WG sign off: $\Lambda_c^+ \to phh'$ relative branching fractions

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Analysis overview

- Glasgow analysis just attained WG sign off:
  - Measuring the following quantities:

$$\mathcal{B}(\Lambda_c^+ \to pK^-K^+)/\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+)$$
$$\mathcal{B}(\Lambda_c^+ \to p\pi^-\pi^+)/\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+)$$
$$\mathcal{B}(\Lambda_c^+ \to p\pi^-K^+)/\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+)$$

  - Analysis makes independent measurements with two sources of Λ_c:
    - those promptly produced
    - from semileptonic $\Lambda_b^0 \to \Lambda_c^+(pK^-\pi^+)\mu^-\overline{\nu}_\mu$.
  - DCS mode blind in both channels in this analysis.
  - Using full 2011 dataset at $\sqrt{s} = 7\ \mathrm{TeV}$
  - Stripping17b, Reco14.
- Most recent ANA version here.

Current results

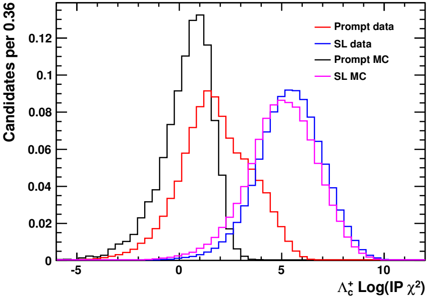
- At present:

Measurement	Prompt [%]	Semileptonic TOS [%]
$\frac{\mathcal{B}(\Lambda_c^+ \to pK^-K^+)}{\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+)}$	$2.03 \pm 0.07 \pm 0.10$	$1.68 \pm 0.03 \pm 0.07$
$\frac{\mathcal{B}(\Lambda_c^+ \to p\pi^-\pi^+)}{\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+)}$	$7.04 \pm 0.19 \pm 0.34$	$7.45 \pm 0.06 \pm 0.24$
$\frac{\mathcal{B}(\Lambda_c^+ \to pK^-K^+)}{\mathcal{B}(\Lambda_c^+ \to p\pi^-\pi^+)}$	$28.81 \pm 1.29 \pm 1.73$	$22.59 \pm 0.40 \pm 0.90$

- Efforts with efficiencies have improved agreement significantly.
- $\mathcal{B}(\Lambda_c^+ \to p\pi^-\pi^+)/\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+)$ agree within error - 0.9 σ.
- But $\mathcal{B}(\Lambda_c^+ \to pK^-K^+)/\mathcal{B}(\Lambda_c^+ \to pK^-\pi^+)$ disagree at 2.6 σ level.

Secondary contamination

- Our selections very similar to 2011 x-sec analysis.
- Secondary contamination in Λ_c wasn't a problem there - turns out it is for us.
- Shown - $\log(IP\chi^2)$ distributions for prompt and SL data/MC.
- Clear and significant secondary contamination.



New prompt fits

- New strategy - extract the true prompt signal distribution.
- Perform this with 2D fit to m(Λ_c) – log (Λ_c $IP\chi^2$).
- Obviously will result in different signal yields.
- Acquire new set of sWeights which will change re-weighting of stripping and PID efficiencies.

$IP\chi^2$ modelling

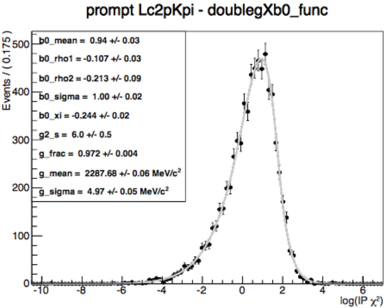
- Using same paramaterisation as in 2010 charm x-sec analysis.
- Bukin function: a Novosibirsk function with extended tail functions.

$$\mathrm{Buk}(x;\mu,\sigma,\xi,\rho_L,\rho_R)=\begin{cases}\exp\left[\rho_1\frac{(x-x_1)^2}{(\mu-x_1)^2}+\frac{(x-x_1)\xi\sqrt{\xi^2+1}\cdot\sqrt{2\log 2}}{\sigma\left(\sqrt{\xi^2+1}-\xi\right)^2\log\left(\sqrt{\xi^2+1}+\xi\right)}-\log 2\right] & x<x_1\equiv\mu+\sigma\sqrt{2\log 2}\left(\frac{\xi}{\sqrt{\xi^2+1}}-1\right)\\ \exp\left[-\log 2\cdot\left[\frac{\log\left(1+2\xi\sqrt{\xi^2+1}\cdot\frac{x-\mu}{\sigma\sqrt{2\log 2}}\right)}{\log\left(1+2\xi\left(\xi-\sqrt{\xi^2+1}\right)\right)}\right]^2\right] & x_1<x<x_2\\ \exp\left[\rho_2\frac{(x_2-x)^2}{(x_2-\mu)^2}+\frac{(x_2-x)\xi\sqrt{\xi^2+1}\cdot\sqrt{2\log 2}}{\sigma\left(\sqrt{\xi^2+1}+\xi\right)^2\log\left(\sqrt{\xi^2+1}+\xi\right)}-\log 2\right] & x>x_2\equiv\mu+\sigma\sqrt{2\log 2}\left(\frac{\xi}{\sqrt{\xi^2+1}}+1\right)\end{cases} \quad (1)$$

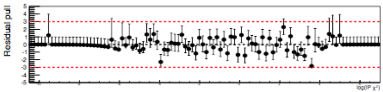
- $\sqrt{2\log 2\sigma}$ is FWHM, ξ is assymetry parameter, ρ are tail parameters.
- x_1 and x_2 are turnover points where function has half max value.

Single-component fits with simulation

- Use filters to acquire pure prompt and secondary species in MC.
- $\log(IP\chi^2)$ distributions shown for prompt and secondary MC.

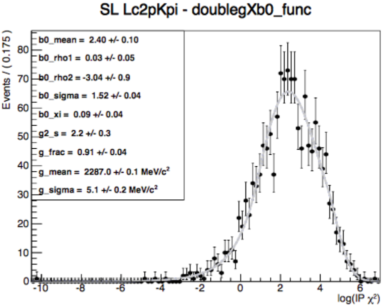


(b)



(d)

prompt



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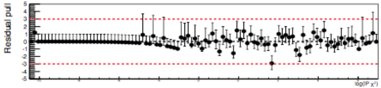
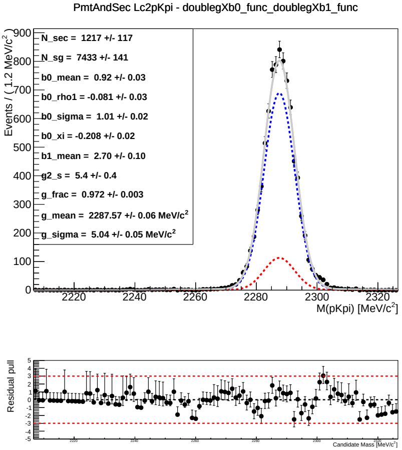


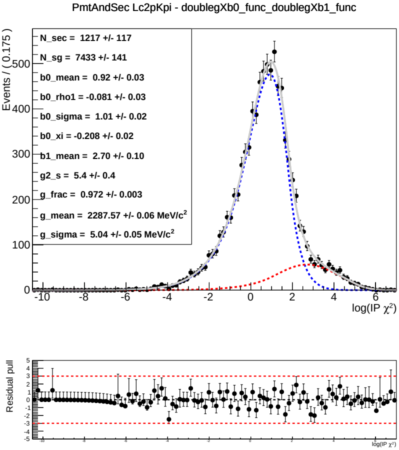
(d)

secondary

Fully unconstrained two-component fit to MC

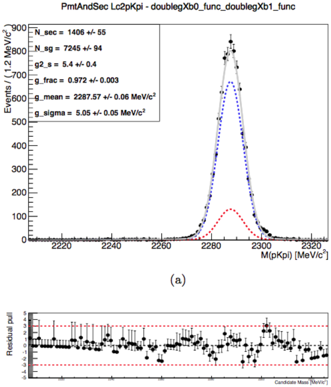
- Two-component fit to $\Lambda_c^+ \to pK^-\pi^+$ shown.
- True prompt N $=$ 7225, sec N $=$ 1426. Convergence and roughly within error.
- But convergence problems with other modes.





Fully contrained $\log(IP\chi^2)$

- Fully constrain the $\log(IP\chi^2)$ distributions to their values from simulation.
- Fits now converge and with lower errors - but data/MC are different.
- What can be safely constrained and what should be unconstrained?



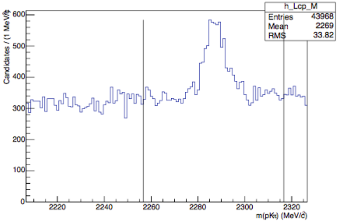
(a) (b)

(c) (d)

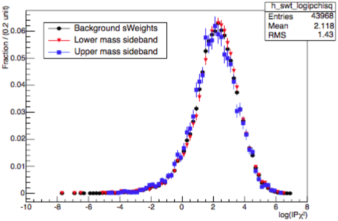
Strategy for constraints

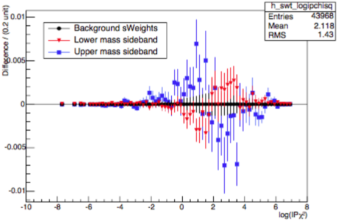
- Semileptonic data/MC comparison shows that secondaries are likely modelled better than prompt.
- So allow prompt $\log(IP\chi^2)$ distribution as much freedom as possible.
- Prompt ρ_2 parameter has high errors - dominated by secondaries. Constrained to simulation.
- Secondary mean floated, all other parameters constrained.
- 2-component fits under these conditions converge for all modes.

- First question - are mass and $\log(IP\chi^2)$ correlated for combinatoric?
- Compare sWeighted background to upper and lower sidebands.
- Some non-trivial structures but effect is very low - assume independence for now.



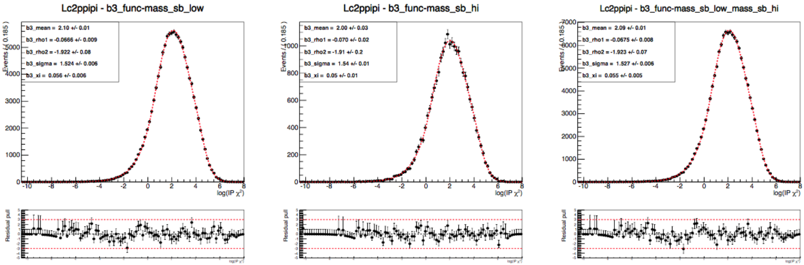
(a)





Combinatoric fit model

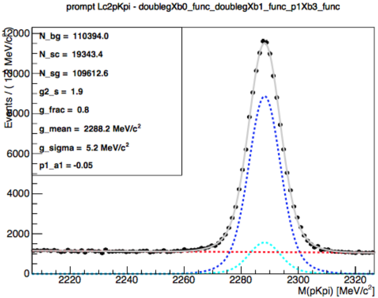
- Fits with Bukin to combinatoric $\log(IP\chi^2)$ for $\Lambda_c^+ \to p\pi^-\pi^+$ shown.
- (a) lower sideband, (b) upper, (c) total.
- Residuals acceptable for now. Better than, e.g., bifurcated Gaussian.
- In full models either use fully constrained Bukin or histogram PDF.



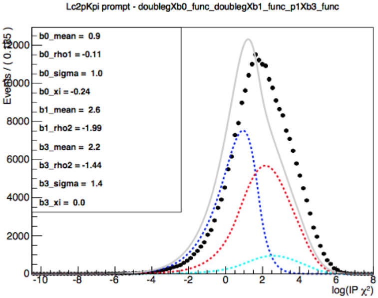
(a) (b) (c)

3-component fit for $\Lambda_c^+ \to pK^-\pi^+$- initial conditions

- Initial conditions taken from simulation fits.
- Initial assumption of secondary fraction - 15 %.
- Shown - data with initial condition PDFs.



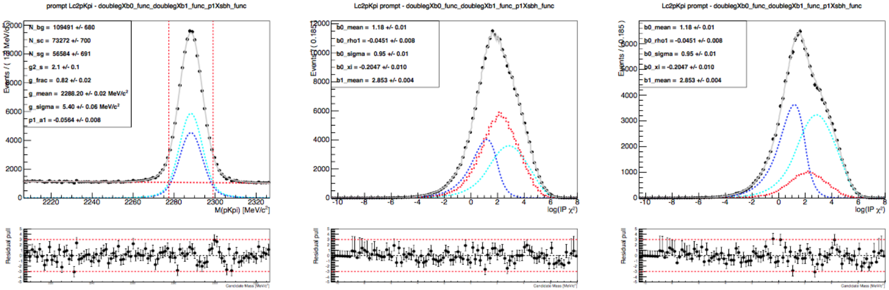
(a)



(b)

3-component fit for $\Lambda_c^+ \to pK^-\pi^+$- fit results

- Fit converges with accurate error matrix.
- Histogram PDF combinatoric and Bukin combinatoric compatible.
- (a) mass, (b) $\log(IP\chi^2)$, (c) $\log(IP\chi^2)$ projections in signal region.
- Secondary fraction is fitted to large value.
- Large combinatoric component in Cabibbo-suppressed modes - fits do not converge.



(a) (b) (c)

Summary

- Once new fit models are acquired re-perform efficiency re-weightings.

BACKUP