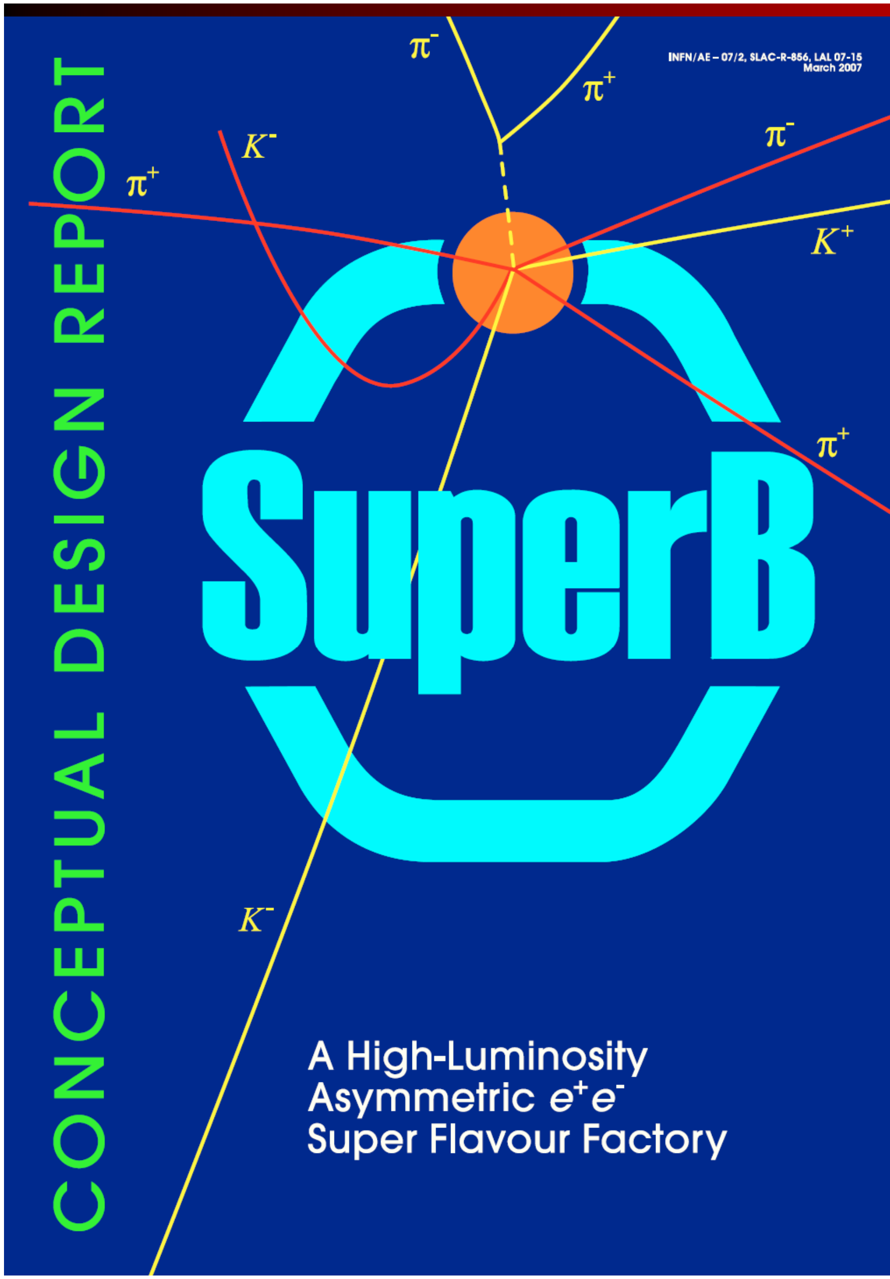

The Physics Case For a Super B Factory

Adrian Bevan

Queen Mary
University of London

Overview

- Physics
  - Super B physics case.
  - Matter-antimatter asymmetry.
  - Higgs and new physics constraints.
- Accelerator
  - Physics driven target luminosity.
  - Location(s) and current design.
- Detector
  - Current design.
- Conclusions

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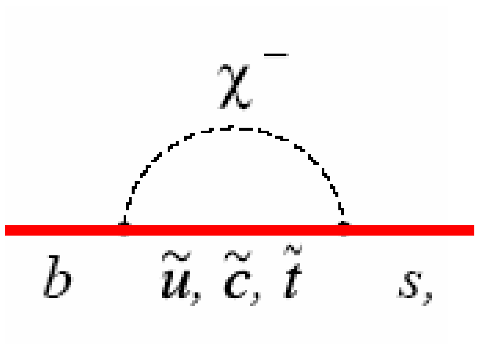
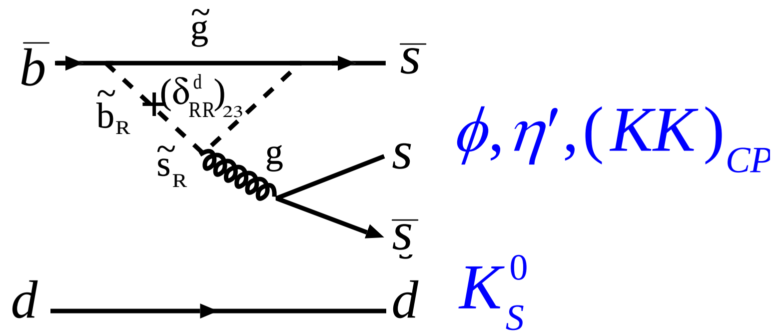
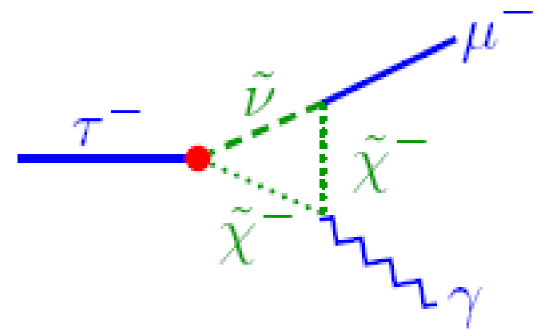
Super B physics case







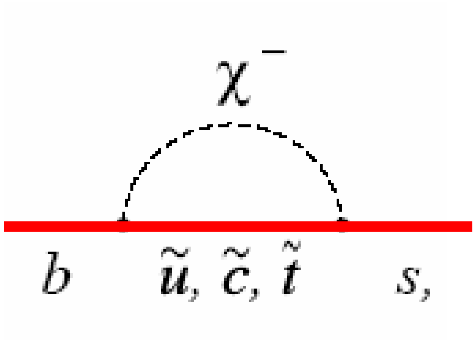
- There is new physics at Λ~TeV.
  - it will have a flavour structure.
  - It will affect precision measurements at low energies through virtual loop corrections.

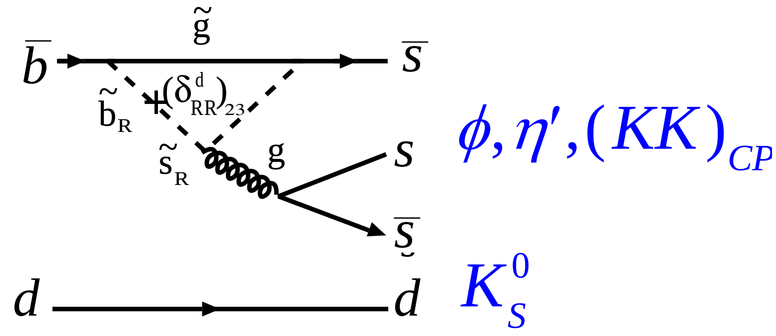
<u>AIMS:</u>

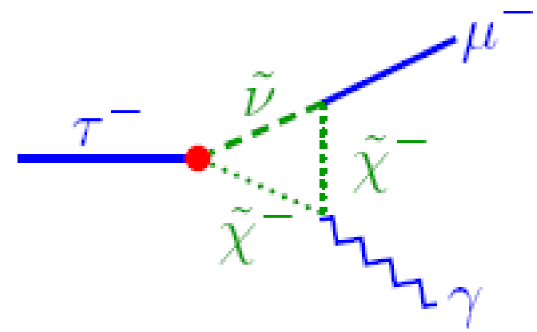
(1) Precision understanding of SM flavour physics.

(2) Elucidate flavour structure beyond the SM.

Super B physics case







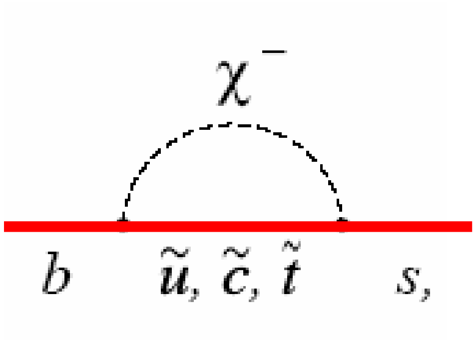
- There is no new physics at Λ~TeV.
  - Higher scale new particles will affect precision measurements at low energies through virtual loop corrections.

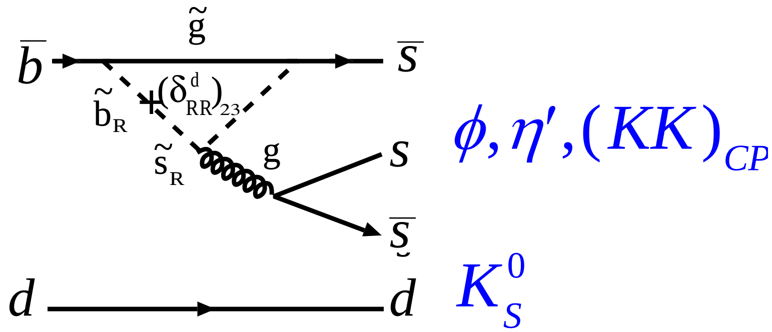
AIMS:

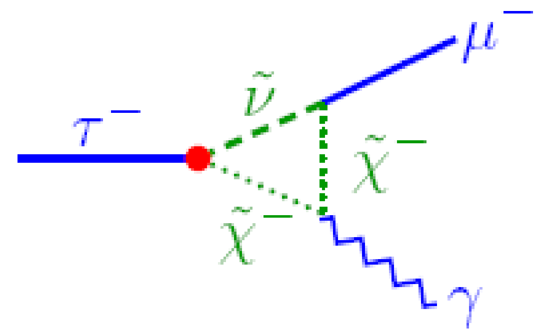
(1) Precision understanding of SM flavour physics.

(2) Constrain flavour structure beyond the SM.

Super B physics case







- There is new physics at Λ~TeV.
  - it will have a flavour structure.
  - It will affect precision measurements at low energies through virtual loop corrections.
- Many physics channels are complementary to the LHC programmes.
- Many measurements are still experimentally limited at 75ab^{-1}.

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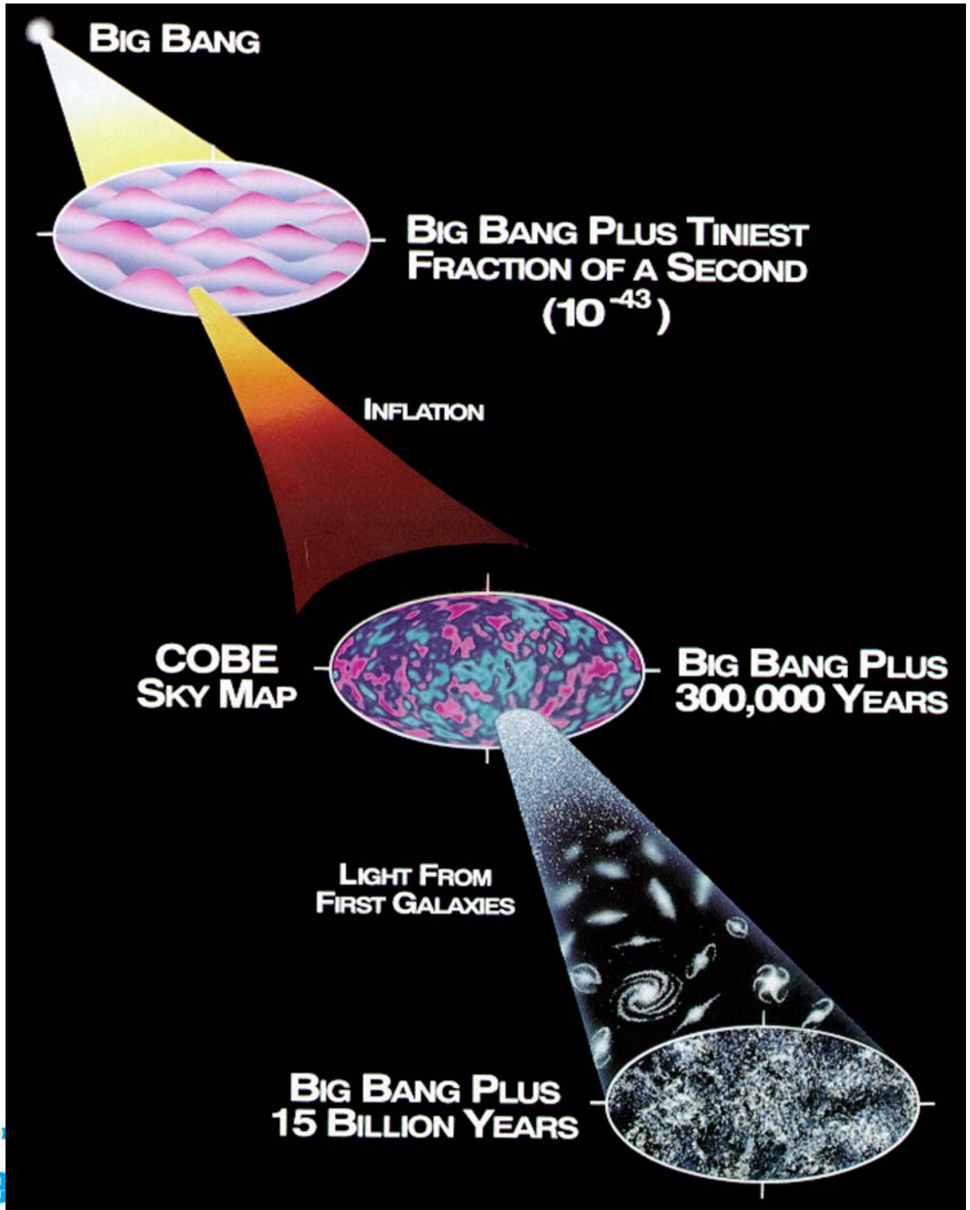
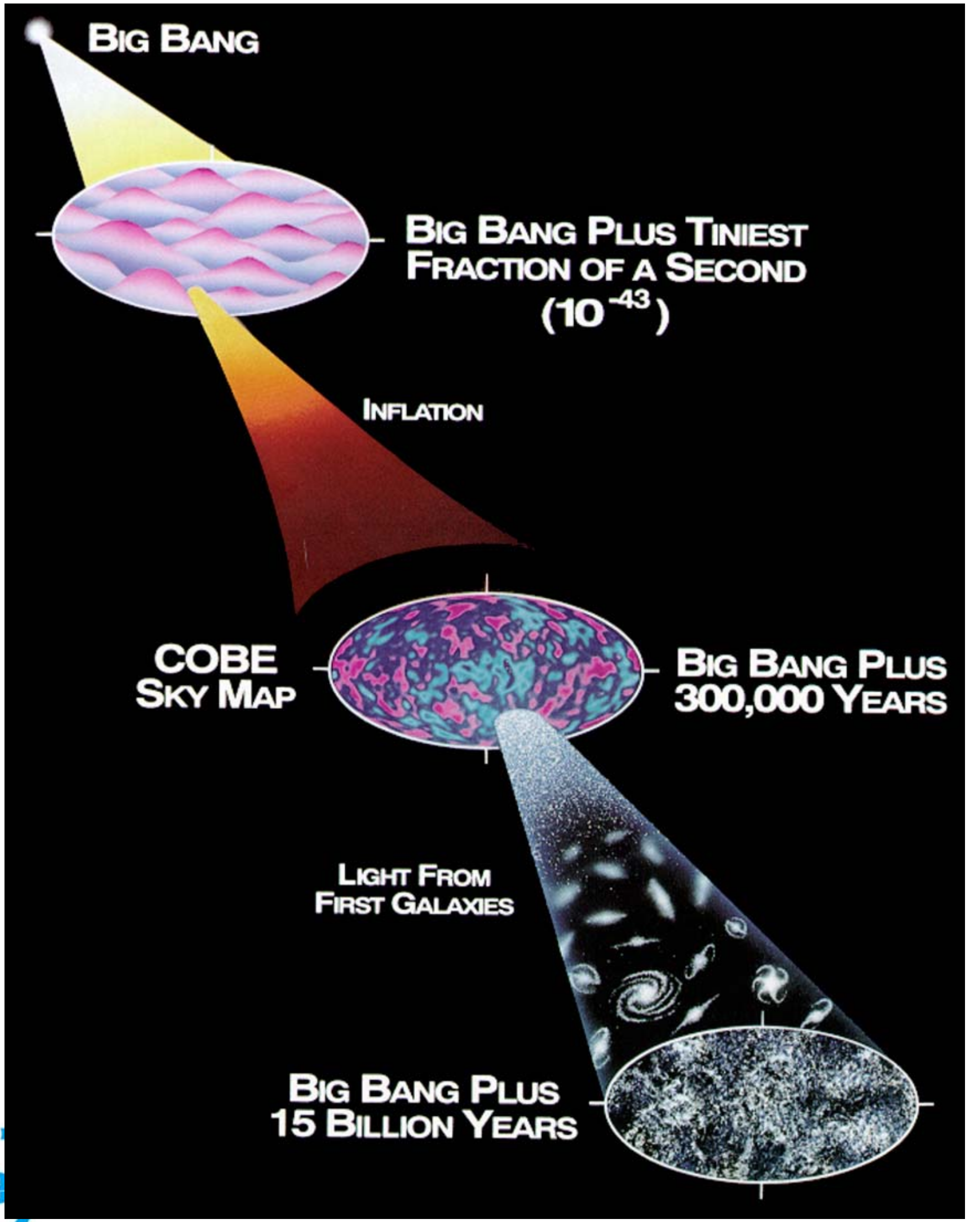
Matter-antimatter asymmetry



Equal amounts of matter and anti-matter created in the big bang.

Matter-antimatter asymmetry

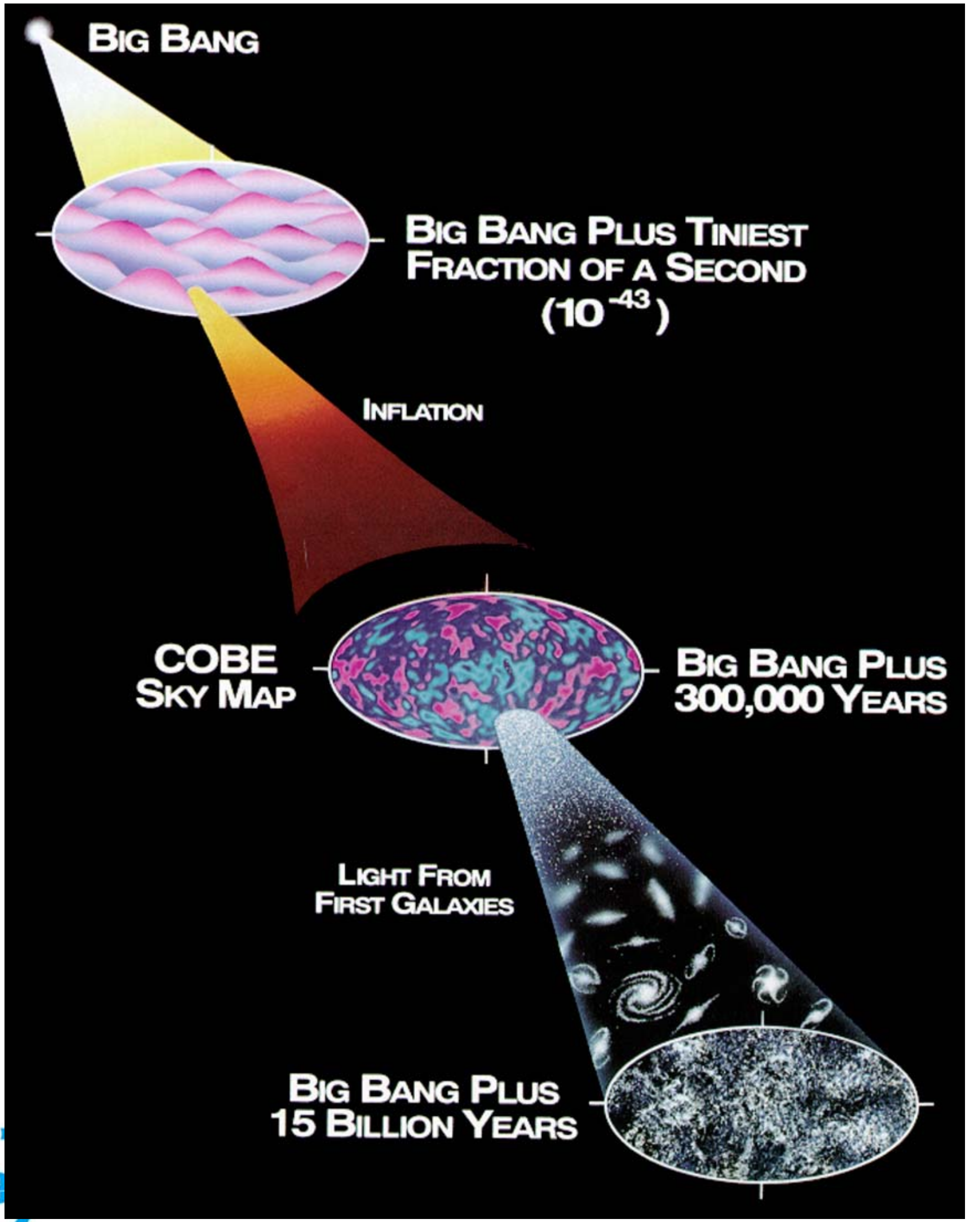


Equal amounts of matter and anti-matter created in the big bang.

↓

The universe expands, cools and the matter annihilates all of the anti-matter.

Matter-antimatter asymmetry



Equal amounts of matter and anti-matter created in the big bang.

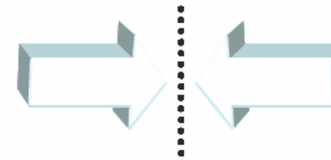
The universe expands, cools and the matter annihilates all of the anti-matter.

We are trying to understand the mechanism that left us in this matter dominated universe.

What defines this broken symmetry?

C, P, and T

- Parity, **P**
  - Reflection of a system through the origin, converting right-handed into left-handed coordinate systems.
  - Vectors (momentum) change sign, but axial vectors (spin) remain unchanged.



$\mathbf{r} \rightarrow -\mathbf{r}$

$\mathbf{p} \rightarrow -\mathbf{p}$

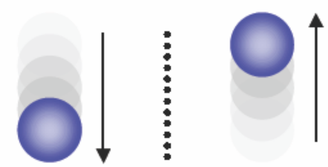
$\mathbf{L} \rightarrow \mathbf{L}$

- Charge Conjugation, **C**
  - Change all particles into anti-particles and visa versa.

$e^{-} \rightarrow e^{+}$

$\gamma \rightarrow \gamma$

- Time Reversal, **T**
  - Reverse the arrow of time: reverse all time-dependent quantities, e.g. momentum.



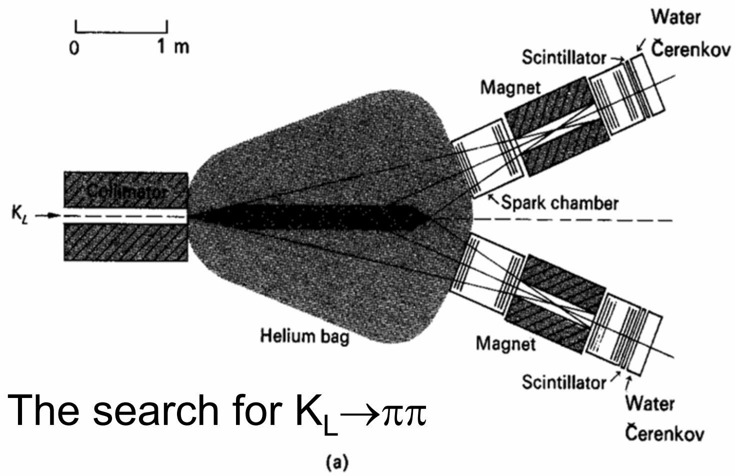
$t \rightarrow -t$

Need CP violation to generate a matter-antimatter asymmetry

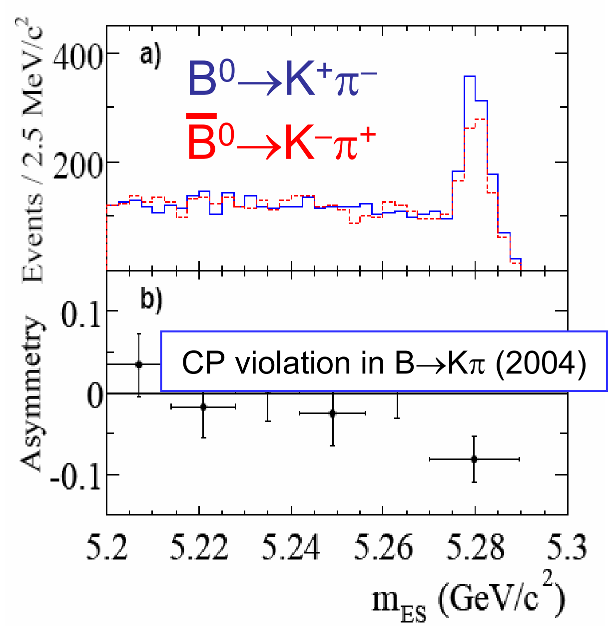
Sakharov, JETP Lett. 5 (1967), 24

Observation of CP violation

- CP violation was first observed in K-meson decays ...
  - Christenson et al. 1964
- ... and later in B-meson decays
  - BaBar & Belle, 2001.

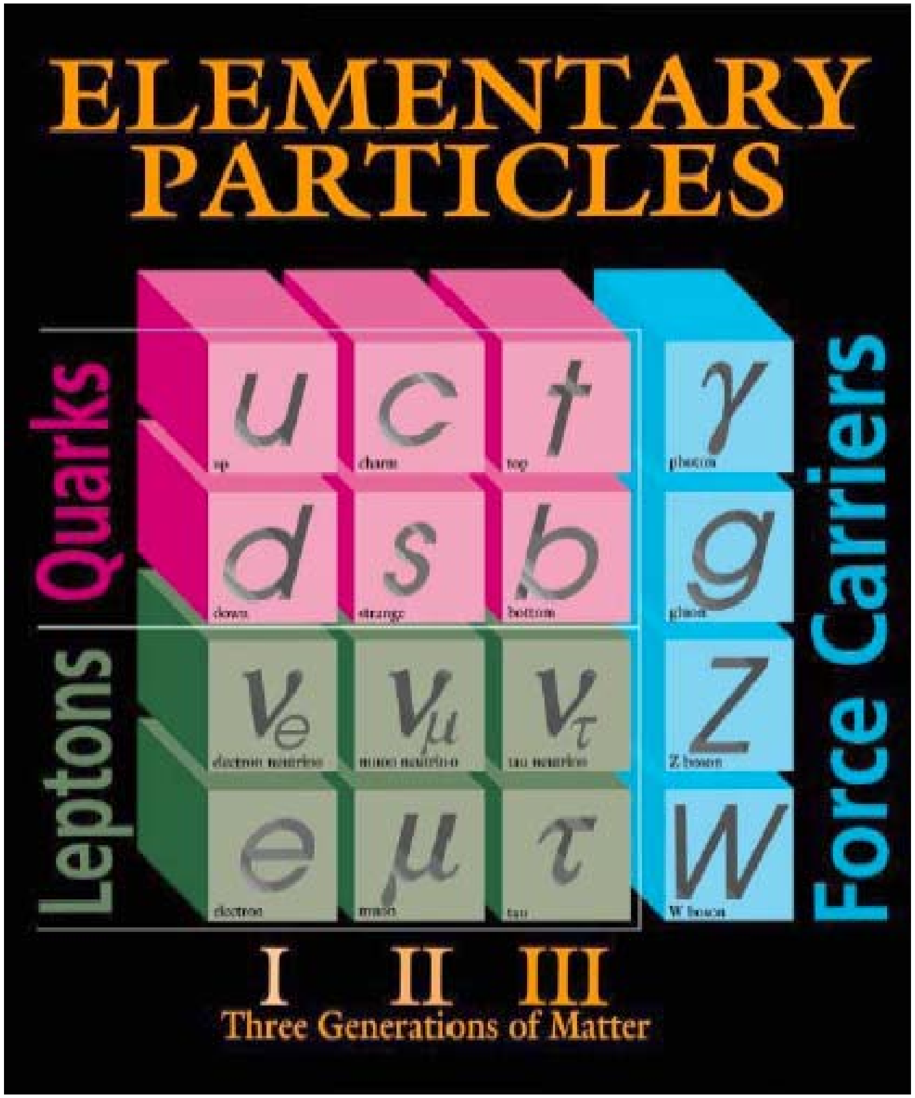


The search for $K_L \to \pi\pi$



Observed level of CP violation is 9 orders of magnitude too small to explain our universe.

Fundamental particles



Fundamental particles

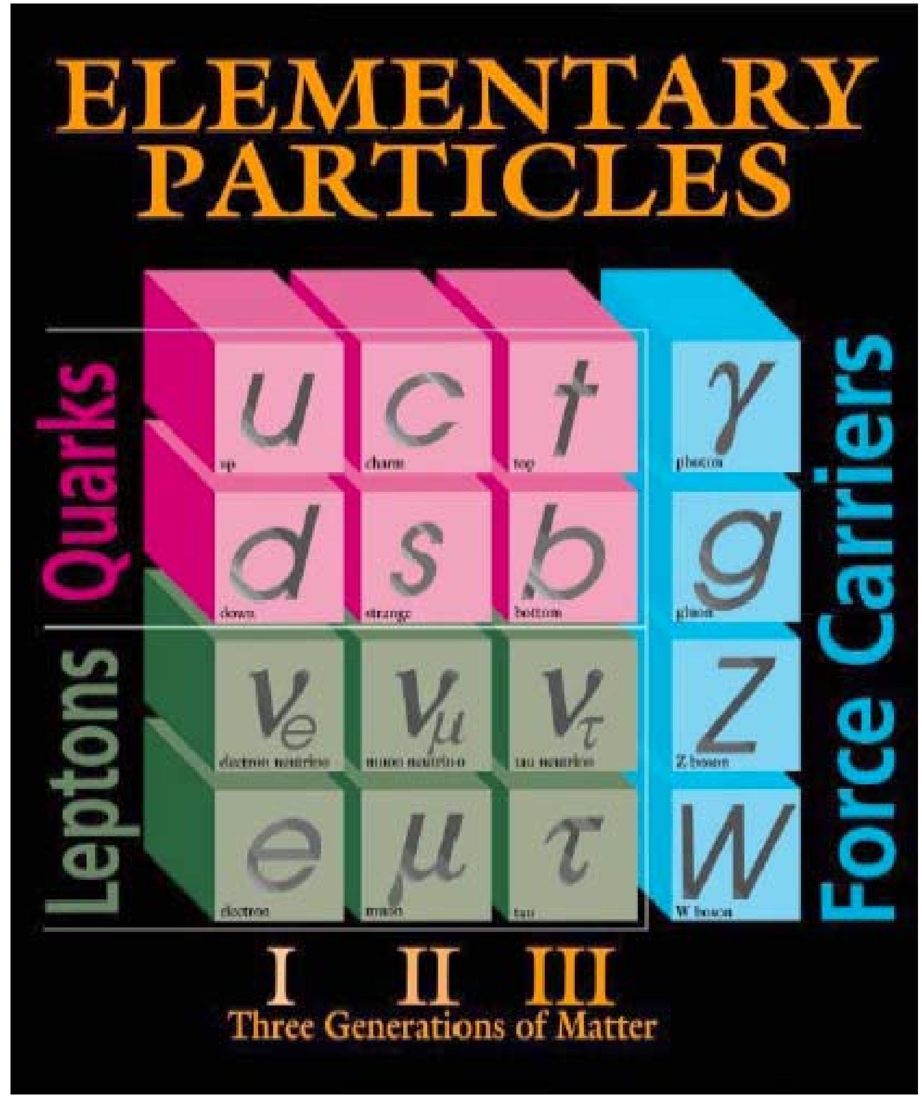
- Quarks change type through interactions with a $W^{\pm}$.

- Starting to probe lepton sector with neutrino experiments e.g. T2K.

$$\nu_{\mu} \rightarrow \nu_{\tau} \quad \text{(Super K)}$$

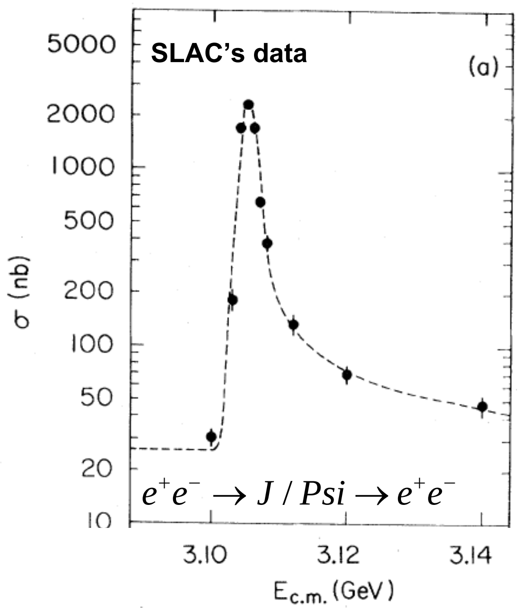
$$\nu_{\mu} \rightarrow \nu_{e} \quad \text{(searching for)}$$

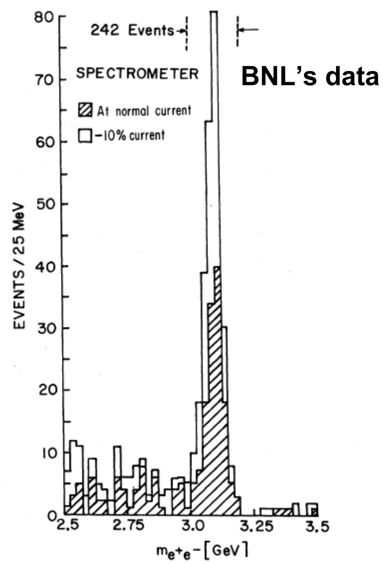
- No observed lepto-quark interactions.

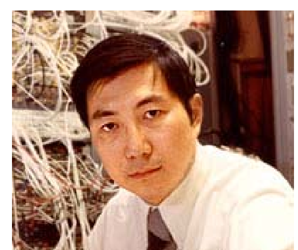


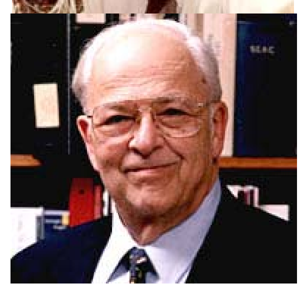
The GIM mechanism

- Before 1970:
  - Technical problems existed in calculations of kaon decays with only the know quarks at that time: *u*,*d* and *s*.
- 1970: PRD **2** 1285
  - Glashow Iliopoulos and Maiani postulated the charm quark as a way to solve these problems.
- 'November revolution': 1974 groups at Brookhaven and SLAC independently discovered the J/Psi, establishing the charm quark.
  - Burt Richter and Sam Ting shared the 1976 Noel Prize for physics for their discovery.









… and we now know 6 quarks exist.

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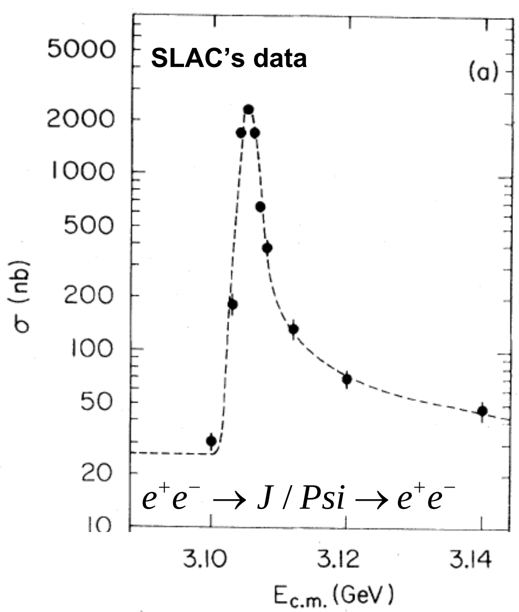
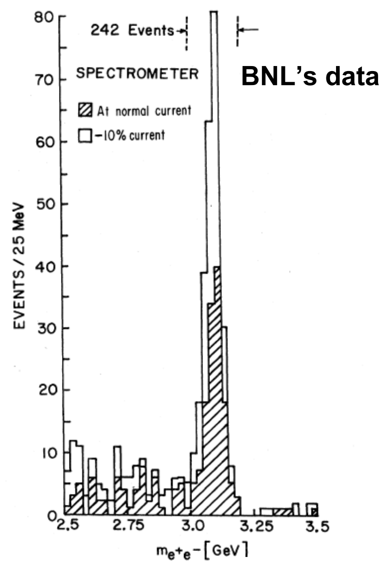
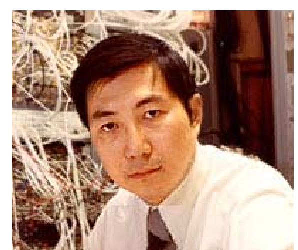
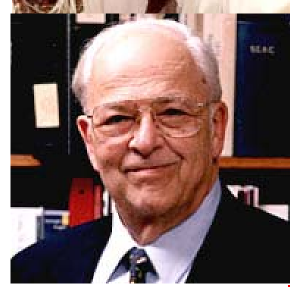






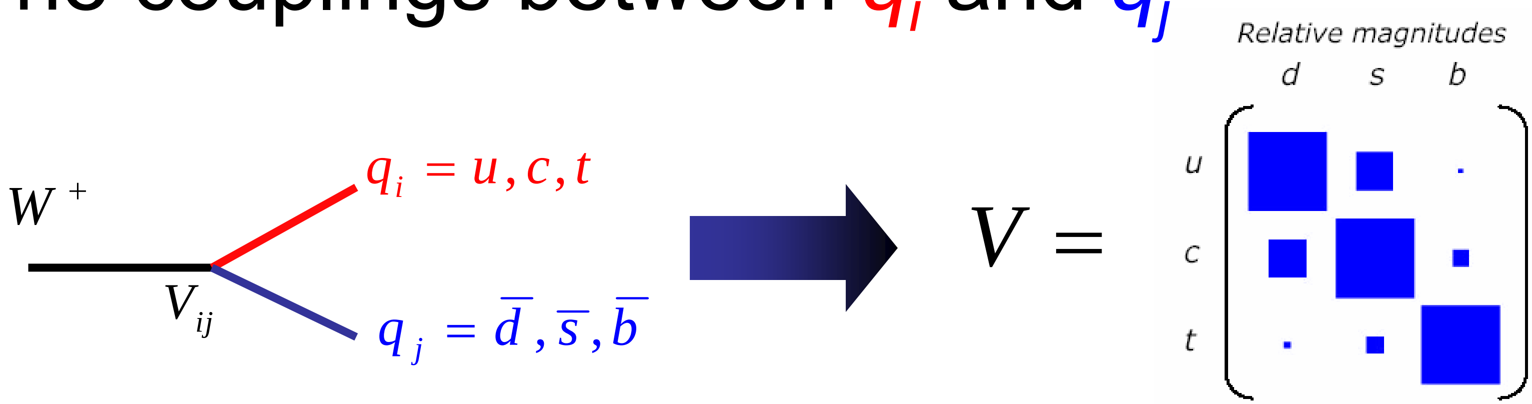


Historically, virtual effects have led to a number of discoveries in particle physics.

… and we now know 6 quarks exist.

The CKM matrix

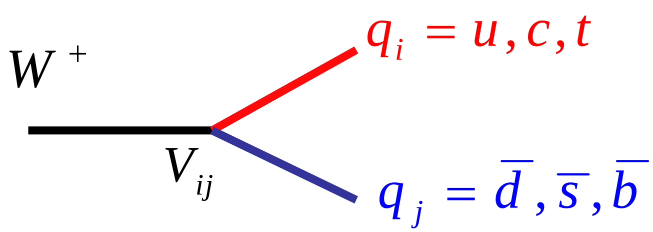
- The couplings between q_i and q_j



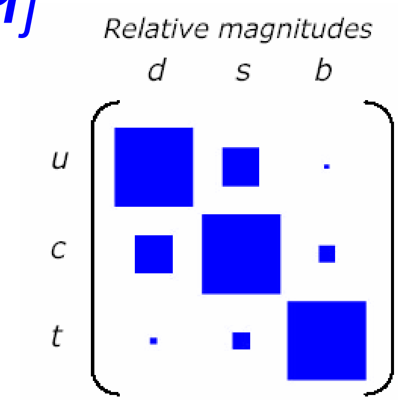
- Form a 3x3 unitary matrix: CKM Matrix

The CKM matrix

- The couplings between q_i and q_j



$V =$



- Form a 3x3 unitary matrix: CKM Matrix

Wolfenstein Parameterisation:

$$V = \begin{pmatrix} 1-\lambda^2/2 & \lambda & A\lambda^3(\rho - i\eta) \\ -\lambda & 1-\lambda^2/2 & A\lambda^2 \\ A\lambda^3(1-\rho-i\eta) & -A\lambda^2 & 1 \end{pmatrix} + O(\lambda^4)$$

$\lambda \sim 0.22$

$A \sim 0.8$

$\rho \sim 0.2 - 0.27$

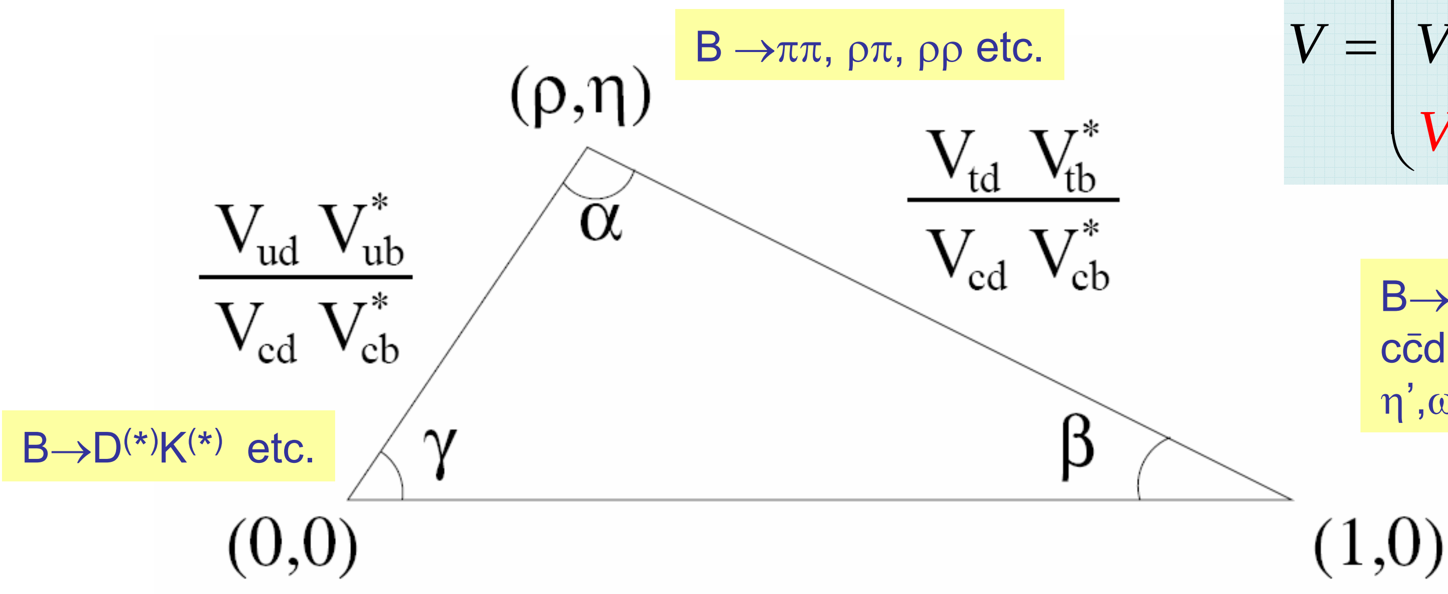
$\eta \sim 0.28 - 0.37$

Understanding Standard Model CP Violation means accurate measurements of ρ and η

The unitarity triangle

- Study decays involving $b \to u$ and $t \to d$ transitions to probe the weak phase of V_{ub} and V_{td}.

$$V = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix}$$

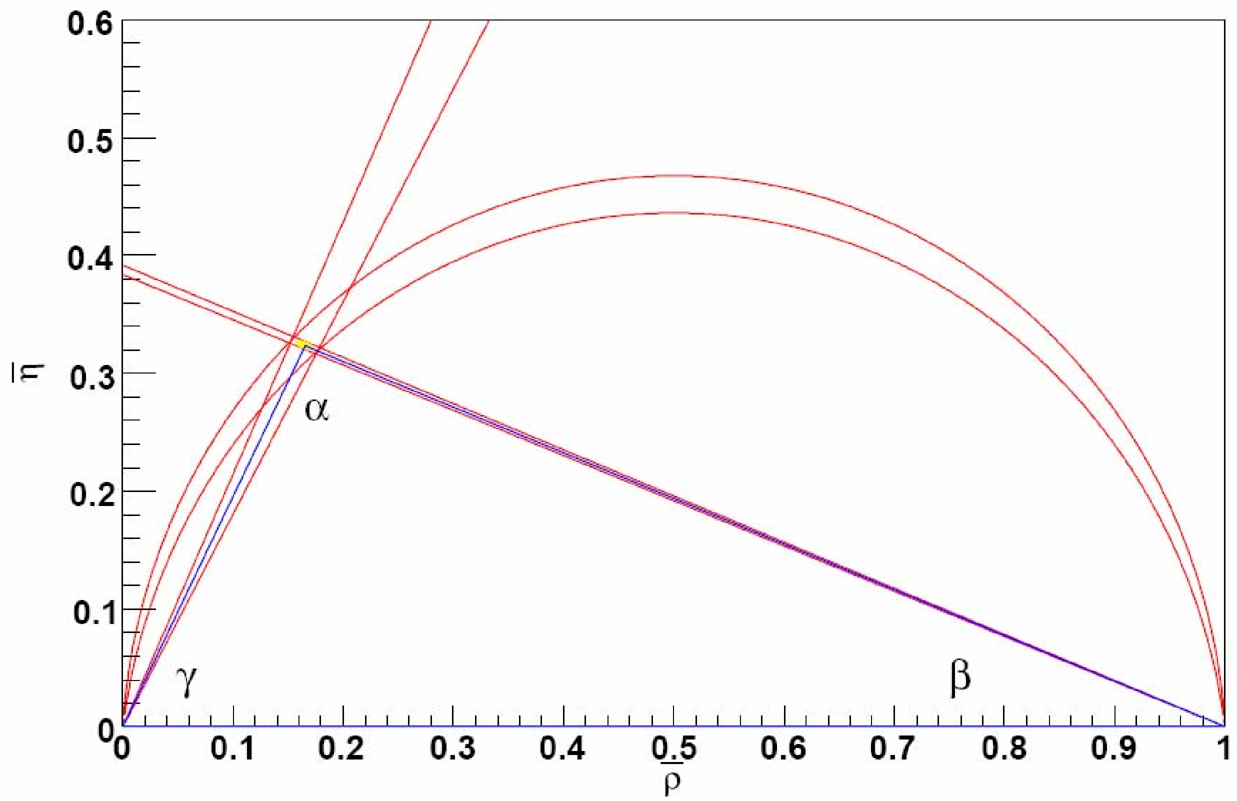


$B \to c\bar{c}s$ (e.g. $J/\psi K^0$), $c\bar{c}d$ (e.g. $J/\psi \pi^0$), $\eta', \omega, \phi K^0$ etc.

- B-factories have measured β to ~1° in $c\bar{c}s$, and starting to do precision measurements in charmless $b \to s$ penguin decays.
- α is measured to 7°.
- Now starting to constrain γ.

Elucidating the CKM mechanism

- With 50 ab^{-1} : precision over-constraint of the UT!



α Use ππ, ρπ, ρρ

β Use $c\bar{c}s$, assume theory error can be better constrained.

γ Use B→DK, $D^0 \to \pi^+\pi^- K_s$

CKM Metrology with unprecedented precision

$\alpha \sim 1 - 2^\circ$

$\beta \sim 0.2^\circ$

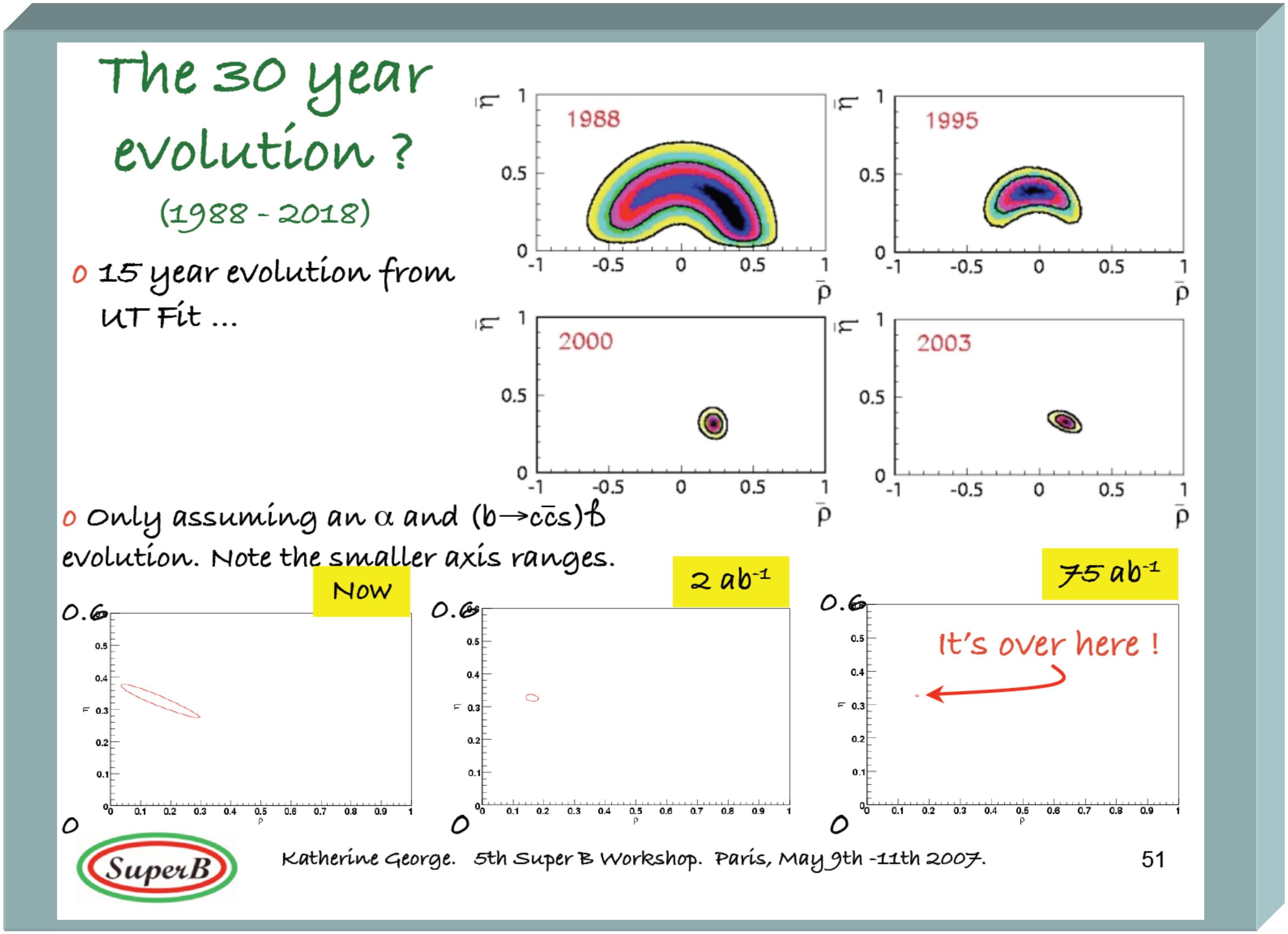
$\gamma \sim 2^\circ$

$\bar{\rho} = 0.165 \pm 0.009 \quad (5\%)$

$\bar{\eta} = 0.324 \pm 0.004 \quad (1.3\%)$

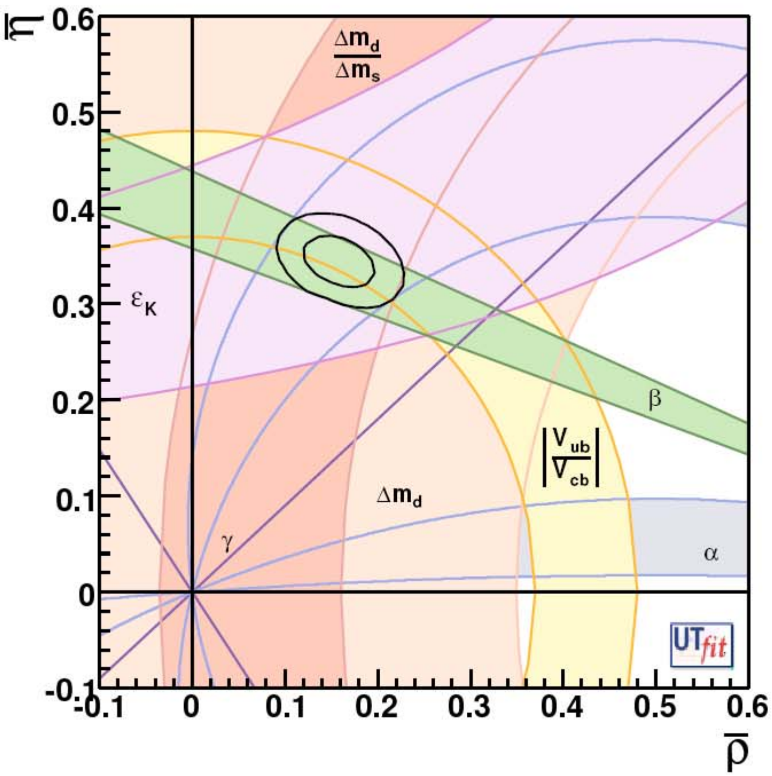
Just angles

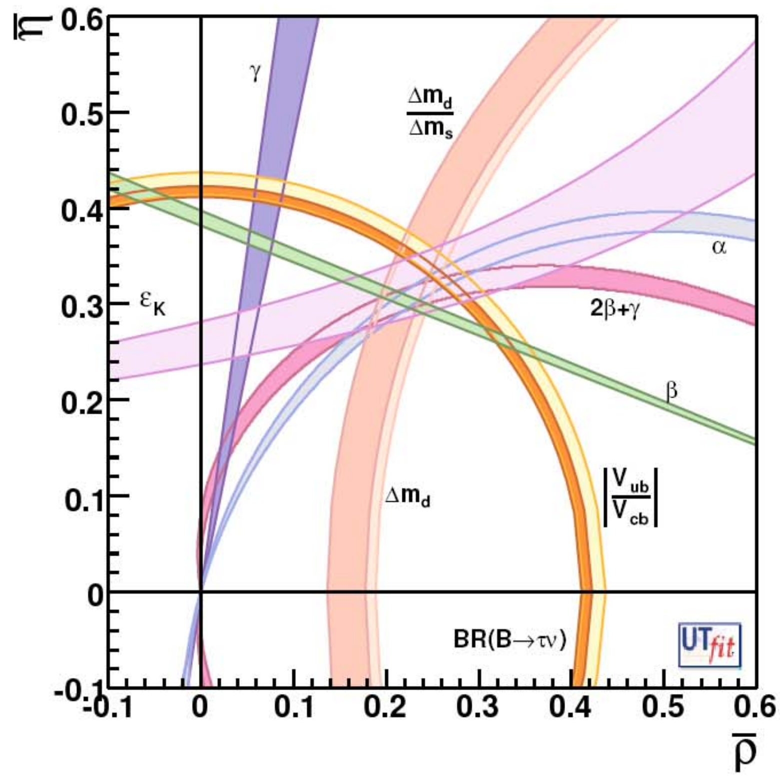
30 evolution of the $\bar{\rho}-\bar{\eta}$ plane



Can we break the unitarity triangle?

Current Precision with all constraints.





Extrapolating existing measurements
to super-B luminosity.

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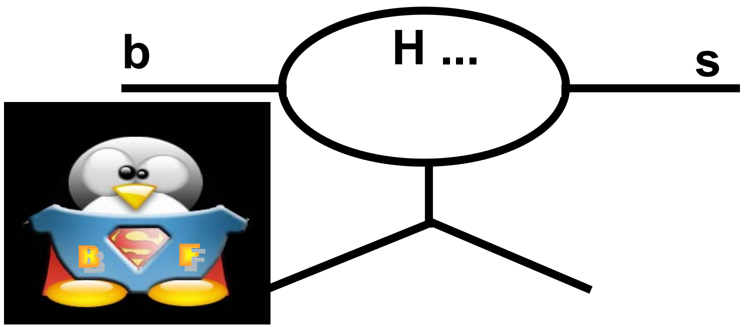
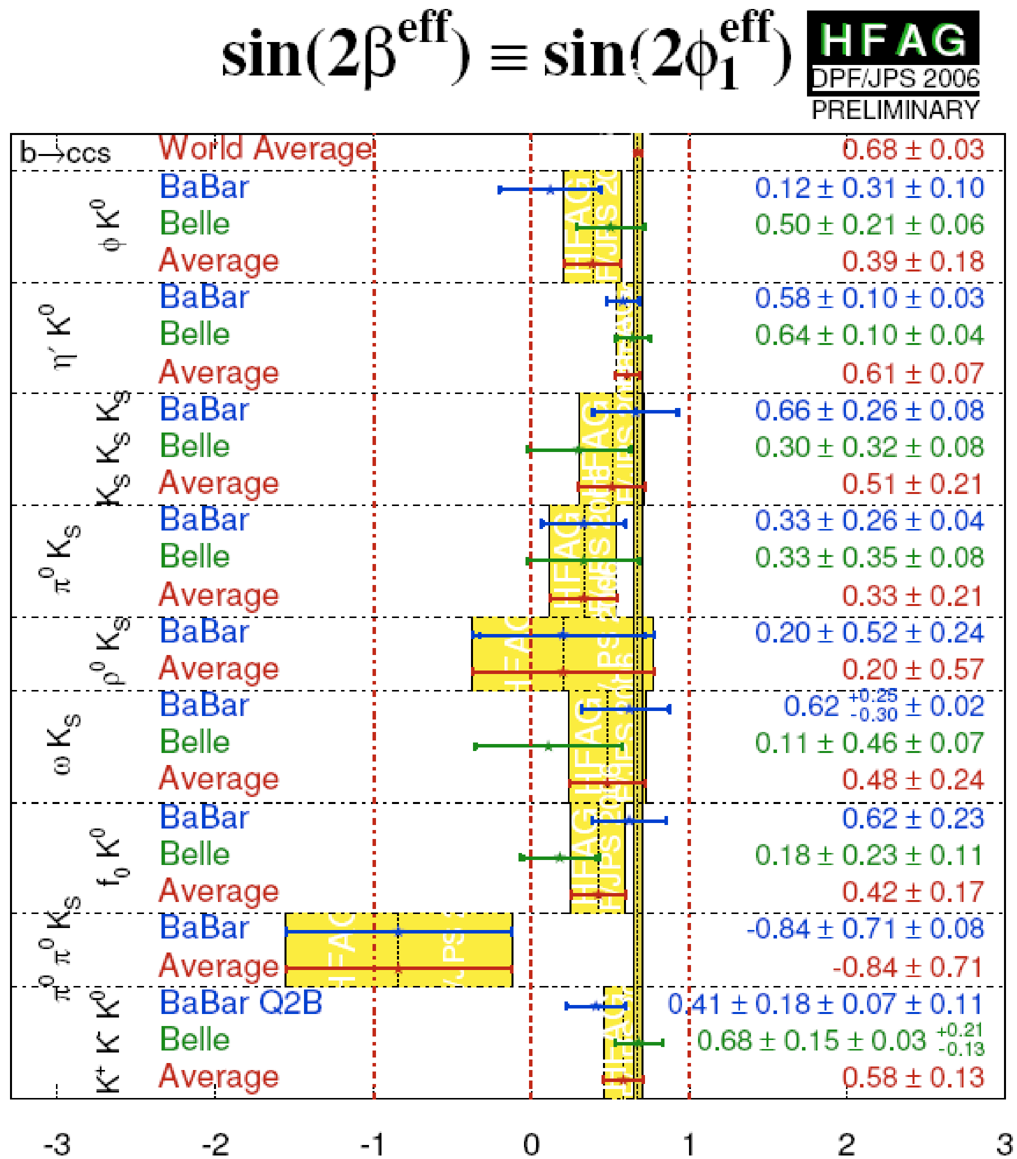
b→s 'penguin' loops



- $\sin 2\beta$ from $c\bar{c}s$ can differ from other loop dominated $\sin 2\beta_{eff}$ if new particles contribute to the loop.
- Need high statistics to observe deviation for any given mode.
- $\eta' K^0$, $K^+K^-K^0$ and ϕK^0 are the 'golden modes'

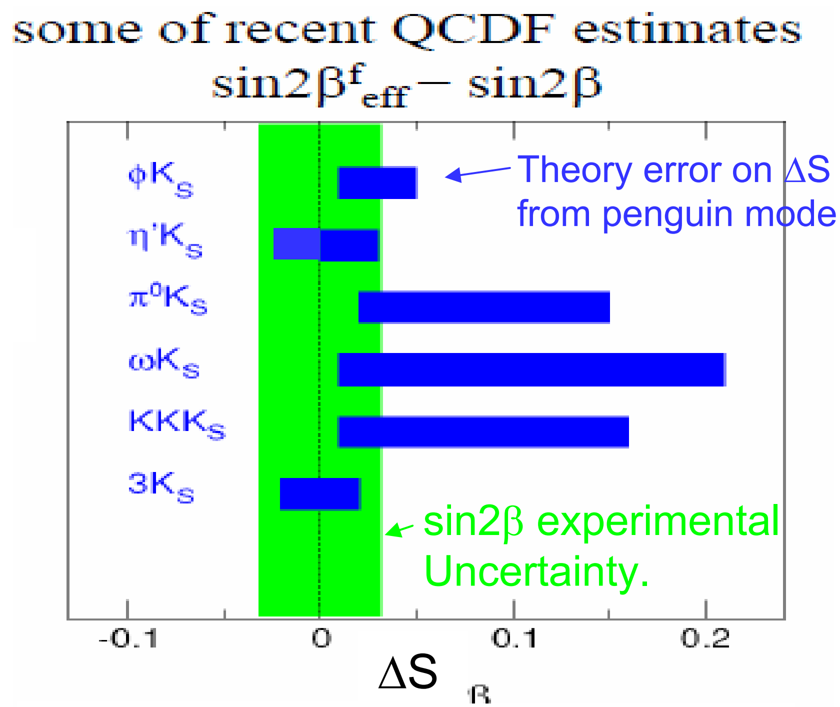


Standard Model corrections to ΔS

- A variety of theoretical calculations have been made to estimate the theory error on ΔS mode by mode.

- Current best levels of constraint are ~0.01.

- This theory error becomes a limiting factor with approx $50 ab^{-1}$ of data.



QCDF: (Beneke, PLB620 (2005), 143-150, Cheng et al., PRD72 (2005) 094003 etc.
SCET: (Williamson & Zupan, hep-ph/0601214)
Can estimate ΔS and mostly see a positive shift.

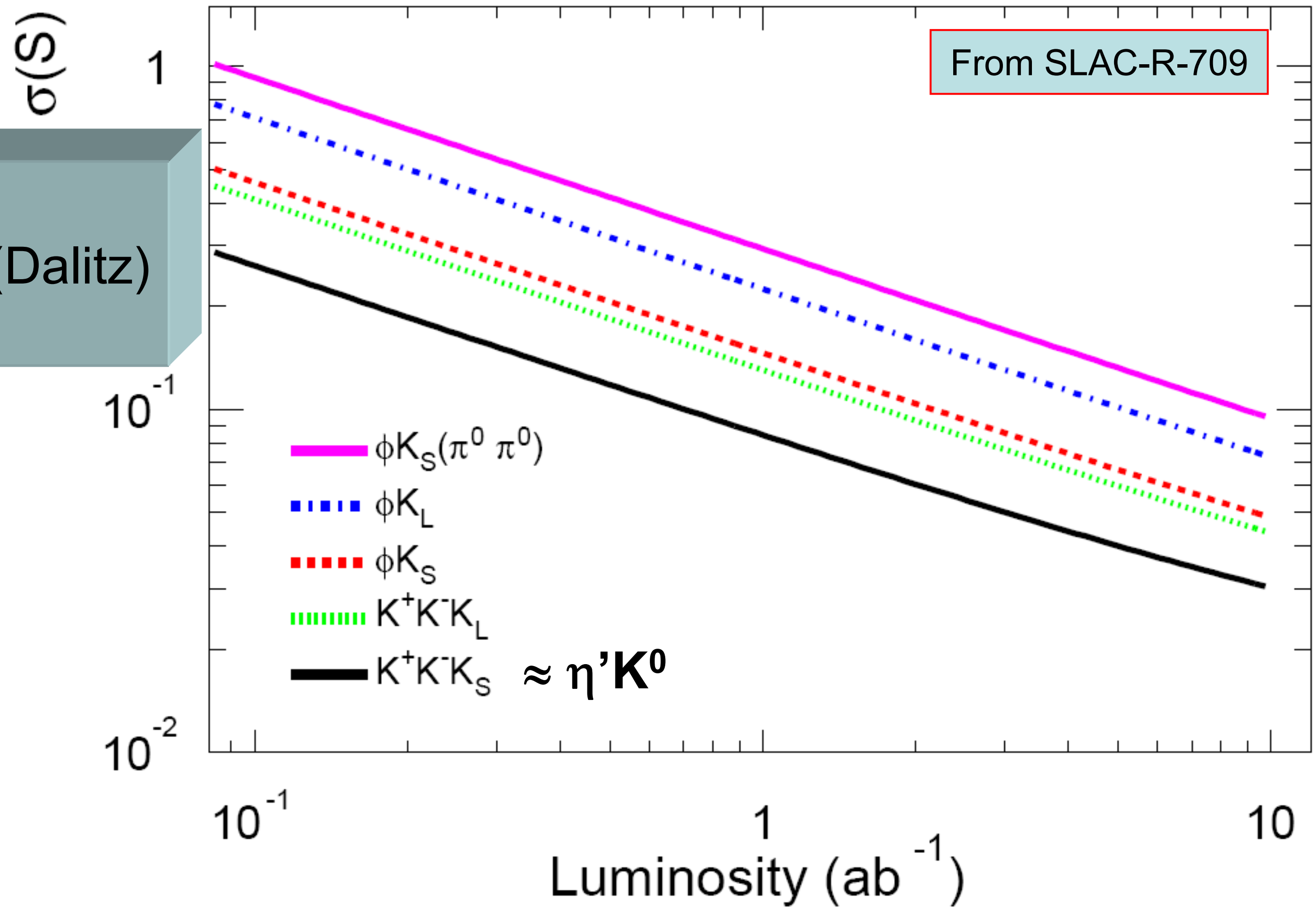
SU(3): Grossman *et al*, PRD68 (2003) 015004; Gronau *et al*, PRD71 (2005) 074019; …).

- $\eta' K^0$ is the most promising channel
  - most precise $\sin 2\beta_{eff}$ currently measured & CPV has been observed
  - $B \to K^+ K^- K_s$ (ϕK_s) is next on the list.

Predictions for the future

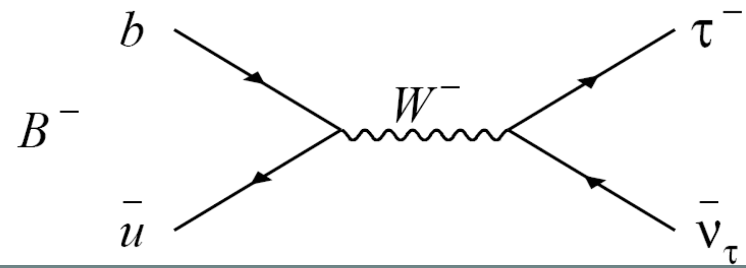
- Extrapolations from BaBar analysis indicate % level precision at ~50ab^{-1}.

Best: $B \to \eta' K^0$
2^{nd} best: $B \to K^+K^-K^0$ (Dalitz)
3^{rd} best: $B \to \phi K^0$



$B^+ \rightarrow \tau^+ \nu$

- Suppressed by V_{ub}

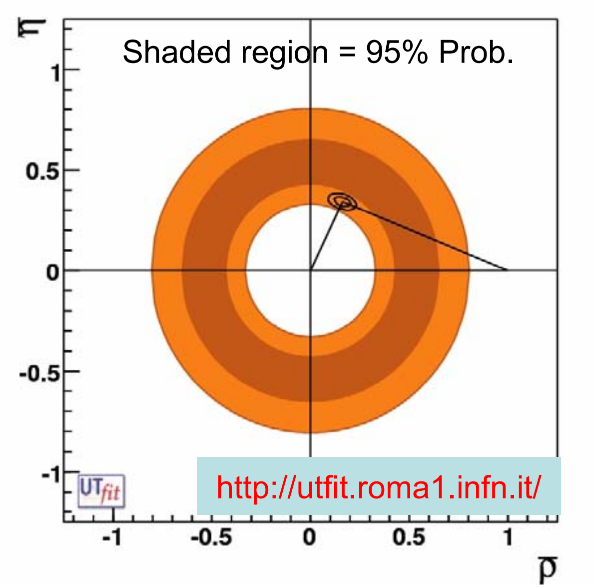


SM prediction
$(1.59 \pm 0.40) \times 10^{-4}$

$$\mathcal{B}_{SM}(B^+ \rightarrow l^+ \upsilon_l) = \frac{G_F^2 m_B m_l^2}{8\pi}\left(1 - \frac{m_l^2}{m_B^2}\right) f_B^2 \, |V_{ub}|^2 \, \tau_B$$

– Within the SM, this measurement can be used to constrain f_B.

- Can constrain the apex of the unitarity triangle using this measurement
  - Complements the angle measurements



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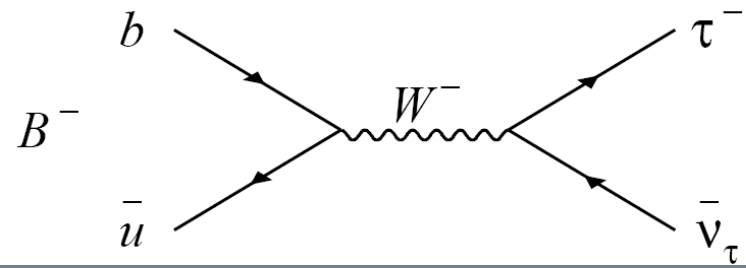

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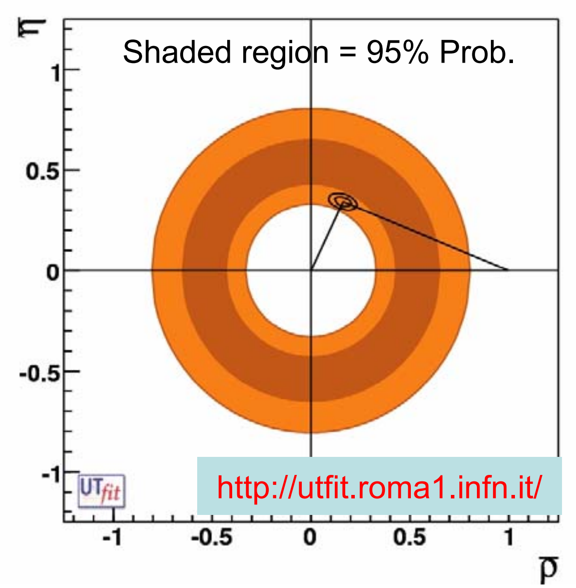
  - Can replace W^+ with H^+
  - $\mathcal{B}$ can be suppressed or enhanced by a factor of r_H.

$$r_H = \left(1 - \frac{m_B^2}{m_H^2}\tan^2\beta\right)^2$$

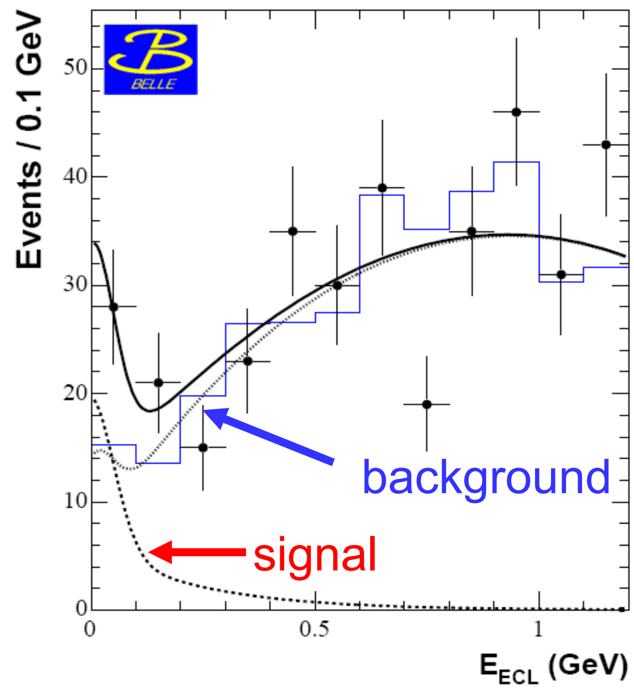
2HDM: W.S. Hou, PRD **48**, 2342 (1993).



$B^+ \to \tau^+ \nu$

hep-ex/0608019
PRL**97** (2006) 251802

- Reconstruct signal decay.
- and other B in the event:
  - Belle: fully reconstruct B mesons in 180 channels.
  - BaBar: Tag with $B \to D^{(*)} l \upsilon$.
- Look at the remaining energy in the calorimeter: signal peaks at $E_{ECL/extra}=0$.



BELLE

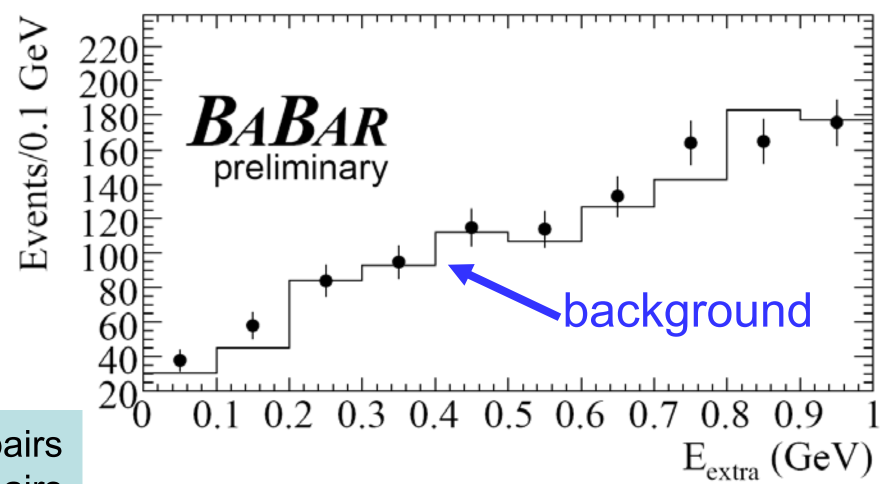
$$\mathcal{B} = (1.79^{+0.56+0.39}_{-0.49-0.46}) \times 10^{-4}$$

(revised). 3.5 σ significance

BABAR

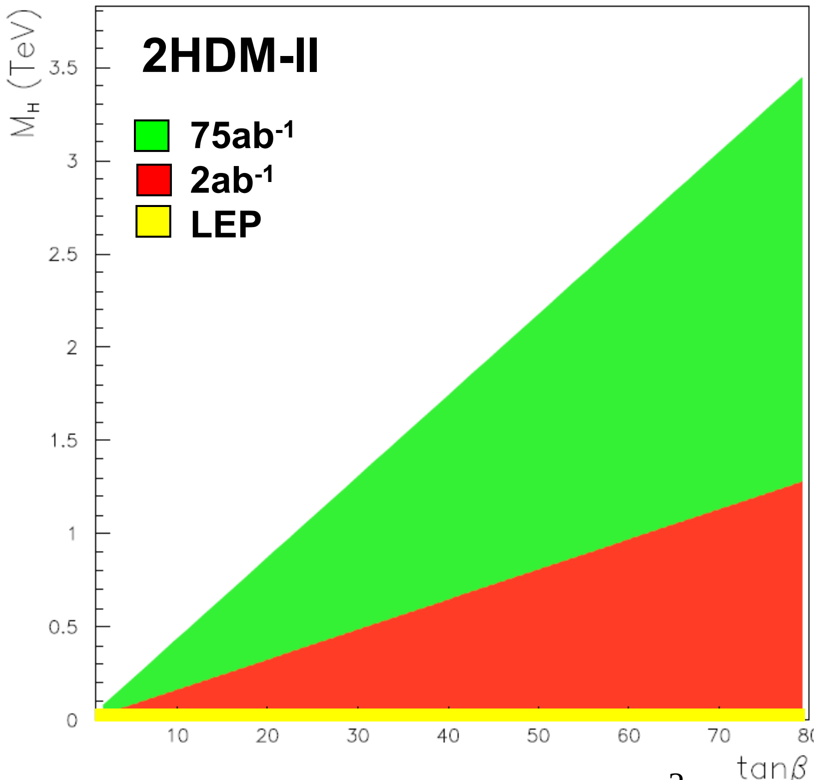
$$\mathcal{B} = (0.88^{+0.68}_{-0.67} \pm 0.11) \times 10^{-4}$$

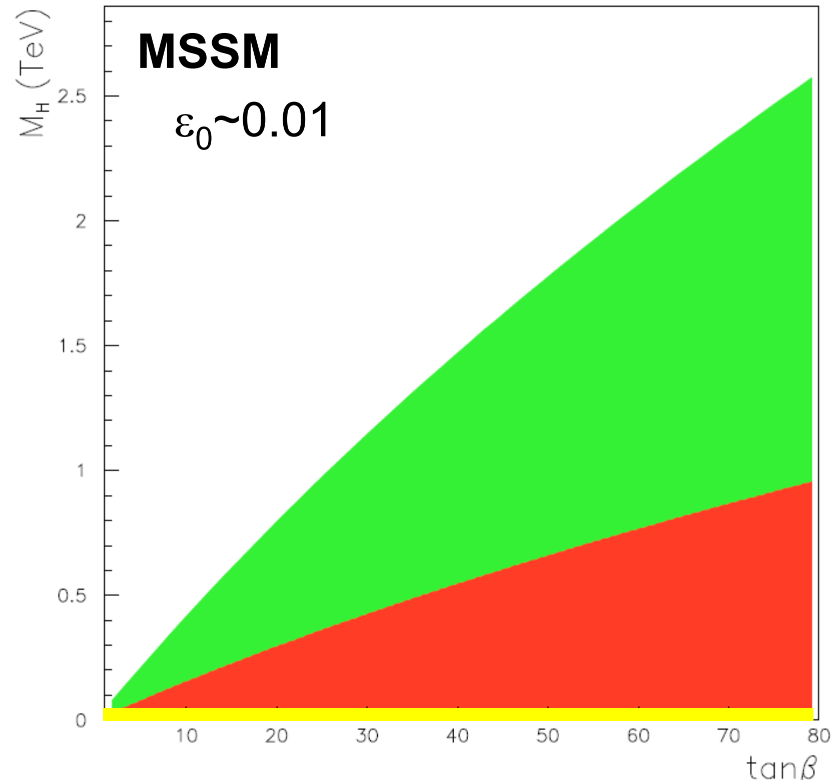
$$\text{BF} < 1.80 \times 10^{-4} @ 90\%\text{CL}$$



BaBar: 320×10^6 B pairs
Belle: 449×10^6 B pairs

$B^+ \to \tau^+ \nu$





$$r_H = \left(1 - \tan^2\beta \frac{m_B^2}{m_H^2}\right)^2$$

$$r_H = \left(1 - \frac{\tan^2\beta}{1+\varepsilon_0 \tan\beta} \frac{m_B^2}{m_H^2}\right)^2$$

- Multi TeV search capability for large tanβ.

Charm equivalent:
$D_s^+ \to \mu^+\nu,\ \tau^+\nu$

Minimal Flavour Violation (MFV)

- Suppose that there are no new physics flavour couplings (MFV).
  - CP violation comes from the known SM Yukawa couplings.
  - NP contribution in $\Delta F=2$ transitions is

SM Scale ~2.4 TeV

$$\Lambda_0 = Y_t \sin^2\theta_W m_W / \alpha$$

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

Wilson coefficient $O(1)$

New Physics Scale

Minimal Flavour Violation (MFV)

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$$\Lambda_0 = Y_t \sin^2\theta_W m_W / \alpha$$

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

Wilson coefficient $O(1)$

New Physics Scale

  - Worst case scenario: sensitive to NP at 600GeV
  - Relaxing the MFV hypothesis gives sensitivity up to 14TeV at a Super B Factory.

Target precision

† Systematics limited
* Theoretically limited.

Observable	B Factories (2 ab^{-1})	Super$B$ (75 ab^{-1})
$\sin(2\beta)$ $(J/\psi\, K^0)$	0.018	0.005 (†)
$\cos(2\beta)$ $(J/\psi\, K^{*0})$	0.30	0.05
$\sin(2\beta)$ (Dh^0)	0.10	0.02
$\cos(2\beta)$ (Dh^0)	0.20	0.04
$S(J/\psi\, \pi^0)$	0.10	0.02
$S(D^+D^-)$	0.20	0.03
$S(\phi K^0)$	0.13	0.02 (*)
$S(\eta' K^0)$	0.05	0.01 (*)
$S(K^0_S K^0_S K^0_S)$	0.15	0.02 (*)
$S(K^0_S \pi^0)$	0.15	0.02 (*)
$S(\omega K^0_S)$	0.17	0.03 (*)
$S(f_0 K^0_S)$	0.12	0.02 (*)
γ $(B \to DK$, $D \to CP$ eigenstates)	$\sim 15^\circ$	2.5°
γ $(B \to DK$, $D \to$ suppressed states)	$\sim 12^\circ$	2.0°
γ $(B \to DK$, $D \to$ multibody states)	$\sim 9^\circ$	1.5°
γ $(B \to DK$, combined)	$\sim 6^\circ$	1–2°
α $(B \to \pi\pi)$	$\sim 16^\circ$	3°
α $(B \to \rho\rho)$	$\sim 7^\circ$	1–2° (*)
α $(B \to \rho\pi)$	$\sim 12^\circ$	2°
α (combined)	$\sim 6^\circ$	1–2° (*)
$2\beta + \gamma$ $(D^{(*)\pm}\pi^\mp$, $D^\pm K^0_S \pi^\mp)$	20°	5°

See Super B workshop V summary talks by

K. George (sin 2β / S rows)

A. Bondar (γ rows)

A. Bevan (α rows)

for recent summaries

Super B Workshop V, http://indico.lal.in2p3.fr/conferenceDisplay.py?confId=167

Target precision

† Systematics limited
* Theoretically limited.

Observable	B Factories (2 ab^{-1})	Super$B$ (75 ab^{-1})
$\|V_{cb}\|$ (exclusive)	4% (∗)	1.0% (∗)
$\|V_{cb}\|$ (inclusive)	1% (∗)	0.5% (∗)
$\|V_{ub}\|$ (exclusive)	8% (∗)	3.0% (∗)
$\|V_{ub}\|$ (inclusive)	8% (∗)	2.0% (∗)
$\mathcal{B}(B \to \tau\nu)$	20%	4% (†)
$\mathcal{B}(B \to \mu\nu)$	visible	5%
$\mathcal{B}(B \to D\tau\nu)$	10%	2%
$\mathcal{B}(B \to \rho\gamma)$	15%	3% (†)
$\mathcal{B}(B \to \omega\gamma)$	30%	5%
$A_{CP}(B \to K^*\gamma)$	0.007 (†)	0.004 († ∗)
$A_{CP}(B \to \rho\gamma)$	~ 0.20	0.05
$A_{CP}(b \to s\gamma)$	0.012 (†)	0.004 (†)
$A_{CP}(b \to (s+d)\gamma)$	0.03	0.006 (†)
$S(K_S^0\pi^0\gamma)$	0.15	0.02 (∗)
$S(\rho^0\gamma)$	possible	0.10
$A_{CP}(B \to K^*\ell\ell)$	7%	1%
$A^{FB}(B \to K^*\ell\ell)s_0$	25%	9%
$A^{FB}(B \to X_s\ell\ell)s_0$	35%	5%
$\mathcal{B}(B \to K\nu\bar{\nu})$	visible	20%
$\mathcal{B}(B \to \pi\nu\bar{\nu})$	–	possible

The physics programme

The physics programme

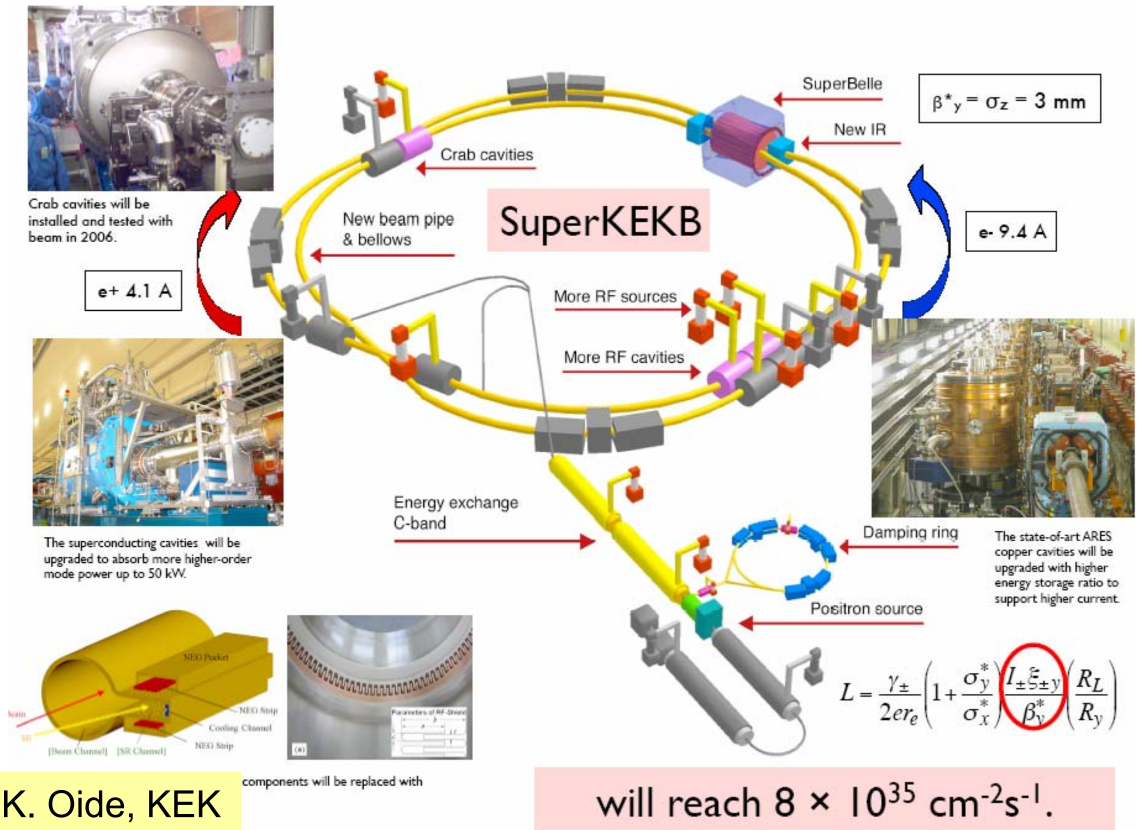
The physics programme

Overview

- Physics
  - Super B physics case.
  - Matter-antimatter asymmetry.
  - Higgs and new physics constraints.
- Accelerator
  - Physics driven target luminosity.
  - Location(s) and current design.
- Detector
  - Current design.
- Conclusions

Physics driven target luminosity: 10^{36}

- Most measurements are experimentally limited with data samples of $75ab^{-1}$.
- To achieve this in a reasonable time, we need to have a luminosity of $\sim 10^{36}\ cm^{-2}s^{-1}$.

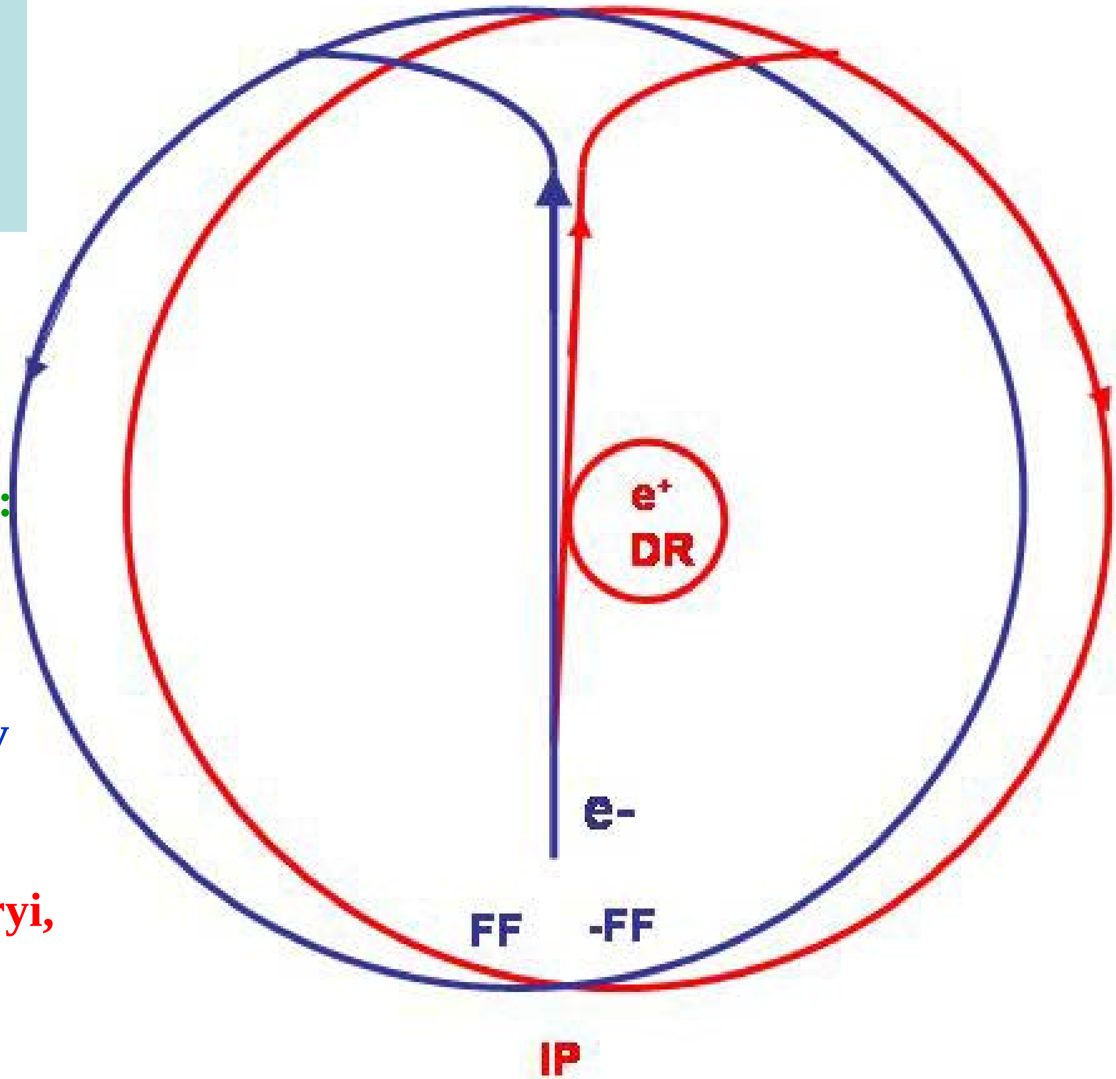


K. Oide, KEK

- **Upgrading KEK-B will give $\mathcal{L} \sim 0.5 \times 10^{36}$.**
- **Limited by power budget of the lab.**
- **Expensive to operate vs. low emittance concept.**

Accelerator concept

Based on ILC damping ring and final focus designs.



SuperB Contributors (Accelerator):
BINP: Koop, Levichev, Shatilov
KEKB: Ohmi

LNF: Biagini, Raimondi, Zobov

Pisa: Giorgi, Paoloni
SLAC: Novokhatski, Seeman, Seryi, Sullivan, Wienands

Crossing angle = 2*15 mrad

Ring Parameters

Energy (GeV)	4	7
C (m)	2762	2762
B_w (T)	1.4	1.05
L_{bend}(m)	2.1	10.8
N. bends	96	96
B_{bend} (T)	0.439	0.144
Uo (MeV/turn)	2.3	4.1
Wiggler sections	4	4
σ_z (mm)	7.0	7.0
τ_s (ms)	17	17
ε_x (nm)	0.79	0.71
Emittance ratio	0.25%	0.25%
ΔE	1.0×10^{-3}	1.1×10^{-3}
Momentum compaction	1.85×10^{-4}	3.90×10^{-4}
ν_s	0.012	0.026
Vrf (MV)	5.5	19
N_{part} ($\times10^{10}$)	3.31	1.89
I_{beam} (A)	2.5	1.44
Tousheck lifetime (min)	95	1100
P_{beam}(MW)	5.7	5.9
Frf (MHz)	476	
$N_{bunches}$	4167	
Gap	5%	
P_{wall} (MW) (50% eff) 2 rings	23.2	

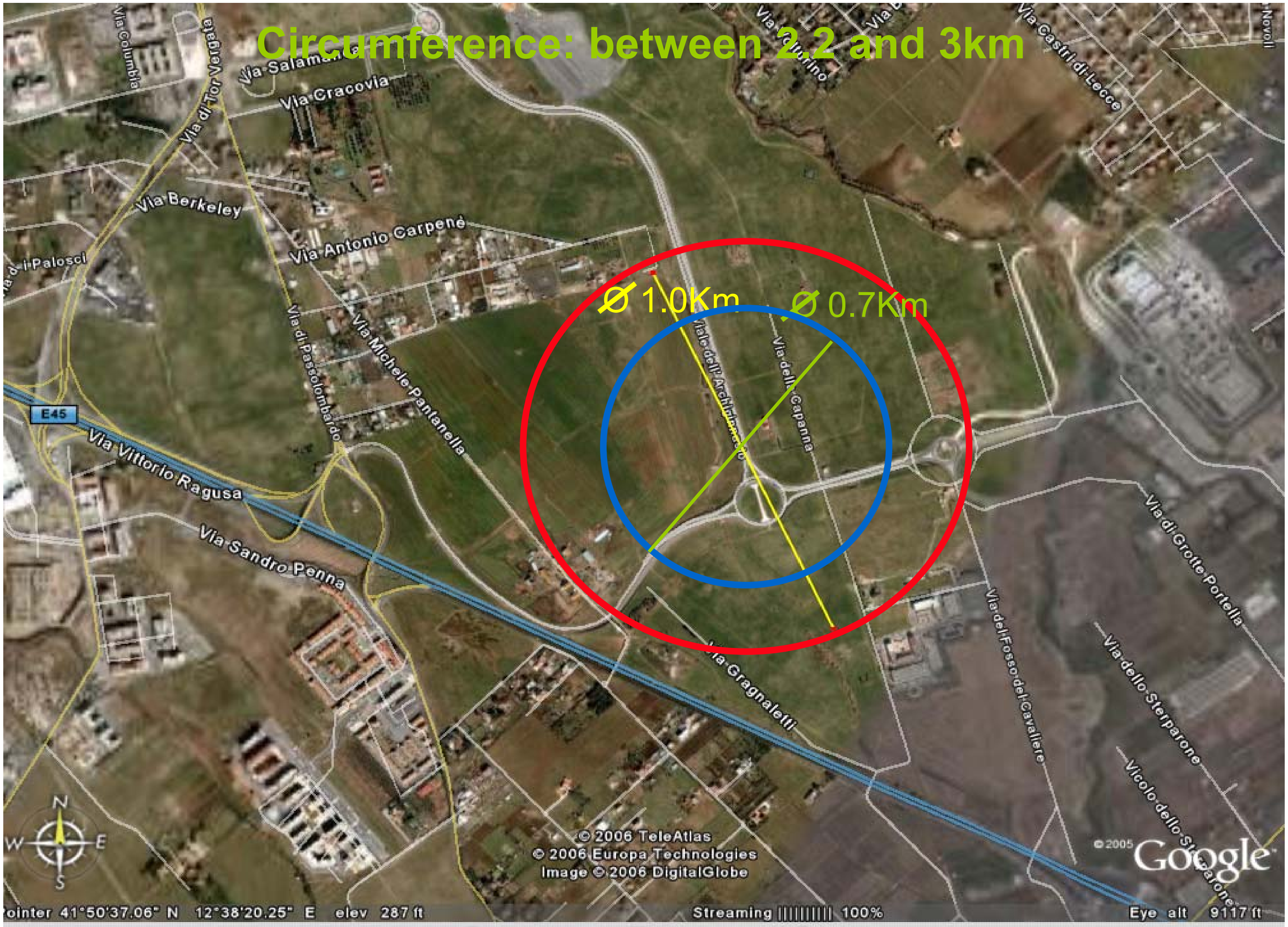
IP Parameters

βx	20mm
σx	4μm
σxp	200μrad
βy	200μm
σy	20nm
σyp	100μrad
σz	7mm
$2^*\theta$	30mrad

$L > 10^{36}\ cm^{-2}\ s^{-1}$

POWER: 35MW

Possible Site: Tor Vergata Campus (Rome)



Overview

- Physics
  - Super B physics case.
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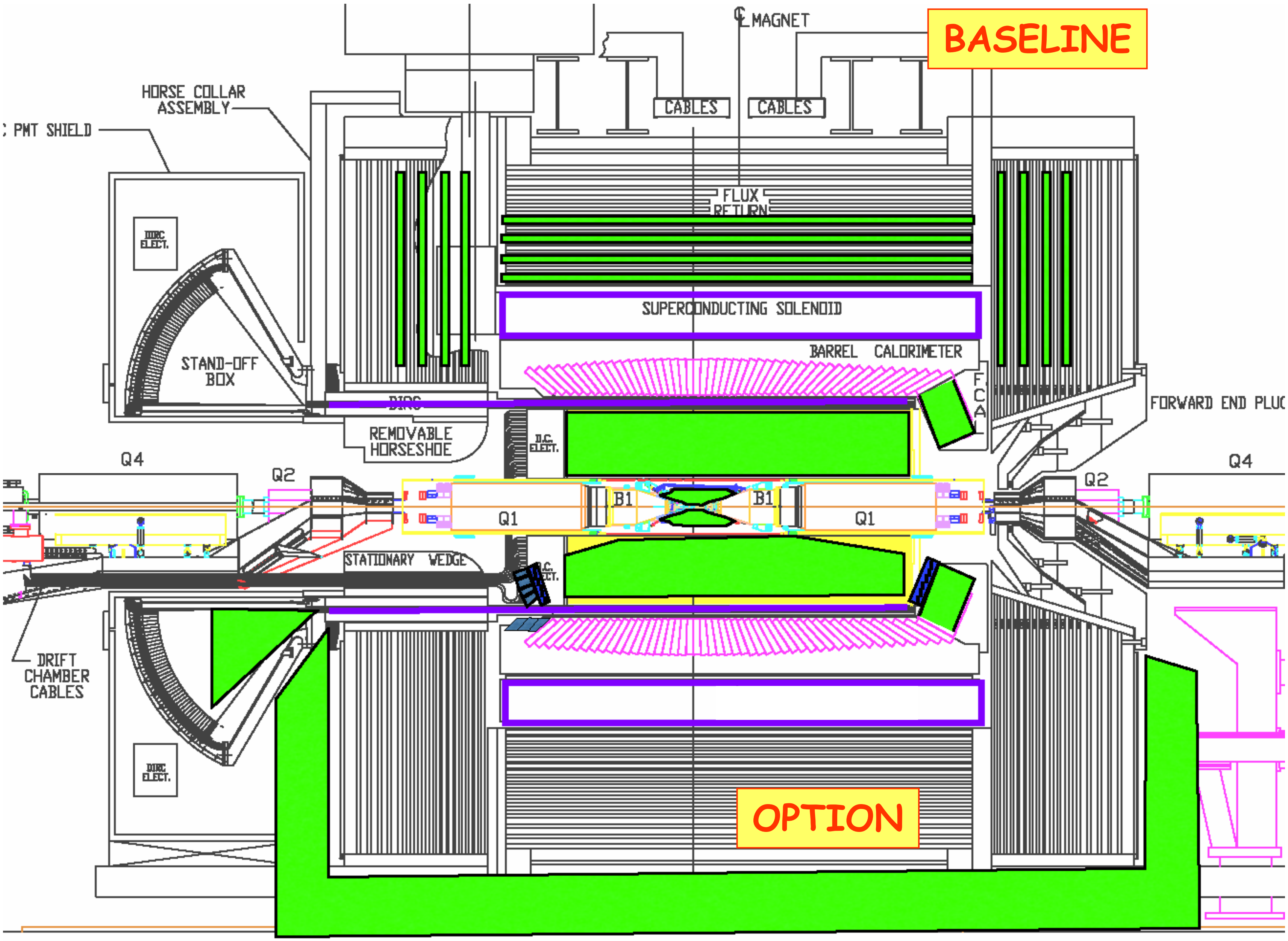
  - Higgs and new physics constraints.
- Accelerator
  - Physics driven target luminosity.
  - Location(s) and current design.
- Detector
  - Current design.
- Conclusions

Current design



Project Timeline

- Overall schedule dominated by:
  - Site construction
  - PEP-II/Babar disassembly, transport, and reassembly
- Possible to reach the commissioning phase after 5 years from T0.
- Physics from circa 2015.

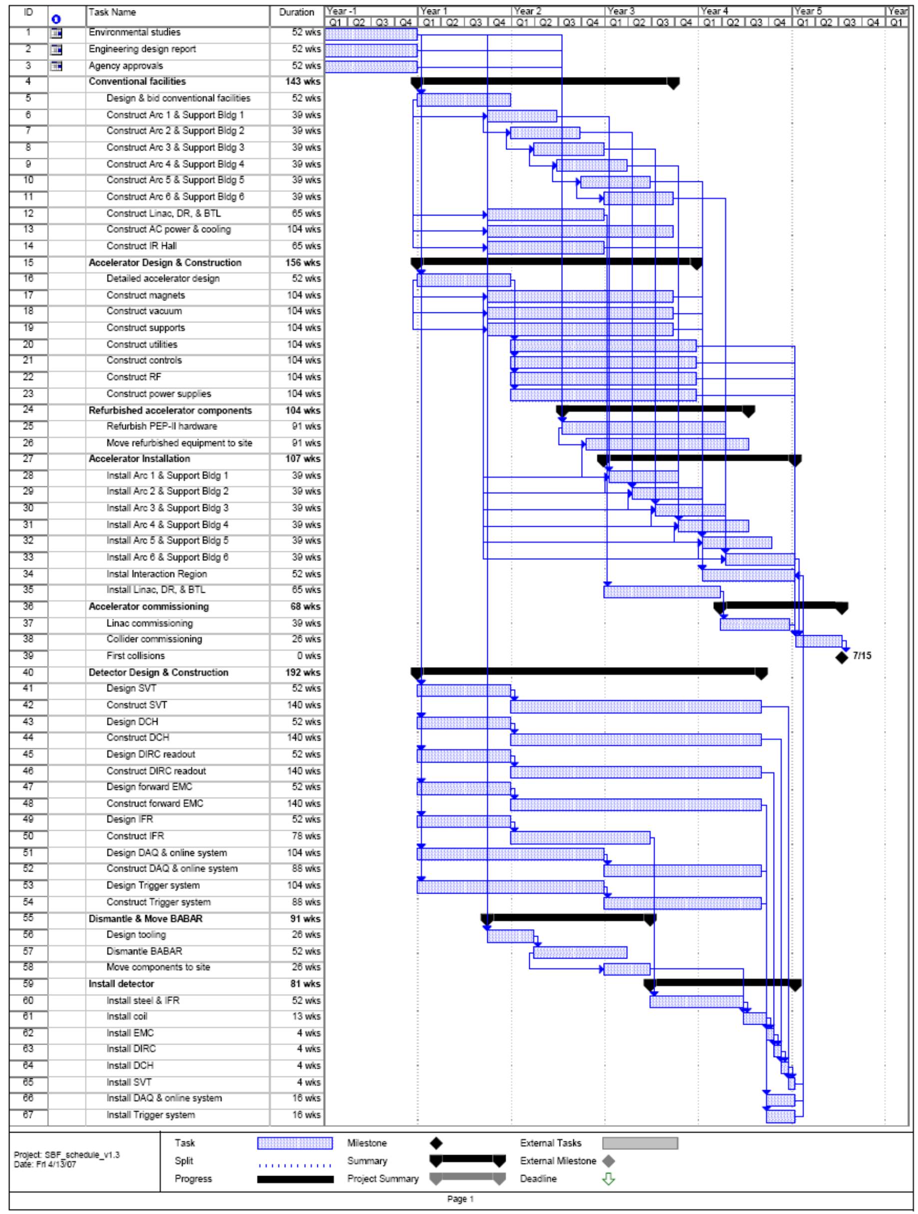


Figure 5-1. *Overall schedule for the construction of the SuperB project.*

Overview

- Physics
  - Super B physics case.
  - Matter-antimatter asymmetry.
  - Higgs and new physics constraints.
- Accelerator
  - Physics driven target luminosity.
  - Location(s) and current design.
- Detector
  - Current design.
- Conclusions

Conclusions

- Worlds largest samples of:
  - B-mesons 80 billion
  - D-mesons 40 billion
  - τ-leptons 64 billion

  } in 75 ab^{-1}

- Worlds brightest e^+e^- collider: 10^{36} $cm^{-2}s^{-1}$
  - Highest luminosity e^+e^- collider proposed.
  - Highest e^+ and e^- currents ever stored in an accelerator [4.6 A and 2.6 A, respectively].

- Massive amounts of data written to disk:
  - BaBar has over several hundred Tb of data on disk, Super B would collect tens of Pb.
  - Need GRID technology.
  - Need alternative storage media for analysis?

Conclusions

- Matter-antimatter asymmetry:
  - Precision constraint of CKM mechanism through α (1°) and β (0.2°) measurements.
  - Over-constrain mechanism with γ (1°), V_{ub}, and V_{cb} measurements.

- Higgs and new physics:
  - Provide indirect constraints up to 14TeV.
  - Elucidate flavour couplings beyond the SM.
  - … explain the matter-antimatter asymmetry?

F. Forti, Pisa

Cost estimate

- A full cost estimate of the SuperB project has been done
  - Based on Babar/PEP-II actual costs
  - Escalated from 1995 to 2007
  - Bottom-up for almost all elements
- Separate new components from reused elements
  - Replacement value of reused components = how much would it cost today to rebuild those components (extrapolated from Babar/PEP-II costs)
  - New costs: everything that's needed today, including refurbishing
  - Transport is not included, but disassembly and reassembly is.
- Keep separate categories:
  - EDIA: engineering, design, inspection and administration (man-months)
  - Labour: technicians (man-months)
  - Materials and Services: 2007 Euros.
- All details available in the CDR
  - We have not tried to fully optimize the cost yet. Some reduction might be possible

F. Forti, Pisa

Accelerator and site costs

WBS	Item	EDIA mm	Labor mm	M\&S kEuro	Rep.Val. kEuro
1	**Accelerator**	**5429**	**3497**	**191166**	**126330**
1.1	Project management	2112	96	1800	0
1.2	Magnet and support system	666	1199	28965	25380
1.3	Vacuum system	620	520	27600	14200
1.4	RF system	272	304	22300	60000
1.5	Interaction region	370	478	10950	0
1.6	Controls, Diagnostics, Feedback	963	648	12951	8750
1.7	Injection and transport systems	426	252	86600	18000

WBS	Item	EDIA mm	Labor mm	M\&S kEuro	Rep.Val. kEuro
2.0	**Site**	**1424**	**1660**	**105700**	**0**
2.1	Site Utilities	820	1040	31700	0
2.2	Tunnel and Support Buildings	604	620	74000	0

Note: site cost estimate not as detailed as other estimates.

F. Forti, Pisa

Detector cost

WBS	Item	EDIA mm	Labor mm	M\&S kEuro	Rep.Val. kEuro
1	**SuperB detector**	**3391**	**1873**	**40747**	**46471**
1.0	**Interaction region**	**10**	**4**	**210**	**0**
1.1	**Tracker (SVT + L0 MAPS)**	**248**	**348**	**5615**	**0**
1.1.1	**SVT**	**142**	**317**	**4380**	**0**
1.1.2	***L0 Striplet option***	***23***	***33***	***324***	***0***
1.1.3	**L0 MAPS option**	**106**	**32**	**1235**	**0**
1.2	**DCH**	**113**	**104**	**2862**	**0**
1.3	**PID (DIRC Pixilated PMTs + TOF)**	**110**	**222**	**7953**	**6728**
1.3.1	**DIRC barrel - Pixilated PMTs**	**78**	**152**	**4527**	**6728**
1.3.1	***DIRC barrel - Focusing DIRC***	***92***	***179***	***6959***	***6728***
1.3.2	**Forward TOF**	**32**	**70**	**3426**	**0**
1.4	**EMC**	**136**	**222**	**10095**	**30120**
1.4.1	**Barrel EMC**	**20**	**5**	**171**	**30120**
1.4.2	**Forward EMC**	73	152	6828	0
1.4.3	**Backward EMC**	42	65	3096	0
1.5	**IFR (scintillator)**	**56**	**54**	**1268**	**0**
1.6	**Magnet**	**87**	**47**	**1545**	**9623**
1.7	**Electronics**	**286**	**213**	**5565**	**0**
1.8	**Online computing**	**1272**	**34**	**1624**	**0**
1.9	**Installation and integration**	**353**	**624**	**3830**	**0**
1.A	**Project Management**	**720**	**0**	**180**	**0**

Note: options in italics are not summed. We chose to sum the options we considered most likely/necessary.

F. Forti, Pisa

Schedule

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- Physics from circa 2015.

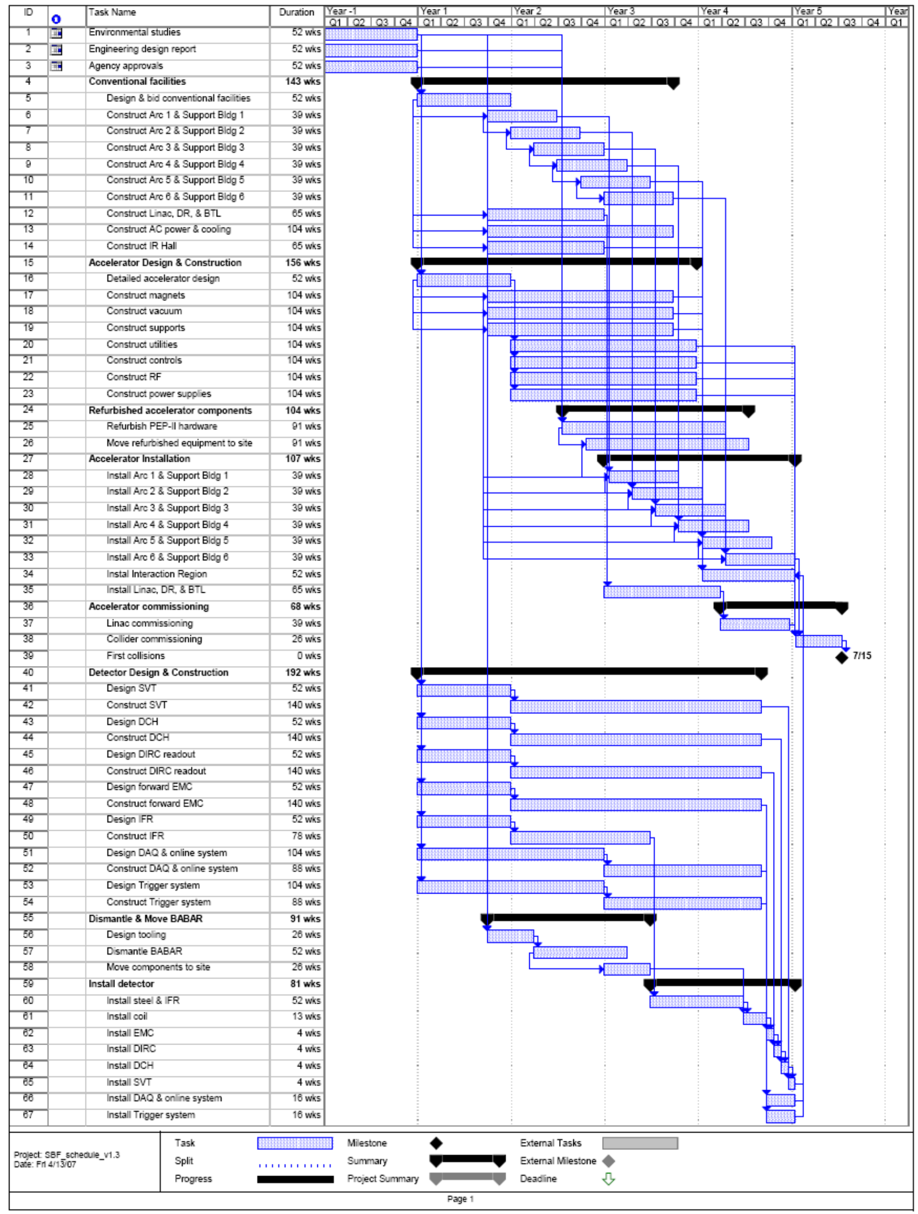


Figure 5-1. *Overall schedule for the construction of the SuperB project.*

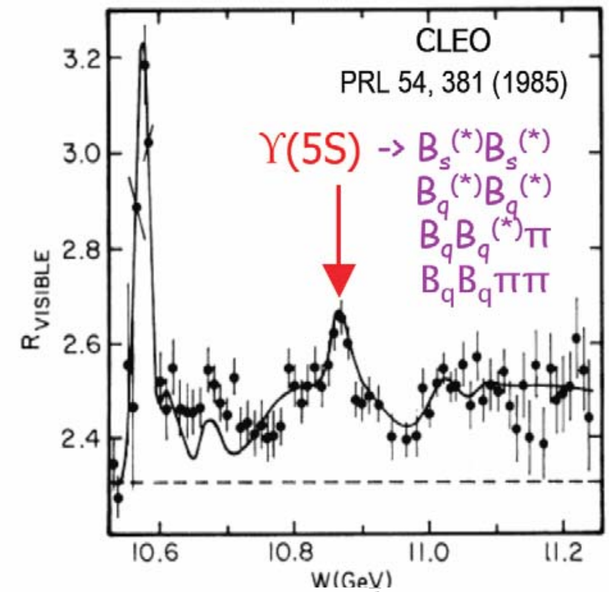
What money ?

F. Forti, Pisa

- The SuperB budget model still needs to be fully developed. It is based on the following elements (all being negotiated)
  - Italian government ad hoc contribution
  - Regione Lazio contribution
  - INFN regular budget
  - EU contribution
  - In-kind contribution (PEP-II + Babar elements)
  - Partner countries contributions
- Clearly the SuperB project is inherently international and will need to be managed internationally

Υ(5S) Potential

- Can collect ~30ab^{-1} @ Υ(5S)
  - Access to $B_s^{(*)}$ mesons.
  - e.g. Time integrated analysis:
    - See Baracchini et al., hep-ph/0703258, F. Renga at the Super B V WS.

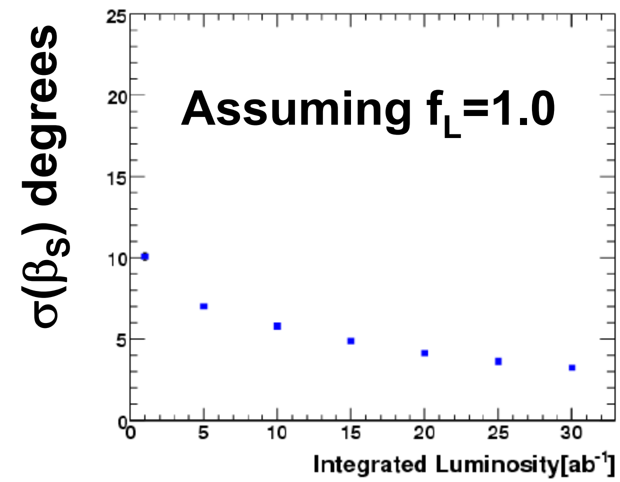


$$A_{CP}^{f} = \left(\frac{1-y^2}{1+x^2}\right)^2 \frac{(1-x^2)(1-|\lambda_{CP}^{f}|^2) + 4x\mathcal{I}m(\lambda_{CP}^{f})}{(1+y^2)(1+|\lambda_{CP}^{f}|^2) - 4y\mathcal{R}e(\lambda_{CP}^{f})}$$

$$\lambda_{CP}^{f} = \frac{q}{p}\frac{\overline{A}_f}{A_f}$$

$$x = \Delta m/\Gamma, \; y = \Delta\Gamma/2\Gamma$$

- Can measure β_s to <5° from $B_S \rightarrow J/Psi\ \phi$ using the sign of Δt.



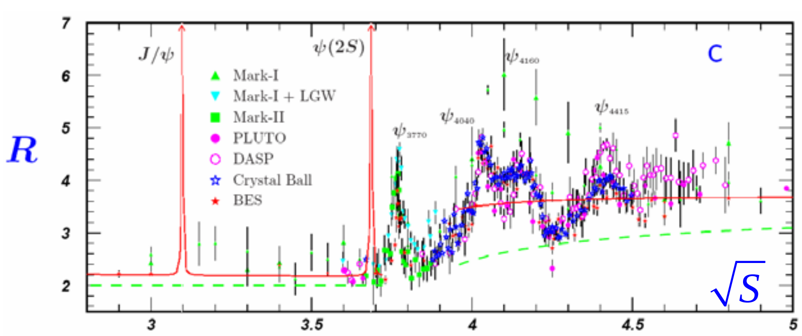
Charm Physics

e.g. see Bigi, hep-ph/0608225

- Charm sector is unique: only up type quark to give access to the full range of NP effects.
- Provides tools to validate QCD and theoretical tools B-physics studies.
- Improve understanding of D^0-$\bar{D}^0$ mixing.

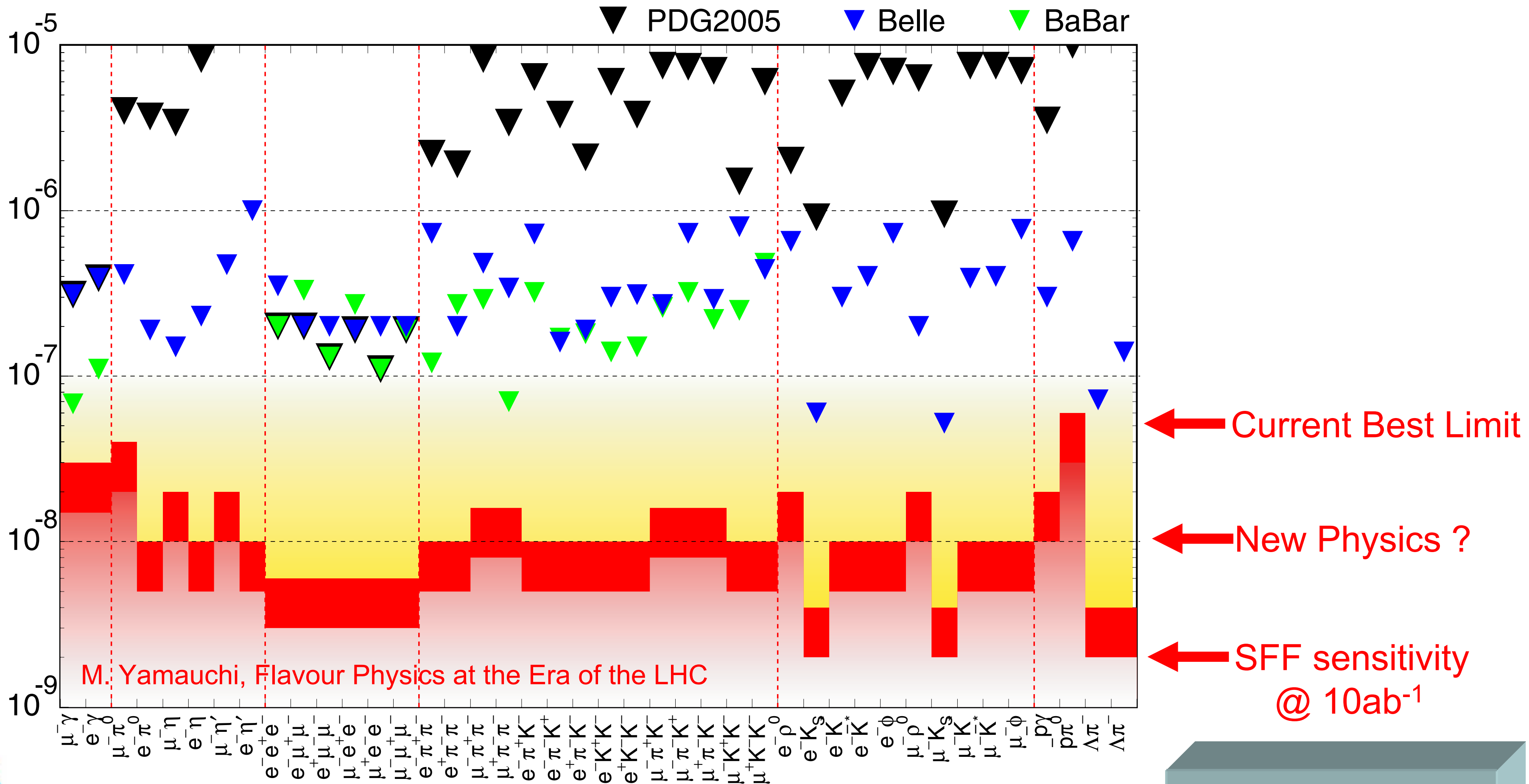
$$x \equiv 2\frac{m_B - m_A}{\Gamma_B + \Gamma_A}, \quad y \equiv \frac{\Gamma_B - \Gamma_A}{\Gamma_B + \Gamma_A}$$

- Search for CPV in D decay.
  - Rich structure in $D \to PP$, PV, VV decays (c.f. B decays).
    - $\Delta C=1$ and $\Delta C=2$ transitions.
    - VV decays sensitive to T-odd triple products and provide windows on the dynamics of the processes involved.
    - Time dependent Dalitz plots needed to fully exploit this area (c.f. $B \to \pi^+\pi^-\pi^0$).
- Charm baryons.
  - Λ_c branching fractions.
- Precision R scan.



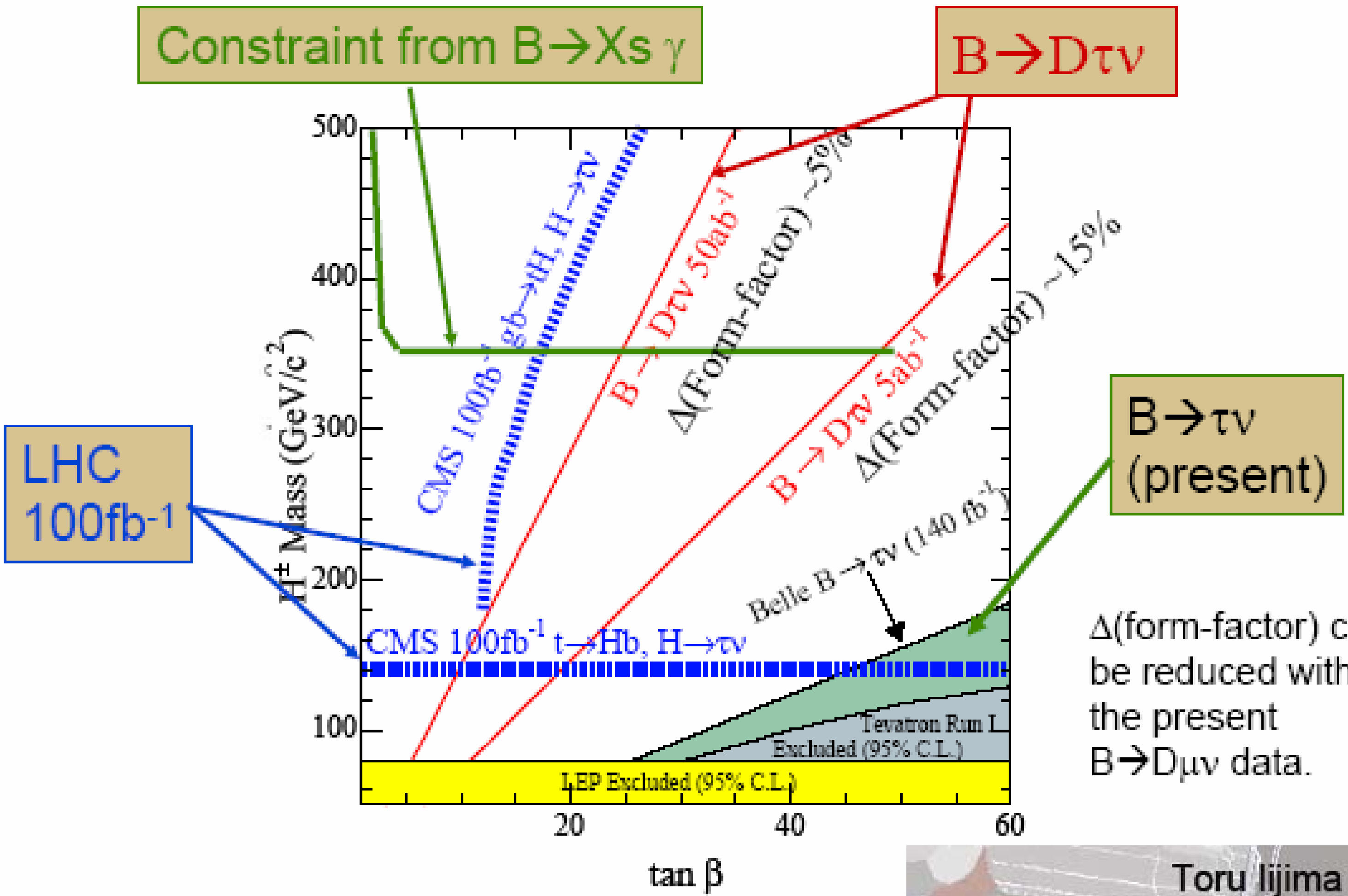
τ physics

- CDR comprehensively covers LFV searches.
- SUSY breaking at low energies should result in large FCNC [e.g. $\tau \to \mu\gamma$, $\mu \to e\gamma$].



+ NP searches

NP constraint projection (2005)



Δ(form-factor) can be reduced with the present B→Dμν data.

Toru Iijima
Nagoya University

April 20, 2005
2nd Super B Factory Workshop in Hawaii