1 Data Selection

1.1 Event Selection and Mixing

The events used in this study were selected with the class AliFemtoEventCutEstimators according to the following criteria:

- Triggers
  - minimum bias (kMB)
  - central (kCentral)
  - semi-central (kSemiCentral)
- z-position of reconstructed event vertex must be within 10 cm of the center of the ALICE detector
- the event must contain at least one particle of each type from the pair of interest

The event mixing was handled by the AliFemtoVertexMultAnalysis class, which only mixes events with like vertex position and centrality. The following criteria were used for event mixing:

- Number of events to mix = 5
- Vertex position bin width = 2 cm
- Centrality bin width = 5

The AliFemtoEventReaderAODChain class is used to read the events. Event flatteneing is not currently used. FilterBit(7). The centrality is determined by the "V0M" method of AliCentrality, set by calling AliFemtoEventReaderAOD::SetUseMultiplicity(kCentrality). We utilize the SetPrimaryVertexCorrectionTPCPoints switch, which causes the reader to shift all TPC points to be relative to the event vertex.

1.2 $K^{\pm}$ Track Selection

Charged kaons are identified using the AliFemtoESDTrackCutNSigmaFilter class. The specific cuts used in this analysis are as follows:

Track Selection:

- Kinematic range:
  - $0.14 < p_{\mathrm{T}} < 1.5$ GeV/c
  - $|\eta| < 0.8$
- FilterBit(7)
  - TPC tracks
- Track Quality
  - Minimum number of clusters in the TPC (fminTPCncls) = 80
  - Maximum allowed χ^2/N_{DOF} for ITS clusters = 3.0
  - Maximum allowed χ^2/N_{DOF} for TPC clusters = 4.0
- Primary Particle Selection:

    - Maximum XY impact parameter = 2.4 cm
    - Maximum Z impact parameter = 3.0 cm
- Remove particles with any kink labels (fRemoveKinks = true)
- Maximum allowed sigma to primary vertex (fMaxSigmaToVertex) = 3.0

$K^{\pm}$ Identification:

- PID Probabilities:
    - K: > 0.2
    - π: < 0.1
    - μ: < 0.8
    - p: < 0.1
- Most probable particle type must be Kaon (fMostProbable=3)
- TPC and TOF N_{σ} cuts:
    - $p < 0.4$ GeV/c: $N_{\sigma K,TPC} < 2$
    - $0.4 < p < 0.45$ GeV/c: $N_{\sigma K,TPC} < 1$
    - $0.45 < p < 0.8$ GeV/c: $N_{\sigma K,TPC} < 3$ & $N_{\sigma K,TOF} < 2$
    - $0.8 < p < 1.0$ GeV/c: $N_{\sigma K,TPC} < 3$ & $N_{\sigma K,TOF} < 1.5$
    - $p > 1.0$ GeV/c: $N_{\sigma K,TPC} < 3$ & $N_{\sigma K,TOF} < 1$
- Electron Rejection: Reject if $N_{\sigma e^-,TPC} < 3$
- Pion Rejection: Reject if:
    - $p < 0.65$ GeV/c
        * if TOF and TPC available: $N_{\sigma\pi,TPC} < 3$ & $N_{\sigma\pi,TOF} < 3$
        * else
            · $p < 0.5$ GeV/c: $N_{\sigma\pi,TPC} < 3$
            · $0.5 < p < 0.65$ GeV/c: $N_{\sigma\pi,TPC} < 2$
    - $0.65 < p < 1.5$ GeV/c: $N_{\sigma\pi,TPC} < 5$ & $N_{\sigma\pi,TOF} < 3$
    - $p > 1.5$ GeV/c: $N_{\sigma\pi,TPC} < 5$ & $N_{\sigma\pi,TOF} < 2$

The purity of the $K^{\pm}$ collections was estimated using the HIJING MC data, for which the true identity of each reconstructed $K^{\pm}$ particle is known. Therefore, the purity may be estimated as:

$$Purity(K^{\pm}) = \frac{N_{true}}{N_{reconstructed}} \tag{1}$$

Purity(K^+) $\approx$ Purity(K^-) $\approx 97\%$

<table>
<tr><th colspan="4">$K^{\pm}$ selection</th></tr>
<tr><td colspan="3">$|\eta|$</td><td>< 0.8</td></tr>
<tr><td colspan="3">p_{T}</td><td>$0.14 < p_{\mathrm{T}} < 1.5$ GeV/c</td></tr>
<tr><td colspan="3">FilterBit</td><td>7</td></tr>
<tr><td colspan="3">Min. number of clusters in the TPC</td><td>80</td></tr>
<tr><td colspan="3">Max. allowed χ^2/N_{DOF} for ITS clusters</td><td>3.0</td></tr>
<tr><td colspan="3">Max. allowed χ^2/N_{DOF} for TPC clusters</td><td>4.0</td></tr>
<tr><td colspan="3">Maximum XY impact parameter</td><td>2.4 cm</td></tr>
<tr><td colspan="3">Maximum Z impact parameter</td><td>3.0 cm</td></tr>
<tr><td colspan="3">Remove particles with any kink labels</td><td>true</td></tr>
<tr><td colspan="3">Maximum allowed sigma to primary vertex</td><td>3.0</td></tr>
<tr><td colspan="4">PID Probabilities</td></tr>
<tr><td></td><td colspan="2">K</td><td>> 0.2</td></tr>
<tr><td></td><td colspan="2">π</td><td>< 0.1</td></tr>
<tr><td></td><td colspan="2">μ</td><td>< 0.8</td></tr>
<tr><td></td><td colspan="2">p</td><td>< 0.1</td></tr>
<tr><td colspan="3">Most probable particle type</td><td>Kaon (fMostProbable=3)</td></tr>
<tr><td colspan="4">TPC and TOF Nσ Cuts</td></tr>
<tr><td></td><td colspan="2">$p < 0.4$ GeV/c</td><td>$N_{\sigma K,\mathrm{TPC}} < 2$</td></tr>
<tr><td></td><td colspan="2">$0.4 < p < 0.45$ GeV/c</td><td>$N_{\sigma K,\mathrm{TPC}} < 1$</td></tr>
<tr><td></td><td colspan="2">$0.45 < p < 0.80$ GeV/c</td><td>$N_{\sigma K,\mathrm{TPC}} < 3$ & $N_{\sigma K,\mathrm{TOF}} < 2$</td></tr>
<tr><td></td><td colspan="2">$0.80 < p < 1.0$ GeV/c</td><td>$N_{\sigma K,\mathrm{TPC}} < 3$ & $N_{\sigma K,\mathrm{TOF}} < 1.5$</td></tr>
<tr><td></td><td colspan="2">$p > 1.0$ GeV/c</td><td>$N_{\sigma K,\mathrm{TPC}} < 3$ & $N_{\sigma K,\mathrm{TOF}} < 1$</td></tr>
<tr><td colspan="3">Electron Rejection</td><td>Reject if $N_{\sigma e^-,\mathrm{TPC}} < 3$</td></tr>
<tr><td colspan="4">Pion Rejection: Reject if:</td></tr>
<tr><td rowspan="3">$p < 0.65$ GeV/c</td><td>if TOF and TPC available</td><td></td><td>$N_{\sigma\pi,\mathrm{TPC}} < 3$ & $N_{\sigma\pi,\mathrm{TOF}} < 3$</td></tr>
<tr><td rowspan="2">else</td><td>$p < 0.5$ GeV/c</td><td>$N_{\sigma\pi,\mathrm{TPC}} < 3$</td></tr>
<tr><td>$0.5 < p < 0.65$ GeV/c</td><td>$N_{\sigma\pi,\mathrm{TPC}} < 2$</td></tr>
<tr><td colspan="3">$0.65 < p < 1.5$ GeV/c</td><td>$N_{\sigma\pi,\mathrm{TPC}} < 5$ & $N_{\sigma\pi,\mathrm{TOF}} < 3$</td></tr>
<tr><td colspan="3">$p > 1.5$ GeV/c</td><td>$N_{\sigma\pi,\mathrm{TPC}} < 5$ & $N_{\sigma\pi,\mathrm{TOF}} < 2$</td></tr>
</table>

Table 1: $K^{\pm}$ selection

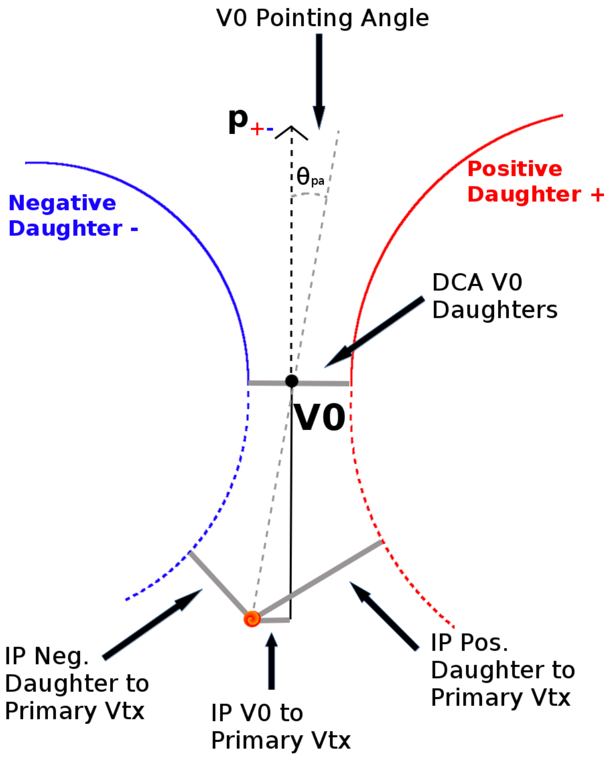


Fig. 1: V0 Reconstruction

1.3 V0 Selection

$\Lambda(\bar{\Lambda})$ and $\mathrm{K^0_S}$ 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 ensure a true and reliable signal, one must ensure good purity of the V0 collection. The purity of the collection is calculated as:

$$Purity = \frac{Signal}{Signal + Background} \tag{2}$$

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 the distribution be constructed immediately before the final m_{inv} cut, otherwise, it would be impossible to estimate the background. As demonstrated in Figures 3 and 5, the background is fit with a polynomial outside of the peak region of interest in order to extrapolate 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.

1.3.1 Λ 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::kTPCrefit)
   iv. DCA πp Daughters < 0.4 cm

   (b) Pion Specific Daughter Cuts
   i. $p_{\mathrm{T}} > 0.16$ GeV/c
   ii. DCA to prim vertex > 0.3 cm
   iii. TPC and TOF Nσ Cuts
      A. $p < 0.5$ GeV/c : N$\sigma_{\mathrm{TPC}} < 3$
      B. $p > 0.5$ GeV/c :
         – if TOF & TPC available: N$\sigma_{\mathrm{TPC}} < 3$ & N$\sigma_{\mathrm{TOF}} < 3$
         – else N$\sigma_{\mathrm{TPC}} < 3$

   (c) Proton Specific Daughter Cuts
   i. $p_{\mathrm{T}} > 0.5(p)$ $[0.3(\bar{p})]$ GeV/c
   ii. DCA to prim vertex > 0.1 cm
   iii. TPC and TOF Nσ Cuts
      A. $p < 0.8$ GeV/c : N$\sigma_{\mathrm{TPC}} < 3$
      B. $p > 0.8$ GeV/c :
         – if TOF & TPC available: N$\sigma_{\mathrm{TPC}} < 3$ & N$\sigma_{\mathrm{TOF}} < 3$
         – else N$\sigma_{\mathrm{TPC}} < 3$

2. V0 Cuts
   (a) $|\eta| < 0.8$
   (b) $p_{\mathrm{T}} > 0.4$ GeV/c
   (c) $|m_{\mathrm{inv}} - m_{\mathrm{PDG}}| < 3.8$ MeV
   (d) DCA to prim. vertex < 0.5 cm
   (e) Cosine of pointing angle > 0.9993
   (f) OnFlyStatus = false
   (g) Decay Length < 60 cm

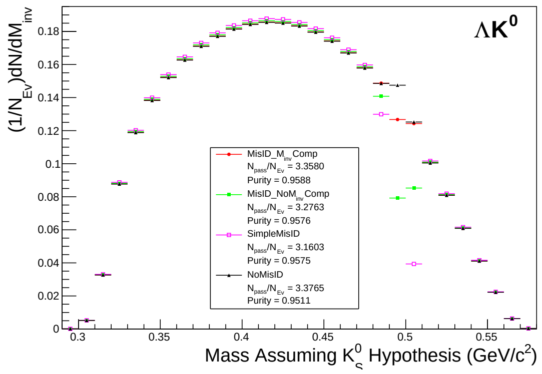
3. Shared Daughter Cut for V0 Collection
   – Iterate through V0 collection to ensure that no daughter is used in more than one V0 candidate

Figure 2a shows the mass assuming $\mathrm{K^0_S}$ hypothesis for the Λ collection, i.e. assume the daughters are $\pi^+\pi^-$ instead of $\mathrm{p}^+\pi^-$. 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 $\mathrm{K^0_S}$ contamination is visible, although not profound, in both, in the slight peaks around m_{inv} = 0.497 GeV/c^2. If one simply cuts out the entire peak, good Λ particles will be lost. Ideally, the Λ selection and $\mathrm{K^0_S}$ misidentification cuts are selected such that the peak is removed from this plot while leaving the underlying distribution continuous. To attempt to remove these $\mathrm{K^0_S}$ contaminations without throwing away good Λ and $\bar{\Lambda}$ particles, the following misidentification cuts are imposed; a $\Lambda(\bar{\Lambda})$ candidate is rejected if all of the following criteria are satisfied:

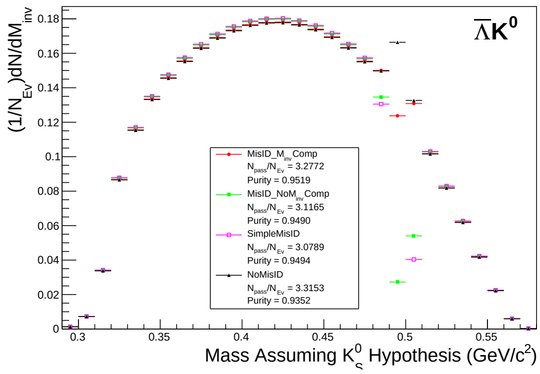
– $\left|m_{\mathrm{inv,\ K^0_S\ Hypothesis}} - m_{\mathrm{PDG,\ K^0_S}}\right| < 9.0$ MeV/c^2

Λ selection		
$\|\eta\|$		< 0.8
p_T		> 0.4 GeV/c
$\|m_{inv} - m_{PDG}\|$		< 3.8 MeV
DCA to prim. vertex		< 0.5 cm
Cosine of pointing angle		> 0.9993
OnFlyStatus		false
Decay Length		< 60 cm
Shared Daughter Cut		true
Misidentification Cut		true
Daughter Cuts (π and p)		
$\|\eta\|$		< 0.8
SetTPCnclsDaughters		(80)
SetStatusDaughters		(AliESDtrack::kTPCrefit)
DCA πp Daughters		< 0.4 cm
π-specific cuts		
p_T		> 0.16 GeV/c
DCA to prim vertex		> 0.3 cm
TPC and TOF Nσ Cuts		
$p < 0.5$ GeV/c		N$\sigma_{TPC} < 3$
$p > 0.5$ GeV/c	if TOF & TPC available	N$\sigma_{TPC} < 3$ & N$\sigma_{TOF} < 3$
	else	N$\sigma_{TOF} < 3$
p-specific cuts		
p_T		$> 0.5(p)$ $[0.3(\bar{p})]$ GeV/c
DCA to prim vertex		> 0.1 cm
TPC and TOF Nσ Cuts		
$p < 0.8$ GeV/c		N$\sigma_{TPC} < 3$
$p > 0.8$ GeV/c	if TOF & TPC available	N$\sigma_{TPC} < 3$ & N$\sigma_{TOF} < 3$
	else	N$\sigma_{TOF} < 3$

Table 2: Λ selection



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



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

Fig. 2: Mass assuming $\mathrm{K^0_S}$-hypothesis for V0 candidates passing all Λ (2a) and $\bar{\Lambda}$ (2b) cuts. The "NoMisID" distribution (black triangles) uses the V0 finder without any attempt to remove misidentified $\mathrm{K^0_S}$ The slight peak in the "NoMisID" distribution around m_{inv} = 0.5 GeV/c^2 contains misidentified $\mathrm{K^0_S}$ particles in our $\Lambda(\bar{\Lambda})$ collection. "SimpleMisID" (pink squares) simply cuts out the entire peak, which throws away some good Λ and $\bar{\Lambda}$ 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. "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.

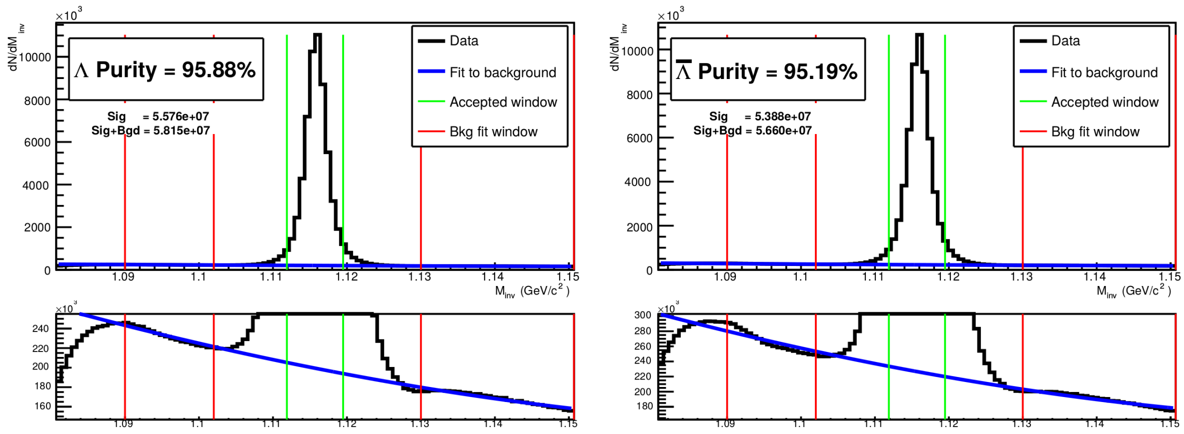
- Positive and negative daughters pass π daughter cut implemented for $\mathrm{K^0_S}$ reconstruction
- $\left| m_{\mathrm{inv,\ K^0_S\ Hypothesis}} - m_{\mathrm{PDG,\ K^0_S}} \right| < \left| m_{\mathrm{inv,\ \Lambda(\bar{\Lambda})\ Hypothesis}} - m_{\mathrm{PDG,\ \Lambda(\bar{\Lambda})}} \right|$

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

1.3.2 $\mathrm{K^0_S}$ *Reconstruction*

The following cuts were used to select good $\mathrm{K^0_S}$ candidates:

1. Pion Daughter Cuts
   (a) $|\eta| < 0.8$
   (b) SetTPCnclsDaughters(80)
   (c) SetStatusDaughters(AliESDtrack::kTPCrefic)
   (d) DCA $\pi^+\pi^-$ Daughters < 0.3 cm
   (e) $p_{\mathrm{T}} > 0.15$ GeV/c
   (f) DCA to prim vertex > 0.3 cm
   (g) TPC and TOF Nσ Cuts
      i. $p < 0.5$ GeV/c : N$\sigma_{\mathrm{TPC}} < 3$
      ii. $p > 0.5$ GeV/c :
         – if TOF & TPC available: N$\sigma_{\mathrm{TPC}} < 3$ & N$\sigma_{\mathrm{TOF}} < 3$
         – else N$\sigma_{\mathrm{TPC}} < 3$



(a) Λ Purity (b) $\bar{\Lambda}$ Purity

Fig. 3: Invariant mass (m_{inv}) distribution for all Λ (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 regions over which the background was fit, and the blue line shows the background fit. These distributions are used to calculate the collection purities, Purity(Λ) $\approx$ Purity($\bar{\Lambda}$) $\approx$ 95%.

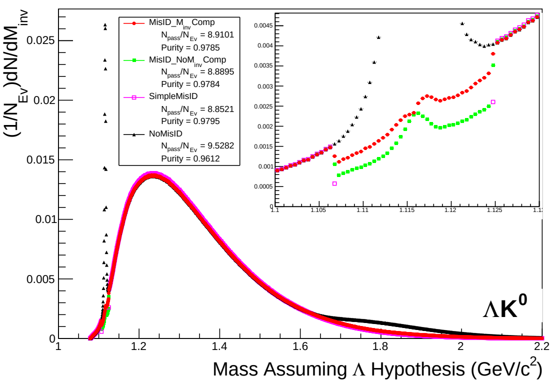
2. $\mathrm{K^0_S}$ Cuts
   (a) $|\eta| < 0.8$
   (b) $p_{\mathrm{T}} > 0.2$ GeV/c
   (c) $m_{\mathrm{PDG}} - 13.677$ MeV $< m_{\mathrm{inv}} < m_{\mathrm{PDG}} + 2.0323$ MeV
   (d) DCA to prim. vertex < 0.3 cm
   (e) Cosine of pointing angle > 0.9993
   (f) OnFlyStatus = false
   (g) Decay Length < 30 cm
3. Shared Daughter Cut for V0 Collection
   – Iterate through V0 collection to ensure that no daughter is used in more than one V0 candidate

As can be seen in Figure 4, some misidentified Λ and $\bar{\Lambda}$ particles contaminate our $\mathrm{K^0_S}$ sample. Figure 4a 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 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 Λ contamination can be seen in 4a, and the $\bar{\Lambda}$ contamination in 4b, in the peaks around m_{inv} = 1.115 GeV/c^2. Additionally, the $\bar{\Lambda}$ contamination is visible in Figure 4a, and the Λ contamination visible in Figure 4b, 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 4a (misidentified $\bar{\Lambda}$ particles in the sharp peak of Figure 4b) approximately equals the excess found in the 1.65 $< m_{\mathrm{inv}} <$ 2.1 GeV/c^2 region of Figure 4a (Figure 4b).

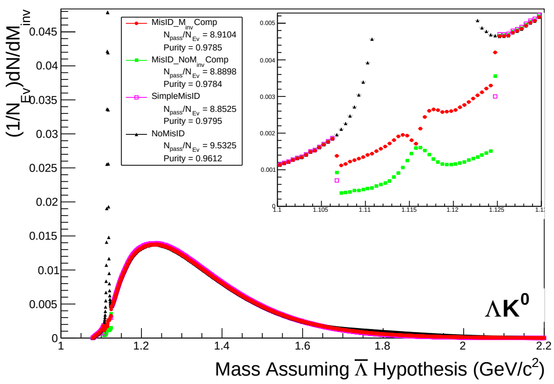
The peaks around m_{inv} = 1.115 GeV/c^2 in Figure 4 contain both misidentified $\Lambda(\bar{\Lambda})$ particles and good $\mathrm{K^0_S}$. If one simply cuts out the entire peak, some good $\mathrm{K^0_S}$ particles will be lost. Ideally, the $\mathrm{K^0_S}$ selection and $\Lambda(\bar{\Lambda})$ 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 following misidentification cuts are imposed; a $\mathrm{K^0_S}$ candidate is rejected if all of the following criteria are satisfied (for either Λ- or $\bar{\Lambda}$-hypothesis):

K^0_S **selection**		
$\lvert\eta\rvert$		< 0.8
p_T		> 0.2 GeV/c
$m_{PDG} - 13.677$ MeV $< m_{\mathrm{inv}} < m_{\mathrm{PDG}} + 2.0323$ MeV		
DCA to prim. vertex		< 0.3 cm
Cosine of pointing angle		> 0.9993
OnFlyStatus		false
Decay Length		< 30 cm
Shared Daughter Cut		true
Misidentification Cut		true
$\pi^{\pm}$ **Daughter Cuts**		
$\lvert\eta\rvert$		< 0.8
SetTPCnclsDaughters		(80)
SetStatusDaughters		(AliESDtrack::kTPCrefit)
DCA $\pi^+\pi^-$ Daughters		< 0.3 cm
p_T		> 0.15 GeV/c
DCA to prim vertex		> 0.3 cm
TPC and TOF Nσ Cuts		
$p < 0.5$ GeV/c		N$\sigma_{\mathrm{TPC}} < 3$
$p > 0.5$ GeV/c	if TOF & TPC available	N$\sigma_{\mathrm{TPC}} < 3$ & N$\sigma_{\mathrm{TOF}} < 3$
	else	N$\sigma_{\mathrm{TOF}} < 3$

Table 3: K^0_S selection



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



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

Fig. 4: Mass assuming Λ-hypothesis (4a) and $\bar{\Lambda}$-hypothesis (4b) for K^0_S 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 (4a) and $\bar{\Lambda}$ (4b) particles in our K^0_S collection. "SimpleMisID" (pink squares) simply cuts out the entire peak, which throws away some good K^0_S 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. "N$_{\mathrm{pass}}$/N$_{\mathrm{ev}}$" is the total number of K^0_S 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 $\bar{\Lambda}$ (4a) and Λ (4b) particles in our K^0_S collection.

– $\left| m_{\text{inv, }\Lambda(\bar{\Lambda})\text{ Hypothesis}} - m_{\text{PDG, }\Lambda(\bar{\Lambda})} \right| < 9.0\ \text{MeV}/c^2$

– 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

– $\left| m_{\text{inv, }\Lambda(\bar{\Lambda})\text{ Hypothesis}} - m_{\text{PDG, }\Lambda(\bar{\Lambda})} \right| < \left| m_{\text{inv, }K^0_S\text{ Hypothesis}} - m_{\text{PDG, }K^0_S} \right|$

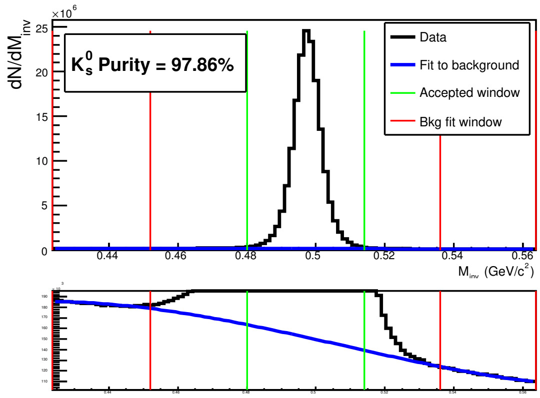


Fig. 5: Invariant mass (m_{inv}) distribution for all K^0_S candidates immediately before the final invariant mass cut. The bottom figure is zoomed to show the background with fit. The vertical green lines represent the m_{inv} cut used in the analyses, the red vertical lines delineate the regions over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

1.3.3 V0 Purity Background Estimation

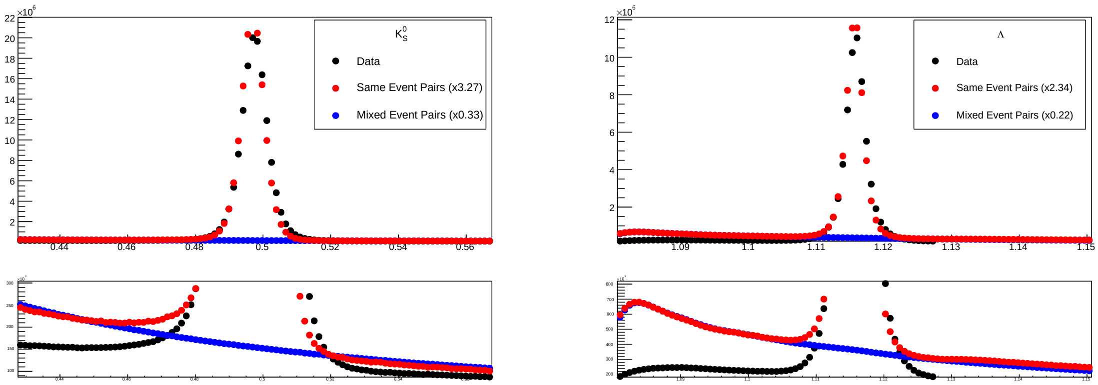
As previously stated, the backgrounds in the m_{inv} distributions are modeled by a polynomial which is fit outside of the final cut region in an attempt to estimate the background within the cut region. As this estimate of the background under the mass peak is vital for our estimate of our V0 purity, it is important for us to ensure that our estimate is accurate. More specifically, it is necessary that we ensure the background is well described by a polynomial fit within the cut region.

To better understand our background, we studied V0 candidates reconstructed with daughters from different events. These mixed-event V0s certainly do not represent real, physical V0s (a single V0 cannot have daughters living in two different events!), but, rather, represent a large portion of the background creeping into our analysis.

The standard AliFemto framework is not equipped to handle this situation, as most are not interested in these fake-V0s. Therefore, we built the AliFemtoV0PurityBgdEstimator class to handle our needs. In addition to finding fake-V0s using mixed-event daughters, we also used our AliFemtoV0PurityBgdEstimator class to find real-V0s using same-event daughters. The purpose here was to compare our simple V0 finder (in AliFemtoV0PurityBgdEstimator) to the established V0 finder used in standard AliFemto analyses.

Figure 6 shows the results of our study. In the figures, the black points, marked "Data", correspond to V0s found using the standard V0-finder, and to the V0s used in my analyses. The red points show real V0s reconstructed with our personal V0-finder (in AliFemtoV0PurityBgdEstimator) using same-event daughters, and the blue points show fake-V0s reconstructed with our personal V0-finder using mixed-event daughters. Both the red and blue points have been scaled by different factors (listed in the figure's legends) to nicely align all three data on a single plot.

Figure 6 shows that our personal V0-finder does a good, but not perfect, job of matching the shape of the m_{inv} plots obtained from the data. The scale factor listed in the legend reveals that we are only finding



(a) K^0_S (b) Λ

Fig. 6: V0 Purity Background Estimation. The black points, marked "Data", correspond to real V0s found using the standard V0-finder (i.e. the V0s used in my analyses). The red points, marked "Same Event Pairs", show real V0s reconstructed with our personal V0-finder in AliFemtoV0PurityBgdEstimator. These data are scaled by a factor (listed in the legend) to match their *Signal* + *Background* value in the cut region with that of the data. The blue points, marked "Mixed Event Pairs", show fake-V0s reconstructed with our personal V0-finder using mixed-event daughters. The blue points are scaled by a factor (listed in the legend) to closely match the red points in the side-band region.

1/3 - 1/2 of the V0s found by the standard V0-finder. These two points are not of concern, as our purpose here was to gain a sense of the broad shape of the background. It is revealed in Fig. 6, when studying the red and blue points, that the background distribution within the mass peak region is simply a smooth connection of the backgrounds outside of the cut region, as we assumed. Therefore, our method of fitting the background outside of the cut region, fitting with a smooth polynomial, and extrapolating to the cut region is justified.

1.4 Ξ Reconstruction

Our motivation for studying $\Xi^-K^\pm$ systems is to attempt to better understand the striking difference in the ΛK^+ and ΛK^- data at low k^* (Figure **??**).

The reconstruction of Ξ particles is one level above V0 reconstruction. V0 particles are topologically reconstructed by searching for the charged daughters' tracks into which they decay. With Ξ particles, we search for the V0 particle and charged daughter into which the Ξ decays. In the case of Ξ^-, we search for the Λ (V0) and π^- (track) daughters. We will refer to this π as the "bachelor π".

The following cuts were used to select good Ξ^- ($\bar{\Xi}^+$) candidates:

1. V0 Daughter Reconstruction
   (a) V0 Daughter Particle Cuts
      i. Cuts Common to Both Daughters
         A. $|\eta| < 0.8$
         B. SetTPCnclsDaughters(80)
         C. SetStatusDaughters(AliESDtrack::kTPCrefic)
         D. SetMaxDcaV0Daughters(0.4)
      ii. Pion Specific Daughter Cuts
         A. $p_T > 0.16$
         B. DCA to prim vertex > 0.3

iii. Proton Specific Daughter Cuts
A. $p_T > 0.5(p)$ $[0.3(\bar{p})]$ GeV/c
B. DCA to prim vertex > 0.1

(b) V0 Cuts
i. $|\eta| < 0.8$
ii. $p_T > 0.4$ GeV/c
iii. $|m_{inv} - m_{PDG}| < 3.8$ MeV
iv. DCA to prim. vertex > 0.2 cm
v. Cosine of pointing angle to Ξ decay vertex > 0.9993
vi. OnFlyStatus = false
vii. Decay Length < 60 cm
viii. The misidentification cuts described in Section 1.3.1 are utilized

2. Bachelor π Cuts
   (a) $|\eta| < 0.8$
   (b) $p_T < 100$ GeV/c
   (c) DCA to prim vertex > 0.1 cm
   (d) SetTPCnclsDaughters(70)
   (e) SetStatusDaughters(AliESDtrack::kTPCrefic)
3. Ξ Cuts
   (a) $|\eta| < 0.8$
   (b) $0.8 < p_T < 100$ GeV/c
   (c) $|m_{inv} - m_{PDG}| < 3.0$ MeV
   (d) DCA to prim. vertex < 0.3 cm
   (e) Cosine of pointing angle > 0.9992
4. Shared Daughter Cut for Ξ Collection
   – Iterate through Ξ collection to ensure that no daughter is used in more than one Ξ candidate
   – Remove any candidate in which the bachelor π is also a daughter of the Λ (implemented in AliFemtoXiTrackPairCut class)

The purity of our Ξ and $\bar{\Xi}$ collections are calculated just as those of our V0 collections 1.3. Figure 8, which is used to calculate the purity, shows the m_{inv} distribution of our $\Xi(\bar{\Xi})$ candidates just before the final m_{inv} cut. Currently, we have Purity(Ξ^-) $\approx 90\%$ and Purity($\bar{\Xi}^+$) $\approx 92\%$.

1.5 Pair Selection

It is important to obtain true particle pairs in the analysis. In particular, contamination from pairs constructed with split or merged tracks, and pairs sharing daughters, can introduce an artificial signal into the correlation function, obscuring the actual physics. We impose the following pair cuts to combat these issues:

1. Shared Daughter Cut for Pairs

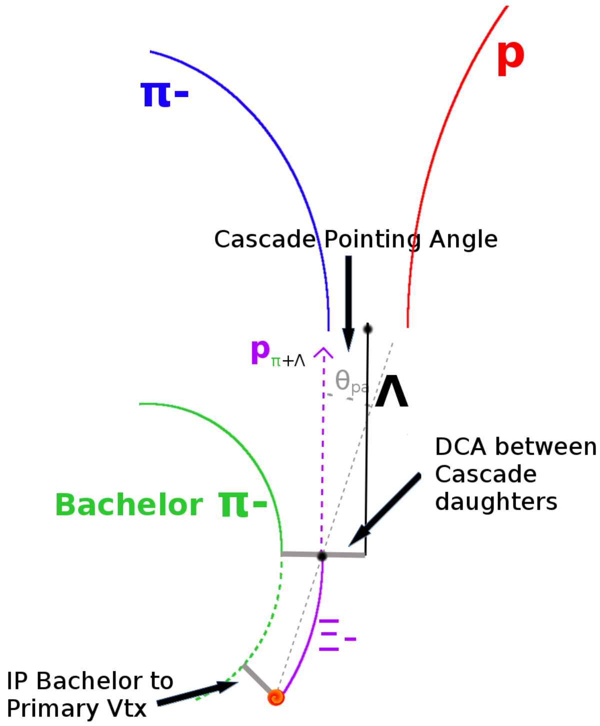
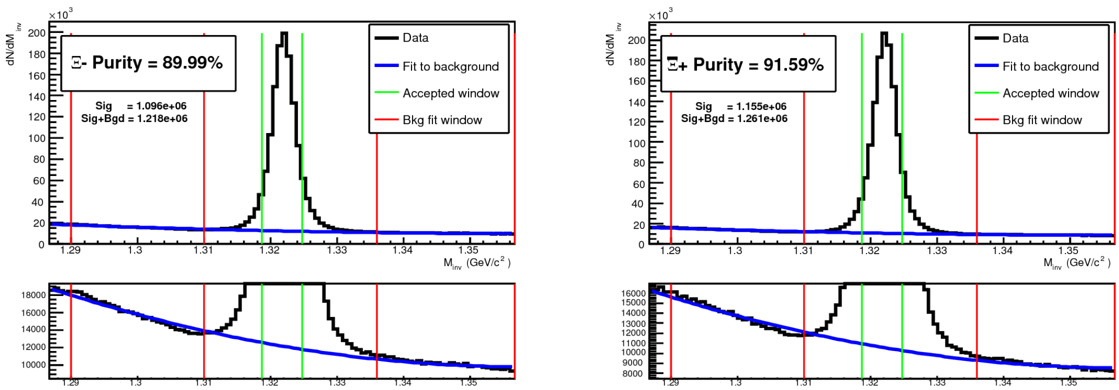


Fig. 7: Ξ Reconstruction



(a) Ξ^- Purity (b) $\bar{\Xi}$ Purity

Fig. 8: Invariant mass (m_{inv}) distribution for all Ξ^- (a) and $\bar{\Xi}^+$ (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 regions over which the background was fit, and the blue line shows the background fit. These distributions are used to calculate the collection purities, Purity(Ξ^-) $\approx$ 90% and Purity($\bar{\Xi}^+$) $\approx$ 92%.

(a) V0-V0 Pairs (i.e. ΛK^0_S analyses)
   – Remove all pairs which share a daughter
      – Ex. Λ and K^0_S particles which share a π^- daughter are not included
(b) V0-Track Pairs (i.e. $\Lambda K^\pm$ analyses)
   – Remove pairs if Track is also used as a daughter of the V0
      – In these analyses, this could only occur if, for instance, a K is misidentified as a π or p in the V0 reconstruction

(c) Ξ-Track Pairs

- Remove pairs if Track is also used as a daughter of the Ξ
  - In these analyses, this could only occur if, for instance, a K is misidentified as a π or p in the V0 reconstruction, or misidentified as bachelor π.

2. Average Separation Cuts (AvgSep)

- Used to cut out splitting and merging effects
- The motivation for these cuts can be seen in Figures 9, 10, and 11, in which average separation correlation functions are presented

(a) ΛK^0_S Analyses

- AvgSep > 6.0 cm for like charge sign daughters
  - ex. p daughter of Λ and π^+ daughter of K^0_S
- No cut for unlike-sign daughters

(b) $\Lambda K^\pm$ Analyses

- AvgSep > 8.0 cm for daughter of $\Lambda(\bar{\Lambda})$ sharing charge sign of $K^\pm$
  - ex. in ΛK^+ analysis, p daughter of Λ with K^+
- No cut for unlike signs

(c) $\Xi^- K^\pm$ Analyses

- AvgSep > 8.0 cm for any daughter of Ξ sharing charge sign of $K^\pm$
  - ex. in $\Xi^- K^-$ analysis, π^- daughter of Λ daughter with K^-, and bachelor π^- daughter with K^-
- No cut for unlike signs

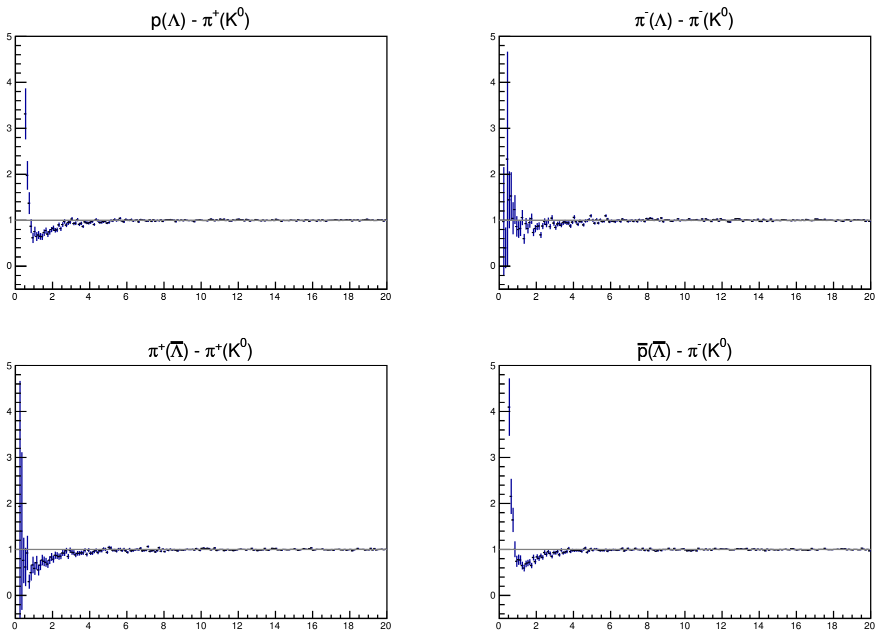


Fig. 9: Average separation (cm) correlation functions of $\Lambda(\bar{\Lambda})$ and K^0_S Daughters. Only like-sign daughter pairs are shown (the distributions for unlike-signs were found to be flat). The title of each subfigure shows the daughter pair, as well as the mother of each daughter (in "()"), ex. top left is p from Λ with π^+ from K^0_S.

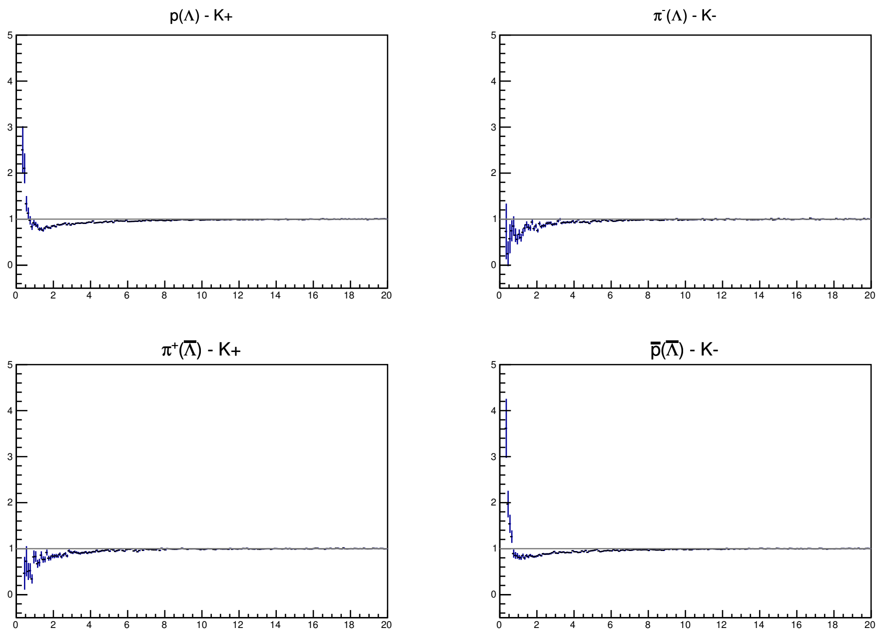
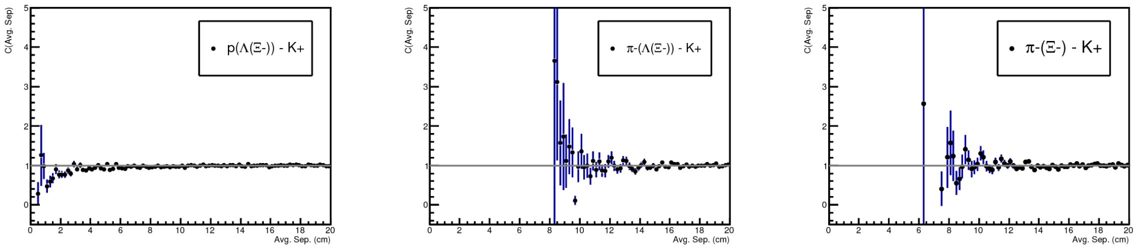
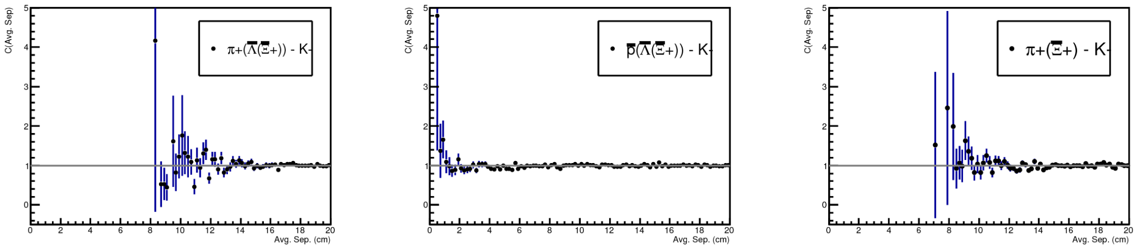


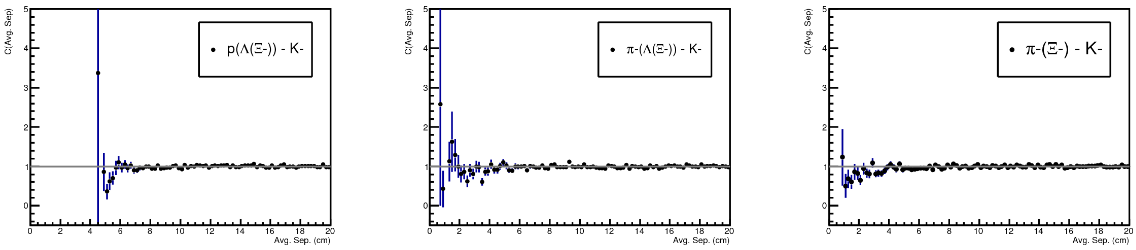
Fig. 10: Avgerage separation (cm) correlation functions of $\Lambda(\bar{\Lambda})$ Daughter and $K^{\pm}$. Only like-sign pairs are shown (unlike-signs were flat). In the subfigure titles, the particles in "()" represent the mothers, ex. top left is p from Λ with K^{+}.



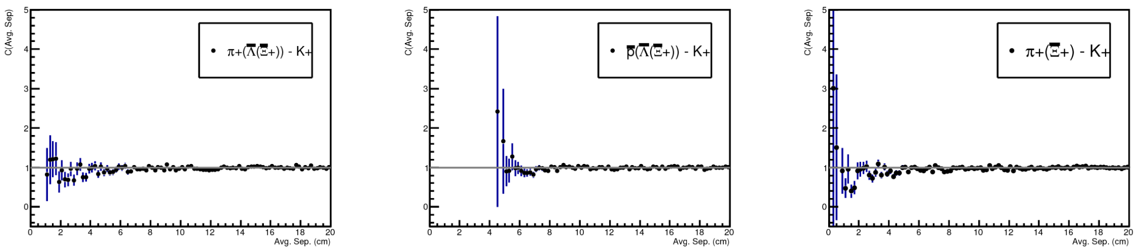
(a) Ξ^{-}K^{+}



(b) $\bar{\Xi}^{+}$K^{-}



(c) Ξ^{-}K^{-}



(d) $\bar{\Xi}^{+}$K^{+}

Fig. 11: Avgerage separation (cm) correlation functions of Ξ Daughter and K$^{\pm}$. In the subfigure titles, the particles in "()" represent the mothers, ex. top left is p from Λ from Ξ^{-} with K^{+}.