0.0.1 $\mathrm{K^0_S}$ *Reconstruction*

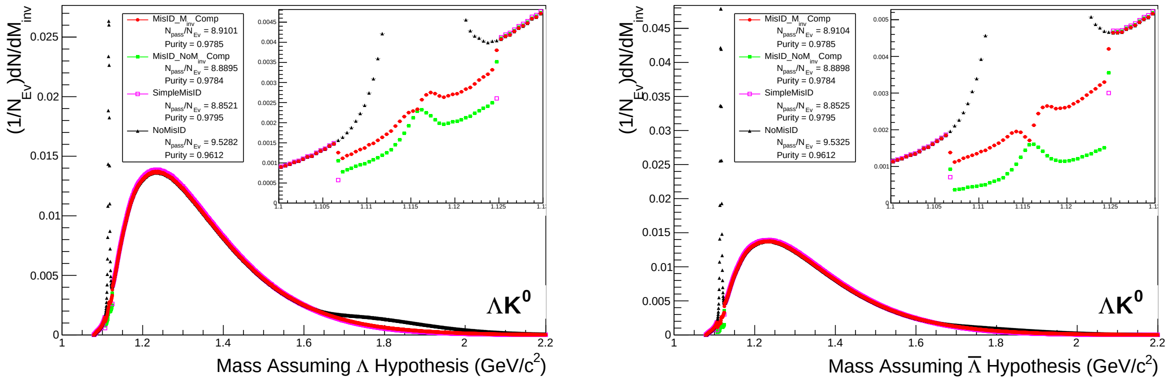
The following cuts, in addition to the misidentification and shared daughter cuts presented in Sec. **??**, were used to select good $\mathrm{K^0_S}$ candidates:

<table>
<tr><th colspan="3">$\mathrm{K^0_S}$ selection</th></tr>
<tr><td colspan="2">$|\eta|$</td><td>< 0.8</td></tr>
<tr><td colspan="2">p_{T}</td><td>> 0.2 GeV/c</td></tr>
<tr><td colspan="3">$m_{PDG} - 13.677$ MeV $< m_{\mathrm{inv}} < m_{\mathrm{PDG}} + 2.0323$ MeV</td></tr>
<tr><td colspan="2">DCA to prim. vertex</td><td>< 0.3 cm</td></tr>
<tr><td colspan="2">Cosine of pointing angle</td><td>> 0.9993</td></tr>
<tr><td colspan="2">OnFlyStatus</td><td>false</td></tr>
<tr><td colspan="2">Decay Length</td><td>< 30 cm</td></tr>
<tr><td colspan="2">Shared Daughter Cut</td><td>true</td></tr>
<tr><td colspan="2">Misidentification Cut</td><td>true</td></tr>
<tr><th colspan="3">$\pi^{\pm}$ Daughter Cuts</th></tr>
<tr><td colspan="2">$|\eta|$</td><td>< 0.8</td></tr>
<tr><td colspan="2">Number of clusters in TPC</td><td>> 80</td></tr>
<tr><td colspan="2">Daughter Status</td><td>kTPCrefit</td></tr>
<tr><td colspan="2">DCA $\pi^+\pi^-$ Daughters</td><td>< 0.3 cm</td></tr>
<tr><td colspan="2">p_{T}</td><td>> 0.15 GeV/c</td></tr>
<tr><td colspan="2">DCA to prim vertex</td><td>> 0.3 cm</td></tr>
<tr><td colspan="3">TPC and TOF Nσ Cuts</td></tr>
<tr><td colspan="2">$p < 0.5$ GeV/c</td><td>N$\sigma_{\mathrm{TPC}} < 3$</td></tr>
<tr><td rowspan="2">$p > 0.5$ GeV/c</td><td>if TOF & TPC available</td><td>N$\sigma_{\mathrm{TPC}} < 3$ & N$\sigma_{\mathrm{TOF}} < 3$</td></tr>
<tr><td>else</td><td>N$\sigma_{\mathrm{TOF}} < 3$</td></tr>
</table>

Table 1: $\mathrm{K^0_S}$ selection

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

The peaks around m_{inv} = 1.115 GeV/c^2 in Figure **??** contain both misidentified $\Lambda(\bar{\Lambda})$ particles and good $\mathrm{K^0_S}$. If one simply cuts out the entire peak, some good $\mathrm{K^0_S}$ particles will be lost. Ideally, the $\mathrm{K^0_S}$ selection and $\Lambda(\bar{\Lambda})$ misidentification cuts can be selected such that the peak is removed from this plot while leaving the underlying distribution continuous. To attempt to remove these Λ and $\bar{\Lambda}$ contaminations without throwing away good $\mathrm{K^0_S}$ particles, the misidentification cuts introduced in Sec. **??** were imposed.



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

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

Fig. 1: Mass assuming Λ-hypothesis (**??**) and $\bar{\Lambda}$-hypothesis (**??**) for $\mathrm{K_S^0}$ collection. The "NoMisID" distribution (black triangles) uses the V0 finder without any attempt to remove misidentified Λ and $\bar{\Lambda}$. The peak in the "NoMisID" distribution around m_{inv} = 1.115 GeV/c^2 contains misidentified Λ (**??**) and $\bar{\Lambda}$ (**??**) particles in our $\mathrm{K_S^0}$ collection. "SimpleMisID" (pink squares) simply cuts out the entire peak, which throws away some good $\mathrm{K_S^0}$ particles. "MisID_NoM$_{\mathrm{inv}}$Comp" (green squares) uses the misidentification cut outlined in the text, but does not utilize the final invariant mass comparison step. "MisID_M$_{\mathrm{inv}}$Comp" (red circles) utilizes the full misidentification methods, and is currently used for this analysis. "$\mathrm{N_{pass}/N_{ev}}$" is the total number of $\mathrm{K_S^0}$ 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 $1.65 < m_{\mathrm{inv}} < 2.1$ GeV/c^2 shows misidentified $\bar{\Lambda}$ (**??**) and Λ (**??**) particles in our $\mathrm{K_S^0}$ collection.