Overview and goals

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3rd Workshop on SuperB
SLAC June 14- 17, 2006

OUTLINE

- So far…
- Status of SuperB activity
- Goals of the workshop

Since 2nd SuperB Workshop (march 06)

Since beginning of SuperB International Study Group the goal was clear:

Study physics case, machine and detector for a Super Flavor Factory with a luminosity higher than 10^{36}, to study physics in b, c and τ sectors.

Prepare by the end of 2006 a Report “CDR” to be delivered to the President of INFN and presented to the International Community.

Events:

UK meeting on SuperB in Daresbury 26-26 April

Cern Workshop on Flavour 15-17 May (discussion and comparison SuperB-SuperKEKB and LHCb)

Round table in Elba on Future Machines 23 May :

presentation of Suzuki containing SuperKEKB possibilty (4 1035 and 40-50 ab-1 by 2020)

presentation of Petronzio containing the SuperB option as one of priorities of INFN

On physics case

On the physics case a lot of documents are available they are the result of three years of Physics workshops in Slac ,in KEK and Joint meetings in Hawaii .

Three years of Physics Workshops have produced heavy documents . See for example:

The Discovery Potential of a Super B Factory (Slac-R-709)

Letter of Intent for KEK Super B Factory (KEK Report 2004-4)

Physics at Super B Factory (hep-ex/0406071)

At the URL :

www.pi.infn.it/SuperB

you can find documents and links to documents

On physics case

The physics case for a Super Flavour Factory is solid if :

See

BABAR Analysis Document #828
Version 2.0
July 26, 2004

Report from the Roadmap Committee

Roadmap Committee

F. Forti, M. Giorgi, D.G. Hitlin, H. Jawahery, Y. Karyotakis, D.B. MacFarlane, S. Playfer, S.H. Robertson, A. Roodman, R.H. Schindler, J. Seeman, J.G. Smith, M. Sullivan, C. Touramanis, R. Waldi, W. Wisniewski

•The sample of data available in a few years of running would be bigger than 50 ab -1 and approaching 100 ab -1 (10 11 BBbar, tau and charm pairs) .

•The running period is overlapped to LHC. (Results from Super Flavour and LHC are largely complementary).

On physics case..

This issue has been widely presented and discussed in the CERN series of workshops

Flavour Physics in the era of LHC

The first 3 worksops in Nov 2006, Feb 2006, May 2006

The May workshop included a special session devoted to High intensity, High luminosity flavour experiments and a round table chaired by I.Bigi to compare expected performance and physics reach of SuperB, SuperKEKB and LHCb .

.Next CERN meeting october 10-12,2006

On physics case

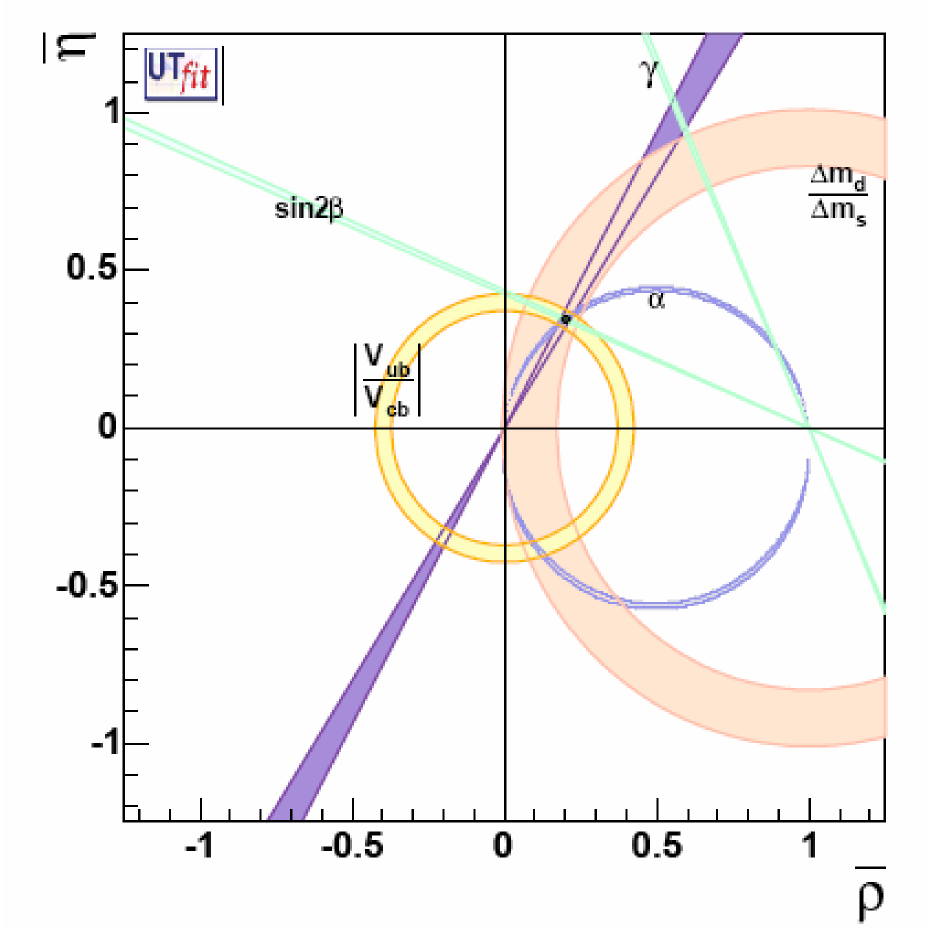
The physics case is continuing to be refined with the solid contribution of theorists.

Even in this workshop a preliminary report will be presented by the ad-hoc subgroup, s to study the physics reach on τ and charm and the possible impact on the machine and detector design.

More on our 4th workshop to be held in october 2006.

On this subject I will only show in this presentation a few vignettes

UNIVERSAL UT fit with 50 ab^{-1}



Universal fit makes only use of quantities independent of NP contributions within MFV

$b \rightarrow sl^+l^-$ precision measurements

New Physics – $K^{(*)}\ l^+l^-$, sl^+l^-		**e^+e^- Precision**			
Measurement	**Goal**	**3/ab**	**10/ab**	**50/ab**	**100/ab**
$\mathcal{B}(B\longrightarrow K\mu^+\mu^-)\ /\mathcal{B}(B\longrightarrow Ke^+e^-)$	SM: 1	~8%	~4%	~2%	~1.5%
$A_{CP}(B\longrightarrow K^*\ l^+l^-)$ (all) (high mass)	SM: < 0.05%	~6% ~12%	~3% ~6%	~1.5% ~3%	~1.1% ~2%
$A^{FB}(B\longrightarrow K^*l^+l^-) : \hat{s}_0$	SM: ±5%	~20%	~9%	9%	
$A^{FB}(B\rightarrow sl^+l^-) : \hat{s}_0$		27%	15%	6.7%	5.0%
$A_{FB}\ (B\rightarrow sl^+l^-) : C_9\, , C_{10}$		36-55%	20-30%	9-13%	7-10%

Extrapolation at high Lumi

CPV in Rare Decays		e^+e^- Precision		
Measurement	Goal	3/ab	10/ab	50/ab
$S(B^0 \to \phi K_S^0)$	$\approx 5\%$	16%	8.7%	3.9%
$S(B^0 \to \eta' K_S^0)$	$\approx 5\%$	5.7%	3%	1%
$S(B^0 \to K_S^0 \pi^0)$		8.2%	5%	4%
$S(B^0 \to K_S^0 \pi^0 \gamma)$	SM: $\approx 2\%$	11%	6%	4%
$A_{CP}(b \to s\gamma)$	SM: $\approx 0.5\%$	1.0%	0.5%	0.5%
$A_{CP}(B \to K^* \gamma)$	SM: $\approx 0.5\%$	0.6%	0.3%	0.3%

Rare Decays

MEASUREMENT	Goal	3/ab	10/ab	50/ab	100/ab
$\mathcal{B}(B\rightarrow D^*\tau\nu)$	SM: $\mathcal{B}$: 8x10^{-3}	10.2%	5.6%	2.5%	
$\mathcal{B}(B\rightarrow s\,\nu\nu)K,K^*$	SM:Theory ~5% 1 excl: 4x10^{-6}	~1σ	>3σ	>4σ	>5σ
$\mathcal{B}(B\rightarrow invisible)$		<2x10^{-6}	<1x10^{-6}	<4x10^{-7}	<2.5x10^{-7}
$\mathcal{B}(B_d\rightarrow\mu\mu)$	~8x10^{-11}	<3x10^{-8}	<1.6x10^{-8}	<7x10^{-9}	<5x10^{-9}
$\mathcal{B}(B_d\rightarrow\tau\tau)$	~1x10^{-8}	<1x10^{-3}	O(10^{-4})	?	?
$\mathcal{B}(\tau\rightarrow\mu\gamma)$ now< 7 10^{-8}				?	<10^{-10}
$\mathcal{B}(\tau\rightarrow\mu h)$ now < 10^{-7}				?	<10^{-10}

SuperB-Factories Parameters brfore SuperB activity (may05)

	PEP-II LER	PEP-II HER	Super PEP LER	Super PEP HER	KEKB LER	KEKB HER	SuperKEKB LER	SuperKEKB HER	
Energy	3.1	9.0	3.5	8.0	3.5	8.0	3.5	8.0	GeV
Particle	e^+	e^-	e^-	e^+	e^+	e^-	e^-	e^+	
Circumference	2200		2200		3016		3016		m
Current	2.45	1.55	15.5	6.8	1.73	1.26	9.4	4.1	A
Bunches	1588		6900		1388		5000		
Curr/bunch	1.54	0.98	2.25	0.99	1.25	0.91	1.88	0.82	mA
Spacing	1.26		0.31		1.77 or 2.36		0.59		m
Cross. Angle	0		30		22		30		mrad
Emittance ϵ_x	27	51	28	28	19	24	24	24	nm
β_x^*	50	32	15	15	59	56	20	20	cm
β_y^*	1.05	1.05	0.15	0.15	0.65	0.62	0.30	0.30	cm
Hor. Size @IP	170 (Σ)		65	65	103	116	69	69	μm
Ver. Size @IP	7.2 (Σ)		.6	.6	2.1	2.1	.73	.73	μm
Bunch Length	11	11	1.75	1.75	~ 7	~ 7	3.0	3.0	mm
RF Voltage	3.8	16.5	43	33	8	15	15	20	MV
RF Freq.	476		952		509		509		MHz
ξ_x	0.053	0.055	0.105	0.105	0.110	0.073	0.152	0.152	
ξ_x,dynamical effects							0.041	0.041	
ξ_y	0.064	0.046	0.107	0.107	0.092	0.056	0.215	0.215	
ξ_y,dynamical effects							0.187	0.187	
Luminosity	0.921		70		1.562		40		$10^{34}/cm^2/s$

Summary from Oide's talk at 2005 2nd Hawaii SuperBF Workshop

- Present design of SuperKEKB hits fundamental limits in the beam-beam effect and the bunch length (HOM & CSR).
- Higher current is the only way to increase the luminosity.
- Many technical and cost issues are expected with a new RF system.

HIGH CURRENT and HIGH BACKGROUND IS A BIG ISSUE FOR :

DETECTOR DESIGN

WALL POWER NEEDED

•We need a completely different collider scheme.....

From Hawaii 05

The new proposal was derived after the Pantaleo Raimondi idea of synergy with Linear collider project.

This idea was discussed and refined in the two worshops of Nov2005 and March 2006.

Simulations of beam beam have been performed

A preliminary lattice scheme has been designed for damping ring lengths of 6 Km, 3 Km and less than 3 Km.

Original idea

Basic Idea comes from the ATF2-FF experiment:

- it seems possible to acheive spot sizes at the focal point of about 2μ*20nm at very low energy (1 GeV), out from the damping ring

Rescaling at about 5 GeV

Is it worth to explore the potentiality of a Collider based on a scheme similar to the Linear Collider

P. Raimondi, 2005 2nd Hawaii SuperBF Workshop

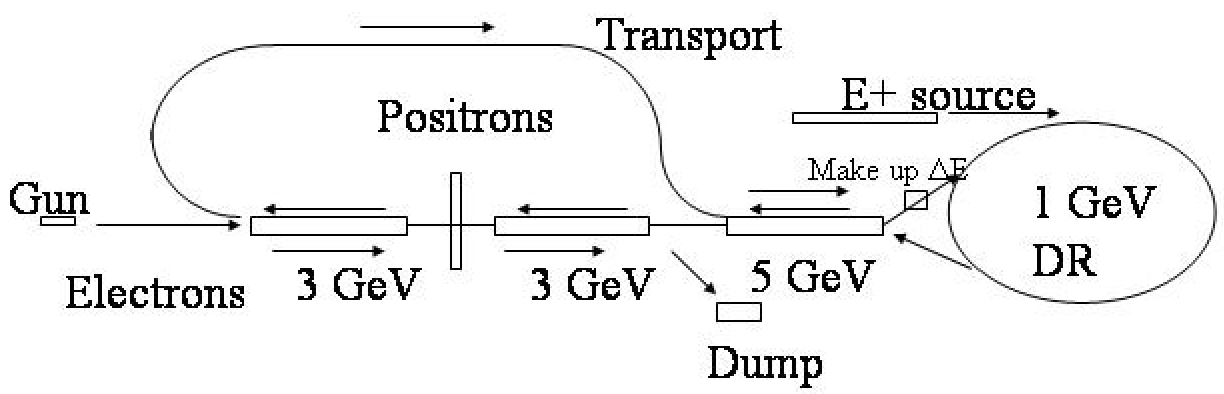
First elaboration

Basic layout:

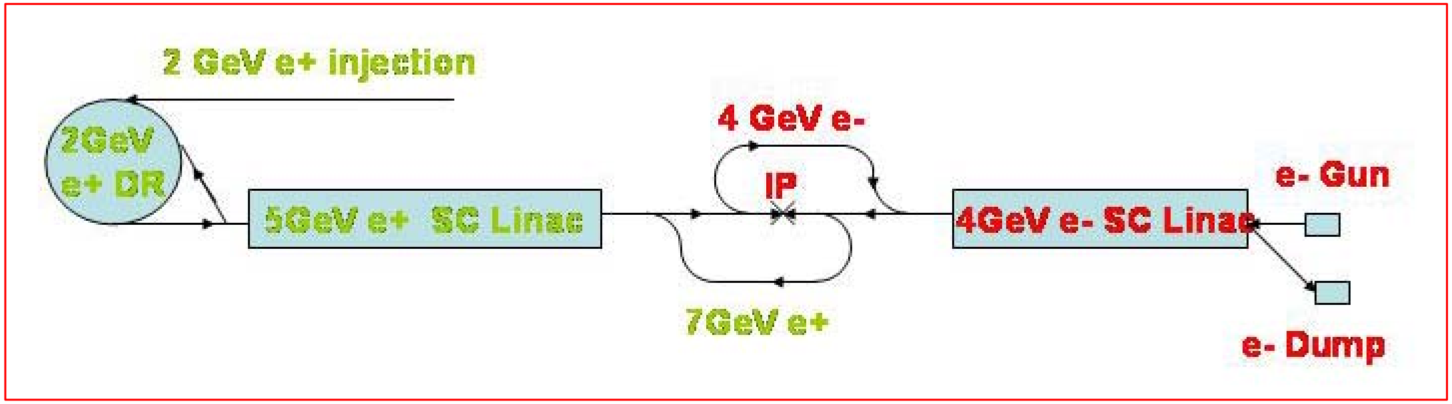
- 3-6 Km damping rings (ILC)
- 10000-20000 bunches, 6-12 A currents
- Normalized $\varepsilon_{nx}=6x10^{-6}$ m, $\varepsilon_{ny}=6x10^{-8}$,
- Very short damping time
- Luminosity in the 10^{36} cm^{-2} s^{-1} range

- Estract the beams at 100-1000 Hz, perform a bunch compression, focus them, collide and reinject the spent beam in the DR, with energy recovery in Linacs
- Maintain the currents constant in the DR with continuos injection
- Beam-beam simulated with GuineaPig code (ILC)

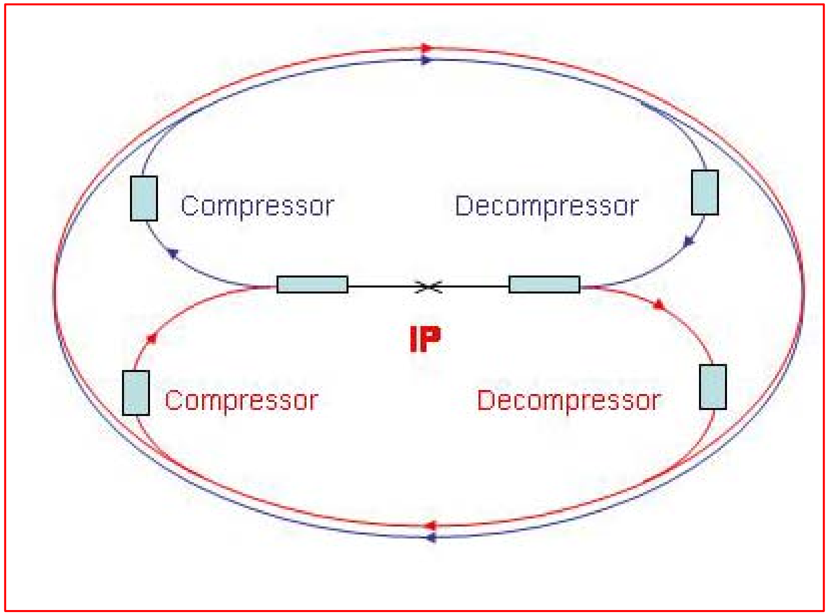
Various layouts between workshop I and II



Still…



2 GeV e+ injection
2GeV e+ DR
5GeV e+ SC Linac
4 GeV e-
IP
4GeV e- SC Linac
e- Gun
7GeV e+
e- Dump



Compressor
Decompressor
IP
Compressor
Decompressor

Main issues

High disruption trquiring very high dissipation in the damping rings.

The wall power required is very high.

Between several hundreds of MW to a GW.

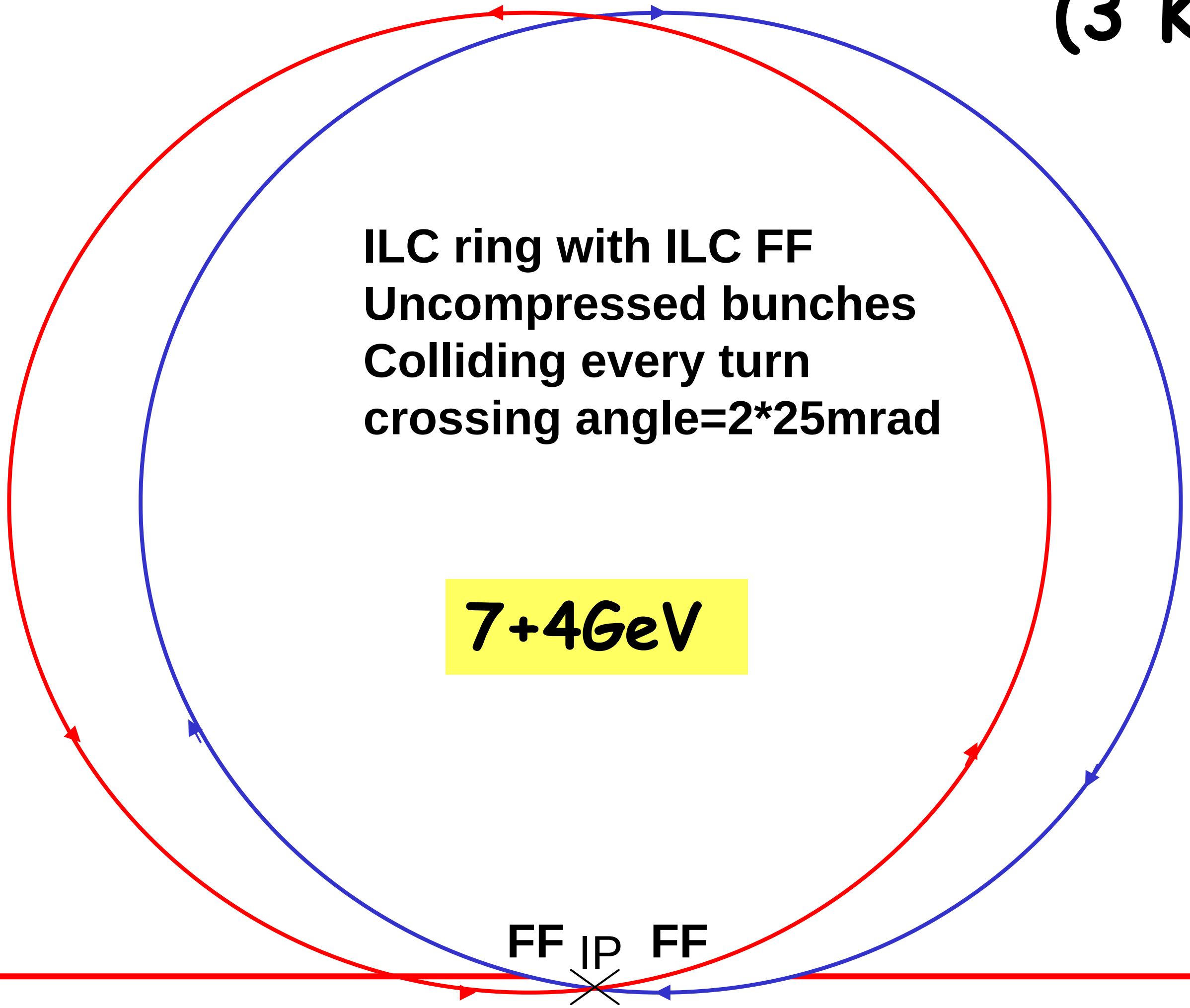
Background inside the detector is maintained at a very acceptable level,

ALLOWING THE DESIGN OF THE DETECTOR WITH THE PRESENT TECHNOLOGY

Solution

Synergy with ILC + CRAB WAIST

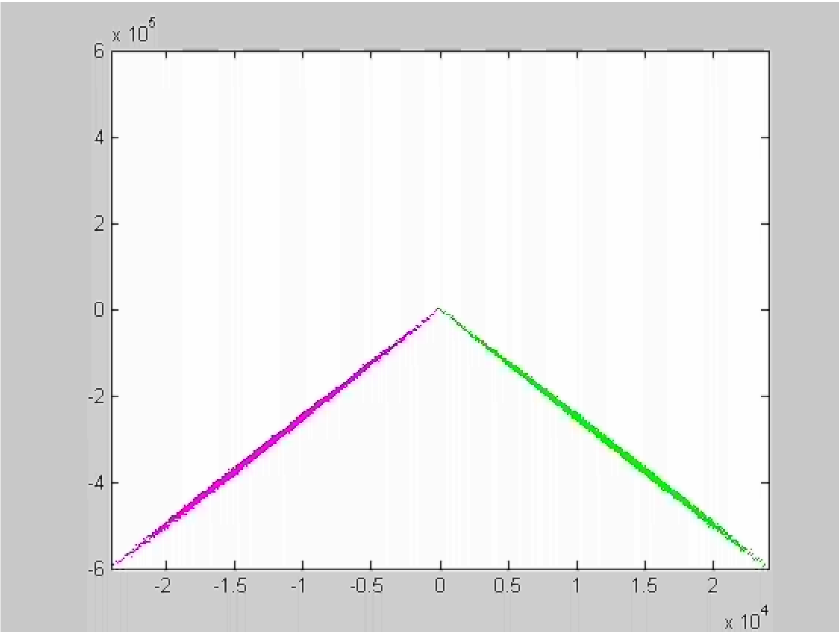
(3 Km/ 6Km)



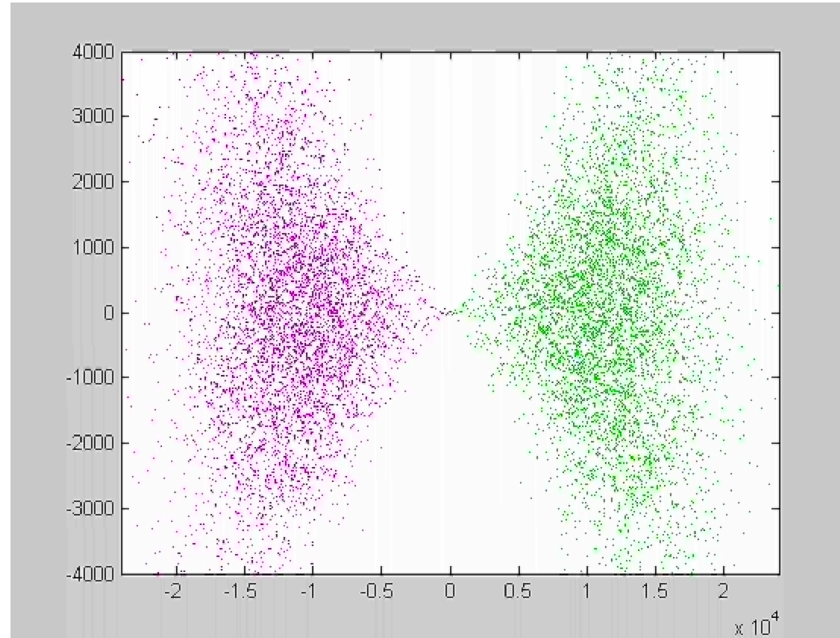
BKGD expected lower than in BaBar at PEPII.

1.0 cm Beam pipe possible inside SVT

Pantaleo's movie of the year: SIMULATION!



Horizontal Plane



Vertical Plane **(Guinea Pig)**

CRAB WAIST x-ing negligible disruption

Collisions with uncompressed beams

Crossing angle = 2*25mrad

Relative Emittance growth per collision about $1.5*10^{-3}$

($\varepsilon_{after\_collision}/\varepsilon_{before\_collision}=1.0015$)

Total Wall Power (66% transfer eff.): 34 MW !!

	LER 4 GeV	*HER 7 GeV*
C (m)	3006.	3006.
B_w (T)	1.6	1.6
L_{bend}(m)	5.6	11.2
B_{bend} (T)	0.078	0.136
Uo (MeV/turn)	4.6	7.8
N. wigg. cells	8	4
τ_x (ms)	17.5	18.
τ_s (ms)	8.8	9.
ε_x (nm)	0.54	0.54
σ_E	$1.1\text{x}10^{-3}$	$1.45\text{x}10^{-3}$
I_{beam} (A)	2.5	1.4
P_{beam}(MW)	11.5	10.9

Also
6000 m.

N_{bunch}=5000
/10000

cm σ_E=0.9x10^{-3}

0.5x10-3

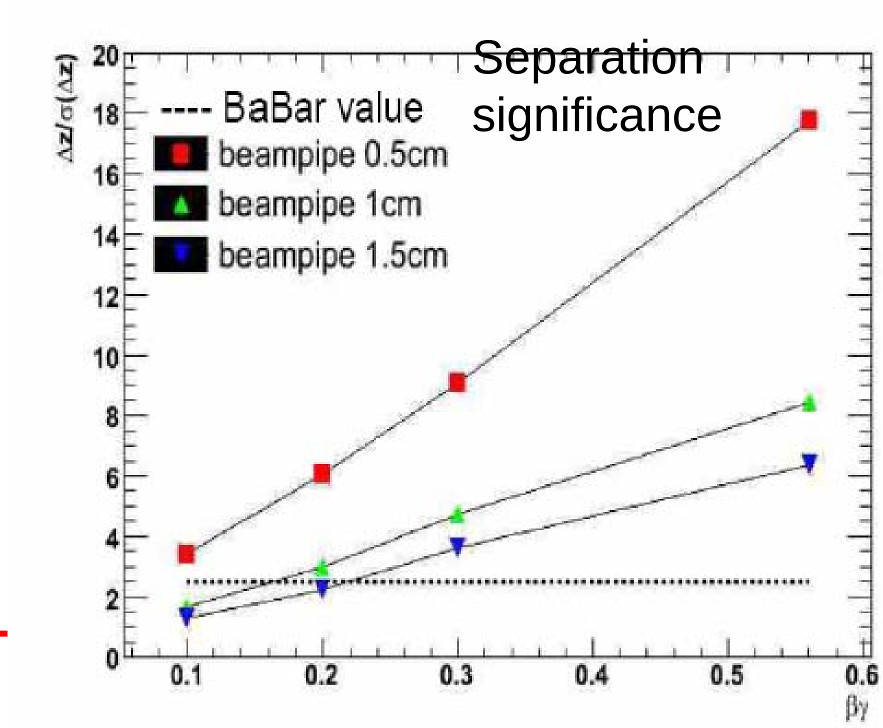
Beam Pipe Radius

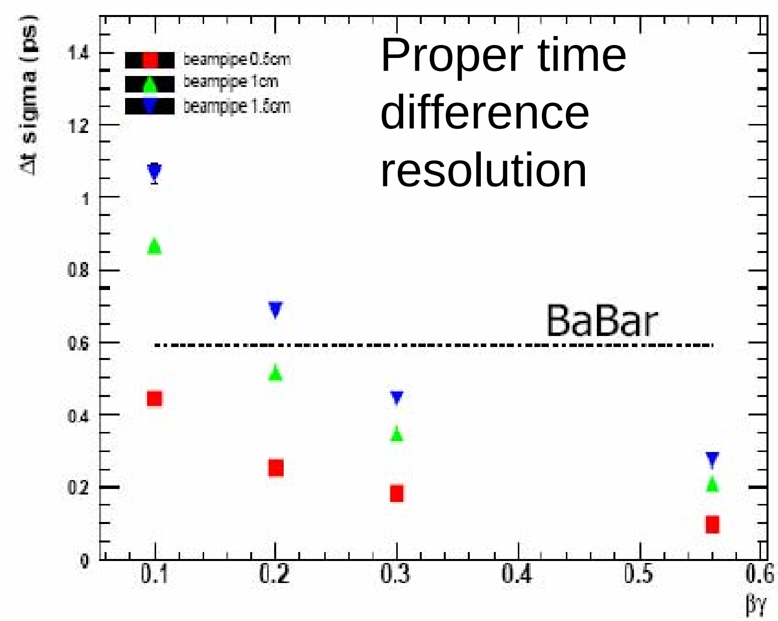
- Small beam pipe radius possible because of small beam size
  - Studied impact of boost on vertex separation (B→ππ)
  - Beampipe hypothesis (no cooling)
    - 5um Au shield to protect from soft photons
    - 0.5cm → 200um Be and 5um hit resolution (0.21% X0)
    - 0.5cm → 300um Be and 10um hit resolution (0.24% X0)
    - 0.5cm → 500um Be and 10um hit resolution (0.29% X0)
  - Rest of tracking is Babar
  - Beam pipe needs to be cooled.Study is in progress to keep total thickness low in the order of % of χ_{rad}

7+4GeV

Boost $\beta\gamma$=.28

Instead of 0.56





Detector comments

Background should be lower than in Babar. Occupancy would be OK in Vertex Detector even with a smaller radius beam pipe. (from 3cm of Babar down to 1.cm). Simulations are currently run for interaction region and Bgkd.

Apparatus would be more hermetic than Babar and Belle (7+4 GeV).

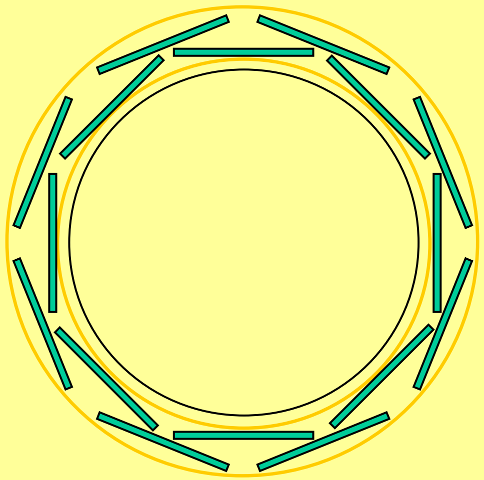
Detectors don't require a major R&D

PID would be needed also in forward/backward direction.

By reducing Lorentz boost higher resolution vertex is needed (MAPS?)

R&D on EMC (Babar Caltech..)

R&D on PID (Babar: Slac) (Belle :KeK ,Lubijana



x5 scale with 10mm radius BP, 6mm pixel chip

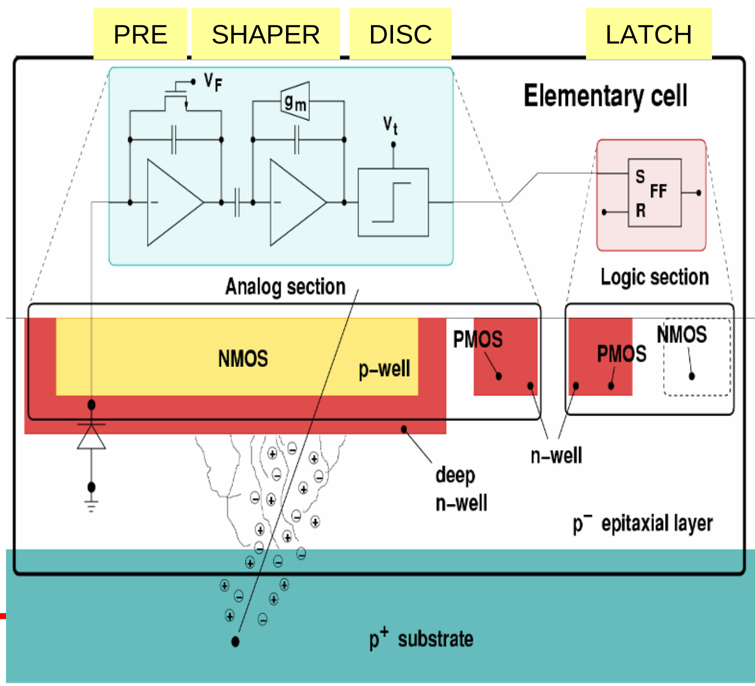
R&D on Maps within Belle (Hawaii group)and Babar (Pisa+Slac)

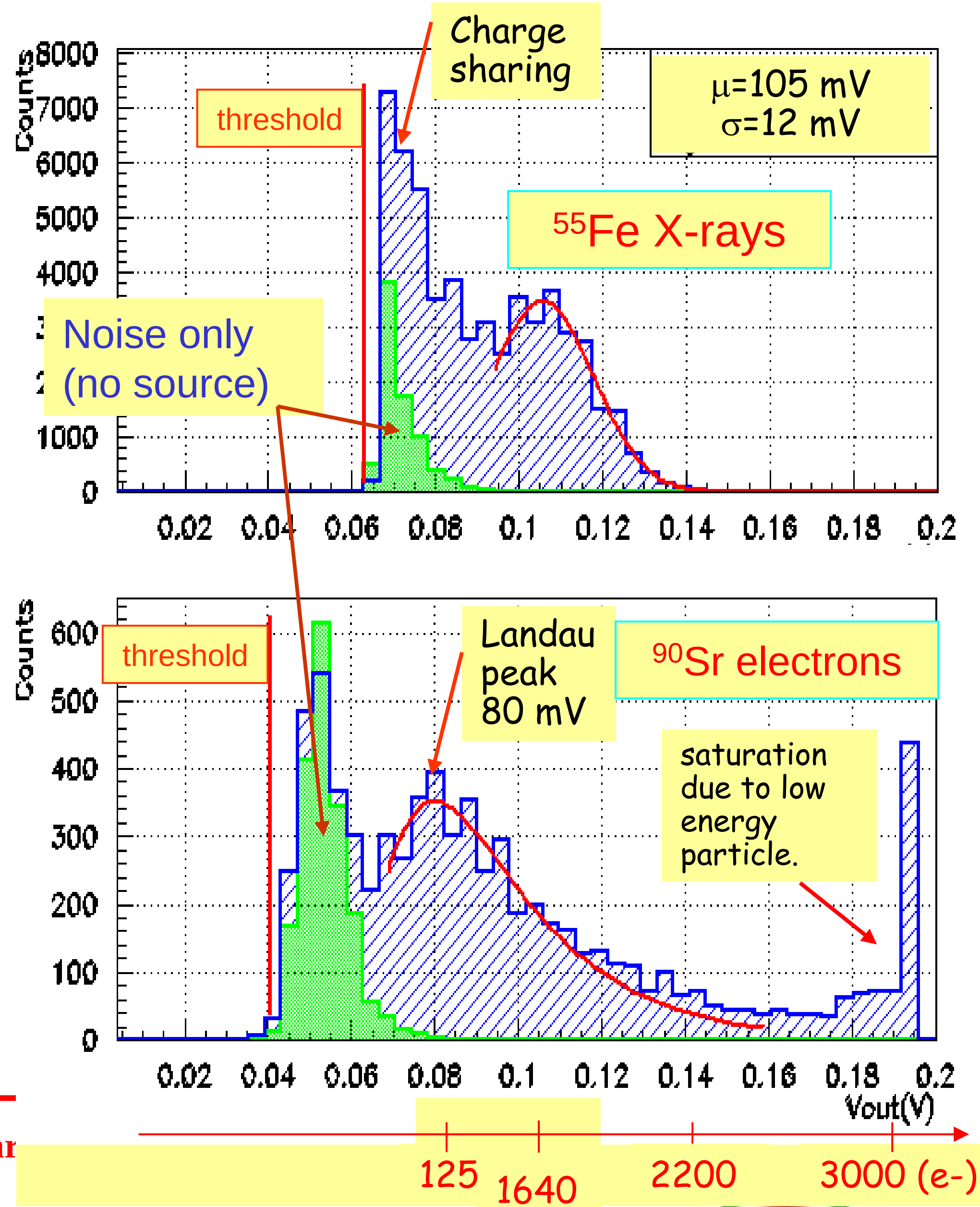
- Two monolithic active pixel layers glued on beam pipe
  - Since active region is only ~10μm, silicon can be thinned down to ~50μm.Good resolution O(5μm).
  - Improves pattern recognition robustness and safety against background

MAPS R&D

ST 0.13um triple well technology
Single pixels tested with source
Full signal processing chain

- SLIM chip (Babar collabor.)





Goals

Preliminary evaluation of need for special runs on tau and charm Evaluation of needs for special runs symmetric, at c.m. energies even lower than 10 GeV.

Evaluation of benefits with one polarized beam

Better definition of a single machine design

fix one minimum circumference of the machine

Study of the interaction region and Background

Beam pipe preliminary design

(to move on to a realistic design of vertex-tracker with an adequate R&D)

Final considerations

Site of SuperB is not defined and will remain undefined for quite a while. The machine can stay in an existing tunnel of 6 Km, 3 Km and perhaps 2 Km. Any offer will be welcome, providing is within a true international spirit of cooperation between partners with equal dignity.

However INFN is a strong supporter in this enterprise.

INFN will try to gain the support of italian government for such an international project. If the site would be located in Italy, near Frascati, the tunnel and some industrial building would be built from scratch. After this workshop we must give to the President of INFN a preliminary but realistic evaluation of the size of the tunnel and at least of the minimum volume of surface buildings needed as infrastructure (assembly hall, MCC, experimental counting room etc..)

A preliminary, approximate but fair estimate of the time for procurement and assembly and of the cost of machine components should also be made.