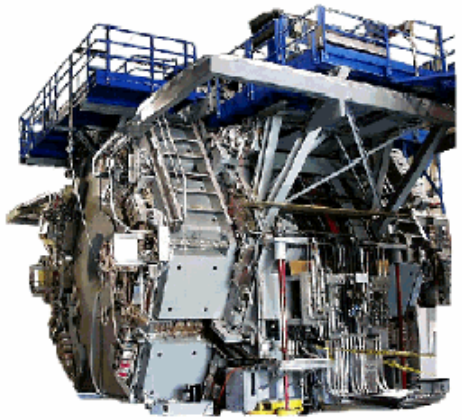
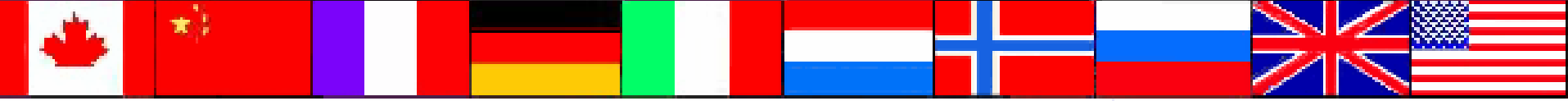


BABAR Future Plans

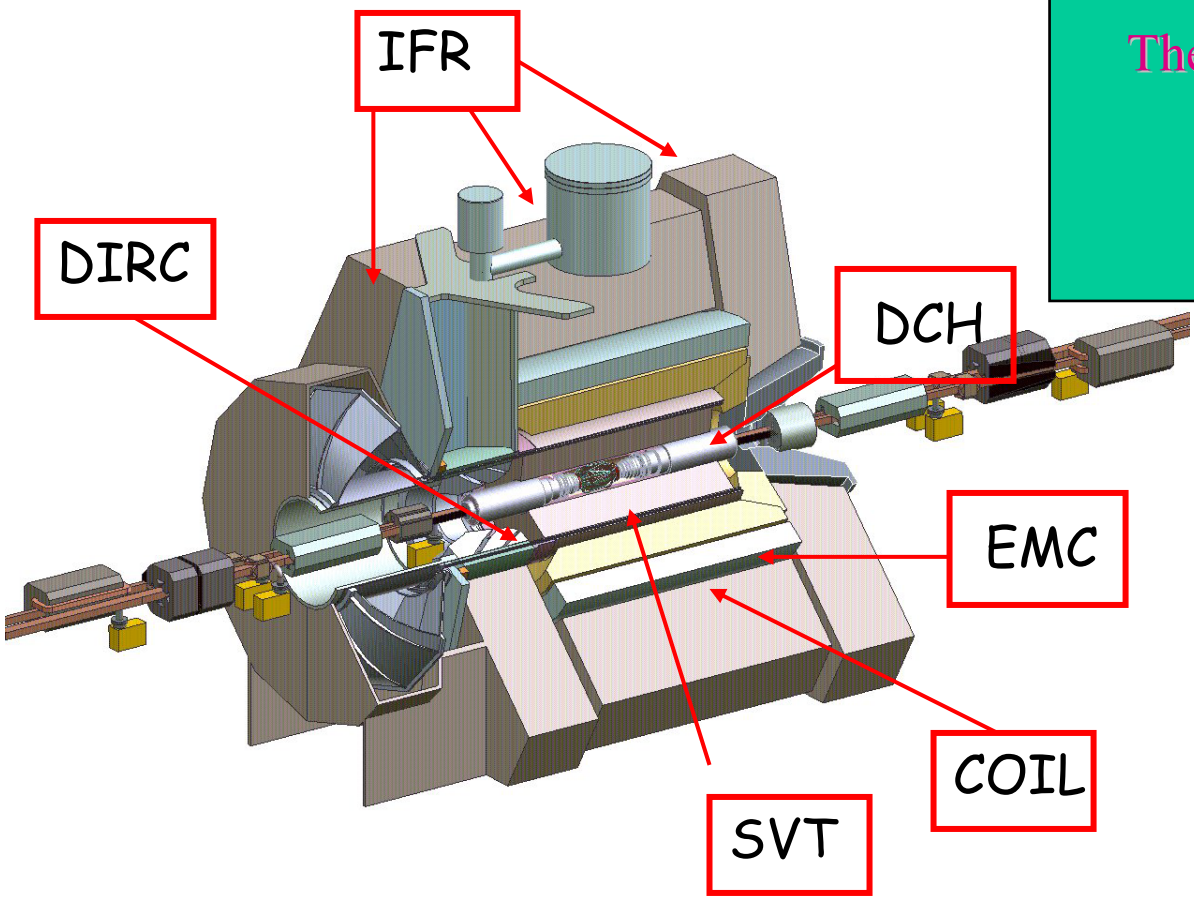
Marcello A. Giorgi

on behalf of BaBar Collaboration

FPCP 2003- PARIS



Canada	China	France	Germany	Italy	The Netherlands	Norway	Russia	United Kingdom	USA
[4/18]	[1/5]	[5/55]	[3/30]	[11/101]	[1/2]	[1/3]	[1/9]	[10/66]	[38/290]



The *BABAR* Collaboration

10 Countries
75 Institutions
579 Physicists

BABAR

BaBar Physics Mission

New environment: high luminosity asymmetric collider

1)Search for CP violation in B meson decays largely predicted by the Standard Model

2)Test extensively at this low energy scale the Standard Model by measuring precisely enough quantities to impose constraints on the Standard Model parameters

~~CP~~ in b sector is **FOUND !**

TRY to open windows on new Physics beyond Standard Model

Rare B decays, Charm study, Tau rare decays

(FY03) CP, T, CPT

A simultaneous fit to tagged and untagged data gives :

Δm ,$\sin 2\beta$ (consistent with previous analysis)

$|\bar{A}_{cp}/ A_{cp}|$ (consistent with no direct CP violation (4.5%)

(Wrong tag with K due to DCS allowed. $\Delta\Gamma/\Delta$ m, z, λ, |q/p| left free!)

$$\begin{aligned}
\mathrm{sign}(\mathrm{Re}\,\lambda_{CP}) \times \Delta\Gamma/\Gamma &= -0.008 \pm 0.037 \pm 0.018 \quad [-0.084, +0.068] \\
|q/p| &= 1.029 \pm 0.013 \pm 0.011 \quad [+1.001, +1.057] \\
(\mathrm{Re}\,\lambda_{CP}/|\lambda_{CP}|) \times \mathrm{Re}\,z &= 0.014 \pm 0.035 \pm 0.034 \quad [-0.072, +0.101] \\
\mathrm{Im}\,z &= 0.038 \pm 0.029 \pm 0.025 \quad [-0.028, +0.104]
\end{aligned}$$

90% CL

$$z = 2\frac{\delta M - (i/2)\delta\Gamma}{\Delta m - (i/2)\Delta\Gamma}$$

$$a_T = (0.5 \pm 1.2 \pm 1.4)\% \approx \frac{1-|q/p|^4}{1+|q/p|^4}$$

From dileptons

Measurement of $\sin 2\beta = 0.741 \pm 0.067 \pm 0.034$

BaBar achievements on CP

$dN \propto \exp(-|\Delta t|/\tau_B)\,(1 \pm D\,(S \sin(\Delta m \Delta t) - C\cos(\Delta m \Delta t)))\otimes R$

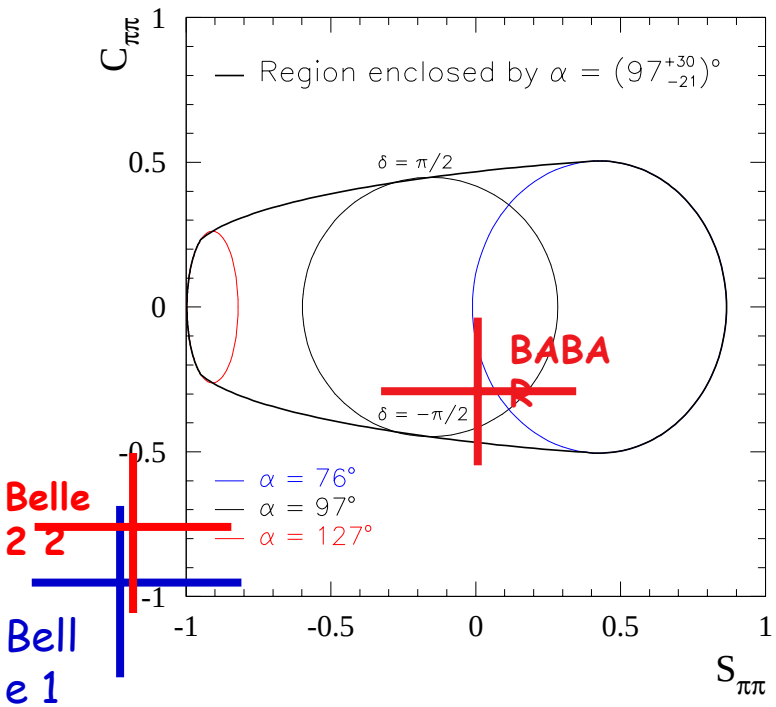
A simultaneous fit to tagged and untagged data gives :

Δm ,$\sin 2\beta$ (consistent with previous analysis)

$|A_{cp}/A_{cp}|$ (consistent with no direct CP violation (4.5%)

(Wrong tag with K due to DCS allowed. $\Delta\Gamma/\Delta$ m, z, λ, |q/p| left free!)

Measurement of $\sin 2\beta = 0.741 \pm 0.067 \pm 0.034$



cf. Gronau and Rosner, *Phys. Rev. D65, 093012 (2002)*

$\sin 2\alpha_{eff}$ from $B^0 \to \pi^+\pi^-$

$$S_{\pi\pi} = 0.02 \pm 0.34(stat) \pm 0.05(syst)$$

$$C_{\pi\pi} = -0.30 \pm 0.25(stat) \pm 0.04(syst)$$

$\alpha_{eff} = \alpha + \delta$ δ is a strong phase

With no informations about penguin pollution:

Measure $S_{\pi\pi}$ and $C_{\pi\pi}$ from both $\sin\Delta m\Delta t$ and $\cos\Delta m\Delta t$ terms .

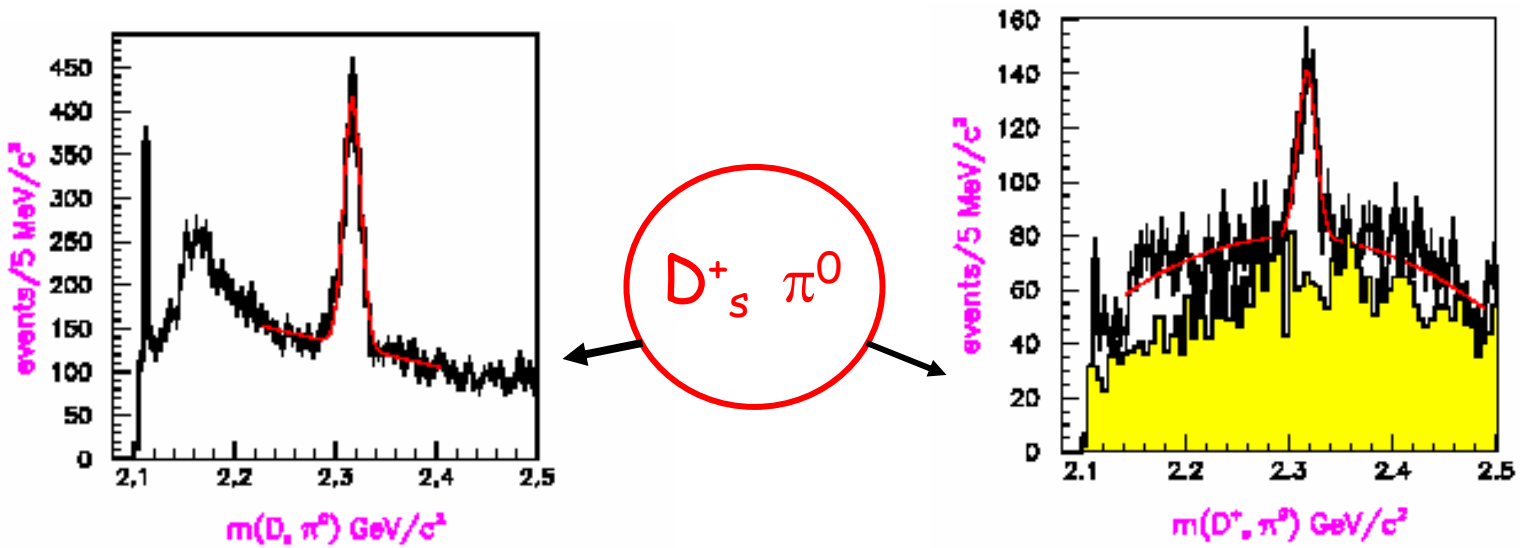
- *Compare with predicted $S_{\pi\pi}$ and $C_{\pi\pi}$ values for given α, β, $|P/T|$, and δ.*

Assume for instance:

$\alpha = (97_{-21}^{+30})°$, $\beta = 26°$ $|P/T| = 0.28$, $-\pi/2 < \delta < \pi/2$

Not only B Physics in BABAR !

A new state decaying into $D^+_s(1970)$ and π^0 has been discovered by us and recently confirmed by CLEO!

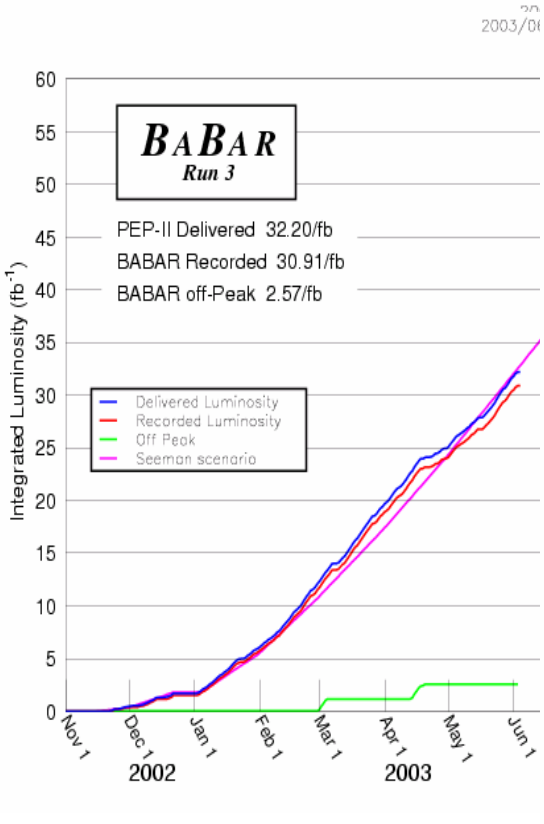


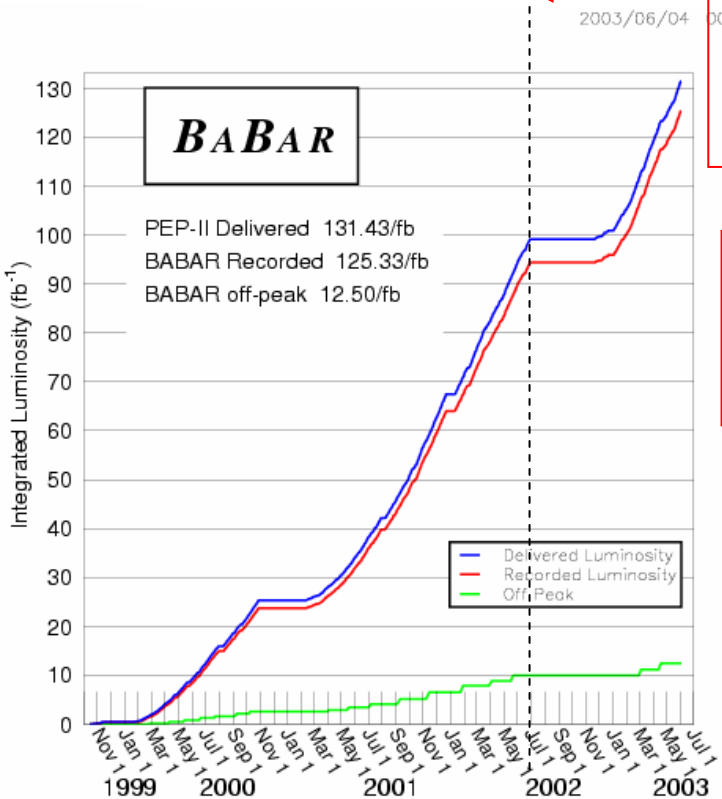
$D^+_s \to K^+K^- \pi^+$

$D^+_s \to K^+K^- \pi^+ \pi^0$

Luminosity: Present and Future

So far in Run 3: On peak 30.91 fb^{-1}
Off peak 2.57 fb^{-1}





Summer 2002 and Winter 2003:
Run 1 + Run 2
On peak 83.9 fb^{-1}
Off peak 9.6 fb^{-1}
92 M BB pairs

FY2002

Summer 2003:
Run 3
add 40 fb^{-1}

FY2003

By end 2006:
500 fb^{-1}

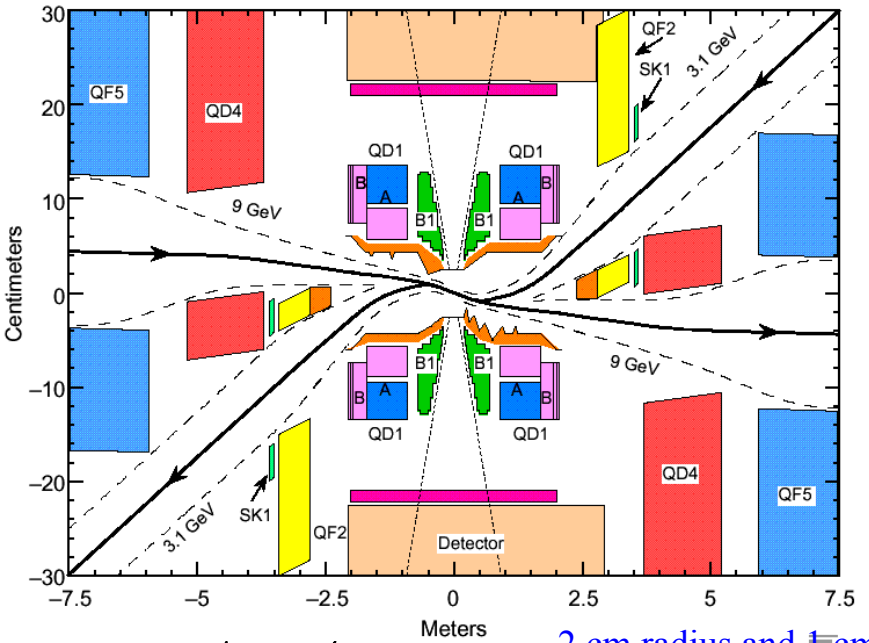
Longer term

By the end of the decade:
1÷2 ab^{-1}

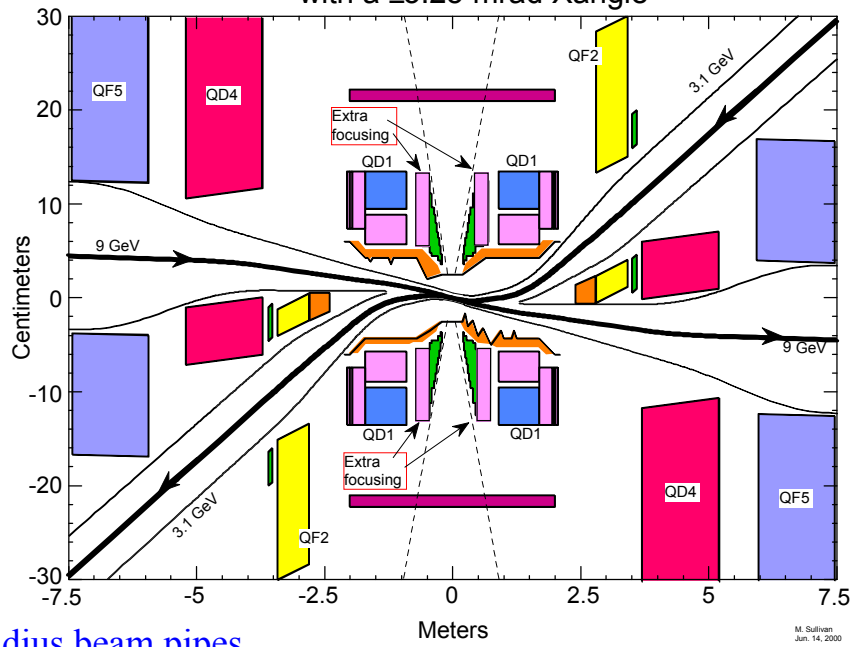
PEP-II Upgrade Plans

		Now	<2005 Projected	>2005 Upgrade	
	LER energy	3.1	3.1	3.1?	GeV
→	HER energy	9.0	9.0	9.0?	GeV
→	LER current	1.8	2.4	3.3	A
→	HER current	1.0	1.4	1.5	A
→	β_y^*	**12.5**	**9.0**	**5.0**	mm
	β_x^*	35	35	35	cm
	X emittance	50	50	50	nm-rad
	Estimated σ_y^*	5	4.3	3	μm
	Bunch spacing	1.89	1.89	1.26	m
	Number of bunches	921	1130	1700	
→	Collision angle	head-on	head-on	**±3.25**	mrads
	Beam pipe radius	2.5	2.5	2.5	cm
	Luminosity	5×10^{33}	8×10^{33}	**2×10^{34}**	$cm^{-2}\ sec^{-1}$

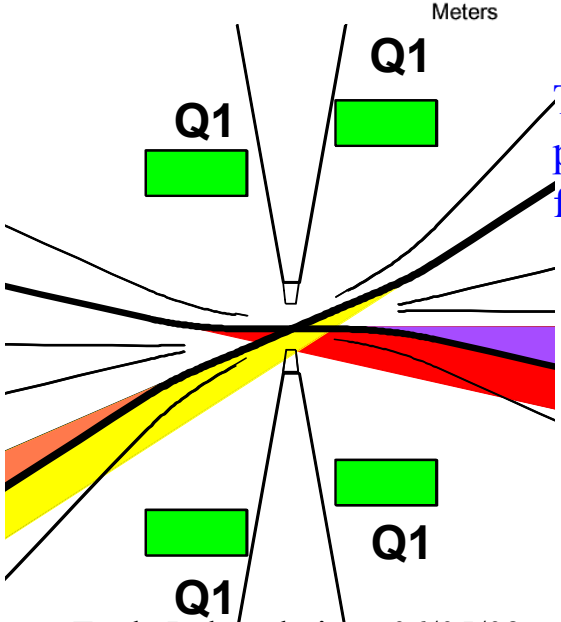
PEP-II Interaction Region



$2x10^{34}$ Interaction Region
with a ±3.25 mrad Xangle



2 cm radius and 1 cm radius beam pipes



The 1 cm radius beam pipe intercepts about 5 kW of power from the LER and nearly the same amount from HER

Minimum amount of material in the detector beampipe

This conflicts with having enough SR shielding (usually a thin coating of Au) to keep detector occupancy at acceptable levels

Minimum radius for the beam pipe

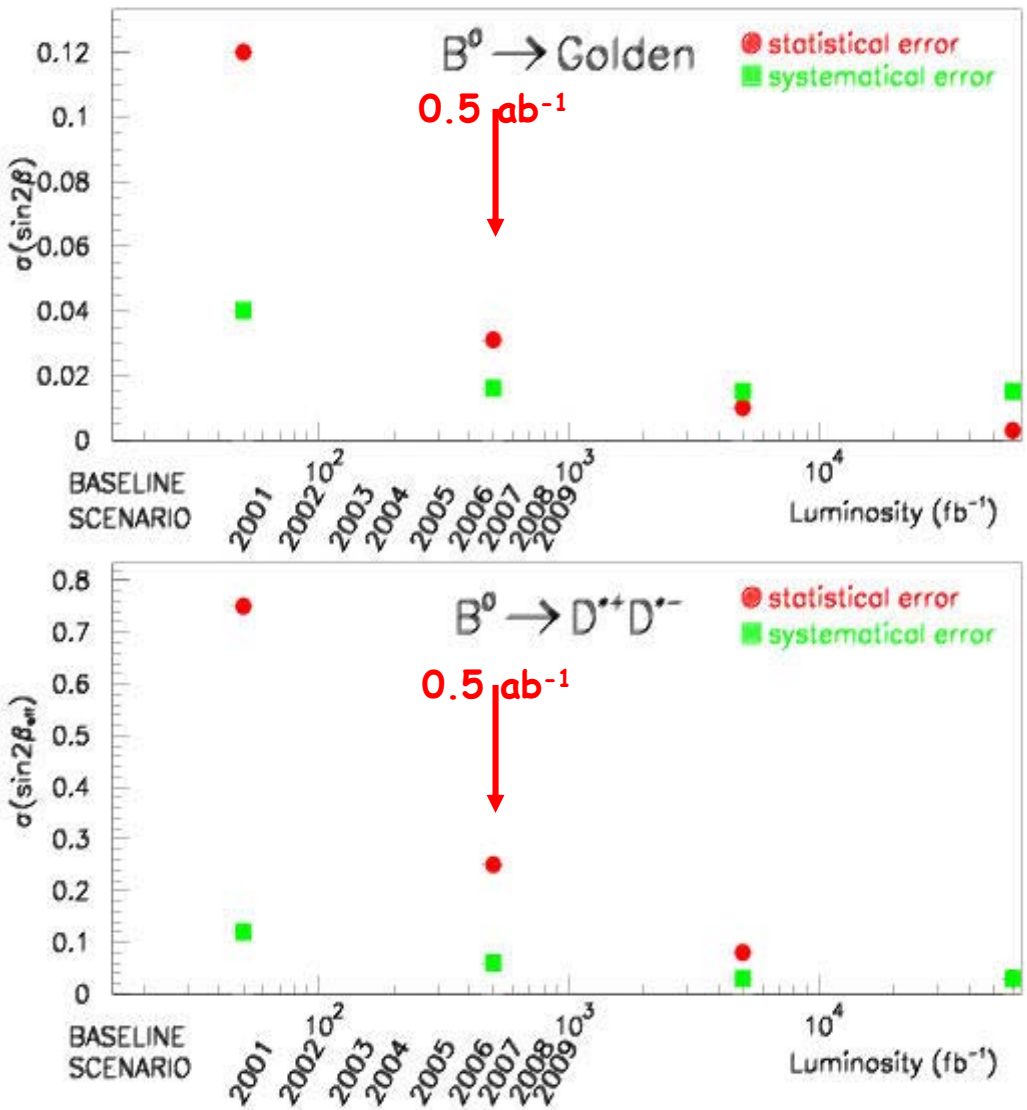
This must be balanced with the requested thickness of the beam pipe. The smaller the beam pipe the more power it must be able to handle (kW).

(>FY03) What next for Sin 2β

We can improve the expt. error on sin2β with luminosity in time dependent asymmetry for channels as:
b→ccs $O(\lambda^2)$ (golden mode as J/ψKs) or

b→ccd $O(\lambda^3)$ (such as $D^{(*)+}\ D^{(*)-}$) ,

where the leading term gives sin2β



(>FY03) What next for Sin 2β

Pure penguin process $B \longrightarrow \Phi K_s$

NEW PHYSICS ?

New quanta in the loop?

The present value with 80 /fb is:

$$S=\sin 2\beta = -0.19^{+0.52}_{-0.50}\ stat. \pm 0.09\ syst.$$

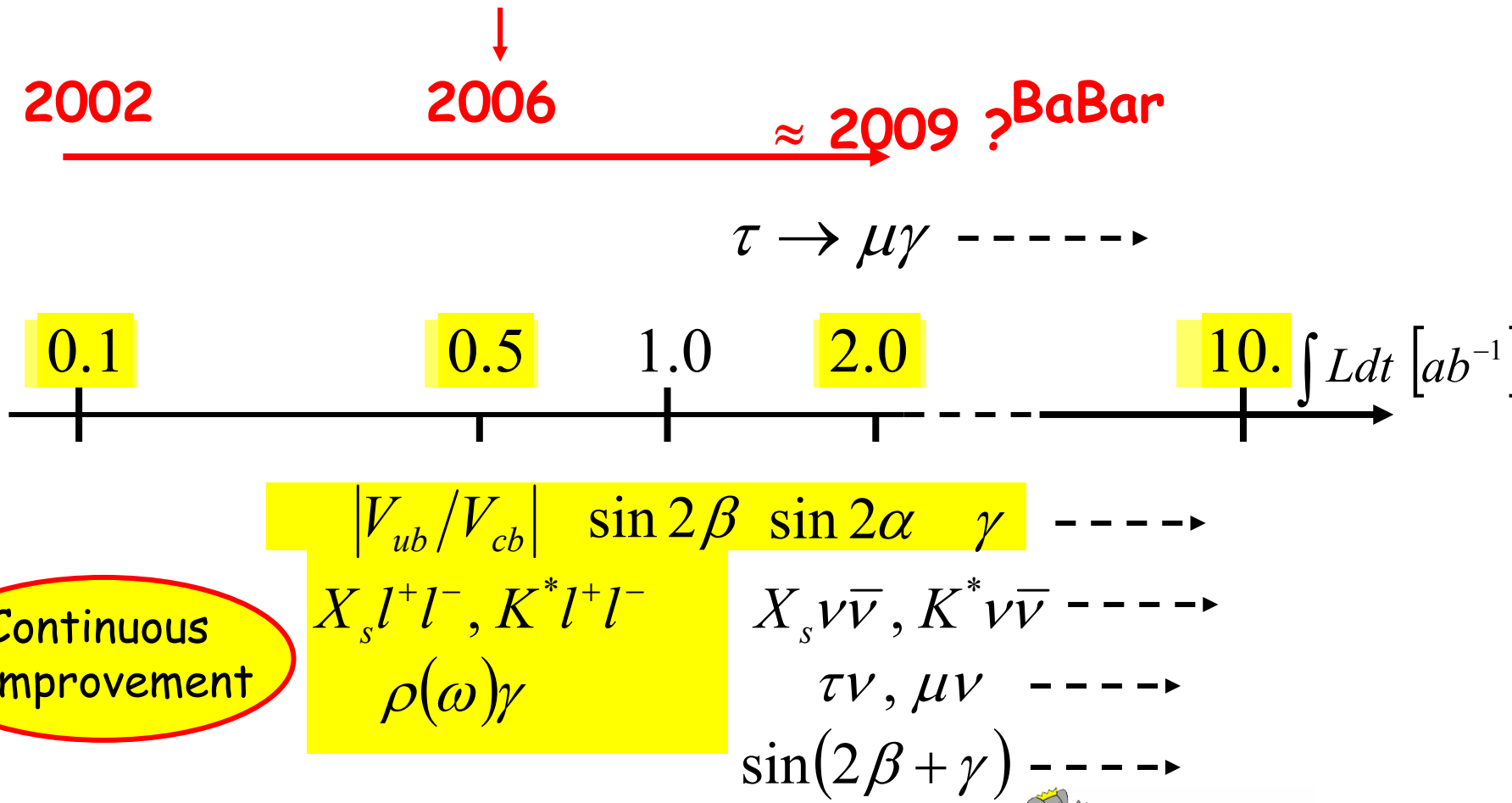
But also $B \longrightarrow \eta' K$ and $B \longrightarrow K K K$

How to go from α_{eff} to α ?

$\pi\pi$ channel with isospin analysis?

$\rho\pi$ with Dalitz plot analysis?

Integrated luminosity vs physics



Some comments about comparison with Hadron machine expts.

CKM parameters	BABAR/Belle	BTeV/LHC-B
	$2\ ab^{-1}$	$10^7\ s$
$Sin2\beta$(charmonium)	0.015stat/0.018syst	0.025/0.014
$Sin2\beta$ (penguins $b\rightarrow sss$)	0.10 stat	----
in $2S\alpha_{eff}(B^0 \rightarrow \pi+ \pi-)$	0.06 stat	0.024/0.056
$\alpha_{eff} - \alpha$ ($B^0 \rightarrow \pi^0 \pi^0$)	<10°	----
$Sin(2\beta-\gamma)$ ($B^0 \rightarrow D^*\pi^0 \pi^0$)	0.15	----
γ ($B \rightarrow DK$)	7°	<10°/<19°
|Vub|	1.4%+ Th. Unc.(now at best 10%)	----

Of course Bs mixing and decay can be studied well at hadron machines (γ and a lot of good physics from Bs see talk of R.Fleisher at this conference.

Rare decays - Summary

Channel	BF	BTeV/LHC-B (10^7 s)	BABAR/BELLE (2 ab^{-1})
$b \to s\gamma$	$3.3 \pm 0.3 \times 10^{-4}$	----	44.0K 6.8K(Btagged)
$B \to K^*\gamma$	5×10^{-5}	25K	24.0K
$B \to \rho(\omega)\gamma$	2×10^{-6}	----	1.2K
$b \to s\mu^+\mu^-$	$6.0 \pm 1.5 \times 10^{-6}$	3.6K	1.2K
$b \to se^+e^-$			1.4K
$B \to K^*\mu^+\mu^-$	$2.0 \pm 1 \times 10^{-6}$	2.2K/4.5K	0.5K
$B \to K^*e^+e^-$			0.6K
$b \to s\nu\nu$	$4.1 \pm 0.9 \times 10^{-5}$	----	30
$BK^*\nu\nu$	5.0×10^{-6}	----	6
$B \to \tau\nu$	5×10^{-5}	----	70
$B \to \mu\nu$	5×10^{-7}		35
$\tau \to \mu\gamma$			Limit< 10^{-8}

Asymmetries!

Rates...
Fully reconstructed B on the other side are used
The so called **B beam** option

Bfactory and hadron machine measurements are complementary !

What about Detector? SVT!

BABAR is a VERY good detector: very difficult to improve it!! (On IFR barrel is the **only** major intervention needed)

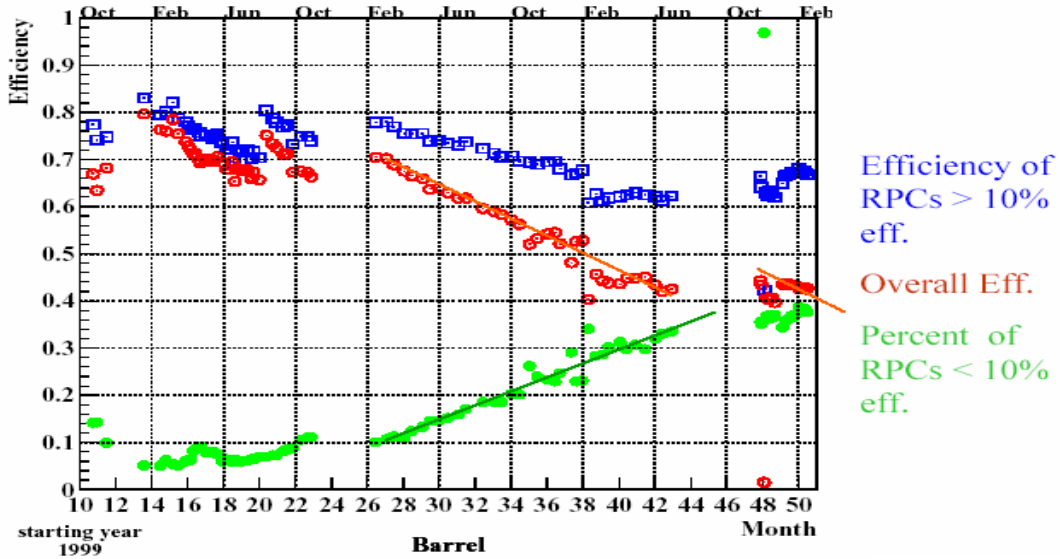
SVT is 98% efficient. No degradation due to irradiation has been observed so far

SVT so far tested for rad hardness up to 4 Mrad (OK!) rad tests are going on.

Partial SVT replacement is considered by 2005. Almost 50% of modules built as spare.

IFR Barrel Upgrade

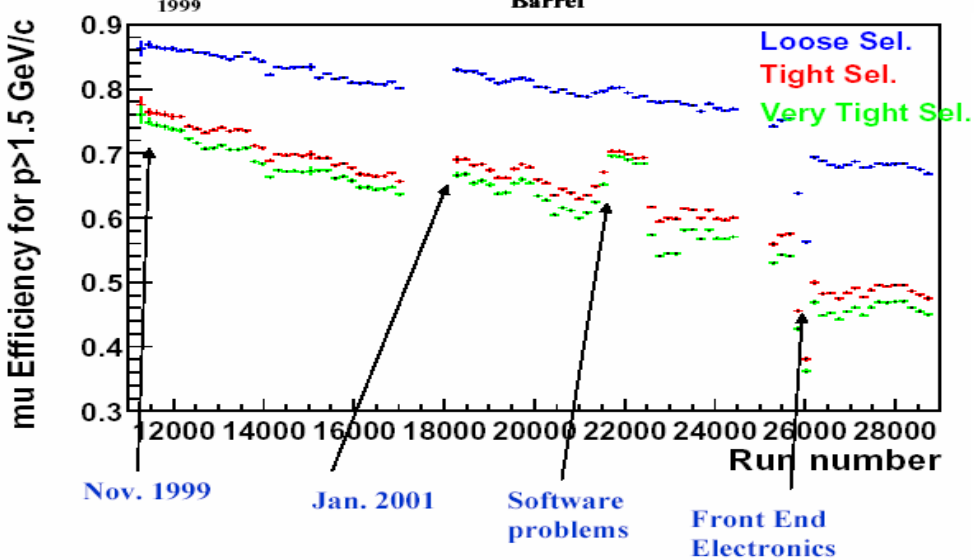
Many RPCs die since 1999.
Fraction effectively dead is now almost 40%



Muon selectors losing efficiency

Decision taken to increase the thickness of the absorber and to replace the bakelite RPC with a more robust detector (Limited StreamerTube).

INTALLATION 2004 &2005



Summary

FY2003-

Decision taken to rebuild the IFR Barrel with a new technology (LST)

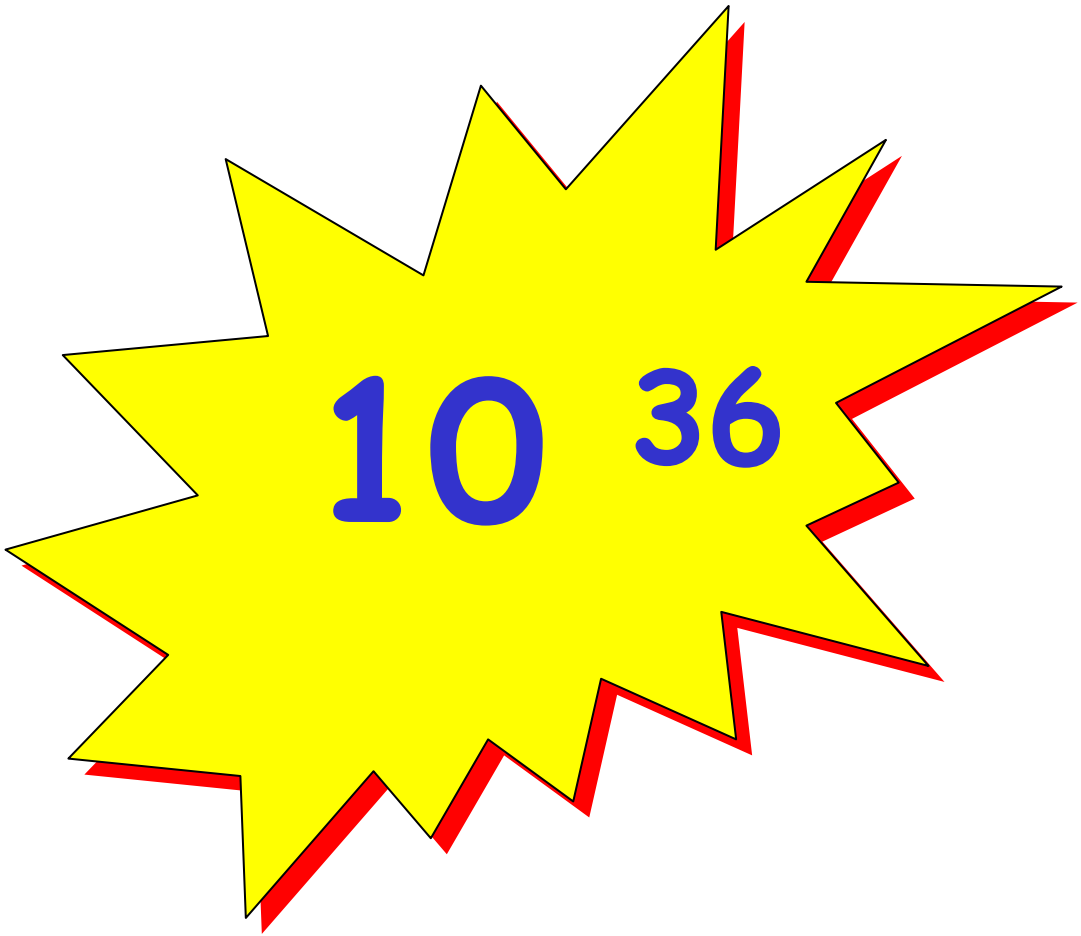
Preliminary measurements of pure penguin processes for sin2β, measurements of Vub, B->DK, B->$\rho\pi$.

FUTURE – In 2005 install IFR Barrel and Spare modules of SVT, to replace the heavily irradiated on horizontal plane.

Approach the precision measurement with 0.5/ab of integrated luminosity . Towards more than 1.0/ab explore possible openings for new physics.

Study of CP asymmetries but also rare decays in b, c and tau sectors.

AND for MORE....



BACKUP SLIDES

Some comments about comparison with Hadron machine expts.

	Lumi(10^{33})	σ_{bb}(nb)	bb(10^7/year)	σ_{bb}/σ_{qq}
Bfactories	10	1.1	11	$3\ 10^{-1}$
BTeV	0.2	100000	20000	$1\ 10^{-3}$
LHC-B	0.15	5 105	75000	$5\ 10^{-3}$

The extraction of α from $\alpha_{effective}$ is possible using Bfactory data.

π^0 reconstruction is an essential ingredient!

Bfactory allow the $\rho\pi$ channel analysis (π^0 are involved!)

Time dependent rate, flavor mixing and CP, T, CPT

CPV in Mixing Decay

CPV direct

Time dependent rate:

$$d\mathcal{N} \propto \exp(-|\Delta t|/\tau_B)\,(\,1 \pm D\,(S \sin(\Delta m \Delta t) - C\cos(\Delta m \Delta t))\,) \otimes R$$

$$\lambda = \eta_{cp}\frac{q}{p}\frac{\overline{A}_{cp}}{A_{cp}}$$

$$S = \frac{2\,\mathrm{Im}\,\lambda}{1+|\lambda|^2}$$

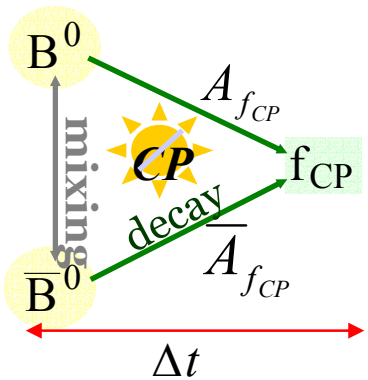
$$C = \frac{1-|\lambda|^2}{1+|\lambda|^2}$$

D is the mis-tag dilution

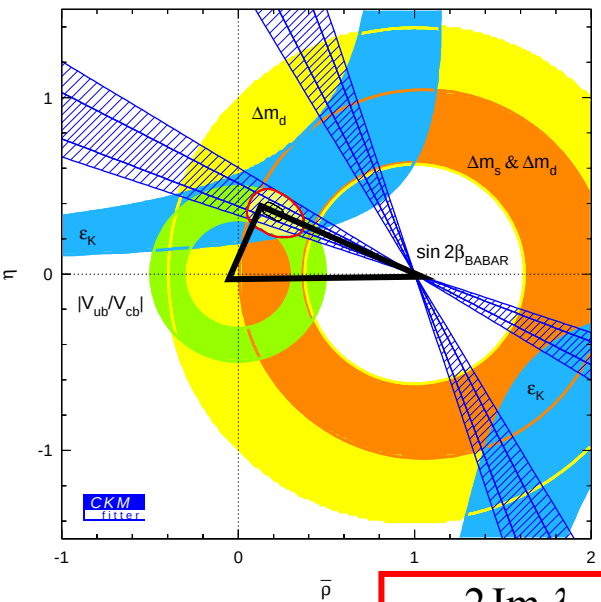
R is the time resolution

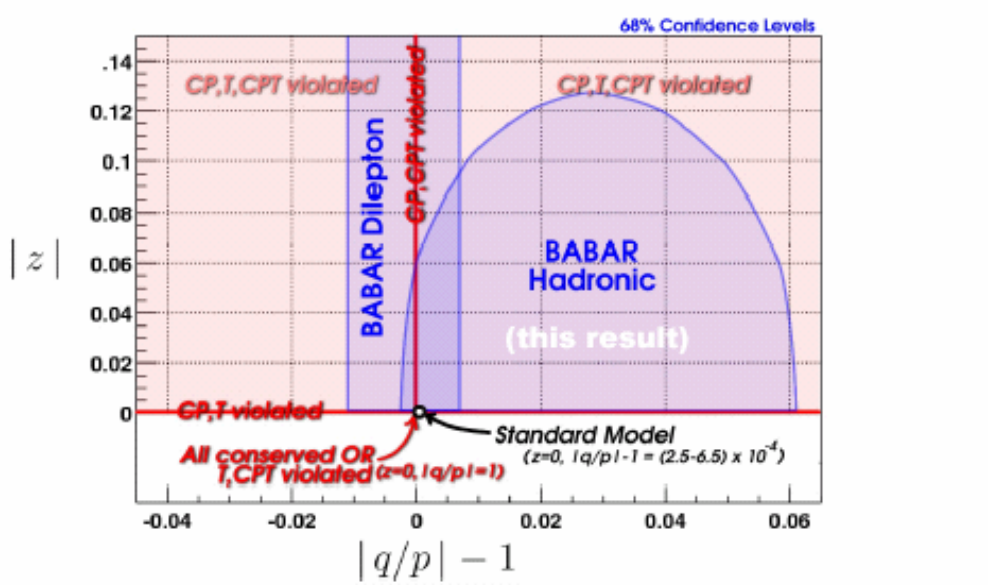
$$z = 2\frac{\delta M - (i/2)\delta\Gamma}{\Delta m - (i/2)\Delta\Gamma}$$

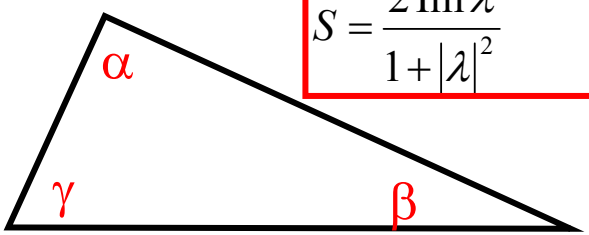
z≠0 CP & CPT violation



(FY03) CP, T, CPT







$$S = \frac{2\,\mathrm{Im}\,\lambda}{1+|\lambda|^2} \qquad C = \frac{1-|\lambda|^2}{1+|\lambda|^2}$$

$$a_T = (0.5 \pm 1.2 \pm 1.4)\% \approx \frac{1-|q/p|^4}{1+|q/p|^4}$$

From dileptons

Measurement of sin2β=0.741 ± 0.067 ± 0.034

$\sin 2\alpha_{eff}$ from $B^0 \to \pi^+\pi^-$

$\alpha=(97_{-21}^{+30})°$, $\beta=26°$

$|P/T|=0.28$

Tree and Penguin amplitudes contribute to this channel

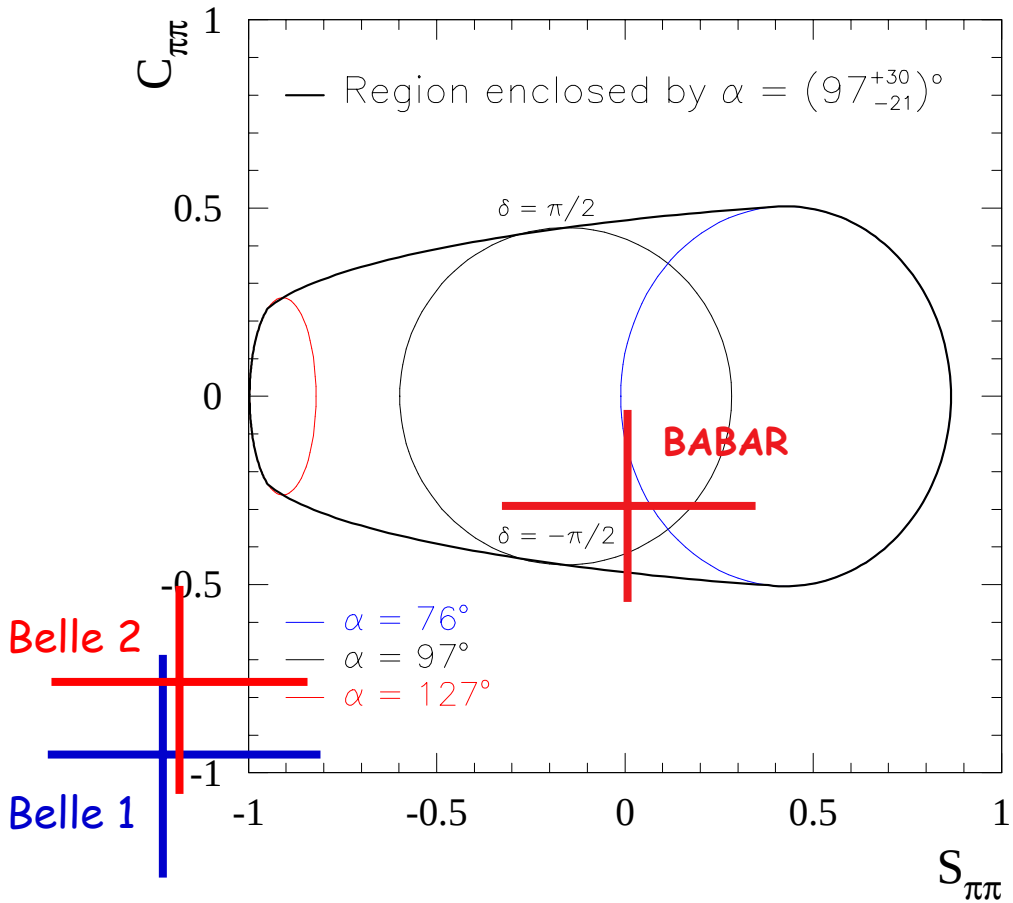
$-\pi/2<\delta<\pi/2$

$\alpha_{eff} = \alpha + \delta$ δ is a strong phase

In absence of informations about penguin pollution:

- *Measure $S_{\pi\pi}$ and $C_{\pi\pi}$ from both $\sin\Delta m\Delta t$ and $\cos\Delta m\Delta t$ terms .*
- *Compare with predicted $S_{\pi\pi}$ and $C_{\pi\pi}$ values for given α, β, $|P/T|$, and δ. Assume for instance:*

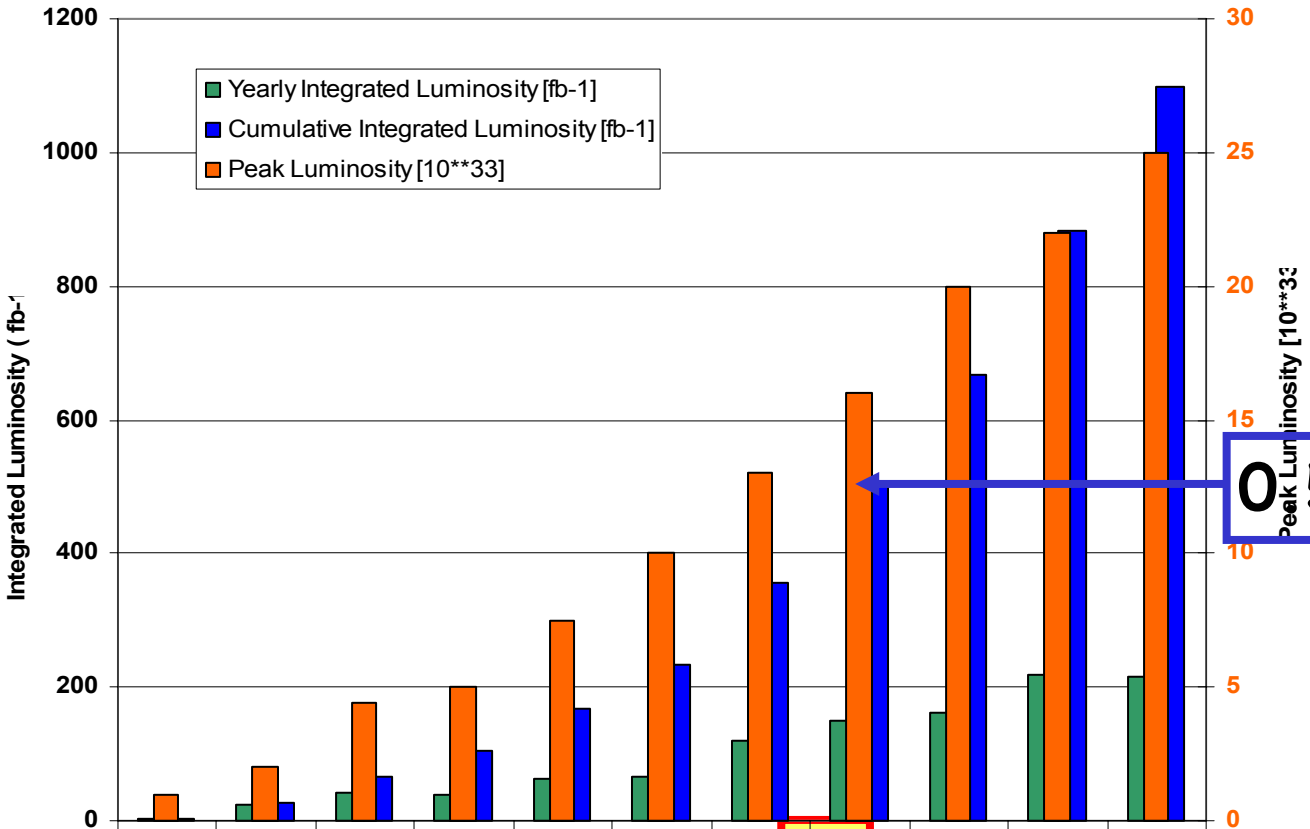
$$\alpha = (97\ ^{+30}_{-21})°$$
$$\beta = 26°$$
$$|P/T| = 0.28$$
$$-\frac{\pi}{2} < \delta < \frac{\pi}{2}$$



cf. Gronau and Rosner, *Phys. Rev. D65, 093012 (2002)*

BACKUP

PEPII – "adiabatic" scenario



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Yearly Integrated Luminosity [fb-1]	3	23	41	39	62,6	66,1	120,1	151	160,1	217	216
Cumulative Integrated Luminosity [fb-1]	3	26	67	106	168,6	234,7	354,8	505,8	665,9	882,9	1098,9
Peak Luminosity [10**33]	1	2	4,4	5	7,5	10	13	16	20	22	25

0.5 ab^{-1}

2006

1.6×10^{34}