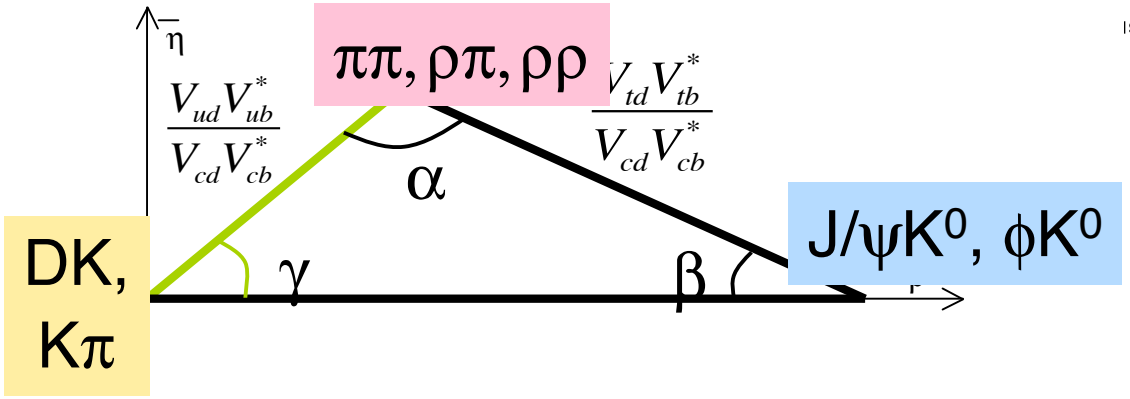
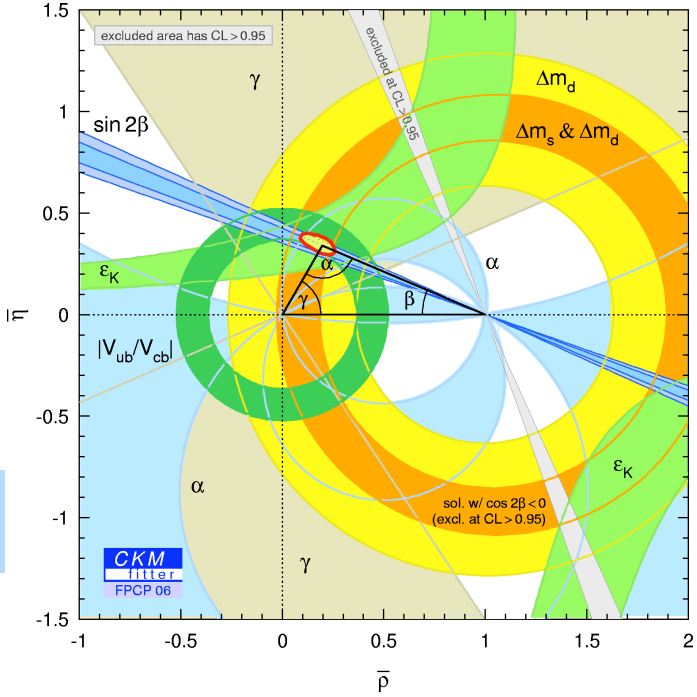
Charmless B-decays at BaBar

Matt Graham

Why Charmless?

- huge variety of physics can be found in charmless decays
  - can extract all three UT angles
  - potential New Physics can be seen in penguin transitions
  - large range of BFs for these “rare” decays
  - BFs and CP asymmetries are important inputs for theoretical models (e.g. PQCD, SCET, factorization etc…)

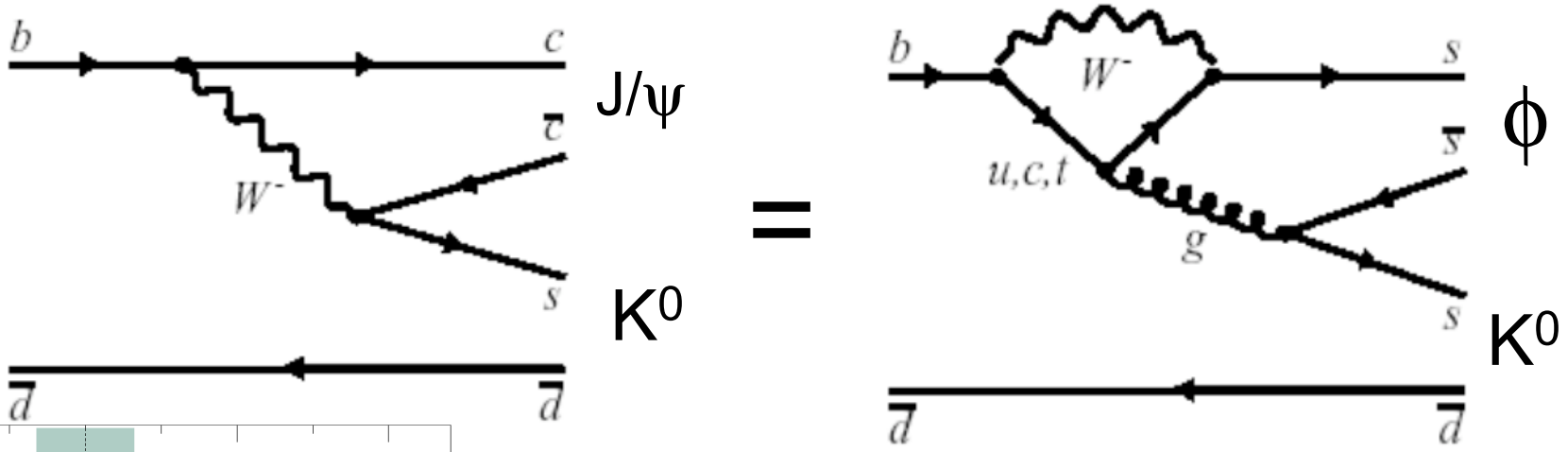


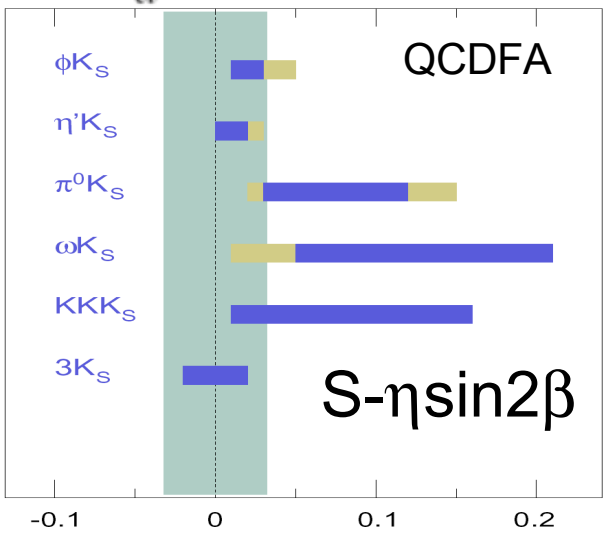


SLAC Participation in the Charmless World

* Convenerships:
  - Charmless 2-body: A. Roodman (2007-Present)
  - Charmless 3-body: M. Graham (2004-Present), D. Dujmic (2005-2007)
* Analysis:
  - $h^+\pi^0/\pi^0\pi^0$: AR, M. Allen, I. Ofte
  - $K^+K^-K^0$/ $K_sK_sK^+$: AR, DD, J. Thompson, H. Kim, B. Lindquist
  - $K^+\pi^-\pi^0$: AR, MG, A. Wagner
  - $K_s\pi^+\pi^-$: MG
  - $K_s\pi^0\pi^0$: AR, MA
  - $\pi^+\pi^-\pi^0/\rho^+\rho^-$: MG
  - ppbarh: T. Hrynova
  - $\Lambda\Lambda h$: MG, B. Butler

sin2β From Penguin Decays

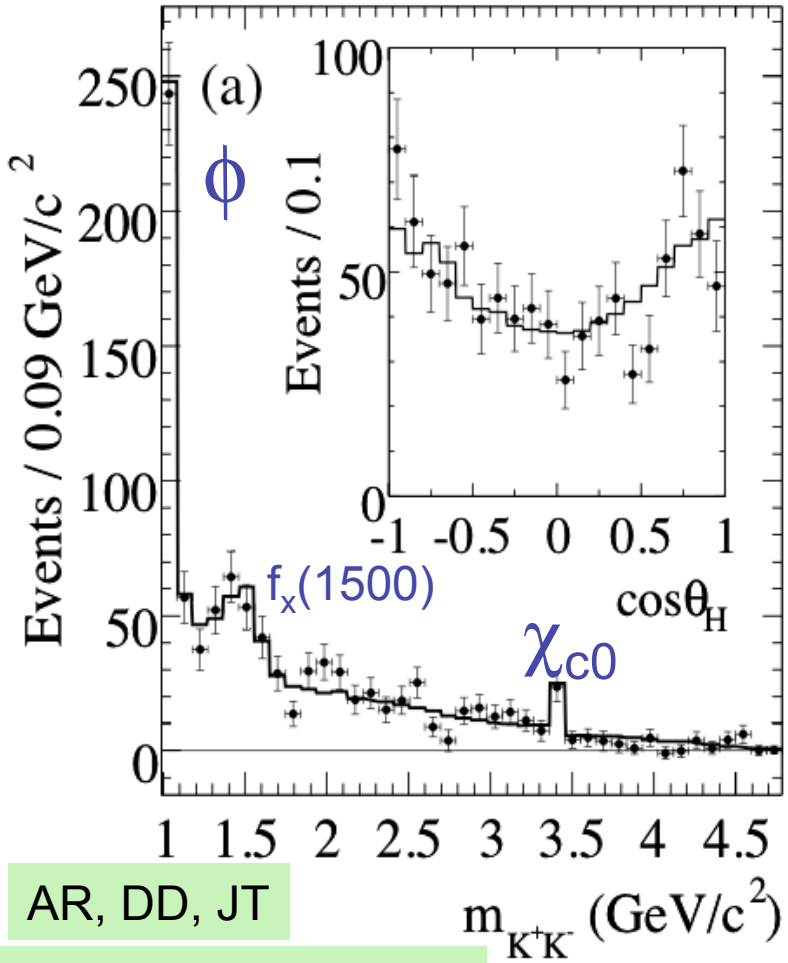




- penguin dominated b→(qqbar)s decays have the same weak phase as b →(ccbar)s and thus the TD-CPV parameters should be S=ηsin2β and C=0 in the SM
- other SM diagrams contribute a small shift and is expected to increase S

2-body: [Beneke; PL B620, 143 (2005)]
3-body: [Cheng,Chua,Soni; PRD72, 094003 (2005)]

Measuring β: $B^0 \to K^+K^-K^0$ Dalitz Plot Analysis

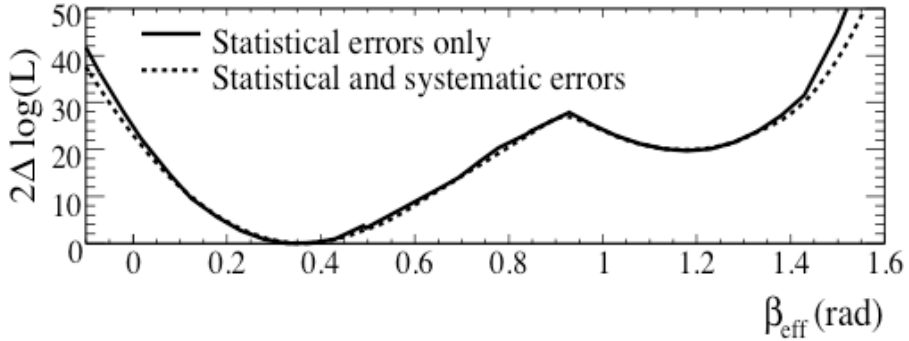


AR, DD, JT

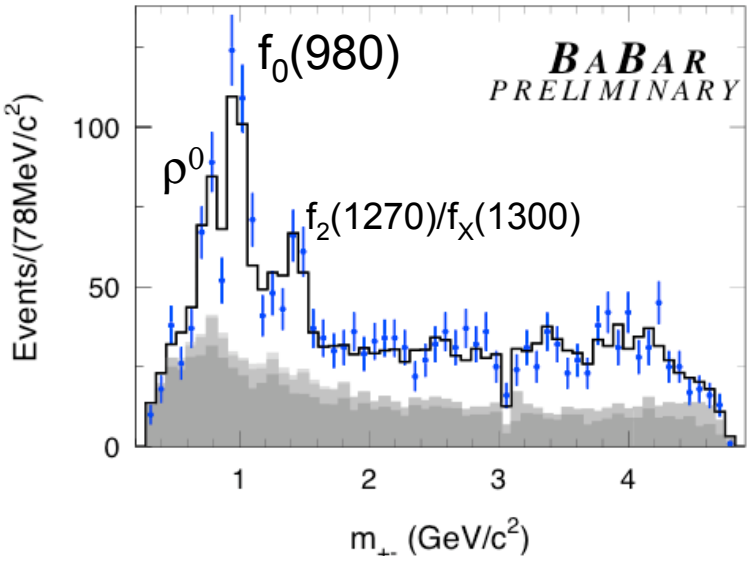
PRL 99, 1610802,2007

- we perform a time-dependent Dalitz plot amplitude analysis: includes φ(1020), $f_0(980)$, "$f_X(1500)$", χ_{c0}, and a non-resonant component
- interference between CP-Odd and CP-Even terms allows us to extract β_{eff}

$\beta_{eff} = (18.9 \pm 4.6 \pm 1.7)^o$
mirror solution disfavored
@ 4.5σ

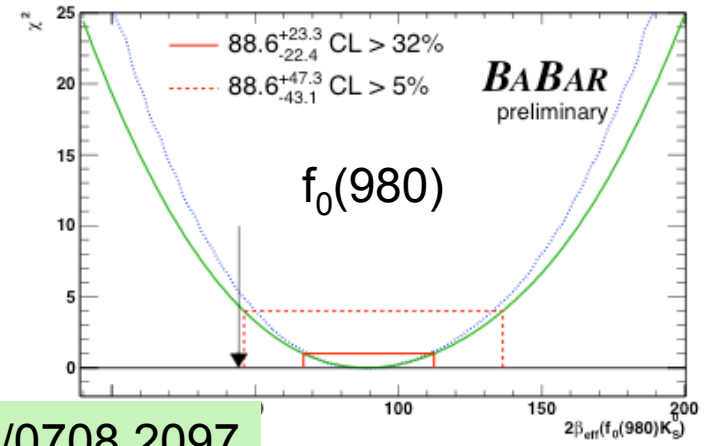


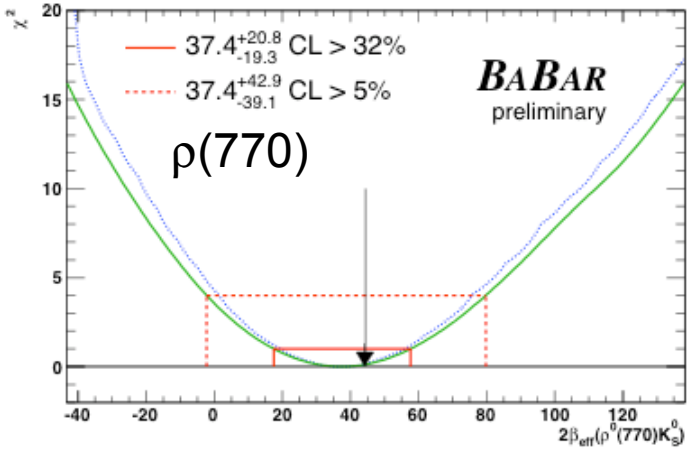
Measuring β: $B^0 \to \pi^+\pi^- K_S$ Dalitz Plot Analysis



- another TD-DP amplitude analysis; more going on here…
- includes ρ(770), $f_0(980)$, $f_2(1270)$, "$f_X(1300)$", and a non-resonant component
- additionally, there are self-tagging modes: K*(892), $K^*_0(1430)$

$\beta_{eff}(f_0(980)K_s)=(44.3 \pm 11.5)^o$
$\beta_{eff}(\rho(770)Ks)=(18.7 \pm 10.0)^o$





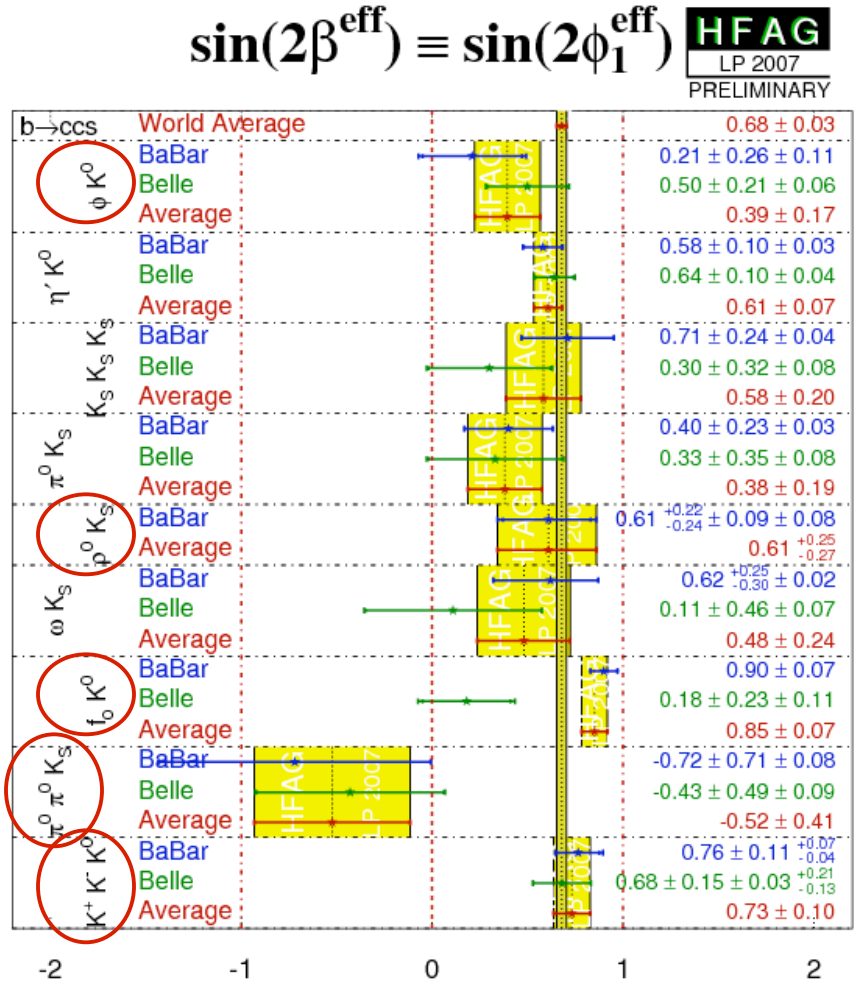
MG

hep-ex/0708.2097

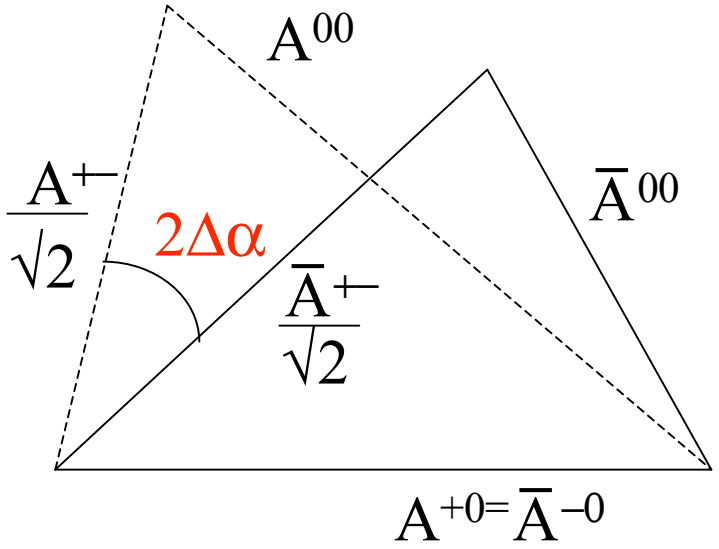
Status of sin2β from Penguins

Naïve average of S now in excellent agreement with SM….

BUT: most of the measurements are still below the SM…the very small errors on $K^+K^-K_s$ and f_0K_s help to pull the average up.



Measuring α: The Isospin Analysis

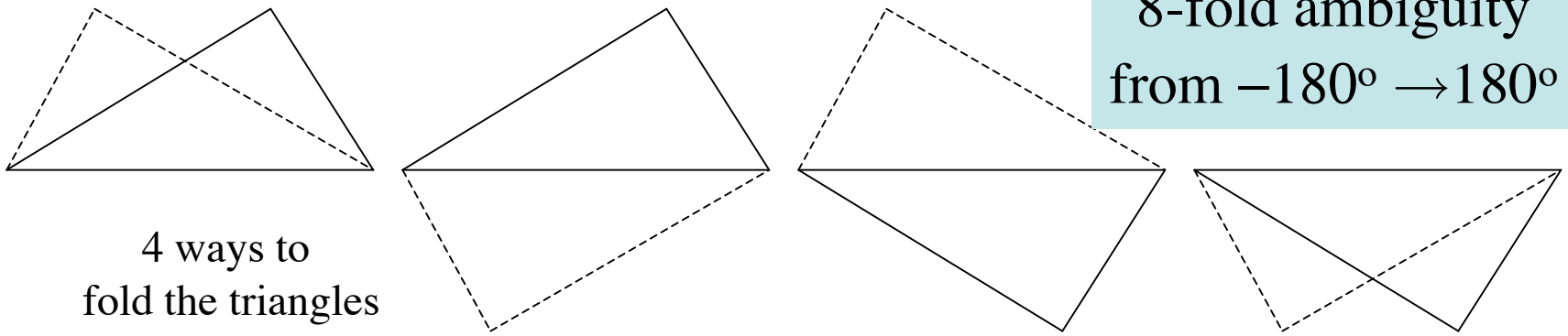


$A^{+-}=A(B^0\to\pi^+\pi^-)$
$\bar{A}^{+-}=A(B^0\to\pi^+\pi^-)$ BF, S, C

$A^{00}=A(B^0\to\pi^0\pi^0)$
$\bar{A}^{00}=A(B^0\to\pi^0\pi^0)$ BF, S, C

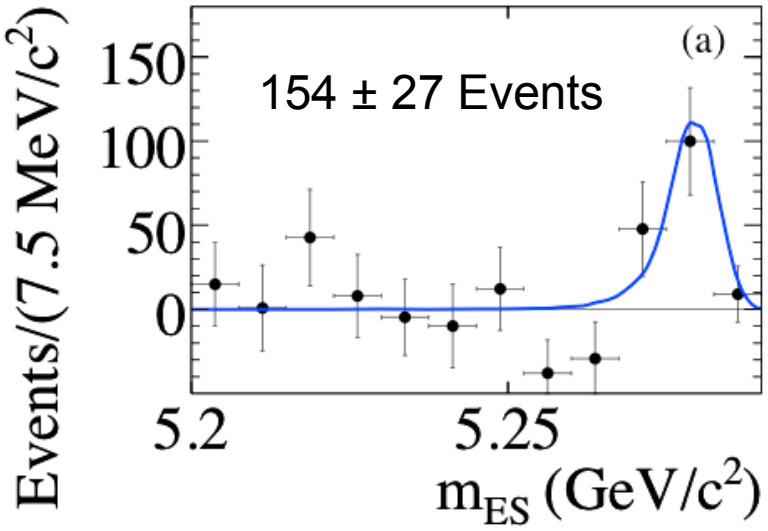
$A^{+0}=A(B^+\to\pi^+\pi^0)$
$\bar{A}^{-0}=A(B^-\to\pi^-\pi^0)$ BF, A_{cp}

8-fold ambiguity from $-180^o \to 180^o$



4 ways to fold the triangles

Measuring α: $B \to \pi^0\pi^0$

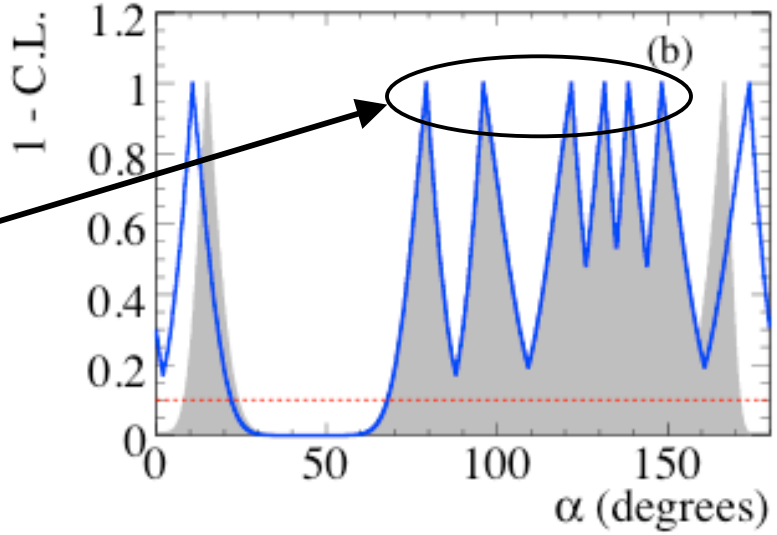


- crucial mode for ππ isospin analysis
- can't extract S, but can get C!

$BF(\pi^0\pi^0) = (1.5 \pm 0.28) \times 10^{-6}$

$C(\pi^0\pi^0) = -0.49 \pm 0.35$

without $C(\pi^0\pi^0)$, the peaks here are completely unresolved!



AR, MA

PRD 76, 091102, 2007.

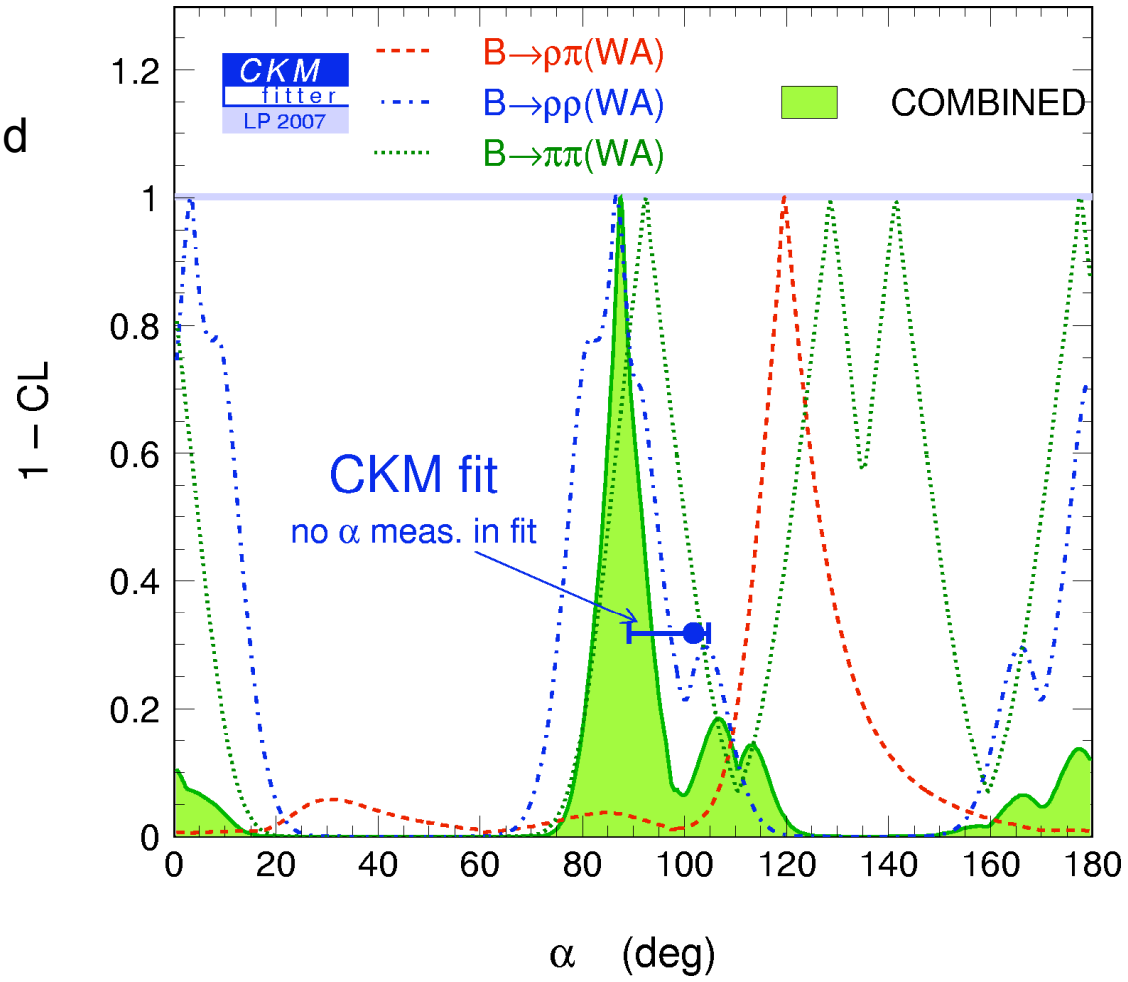
Status of α

SLAC has also been involved in the analysis of $B^0 \to \rho^+\rho^-$ and $B^0 \to \rho\pi$ (both MG)…

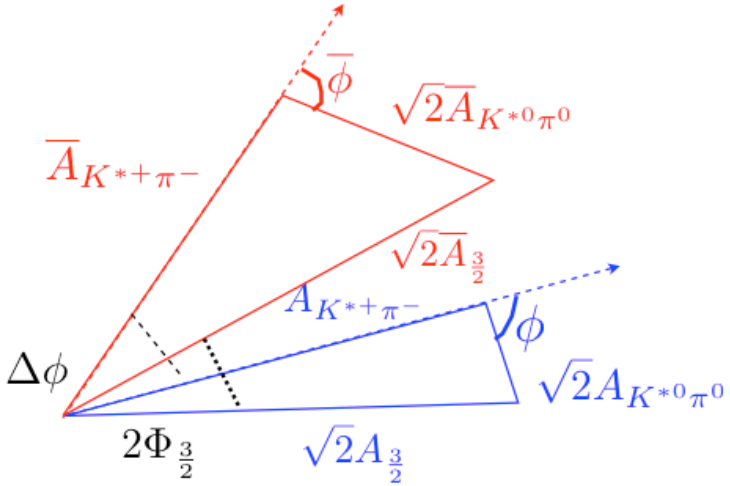
Combining all results, we have:

$\alpha = 87.5 \pm 5.8$ at 1σ

*** this doesn't include newest $\pi^0\pi^0$ result!!!



Measuring γ: $B^0 \to K\pi\pi$ Dalitz Plots



- Can use an isospin decomposition in the Kπ system to extract γ
- Need the relative phases between the different Kπ isospin states…interference!
  - •can't use the 2-body states ($K^+\pi^-$, $K^0\pi^0$)
  - •must use 3-body decays→Dalitz plots

Need phases between:

($K^{*+}\pi^-$, $K^{*0}\pi^0$)
($K^{*-}\pi^+$, $\overline{K}^{*0}\pi^0$) } $B^0 \to K^+\pi^-\pi^0$
($K^{*+}\pi^-$, $K^{*-}\pi^+$) } $B^0 \to K_s\pi^+\pi^-$

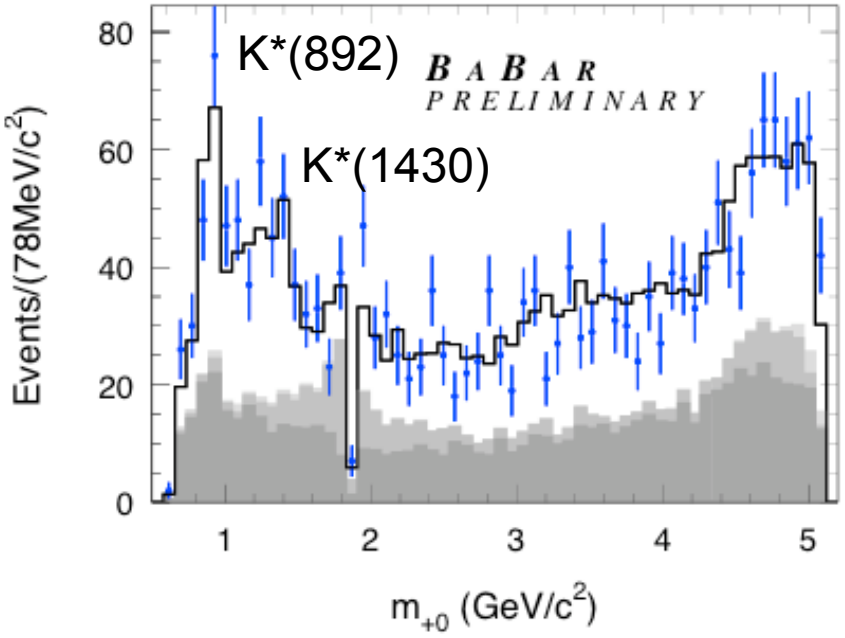
$$A_{1,\frac{3}{2}} = \frac{1}{\sqrt{2}}A(B^0 \to K^{*+}\pi^-) + A(B^0 \to K^{*0}\pi^0)$$

$$A_{1,\frac{3}{2}} = \frac{1}{\sqrt{2}}A(B^+ \to K^{*0}\pi^+) + A(B^+ \to K^{*+}\pi^0)$$

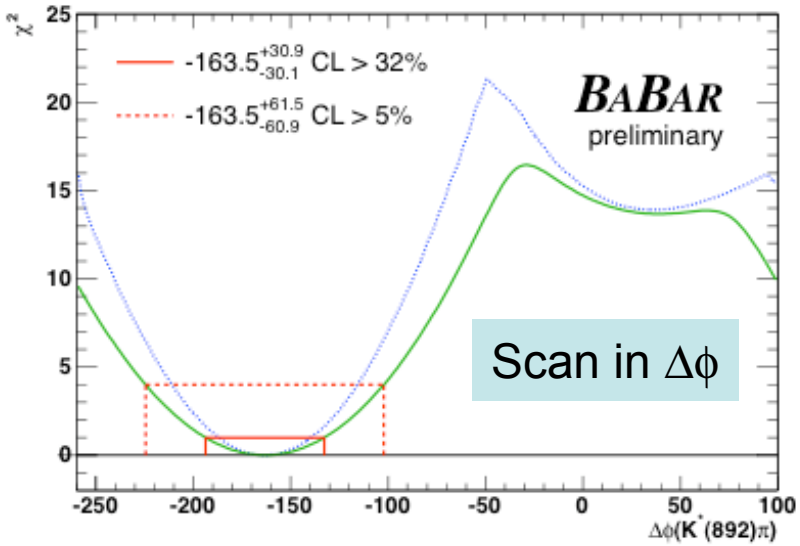
$$R_I = \frac{\overline{A}_I}{A_I} \Rightarrow \gamma = -\frac{1}{2}arg\left(R_I\right)$$

Ciuchini et al.,
PRD 74, 051301, 2006

Measuring γ: $B^0 \to \pi^+\pi^- K_s$ Dalitz Plot



- Same analysis as the $f_0(980)K_s$ and $\rho(770)K_s$ TD-CPV results!
- Sensitivity to $\Delta\phi(K^{*+}\pi^-, K^{*-}\pi^+)$ comes (mainly) from common interference between K* and ρ(770) and NR



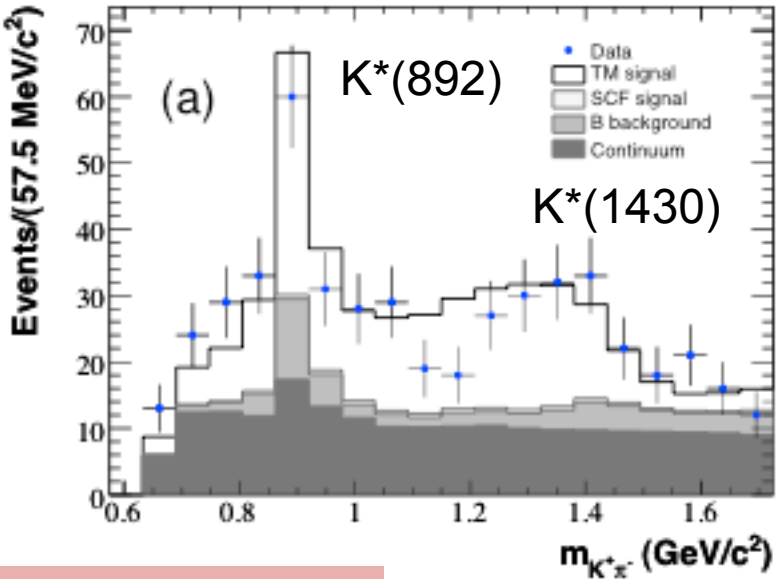
$\Delta\phi(K^{*+}\pi^-, K^{*-}\pi^+) = (164 \pm 31)^o$
mirror solution disfavored
@ 3.7σ significance

MG

hep-ex/0708:2097

225M B-Pairs

Measuring γ: $B^0 \to \pi^-\pi^0 K^+$ Dalitz Plot

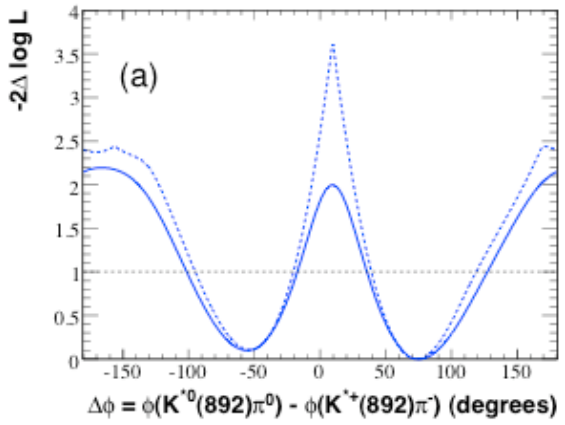


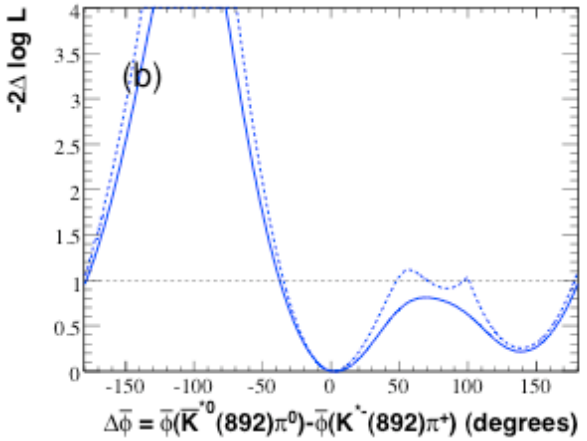
- Spin-off of the $\pi^+\pi^-\pi^0$ DP analysis
- Tricky! Poorer resolution than $K_s\pi^+\pi^-$ due to π^0; more going on in the DP than in $\pi^+\pi^-\pi^0$
- Current result just published recently on Runs 1-4 by the Paris group; we are working on an update

No significant constraint on the phases…should do better with full dataset

Paris/MG,AW

hep-ex/0711:4417





Future Plans

* Complete the KKK Dalitz plot picture with full dataset:
  - update of $K^+K^-K_s$ time-dependent DP analysis is almost done
  - plan on doing DP analysis of $K^+K^-K^+$ (update) and $K_sK_sK^+$ (for the first time
* Use full dataset to extract γ in $B^0 \to K\pi\pi$
  - update of $B^0 \to K^+\pi^-\pi^0$ is almost complete
  - plan to update $B^0 \to K_s\pi^+\pi^-$ for next summer
  - investigate using $K^*_0(1430)\pi$ system to extract γ
* Use full dataset to extract α in $B^0 \to \pi^+\pi^-\pi^0$
  - work has begun; plan to have result for next summer

Summary

* This is an interesting and challenging time to be doing physics analysis on BaBar
* Since we won't have more data, the results we make public from now on are likely the final word from BaBar
* Our goal is give as complete and coherent picture as possible…and extract as much information as we can!
* Our physics goals center around understanding the KKK and $\pi\pi$K Dalitz plot composition and use that knowledge to measure β_{eff} and γ