Study of exclusive $B \to D_s^{(*)} X$ decays at BaBar

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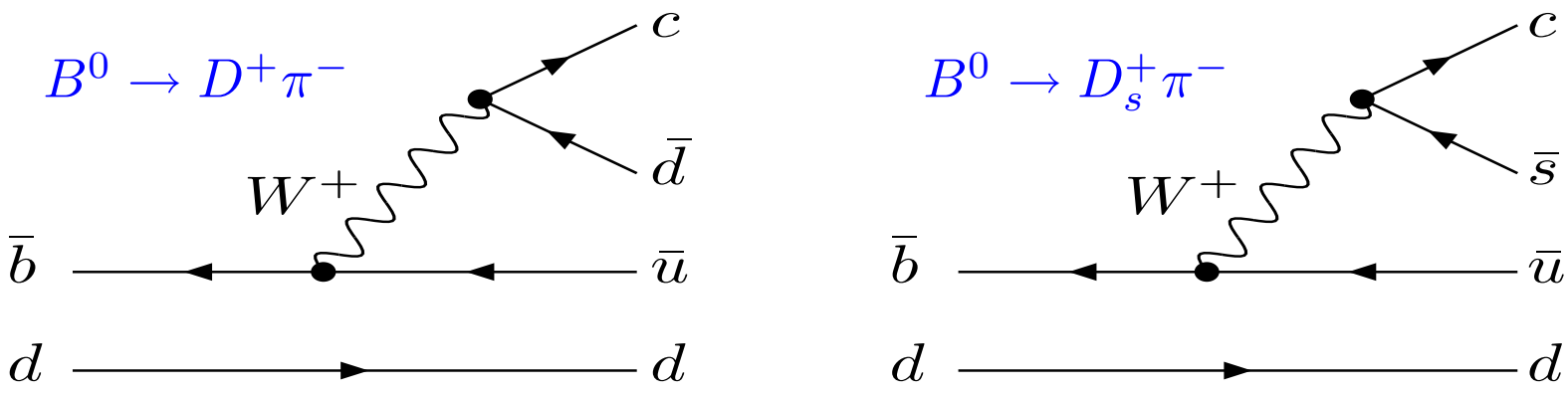
On behalf of BaBar Collaboration

- Introduction
- Recent exclusive $B \to D_s^{(*)} X$ measurements from BaBar:
  - $B^0 \to D_s^{(*)+} \pi^-,\ K^-$
  - $B^+ \to D_s^+ \pi^0$
  - $B^+ \to D_s^{(*)-} K^+ \pi^+$
- Summary

$B^0 \to D_s^{(*)+}\pi^-$: motivation

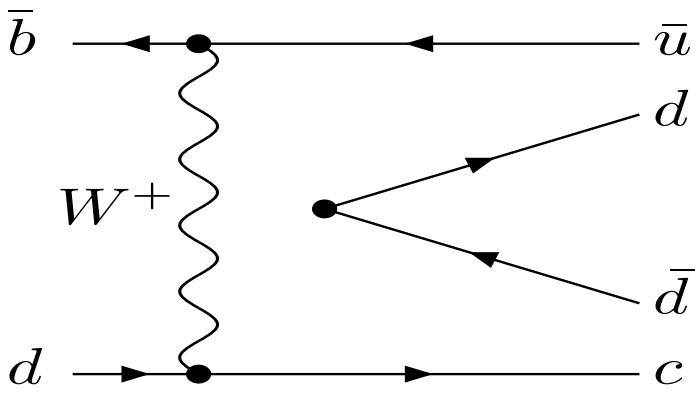


- Motivated by measurement of $\sin(2\beta+\gamma)$ in $B^0 \to D^{(*)}\pi$
- ... which requires knowledge of
  $r(D^{(*)}\pi) = |A(B^0 \to D^{(*)+}\pi^-)/A(B^0 \to D^{(*)-}\pi^+)|$
- An estimate of $r(D^{(*)}\pi)$ may be obtained via $B^0 \to D_s^+\pi^-$:

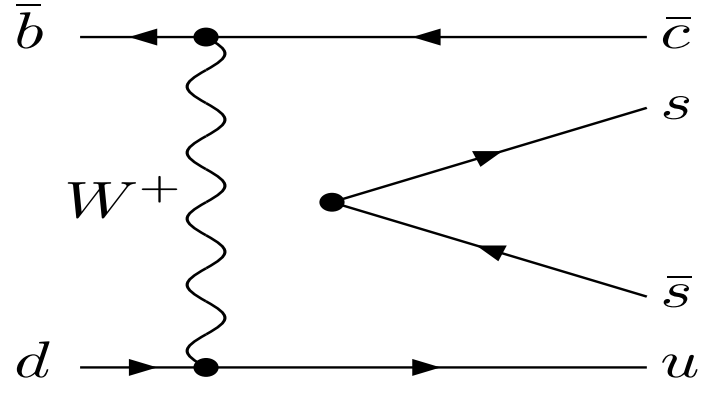
$$r(D^{(*)}\pi) = \tan\theta_c \, \frac{f_{D^{(*)}}}{f_{D_s^{(*)}}} \sqrt{\frac{\mathcal{B}(B^0 \to D^{(*)+}\pi^-)}{\mathcal{B}(B^0 \to D^{(*)-}\pi^+)}}$$

- SU(3) accuracy $\sim 30\%$

$B^0 \to D_s^{(*)-} K^+$: motivation



$B^0 \to D^+ \pi^-$



$B^0 \to D_s^- K^+$

- Probes the size of W-exchange contributions in $B^0 \to D^{(*)}\pi$
- Have to be careful: FSI may interfere [1]
- Also interesting for an estimate of the relative strength of the short/long distance effects

[1] B. Blok *et. al* Phys. Rev. Lett. 78, 3999 (1997)

$B^0 \to D_s^{(*)}\pi,\ K$: previous results

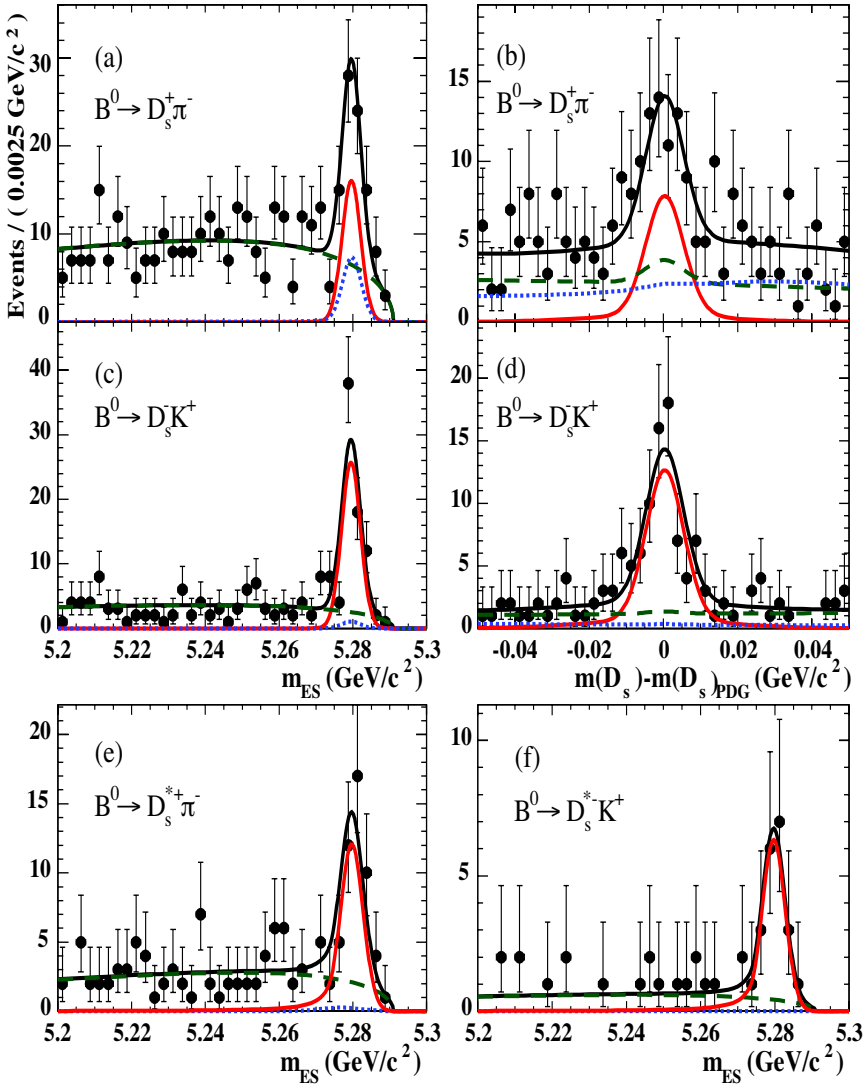
- 2 measurements from BaBar & Belle (in units of 10^{-5}):

Mode	BaBar[1], 77 fb^{-1}	Belle[2], 79 fb^{-1}
$B^0 \to D_s^+\pi^-$	$3.2 \pm 0.9 \pm 1.0$	$2.4^{+1.1}_{-0.9} \pm 0.6$
$B^0 \to D_s^{*+}\pi^-$	< 4.1 @90% $C.L.$	–
$B^0 \to D_s^- K^+$	$3.2 \pm 1.0 \pm 1.0$	$4.5^{+1.4}_{-1.2} \pm 1.1$
$B^0 \to D_s^{*-} K^+$	< 2.5 @90% $C.L.$	–

[1] BaBar Collaboration, B. Aubert *et. al*, Phys. Rev. Lett. 90, 181803 (2003)

[2] Belle Collaboration, P. Krokovny *et. al*, Phys. Rev. Lett. 89, 231804 (2002)

$B^0 \to D_s^{(*)}\pi,\ K$: fit to the data (210 fb^{-1})



- Curves on the plots: Signal, Combinatorial bkg, Peaking bkg, Total fit PDF
- $B^0 \to D_s\pi,\ K$
  - 2D fit $m_{ES} \otimes m(D_s)$
  - To account for charmless and charmonium backgrounds
- $B^0 \to D_s^*\pi,\ K$
  - 1D fit m_{ES}
  - Charmless and charmonium backgrounds are negligible

$B^0 \to D_s^{(*)}\pi,\ K$: results

- Results from the fit to the data (hep-ex/0604012):

Mode	N_{sig}	$\mathcal{B}$, $[10^{-5}]$
$B^0 \to D_s^+\pi^-$	48 ± 11	$1.3 \pm 0.3 \pm 0.2$
$B^0 \to D_s^{*+}\pi^-$	42 ± 9	$2.8 \pm 0.6 \pm 0.5^*$
$B^0 \to D_s^- K^+$	77 ± 12	$2.5 \pm 0.4 \pm 0.4$
$B^0 \to D_s^{*-} K^+$	22 ± 5	$2.0 \pm 0.5 \pm 0.4$

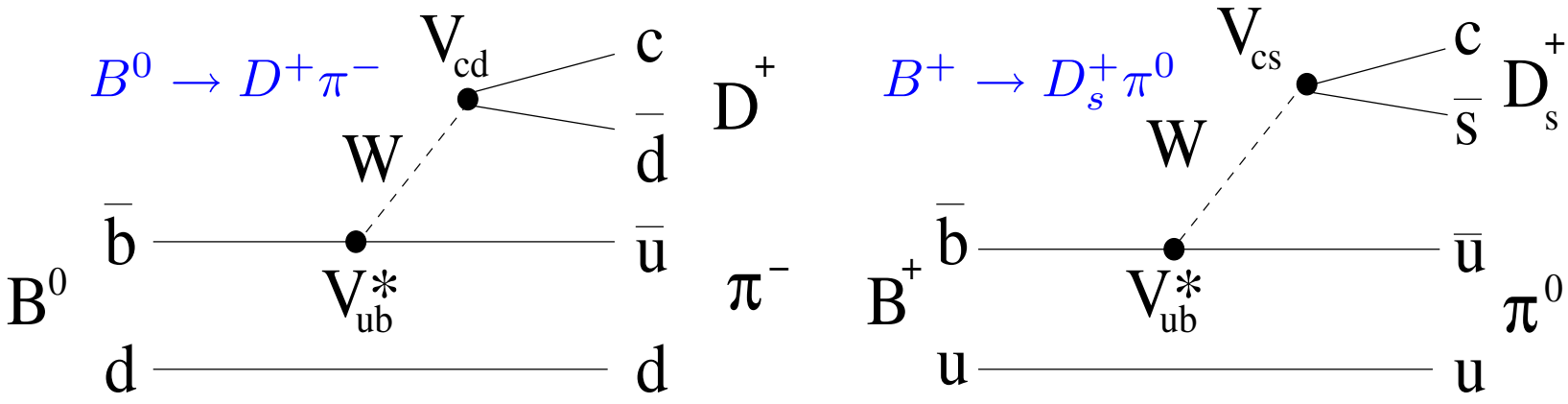
* first observation

$$r(D\pi) = (1.3 \pm 0.2 \pm 0.1) \cdot 10^{-2}$$

$$r(D^*\pi) = (1.9 \pm 0.2 \pm 0.2) \cdot 10^{-2}$$

← assuming SU(3)

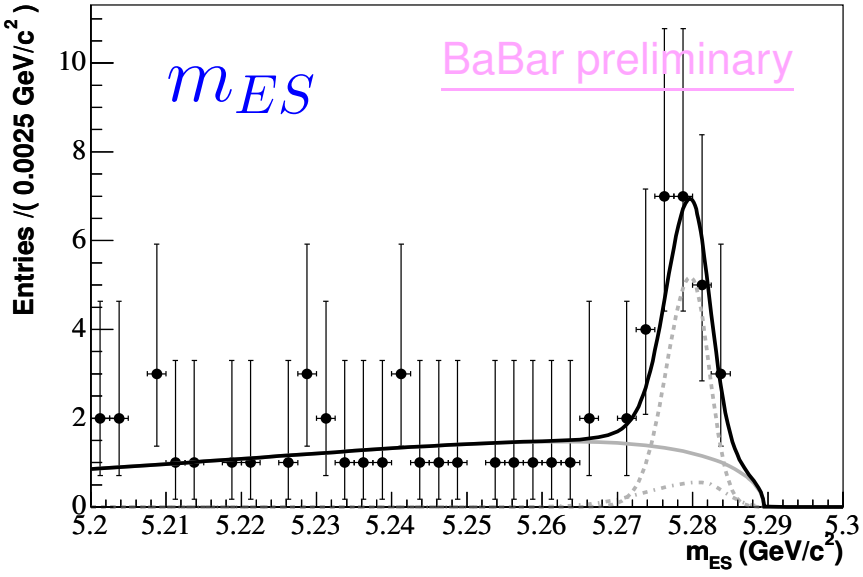
$B^0 \to D_s^+ \pi^0$: motivation

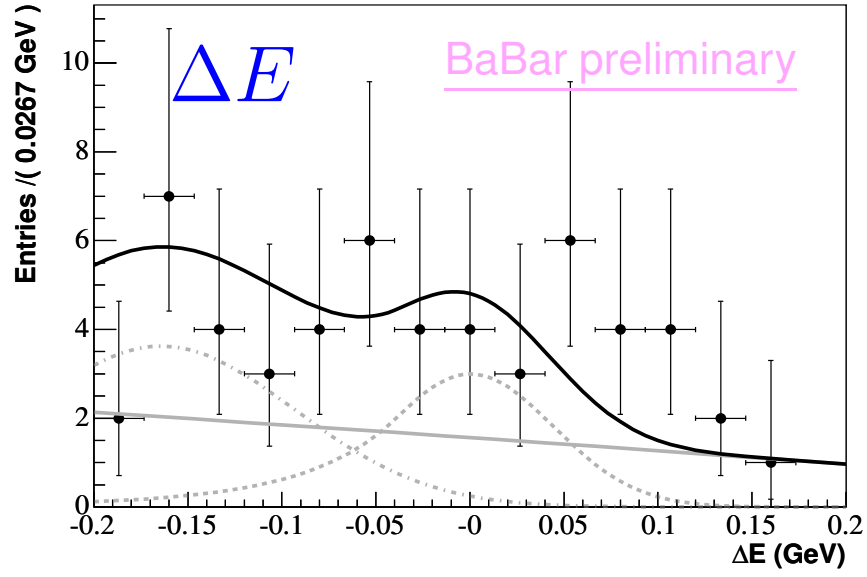


- Similar considerations to $B^0 \to D_s^+ \pi^-$ ($\sin(2\beta+\gamma)$ in $B^0 \to D^{(*)}\pi$)
- Another way to estimate $r(D\pi) = |A(B^0 \to D^+\pi^-)/A(B^0 \to D^-\pi^+)|$
- ... using $B^0 \to D_s^+ \pi^0$ this time:

$$r(D\pi) = \frac{|V_{cd}|}{|V_{cs}|}\frac{f_D}{f_{D_s}}\sqrt{2\frac{\tau_{B^0}}{\tau_{B^+}}\frac{\mathcal{B}(B^+ \to D_s^+\pi^0)}{\mathcal{B}(B^0 \to D^-\pi^+)}}$$

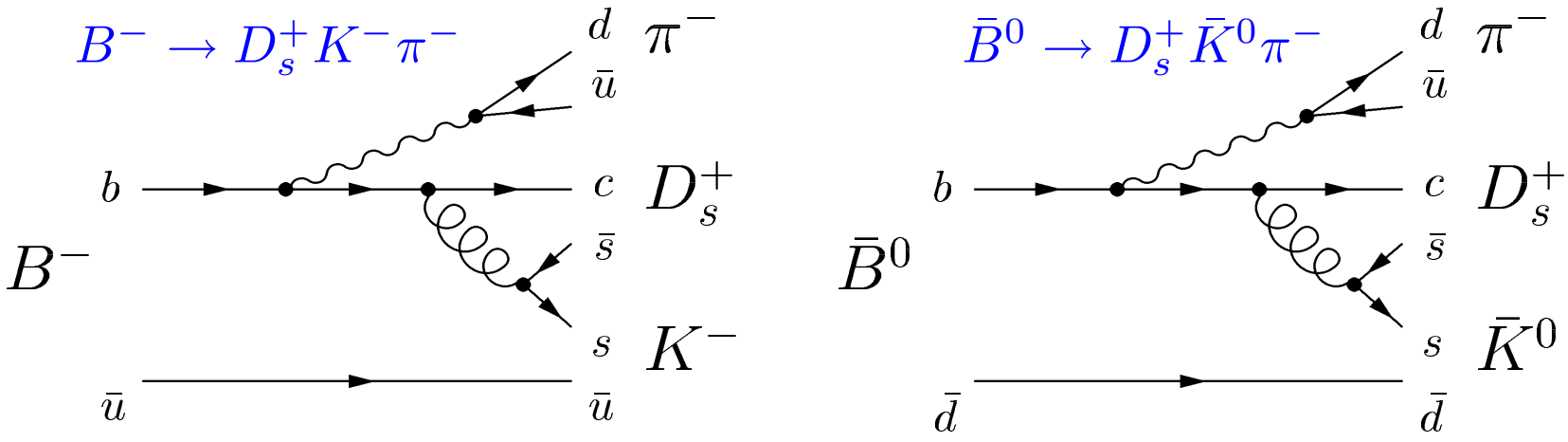
$B^0 \to D_s^+ \pi^0$: results (210 fb^{-1})





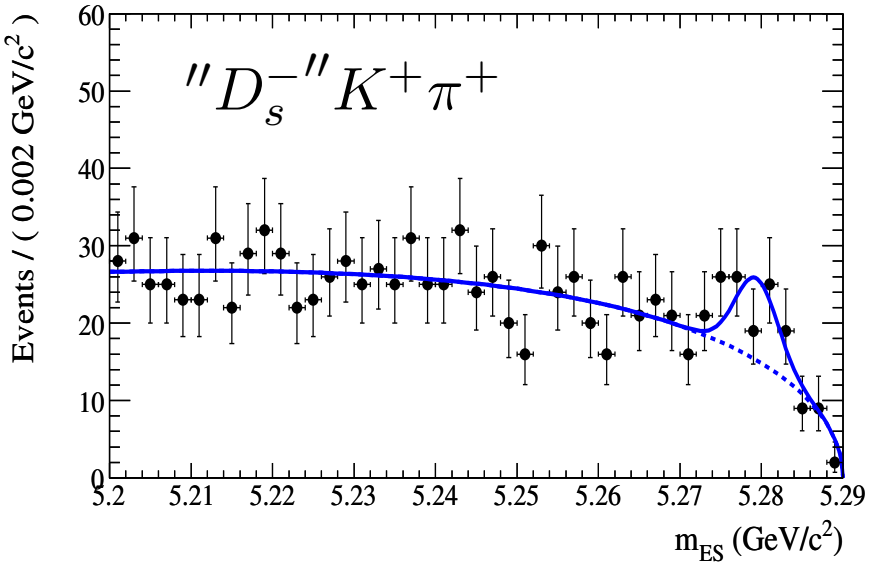
- 2D fit of $m_{ES} \otimes \Delta E$
- Peaking bkg from MC and validated using ΔE, D_s^+ sidebands
- Fit results:
  - $N_{sig} = 19.6^{+6.8}_{-6.0}$ ← **4.7σ significance**
  - $\mathcal{B}(B^0 \to D_s^+ \pi^0) = (1.5^{+0.5}_{-0.4} \pm 0.1 \pm 0.2) \cdot 10^{-5}$ (sub. to PRL)

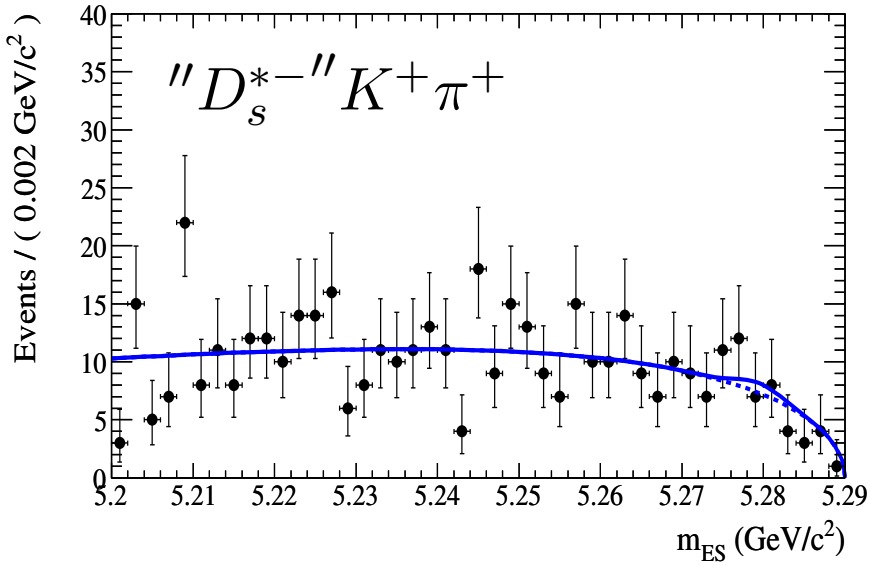
$B^- \to D_s^{(*)+} K^- \pi^-$: motivation



- Decays with anti-correlated B and D_s flavors ($B^- \to D_s^+ X$) have been observed inclusively (BaBar Collaboration, `hep-ex/0606026`).
- Lower vertex D_s^+ production with $s\bar{s}$ popping - this kind of exclusive decays has never been seen before (upper limits from ARGUS, CLEO).
- Potentially large contribution from $D^{**} \to D_s K$

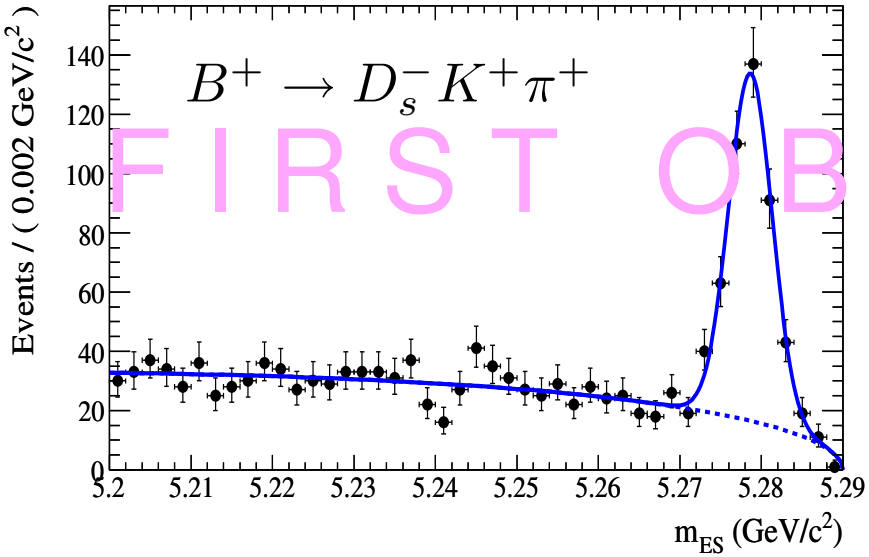
$B^- \to D_s^{(*)+} K^- \pi^-$: peaking background

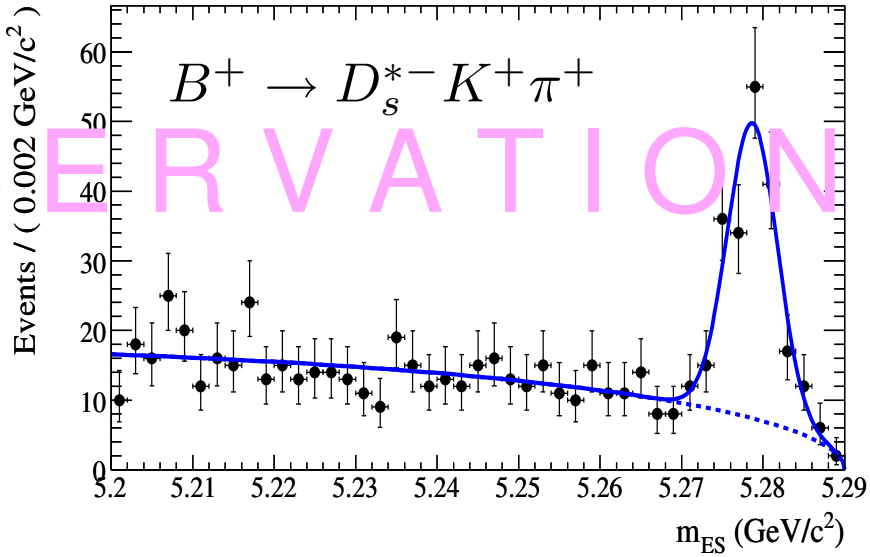




- $D_s^- K^+\pi^+$ peaking contribution was found to be due to charmless and charmonium $B^\pm$ decays.
- This contribution was evaluated using D_s^+ mass sidebands in the data, when no mass constraint on D_s^+ was applied.
- We found 23 ± 8 peaking background events in the data for $D_s^- K^+\pi^+$, and no peaking contribution for $D_s^{*-} K^+\pi^+$.

$B^- \to D_s^+ K^- \pi^-$: fit to the data (292 fb^{-1})





FIRST OBSERVATION

- 1D fit to the m_{ES} spectra
- $B^+ \to D_s^- K^+ \pi^+$: 370 ± 26 (peaking subtracted),
  $B^+ \to D_s^{*-} K^+ \pi^+$: 164 ± 16
- Measured branching fractions (`hep-ex/0607062`):
  - $\mathcal{B}(B^- \to D_s^+ K^- \pi^-) = (1.88 \pm 0.13 \pm 0.41) \cdot 10^{-4}$
  - $\mathcal{B}(B^- \to D_s^{*+} K^- \pi^-) = (1.84 \pm 0.19 \pm 0.40) \cdot 10^{-4}$

Conclusions

Impressive set of $B \to D_s^{(*)} X$ analyses from BaBar in 2006:

First observations

- $B^0 \to D_s^{*+} \pi^-$
- $B^0 \to D_s^{*+} K^-$
- $B^+ \to D_s^+ \pi^0$
- $B^- \to D_s^+ K^- \pi^-$
- $B^- \to D_s^{*+} K^- \pi^-$

Improved measurements:

- $B^0 \to D_s^+ \pi^-$
- $B^0 \to D_s^+ K^-$

Other interesting $B \to D_s^{(*)} X$ results from BaBar are coming soon!