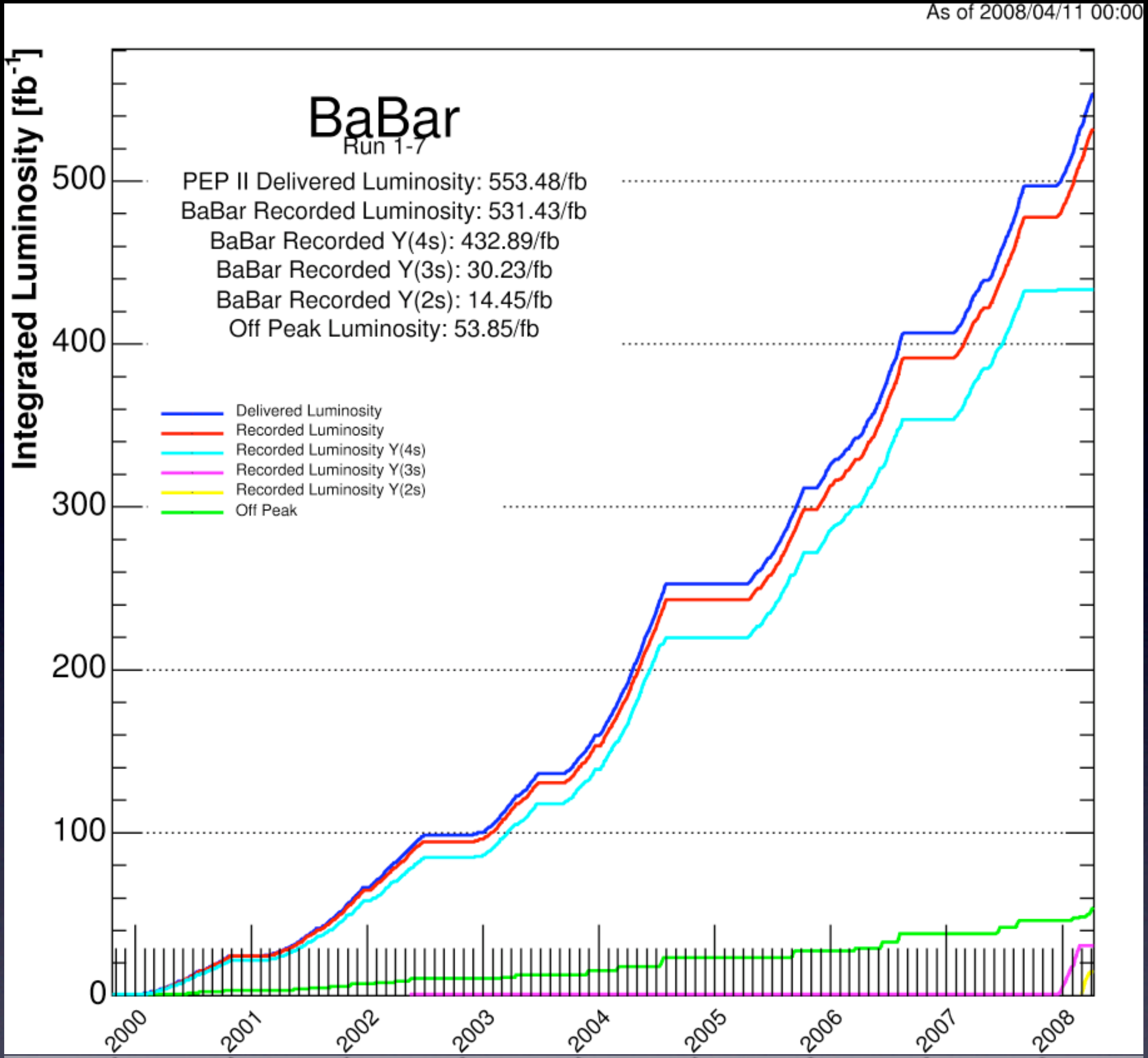
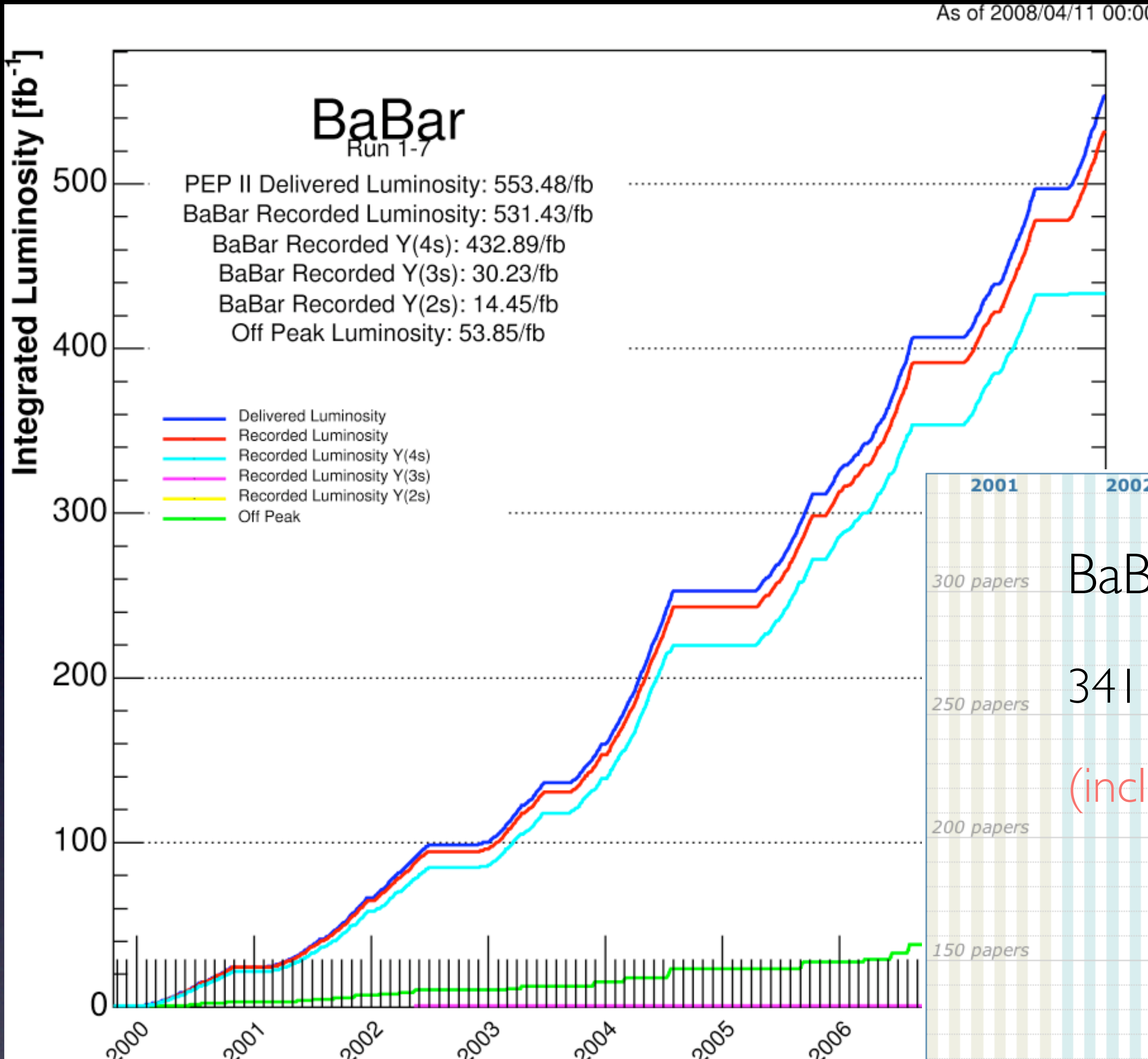
BaBar Hot Topics

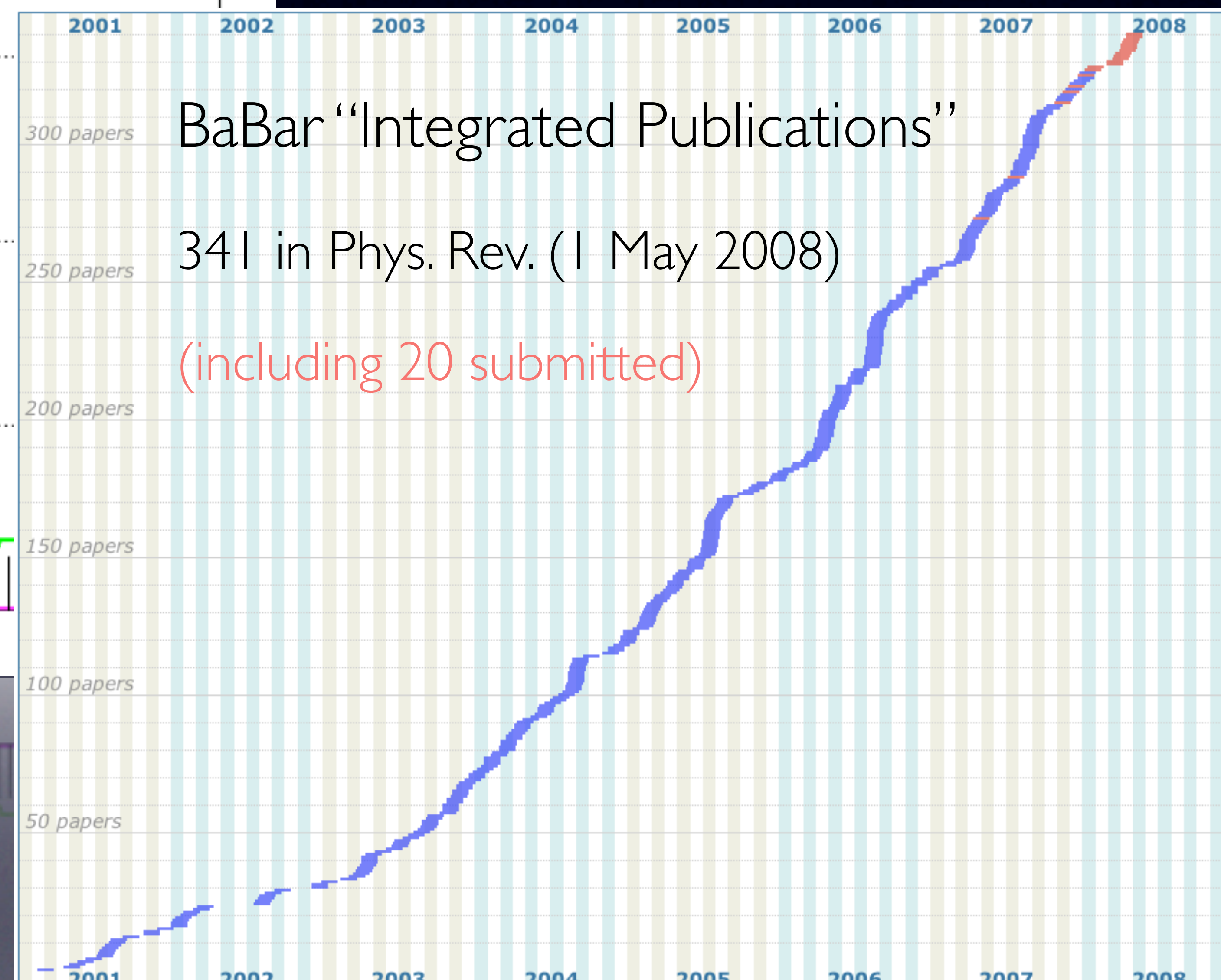
David Kirkby
UC Irvine

Flavor Physics & CP Violation
Taipei, 5 May 2008



Final collisions 12:43pm, Monday 7 Apr 2008

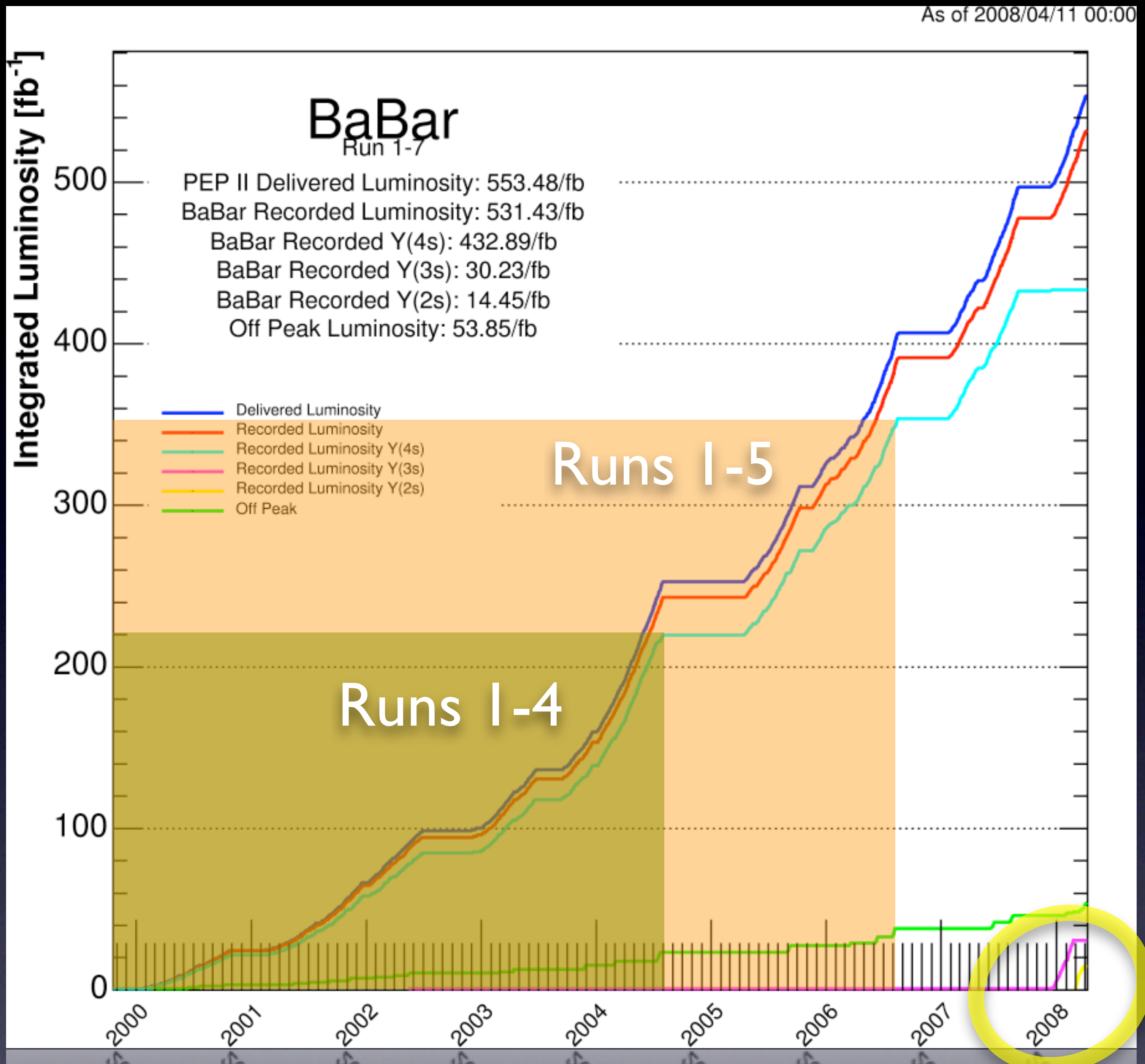




BaBar “Integrated Publications”

341 in Phys. Rev. (1 May 2008)

(including 20 submitted)



Semileptonic D_s decays

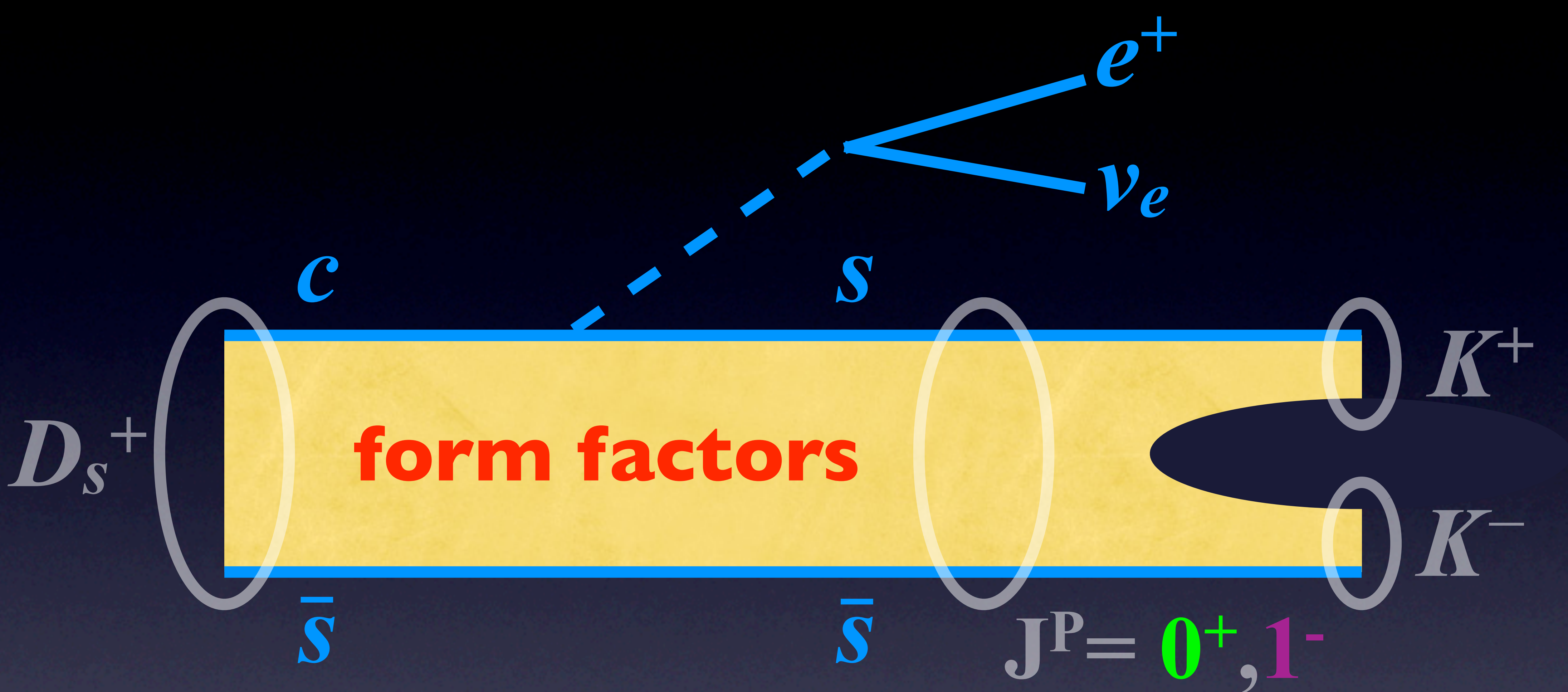
Exclusive $b \to u \ell \nu$

Towards γ with $B \to D^* K$

Energy scans

All results preliminary!

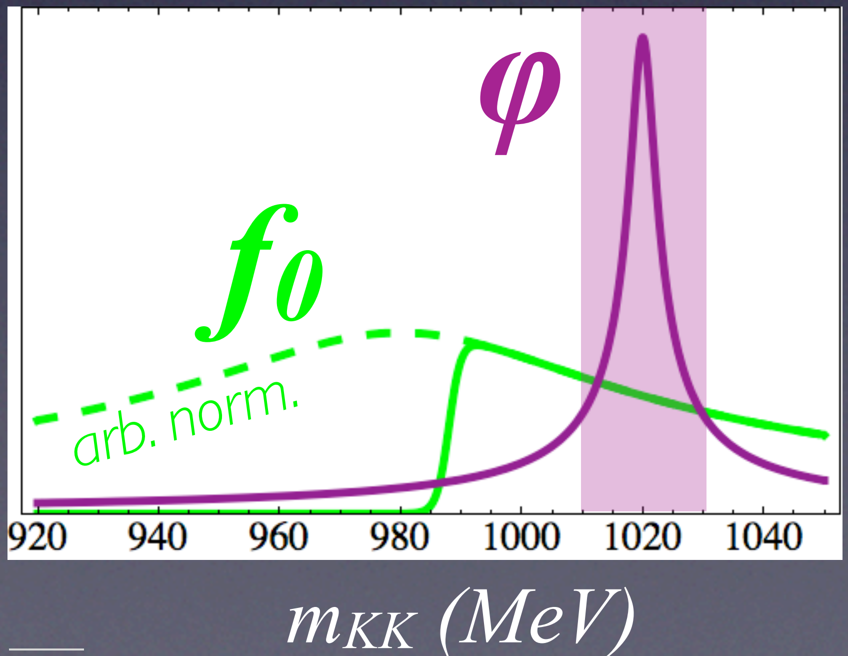
Semileptonic D_s Decays



s quark improves reliability of LQCD

narrow φ simplifies J=1 FF analysis

sensitive to possible J=0 contribution



SEMILEPTONIC D_S DECAYS

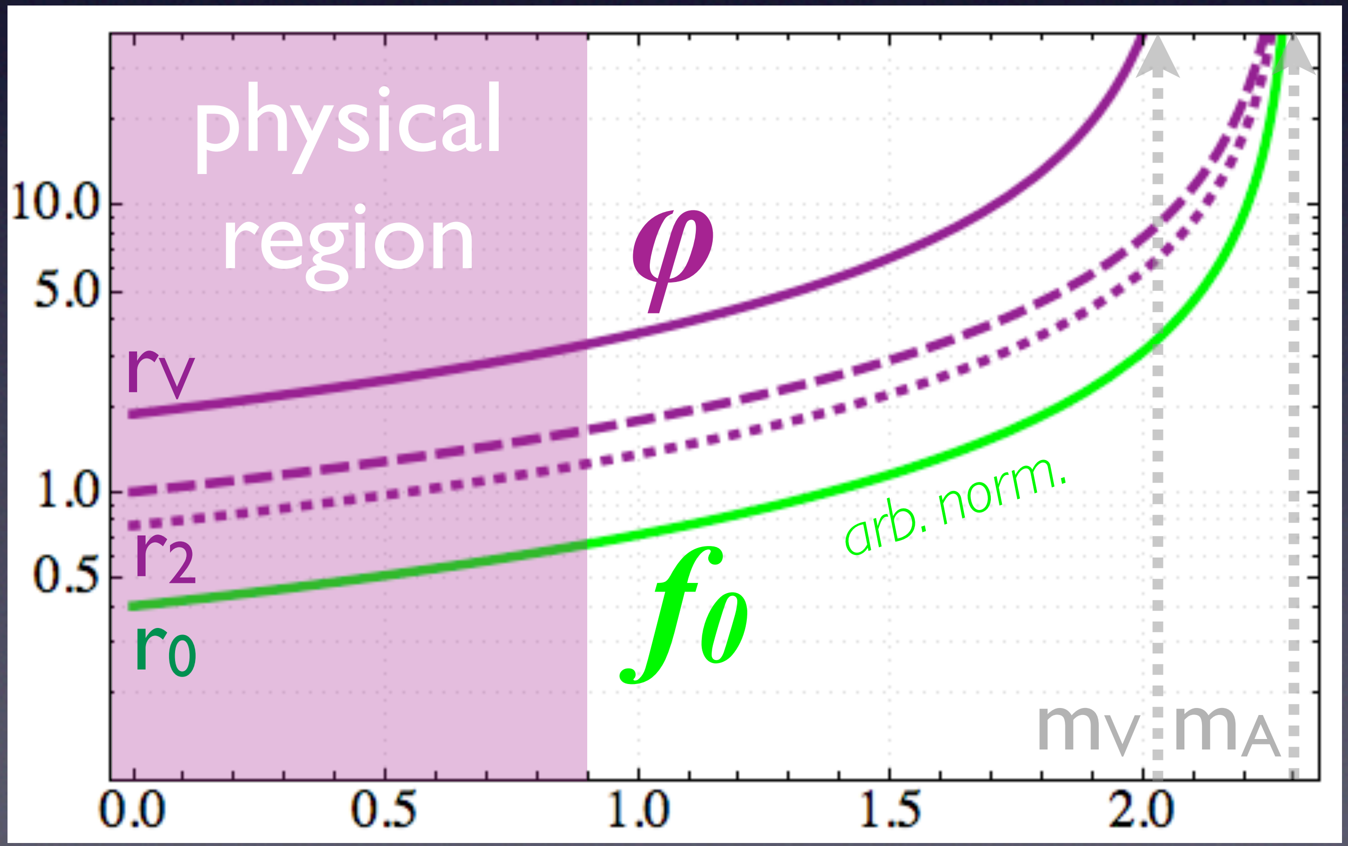
Decay rate via phi depends on 3 form factors ($m_e \sim 0$).

Use partial-wave expansion limited to J=0,1. Express form factors in terms of 1 f_0 and 3 φ contributions.

Assume single poles dominate.

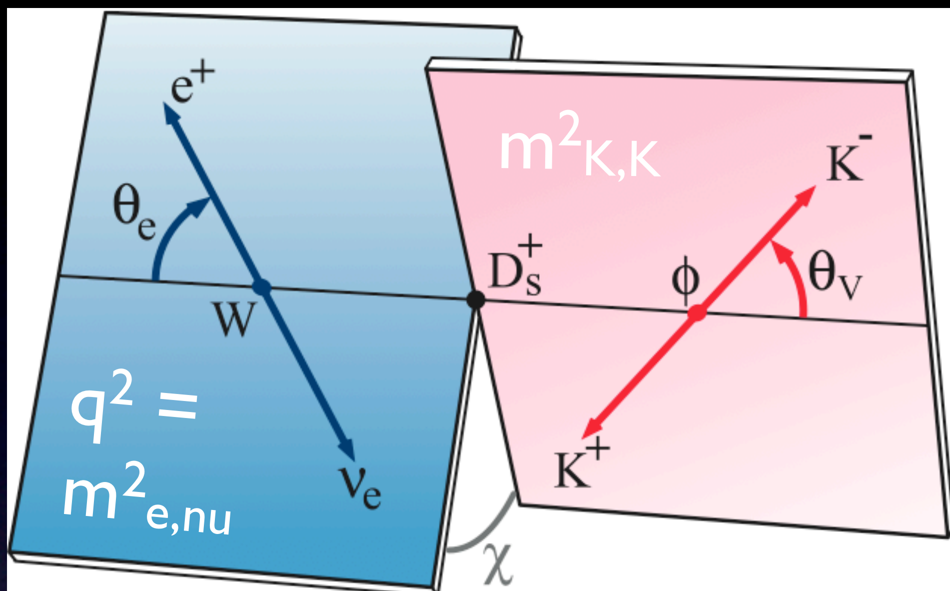
6 parameters:

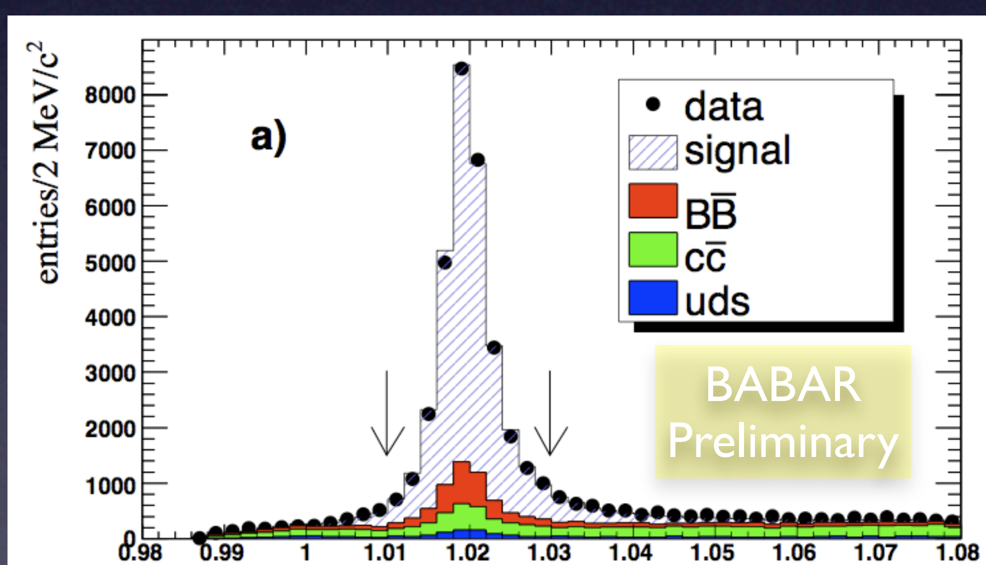
- 3 $q^2=0$ intercepts relative to $r_1=1$
- 2 pole masses (fix $m_V=2.1$ GeV^2)



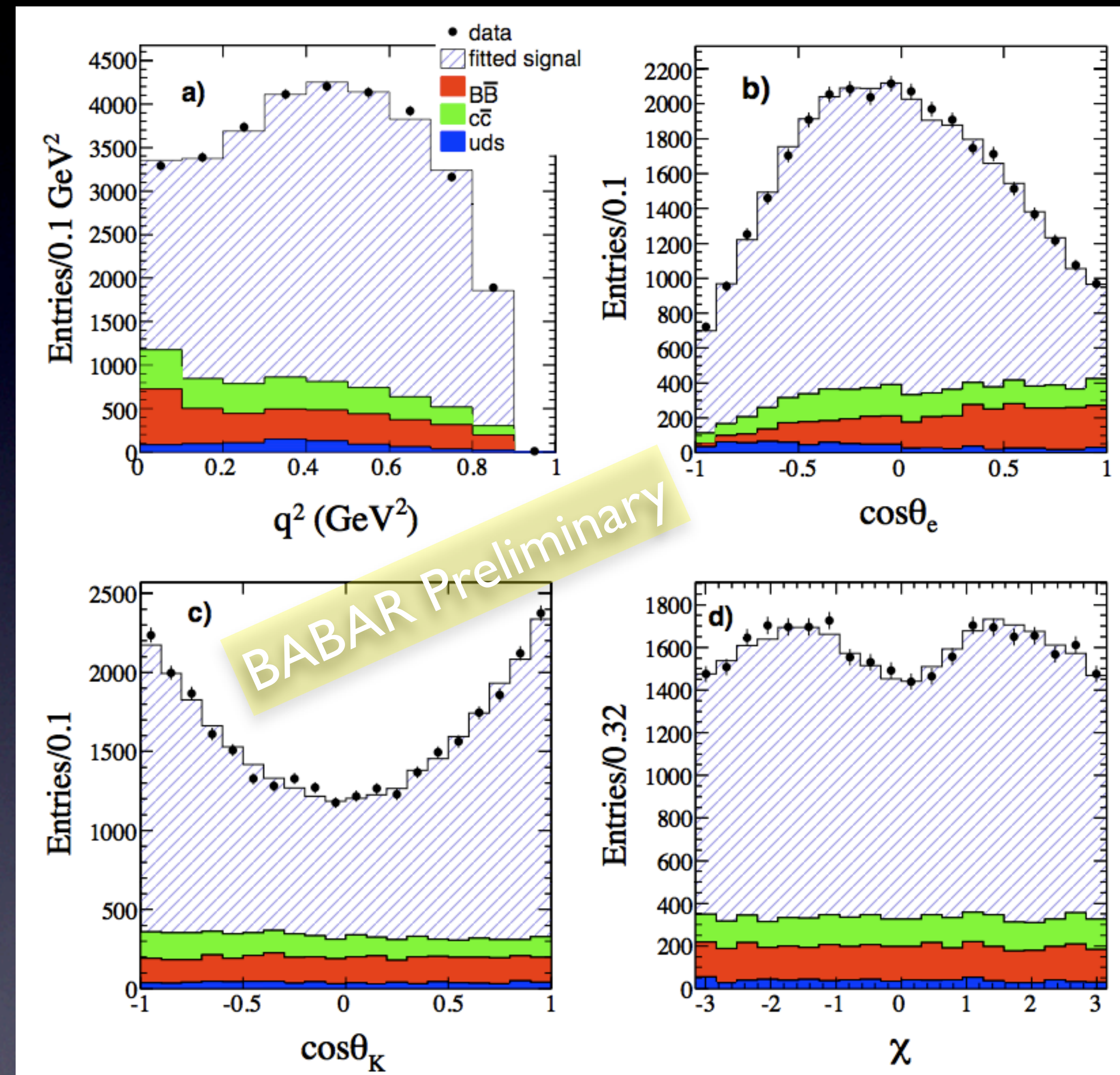
$q^2 = m_{e\nu}^2$ (GeV^2)

SEMILEPTONIC D_S DECAYS





m_{KK} (GeV)



Results from 214/fb of e^+e^- to $c\bar{c}$.

Event selection similar to D^0 to K^-e^+nu in PRD76 052005 (2007).

Semileptonic D_s Decays

$N_{sig} = 25{,}152 \pm 177 \pm 367$

$r_V = 1.868 \pm 0.061 \pm 0.079$

$r_2 = 0.763 \pm 0.072 \pm 0.062$

$r_0 = 15.3 \pm 2.6 \pm 1.0$

$m_A = 2.30\,^{+0.24}_{-0.18} \pm 0.21$ GeV

BABAR Preliminary

Semileptonic D_s Decays

BABAR Preliminary

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$m_A = 2.30\,^{+0.24}_{-0.18} \pm 0.21$ GeV

Normalize to hadronic decay over m_{KK} = 1.0095-1.0295 GeV:

$$\mathcal{B}(D_s^+ \to K^+K^-e^+\nu_e)/\mathcal{B}(D_s^+ \to K^+K^-\pi^+) = 0.554 \pm 0.006 \pm 0.014.$$

Consistent with universality of charm meson semileptonic decay widths.

SEMILEPTONIC D_S DECAYS

BABAR Preliminary

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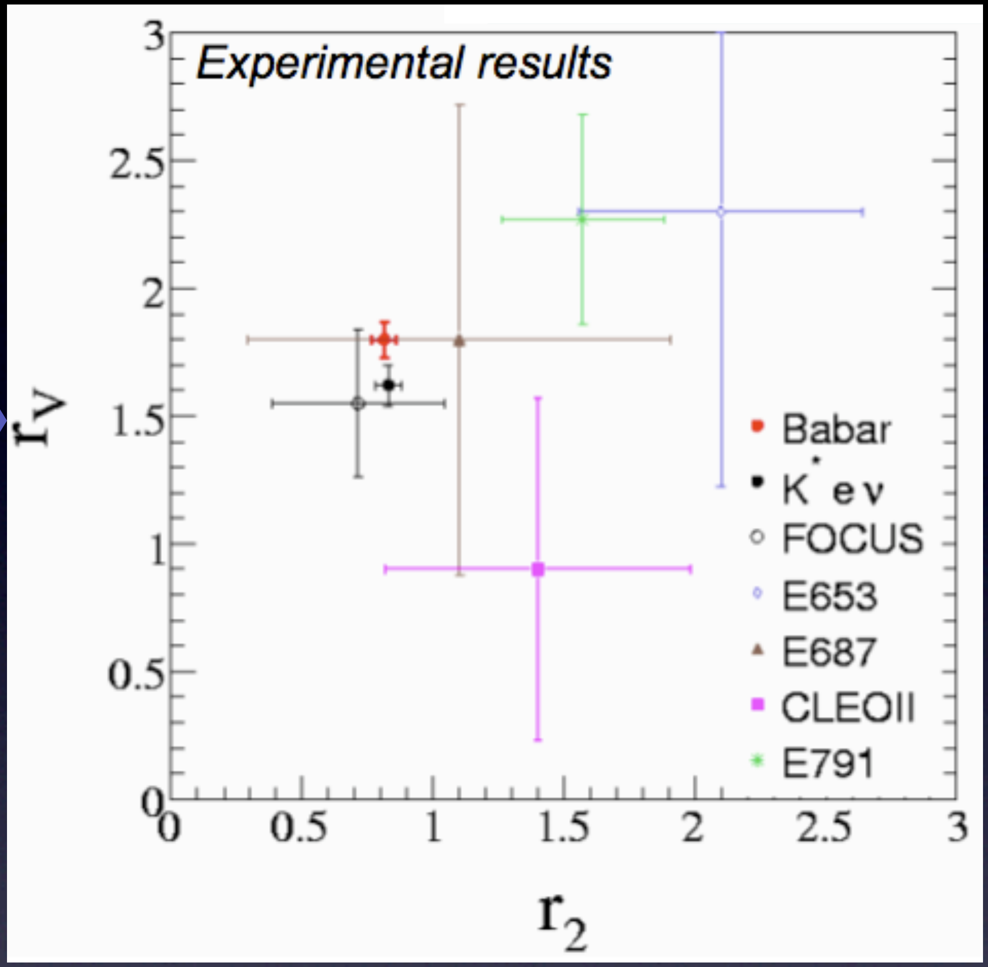

Refit with m_A=2.5 GeV, r_0=0 for consistency with previous measurements

SEMILEPTONIC D_S DECAYS

BABAR Preliminary

$N_{sig} = 25,152 \pm 177 \pm 367$

$r_V = 1.868 \pm 0.061 \pm 0.079$

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$m_A = 2.30\,^{+0.24}_{-0.18} \pm 0.21$ GeV

$r_V = 1.35 \pm 0.08$

$r_2 = 0.98 \pm 0.09$

+ BF($D_S \to KK\pi$), BF($\varphi \to KK$), D_S lifetime, V_{cs}:

$$A_1(q^2 = 0) = 0.605 \pm 0.012 \pm 0.018 \pm 0.018$$

$A_1(q^2{=}0) = 0.63 \pm 0.02$

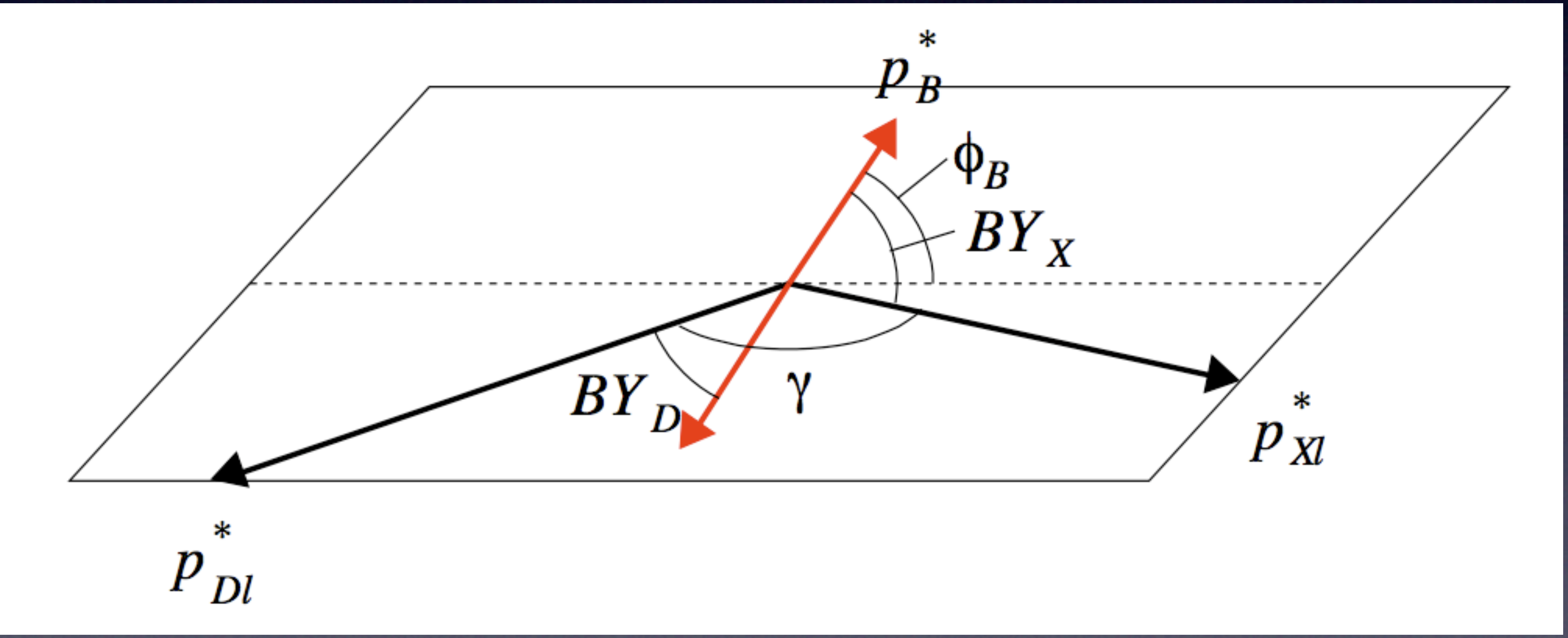
$q^2{=}0$ vector results in good agreement with recent LQCD calculations

hep-lat/0109035

EXCLUSIVE $b \to u\ell\nu$

$$D^{(*)}\ell\nu \leftarrow B \leftarrow \Upsilon(4S) \rightarrow B \rightarrow P\ell\nu$$

exclusive: higher purity, lower yield

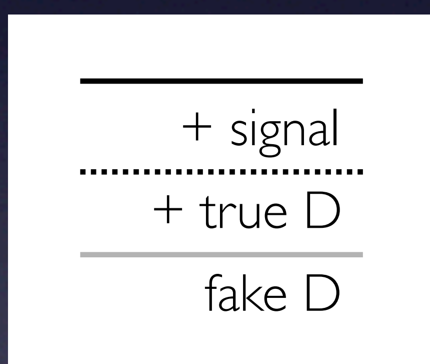


Use ϕ_B as primary analysis variable.

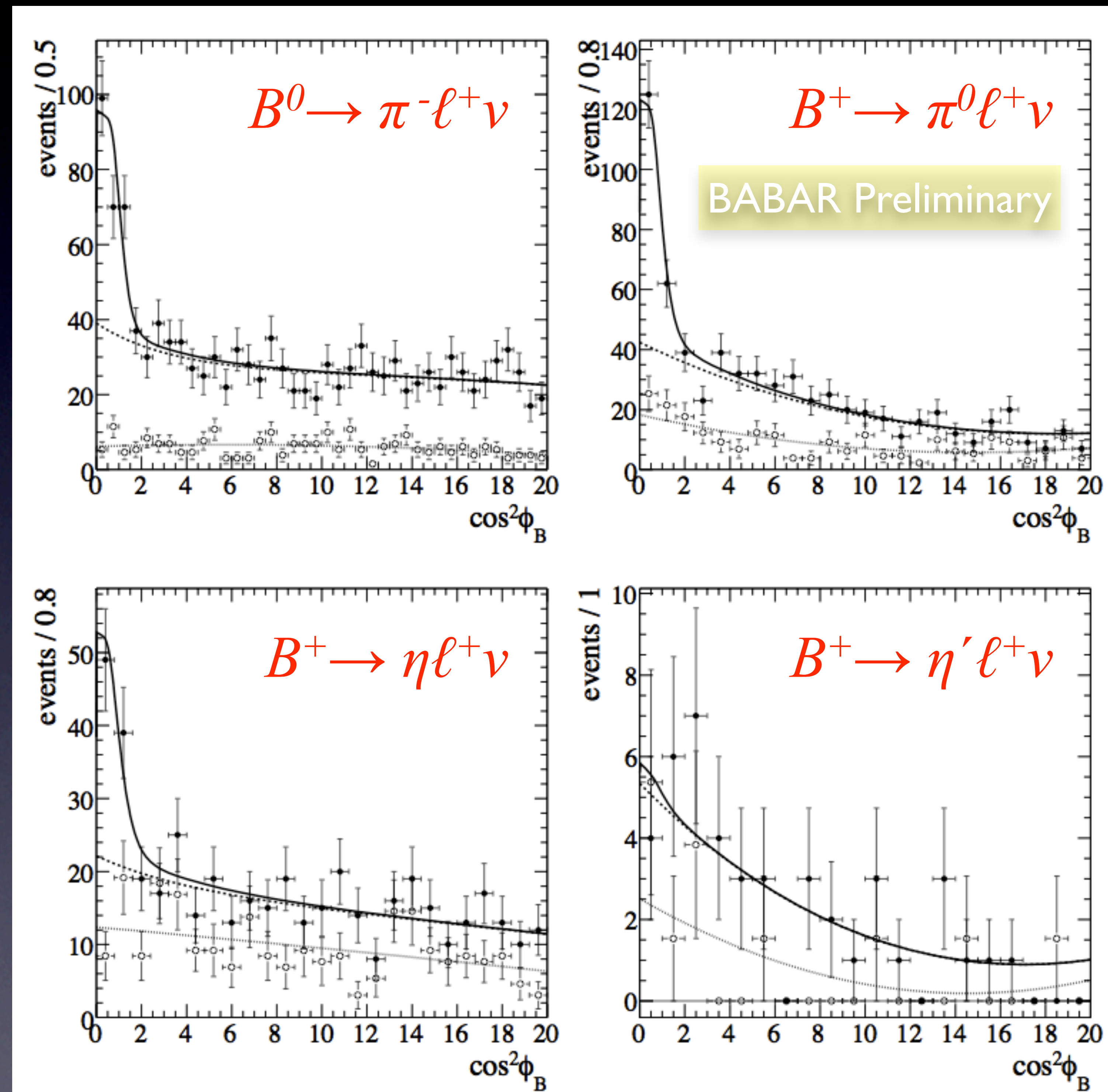
EXCLUSIVE $b \to u\ell\nu$

Results from 348/fb.

Decays selected from recoil of $B \to D^{(*)}\ell\nu$



Data fit separately in 3 bins of $q^2 = m^2_{\ell\nu}$



Exclusive $b \to u\ell v$

$$\mathcal{B}(B^0 \to \pi^- \ell^+ \nu_\ell) = (1.38 \pm 0.21 \pm 0.07) \times 10^{-4},$$

$$\mathcal{B}(B^+ \to \pi^0 \ell^+ \nu_\ell) = (0.96 \pm 0.15 \pm 0.07) \times 10^{-4},$$

$$\mathcal{B}(B^+ \to \eta \ell^+ \nu_\ell) = (0.64 \pm 0.20 \pm 0.30) \times 10^{-4},$$ 3.2σ

$$\mathcal{B}(B^+ \to \eta' \ell^+ \nu_\ell) < 0.47 \times 10^{-4}$$ 90% CL

BABAR Preliminary

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$$\mathcal{B}(B^+ \to \eta \ell^+ \nu_\ell) = (0.64 \pm 0.20 \pm 0.30) \times 10^{-4},$$ 3.2σ

$$\mathcal{B}(B^+ \to \eta' \ell^+ \nu_\ell) < 0.47 \times 10^{-4}$$ 90% CL

$$\mathcal{B}(B^+ \to \eta' \ell^+ \nu_\ell)/\mathcal{B}(B^+ \to \eta \ell^+ \nu_\ell) < 0.57$$ 90% CL

BABAR Preliminary

Exclusive $b \to u\ell v$

$$\mathcal{B}(B^0 \to \pi^- \ell^+ \nu_\ell) = (1.38 \pm 0.21 \pm 0.07) \times 10^{-4},$$
$$\mathcal{B}(B^+ \to \pi^0 \ell^+ \nu_\ell) = (0.96 \pm 0.15 \pm 0.07) \times 10^{-4},$$
$$\mathcal{B}(B^+ \to \eta \ell^+ \nu_\ell) = (0.64 \pm 0.20 \pm 0.30) \times 10^{-4},$$
$$\mathcal{B}(B^+ \to \eta' \ell^+ \nu_\ell) < 0.47 \times 10^{-4}$$

Assuming isospin symmetry,

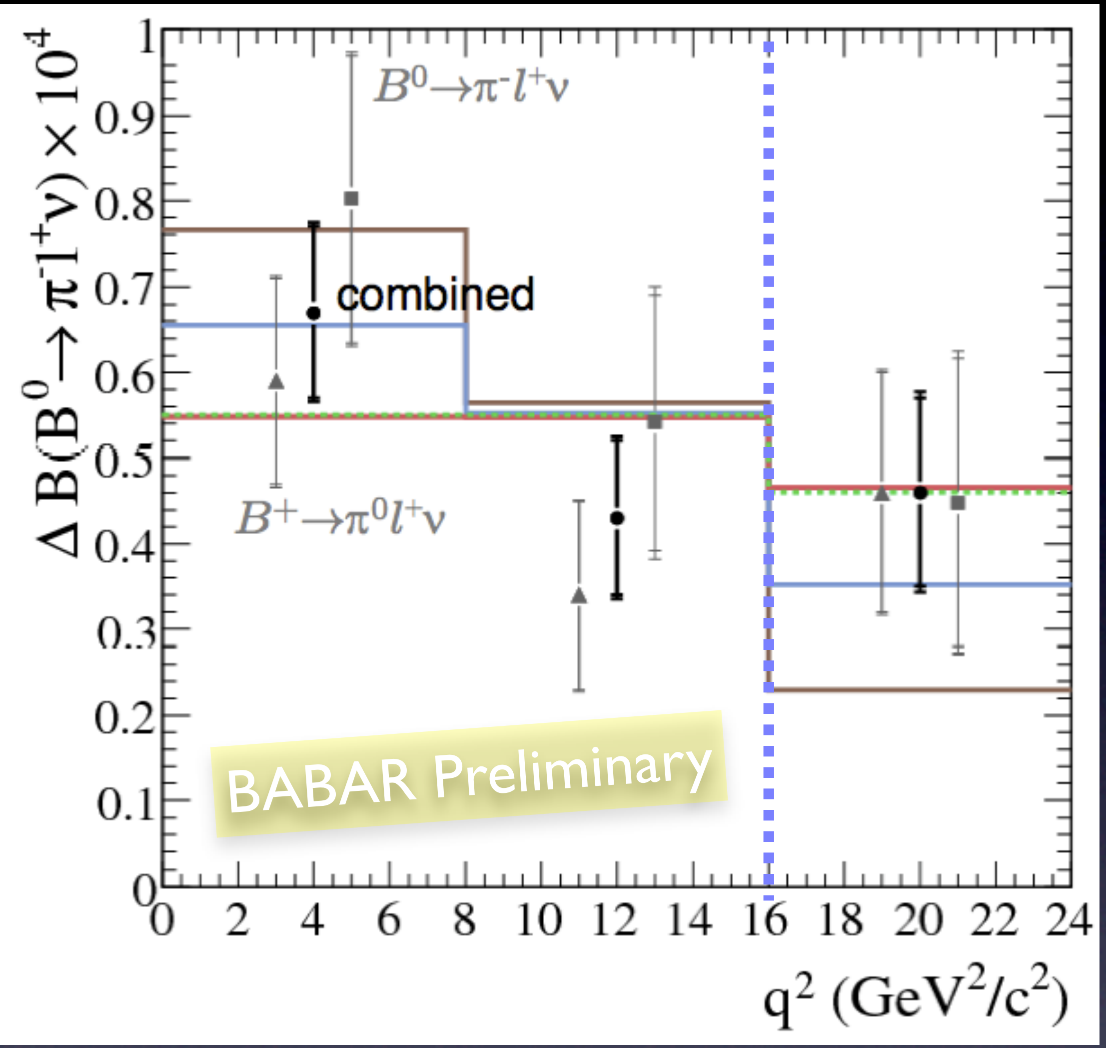
which predicts $B^0/B^+ \sim 1.9$

$$\mathcal{B}(B^0 \to \pi^- \ell^+ \nu_\ell) = (1.54 \pm 0.17 \pm 0.09) \times 10^{-4}$$

BABAR Preliminary

Exclusive $b \to u\ell v$

$$|V_{ub}| = \sqrt{\frac{\Delta\mathcal{B}}{\tau_B \Delta\zeta}}$$

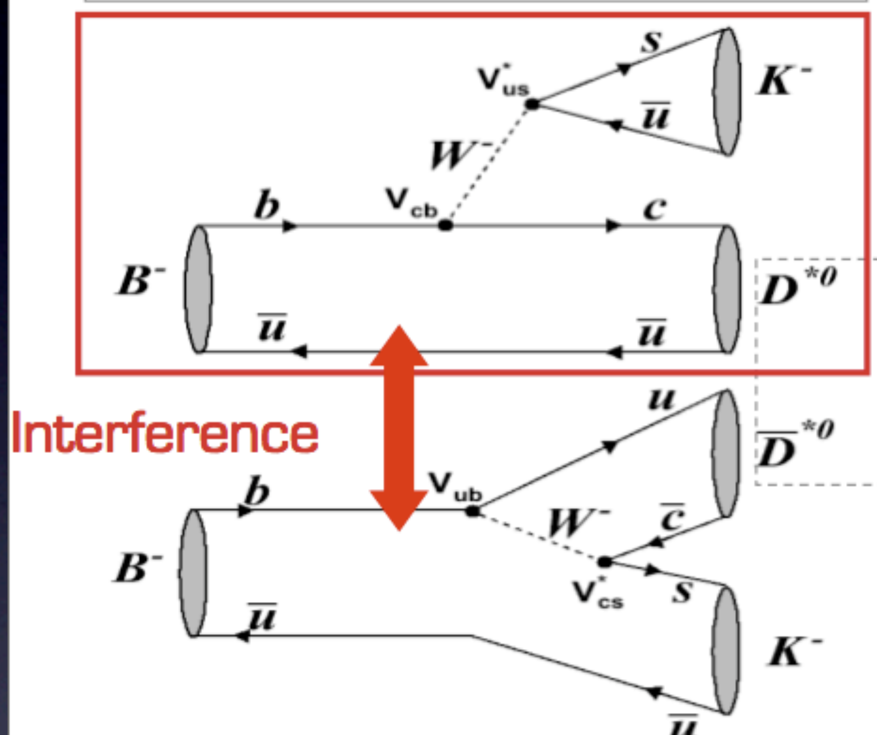


	q^2	$\Delta\zeta$	$\lvert V_{ub}\rvert$ (10^{-3})
Ball & Zwicky [7]	< 16	5.44 ± 1.43	$3.6 \pm 0.2 \pm 0.1^{+0.6}_{-0.4}$
Gulez et al. [13]	> 16	2.07 ± 0.57	$3.8 \pm 0.4 \pm 0.2^{+0.7}_{-0.4}$
Okamoto et al. [14]	> 16	1.83 ± 0.50	$4.0 \pm 0.5 \pm 0.2^{+0.7}_{-0.5}$
Abada et al. [15]	> 16	1.80 ± 0.86	$4.1 \pm 0.5 \pm 0.2^{+1.6}_{-0.7}$

BABAR Preliminary

Towards γ with $B \to D^*K$

$$A(B^- \to D^{(*)0}K^-) \propto V_{cb}V_{us}^* \propto \lambda^3$$



$$A(B^- \to \bar{D}^{(*)0}K^-) \propto V_{ub}V_{cs}^* \propto \lambda^3\sqrt{\bar{\rho}^2 + \bar{\eta}^2}\, e^{i(\delta_B - \gamma)}$$

Common principle : $D^{(*)} = D^{(*)0} + \bar{D}^{(*)0}$ admixture

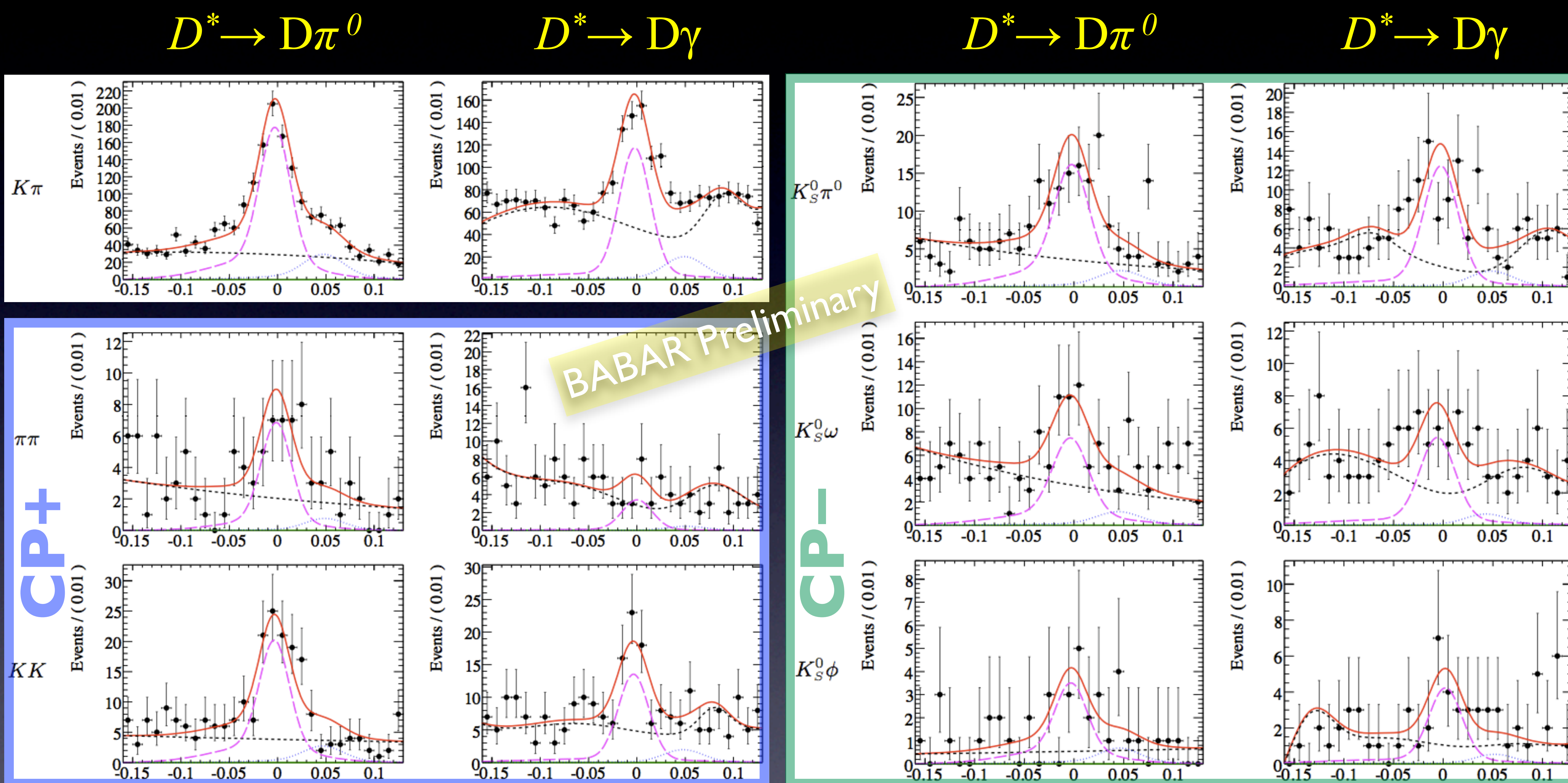
Common final state ⇨ interference ⇨ access to γ
(D^0-$\bar{D}^0$ mixing neglected)

3 methods		
GLW	***ADS***	***GGSZ***
CP Modes	*DCS Modes*	*3-body: Dalitz*
CP +: K^+K^-, $\pi^+\pi^-$	$D^{(*)0} \to K^+\pi^-$ *Suppr.*	$K_S\pi^+\pi^-$
CP-: $K_S\phi$, $K_S\omega$, $K_S\pi^0$	$D^{(*)0} \to K^-\pi^+$ *Fav.*	$K_SK^+K^-$
		$\pi^+\pi^-\pi^0$

- **Theoretically clean** (*no penguin pollution)*
- **3 common unknowns** *(1 set for each mode)*
  - γ, *weak phase difference*
  - δ_B, *strong phase difference*
  - $r_B^{(*)} \equiv \left| \dfrac{A(B^- \to \bar{D}^{(*)0}K^-)}{A(B^- \to D^{(*)0}K^-)} \right| \sim 0.1 - 0.2$

This talk: update to GLW results

Towards γ with B → D*K

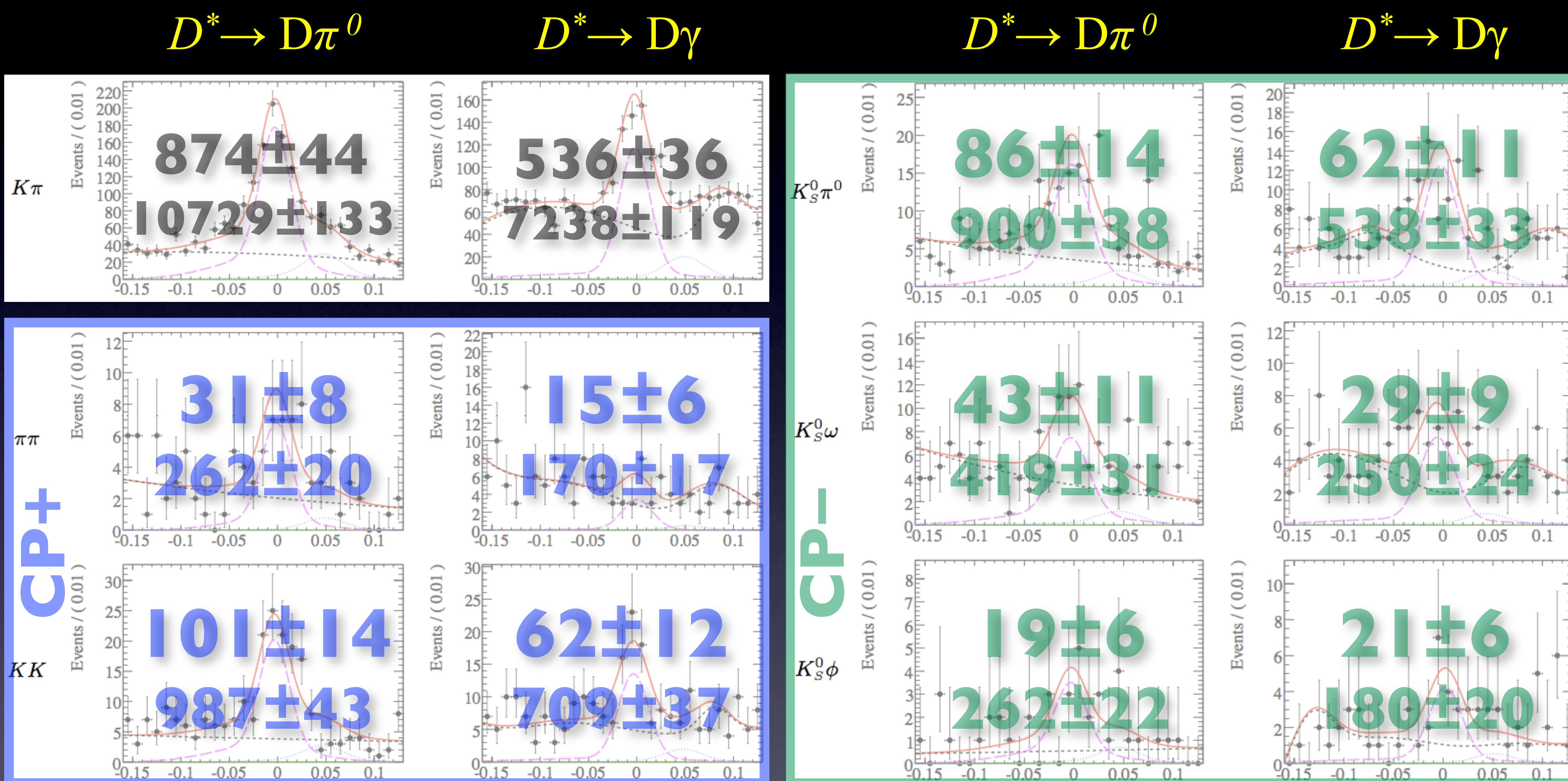


(D^*K candidate energy) – (beam energy) [GeV, in Y(4S) rest frame]

combined | signal K | signal π | BG K

Results from 347/fb.
Plots enhanced with K-ID.

Towards γ with $B \to D^*K$



Compare yields of D*K to D*pi to cancel systematics.
Errors statistical only.

Towards γ with $B \to D^*K$

Combine decay modes to calculate CP asymmetries and CP/non-CP ratios

$A^* =$
-0.06±0.04±0.01

BABAR Preliminary

CP+

$A^*_{CP+} =$
-0.11±0.09±0.01

$R^*_{CP+} =$
1.31±0.13±0.03

CP−

$A^*_{CP-} =$
+0.06±0.10±0.02

$R^*_{CP-} =$
1.09±0.12±0.04

$$A^*_{CP\pm} \equiv \frac{\mathcal{B}(B^- \to D^*_{CP\pm}K^-) - \mathcal{B}(B^+ \to D^*_{CP\pm}K^+)}{\mathcal{B}(B^- \to D^*_{CP\pm}K^-) + \mathcal{B}(B^+ \to D^*_{CP\pm}K^+)}, \quad R^*_{CP\pm} \equiv \frac{\mathcal{B}(B^- \to D^*_{CP\pm}K^-) + \mathcal{B}(B^+ \to D^*_{CP\pm}K^+)}{\left[\mathcal{B}(B^- \to D^{*0}K^-) + \mathcal{B}(B^+ \to \overline{D}^{*0}K^+)\right]/2}.$$

Towards γ with $B \to D^*K$

$A^* =$
-0.06±0.04±0.01
zero

BABAR Preliminary

CP+

$A^*_{CP+} =$
-0.11±0.09±0.01
-0.18±0.10

$R^*_{CP+} =$
1.31±0.13±0.03
1.06±0.06

CP−

$A^*_{CP-} =$
+0.06±0.10±0.02
+0.20±0.10

$R^*_{CP-} =$
1.09±0.12±0.04
0.98±0.05

Results consistent with SM-fit $\gamma=(67.6\pm4.0)^\circ$ and
D^*K / $\overline{D}^*K$ amplitude ratio from BABAR Dalitz analysis of $D^{(*)}K^{(*)}$

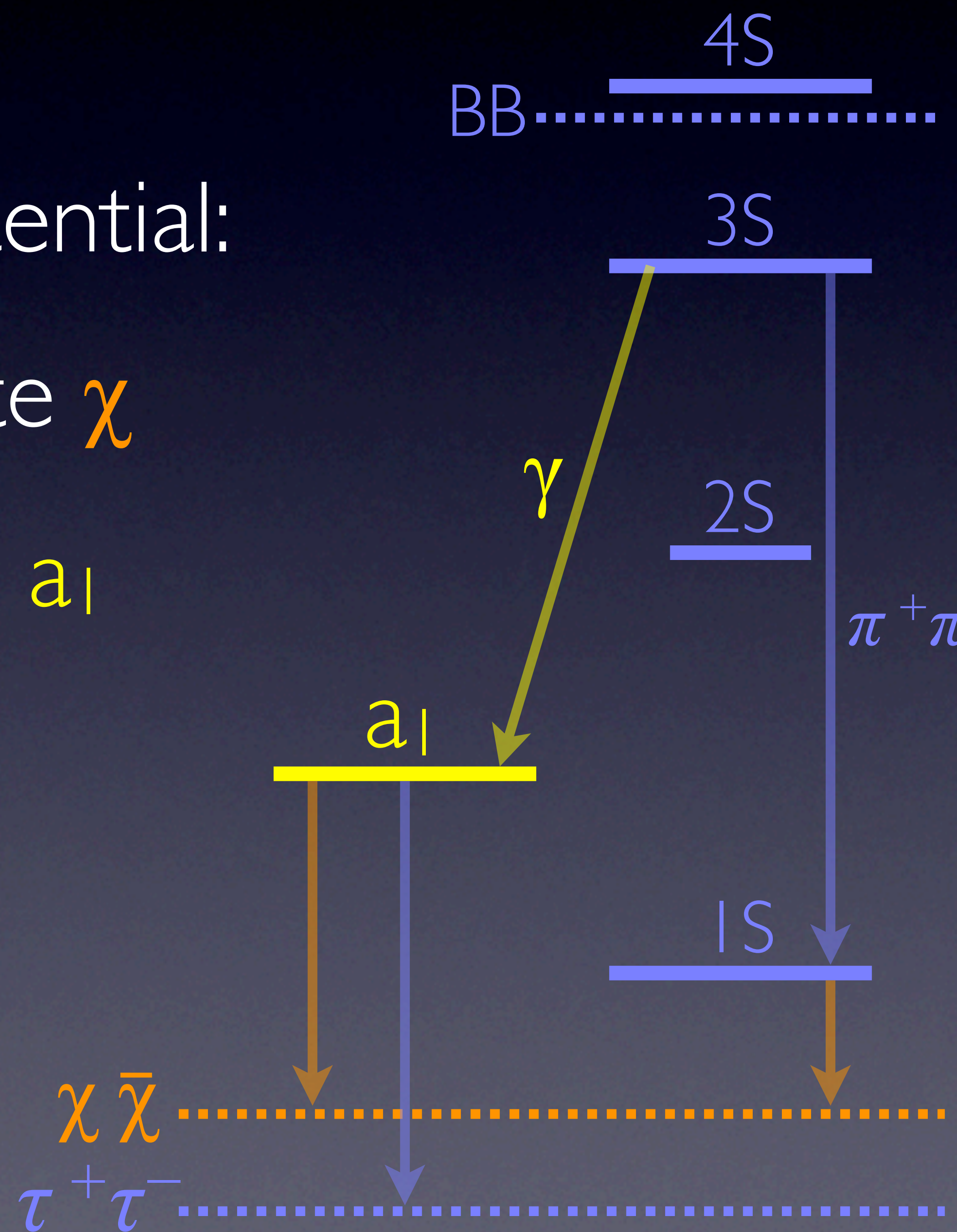
arXiv:0804.2089

Energy Scan: Why?

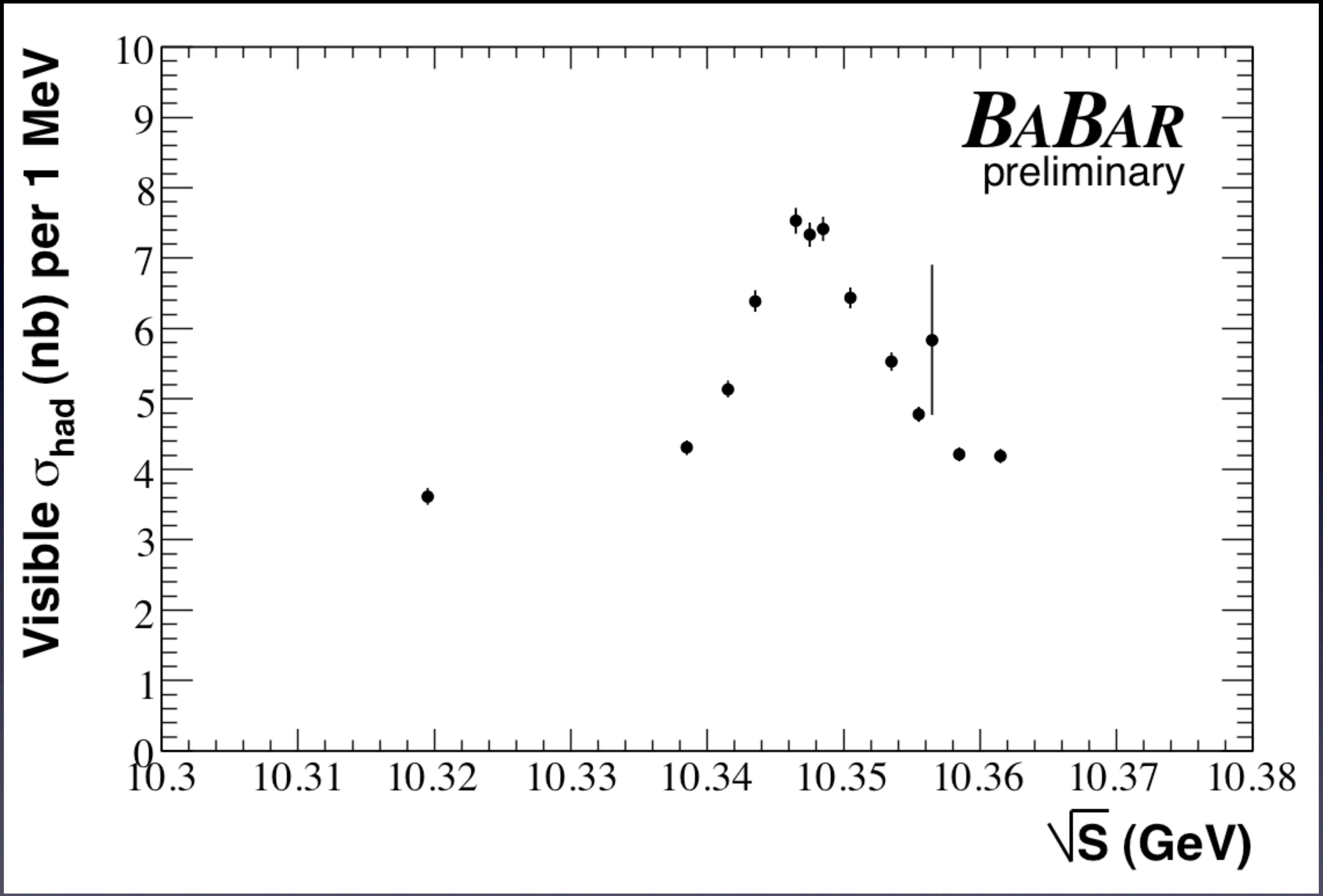
Opportunity to significantly increase world samples of Υ(3S) and Υ(2S).

Examples of new physics potential:

- light dark matter candidate χ
- next-to-MSSM light Higgs a_1



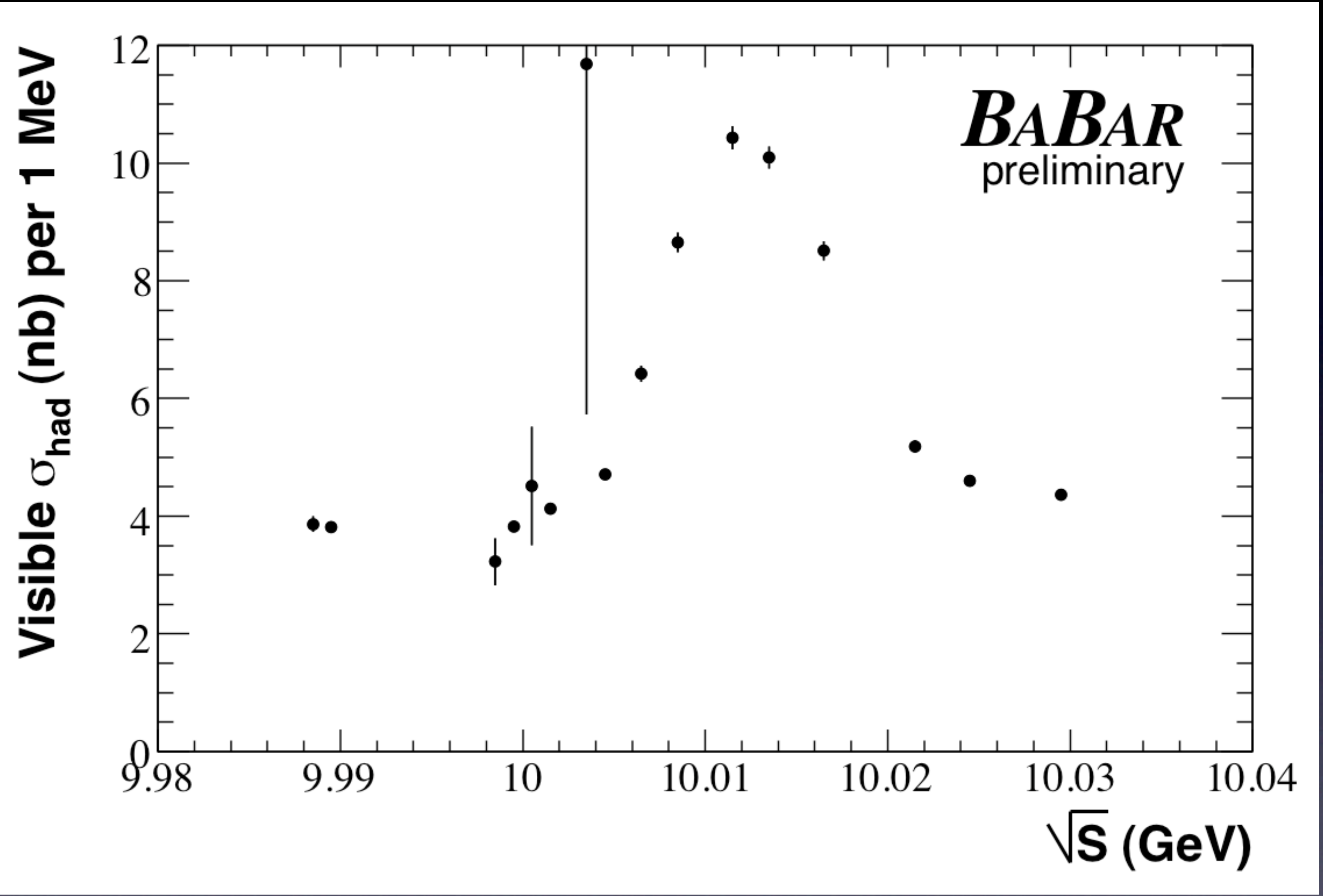
Energy Scan: Υ(3S)



peak σ = 4.2 ± 0.2(stat) nb [±5% syst]

~120M Υ(3S) [10x Belle, 25x CLEO]

Energy Scan: Υ(2S)



peak σ = 7.3 ± 0.3(stat) nb [±7% syst]

~100M Υ(2S) [12x CLEO]

HIGHLIGHTS

Semileptonic Ds

First measurement of q^2 dependence

First observation of S-wave (>5σ)

Exclusive $b \longrightarrow u\ell\nu$

First BABAR results for $B^+ \longrightarrow \eta\, \ell^+\nu\,,\ \eta'\ell^+\nu$

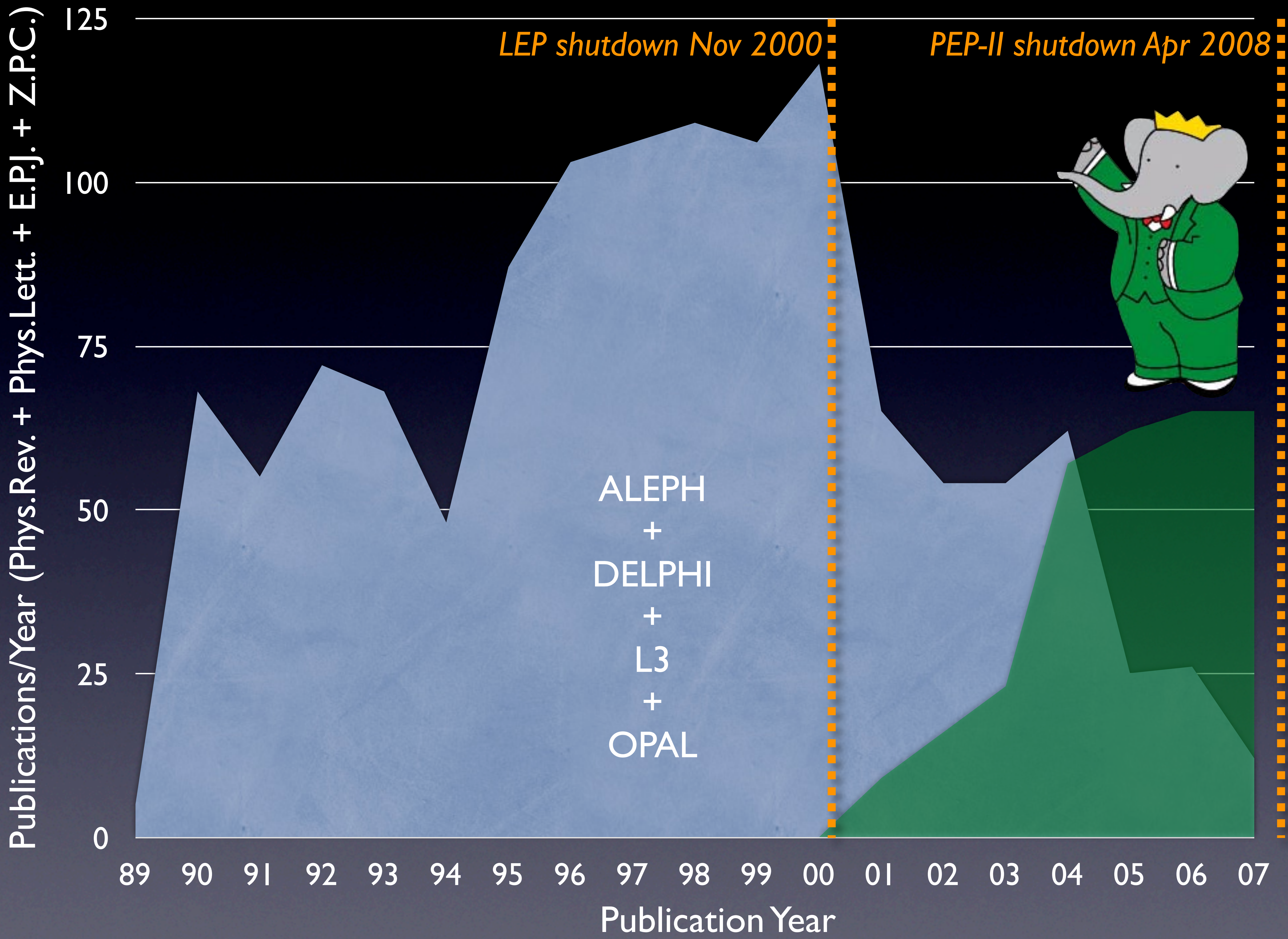
$\mathbf{B \rightarrow D^*K}$

First BABAR GLW results for CP−

First GLW results for $D^* \longrightarrow \mathbf{D}\gamma$

Energy Scan

Stay tuned for summer results...



Publications/Year (Phys.Rev. + Phys.Lett. + E.P.J. + Z.P.C.)
125
100
75
50
25
0
LEP shutdown Nov 2000
PEP-II shutdown Apr 2008
ALEPH
+
DELPHI
+
L3
+
OPAL
89
90
91
92
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95
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97
98
99
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02
03
04
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06
07
Publication Year