Investigating system size dependence of strange hadron production at 200 GeV at STAR

Xiongxiong Xu (ailondx@rcf.rhic.bnl.gov)
Tsinghua University, *for the STAR Collaboration*

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Abstract

There are significant discussions in the field about the initial conditions, including the size of the system, needed to generate a quark-gluon plasma (QGP). Strangeness production serves as a sensitive probe into the properties of the QGP. It is expected that the Ω/ϕ ratios in different colliding systems may reveal the minimum colliding system size required to produce QGP.

In this poster, we will present the transverse-momentum (p_{T}) spectra of strange hadron ($\phi, \Omega, \overline{\Omega}$) in isobar (Ru+Ru and Zr+Zr) and O+O collisions at $\sqrt{s_{\mathrm{NN}}}$ = 200 GeV at mid-rapidity (y < |0.5|) and the Ω/ϕ ratios in those colliding systems. The O+O system has the extended kinematic coverage benefit from the iTPC upgrade, which extended the rapidity coverage and enhanced the particle identification capability compared with previous results.

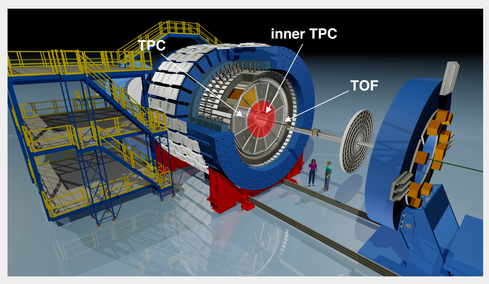
Motivation

- Update Ω/ϕ ratio as a function of p_{T} in different colliding systems to explore the minimum colliding system size required to produce QGP.
- Precise measurement of $\Omega(\overline{\Omega})$ yields to investigate the system size dependence of strangeness production.

STAR Detector

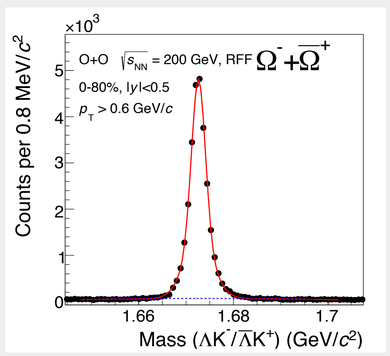
iTPC (STAR Inner Sector TPC Upgrade) :

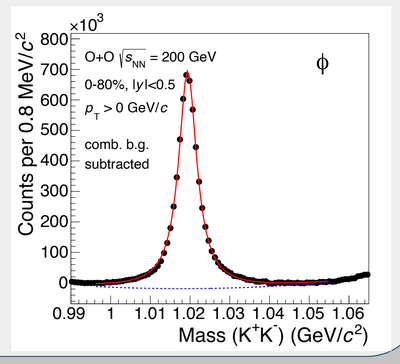
- Larger rapidity coverage — Iηl from 1.0 to 1.5
- Better PID — improved dE/dx resolution
- Lower p_{T} limit — from 125 to 60 MeV/c
- Efficiency of strangeness reconstruction improved significantly



Analysis

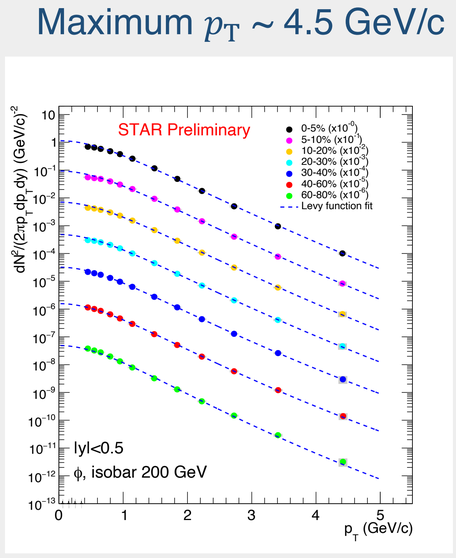
- Dataset: Run18 isobar 200 GeV and Run21 O+O 200 GeV
- ~730M minimum bias events for isobar
- ~370M minimum bias events for O+O
- Particle identification with TPC(dE/dx) and TOF($1/\beta$)
- KFParticle method used in Ω reconstruction – efficiency improved at high p_{T}
- p_{T} region of Ω: 0.8 ~ 4.6 GeV/c
- p_{T} region of ϕ: 0.4 ~ 5.0 GeV/c
- Signal extraction: rotational (for Ω) and mix-event (for ϕ) for combinational background, polynomial fit for residual background & double gaussian fit for signal

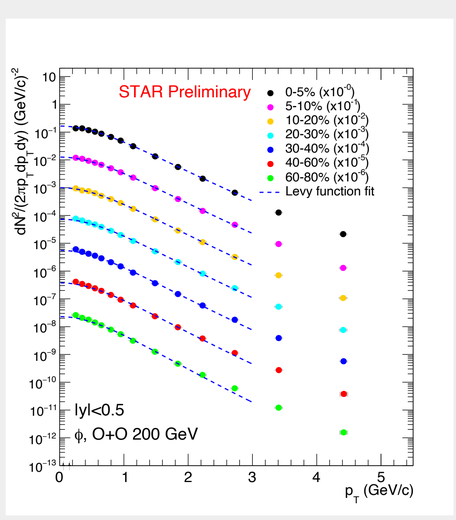




ϕ Meson p_{T} Spectra

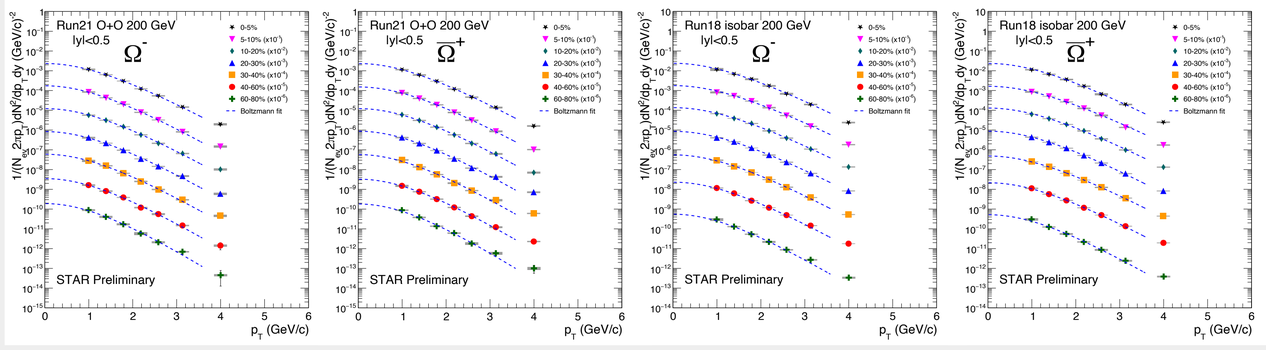
- Precise measurement for 7 centrality (parameter indicating how central the event is) bins
- Maximum p_{T} ~ 4.5 GeV/c





Ω Baryon p_{T} Spectra

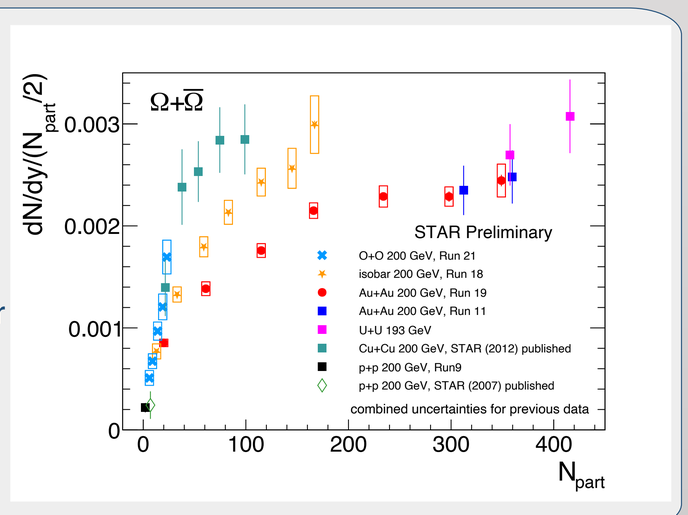
- Precise measurement for 7 centrality bins
- Maximum p_{T} ~ 4 GeV/c
- Low p_{T} extrapolation with Boltzmann function fit; fraction of the integral yield covered by the measured data points: 62 ~ 70%



dN/dy Yields

- N_{part} (number of participant nucleons) scaled Ω yields increase faster with the increasing N_{part} from large (Au+Au) towards small (O+O) systems.
- May result from higher N_{coll} (number of binary collisions) corresponding to the same N_{part} in smaller systems.

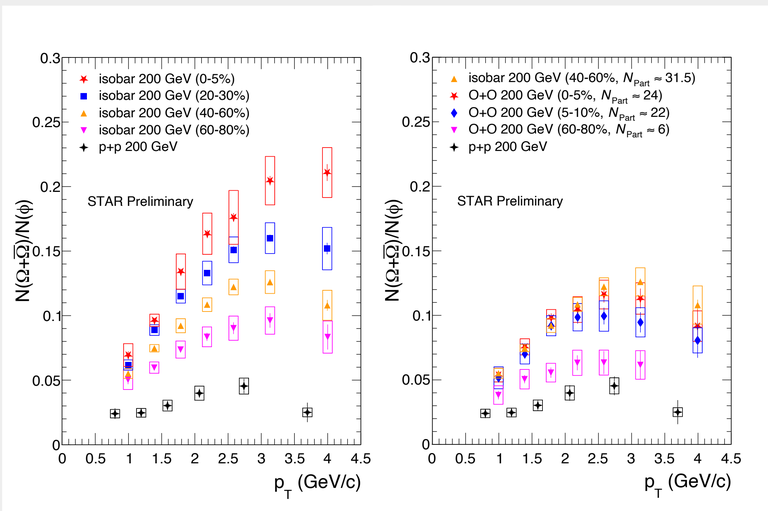
Run11 data points N_{part} shifted for clarity
p+p: STAR, Phys. Rev. C 75 (2007) 064901
Cu+Cu: STAR, Phys. Rev. Lett. 108 (2012) 072301



Ω/ϕ Ratio

- In isobar and O+O collisions, Ω over ϕ enhancement is observed with respect to p+p collisions. Enhancement increases from peripheral to central collisions.
- For collisions with **similar** N_{part}, enhancement in central O+O is **consistent** with 40-60% isobar.

p+p 200 GeV $\Omega + \overline{\Omega}$: X. Zhu, QM2014;
p+p 200 GeV ϕ: STAR, Phys. Rev. C 79(2009) 064903



Summary and Outlook

- Precise measurement of $\phi, \Omega, \overline{\Omega}$ p_{T} spectra and $\Omega, \overline{\Omega}$ yields in isobar and O+O collisions at 200 GeV are achieved.
- N_{part} scaled Ω yield increases faster with the increasing N_{part} from large (Au+Au) towards small (O+O) system.
- In isobar and O+O collisions, Ω over ϕ enhancement is observed with respect to p+p collisions. Enhancement increases from peripheral to central collisions.
- For collisions with **similar** N_{part}, Ω over ϕ enhancement in central O+O is **consistent** with 40-60% isobar; analysis with high-multiplicity triggered O+O events is ongoing.

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