The Super Flavour Factory

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OXFORD

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Outline

- A bit of Physics
- Progress in understanding the High Luminosity machine
  - Now a Machine Baseline.
- A Detector Baseline
- About the process: a touch of History
  - Report from ECFA to CERN Council
  - INFN formal start up of TDR Phase
- Organizing the TDR effort.
  - Organization of Accelerator effort
  - Detector organization
  - Physics

Next steps.

Super Flavour Physics

GOAL:

NEW PHYSICS beyond SM

Measurements in:

beauty , charm, tau

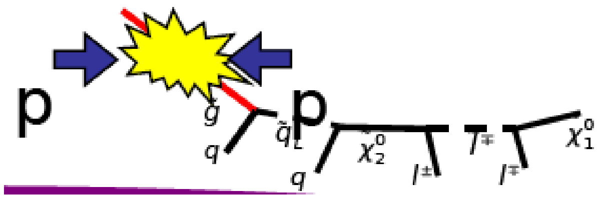
CPV asymmetries, FCNC loops, LFV,

Tau mag.moment, EDM

How move to New Physics

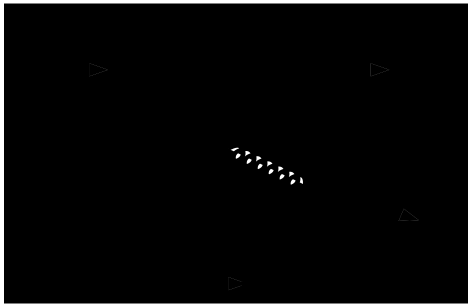
Move to New Physics in two ways:

Relativistic way



LHC (Energy Frontier)

Quantum way



Flavor (High precision measurements)

The two ways are complementary

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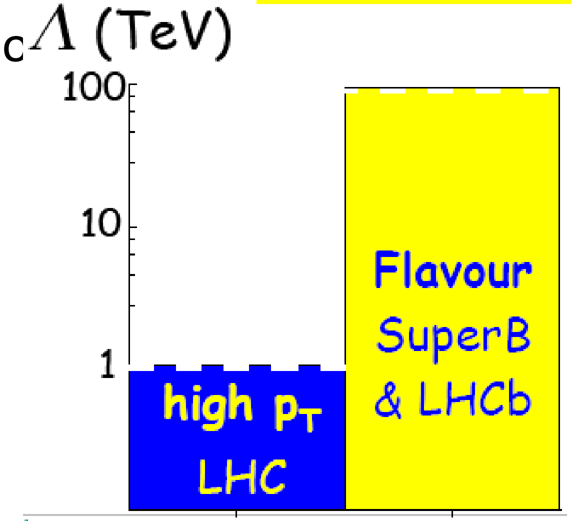
High Luminosity potential

- Flavour precision measurements sensitive to New Physics (NP)
  - Measure interference effect in known processes
  - Measure decays: rare or forbidden in Standard Mc
- NP effects governed by
  - New Physics Scale NP(Λ)
  - Effective coupling C
    - Different Intensities (from interactions)
    - Different Patterns (for instance from simmetries)

See M.Ciuchini Talk at Orsay SuperB workshop. Feb.17,09



With 7-10x10[10] pair bb, cc, ττ (75-100 ab^{-1}) it is possible

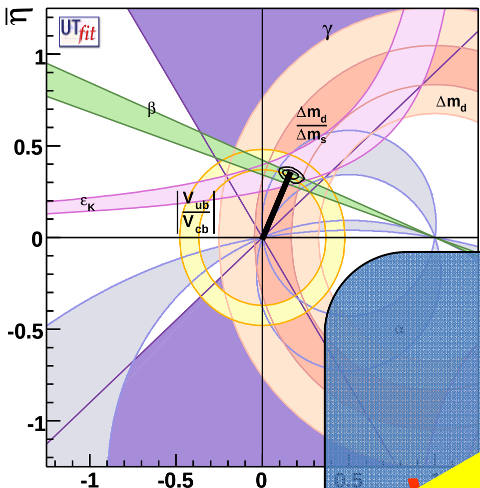
NP(Λ) found at LHC
- Determine couplings FV e CPV of NP
- Look for heavier states
- Study the flavour structure of NP

NP(Λ) not found at LHC
- Look for indirect signals of NP
- Link them to explaining NP models
- Constrain regions in parameter space with NP(Λ) sensitivity up several tens of TeV.

Some channels as τ LFV clear segnals of NP

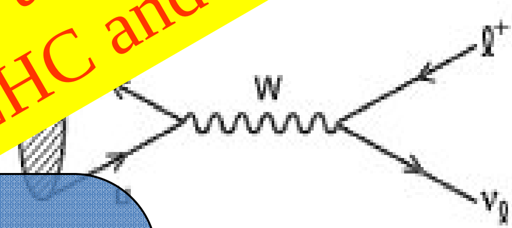
(Some) Results of B-Factories

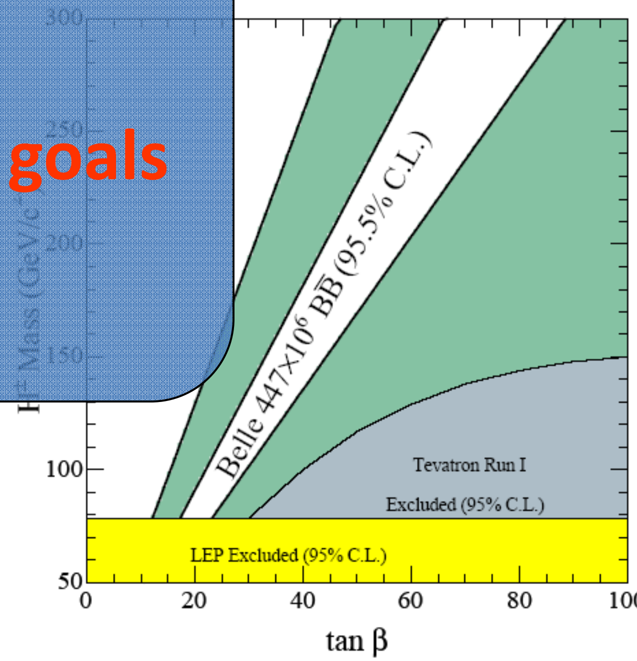
Unitarity Triangle precision measurements

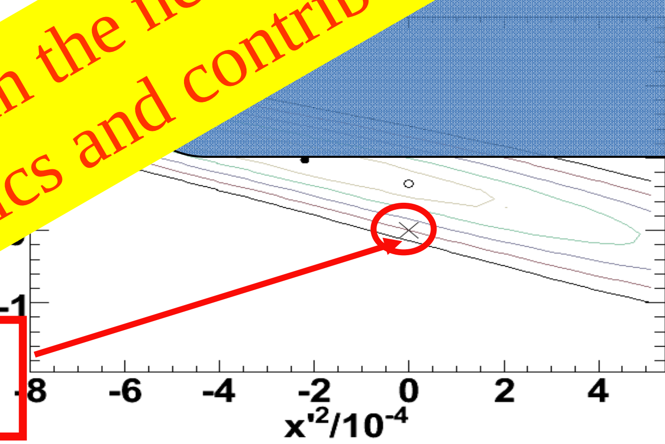


Spectroscopy of new, unexpected states

B→τν ... s on M...







No Mixing

... d the original goals

What in the next decade will e+ e- factories say about new physics and contribute as complementary to LHC and LHCb ?

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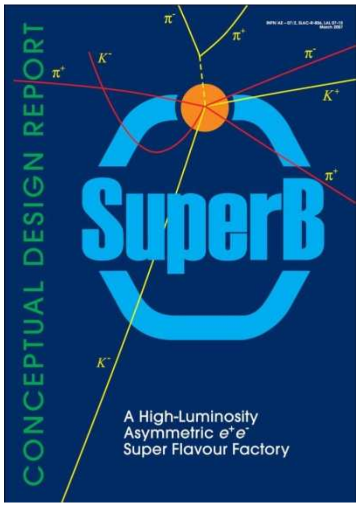
Physics activity

Physics goals have been discussed inside the SuperB community in the CDR published in May 2007 and in the proceedings of the Valencia SuperB Workshop in 2008 .It was reviewed in April 2008 by the IRC appointed by the President of INFN.



arXiv:0709.0451

Proceedings
of
Super*B* Workshop VI

New Physics
at the
Super Flavour Factory

Valencia, Spain
January 7-15, 2008

arXiv:0810.1312

Activity in 2009, preliminary document with "realistic" sensitivities ready by the end of 2009

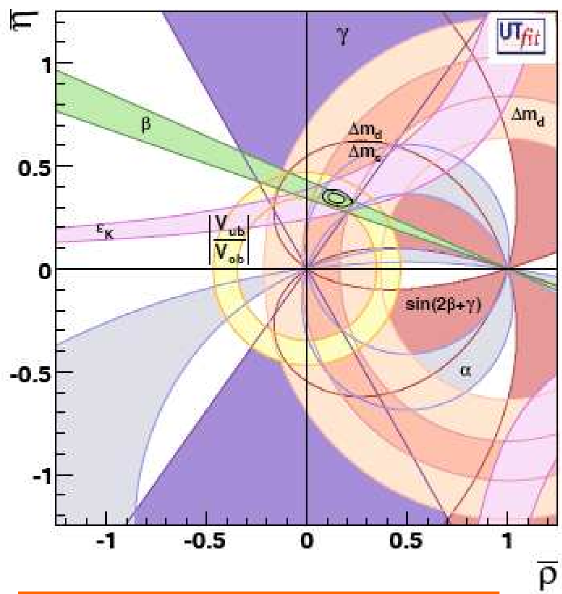
THE UNIVERSITY OF WARWICK

www.ippp.dur.ac.uk

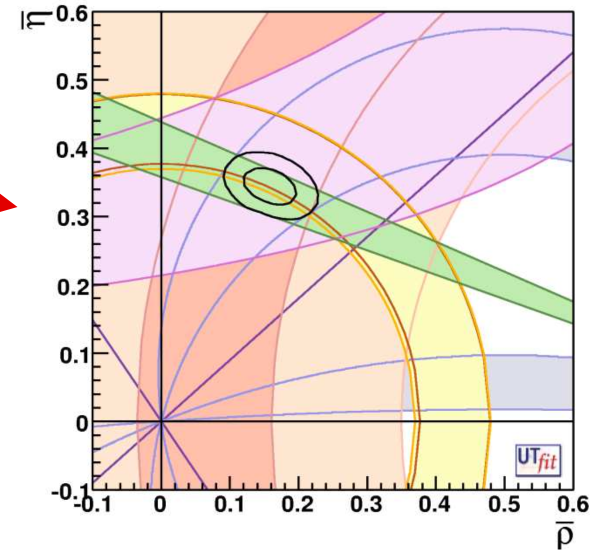
Workshop on New Physics with SuperB

14th-17th April 2009

Improving CKM precision



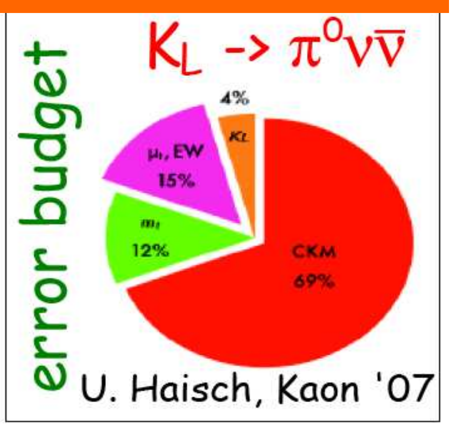
NOW !



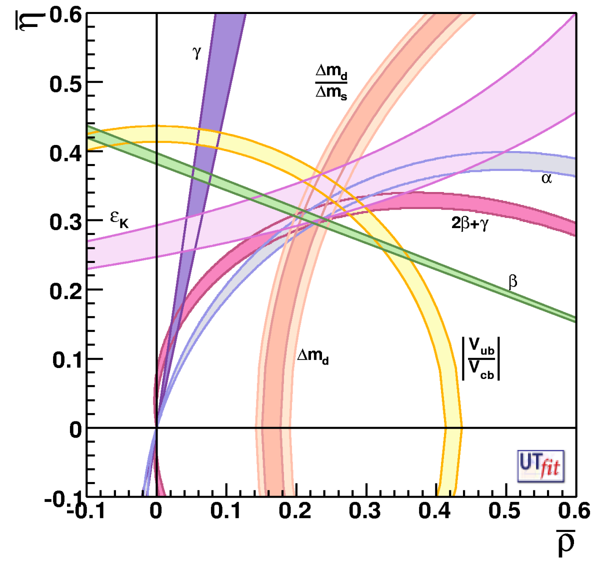
$\rho = 0.163 \pm 0.028$
$\eta = 0.344 \pm 0.016$

$\rho = \pm 0.0028$
$\eta = \pm 0.0024$

Improving CKM is crucial to look for NP



75 ab-1 SuperB and Lattice calculation improvement



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B Physics @ Y(4S)

	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)	$\sim 15°$	2.5°
γ $(B \to DK,\ D \to$ suppressed states)	$\sim 12°$	2.0°
γ $(B \to DK,\ D \to$ multibody states)	$\sim 9°$	1.5°
γ $(B \to DK$, combined)	$\sim 6°$	1–2°
α $(B \to \pi\pi)$	$\sim 16°$	3°
α $(B \to \rho\rho)$	$\sim 7°$	1–2° (∗)
α $(B \to \rho\pi)$	$\sim 12°$	2°
α (combined)	$\sim 6°$	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

	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}

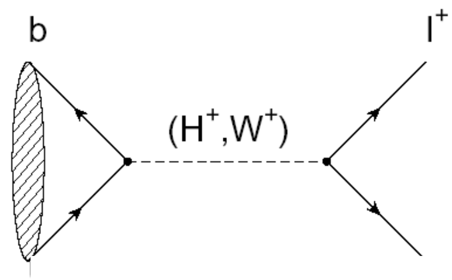
τ Physics

	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 @ Y(5S)

	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_{SL}^s	0.006	0.004
A_{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°

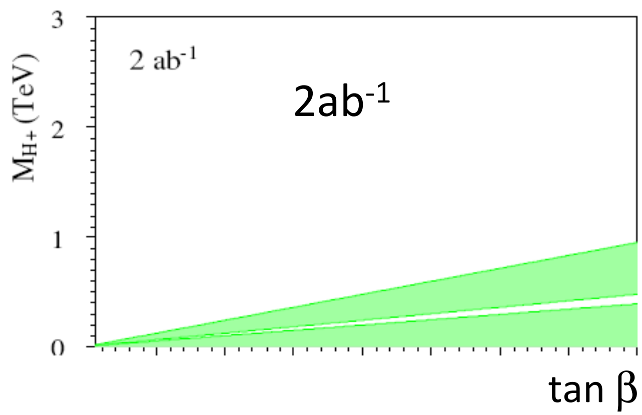
Higgs-mediated NP in MFV at large tanβ

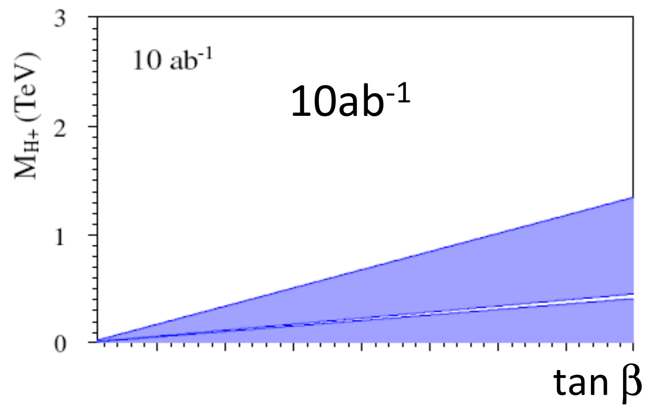


$$BR(B\to\tau\nu)=BR_{SM}(B\to\tau\nu)\left(1-\frac{m_B^2}{M_H^2}\tan^2\beta\right)^2$$

$2ab^{-1}$

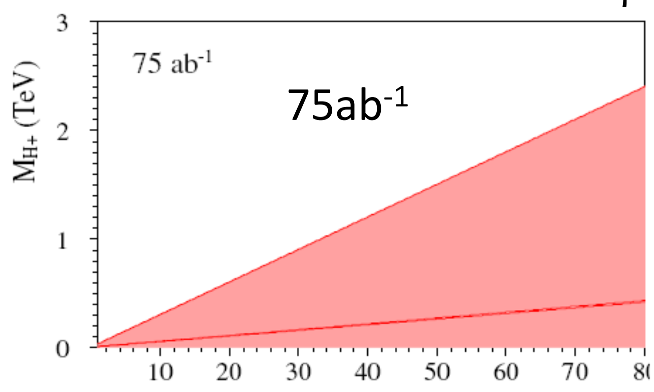
M_H~0.4-0.8 TeV
for tanβ~30-60



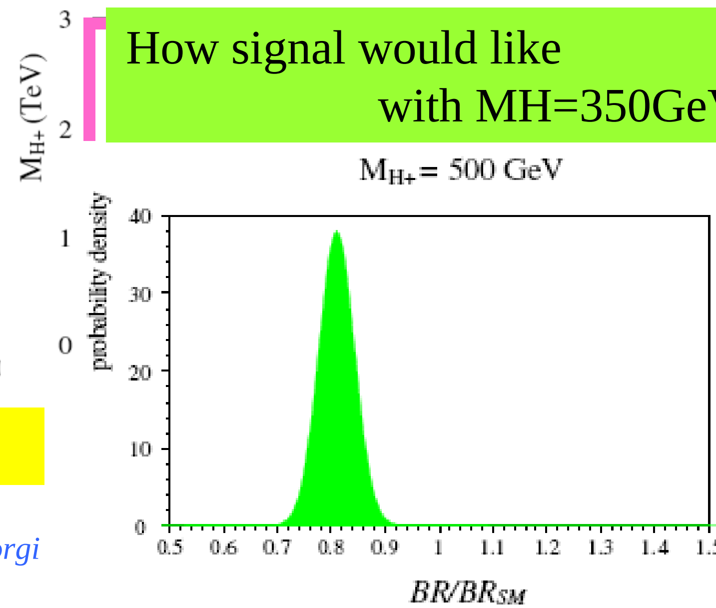


SuperB -$75ab^{-1}$

M_H~1.2-2.5 TeV
for tanβ~30-60



How signal would like
with MH=350GeV



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

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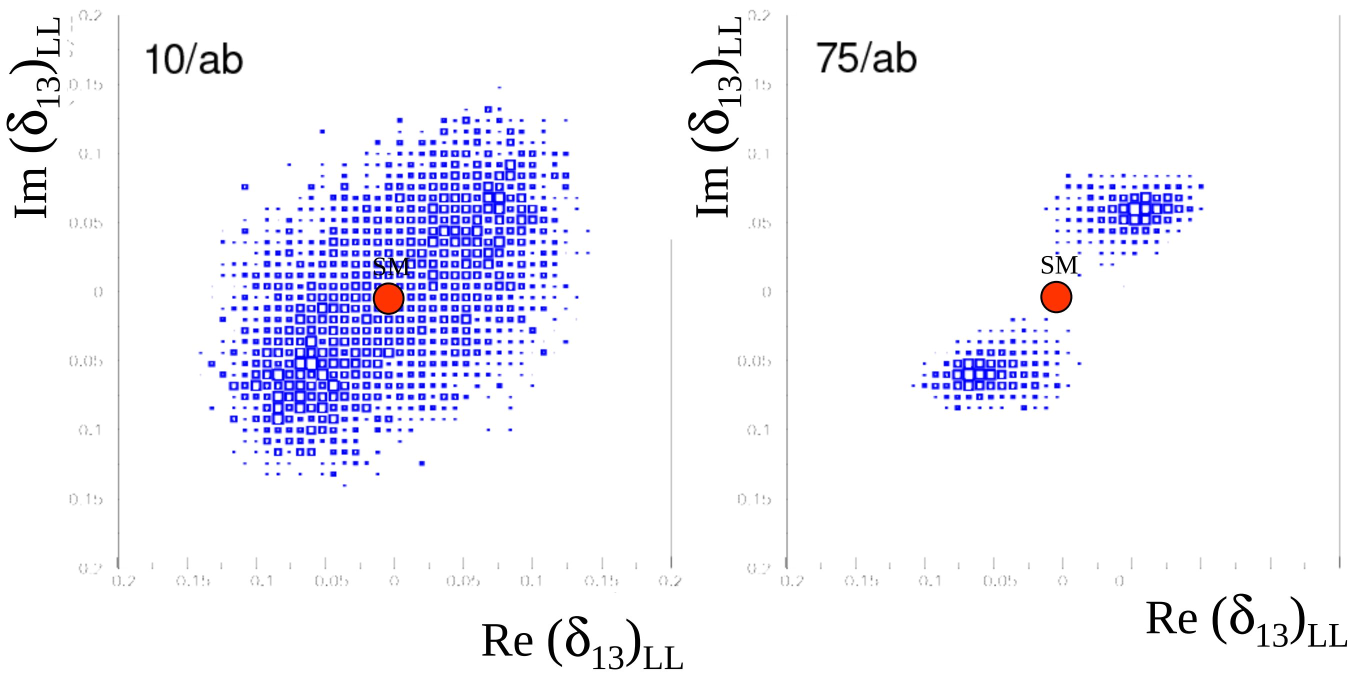
Determination of coupling [in this case : $(\delta_{13})_{LL}$]

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



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

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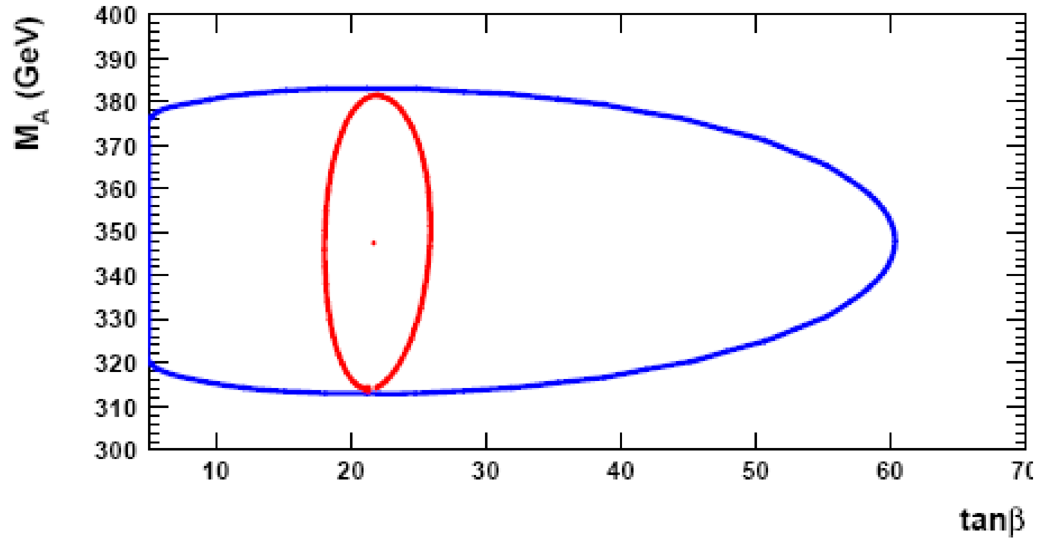
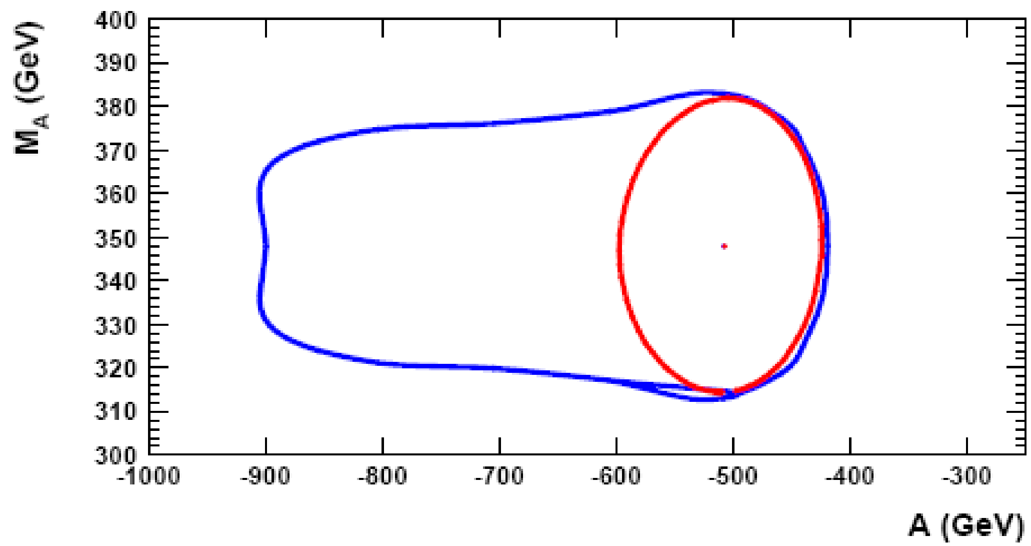
COMPLEMENTARY: LHC and Flavour with 75 ab^{-1}



IF LHC DISCOVERS SUPERSYMMETRY

EXAMPLE FROM VALENCIA PROCEEDINGS

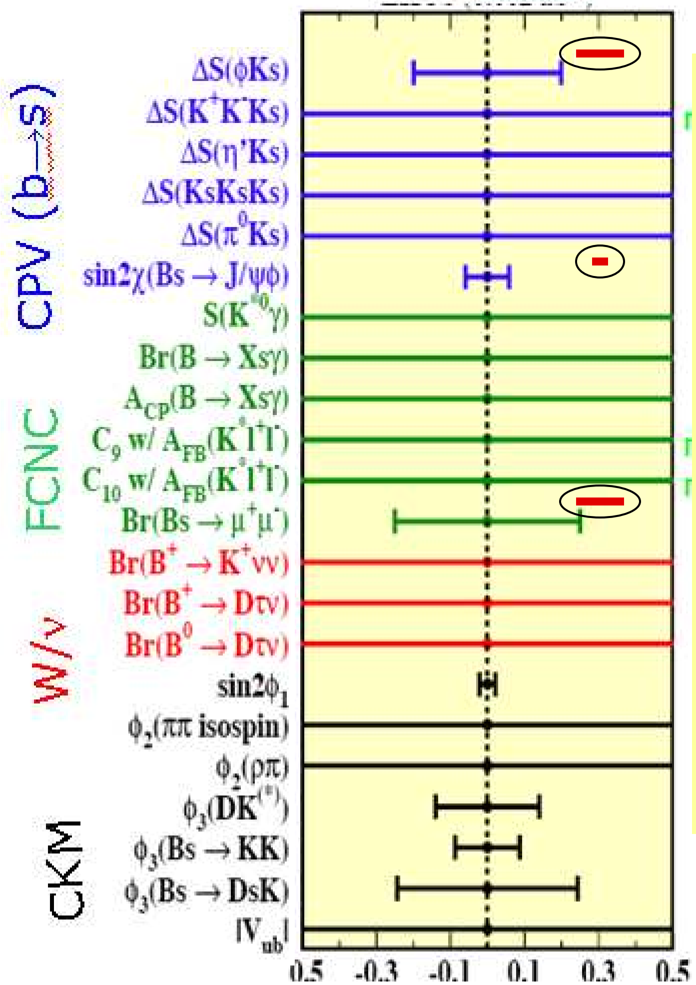


Red are LHC+EW constraints + SuperB

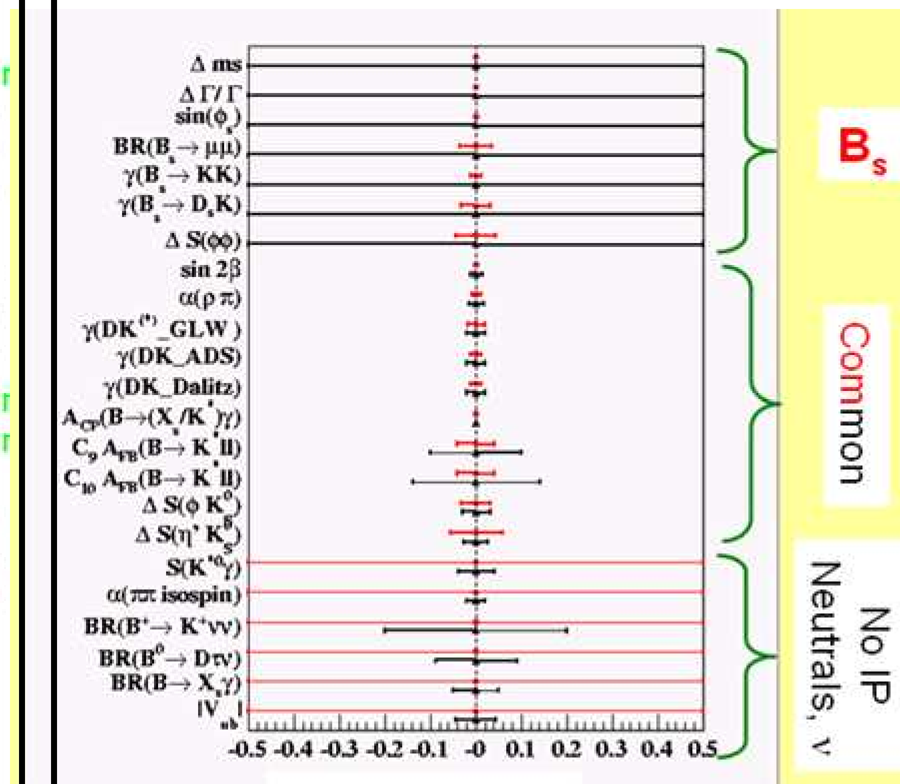
Blue is LHC alone

From LHCb, expect:

2fb^{-1} LHCb



LHC upgrade with 100fb^{-1}



Only LHCb?

F.Muheim

SuperLHCb vs. SuperBfactory at 50 ab^{-1}

Requirements to the physics goal (NOT ONLY LUMINOSITY!)

- $L_{peak} \geq 10^{36}$ $cm^{-2}s^{-1}$ (asymmetric 7.0+4.0 GeV $E_{cm} = m_{Y(4s)}$).
- 85% Polarization di e^- (7.0GeV) for τ :
  - T and CP Violation
  - BKG reduction in LFV, distinguish among LFV models.
  - τ g-2.
- Option to run *SuperB* still with a luminosity of 10^{35} $cm^{-2}s^{-1}$ at charm threshold (4 .0 GeV) . Pure DD_{bar}, no additional fragmentation.
- High signal/bkg : optimal for channels with
- Quantum Coherence: unique opportunity to measure D^0-D^0_{bar}relative phase.
- ~10^9 DD /month at 10^{35} $cm^{-2}s^{-1}$. (using
  $\sigma(e^+e^- \rightarrow D^0D^0)$~3.6 nb + $\sigma(e^+e^- \rightarrow D^+D^-)$~2.8 nb ~ 6.4 nb as measured by CLEO-C)
- Misure dipendenti dTime dependent measurements at4 GeV as for B sector at Y(4s) in BABAR and Belle. I will be only possible at *SuperB.*

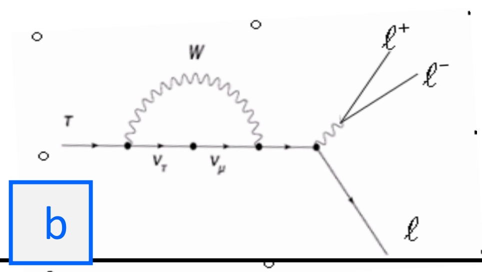
In TDR these topics should be better addressed.

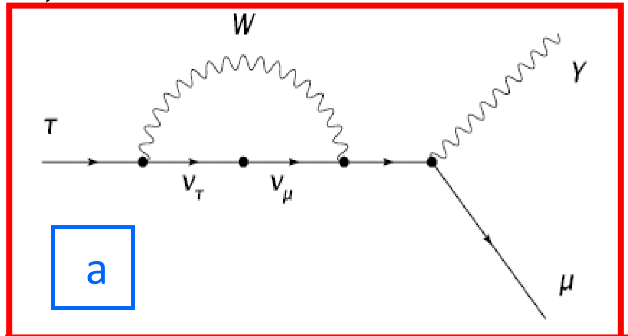
LFV in tau and muon decay

Standard Model allows LFV.In charged leptons it can occur in loops with expected low branching fractions. Es: expected Br ($\tau \rightarrow \mu\gamma$) <O ($10^{-40} \div 10^{-54}$)

Even less in 3 leptons

For this contribution

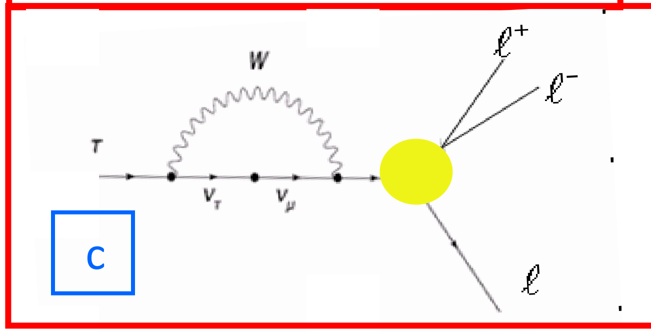




But with all contributions c becomes larger than b and c expected same order of a :

$$Br(\tau \to \mu\gamma) = \frac{3\alpha}{32\pi}\left|\sum_{i=1,2} U^*_{\tau i} U_{\mu i} \frac{\Delta m^2_{li}}{m^2_W}\right|^2 < 10^{-54}$$

$$\Delta m^2_{ij} = m^2_{\nu i} - m^2_{\nu j}$$



90% CL limits

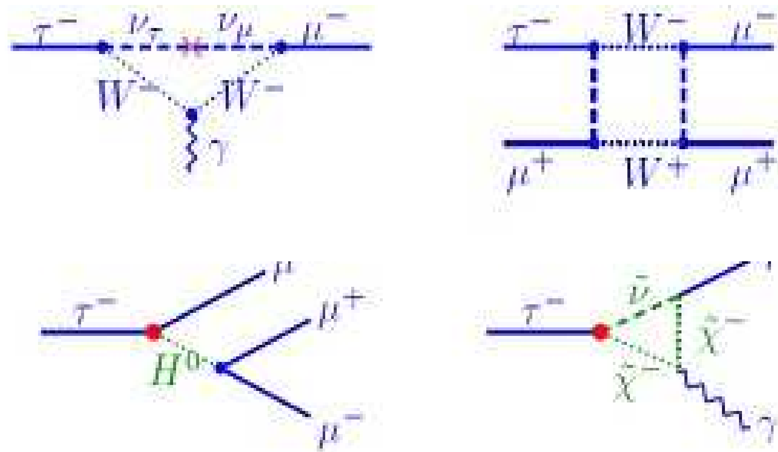
Br ($\tau^- \to e^-\gamma$)	<	12×10^{-8}
Br ($\tau^- \to \mu^-\gamma$)	<	4.1×10^{-8}
Br ($\tau^- \to e^-\gamma$)	<	11×10^{-8}
Br ($\tau^- \to \mu^-\gamma$)	<	6.7×10^{-8}

Observable lepton decays with FV will allow a clear indication of New Physics.Many New Physis models predict strong enhancement of violating decays of μ and τ. In many models measurable and even quite large τ BR [O(10^{-8})] are expected.

is also a τ factory → golden measurement LFV

(Complementarity with μ → e γ)

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}



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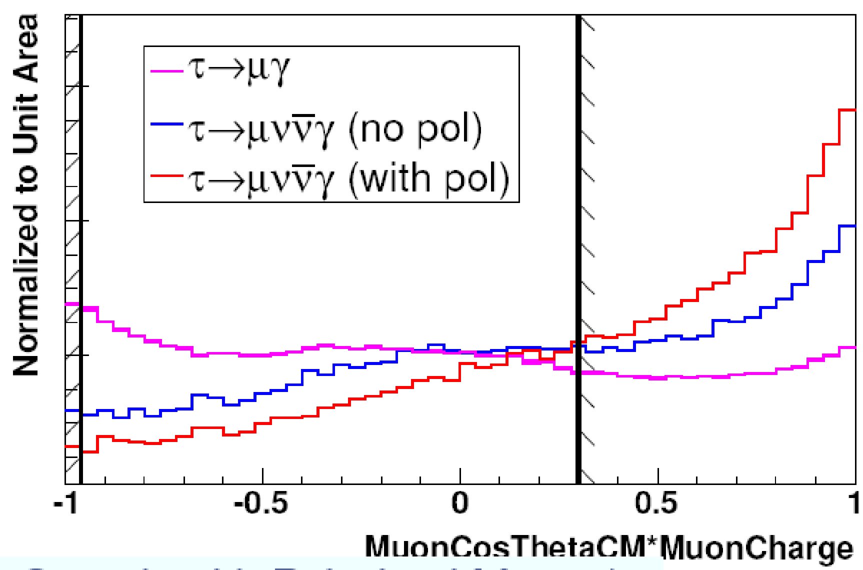
Further improvements if polarized beams:



Optimization of BKG rejection is in progress. Pol. Helps also to discriminate models. In some model there is a strong effect on the angular distribution of μ from signal:

(see hep-ph/9604296, Y.Kuno, Y.Okada, $\mu \to e\gamma$ Search with Polarized Muons)

Comparison with Snowmass points on Tau using also Polarization

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

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

- NP predictions for experimentally constrained SUSY in a number of standard scenarios
  B.C.Allanach *et al.*, hep-ph/0202233

LFV	Snowmass points predictions						Super*B*	
	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 a factor 2.5 and 4.5 in $\tau \to \mu\gamma$ and >5 in $\tau \to 3\mu$

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

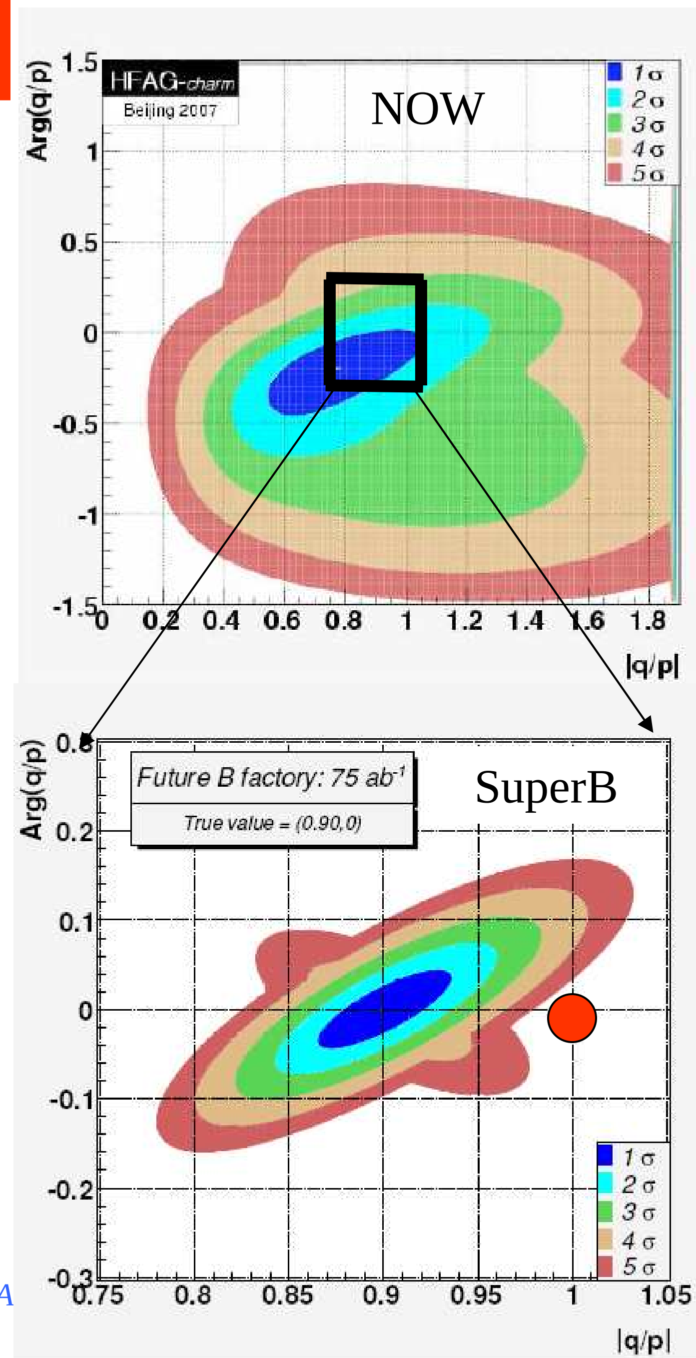
Charm

- Charm events at threshold are very clean: pure DD, no additional fragmentation
- High signal/bkg ratio: optimal for decays with neutrinos.
- Quantum Coherence: new and alternative CP violation measurement wrt to $\Upsilon(4S)$. Unique opportunity to measure D^0-D^0 relative phase.
- Increased statistics is not an advantage running at threshold: cross-section 3x wrt 10GeV but luminosity 10x smaller.
- SuperB lumi at 4 GeV = 10^{35} cm^{-2}s^{-1} produces ~10^9 DD pairs per month of running. (using Cleo-c cross-section measurement [$\sigma(e^+e^- \rightarrow D^0D^0)$~3.6 nb] +[$\sigma(e^+e^- \rightarrow D^+D^-)$~2.8 nb] ~ 6.4 nb)
- Super tau-charm could well study mixing and CP violation direct/indirect , but not in time dependent analysis as done in in B factories.
- Time-dependent measurements at 4 GeV **only** possible at SuperB to extract weak Phase thanks to the improved time measurement and to the option of running at charm threshold.

CP Violation in charm from mixing

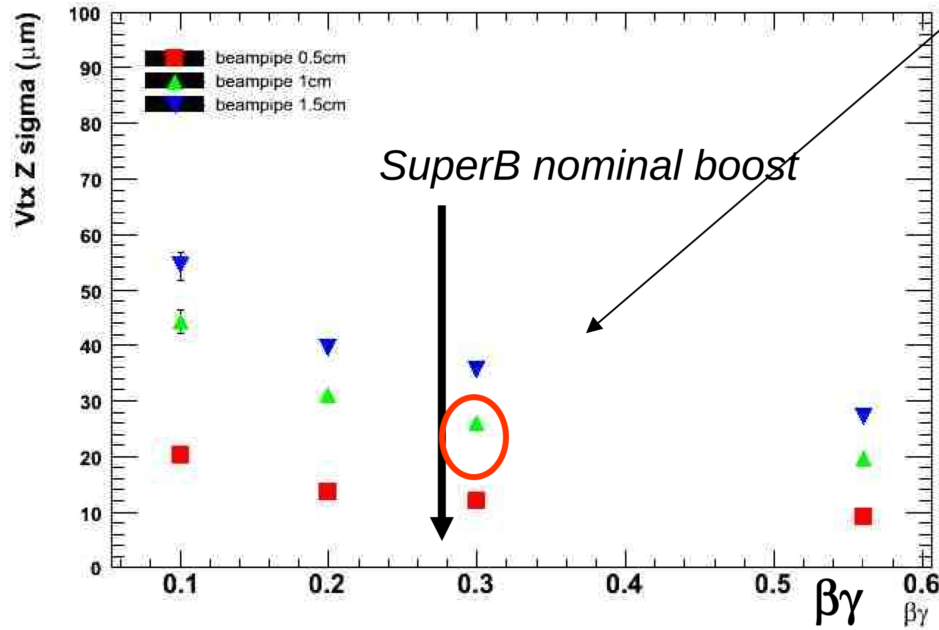
Mode	Observable	$\Upsilon(4S)$ $(75\ \text{ab}^{-1})$	$\psi(3770)$ $(300\ \text{fb}^{-1})$
$D^0 \to K^+\pi^-$	x'^2	3×10^{-5}	
	y'	7×10^{-4}	
$D^0 \to K^+K^-$	y_{CP}	5×10^{-4}	
$D^0 \to K_S^0\pi^+\pi^-$	x	4.9×10^{-4}	
	y	3.5×10^{-4}	
	$\|q/p\|$	3×10^{-2}	
	ϕ	2°	
$\psi(3770) \to D^0\overline{D}^0$	x^2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

Achievable in SuperB but also in 10^{35} Super τ charm



Time dependent measurements at DD threshold: only possible at SuperB

- Proper time resolution dominated by decay vertex resolution.
  - Production vertex precisely determined thanks to nm beamspot dimensions



With Super*B* lumi at 4 GeV = 10^{35} cm^{-2}s^{-1} expected ~10^9 $D\bar{D}$ per month

$\beta\gamma ct = 0.28 \times 120\ \mu m \sim 30\mu m$

Average flight distance similar to vertex resolution $\rightarrow \sigma_t \sim \tau$

Summary of Physics Goals

- Increase by O(10) the precision of BaBar &Belle (*)
- Challenge CKM at the level of 1% (*)
- τ LFV sensitivity improvement by a factor between 10 and 100.
- Explore T-violation in τ .
- Search for magnetic structure of τ .
- Explore CPV in Charm.
- Great new Spectroscopy exploration.

Beam Polarization option and possibility to run at charm threshold

It can be allowed with 75 ab^{-1} in 5 years at Y(4s) and a few months at Charm threshold with peak lumi of 10^{35} cm^2 s^{-1}.

Super flavor factory projects

Machine project	Cms Energy (GeV)	Mode	Polarization of e^- beam >80% for τ	Luminosity ($cm^{-2}\ s^{-1}$)
Super c-τ BINP (Russia)	3.0÷4.5	Symmetric	Yes	$1 \div 2\ 10^{35}$
SuperKEKB (Japan)	10.58	Asymmetric	No	$2 \div 8\ 10^{35}$
Super*B*-Roma	10.58 4.0	Asymmetric	Yes	$1 \div 4\ 10^{36}$

SuperB is expected to integrate 75 ab^{-1} in 5 years

MACHINE progress and design as reviewed by MiniMac

PARAMETER REQUIREMENTS FROM PHYSICS

Parameter	Requirement	Comment
Luminosity (top-up mode)	10^{36} cm^{-2}s^{-1} @ $\Upsilon(4S)$	
Integrated luminosity	75 ab^{-1}	Based on a “New Snowmass Year” of 1.5 x 10^{7} seconds (PEP-II experience-based)
CM energy range	*t* threshold to Υ (5*S*)	
Minimum boost	$\beta\gamma$= 0.28 (4x7 GeV)	1 cm beampipe radius. First measurement at 1.5 cm
e^{-} Polarization	60-85%	Enables *t CP* and *T* violation studies, measurement of *t g*-2 and improves sensitivity to lepton flavor-violating decays. Detailed simulation, needed to ascertain a more precise requirement, are in progress.

TOOLS (1):Luminosity

For gaussian bunches:

$$\mathcal{L} = f_{\text{coll.}} \times \frac{N_{e^+} N_{e^-}}{4\pi \, \sigma_x \, \sigma_y} \times R_l$$

geometrical Reduction factor

N_e^+ (N_e^-) is the number of positrons (electrons) in a bunch

f_{coll} is the collision frequency

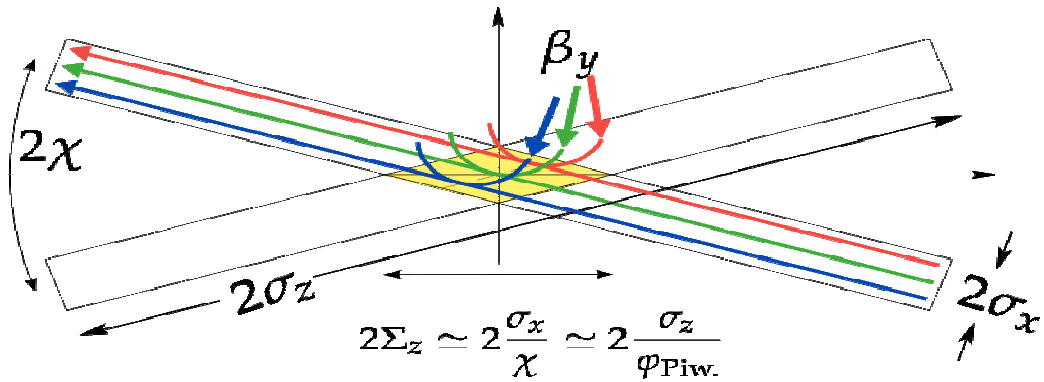
σ_x (σ_y) is the horizontal (vertical) r.m.s. size at the I.P.

R_l is the Luminosity Reduction factor by incomplete overlap: crossing angle and "hour glass" effect.

•TRADITIONAL (brute force): increase the numerator Currents increase: from 1A on 2 A up to 4.1 A on 9.4 A- **Wall Plug Power**, HOM,CSR: hard to surpass 5 10^{35} cm^2s^{-1} **Crab Crossing** to increase $\mathbf{R_l}$ and to optimize beam dynamic

•Super*B*: decrease the denominator (same currents as PEP-II) Bunch sizes: from σ_y = 3μm down to σ_y = 40 nm Luminosity: 10^{36} cm^2s^{-1} (baseline) . **Crab Waist** and large **Piwinsky** angle to optimize beam dynamic

Crab Waist :The SuperB solution



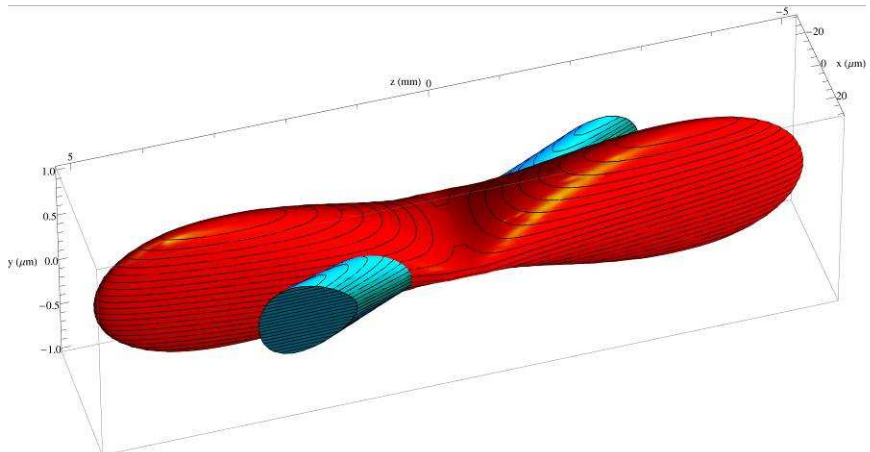
- Crab waist: modulation of the y-waist position, particles collides a same β_y realized with a sextupole upstream the IP.
- Minimization of nonlinear terms in the beam-beam interaction: reduced emittance growth, suppression of betatron and sincro-betatron coupling
- Maximization of the bunch-bunch overlap: luminosity gain
- Low wall power

SuperB and Super c-τ are based on the crabwaist concept invented in 2006 by P.Raimondi in 2006.

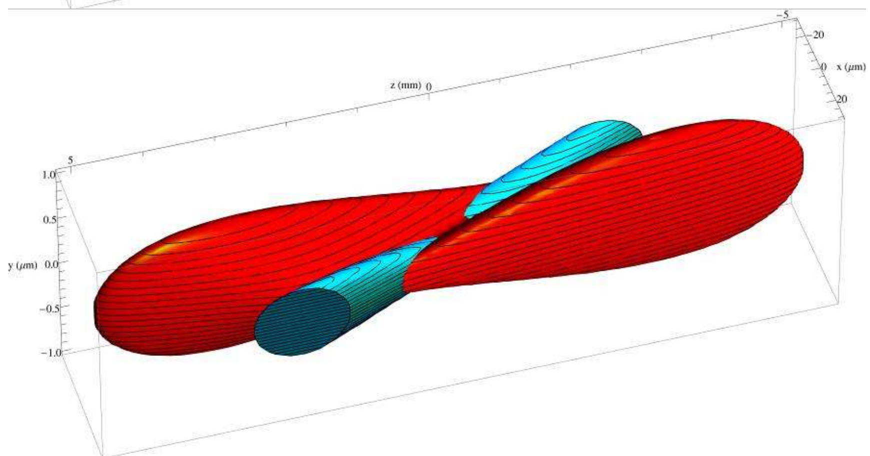
TESTED IIN LNF WITH DAFNE (500 MeV beams)

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

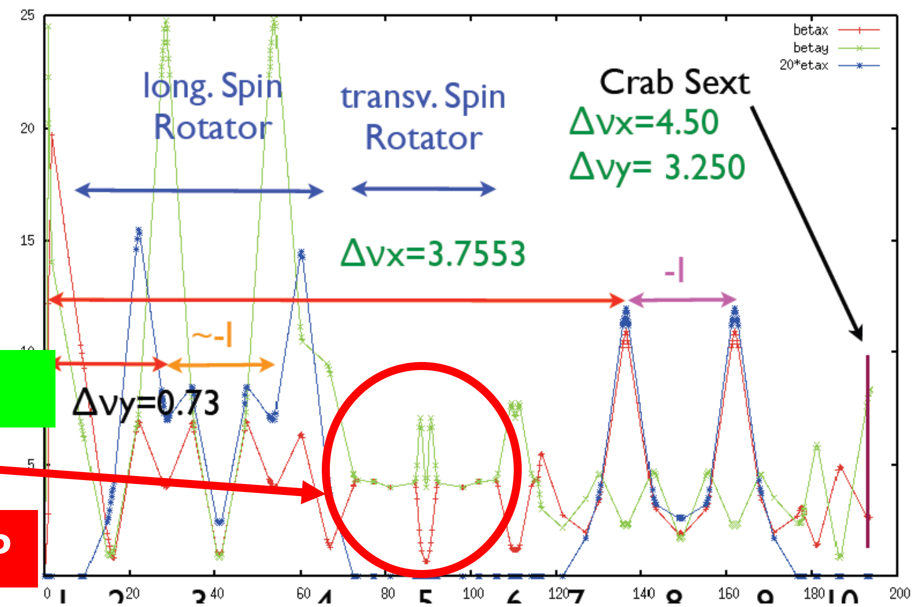
TOOLS (2):Polarization

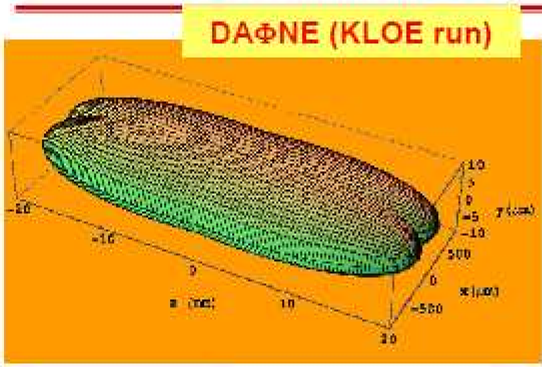
- Polarization of one beam is included in *SuperB and also in Super τ–charm*
  - Polarization in LER would be less expensive, in HER easier
  - HER chosen for SuperB
- Longitudinal polarization times and short beam lifetimes indicate a need to inject vertically polarized electrons.
  - The plan is to use a polarized e^- source similar to the SLAC SLC source.
- There are several possible IP spin rotators:
  - Solenoids look better at present (vertical bends give unwanted vertical emittance growth)

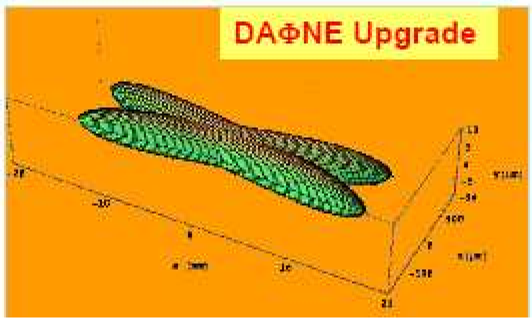
- Expected longitudinal polarization at IP ~ 87%(inj) x 97%(ring) = 85%(effective)
- Polarization section implementation in lattice is in progress

Half IR with spin rotator (Wienands, Wittmer)

Marcello

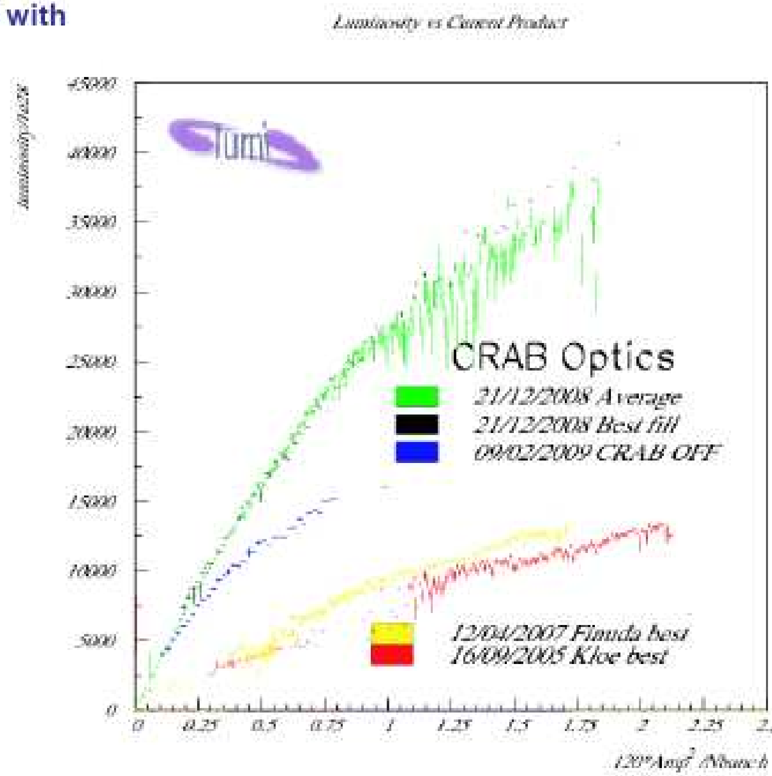






	DAΦNE (KLOE run)	DAΦNE Upgrade
I_{bunch} (mA)	13	13
N_{bunch}	110	110
β_y^* (cm)	1.8	0.85
β_x^* (cm)	160	26
σ_y^* (μm)	5.4 low curr	3.1
σ_x^* (μm)	700	260
σ_z (mm)	25	20
Horizontal tune shift	0.04	0.008
Vertical tune shift	0.04	0.055
θ_{cross} (mrad) (half)	12.5	25
$\Phi_{Piwinski}$	0.45	2.0
L ($cm^{-2}s^{-1}$)	1.5×10^{32}	$>5 \times 10^{32}$

3 times more luminosity obtained with 3 times smaller vertical beam



Great success of “CRAB WAIST “ test at LNF.

Crab Waist test was successful

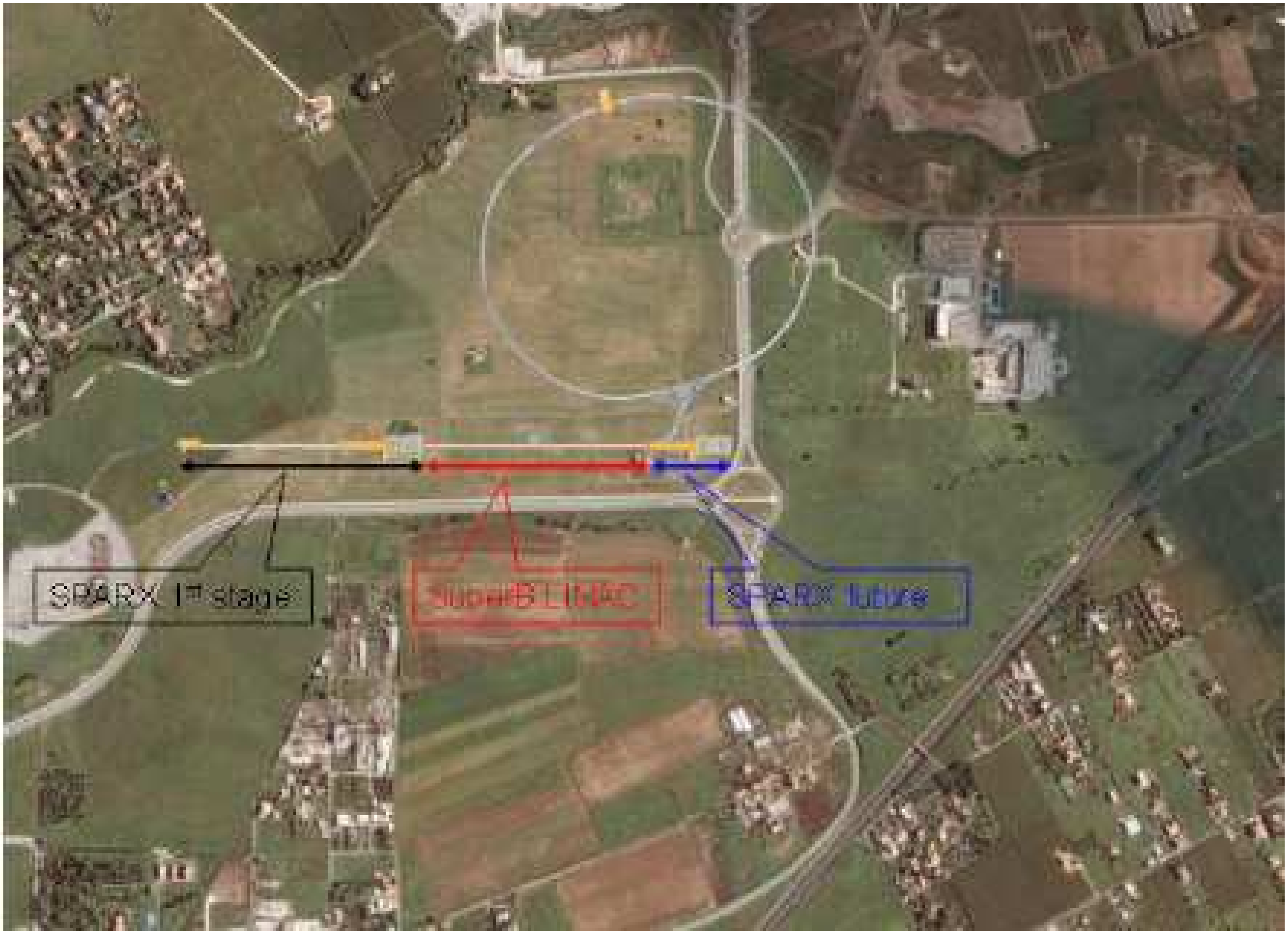
DaΦne test in Frascati very successful, the luminosity has grown by more than a factor 3 as expected from simulations.
All the results agree with beam beam simulations, now also with strong-strong.

SuperB PARAMETERS

J.Seeman @MiniMac

LER/HER	Unit	June 2008	Jan. 2009	March 2009	LNF site
E+/E-	GeV	4/7	4/7	4/7	4/7
L	$cm^{-2}\ s^{-1}$	$1x10^{36}$	$1x10^{36}$	$1x10^{36}$	$1x10^{36}$
I^+/I^-	Amp	1.85 /1.85	2.00/2.00	2.80/2.80	2.70/2.70
N_{part}	$x10^{10}$	5.55 /5.55	6/6	4.37/4.37	4.53/4.53
N_{bun}		1250	1250	2400	1740
I_{bunch}	mA	1.48	1.6	1.17	1.6
$\theta/2$	mrad	25	30	30	30
β_x^*	mm	35/20	35/20	35/20	35/20
β_y^*	mm	0.22 /0.39	0.21 /0.37	0.21 /0.37	0.21 /0.37
ε_x	nm	2.8/1.6	2.8/1.6	2.8/1.6	2.8/1.6
ε_y	pm	7/4	7/4	7/4	7/4
σ_x	µm	9.9/5.7	9.9/5.7	9.9/5.7	9.9/5.7
σ_y	nm	39/39	38/38	38/38	38/38
σ_z	mm	5/5	5/5	5/5	5/5
ξ_x	X tune shift	0.007/0.002	0.005/0.0017	0.004/0.0013	0.004/0.0013
ξ_y	Y tune shift	0.14 /0.14	0.125/0.126	0.091/0.092	0.094/0.095
RF stations	LER/HER	5/6	5/6	5/8	6/9
RF wall plug power	MW	16.2	18	25.5	30.
Circumference	m	1800	1800	1800	1400

SITES : Tor Vergata……..



LNF option

From MiniMac

MiniMac was appointed by the President

of INFN at end of June 2008

Mini Machine Advisory Committee

- Klaus Balewski (DESY)
- John Corlett (LBNL)
- Jonathan Dorfan (SLAC, Chair)
- Tom Himel (SLAC/ DESY)
- Claudio Pellegrini (UCLA)
- Daniel Schulte (CERN)
- Ferdi Willeke (BNL)
- Andy Wolski (Liverpool)
- Frank Zimmermann (CERN)

First meeting in July 16-17,2008

No glaring showstoppers

RECOMMENDATION:

Form a management structure!

Link to meetings and reports:

http://www.pi.infn.it/SuperB/reviews

- Very exciting project -- Committee is exhilarated by the challenge
- Physics requirement of 10**36 cm-2 sec-1 or 75 ab-1/5yr is very demanding
- Committee considers the SINGLE MOST ESSENTIAL ingredient for moving forward is the formation of a sanctioned management structure which formally incorporates a dedicated machine design team. The team members must have the strong support of their home institutions to work on the design. The team needs a designated leader, who is as close to full time as is possible
- The Committee sees no glaring showstoppers wrt achieving the design performance. However, in several key areas, more work is needed before the design can be blessed

From J. Dorfan report of MINI MAC April 24,2009

…. "Mini-MAC now feels secure in enthusiastically encouraging the SuperB design team to proceed to the TDR phase, with confidence that the design parameters are achievable"

Machine is possible!

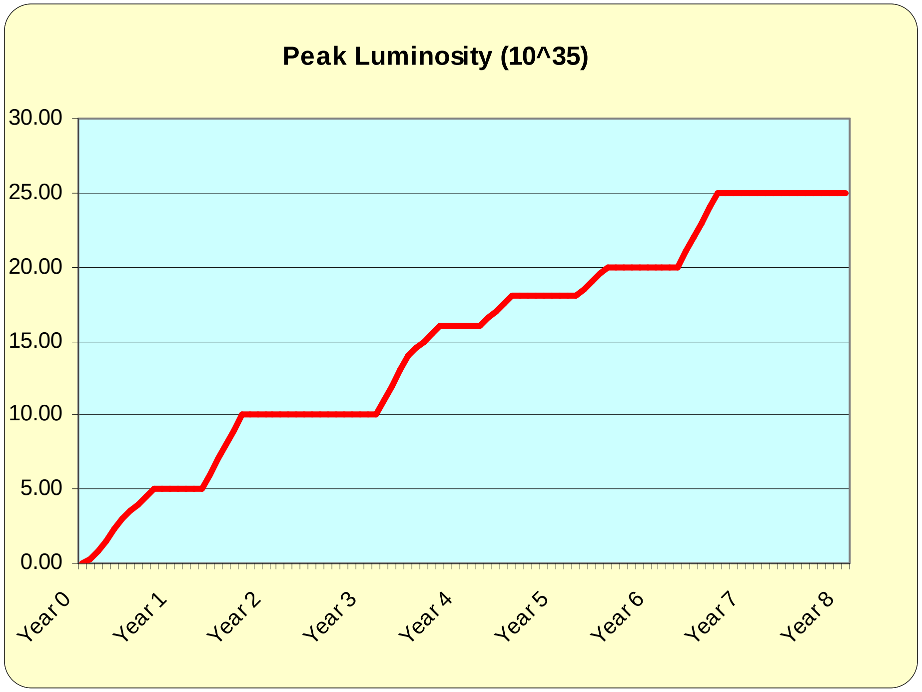
The 2 rings can be built largely with the components of PEPII:

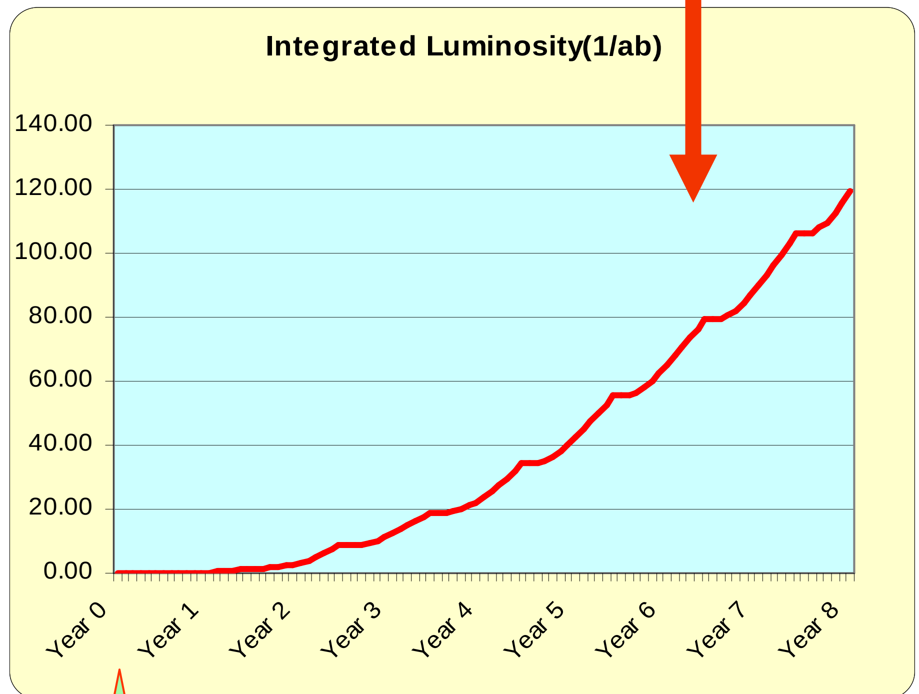
Magnets and RF stations.

With 7th year integrated Luminosity can grow at rate of ~40 ÷ 60 ab^{-1}/year

SuperB expectation

>80ab-1 after 6 years



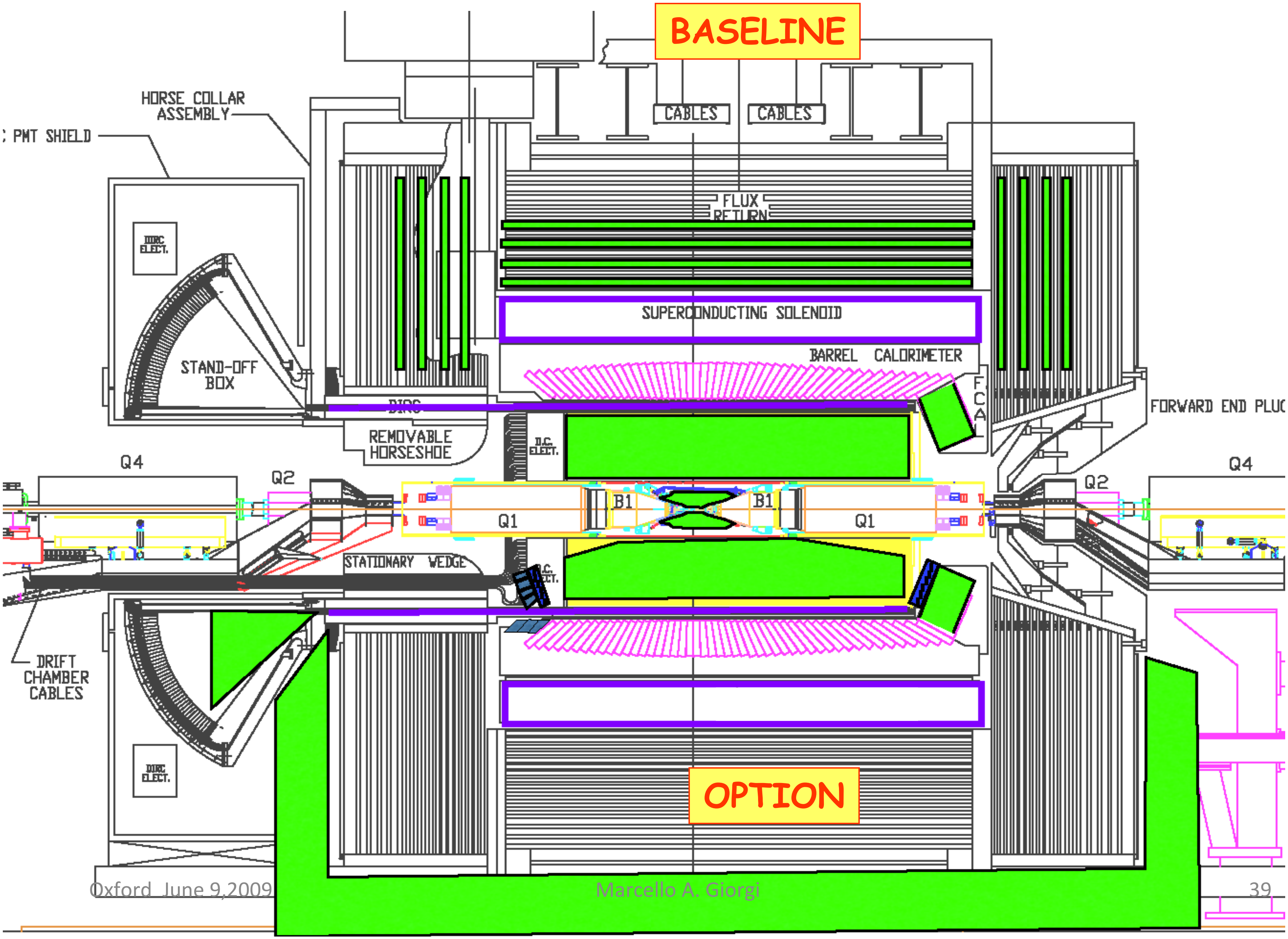


With more money a second interaction can be included in SuperB, without compromising on Luminosity!

2015 ?

About Detector

Detector Layout – Reuse parts of Babar

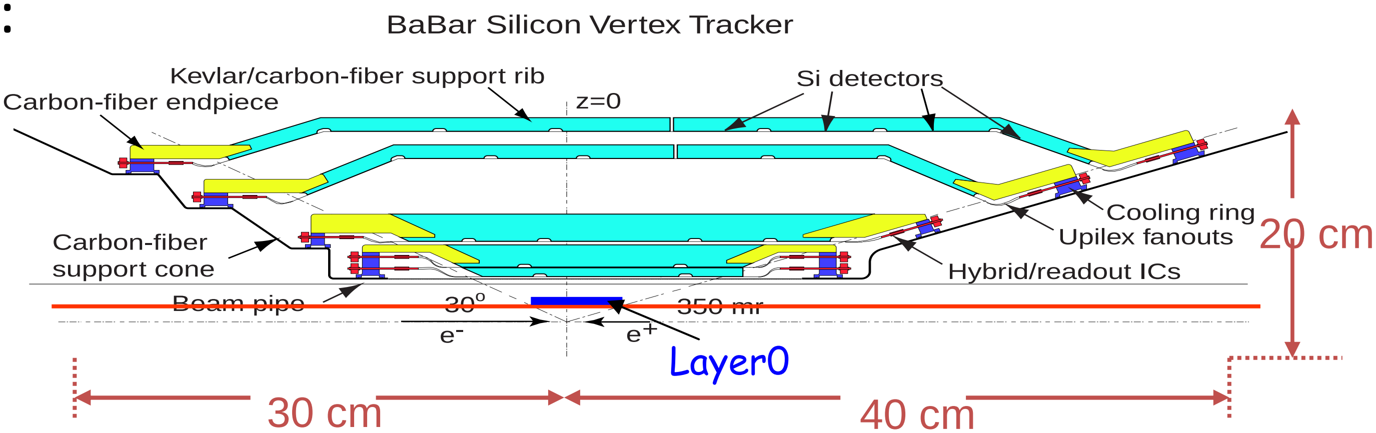


Detector Evolution-B Factory(BABAR) to SuperB

- CDR Baseline based on BaBar. It reuses
  - Fused Silica bars of the DIRC
  - DIRC & DCH Support
  - Barrel EMC CsI(Tl) crystals and mechanical structure
  - Superconducting coil & flux return (with some redesign).
- **Some elements have aged and need replacement. Others require moderate improvements to cope with the high luminosity environment, the smaller boost (4x7 GeV), and the high DAQ rates.**
  - Small beam pipe technology
  - Thin silicon pixel detector for first layer, and a new 5 layer SVT.
  - New DCH with CF mechanical structure, modified gas and cell size
  - New Photon detection for DIRC fused silica bars
  - Possible Forward PID system (TOF in Baseline option)
  - New Forward calorimeter crystals (LYSO).Backward veto
  - Minos-style extruded scintillator for instrumented flux return
  - Electronics and trigger- x100 real event rate
  - Computing- to handle massive date volume

Detector Issues:

SVT



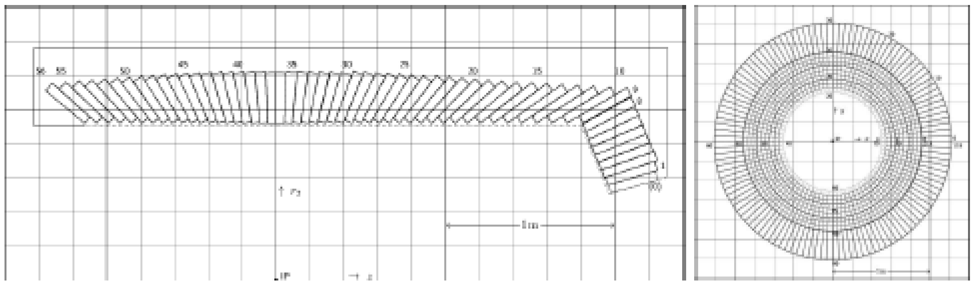
- Smaller machine asymmetry

➔ Need a new SVT (very similar to that of the 5 layer BaBar SVT) supplemented by a new layer 0 to measure the first hit as close as possible to the production vertex. Goal is coverage to 300 mrad both forward and backward.

- Beam pipe radius and thickness are crucial to obtain adequate resolution in vertex separation.

Options:MAPS, Hybrid Pixels, Striplets (the latter is difficult due to the expected Bhabha occupancy)

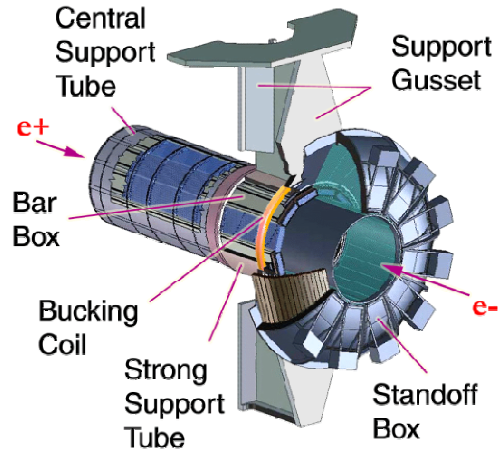
Forward EMC



- Forward Endcap EMC
  - Inner BaBar Crystals are radiation damaged. Need replacement.
  - At forward angles in SuperB, CsI(Tl) is too slow (occupancy) and radiation soft.
  - Propose LYSO.

- Baseline is to reuse BaBar DIRC barrel-only design.
  - Excellent performance to 4 GeV/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 senstive to backgrounds so volume reduction is desirable.

PID



- Photon detector replacement
  - Baseline... Use pixelated fast PMTs with a smaller SOB to improve background performance by ~x50-100 with ~ identical PID performance.
  - Several other photon detector options are considered in the CDR.

OPTIONS for the Forward PID

- Modest solid angle but event acceptance for “veto physics” or decays with multiple particles (e.g., B➔ K_sKK) scale much faster than linearly. Physics case needs to be established.

- Not just a PID problem. Overall detector optimization required.
  - Adds material before EMC.
  - Takes space from tracking or EMC.

- Aerogel RICH and Very Fast Cherenkov-based TOF seem plausible.

  - Space requirements.
  - Fast tubes have substantial material. SiPMs are noisy and neutron sensitive.
  - R&D underway

Detector Technical Board

Detector Coordinators – B.Ratcliff, F. Forti
Technical Coordinator – W.Wisnieswki

- SVT – G. Rizzo
- DCH – G. Finocchiaro
- PID – N.Arnaud, J.Va'vra
- EMC – D.Hitlin → C.Cecchi, F.Porter
- IFR – R.Calabrese
- Magnet – W.Wisniewski
- Electronics, Trigger, DAQ – D. Breton, U. Marconi
- Online/DAQ –
- Offline SW –
  - Simulation coordinator – D.Brown
  - Fast simulation – M. Rama
  - Full Simulation – F. Bianchi
- Rad monitor –
- Lumi monitor –
- Background simulation & Machine Detector Interface — M.Boscolo, E.Paoloni +M.Sullivan

Detector R&D

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

Sys	R&D	Engineering
SVT	Layer 0 thin pixels Low mass mechanical support	Silicon strip layers Readout architecture
DCH	High speed waveform digitizing	CF mechanical structure Gas speed, cell size
Barrel PID	Photon detection for quartz bars	Standoff box replacement
Forw PID	Time of flight option Focusing RICH option	Mechanical integration. Electronics
EMC	LYSO characterization Light detection	Readout electronics Forward EMC mechanical support
IFR	Fiber disposition in scintillator	Location of photo-detectors
ETD	High speed data link Radiation hard devices	Trigger strategy Bhabha rejection

SuperB is now in TDR Phase.

A bit of HISTORY about the PROCESS

Several preparatory meetings from 2005 to form the community and to prepare the CDR, delivered in may 2007.

IRC appointed by the President of INFN in summer 2007 (Chair: John Dainton)
Preliminary meeting in Rome end July 2007 (committee with INFN management and proponents).
First review meeting in LNF Nov. 12-13 , 2007.
Final meeting before report to President of INFN in Rome, Apr. 29-30, 2008 .

IRC has delivered the report to the President of INFN on May 30,2008.

Comments on reviews

- Link to meetings and reports:
  http://www.pi.infn.it/SuperB/reviews
- Dainton committee →
- Mini MAC

John Dainton
INFN SuperB
La Biolada
June 1st 2008

IRC First report

The Cockcroft Institute
UNIVERSITY OF LIVERPOOL

5. **Conclusion**

- recommend strongly continuation of work for 10^{36} cm^{-2} s^{-1} asymmetric e^+e^- collider
- even more concerted effort to fully evaluate physics potential ↔ machine specifications
- major design program to establish credibility of machine now critical ← showstoppers?
- MAC now essential
- preservation of detectors
  PEP2 components

↳ increasing global involvement if timescale for a TDR is to be met

---

•Very exciting project -- Committee is exhilarated by the challenge
•Physics requirement of 10**36 cm-2 sec-1 or 75 ab-1/5yr is very demanding
•Committee considers the SINGLE MOST ESSENTIAL ingredient for moving forward is the formation of a sanctioned management structure which formally incorporates a dedicated machine design team. The team members must have the strong support of their home institutions to work on the design. The team needs a designated leader, who is as close to full time as is possible

•The Committee sees no glaring showstoppers wrt achieving the design performance. However, in several key areas, more work is needed before the design can be blessed

FROM P 5

(Report released May 2008)

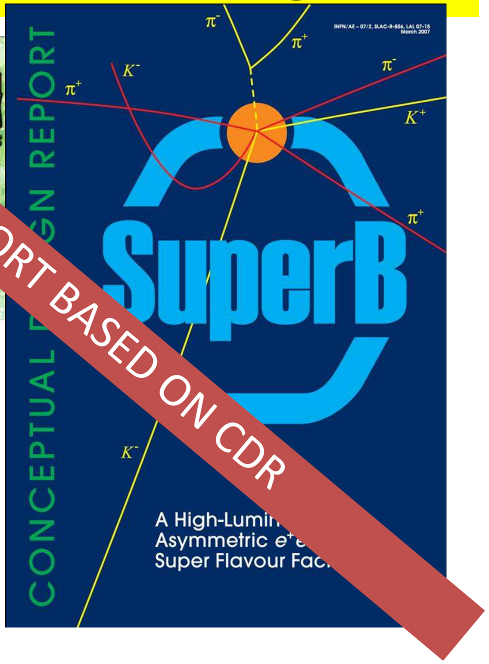
High-sensitivity Measurements

- The latest developments in accelerator and detector technology make possible promising new scientific opportunities through measurement of rare processes. Incisive experiments, complementary to experiments at the LHC, would probe the Terascale and possibly much higher energies.
- The panel recommends pursuing the muon-to-electron conversion experiment, subject to approval by the Fermilab PAC, under all budget scenarios considered by the panel.
- The intermediate budget scenario would allow in addition pursuing significant participation in one overseas next-generation B factory.
- The more favorable funding scenario, scenario C, would allow for pursuing a program in rare K decay experiments at Fermilab as well.

Presentations of the SuperB Project at ECFA meetings

Manchester ('07) :

Lisbon (March'08) :



Some Highlight on Physics Program
Quick update on Detector
Accelerator : preliminary results from test on SuperB concepts in DaΦne upgrade at LNF.

RN (Nov28,2008):

The ECFA ad hoc Subcommittee:
T.Nakada(chair),Y.Karyotakis,F.Linde,B Spaan attended the May2008 SuperB Workshop in Elba and met with INFN Management and SuperB proponents in October 2008.

Quick update at CERN on Physics Program and Detector
Accelerator test results
Update on Process and Organization for TDR

ECFA reported on SuperB at Cern Council in European session (DEC.08)

From 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** Y**(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 to obtain luminosity of ≥1036 cm−2s−1, two orders of magnitude more than what has been achieved up to now, without increasing the beam currents. This is a distinct advantagefor some of the machine operation aspects and background to the experiment, as well as for the running cost of the machine. 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.**

- project was presented in Sept 09 by R.Petronzio at CERN Council.
- Several meetings with S. Stapnes (secretary of the European Strategy Group) since last summer
- March 20, 2009 in LNF meeting with the European Laboratory Directors, in a meeting promoted by the Strategy Group to discuss possibility to help SuperB. (S.Stapnes was attending).

All Directors expressed their support, the two french and Cern directors promised their help with people participating to the TDR Phase.

Meanwhile…

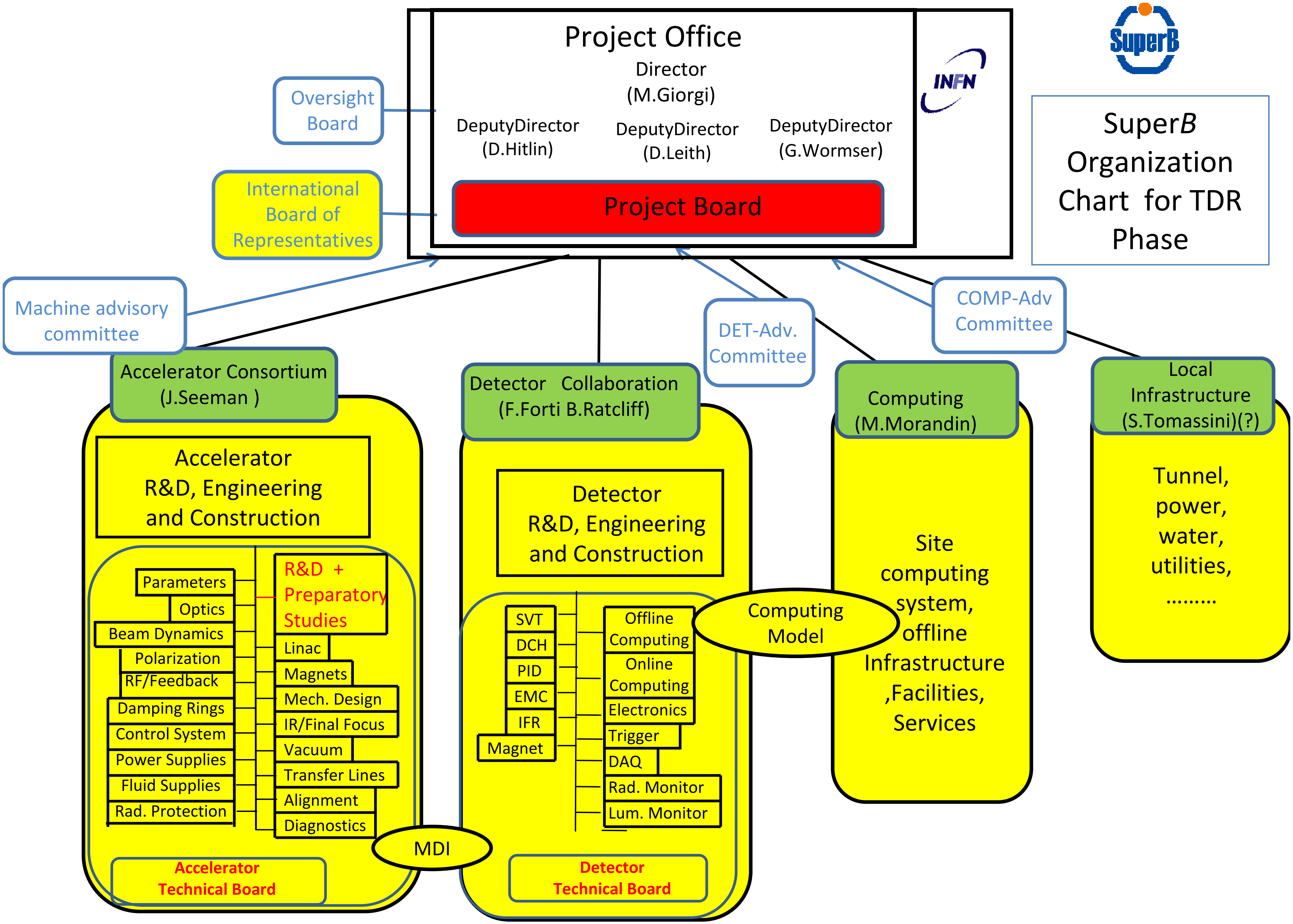
TDR phase was approved last December 2008 by the Board of Directors of INFN.

The document will be ready before the end of 2010

May 29, 2009 –The INFN Board of Directors has approved the INFN Special Project inside SuperB TDR to handle Financial Resources

June 18 the President of INFN will update the CERN Council on SuperB.

THE SuperB TDR ORGANIZATION


Project Office
Director
(M.Giorgi)
DeputyDirector
(D.Hitlin)
DeputyDirector
(D.Leith)
DeputyDirector
(G.Wormser)
Project Board
INFN
SuperB Organization Chart for TDR Phase
Oversight Board
International Board of Representatives
Machine advisory committee
DET-Adv. Committee
COMP-Adv Committee
Accelerator Consortium
(J.Seeman)
Accelerator R&D, Engineering and Construction
Parameters
Optics
Beam Dynamics
Polarization
RF/Feedback
Damping Rings
Control System
Power Supplies
Fluid Supplies
Rad. Protection
R&D + Preparatory Studies
Linac
Magnets
Mech. Design
IR/Final Focus
Vacuum
Transfer Lines
Alignment
Diagnostics
MDI
Accelerator Technical Board
Detector Collaboration
(F.Forti B.Ratcliff)
Detector R&D, Engineering and Construction
SVT
DCH
PID
EMC
IFR
Magnet
Offline Computing
Online Computing
Electronics
Trigger
DAQ
Rad. Monitor
Lum. Monitor
Computing Model
Detector Technical Board
Computing
(M.Morandin)
Site computing system, offline Infrastructure ,Facilities, Services
Local Infrastructure
(S.Tomassini)(?)
Tunnel, power, water, utilities, ...

Some of the Functions of SuperB Project office as approved by the International Steering committee .

Functions of Project Office

Funding Agency Interactions

-Interface with funding agencies

-International Coordination

-External Affairs

-Manage funding

Central Project Management

-Manageoverall project budget/schedule

-Manage project change control

-Administrative

-Quality Assurance

Technical Services

-Facilities Services

-Material and Logistical Services

- Engineering Support

-Laboratory Fabrication Shop

Administrative Services

- Plannning Personnel

-Education, Outreach

-Technology Transfer

Project Board

Project Board is the new entity inside the Project Office. It is appointed by the Director.

"*Charge: Review and propose to the* SuperB *Project Director the general parameters of the SuperB project that overlap the boundaries between the accelerator, detector, site, computing, and physics analysis. Provide a forum in which all major decision of the management group will be fully discussed with the technical leaders."*

Members:

Maria Enrica Biagini, Francesco Forti, Marcello Giorgi,

David Hitlin, David Leith, Mauro Morandin, Pantaleo Raimondi,

Blair Ratcliff, Claudio Sanelli, John Seeman, Michael Sullivan, Sandro Tomassini, Guy Wormser

Physics activity is coordinated by a group of 4 conveners:

A.Bevan -QMUL
D.Brown -LBNL
M.Ciuchini -INFN Roma3
A.Stocchi -LAL Orsay

This group reports to the Directorate.
After Warwick Workshop they are planning another workshop in Frascati Dec 2009 before delivering the update of SuperB Physics Program.

Steering Committee to evolve to the

International Board of Representatives

Since 2006 a Steering Committee is in place

M.G. (INFN Italy-Chair)
W.Gradl (Germany)
P.Harrison (UK) (New appointment soon)
D.Hitlin (USA)
H.Jawahery (USA)
D.Leith (USA)
E.Levichev(Russia)
F. Martinez-Vidal (Spain)
P.Raimondi (INFN Italy)
M.Roney (Canada)
G.Wormser (France)

+ Detector Coordinators +Accelerator Coordinators

This committee is in a restructuring phase and will evolve into the International board of representatives.

Super-B Accelerator Contributors for the TRD (J.Seeman @HEPAP DOE May 2009)

D. Alesini, M. E. Biagini, R. Boni, M. Boscolo, A. Clozza, T. Demma, A. Drago, M. Esposito, A.Gallo, S. Guiducci, V. Lollo, G. Mazzitelli, C. Milardi, L. Pellegrino, M. Preger, P. Raimondi, R. Ricci, C. Sanelli, G. Sensolini, M. Serio, F. Sgamma, A. Stecchi, A. Stella, S. Tomassini, C. Vaccarezza, M. Zobov (LNF, Italy)

K. Bertsche, A. Brachmann, Y. Cai, A. Chao, A. DeLira, M. Donald, A. Fisher, D. Kharakh, A.Krasnykh, N. Li, D. MacFarlane, Y. Nosochkov, A. Novokhatski, M. Pivi, J. Seeman, M. Sullivan, U. Wienands, J. Weisend, W. Wittmer, G. Yocky (SLAC, US)

A. Bogomiagkov, S.Karnaev, I. Koop, E. Levichev, S. Nikitin, I. Nikolaev, I. Okunev, P. Piminov, S. Siniatkin, D. Shatilov, V. Smaluk, P. Vobly (BINP, Russia)

G. Bassi, A. Wolski (Cockroft Institute, UK)

S. Bettoni (CERN)

M. Baylac, J. Bonis, R. Chehab, J. DeConto, Gpmez, A. Jaremie, G. Lemeur, B. Mercier, F. Poirier, C. Prevost, C. Rimbault, Tourres, F. Touze, A. Variola (CNRS, France)

A.Chance, O. Napoly (CEA Saclay, France) F. Bosi, E. Paoloni (Pisa)

At present approximate totals:

- 10 FTEs from LNF
- 4.5 FTEs from SLAC
- 3 FTEs from BINP Novosibirsk
- 2.5 FTEs from France
- 0.5 FTEs from Pisa

TDR will be ready by end 2010 with engineering details

Reuse of components

Reuse in SuperB of BABAR and PEPII will be defined soon. About PEPII there was a constructive interactions between INFN management and the SLAC Directorate.

D&D Review last March 23-24 at SLAC.
INFN Board of Director has approved the agreement INFN-DOE concerning the reuse of components.
They will be preserved and before Dec. 31 2009 INFN should confirm the interest about receiving them.

END