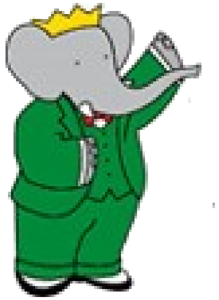
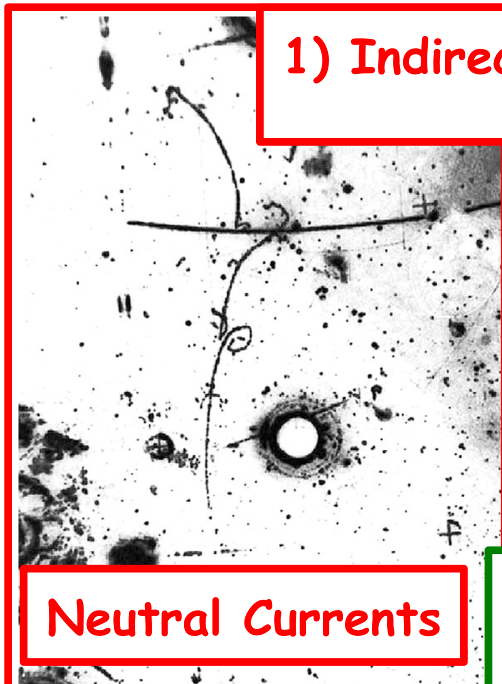
Constraints on New Physics in hadronic b→s decays



Maurizio Pierini
CERN PH

The Success of the SM

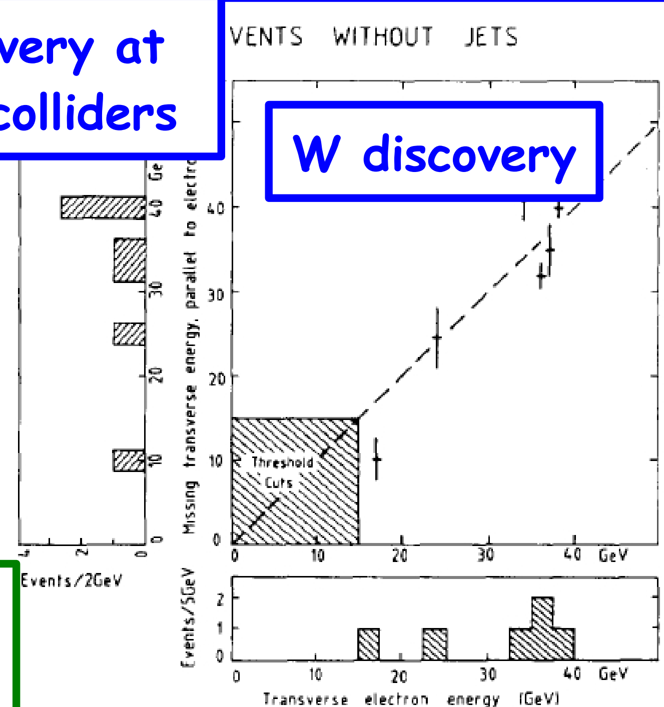
1) Indirect evidence



Neutral Currents

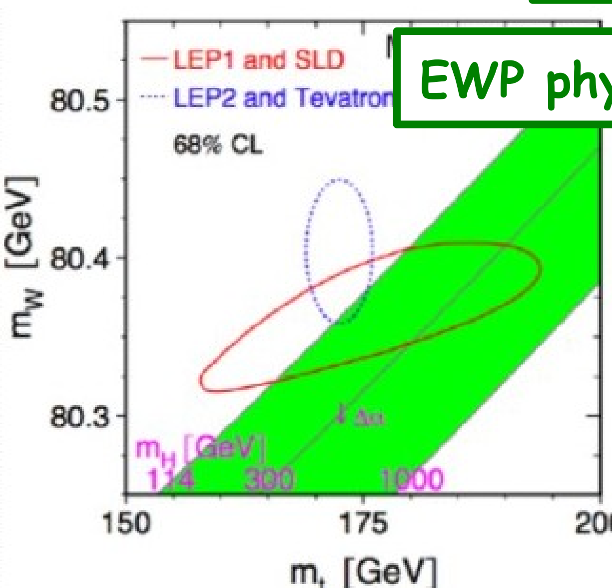
2) The dicovery at hadron colliders

W discovery

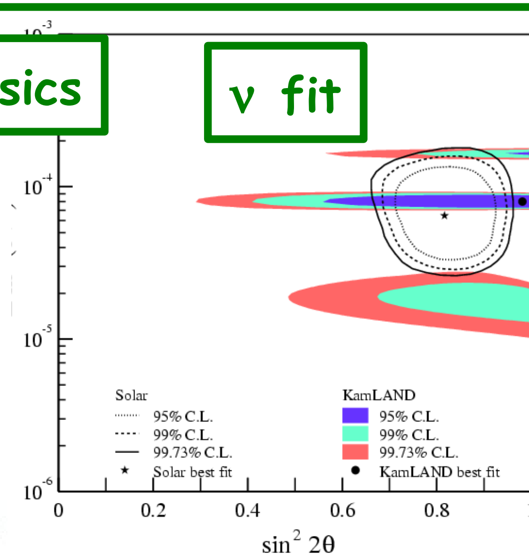


3) precision tests at e^+e^- colliders (and not only...)

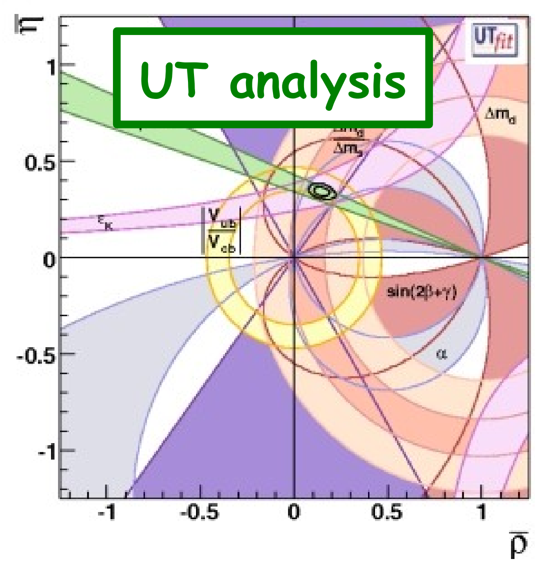
EWP physics



ν fit

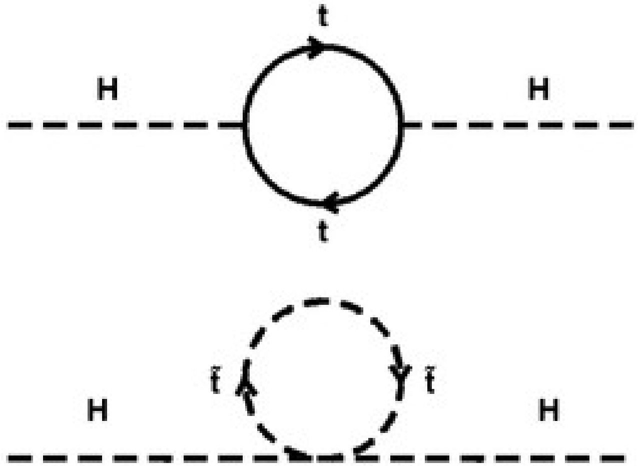


UT analysis



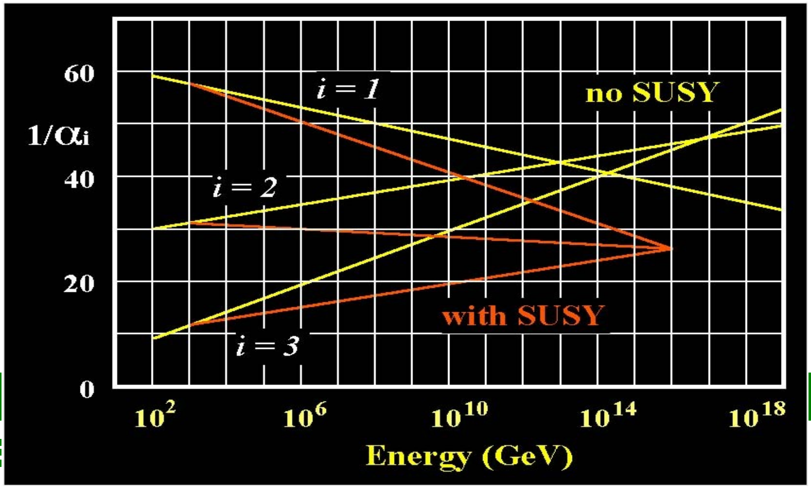
Open Issues With The SM

Dark Matter: Standard Model does not provide a satisfactory candidate for dark matter (ν's are not enough)



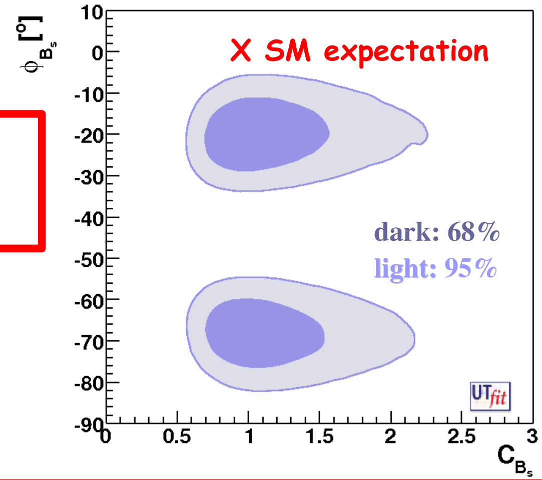
Hierarchy problem:
Renormalization of Higgs mass gives $\sim\Lambda_{plank}$ correction, but we want it O(100) GeV. We don't want fine-tuning, so we need something (a new symmetry? ED?) to protect m_H

Grand Unification: coupling constants of weak, strong and EM interactions do not cross in a single point if we assume the SM. They do in New Physics scenarios (SUSY)

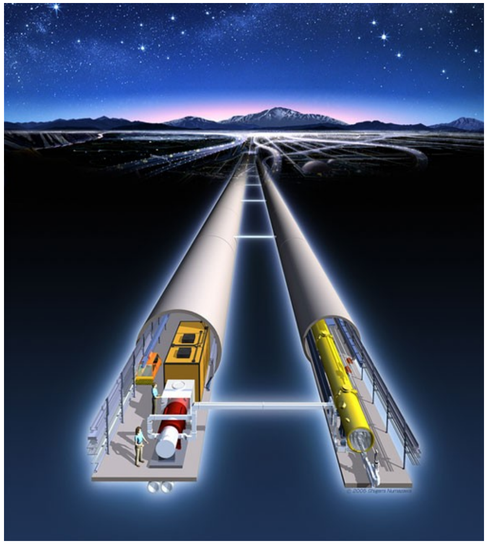


The path to New Physics

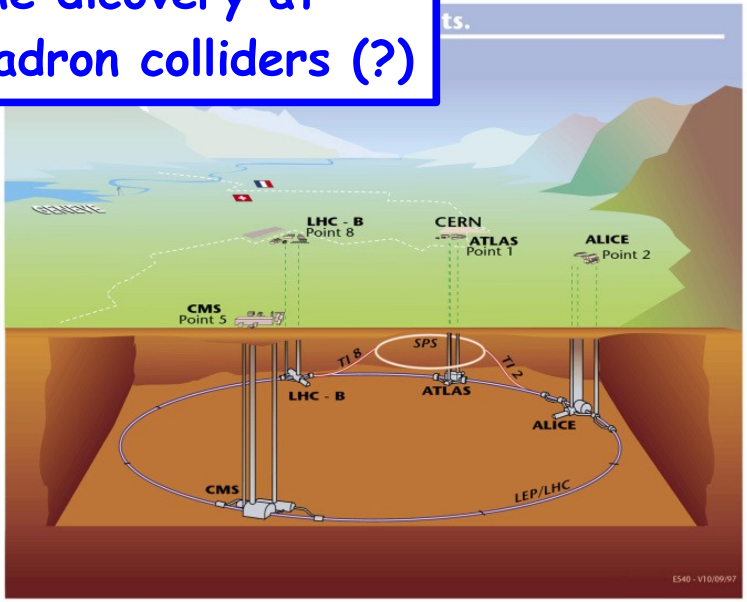
1) Indirect evidence (?)



3) precision tests at e^+e^- colliders (?)



2) The dicovery at hadron colliders (?)



Going beyond the SM

The SM works beautifully up to a few hundred GeV's, but it must be an effective theory valid up to a scale $\Lambda \leq M_{planck}$

$$\mathcal{L}(M_W) = \Lambda^2 H^\dagger H + \lambda (H^\dagger H)^2 + \mathcal{L}_{SM}^{gauge} + \mathcal{L}_{SM}^{Yukawa} + \mathcal{L}^5/\Lambda + \mathcal{L}^6/\Lambda^2$$

EW scale

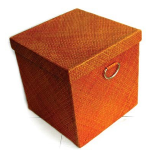
NP contribution to EW precision, FCNC processes, CPV, etc.

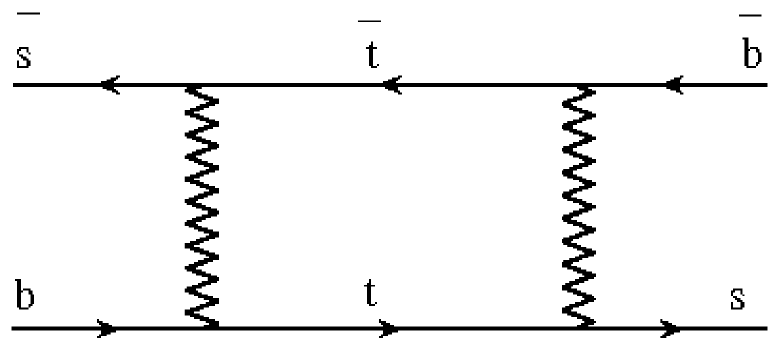
The new contributions in general introduce **new sources of CP violation and flavor mixing**. The **consistency of the Standard Model** becomes a **puzzle** in this framework.

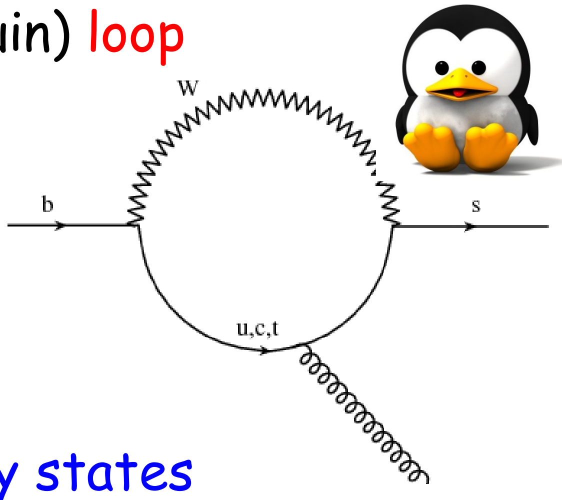
We should see some discrepancy!!!!

b→s transitions

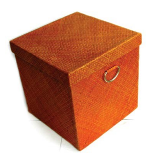
Since FCNC are forbidden at the tree level in the SM, b→s transitions proceed through a (box or penguin) loop

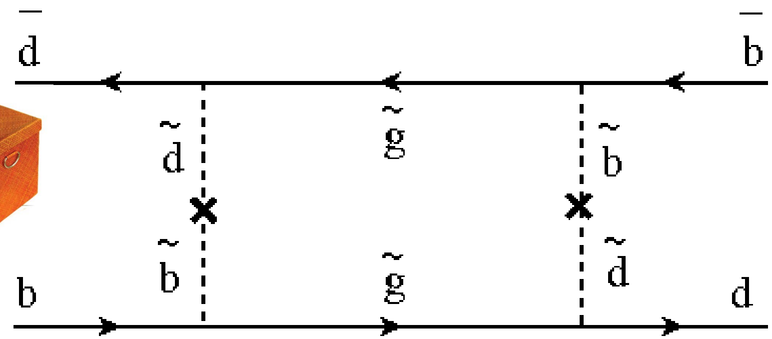


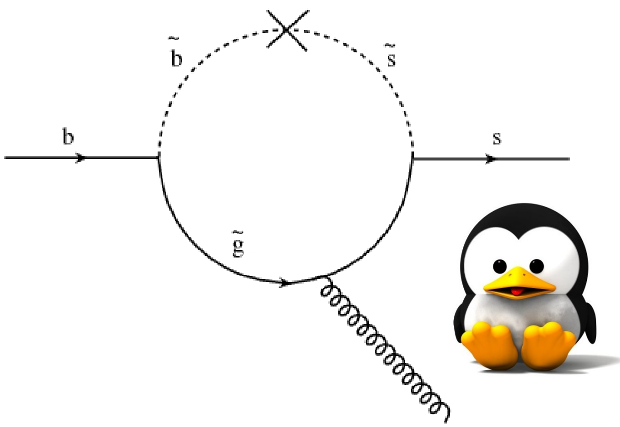




NP can contribute through the virtual effects of new heavy states running in the loops





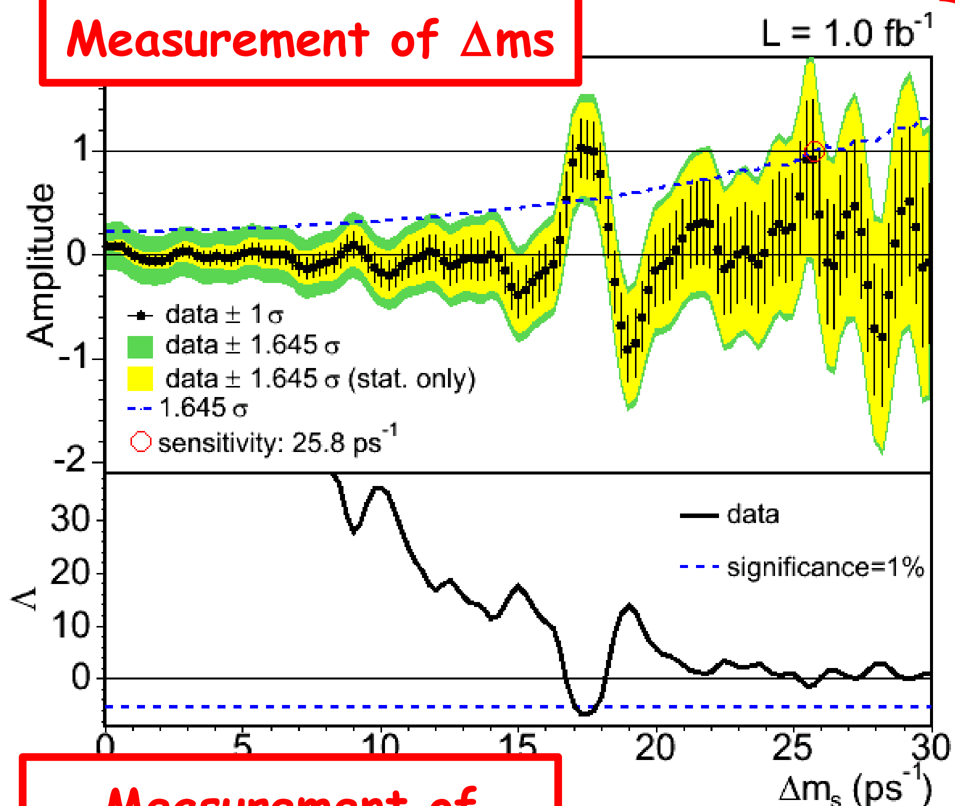


Several experimental observables

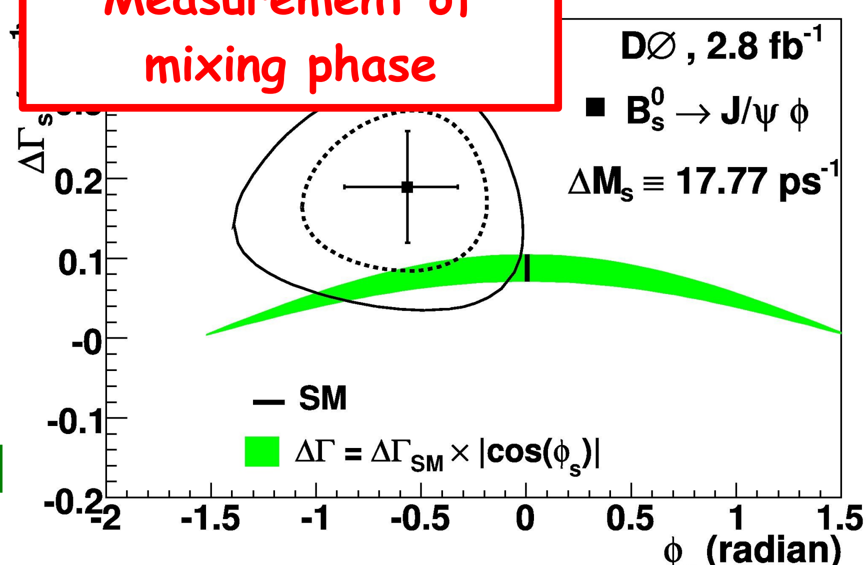
- Bs mixing
- BR(b→sγ)
- BR & time-dependent CP asymmetries of hadronic B decays

Bs mixing

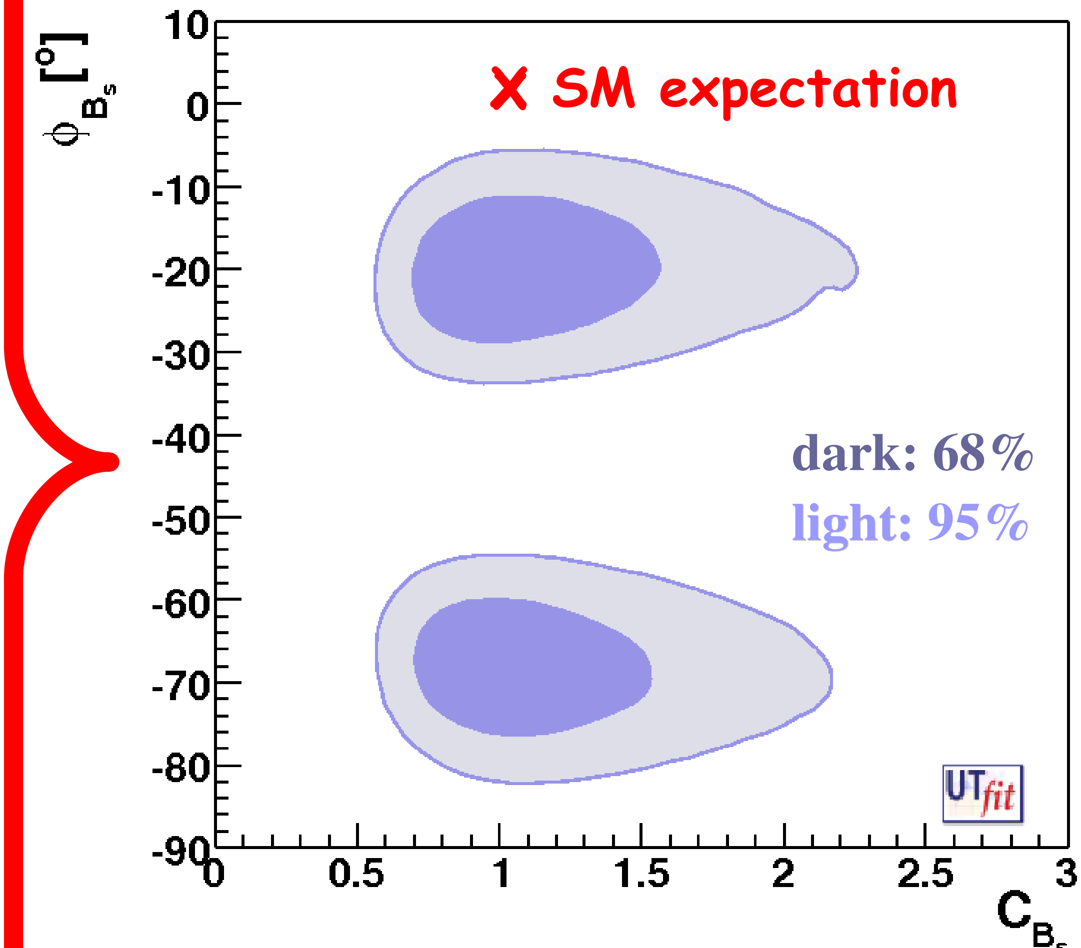
Measurement of Δms



Measurement of mixing phase



$$C_{B_s} e^{-2i\phi_{B_s}} = \frac{\langle \overline{B}_s | H_{eff}^{SM} + H_{eff}^{NP} | B_s \rangle}{\langle \overline{B}_s | H_{eff}^{SM} | B_s \rangle}$$



Hadronic b→s decays

Very rich phenomenology

- BR and direct CP asymmetries in sets of four isospin-conjugated states ($B\to K\pi$, $B\to K^*\pi$, $B\to K\rho$)
- Time dependent analysis of $B^0\to K^0h^0$ decays ($h^0= \pi^0, \omega, \eta', \phi, \rho^0$)
- For PV decays: Dalitz plot to directly access the decay amplitudes

Covered in this seminar

One of the most rich and exiting parts of the physics program for the B factories

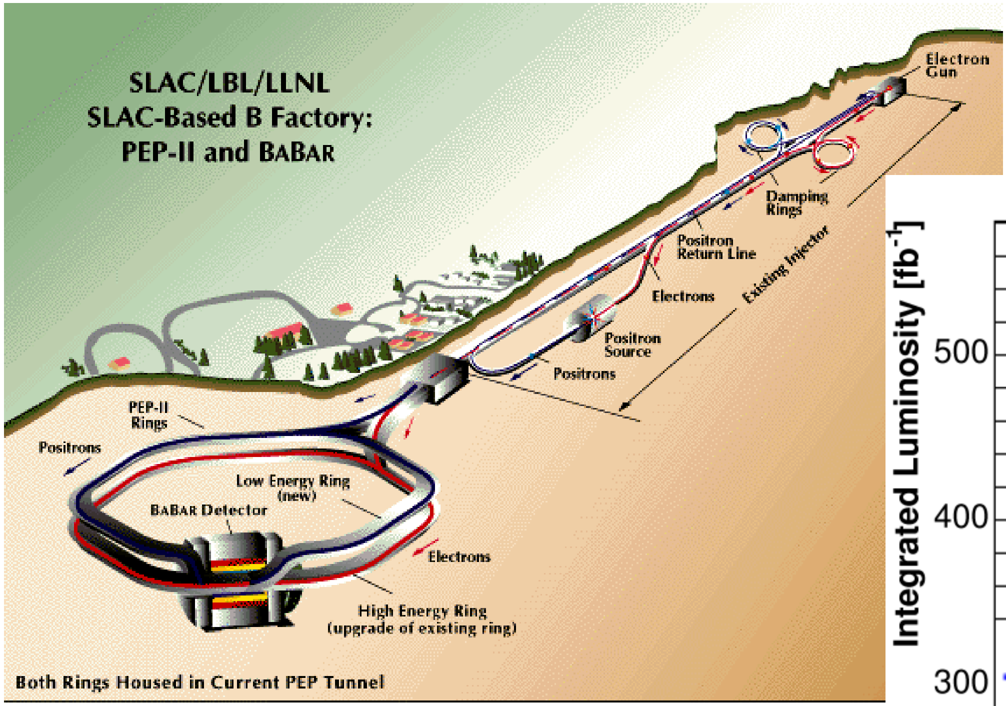
The experimental challenge:

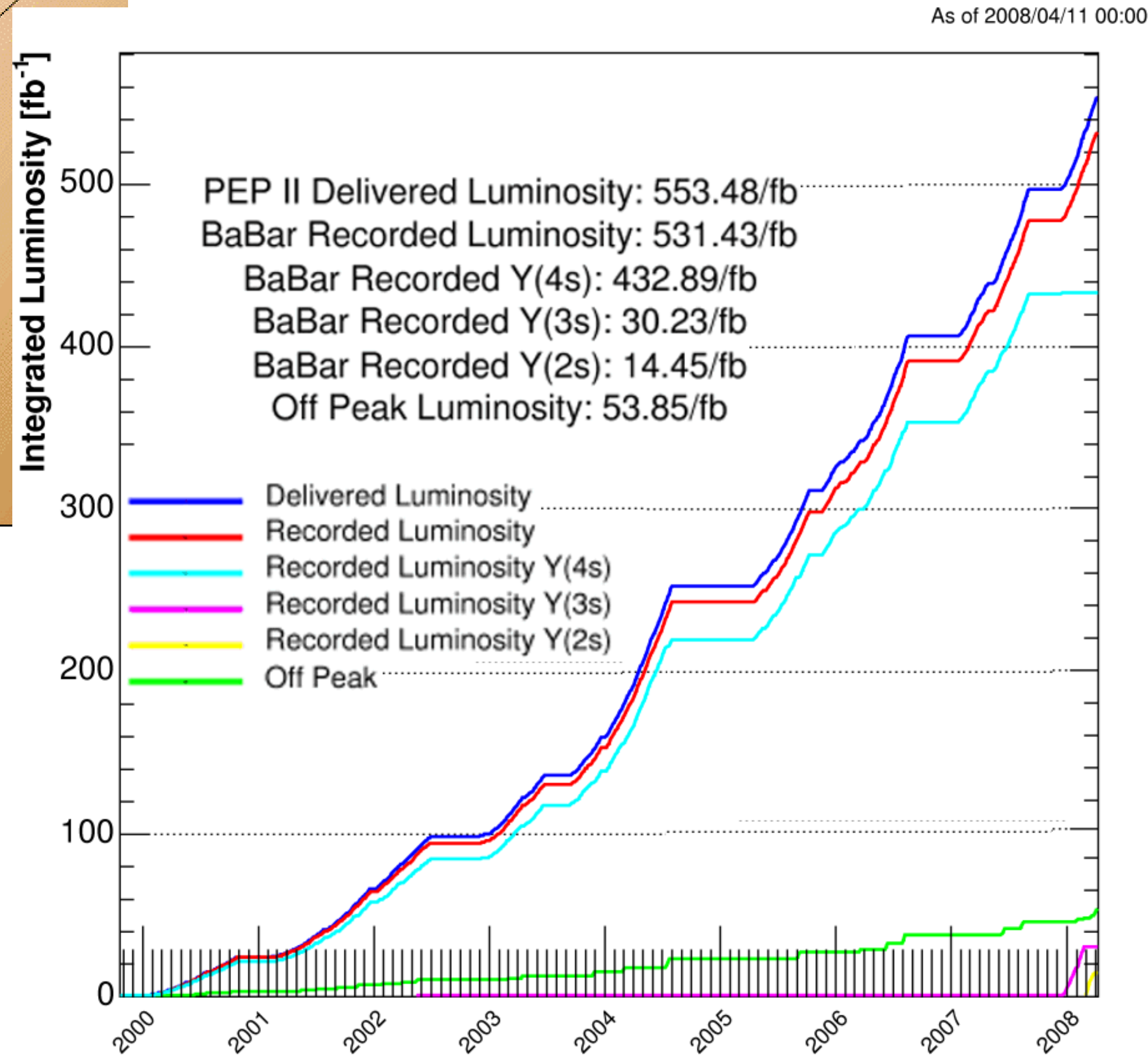
- BR ~ 10^-5
- large contamination from ee qq events
- Possible cross-feed among the channels
- (for some of the channels) no charged track coming from the primary vertex

The experimental handles

- Closed kinematic
- Topological variables
- Use of the full decay chain
- Particle ID for K/π separation

PEP-II B Factory





The BaBar detector

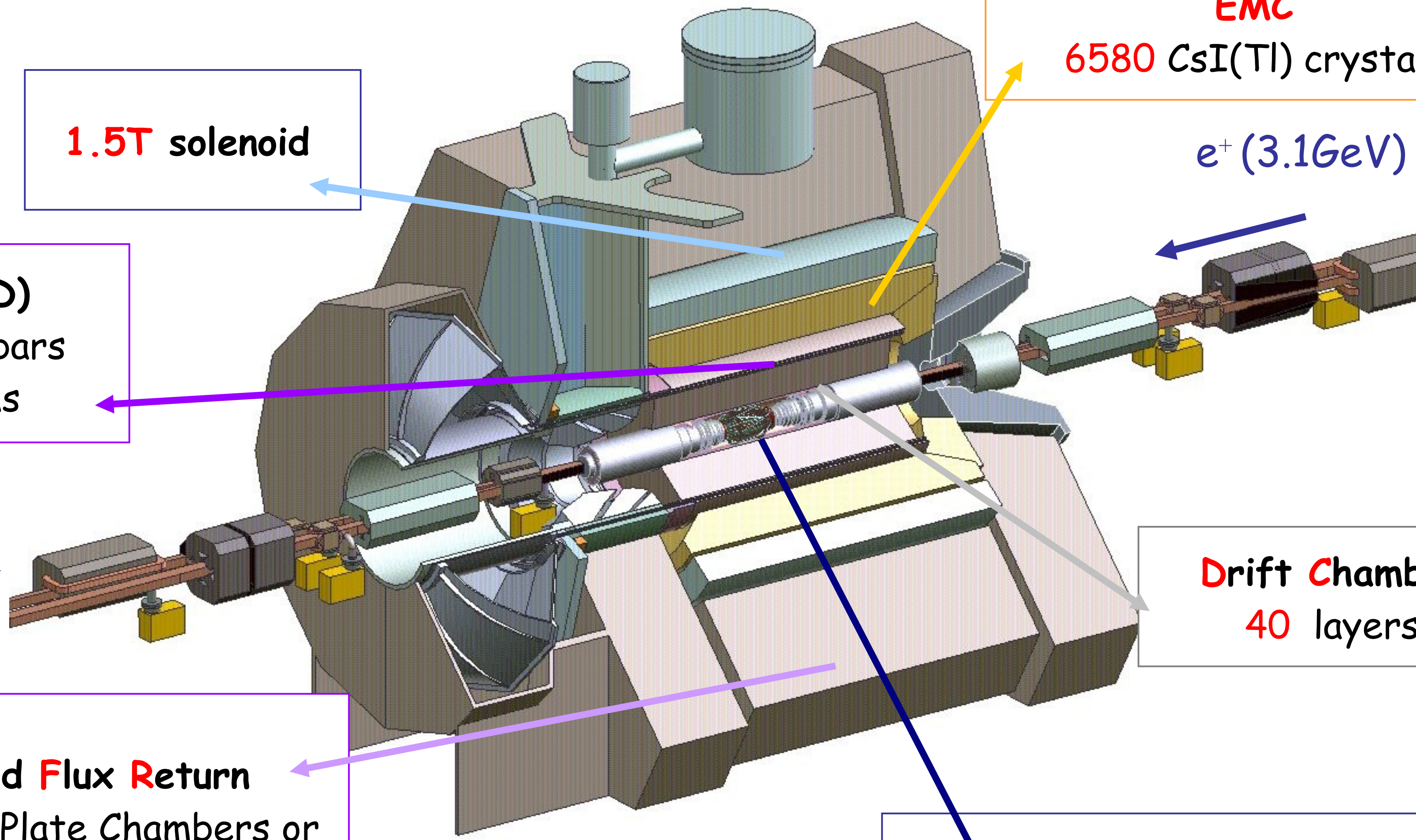
EMC
6580 CsI(Tl) crystals

e^+ (3.1GeV)

1.5T solenoid

DIRC (PID)
144 quartz bars
11000 PMs

e^- (9GeV)

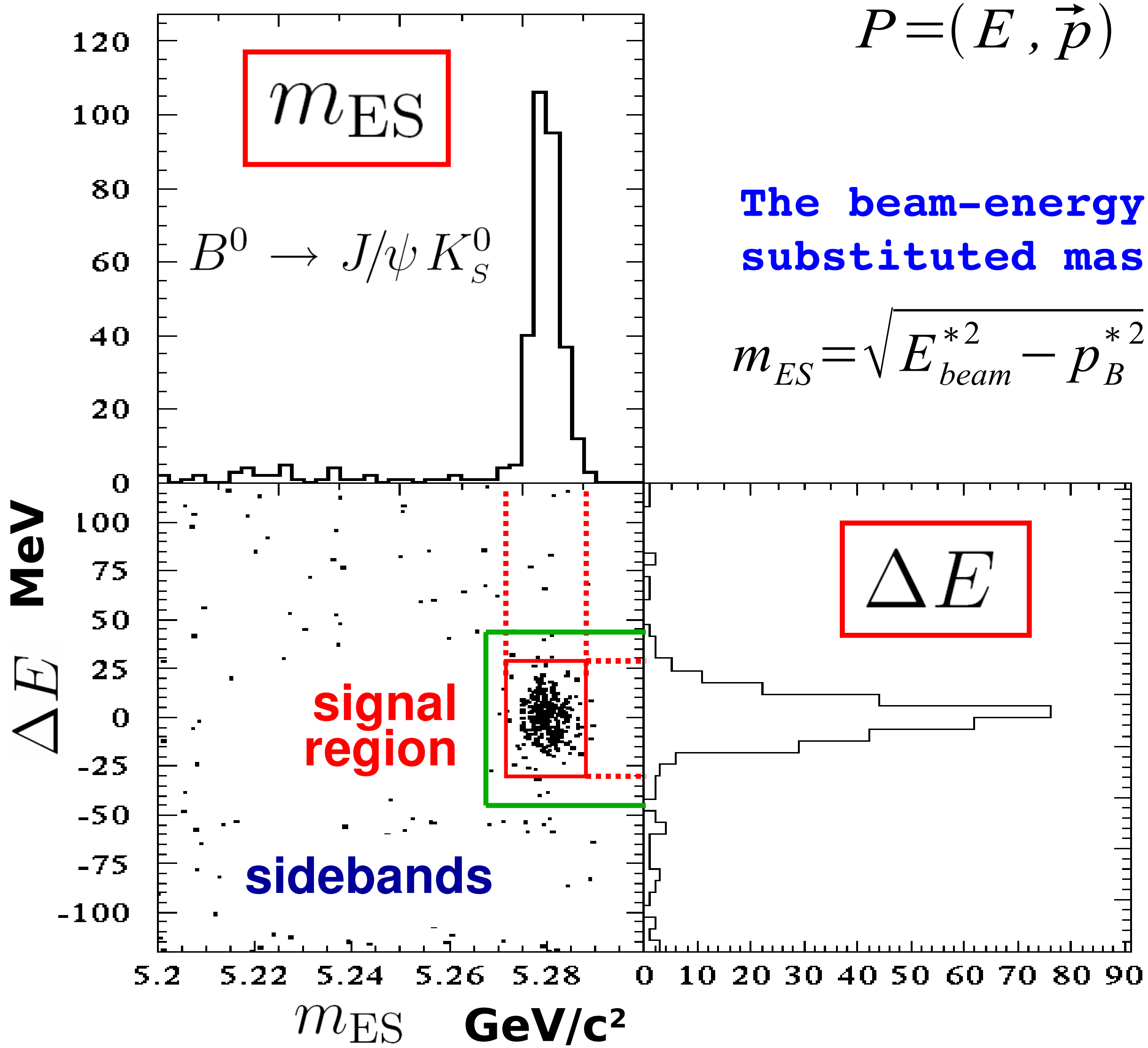


Drift Chamber
40 layers

Instrumented Flux Return
Iron / Resistive Plate Chambers or Limited Streamer Tubes (muon / neutral hadrons)

Silicon Vertex Tracker
5 layers, double sided strips

Closed kinematic



Lab frame $P=(E,\vec{p})$ → **Boost** → **CM frame** $P^*=(E^*,\vec{p}^*)$

The beam-energy substituted mass

$$m_{ES}=\sqrt{E^{*2}_{beam}-p^{*2}_B}$$

The energy difference

$$\Delta E=E^*_{beam}-\sqrt{s}/2$$

Two independent analysis variables

$$\sigma_{m_{ES}}\approx 2.6\, MeV/c^2$$

dominated by beam energy spread

$$\sigma_{\Delta_E}\approx 10\div 40\, MeV/c^2$$

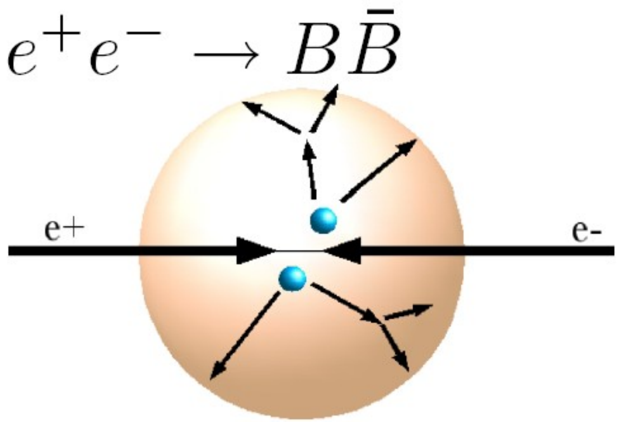
dominated by energy resolution

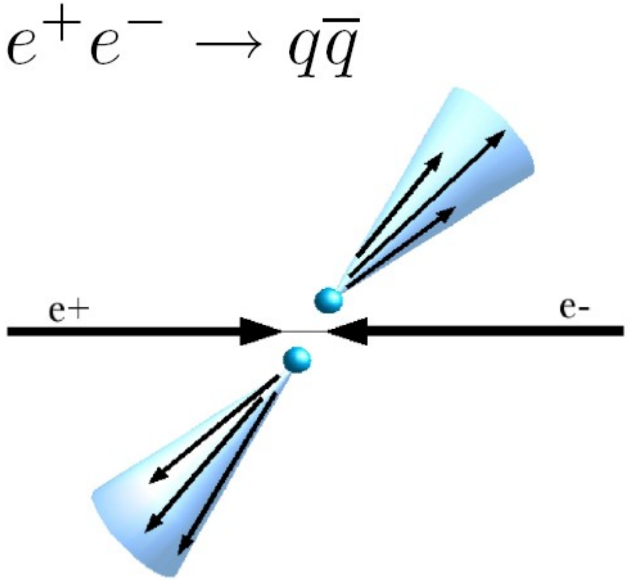
Topological variables (I)

Main source of background from $e^+e^- \to \bar{q}q$.
Difference in topology to reject them

B produced ~ at rest
isotropic topology

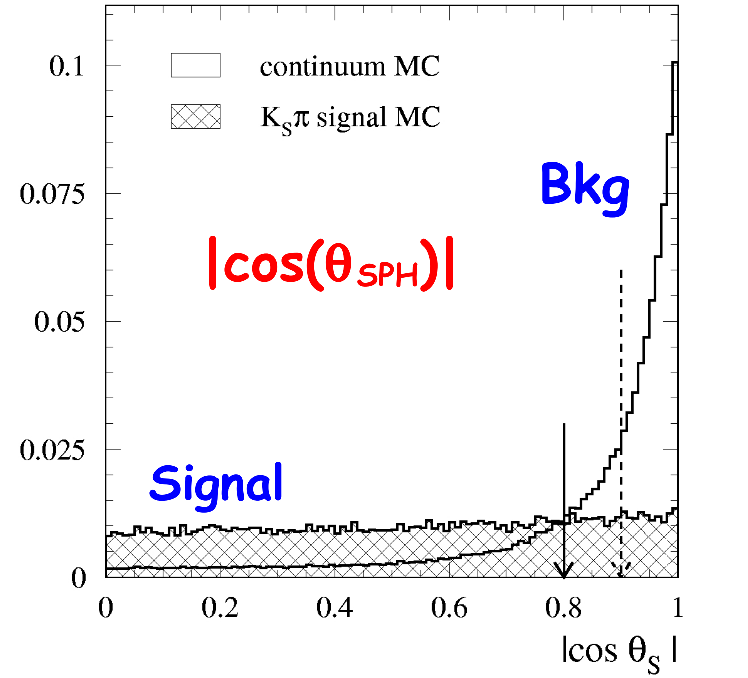
$\bar{q}q$ events decaying with large phase space
jet-like topology

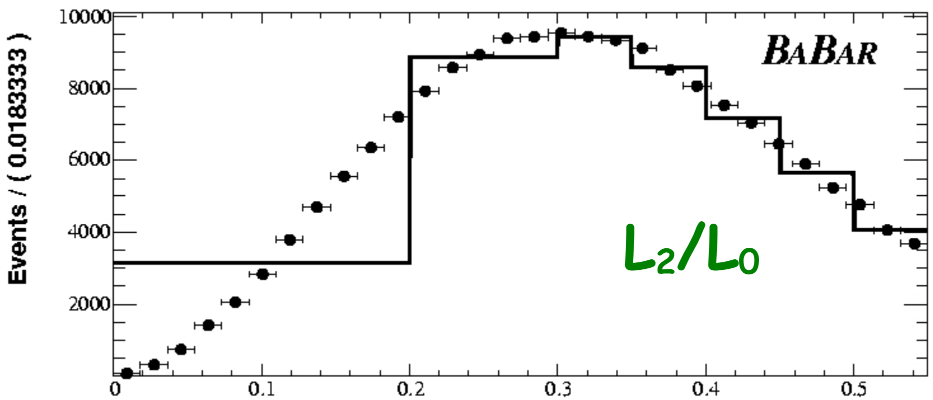


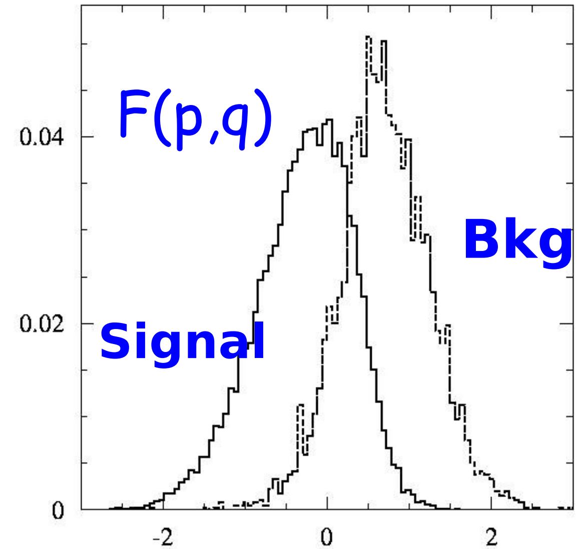


Topological variables (II)

- Several possible topology variables
  - Angular distance between the B and the rest of the event ($|\cos(\theta_{SPH})|$)
  - Legendre Polynomials L_2/L_0
  - Fisher Discriminat F(p,q)
  - Neural Net/Boosted Decision Trees
- Cut in the selection (80-90% eff. on signal)
- Residual discriminating power in the likelihood fit



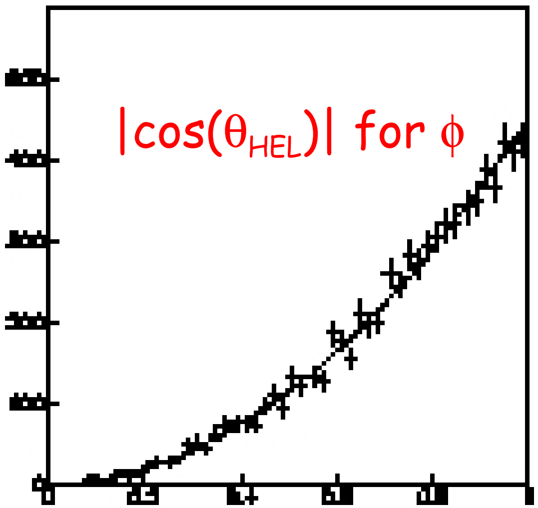


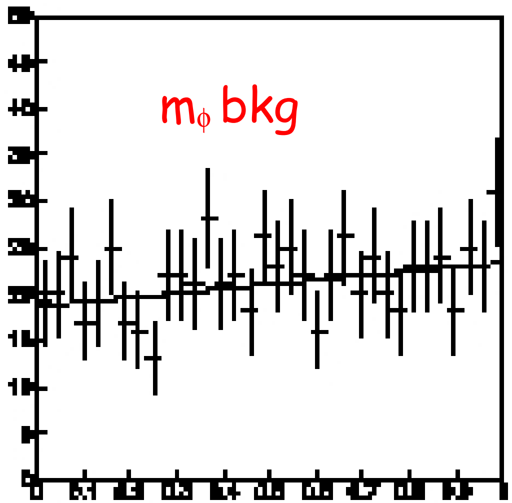


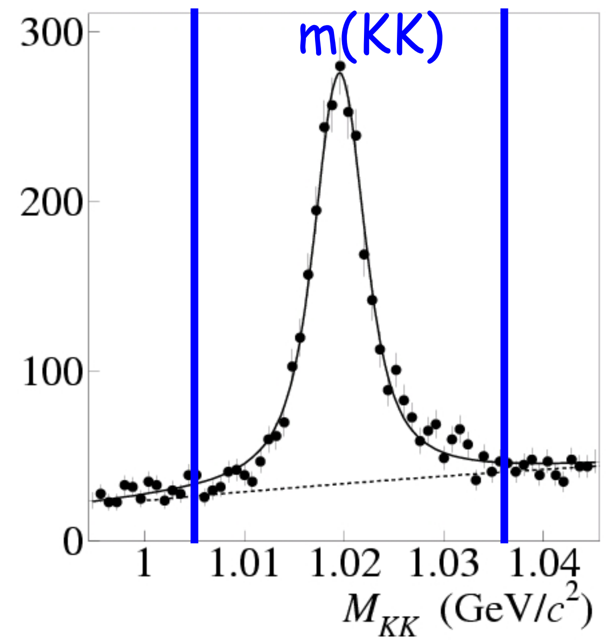
Use of the full decay chain

Final states with same multiplicity
but different resonances (e.g. ϕ vs. f_0)

- We use **helicity** and **invariant mass**

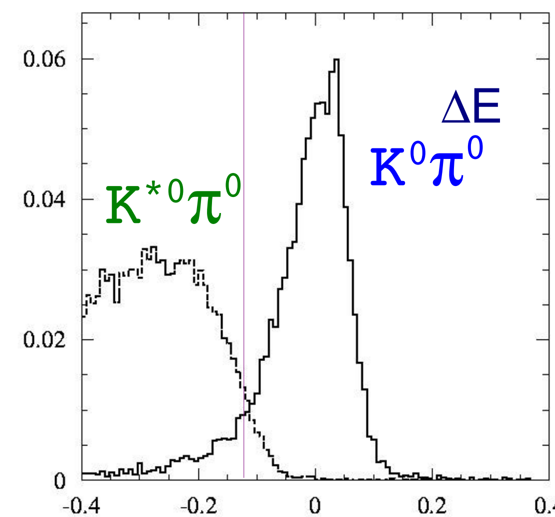






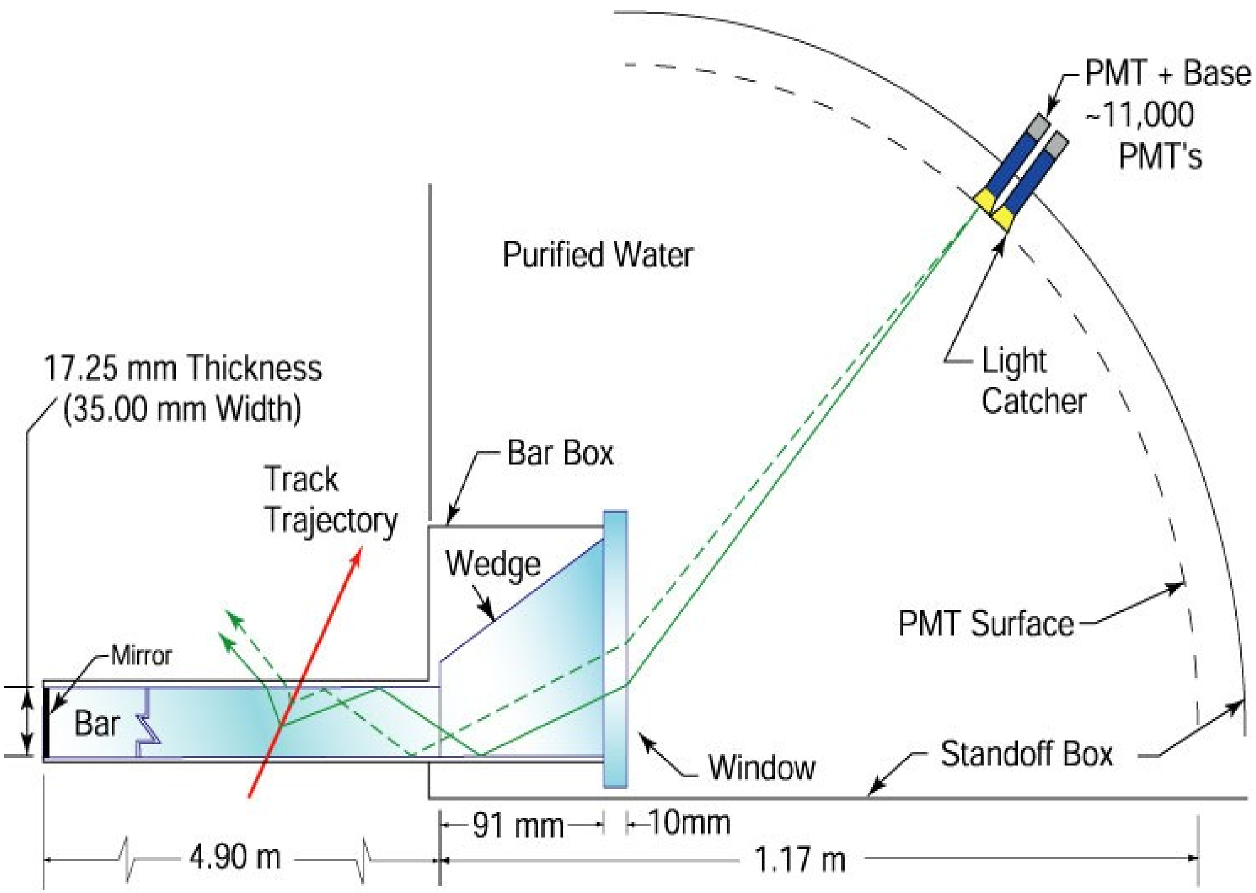
Final states with higher multiplicity

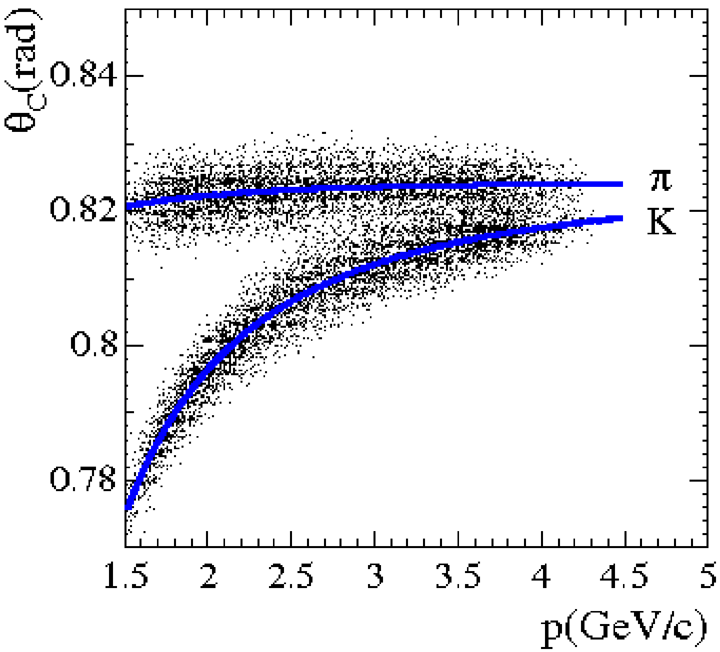
- Strongly suppressed by **lower cut on ΔE**



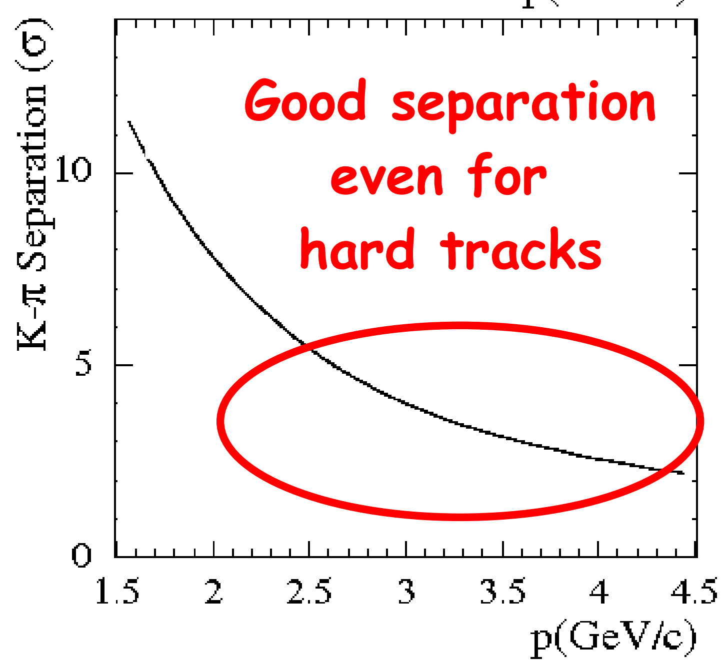
Irreducible and combinatoric background is taken into account in the likelihood

Particle ID for K/π separation





The pull of the measured Cherenkov angle is parameterized as a Gaussian with $m(\vec{p})$ and $\sigma(\vec{p})$ and used in the ML fit



The Maximum Likelihood Fit

Signal

pdf for Kinematic Variables

Additional Variables (mass, helicity, ...) for BB bkg rejection

$$\mathcal{L} = e^{-(N_S + N_{qq} + N_{BB})} \prod_{j}^{N_{TOT}}$$

$$N_S \cdot P_S^j(m_{ES}) \cdot P_S^j(\Delta_E) \cdot P_S^j(f(L_{2,} L_0, ...)) \cdot P_S^j(m, H) \cdot P_S^j(\Delta t) +$$

$$N_{qq} \cdot P_{qq}^j(m_{ES}) \cdot P_{qq}^j(\Delta_E) \cdot P_{qq}^j(f(L_{2,} L_0, ...)) \cdot P_{qq}^j(m, H) \cdot P_{qq}^j(\Delta t) +$$

$$N_{BB} \cdot P_{BB}^j(m_{ES}) \cdot P_{BB}^j(\Delta_E) \cdot P_{BB}^j(f(L_{2,} L_0, ...)) \cdot P_{BB}^j(m, H) \cdot P_{BB}^j(\Delta t)$$

Poisson factor for Extended Maximum Likelihood Fits

$\overline{qq}$ Background

$\overline{BB}$ Background

pdf For Topological Variables (Fisher, NN, ...)

Δt information (to measures S and C)

QED corrections to B→Kπ decay

- Important for $B \to K^+\pi^-$ given the reached experimental precision
- Spectrum of soft photons unobserved
- Need to correct the final result for its effect

$$\Gamma^{meas}_{P_1P_2}(E^{max}) = \Gamma(H \to P_1 P_2 + n\gamma)\,|_{\sum E_\gamma < E^{max}} = \Gamma^0_{P_1P_2}(\mu)\, G^0_{P_1P_2}(E^{max}_\gamma;\mu)$$

this is what necessarly is measured *this is what is needed in phenomenology*

- Use Monte Carlo to interpret data from rare decays :
- Different approach :

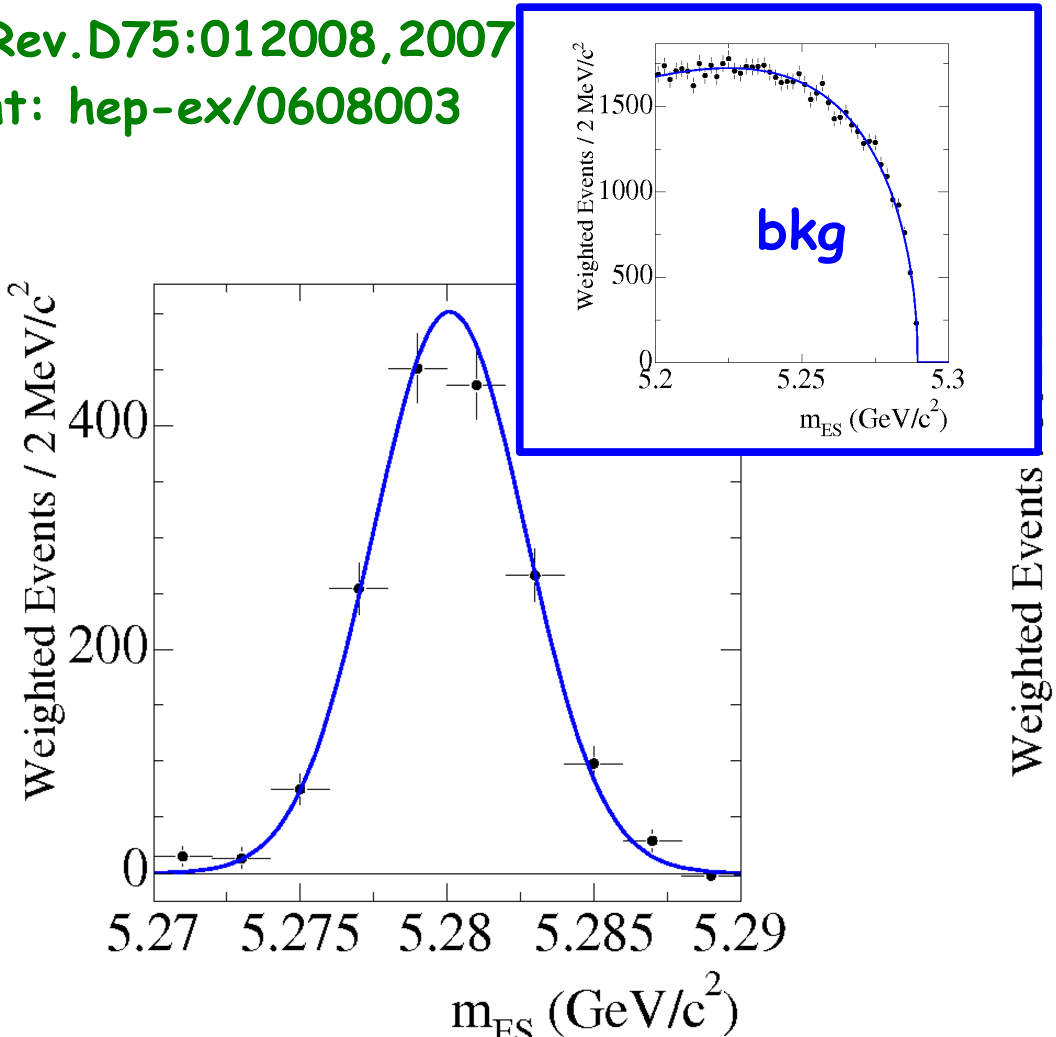
Belle: m_{ES} and ΔE shapes from MC+FSR simulation

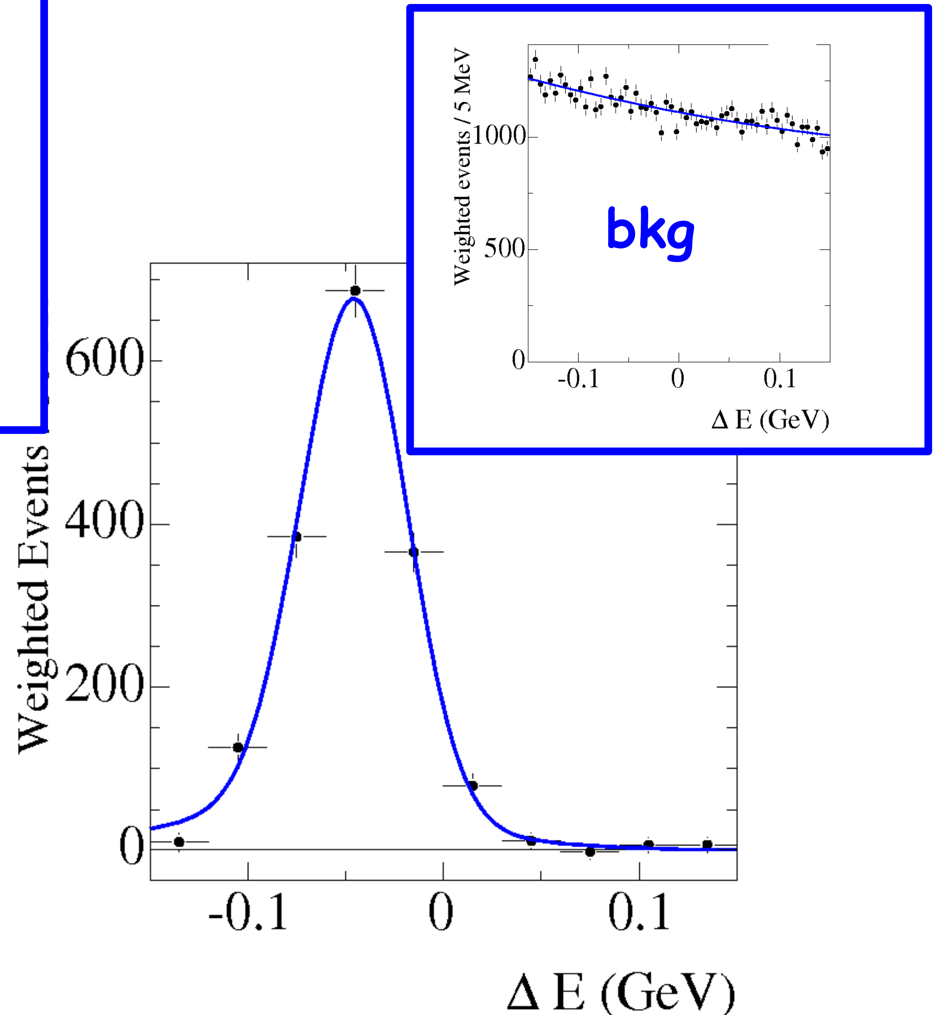
BaBar: theoretical QED calculation(*) to correct MC; quote both BR with a cut on photons energy and non-radiative BR

(*) Baracchini and Isidori Phy.s. Lett. B 633: 309-313 (2006)

BR of $B^0 \to K^+\pi^-$ decays

Phys.Rev.D75:012008,2007
e-Print: hep-ex/0608003



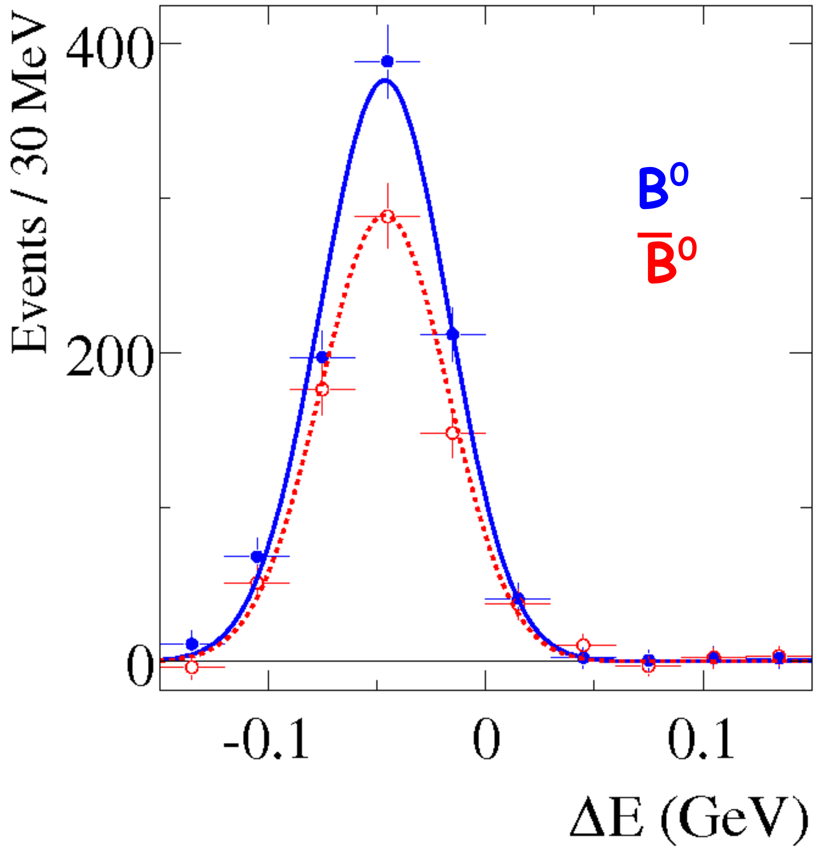


$BR(B^0 \to K^+\pi^-) = (19.1 \pm 0.6 \pm 0.6) \times 10^{-6}$

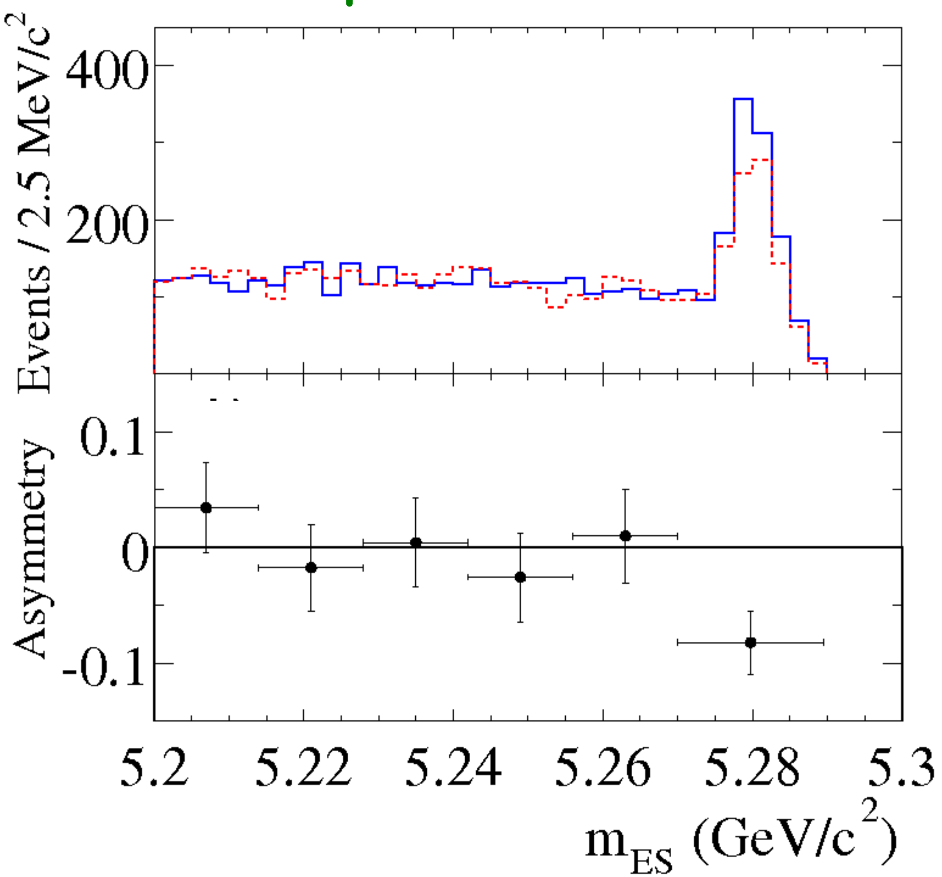
$BR(B^0 \to K^+\pi^-) = (18.1 \pm 0.6 \pm 0.6)\times 10^{-6}$ $\Gamma(E\gamma^{max}) = 0.947 \pm 0.005$

A_{CP} of $B^0 \to K^+\pi^-$ decays

Phys.Rev.Lett.93:131801,2004.
e-Print: hep-ex/0407057



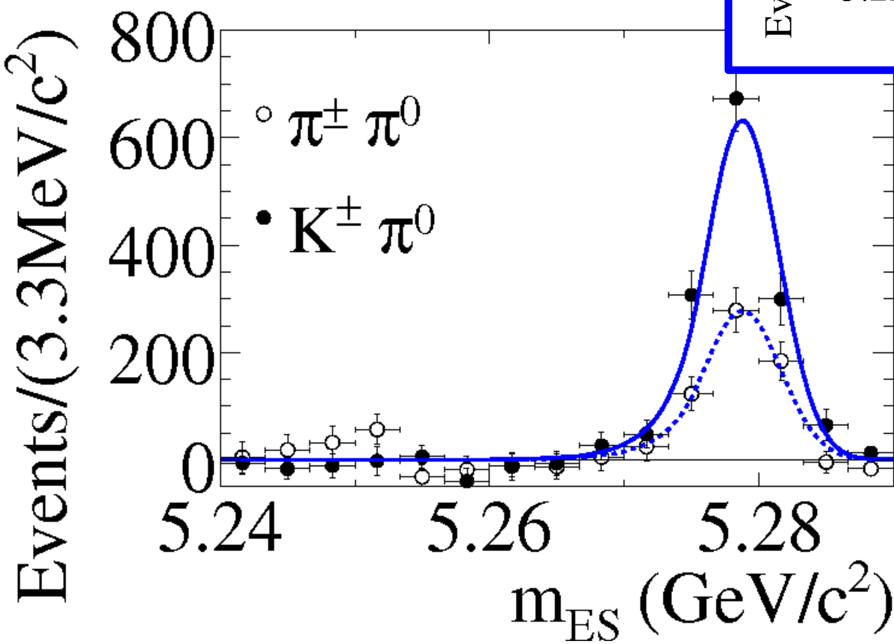
Phys.Rev.Lett.99:021603,2007.
e-Print: hep-ex/0703016

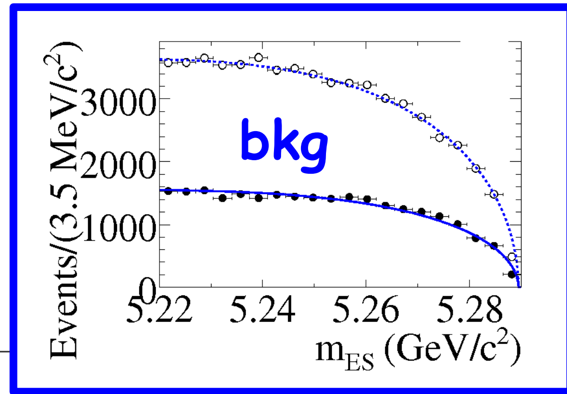


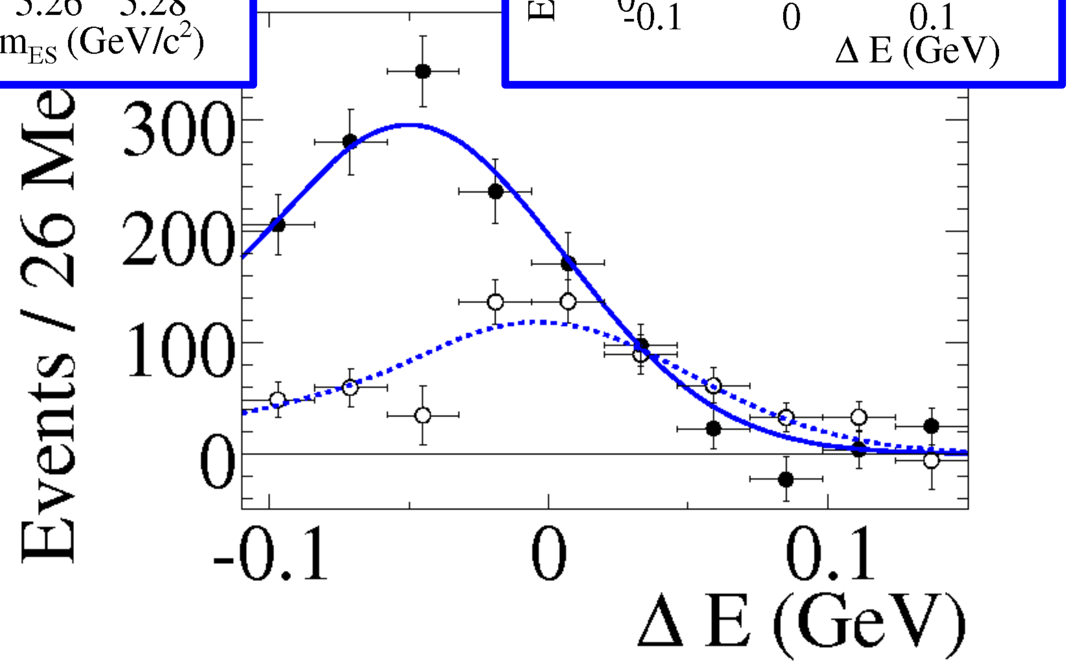
$$A_{CP}(B^0 \to K^+\pi^-) = \frac{N(\overline{B}^0) - N(B^0)}{N(\overline{B}^0) + N(B^0)} = -0.107 \pm 0.0.018 ^{+0.007}_{-0.004}$$

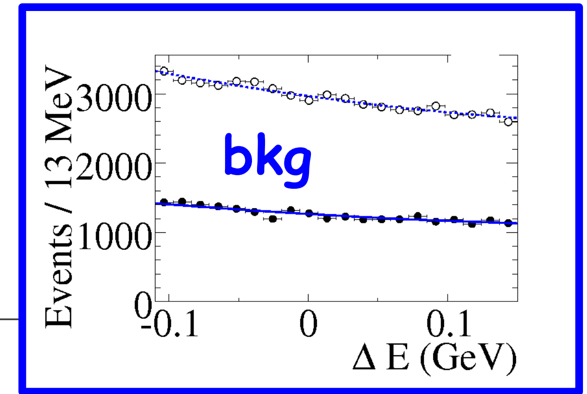
BR and A_{CP} of $B^+ \to K^+\pi^0$ decays

Phys.Rev.D76:091102,2007.
e-Print: arXiv:0707.2798 [hep-ex]







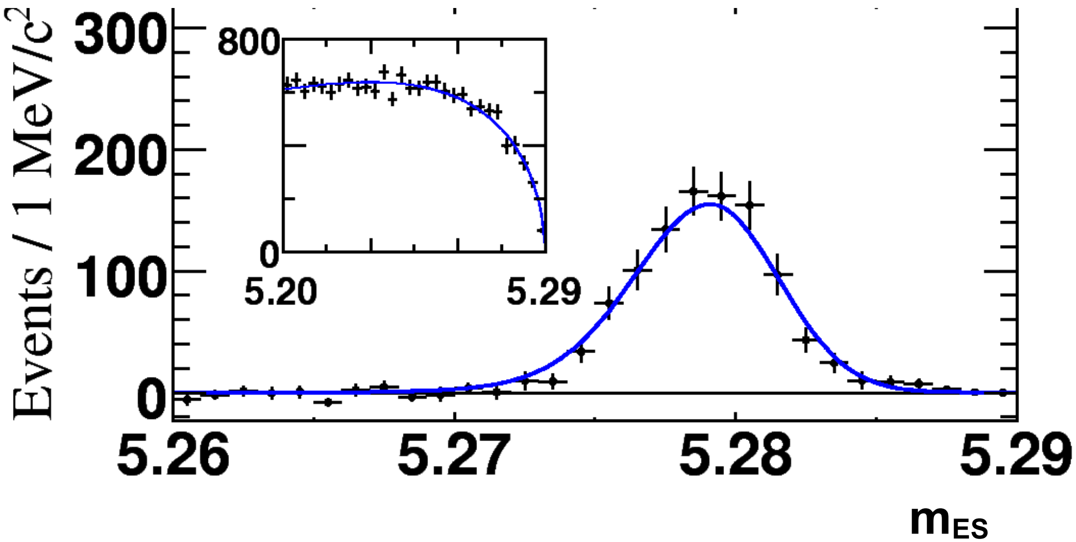


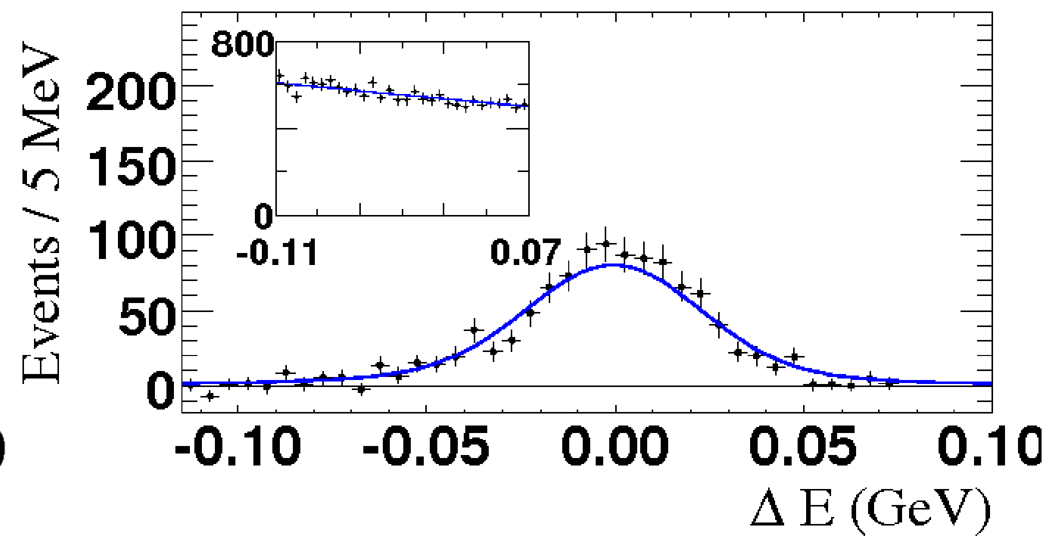
$BR(B^+ \to K^+\pi^0) = (13.6 \pm 0.6 \pm 0.7) \times 10^{-6}$

$A_{CP}(B^+ \to K^+\pi^0) = 0.030 \pm 0.039 \pm 0.010$

BR and A_{CP} of $B^+ \to K^0 \pi^+$ decays

Phys.Rev.Lett.97:171805,2006.
e-Print: hep-ex/0608036





$BR(B^+ \to K^0 \pi^+) = (23.9 \pm 1.1 \pm 1.0) \times 10^{-6}$

$A_{CP}(B^+ \to K^0 \pi^+) = -0.029 \pm 0.039 \pm 0.010$

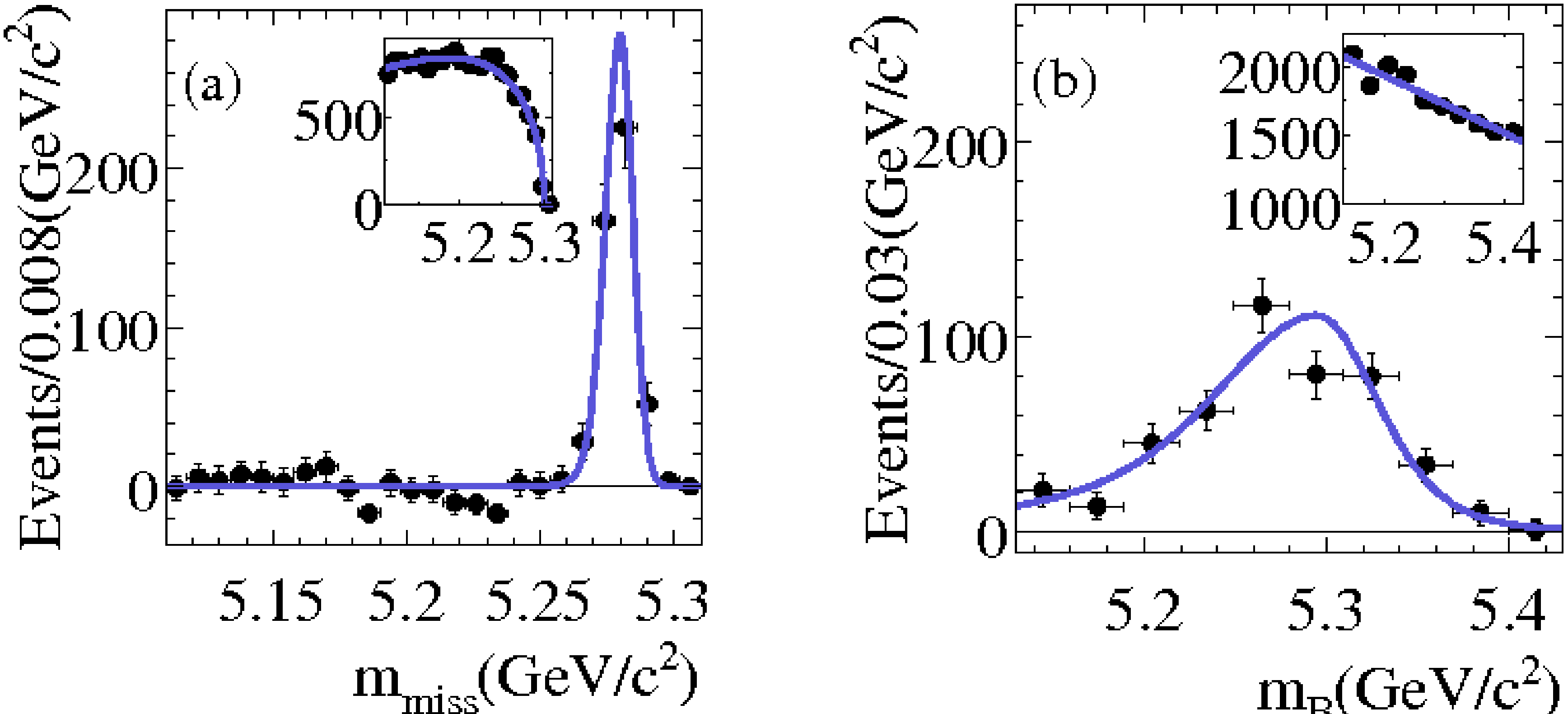
BR of $B^0 \to K^0\pi^0$ decays

Additional issue: m_{ES} and ΔE correlated because of π^0 energy resolution

use m_B and m_{Miss}(*) (lower correlation)

(*) m_{ES}-like variable for the unRECO B + mass constraint on RECO B

Phys.Rev.D77:012003,2008.
e-Print: arXiv:0707.2980 [hep-ex]



$$BR(B^0 \to K^0\pi^0) = (10.3 \pm 0.7 \pm 0.6) \times 10^{-6}$$

The B→Kπ "puzzle"

Tension between experimental measurements and theoretical predictions recently caused strong claims

Average of BaBar and Belle results (HFAG)

	QCDF [50]	PQCD [54, 55]	SCET [58]	exp
$BR(\pi^- \bar{K}^0)$	$19.3^{+1.9}_{-1.9}{}^{+11.3}_{-7.8}{}^{+1.9}_{-2.1}{}^{+13.2}_{-5.6}$	$24.5^{+13.6}_{-8.1}$	$20.8 \pm 7.9 \pm 0.6 \pm 0.7$	23.1 ± 1.0
$A_{CP}(\pi^- \bar{K}^0)$	$0.9^{+0.2}_{-0.3}{}^{+0.3}_{-0.3}{}^{+0.1}_{-0.1}{}^{+0.6}_{-0.5}$	0 ± 0	< 5	0.9 ± 2.5
$BR(\pi^0 K^-)$	$11.1^{+1.8}_{-1.7}{}^{+5.8}_{-4.0}{}^{+0.9}_{-1.0}{}^{+6.9}_{-3.0}$	$13.9^{+10.0}_{-5.6}$	$11.3 \pm 4.1 \pm 1.0 \pm 0.3$	12.8 ± 0.6
$A_{CP}(\pi^0 K^-)$	$7.1^{+1.7}_{-1.8}{}^{+2.0}_{-2.0}{}^{+0.8}_{-0.6}{}^{+9.0}_{-9.7}$	-1^{+3}_{-5}	$-11 \pm 9 \pm 11 \pm 2$	4.7 ± 2.6
$BR(\pi^+ K^-)$	$16.3^{+2.6}_{-2.3}{}^{+9.6}_{-6.5}{}^{+1.4}_{-1.4}{}^{+11.4}_{-4.8}$	$20.9^{+15.6}_{-8.3}$	$20.1 \pm 7.4 \pm 1.3 \pm 0.6$	19.4 ± 0.6
$A_{CP}(\pi^+ K^-)$	$4.5^{+1.1}_{-1.1}{}^{+2.2}_{-2.5}{}^{+0.5}_{-0.6}{}^{+8.7}_{-9.5}$	-9^{+6}_{-8}	$-6 \pm 5 \pm 6 \pm 2$	-9.5 ± 1.3
$BR(\pi^0 \bar{K}^0)$	$7.0^{+0.7}_{-0.7}{}^{+4.7}_{-3.2}{}^{+0.7}_{-0.7}{}^{+5.4}_{-2.3}$	$9.1^{+5.6}_{-3.3}$	$9.4 \pm 3.6 \pm 0.2 \pm 0.3$	10.0 ± 0.6
$A_{CP}(\pi^0 \bar{K}^0)$	$-3.3^{+1.0}_{-0.8}{}^{+1.3}_{-1.6}{}^{+0.5}_{-1.0}{}^{+3.4}_{-3.3}$	-7^{+3}_{-3}	$5 \pm 4 \pm 4 \pm 1$	-12 ± 11

Only SCET includes a non-factorizable $O(\Lambda_{QCD}/m_b)$ charming penguin

All these approaches neglect the CKM suppressed $O(\Lambda_{QCD}/m_b)$ corrections

The B→Kπ Decay Amplitude

CKM enhanced | CKM suppressed

$$A(B^0 \to K^+\pi^-) = V_{ts} V_{tb}^* \times P_1 - V_{us} V_{ub}^* \times \{E_1 - P_1^{GIM}\}$$

$$A(B^+ \to K^0\pi^+) = -V_{ts} V_{tb}^* \times P_1 + V_{us} V_{ub}^* \times \{A_1 - P_1^{GIM}\}$$

$$\sqrt{2} \cdot A(B^+ \to K^+\pi^0) = V_{ts} V_{tb}^* \times P_1 - V_{us} V_{ub}^* \times \{E_1 + E_2 + A_1 - P_1^{GIM}\}$$

$$\sqrt{2} \cdot A(B^0 \to K^0\pi^0) = -V_{ts} V_{tb}^* \times P_1 - V_{us} V_{ub}^* \times \{E_2 + P_1^{GIM}\}$$

Buras & Silvestrini hep-ph/9812392

The ingredients:

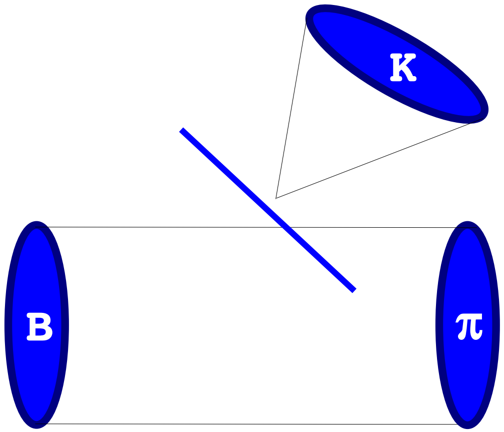
- The elements of the CKM matrix (from the UT analysis)
- Color Allowed (E_1) and Color suppressed (E_2) tree-level emissions
- Charming (P_1) and GIM (P_1^{GIM}) penguins
- Annihilation (A_1)

Perturbative Approaches

Perturbative calculations are possible in $m_b \to \infty$ limit

- pQCD by Keum, Li & Sanda hep-ph/0004004
- QCD Factorization by BBNS hep-ph/0006124
- SCET by BPRS hep-ph/0401188

$$\langle B^0 | J_\mu J^\mu | K\pi \rangle = \langle B^0 | J_\mu | \pi \rangle \langle 0 | J^\mu | K \rangle (1 + O(\alpha_s)) + \cancel{O\left(\frac{\Lambda_{QCD}}{m_b}\right)}$$



- A clear demonstration that penguins do factorize is still missing (Bauer et al. hep-ph/0401188 vs Beneke et al. hep-ph/0411171)
- As previously pointed out (Ciuchini et al. hep-ph/9703353) Λ_{QCD}/m_b contributions may play a relevant role in phenomenology ($m_b \not\to \infty$)

A phenomenological approach

One can move from the exact calculation to some model dependent approach, but all Λ_{QCD}/m_b terms have to be considered

- P_1 is doubly Cabibbo enhanced, so it plays the major role
- Nevertheless, the others are important

In principle: we have enough observables to determine all the parameters (4 complex RGI) and preserve some sensitivity

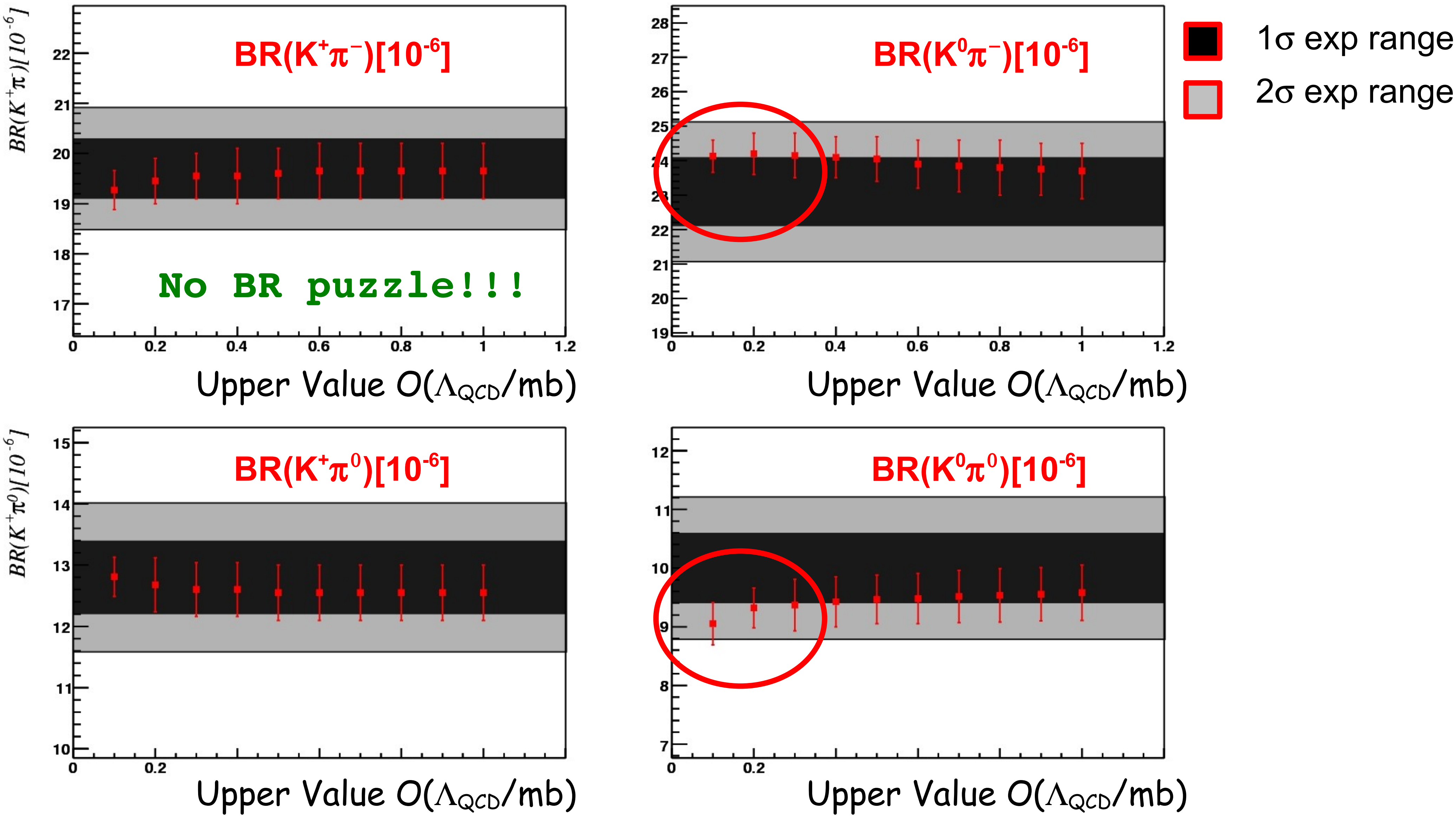
In practice: we are not precisely sensitive to the doubly Cabibbo suppressed Λ_{QCD}/m_b terms (which are ~% corrections to BR's)

What we can do:

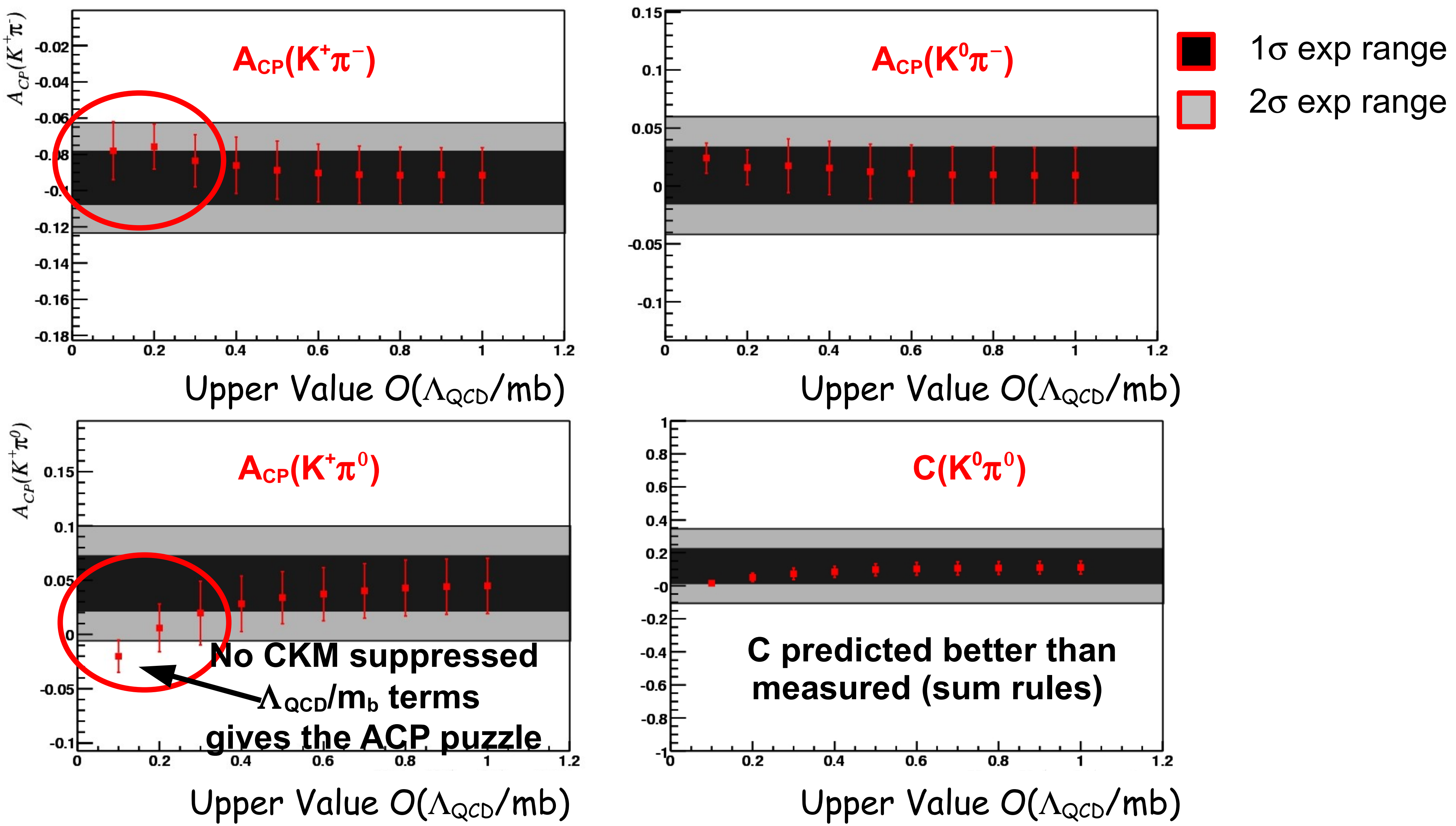
- Describe E_1 in factorization
- Fit for the leading term P_1
- Vary the other in some *a-priori fixed range*
- Use BR and direct CP asymmetries to obtain information on $S(K^0\pi^0)$

We can still obtain a prediction on S within the Standard Model, but the error on it will depend on the chosen range

Result on $B \to K\pi$ (I)

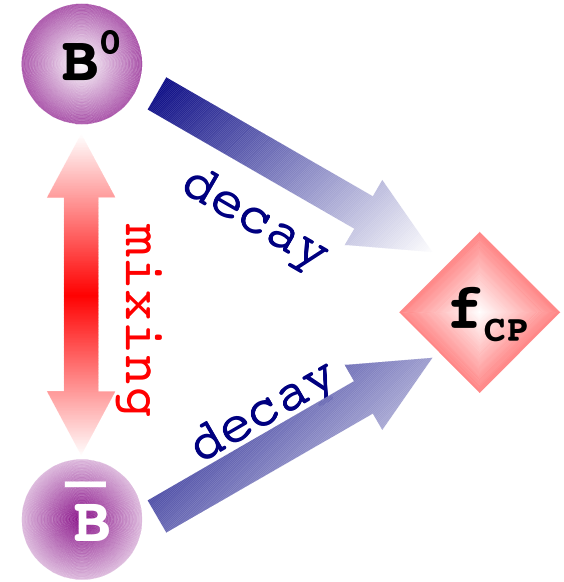


Result on $B \to K\pi$ (II)



Time dependent measurements

$$\lambda_{f_{CP}} = \underbrace{\frac{q}{p}}_{\text{mixing}} \cdot \overbrace{\frac{\overline{A}_{f_{CP}}}{A_{f_{CP}}}}^{\text{decay}} = |\lambda_{f_{CP}}| \cdot e^{-2i\phi_{CP}}$$



$$\mathbf{A_{f_{CP}}} = \frac{\Gamma(\overline{\mathbf{B}}^0_{\mathbf{phys}}(\mathbf{t}) \to \mathbf{f_{CP}}) - \Gamma(\mathbf{B}^0_{\mathbf{phys}}(\mathbf{t}) \to \mathbf{f_{CP}})}{\Gamma(\overline{\mathbf{B}}^0_{\mathbf{phys}}(\mathbf{t}) \to \mathbf{f_{CP}}) + \Gamma(\mathbf{B}^0_{\mathbf{phys}}(\mathbf{t}) \to \mathbf{f_{CP}})}$$
$$= \mathbf{C_{f_{CP}}} \cos(\Delta \mathbf{m_d} \Delta \mathbf{t}) + \mathbf{S_{f_{CP}}} \sin(\Delta \mathbf{m_d} \Delta \mathbf{t})$$

$$S_{f_{CP}} = -\frac{2\eta_{CP}\Im\lambda_{f_{CP}}}{1+|\lambda_{f_{CP}}|^2}$$

$$C_{f_{CP}} = \frac{1-|\lambda_{f_{CP}}|^2}{1+|\lambda_{f_{CP}}|^2}$$

With only one CKM term in the decay ($A = \overline{A}$)

$C = ٠$; $S = \sin(٢\beta)$

$S \sim \sin 2\beta$ in $b \to s$ penguin decays (I)

$$A(B^0 \to K^0 h^0) = V_{ts} V_{tb}^* \times P \left(1 + \frac{V_{us} V_{ub}^*}{V_{ts} V_{tb}^*} \frac{T + P^{GIM}}{P}\right)$$

We define

$r_F = |V_{us} V_{ub}| / |V_{ts} V_{tb}| \times (T + P^{GIM})/P$

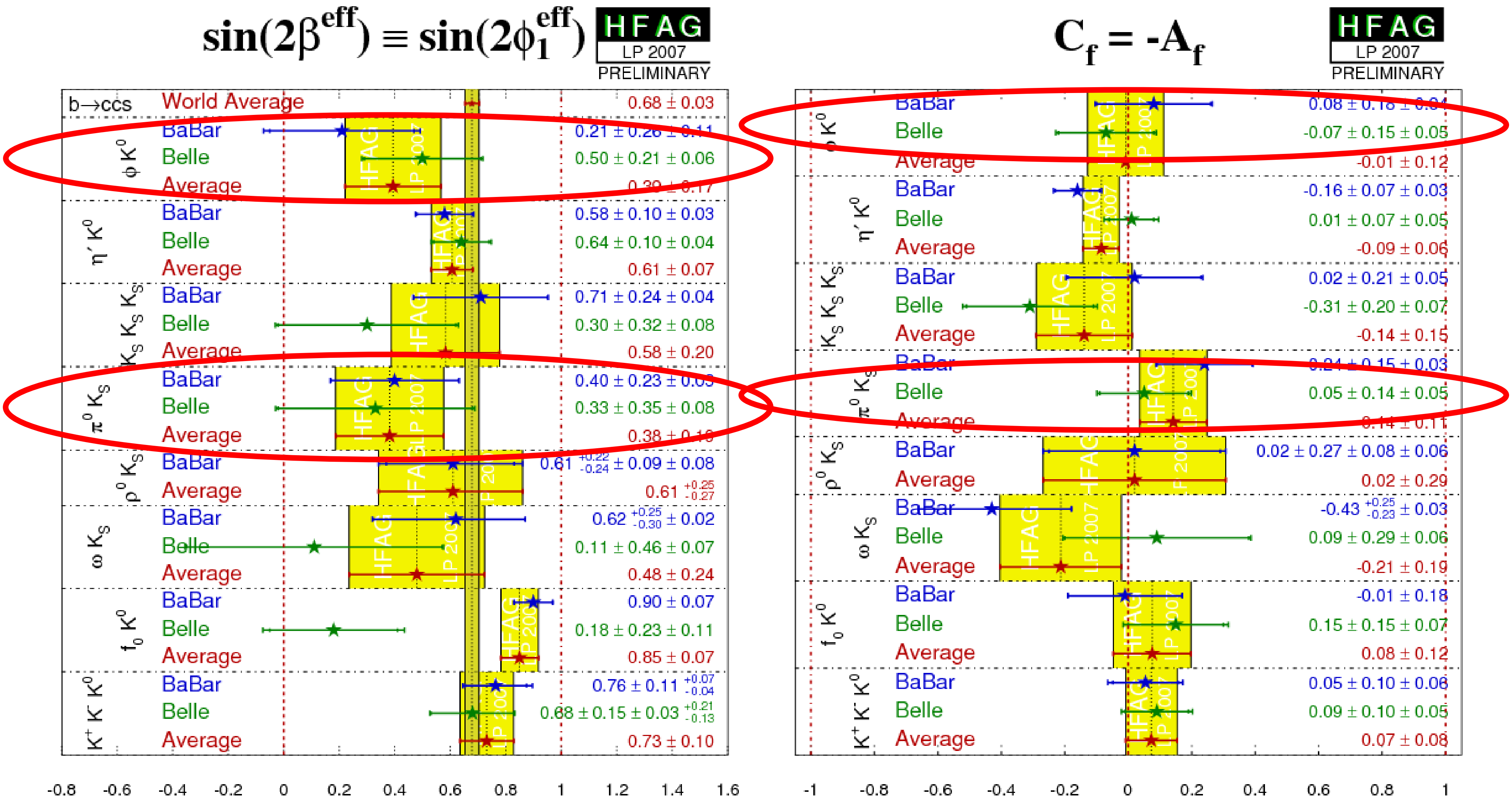
ϕ_M = Bd mixing phase, i.e. β

βs = Bs mixing phase in the SM

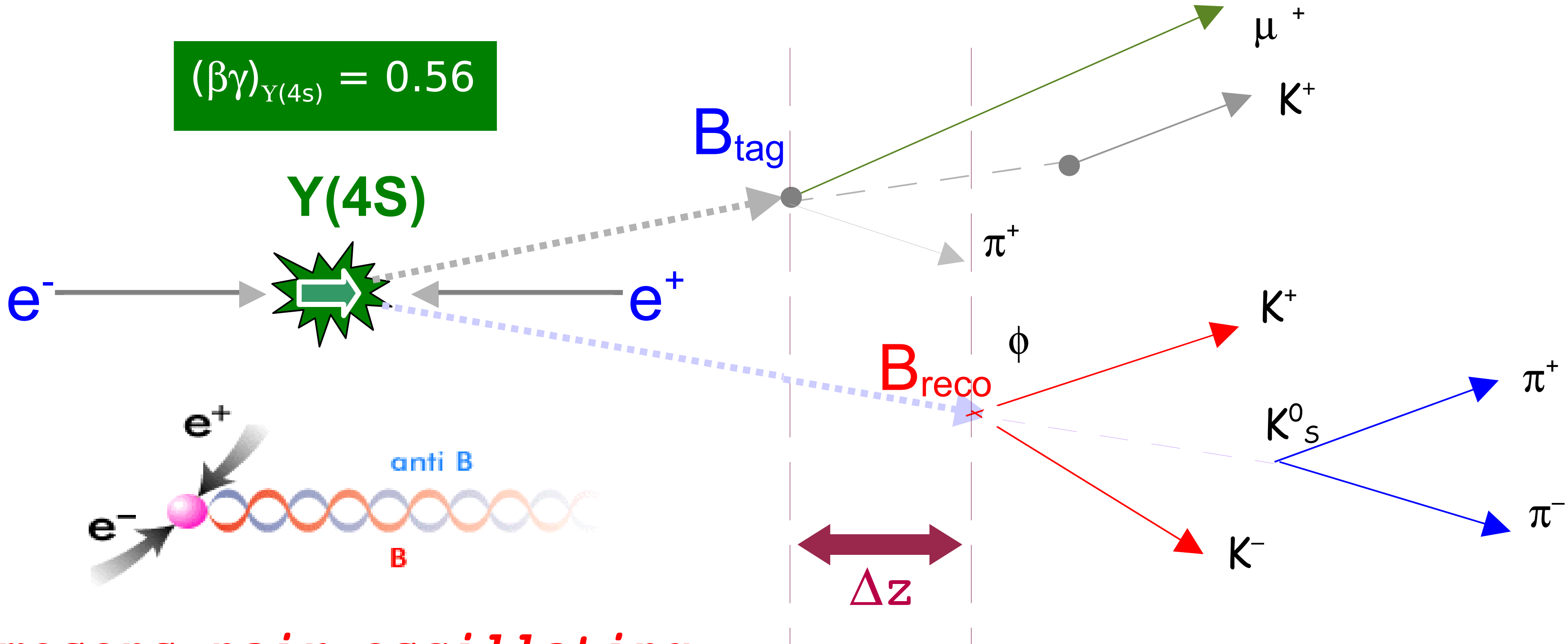
$$S_F = \frac{\sin(2(\beta_s + \phi_M)) + |r_F|^2 \sin(2(\phi_M + \gamma)) + 2\,\mathrm{Re}\, r_F \sin(\beta_s + 2\phi_M + \gamma)}{1 + |r_F|^2 + 2\,\mathrm{Re}\, r_F \cos(\beta_s - \gamma)}$$

- In the SM and assuming a single amplitude (r_F=0) S= $\sin(2\beta+2\beta s)$, $\beta s \ll \beta$
- BSM, S can deviates from $\sin 2\beta$ if we have NP in Bd or Bs mixing
- A departure from $\sin 2\beta$ in the SM can also be induced by hadronic effects ($r_F \neq 0$)

S~sin2β in b→s penguin decays (II)



Vertex Reconstruction

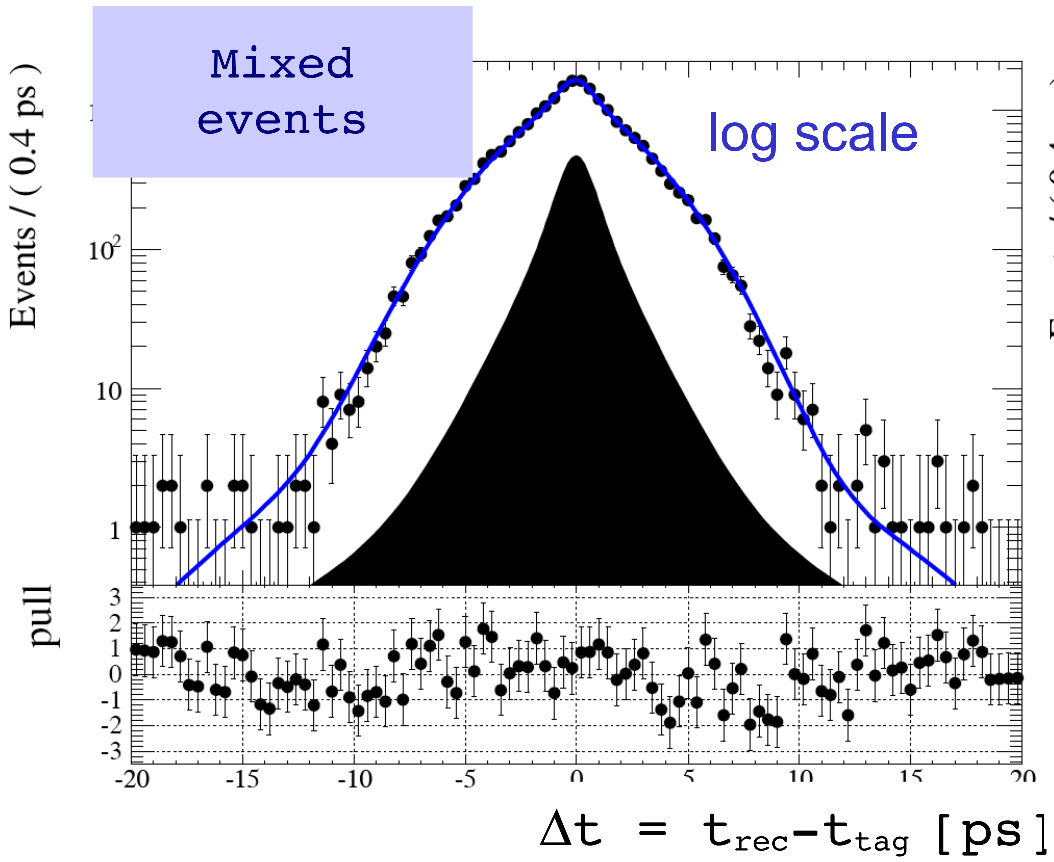


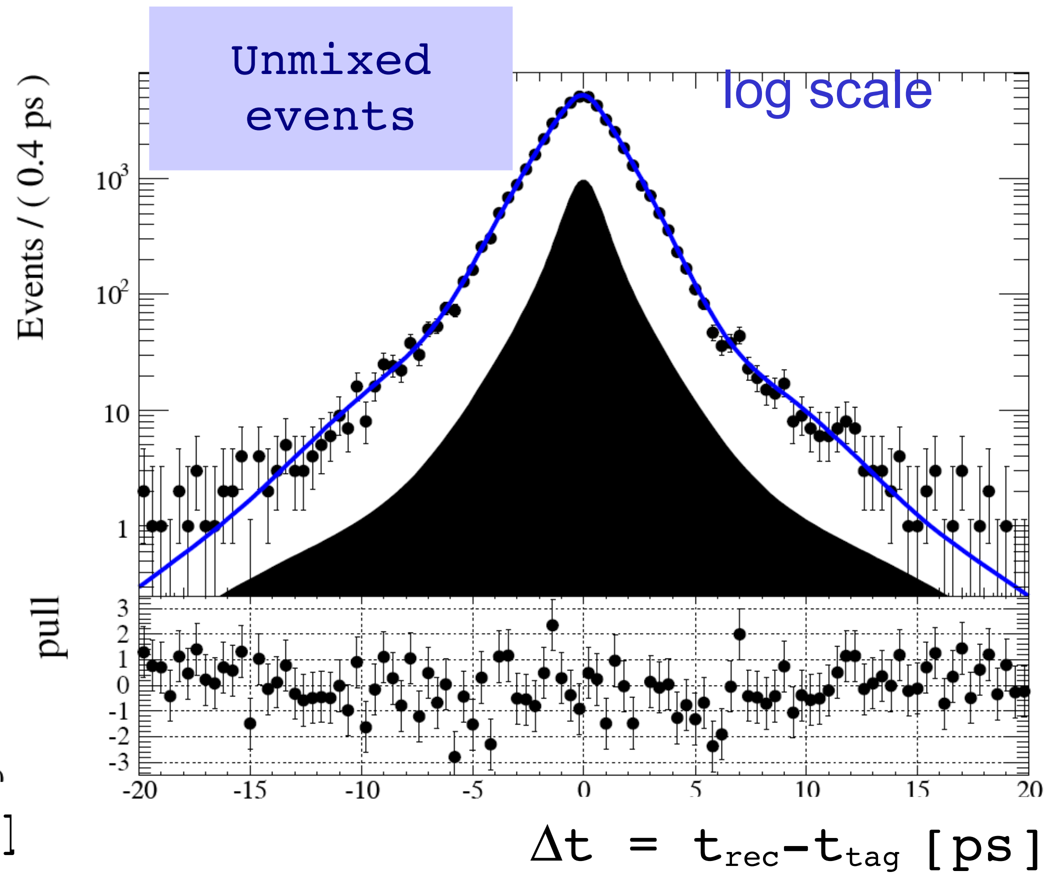
B mesons pair oscillating in a coherent state

$$<|\Delta z|> \sim 200\,\mu m$$

$$\Delta t \approx \frac{\Delta z}{<\beta\gamma> c}$$

Δt p.d.f.(from data)

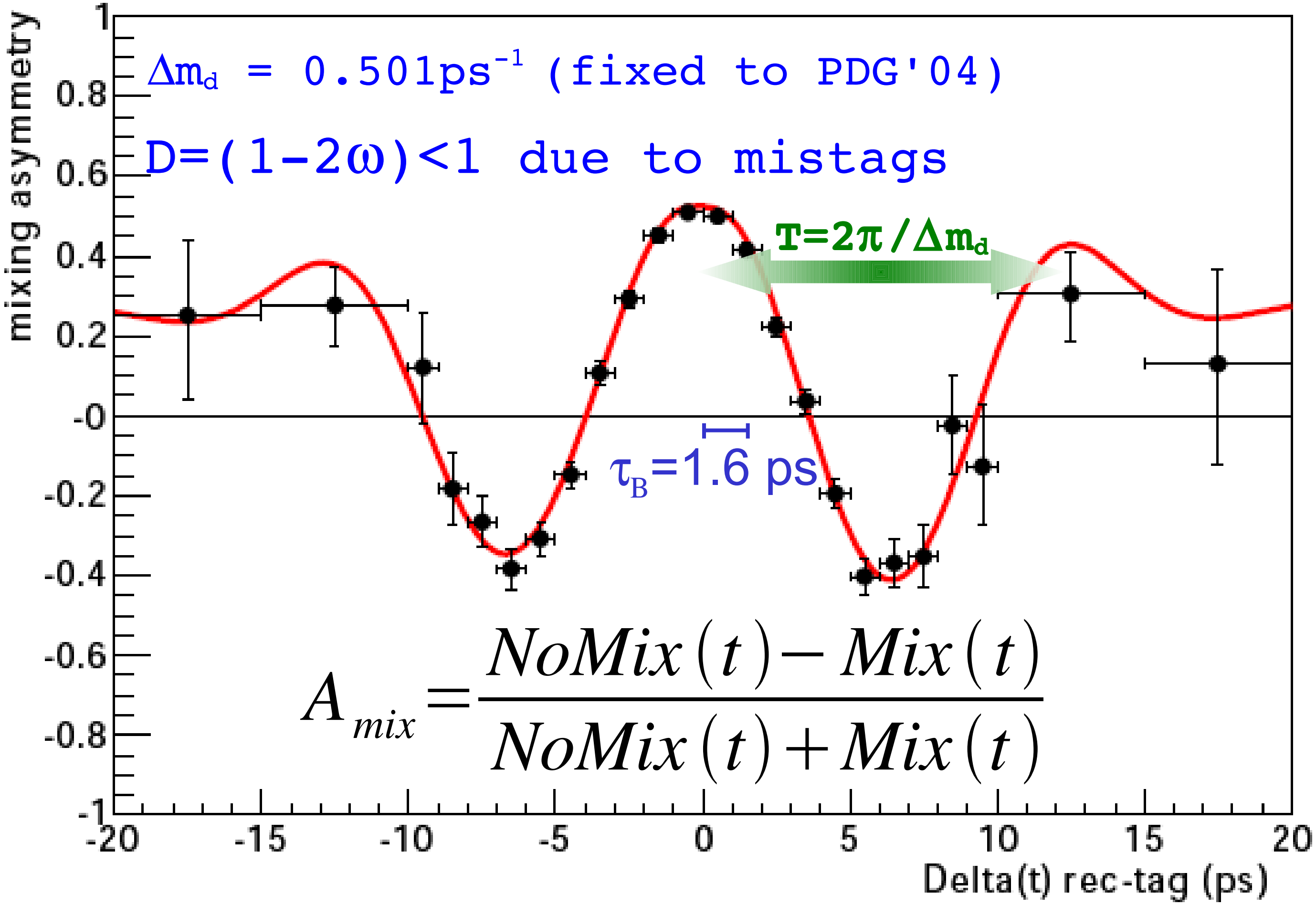




Vertex resolution function measured on data, using a sample of fully reconstructed B events

Mistag (ω) measurement (from data)

$$f_{\substack{Unmized\\Mixed}} = \left\{ \frac{e^{-|\Delta t|/\tau_B}}{4\tau_B} [1 \pm (1-2\omega)\cos(\Delta m_d \Delta t)] \right\} \otimes R(\Delta t)$$



Separately determine *D* for each tag category.

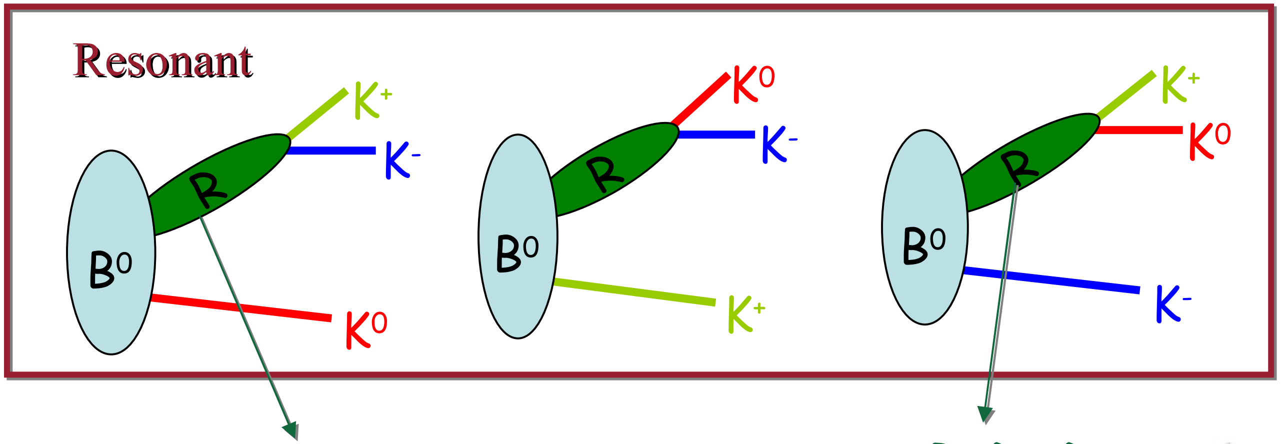
Overall tagging performance

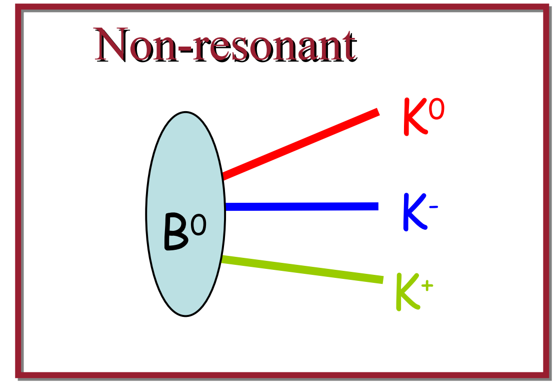
$\varepsilon = (74.9 \pm 0.2)\%$

$Q = \varepsilon(1-2\omega)^2$
$= (30 \pm 0.4)\%$

Measurement of $B^0 \to \phi K^0$ (I)

$K^+K^-K^0$ Dalitz plot composition:





eg.: $R=\phi, f_0(980)$

NB: they have opposite CP

eg.: $R=D^+, D_s^+$

$B^0 \to K^+K^-K^0$ amplitude in the Isobar Model:

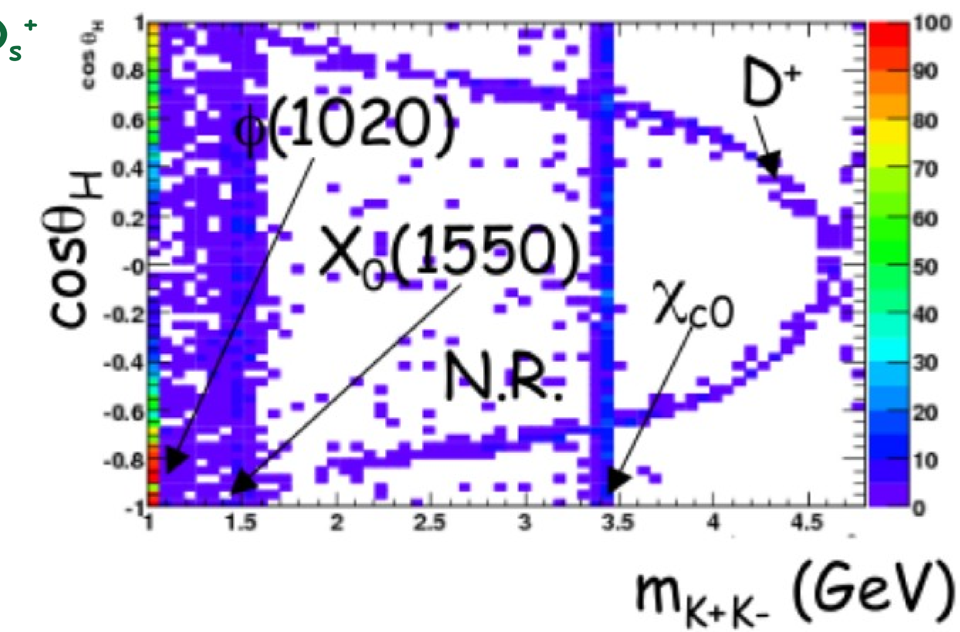
$$A = \sum_r c_r f_r$$

$$\bar{A} = \sum_r \bar{c}_r \bar{f}_r$$

f_r=resonant amplitudes, NR

c_r=complex isobar coefficients

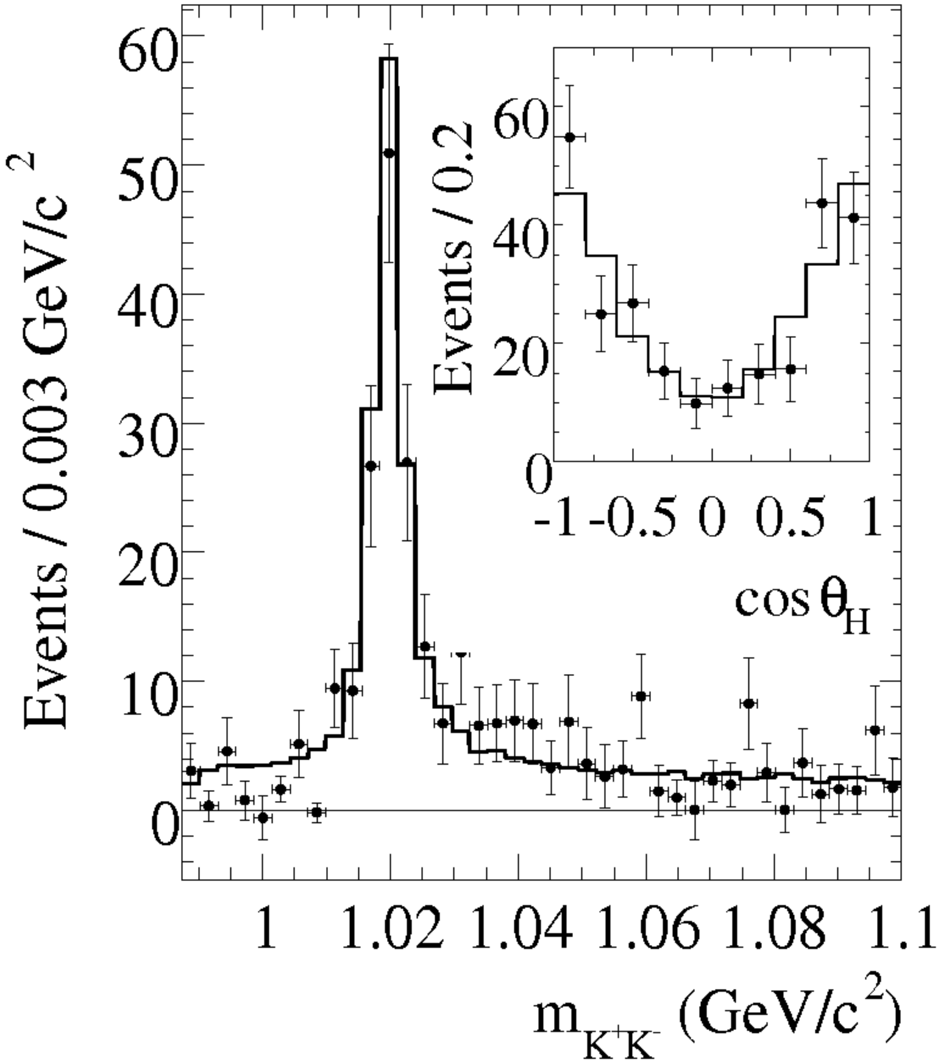
the f_r's interfere!



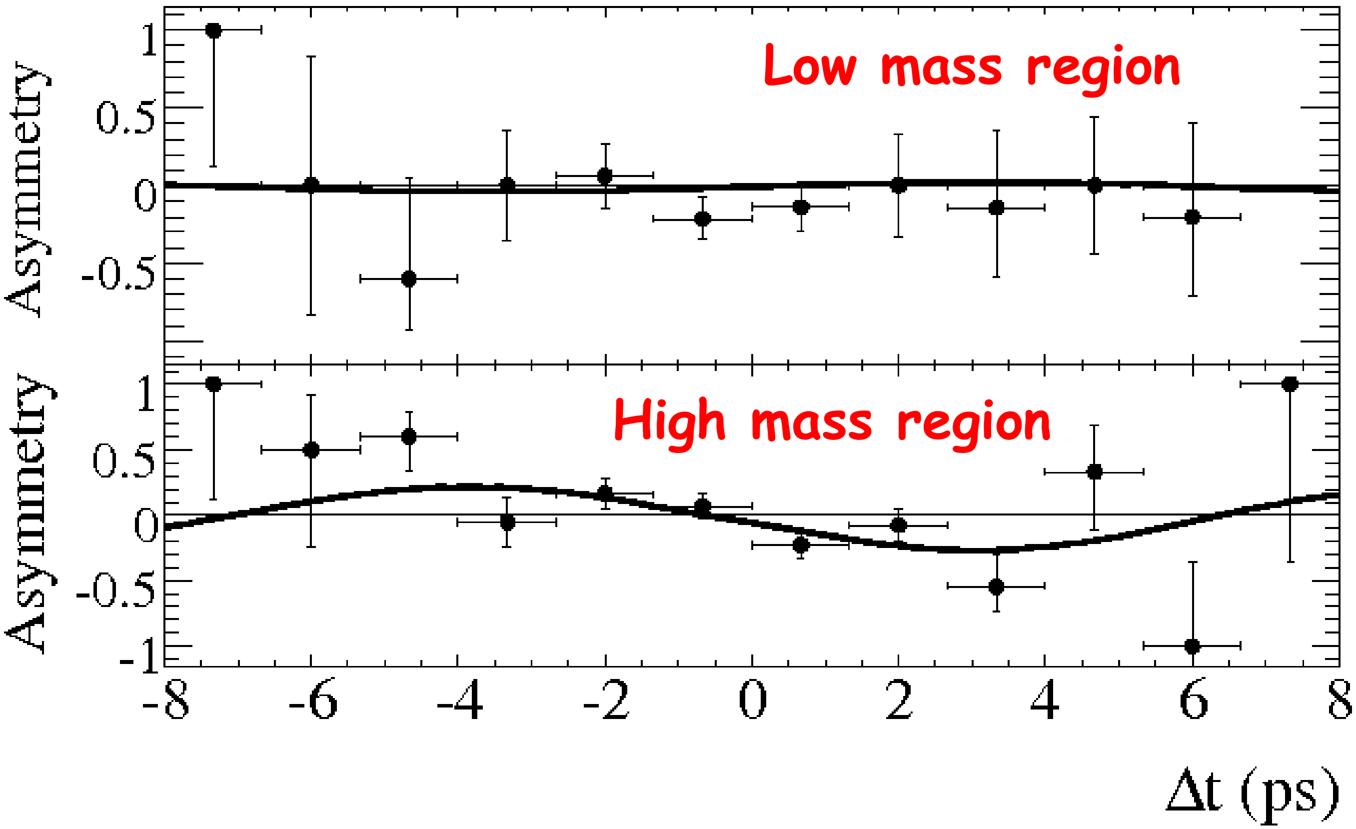
Measurement of $B^0 \to \phi K^0$ (II)

ϕ component disentangled from the other structures contributing to the Dalitz plot

Isobar Mode	Amplitude c_r	Phase φ_r (rad)	$\mathcal{F}_r$ (%)
ϕK^0	0.0085 ± 0.0010	-0.016 ± 0.234	12.5 ± 1.3
$f_0 K^0$	0.622 ± 0.046	-0.14 ± 0.14	40.2 ± 9.6
$X_0(1550) K^0$	0.114 ± 0.018	-0.47 ± 0.20	4.1 ± 1.3
$(K^+K^-)_{NR} K^0$	1 (fixed)	0 (fixed)	
$(K^+K^0)_{NR} K^-$	0.33 ± 0.07	1.95 ± 0.27	112.0 ± 14.9
$(K^-K^0)_{NR} K^+$	0.31 ± 0.08	-1.34 ± 0.37	
$\chi_{c0}(1P) K^0$	0.0306 ± 0.0049	${}^{0.81}_{-2.33} \pm 0.54$	3.0 ± 1.2
$D^- K^+$	1.11 ± 0.17		3.6 ± 1.5
$D_s^- K^+$	0.76 ± 0.14		1.8 ± 0.6



Measurement of $B^0 \to \phi K^0$ (III)



$C(B^0 \to \phi K^0) = -0.18 \pm 0.20 \pm 0.10$

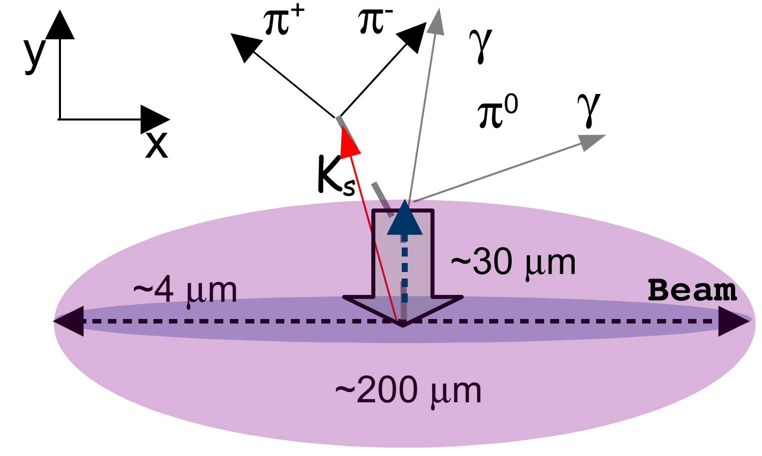
$S(B^0 \to \phi K^0) = 0.21 \pm 0.26 \pm 0.11$

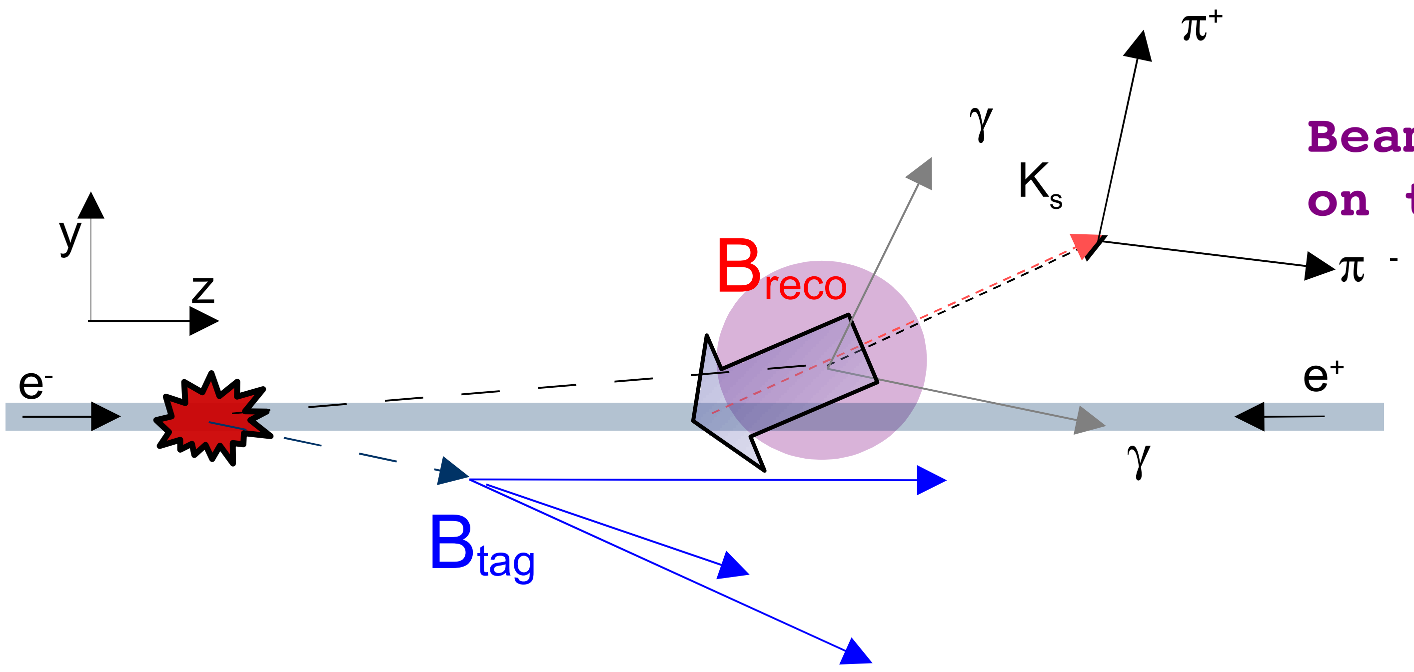
Vertexing for $B^0 \to K^0\pi^0$(I)

No charged tracks from the B vertex.

Extrapolate back the K_S:

- Using the constraint of the beam spot on the transverse plane
- Requiring the K_S to decay in the inner part of the SVT





Beam spot constraint on transverse plane

Vertexing for $B^0 \to K^0\pi^0$(II)

We split our sample in 4 K_S classes

Class I&II determine S

Class I: 1 z & 1 ϕ hit in SVT layers 1-3 for both $\pi^\pm$

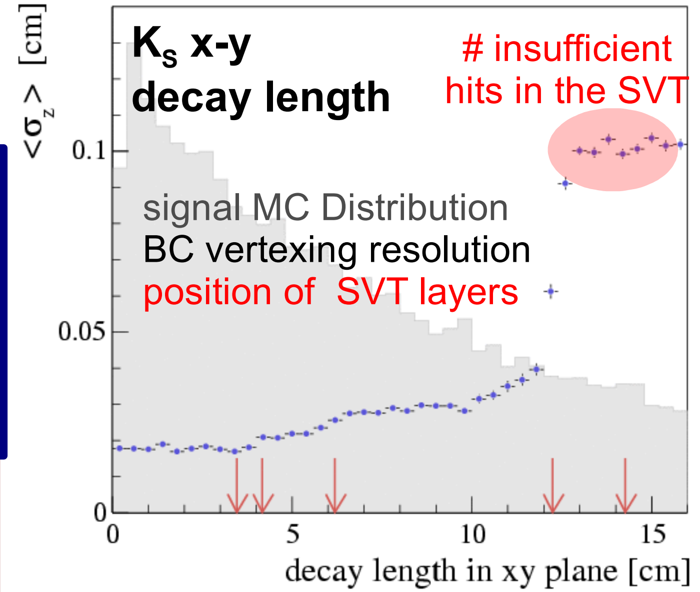
Class II: not Class I events with 1 z & 1ϕ SVT hit for both $\pi^\pm$

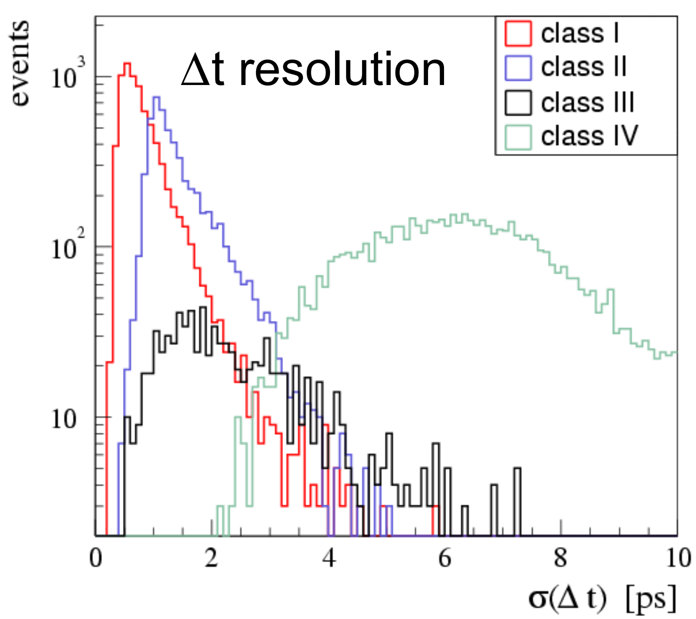
Class III: 1 SVT hit on both $\pi^\pm$

Class IV: no SVT hit

All classes determine C

class	$B^0 \to \phi K^0_S$	$B^0 \to K^{*0}\gamma$	$B^0 \to K^0_S\pi^0$	$B^0 \to J/\psi K^0_S$
I	0.77 ± 0.01	0.469 ± 0.003	0.373 ± 0.003	0.479 ± 0.003
II	0.19 ± 0.01	0.280 ± 0.003	0.273 ± 0.003	0.261 ± 0.002
III	0.015 ± 0.003	0.049 ± 0.001	0.045 ± 0.002	0.061 ± 0.002
IV	0.028 ± 0.004	0.201 ± 0.002	0.308 ± 0.003	0.198 ± 0.002

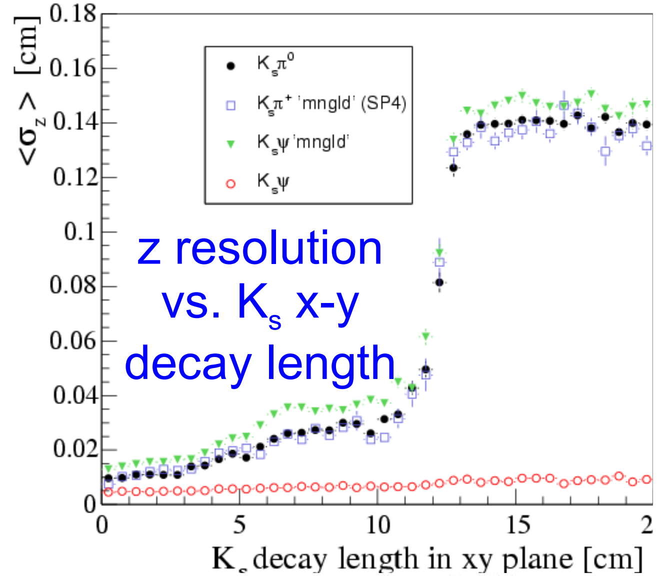


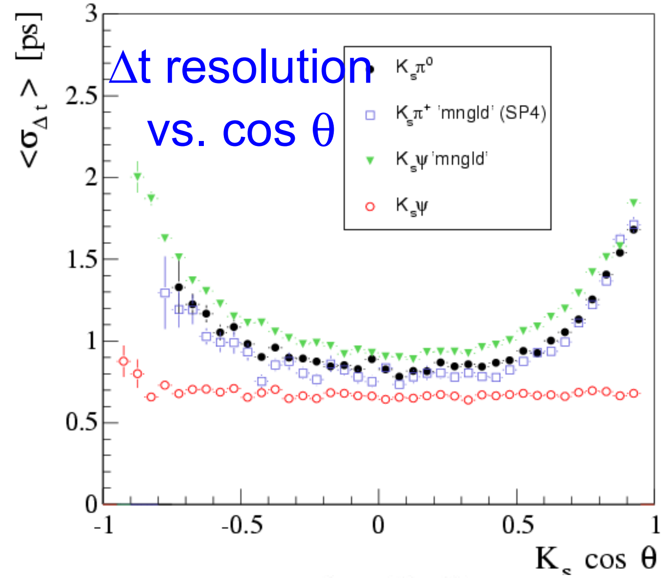


Vertexing for $B^0 \to K^0\pi^0$(III)

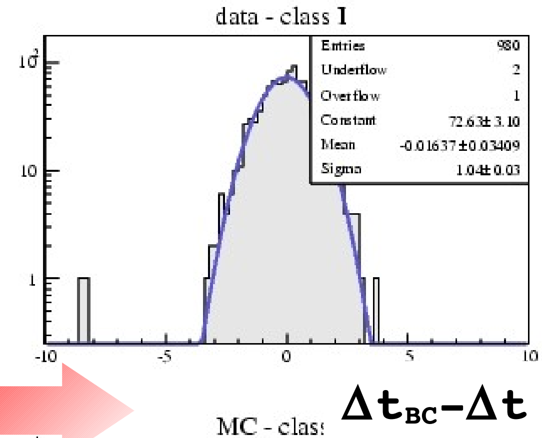
Validation on J/ψ Ks (standard vtx. vs BC vtx).

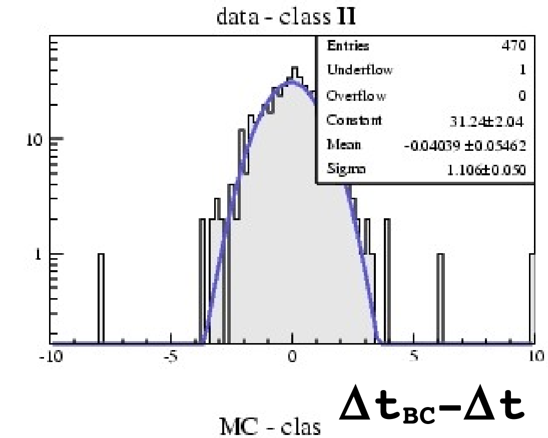
	nominal	mangled
C	-0.009 ± 0.053	-0.024 ± 0.056
S	0.714 ± 0.075	0.702 ± 0.089
τ	1.502 ± 0.056	1.543 ± 0.074
b^{core}_{other}	-0.19 ± 0.21	-0.146 ± 0.058
s^{core}_{other}	1.079 ± 0.100	1.085 ± 0.099
f^{out}	0.0010 ± 0.0051	0.0056 ± 0.0058
f^{tail}	0.044 ± 0.043	0 ± 0.075

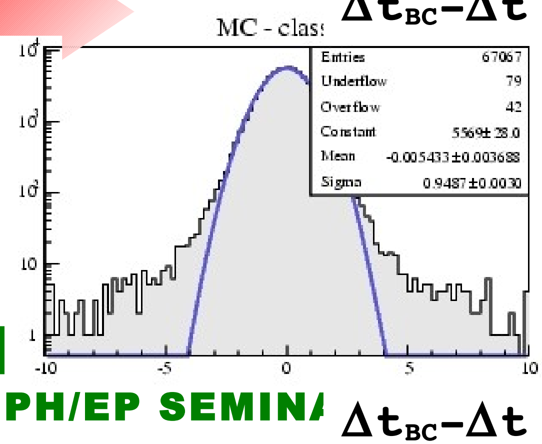


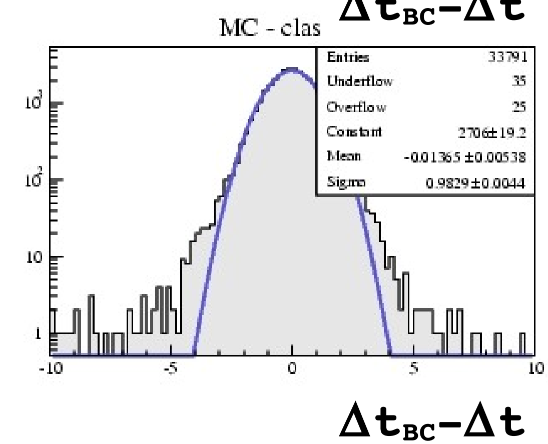


Comparison data vs. MC to parameterize Δt: ~1% difference in the outliers fraction (quoted systematic effect for BC vtx)



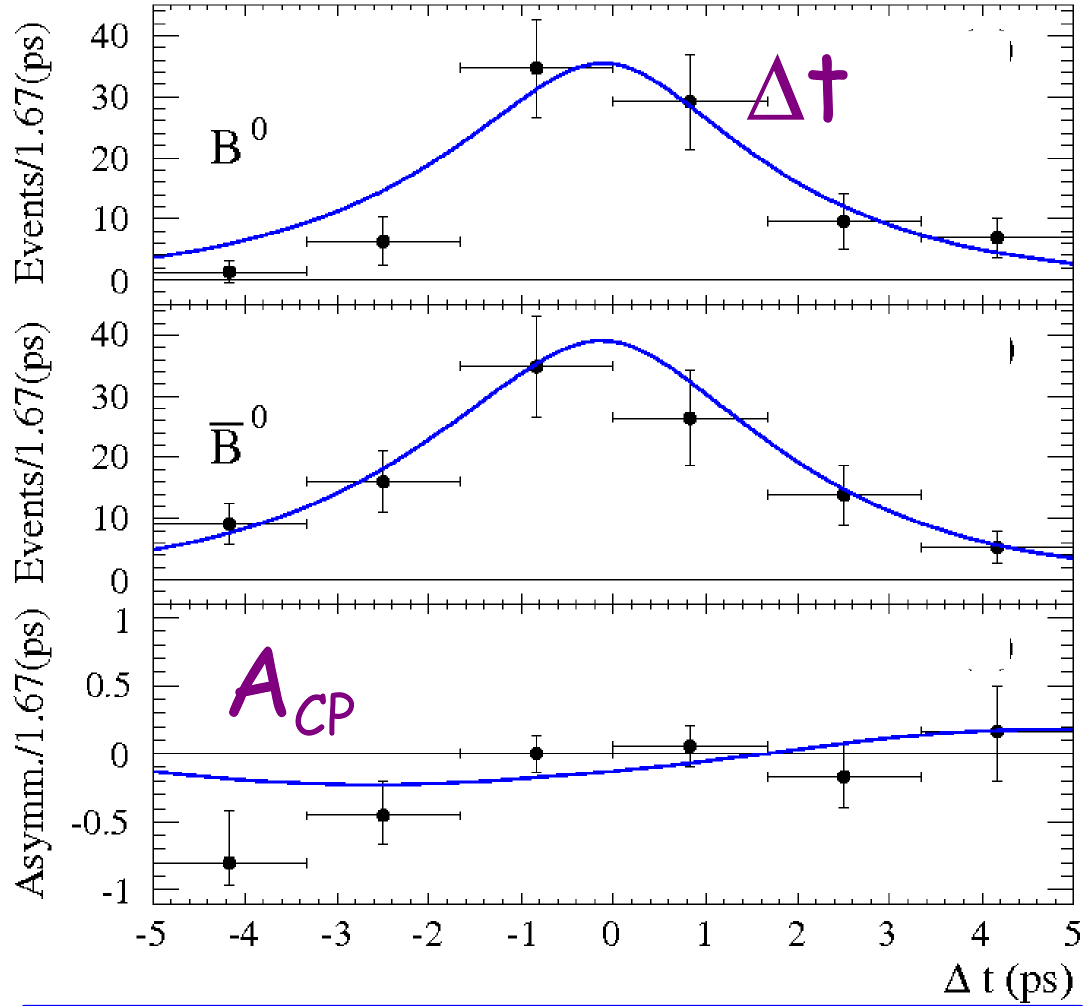






Measurement of $B^0 \rightarrow K_S \pi^0$

Phys.Rev.D77:012003,2008
e-Print: arXiv:0707.2980
[hep-ex]

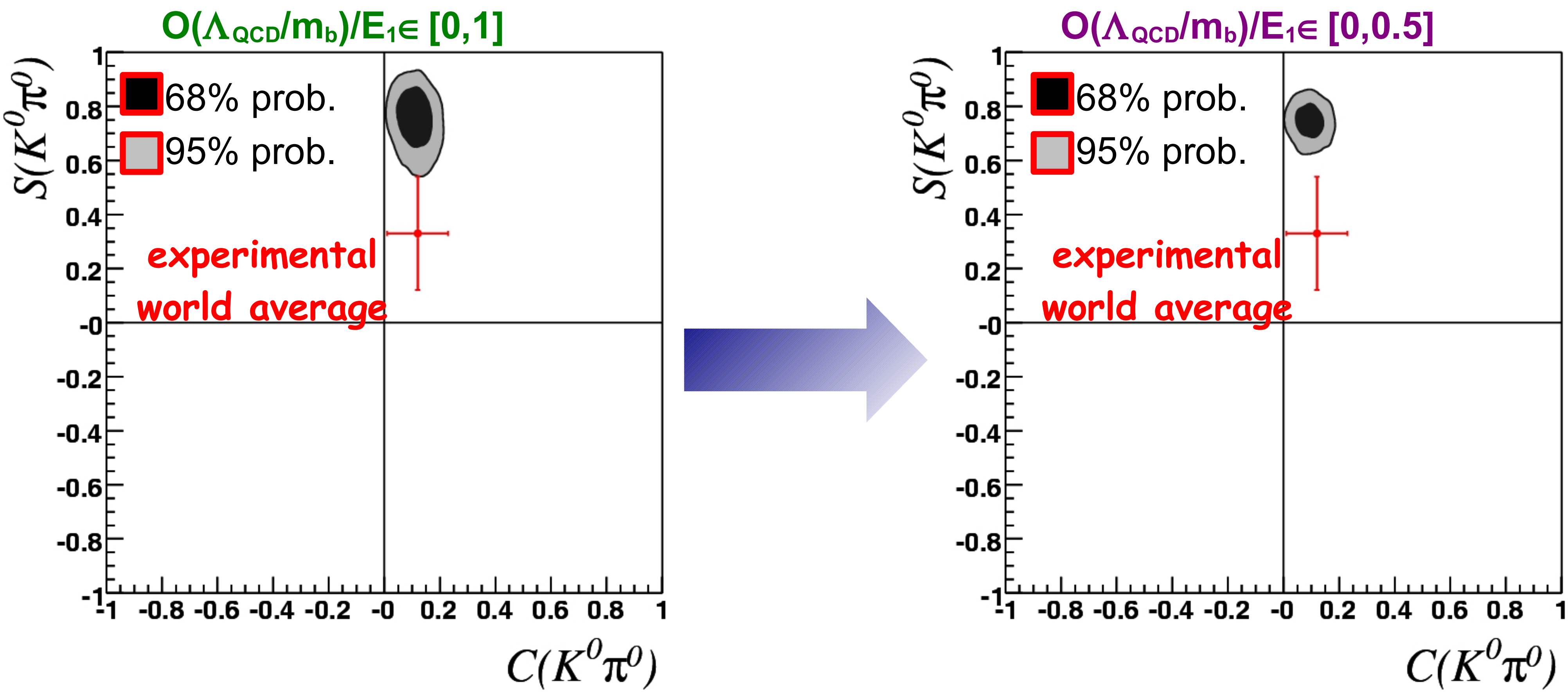


$C(B^0 \rightarrow K^0 \pi^0) = 0.24 \pm 0.15 \pm 0.03$

$S(B^0 \rightarrow K^0 \pi^0) = 0.40 \pm 0.23 \pm 0.03$

Test of SM: $S_{K\pi}$ vs $C_{K\pi}$

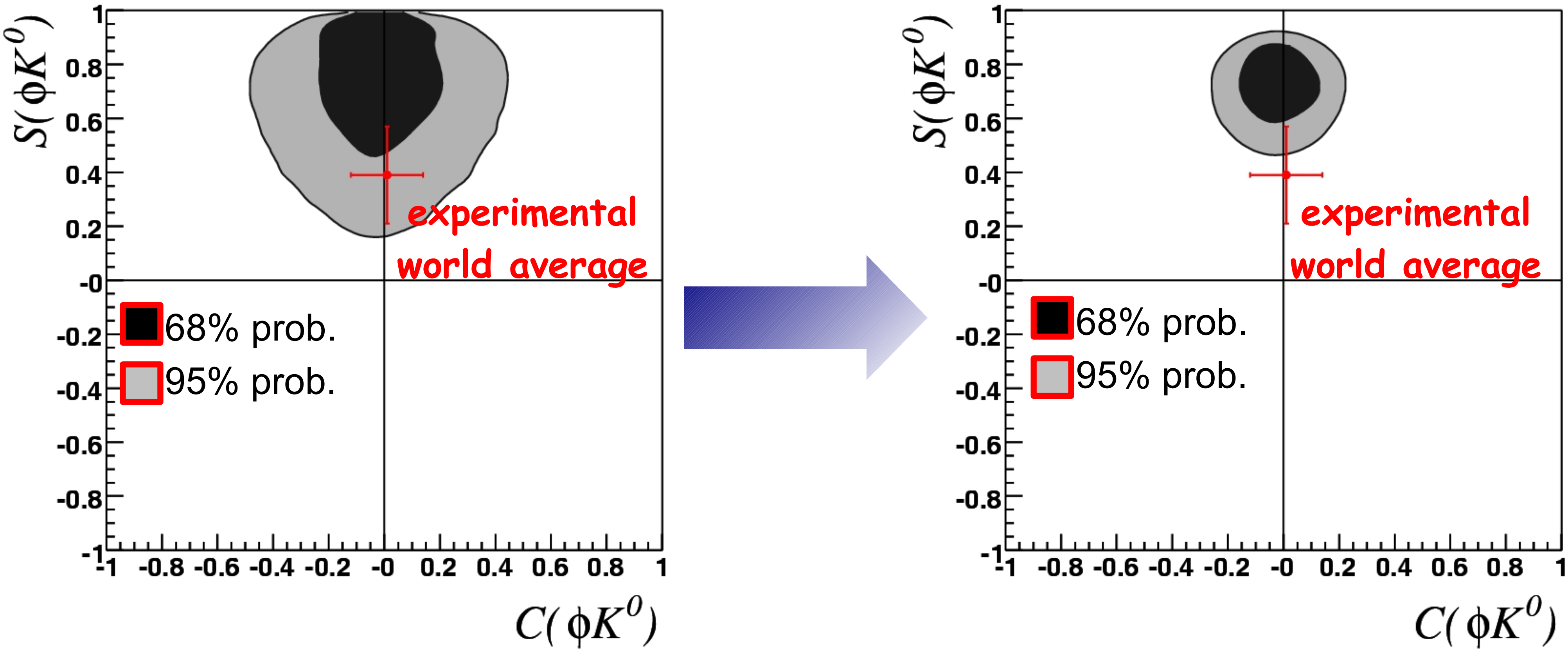
Since C is better determined by the fit than by the experiment, we have information on it from the other variables + SU(2) relations (all isospin sum rules are implicit in the parameterization). We can remove also C from the set of inputs and look at the agreement in the S vs C plane



Test of SM: $S_{\phi K}$ vs $C_{\phi K}$

- For the golden mode $B \to \phi K^0$ less control on the CKM-suppressed hadronic corrections lead to bigger uncertainty
- Some "educated guess" is needed in this case to do better (flavor symmetry, infinite m_b limit, ...)

$O(\Lambda_{QCD}/m_b)/E_1 \in [0,1]$ $\qquad$ $O(\Lambda_{QCD}/m_b)/E_1 \in [0,0.5]$



Conclusions

With LHC ready to start and the ILC on the horizon, flavor physics can still play an important role, indirectly constraining the presence of new particles through testing their virtual effects in loop-mediated processes

The recent results from Tevatron focus even more our attention on $b \to s$ decays

The study of hadronic $b \to s$ decays at the B factories represents a rich source of information for phenomenology

Two main subjects of discussion

- **BR and CP asymmetries in $K\pi$:** the claim of a puzzle in the CP asymmetry is more related to the level of approximation of the calculations than to NP
- **Time-dependent asymmetry in $b \to s$ decays:** the "hint of departure" from the SM is reduced with the increased statistics, but the tendency is confirmed for $B^0 \to \phi K^0$ and $B^0 \to K^0 \pi^0$

The role of Λ_{QCD}/m_b correction is crucial to interpret the results. It can explain A_{CP} in $B \to K\pi$, not the low values of TD CP asymmetries (the real test of the SM for hadronic B decays at the B factories)

Backup Slides

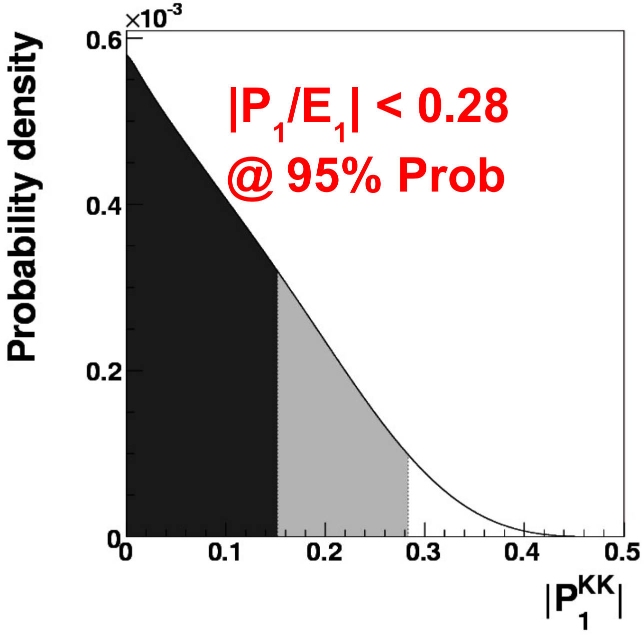
B→KK and magnitude of $O(\Lambda_{QCD}/m_b)$

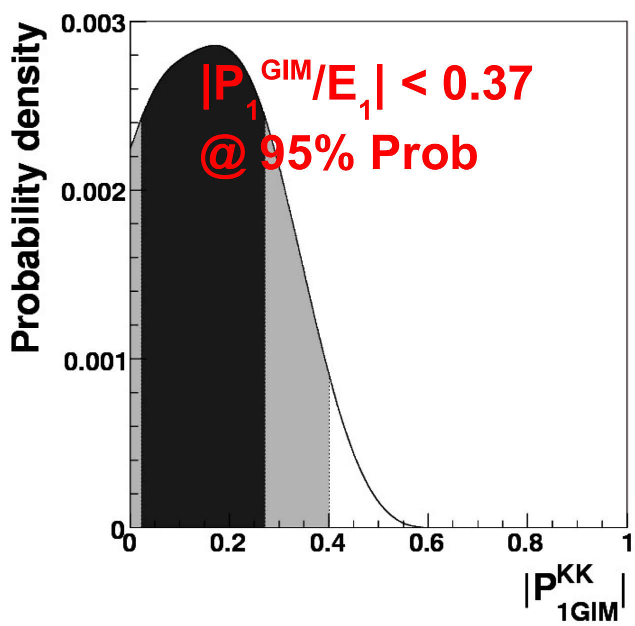
3 RGI (i.e. 5 real parameters to fit) vs. 2BR, 2 direct CP asymmetry and S(K+K-)

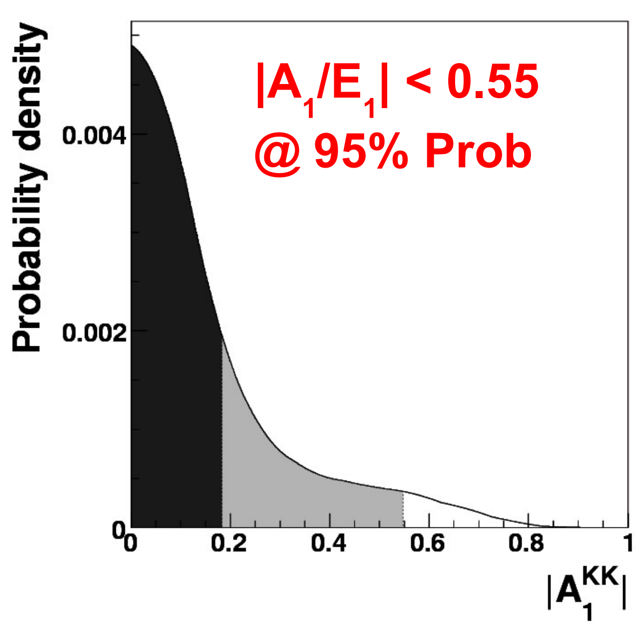
$$A(B^+ \to K^+ K^0) = -V_{td} V_{tb}^* \times P_1 + V_{ud} V_{ub}^* \times \{A_1 - P_1^{GIM}\}$$

$$A(B^+ \to K^0 K^0) = -V_{td} V_{tb}^* \times P_1 - V_{ud} V_{ub}^* \times \{P_1^{GIM}\}$$

Even with still large experimental errors, large values of the parameters are suppressed. Even with SU(3) broken @100% we do not expect large enhancements







PEP-II records

Last update:
April 8, 2008

Peak Luminosity

12.069×10^{33} cm^{-2}sec^{-1}	August 16, 2006
1722 bunches 2900 mA LER 1875 mA HER	

Integration records of delivered luminosity

Best shift (8 hrs, 0:00, 08:00, 16:00)	339.0 pb^{-1}	Aug 16, 2006
Best 3 shifts in a row	910.7 pb^{-1}	Jul 2-3, 2006
Best day	858.4 pb^{-1}	Aug 19, 2007
Best 7 days (0:00 to 24:00)	5.411 fb^{-1}	Aug 14-Aug 20, 2007
Best week (Sun 0:00 to Sat 24:00)	5.137 fb^{-1}	Aug 12-Aug 18, 2007
Peak HER current	2069 mA	Feb 29, 2008
Peak LER current	3213 mA	Apr 7, 2008
Best 30 days	19.776 fb^{-1}	Aug 5 – Sep 3, 2007
Best month	19.732 fb^{-1}	August 2007

Total delivered 557 fb^{-1}

PEP-II turned off April 7, 2008