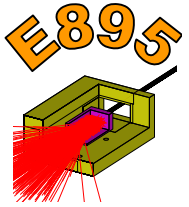
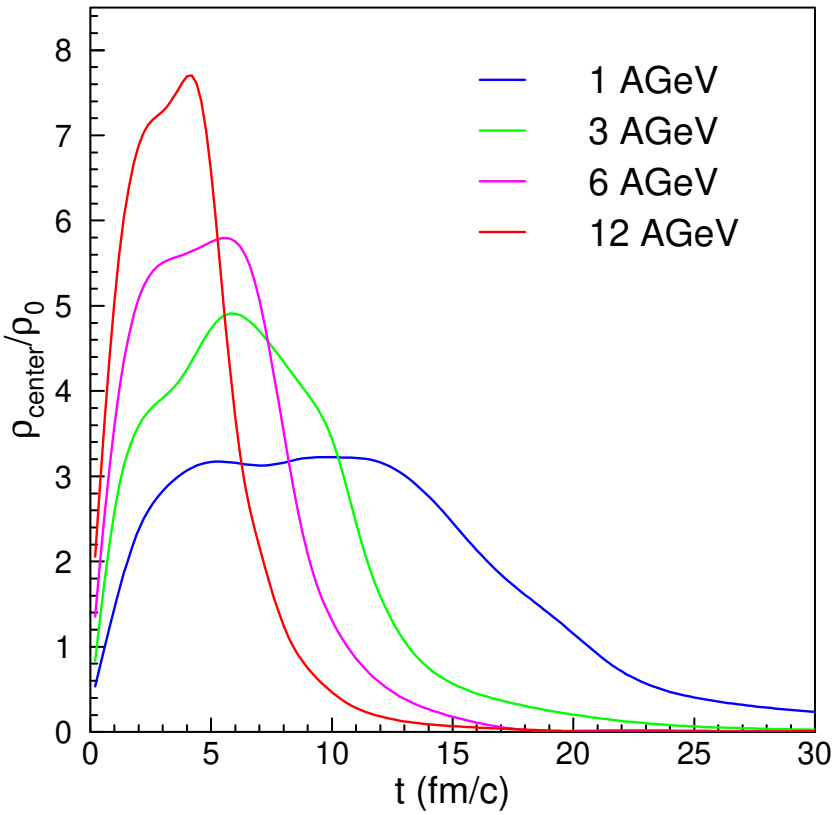
Production and collective behavior of strange particles in Au + Au collisions at 2-8 AGeV

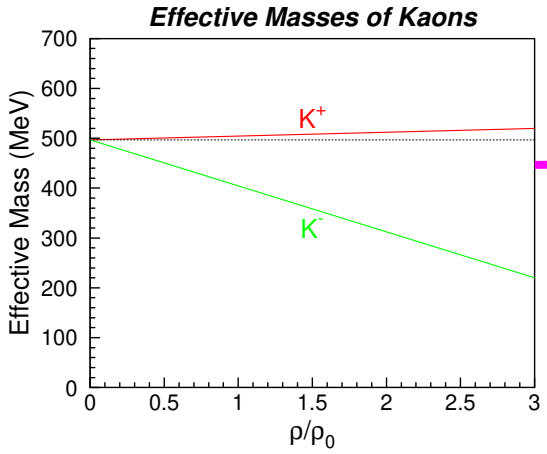


C. Pinkenburg for the E895 Collaboration

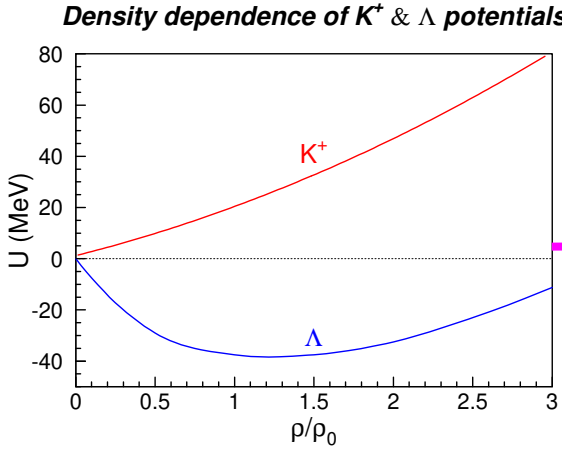
- Calculations
- E895 experimental setup
- Strangeness with E895
- Yields
- Sideward and Radial Flow
- Λ-p correlation
- Conclusions

Baryon Density





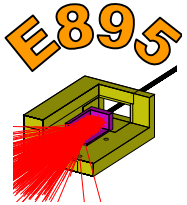
E895

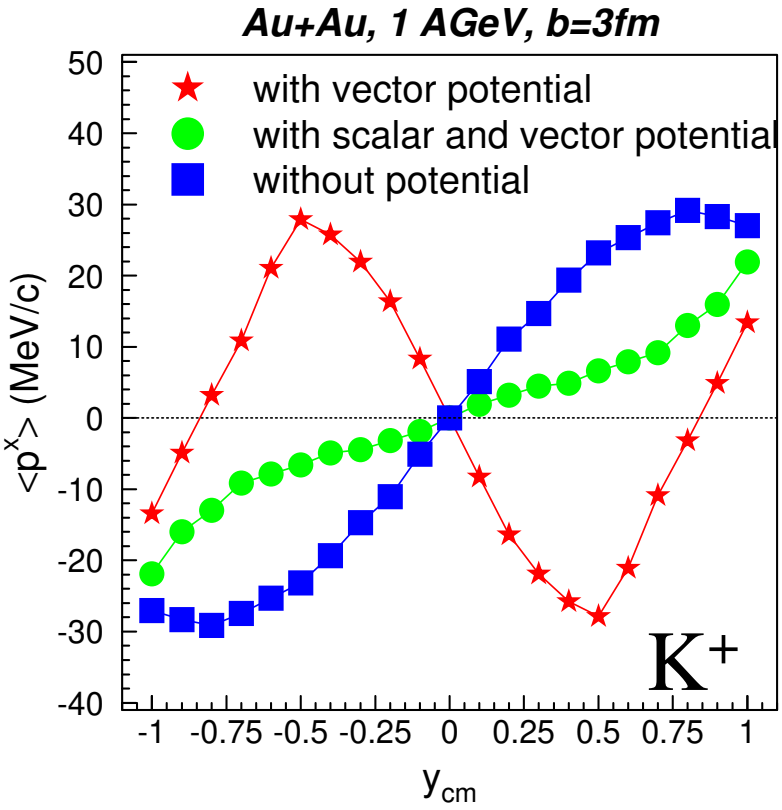


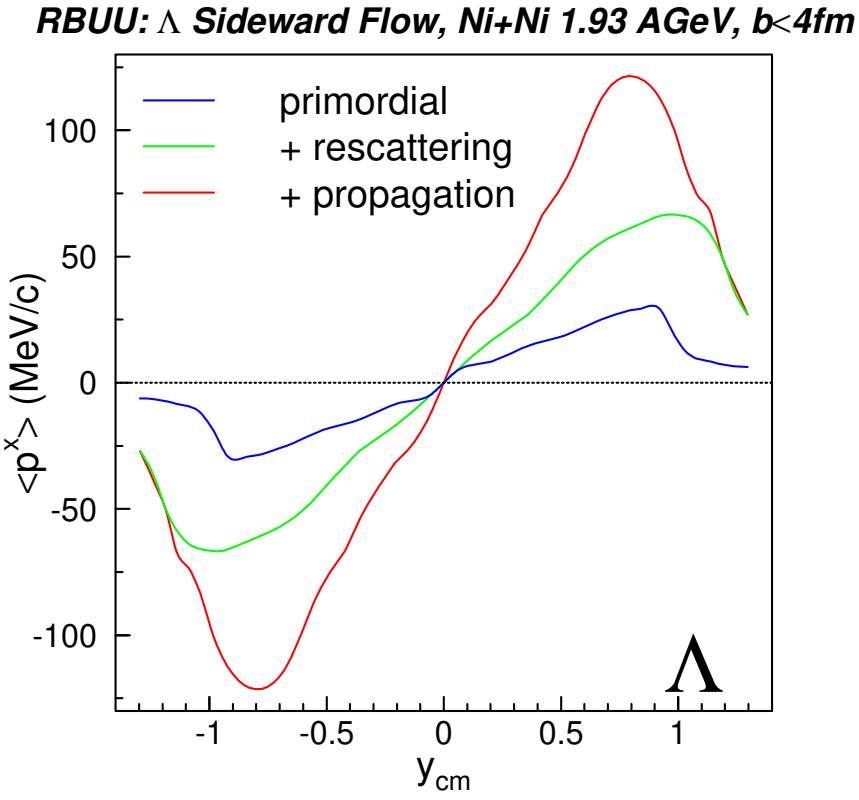
E895

Strong Density Dependence of Kaon and Λ Potentials
E895 probes $\rho/\rho_0 \approx 3\text{-}6$

Strange Hadron Flow

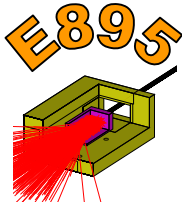




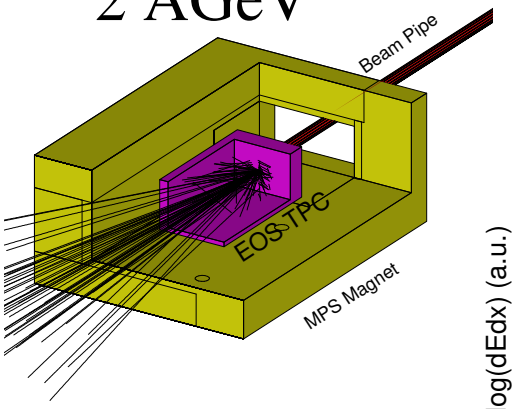


Sideward Flow of strange Particles is very sensitive to Potentials
Direction of Kaon Flow gives already some insight
Magnitude of the Λ Flow depends on Λ potential

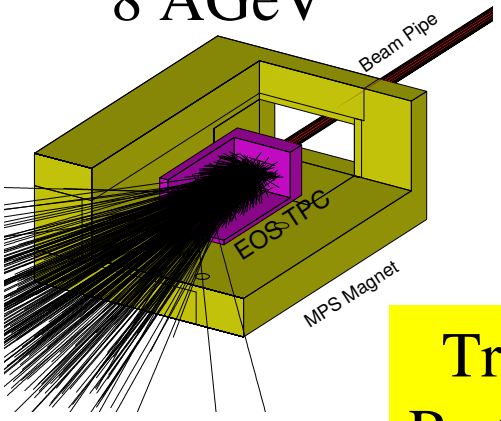
E895 Experimental Setup

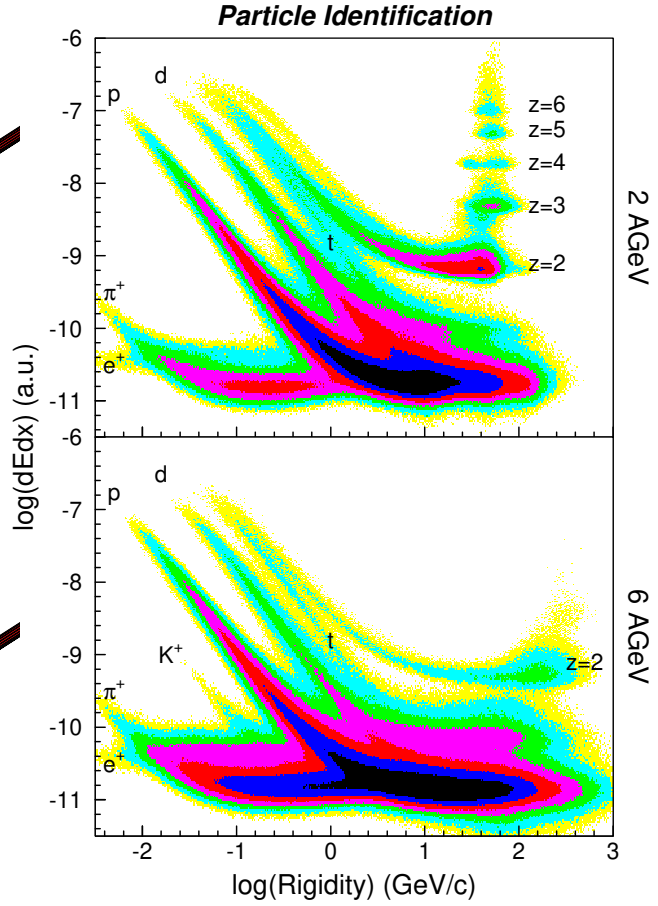


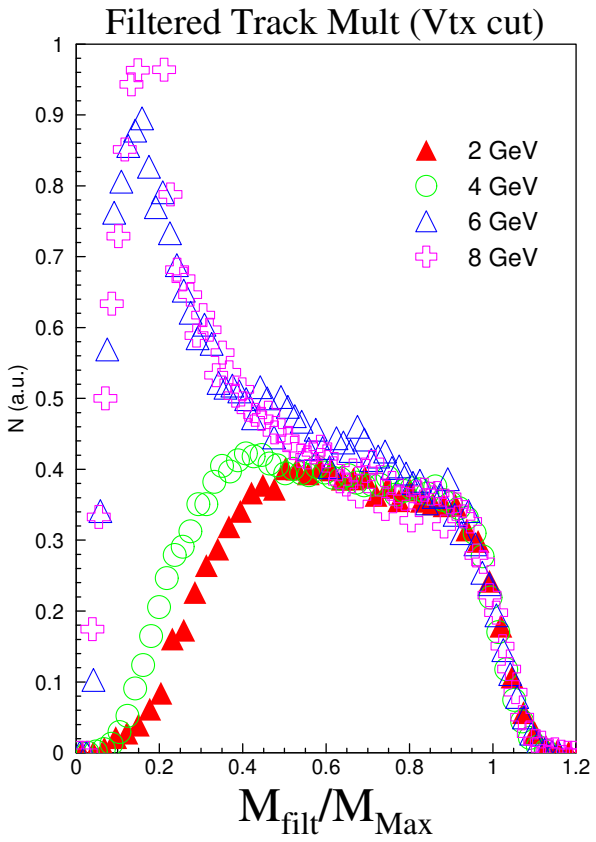
2 AGeV



8 AGeV

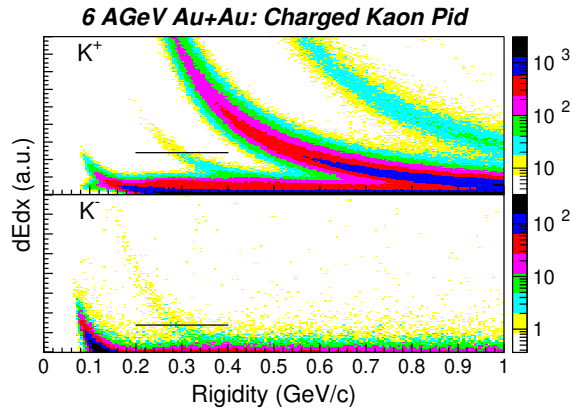


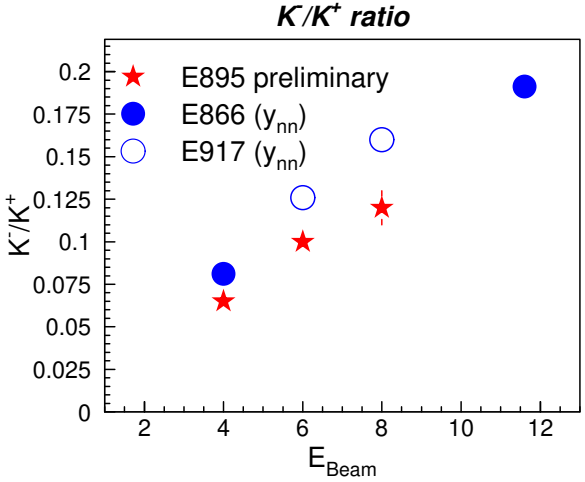


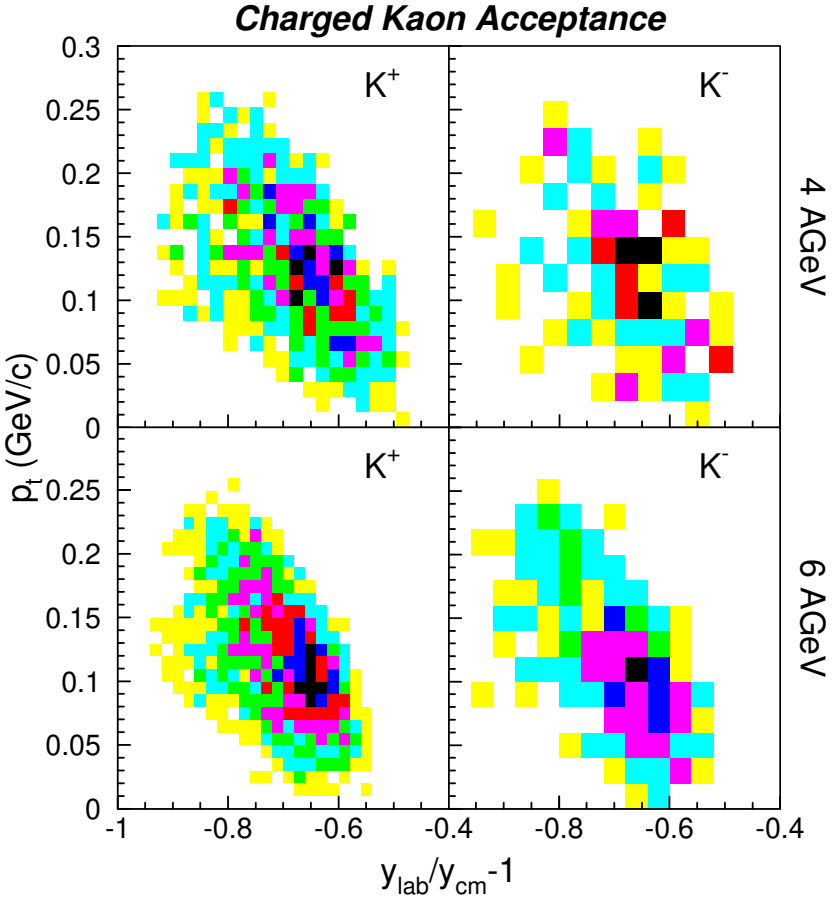


Track/Hit Density is a challenge (higher than STAR)
Particle Id via Energy Loss and Curvature in Mag Field
Impact Parameter Determination via Track Multiplicity

Charged Kaon PId







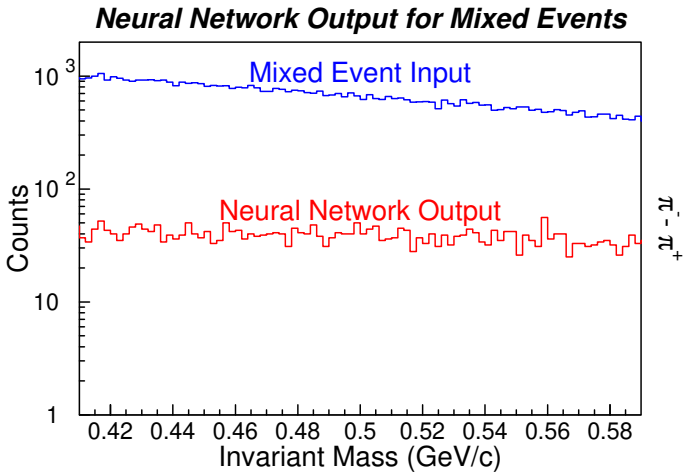
PId of Charged Kaons limited to low p_t and backward Rapidity

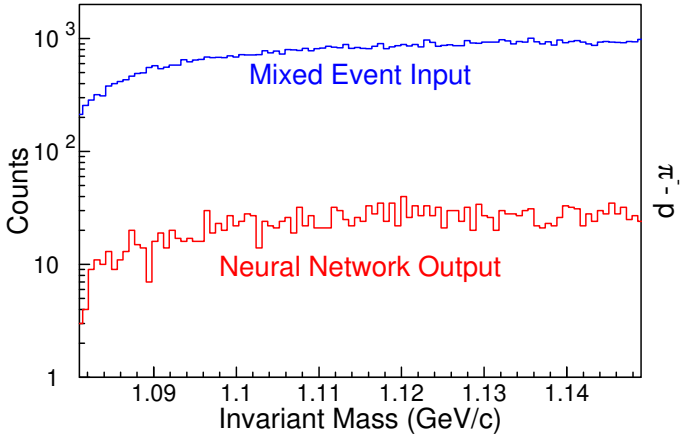
Uncorrected Ratios consistent with E866/E917 (different p_t/y range!)

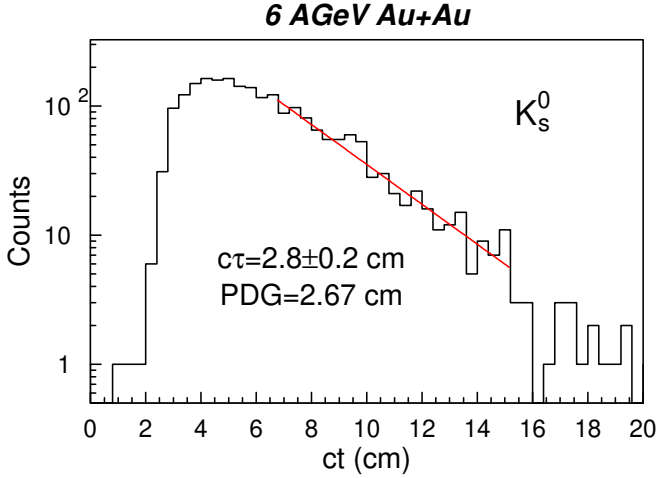
Ratios consistent ⟶ negligible Pion contamination

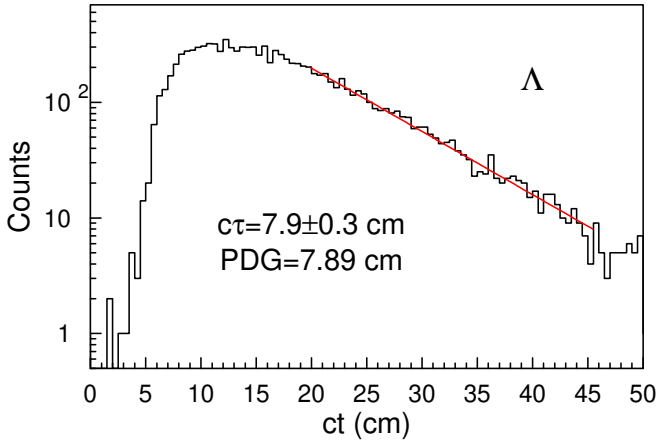
Comparisons: Beware of E895 p_t/y acceptance!

V0 Reconstruction



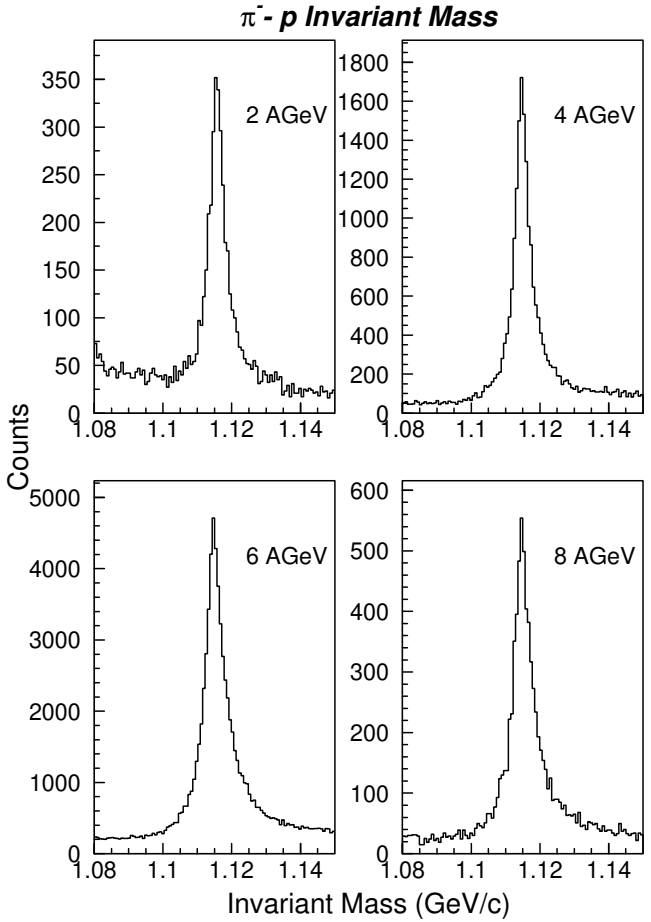


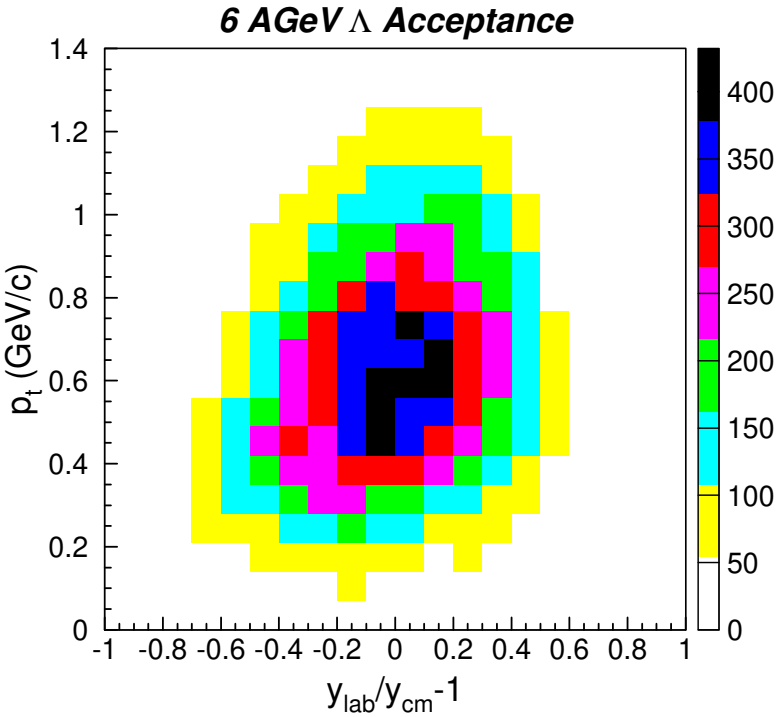




V0 reconstruction accomplished by neural network
Acceptance Corrections derived from embedded V0's
No artificial mass peaks in mixed pairs
cτ value is very close to PDG value

Λ Reconstruction

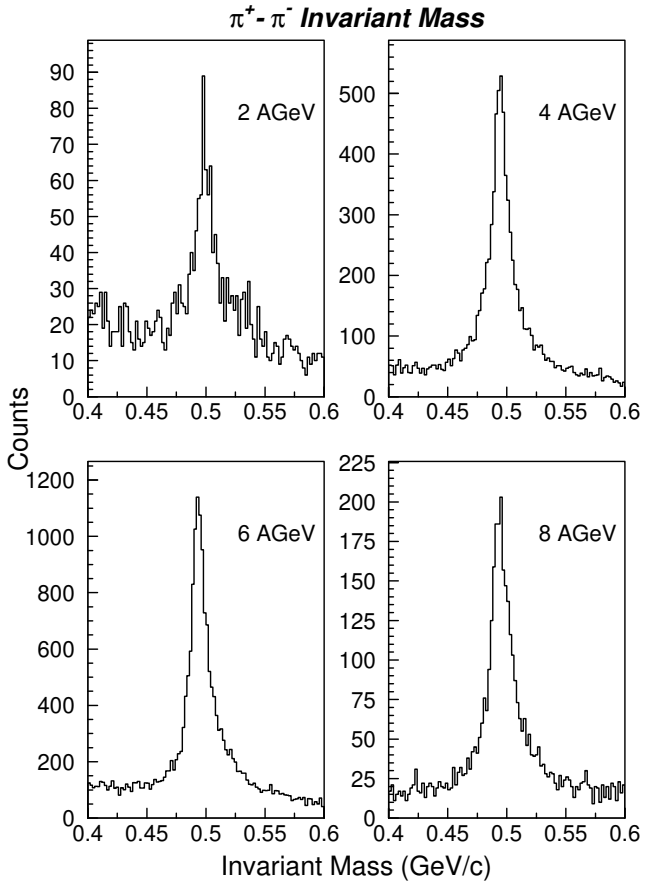


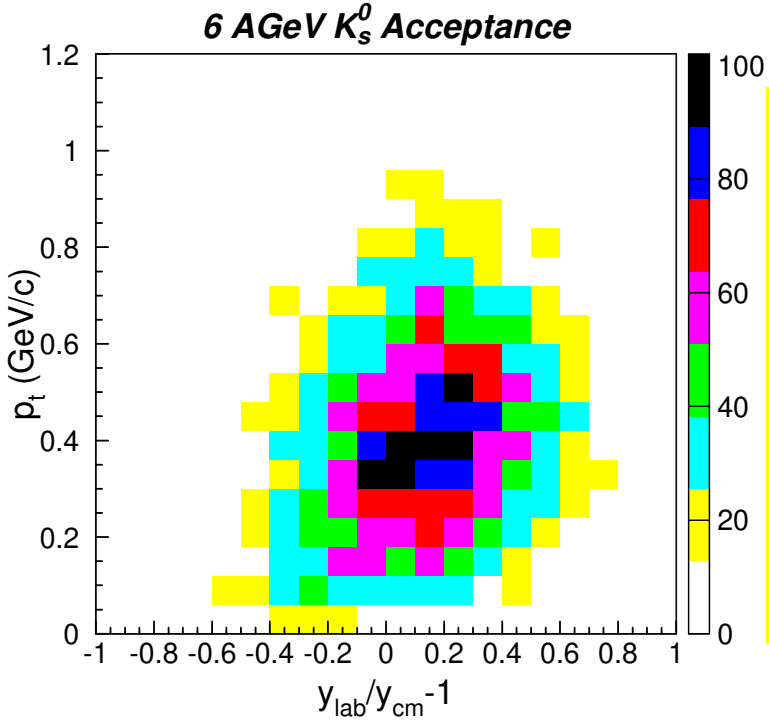


Good Peak to Background
Large uniform acceptance
some low p_t losses

E_{Beam}	# of <Λ>	FWHM	<Λ> rec/evt	<Λ> rec eff	<Λ> Mult
2 AGeV	**3045**	**5 MeV**	**0.034±0.002**	**5.9±0.3%**	**0.58±0.04**
4 AGeV	**14753**	**6 MeV**	**0.230±0.004**	**4.2±0.2%**	**5.5±0.3**
6 AGeV	**50568**	**6 MeV**	**0.302±0.003**	**2.6±0.2**	**11.6±0.9**
8 AGeV	**5977**	**6 MeV**	**0.26±0.01**	**1.6±0.1**	**16±1**

K^0_s Reconstruction

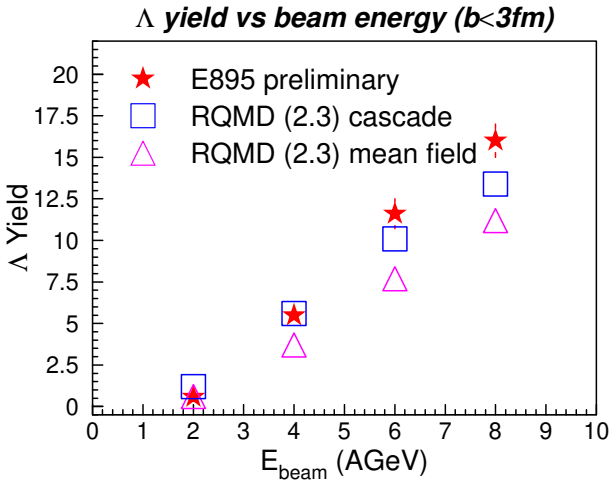


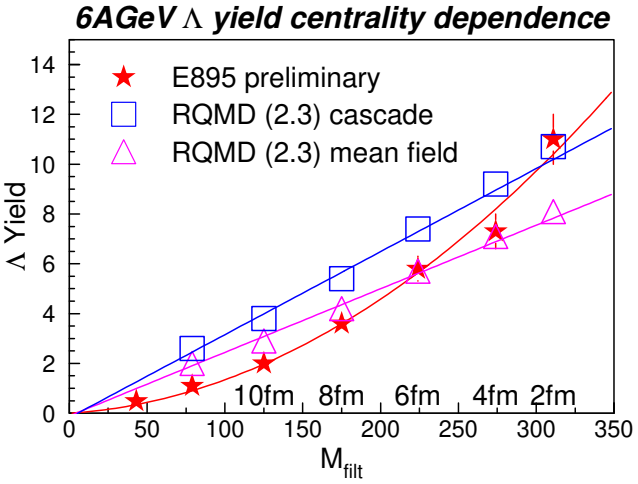


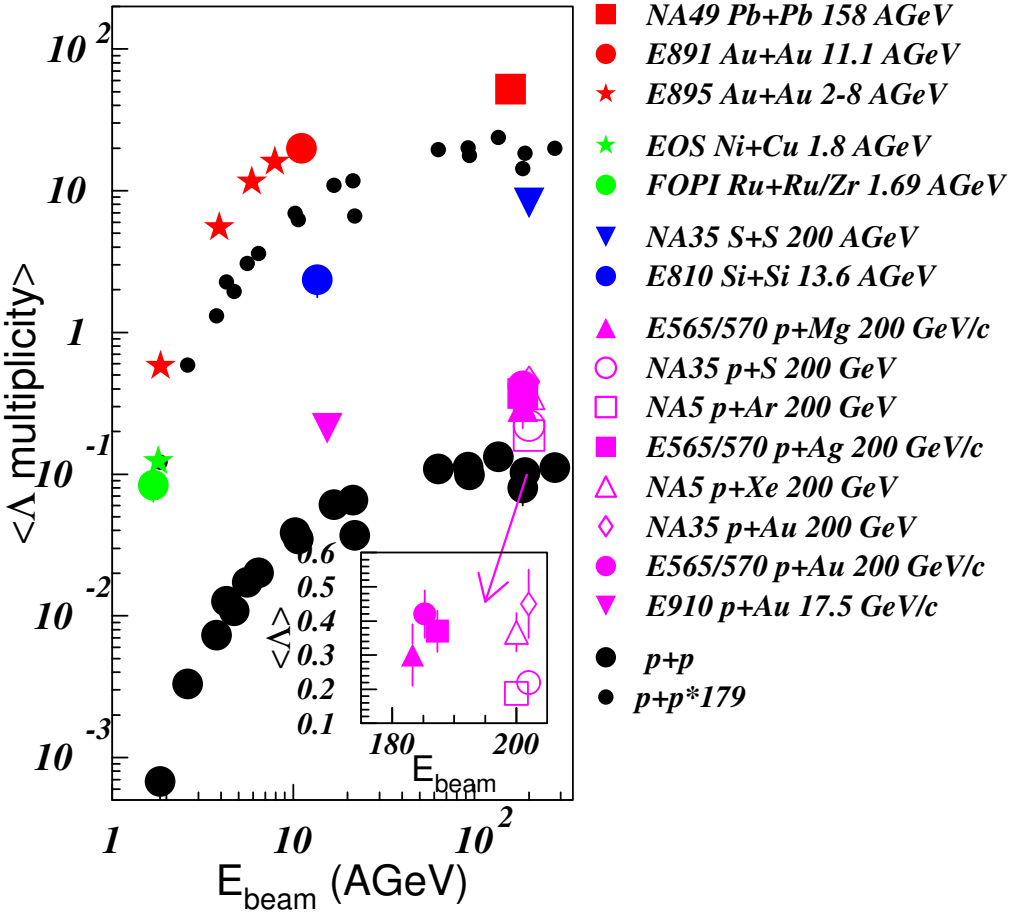
Good Peak to Background
Large uniform acceptance losses at backward rapidity

E_{Beam}	# of K^0_S	FWHM	K^0_S rec/evt	K^0_S rec eff	K^0_S Mult
2 AGeV	**556**		**0.0059±0.0007**	**3.2±0.2%**	**0.18±0.02**
4 AGeV	**5537**	**18 MeV**	**0.067±0.002**	**3.4±0.2%**	**2.0±0.1**
6 AGeV	**11295**	**14 MeV**	**0.060±0.001**	**1.5±0.1%**	**4.0±0.3**
8 AGeV	**2314**	**17 MeV**	**0.089±0.006**	**0.9±0.1%**	**10±1**

Λ Yields

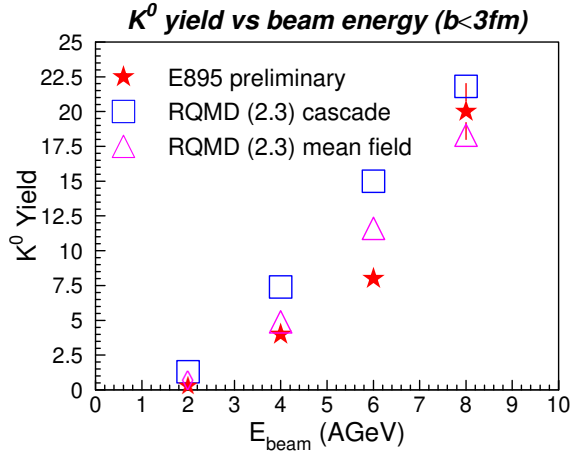


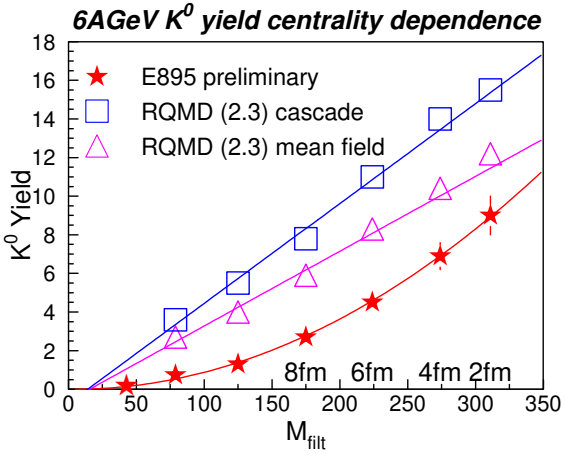


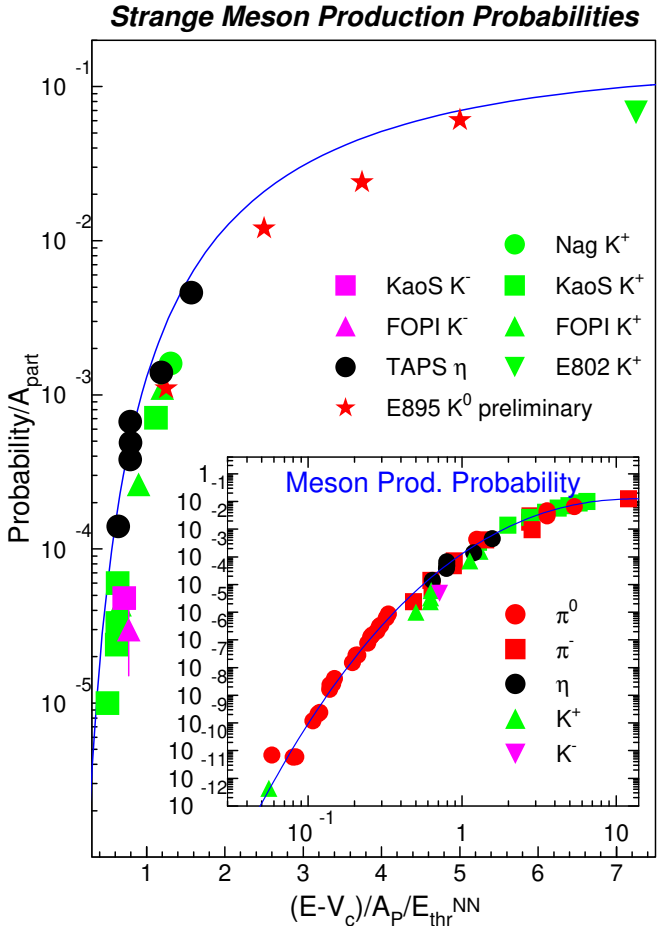


RQMD reproduces the Λ multiplicity in central events
but fails in the non linear Impact Parameter dependency
Λ yields follow expected systematics, enhancement compared to p-p

K^0_S Yields



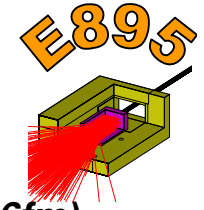


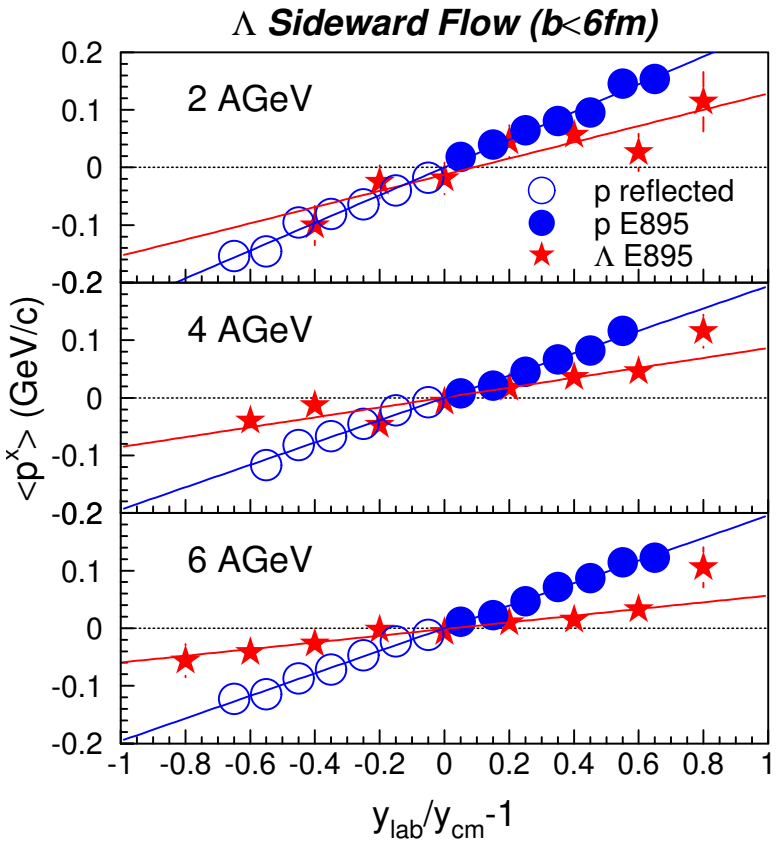


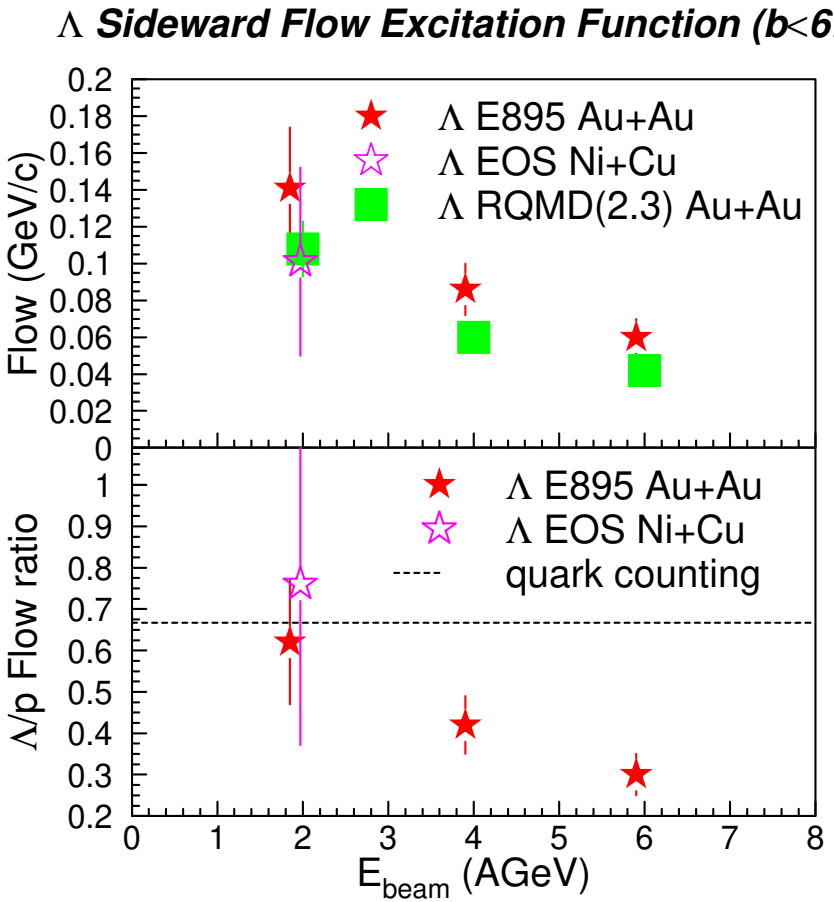
V.Metag, Prog. Part. Nucl. Phys 30 (1993) 75

RQMD overpredicts K^0_S production
similar non linear centrality dependence to E802 for K^+/K^-
K^0_S follow Meson Production systematics

Λ Sideward Flow







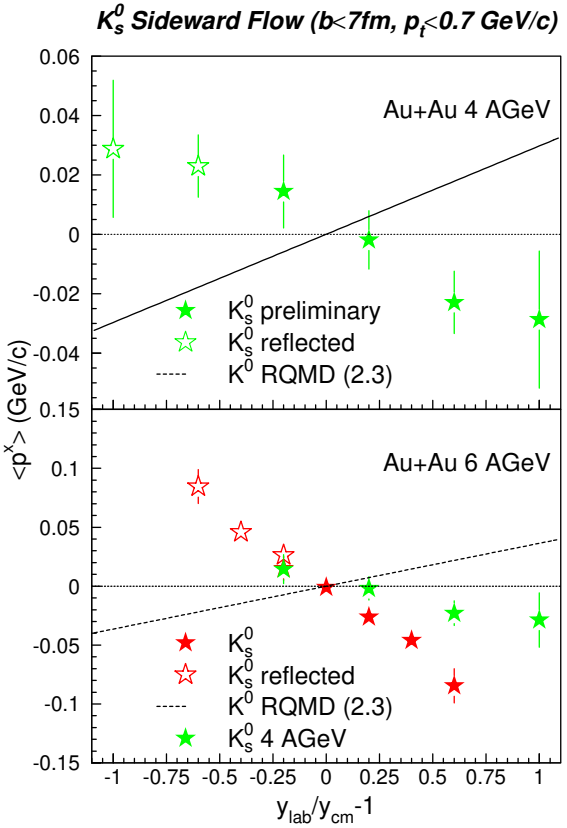
Λ sideward flow smaller than proton flow and diminishes faster

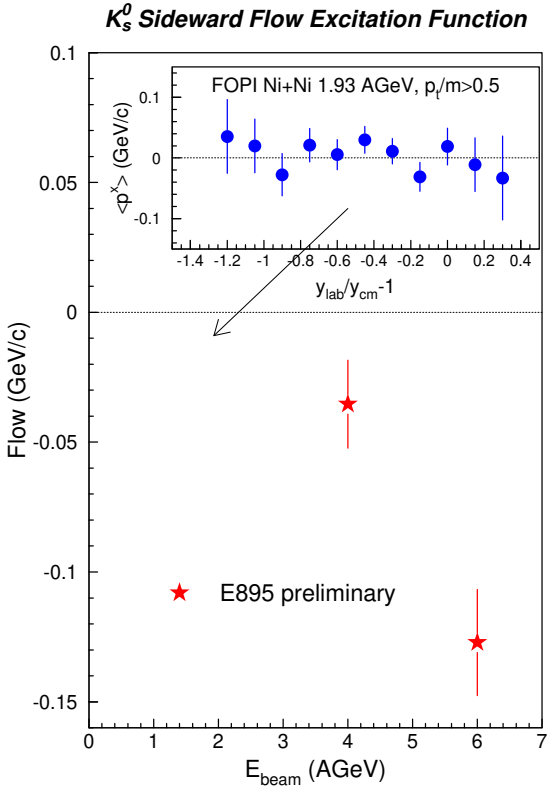
Λ sideward flow increases with system size

Flow ratio deviates from 2/3 with increasing beam energy

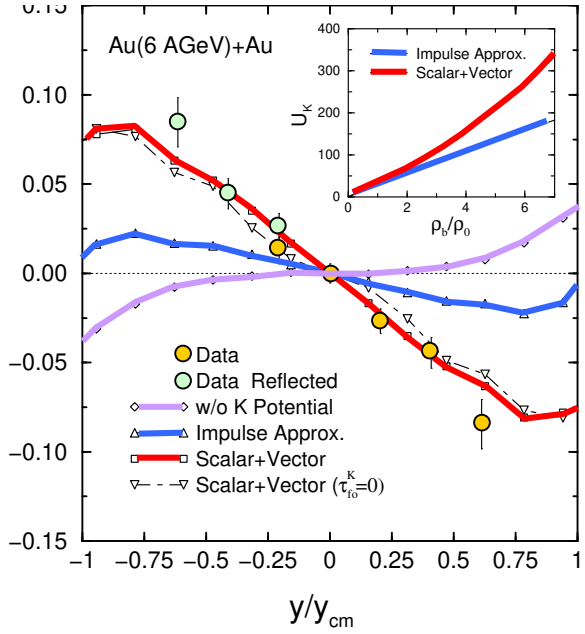
Density dependence of Λ potential?

K^0_S Sideward Flow





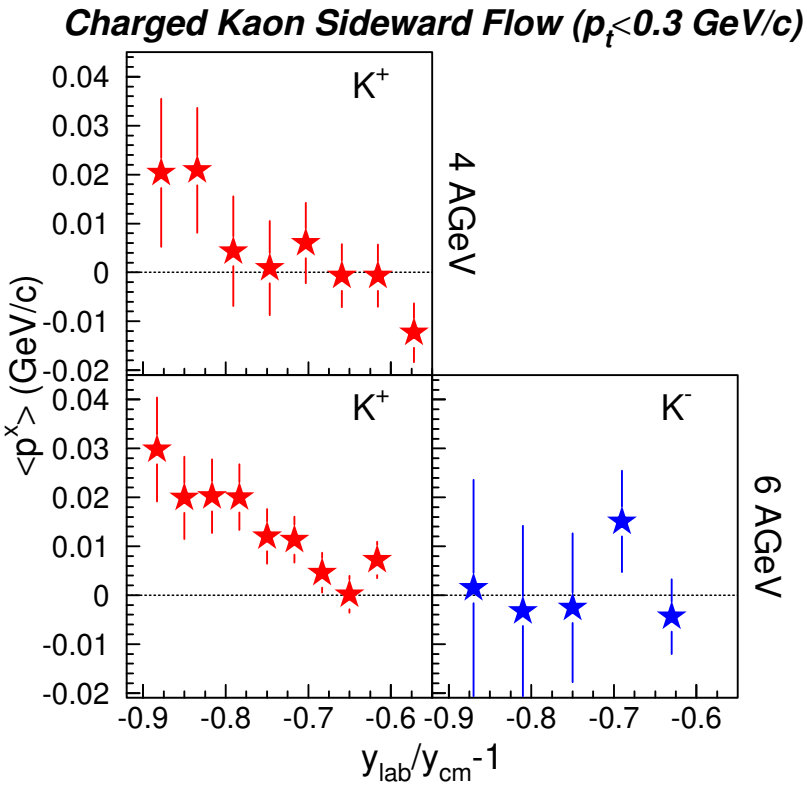
J. Ritman ZPA 352 (1995) 355

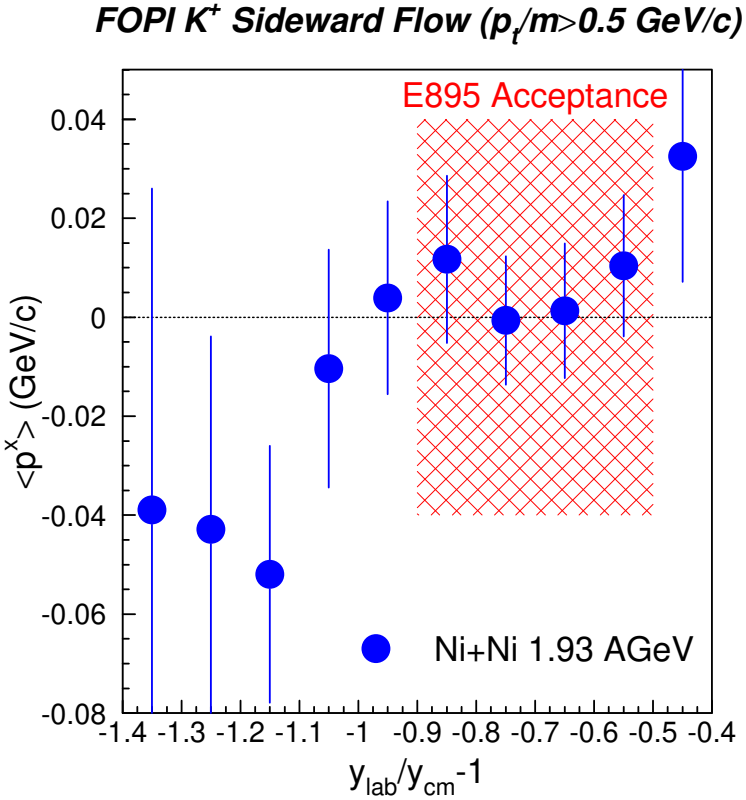


S. Pal PRC 62 (2000), 061903

K^0_S exhibits anti flow pattern in contrast to RQMD
Anti flow increases with beam energy!
ART requires Kaon potential to reproduce the 6 AGeV K^0_S data
Excitation function should give handle on density dependence of K-Pot.

Charged Kaon Sideward Flow

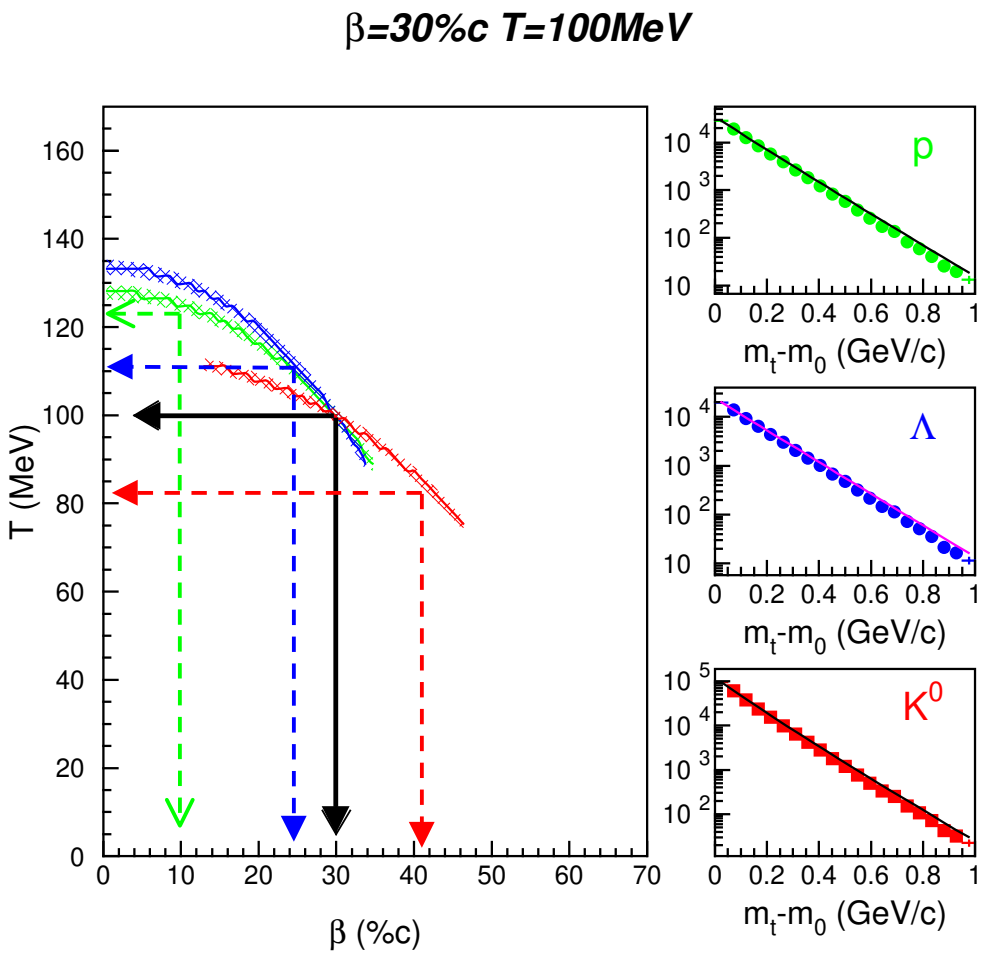




J. Ritman ZPA 352 (1995) 355

K^+ seem to follow the K^0_S pattern: increasing anti flow with E_{Beam}
K^- flow is consistent with no flow
Comparisons: Beware of E895 acceptance for charged Kaons

Radial Flow



The Temperature and velocity of a common source can be extracted by fitting midrapidity m_t spectra with

$$\frac{1}{m_t^2}\frac{dN}{dm_t} \propto e^{-\gamma m_t/T}\left[\frac{\sinh(\alpha)}{\alpha}\left(\gamma+\frac{T}{m_t}\right)-\frac{T}{m_t}\cosh(\alpha)\right]$$

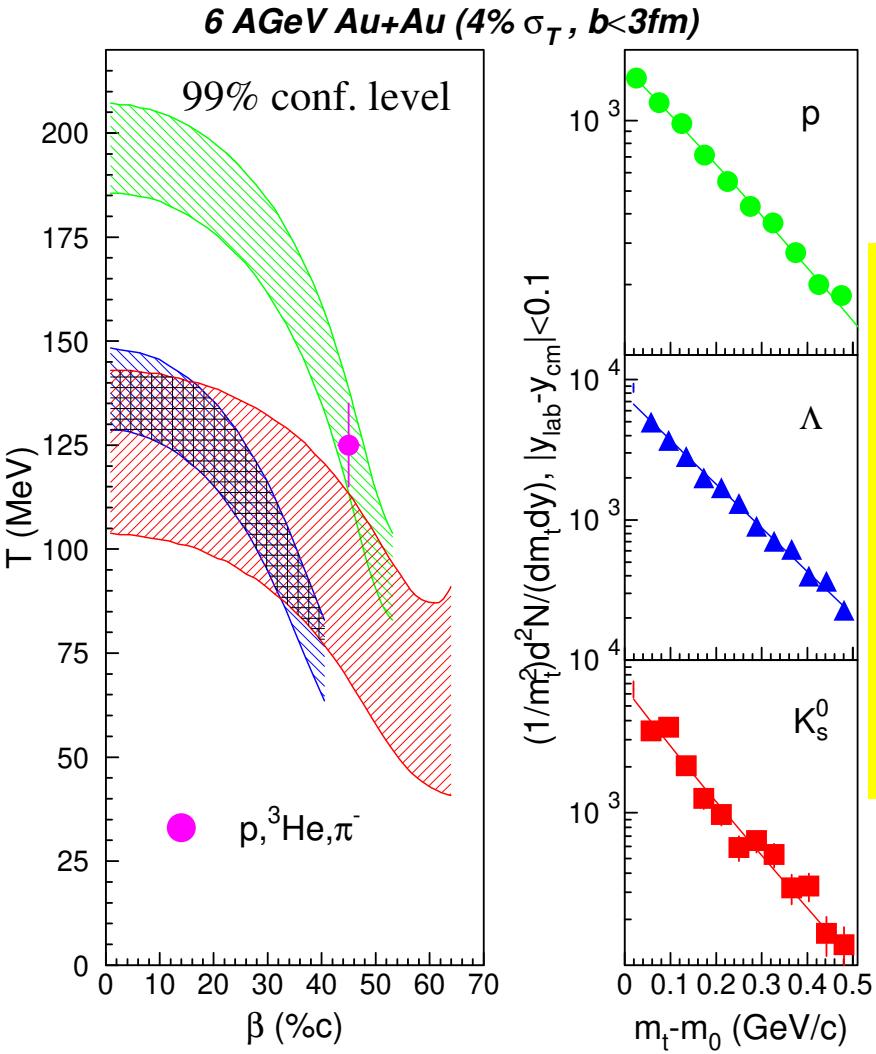
$$\alpha = \beta\gamma p/T \qquad \gamma = \sqrt{1-\beta^2}$$

Siemens, Rasmussen, PRL 42 (1979) 880

Temperature and velocity are highly correlated, a fit to a single particle spectrum doesn't normally yield a unique result

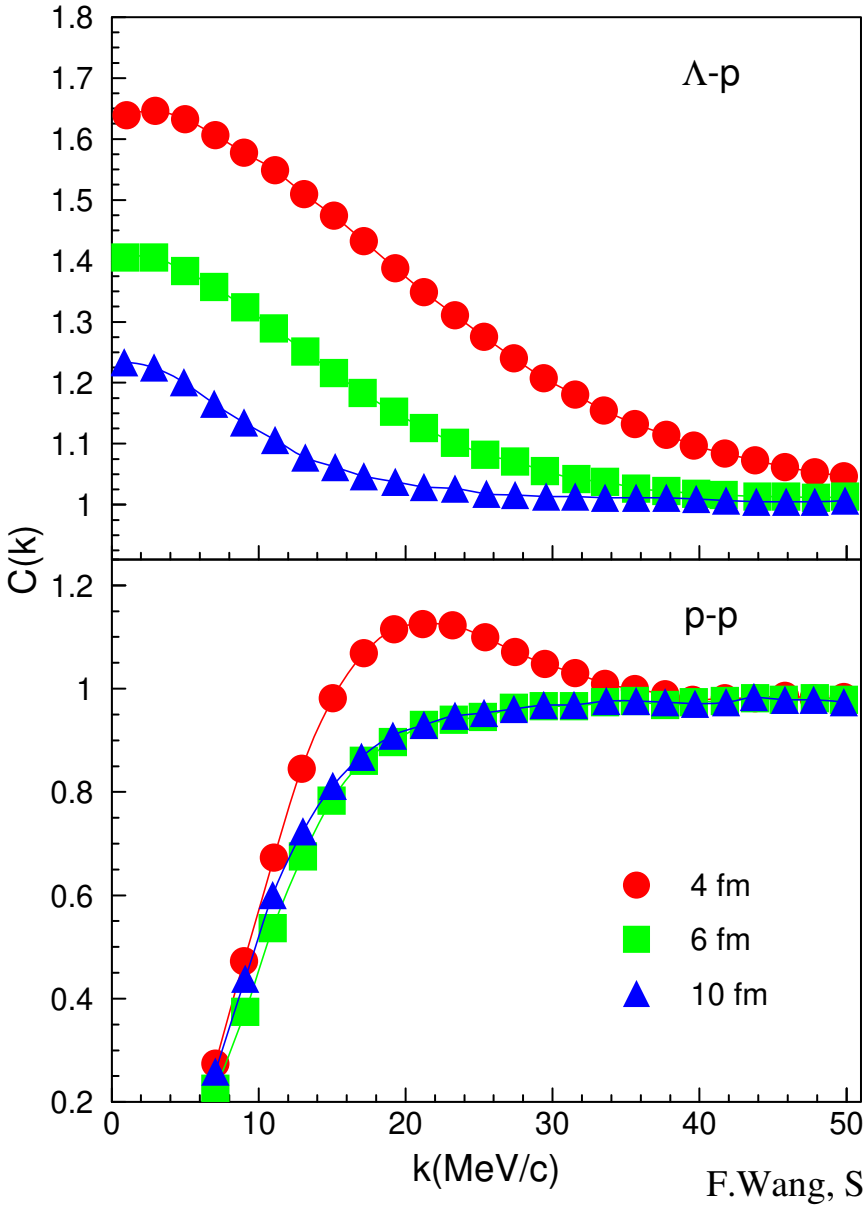
Consistency check: The input parameters of a simulated source are recovered from the overlap of the S-R fits to the particle spectra
Assumption: We don't live in the "dashed" world

Radial Flow of Strange Particles



Surprise!
The S-R fit to the m_t spectra of Proton and Λ shows no overlap in β/T space excluding a common freezeout of proton and Λ
The overlap of non strange particles is consistent with the K_S^0

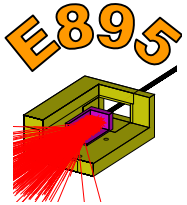
Λ Proton Correlation

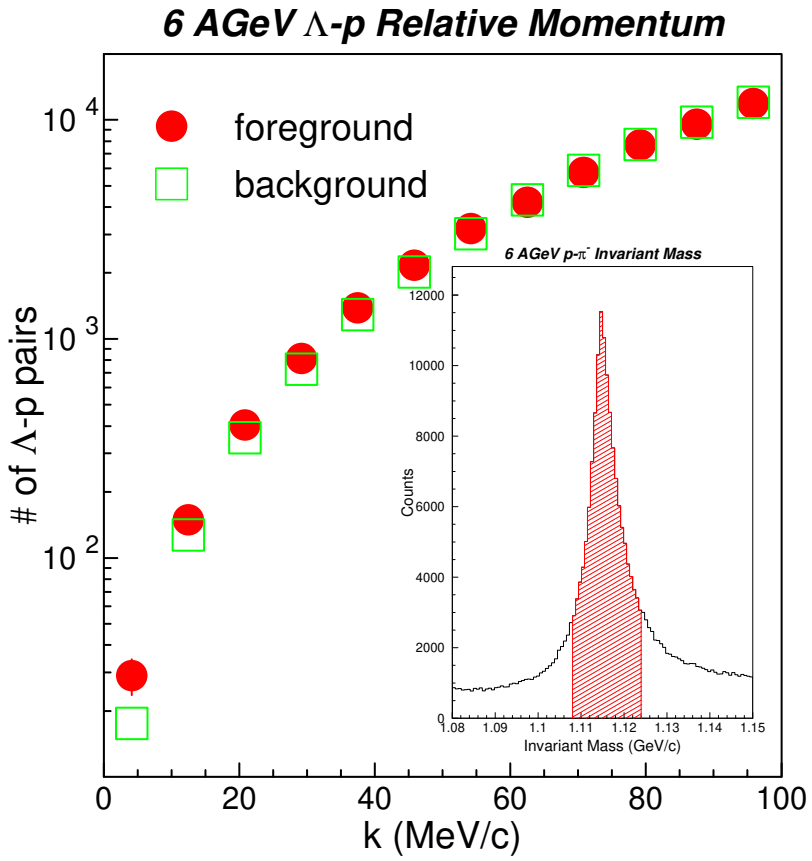


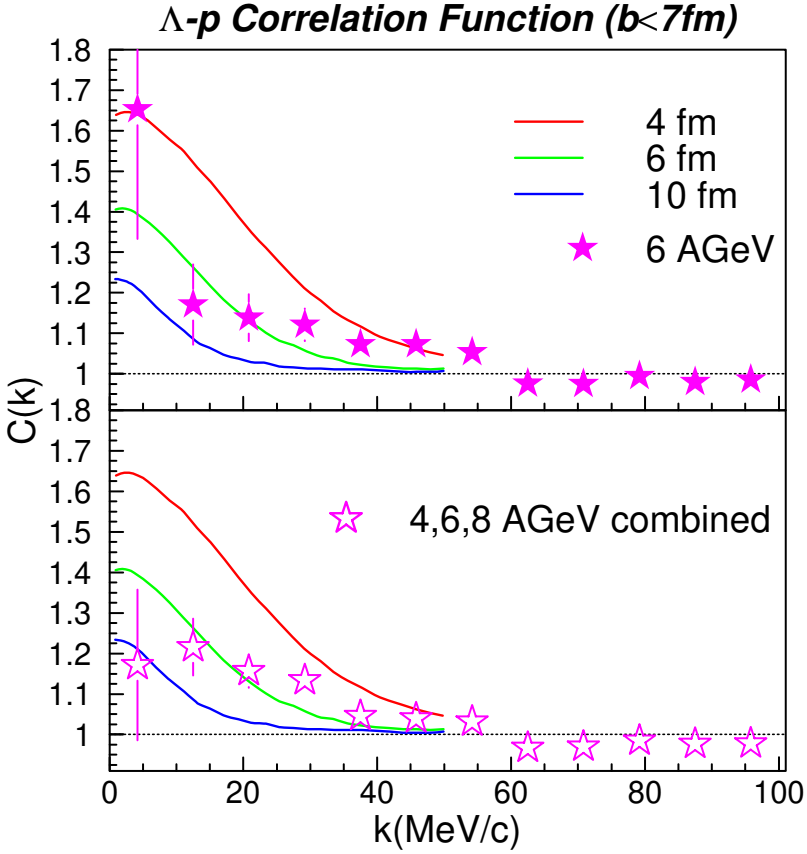
Λ-Proton correlations allow a more sensitive determination of the source size than p-p correlations

F.Wang, S. Pratt PRL 83 (1999) 3138

6 AGeV Λ-Proton Correlation

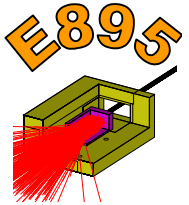






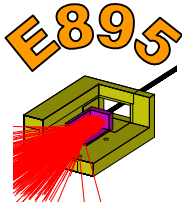
100000 Λ above background, 50000 Λ-p pairs
A weak correlation is observed indicating a large source size
This contradicts somewhat the radial flow result.

Conclusions



- Yields follow expected systematics
- Impact parameter dependence of yields non linear
- Λ sideward flow diminishes faster than proton sideward flow
- K^0_S exhibits growing anti flow
- K^+ show qualitatively similar flow behavior
- Explanation of kaon sideward flow needs kaon potential
- Sideward flow excitation functions should provide insight into density dependance of potentials
- Radial Flow may hint to different freeze out conditions for strange particles. of strange particles (or the Λ is very special)
- Λ p correlation show large source size
- How to reconcile radial flow and correlation result??

E895 Collaboration



- Stony Brook: N.N.Ajitanand, J.M.Alexander, P.Chung, M.L.Gilkes, R.L.McGrath, R.A.Lacey, J.Lauret, C. Law, C.Pinkenburg
- Ohio State: A.C.Das, M.A.Lisa
- LBNL: D.Best, T.Case, K.Crowe, G.Odyniec, D.L.Olson, G.Rai, H.G.Ritter, L.S.Schroeder, N.T.B.Stone, T.J.M.Symons
- UC Davis: M.Anderson, F.P.Brady, W.Caskey, D.Cebra, J.L.Chance, J.E.Draper, M.Heffner, J.Klay, J.L.Romero, L.Wood
- Kent State: D.Keane, M.Justice, H.Liu, S.Wang, S.Panitkin, R.Witt
- CMU: M.Kaplan, Z. Milosevich, J.Whitfield
- BNL: S.Gushue
- Columbia: B.Cole
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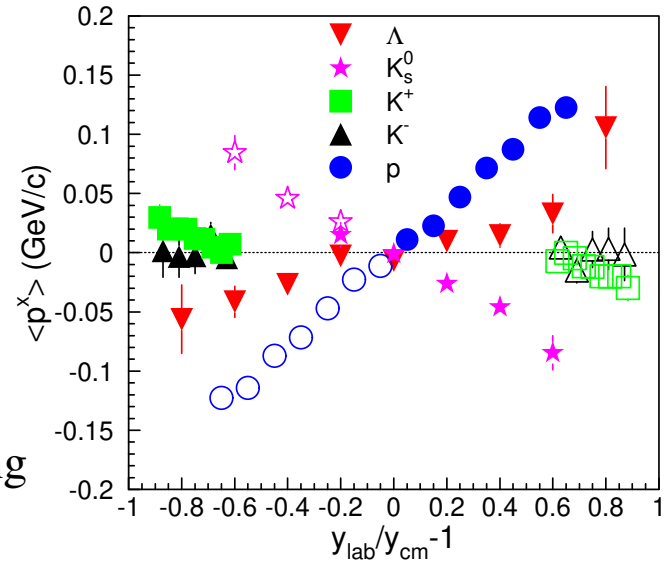
- Auckland: D. Krofcheck
- St. Mary's College: J.C.Kintner
- Harbin Institute : L.Huo, Y.M.Liu, W.N.Zhang

6 AGeV Strangeness Sideward Flow with E895



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