Systematics in TagMix and $\sin 2\beta$

R. N. Cahn

LBNL

$\sin 2\beta$ Meeting

July 6, 2000

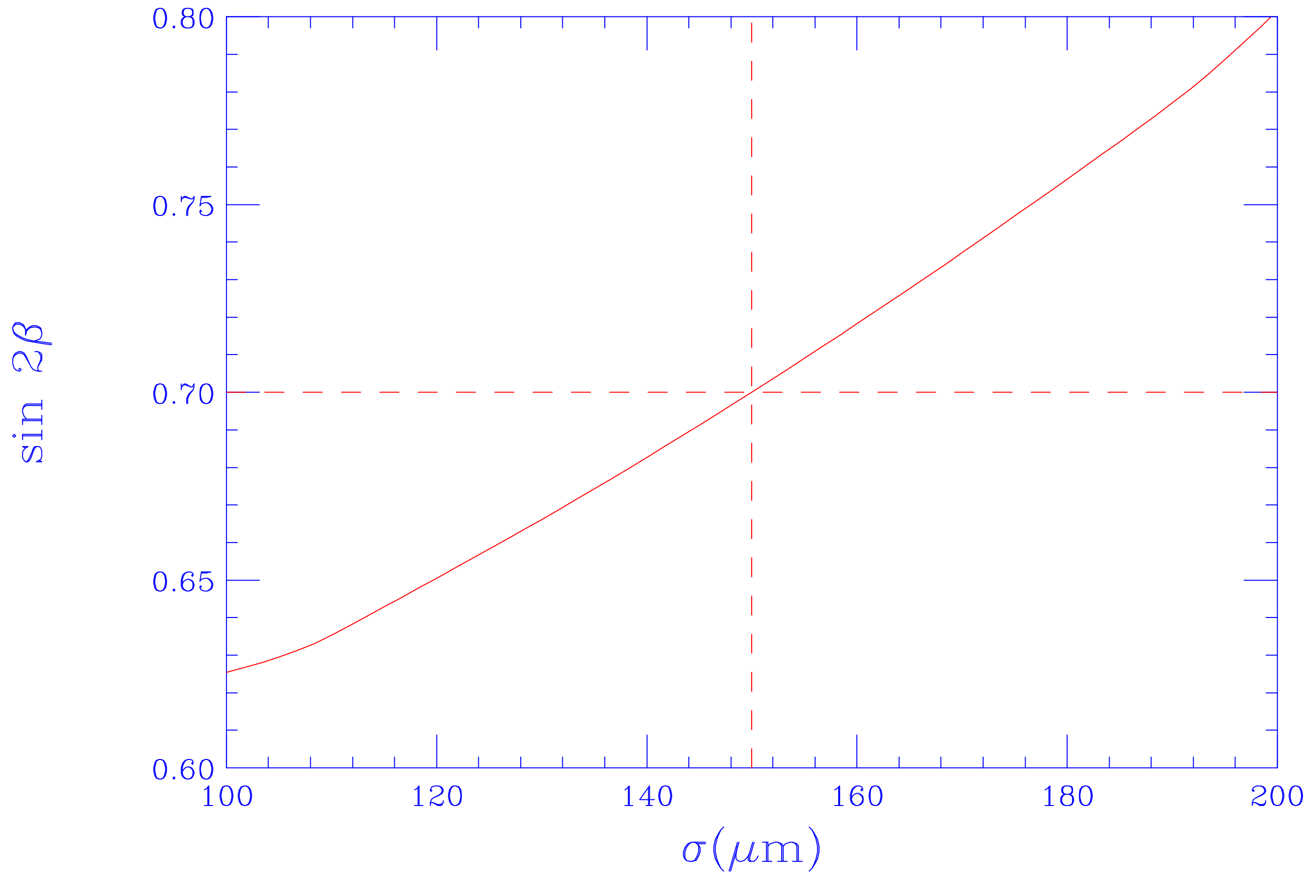
Outline

- Issues Unrelated to Dilutions
  - Effect of $\sigma_{CP} \neq \sigma_{TM}$
  - Effect of Uncertainty in Δm and Γ
- Issues Related to Dilutions
  - Common to nonleptonic and semileptonic
    * Effect of Uncertainty in Δm and Γ
    * Effect of Uncertainty in Resolution Shape
    * Can We Ignore Oscillating Background?
  - Nonleptonic analysis
  - Semileptonic analysis
  - Comments

If $\sigma(\Delta z)_{CP} \neq \sigma(\Delta z)_{TM}$ (from last week)

True values: $\sin 2\beta = 0.7, \sigma = 150\mu$m

$\sin 2\beta$ deduced vs. σ_{CP} used



What to set as systematic error on $|\sigma_{TM} - \sigma_{CP}|$, $|\sigma_{MC\ \psi K_S} - \sigma_{B\ reco}|$?

Effect of Uncertainty in Δm, Γ on $\sin 2\beta$

Γ	Δm	A
1.52	0.464	0.698
1.56	0.464	0.700
1.60	0.464	0.702
1.56	0.446	0.694
1.56	0.482	0.704

Table 1: For assumed $\Gamma = 1.56$ ps and $\Delta m = 0.464$ ps^{-1}, the value of $A = \sin 2\beta$ deduced for various true values of Γ and Δm.

Calculated with all variables except asymmetry fixed.

Negligible.

Effect of Uncertainty in Δm and Γ on Dilution

Γ	Δm	D
1.52	0.464	0.601
1.56	0.464	0.600
1.60	0.464	0.599
1.56	0.446	0.606
1.56	0.482	0.593

Table 2: For assumed $\Gamma = 1.56$ ps and $\Delta m = 0.464$ ps^{-1}, the value of D deduced for various true values of Γ and Δm for a true value $D = 0.6$.

Calculated with all variables except dilution fixed.
Very small effect.

Uncertainty in Resolution Shape

Fit single gaussian to double gaussian distribution

σ_{core}	σ_{tail}	$frac_{core}$	D_{in}	σ	D_{out}
100	300	1.000	0.6	100	0.600
100	300	0.800	0.6	144	0.595
100	300	0.600	0.6	189	0.594

Table 3: Simulation of using a single gaussian to fit a double gaussian resolution function. The value of the single σ determined is close to the rms of the input σs. The effect on the dilution is only 1% in the extreme case.

- BAD #64 gives systematics 0.010 - 0.017
- Probably overestimates

Can We Ignore Oscillating Background?

(shown last week)

	Input	Output
$D(B^0)$	0.6	0.635
$D(B^{\pm})$	0.7	0.373
$f(B^0$	0.9, fixed	0.9, fixed
$f(comb)$	0.8, fixed	0.8
$f(\tau = 0)$	0.333	0.329
$f(\tau = 1.56\ \mathrm{ps})$ no mixing	0.333	0.671
$f(\tau = 1.56\ \mathrm{ps})$ mixing	0.333	0.0, fixed
$D(\tau = 0)$	0.4, fixed	0.4, fixed
$D(\tau = 1.56\ \mathrm{ps})$	0.4, fixed	0.4, fixed
$D(\tau = 1.56\ \mathrm{ps})$	0.4, fixed	0.4, fixed

Check above results:

Oscillating: Conserved $\sum f_0^i D_0^i$:

In:

$0.9 \times 0.8 \times 0.6 + (1/3) \times 0.2 \times 0.4 = 0.459$

Out:

$0.9 \times 0.8 \times 0.635 = 0.457$

Non-oscillating Conserved: $\sum f_\pm^i D_\pm^i$:

In:

$0.1 \times 0.8 \times 0.7 + (2/3) \times 0.2 \times 0.4 = 0.109$

Out:

$0.1 \times 0.8 \times 0.373 + (3/3) \times 0.2 \times 0.4 = 0.110$

Effect is not negligible.

Nonleptonic Analysis in BAD #64

- Uncertainty in method: limited by MC statistics $(0.01 - 0.03)$
- B lifetime (< 0.01)
- Resolution Shape $(0.01 - 0.02)$
- Outliers (0.01)
- Background resolution function (not yet in Table)
- Charged B (not yet in Table)
- Oscillatory background ?

Semileptonic Analysis

- More background complicates analysis
- Must input externally determined quantities
- Measure efffective dilution
- Correct for oscillating backgrounds
- Correct for non-oscillating backgrounds
- All done by Minuit out of sight

- Three time components
  - Prompt (even in "signal")
  - Non-Oscillatory
  - Oscillatory

- $$f_{sig} + \sum_i f^i_{osc} + \sum_i f^i_{non} + f_{prompt} = 1 \tag{1}$$

- $$D_{sig} = \frac{1}{f_{sig}} \left(r - \sum_i f^i_{osc} D^i_{osc} \right) \tag{2}$$

$$\delta D = \frac{\partial D}{\partial f_{bkgd}} \delta f_{bkgd} = \frac{D}{f_{sig}} \delta f_{bkgd} \approx \delta f_{bkgd}$$

	f	Syst. Error	Error in D_{sig}
charged B	0.08?	0.05?	0.04?
combinatorial	0.20?	0.02?	0.02?
charm	0.04?	0.02?	0.02?
wrong/fake lepton	0.04?	0.02?	0.02?

Table 4: Major systematic errors on the dilution. In a complete analysis, this would be done separately for each tag category. Here we display the errors for a representative category with a dilution near 0.6. We need your input.

Errors in $\sum_i f^i_{osc} D^i_{osc}$ primarily statistical.

Comments

- Nonleptonic analysis
  - Generally in good shape
  - Concern about oscillating background
  - Will dominate in long-term
- Semileptonic analysis
  - Need to nail down background fractions
  - Provides good check of nonleptonic
  - Improvements possible in analysis scheme
- Need to connect to Δm analysis