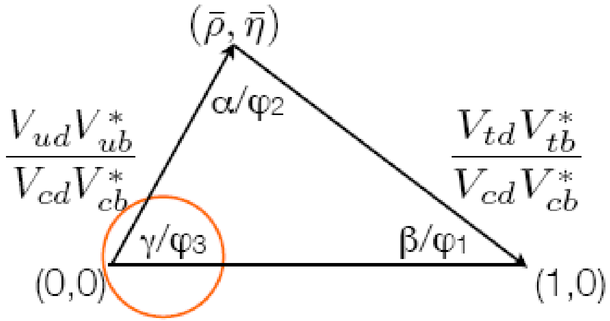


@ SuperB

Prospects for γ at SuperB Flavor Factory (SSF)

Rome, Sept. 9-13

F. Martínez-Vidal

IFIC – **Universitat de València-CSIC**

VNIVERSITAT DE VALÈNCIA CSIC

γ @ SuperB Flavor Factory?

- All measurements of observables sensitive to γ at current B Factories are statistically limited (~500M $B\bar{B}$ pairs × 2)
  $$\gamma = (67^{+32}_{-25})^{o}$$
  - As of ICHEP'08 (CKMFitter Group, WA):
  - Although not all the statistics yet analyzed by BaBar/Belle

- A measurement of γ @ 1^{o} level combined with a determination of $|V_{ub}|$ @ 2%, is crucial for a precise model-independent determination of the CKM matrix
  - $|V_{ub}|$ @2% level is a benchmark goal for the SSF Physics Case (can only be done at an $e^{+}e^{-}$ machine), and significant amount of work has been done
  - So far, γ considered less critical for Physics Case and little work has been done
  - LHCb (10 fb^{-1}) will certainly make a significant step forward in precision ($2\text{-}3^{o}$?)
- Goal at SuperB is to reach 1^{o} or better precision…

Assumptions and strategy

- SuperB has an initial peak luminosity of $10^{36}\mathrm{cm}^{-2}\mathrm{s}^{-1}$ on the $\Upsilon(4S)$
  - Can integrate 15 ab^{-1} in a Snowmass Year of 10^7 s
  - Data taking starts ~2015 + 5 years of operation $\Rightarrow$ 75 ab^{-1} on the $\Upsilon(4S)$ by ~2020
- SuperB can operate at different energies
  - L_{peak} scales with s $\Rightarrow L_{peak} \sim 10^{35}\ \mathrm{cm}^{-2}\mathrm{s}^{-1}$ @ $\psi''(3770)$
  - 5% of running time @ $\psi''(3770) \Rightarrow$ 3 moths over 5 years

- Beam energies 7 GeV e^- on 4 GeV e^+
- SuperB will be able to work with 80% polarized electron beam (not relevant for γ)

- Extrapolate current BaBar analyses on charged $B \rightarrow D^{(*)0}K^{(*)}$ decays, assuming the same detector performance (conservative), and combine ~correctly
- Make considerations on how to improve systematic uncertainties and/or reduce model dependence (running at $D\overline{D}$ threshold and model independent approach)

$B^+ \to D^{(*)}K^{(*)+}$ Dalitz method

Giri, Grossman, Soffer, Zupan, PRD **68**, 054018 (1993)
Poluetkov *et al.*, PRD **70**, 072003 (2004)

- Neutral D reconstructed in 3-body self-conjugate final state ($K_S\pi^+\pi^-$, $K_SK^+K^-$, $\pi^0\pi^+\pi^-$)
- Extract γ from fit to Dalitz-plot distribution of D^0 daughters

$$\Gamma_\pm(m_-^2, m_+^2) \propto |A_{D\pm}|^2 + r_B^2 |A_{D\mp}|^2 + 2\lambda \{x_\pm \mathrm{Re}[A_{D\pm}A_{D\mp}^*] + y_\pm \mathrm{Im}[A_{D\pm}A_{D\mp}^*]\}$$

$m_\pm = m(K_S h^\pm)$
$A_{D\mp} = D^0/\bar{D}^0 \to K_S^0 h^+ h^-$ decay amplitudes
$\lambda = +1$ for $B \to D^0K$, $D^{*0}[D^0\pi^0]K$, D^0K^*
$\quad -1$ for $B \to D^{*0}[D^0\gamma]K$

λ accounts for different parity of $D^{*0} \to D^0\gamma$ wrt $D^0\pi^0$

$$x_\pm = \kappa r_B \cos(\delta_B \pm \gamma)$$
$$y_\pm = \kappa r_B \sin(\delta_B \pm \gamma)$$
$$\kappa^2 r_B^2 = x_\pm^2 + y_\pm^2$$

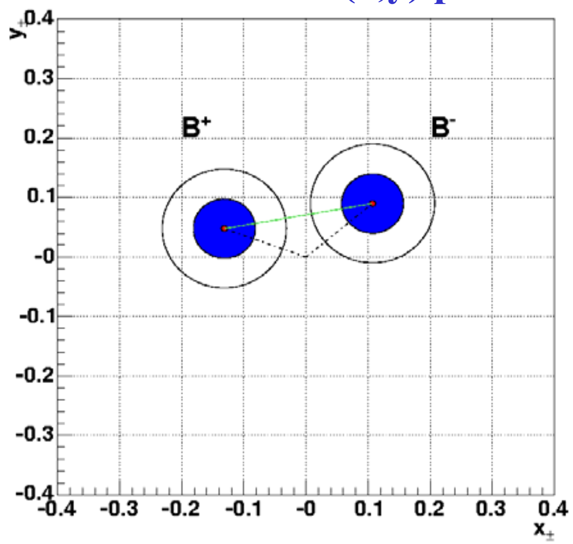
Cartesian CP parameters

$0<\kappa<1$ accounts for natural width of K^*

- 2-fold γ ambiguity: $(\delta_B,\gamma) \to (\delta_B+\pi, \gamma+\pi)$
- As interference depends on Dalitz position requires modelization of $A_{D\pm}(m_-^2, m_+^2)$

Extract $D^0/\bar{D}^0$ decay amplitudes from DP analysis of high-statistics $c\bar{c}$ sample with flavor-tagged D^0 decays from $D^{*+} \to D^0\pi^+$

Constraints on (x,y) plane



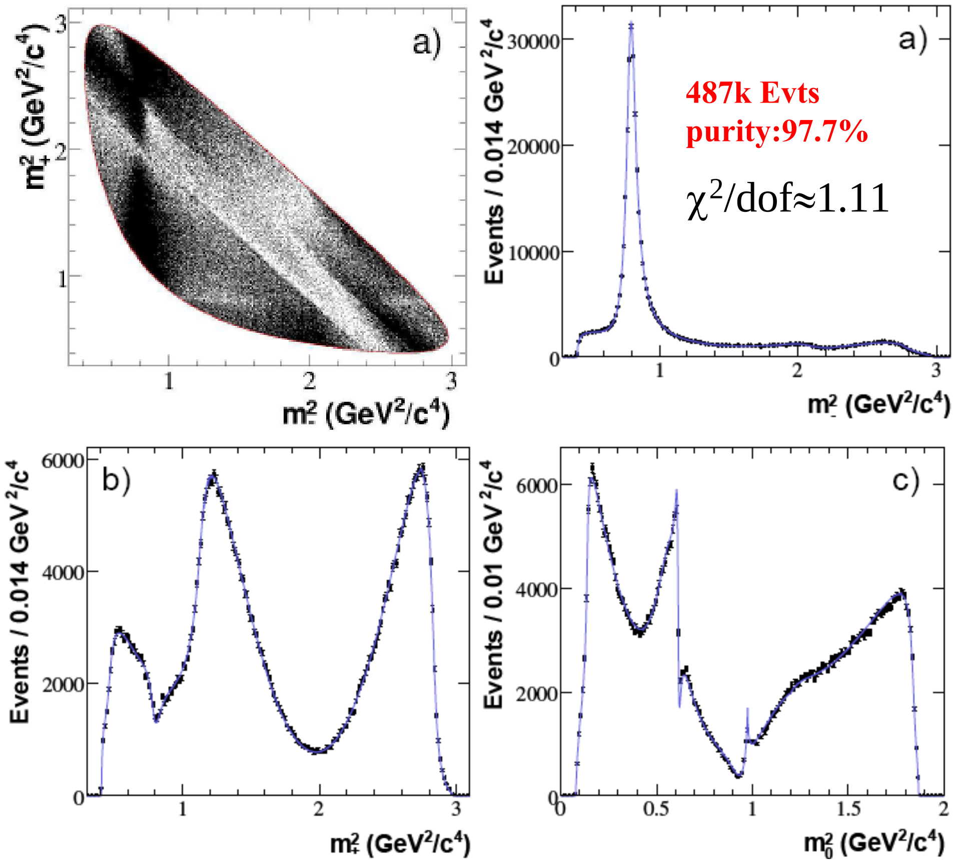
$D^0 \to K_S\pi^+\pi^-$ BaBar Model

PRD78, 034023 (2008)

351 fb^{-1}

- 10 BW resonances (isobar) for P (dominant) and D waves
- K-matrix for $\pi\pi$ and $K\pi$ (LASS) S-waves
  - K-matrix deals with broad, overlapping, multi-channel scalar resonances

	Component	a_r	ϕ_r (deg)	Fraction (%)
CA $K^*\pi$	$K^*(892)^-$	1.740 ± 0.010	139.0 ± 0.3	55.7 ± 2.8
	$K_0^*(1430)^-$	8.2 ± 0.7	153 ± 8	10.2 ± 1.5
	$K_2^*(1430)^-$	1.410 ± 0.022	138.4 ± 1.0	2.2 ± 1.6
	$K^*(1680)^-$	1.46 ± 0.10	-174 ± 4	0.7 ± 1.9
DCS $K^*\pi$	$K^*(892)^+$	0.158 ± 0.003	-42.7 ± 1.2	0.46 ± 0.23
	$K_0^*(1430)^+$	0.32 ± 0.06	143 ± 11	< 0.05
	$K_2^*(1430)^+$	0.091 ± 0.016	85 ± 11	< 0.12
$\pi\pi$ P- and D-waves	$\rho(770)^0$	1	0	21.0 ± 1.6
	$\omega(782)$	0.0527 ± 0.0007	126.5 ± 0.9	0.9 ± 1.0
	$f_2(1270)$	0.606 ± 0.026	157.4 ± 2.2	0.6 ± 0.7
$\pi\pi$ S-wave (K-matrix)	β_1	9.3 ± 0.4	-78.7 ± 1.6	
	β_2	10.89 ± 0.26	-159.1 ± 2.6	
	β_3	24.2 ± 2.0	168 ± 4	
	β_4	9.16 ± 0.24	90.5 ± 2.6	
	$f_{11}^{\rm prod}$	7.94 ± 0.26	73.9 ± 1.1	
	$f_{12}^{\prime\rm prod}$	2.0 ± 0.3	-18 ± 9	
	$f_{13}^{\prime\rm prod}$	5.1 ± 0.3	33 ± 3	
	$f_{14}^{\prime\rm prod}$	3.23 ± 0.18	4.8 ± 2.5	
	$s_0^{\rm prod}$	-0.07 ± 0.03		
	$\pi\pi$ S-wave			11.9 ± 2.6
$K\pi$ S-wave (LASS, K-matrix)	M (GeV/c^2)	1.463 ± 0.002		
	Γ (GeV/c^2)	0.233 ± 0.005		
	F	0.80 ± 0.09		
	ϕ_F	2.33 ± 0.13		
	R	1		
	ϕ_R	-5.31 ± 0.04		
	a	1.07 ± 0.11		
	r	-1.8 ± 0.3		



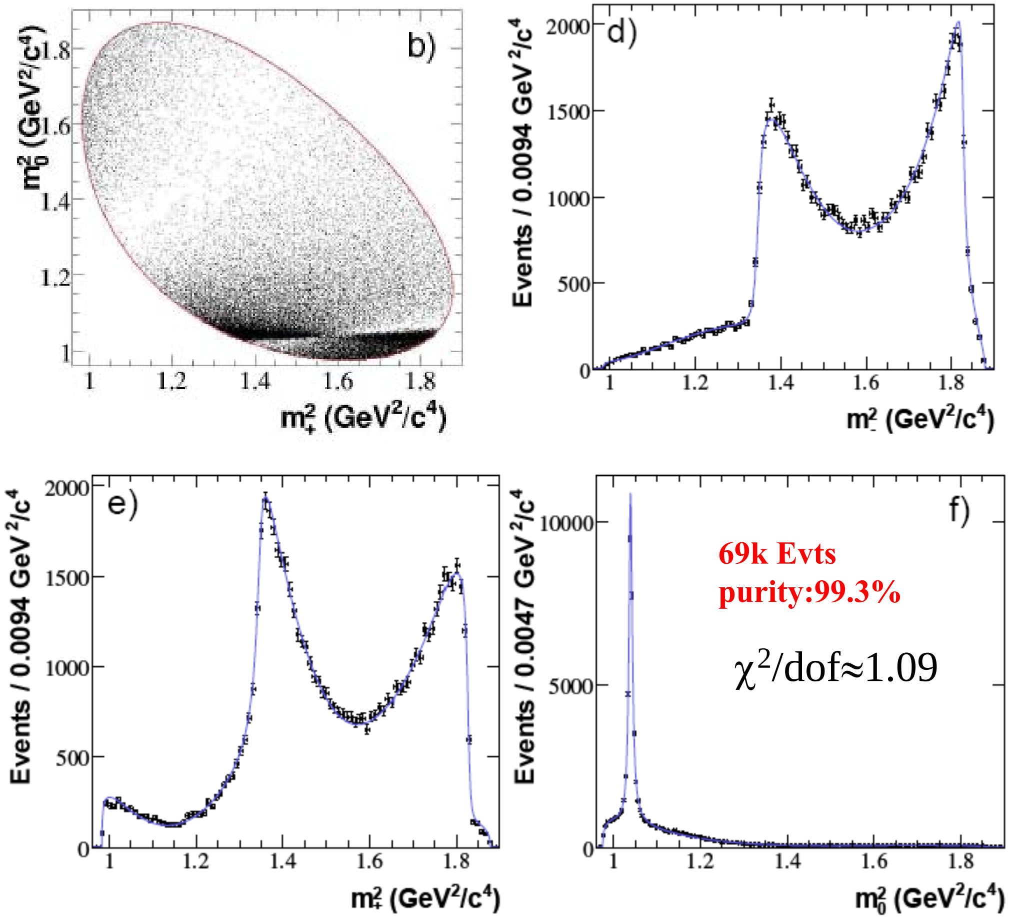
$D^0 \to K_S K^+ K^-$ BaBar Model

PRD78, 034023 (2008)

351 fb^{-1}

- Isobar model, dominated by S-wave $K_S a_0(980)$, with significant contribution from $K_S a_0(1450)$, and P-wave K_S $\phi(1020)$

Component	a_r	ϕ_r (deg)	Fraction (%)
$K_S^0 a_0(980)^0$	1	0	55.8
$K_S^0 \phi(1020)$	0.227 ± 0.005	-56.2 ± 1.0	44.9
$K_S^0 f_0(1370)$	0.04 ± 0.06	-2 ± 80	0.1
$K_S^0 f_2(1270)$	0.261 ± 0.020	-9 ± 6	0.3
$K_S^0 a_0(1450)^0$	0.65 ± 0.09	-95 ± 10	12.6
$K^- a_0(980)^+$	0.562 ± 0.015	179 ± 3	16.0
$K^- a_0(1450)^+$	0.84 ± 0.04	97 ± 4	21.8
$K^+ a_0(980)^-$	0.118 ± 0.015	138 ± 7	0.7



$B^+ \to D^{(*)}K^{(*)+}$ BaBar Dalitz results

PRD78, 034023 (2008)

$383 \times 10^6\ B\bar{B}$

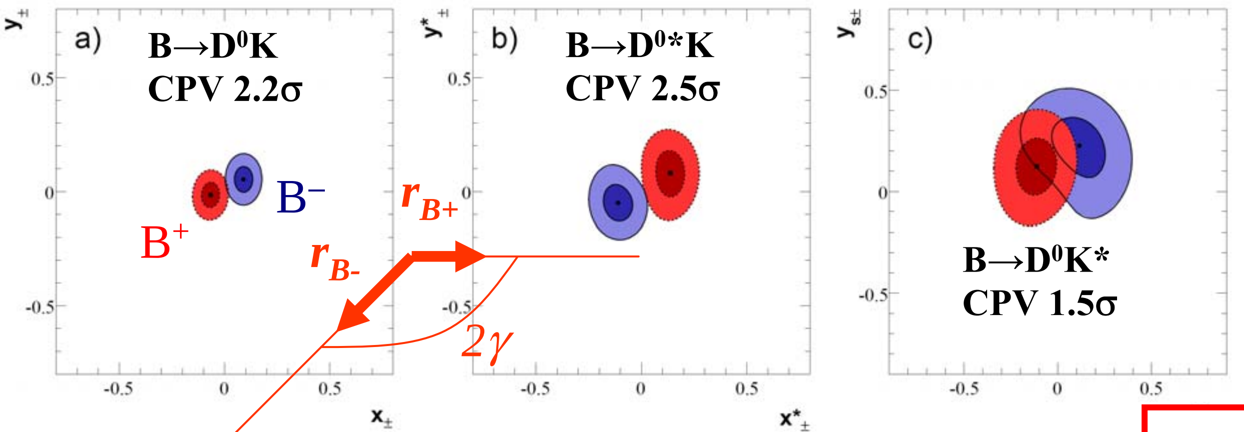
Parameters	$B^- \to \tilde{D}^0 K^-$	$B^- \to \tilde{D}^{*0} K^-$	$B^- \to \tilde{D}^0 K^{*-}$
x_- , x_-^* , x_{s-}	$0.090 \pm 0.043 \pm 0.015 \pm 0.011$	$-0.111 \pm 0.069 \pm 0.014 \pm 0.004$	$0.115 \pm 0.138 \pm 0.039 \pm 0.014$
y_- , y_-^* , y_{s-}	$0.053 \pm 0.056 \pm 0.007 \pm 0.015$	$-0.051 \pm 0.080 \pm 0.009 \pm 0.010$	$0.226 \pm 0.142 \pm 0.058 \pm 0.011$
x_+ , x_+^* , x_{s+}	$-0.067 \pm 0.043 \pm 0.014 \pm 0.011$	$0.137 \pm 0.068 \pm 0.014 \pm 0.005$	$-0.113 \pm 0.107 \pm 0.028 \pm 0.018$
y_+ , y_+^* , y_{s+}	$-0.015 \pm 0.055 \pm 0.006 \pm 0.008$	$0.080 \pm 0.102 \pm 0.010 \pm 0.012$	$0.125 \pm 0.139 \pm 0.051 \pm 0.010$

±stat. ±syst.(exp.) ±syst.(Dalitz model)

$$x_\pm = \kappa r_B \cos(\delta_B \pm \gamma)$$
$$y_\pm = \kappa r_B \sin(\delta_B \pm \gamma)$$

Distance between (B^+B^-) points is $2r_B|\sin 2\gamma|$

See V. Tisserand talk



3σ evidence for CPV

From measured CP parameters: ($x\pm$, $y\pm$), ($x^*\pm$, $y^*\pm$),($x_s\pm$, $y_s\pm$) perform frequentist interpretation removing unphysical regions ($r_{B+} \neq r_{B-}$ ...). Assume Gaussian PDF for all (x,y)

- r_B, r^*_B, r_{sB}
- δ_B, δ^*_B, δ_{sB}
- γ

Physics params

extract 1D CL intervals

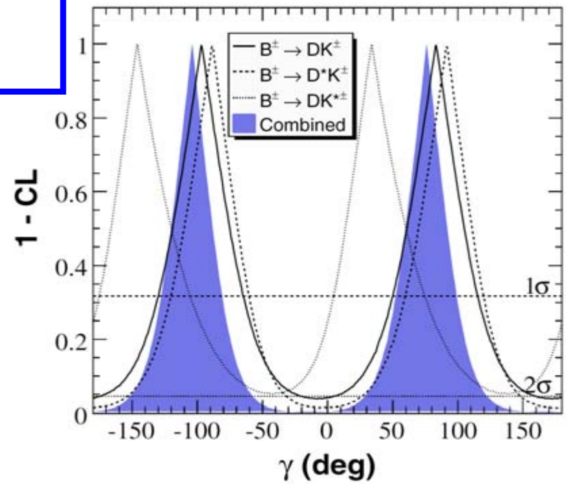
$$\gamma[\mathrm{mod}\ \pi] = (76^{+23}_{-24})^\circ\ \{5, 5\}^\circ$$

±tot {syst. exp., syst. model}

$r_B(DK)$= $(8.6 \pm 3.5)\%\ \{1.0, 1.1\}\%$

$r_B(D^*K)$= $(13.5 \pm 5.1)\%\ \{1.1, 0.5\}\%$

$\kappa r_B(DK^*)$=$(16.3^{+8.8}_{-10.5})\%\ \{3.7, 2.1\}\%$



$B^+ \to D^{(*)}K^{(*)+}$ BaBar Dalitz systematic errors

Experimental systematic error

Source	x_-	y_-	x_+	y_+	x_-^*	y_-^*	x_+^*	y_+^*	x_{s-}	y_{s-}	x_{s+}	y_{s+}
m_{ES}, ΔE, $\mathcal{F}$ shapes	0.001	0.001	0.001	0.002	0.002	0.004	0.004	0.005	0.003	0.002	0.001	0.004
Real D^0 fractions	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.001	0.002	0.004	0.001	0.001
Charge-flavor correlation	0.002	0.002	0.001	0.001	0.002	0.002	0.002	0.001	0.001	0.002	0.001	0.001
Efficiency in the Dalitz plot	0.002	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.002	0.003	0.001	0.005
Background Dalitz plot shape	0.012	0.007	0.013	0.003	0.010	0.007	0.007	0.007	0.014	0.006	0.012	0.005
$B^- \to D^{*0}K^-$ cross feed	...	...	...	...	0.003	0.002	0.007	0.001	...	...	...	...
CP violation in $D\pi$ and $B\bar{B}$ bkg	0.001	0.001	0.001	0.001	0.005	0.001	0.001	0.004	0.006	0.002	0.003	0.001
Non-K^* $B^- \to \tilde{D}^0 K_S^0 \pi^-$ decays	...	...	...	...	...	...	...	...	0.035	0.058	0.025	0.045
Total experimental	0.015	0.007	0.014	0.006	0.014	0.009	0.014	0.010	0.039	0.058	0.028	0.051

Estimated irreducible experimental systematic error: 0.003

Dalitz model systematic error

Source	x_-	y_-	x_+	y_+	x_-^*	y_-^*	x_+^*	y_+^*	x_{s-}	y_{s-}	x_{s+}	y_{s+}
Mass and width of Breit-Wigner's	0.001	0.001	0.001	0.002	0.001	0.002	0.001	0.003	0.003	0.001	0.002	0.002
$\pi\pi$ S-wave K-matrix solutions	0.003	0.012	0.003	0.001	0.003	0.007	0.002	0.009	0.001	0.001	0.013	0.003
$K\pi$ S-wave parametrization	0.001	0.001	0.002	0.004	0.001	0.003	0.001	0.003	0.005	0.001	0.004	0.002
Angular dependence	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.003	0.001	0.003	0.001
Blatt-Weisskopf radius	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.003
Add/remove resonances	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.001	0.001	0.001	0.002
Dalitz plot efficiency	0.006	0.004	0.008	0.001	0.002	0.004	0.002	0.003	0.008	0.001	0.008	0.004
Background Dalitz plot shape	0.003	0.002	0.004	0.001	0.001	0.001	0.001	0.001	0.004	0.001	0.004	0.002
Normalization and binning	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.002	0.002	0.001	0.003	0.001
Mistag rate	0.008	0.006	0.006	0.005	0.002	0.001	0.002	0.003	0.008	0.010	0.004	0.007
Dalitz plot complex amplitudes	0.002	0.002	0.003	0.004	0.001	0.001	0.002	0.006	0.003	0.003	0.004	0.002
Total Dalitz model	0.011	0.015	0.011	0.008	0.004	0.010	0.005	0.012	0.014	0.011	0.018	0.010

~Irreducible

Estimated irreducible Dalitz model systematic error: 0.006

$B^+ \to D^{(*)}K^{(*)+}$ GLW method

Gronau, London, PLB **253**, 483 (1991)
Gronau, Wyler, PLB **265**, 172 (1991)

- Neutral D reconstructed in CP-eigenstate final state (CP-even: K^+K^-,$\pi^+\pi^-$ and CP-odd: $K_S\pi^0$, $K_S\omega$, $K_S\phi$) and Cabibbo-favored $K\pi$ final state
- Use measured $B^\pm$ yields to determine GLW observables

$$R_{CP\pm} = \frac{\Gamma(B^- \to D_{CP\pm}K^-) + \Gamma(B^+ \to D_{CP\pm}K^+)}{[\Gamma(B^- \to D^0K^-) + \Gamma(B^+ \to \overline{D}^0 K^+)]/2} = 1 \pm 2r_B \cos\gamma \cos\delta_B + r_B^2$$

4 observables (3 independent), 3 unknowns: r_B, δ_B, γ

$$A_{CP\pm} = \frac{\Gamma(B^- \to D_{CP\pm}K^-) - \Gamma(B^+ \to D_{CP\pm}K^+)}{\Gamma(B^- \to D_{CP\pm}K^-) + \Gamma(B^+ \to D_{CP\pm}K^+)} = \frac{\pm 2r_B \sin\delta_B \sin\gamma}{R_{CP\pm}}$$

$$A_{CP+}R_{CP+} = -A_{CP-}R_{CP-}$$

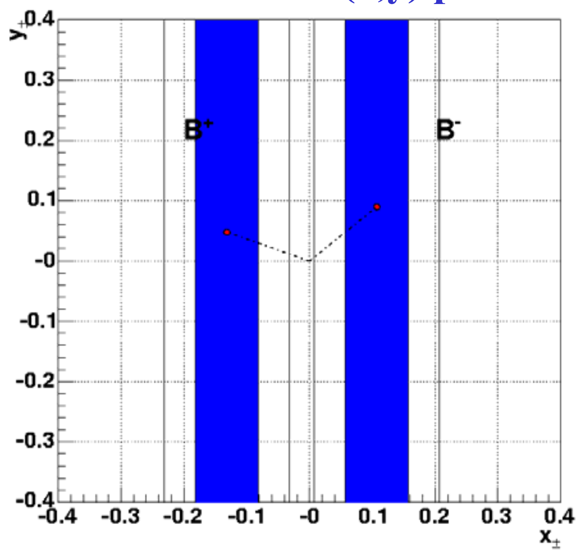
- Extract x± for combination with Dalitz method

$$x_\pm = \frac{R_{CP+}(1 \mp A_{CP+}) - R_{CP-}(1 \mp A_{CP-})}{4}$$

$$r_B^2 = x_\pm^2 + y_\pm^2 = \frac{R_{CP+} + R_{CP-} - 2}{2}$$

- 8-fold γ ambiguity

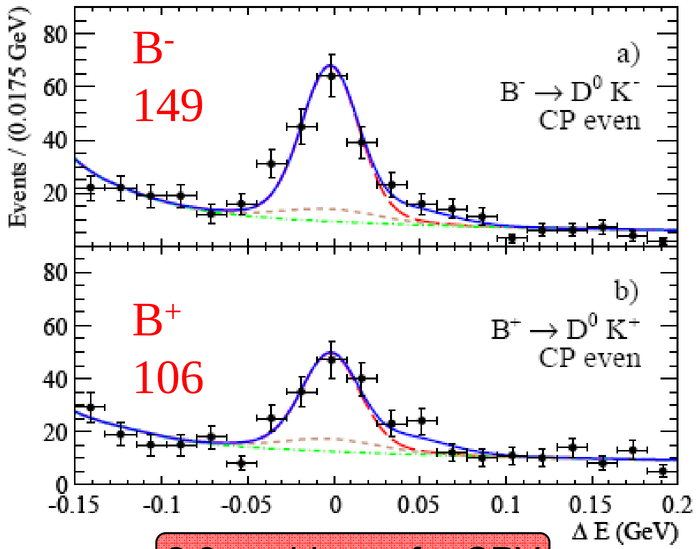
Constraints on (x,y) plane



$B^+ \rightarrow D^{(*)}K^{(*)+}$ BaBar GLW results

383x10⁶ $B\bar{B}$

$B^\pm \rightarrow DK^\pm$



2.8σ evidence for CPV

PRD77, 111102(R) (2008) | arXiv:0807.2408 hep/ex | PRELIMINARY

	$B^+ \rightarrow DK^+$	$B^+ \rightarrow D^*K^+$	$B^+ \rightarrow D^0K^{*+}$
A_{CP+}	0.27±0.09±0.04	-0.11±0.09±0.01	0.09±0.13±0.05
A_{CP-}	-0.09±0.09±0.02	0.06±0.10±0.02	-0.23±0.21±0.07
R_{CP+}	1.06±0.10±0.05	1.31±0.13±0.04	2.17±0.35±0.09
R_{CP-}	1.03±0.10±0.05	1.10±0.12±0.04	1.03±0.27±0.13
x_+	-0.09±0.05±0.02	-0.09±0.07±0.02	0.18±0.14±0.05
x_-	0.10±0.05±0.03	-0.02±0.06±0.02	0.38±0.14±0.05
r_B^2	0.05±0.07±0.03	0.22±0.09±0.03	-

$x_\pm$ competitive with Dalitz

$B^\pm \rightarrow DK^\pm$

Source	ΔR_{CP+}	ΔR_{CP-}	ΔA_{CP+}	ΔA_{CP-}
Fixed fit parameters	0.036	0.019	0.010	0.002
Peaking background	0.029	0.037	0.031	0.003
Detector charge asym.	···	···	0.022	0.022
Opp. CP bkg. in $K_S^0\omega$	···	0.002	···	0.007
$R_{CP\pm}$ vs $R_\pm/R$	0.026	0.025	···	···
K/π efficiency	0.002	0.007	···	···
Total	0.053	0.049	0.039	0.023

Estimated irreducible experimental systematic error on $R_{CP\pm}$, $A_{CP\pm}$: 0.01

$B^+ \to D^{(*)}K^{(*)+}$ ADS method

Atwood, Dunietz, Soni, PRL **78**, 3257 (1997), PRD **63**, 036005 (2001)

- Neutral D reconstructed in $K^+\pi^-$ ($K^+\pi^-\pi^0$ and $K^+\pi^-\pi^+\pi^-$ not used here) DCS decays
- Use measured $B^\pm$ yields to determine ADS observables

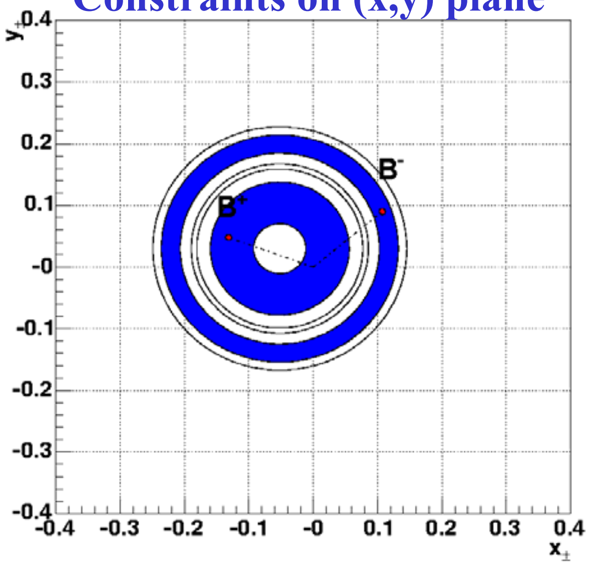
$$R_{ADS} = \frac{\Gamma(B^- \to D[K^+\pi^-]K^-) + \Gamma(B^+ \to D[K^-\pi^+]K^+)}{\Gamma(B^- \to D[K^-\pi^+]K^-) + \Gamma(B^+ \to D[K^+\pi^-]K^+)} = 2r_B r_D \cos\gamma \cos(\delta_B + \delta_D) + r_B^2 + r_D^2$$

$$A_{ADS} = \frac{\Gamma(B^- \to D[K^+\pi^-]K^-) - \Gamma(B^+ \to D[K^-\pi^+]K^+)}{\Gamma(B^- \to D[K^+\pi^-]K^-) + \Gamma(B^+ \to D[K^-\pi^+]K^+)} = \frac{2r_B r_D \sin\gamma \sin(\delta_B + \delta_D)}{R_{ADS}}$$

- Not enough information (2 observables, 5 unknows)
  - r_D, δ_D external inputs
    - $r_D = 0.0603 \pm 0.0025$, assumed all irreducible
    - $\cos\delta_D = \cos 60^o \pm 0.35 \pm 0.07$, assume 0.035 irreducible
  - Still unsolvable $\Rightarrow$ constraints on r_B

$$(x_\mp + r_D \cos\delta_D)^2 + (y_\mp - r_D \sin\delta_D)^2 = R_{ADS}(1 \pm A_{ADS})$$

Constraints on (x,y) plane



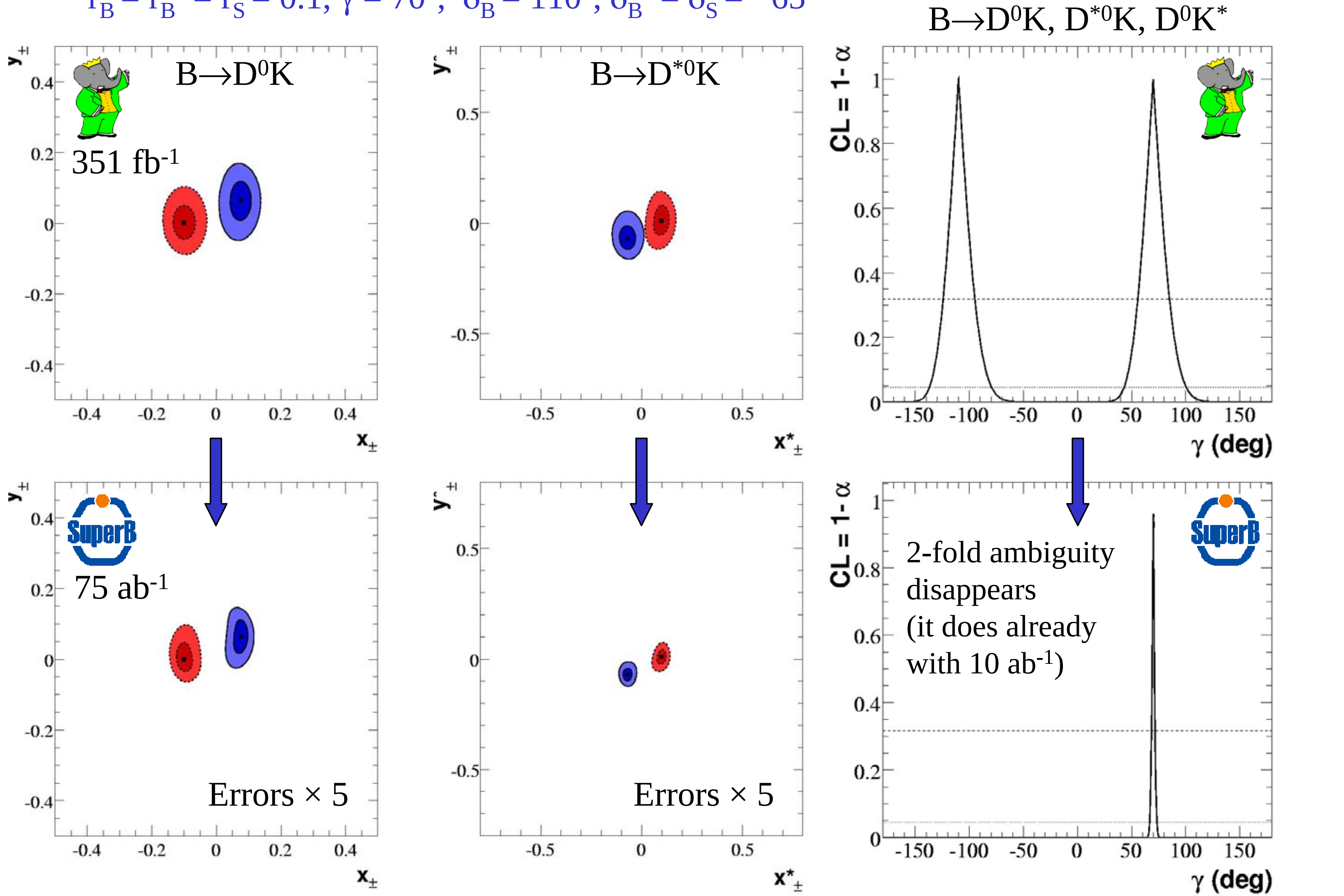
- R_{ADS}, A_{ADS} poorly measured so far
  - Evaluate $B^\pm$ yields using yields of normalization channel (CA) from current BaBar analyses + assumptions on values of physics parameters

Estimated irreducible experimental systematic error on R_{ADS}, A_{ADS}: 0.01

Experimentally similar to GLW analysis

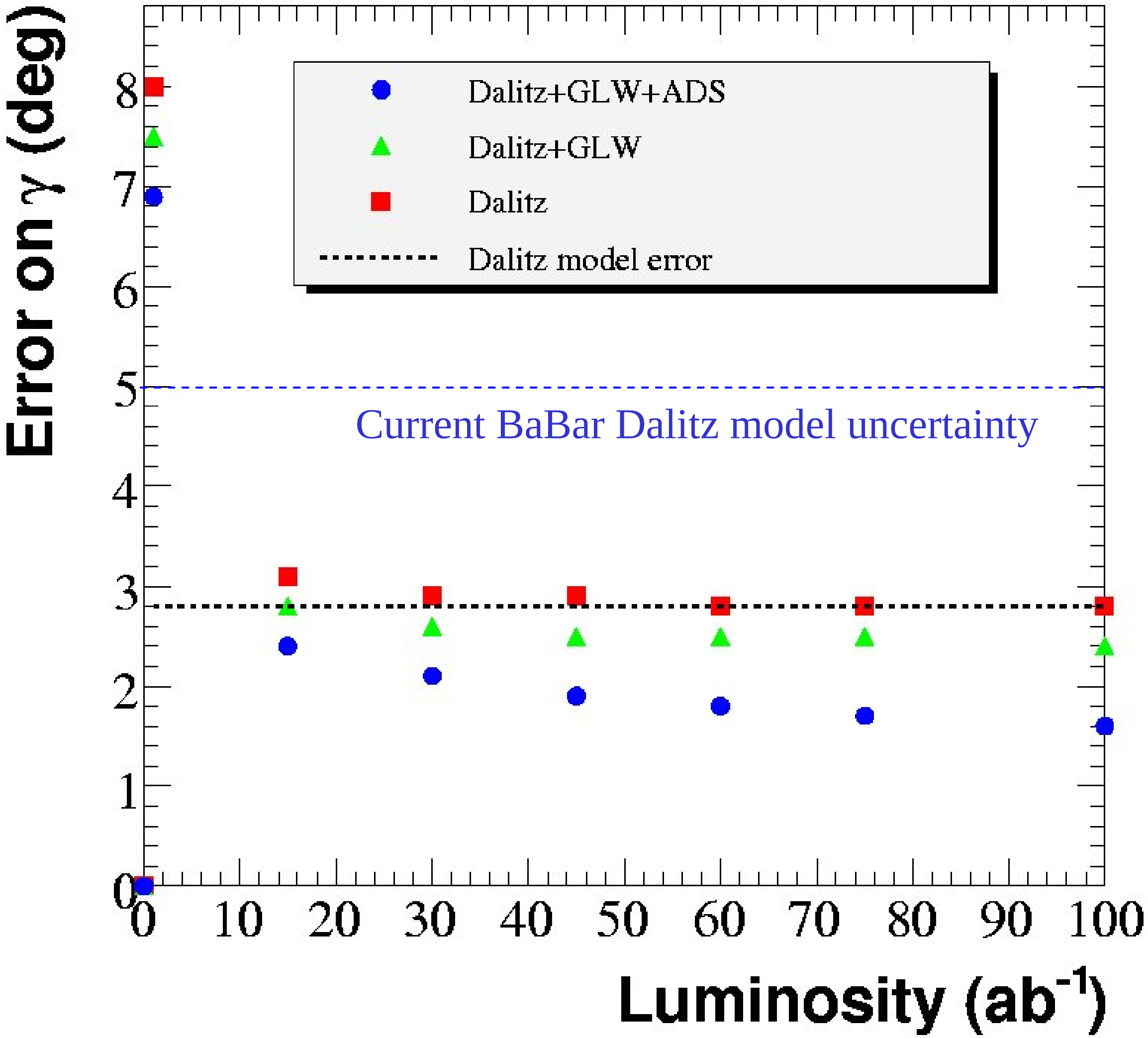
$B^+ \to D^{(*)}K^{(*)+}$ Dalitz+GLW+ADS projections

$r_B = r_B{}^* = r_S = 0.1,\ \gamma = 70^o,\ \delta_B = 110^o,\ \delta_B{}^* = \delta_S = -65^o$



$B^+ \to D^{(*)} K^{(*)+}$ Dalitz+GLW+ADS projections

$r_B = r_B^* = r_S = 0.1$, $\gamma = 70^o$, $\delta_B = 110^o$, $\delta_B^* = \delta_S = -65^o$



L (ab^{-1})	Dalitz	+GLW	+ADS
0.35×10^{-3}	19	17	15
1	8.0	7.5	6.9
15	3.1	2.8	2.4
30	2.9	2.6	2.1
45	2.8	2.5	1.9
60	2.8	2.5	1.8
75	2.8	2.5	1.7
100	2.8	2.4	1.6

Reducing Dalitz model dependence/systematics

- Dalitz model systematic uncertainty seems to be under control up to ~3^{o} level
- Further reduction seems difficult and/or impossible
  - Phenomenological Dalitz models with quasi-two body (Q2B) approach is an approximation to the 3-body dynamics
  - Some arbitrarity in the evaluation of the Q2D model systematic uncertainty
- Need model independent or quasi model independent method to:
  - Assess level of understanding of phenomenological model, or
  - Perform a (quasi) model independent analysis of γ
- Initially proposed by Gili et al. Giri et al, PRD **68**, 054018 (2003)

  and further investigated by Bondar and Poluektov. Bondar and Poluektov, Eur. Phys. J. C 47, 347 (2006) arXiv:0801.0840 [hep-ex]

- Other approaches, like a full PWA of ultra high statistics D^0 tagged samples not yet investigated

Model Independent Approach

- Dalitz-plot distribution of D^0 daughters (rewritten)

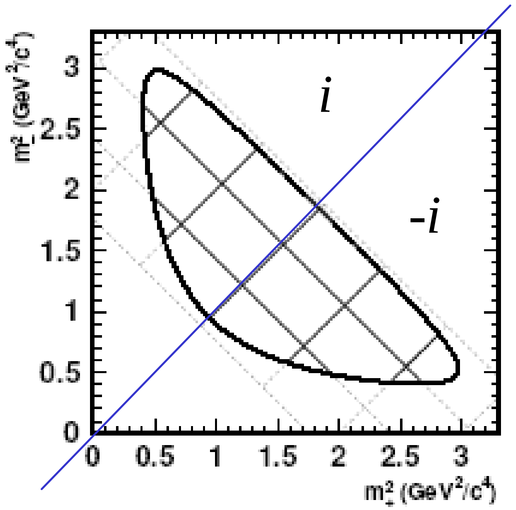
$$\Gamma_{\pm}(m_-^2, m_+^2) \propto |A_{D\pm}|^2 + r_B^2 |A_{D\mp}|^2 + 2\lambda\sqrt{|A_{D\pm}||A_{D\mp}|}(x_{\pm} c + y_{\pm} s)$$

$$A_{D\mp} \equiv |A_{D\mp}| e^{i\delta_{D\mp}} \equiv |A_D(m_\mp^2, m_\pm^2)| e^{i\delta_D(m_\mp^2, m_\pm^2)}$$

$$c = \cos(\delta_{D\pm} - \delta_{D\mp}) \equiv \cos\Delta\delta_D$$
$$s = \sin(\delta_{D\pm} - \delta_{D\mp}) \equiv \sin\Delta\delta_D$$

$\Delta\delta_D$: Phase difference between symmetric Dalitz plot points

- Bin the Dalitz plot



$$c_{\pm i} \propto \int_{D_{\pm i}} \cos(\delta_{D\pm} - \delta_{D\mp}) dm_+^2 dm_-^2 = c_{\mp i}$$
$$s_{\pm i} \propto \int_{D_{\pm i}} \sin(\delta_{D\pm} - \delta_{D\mp}) dm_+^2 dm_-^2 = -s_{\mp i}$$

$$i \to -i \equiv m_-^2 \to m_+^2$$

- If we have "optimal" binning and s_i, c_i are known in some way, we can obtain (x,y) by counting the number of $B^{\pm}$ events in each bin of the D^0 Dalitz plot
  - This equires $\psi''(3770) \to D\bar{D}$ correlated data

Model Independent Approach (con’t)

Bondar and Poluektov, arXiv:0801.0840 [hep-ex]

- Number of events for
  - $B^{\pm}\rightarrow DK^{\pm}$ data @ $\Upsilon(4S)$:

$$\boxed{\langle N_i \rangle \propto K_i + r_B^2 K_{-i} + 2\sqrt{K_i K_{-i}}(xc_i + ys_i)}$$

  - CP tagged $D^0\rightarrow K_S\pi\pi$ @ $\psi''(3770)$:

$$\boxed{\langle M_i \rangle \propto K_i + K_{-i} \pm 2\sqrt{K_i K_{-i}}\, c_i}$$

± for stands for CP±

  - Doubly tagged $D^0\rightarrow K_S\pi\pi$ @ $\psi''(3770)$

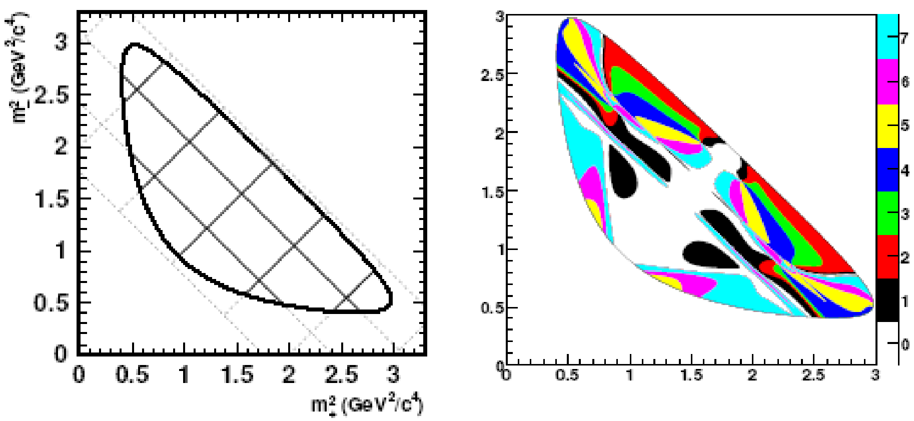
$$\boxed{\langle M_{ij} \rangle \propto K_i K_{-j} + K_{-i} K_j - 2\sqrt{K_i K_{-i} K_j K_{-j}}(c_i c_j + s_i s_j)}$$

  - Flavor tagged D^0 @ $\Upsilon(4S)$: $\boxed{K_i}$

$\Rightarrow$ c_i, s_i, $x_{\pm}$, $y_{\pm}$

- Optimization of binning (2nd order model dependence)

Square bins $\Rightarrow$ $\Delta\delta_D$ bins



Model Independent Approach: projections

- For ~1000 CP and $K_S\pi\pi$ tagged $K_S\pi\pi$ events (corresponding to 750 pb^{-1} from CLEO-c)

Binning	Q	B-stat. err.		D_{CP}-stat. err.		$(K_S^0\pi^+\pi^-)^2$-stat. err.	
		σ_x	σ_y	σ_x	σ_y	σ_x	σ_y
$\mathcal{N} = 8$ (uniform)	0.57	0.033	0.060	0.005	0.010	0.015	0.032
$\mathcal{N} = 8$ ($\Delta\delta_D$)	0.79	0.027	0.037	0.004	0.007	0.005	0.010
$\mathcal{N} = 8$ (optimal)	0.89	0.023	0.032	0.006	0.011	0.008	0.011
$\mathcal{N} = 19$ (uniform)	0.69	0.027	0.055	0.004	0.011	-	-
$\mathcal{N} = 20$ ($\Delta\delta_D$)	0.82	0.027	0.035	0.005	0.007	-	-
$\mathcal{N} = 20$ (optimal)	0.96	0.022	0.029	0.008	0.011	-	-
Unbinned	-	0.021	0.028	-	-	-	-

Bondar and Poluektov, arXiv:0801.0840 [hep-ex]

- σ_x,σ_y~0.01 $\Rightarrow$ σ_γ ~ 5°, both consistent with current BaBar Dalitz model uncertainty
- Mostly reducible, up to an experimental irreducible contribution

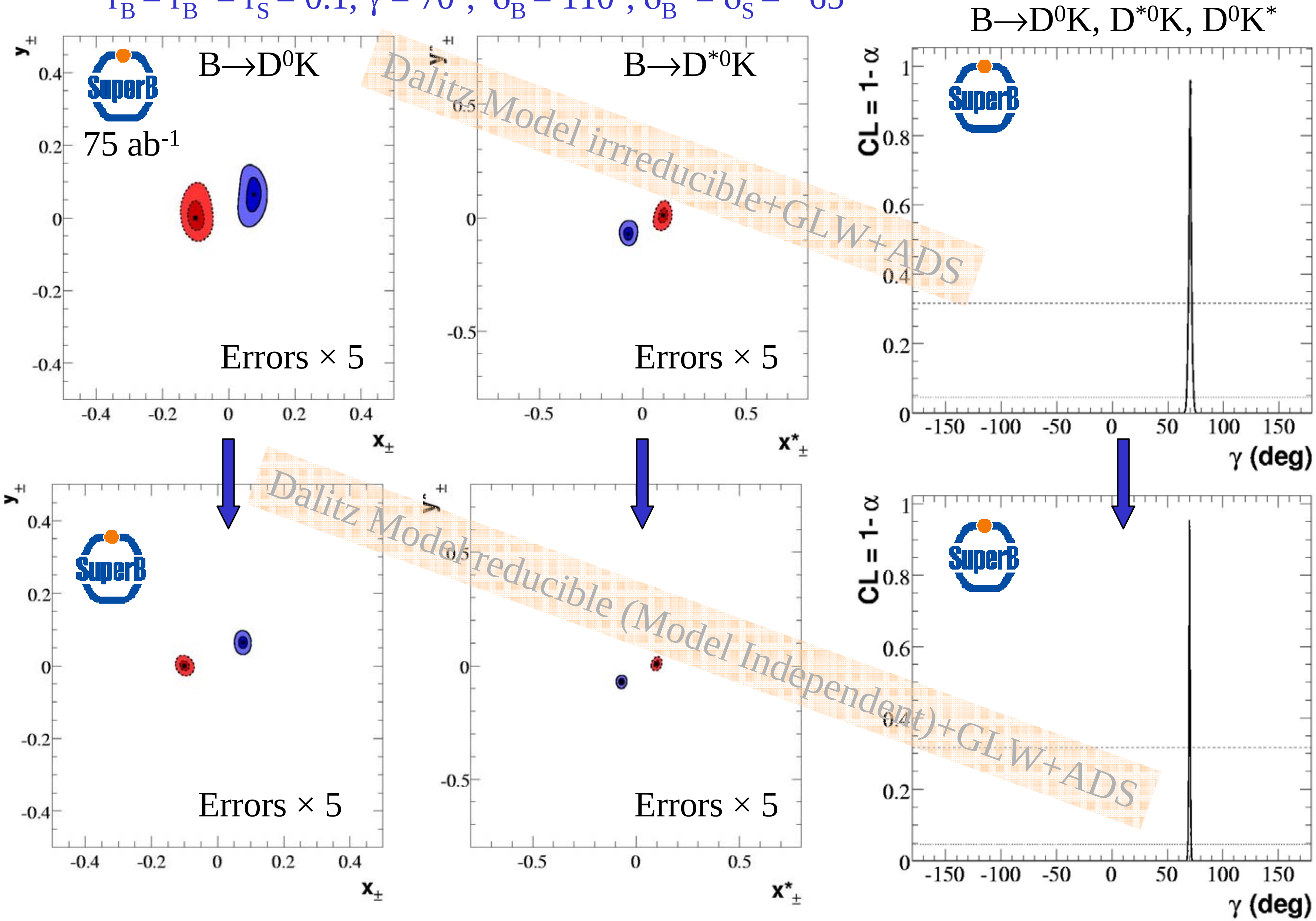
- SuperB running at $\psi''(3770)\rightarrow D\bar{D}$ correlated data for 3 moths

Required for other purposes ($D\bar{D}$ mixing and CPV)

  - Scale $D\bar{D}$ data with factor 10% peak luminosity @ Υ(4S) × 5% running time
    $\Rightarrow$ 375 fb^{-1} $D\bar{D}$ correlated data (×500 CLEO-c, ×25 BES-III statistics)
  - σ_x,σ_y ~ 0.0005, well below assumed 0.003 irreducible experimental systematics
    - ~1 week of running would be enough, but largest statistics will reduce to negligible level binning systematic uncertainty
  - In our exercise, assume "Dalitz model uncertainty" scaling with luminosity

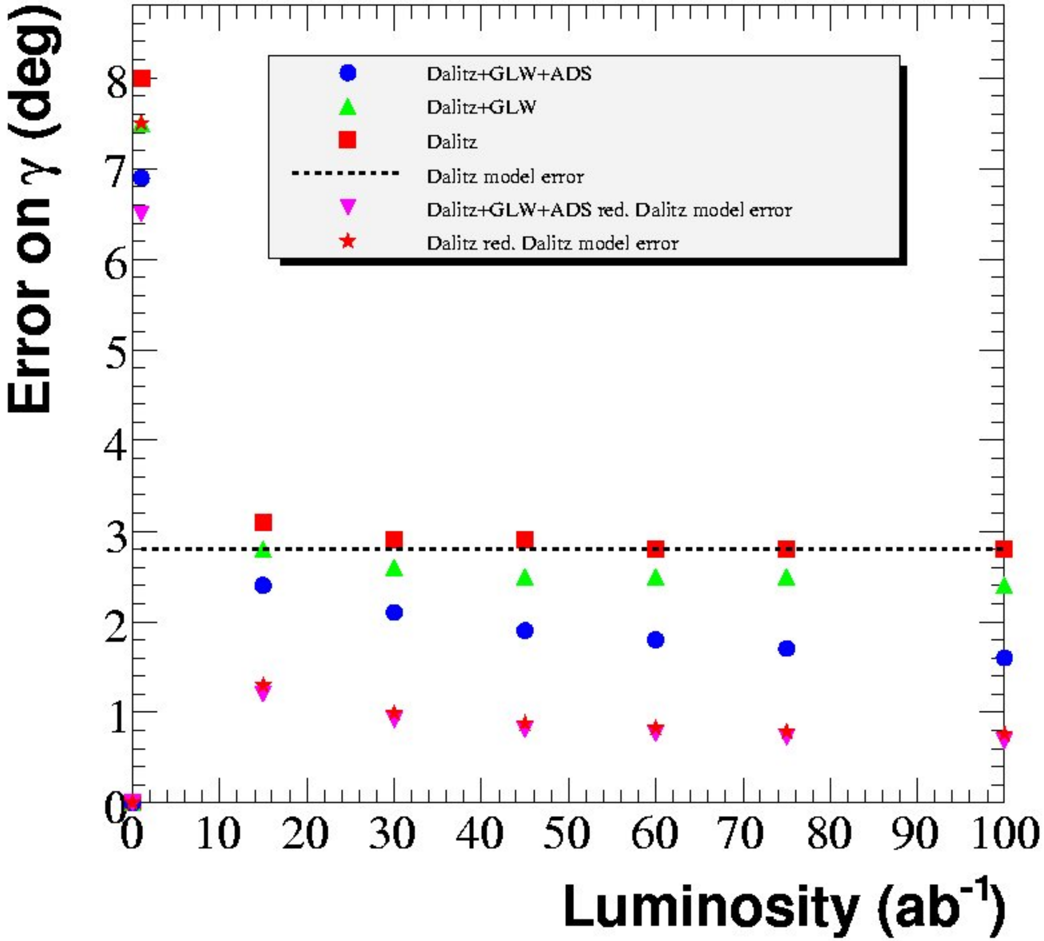
$B^+ \to D^{(*)}K^{(*)+}$ Dalitz+GLW+ADS projections

$r_B = r_B^* = r_S = 0.1$, $\gamma = 70^o$, $\delta_B = 110^o$, $\delta_B^* = \delta_S = -65^o$



$B^+ \to D^{(*)}K^{(*)+}$ Dalitz+GLW+ADS projections

$r_B = r_B^* = r_S = 0.1$, $\gamma = 70^o$, $\delta_B = 110^o$, $\delta_B^* = \delta_S = -65^o$



Dalitz Model irrreducible+ GLW+ADS (columns Dalitz, +GLW, +GLW+ADS)

Dalitz Model reducible (Model Independent)+ GLW+ADS (last two columns)

L (ab^{-1})	Dalitz	+GLW	+GLW +ADS	Dalitz	+GLW +ADS
0.35×10^{-3}	19	17	15	19	15
1	8.0	7.5	6.9	7.5	6.5
15	3.1	2.8	2.4	1.3	1.19
30	2.9	2.6	2.1	0.99	0.92
45	2.8	2.5	1.9	0.88	0.81
60	2.8	2.5	1.8	0.83	0.76
75	2.8	2.5	1.7	0.79	0.72
100	2.8	2.4	1.6	0.76	0.68

Conclusion

- Measurement of γ at the B Factories was unexpected
  - r_B ratios confirmed to be ~0.1 (and >0) $\Rightarrow$ reliable predictions
  - $\delta\gamma$~20^o now, largely dominated by $B^+ \to D^{(*)}K^{(*)+}$ Dalitz
  - $\delta\gamma$~10^o after final analyses and combinations of current B Factories
- SSF can reach $\delta\gamma$~1^o and below with:
  - Combination of charged modes: $B^+ \to D^{(*)}K^{(*)+}$. Self-tagging neutral modes, e.g. $B^0 \to D^{(*)}K^{(*)0}$, may help
  - Combination of methods: Dalitz, GLW, ADS
  - Use of correlated data (CP tagged $K_S\pi\pi$,K_SKK and doubly tagged $K_S\pi\pi$,K_SKK)
    - SFF is a unique facility to provide large samples of correlated charm data
      - Enough with **3 months of data taking at ψ''(3770)** over a 5 years period
      - Key data also for other analyses (e.g. D-mixing and CPV in charm)
    - **<u>Only way to reach sub degree precision</u>**