B Decays to $D_s^{(*)}$ and D^*

Submitted papers:
BABAR-CONF-00/13
BABAR-CONF-00/06

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Measurements and Data sample

- *The data were taken*
  - at Υ(4s) c.m. energy (on resonance sample), and:
  - 40 MeV below the BB threshold (off resonance sample).

Study of inclusive $D_s^{(*)}$ production in B Decay.

Measurement of $B^0 \to D_s^{(*)+} D^{*-}$ Branching Ratio with a partial reconstruction technique.

} *L~ 7.7 fb^{-1} on resonance*

} *L~ 1.2 fb^{-1} off resonance*

Measurement of the Branching Ratios of $B^0 \to D^{*+} \pi^-$ and $B^0 \to D^{*+} \rho^-$

} *L~ 5.2 fb^{-1}*

Introduction

- **Motivation**
  - Study the mechanism leading to the creation of cs quark pair
  - Test the factorization models of B decays to open charm
  - Study detector performance
  - Validation tests for other measurements, like B^0 lifetime, B^0 mixing and CP study

- **The detector**
  - Charged particle tracking :
    - Silicon Vertex Tracker and Drift Chamber.
      Momentum resolution ($p_T/p_T)^2=(0.0015p_T)^2+(0.005)^2$ [GeV]
  - Particle identification:
    - dE/dx in SVT and DCH; Chernkov angle in DIRC.
      K identification up to about 3.5 GeV
  - Photon detection:
    - CsI(Tl) crystal calorimeter

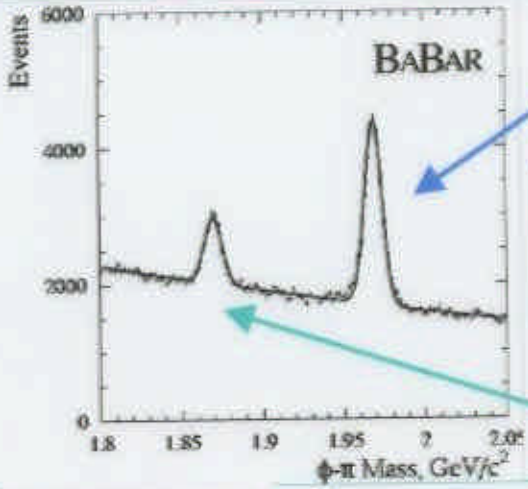
D_s production in B decay

Decay channel: $D_s^{\pm} \to \phi\,\pi^{\pm}$, $\phi \to K^+K^-$

Selection criteria:

- Kaon ID
- $|M(KK) - M_\phi| < 8.0$ MeV
- $|\cos\theta_H| > 0.3$

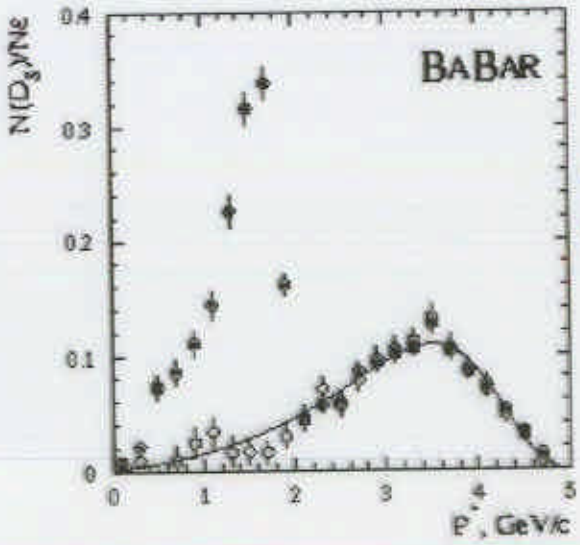
Efficiency: 40.5 ± 1.0%



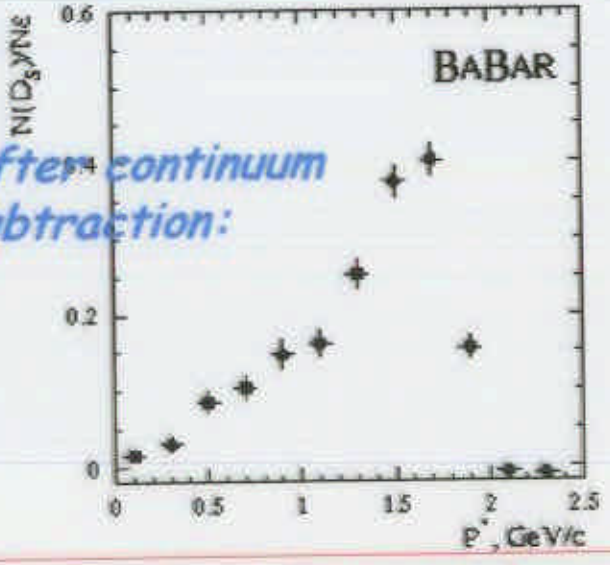
Signal $D_s^{\pm} \to \phi\,\pi^{\pm}$

$N_{Ds\pm}$: 18270 ±200
M=1968.5 ±0.1Mev
σ=5.4 ±0.1MeV

Cabibbo sup. $D^{\pm} \to \phi\,\pi^{\pm}$



After continuum subtraction:



Systematic source	Error %
N_{BB}	3.6
Track efficiency	7.5
Part. id	0.8
BR($\phi \to K^+K^-$)	1.6
Other contr.	3.0
total	9.0

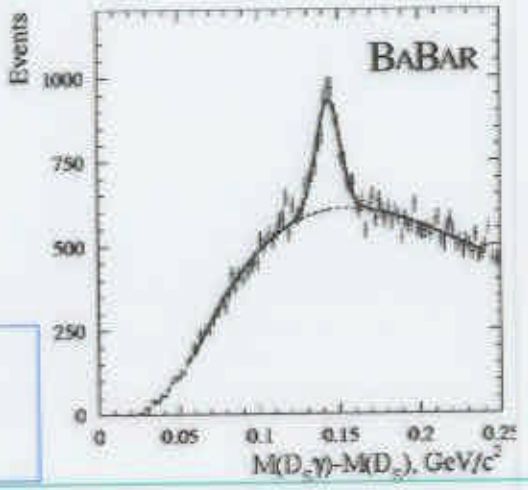
$BR(B \to D_s^{\pm} X) = (11.9 \pm 0.3 \pm 1.1 \pm 3.0) \times 10^{-2}$ assuming $BR(D_s^{\pm} \to \phi\,\pi^{\pm}) = (3.6 \pm 0.9)\%$

D_s^* production in B decay

Decay channel: $D_s^{*\pm} \to D_s^{\pm} \gamma$, $\phi \pi^{\pm}$, K^+K^-

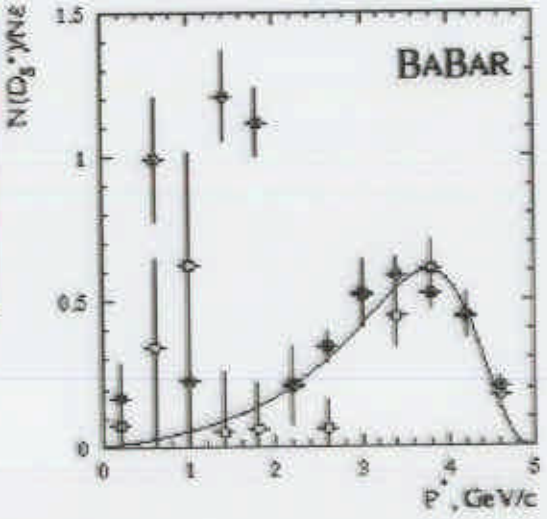
Selection criteria
- $E^*\gamma > 110$ MeV
- Veto γ's from π^0
- $1953 < M(\phi\pi) < 1984$ MeV

$N(D_s^*) = 3030 \pm 151$
$\Delta M = 143.4 \pm 0.3$ MeV
$\sigma = 7.4 \pm 0.4$ MeV



$BR(B \to D_s^{*\pm} X) = (6.8 \pm 0.7 \pm 0.8 \pm 1.7) \times 10^{-2}$

assuming $BR(D_s^{\pm} \to \phi \pi^{\pm}) = 3.6 \pm 0.9\%$



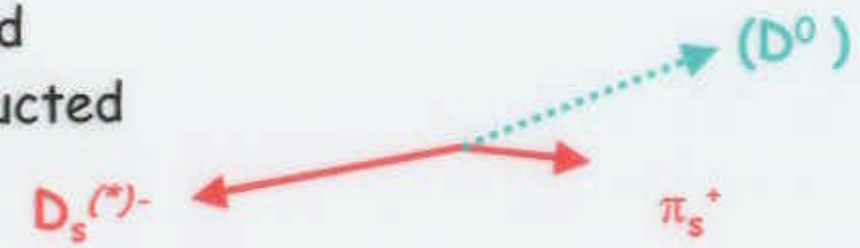
Systematic Sources	Error%
N_{BB}	3.6
Track efficiency	7.5
Photon effic.	2.5
Part. id	0.8
$BR(\phi \to K^+K^-)$	1.6
$BR(D_s^* \to D_s \gamma)$	2.7
Other contrib.	7.7
total	12.0

$B^0 \to D_s^{(*)+} D^{*-}$ Branching Ratios

Method:

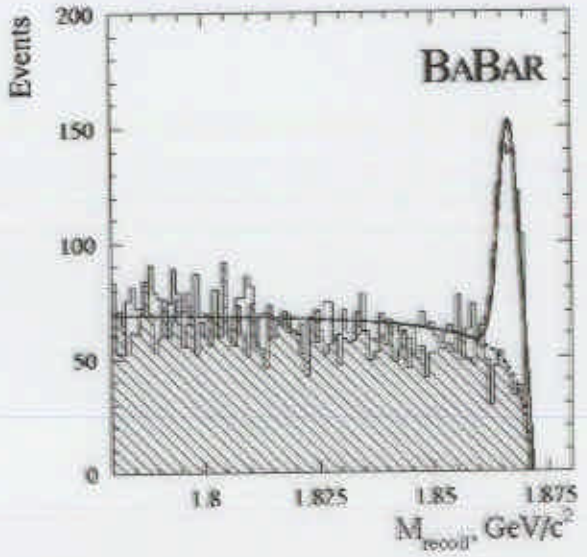
$D_s^{(*)-}$ fully reconstructed

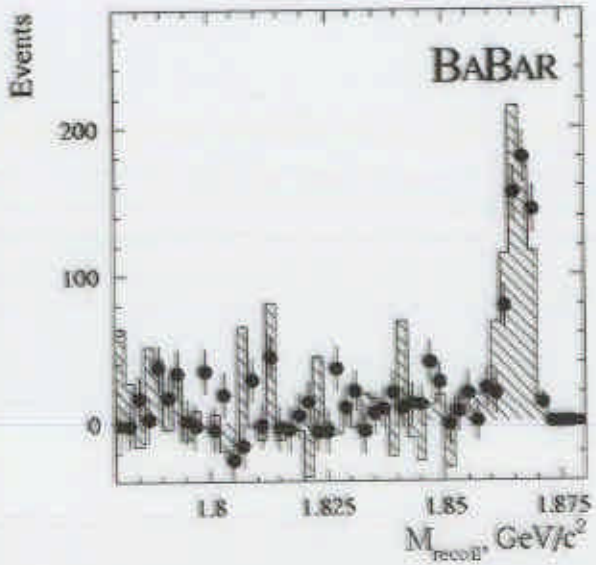
$D^{*+} \to (D^0)\ \pi_s^+$ partially reconstructed

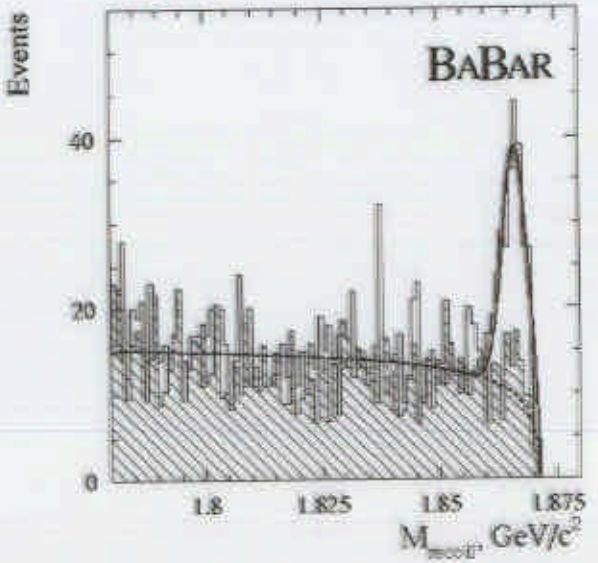


$D_s^+ - \pi$ missing mass ⟶ Bkgd subtracted

$D_s^{*+} - \pi$ missing mass







$B^0 \to D_s^{(*)+} D^{*-}$ Branching Ratios

Yield from the missing mass after background subtraction:

$N_{B^0 \to D_s^+ D^{*-}}$: 628 ± 55

Efficiency: 32.8 ± 1.8%

$N_{B^0 \to D_s^{*+} D^{*-}}$: 195 ± 29

Efficiency: 7.5 ± 1.5%

Feed through: **14.9 ± 1.2%**

from $B^0 \to D_s^{*+} D^{*-}$ *to* $D_s^+ D^{*-}$

$B^0 \to D_s^+ D^{*-}$	$B^0 \to D_s^{*+} D^{*-}$
$BR = (7.1 \pm 2.4 \pm 2.5 \pm 1.8^*) \times 10^{-3}$	$BR = (2.5 \pm 0.4 \pm 0.5 \pm 0.6^*) \times 10^{-2}$
PDG: $BR = (9.6 \pm 3.4) \times 10^{-3}$	PDG: $BR = (2.0 \pm 0.7) \times 10^{-2}$

* due to $BR(D_s^\pm \to \phi \pi^\pm) = 3.6 \pm 0.9\%$

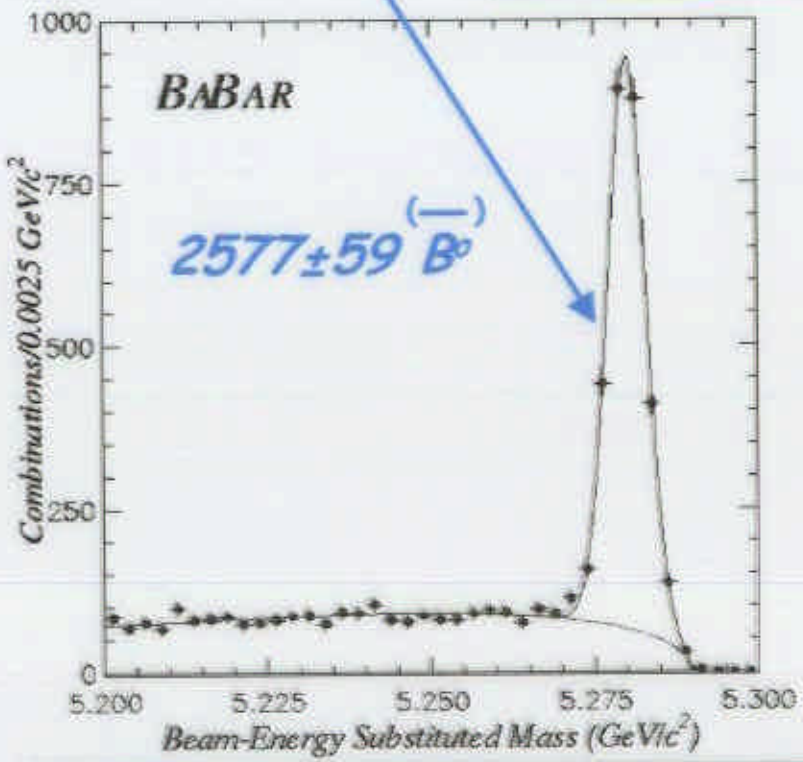
Exclusive modes reconstructed

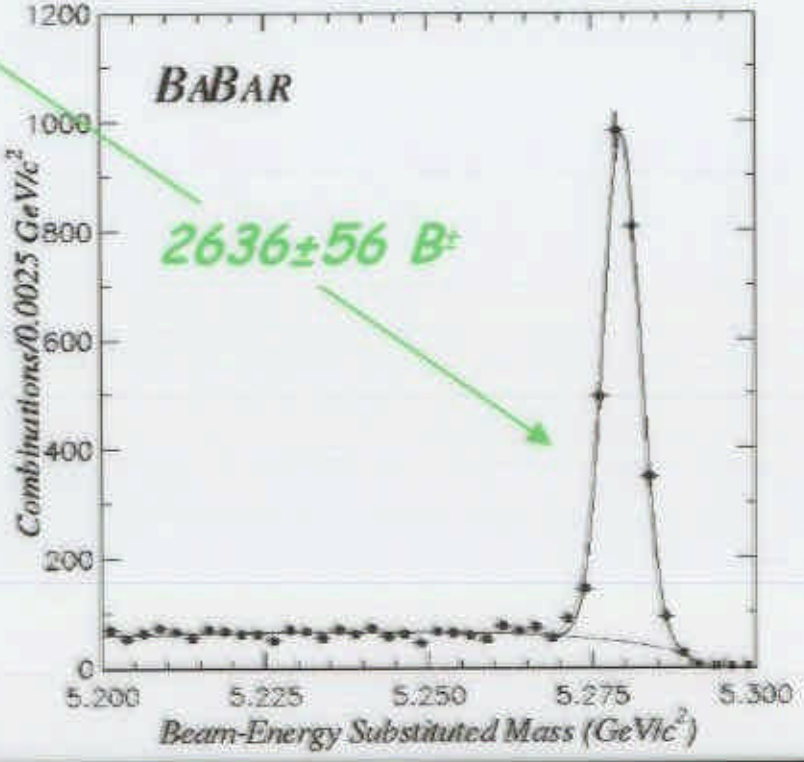
$B^0 \to D^{(*)+}\pi^-$
$B^0 \to D^{(*)+}\rho^-$
$B^0 \to D^{(*)+}a_1^-$
$B^0 \to J/\Psi\ K^{*0}$

$B^- \to D^{(*)0}\pi^-$
$B^- \to D^{(*)0}\rho^-$
$B^- \to D^{(*)0}a_1^-$
$B^- \to J/\Psi\ K^-$
$B^- \to \Psi(2s)\ K^-$

$D^{*0} \to D^0\pi^0$
$D^{*-} \to D^0\pi^-$
$J/\Psi \to l^+l^-$
$\Psi(2s) \to l^+l^-\pi^+\pi^-$

$D^0 \to K^-\pi^+,\ K^-\pi^+\pi^0,$
$K_S\pi^-\pi^+,\ K^-\pi^+\pi^-\pi^+$
$D^+ \to K^-\pi^+\pi^+, K_S\pi^-\pi^+$





$B^0 \to D^{*+} \pi^-$ and $B^0 \to D^{*+} \rho^-$ selection

Exclusively reconstructed

Decay chain:

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

$B^0 \to D^{*+} \rho^-$, $D^{*+} \to D^0 \pi^+$, $\rho^- \to \pi^- \pi^0$, $D^0 \to K^- \pi^+$

$BR(D^* \to D^0 \pi_s) = (68.3 \pm 1.4)\%$

$BR(D^0 \to K\pi) = (3.83 \pm 0.09)\%$

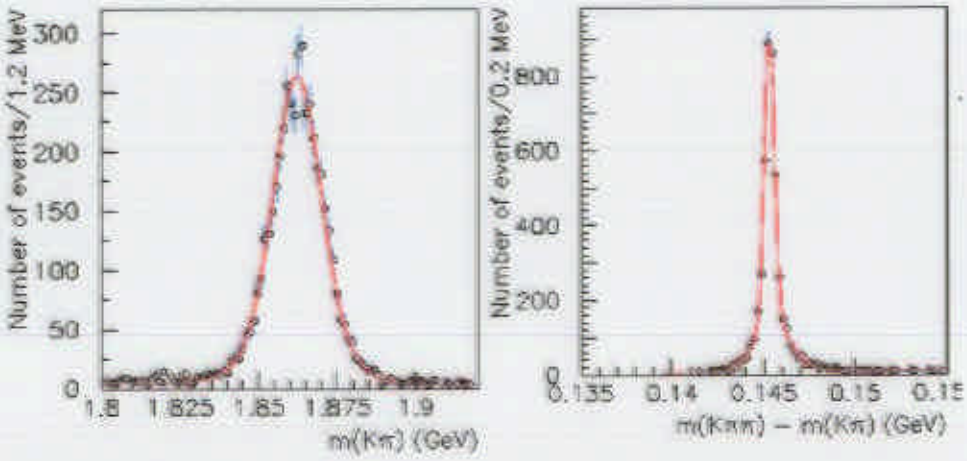
Simple selection:

- $R2 < 0.5$ second Fox-Wolfram moment
- $P_t(\pi_s) > 70$ MeV
- 2.5σ $m(K\pi)$
- 2.5σ $m(K\pi\pi) - m(K\pi)$

$\rho \to \pi\pi^0$

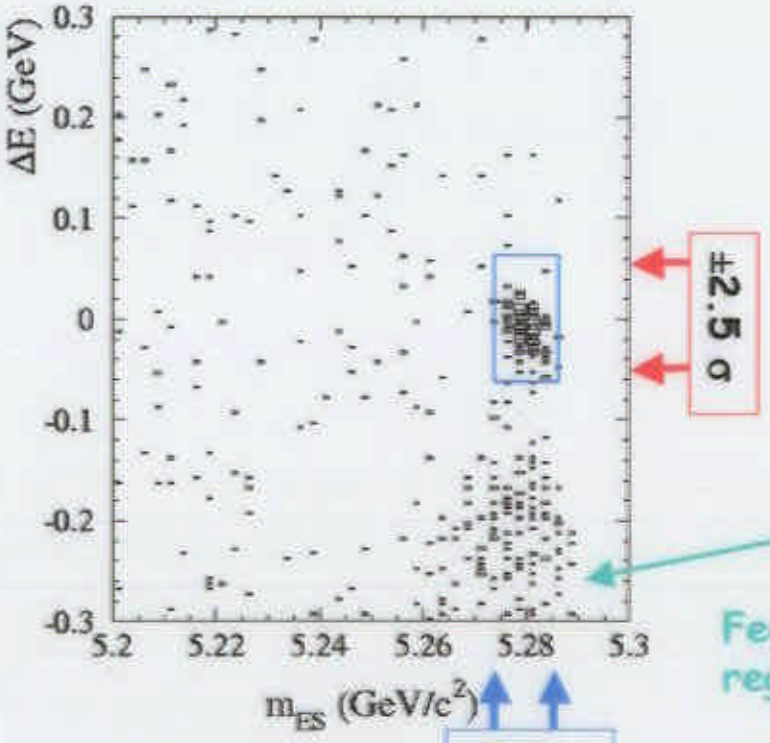
$E_\gamma > 30$MeV

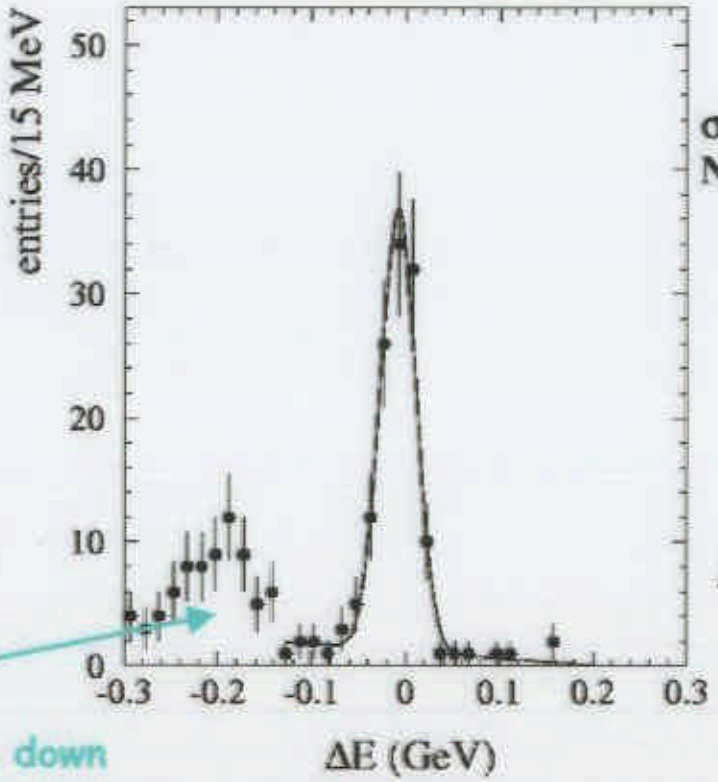
$620 < m(\pi\pi^0) < 920$ MeV/c^2



$B^0 \to D^{*+}\pi^-$ signal

Clear signal, low background





σ= 18.8±0.9MeV

$N_{D^{*}\pi}$=111 ±11

$$\Delta E = E_B^* - \frac{\sqrt{s}}{2}$$

Feed down region

$$m_{ES} = \sqrt{\left(\frac{\sqrt{s}}{2}\right)^2 - p_B^{*2}}$$

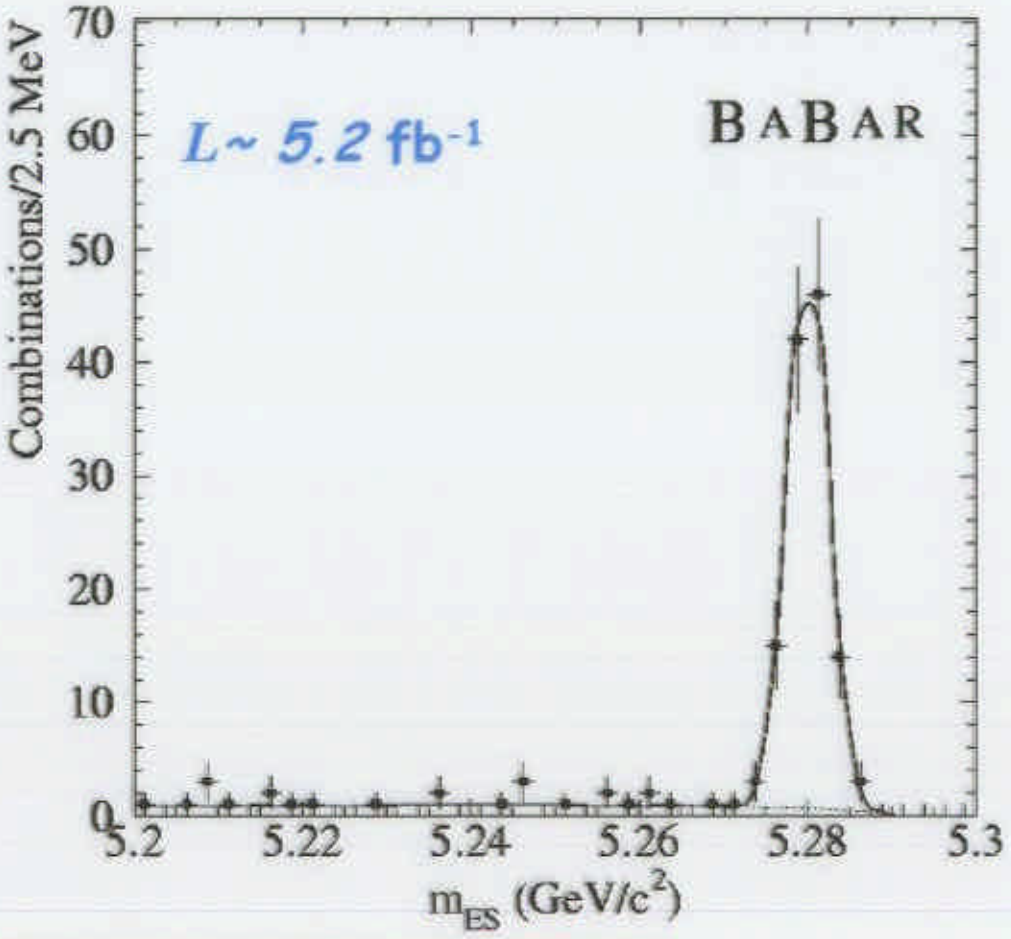
Efficiency: ε = 27.0 ± 1.0 %

Results: BR($B^0 \to D^{*+}\pi^-$)

$\sigma_{m_{ES}} = 2.45 \pm 0.18$ MeV/c^2

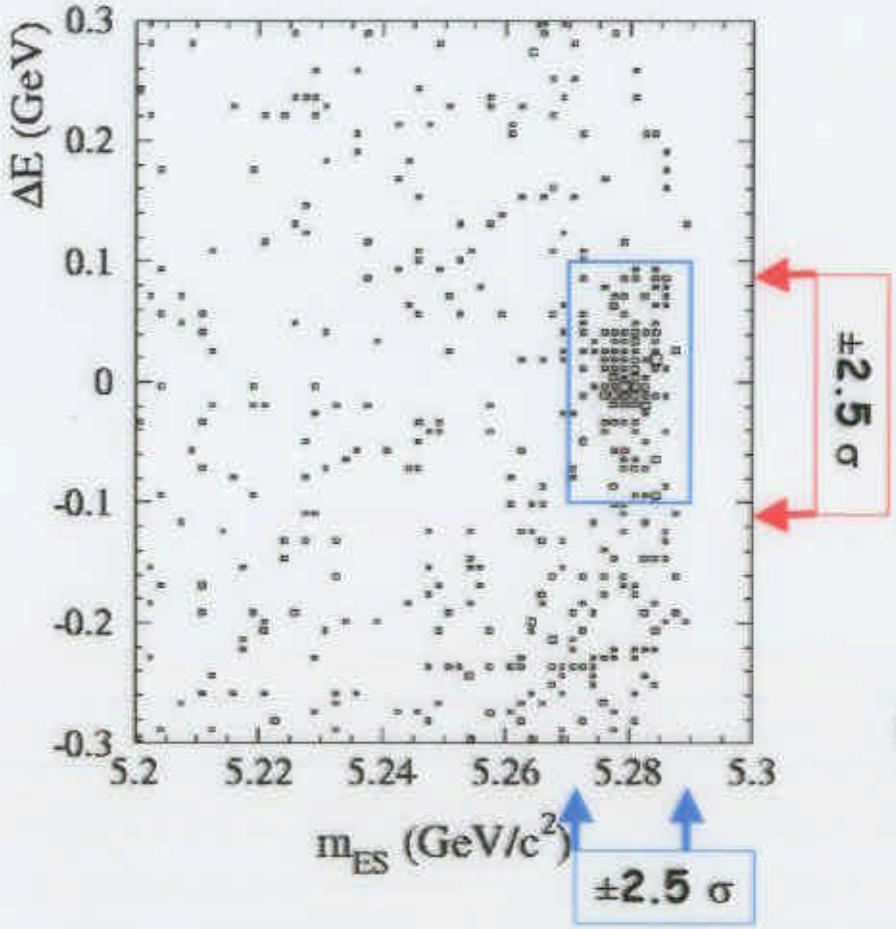
Observed Yield: 119 ±11 evts

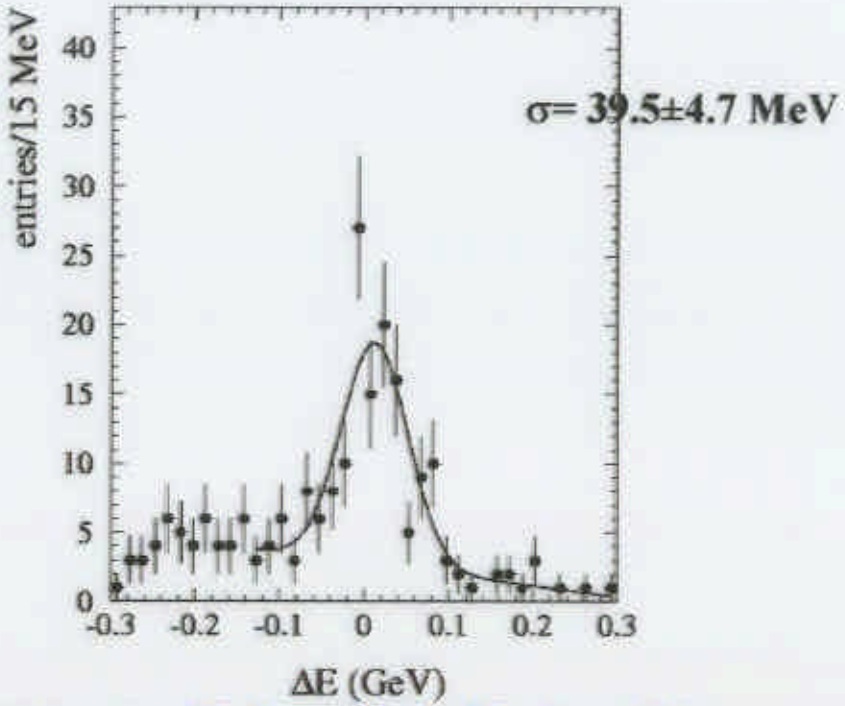
Systematic Sources	Error%
$N_{B\bar{B}}$	3.6
Track efficiency	7.9
Monte Carlo stat.	4.0
Selection criteria variation	3.0
Daughter BR	2.5
total	10.3 %



$$BR(B^0 \to D^{*+}\pi^-) = (2.9 \pm 0.3 \pm 0.3) \times 10^{-3}$$

$B^0 \to D^{*+}\rho^-$ signal





Efficiency: $\varepsilon = 7.6 \pm 0.6$ % *for* $D^*\rho$

$\varepsilon = 1.1 \pm 0.3$ % *for* $D^*\pi\pi^0$

A Dalitz analysis of $D^*\pi\pi^0$ will be produced on the full statistics of the year 2000 run.

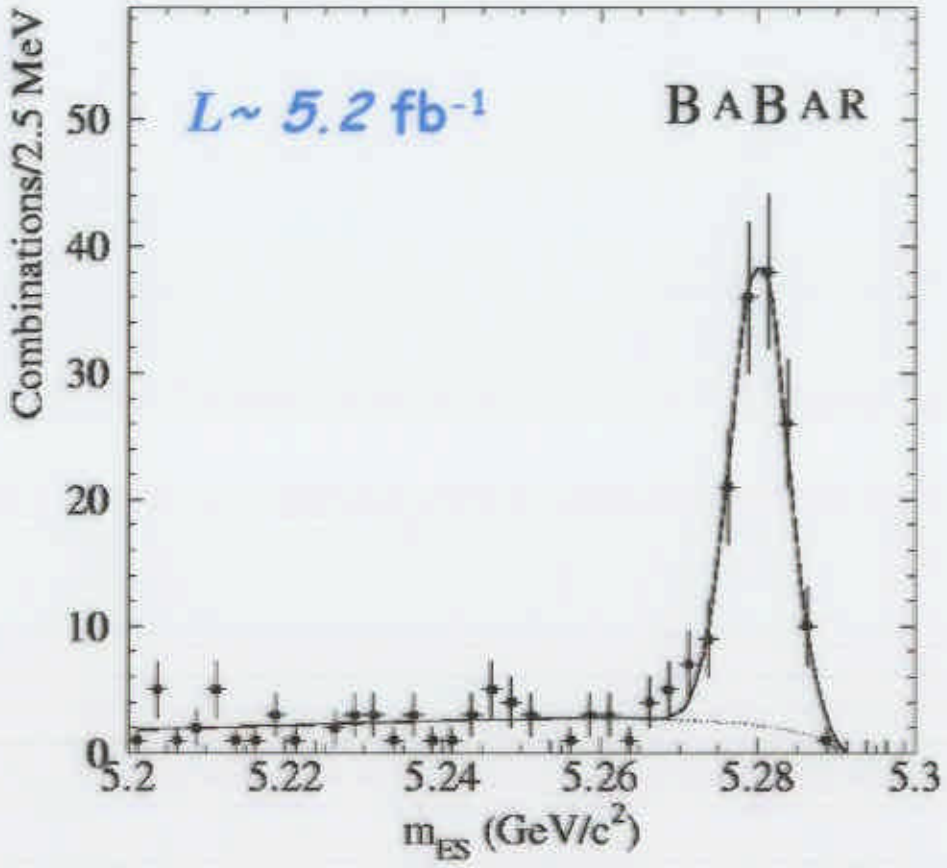
Upper limit on the continuum contribution by CLEO: <9% at 90% CL.

Results BR($B^0 \to D^{*+}\rho^-$)

σ_{mES} =3.5 ±0.3 MeV/c^2

Observed Yield: 131 ±13 evts

Systematic Sources	Error%
N_{BB}	3.6
Track efficiency	7.9
Monte Carlo stat.	8.0
π^0 efficiency	5.0
Selection criteria variation	3.0
Daughter BR	2.5
Selected ΔE range variation	10.
Two Hemisphere ρ helicity angle	15.
total	22.5

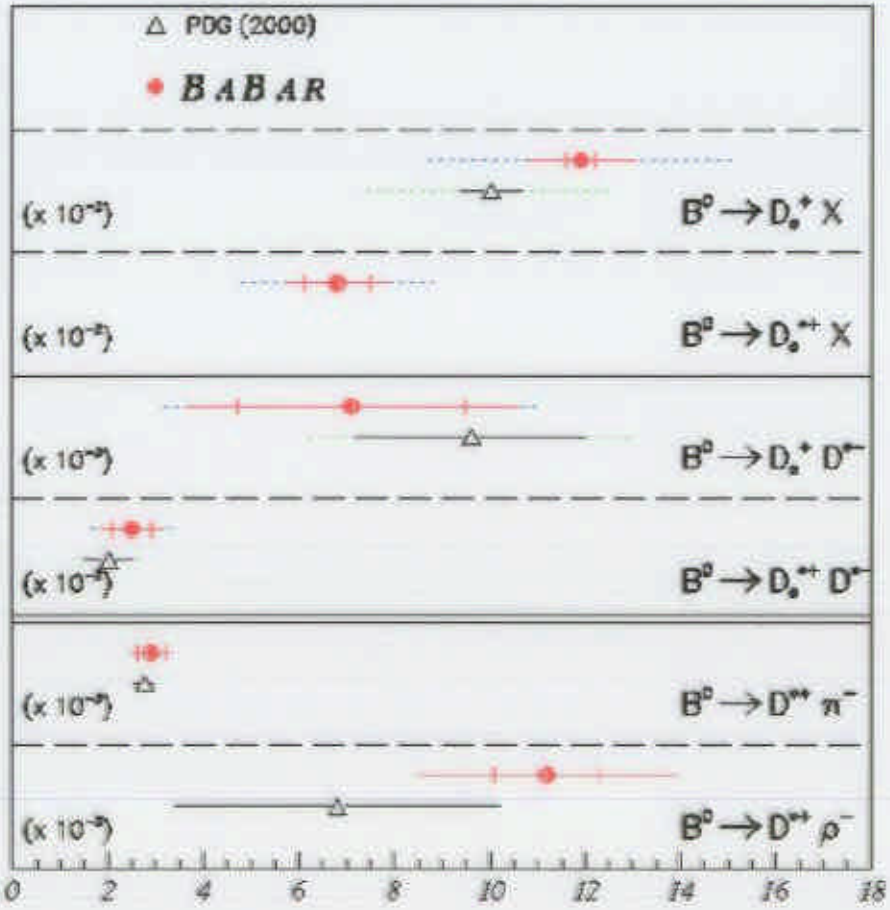


Assuming (on the basis of existing limits) that the BR is dominated by the $D^*\rho$ channel, our determination of BR is

$$BR(B^0 \to D^{*+}\rho^-) = (11.2 \pm 1.1 \pm 2.5) \times 10^{-3}$$

Summary

Preliminary results on BR of hadronic B decays to open charm have been presented



With the luminosity accumulated so far, BABAR measured these BR with good precision.

More exclusive B modes have been reconstructed and can be used to study the hadronic B decay dynamics.