CHARM DECAYS AT BABAR

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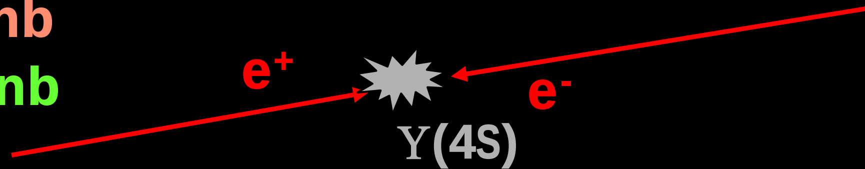
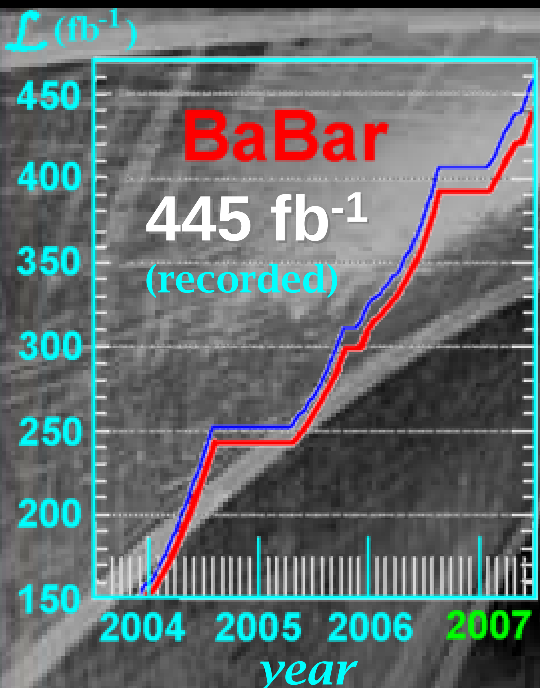
So much charm!

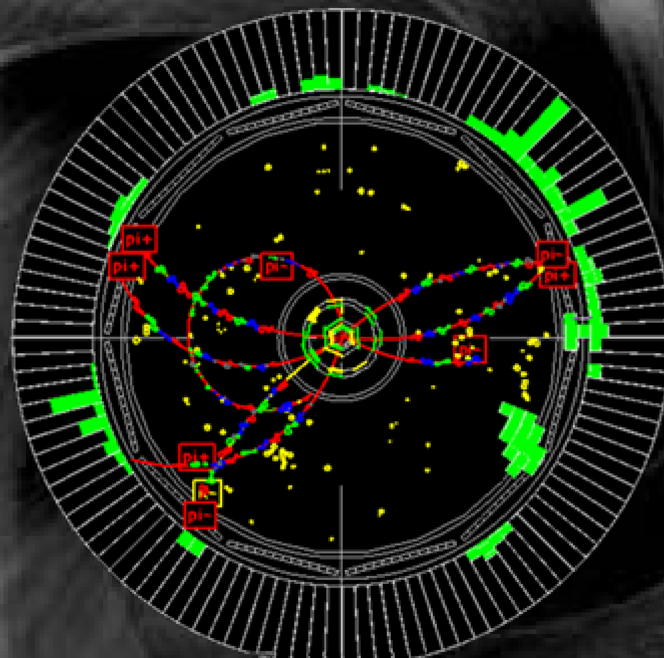
@ $\sqrt{s}$ =10.58 GeV

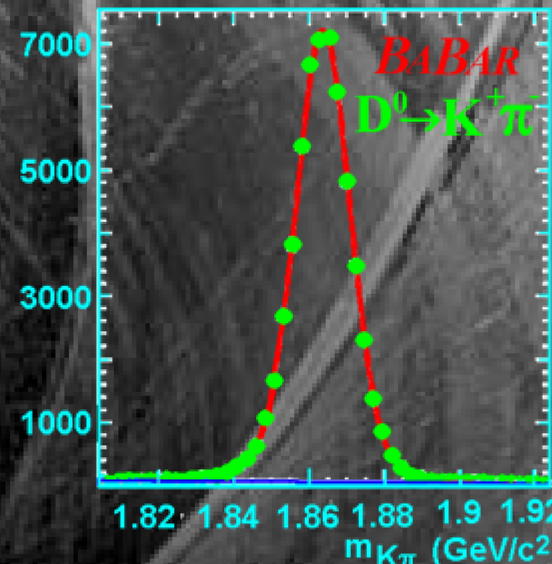
$\sigma(e^+e^- \to B\bar{B})$ = 1.1 nb

$\sigma(e^+e^- \to c\bar{c})$ = 1.3 nb









More than 1 billion of charm hadrons!

007: Successful missions

- Leptonic decays ($D_s \to \mu\nu$, Published PRL'07)
- Semileptonic decays ($D^0 \to K^- e^+ \nu$, accepted by PRD)
- D branching fractions ($D^0 \to K^- \pi^+$, submitted to PRL)
- Dalitz analyses ($D^0 \to K^+ K^- \pi^0$, accepted by PRD)
- Charm baryons (Ω_c , accepted by PRL)
- Charm spectroscopy (T. Schroeder, Strong Interactions-II)
- D^0-$\overline{D}^0$ mixing (J. Coleman, this session)

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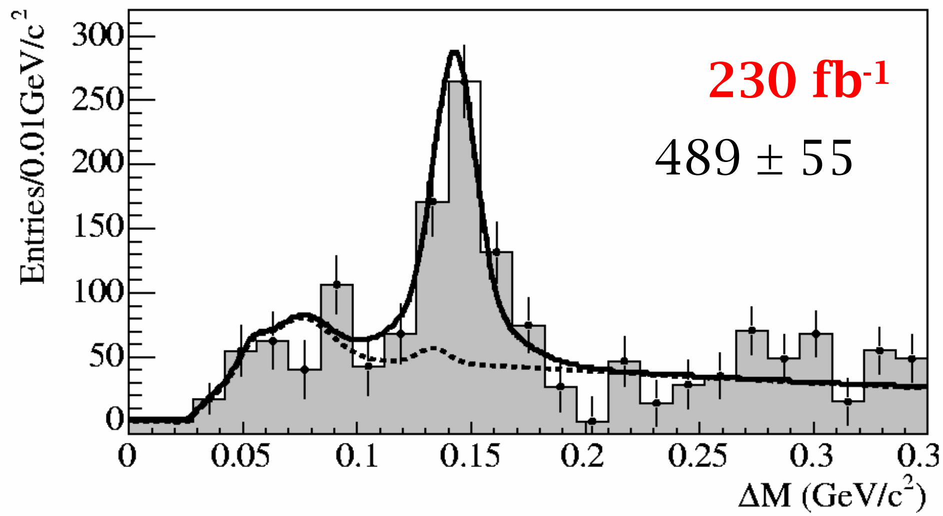
$D_s \to \mu\nu$

Phys. Rev. Lett. 98 ('07) 141801

- 5×10^5 charm tagged events
- $D^*_s \to D_s\gamma$, $D_s \to \mu\nu$ in the recoil

  ⟶ $\Delta m = mD^*_s - mD_s$

- Normalized to $D^*_s \to D_s\gamma$, $D_s \to \phi\pi$



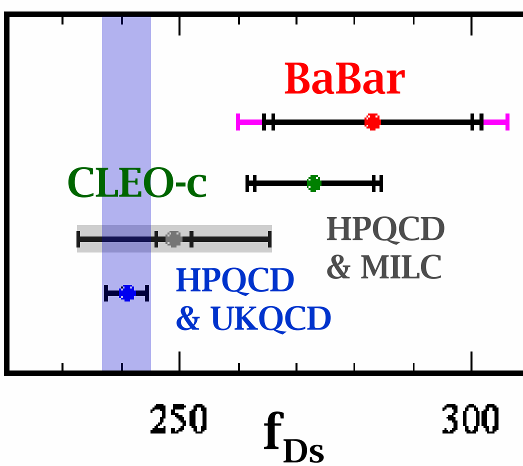
$$B(D_s \to \mu\nu) = (0.674 \pm 0.083 \pm 0.026 \pm 0.066)\%$$

$$f_{Ds} = (283 \pm 17 \pm 7 \pm 14)\ \text{MeV}$$

CLEO-c $f_{Ds} = (273 \pm 10 \pm 5)$ MeV (FPCP '07)

LQCD $f_{Ds} = (249 \pm 3 \pm 16)$ MeV (PRL 95 ('05) 122002)

LQCD $f_{Ds} = (241 \pm 3)$ MeV (arXiv:0706.1726)



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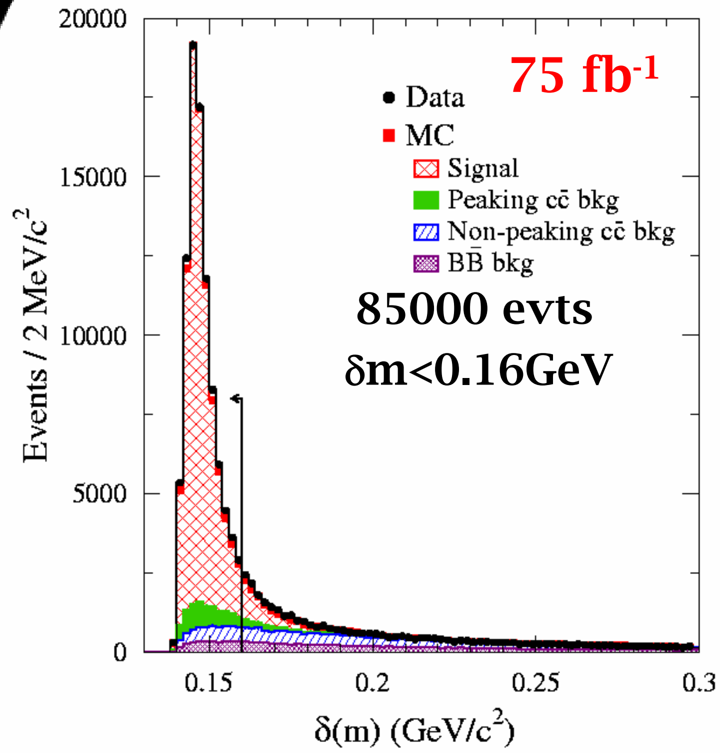
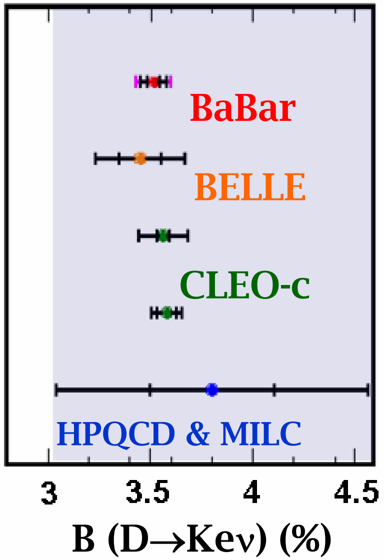
$D^0 \to K^- e^+ \nu$

arXiv:0704.0020, accepted by PRD



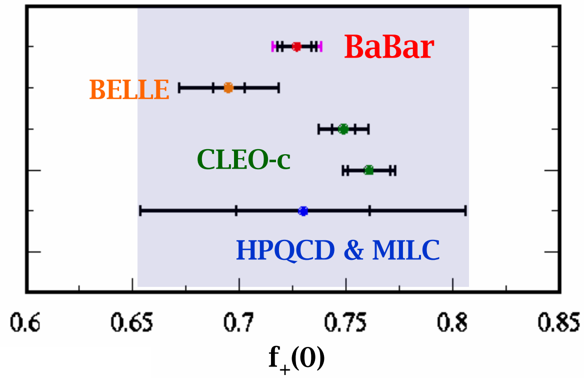
- Untagged analysis $D^{*+} \to D^0 \pi^+$, $D^0 \to K^- e^+ \nu$
  - ⟶ $\Delta m = mD^{*+} - mD^0$
- Kinematic fit: $q^2 = (p_D - p_K)^2 = (p_e + p_\nu)^2$
- Form factor from the unfolded q^2 distribution
- Normalized to $D^0 \to K^- \pi^+$

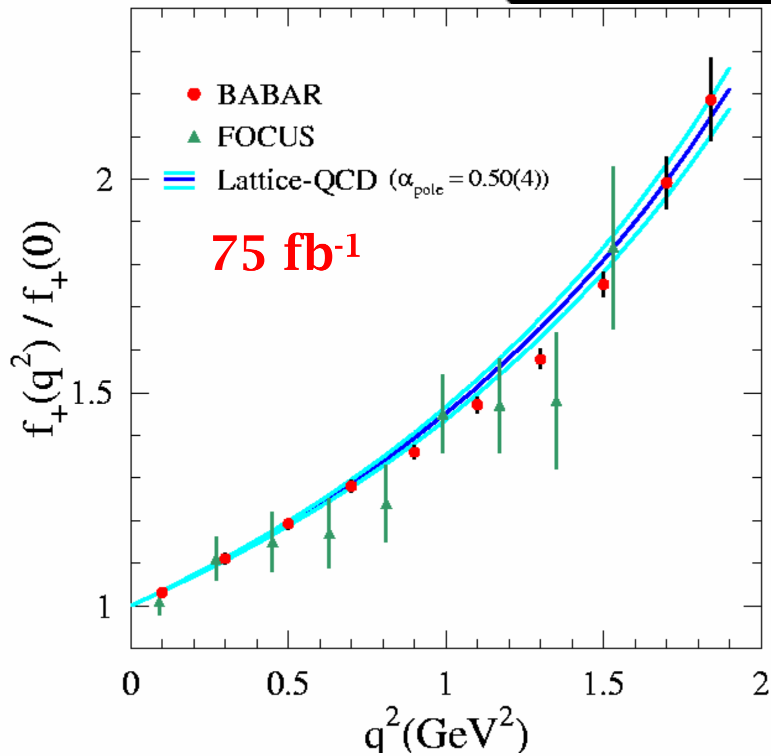


$B(D^0 \to K^- e^+ \nu) =$
$(3.522 \pm 0.027 \pm 0.045 \pm 0.065)\%$

◈ $f_+(q^2)$ form factor:

$f_+(0) = 0.727 \pm 0.007 \pm 0.005 \pm 0.007$



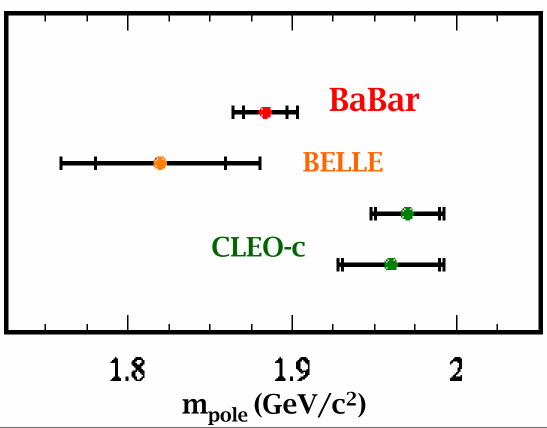


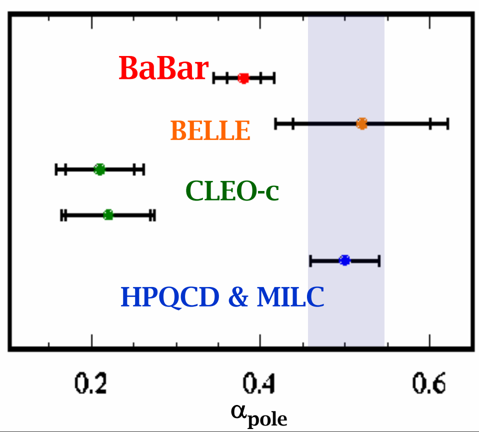
Pole form factor:

$$\left|f_+(q^2)\right| = \frac{f_+(0)}{1 - \frac{q^2}{m^2_{pole}}}$$

Modified pole:

$$\left|f_+(q^2)\right| = \frac{f_+(0)}{\left(1 - \frac{q^2}{m^2_{D_s^*}}\right)\left(1 - \frac{\alpha_{pole} q^2}{m^2_{D_s^*}}\right)}$$





$m_{pole} = (1.884 \pm 0.012 \pm 0.015)$ GeV/c²

$\alpha_{pole} = 0.377 \pm 0.023 \pm 0.029$

$B(D^0 \to K^-\pi^+)$

arXiv:0704.2080, submitted to PRL

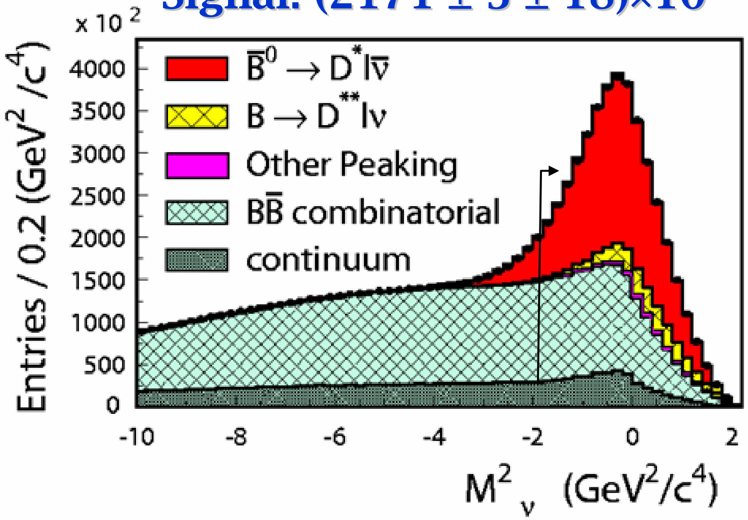
- **Partial reconstruction**

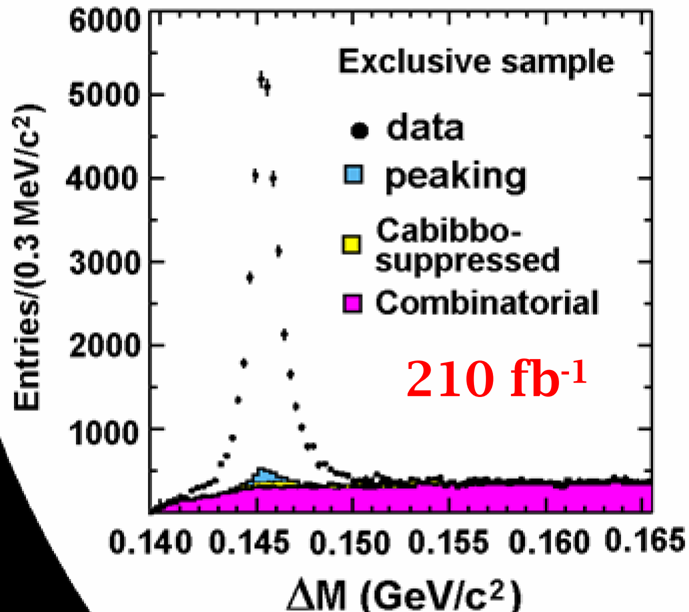
  $B^0 \to D^{*+} X \ell^- \nu \quad (\ell = \mu, e)$

  $D^{*+} \to D^0 \pi^+$

$\longrightarrow M_\nu^2 = (E_{beam} - E_{D^*} - E_\ell)^2 - (\vec{p}_{D^*} + \vec{p}_\ell)^2$

Signal: $(2171 \pm 3 \pm 18) \times 10^3$





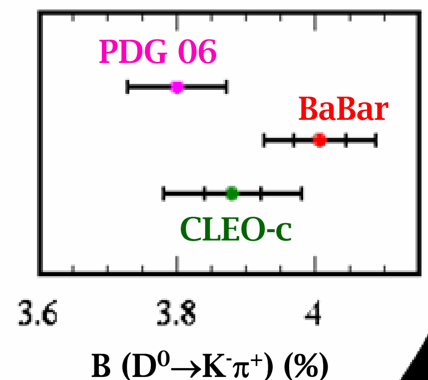
- **Exclusive $D^0 \to K^-\pi^+$**

  $\Delta m = m(D^0\pi^+) - mD^0$

$\longrightarrow$ **Signal: 33810 ± 290**

$\varepsilon^{eff}_{K\pi} = 38\ \%$

$\downarrow$



$B(D^0 \to K^-\pi^+) = (4.007 \pm 0.037 \pm 0.070)\%$

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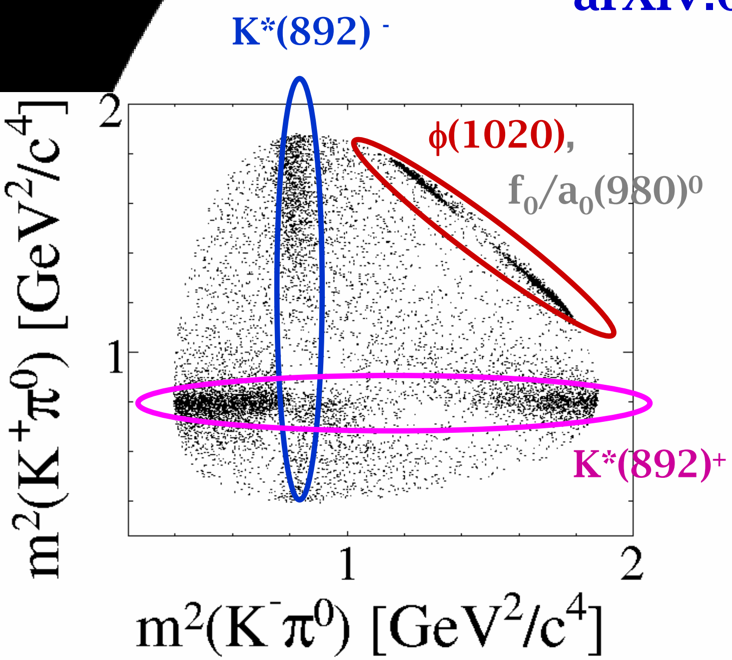
$D^0 \to K^+K^-\pi^0$ Dalitz analysis

(Live and let die)

385 fb^{-1}

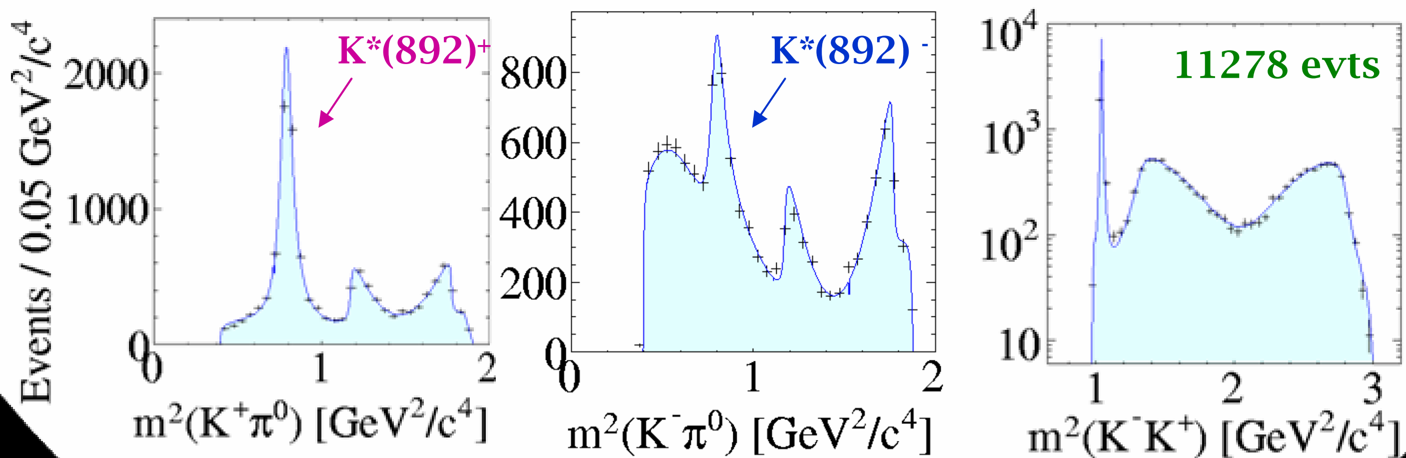
arXiv:0704.3593, accepted by PRD



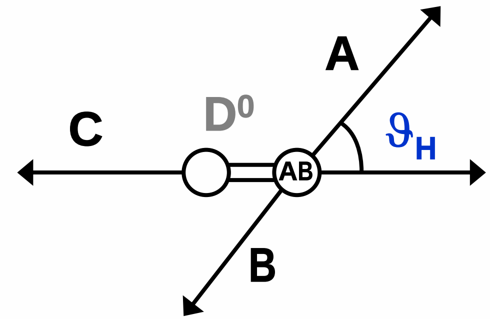
- Allow to extract r_D and $\delta_D \to$ key for γ_{CKM}
- Give light on the scalar sector (κ?)
- **Amplitude analysis**:

  Fit relative amplitudes, phases →

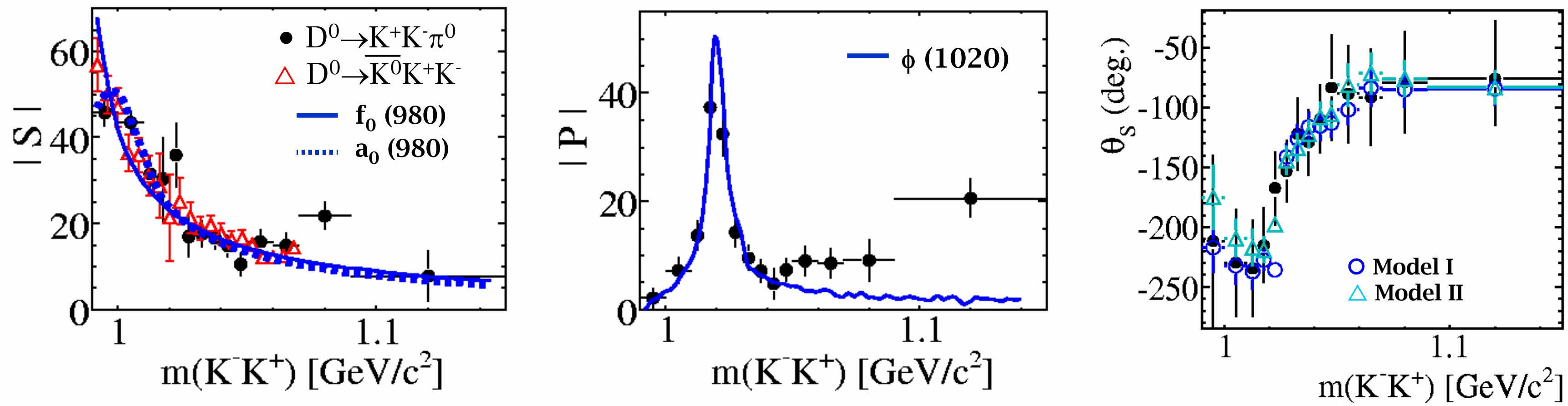
  - Large contribution from K*(892)$^+$ (45%), K*(892)$^-$ (16%) and φ(1020) (19%)
  - f_0/a_0(980) (6-7%):
  - Kπ (S-wave) (16%): LASS amplitude, consistency with no κ(800)



⭑ Partial waves:



Event weights
$\rightarrow Y^0_\ell(\cos\vartheta_H)$/eff.



$$r_D e^{i\delta_D} = \frac{a_{D^0 \rightarrow K^{*-}K^+}}{a_{D^0 \rightarrow K^{*+}K^-}} e^{i(\delta_{K^{*-}K^+} - \delta_{K^{*+}K^-})}$$

$r_D = 0.599 \pm 0.013 \pm 0.011$

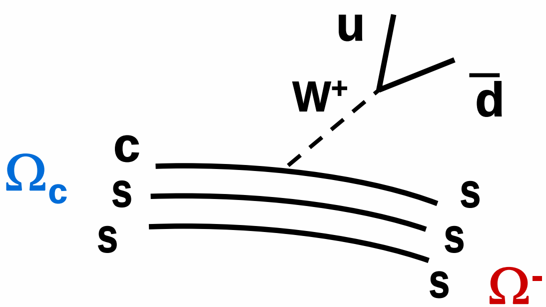
$\delta_D = -35.5^o \pm 1.9^o \pm 2.2^o$

CLEO-c: $r_D = 0.52 \pm 0.05 \pm 0.04$
$\delta_D = -28^o \pm 8^o \pm 11^o$

Ω_c decay

hep-ex/0703030, accepted by PRL

- Charm baryons little explored
- BaBar has exclusively reconstructed:

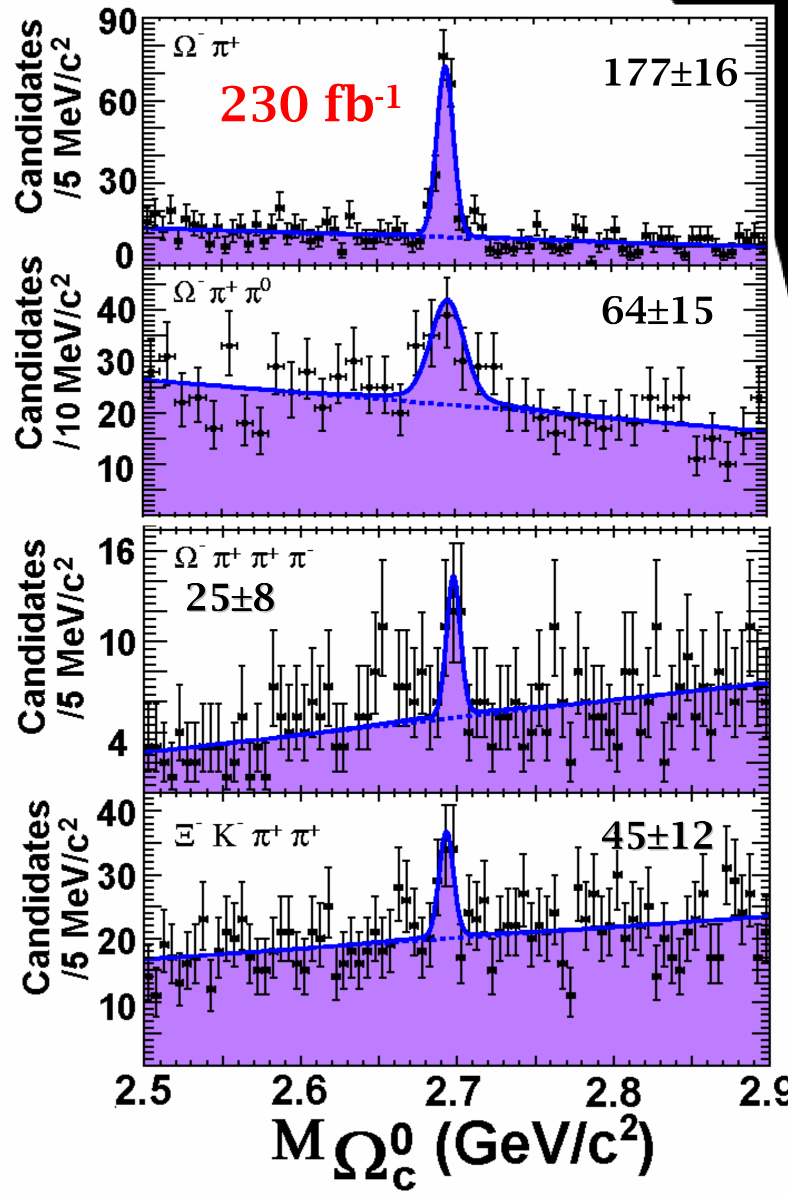


$\Omega_c \to \Omega^- \pi^+$,
$\Omega^- \pi^+ \pi^0$,
$\Omega^- \pi^+ \pi^- \pi^+$,
$\Xi^- K^- \pi^+ \pi^+$

$$\frac{\mathcal{B}(\Omega_c^0 \to \Omega^- \pi^+ \pi^0)}{\mathcal{B}(\Omega_c^0 \to \Omega^- \pi^+)} = 1.27 \pm 0.31 \pm 0.11$$

$$\frac{\mathcal{B}(\Omega_c^0 \to \Omega^- \pi^+ \pi^+ \pi^-)}{\mathcal{B}(\Omega_c^0 \to \Omega^- \pi^+)} = 0.28 \pm 0.09 \pm 0.01$$

$$\frac{\mathcal{B}(\Omega_c^0 \to \Xi^- K^- \pi^+ \pi^+)}{\mathcal{B}(\Omega_c^0 \to \Omega^- \pi^+)} = 0.46 \pm 0.13 \pm 0.03$$



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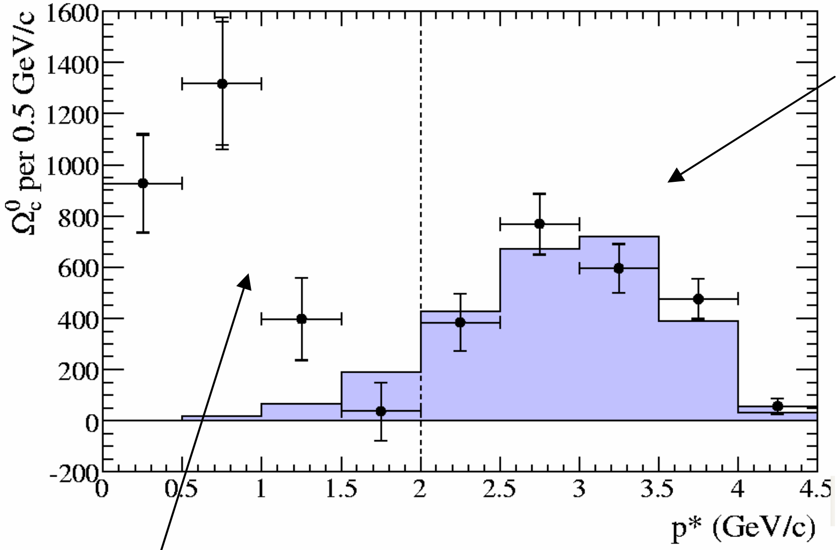
Ω_c production

- **First evidence of Ω_c production in B decays:**

$p^*_{\Omega_c}$ spectrum ($\Omega_c \to \Omega^- \pi^+$)



Ω_c from continuum
(2583 ± 289)

Fit to Bowler fragmentation function

Ω_c from B decays
(2426 ± 414)

$$B(B \to \Omega_c X) \cdot B(\Omega_c \to \Omega^- \pi^+) = (5.2 \pm 0.9 \pm 0.05) \times 10^{-6}$$

- Ω_c cross section @ Y(4S)

$$\sigma(e^+e^- \to \Omega_c X) \cdot B(\Omega_c \to \Omega^- \pi^+) = (11.2 \pm 1.3 \pm 1.0) \text{ fb}$$

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Summary

- $D_s \to \mu\nu$: f_{Ds} measured with 8% precision
- $D^0 \to K^- e^+ \nu$: 1% accuracy in m_{pole} , 10% in α_{pole}
  $f_+(0)$ accuracy below 2%
- $B(D^0 \to K^-\pi^+)$ measured with 2% accuracy
- $D^0 \to K^+K^-\pi^0$ Dalitz: r_D precision below 3%
  δ_D with 8% precision
- First evidence of Ω_c production in B decays

Backup

$D^0 \to K^+K^-\pi^0$ Dalitz analysis

	Model I		
State	Amplitude, a_r	Phase, ϕ_r (°)	Fraction, f_r (%)
$K^*(892)^+$	1.0 (fixed)	0.0 (fixed)	45.2±0.8±0.6
$K^*(1410)^+$	2.29±0.37±0.20	86.7±12.0±9.6	3.7±1.1±1.1
$K^+\pi^0(S)$	1.76±0.36±0.18	-179.8±21.3±12.3	16.3±3.4±2.1
$\phi(1020)$	0.69±0.01±0.02	-20.7±13.6±9.3	19.3±0.6±0.4
$f_0(980)$	0.51±0.07±0.04	-177.5±13.7±8.6	6.7±1.4±1.2
$[a_0(980)^0]$	[0.48±0.08±0.04]	[-154.0±14.1±8.6]	[6.0±1.8±1.2]
$f_2'(1525)$	1.11±0.38±0.28	-18.7±19.3±13.6	0.08±0.04±0.05
$K^*(892)^-$	0.601±0.011±0.011	-37.0±1.9±2.2	16.0±0.8±0.6
$K^*(1410)^-$	2.63±0.51±0.47	-172.0±6.6±6.2	4.8±1.8±1.2
$K^-\pi^0(S)$	0.70±0.27±0.24	133.2±22.5±25.2	2.7±1.4±0.8

	Model II		
State	Amplitude, a_r	Phase, ϕ_r (°)	Fraction, f_r (%)
$K^*(892)^+$	1.0 (fixed)	0.0 (fixed)	44.4±0.8±0.6
$K^*(1410)^+$			
$K^+\pi^0(S)$	3.66±0.11±0.09	-148.0±2.0±2.8	71.1±3.7±1.9
$\phi(1020)$	0.70±0.01±0.02	18.0±3.7±3.6	19.4±0.6±0.5
$f_0(980)$	0.64±0.04±0.03	-60.8±2.5±3.0	10.5±1.1±1.2
$[a_0(980)^0]$	[0.68±0.06±0.03]	[-38.5±4.3±3.0]	[11.0±1.5±1.2]
$f_2'(1525)$			
$K^*(892)^-$	0.597±0.013±0.009	-34.1±1.9±2.2	15.9±0.7±0.6
$K^*(1410)^-$			
$K^-\pi^0(S)$	0.85±0.09±0.11	108.4±7.8±8.9	3.9±0.9±1.0