Hyperons in BiBi collisions at MPD-NICA

Preliminary analysis of production at generation, simulation and reconstruction level.

Alejandro Ayala, Eleazar Cuautle, Isabel Domínguez, M. Rodríguez-Cahuantzi, Ivonne Maldonado*, María Elena Tejeda-Yeomans

*Facultad de Ciencias Físico Matemáticas, Universidad Autónoma de Sinaloa
ivonne.alicia.maldonado@gmail.com

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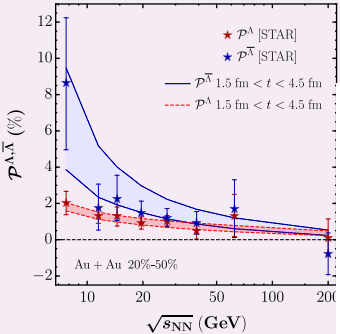
Outline

Section 1

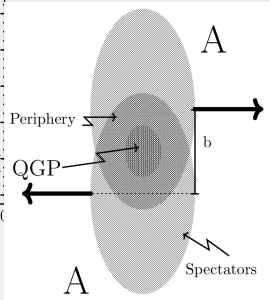
Motivation

Motivation: Core meets Corona



Polarization of Λ and $\bar{\Lambda}$ compared with data from the BES[Nature 548,62-65(2017)]

A two component source to explain Λ and $\bar{\Lambda}$ global polarization in semi-central heavy-ion collisions.
J.Phys.Conf.Ser. V. 1602 no 1 (2020) 012032, Phys.Lett.B. V810 (2020)135818



$$\mathcal{P}^{\Lambda} = \frac{z\frac{N_{\Lambda_{QGP}}}{N_{\Lambda_{REC}}}}{\left(1+\frac{N_{\Lambda_{QGP}}}{N_{\Lambda_{REC}}}\right)} \quad (1)$$

$$\mathcal{P}^{\bar{\Lambda}} = \frac{(\frac{\bar{z}}{w})\frac{N_{\Lambda_{QGP}}}{N_{\Lambda_{REC}}}}{\left(1+(\frac{1}{w})\frac{N_{\Lambda_{QGP}}}{N_{\Lambda_{REC}}}\right)} \quad (2)$$

- $z(\bar{z})$ intrinsic polarization
- $w \rightarrow \bar{\Lambda}/\Lambda$ ratio in periphery;
- `QGP` $\rightarrow$ central region
- `REC` $\rightarrow$ periphery region

Section 2

Analyzed Data

Analyzed data: BiBi at $\sqrt{s_{NN}} = 11\text{GeV/c}$

- Generation of ≈ 100000 events of $Bi + Bi$ for each different centrality sets of data
  - Minimum Bias,
  - Central collisions $b < 4$ fm,
  - Semi-Central collisions $6 < b < 8$ fm
  - Peripheral collisions $b > 10$fm
- Generator $\rightarrow$ UrQMD
- Transport $\rightarrow$ GEANT3
  - TPC, TOF, EMC, ZDC
- Reconstruction analysis $\rightarrow$ Only TPCKalmanTracks

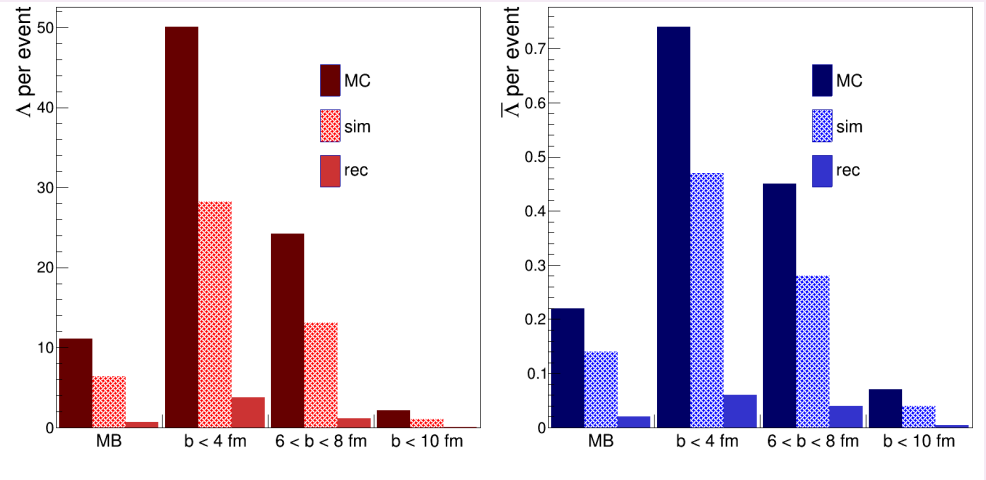
Data type: MC/Sim/Rec

Number of Λ and $\bar{\Lambda}$ per event at each data set

- MC data $\rightarrow$ Λ and $\bar{\Lambda}$ generated by UrQMD + particle decays, secondary interactions by GEANT3 transport package
- Sim data $\rightarrow$ Find-able Λ and $\bar{\Lambda}$, identified by the products of its charged decay and with $p_{T>0.001}$ and $|\eta| < 1.3$
- Rec data $\rightarrow$ Reconstructed Λ and $\bar{\Lambda}$, identified by combination of secondary tracks of opposite charge.

Data	Generated		Simulated		Reconstructed	
Sample	Λ	$\bar{\Lambda}$	Λ	$\bar{\Lambda}$	Λ	$\bar{\Lambda}$
MB	11.8	0.22	6.36	0.14	0.66	0.02
$b < 4$ fm	50.6	0.74	28.2	0.47	3.78	0.06
$6 < b < 8$ fm	24.0	0.45	13.1	0.28	1.16	0.04
$b > 10$ fm	2.12	0.07	1.10	0.04	0.05	0.004

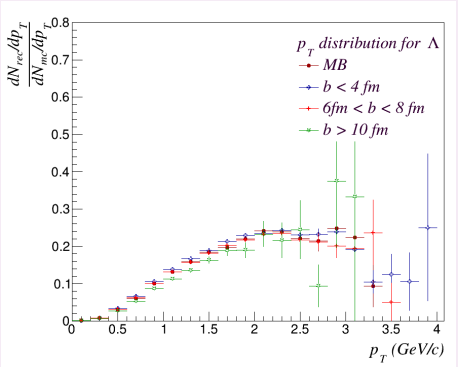
Comparison: MC/Sim/Rec

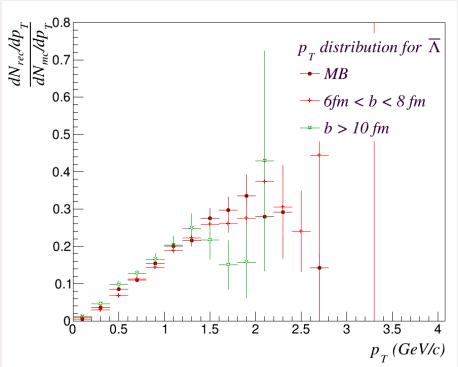


Number of Λ and $\bar{\Lambda}$ per event at each level of analysis and impact parameters

Maximum efficiency for reconstruction in p_T

The efficiency for Λ and $\bar{\Lambda}$ for each data set is similar



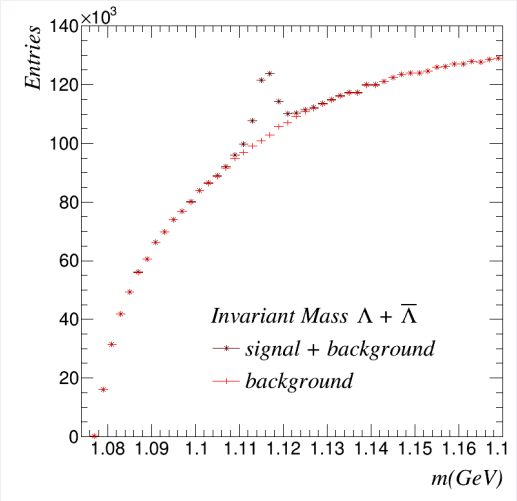


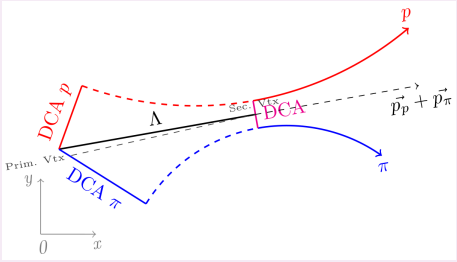
Maximum efficiency with MC association

Section 3

Reconstruction

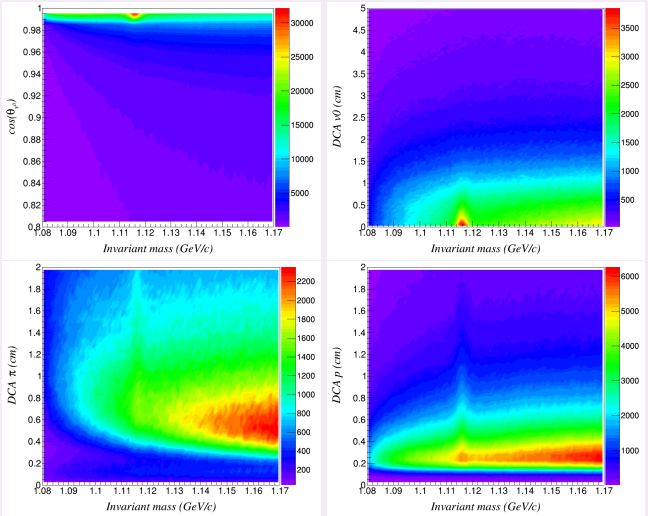
Reconstruction: Kinematic and topological variables





Variable	Cut
Cos of Angle	?
DCA V^0	? cm
DCA $p-$track	? cm
DCA $\pi-$track	? cm

Cuts for selection



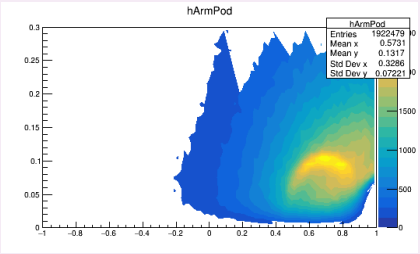
Most of Λ and $\bar{\Lambda}$ are in:

- $\cos(\theta) > 0.98$
- DCA $V^o < 0.5$ cm
- DCA $p - track > 0.1$ cm
- DCA $\pi - track > 0.3cm$

Some cuts distinguish Λ from $\bar{\Lambda}$

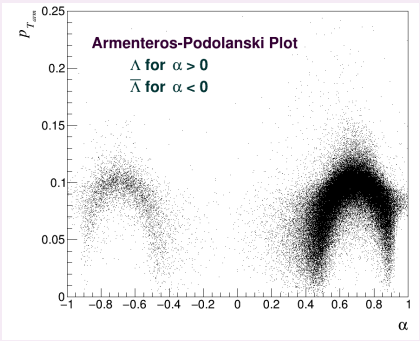
Distinguish between Λ and $\bar{\Lambda}$

$$\alpha = \frac{p_L^+ - p_L^-}{p_L^+ + p_L^-} \qquad (3)$$



We use:

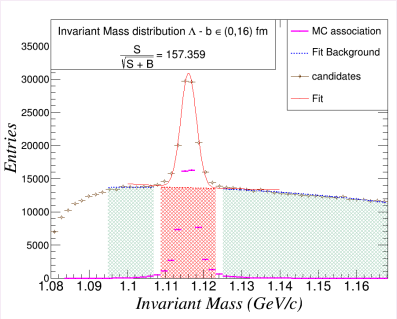
- $\alpha > 0$ for Λ
- $\alpha < 0$ for $\bar{\Lambda}$



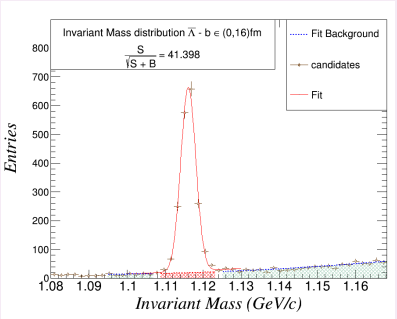
Even with cuts the background difficult to visualize $\bar{\Lambda} \rightarrow$ we use MC association

Invariant Mass with Preliminary Cuts

Λ - in MB data set



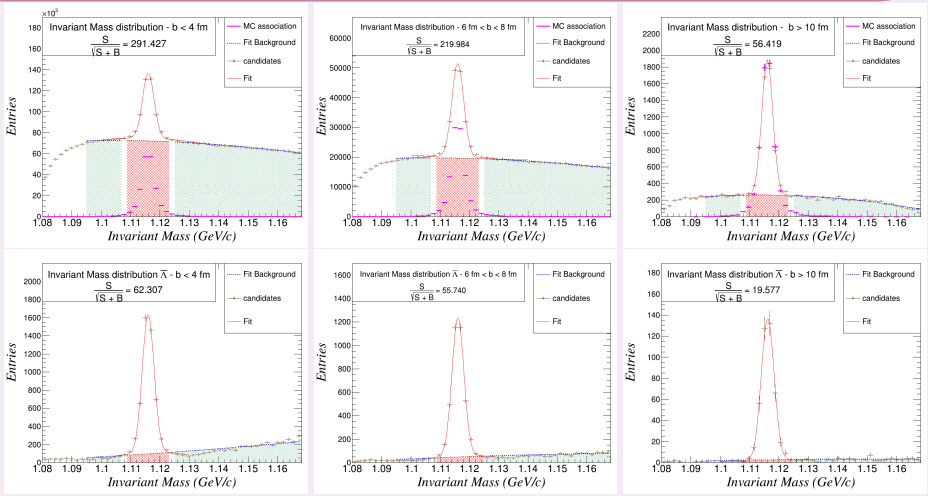
$\bar{\Lambda}$ - in MB data set



Variable	Cut
Cos of Angle	< 0.98
DCA V^0	< 0.5 cm
DCA $p-$track	> 0.1 cm
DCA $\pi-$track	> 0.3 cm

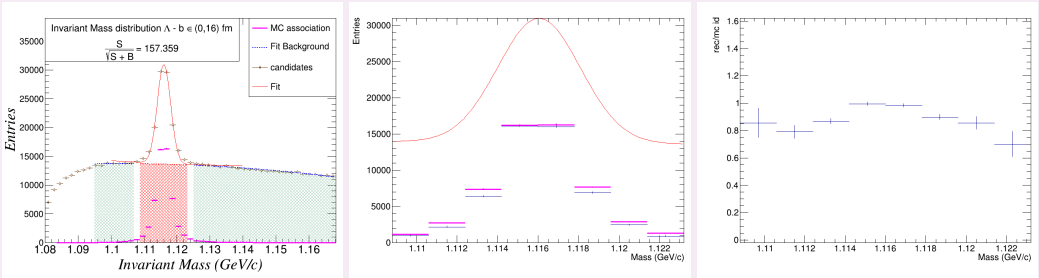
Significance measured in 3.5σ from the peak.

Invariant Mass at different b



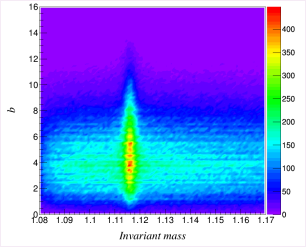
Signal decreases with impact parameter

Invariant Mass ratio for Λ

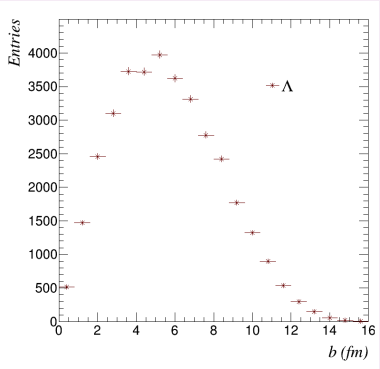


Background subtraction and comparison with MC association of V^o candidates

Λ and $\bar{\Lambda}$ vs Impact Parameter

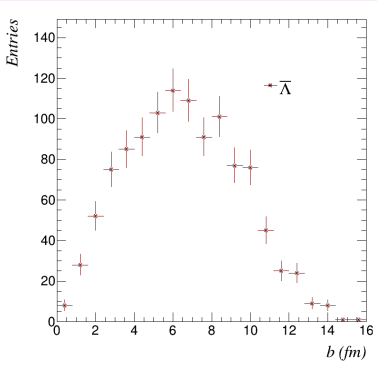


To do:
With bin counting background subtraction method we can clean the signal to get distributions like these at right

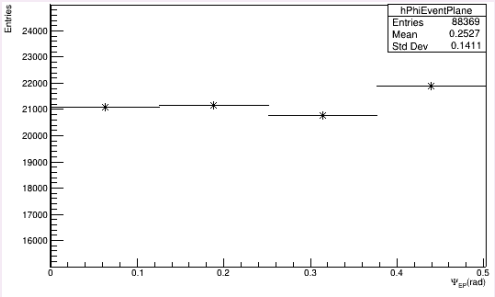


Code:
$b = (\text{FairMCEventHeader}*) \rightarrow \text{GetB}();$

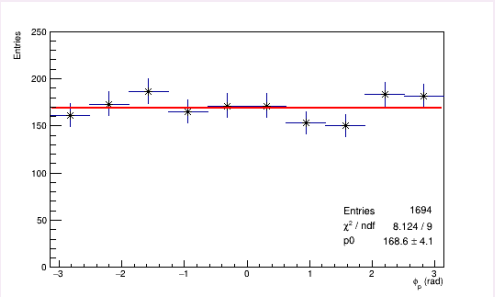
For these two distributions we get the MC identification of the reconstructed tracks after kinematic cuts



Angular distributions: ϕ_p and Ψ_{EP}

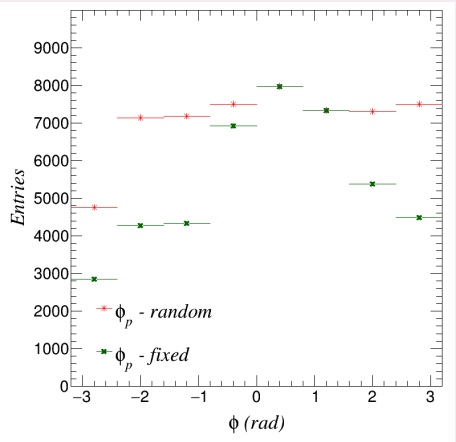


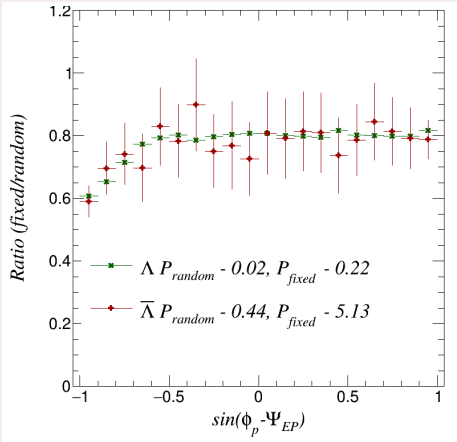
MC $\rightarrow$ randomly in $(0, 30^o)$ isotropic distribution



Azimuthal angle of baryons is constant, there is not polarization

Preliminary - $\sin(\phi_p - \Psi_{EP})$





inhomogeneous azimuthal baryon decay distribution lead to different estimations of polarization.

Section 4

Summary

Summary

- We have presented a general overview of Λ and $\bar{\Lambda}$ reconstruction using the MPD, aimed at measuring the hyperon global polarization for NICA energies.
- We plan to get the polarization with the measured event plane and to improve the selection of Λ and $\bar{\Lambda}$ considering the particle identification for the decay product tracks and improving the topological cuts to increase the significance.
- We plan to model the azimuthal angular distributions of the decay baryons to simulate polarization of particles coming from the different density regions, and compare with results obtained with other generators such as DCM-SMM and DCM-QGSM.

¡GRACIAS!