Production of Λ and $\bar{\Lambda}$ in Au+Au collisions at $\sqrt{s_{NN}} = 19.6$ GeV at RHIC

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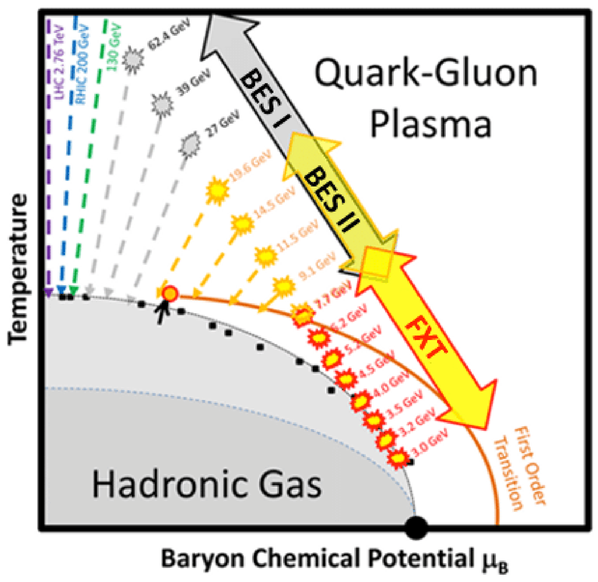
I. Motivation

RHIC Beam Energy Scan Program

- Study of QCD phase diagram.
- Search for the QCD critical point.
- Search for the first order phase transition.

BES-I
$\sqrt{s_{NN}}$ = 62.4, 39, 27, 19.6, 14.5, 11.5, 7.7 GeV

BES-II
$\sqrt{s_{NN}}$ = 54.4, 27, 19.6, 17.3, 14.6, 11.5, 9.2, 7.7 GeV (Collider mode)
$\sqrt{s_{NN}}$ = 13.7, 11.5, 9.2, 7.7, 7.2, 6.2, 5.2, 4.5, 3.9, 3.5, 3.2, 3.0 GeV (FXT)

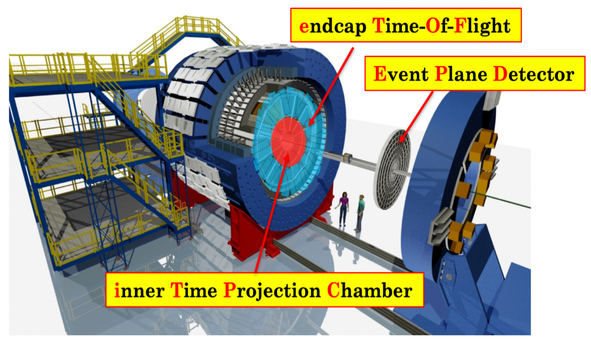


- Strange hadrons (Λ, Ξ, Ω) are excellent probes for identifying the phase bounday and the onset of deconfinement.

II. The STAR Detector

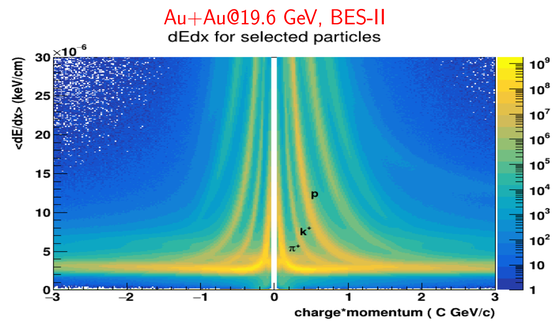
Solenoidal Tracker At RHIC (STAR) consists of several sub-detectors.

Time Projection Chamber (TPC) and the Time-of-flight (TOF) are the main sub-detectors for particle identification.



Time Projection Chamber (TPC)

- Tracking, momentum measurement.
- PID through dE/dx.



iTPC upgrade

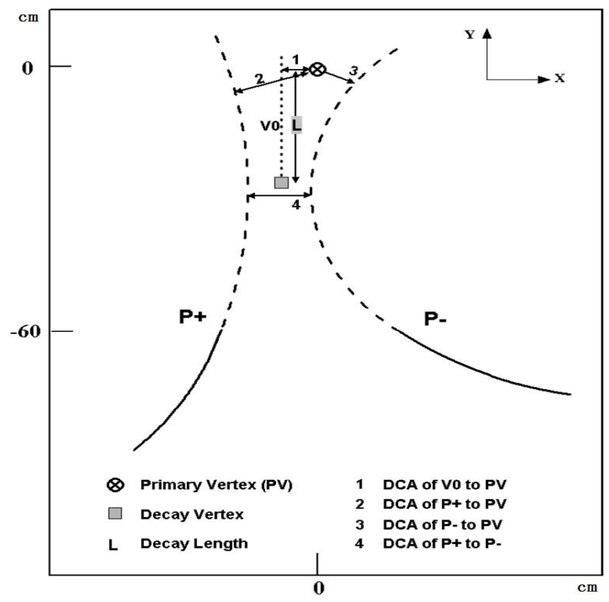
- Better momentum resolution and dE/dx resolution.
- Improved acceptance:
  $|\eta| < 1.0 \longrightarrow |\eta| < 1.5$
- Lower p_T acceptance and broader rapidity acceptance for strange hadron reconstruction.

III. Analysis Method

- Λ ($\bar{\Lambda}$) are weakly decaying particles.
- From the primary vertex, where a heavy ion collision occurs, these particles travel some distance depending on their decay length or lifetime, and decay into daughter particles proton and π which are stable and detected by the detectors [1].

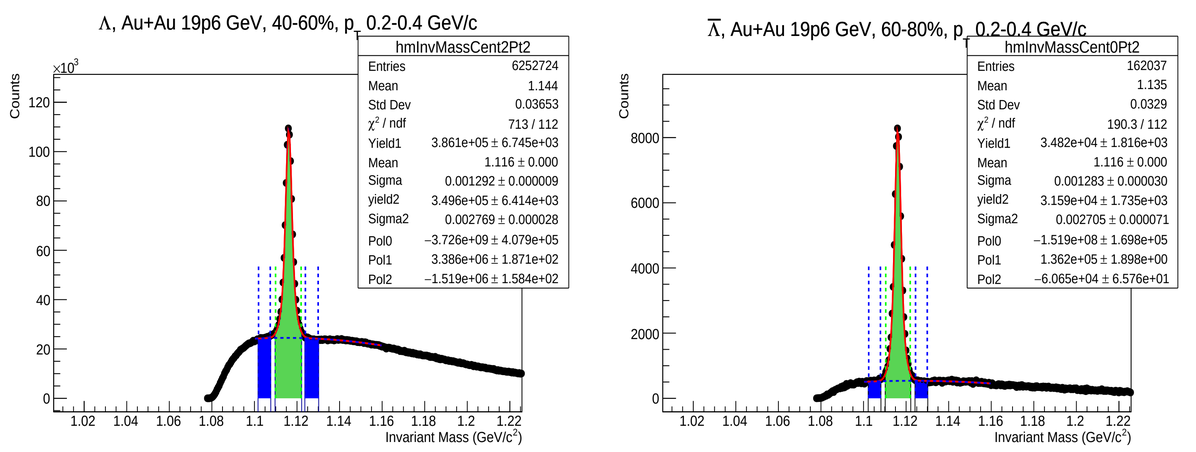
$$\Lambda\ (\bar{\Lambda}) \longrightarrow \mathrm{p}(\bar{p}) + \pi^-\ (\pi^+)$$

Decay topology of $\Lambda(\bar{\Lambda})$:



- Fit the invariant mass distribution with double Gaussian and second order polynomial.

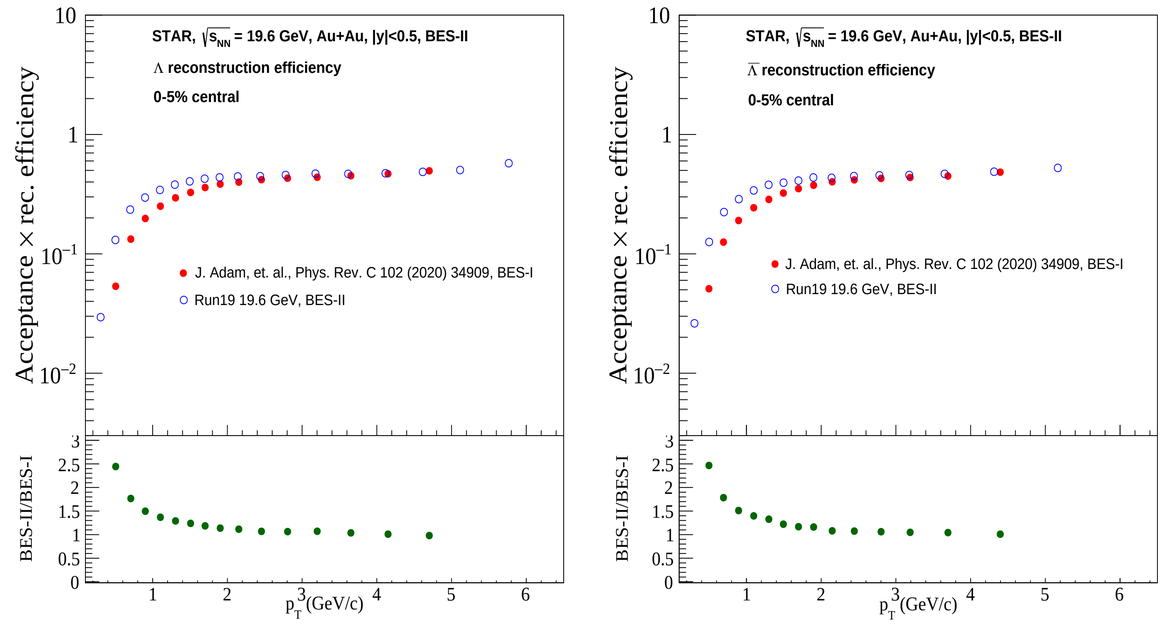
$$a_0 + a_1 x + a_2 x^2 + \frac{Y_1}{\sqrt{2\pi}\sigma_1} \exp\left(\frac{-(m-m_0)^2}{2\sigma_1^2}\right) + \frac{Y_2}{\sqrt{2\pi}\sigma_2} \exp\left(\frac{-(m-m_0)^2}{2\sigma_2^2}\right)$$



- The residual background left after applying the topological cuts is estimated by the polynomial fit function.

IV. $\Lambda(\bar{\Lambda})$ Reconstruction Efficiency

- To study the tracking efficiency, embedding data are used in the STAR experiment where simulated particles are embedded into real data.
- The acceptance and reconstruction efficiency are calculated by dividing the number of reconstructed $\Lambda(\bar{\Lambda})$ by that of input MC ones.



- The iTPC upgrade significantly enhances the reconstruction efficiency at low p_T region.

V. Summary

- High statistics data sets at low energies are recorded in BES-II for studying the QCD phase diagram.
- The upgrade of the inner sectors of the Time Projection Chamber (iTPC) provides a wider rapidity coverage, lower p_T cutoff, and better momentum and dE/dx resolution.
- The iTPC upgrade significantly enhances the reconstruction efficiency of $\Lambda(\bar{\Lambda})$ at low p_T region in BES-II in comparision to BES-I.

References:

[1] STAR, J. Adam et al. Phys. Rev. C 102, (2020) 034909

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