SuperB Status-FPCP-2011

- Synopsis
- Physics Motivation
- Project Status
- Accelerator
- Detector
- Summary

Blair Ratcliff, SLAC
On behalf of the SuperB Community

Project Synopsis

- **Precision meaurements,** with x10 better precision than present B factories, of flavor physics observables provide crucial, complementary information for understanding new physics in the era of LHC.

- SuperB is a **very high luminosity** asymmetric e^+e^- collider in the 10 GeV region which can collect 75 ab-1 in 5 years (Lumi = 10^{36} $cm^{-2}s^{-1}$) .

- **Innovative accelerator concept** allows x100 increase in Lumi compared to BaBar with no increase in wall plug power, a polarized e^- beam, substantial headroom and flexibility in operations, ability to run near charm threshold, potential upgrade path to 4x 10^{36} $cm^{-2}s^{-1}$, with only modest increases in detector backgrounds.

- **Reuses major pieces of equipment** from both PEP-II and BaBar (~135M€ value)

- SuperB project **approved by the Italian Government** with multi-year funding commitment!

- **Project Documentation**
  - CDR (2007) http://web.infn.it/superb/images/stories/upload_file/superb-cdr.pdf
  - Progress Reports(2010)
    - Physics: http://arxiv.org/abs/1008.1541
    - Detector: http://arxiv.org/abs/1007.4241
    - Collider: http://arxiv.org/abs/1009.6178

Physics Motivation

Physics at SuperB

- Extremely Broad Frontier Physics Program
  - Precision (~1%) tests of CKM
    - Will Measure angles and sides at $\Upsilon(4S)$
    - Measure other CKM elements at charm threshold
    - Pattern of deviation, if any, from SM can diagnose the NP being seen
  - Program of τ physics including LFV,EDM,CPV,g-2
  - Precision EW physics with polarized beam
  - And so much more!
    - CPV at Charm threshold
    - Low energy e^+e^- physics via ISR (Radiative return)
    - Spectroscopy and exotics
    - Search for light dark matter and light Higgs
    - The Y(5S) region

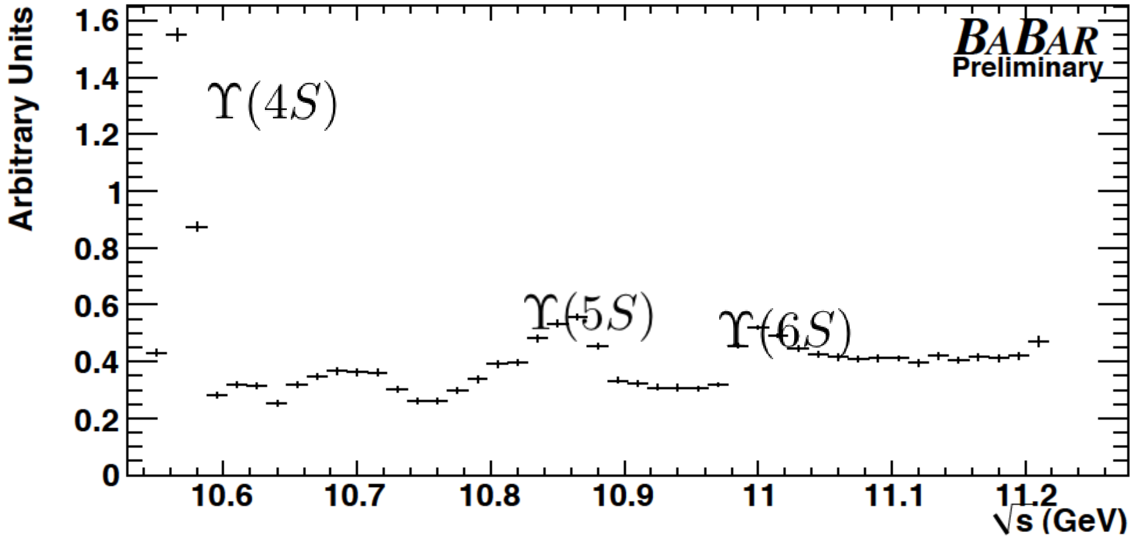
- Discovery Science: Strong Physics Motivation Independent of LHC Findings
  - If LHC finds NP, essential to measure flavor couplings
  - IF LHC does not find NP, unique approach to multi-TeV scale

- Clean, high precision experimental environment.
  - Excellent detector with good hadronic PID, γ detection, lepton ID, etc.
  - B-recoil technique for decays like $B \rightarrow \tau\nu$, $B \rightarrow D^*\tau\nu$, etc.
  - Polarized e^- beam for cleaner τ LFV studies and precision EW
  - Ability to run in Y region as well as at lower energies.

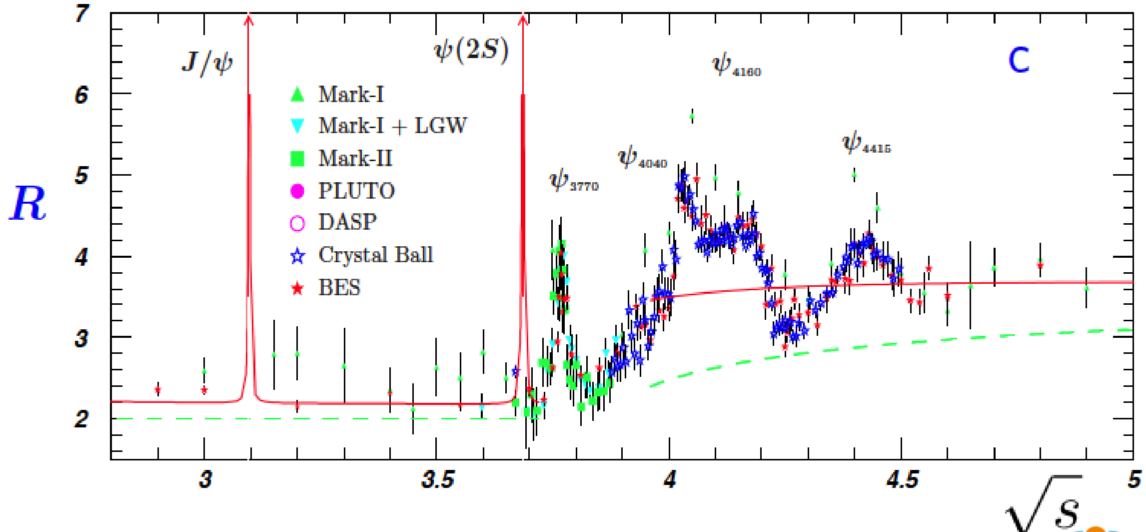
  ➔ Clean signals in a wide variety of modes and physics channels.

SuperB Data Sample

- ϒ(4S) region:
  - 75ab−1 at the 4S
  - Also run above / below the 4S
  - ~75 x10^9 B, D and τ pairs



- ψ(3770) region:
  - 500fb^{-1} at threshold
  - Also run at nearby resonances
  - ~2 x 10^9 D pairs



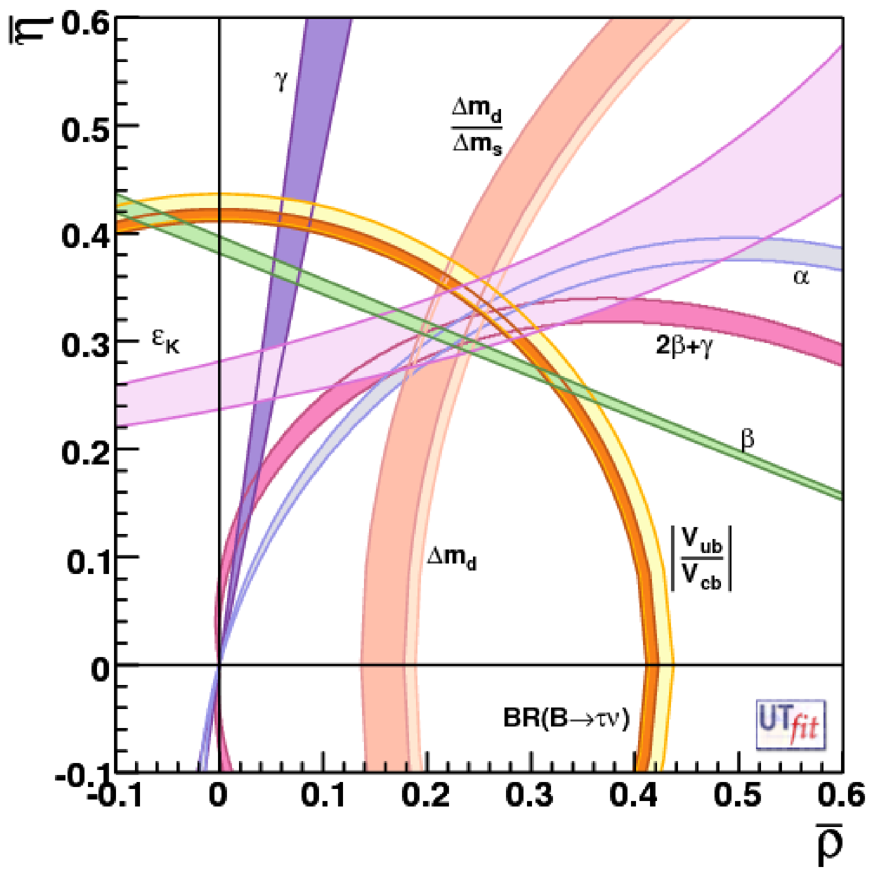
Some Topics of Interest for SuperB

- **Precision determination of CKM parameters**
  - Measurements of $\alpha, \beta, \gamma, f_B, \Delta m_d, V_{ub}$ and V_{cb}
- **Sensitive searches for charged lepton flavor violation (LFV) in rare τ decays**
  - Charged lepton flavor violation in rare τ decays
  - *CP* violation in τ decay and *T* violation in τ production
  - Limits on a τ EDM and anomalous magnetic moment
- **Measurements of *CP*-violating asymmetries in rare penguin-dominated *B* decays and in *D* decays**
  - *CP*-violating asymmetries in penguin modes such as $B \to \phi K_s^0$ or $B \to \eta' K_s^0$, which differ from those in tree-dominated decays such as $B \to J/\psi K_s^0$ due to the presence of additional New Physics phases
  - *CP*-violating asymmetries in FCNC decays such as $b \to s\gamma$ and $b \to sll$
  - Sensitive searches for *CP* violation in D^0 decays, motivated by the unexpectedly large value of mixing found at the *B* Factories
- **Measurements of kinematic distributions and branching ratios in rare *B* and *D* decays**
  - Forward-backward asymmetry in $b \to sll$ decays
  - Branching fraction for $B \to \tau \upsilon_\tau$ decay
- **Sensitive studies of the rich spectroscopy found in Υ decays, and searches for exotic states.**

Precision CKM Constraints

- Unitarity Triangle Angles
  - $\sigma(\alpha)$ = 1−2°
  - $\sigma(\beta)$ = 0.1°
  - $\sigma(\gamma)$ = 1−2°
- CKM Matrix Elements
  - $|V_{ub}|$
    - Inclusive σ = 2%
    - Exclusive σ = 3%
  - $|V_{cb}|$
    - Inclusive σ = 1%
    - Exclusive σ = 1%
  - $|V_{us}|$
    - Can be measured precisely using τ decays
  - $|V_{cd}|$ and $|V_{cs}|$
    - can be measured at/near charm threshold.
- SuperB Measures the sides and angles of the Unitarity Triangle

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



The “DNA Chip”

The pattern of observable effects in the flavor sector in a selection of SUSY and non-SUSY models, from Raidal et. al.; ★★★ signals large effects, ★★ visible but small effects, and ★ implies that the given model does not predict sizable effects in that observable.

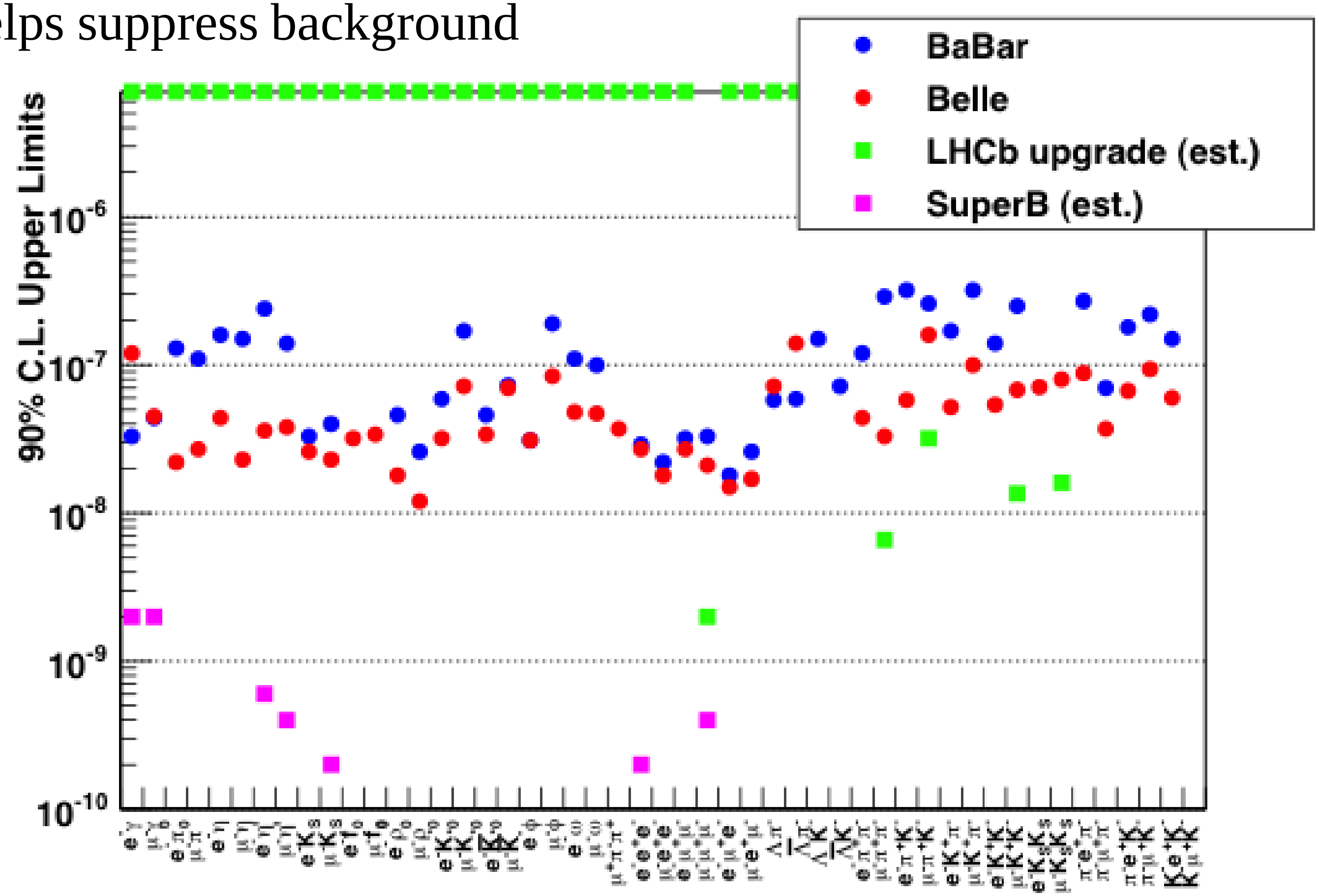
	AC	RVV2	AKM	δLL	FBMSSM	LHT	RS
$D^0 - \bar{D}^0$	★★★	★	★	★	★	★★★	?
ϵ_K	★	★★★	★★★	★	★	★★	★★★
$S_{\psi\phi}$	★★★	★★★	★★★	★	★	★★★	★★★
$S_{\phi K_S}$	★★★	★★	★	★★★	★★★	★	?
$A_{CP}(B \to X_s\gamma)$	★	★	★	★★★	★★★	★	?
$A_{7,8}(B \to K^*\mu^+\mu^-)$	★	★	★	★★★	★★★	★★	?
$A_9(B \to K^*\mu^+\mu^-)$	★	★	★	★	★	★	?
$B \to K^{(*)}\nu\bar{\nu}$	★	★	★	★	★	★	★
$B_s \to \mu^+\mu^-$	★★★	★★★	★★★	★★★	★★★	★	★
$K^+ \to \pi^+\nu\bar{\nu}$	★	★	★	★	★	★★★	★★★
$K_L \to \pi^0\nu\bar{\nu}$	★	★	★	★	★	★★★	★★★
$\mu \to e\gamma$	★★★	★★★	★★★	★★★	★★★	★★★	★★★
$\tau \to \mu\gamma$	★★★	★★★	★	★★★	★★★	★★★	★★★
$\mu + N \to e + N$	★★★	★★★	★★★	★★★	★★★	★★★	★★★
d_n	★★★	★★★	★★★	★★	★★★	★	★★★
d_e	★★★	★★★	★★	★	★★★	★	★★★
$(g-2)_\mu$	★★★	★★★	★★	★★★	★★★	★	?

GLOSSARY	
AC [5]	RH currents & U(1) flavor symmetry
RVV2 [6]	SU(3)-flavored MSSM
AKM [7]	RH currents & SU(3) family symmetry
δLL [8]	CKM-like currents
FBMSSM [9]	Flavor-blind MSSSM
LHT [10]	Little Higgs with T Parity
RS	Warped Extra

τ Lepton Flavor Violation (LFV)

- ν mixing leads to a low level of charged LFV ($B \sim 10^{-54}$)
  $\rightarrow$ Enhancements to observable levels are possible with new physics
- e^- beam polarization helps suppress background

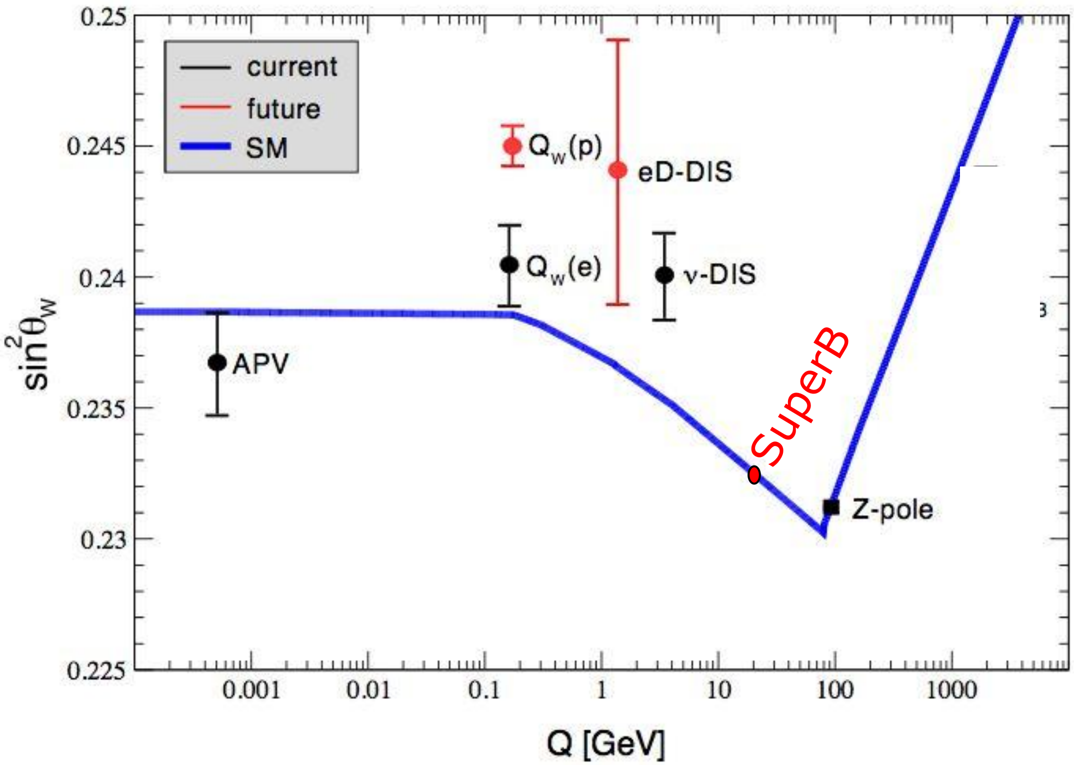
- One to two orders of magnitude improvement at SuperB over current limits



- Only a few modes extrapolated so far for SuperB

Precision Electroweak: Another Impact of Polarization

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



- Measure LR asymmetry in

$$\left.\begin{array}{lll} e^+e^- & \rightarrow & c\bar{c} \\ e^+e^- & \rightarrow & \mu^+\mu^- \\ e^+e^- & \rightarrow & \tau^+\tau^- \end{array}\right. \text{ at the } \Upsilon(4S)$$

- To same precision as LEP/SLC at the Z-pole
- Can also perform crosscheck at ψ(3770)

Golden Measurements: CKM

- Comparison of relative benefits of SuperB (75ab^{-1})

vs.
- existing measurements
- LHCb (5fb^{-1})
- LHCb upgrade (50fb^{-1})

Observable/mode	Current (now)	LHCb (2017)	Super$B$ (2021)	LHCb upgrade	Theory
α					
β from $b \to c\bar{c}s$					
$B_d \to J/\psi \pi^0$					
$B_s \to J/\psi K_S^0$					
γ					
$\|V_{ub}\|$ inclusive					
$\|V_{ub}\|$ exclusive					
$\|V_{cb}\|$ inclusive					
$\|V_{cb}\|$ exclusive					

LHCb can only use ρπ

β theory error B_d
β theory error B_s

Need an e^+e^- environment to do a precision measurement using semi-leptonic B decays.

Experiment: No Result Moderate Precision Precise Very Precise

Theory: Moderately clean Clean Need lattice Clean

Project Status

Approval Milestones in Italy

- **April 2010**: SuperB becomes one of 14 Italian National Research Program (PNR) Flagship Projects
  - Cooperation between INFN and IIT (Italian Institute of Technology)
    - ➔ HEP experiment and light source
- **Dec. 2010:** Approval by Ministry of Instruction, University and Research and Parliment with 19 M€ provided as first part of a multi-year funding plan.
- **April 2011:** Full Italian government approval of the PNR, including 250M€ for SuperB

Interactions News Wire #14 - 11
19 April 2011 http://www.interactions.org
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Source: INFN
Content: Press Release
Date Issued: 19 April 2011
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The Italian Government Approved the Long-Term Funding for SuperB

The Italian Minister for Instruction, University and Research, Mariastella Gelmini announced today that *the long-term funding of the SuperB Factory was appproved by the Italian government. The project, sponsored by the National Institute of Nuclear Physics is one of 14 flagship projects of the National Plan for Research in Italy.*

- **http://www.interactions.org/cms/?pid=1030662**

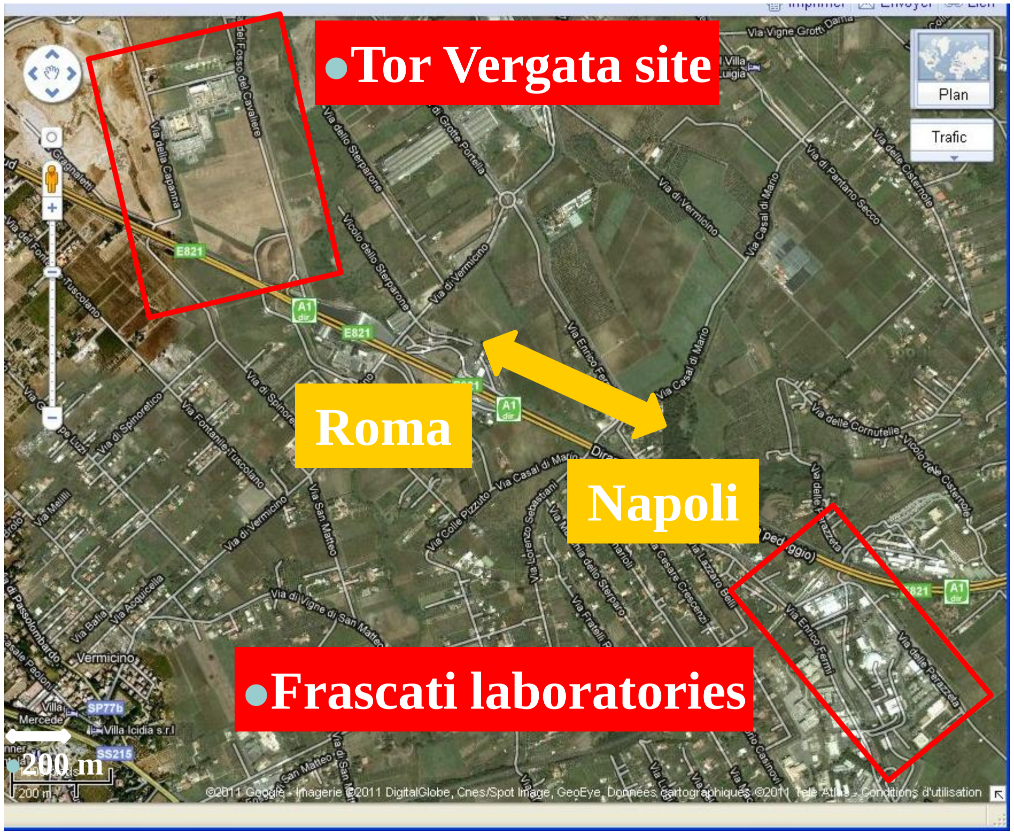
SuperB Funding in INFN present 3-year plan

- INFN Funding plan for accelerator/infrastructure
- Computing funding from special funds for development of the South of Italy
- Detector funding (50% of new money) (~25M€) from ordinary funding agency (INFN Gruppo Uno) budget; Remainder from regional contributions and reuse
- Reuse of parts of PEP-II and Babar offsets 135M€
- Joint Russian/Italian funding agreement SuperB/Ignator (~100M €)
- IIT contribution (100M€) mainly for synchrotron light beam lines construction

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
Costo Totale del progetto (563.3 M€)	42.3	85.9	105.5	60.8	60.8	60.8	36.8	36.8	36.8	36.8

256M

Site



- Several choices identified
- Preferred choice is Tor Vergata near LNF Frascati
- Under review for technical compatibility
- Announcement expected soon and in any case by summer

Accelerator

Accelerator Design Goals

Parameter	Goal	Remark
Integrated Luminosity @ Υ(4S) (5 years)	75 ab^{-1}	Use " New Snowmass Year" =1.5 x 10^7 seconds (from PEP-II experience)
Average Luminosity (Top-up mode)	10^{36} $cm^{-2}s^{-1}$	Flexible parameter space. Peak Lumi, upgradable to 4 x 10^{36} $cm^{-2}s^{-1}$
Wall Plug Power	< 20 MW	Similar to PEP-II (22 MW)
Detector Backgrounds	Beam-Gas similar to PEP-II	Dominated by Radiative Bhabbas
Energy Range	Charm Threshold to above Υ(5S)	
Boost	$\beta\gamma$ = 0.23	Need 1 cm radius beampipe with first measurement at 1.5 cm
Longitudinal Polarization (e^-)	~80%	Enables τ CPT studies and improves LPV sensitivities

How to Get to L = 10^{36} $cm^{-2}s^{-1}$

➔Combine techniques demonstrated as indicated:

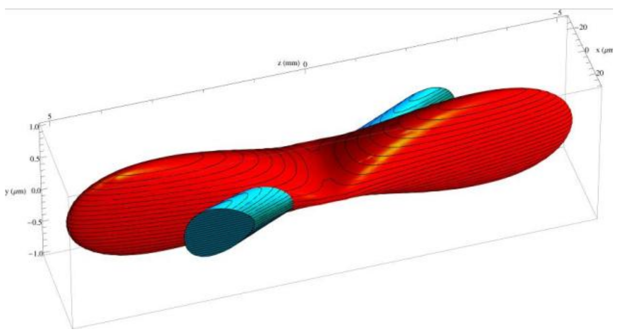
J. Seeman, HEPAP, May 2009

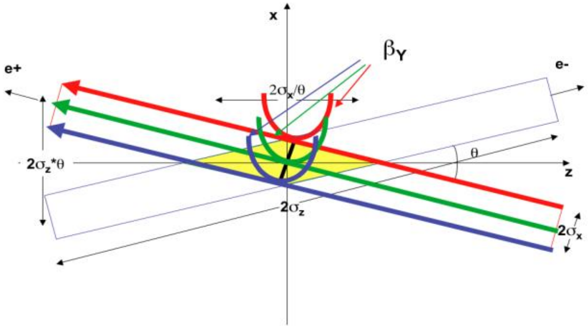
- Crossing angle IR with large Piwinski angle (DAΦNE, KEKB)
- Very low IR vertical and horizontal beta functions (ILC)
- Low horizontal and vertical emittances (Light sources)
- Ampere beam currents (PEP-II, KEKB)
- Crab waist scheme (Frascati, DAΦNE)

Crab Waist Enhancement

- y waist shifted in z using a sextupole on both sides of the IP at proper phase
- Particles in both beams collide in minimum β_y region➔net luminosity gain.
- Supression of x-y resonances

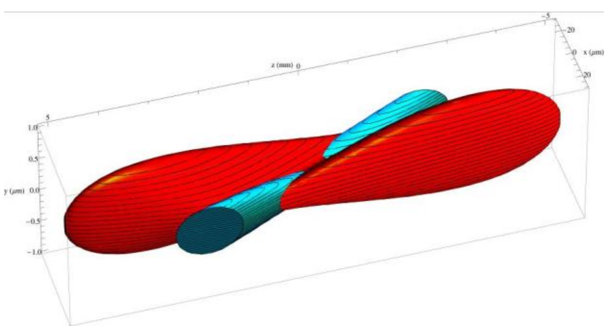
Pantaleo Raimondi, LNF

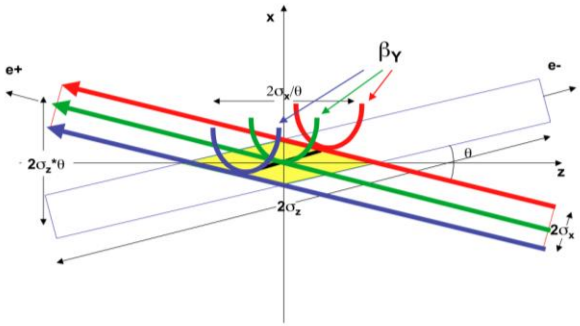




Crab Sextapoles

OFF

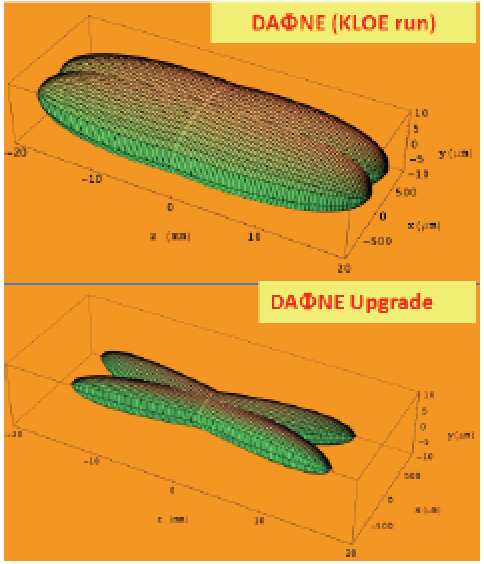




ON

Crab Waist Demonstrated at Daphne

- DAΦNE e+e- collider at Frascati with Ecm @ Φ (1020 MeV)
- Upgraded to test crab waist scheme
- Crab Waist effectiveness successfully demonstrated in working collider
- Gains of ~ factor of 3 in luminosty



	DAΦNE (KLOE run)	DAΦNE Upgrade
I_{bunch} (mA)	13	13
N_{bunch}	110	110
β_y^* (cm)	1.8	0.85
β_x^* (cm)	160	26
σ_y^* (μm)	5.4 low curr	3.1
σ_x^* (μm)	700	260
σ_z (mm)	25	20
Horizontal tune shift	0.04	0.008
Vertical tune shift	0.04	0.055
θ_{cross} (mrad) (half)	12.5	25
$\Phi_{Piwinski}$	0.45	2.0
L ($cm^{-2}s^{-1}$)	1.5×10^{32}	$>5\times10^{32}$

Flexible Machine Parameters for Baseline *L* (9/2010).

		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	8.872	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:
1.Lower y-emittance
2. Higher currents (x2 bunches)

Upgradable to ~4x Higher Lumi

RF power includes SR and HOM

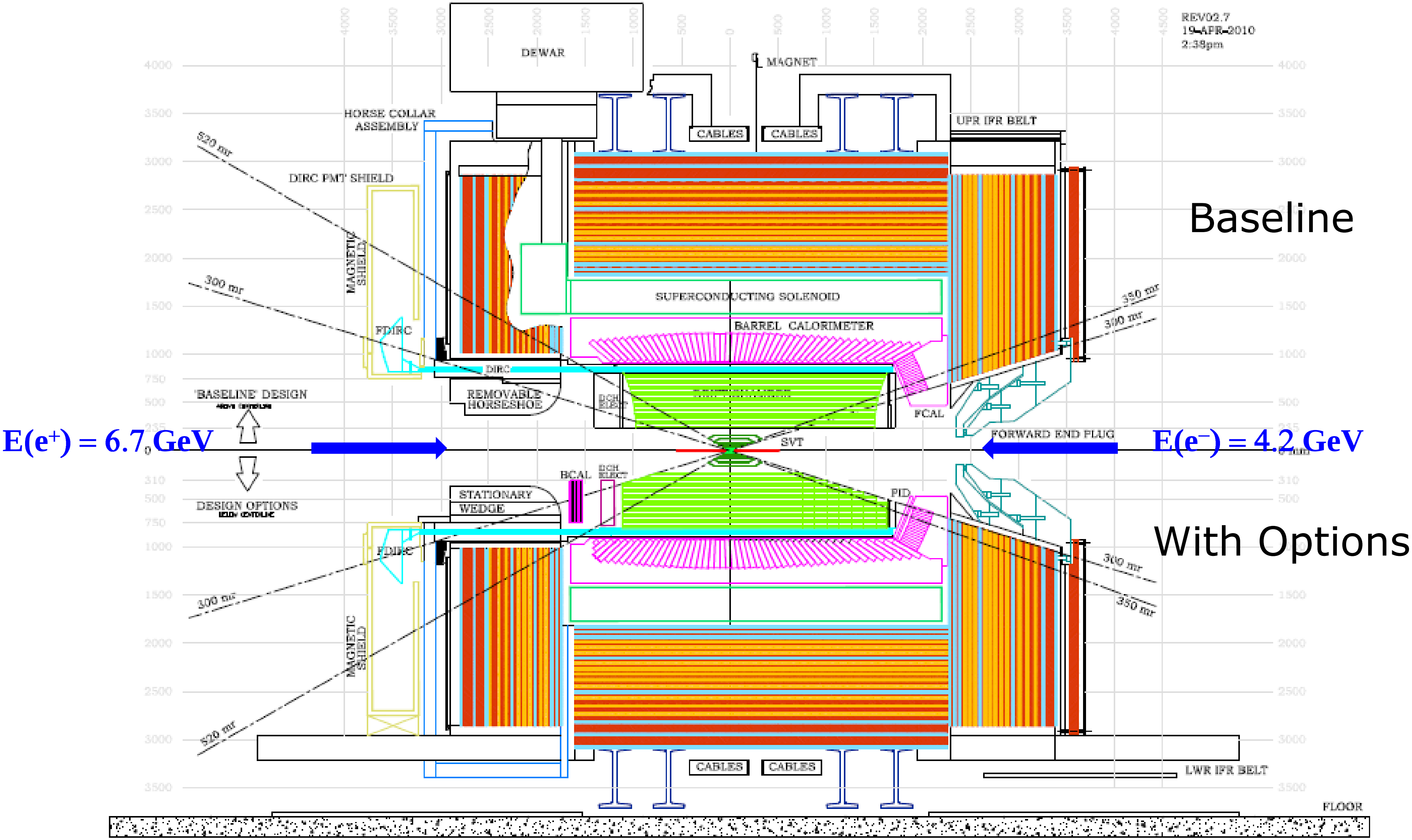
SuperB

Detector

Detector Evolution-BaBar to SuperB

- **SuperB based on the "BaBar Prototype". It reuses**
  - Fused Silica bars and barboxes of the DIRC
  - DIRC & DCH Support
  - Barrel EMC CsI(Tl) crystals and mechanical structure
  - Superconducting coil & flux return (with some redesign).
- **Require moderate design improvement and R&D to cope with the new machine IR, high luminosity environment, the smaller boost (4.2x6.7 GeV), and the high DAQ rates.**
  - Small beam pipe technology
  - Thin silicon pixel detector for first layer, and a new 5 layer SVT.
  - New DCH with CF mechanical structure, modified gas and cell size
  - New Photon camera for DIRC fused silica bars
  - Possible Forward PID system
  - New Forward calorimeter crystals (Possibly LYSO).Backward veto option
  - Minos-style extruded scintillator for instrumented flux return
  - Electronics and trigger- x100 real event rate
  - Computing- to handle massive date volume

SuperB Detector



Detector Issues for Design and R&D

System	Baseline	Issues (technical OR manpower; R&D)
MDI	Initial IR designed	Magnetic elements and radiation masks. Design of tungsten shields. Background simulations: global map, detector occupancy
SVT	6-layer silicon	Technology for Layer 0: striplets or pixels. Thin pixels R&D. Readout chip for strips. Mechanical design.
DCH	Stereo-axial He-based	Dimensions (inner radius, length). Mechanical structure Cluster counting option.
EMC	Barrel: CsI(Tl) Forw: LYSO	Electronics and trigger. Mechanical structure Forward EMC technology: LYSO / LYSO+CsI(Tl); Pure CsI. Backward EMC: cost/benefit analysis
PID	DIRC w/ FBLOCK	FBLOCK design. Photon detection. Mechanical structure Forward PID: cost/benefit analysis. Different technologies.
IFR	Scintillator+ fibers	8 vs 9 layers, and optimized configuration. 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. Headroom.

Detector Status

- Design well advanced
  - Based on BaBar as the “prototype”
- Remaining Generic Detector Options to be decided by summer.
- Proto-Detector Organization is in place. Will change to a collaboration organization after the collaboraiton is formed starting next week.
- R&D well advanced across detector systems allowing final designs to proceed.
- Aiming for final design document (TDR) in about one year and will begin fabrication then.

Summary

Summary

- SuperB offers an extremely broad program of exciting physics with sensitivity to New Physics while being complementary to LHC
- Approved as Flagship project of Italian government with approved funding
- Large International Community participating in all phases of the design. Hope for further growth during the next few months
- Innovative machine design reusing PEP-II components with beam currents and wall plug power similar to present generation B factories
- State of the art detector based on BaBar
- After many years as a Proto-Collaboration, the first meeting of the **SuperB Collaboration** will be held at Elba next week. Hope to see many of you there.

More Observables

Experiment: Red: No Result; Yellow: Moderate Precision; Blue: Precise; Green: Very Precise

Theory: Yellow: Moderately clean; Blue: Clean Need lattice; Green: Clean

Observable/mode	Current (now)	LHCb (2017)	Super$B$ (2021)	LHCb upgrade (2030?)	theory	
τ Decays						
$\tau \to \mu\gamma$	Yellow	Yellow	Green	Yellow	Green	Benefit from polarised e^- beam
$\tau \to e\gamma$	Yellow	Yellow	Green	Yellow	Green	
$B_{u,d}$ Decays						
$B \to \tau\nu, \mu\nu$	Yellow	Red	Blue	Red	Blue	very precise with improved detector
$B \to K^{(*)+}\nu\overline{\nu}$	Red	Red	Green	Red	Green	Statistically limited: Angular analysis with >75ab^{-1}
S in $B \to K^0_S\pi^0\gamma$	Yellow	Red	Green	Red	Yellow	Right handed currents
S in other penguin modes	Yellow	Yellow	Green	Blue	Yellow	SuperB measures many more modes
$A_{CP}(B \to X_s\gamma)$	Blue	Yellow	Green	Yellow	Green	systematic error is main challenge
$BR(B \to X_s\gamma)$	Blue	Yellow	Green	Yellow	Yellow	control systematic error with data
$BR(B \to X_s\ell\ell)$	Yellow	Red	Green	Red	Green	
$BR(B \to K^{(*)}\ell\ell)$	Yellow	Blue	Green	Green	Yellow	SuperB measures e mode well, LHCb does μ
B_s Decays						
$B_s \to \mu\mu$	Red	Blue	Red	Green	Green	
β_s from $B_s \to J/\psi\phi$	Red	Blue	Red	Green	Green	
$B_s \to \gamma\gamma$	Red	Red	Blue	Red	Green	
a_{sl}	Red	Red	Green	Red	Green	
D Decays						
mixing parameters	Yellow	Blue	Green	Green	Green	
CPV	Red	Blue	Green	Green	Green	Clean NP search
Precision EW						
$\sin^2\theta_W$ at $\Upsilon(4S)$	Red	Red	Green	Red	Green	Theoretically clean
$\sin^2\theta_W$ at Z-pole	Red	Blue	Red	Green	Yellow	b fragmentation limits interpretation

SuperB

Crab Waist with Large Piwinski Angle

- Piwinski angle $\phi \approx \frac{\sigma_z}{\sigma_x}\frac{\theta}{2} >> 1$

With horizonal (longitudinal) beam size $\sigma_x(\sigma_z)$ and crossing angle θ

- If β_y* is comparable to overlap scale (σ_x/θ) then

$\beta_y^* \approx \frac{\sigma_x}{\theta} << \sigma_z$ and we get small β_y* without small σ_z

- Can use long beams and still get small overlap region

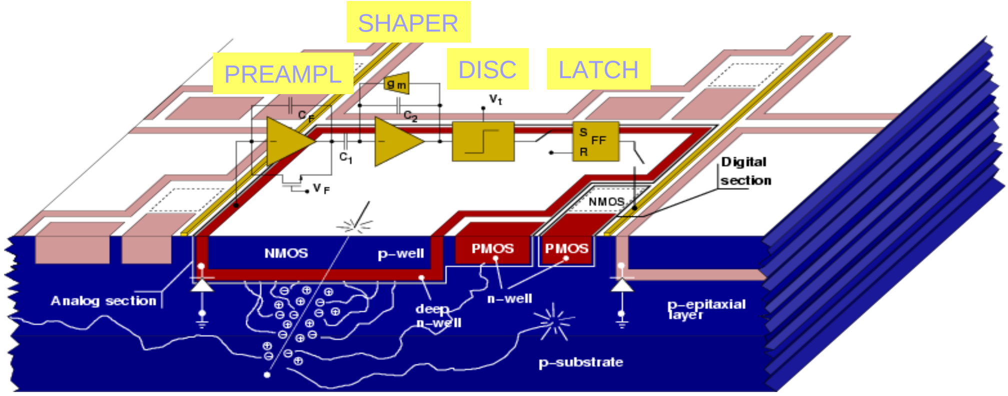
Show and Tell Example-R&D to Develop SVT layer 0 Technology

- Candidate Technolgies (ordered starting with simplest)
  - Striplets
    - → Mature technology, not so robust against bkg occupancy
  - Hybrid pixels
    - → Viable, although large material budget
  - CMOS MAPS
    - → New & challenging technology: fast readout needed (high rate)
  - Thin pixels with vertical integration
    - → Reduced of material and improved performance

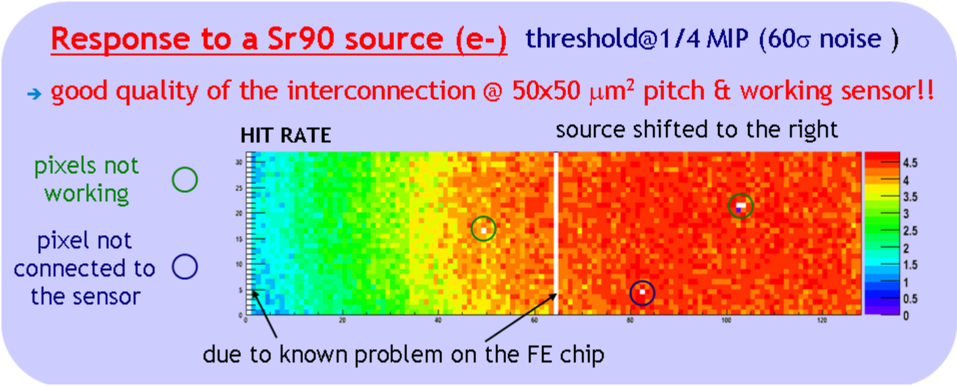
➔pixel R&D ongoing
- Performance: efficiency, & hit resolution
- Radiation hardness
- Readout architecture
- Power & cooling

CMOS MAPS with

in pixel sparcification

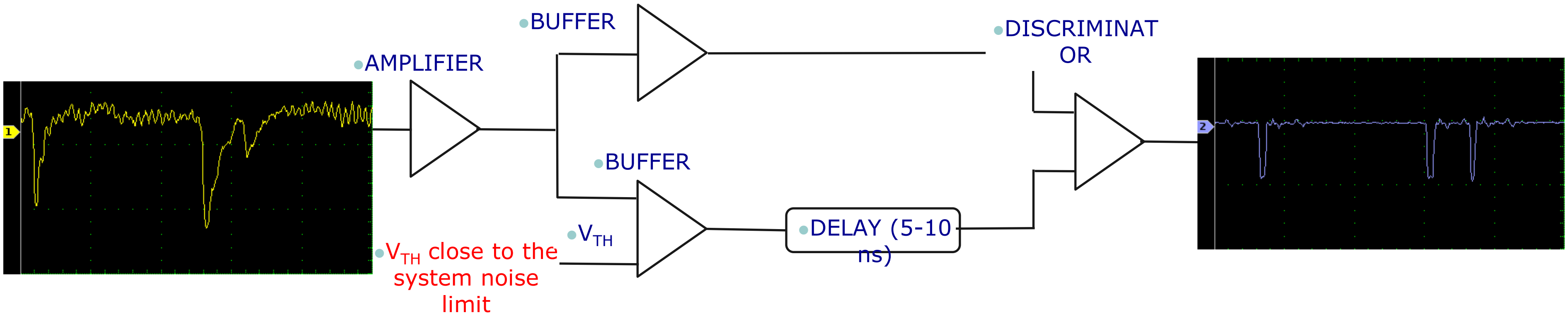


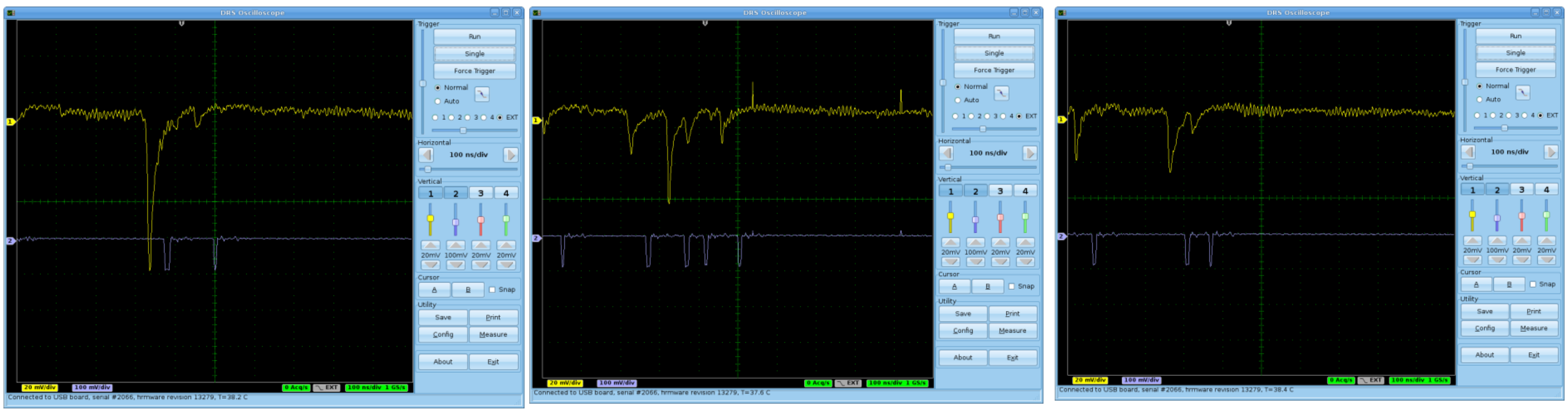
First Test of a hybrid pixel matrix with 50×50 μm^2 pitch



Show and Tell Example-DCH R&D on Cluster Counting

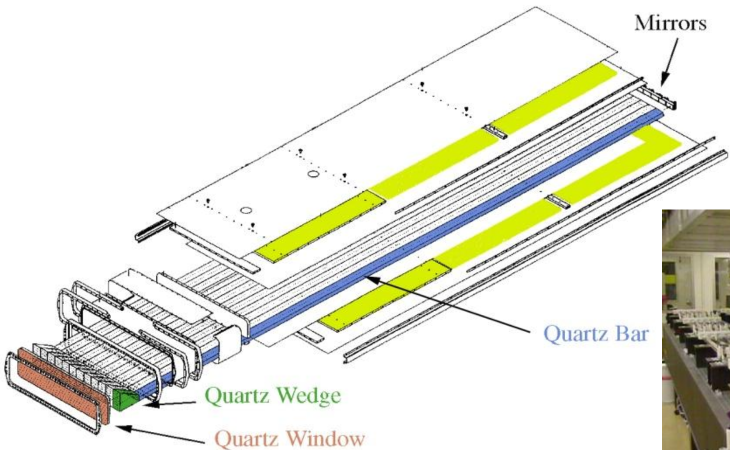
Local derivative method



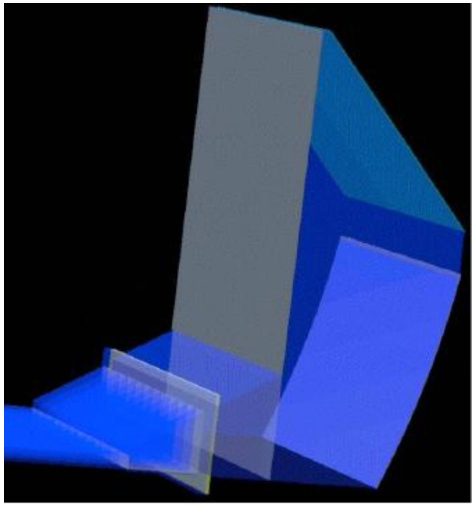


- First tests on 2.5m long, 24mm side square tube in He-CH_4 mixture
  - threshold and delay still to be optimized

Show and Tell Example-FDRIC Camera

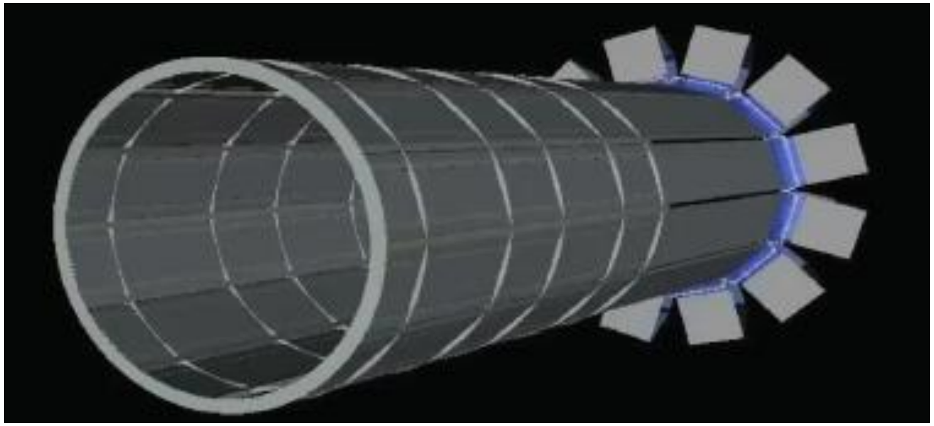


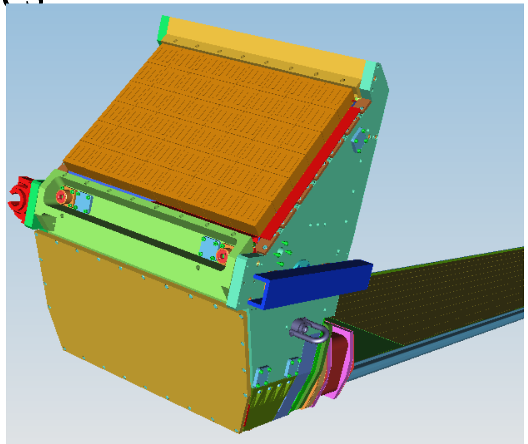
New photon camera



Geant4 simulation

- Photon cameras at the end of bar boxes





Camera housing design

Show and Tell Example-IFR Scintillator Construction for R&D