

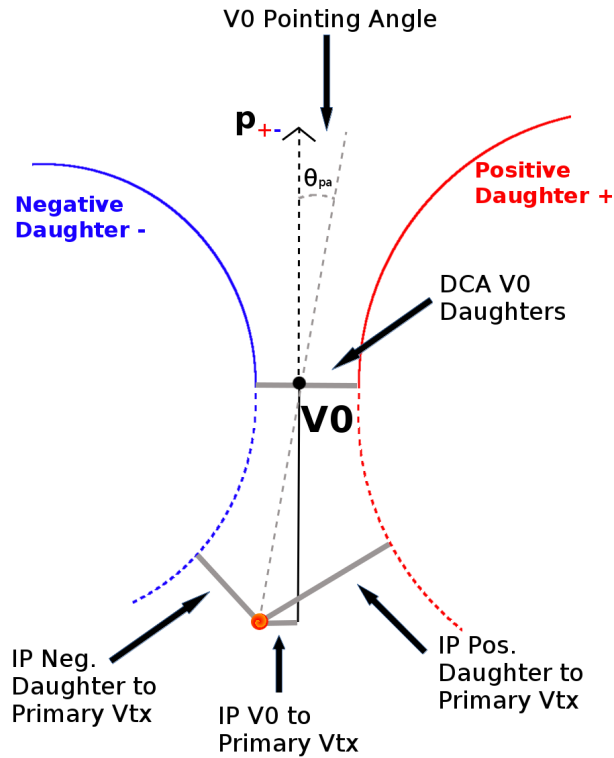
## 0.1 V0 Selection

$\Lambda$  ( $\bar{\Lambda}$ ) and  $K_S^0$  are neutral particles which cannot be directly detected, but must instead be reconstructed through detection of their decay products, or daughters. This process is illustrated in Figure 1. In general, particles which are topologically reconstructed in this fashion are called V0 particles. The class `AliFemtoV0TrackCutNSigmaFilter` (which is an extension of `AliFemtoV0TrackCut`) is used to reconstruct the V0s.

In order to obtain a true and reliable signal, one must ensure good purity of the V0 collection. The purity of the collection is calculated as:

$$Purity = \frac{Signal}{Signal + Background} \quad (1)$$

In order to obtain both the signal and background, the invariant mass distribution ( $M_{inv}$ ) of all V0 candidates must be constructed immediately before the final invariant mass cut. Examples of such distributions can be found in Figures 3 and 5. It is vital that this distribution be constructed immediately before the final  $M_{inv}$  cut, otherwise it would be impossible to estimate the background. As shown in Figures 3 and 5, the background is fit (with a polynomial) outside of the peak region of interest to obtain an estimate for the background within the region. Within the  $M_{inv}$  cut limits, the background is the region below the fit while the signal is the region above the fit.



**Fig. 1:** V0 Reconstruction

### 0.1.1 $\Lambda$ Reconstruction

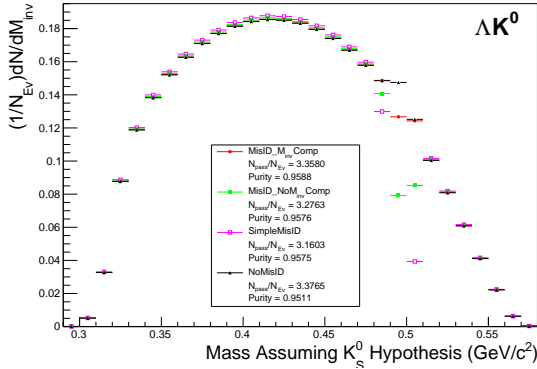
The following cuts were used to select good  $\Lambda$  ( $\bar{\Lambda}$ ) candidates:

1. Daughter Particle Cuts

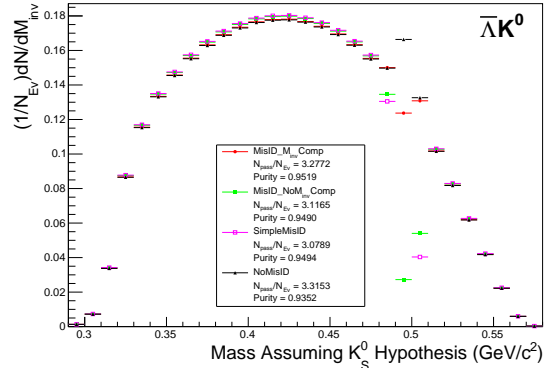
- (a) Cuts Common to Both Daughters
  - i.  $|\eta| < 0.8$
  - ii. SetTPCnclsDaughters(80)
  - iii. SetStatusDaughters(AliESDtrack::kTPCrefic)
  - iv. SetMaxDcaV0Daughters(0.4)
- (b) Pion Specific Daughter Cuts
  - i.  $p_T > 0.16$
  - ii. DCA to prim vertex  $> 0.3$
- (c) Proton Specific Daughter Cuts
  - i.  $p_T > 0.5(p) [0.3(\bar{p})]$  GeV/c
  - ii. DCA to prim vertex  $> 0.1$

## 2. V0 Cuts

- (a)  $|\eta| < 0.8$
- (b)  $p_T > 0.4$
- (c)  $|m_{inv} - m_{PDG}| < 3.8$  MeV
- (d) Cosine of pointing angle  $> 0.9993$
- (e) OnFlyStatus = false
- (f) Decay Length  $< 60$  cm



(a) Mass assuming  $K_S^0$ -hypothesis for  $\Lambda$  collection, i.e. assume the daughters are  $\pi^+\pi^-$  instead of  $p^+\pi^-$ .



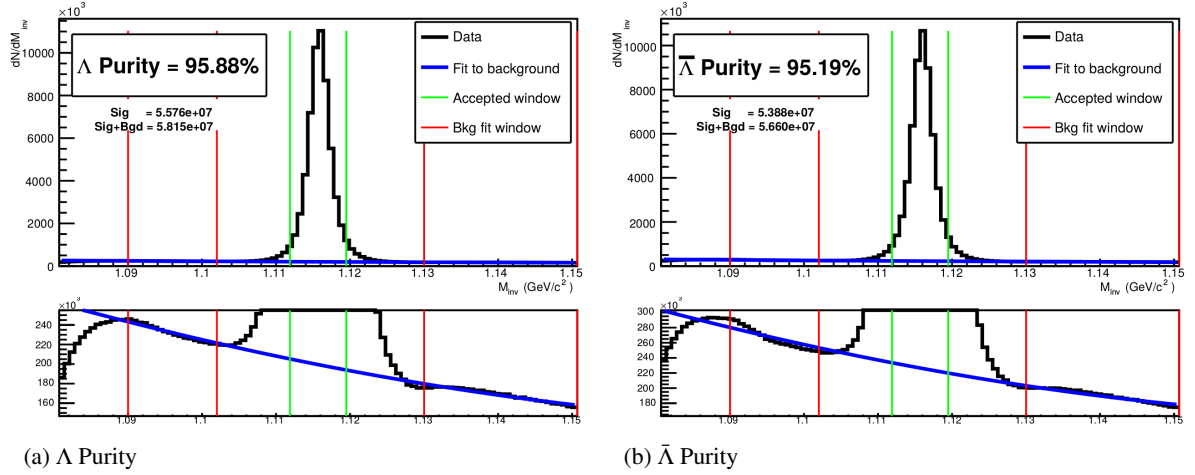
(b) Mass assuming  $K_S^0$ -hypothesis for  $\bar{\Lambda}$  collection, i.e. assume the daughters are  $\pi^+\pi^-$  instead of  $\pi^+\bar{p}^-$ .

**Fig. 2:** Mass assuming  $K_S^0$ -hypothesis for V0 candidates passing all  $\Lambda$  (2a) and  $\bar{\Lambda}$  (2b) cuts. The “NoMisID” distribution (black triangles) uses the V0 finder without any attempt to remove misidentified  $K_S^0$ . The slight peak in the “NoMisID” distribution around  $m_{inv} = 0.5$  GeV/c<sup>2</sup> contains misidentified  $K_S^0$  particles in our  $\Lambda(\bar{\Lambda})$  collection. “SimpleMisID” (pink squares) simply cuts out the entire peak, which throws away some good  $\Lambda$  and  $\bar{\Lambda}$  particles. “MisID\_NoM<sub>inv</sub>Comp” (green squares) uses the misidentification cut outlined in the text, but does not utilize the invariant mass comparison method. “MisID\_M<sub>inv</sub>Comp” (red circles) utilizes the full misidentification methods, and is currently used for this analysis. “ $N_{pass}/N_{ev}$ ” is the total number of  $\Lambda(\bar{\Lambda})$  particles found, normalized by the total number of events. The purity of the collection is also listed.

Figure 2a shows the mass assuming  $K_S^0$  hypothesis for the  $\Lambda$  collection, i.e. assume the daughters are  $\pi^+\pi^-$  instead of  $\pi^+\bar{p}^-$ . Figure 2b is a similar plot, but is for the  $\bar{\Lambda}$  collection, i.e. assume the daughters are  $\pi^+\pi^-$  instead of  $\pi^+\bar{p}^-$ . The  $K_S^0$  contamination is visible, although not profound, in both in the slight

peaks around  $m_{inv} = 0.497 \text{ GeV}/c^2$ . If one simply cuts out the entire peak, good  $\Lambda$  particles will be lost. Ideally, the  $\Lambda$  selection and  $K_S^0$  misidentification cuts are selected such that the peak is removed from this plot while leaving the distribution continuous.

Figure 3 shows the invariant mass ( $M_{inv}$ ) distribution of all  $\Lambda(\bar{\Lambda})$  candidates immediately before the final invariant mass cut. These distributions are used to calculate the collection purities. The  $\Lambda$  and  $\bar{\Lambda}$  purities are found to be:  $\text{Purity}(\Lambda) \approx \text{Purity}(\bar{\Lambda}) \approx 95\%$ .



**Fig. 3:** Invariant mass ( $M_{inv}$ ) distribution of all  $\Lambda$  (a) and  $\bar{\Lambda}$  (b) candidates immediately before the final invariant mass cut. The bottom figures are zoomed to show the background with fit. The vertical green lines represent the  $M_{inv}$  cuts used in the analyses, the red vertical lines delineate the region over which the background was fit, and the blue line shows the background fit. These distributions are used to calculate the collection purities,  $\text{Purity}(\Lambda) \approx \text{Purity}(\bar{\Lambda}) \approx 95\%$ .

### 0.1.2 $K_S^0$ Reconstruction

The following cuts were used to select good  $K_S^0$  candidates:

#### 1. Pion Daughter Cuts

- (a)  $|\eta| < 0.8$
- (b) `SetTPCncldsDaughters(80)`
- (c) `SetStatusDaughters(AliESDtrack::kTPCrefic)`
- (d) `SetMaxDcaV0Daughters(0.3)`
- (e)  $p_T > 0.15$
- (f) DCA to prim vertex  $> 0.3$

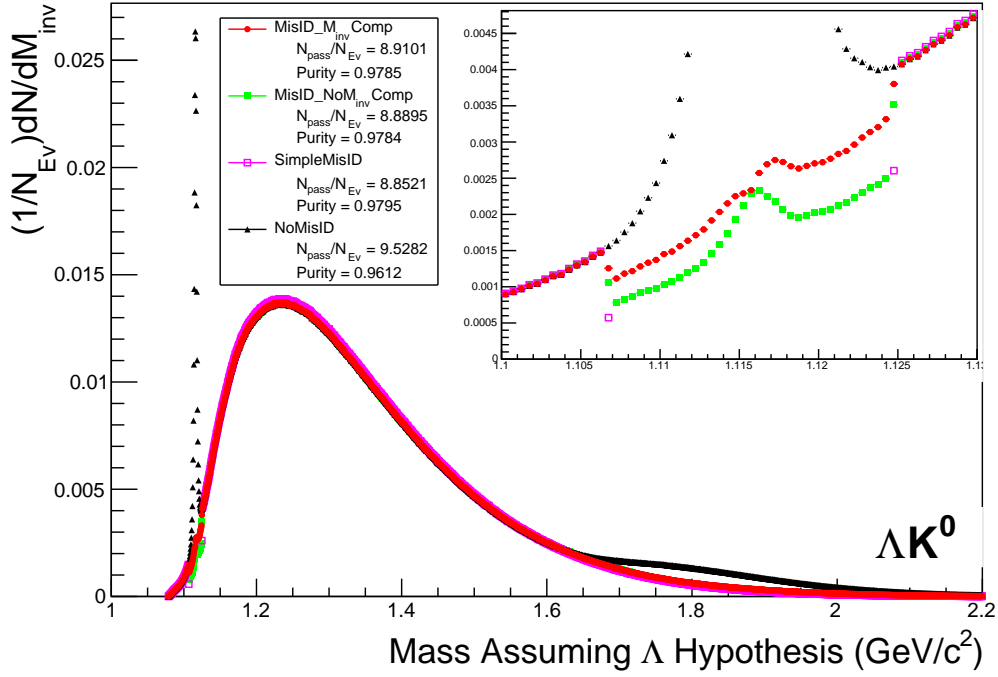
#### 2. $K_S^0$ Cuts

- (a)  $|\eta| < 0.8$
- (b)  $p_T > 0.2$
- (c)  $m_{PDG} - 13.677 \text{ MeV} < m_{inv} < m_{PDG} + 2.0323 \text{ MeV}$
- (d) Cosine of pointing angle  $> 0.9993$
- (e) `OnFlyStatus = false`
- (f) Decay Length  $< 30 \text{ cm}$

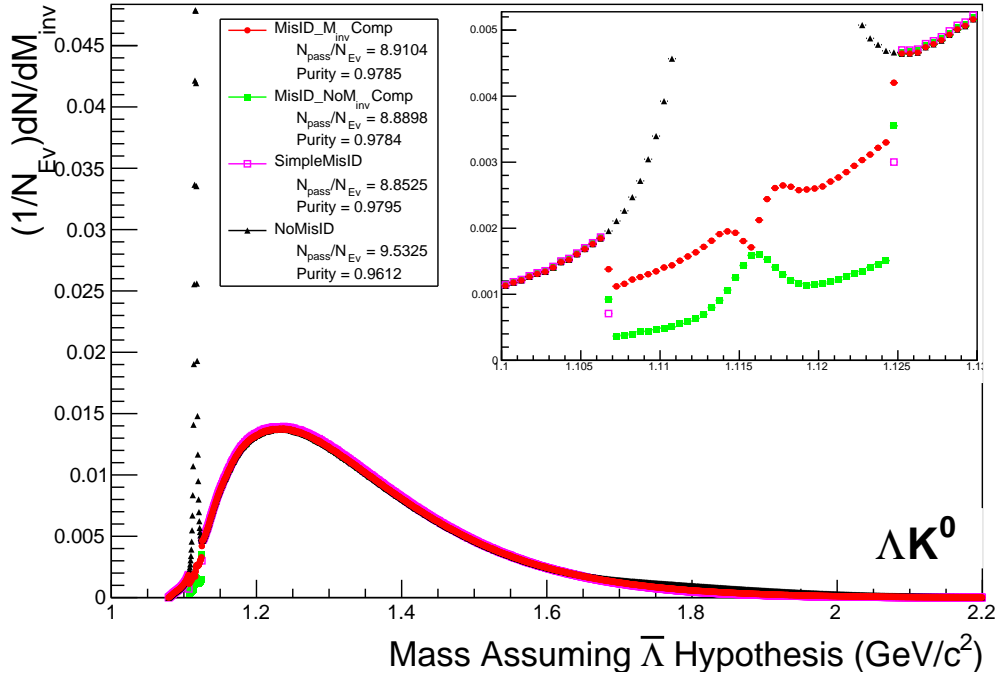
As can be seen in Figure 4, some misidentified  $\Lambda$  and  $\bar{\Lambda}$  particles contaminate our  $K_S^0$  sample. Figure 4a shows the mass assuming  $\Lambda$ -hypothesis for the  $K_S^0$  collection, i.e. assume the daughters are  $p^+\pi^-$  instead of  $\pi^+\pi^-$ . Figure 4b is similar, but shows the mass assuming  $\bar{\Lambda}$  hypothesis for the collection, i.e. assume the daughters are  $\pi^+\bar{p}^-$  instead of  $\pi^+\pi^-$ . The  $\Lambda$  contamination can be seen in 4a, and the  $\bar{\Lambda}$  contamination in 4b, in the peaks around  $m_{inv} = 1.115 \text{ GeV}/c^2$ . Additionally, the  $\bar{\Lambda}$  contamination is visible in Figure 4a, and the  $\Lambda$  contamination visible in Figure 4b, in the region of excess around  $1.65 < m_{inv} < 2.1 \text{ GeV}/c^2$ . This is confirmed as the number of misidentified  $\Lambda$  particles in the sharp peak of Figure 4a (misidentified  $\bar{\Lambda}$  particles in the sharp peak of Figure 4b) approximately equals the excess found in the  $1.65 < m_{inv} < 2.1 \text{ GeV}/c^2$  region of Figure 4a (Figure 4b).

The peaks around  $m_{inv} = 1.115 \text{ GeV}/c^2$  in Figure 4 contain both misidentified  $\Lambda$  ( $\bar{\Lambda}$ ) particles and good  $K_S^0$ . If one simply cuts out the entire peak, some good  $K_S^0$  particles will be lost. Ideally, the  $K_S^0$  selection and  $\Lambda(\bar{\Lambda})$  misidentification cuts can be selected such that the peak is removed from this plot while leaving the distribution continuous. To attempt to remove these  $\Lambda$  and  $\bar{\Lambda}$  contaminations without throwing away good  $K_S^0$  particles, the following misidentification cuts are imposed; a  $K_S^0$  candidate is rejected if all of the following criteria are satisfied:

- $|m_{inv, \Lambda(\bar{\Lambda}) \text{ Hypothesis}} - m_{PDG, \Lambda(\bar{\Lambda})}| < 9.0 \text{ MeV}/c^2$
- Positive daughter passes  $p^+(\pi^+)$  daughter cut implemented for  $\Lambda(\bar{\Lambda})$  reconstruction
- Negative daughter passes  $\pi^-(\bar{p}^-)$  daughter cut implemented by  $\Lambda(\bar{\Lambda})$  reconstruction

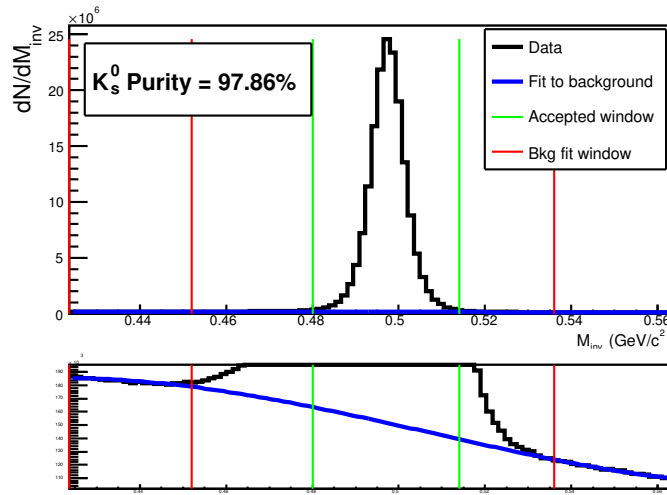


(a) Mass assuming  $\Lambda$ -hypothesis for  $K_S^0$  collection, i.e. assume the daughters are  $p^+\pi^-$  instead of  $\pi^+\pi^-$ .



(b) Mass assuming  $\bar{\Lambda}$ -hypothesis for  $K_S^0$  collection, i.e. assume the daughters are  $\pi^+\bar{p}^-$  instead of  $\pi^+\pi^-$ .

**Fig. 4:** Mass assuming  $\Lambda$ -hypothesis (4a) and  $\bar{\Lambda}$ -hypothesis (4b) for  $K_S^0$  collection. The “NoMisID” distribution (black triangles) uses the V0 finder without any attempt to remove misidentified  $\Lambda$  and  $\bar{\Lambda}$ . The peak in the “NoMisID” distribution around  $m_{inv} = 1.115 \text{ GeV}/c^2$  contains misidentified  $\Lambda$  (4a) and  $\bar{\Lambda}$  (4b) particles in our  $K_S^0$  collection. “SimpleMisID” (pink squares) simply cuts out the entire peak, which throws away some good  $K_S^0$  particles. “MisID\_NoM<sub>inv</sub>Comp” (green squares) uses the misidentification cut outlined in the text, but does not utilize the invariant mass comparison method. “MisID\_M<sub>inv</sub>Comp” (red circles) utilizes the full misidentification methods, and is currently used for this analysis. “ $N_{pass}/N_{Ev}$ ” is the total number of  $K_S^0$  particles found, normalized by the total number of events. The purity of the collection is also listed. Also note, the relative excess of the “NoMisID” distribution around  $1.65 < m_{inv} < 2.1 \text{ GeV}/c^2$  shows misidentified  $\bar{\Lambda}$  (4a) and  $\Lambda$  (4b) particles in our  $K_S^0$  collection.



**Fig. 5:** Invariant mass ( $M_{inv}$ ) distribution of all  $K_S^0$  candidates immediately before the final invariant mass cut. The bottom figure is zoomed to show the background with fit. The vertical green lines represent the  $M_{inv}$  cut used in the analyses, the red vertical lines delineate the region over which the background was fit, and the blue line shows the background fit. This distribution is used to calculate the collection purity,  $\text{Purity}(K_S^0) \approx 98\%$ .