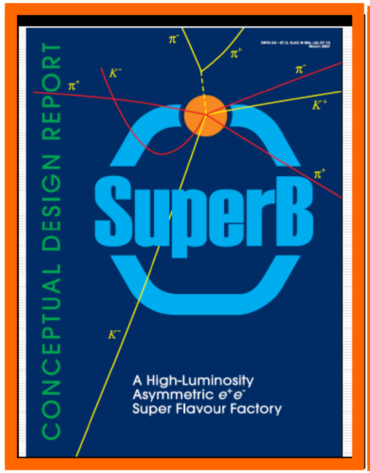


The Super Flavour Factory Project

Achille Stocchi
Alessandro Variola

Grenoble 8 Janvier 2009

Why the choice of a Super Flavour Factory, asymmetric ?

Is a Super Flavor Factory (SFF) a discovery machine in LHC era ?

Why $>10^{36}$ luminosity needed ?

Is SFF complementary to LHC ?

Would not be LHCb enough to perform flavour studies ?

…..

How to built such a Flavour Factory ?

Physics Case

B factories have shown that a variety of measurements can be performed in the clean environment.

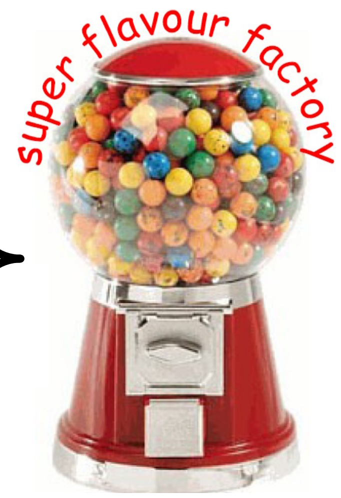
→ Asymmetric B factory

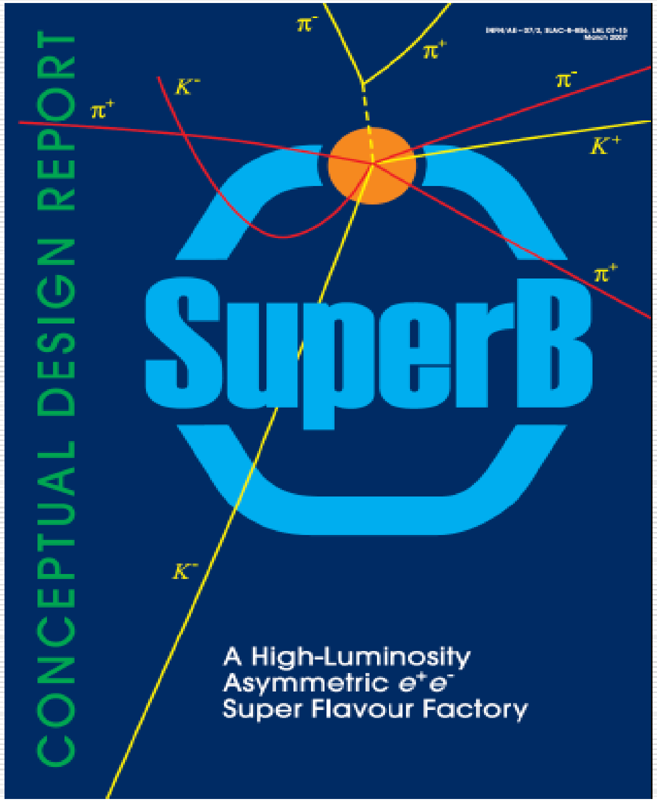
The systematic errors are very rarely irreducible and can almost on all cases be controlled with control samples. (up to..50-100ab^{-1})

→ High luminosity

Many measurements can be done at different energies (charm/τ threshold, U(5S))

→ Flavour factories





3 Chapters : Physics Case
Detector
Machine

444 pages

320 signers
~80 institutions

Special specific meeting
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

49 signers
~24 institutions

Abstract

The sixth Super$B$ Workshop was convened in response to questions posed by the INFN Review Committee that is evaluating the Super$B$ project at the request of INFN. The various working groups addressed the capability of a high-luminosity flavor factory that can gather a data sample of 50 to 75 ab^{-1} in five years to elucidate New Physics phenomena unearthed at the LHC.

Super Flavour Factory

$> 10^{36}$cm^{-2} sec^{-1} → >15ab^{-1} per year
(today ~10^{34}cm^{-2} sec^{-1} Babar~400fb^{-1} Belle~700fb^{-1})

Background machine ~ to the present one

Possibility of running at lower (τ-charm) and higher energy (B_s)

B physics @ U(4S)

Observable	B Factories (2 ab^{-1})	Super$B$ (75 ab^{-1})
$\sin(2\beta)$ (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
α $(B \to \pi\pi)$	$\sim 16°$	$3°$
α $(B \to \rho\rho)$	$\sim 7°$	1–2° $(*)$
α (combined)	$\sim 6°$	1–2° $(*)$
[redacted]		
[redacted]		
[redacted]		
$S(K_S^0K_S^0K_S^0)$	0.15	0.02 $(*)$
$S(K_S^0\pi^0)$	0.15	0.02 $(*)$
$S(\omega K_S^0)$	0.17	0.03 $(*)$
$S(f_0K_S^0)$	0.12	0.02 $(*)$
$\|V_{cb}\|$ (exclusive)	4% $(*)$	1.0% $(*)$
$\|V_{cb}\|$ (inclusive)	1% $(*)$	0.5% $(*)$
$\|V_{ub}\|$ (exclusive)	8% $(*)$	3.0% $(*)$
$\|V_{ub}\|$ (inclusive)	8% $(*)$	2.0% $(*)$

Observable	B Factories (2 ab^{-1})	Super$B$ (75 ab
$\mathcal{B}(B \to \tau\nu)$	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%
$A_{CP}(B \to \rho\gamma)$	~ 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 $(*)$
[redacted]		
$A^{FB}(B \to X_s\ell\ell)s_0$	35%	5%
$\mathcal{B}(B \to K\nu\bar{\nu})$	visible	20%
$\mathcal{B}(B \to \pi\nu\bar{\nu})$	–	possible

[redacted]

Similar precision at LHCb

τ physics

Process	Sensitivity
$\mathcal{B}(\tau \to \mu\gamma)$	2×10^{-9}
$\mathcal{B}(\tau \to e\gamma)$	2×10^{-9}
[redacted]	
$\mathcal{B}(\tau \to eee)$	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}

Charm at U(4S) and threshold

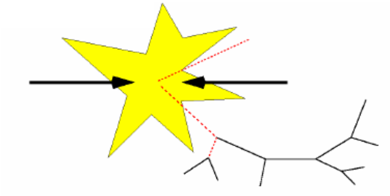
Mode	Observable	B Factories (2 ab^{-1})	Super$B$ (75 ab^{-1})
[redacted]			
	$x_D'^2$	1–2 $\times 10^{-4}$	3×10^{-5}
$D^0 \to K_S^0\pi^+\pi^-$	y_D	2–3 $\times 10^{-3}$	5×10^{-4}
	x_D	2–3 $\times 10^{-3}$	5×10^{-4}
Average	y_D	1–2 $\times 10^{-3}$	3×10^{-4}
	x_D	2–3 $\times 10^{-3}$	5×10^{-4}
$D^0 \to K^+\pi^-$	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	*To be evaluated at LHCb*	4.9×10^{-4}
	y		3.5×10^{-4}
	$\lvert q/p\rvert$		3×10^{-2}
	ϕ		2°

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

B_s at U(5S)

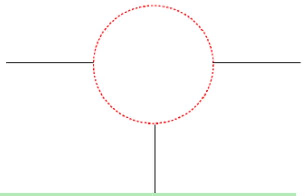
Observable	Error with 1 ab^{-1}	Error with 30 ab^{-1}
[redacted]		
A_{SL}^s	0.006	0.004
[redacted]		
$\lvert V_{td}/V_{ts}\rvert$	0.08	0.017
$\mathcal{B}(B_s \to \gamma\gamma)$	38%	7%
[redacted]		
β_s from $B_s \to K^0\bar{K}^0$	24°	11°

Exploration of two frontiers



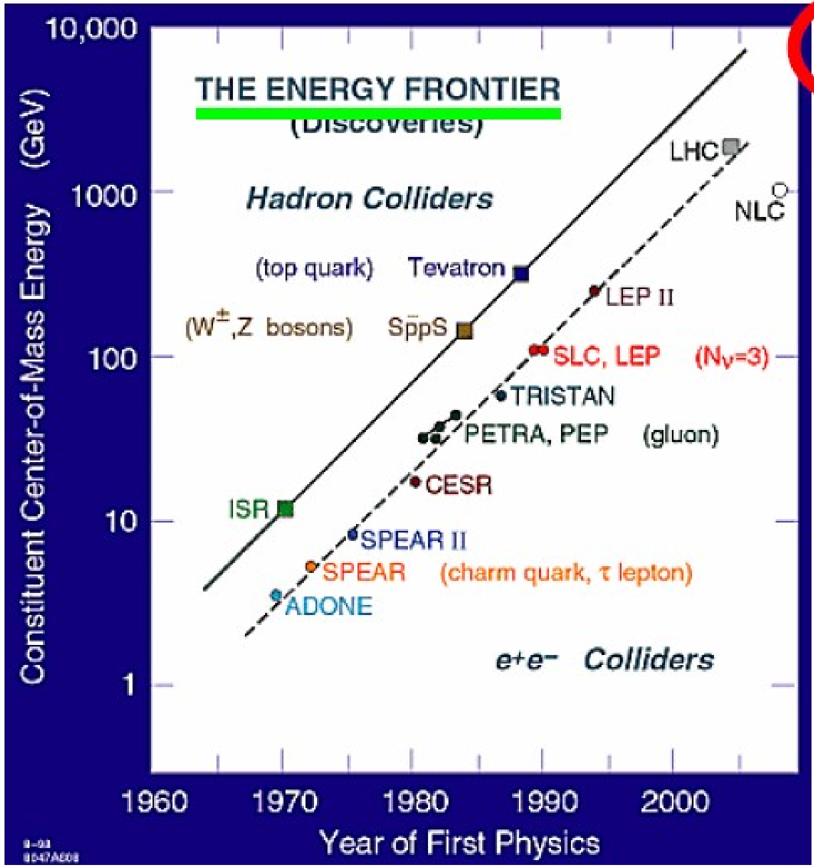
“Relativistic path”

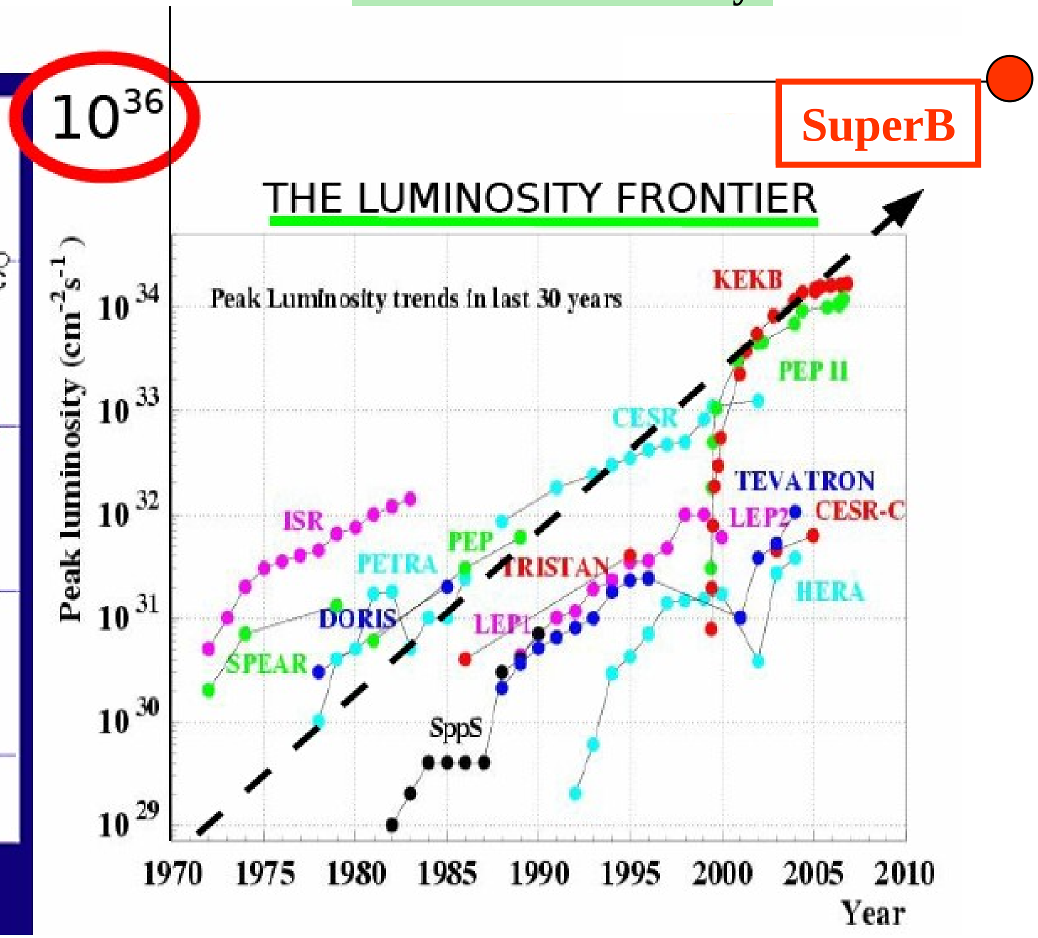
Crucial : Center-of-mass energy



“Quantum path”

Crucial : Luminosity





The problem of particle physics today is :
where is the NP scale $\Lambda \sim 0.5, 1 \ldots 10^{16}$ TeV

The quantum stabilization of the Electroweak Scale
suggest that $\Lambda \sim 1$ TeV
LHC will search on this range

What happens if the NP scale is at 2-3..10 TeV
…naturalness is not at loss yet…

Flavour Physics explore also this range

We want to perform flavour measurements such that :
- if NP particles are discovered at LHC we able study the flavour structure of the NP
- we can explore NP scale beyond the LHC reach

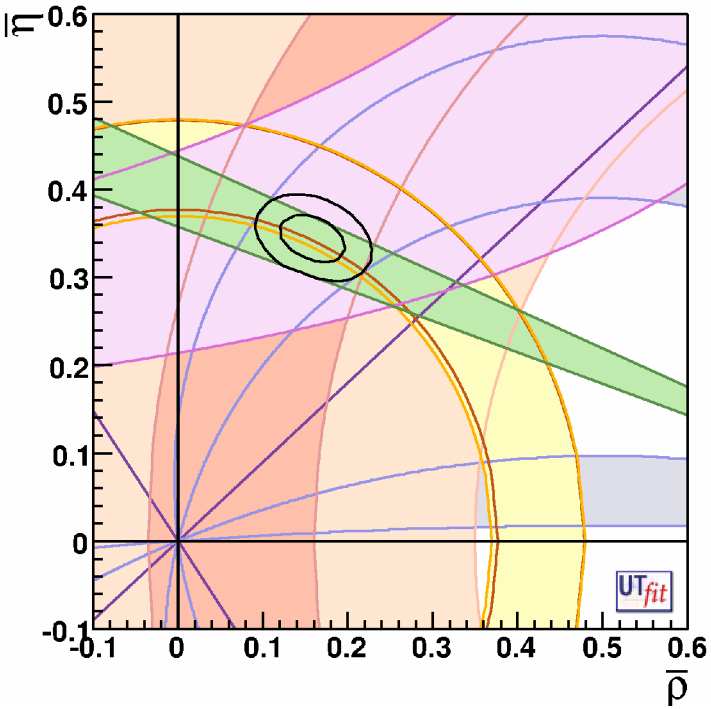
$$\frac{|\delta_{bq}|}{\Lambda_{eff}}$$

10^{34} luminosity to have measurable effects <u>(anyhow)</u> if NP particle with masses at the <u>EW scale</u>

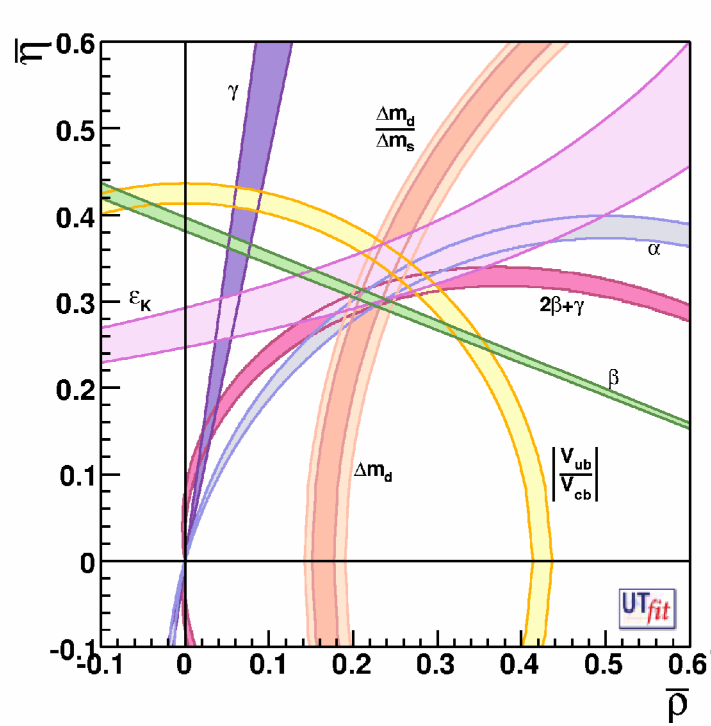
10^{36} luminosity to have measurable effects <u>(anyhow)</u> if NP particle with masses at the <u>TeV scale</u>

In SM

Today



SuperB+Lattice improvements

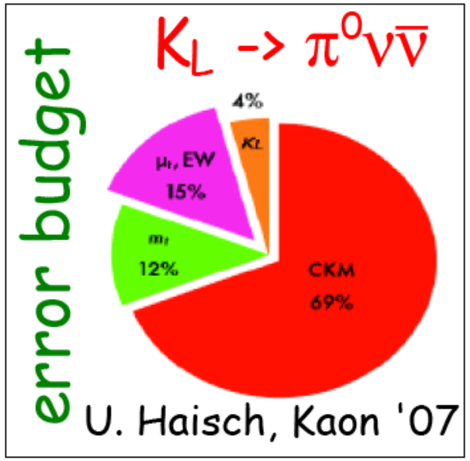


ρ = 0.163 ± 0.028
η = 0.344± 0.016

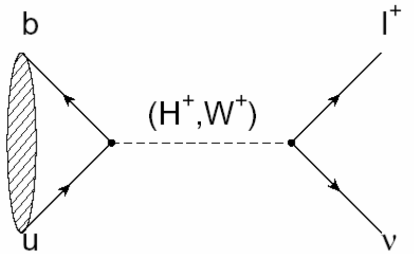
↓

ρ = ± 0.0028
η = ± 0.0024

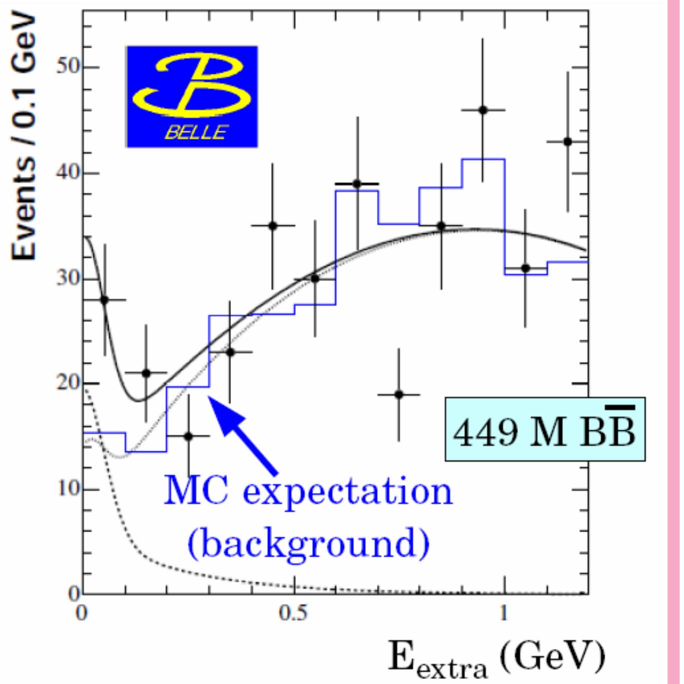
Improving CKM is crucial to look for NP



leptonic decay B→lν



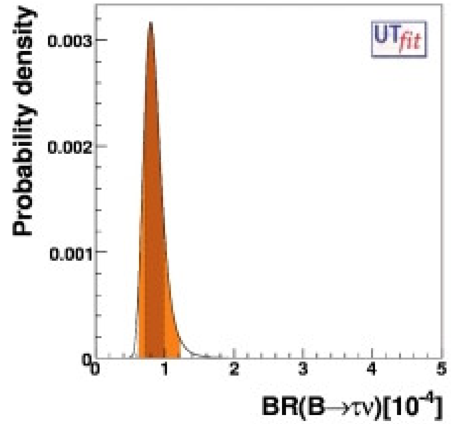
Milestone :
First leptonic decay seen on B meson



Exp. likelihood BABAR+BELLE
BR(B → τ ν) = (1.31 ± 0.48) 10^{-4}

First test can be done, not yet precise

SM expectation



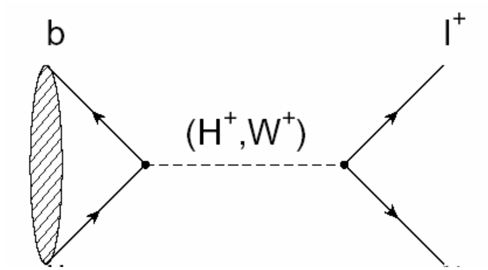
BR(B → τ ν) = (0.85 ± 0.13) 10^{-4}

Observable	B Factories (2 ab^{-1})	SuperB
$\mathcal{B}(B \to \tau\nu)$	20%	4% (†)
$\mathcal{B}(B \to \mu\nu)$	visible	5%
$\mathcal{B}(B \to D\tau\nu)$	10%	2%

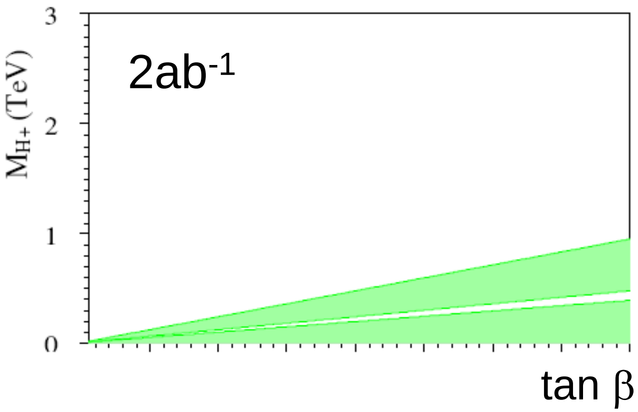
(+) systematically limited (to be studied with the improved detector)

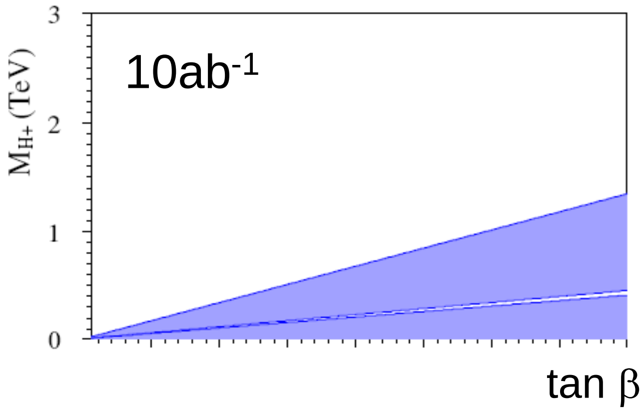
Br(B→τν) up to 3-4% (below limited by systematics) ..probably not with improved detector.
Br(B→μν) can be measured with the same precision not limited by syst.

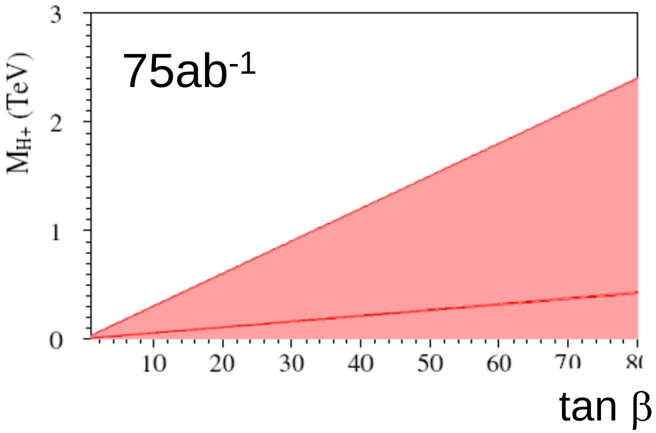
Higgs-mediated NP in MFV at large tanβ



$$BR(B \to \tau\nu) = BR_{SM}(B \to \tau\nu)\left(1 - \frac{m_B^2}{M_H^2}\tan^2\beta\right)^2$$







$2ab^{-1}$

M_H~0.4-0.8 TeV for tanβ~30-60

SuperB -$75ab^{-1}$

M_H~1.2-2.5 TeV for tanβ~30-60

Importance of having very large sample >$75ab^{-1}$

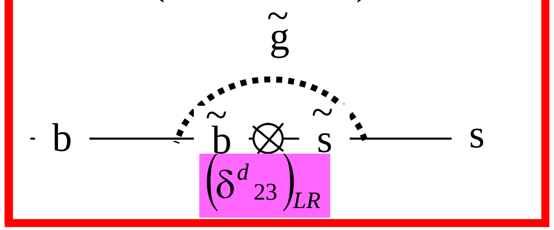
MSSM+generic soft SUSY breaking terms

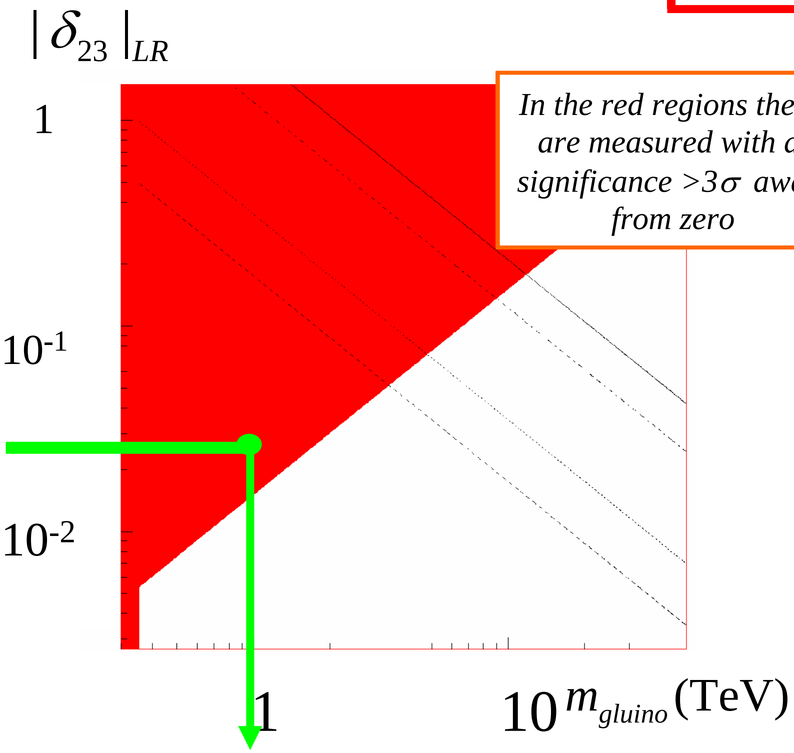
Flavour-changing NP effects in the squark propagator

→ NP scale SUSY mass $\tilde{m} \sim m_{\tilde{g}}$

→ flavour-violating coupling $(\delta^q_{ij})_{AB} \equiv \frac{(M^2_{ij})^q_{AB}}{\tilde{m}^2}$

New Physics contribution (2-3 families)

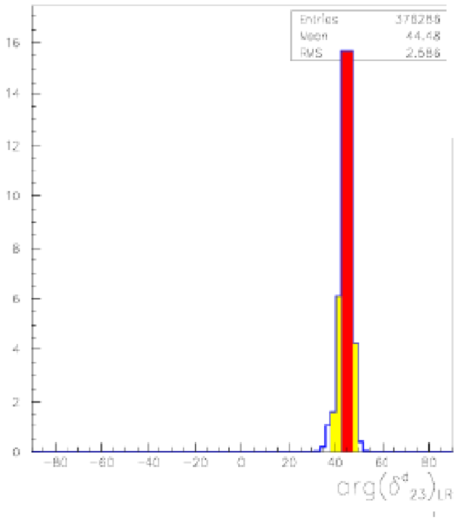




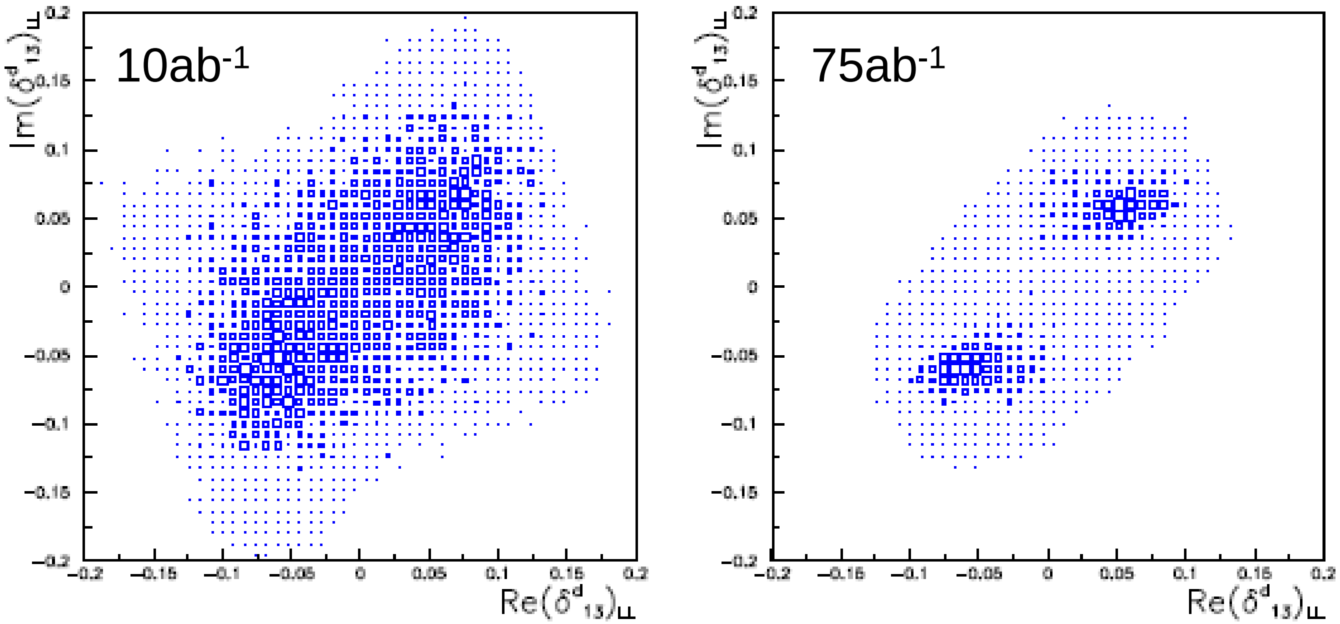
In the red regions the δ are measured with a significance >3σ away from zero

$|\delta_{23}|_{LR}$ = (0.026 ± 0.005)

$Arg(\delta_{23})_{LR}$=(44.5± 2.6)°



1 TeV



Determination of Susy mass insertion parameter $(\delta_{13})_{LL}$

with 10 ab^{-1} and 75 ab^{-1}

Importance of having very large sample >75ab^{-1}

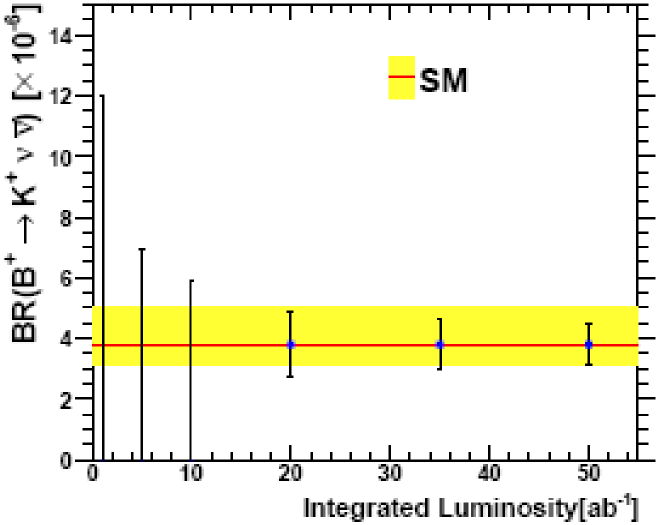
GOLDEN MODES

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

X The GOLDEN channel for the given scenario

● Not the GOLDEN channel for the given scenario but can show experimentally measurable deviations from SM.

Branching fraction Br(B → K ν ν)

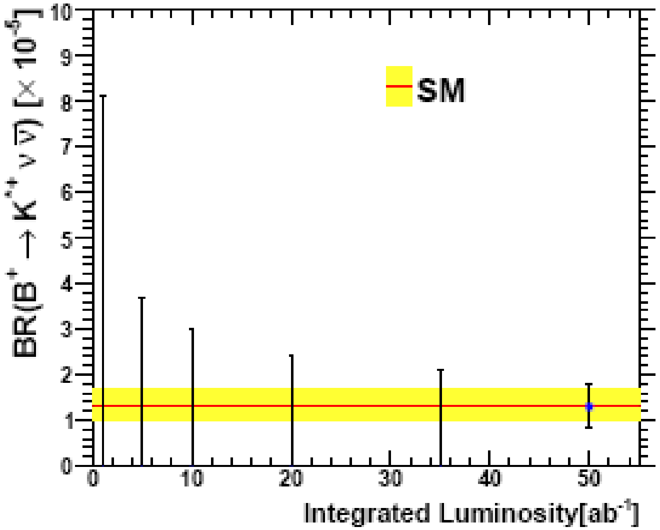


$$B^+ \to K^+ \nu \bar{\nu}$$

Today

The best UL < 14 10^{-6}

SM BF= 4 10^{-6}

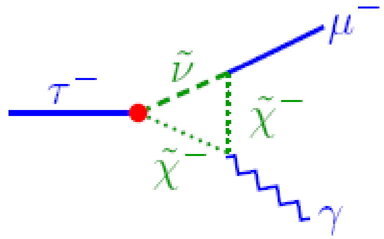


$$B^+ \to K^{*+} \nu \bar{\nu}, (K^+ \to K_S \pi^+)$$

~10ab^{-1} are needed for observation
>50ab^{-1} for precise measurement

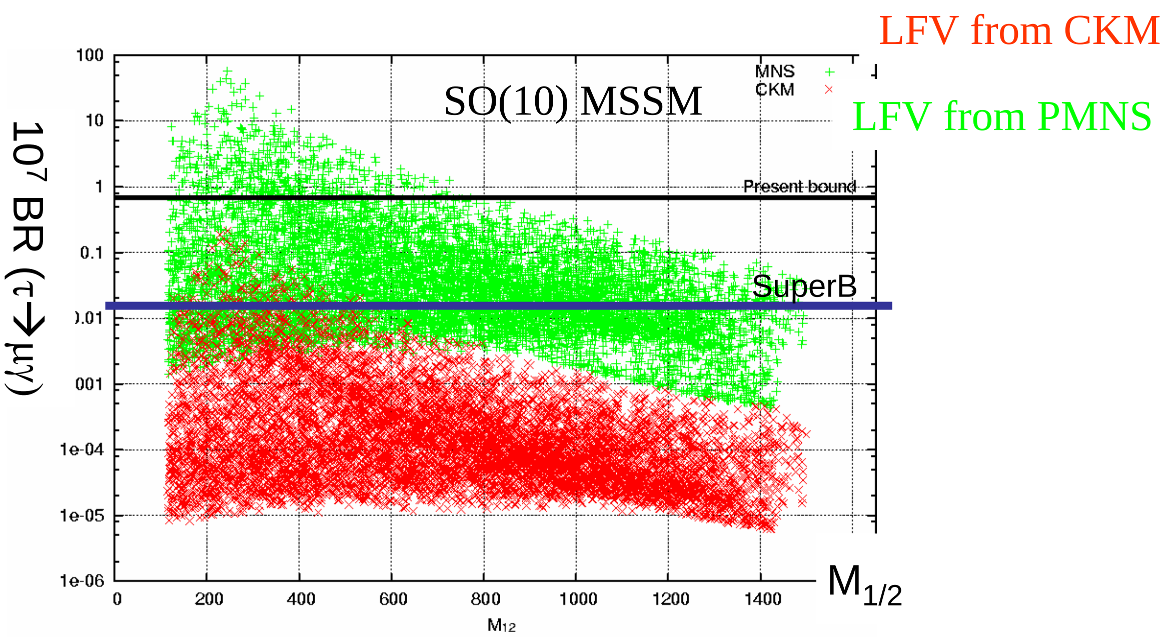
Lepton Flavour Violation $\tau \to \mu\gamma$. We can gain a very important order of magnitude $10^{-8} \to 10^{-9}$

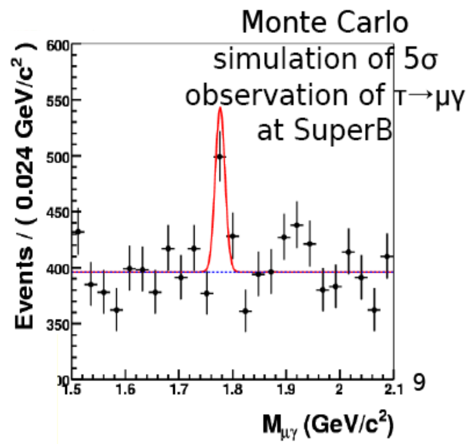
Complementarity with $\mu \to e\gamma$



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}

MEG sensitivity $\mu \to e\gamma$ $\sim 10^{-13}$





Charm Physics

Charm physics using the charm produced at Υ(4S)

Charm physics at threshold **0.3 ab^{-1}**

Consider that running 2 month at threshold we will collect 500 times the stat. of CLEO-C

Strong dynamics and CKM measurements

@threshold(4GeV)

D decay form factor and decay constant @ 1%
Dalitz structure useful for γ measurement

ξ~1%,
exclusive V_{ub} ~ few %
syst. error on γ from Dalitz Model <1^o

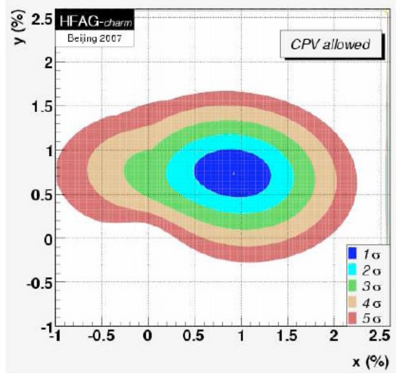
Rare decays FCNC down to 10^{-8}

@threshold(4GeV)

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

D mixing

Better studied using the high statistics collected at Υ(4S)

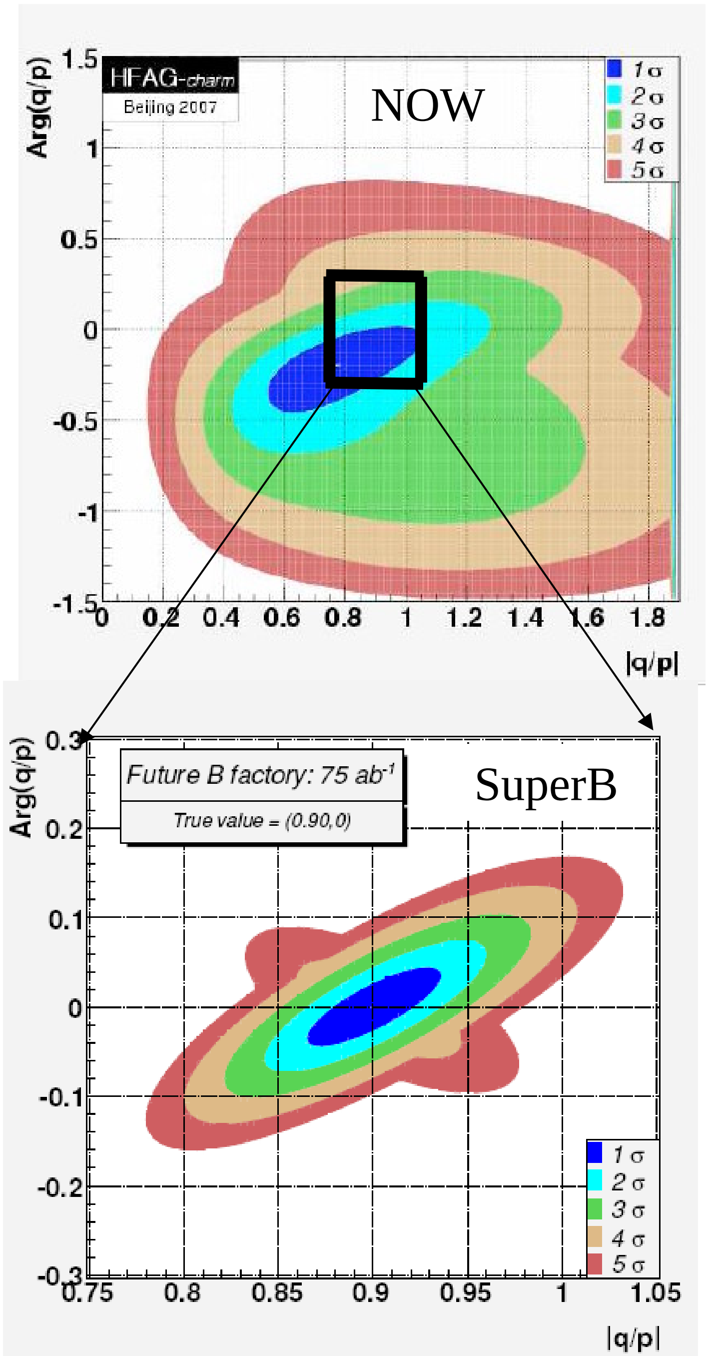


Mode	Observable	B Factories (2 ab^{-1})	Super$B$ (75 ab^{-1})
$D^0 \to K^+K^-$	y_{CP}	$2\text{–}3 \times 10^{-3}$	5×10^{-4}
$D^0 \to K^+\pi^-$	y'_D	$2\text{–}3 \times 10^{-3}$	7×10^{-4}
	x'^2_D	$1\text{–}2 \times 10^{-4}$	3×10^{-5}
$D^0 \to K^0_S\pi^+\pi^-$	y_D	$2\text{–}3 \times 10^{-3}$	5×10^{-4}
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

CP Violation in mixing could now addressed

CP Violation in charm

Mode	Observable	$\Upsilon(4S)$ $(75\ \text{ab}^{-1})$	$\psi(3770)$ $(300\ \text{fb}^{-1})$
$D^0 \to K^+\pi^-$	x'^2	3×10^{-5}	
	y'	7×10^{-4}	
$D^0 \to K^+K^-$	y_{CP}	5×10^{-4}	
$D^0 \to K^0_S\pi^+\pi^-$	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		$(1-2) \times 10^{-3}$
	$\cos\delta$		$(0.01-0.02)$



Summary

SFF can perform many measurements at <1% level of precision

Precision on CKM parameters will be improved by more than a factor 10

NP will be studied (measuring the couplings) if discovered at LHC

if NP is not (or “partially”) seen at the TeV, SFF is the way of exploring NP scales of the several TeV (in some scenario several (>10)TeV..)

… and do not forget… **SFF** is also a **Super-Super τ-charm factory**…

..and also…spectroscopy, variables sensitive to polarization, CP violation in τ and D…

Machine

Slides prepared with
the help of
Alessandro Variola

$$L \propto D \frac{f_r N^2}{(\sigma_x \sigma_y)} \frac{1}{\sqrt{1+\Phi^2}}$$

$$\Phi = \frac{\sigma_z}{\sigma_x} tg(\frac{\vartheta}{2})$$

$$D \approx \frac{N\sigma_z}{(\sigma_x \sigma_y)}$$

"The Crab waist scheme"

To have large luminosity

1) Single passage : D (disruption) high [profit of beam-beam effects (pinch)] small σ_x, σ_y

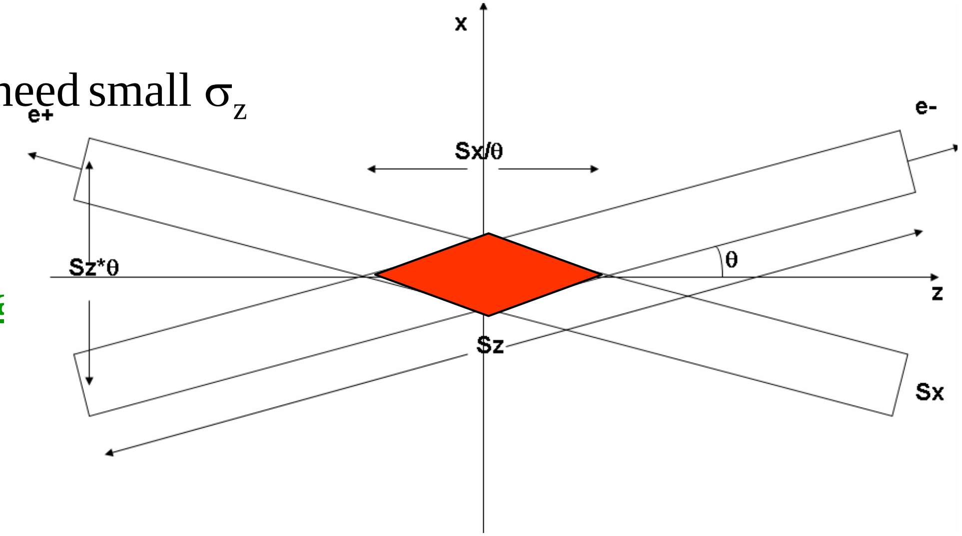
2) The beam has to be re-utilized in an accumulation ring → to maxime f_r →D "small"

3)To keep D small and small σ_x, σ_y we also need small σ_z

→ Crossing angle interaction

Swap the x with z requirements with a crossing a

from Hourglass effect $\Rightarrow \beta_y \geq \sigma_z$



In this scheme we obtain the possibility to work with very small beta

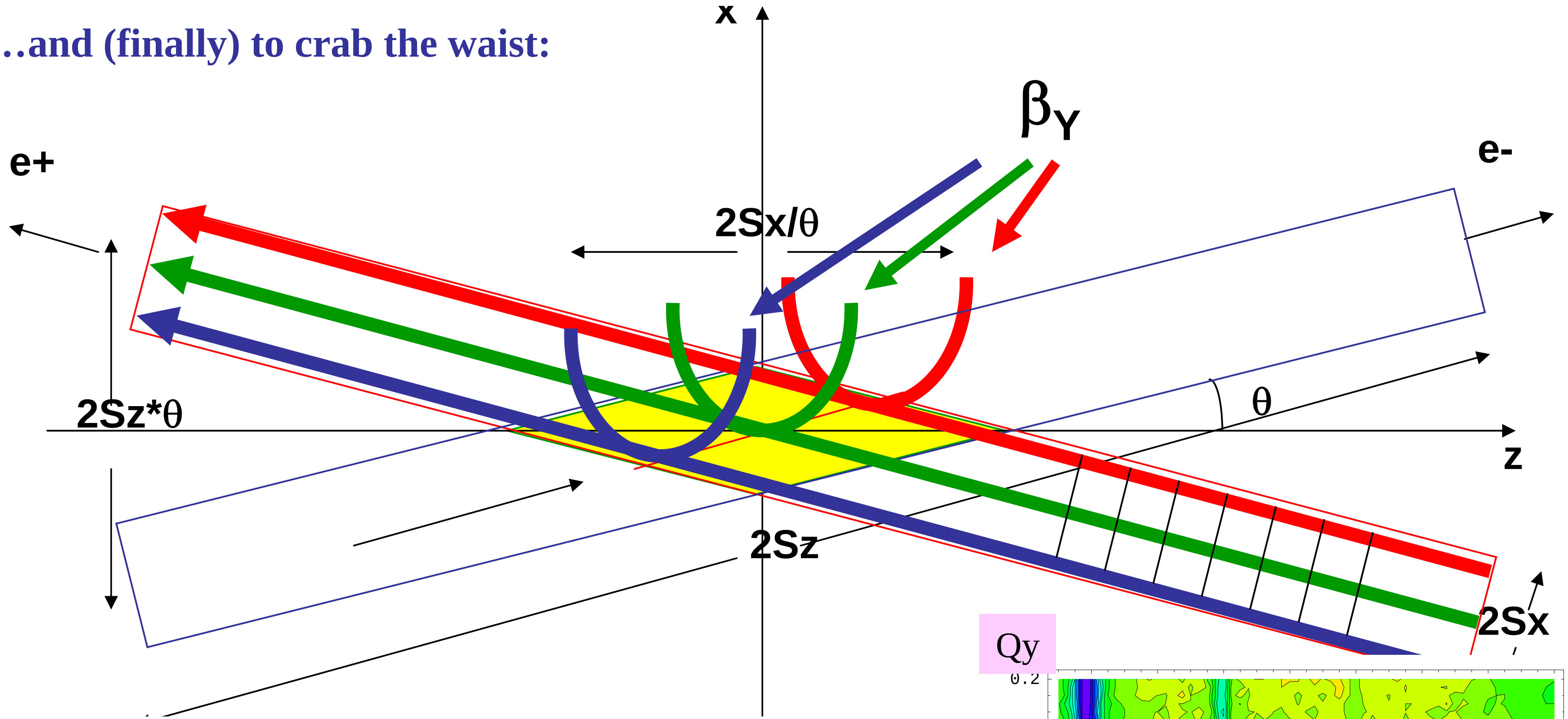
But :

Introduces B(x)-B(y) and S(z)-B(x,y) resonances (strong coordinates coupling).

"Crab Waist pensaci tu…"

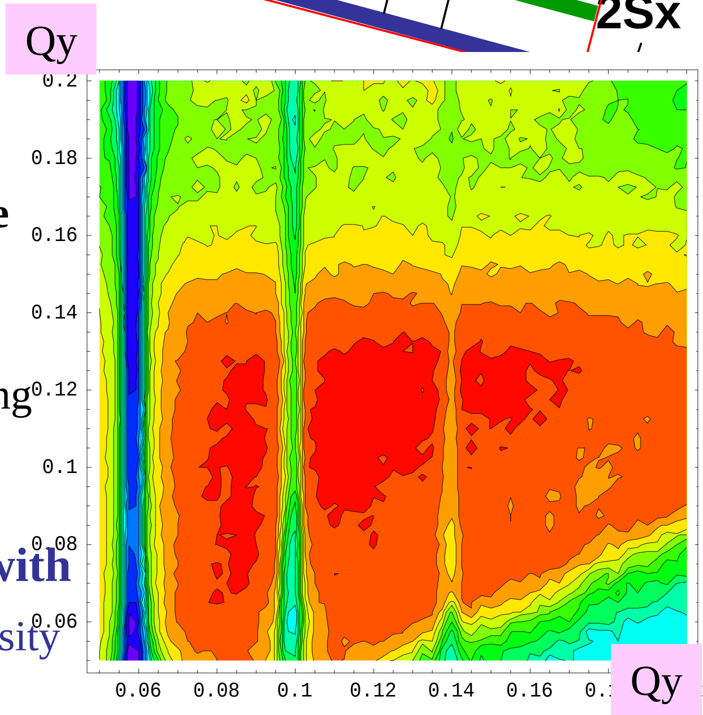
("Fait quelque chose pour moi…")

…and (finally) to crab the waist:



Why? Crabbed waist removes betatron coupling resonances introduced by the crossing angle (betatron phase and amplitude modulation)

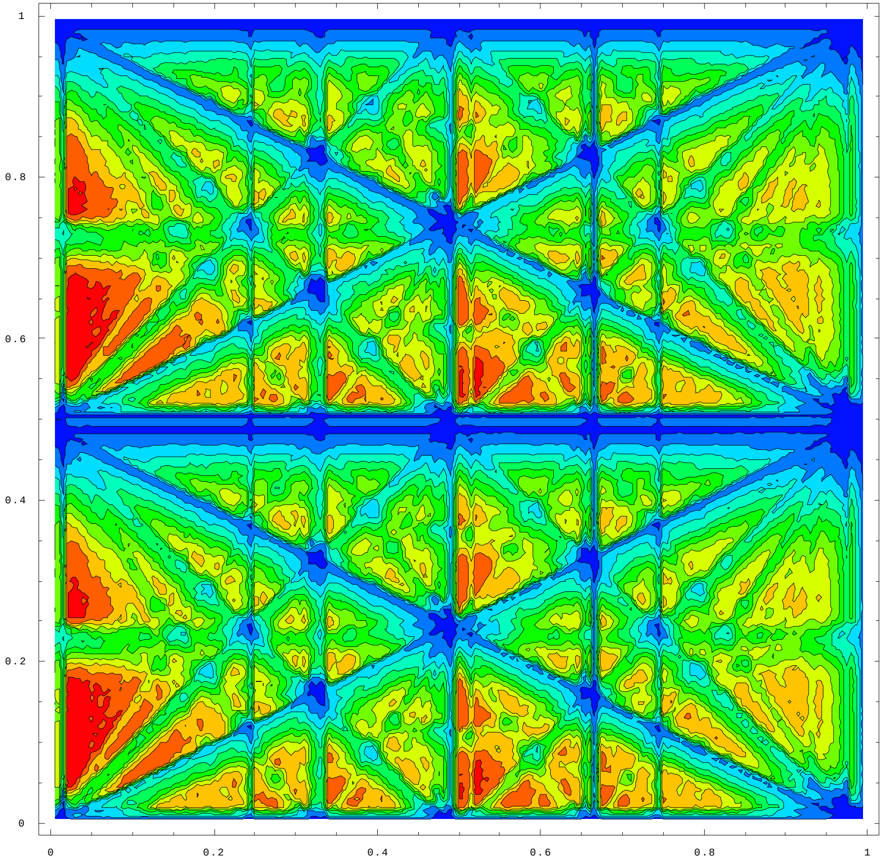
Conceptually simple : restore the B-B effects to those we have quadrupoles focalising in 2D (compensate the effects of the crossing angle

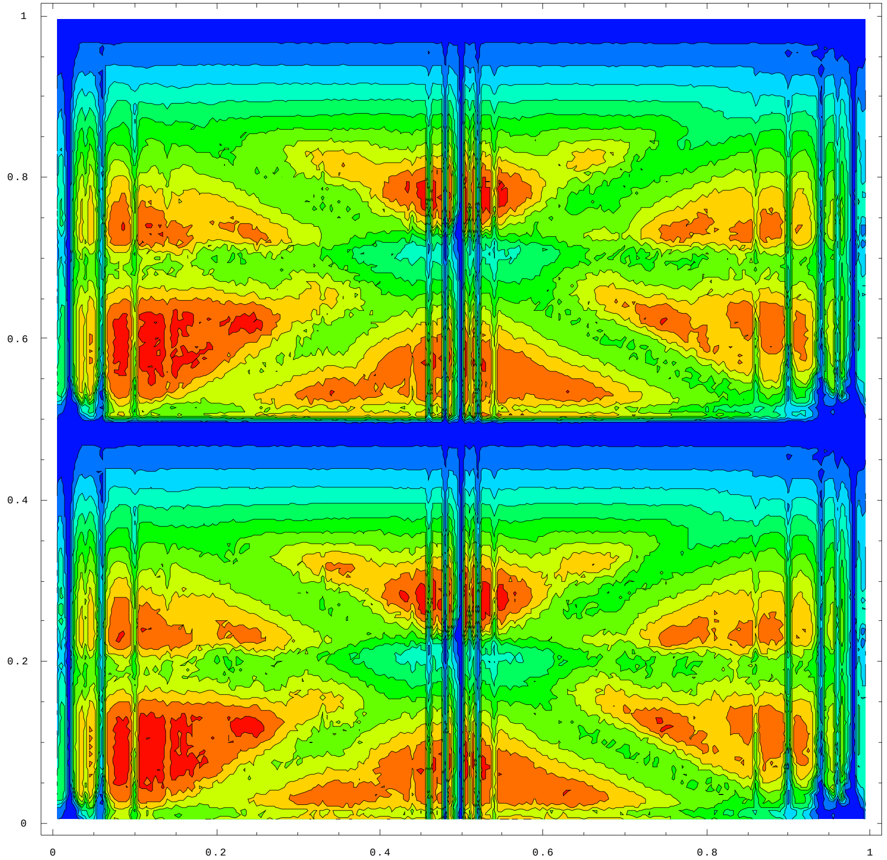


Vertical waist has to be a function of x: **Crabbed waist realized with a sextupole** in phase with the IP in X and at $\pi/2$ in Y slight luminosity increase.

Example of x-y resonance suppression

D.Shatilov's (BINP), ICFA08 Workshop





Typical case (KEKB, DAΦNE):

1. low Piwinski angle $\Phi < 1$
2. β_y comparable with σ_z

Crab Waist On:

1. large Piwinski angle $\Phi >> 1$
2. β_y comparable with σ_x/θ

Luminosity x 10^{36}	1		2,4		3,4	
Circumference (m)	2250	2250	2250	2250	2250	2250
Revolution frequency (MHz)	0,13	0,13	0,13	0,13	0,13	0,13
Eff. long. polarization (%)	0	80	0	80	0	80
RF frequency (MHz)	476	476	476	476	476	476
Harmonic number	3570	3570	3570	3570	3570	3570
Momentum spread	8,4E-04	9,0E-04	1,0E-03	1,0E-03	1,0E-03	1,0E-03
Momentum compaction	1,8E-04	3,0E-04	1,8E-04	3,0E-04	1,8E-04	3,0E-04
Rf Voltage (MV)	6	18	6	18	7,5	18
Energy loss/turn (MeV)	1,9	3,3	2,3	4,1	2,3	4,1
Number of bunches	1733	1733	3466	3466	3466	3466
Particles per bunch x10^{10}	6,16	3,52	5,34	2,94	6,16	3,52
Beam current (A)	2,28	1,30	3,95	2,17	4,55	2,60
Beta y* (mm)	0,30	0,30	0,20	0,20	0,20	0,20
Beta x* (mm)	20	20	20	20	20	20
Emit y (pmr)	4	4	2	2	2	2
Emit x (nmr)	1,6	1,6	0,8	0,8	0,8	0,8
Sigma y* (microns)	0,035	0,035	0,020	0,020	0,020	0,020
Sigma x* (microns)	5,657	5,657	4,000	4,000	4,000	4,000
Bunch length (mm)	6	6	6	6	6	6
Full Crossing angle (mrad)	34	34	34	34	34	34
Wigglers (#)	4	2	4	4	4	4
Damping time (trans/long)(ms)	32/16	32/16	25/12.5	25/12.5	25/12.5	25/12.5
Luminosity lifetime (min)	10,4	5,9	7,4	4,1	6,1	3,5
Touschek lifetime (min)	5,5	38	2,9	19	2,3	15
Effective beam lifetime (min)	3,6	5,1	2,1	3,4	1,7	2,8
Injection rate pps (100%)	4,9E+11	2,0E+11	1,5E+12	5,0E+11	2,1E+12	7,2E+11
Tune shifts (x/y) (from formula)	0.004/0.17	0.004/0.17	0.007/0.16	0.007/0.16	0.009/0.2	0.009/0.2
RF Power (MW)	17		35		44	

•Possibility of energy scaling to work at the τ/charm center of mass with an estimated luminosity loss of an order of magnitude.

10^{36}cm^{-2} sec^{-1} → 15ab^{-1} per year

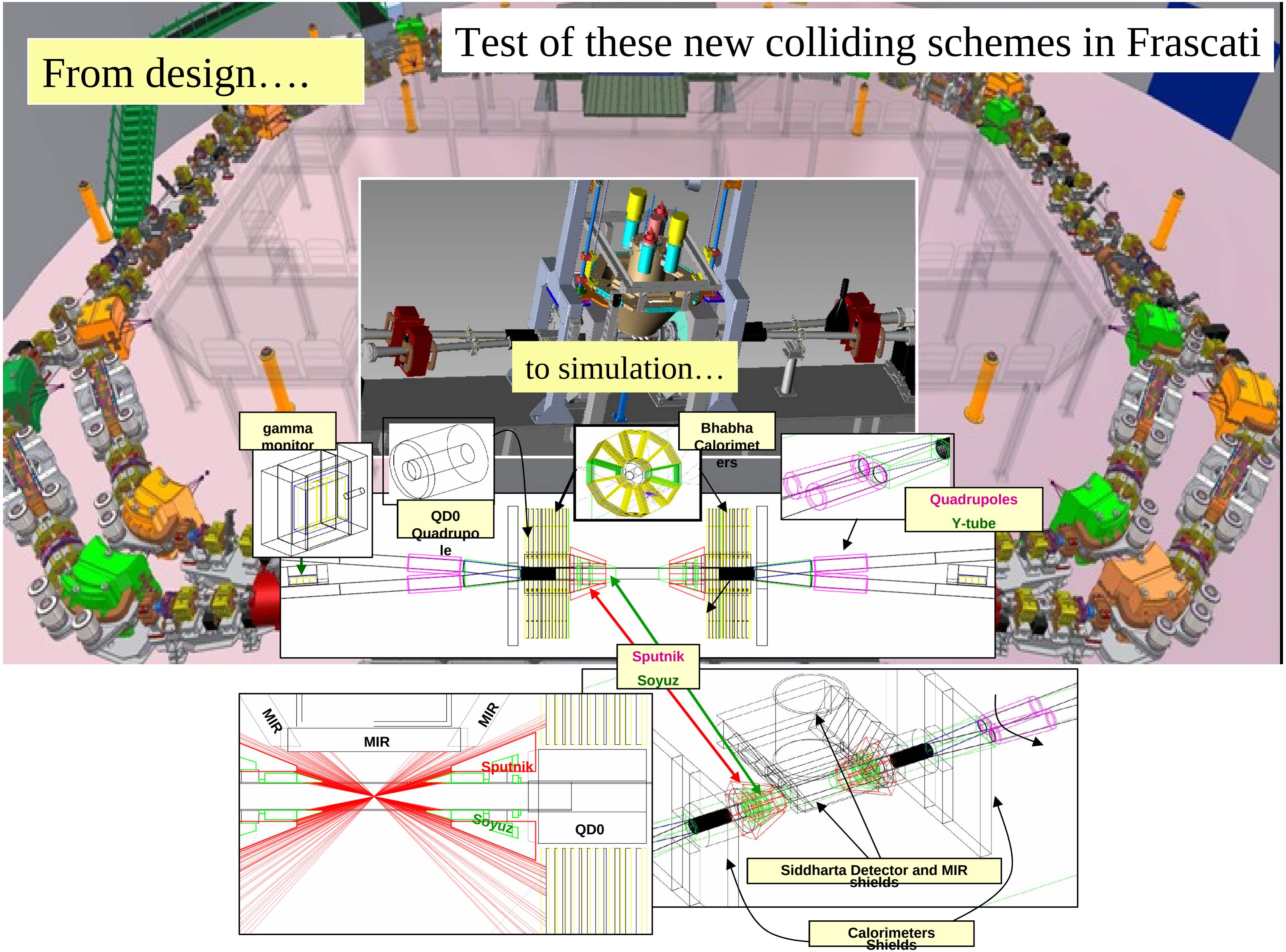
3,4×10^{36}cm^{-2} sec^{-1} → ~50ab^{-1} per year

- Other possibilities to further improve the luminosity not discussed here..
- Possibility of having two Interaction Regions (even better for the machine stability)

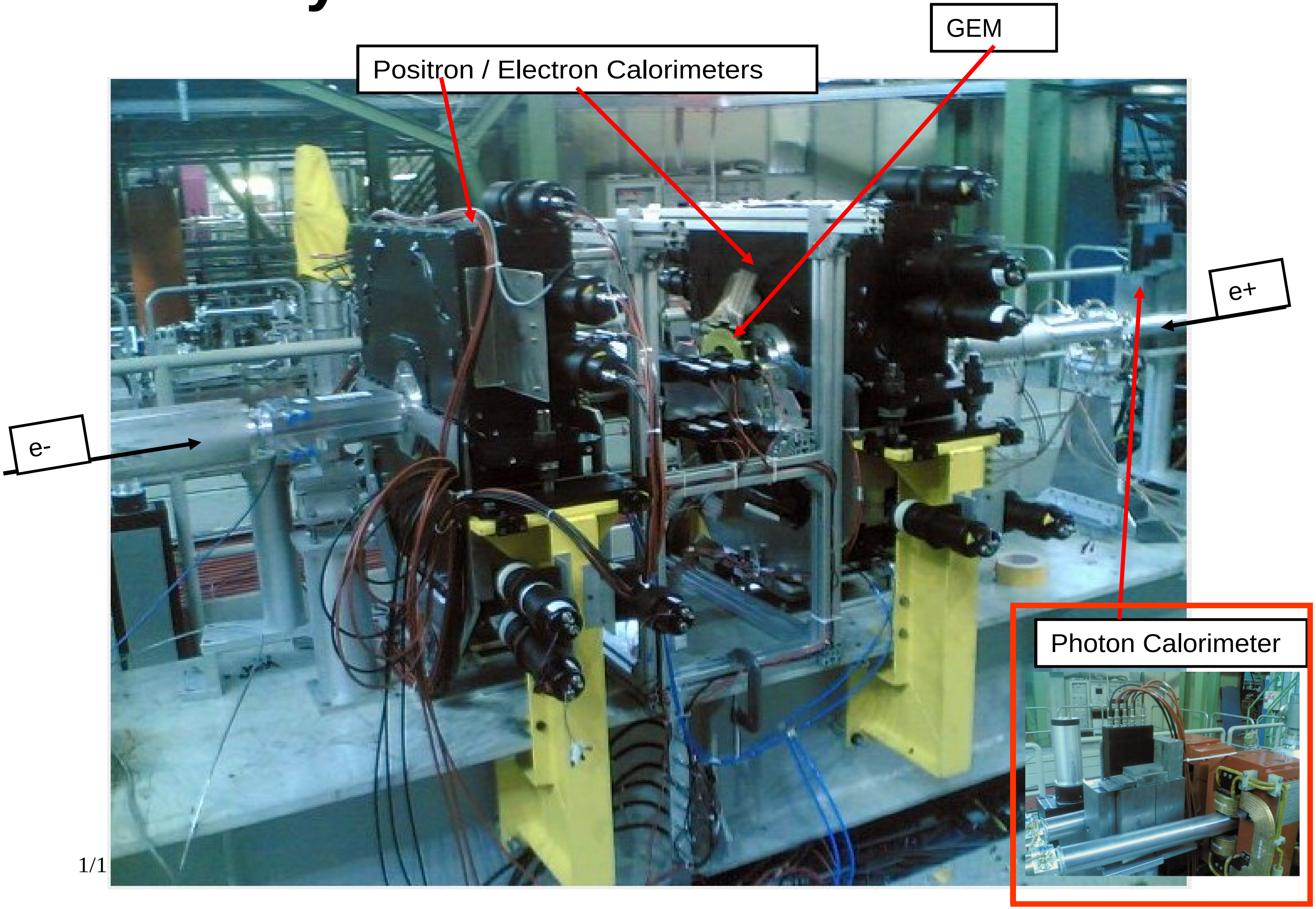
In a condense table

	PEPII	KEKB	SuperB
current	2.5 A	1.7 A	2.3 A
betay	10 mm	6 mm	0.3 mm
betax	400 mm	300 mm	20 mm
Emitx (sigmax)	23 nm	~ 20 nm	1,6 nm
y/x coupling	0,5-1	0.25 %	0,25 %
Bunch length	10 mm	6 mm	6 mm
τ	16/32 msec	16/32 msec	16/32 msec
ζy	0.07	0.1	0.17
L	$1.2\ 10^{34}$	$1.7\ 10^{34}$	$1\ 10^{36}$

Test of these new colliding schemes in Frascati



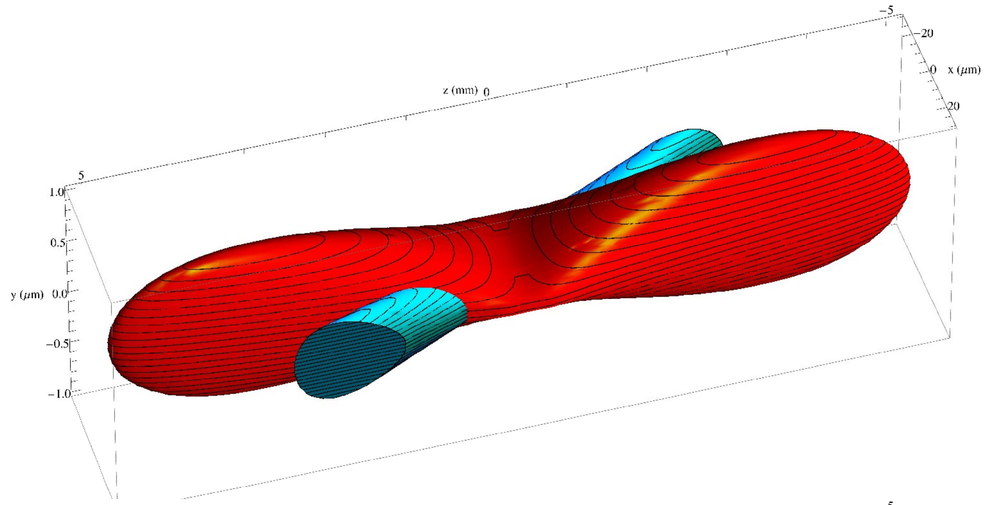
To Reality…



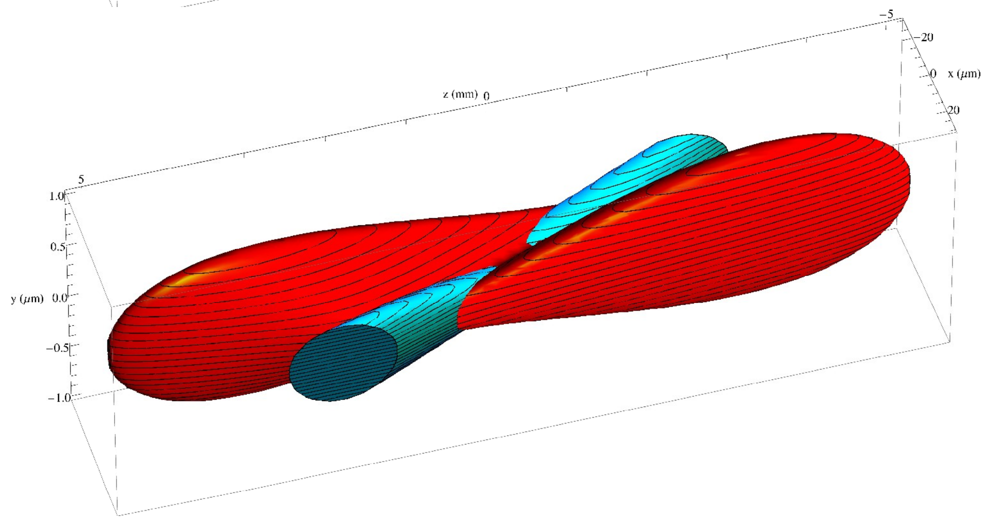
GEM
Positron / Electron Calorimeters
e+
e-
Photon Calorimeter

Beams distribution at IP @ Dafne

E. Paoloni



Without
Crab-sextupoles



With
Crab-sextupoles

All particles from both beams collide in the minimum β_y region, with a net luminosity gain

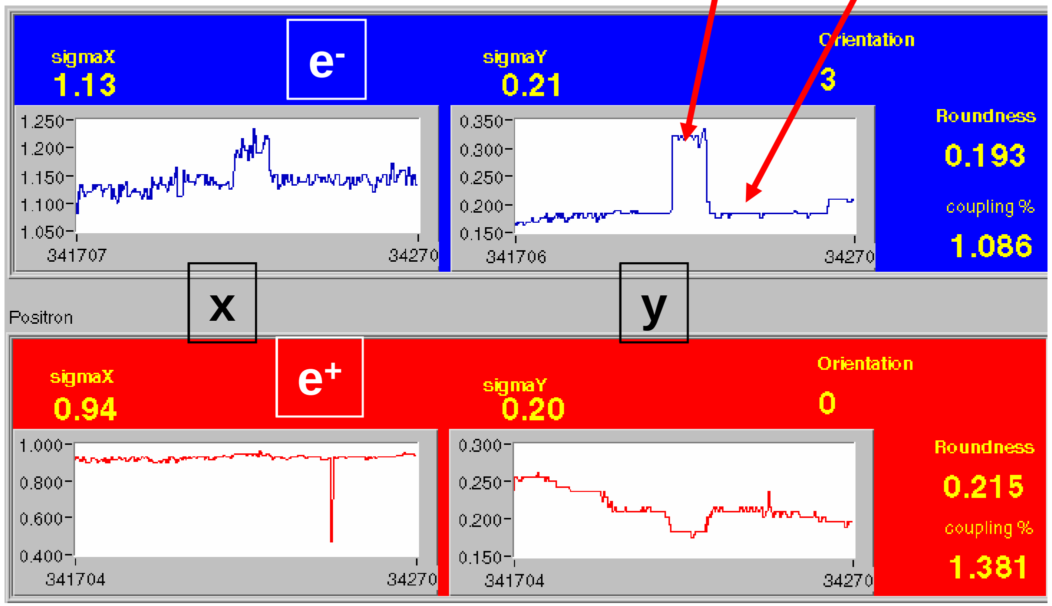
Effect of crab sextupoles on luminosity

A huge work on machine optimization has been done and is still in progress in term of feedbacks systems tuning, background minimization and tuning of the machine luminosity

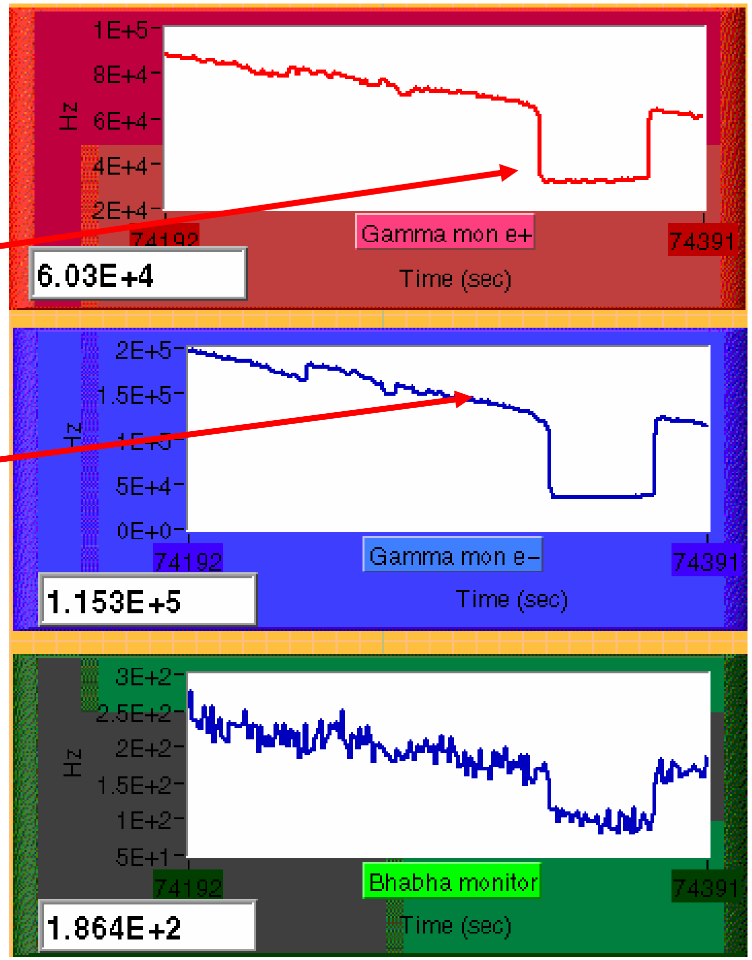
Crab OFF

Crab ON

Transverse beam dimensions at the Synchrotron Light Monitor



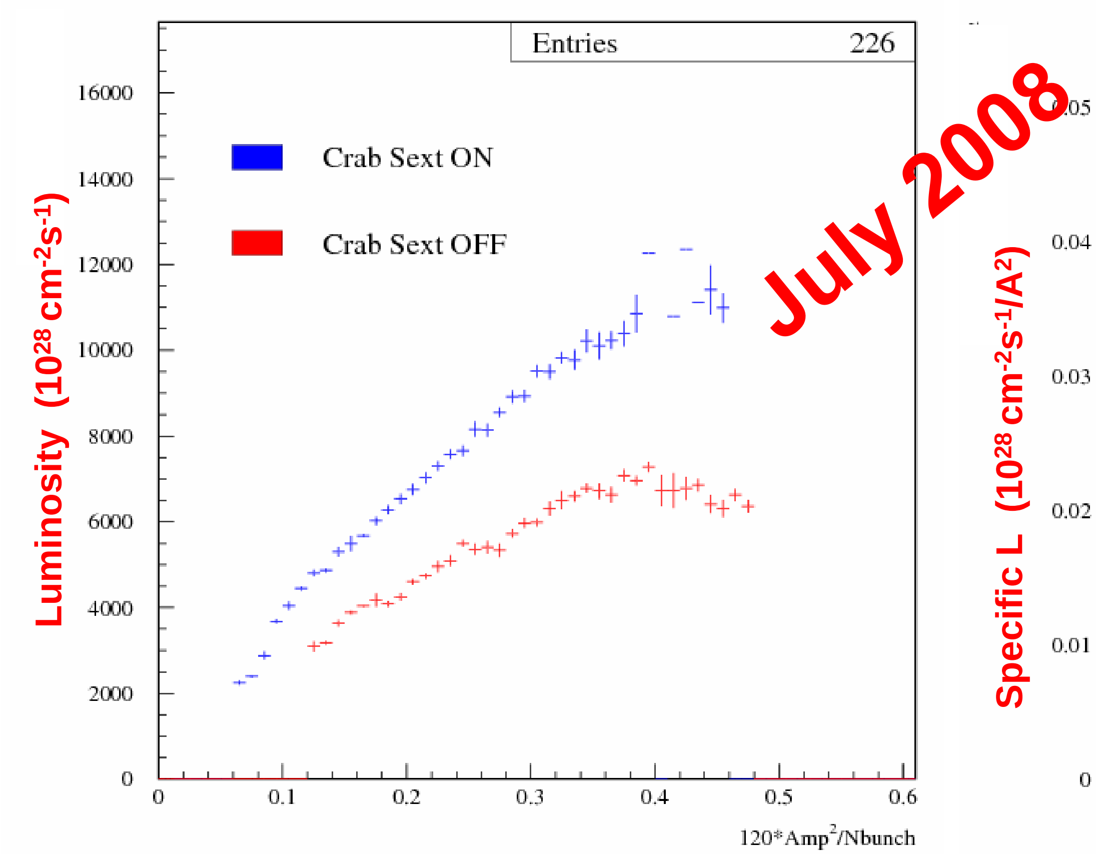
LUMINOMETERS

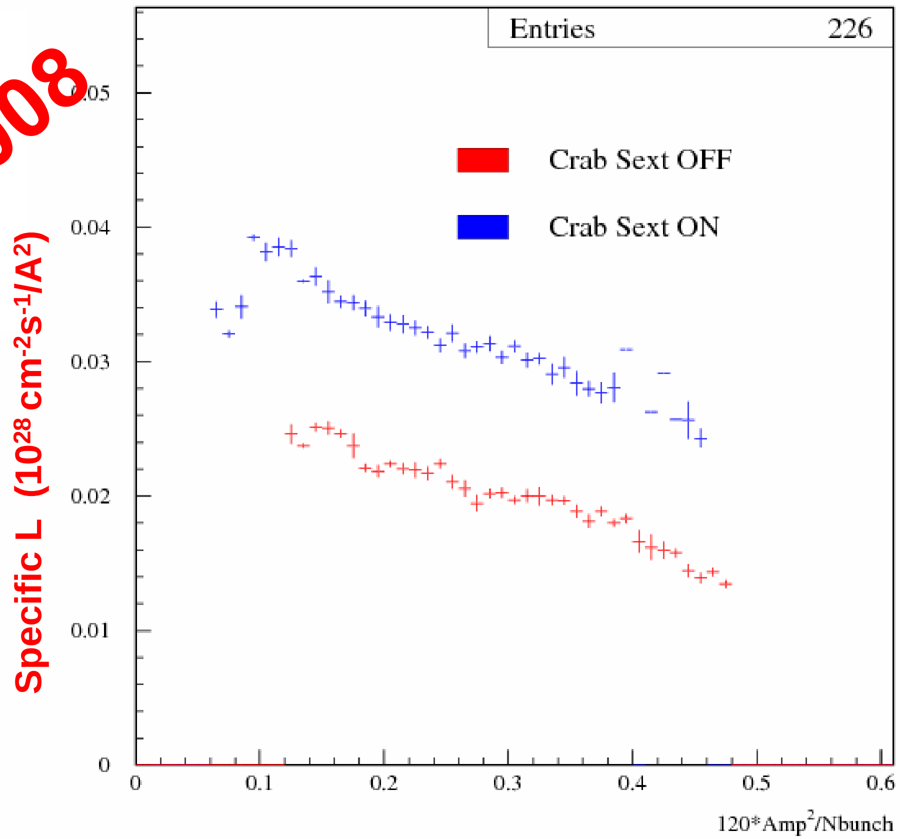


Blow-up in beam sizes and decrease in Bhabha rates observed when crab sextupols for one ring OFF (other ring ON)

Luminosity, crab ON/OFF

Luminosity | **95 Bunches** | **Specific Luminosity**

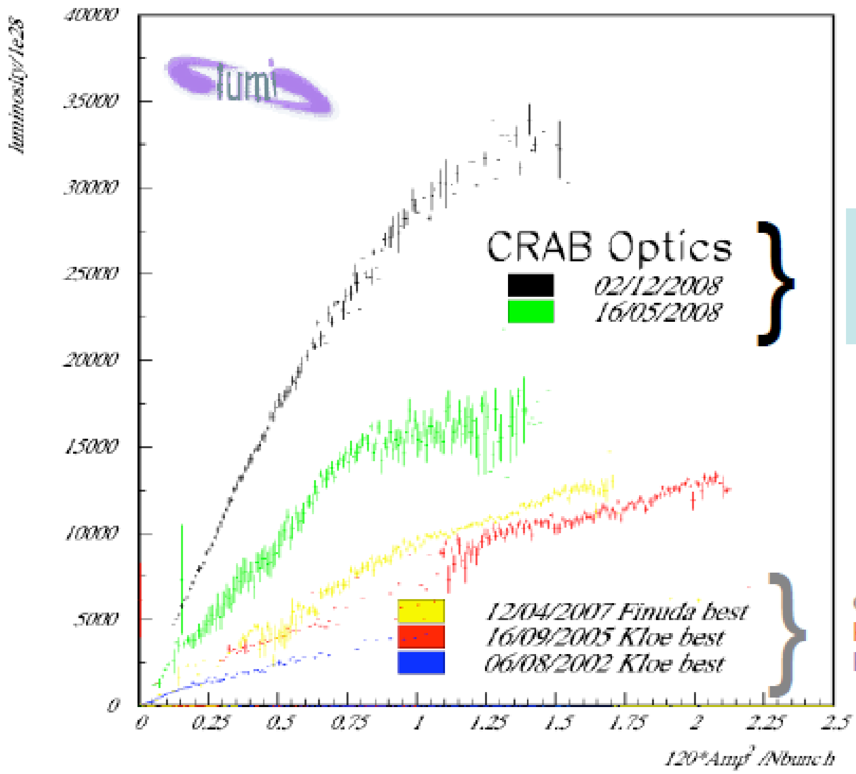




$$L_{sp} = \frac{N_b \, L_{peak}}{I^+ I^-} \; [cm^{-2} s^{-1} / A^2]$$

Comparison of KLOE runs and first Siddharta results

DAΦNE Luminosity versus colliding currents



NEW COLLISION SCHEME:
Large Piwinski angle
Crab-Waist compensation SXTs
θ_{PW} = 1.9 β_y = 9.0 [mm]

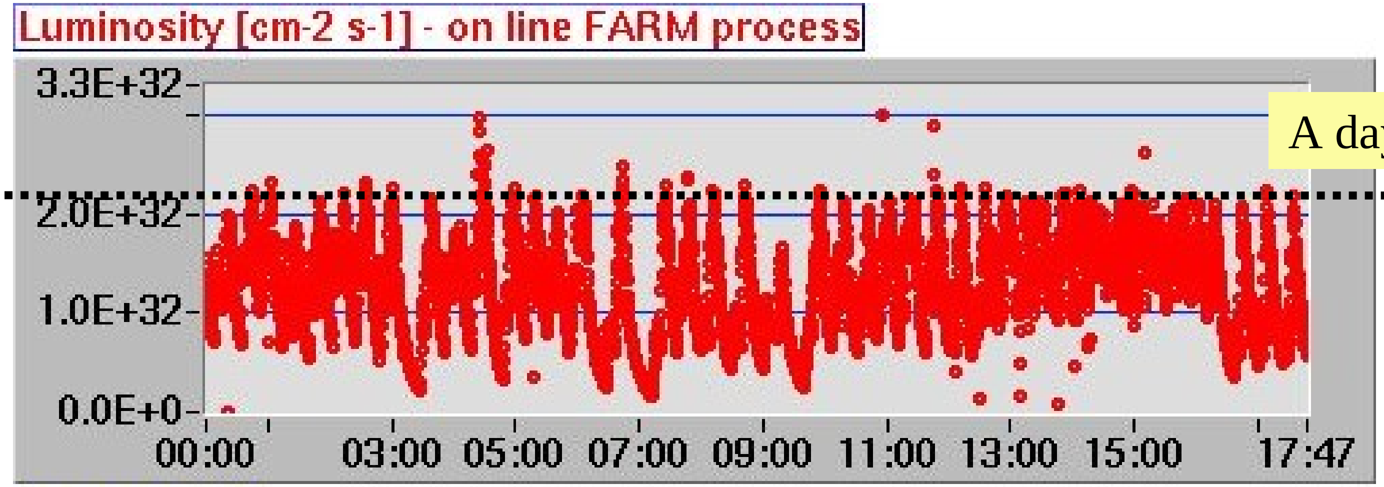
original collision scheme
KLOE 2005 θ_{PW} = 0.6 β_y = 18. [mm]
KLOE 2002 θ_{PW} = 0.3 β_y = 25. [mm]

Amp^2 / N_{bunch}

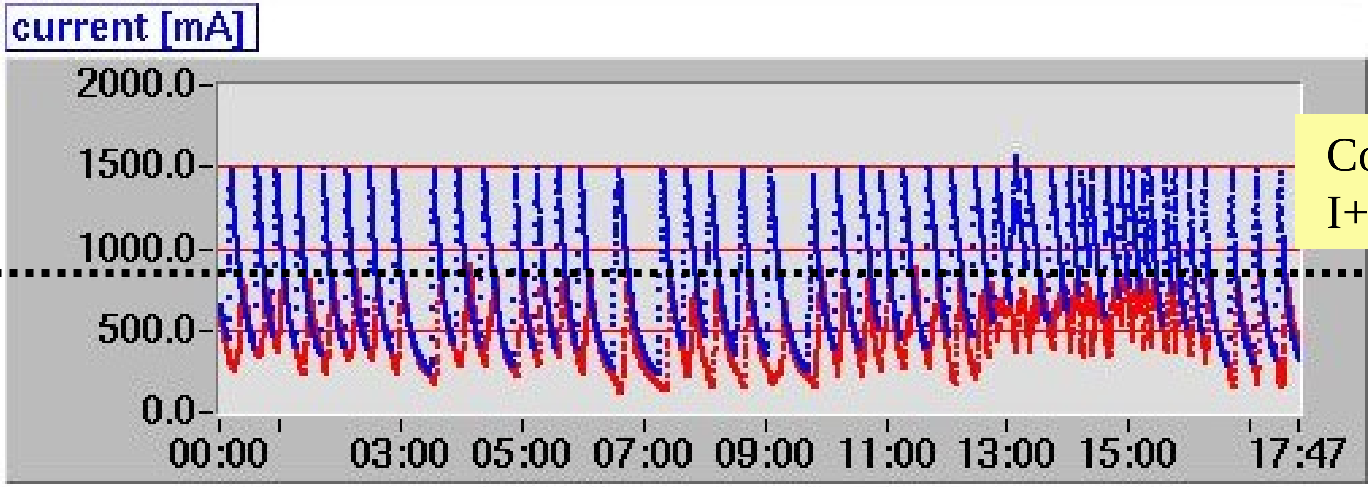
We are still running

	KLOE run	Upgrade
β_y* (cm)	1.7	0.65
β_x* (cm)	170	20
σ_y* (μm)	7	2.6
σ_x* (μm)	700	200

15 November 2008. A date to remember !



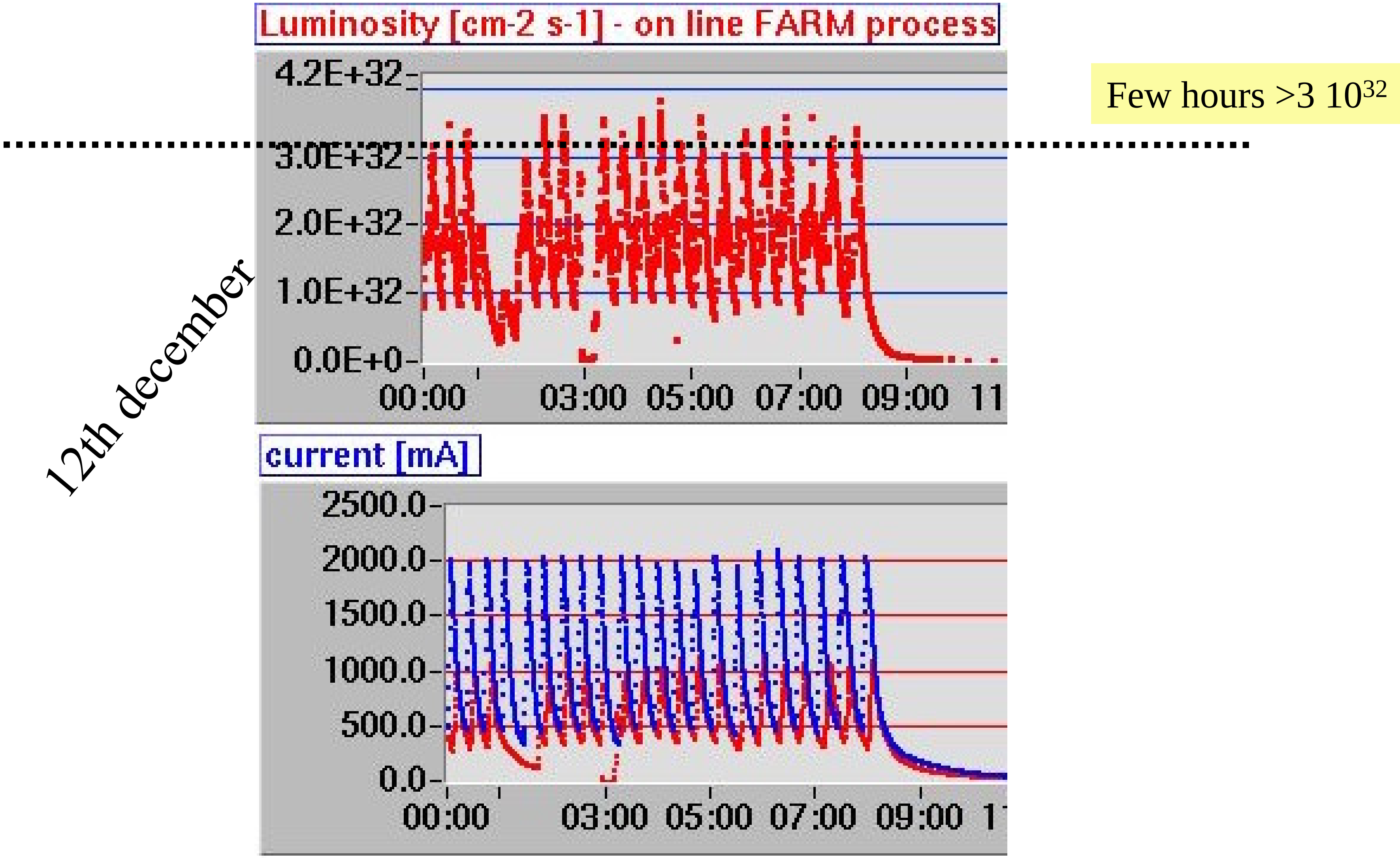
A day at ~ 2.1 10^{32}



Colliding at best

I+I- ~ 0.9× 0.9

And after this we are passing from record to record…



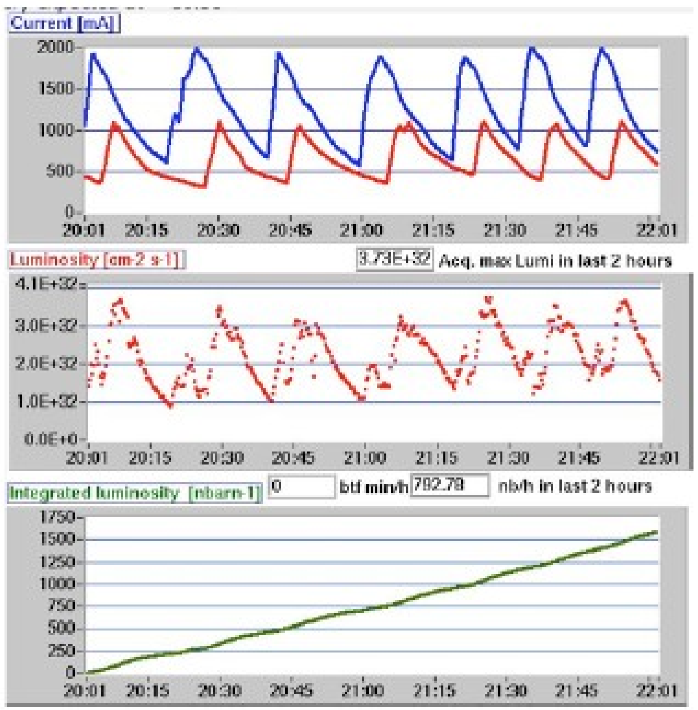
DAFNE latest results

Recent Achievements

$L_{peak} = 4.05\ cm^{-2}s^{-1}$

$L_{\int 1\ hour} = .79\ pb^{-1}$

Dec. 5th 2008



+ 150 % (FINUDA 2007)

The experiment is still on going

ILC synergy …..
How to extrapolate the Dafne results to SuperB

Unit	Super*B* LER	Super*B* HER	ILC DRs
Beam energy (GeV)	4	7	5
Circumference (m)	2249	2249	6695
Particles per bunch →	6.16×10^{10}	3.52×10^{10}	2×10^{10}
Number of bunches	1733	1733	2767
Average current (A) →	2.28	1.30	0.40
Horizontal emittance (nm)	1.6	1.6	0.8
Vertical emittance (pm)	4	4	2
Bunch length (mm)	6	6	9
Energy spread (%)	0.084	0.09	0.13
Momentum compaction	1.8×10^{-4}	3.1×10^{-4}	4.2×10^{-4}
Transverse damping time (ms)	32	32	25
RF voltage (MV)	6	18	24
RF frequency (MHz)	476	476	650

RINGS

Table 3-14. *IP Parameters for early ILC-like design and current Super$B$ concept. For the Super$B$ design, the first entry is for the LER and the bracketed number of for the HER.*

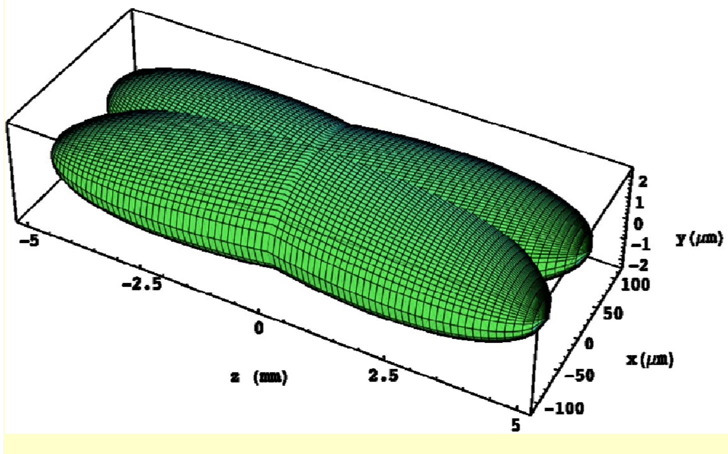
Parameter	Early ILC-like	Super*B*
Horizontal emittance ε_x (nm-rad)	0.8	1.6
Vertical emittance ε_y (pm-rad)	2	4
IP horizontal β_x (mm)	9	20
IP vertical β_y (mm)	0.08	0.30
Horizontal beam size σ_x (μm)	2.67	5.66
Vertical beam size σ_y (nm)	12.6	35
Bunch length σ_z (mm)	6	6
Momentum spread σ_e ($\times 10^{-4}$	10	8.4 (9.0)
Crossing angle θ (mrad)	2×25	2×17
No. particles/bunch N_{part} ($\times 10^{10}$)	2.5	6.2 (3.5)
No. bunches N_{bunch}	6000	1733

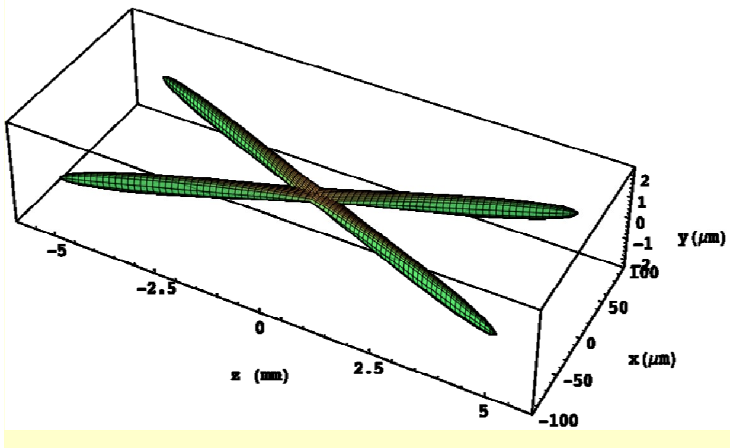
IP

Comparison of SuperB to Super-KEKB

Parameter	Units	*SuperB*	Super-KEKB
Energy	GeV	4x7	3.5x8
Luminosity	10^{36}/ cm^2/s	1.0 to 2.0	0.5 to 0.8
Beam currents	A	1.9x1.9	9.4x4.1
β_y*	mm	0.22	3.
β_x*	cm	3.5x2.0	20.
Crossing angle (full)	mrad	48.	30. to 0.
RF power (AC line)	MW	20 to 25	80 to 90
Tune shifts	(x/y)	0.0004/0.2	0.27/0.3

IP beam distributions for KEKB



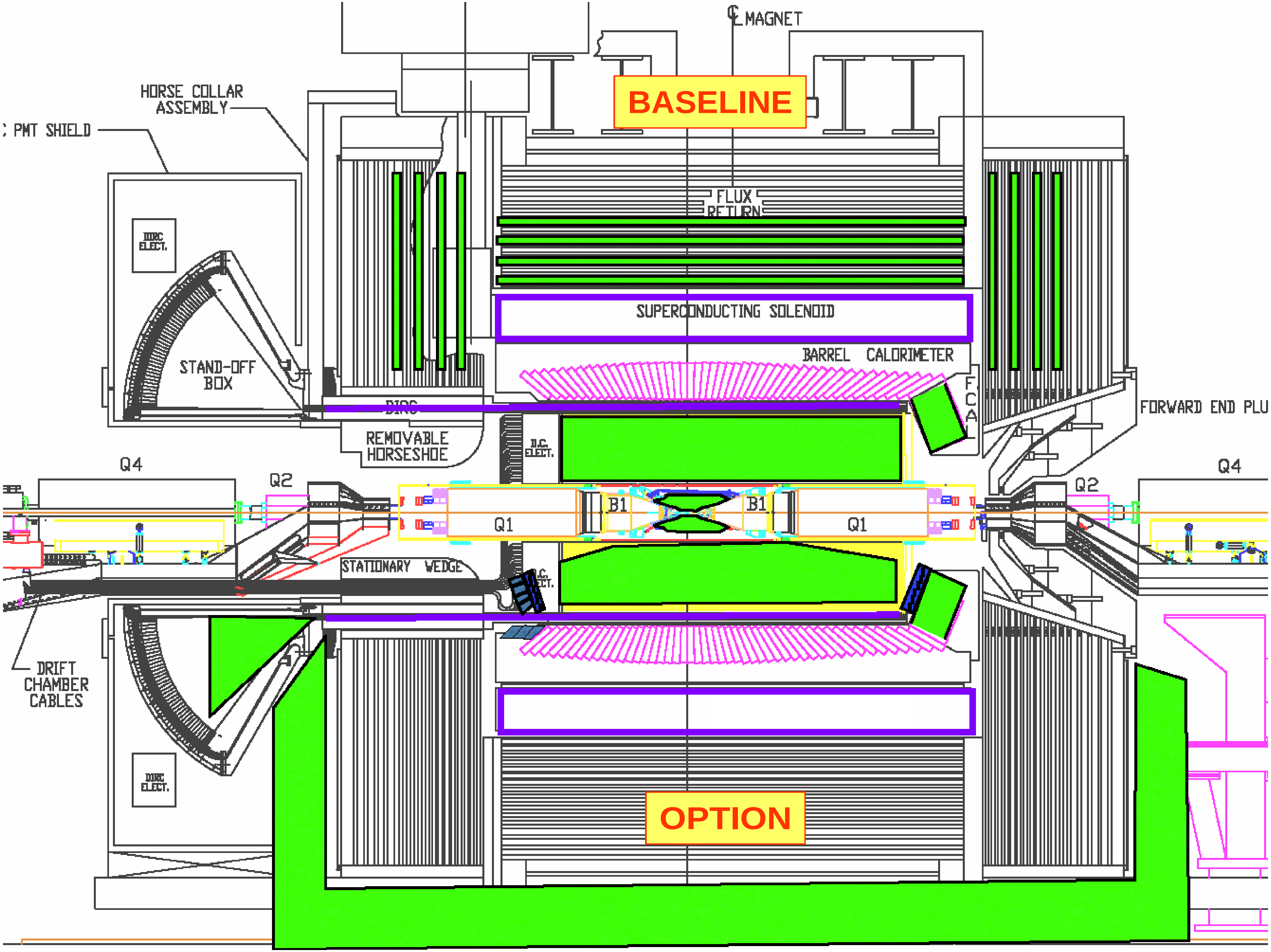


IP beam distributions for *SuperB*

Conclusions

- SuperB machine based on:
- 1) Crab Waist principle
- 2) PEP hardware
- 3) Existing ILC R&D (synergies)
- The Dafne test results are exciting!!!!
- TDR phase starting and French labs are welcome

Detectors

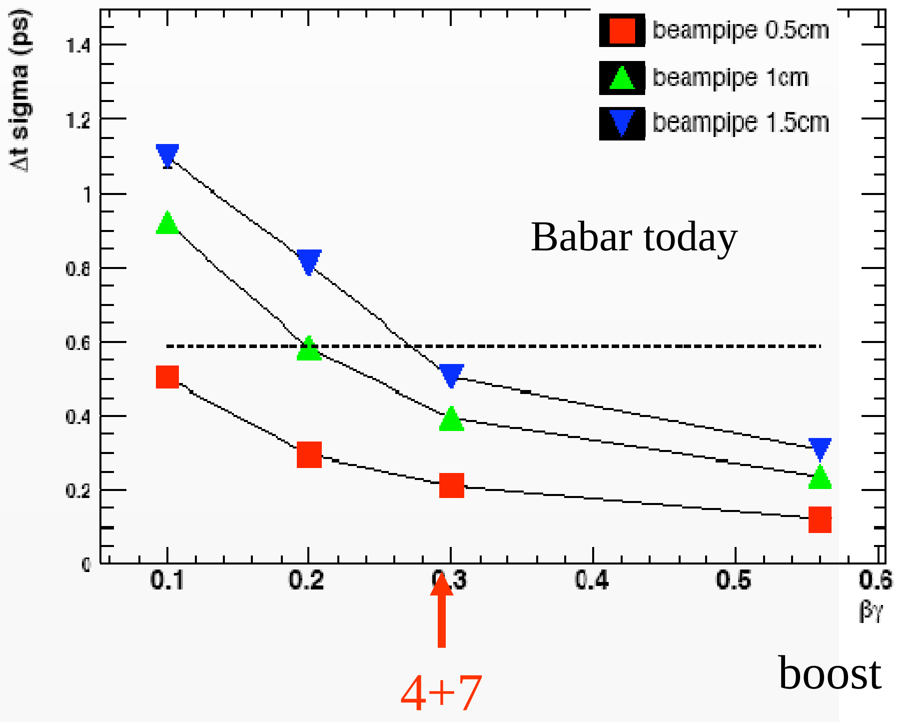


MAGNET
BASELINE
HORSE COLLAR ASSEMBLY
PMT SHIELD
DIRC ELECT.
FLUX RETURN
SUPERCONDUCTING SOLENOID
BARREL CALORIMETER
STAND-OFF BOX
DIRC
REMOVABLE HORSESHOE
D.C. ELECT.
FCA
FORWARD END PLU
Q4
Q2
B1
Q1
STATIONARY WEDGE
DRIFT CHAMBER CABLES
OPTION

- **Baseline interaction region defined**
  - 300 mrad line separating detector from accelerator, backward and forward
  - No support tube
    - although magnet support still needs to be fleshed out
  - 1 cm inner radius of the beam pipe

Forw (mrad)	Back (mrad)	Coverage
350	500	91.2%
350	350	93.1%
300	300	94.9%
200	200	97.7%
100	100	99.4%

- **Energy asymmetry**
  - 4x7 ok **if** we can use a 1cm beam pipe and get enough vertex resolution.



Try to reuse parts of Babar as much as possible

- Quartz bars of the DIRC
- Barrel EMC CsI(Tl) crystal and mechanical structure
- Superconducting coil and flux return yoke.

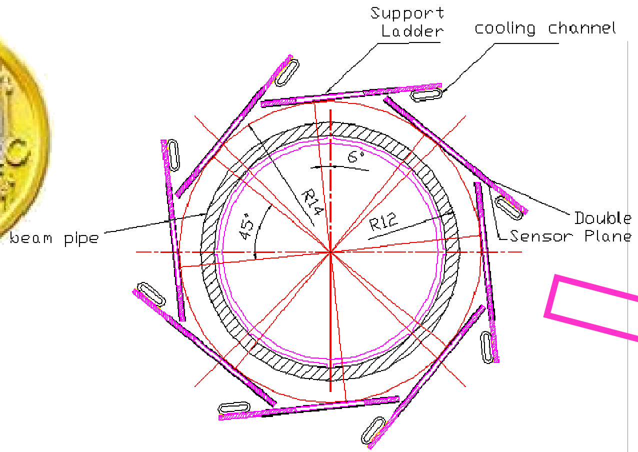
R&D and engineering required

- Small beam pipe technology
- Thin silicon pixel detector for first layer
- Drift chamber CF mechanical structure, gas and cell size
- Photon detection for DIRC quartz bars
- Forward PID system (TOF or focusing RICH)
- Forward calorimeter crystals (LSO)
- Minos-style scintillator for Instrumented flux return
- Electronics and trigger
- Computing – large data amount

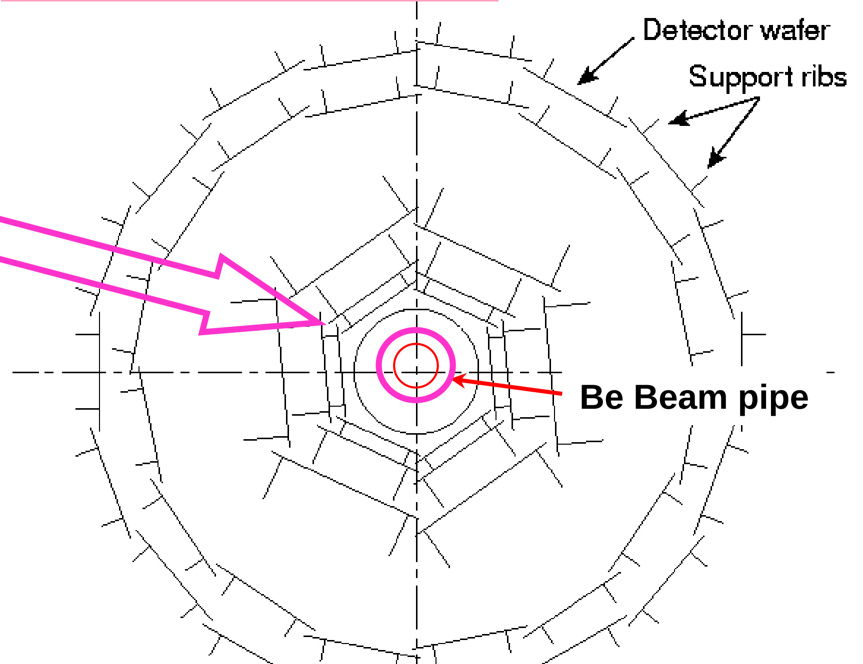
Few examples in the following

I discuss few examples

SVT (silicon detector)



Layer-0 silicon detector



Layer	Radius
0	1.2-1.5 cm
1	3.3 cm
2	4.0 cm
3	5.9 cm
4	9.1 to 12.7 cm
5	11.4 to 14.6 cm

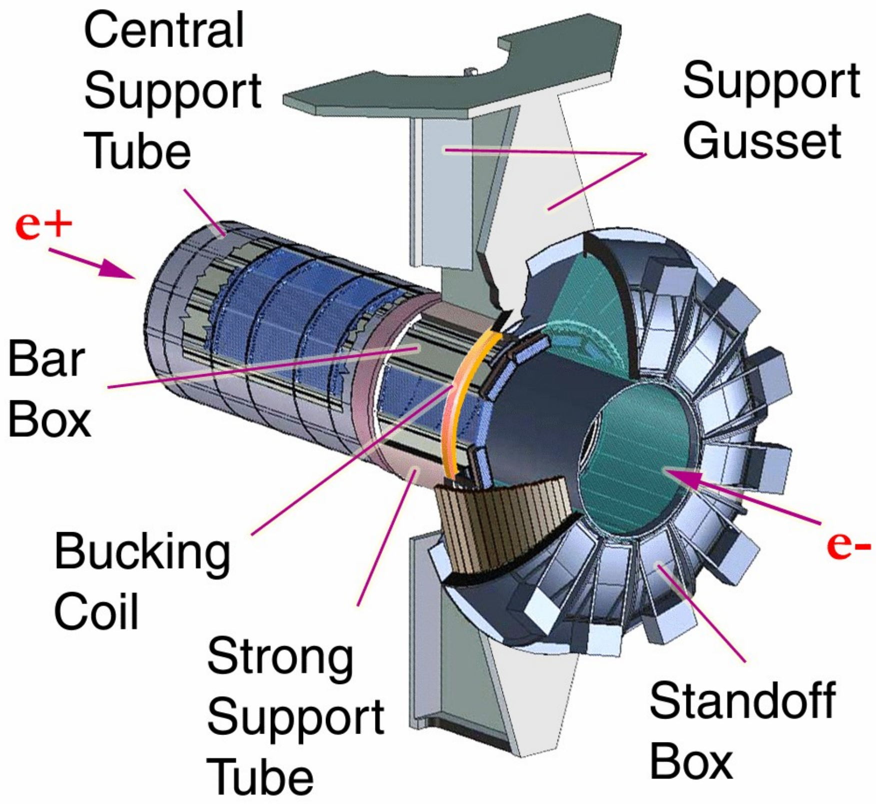
ADDED → Layer 0

BaBar SVT: Layers 1–5

MAPS technology might need more time to become mature for application in SuperB. For the TDR Layer0 design based on Hybrid Pixels:

Particle ID (Cherenkov detector)

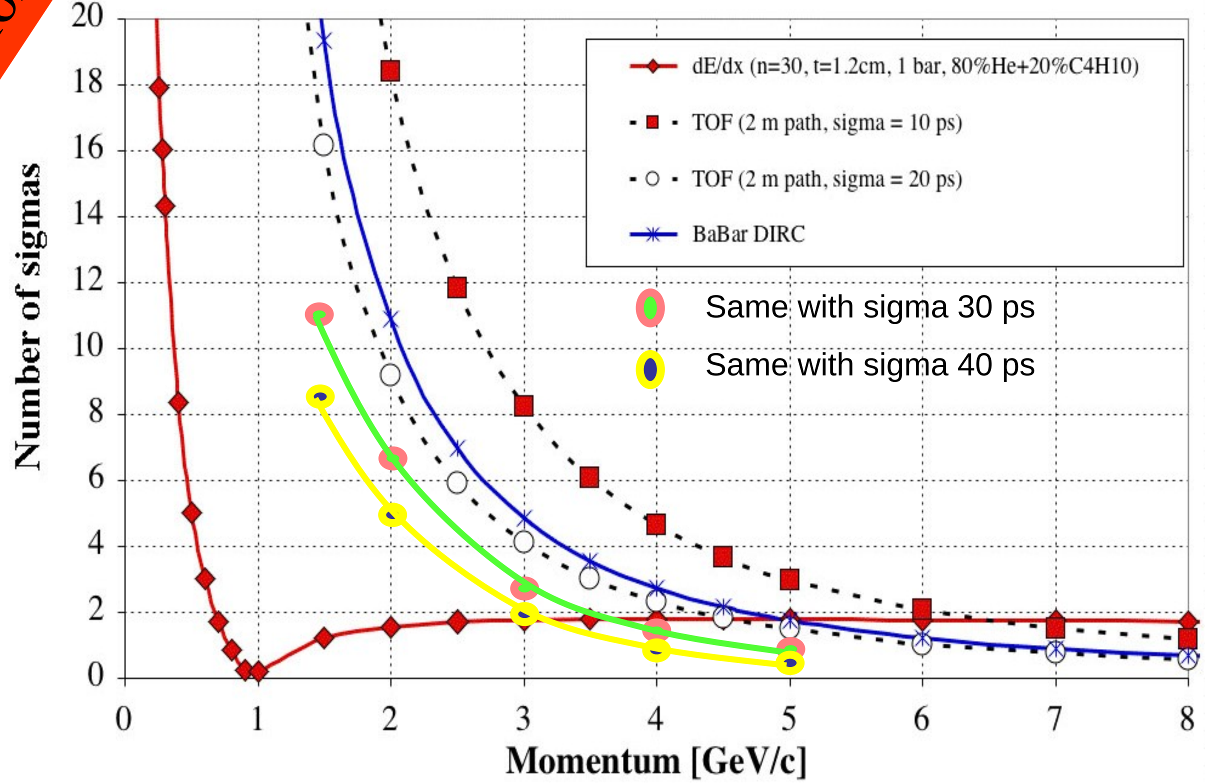
- Barrel DIRC baseline
  - Quartz bars are OK and can be reused
    - Almost irreplaceable
  - PMTs are aging and need to be replaced
  - Keep mechanical support



- Barrel changes from Babar
  - Small SOB choice
  - Optical coupling of bars to photo-detector
  - Wedge or no wedge ?
  - Choice of photodetector
  - Prototyping and beam tests
  - Engineering

Open questions

Do we need a forward PID ?



Time of flight

- Need about 10ps resolution to be competitive with focusing RICH
- 20-30ps OK.
  10 ps needs R&D.

Do we need a backward calorimeter ?

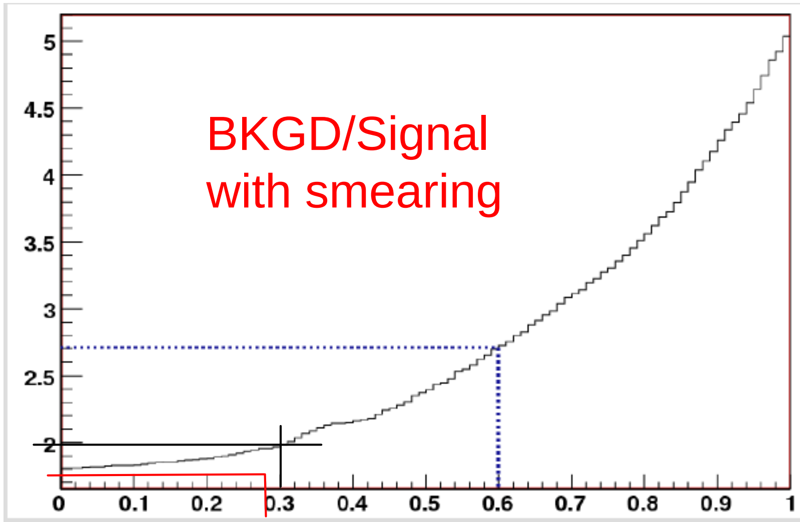
Open questions

Because of material in front will have degraded performance

Physics impact needs to be quantitatively further assessed

Hadronic recoil in $B \to \tau\nu$

Maybe just a VETO device
for rare channels such as $B \to \tau\nu$.



SuperB BaBar

Solution ?

Backward polar angle coverage (radians)

A scintillating tile design provides adequate flexibility ~10K SiPM channels

Conclusions

P
H
Y
S
I
C
S

SuperB (L>10^{36}) is a discovery machine at the TeV scale

→ ***Measurable effects*** ***(anyhow)*** ***if NP particles with masses at the TeV scale***

→ ***Give also the opportunity of exploring NP scales of the several TeV***

M
A
C
H
I
N
E

Machine is challenging and based on new accelerating schemes : "crab waist".

Success of Frascati tests has proven that they work !

D
E
T
C
T
O
R

Detector will be largely inspired from Babar one and will be largely improved

- “Politics”
- Milestones
- What Next

Super B project status

- The Italian process
- The European process
- The US process
- Interferences with KEK roadmap?

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

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

Roma, May 21st 2008

5. Conclusion

We recommend strongly that work towards the realisation of a Super*B* 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 have emerged a number of innovative and noteworthy developments at the cutting-edge of contemporary technique in accelerator physics and 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 considered as rapidly as possible if progress is to continue with the aim of realising Super*B* on the proposed time schedule.

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*.

The project positively received by the IRC

- unique sensitivity to flavour in new physics
  - indirect energy reach < ~ 10 TeV **?**

- new flavour physics beyond few TeV
  - SuperB = (indirect) energy frontier
    → discovery machine

- continue evaluation to establish physics specification

Latest News 19th Dec 2008,

from Marcello Giorgi

"…It is a great pleasure to annonce you that INFN Board of Directors has endorsed the SuperB as a special project. The consensus was unanimously expressed after a long and exhausting discussion. The implications are that thereb is no obstacle to proceed with the TDR and to move to the construction of the strong organization that we need.
The project will receive the financial support ain a very generous way by the Lazio Regional governement. Roberto Petronzio after the vote of the Board was authorized by the Lazio government to officially announce this contribution that could fully cover the cost of the project preparation,
In addition INFN will give extra money through the Gruppo I. Nando Ferroni, chair of Gruppo I, confirmed in front of the Board. INFN will ask us periodical reports to the Board of Directors, to monitor the process.
Roberto Petronzio has also communicated that the funding process for construction with the National Italian Governement has started and in good shape

The European process

8. Flavour physics and precision measurements at the high-luminosity frontier at lower energies complement our understanding of particle physics and allow for a more accurate interpretation of the results at the high-energy frontier; *these should be led by national or regional collaborations, and the participation of European laboratories and institutes should be promoted.*

- European strategy recognition process
  - SuperB project presented to he CERN Council in September 2008. recognition possible in March 2009
  - ECFA subgroup report in Nov 2008

Working Group Report
on
INFN Super Flavour Factory Project
RECFA meeting, Athens, 11 October 2008

RECFA Internal Working Group
Y. Karyotakis, F. Linde, T. Nakada*) and B. Spaan,
*) Chair

Physics III

- A step beyond the "LHCb" era for an e^+e^- machine requires >50 time more statistics than now to be enough to establish any effects of beyond the Standard Model, which exhibit no sign now or in coming couple of years (in particular for "inclusive" $\Delta B=1$ $b \to s$ and $b \to d$ process?).
- LFV, e.g. $\tau \to e\gamma$ would be a big hit. (interesting to see what $\mu \to e\gamma$ will say in coming years)

- The main goal of PEB-II and KEKB was a quantitative test of the KM mechanism of CP violation from the $B_d \to J/\psi K_S$ decays.
  ⇒ CKM parameters were known enough to make a good prediction for the required luminosity.
- For a SuperB project, we do not have such a "success guaranteed" minimum luminosity, since we don't know the New Physics parameters.
  ⇒But this is the case for the most of the high energy frontier accelerators too.

INFN Super Flavour Factory I

- Very high luminosity >$10^{36}cm^{2}s^{-1}$ obtained by colliding tiny beams. (similar to a LC)
  ⇒needs small emittance (similar to a LC damping ring), large crossing angle and crab waist

  But works as a circular collider (Novel idea developed by INFN)

  ☺☺ Its required current not higher than the present machines (RF power 17 MW)
  - affordable operation cost
  - easier operation
  - small background

ILC synergy

- Test being done with DAFNE
  very successful, but still at low currents
- More simulation work needed to fully understand the result
- Machine parameters need some robustness.
- No real design for the complete system.

⇒ to be addressed by the TDR within 1 to 2 years in collaboration with the interested Asian, European and US laboratories.

Conclusions

- Flavour physics is an important part of the European particle physics programme. Rich physics programme.
- An e^+e^- collider at $\Upsilon(4S)$ energy region would be a significant milestone if
  - much more than 50 ab^{-1} by the end of ~2020
  - moderate cost
- INFN Project addresses these points by
  - Very high luminosity $>10^{36}$ with a unique machine concept
  - Reutilizing PEP-II rings and injector, and BaBar
- Machine R&D should be strongly supported for the TDR to show that the concept can be indeed realised.
  (R&D is also useful for the future machines)
- For an approval, there should be
  - a clear plan containing realistic technical milestones
  - required resources and strategy how to obtain them

  with a goal to achieve much more than 50 ab^{-1} data by ~2020 to make a meaningful impact. Much later than this, physics landscape could be drastically different.

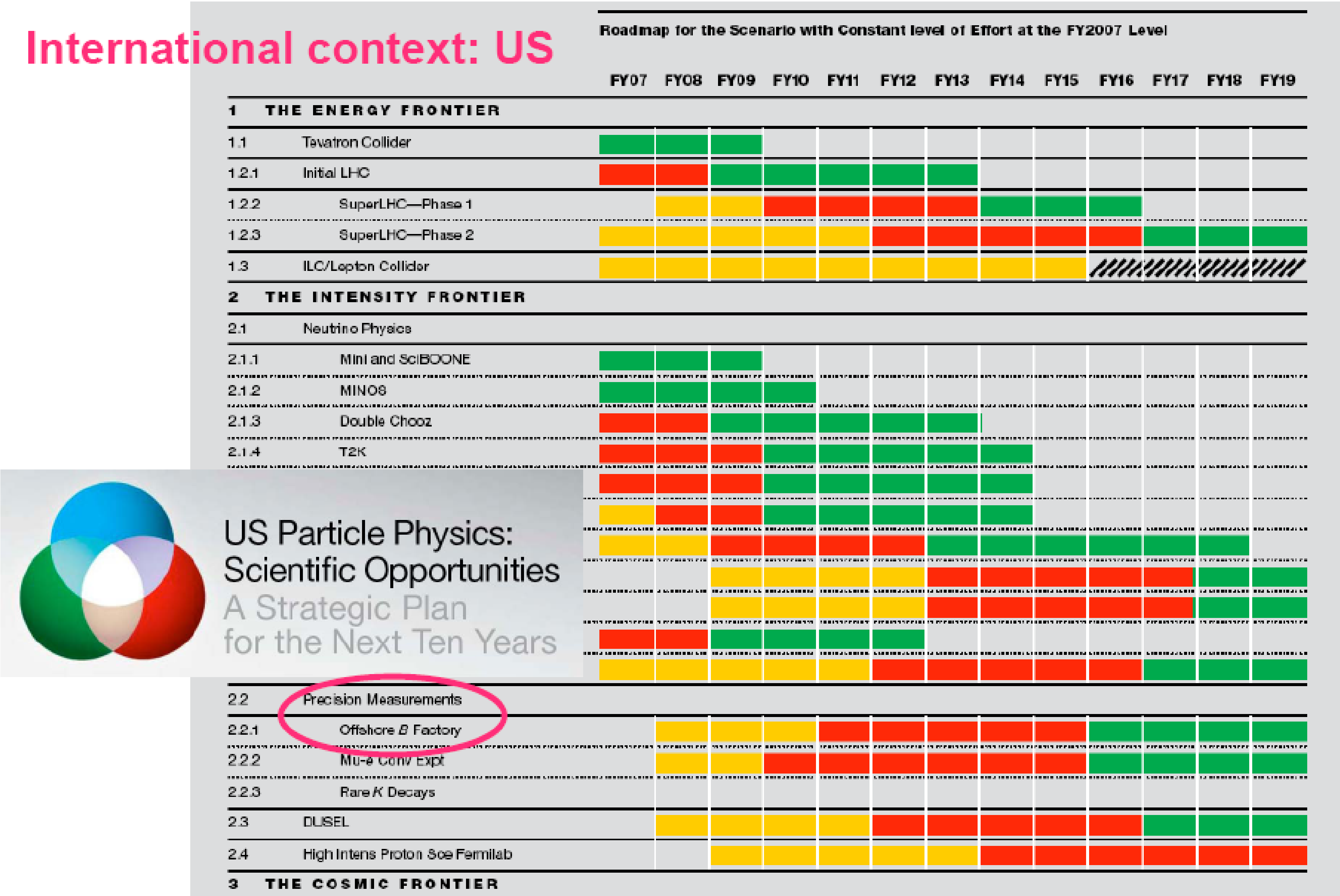
Very ambitious plan and need to move fast.

Eureopean steps in three steps :

- Initial Presentation to Council(Done in Sept 2008): Council takes note
- SPC advises council : Council takes note and comments: March 2009
- Formal recognition once the project is approved

One offshore Super B factory project official part of the US P5 report in « scenario B »

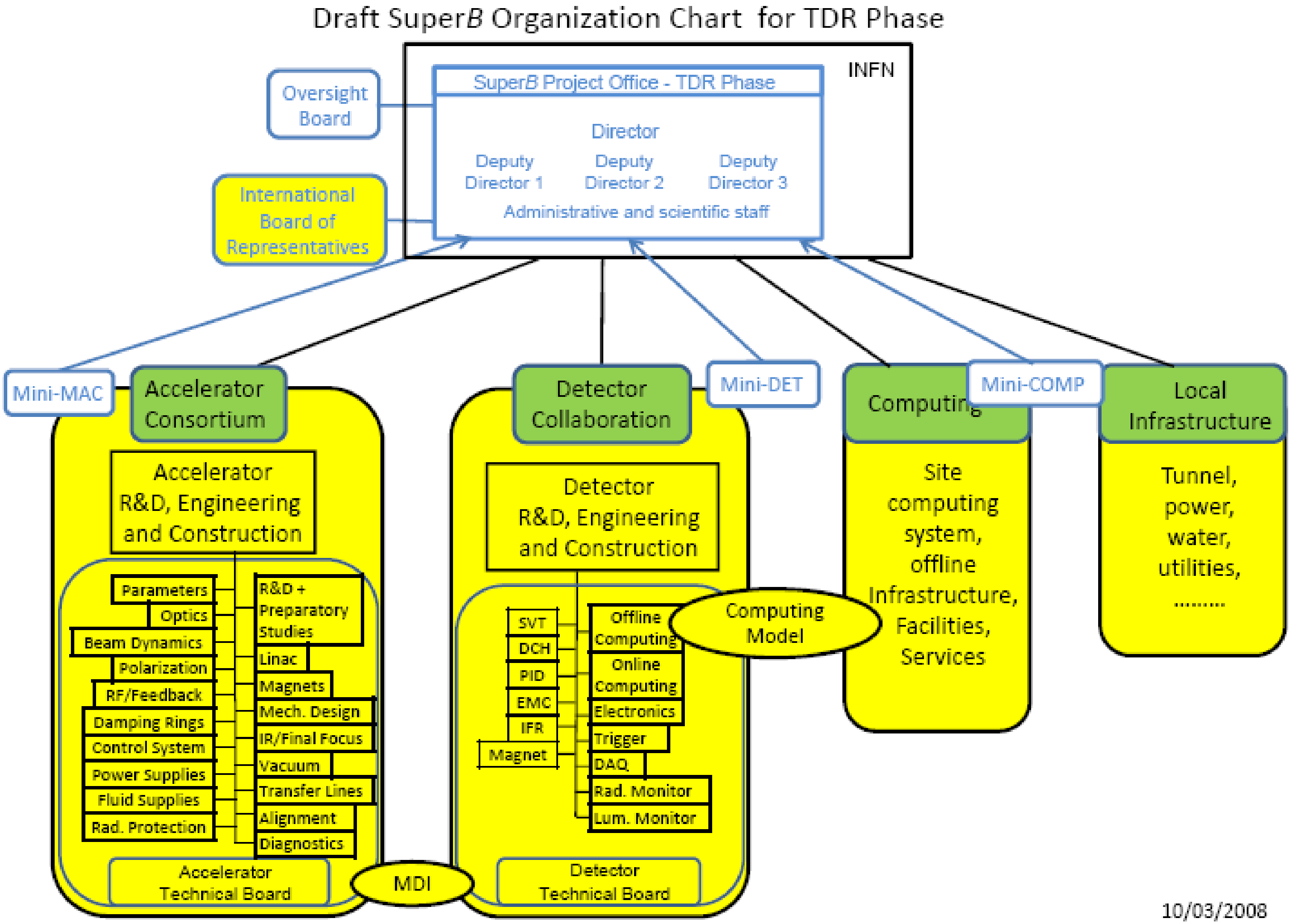
International context: US



Interactions with Japan

- KEKB upgrade part of KEK roadmap
- Nobel prize effect?
- Interference with SuperB project negative or positive?
- The « one joint program , two phases » model ?

TDR organisation



TDR scope and contents

- TDR scope definition
  - By contents, eg « ready to build » documents
  - By schedule, eg « needed in Nov 2010 » for project approval
- 5 different documents
  - Physics, Machine, Site, Detector, Computing
  - Not necessarily issued at the same time
  - « Distance to build » not necessarily the same

Official TDR launch in Februray 2009 in Orsay

Next

- Orsay collaboration meeting Feb 15-18
  - Official launch of the TDR phase
  - Open session on Feb 17
  - Parallel sessions: focus on joint sessions
    - Computing and site
    - Computing and detector
    - Computing and machine?
- Physics workshop in Warwick, April 15-18
- MiniMAC in April as well

..and in France

LAL group already participated in the last two years to

- the CDR
- Frascati tests (still on going)

(under LAL Scientific Council approuval)

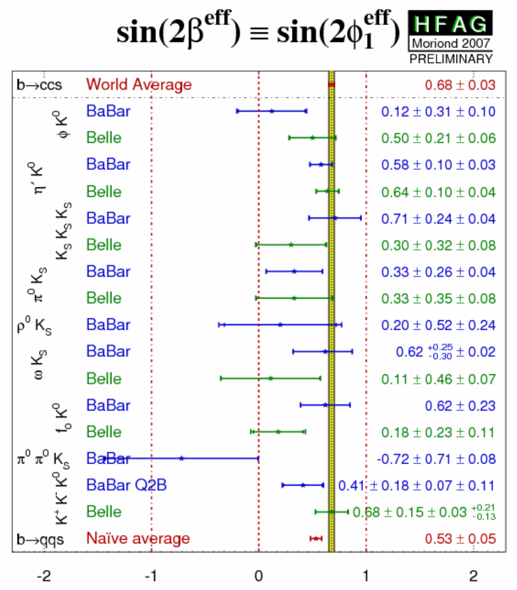
Present LAL group for the TDR

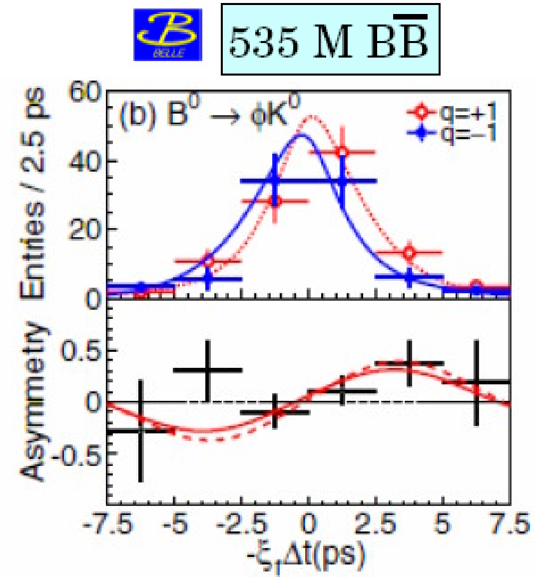
Nicolas
Christophe Beigbeder
Dominique Breton
Leonid Burmistrov
Jihane Maalmi
Alejandro Perez
Achille Stocchi
Vanessa Tocut
Alessandro Variola
Guy Womser

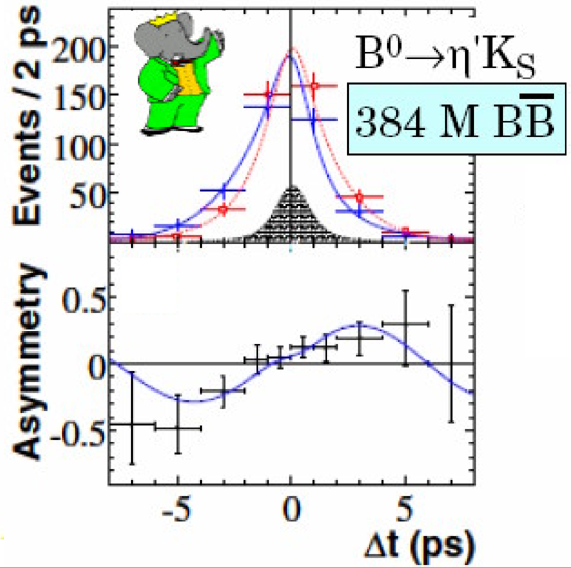
Not yet counting people which will be involved on the polarization studies and machine simulation Studies and on vacuum..

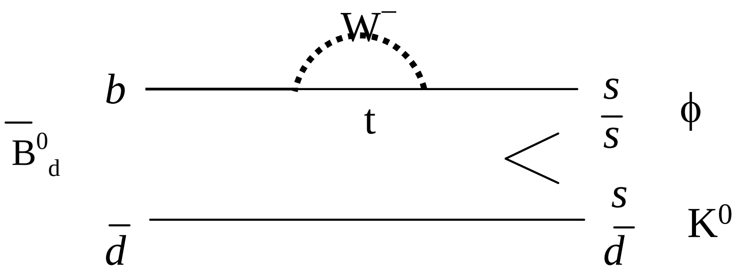
BACKUP MATERIAL

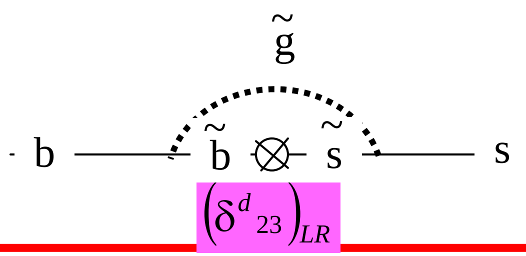
Another example of sensitivity to NP : **sin2β from "s Penguins"…**









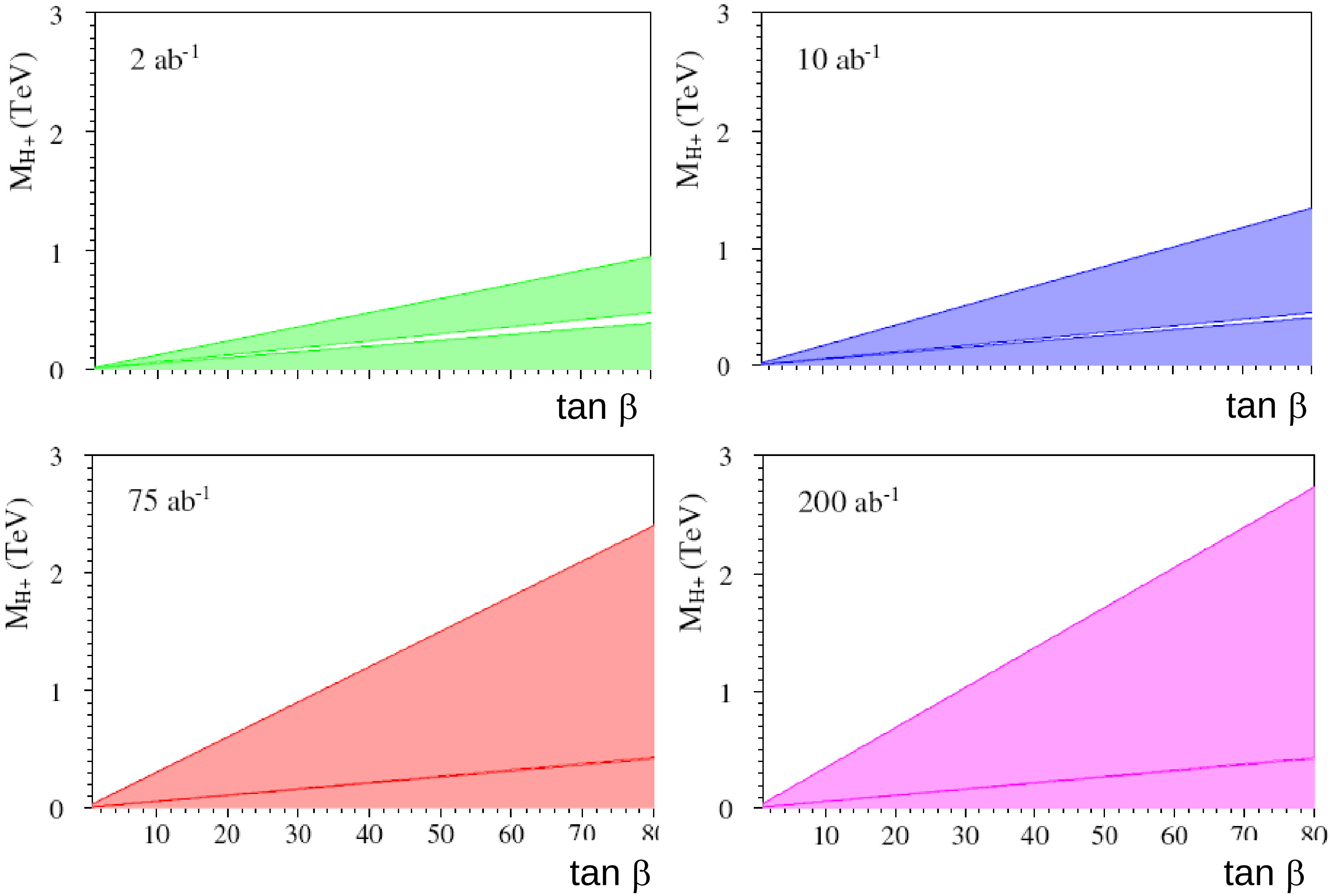


Many channels can be measured with ΔS~(0.01-0.04)

Observable	B Factories (2 ab^{-1})	**SuperB**
$S(\phi K^0)$	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 $(*)$

(*) theoretical limited

more..



B → τ ν and B → μ ν combination

exclusion plots in [M(H^+), tan β]

MFV : Snowmass points on τ

SPS	$M_{1/2}$ (GeV)	M_0 (GeV)	A_0 (GeV)	$\tan\beta$	μ
1 a	250	100	-100	10	> 0
1 b	400	200	0	30	> 0
2	300	1450	0	10	> 0
3	400	90	0	10	> 0
4	300	400	0	50	> 0
5	300	150	-1000	5	> 0

SuperB with 75 ab^{-1}, evaluation assuming the most conservative scenario about syst. errors

LFV	Snowmass points predictions						SuperB	
	1 a	1 b	2	3	4	5	90% UL	**5σ disc**
$BF(\tau \to \mu\gamma) \times 10^{-9}$	4.2	7.9	0.18	0.26	97	0.019	**1÷2**	5
$BF(\tau \to 3\mu) \times 10^{-12}$	9.4	18	0.41	0.59	220	0.043	200	880

SuperKEKB worse by factor $\sqrt{5}$ for $BF(\tau \to \mu\gamma)$ and 5 for $BF(\tau \to \mu\mu\mu)$

Letpon MFV GUT models

$B(\tau\to\mu\gamma):B(\tau\to e\gamma):B(\mu\to e\gamma) \sim \lambda^{-6}:\lambda^{-4}:1 \sim 10^4:500:1$ ← LFV from CKM

SSF <-> MEG

$B(\tau\to\mu\gamma):B(\tau\to e\gamma):B(\mu\to e\gamma) \sim [500\text{–}10]:1:1$ ← LFV from PMNS

Tau g-2

Start with the expt. with μ

$$\Delta a_\mu = a_\mu^{exp} - a_\mu^{SM} \approx (3 \pm 1) \times 10^{-9}$$

assume Super*B* at 75 fb^{-1}, 80% e^- beam polarization

extend to all tau decay channels

combine 2 measurement methods for $Re\{F_2\}$

studies on simulated events show no limiting syst. effects

	Snowmass points predictions						Super*B*
	1 a	1 b	2	3	4	5	exp. resolution
$\Delta a_\mu \times 10^{-9}$	3.1	3.2	1.6	1.4	4.8	1.1	
$\Delta a_\tau \times 10^{-6}$	0.9	0.9	0.5	0.4	1.4	0.3	**<1**

SuperKEKB, without beam polarization, expected worse by factor ≈ 10, and worse systematics

Make use of all the informations (total x-section,angular distribution, f-b asymmetry.
Measure Re and Im parts

Spectroscopy

Super$B$ will open a unique window on this physics because it allows a high statistics study of the current hints of new aggregations of quarks and gluons. Besides the physics one can study in running at the $\Upsilon(4S)$ resonance, the following alternative energies are of interest: $\Upsilon(3S)$ (at least 0.3 ab^{-1}) and a high luminosity scan between 4-5 GeV (5 MeV steps of 0.2 fb^{-1} each would require a total of 40 fb^{-1}) [46]. While this is not huge statistics, this scan is only feasible with Super$B$. The only possible competitor, BES-III, is not planning to scan above 4 GeV, since their data sample would, in any case, be lower than that of the B Factories alone.

Finally, the search for exotic particles among the decay products of the bottomonia can probe regions of the parameters space of non-minimal supersymmetric models that cannot be otherwise explored directly, for instance at LHC. These studies are particularly efficient when producing $\Upsilon(nS)$ mesons with $n < 4$.

The superiority of Super$B$ with respect to the planned upgrade of Belle lies both in the ten times higher statistics, which broadens the range of cross sections the experiment is sensitive to, but also in the flexibility to change center of mass energy.

Mode	Sensitivity		
	Current	Expected (10 ab^{-1})	Expected (75 ab^{-1})
$\mathcal{B}(B \to X_s\gamma)$	7%	5%	3%
$A_{CP}(B \to X_s\gamma)$	0.037	0.01	0.004–0.005
$\mathcal{B}(B^+ \to \tau^+\nu)$	30%	10%	3–4%
$\mathcal{B}(B^+ \to \mu^+\nu)$	not measured	20%	5–6%
$\mathcal{B}(B \to X_s l^+ l^-)$	23%	15%	4–6%
$A_{\mathrm{FB}}(B \to X_s l^+ l^-)_{s_0}$	not measured	30%	4–6%
$\mathcal{B}(B \to K\nu\overline{\nu})$	not measured	not measured	16–20%
$S(K_S^0\pi^0\gamma)$	0.24	0.08	0.02–0.03

MFV : SNOWMASS points

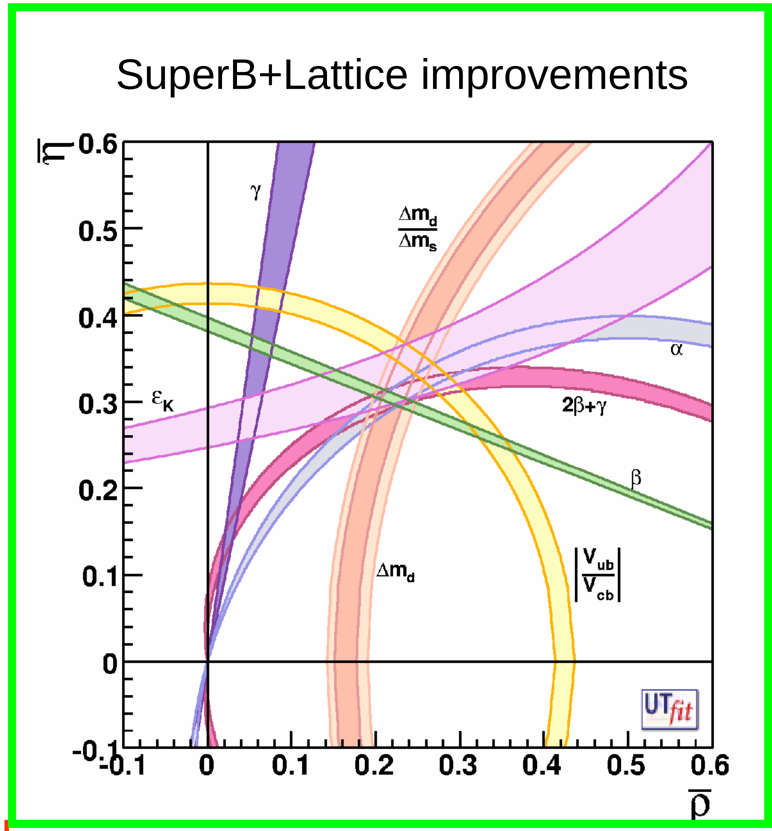
SPS	$M_{1/2}$ (GeV)	M_0 (GeV)	A_0 (GeV)	$\tan\beta$	μ
1 a	250	100	-100	10	> 0
1 b	400	200	0	30	> 0
2	300	1450	0	10	> 0
3	400	90	0	10	> 0
4	300	400	0	50	> 0
5	300	150	-1000	5	> 0

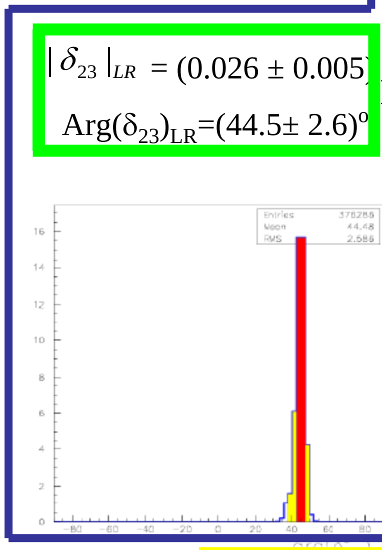
	SPS1a	SPS4	SPS5
$\mathcal{R}(B \to s\gamma)$	0.919 ± 0.038	0.248	0.848 ± 0.081
$\mathcal{R}(B \to \tau\nu)$	0.968 ± 0.007	0.436	0.997 ± 0.003
$\mathcal{R}(B \to X_s l^+ l^-)$	0.916 ± 0.004	0.917	0.995 ± 0.002
$\mathcal{R}(B \to K\nu\overline{\nu})$	0.967 ± 0.001	0.972	0.994 ± 0.001
$\mathcal{B}(B_d \to \mu^+\mu^-)/10^{-10}$	1.631 ± 0.038	16.9	1.979 ± 0.012
$\mathcal{R}(\Delta m_s)$	1.050 ± 0.001	1.029	1.029 ± 0.001
$\mathcal{B}(B_s \to \mu^+\mu^-)/10^{-9}$	2.824 ± 0.063	29.3	3.427 ± 0.018
$\mathcal{R}(K \to \pi^0\nu\overline{\nu})$	0.973 ± 0.001	0.977	0.994 ± 0.001

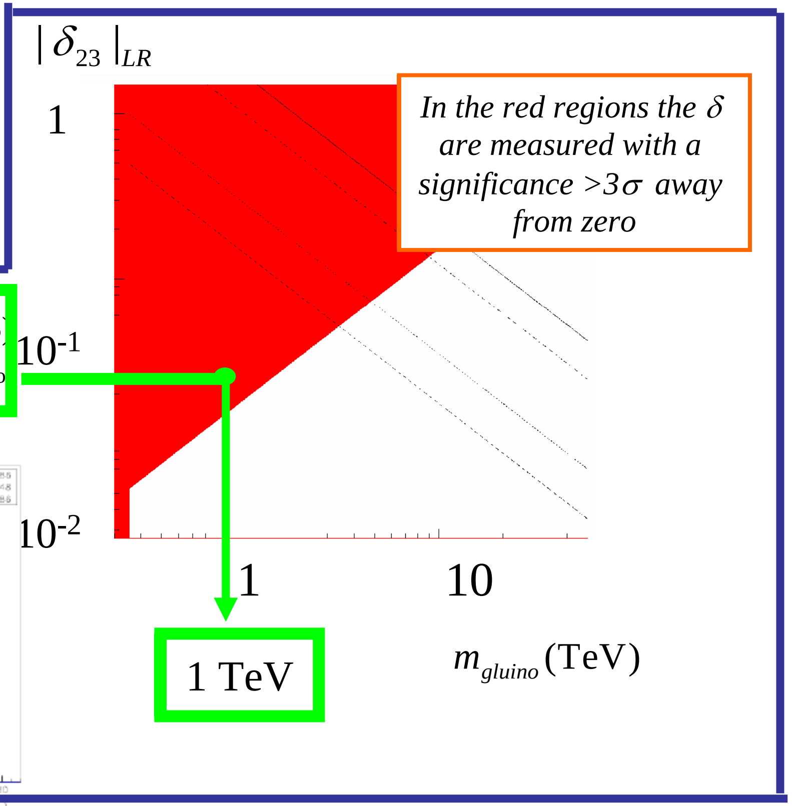
SPS4 ruled out by present values of $B \to s\gamma$.

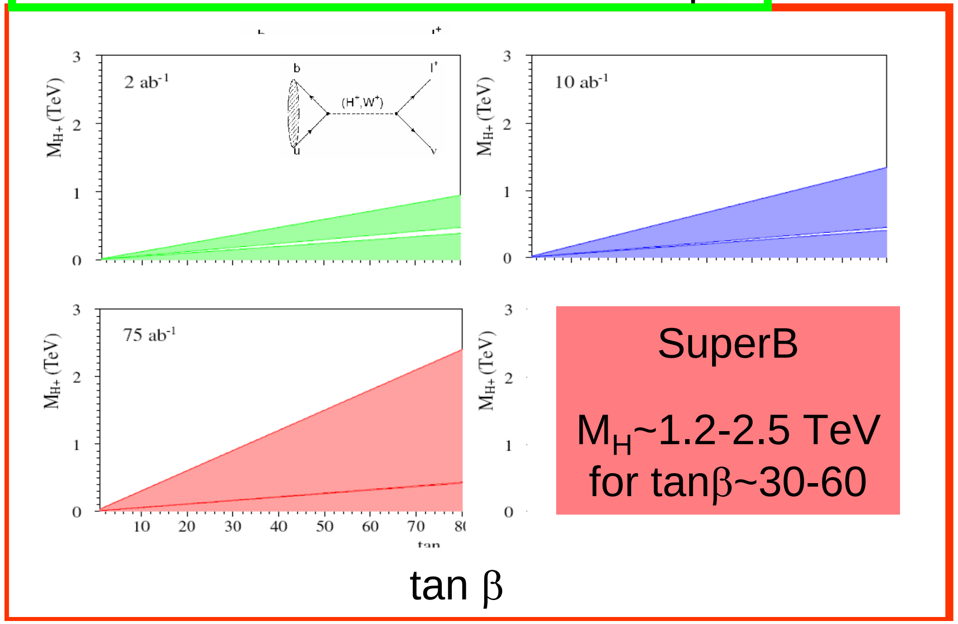
SPS1a is the least favorable for flavour, but SuperB and only SuperB can observe 2 σ deviations in several observables

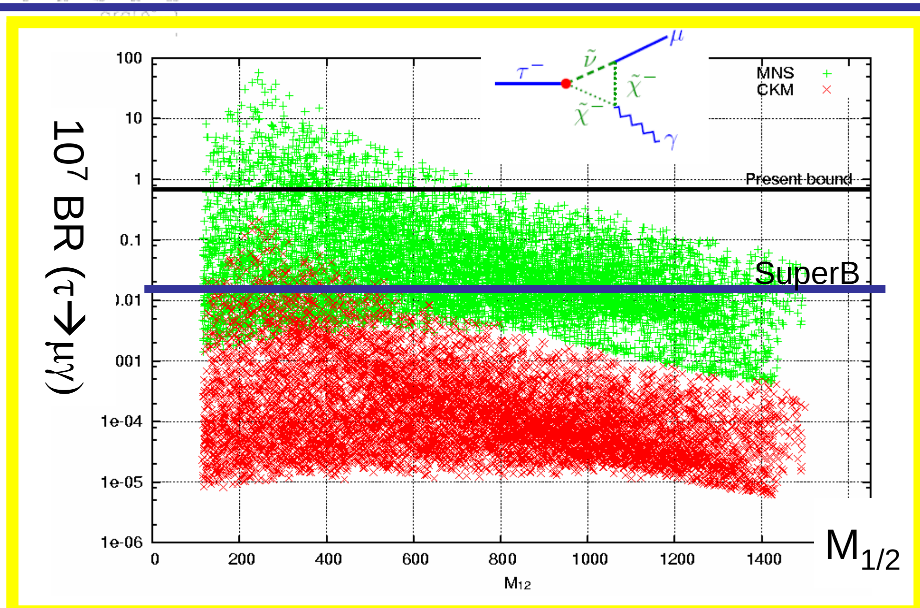
Physics Case
..en pillule…





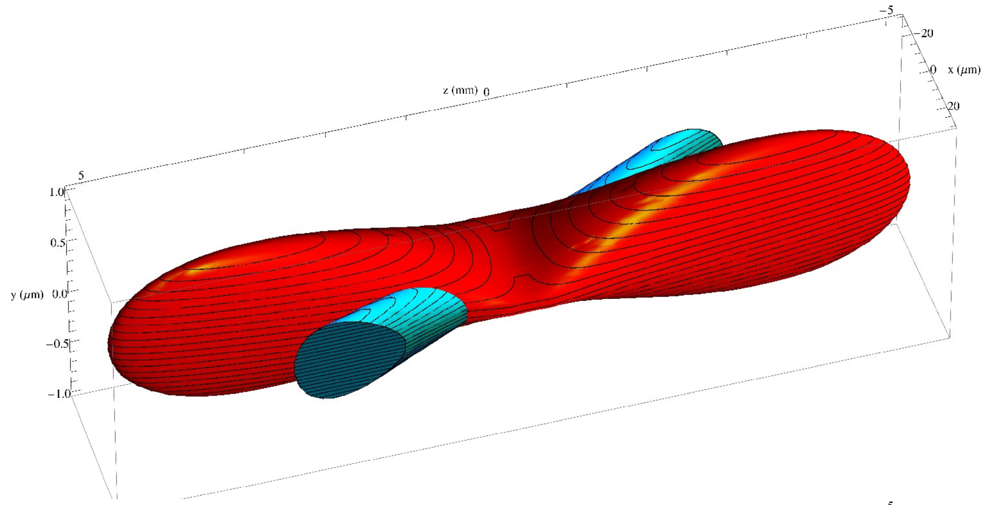




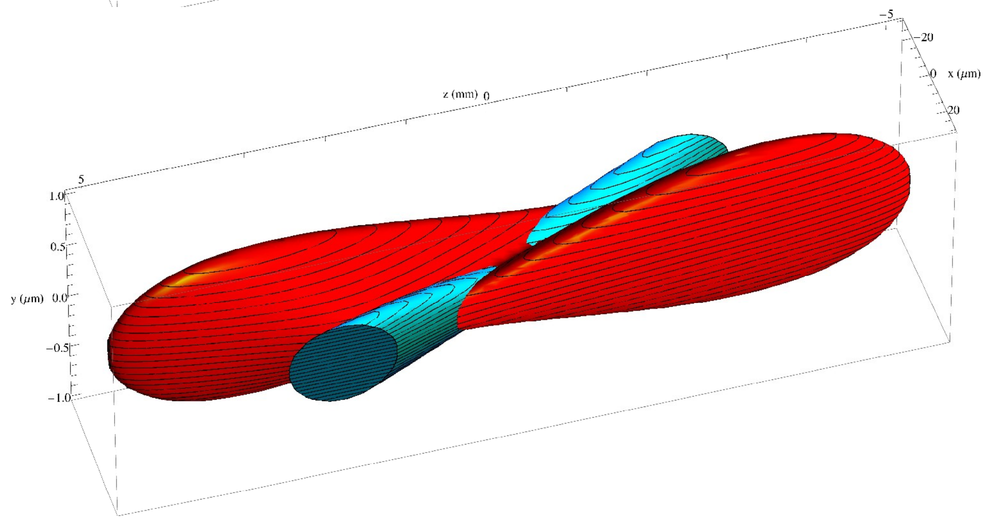


Beams distribution at IP

E. Paoloni



Without
Crab-sextupoles

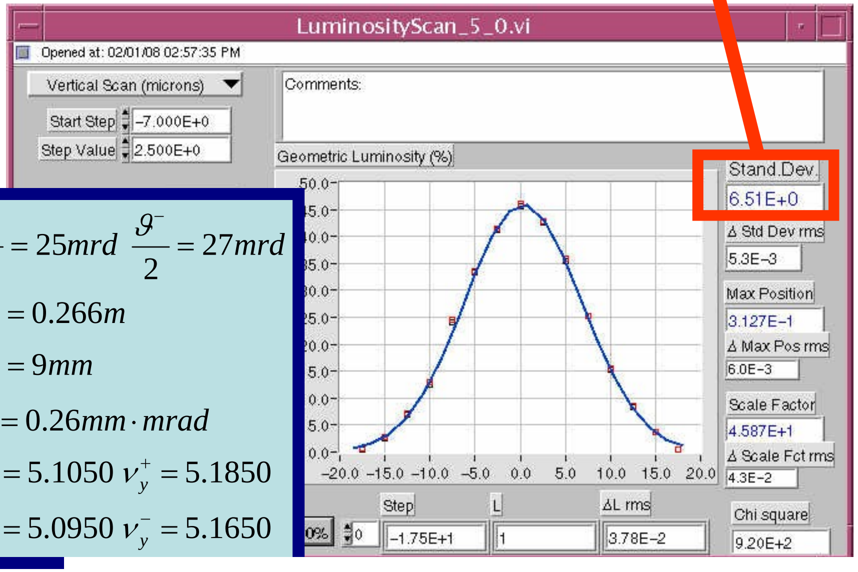


With
Crab-sextupoles

All particles from both beams collide in the minimum β_y region, with a net luminosity gain

$\sigma_y \approx 4\mu m$

Ex. of vertical beam beam scan



$$\frac{\vartheta^+}{2} = 25mrd \quad \frac{\vartheta^-}{2} = 27mrd$$

$$\beta_x^* = 0.266m$$

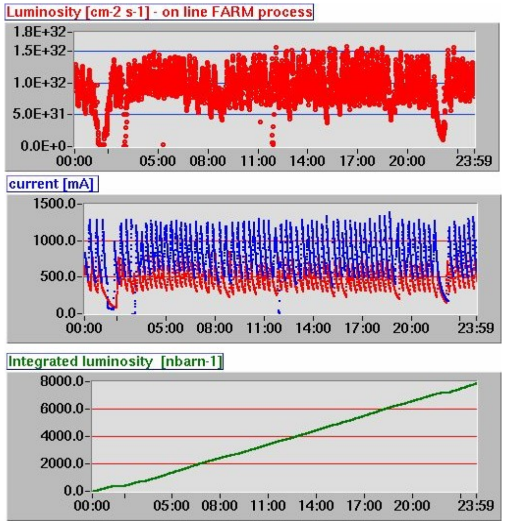
$$\beta_y^* = 9mm$$

$$\varepsilon_x = 0.26mm \cdot mrad$$

$$\nu_x^+ = 5.1050 \;\; \nu_y^+ = 5.1850$$

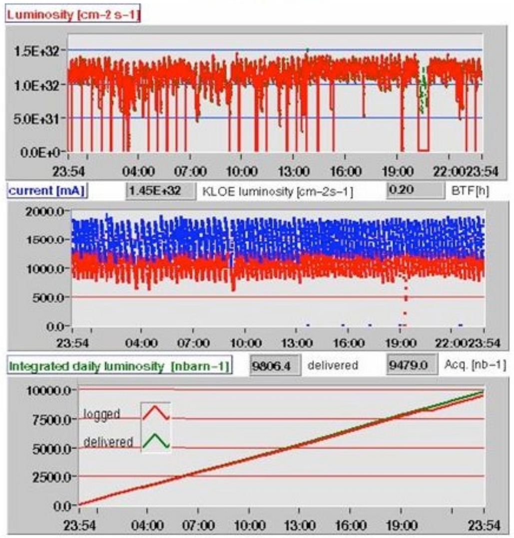
$$\nu_x^- = 5.0950 \;\; \nu_y^- = 5.1650$$

SIDDHARTA



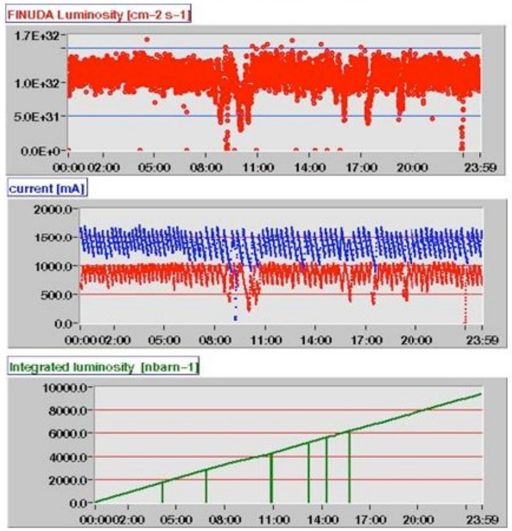
90 bunches, β_y*= 0.9 cm, β_x* = 0.26 m

KLOE



111 bunches, β_y^*= 1.8 cm, β_x^*= 1.5 m

FINUDA

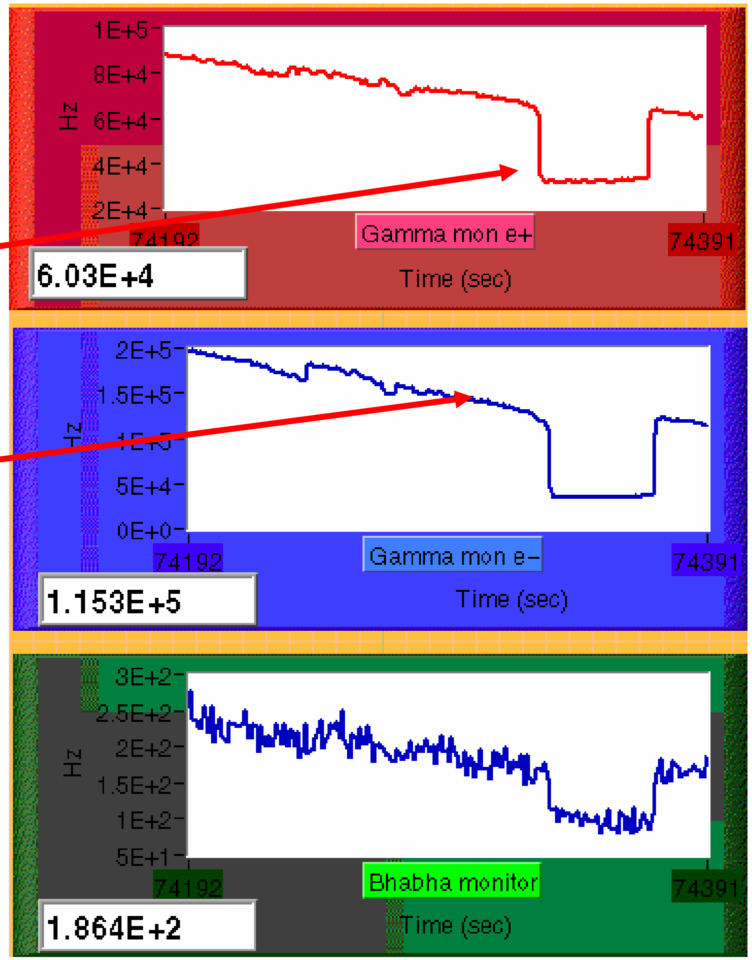


106 bunches, β_y^*= 1.9 cm, β_x^*= 2.0 m

Effect of crab sextupoles on luminosity

A huge work on machine optimization has been done and is still in progress in term of feedbacks systems tuning, background minimization and tuning of the machine luminosity

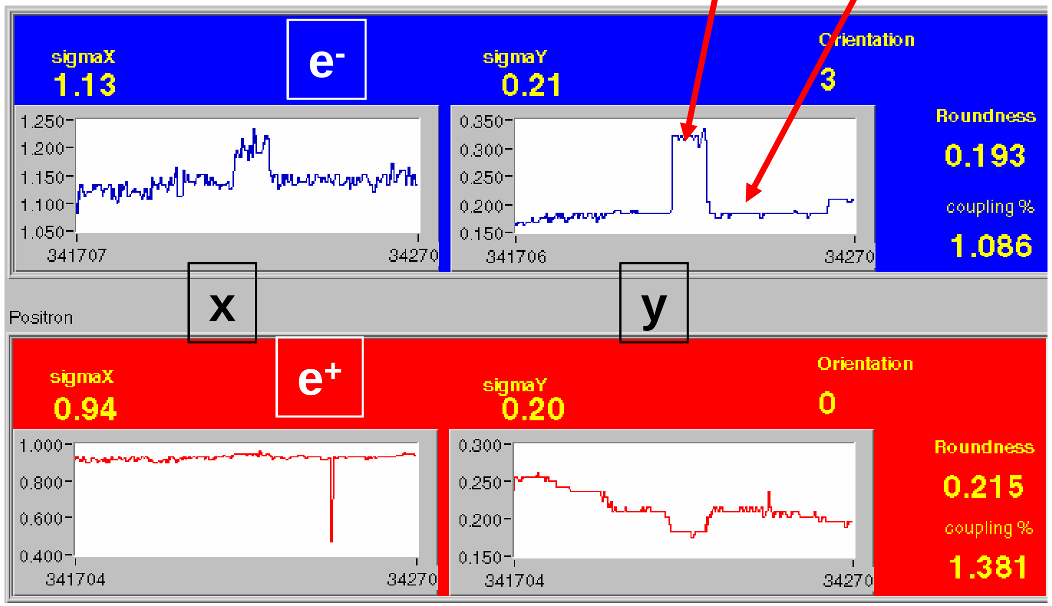
LUMINOMETERS



Crab OFF

Crab ON

Transverse beam dimensions at the Synchrotron Light Monitor



Blow-up in beam sizes and decrease in Bhabha rates observed when crab sextupols for one ring OFF (other ring ON)

From J. Seemans

Schedule

- Overall schedule dominated by:
  - Site construction
  - PEP-II/BaBar disassembly, transport, and reassembly
- The goal is to reach the commissioning phase after about 5 years from the start of the project.

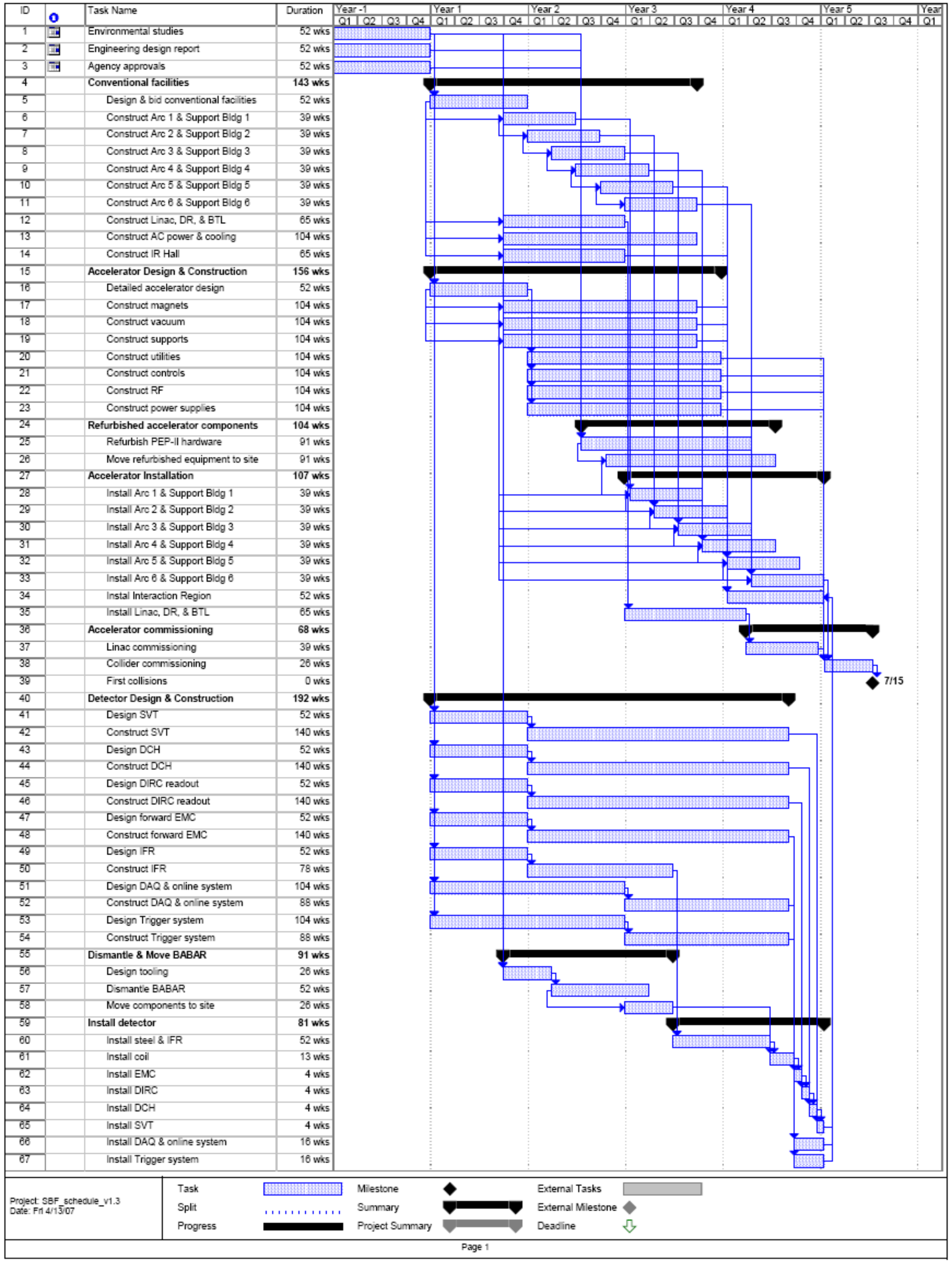


Figure 5-1. *Overall schedule for the construction of the SuperB project.*

DCH (Drift Chamber)

- Basic technology adequate.
- Cannot reuse BaBar DCH because of aging
- Baseline:
  - Same He-C_4H_{10}, same cell shape
  - Carbon fiber endplates instead of Al to reduce thickness
  - → Need to do complete background estimate
- Possible Options/Issues
  - Miniaturization and relocation of readout electronics
    - Critical for backward calorimetric coverage
  - Conical endplate
  - Further optimization of cell size/gas

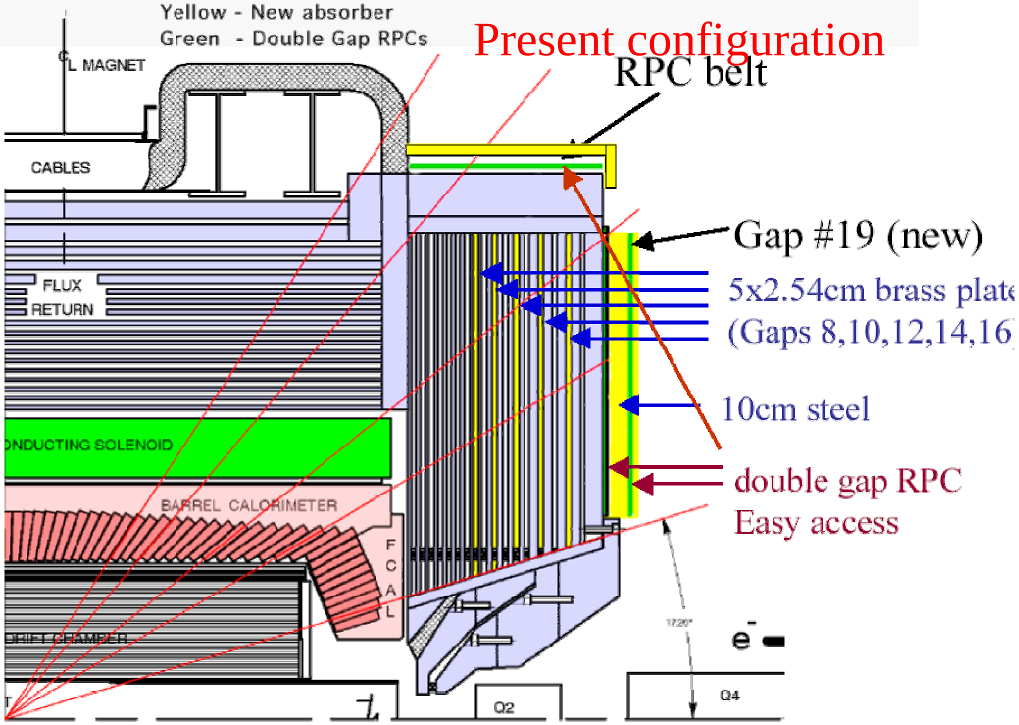
EMC (Electromagnetic Calorimeter)

- Barrel CsI(Tl) crystals
  - Still OK and can be reused (the most expensive detector in BaBar)
  - Baseline is to transport barrel as one device
- Forward Endcap EMC
  - BaBar crystal are damaged by radiation and need to be replaced
  - Occupancy at low angle makes CsI(Tl) too slow
  - Use LSO as baseline
    + gives better performance
    + leaves PID option open
- Backward EMC option
  - Because of material in front will have a degraded performance
    - Maybe just a VETO device for rare channels such as $B \rightarrow \tau\nu$.
  - Physics impact needs to be quantitatively further assessed
  - DIRC bars are necessarily in the middle
  - DCH electronics relocation is critical for the perfomance
  - **A scintillating tile design provides adequate flexibility ~10K SiPM channels**

IFR and steel

- BaBar configuration has too little iron for μ ID
  - > 6.5 λ_I required; 4-5 available in barrel
- Fine segmentation overdid K_L efficiency optimization
  - Focus on m ID : fewer layers and more iron
  - → Is it possible to use the IFR in K_L veto mode ?

- Baseline:
  - Fill gaps in Babar IFR with more iron
  - Leave 7-8 detection layers
  - Need to verify structural issues
  - Extruded scintillators are a safe option
  - Avalanche RPC if evidence of lower rate



Trigger/DAQ/Electronics

- Detailed evaluation in progress
- Should prepare for a trigger rate of 50-100KHz
  - Unless a hardware L1 Bhabha rejector is developed
- Some electronics could be reusable
  - Some front-end cards, power supplies
- The bulk of the electronics is obsolete and unmaintainable
  - Should be remade with state-of-the-art technology
- Clearly a major cost driver
  - Costing using recent experiments experience (LHC)

Test beam goals for 2008-2010

- Silicon Vertex Tracker
  - MAPS pixel devices: resolution, efficiency, readout speed
  - Advanced trigger systems (Associative Memories)
- Drift Chamber
  - Cell size, shape, and gas mixture
- Particle ID system (forward system)
  - Radiators (Aerogel, NaF)
  - Photon detector (MCP, MAPMTs, SiPM)
  - Timing for TOF system
- Electromagnetic Calorimeter
  - Forw: LYSO Crystals leakage, resolution, mechanical structure
  - Back: Lead-scintillator calorimeter resolution
- Instrumented Flux Return
  - Scintillator, fibers, photon detector, readout electronics
  - Detection efficiency, time/space resolution
- Integrated slice
  - Track trigger, material in front of EMC, timing for TOF, forward PID options

The break-through in the machine design is making our life a bit easier.

Still important sources of background:

- Luminosity sources
  - beam-beam
  - radiative Bhabha
- Linear with currents
  - lost particles and s.r.

	Cross section	Evt/bunch xing	Rate
Radiative Bhabha	~340 mbarn (Eγ/Ebeam > 1%)	~680	0.3THz
e^+e^- pair production	~7.3 mbarn	~15	7GHz
Elastic Bhabha	O(10^{-5}) mbarn (Det. acceptance)	~20/Million	10KHz
ϒ(4S)	O(10^{-6}) mbarn	~2/million	1 KHz

Other sources of background

- Touschek background
- Thermal outgassing due to HOM losses;
  Not an issue with these currents
- Injection background