After the Kick-Off

The SuperB Status & Goals

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LNF June 6, 2011

Consiglio Scientifico

The **XVII SuperB Workshop and Kick off Meetiing**

Meeting schedule

Kick off Day

May – June 2011						
Sa	*Su*	*Mo*	*Tu*	*We*	*Th*	*Fr*
28	29	30	31	1	2	3

- Arrival → 28
- Working Sessions → 29
- Kick off Day → 30
- End Working Sessions → 1
- 1st Departure → 2
- Det. Board, Accel. Board, Project. Board, Steering Committee → 2
- 2nd Departure → 3

KICK-OFF DAY

11:00	PLENARY
SML	KICK-OFF DAY
30	Status of the SuperB Project (R.Petronzio)
30	SuperB e il Piano Nazionale della Ricerca (A.Agostini)
30	SuperB nel Campus dell'Università di Tor Vergata (P.Masi)
30	SuperB as High Brilliance Light Source (E. Di Fabrizio)
13:30	*Lunch - Fuoco di Bosco*
15:30	PLENARY
SML	KICK-OFF DAY
30	The European Strategy Session and the New Particle Physics Roadmap (S. Stapnes)
30	Super Flavour Collires and ECFA (T. Nakada)

Tuesday,May 31, 2011	
15.30	Special MINI-PLENARYY

17:00	The LHC(B) Discovery Potential (20') (Slides)	Guy Wilkinson (*University of Oxford*)
17:20	The Super-KEKB and Belle-II Projects (20') (Slides)	Peter Krizan (*Ljubljana Univ. and J. Stefan Institute*)
17:40	The BINP Super Tau-Charm Factory (20') (Slides)	Vladimir Druzhinin (*BINP, Novosibirsk, Russia*)
18:00	The BES-III Project (20') (Slides)	Hai-Bo Li

18:45	PLENARY
SML	Experiment Collaboration Forming

Real Kick-Off

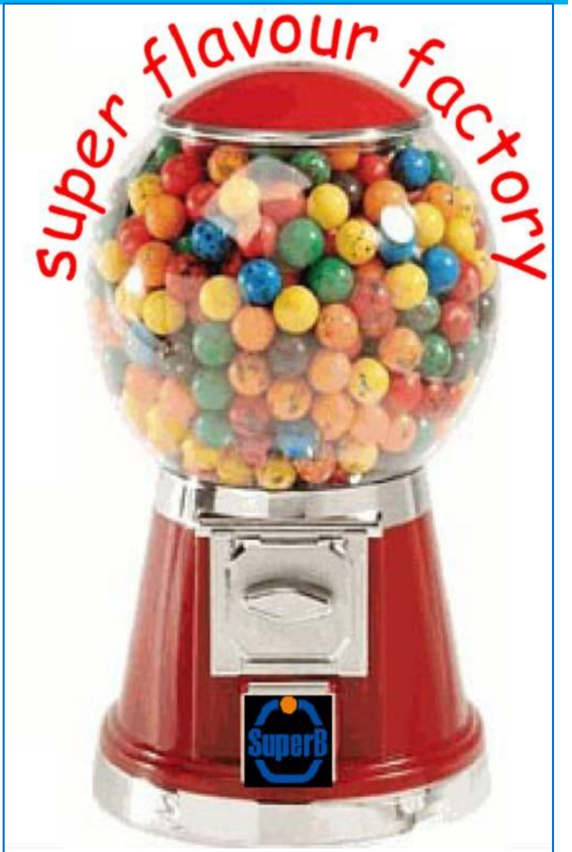
Real Kick-Off

Goals

SuperB is a Super Flavor Factory

High statistics production of $b\bar{b}$, $b\bar{b}$, $\tau^+\tau^-$ pairs.

Follow the high intensity route to New Physics , look at signals through high precision measurements in Flavor/



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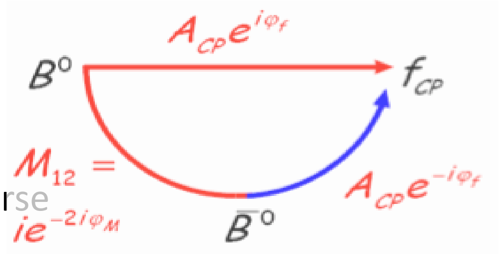
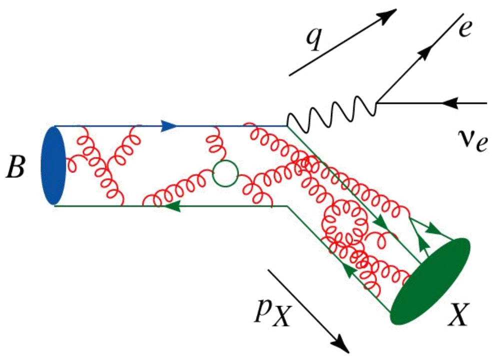
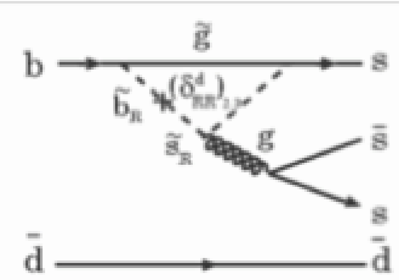
Toward New Physics

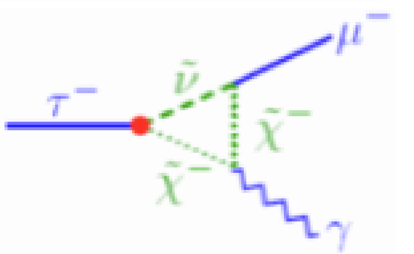
Statistic

1. Explore the origin of CP violation
   - Key element for understanding the matter content of our present universe
   - Established in the B meson in 2001
   - Direct CPV established in B mesons in 2004
2. Precisely measure parameters of the standard model
   - For example the elements of the CKM quark mixing matrix
   - Disentangle the complicated interplay between weak processes and strong interaction effects
3. Search for the effects of physics beyond the standard model in loop diagrams
   - Potentially large effects on rates of rare decays, time dependent asymmetries, lepton flavour violation, …
   - Sensitive even to large New Physics scale, as well as to phases and size of NP coupling constants









Physics programme in a nutshell

- Versatile flavour physics experiment
  - Probe new physics observables in wide range of decays.
    - Pattern of deviation from Standard Model can be used to identify structure of new physics.
    - Clean experimental environment means clean signals in many modes.
    - Polarized e^- beam benefit for τ LFV searches.
  - Best capability for precision CKM constraints of any existing/proposed experiment.
    - Measure angles and sides of the Unitarity triangle
    - Measure other CKM matrix elements at threshold and using τ data.

$B_{u,d}$ physics: Rare Processes and Precision Measurements

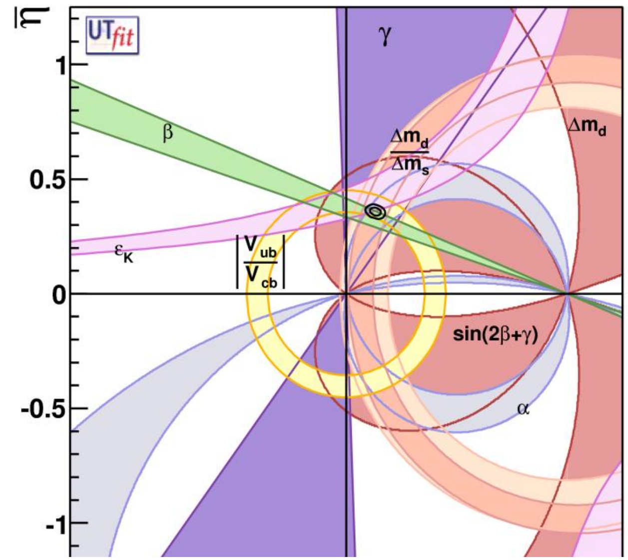
- Goal: Reveal presence of New Physics (NP) using two-pronged attack:
  - Search for **Rare Processes**: NP contributions can be as large as Standard Model ones
    - Large sensitivity to NP
    - Ability to distinguish among NP models
  - Make **Precision Measurements** of many quantities: over constrain the Standard Model predictions
    - NP will often lead to discrepancies in global analyses of measured processes
- SuperB will build on experience of current B-factories.

CKM constraints

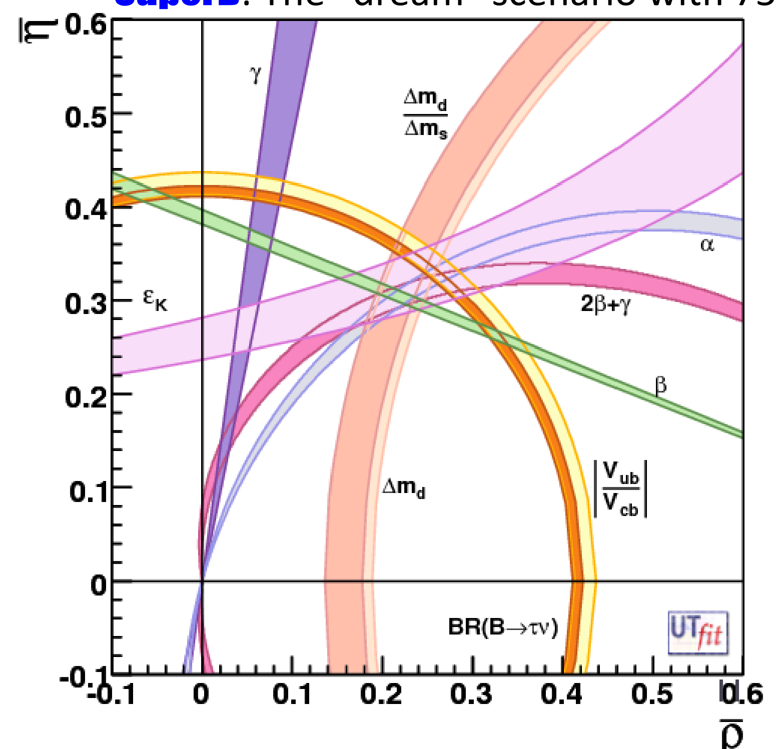
SuperB measures the sides and angles of the Unitarity Triangle (UT)

- Many measurements constrain the sides and angles of the UT: the SM predicts that all measurements “intersect” at apex of the triangle
- When NP is present, the measurements do not yield a unique apex, but you need the high precision of a Super Flavour Factory.

Today:



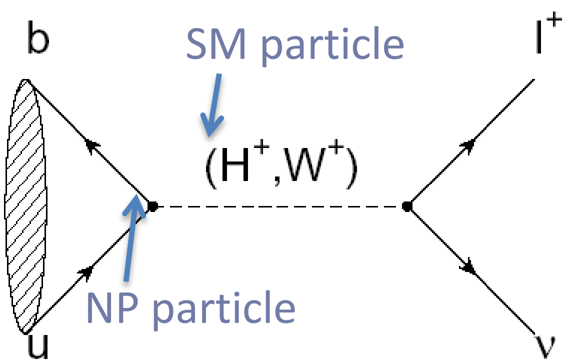
SuperB: The "dream" scenario with $75 ab^{-1}$

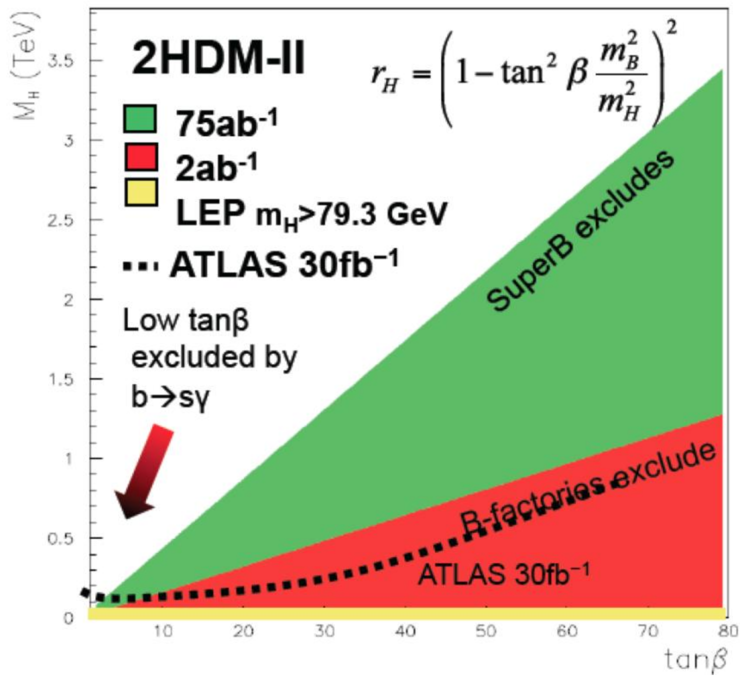


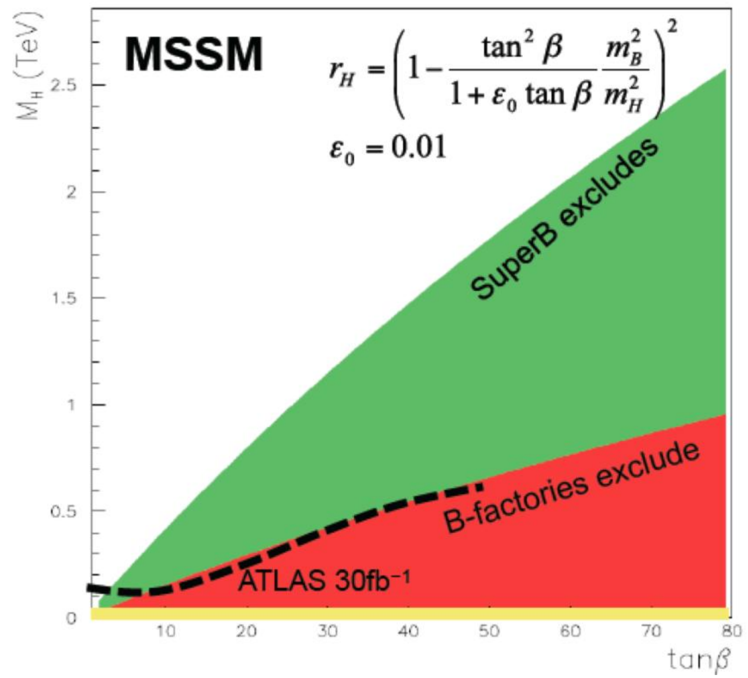
$B_{u,d}$ physics: Rare Decays

- Example: $B^{\pm} \to \tau^{\pm}\nu$
  - Rate modified by presence of H^+

$$r_H = \frac{\mathcal{B}_{SM+NP}}{\mathcal{B}_{SM}}$$







Charm@SuperB: goals

- *Run at Υ(4S):* $\mathcal{L} = 10^{36}\ \mathrm{cm}^{-2}\,\mathrm{sec}^{-1};\ \int \mathcal{L}\,dt = 75\ \mathrm{ab}^{-1}$ at the $\Upsilon(4S)$
  $\beta\gamma=0.238$

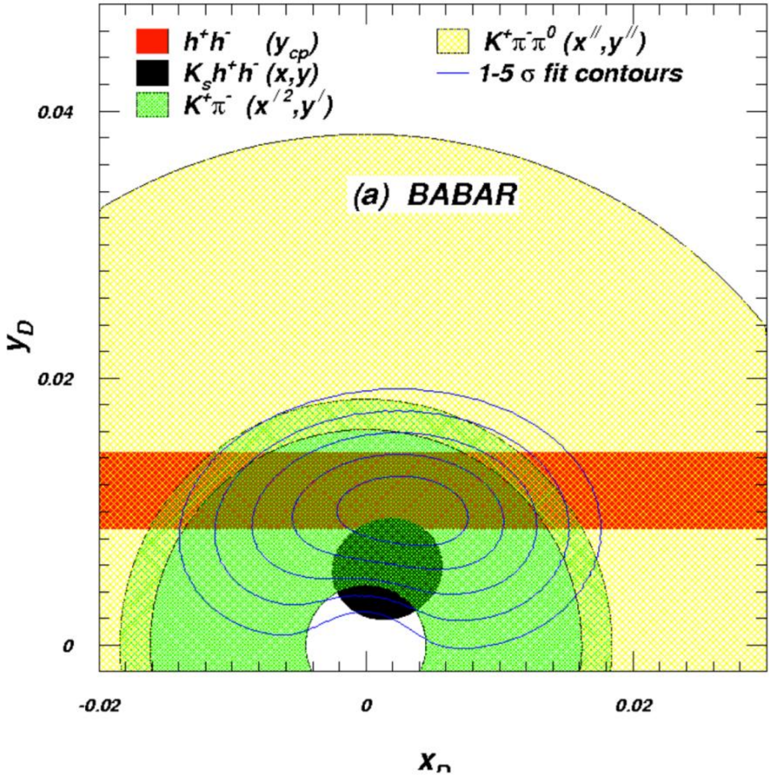
✓ Large improvement in D^0 mixing and CPV: factor 12 improvement in statistical error wrt BaBar ($0.5\ \mathrm{ab}^{-1}$);
✓ time-dependent measurements will benefit also of an improved (2x) D^0 proper-time resolution. [≈1KHz of $c\bar{c}$]

Unique feature of SuperB

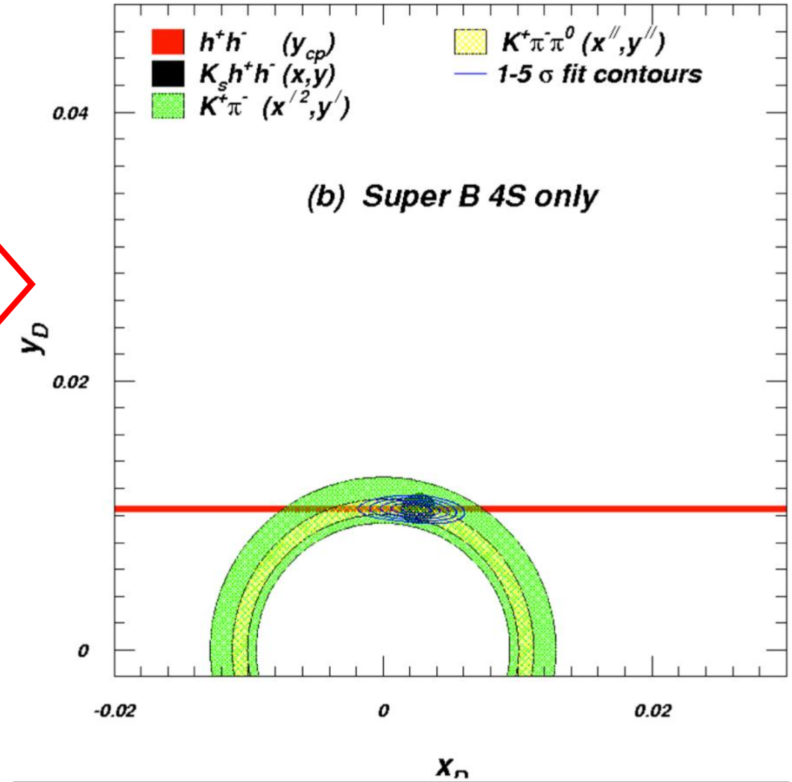
- *Run at ψ(3770):* $\mathcal{L} = 10^{35}\ \mathrm{cm}^{-2}\,\mathrm{sec}^{-1};\ \int \mathcal{L}\,dt = 500\ \mathrm{fb}^{-1}$ at the $\Psi(3770)$
  $\beta\gamma$ up to 0.9

✓ $D\bar{D}$ coherent production with 100x BESIII data and CM boost up to $\beta\gamma=0.9$;
✓ almost zero background environment;
✓ possibility of time-dependent measurements exploiting quantum coherence.

Sensitivity projections with 75 ab^{-1} at Υ(4S)



Fit	$x \times 10^3$	$y \times 10^3$	$\delta^\circ_{K^+\pi^-}$	$\delta^\circ_{K^+\pi^-\pi^0}$
(a)	$3.01^{+3.12}_{-3.39}$	$10.10^{+1.69}_{-1.72}$	$41.3^{+22.0}_{-24.0}$	43.8 ± 26.4
Stat.	(2.76)	(1.36)	(18.8)	(22.4)

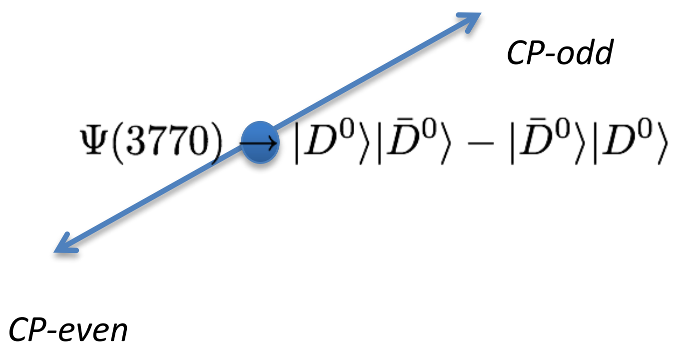


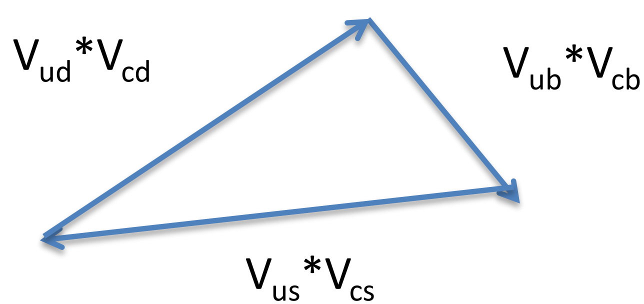
Fit	$x \times 10^3$	$y \times 10^3$	$\delta^\circ_{K^+\pi^-}$	$\delta^\circ_{K^+\pi^-\pi^0}$
(b)	$xxx^{+0.72}_{-0.75}$	$xxx \pm 0.19$	$xxx^{+3.7}_{-3.4}$	$xxx^{+4.6}_{-4.5}$
Stat.	(0.18)	(0.11)	(1.3)	(2.9)

Uncertainties shrink:
$x_D \rightarrow x_D/4$; $y_D \rightarrow y_D/10$
Precision in x_D is limited by Dalitz plot model.

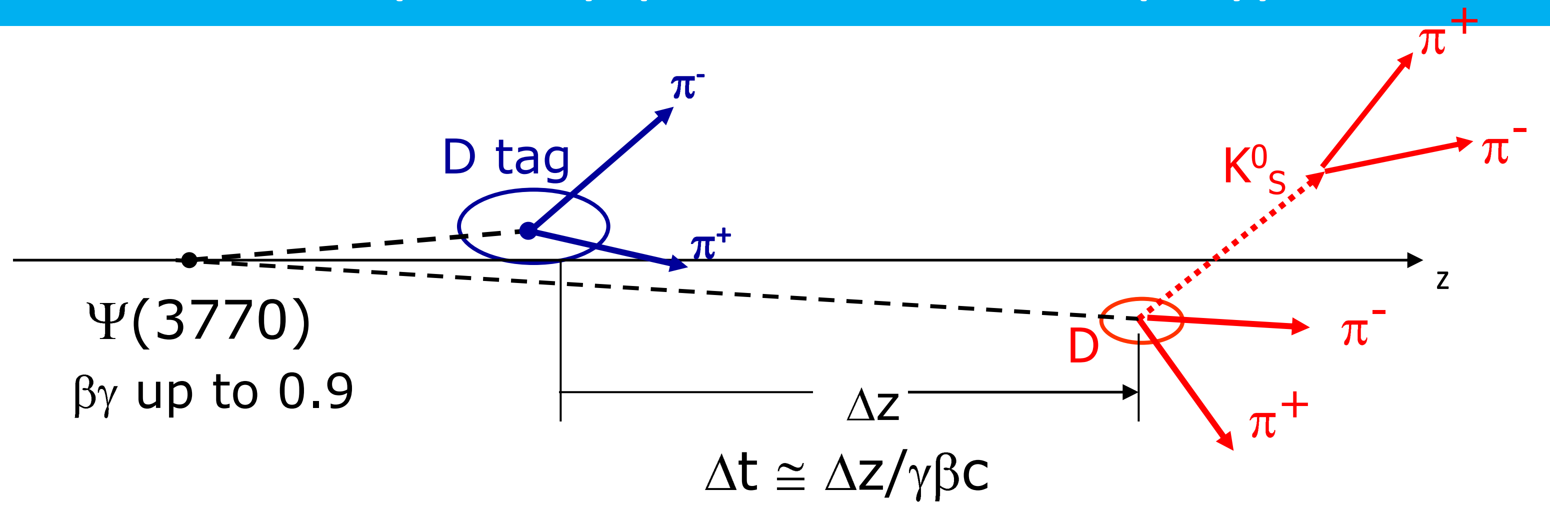
Charm at DD threshold

- Almost zero background analyses: search for rare/forbidden decays, precise measurement of relative D^0-$\bar{D}^0$ strong phases, search for CPV in wrong sign (WS) semileptonic (SL) D^0 decay modes.
- Unique possibilities of time-dependent measurements at $\bar{D}D$ threshold currently under study:
  - coherent production allows time-dependent measurements also withCP-tagged events;
  - CP, T, CPT conservation tests similar to those in K^0-$\bar{K}^0$ and B^0-$\bar{B}^0$ systems;
  - measure of the unitarity triangle in the Charm sector.





Time dependent measurements at the $\Psi(3770)$ (same as for $\Upsilon(4s)$)



1. Reconstruct the decay vertex of the two D mesons

2. Compute the proper time difference Δt

$$\sigma(\Delta t) \propto \frac{\sigma(\Delta z)}{\beta\gamma c}$$

minimum boost needed to achieve the required Δt resolution

Experimental considerations of running at $D\bar{D}$ threshold with boost

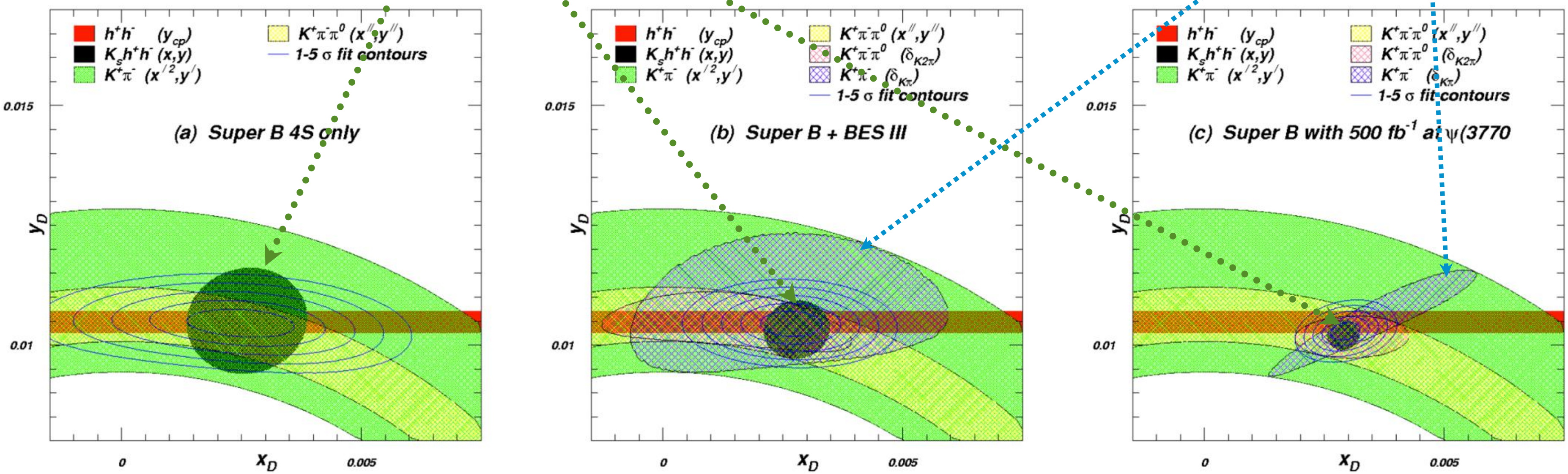
- Pro:
  - Very clean environment, backgroud extremely low;
  - Quantum coherence: mixing and CP, T, CPT analyses;
  - Access to D^0-$\bar{D}^0$ relative phases and possibilities of time-dependent Dalitz plot analyses with a model independent approach;
  - Systematic errors reduction due to background and Dalitz model uncertainties;

- Cons:
  - Time-dependent measurement require larger CM boost compared to the B^0-$\bar{B}^0$ case to achieve adequate time resolution;
  - reconstruction efficiency decreases with large CM boost. Need to optimize the boost value.

- Two improvements in mixing precision come from threshold data:

CAVEAT: NO TIME-DEPENDENT STUDIES INCLUDED YET

- Dalitz plot model uncertainty shrinks
- Information on overall strong phase is added



Fit	$x \times 10^3$	$y \times 10^3$	$\delta^{\circ}_{K^+\pi^-}$	$\delta^{\circ}_{K^+\pi^-\pi^0}$
(b)	$xxx^{+0.72}_{-0.75}$	$xxx \pm 0.19$	$xxx^{+3.7}_{-3.4}$	$xxx^{+4.6}_{-4.5}$
Stat.	(0.18)	(0.11)	(1.3)	(2.9)

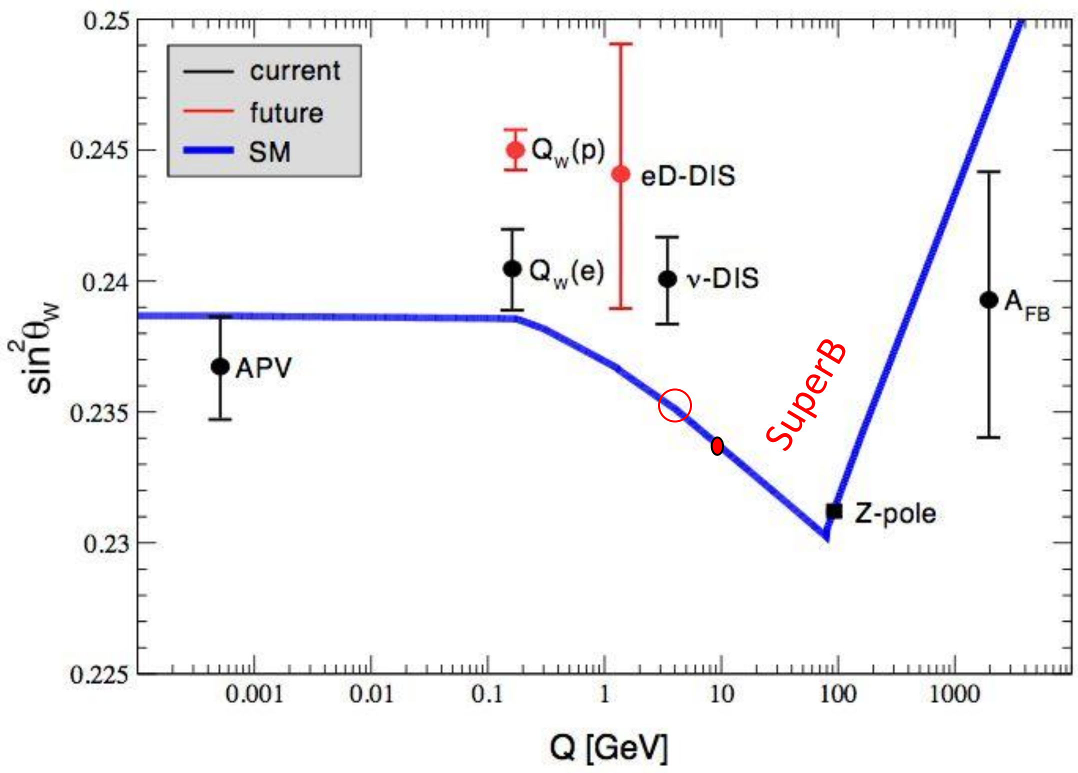
Fit	$x \times 10^3$	$y \times 10^3$	$\delta^{\circ}_{K^+\pi^-}$	$\delta^{\circ}_{K^+\pi^-\pi^0}$
(c)	$xxx \pm 0.42$	$xxx \pm 0.17$	$xxx \pm 2.2$	$xxx^{+3.3}_{-3.4}$
Stat.	(0.18)	(0.11)	(1.3)	(2.7)

Fit	$x \times 10^3$	$y \times 10^3$	$\delta^{\circ}_{K^+\pi^-}$	$\delta^{\circ}_{K^+\pi^-\pi^0}$
(d)	$xxx \pm 0.20$	$xxx \pm 0.12$	$xxx \pm 1.0$	$xxx \pm 1.1$
Stat.	(0.17)	(0.10)	(0.9)	(1.1)

Measurements with Polarization

Precision Electroweak

- $\sin^2\theta_W$ can be measured with polarised e^-



Measure LR asymmetry in

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

at the ϒ(4S) to same precision as LEP/SLC at the Z-pole.

Can also perform crosscheck at ψ(3770).

Is this measurement also possible with Charm?

1. @ Y(4S) . But hadronization correction.
2. Operate at a ccbar vector resonance above open charm threshold Ψ(3770), use the same analysis method as for b.

Polarization at low energies with high luminosity is needed

That is included in the SuperB design

g-2 Reach (Valencia Report 2008)

Δa_μ is not in good agreement with SM

Measuring differential cross section of tau production would lead to measurement of the real part of tau form factor.

SPS	1a	1b	2	3	4	5
$\Delta a_\mu \times 10^{-9}$	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

We began considering 1-3 prong whose experimental selection is cleaner

Need to tag the sample:

Lepton tag: higher purity & higher diluition (at least 3 neutrinos)

Hadronic tag: lower purity & lower diluition (2 neutrinos)

Systematics come mainly from tracking

Should be able to measure the real part $(0.75\text{-}1.7)\mathrm{x}10^{-6}$

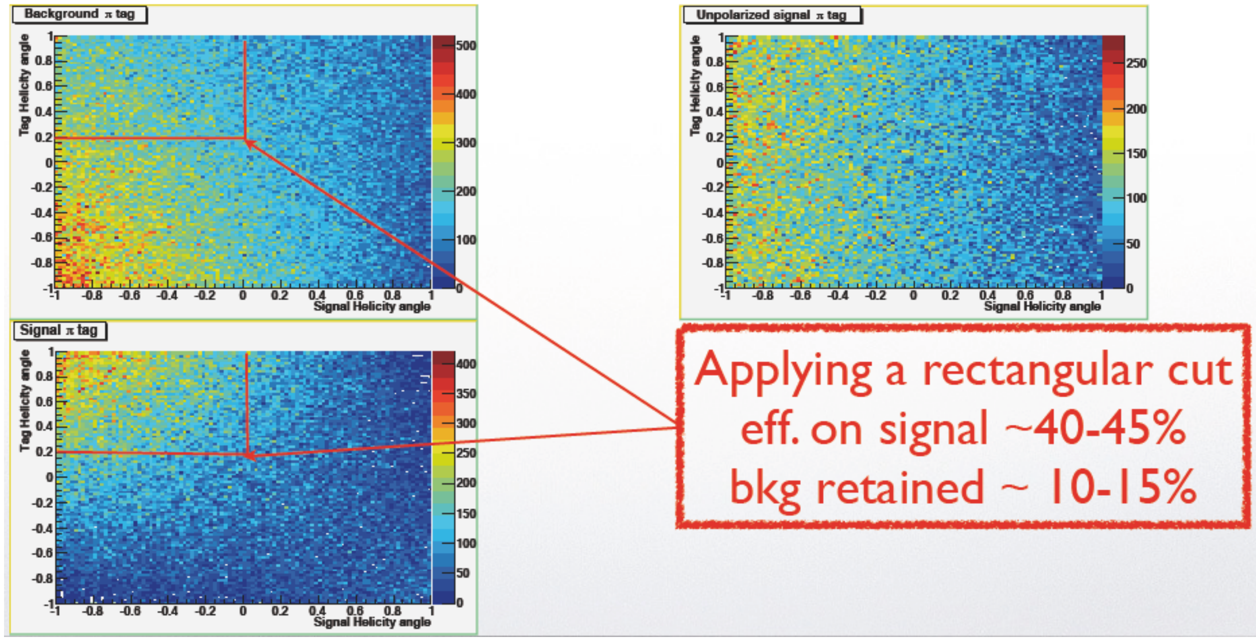
$$\frac{d\sigma}{d\cos(\theta)} = a \cdot \cos(\theta)^2 + b$$

$$a \propto \beta^2 |F_1|^2$$

$$b \propto (2-\beta^2) \cdot |F_1|^2 + 4\mathrm{Re}[F_2]$$

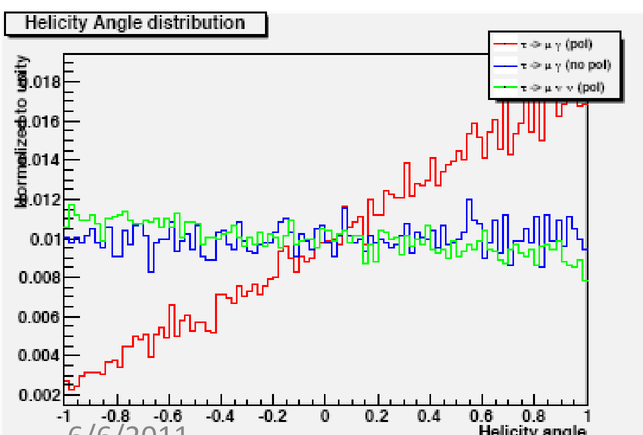
EXPERIMENT ⇓	Cross Section $Re\{F_2\}$	Normal Asymmetry $Im\{F_2\}$
Babar+Belle $2ab^{-1}$	4.6×10^{-6}	2.1×10^{-5}
Super B/Flavor Factory (1 yr. running) $15ab^{-1}$	1.7×10^{-6}	7.8×10^{-6}
Super B/Flavor Factory (5 yrs. running) $75ab^{-1}$	7.5×10^{-7}	3.5×10^{-6}

Polarized beam and tag on leptons and on hadrons (t→ p n /t→ r n) reduces irreducible background!



75 ab^{-1}

Sensitivity improves at least by a factor 2. Equivalent to a factor 4 increase in luminosity.



$B(\tau \to \mu\gamma)\ 2\times 10-9$

$B(\tau \to e\,\gamma)\ 2\times 10-9$

→

$B(\tau \to \mu\gamma)\ 1\times 10-9$

$B(\tau \to e\,\gamma)\ 1\times 10-9$

Polarisation is
- -an important issue for LFV
- -opens the possibility of measuring (g-2)
- -opens measurement of EW parameters

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 (*)
$\|V_{cb}\|$ (exclusive)	4% (*)	1.0% (*)
$\|V_{cb}\|$ (inclusive)	1% (*)	0.5% (*)
$\|V_{ub}\|$ (exclusive)	8% (*)	3.0% (*)
$\|V_{ub}\|$ (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
- channels with π^0, γ's, ν, many Ks…

physics (polarized beams)

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}

Charm at Y(4S) and threshold

Mode	Observable	B Factories ($2\ \mathrm{ab}^{-1}$)	Super$B$ ($75\ \mathrm{ab}^{-1}$)
$D^0 \to K^+K^-$	y_{CP}	$2\text{–}3 \times 10^{-3}$	5×10^{-4}
$D^0 \to K^+\pi^-$	y'_D	$2\text{–}3 \times 10^{-3}$	7×10^{-4}
	x'^2_D	$1\text{–}2 \times 10^{-4}$	3×10^{-5}
$D^0 \to K_S^0\pi^+\pi^-$	y_D	$2\text{–}3 \times 10^{-3}$	5×10^{-4}
	x_D	$2\text{–}3 \times 10^{-3}$	5×10^{-4}
Average	y_D	$1\text{–}2 \times 10^{-3}$	3×10^{-4}
	x_D	$2\text{–}3 \times 10^{-3}$	5×10^{-4}
$D^0 \to K^+\pi^-$	x'^2	*To be evaluated at LHCb*	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°

Channel	Sensitivity
$D^0 \to e^+e^-$, $D^0 \to \mu^+\mu^-$	1×10^{-8}
$D^0 \to \pi^0 e^+e^-$, $D^0 \to \pi^0\mu^+\mu^-$	2×10^{-8}
$D^0 \to \eta e^+e^-$, $D^0 \to \eta\mu^+\mu^-$	3×10^{-8}
$D^0 \to K_S^0 e^+e^-$, $D^0 \to K_S^0\mu^+\mu^-$	3×10^{-8}
$D^+ \to \pi^+e^+e^-$, $D^+ \to \pi^+\mu^+\mu^-$	1×10^{-8}
$D^0 \to e^\pm\mu^\mp$	1×10^{-8}
$D^+ \to \pi^+e^\pm\mu^\mp$	1×10^{-8}
$D^0 \to \pi^0 e^\pm\mu^\mp$	2×10^{-8}
$D^0 \to \eta e^\pm\mu^\mp$	3×10^{-8}
$D^0 \to K_S^0 e^\pm\mu^\mp$	3×10^{-8}
$D^+ \to \pi^-e^+e^+$, $D^+ \to K^-e^+e^+$	1×10^{-8}
$D^+ \to \pi^-\mu^+\mu^+$, $D^+ \to K^-\mu^+\mu^+$	1×10^{-8}
$D^+ \to \pi^-e^\pm\mu^\mp$, $D^+ \to K^-e^\pm\mu^\mp$	1×10^{-8}

B_s at Y(5S)

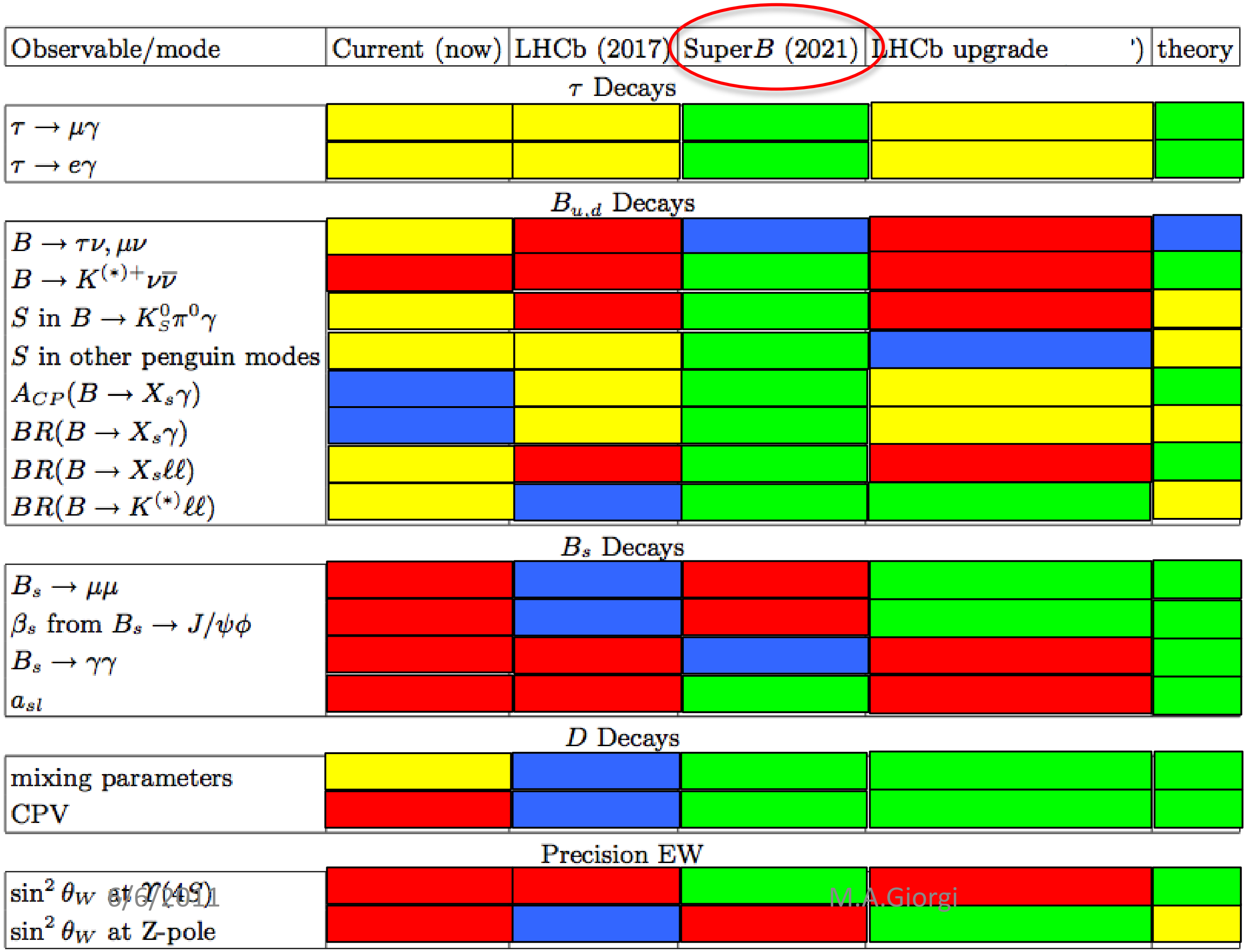
Observable	Error with $1\ \mathrm{ab}^{-1}$	Error with $30\ \mathrm{ab}^{-1}$
$\Delta\Gamma$	$0.16\ \mathrm{ps}^{-1}$	$0.03\ \mathrm{ps}^{-1}$
Γ	$0.07\ \mathrm{ps}^{-1}$	$0.01\ \mathrm{ps}^{-1}$
β_s from angular analysis	20°	8°
A^s_{SL}	0.006	0.004
A_{CH}	0.004	0.004
$\mathcal{B}(B_s \to \mu^+\mu^-)$	-	$< 8 \times 10^{-9}$
$\lvert V_{td}/V_{ts} \rvert$	0.08	0.017
$\mathcal{B}(B_s \to \gamma\gamma)$	38%	7%
β_s from $J/\psi\phi$	16°	6°
β_s from $B_s \to K^0\bar{K}^0$	24°	11°

Bs : Definitively better at LHCb

Many unique quality measurements

Experiment: No Result | Moderate Precision | Precise | Very Precise

Theory: Moderately clean | Clean Need lattice | Clean



Benefit from polarised e⁻ beam

very precise with improved detector

Statistically limited: Ang. analysis with >75ab⁻¹

Right handed currents

SuperB measures many more modes

systematic error is main challenge

control systematic error with data

SuperB measures e mode well, LHCb does μ

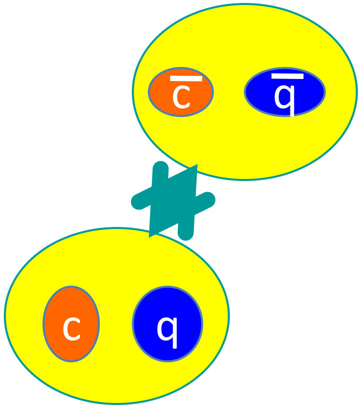
Clean NP search

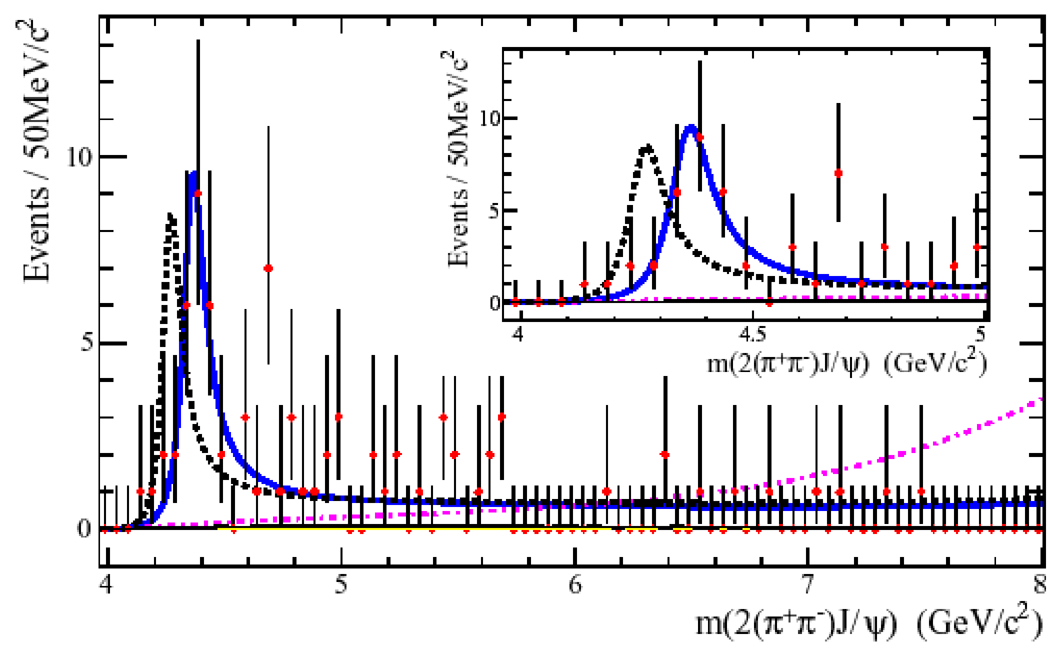
Theoretically clean

b fragmentation limits interpretation

Exotic hadronic spectroscopy

Hints of a new type of particles with more than 3 quarks

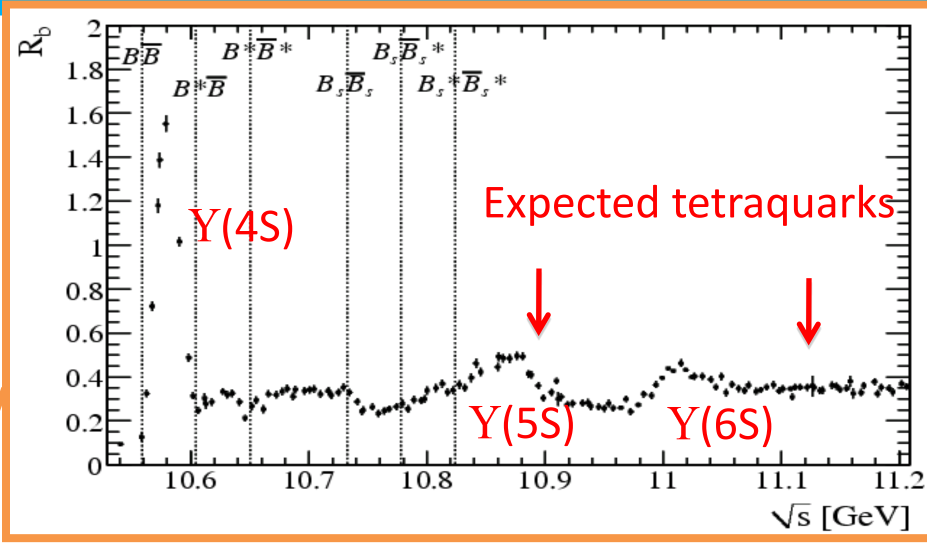


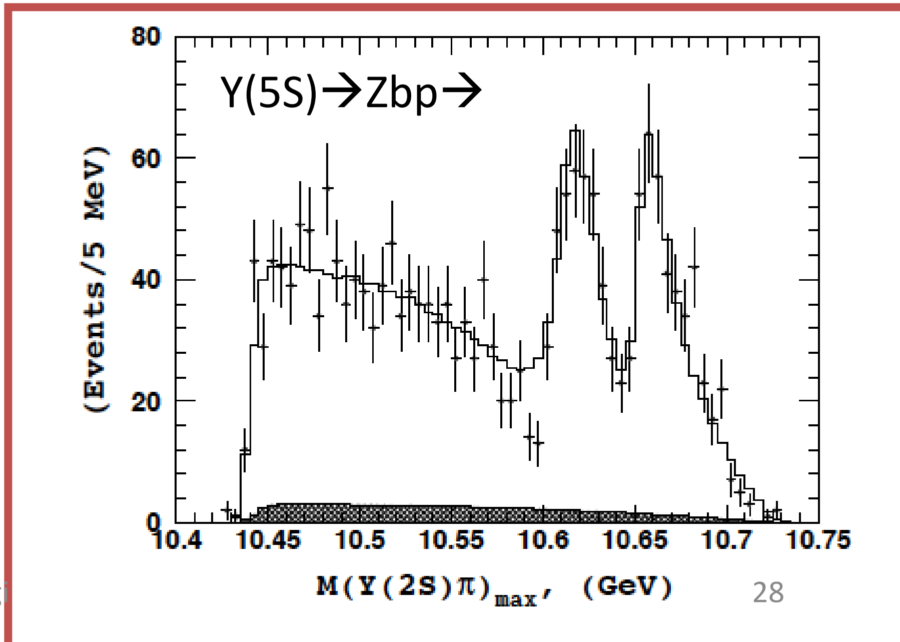


B-Factories produced a lot of results but …

Exotic hadrons @ SuperB

- **Much larger statistics** @Υ(4S) needed
- High luminosity energy scan needed:
  - produce resonances directly (E~4-4.5 GeV)
  - Exploit recent evidence of exotic states produced at Υ(5S)





and Panda: Hadron Spectroscopy e^+e^- vs $\bar{p}p$

e^+e^- collisions
direct formation
two-photon production
initial state radiation (ISR)
B meson decay

+ low hadronic background
+ high discovery potential
- direct formation limited to vector states
- limited mass and width resolution for non vector states

$\bar{p}p$ annihiliation

- high hadronic background
+ high discovery potential
+ direct formation for all (non-exotic) states
+ excellent mass and width resolution for all states

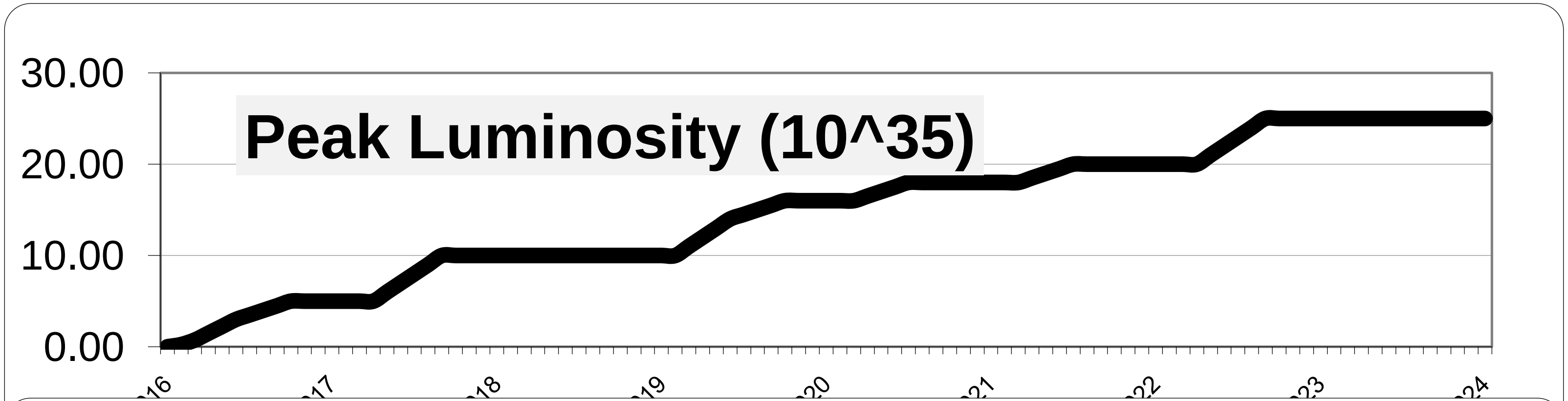
REQUIREMENTS FROM PHYSICS

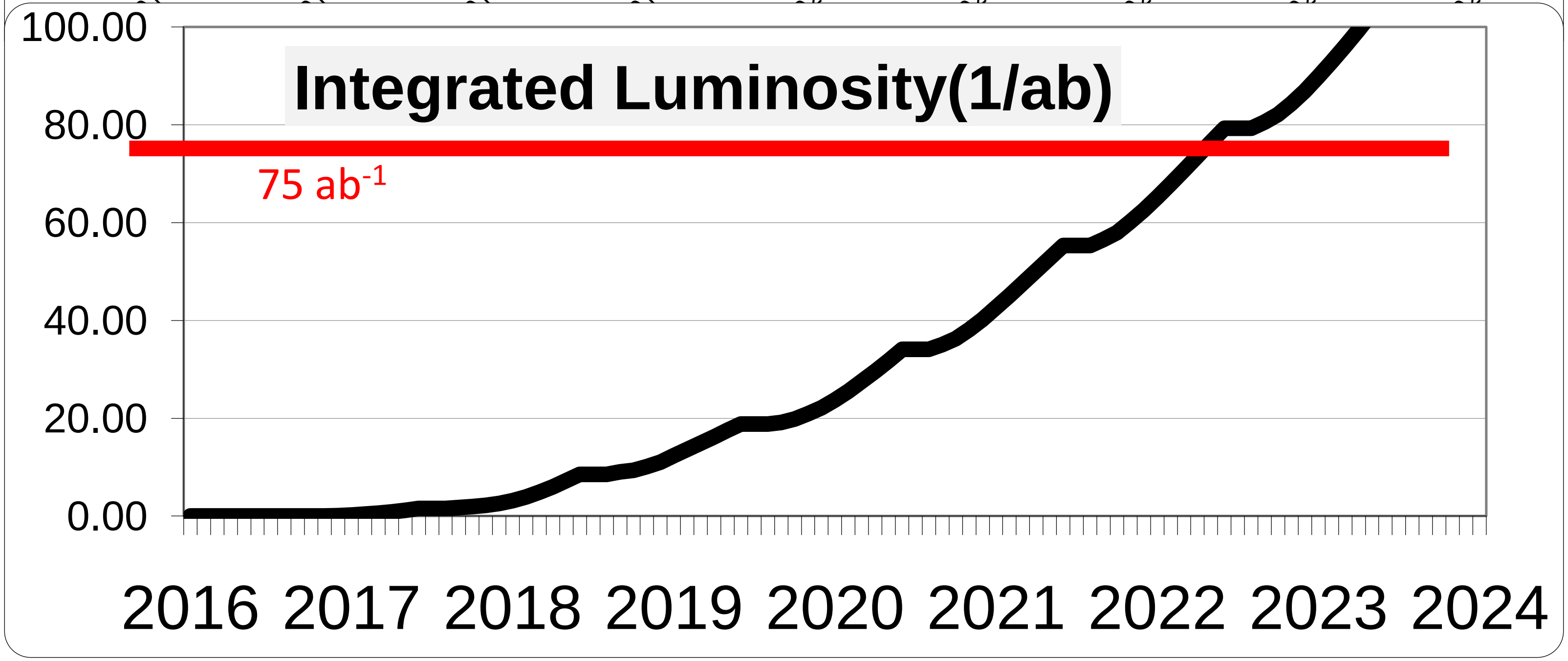
Parameter	Requirement	Comment
Luminosity (top-up mode)	10^{36} $cm^{-2}s^{-1}$ @ $\Upsilon(4S)$	Baseline/Flexibility with headroom at 4. 10^{36} $cm^{-2}s^{-1}$
Integrated luminosity	75 ab^{-1}	Based on a "New Snowmass Year" of 1.5 x 10^7 seconds (PEP-II & KEKB experience-based)
CM energy range	τ threshold to $\Upsilon(5S)$	For Charm special runs (still asymmetric……)
Minimum boost	$\beta\gamma$ ≈0.237 ~(4.18x6.7GeV)	1 cm beam pipe radius. First measured point at 1.5 cm
e^- Polarization Boost up to 0.9 in runs at low energy under evaluation for charm physics	≥80%	Enables τ *CP* and *T* violation studies, measurement of τ *g*-2 and improves sensitivity to lepton flavor-violating decays. Detailed simulation, needed to ascertain a more precise requirement, are in progress.

Future Super B Factories

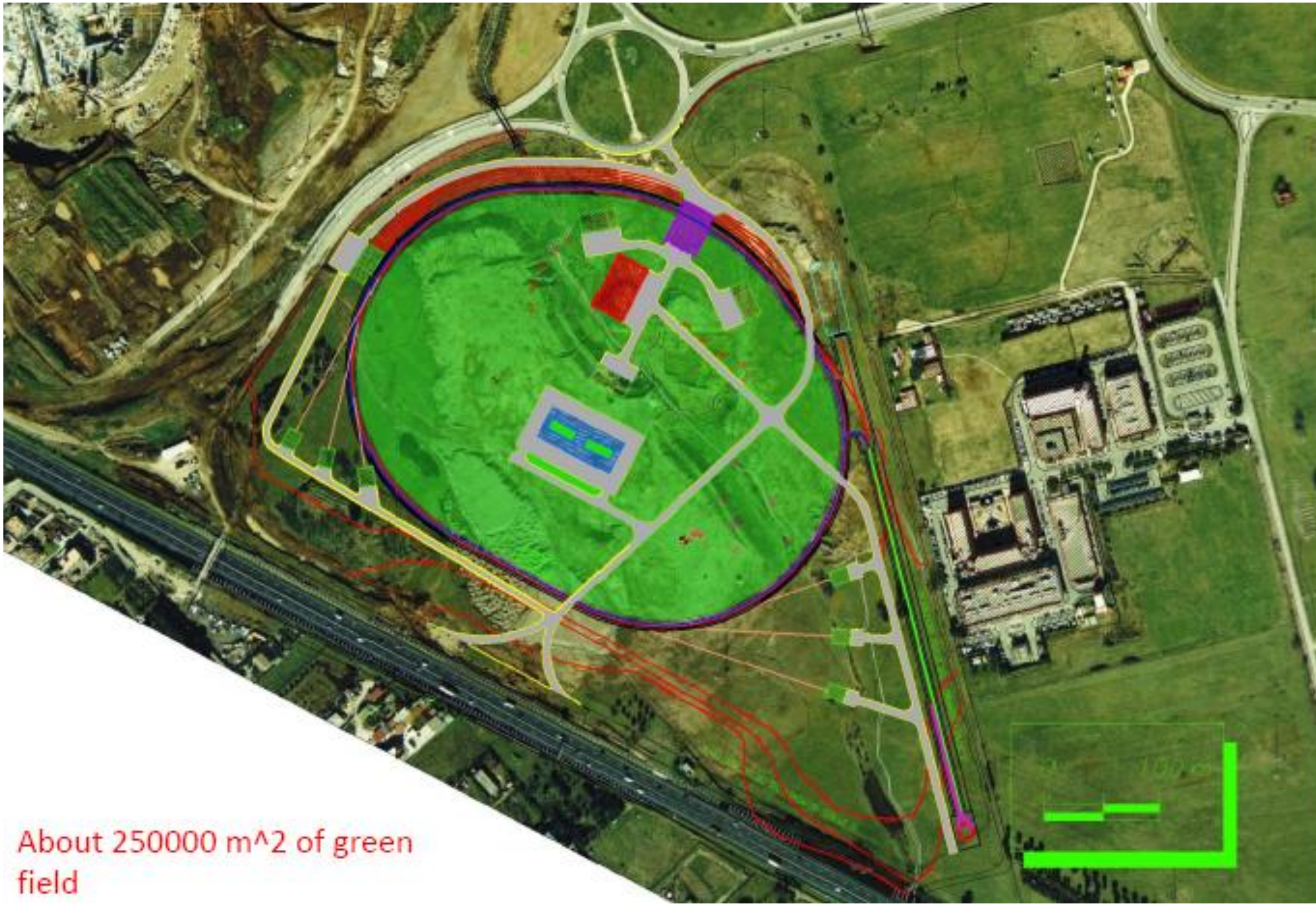
	SuperB	Super KEKB
Peak Luminosity	$>10^{36}$	0.8×10^{36}
Integrated Luminosity	75 ab^{-1}	50 ab^{-1}
Site	Green Field	KEKB Laboratory
Collisions	mid 2016	2015
Polarization	80% electron beam	No
Low energy running	10^{35} @ charm threshold	No
Approval status	Approved	Approved

SuperB Luminosity model





Site (Tor Vergata)



Detector Overview

- Detector design well advanced
  - Based on BaBar “prototype”
  - CDR (2007) http://web.infn.it/superb/images/stories/upload_file/superb-cdr.pdf
  - Detector Progress Report(2010): http://arxiv.org/abs/1007.4241
- Remaining Generic Detector Options to be decided following Detector Geometry Task Force reports and DGWG studies
- Proto-Detector Organization is in place. Needs to be enhanced/modified as collaboration develops.
- R&D ongoing across detector systems allow final designs to proceed.

TDR (early 2012)

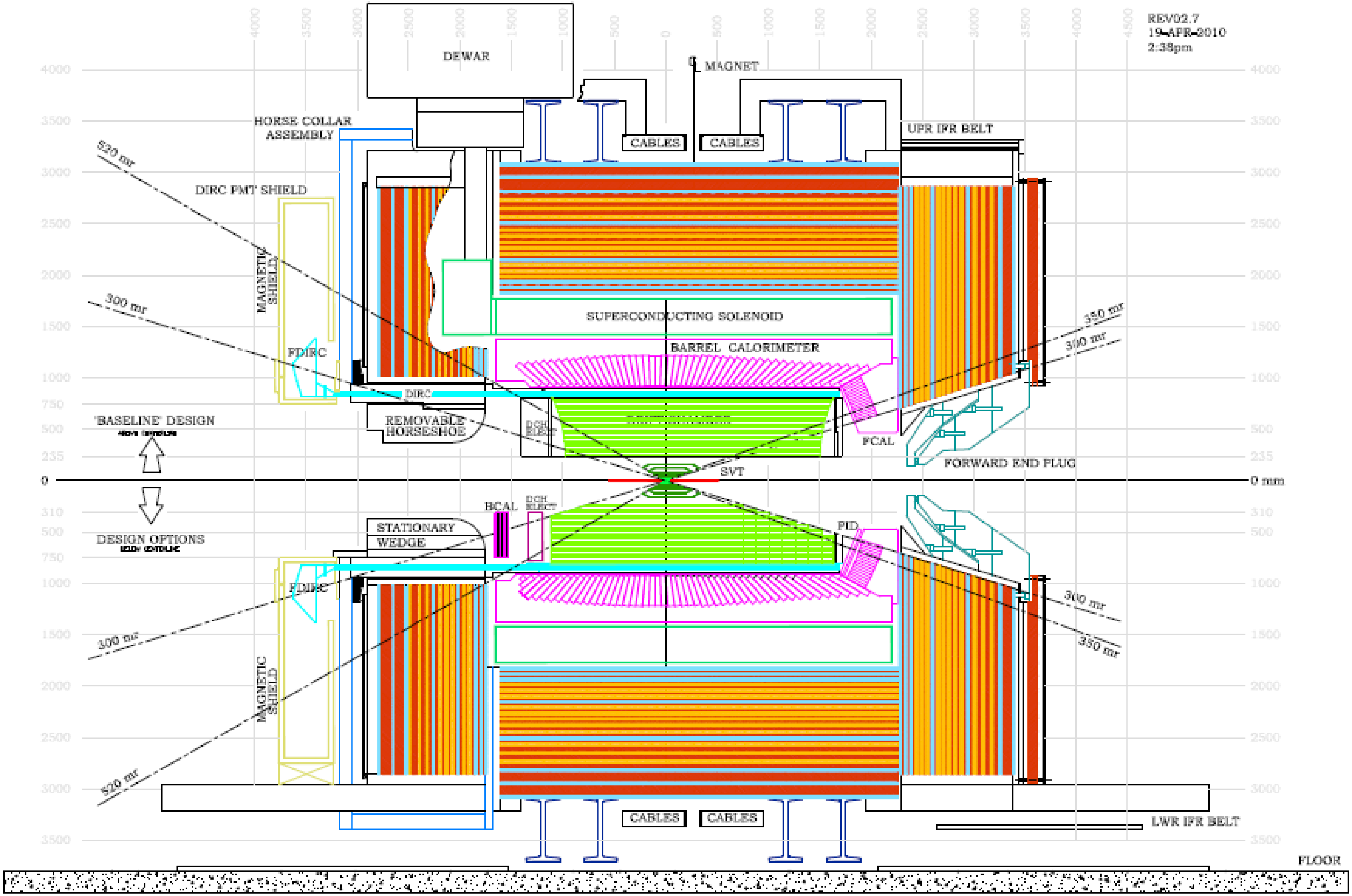
- The Technical Design Report is an essential step to a reviewable design, getting agency funding, and fabricating the detector.
- Conflicting requirements
  - Essential to reach a validated detector technical design taking machine constraints, backgrounds, overall system technical designs, and funding limitations into account.
  - Essential to enlarge the collaboration, define institutional responsibilites, and find resources for designing and building the detector
  - Essential that collaboration members, institutions and countries take ownership of the design and fabrication
  - Essential to move forward rapidly to finalizing the design and writing the TDR

Proto Technical Coordination

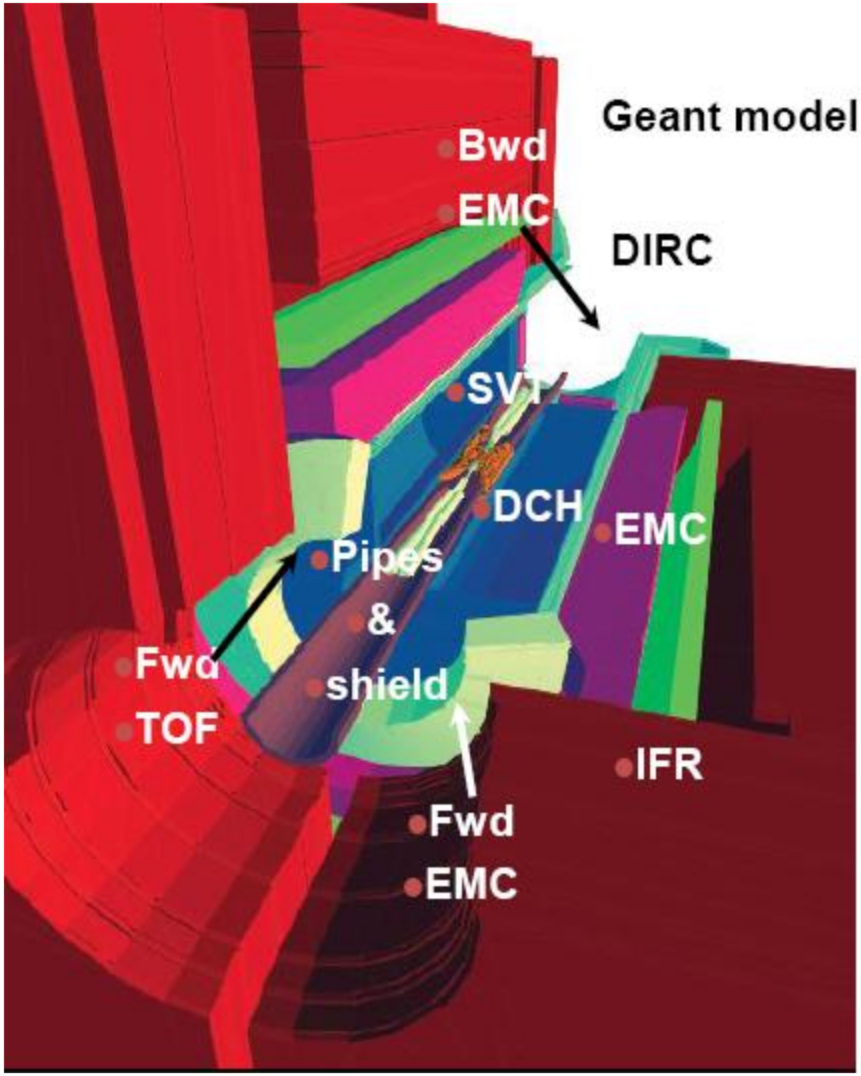
Detector Coordinators – B.Ratcliff, F. Forti
Technical Coordinator – W.Wisniewski

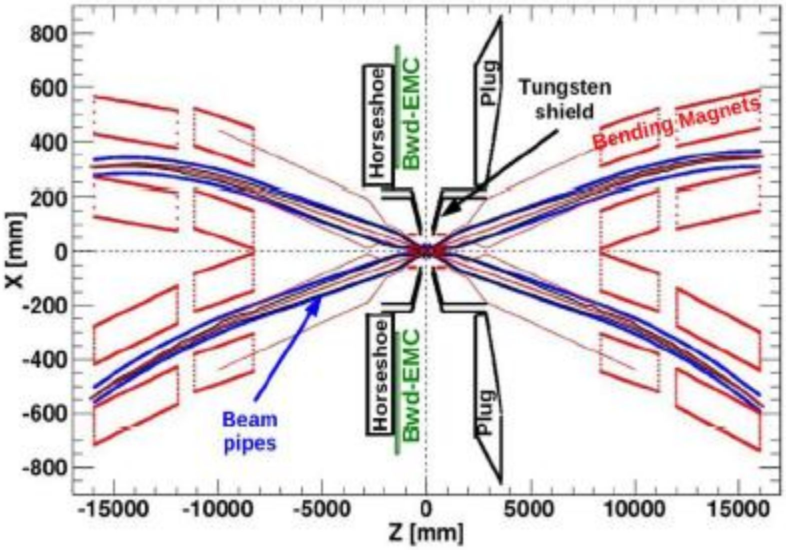
- SVT – G. Rizzo
- DCH – G. Finocchiaro, M.Roney
- PID – N.Arnaud, J.Vavra
- EMC – F.Porter, C.Cecchi
- IFR – R.Calabrese
- Magnet – W.Wisniewski
- Electronics, Trigger, DAQ – D. Breton, U. Marconi
- Online/DAQ – S.Luitz
- Offline SW
  - Simulation coordinator – D.Brown
  - Fast simulation – M. Rama
  - Full Simulation/Computing – F. Bianchi
- Background simulation – M.Boscolo, E.Paoloni
- Rad monitor –
- Lumi monitor –
- Polarimeter -
- Machine Detector Interface –
- Mechanical Integration Team F. Rafelli, W. Wisniewski, System Reps
- Central Electronics Team -
- +DGWG – A. Stocchi, M. Rama
- +Geometry Selection Task Forces- H. Jawahery, W. Wisniewski

SuperB Detector (with options)



Detector Modeled





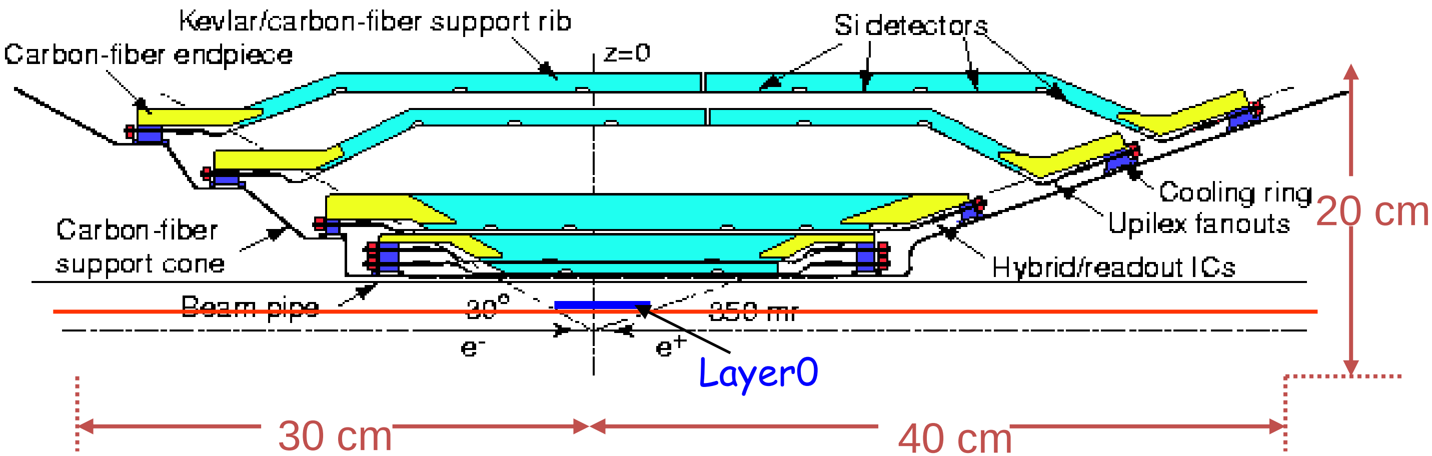
- The whole detector is modeled
- The beam lines and their magnets are modeled +/- 15m from IP
- Recent developments:
  - packaging
  - newest IR layout
  - additional truth information

Background Rates as expected from preliminary studies

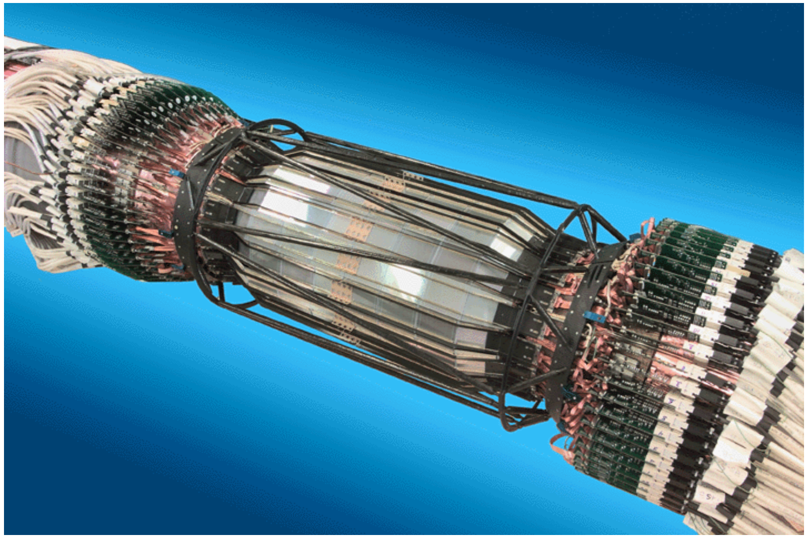
	Cross section	Evt/bunch xing	Rate	Generator
Radiative Bhabha	~340 mbarn (Eγ/Ebeam > 1%)	~850	0.3THz	BBBrem
e^+e^- pair production	~7.3 mbarn	~18	7GHz	Diag36
e^+e^- pair (seen by L0 @ 1.5 cm)	~0.3 mbarn	~0.8	0.3GHz	Diag36
Elastic Bhabha	$O(10^{-4})$ mbarn (Det. acceptance)	~250/Million	100KHz	Bhabhayaga/BHwide
Υ(4S)	$O(10^{-6})$ mbarn	~2.5/Million	1 KHz	
	Loss rate	Loss/bunch pass	Rate	
Touschek (LER)	14 kHz / bunch (+/- 2 m from IP)	~6/100	~14 MHz	Star (M.Boscolo)

- Primary Background Particle will eventually hit the beam pipe showering in the surrounding material
- Ad hoc Monte Carlo generator for primary particles
- Geant4 Based full simulation code for the simulation of the interaction of primary particles with the material

Vertex Detector (SVT)



Bergamo
Bologna
Milano
Pavia
Pisa
Strasbourg
Torino
Trieste
QMUL
(TBC)RAL



in BABAR

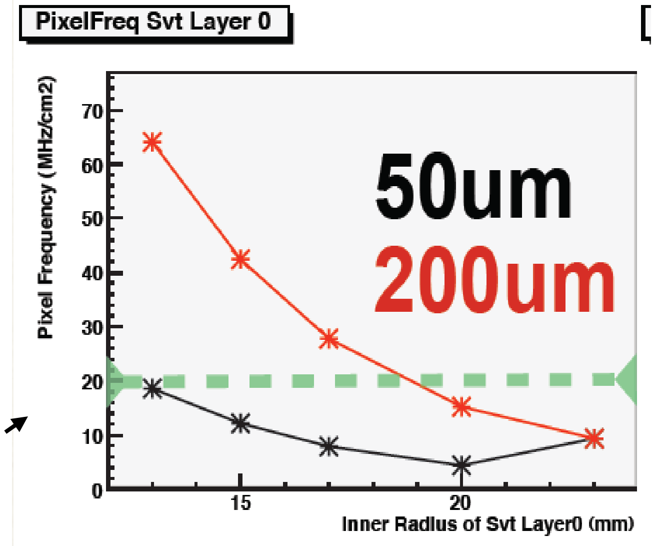
SVT

Definition of Layer0 configuration & performance for the different technologies (striplets-baseline, thin pixel - upgrade)

Update on background:

Hit rate vs Layer0 radius from pairs production depends strongly on sensor thickness: large cluster width for low momentum tracks with large crossing angle

Large difference for thin pixels (50 um) and striplets (200 um).



- Sustainable background hit rate (radius) depends on technology: striplets vs pixel area and readout chip.

1. Development of pixel chip readout architecture continue: data push and triggered with target 100MHz/cm2 (safety x5 included) with timestamp 100 ns. → radius ~1.3cm
2. Evaluate efficiency of FSSR2 readout chip (striplets) vs rate (goal still 100 MHz/cm2):
   – Verilog simulation results not very encouraging! Significant drop in efficiency ~ 20 MHz/cm2
   – Need to interact with Fermilab designers to understand if this is a real issue and in case if modification to digital part is possible.
3. Started to investigate alternative option for striplets readout chip.

DCH Baseline Design

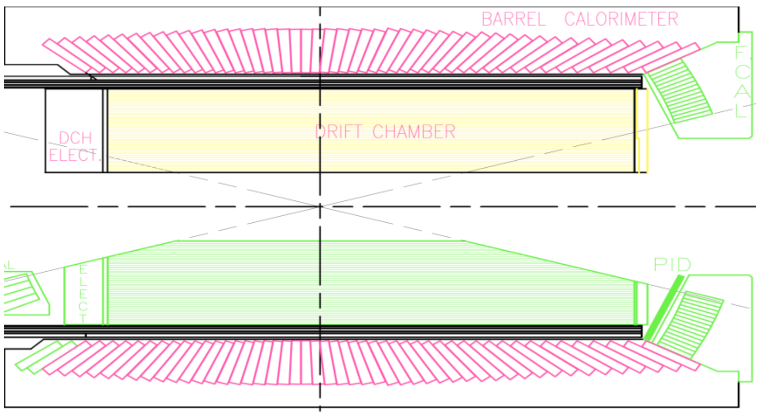
- Provides precision momentum
- Provides particle ID via dE/dx for all low momentum tracks, even those that miss the PID system.
- A new DCH (similar to now aged BaBar DCH, which must be replaced)
  - Similar gas & cell shape (small improvements may be possible)
  - Carbon Fiber end plates (to reduce material before endcaps)
  - New electronics with location optimized.

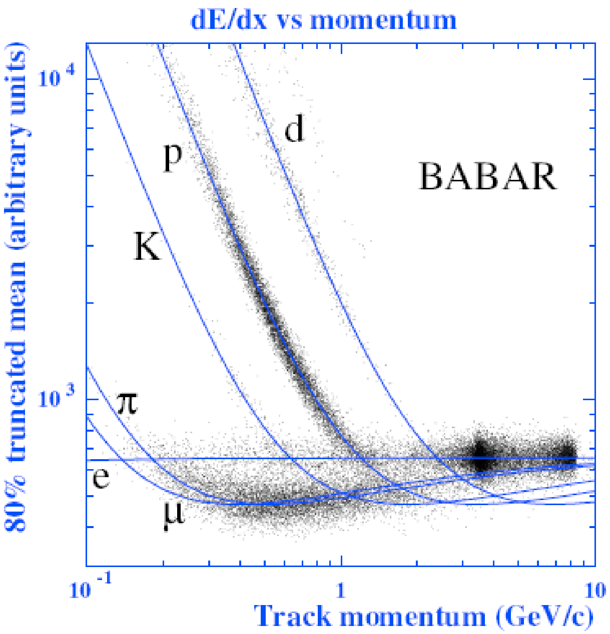
- R&D Issues including:
  - Electronics location and/or mass to reduce effect on backward EMC,
  - Low Mass Endplates
  - Can we do better on dE/dx (counting clusters)?
  - Conical/stepped endplates or other ways to reduce sensitivity close to the beam.
  - Background simulation/shielding optimization.

- R&D has been started.
- Need to test all solutions on prototype,

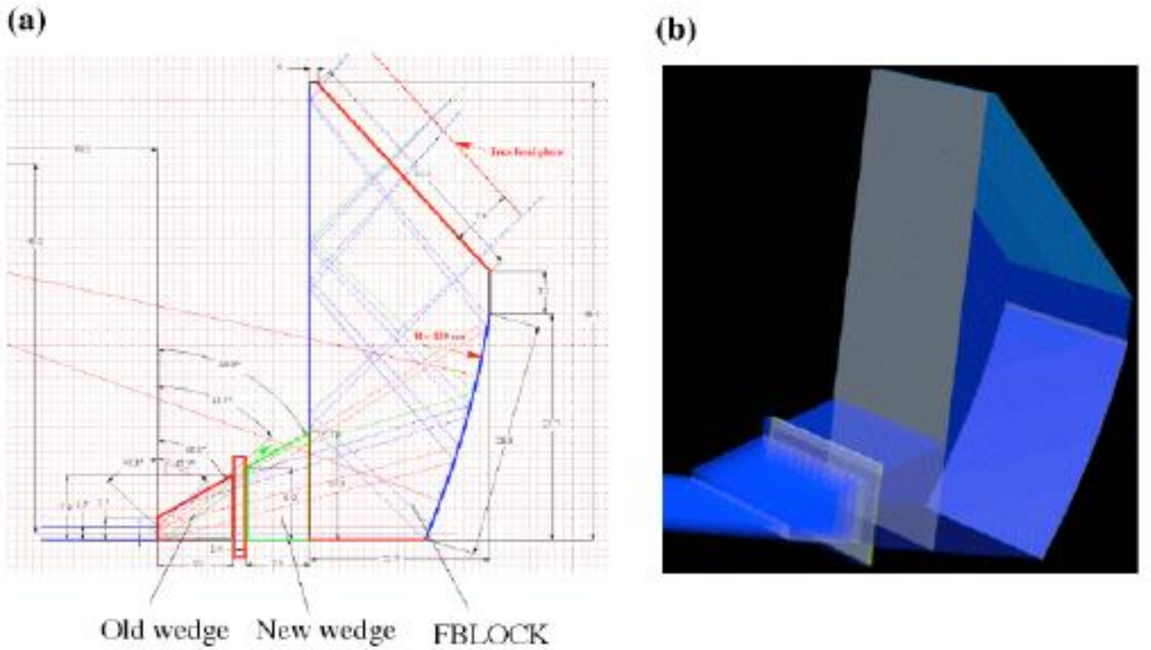
Canada (UBC,Victoria, McGill, Un. Montreal)
LNF

DCH





Barrel PID



(a) FDIRC optical design (dimensions in cm).

(b) Its equivalent in the GEANT 4 MC model.

Figure 17: Barrel FDIRC Design.

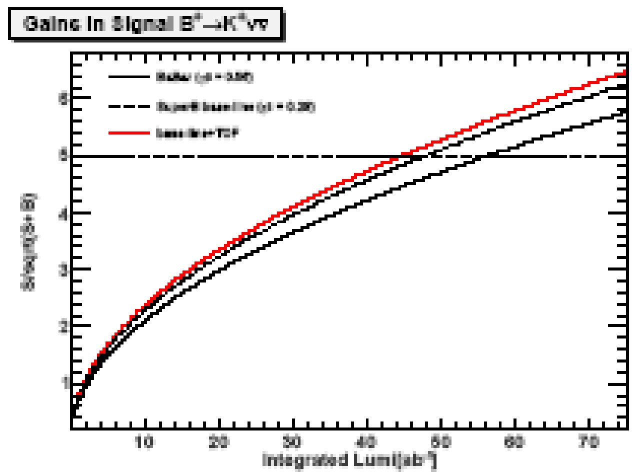
DPR Design

SLAC
Padova
Maryland
LAL Orsay
LPHNE

Forward PID option

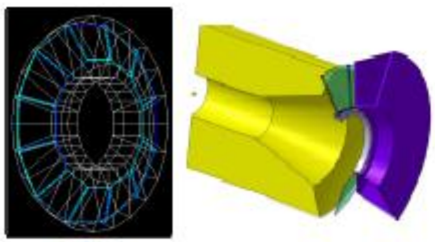
Decision about forward PID has not been taken yet. It is one of the issues in the agenda of the coming General SuperB Collaboration Meeting (Caltech December 14-18).

One benchmark is $B \rightarrow K^{(*)} \nu \bar{\nu}$.



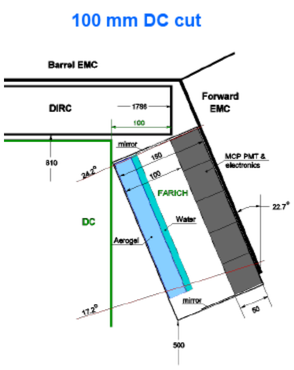
If decision would be YES to Forward PID then there are two options:

TOF



and FARICH.

BINP
Slac
Padova



FARICH has:

- Good K/p separation in 0.6 to 6.0 GeV
- Improves Momentum resolution By > 10%

But about 28% x0 in front of calorimeter

Many channel

CALORIMETER

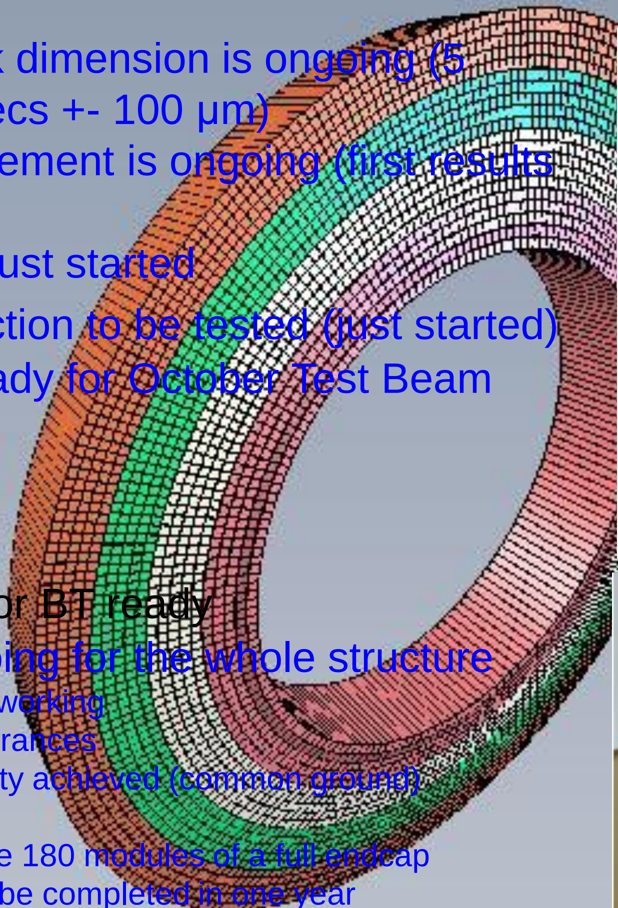
Caltech
Perugia
Roma

CRYSTAL STUDY

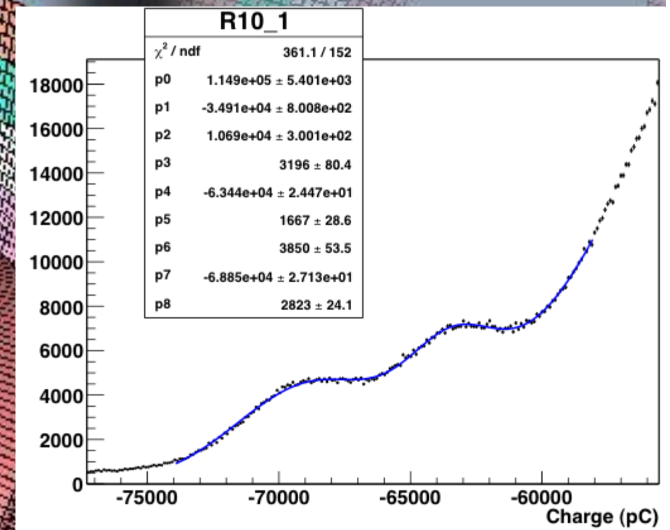
St. Gobain: 12 crystals received for the Beam Test

- Metrology to check dimension is ongoing (5 measured within specs +- 100 μm)
- Light Yield measurement is ongoing (first results as expected)
- Uniformity testing just started

SIPAT: new production to be tested (just started) schedule is to be ready for October Test Beam



LY(1.17MeV)=1003 p-e/MeV
LY(1.33MeV)=962 p-e/MeV



MECHANICS

Prototype structure for BT ready

Development is ongoing for the whole structure

- Production method working
- Precision within tolerances
- Electrical conductivity achieved (common ground)

What remains:

- Cost estimate in view of the 180 modules of a full endcap
- schedule for production to be completed in one year
- optical performance (to be studied with single cells)
- structural behavior (module elastic characterization, FEA of the support shell….)

Forward & Backward Calorimeter

The SuperB calorimeter will reuse the Babar barrel of CsI crystals. In the forward endcap CsI will be replced with YLSO crystals, while for the backward the solution is lead+scintillating fibers 2.8 mm Pb alternated with scintillator for different layers there are different patterns :

- Right handed logarithmic spiral
- Left-handed logarithmic spiral
- Radial wedge

The readout fibers are embedded in grooves cut in scintillator.

As Photo-Detector a pixel device will be used Either MPPC or SiPM.

Bergen

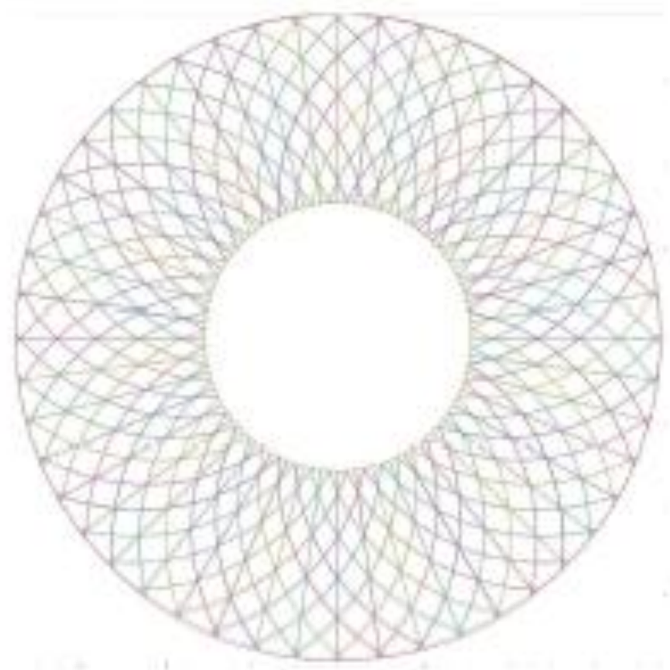


Figure 27: The backward EMC, showing the scintillator strip geometry for pattern recognition.

IFR Advancements): Simulations

Fast Simulation

PID tables for muons and pions, based on optimization results, are in preparation and will replace the BaBar tables in the next event production

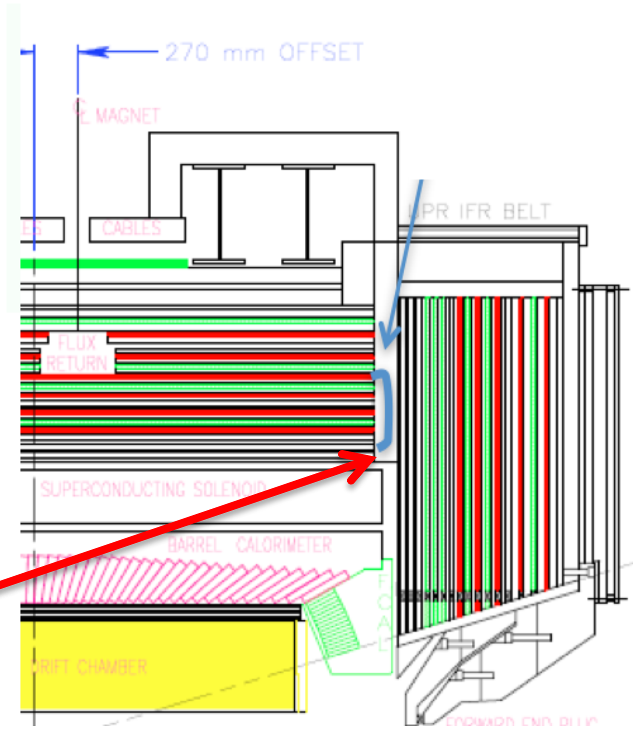
Ferrara
Krakow

Detector Optimization

Added and tested a 9-layers configuration
Started with K_L study.

Background studies

Neutron background analysis continues with the study of possible shielding and remediation: added polyethylene shielding, investigating the possibility to move the SiPM of the inner layers in a outer gap.



Baseline Design from DPR

Bologna
Napoli
.....
LAL Orsay
SLAC

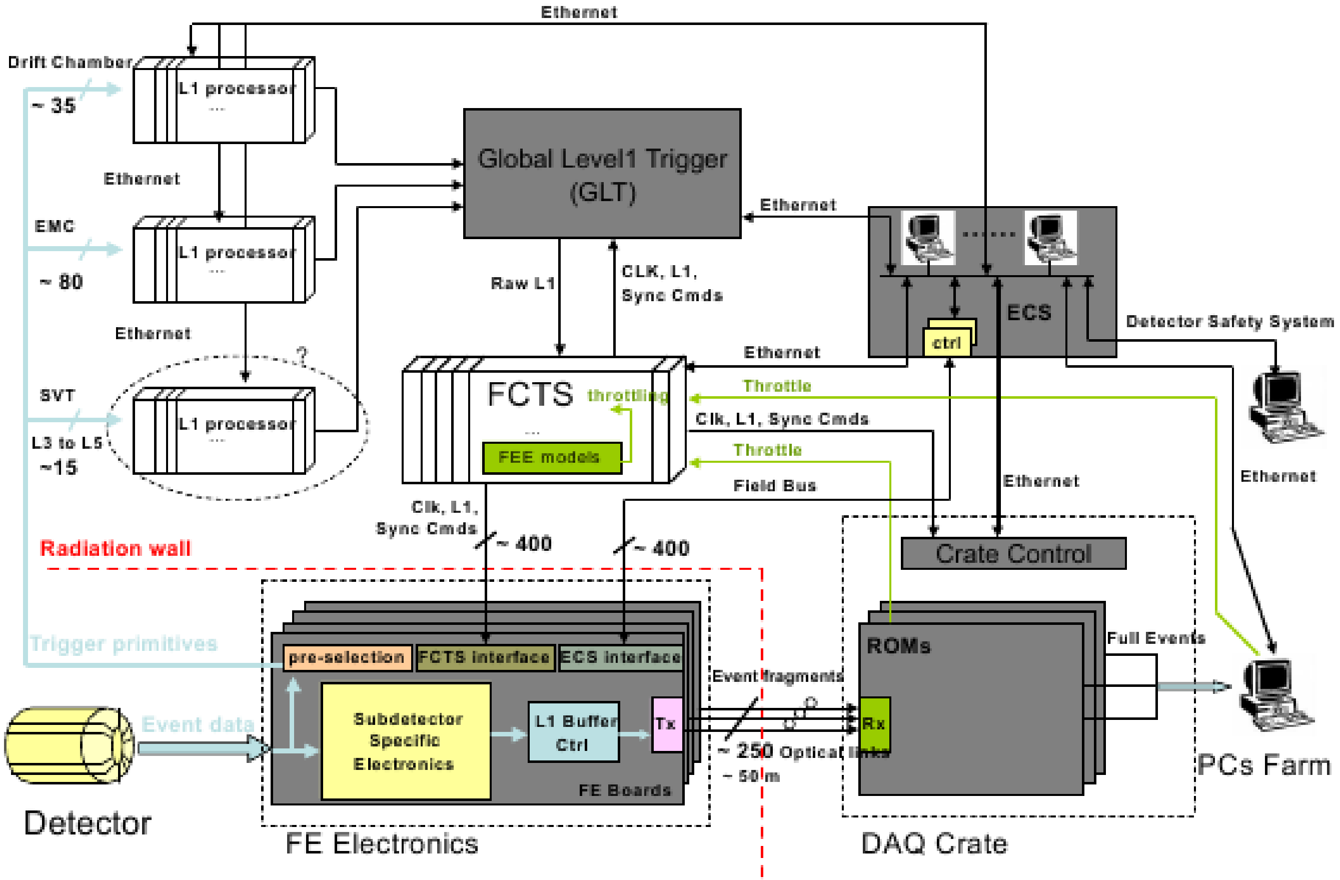


Figure 34: Overview of the ETD and Online global architecture

Systems with not yet assigned responsibilities

- Luminosity monitor
- Polarimeter
- Radiation monitors

Options by:
Cagliari
Catania
Roma II
Krakow
Ohio

END