Topological Cuts Selection for Λ^0 y $\bar{\Lambda}^0$ Selection

I.A. Maldonado-Cervantes

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Introduction

The Λ^0 finding procedure starts with the selection of secondary tracks. Every secondary track is combined with all the other secondary tracks having an opposite charge to define the secondary vertex position. Afterward the vertex position is defined, the Λ^0 finding procedure checks whether the momentum of the candidate points well back to the primary vertex.

Cut Optimization

Selection of the next topological cuts:

- DCA of negative daughter track to primary vertex position
- DCA of positive daughter track to primary vertex position
- DCA between positive daughter track and negative daughter track
- Cosine of the angle of the reconstructed momentum of the V^0 w.r.t. line joining primary and secondary vertexes

At the nexts plots is shown the distribution of the topological variables for associated primary Λ^0 y $\bar{\Lambda}^0$

Invariant mass distribution, signal and background

To get the significance of the invariant mass distribution at first we get the signal, substracting the background histogram from the invariant mass distribution. The background histogram is obtained with the TSpectrum class shown in the next lines; be h the invariant mass histogram of Λ^0 then:

$$\text{TH1 *hb} = \text{s}- >\text{Background(h,20,"sames")}$$

This function calculates the background spectrum in the input histogram h, and the background is returned as a histogram. We use the default value for the iterations 20.
The background estimation algorithm is based on Sensitive NonLinear Iterative Peak clipping algorithm (SNIP). In which the baseline of spectrum is calculated with:

$$v(i) = log[log(\sqrt{(}y(i)+1)+1)+1] \quad (1)$$

where $y(i)$ are the counts in the channel i. We average the values $v_{p-1}(i-p)$, $v_{p-1}(i+p)$ and compare with $v_{p-1}(i)$ and obtain the value:

$$v_p(i) = minv_{p-1}, \frac{v_{p-1}(i+p)+v_{p-1}(i-p)}{2} \quad (2)$$

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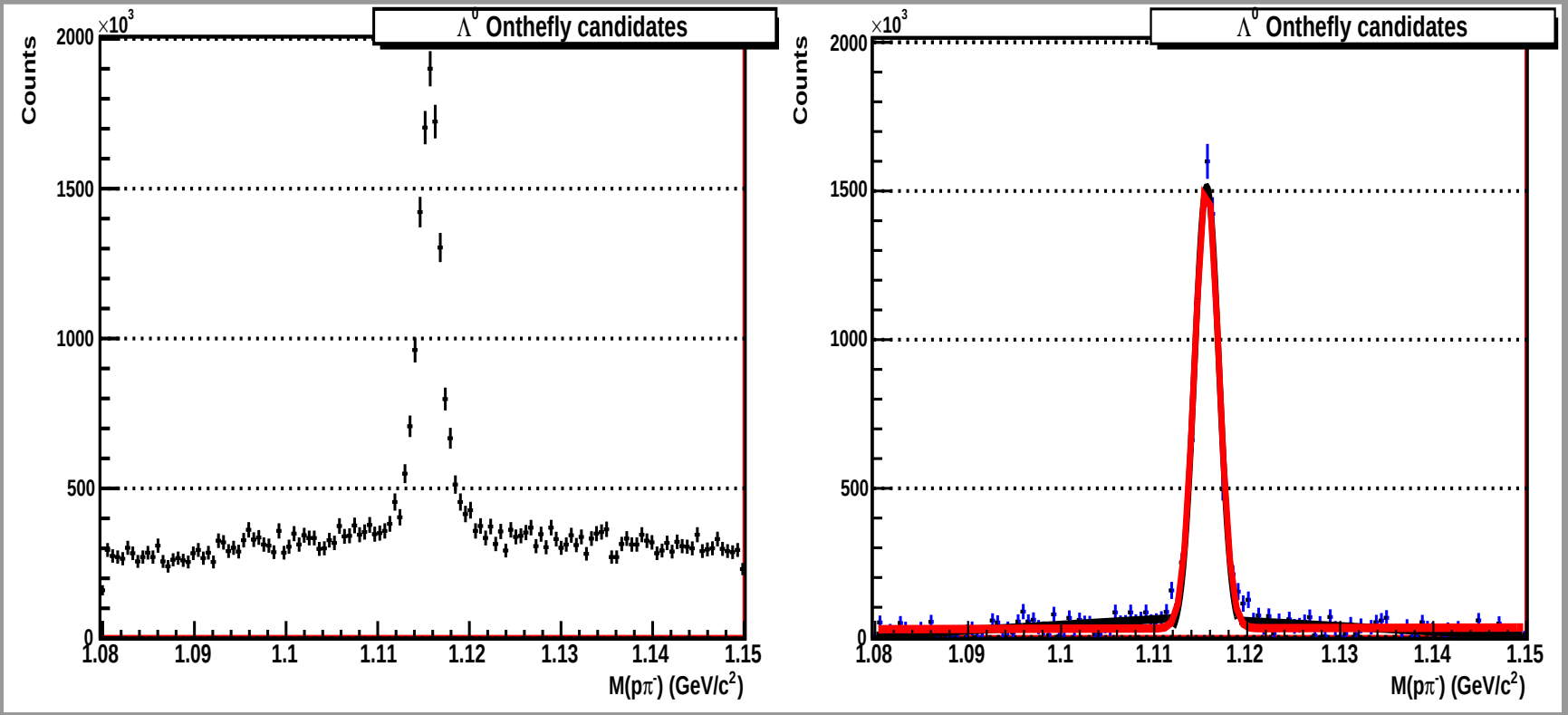
Significance distribution

$$Significance = \frac{signal}{\sqrt{signal + background}} \left(1 \pm \sqrt{\left(\frac{\delta s}{s}\right)^2 + \left(\frac{\delta(s+b)}{2(s+b)}\right)^2}\right) \quad (3)$$

- s - signal
- b - background

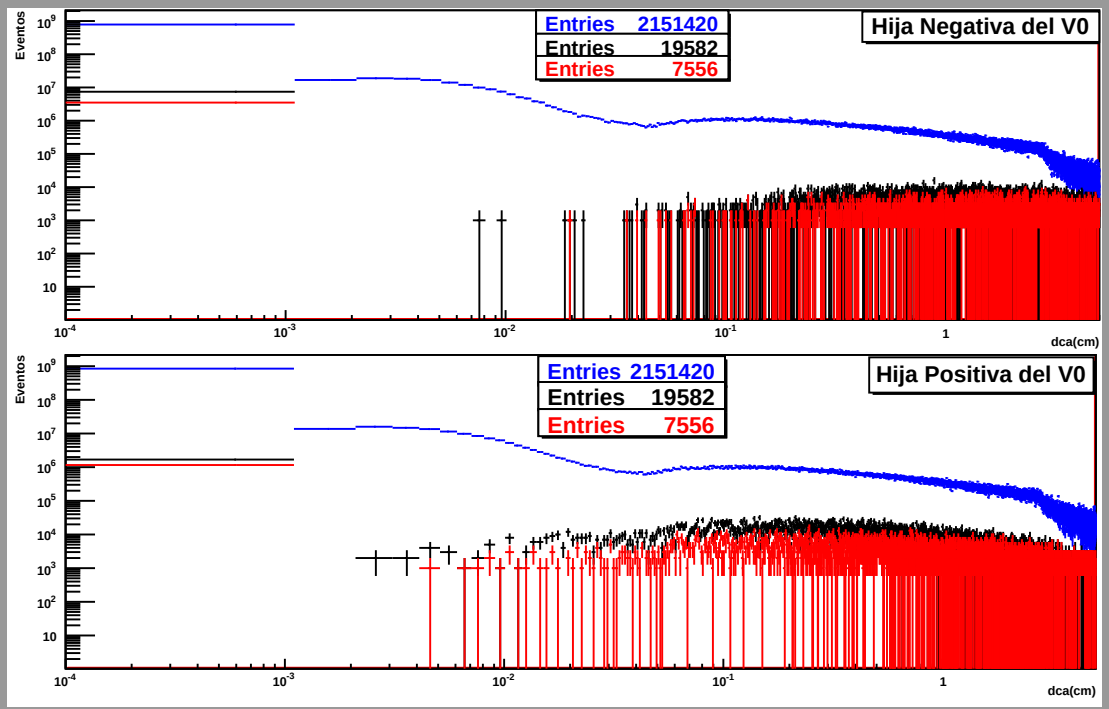
Invariant Mass Histogram

Corte en DCAPosToPrimVertex > 0.05 y DCANegToPrimVertex > 0.125. Se tienen $7088 \pm 84 \Lambda^0$'s en la señal y 20128 ± 142 en background. Por lo cual la significancia es de 42.96 ± 0.52



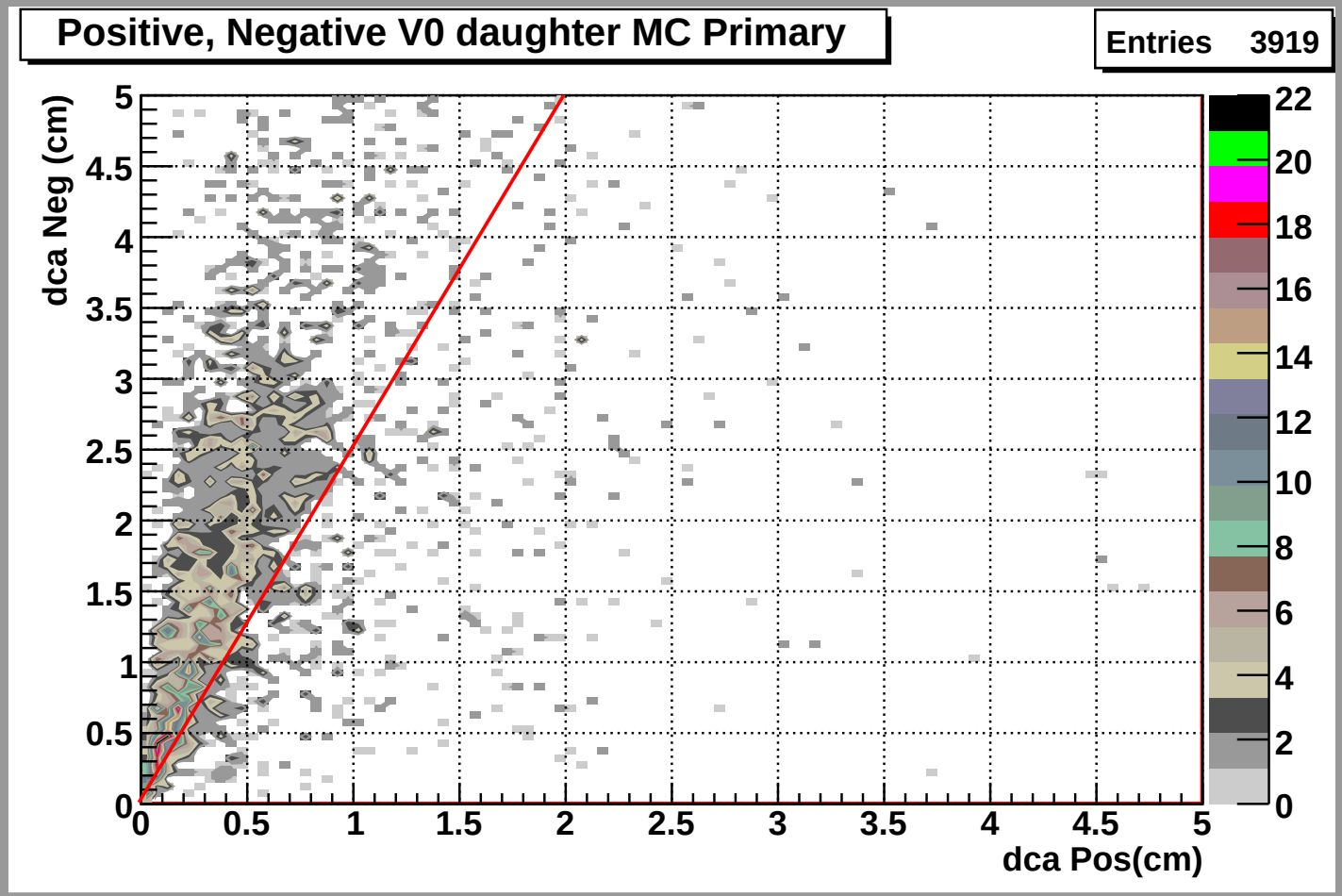
Distribution of DCA To Primary Vertex for Λ^0

At the next plot is shown the distribution for all V0 in black, for all Λ^0 in blue and for primary Λ^0 in red. The upper plot represents the DCA of protons to primary vertex and the second the pions.



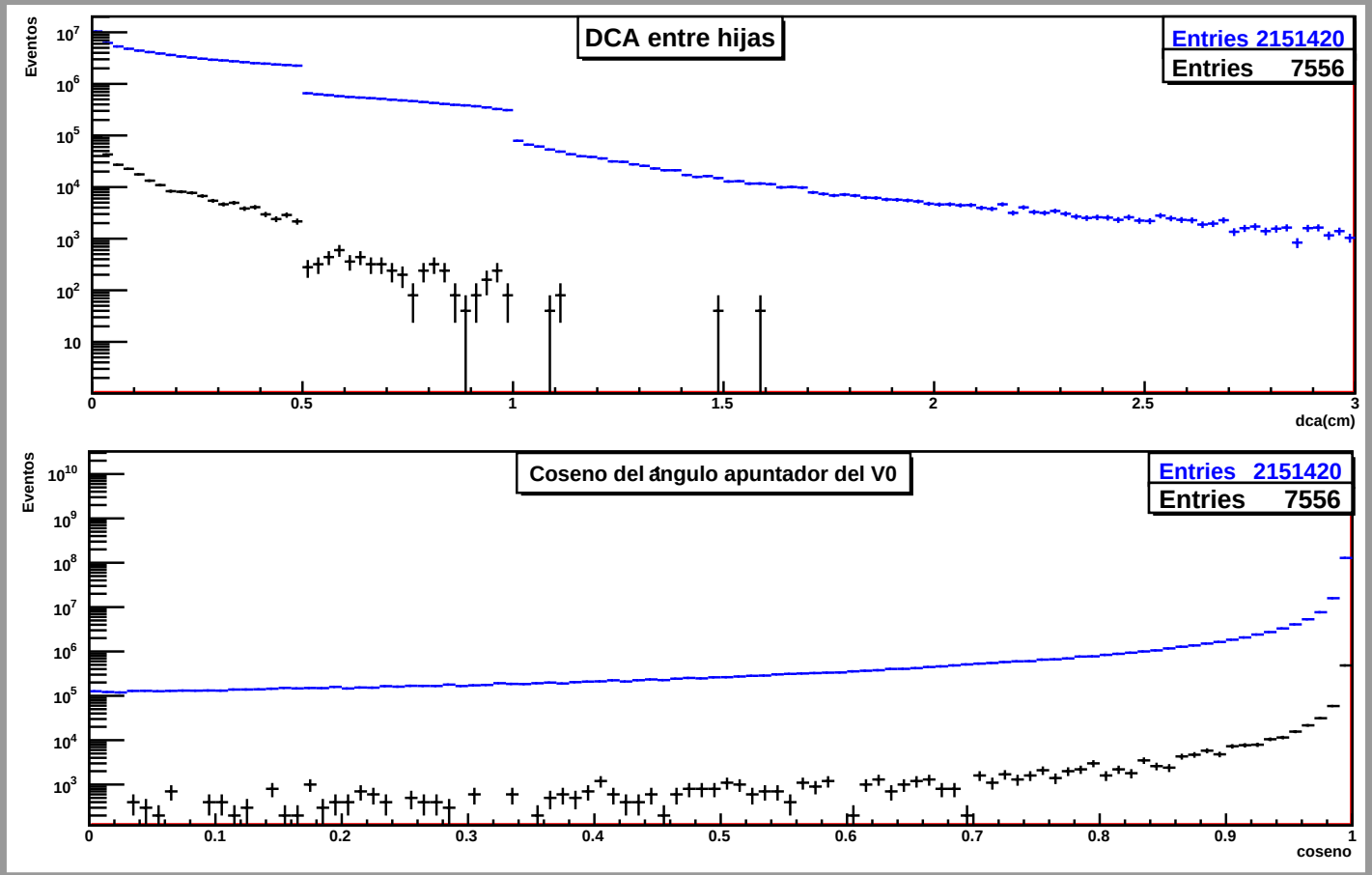
Correlation between DCA to primary vertex of negative and positive daughter tracks

From the plot, we can select the cuts on DCA of negative daughter $\pi^- > 2.5$ of DCA of positive daughter p^+.



DCA between daughter tracks and Cosine of pointing angle

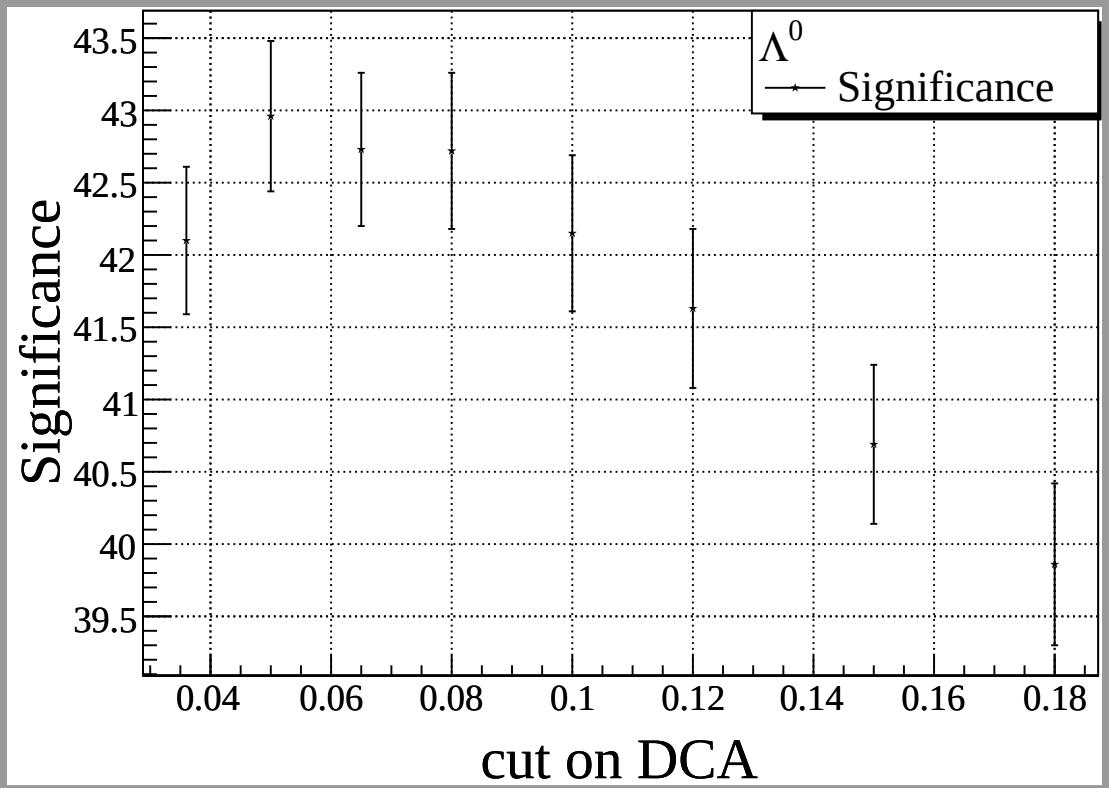
At the next plot is shown the distribution for all V0 in black and for primary Λ^0 in blue. The upper plot represents the DCA between protons and pions. The below plot is the distribution of cosine of pointing angle.



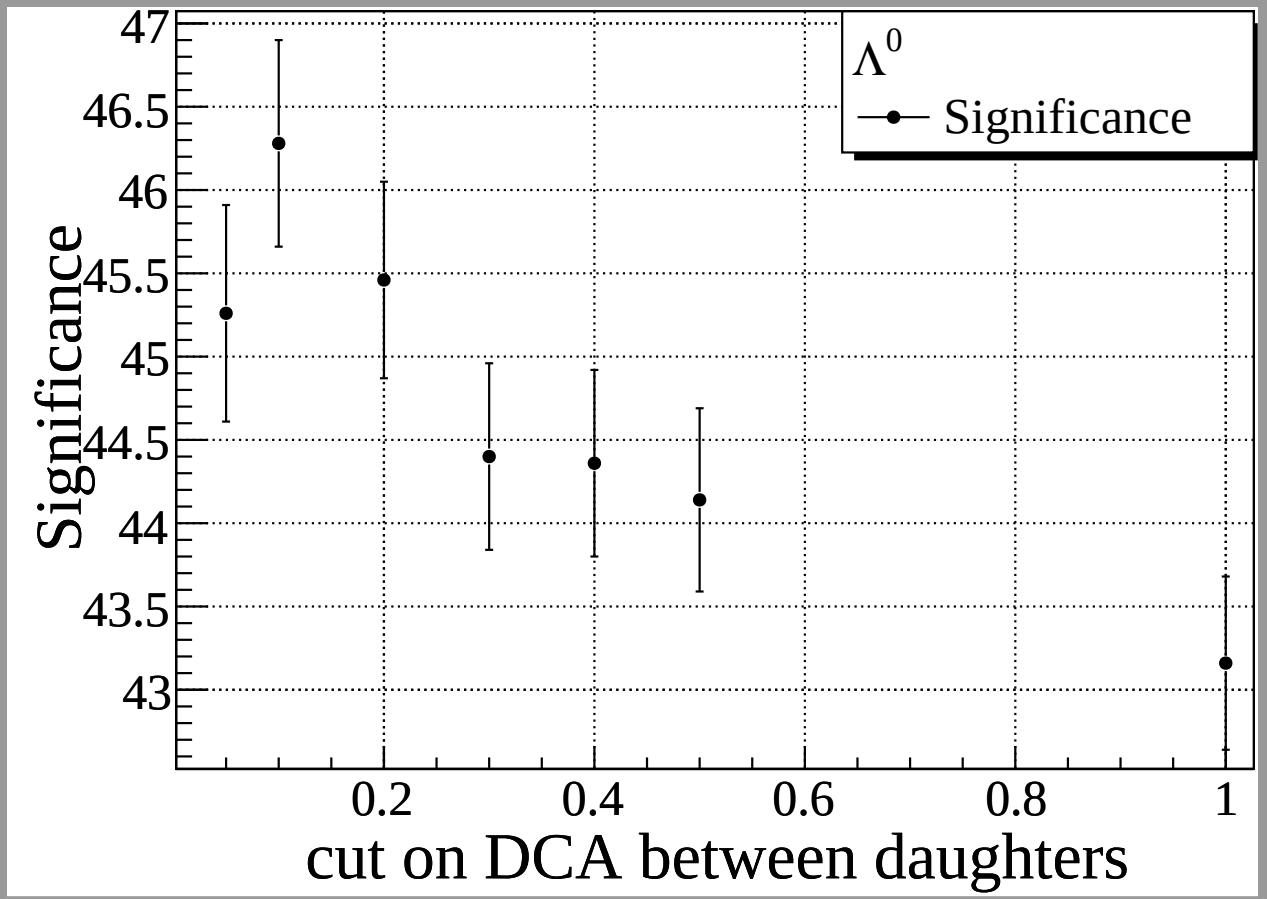
Significance distribution for cuts in DCA To Primary Vertex for Λ^0

This distribution is generated with cuts on DCA to primary vertex of the p and π related by:

$$DCA_{\pi} > 2.5 DCA_{p} \tag{4}$$

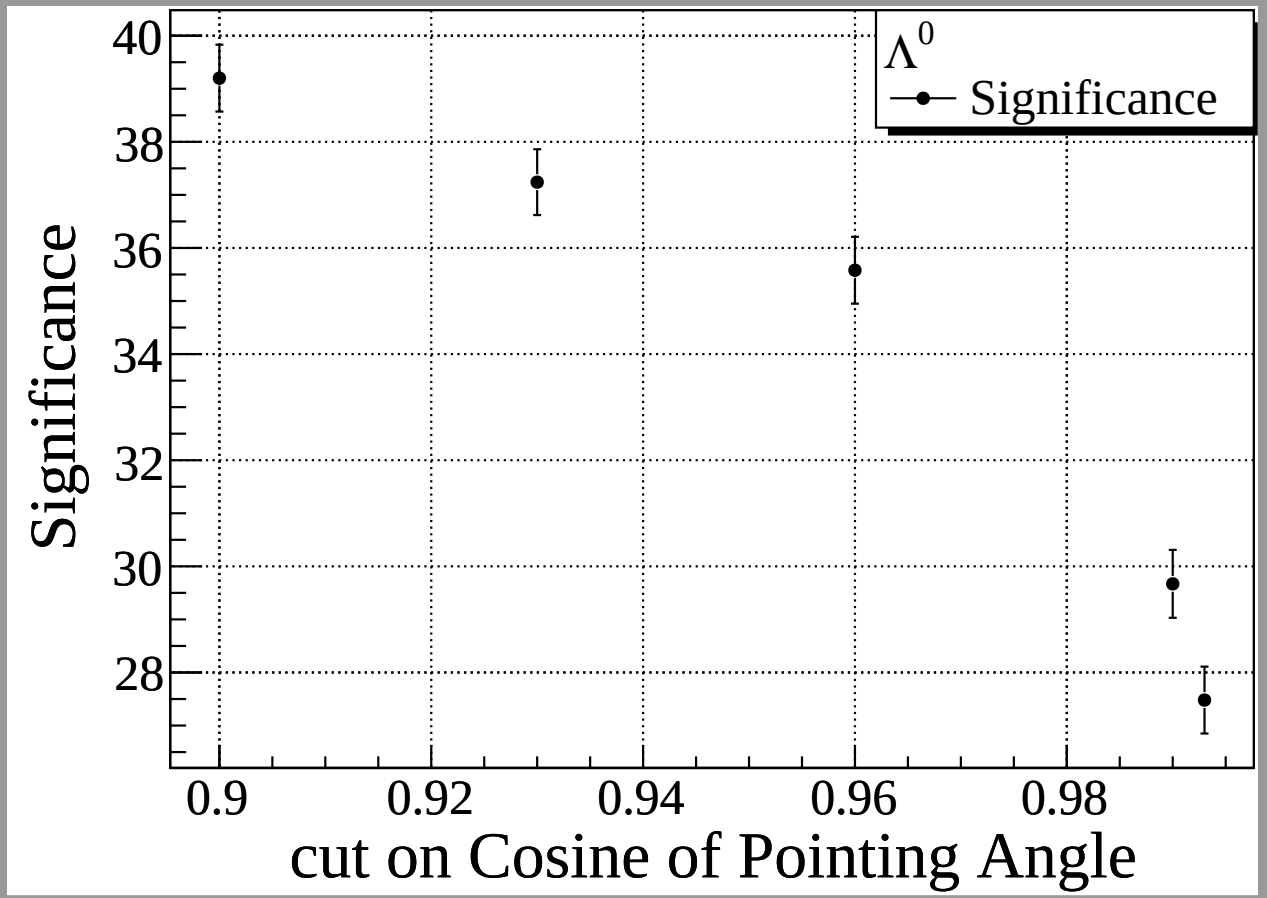


Significance distribution add the cut in DCA between daughter tracks



$DCA_p = 0.05$ cm, $DCA_\pi = 0.125$cm.

Significance distribution add the cut in Cosine of Pointing Angle

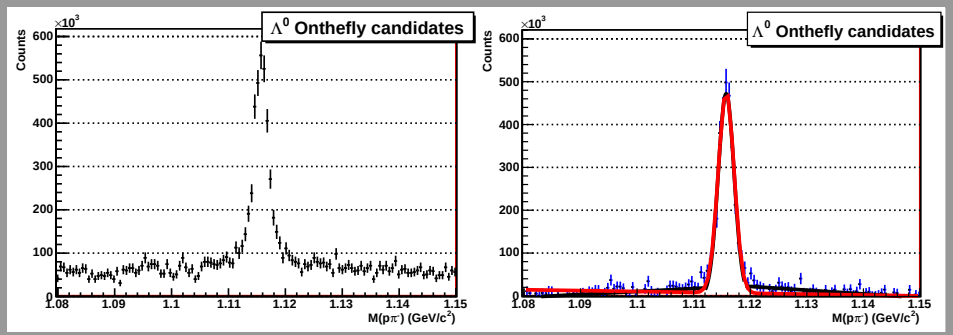


$DCA_p > 0.05$ cm, $DCA_\pi > 0.125$ cm, DCA between daughters < 0.1 cm.

Λ^0 Invariant Mass Distribution

We select the following cuts:

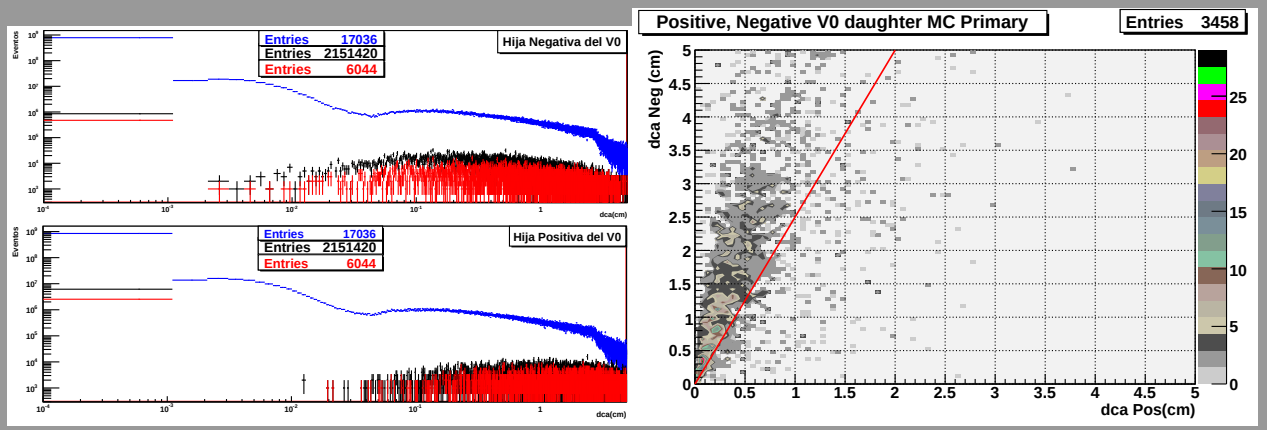
- DCA_{π^-} to Primary Vertex > 0.125 cm
- DCA_p to Primary Vertex > 0.05 cm
- DCA between daughter tracks < 0.1 cm
- Cosine of pointing Angle > 0.99



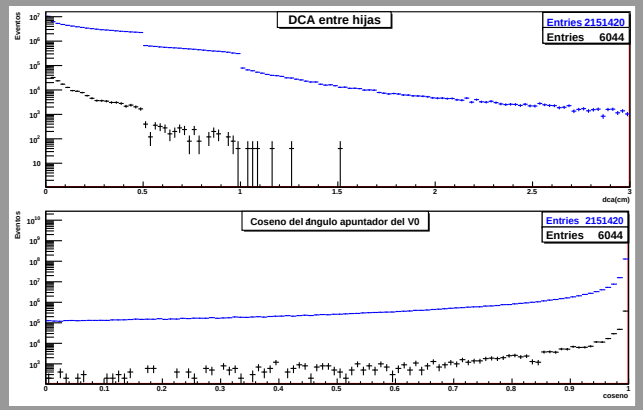
The Invariant mass is 1.11574 ± 0.00140 GeV/c^2; with a Significance of 29.67 ± 0.64. There are 2338 ± 48 Λ^0s of 7556 primaries; the 30 % or 12% for all Λ^0.

Cut selection for $\bar{\Lambda}^0$

In the case of $\bar{\Lambda}^0$ we also have the geometrical variable distribution for which we select the appropiate cuts.



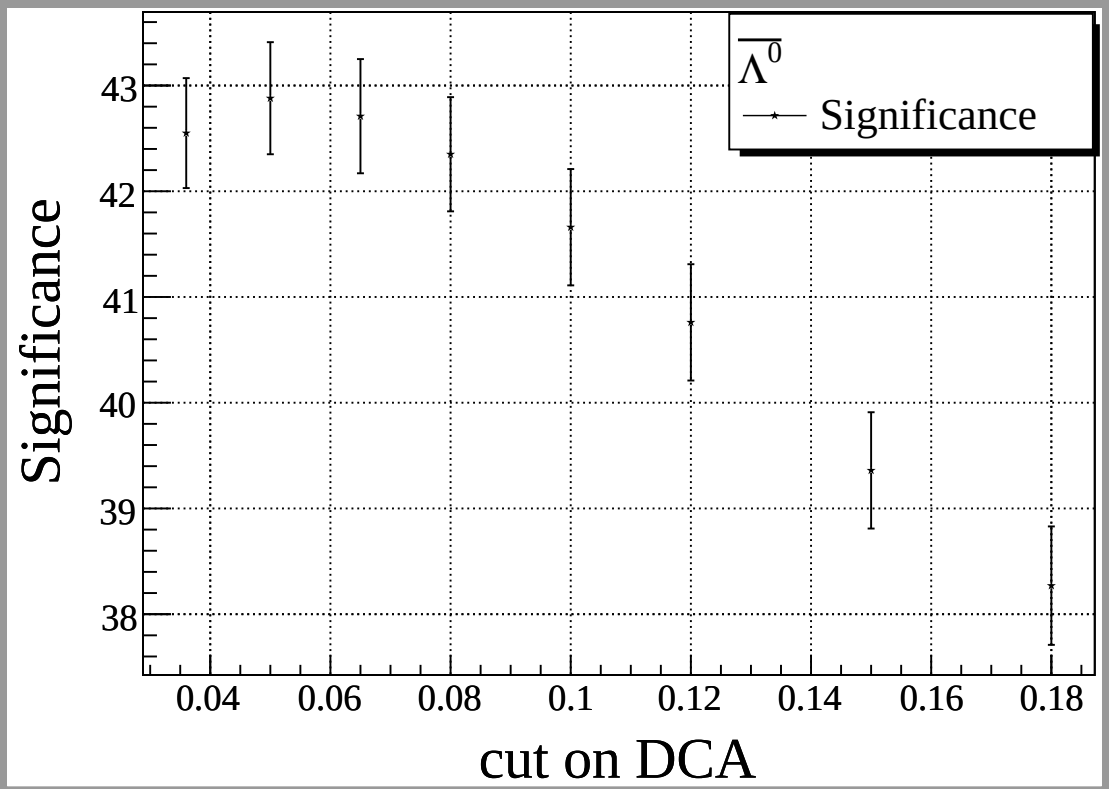
$$DCA_{\pi^+} > 2.5 DCA_{p^-} \tag{5}$$



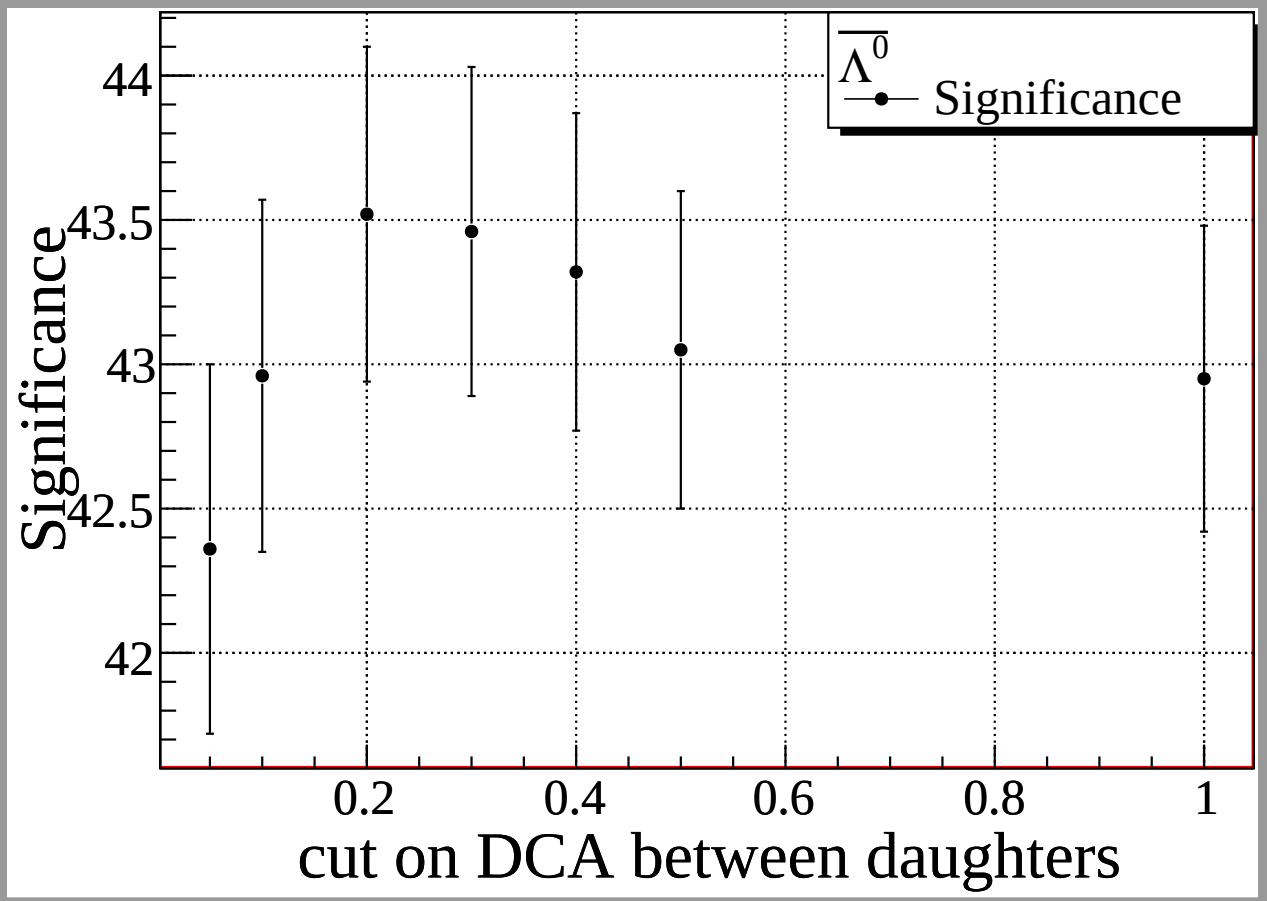
Significance distribution for cuts in DCA To Primary Vertex for $\bar{\Lambda}^0$

This distribution is generated with cuts on DCA to primary vertex of the p^- and π^+ related by:

$$DCA_{\pi^+} > 2.5 DCA_{p^-} \tag{6}$$

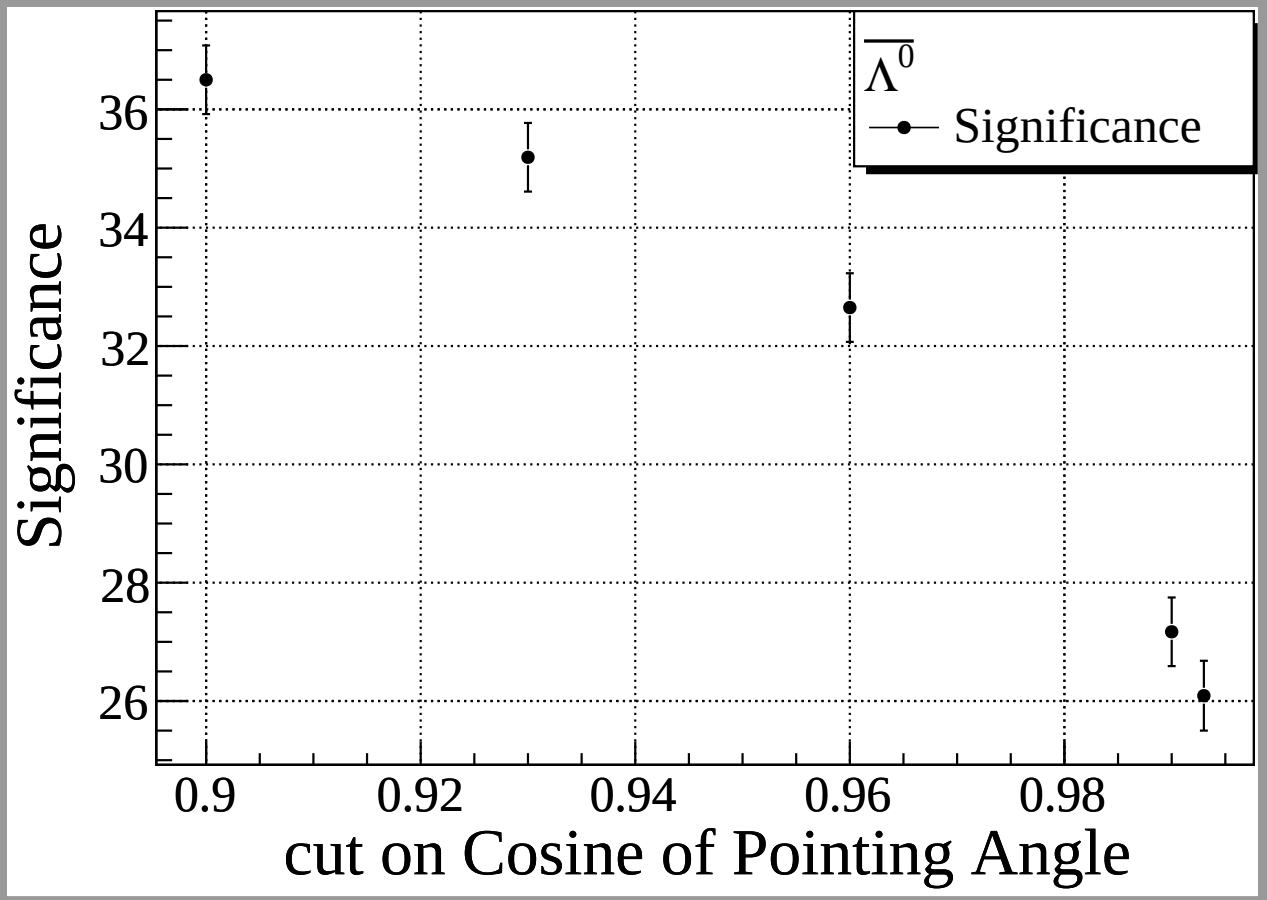


Significance distribution add the cut in DCA between daughter tracks



$DCA_{p^-} = 0.05$ cm, $DCA_{\pi^+} = 0.125$cm.

Significance distribution add the cut in Cosine of Pointing Angle

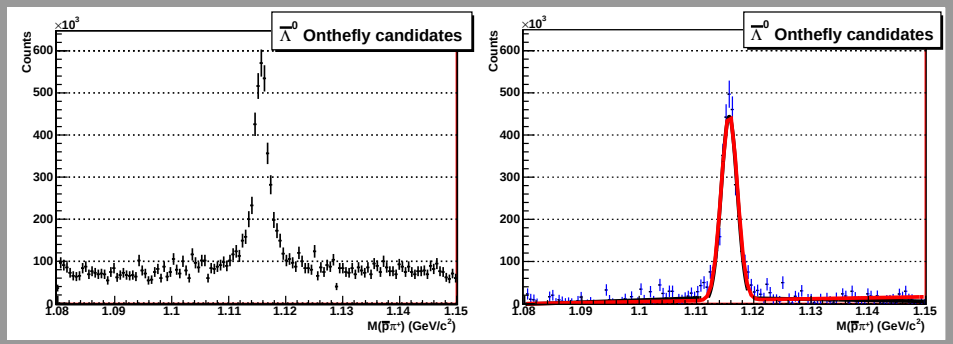


$DCA_{p^-} > 0.05$ cm, $DCA_{\pi^+} > 0.125$ cm, DCA between daughters < 0.2 cm.

$\bar{\Lambda}^0$ Invariant Mass Distribution

We select the following cuts:

- DCA_{π^+} to Primary Vertex > 0.125 cm
- DCA_{p^-} to Primary Vertex > 0.05 cm
- DCA between daughter tracks < 0.2 cm
- Cosine of pointing Angle > 0.99



The Invariant mass is 1.11572 ± 0.00141 GeV/c^2; with a Significance of 27.17 ± 0.58. There are 2322 ± 48 $\bar{\Lambda}^0$ reconstructed of 6044 primaries generated, the 38 % or 13 % for all Λ^0

Λ^0 and $\bar{\Lambda}^0$

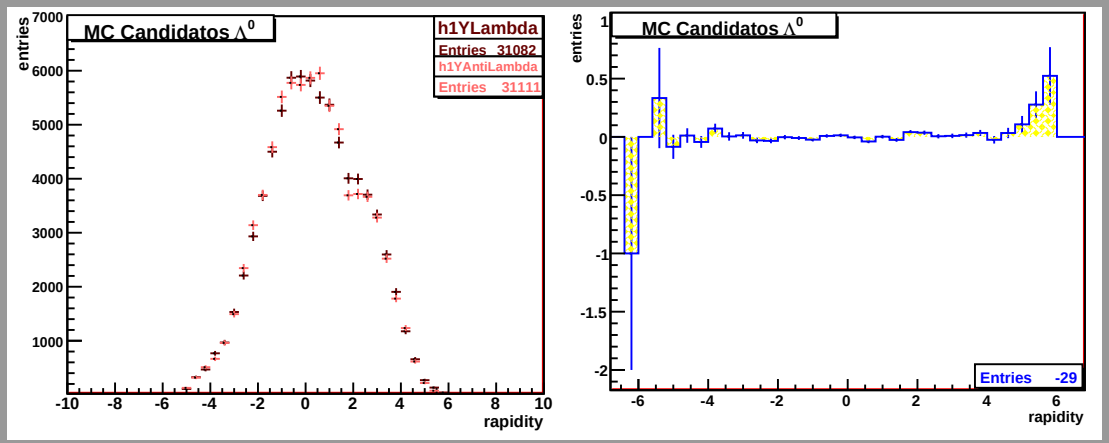
The next table shows the percentage of associated primary Λ^0 and $\bar{\Lambda}^0$ after each cut.

Λ^0				
Cut	Signal	Primary Λ^0	%	Significance
DCA To Primary Vertex	7088 ± 84	3254	43 %	42.96 ± 0.52
DCA between daughters	5930 ± 77	2280	30 %	46.28 ± 0.62
Cosine of pointing angle	2338 ± 48	862	11 %	46.28 ± 0.62
$\bar{\Lambda}^0$				
DCA To Primary Vertex	6910 ± 83	3062	50 %	42.88 ± 0.53
DCA between daughters	5978 ± 77	2406	39 %	43.52 ± 0.58
Cosine of pointing angle	2338 ± 48	1006	16 %	27.17 ± 0.58

Rapidity assimetry for Λ^0-$\bar{\Lambda}^0$

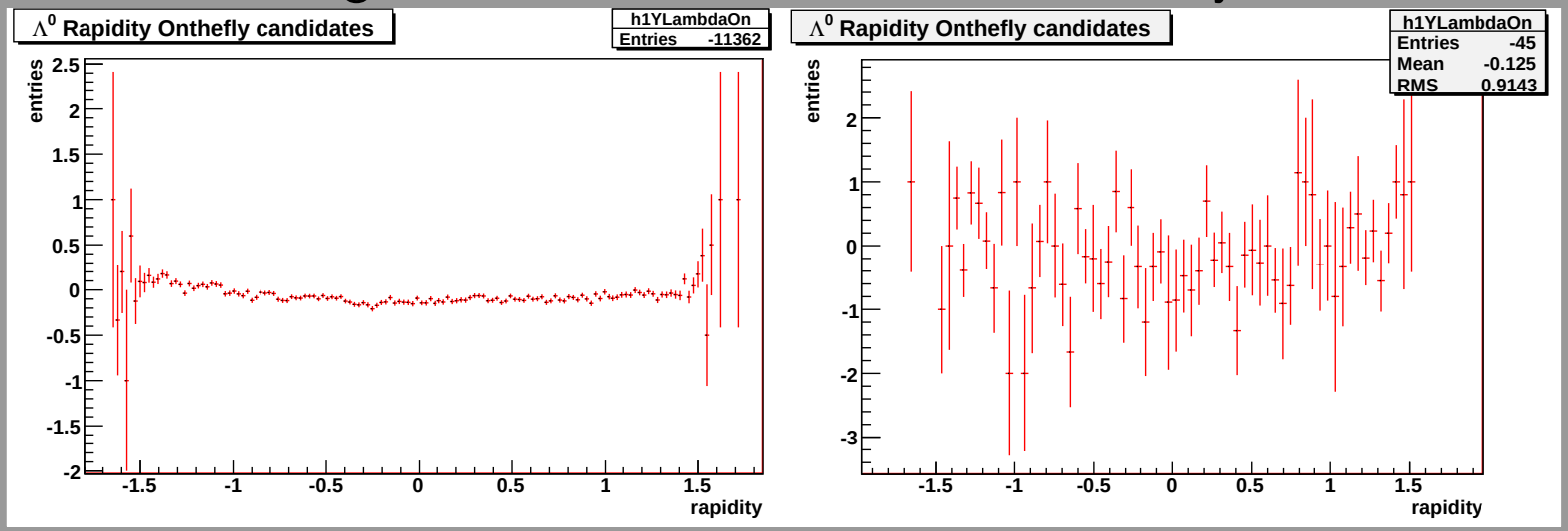
With Λ^0 and $\bar{\Lambda}^0$ we can measure the baryon stopping at mid rapidity.
With Montecarlo data we obtain the asimetry for rapidity distributions of Λ^0 and $\bar{\Lambda}^0$

$$A = \frac{Y_{\Lambda^0} - Y_{\bar{\Lambda}^0}}{Y_{\Lambda^0} + Y_{\bar{\Lambda}^0}} \tag{7}$$



Reconstructed

We get the same distribution with Reconstructed data we should clean the signal to avoid contribution of secundary Λ^0s.



Summary

With the significance distribution, it is possible to select the best cut for:

- DCA of positive daughter to primary Vertex
- DCA of negative daughter to primary Vertex
- DCA between daughters tracks

but it is not possible to select the best cut for Cosine of pointing angle because the distribution is decreasing. We choose the cut for Offline Λ^0s; Cosine of pointing angle > 0.99.
We can measure the rapidity assimetry distribution of Λ^0, $\bar{\Lambda}^0$ production at mid-rapidity.