Non-identical Particle Correlations at 62 and 200 GeV at STAR

Petr Chaloupka

Nuclear Physics Institute

Academy of Sciences of the Czech Republic

for the STAR collaboration

Outline

Motivation:

- **sizes of** and **shift between** emission sources
- **testing flow**
- interaction potentials of hadrons

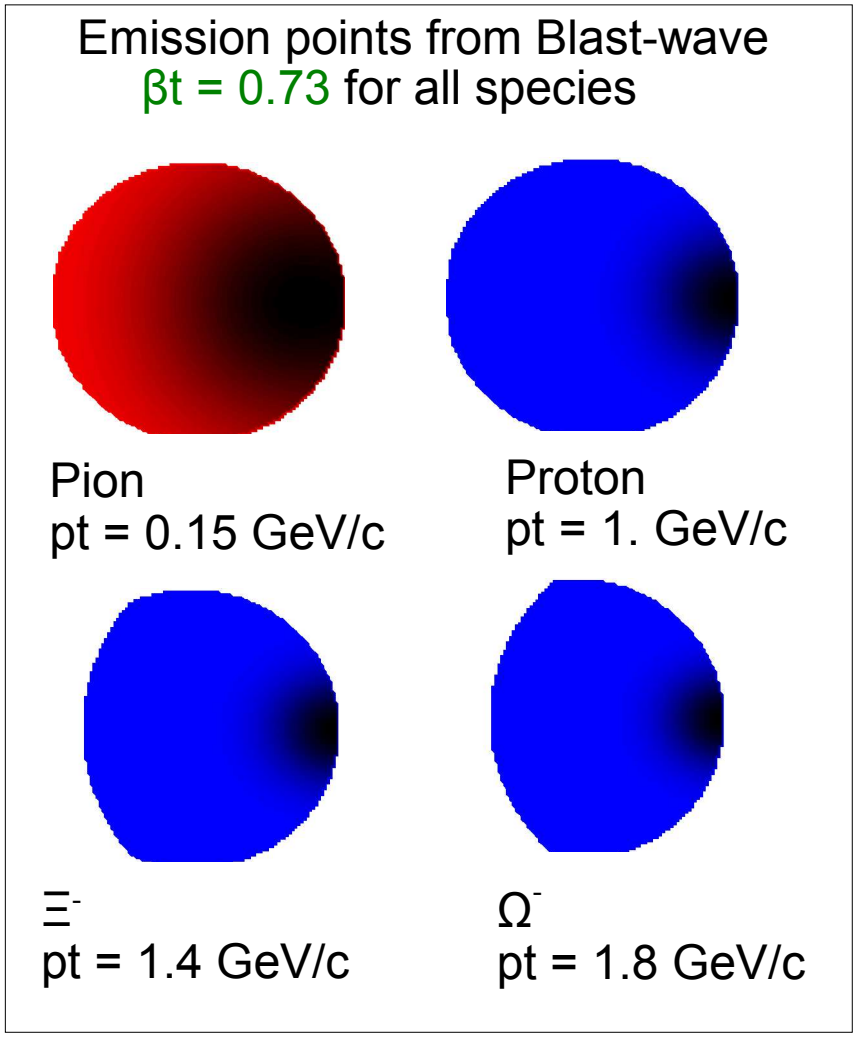
Current results on:

- proton-antiproton
- proton-lambda, antiproton-lambda
- pion-cascade

Model comparisons

Conclusions

Effects of transverse flow

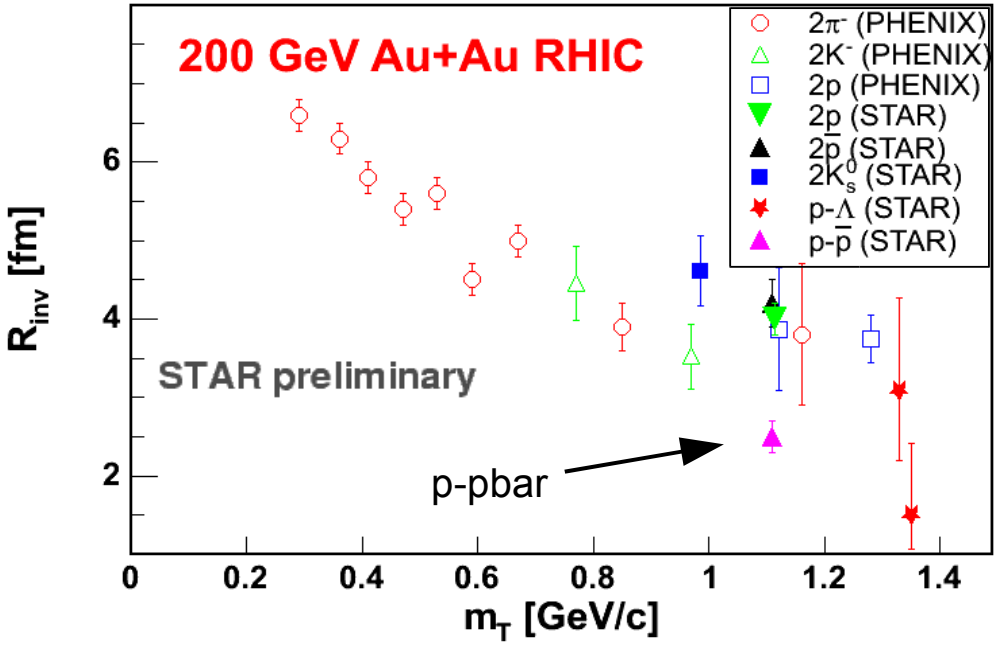


- Correlation between momentum and emission point
- Effective **reduction of source size** and **shift** in average emission point
- Effect **increases with m_T**

Non-identical correlations can test flow by measuring sizes and shifts of the sources

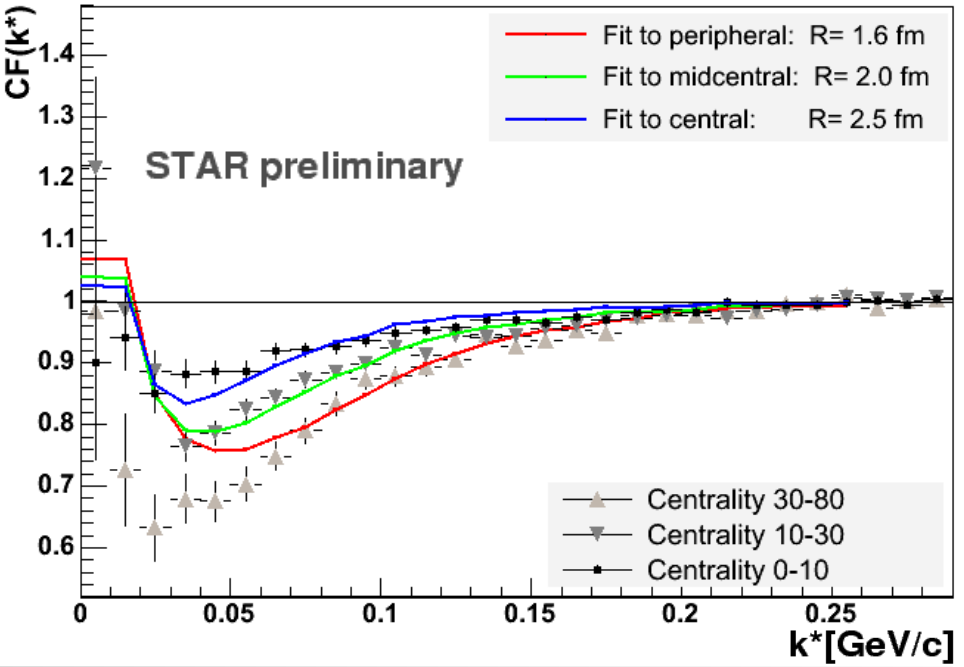
p-$\bar{p}$ at 200GeV AuAu

- Reasonable **centrality dependence**
- **Fits into the flow picture**
- Extracted sizes differ from p-p , pbar-pbar measurements



Possible explanations:

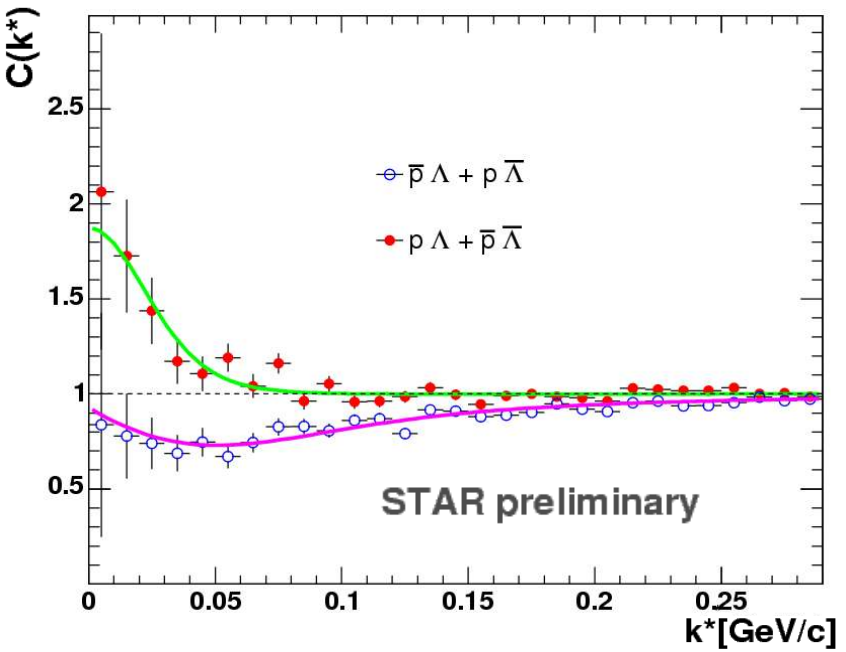
- residual correlations feed-down
- p-wave contribution
- revise scattering length
- smoothness assumption breakdown
- geometry of the two-particle source

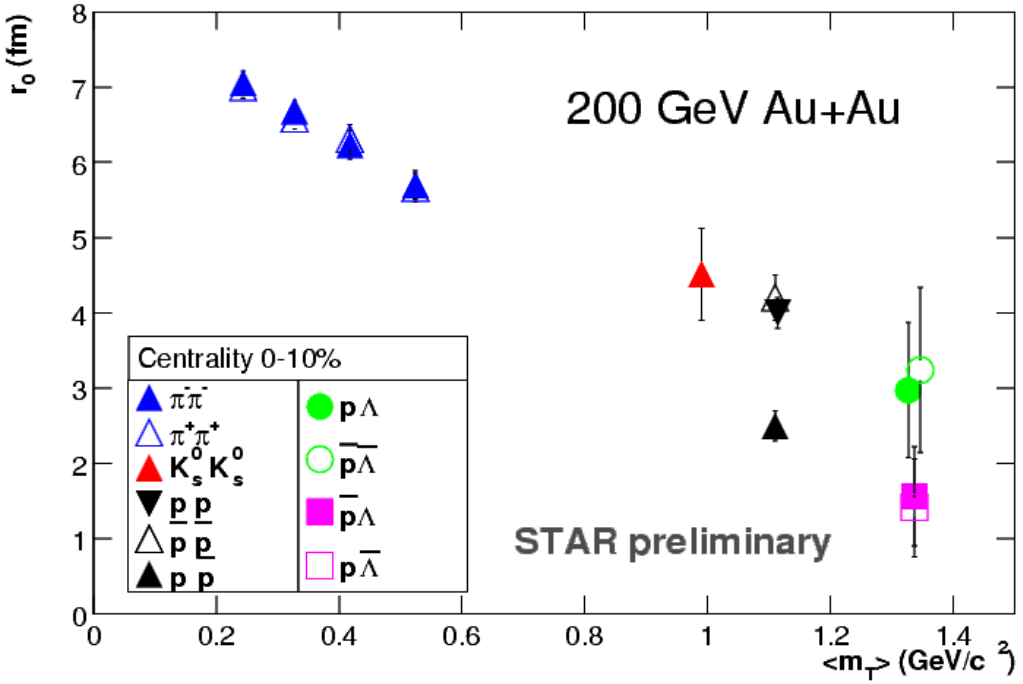


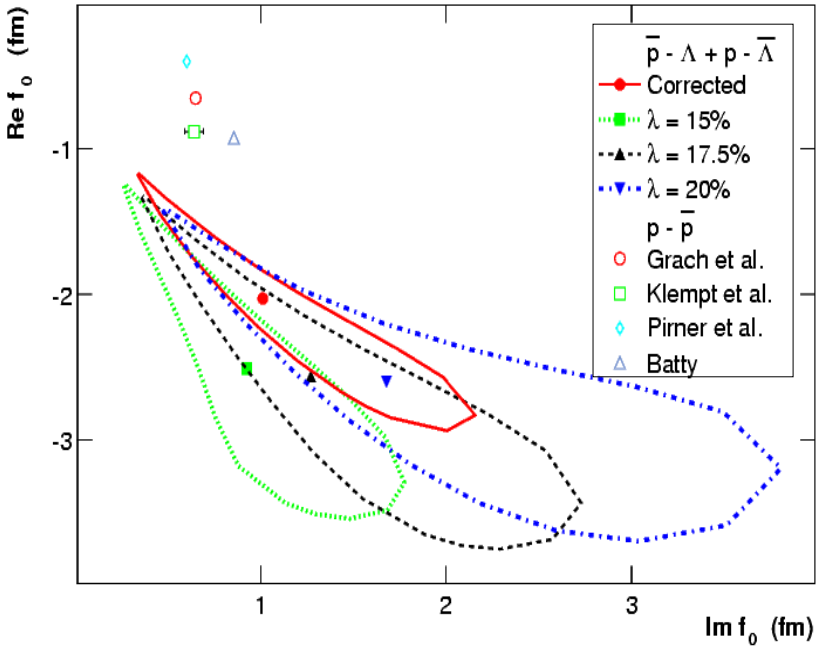
Poster on p-p and p-pbar correlations at 200 and 62 GeV by Hanna Gos

p–Λ, p̄–Λ̄ and p–Λ̄, p̄–Λ in 200GeV AuAu

- **Proton-lambda source size measured**
  - CF fitted using known potential
- **For antiproton-lambda scattering length extracted for the first time**
- Measured sizes **fit into the flow picture**
- Non-trivial particle purity corrections, and correlated feed-down from lambda-lambda

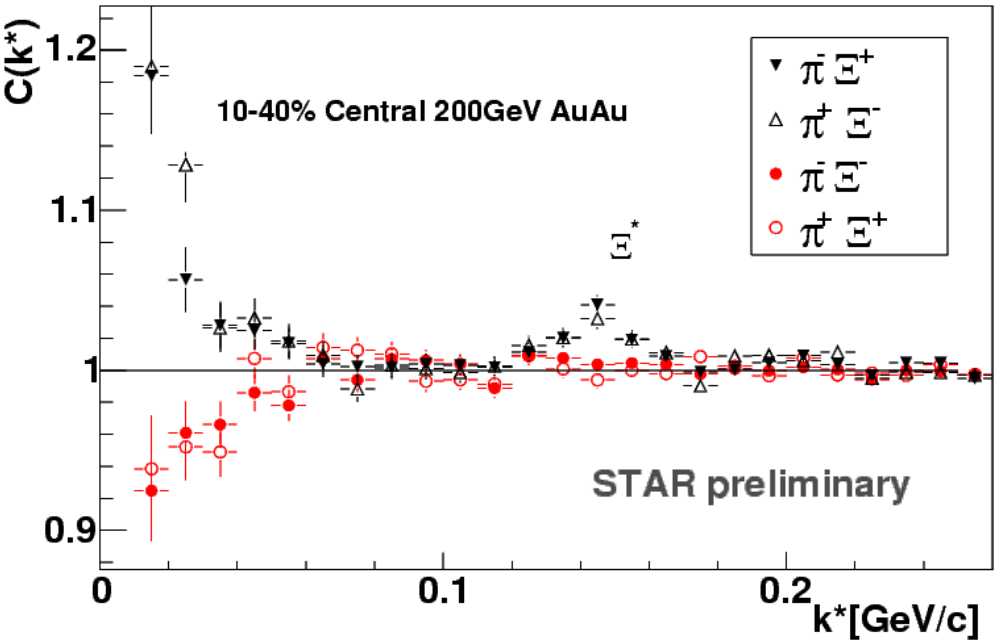


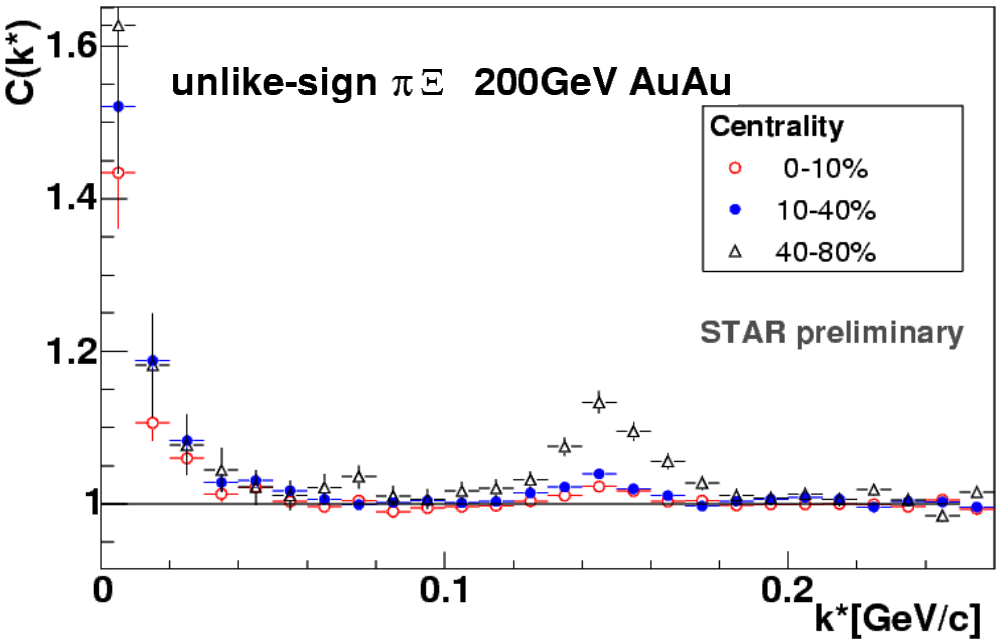




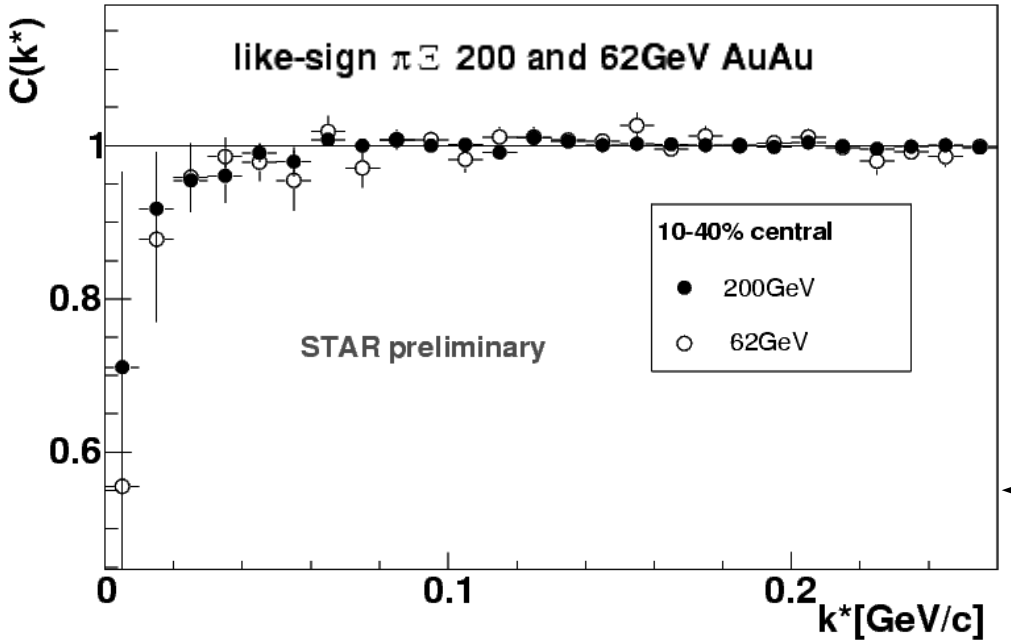
π–Ξ in 200GeV AuAu

- Data from RHIC's year 2004 high statistics AuAu run
- Data corrected for π and Ξ sample purities
- **Coulomb and strong** (**Ξ*1530**) final state interaction effects present.
- **Centrality dependence** observed, particularly strong in the Ξ* region

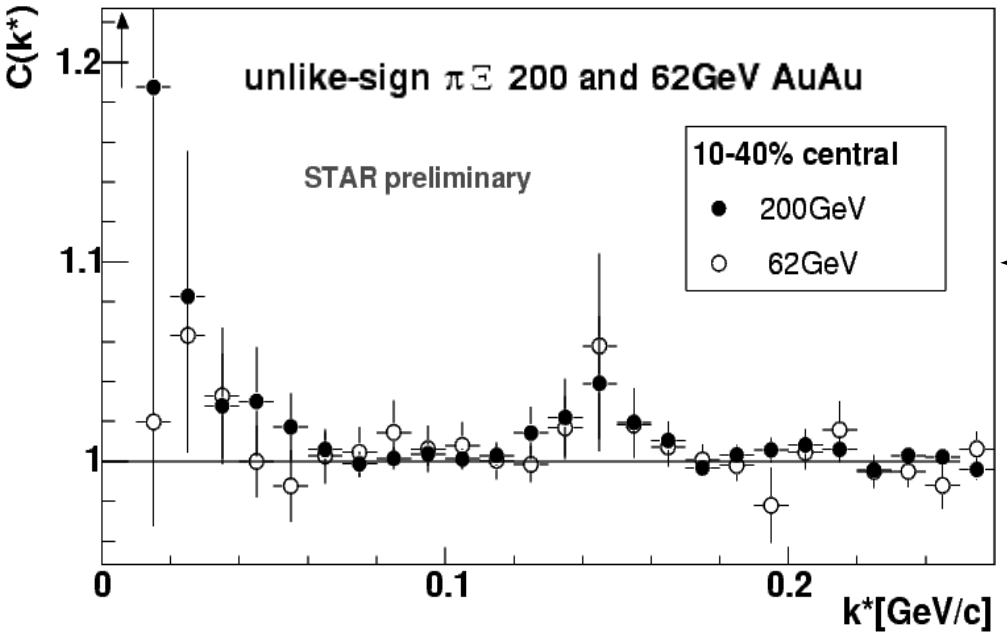


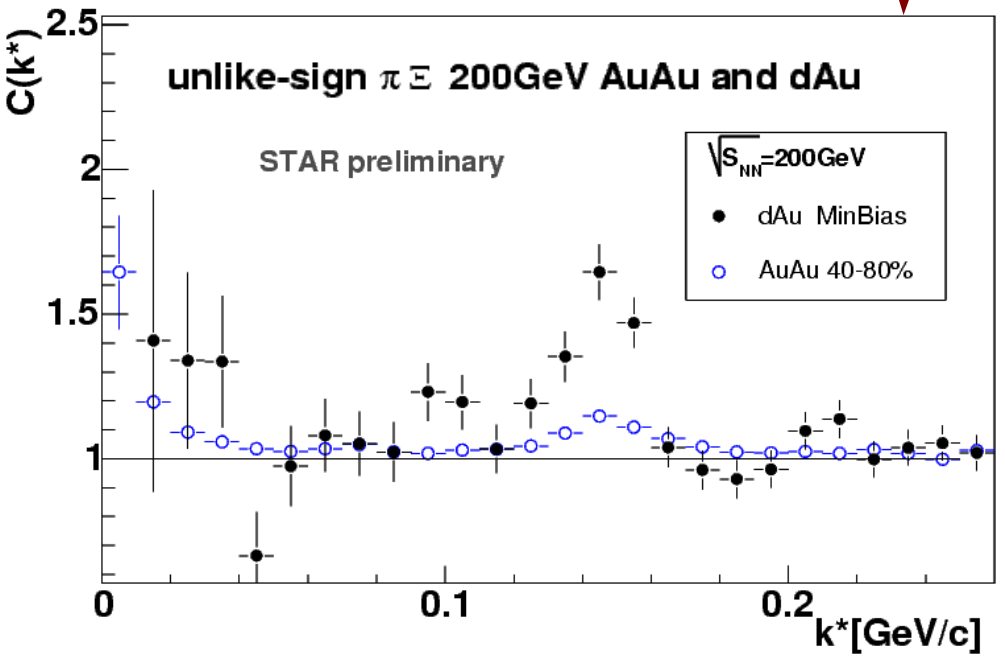


π–Ξ systematics



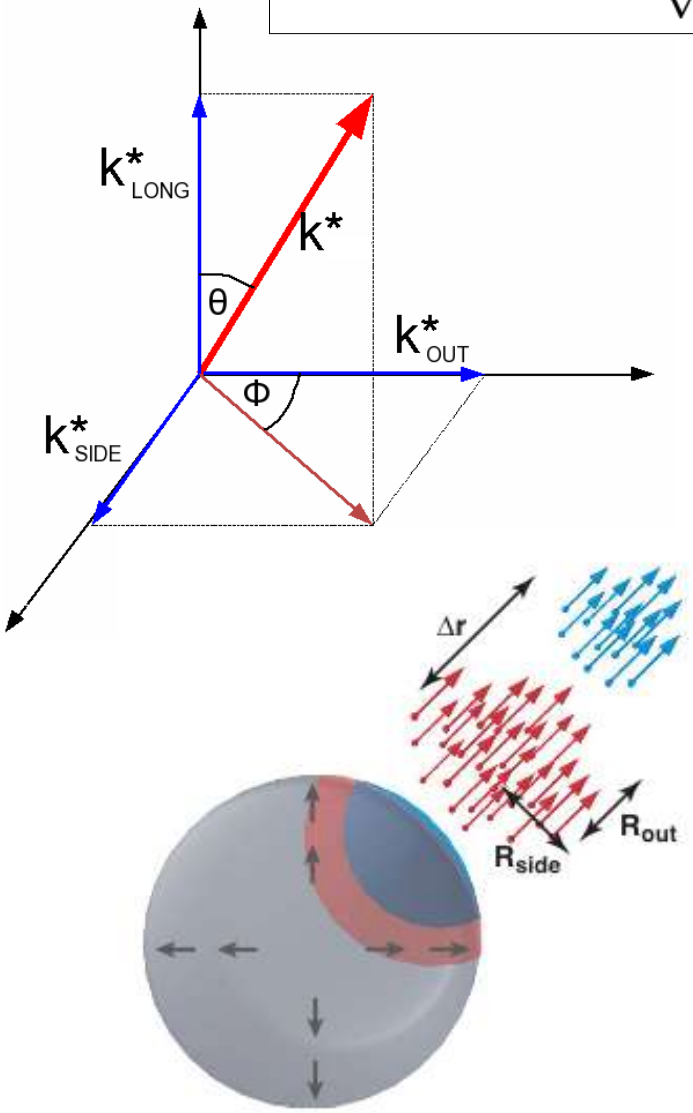
- π–Ξ CF measured for the first time in **62GeV AuAu** and **200GeV dAu** collisions
- No significant energy dependence
- Strong **system dependence**





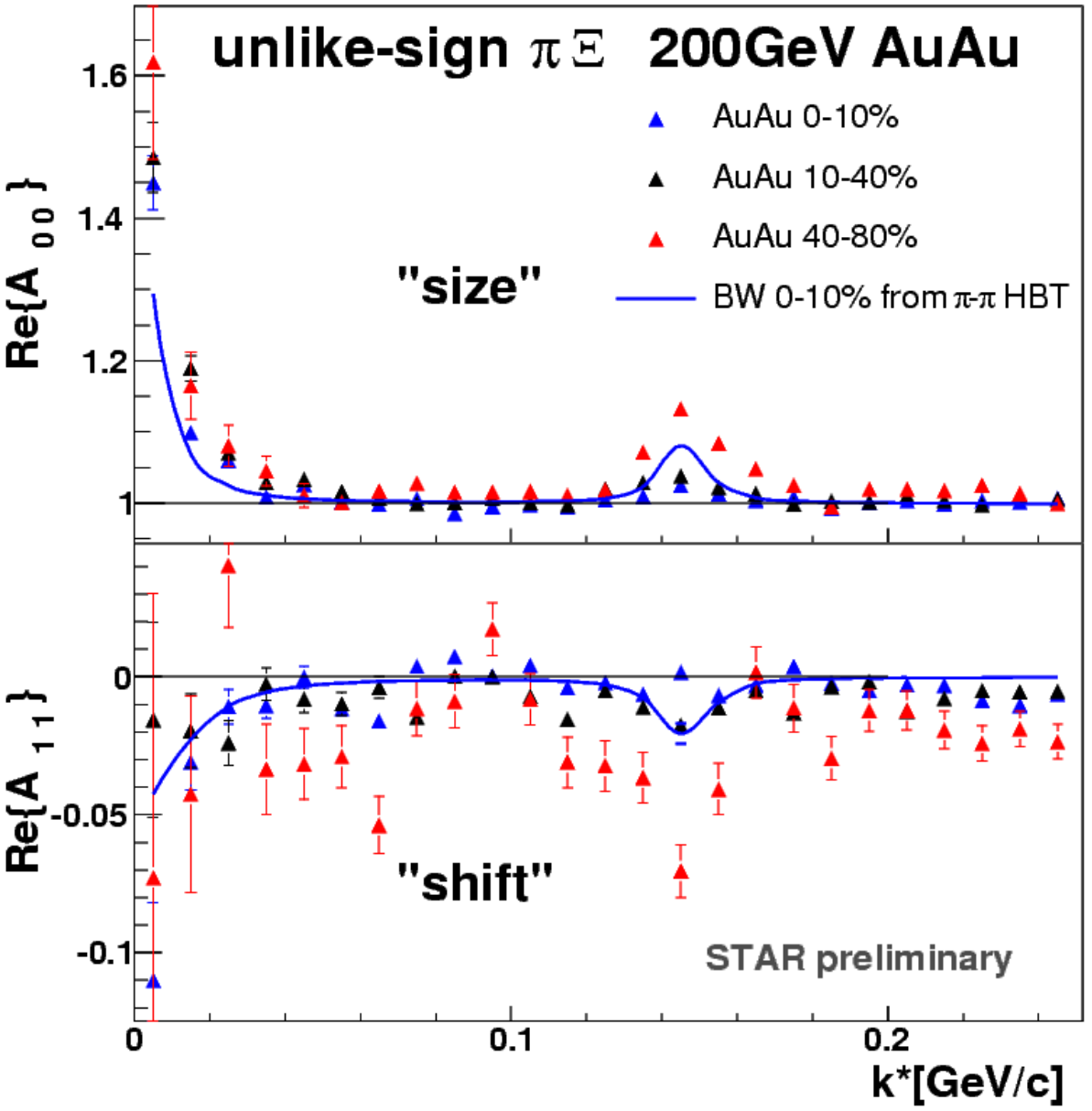
Spherical harmonics decomposition

$$A_{l,m}(|\vec{k}^*|) = \frac{\Delta_{\cos\theta}\Delta\varphi}{\sqrt{4\pi}} \sum_{i}^{\text{all bins}} Y_{l,m}(\theta_i, \varphi_i) C(|\vec{k}^*|, \cos\theta_i, \varphi_i)$$



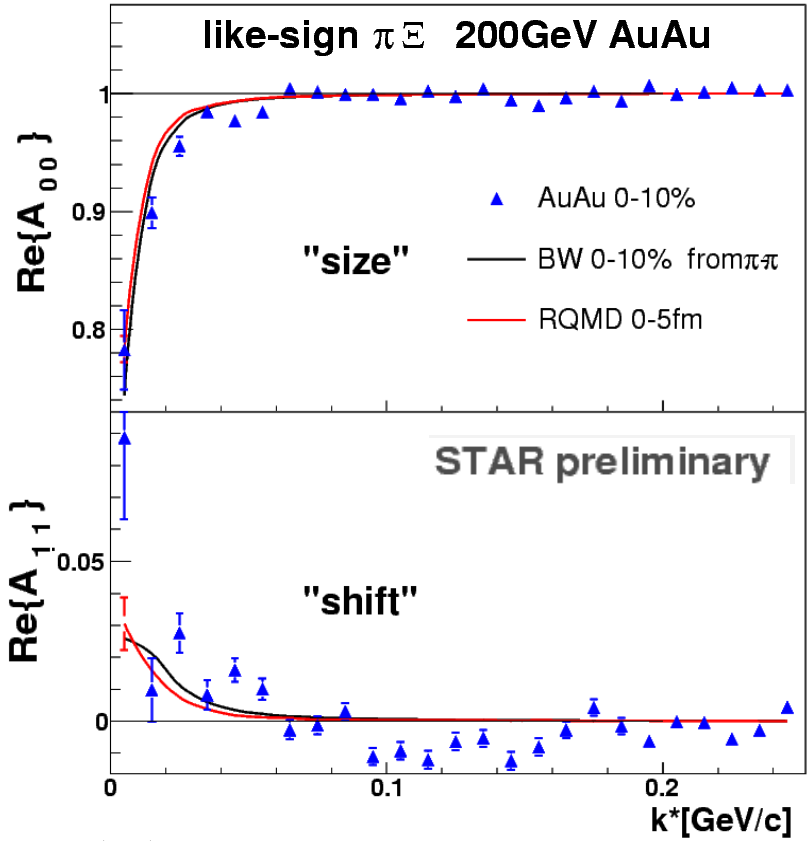
- Testing symmetry in k* space by decomposition of CF into spherical harmonics
- Different A_{lm} coefficients correspond to different symmetries of the source
- A_{00} - angularly averaged CF
- **A_{11} to study shift in R_{out} direction**

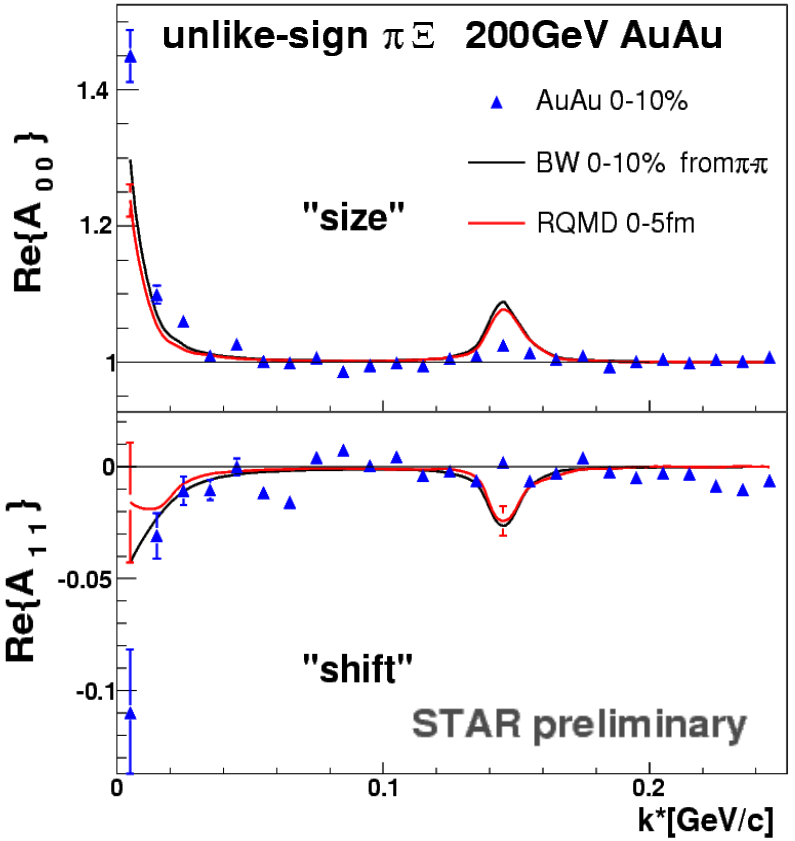
Accessing shift between sources



- $A_{11} \neq 0$ in Coulomb and strong region
- Shift in the average emission point between $\pi - \Xi$

Model comparison





Model:

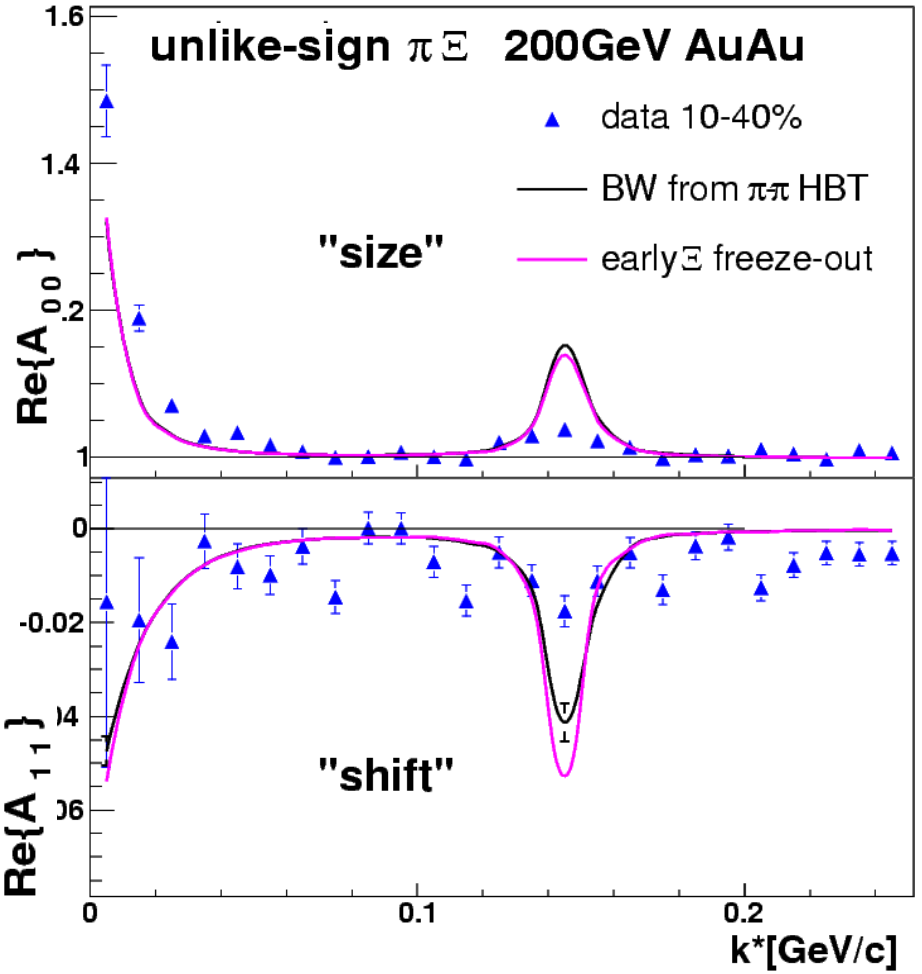
- S. Pratt's FSI **(Phys.Rev. C68, 054901(2003))**

  +
- Emission points from:
  - Blastwave- constrained by π–π HBT
  - RQMD

- Difference between measured and calculated CF under investigation
- Observed **shift agrees** qualitatively **with flow scenario**.

Early freeze-out ?

- Is this due to early freeze-out? (Could we tell?)
- Competing changes – small overall effect
- Assumed early freeze-out scenario – **small effect on CF**



BW parameters	π	Ξ	Ξ early freeze-out
T[Mev]	103	103	150
ρ	0.93	0.93	0.75
R[fm]	10.3	10.3	9
τ[fm]	6.9	6.9	5
Δτ[fm]	2	2	2

Conclusions

- Non-identical particle correlations for baryons were measured by STAR experiment. Source sizes and **scattering length were extracted for first time for antiproton-lambda**. Results qualitatively agree with flow picture.

- First **high statistics measurements of π–Ξ** correlations in 200 and 62 GeV AuAu and 200 GeV dAu collisions presented.

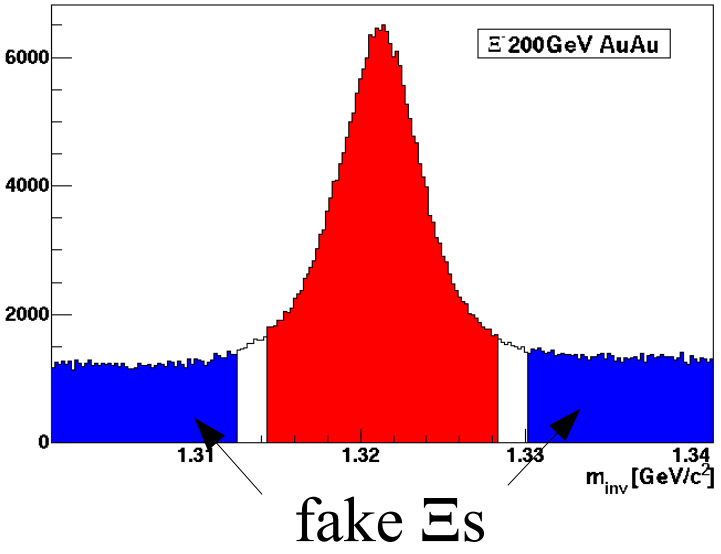
- Very good sensitivity to source size in Ξ* peak was found. Theoretical input needed.

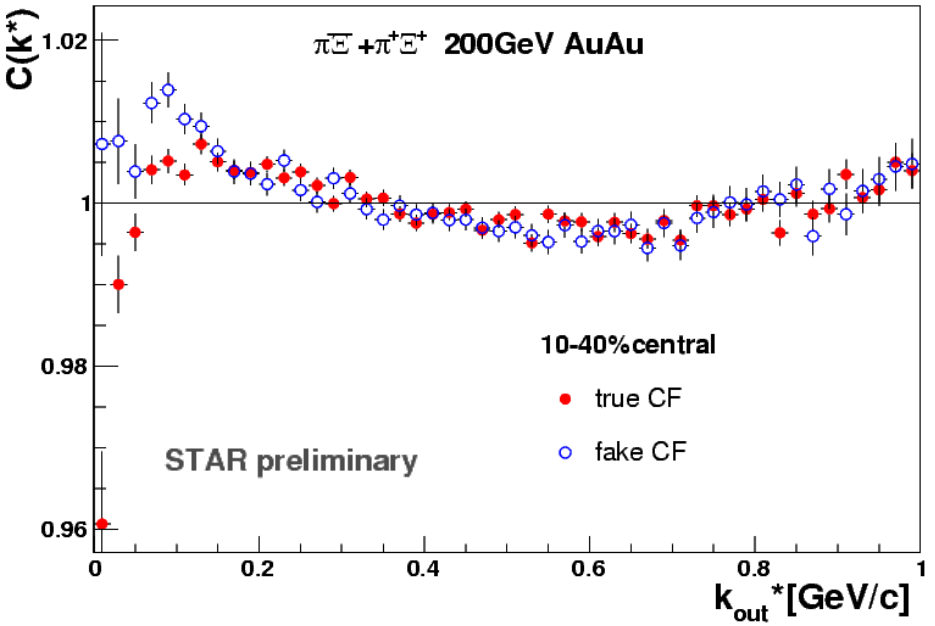
- Using new spherical harmonics representation of data we observe clear **shift between average emission points of π and Ξ** sources in qualitative agreement with transversally **expanding source**.

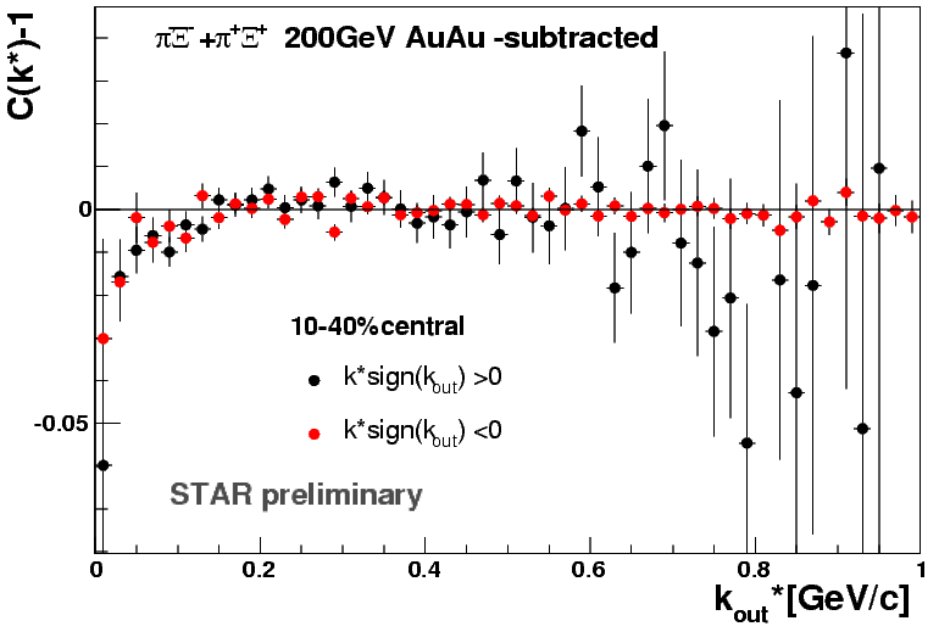
Additional and backup slides

Remaining technical challenges

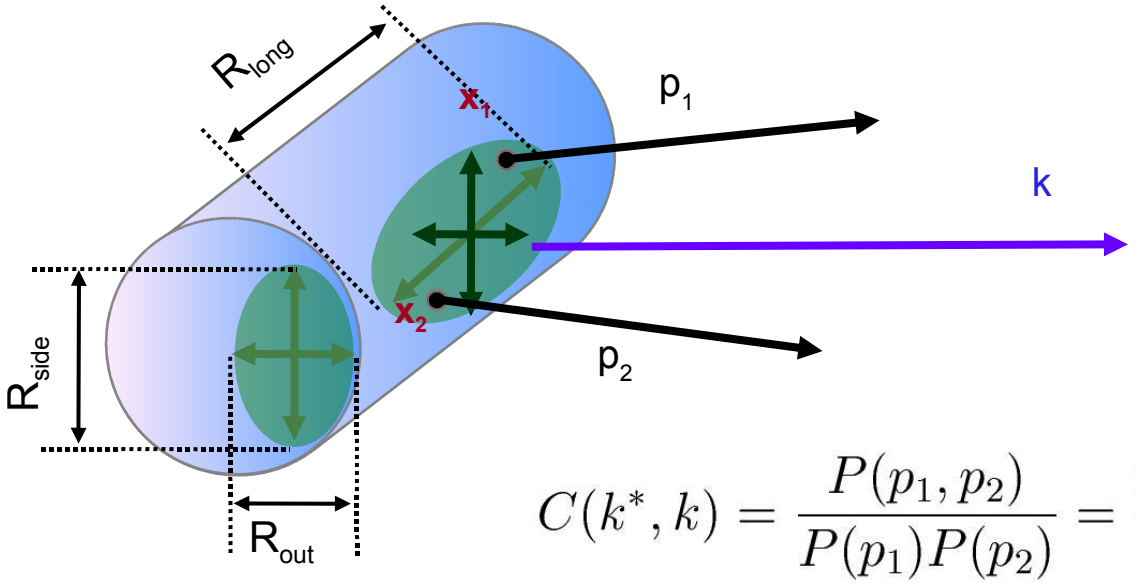
- **Non-flat baseline issue**
- Wide k* structure in CF, dip in low k* possible source: flow, detector effects-currently being investigated
- **Using fake Ξs** to construct correlation function with similar baseline behaviour for corrections





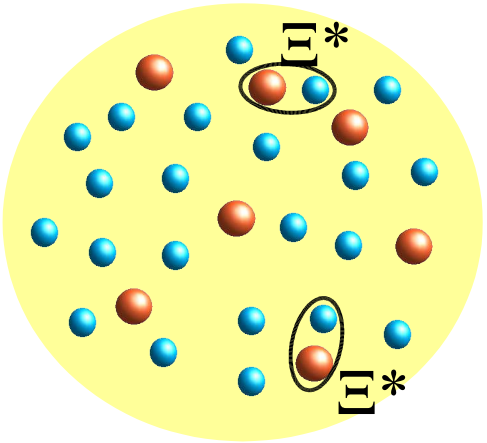


Non-identical particle correlations



$$\vec{k} = \frac{\vec{p}_1 + \vec{p}_2}{2}$$
$$\vec{k}_1^* = -\vec{k}_2^*$$

$$C(k^*, k) = \frac{P(p_1, p_2)}{P(p_1)P(p_2)} = \frac{\text{real event pairs}}{\text{mixed pairs}} \sim 1/\text{volume}$$



π

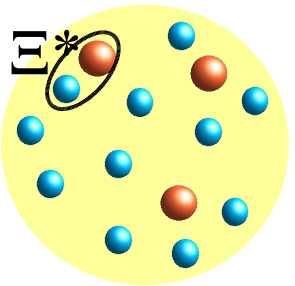
X

$N_\pi = 23$

$N_\Xi = 7$

$N_{\Xi^*} = 2$

$N_{\Xi^*}/N_{\pi\Xi} \sim 0.01$



$N_\pi = 11$

$N_\Xi = 3$

$N_{\Xi^*} = 1$

$N_{\Xi^*}/N_{\pi\Xi} \sim 0.03$