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# Introduction to a search for $\Xi_{cc}^{+}$

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24/11/2011

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# Current State of CB Research

- BABAR and Belle have given many results in recent years on charmed baryons.
- First observations,  $\Theta_h$  distributions, BRs etc. of a variety of  $\Xi_c$ ,  $\Sigma_c$  and  $\Omega_c$  states.
- Still many rich avenues of physics to be investigated.
- For more info see Matt Charles' [synopsis paper](#) (from CHARM 2009).

# Doubly Charmed Production

- Still poorly charted (all 1 star PDG rating).
- SELEX claimed first observation of  $\Xi_{cc}^+ \rightarrow \Lambda_c^+ K^- \pi^+$  in 2002 ( $6.3\sigma$ ), in 2005 observed  $\Xi_{cc}^+ \rightarrow \Lambda_c^+ K^- D^+$ .
- However, subsequent searches at FOCUS and BABAR found no evidence for doubly charmed production.
- SELEX also found a lifetime of the  $\Xi_{cc}^+$  smaller than 33fs with 90% confidence level, much lower than theory predicts.
- It is hoped we may resolve this tension at LHCb.

# First sample of $\Xi_{cc}^+$ MC

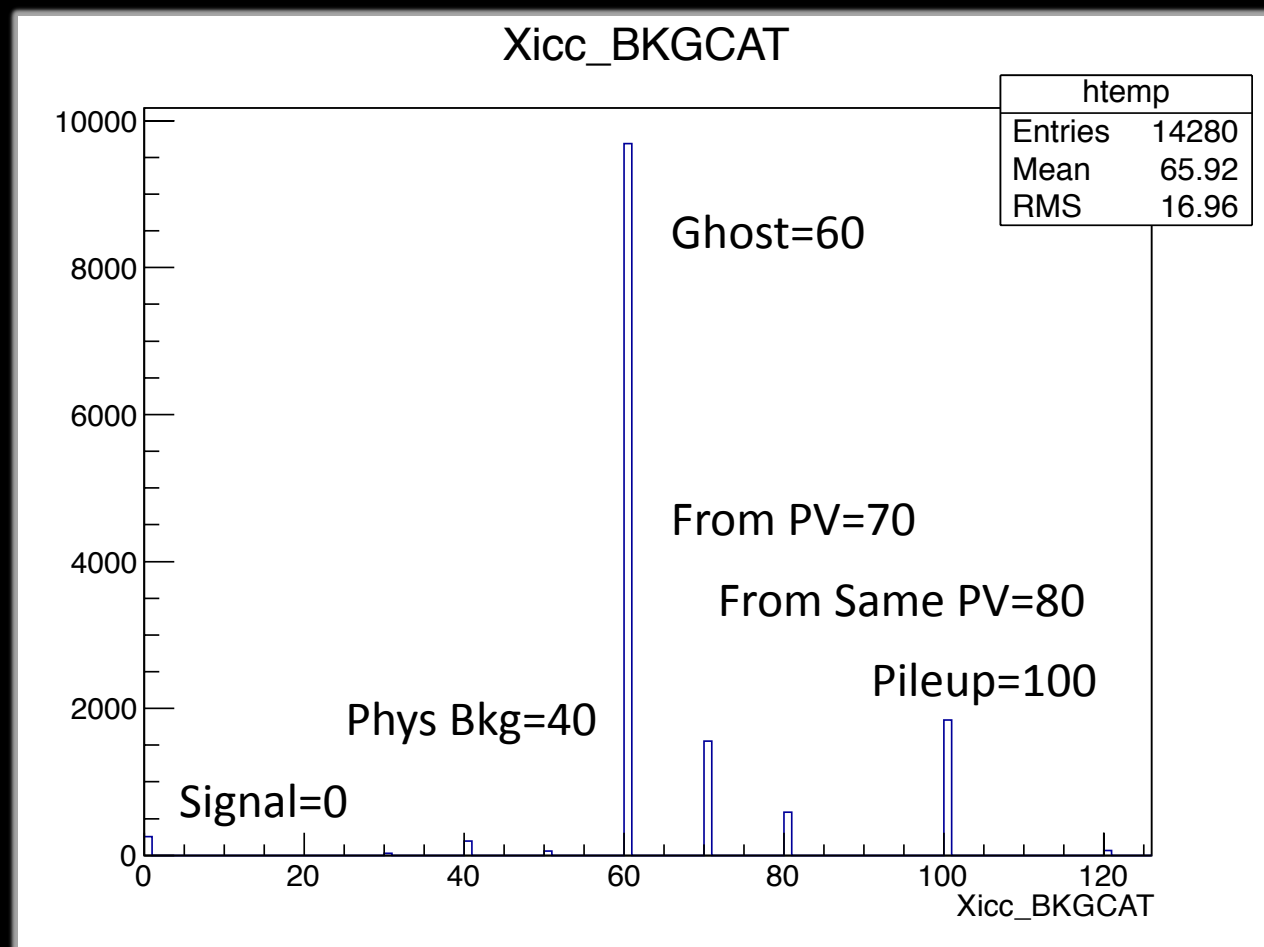
- Produced by Feng by interfacing genxicc2.0 to Gauss (see talk from Joint Charm meeting 6<sup>th</sup> October [here](#)).
- Simulated 25k  $\Xi_{cc}^+ \rightarrow \Lambda_c^+ K^- \pi^+$ ,  $\Lambda_c^+ \rightarrow p K^- \pi^+$  events.
- We have a first look at efficiency and signal yields.

# $\Xi_{cc}^+$ MC Selection

- Very loose  $\Xi_{cc}^+$  selection applied:
  - Vertex  $\text{Chi}^2 < 20$
  - DOCA  $< 0.5\text{mm}$
- Loose  $\Lambda_c^+$  selection :
  - Pt  $> 1\text{GeV}$
  - DIRA  $> 0.98$
  - BPVVDCHI2  $> 9$
  - Vertex  $\text{Chi}^2 < 20$
  - DOCA  $< 0.5\text{mm}$
  - Mass window  $\pm 110\text{MeV}$
  - All daughters:
    - P  $> 2\text{GeV}$
    - Track  $\text{Chi}^2 < 5$

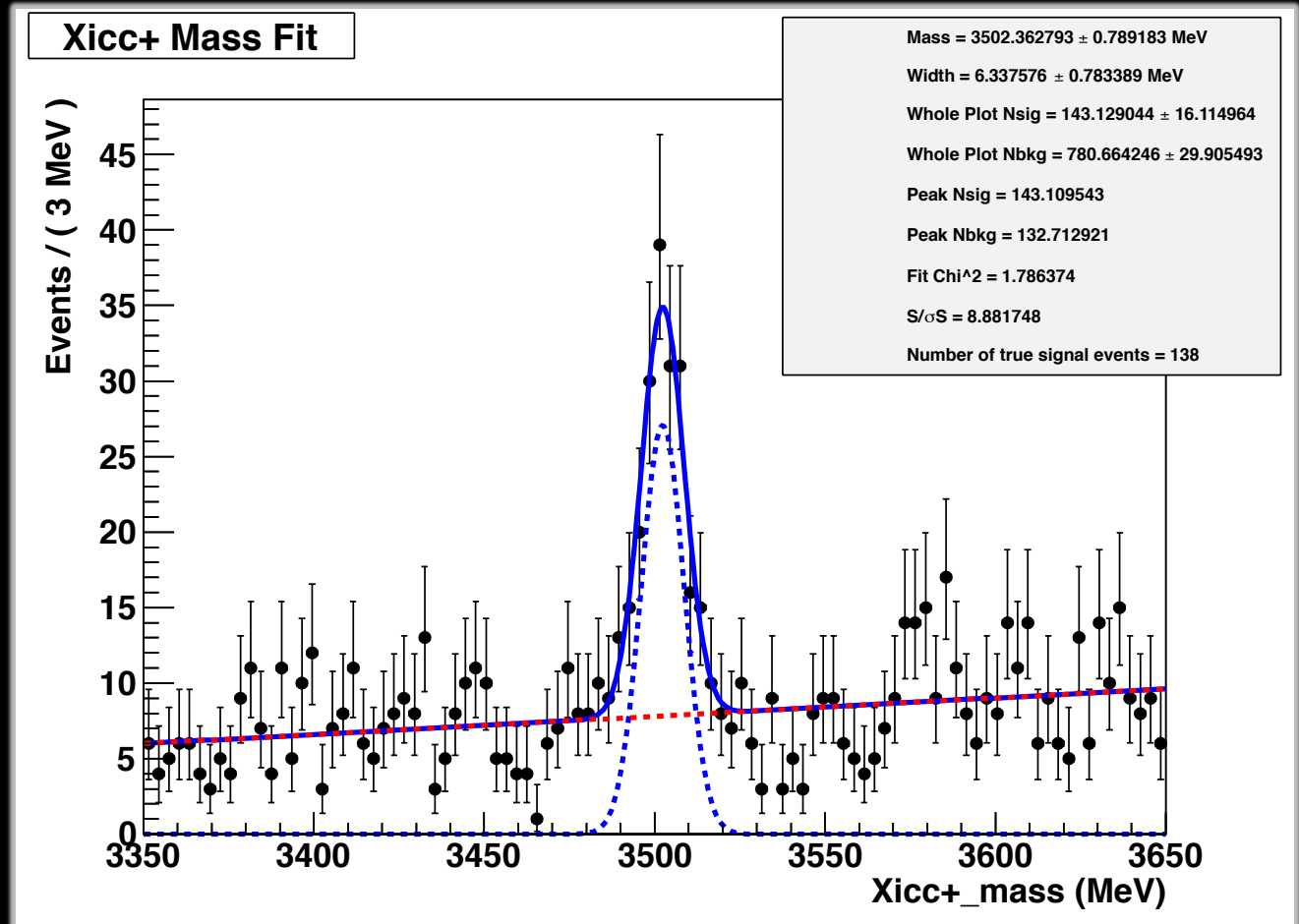
# $\Xi_{cc}^+$ MC Background Categories

- 254 signal events.
- Naive efficiency of around 1%.
- Major backgrounds are ghosts and pileup.



# $\Xi_{cc}^+$ MC Mass Fit

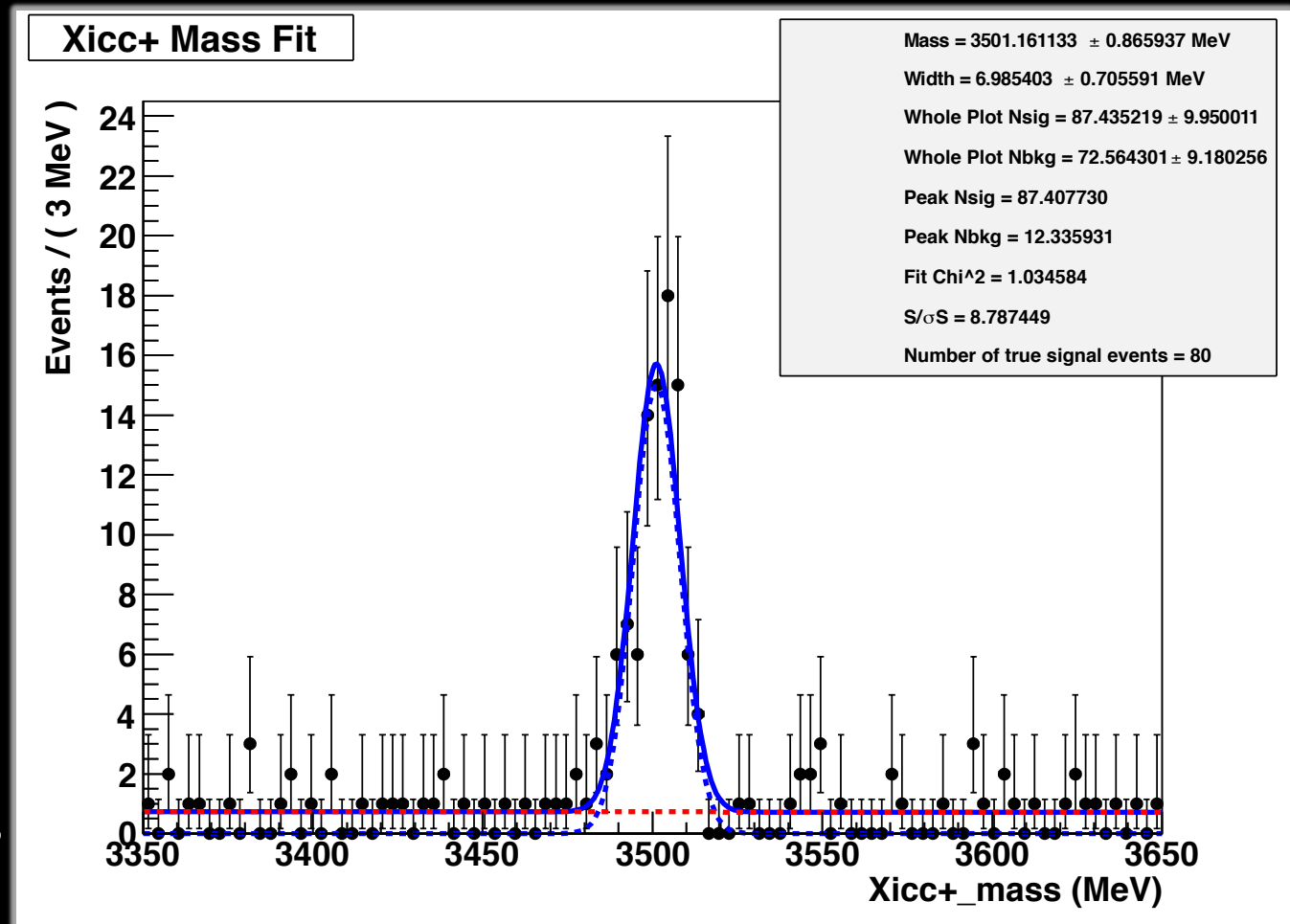
- $\pm 15\text{MeV}$   $\Lambda_c^+$  mass window to suppress reflections.
- 1<sup>st</sup> order Polynomial background & Gaussian signal.
- Good agreement in MC truth Nsig & fitted Nsig.





# Application of stripping to MC

- Speculative stripping code (by Matt Charles) has been running since stripping 14.
- Cuts are harsher than previous selection.
- Comparable significance but perhaps sidebands are being killed.



# Future Work

- Currently undertaking  $\Lambda_c^+$  selection optimisation.
- Will look for DCS mode ( $\Lambda_c^+ \rightarrow pK^+\pi^-$ ), make relative BR measurements.
- Search for  $\Xi_{cc}^+$  and  $\Xi_{cc}^{++}$ .
- If we find enough  $\Xi_{cc}^+$  and  $\Xi_{cc}^{++}$ , look for  $\Omega_{cc}^+$  and  $\Omega_{ccc}^{++}$  (optimistic!).

# Backup

- Full list of Matt's stripping cuts in...

`/afs/cern.ch/lhcb/software/releases/STRIPPING/STRIPPING_v2r5p1/Phys/  
StrippingSelections/python/StrippingSelections/StrippingXicc.py`