The SuperB project: physics and detector

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Les Rencontres de Physique de la Vallée d'Aoste

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The role of SuperB

* New Physics (NP) is expected beyond the Standard Model
  - at what scale Λ? 0.5,1, 10…10^{16} TeV?

* Two scenarios:
  - LHC finds New Physics (Λ is known)
    - SuperB can study the flavour structure of NP, measure the flavour couplings, search for even heavier states
  - The NP scale is above the LHC reach
    - explore the NP scale beyond the LHC reach (up to $\Lambda \sim$ 10TeV or more), look for indirect NP signals, understand where they may come from

$$\frac{|\delta_{bq}|}{\Lambda_{eff}}$$

* *Complementary* to LHC
  - Many rare decay final states are only accessible to SuperB
  - Sensitive to off-diagonal terms in the squark mixing matrix.
  - Test *CP*, *CPT*, and Lepton Flavour Violation (LFV) in τ decay, τ anomalous magnetic moment.
  - Search for *CP* (and *CPT*) violation in *D* decays
  - possibility of running at different CM energies

Data sample of the Super Flavour Factory

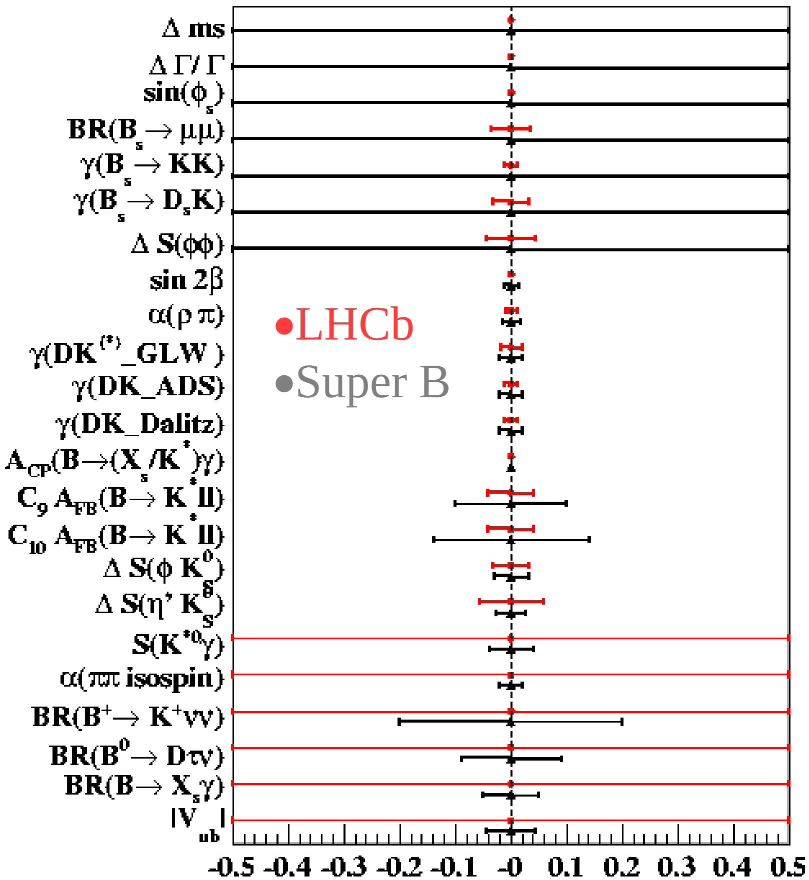
* sensitivity goals of SuperB project achievable with a dataset ~ two orders of magnitude larger than current B-factories
  – BaBar/Belle: 0.53/0.85ab^{-1} (tot: 1.5x10^{9} Y(4S)→BB)
* baseline Luminosity: L=10^{36} cm^{-2} s^{-1} . Compare peak luminosity of BaBar (1.2x10^{34}) and Belle (1.7x10^{34})
* 5 years of running at L=10^{36} cm^{-2} s^{-1} → 75ab^{-1}
* possibility of running at
  – $\Psi(3770)$→DD , Y(5S)→BsBs
* above dataset with:
  – increased detector hermiticity w.r.t. BaBar
  – machine backgrounds expected to be comparable(?) to BaBar
  – reasonable electricity costs

Super Flavour factory vs. Super LHCb

Sensitivity Comparison

LHCb 100 fb^{-1} vs Super-B factory 50 ab^{-1}

sLHCb reach from G. Wilkinson
1st LHCb collaboration upgrade workshop



Preliminary

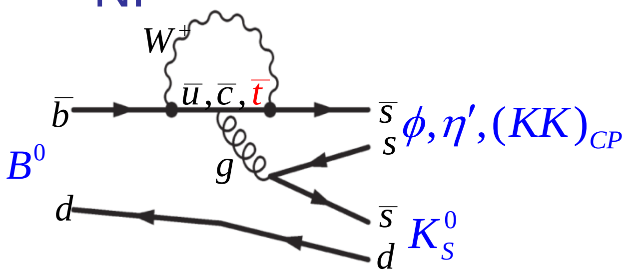
B_s time dependent analysis only accessible to LHCb

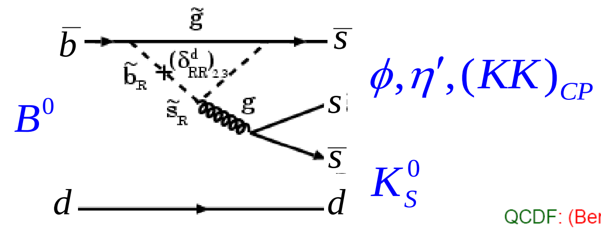
Common

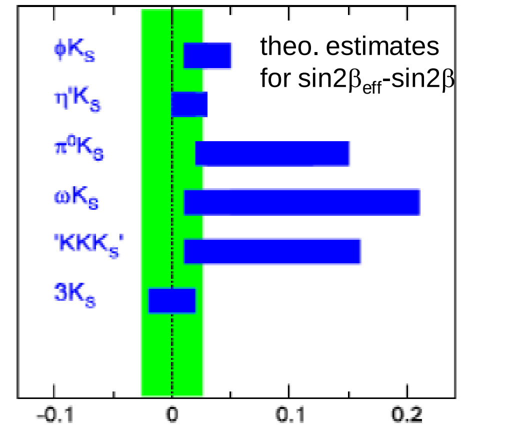
No neutrals, ν, only accessible to SuperB

New Physics in |ΔF|=1 transitions

- FCNC processes mediated by loops in SM can receive significant contributions from NP



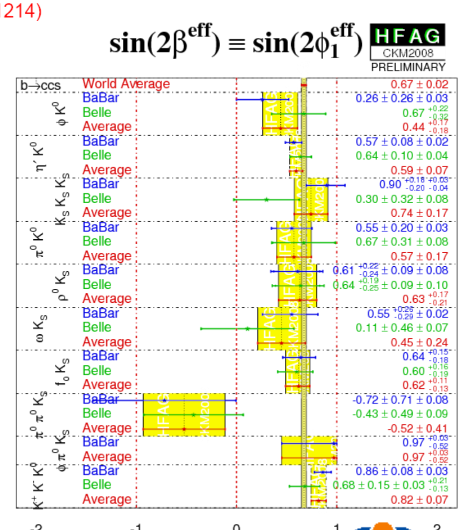




QCDF: (Beneke, PLB620 (2005), 143-150, Cheng et al., PRD72 (2005) 094003 etc.
SCET: (Williamson & Zupan, hep-ph/0601214)

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

- SM corrections to the dominant loop diagram must be evaluated carefully
  - O(0.01) correction for B→η'Ks and 3Ks
  - SM corrections tend to prefer $\sin 2\beta_{eff}-\sin 2\beta>0$
  - exp. results overall statistically compatible with SM
- Need to look at as many modes as possible
- With SuperB @75ab^{-1} exp. errors at the level of 0.01-0.03, smaller than theory uncertainties

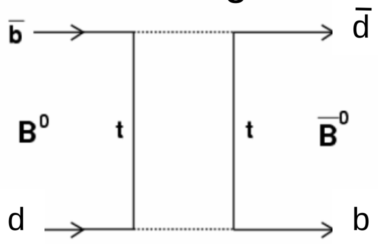


New Physics in |ΔF|=2 transitions

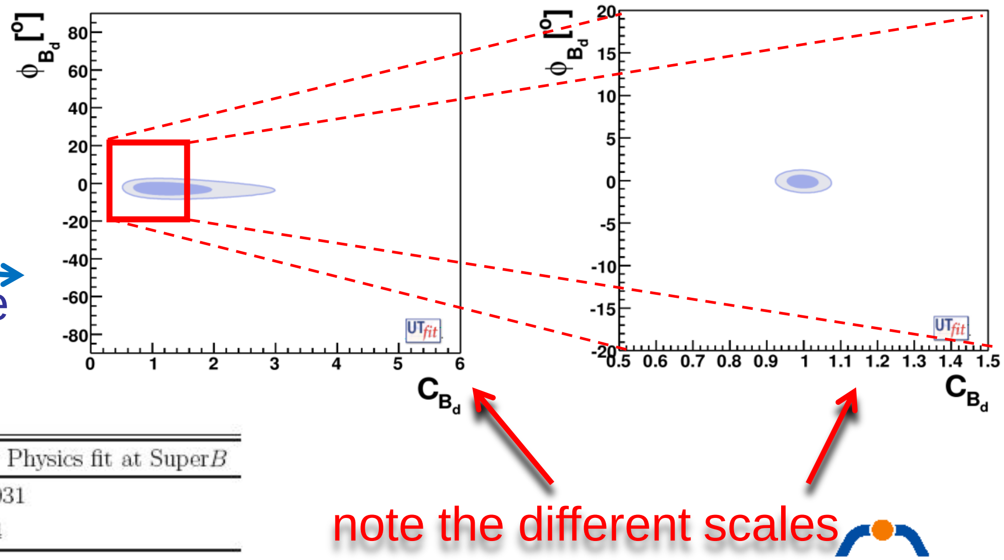
- ΔF=2 transitions mediated by box diagrams
- NP can contribute to these processes
  - parameterize NP as:

$$C_q e^{i\phi_q} = \frac{\langle B_q^0 | H_{SM+NP} | \overline{B}_q^0 \rangle}{\langle B_q^0 | H_{SM} | \overline{B}_q^0 \rangle}$$

B mixing



hep-ph/0509219



- In SM C_q=1 and ϕ_q=0
- present measurements already constrain NP in B_d mixing
- SuperB will dramatically improve the constraint

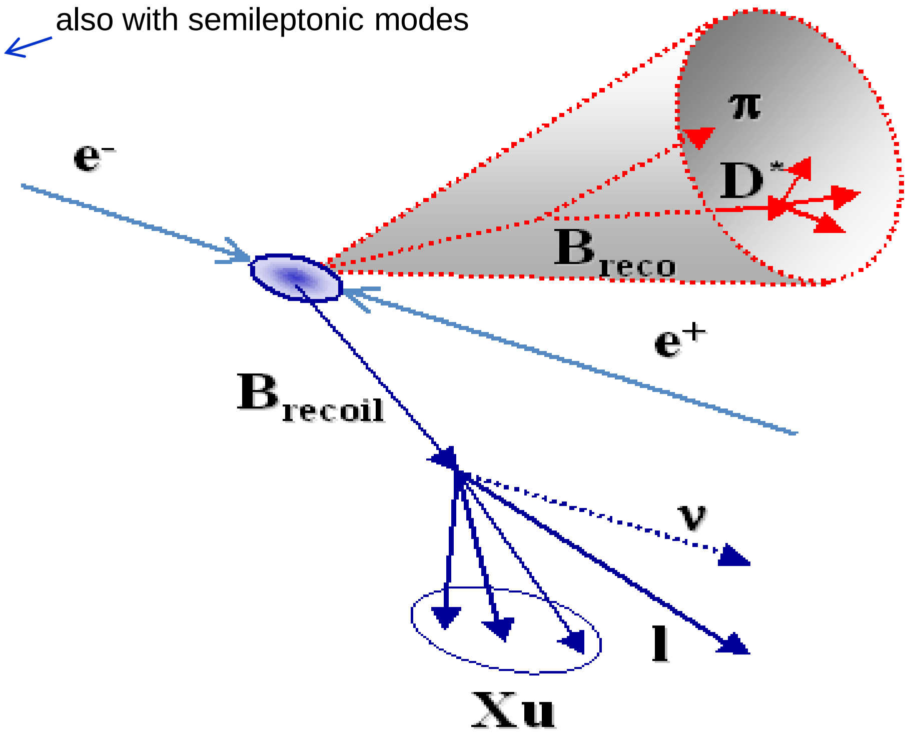
Parameter	New Physics fit today	New Physics fit at SuperB
C_{B_d}	1.24 ± 0.43	± 0.031
ϕ_{B_d} (°)	-3 ± 2	± 0.4

B-recoil technique

Powerful technique possible only at e^+e^- B-factories

- Fully reconstruct one of the two B in hadronic modes
  - Relatively high efficiency: a few 0.1%
  - $> 10^7$ recoil B's in $10ab^{-1}$
- Search signal B decay in the remaining of the event
  - High purity sample
  - Can look at channels with a lot of missing energy
  - For example BR(B→nothing) measured, $B \to K\nu\bar{\nu}$, $B \to \tau\nu$, ...

also with semileptonic modes



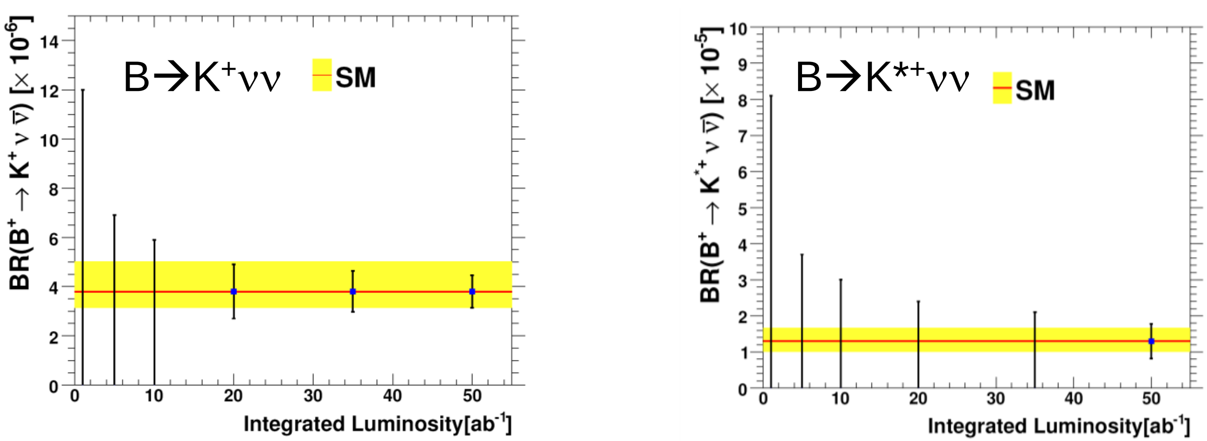
unique feature of e^+e^- machine

Recoil kinematics well known
Recoil flavour and charge are determined

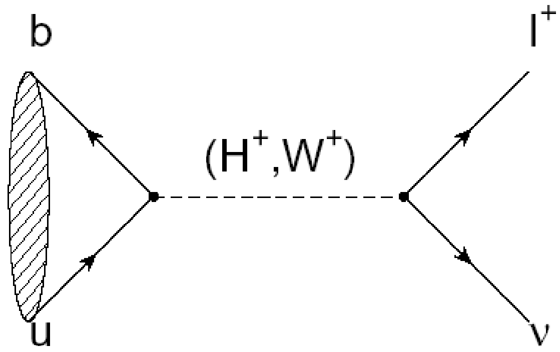
NP search in B→s invisible

* $B \to K^{(*)} \nu\bar{\nu}$ can probe NP in Z^0 penguins
* Best exp. bound: $BF(B \to K \nu\bar{\nu}) < 14 \times 10^{-6}$
* SM prediction: 4×10^{-6} → 20% error with $75 ab^{-1}$
* B-recoil analysis crucial for this analysis
  – measurement only possible at e^+e^- (Super)B-factories
  – important to improve detector hermiticity: bkg-dominated, 30% bkg reduction corresponds to 1/0.7~1.40 more luminosity

closely related to $K \to \pi\nu\bar{\nu}$



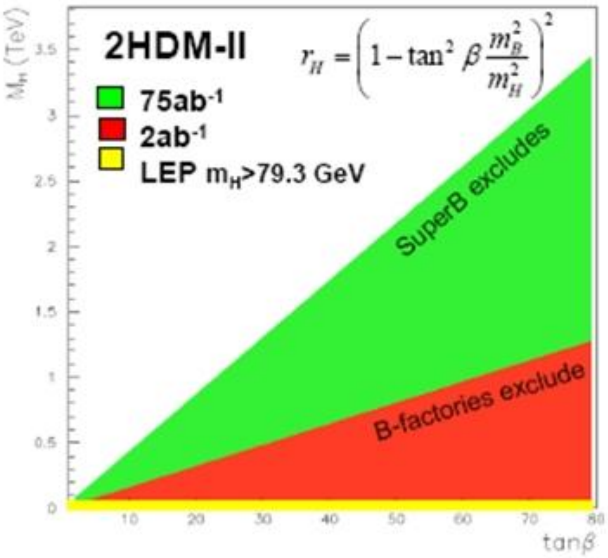
NP constraints from B→lν in large tanβ scenarios



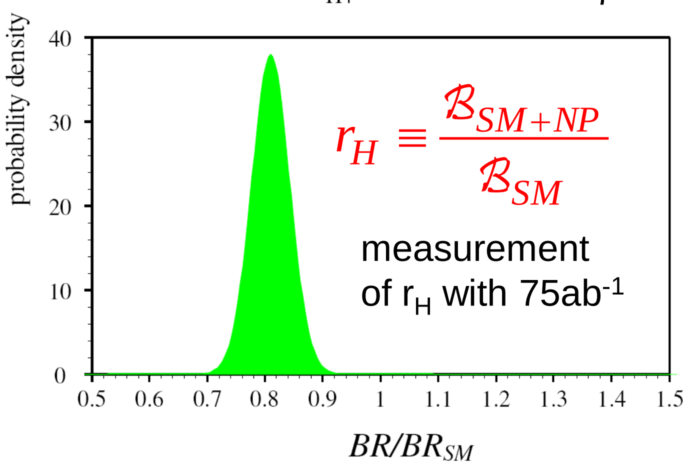
SUSY Higgs contribution in 2HDM

$$r_H \equiv \frac{\mathcal{B}_{SM+NP}}{\mathcal{B}_{SM}} = \left(1 - \frac{m_B^2}{m_H^2}\tan^2\beta\right)^2$$

exclusion regions in the m(H⁺)-tanβ plane from BF(B→τν) and BF(B→μν)



M_{H+} = 500 GeV tanβ=30



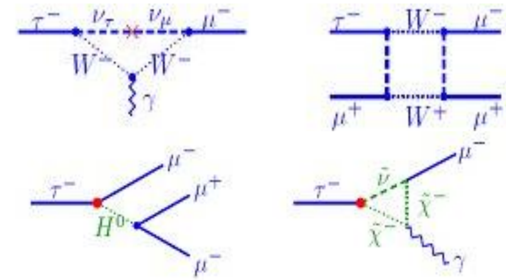
$$r_H \equiv \frac{\mathcal{B}_{SM+NP}}{\mathcal{B}_{SM}}$$

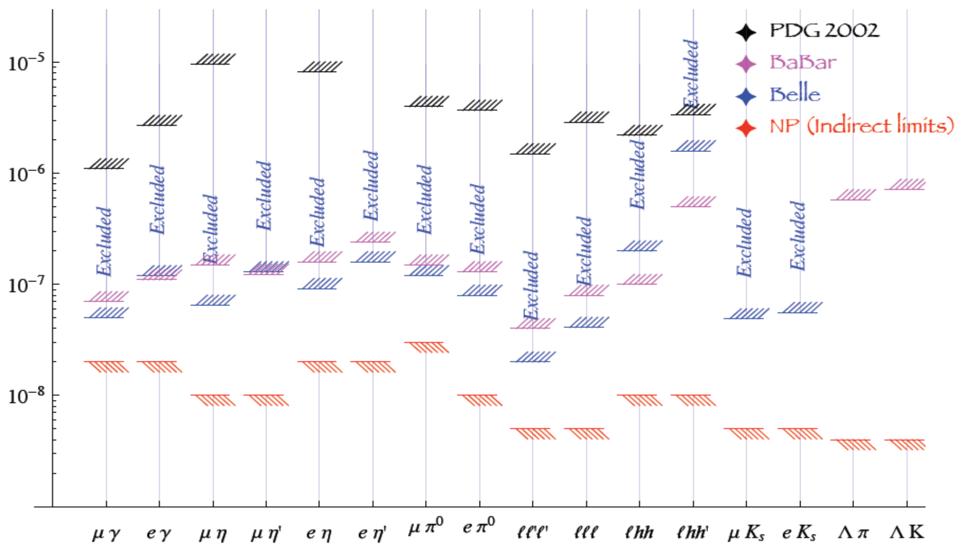
measurement of r_H with $75ab^{-1}$

SuperB is a tau factory

- $\sigma(\tau^+\tau^-)$=0.89nb @ CM E=M(Y(4S))
- ~12 billions tau pairs/year

- LFV negligeably small in SM
- larger in several SM extensions





Process	Sensitivity @75 ab^{-1}
$\mathcal{B}(\tau \to \mu\,\gamma)$	2×10^{-9}
$\mathcal{B}(\tau \to e\,\gamma)$	2×10^{-9}
$\mathcal{B}(\tau \to \mu\,\mu\,\mu)$	2×10^{-10}
$\mathcal{B}(\tau \to eee)$	2×10^{-10}
$\mathcal{B}(\tau \to \mu\eta)$	4×10^{-10}
$\mathcal{B}(\tau \to e\eta)$	6×10^{-10}
$\mathcal{B}(\tau \to \ell K^0_S)$	2×10^{-10}

further improvement with polarized beam

decay	$f = 500$ GeV
$\tau \to e\gamma$	$1 \cdot 10^{-8}$
$\tau \to \mu\gamma$	$2 \cdot 10^{-8}$
$\tau^- \to e^- e^+ e^-$	$2 \cdot 10^{-8}$
$\tau^- \to \mu^- \mu^+ \mu^-$	$3 \cdot 10^{-8}$

upper bound on LFV decay BF in LHT model with NP scale f=500GeV

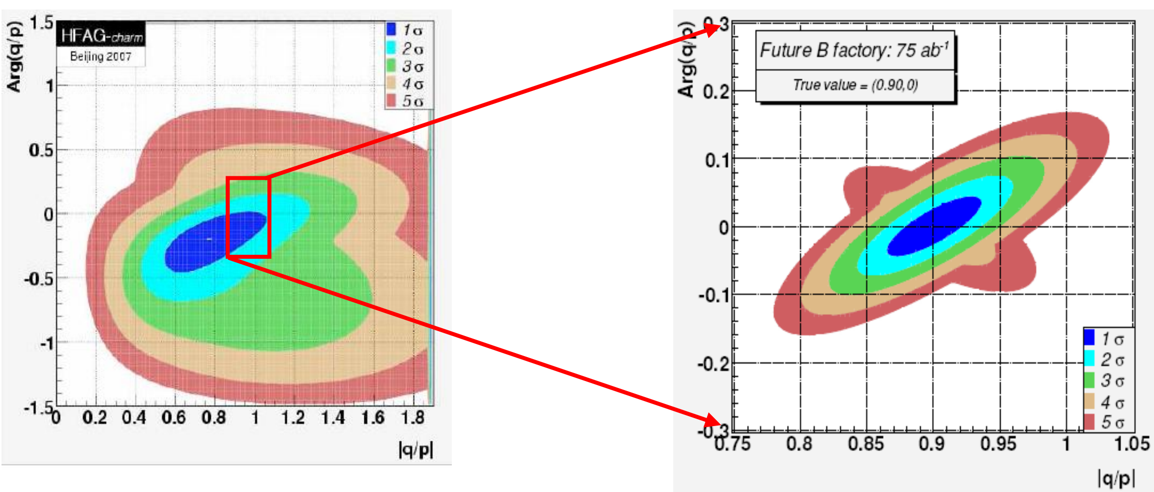
CPV in charm decays

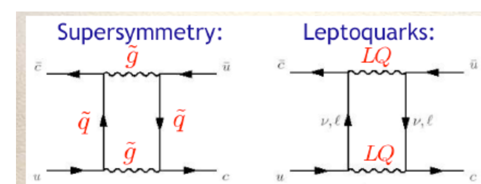
- D mixing observed by BaBar and Belle
- Size of charm sample at SuperB reduces errors by an order of magnitude
- Plus, possibility of running @ Ψ(3S):

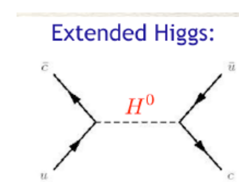
in 4 months ~0.3ab^{-1} → 1000x CLEO-c, 10x BESIII !!

Mode	Observable	B Factories (2 ab^{-1})	Super$B$ (75 ab^{-1})
$D^0 \to K^+K^-$	y_{CP}	2–3×10^{-3}	5×10^{-4}
$D^0 \to K^+\pi^-$	y'_D	2–3×10^{-3}	7×10^{-4}
	x'^2_D	1–2×10^{-4}	3×10^{-5}
$D^0 \to K^0_S\pi^+\pi^-$	y_D	2–3×10^{-3}	5×10^{-4}
	x_D	2–3×10^{-3}	5×10^{-4}
Average	y_D	1–2×10^{-3}	3×10^{-4}
	x_D	2–3×10^{-3}	5×10^{-4}

- Measurement of D oscillations opens new window to search of CPV in charm. Observation of CPV would provide unequivocal NP signals

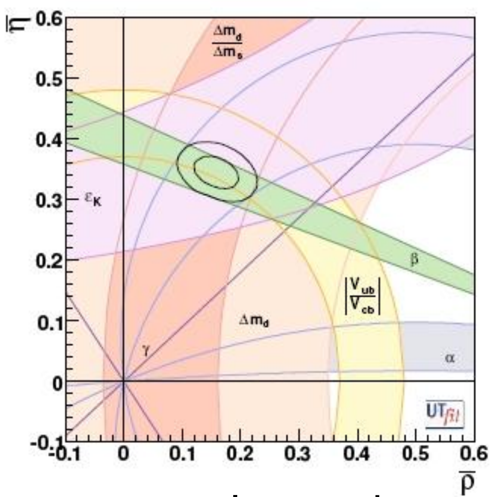




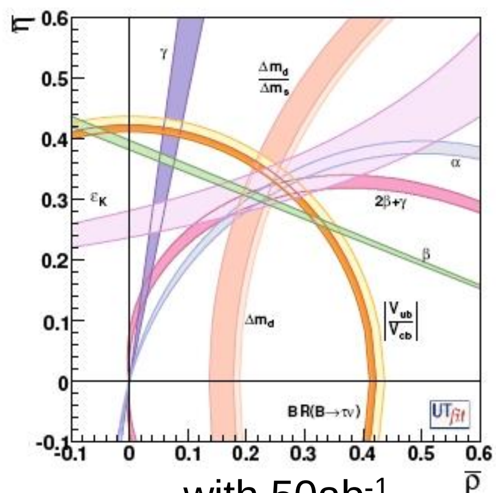


CKM matrix at 1%

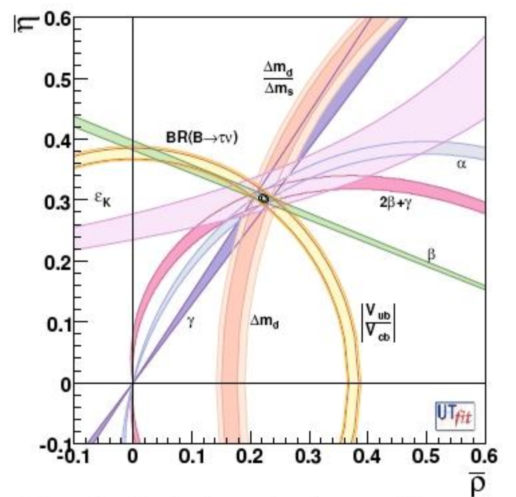
Precise measurement of CKM matrix elements is the prelude of the SuperB physics program



ρ–η plane today



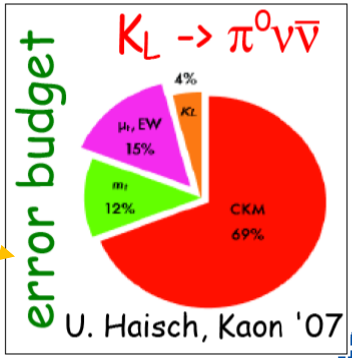
with 50ab^{-1}
(+ lattice improvements)



50ab^{-1}, if SM holds

Parameter	SM Fit today	SM Fit at Super$B$
$\overline{\rho}$	0.163 ± 0.028	± 0.0028
$\overline{\eta}$	0.344 ± 0.016	± 0.0024
α (°)	92.7 ± 4.2	± 0.45
β (°)	22.2 ± 0.9	± 0.17
γ (°)	64.6 ± 4.2	± 0.38

Precise CKM knowledge crucial for NP searches. Here just an example



in some cases a reduction of theoretical error (e.g. Vub) is required (should be possible)

B Physics @ $\Upsilon(4S)$

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 (∗)
$S(K_S^0 K_S^0 K_S^0)$	0.15	0.02 (∗)
$S(K_S^0 \pi^0)$	0.15	0.02 (∗)
$S(\omega K_S^0)$	0.17	0.03 (∗)
$S(f_0 K_S^0)$	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° (∗)
$2\beta+\gamma$ $(D^{(*)\pm}\pi^\mp, D^\pm K_S^0 \pi^\mp)$	20°	5°

Observable	B Factories (2 ab^{-1})	Super$B$ (75 ab^{-1})
$\lvert V_{cb}\rvert$ (exclusive)	4% (∗)	1.0% (∗)
$\lvert V_{cb}\rvert$ (inclusive)	1% (∗)	0.5% (∗)
$\lvert V_{ub}\rvert$ (exclusive)	8% (∗)	3.0% (∗)
$\lvert V_{ub}\rvert$ (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

Charm mixing and CP

Mode	Observable	$\Upsilon(4S)$ (75 ab^{-1})	$\psi(3770)$ (300 fb^{-1})
$D^0 \to K^+\pi^-$	x'^2	3×10^{-5}	
	y'	7×10^{-4}	
$D^0 \to K^+K^-$	y_{CP}	5×10^{-4}	
$D^0 \to K_S^0\pi^+\pi^-$	x	4.9×10^{-4}	
	y	3.5×10^{-4}	
	$\lvert q/p\rvert$	3×10^{-2}	
	ϕ	2°	
$\psi(3770) \to D^0\overline{D}^0$	x^2		$(1-2) \times 10^{-5}$
	y		$(1-2) \times 10^{-3}$
	$\cos\delta$		$(0.01-0.02)$

Charm FCNC

Channel	Sensitivity
$D^0 \to e^+e^-$, $D^0 \to \mu^+\mu^-$	1×10^{-8}
$D^0 \to \pi^0e^+e^-$, $D^0 \to \pi^0\mu^+\mu^-$	2×10^{-8}
$D^0 \to \eta e^+e^-$, $D^0 \to \eta\mu^+\mu^-$	3×10^{-8}
$D^0 \to K_S^0e^+e^-$, $D^0 \to K_S^0\mu^+\mu^-$	3×10^{-8}
$D^+ \to \pi^+e^+e^-$, $D^+ \to \pi^+\mu^+\mu^-$	1×10^{-8}
$D^0 \to e^\pm\mu^\mp$	1×10^{-8}
$D^+ \to \pi^+e^\pm\mu^\mp$	1×10^{-8}
$D^0 \to \pi^0e^\pm\mu^\mp$	2×10^{-8}
$D^0 \to \eta e^\pm\mu^\mp$	3×10^{-8}
$D^0 \to K_S^0e^\pm\mu^\mp$	3×10^{-8}
$D^+ \to \pi^-e^+e^+$, $D^+ \to K^-e^+e^+$	1×10^{-8}
$D^+ \to \pi^-\mu^+\mu^+$, $D^+ \to K^-\mu^+\mu^+$	1×10^{-8}
$D^+ \to \pi^-e^\pm\mu^\mp$, $D^+ \to K^-e^\pm\mu^\mp$	1×10^{-8}

τ Physics

Process	Sensitivity
$\mathcal{B}(\tau \to \mu\gamma)$	2×10^{-9}
$\mathcal{B}(\tau \to e\gamma)$	2×10^{-9}
$\mathcal{B}(\tau \to \mu\mu\mu)$	2×10^{-10}
$\mathcal{B}(\tau \to eee)$	2×10^{-10}
$\mathcal{B}(\tau \to \mu\eta)$	4×10^{-10}
$\mathcal{B}(\tau \to e\eta)$	6×10^{-10}
$\mathcal{B}(\tau \to \ell K_S^0)$	2×10^{-10}

B_s Physics @ $\Upsilon(5S)$

Observable	Error with 1 ab^{-1}	Error with 30 ab^{-1}
$\Delta\Gamma$	0.16 ps^{-1}	0.03 ps^{-1}
Γ	0.07 ps^{-1}	0.01 ps^{-1}
β_s from angular analysis	20°	8°
$A^s_{\rm SL}$	0.006	0.004
$A_{\rm CH}$	0.004	0.004
$\mathcal{B}(B_s \to \mu^+\mu^-)$	-	$< 8 \times 10^{-9}$
$\lvert V_{td}/V_{ts}\rvert$	0.08	0.017
$\mathcal{B}(B_s \to \gamma\gamma)$	38%	7%
β_s from $J/\psi\phi$	10°	3°
β_s from $B_s \to K^0\bar{K}^0$	24°	11°

Summary

	H^+ high $\tan\beta$	Minimal FV	Non-Minimal FV (1-3)	Non-Minimal FV (2-3)	NP Z-penguins	Right-Handed currents
$\mathcal{B}(B \to X_s\gamma)$		■		●		●
$A_{CP}(B \to X_s\gamma)$				■		●
$\mathcal{B}(B \to \tau\nu)$	■ -CKM					
$\mathcal{B}(B \to X_s l^+ l^-)$				●	●	●
$\mathcal{B}(B \to K\nu\overline{\nu})$				●	■	
$S(K_S\pi^0\gamma)$						■
β			■ -CKM			●

arXiv:0810.1312

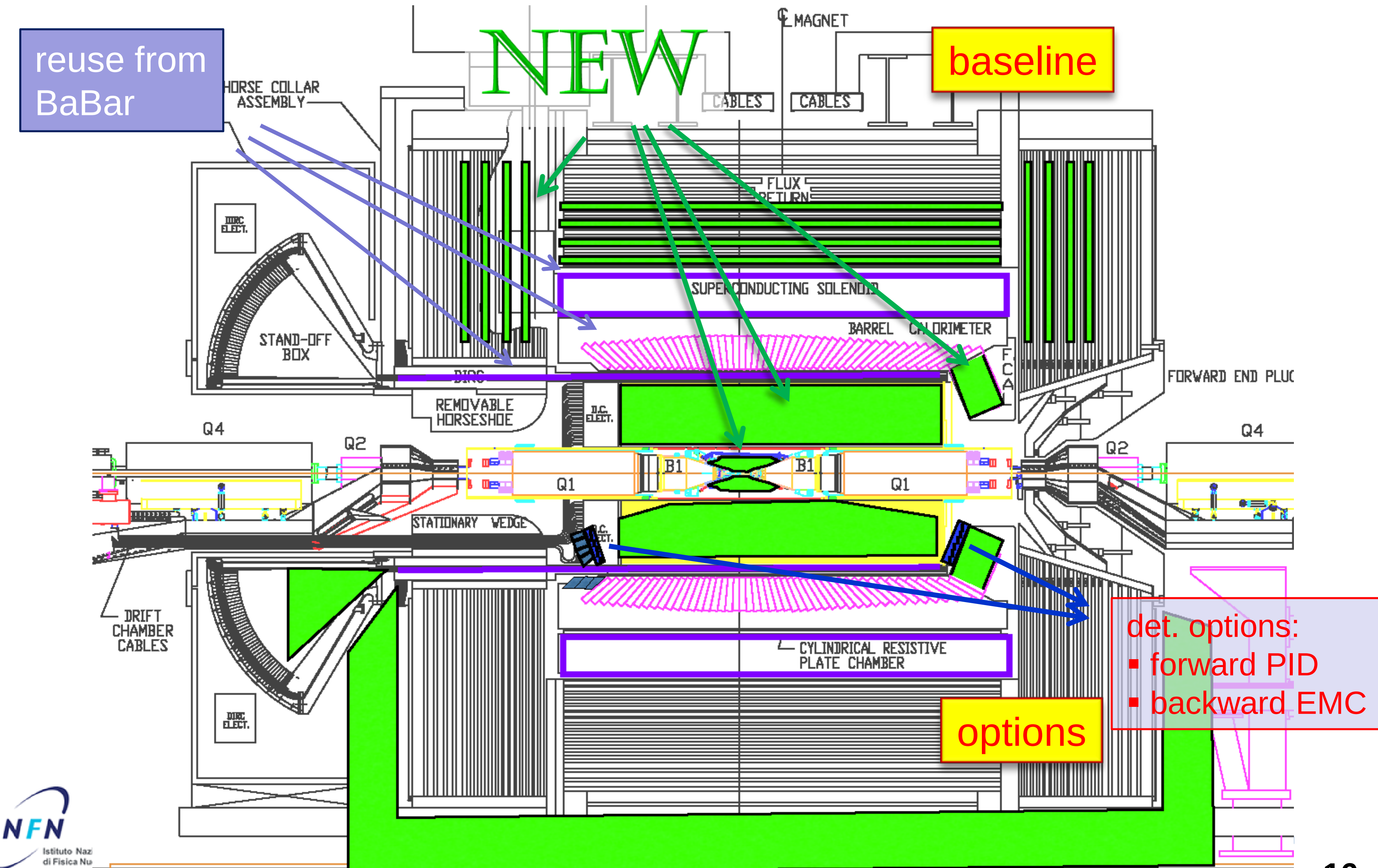
■ Golden mode for a given scenario
● Non-golden, but still sensitive to deviations from the SM
-CKM requires high precision on CKM parameters (obtainable with SuperB)

* If NP is discovered at LHC, SuperB will study it (measuring the couplings) through a large number of NP-sensitive decays
* If NP is not seen at the 1TeV scale by LHC, SuperB offers the chance to explore NP scales of several TeV (even higher in some scenarios) with measurements in the B, charm and τ sectors
* Dramatic improvement of CKM parameters uncertainty

Note: Super Flavour Factory is a unique laboratory for spectroscopy

DETECTOR

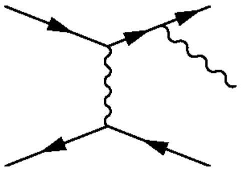
Detector layout

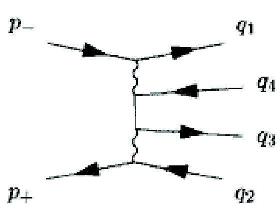


Machine backgrounds

- Two colliding beams
  - radiative Bhabha → *dominant effect on lifetime*
  - $e^+e^- e^+e^-$ production → *~3% contribution to lifetime, important source for SVT layer-0*
- Single beam
  - synchrotron radiation → *strictly connected to IR design*
  - Touschek → *negligible in BaBar, important in SuperB*
  - beam-gas
  - intra-beam scattering

	Cross section	Evt/bunch$_{xing}$	Rate
Beam Strahlung	~ 340 mbarn (Eγ/Ebeam > 1%)	~680	0.3THz
	~ 40 mbarn (Eγ/Ebeam > 50%)	~80	35GHz
pair production	~7.3 mbarn	~15	7GHz
Elastic Bhabha	O(10^{-4}) mbarn (Det. acceptance)	~200/Million	100KHz
Υ(4S)	O(10^{-6}) mbarn	~2/Million	1 KHz





Paoloni

Time-dependent measurement vs. beam energies asymmetry

* In SuperB reduced asymmetry (7 on 4 GeV, $\beta\gamma$=0.28)
  – compare BaBar: 9 on 3.1 GeV, $\beta\gamma$=0.56, and Belle: 8 on 3.5 GeV, $\beta\gamma$=0.45
  – easier to obtain very low horizontal emittances, easier IR design
  – increased angular coverage of decay products →better hermiticity!
* Time-dependent analyses need to separate the two B vertices:
  – $\beta\gamma$=0.56 (BaBar): $\langle\Delta L\rangle$=250μm ; $\beta\gamma$=0.28 (SuperB): $\langle\Delta L\rangle$=125μm

Time-dependent measurement vs. beam energies asymmetry

- In SuperB reduced asymmetry (7 on 4 GeV, $\beta\gamma$=0.28)
  - compare BaBar: 9 on 3.1 GeV, $\beta\gamma$=0.56, and Belle: 8 on 3.5 GeV, $\beta\gamma$=0.45
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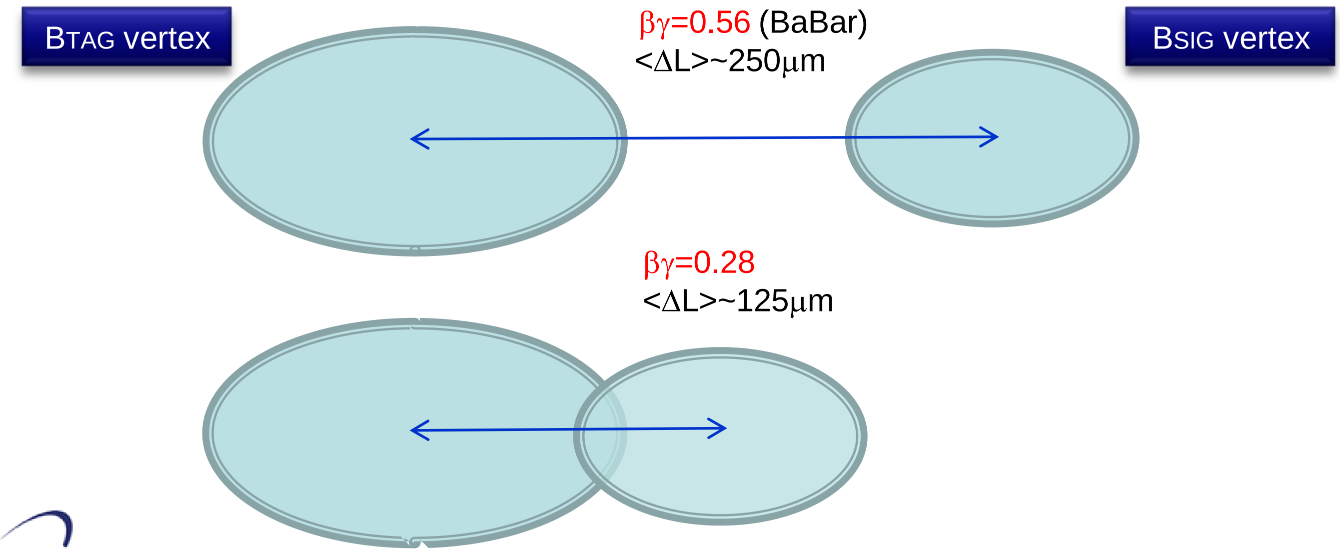
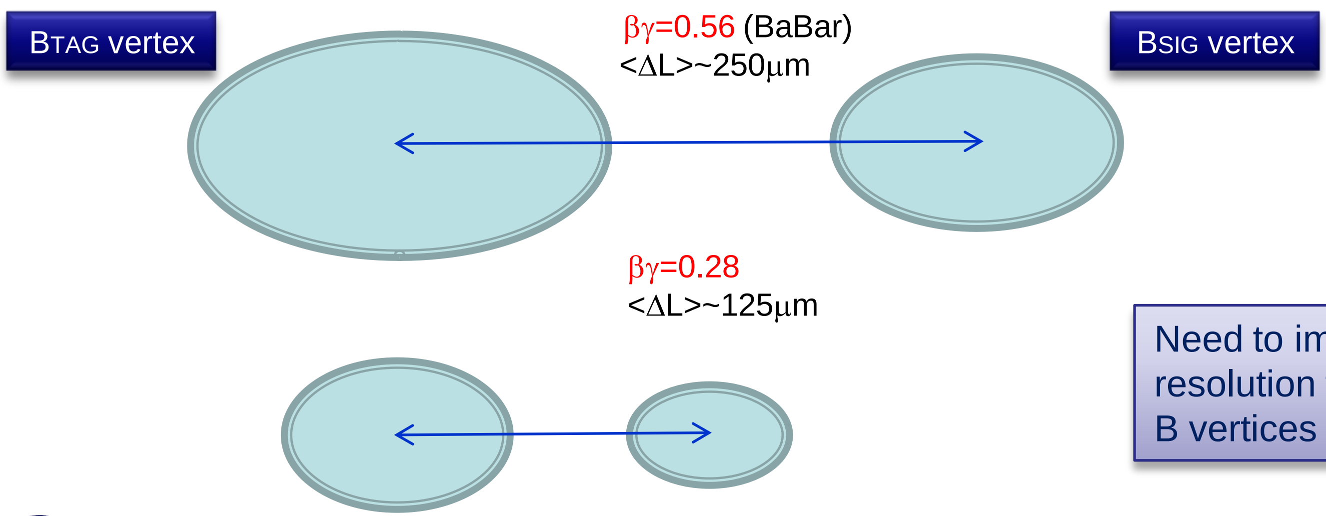
  - increased angular coverage of decay products →better hermiticity!
- Time-dependent analyses need to separate the two B vertices:
  - $\beta\gamma$=0.56 (BaBar): <ΔL>=250μm ; $\beta\gamma$=0.28 (SuperB): <ΔL>=125μm



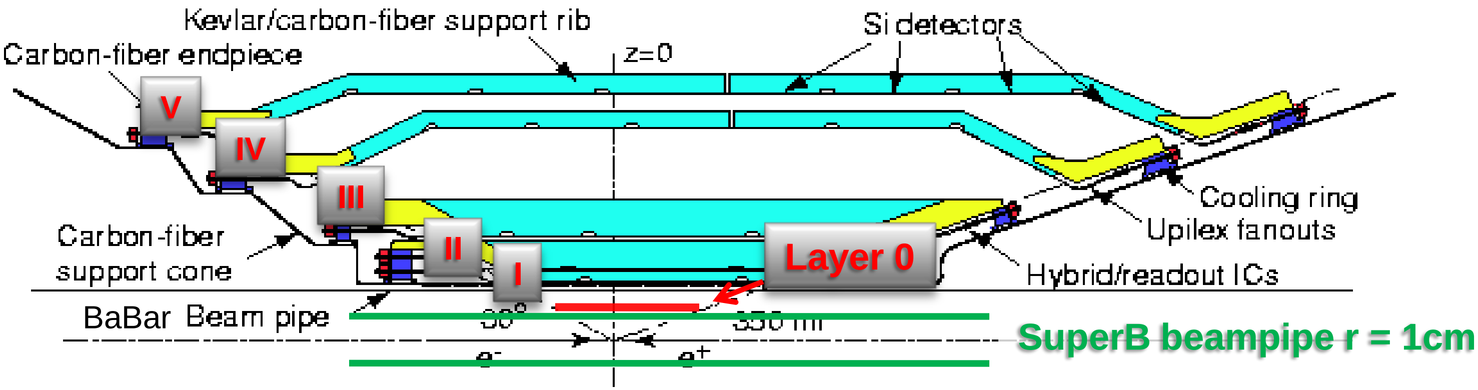
Time-dependent measurement vs. beam energies asymmetry

- In SuperB reduced asymmetry (7 on 4 GeV, $\beta\gamma=0.28$)
  - compare BaBar: 9 on 3.1 GeV, $\beta\gamma=0.56$, and Belle: 8 on 3.5 GeV, $\beta\gamma=0.45$
  - easier to obtain very low horizontal emittances, easier IR design
  - increased angular coverage of decay products $\rightarrow$better hermiticity!
- Time-dependent analyses need to separate the two B vertices:
  - $\beta\gamma=0.56$ (BaBar): $\langle\Delta L\rangle=250\mu m$; $\beta\gamma=0.28$ (SuperB): $\langle\Delta L\rangle=125\mu m$
  - Reduce the beam pipe radius and put 1st tracker layer as close as possible to IP
  - mimize material before 1st layer



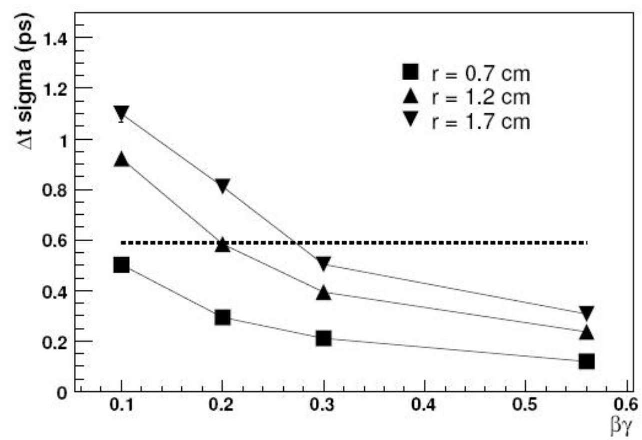
Need to improve vertex resolution to separate the B vertices if $\beta\gamma=0.28$

The vertex detector



* For R>3cm use design similar to BaBar SVT
  – double-sided silicon sensors
  – 300μm thick,10-25μm spatial resolution
* Add layer0
  – beam pipe radius 1.0cm
  – layer0 radius 1.5cm
  – spatial reso 10μm
  – thickness (beam pipe + L0) ≤1.0% X0
* Goal coverage of 300mrad in both directions

Impact of boost on Δt resolution



Layer 0

* Layer 0:
  – rad. hard: >5MHz/cm2, 1MRad/yr; thin: ~0.5% X0
  – different options: striplets, CMOS MAPs, hybrid pixels

Striplets option: mature technology, not so robust against background.

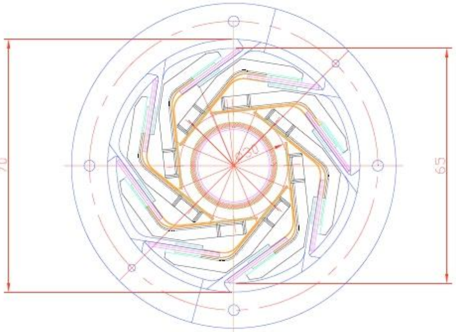
* Marginal with background rate higher than ~ 5 MHz/cm^2
* Moderate R&D needed on module interconnection/mechanics/FE chip (FSSR2)

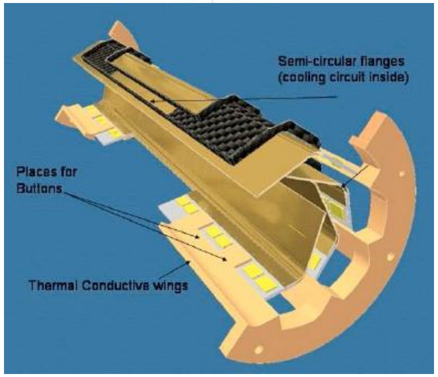
CMOS MAPS option

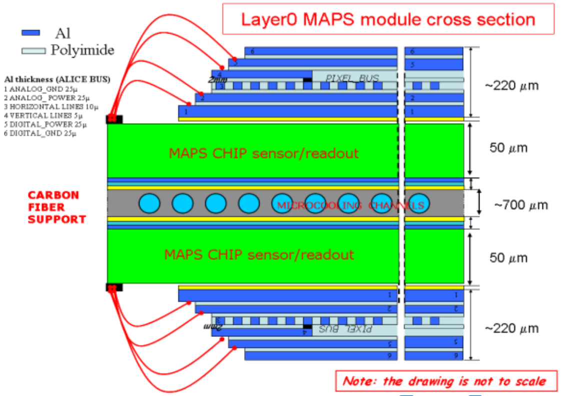
* new & challenging technology:
* can provide the required thickness
* existing devices are too slow
* Extensive R&D ongoing (SLIM5-Collaboration) on 3-well devices 50x50um^2

Hybrid Pixel Option: tends to be too thick + large pitch

* Alice hybrid pixel module ~ 1% X0, pitch 50x150 um2
* Possible material/pitch reduction with the latest technology improvements.
* Viable option but requires some R&D

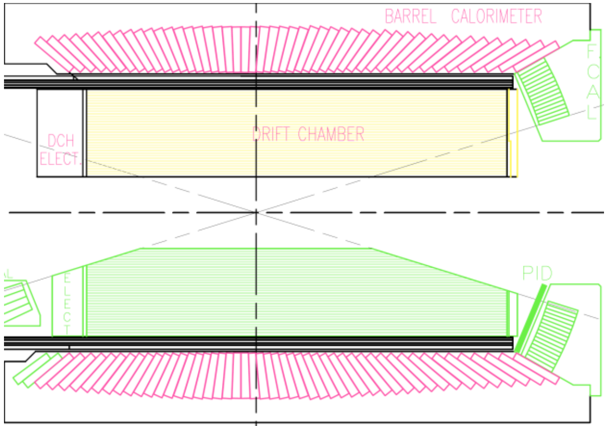






Istituto Nazionale di Fisica Nucleare

The drift chamber

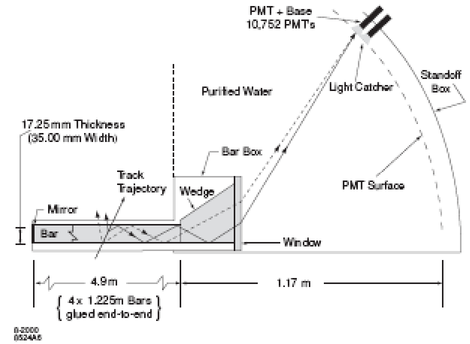


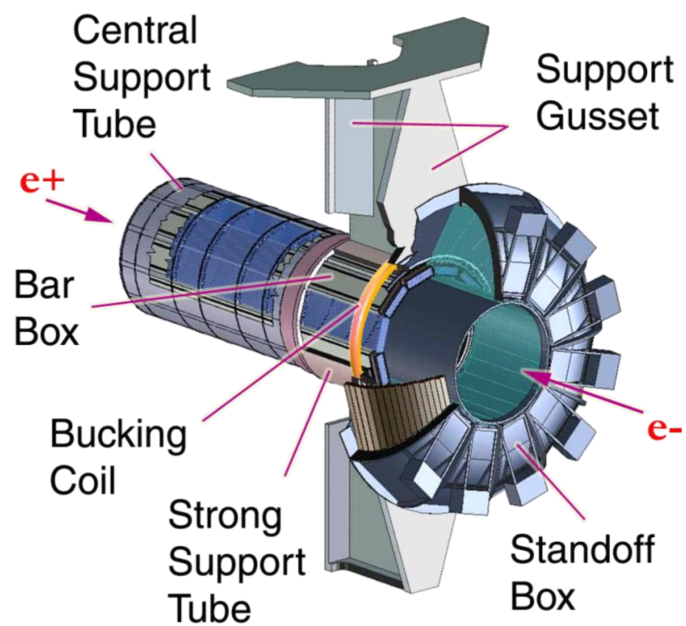
Build on *BABAR* drift chamber concept: no major R&D effort needed, but:

* Lighter structure, all in Carbon Fiber (CF)
  - Preliminary studies show that dome-shaped CF end-plates with X0~2% seem achievable (compare 13-26% in BaBar DCH)
* Design faster&lighter electronics (taking into account detectors options to be possibly installed behind backward end-plates)
* To control expected increase in occupancy:
  - studying faster gas mixtures
  - considering smaller cells
  - alternative solutions being explored
    - tapered shape of end-plates

PID

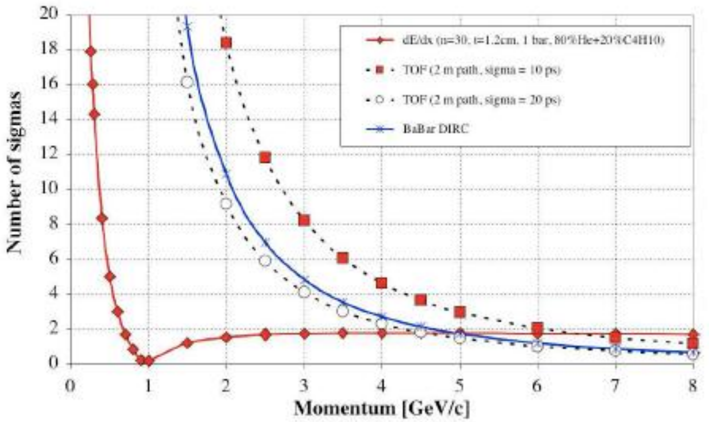
* Hadronic PID system essential for P(π,K)>0.7GeV/c (use dE/dx for p<0.7GeV/c)
* Baseline is to reuse BaBar DIRC barrel-only design
  - Excellent performance to 4GeV/c
  - Robust operation
  - Elegant mechanical support
  - Photon detectors outside field region
  - Radiation hard fused silica radiators
  - But… PMTs are slow and aging. Need replacement. Large SOB region sensitive to backgrounds so volume reduction is desirable
* Photon detector replacement
  - Baseline: Use pixelated fast PMTs with a smaller SOB to improve background performance by x50-100 with identical PID performance



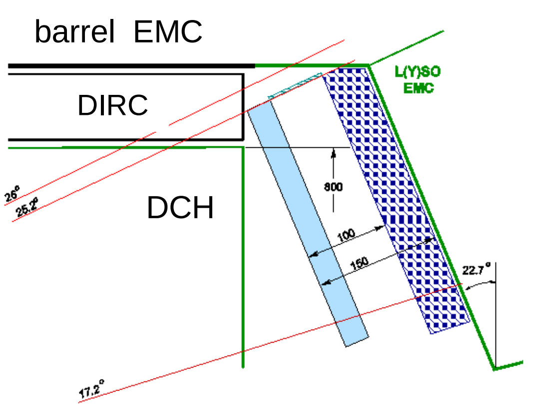


Forward PID

* Modest solid angle but event acceptance for “veto physics” or decays with multiple particles scale faster than linearly.
  Physics case needs to be established

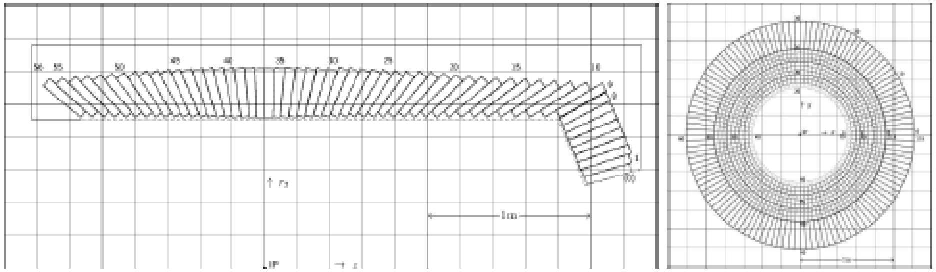


* Not just a PID problem. Overall detector optimization required
  * material in front of EMC
  * takes space from DCH or EMC



* Aerogel RICH and Very Fast Cherenkov-based TOF under investigation

The electromagnetic calorimeter



BaBar Barrel
5760 CsI(Tl) Crystals

$$\frac{\sigma_E}{E} = \frac{2.30\%}{\sqrt[4]{E(GeV)}} \oplus 1.35\% \qquad \sigma_\theta = \frac{4mrad}{\sqrt{E(GeV)}}$$

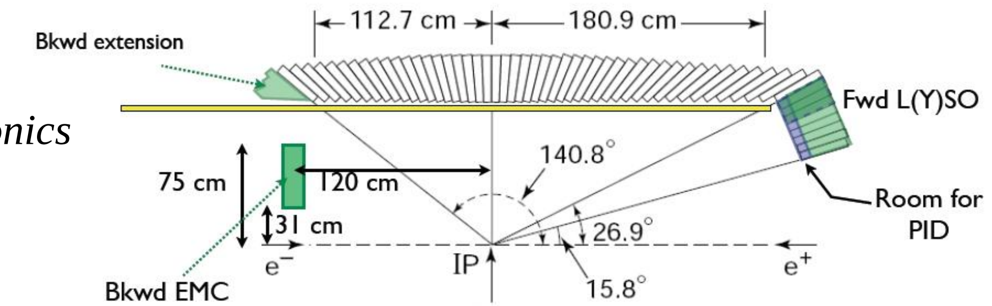
Essential detector to measure energy and direction of γ and e, discriminate between e and π, and detect neutral hadrons

* Barrel
  * BaBar barrel crystals not suffering signs of radiation damage. They're sufficiently fast and radiation hard for SuperB needs

  ➔They can be reused. (Would have been) most expensive detector component
  * Background dominated by radiative Bhabhas. IR shielding design is crucial
* Endcaps
  * Best possible hermiticity important for key physics measurements
  * New forward endcap
  * backward endcap is an option

Forward and backward EMC

* Forward endcap
  – BaBar CsI(Tl) endcap inadequate for higher rates and radiation dose of Super*B*
    • *Need finer granularity*
    • *Faster crystals and readout electronics*
    • *comparable total X0*

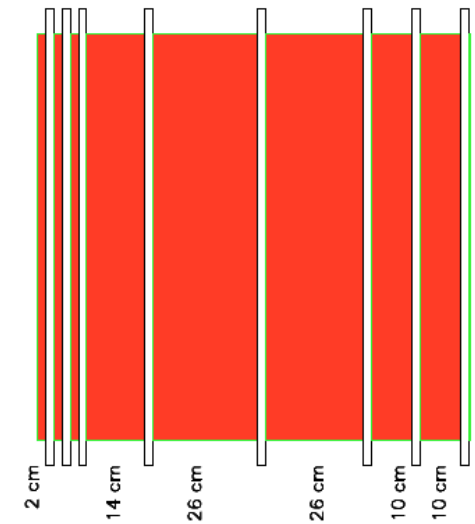


  – Option 1: LYSO crystals
    - frees 10cm for a forw. PID system
    - radiation hard, fast, small Moliere radius, good light yield
    - expensive (~40$/cc) at the moment
  – Option 2: retain 3 outer rings of CsI(Tl), LYSO the others
    - less expensive
    - no space for forw. PID system
* Backward endcap (option)
  – Pb plates and scintillating tiles with fiber readout to SiPMs

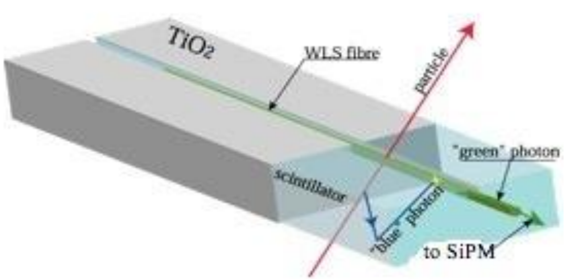
2.5 x 2.5 x 20 cm (18 X_0) Bar

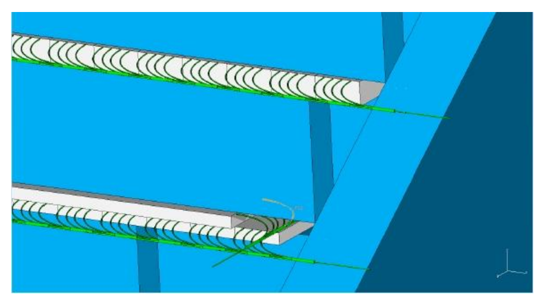
The IFR

* Provides discrimination between μ and $\pi^{\pm}$. Help detection and direction measurement of K_L (together with EMC)
* Composed by 1 hexagonal barrel + 2 endcaps as in BaBar
* Add absorber w.r.t. BaBar to improve π/μ separation. Amount and distribution to be optimized
  – 7-8 absorber layers
  – reuse of BaBar IFR iron under evaluation

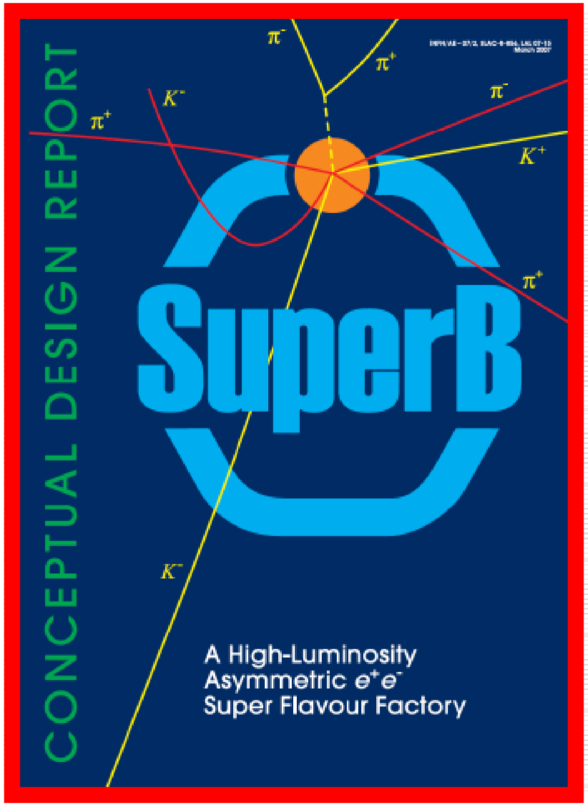


* Use extruded scintillator a la MINOS coupled to geiger mode APDs through WLS fibers
  – expected hit rates of O(100) Hz/cm^{2}d
  – single layer or double coord. layout depending on the x-y resolution needs





To know more



- Physics case
- Detector
- Machine

444 pages
320 signers
~80 institutions

www.pi.infn.it/SuperB/?q=CDR

Special physics workshop to answer the IRC questions on physics and sharpen the physics case

Proceedings
of
Super*B* Workshop VI

New Physics
at the
Super Flavor Factory

Valencia, Spain
January 7-15, 2008

arXiv:0810.1312

Next physics meeting:
Warwick, UK 14-17 April 2009

http:/ /www2.warwick.ac.uk/fac/sci/physics/resarch/epp/meetings/superb2009/

1st report of the IRC

First Report
of the International Review Committee[1] (IRC)
for the Super*B* Project

Hiroaki Aihara, John Dainton, Young Kee Kim, Jacques Lefrançois, Antonio Masiero, Steve Myers, Tatsuya Nakada[2], Daniel Schulte, Abe Seiden

Roma, May 21st 2008

The International Review Committee setup by the president of INFN to evaluate the SuperB CDR reported very favorably

5. Conclusion

We recommend strongly that work towards the realisation of a Super*B*, taken to be an asymmetric e^+e^- collider with luminosity at least 10^{36} cm^{-2} s^{-1}, continues.

The Super*B* concept is at an important stage. The significance of the physics programme at such a machine continues to be developed, increasing in both scope and importance. It motivates an even more concerted effort to meet many technical challenges, in particular concerned with the design of storage rings which meet the physics specification.

So far there has been no "showstopper"; rather there has emerged a number of innovative and noteworthy developments at the cutting-edge of contemporary technique in accelerator physics and of detector technology. There still remains the possibility of insurmountable technical challenges, in particular in establishing the physics of machine performance which, in some aspects, address fundamental issues of accelerator physics. Beginning as soon as possible, these challenges must be addressed if progress is to continue with the aim of realising Super*B* on the proposed time schedule. To this end, it is now both timely and highly appropriate that a Machine Advisory Committee be established to oversee progress in the many critical issues faced in the design of the Super*B* asymmetric collider.

It is clear from the above that it is essential at this time to ensure appropriate conservation and preservation of detector and machine components from PEP2 and *BaBar* which could be incorporated into Super*B*.

ECFA report

Report on the INFN Super Flavour Factory Project

Working Group set up by the restricted meeting of ECFA

Y. Karyotakis (LAPP, France), F. Linde (Nikhef, the Netherlands),
B. Spaan (Uni. Dortmund, Germany)
Chaired by T. Nakada (EPFL, Switzerland)

Introduction

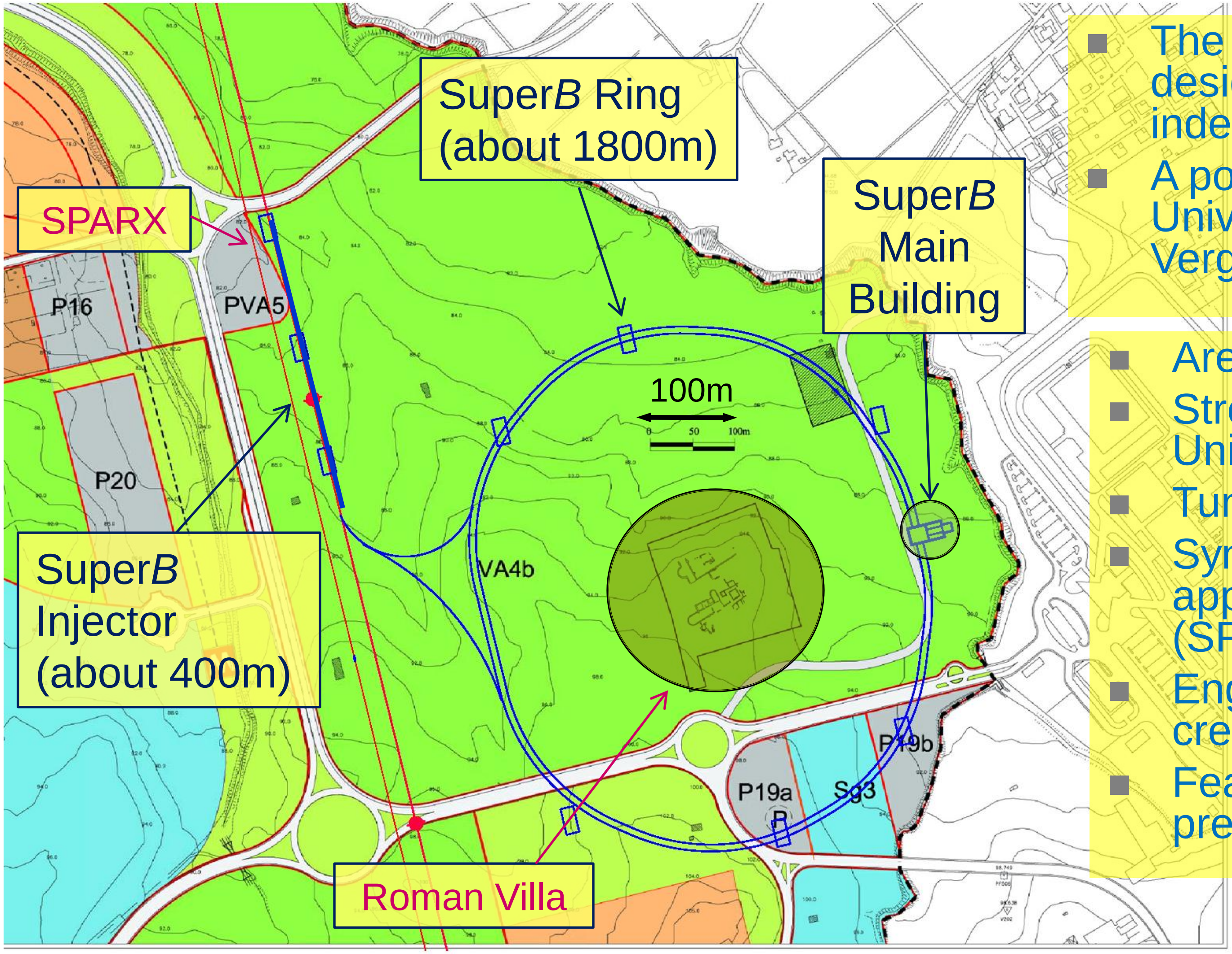
INFN requested European Committee for Future Accelerator (ECFA) to form an opinion on their Super Flavour Factory project during its restricted meeting (RECFA) in Lisbon on 29th of March 2008. Following a proposal by the ECFA chair, K. Meier, RECFA asked one of its members, T. Nakada, to form and chair an internal working group who should prepare a report, which should then be endorsed by ECFA. The working group consists of the four authors of this report. The report consists of a physics section describing the current status of flavour physics and the significance of a future Super Flavour Factory, a short description of the INFN project as understood by the working group, consideration of the global situation, and finally a summary.

* We consider that **flavour physics should be seen as an important part of the European research programme of elementary particle physics**, complementary to physics provided by the energy frontier experiments. For the coming ~5 years, LHCb will do this job in the b and c quark sectors. To follow-up this progress, **collecting 50 ab^{-1} or more at Υ(4S) energy with e^+e^- storage rings by the end of the next decade would be a significant milestone, if this can be realised at a moderate cost**.
* The INFN Super Flavour Factory project team proposes a novel scheme […]. This idea of obtaining a high luminosity with tiny beam spots at the collision point based on very small emittance beams and crab waist collisions could revolutionize the design of the future colliders. **Therefore, westrongly support the R&D effort to see if such a machine can really be built.**
* The current tests at DAFNE are promising and we would like to congratulate the team for this impressive achievement. **However, a substantial amount of work is still required for producing a Technical Design Report**, […]
* Given the complexity of the project, we feel that **a clear plan containing realistic technical milestones and resource requirements together with a strategy how to obtain them is needed as a necessary condition for an approval of the project**.
* Such a plan should aim at **obtaining an integrated luminosity of significantly more than 50 ab^{-1} by not much later than the end of the next decade**. Given the very ambitious time scale, a clear decision taking process must be established soon.

The TDR phase

* In Dec. 2008 the INFN board of directors has endorsed the SuperB as a special project
* The project will receive a significant funding from the Lazio regional government starting in 2009. Funds also from INFN Gruppo 1
* TDR phase started officially in Feb. 2009 at Orsay WS
* Document requested for approval by Italian Government by end of 2009. As complete as possible on machine and site, with snapshot on physics, detectors and computing
* Final TDR document by end 2010 – beginning 2011

A site for SuperB



- The SuperB conceptual design is largely site independent
- A possible site is on the Università di Roma Tor Vergata campus

- Area available
- Strong interest of University and INFN
- Tunnel at about -12m
- Synergy with approved FEL (SPARX)
- Engineering group created
- Feasibility study in preparation

A site for SuperB

Conclusions

* The physics case for a high luminosity e^+e^- B factory is clearly established
* The SuperB accelerator design allows to reach $L=10^{36} cm^{-2}s^{-1}$ and collect $75 ab^{-1}$ (>80 10^9 BB pairs) in 5 years
* Encouraging feedback from ECFA and International Review Committee
* TDR phase started, generous funding from the Italian Lazio Region. TDR phase will complete in 2 years
* Growing international interest and participation