Hyperon global Polarization

STRATEGY

I. A. Maldonado C. for MexNICA *ivonne.alicia.maldonado@gmail.com*
FCFM - UAS

November 17^{th}, 2020

Instituto de Ciencias Nucleares UNAM

Index

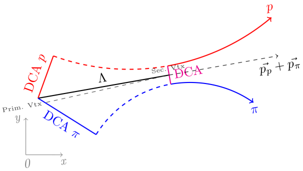
Measurement procedure of Hyperon Global Polarization

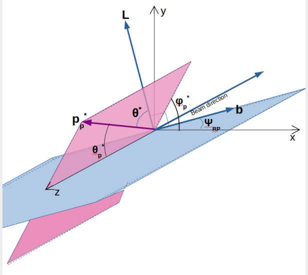
1. Λ and $\bar{\Lambda}$ identification through their decay products and measurement of the azimuthal angle of the decay baryon ϕ_p^*
2. Measurement of the Event Plane angle Ψ_{EP} and its Resolution R_{EP}
3. Polarization as a function of the difference of these angles

Polarization

$$\mathcal{P}_H = \frac{8}{\pi \alpha_H} \frac{\left\langle \sin\left(\phi_p^* - \Psi_{EP}^{(1)}\right)\right\rangle}{R_{EP}}$$

$\alpha_H = 0{,}642 \pm 0{,}013$ - hyperon decay parameter





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

- Generation of $\approx 100,000$ events of Bi+Bi for each different centrality sets of data
  - Minimum Bias,
  - Central collisions $b < 4$ fm,
  - Semi-Central collisions 6 fm $< b <$ 8 fm
  - Peripheral collisions $b >$ 10 fm
- Generator $\rightarrow$ UrQMD
- Transport $\rightarrow$ GEANT3
  - TPC, TOF, EMC, ZDC
- Reconstruction analysis $\rightarrow$ TPCKalmanTracks

Data type: MC/Sim/Rec

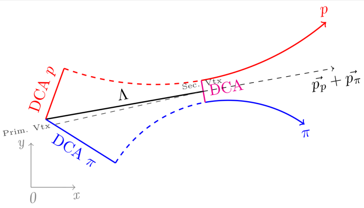
- MC data $\rightarrow$ Λ and $\bar{\Lambda}$ generated by UrQMD + particle decays, secondary interactions by GEANT3 transport package
- Sim data $\rightarrow$ Findable Λ and $\bar{\Lambda}$, identified by the products of its charged decay and with $p_T > 0{,}001(\mathrm{GeV}/c)$ and $|\eta| < 1{,}3$
- Rec data $\rightarrow$ Reconstructed Λ and $\bar{\Lambda}$, identified by combination of secondary tracks of opposite charge.

MC and Sim data required for efficiency and acceptance corrections

Λ and $\bar{\Lambda}$ identification

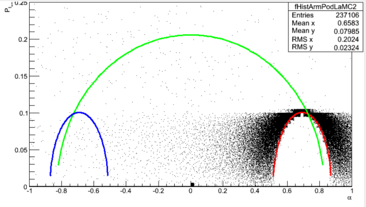
- Cuts on Kinematical and Topological variables

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



- Armenteros-Podolanski variables

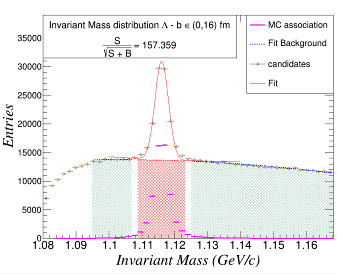
$$\alpha = \frac{p_L^+ - p_L^-}{p_L^+ + p_L^-} \quad vs. \quad p_T^{(\pm)}$$



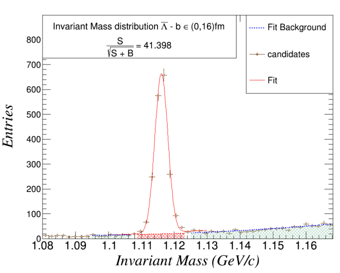
$\alpha > 0$ for Λ and $\alpha < 0$ for $\bar{\Lambda}$.

Invariant Mass distribution and background subtraction

Λ - MB set



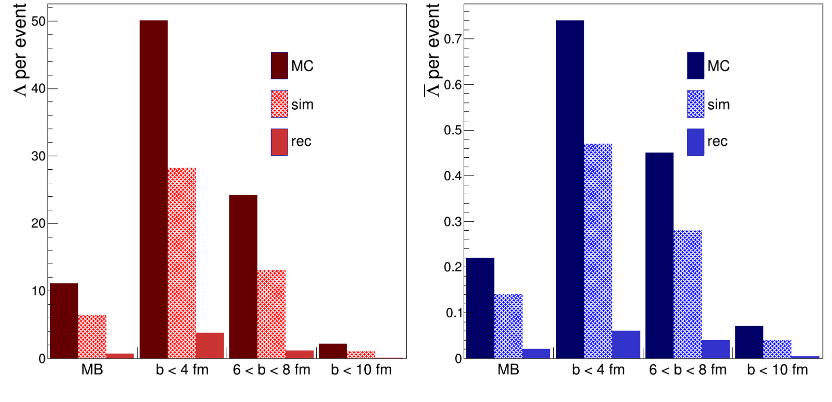
$\bar{\Lambda}$ - MB set



- Selection should be improved with PID
- Fit $\rightarrow$ Gaussian + polynomial
- Bin Counting background subtraction method $\rightarrow$ Clean signal to get the different variables: ϕ^*_p, p_T, y, etc.

We can estimate also the number of particles in different subsets of impact parameter

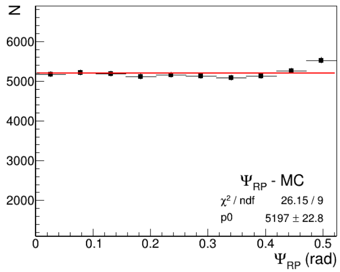
Number of hyierons per event



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

Event plane with p_T and E_{Loss}

MC $\rightarrow \Psi_{RP}$ randomly in $(0, 30^o)$ isotropic distribution



For reconstructed data we can use the Flow's technique

For simulated data we get the Event plane angle $\Psi_{EP}^{(1)}$:

$$\Psi_{EP}^{(n)} = \frac{1}{n} \arctan \frac{Q_y}{Q_x}$$

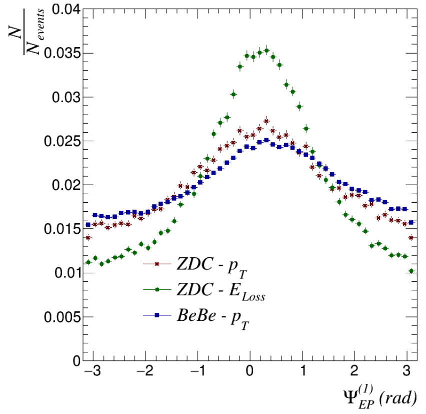
where:

$$Q_x = \sum_i w_i \cos(n\phi_i)$$

$$Q_y = \sum_i w_i \sin(n\phi_i)$$

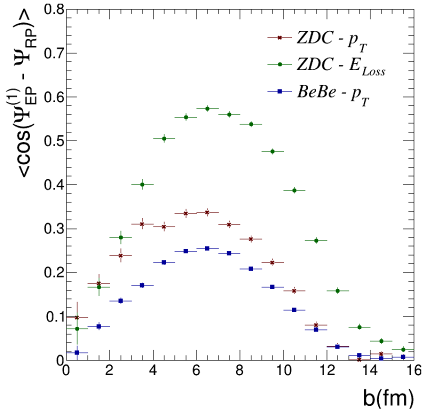
Where w_i is p_T for both TPC and ZDC points or E_{Loss} for ZDC points

Event Plane Angle $\Psi_{EP}^{(1)}$



Bi + Bi at $\sqrt{s_{NN}} = 11$ GeV
BmdPoints and ZdcPoints, similar analysis
For BeBe analysis we use ≈ 500000 events
difference between Energy loss and pt weight

Event Plane Angle Resolution $R^{(1)}_{EP}$

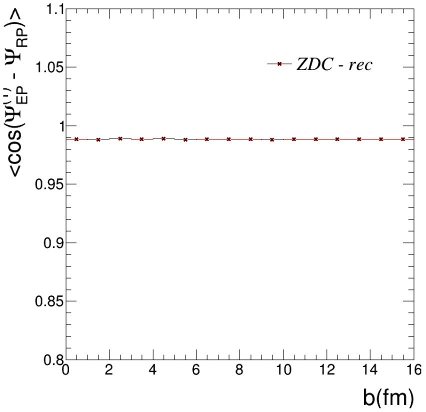


$$R^{(1)}_{EP} = \left\langle cos(\Psi^{(1)}_{EP} - \Psi_{RP}) \right\rangle$$

Bi + Bi at $\sqrt{s_{NN}} = 11$ GeV
higher with energy

Event plane for reconstructed data

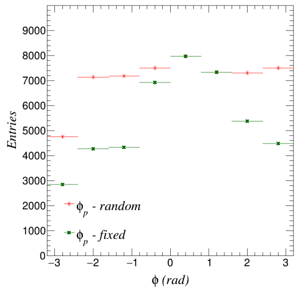
For this case $w_i = \frac{E_i}{E_{Total}}$ is the energy in each module, divided by the total energy deposited in all modules and ϕ_i is the azimuthal angle of each module $\rightarrow$ MpdCalculator macro

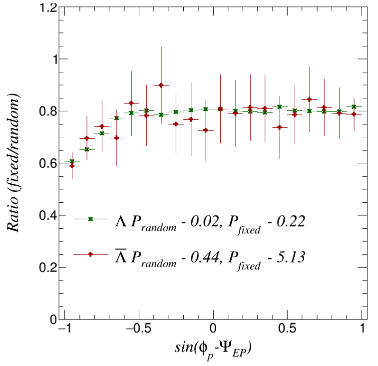


Preliminary $\sin(\phi_p - \Psi_{RP})$

We use the Ψ_{RP} and a random ϕ_p distribution as a first approximation.

$$\mathcal{P}_H = \frac{8}{\pi \alpha_H} \left\langle \sin(\phi_p^* - \Psi_{RP}) \right\rangle$$

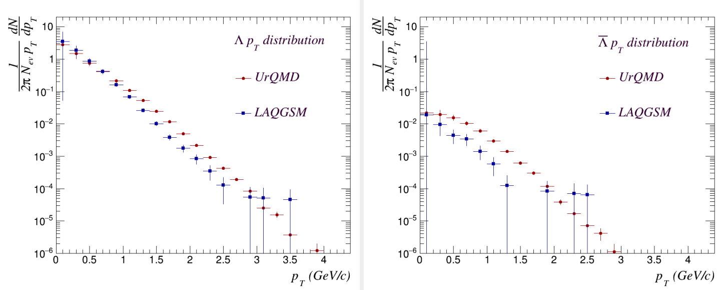




A change in ϕ_p produces a change in $\mathcal{P}_\mathcal{H}$

p_T distribution for Λ and $\bar{\Lambda}$

Comparison of p_T distribution between UrQMD and LAQGSM



Only MC analysis

LAQGSM $\approx$ 1000 events

Later we want to compare also with DCM-SMM

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 have an estimation of the evet plane angle with BeBe and ZDC detector.
- 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 or LAQGSM.