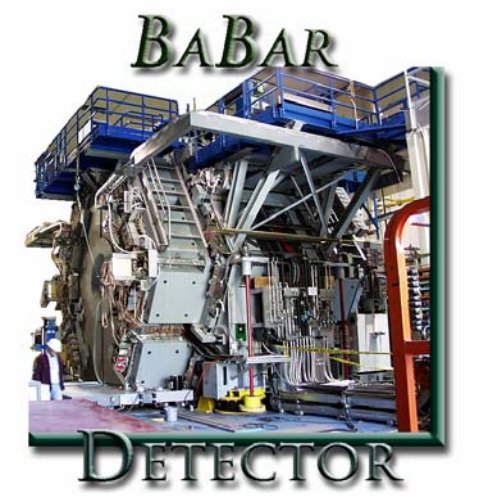
Baryonic b→c decays at BaBar

Sepehr Saremi

University of Massachusetts (Amherst)

Representing The BaBar Collaboration



DPF 2006 conference
Oct. 29th – Nov. 3rd
Honolulu, Hawai'i

Outline

- Results of the following two sets of analyses:

$$\bar{B}^0 \to \Lambda_c^+ \bar{p} \quad ; \quad B^- \to \Lambda_c^+ \bar{p} \pi^-$$

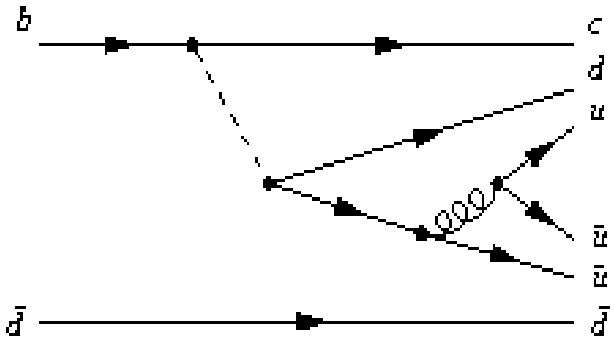
$$B^0 \to \bar{D}^{(*)0} p \bar{p} \quad ; \quad B^0 \to D^{(*)-} p \bar{p} \pi^+$$

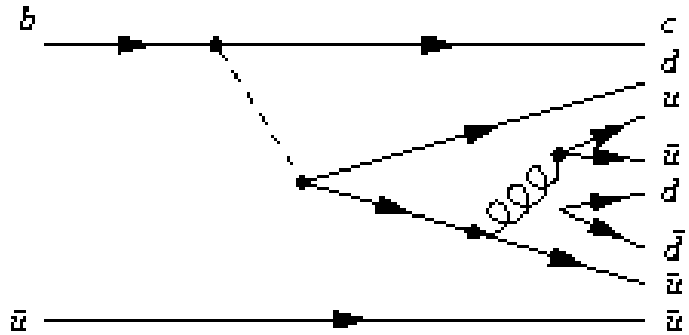
For each analysis set:

- Motivation
- Analysis Method and Event Selection
- Fit Results
- Branching Fractions
- Di-Baryon Invariant Mass Distributions
- Conclusion

*) Use of charge conjugate states is implied throughout

$\bar{B}^0 \to \Lambda_c^+ \bar{p}$ and $B^- \to \Lambda_c^+ \bar{p} \pi^-$





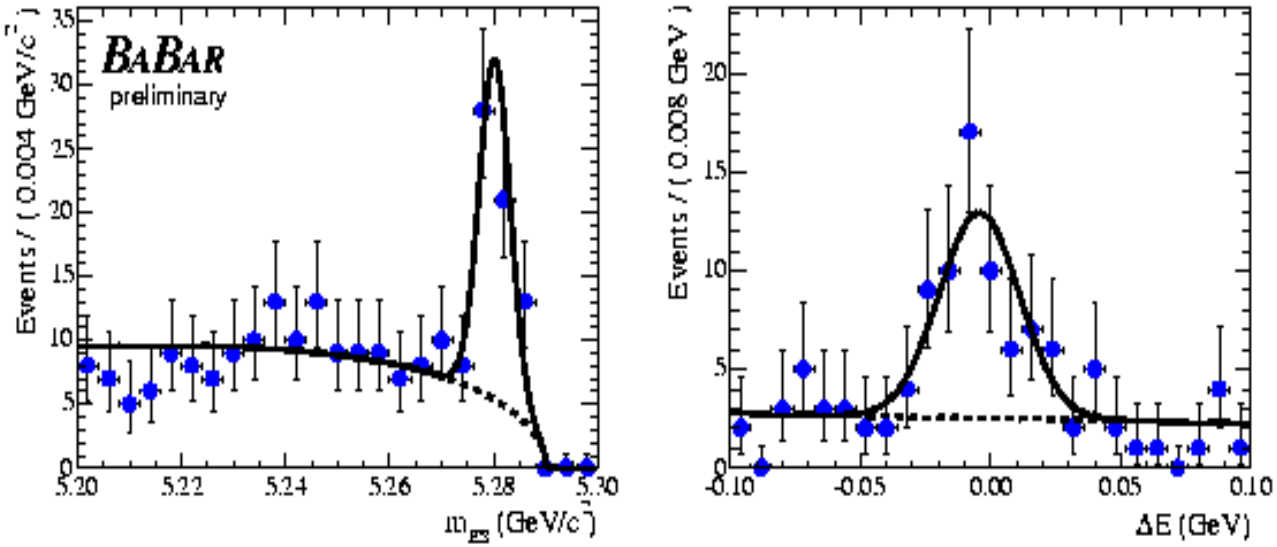
- Theoretical interest in the suppression of baryonic 2-body modes with respect to 3-body ones
- Investigation of the di-baryon enhancement at threshold for the 3-body decays

hep-ex/0607055

Strategy and Selection

- The sample corresponds to integrated luminosity of 210 fb^{-1}.
- Selection criteria optimized using $S/\sqrt{S+B}$
- Reconstruct Λ^+_c in the decay mode $\Lambda^+_c \rightarrow pK^-\pi^+$
- Construct a linear (Fisher) discriminant F from several event shape variables for background rejection.
- 2-D fit in ΔE and m_{ES}
- For $B \rightarrow \Lambda_c \bar{p} \pi$ channel, the signal PDF incorporates correlation between ΔE and m_{ES}.

Fit Results for $\bar{B}^0 \to \Lambda_c^+ \bar{p}$

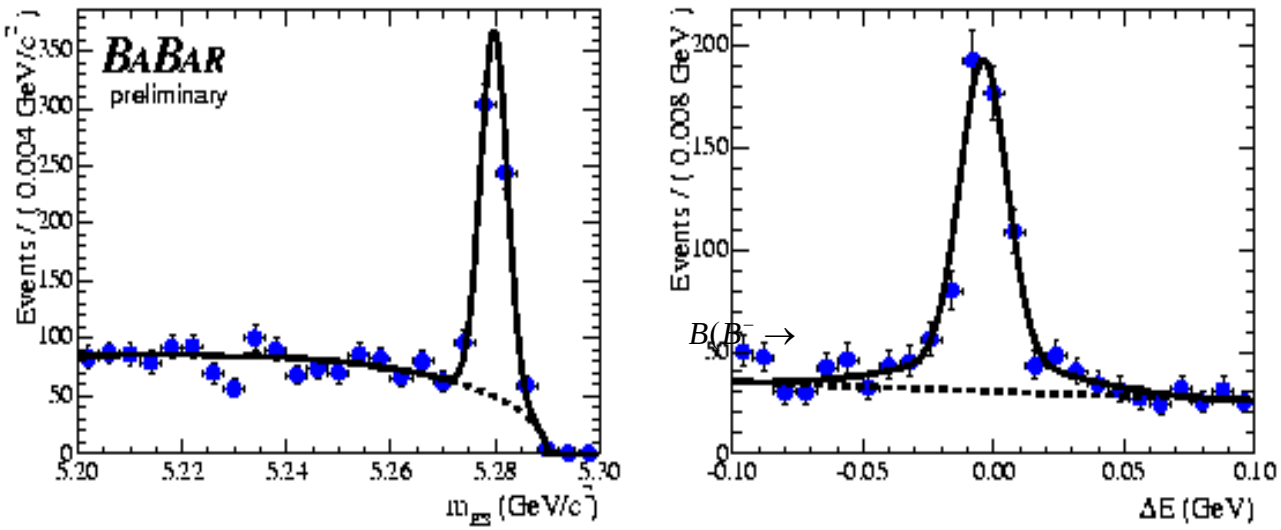


$$N_{sig} = 50 \pm 8$$

From $\Lambda_c \to pK\pi$ branching fraction

$$BF(\bar{B}^0 \to \Lambda_c^+ \bar{p}) = (2.15 \pm 0.36 \pm 0.13 \pm 0.56) \times 10^{-5}$$

Fit Results for $B^- \to \Lambda_c^+ \bar{p} \pi^-$

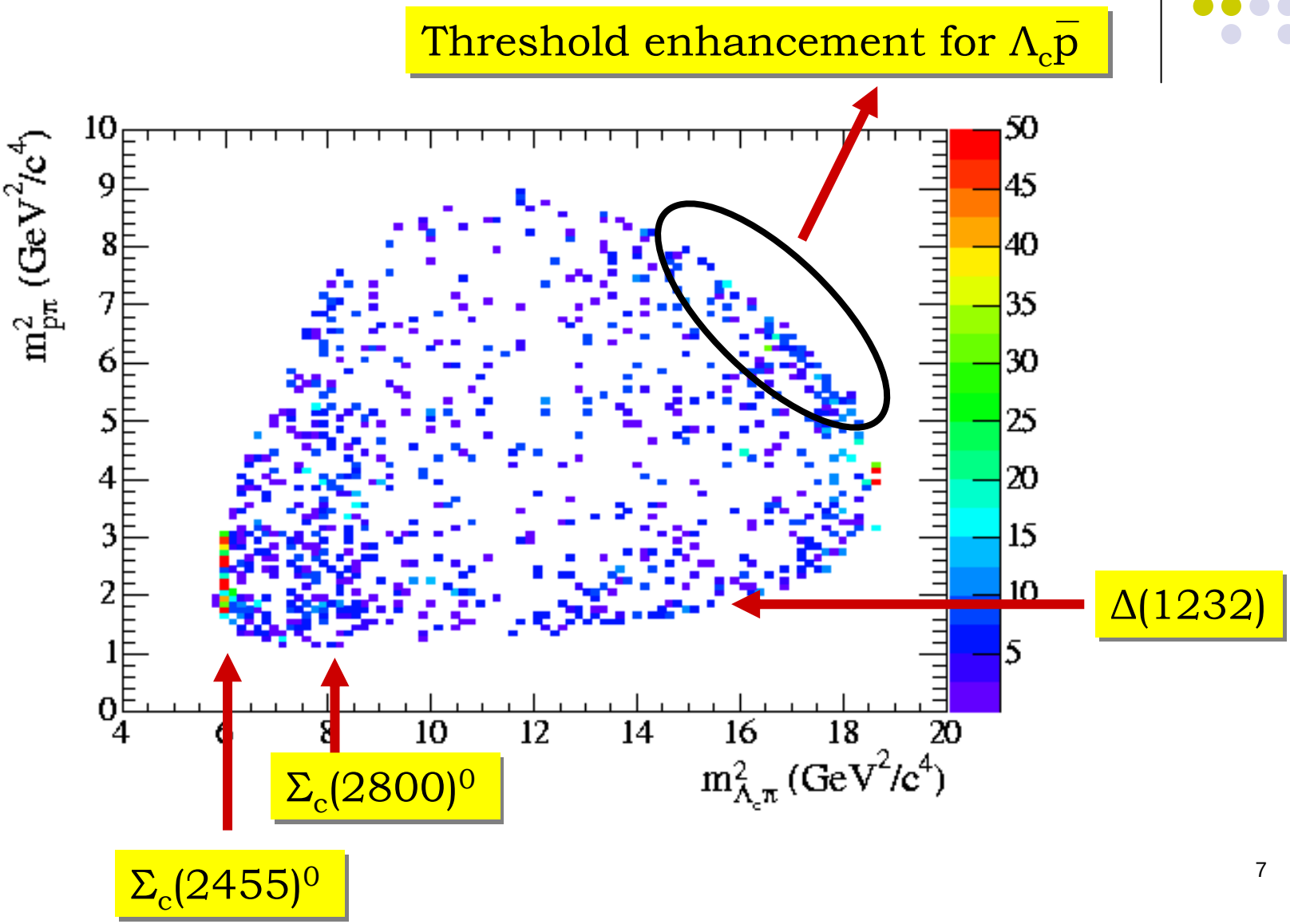


$N_{sig} = 571 \pm 34$

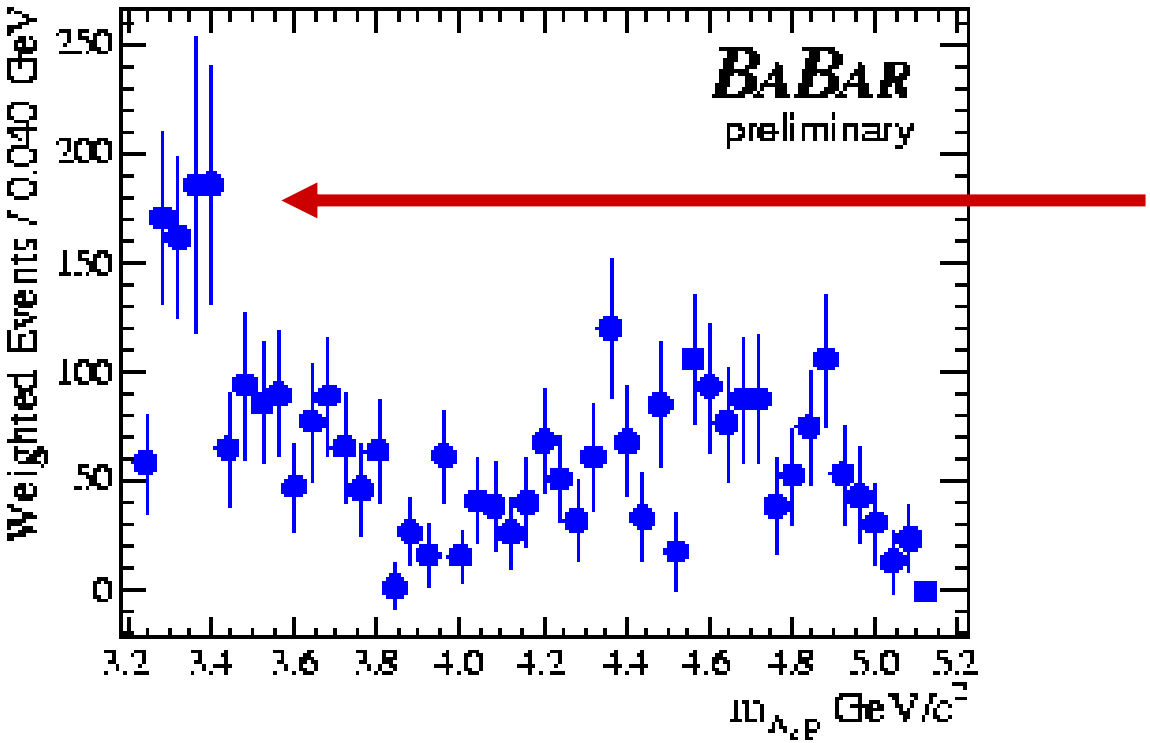
From $\Lambda_c \to pK\pi$ branching fraction

$$BF(B^- \to \Lambda_c^+ \bar{p} \pi^-) = (3.53 \pm 0.18 \pm 0.31 \pm 0.92) \times 10^{-4}$$

Dalitz Plot


Threshold enhancement for $\Lambda_c\bar{p}$
$\Delta(1232)$
$\Sigma_c(2800)^0$
$\Sigma_c(2455)^0$
$m^2_{p\pi}$ (GeV^2/c^4)
$m^2_{\Lambda_c\pi}$ (GeV^2/c^4)
0
1
2
3
4
5
6
7
8
9
10
4
6
8
10
12
14
16
18
20
5
10
15
20
25
30
35
40
45
50

Baryon-Antibaryon system



There is a clear threshold enhancement near 3.3 GeV/c^2. This effect has been seen in other 3-body baryonic B decays.

$B^0 \to \bar{D}^{(*)0} p\bar{p}$ and $B^0 \to D^{(*)-} p\bar{p}\pi^+$

- The study of these modes may help clarify the dynamics of baryonic B decays.
- Investigate the mass distributions for the exotic ($\bar{c}quud$) and non-exotic ($\bar{c}q\bar{u}\bar{u}\bar{d}$) combinations of $\bar{D}^{(*)}$ mesons and p or $\bar{p}$ where q is a u or d quark.

exotic:
$D^{(*)-}p$ and $\bar{D}^{(*)0}p$

non-exotic:
$D^{(*)-}\bar{p}$ and $\bar{D}^{(*)0}\bar{p}$

- Study the proton-antiproton system.
- Search for the H1 pentaquark.

hep-ex/0607039

Strategy and Selection

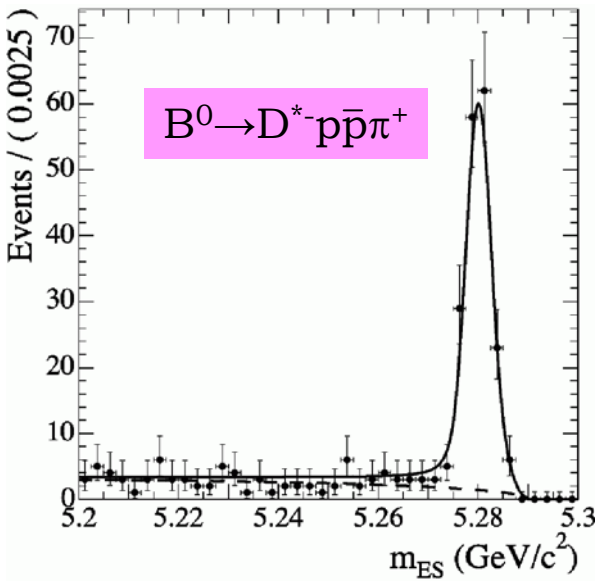
- Consider 3 D^0 decay modes: $D^0 \to K^-\pi^+$, $D^0 \to K^-\pi^+\pi^0$ and $D^0 \to K^-\pi^+\pi^+\pi^-$
- One D^- decay channel: $D^- \to K^+\pi^-\pi^-$
- After applying selection criteria, perform a maximum likelihood fit using ΔE and m_{ES}
- The signal PDF includes correlation between ΔE and m_{ES}:

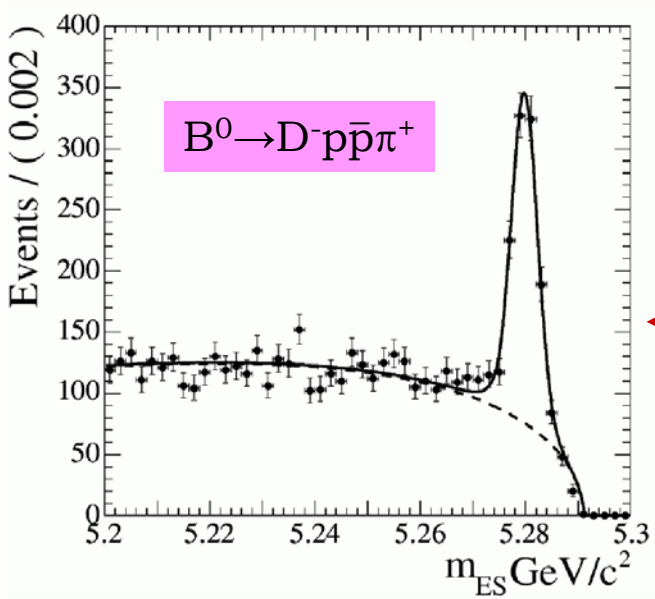
$$L = e^{-N'} \cdot \prod_{i=1}^{N} \{ N_{sig} \cdot [f_I \cdot P_I^i + f_{II} \cdot P_{II}^i] + N_{bkg} \cdot P_{bkg}^i \}$$

$$P_{II}(m_{ES}, \Delta E) = G(m_{ES}) G_1(\Delta E) + P(m_{ES}) G_2(\Delta E)$$

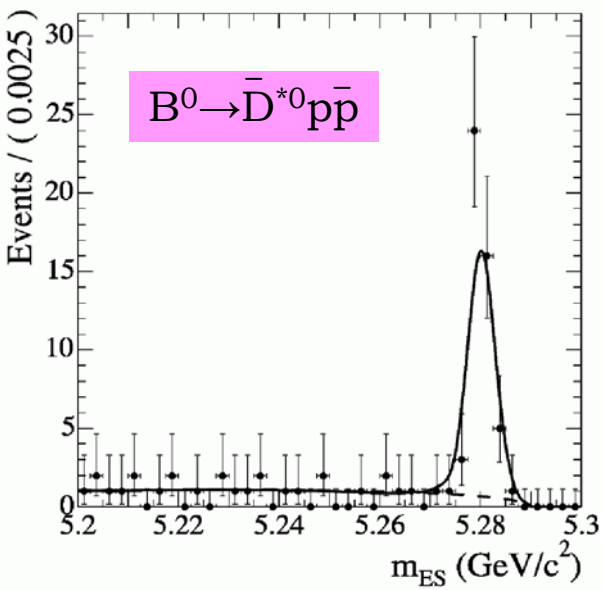
G: Gaussian
P: Polynomial

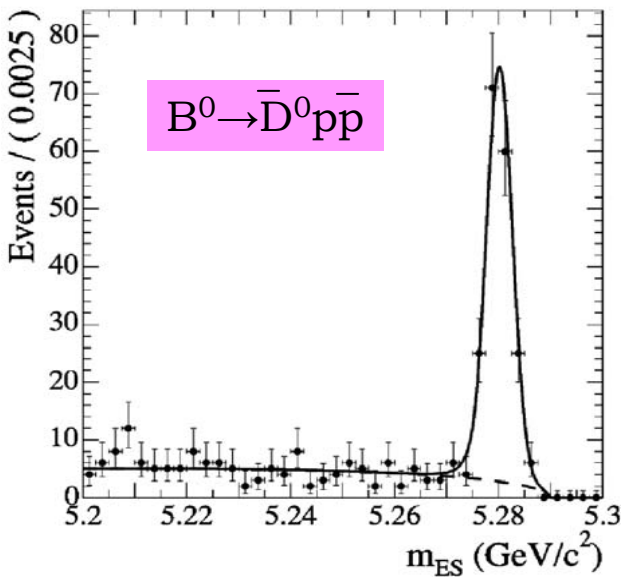
Fit Results





This plot was made using:
$D^- \to K^+\pi^-\pi^-$





The rest of the plots are for:
$D^0 \to K^-\pi^+$

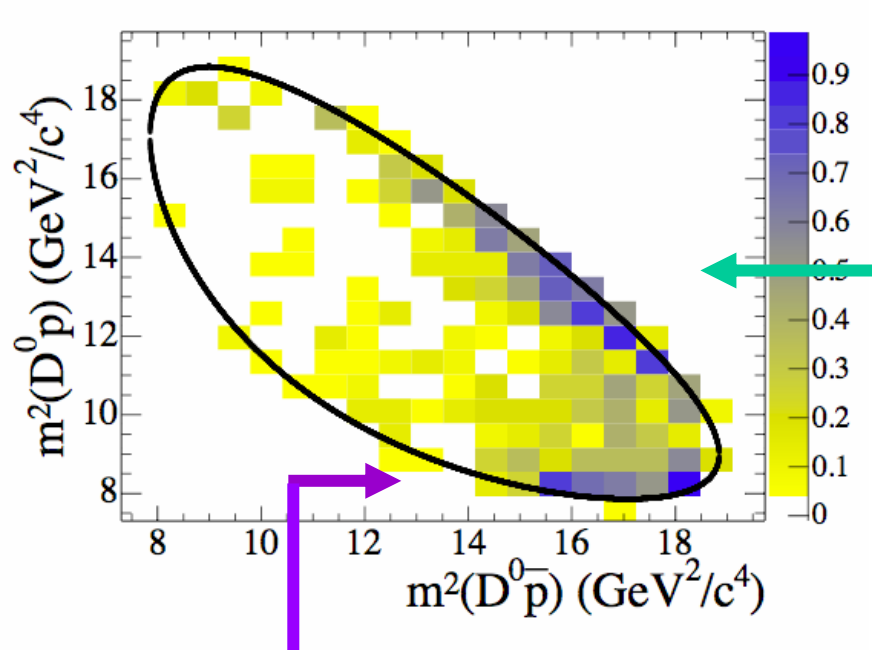
Branching Fractions

Based on 210 fb^{-1}

		Yield	BF (10^{-4})	Average (10^{-4})
$B \to \bar{D}^0 p\bar{p}$	$D \to K\pi$	214 ± 16	1.09 ± 0.08 ± 0.08	1.13 ± 0.06 ± 0.08
	$D \to K\pi\pi\pi$	320 ± 26	1.24 ± 0.10 ± 0.11	
	$D \to K\pi\pi^0$	514 ± 38	1.15 ± 0.08 ± 0.10	
$B \to \bar{D}^{*0} p\bar{p}$	$D \to K\pi$	57 ± 9	1.21 ± 0.17 ± 0.11	1.01 ± 0.10 ± 0.09
	$D \to K\pi\pi\pi$	46 ± 12	0.75 ± 0.18 ± 0.09	
	$D \to K\pi\pi^0$	104 ± 19	1.08 ± 0.14 ± 0.14	
$B \to D^- p\bar{p}\pi$	$D \to K\pi\pi\pi$	1166 ± 47	3.38 ± 0.14 ± 0.29	3.38 ± 0.14 ± 0.29
$B \to D^{*-} p\bar{p}\pi$	$D \to K\pi$	241 ± 18	4.84 ± 0.40 ± 0.44	4.81 ± 0.22 ± 0.44
	$D \to K\pi\pi\pi$	311 ± 24	5.05 ± 0.42 ± 0.59	
	$D \to K\pi\pi^0$	522 ± 32	4.71 ± 0.30 ± 0.50	

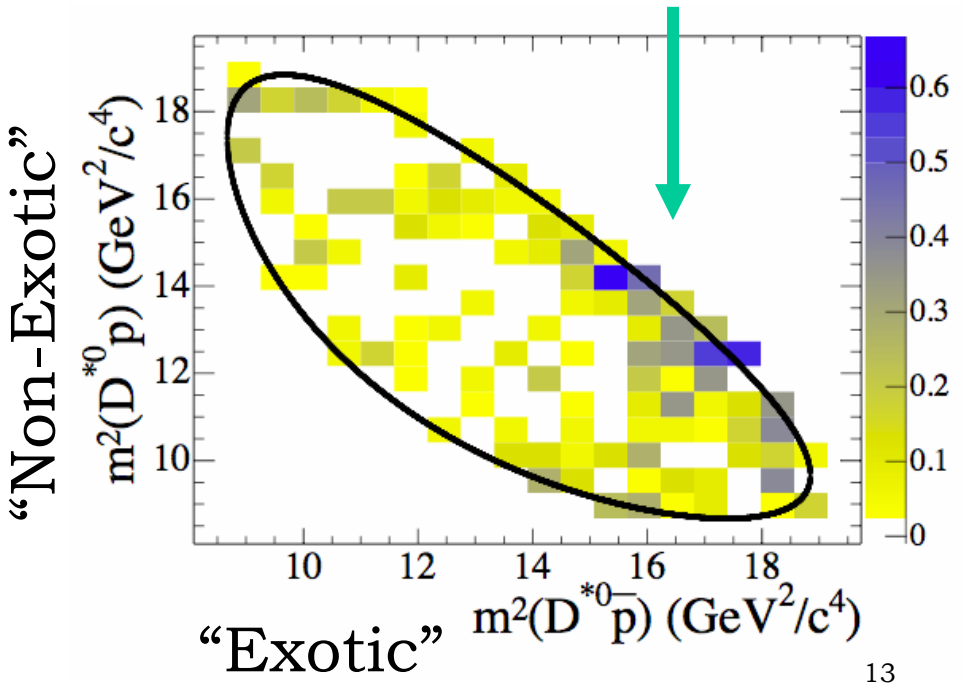
Dalitz Plots for 3-Body Decays

These are efficiency corrected plots



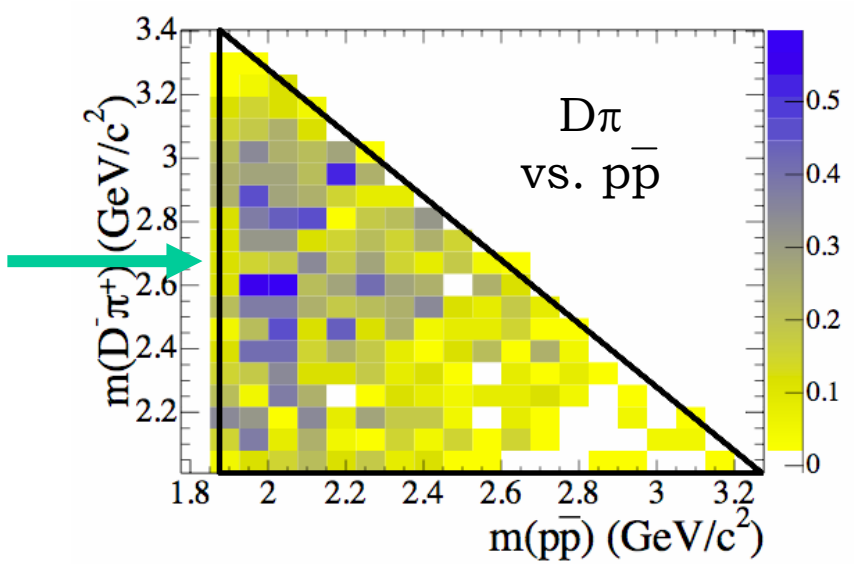
Enhancement at low $p\bar{p}$ mass

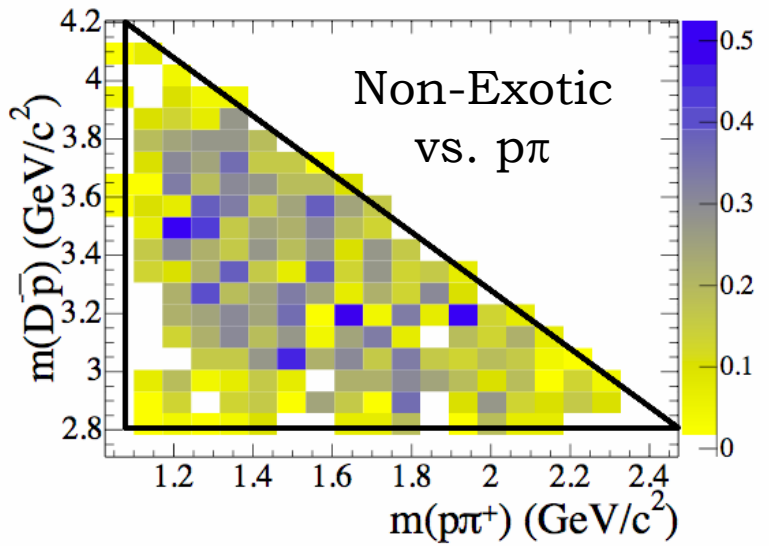
Enhancement at low D^0p mass?

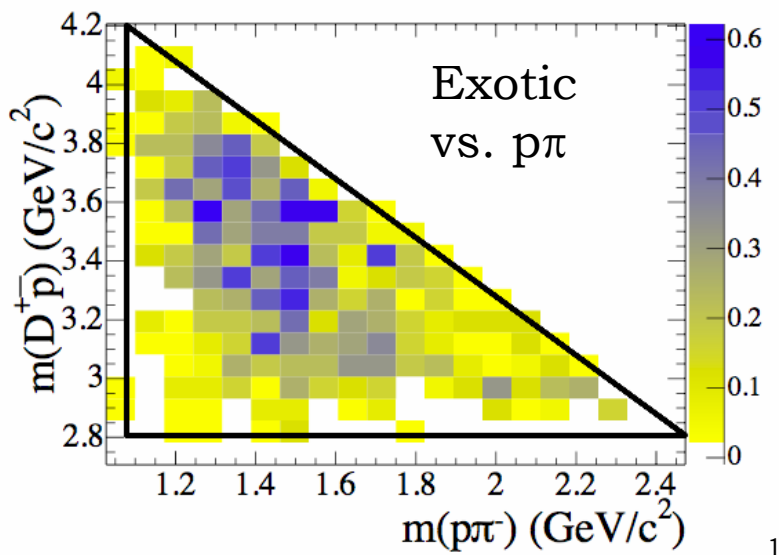


2D Projections for 4-Body Decays

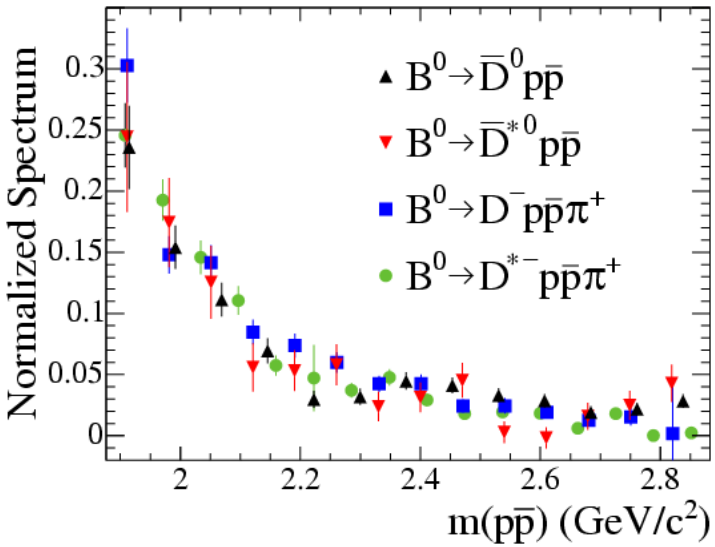
Also has $p\bar{p}$ enhancement





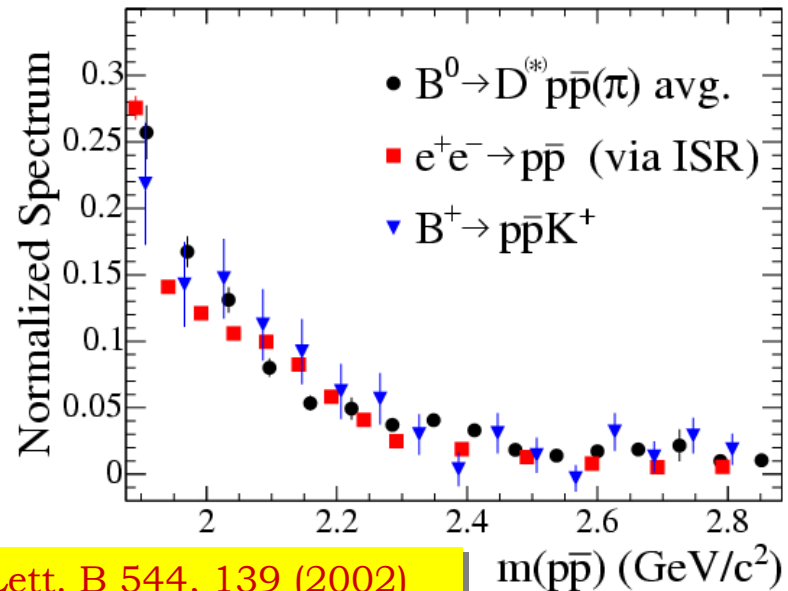


Proton-Antiproton System



The phase-space-corrected $p\bar{p}$ invariant mass for $B^0 \to \bar{D}^0 p\bar{p}$, $B^0 \to \bar{D}^{*0} p\bar{p}$, $B^0 \to D^- p\bar{p}\pi^+$ and $B^0 \to D^{*-} p\bar{p}\pi^+$

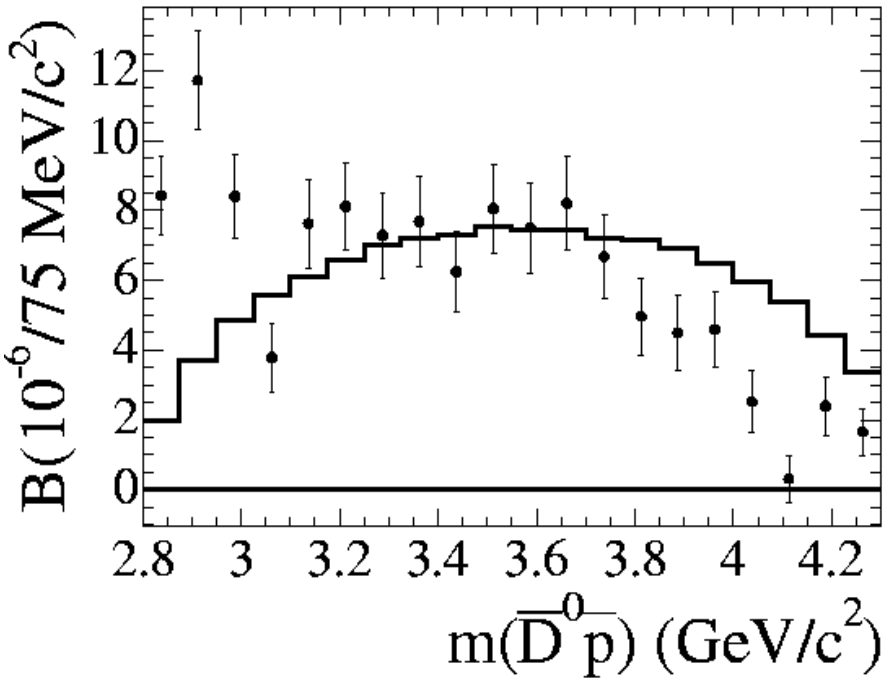
Comparing the average of the four decay modes with $e^+e^- \to p\bar{p}$ and $B^+ \to p\bar{p}K^+$

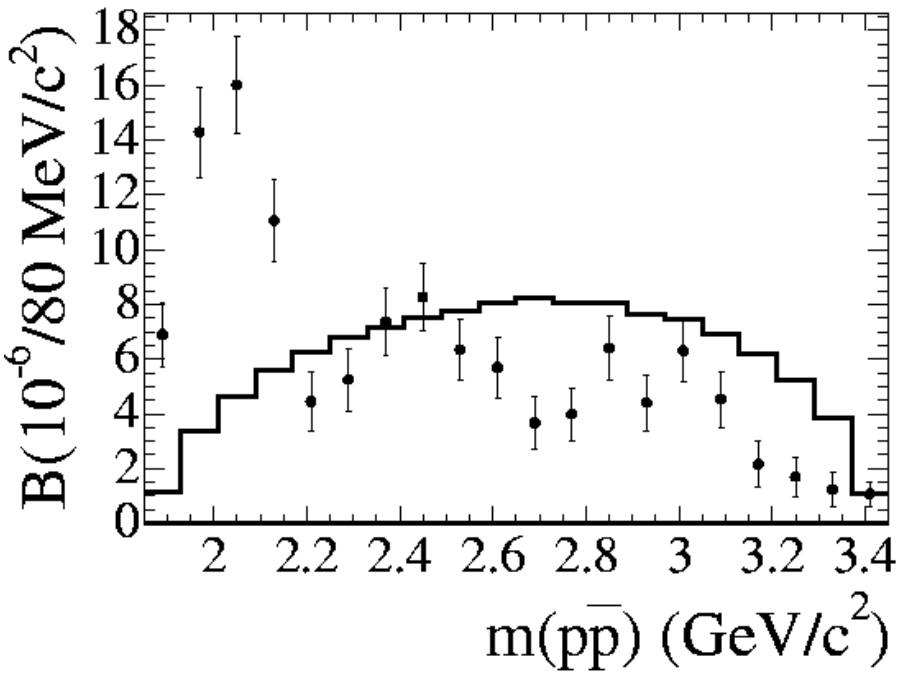


May be due to a broad gluonic resonance (*) or short range correlations between p and $\bar{p}$ (**)

* Phys. Lett. B 544, 139 (2002)
** Phys. Rev. D 69, 094014 (2004)

Comparison With Phase Space





The low mass excess in $B^0 \to \overline{D}^0 p\bar{p}$ appears to be a threshold enhancement as in the $p\bar{p}$ case.

Limits on H1 Pentaquark

There was a claim by H1 for a Pentaquark signal at 3.1 GeV in $D^{*-}p$ with a (Gaussian) width of 7 MeV (consistent with resolution).

H1 Collaboration, A. Aktas et al., Phys. Lett. B 588, 17 (2004)

We look in both $D^{-}p$ and $D^{*-}p$; perform the $m_{ES}/\Delta E$ fit in bins of mass and fit to resolution convoluted Breit-Wigner and Argus functions.

$B^0 \to \Theta_c \bar{p}\pi \to D^{-}p\bar{p}\pi$	$<9 \times 10^{-6}$
$B^0 \to \Theta_c \bar{p}\pi \to D^{*-}p\bar{p}\pi$	$<14 \times 10^{-6}$

Conservatively use Γ=25 MeV

@ 90% C.L.

Also looked inclusively in e^+e^- (PRD-RC 73, 091101 (2006))

Conclusions

- ✓ The branching fractions for 2-body and 3-body decays of B to Λ_c have been measured. Their ratio is:

$$\frac{BF(B^- \to \Lambda_c^+ \bar{p}\pi^-)}{BF(\bar{B}^0 \to \Lambda_c^+ \bar{p})} = 16.4 \pm 2.9 \pm 1.4$$

Theory prediction ~ 10
Cheng, J. Korean Phys. Soc. 45, S245 (2004)

- ✓ The branching fraction for $B^0 \to D^{(*)-} p\bar{p}\pi$ channels is higher than those of $B^0 \to \bar{D}^{(*)0} p\bar{p}$.

- ✓ There are threshold enhancements for all di-baryon systems.

- ✓ There is no evidence for H1 pentaquark production in B decays, in agreement with previous inclusive production search (PRD-RC 73, 091101 (2006)).