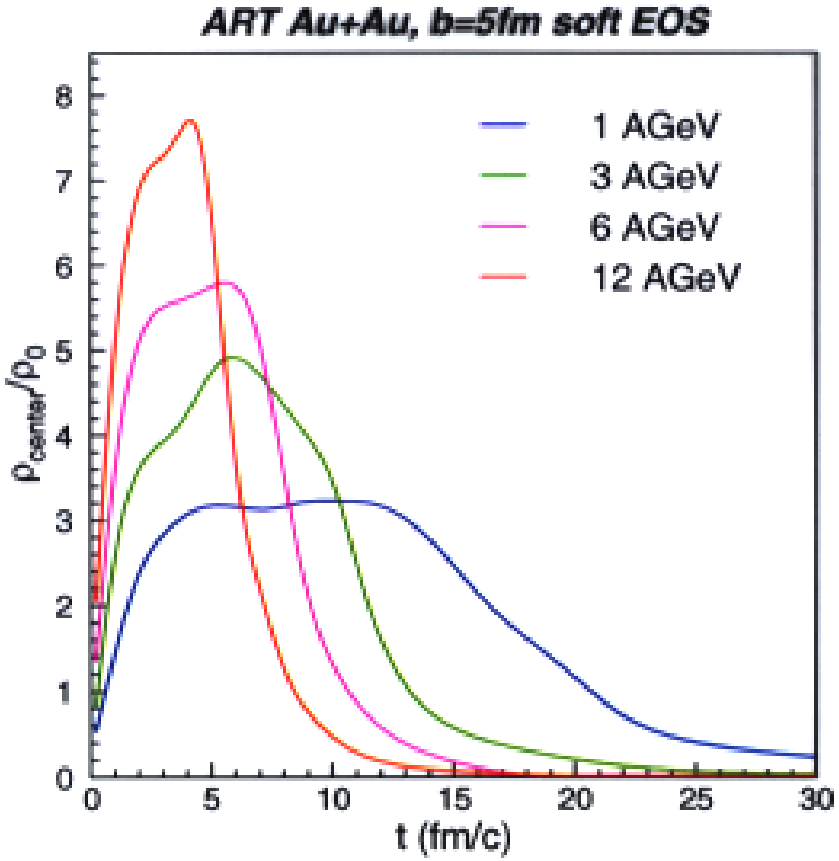
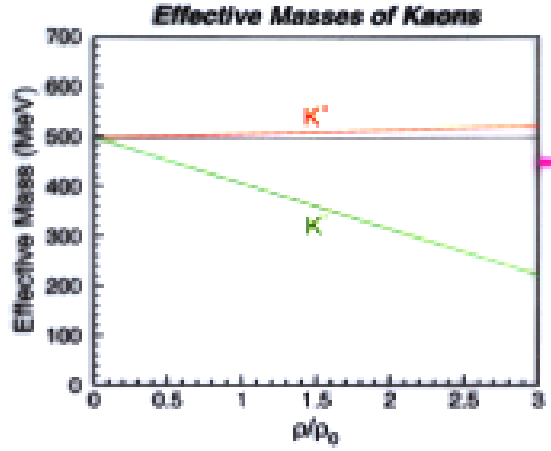
Production and collective behavior of strange particles in Au + Au collisions at 2-8 AGeV

C. Pinkenburg for the E895 Collaboration

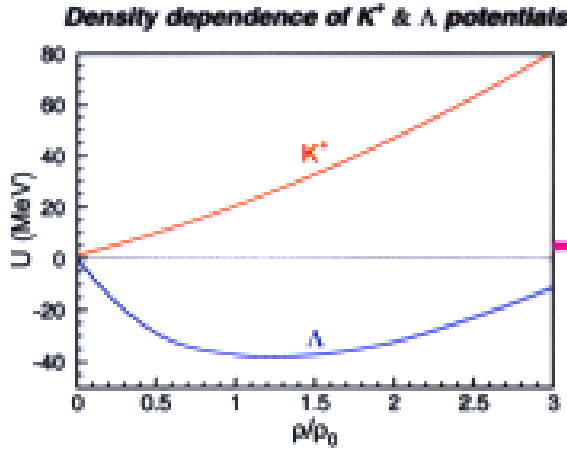
- Calculations
- E895 experimental setup
- Strangeness with E895
- Yields
- Sideward and Radial Flow
- Λ-p correlation
- Conclusions

Baryon Density





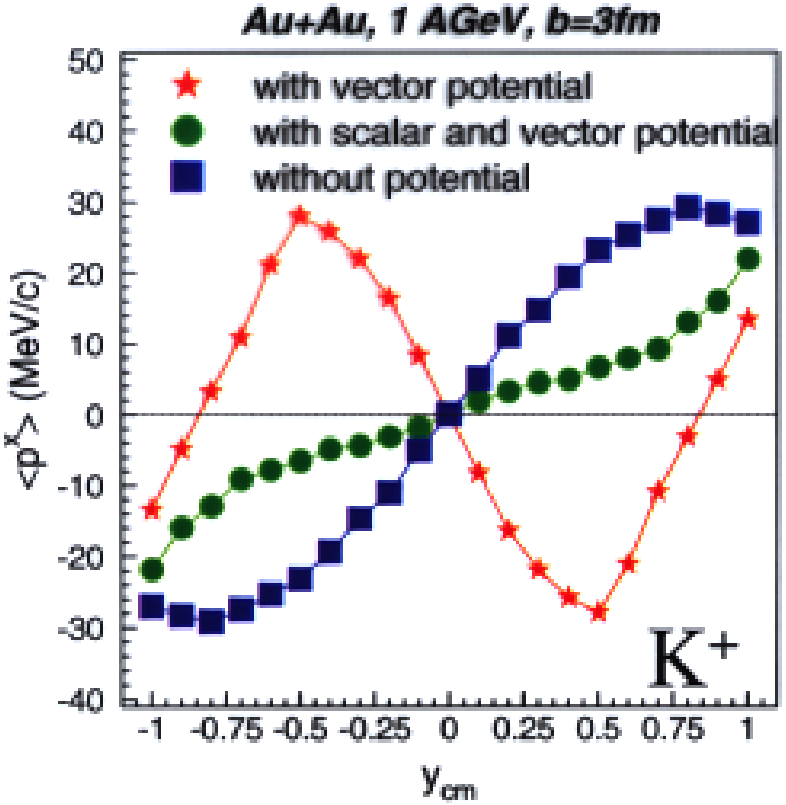
E895

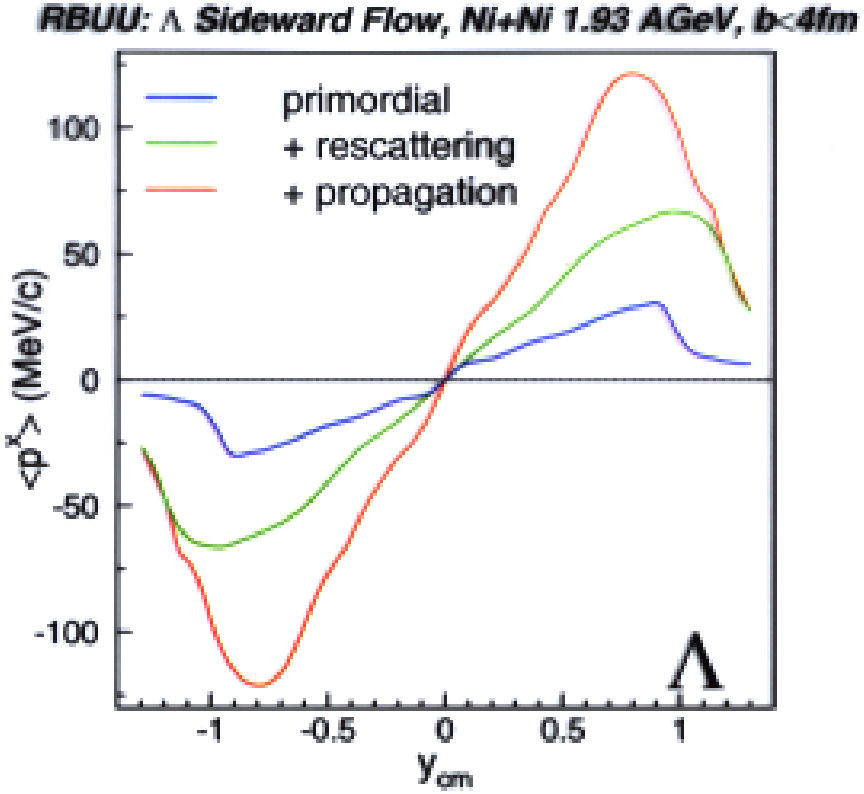


E895

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

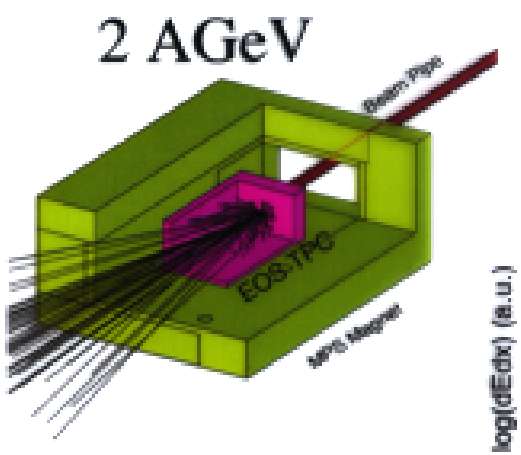
Strange Hadron Flow

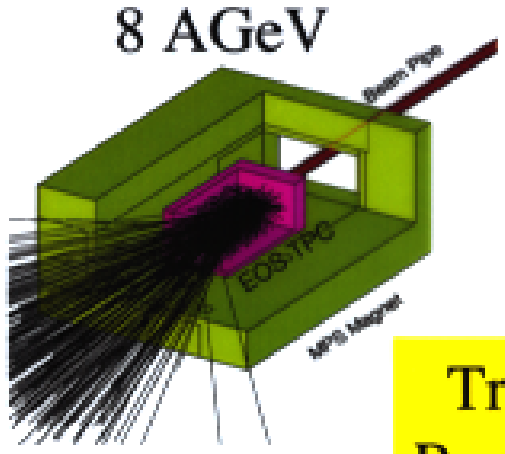


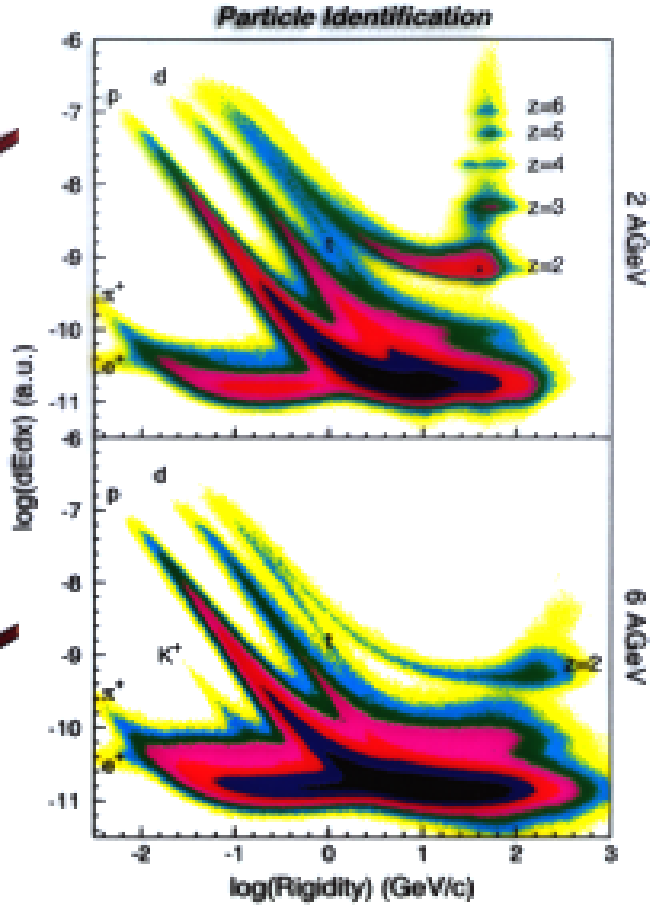


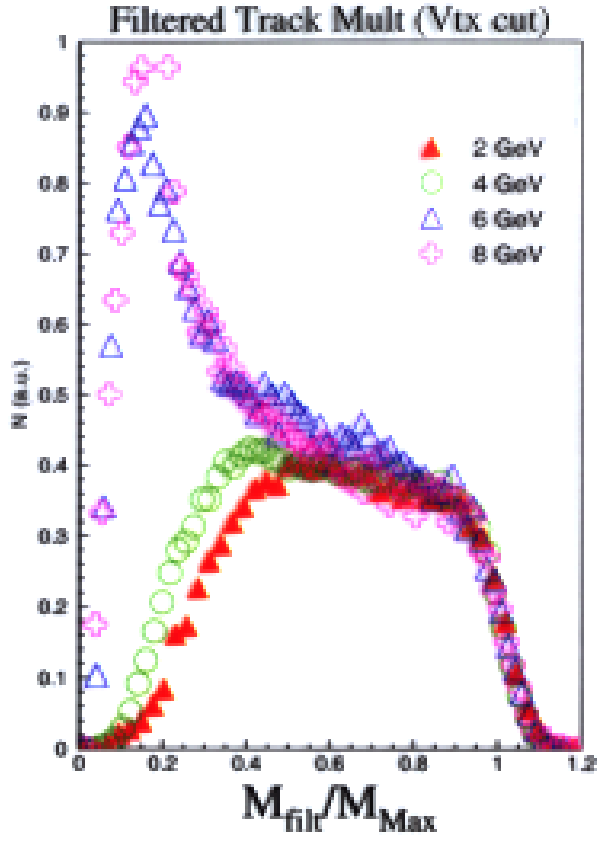
Sideward Flow of strange Particles is very sensitive to Potentials
Direction of Kaon Flow gives already some insight
Magnitude of the Λ Flow depends on Λ potential

E895 Experimental Setup



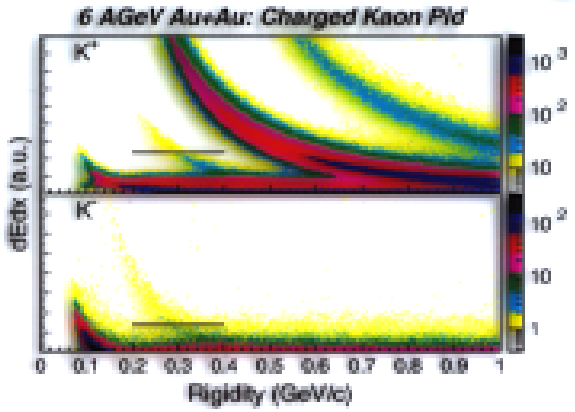


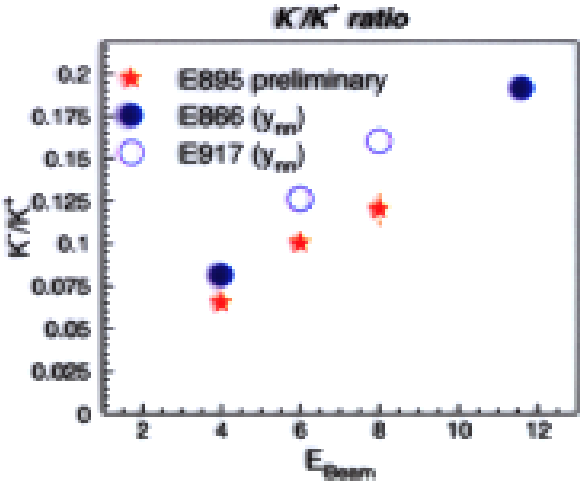


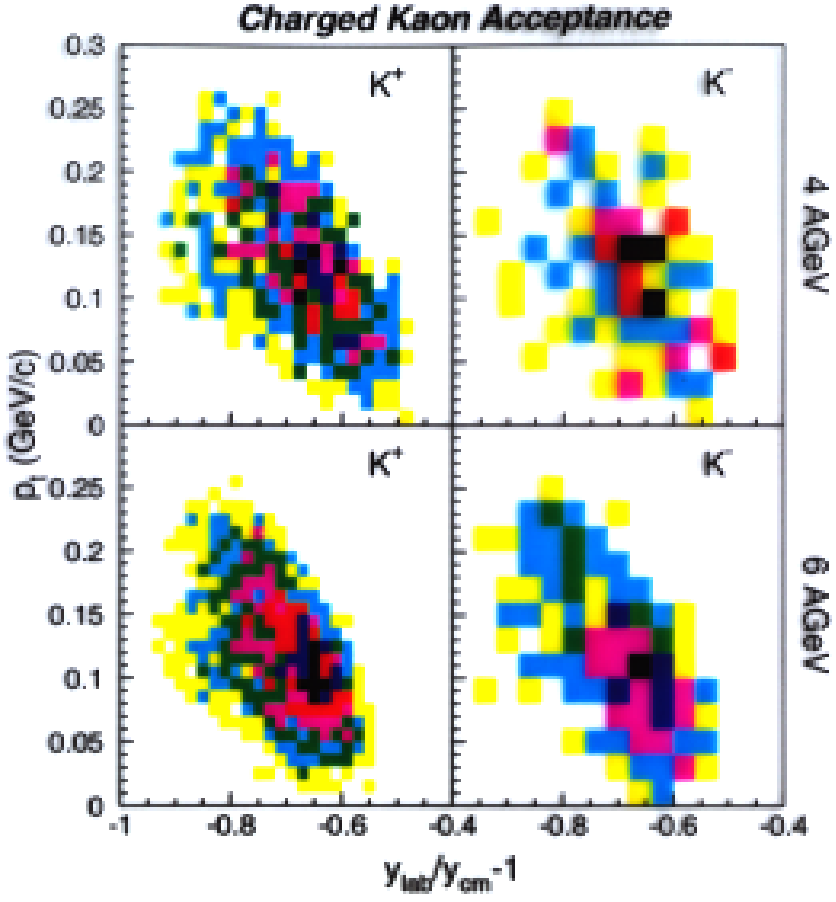


Track/Hit Density is a challenge (higher than STAR)
Particle Id via Energy Loss and Curvature in Mag Field
Impact Parameter Determination via Track Multiplicity

Charged Kaon PId







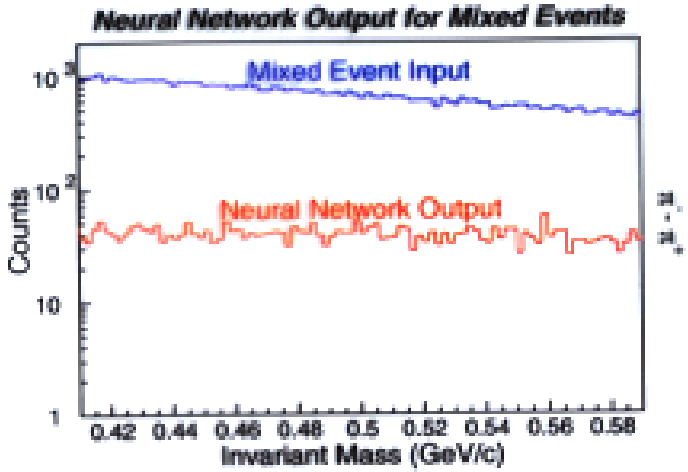
PId of Charged Kaons limited to low p_t and backward Rapidity

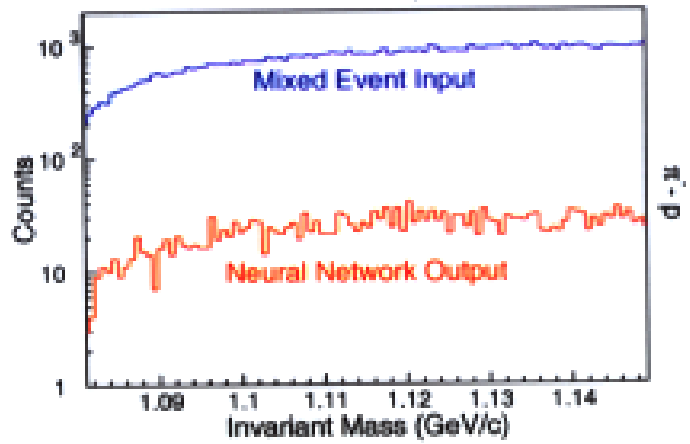
Uncorrected Ratios consistent with E866/E917 (different p_t/y range!)

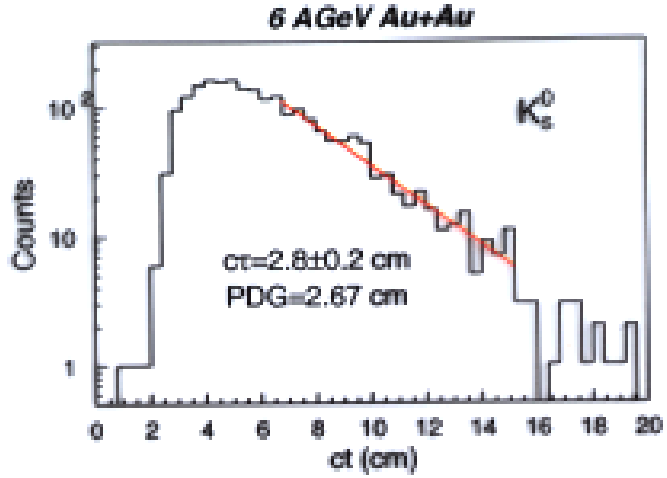
Ratios consistent ⟶ negligible Pion contamination

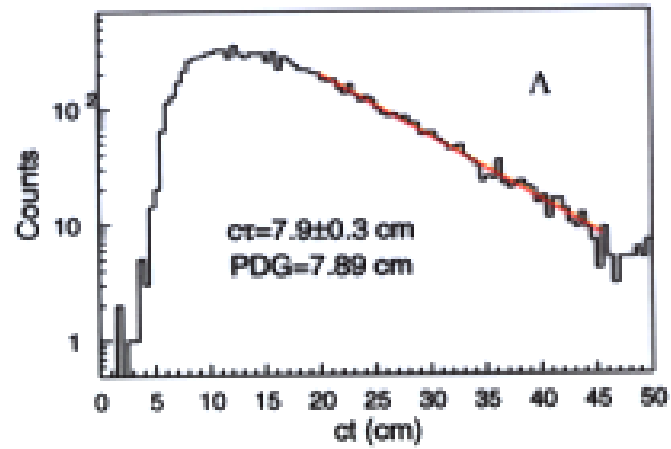
Comparisons: Beware of E895 p_t/y acceptance!

V0 Reconstruction



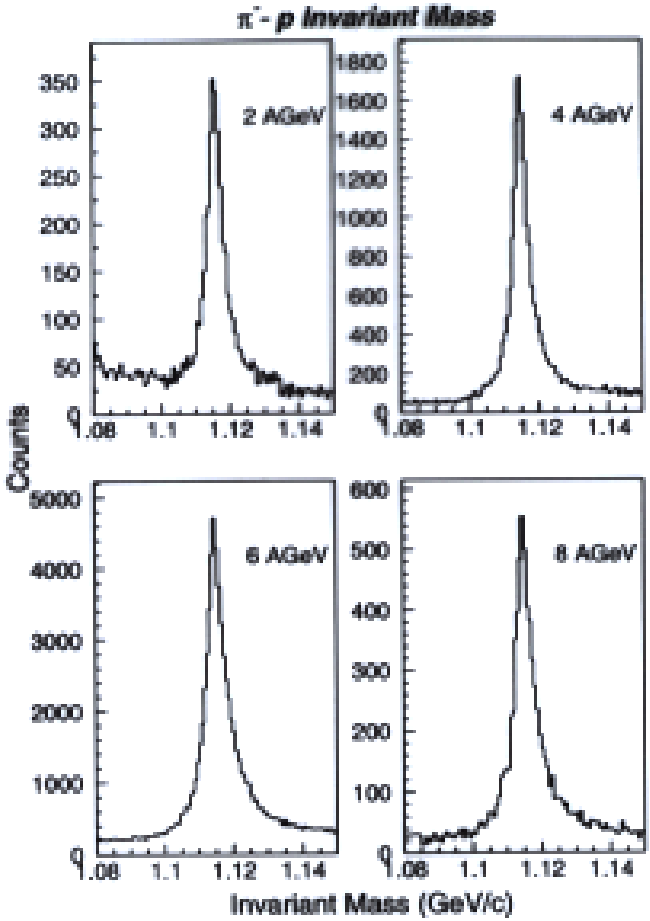


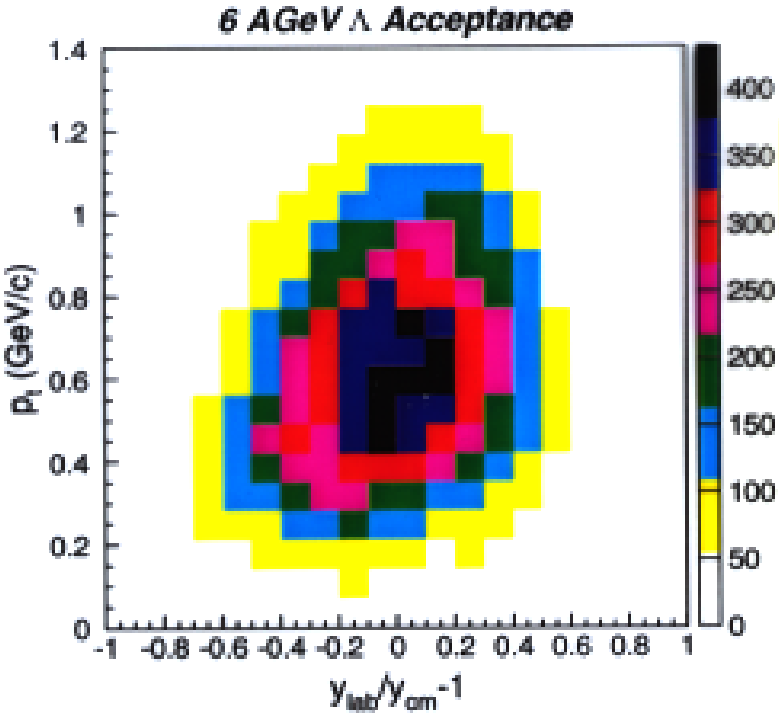




V0 reconstruction accomplished by neural network
Acceptance Corrections derived from embedded V0's
No artificial mass peaks in mixed pairs
cτ value is very close to PDG value

Λ Reconstruction

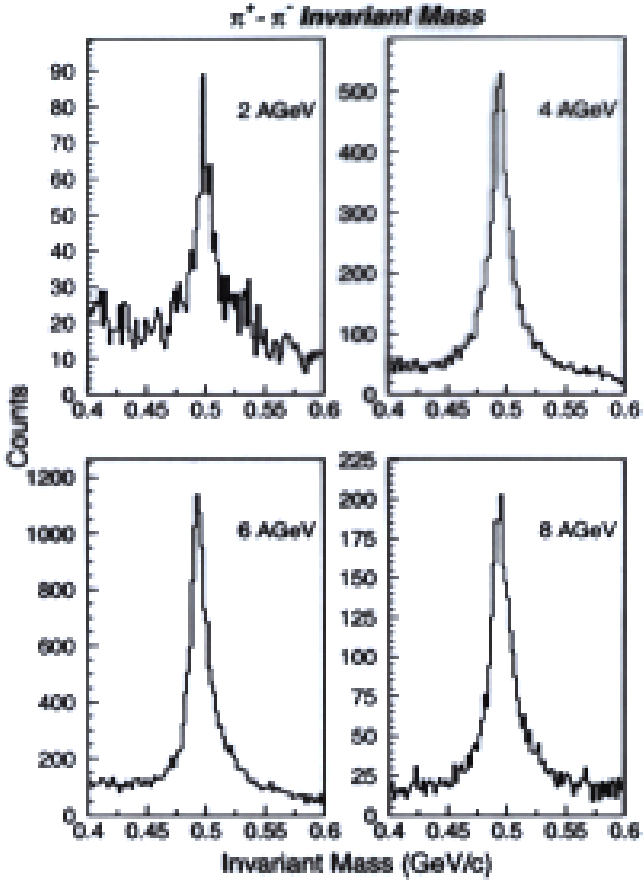


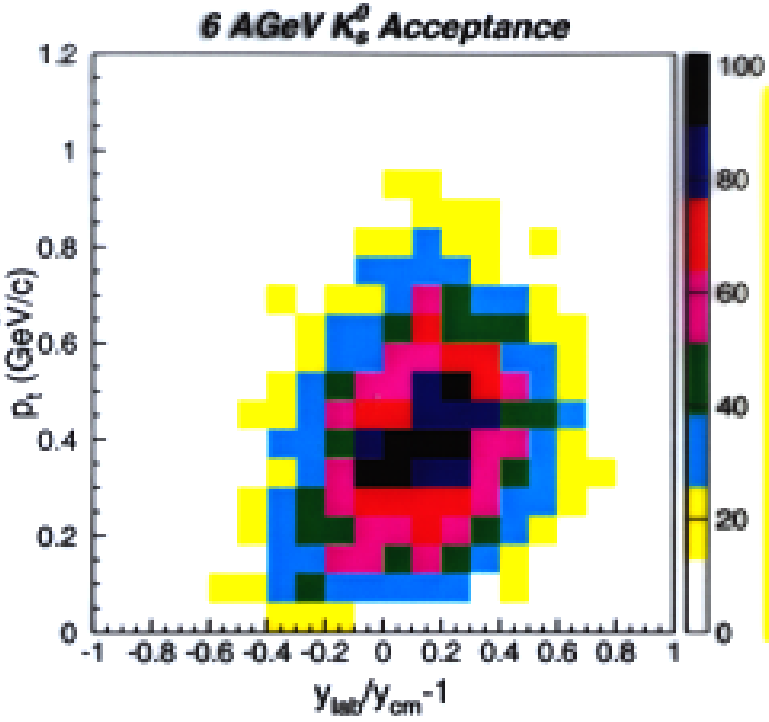


Good Peak to Background
Large uniform acceptance
some low p_t losses

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

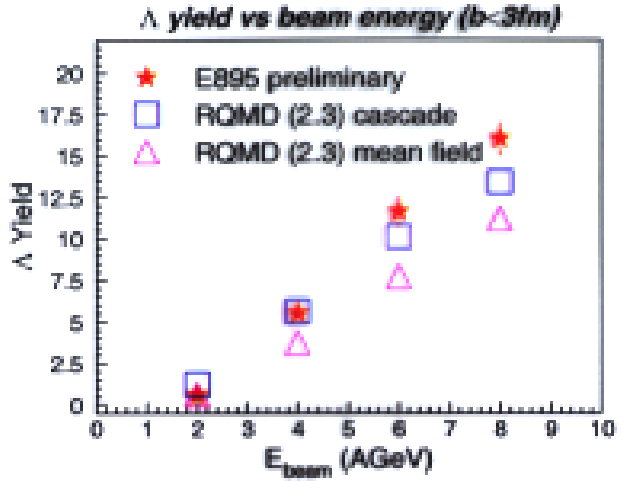


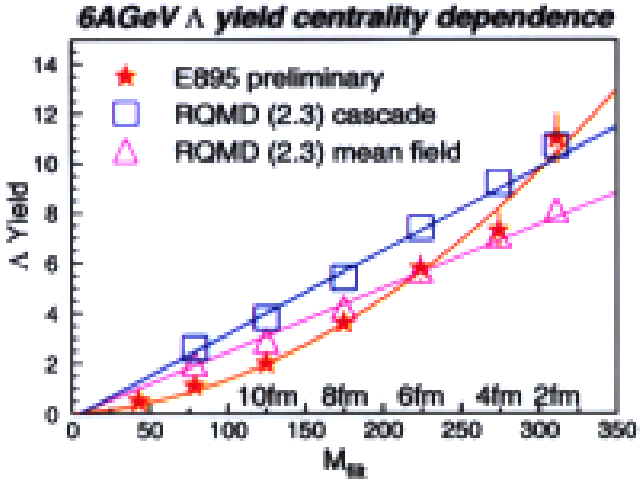


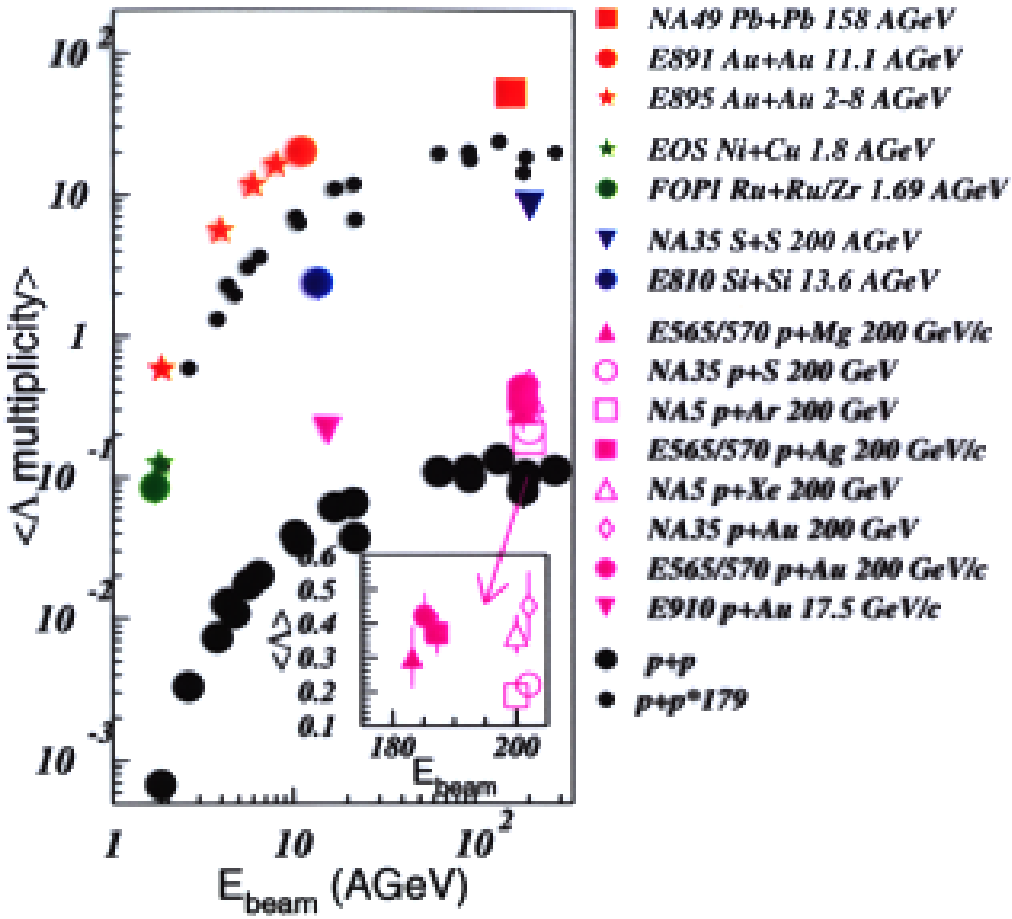
Good Peak to Background
Large uniform acceptance
losses at backward rapidity

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

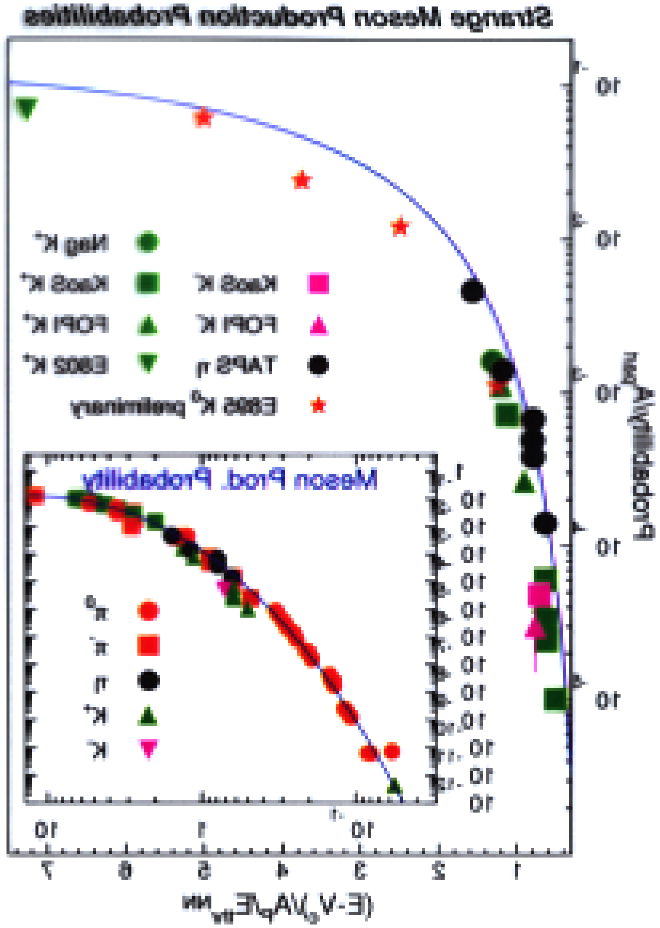




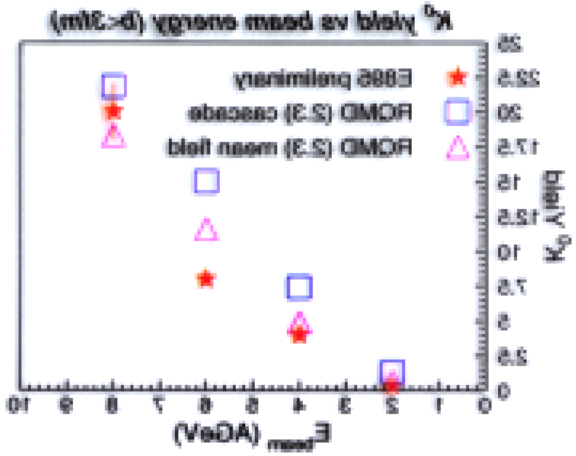


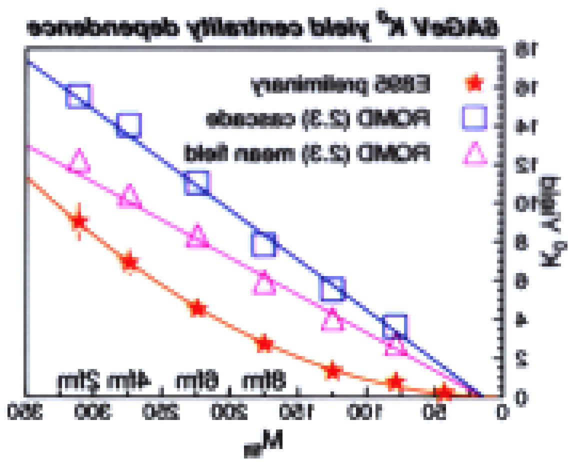
RQMD reproduces the Λ multiplicity in central events
but fails in the non linear Impact Parameter dependency
Λ yields follow expected systematics, enhancement compared to p-p

K^0_S Yields



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



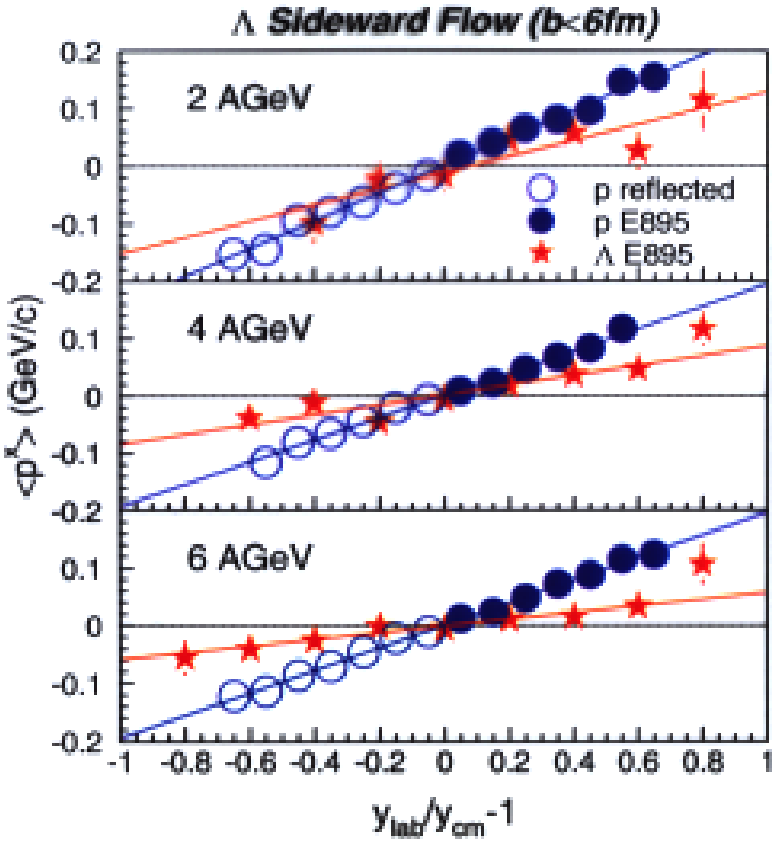


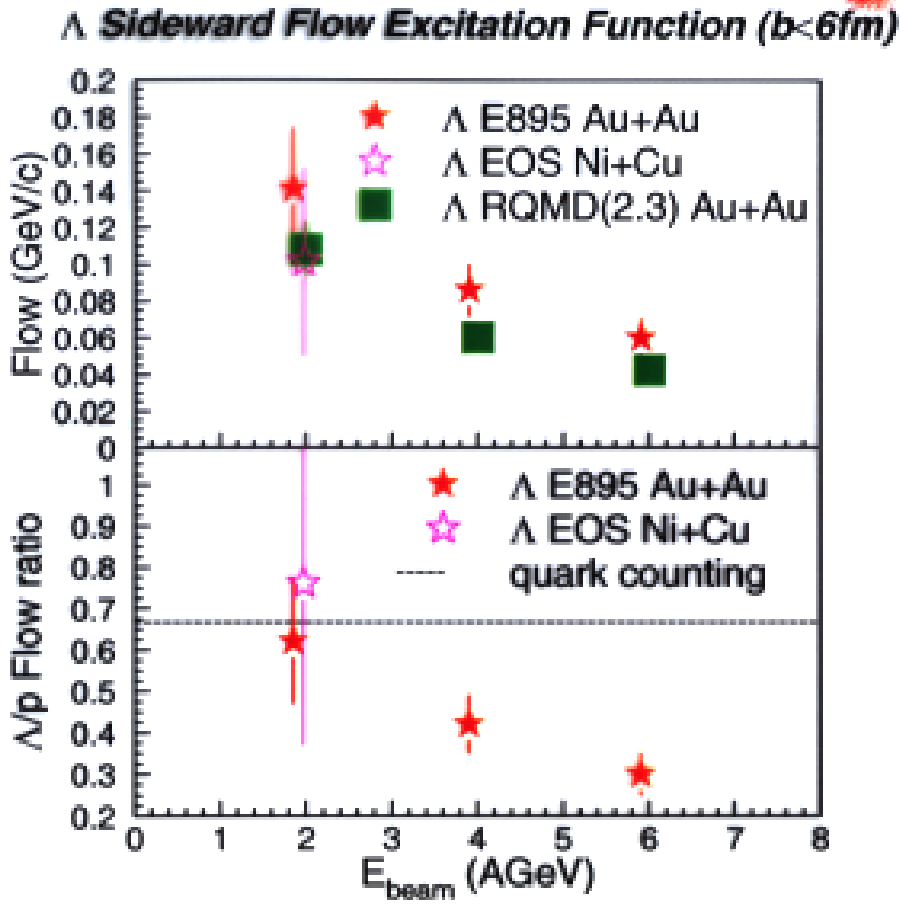
RQMD overpredicts K^0_S production

similar non linear centrality dependence to E802 for K^+/K^-

K^0_S follow Meson Production systematics

Λ Sideward Flow





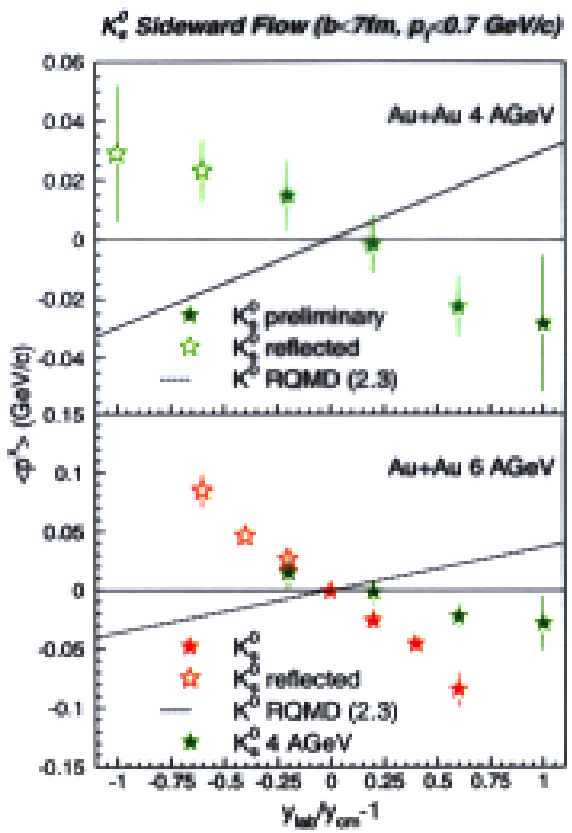
Λ sideward flow smaller than proton flow and diminishes faster

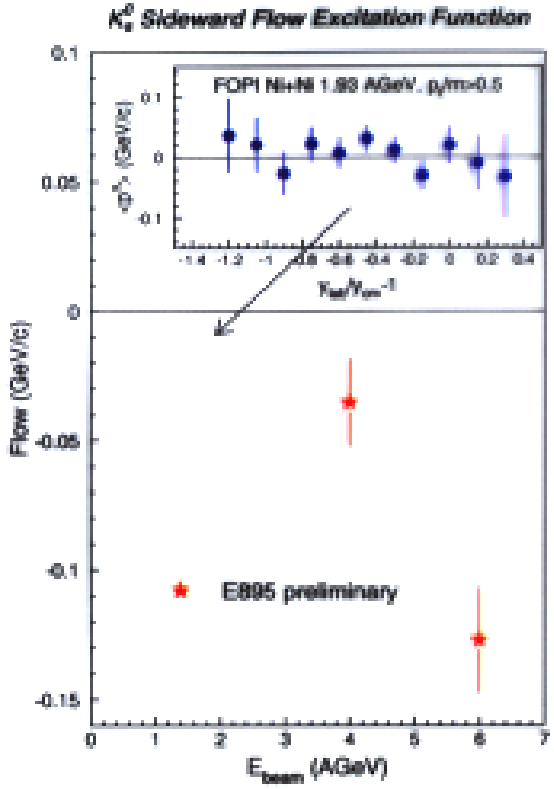
Λ sideward flow increases with system size

Flow ratio deviates from 2/3 with increasing beam energy

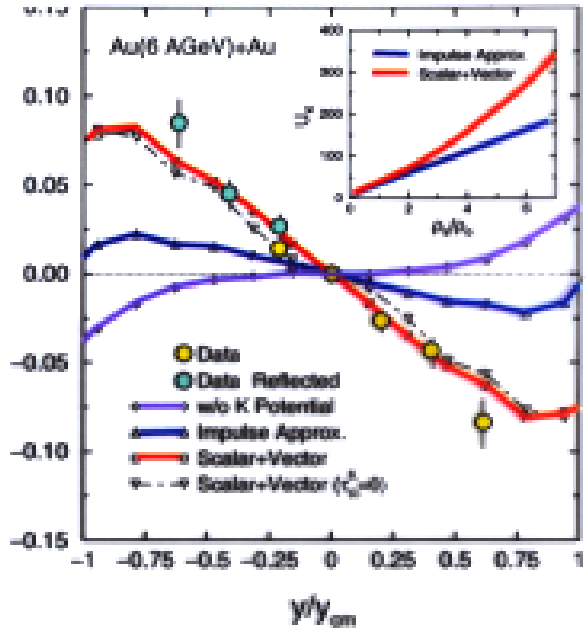
Density dependence of Λ potential?

K^0_S Sideward Flow





J. Ritman ZPA 352 (1995) 355



S. Pal PRC 62 (2000), 061903

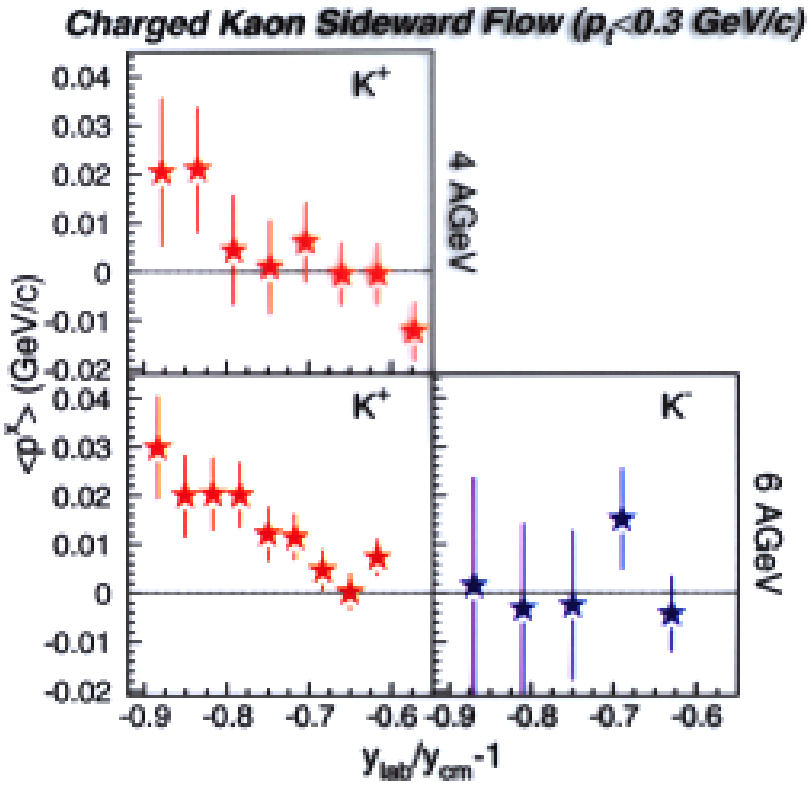
K^0_S exhibits anti flow pattern in contrast to RQMD

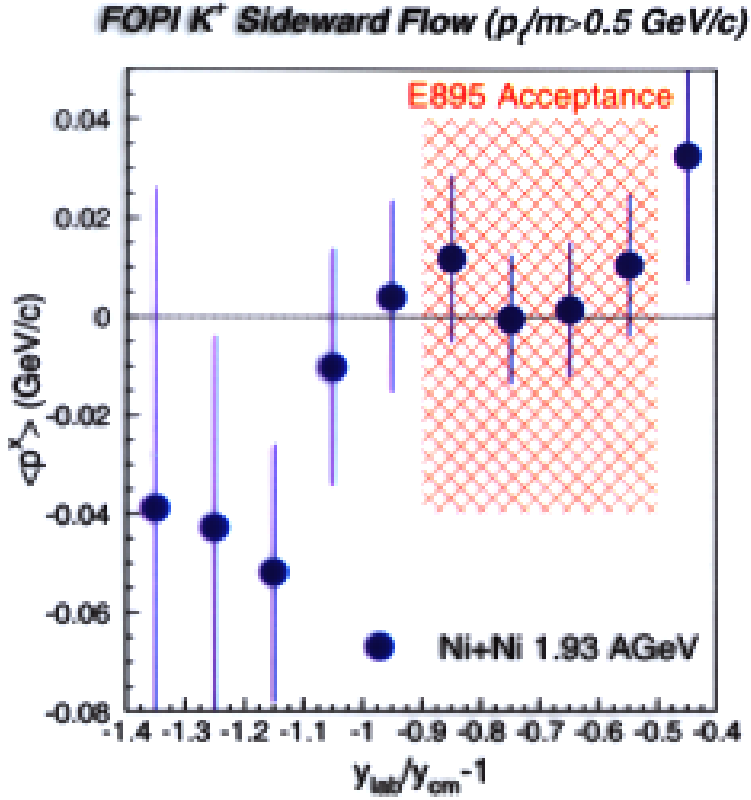
Anti flow increases with beam energy!

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

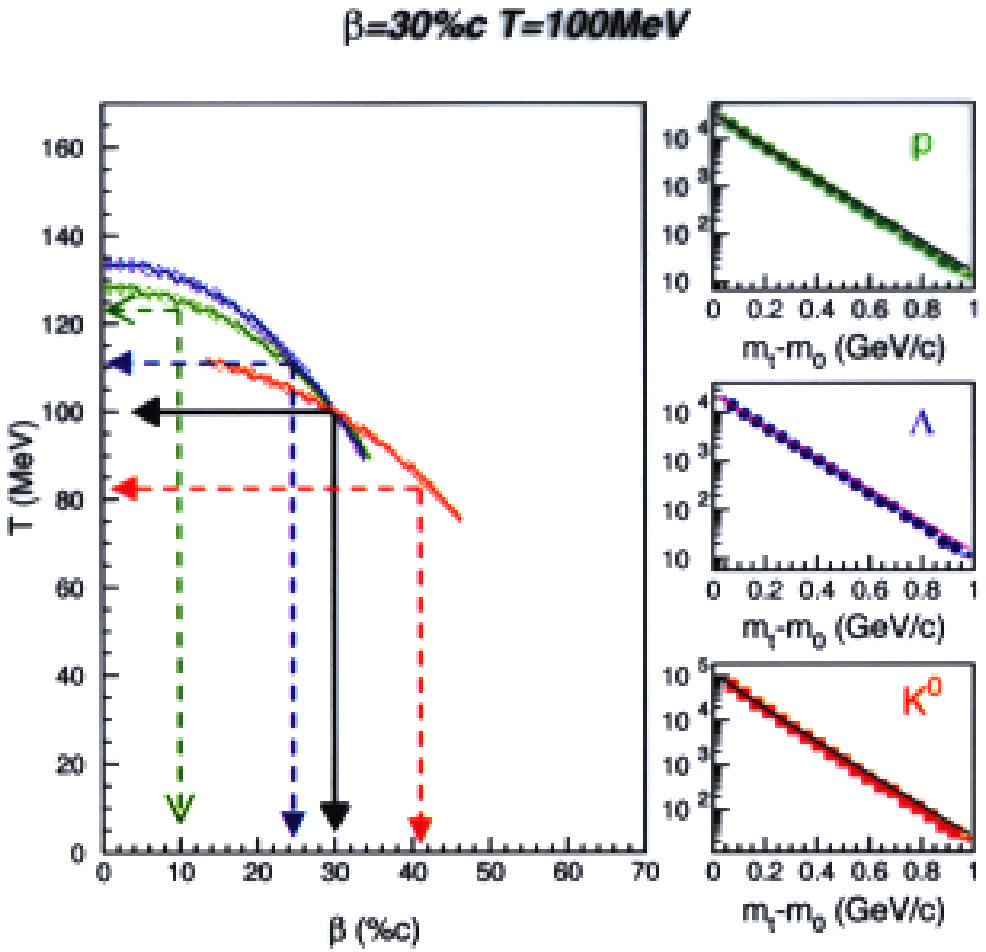




J. Ritman ZPA 352 (1995) 355

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

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

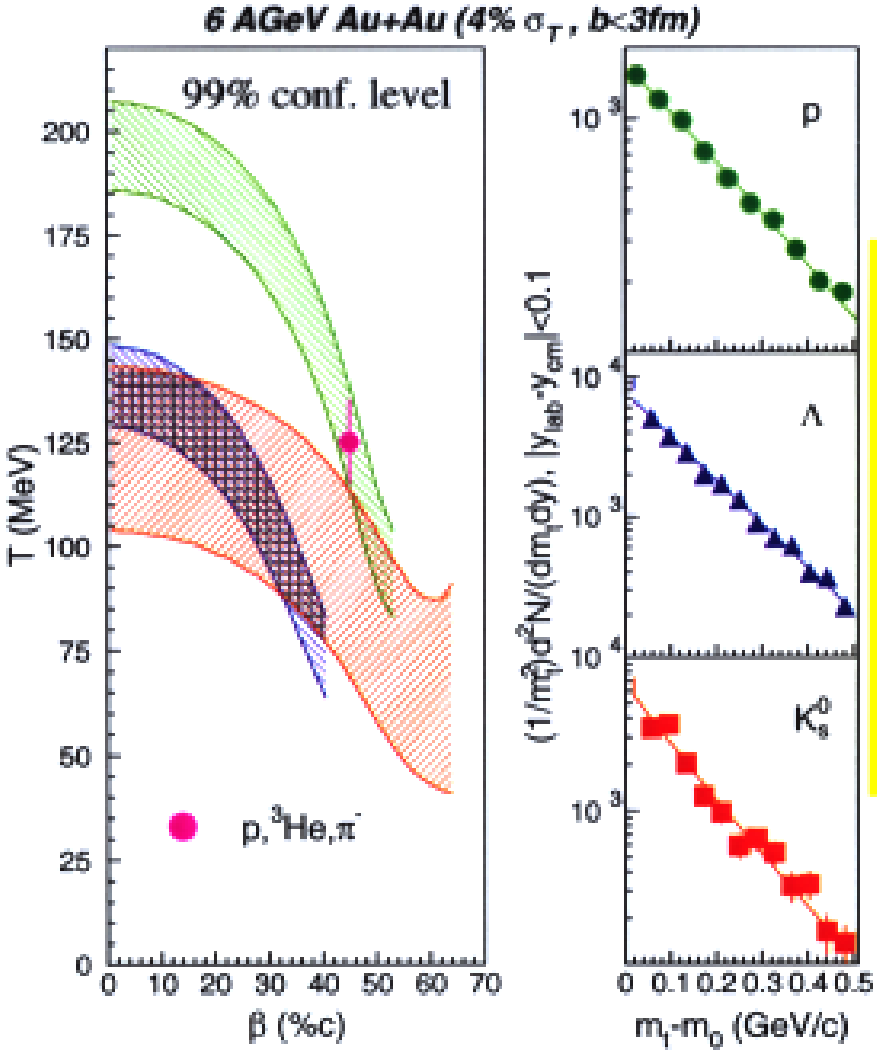
$$\alpha = \beta\gamma p/T \qquad \gamma = \sqrt{1-\beta^2}$$

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

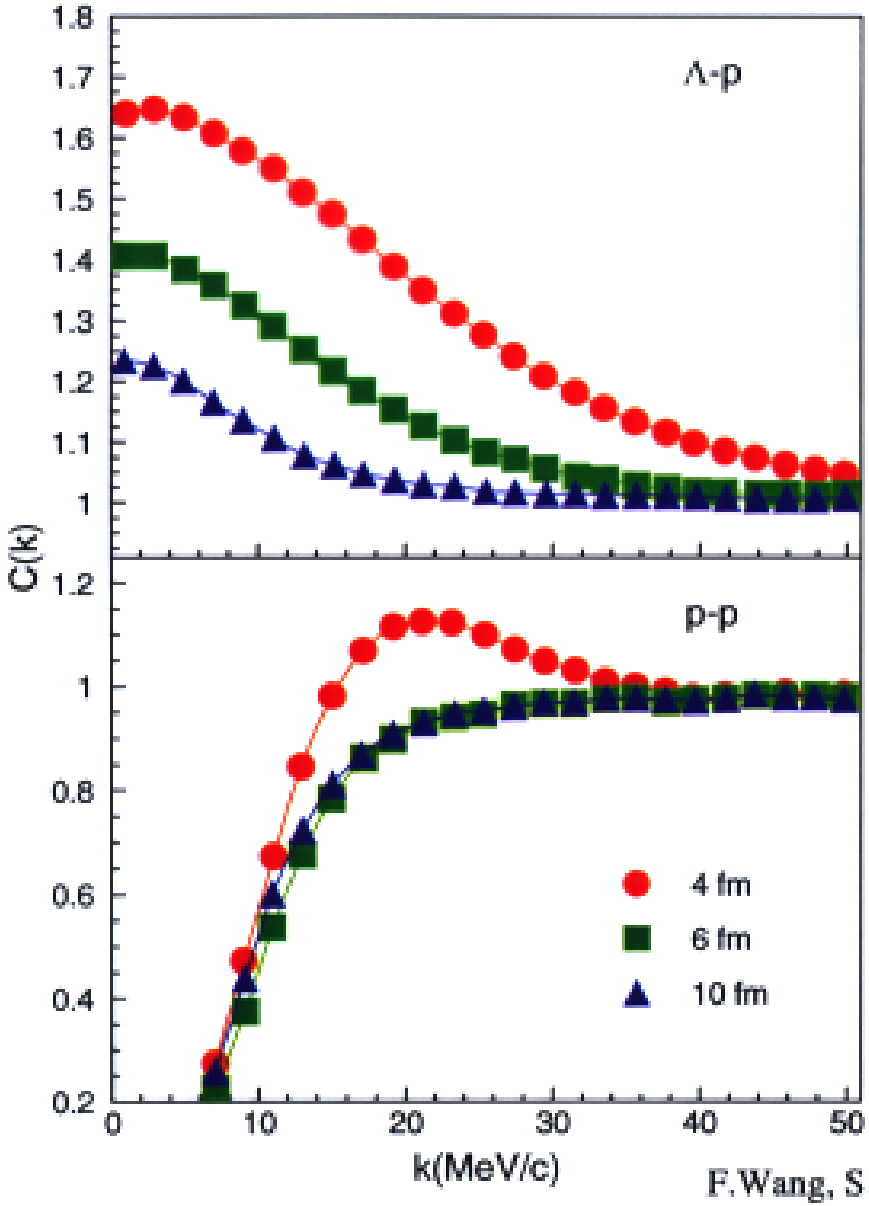
Consistency check: The input parameters of a simulated source are recovered from the overlap of the S-R fits to the particle spectra
Assumption: We don't live in the "dashed" world

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^0_S

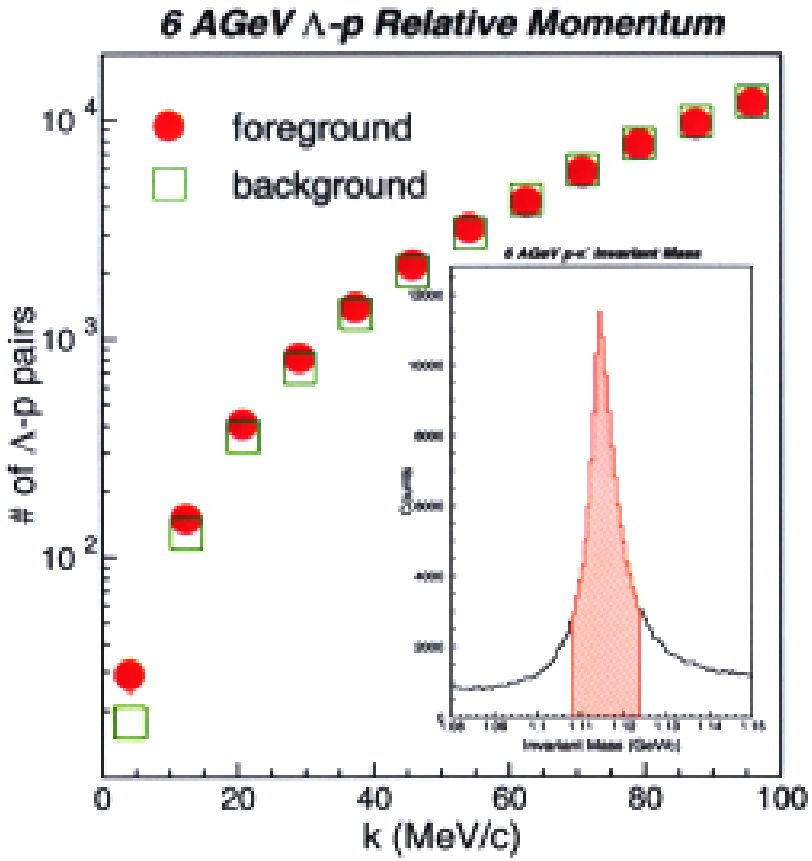
Λ Proton Correlation

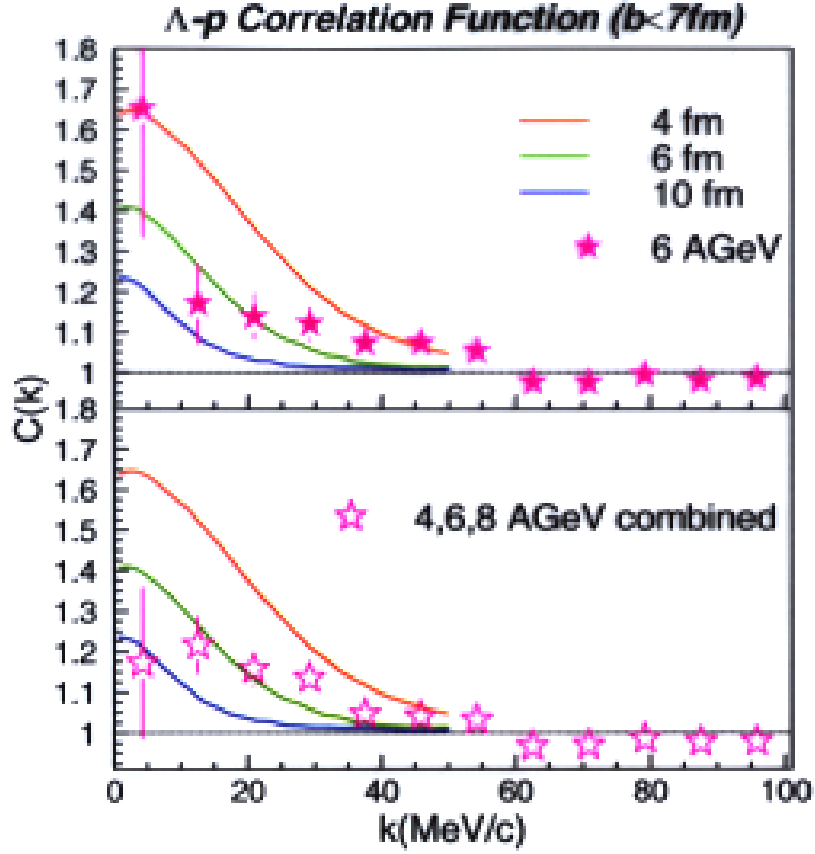


Λ-Proton correlations allow a more sensitive determination of the source size than p-p correlations

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

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6 AGeV Strangeness Sideward Flow with E895