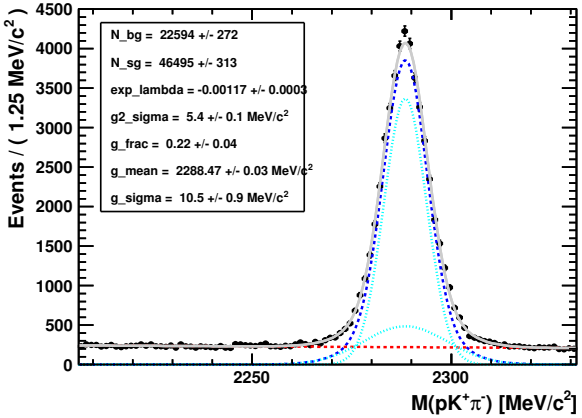
Tight DIRA prompt analysis

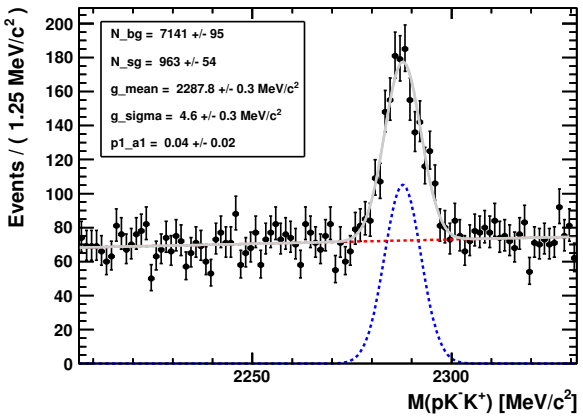
- Re-ran prompt analysis with a tight prompt DIRA cut.
- DIRA increased from 0.9999 to 0.99999.
  - Or being less obtuse, the maximum angle between the reconstructed Λ_c momentum and displacement vector of reconstructed Λ_c vertex from reconstructed PV - tightened from 0.14 mrad to 0.0044 mrad.

Raw yields

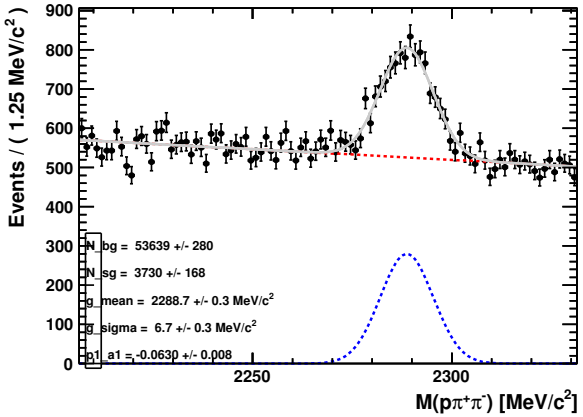
Fits shown - some odd structures in $\Lambda_c^+ \to pK^-\pi^+$?



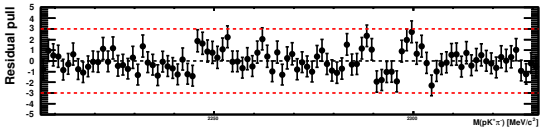
$\Lambda_c^+ \to pK^-\pi^+$

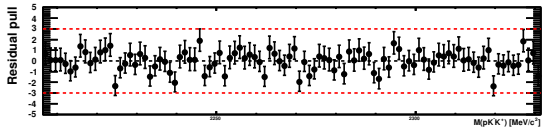


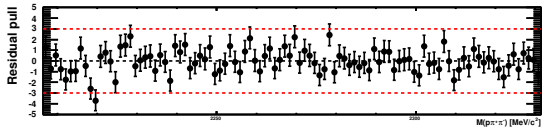
$\Lambda_c^+ \to pK^-K^+$



$\Lambda_c^+ \to p\pi^-\pi^+$







- Raw signal ratios, change from main analysis:
  - $\mathcal{B}(\Lambda_c^+ \to pK^-K^+)/\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+)$: (1.89 ± 0.08) % to (1.86 ± 0.10) %
  - $\mathcal{B}(\Lambda_c^+ \to p\pi^-\pi^+)/\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+)$: (7.47 ± 0.28) % to (7.22 ± 0.32) %
- Changes are very small, within errors. But mildly support theory that there's more secondary in $\Lambda_c^+ \to p\pi^-\pi^+$.

PID efficiencies

- Errors on efficiencies are low, percent level. Neglect them in these figures.
- Changes:

Measurement	Standard Prompt [%]	Tight DIRA prompt [%]
$\Lambda_c^+ \to pK^-\pi^+$	42.7	42.1
$\Lambda_c^+ \to pK^-K^+$	38.62	37.0
$\Lambda_c^+ \to p\pi^-\pi^+$	45.4	48.4

- $\Lambda_c^+ \to p\pi^-\pi^+$ efficiencies go up significantly - worrying.

Stripping efficiencies

- Compare some direct re-weighted efficiencies with 8x8 bins in invariant mass vars.

Measurement	Standard Prompt	Tight DIRA Prompt
$\Lambda_c^+ \to pK^-\pi^+$	2.91e-3	1.64e-3
$\Lambda_c^+ \to pK^-K^+$	2.69e-3	1.52e-3
$\Lambda_c^+ \to p\pi^-\pi^+$	3.44e-3	1.85e-3

Branching fractions

- Given the central values will demonstrably not change much for $\mathcal{B}(\Lambda_c^+ \to pK^-K^+)/\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+)$ I don't want to spend much time re-evaluating the systematics. Will take systematics from the existing prompt analysis.
- Have noticed that our statistical uncertainties are being underestimated in the main analyses. I have a script which calculates the root of the sum of weights squared to reproduce the statistical error on the signal yield, but it gives lower values than sigmaS on the fits?
  - Either way the errors don't rise enough to bring down the disagreement - remember prompt is already systematically limited by a huge extent, so overall prompt/SL agreement is largely unchanged.
- Comparison of BFs with updated stat errors:

Measurement	Standard Prompt [%]	Tight DIRA prompt [%]
$\mathcal{B}(\Lambda_c^+ \to pK^-K^+)/\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+)$	$2.03 \pm 0.08 \pm 0.10$	$2.05 \pm 0.10 \pm 0.10$
$\mathcal{B}(\Lambda_c^+ \to p\pi^-\pi^+)/\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+)$	$7.04 \pm 0.26 \pm 0.34$	$5.53 \pm 0.24 \pm 0.27$

Branching fractions - comments

Measurement	Standard Prompt [%]	Tight DIRA prompt [%]
$\mathcal{B}(\Lambda_c^+ \to pK^-K^+)/\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+)$	$2.03 \pm 0.08 \pm 0.10$	$2.05 \pm 0.10 \pm 0.10$
$\mathcal{B}(\Lambda_c^+ \to p\pi^-\pi^+)/\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+)$	$7.04 \pm 0.26 \pm 0.34$	$5.53 \pm 0.24 \pm 0.27$

- No change on $\mathcal{B}(\Lambda_c^+ \to pK^-K^+)/\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+)$. Very odd. Implies we're either not cutting much secondary (unlikely with the tight DIRA cut), or the secondary fractions are very similar in $\Lambda_c^+ \to pK^-K^+$ and $\Lambda_c^+ \to pK^-\pi^+$.
  - Also implies that the different kinematics make no difference on the $\Lambda_c^+ \to pK^-K^+$ efficiencies - but we know the kinematics change between prompt and sec from the 2D fits to the CF mode - very clear.
- The $\mathcal{B}(\Lambda_c^+ \to p\pi^-\pi^+)/\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+)$ is going haywire. The PID efficiency jumps up so much and I can't think of anything convincing that would explain this. Might expect some differences from different kinematics - but this is very suspect.
- I'm rapidly losing confidence in the efficiency extraction procedures. They don't seem very stable to what I'd expect to be stable selections. Is this a bias in the sWeights from the variable correlations?

What next?

- I'm losing confidence in our efficiency extractions - but I'm still confident that the 1D fit to the Λ_c mass extracts an admixture of prompt and signal from the combinatoric successfully. The pulls work, the sWeighted control variables look sensible - anything problematic from the sWeights comes from correlations with the variables we bin in for efficiencies.
- So first - want to plot the relative raw yields of the CS modes to CF as a function of minimum DIRA - this will give any evidence if the secondary fractions are different between the modes - easy to do given the software package rework.
- I want to redo the prompt analysis but without the data-driven efficiencies. So for PID this is simple - we just use simulated $\Lambda_c^+ \to phh'$ and see if the results change dramatically, or are more stable with respect to different selections on the Λ_c candidate. For stripping this is... maybe impossible? We could re-weight with some naive models but there *are* no models for the CS modes. Troubling.
- Want to take some time to make the calculation of systematic uncertainties simpler. Too much user input is required to get out systematic uncertainties at this point and they should be easy to automate.