Status of SuperB Project

Guy Wormser

On behalf of the SuperB Project

LAL Orsay

La Thuile, March 5, 2011

Take home Message

- SuperB is approved by the Italian governement!
- 19 M€ received in 2010, 50 M€ will follow in 2011
- First large scale project in Europe besides CERN since HERA in ~1985
- First beams in 2016. 15 ab-1 per year
- SuperB key tool to unravel New Physics in complement to the LHC

Talk outline

- Physics goal of SuperB in a nutshell
- SuperB is approved !!!
- SuperB Physics reach
- The machine design
- The detector and detector R&D
- 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

A conversation between Flavour Physics and LHC energy frontier discovery program

- When evidence is found for New Physics at the LHC, attention will turn to understanding the details
  - Is it SUSY? What type of symmetry breaking?
  - Is it extra dimensions? Are they warped?
- Super*B/LHCb* will be crucial to an understanding of the flavor sector of any type of new physics
  - Is there charged lepton flavor violation?
  - Are there new CP phases ?
  - Is there a charged Higgs ?
  - Is there minimal flavor violation in the (s)quark sector?

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 approval and funding process (1)

- In March 2010, the Italian governement preselected a list of Flagship projects, as part of an economy stimulus package. SuperB was ranked first in this list.
- On December 3, 2010, the governemenet decided to immediately release funds for 6 of these projects, among which SuperB, the largest of them.
- This was presented to both Chambers of the Italian parliament and were approved on December 15, 2010. A sum of 19 M€ was allocated for SuperB and transferred to INFN!

Progetti Bandiera

(not by alphabetical order!)

March 2010

Gli interventi

Progetto	Settore	Valore stimato (milioni)
Super B Factory	Fisica	650
Cosmo - Skymed II generation	Aerospazio	N.D.
Epigenomica	Medicina	N.D.
3N - Network nazionale delle nanotecnologie	Industria	300
Ritmare - Ricerca ita. per il mare	Industria	795
Sintonia - Sistema integrato di telecomunicazioni	Aerospazio	671
Ipi - Invecchiamento e pop. isolate	Medicina	90
Agro Alimentare	Agricoltura	100
L'ambito nucleare	Energia	53,5
Recupero e rilancio della Villa dei Papiri	Beni cluturali	20
Elettra-Fermi-Eurofel	Industria	191
Astri - Astrofisica con specchi a tecnologia replicante italiana	Aerospazio	8
Controllo delle crisi nei sistemi complessi socio-economici	Economica	30
La fabbrica del futuro	Industria	30

Funded Flagship Projects December 2010

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Extracts from official documents of Italian Government and Italian Parliament

SENATO DELLA REPUBBLICA

XVI LEGISLATURA

N. 303

ATTO DEL GOVERNO

SOTTOPOSTO A PARERE PARLAMENTARE

Schema di decreto ministeriale recante ripartizione del Fondo ordinario per gli enti e le istituzioni di ricerca, per l'anno 2010

SENATO DELLA REPU... ICA
Segretariato Ge...
Data - 6 DIC. 2010

Ministero dell' Istruzione, dell' Università e della Ricerca

DIPARTIMENTO PER L'UNIVERSITÀ, L'ALTA FORMAZIONE ARTISTICA, MUSICALE E COREUTICA E PER LA RICERCA

DIREZIONE GENERALE PER IL COORDINAMENTO E LO SVILUPPO DELLA RICERCA

Prot. 1417

Roma, 3 DIC. 2010

Al Presidente del Senato della Repubblica
Palazzo Madama
00186 ROMA

Ministerial act sent to parliament on DEC 3 , 2010

The SuperB paragraph

All'Istituto Nazionale di Fisica Nucleare (INFN) viene accordato, nell'ambito dei progetti bandiera, un contributo di € 19.000.000,00 a del progetto pluriennale di ricerca "SuperB Factory", avente quale obiettivo la realizzazione di un acceleratore per elettroni e positroni ad alta luminosità in grado di rispondere ad esigenze di ricerca di base e di fisica applicata. Il progetto vede il coinvolgimento di enti e Università, nonché di aziende dei vari settori di attività. Numerose e prevedibili appaiono le ricadute in settori di interesse del paese, soprattutto nei confronti dell'ampliamento di orizzonti scientifici di base e particolari applicazioni riguardanti la rivelazione di particelle, tecniche avanzate di simulazione, metrologia nanometrica etc.

The approval and funding process (2)

- The Italian parliament decided that an envelop of 8% of the Research budget , ie 150 M€ per year, will be devoted to the multi-year funding of these projects
- In parallel, INFN prepared in its ‘Piano Triennale’ 2010-2012 a funding profile for the SuperB project. This plan has been approved by the governement.
- As a result, 50 M€ will be allocated to SuperB in 2011.

The act says that 8% of the Full Budget of the Research agencies will be used from now on to ensure the full funding of the multiyear Progetti Bandiera.

SuperB is the only one quoted as multiyear.

Inside the 8% national '(150 M€ per year) stays comfortable the 270 M€ requested by INFN in 5 years .

The Minister Act was finally approved by the Senate and Chamber on Dec 14 and 15, 2010

http://www.camera.it/453?shadow_organo_parlamentare=1500&bollet=_dati/leg16/lavori/bollet/201012/1215/html/07

Quanto alle indicazioni per il biennio successivo – da fornirsi ai sensi del disposto di cui all'art. 7 comma 2 del citato decreto legislativo 204/1998 – il provvedimento che si sottopone alle valutazioni delle Commissioni parlamentari prevede che gli enti destinatari delle assegnazioni potranno considerare quale dato certo per la predisposizione del proprio bilancio di previsione 2011 l'87% delle assegnazioni ordinarie stabilite per il corrente esercizio. Tale indicazione è in linea con quanto disposto dall'art. 4, comma 2, del D.Lgs. n. 213/2009 di riordino degli enti, che stabilisce che a decorrere dal 2011 una quota non inferiore al 7% dello stanziamento, con progressivi incrementi per gli anni successivi, dovrà essere destinata "al finanziamento premiale di specifici programmi e progetti, anche congiunti, proposti dagli enti" e che "I criteri e le motivazioni di assegnazione della predetta quota sono disciplinate con decreto avente natura non regolamentare del Ministro". In attuazione della predetta disposizione nel 2011 un accantonamento pari al 7% del Fondo verrà destinato alle finalità di cui al citato decreto legislativo. Un ulteriore accantonamento, corrispondente all'8% delle disponibilità del Fondo, verrà invece utilizzato per dare continuità al

11

INFN Triennal plan (2010-2012)

Componenti Super B	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Sviluppo Acceleratore (130 M€) Costruzione infrastrutture, Sviluppo damping rings, Sviluppo transfer lines, Messa in funzione linac, Damping lines transfer lines, Costruzione facility end-user	20	50	60							
Sviluppo Centri Calcolo (43 M€) Sviluppo progettazione costruzione centro di calcolo per analisi dati	5	15	23							
Completamento Acceleratore (126 M€) Installazione componenti negli archi acceleratore, Installazione zona di interazione, Messa in funzione acceleratore				42	42	42				
Utilizzo installazione (80 M€) Costi operazione e manutenzione acceleratore							20	20	20	20
Totale Infrastrutture tecniche (379 M€)	25	65	83	42	42	42	20	20	20	20
Overheads INFN (34.3 M€ equivalente al 9%)	2.3	5.9	7.5	3.8	3.8	3.8	1.8	1.8	1.8	1.8
Cofinanziamento INFN (150 M€)	15	15	15	15	15	15	15	15	15	15
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

The act of Minister is linked to the Plan of INFN

The Three Year Plan of INFN, that each year is updated and extended by one year) approved in 2011 by the Board of Directors of INFN contains the spending profile for the SuperB construction. It was submitted to the Ministry of Science (MIUR) and accepted.

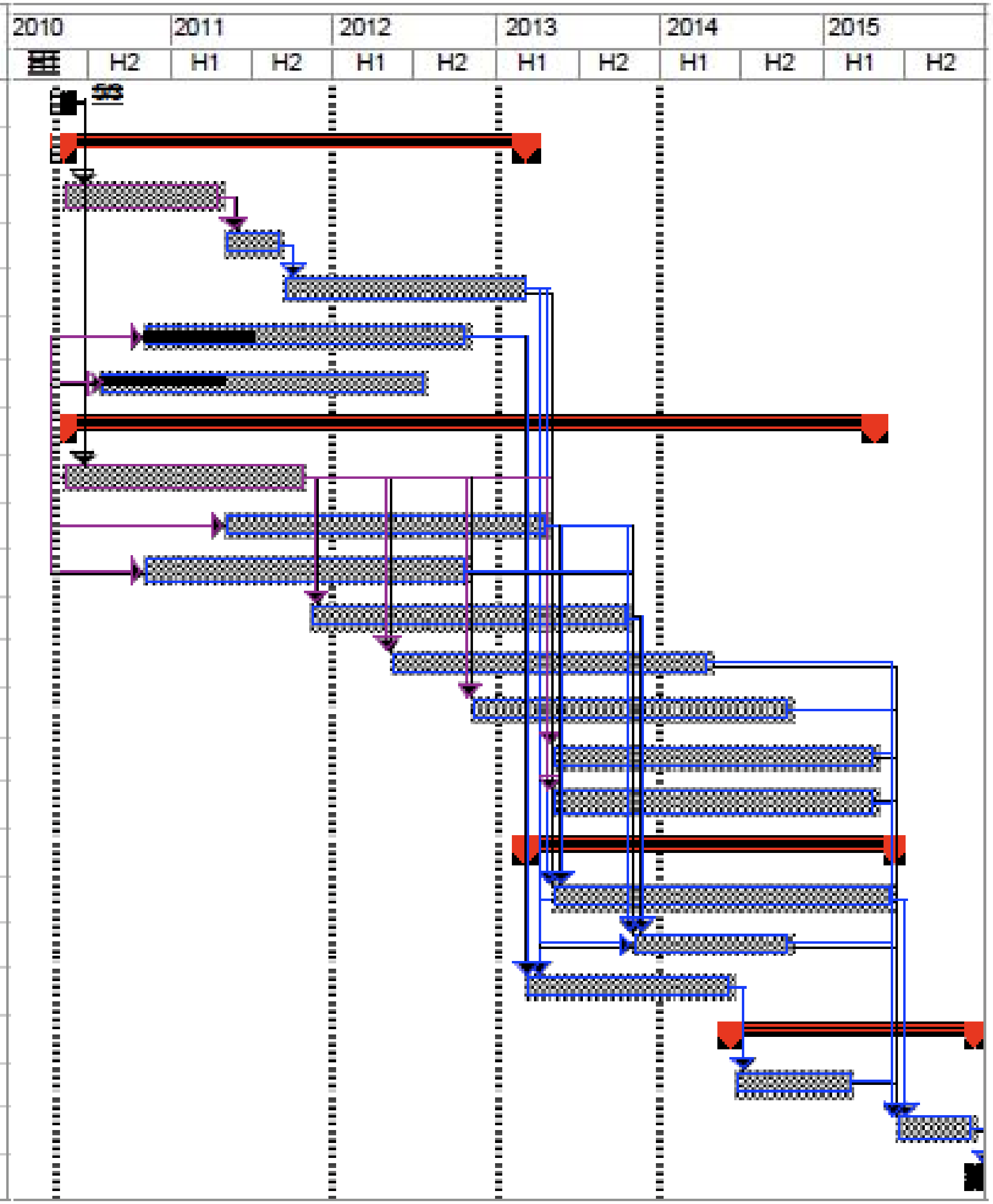
What needed now to guarantee the funding continuity?
A Program Agreement signed by INFN and Minister.

i.e. INFN accepts the funding plan and the conditions given by Ministry (monitoring, evaluation ….)
Money will be given year by year subject to fulfill the conditions.

In 2011 extra 50 M€ expected.

The theoretical schedule

ID	Task Name	Duration
1	Aprrovazione	0 wks
2	**Infrastrutture**	**149 wks**
3	Progettazione edilizia civile	52 wks
4	Gara edilizia civile	19 wks
5	Costruzione Tunnel, Edifici, e Sala sperim	78 wks
6	Progetto/gara Linac, DR, & BTL	104 wks
7	Progetto e gara Elettr., Raffredd., Cryo.	104 wks
8	**Progetto & Costruzione Acceleratore**	**260 wks**
9	Progettazione acceleratore	78 wks
10	Costruzione magneti	104 wks
11	Costruzione sistema vuoto	104 wks
12	Costruzione supporti	104 wks
13	Costruzione utilities	104 wks
14	Costruzione controlli	104 wks
15	Costruzione RF	104 wks
16	Costruzione alimentatori	104 wks
17	**Installazione Acceleratore**	**117 wks**
18	Installazione nel tunnel	110 wks
19	Installazione Zona Interazione	52 wks
20	Installazione Linac, DR, & BTL	65 wks
21	**Commissioning Acceleratore**	**78 wks**
22	Commissioning Linac	39 wks
23	Commissioning Fasci	26 wks
24	Prime collisioni	0 wks



Key milestones

- Site choice Summer 2011
- Start civil engineering End 2011
- Machine end Detector TDR end 2011
- Start machine installation Early 2013
- First collisions Beg 2016
- (Many machine elements are reused from PEP-II)

SuperB scope

- The SuperB project covers :
  - An asymmetric e+e- collider for B, tau and charm physics with a polarized e- beam
  - A very intense light source with 3 , growing up to 10, light beamlines
  - A SuperB detector
  - A very large computing system
  - Site and infrastructure

SuperB Machine is an international project

- 3 main sources of income for material:
  - The 270 M€ coming from the Italian government
  - In-kind contribution from US : PEP-II hardware (value estimated around 120 M€)
  - An estimated 100 M€ from Italian Institute of Technology for the light source
- Brainpower will come from an international team consisting for the moment of :
  - Italy, US, France, Russia, UK
- Detailed project organization ongoing now. Should be ready in June 2011 at the latest

(Many areas where help is welcome. Time to join!)

SuperB detector will be built by a « classical » international collaboration

- The detector will reuse BABAR components and will cost an extra 50 M€
- INFN will cover on its own budget (Gruppo 1) around 50% of this cost
- ~25 M€ will therefore have to be found from international partners.
- Presently participation of : Italy, Canada, France, Germany, Poland, Russia, Spain, UK, US
- The collaboration is still open. Lots of things to do. Consider joining! First formal meeting May 28 in Elba.

Present and future goals of Flavour Physics

It is a game of couplings and scales

→ if NP particles are discovered at LHC we have to be able to study the flavour structure of the NP

("reconstructing" the NP Lagrangian)

→ in addition, have the capability to explore NP scale beyond the LHC reach

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

Coupling δ	PRECISION 20% today	PRECISION 10% Tomorrow (2010-2015) (LHCb,MEG,NA62…)	PRECISION 1% after tomorrow (>2015)
Order 1	Λ_{eff} ~ 20 TeV	Λ_{eff} ~ 30 TeV	Λ_{eff} ~ 100 TeV
MFV	Λ_{eff} ~ 180 GeV	Λ_{eff} ~ 250 GeV	Λ_{eff} ~ 800 GeV

The actors in the next decade

Which NP will be ??

- 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 ($\tau \to \mu\mu\mu$)
- Br ($B \to K \nu\nu$)
- A_{CP} ($B \to X_s \gamma$)
- Br ($B \to K_S \pi^0 \gamma$)
- Br ($\tau \to \mu\gamma$)
- ACP($B_s \to J/\psi \phi$)

- NMFV (1-3)
- MFV
- MFV-GUT
- RH-currents
- NMFV (2-3)
- H$^+$ - high tanβ
- Z penguins
- LHT Models

Many of these channels could be studied by SuperB

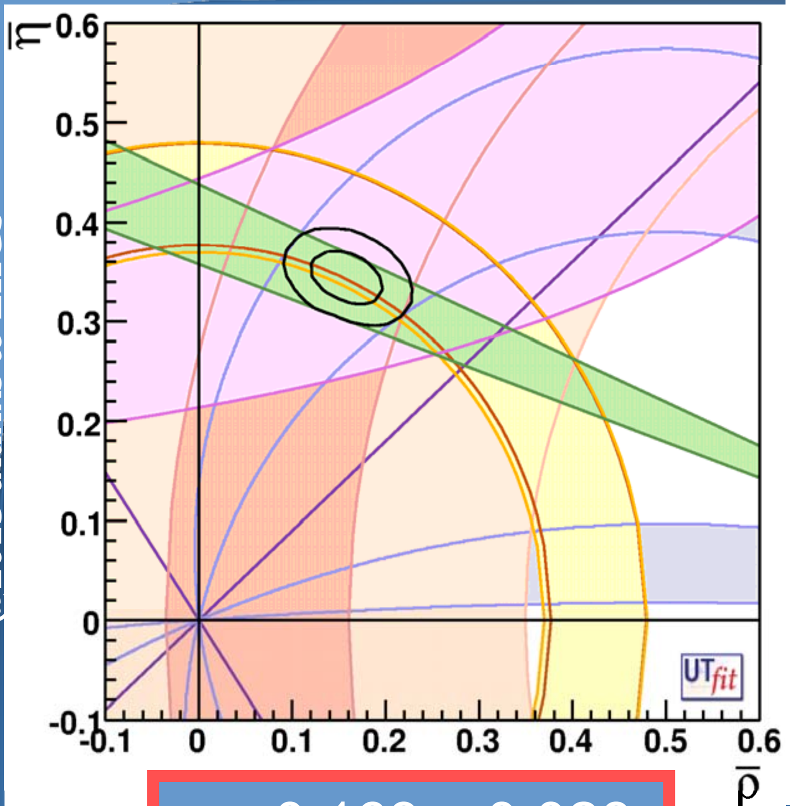
SuperB Golden channels

- To pay tribute to the very impressive success of LHCB, I just list channels that CAN'T be studied there :
  - Inclusive $b \to s\gamma$
  - $B \to K\nu\nu$
  - $B \to \tau\nu$
  - $\tau \to \mu\gamma$
- And many many more…..

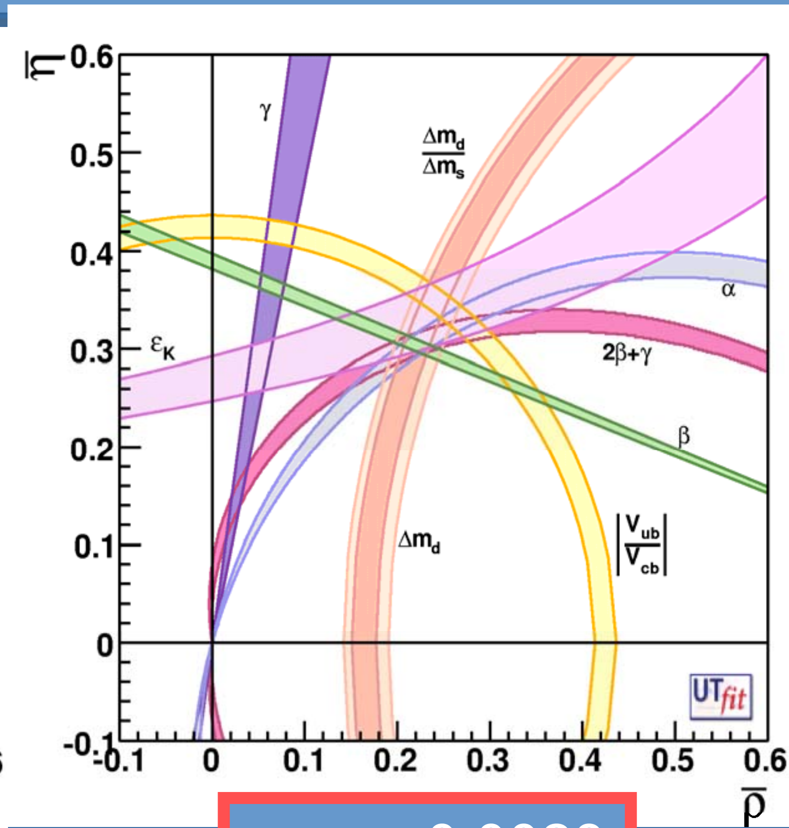
1 Determination of CKM parameters and New Physics

This situation will be different
@2015 thanks to LHCb

Today



Future (SuperB) + Lattice improvements



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

→

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

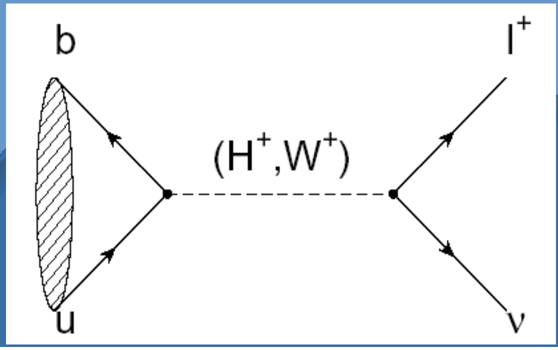
players are :

$\gamma, \alpha, \beta .., V_{ub}$
and Lattice !

Improving CKM is crucial to look for NP

Important also in K physics :
$K \rightarrow \pi \nu \nu$, CKM errors dominated the error budget

2 Leptonic decay B → l ν

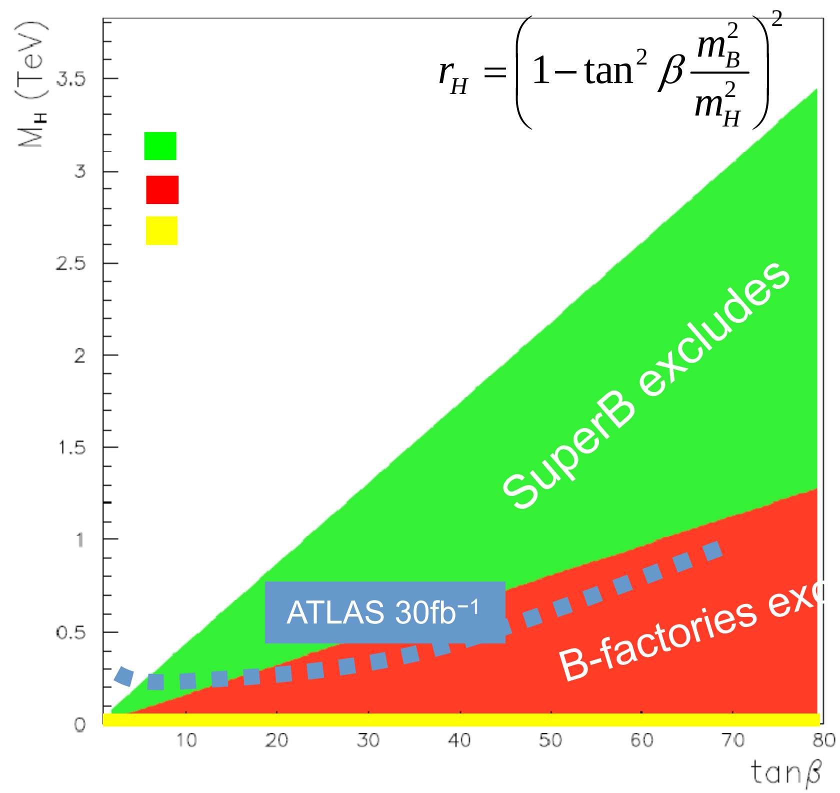


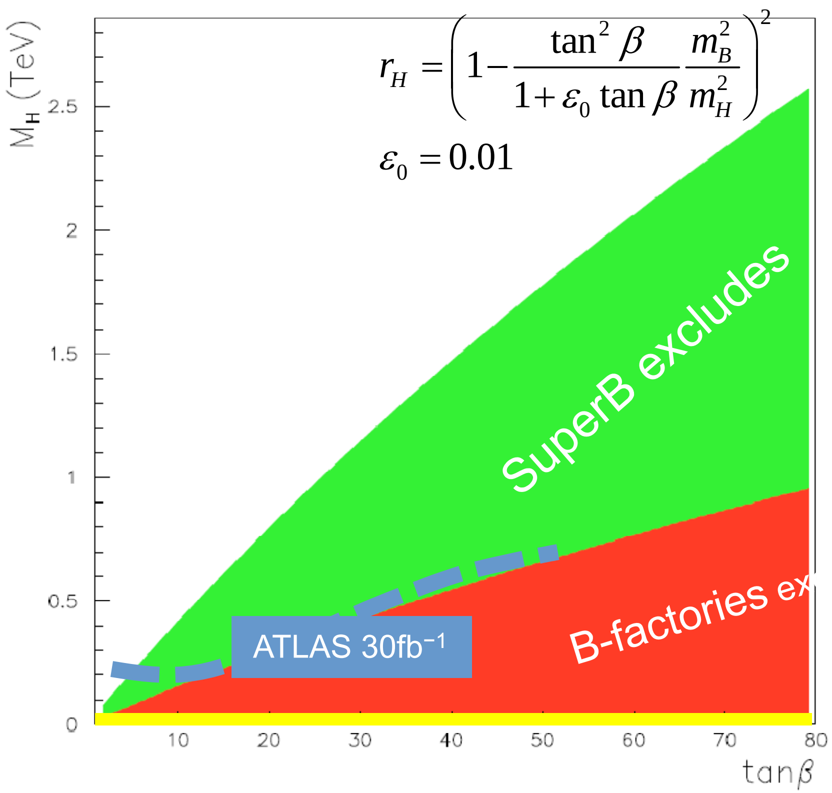
$$BR(B\to\tau\nu)=BR_{SM}(B\to\tau\nu)\left(1-\frac{m_B^2}{M_H^2}\tan^2\beta\right)^2$$

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

SuperB -75ab^{-1}

M_H~1.2-2.5 TeV for tanβ~30-60

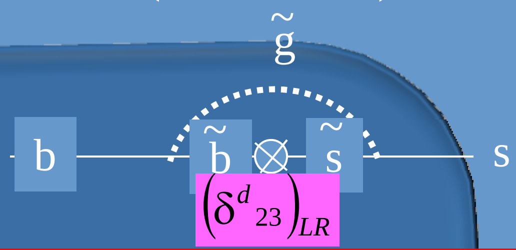




3

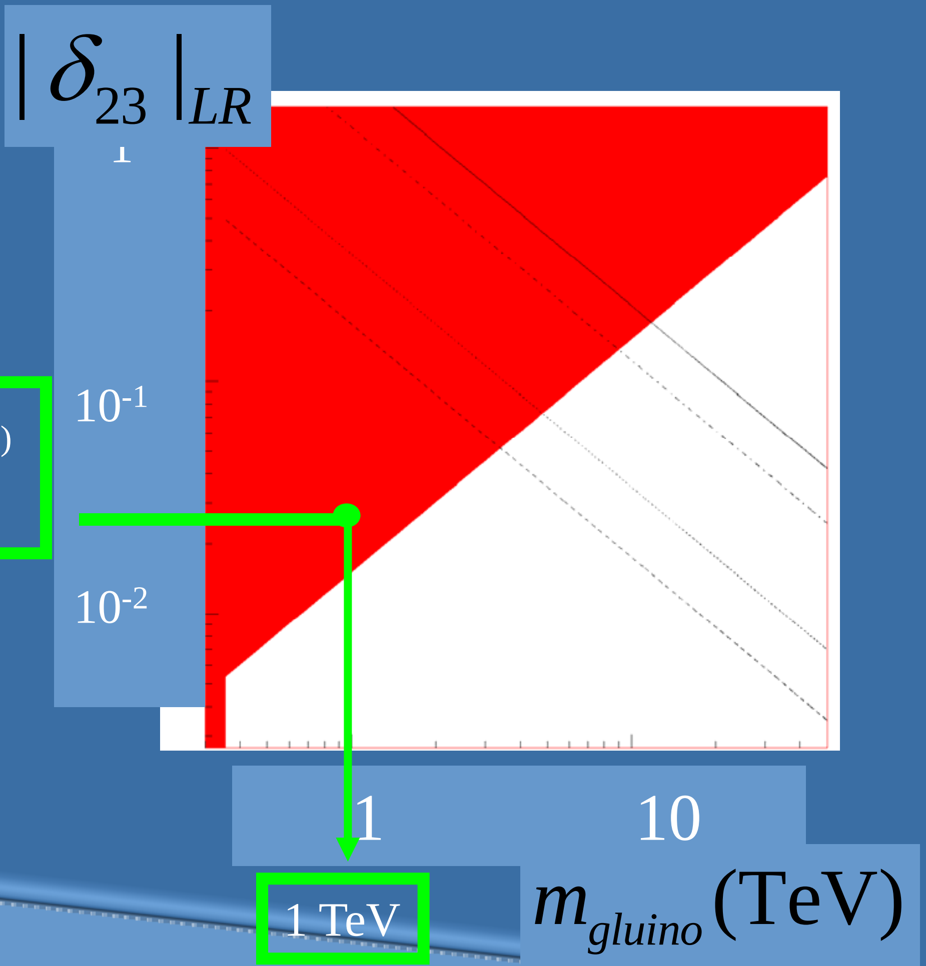
MSSM+generic soft SUSY breaking terms

New Physics contribution (2-3 families)



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

$Arg(\delta_{23})_{LR}$=(44.5± 2.6)^o



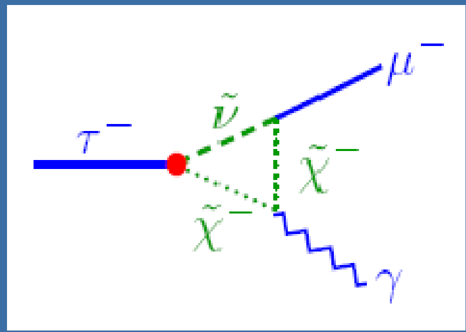
Here the players are :

- $(B \to X_s \gamma)$
- $(B \to X_s l^+l^-)$
- $A_{CP}(B \to X_s \gamma)$

4

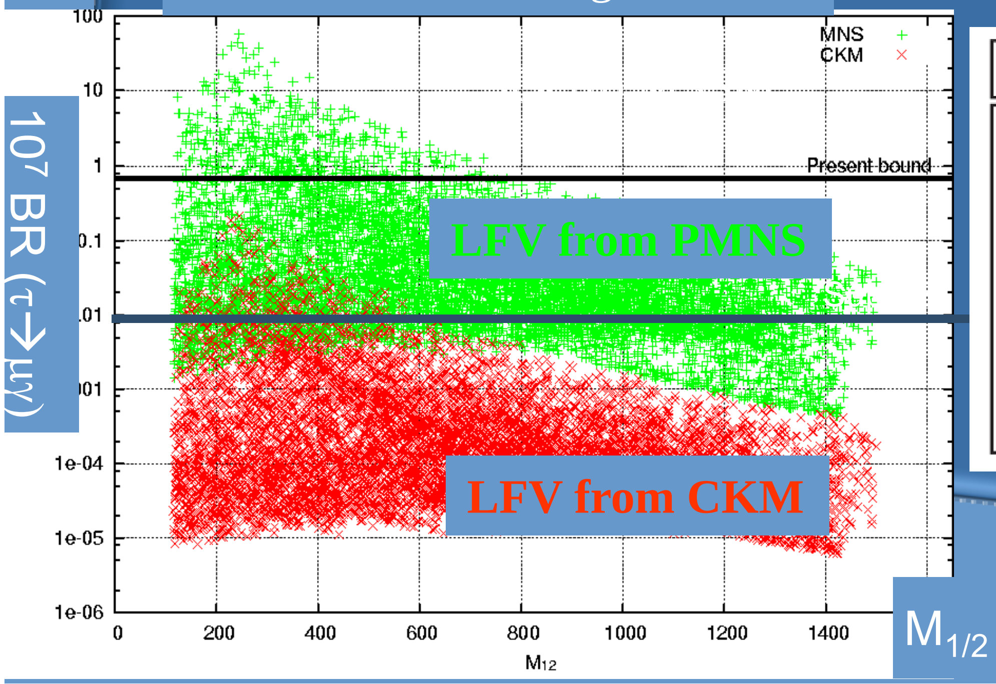
Lepton Flavour Violation in τ decays

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}
$\mathcal{B}(\tau \to \ell K^0_s)$	2×10^{-10}



MEG sensitivity μ→eγ ~10^{-13}
Preliminary results < 1.5 10^{-11}

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	$\sim 1\cdot10^{-2}$	$\sim 1\cdot10^{-2}$
$\frac{\mathcal{B}(\tau^-\to \mu^-\mu^+\mu^-)}{\mathcal{B}(\tau\to \mu\gamma)}$	0.4...2.3	$\sim 2\cdot10^{-3}$	0.06...0.1
$\frac{\mathcal{B}(\tau^-\to e^-\mu^+\mu^-)}{\mathcal{B}(\tau\to e\gamma)}$	0.3...1.6	$\sim 2\cdot10^{-3}$	0.02...0.04
$\frac{\mathcal{B}(\tau^-\to \mu^-e^+e^-)}{\mathcal{B}(\tau\to \mu\gamma)}$	0.3...1.6	$\sim 1\cdot10^{-2}$	$\sim 1\cdot10^{-2}$
$\frac{\mathcal{B}(\tau^-\to e^-e^+e^-)}{\mathcal{B}(\tau^-\to e^-\mu^+\mu^-)}$	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

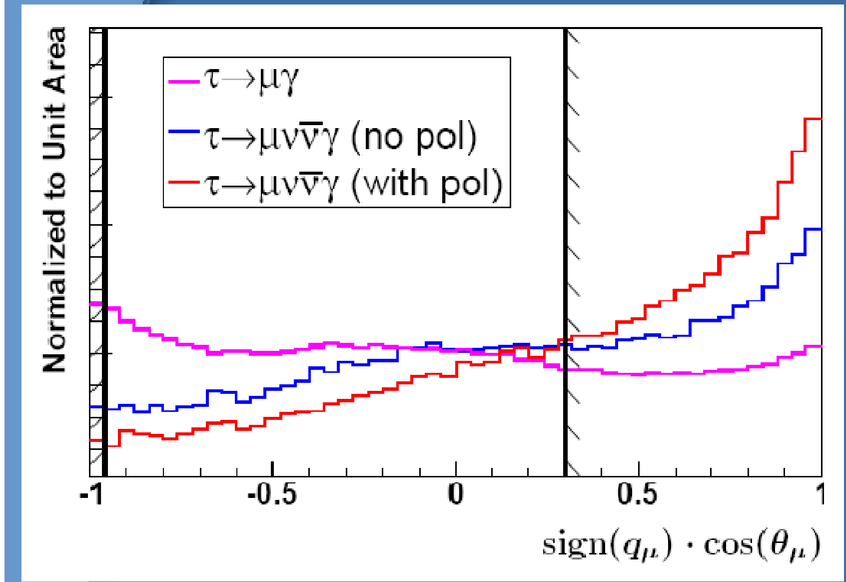
Lepton flavor violation (LFV)

- 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: $\tau \to \mu\gamma, \tau \to \ell\ell\ell$
- Strong benefits of a polarized beam !

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

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

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

	Snowmass points predictions						SuperB
	1a	1b	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)
- -electroweak physics (neutral current)

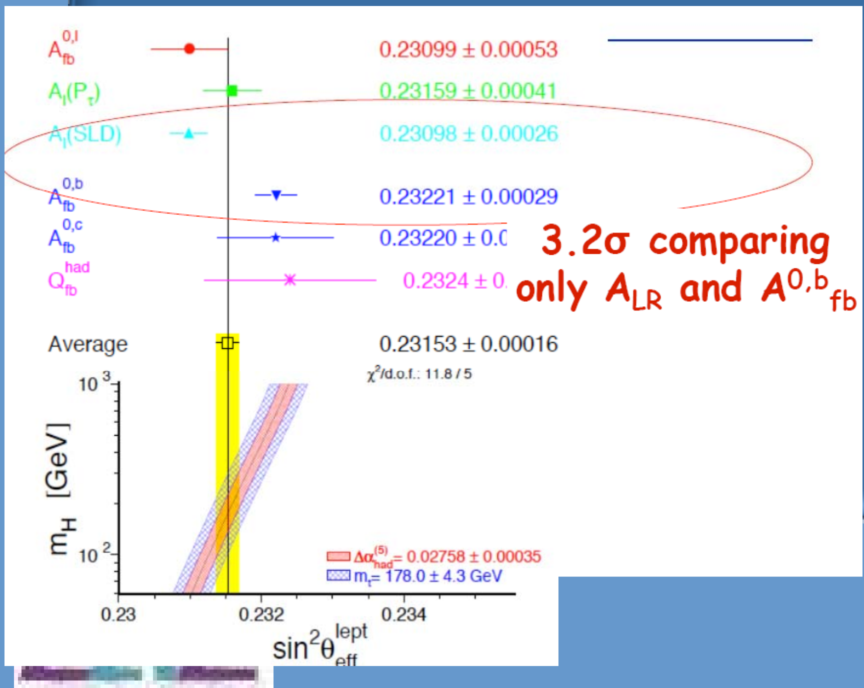
Under study

SuperB

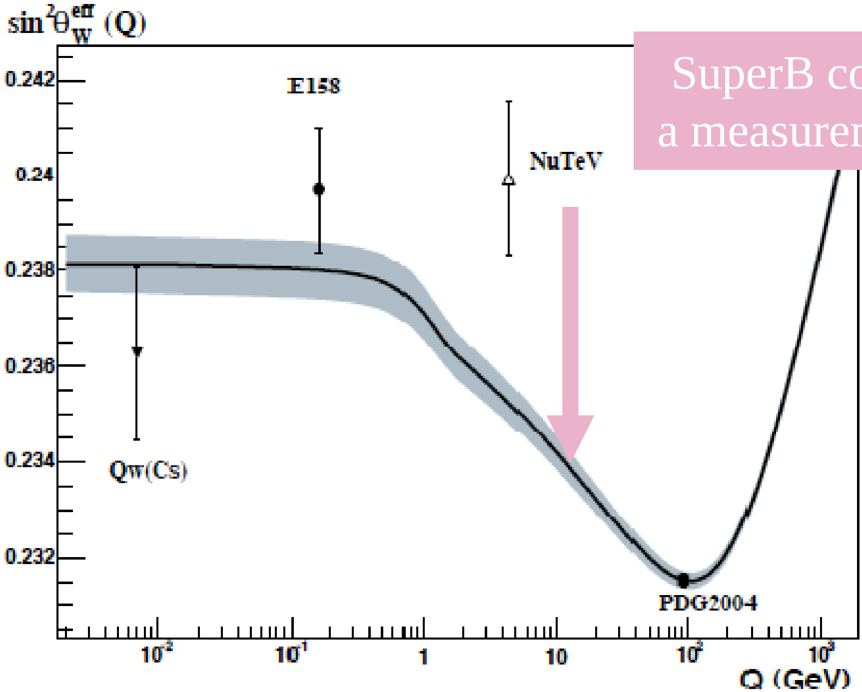
Electroweak physics at SuperB

- with polarized e^- beam can measure $\mu^+\mu^-$ LR rate asymmetry to 1.1% (SLD: 1.4%)
  - → beam polarization should be known to 0.5% (as in SLD)
  - → $\sin^2\theta_W^{EFF}$ measurement up to ±0.00018 at Υ(4x) (SLD: ±0.00026)
  - → $\frac{A_{LR}(\text{muons})}{A_{LR}(bb)}$ → precise μ/b weak NC coupling ratio where polarization uncertainties cancel
    - → can investigate LEP A_{FB}^{bb} vs. SLD A_{LR} 3.2σ discrepancy

at SuperB: γ-Z interference term dominates over pure Z-exchange



3.2σ comparing only A_{LR} and $A^{0,b}_{fb}$



SuperB could add a measurement here

FIG. 2: Predicted variation [18] of $\sin^2\theta_W^{\rm eff}$ as a function of momentum transfer Q (solid line) and its estimated theoretical uncertainty (shaded area). Results of prior low energy experiments [6, 16] (closed triangle, shown at an arbitrarily higher Q) and [7] (open triangle) are overlaid together with the Z^0 pole value [16] (square) and this measurement (circle).

5

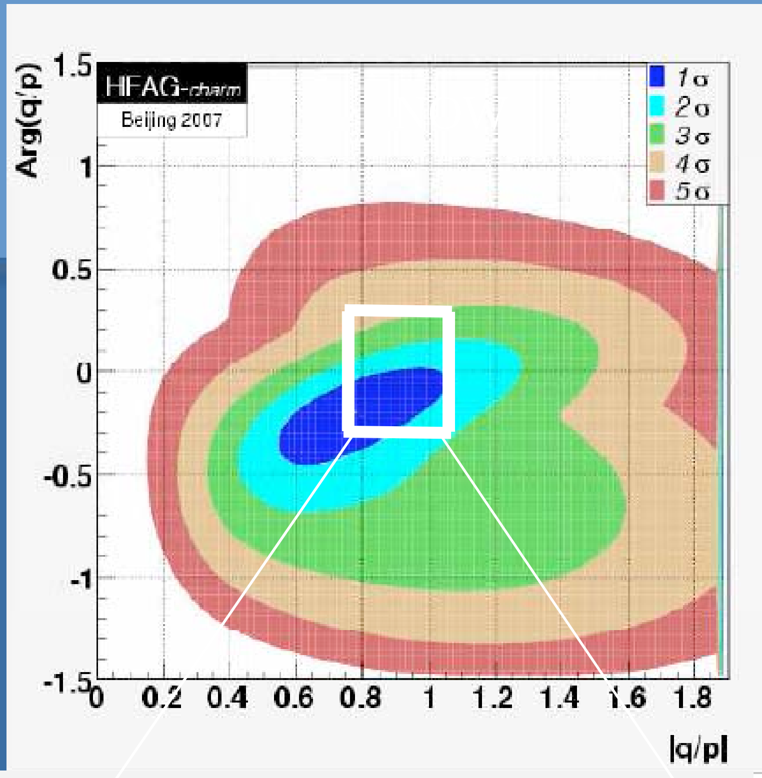
CP Violation in charm

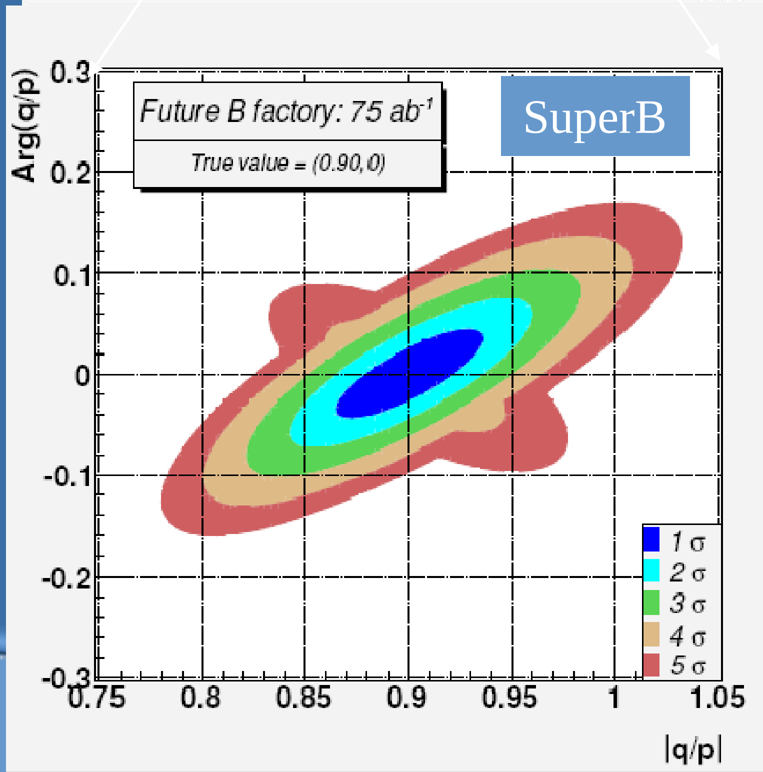
To be evaluated at LHCb

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

CPV in D system negligible in SM

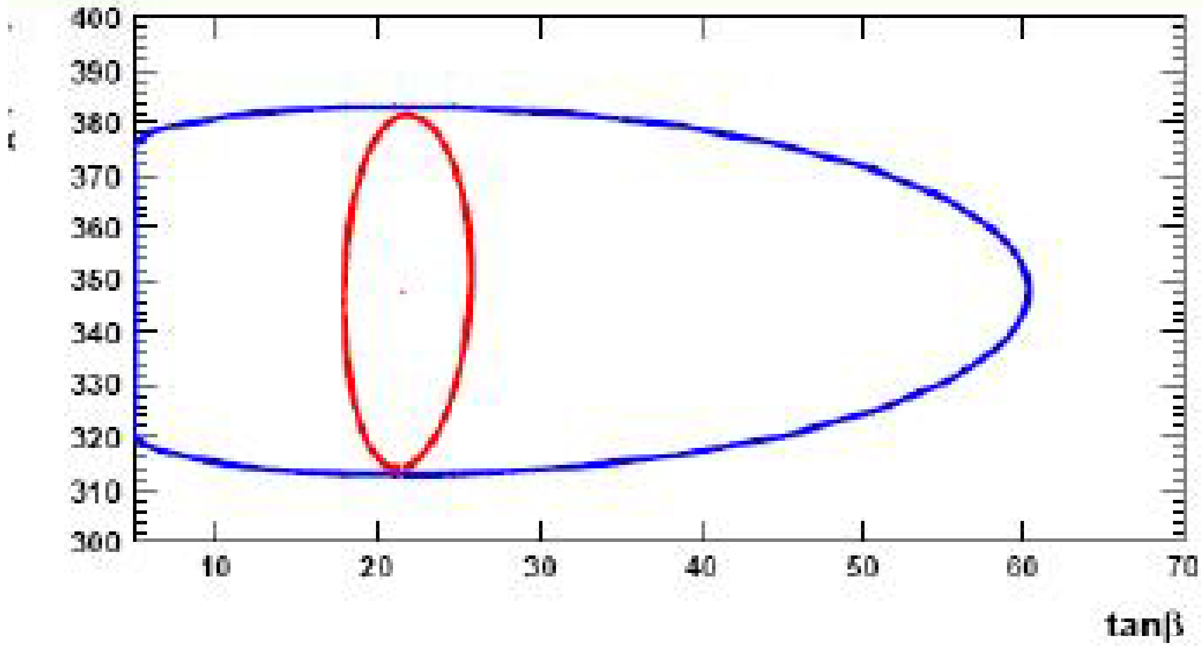
Mode	Observable	$\Upsilon(4S)$ ($75\ \mathrm{ab}^{-1}$)	$\psi(3770)$ ($300\ \mathrm{fb}^{-1}$)
$D^0 \to K^+\pi^-$	x'^2	3×10^{-5}	
	y'	7×10^{-4}	
$D^0 \to K^+K^-$	y_{CP}	5×10^{-4}	
$D^0 \to K_S^0\pi^+\pi^-$	x	4.9×10^{-4}	
	y	3.5×10^{-4}	
	$\lvert q/p \rvert$	3×10^{-2}	
	ϕ	2°	
$\psi(3770) \to D^0\overline{D}^0$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



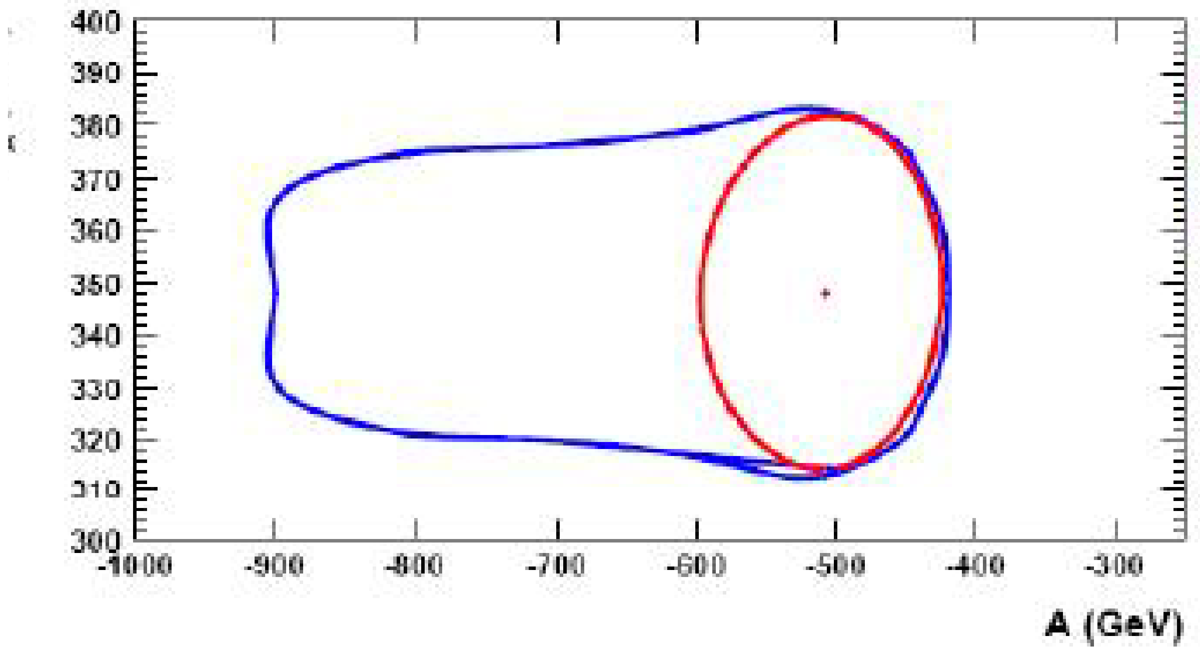


CPV in D sector is a clear indication of New Physics !

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



IF LHC DISCOVERS SUPERSYMMETRY



Red are LHC+EW constraints+SuperB

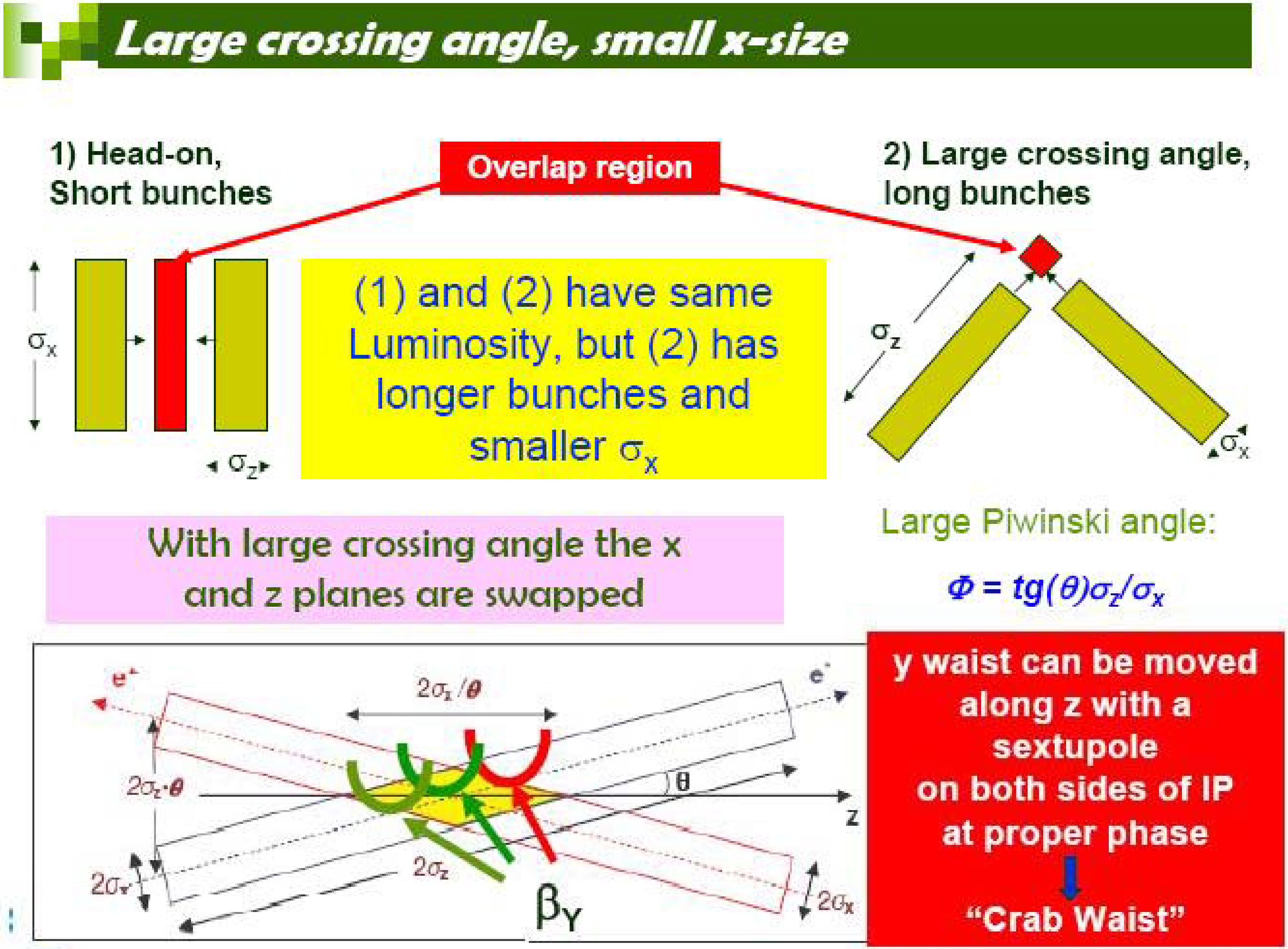
Blue is LHC alone

The machine requirements

Accelerator Parameters Requirements from Physics

Parameter	Requirement	Comment
Luminosity (top-up mode)	$\geq 10^{36}$ cm^{-2}s^{-1} @ Υ(4*S*)	It can extend up to an ultimate peak luminosity of 4 10^{36} cm^{-2}s^{-1}
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	τ 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 τ *CP* and *T* violation studies, measurement of τ *g*-2 and improves sensitivity to lepton flavor-violating decays.

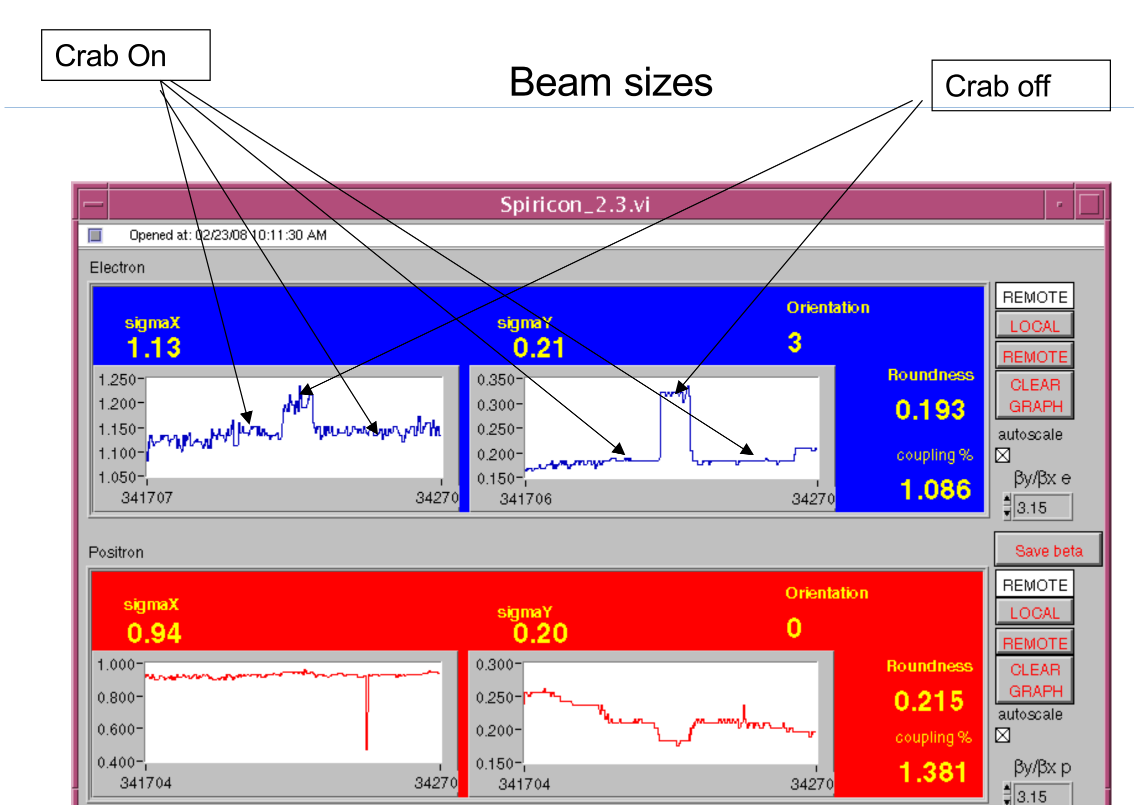
Crab waist crossing, a superb idea by P. Raimondi (LNF)

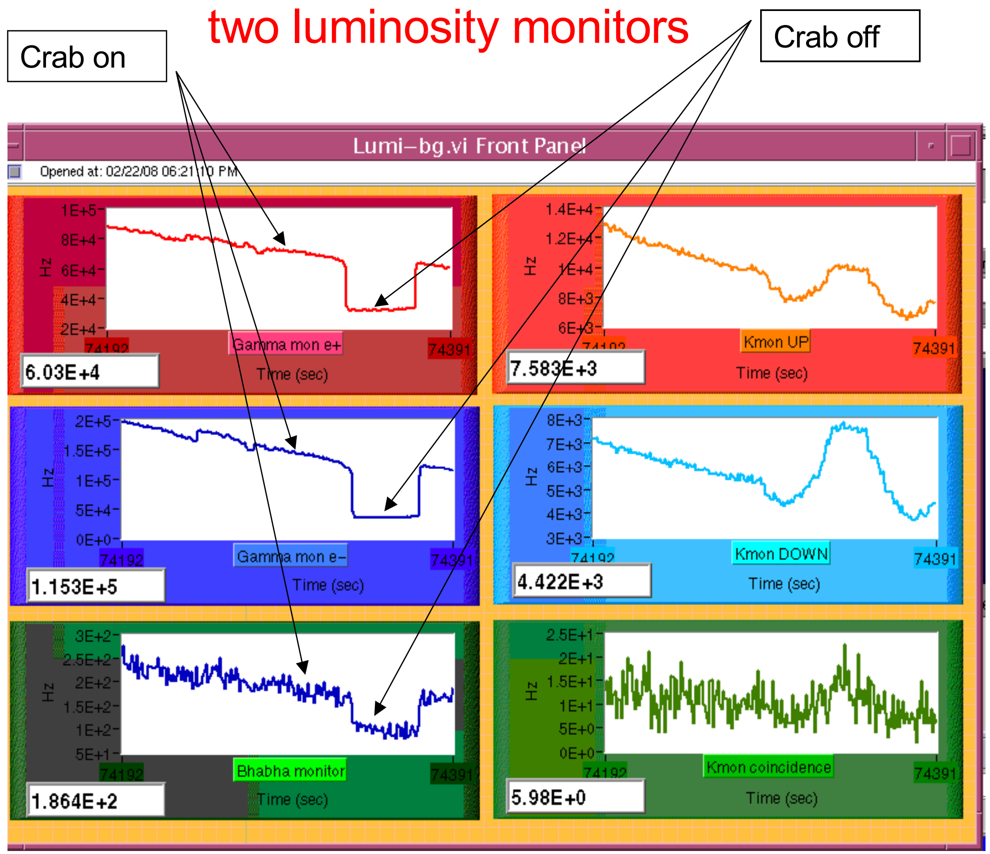


Crab waist for pedestrians

- In order to get very high lumi, need transverse beam size of nanometer scale
- To benefit from this, need effective sigma_z very small
- Extremely hard to do by conventionnal techniques
- Use long sigma-z at large angle
- This create vey large indesirable beam-beam effects
- Get rid of the beam-beam effects by pre-distorsion of the beams!!!

Crab Waist Works: First Experimental Evidence



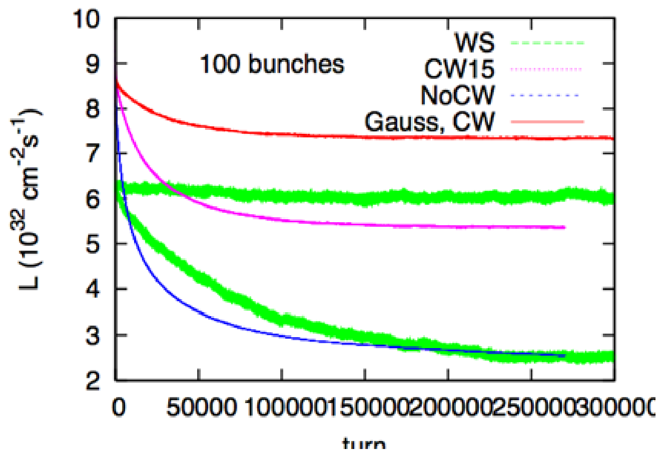


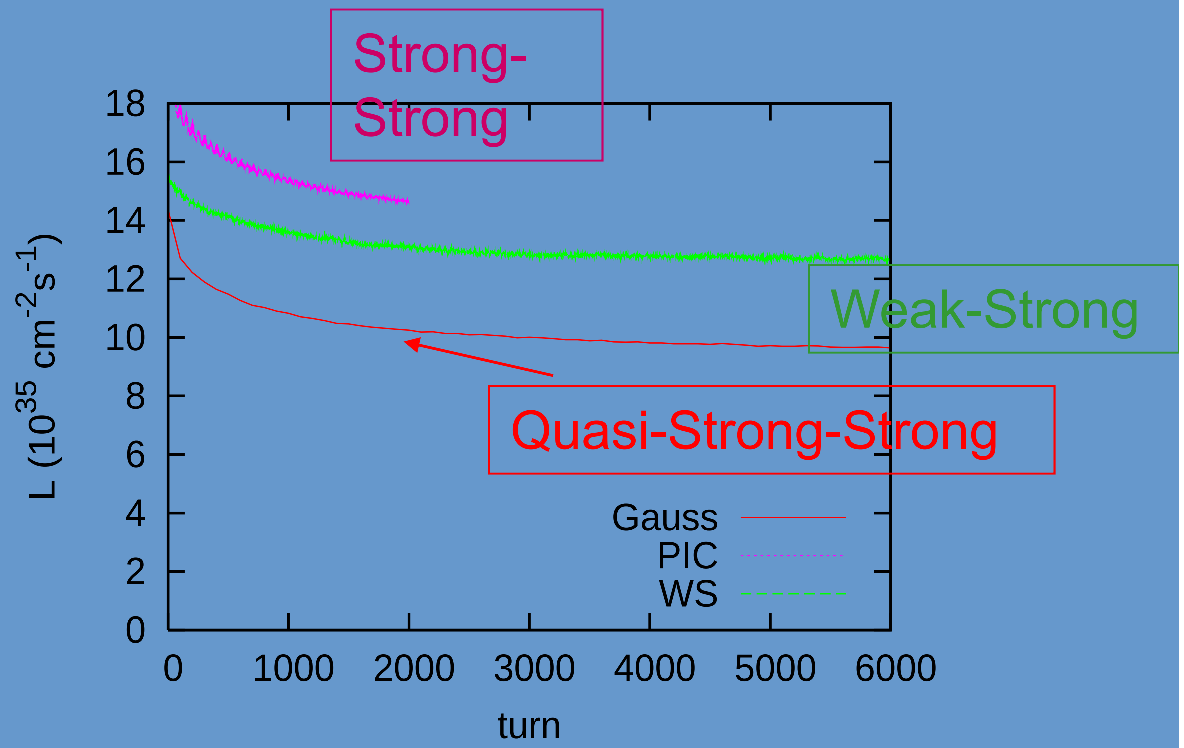
A luminosity of 4.5 10**32 was achievd in DAPHNE, 3 times higher than before, and in good agreement with simulations!

Simulations for SuperB

DAFNE

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

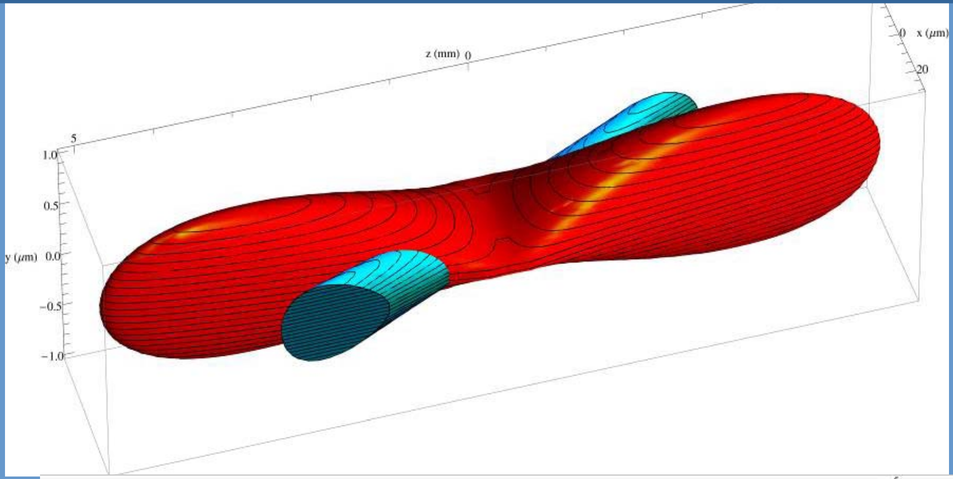




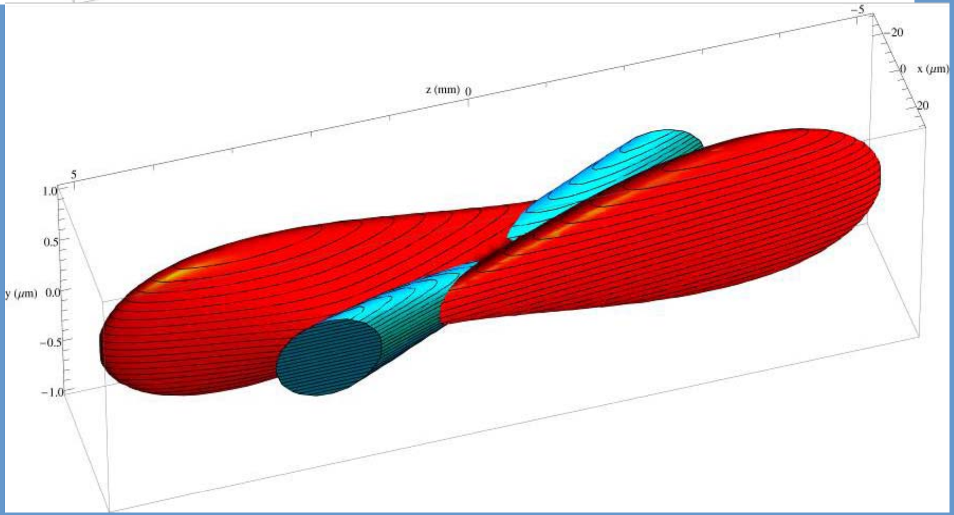
K. Ohmi

Beams distribution at IP

E. Paoloni



Without
Crab-sextupoles



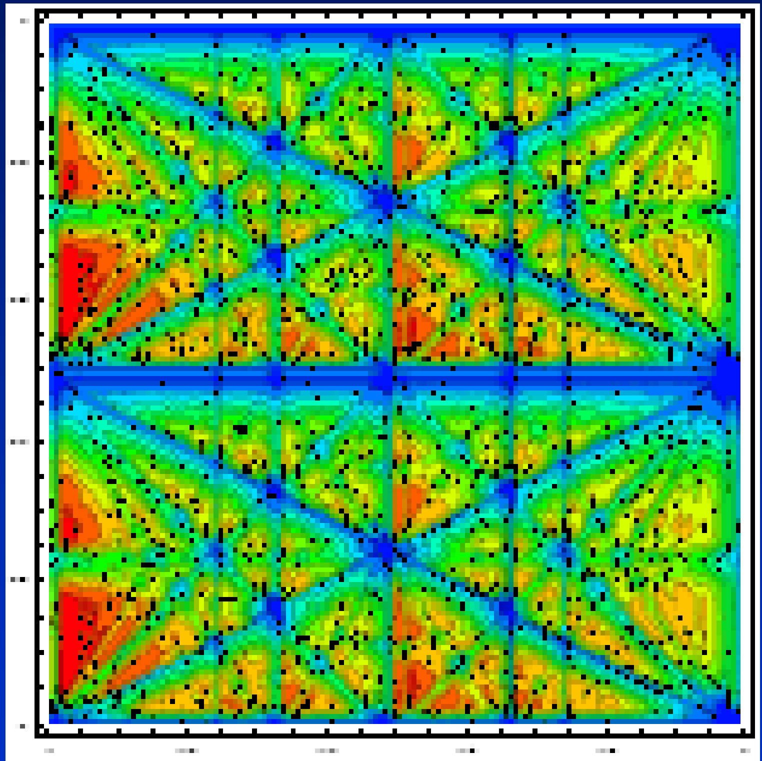
With
Crab-sextupoles

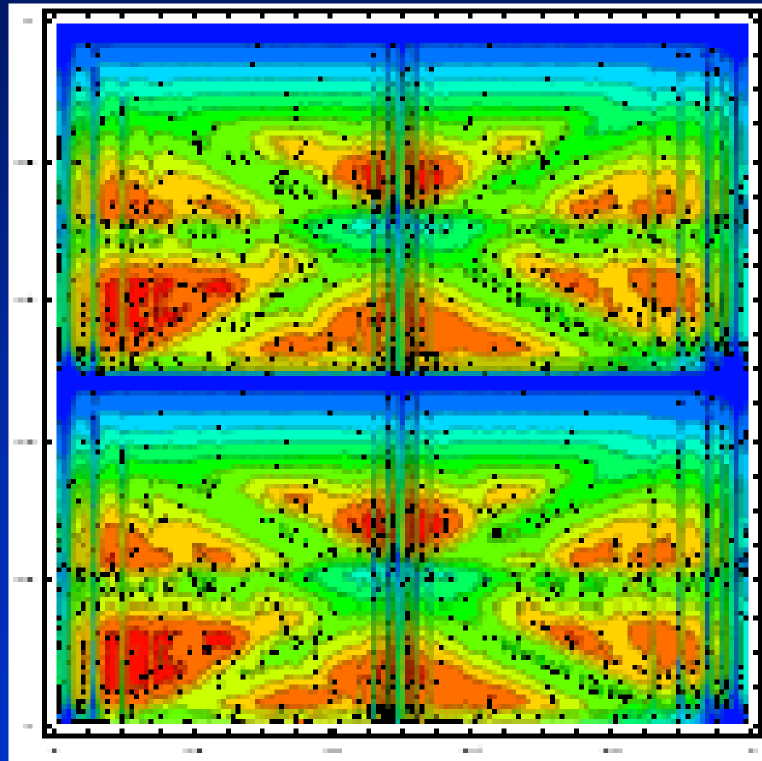
All particles from both beams collide in the minimum β_y region, with a net luminosity gain

Example of x-y resonance suppression

D.Shatilov's (BINP), ICFA08 Workshop

Much higher luminosity!





Typical case (KEKB, DAΦNE):

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

Crab Waist On:

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

Machine paprameters. Flexibility built in!

		Base Line		Low Emittance		High Current		Tau/Charm (prelim.)	
Parameter	Units	HER (e+)	LER (e-)	HER (e+)	LER (e-)	HER (e+)	LER (e-)	HER (e+)	LER (e-)
LUMINOSITY	$cm^{-2}\ s^{-1}$	1.00E+36		1.00E+36		1.00E+36		1.00E+35	
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)	mrad	66		66		66		66	
Piwinski angle	rad	22.88	18.60	32.36	26.30	14.43	11.74	8.80	7.15
β_x @ IP	cm	2.6	3.2	2.6	3.2	5.06	6.22	6.76	8.32
β_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
ε_x (without IBS)	nm	1.97	1.82	1.00	0.91	1.97	1.82	1.97	1.82
ε_x (with IBS)	nm	2.00	2.46	1.00	1.23	2.00	2.46	5.20	6.4
ε_y	pm	5	6.15	2.5	3.075	10	12.3	13	16
σ_x @ IP	μm	7.211	6.872	5.099	6.274	10.060	12.370	18.749	23.076
σ_y @ IP	μm	0.036	0.036	0.021	0.021	0.054	0.054	0.092	0.092
Σ_x	μm	11.433		8.085		15.944		29.732	
Σ_y	μm	0.050		0.030		0.076		0.131	
σ_L (0 current)	mm	4.69	4.29	4.73	4.34	4.03	3.65	4.75	4.36
σ_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	
Ion gap	%	2		2		2		2	
RF frequency	Hz	4.76E+08		4.76E+08		4.76E+08		4.76E+08	
Harmonic number		1998		1998		1998		1998	
Number of bunches		978		978		1956		1956	
N. Particle/bunch		5.08E+10	6.56E+10	3.92E+10	5.06E+10	4.15E+10	5.36E+10	1.83E+10	2.37E+10
Tune shift x		0.0021	0.0033	0.0017	0.0025	0.0044	0.0067	0.0052	0.0080
Tune shift y		0.0970	0.0971	0.0891	0.0892	0.0684	0.0687	0.0909	0.0910
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
σ_E (full current)	dE/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 σ_E	dE/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	17.08		12.72		30.48		3.11	

Tau/charm threshold running at 10^{35}

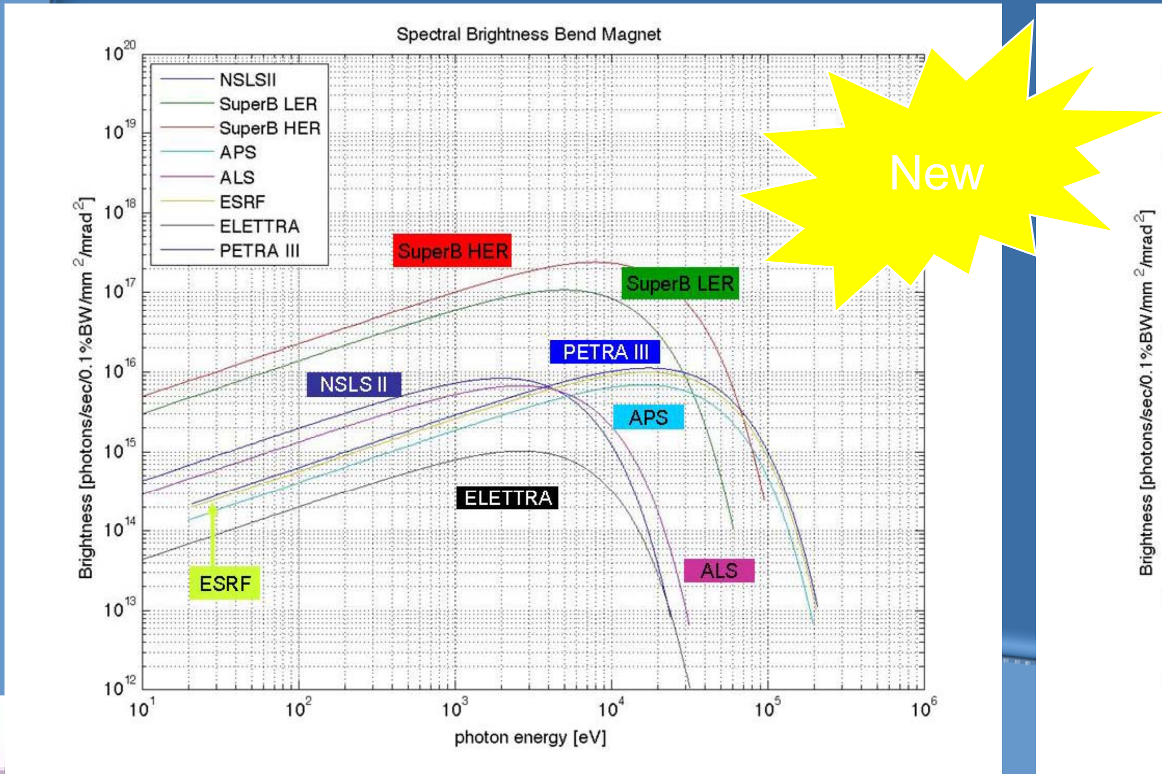
Baseline + other 2 options:
- **Lower y-emittance**
- **Higher currents (twice bunches)**

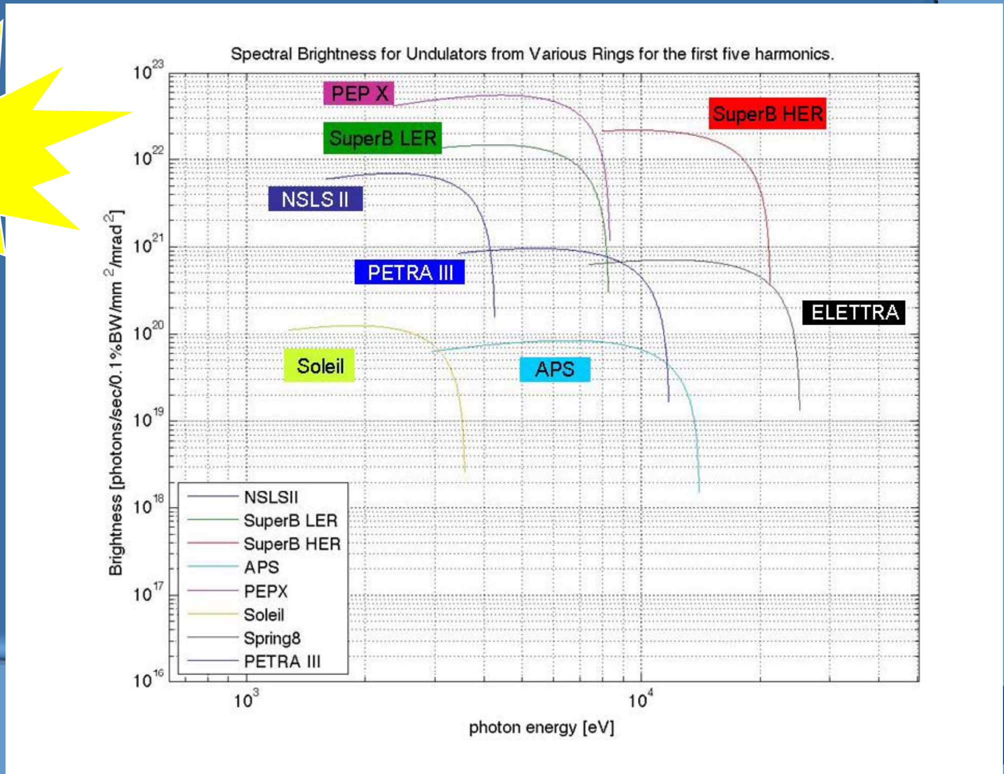
Baseline:
- **Higher emittance due to IBS**
- **Asymmetric beam currents**

RF power includes SR and HOM

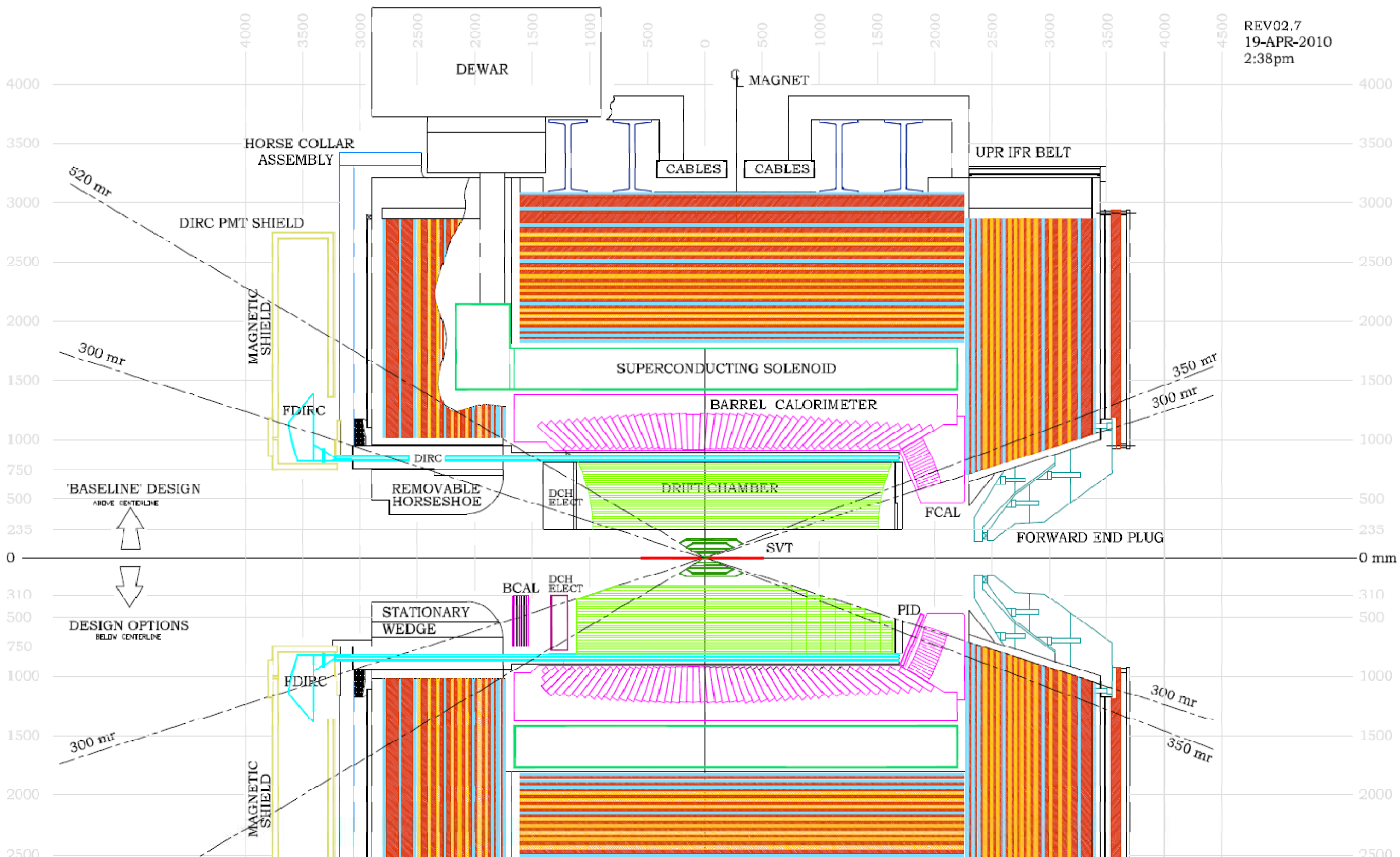
Synchrotron light properties @ SuperB

- Comparison of brightness and flux from bending magnets and undulators for different energies dedicated SL sources & SuperB HER and LER
- Synchrotron light properties from dipoles are competitive
- Assumed undulators characteristics as NSLS-II
- Light properties from undulators still better than most LS, slightly worst than PEP-X (last generation project)





SuperB Detector (with options)



SuperB Detector

- Babar and Belle designs have proven to be very effective for B-Factory physics
  - Follow the same ideas for SuperB detector
- A SuperB detector is possible with today's technology. Main issues:
  - Machine backgrounds – larger
  - Beam energy asymmetry – smaller
  - Strong interaction with machine design
- Try to reuse parts of Babar as much as possible
  - Quartz bars of the DIRC
  - Barrel EMC CsI(Tl) crystal and mechanical structure
  - Superconducting coil and flux return yoke.
- Moderate R&D and engineering required
  - Small beam pipe technology
  - Thin silicon pixel detector for first layer
  - Drift chamber CF mechanical structure, gas and cell size
  - Photon detection for DIRC quartz bars
  - Forward PID system (TOF or focusing RICH)
  - Forward calorimeter crystals (LSO)
  - Minos-style scintillator for Instrumented flux return
  - Electronics and trigger
  - Computing – large data amount

Options under consideration

6 Layer SVT	LO Striplets @ 1.6cm if background is acceptable as default. MAPS Option. Retain 5 Layer outer detector.
SVT – DCH transition radius	~> than 20 cm determined by beam element cryostats to allow easy installation
Backward EMC	Inexpensive Veto device bringing 8-10% sensitivity improvements for B→|{. Low momentum PID via TOF? Technical Issues?
Forward PID	Physics gains about 5% in B→K(*){{. Somewhat larger gains for higher multiplicities Open technical options/interactions with EMC
Absorber in IFR	Optimized layout. Plan to reuse yoke. Still need to resolve engineering questions.

Decision mid 2011

White Paper Budget

- CDR Budget →

Item	*EDIA mm*	*Labor mm*	*M&S kEuro*	*Rep.Val. kEuro*
Detector	3391	1873	40747	46471

WBS	*Item*	*EDIA mm*	*Labor mm*	*M&S kEuro*	*Rep.Val. kEuro*
1	**SuperB detector**	**4037**	**2422**	**52953**	**48922**
1.0	Interaction region	21	12	860	0
1.1	Tracker (SVT + Strip + MAPS)	408	442	6444	0
1.2	DCH	165	139	3421	0
1.3	PID	116	236	5820	7138
1.4	EMC	219	360	12147	31574
1.5	IFR	37	184	1374	0
1.6	Magnet	93	59	3767	10210
1.7	Electronics	994	342	9234	0
1.8	Online System	912	24	2074	0
1.9	Installation and integration	353	624	7596	0
1.A	Project Management	720	0	216	0

R&D and Engineeering Summary

Sys	R&D	Engineering
SVT	Layer 0 thin pixels Low mass mechanical support	Silicon strip layers Readout architecture
DCH	High speed waveform digitizing Cluster counting	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, Other crystals Prototype Module Test	Readout electronics Forward EMC mechanical support
IFR	SiPM performance Prototype Module Test	Location of photo-detectors Absorber thickness definition
ETD	High speed data link Radiation hard devices	Trigger strategy Bhabha rejection

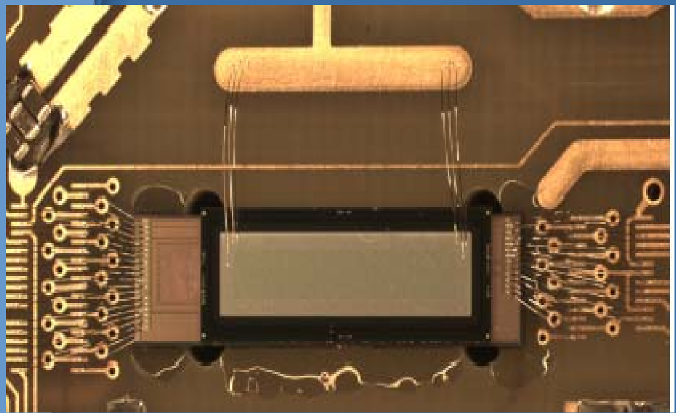
Backgrounds simulation

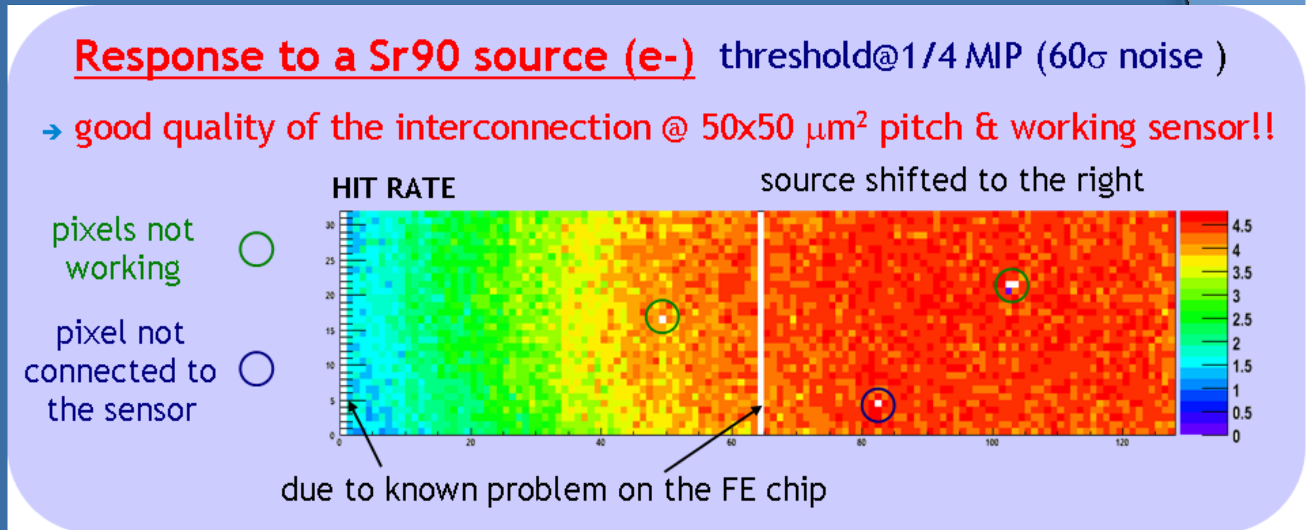
- Improvements of the SuperB Geant4 model
  - Better model of the SVT.
  - Latest IR design & lattice parameters
  - Beam pipe modeled up to the first dipole
    - ~12 m from the IP
  - Better beam pipe model at the IP
- Check of the correctness of the magnetic model
    - good agreement with independent beam simulations
- Work together with DaΦne Team to understand background sources

SVT Update: Main progress on pixel R&D

Hybrid Pixel

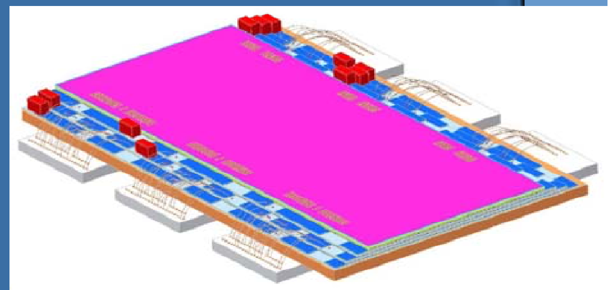
- First results on Front-End chip bump-bonded to sensor matrix





Prototype hybrid pixel module in preparation:

- Bump-bonding of 3 FE chips with sensor matrix
- Finalize Al bus design for prototype module



New version of FE chip for hybrid pixel in preparation:

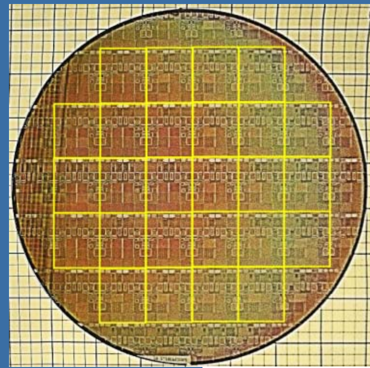
- With vertical integration (2 CMOS layers interconnected)
- New readout architecture (data push & triggered version implemented)
- Threshold tuning at pixel level

SVT Update: Main progress on pixel R&D

CMOS MAPS

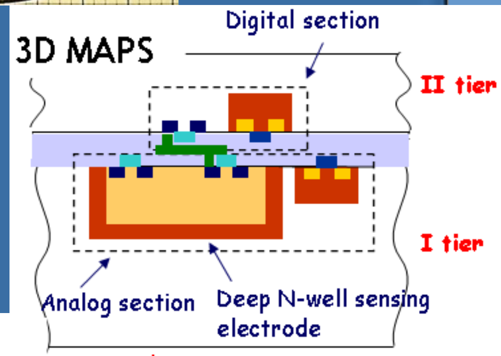
- Radiation damage studies: charge collection after neutron irrad. up to ~ $7x10^{12} n/cm^2$ → ~$3.5x10^{12} n/cm^2/yr$ expected in Layer0

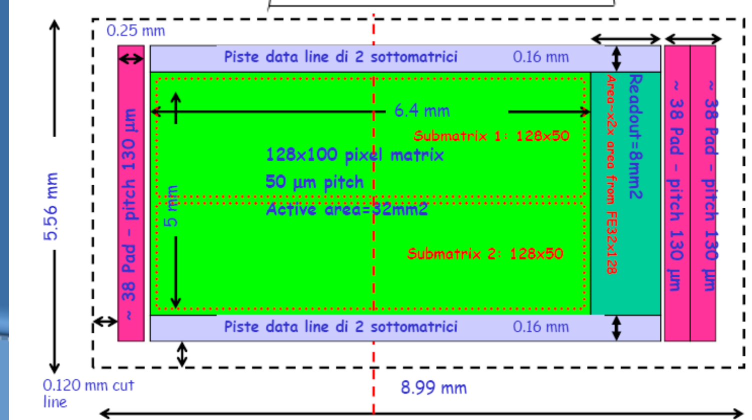
After a long delay first MAPS with vertical integration process (Chartered 130 nm) finally getting ready.
- 2D wafer delivered- 3D wafers due in Feb 2011



First Chartered 2D wafer delivered

Vertically integrated MAPS for the II 3D run (June 2011) in preparation:
- Simulation of the new readout architecture ready (data push & triggered version)
  - » Efficiency vs trigger latency studied
- Large matrix area (128x100 pixel): layout of the digital tier for matrix ready.

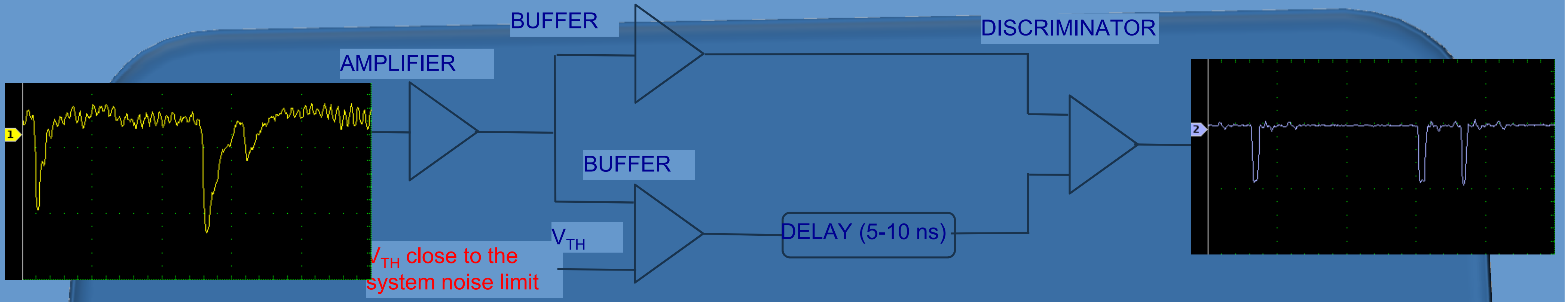


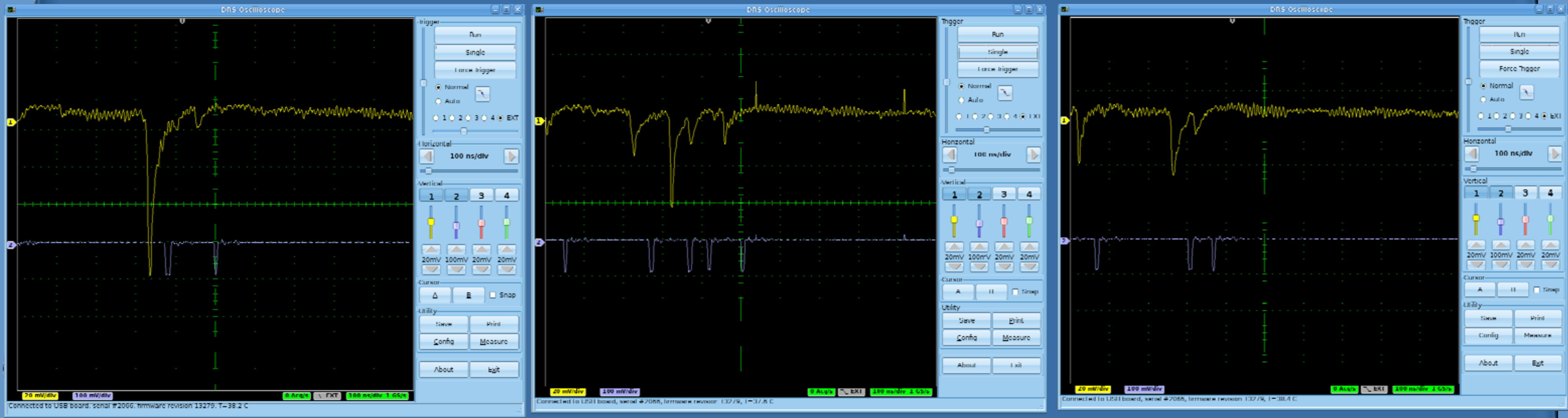


Getting organized for 2011 Testbeam

R&D on Cluster Counting

Local derivative method



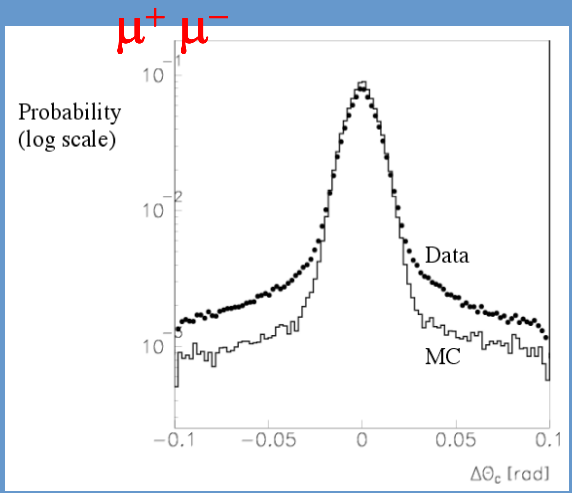


- First tests on 2.5m long, 24mm side square tube in He-CH_4 mixture
  - threshold and delay still to be optimized

Barrel PID

- **FBLOCK** [SLAC]
  - Raw block has been produced by Corning and is ready to be shipped.
  - Had to make a new quote request for the FBLOCK machining operation because a buyer made a silly mistake in the first round. The search has 10 companies involved.

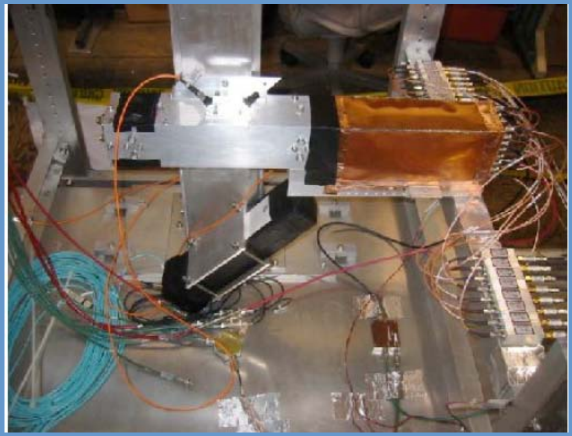
- **FDIRC prototype studies in CRT** [SLAC]
  - FDIRC prototype is now being used to study Cherenkov ring resolution & its tails.
  - BaBar DIRC:



- **Bar boxes removed from BaBar** [SLAC + LAL + Saclay]
  - And safely stored. Bars look good to visual inspection.
  - Some PMT studies performed.

Matt is happy:

Forward PID



- **FARICH** [Novosibirsk]
  - Test beam in progress

- **DIRC-like TOF** [LAL-Orsay + SLAC]
  - Large data sample collected in CRT telescope.
  - Analysis in progress

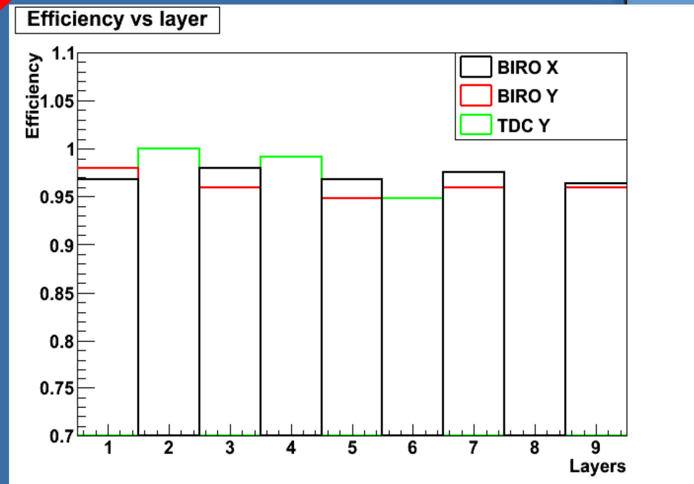
- **A simple pixilated TOF using a LYSO crystal** [SLAC]
  - Caltech provided a full size LYSO crystal. SLAC prepared a detector setup.
  - The prototype with **4x4 G-APD array** readout is now being tested in CRT.
  - More simple version with **single 3mm x 3mm G-APD** will be tested in January.
  - Data taking in progress.

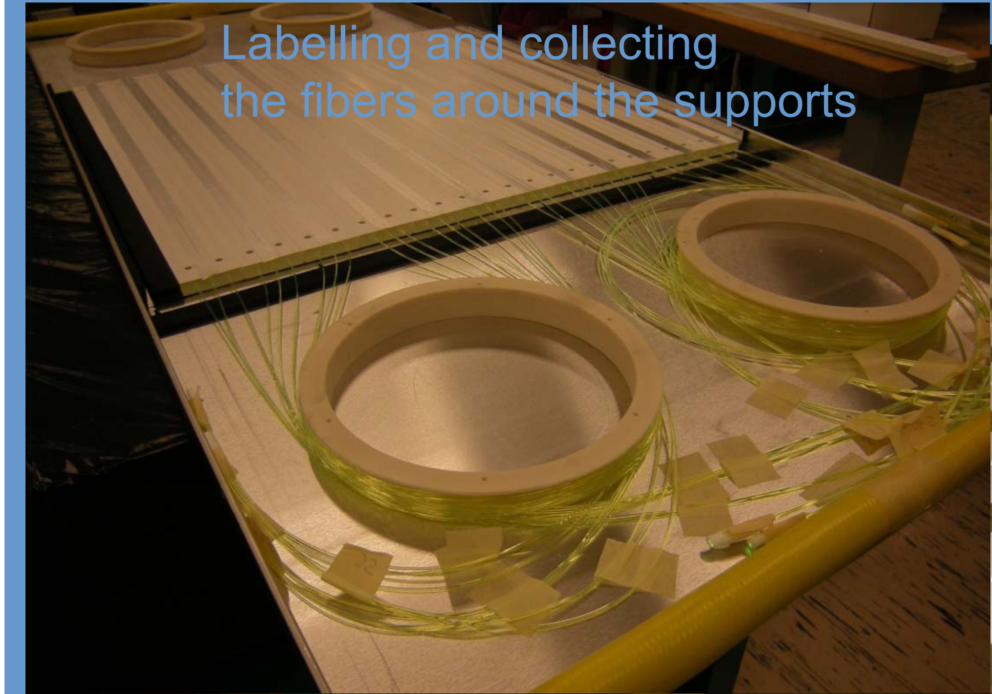
- **Electronics** [LAL-Orsay]
  - Ongoing work on ASICS and system sides
  - Design of a 16 channel board

  → One step further towards a demonstration that 10 ps precision can be achieved with 100+ channels

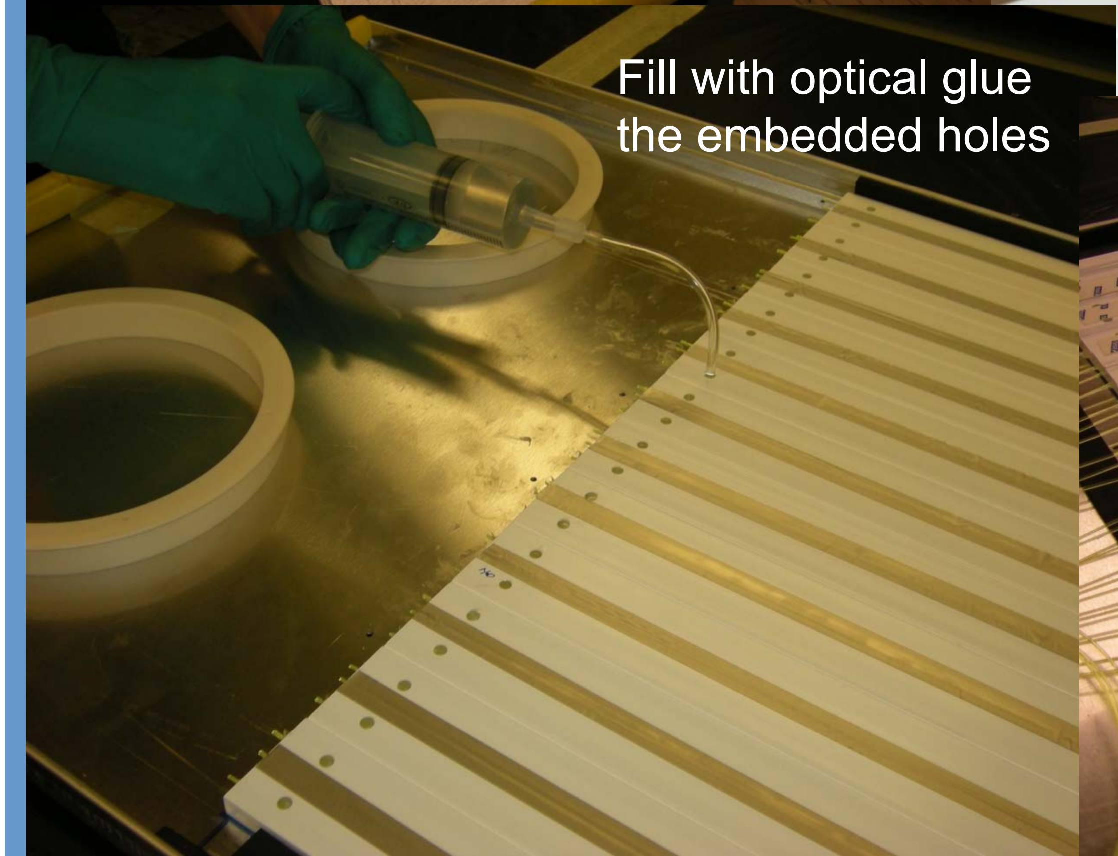
IFR Update

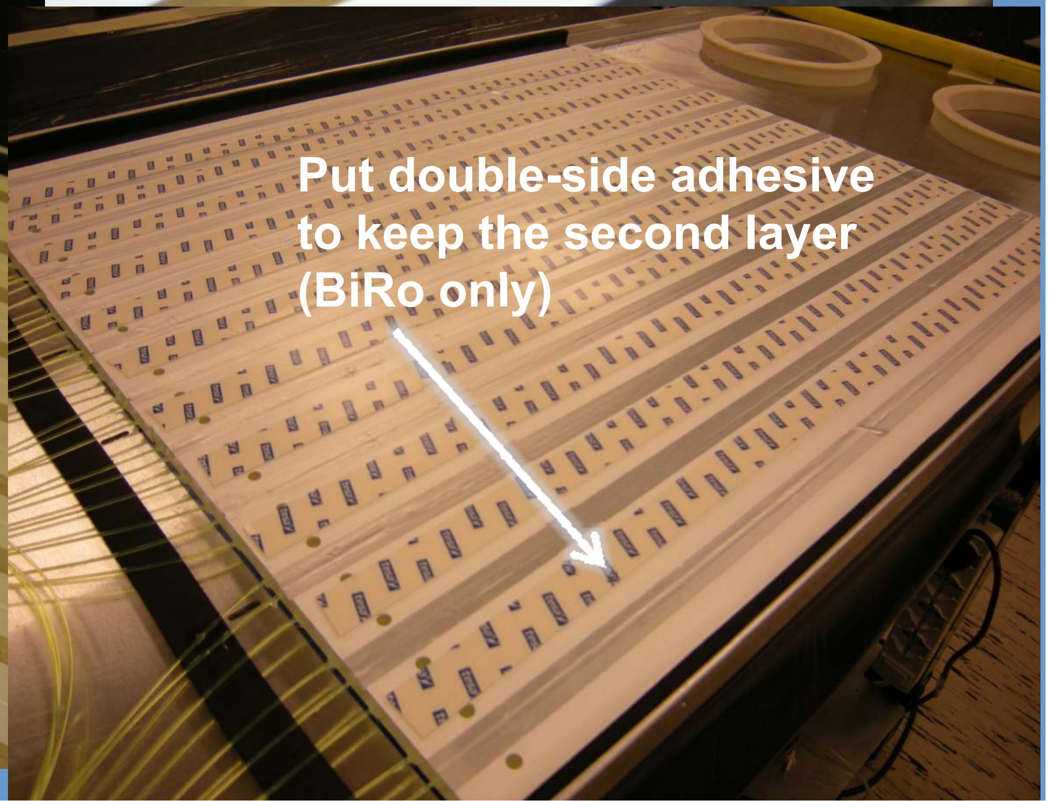
- All needed SiPM received and characterized
- Prototype completed, tested with cosmic and shipped to FNAL
- Prototype tested (1-7 Dec 2010) at Fermilab Meson Area
- 9 layer configuration tested with different readout schemes
  (5 BiRO layers and 4 TDC layers)




Labelling and collecting
the fibers around the supports


Fill the machined grooves
with optical grease and cover
it with stripes of reflecting
aluminum (BiRo only)


Fill with optical glue
the embedded holes


Put double-side adhesive
to keep the second layer
(BiRo only)

SuperB GRID

Legenda
- Link a 10 Gbps
- Link a 2.5 Gbps
- Link a 1 Gbps

● Futuri centri di calcolo e nodi GRID per SuperB

● Centro di calcolo INFN per LHC

Conclusions

- Flavor physics is a necessary complement of the LHC to unravel the detailed structure of the new physics soon to be discovered
- SuperB project has just been approved by the Italian Government! A major project in Europe at the national scale, since HERA
- A very ambitious and innovative machine, state-of-the art detector, and an aggressive planning
- First beams just in time for the XXXth Rencontres de Physique de la Vallée d'Aoste!