

$\Lambda(1520)$, $\Sigma(1385)^\pm$ and $K^*(892)^\pm$ resonance production in BiBi@9.2 GeV

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Analysis Details: $\Lambda(1520) \rightarrow p + K$

❖ 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 $2.0 \cdot \sigma$ // maximum DCA for a track ($\sigma = \sigma(p_T, \text{centrality})$)

Pair cuts:

mYCut 0.5 // pair rapidity cut

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

Event selection:

mZvtxCut 130 // cut on vertex z coordinate

PID cuts:

mPIDsigTPC 2 // dEdx PID parameters

mPIDsigTOF 2 // dEdx PID parameters

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mPtminCut 0.1 // minimal pt for a track

mDCACut $2.0 \cdot \sigma$ // 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

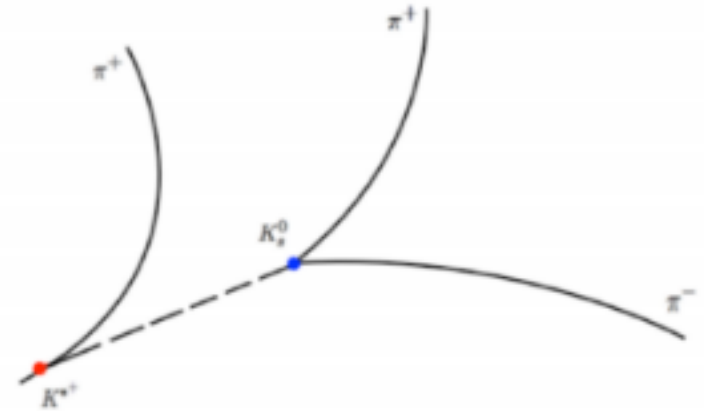
mPAKs 0.1 // maximum pointing angle for Ks

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 $2.0 \cdot \sigma$ // 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

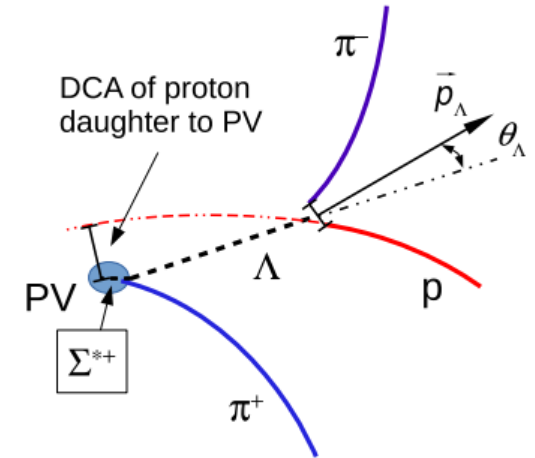
mPALam 0.1 // maximum pointing angle for Lambda

mDecayLam 0.5 // minimum decay distance for Lambda

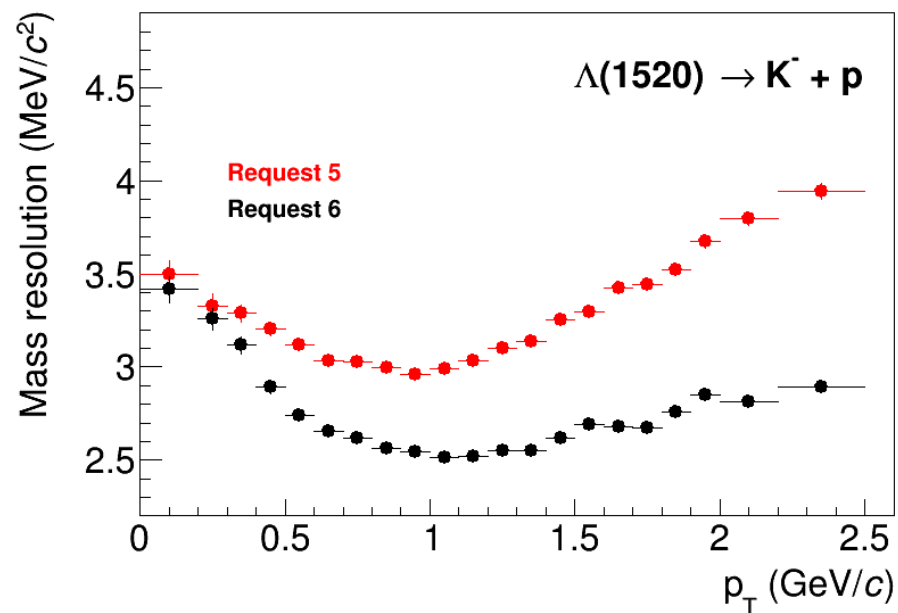
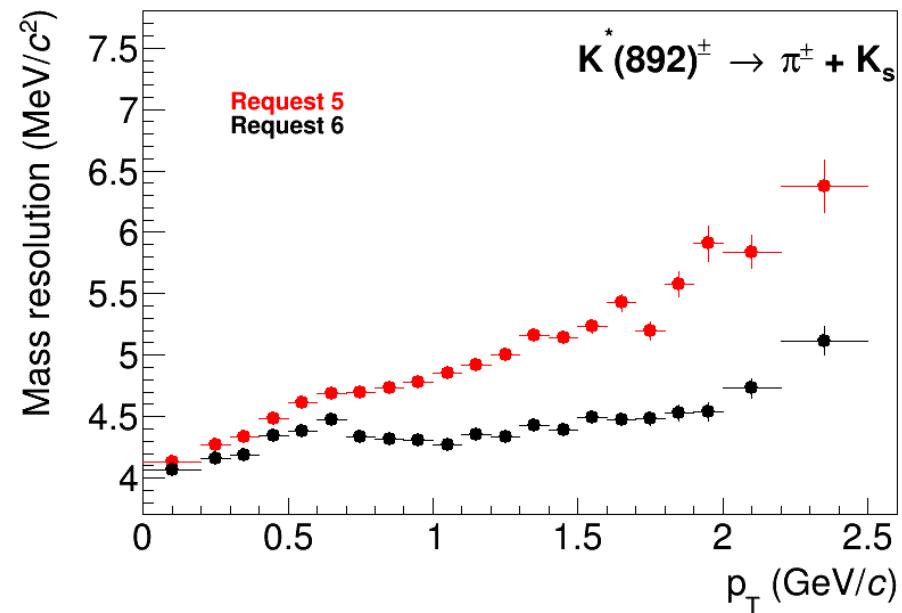
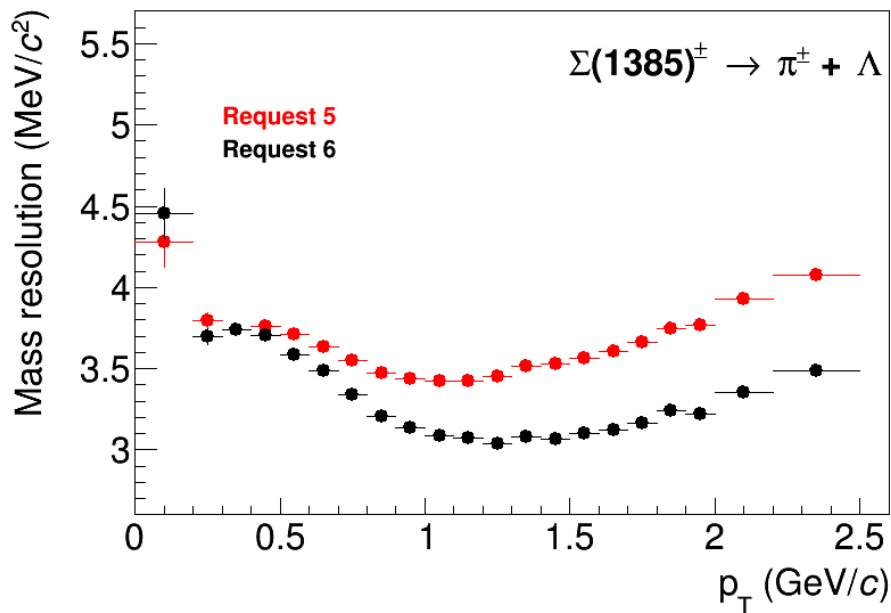
mDistLam 1.0 // maximum distance between p-pi in the secondary vertex from Lambda

mNSigmaLam 2.0 // n-sigma selection for Lambda candidates

mWidthLam $2e-3$ // width of Lambda peak

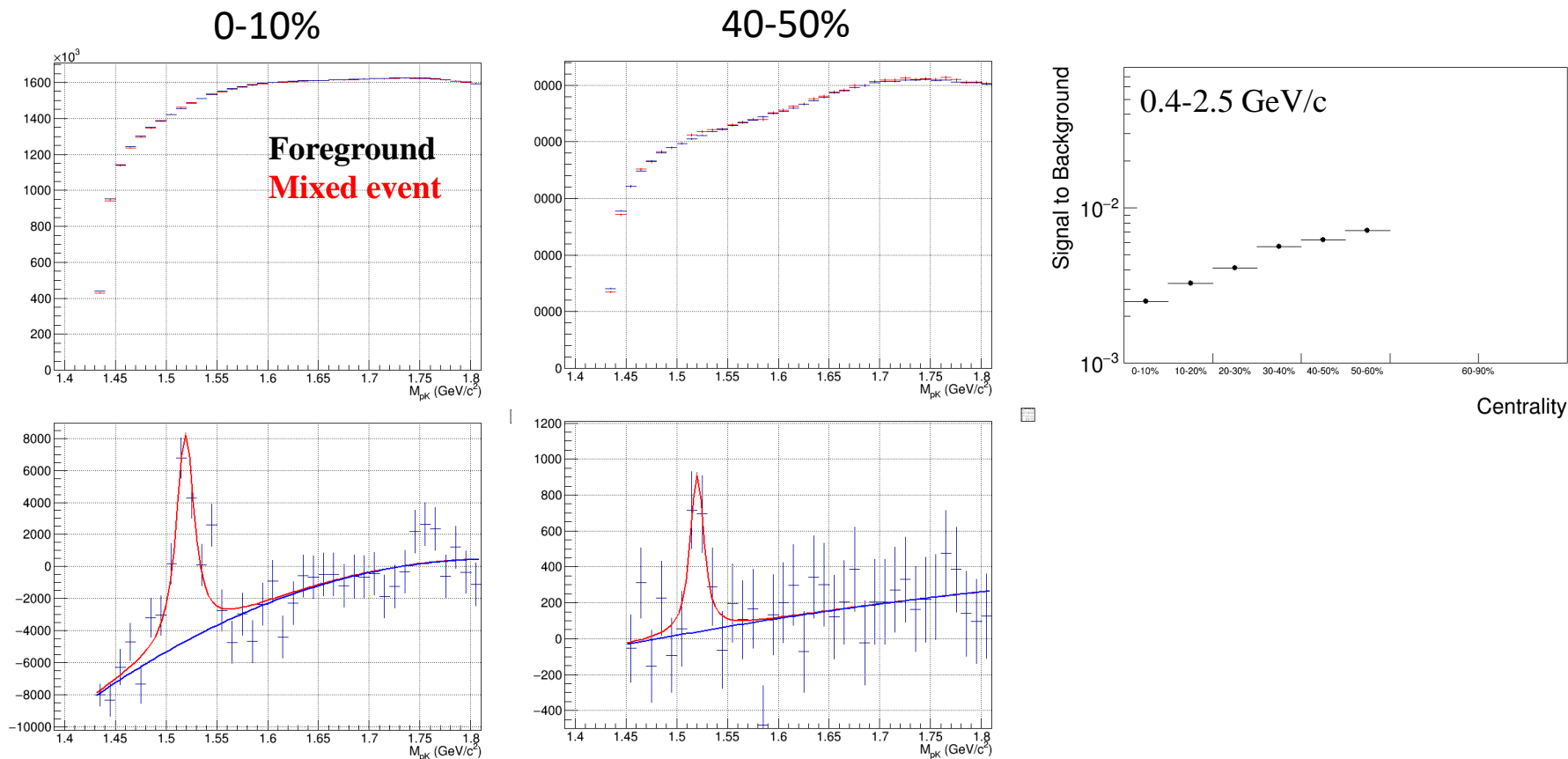


Mass Resolution for resonances



$\Lambda(1520)$, reconstructed peaks

- ❖ Full chain simulation and reconstruction, $p_T = 0.6-0.8$ GeV/c, $\Lambda(1520) \rightarrow p + K^-$, $|y| < 0.5$

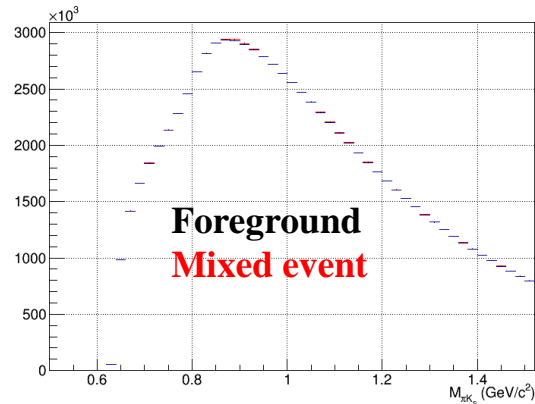


- ❖ Mixed-event combinatorial background is scaled to foreground at high mass and subtracted
- ❖ Distributions are fit to Voigtian function + polynomial (mass resolution fixed to estimated value, Γ - free parameter)
- ❖ Signal can be reconstructed at $p_T > 0.4$ GeV/c in central and semi-central collisions,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

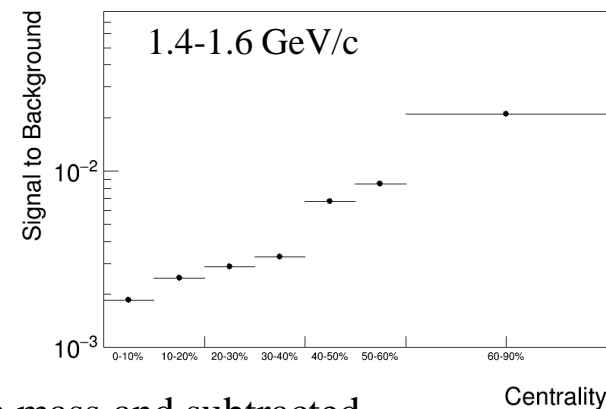
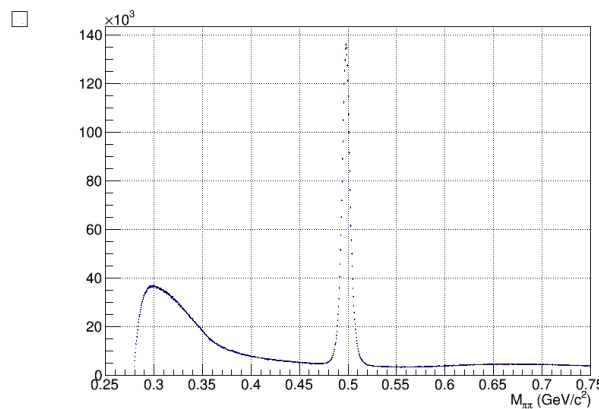
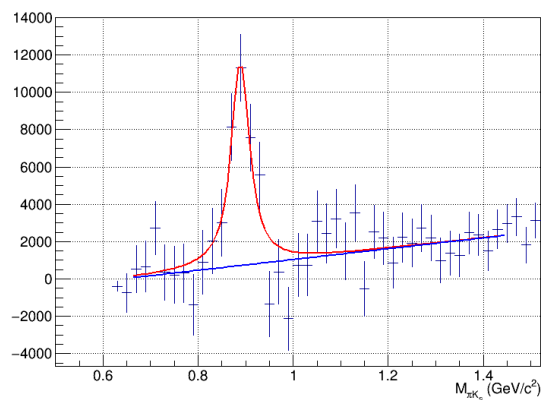
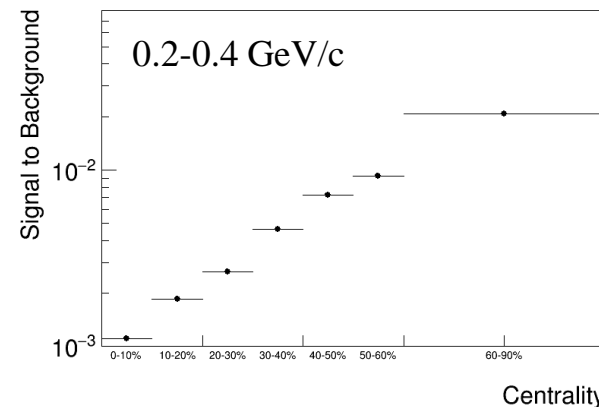
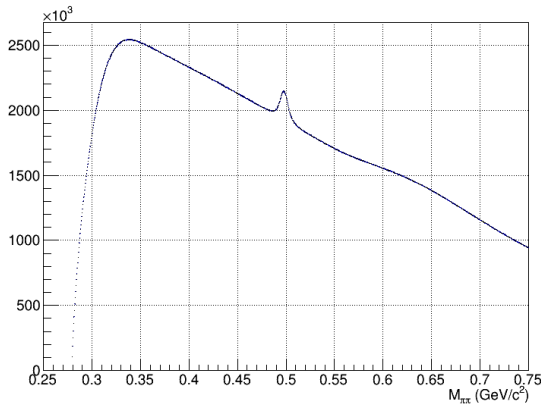
$K^*(892)^\pm$, reconstructed peaks

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

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



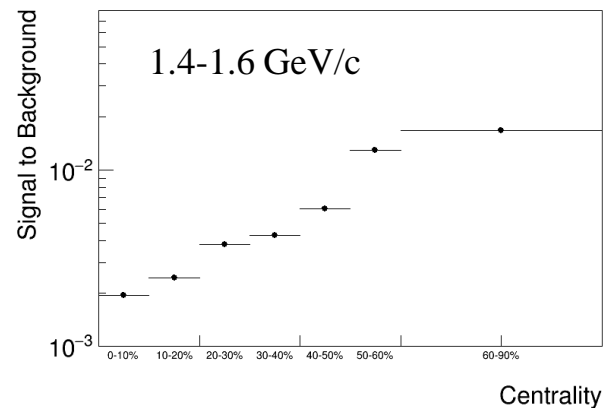
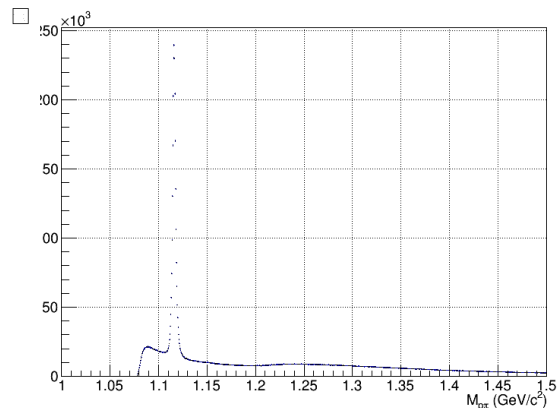
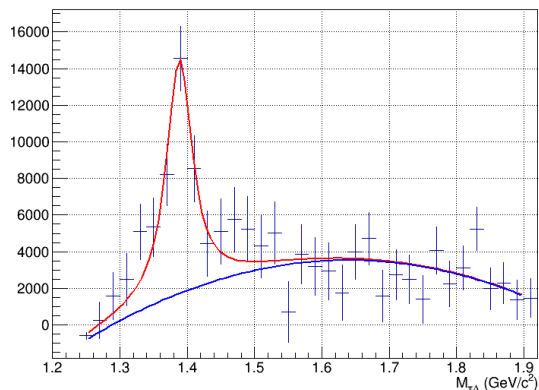
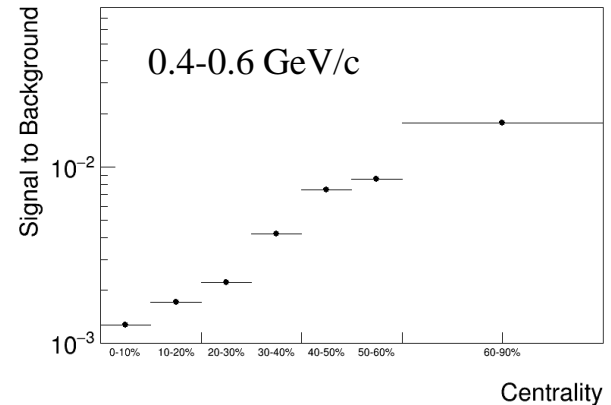
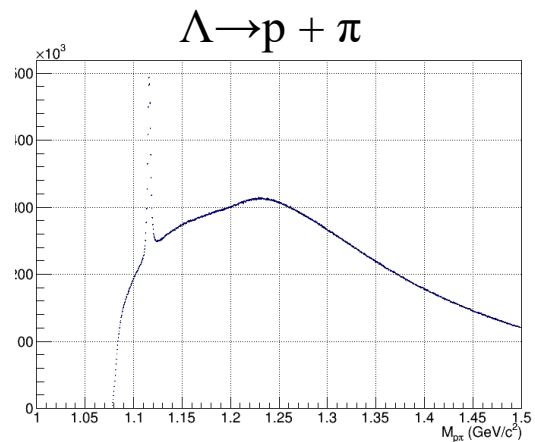
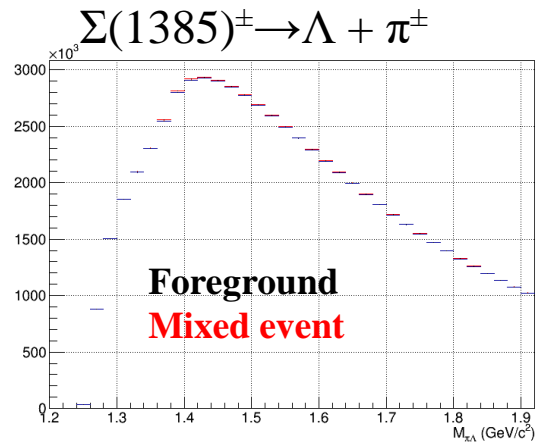
$K_s \rightarrow \pi^- + \pi^+$



- ❖ 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

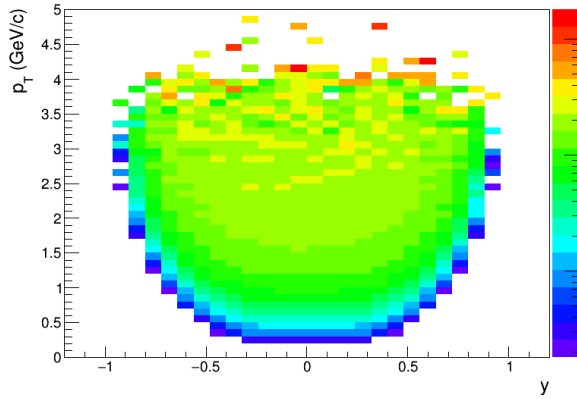
- ❖ Full chain simulation and reconstruction, $p_T = 0.6-0.8$ GeV/c, $\Sigma(1385)^\pm \rightarrow \Lambda + \pi^\pm, (\Lambda \rightarrow p + \pi) |y| < 0.5$



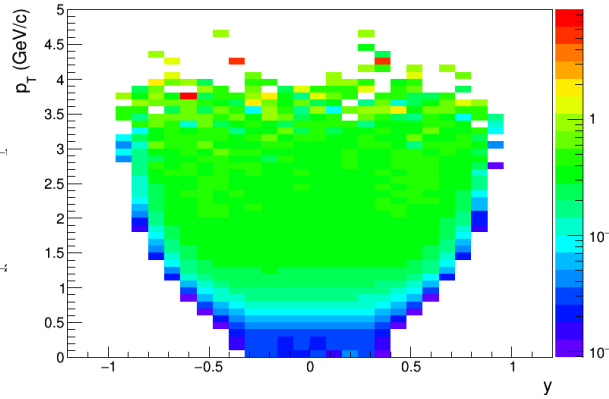
- ❖ Mixed-event combinatorial background is scaled to foreground at high mass and subtracted
- ❖ Distributions are fit to Voigtian function + polynomial (mass resolution fixed to estimated value, Γ - free parameter)
- ❖ Signal can be reconstructed at $p_T > 0.2$ GeV/c in semi-central and at $p_T > 0.4$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

Reconstruction efficiencies

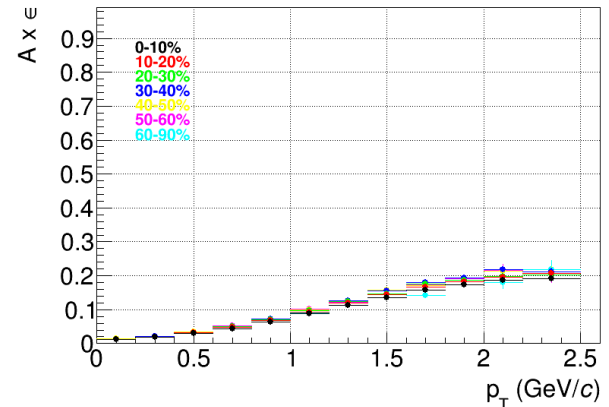
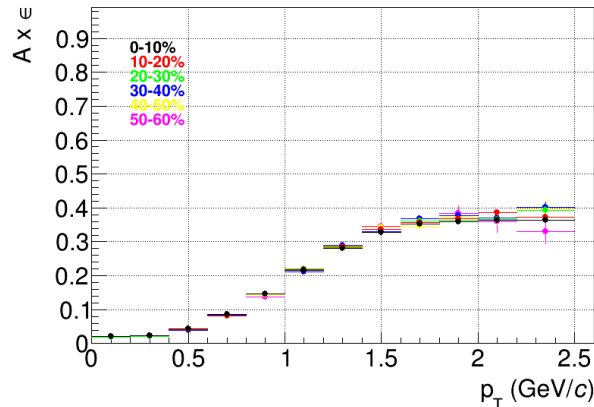
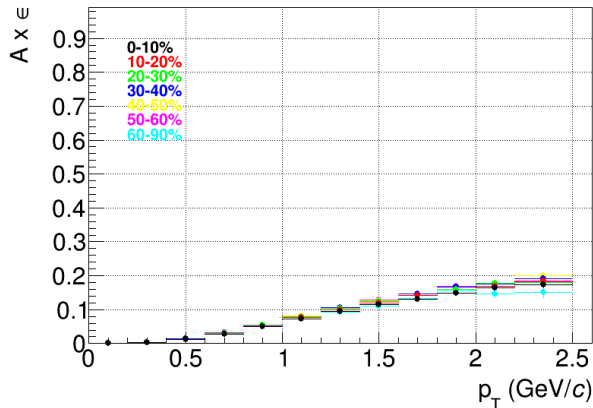
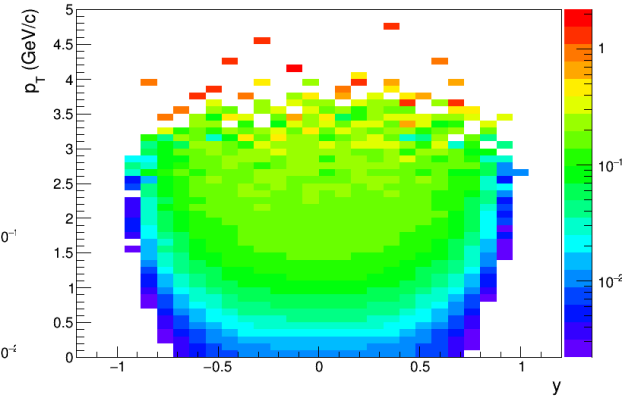
$\Sigma(1385)^\pm$



$\Lambda(1520)$



$K^*(892)^\pm$

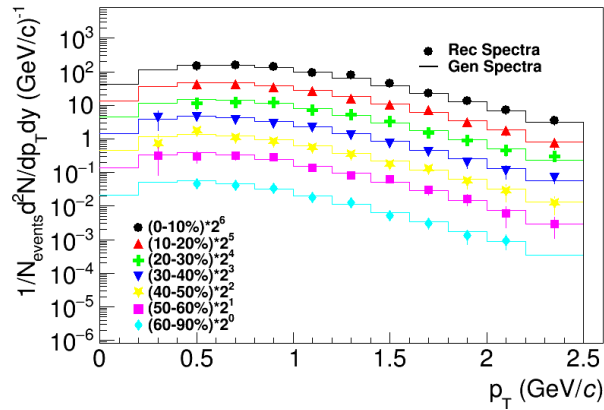


- ❖ Reasonable efficiencies in the wide p_T range, $|y| < 0.5$
- ❖ Measurements are possible from 0 momentum for $K^*(892)^\pm$ and from 0.2-0.4 GeV/c for $\Lambda(1520)$ and $\Sigma(1385)^\pm$
- ❖ Modest centrality dependence

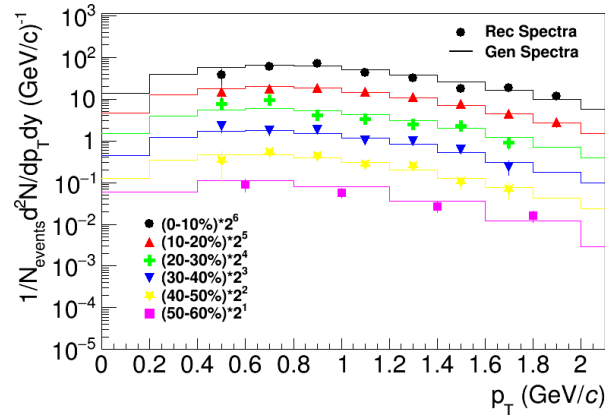
MC closure tests

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

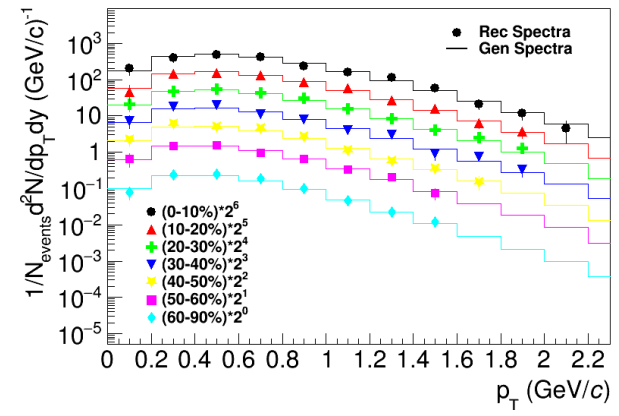
$\Sigma(1385)^\pm$



$\Lambda(1520)$



$K^*(892)^\pm$



- ❖ Reconstructed spectra match the generated ones within uncertainties
- ❖ First measurements for resonances in centrality dependent analysis will be possible with accumulation of $\sim 10^8$ A+A events
- ❖ Measurements are possible starting from \sim zero momentum \rightarrow 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 $\sim 10^8$ A+A events
- ✓ Measurements are possible starting from very low momenta with decent mass resolution \rightarrow 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:
 - ✓ $|Z_{\text{vrtx}}| < 50$ 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:
 - ✓ $|\text{DCA}(x,y,z)| < 2\sigma$
 - V0 & cascades:
 - ✓ topology cuts for weakly decaying secondary particles ($K_s \rightarrow \pi\pi$)
- Combinatorial background:
 - ✓ event mixing ($|\Delta_{Z_{\text{vrtx}}}| < 2$ cm, $|\Delta_{\text{Mult}}| < 20$, $N_{\text{ev}} = 10$)

Resonances

$\rho(770)$ $K^*(892)^0$ $K^*(892)^+$ $\phi(1020)$ $\Sigma(1385)^\pm$ $\Lambda(1520)$ $\Xi(1530)$

$$\frac{u\bar{u} + d\bar{d}}{\sqrt{2}}$$

$d\bar{s}$

$u\bar{s}$

$s\bar{s}$

uus
 dds

uds

uss

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	$K^-\bar{p}$	22.5
Ξ^{*0}	1532	9.1	$\pi^+\Xi^-$	66.7