Strange Hadron Production in O+O Collisions at $\sqrt{s_{NN}}$ = 200 GeV at STAR

Iris Ponce (*for the STAR Collaboration*)
Wright Laboratory, Yale University iris.ponce@yale.edu

1) Introduction

•At high temperatures QCD matter becomes a new state of matter called the Quark-Gluon plasma (QGP). The QGP behaves as deconfined strongly coupled fluid.

•Its existence was predicted in 1975 and experimentally discovered in the early 2000s.

•The QGP is predicted to have existed in the early universe in the first μs after the Big Bang.

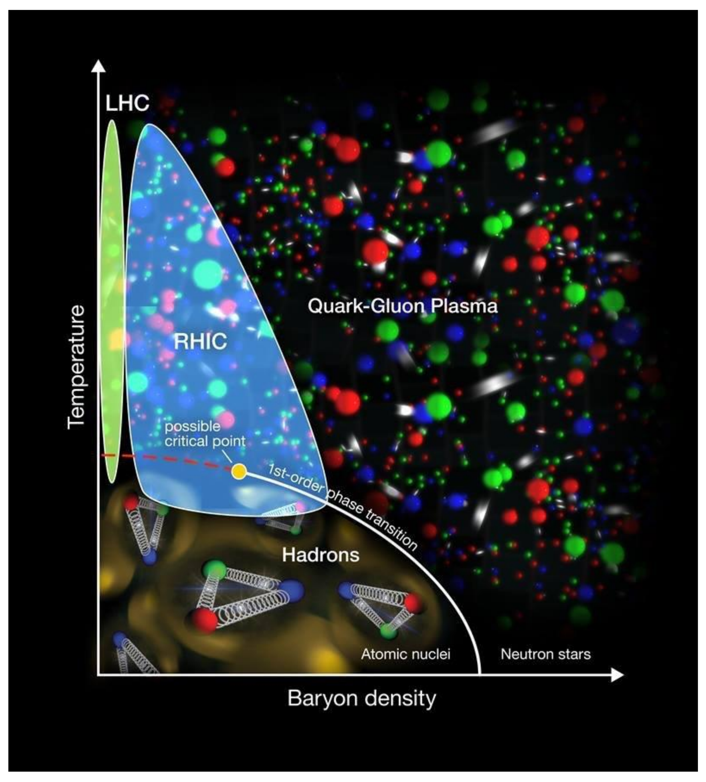


Figure 1: The QGP phase diagram [1]

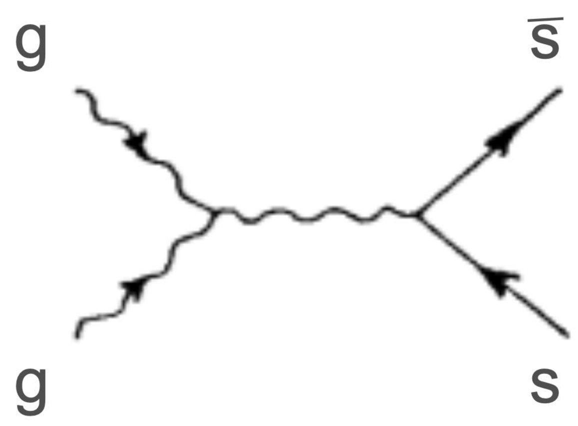


Figure 2: Lowest Order Feynman diagram for ss production [2]

•Strangeness enhancement was one of the first observables predicted as a signature of the QGP.

•The thermal production of s-sBar quark pairs is favorable in the QGP since the s-sBar masses are close to the QGP transition temperature ~157 MeV.

- 2 x m_s ~192 MeV
- There are abundant thermal gluons in the QGP medium.

2) Motivation

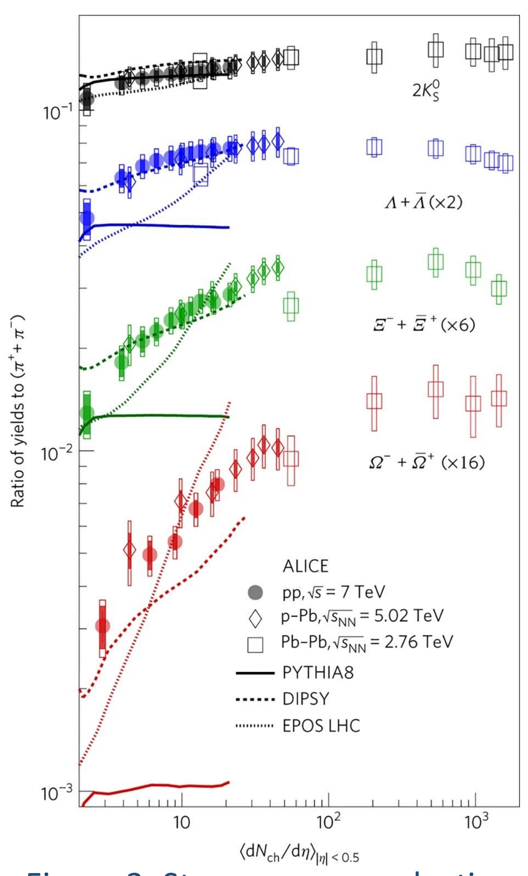


Figure 3: Strangeness production at ALICE[3]

•A smooth increase in the ratio of strange hadron production to the pion yield as a function of multiplicity has been found in various collision systems (p+p, p+A, A+A) at TeV collision energies.

- STAR has observed a similar trend.

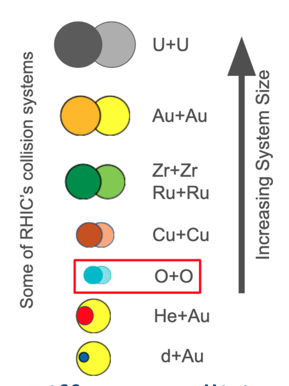


Figure 4: Different collision systems at RHIC

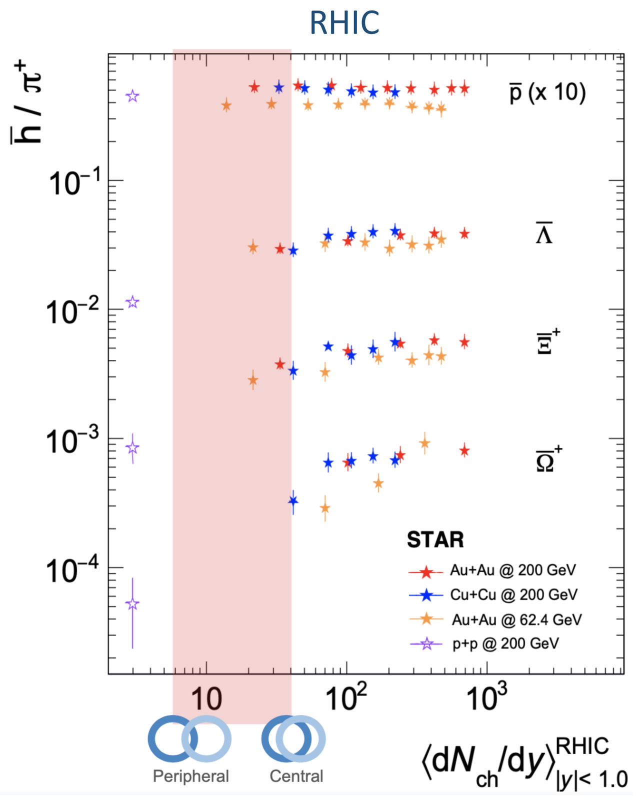


Figure 5: Strangeness production at STAR

2a) STAR Detector

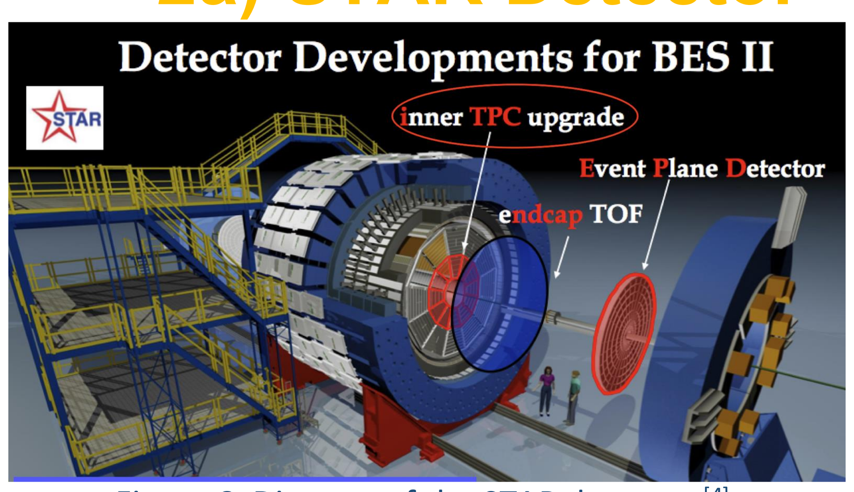


Figure 6: Diagram of the STAR detector [4]

•From 2018 on, STAR had two detector upgrades: iTPC and eTOF

- Improved coverage: From $|\eta| < 1.0$ => $|\eta| < 1.5$
- Lower p_T coverage 125 MeV => 60 MeV
- Extended PID with eTOF

•There are ~650M O+O minimum bias events total at $\sqrt{s_{NN}}$ = 200 GeV.

- ¼ of the O+O run was taken with the magnetic field reversed.
- Testing calibration and TPC distortions

3) Particle Reconstruction

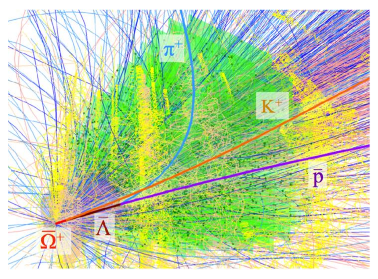


Figure 7: Simulated anti-Ω decay

•Using Kalman Filter Particle (KF Particle) reconstruction algorithm.

•The signal (without background subtraction) region is [μ-3σ,μ+3σ], and the background region is [0 to μ-3σ, μ+3σ to 1.135 GeV/c^2].
•Fitting function: 2nd poly (for background + double Gauss function (signal).

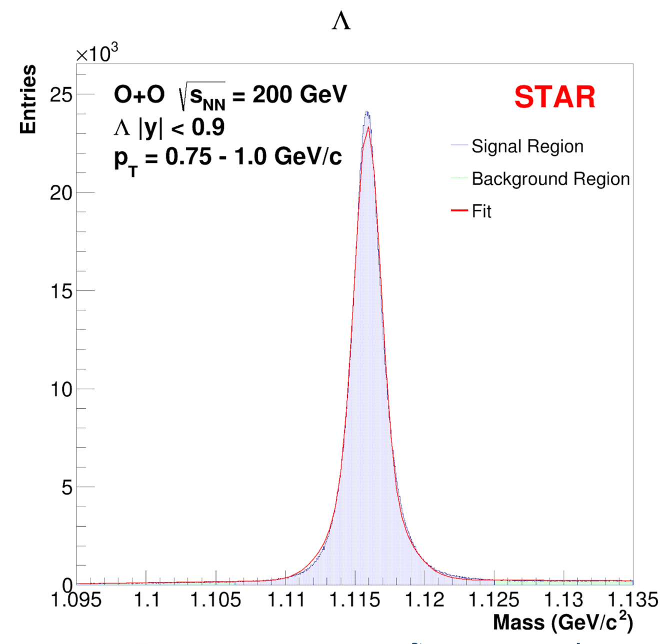


Figure 8: Invariant Λ mass peak

The blue region is the signal w.o background subtraction.
The green region is the background region (very small)..

There is good coverage through 0 - 80% centralities for multi-strange hadrons.

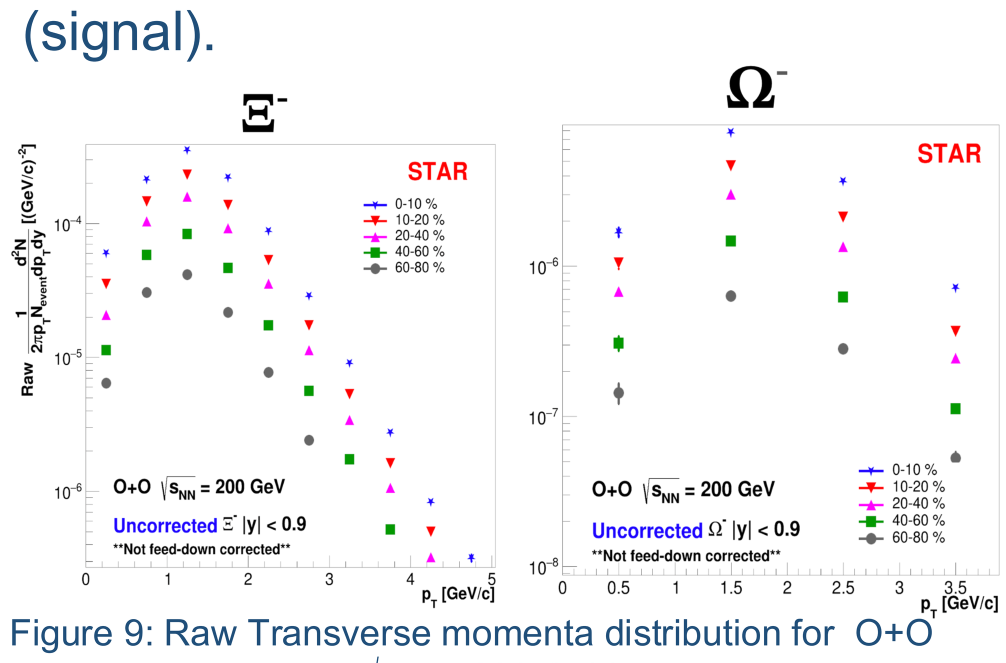


Figure 9: Raw Transverse momenta distribution for O+O at $\sqrt{s_{NN}}$ = 200 GeV

5) p_T Spectra and Particle Yields

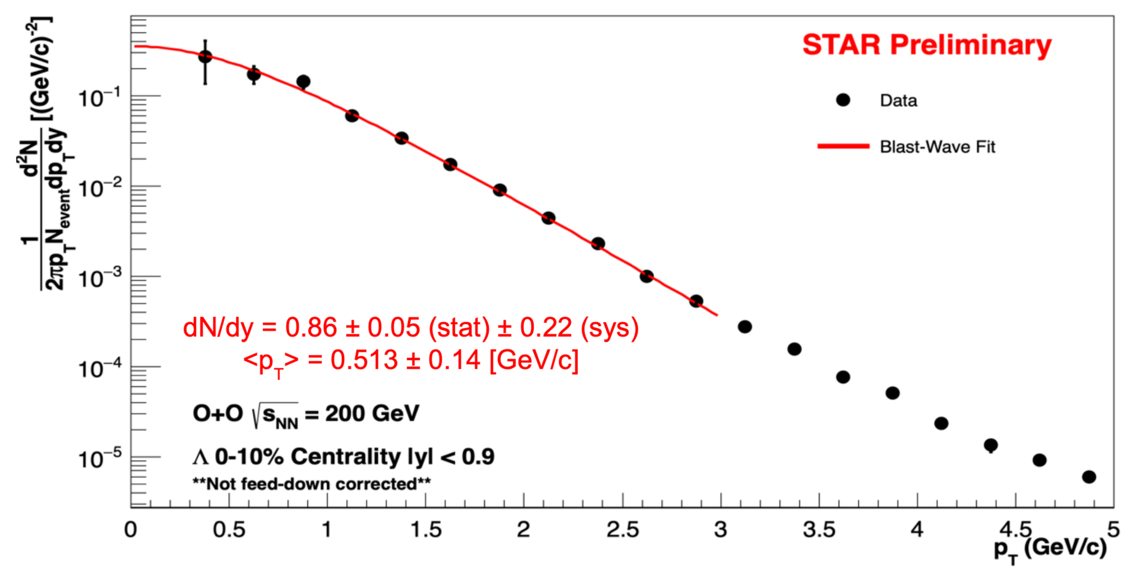


Figure 10: Corrected p_T spectrum for Λ's in Central O+O Collisions

- The p_T spectra is calculated from the Λ's invariant mass distributions in different momentum ranges.
- The Λ p_T spectra is the average of both magnetic field configurations.

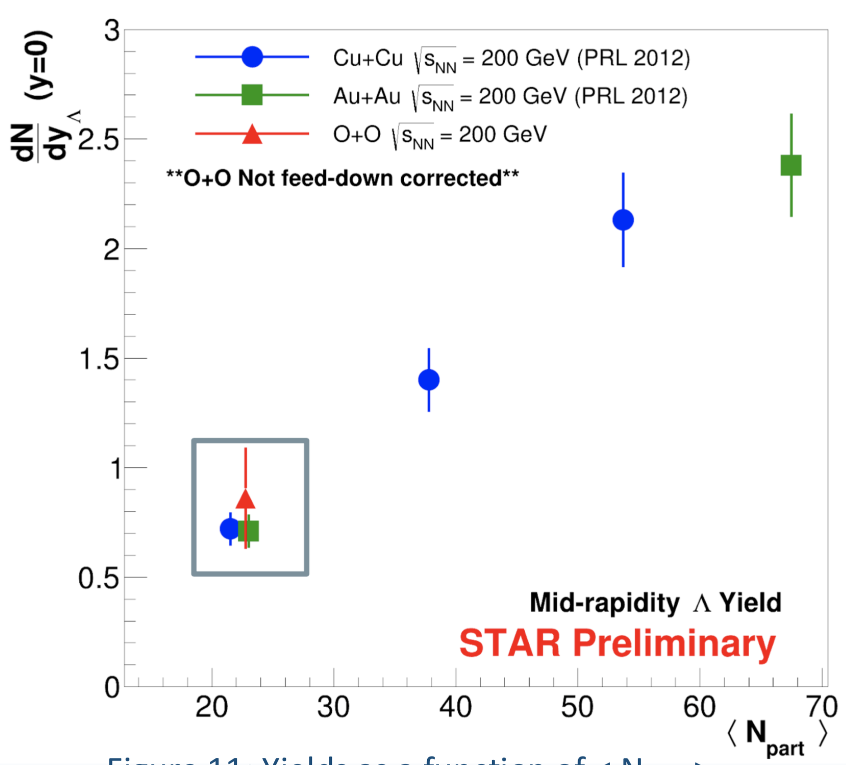


Figure 11: Yields as a function of < N_{part} >

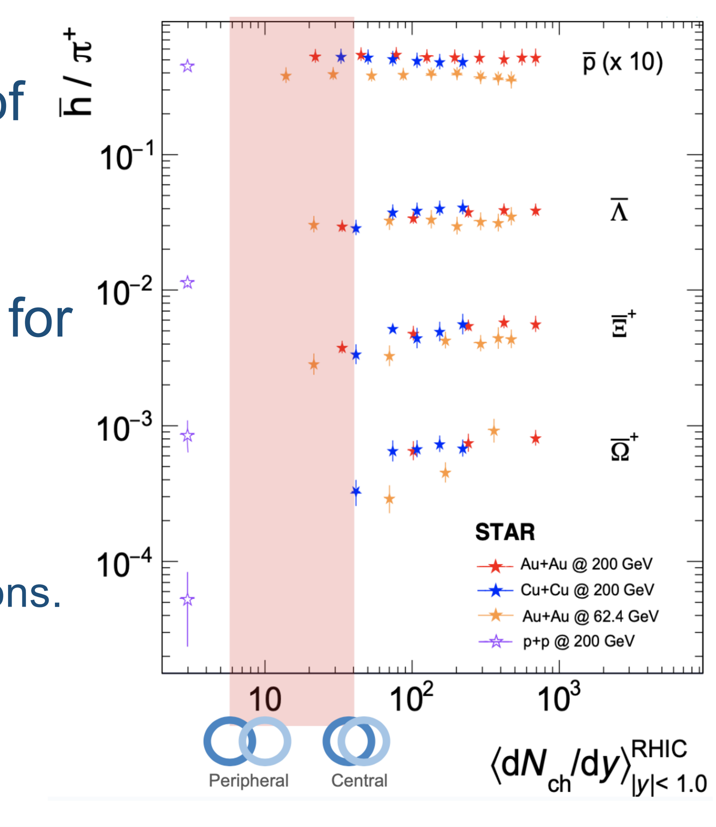
Most central O+O collisions have a similar < N_{part}> as peripheral Au+Au collisions.

Integrating the Λ p_T spectrum from 0 to ∞ the yield (dN/dy) is 0.86 ± 0.05 ± 0.22

**O+O yield is not feed-down corrected.

6) Summary and Outlook

- The O+O dataset can fill in the gaps in the low multiplicity regions in the ratio of strange hadron production to the pion yield for the STAR data.
- We presented the first yield calculation for Λ's in the 0-10% centrality region for O+O.
- Extend the analysis to other hyperons.
  x) The raw p_T spectra are pending the corrections.
- Use thermal model for freeze-out parameter (e.g. μ_B , T_{ch}) extraction.



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