Status of SuperB Project

Guy Wormser

LAL Orsay

CERN, December 16 2009

Talk outline

- Brief Physics case for SuperB
- Present SuperB project Status
- The tests in Frascati
- The machine design
- The detector and detector R&D
- Next steps
- Conclusion

Flavour physics in the LHC era

- The main objective is to unravel the flavor structure of the New Physics and the mechanisms causing its specific pattern
- Very good sensitivity to NP thru CP violation asymmetries and rare decays
- Double-prong attack on the quark and lepton sectors

Coupling δ	r=20% today	r=10% tomorrow	r=1% after tomorrow
Order 1	$\Lambda_{eff} \sim 20$ TeV	$\Lambda_{eff} \sim 30$ TeV	$\Lambda_{eff} \sim 100$ TeV
MFV	$\Lambda_{eff} \sim 180$ GeV	$\Lambda_{eff} \sim 250$ GeV	$\Lambda_{eff} \sim 800$ GeV

WHAT IS REALLY STRANGE IS
THAT WE DID NOT SEE ANYTHING….

With masses of New Particles at few hundred GeV effects on measurable quantities should be important

$\Lambda_{eff} <\sim 1$TeV
+ flavour-mixing protected by additional symmetries (as MFV)

Couplings can be still large if $\Lambda_{eff} > 1..10..$TeV

Is there a no-loose theorem?

- In the assumption of a MFV scenario, is the LHC mass range well covered?
- Is the sensitivity in the leptonic sector meaningful in the LHC era?
  - The answer is PROBABLY YES if you can integrate at least 75 ab^{-1} with a Super B machine
- This requires a luminosity in excess of 10^{36} during 5 years

The actors in the next decade

Br $(B \to X_s \gamma)$

Br,ACP $(B \to X_s\, l\, l)$

Br $(B_s \to \mu\mu)$

Br $(K^0 \to \pi^0 \nu\nu)$

β

Br $(B \to \tau\nu\,,\, \mu\upsilon)$

Br $(\mu \to e\, \gamma)$

$(g - 2)_\mu$

Br $(K^+ \to \pi^+ \nu\nu)$

Br $(\tau \to \mu\mu\mu)$

A_{CP} $(B \to X_s \gamma)$

Br $(B \to K\, \nu\nu)$

Br $(B \to K_S \pi^0 \gamma)$

Br $(\tau \to$

μ

ACP$(B_s \to J/\psi\, \phi)$

Which NP will be ??

NMFV (1-3)

MFV

RH-currents

NMFV (2-3)

MFV-GUT

H^+ - high tanβ

Z penguins

LHT Models

B physics @ Y(4S)

Variety of measurements for any observable

Observable	B Factories (2 ab^{-1})	Super$B$ (75 ab^{-1})
$\sin(2\beta)$ $(J/\psi\, K^0)$	0.018	0.005 (†)
$\cos(2\beta)$ $(J/\psi\, K^{*0})$	0.30	0.05
$\sin(2\beta)$ (Dh^0)	0.10	0.02
$\cos(2\beta)$ (Dh^0)	0.20	0.04
$S(J/\psi\, \pi^0)$	0.10	0.02
$S(D^+D^-)$	0.20	0.03
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° (∗)
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°
$2\beta+\gamma$ $(D^{(*)\pm}\pi^\mp$, $D^\pm K^0_S\pi^\mp)$	20°	5°
$S(\phi K^0)$	0.13	0.02 (∗)
$S(\eta' K^0)$	0.05	0.01 (∗)
$S(K^0_S K^0_S K^0_S)$	0.15	0.02 (∗)
$S(K^0_S \pi^0)$	0.15	0.02 (∗)
$S(\omega K^0_S)$	0.17	0.03 (∗)
$S(f_0 K^0_S)$	0.12	0.02 (∗)
$\lvert V_{cb}\rvert$ (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% (∗)

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%
$A_{CP}(B \to K^*\gamma)$	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 (†)
$S(K^0_S\pi^0\gamma)$	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

🟥 Possible also at LHCb

🟥 Similar precision at LHCb

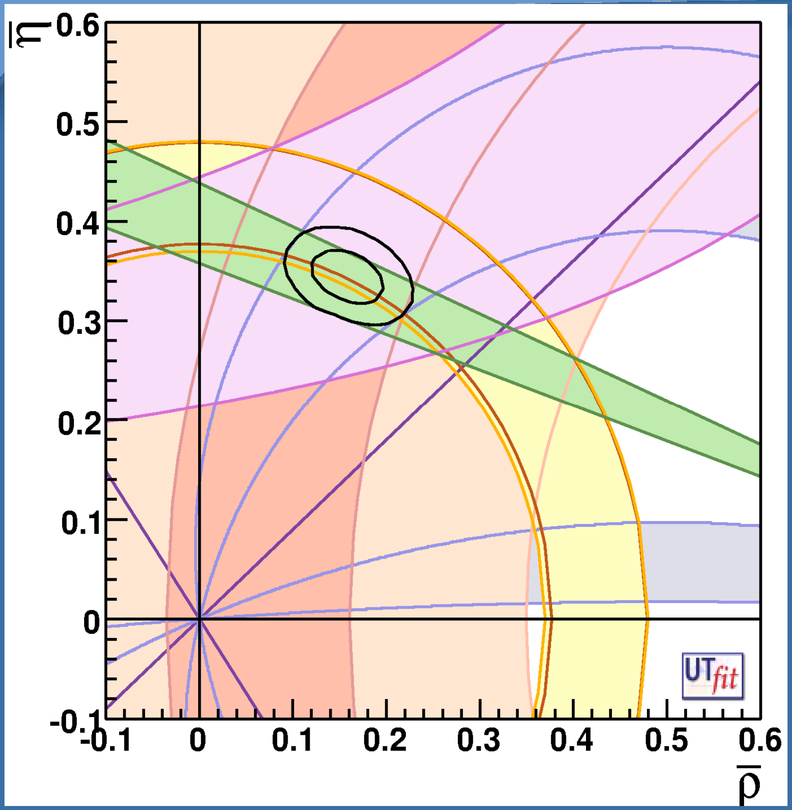
Example of « SuperB specifics »

- inclusive in addition to exclusive analyses

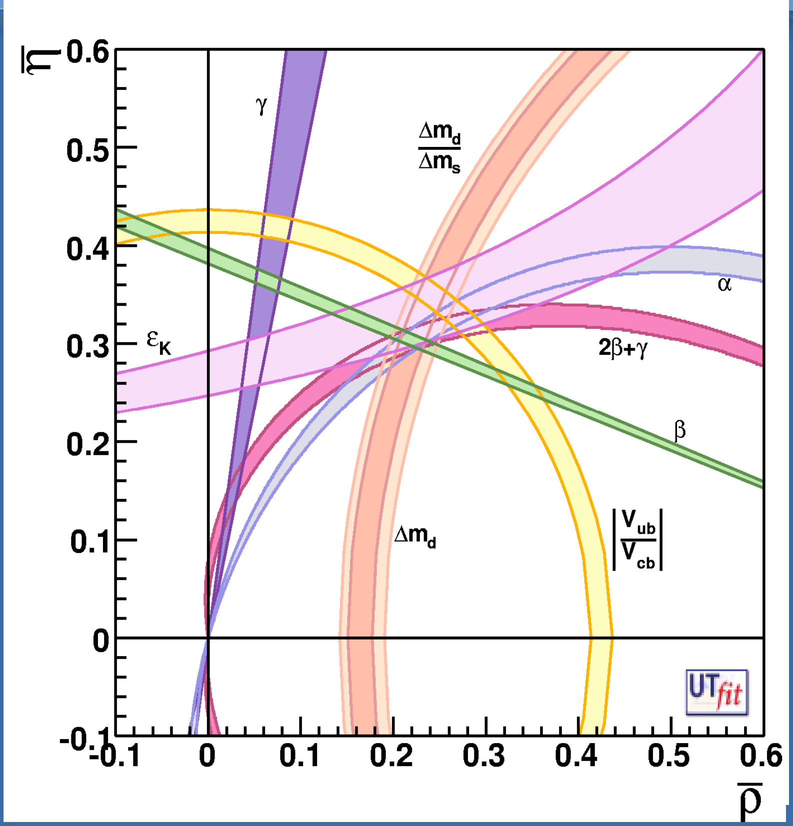
1

Determination of CKM parameters and New Physics

Today



Future (SuperB) + Lattice improvements



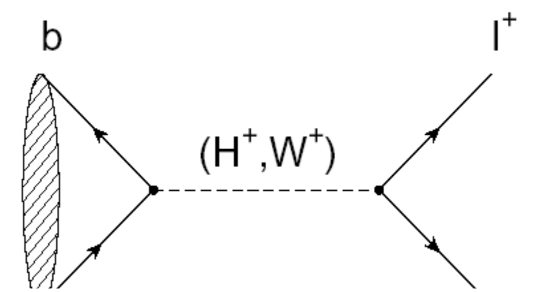
$\rho = 0.163 \pm 0.028$
$\eta = 0.344 \pm 0.016$

Improving CKM is crucial to look for NP

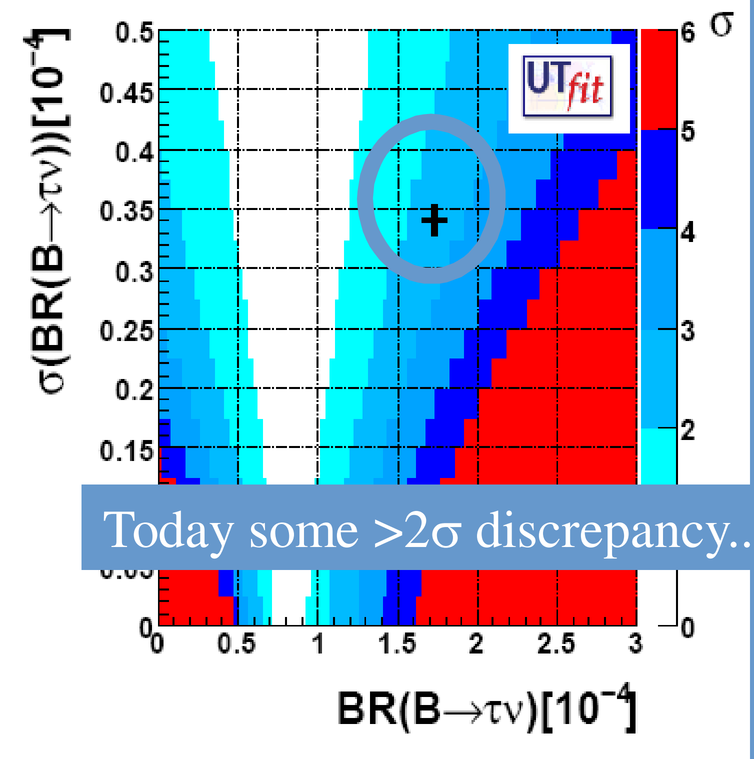
$\rho = \quad \pm 0.0028$
$\eta = \quad \pm 0.0024$

2

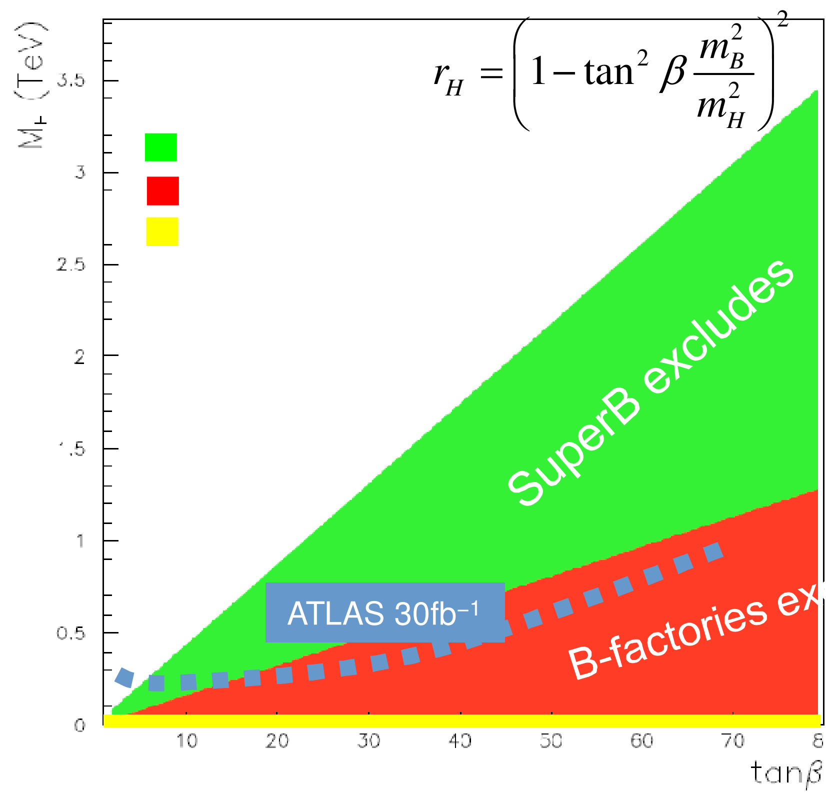
Leptonic decay B → l ν



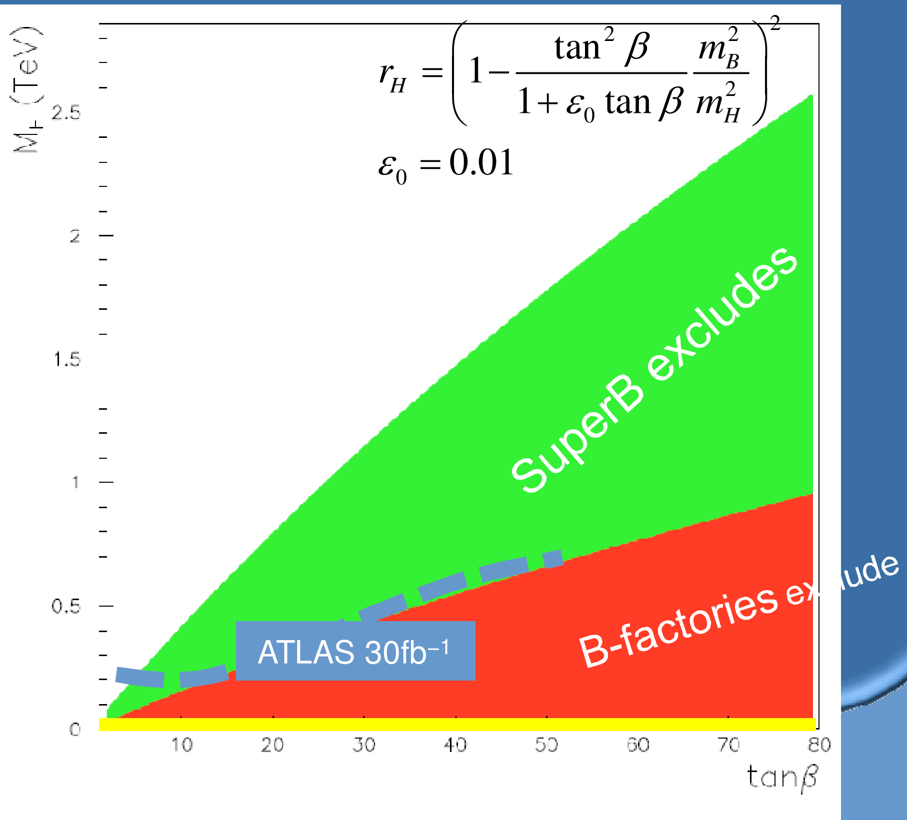
$$\mathrm{BR}(B\to\tau\nu)=\mathrm{BR}_{\mathrm{SM}}(B\to\tau\nu)\left(1-\frac{m_B^2}{M_H^2}\tan^2\beta\right)^2$$



Today some >2σ discrepancy..



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



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

$$\varepsilon_0=0.01$$

3

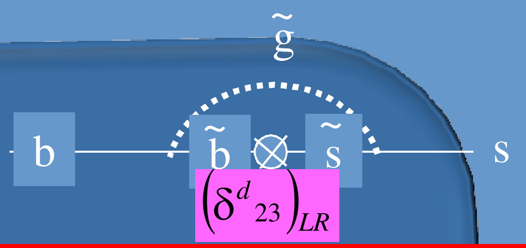
MSSM+generic soft SUSY breaking terms

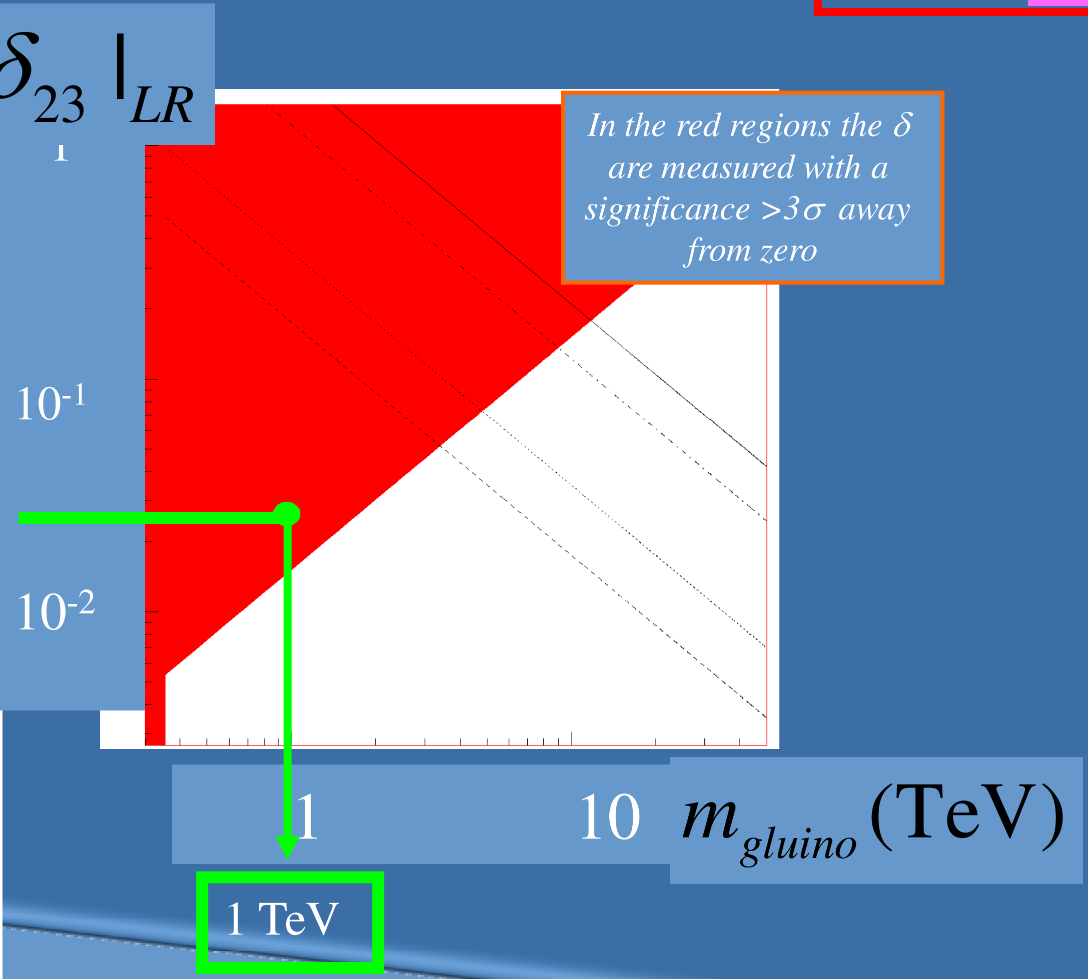
Flavour-changing NP effects in the squark propagator

→ 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)

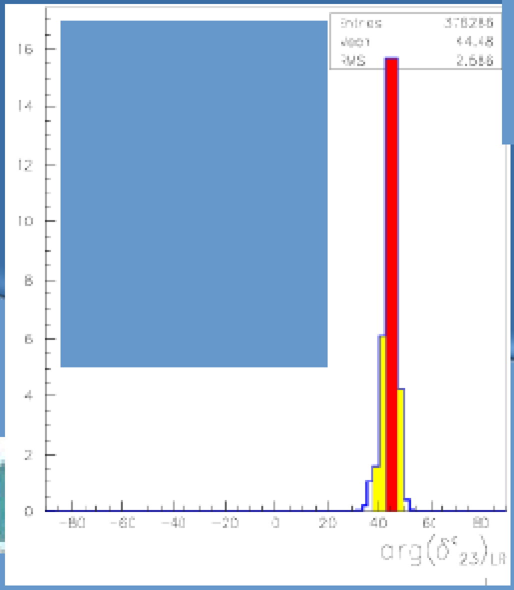




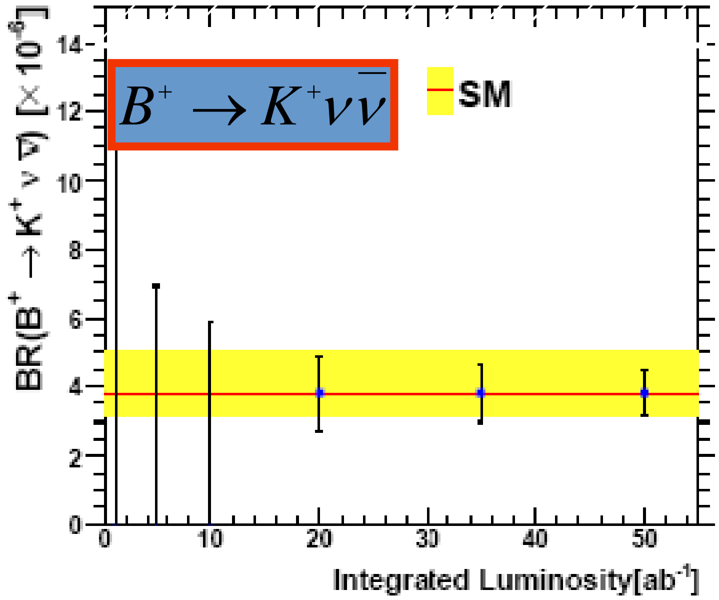
In the red regions the δ are measured with a significance $>3\sigma$ away from zero

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

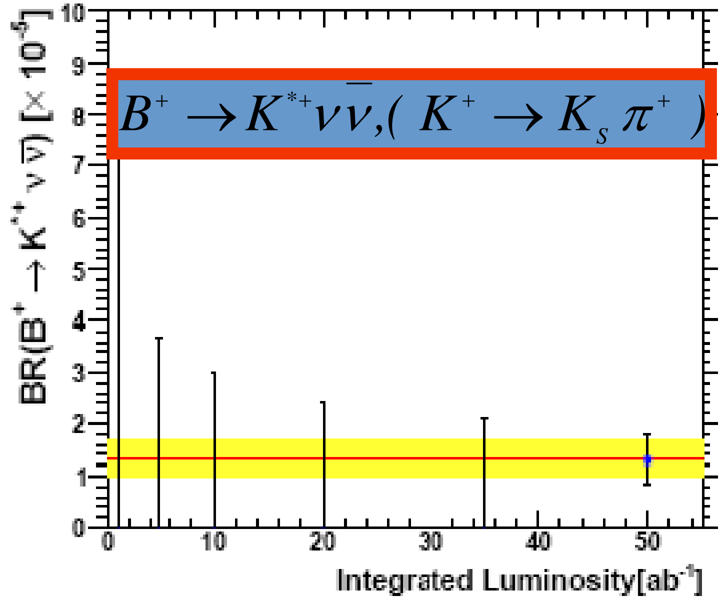
$\mathrm{Arg}(\delta_{23})_{LR}=(44.5 \pm 2.6)^{\circ}$



Br(B → K ν ν) – Z penguins and Right-Handed currents



today

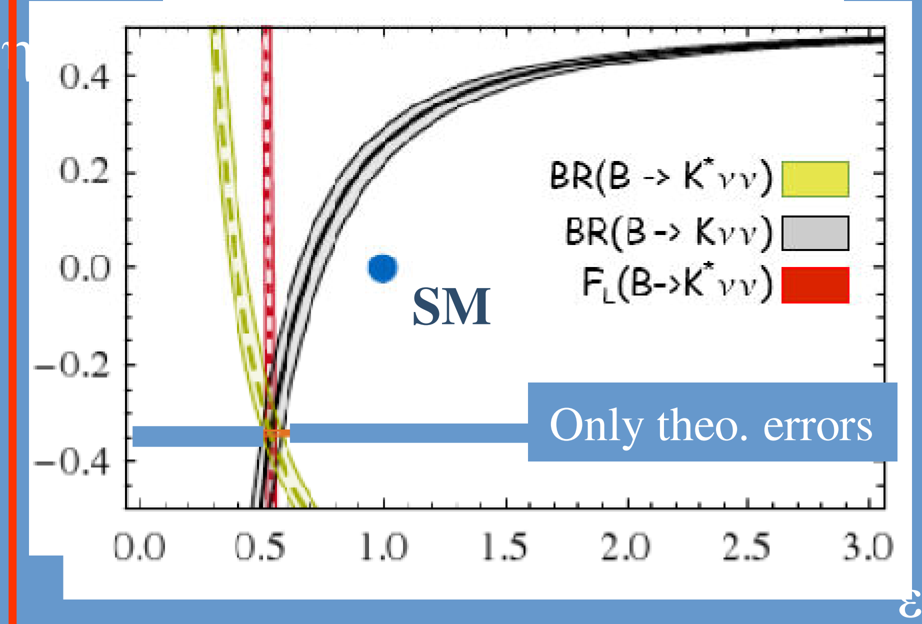


~[20-40] ab^{-1} are needed for observation
>>50ab^{-1} for precise measurement

Altmannshofer et al, arXiv:0902.0160

$$\epsilon = \frac{\sqrt{|C_L^\nu|^2 + |C_R^\nu|^2}}{|(C_L^\nu)^{\mathrm{SM}}|}$$

$$\eta = \frac{-\mathrm{Re}\,(C_L^\nu C_R^{\nu *})}{|C_L^\nu|^2 + |C_R^\nu|^2}$$



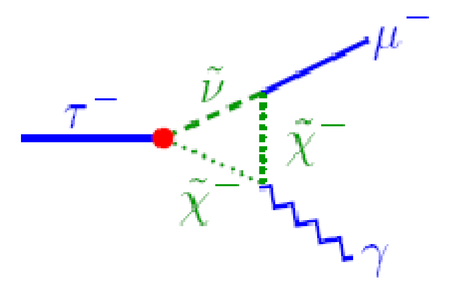
If these quantities are measured @ <~10% deviations from the SM can be observed

Lepton flavor violation (LFV)

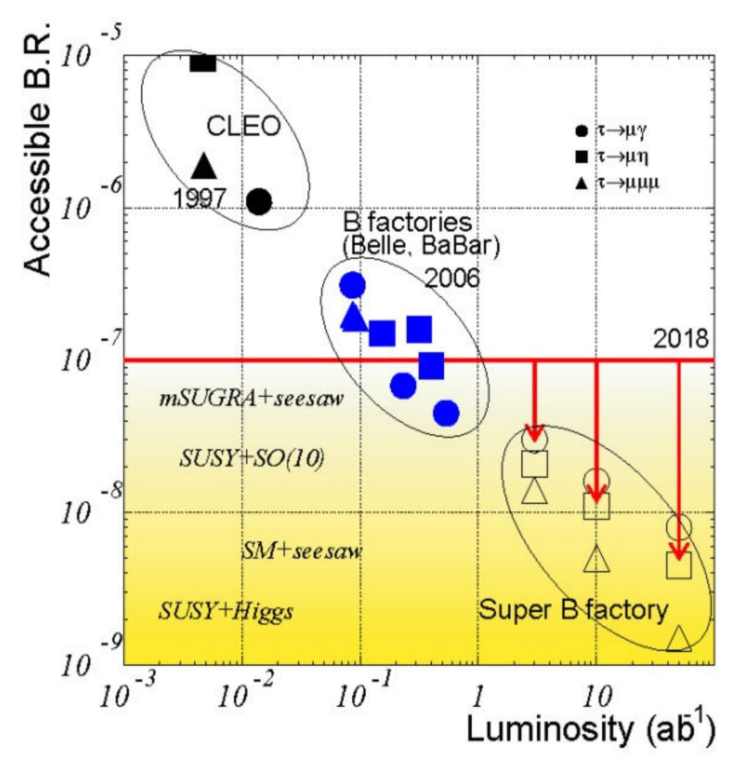
- Lepton flavor violation is unobservably small in the Standard Model
- Neutrino mixing proves that there is neutral LFV
- The next natural question is whether there is charged LFV?
- Will the neutrino pattern be repeated?
  - If so, then LFV will be largest in 3→2 transitions
    - Best bets: $\tau \rightarrow \mu\gamma, \tau \rightarrow \ell\ell\ell$

Lepton Flavour Violation in τ decays

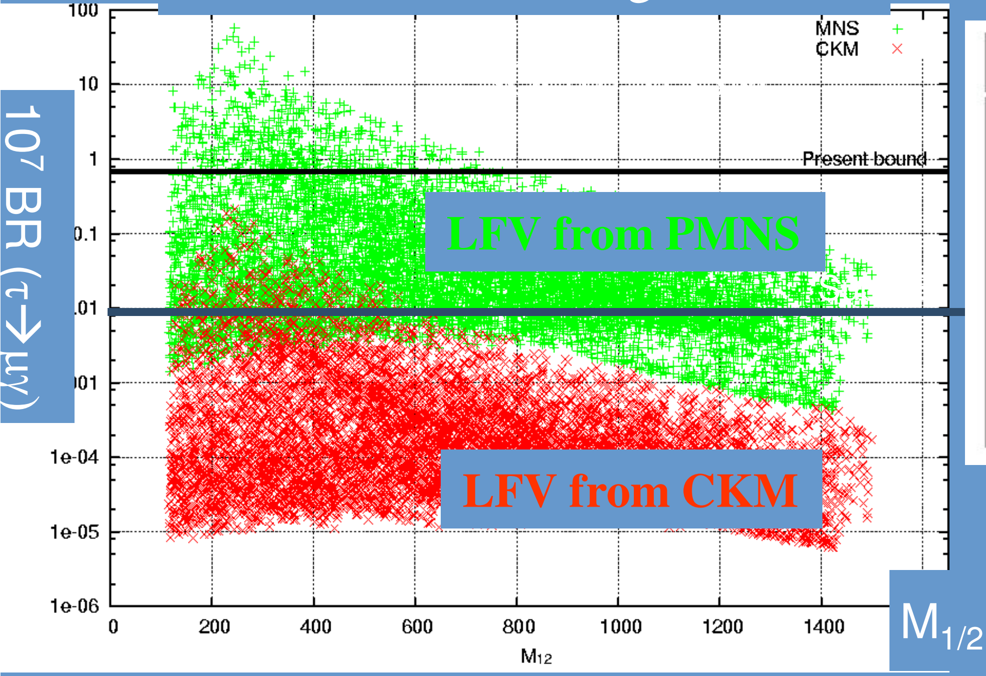
Process	Sensitivity
$\mathcal{B}(\tau \to \mu\gamma)$	2×10^{-9}
$\mathcal{B}(\tau \to e\gamma)$	2×10^{-9}
$\mathcal{B}(\tau \to \mu\mu\mu)$	2×10^{-10}
$\mathcal{B}(\tau \to eee)$	2×10^{-10}
$\mathcal{B}(\tau \to \mu\eta)$	4×10^{-10}
$\mathcal{B}(\tau \to e\eta)$	6×10^{-10}
$\mathcal{B}(\tau \to \ell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



MEG sensitivity μ→eγ ~10-1
Preliminary results < 3 10-



Masurements and origin of LFV



Discrimination between SUSY and LHT

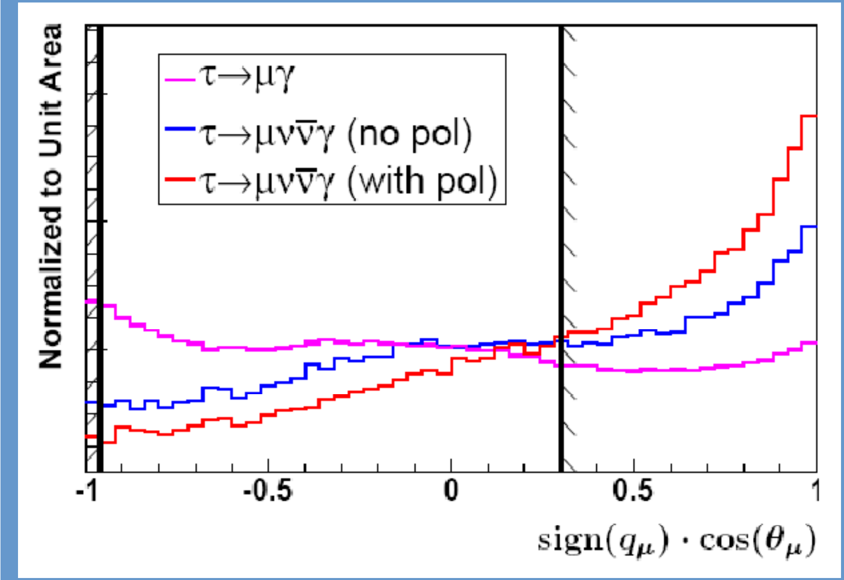
ratio	LHT	MSSM (dipole)	MSSM (Higgs)
$\frac{\mathcal{B}(\tau^- \to e^- e^+ e^-)}{\mathcal{B}(\tau \to e\gamma)}$	0.4 . . . 2.3	$\sim 1 \cdot 10^{-2}$	$\sim 1 \cdot 10^{-2}$
$\frac{\mathcal{B}(\tau^- \to \mu^- \mu^+ \mu^-)}{\mathcal{B}(\tau \to \mu\gamma)}$	0.4 . . . 2.3	$\sim 2 \cdot 10^{-3}$	0.06 . . . 0.1
$\frac{\mathcal{B}(\tau^- \to e^- \mu^+ \mu^-)}{\mathcal{B}(\tau \to e\gamma)}$	0.3 . . . 1.6	$\sim 2 \cdot 10^{-3}$	0.02 . . . 0.04
$\frac{\mathcal{B}(\tau^- \to \mu^- e^+ e^-)}{\mathcal{B}(\tau \to \mu\gamma)}$	0.3 . . . 1.6	$\sim 1 \cdot 10^{-2}$	$\sim 1 \cdot 10^{-2}$
$\frac{\mathcal{B}(\tau^- \to e^- e^+ e^-)}{\mathcal{B}(\tau^- \to e^- \mu^+ \mu^-)}$	1.3 . . . 1.7	~ 5	0.3 . . . 0.5
$\frac{\mathcal{B}(\tau^- \to \mu^- \mu^+ \mu^-)}{\mathcal{B}(\tau^- \to \mu^- e^+ e^-)}$	1.2 . . . 1.6	~ 0.2	5 . . . 10

The ratio τ→ lll / τ→ μγ is not suppressed in
LHT by α_e as in MSSM

Polarized beams

Polarized beam is
(SuperB specific)

LFV analyses :
novel additional handle on backgrounds

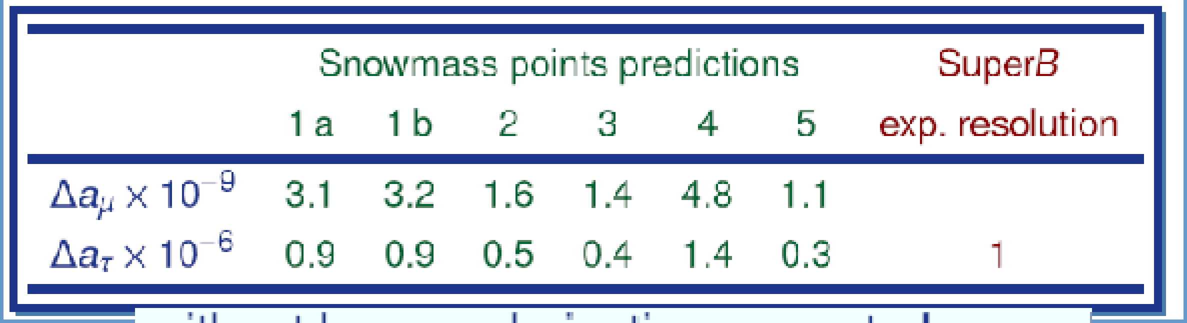


τ anomalous moment **(g-2)**

The anomalous tau momentum influence both the **angular distribution** and the **τ polarization**. Measure the Re(F2) and Im(F2) of the (g-2) from factor

$$\Delta a_\mu = a_\mu^{\mathrm{exp}} - a_\mu^{\mathrm{SM}} \approx (3\pm1)\times10^{-9}$$

$$\Delta a_\tau/\Delta a_\mu \sim m_\tau^2/m_\mu^2 . \xrightarrow{\text{NP effects}} \Delta a_\tau \sim 10^{-6}$$



	Snowmass points predictions						SuperB
	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

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

Polarisation is
- -an important issue for LFV
- -opens the possibility of measuring (g-2)
- -….

Under study

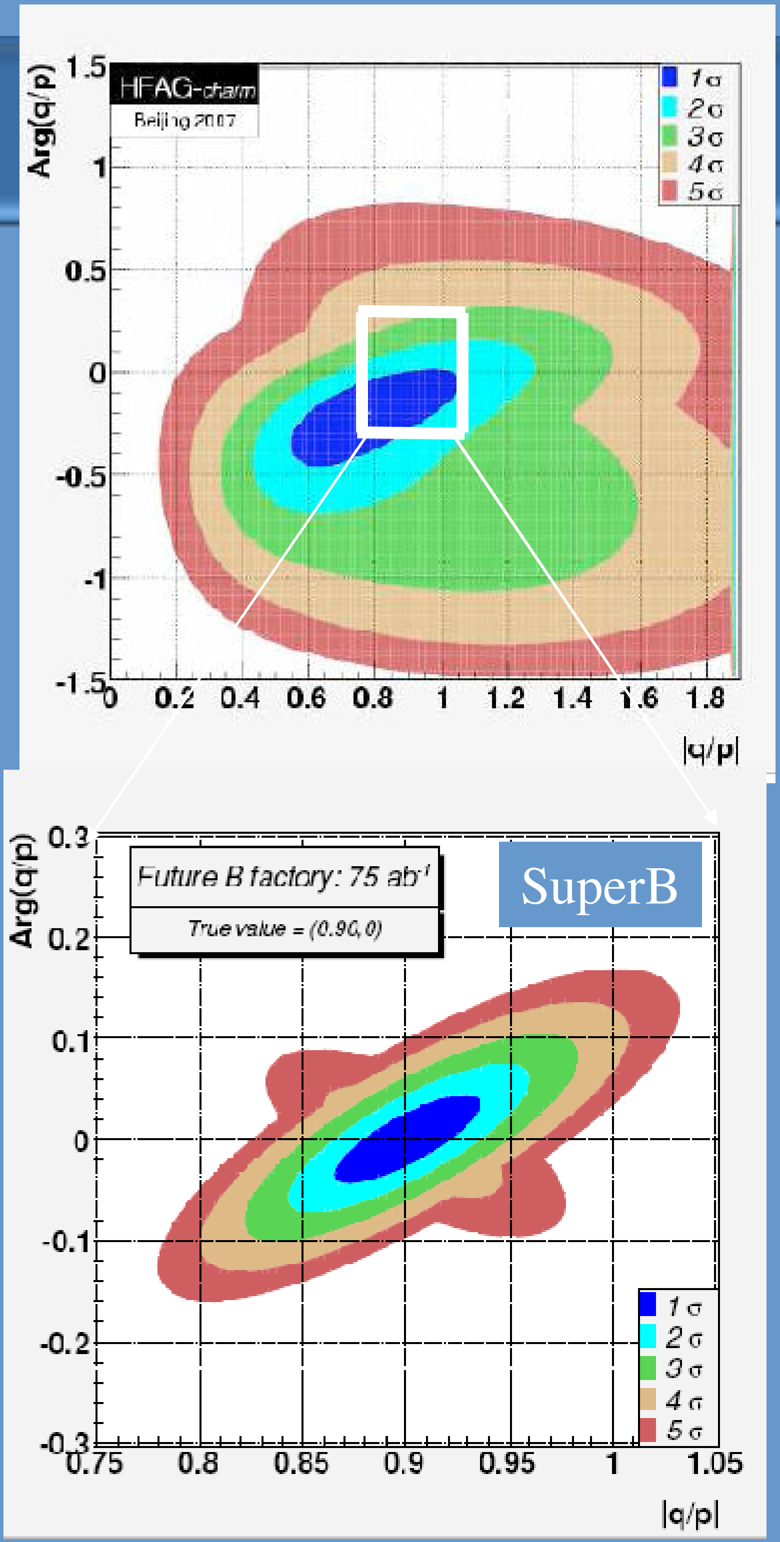
CP Violation in charm

$$\varphi \sim \frac{2\eta A^2 \lambda^5}{\lambda} \sim O(10^{-3})$$

CPV in D system negligible in SM

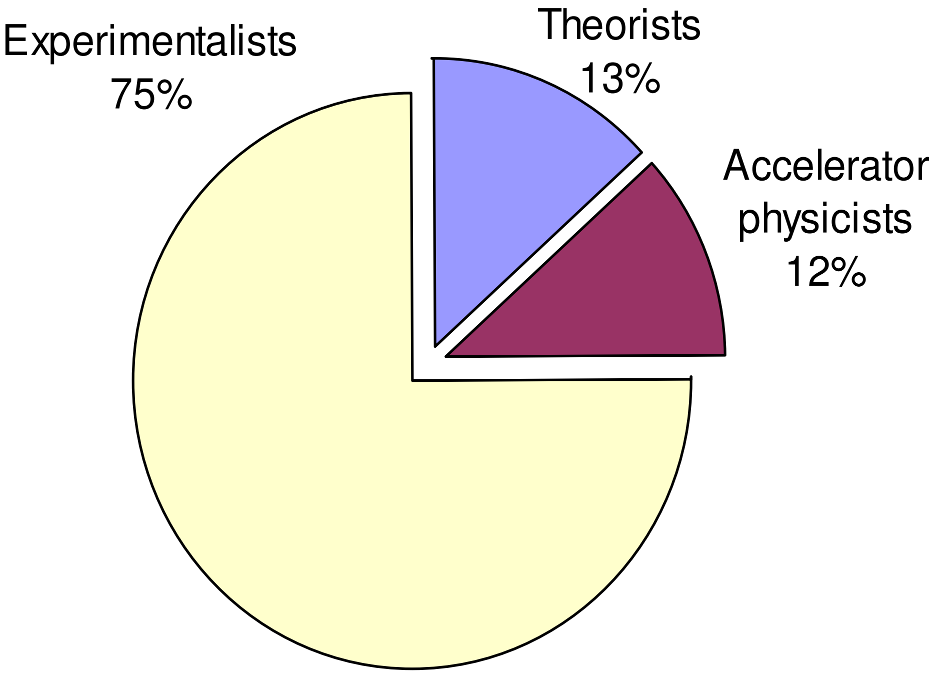
Mode	Observable	$\Upsilon(4S)$ (75 ab^{-1})	$\psi(3770)$ (300 fb^{-1})
$D^0 \to K^+\pi^-$	x'^2	3×10^{-5}	
	y'	7×10^{-4}	
$D^0 \to K^+K^-$	y_{CP}	5×10^{-4}	
$D^0 \to K_S^0\pi^+\pi^-$	x	4.9×10^{-4}	
	y	3.5×10^{-4}	
	$\vert q/p \vert$	3×10^{-2}	
	ϕ	2°	
$\psi(3770) \to D^0\overline{D}^0$	x^2		$(1-2) \times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

CPV in D sector is a clear indication of New Physics !

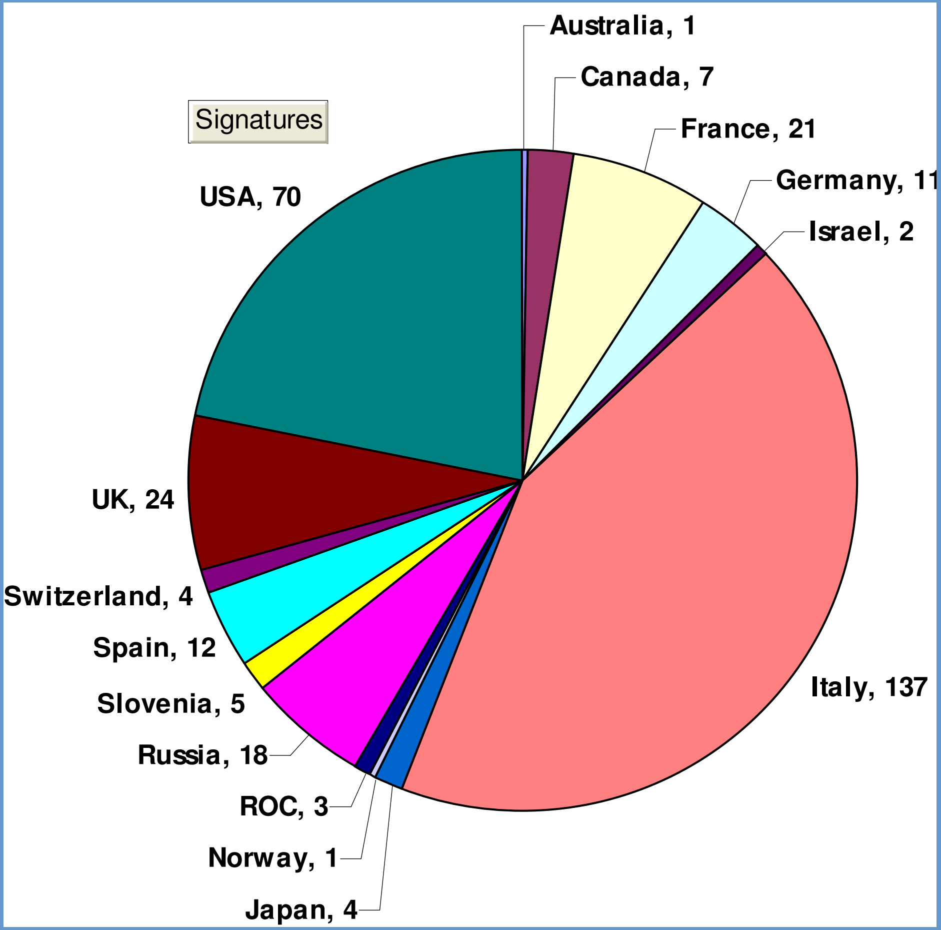


CDR signatures: some numbers

- 320 Signatures
- About 85 institutions
- 174 Babar members
  - 65 non Babar exper.



Signatures breakdown by type



Signatures breakdown by country

The machine :A new “superb” idea!

P. Raimondi’s idea to focus more the beams at IP and have a “large” crossing angle → large Piwinski angle

- Ultra-low emittance (ILC-DR like)
- Very small β at IP
- Large crossing angle
- “Crab Waist” scheme

- Small collision area
- Lower β is possible

- NO parasitic crossings
- NO synchro-betatron resonances due to crossing angle

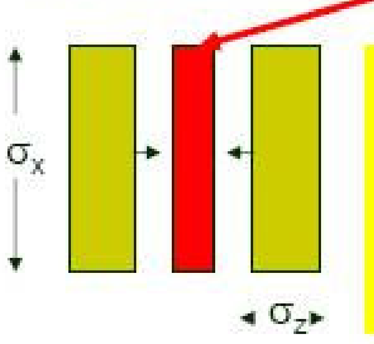
Test started at DAΦNE in November !!!

Large crossing angle, small x-size

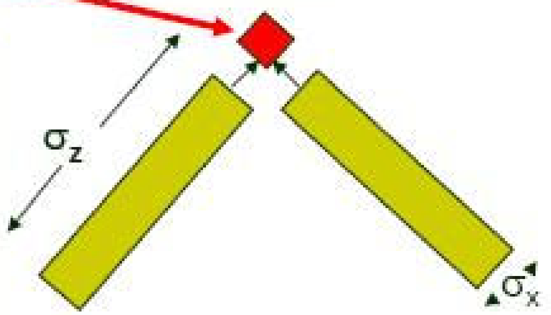
1) Head-on,
Short bunches

Overlap region

2) Large crossing angle,
long bunches



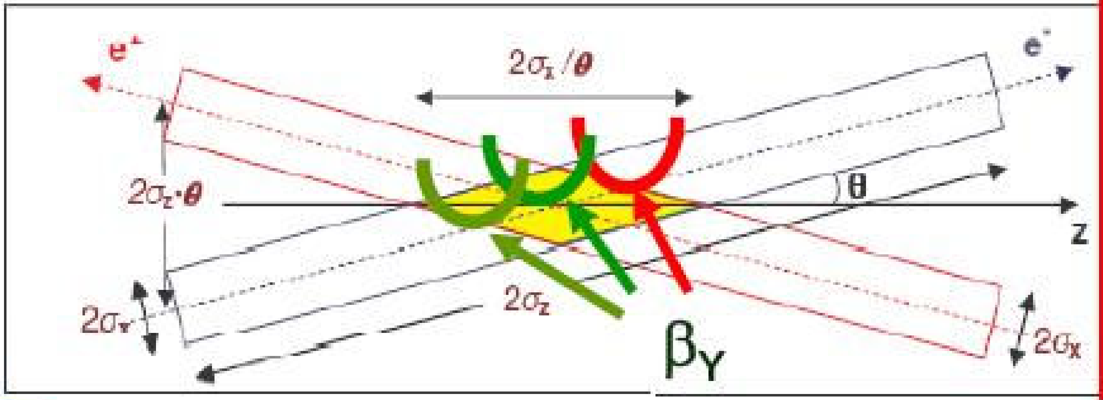
(1) and (2) have same Luminosity, but (2) has longer bunches and smaller σ_x



With large crossing angle the x and z planes are swapped

Large Piwinski angle:

$\Phi = tg(\theta)\sigma_z/\sigma_x$



y waist can be moved along z with a sextupole on both sides of IP at proper phase

⬇

"Crab Waist"

Crab Waist Advantages

1. Large Piwinski's angle

$$\Phi = tg(\theta)\sigma_z/\sigma_x$$

a) Luminosity gain with N

b) Very low horizontal tune shift

2. Vertical beta comparable with overlap area

$$\beta_y \approx \sigma_x/\theta$$

a) Geometric luminosity gain

b) Lower vertical tune shift

c) Vertical tune shift decreases with oscillation amplitude

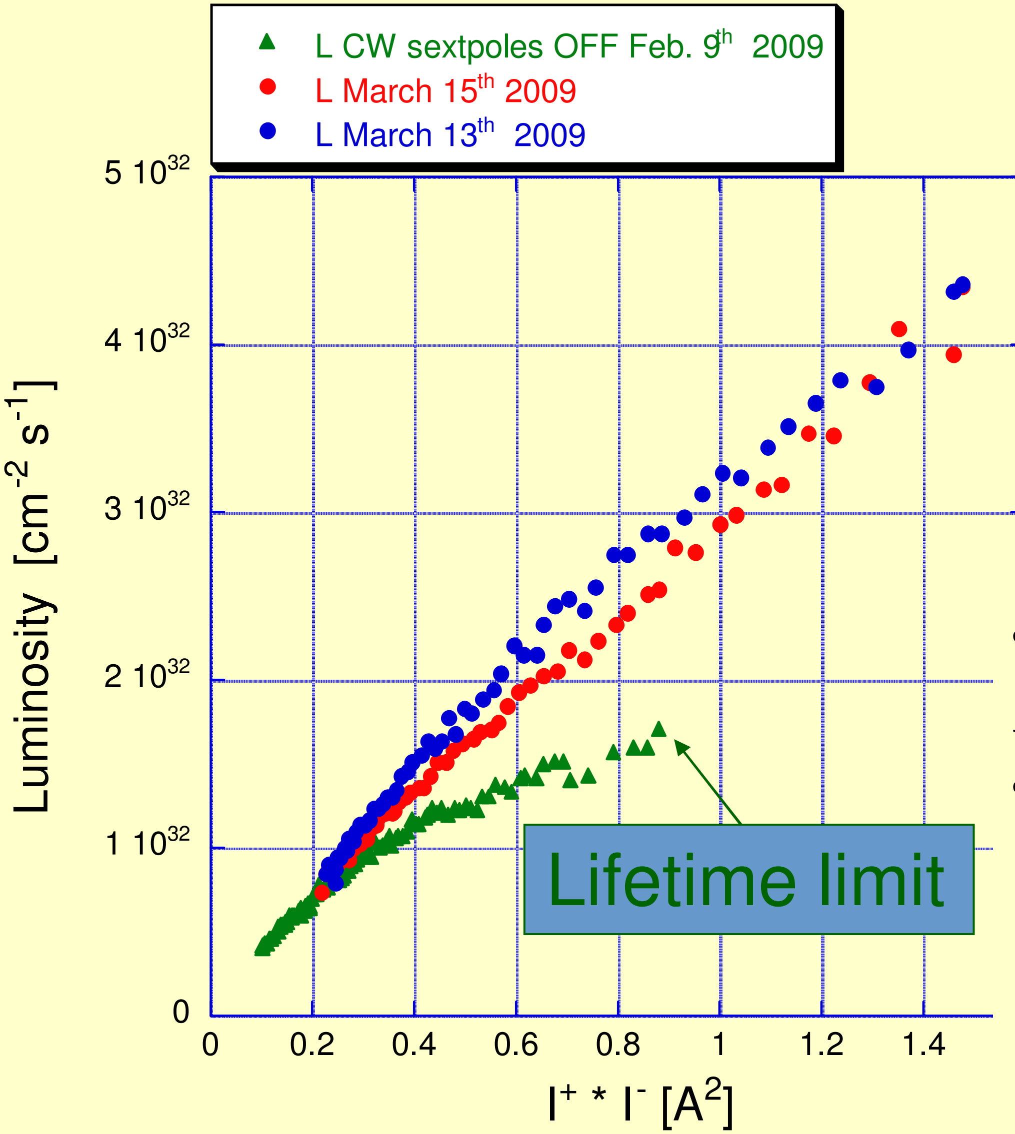
d) Suppression of vertical synchro-betatron resonances

3. Crabbed waist transformation

$$y = xy'/(2\theta)$$

a) Geometric luminosity gain

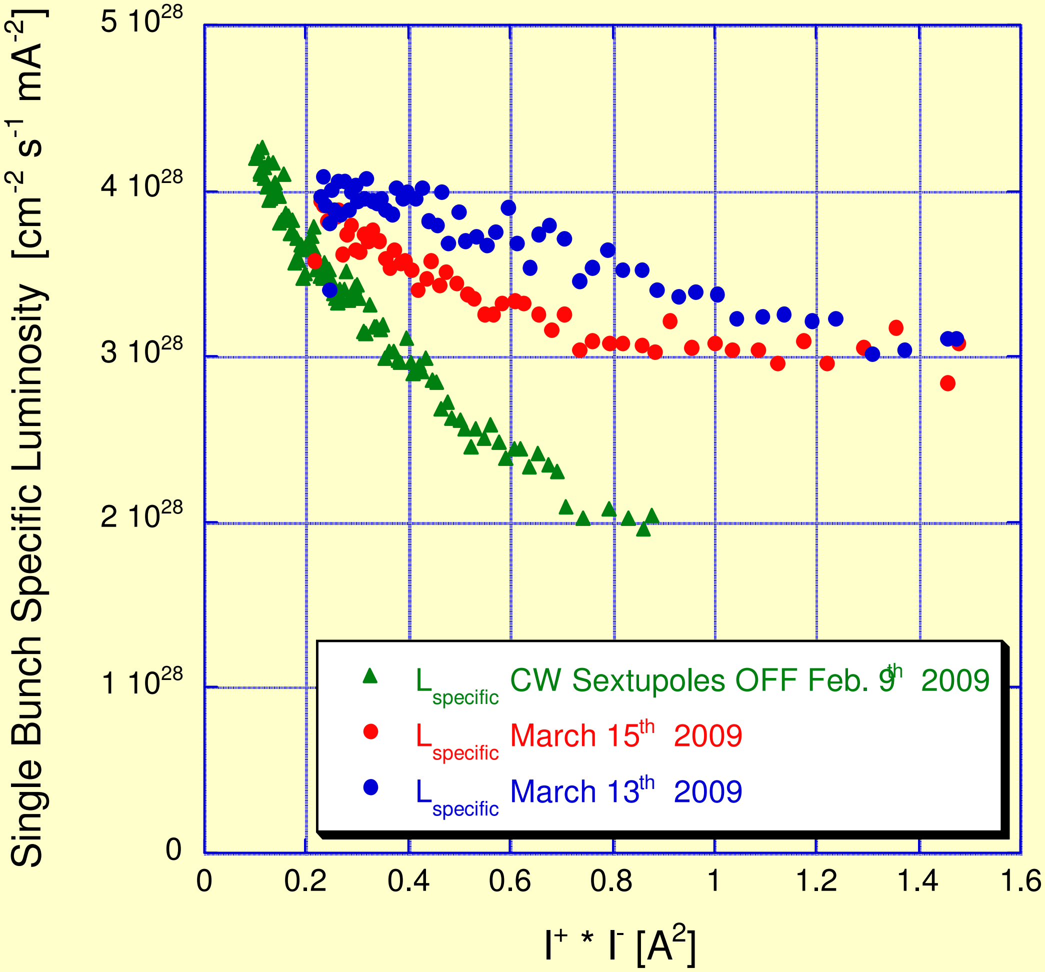
b) Suppression of X-Y betatron and synchro-betatron resonances



Lifetime limit

Crab on/off Luminosity vs Current Product

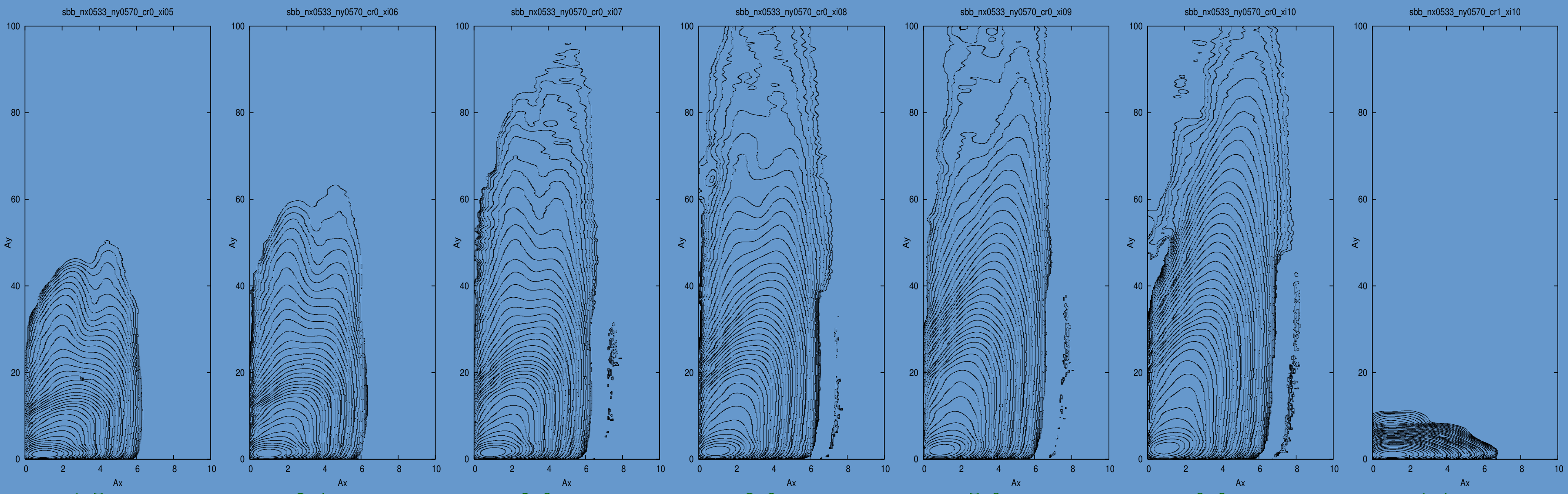
Crab on/off Specific Luminosity vs Current Product



Beam Blowup and Tails in SuperB

Bunch Current

0.5 0.6 0.7 0.8 0.9 1.0 1.0 + crab

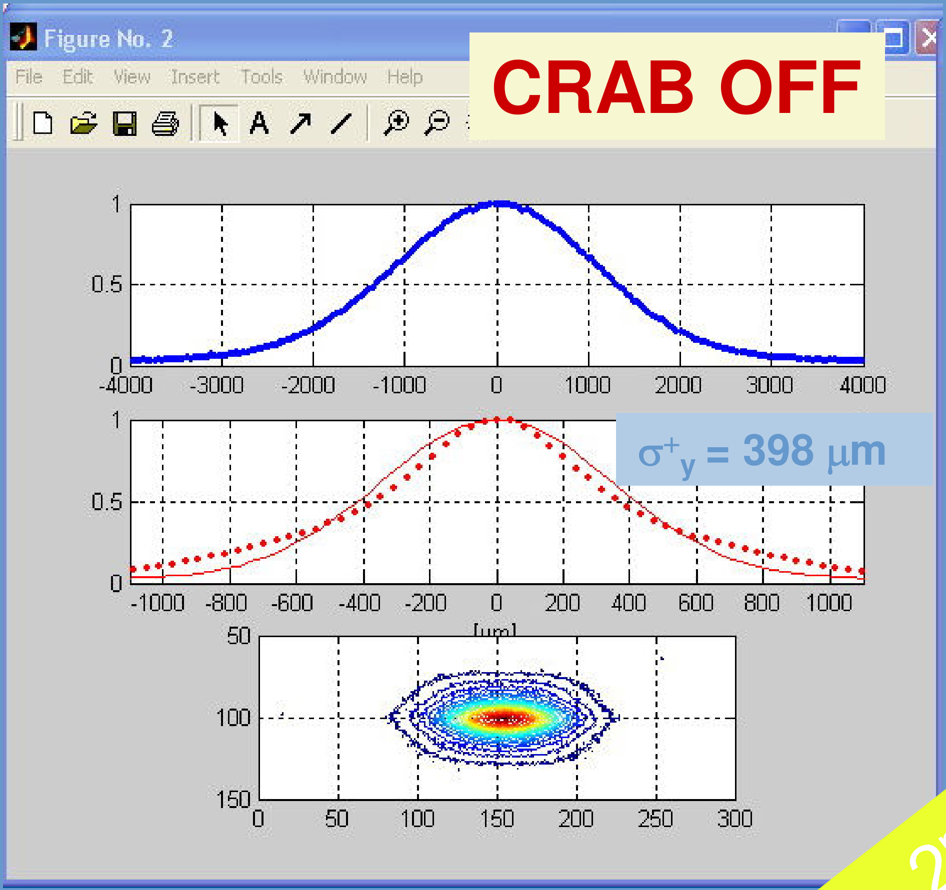


1.5 2.1 2.9 3.9 5.0 6.6 1.1

Crab Sextupoles Off

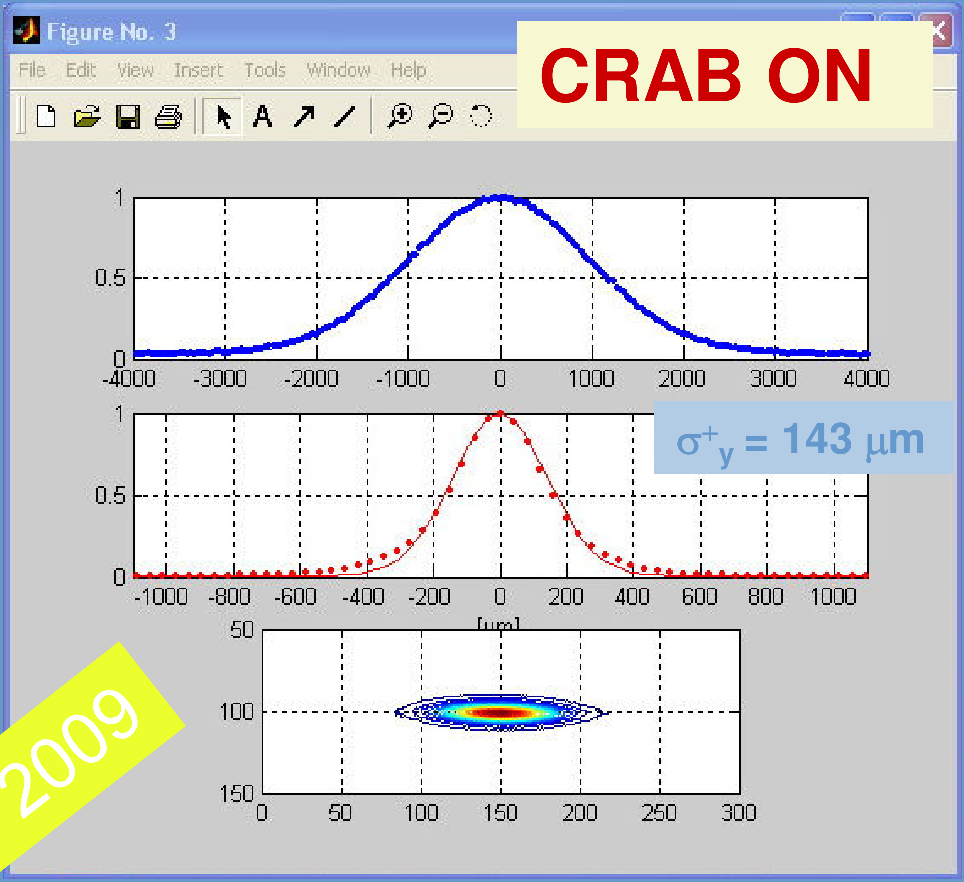
Crab Sextupoles On

Transverse Beam Profile Measurements



CRAB OFF

$\sigma^+_y = 398\ \mu m$



CRAB ON

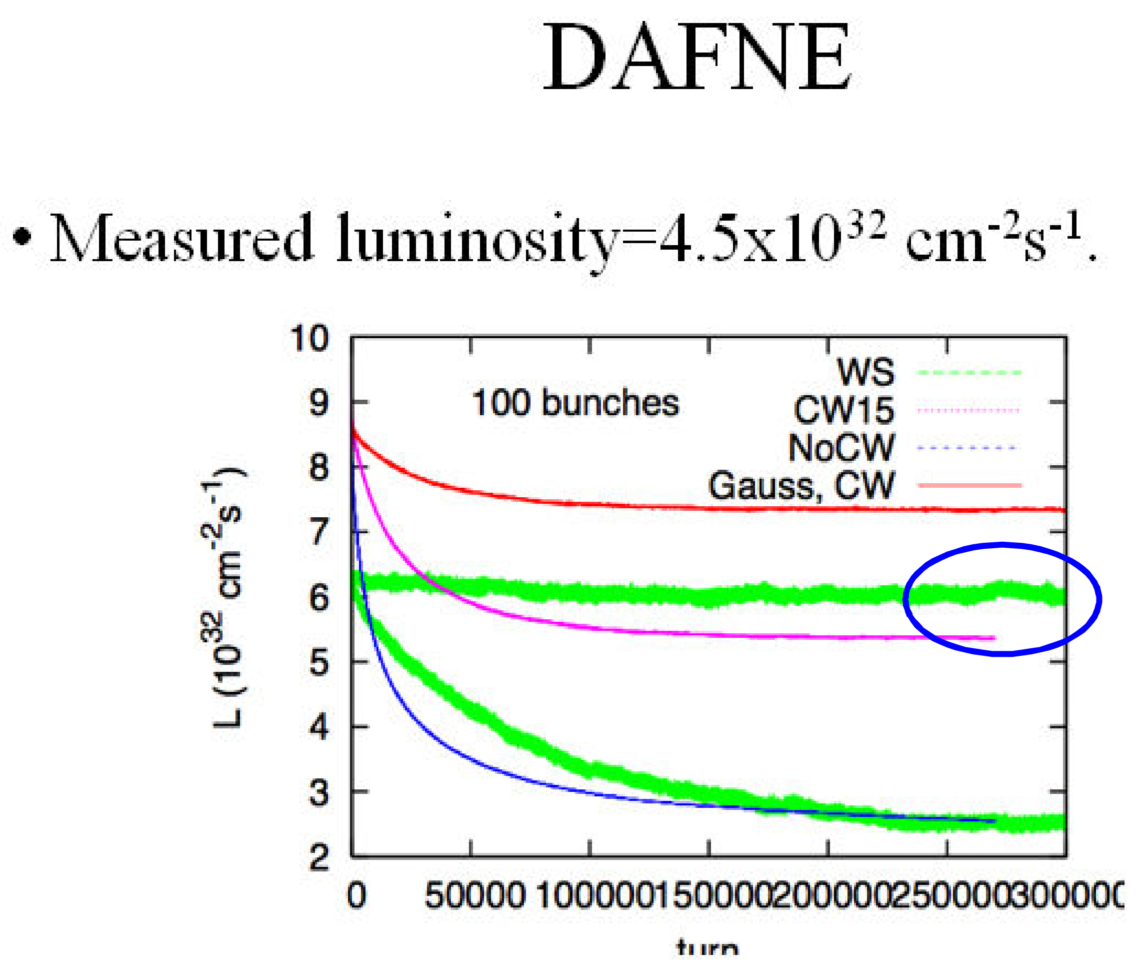
$\sigma^+_y = 143\ \mu m$

Nov. 2nd 2009

103 colliding bunches

Beam-Beam Simulation of DAFNE (Ohmi)

-



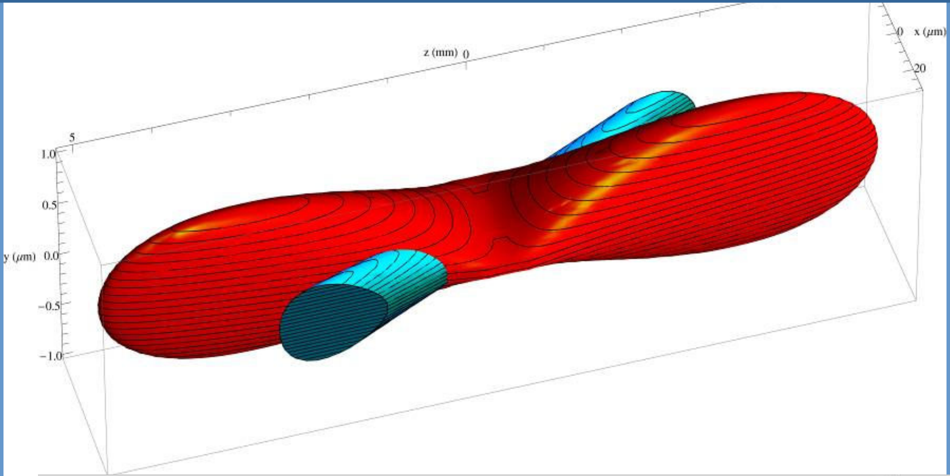
DAFNE

- Measured luminosity=4.5x10^{32} cm^{-2}s^{-1}.

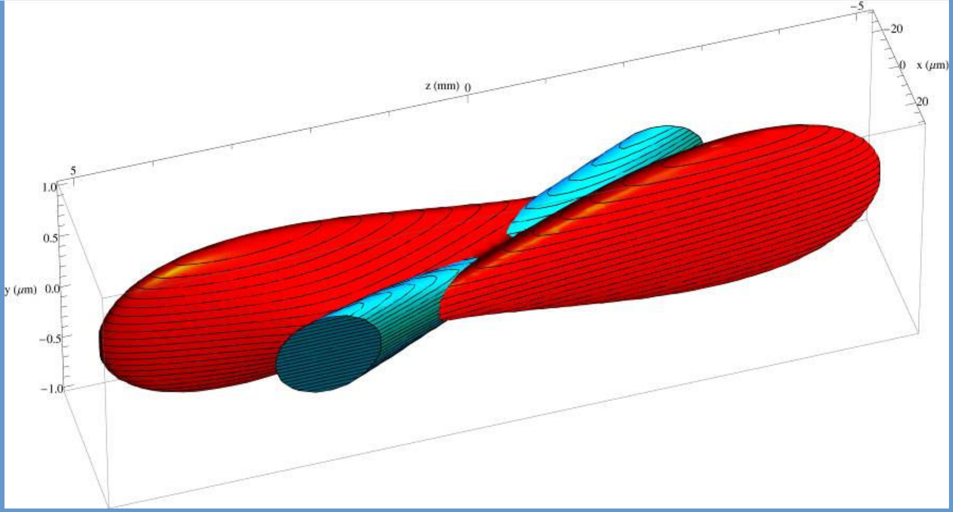
(Fall 2008)

Beams distribution at IP

E. Paoloni



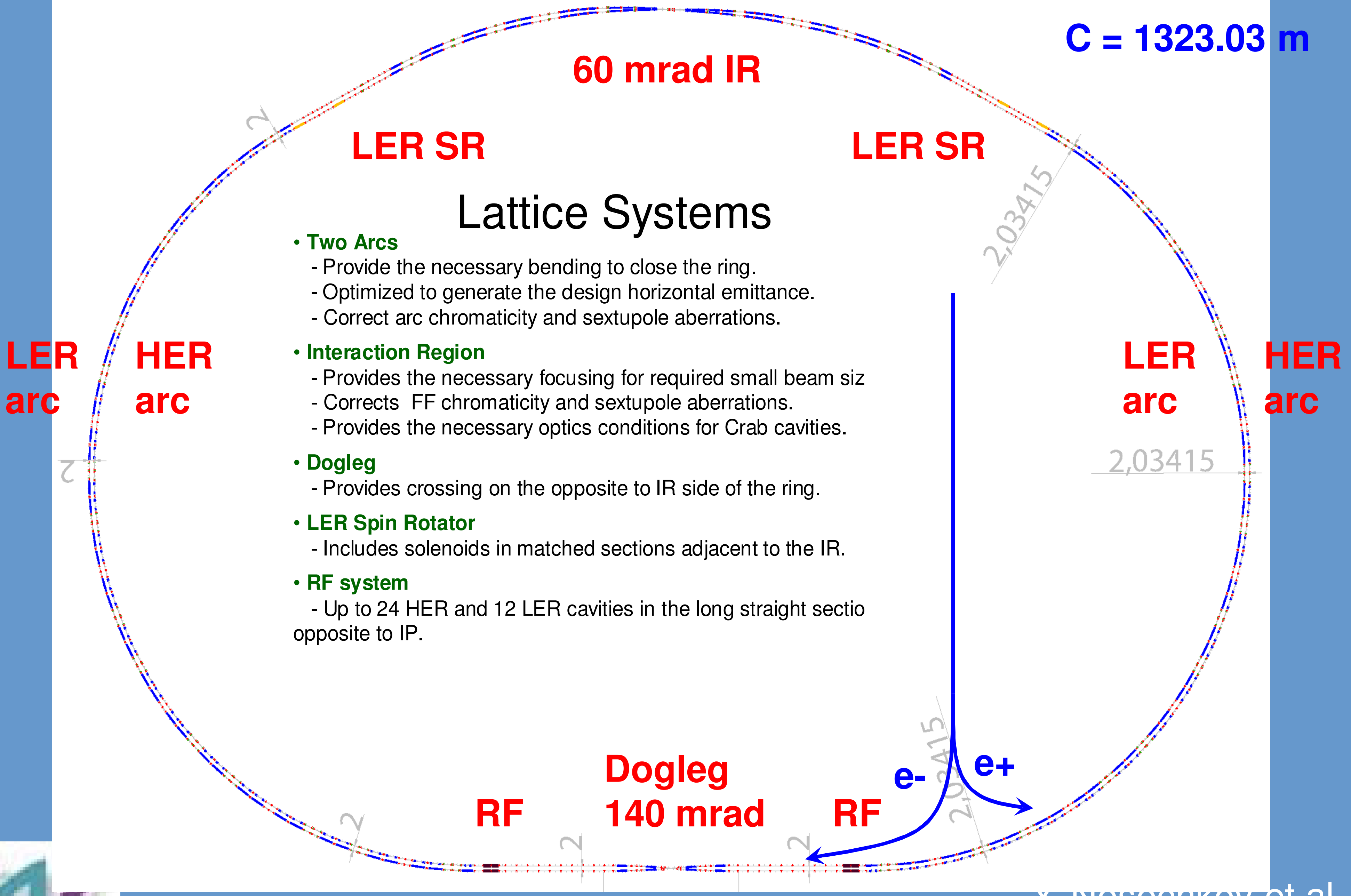
Without
Crab-sextupoles



With
Crab-sextupoles

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

Latest Ring Layout



Lattice Systems

- **Two Arcs**
  - Provide the necessary bending to close the ring.
  - Optimized to generate the design horizontal emittance.
  - Correct arc chromaticity and sextupole aberrations.
- **Interaction Region**
  - Provides the necessary focusing for required small beam siz
  - Corrects FF chromaticity and sextupole aberrations.
  - Provides the necessary optics conditions for Crab cavities.
- **Dogleg**
  - Provides crossing on the opposite to IR side of the ring.
- **LER Spin Rotator**
  - Includes solenoids in matched sections adjacent to the IR.
- **RF system**
  - Up to 24 HER and 12 LER cavities in the long straight sectio opposite to IP.

Y. Nosochkov et al.

Parameters flexibility (1)

Seeman

- Parameters adjusted to achieve 10^{36} in several ways:
  - Vertical emittance in HER and LER larger by x4
  - β_y^* larger by 40% in both rings
  - Vertical emittance and by* larger by 40% in both rings
  - Emittance x and y larger by 40%
  - Vertical tune shift lowered from 0.117 to 0.09

- Assume maximum currents are 3.5 A in both rings as suggested by Novokhatski and Bertsche

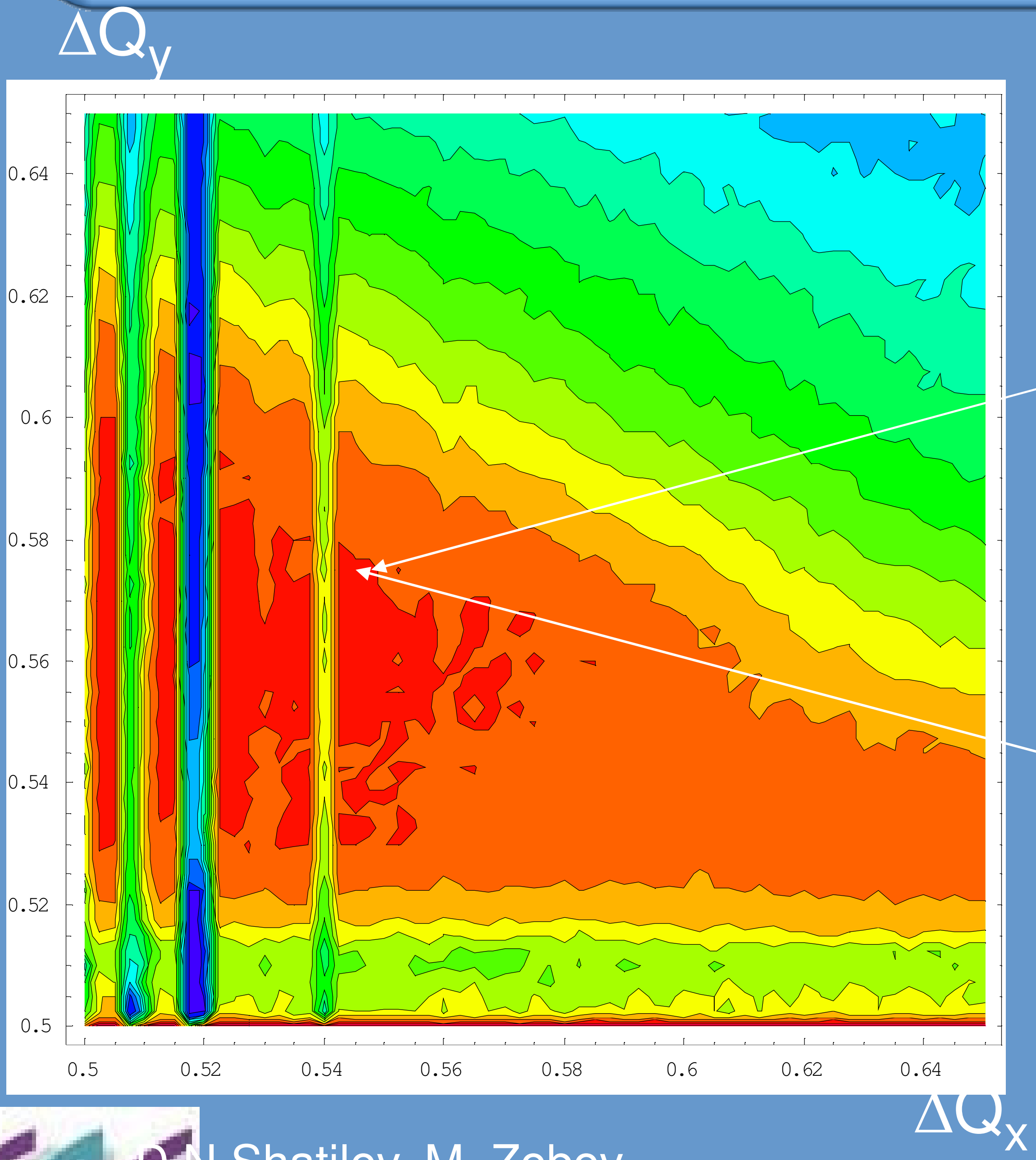
- Beam energies possibilities (larger boost):
  - 4.18/6.71
  - 4.0/7.0 (not good for polarization)
  - 3.85/7.27
  - 3.75/7.5
  - 3.5/8

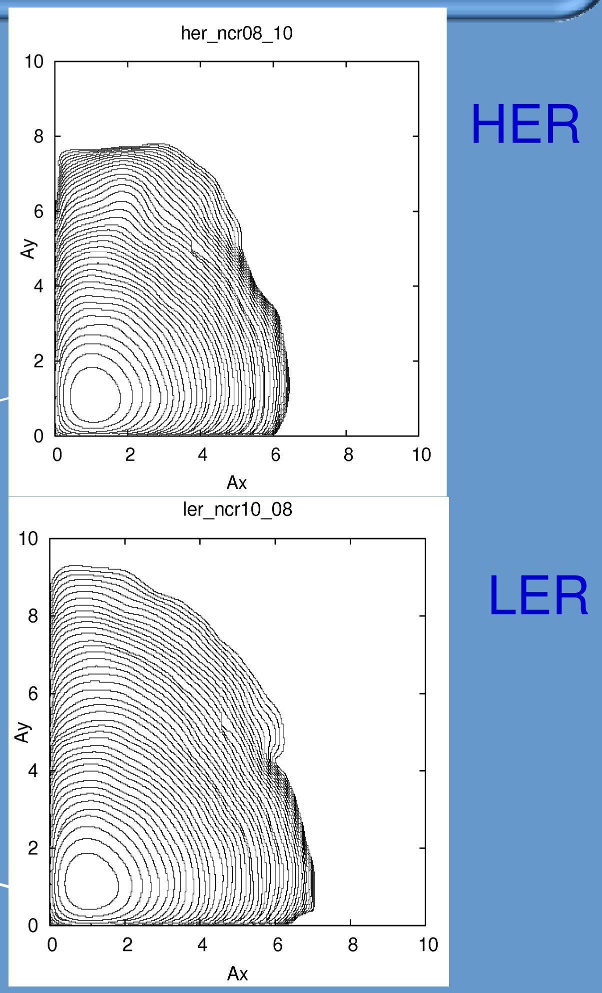
Parameters flexibility (2)

Seeman

- Many parameter possibilities for 10^{36} are available keeping the beam current below 3.5 A with the nominal at 2.1 A
- Varying the beam energies modestly to get more boost keeps the luminosity about constant but the RF power increases at fixed beam currents from 12 to 19 MW (and IBS gets more crucial in LER)

SuperB Luminosity Tune Scan



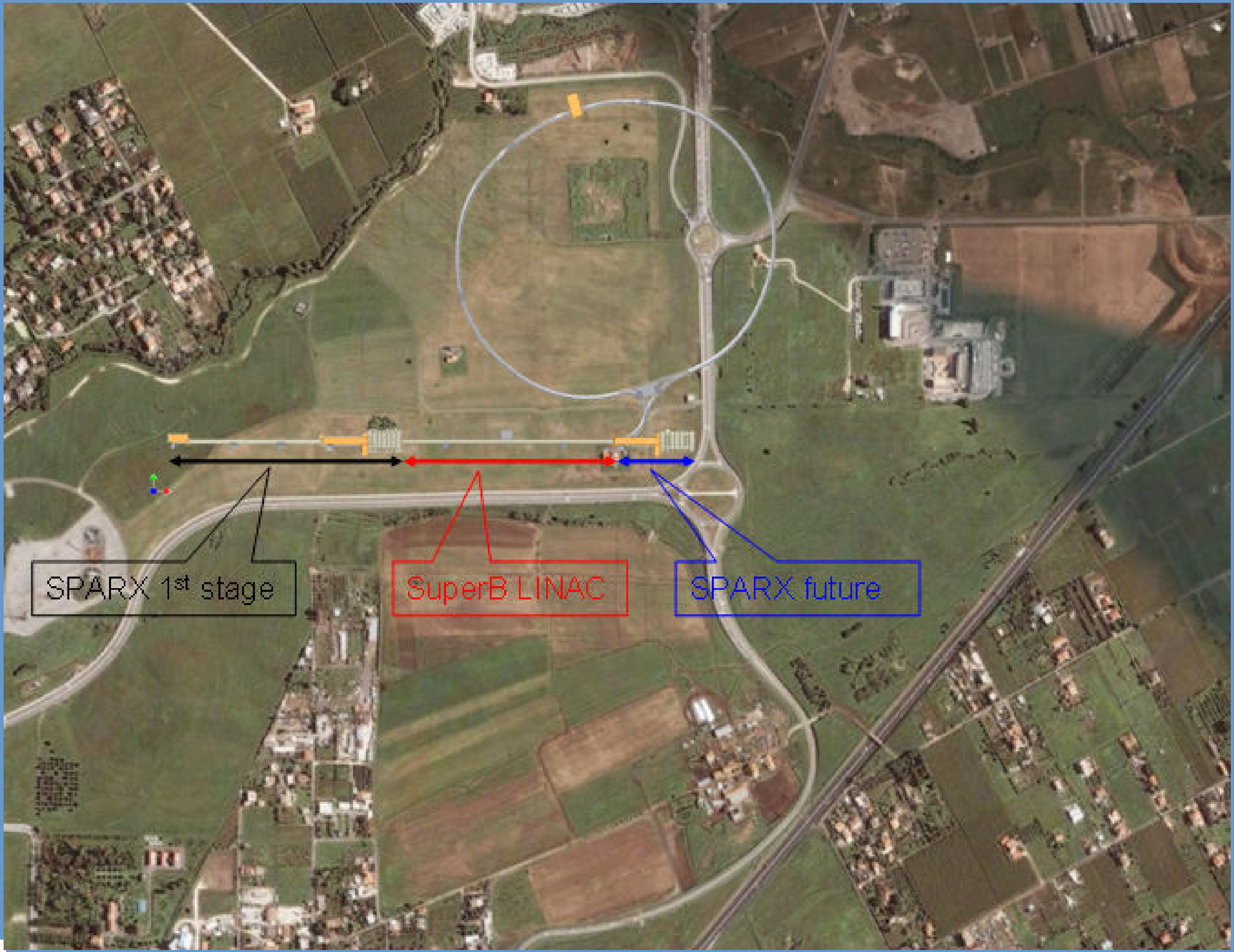


Tunes: (0.542, 0.580, 0.01)
$N_p = 5.74 \cdot 10^{10}$; $N_b = 1011$

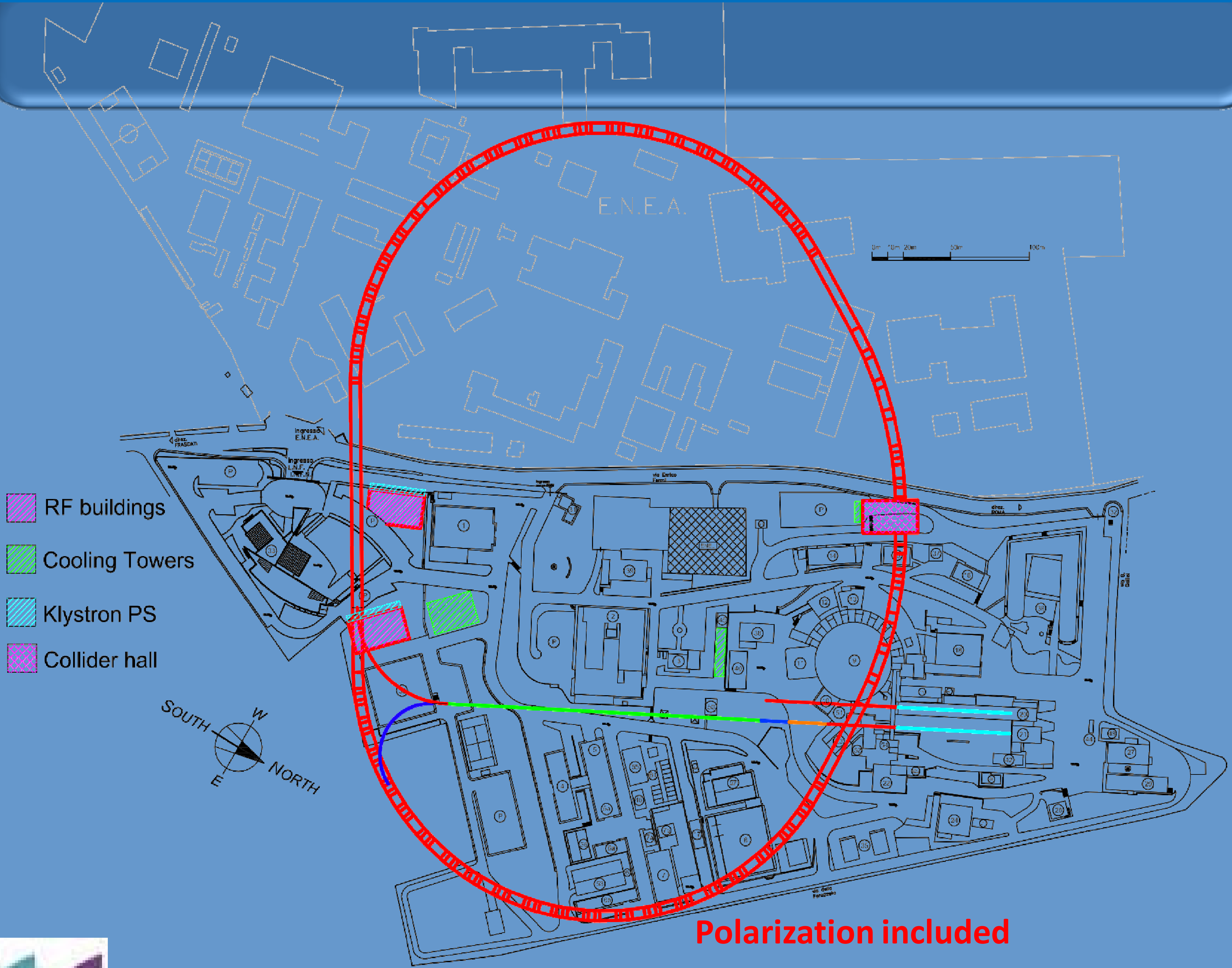
$L = 1.07 \times 10^{36}\ \mathrm{cm}^{-2}\mathrm{s}^{-1}$

D.N.Shatilov, M. Zobov

Tor Vergata Site



SuperB Site independent now can fit also @ LNF



Polarization included

1st Geological Survey

Soil Samples at point 4

FOTO SONDAGGIO S4

Da 0 a 5 metri

Da 5 a 10 metri

Da 10 a 15 metri

Da 15 a 20 metri

Da 20 a 25 metri

Da 25 a 30 metri

Sede legale ed amministrativa:
Via Giovanni Reich, n° 6 – 24020 Torre Boldone (BG)
tel. 035-19951935-- fax. 035-19951936

C.F. 01972080343
P.IVA 02852210166

1 di 2

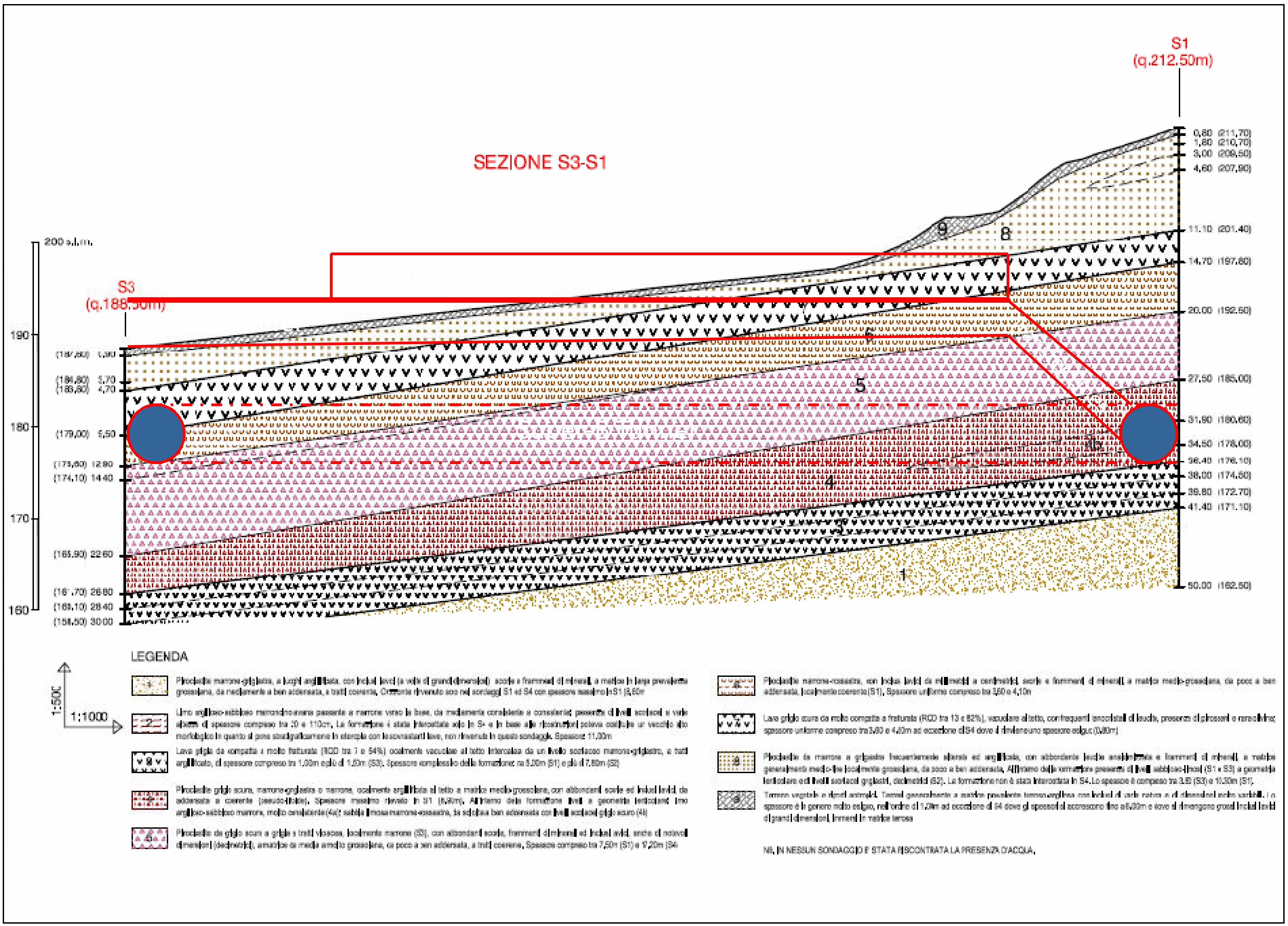
Da 30 a 35 metri

Da 35 a 40 metri

Da 40 a 45 metri

Da 45 a 50 metri

1st Geological Survey



LEGENDA

1 — Piroclastite marrone-grigiastra, a luoghi argillificata, con inclusi lavici (a volte di grandi dimensioni), scorie e frammenti di minerali, a matrice in larga prevalenza grossolana, da mediamente a ben addensata, a tratti coerente. Orizzonte rinvenuto solo nei sondaggi S1 ed S4 con spessore massimo in S1 (3,60m

2 — Limo argilloso-sabbioso marroncino-avana passante a marrone verso la base, da mediamente consistente a consistente; presenza di livelli scoriacei a varie altezze di spessore compreso tra 20 e 110cm. La formazione è stata intercettata solo in S4 e in base alle ricostruzioni poteva costituire un vecchio alto morfologico in quanto si pone stratigraficamente in eteropia con le sovrastanti lave, non rinvenute in questo sondaggio. Spessore 11,00m

3 — Lava grigia da compatta a molto fratturata (RQD tra 1 e 54%) localmente vacuolare al tetto. Intercalata da un livello scoriaceo marrone-grigiastro, a tratti argillificato, di spessore compreso tra 1,00m e più di 1,60m (S3). Spessore complessivo della formazione: tra 5,00m (S1) e più di 7,80m (S2)

4 — Piroclastite grigio scura, marrone-grigiastra o marrone, localmente argillificata al tetto a matrice medio-grossolana, con abbondanti scorie ed inclusi lavici, da addensata a coerente (pseudo-litoide). Spessore massimo rilevato in S1 (6,90m). All'interno della formazione livelli a geometria lenticolare: limo argilloso-sabbioso marrone, molto consistente (4a); sabbia limosa marrone-rossastra, da sciolta a ben addensata con livelli scoriacei grigio scuro (4)

5 — Piroclastite da grigio scura a grigia a tratti violacea, localmente marrone (S2), con abbondanti scorie, frammenti di minerali ed inclusi lavici, anche di notevoli dimensioni (decimetrici), a matrice da media a molto grossolana, da poco a ben addensata, a tratti coerente. Spessore compreso tra 7,50m (S1) e 17,20m (S4

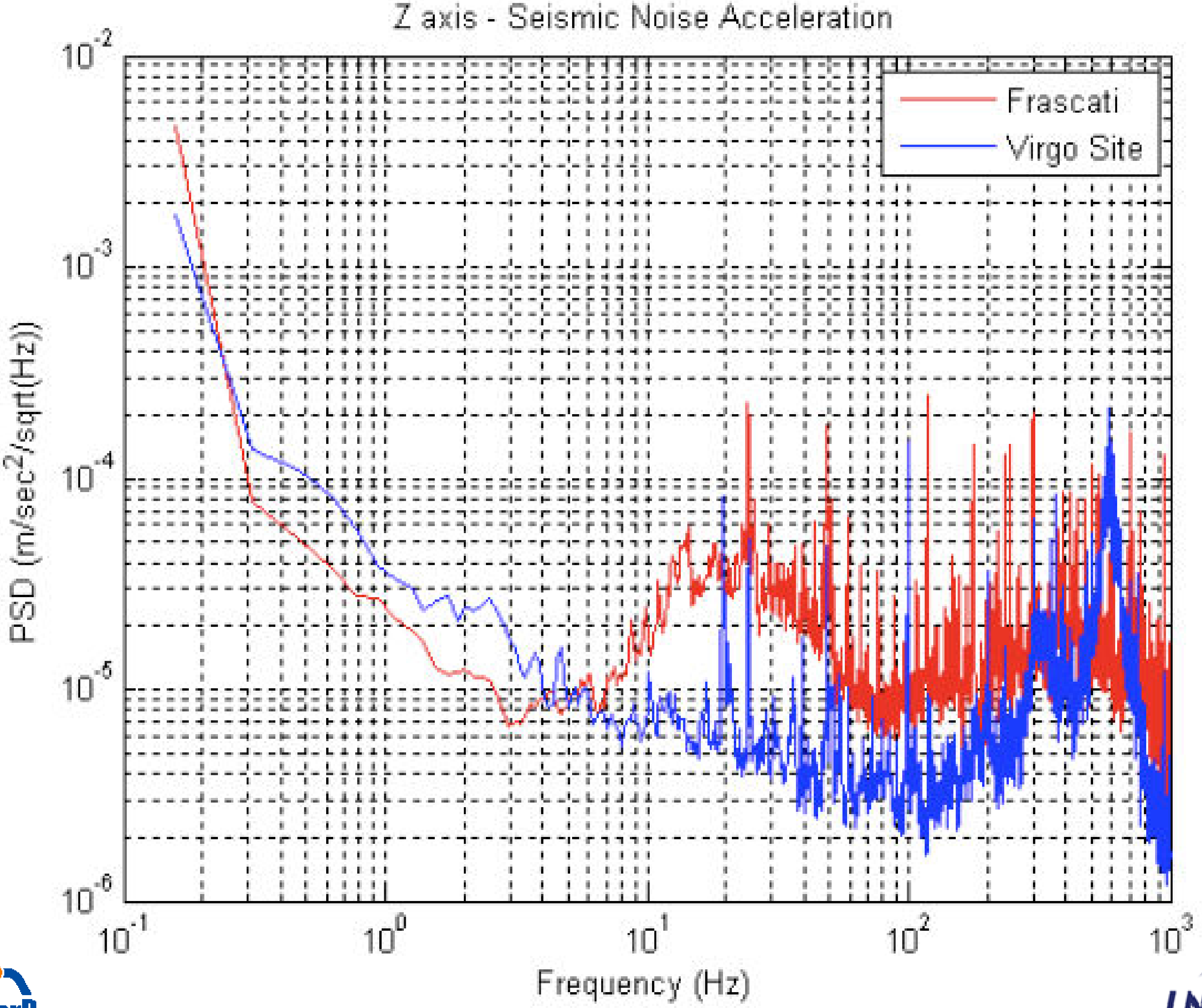
6 — Piroclastite marrone-rossastra, con inclusi lavici da millimetrici a centimetrici, scorie e frammenti di minerali, a matrice medio-grossolana, da poco a ben addensata, localmente coerente (S1). Spessore uniforme compreso tra 3,60 e 4,10m

7 — Lava grigio scura da molto compatta a fratturata (RQD tra 13 e 82%), vacuolare al tetto, con frequenti cristalli di leucite, presenza di pirosseni e rara olivina; spessore uniforme compreso tra 3,60 e 4,60m ad eccezione di S4 dove si rinviene uno spessore esiguo (0,80m)

8 — Piroclastite da marrone a grigiastra frequentemente alterata ed argillificata, con abbondante leucite analcimizzata e frammenti di minerali, a matrice generalmente medio-fine localmente grossolana, da poco a ben addensata. All'interno della formazione presenza di livelli sabbioso-limosi (S1 e S3) a geometria lenticolare e di livelli scoriacei grigiastri, decimetrici (S2). La formazione non è stata intercettata in S4. Lo spessore è compreso tra 3,50 (S3) e 11,30m (S1).

9 — Terreno vegetale e riporti antropici. Terreni generalmente a matrice prevalente limoso-argillosa con inclusi di varia natura e di dimensioni molto variabili. Lo spessore è in genere molto esiguo, nell'ordine di 1,00m ad eccezione di S4 dove gli spessori si accrescono fino a 6,00m e dove si rinvengono grossi inclusi lavici di grandi dimensioni, immersi in matrice terrosa

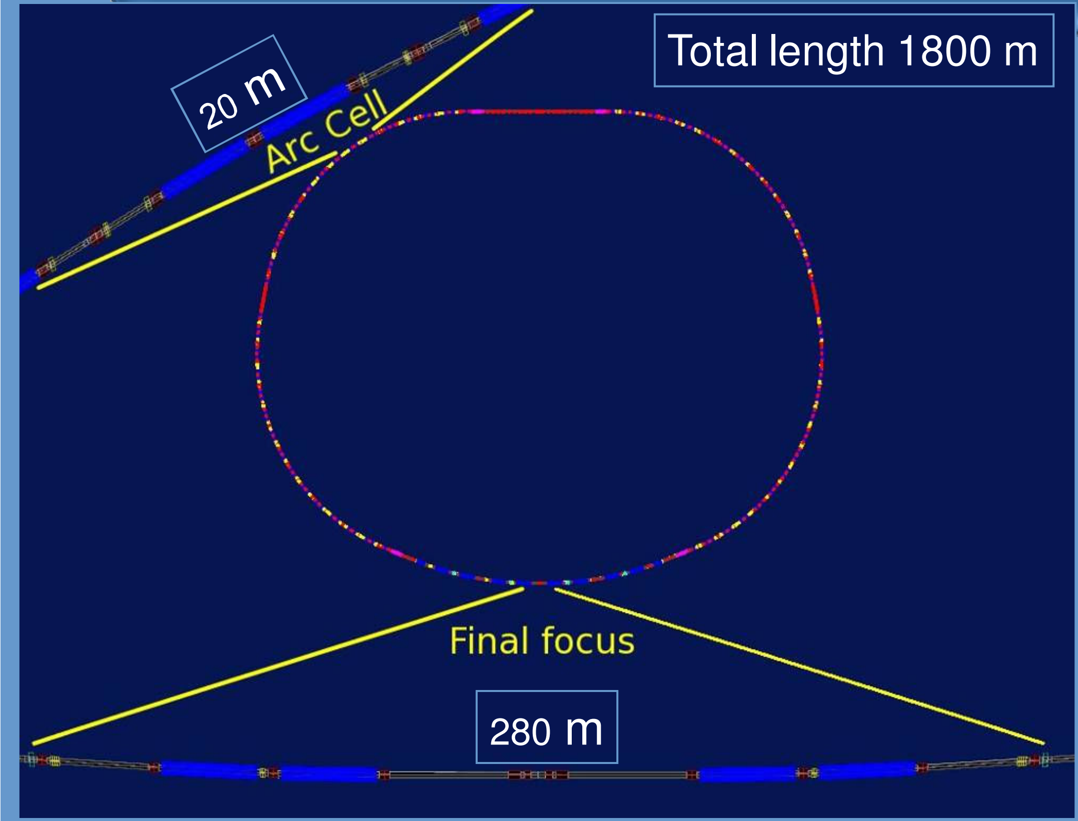
NB. IN NESSUN SONDAGGIO E' STATA RISCONTRATA LA PRESENZA D'ACQUA.



Z axis - Seismic Noise Acceleration

All lattices reuse PEP-II hardware

M. Biagini



Available

Needed

Quads

L_{mag} (m)	0.45	5.4
PEP HER	-	194
PEP LER	194	-
SBF HER	-	130
SBF LER	224	18
SBF Total	224	148
Needed	30	0

L_{mag} (m)	0.56	0.73	0.43	0.7	0.4
PEP HER	202	82	-	-	-
PEP LER	-	-	353	-	-
SBF HER	165	108	-	2	2
SBF LER	88	108	165	2	2
SBF Total	253	216	165	4	4
Needed	51*	134	0	4	4

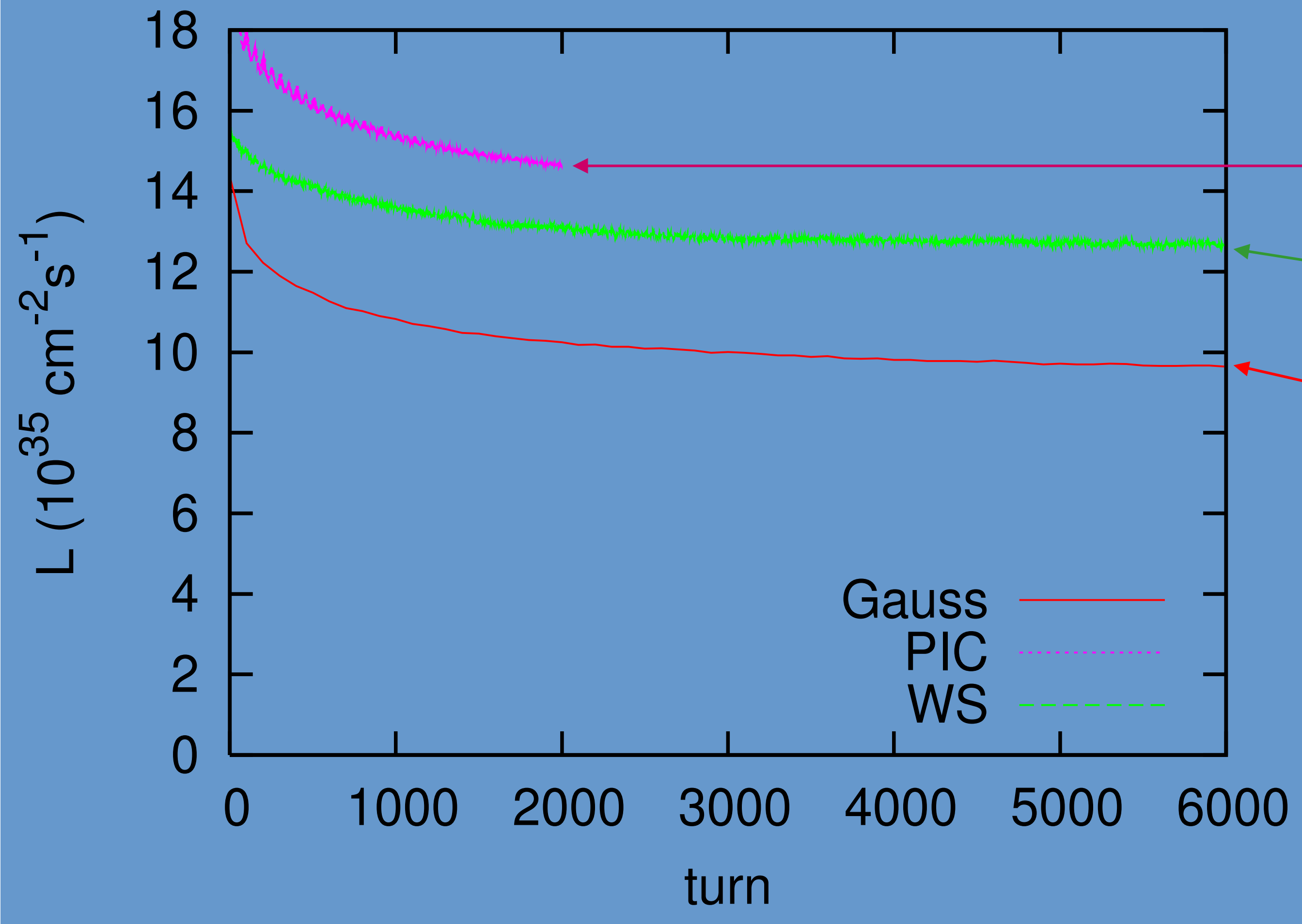
Sexts

L_{mag} (m)	0.25	0.5
PEP HER/LER	188	-
SBF Total	372	4
Needed	184	4

All PEP-II magnets are reused. Dimensions and fields are properly sized.

Simulations for SuperB

(M. Zobov's talk)



Strong-Strong

Weak-Strong

Quasi-Strong-Strong

K. Ohmi

Machine Advisory Committee statement on Viability

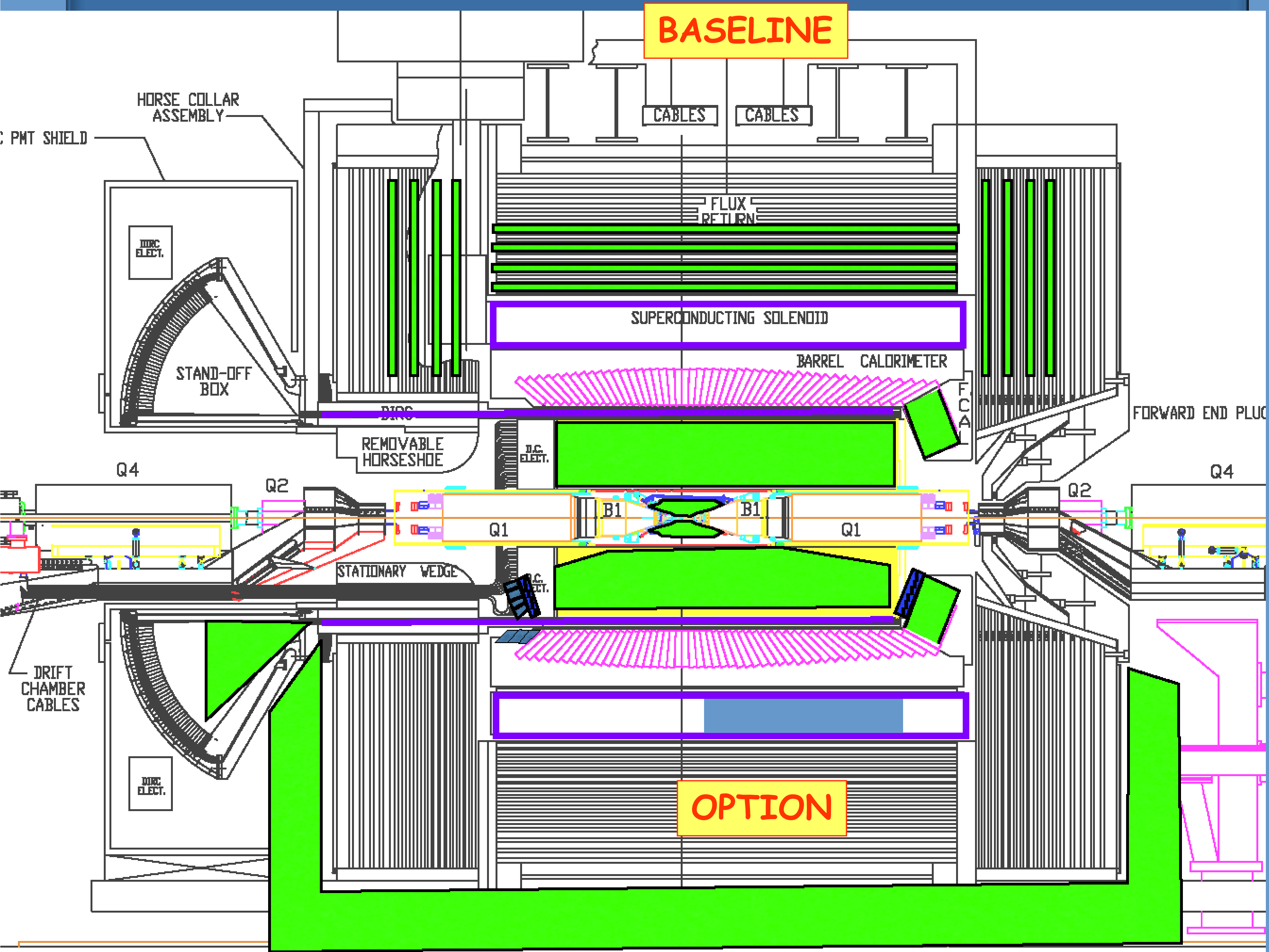
- Important progress since last meeting. Examples
  - Crab waist studies very convincing
    - Demonstrated improvement of ~3 from CW
  - Beam-beam simulation
    - Benchmarked at DAΦNE
    - Increased confidence in weak-strong given validation from strong-strong
  - New IR design
    - Removes cold bore
    - BSC increased significantly
    - Reduced power levels on components
    - Faster separation (larger crossing angle)

- Mini-MAC recognizes this important progress

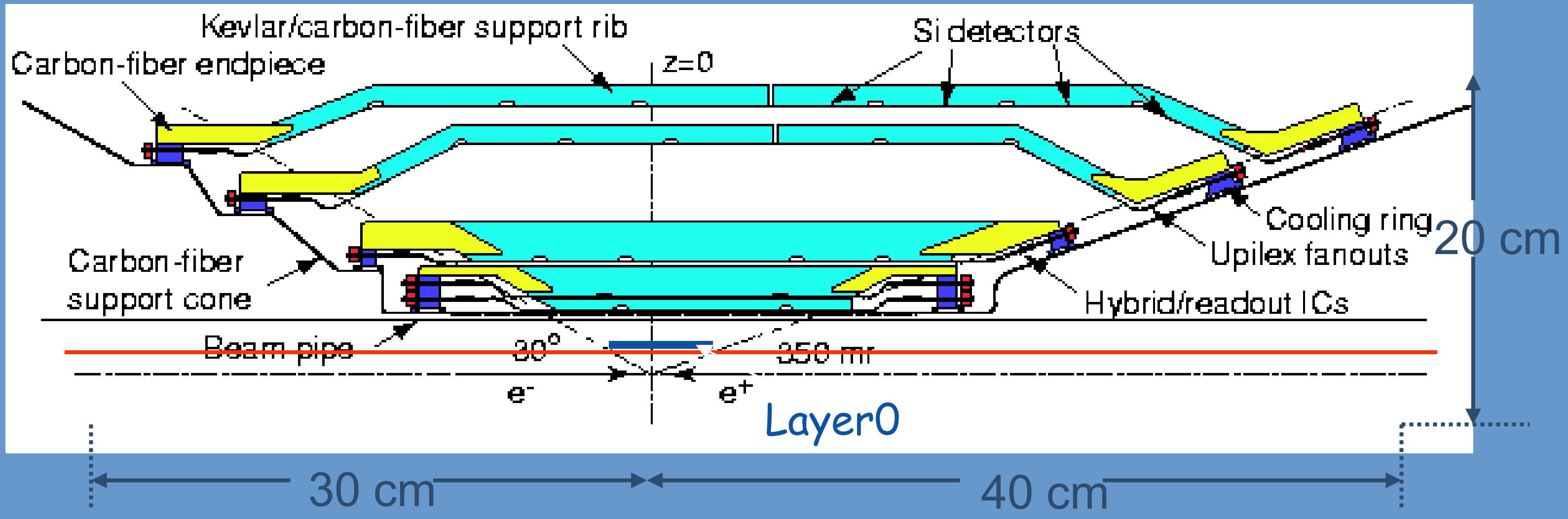
1. Viability continued

- 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

Detector Layout – Reuse parts of Babar (or Belle)

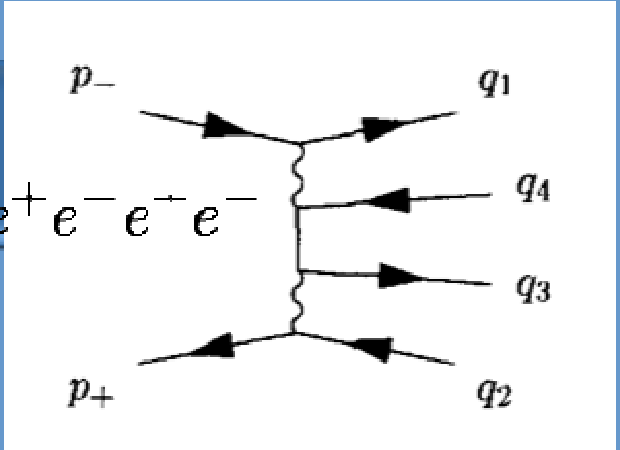


Vertex Detector (SVT)



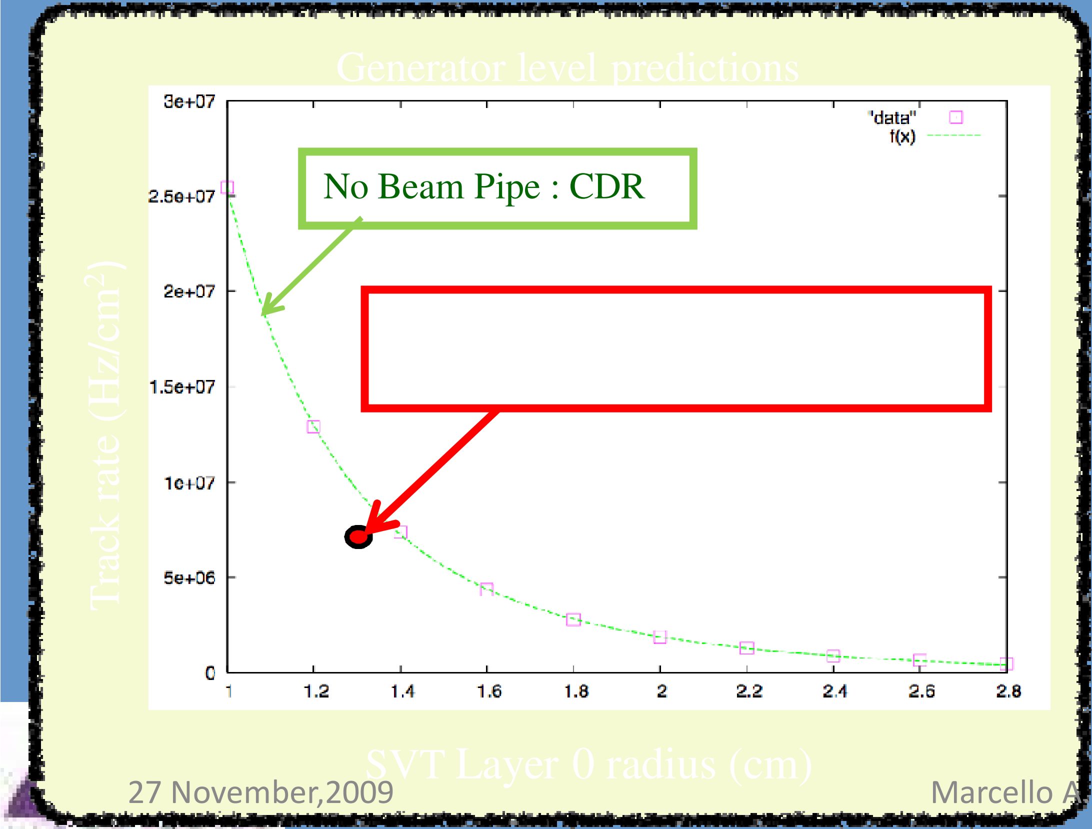
Pair Production status

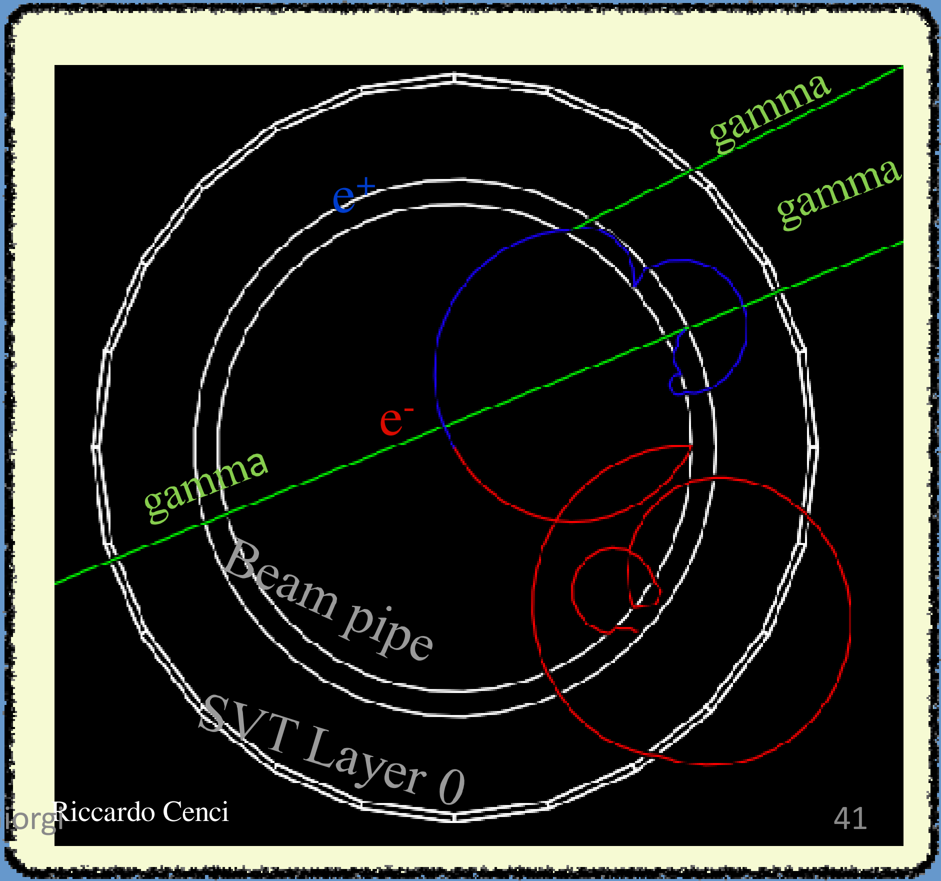
- New simulations
- The detector solenoidal field is the main trap to keep low p_t particles away from the detector $e^+e^- \rightarrow e^+e^-e^+e^-$
- Geant 4 simulation to predict the hit rate on Layer0 in progress
- In pixel detectors hit rate depends on the number of pixels involved in a sensor xing, i.e. on the sensor thickness and the xing angle.
- Preliminary : 7.8 MHz/Cm² crossings in L0 (300μm Si)



Dominant Feynman graph

Geant4 Sim

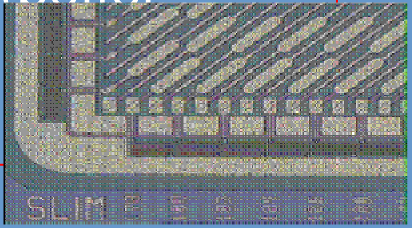




SVT Update I

SVT Background studies

- Expected rates at Layer0 location reduced w.r.t results presented at SLAC (bug found in the code):
  - Now 100 MHz/cm2 (safety x 5 included). Still some checks needed.
- Layer0 with striplets could become again a realistic option (better performance/less material w.r.t hybrid pixel)
  - Occupancy will be ~ 10% (safety x5 included) in 100 ns.



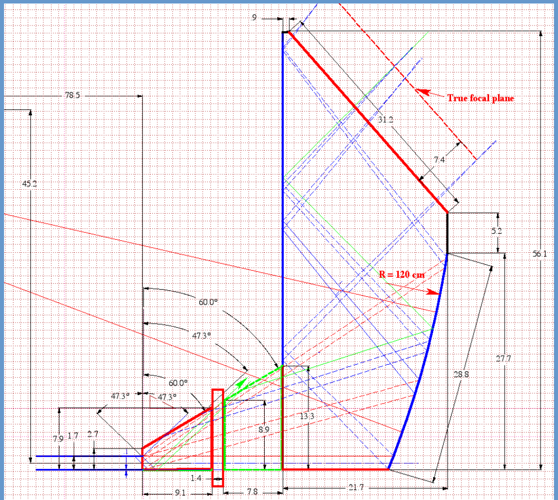
Progress in SVT FastSim studies

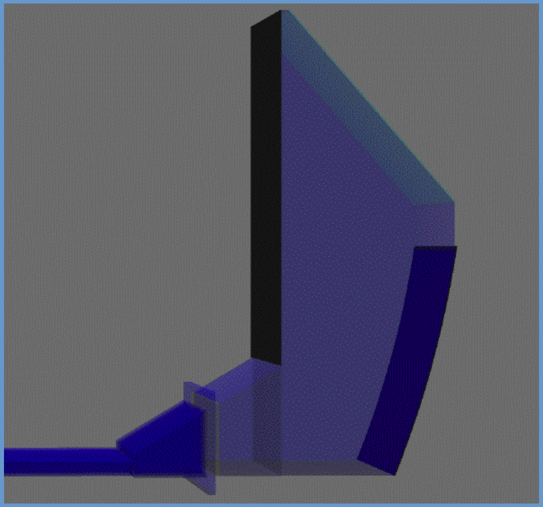
- Sensitivity on time dependent measurements compared for Layer0 based on Hybrid Pixel/Striplets with different radii and machine boost.
- Tracking performance compared with different SVT configurations: Layer0 + 3 / 4 / 5 external strip layers:

Barrel PID

- Improved FBLOCK design (SLAC): all rays focused and ~perpendicular to the detector plane external wedge (⇒ larger cylindrical mirror) + micro-wedge (to help θ_C resolution) added
- Geant4 MC study of the FBlock (Maryland): $\sigma_{\theta C}$ ~ 9 mrad (w/o chromatic corrections)
  → Various studies in progress: micro-wedge, glue joints, FBLOCK side reflectivity, etc.

Jerry's design 12a.vc6





Corresponding Geant 4 design

- New FDIRC mechanical design (Massimo Benettoni, Padova)
- First preliminary bids for BLOCK manufacturing (SLAC)
- Software fixes for BLAB2 chip to be installed in FDIRC prototype this month
- New BLAB3 chip arrived at SLAC

(Hawaii)

- First estimation of the number of links needed by the DAQ (Orsay, ETD)

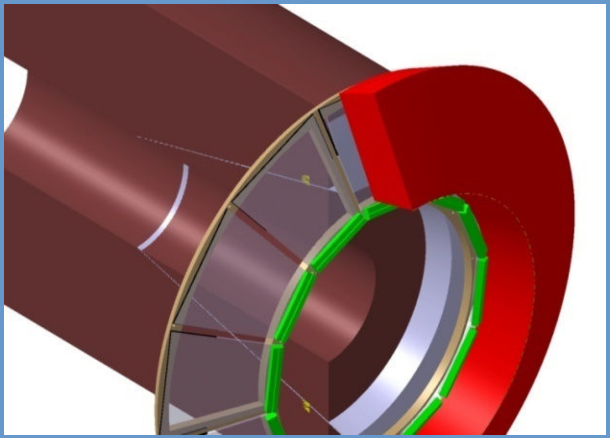
Forward PID

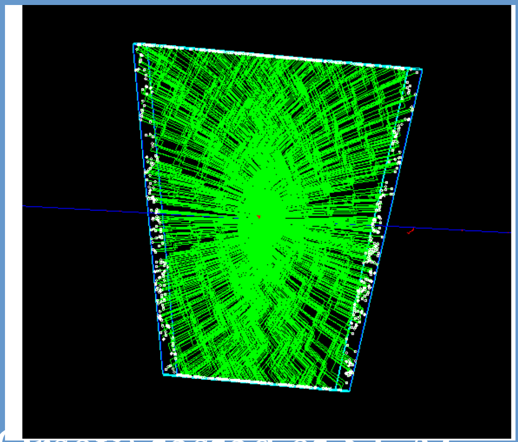
- Geant 4 simulation of the ‘DIRC-like’ TOF detector started (Orsay)
  → Starting point: SLAC-Maryland package
  → Collaboration with a group from the Taras-Shevchenko Ntl. Univ. of Kiev (Ukraine)
  → First results to be presented this week

\

- Progress on the mechanical design for the ‘DIRC-like’ TOF
  → Joint engineering meeting Orsay-CERN (M. Lebeau)-Perugia last Friday

DCH
Forward PID
Forward EMC





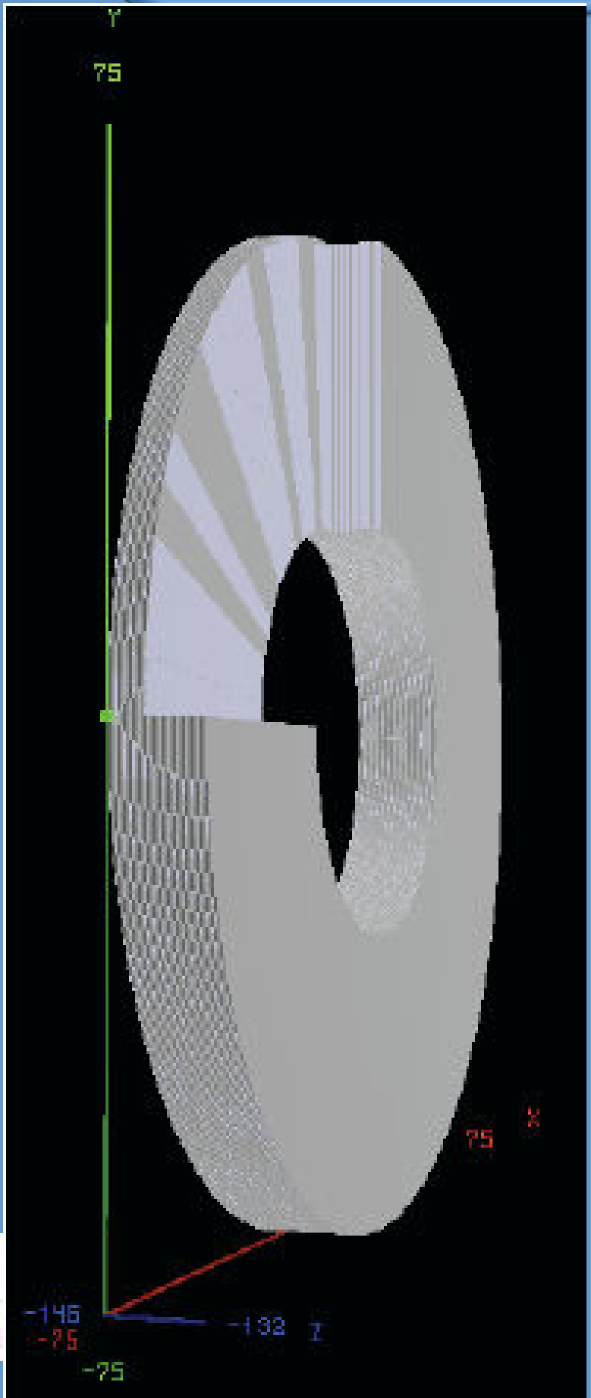
2 GeV K
crossing
TOF sector

- Waveform digitizing electronics « WaveCatcher » (Orsay) tested at SLAC

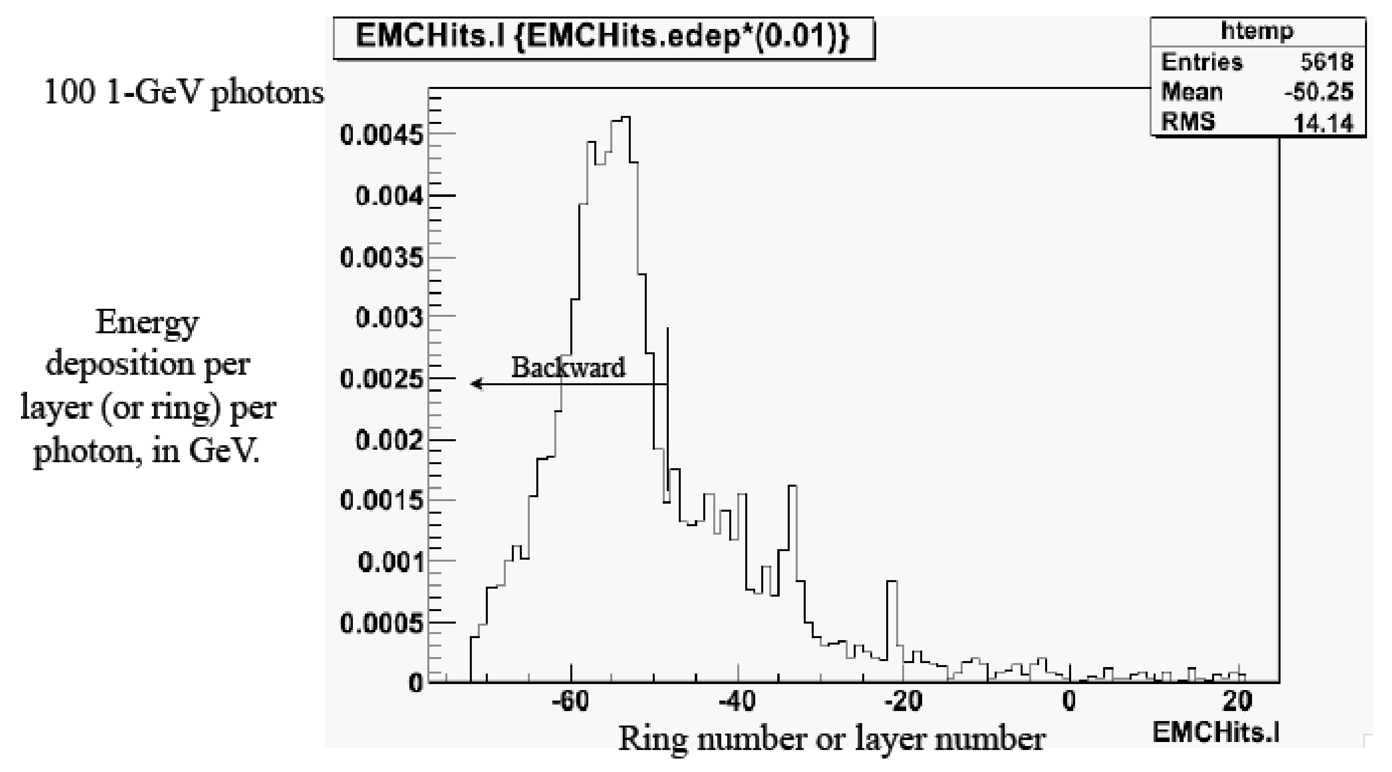
- Analysis of test-bench data for the ‘pixilated’ TOF detector to be presented this week (SLAC, Orsay, Hawaii)

- New MC predictions of the Aerogel RICH performances (Novosibirsk)
  → Included in SLAC graph summarizing the overall performances of all PID detectors
- Development of the aerogel forward RICH prototype (Novosibirsk)

Simulation of Backward Endcap-Pb/scintillator



Geometry description in gdml file is now available

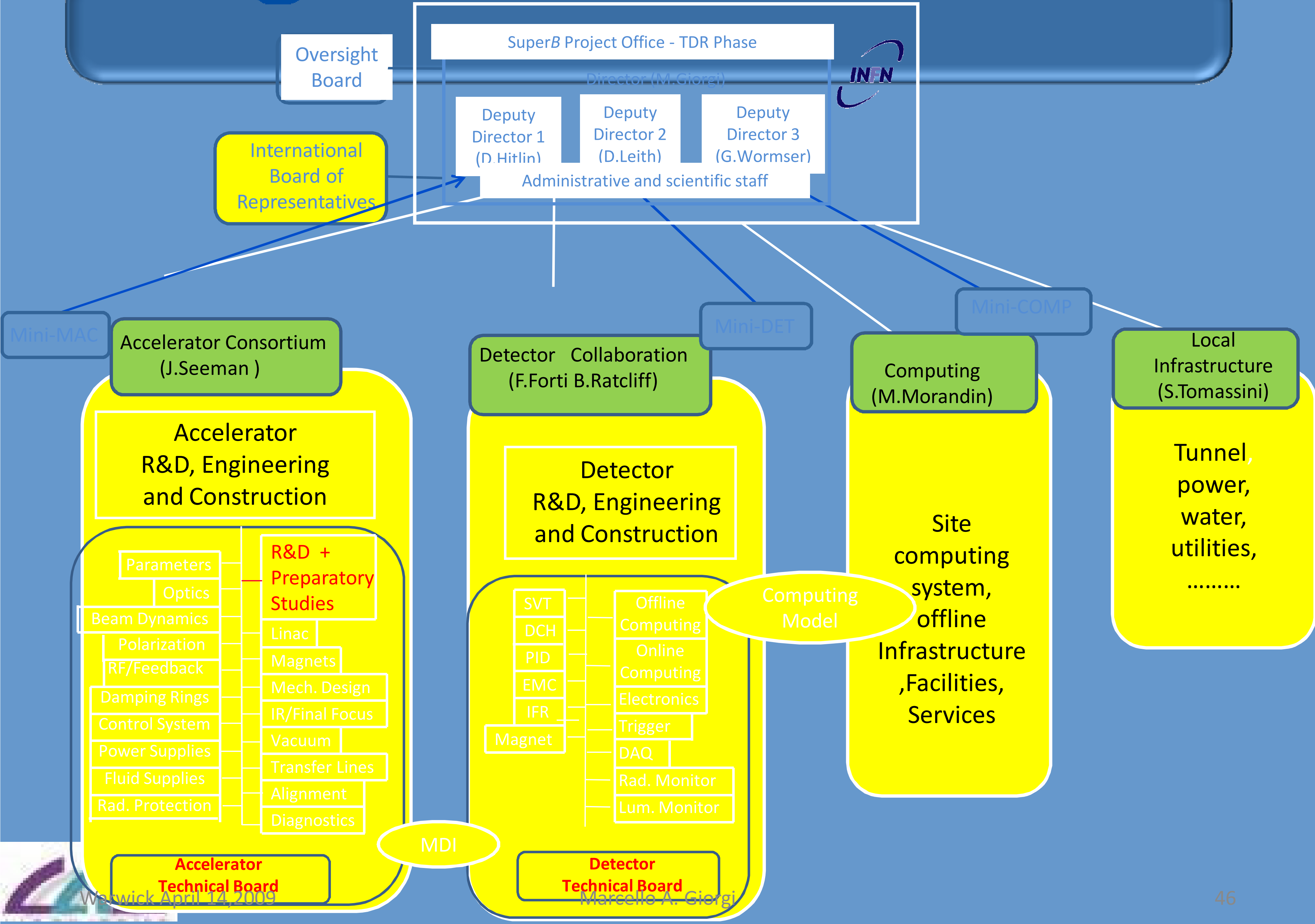


Sensitive part of the detector is scintillator→ Only a fraction of shower energy will be recorded.

Fast sim has an unrealistic description of the geometry → study a link between fast and full sim

Reconstruction algorithm has to be developed

Organization Chart for TDR Phase



Oversight Board

SuperB Project Office - TDR Phase

Director (M.Giorgi)

Deputy Director 1 (D.Hitlin)

Deputy Director 2 (D.Leith)

Deputy Director 3 (G.Wormser)

Administrative and scientific staff

International Board of Representatives

Mini-MAC

Mini-DET

Mini-COMP

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

Accelerator Technical Board

MDI

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

Detector Technical Board

Computing Model

Computing (M.Morandin)

Site computing system, offline Infrastructure ,Facilities, Services

Local Infrastructure (S.Tomassini)

Tunnel, power, water, utilities, ………

Steering Committee

Since 2006 a Steering Committee is in place

M.Giorgi (INFN Italy-Chair)
W.Gradl (Germany)
T. Gershon (UK)
D.Hitlin (USA)
H.Jawahery (USA)
D.Leith (USA)
E.Levichev(Russia)
T. Leziak (Poland)
F. Martinez-Vidal (Spain)
P.Raimondi (INFN Italy)
M.Roney (Canada)
G.Wormser (France)

+ Detector Coordinators +Accelerator Coordinators

This committee will evolve into the International board of representatives.

Detector R&D

- Main parts of Babar to reuse
  - Quartz bars of the DIRC
  - Barrel EMC CsI(TI) 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

ILC and Super B synergies

- Machine
  - The superB rings and ILC damping rings are extremely similar: same goal in terms of emittance
  - Strong similarity between SuperB Interaction regions and ILC interaction region
  - Same electron polarisation scheme
- Detector
  - Vertex detector R&D quite similar
  - Electronics, trigger, DAQ,…

Towards SuperB approval

- May 2008, Physics case positively reviewed by IRC
- Sep 2008 Presentation to CERN Council (European Strategy session)
- Nov 2008 : ECFA report
- Dec 2008 : SuperB TDR phase approved by INFN. Regional government votes 5M€/year support for TDR preparation
- 15 Feb 2009 Official launch of the TDR Phase in Orsay
- March 9 2009 : Interview of the Italian Minister of Research (after a visit to Frascati and CERN) : Plan to support research to be presented at the next G8 meeting includes a « machina » to be built in Italy to attract international researchers
- March 20, 2009: Large European Laboratory directors meeting : unanimous support for SuperB TDR
- April 24, 2009 : Report from the Machine Advisory Committee
- September 2009 Cern council recognizes that SuperB is integral part of the European Strategy
- October 2009 : SuperB is the first priority of the Italian Ministry of Research to be included in the Italian Stimulus Package

March 14, 2009


CORRIERE DELLA SERA

INTERVISTA SULLA RICERCA: IL PIANO PER SCEGLIERE LE AREE DI INVESTIMENTO, LA RIFORMA DEGLI ENTI E L'ASSUNZIONE DI NUOVI ADDETTI

«Grande opera per attirare cervelli stranieri»

Il ministro Gelmini: nascerà in Italia sul modello del Cern e rilancerà i nostri scienziati. Recupereremo il lavoro precario sulla base del merito e delle necessità . Le risorse deriveranno dalla cancellazione di piccoli progetti senza utilità

Ministro Mariastella Gelmini, per alcuni lei ha dimenticato il mondo della ricerca scientifica che assieme alla pubblica istruzione e all' Università è il suo terzo compito.... «Stiamo lavorando e per giugno sarà pronto il piano nazionale della ricerca in occasione del G8» E che cosa prevede? «Stabiliamo delle priorità per trasformare la situazione di crisi in cui ci troviamo in un' opportunità di rilancio. Le risorse non sono certo ampie ma il settore, grazie anche all' intervento del presidente

....

B GRANDE INFRASTRUTTURA Sarà costruita una «macchina» (sul modello dell' acceleratore Lhc di Ginevra) in grado di effettuare ricerca d' avanguardia a livello internazionale e di attirare scienziati stranieri

http://archiviostorico.corriere.it/2009/marzo/14/Grande_opera_per_attirare_cervelli_co_9_090

The next steps

- Next SuperB general meeting March 2010 in Annecy
- Encouraging statement from Italian governement is expected ANY MOMENT
- Bilateral MoUs to be signed between INFN and international partners
- Intermediate document to be transmitted to Italian governement early 2010
- Groundbreaking start hoped in 2011, together with SPARC-X project
- TDR written : end 2010

International participation

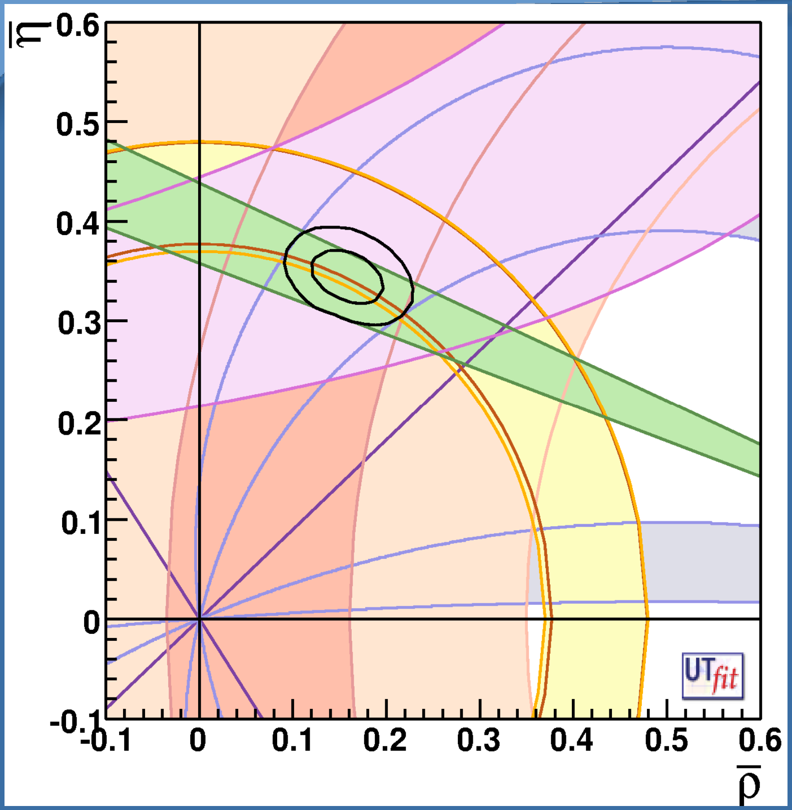
- US
  - DoE asked SLAC to evaluate 3 scenarios with increasing US participation. Decision due early 2010
- France
  - SuperB TDR participation approved at IN2P3 scientific Council in June 2009
  - IRFU/CEA, LAL, LAPP, LPSC, LPNHE collaboration
- Poland
  - Krakow group recently joined (KIT, Krakow Univ)
- Canada
  - U. of Victoria group approved by IPP
- UK, Spain
  - Many contacts and discussions

Conclusions

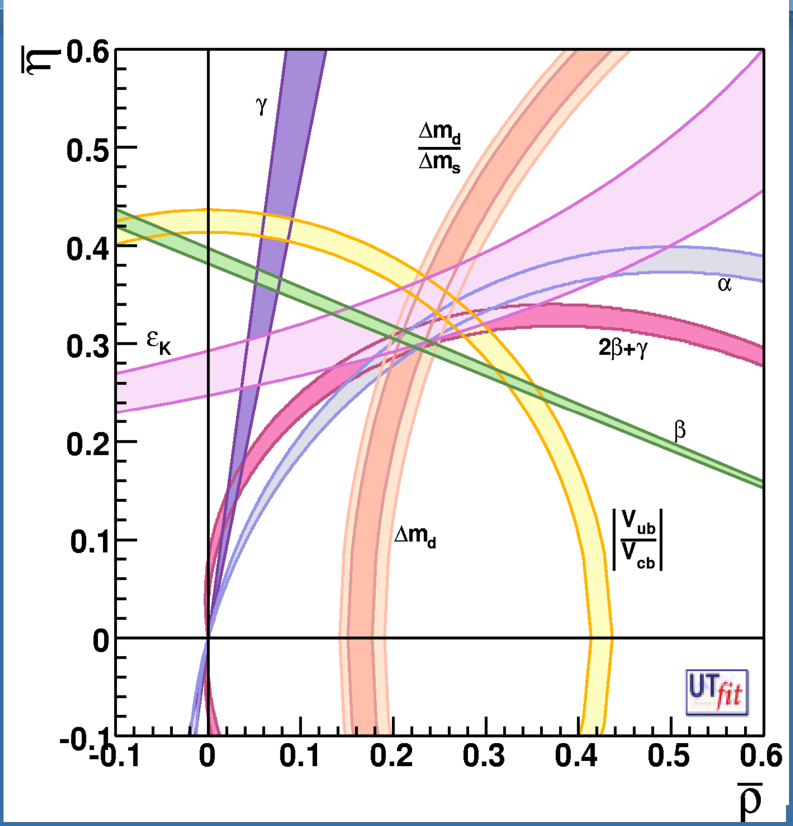
- Flavor physics presents an very exciting opportunity to understand new physics uncovered at the LHC
- LCHb and SuperB factory are very complementary tools.
- A superb new idea to build a machine of unprecedented luminosity. Tests at DAFNE demonstrated the concept!
- Machine Advisory Committee endorsed the machine feasability.
- There is a real chance that a SuperB project be approved in Europe very vigorously pushed by the Italian government
- TDR phase now in full steam, time to join! To be completed by end 2010
- Important synergy with ILC key elements
- Expected first beams in 2015….

Determination of CKM parameters and New Physics

Today



SuperB+Lattice improvements



Improving CKM is crucial to look for NP

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

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

Let's consider (reductively) the GOLDEN MATRIX for B physics

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

X The GOLDEN channel for the given scenario

○ Not the GOLDEN channel for the given scenario,

but can show experimentally measurable deviations from SM.

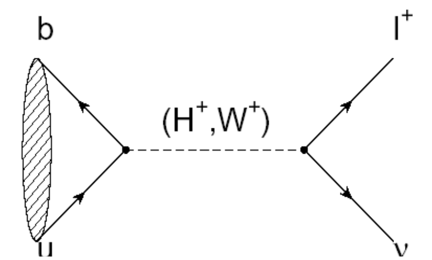
« SuperB specifics »

inclusive analyses

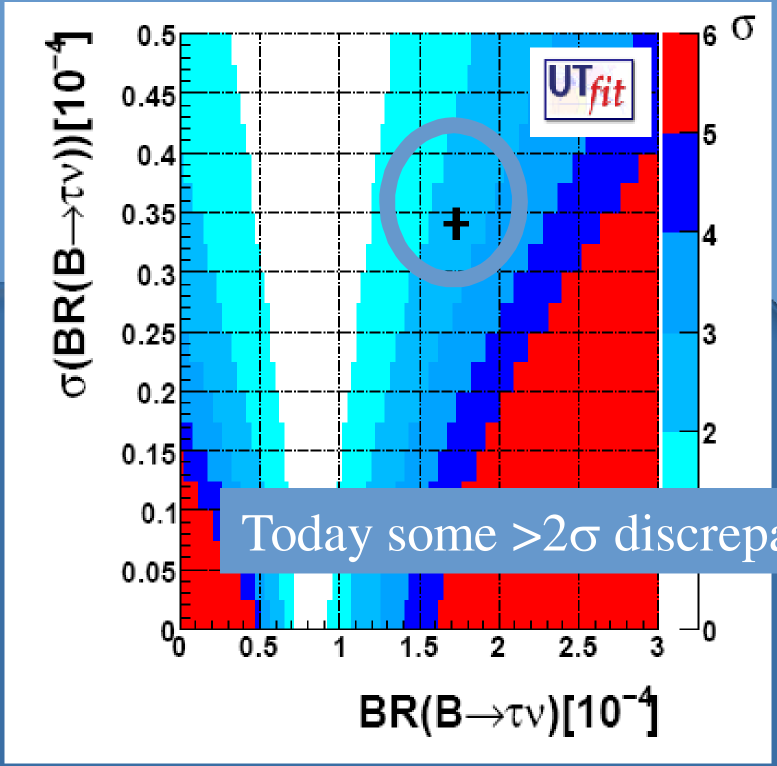
channels with π^0, γ, ν, many Ks…

In the following some examples of ↓ →

Leptonic decay B → l ν



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



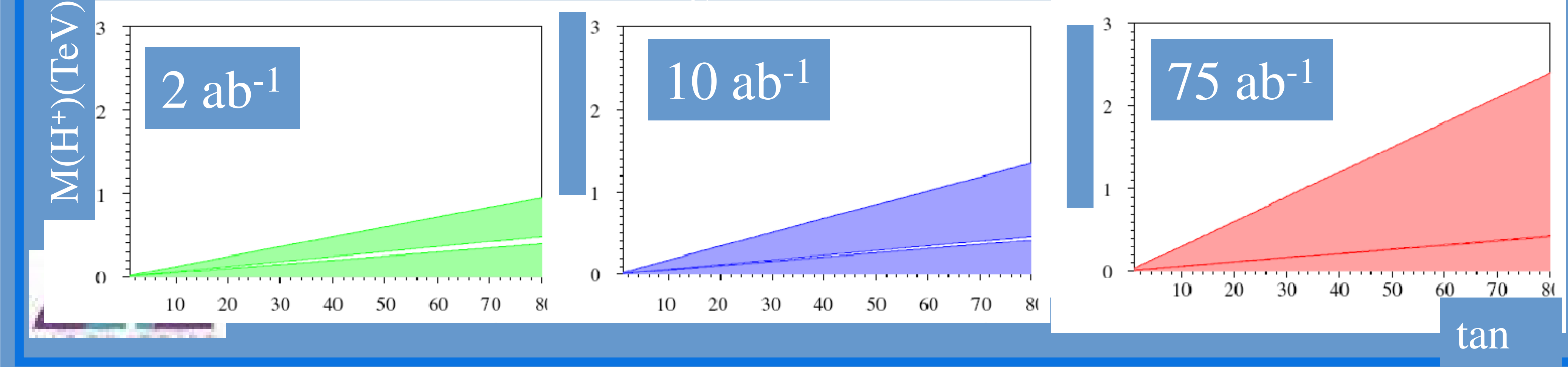
Today some >2σ discrepancy..

Observable	B Factories (2 ab^{-1})	Super$B$ (75 ab^{-1})
$\mathcal{B}(B\to\tau\nu)$	20%	4% (†)
$\mathcal{B}(B\to\mu\nu)$	visible	5%
$\mathcal{B}(B\to D\tau\nu)$	10%	2%

SuperB -75ab^{-1}

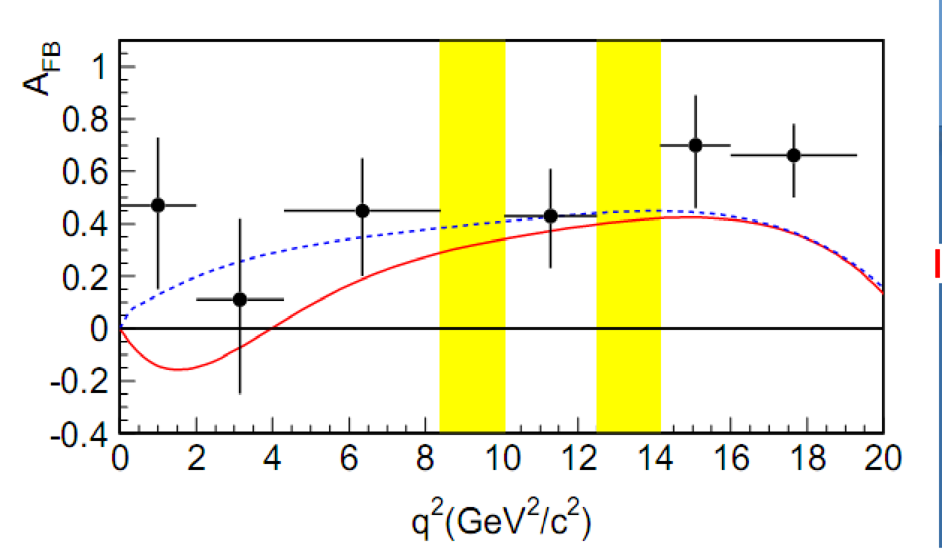
M_H~1.2-2.5 TeV for tanβ~30-60

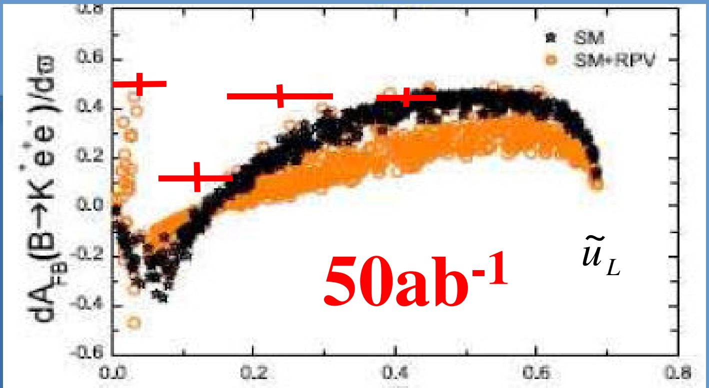
Exclusion regions @ 2σ in case of no-signal



New Physcs in b→s transitions

$B \to K^* l^+ l^-: A_{FB}$





Y.-G. Xu et al., PRD74, 114019 (2006)

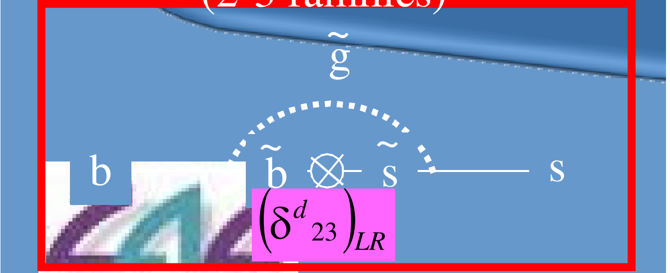
Flavour-changing NP effects in the squark propagator

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

→ flavour-violating coupling

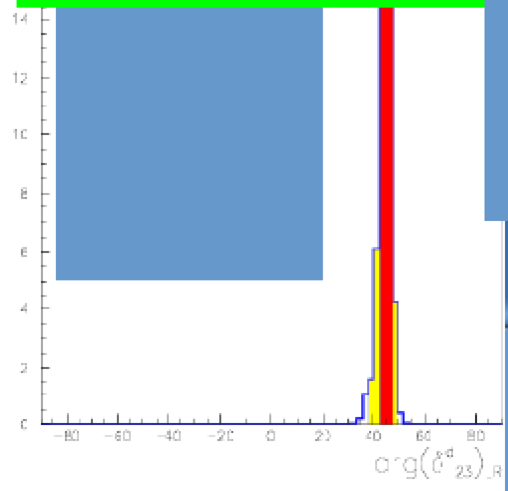
$$(\delta_{ij}^q)_{AB} \equiv \frac{(M_{ij}^2)_{AB}^q}{\tilde{m}^2}$$

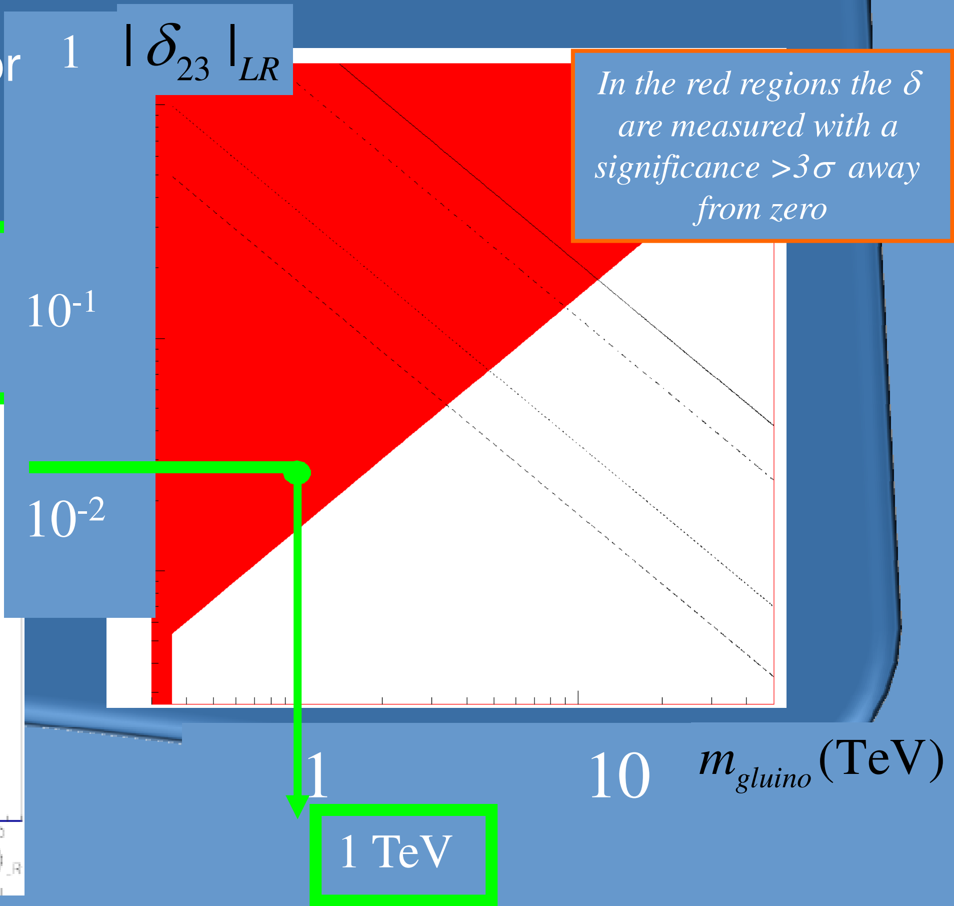
New Physics contribution
(2-3 families)



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

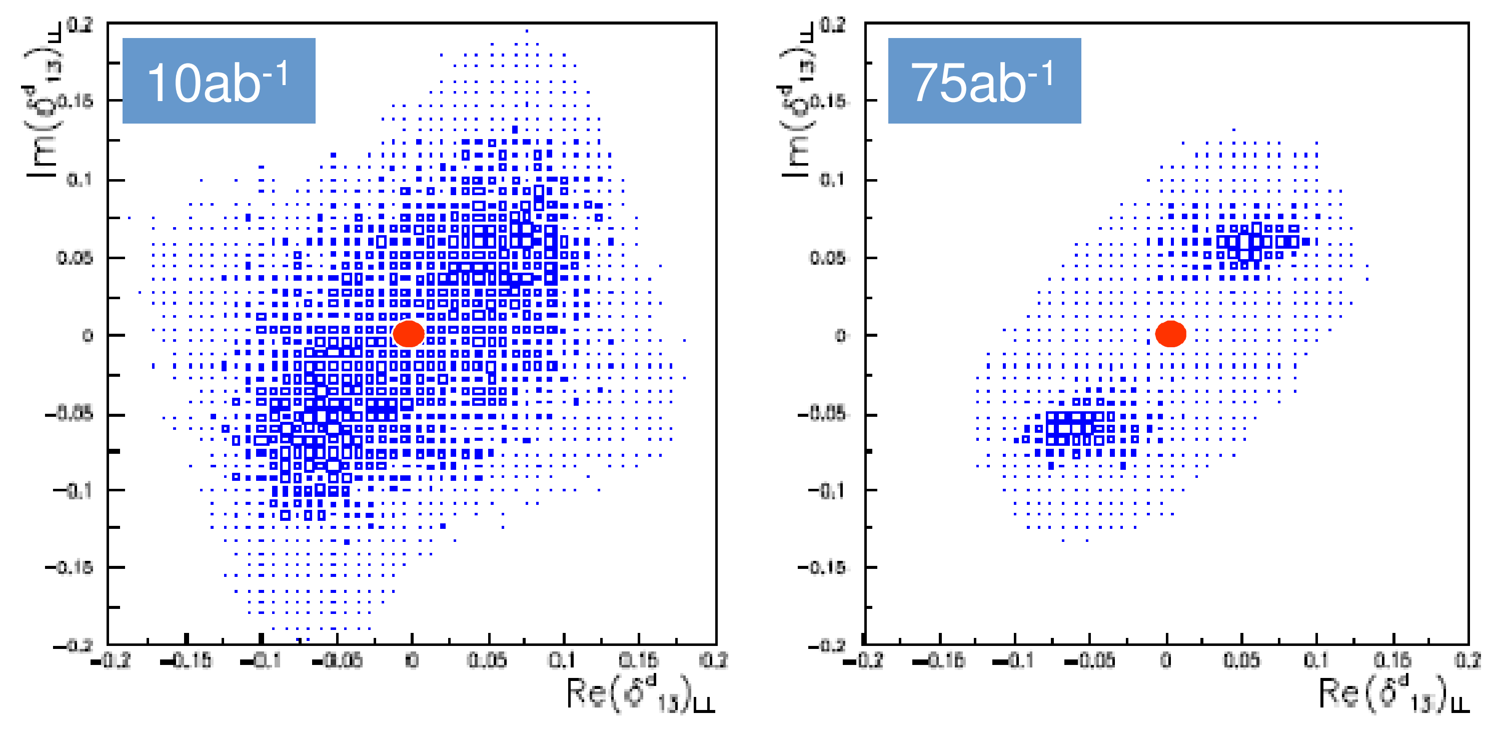
$\mathrm{Arg}(\delta_{23})_{LR}=(44.5\pm 2.6)^o$





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

New Physcs in b→d transitions



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}

Comparison of Super-B to “Old” SuperKEKB

Parameter		Super-B	Super-KEKB
Energy	GeV	4x7	3.5x8
Luminosity	10^{36} /cm^2/s	1.0	0.4
Beam Currents	Amps	1.9x1.9	10.0x4.0
βy^*	mm	0.22/0.39	3.0
βx^*	cm	3.5x2.0	20.
Crossing angle (full)	mrad	48	30
RF power (AC line)	MW	17	~85
Tune shifts	(x/y)	0.004/0.15	0.24/0.40

Super-KEKB → Nano-Beam Collider (April 2009) (Oide)

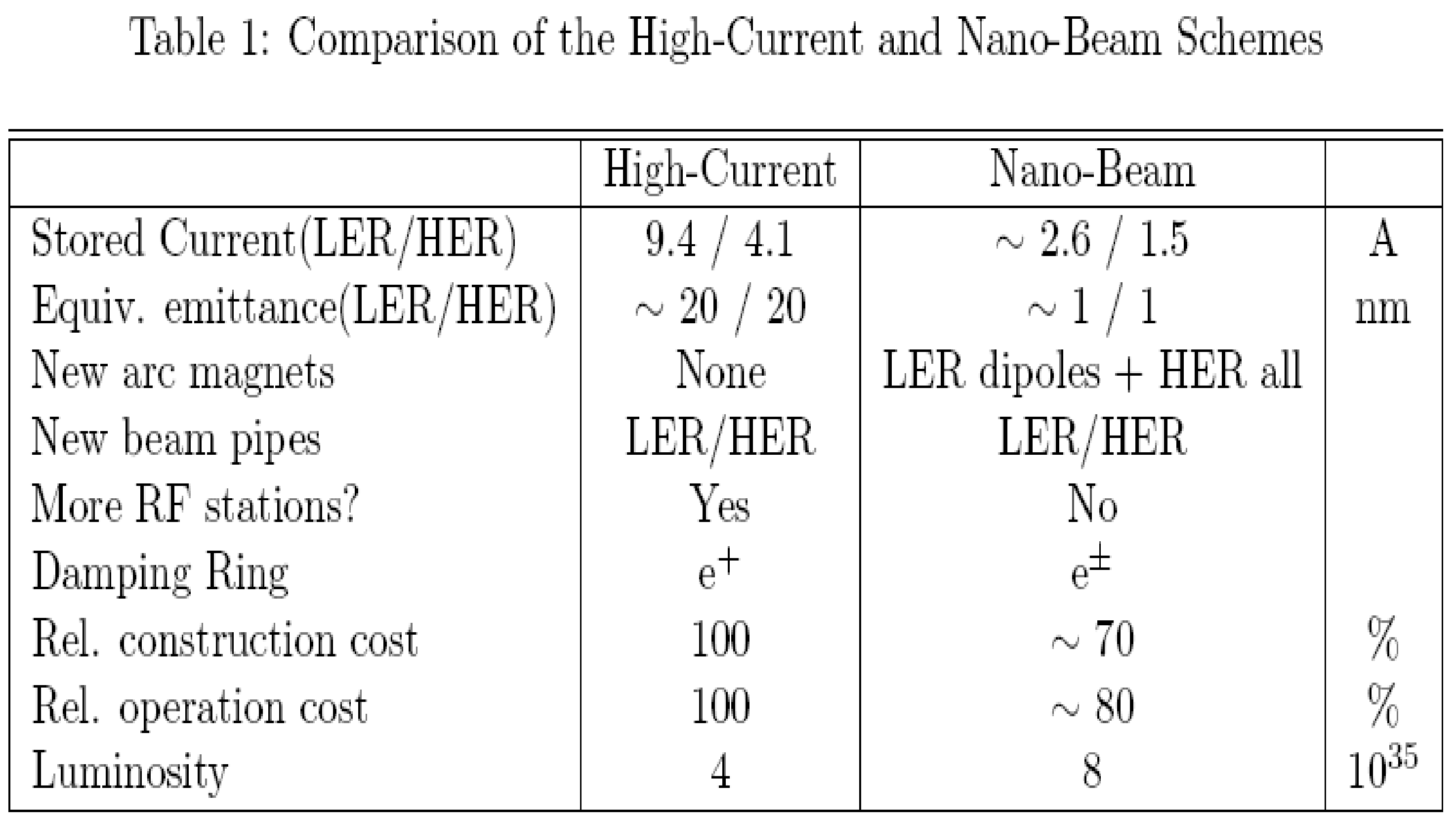
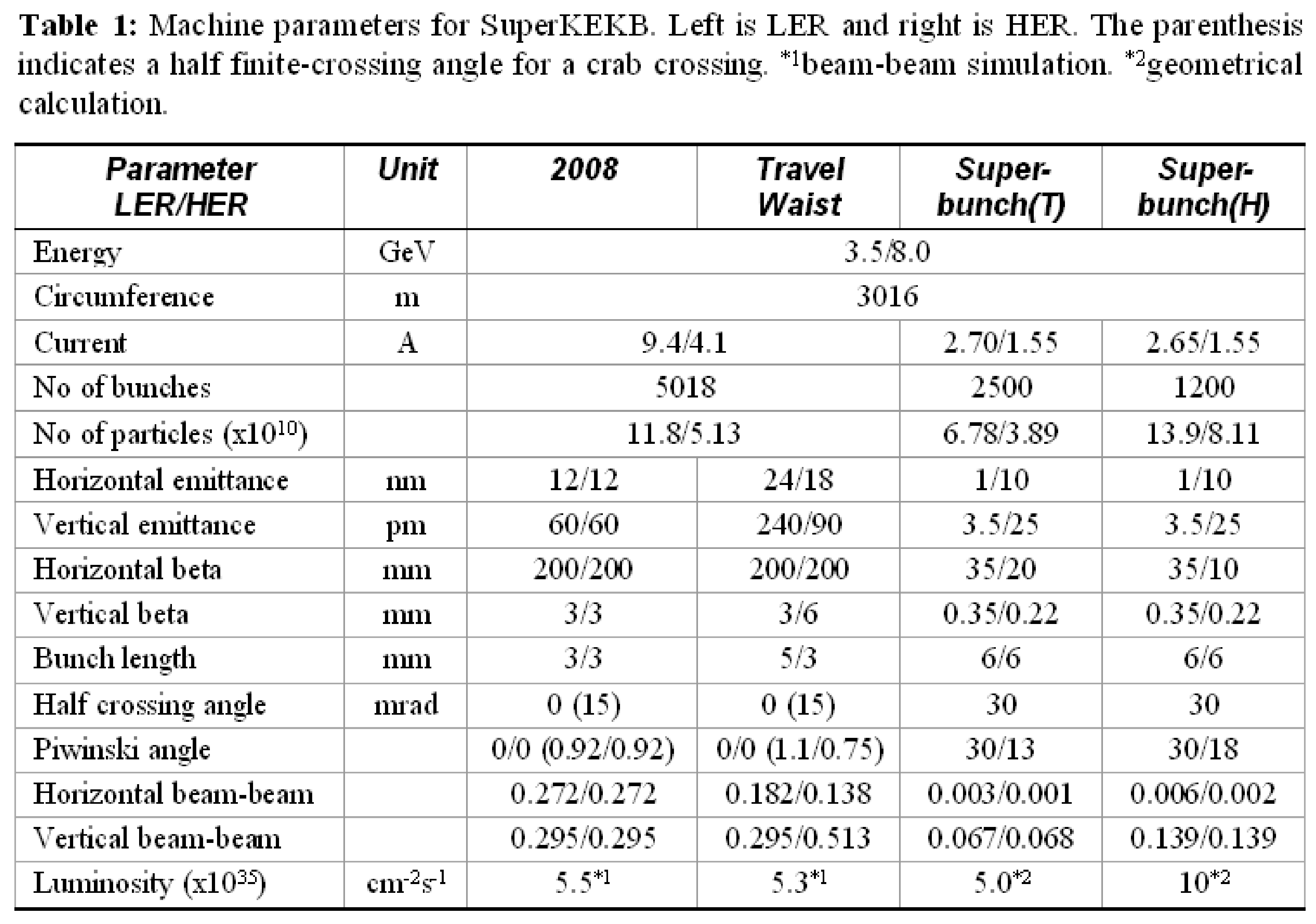


Table 1: Comparison of the High-Current and Nano-Beam Schemes

	High-Current	Nano-Beam	
Stored Current(LER/HER)	9.4 / 4.1	~ 2.6 / 1.5	A
Equiv. emittance(LER/HER)	~ 20 / 20	~ 1 / 1	nm
New arc magnets	None	LER dipoles + HER all	
New beam pipes	LER/HER	LER/HER	
More RF stations?	Yes	No	
Damping Ring	e^+	$e^\pm$	
Rel. construction cost	100	~ 70	%
Rel. operation cost	100	~ 80	%
Luminosity	4	8	10^{35}

Super-KEKB options (Ohnishi April 2009)



- **Table 1:** Machine parameters for SuperKEKB. Left is LER and right is HER. The parenthesis indicates a half finite-crossing angle for a crab crossing. *1beam-beam simulation. *2geometrical calculation.

Parameter LER/HER	***Unit***	***2008***	***Travel Waist***	***Super-bunch(T)***	***Super-bunch(H)***
Energy	GeV	3.5/8.0			
Circumference	m	3016			
Current	A	9.4/4.1		2.70/1.55	2.65/1.55
No of bunches		5018		2500	1200
No of particles ($\times10^{10}$)		11.8/5.13		6.78/3.89	13.9/8.11
Horizontal emittance	nm	12/12	24/18	1/10	1/10
Vertical emittance	pm	60/60	240/90	3.5/25	3.5/25
Horizontal beta	mm	200/200	200/200	35/20	35/10
Vertical beta	mm	3/3	3/6	0.35/0.22	0.35/0.22
Bunch length	mm	3/3	5/3	6/6	6/6
Half crossing angle	mrad	0 (15)	0 (15)	30	30
Piwinski angle		0/0 (0.92/0.92)	0/0 (1.1/0.75)	30/13	30/18
Horizontal beam-beam		0.272/0.272	0.182/0.138	0.003/0.001	0.006/0.002
Vertical beam-beam		0.295/0.295	0.295/0.513	0.067/0.068	0.139/0.139
Luminosity ($\times10^{35}$)	$cm^{-2}s^{-1}$	5.5*1	5.3*1	5.0*2	10*2