$
- Measurements are possible from 0 momentum for K*(892)$^{\pm}$ and from 0.2-0.4 GeV/c for Λ(1520) and Σ(1385)$^{\pm}$
- Modest centrality dependence

MC closure tests

- Full chain simulation and reconstruction, p_T ranges are limited by the possibility to extract signals, $|y| < 0.5$

$\Sigma(1385)^{\pm}$ $\Lambda(1520)$ $K^*(892)^{\pm}$



- Reconstructed spectra match the generated ones within uncertainties
- First measurements for resonances in centrality dependent analysis will be possible with accumulation of ~ 10^8 A+A events
- Measurements are possible starting from ~ zero momentum → sample most of the yield, sensitive to possible modifications

Summary

- ❖ Measurement of resonances contribute to the MPD physical program
  - ✓ hadronic phase properties, strangeness production, hadronization mechanisms and collectivity, hadrochemistry, spin alignment etc …
- ❖ First measurements for resonances in centrality dependent analysis will be possible with accumulation of ~ 10^8 A+A events
- ✓ Measurements are possible starting from very low momenta with decent mass resolution → high sensitivity to different physics phenomena most prominent at low p_T

Backup slides

Feasibility studies, framework

- Simulated minbias AuAu@11 collisions using UrQMD 3.4 with default settings
- Tracked simulated particles through the MPD Phase-I detector using *mpdroot*
- Analysis cuts were optimized for higher signal significance (no p_T variation)
  - Event selection:
    - ✓ $|Z_{vrtx}| < 50$ cm, realistic distribution
  - Basic track selections:
    - ✓ number of TPC hits > 24
    - ✓ $|\eta| < 1.0$
    - ✓ $p_T > 50$ MeV/c
    - ✓ TPC-TOF combined PID, probability > 0.5
    - ✓ TPC-refit for kaons and protons based on track PID hypothesis
  - Primary tracks:
    - ✓ $|\mathrm{DCA}(x,y,z)| < 2\sigma$
  - V0 & cascades:
    - ✓ topology cuts for weakly decaying secondary particles ($K_s \rightarrow \pi\pi$)
- Combinatorial background:
  - ✓ event mixing ($|\Delta_{Zvrtx}| < 2$ cm, $|\Delta_{Mult}| < 20$, $N_{ev} = 10$)

Resonances

Particle	Mass (MeV/c^2)	Width (MeV/c^2)	Decay	BR (%)
ρ^0	770	150	$\pi^+\pi$	100
$K^{*\pm}$	892	50.3	$\pi^\pm K_s$	33.3
K^{*0}	896	47.3	πK^+	66.7
ϕ	1019	4.27	K^+K^-	48.9
Σ^{*+}	1383	36	$\pi^+\Lambda$	87
Σ^{*-}	1387	39.4	$\pi\Lambda$	87
$\Lambda(1520)$	1520	15.7	K^-p	22.5
Ξ^{*0}	1532	9.1	$\pi^+\Xi^-$	66.7