Hadron ID and Hyperon Measurements with CBM at SIS100

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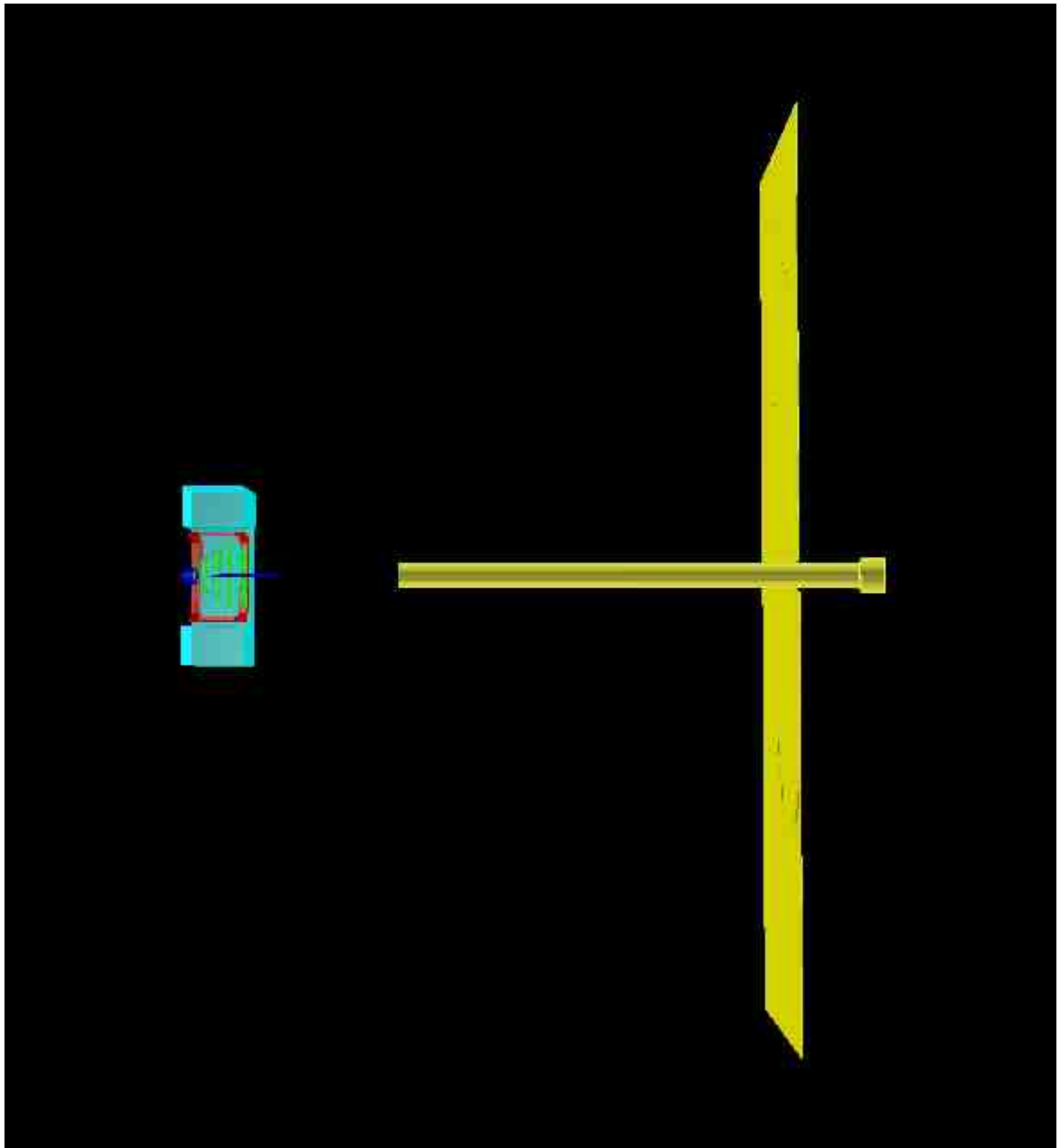
Workshop on CBM at SIS100
27-th of April 2009
GSI, Darmstadt

Hadron ID

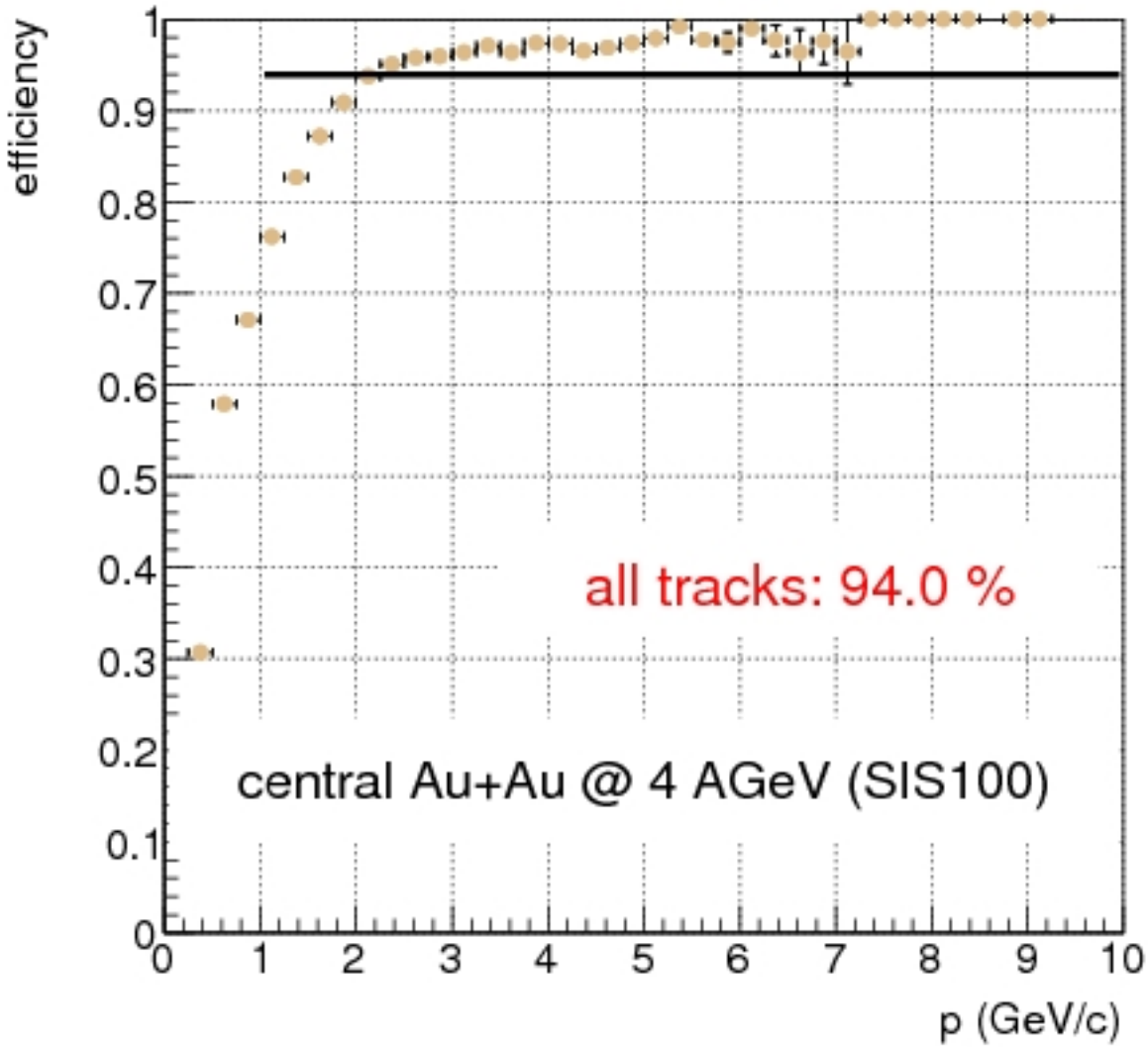
The Setup

STS
Magnet
TOF at 10m

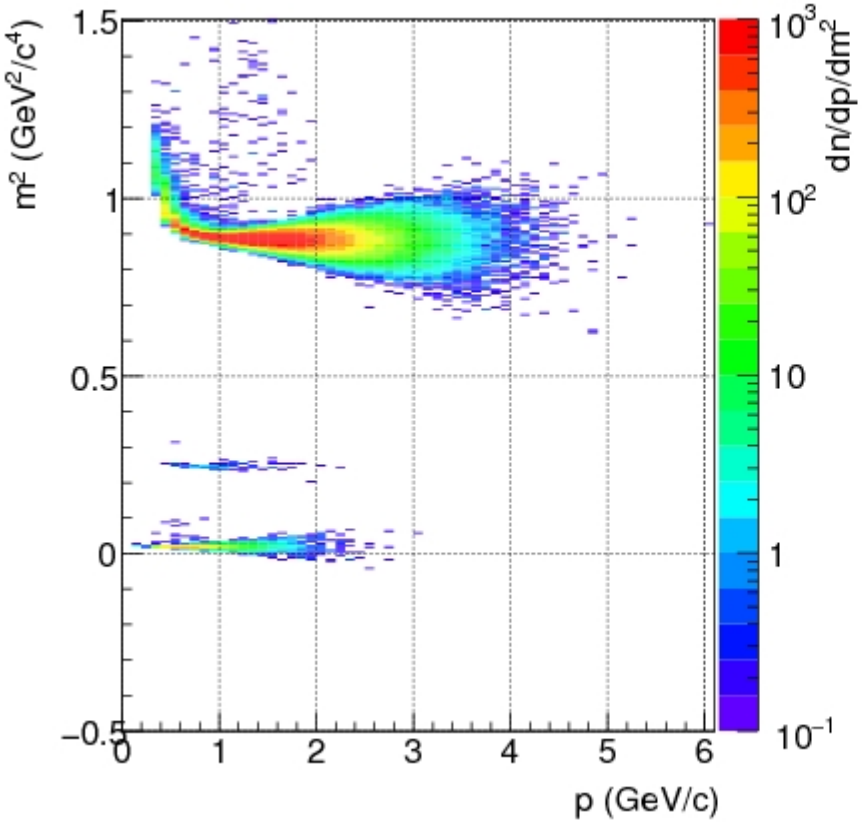


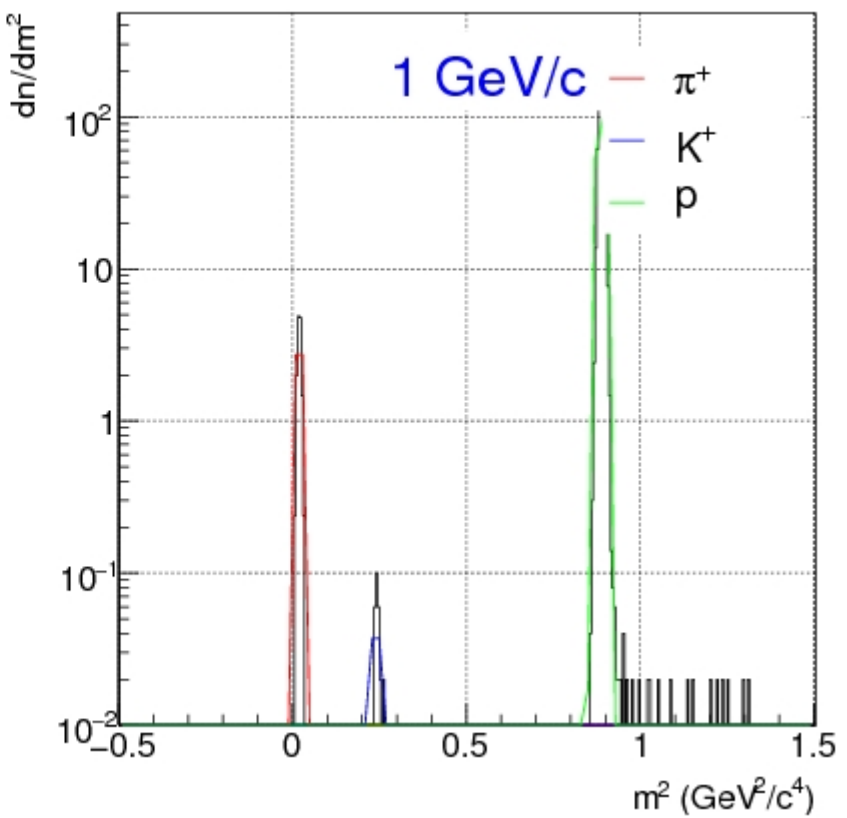
Reconstruction at 4*A* GeV

No intermediate tracking



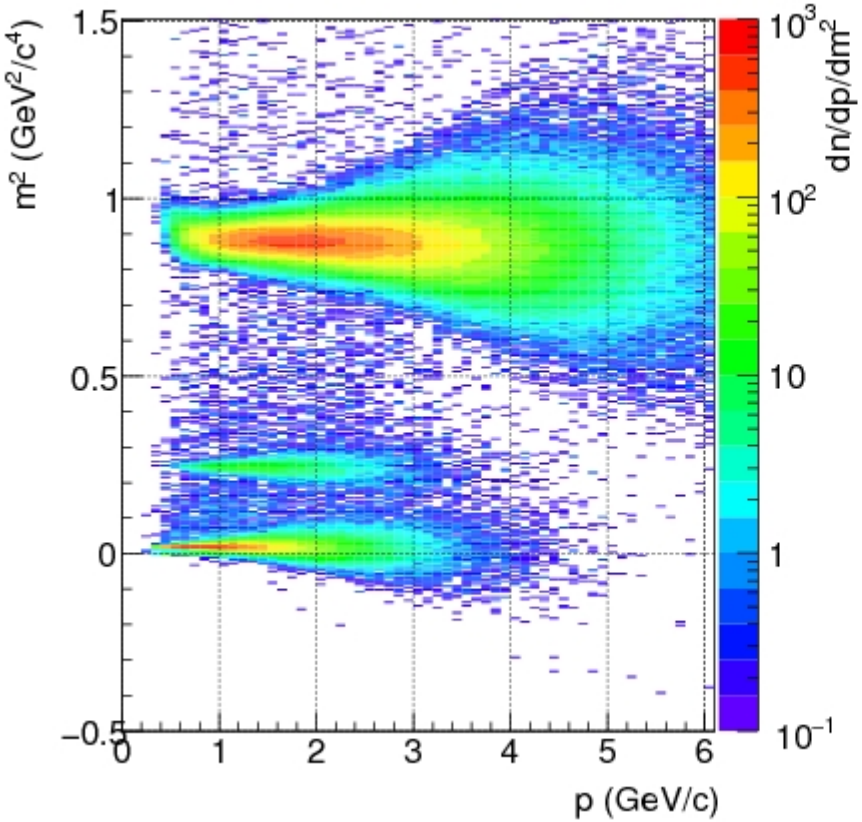
TOF Spectrum at 2*A* GeV

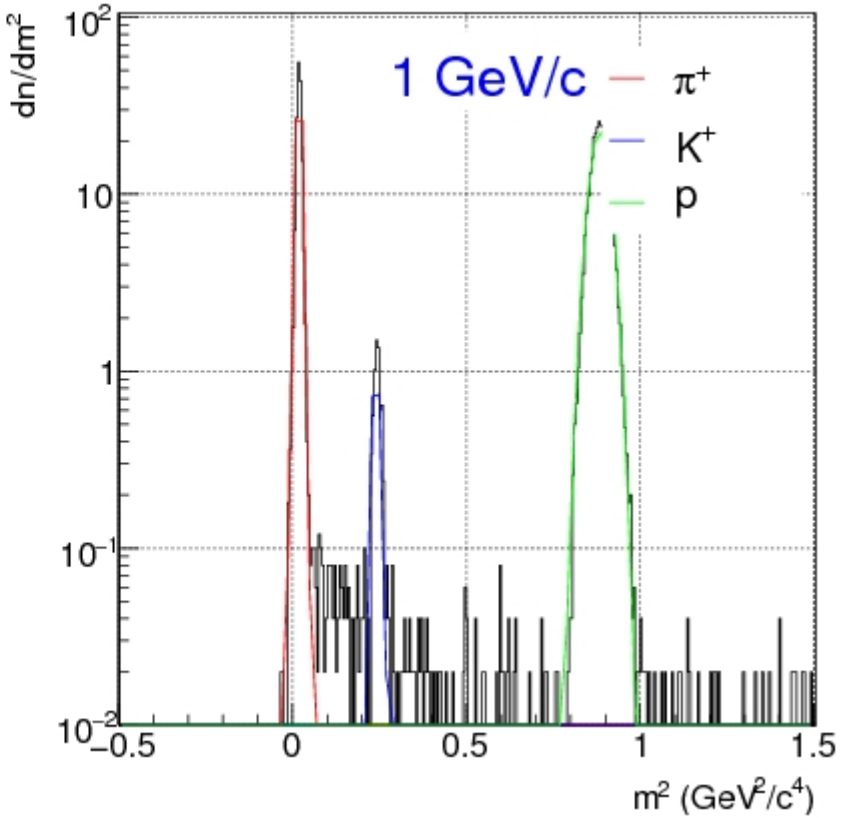




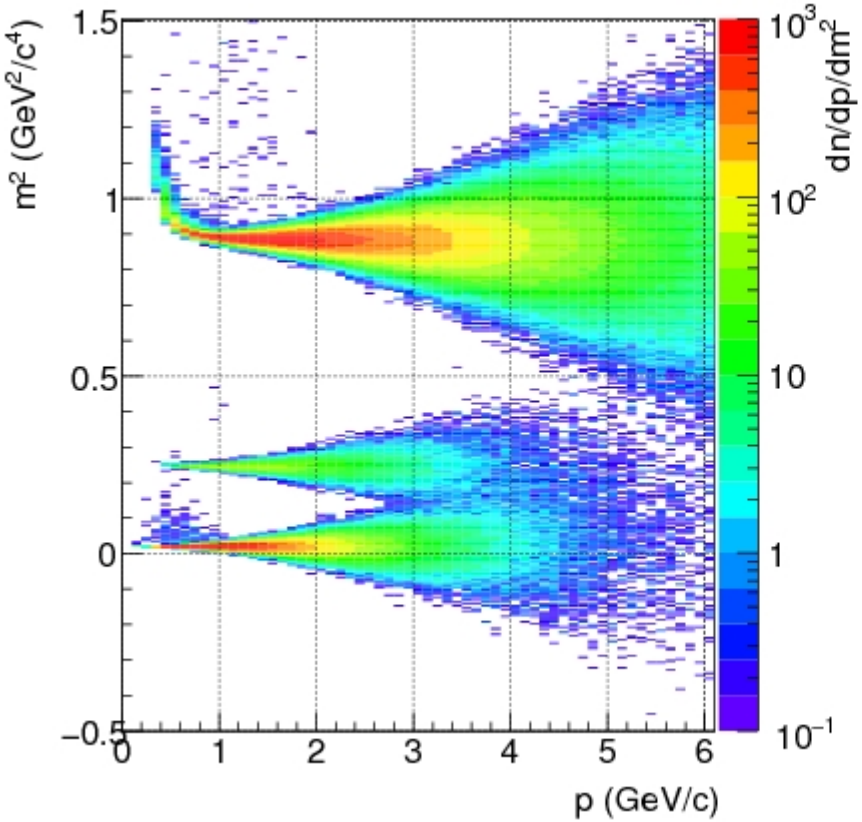
TOF Spectrum at 4*A* GeV

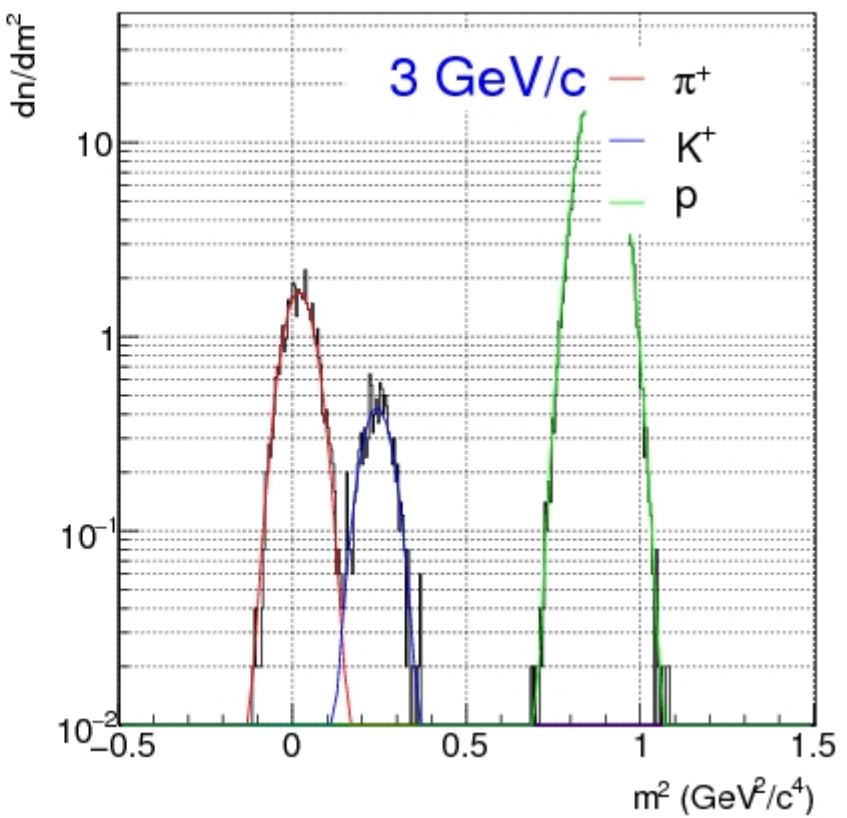
RECO



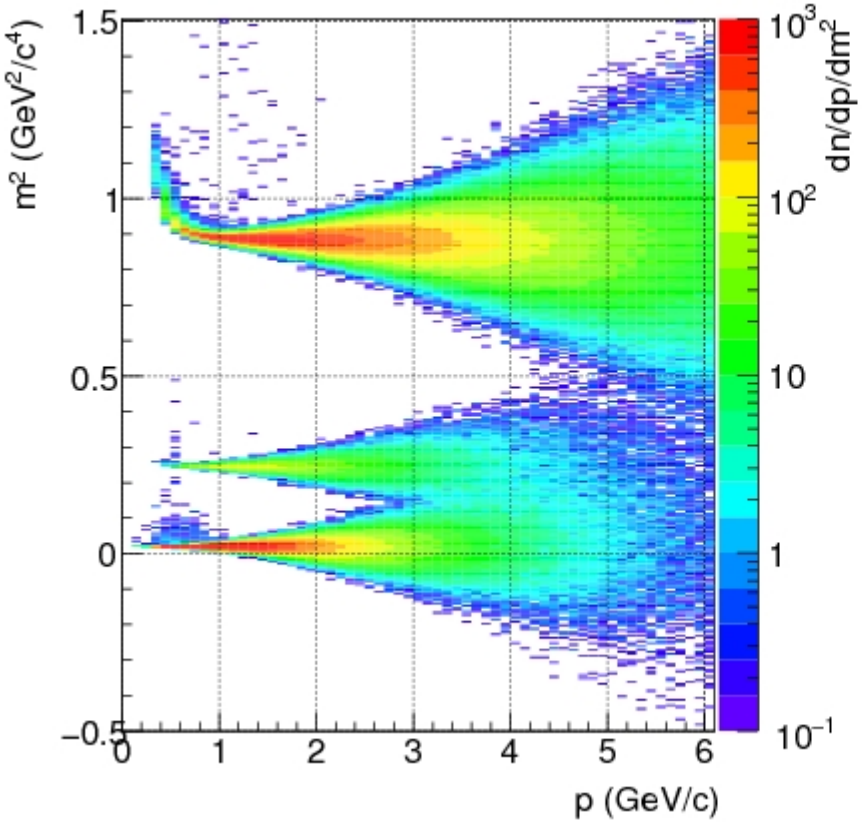


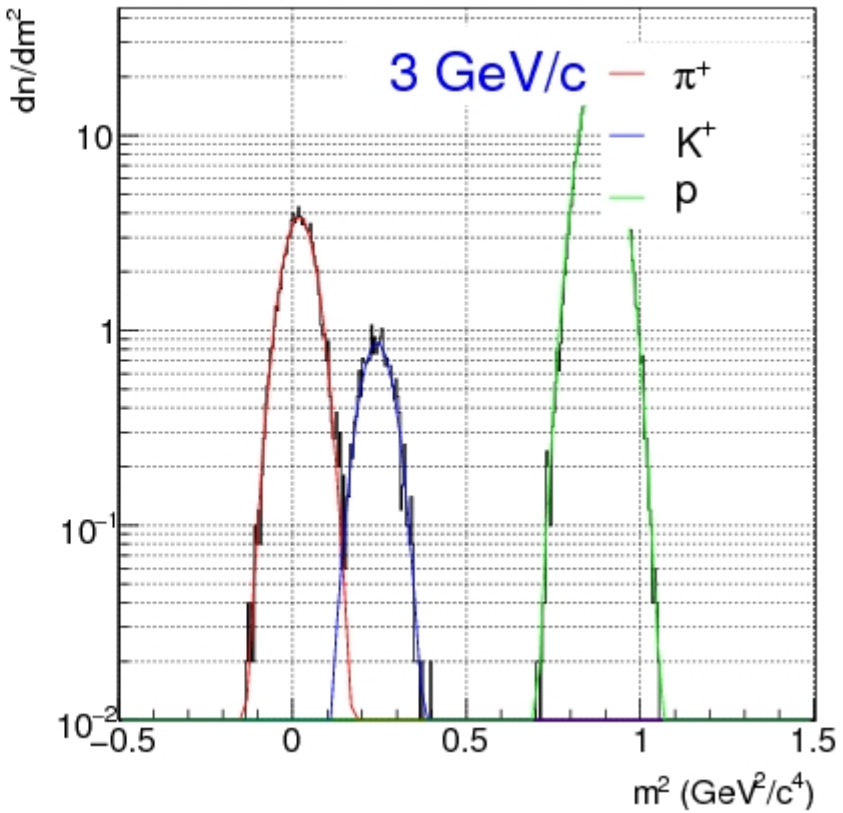
TOF Spectrum at 6*A* GeV



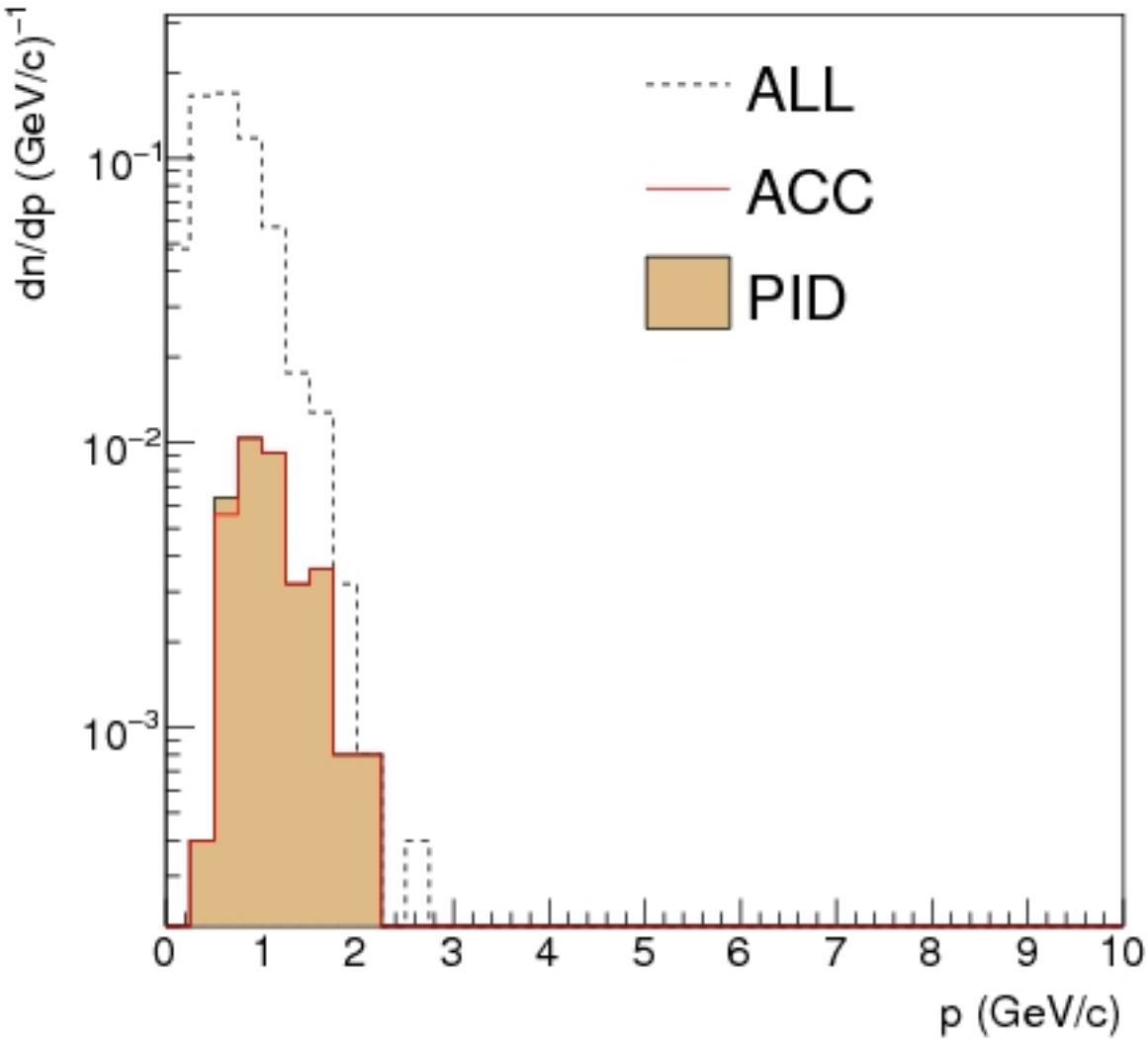


TOF Spectrum at 8*A* GeV



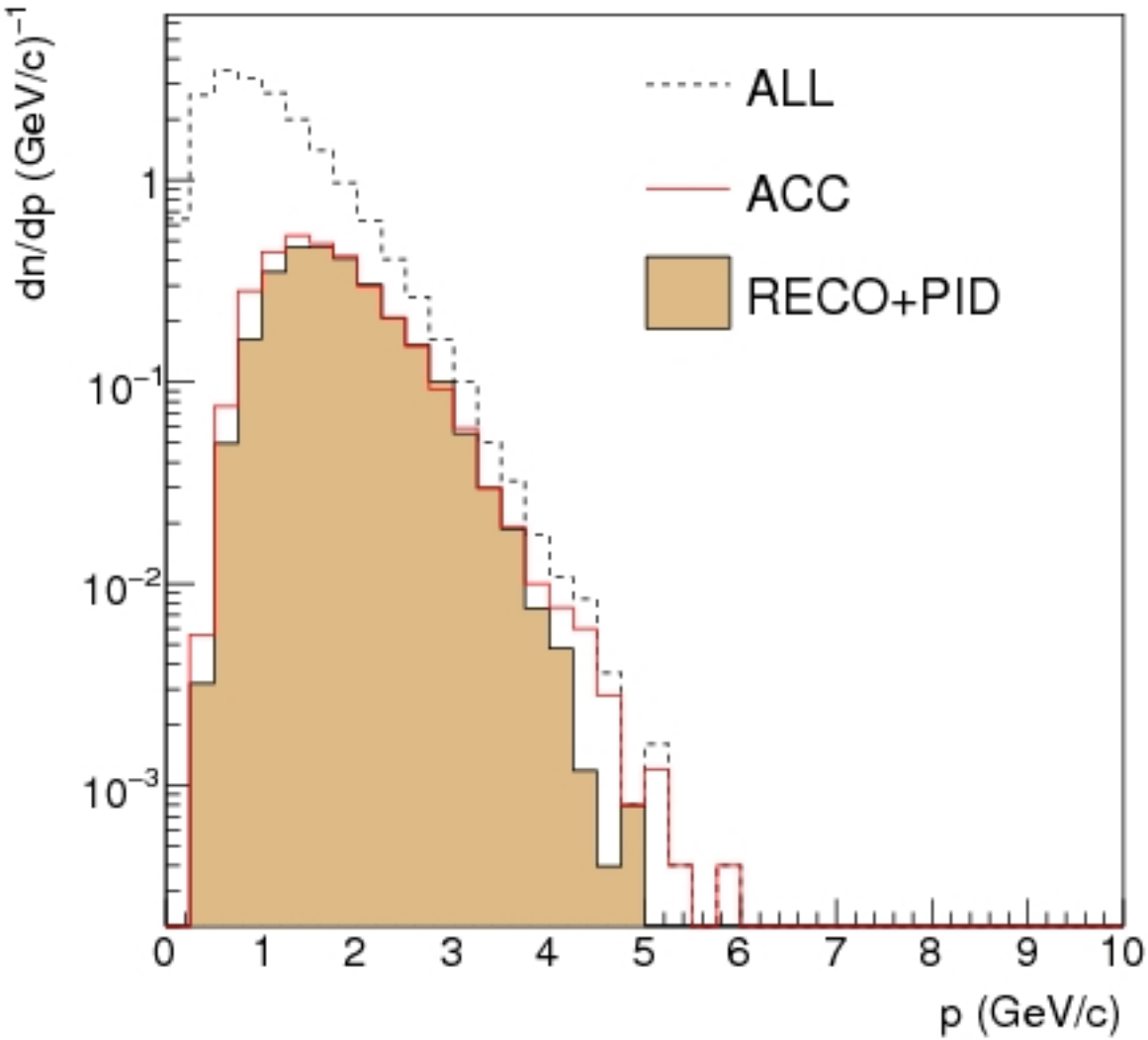


Momentum Spectra at 2*A* GeV

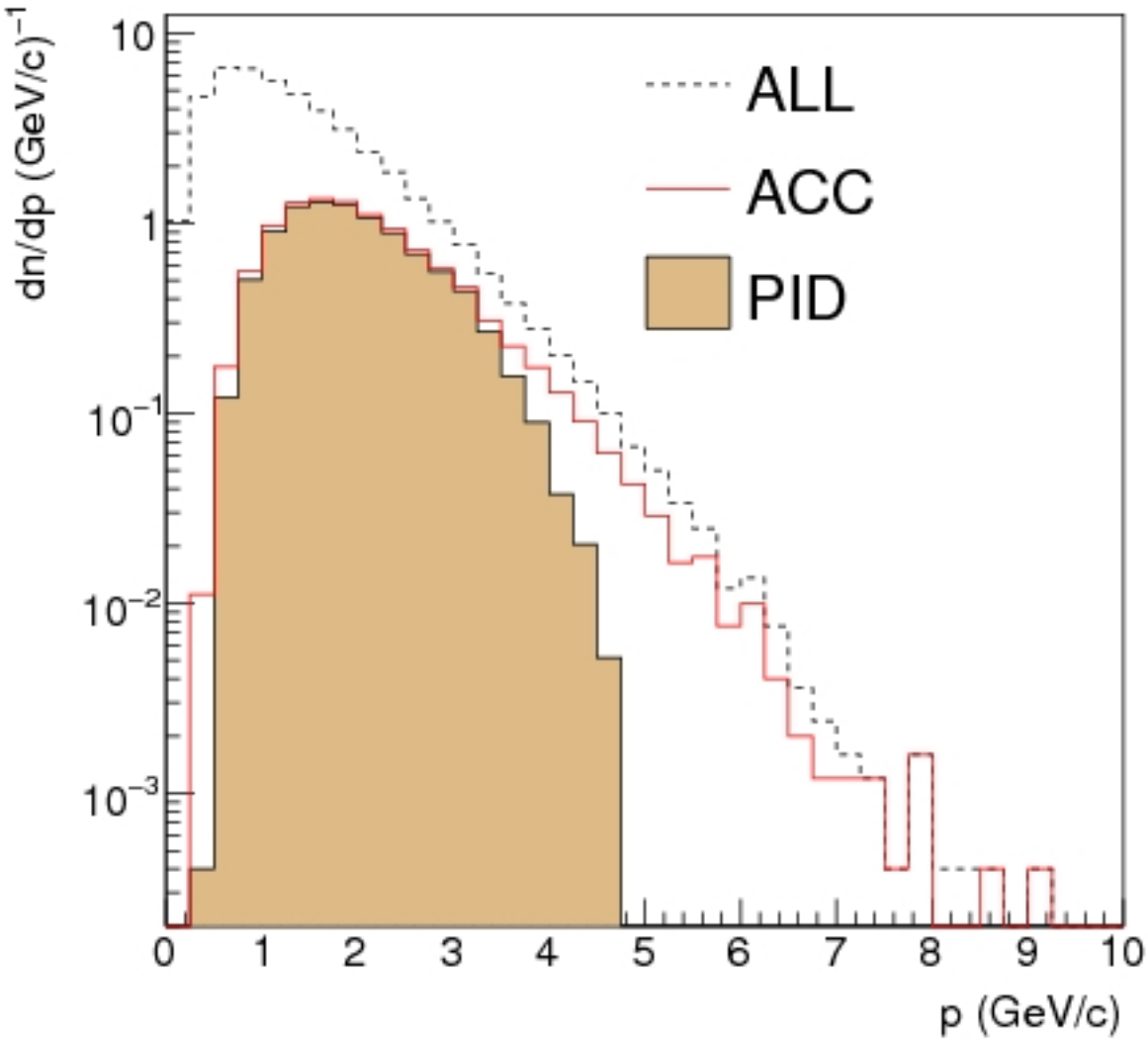


Momentum Spectra at 4*A* GeV

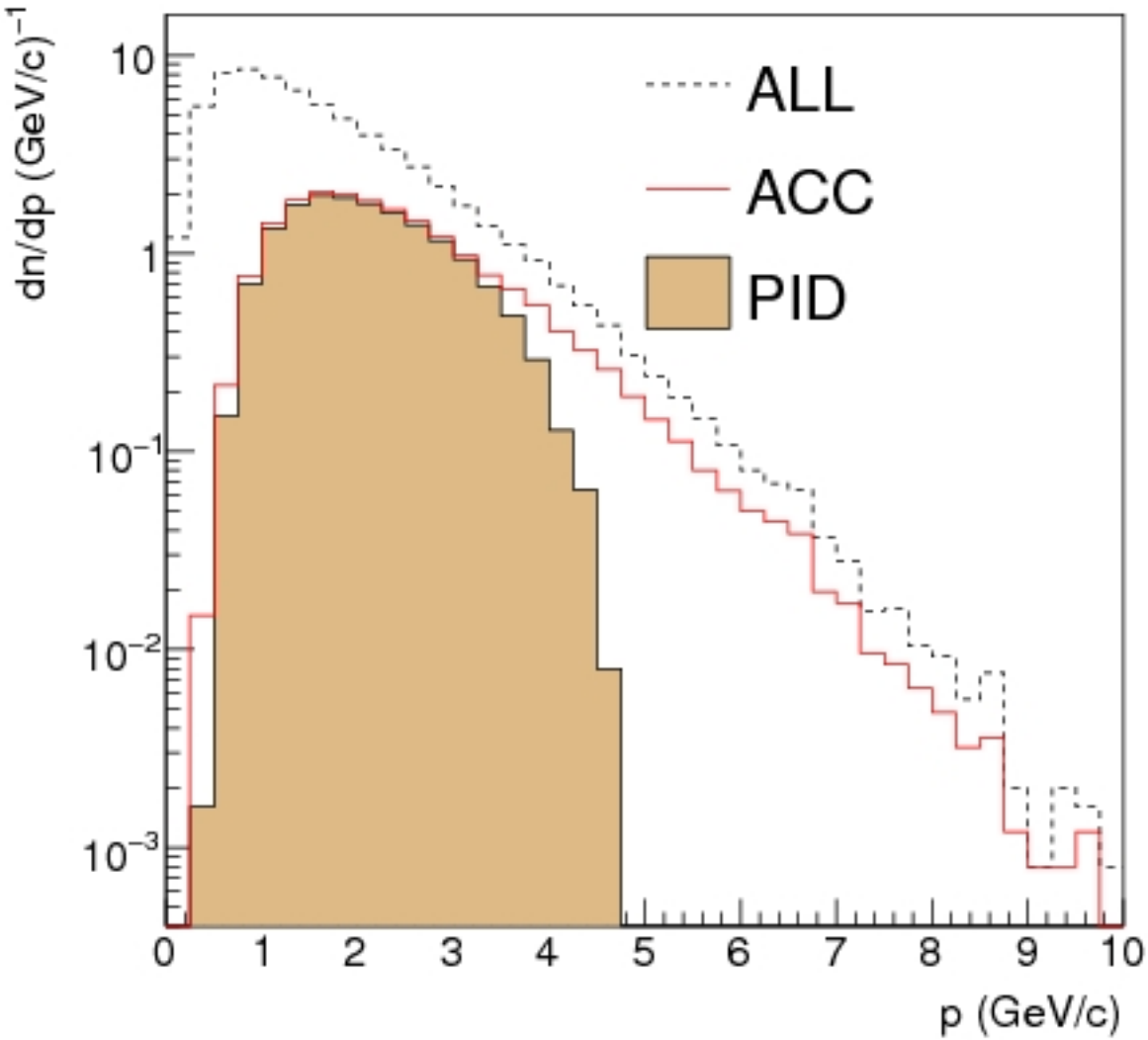
RECO



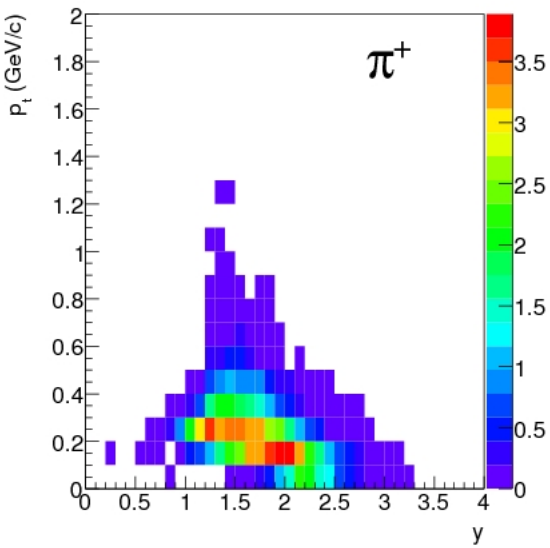
Momentum Spectra at 6*A* GeV

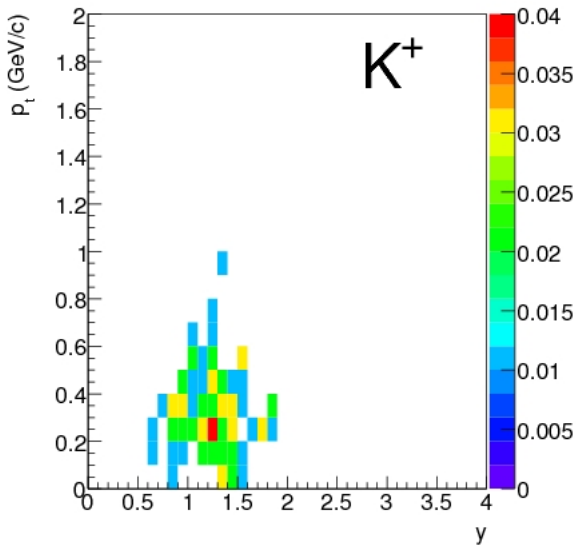


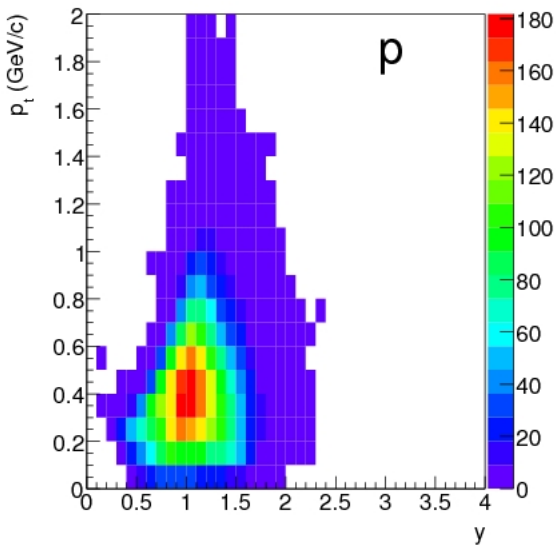
Momentum Spectra at 8*A* GeV



Phase-space Coverage at 2*A* GeV

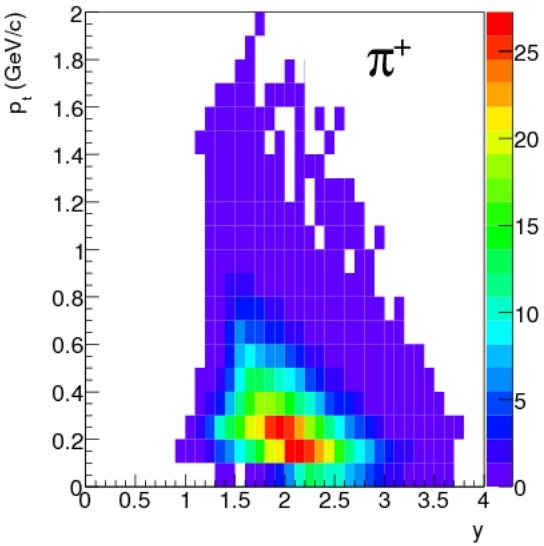


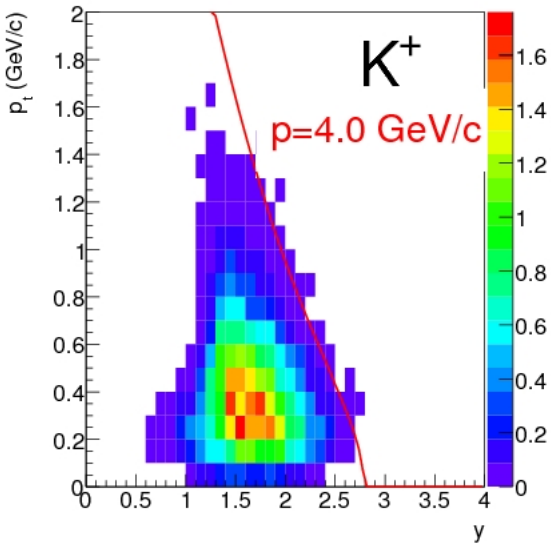


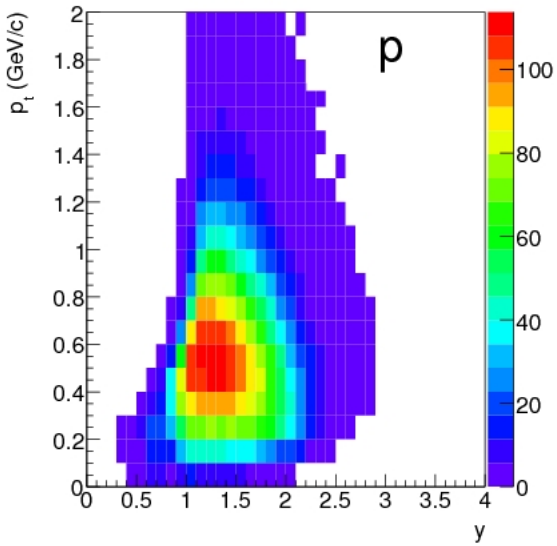


Phase-space Coverage at 4*A* GeV

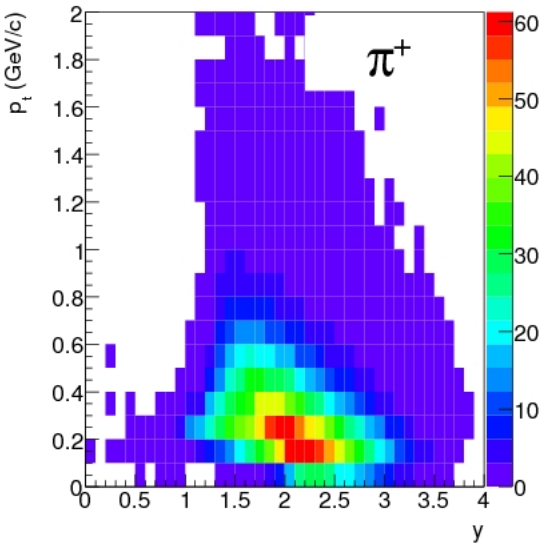
RECO

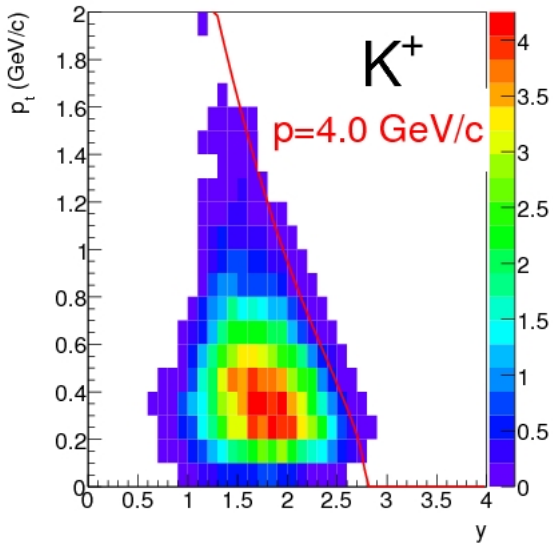


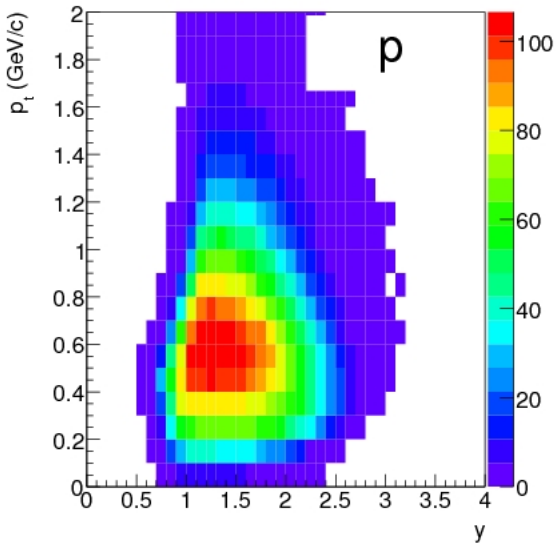




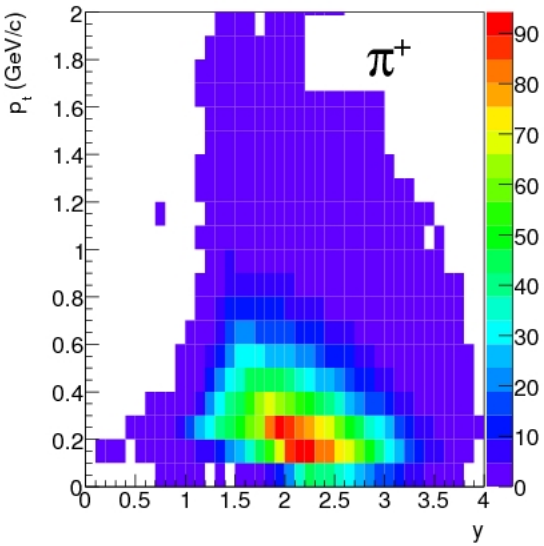
Phase-space Coverage at 6*A* GeV

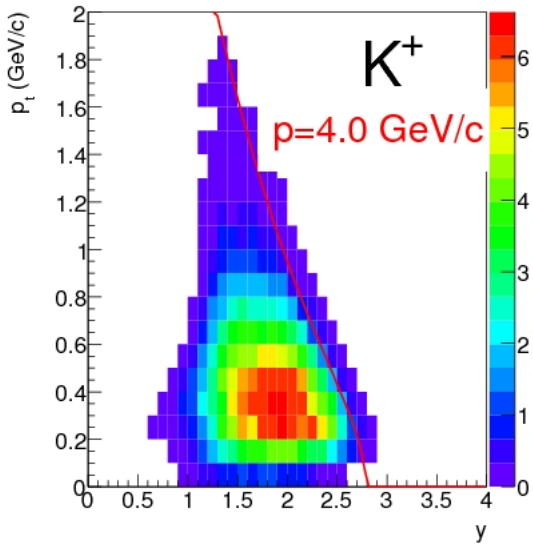


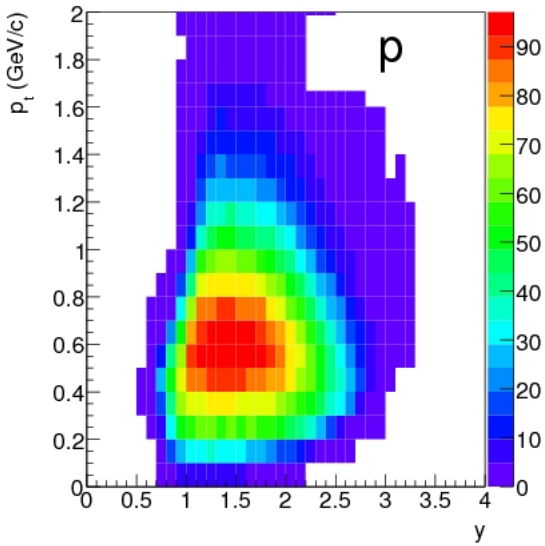




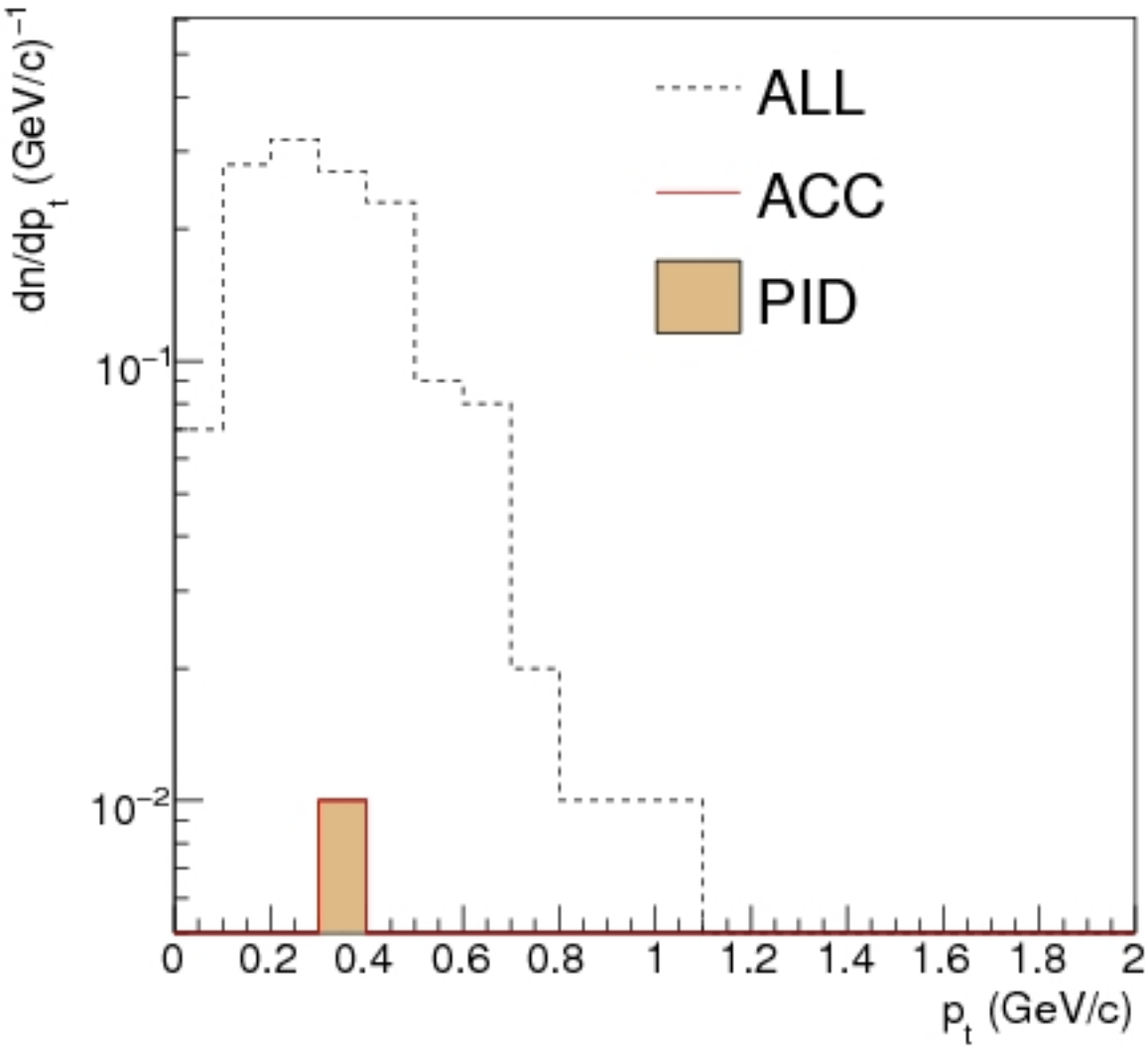
Phase-space Coverage at 8*A* GeV





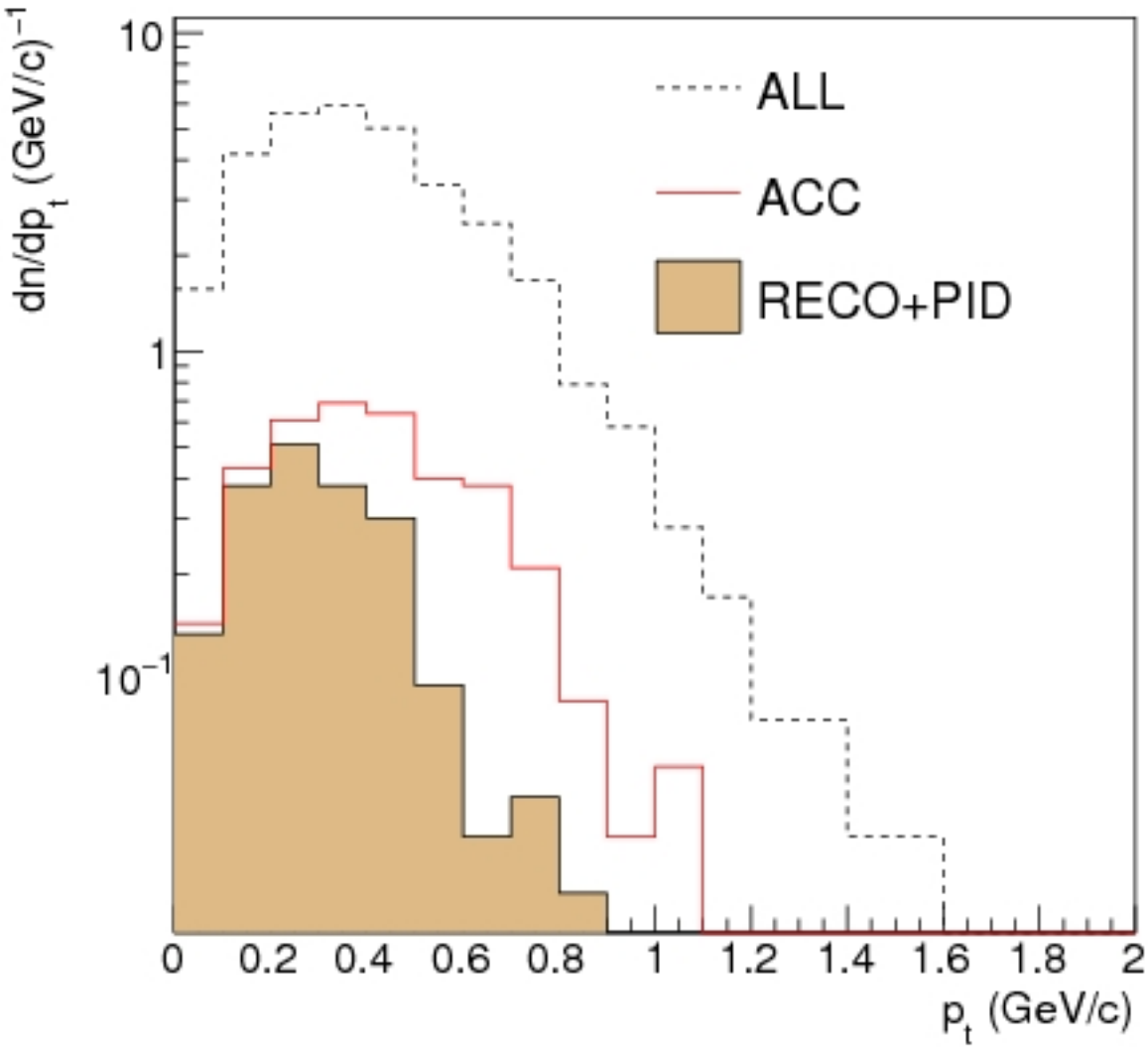


P_t at midrapidity at 2*A* GeV

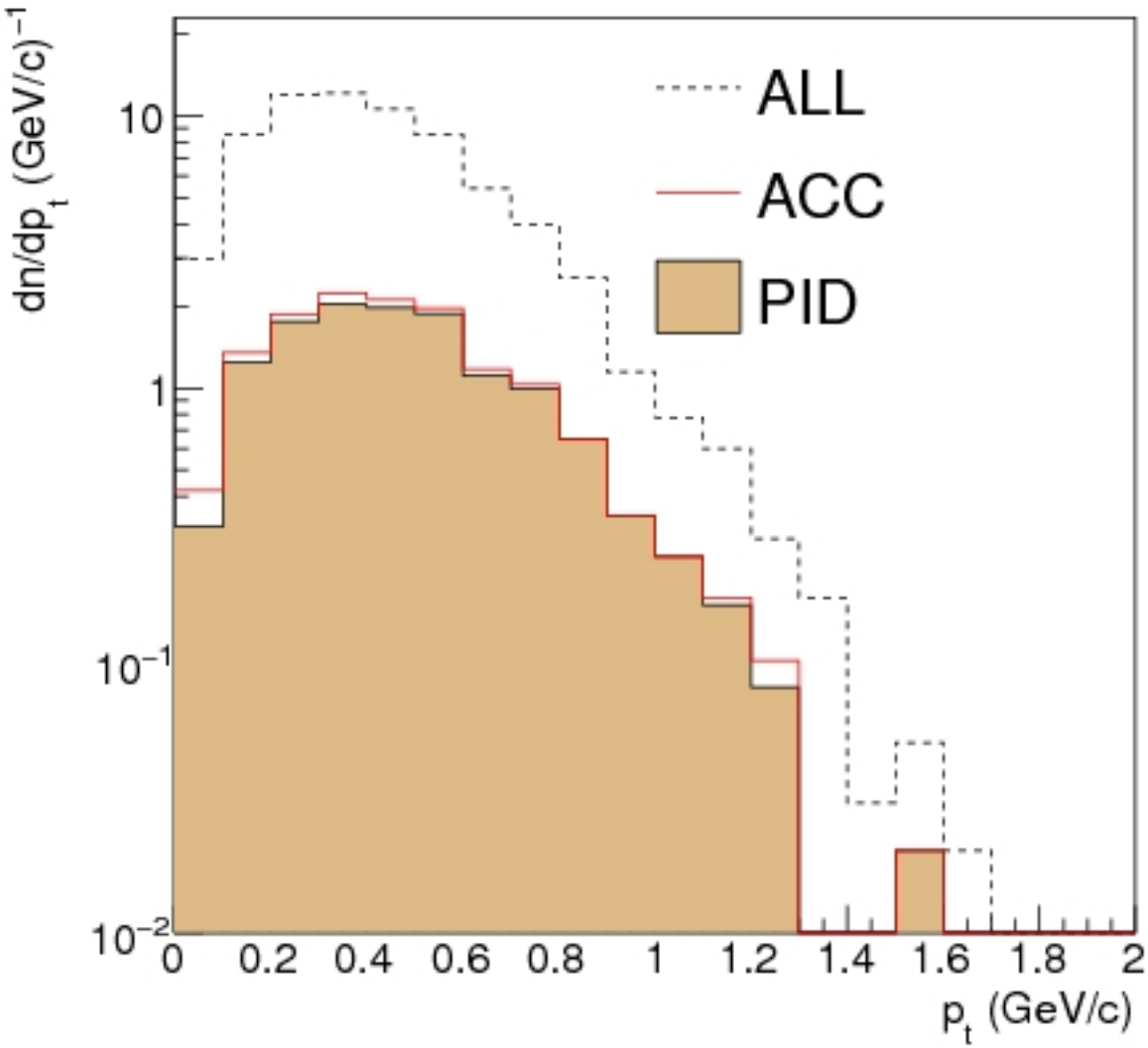


P_t at midrapidity at 4*A* GeV

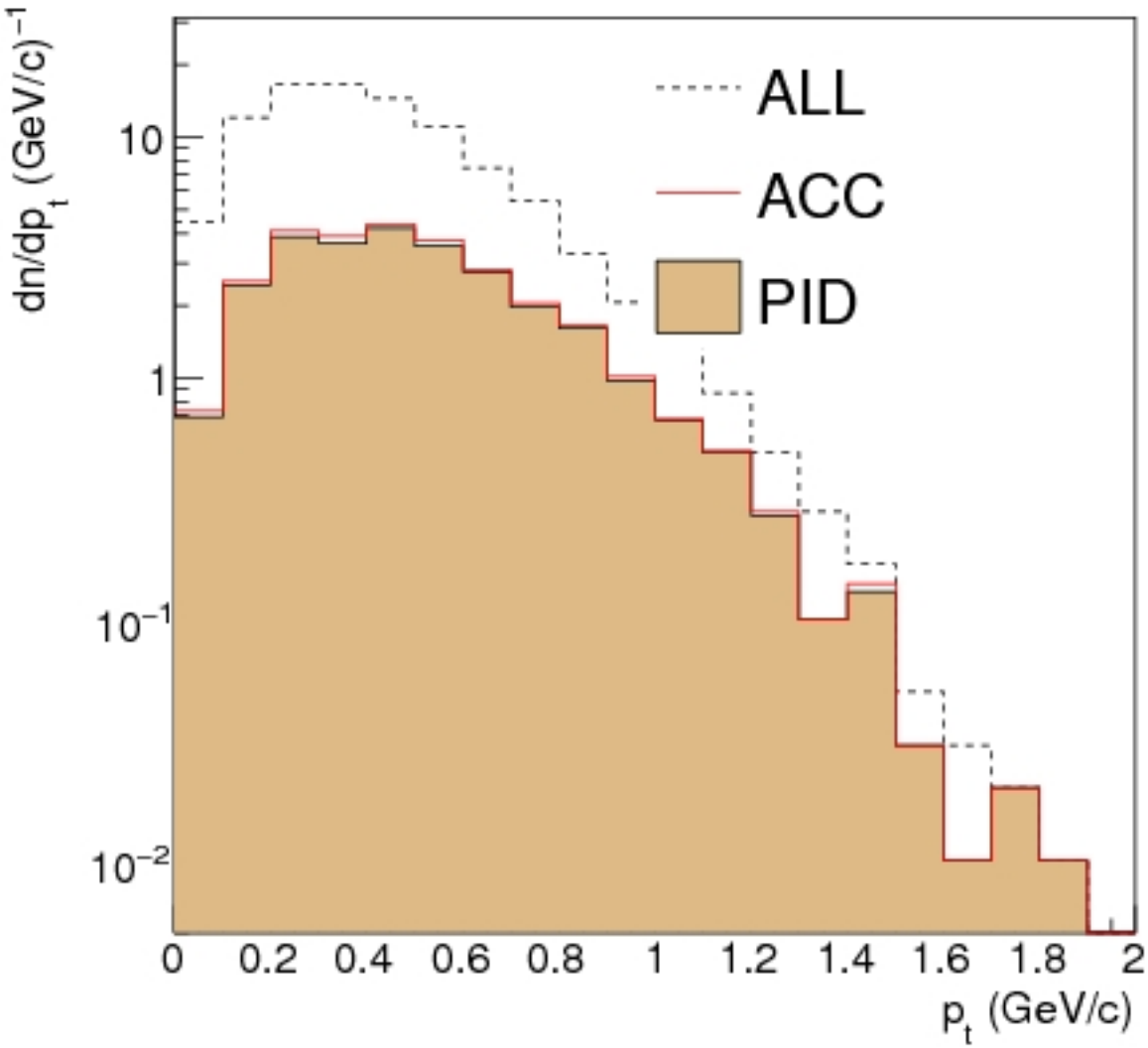
RECO



P_t at midrapidity at 6*A* GeV



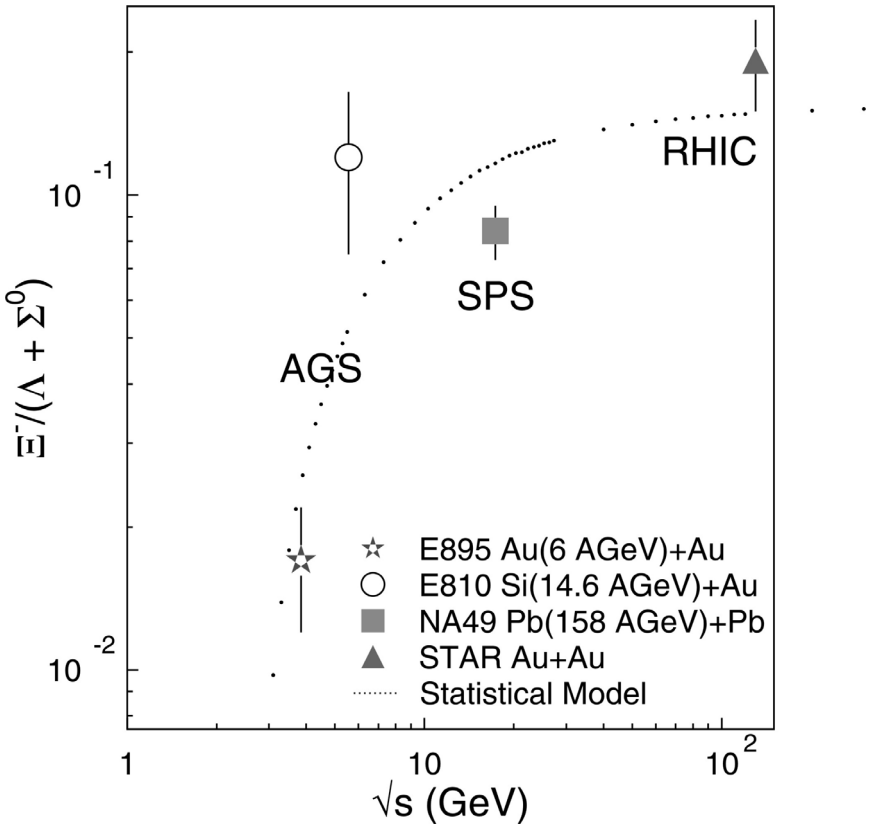
P_t at midrapidity at 8*A* GeV



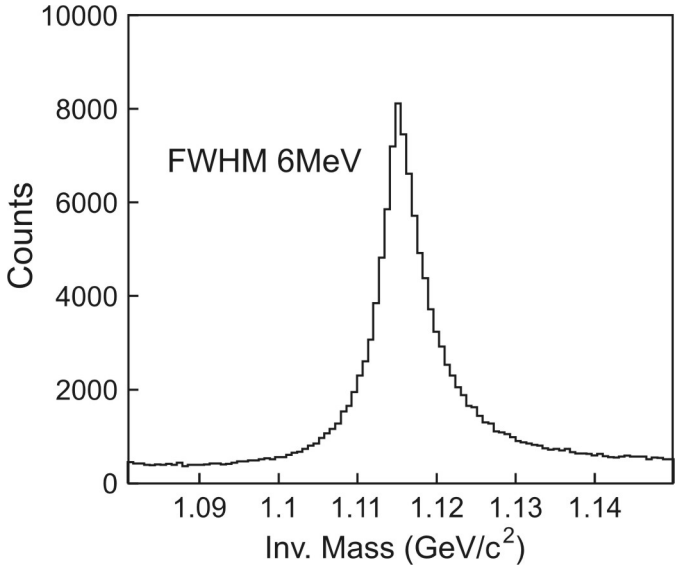
Hyperon Measurements

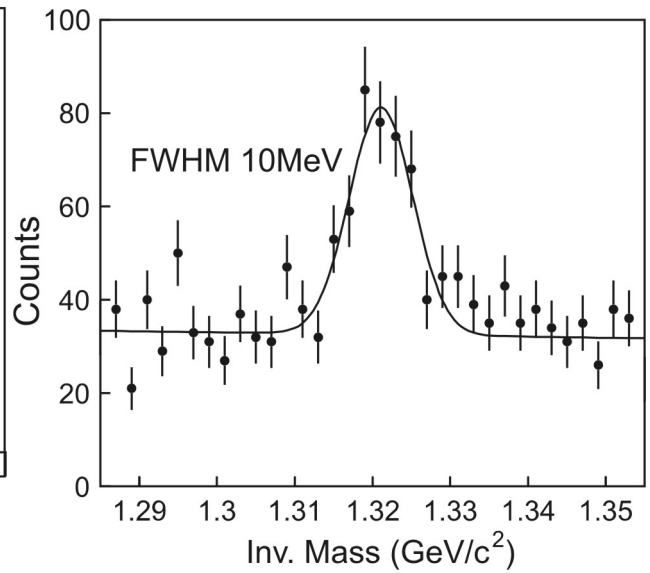
Motivation

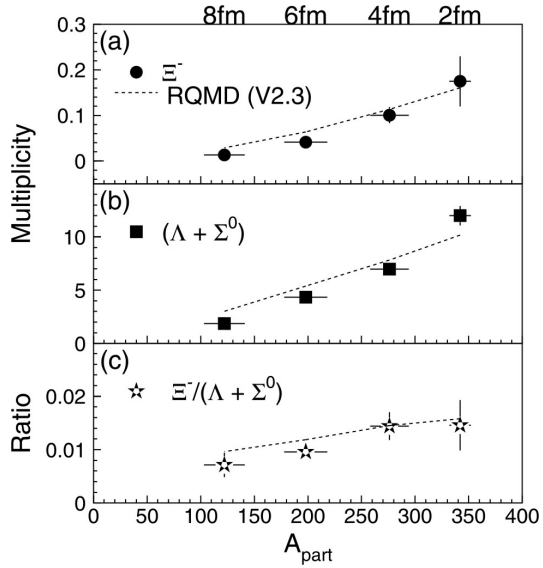
- The idea to measure multistrange hyperons at low energies with SIS 100
- Energy range: 2-10 AGeV
- Setup:
  - STS without MVD
  - TOF at 4 m ?



Hyperons at AGS



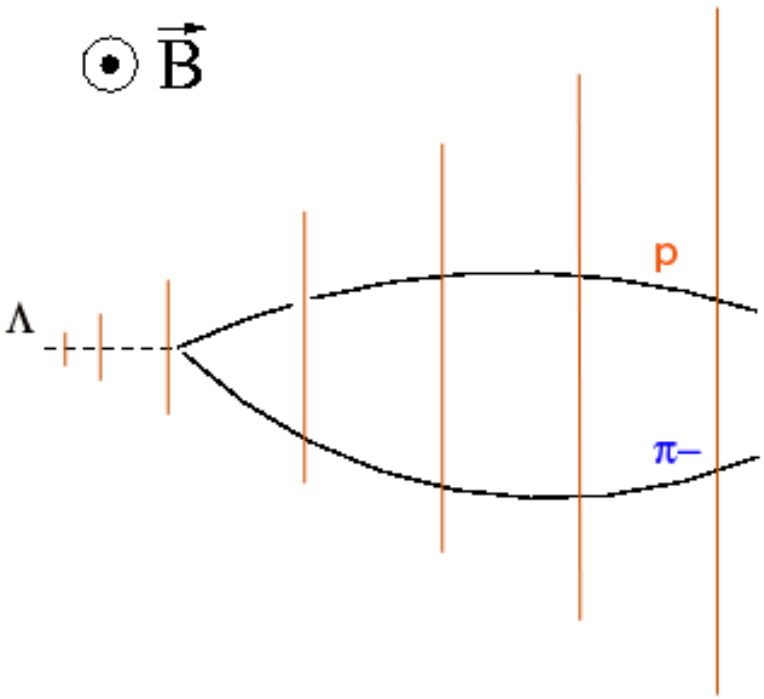


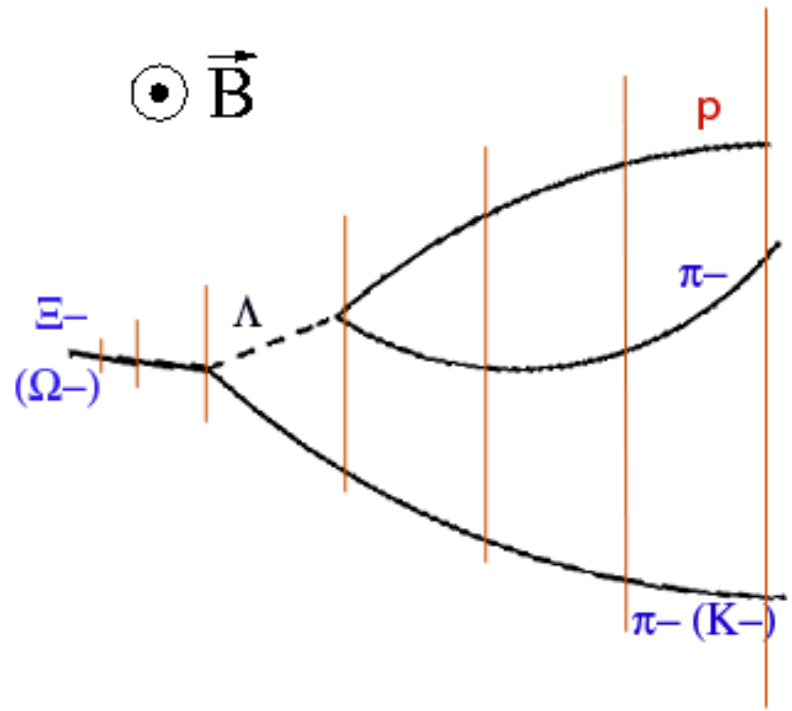


- Threshold production of Xi measured in Au+Au collisions @ 6 GeV
- Main detector: TPC with PID capabilities
- ~250 Xi measured in 4 centrality bins
- Results consistent with UrQMD
- Neural network algorithm used for the bgd suppression

Hyperon properties

Particle	Quark content	Mass (GeV/c^2)	Lifetime $c\tau$ (cm)	Multiplicity at 6 GeV	Decay channel	BR
$\Lambda+\Sigma^0$	uds	1.116	7.89	13	$p\ \pi^-$	63.9%
Ξ^-	dss	1.321	4.91	~0.12	$\Lambda\ \pi^-$	99.9%
Ω^-	sss	1.672	2.46	$\sim 7\cdot 10^{-4}$	$\Lambda\ K^-$	67.8%





Background suppression strategy

Cut variables:

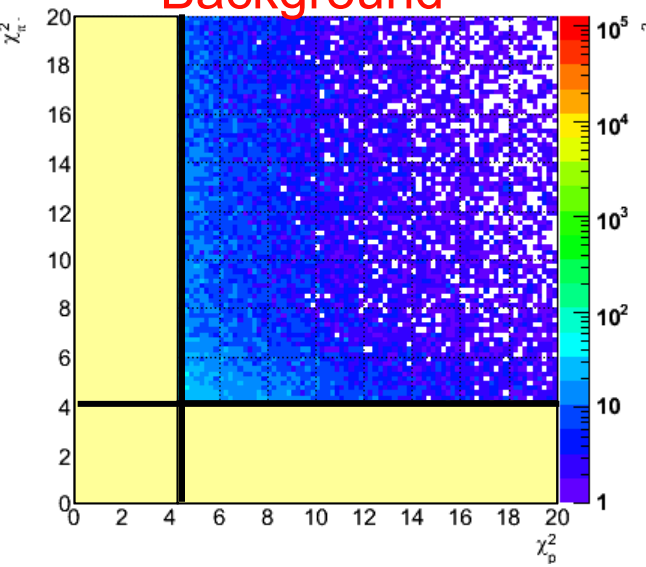
- Single track cuts:
  - impact parameter in the target plane for positive and negative tracks
- Vertex quality cuts:
  - distance of closest approach,
  - chi2 of the fitted vertex
- Additional topological cuts:
  - Position of the fitted decay vertex along the beam axis
  - Impact parameter of the reconstructed mother track

- No particle identification is used

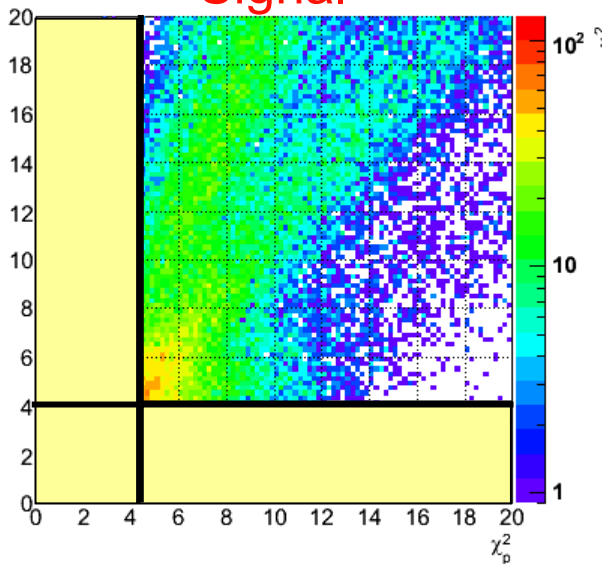
The goal: maximum significance

2-dimensional significance optimization

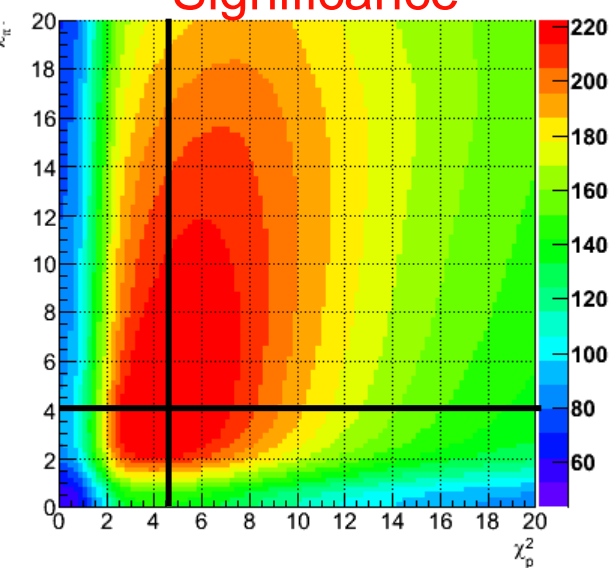
Background



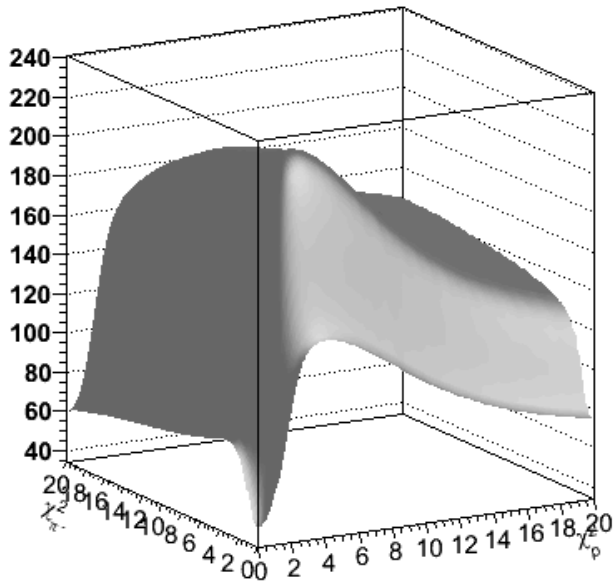
Signal



Significance



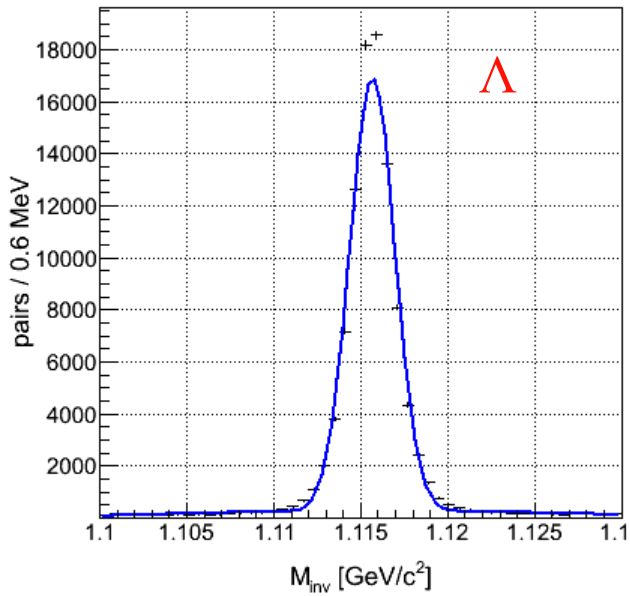
- Significance as function of cut variables has very nontrivial shape, therefore two dimensional analysis was developed.
- Cut variables are grouped in pairs:
  - Single track cuts: impact parameters for positive and negative tracks
  - Vertex quality cuts: distance of closest approach, chi2 of the fitted vertex
  - Additional cuts: z-position of secondary vertex, impact parameter of the mother track

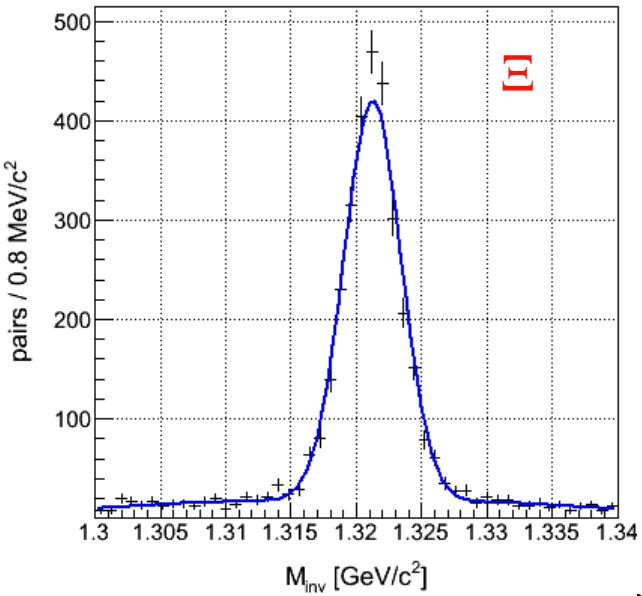


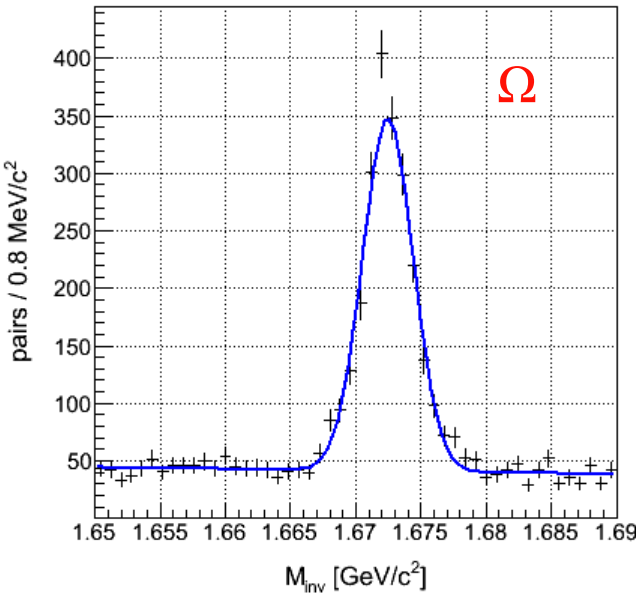
Hyperons at 6 AGeV

- S/B ratio is even better than at 25 GeV
- Omega reconstruction probability after cuts is of the order of 10^{-5}, therefore development of trigger on Omega is desired

Particle	$\Lambda + \Sigma^0$	Ξ^-	Ω^-
Yield/event	12.8	0.118	$7.2 \cdot 10^{-4}$
Statistics	10^5	$9.4 \cdot 10^5$	$1.4 \cdot 10^8$
σ_m, MeV/c^2	1.31	2.21	1.96
Acceptance	25.1%	13.6%	13.9%
Rec. efficiency	73.4%	53.5%	64.9%
Cut efficiency	40.1%	35.1%	21.7%
Total efficiency	7.4%	2.6%	2.0%
S/B ratio	65	49.3	4.3
Significance	294	17.8	39



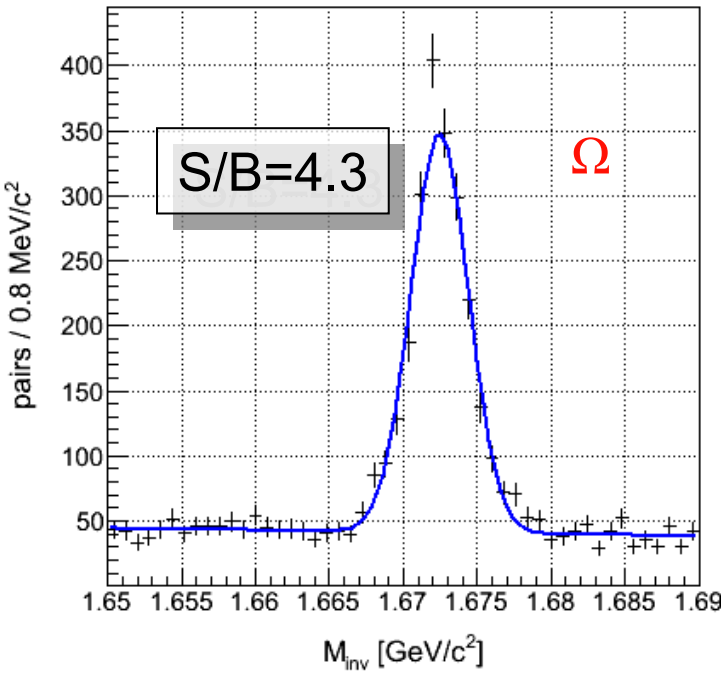




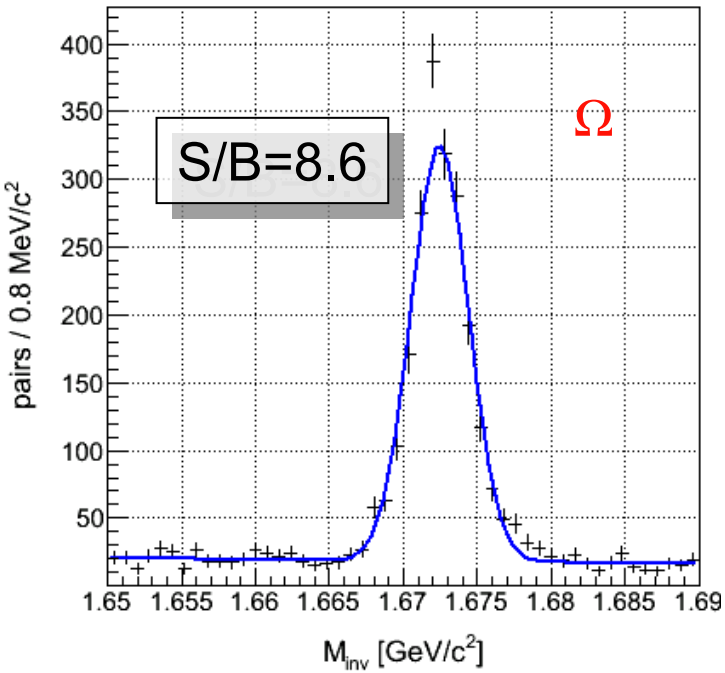
Hyperons @ 6 GeV with PID

- $\Omega^- \rightarrow \Lambda K^-$, main background comes from π^- mistaken with K^- PID hypothesis
- Only 25% of K- tracks survive on the distance of 10 m, thus Ω^- acceptance with TOF is at least 4 times lower. Therefore the background π^- rejection with TOF PID is preferred.
- Semi-perfect PID: Pion tracks, which have MC points in TOF are rejected from combinatorics

No PID



π- rejection



Preliminary conclusion: pion rejection does not help much, at least at 6 GeV