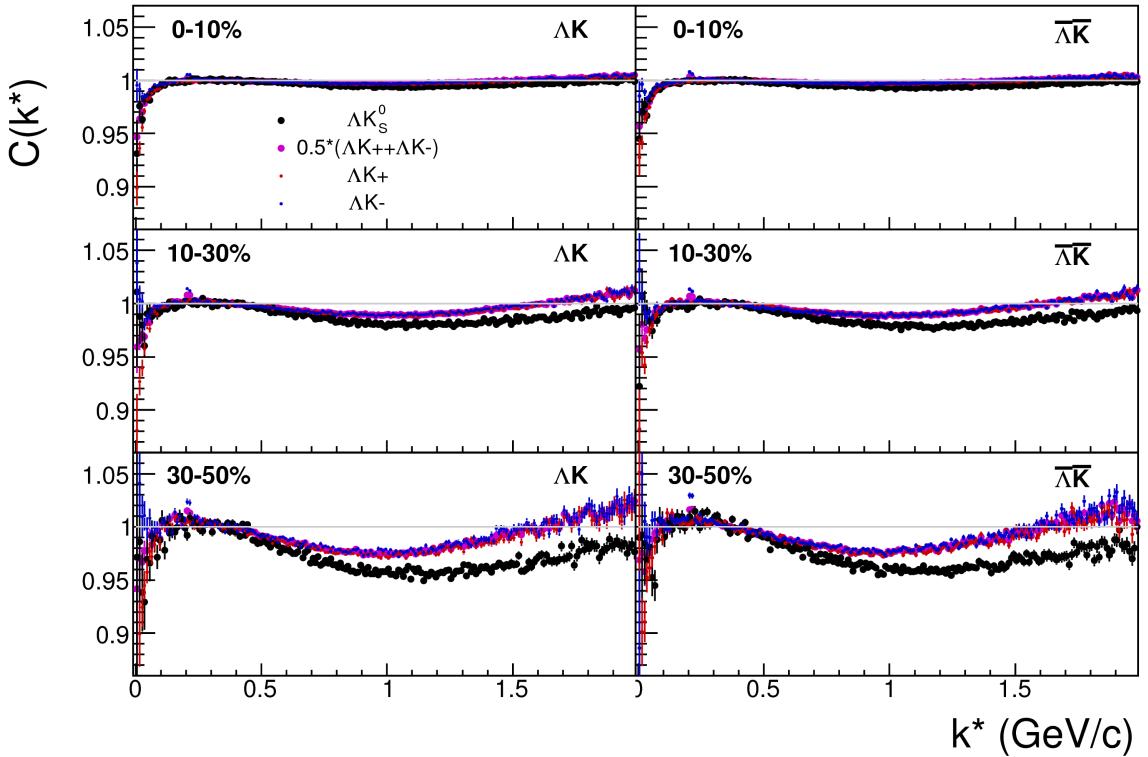


## 0.1 Non-Flat Background

We observe a significant non-femtoscopic, non-flat, background in all of our correlations at large  $k^*$ . This background increases with decreasing centrality, is the same amongst all  $\Lambda K^\pm$  pairs, and is more pronounced in the  $\Lambda K_S^0$  system, as can be seen in Fig. 1. Figure 2a shows that THERMINATOR 2 simulation does a good job of describing the difference in backgrounds between  $\Lambda K^\pm$  and  $\Lambda K_S^0$ .

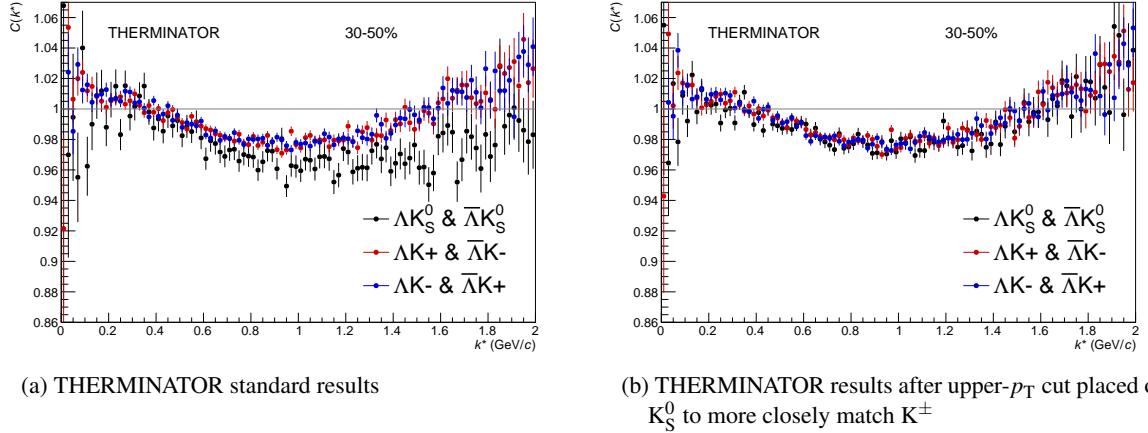
Before beginning, it is important to note that the difference in  $\Lambda K^\pm$  and  $\Lambda K_S^0$  backgrounds is due mainly to the difference in kinematic cuts, not due to any interesting physics. Figure 2b shows that, for THERMINATOR simulation, when restrictions are imposed on the  $p_T$  of the  $K_S^0$  to more closely match the  $K^\pm$  cuts, the backgrounds align much better. Therefore, we conclude that the difference in background between  $\Lambda K^\pm$  and  $\Lambda K_S^0$  observed in our experimental data is simply due to a difference in kinematic cuts between  $K^\pm$  and  $K_S^0$  particles.



**Fig. 1:** A comparison on the non-femtoscopic backgrounds observed in our our  $\Lambda K$  experimental data.

It is suggested that this background effect is due primarily to particle collimation associated with elliptic flow [?]. More specifically, these backgrounds result from mixing events with unlike event-plane angles ( $\Psi_{EP}$ ). As explained in [?], when elliptic flow is present, all particles are more likely to be emitted in a specific direction (in-plane), as opposed to a perpendicular direction. Therefore, the difference in momenta for pairs of particles tends to be smaller, compared to the case of no flow. In the case of mixed-event pairs, the two events used do not share an event-plane, and therefore there is no collimation effect in the pairs from flow. As a result, pairs with larger momentum are more likely when mixed-events are used, causing the correlation function to be observed below unity. In general, a dip below unity, at a given  $k^*$ , means it is more probable to find a pair at that  $k^*$  when the daughters are taken from mixed-events, as compared to when they are taken from the same event.

This same reasoning suggests that the background should lead to an enhancement at low- $k^*$ . The enhancement at high- $k^*$  ( $k^* \gtrsim 1.5$  GeV/c) does not result from the collective flow of the system. We are not



**Fig. 2:** THERMINATOR 2 simulation for  $\Lambda K^+$  (red),  $\Lambda K^-$  (blue), and  $\Lambda K_S^0$  (black). In 2a, we show the standard THERMINATOR 2 results. THERMINATOR 2 does a good job describing qualitatively the different between the  $\Lambda K^\pm$  and  $\Lambda K_S^0$  backgrounds. In 2b, an upper- $p_T$  cut was placed on the  $K_S^0$  particles to more closely match the  $K^\pm$  kinematic cuts. After this tweak, the  $\Lambda K^\pm$  and  $\Lambda K_S^0$  backgrounds agree much better.

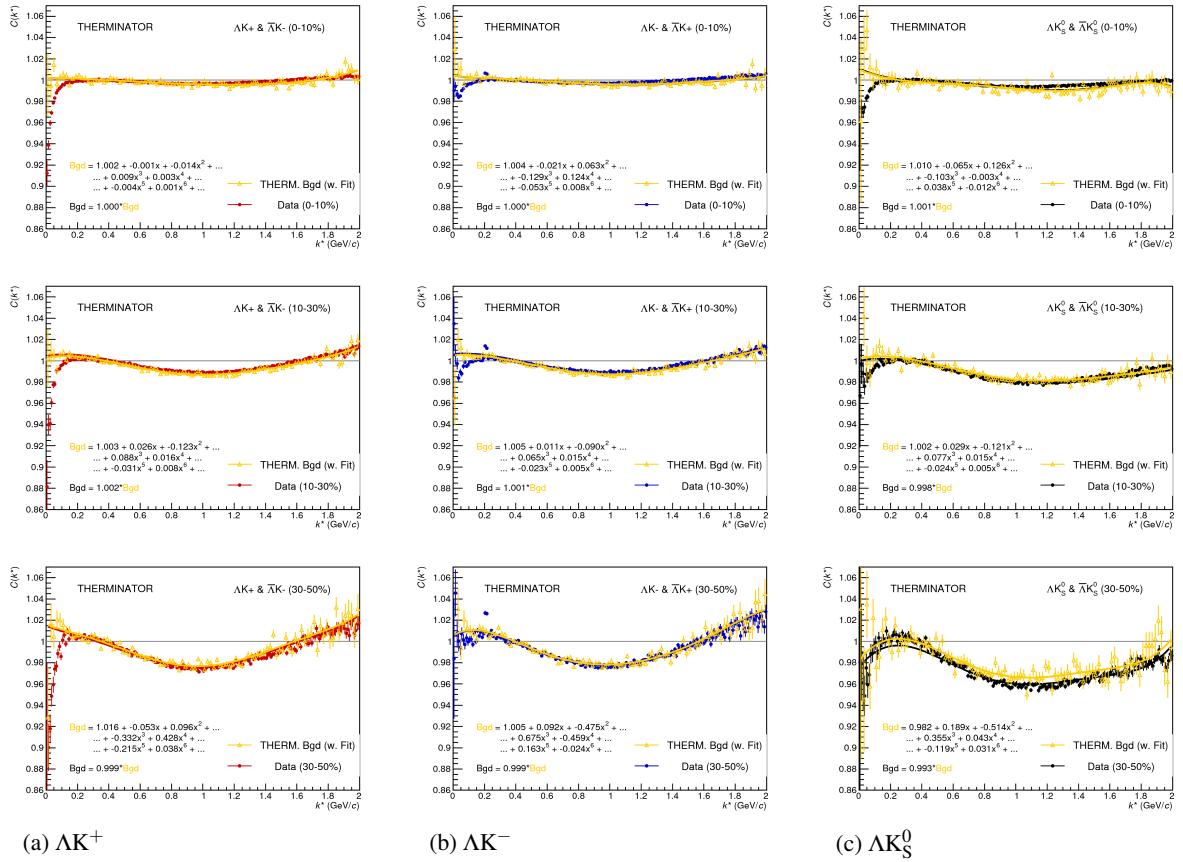
certain was causes this enhancement, but typical suspects are jet-like correlations and resonance decays.

We can split our correlation functions into three main regions. First, the low- $k^*$  region ( $k^* \lesssim 0.3$  GeV/c) contains the femtoscopic correlations, as well as a likely enhancement from the background. The intermediate- $k^*$  region ( $0.3 \lesssim k^* \gtrsim 1.5$  GeV/c) contains a suppression from the background. Finally, the high- $k^*$  region ( $k^* \gtrsim 1.5$  GeV/c) contains an enhancement with unknown origin.

THERMINATOR 2 simulation has been shown to reproduce the background features in a  $\pi K$  analysis [?]. As the background effect can be attributed mainly to elliptic flow, which is a global feature of the system, we suspected THERMINATOR 2 could also, at least qualitatively, describe our backgrounds. After ensuring each simulated event received a random event-plane angle ( $\Psi_{EP}$ )<sup>1</sup>, we found THERMINATOR 2 did a good job of describing our data qualitatively, and, in many cases, quantitatively. Figure 3 shows the THERMINATOR 2 simulation (gold) together with experimental data (red, blue, or black). The figure also shows a 6<sup>th</sup>-order polynomial fit to the simulation (gold), as well as the fit polynomial scaled to match the data (red, blue, black).

Figure 4 shows three different correlation function generated using THERMINATOR 2 simulation (“Cf w/o Bgd (A)”, “Cf w. Bgd (B)”, “Bgd(C)”), as well as two histograms describing the relation between the three (“Ratio (B/C)”, “1+Diff(B-C)”). “Cf w/o Bgd (A)” shows a correlation function with a femtoscopic correlation, but without background. When THERMINATOR 2 is run without randomizing event planes, and therefore having all events share a common event plane, no background is observed, as expected. The femtoscopic correlation effect was introduced by assuming a set of scattering parameters for the system, and weighting the numerators appropriately. The second correlation, ”Cf w. Bgd (B)”, shows a correlation function with both a femtoscopic correlation and a background (most closely matches our situation in experiment). To generate the background, each event was given a random event-plane angle, as is given to us in experiment. To generate the femtoscopic correlation, the same numerator weighting procedure was used. Finally, ”Bgd (C)”, shows a correlation function with a non-femtoscopic background, but no femtoscopic correlation, i.e. background only. This is generated just as ”Cf w. Bgd (B)”, with randomized event planes, but unit weights are used when filling the numerators, so no femtoscopic effects are included.

<sup>1</sup>default was for all events to share a common event plane



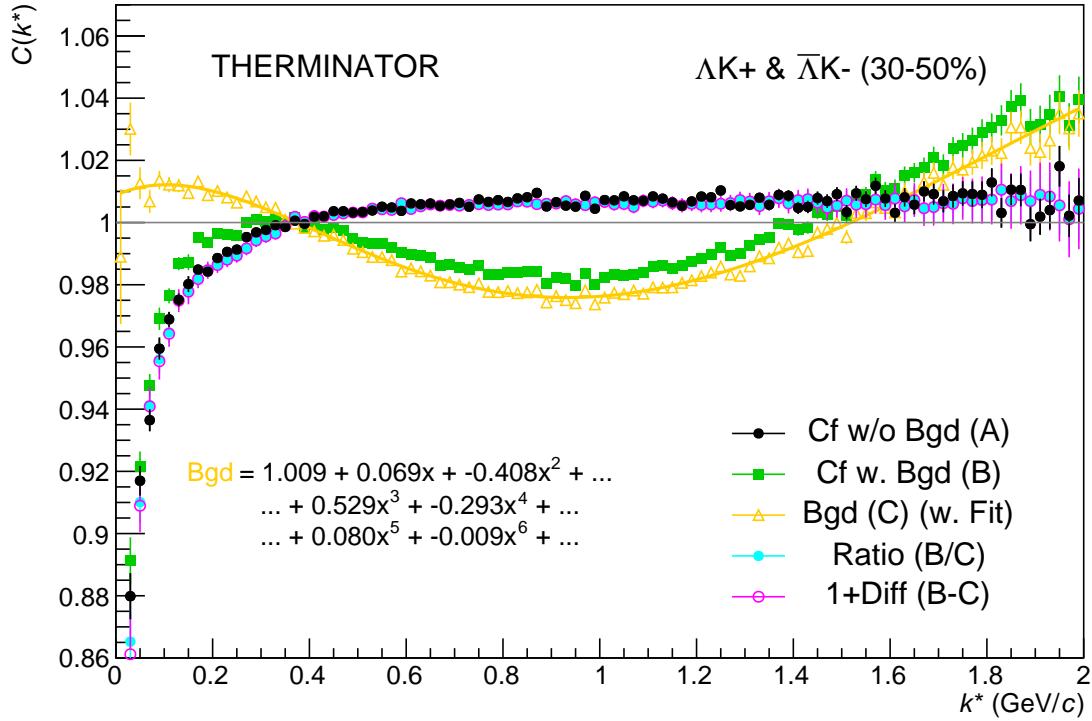
**Fig. 3:** THERMINATOR 2 simulation (gold) together with experimental data (red, blue, or black). The left column shows results for  $\Delta K^+$  (3a), middle for  $\Delta K^-$  (3b), and right for  $\Delta K_S^0$  (3c). A 6<sup>th</sup>-order polynomial fit to the simulation is shown as a solid gold line, and whose fit parameters are printed on the lower left of each plot. This polynomial is scaled to match the experimental data; the value of this scale is printed in the lower left corner of each plot. The polynomial fit with scale factor applied is drawn in a color matching the experimental data (red, blue, black).

The main point of Fig. 4 is that the black points match the blue (and purple) points; or, equivalently:

$$C_{fw/oBgd} = \frac{C_{fw.Bgd}}{Bgd} \rightarrow C_{theory} = \frac{C_{exp}}{F_{Bgd}} \rightarrow C_{exp} = C_{theory} \cdot F_{Bgd} \quad (1)$$

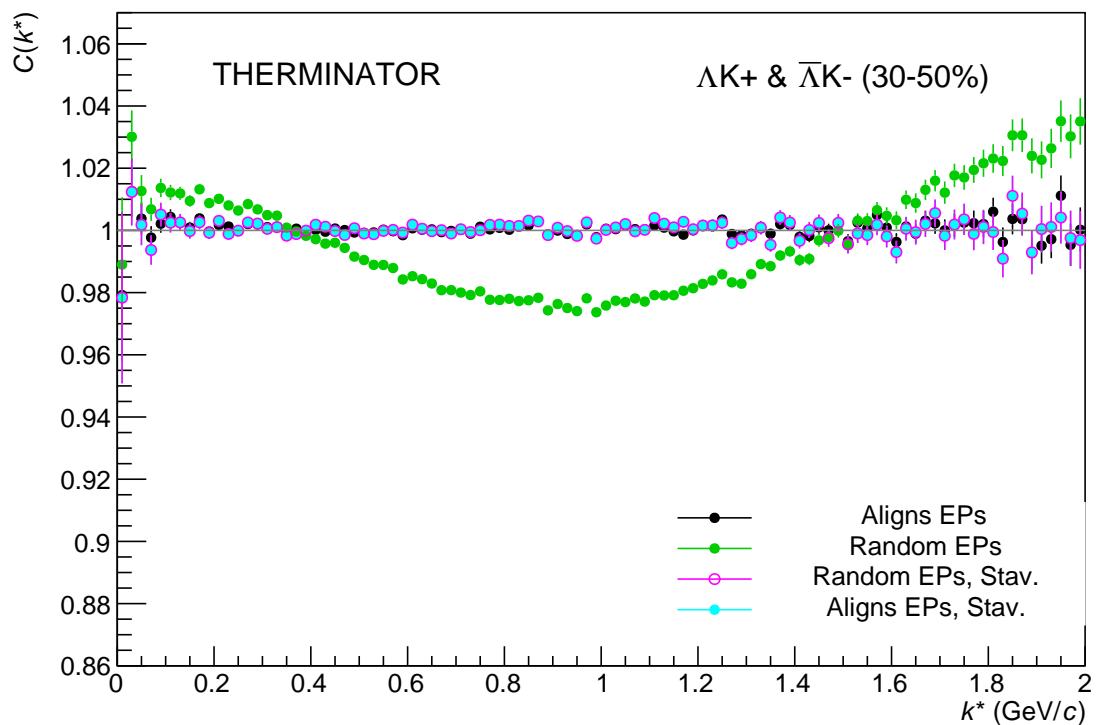
As shown and described in Fig 4 and Eq. 1, THERMINATOR 2 simulation shows the non-femtoscopic background affects the correlation function as a separable scale factor. We expect this behavior to be roughly the same in the experimental data.

Figure 5 demonstrates the use of the Stavinsky method with THERMINATOR 2. In the figure, unit weights were used for all numerators, so no femtoscopic signal is included, only background effects. The black points show an ideal, experimentally unreachable, situation of aligning all of the event-plane angles. With THERMINATOR 2, when the event-planes are aligned, the background signal is killed. The green points show the case of random event-plane angles, a situation more closely matching that of experiment. The purple points show the affect of applying the Stavinsky method to the case of random event-planes. The figure shows that this method effectively kills the non-flat background (i.e. the procedure takes the green points to the purple). Finally, the blue points show the effect of applying the Stavinsky method when all of the event-planes are aligned. This shows that the Stavinsky method



**Fig. 4:** Correlation with background decomposition with THERMINATOR. "Cf w/o Bgd (A)" shows a correlation function with a femtoscopic correlation, but without background. "Cf w. Bgd (B)", shows a correlation function with both a femtoscopic correlation and a background (most closely matches our situation in experiment). "Bgd (C)", shows a correlation function with a non-femtoscopic background, but no femtoscopic correlation, i.e. background only.

does not introduce any signal to an already flat background.



**Fig. 5:** The use of the Stavinsky method with THERMINATOR 2. Unit weights were used for all numerators, so no femtoscopic signal is included, only background effects. The black points show an ideal, experimentally unreachable, situation of aligning all of the event-plane angles. The green points show the experimental situation of random event-plane angles. The purple points shown the affect of applying the Stavinsky method to the case of random event-planes. Finally, the blue points show the effect of applying the Stavinsky method when all of the event-planes are aligned.