Study of strange particle production in Xe+CsI interactions at √s = 3.26 AGeV at the BM@N experiment

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Experiment goals

Study of the strangeness production is one the main physics topics of heavy-ion experiments. Strange probes provide information about properties of hot and dense nuclear matter produced in high-energy nuclear interactions, in particular, its equation of state.

BM@N detector at Nuclotron-NICA

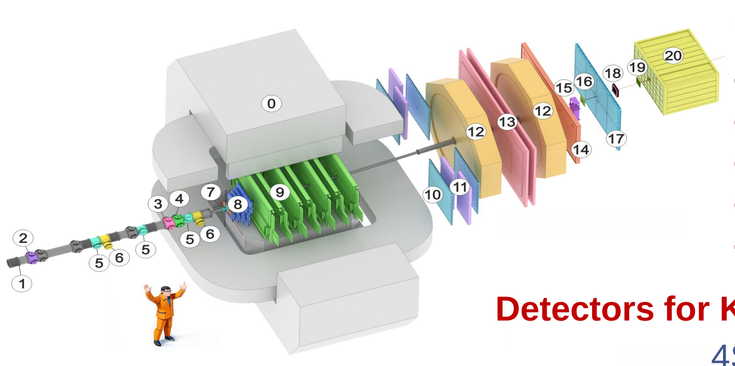


Fig. BM@N setup

Characteristics:

- **Magnet:** <= 1.0 T dipole
- **Tracking:** Si, GEM
- **Particle ID:** TOF, GEM
- **T0, Triggering:** scintillators
- **Centrality, Event Plane:** FHCal

Detectors for K^0_s and Λ decay reconstruction:

4Si + 7GEM stations

First physics run with full configuration Dec. 2022 - Jan. 2023 Xe^{124} + CsI interactions, beam kinetic energy 3.8A GeV: main trigger covers centrality < 70-75% (85% events), min bias trigger (7% events), beam trigger (3% events) ~500M triggers recorded

Transverse mass spectra of K^0_s (2M)

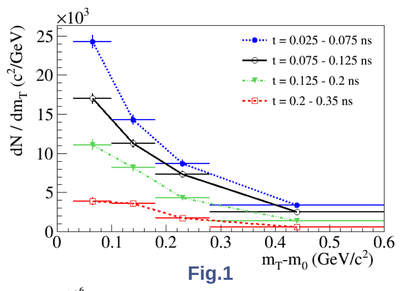


Fig.1

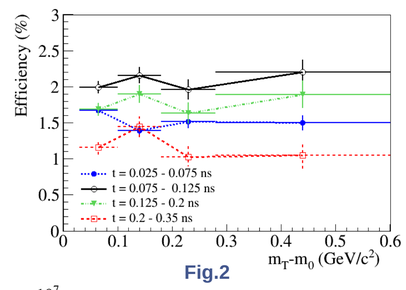


Fig.2

Boltzmann distribution:

$$\frac{1}{m_t^2}\frac{d^2M}{dm_t dy} = C(y)\exp\left(-\frac{(m_t-m_0)c^2}{T_B(y)}\right)$$

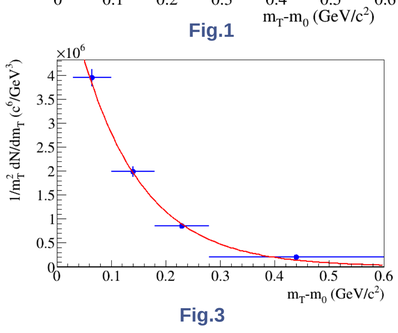


Fig.3

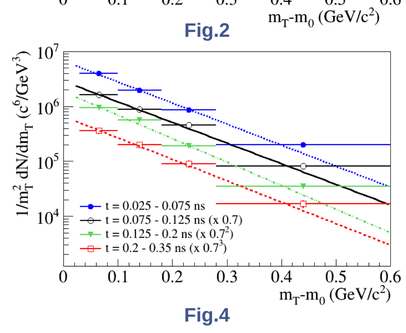


Fig.4

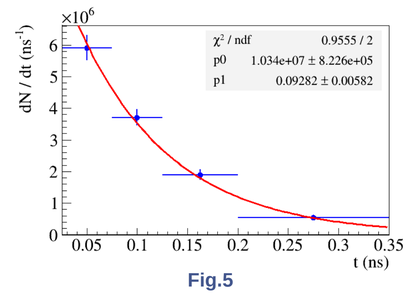


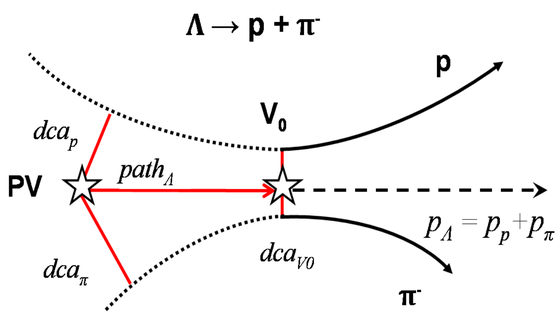
Fig.5

Fig.1-2. Yields and efficiencies vs m_T for different lifetime intervals
Fig.3. Corrected for efficiency m_T spectrum
Fig.4. m_T spectra for different lifetimes fitted to the Boltzmann function to obtain effective temperatures (inverse slopes) and integrated particle yields
Fig.5. K^0_s decay curve reconstructed from integrated m_T spectra for different lifetimes

Effective temperature:

T1 = 113±3 MeV
T2 = 116±3 MeV
T3 = 104±4 MeV
T4 = 111±8 MeV

Decay topology



Basic selection criteria (topological cuts):

- distances of the closest approach to primary vertex of decay products (dca_p)
- 2-track distance (dca_{V0})
- decay length (path)

Transverse mass and rapidity spectra of Λ

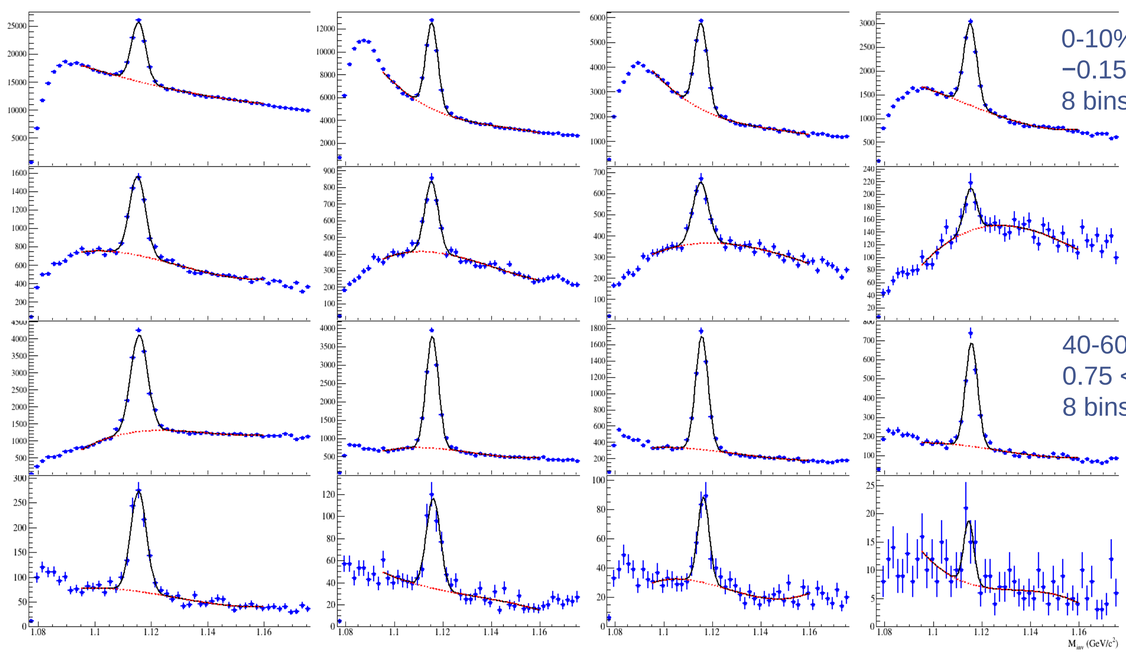


Fig.1

Lifetime measurement of K^0_s and Λ (2M)

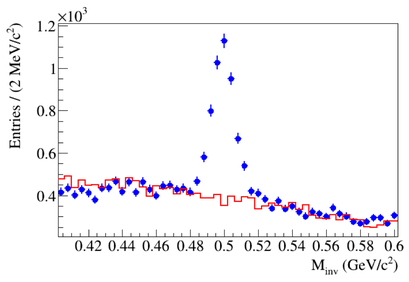


Fig.1

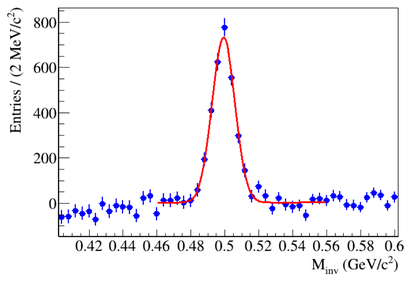


Fig.2

$K^0_s \rightarrow \pi^+ + \pi^-$

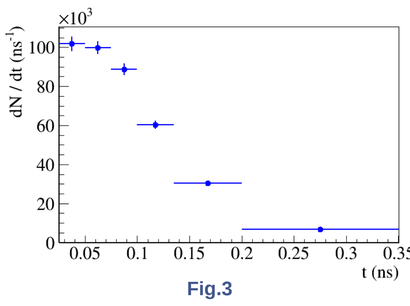


Fig.3

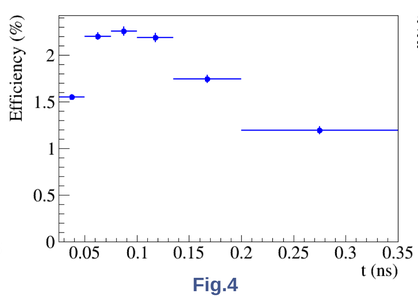


Fig.4

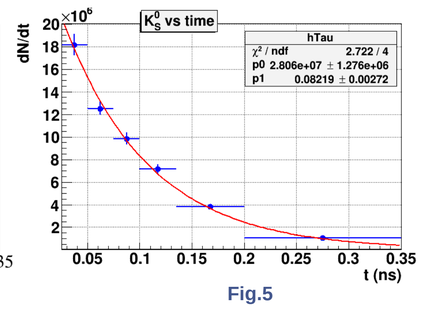


Fig.5

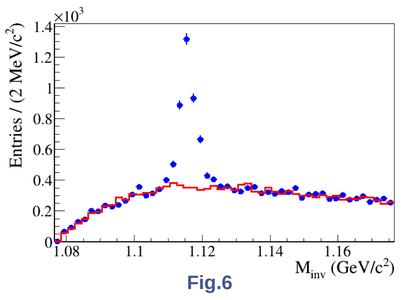


Fig.6

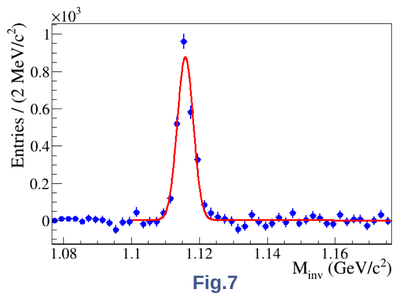


Fig.7

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

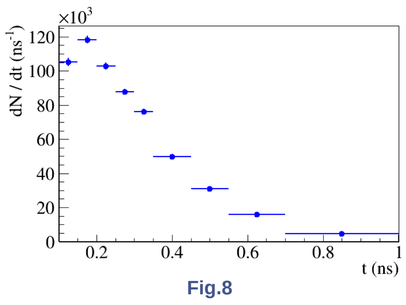


Fig.8

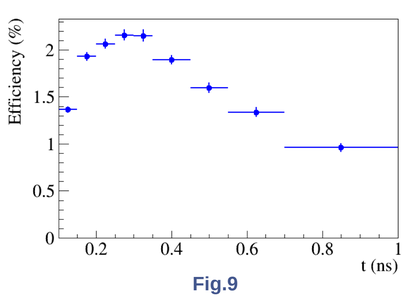


Fig.9

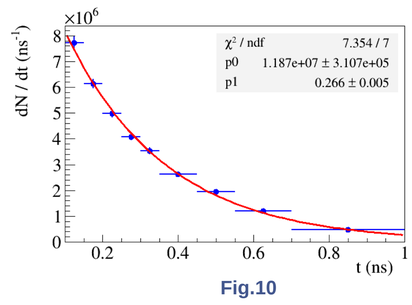


Fig.10

Fig.1-2. Invariant mass of K^0_s before and after background subtraction
Fig.3-5. Reconstructed K^0_s meson yield versus lifetime, efficiency and decay curve of K^0_s
Fig.6-7. Invariant mass of Λ before and after background subtraction
Fig.8-10. Reconstructed Λ hyperon yield versus lifetime, efficiency and decay curve of Λ

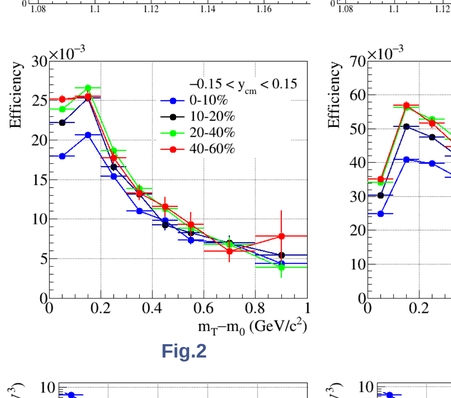


Fig.2

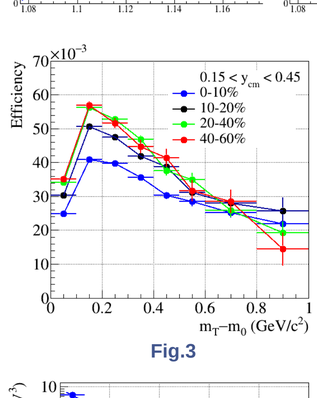


Fig.3

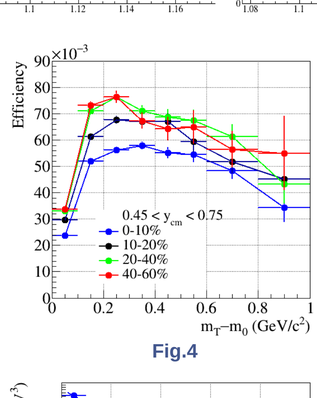


Fig.4

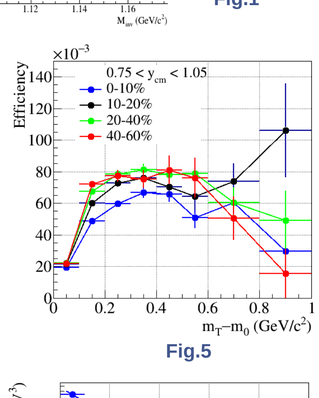


Fig.5

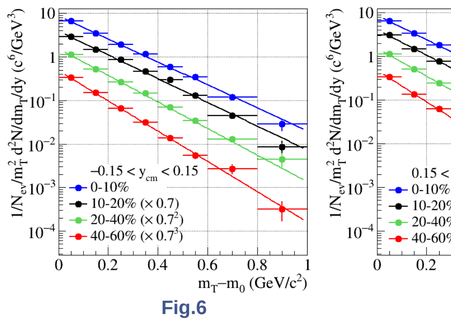


Fig.6

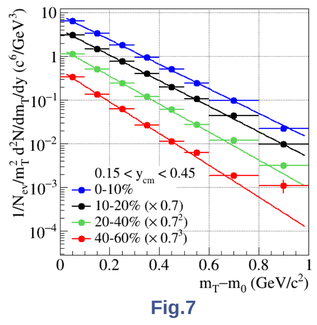


Fig.7

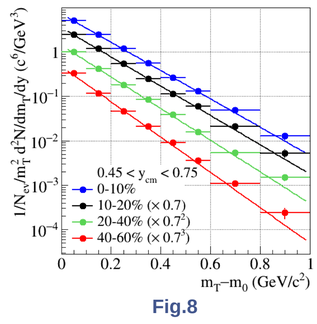


Fig.8

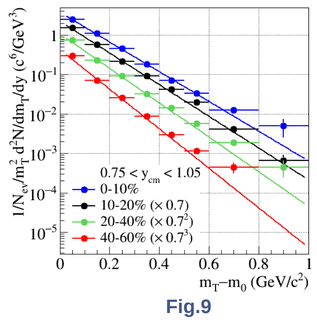


Fig.9

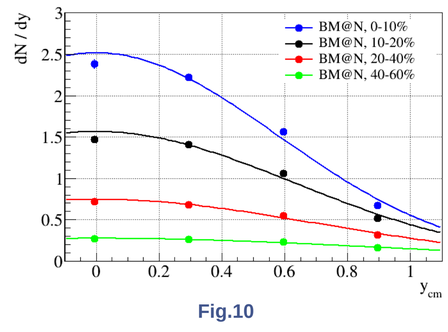


Fig.10

Statistics: 60M events

Fig.1. Invariant mass of Λ for 2 centralities and 8 m_T bins
Fig.2-5. Efficiencies of Λ for 4 rapidity and 4 centrality intervals
Fig.6-9. m_T spectra for 4 rapidity and 4 centrality intervals fitted to the Boltzmann function
Fig.10. Rapidity spectra for different centralities fitted to the Gaussian function

Conclusions

The results presented demonstrate that the BM@N experiment provides good conditions for measurement of strange particle production in heavy-ion interactions at Nuclotron-NICA. Physics analyses of collected data are underway.