Contribución al período intensivo de análisis de datos del experimento BABAR en la Factoría de mesones B de SLAC

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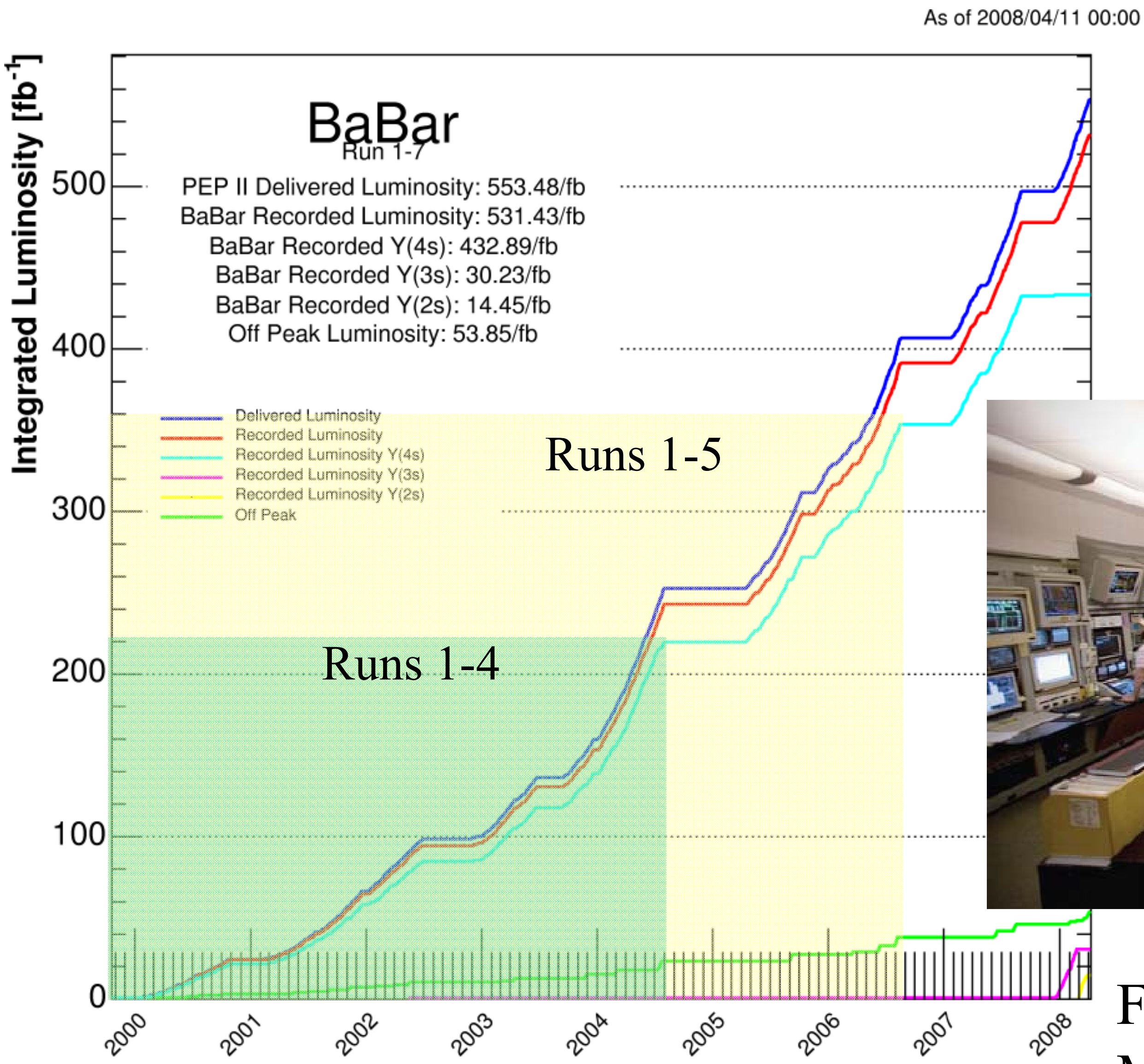
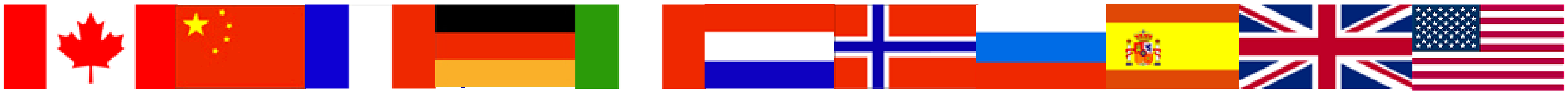
IFIC, Universitat de València-CSIC

Comisión de Expertos de Física de Partículas

26 de Mayo de 2008, Madrid

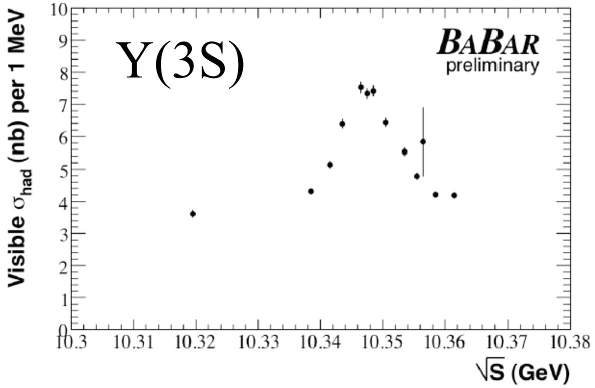


Final collisions 12:43pm,
Monday 7 Apr 2008

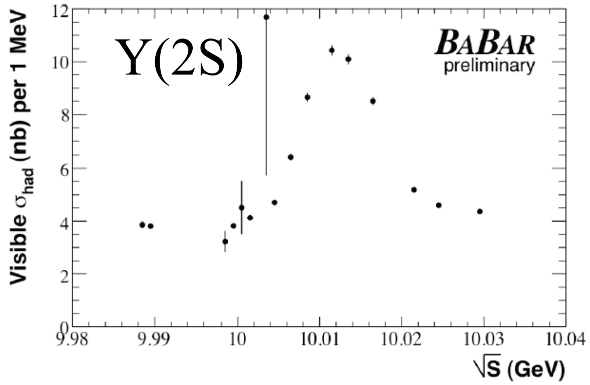


Energy Scan: Why?

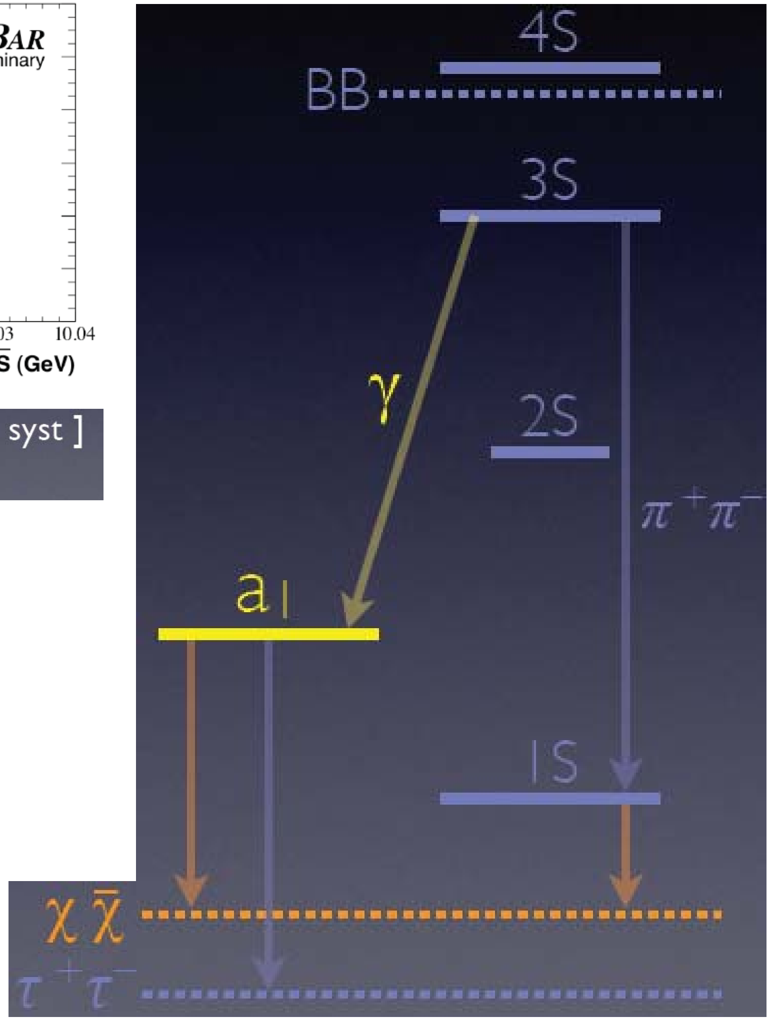
- Opportunity to significantly increase world samples of Υ(3S) and Υ(2S)



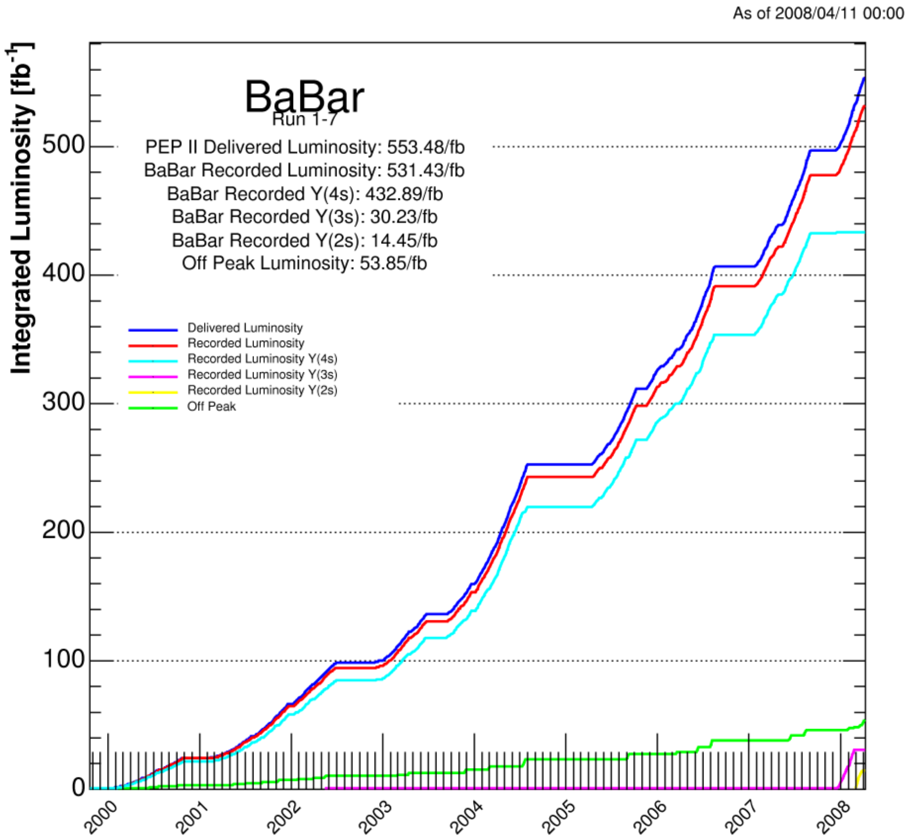
peak σ = 4.2 ± 0.2(stat) nb [±5% syst]
~120M Υ(3S) [10x Belle, 25x CLEO]

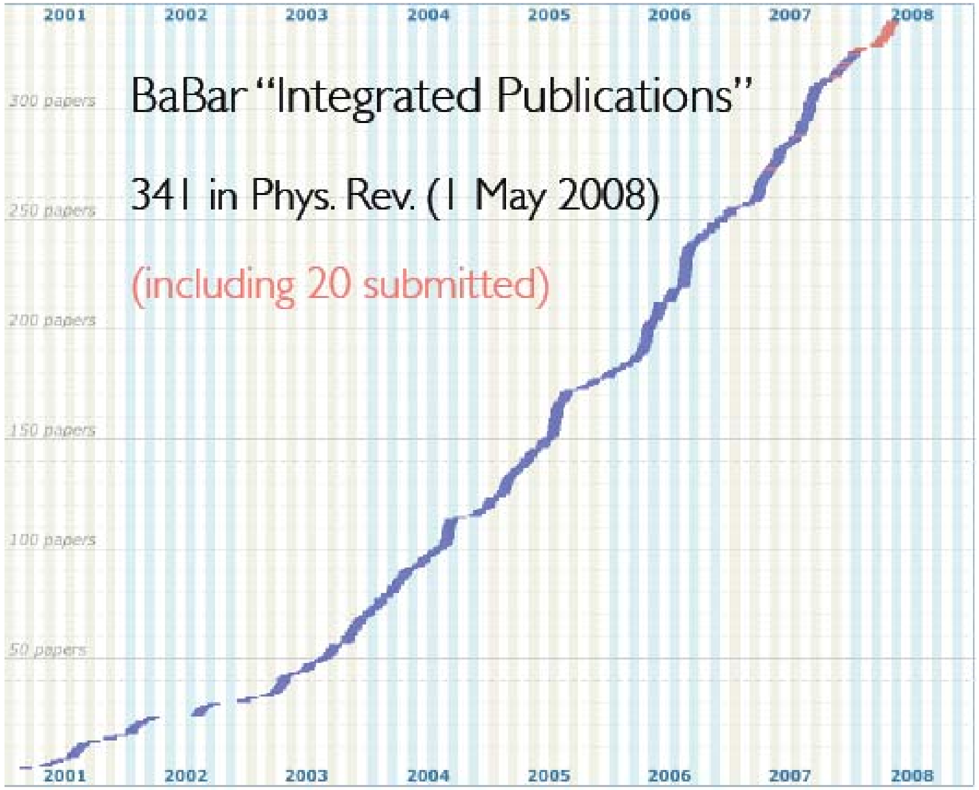


peak σ = 7.3 ± 0.3(stat) nb [±7% syst]
~100M Υ(2S) [12x CLEO]

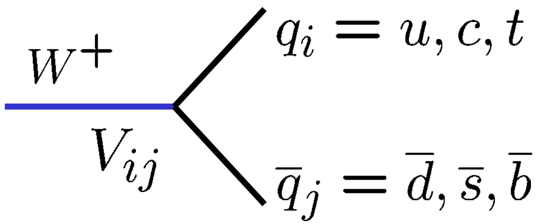


- Enhance knowledge on spectroscopy
  - Missing SM $\eta_b(nS)$, $h_b(nS)$
  - Look for surprises
- Search for exotic physics, like
  - Light dark matter candidate χ
  - Next-to-MSSM light Higgs a_1


As of 2008/04/11 00:00
BaBar
Run 1-7
PEP II Delivered Luminosity: 553.48/fb
BaBar Recorded Luminosity: 531.43/fb
BaBar Recorded Y(4s): 432.89/fb
BaBar Recorded Y(3s): 30.23/fb
BaBar Recorded Y(2s): 14.45/fb
Off Peak Luminosity: 53.85/fb
Delivered Luminosity
Recorded Luminosity
Recorded Luminosity Y(4s)
Recorded Luminosity Y(3s)
Recorded Luminosity Y(2s)
Off Peak
Integrated Luminosity [fb-1]
0
100
200
300
400
500
2000
2001
2002
2003
2004
2005
2006
2007
2008


BaBar "Integrated Publications"
341 in Phys. Rev. (1 May 2008)
(including 20 submitted)
50 papers
100 papers
150 papers
200 papers
250 papers
300 papers
2001
2002
2003
2004
2005
2006
2007
2008

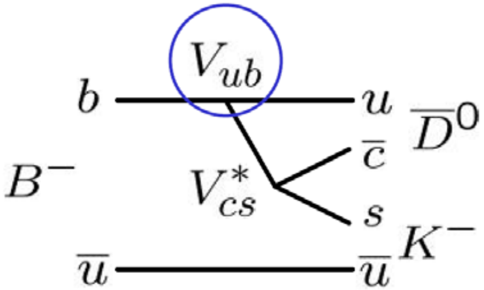
CP violation in the SM



$$V_{CKM} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} \approx \begin{pmatrix} 1-\frac{\lambda^2}{2} & \lambda & A\lambda^3(\rho - i\eta) \\ -\lambda & 1-\frac{\lambda^2}{2} & A\lambda^2 \\ A\lambda^3(1-\rho-i\eta) & -A\lambda^2 & 1 \end{pmatrix}$$

γ = phase of V_{ub}

($b \rightarrow u$ transition)

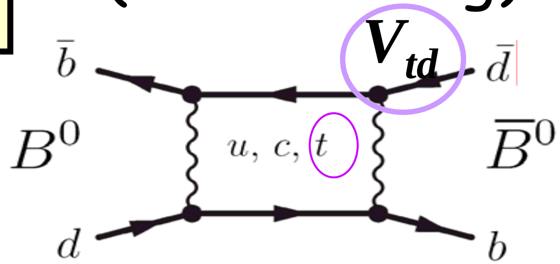


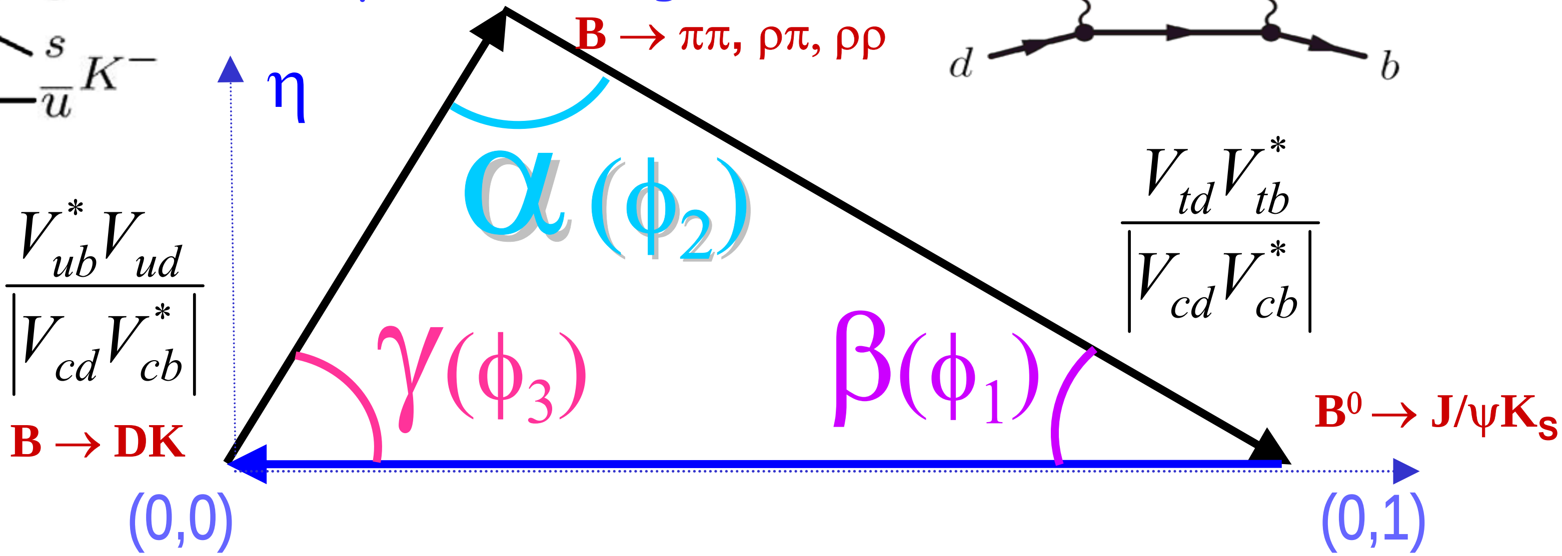
$$V_{ud}V^*_{ub} + V_{cd}V^*_{cb} + V_{td}V^*_{tb} = 0$$

The Unitarity Triangle

β = phase of V_{td}

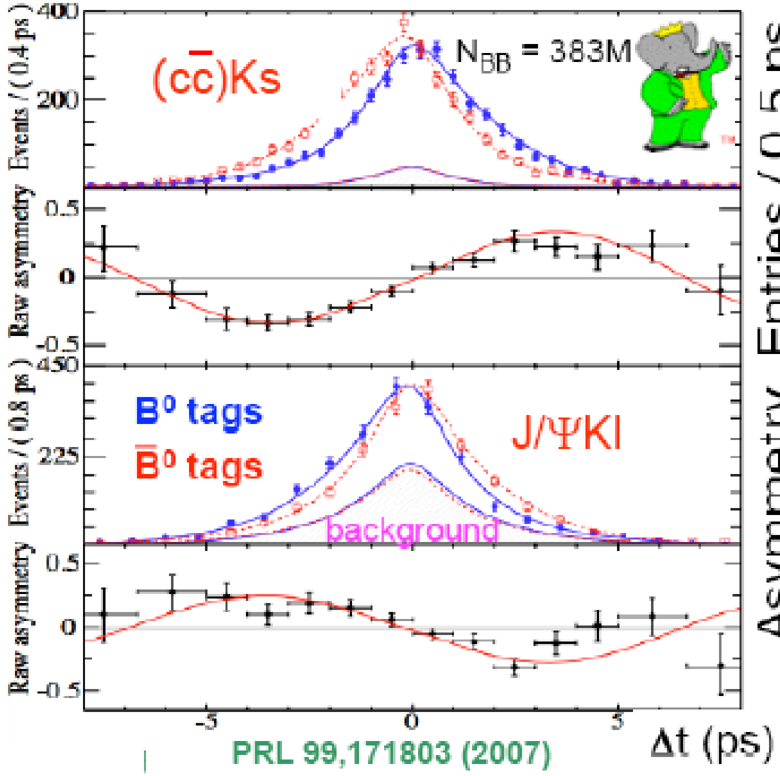
(B^0-$\bar{B}^0$ mixing)

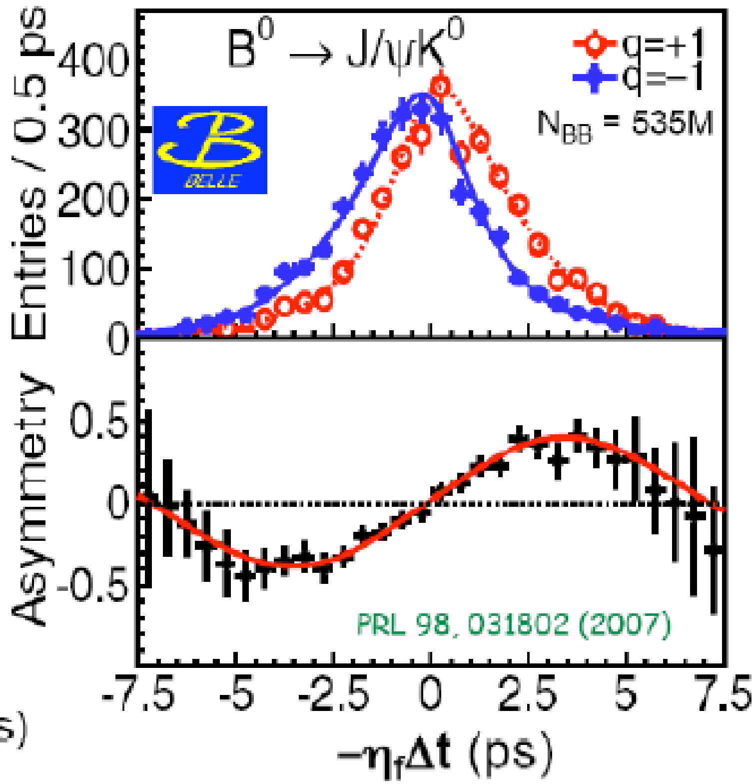




$\alpha = \pi - \beta - \gamma$ (B^0 mixing and $b \rightarrow u$ transition)

$\sin 2\beta$ from $b \to c\bar{c}s$ is a precise measurement





$$S = \sin 2\beta = 0.714 \pm 0.032 \pm 0.018$$
$$C = 0.049 \pm 0.022 \pm 0.017$$

$$S = 0.642 \pm 0.031 \pm 0.017$$
$$C = 0.018 \pm 0.021 \pm 0.014$$

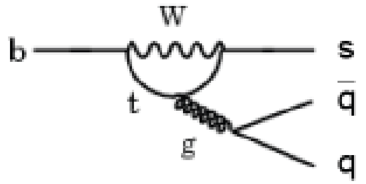
Good reference to make comparison with NP-sensitive modes

$\cos 2\beta < 0$ ruled out by several $\cos 2\beta$ measurements

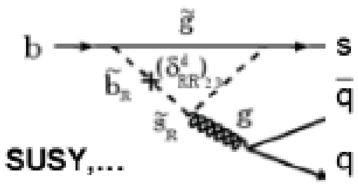
SM theoretical uncertainties and contribution from NP via loop diagrams DCS suppressed

sin2β from b → s

SM contribution



Possible NP contribution

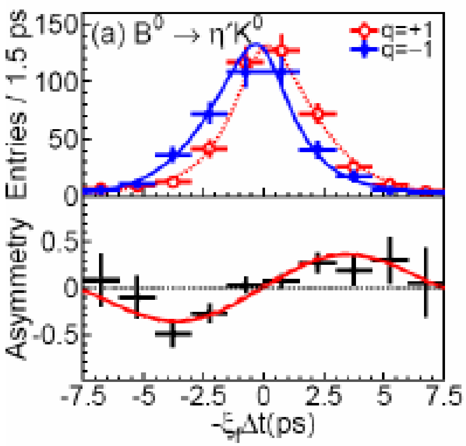


BF~10^{-5}, large background from continuum

$B^0 \to \eta' K_S$

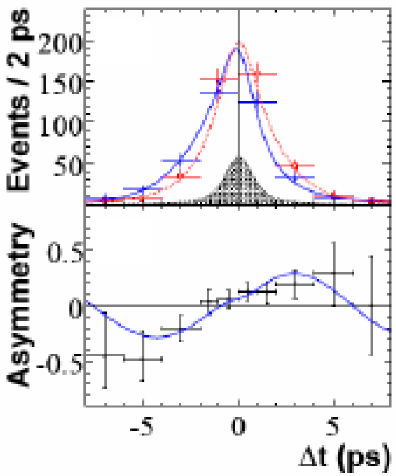
N_{BB}= 547M

PRD 98,031802(2007)

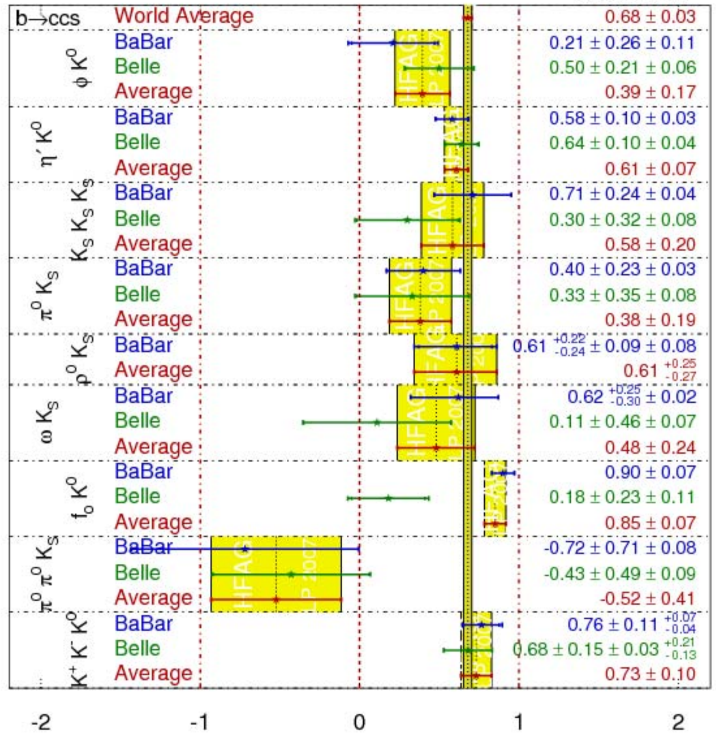


N_{BB}= 384M

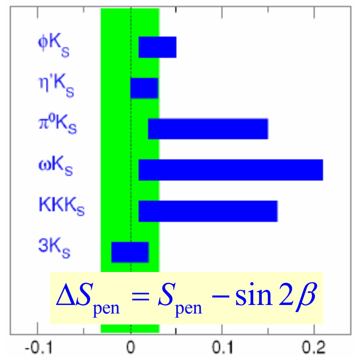
PRD 98,031801(2007)



$\sin(2\beta^{\rm eff}) \equiv \sin(2\phi_1^{\rm eff})$

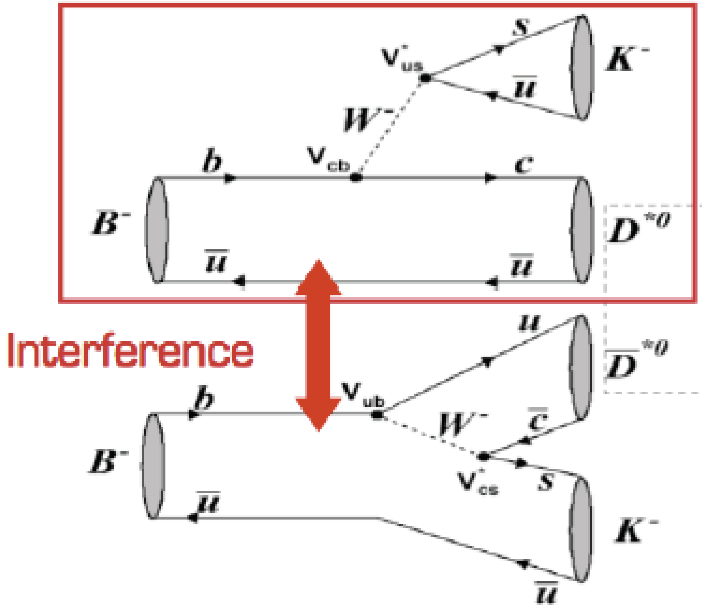


S in SM ~ sin2β but there are theoretical uncertainties related to SM suppressed contributions (hadronic uncertainties)



γ: the impossible made possible

$$A(B^- \to D^{(*)0}K^-) \propto V_{cb}V_{us}^* \propto \lambda^3$$



$$A(B^- \to \overline{D}^{(*)0}K^-) \propto V_{ub}V_{cs}^* \propto \lambda^3\sqrt{\overline{\rho}^2+\overline{\eta}^2}\,e^{i(\delta_B-\gamma)}$$

Common principle : $D^{(*)} = D^{(*)0} + \overline{D}^{(*)0}$ admixture

Common final state ⇨ interference ⇨ access to γ

(D^0-$\overline{D}^0$ mixing neglected)

3 methods		
GLW	***ADS***	***GGSZ***
CP Modes	*DCS Modes*	*3-body: Dalitz*
$CP+$: $K^+K^-, \pi^+\pi^-$	$D^{(*)0}\to K^+\pi^-$ *Suppr.*	$K_S\pi^+\pi^-$
$CP-$: $K_S\phi$, $K_S\omega$, $K_S\pi^0$	$D^{(*)0}\to K\pi^+$ *Fav.*	$K_SK^+K^-$
		$\pi^+\pi^-\pi^0$

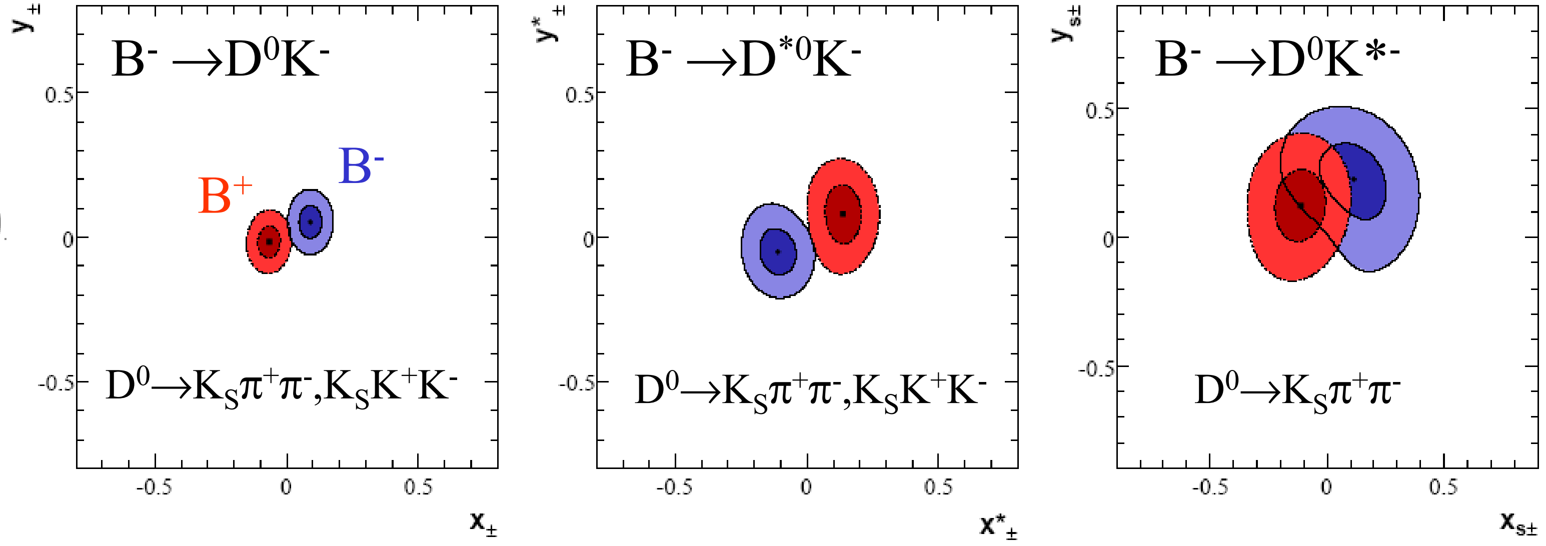
- **Theoretically clean** (*no penguin pollution*)
- **3 common unknowns** (*1 set for each mode*)
  - γ, *weak phase difference*
  - δ_B, *strong phase difference*
  - $r_B^{(*)} \equiv \left|\dfrac{A(B^-\to\overline{D}^{(*)0}K^-)}{A(B^-\to D^{(*)0}K^-)}\right| \sim 0.1 - 0.2$

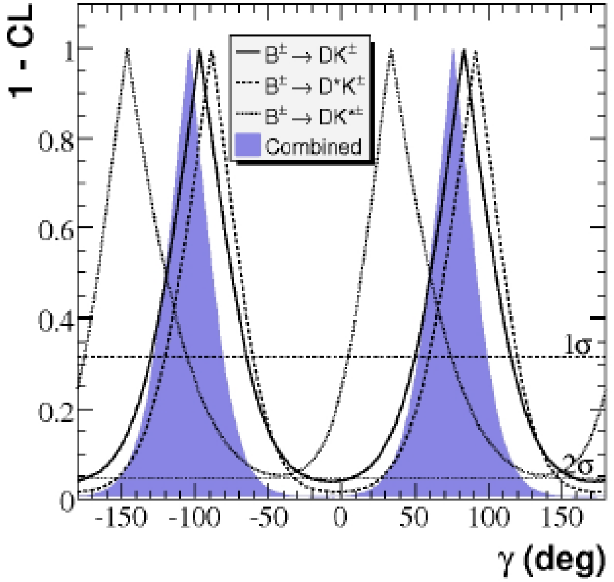
γ from Dalitz (Golden) method

arXiv:0804.2089 [hep-ex] submitted to Phys. Rev. D

$x_{\pm} = r_B \cos(\delta \pm \gamma)$

$y_{\pm} = r_B \sin(\delta \pm \gamma)$



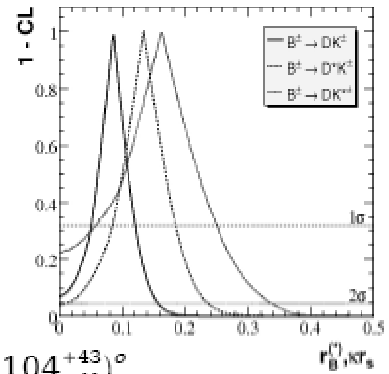


$\delta(DK) = (109^{+28}_{-31})^o$, $\delta(D^*K) = (-63^{+28}_{-30})^o$, $\delta(DK^*) = (104^{+43}_{-41})^o$

$\gamma/\phi_3 = (76^{+23}_{-24})^o (mod.180^o)$
$r_B(DK) = 0.086 \pm 0.035$
$r_B(D*K) = 0.135 \pm 0.051$
$r_S(DK*) = 0.181^{+0.100}_{-0.118}$

BaBar, 383M $B\bar{B}$ pairs

3σ evidence for direct CPV in charged B→DK decays



Belle, 635M $B\bar{B}$ pairs

$\gamma/\phi_3 = (76^{+12}_{-13} \pm 4 \pm 9)^o (mod.180^o)$
$r_B(DK) = 0.16 \pm 0.04 \pm 0.01 \pm 0.05$
$r_B(D*K) = 0.21 \pm 0.08 \pm 0.02 \pm 0.05$

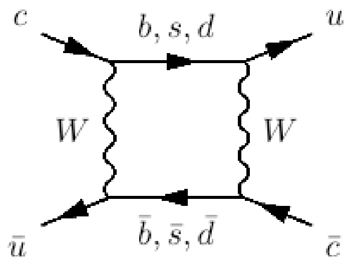
$\delta(DK) = (136^{+14}_{-16} \pm 4 \pm 23)^o$
$\delta(D^*K) = (343^{+20}_{-22} \pm 4 \pm 23)^o$
$(mod.180^o)$

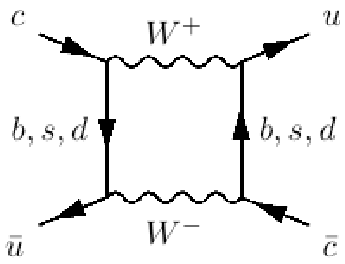
Physics Areas			Number of Publications	Number of ongoing analyses
B Physics	CKM parameters	The angle β	31	14
		The angle α	10	8
		The angle γ	20	6
		V_{ub} & V_{cb}	15	19
	B Meson Decays	Charmless B Decays	53	22
		Hadronics B Decays	44	15
		Radiative B decays	18	11
		Leptonic B decays	7	18
Quarkonium			16	17
Charm Physics	Charm decays		24	27
	D0 mixing and CPV		5	5
Tau Physics	Lepton Flavor Violation		5	15
	Tau Decays & lifetime		3	5
ISR Physics			11	19

- Unexpected discovery of many new states:
  - Charmonium (-like) States: η_c, h_c, X(3872), X/Y/Z(3940), Y(4260) etc.
  - Charm mesons: D's, D_{sJ}'s
  - Charm (double) baryon: Σ_c, Ω_c, Λ_c, Ξ_c, Ξ_{cc}
- Strong evidence of D^0-$\overline{D}^0$ mixing

D^0-$\bar{D}^0$ mixing and the SM

- Short-distance contributions from mixing box diagrams in the Standard Model are expected to be small :
  - *b* quark is CKM-suppressed
  - *s* and *d* quarks are GIM suppressed
  - mainly contributes to the mass difference $\boldsymbol{x} \approx O(10^{-5})$ or less

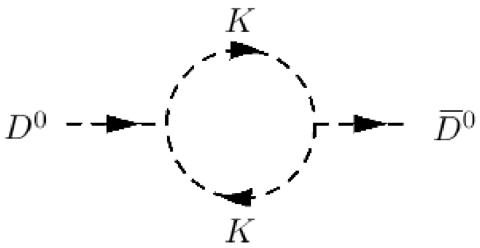


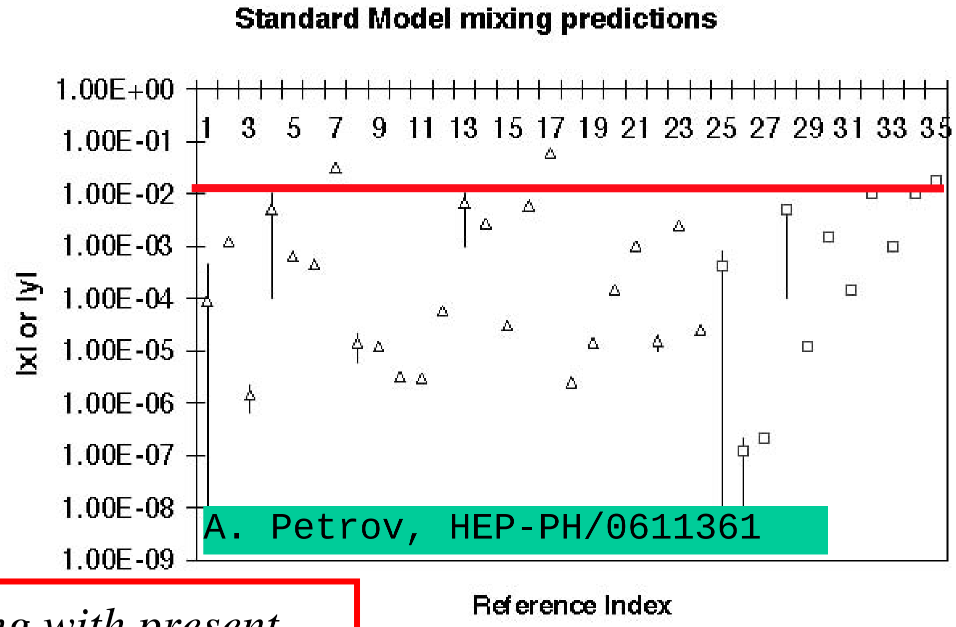


$$x = \frac{m_2 - m_1}{\Gamma} \qquad \Gamma = \frac{\Gamma_2 + \Gamma_1}{2}$$

$$y = \frac{\Gamma_2 - \Gamma_1}{2\Gamma}$$

- Long-distance contributions dominate but hard to estimate precisely
  - expect $|y| \leq 0.01$
  - $|x| \sim 0.1 - 1|y|$





- No CP violation in mixing expected in SM with current experimental sensitivity

An observation of CP violation in charm mixing with present experimental sensitivity would provide evidence of New Physics

PRL 98, 211802 (2007) PHYSICAL REVIEW LETTERS week ending 25 MAY 2007

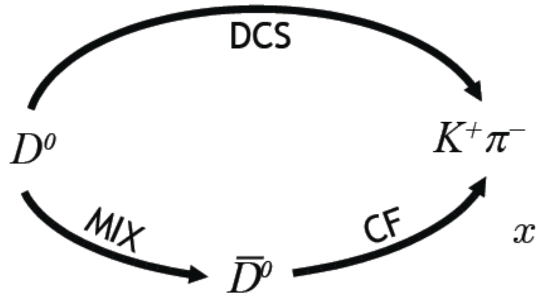
(BABAR Collaboration)

Evidence for D^0-$\overline{D}^0$ Mixing

- **Reconstruct Wrong Sign (WS) decays:** $D^{*+} \rightarrow D^0 \pi_S^{+}, D^0 \rightarrow K^{+}\pi^-$
- **WS decays** come from two sources:
  - Double-Cabibbo-suppressed (DCS) D^0 decay: $D^0 \rightarrow K^+\pi^-$
  - D^0 has mixed into D^0, followed by CF decay: $D^0 \rightarrow \overline{D}^0 \rightarrow K^+\pi^-$

Discriminate DCS and mixing by their different time evolution

Also have interference effect:



Expected relative rates
CF : DCS : Mixed
1000 : 5 : 0.1

$$x = \frac{m_2 - m_1}{\Gamma} \qquad \Gamma = \frac{\Gamma_2 + \Gamma_1}{2}$$

$$y = \frac{\Gamma_2 - \Gamma_1}{2\Gamma}$$

- Exploit different time dependence. Approx. x,y <<1:

$$\frac{d\Gamma}{dt}\left[\left|D^0(t)\right\rangle \rightarrow f\right] \propto e^{-\Gamma t}\left(\underbrace{R_D}_{\text{DCS}} + \underbrace{\sqrt{R_D}\,y'(\Gamma t)}_{\text{Interference}} + \underbrace{\frac{x'^2 + y'^2}{4}(\Gamma t)^2}_{\text{Mixing}}\right)$$

$$x' = x\cos\delta_{K\pi} + y\sin\delta_{K\pi}$$

$$y' = -x\sin\delta_{K\pi} + y\cos\delta_{K\pi}$$

$D^0 - \bar{D}^0$ relative phase
not directly measurable at B-factories

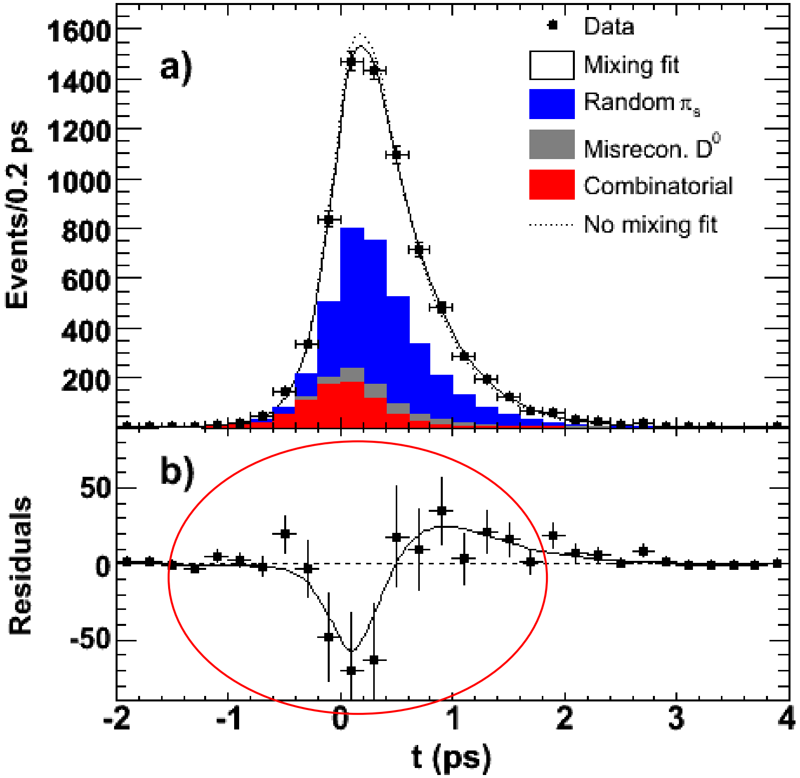
$$R_D = \frac{\Gamma\left(D^0 \rightarrow K^+\pi^-\right)}{\Gamma\left(D^0 \rightarrow K^-\pi^+\right)};\ 3\cdot 10^{-3}$$

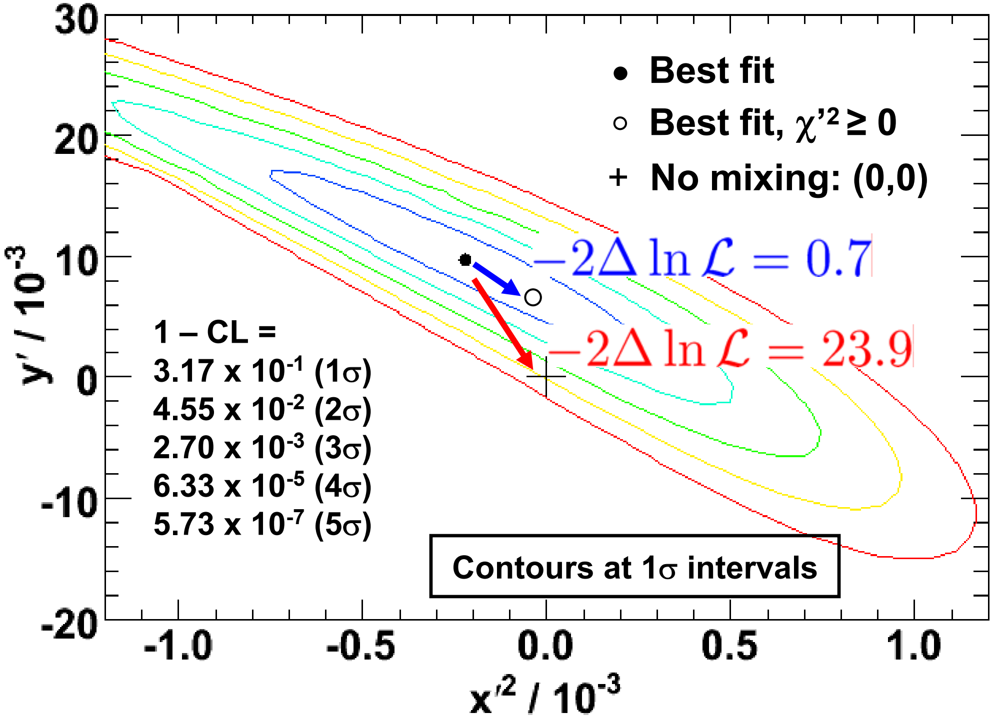
PRL 98, 211802 (2007) PHYSICAL REVIEW LETTERS week ending 25 MAY 2007

(*BaBar* Collaboration)

Evidence for D^0-$\overline{D}^0$ Mixing

• Analysis of the proper time distribution of WS events permits extraction of D^0 mixing parameters y', x'^{2}





Evidence confirmed by Belle and CDF

R_D: $(3.03 \pm 0.16 \pm 0.10) \times 10^{-3}$
x'^2: $(-0.22 \pm 0.30 \pm 0.21) \times 10^{-3}$
y': $(9.7 \pm 4.4 \pm 3.1) \times 10^{-3}$

The no-mixing point is at the 3.9σ contour

Contribution to BaBar: research group and short history

Members of the Group:

F. Martínez-Vidal (Profesor Titular, UV)

E. Graugés Pous (Prof. Contratado Doctor, UB)

A. Oyanguren Campos (I3P-CSIC)

V. Azzolini (Juan de la Cierva, UV)

N. López-March (Contratada proyecto, UV)

D. Milanés Carreño (Contratado proyecto, UV)

J. Garra Ticó (Becario FPU, UB)

Membership since September'04

MOU signed by CSIC in July'05

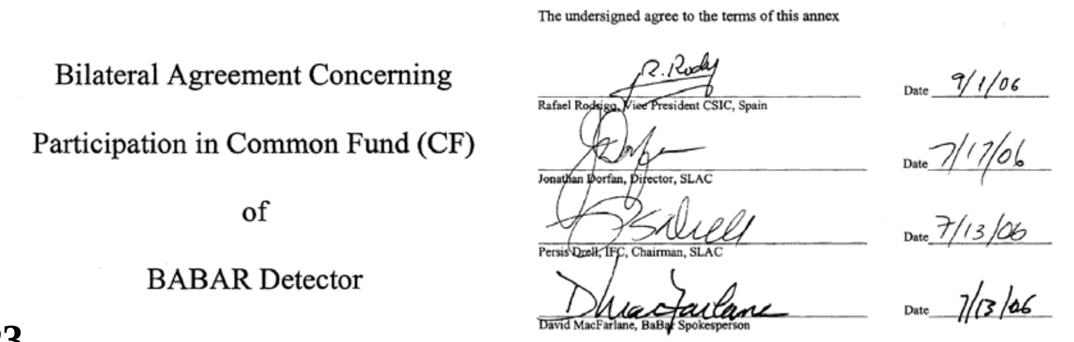
Previous and current funding:

FPA2002-11468-E, FPA2002-11461-E (2004-2005)

FPA2004-02829 (2005)

FPA2005-05142 (2006-2008)

Bilateral agreements with INFN and IN2P3



Bilateral Agreement Concerning

Participation in Common Fund (CF)

of

BABAR Detector

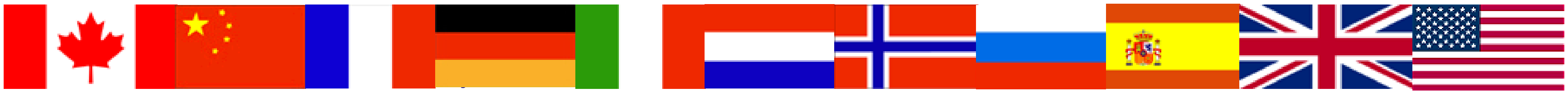
The undersigned agree to the terms of this annex

Rafael Rodrigo, Vice President CSIC, Spain — Date 9/1/06

Jonathan Dorfan, Director, SLAC — Date 7/17/06

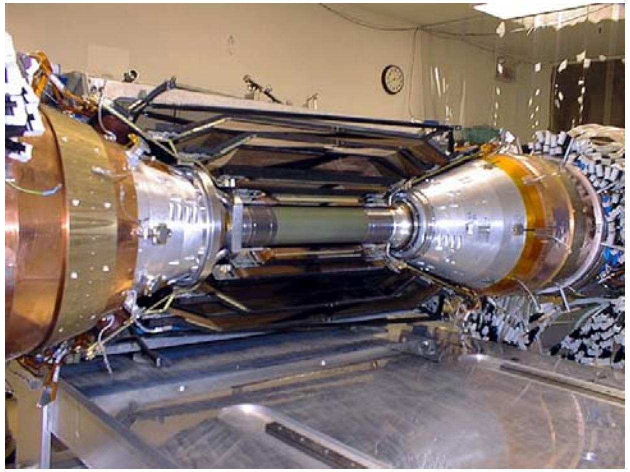
Persis Drell, IFC, Chairman, SLAC — Date 7/13/06

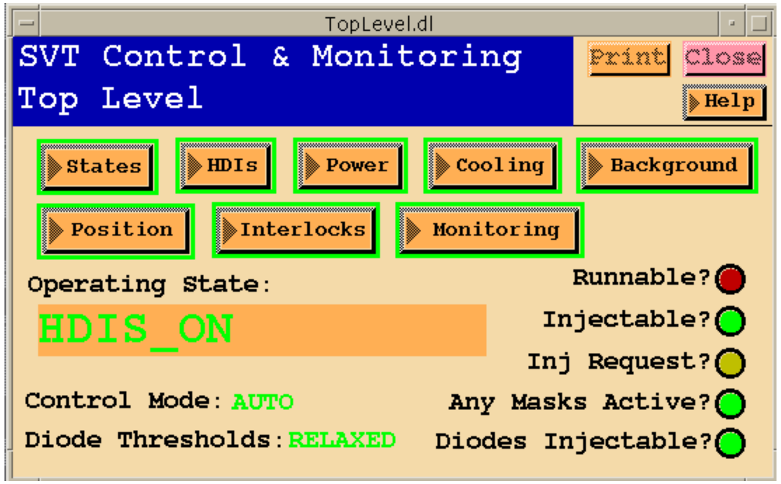
David MacFarlane, BaBar Spokesperson — Date 7/13/06



Contribution to BaBar: tasks

- Common tasks and responsabilities (2006-up to now)
  - Silicon Vertex Tracker (SVT) commissioning (on-line operations). Since Apr'06 one person on site (on-call)





    - Alarm and Interlock systems
    - Maintenance of external components, cooling, power supplies, etc.
    - Data Quality Assurance
  - Data Quality Group (DQG)
    - Run Quality Manager (on-site)
    - Particle ID Quality Manager (remote)
  - Off-line prompt reconstruction production (Padova Farm, remote)
  - Improvements of SVT pattern recognition
- **Active contribution to data taking (shifts)**

The "core" Physics Analysis Program

Core physics areas	Analysis Channels
CKM: Angle β Measurements of Time-Dependent CP Asymmetries and direct CP asymmetries	sin2β from $B \to c\bar{c}K^0$
	cos2β from $B \to J/\psi K^{*0}$
	β from $B \to Dh$
	β from $B \to D^{(*)+}D^{(*)-}$
CKM : Angle α Measurements of decay rates, TDCP asymmetries and direct CP asymmetries	$B \to \pi\pi\ [\pi^+\pi^-, \pi^+\pi^0, \pi^0\pi^0], K\pi, KK$
	$B \to 3\pi$ Dalitz analysis
	$B \to \rho\rho\ [\rho^+\rho^-, \rho^+\rho^0, \rho^0\rho^0]$
	$B \to A_1\pi$
CKM: Angle γ Measurements of Rates, Direct CP asymmetry and Dalitz Analysis	$B \to D^{(*)+}K^{(*)-}$ [Dalitz analysis, GLW, ADS]
	$B \to D^{(*)0}K^{(*)0}$
	$B \to D^{(*)}\pi$
	$B \to D^{(*)}\rho$
CKM: V_{ub}	Inclusive $B \to X_u l\nu$
	Exclusive $B \to X_u l\nu\ [B \to \pi\ l\nu, B \to \rho\ l\nu, \ldots]$
Loop Dominated Processes As probes of New Physics	**Radiative B decays:** Inclusive and exclusive $B \to s\gamma$ [Rate, A_{ch},..] • TDCP in $B \to K^{*0}\gamma$ [Probe of helicity of γ] Inclusive and exclusive $B \to d\gamma$ [Rate, A_{ch},..] Inclusive and exclusive $B \to sl^+l^-$ [Rate, A_{ch},A_{FB}, ..] Search for $B \to s\nu\bar{\nu}$
	TDCP in Gluonic Penguin Dominated Channels: $B \to K^0\phi,\ K^0\eta',\ K^0K^+K^-,\ K^0\pi^0,\ K^0K_s^0K_s^0,$ $K^0\rho,\ K^0\omega,\ K^0\pi^0\pi^0$
	Charmless Decay Properties: Decay Rate, Direct CP, Polarization $B \to VV$ *Decays* $(\rho\rho, \phi K^*, \rho K^*, \omega\rho, \omega K^*, ..)$ $B \to \eta'\pi^0, \eta\pi^0, \eta'\eta, \eta'\eta', \eta\eta$ (*for* $SU(3)$ *analysis*) $B \to \rho K, \eta K, K\pi\pi, 3K, 3\pi$
Leptonic B and Charm decays: B and D decay Constant (LQCD) Probe of New Physics	$B^+ \to \tau^+\nu,\ B^+ \to l\nu(\gamma),\ B \to ll,$ $D_s^+ \to l^+\nu$
Charm Physics	D^0 mixing and CPV Rare Charm Decays ($D \to ll$, FCNC in charm decays)
Tau Physics	**Lepton Flavor Violation:** $\tau \to \mu\gamma,\ e\gamma,\ \tau \to lll,\ l\pi^0,\ l\eta,\ l\eta',\ lK_s^0,$

BaBar Internal Document #1228

BAD 1228 v5, October 12, 2005

BaBar Physics Reach Assessment

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Charge

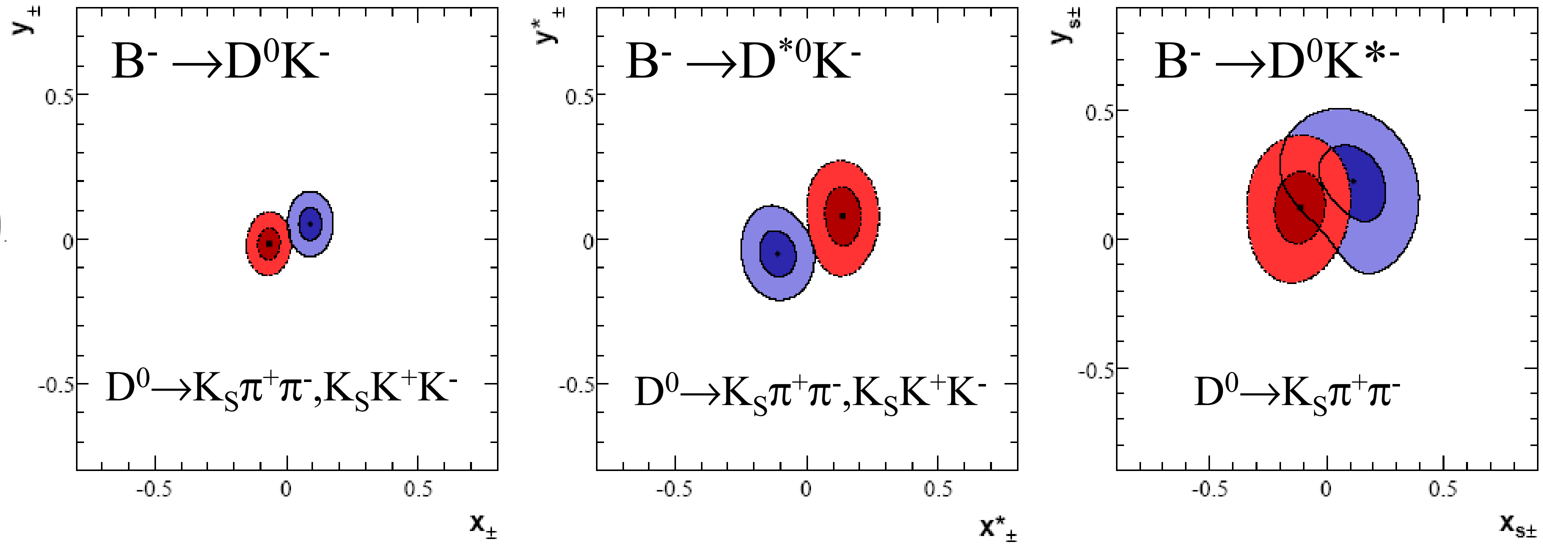
Over the past several years a wide variety of new techniques for measuring angles and sides of the unitarity triangle and for searching for New Physics deviations from the Standard Model predictions have been developed. In addition, many of the techniques considered critical in previous long-term planning studies for the B Factories have now been applied to data, thereby giving us a better understanding of systematic errors and more reliable measurement projections. The full suite of current analyses therefore provides a good guide for projections of the statistical and systematic errors that might be expected as data samples are substantially increased over the coming years. In parallel theoretical work on improving our understanding of Standard Model heavy quark physics, as well as the impact of various New Physics scenarios, has also made great strides.

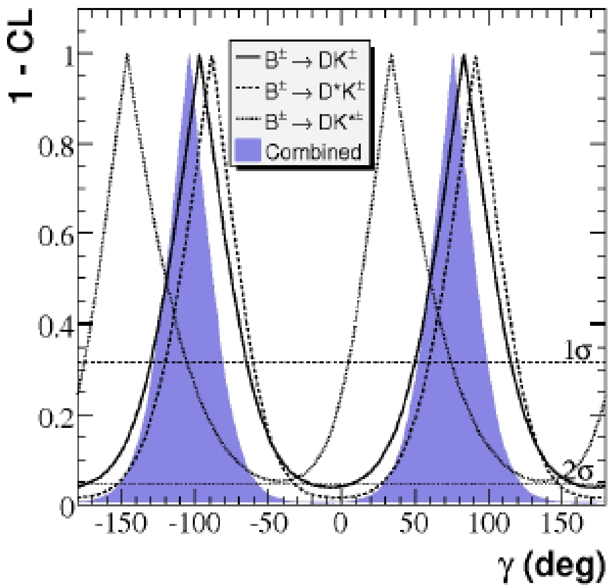
Based on this improved experimental and theoretical framework, the task force is asked to update the projections of the physics reach of *BABAR* assuming integrated delivered luminosities of 0.5, 1 and 2 ab^{-1}. This work will form the basis for understanding the impact on physics of continuing *B* Factory operation through to FY2008 (when ≈1 ab^{-1} is projected to be accumulated) and beyond (up to 2 ab^{-1}). The task force should identify a broad range of key physics benchmarks for projecting physics capabilities with these data samples. It should also look at a few representative examples of plausible New Physics extensions of the Standard Model, either motivated by current discrepancies in *B* Factory data or by fundamental interest in searches with improved sensitivity, to construct scenarios and arguments for the impact of 1 and 2 ab^{-1} data samples, taking into account the development of similar samples from the KEK *B* Factory as well.

Physics Analysis: γ from Dalitz (Golden) method

arXiv:0804.2089 [hep-ex] submitted to Phys. Rev. D

$$x_{\pm} = r_B \cos(\delta \pm \gamma)$$
$$y_{\pm} = r_B \sin(\delta \pm \gamma)$$



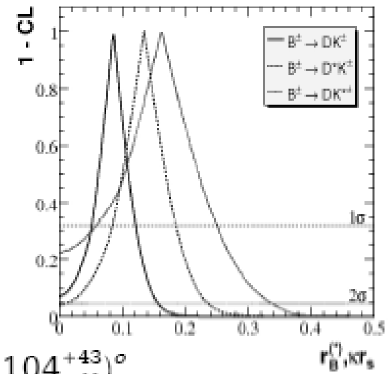


$\delta(DK)=(109^{+28}_{-31})^o$, $\delta(D^* K)=(-63^{+28}_{-30})^o$, $\delta(DK^*)=(104^{+43}_{-41})^o$

$$\boxed{\begin{array}{l} \gamma/\phi_3=(76^{+23}_{-24})^o(mod.180^o) \\ r_B(DK)=0.086\pm0.035 \\ r_B(D*K)=0.135\pm0.051 \\ r_S(DK*)=0.181^{+0.100}_{-0.118} \end{array}}$$

BaBar, 383M $B\overline{B}$ pairs

3σ evidence for direct CPV in charged B→DK decays



Belle, 635M $B\overline{B}$ pairs

$$\boxed{\begin{array}{l} \gamma/\phi_3=(76^{+12}_{-13}\pm4\pm9)^o(mod.180^o) \\ r_B(DK)=0.16\pm0.04\pm0.01\pm0.05 \\ r_B(D*K)=0.21\pm0.08\pm0.02\pm0.05 \end{array}}$$

$$\delta(DK)=(136^{+14}_{-16}\pm4\pm23)^o$$
$$\delta(D^* K)=(343^{+20}_{-22}\pm4\pm23)^o$$
$$(mod.180^o)$$

Physics Analysis: γ from Dalitz (Golden) method

- Original analysis published in **Phys. Rev. Lett 95, 121802 (2005)**, based on 227M $B\bar{B}$ pairs
- Significant improvement in updated analysis
  arXiv:0804.2089 [hep-ex]
  submitted to Phys. Rev. D
  - 383M $B\bar{B}$ pairs (Run1-Run5)
  - Increased effective reconstruction efficiency (+30%)
  - Improved background treatment
  - Used for the first time $D^0 \to K_S KK$
  - Use of K-matrix formalism to describe complex ππ and Kπ S-wave dynamics (first time)
- Most precise measurement of

$$x_{\pm} = r_B \cos(\delta \pm \gamma)$$

$$y_{\pm} = r_B \sin(\delta \pm \gamma)$$

- Improves by a factor 2 previous errors
  - Dalitz model x2 smaller than Belle
- Stringent constraints on r_B for DK, D*K and DK* channels

Component	$\Re\{a_r e^{i\phi_r}\}$	$\Im\{a_r e^{i\phi_r}\}$	Fraction (%)
$K^*(892)^-$	-1.314 ± 0.010	1.141 ± 0.009	55.7 ± 2.8
$K_0^*(1430)^-$	-7.3 ± 0.4	3.7 ± 1.2	10.2 ± 1.5
$K_2^*(1430)^-$	-1.054 ± 0.019	0.936 ± 0.025	2.2 ± 1.6
$K^*(1680)^-$	-1.45 ± 0.10	-0.16 ± 0.10	0.7 ± 1.9
$K^*(892)^+$	0.116 ± 0.004	-0.107 ± 0.003	0.46 ± 0.23
$K_0^*(1430)^+$	-0.26 ± 0.05	0.19 ± 0.07	< 0.05
$K_2^*(1430)^+$	0.008 ± 0.017	0.091 ± 0.016	< 0.12
$\rho(770)^0$	1	0	21.0 ± 1.6
$\omega(782)$	-0.031 ± 0.001	0.042 ± 0.001	0.9 ± 1.0
$f_2(1270)$	-0.559 ± 0.026	0.232 ± 0.023	0.6 ± 0.7
β_1	1.82 ± 0.25	-9.1 ± 0.4	
β_2	-10.18 ± 0.19	-3.9 ± 0.5	
β_3	-23.7 ± 2.0	5.0 ± 1.6	
β_4	-0.1 ± 0.4	9.16 ± 0.24	
f_{11}^{prod}	2.19 ± 0.15	7.6 ± 0.3	ππ S-wave
$f_{12}^{\prime prod}$	1.9 ± 0.3	-0.6 ± 0.3	
$f_{13}^{\prime prod}$	4.3 ± 0.3	2.8 ± 0.3	
$f_{14}^{\prime prod}$	3.22 ± 0.18	0.27 ± 0.14	
s_0^{prod}	-0.07 ± 0.03		
$\pi\pi$ S-wave			11.9 ± 2.6
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		Kπ S-wave
ϕ_R	-5.31 ± 0.04		
a	1.07 ± 0.11		
r	-1.8 ± 0.3		

Physics Analysis: D^0-$\overline{D}^0$ mixing

$\mathcal{R}$, time-dependent decay rate

Wrong sign hadronic: $D^0 \to K^+ \pi^-$

$$\mathcal{R} = e^{-\Gamma t}\left\{ r_D + \sqrt{r_D} y' t + \frac{x'^2 + y'^2}{4} t^2 \right\}$$

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} \cos\delta & \sin\delta \\ -\sin\delta & \cos\delta \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$

CP eigenstates: $D^0 \to h^+ h^-$

$$\mathcal{R} \simeq e^{-\Gamma(1+y_{CP})t}$$

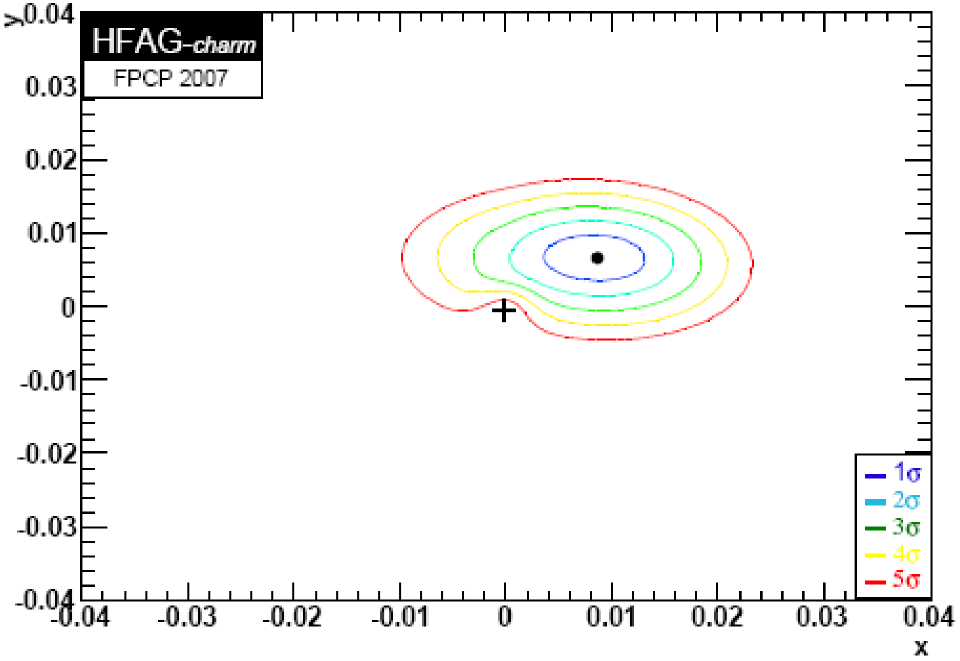
$$y_{CP} = y\cos\phi \simeq \frac{\tau_{K^-\pi^+}}{\tau_{h^+h^-}} - 1$$

$$y_{CP} = (1.31 \pm 0.32 \pm 0.25)\%$$

Wrong sign semileptonic: $D^0 \to K^+ l^- \nu$

$$\mathcal{R} = e^{-\Gamma t}\left\{1 + R_M t^2\right\}, \qquad R_M \equiv \frac{x^2 + y^2}{2}$$

$$R_M = (0.004^{+0.07}_{-0.06})\%$$



Dalitz technique $D^0 \to K_S h^+ h^-$

$$\mathcal{R} = e^{-\Gamma(1+y)t}|A_1|^2 + e^{-\Gamma(1-y)t}|A_2|^2 + 2e^{-\Gamma t}(\cos(\Gamma x t)\Re(A_1 A_2^*) + \sin(\Gamma x t)\Im(A_1 A_2^*))$$

Dalitz technique is the only able to measure directly x,y, with sign and w/o rotations

Physics Analysis: D^0-$\overline{D}^0$ mixing

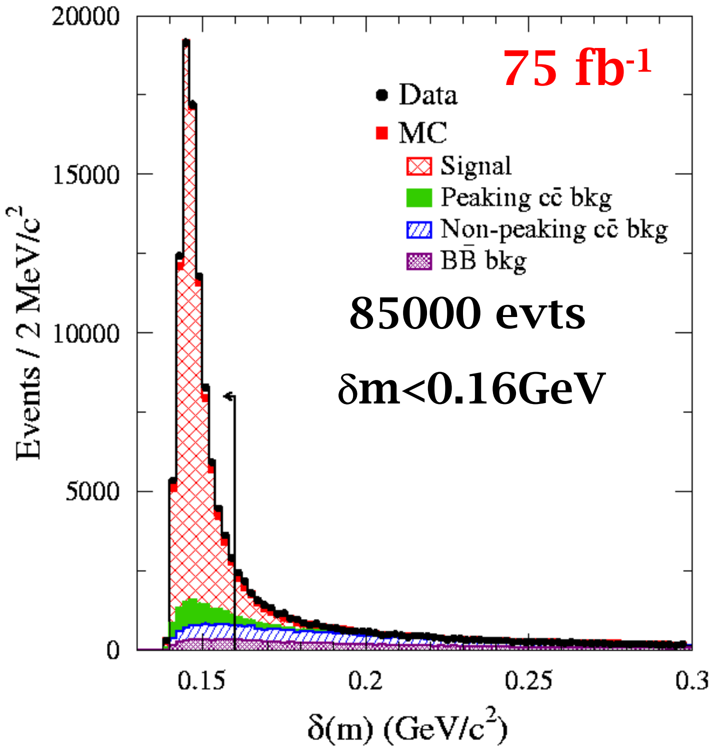
- As today, one of the main milestones of the experiment
- Apply all expertise from γ analysis
  - Leading the project, with close collaboration with INFN-Pisa and Cincinnati groups
- Very challenging
  - Looking for O(1%) effects
  - Precise understanding of background and mistags
    - Now ready (after >6 month of work)
  - Stressing computing
    - Time-dependent Dalitz fit, with huge statisticis (>500K events)
    - Parallel processing (multicore machines and MPI)
    - The bottle neck now
      - Help from SLAC computing decisive
- So far, using Run1-Run5 data
- Targeting ICHEP'08, but more likely will fail due to technical challenges

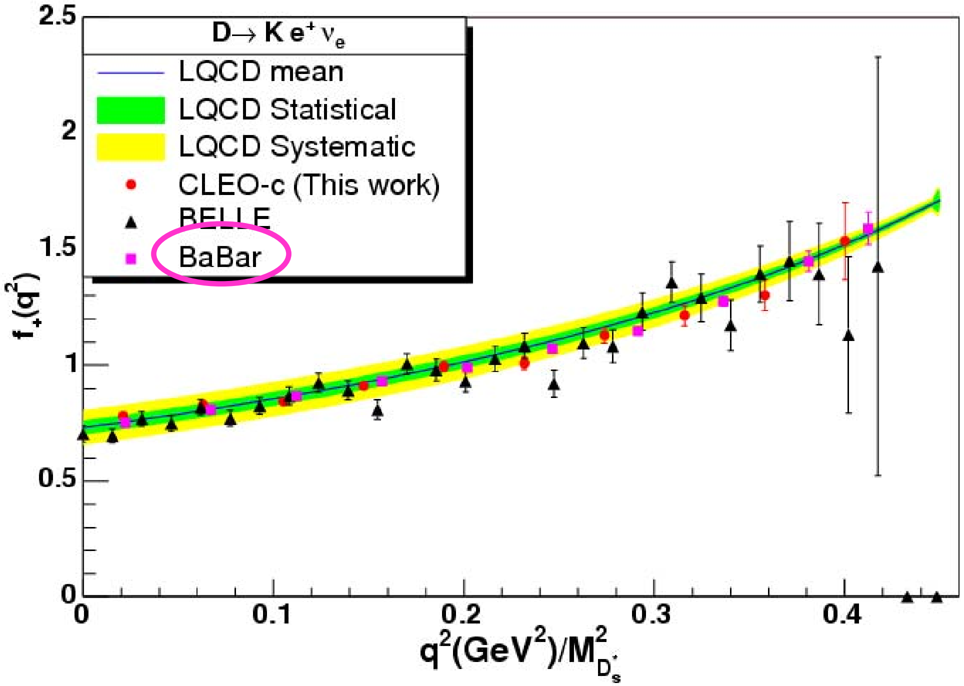
Physics Analysis: Semileptonic D decays

$D \rightarrow K\, e\, \nu$ decay channel:

- **Most precise measurement of the q^2 dependence of $f_+(q^2)$**

Phys. Rev. D 76, 052005 (2007)





Experiment	$m_{\rm pole}$ (GeV/c^2)	$\alpha_{\rm pole}$
CLEO III	$1.89 \pm 0.05^{+0.04}_{-0.03}$	$0.36 \pm 0.10^{+0.03}_{-0.07}$
FOCUS	$1.93 \pm 0.05 \pm 0.03$	$0.28 \pm 0.08 \pm 0.07$
BELLE	$1.82 \pm 0.04 \pm 0.03$	$0.52 \pm 0.08 \pm 0.06$
Prel. CLEO-c	$1.96 \pm 0.03 \pm 0.01$	$0.22 \pm 0.05 \pm 0.02$
Prel. CLEO-c	$1.97 \pm 0.02 \pm 0.01$	$0.21 \pm 0.04 \pm 0.03$
This analysis	$1.893 \pm 0.012 \pm 0.015$	$0.36 \pm 0.02 \pm 0.03$

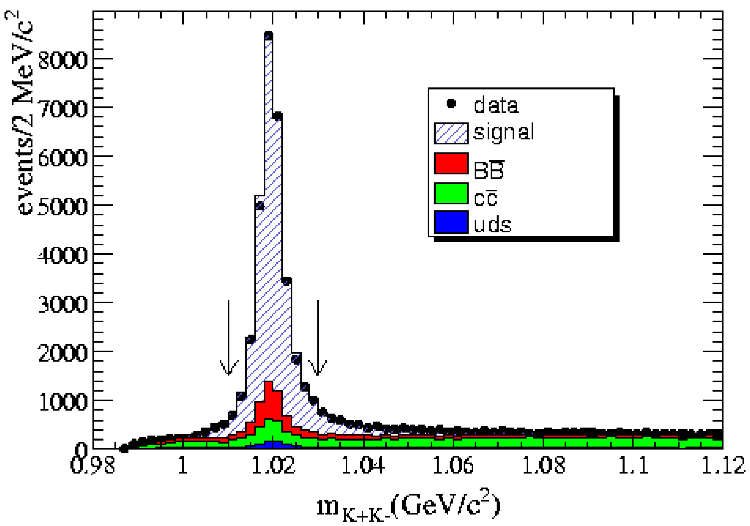
Lattice: α= 0.50 ± 0.04

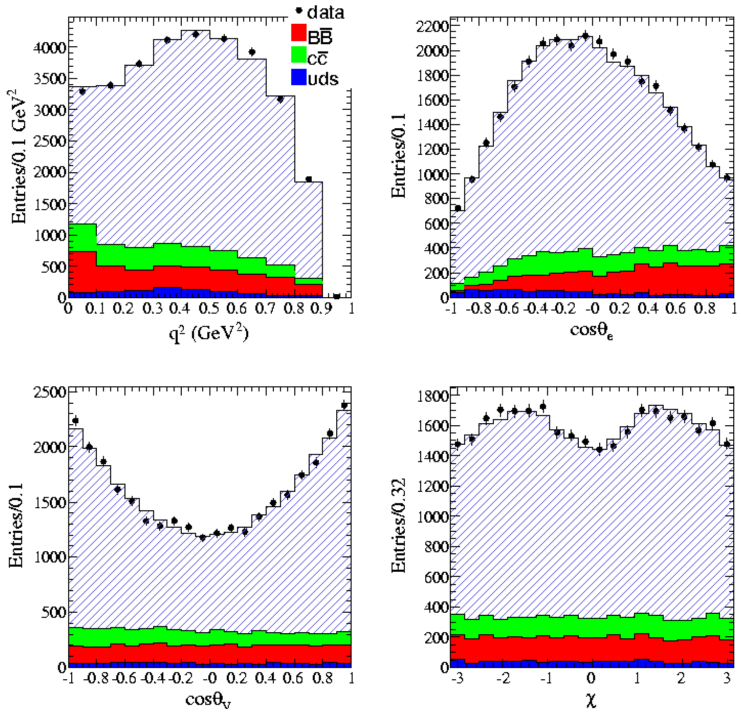
Physics Analysis: Semileptonic D decays

$D \rightarrow KK e \nu$ decay channel:

New at FPCP '08

- **First measurement of the q^2 dependence**





Form factors parameters:

$$r_V = 1.868 \pm 0.061 \pm 0.079$$

$$r_2 = 0.763 \pm 0.072 \pm 0.062$$

$$m_A = 2.30^{+0.24}_{-0.18} \pm 0.21 \ \mathrm{GeV/c^2}$$

$$A_1(0) = 0.605 \pm 0.012 \pm 0.018 \pm 0.018$$

Lattice (2001, quenched):

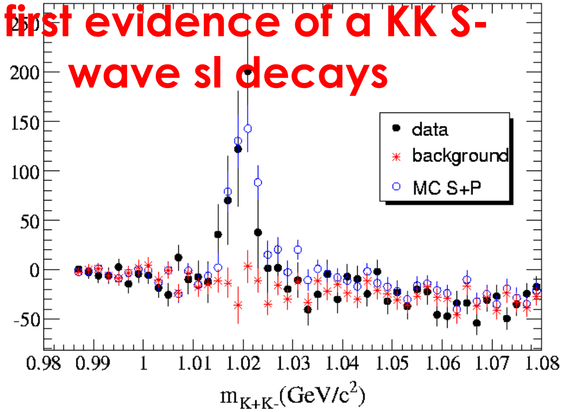
r_V = 1.35 +0.08 -0.06

r_2 = 0.98 ± 0.09

$m_A = 2.42^{+0.23}_{-0.16}$ GeV

$A_1(0)$=0.63 ± 0.02

+ first evidence of a KK S-wave sl decays



Ph.D. thesis J . Serrano (LAL – Orsay)

Physics Analysis: Semileptonic D decays

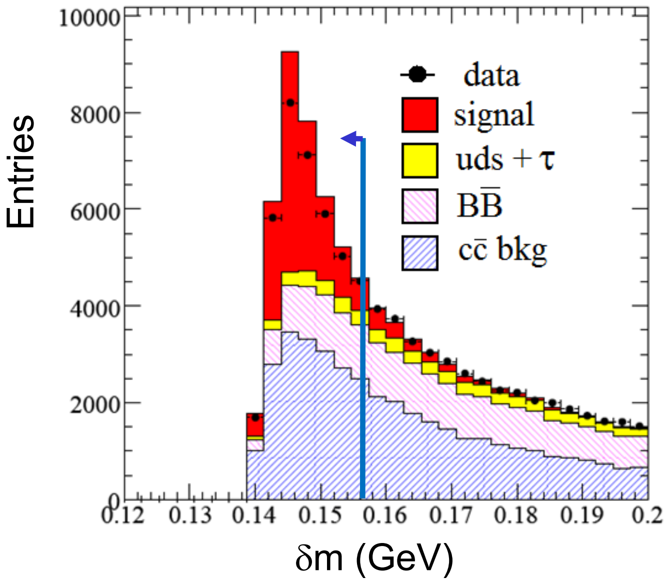
$D \rightarrow \pi e \nu$ decay channel:

On going

$D \rightarrow K\pi e \nu$ decay channel:

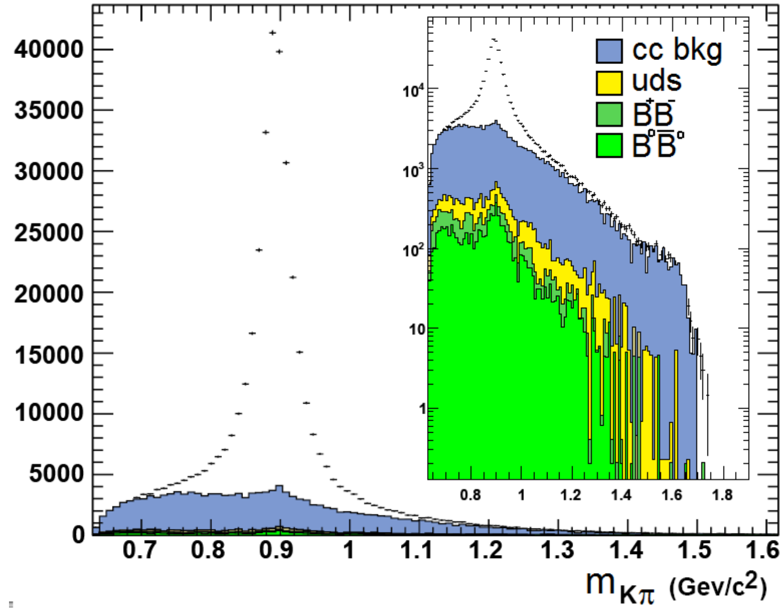
- **$D^{*+} \rightarrow D^0\pi^+$, $D^0 \rightarrow \pi^- e^+ \nu$**

230 fb^{-1} (Run4+5) $\rightarrow$ ~ 30000 candidates (60% bkg)



- **$D^+ \rightarrow K^- \pi^+ e^+ \nu$**

340 fb^{-1} (Run1-5) $\rightarrow$ ~ 300K candidates (33% bkg)



Prospects:

$$\left.\frac{d\Gamma(B \to \pi e \overline{\nu}_e)/dw}{d\Gamma(D \to \pi e \overline{\nu}_e)/dw}\right|_{same\ w} = \left|\frac{V_{ub}}{V_{cd}}\right|^2 \left(\frac{M_B}{M_D}\right) \left|\frac{f_+^{B\to\pi}}{f_+^{D\to\pi}}\right|^2$$

CLEO-c: 281 pb^{-1} (2500 signal evts)

FOCUS: 18245 candidates (21% bkg)

It will provide a determination of |Vub|

Physics Analysis: Inclusive SL B decays, $|V_{ub}|$

L_{data}: ~ 348 fb^{-1}
383 M $B\bar{B}$ pairs

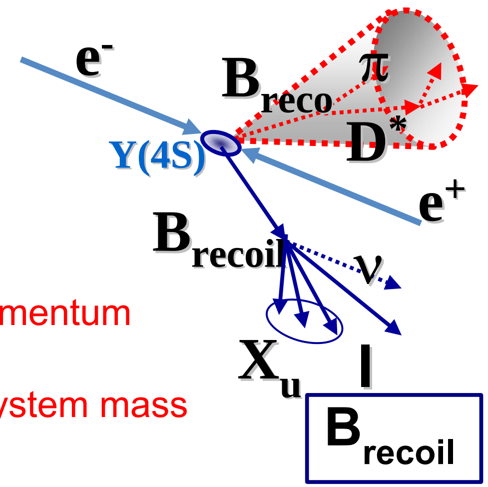
Phys.Rev.Lett.100:171802,2008

m_b = (4.59 +- 0.04) GeV/c2
μ_π^2= (0.40 +- 0.04) GeV^2/c^2
kinetic scheme

Kinematic region	$\Delta\mathcal{B}(B\to X_u l\nu)$ Δ (stat. sys. th.)	$\lvert V_{ub}\rvert$ (10^{-3}) Δ (stat. sys. th.)	Theory
M_X < 1.55 GeV/c^2	1.18 ± 0.09 ± 0.07 ± 0.01	4.27 ± 0.16 ± 0.13 ± 0.30	BLNP
		4.56 ± 0.17 ± 0.14 ± 0.32	DGE
P_l> 0.66 GeV/c^2	0.95 ± 0.10 ± 0.08 ± 0.01	3.88 ± 0.19 ± 0.16 ± 0.28	BLNP
		3.99 ± 0.20 ± 0.16 ± 0.24	DGE
M_X < 1.7 GeV/c^2 & q^2 >8.0 GeV^2/c^2	0.81 ± 0.08 ± 0.07 ± 0.02	4.57 ± 0.22 ± 0.19 ± 0.30	BLNP
		4.64 ± 0.23 ± 0.19 ± 0.25	DGE
		4.93 ± 0.24 ± 0.20 ± 0.36	BLL

1 Data Set and
3 overlapping phase space

give 7 values for |Vub| !
All errors correlated!
Stat: 3.8%
Syst: 3.0%
Theory: 7 % (SF errors dominate, mb)



p_ℓ = lepton momentum
$q^2 = (p_\ell + p_\nu)^2$
M_X = hadron system mass

in BLNP framework, experimental correlation
. agreement at 1 σ level for the M_X and combined (M_X,q2)
. P+ differs from the two others at a 2.5 σ level.

The M_X analysis
. largest portion of phase space
. most precise determination of |Vub|

BLNP and DGE frameworks gives consistent results, within the theoretical uncertainty

Current Inclusive $|V_{ub}|$ measurements

BLNP - HFAG

$|Vub| = (3.98 \pm 0.15_{exp} \pm 0.30_{mb+theory}) \times 10^{-3}$

Total Error: 8.3 % total

$\pm 2.0_{stat}$ $\pm 2.5_{exp}$
$\pm 1.8_{bc\ model}$ $\pm 1.1_{bu\ model}$ } Exp. 3.9%

$\pm 6.3_{HQE\ param}$ $\pm 0.4_{SF\ form}$
$\pm 0.7_{sub\ SF}$ $\pm 3.6_{matching}$
$\pm 1.4_{WA}$ } Theory 8.1%

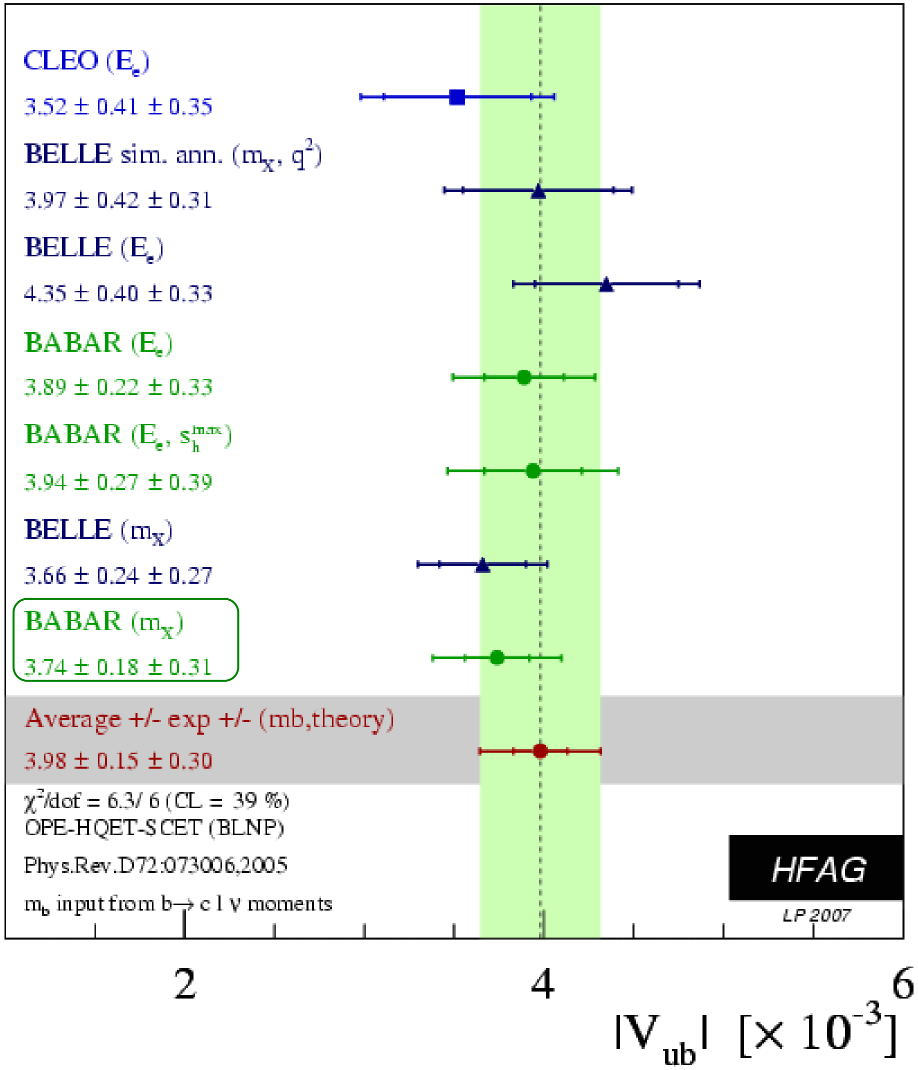
Use only the partial B from m_X for the Breco analyses as experimental correlation among the variables are not published

"Tension" with exclusive decays:
$|V_{ub}| = (3.33 \pm 0.21^{+0.58}_{-0.38}) \times 10^{-3}$

.. Consistent with global UT fit
$|Vub| = (3.44 \pm 0.16) \times 10^{-3}$ [UTFit]

HFAG results are rescaled to common HQE inputs:
$m_b(SF)=4.707+0.059/-0.053$ GeV
$\mu_\pi^2=0.216+0.054/-0.076\ GeV^2$

BNLP + only b→ c l ν moments



Organization of the "SuperB Workshop VI"

Goals:

- Sharpening the discovery potential of the SuperB Flavor Factory
- Simulation studies (detector+machine)

Working groups:

WG1: Tau Physics (including LFV and Universality tests)

WG2: Charm Physics (CPV)

WG3: B Phenomenology

WG4:Charm Spectroscopy and ISR

(WG5: Physics tools)

Proceedings
of
Super*B* Workshop VI

New Physics
at the
Super Flavor Factory

Valencia, Spain
January 7-15, 2008

Proposed Physics Analysis Activities

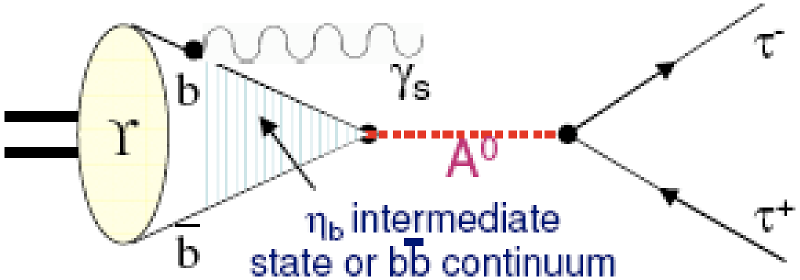
Goal: Give significant contribution to the legacy results of the experiment in some of the most relevant "core" analyses

1. Measurement of CKM angle γ with Dalitz technique (and combined)
2. Observation of D^0-$\overline{D}^0$ mixing and measurement of mixing parameters with Dalitz technique
3. Charm form factors (LQCD)
4. $|V_{ub}|$ (inclusive method)

- Use full data sample with last processing (R24)
  - Available by end of 2008
  - All results so far based on Run1-Run5 data
    - Run6 adds ~30% more data
  - R24 benefits from a significantly better tracking, adding about 15% more signal, with less bkg (analysis dependent)
- Finish and defend the 3 PhD theses of the students of the group
- Put our hands in the Y(3S), Y(2S) physics
  - In fact, we are already there…

Testing lepton universality

- Possible deviations from lepton universality are expected in some models beyond SM, for example via the mixing with a light pseudo-scalar Higgs bosson



[1] *M.A. Sanchiz Lozano, Int. J. Mod. Phys. A 19, 2183 (2004)*

E. Fullana and M. A. Sanchis-Lozano, Phys. Lett. B 653 (2007) 67

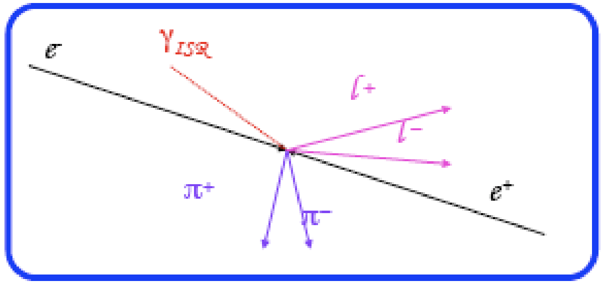
- Possible existence of a light A^0 Higgs boson not yet excluded (NMSSM, 2HDM)
  - With tan β ~7÷21 and m(A^0)~ 2m_b~10 GeV: $R_{\tau\mu}-1 \sim O(10)\%$
- Previous measurements of CLEO (~1.2/fb at each Υ peak: ~10^7 Υ):

$R_{ll'}$ (l,l'=τ, μ) → From cross-section measurement on- and off-peaks.

Υ(3S) : 1.07 ± 0.08 (stat) ± 0.05 (syst)
Υ(2S) : 1.04 ± 0.04 (stat) ± 0.05 (syst)
Υ(1S) : 1.02 ± 0.02 (stat) ± 0.05 (syst)

Testing lepton universality

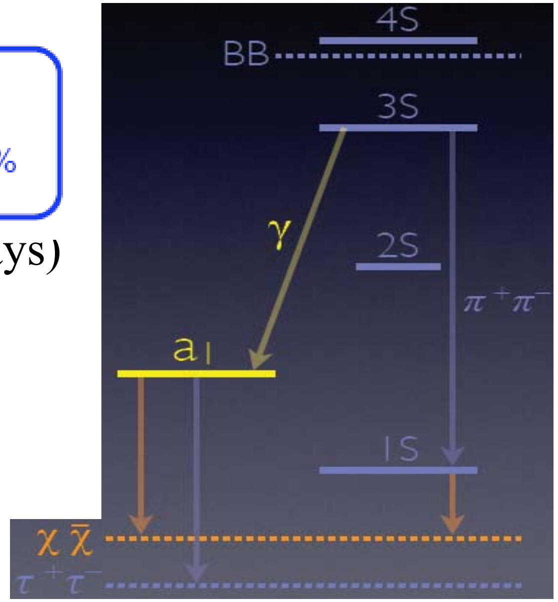
- Large sample of Y(4S) at hand
  - Exploit ISR production of Y(nS), n=1,2,3
  - One may use γ_{ISR} to tag events (small efficiency ~10%)
  - Or study Y transitions like Y(mS) →Y(nS) π+π−, m > n
    - π+π− pair tags well the event (~monochromatic)



BR(Y(2S) →Y(1S) π+π−) = 19%
BR(Y(3S) →Y(2S) π+π−) = 3%, BR(Y(3S) →Y(1S) π+π−) = 4%
Y(4S) →Y (1,2S) π+π− has a tiny branching fraction

BR(Y→ll) ~ 2%
BR(τ→lνν) ~ 18%

  - Consider all cases *l* = e, μ,τ ,with τ→e/μ ν ν (and other τ decays)
  - But Y(nS), n<4 production via ISR has small xsection (15, 15, 30 pb, n=1,2,3): 100 fb^{-1} at Y(4S) ~ 1 fb^{-1} at Y(3S)



- Y(3S), Y(2S) data, very significant increase in statistical power
  - Events identified with the same decay chain:

Y(3S)→Y(nS)π+π−, Y(nS)→l+l− with n = 1,2

&

Y(2S)→Y(1S)π+π−, Y(n1S)→l+l−

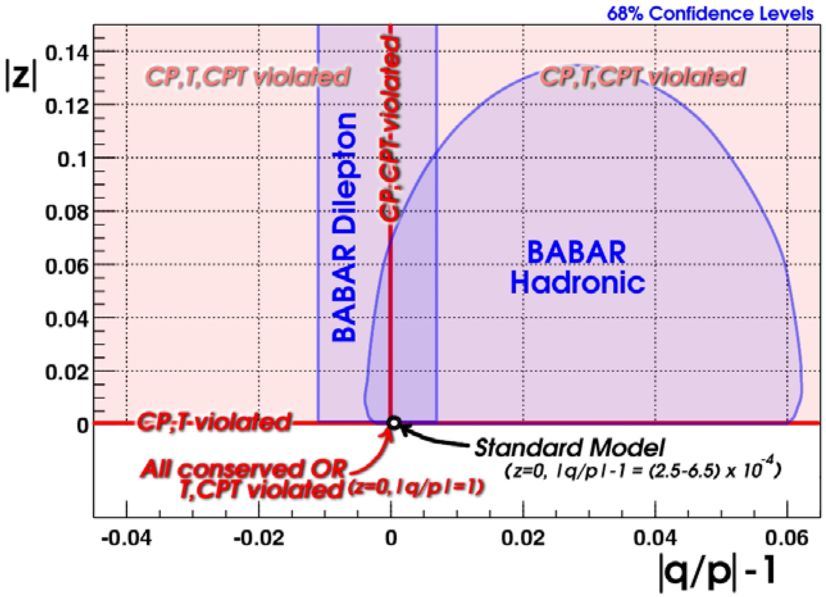
  - Analysis ~ same as at Y(4S) analysis, with some differences in cutsslight correction of cuts
- Systematics to be kept under control

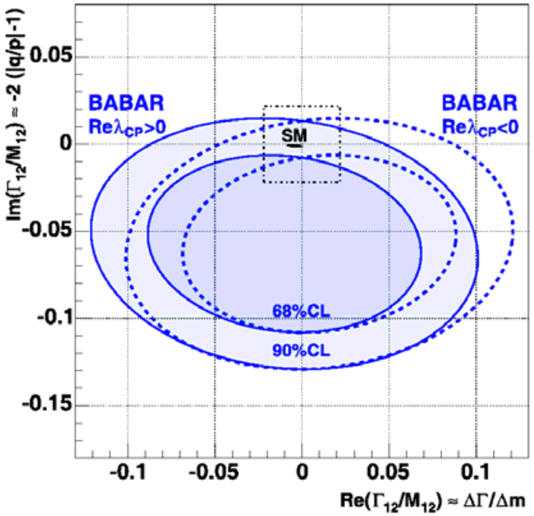
CP/T/CPT tests and $\Delta\Gamma/\Gamma$ measurement

Look for New Physics signatures at GUT-scale (e.g. Quantum Gravity)

Measure *corrections to 'naïve' CP violating and mixing picture* (CP/T/CPT violation in B^0B^{0bar} mixing and $\Delta\Gamma$ effects)

Work initially motivated by:
- J.Bernabéu et al., PLB 464, 117 (1999); NPB 590, 19 (2000).
- V.A.Kostelecký et al., PLB 344, 259 (1995); PRD 54, 5585 (1996), PRD 64, 076001 (2001)





PRL 92,181801 (2004)
PRD70,012007 (2004)

Run1+Run2 data
("pilot" analysis)

- Plan to update with final data sample
- Test T-violation using CP-eigenstates (instead of flavor-eigenstates) a la CPLEAR

J.Bernabéu et al.

Project proposal: extension and staff

2 years funding: 2009-2010
(Intense Analysis Period)

Members of the Group:

F. Martínez-Vidal (Profesor Titular, UV)	**(EDP=1)**
A. Oyanguren Campos (I3P-CSIC, until Sep'09)	**(EDP=0.5)**
V. Azzolini (Juan de la Cierva, UV, until Dec'09)	**(EDP=0.5)**
N. López-March (Contratada proyecto, UV)	**(EDP=1)**
D. Milanés Carreño (Contratado proyecto, UV)	**(EDP=1)**

Waiting for RyC applications:
- A. Oyanguren
- G. Simi (now at Maryland). If successful, EDP=0.5

V. Azzolini applying for postdoct at ATLAS
(doing our best to share BaBar and ATLAS activities)

Project proposal: budget

Personal	95760 €	1 Contrato Tecnico Superior Investigacion 37,5h = 2 contratados predoctorales × 2 years
Complementos salariales	8400 €	
Pequeño equipamiento	4400 €	2 PC deskstops (or 8-multicore workstation) + 1 laptop + books
Material fungible (mensajería)	200 €	
Viajes y dietas	60890 €	• Coll. Meetings at SLAC: 5 × 2 meet/year × 2 years × 8 days × 130€ + 20×700€ = 34800€ • Meetings in Europe: 5 × 1 meet/year × 2 years × 5 days × 130€ + 10 × 450€ = 11000€ • Interchange Valencia-Barcelona: 5 × 120€ + 6 × 80€ = 1000€ • "SuperB Factory" meetings: 4 × 7days ×130€ + 4 × 450€ = 5440€ • Conferences : 5 × 7 days × 130€ + 5 × 700€ + 5 × 120€ fees = 8650€
Varios (Contribution to "OCF")	26214 € ~~80938 €~~	9050$ × 3PhDs × 2 years × 70% ÷ 1.45 € /$ Number of PhDs frozen to 2008 counting (IFC decision, January 2008)
Total costes directos	**195864 €**	

Project proposal: OCF FY07 and FY08

BaBar Common Fund
Share and Invoice Calculation for 1/1/08 Through 12/31/08 (Calendar Year 2008) Updated:
($ in Thousands) CSC Model

A	B	C	D	E	F	G	H	I	K	L	M	N	O	P	Q	R
Country	2008 PHD Count	2008 CF Fraction (%)	Operating CF Share (K$)	Computing Contribut'n No Tier A (K$)	Ttl Without Tier A	Computg CF Share With Tier A	Tier A Credit	Computing Contribut'n W/ Tier A	Net OCF & Comput'g (Cooked) (K$)	In Kind Work Rec'd	Revised NET to Invoice	Pre-Payment	Prior Yr (Credit) & Prepayment	Adjusted Net To Invoice (FINAL)	Adjusted Net To Invoice (as Proposed in July)	Adjusted Net To Invoice Change (Current - July)
Canada	12	3.7%	81.5	41.4	122.9	21.4		21.4	102.6	56.5	46.1		-	46.1	114.3	(68.2)
Canada Original Due (1)			81.5		81.5			-	81.2	56.5	24.7			24.7	65.2	(40.5)
Computing Upgrade				41.4	41.4	21.4		21.4	21.3		21.3			21.3	49.0	(27.7)
China																
France	29	8.8%	196.9	100.1	297.1	51.7	(256.2)	(204.5)	-		-	-	-	-	65.8	(65.8)
France IN2P3 (4)	24	7.3%	163.0	82.9	245.8	42.8	(212.0)	(169.2)	-		-			-	48.3	(48.3)
France CEA	5	1.5%	34.0	17.3	51.2	8.9	(44.2)	(35.3)	-		-			-	17.6	(17.6)
Germany	12	3.7%	81.5	41.4	122.9	21.4	(27.0)	(5.6)	75.6		75.6	101.2	(41.1)	(66.7)	86.4	(153.1)
Bochum	1	0.3%	6.8	3.5	10.2	1.8	(2.3)	(0.5)	6.3		6.3	13.0		(6.7)	(3.5)	(3.2)
Dresden	3	0.9%	20.4	10.4	30.7	5.4	(6.8)	(1.4)	18.9		18.9	30.0	(24.7)	(35.8)	8.0	(43.8)
Univ. Dortmund	2	0.6%	13.6	6.9	20.5	3.6	(4.5)	(0.9)	12.6		12.6		(19.3)	(6.7)	19.0	(25.7)
Univ. Heidelberg	2	0.6%	13.6	6.9	20.5	3.6	(4.5)	(0.9)	12.6		12.6	45.2	18.9	(13.7)	28.5	(42.1)
Univ. Karlsruhe	2	0.6%	13.6	6.9	20.5	3.6	(4.5)	(0.9)	12.6		12.6		3.9	16.5	28.5	(11.9)
Rostock	2	0.6%	13.6	6.9	20.5	3.6	(4.5)	(0.9)	12.6		12.6	13.0	(19.9)	(20.3)	6.0	(26.2)
Italy	70	21.3%	475.4	241.7	717.0	124.8	(264.1)	(139.3)	335.0		335.0			335.0	501.5	(166.6)
~~The Netherlands~~	~~1~~	~~0.3%~~	~~6.8~~	~~3.5~~	~~10.2~~	~~1.8~~		~~1.8~~	~~8.5~~		~~8.5~~			~~8.5~~	~~11.4~~	~~(2.8)~~
Spain	4	1.2%	27.2	13.8	41.0	7.1		7.1	34.2		34.2			34.2	45.5	(11.3)
Norway (2)	2	0.6%	13.6	6.9	20.5	3.6		3.6	17.1	17.1						
Russia (2)	9	2.7%	61.1	31.1	92.2	16.1		16.1	76.9	76.9						
UK	31	9.5%	210.5	107.0	317.5	55.3	-	55.3	264.9		264.9	-		264.9	432.6	(167.6)
Subtotal	**170**	**51.8%**	**1,154.5**	**586.9**	**1,741.4**	**303.2**	**(547.4)**	**(244.2)**	**914.8**	**150.5**	**764.3**	**101.2**	**(41.1)**	**622.0**	**1,257.5**	**(635.5)**
US	158	48.2%	1,073.0	545.5	1,618.4	281.8		281.8	1,350.3		1,350.3					
Total	**328**	**100.0%**	**2,227.5**	**1,132.3**	**3,359.8**	**585.0**	**(547.4)**	**37.6**	**2,265.1**	**150.5**	**2,114.6**					

FY08
34.2 k$

BABAR COMMON FUND INVOICING & PAYMENT RECORD 2007
(in thousands)

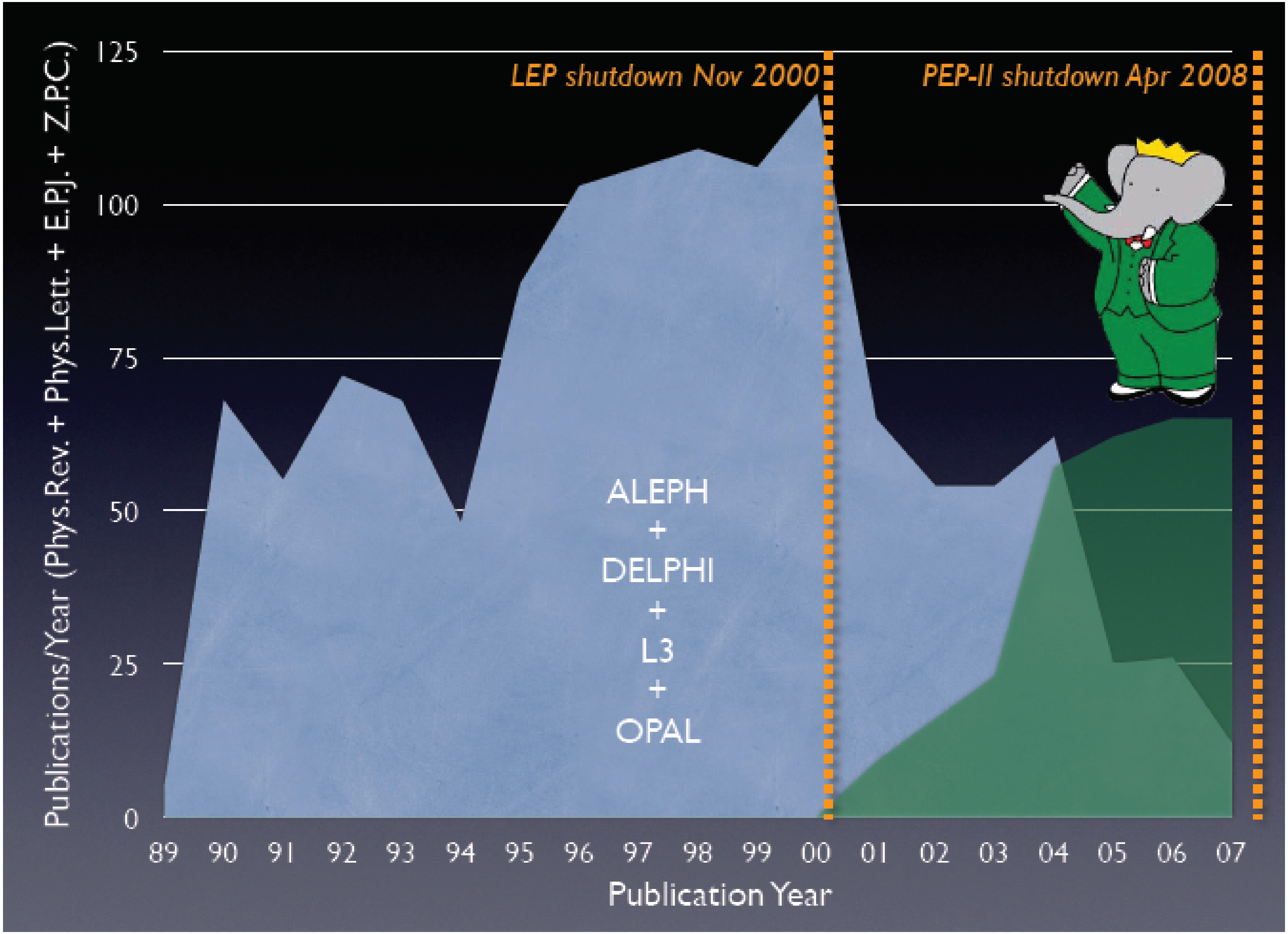
Updated: Jan 11, 2008

COLLABORATOR	SHARE	INVOICE	DATE	RECEIVED	DATE	REC'V - SHARE	Comments
Univ of British Columbia	54.1	54.1	1/23/2007	54.1	5/14/2007		
Univ of British Columbia-Computing	25.1	25.1	1/23/2007	-		(25.1)	
UK Rutherford Appleton Lab	343.7	343.7	1/23/2007	343.7	3/7/2007	-	
Germany Rhur-Bochum	6.3	6.5	11/7/2006	6.5	12/6/2006	-	*1
Germany Dresden	25.3	50.0	11/7/2006	50.0	12/2006	24.7	*1
Germany Universitat Dortmund	12.6	32.0	11/7/2006	32.0	12/6/2006	19.3	*1
Germany Univ of Heidelberg	18.9	-		-		(18.9)	*1
Universitat Karlsruhe	18.9	15.0	11/7/2006	15.0	12/7/2006	(3.9)	*1
Germany Rostock	12.6	32.5	11/7/2006	32.5	12/8/2006	19.9	*1
IN2P3	-	-		-			
CEA	-	-		-			
INFN 1st Installment	317.2	180.0	2/7/2007	180.0	4/7/2007	(137.2)	*2
INFN 2nd Installment		137.2	10/8/2007	137.2	12/12/2007	137.2	*2
~~NIKHEF~~	~~9.0~~	~~9.0~~	~~1/23/2007~~	~~9.0~~	~~2/7/2007~~	~~-~~	
IFIC-Instituto de Fisica Corpuscular -Spain	36.2	36.2	1/23/2007	36.2	3/7/2007	-	
Total	880.0	921.3		896.1		16.0	

FY07: 36.2 k$

Concluding remarks

- BaBar has been very successful in taking, analyzing and releasing many and important results
- Unfortunately, abrupt and unexpected DOE decision has cut the Run7, where PEP-II was ready to double Υ(4S) integrated luminosity
- In turn, we have large Υ(3S) and Υ(2S) samples (×10)
- The group of this project, even if small, has had and is having an active participation in Collaboration activities with leadership in some areas
- We would really like to conclude this participation in the best way, by significantly contributing to the legacy of the experiment


LEP shutdown Nov 2000
PEP-II shutdown Apr 2008
Publications/Year (Phys.Rev. + Phys.Lett. + E.P.J. + Z.P.C.)
125
100
75
50
25
0
ALEPH
+
DELPHI
+
L3
+
OPAL
89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07
Publication Year

BABAR™

Venue for the June 2009 BABAR collaboration meeting

Valencia

June 15th to 18th, 2009