CP-violation: state of art and prospects

(Unitary Triangle , Standard Model and New Physics)

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Outline

Once upon a time the quest for

simmetry

has brought to the construction of two

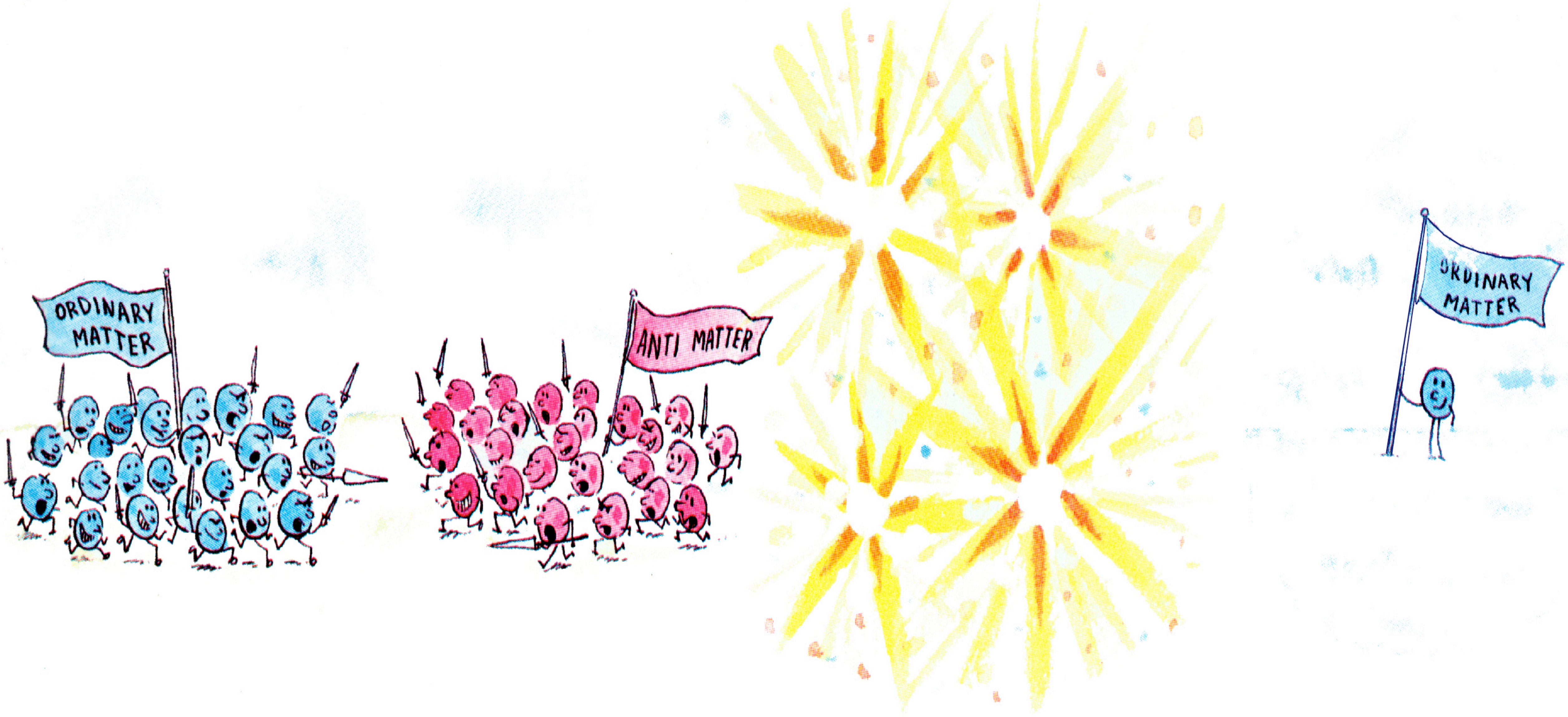
asymmetric

colliders for explaining the

asymmetry

of the Universe

What is all about



For every billion ordinary particles annihilating with antimatter in the early Universe, one extra was left "standing."

The Foundations: CKM

652

Progress of Theoretical Physics, Vol. 49, No. 2, February 1973

CP-Violation in the Renormalizable Theory of Weak Interaction

Makoto KOBAYASHI and Toshihide MASKAWA

Department of Physics, Kyoto University, Kyoto

(Received September 1, 1972)

In a framework of the renormalizable theory of weak interaction, problems of CP-violation are studied. It is concluded that no realistic models of CP-violation exist in the quartet scheme without introducing any other new fields. Some possible models of CP-violation are also discussed.

UNITARY SYMMETRY AND LEPTONIC DECAYS

Nicola Cabibbo
CERN, Geneva, Switzerland

(Received 29 April 1963)

We present here an analysis of leptonic decays based on the unitary symmetry for strong interactions, in the version known as "eightfold way,"[1] and the V-A theory for weak interactions.[2,3] Our basic assumptions on J_μ, the weak current of strong interacting particles, are as follows:

(1) J_μ transforms according to the eightfold representation of SU_3. This means that we neglect currents with $\Delta S = -\Delta Q$, or $\Delta I = 3/2$, which should belong to other representations. This limits the scope of the analysis, and we are not able to treat the complex of K^0 leptonic decays, or $\Sigma^+ \to n + e^+ + \nu$ in which $\Delta S = -\Delta Q$ currents play a role. For the other processes we make the hypothesis that the main contributions come from that part of J_μ which is in the eightfold representation.

(2) The vector part of J_μ is in the same octet as the electromagnetic current. The vector contribution can then be deduced from the electromagnetic properties of strong interacting particles. For $\Delta S = 0$, this assumption is equivalent to vector-

$$(d', s', b') = V \begin{pmatrix} d \\ s \\ b \end{pmatrix}, \quad V = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix}$$

The Vision

Crazy idea
Asymmetric Collider
Pier Oddone

AN ASYMMETRIC B-MESON FACTORY AT PEP

A. Garren, S. Chattopadhyay, Y. Chin, P. Oddone, and M. S. Zisman
Lawrence Berkeley Laboratory*
M. Donald, G. Feldman, J. M. Paterson, and J. Rees
Stanford Linear Accelerator Center

Abstract

A preliminary design for a B-factory has been made using asymmetric collisions between positrons in the PEP storage ring and electrons in a new, low-energy ring. The design utilizes small-aperture, permanent-magnet quadrupoles close to the interaction point (IP). Optimization of optical and beam parameters at the IP will be discussed, as well as the lattice design of the interaction region and of the rings.

Introduction

To create large numbers of B-mesons in a way to facilitate separation of the two B-mesons created, an interesting possibility is to make electron positron collisions at unequal energies between

PITHA 81/09

April 1981

NOTES ON THE OBSERVABILITY OF CP VIOLATIONS IN B DECAYS

I. I. Bigi and A. I. Sanda

Abstract:
We describe a general method of exposing CP violations in on-shell transitions of B mesons. Such CP asymmetries can reach values of the order of up to 10% within the Kobayashi-Maskawa model for plausible values of the model parameters. Our dis-

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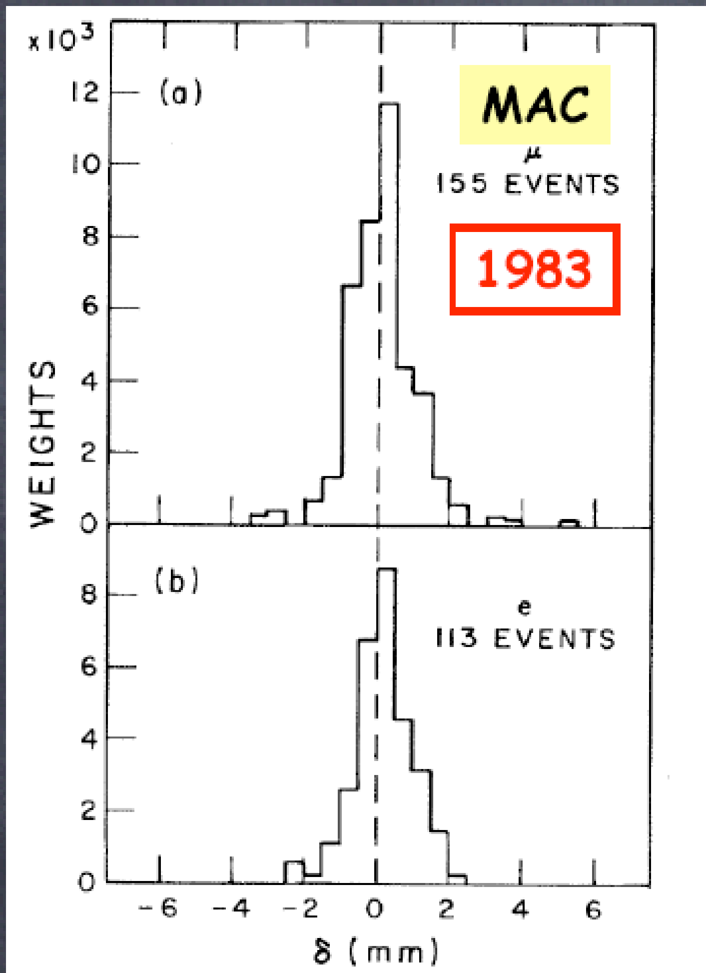
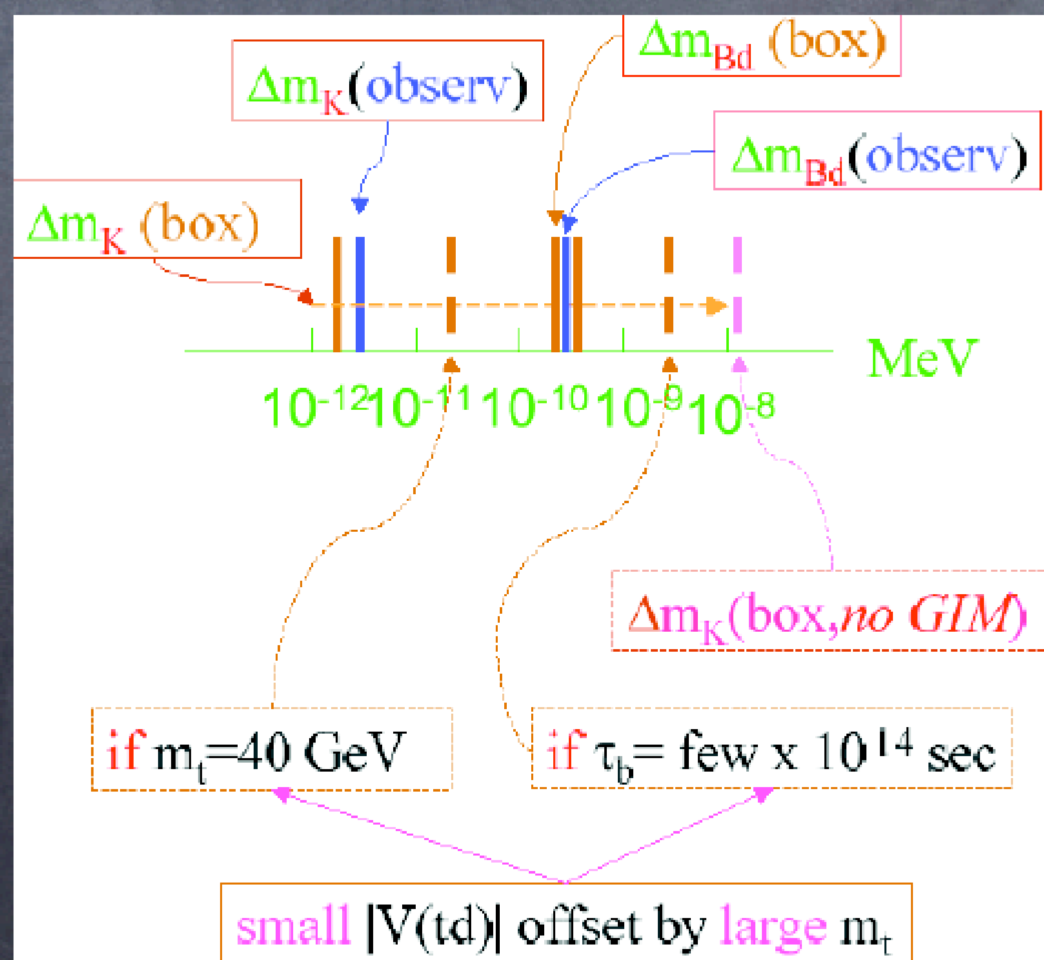
unlike but..... Nature sometime helps !

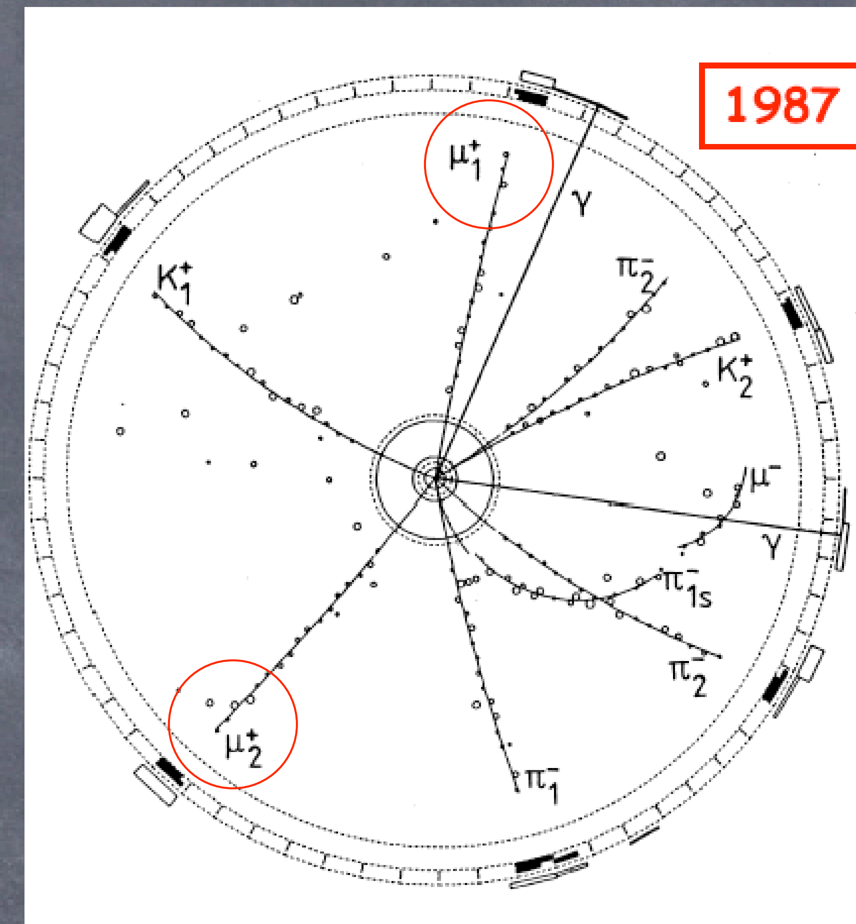


MAC, PRL **51**, 1022 (1983)
MARK II, PRL **51**, 1316 (1983)

1.5 The unreasonable success of the CKM description

quoting I. Bigi





$\chi_d = 0.17 \pm 0.05$

ARGUS, PL B **192**, 245 (1987)

Low Vcb:
long lifetime

High top mass:
large oscillation

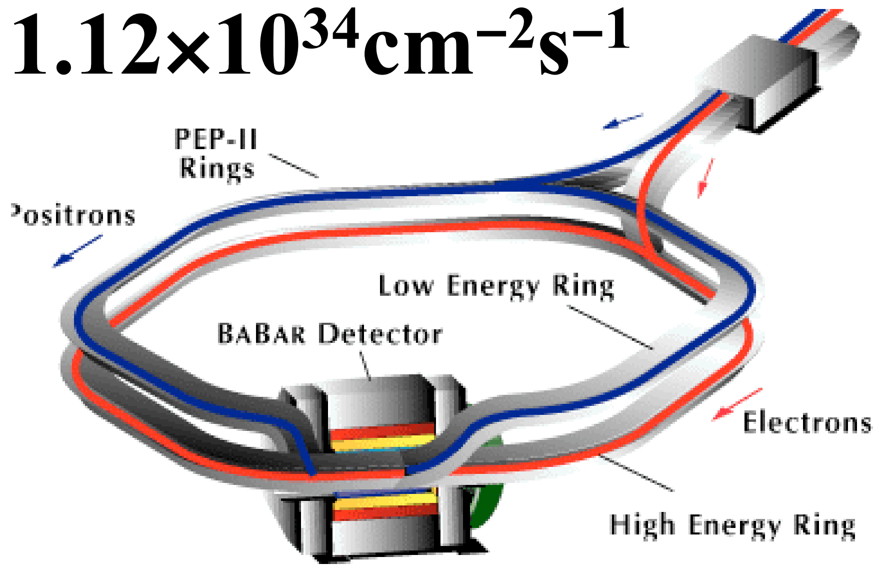
The dream comes true

PEP-II at SLAC

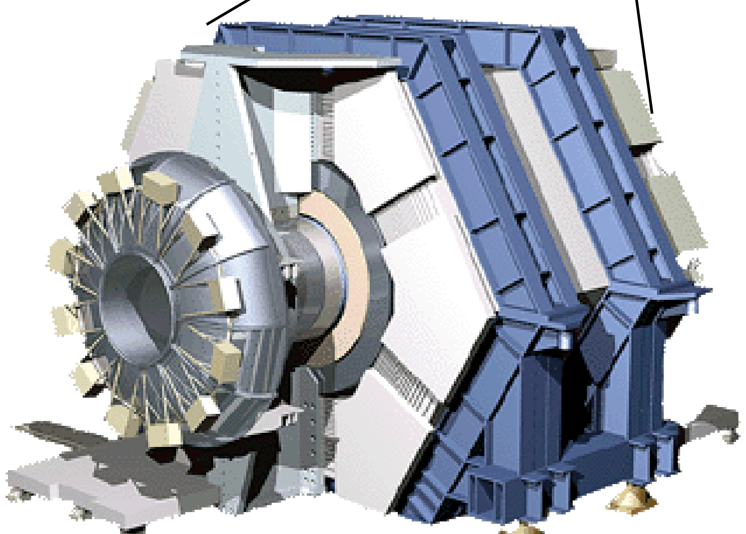
9GeV (e^-) × 3.1GeV (e^+)

peak luminosity:

$1.12\times10^{34}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$

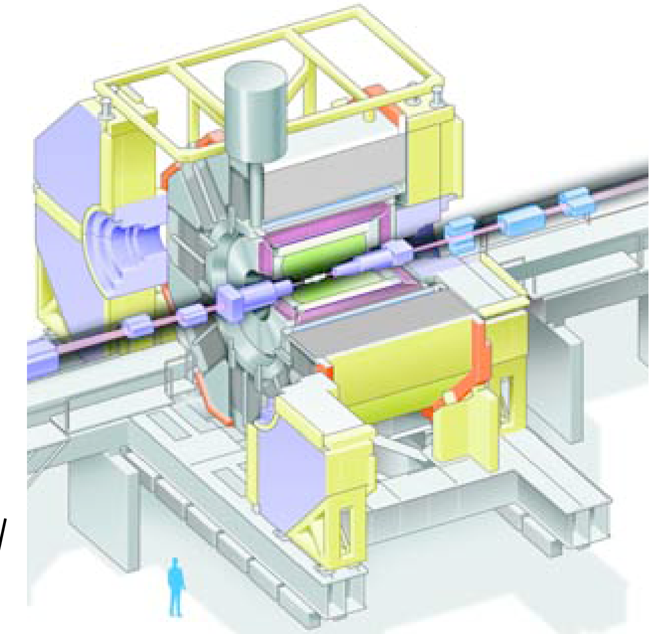


BaBar



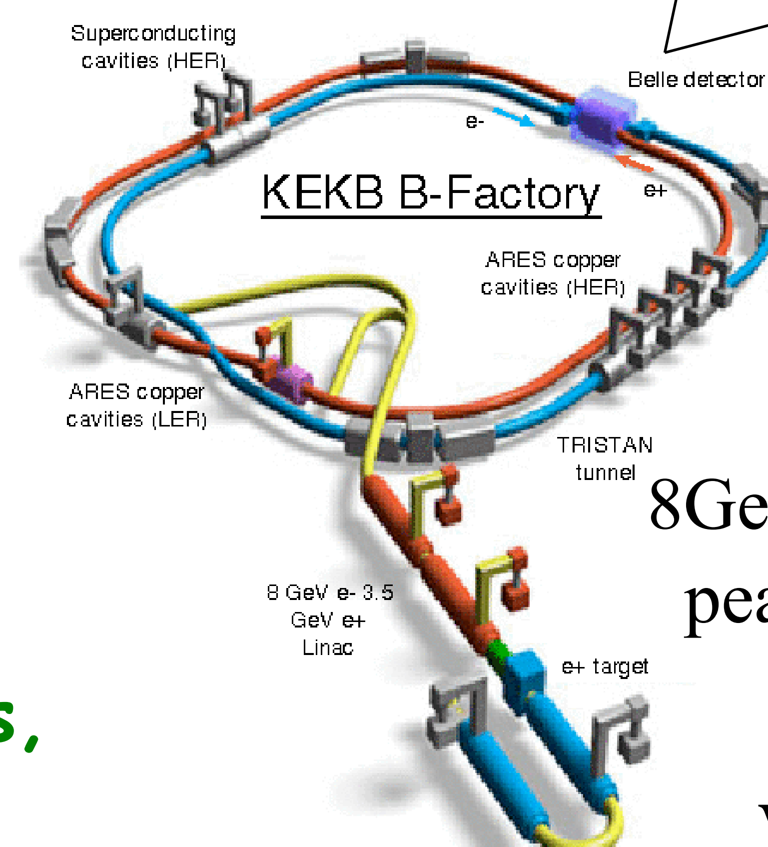
11 nations,
80 institutes,
623 persons

13 countries,
57 institutes,
~400 collaborators



BELLE

Belle



KEKB at KEK

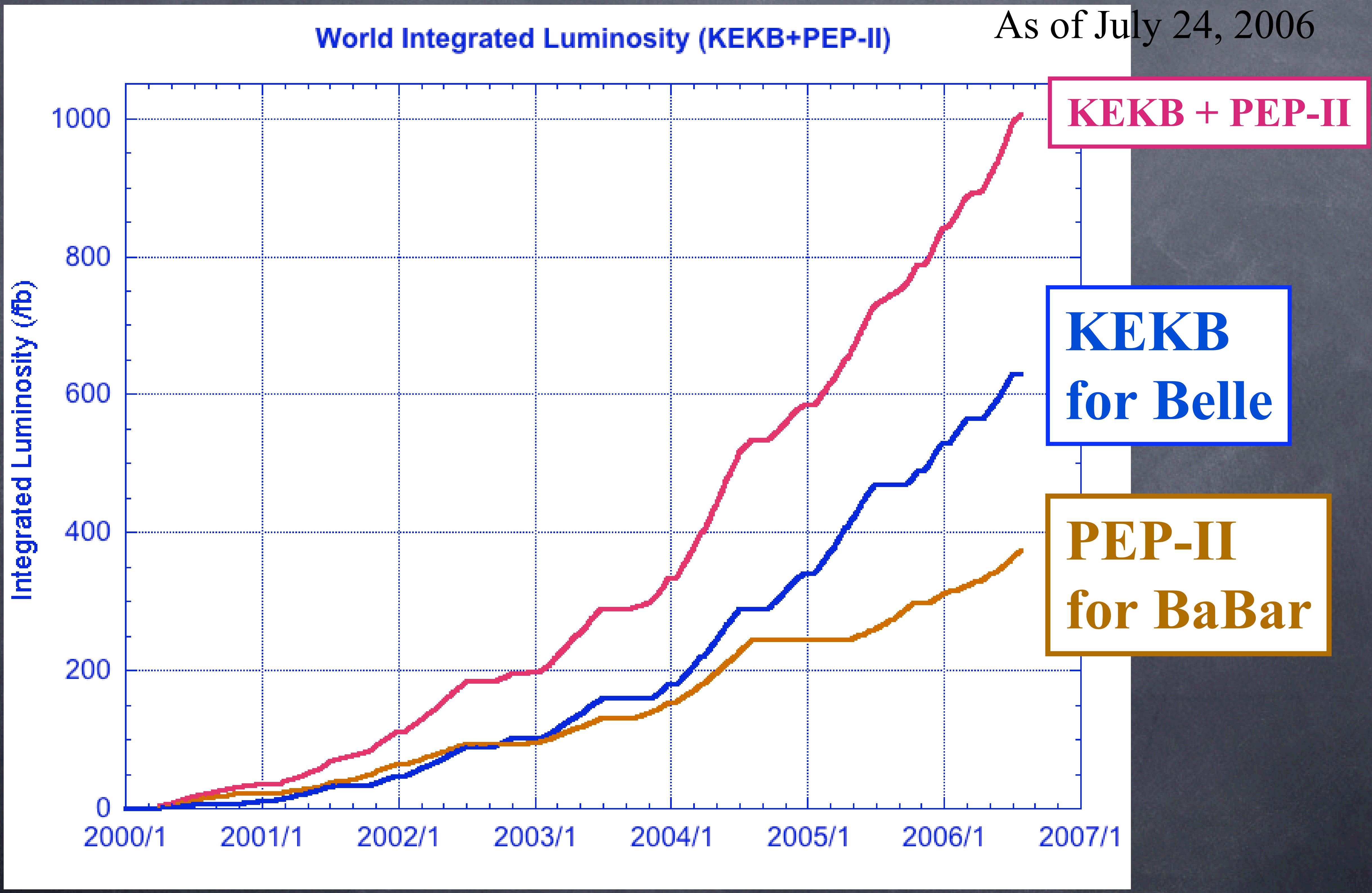
8GeV (e^-) × 3.5GeV (e^+)

peak luminosity:

$1.65\times10^{34}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$

world record

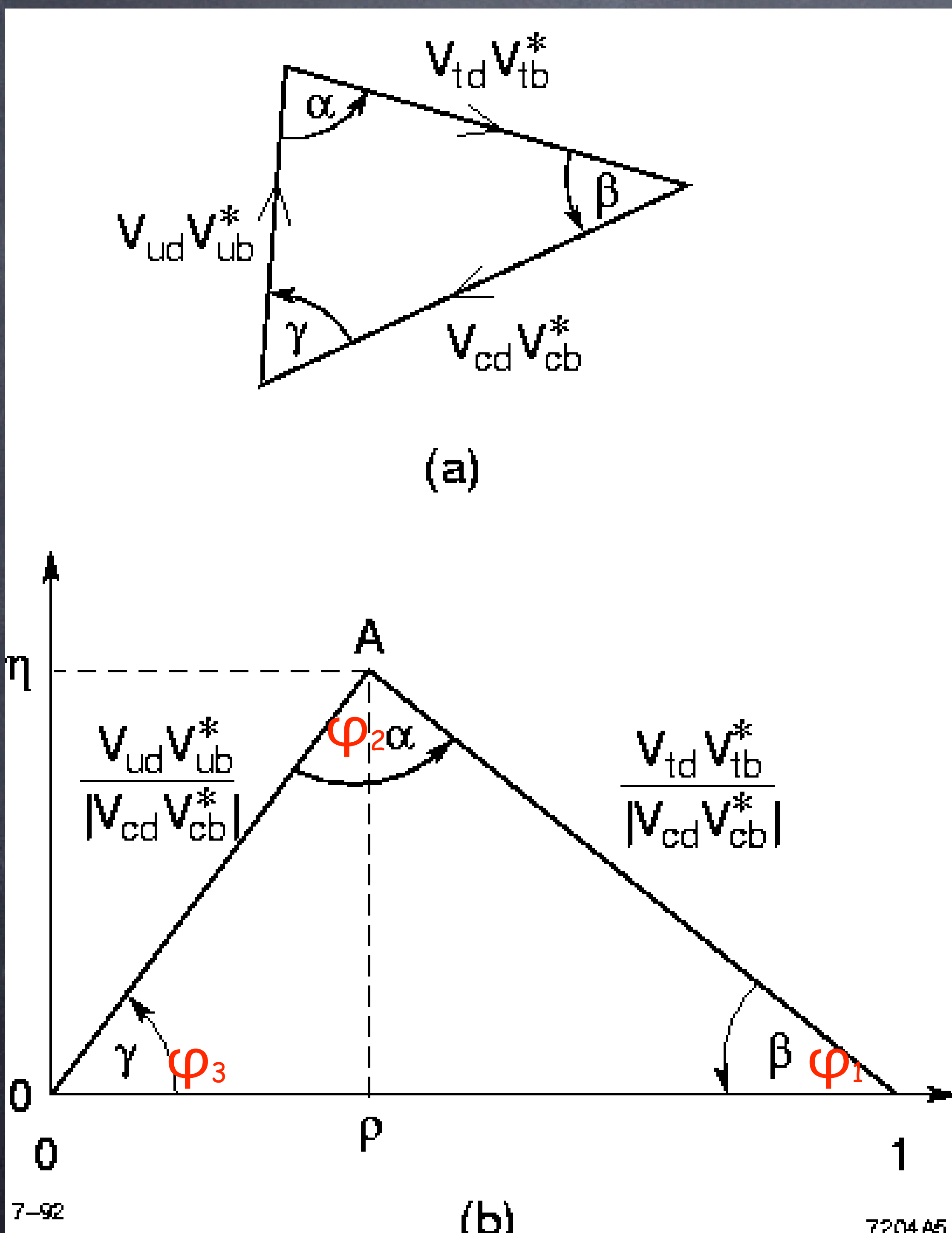
1ab^{-1} or 1GB

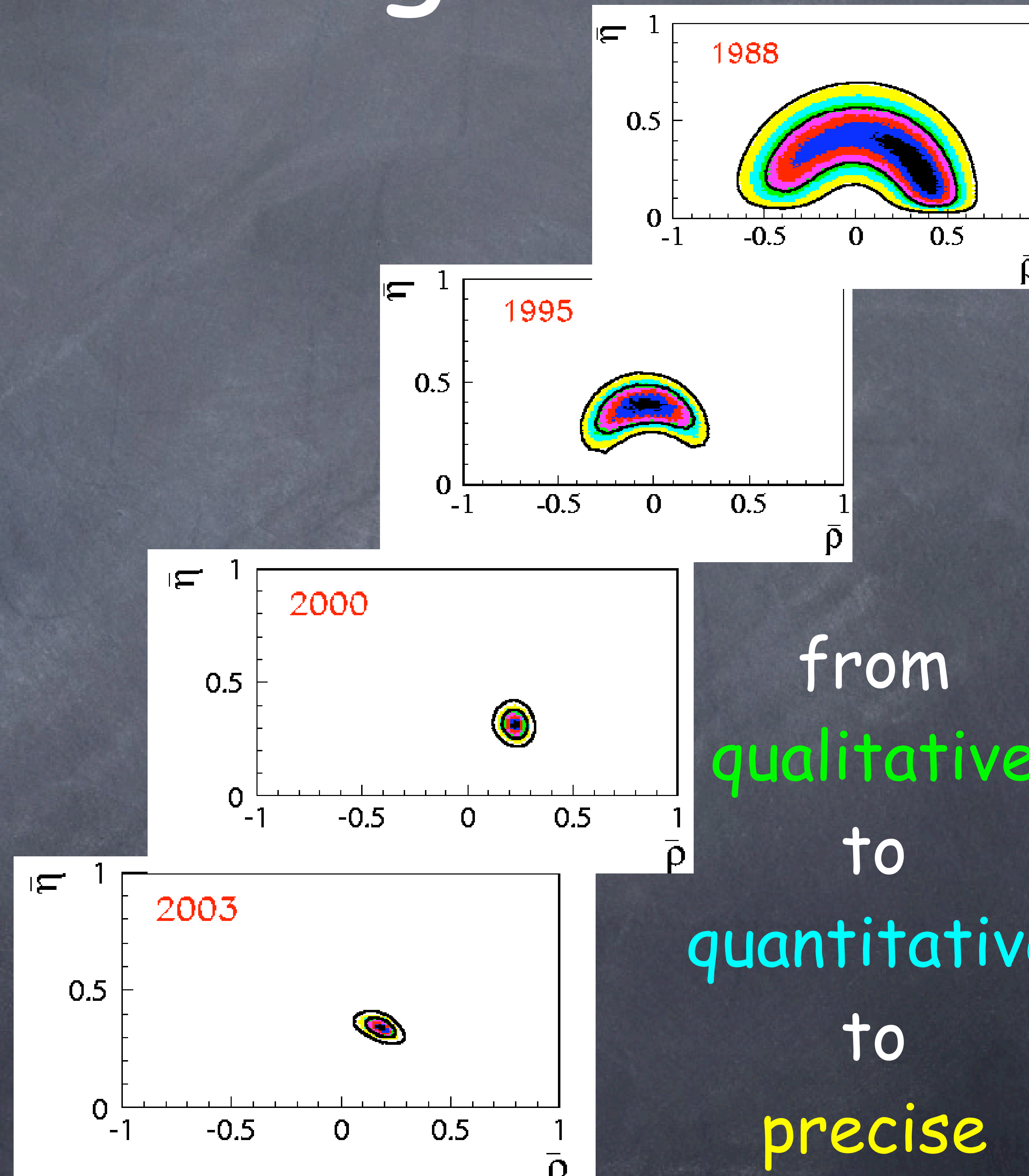


As of July 24, 2006
World Integrated Luminosity (KEKB+PEP-II)
Integrated Luminosity (/fb)
1000
800
600
400
200
0
2000/1
2001/1
2002/1
2003/1
2004/1
2005/1
2006/1
2007/1
KEKB + PEP-II
KEKB for Belle
PEP-II for BaBar

The UTriangle

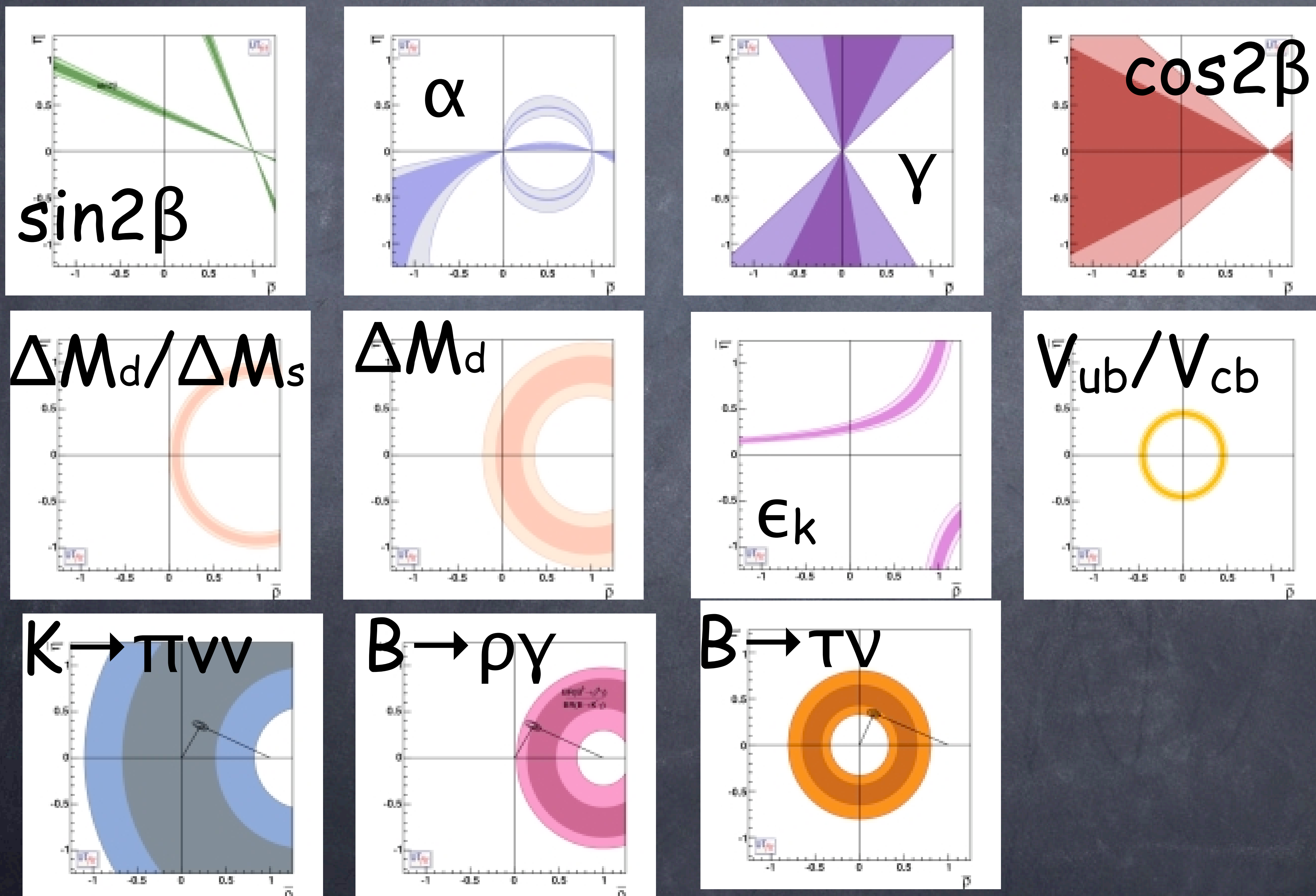
That I will not describe since in front of this audience it would be insulting !



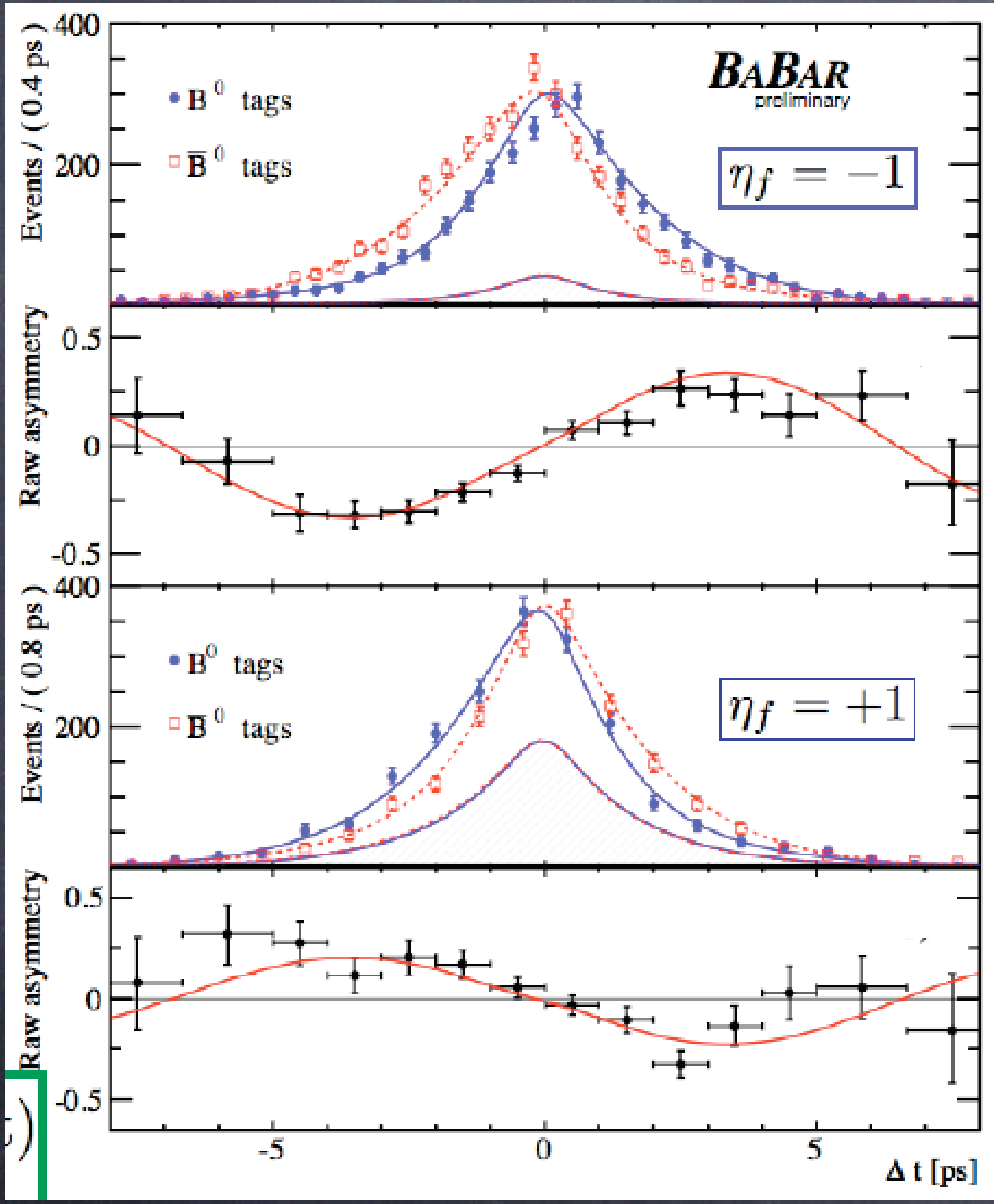


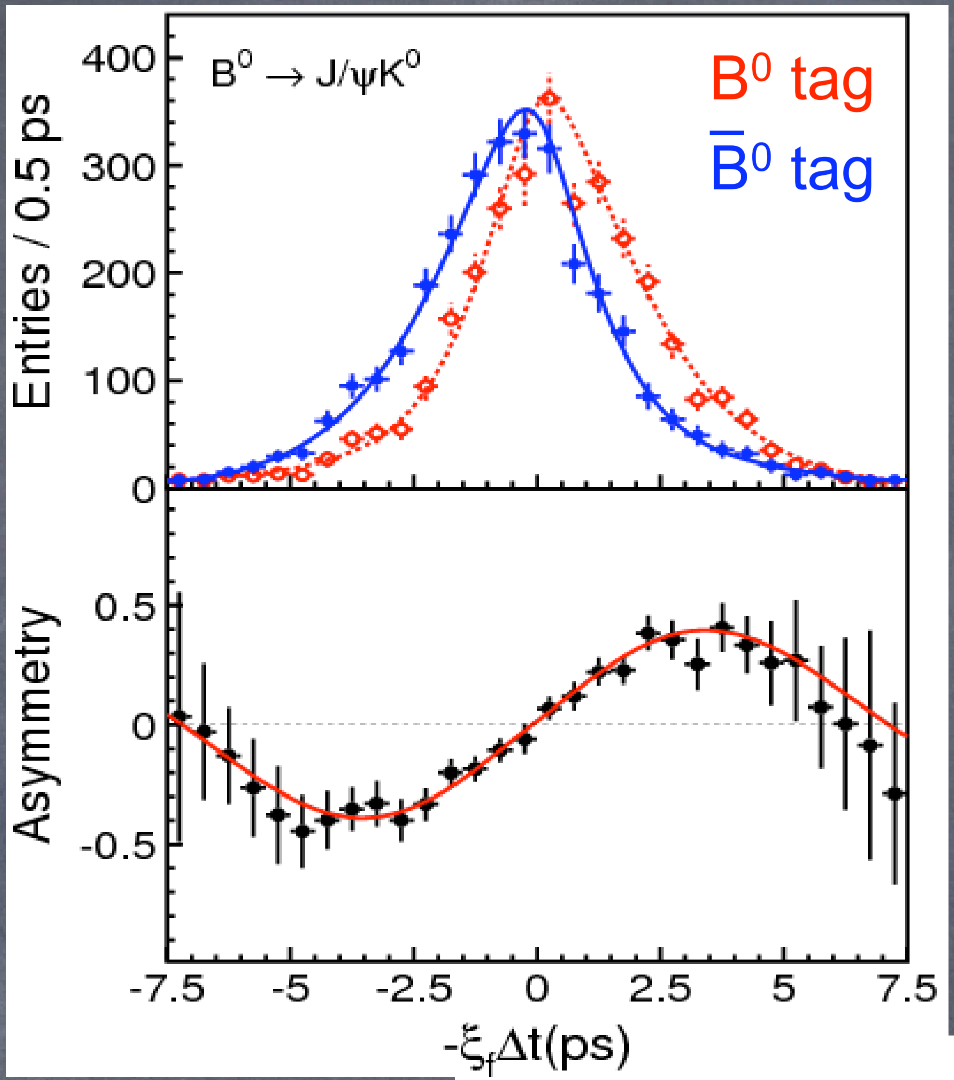
from
qualitative
to
quantitative
to
precise

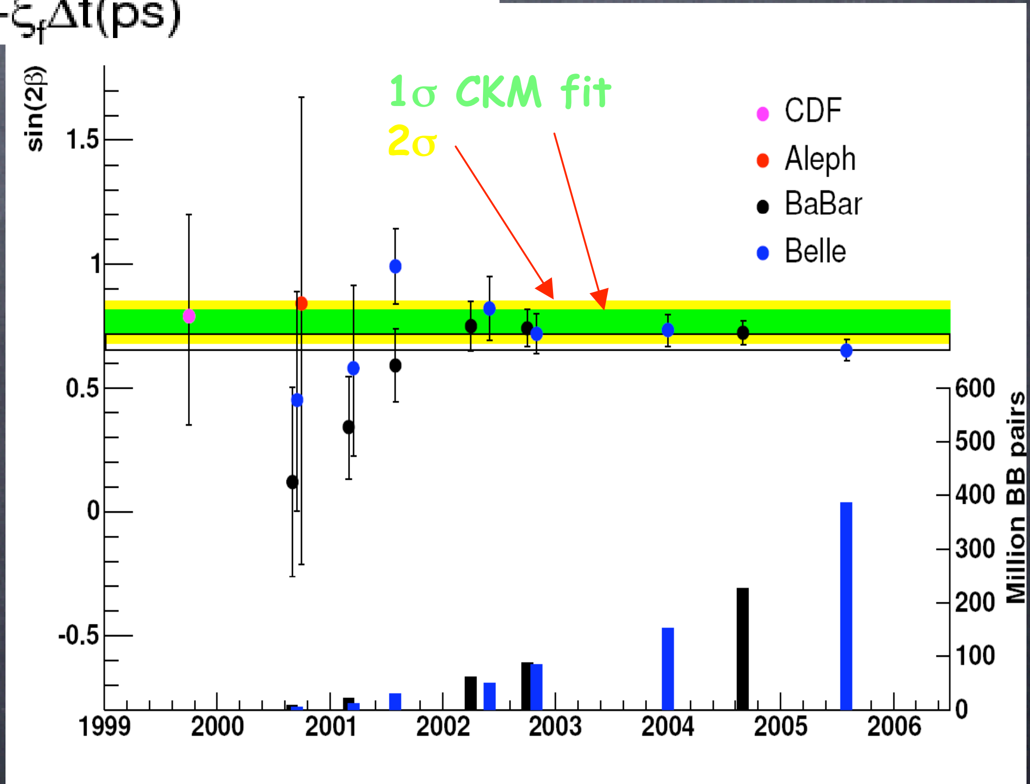
The ingredients



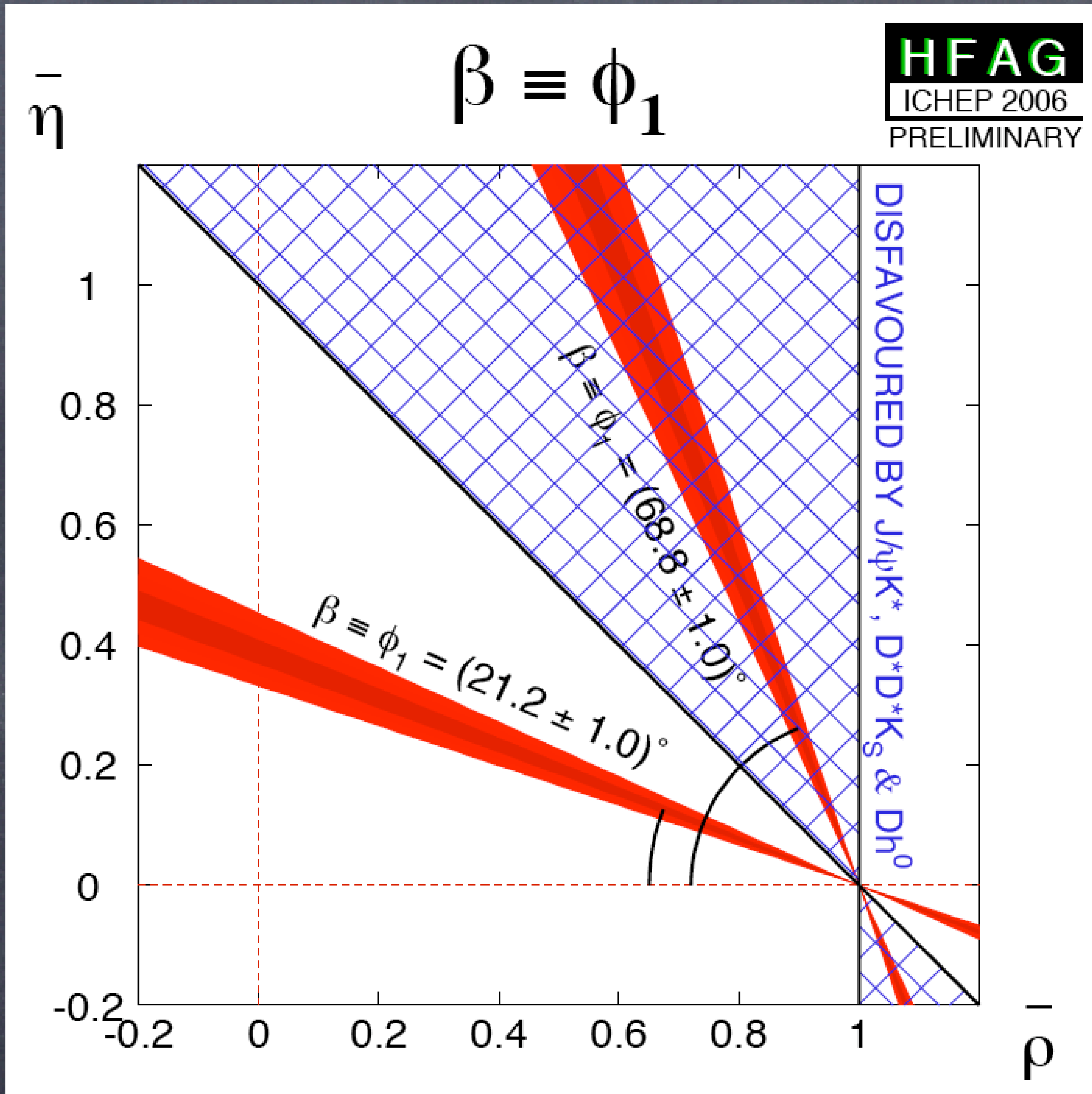
β: the textbook measurement



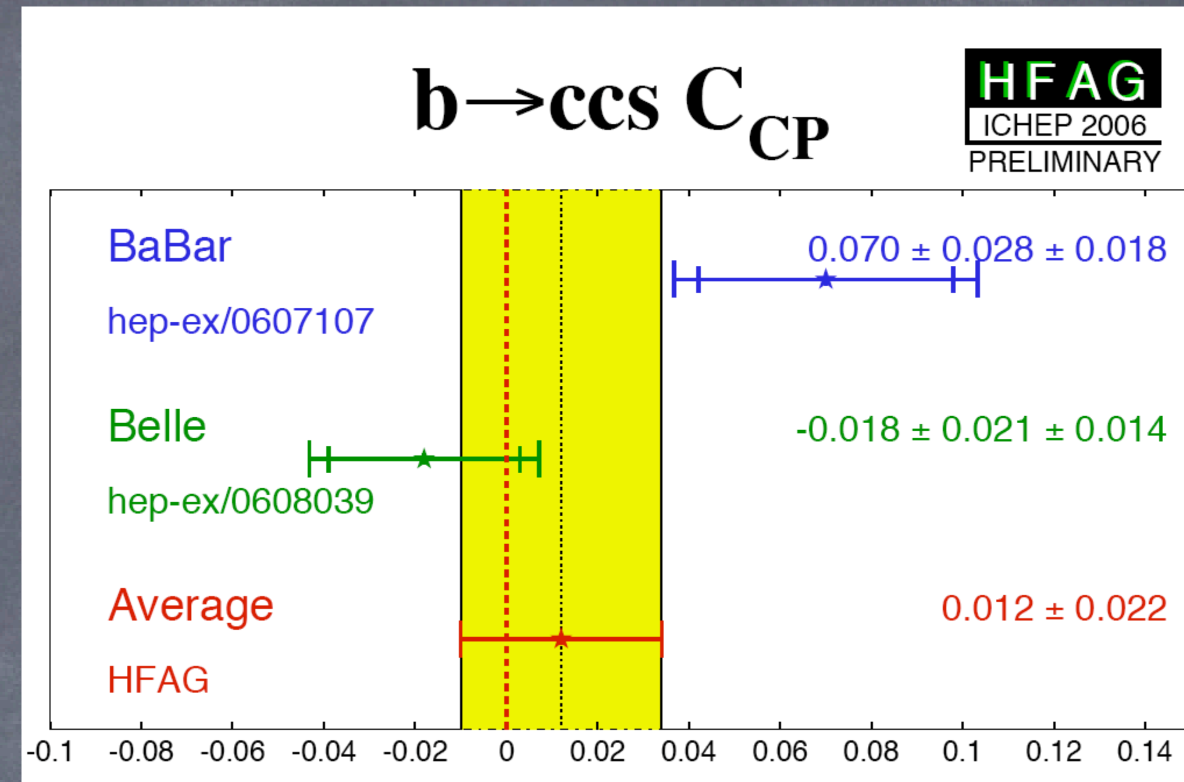




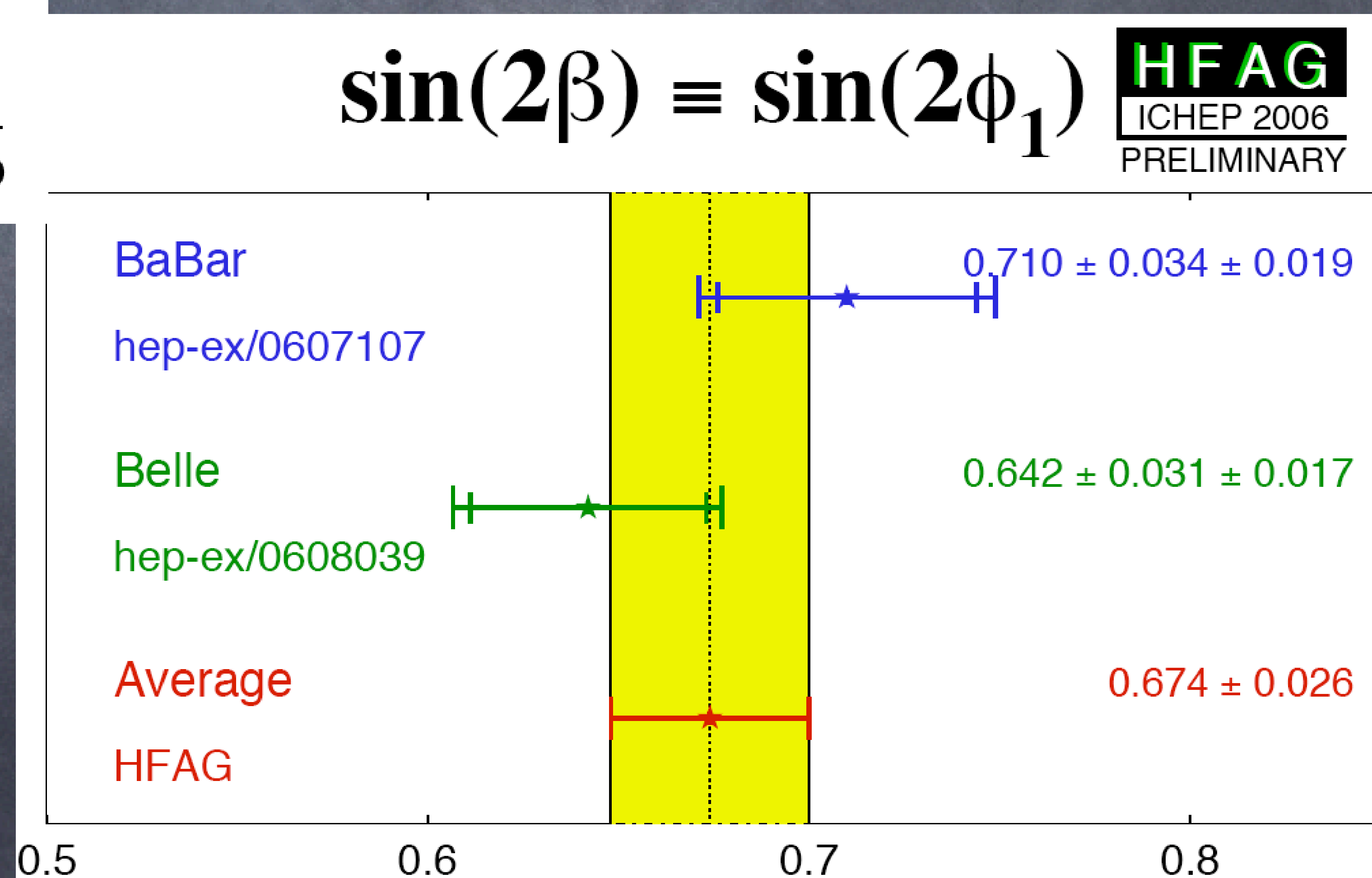
β



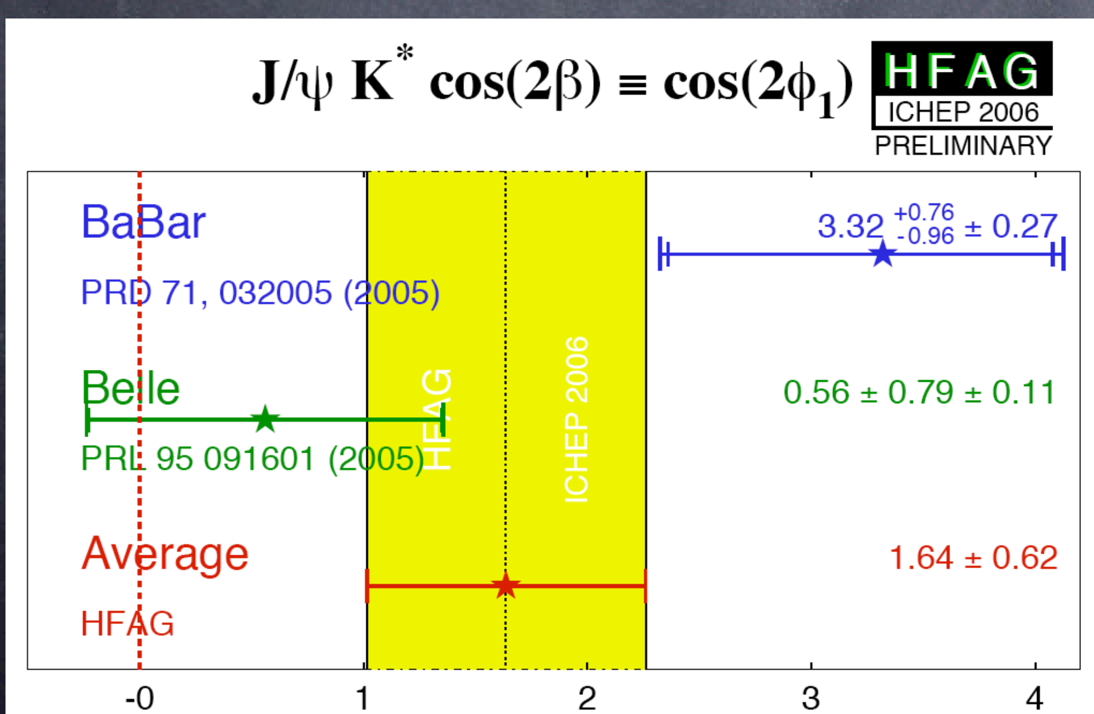
$\beta \equiv \phi_1$
HFAG
ICHEP 2006
PRELIMINARY
$\bar{\eta}$
$\bar{\rho}$
DISFAVOURED BY J/ψK*, D*D*K_S & Dh^0
$\beta \equiv \phi_1 = (68.8 \pm 1.0)^\circ$
$\beta \equiv \phi_1 = (21.2 \pm 1.0)^\circ$
-0.2 0 0.2 0.4 0.6 0.8 1
-0.2 0 0.2 0.4 0.6 0.8 1



b→ccs C_{CP}
HFAG
ICHEP 2006
PRELIMINARY
BaBar
hep-ex/0607107
0.070 ± 0.028 ± 0.018
Belle
hep-ex/0608039
-0.018 ± 0.021 ± 0.014
Average
HFAG
0.012 ± 0.022
-0.1 -0.08 -0.06 -0.04 -0.02 0 0.02 0.04 0.06 0.08 0.1 0.12 0.14



$\sin(2\beta) \equiv \sin(2\phi_1)$
HFAG
ICHEP 2006
PRELIMINARY
BaBar
hep-ex/0607107
0.710 ± 0.034 ± 0.019
Belle
hep-ex/0608039
0.642 ± 0.031 ± 0.017
Average
HFAG
0.674 ± 0.026
0.5 0.6 0.7 0.8



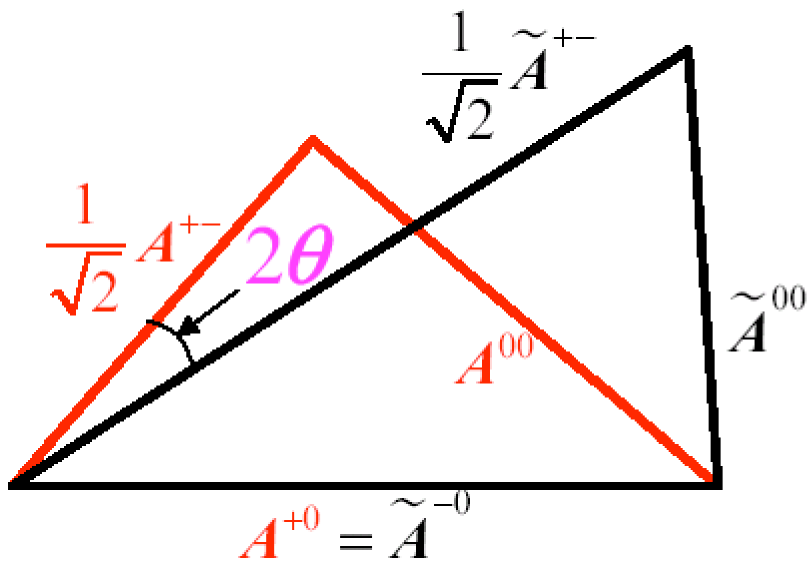
$J/\psi K^* \cos(2\beta) \equiv \cos(2\phi_1)$
HFAG
ICHEP 2006
PRELIMINARY
BaBar
PRD 71, 032005 (2005)
$3.32^{+0.76}_{-0.96} \pm 0.27$
Belle
PRL 95 091601 (2005)
0.56 ± 0.79 ± 0.11
Average
HFAG
1.64 ± 0.62
HFAG
ICHEP 2006
-0 1 2 3 4

α, γ, β' : a pedagogical reminder

- α: measured through what was considered a side channel (if any)
- γ: not even part of the initial planning
- β': a statistically limited cross-chek of the main measurement (β), certainly not a window on New Physics

α : a triangle has reborn from its ashes

almost useless

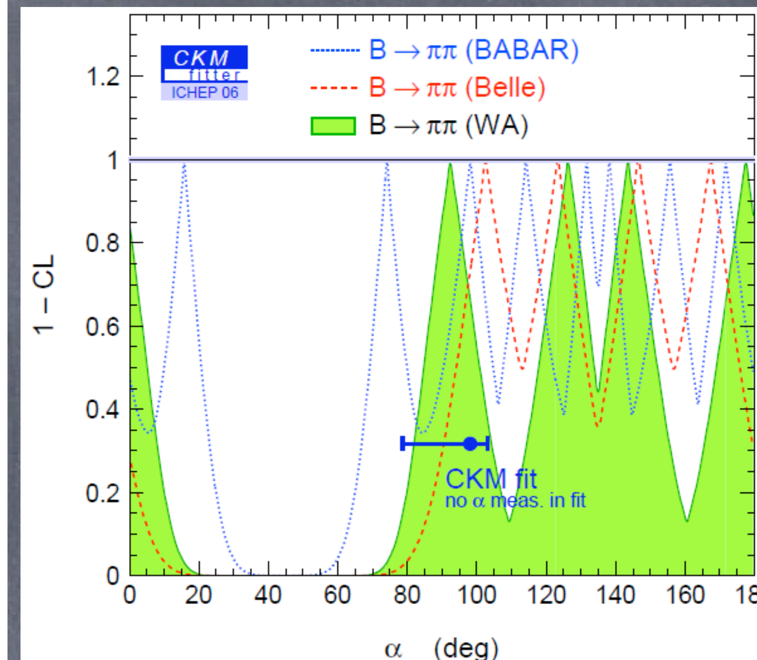


[Gronau-London 1990]

	Amplitude for
$A^{+-}(\bar{A}^{+-})$	$B^0(\bar{B}^0) \to \pi^+\pi^-$
$A^{00}(\bar{A}^{00})$	$B^0(\bar{B}^0) \to \pi^0\pi^0$
$A^{+0}(\bar{A}^{-0})$	$B^+(B^-) \to \pi^+\pi^0(\pi^-\pi^0)$

$$\tilde{A}^{ij} = e^{2\phi_3}\bar{A}^{ij}$$

- Model-independent (symmetry-dependent) method
- SU(2) breaking effect well below present statistical errors



Recent breakthrough: B → ρρ decays

$\frac{|A^{00}|}{|A^{+0}|}, \frac{|A^{00}|}{|A^{+-}|}$ small, $\Delta\alpha_{peng}$ small

$f_L(B^0 \to \rho^+\rho^-) = 0.977 \pm 0.024^{+0.015}_{-0.013}$

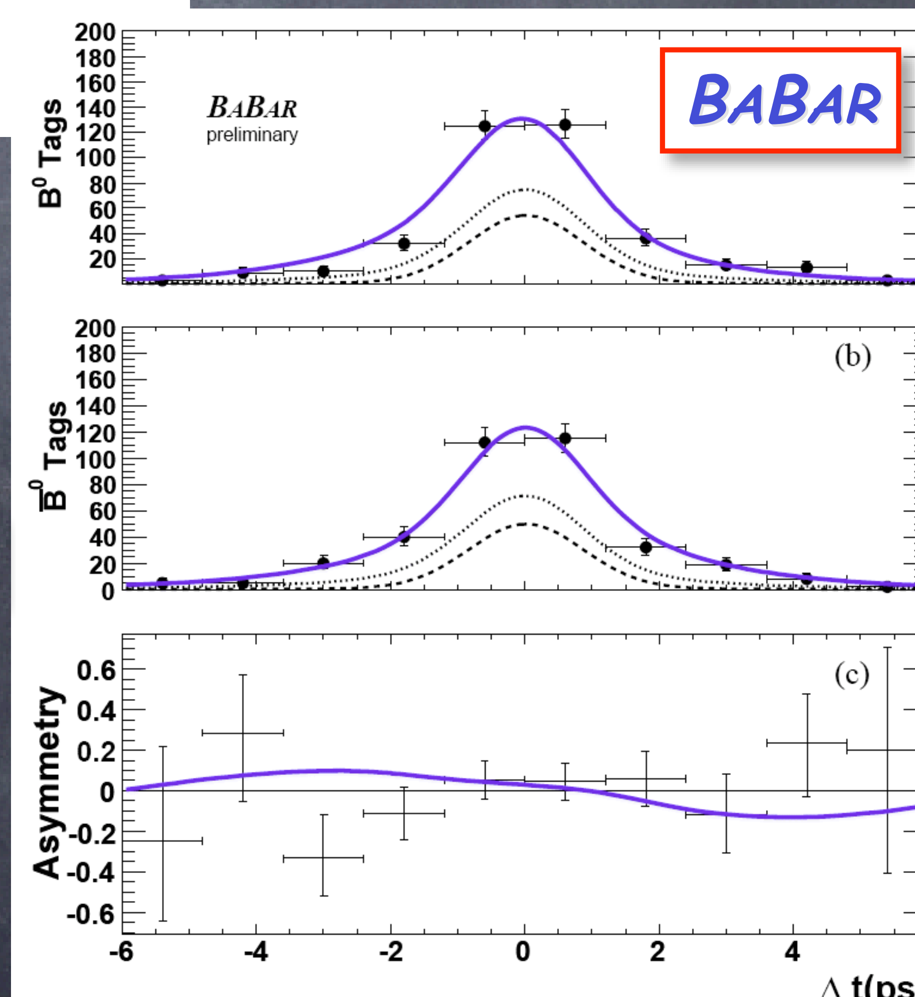
$S_{long} = -0.19 \pm 0.21^{+0.05}_{-0.07}$

$C_{long} = -0.07 \pm 0.15 \pm 0.06$

$Br_{\rho^+\rho^-} = (23.5 \pm 2.2 \pm 4.1) \times 10^{-6}$

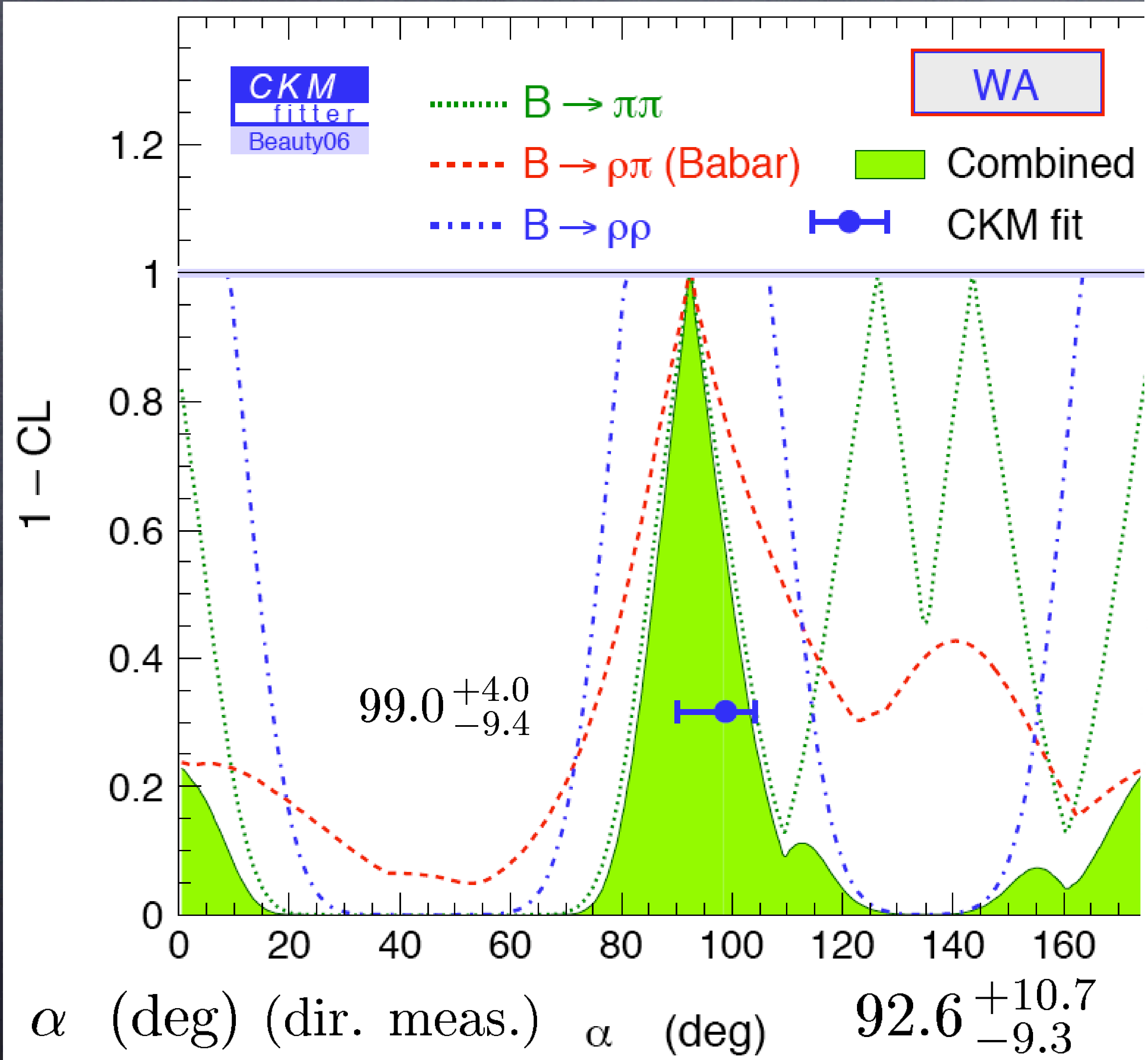
$Br_{\rho^\pm\rho^0} = (16.8 \pm 2.2 \pm 2.3) \times 10^{-6}$

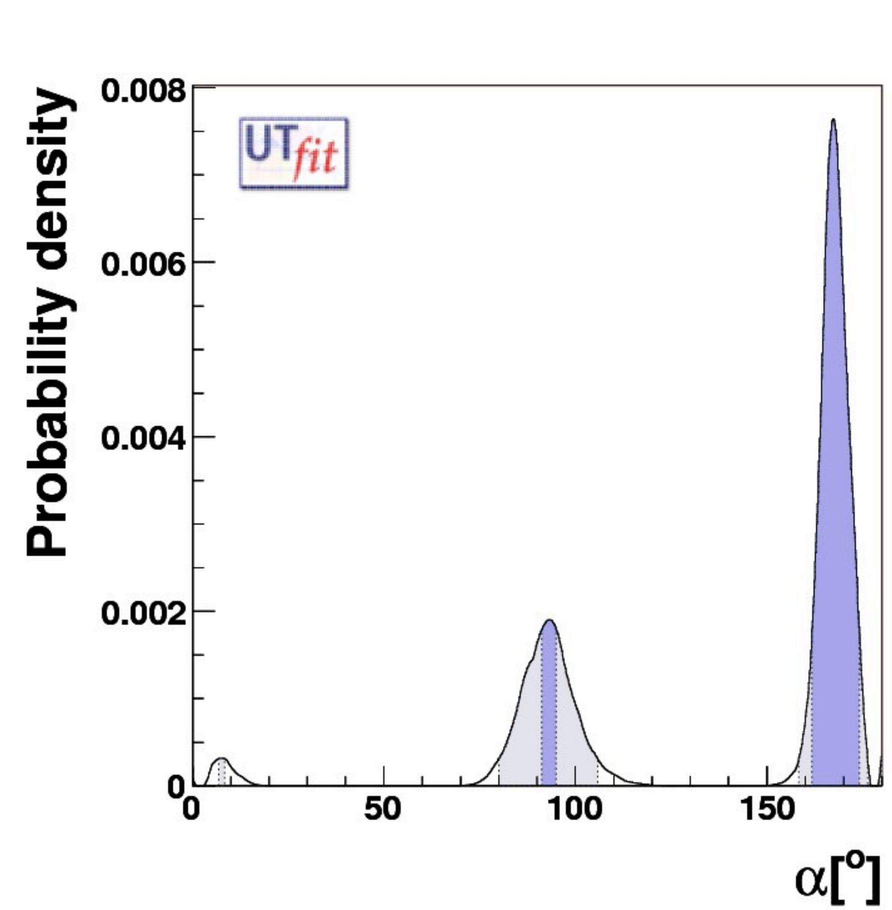
$Br_{\rho^0\rho^0} = (1.16^{+0.37}_{-0.36} \pm 0.27) \times 10^{-6}$



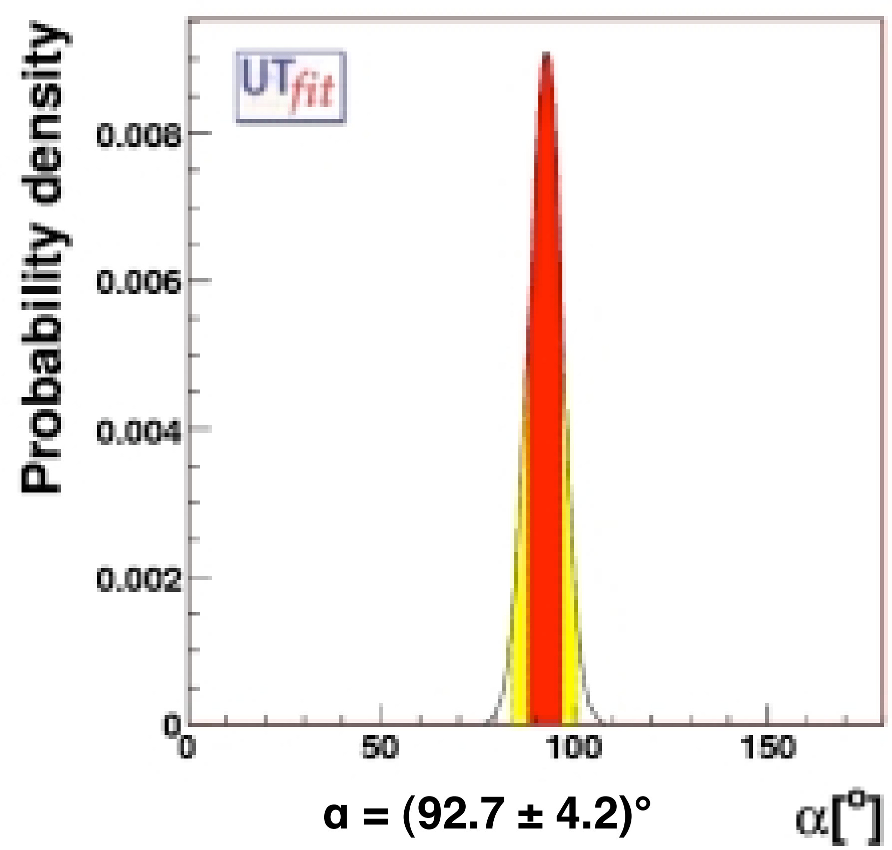
α

a fit per day keeps the doctor away !





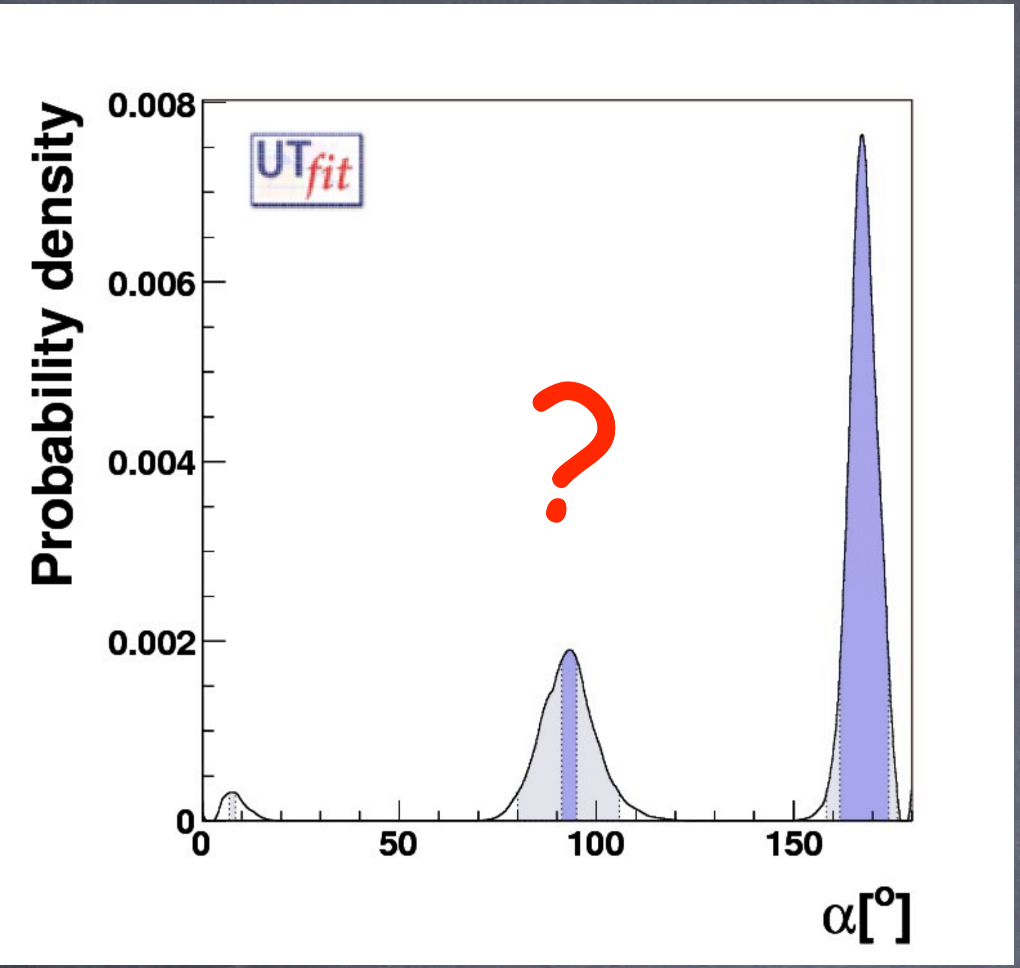
α = (92 ± 7)° (SM solution only)

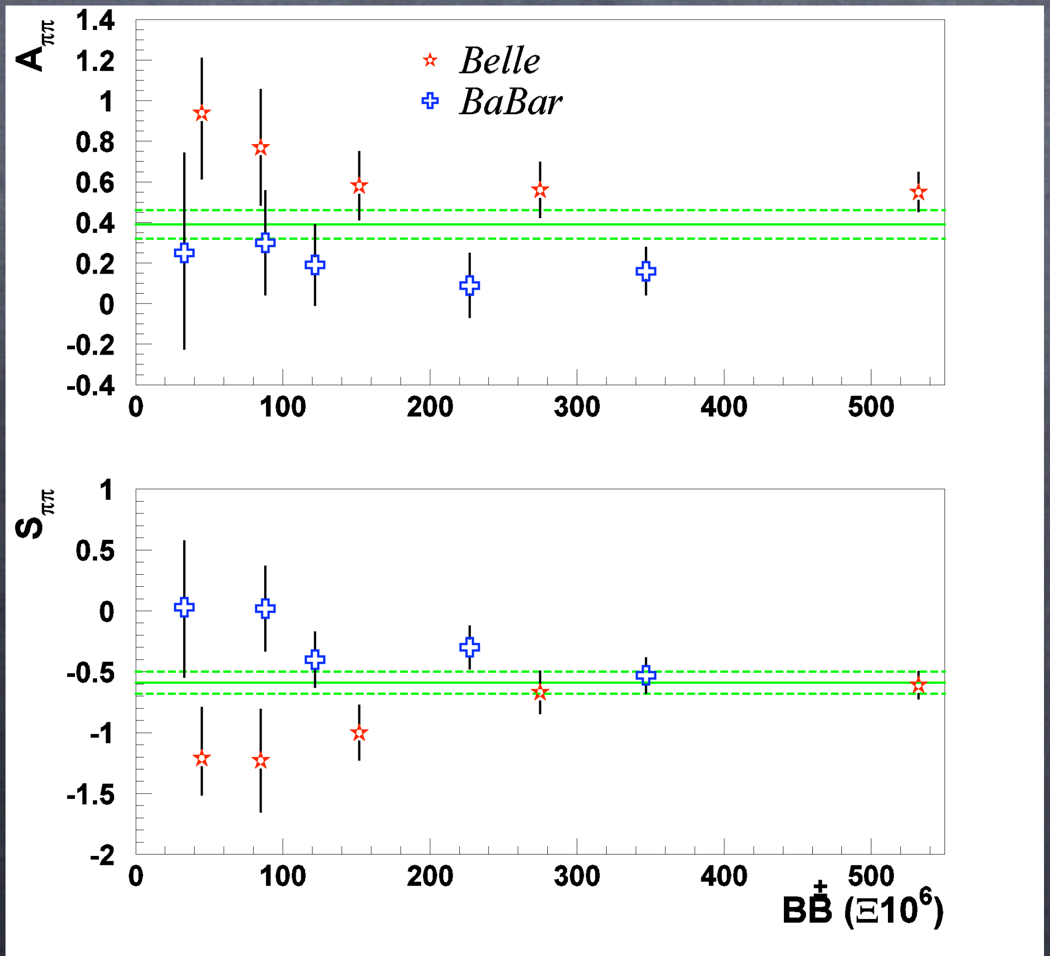


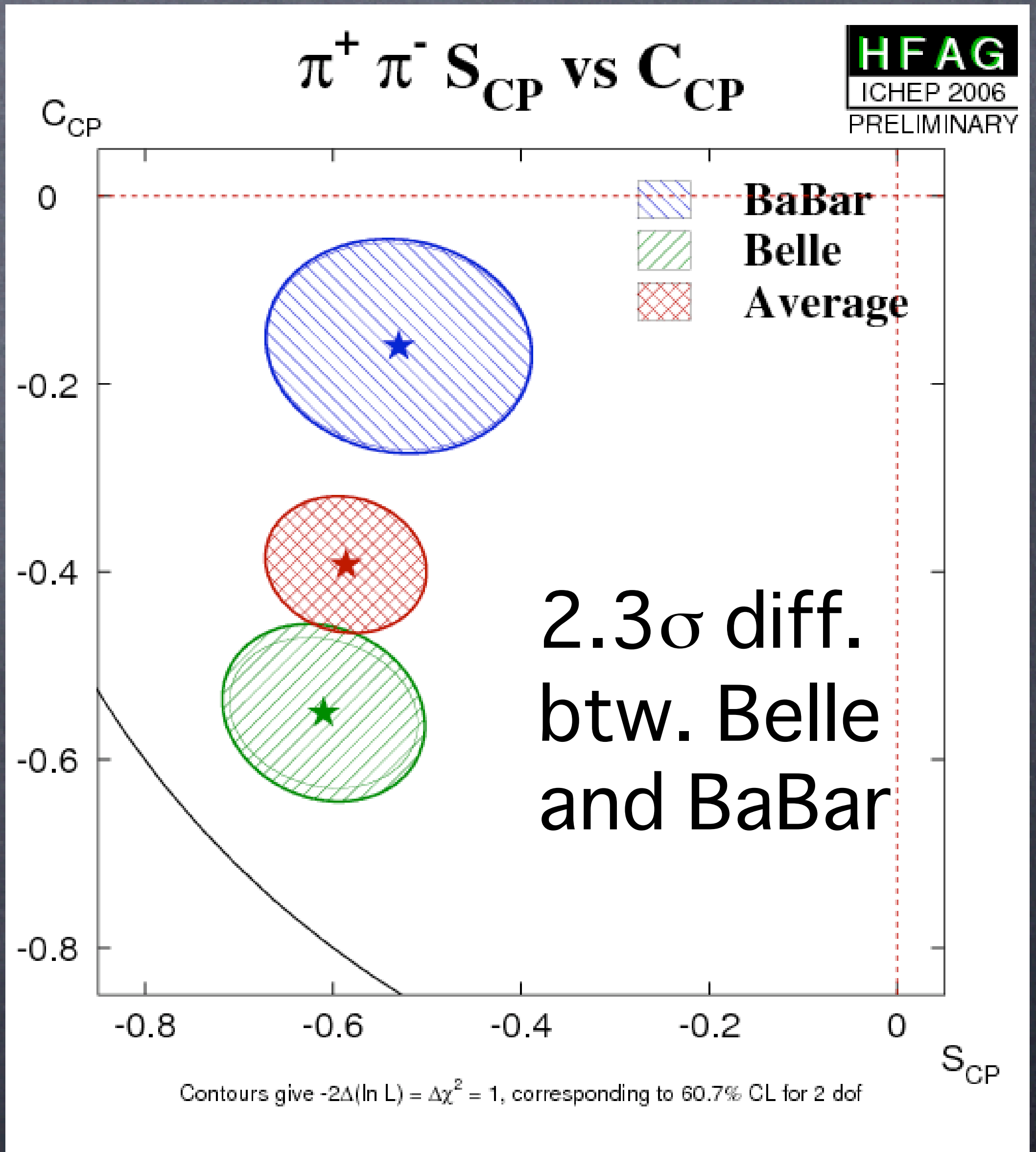
α = (92.7 ± 4.2)°

α : is there a problem ?

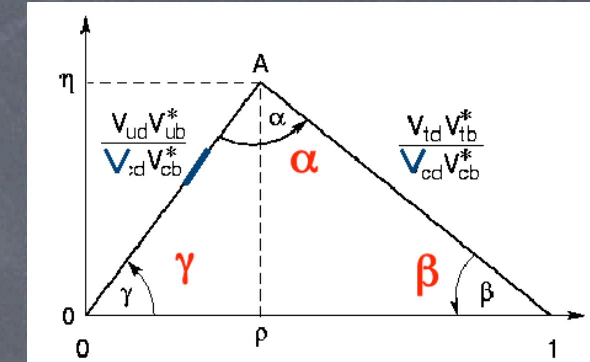
α it is the land where a little of suspence is left. Nothing serious.







γ : where the fantasy took the power



There is no straight (easy) way of measuring it at the B-factories running at the B_d

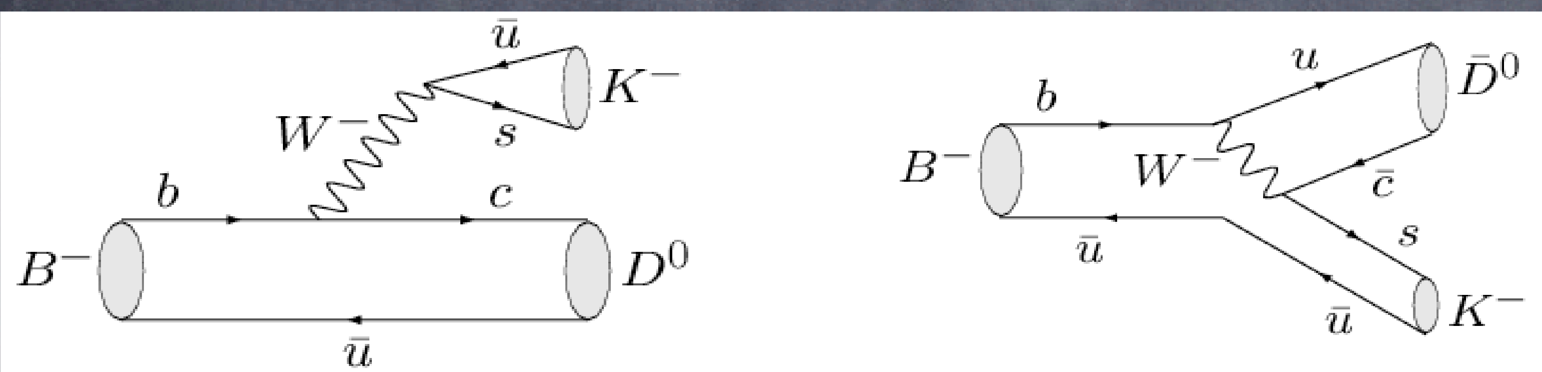
As for β (mixing phase (V_{td}) + real V_{cb} decay) the equivalent for γ is (no mixing phase (V_{ts}) + V_{ub} decay) that unfortunately requires a B_s

Determining γ using $B^\pm \to DK^\pm$ with multibody D decays

Anjan Giri,[1] Yuval Grossman,[1] Abner Soffer,[2] and Jure Zupan[1,3]

$D^0/\overline{D}^0 \to K_s\pi^+\pi^-$

Dalitz analysis



color allowed
$B^- \to D^0 K^- \sim V_{cb} V_{us}^*$
$\sim A\lambda^3$

color suppressed
$B^- \to \overline{D}^0 K^- \sim V_{ub} V_{cs}^*$
$\sim A\lambda^3(\rho + i\eta)$

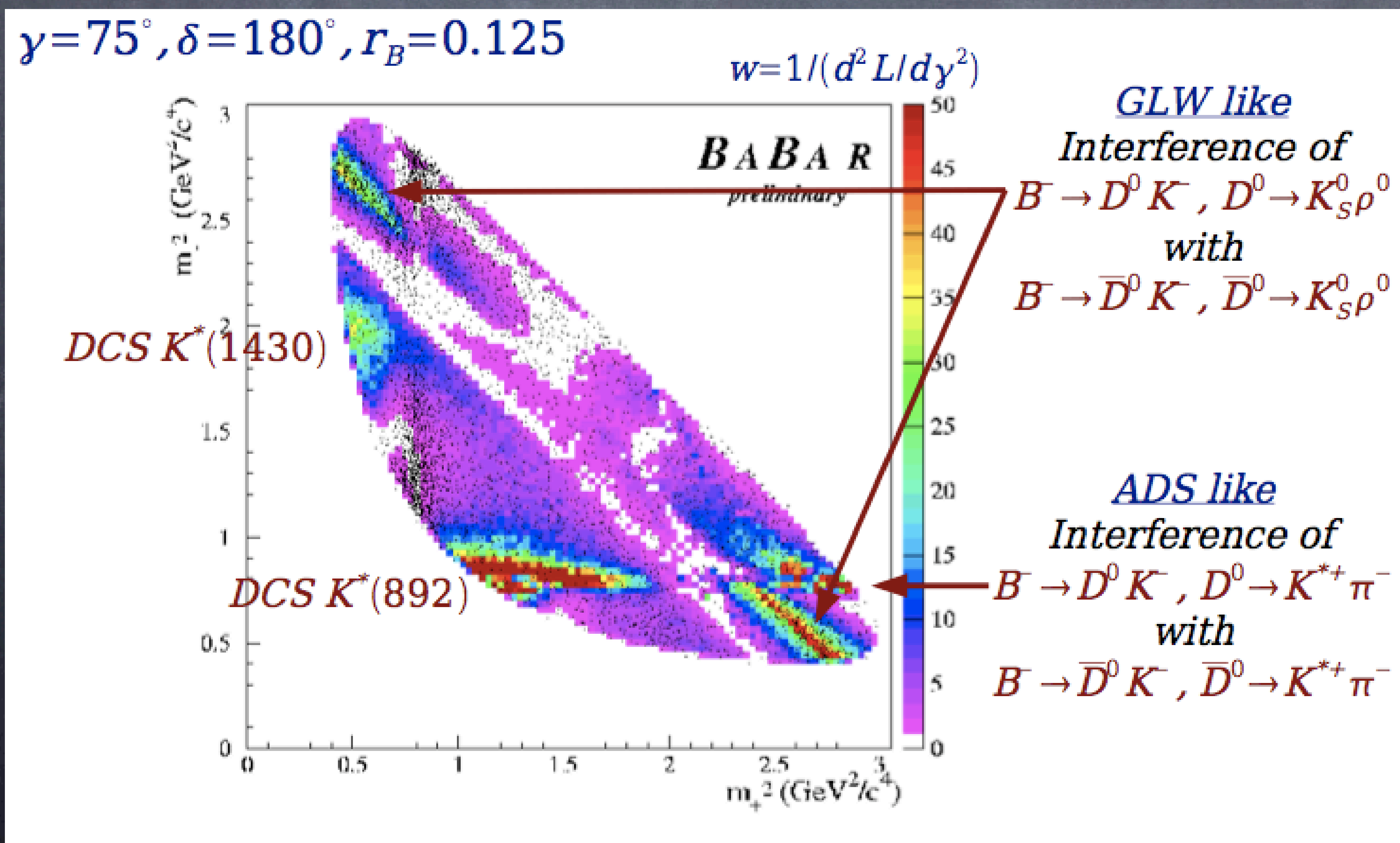
$$r_B = \frac{|A_{suppressed}|}{|A_{favoured}|} \sim \frac{|V_{ub} V_{cs}^*|}{|V_{cb} V_{us}^*|} \times [color\ supp] = 0.1\text{-}0.2$$

$$D^0 \to K_S \pi^+ \pi^- \sim A_D(m_-^2, m_+^2)$$
$$\overline{D}^0 \to K_S \pi^+ \pi^- \sim A_D(m_+^2, m_-^2)$$

Dalitz: do you remember ?

$$A(B^-) = \overbrace{f(M_-^2, M_+^2)}^{B^- \to D} + \overbrace{r_B e^{(-i\gamma+i\delta)} f(M_+^2, M_-^2)}^{B^- \to \bar{D}}$$

$$A(B^+) = \underbrace{f(M_+^2, M_-^2)}_{B^+ \to \bar{D}} + \underbrace{r_B e^{(+i\gamma+i\delta)} f(M_-^2, M_+^2)}_{B^+ \to D}$$



Sensitivity varies over the Dalitz space.

Fit all together

γ, δ, r_B

However : one step forward, two steps backward

ex: BaBar

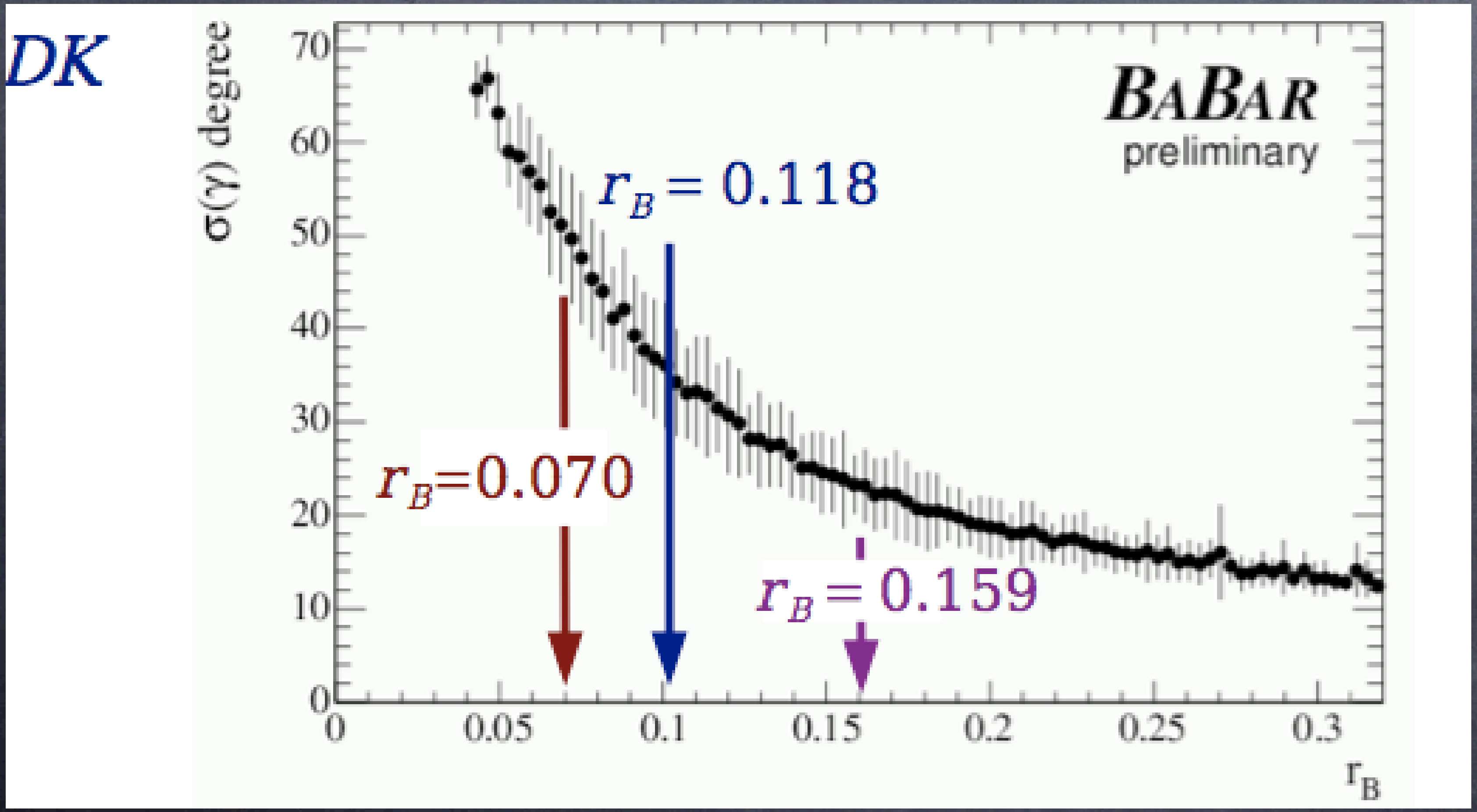
$$r_B = \left|\frac{A(b \to u)}{A(b \to c)}\right|$$

$227\times10^6\, B\bar{B}$ [*PRL95*, 121802 (2005)]

$$\gamma = 70^\circ \pm 31^\circ(stat)^{+12^\circ}_{-10^\circ}(syst)^{+14^\circ}_{-11^\circ}(model)$$

$347\times10^6\, B\bar{B}$ [*hep−ex*/0607104]

$$\gamma = 92^\circ \pm 41^\circ(stat) \pm 11^\circ(syst) \pm 12^\circ(model)$$

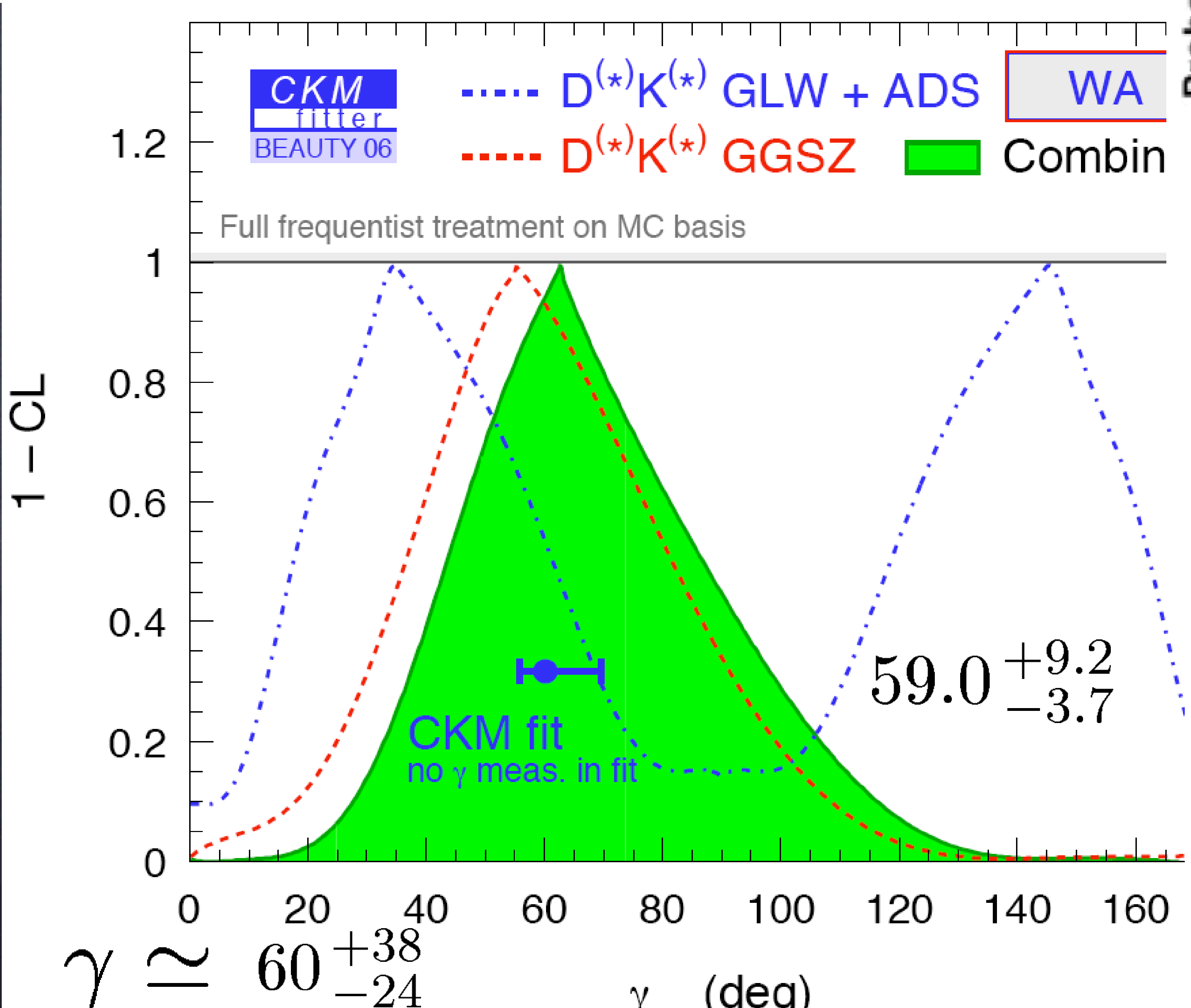


for sure it does not scale as :

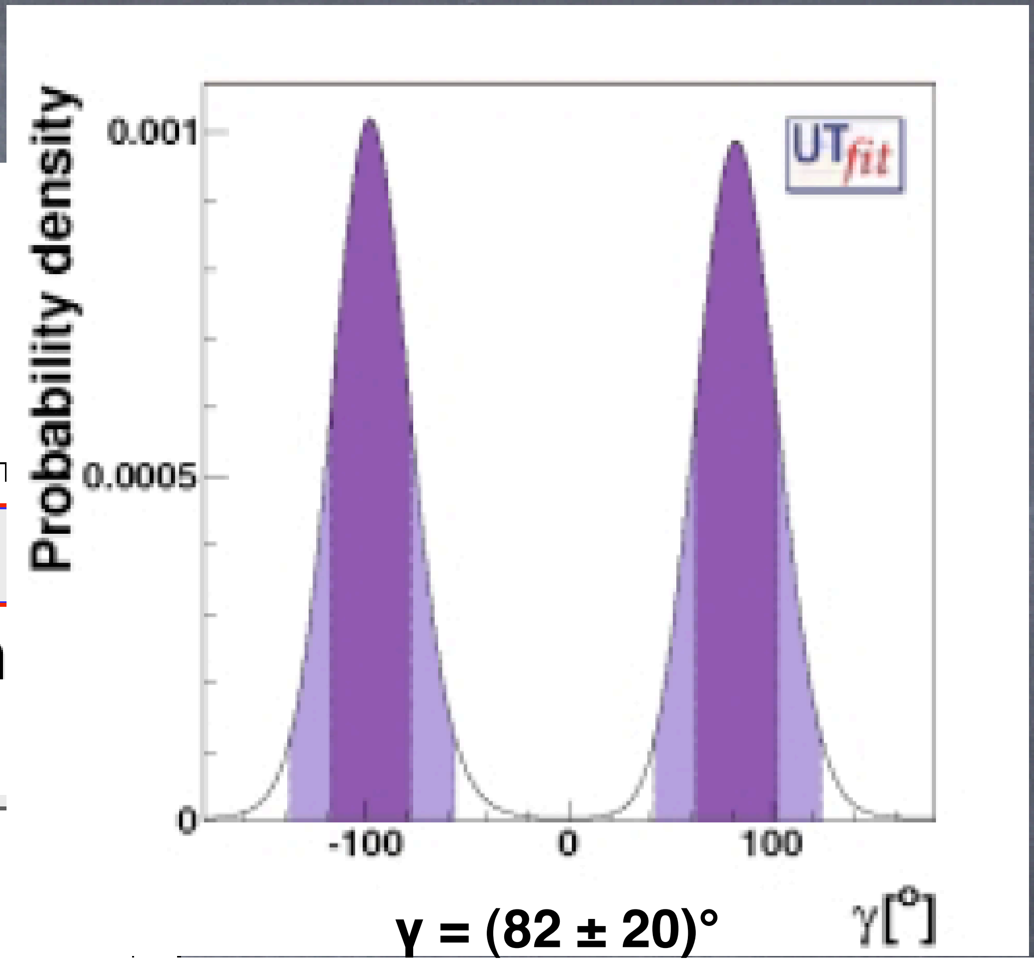
$1/\sqrt{N}$

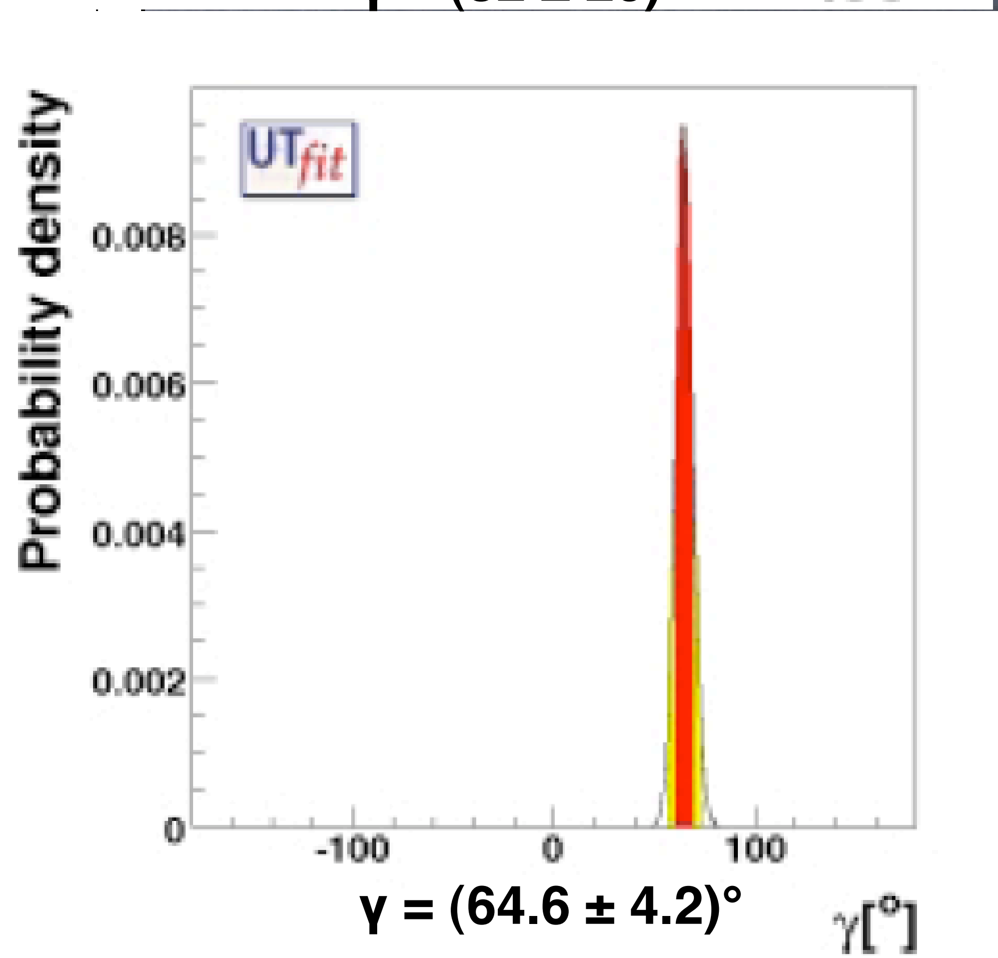
γ

$\sigma_{stat}(\gamma) = 10^\circ \; to \; 15^\circ \; (r_B \sim 0.1 - 0.15) \; @ \; B-factories$

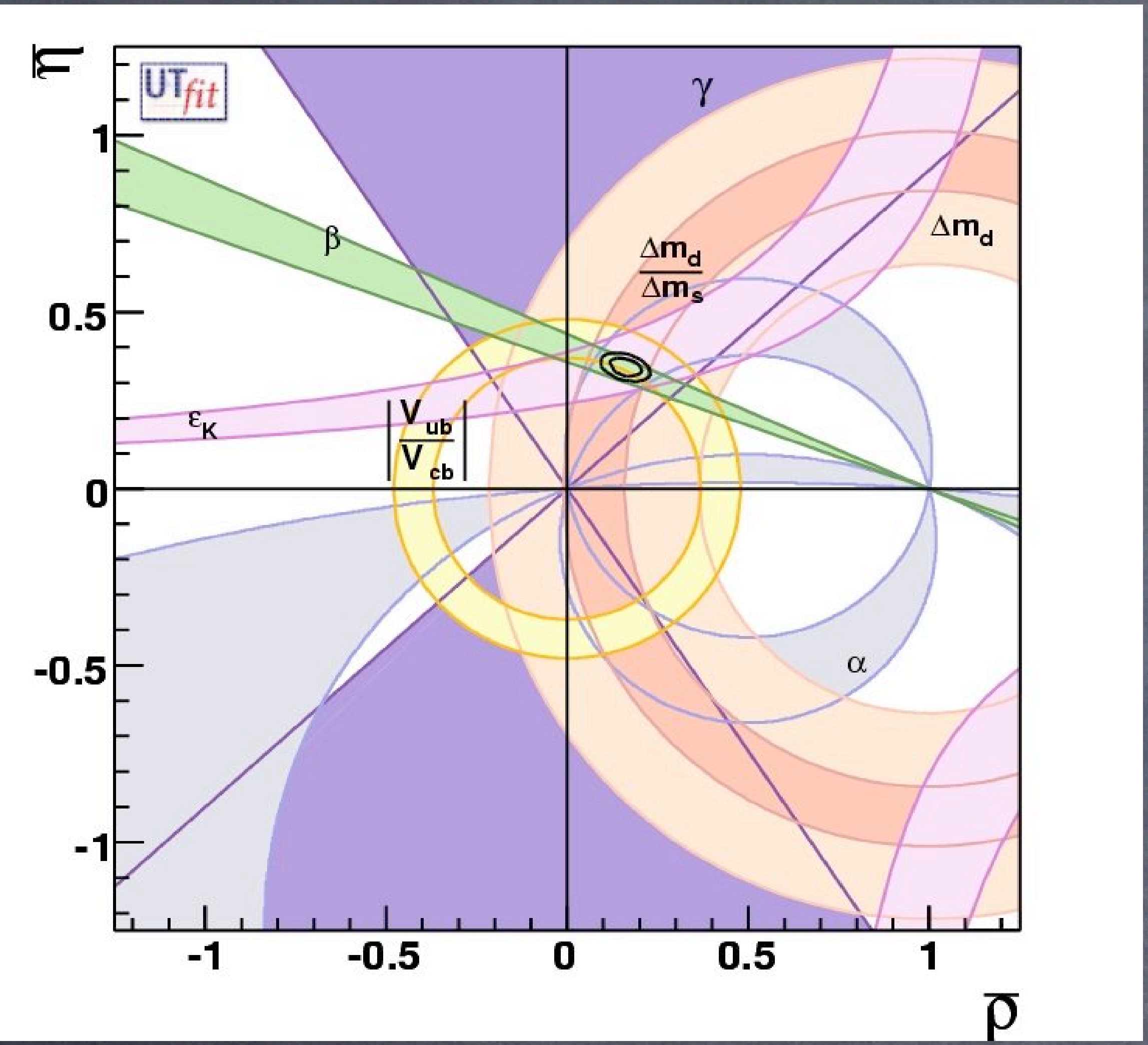


$\gamma \simeq 60^{+38}_{-24}$





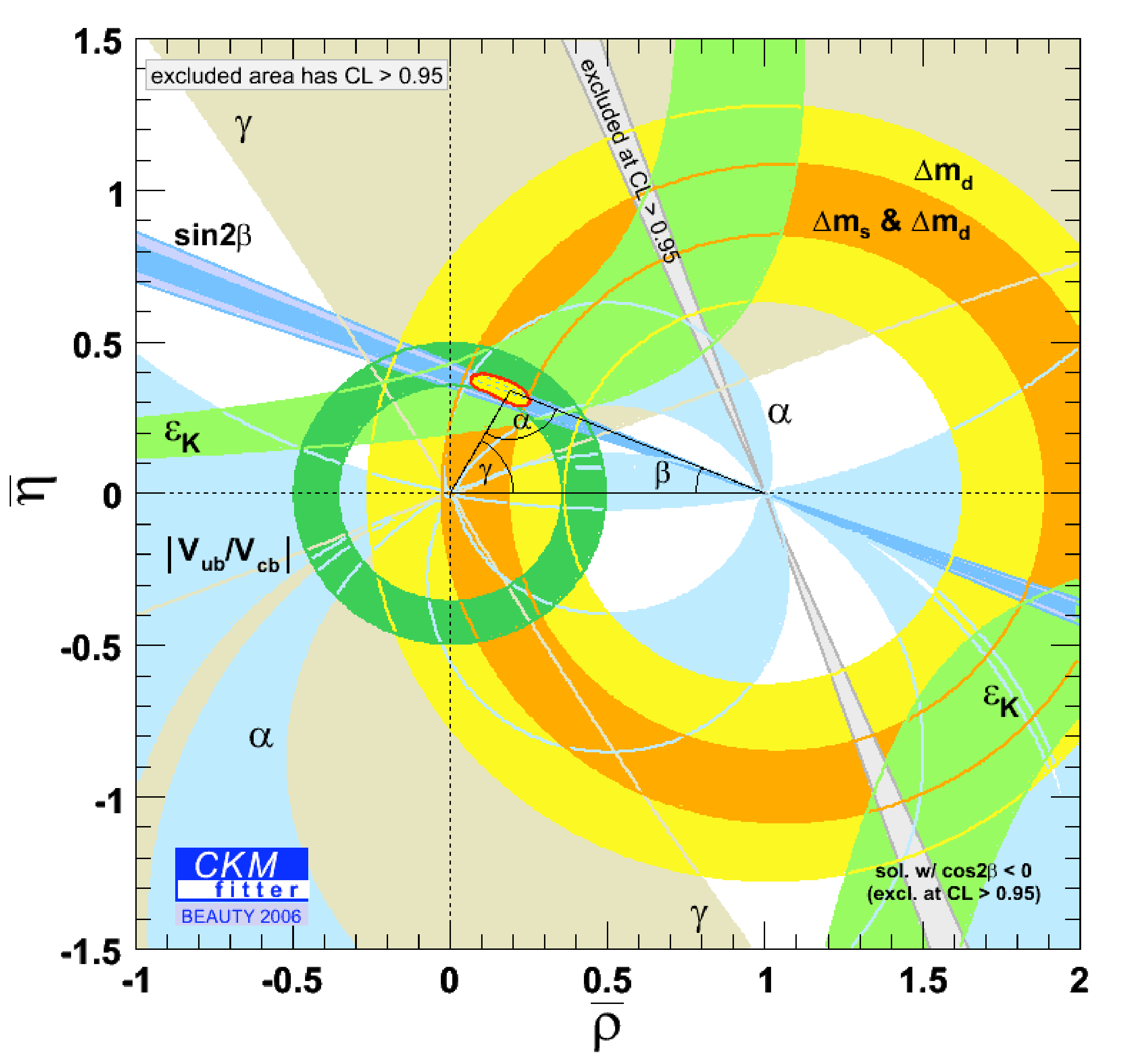
The artistic phase



For most of us
the difference is in the
colors only !

$\rho = 0.163 \pm 0.028$

$\eta = 0.344 \pm 0.016$

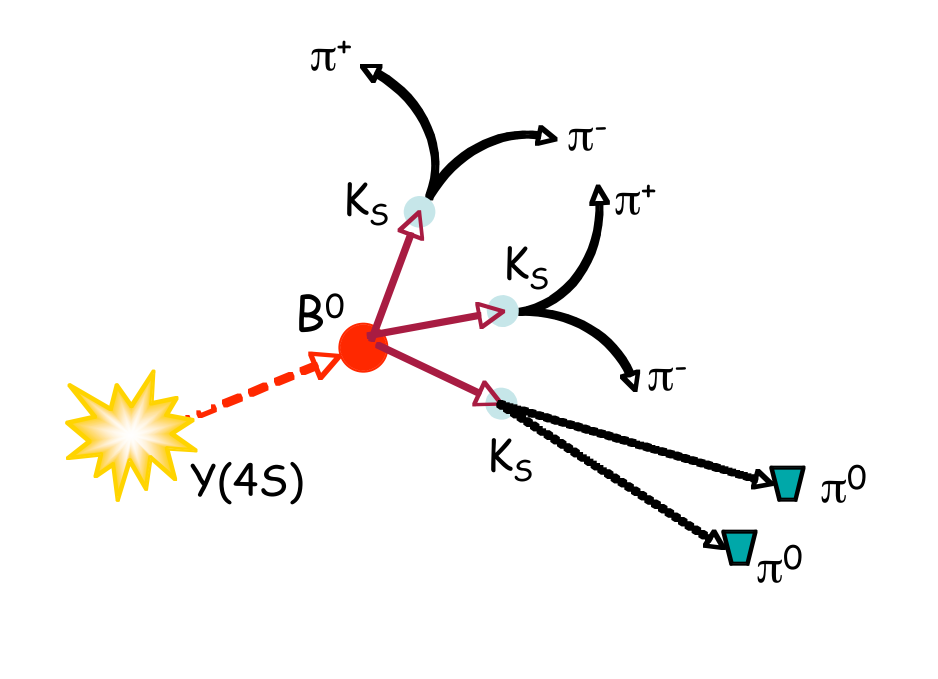


now, do not forget that the triangle has a fourth and hidden angle

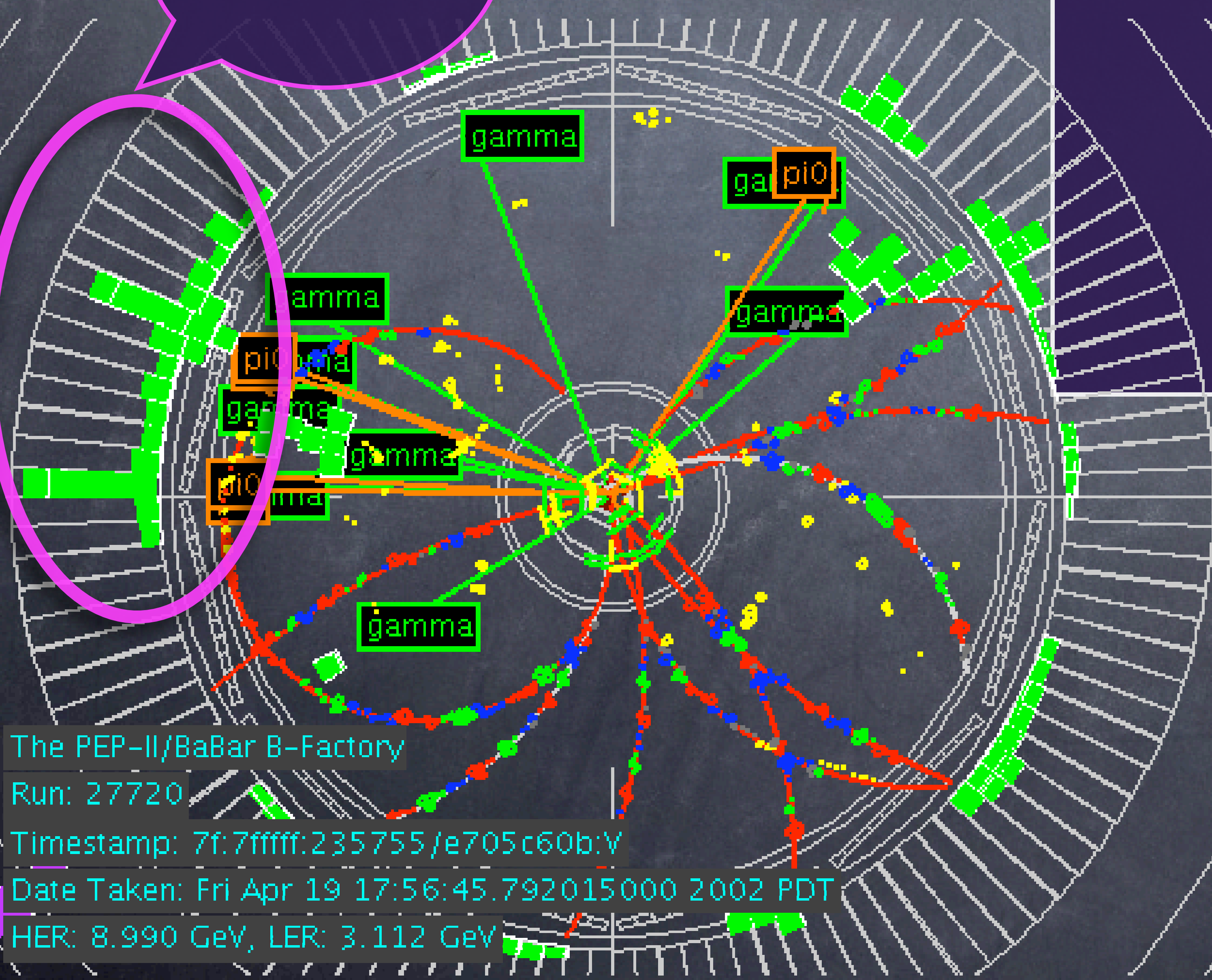
β'

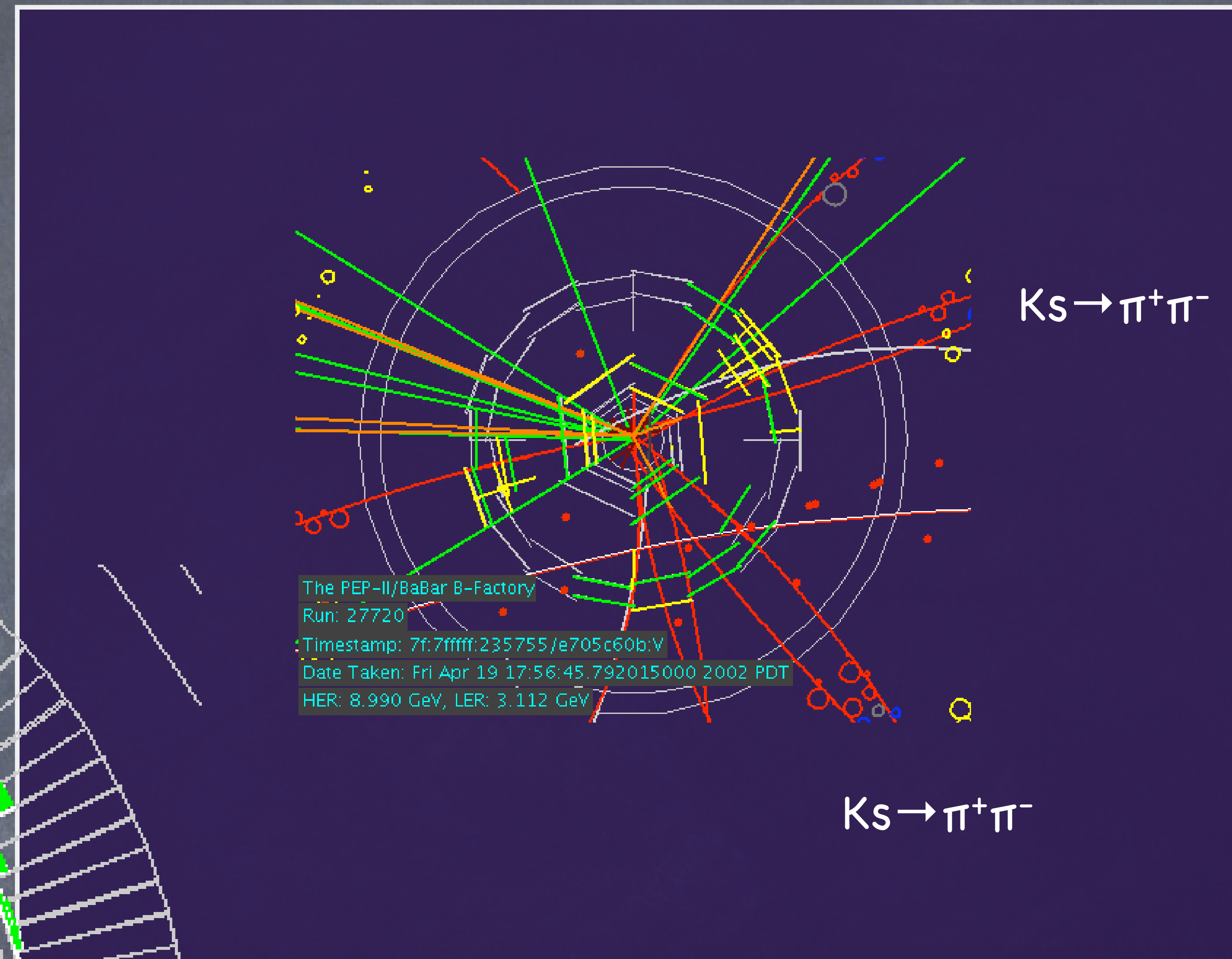
that of the $b \to s s \bar{s}$ transitions

$B^0 \rightarrow K_S K_S K_S$



$K_S \rightarrow 2\pi^0$





$K_S \rightarrow \pi^+\pi^-$

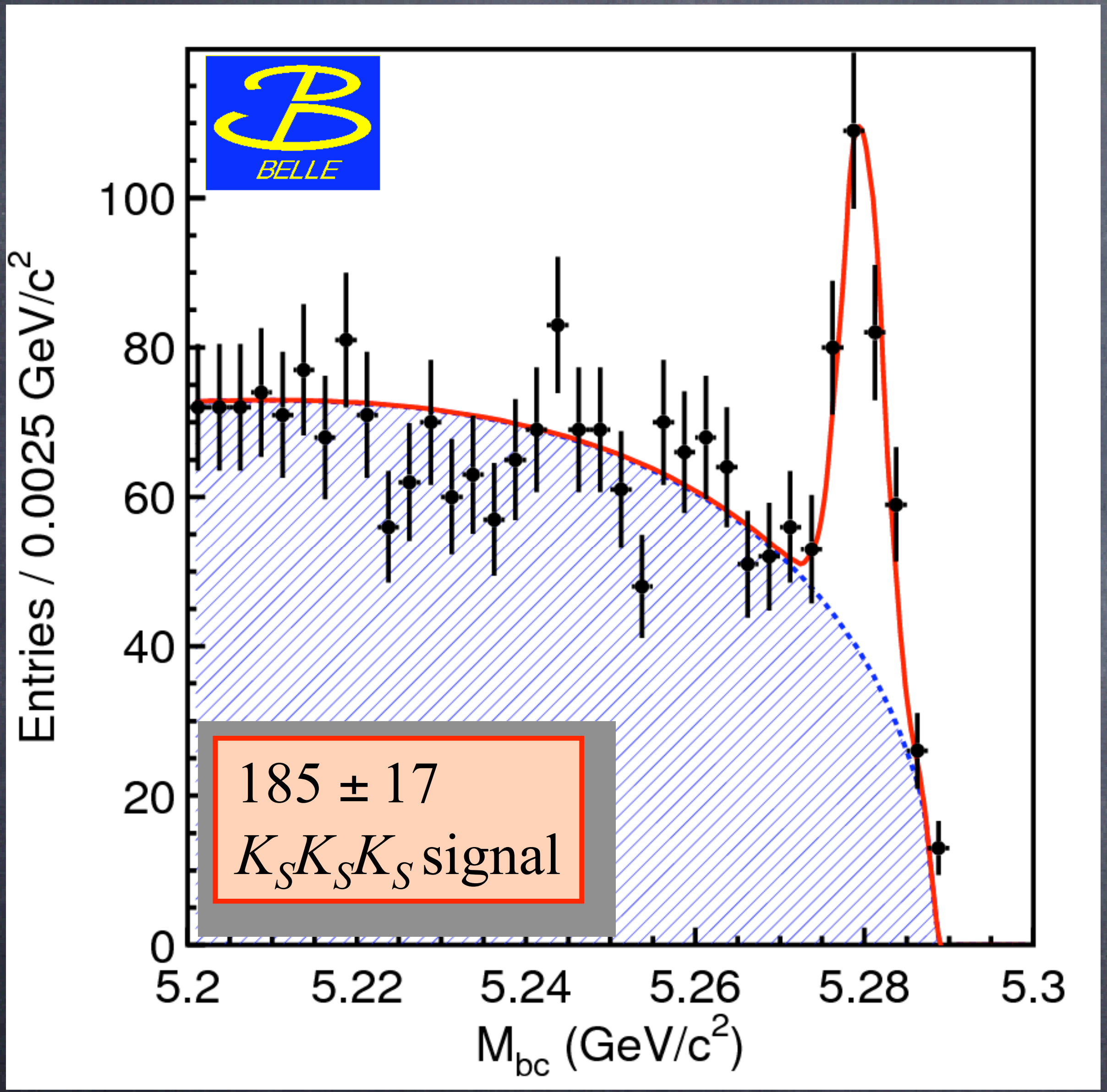
$K_S \rightarrow \pi^+\pi^-$

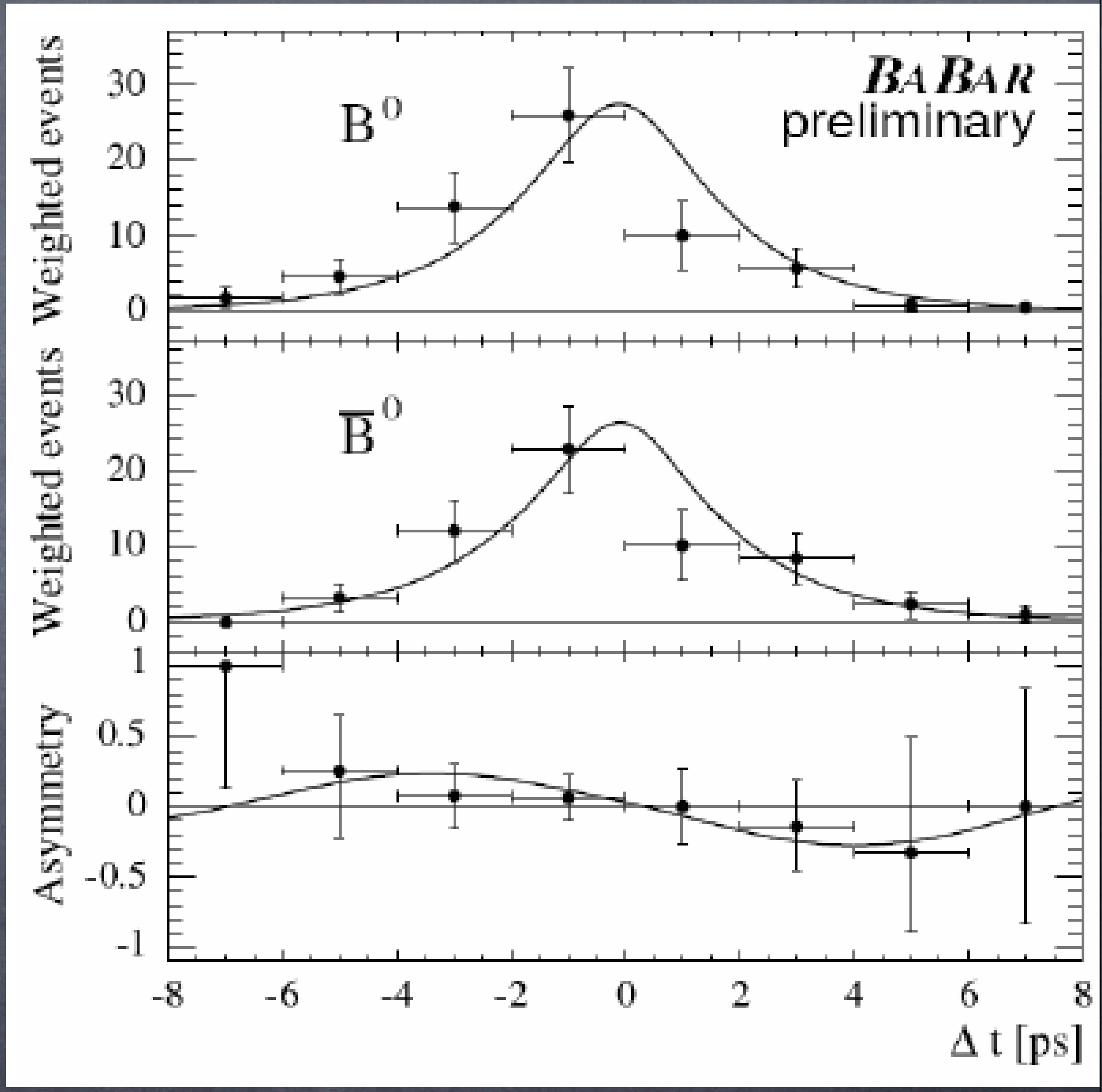
Only doable at an electron collider

and the results are:

"sin2β" $= +0.71 \pm 0.24(\text{stat}) \pm 0.04(\text{syst})$
C $= +0.02 \pm 0.21(\text{stat}) \pm 0.05(\text{syst})$

535M $B\bar{B}$

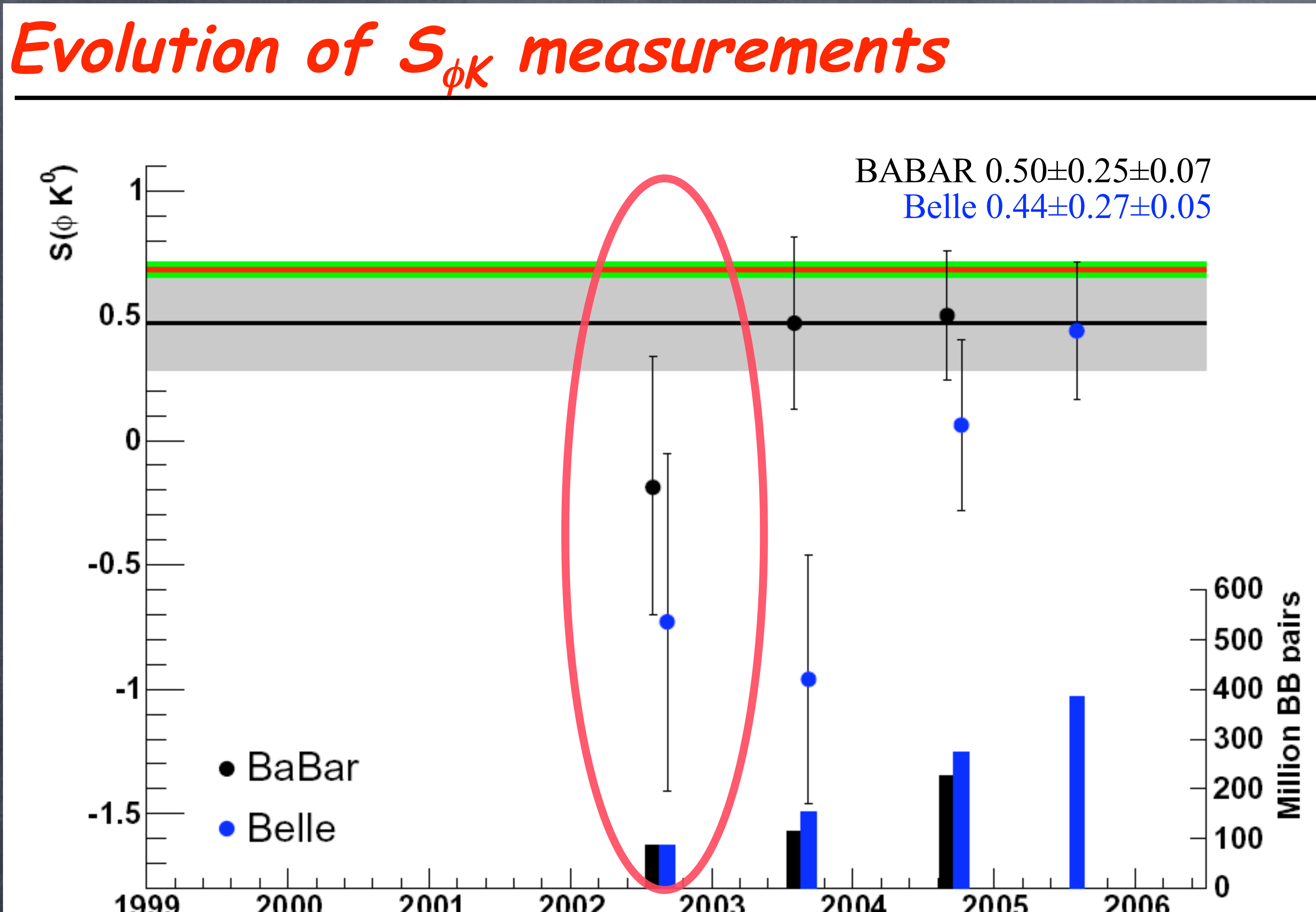




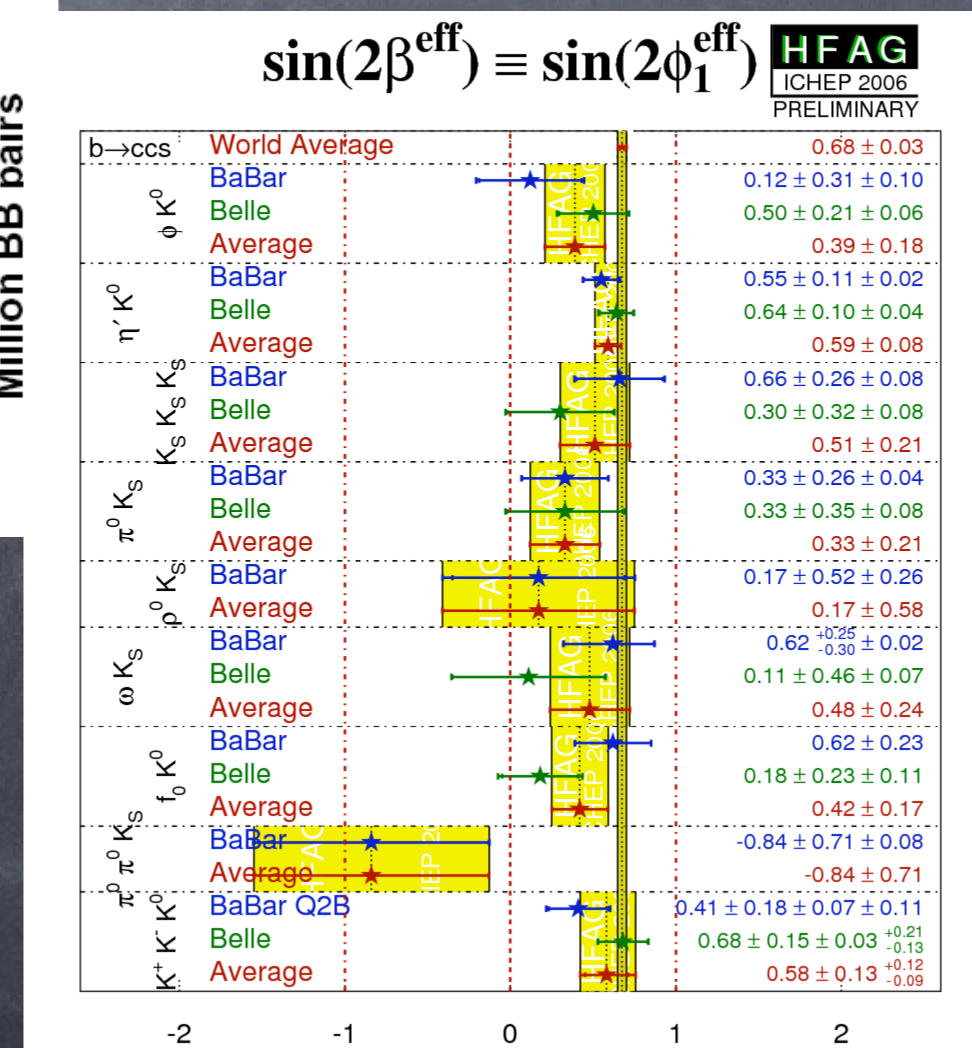
347M $B\bar{B}$

"sin2Φ_1" $= +0.30 \pm 0.32(\text{stat}) \pm 0.08(\text{syst})$
$\mathcal{A}$ $= +0.31 \pm 0.20(\text{stat}) \pm 0.07(\text{syst})$

The shortcut to Fame (β')



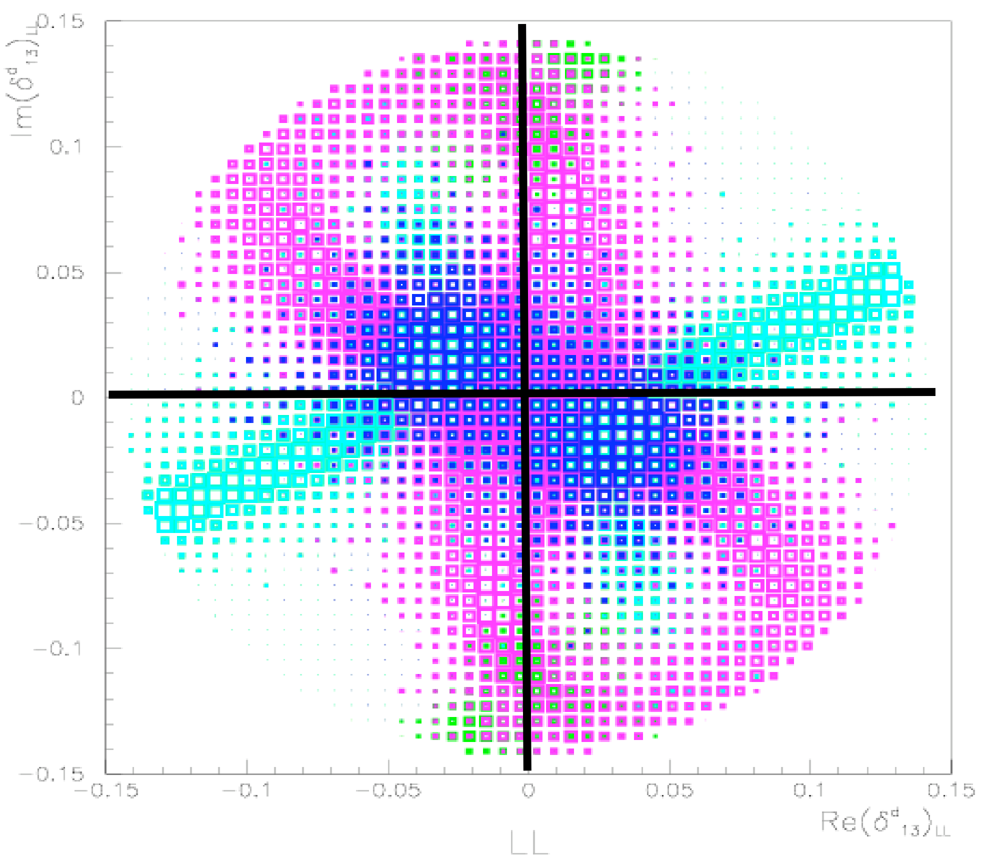
But..........



do you really feel like on the way of getting a NP out of it ?

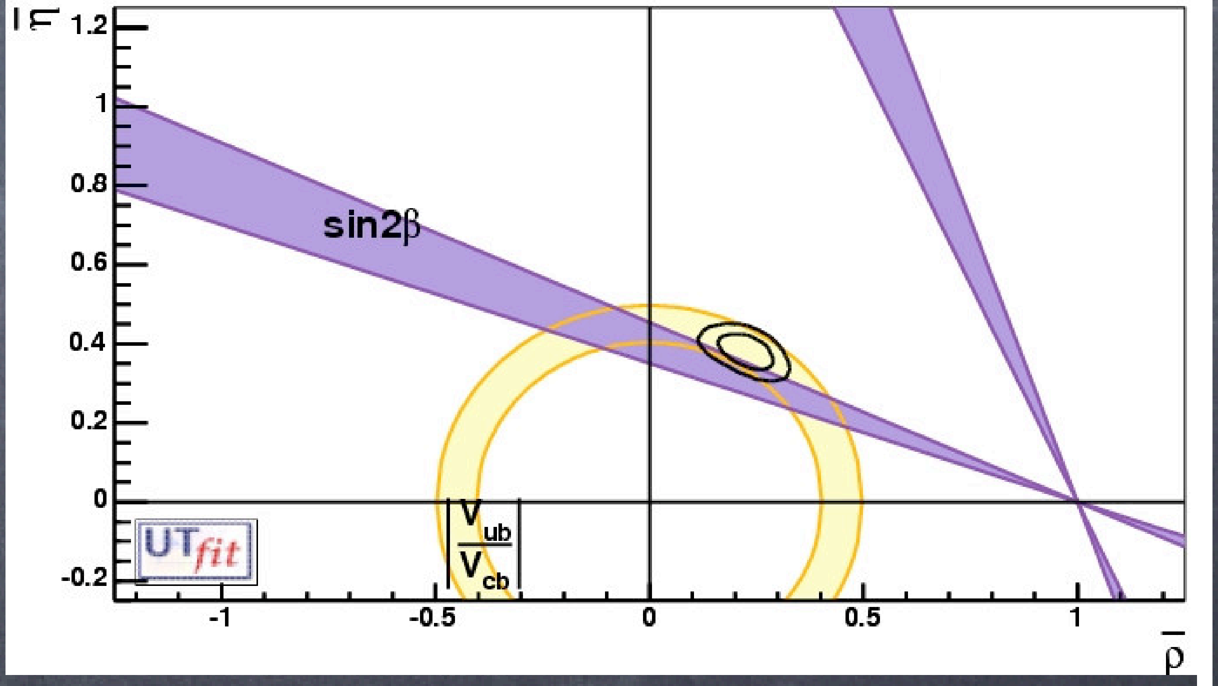
NP: New Physics & Nobel Prize

or maybe elsewhere ?



Re $(\delta^d_{13})_{LL}$ vs Im $(\delta^d_{13})_{LL}$
present

although it is true that the glory is whatever it is not (0,0) , the actual evidence is due to



the tension (!?) between the exclusive and inclusive determination of V_{ub}

Every success story comes to an end

- The B-factories have super-performed
- They have brought B-physics to precision grade
- However the SM has resisted at the 1ab^{-1} fire
- Even if ‘the hope is the last to die’ it is unlikely that it will concede victory with 2ab^{-1} in two years from now
- A new phase (!!!) is needed and it is again unlikely that LHCb alone will be able to shell SM with the intensity desirable

Something not be forgotten ever

Why are B factories so productive?

What Super means ?

I'd say a factor 100 more

We computed luminosity needed

on the basis of 15% CPV

Need about 400 events to get the asymmetry

$B\bar{B} \to (B \to l^+ X)(\psi K_S)\quad \psi \to \mu^+\mu^-;\ K_S \to \pi^+\pi^-$

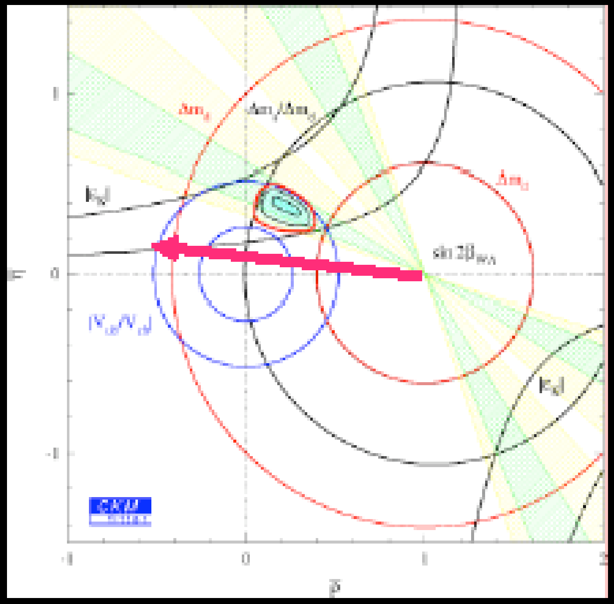
to get a result $.15 \pm .05 \Rightarrow 3\sigma$

$$L = 10^{34}\ sec^{-1}\ cm^{-2}$$

It was 70%

To proporse $300M

project, you have to be conservative



Asym>15%

A.I. Sanda
Nagoya University

Who would have thought that

we would be doing CPV in $B \to K_S K_S K_S$?

The box: shake or open ?

Two Approaches to New Physics

B,K,LFV physics

shake the Box, listen

virtual particles

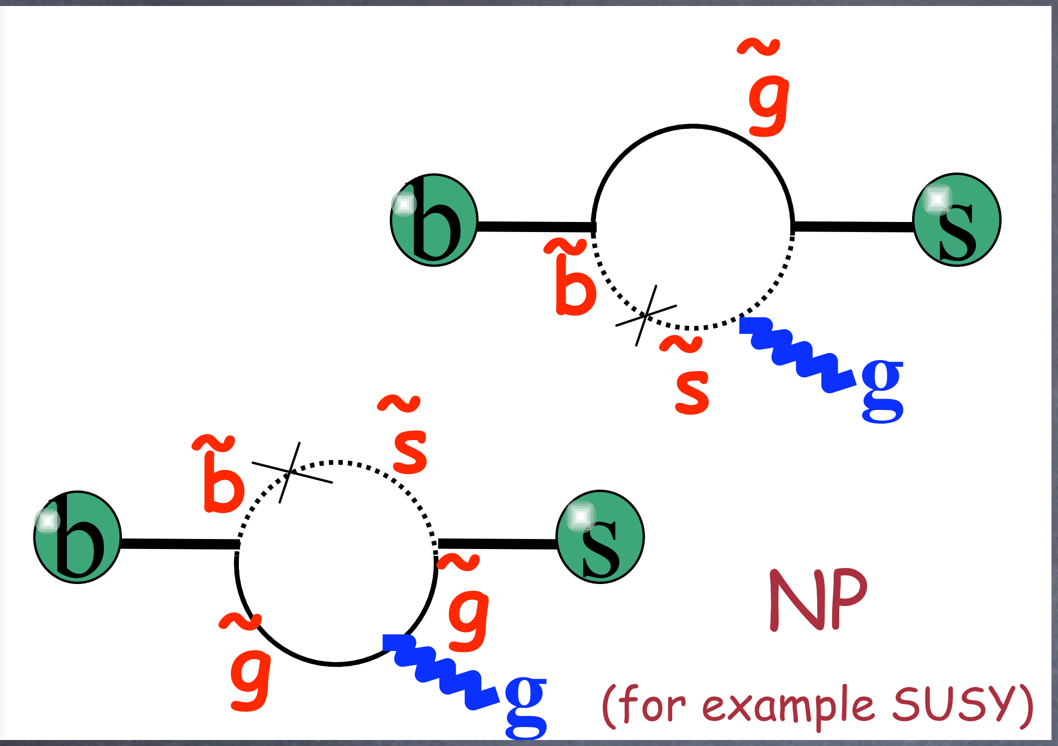
Both !

LHC: open the Box

real particles

January 31, 2005 R. Cahn - EPP2010 - B Physics

The nightmare



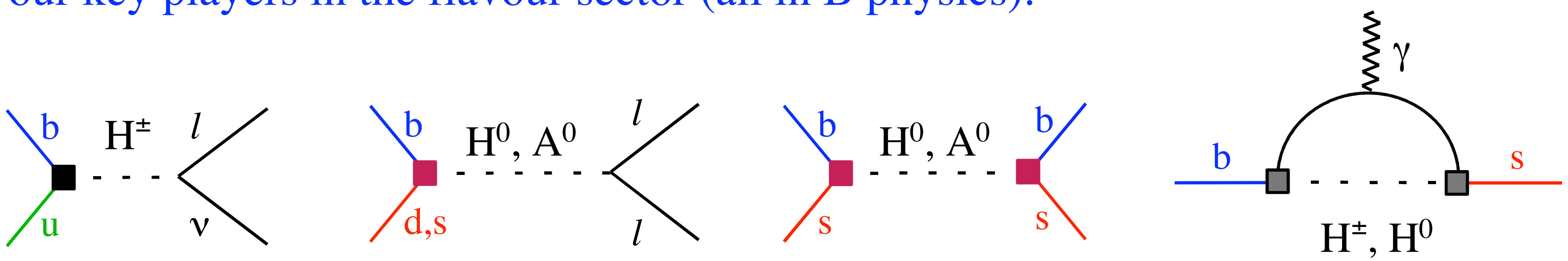
Why has SUSY not observed yet ? (if it exists at all)

- Either it is Obese: Mass is too high (major nightmare)
- Or it is Blind: the phase is the same as SM, MFV (minor nightmare)
- Or both !

$$\frac{|\delta_{bq}|}{\Lambda_{eff}} \quad \text{NP wrt SM} \quad \frac{|V_{tb}^{*}V_{tq}|}{M_W}$$

Are you comfortable with this ?

Four key players in the flavour sector (all in B physics):

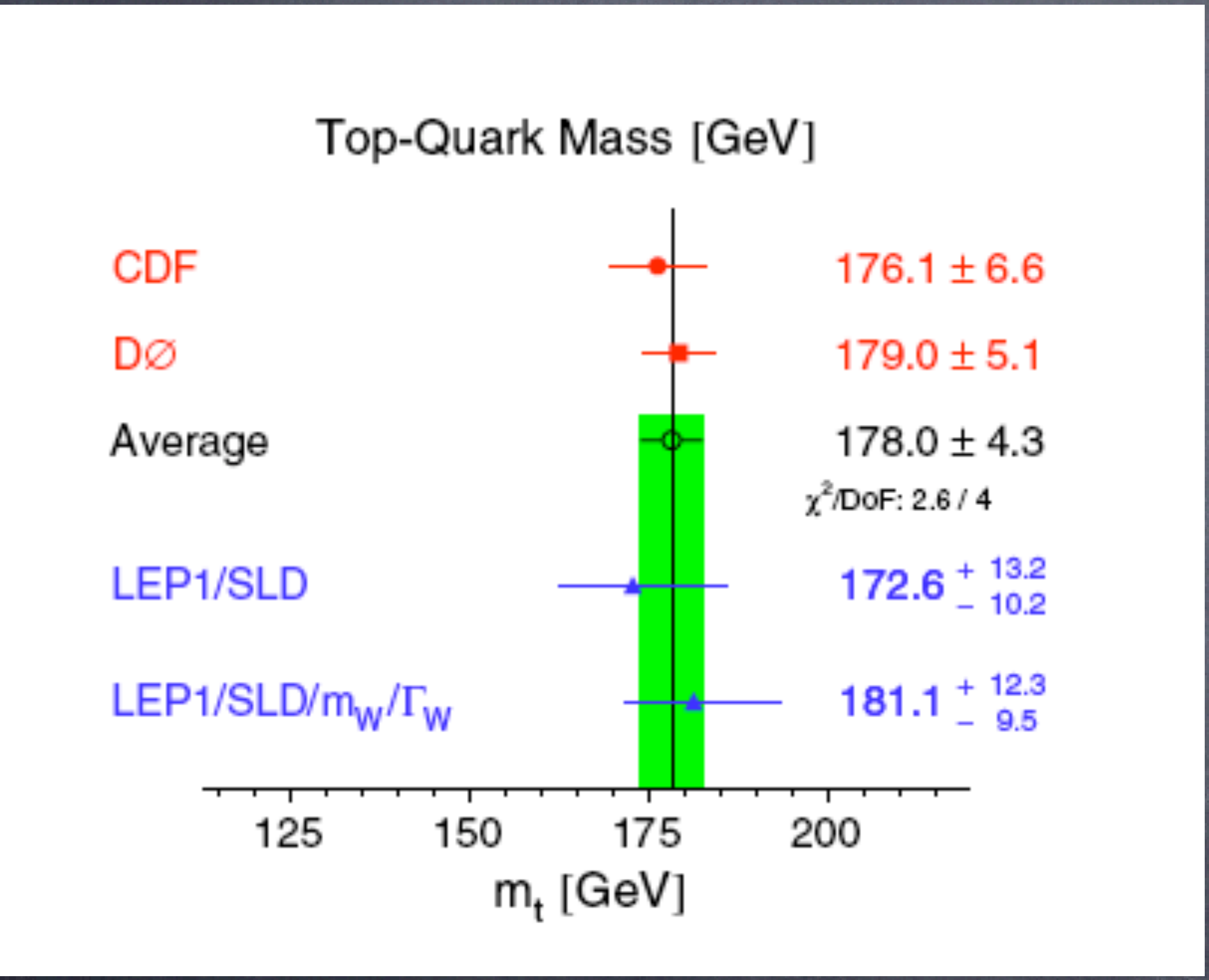


$B^\pm \to l^\pm \nu$	$B_{s,d} \to l^+ l^-$	ΔM_{B_s}	$B \to X_s \gamma$
↓	↓	↓	↓
~(10-50)% suppression	up to 100 × enhancement	~(0-20)% suppression	~(10-50)% enhancement

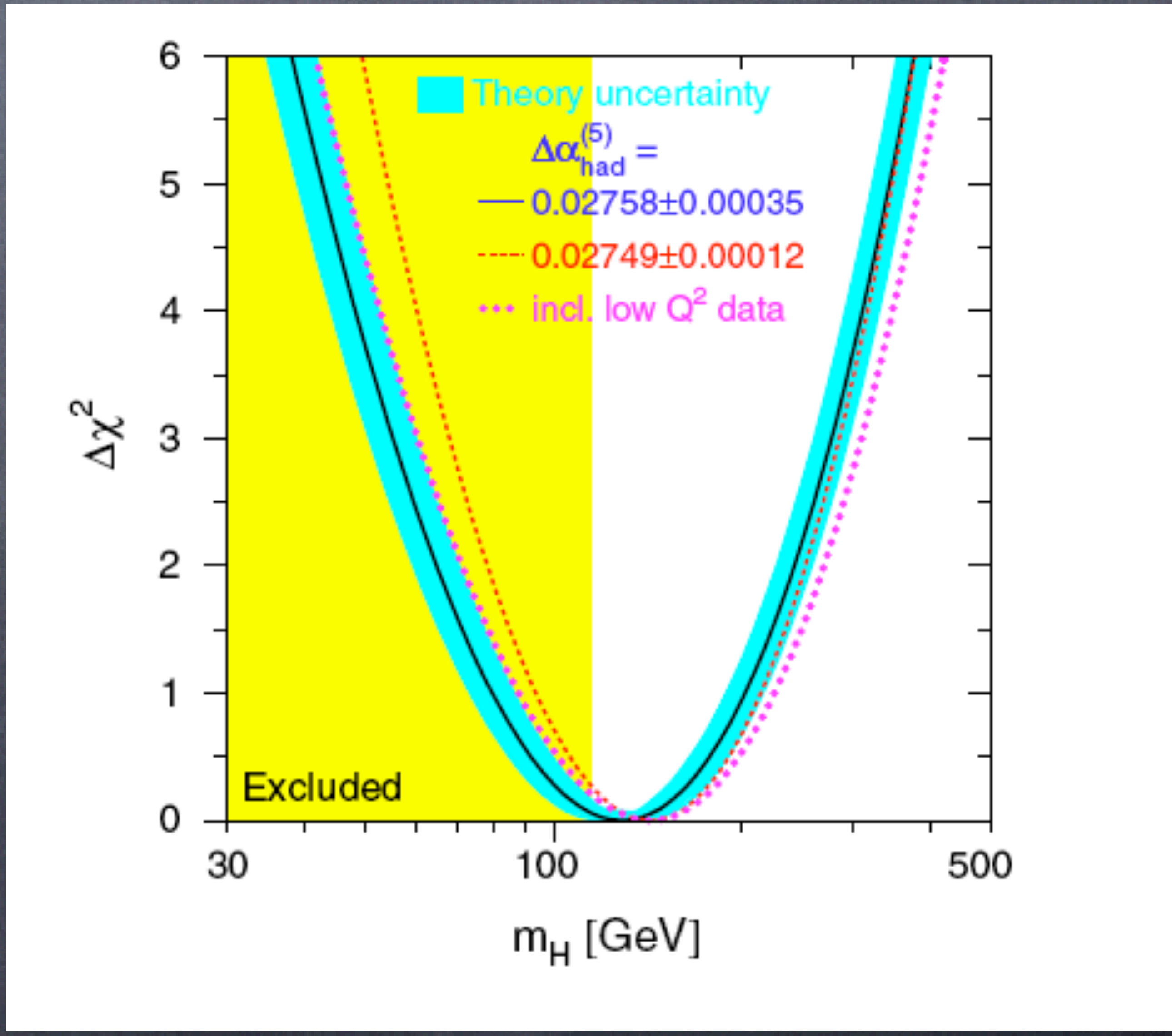
[qualitative general features for $M_H \sim 500$ GeV & $\tan\beta \sim 50$]

this is what you could aim for if you look for big effects (low precision) !

The precise meaning of Precision Physics

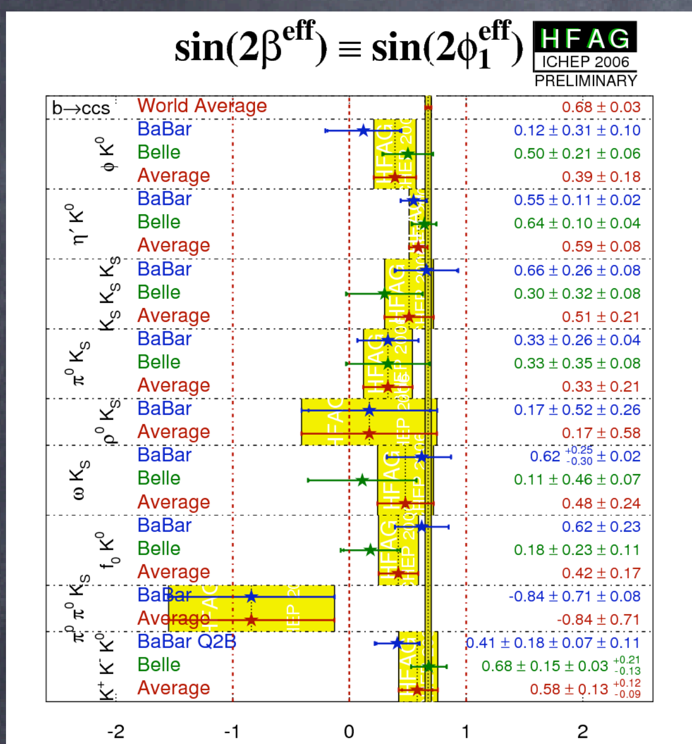


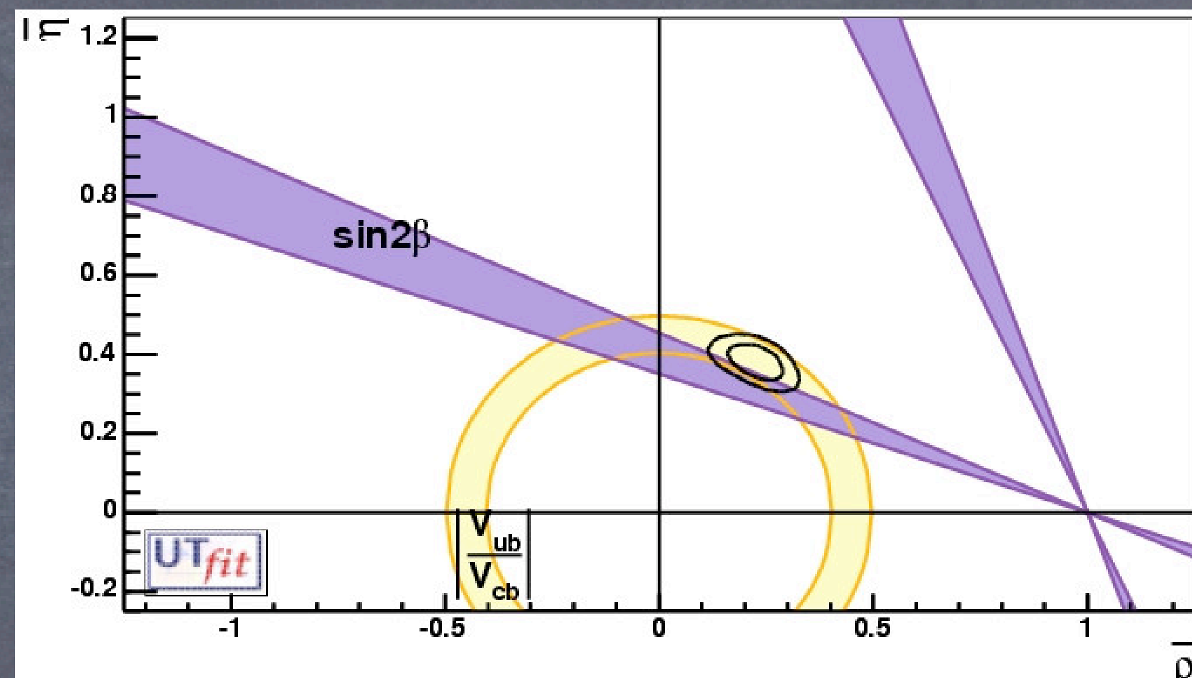
Experimental precision



matches precise calculations

at the present level of modest precision





weakness on both sides:

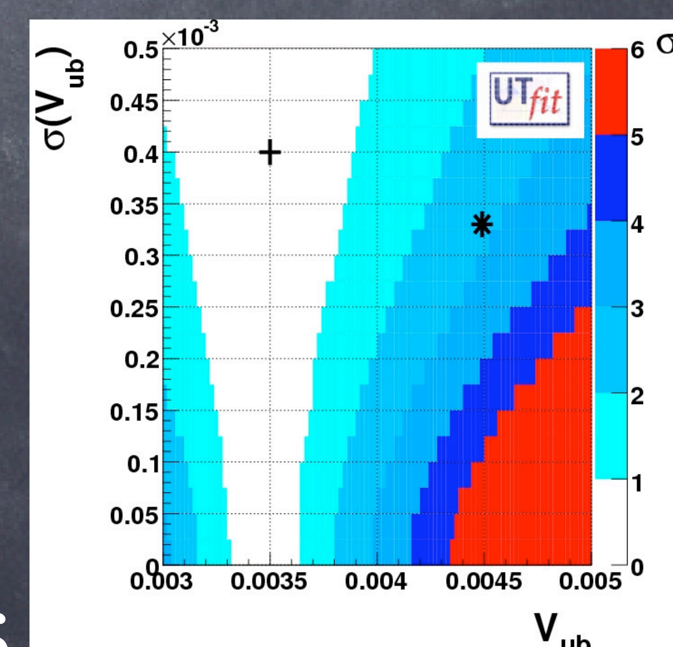
-exp error on β' as well as on the prediction

-inclusive or exclusive Vub

-lattice value for ΔMd,ΔMs, Vts/Vtd

sin2β=0.675±0.026
From direct measurement

sin2β =0.764± 0.039
from indirect determination
(all included by sin2β)



1)any claim will be impossible

2)at most we test theoretical opinions

we have to become immodest !

At the super B factory the experimental determinations of the quantities relevant to the CKM fit ($\sin 2\beta$, α, $\Delta m_{d/s}$, $b \to c$, …) will have reached in most of the cases an accuracy at the level or better than 1%.

Can we calculate hadronic parameters with a 1% precision ?

and there are people who are ready to take up the blame

A. Stocchi

Observable	CKM2008-10 ($2ab^{-1}$)	SuperB ($50ab^{-1}$)	Comments
$\sin(2\beta)$ ($b\to ccs$)	<1°	<1°	no improvement
$\sin(2\beta)$ (Peng.) ϕK $(f_0,\eta'\pi^0)K^0$ 3K	 ~4° ~(6,3,5)° ~3°	 ~2° ~(2,1,2)° ~1°	Globally could be a factor 5 i
α ($\pi\pi,\rho\rho,\rho\pi$)	5°	~1°	
γ (DK)	(5-10)°	(1-2)°	(Tree decay Competi
V_{cb}-incl V_{cb}-excl	1% 4%	0.5? 1%?	More theo. Dep
$B\to D^*\tau\nu$	10-15%	2-3%	SM -se
V_{ub}-incl V_{ub}-excl	10% 10%	2%? 2%?	More theo. Dep
$Br(B\to l\nu)$	20%	4%	>5
$Br(B\to(\rho,\omega),\gamma)$	0.1×10^{-6}	0.03×10^{-6}	$\lvert V_{td}/V_{ts}\rvert$ fro
$Br(B\to\mu\mu)$ $Br(B\to e\mu)$	90%CL @ 1×10^{-8} 90%CL @ 2×10^{-8}	not measurable	Intersting for MFV magnitude..Sy
$A_{FB}(X_s l^+l^-)$ $Br(B\to X_s l^+l^-)$	±0.12 ($s<s_0$) 7% (5-14%syst)	±0.015 ($s<s_0$) 7% (1-6%syst)	Intersting for MF Syst. dif
$A_{FB}(X_s\gamma)$ $A_{FB}(K^*\gamma)$	3% 0.65%	[0.5-1]% ~0.15%	Interesting if σ<(

V. Lubicz

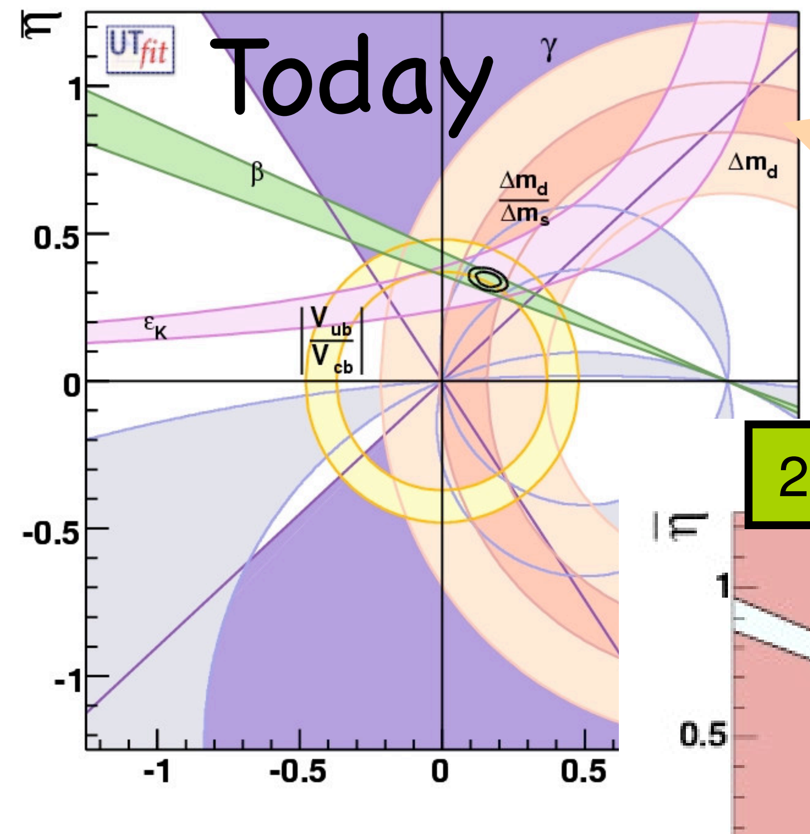
Estimates of error for 2015

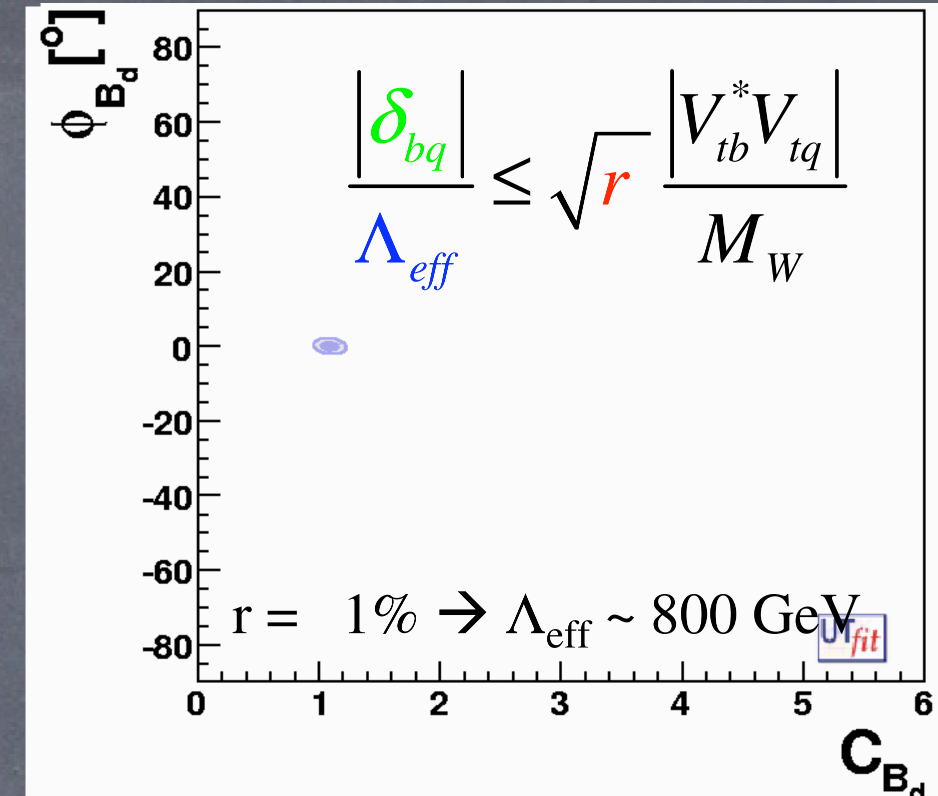
Hadronic matrix element	Current lattice error	6 TFlop Year	60 TFlop Year	1-10 PFlop Year
$f_+^{K\pi}(0)$	0.9% (22% on $1-f_+$)	0.7% (17% on $1-f_+$)	0.4% (10% on $1-f_+$)	**< 0.1%** **(2.4% on $1-f_+$)**
$\hat{B}_K$	11%	5%	3%	**1%**
f_B	14%	3.5 - 4.5%	2.5 - 4.0%	**1 – 1.5%**
$f_{Bs}B_{Bs}^{1/2}$	13%	4 - 5%	3 - 4%	**1 – 1.5%**
ξ	5% (26% on ξ-1)	3% (18% on ξ-1)	1.5 - 2 % (9-12% on ξ-1)	**0.5 – 0.8 %** **(3-4% on ξ-1)**
$\mathcal{F}_{B\to D/D^*l\nu}$	4% (40% on $1-\mathcal{F}$)	2% (21% on $1-\mathcal{F}$)	1.2% (13% on $1-\mathcal{F}$)	**0.5%** **(5% on $1-\mathcal{F}$)**
$f_+^{B\pi}$,...	11%	5.5 - 6.5%	4 - 5%	**2 – 3%**
$T_1^{B\to K^*/\rho}$	13%	----	----	**3 – 4%**

Remember these names !!!

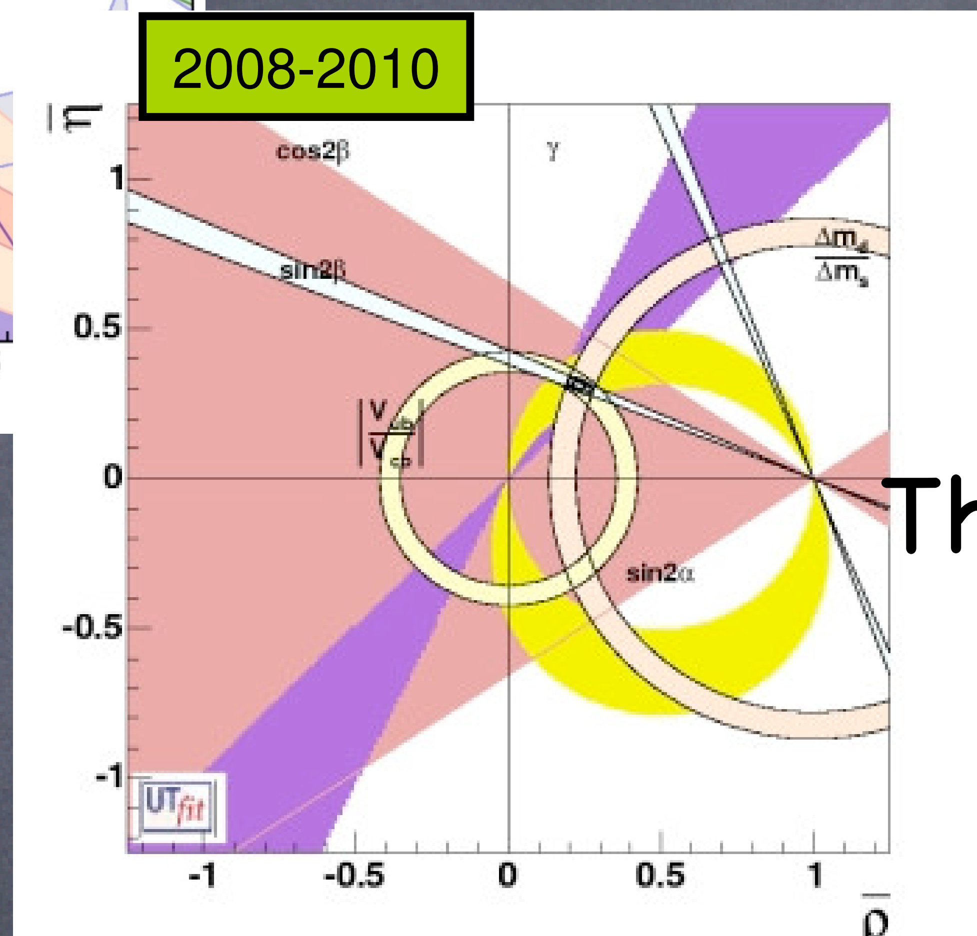
Evolution

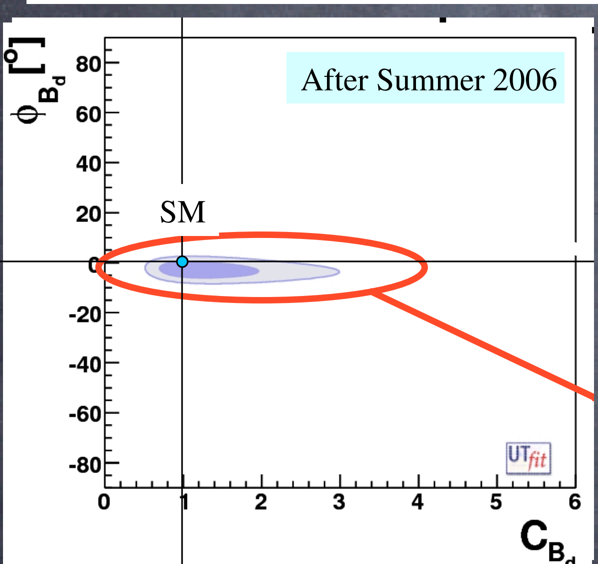
Today

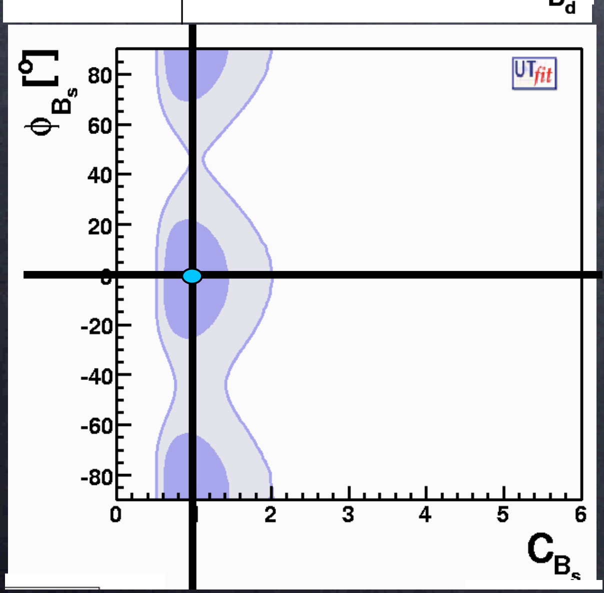




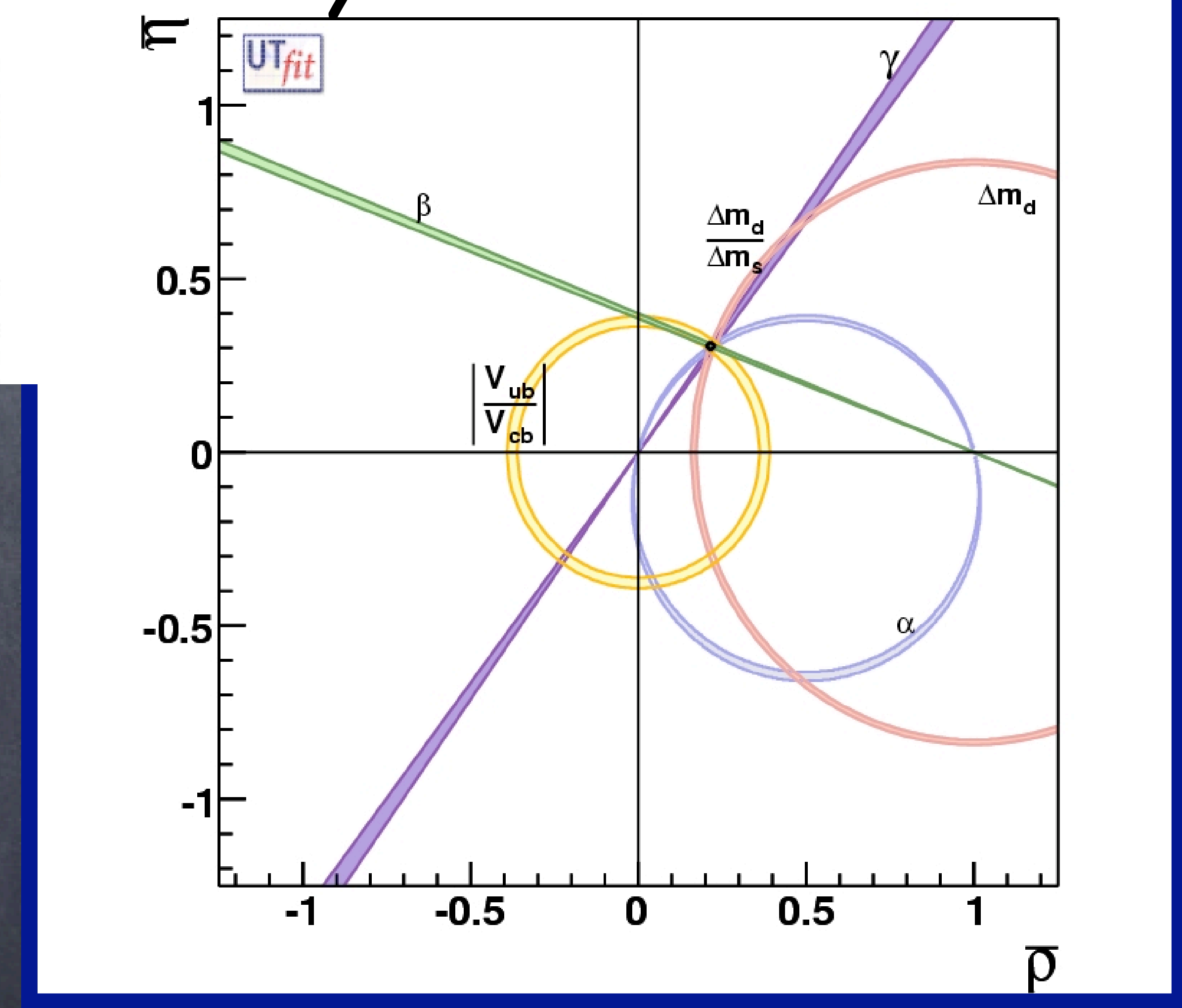
2008-2010







The day after tomorrow



B-physics could shed light on NP on most of its phase space

- MFV:
  - low-scale flavour-blind SUSY breaking (ex. gauge mediation, Scherk-Schwarz): all δ's exactly zero.
  - high-scale flavour-blind SUSY breaking (ex. msugra): nonzero δ's generated by running from M_{pl}:
    - $(\delta^d_{ij})_{LL} \sim V_{ti} V_{tj}\, m_t^2/m_{sq}^2$
    - $(\delta^d_{ij})_{LR} \sim (\delta^d_{ij})_{LL} \times (\delta^d_{jj})_{LR} \sim (\delta^d_{ij})_{LL} \times m_j/m_{sq} \tan\beta$
    - $(\delta^d_{ij})_{RR} \sim (\delta^d_{ii})_{RL} \times (\delta^d_{ij})_{LL} \times (\delta^d_{jj})_{LR} \sim (\delta^d_{ij})_{LL} \times m_i m_j/m_{sq}$

- NON-MFV:
  - high-scale flavour-dependent SUSY breaking (ex. string moduli): nonzero δ's
  - SUSY-GUTs: correlated δ's in quark & lepton sector
  - flavour models:
    - alignment: flavour violation in up-type squarks: chargino contributions to B physics
    - nonabelian symmetries: difficult to suppress new contributions to B physics

MFV

The "worst" case: we still probe virtual particles with masses up to ~12 M_W ~1 TeV

$$S_0(x_t) \to S_0(x_t) + \delta S_0(x_t)$$

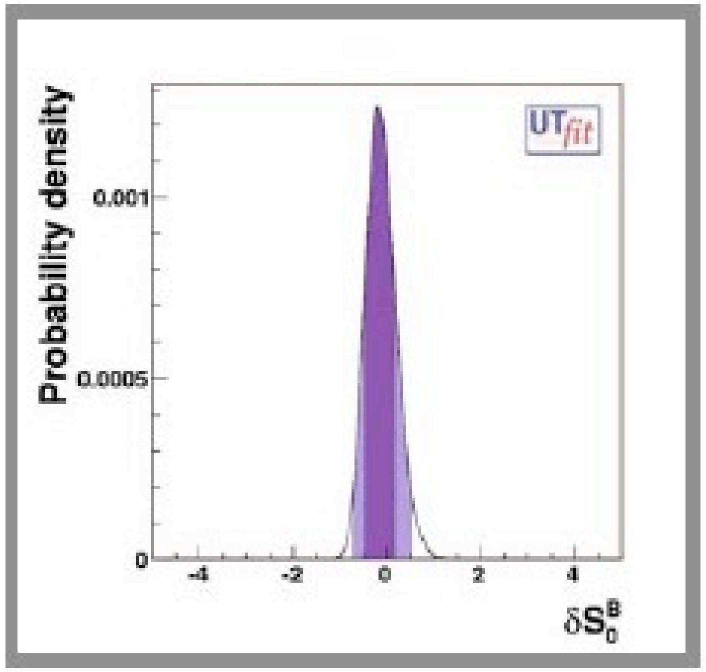
$$\delta S_0(x_t) = 4a\left(\frac{\Lambda_0}{\Lambda}\right)^2$$

$$\Lambda_0 = \frac{\lambda_t \sin^2 \vartheta_W M_W}{\alpha} \simeq 2.4\ \text{TeV}$$

from here to the future !

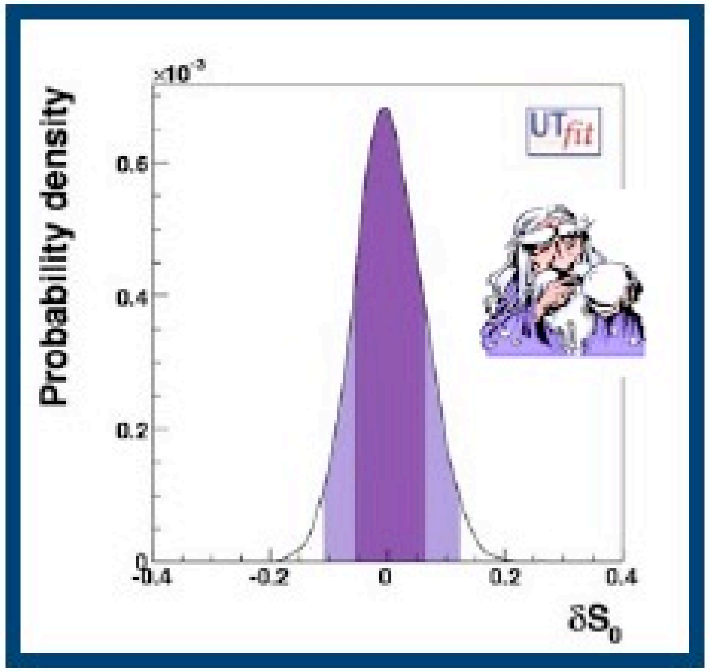
Complementarity to the LHC.

SUSY observed there and partially studied here



$\delta S_0 = -0.16 \pm 0.32$

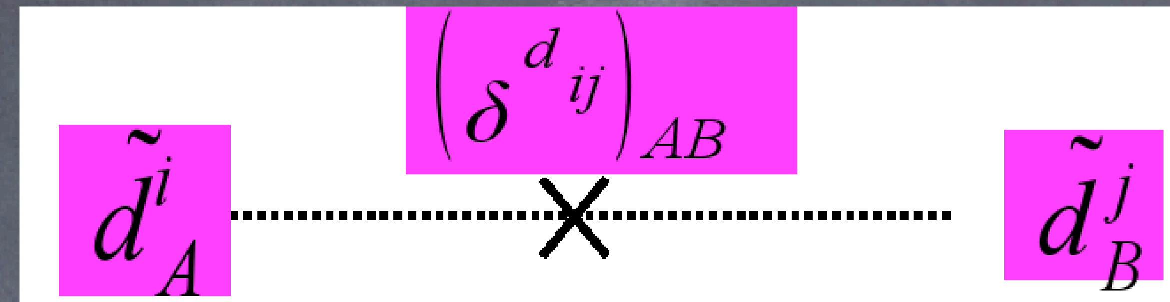
$\Lambda > 5.5$ TeV @95%



$\delta S_0 = 0.004 \pm 0.059$

$\Lambda > 28$ TeV @95%

MSSM



$\delta\rho,\ \delta\eta = 0.05$

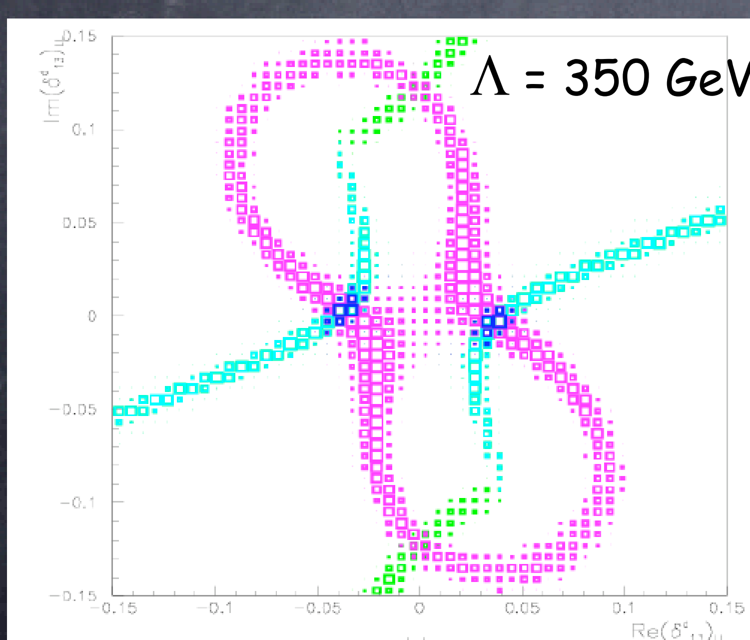
$\delta\Delta m_d$=0.002 ps^{-1}, δsin2b=0.005, δA_{SL}=0.001

$\delta BR(b\rightarrow sll)$~0.02*$BR(b\rightarrow sll)$, $\delta A_{CP}(b\rightarrow sll)$=0.015,

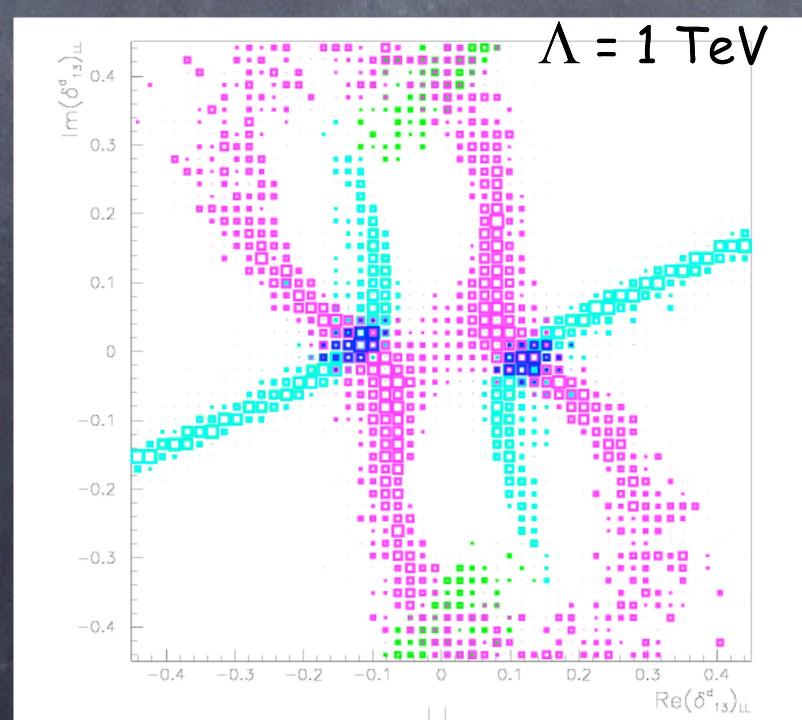
$\delta BR(b\rightarrow s\gamma)$=2 10^{-6}, $\delta A_{CP}(b\rightarrow s\gamma)$=0.005

Assuming natural couplings in SUSY-MI SB probes scales larger than 20 TeV (and up to ~300 TeV)

caveat: depends on coupling (/ by 1-10)

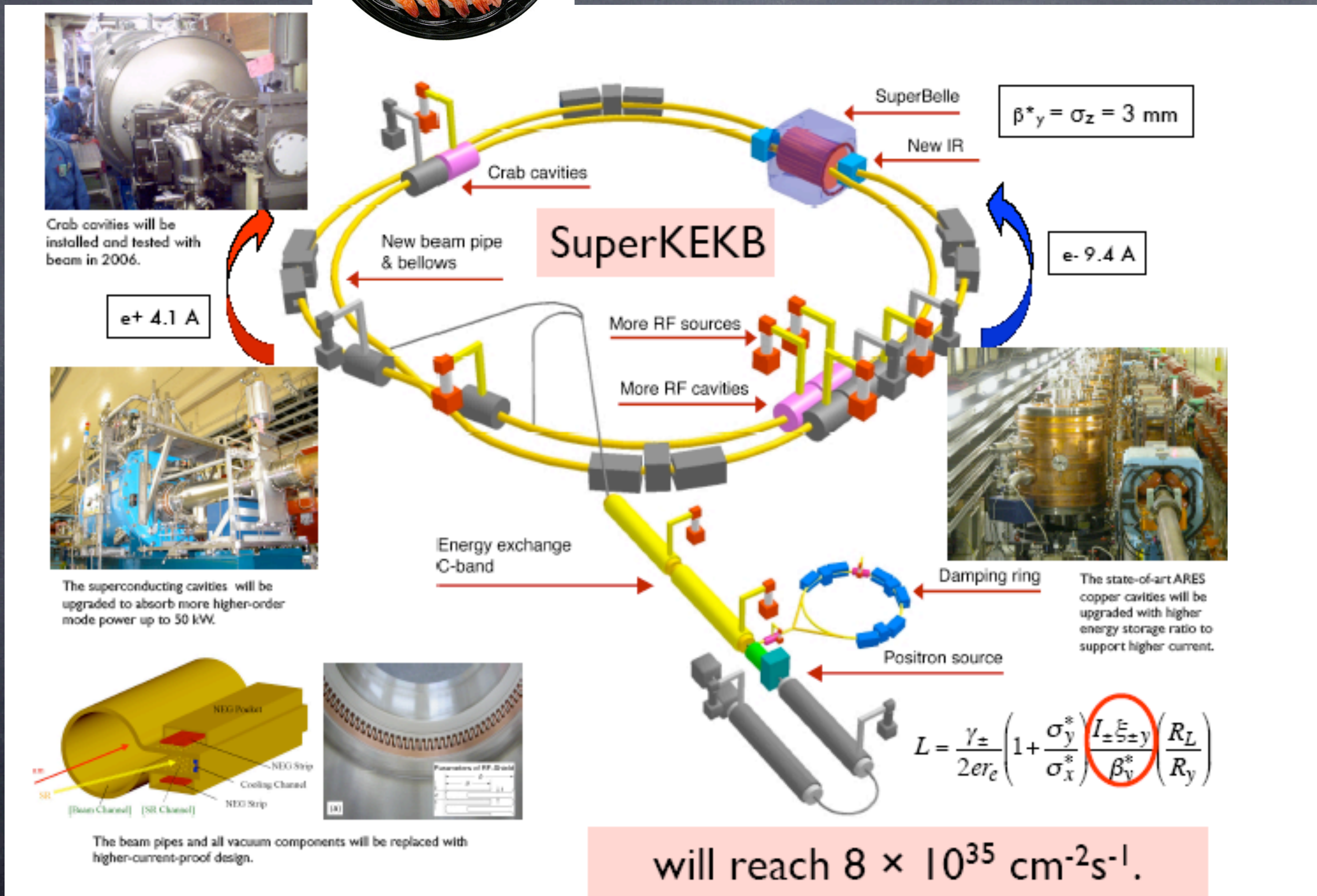


Re $(\delta^d_{13})_{LL}$ vs Im $(\delta^d_{13})_{LL}$



Here, it can be complementary or even a discovery tool

Super-B


Crab cavities will be installed and tested with beam in 2006.
e+ 4.1 A
The superconducting cavities will be upgraded to absorb more higher-order mode power up to 50 kW.
NEG Pocket
NEG Strip
Cooling Channel
NEG Strip
SR
[Beam Channel]
[SR Channel]
The beam pipes and all vacuum components will be replaced with higher-current-proof design.
Crab cavities
New beam pipe & bellows
SuperKEKB
More RF sources
More RF cavities
Energy exchange C-band
SuperBelle
New IR
$\beta^*_y = \sigma_z = 3$ mm
e- 9.4 A
Damping ring
Positron source
The state-of-art ARES copper cavities will be upgraded with higher energy storage ratio to support higher current.
$L = \frac{\gamma_\pm}{2er_e}\left(1+\frac{\sigma_y^*}{\sigma_x^*}\right)\left(\frac{I_\pm\xi_{\pm y}}{\beta_y^*}\right)\left(\frac{R_L}{R_y}\right)$
will reach 8×10^{35} cm^{-2}s^{-1}.

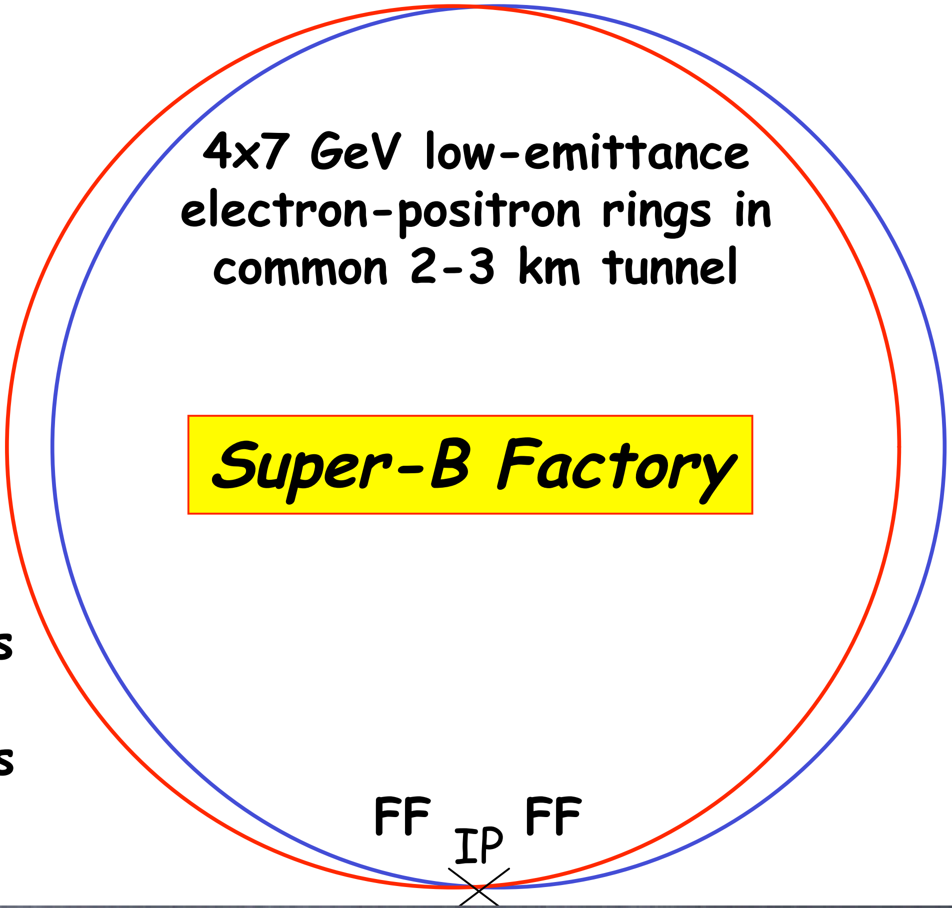
Super-B

Strong physics case for a 10^{36} facility

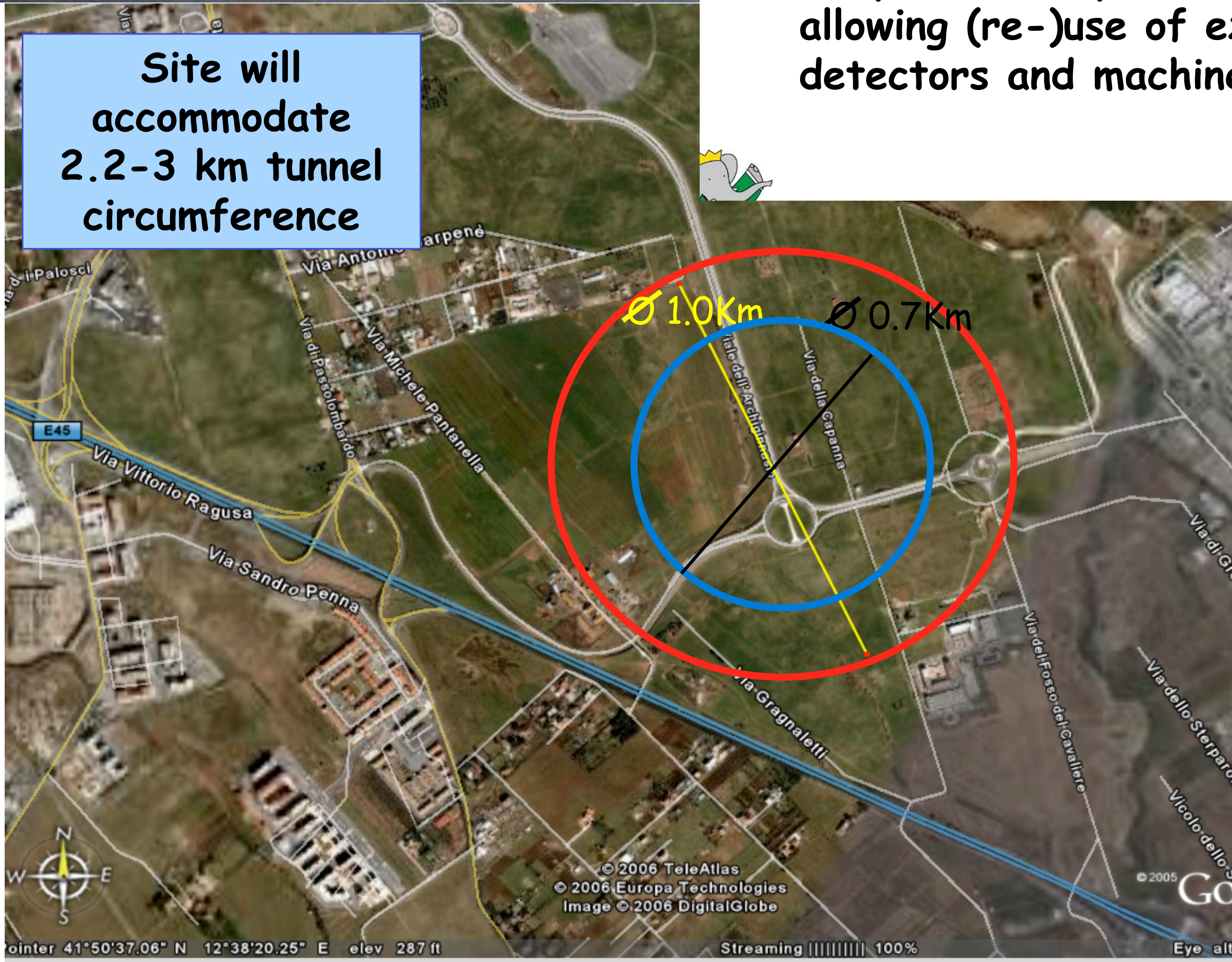
Raimondi, Seeman

New ideas:
- Low-emittance ILC damping rings
- Scaled version ILC final focus
- Large crossing angle and crabbed waist

Features:
- Machine has significant technical overlap with ILC
- Appears to be possible to reach 10^{36} luminosity with currents comparable to present B Factories allowing (re-)use of existing detectors and machine components



Site will accommodate 2.2-3 km tunnel circumference



Conclusion

SuperB

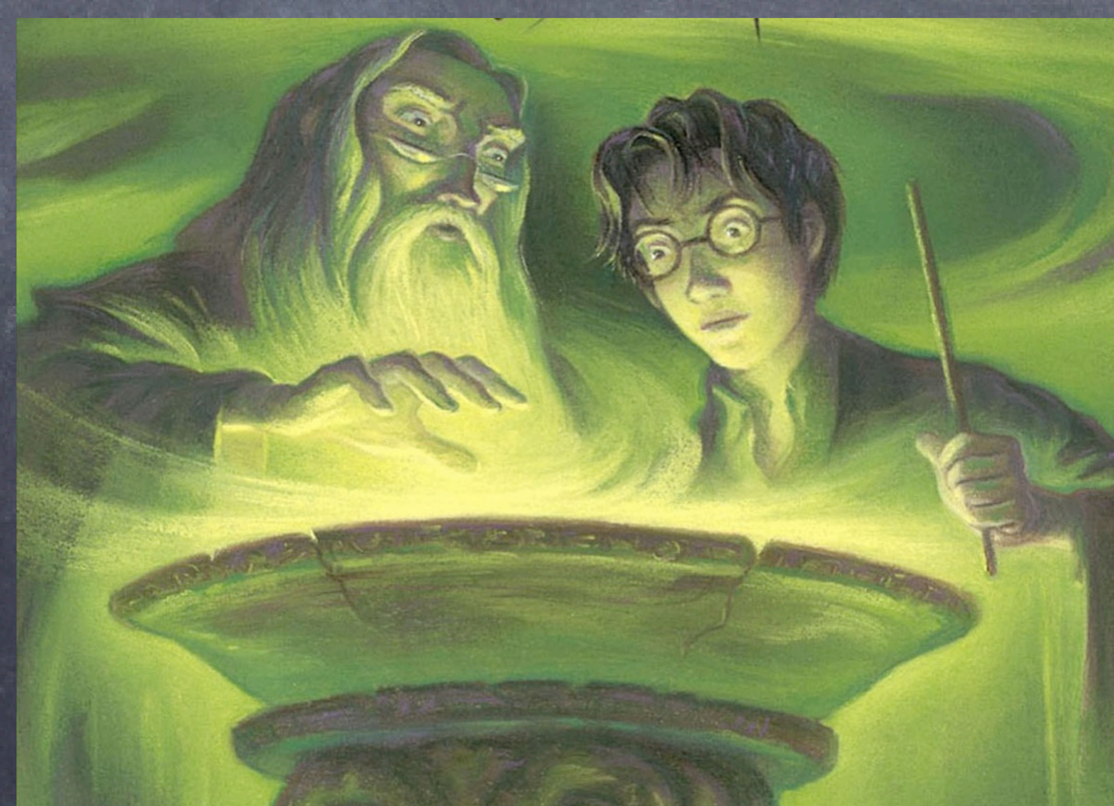
SuperB

LHC

LHC

ILC

ILC



Personally, I love both sushi and spaghetti