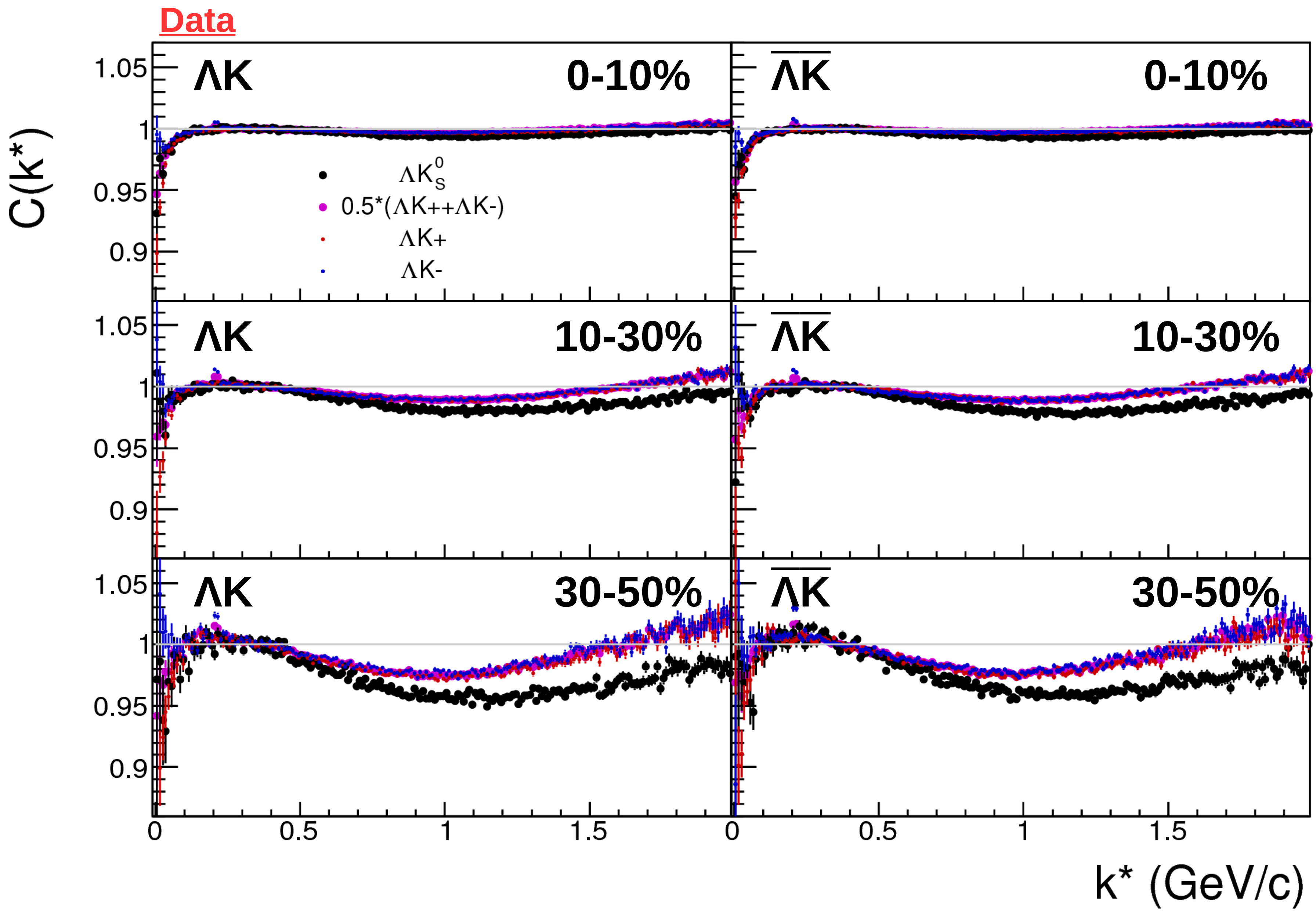
ΛK Femtoscopy in Pb-Pb collisions at 2.76 TeV

Non-Flat Background

Outline

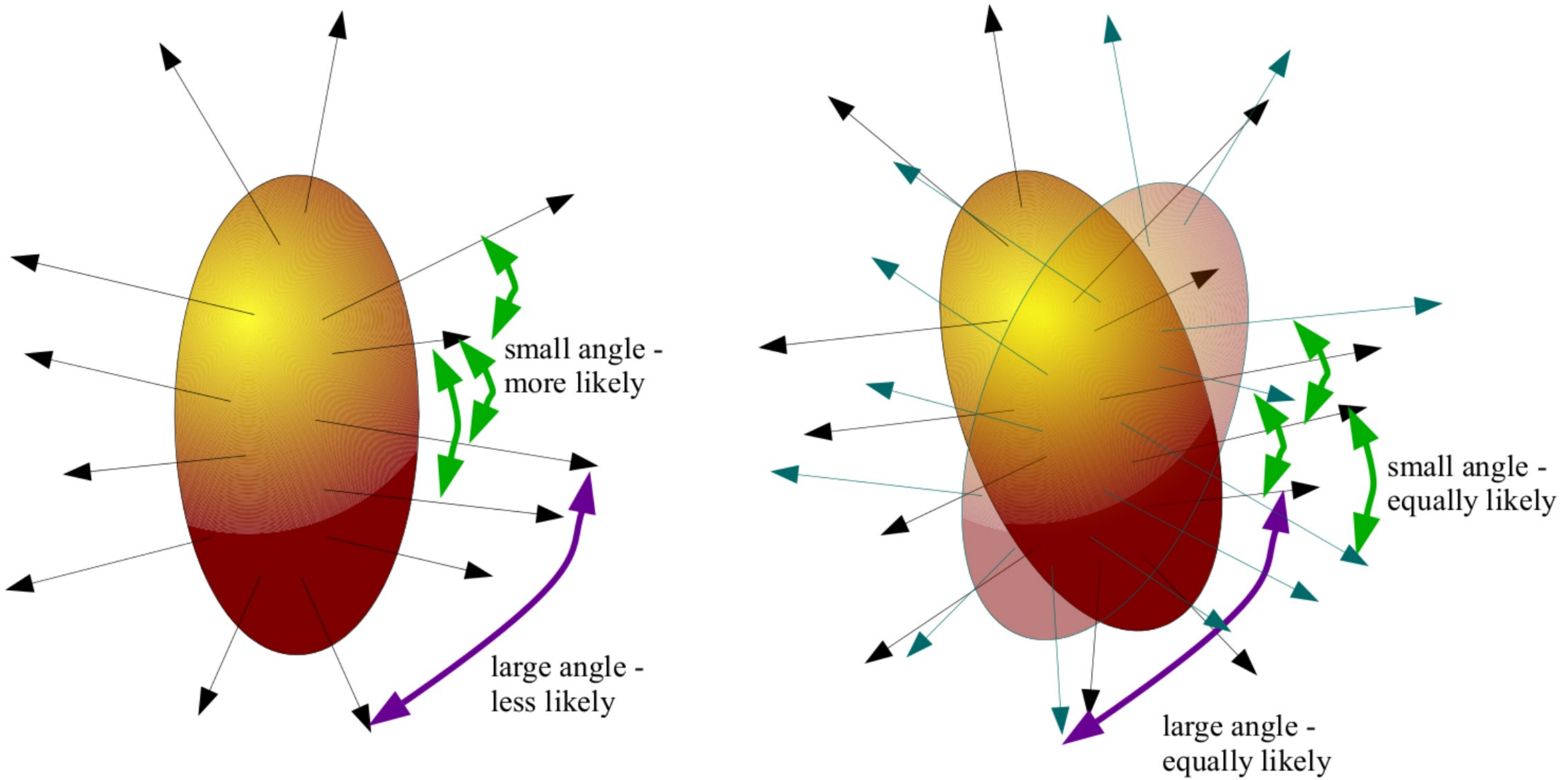
- Significant non-femtoscopic, non-flat background observed in all Cfs at large *k**
  - Increases with decreasing centrality
  - Same amongst all ΛK^{ch} pairs
  - More pronounced for ΛK^0_S system
- Suggested effect is due primarily to particle collimation associated with elliptic flow
  - A Kisiel, Acta Physica Polonica B, 48
- How does the background behave at low *k**?
  - How should we handle this contribution in the fit?

All Cfs out to large *k**



Background from elliptic flow

- Same event (signal)
- Mixed events (background)



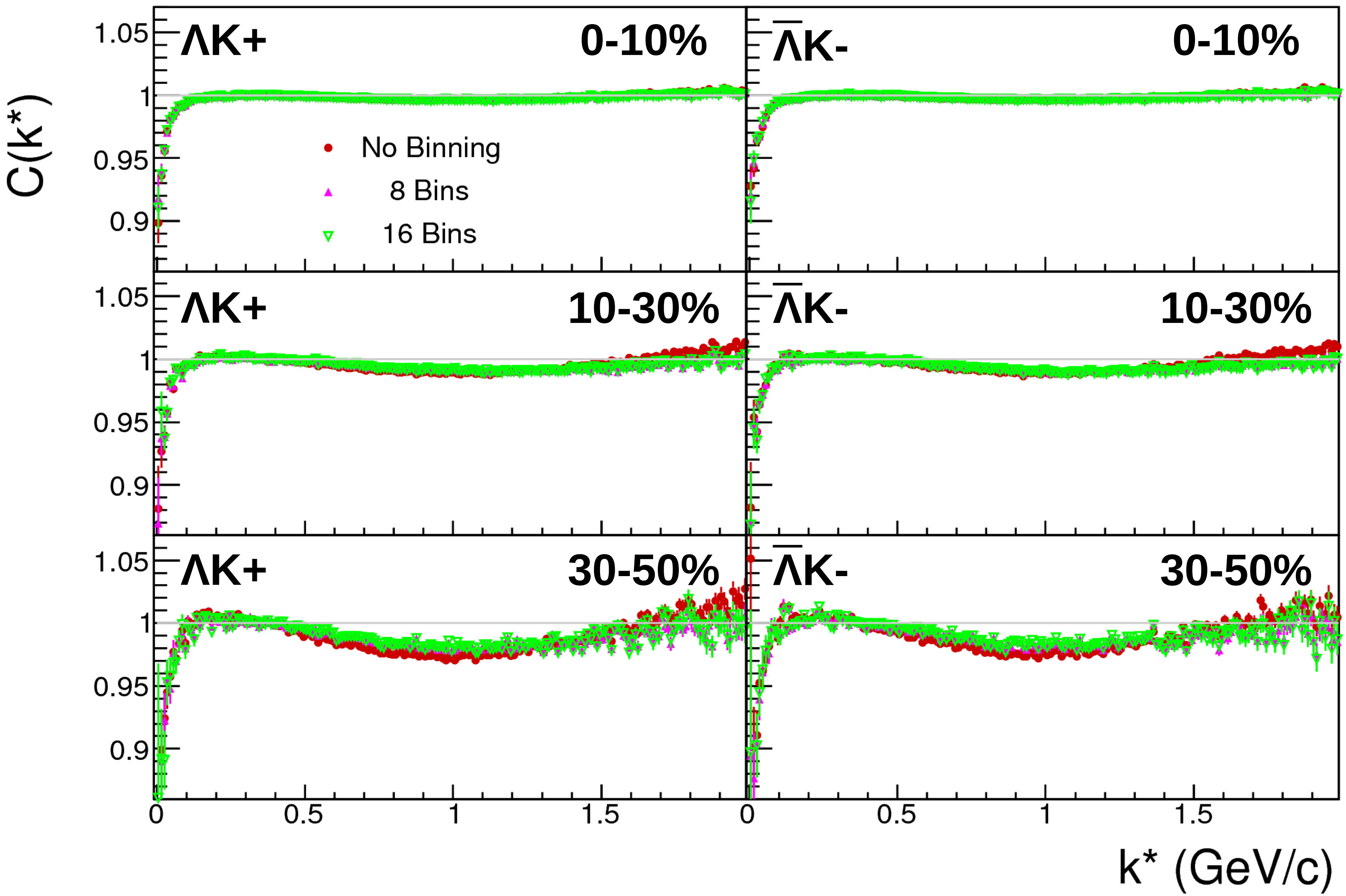
- In “mixed” sample large-k* pair are relatively enhanced (resulting in negative correlation function slope)

Background Correction

- **Ideal world (1)**: Rotate all events to align event plane (EP) angles
  - Not applicable, as azimuthal angle acceptance is not perfectly uniform
- **Ideal world (2)**: Bin events in EP angle, and only mix events within a given bin
  - Finite EP resolution prevents this
  - Slight decrease in background observed when using EP bin size = $\pi/8$
    - No additional reduction observed when using bin size = $\pi/16$
- **Real world**: We must account for the background in our fit

Binning Events in EP Angle

Data

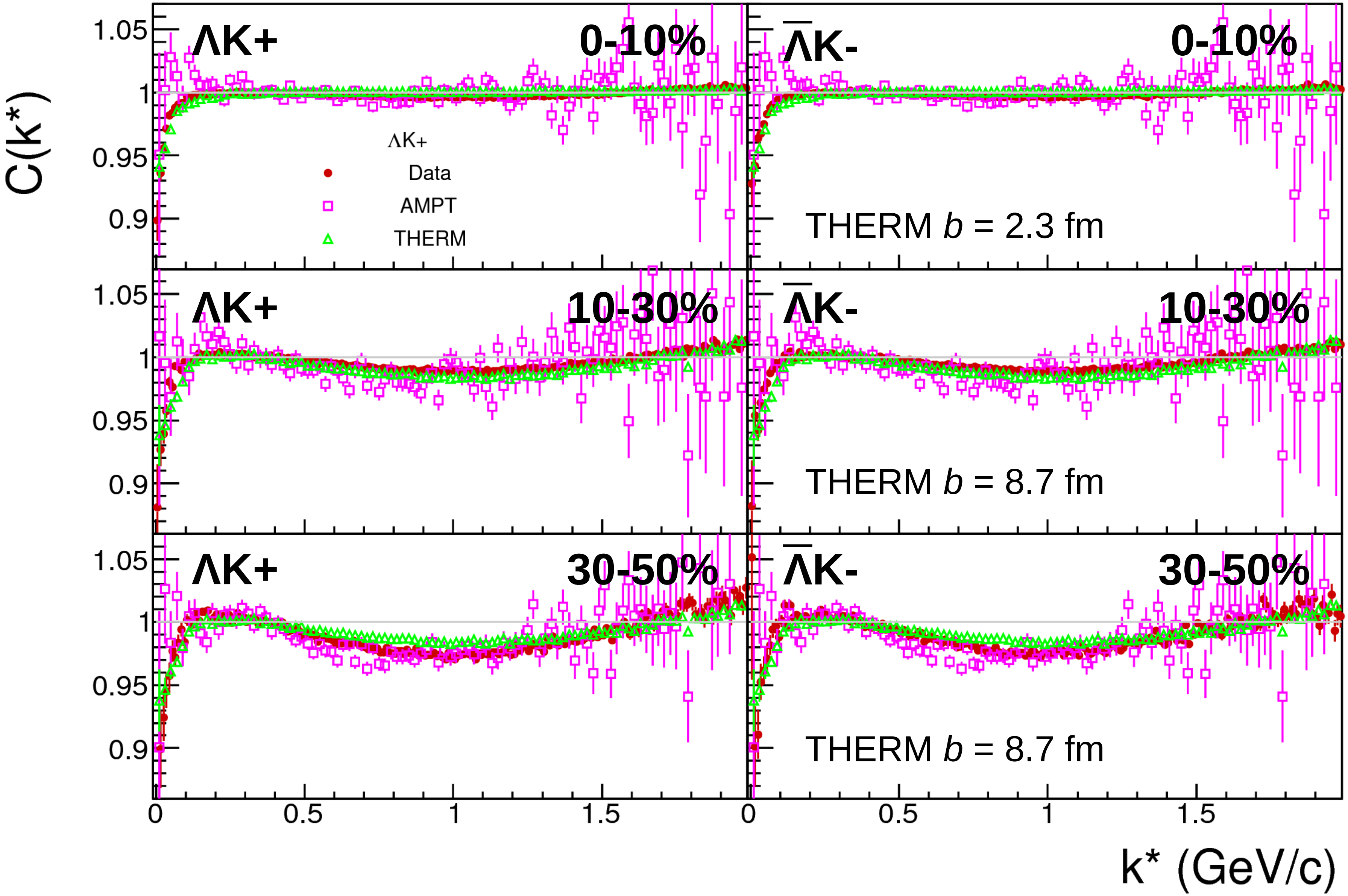


Fit Function

- Multiplicative factor introduced in fitter to account for non-flat background
  - $$C_{fit}(k^*) = C_{th}(k^*)\, F_{bgd}(k^*)$$
  - F_{bgd} fit with linear, polynomial, or Gaussian form
- Three options
  - (1) Fit F_{bgd} first, at large k^* (0.6-0.9 GeV/c), before fitting femtoscopic region (0-0.3 GeV/c)
    - F_{bgd} treated as constant during fitting of femtoscopic region
  - (2) Allow F_{bgd} to vary during fit, and fit over larger region in k^* (0-0.5 GeV/c?)
    - Fitter given more degrees of freedom, makes fitting more difficult
    - Less emphasis placed on signal region
  - (3) Use simulation to fix F_{bgd} before fit
    - Best option to most accurately describe F_{bgd} in femtoscopic region?

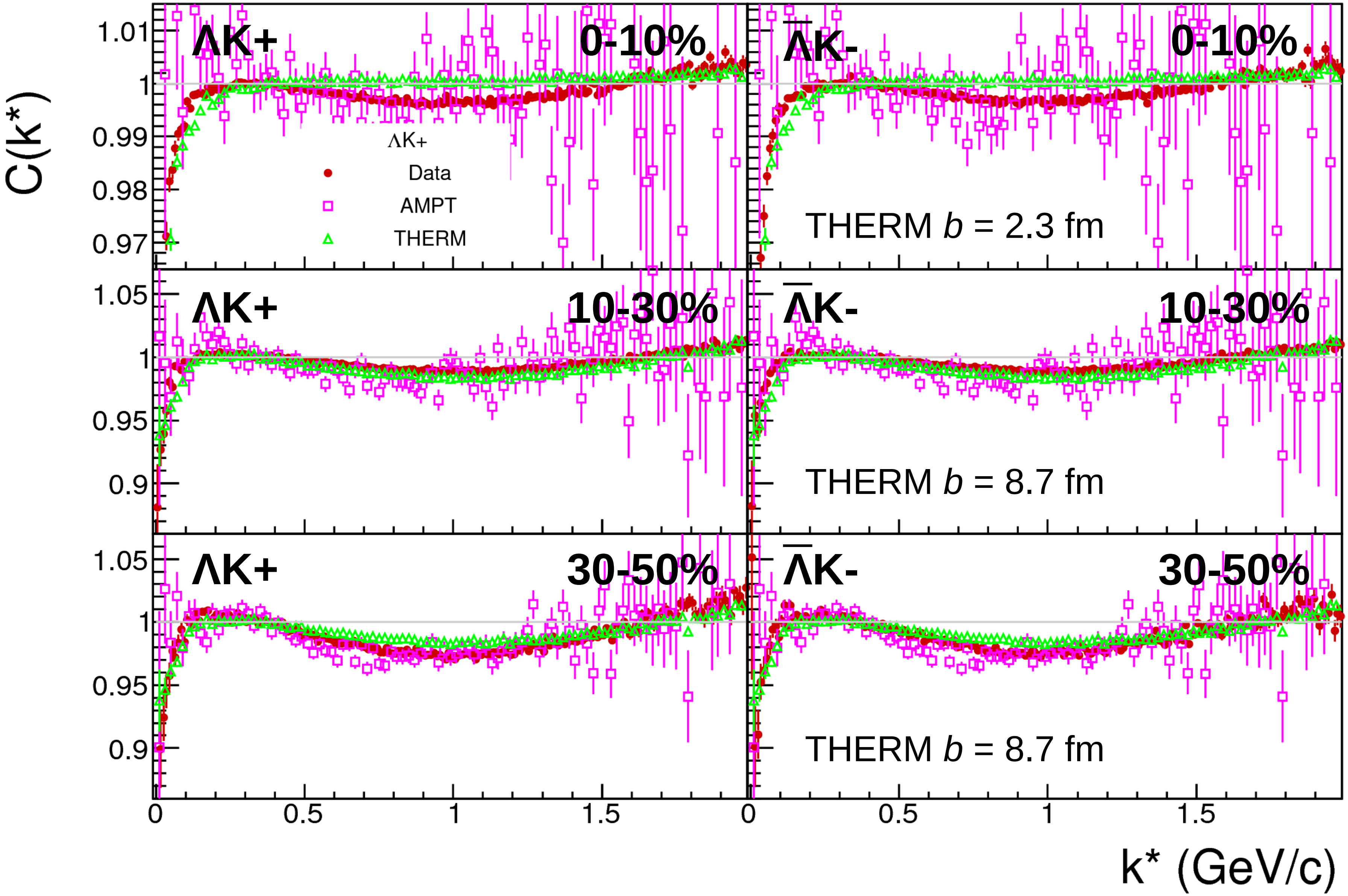
AMPT and THERMINATOR

Data and Simulation



AMPT and THERMINATOR

Data and Simulation



Parameters used in THERM

		THERMINATOR	Data extraction
ΛK+	***Re[f_0]***	-0.5	-1.16
	Im[f_0]	0.5	0.51
	d_0	0	1.08
ΛK-	***Re[f_0]***	0.25	0.41
	Im[f_0]	0.5	0.47
	d_0	0	-4.89
ΛK^0_S	***Re[f_0]***	-0.25	-0.41
	Im[f_0]	0.25	0.20
	d_0	0	2.08

Simulations

- Both AMPT and THERMINATOR reproduce the non-flat background reasonably well
  - THERMINATOR does better in signal reason, as I input rough scattering parameters into the code
- AMPT is statistics hungry
  - Need significantly more events
  - Is this feasible, and where do I obtain these?
- THERMINATOR seems like the better option
  - All b = 8.7 fm events were generated over ~3 days
  - I have hypersurfaces from hydro code for $b = \{2.3, 3.1, 5.7, 7.4, 8.7, 9.9, 10.9, 11.9\}$ fm
  - Could likely generate enough statistics, across all centrality bins, in ~1-2 weeks

THERMINATOR

- Initially, did not observe background
- Calculated EP angle for events, and found all were close to zero
  - Non-flat background results from mixing events with unlike EP angles
  - Not surprising that I was not observing a background
- Remedy: Rotate events by a random angle
  - i.e. rotate momenta and positions of all particles in an event by a common, random, angle

More on THERMINATOR

- THERMINATOR allows me the freedom to better match the data in the signal region
  - When filling numerators, weight pairs with $|\Psi|^2$
    - Input f_0 and d_0 into code
    - Also possible with AMPT, but must additionally supply *R* parameter
    - Methods already implemented in THERMINATOR code, would have to incorporate into AMPT
  - In the end, matching the signal region is not important, as I am interested in the background
    - Obtained using unit weights in numerator, instead of $|\Psi|^2$
    - Although, closely matching the data will make those reviewing my analysis more comfortable

THERMINATOR

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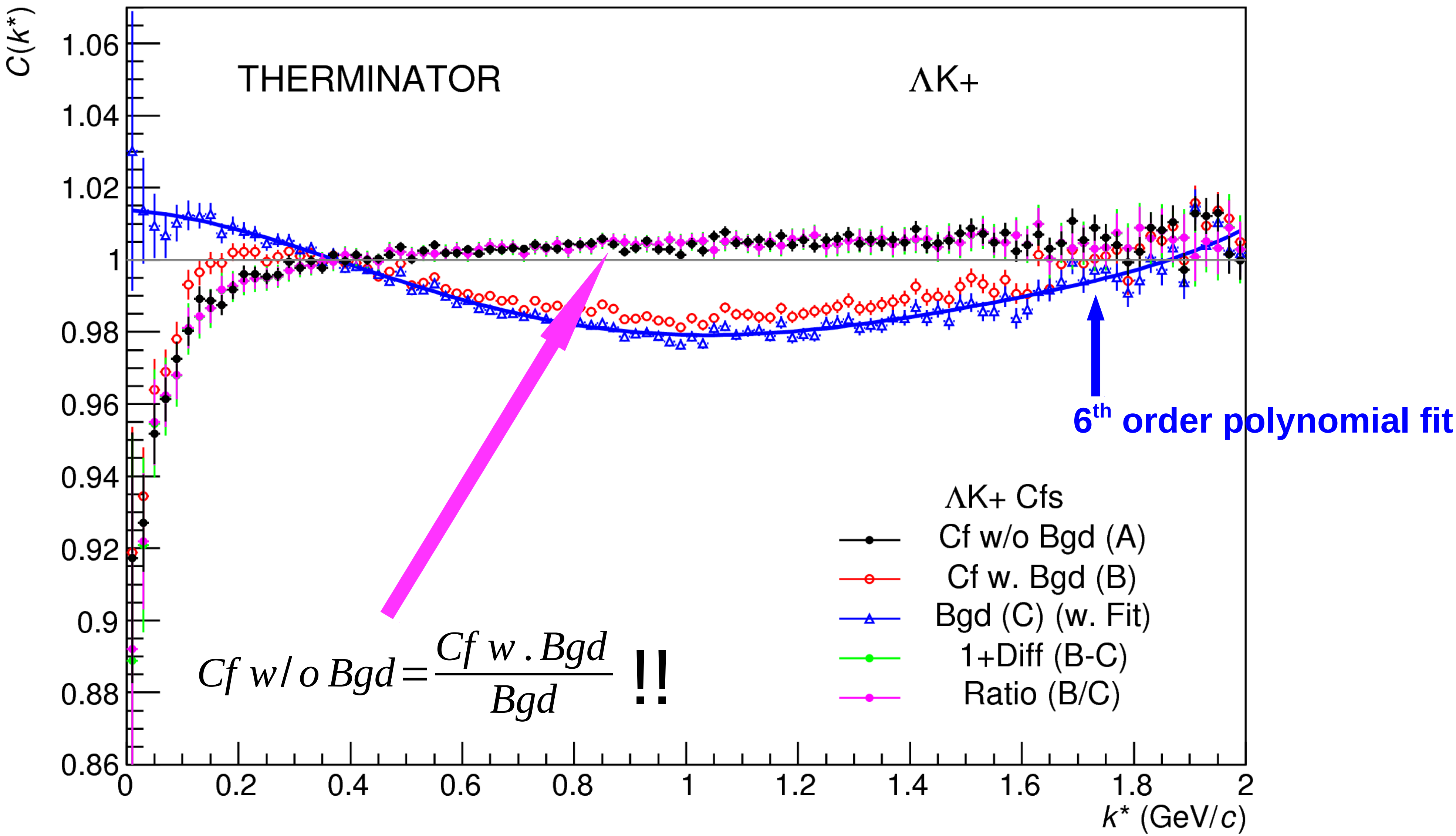
Simulation



Quantitative use of THERM

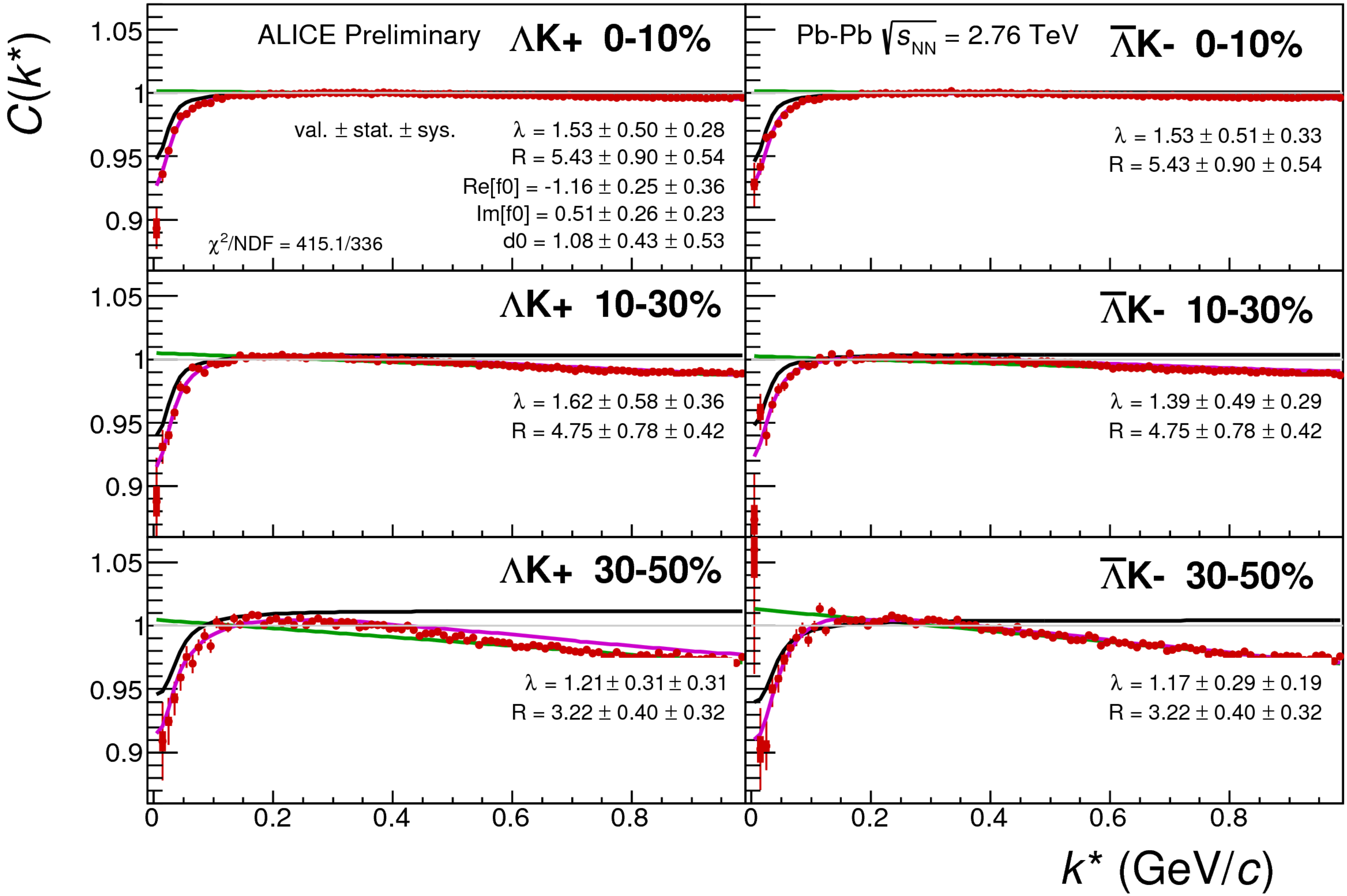
- From the previous slide:

$$Cf\ w/o\ Bgd = \frac{Cf\ w.Bgd}{Bgd} \quad \Rightarrow \quad Cf_{th} = \frac{Cf_{\exp}}{F_{Bgd}} \quad \Rightarrow \quad Cf_{\exp} = Cf_{th} \cdot F_{Bgd}$$

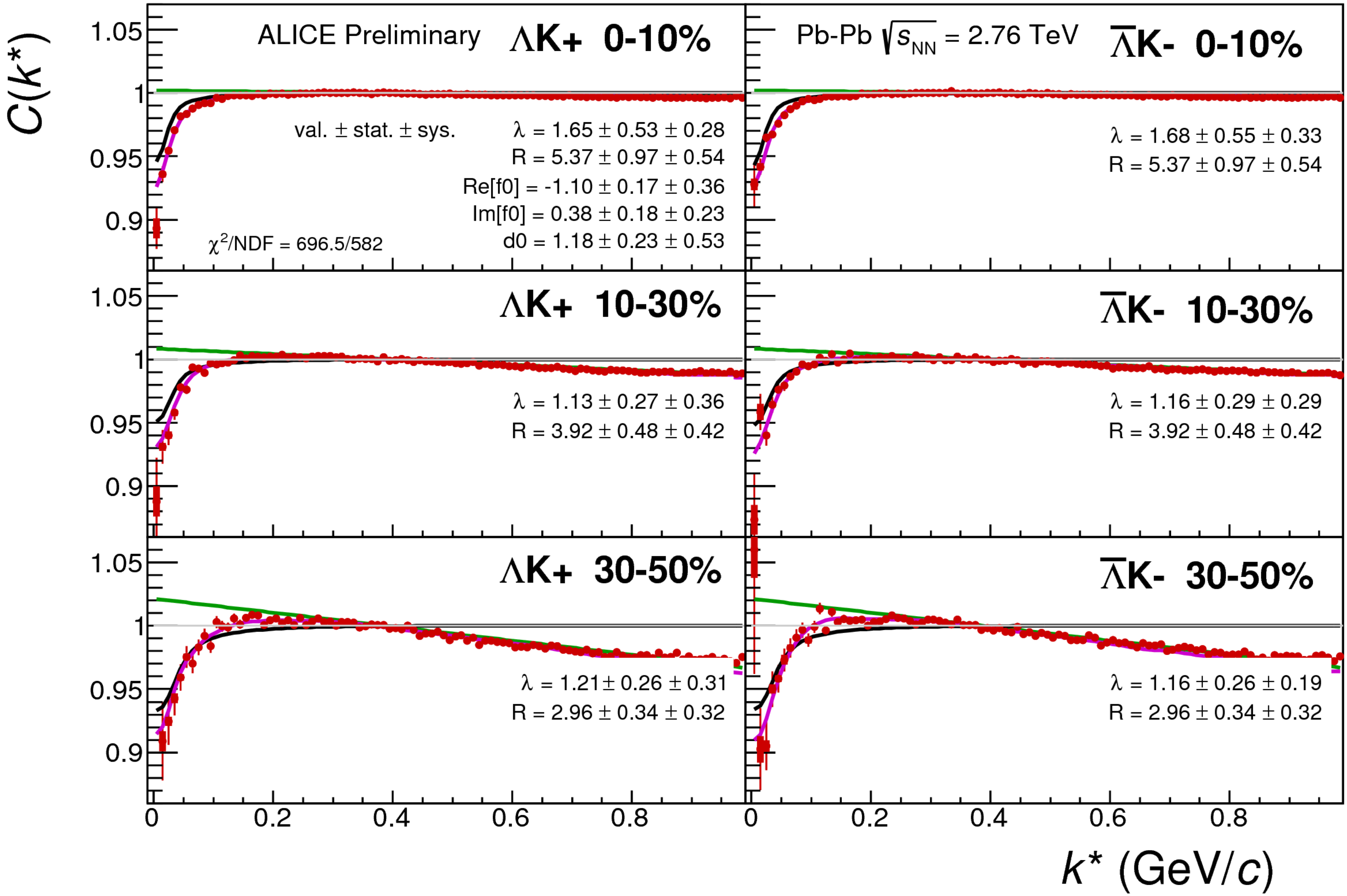
- Proposed fit solution
  - (1) Generate THERMINATOR events needed to build backgrounds for all centrality bins
  - (2) Before fit: Fit the THERMINATOR background, over all k^* (0-2 GeV/c) to obtain F_{bgd}
    - Adam, in paper, suggests 6th order polynomial
    - Shown, for data, backgrounds for:
      - $\Lambda K+ = \bar{\Lambda} K- = \Lambda K- = \bar{\Lambda} K+$
      - $\Lambda K^0_S = \bar{\Lambda} K^0_S$
    - Combine to obtain best statistics, and most stable fit to background
  - (3) Keep F_{bgd} constant while fitting over the signal region

BACKUP

Fit Bgd Beforehand (1)

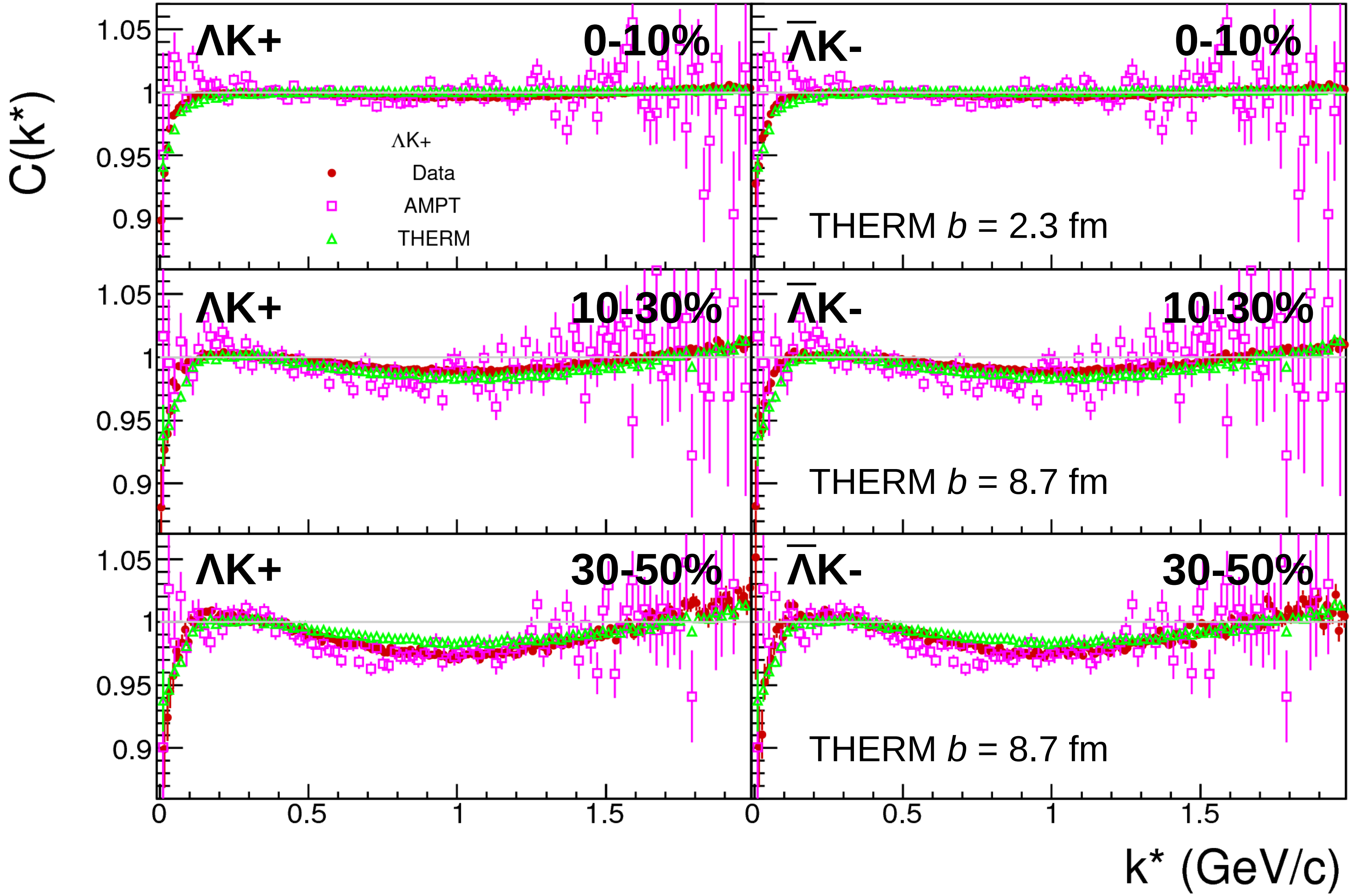


Fit Bgd Simultaneously (2)



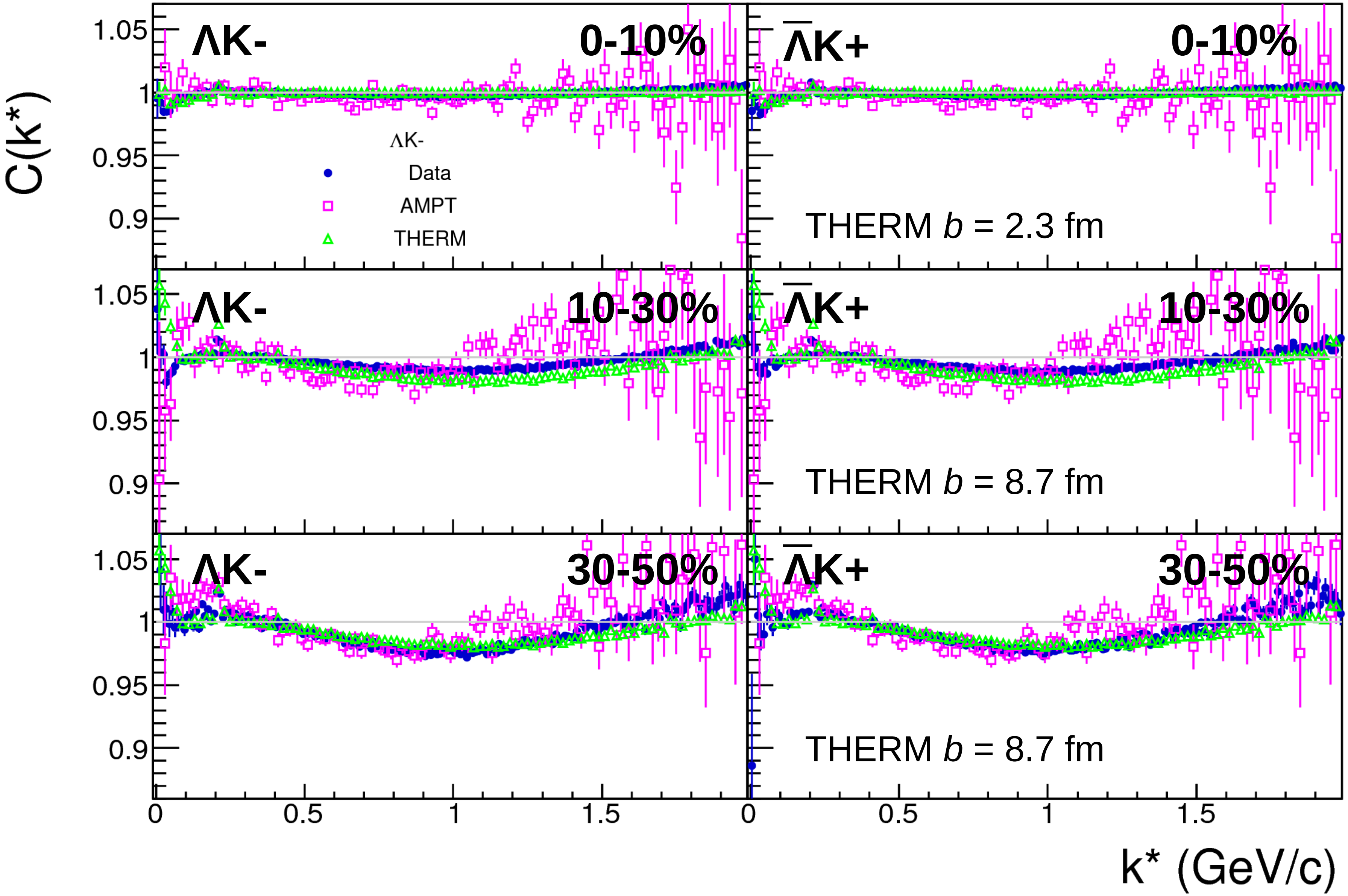
AMPT and THERMINATOR

Data and Simulation



AMPT and THERMINATOR

Data and Simulation



AMPT and THERMINATOR

Data and Simulation