Analysis/Off-Line

MPD – PWG 1

Hyperons in BiBi collisions at MPD-NICA

Preliminary analysis of production at generation, simulation and reconstruction level

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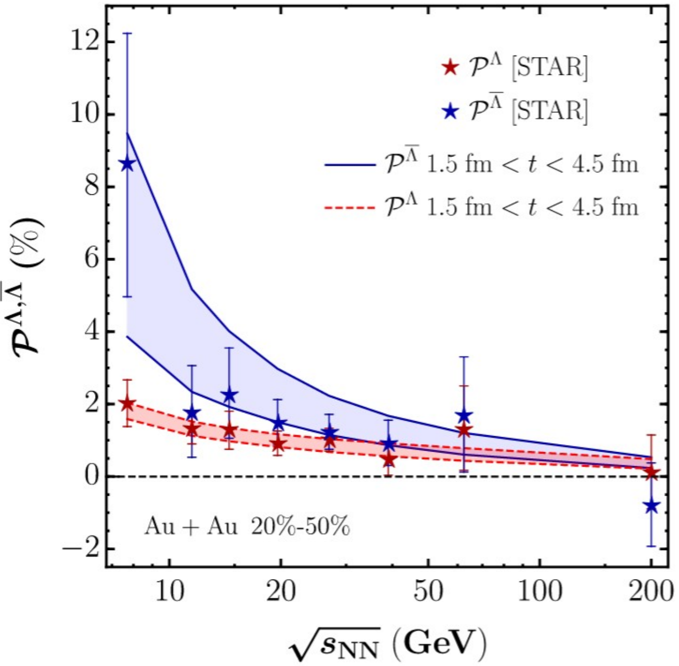
Content

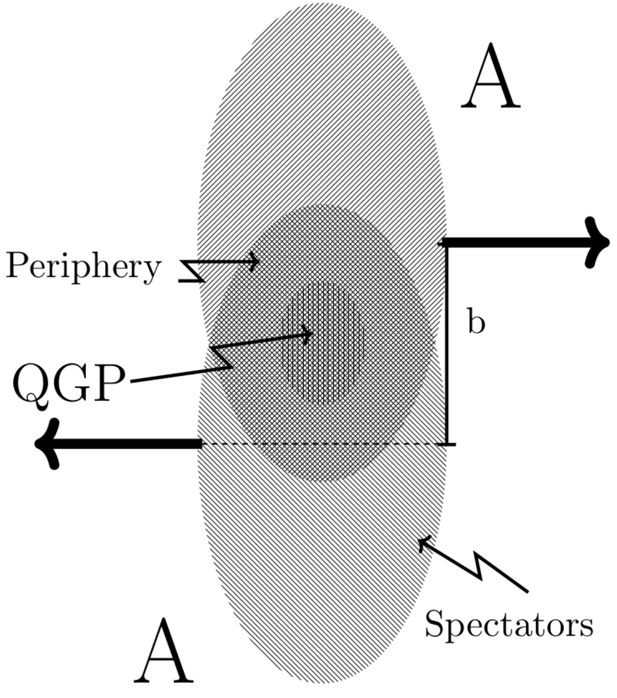
- Motivation
- Production in different sets of collisions and the maximum values that can be reconstructed.
- Pt ratio between the reconstructed and simulated Λ's primary (created by UrQMD) and secondary (interaction with the detector), at $|\eta|<1.3$ to estimate the maximum efficiency, we expect this value to decreases due to the cuts.
- Selection of kinematical cuts to reconstruct Λ and $\bar{\Lambda}$.
- Preliminary angular distribution of decay products

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. https://arxiv.org/abs/2003.13757 https://arxiv.org/pdf/2006.10015.pdf



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

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

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

Data analyzed $\sqrt{s_{NN}}$ =11GeV

- ~ 100000 events for MB/ b<4fm / 6fm<b<8fm /b>10fm
- UrQMD for generation
- Simulation/Reconstruction → Geant3
  - TPC, TOF, EMC, ZDC
- Reconstruction analysis → only with TPCKalmanTracks

Data type: MC/Sim/Rec

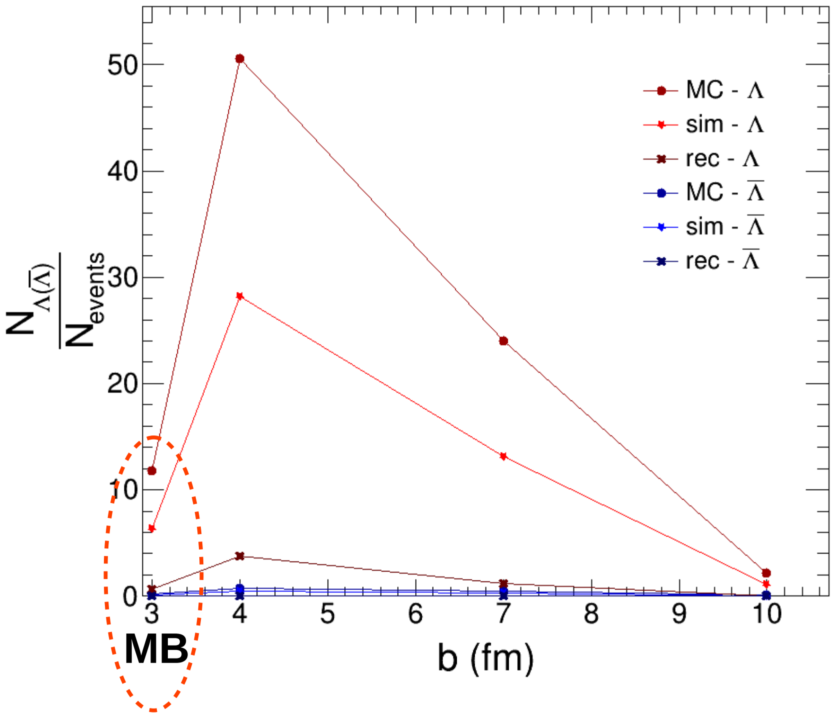
MC data → Λ and $\bar{\Lambda}$ generated by UrQMD + particle decays, secondary interactions by GEANT3 transport package

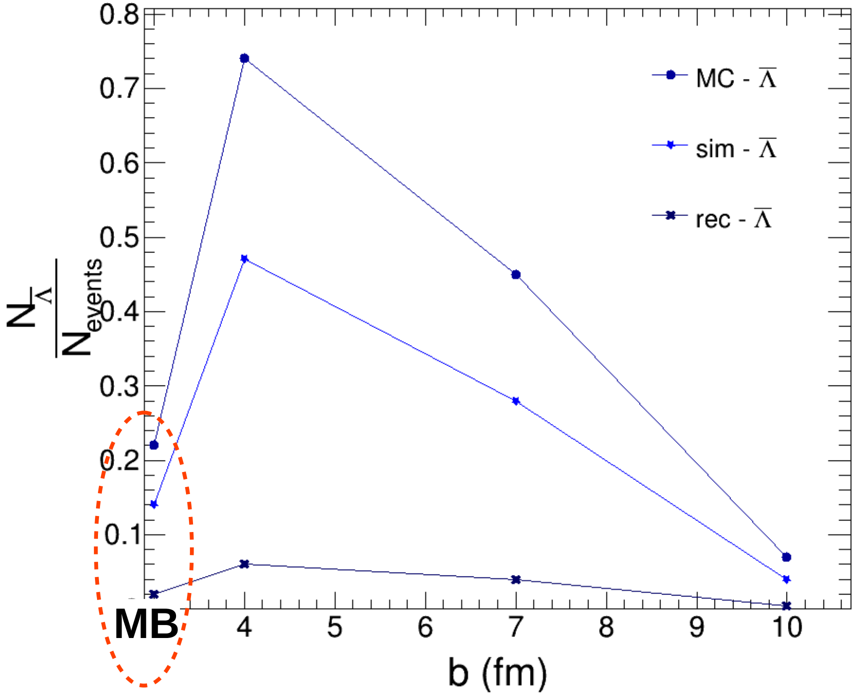
Sim data → Findable Λ and $\bar{\Lambda}$, identification of products of its charged decay and $p_T > 0.001$ GeV/c and $|\eta| < 1.3$

Rec data → Reconstructed Λ and $\bar{\Lambda}$, by combination of identified secondary $p^+(p^-)$ and $\pi^-(\pi^+)$

Data	**Generated**		**Simulated**		**Reconstructed signal**	
	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



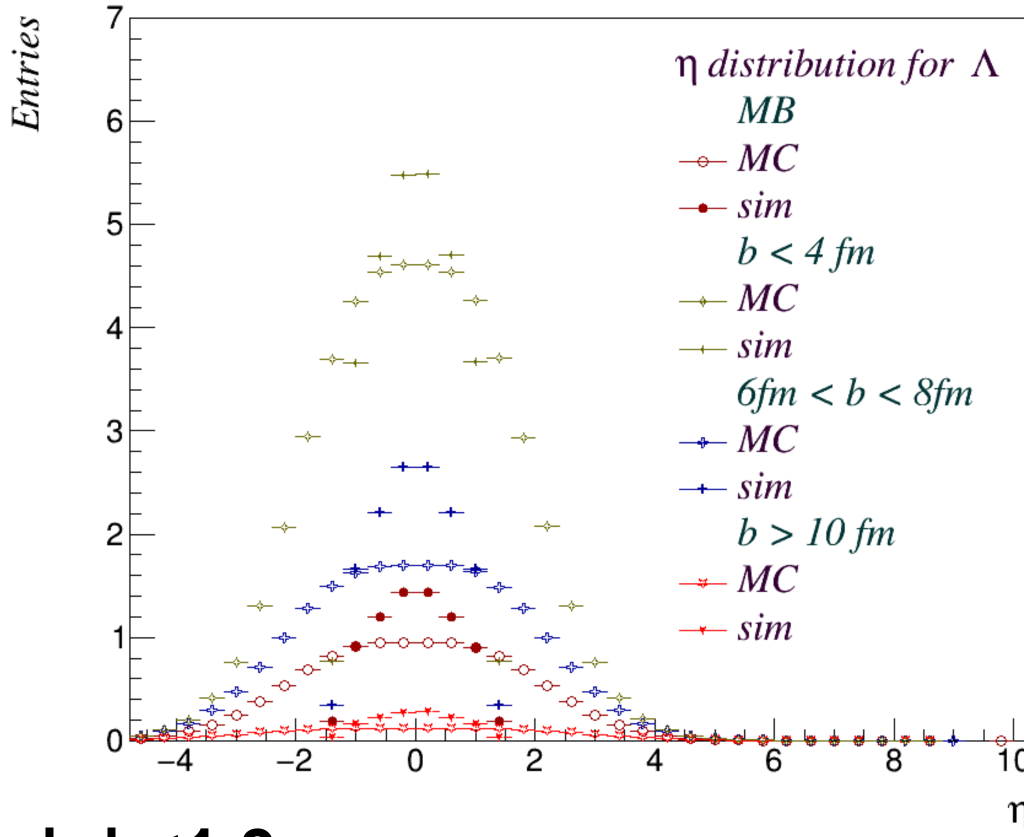


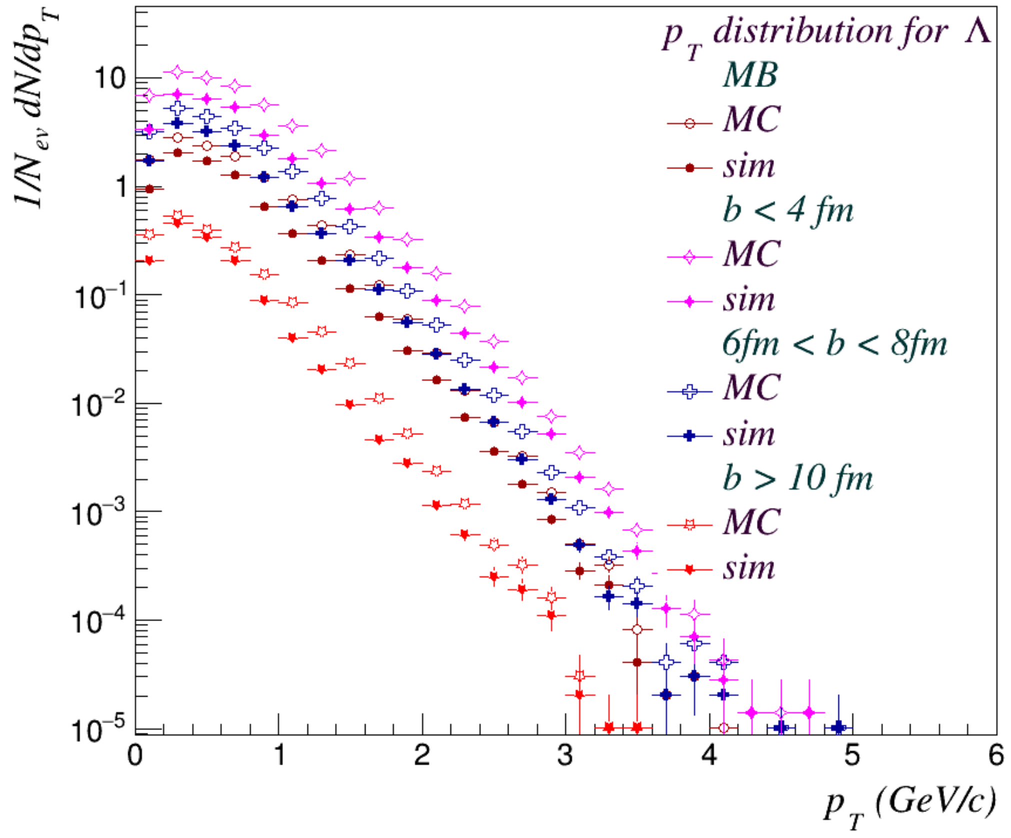
Number of Λ - $\bar{\Lambda}$ per event for different impact parameters

η MC/Sim

p_T MC/Sim

We analyze pt as a reference for the other variables

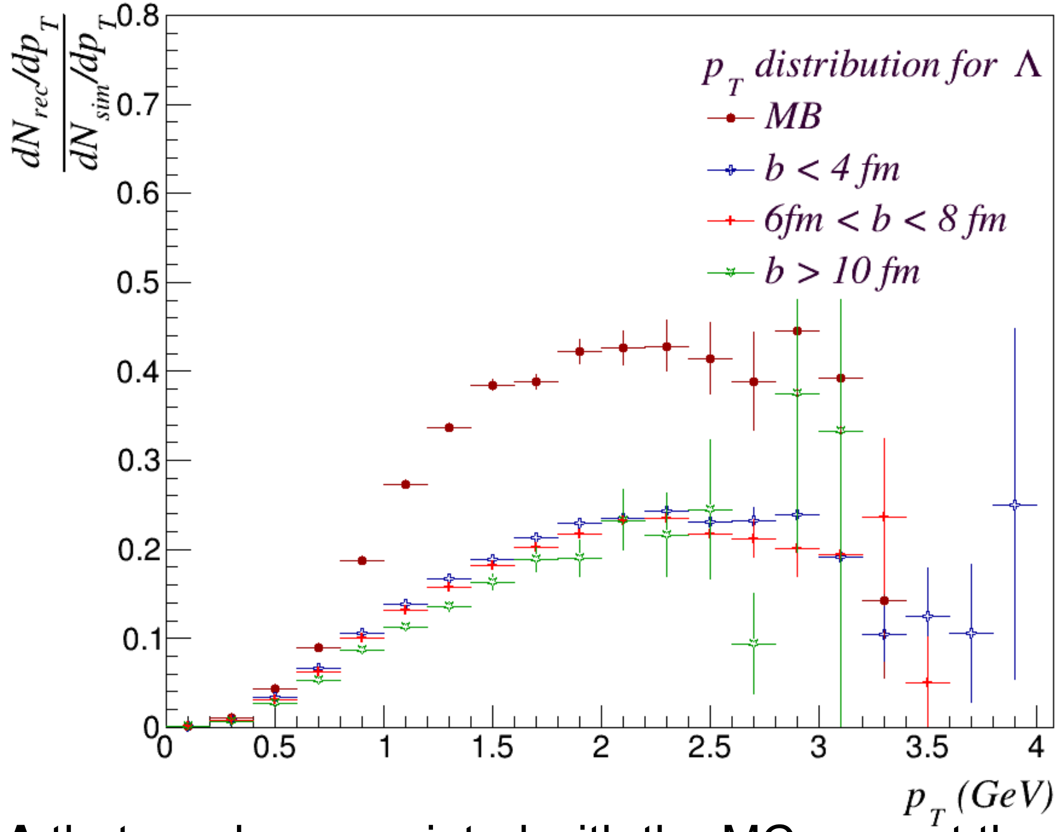




|η| <1.3

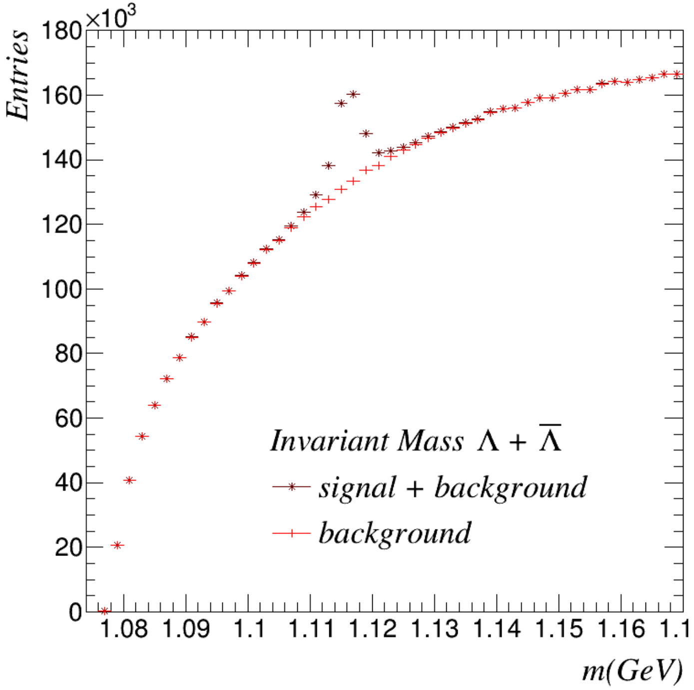
pt > 0.001

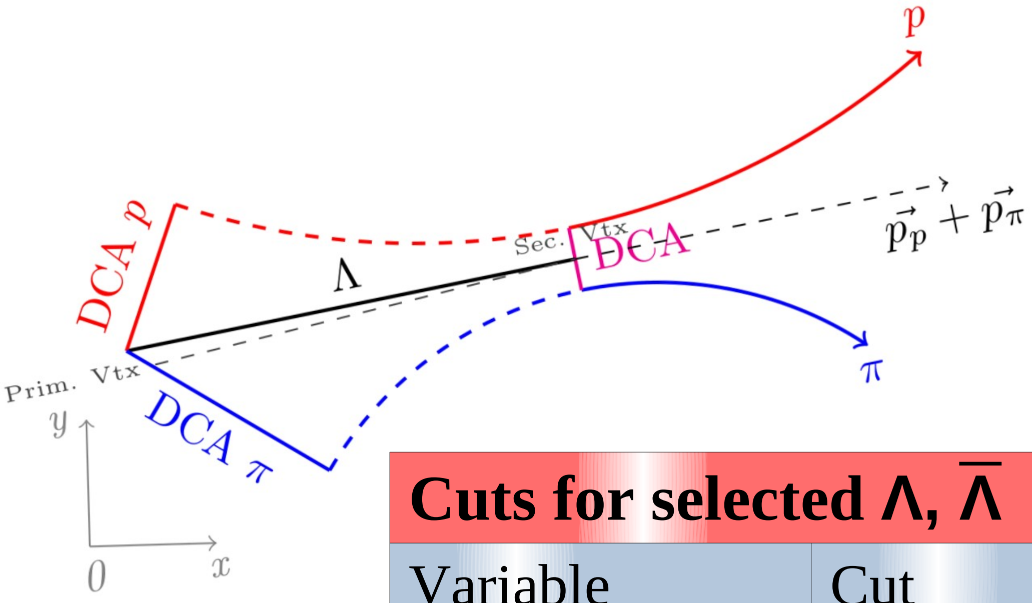
Max. eff for reconstruction in p_T



From candidates for **Λ** that can be associated with the MC, we get the ratio with simulated distributions as a function of pt. There is no difference for different impact parameters → get efficiency/acceptance max value?

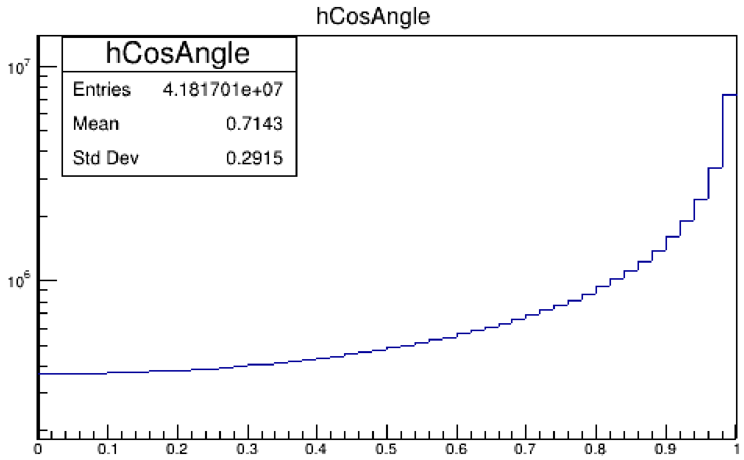
Reconstruction – cuts for selection

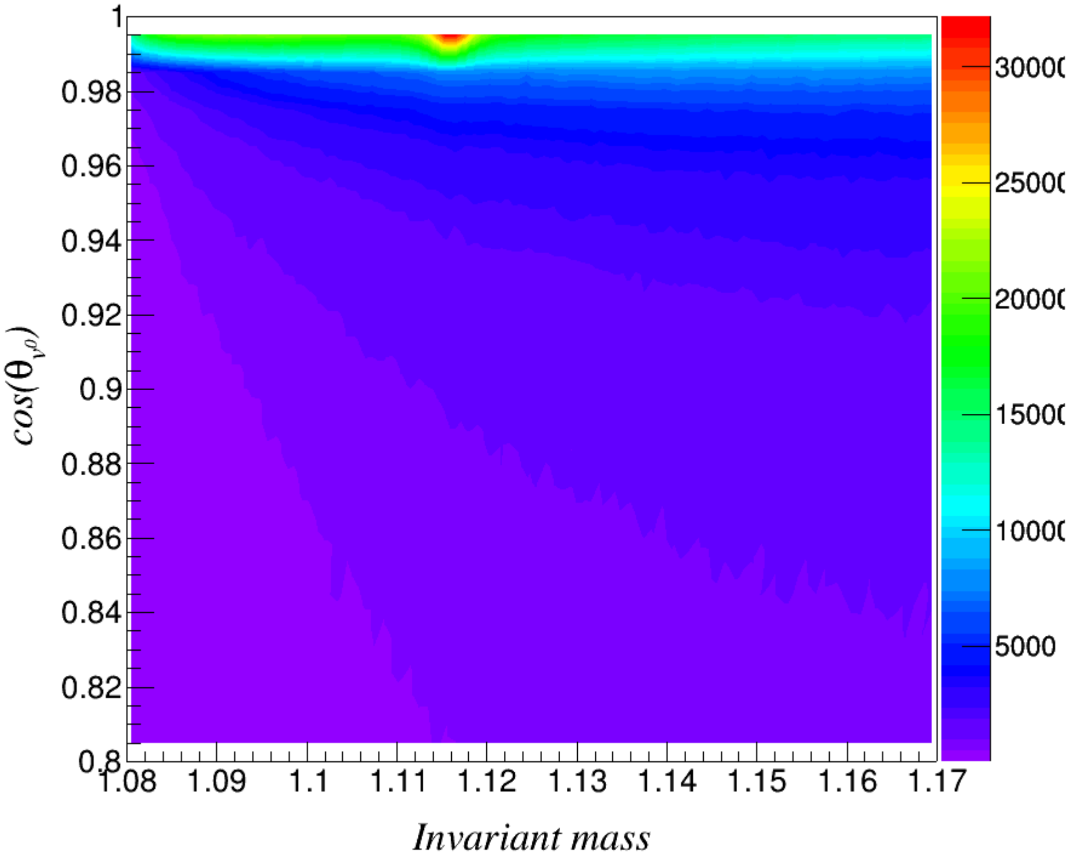




Cuts for selected Λ, $\bar{\Lambda}$	
Variable	Cut
Coseno (θ)	>0.98
DCA V0	<0.5 cm
DCA p-track	>0.1 cm
DCA π-track	>0.3 cm

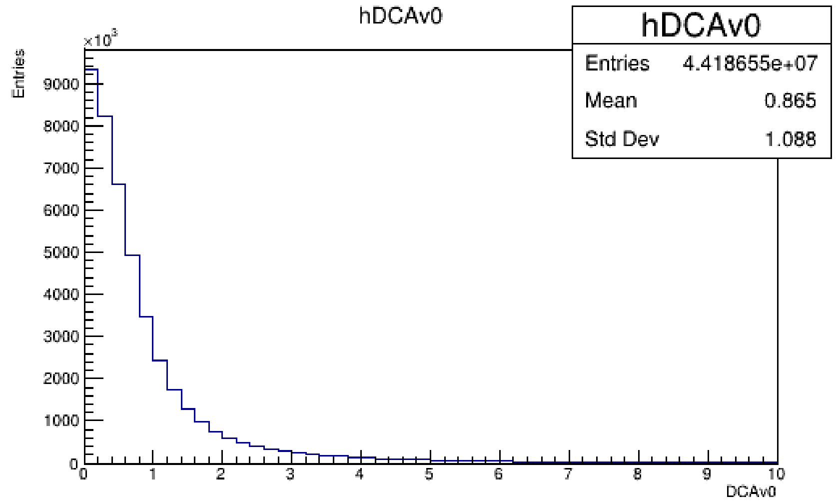
Cosine of Pointing Angle



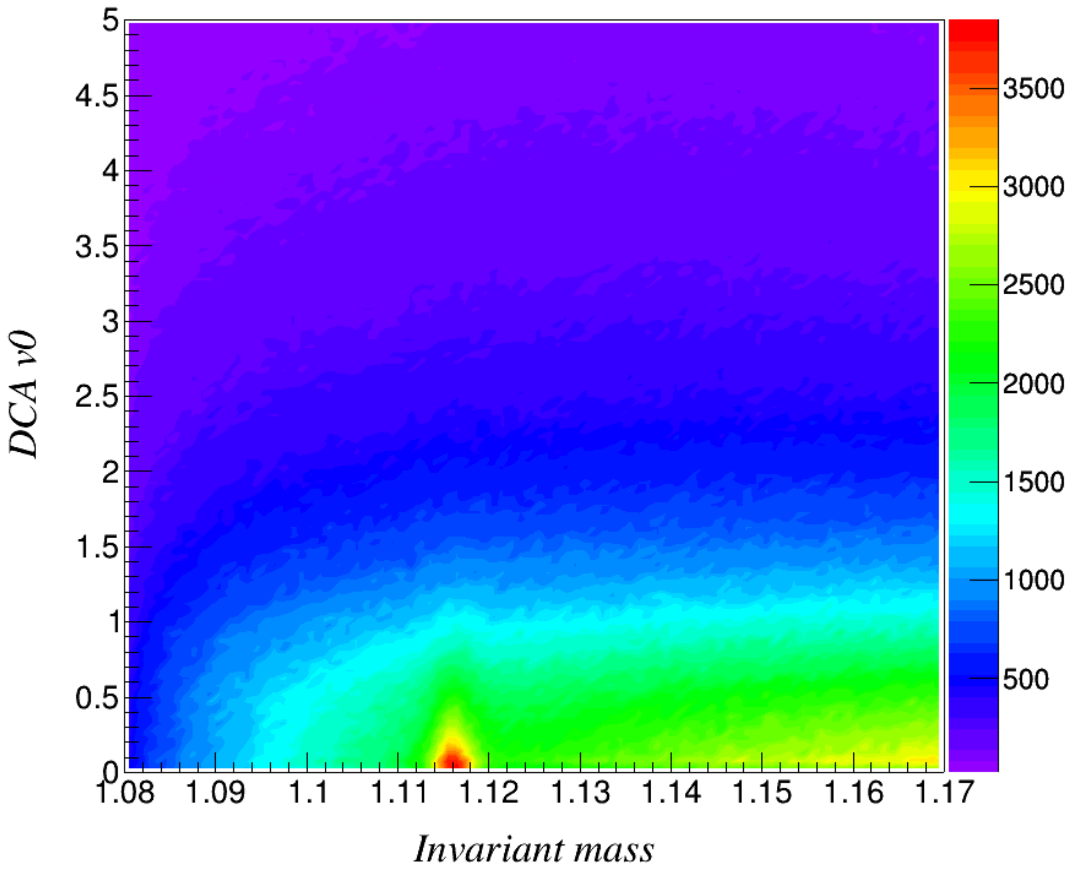


Cos(θ) > 0.98

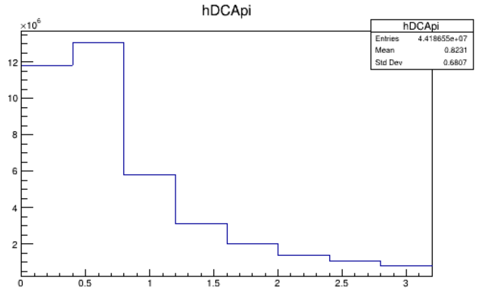
DCA V0

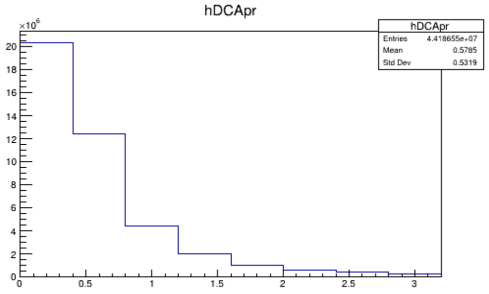


DCAv0 < 0.5 cm



DCA of daughter tracks





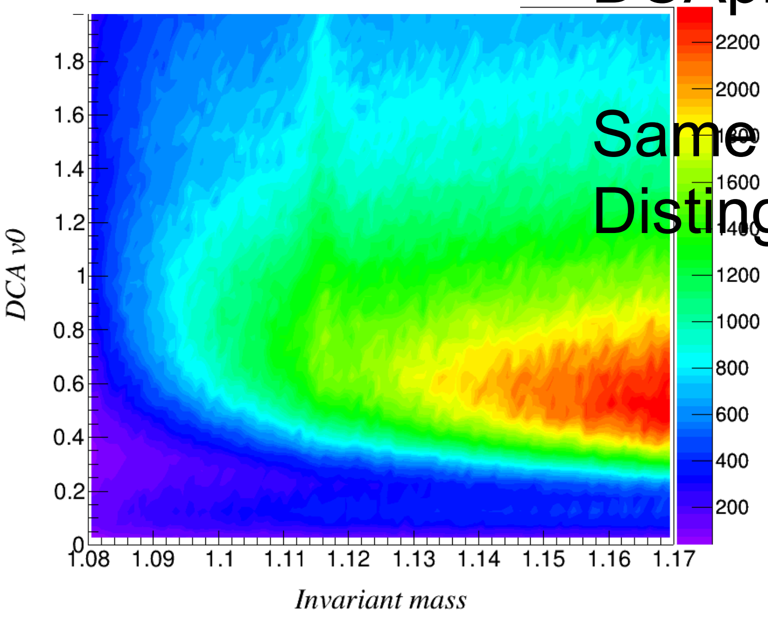
Different cuts for each track

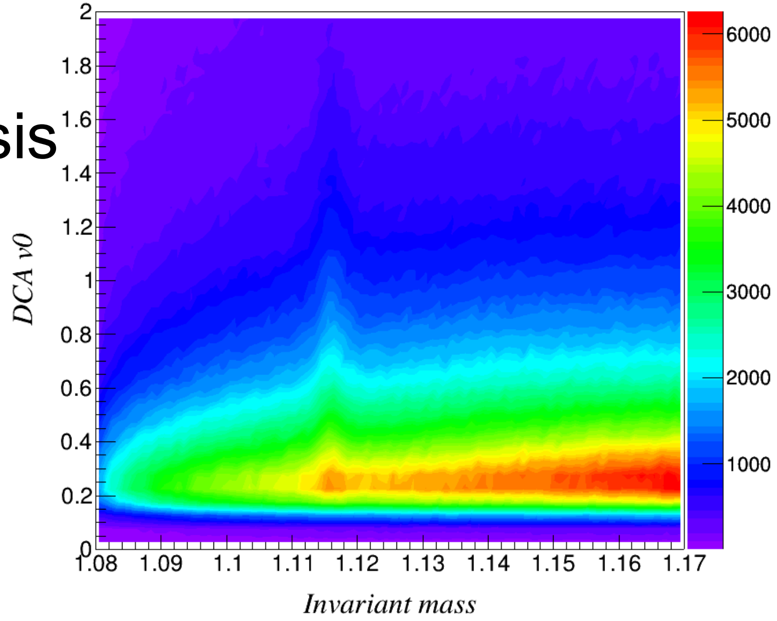
DCApi > 0.3 cm

DCApr > 0.1 cm

Same cut for some analysis

Distinguish Λ from $\overline{\Lambda}$



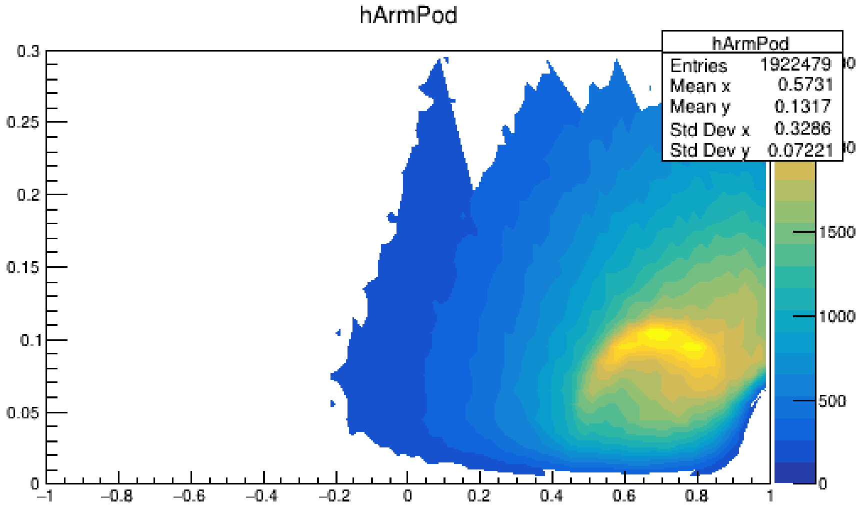


Distinguish between Λ and $\bar{\Lambda}$

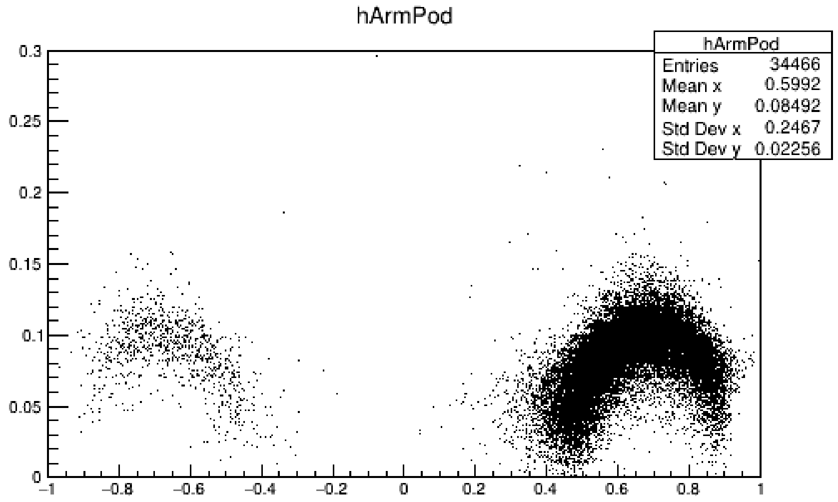
$$\alpha = \frac{p_L^+ - p_L^-}{p_L^+ + p_L^-}$$

We use $\alpha > 0$ to select Λ

$\alpha < 0$ to select $\bar{\Lambda}$

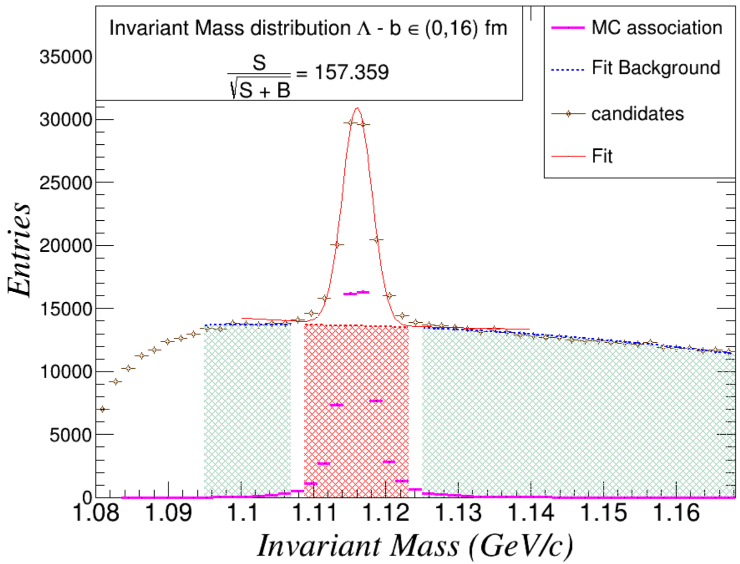


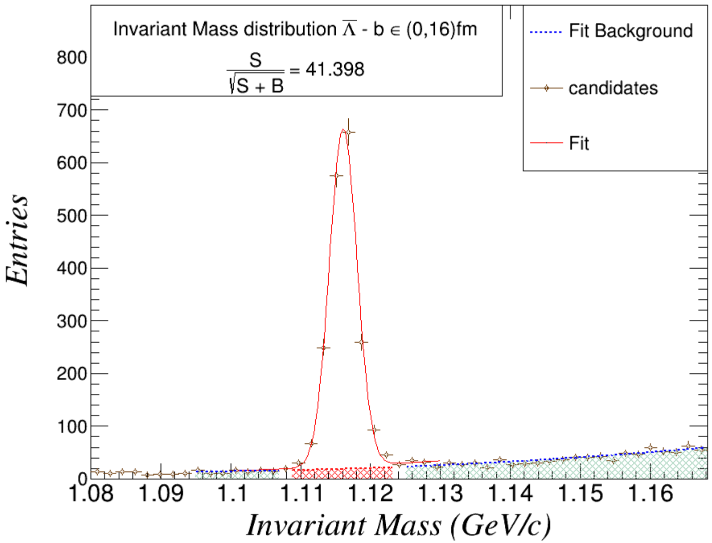
Strong cuts without MC identification, because of the background we can't see Λ



Only a few percent correspond to generated hyperons, as we can see after MC identification of the reconstructed tracks

Invariant Mass with preliminary cuts

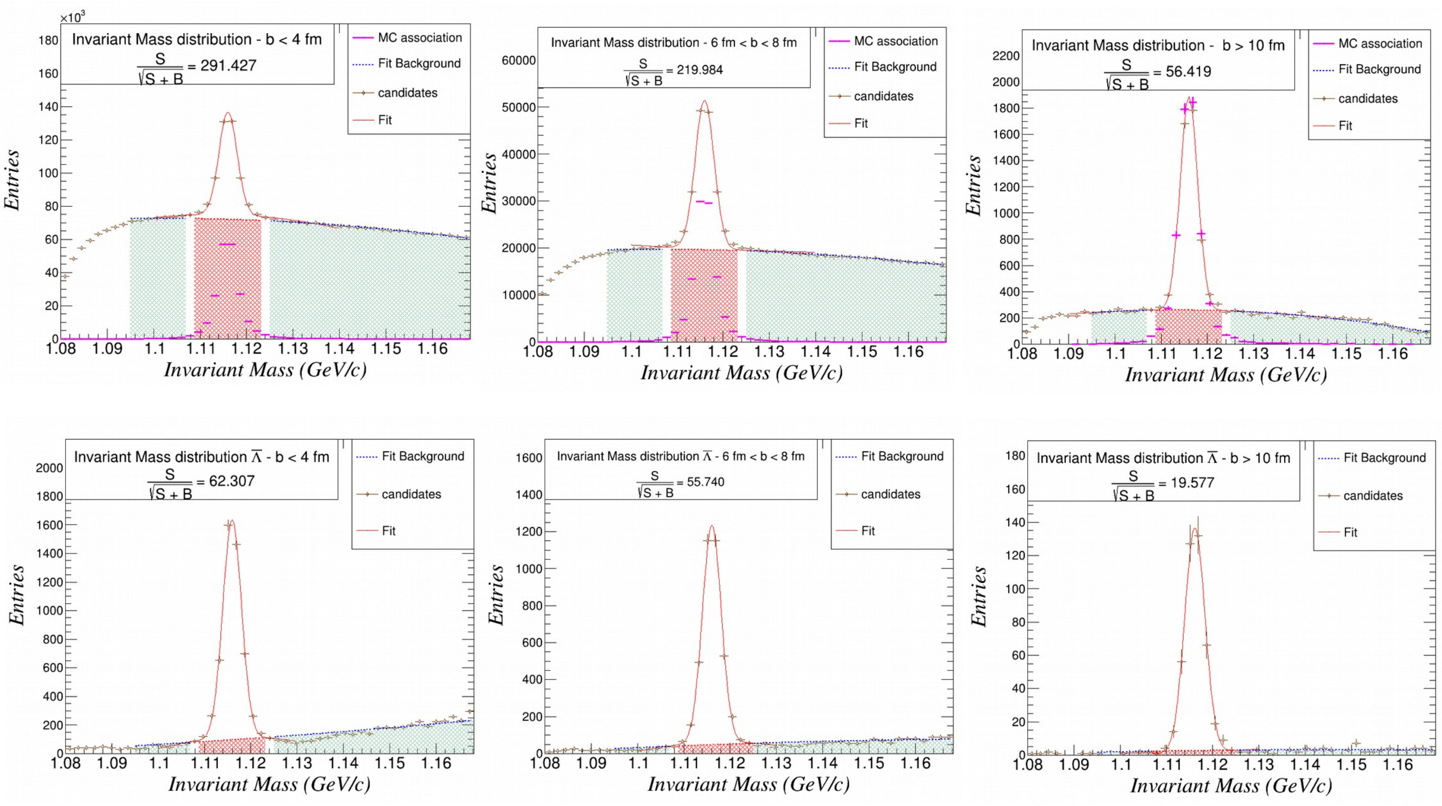




Variable	Cut
Cos of Angle	> 0.98
DCA V0	< 0.5 cm
DCA p-track	> 0.1 cm
DCA π-track	> 0.3 cm

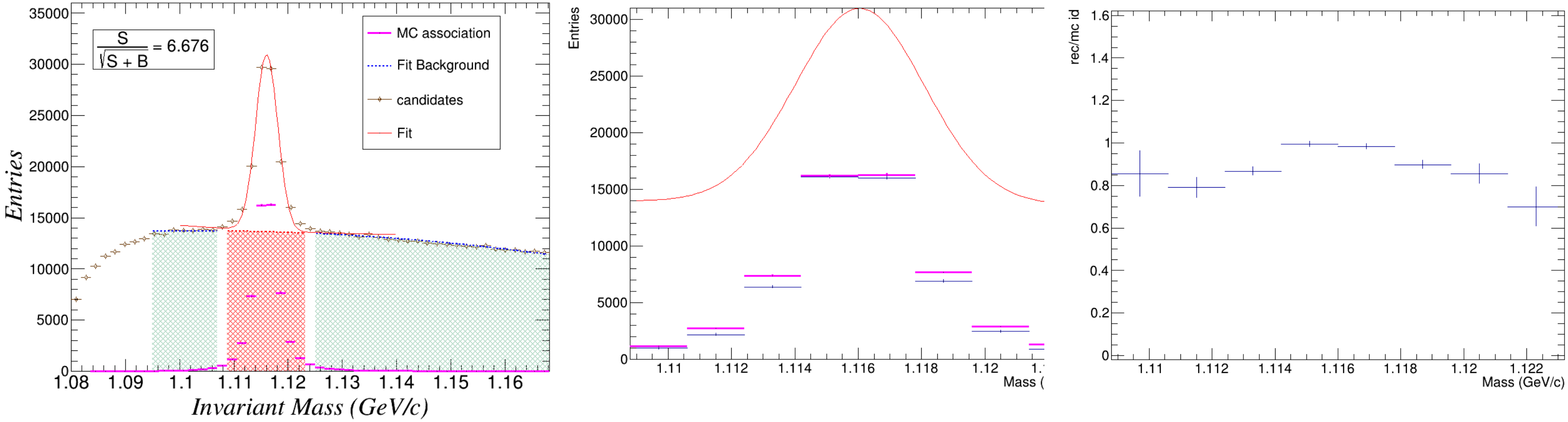
Significance measured in 3.5σ from the peak

Invariant Mass at different b



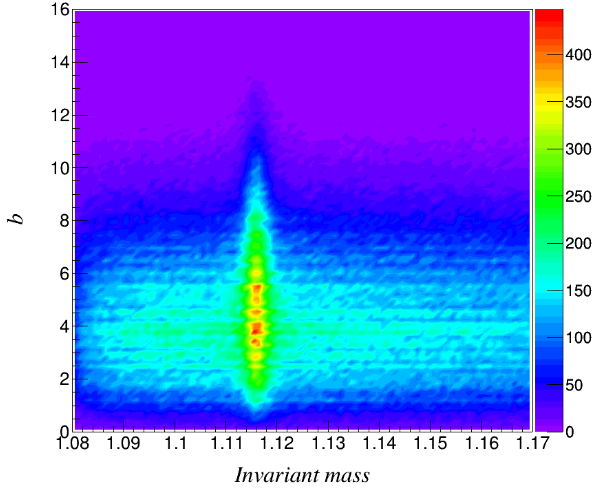
Signal decreases with impact parameter

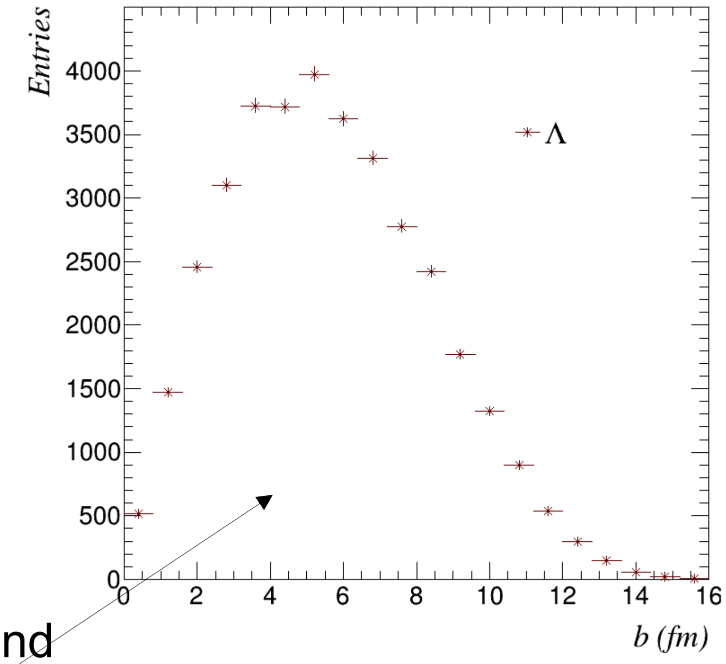
Invariant Mass ratio for Λ



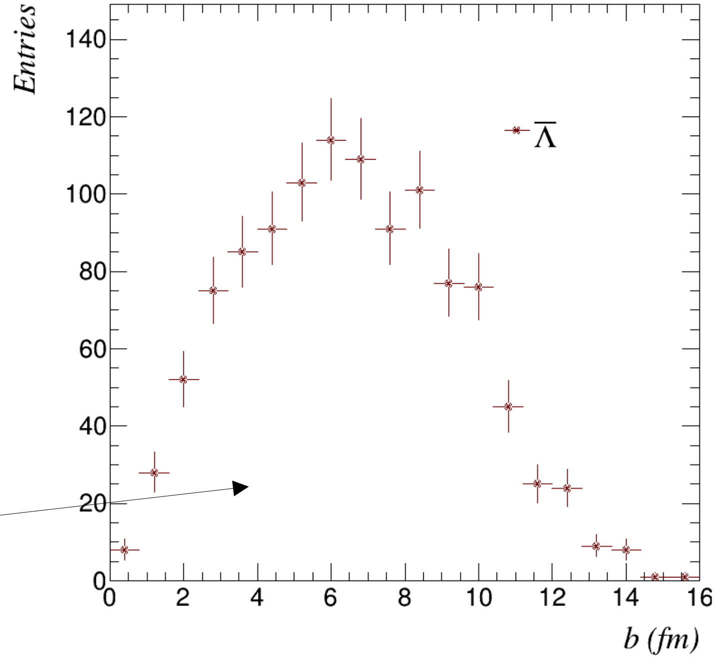
Signal cleaned and compared with MC association of V0 candidates

Λ and Λ vs Impact Parameter





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

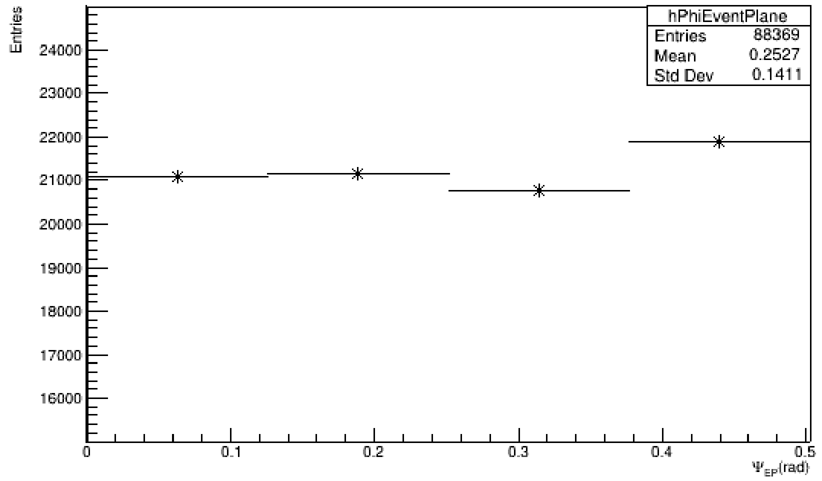


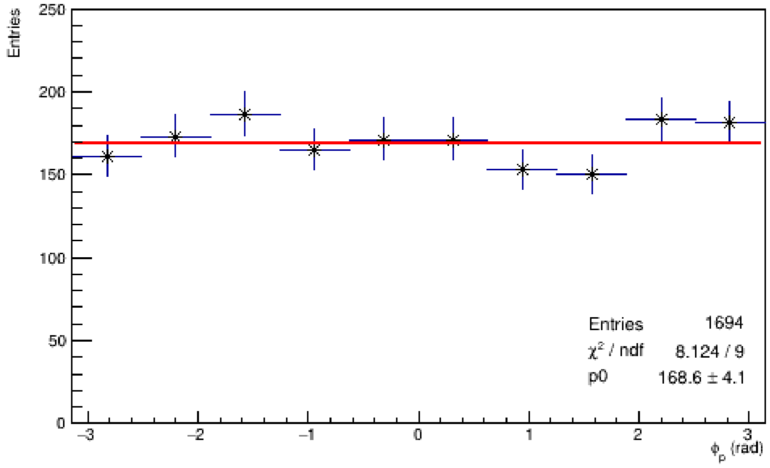
To do:
With bin counting background subtraction method, we can clean the signal to get distributions like

Code:

```
b = (FairMCEventHeader*)→ GetB();
```

Distributions: Φ_p and ψ_{EP}

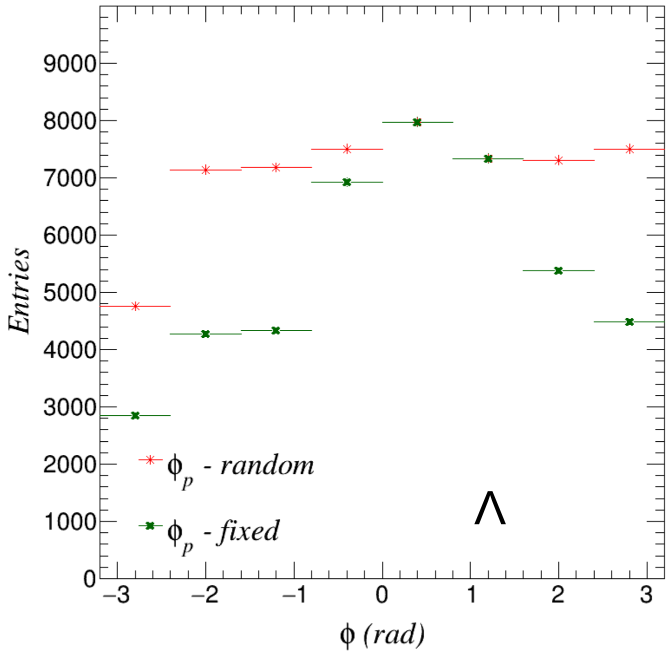


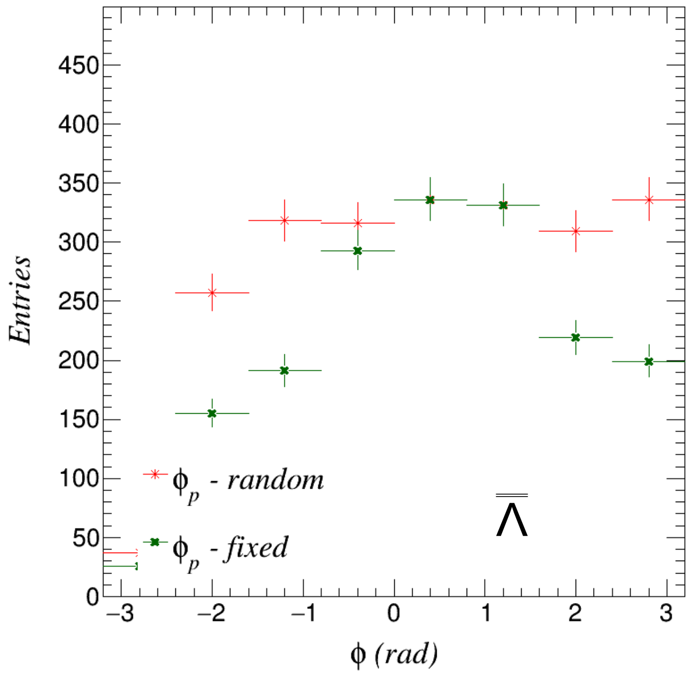


MC → randomly in (0,30°)
Isotropic distribution

Azimuthal angle of baryons is constant, there is not polarization

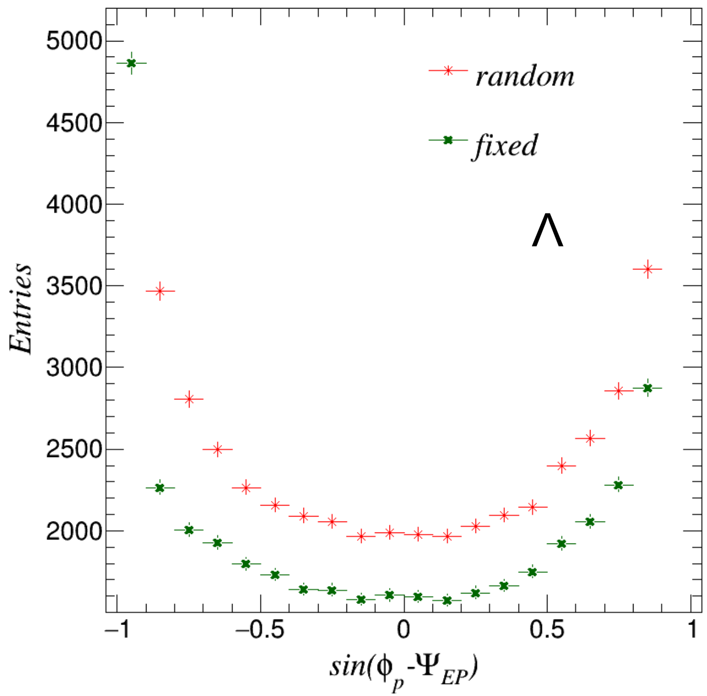
Inducing arbitrary inhomegeneos distribution - Φ_p

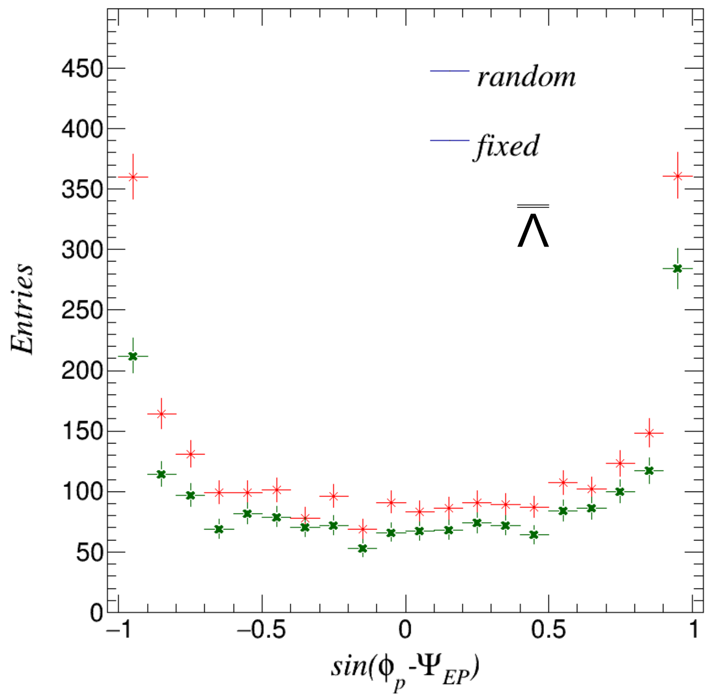




Azimuthal angle of baryons is constant, there is not polarization

Preliminary - sin(Φ_p - ψ_{EP})





Summary

- Comparison of the number of hyperons produced MC, simulated and reconstructed
- We show the preliminary invariant mass distribution for reconstructed hyperons for different sets of impact parameter.
- Angular distribution in terms of azimuthal angle.

To do

- Improve track selection for secondary tracks, include PID.
- Analyze, azimuthal angle for different impact parameters
- Use a reconstructed value for Event plane angle.

Backup

Data type: MC/Sim/Rec

MC data → Λ and $\bar{\Lambda}$ generated by UrQMD + particle decays, secondary interactions by GEANT3 transport package

Sim data → Findable Λ and $\bar{\Lambda}$, identification of products of its charged decay and p_T>0.001 GeV/c and |η|<1.3

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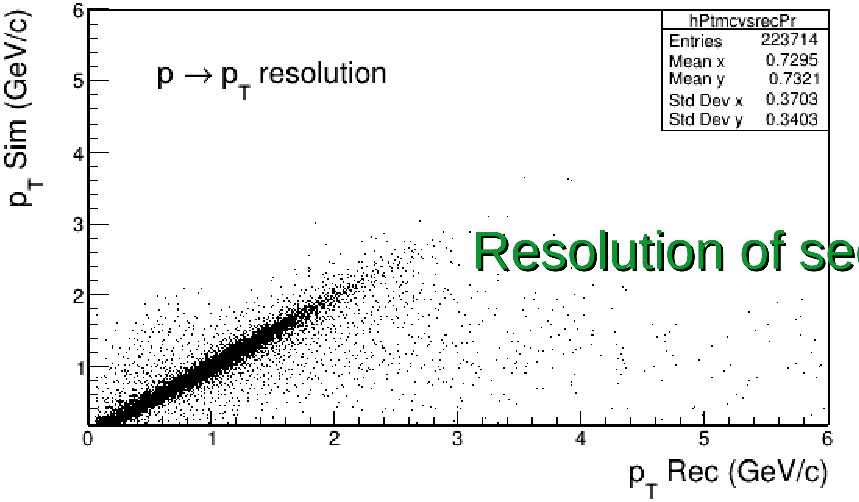

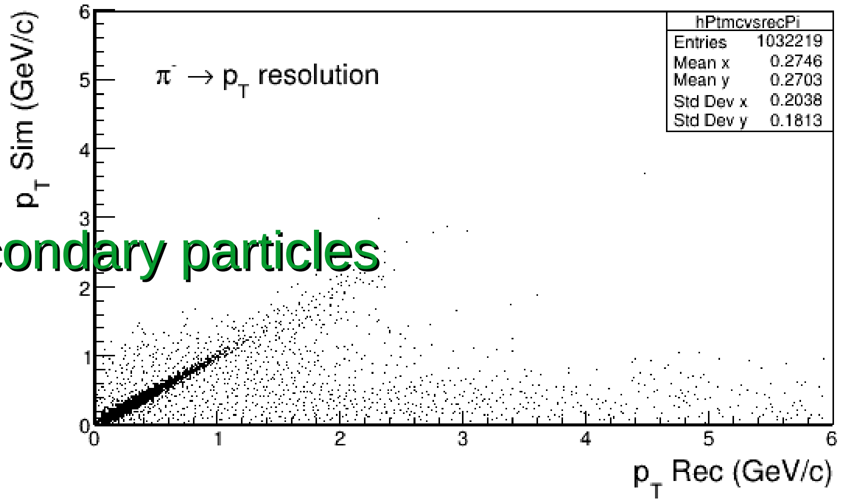

Resolution of secondary particles

Production MC/Sim/Rec

Data	Generated		Simulated		Reconstructed signal	
	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**
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b > 10 fm	**2.12**	**0.07**	**1.10**	**0.04**	**0.05**	**0.004**

But from candidates after **Λ** and **$\bar{\Lambda}$** reconstruction we keep only tracks that have a mass according to pdg value.

With perfect ID – MC we have
The ratio **$\Lambda/\bar{\Lambda}$** increases as b increases

Cuts for selected Λ, $\bar{\Lambda}$	
Variable	Cut
Coseno (θ)	>0.98
DCA V0	<0.5 cm
DCA p-track	>0.3 cm
DCA π-track	>0.1 cm