Strange Baryon Production at RHIC

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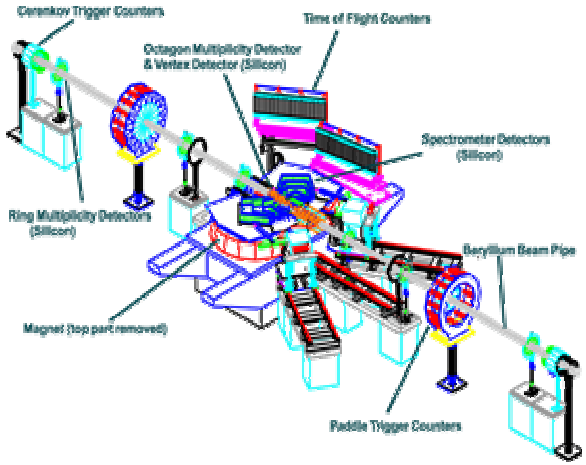
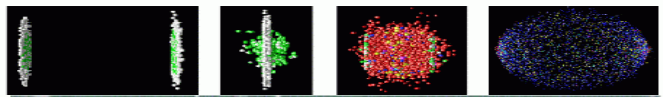
1. Introduction
2. Strangeness measurement and results
   - > results of bulk properties
     (yield, freeze-out T, event anisotropy)
   - > results from intermediate P_T (<10 GeV/c) on
     Nuclear modification factor of Λ and Ks.
3. Summary

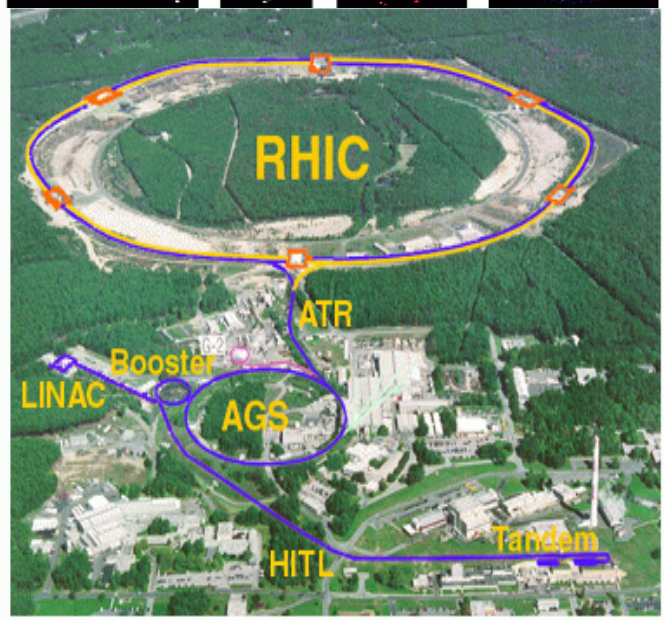
RHIC

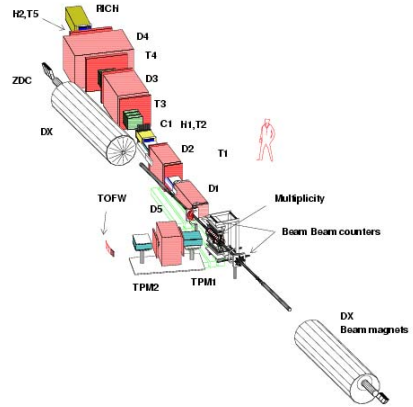


PHOBOS

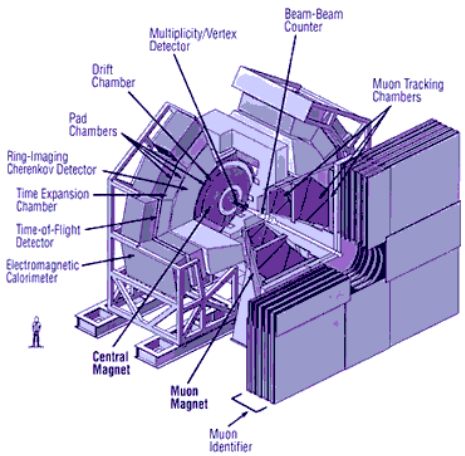
100 GeV/nucleon
(p, d,…Au)



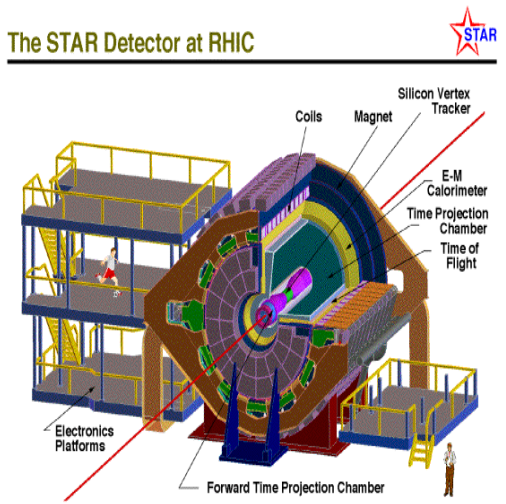




BRAHMS



PHENIX



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Introduction : Physics Goal of RHIC

Identify and study the properties of the matter with partonic degree of freedom:

- **nuclear effects in the intermediate p_T region**
  - initial conditions;
  - parton energy loss due to interaction of dense matter.

- **bulk properties**
  - collision dynamics;
  - collective motion with the partonic degree of freedom;
  - early thermalization (c-quark).

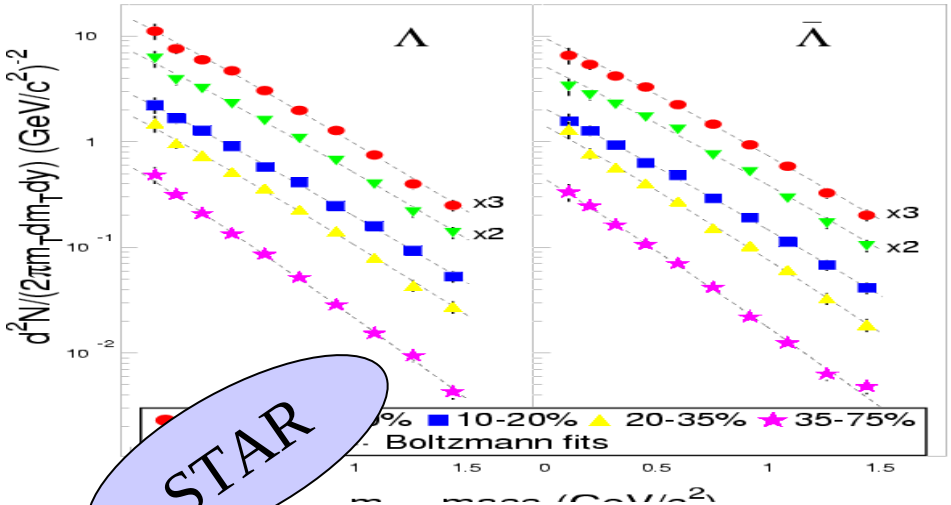
Strange particles can be good probes to both !!!

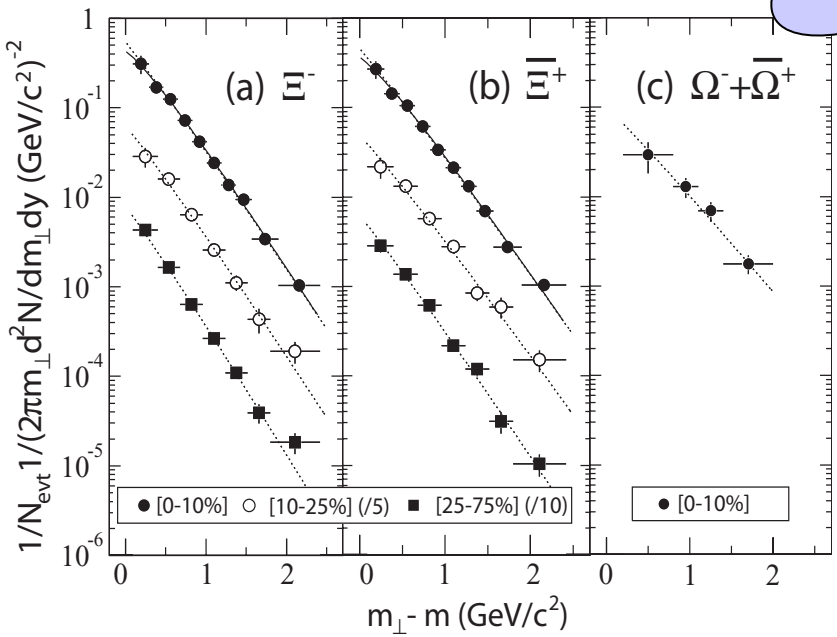
Strange Baryon Measurement at RHIC (130 GeV)

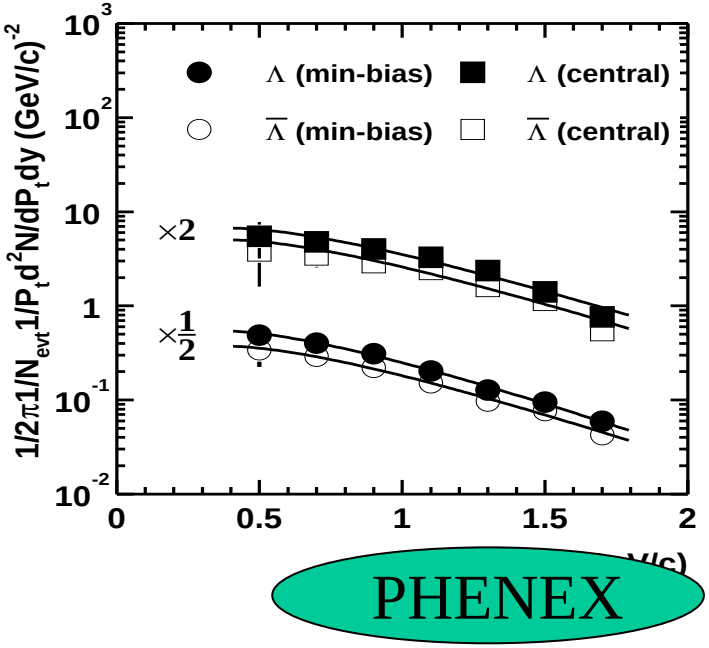
$\Lambda \longrightarrow p + \pi^-$

$\Xi^- \longrightarrow \Lambda + \pi^-$

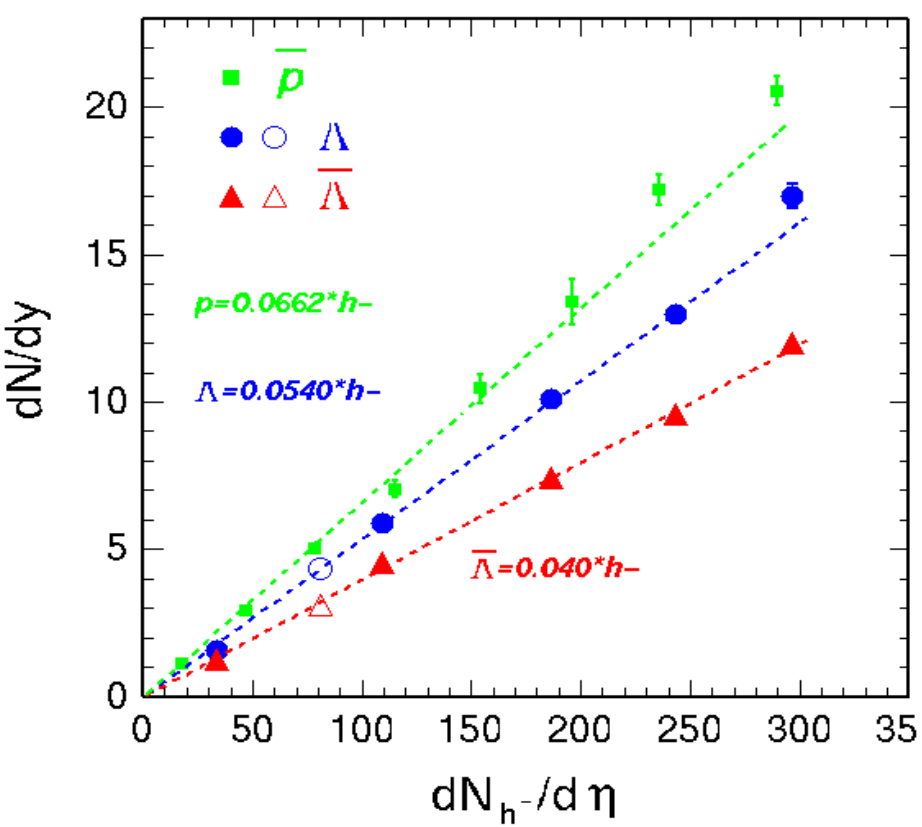
$\Omega^- \longrightarrow \Lambda + \kappa^-$

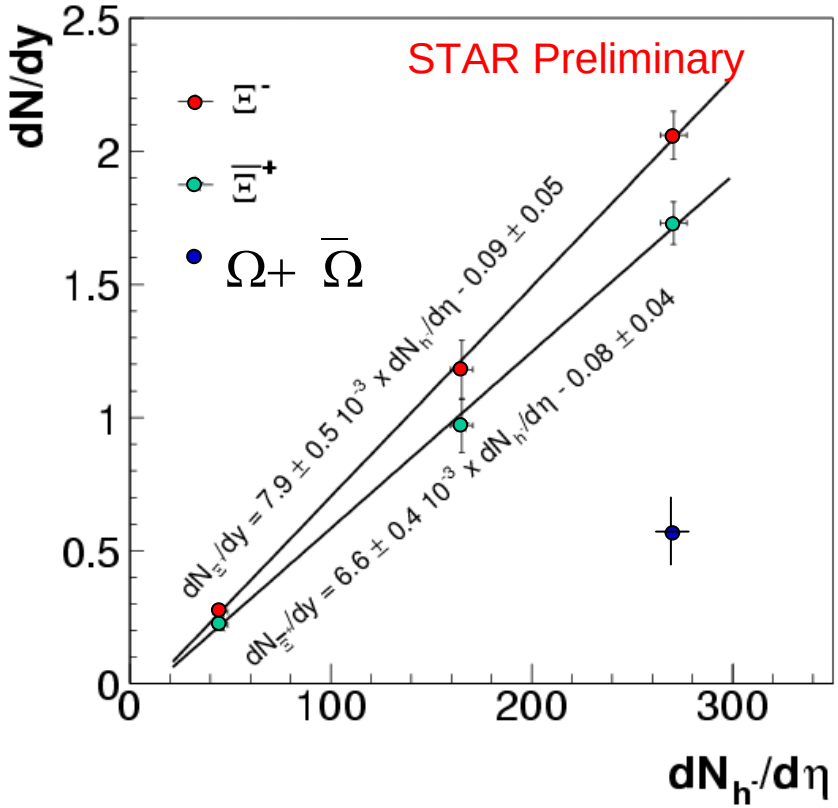






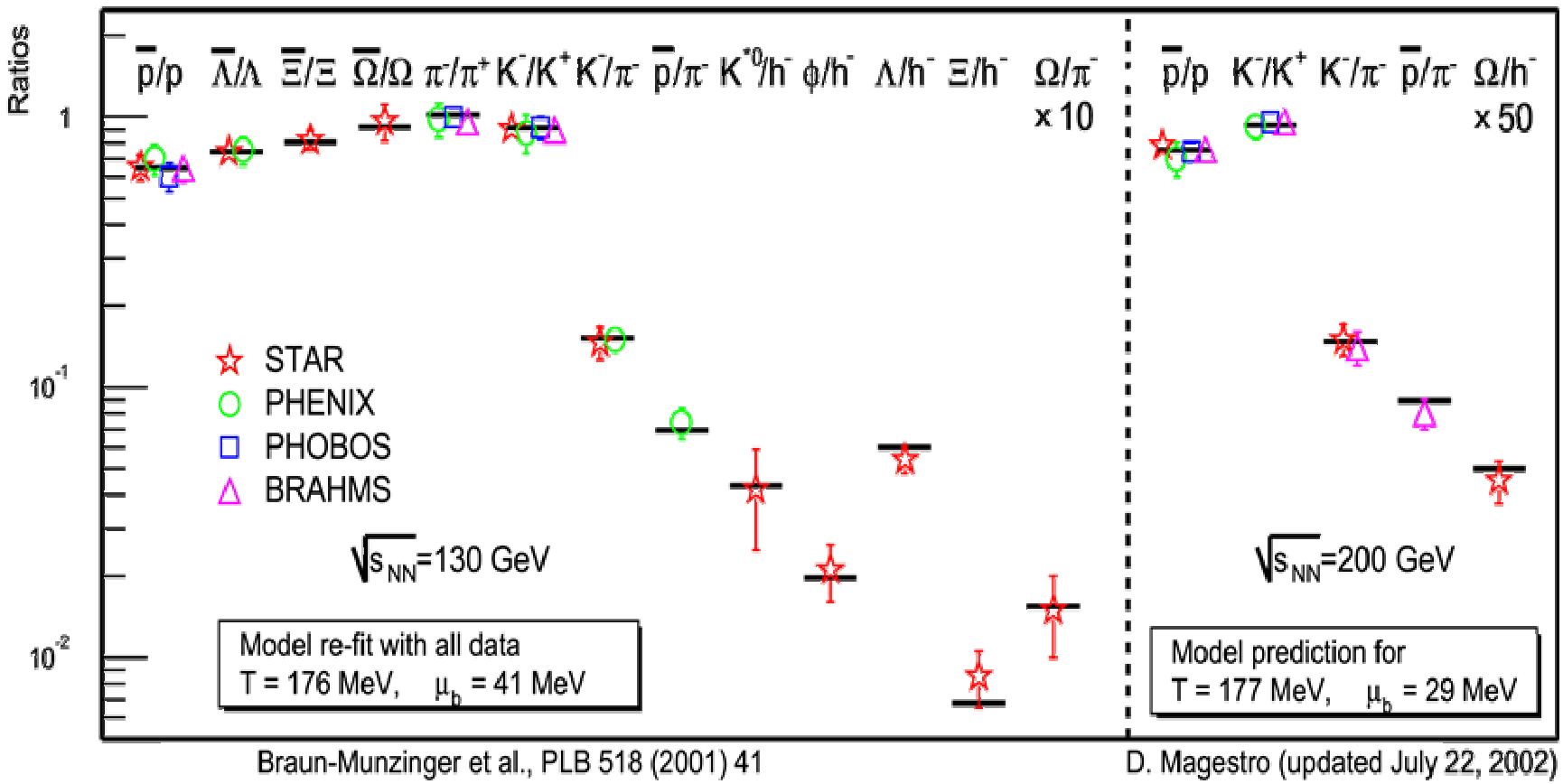
Strange Baryon Yield at Mid-rapidity (130 GeV)





Nearly linear dependence on number of charged particles

Ratio of Particle Yield and Statistic Model: T, μ_b γ_s



(**integrated yield dominated by low pt particles)**

One of the bulk properties: T_{ch} ~ 176 MeV

*(***Chemical freeze-out: particle's yield remain unchanged since** *)*

Strange Baryon and Hydro-dynamic Fit (130 GeV)

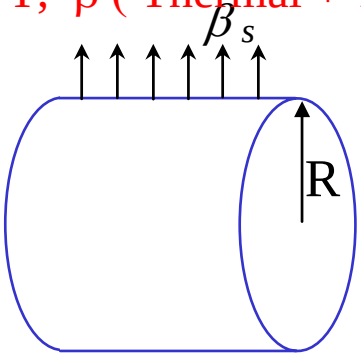
$$\frac{dn}{m_T\, dm_T} \propto \int_0^R r\, dr\, m_T\, K_1\left(\frac{m_T \cosh\rho}{T}\right) I_0\left(\frac{p_T \sinh\rho}{T}\right)$$

where $\rho = \tanh^{-1}\beta_T$

E.Schnedermann et al, PRC48 (1993) 2462

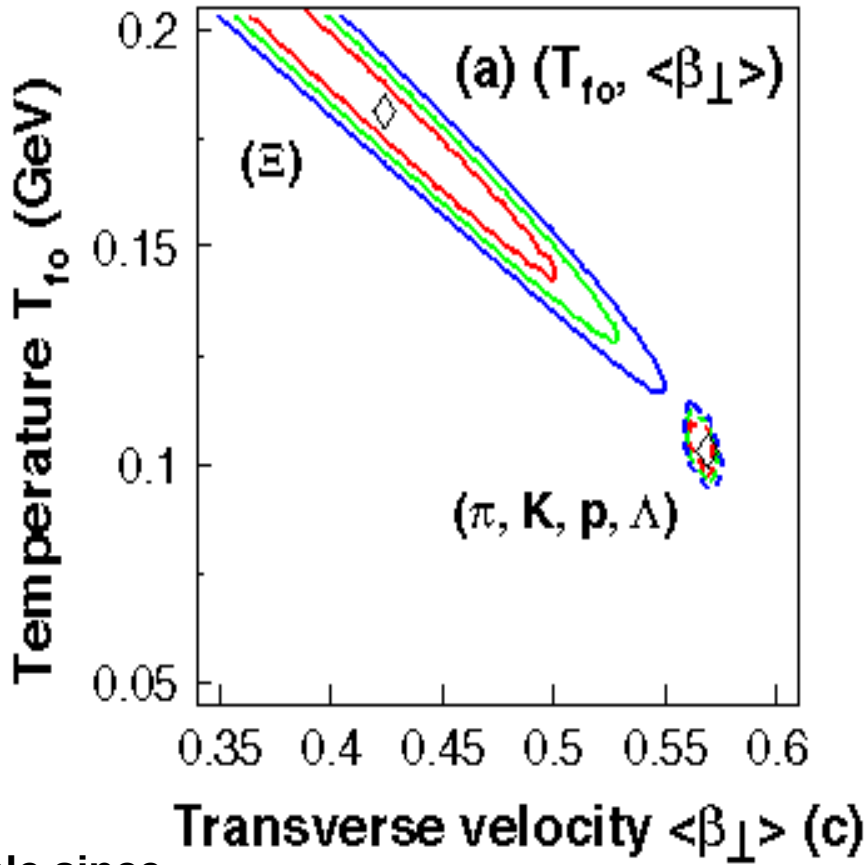
Hydro-dynamic fit:

T, β (Thermal + Transverse flow)



$$\beta_T = \beta_s\, (r/R)^n$$

1 σ, 2σ , 3 σ contours



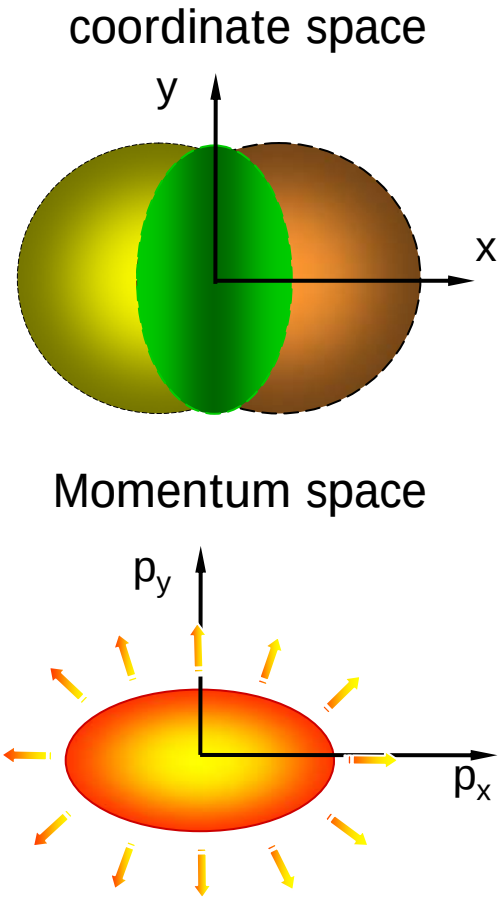
Ξ s behave differently !!

Higher T_{fo}-- >Freeze-out earlier

Thermal freeze-out: particle pT distribution stable since

$T_{fo} \sim T_{ch}$ --→ transverse flow at/before chemical freeze-out, maybe at partonic stage ?

Event Anisotropy– What's Elliptic Flow ?

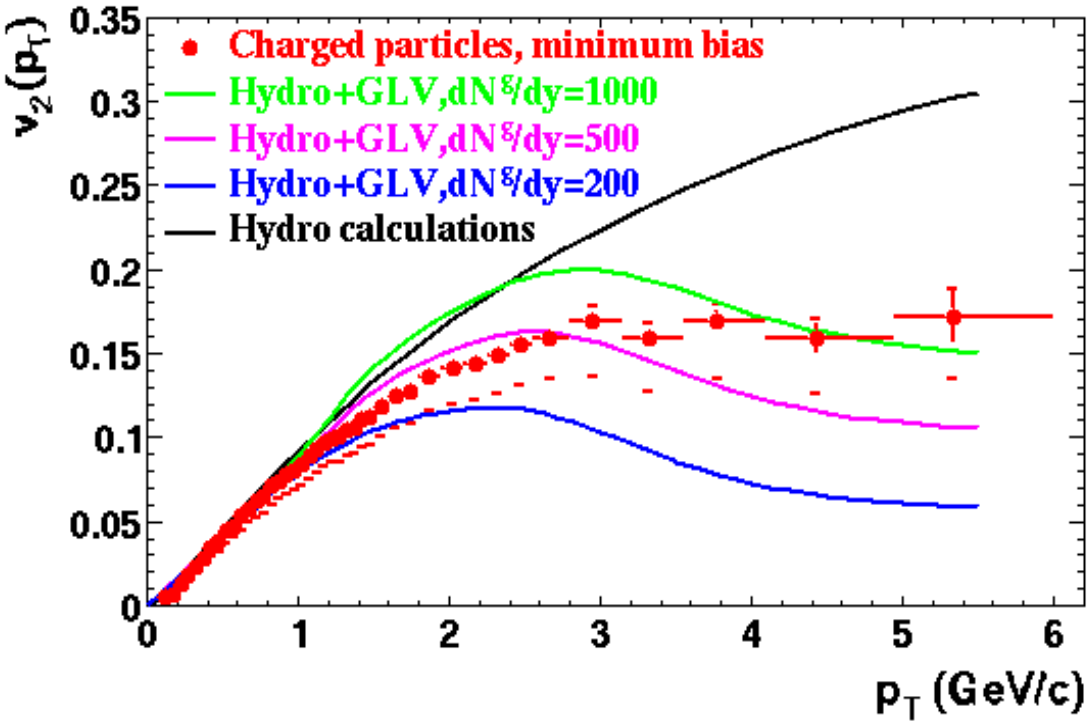


$$E\frac{d^3N}{d^3p}=\frac{1}{2\pi}\frac{d^2N}{p_t dp_t dy}\left(1+\sum_{n=1}^{\infty}2v_n\cos\left(n\left(\varphi-\Psi_r\right)\right)\right)$$

$$v_2=\left\langle\cos 2(\varphi-\Psi_r)\right\rangle,\quad \varphi=\tan^{-1}\left(\frac{p_y}{p_x}\right)$$

Effected by pressure gradient, surface emission pattern, final re-scattering.

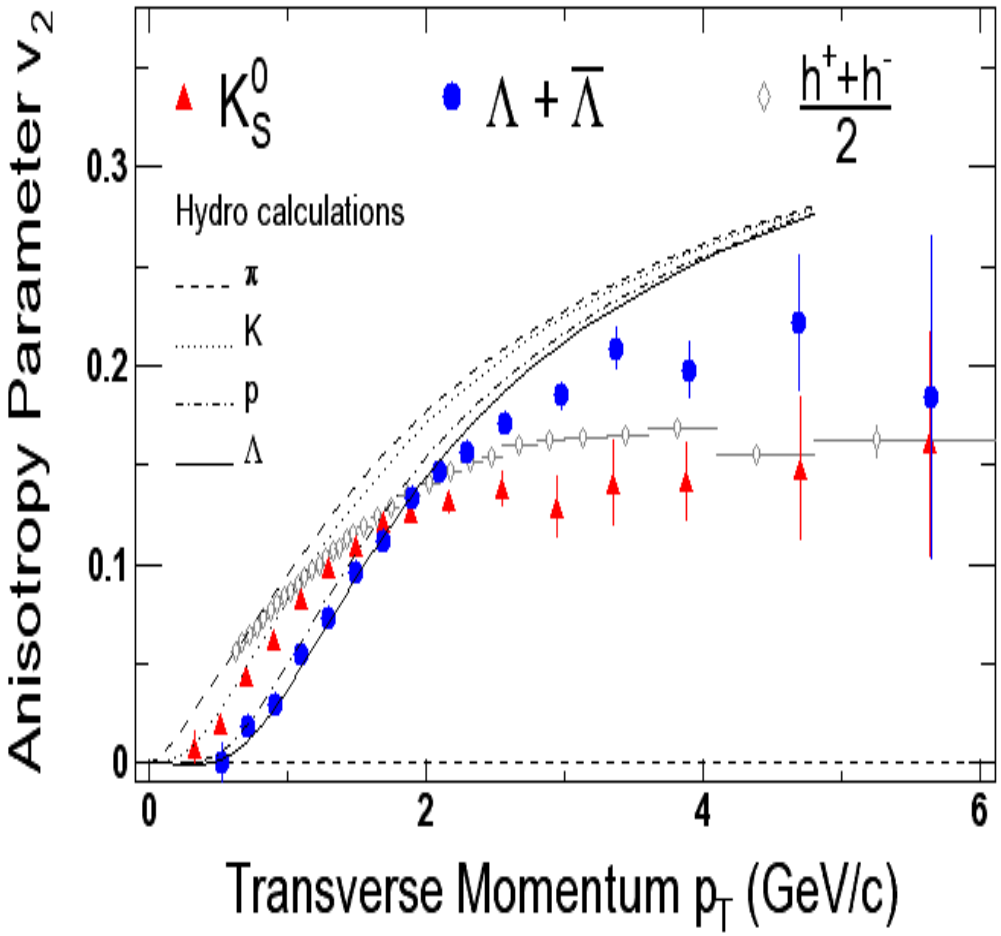
Features of Elliptic Flow at RHIC



Low pt : hydro-like collective behavior

High pt : lower than hydro-limit and the trend consistent with expectation from jet-quenching due to parton energy loss.

Strange Hadron (Ks and Λ) V_2 (200 GeV)



Hydro behavior at pt<2 GeV

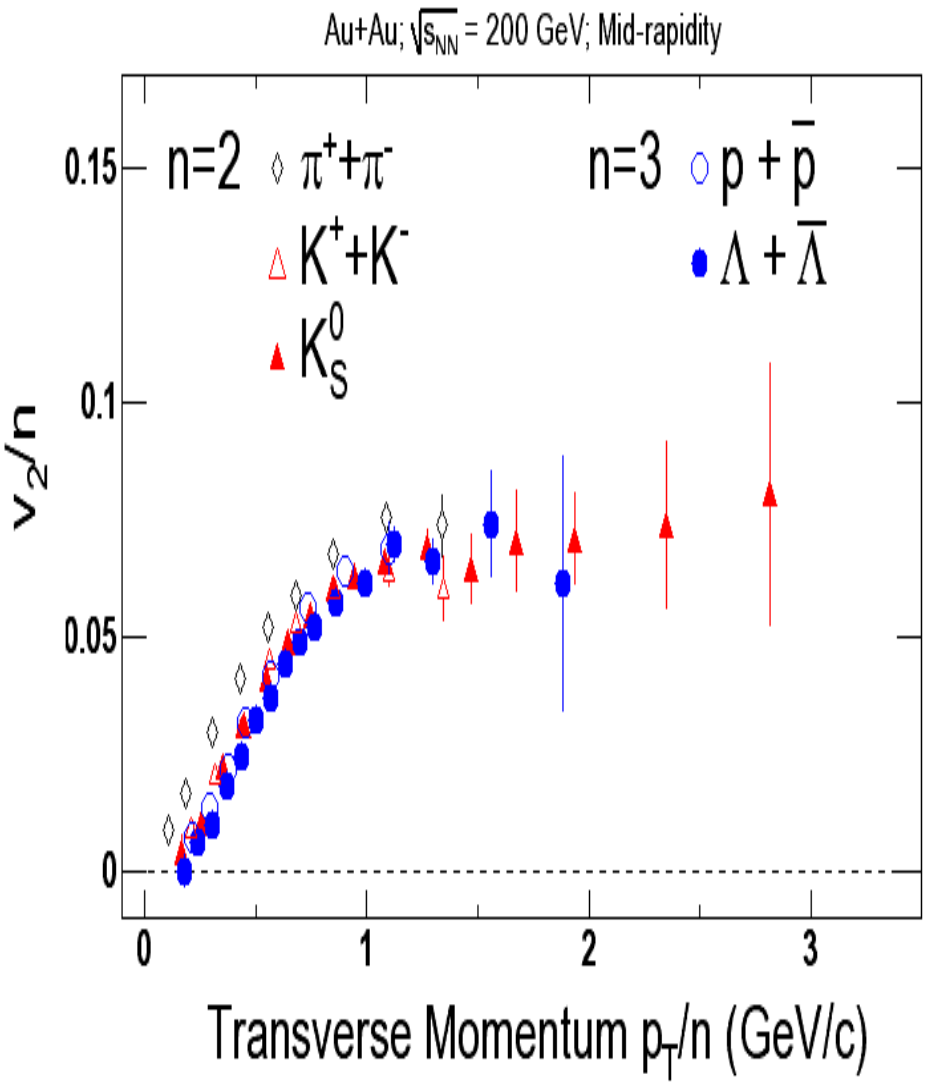
, $V_2(\Lambda) < V_2(K)$

When pt> 2.5GeV,
$V_2(\Lambda) > V_2(K)$!!!

--Energy Loss ?
--Coalescence ?

Partonic dof relevant ?

Strange Particle v2 and Coalescence



V2 ~ n

-> Ξ , Ω v2 = Λ v2

Partonic collectivity at RHIC ?

Z Lin, PRL, 89,202302(02)
S. Voloshin, nu-ex/0210014
R. Fries et al. nucl-th/0301087
D. Molnar et al. nucl-th/0302014

Strange Baryon in Intermediate P_T : Nuclear Modification

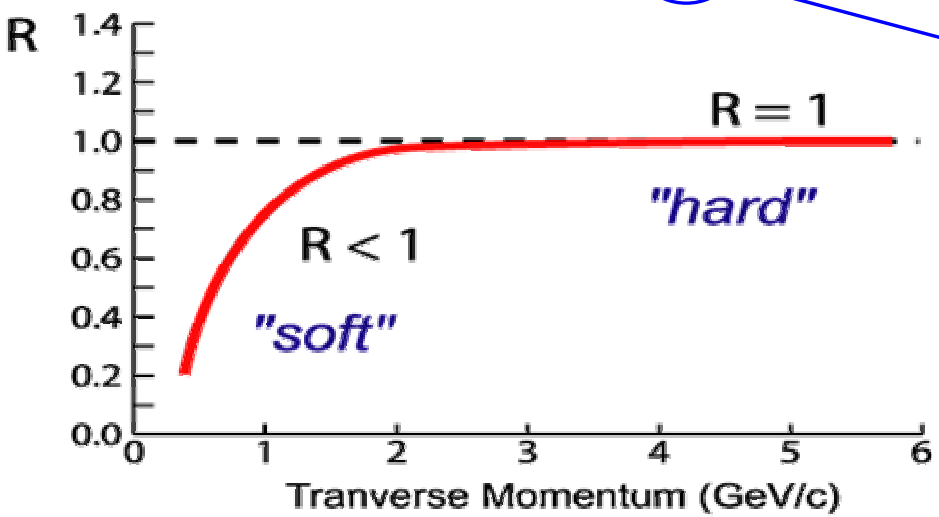
N_{part}: Number of participants
number of incoming nucleons (participants) in the overlap region
N_{bin}: Number of binary collisions
number of equivalent inelastic nucleon-nucleon collisions

Nuclear Modification Factor:

$$R_{AA}(p_T) = \frac{d^2N^{AA}/dp_T d\eta}{T_{AA}\, d^2\sigma^{NN}/dp_T d\eta}$$

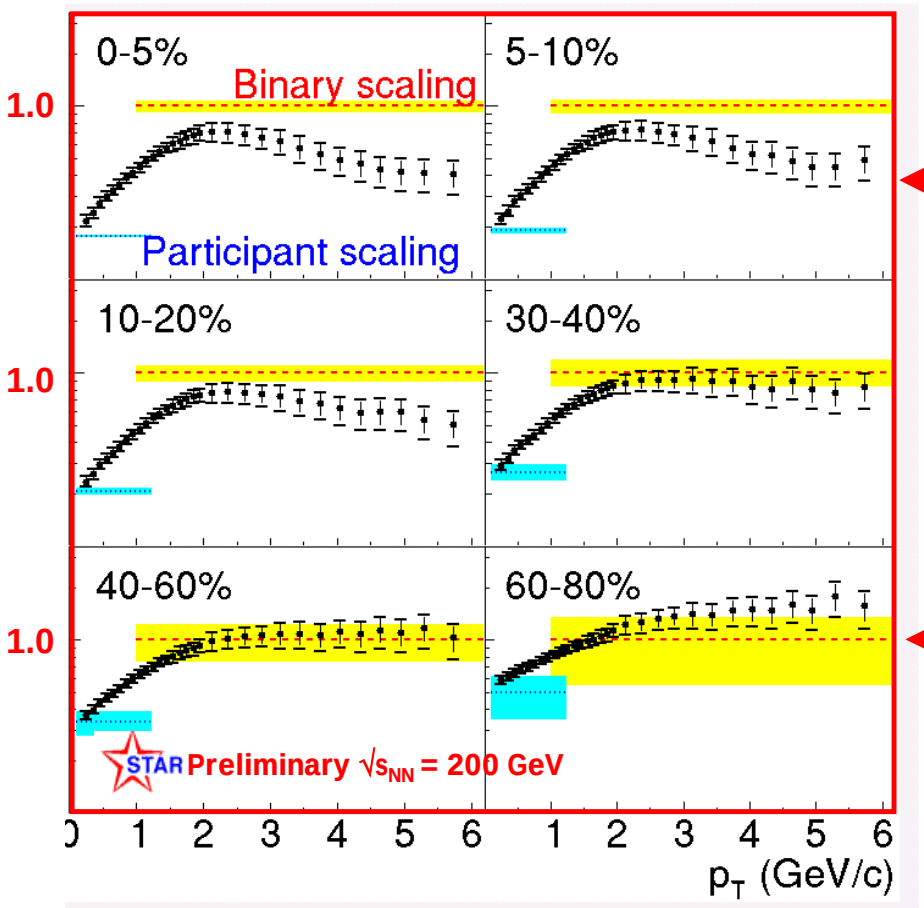
N-N cross section

$\langle N_{binary} \rangle / \sigma_{inel}^{p+p}$



If no "effects":
R < 1 in regime of soft physics
R = 1 at high-p_t where hard scattering dominates

Suppression of High p_T Charged Hadrons



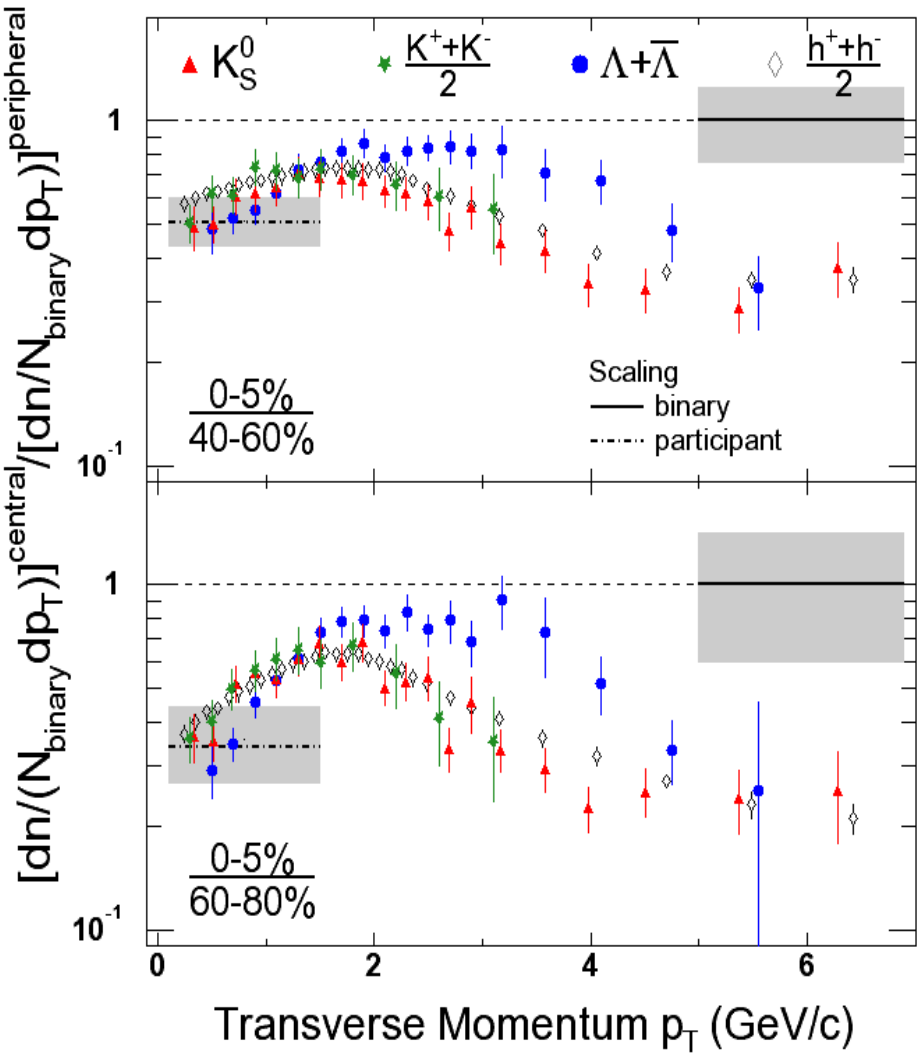
Used UA1 p+$\bar{p}$ 200 GeV data (p_T<6 GeV/c) as reference

Strong Suppression in central Au+Au

N-Binary Scaling in peripheral Au+Au

Similar suppression pattern for π^0 and for 130 GeV Au+Au data and also observed by PHENIX

R_{cp} of Strange Particles



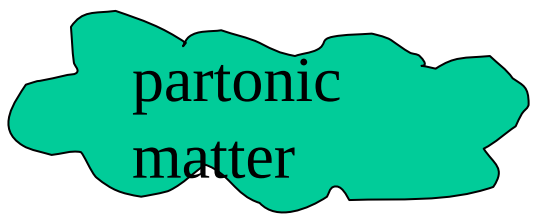
Different pt dependences between $R_{cp}(\Lambda)$ and $R_{cp}(K)$

At pt~5 GeV/c, all the Rcp approach each other.

0-2 GeV, Flow effects ?

2-4 GeV, Coalescence ?

>5GeV, Fragmentation ?



Summary (I)

bulk properties

- **Yield and Freeze-out T**

  -almost linear increase with charged hadrons ;

  - earlier freeze-out and high freeze-out T of multi-strange baryon Ξ -→ partonic radial flow ?

- **Event anisotropy**

  - hydro behavior of v2 at pt< 2GeV/c;

  - heavier particle has larger saturated v2 at pt>2 Gev/c; ?← Coalescence model →? Partonic Collectivity ?

Summary (II)

Nuclear Effects

-Suppression of charged hadron at pt<12 GeV/c ;

-Rcp dependent on particle type at pt< 5 GeV/c;

<- flow (0- 2 GeV/c) ?

<- Coalescence (2- 4 GeV/c) ? (partonic matter ?)

<- fragmentation (> 5 GeV/c) ?

Multi-strange v2 and Rcp measurement in AA and dA coming soon !!!