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

$\text{ART Au+Au, } b=5\text{fm soft EOS}$

Strong Density Dependence of Kaon and $\Lambda$ Potentials
E895 probes $\rho/\rho_0 \approx 3-6$
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
PlD of Charged Kaons limited to low $p_t$ and backward Rapidity
Uncorrected Ratios consistent with E866/E917 (different $p_t/y$ range!)
Ratios consistent $\rightarrow$ negligible Pion contamination
Comparisons: Beware of E895 $p_t/y$ acceptance!
V0 reconstruction accomplished by neural network
Acceptance Corrections derived from embedded V0's
No artificial mass peaks in mixed pairs
ct value is very close to PDG value
Good Peak to Background
Large uniform acceptance
some low $p_t$ losses
**K^0_s Reconstruction**

- **π^+ - π^- Invariant Mass**
  - 2 AGeV
  - 4 AGeV

- **6 AGeV K^0_s Acceptance**

- **Good Peak to Background**
  - Large uniform acceptance losses at backward rapidity

<table>
<thead>
<tr>
<th>E_{Beam}</th>
<th># of K^0_s</th>
<th>FWHM</th>
<th>K^0_s rec/evt</th>
<th>K^0_s rec eff</th>
<th>K^0_s Mult</th>
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</thead>
<tbody>
<tr>
<td>2 AGeV</td>
<td>556</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>4 AGeV</td>
<td>5537</td>
<td>18 MeV</td>
<td>0.067±0.002</td>
<td>3.4±0.2%</td>
<td>2.0±0.1</td>
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<tr>
<td>6 AGeV</td>
<td>11295</td>
<td>14 MeV</td>
<td>0.060±0.001</td>
<td>1.5±0.1%</td>
<td>4.0±0.3</td>
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<tr>
<td>8 AGeV</td>
<td>2314</td>
<td>17 MeV</td>
<td>0.089±0.006</td>
<td>0.9±0.1%</td>
<td>10±1</td>
</tr>
</tbody>
</table>
RQMD reproduces the $\Lambda$ multiplicity in central events but fails in the non linear Impact Parameter dependency. $\Lambda$ yields follow expected systematics, enhancement compared to p-p.
ROMD overpredicts \( K^0 \) production

Similiar non linear centrality dependence to E807 for \( K^+ \) vs \( K^- \)

\( K^0 \) 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?
$K_S^0$ exhibits anti flow pattern in contrast to RQMD
Anti flow increases with beam energy!
ART requires Kaon potential to reproduce the 6 AGeV $K_S^0$ data
Excitation function should give handle on density dependence of K-Pot.
K$^+$ seem to follow the K$^0_S$ pattern: increasing anti flow with $E_{\text{Beam}}$

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

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

\[\alpha = \beta p / T\]

\[\gamma = \sqrt{1 - \beta^2}\]

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 $\Lambda$ shows no overlap in $\beta/T$ space excluding a common freezeout of proton and $\Lambda$
The overlap of non strange particles is consistent with the $K_S^0$
$\Lambda$ Proton Correlation

$\Lambda$-Proton correlations allow a more sensitive determination of the source size than p-p correlations

F. Wang, S. Pratt PRL 83 (1999) 3138
100000 $\Lambda$ above background, 50000 $\Lambda$-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
- $\Lambda$ sideward flow diminishes faster than proton sideward flow
- $K_S^0$ 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 $\Lambda$ is very special)
- $\Lambda$ p correlation show large source size
- How to reconcile radial flow and correlation result??
E895 Collaboration

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