

# The SuperB project

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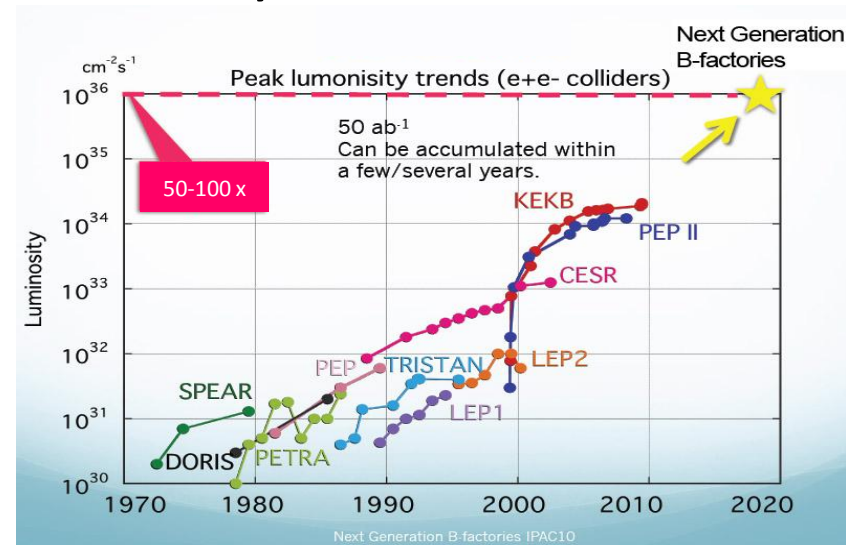
# Outline

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- Physics motivation
- Accelerator
- Detector
- Approval process

# SuperB

- Next generation, high luminosity asymmetric  $e^+e^-$  collider
  - nominal CM energy of 10.58 GeV/c<sup>2</sup> at Y(4S) resonance
  - possibility to run at charm threshold ( $\psi(3770)$ ) and up to Y(5S)
- Baseline luminosity  $L = 1 \times 10^{36} \text{ cm}^{-2} \text{ s}^{-1}$ 
  - $\sim 100$  times the peak luminosity at previous B factories
- $75 \text{ ab}^{-1}$  in 5 years at baseline luminosity
  - $80 \times 10^9 B\bar{B}$  pairs
  - $100 \times 10^9 e^+e^- \rightarrow c\bar{c}$  events
  - $70 \times 10^9 \tau^+\tau^-$  pairs
- longitudinal polarization of  $e^-$  beam (fraction 60-80%)
- To be built near Rome, Italy



# The role of a Super Flavor Factory

Search for physics beyond the SM through the *intensity frontier* path as opposed to the *energy frontier* path of ATLAS and CMS

## Scenarios:

### LHC finds New Physics (NP)

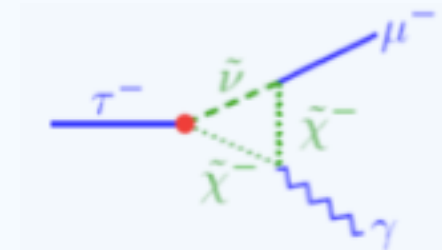
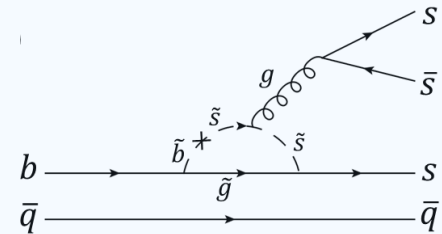
- Shed light on NP flavor structure and couplings
- Indirect searches of heavier states

### LHC does not find NP

- Look for indirect NP signals
- Exclude regions in NP parameter space

### Intensity frontier path

indirect observation of new particles or processes from precise measurement of flavor physics phenomena at lower energy.



# SuperB vs other next generation B factories

## Proposed LHCb upgrade:



- Physics programs significantly complementary
- SuperB: clean  $e^+e^-$  environment
  - allows also reconstruction of final states with neutrinos or multiple photons
- LHCb: large  $b\bar{b}$  production cross section and large boost of B hadrons
  - large amount of B hadrons, time-dependent CPV of  $B_s$ , hadronic environment

## SuperKEKB/Belle II:



- $e^+e^-$  collider with physics programs largely overlapping
- $L_{\text{SuperB}} = 1 \times 10^{36} \text{ cm}^{-2} \text{ s}^{-1}$  vs  
 $L_{\text{SuperKEKB}} = 0.8 \times 10^{36} \text{ cm}^{-2} \text{ s}^{-1}$
- Belle II expected to start earlier
- SuperB additional features
  - polarized  $e^-$  beam
  - possibility of operating near the  $\psi(3770)$  threshold

# The SuperB physics program

$$\int L dt = 75 ab^{-1} :$$

$80 \times 10^9 B\bar{B}$  pairs

$100 \times 10^9 e^+e^- \rightarrow c\bar{c}$  events

$70 \times 10^9 \tau^+\tau^-$  pairs

Physics case documented in:

[SuperB Conceptual Design Report](#)

[arXiv:0709.0451](#)

[NP at the Super Flavor Factory](#)

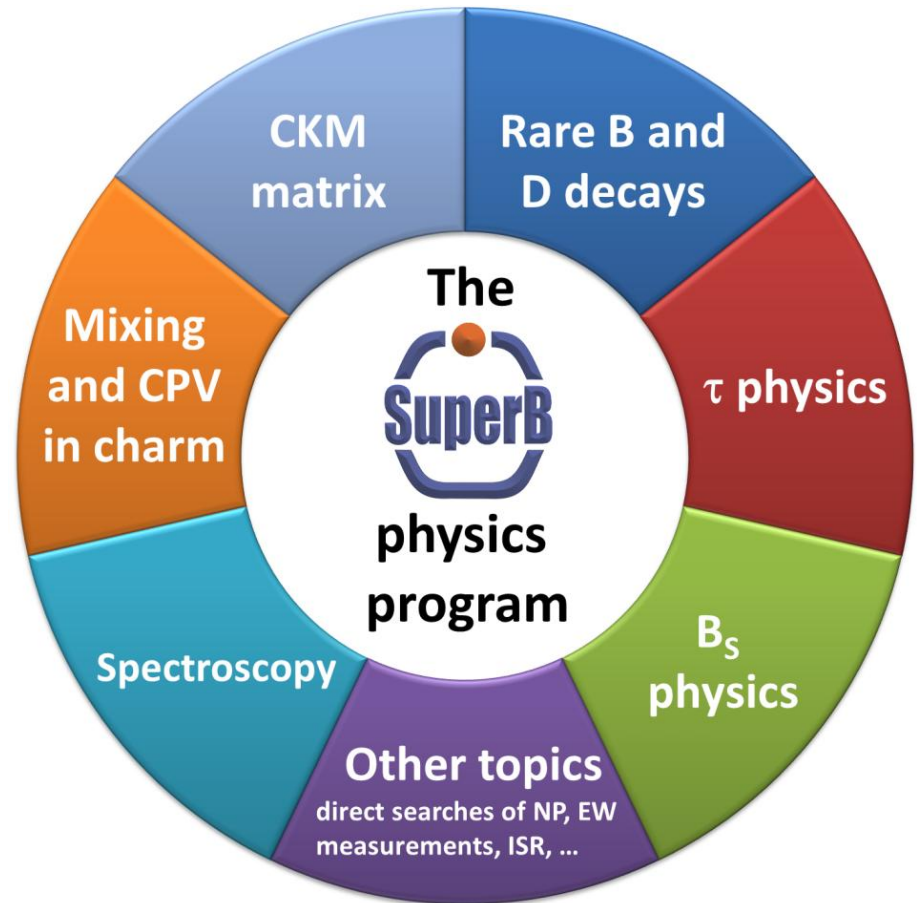
[arXiv:0810.1312](#)

[SuperB physics progress report](#)

[arXiv:1008.1541](#)

[The impact of SuperB on flavour physics](#)

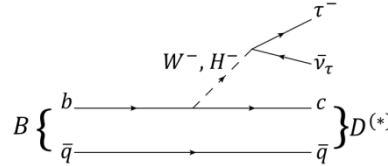
[arXiv:1109.5028](#)



A few examples in following slides

# $B \rightarrow D^{(*)}\tau\nu$ and $B \rightarrow \tau\nu$

BaBar measurement of  
 $\bar{B} \rightarrow D^{(*)}\tau^{-}\bar{\nu}_{\tau}$ ,  $0.43 \text{ ab}^{-1}$



SM calc.

$$R(D) = \frac{BF(\bar{B} \rightarrow D\tau^{-}\bar{\nu}_{\tau})}{BF(\bar{B} \rightarrow Dl^{-}\bar{\nu}_l)} = 0.440 \pm 0.072$$

$$0.297 \pm 0.017$$

$$R(D^{*}) = \frac{BF(\bar{B} \rightarrow D^{*}\tau^{-}\bar{\nu}_{\tau})}{BF(\bar{B} \rightarrow D^{*}l^{-}\bar{\nu}_l)} = 0.332 \pm 0.029$$

$$0.252 \pm 0.003$$

$R(D) + R(D^{*})$  inconsistent with SM ( $3.4\sigma$ ) and exclude the type II 2 Higgs doublet model with 99.8% CL

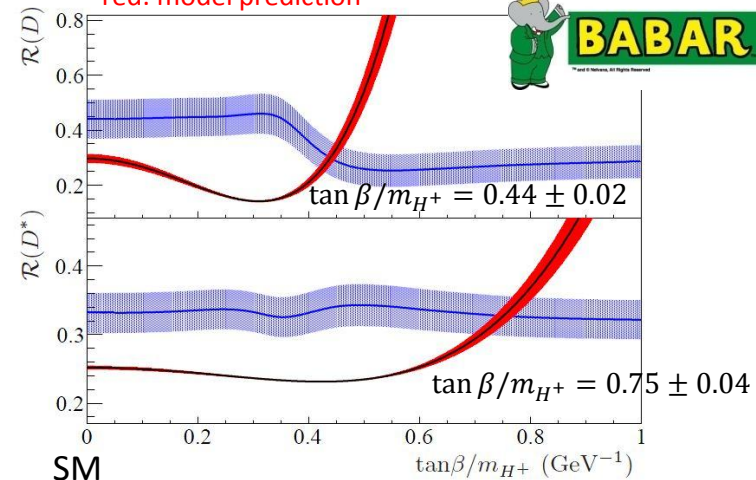
More data needed. Cannot be measured at hadron colliders (neutrinos in final state)

see G. Vasseur tomorrow

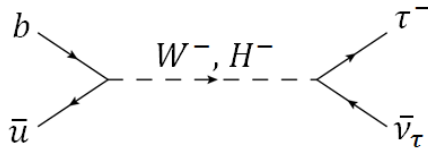
arXiv:1205.5442 sub. to PRL

blue: measured R vs model parameter

red: model prediction



$B^{-} \rightarrow \tau^{-} \bar{\nu}_{\tau}$



$$BF_{2HDM-II} = BF_{SM} \times (1 - \tan^2 \beta m_B^2 / m_H^2)^2$$

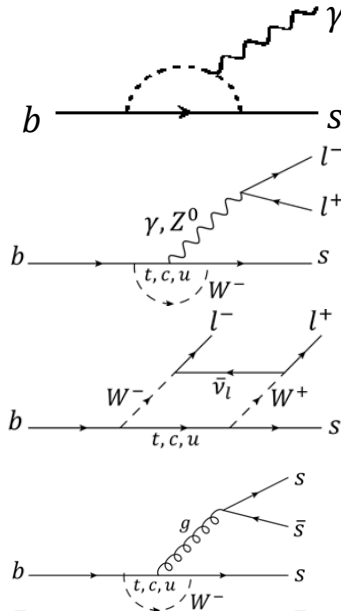
decay mode	expected $BF_{SM}$	2012 $\sigma(BF)/BF_{SM}$	SuperB 75ab <sup>-1</sup> $\sigma(BF)/BF_{SM}$
$B^{-} \rightarrow \tau^{-} \bar{\nu}_{\tau}$	$\sim 10^{-4}$	20%	4%
$B^{-} \rightarrow \mu^{-} \bar{\nu}_{\mu}$	$\sim 5 \times 10^{-7}$	---	5%
$\bar{B} \rightarrow D^{(*)}\tau^{-}\bar{\nu}_{\tau}$	$\sim 10^{-2}$	10%	2%

# Flavor changing neutral currents

$b \rightarrow s\gamma, b \rightarrow sl^+l^-, b \rightarrow sv\bar{\nu}, b \rightarrow s\bar{s}s, \dots$  sensitive probes of NP

extracted from arXiv:1109.5028

examples of SM FCNC diagrams



Observable/mode	Current now	SuperB 75 ab <sup>-1</sup>	theory now
$\text{BR}(B \rightarrow K^{*+}\nu\bar{\nu}) (\times 10^{-6})$	$< 80$	1.1	$6.8 \pm 1.1$
$\text{BR}(B \rightarrow K^+\nu\bar{\nu}) (\times 10^{-6})$	$< 160$	0.7	$3.6 \pm 0.5$
$\text{BR}(B \rightarrow X_s\gamma) (\times 10^{-4})$	$3.55 \pm 0.26$	0.11	$3.15 \pm 0.23$
$A_{CP}(B \rightarrow X_{(s+d)}\gamma)$	$0.060 \pm 0.060$	0.02	$\sim 10^{-6}$
$B \rightarrow K^*\mu^+\mu^-$ (events)	250	10-15k	-
$\text{BR}(B \rightarrow K^*\mu^+\mu^-) (\times 10^{-6})$	$1.15 \pm 0.16$	0.06	$1.19 \pm 0.39$
$B \rightarrow K^*e^+e^-$ (events)	165	10-15k	-
$\text{BR}(B \rightarrow K^*e^+e^-) (\times 10^{-6})$	$1.09 \pm 0.17$	0.05	$1.19 \pm 0.39$
$A_{FB}(B \rightarrow K^*\ell^+\ell^-)$	$0.27 \pm 0.14$	0.04	$-0.089 \pm 0.020$
$B \rightarrow X_s\ell^+\ell^-$ (events)	280	8,600	-
$\text{BR}(B \rightarrow X_s\ell^+\ell^-) (\times 10^{-6})$	$3.66 \pm 0.77$	0.08	$1.59 \pm 0.11$
$S$ in $B \rightarrow K_S^0\pi^0\gamma$	$-0.15 \pm 0.20$	0.03	-0.1 to 0.1
$S$ in $B \rightarrow \eta'K^0$	$0.59 \pm 0.07$	0.01	$\pm 0.015$
$S$ in $B \rightarrow \phi K^0$	$0.56 \pm 0.17$	0.02	$\pm 0.02$

## Complementarity with LHCb. Example:

- LHCb can measure  $B^+ \rightarrow K^+\mu^+\mu^-, B^0 \rightarrow K^{*0}\mu^+\mu^-, B^0 \rightarrow K^{*0}\gamma$  very precisely
- In addition SuperB can extend the set of reconstructed modes including  $B \rightarrow K^{(*)}l^+l^-$  ( $l = e, \mu$ ),  $B \rightarrow X_S l^+l^-$  ( $l = e, \mu$ ),  $B \rightarrow X_S\gamma$   $X_S = \text{inclusive}$ 
  - improved precision, access to additional NP-sensitive observables

# MSSM: flavor violation in quark sector

example: MSSM with generic squark mass matrices

LHCb, SuperB

$$M_{\tilde{d}}^2 \approx \begin{pmatrix} m_{\tilde{d}_L}^2 & m_d(A_d - \mu \tan \beta) & (\Delta_{12}^d)_{LL} & (\Delta_{12}^d)_{LR} & (\Delta_{13}^d)_{LL} & (\Delta_{13}^d)_{LR} \\ & m_{\tilde{d}_R}^2 & (\Delta_{12}^d)_{RL} & (\Delta_{12}^d)_{RR} & (\Delta_{13}^d)_{RL} & (\Delta_{13}^d)_{RR} \\ & & m_{\tilde{s}_L}^2 & m_s(A_s - \mu \tan \beta) & (\Delta_{23}^d)_{LL} & (\Delta_{23}^d)_{LR} \\ & & & m_{\tilde{s}_R}^2 & (\Delta_{23}^d)_{RL} & (\Delta_{23}^d)_{RR} \\ & & & & m_{\tilde{b}_L}^2 & m_b(A_b - \mu \tan \beta) \\ & & & & & m_{\tilde{b}_R}^2 \end{pmatrix}$$

*LHC, ILC - HE frontier* (green box around the first three rows)

*LHCb, SuperB* (red box around the last two columns)

and similarly for  $M_{\tilde{u}}^2$

NP scale:  $m_{\tilde{q}}$

Flavor violating and CP violating couplings:  $(\delta_{ij}^d)_{AB} = (\Delta_{ij}^d)_{AB} / m_{\tilde{q}}^2$

- the energy frontier experiments can probe the diagonal elements
- flavor physics experiments are required to probe off-diagonal terms

# Constraints from $b \rightarrow s\gamma, b \rightarrow sl^+l^-$

example: SuperB can constrain the  $(\delta_{23}^d)_{ij}$  using

■  $\mathcal{B}(B \rightarrow X_s\gamma)$

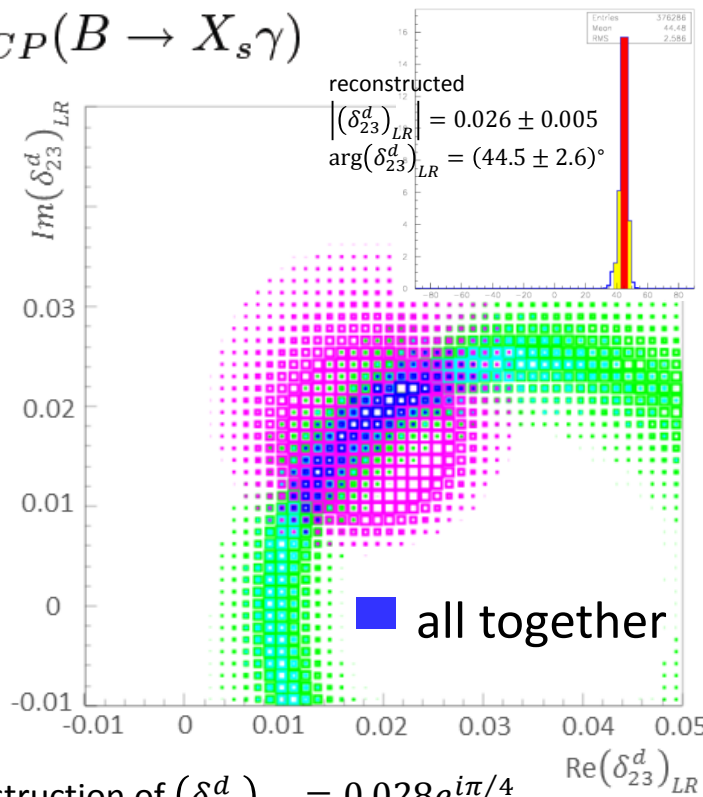
■  $\mathcal{B}(B \rightarrow X_sl^+l^-)$  (dataset: 75ab<sup>-1</sup>)

■  $\mathcal{A}_{CP}(B \rightarrow X_s\gamma)$

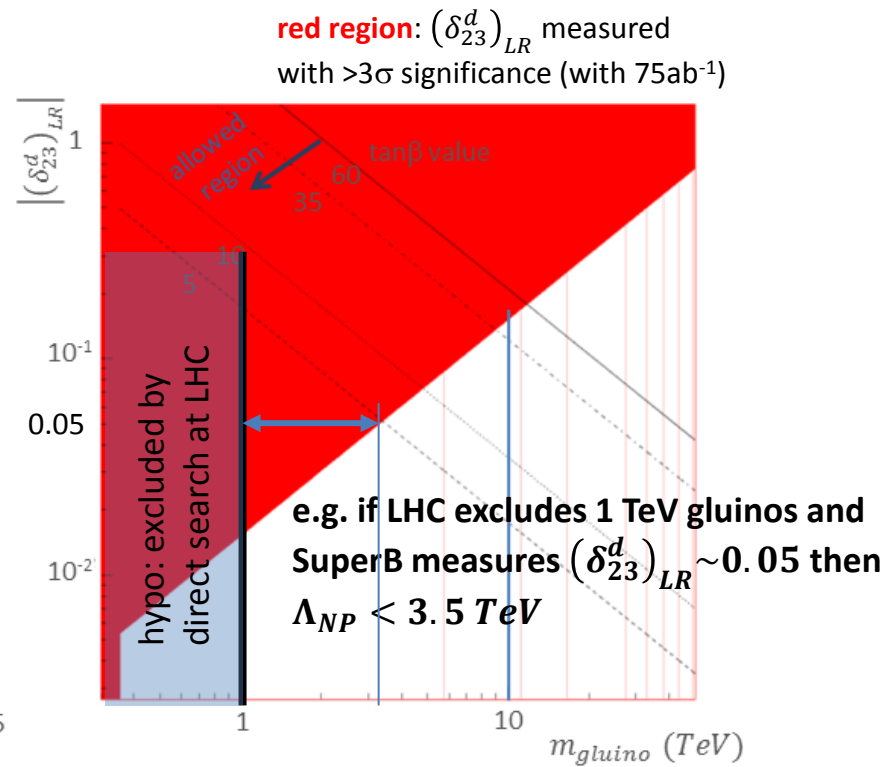
L.J. Hall et al, Nucl Phys B 267 (1986)

M. Ciuchini et al, PRD67,075016 (2003)

arXiv:0709.0451



reconstruction of  $(\delta_{23}^d)_{LR} = 0.028e^{i\pi/4}$   
for  $\Lambda_{NP} = m_{\tilde{g}} = m_{\tilde{q}} = 1 \text{ TeV}$

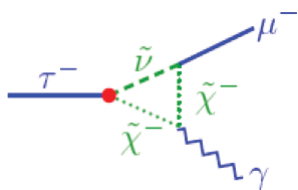


# $\tau$ physics

$\sigma(e^+e^- \rightarrow \tau^+\tau^-)_{\sqrt{s}=M(Y(4S))} \sim \sigma(e^+e^- \rightarrow Y(4S) \rightarrow B\bar{B}) \Rightarrow$  SuperB is a **tau factory**

- Lepton flavor violation

ν mixing leads to  $BF \sim 10^{-54}$   
 → Enhancement to observable  
 levels possible with new physics

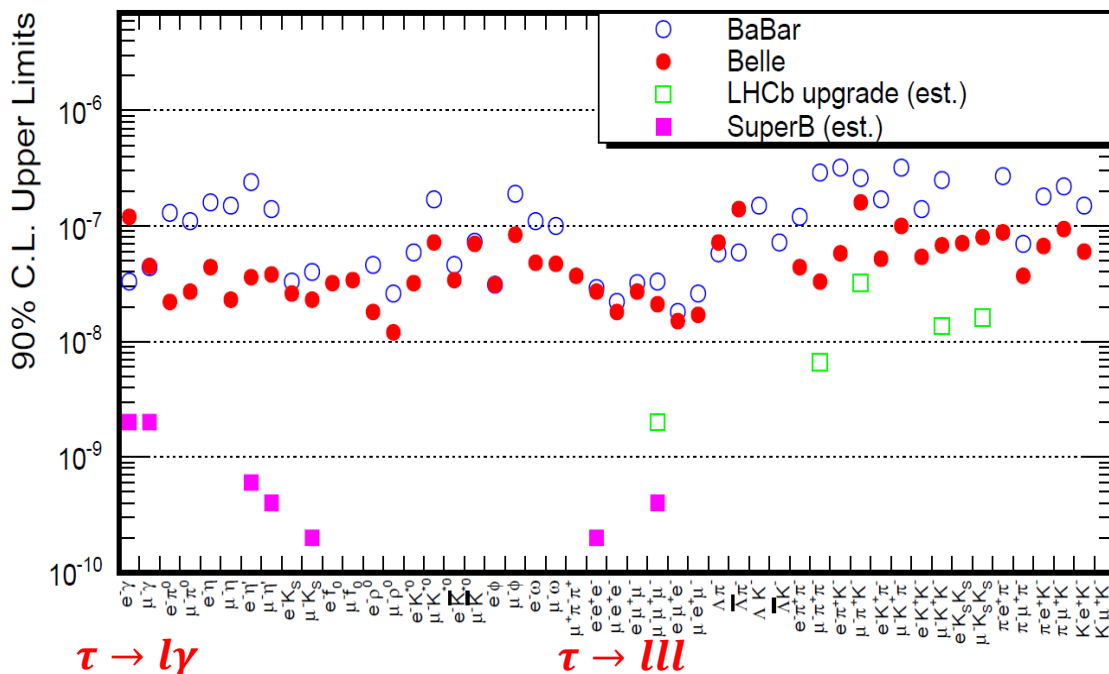


Up to two orders of magnitude improvement at SuperB over current limits

Hadron machines are in general  
not competitive

e<sup>-</sup> beam polarization helps  
suppress background or  
discriminate among NP models

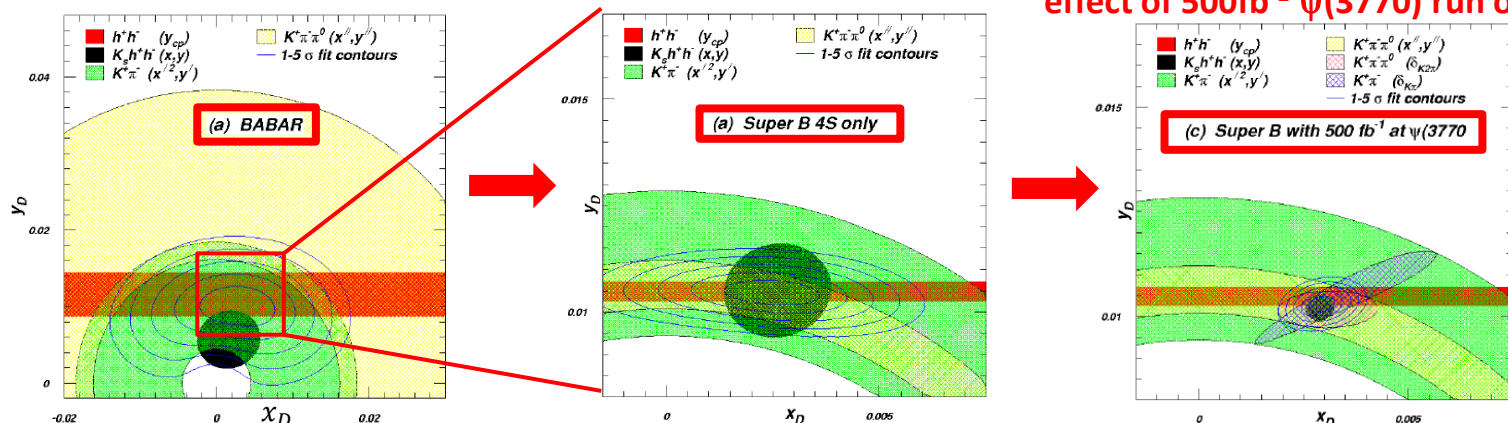
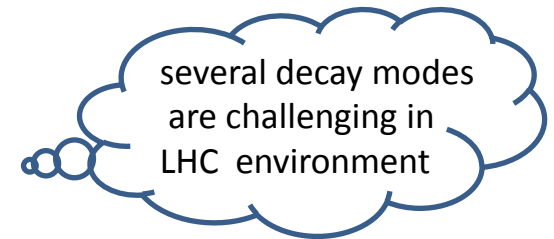
- CP violation
- precision  $|V_{us}|$  measurement
- $\tau$  g-2
- $\tau$  EDM



# Charm physics

$\sigma(e^+e^- \rightarrow c\bar{c})_{\sqrt{s}=M(Y(4S))} \sim 1.3 \sigma(e^+e^- \rightarrow Y(4S) \rightarrow B\bar{B}) \rightarrow$  SuperB is a **charm factory**  
possible  $1\text{ab}^{-1}$  **run at  $\psi(3770)$**  (1 year) extends the charm physics program

- search for CPV in D mixing
  - 10x reduction of  $\sigma(|q/p|)$  and  $\sigma(\arg(q/p))$
- precision measurement of D mixing parameters
- study of direct CPV in charm decays
  - DCS, SCS, multibody, ...
  - can shed light on nature of  $\Delta A_{CP}(K^-K^+, \pi^+\pi^-)$  with related channels ,e.g.  $D \rightarrow \rho\rho, D \rightarrow \pi\pi, D \rightarrow \text{multibody}$
- search for rare or forbidden charm decays
  - e.g.  $D \rightarrow \gamma\gamma, D \rightarrow l^+l^-, \text{LFV } D \rightarrow e^+\mu^-, \dots$



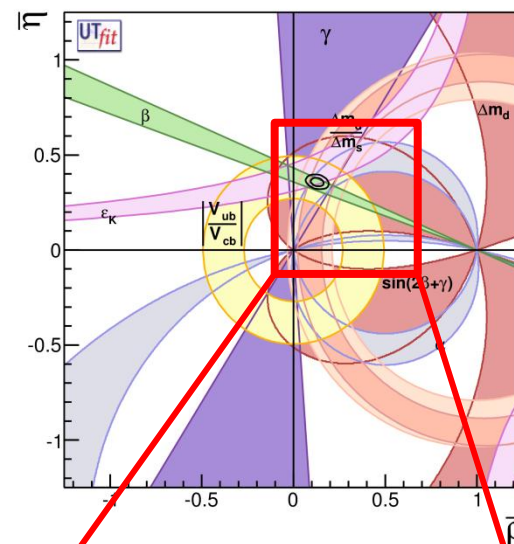
# Precision CKM constraints

- Unitarity triangle angles

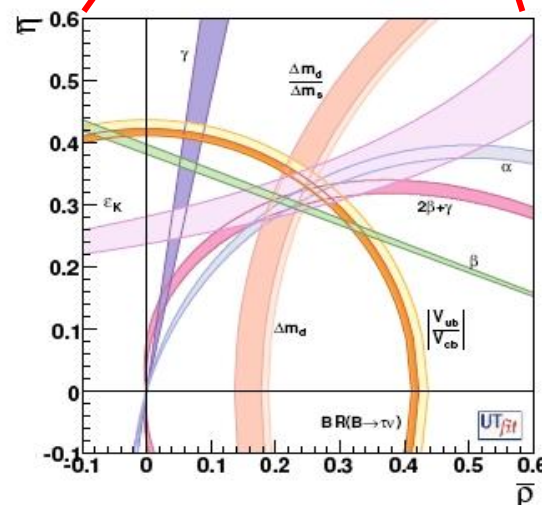
- $\sigma(\alpha) = 1^\circ$
- $\sigma(\beta) = 0.1^\circ$
- $\sigma(\gamma) = 1^\circ$

- CKM matrix elements

- $|V_{ub}|$ 
  - inclusive  $\sigma = 2\%$
  - exclusive  $\sigma = 3\%$
- $|V_{cb}|$ 
  - inclusive  $\sigma = 0.5\%$
  - exclusive  $\sigma = 1\%$
- $|V_{us}|$ 
  - can be measured using  $\tau$  decays
- $|V_{cd}|$  and  $|V_{cs}|$ 
  - can be measured at/near charm threshold



June 2012

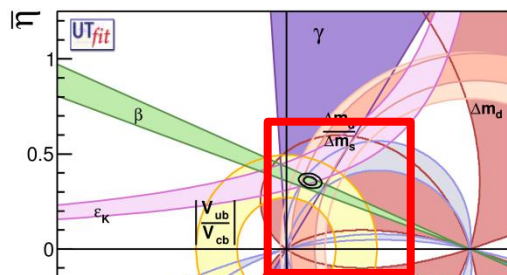


SuperB with  $50\text{ab}^{-1}$ .  
Large disagreement for illustrative purposes

# Precision CKM constraints

- Unitarity triangle angles

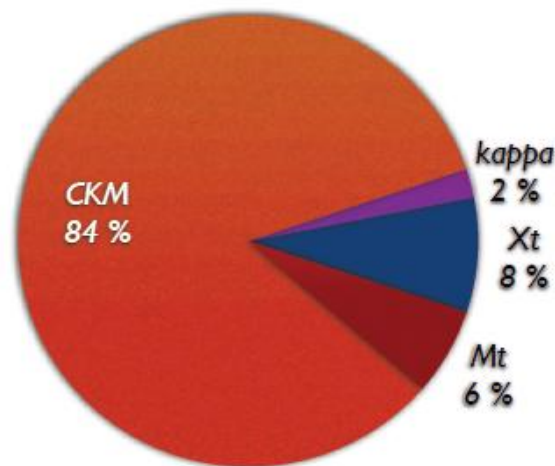
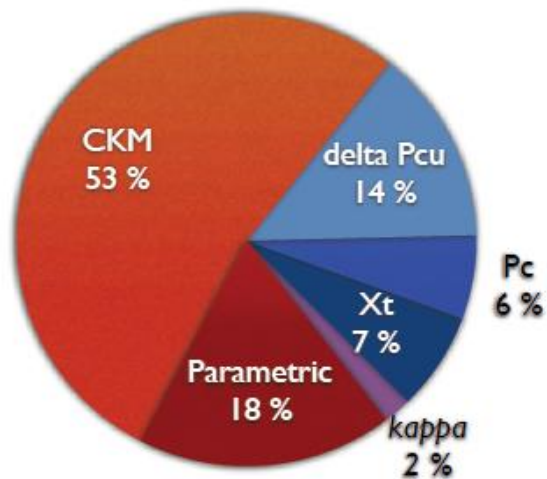
- $\sigma(\alpha) = 1^\circ$
- $\sigma(\beta) = 0.1^\circ$
- $\sigma(\gamma) = 1^\circ$



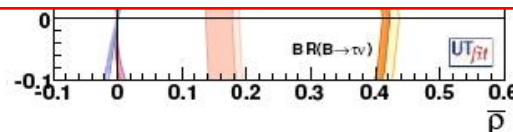
June 2012

- CKM  $K^+ \rightarrow \pi^+ \nu \bar{\nu}$  and  $K_L \rightarrow \pi^0 \nu \bar{\nu}$  error budgets

Martin Gorbahn, Monday morning



can be measured at/near charm threshold



SuperB with  $10 \text{ ab}^{-1}$ .  
large  
disagreement  
for illustrative  
purposes

# Interplay between measurements and theory

## Need to combine flavor measurements to disclose NP nature

Altmannshofer et al, Nucl. Phys. B830, 17 (2010), 0909.1333. See also arXiv:1008.1541

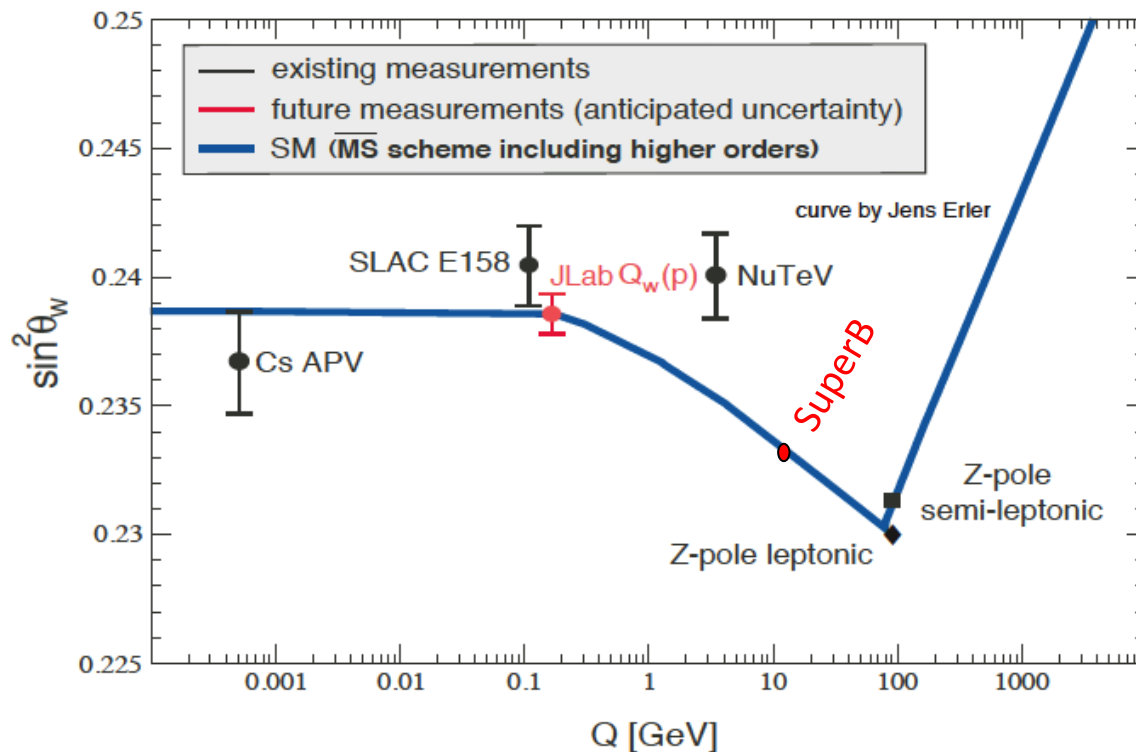
Observable/mode	$H^+$ high $\tan\beta$	MFV	non-MFV	NP Z penguins	Right-handed currents	LTH	SUSY				
							AC	RVV2	AKM	$\delta LL$	FBMSSM
→ $\tau \rightarrow \mu\gamma$							***	***	*	***	***
→ $\tau \rightarrow \ell\ell\ell$						***					
→ $B \rightarrow \tau\nu, \mu\nu$	*** (CKM)										
→ $B \rightarrow K^{(*)+}\nu\bar{\nu}$			*	***			*	*	*	*	*
→ $S$ in $B \rightarrow K_s^0\pi^0\gamma$					***						
→ $S$ in other penguin modes			*** (CKM)		***		***	***	*	***	***
→ $A_{CP}(B \rightarrow X_s\gamma)$			***		***		*	*	*	***	***
→ $BR(B \rightarrow X_s\gamma)$		***	*		*						
→ $BR(B \rightarrow X_s\ell\ell)$			*	*	*						
→ $B \rightarrow K^{(*)}\ell\ell$ (FB Asym)							*	*	*	***	***
$B_s \rightarrow \mu\mu$							***	***	***	***	***
$\beta_s$ from $B_s \rightarrow J/\psi\phi$							***	***	***	*	*
→ $a_{sl}$						***					
→ Charm mixing							***	*	*	*	*
→ CPV in Charm	***									***	

→ : measured at SuperB

\*\*\* large effects  
 \*\*\* visible but small effects  
 \* negligible effects

# Precision electroweak measurements

- $\sin^2 \theta_W$  can be measured with **polarized  $e^-$  beam**
  - $\sqrt{s} = M(Y(4S))$  is theoretically clean, cf. b fragmentation at  $Z^0$  pole



Measure LR asymmetry in

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

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

$$e^+e^- \rightarrow \tau^+\tau^-$$

$$e^+e^- \rightarrow \mu^+\mu^-$$

at the  $Y(4S)$  to same precision as LEP/SLC at the  $Z^0$  pole.

Complements measurements planned/underway at lower energies (QWeak/MESA).

# A rich physics program

## B Physics @ Y(4S)

Observable	B Factories (2 ab <sup>-1</sup> )	SuperB (75 ab <sup>-1</sup> )
$\sin(2\beta) (J/\psi K^0)$	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
$\sin(2\beta) (D^0)$	0.10	0.02
$\cos(2\beta) (D^0)$	0.20	0.03
$\sin(2\beta) (D^+)$	0.13	0.02 (*)
$\cos(2\beta) (D^+)$	0.05	0.01 (*)

## Charm FCNC

### Channel

$D^0 \rightarrow e^+e^-, D^0 \rightarrow \mu^+\mu^-$	$1 \times 10^{-8}$
$D^0 \rightarrow \pi^0 e^+e^-, D^0 \rightarrow \pi^0 \mu^+\mu^-$	$2 \times 10^{-8}$
$D^0 \rightarrow \eta e^+e^-, D^0 \rightarrow \eta \mu^+\mu^-$	$3 \times 10^{-8}$
$D^0 \rightarrow K_s^0 e^+e^-, D^0 \rightarrow K_s^0 \mu^+\mu^-$	$3 \times 10^{-8}$
$D^+ \rightarrow \pi^+ e^+e^-, D^+ \rightarrow \pi^+ \mu^+\mu^-$	$1 \times 10^{-8}$
$D^0 \rightarrow e^\pm \mu^\mp$	$1 \times 10^{-8}$
$D^+ \rightarrow \pi^+ e^\pm \mu^\mp$	$1 \times 10^{-8}$
$D^0 \rightarrow \pi^0 e^\pm \mu^\mp$	$2 \times 10^{-8}$
$D^0 \rightarrow \eta e^\pm \mu^\mp$	$3 \times 10^{-8}$
$D^0 \rightarrow K_s^0 e^\pm \mu^\mp$	$3 \times 10^{-8}$
$D^+ \rightarrow \pi^+ e^+e^+, D^+ \rightarrow K^+ e^+e^+$	$1 \times 10^{-8}$
$D^+ \rightarrow \pi^+ \mu^+\mu^+, D^+ \rightarrow K^+ \mu^+\mu^+$	$1 \times 10^{-8}$
$D^+ \rightarrow \pi^+ e^\pm \mu^\mp, D^+ \rightarrow K^+ e^\pm \mu^\mp$	$1 \times 10^{-8}$

### Sensitivity

$B(B \rightarrow \rho\gamma)$	15%	3% (†)
$B(B \rightarrow \omega\gamma)$	15%	3% (†)
$A_{CP}(B \rightarrow \rho\gamma)$	$\sim 0.20$	0.05
$A_{CP}(B \rightarrow \omega\gamma)$	0.012 (†)	0.001 (†)
$A_{CP}(b \rightarrow (s+d)\gamma)$	0.03	0.006 (†)
$S(K_s^0 \pi^0 \gamma)$		
$S(\rho^0 \gamma)$		

The menu is much wider

## ISR

## B<sub>s</sub> Physics @ Y(5S)

Observable	Error with
$\Delta\Gamma$	0.16 ps
$\Gamma$	0.07 ps
$\beta_s$ from angular analysis	20°
$A_{SL}^s$	0.006
$A_{CH}$	0.004
$B(B_s \rightarrow \mu^+\mu^-)$	-
$ V_{td}/V_{ts} $	0.08
$B(B_s \rightarrow \gamma\gamma)$	38%
$\beta_s$ from $J/\psi\phi$	10°
$\beta_s$ from $B_s \rightarrow K^0 \bar{K}^0$	24°

## τ Physics

Process	Sensitivity
$B(\tau \rightarrow \mu\gamma)$	$2 \times 10^{-9}$
$B(\tau \rightarrow e\gamma)$	$2 \times 10^{-9}$
$B(\tau \rightarrow \mu\mu\mu)$	$2 \times 10^{-10}$
$B(\tau \rightarrow eee)$	$2 \times 10^{-10}$
$B(\tau \rightarrow \mu\eta)$	$4 \times 10^{-10}$

## Charm mixing and CP

Mode	Observable	Y(4S) (75 ab <sup>-1</sup> )	ψ(3770) (300 fb <sup>-1</sup> )
$D^0 \rightarrow K^+\pi^-$	$x'^2$	$3 \times 10^{-5}$	
	$y'$	$7 \times 10^{-4}$	
$D^0 \rightarrow K^+K^-$	$y_{CP}$	$5 \times 10^{-4}$	
$D^0 \rightarrow K_s^0 \pi^+ \pi^-$	$x$	$4.9 \times 10^{-4}$	
	$y$	$3.5 \times 10^{-4}$	
$\psi(3770) \rightarrow D^0 \bar{D}^0$			$(1-2) \times 10^{-5}$
	$y$		$(1-2) \times 10^{-3}$
	$\cos \delta$		(0.01-0.02)

## Spectroscopy

# SuperB accelerator concept

- A 2 rings, asymmetric energies collider ( $e^-$  4.2 GeV,  $e^+$  6.7 GeV)
  - large Piwinsky angle and crab waist collision scheme
  - ultra low emittance lattices - ideas taken from ILC design
  - target baseline luminosity  $10^{36} \text{ cm}^{-2} \text{ s}^{-1}$  at  $Y(4S)$
  - longitudinally polarized  $e^-$  beam (fraction 60-80%)
  - possibility to run down to charm threshold with  $L=10^{35} \text{ cm}^{-2} \text{ s}^{-1}$
  - beam currents similar to PEP-II (RF power 17MW, limited beam background)
- Design criteria:
  - minimize building costs
  - minimize running cost
  - reuse some parts of PEP-II (BaBar B-factory)
- SuperB may host a hard X-FEL
  - using the SuperB linac
  - no interference with flavor factory operations

# Collision scheme

1

"nano beams"

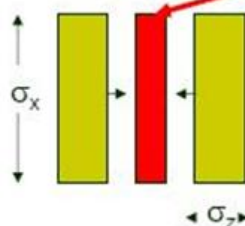
$$L = \frac{N^+ N^-}{4\pi\sigma_y \sqrt{\left(\sigma_z \tan \frac{\theta}{2}\right)^2 + \sigma_x^2}} f_c$$

Increase  $L$  by reducing the beam size at the IP

2

Large Piwinsky angle

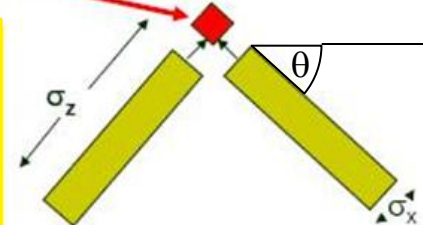
1) Head-on,  
Short bunches



Overlap region

(1) and (2) have same overlap region but (2) has longer bunches and smaller  $\sigma_x$

2) Large crossing angle,  
long bunches



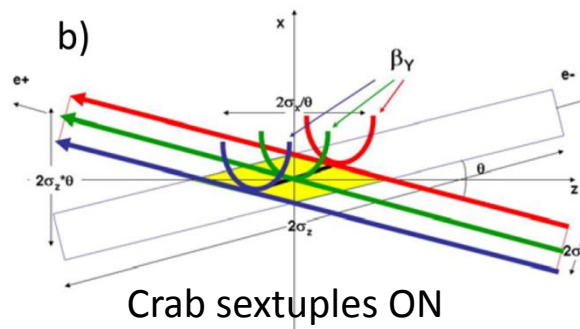
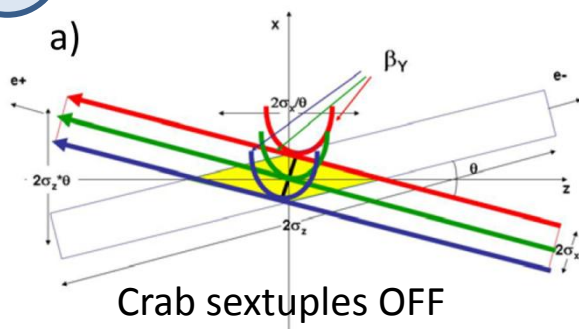
Conventional scheme

Large Piwinsky angle scheme

$$\Phi = \tan \theta \frac{\sigma_z}{\sigma_x}$$

3

crab waist



With crab waist:

- suppression of vertical synchro-betatron resonances
- maximize overlap of beams

Collision scheme with large Piwinsky angle + crab waist successfully tested at DAFNE in 2009 (3x luminosity increase with CW ON). New tests ongoing at DAFNE with KLOE-2 installed (0.5 T solenoidal magnetic field ON)

# Parameter table

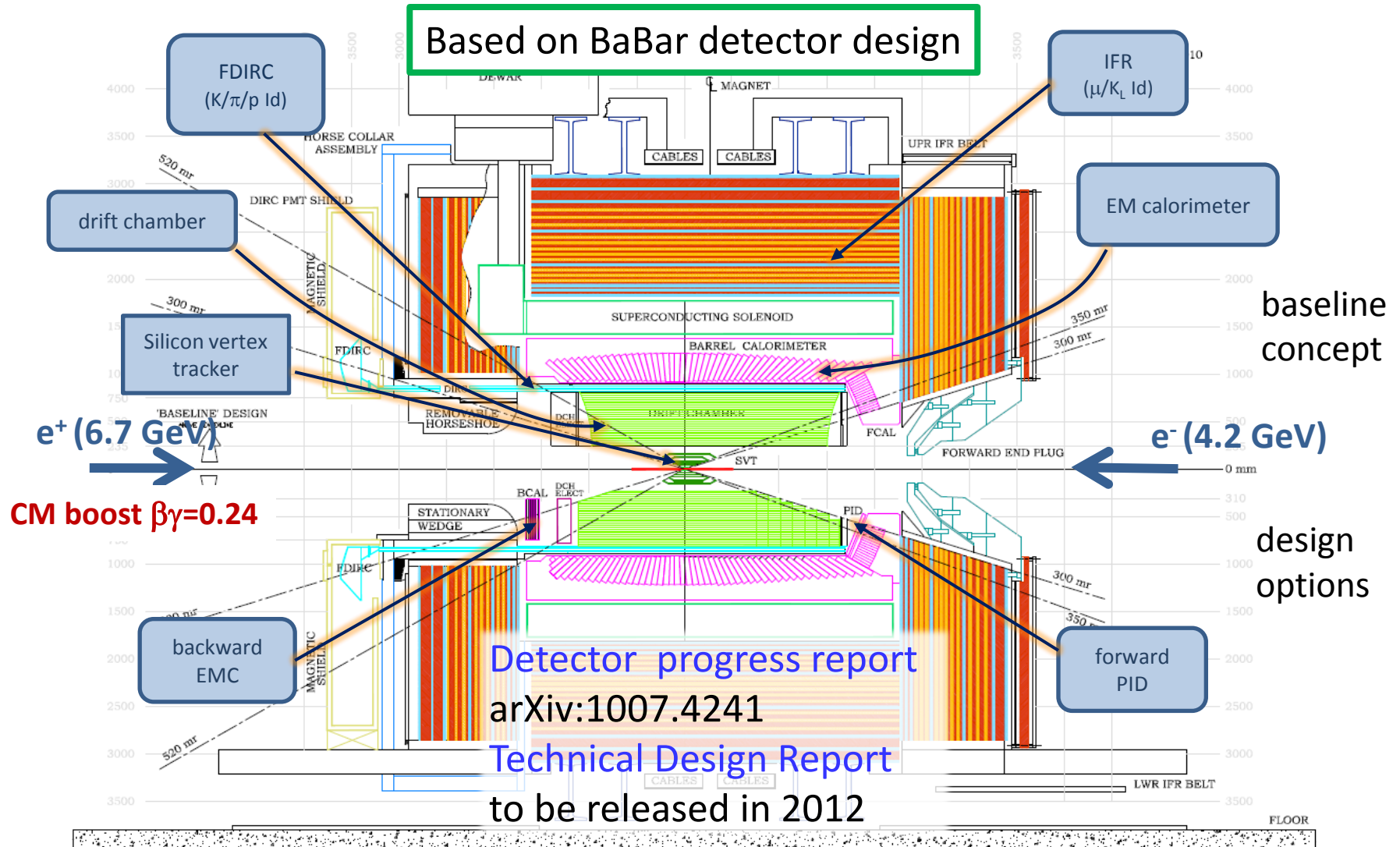
- Baseline + 2 options
  - Lower emittance
  - Higher currents
- charm threshold option  
with  $L=10^{35} \text{ cm}^{-2}\text{s}^{-1}$
- RF power includes
  - Synchrotron radiation
  - High Order Modes

Parameter	Units	Base Line		Low Emittance		High Current		$\tau/\text{charm}$	
		HER (e+)	LER (e-)	HER (e+)	LER (e-)	HER (e+)	LER (e-)	HER (e+)	LER (e-)
LUMINOSITY ( $10^{36}$ )	$\text{cm}^{-2} \text{s}^{-1}$	1		1		1		1	
Energy	GeV	6.7	4.18	6.7	4.18	6.7	4.18	2.58	1.61
Circumference	m	1258.4		1258.4		1258.4		1258.4	
X-Angle (full)	mrاد	60		60		60		60	
Piwiniski angle	rad	20.80	16.91	29.42	23.91	13.12	10.67	8.00	6.50
$\beta_x$ @ IP	cm	2.6	3.2	2.6	3.2	5.06	6.22	6.76	8.32
$\beta_y$ @ IP	cm	0.0253	0.0205	0.0179	0.0145	0.0292	0.0237	0.0658	0.0533
Coupling (full current)	%	0.25	0.25	0.25	0.25	0.5	0.5	0.25	0.25
$\epsilon_x$ (without IBS)	nm	1.97	1.82	1.00	0.91	1.97	1.82	1.97	1.82
$\epsilon_x$ (with IBS)	nm	2.00	2.46	1.00	1.23	2.00	2.46	5.20	6.4
$\epsilon_y$	pm	5	6.15	2.5	3.075	10	12.3	13	16
$\sigma_x$ @ IP	$\mu\text{m}$	7.211	8.872	5.099	6.274	10.060	12.370	18.749	23.076
$\sigma_y$ @ IP	$\mu\text{m}$	0.036	0.036	0.021	0.021	0.054	0.054	0.092	0.092
$\Sigma_x$	$\mu\text{m}$	11.433		8.085		15.944		29.732	
$\Sigma_y$	$\mu\text{m}$	0.050		0.030		0.076		0.131	
$\sigma_L$ (0 current)	mm	4.69	4.29	4.73	4.34	4.03	3.65	4.75	4.36
$\sigma_L$ (full current)	mm	5	5	5	5	4.4	4.4	5	5
Beam current	mA	1892	2447	1460	1888	3094	4000	1365	1766
Buckets distance	#	2		2		1		1	
Buckets distance	ns	4.20		4.20		2.10		2.10	
Ion gap	%	2		2		2		2	
RF frequency	MHz	476		476		476		476	
Harmonic number		1998		1998		1998		1998	
Number of bunches		465		465		931		931	
N. Particle/bunch ( $10^{10}$ )		5.08	6.56	3.92	5.06	4.15	5.36	1.83	2.37
Tune shift x		0.0026	0.0040	0.0020	0.0031	0.0053	0.0081	0.0063	0.0096
Tune shift y		0.1067	0.1069	0.0980	0.0981	0.0752	0.0755	0.1000	0.1001
Long. damping time	msec	13.4	20.3	13.4	20.3	13.4	20.3	26.8	40.6
Energy Loss/turn	MeV	2.11	0.865	2.11	0.865	2.11	0.865	0.4	0.166
$\sigma_E$ (full current)	$\delta E/E$	6.43E-04	7.34E-04	6.43E-04	7.34E-04	6.43E-04	7.34E-04	6.94E-04	7.34E-04
CM $\sigma_E$	$\delta E/E$	5.00E-04		5.00E-04		5.00E-04		5.26E-04	
Total lifetime	min	4.23	4.48	3.05	3.00	7.08	7.73	11.41	6.79
Total RF Power	MW	16.38		12.37		28.83		2.81	

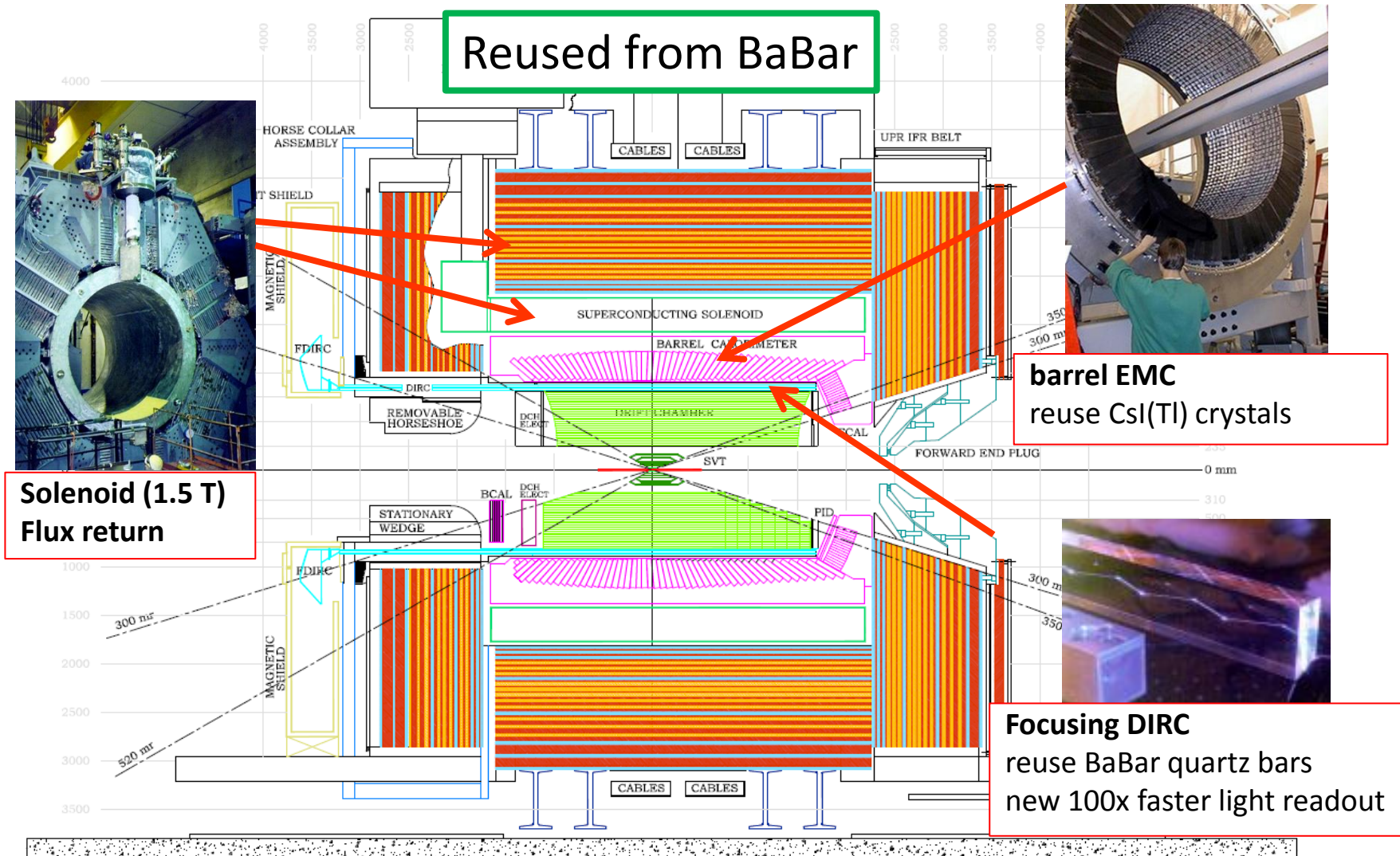
Accelerator progress  
report: [arXiv:1009.6178](https://arxiv.org/abs/1009.6178)

TDR expected in 2013

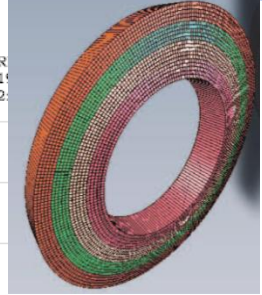
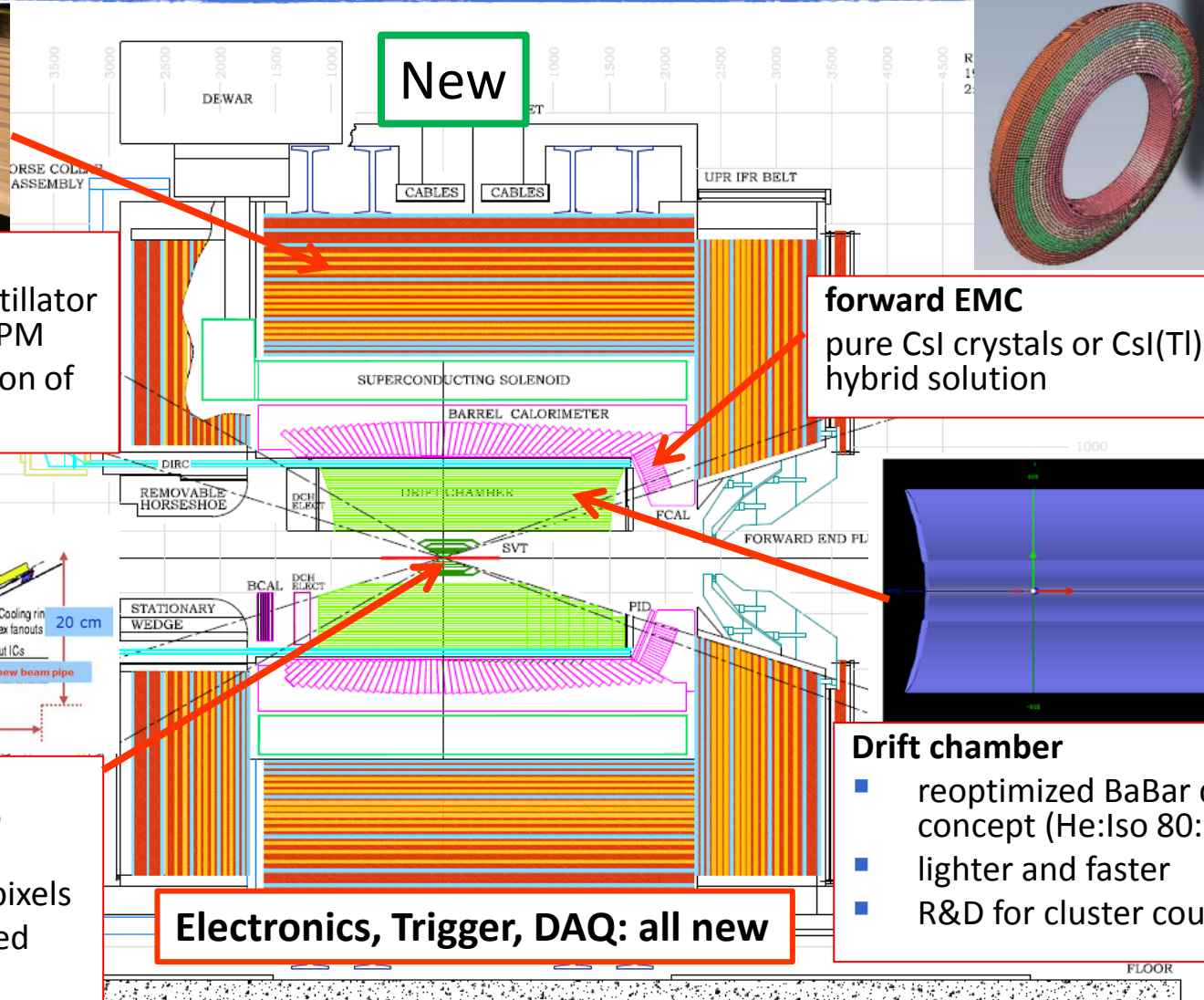
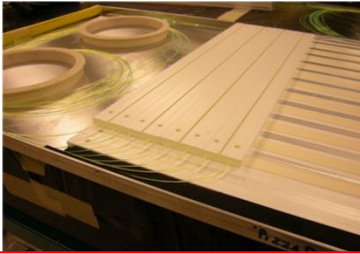
# The SuperB detector



# The SuperB detector



# The SuperB detector

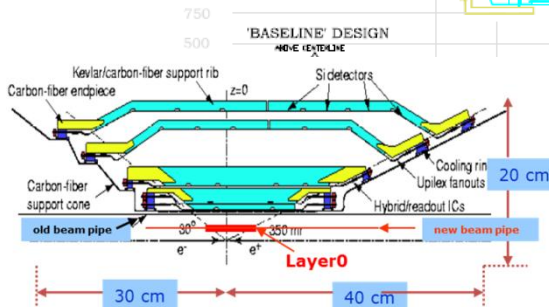


## IFR

- replace LSST with scintillator + WLS fibers + silicon PM
- amount and distribution of iron re-optimized

## forward EMC

- pure CsI crystals or CsI(Tl)+LYSO hybrid solution



## Silicon Vertex Tracker

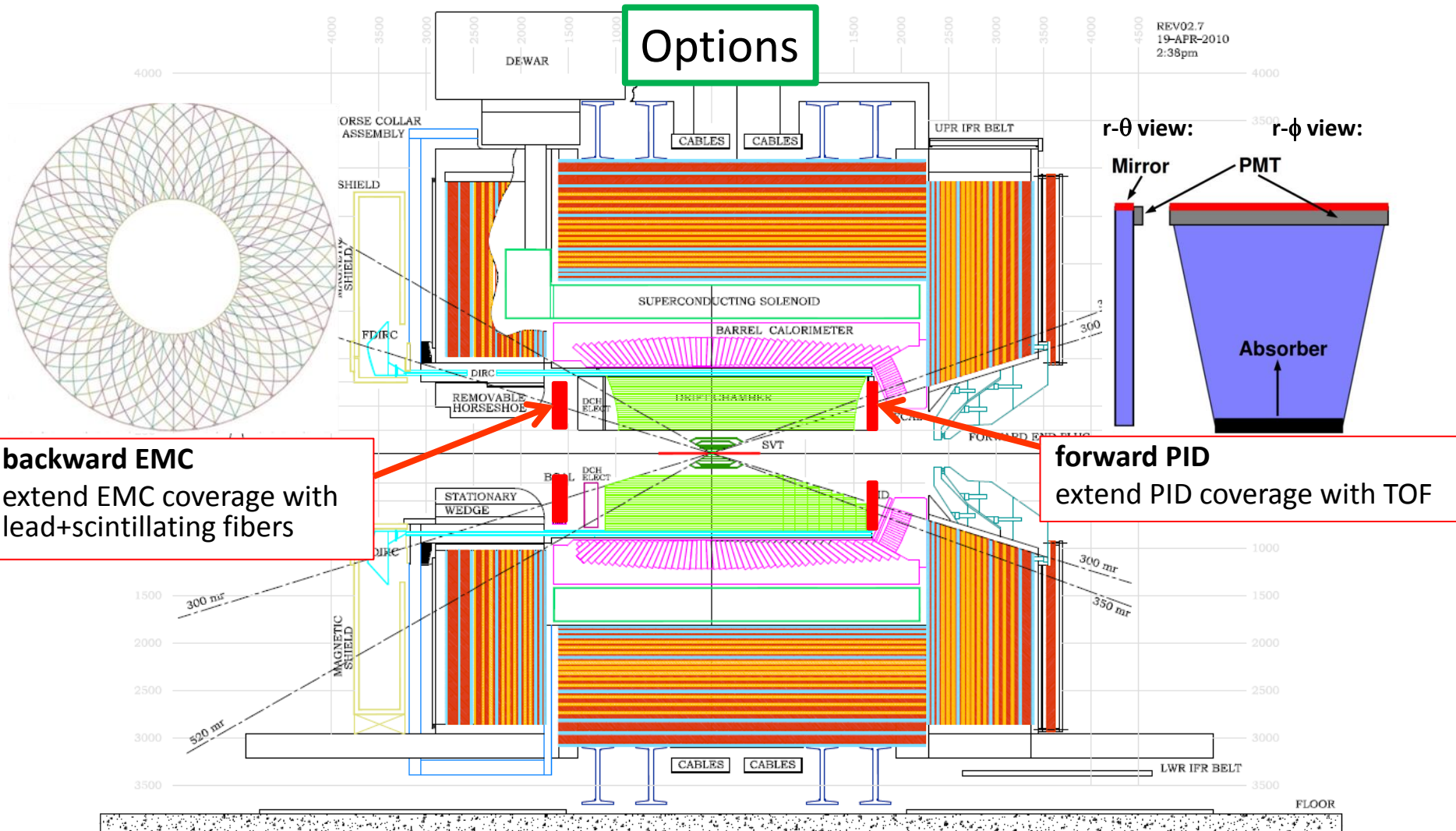
- Layer-0 close to the IP technology: striplets (baseline for TDR) or pixels
- 5 layers of double-sided microstrip sensors

**Electronics, Trigger, DAQ: all new**

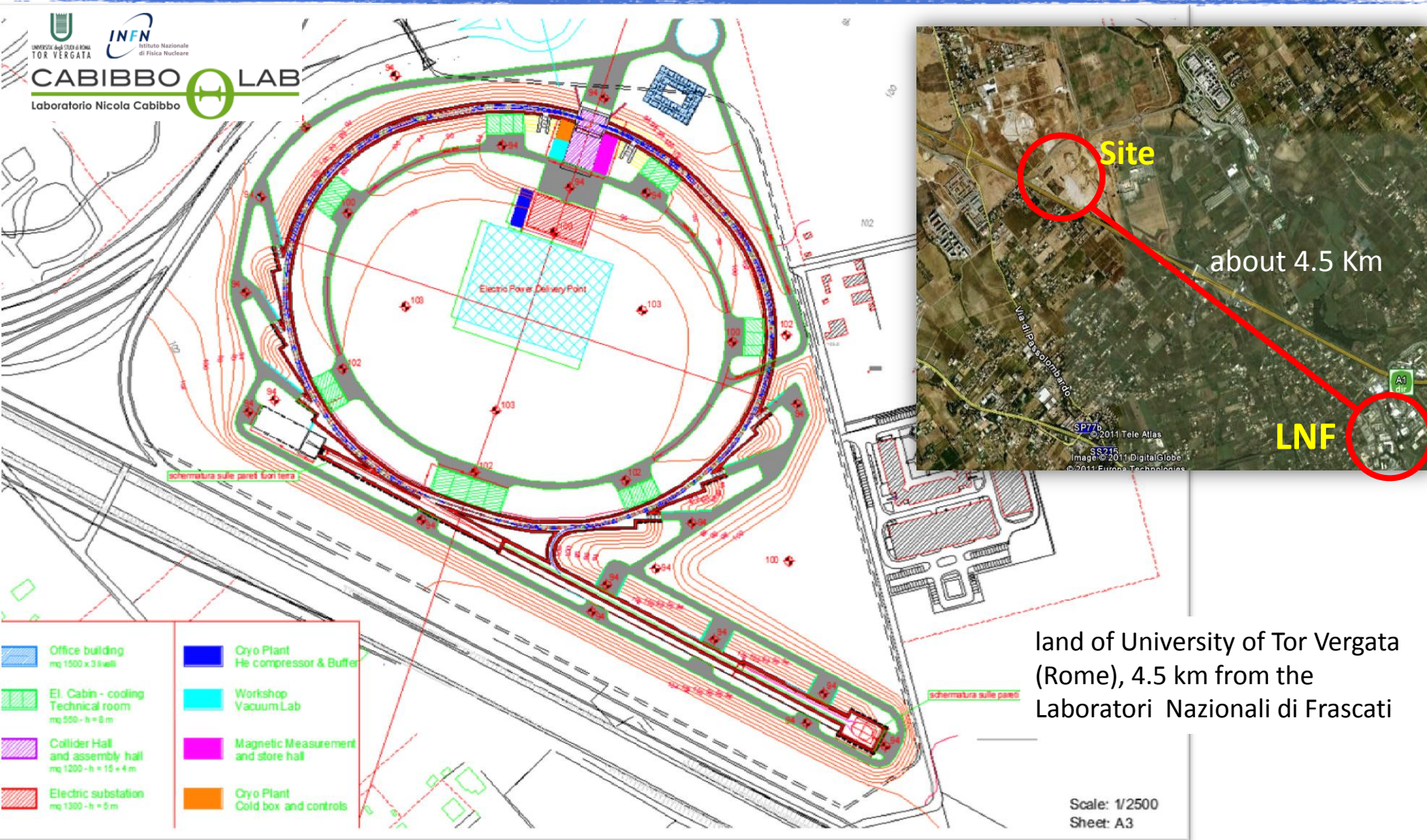
## Drift chamber

- reoptimized BaBar design concept (He: Iso 80:20)
- lighter and faster
- R&D for cluster counting

# The SuperB detector



# The site



land of University of Tor Vergata  
(Rome), 4.5 km from the  
Laboratori Nazionali di Frascati

# Project governance

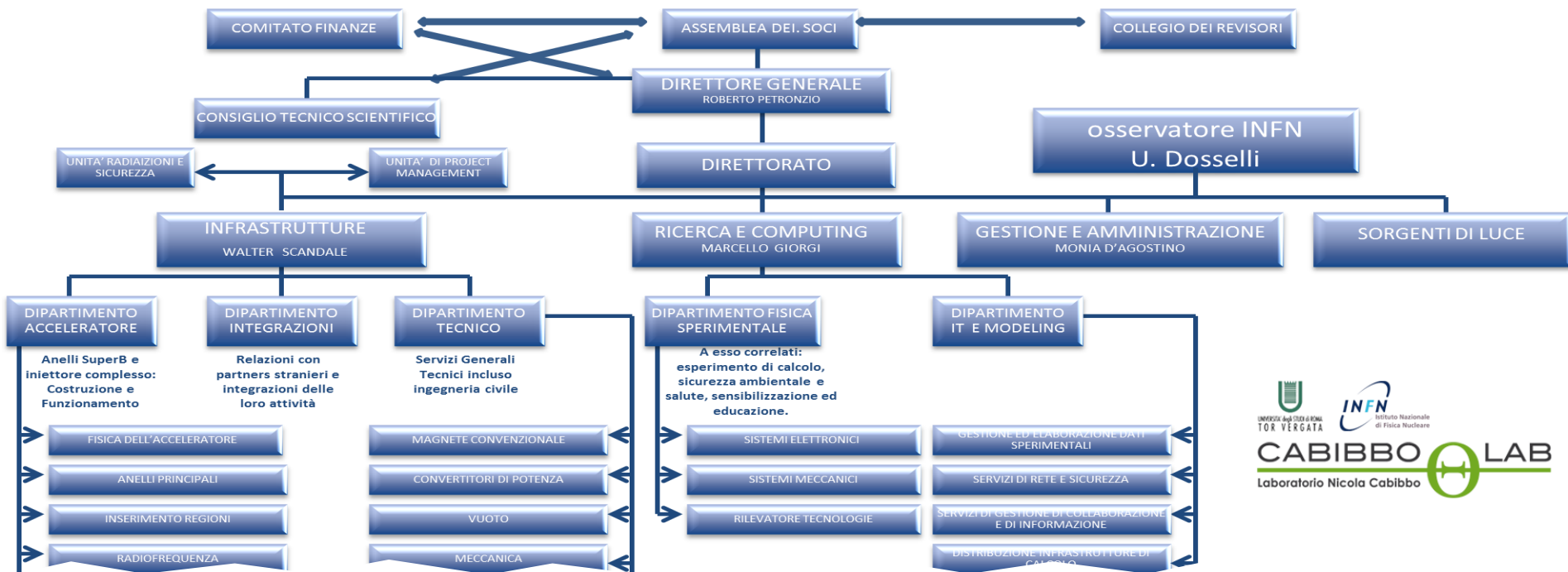
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- Three phases:
    - INFN: the starting phase
    - Consortium: as an independent legal entity
      - Following main European infrastructures
      - More flexibility in the organisation
      - Can directly associate foreign partners (EGO like)
      - An “intermediate solution”
    - European consortium (ERIC): the final structure
- ← present phase

The consortium Cabibbo Lab was created on Oct 7<sup>th</sup> 2011  
<http://www.cabibbolab.it/>

# The Cabibbo Lab

- A CERN like management structure
  - A director general and a directorate
  - A scientific evaluation committee
  - A finance evaluation committee



# Costing review

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- About 250 M€ allocated by the Italian Government so far
- Costing review requested to estimate the project total cost
- WBS for costing just completed
- Costing document sent to Finance Committee
- Report from committee for Italian Ministry of Research expected by end of November with an intermediate iteration

Ministerial review of all “flagship projects” in Fall 2012

# Approval path and next steps

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- 2009: Special project SuperB-TDR approved by Italian INFN
- 2010: SuperB included in Italian National Research Plan by Ministry of Research as flagship project
- 2011: Consortium Cabibbo Lab established
- 2012:
  - Governance of Cabibbo Lab defined
  - Accelerator management in place
  - Costing WBS
  - Costing review
  - MOUs (INFN, France, SLAC, UK, Russia,...)
  - Lattice completion (LNF+BINP+LAL)
  - Detector TDR
  - Finance committee report to Italian Ministry of Education, University and Research
- 2013:
  - Accelerator TDR
  - Possible start of civil engineering

# Summary

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- SuperB has a very reach physics program
  - super B, tau, charm factory in a ‘clean’ environment
  - complementary with an upgraded LHCb
  - large overlap with SuperKEKB+Belle2, a few additional features
- Based on innovative  $e^+e^-$  collision scheme
  - “nano” beams
  - baseline luminosity  $10^{36} \text{ cm}^{-2} \text{ s}^{-1}$
- Detector design in advanced stage
  - a few technology options still open but overall mature
  - TDR in 2012
- Approval path
  - costing review in progress
  - next months very important for the future of the project

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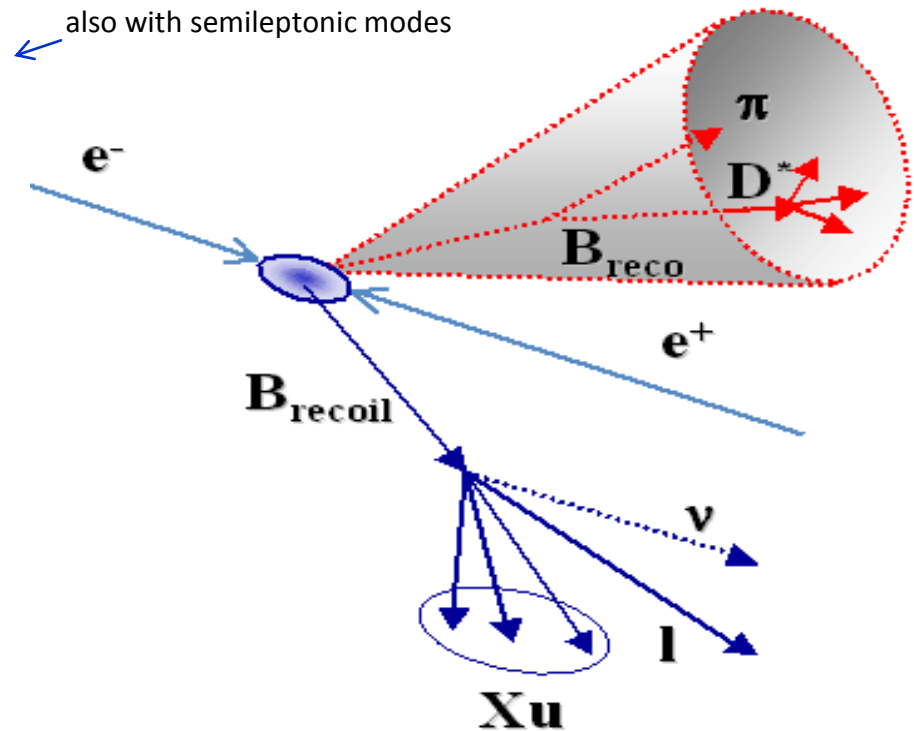
## BACKUP SLIDES

# B recoil technique

## Powerful technique possible at $e^+e^-$ B-factories

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

unique feature of  $e^+e^-$  machine



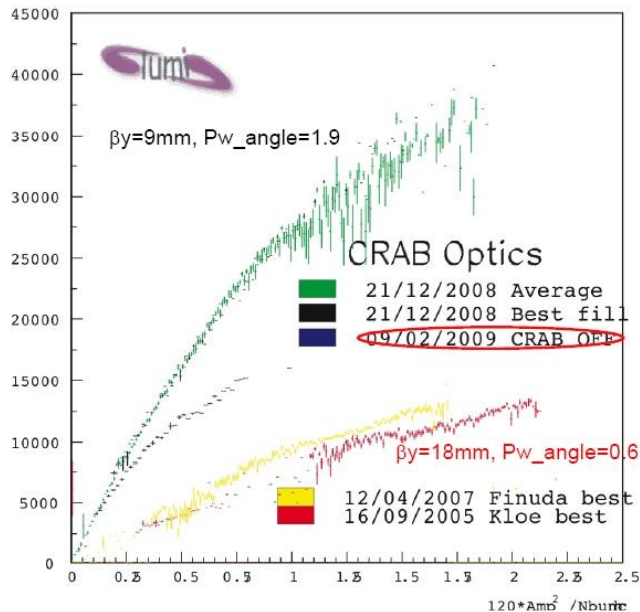
**Recoil kinematics well known**  
**Recoil flavour and charge are determined**

# Detector R&D

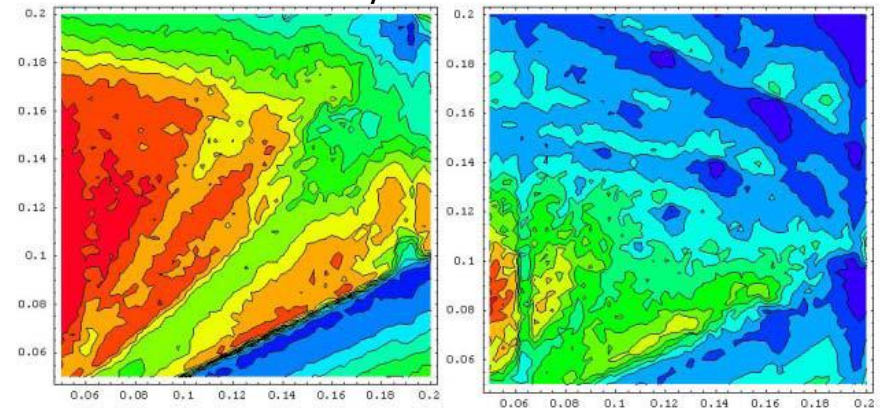
System	Baseline	Challenges and R&D
MDI	Initial IR designed	Magnetic elements and radiation masks. Design of tungsten shields. Cryostats radius Background simulations: global map, detector occupancy
SVT	6-layer silicon Striplets Layer 0	Technology for Layer 0: striplets or pixels. Thin pixels R&D. Readout chip for strips. Readout architecture. Mechanical design.
DCH	Stereo-axial He-based	Dimensions (inner radius, length). Mechanical structure. Cluster counting option.
EMC	Barrel: CsI(Tl)  Forw: LYSO+CsI(Tl)	Electronics and trigger. Mechanical structure. Transport and refurbishing. Forward EMC technology: LYSO; LYSO+CsI(Tl); Pure CsI. Backward EMC: cost/benefit analysis
PID	DIRC w/ FBLOCK	Focusing Block design. Photon detection. Mechanical structure Forward PID: cost/benefit analysis. Prove TOF technology.
IFR	Scintillator+ fibers	8 vs 9 layers. SiPM radiation damage and location. Extra 10cm iron. Mechanical design and yoke reuse.
ETD	Synchronous const. latency	Fast link rad hardness. L1Trigger (jitter and rate). ROM design. Link to computing for HLT.

# Crab waist tests at DAFNE (2009)

luminosity scan in the tunes plane performed for DAFNE in the Siddharta configuration



Red: max. luminosity Blue: minimum



Crab ON  $\rightarrow 0.6/\theta$

$$L_{\max} = 2.97 \times 10^{33} \text{ cm}^{-2} \text{ s}^{-1}$$

$$L_{\min} = 2.52 \times 10^{32} \text{ cm}^{-2} \text{ s}^{-1}$$

Crab OFF

$$L_{\max} = 1.74 \times 10^{33} \text{ cm}^{-2} \text{ s}^{-1}$$

$$L_{\min} = 2.78 \times 10^{31} \text{ cm}^{-2} \text{ s}^{-1}$$

- When the crab waist is turned off:
  - beam size increases
  - luminosity drops down

with the crab waist:

- many X-Y betatron resonances disappear or become weaker
- good working area is significantly enlarged ( $\rightarrow$  larger integrated luminosity)