The SuperB project

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On behalf of the SuperB collaboration

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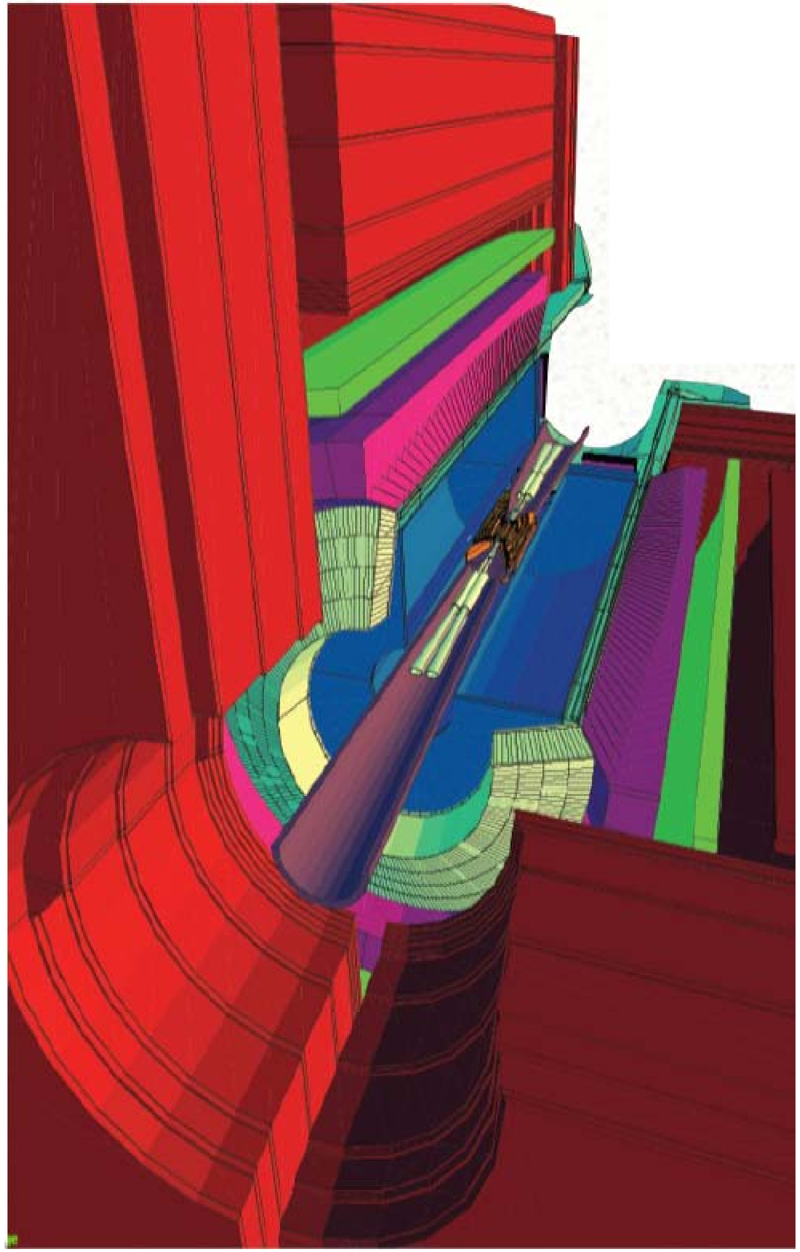
Outline

- SuperB in a nutshell
- The SuperB physics program
  - Why a super flavour factory?
  - A wide physics program
- The SuperB collider
- The SuperB detector
  - Zoom on the charged particle identification (PID) system
- Status of the SuperB project
- Summary



SuperB in a nutshell

- Precision flavor physics measurements
  - Observables provide crucial & complementary information for understanding New Physics (NP) in the LHC era
  - ×10 better precision than present B-Factories

- Very high luminosity
  - Asymmetric e^+e^- collider at the $\Upsilon(4S)$ resonance
    → Energy can be moved from $\psi(3770)$ to $\Upsilon(6S)$
  - Luminosity of 10^{36} cm^{-2}s^{-1} or higher
    → Collect 75 ab^{-1} in 5 years of nominal running – based on ‘New Snowmass Year’

- Innovative accelerator concept
  - Luminosity 100× higher w.r.t. BaBar with ~same wall plug power
  - Polarized electron beam
  - Ability to run at various energies
  - Luminosity as high as 4 10^{36} cm^{-2}s^{-1} foreseen

- Reuse of major pieces of equipment
  - PEP-II B-Factory and BaBar

The SuperB physics program

The SuperB physics goals

- Pre-LHCb era: BaBar, Belle and the Tevatron
  - CKM theory confirmed at leading order
  - Indirect constraints on NP that are still valid (e.g. H^+ searches)

- LHCb will have re-defined some flavour physics areas when SuperB starts running

- If NP found at the LHC, focus on understanding the overall framework
  → Crucial role for SuperB/LHCb

- SuperB very ambitious goal: unravel the flavor structure of NP
  - Very good sensitivity through CP violation asymmetries and rare decays
  → Double-prong attack on the quark and lepton sectors
  - SuperB results will help constraining flavour dynamics at high energy

- Very large dataset ($\geq 75\ ab^{-1}$) needed to reach meaningful sensitivity in leptonic sector

- No indications so far of any NP
  → Key role for SuperB in a « super-standard » picture

The case for SuperB

- Energy path vs. quantum path
  - Model-dependent indirect NP probes can reach higher scales than direct searches
    → Size of couplings
  - Model-dependent direct searches for NP have found nothing so far (unfortunately)

- Scenarii
  - LHC finds NP incompatible with flavor data: theory to be fixed
  - LHC finds NP compatible with flavor data: use flavor data to constraint models
  - LHC finds nothing: indirectly probe high energy effects

  → All offer an important role to SuperB

- Decoding NP will not be easy

- Many viable models of NP (still)

  → Each model guides some dedicated analysis
  - At most one of them is right

Time dependent (TD) analysis: BaBar vs. SuperB

- The two main ingredients are Δt resolution and flavor tagging
  $\rightarrow$ Changes between BaBar and SuperB

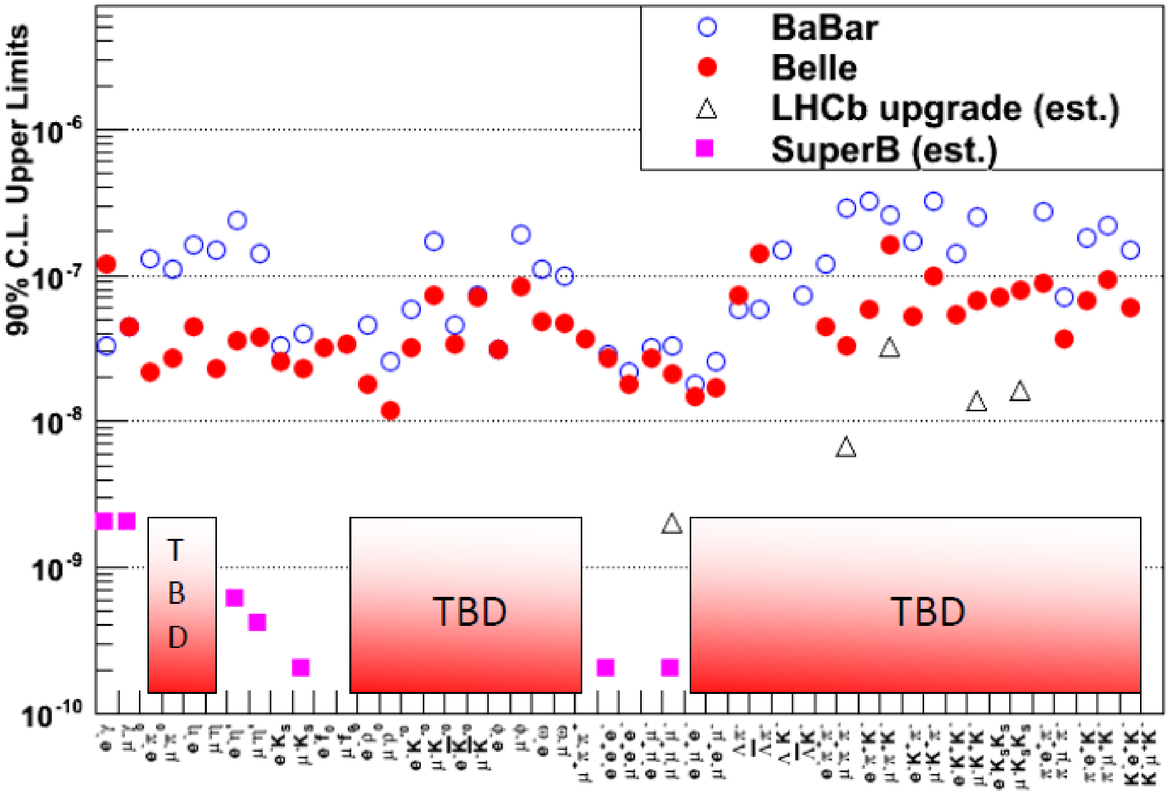
- Smaller boost at SuperB
  $\rightarrow$ smaller Δz and hence worst Δt in principle
- Therapy
  - Additional silicon layer (L0) at 1.60 cm radius
  - Reduce beam spot size
  - Lower material budget for the beam pipe

$\Rightarrow$ Preliminary studies show that the Δt precision is comparable to the BaBar one

- Flavor tagging based on multivariate techniques like in BaBar
  - Isolated high-momentum lepton, K or soft π (from D^* decays)
  - Figure of merit: $Q = \varepsilon_{tag}(1-2\omega)^2$
    with ε_{tag} = tagging efficiency and ω = mistag probability
    $\rightarrow$ Resolution on the TD analysis parameters (S, C) scales like $1/\sqrt{Q}$
- Expectation: $Q_{SuperB} > Q_{BaBar}$
  - Better vertexing, larged tracking coverage
    and improved charged particle identification (PID)

τ Lepton Flavor Violation (LFV)

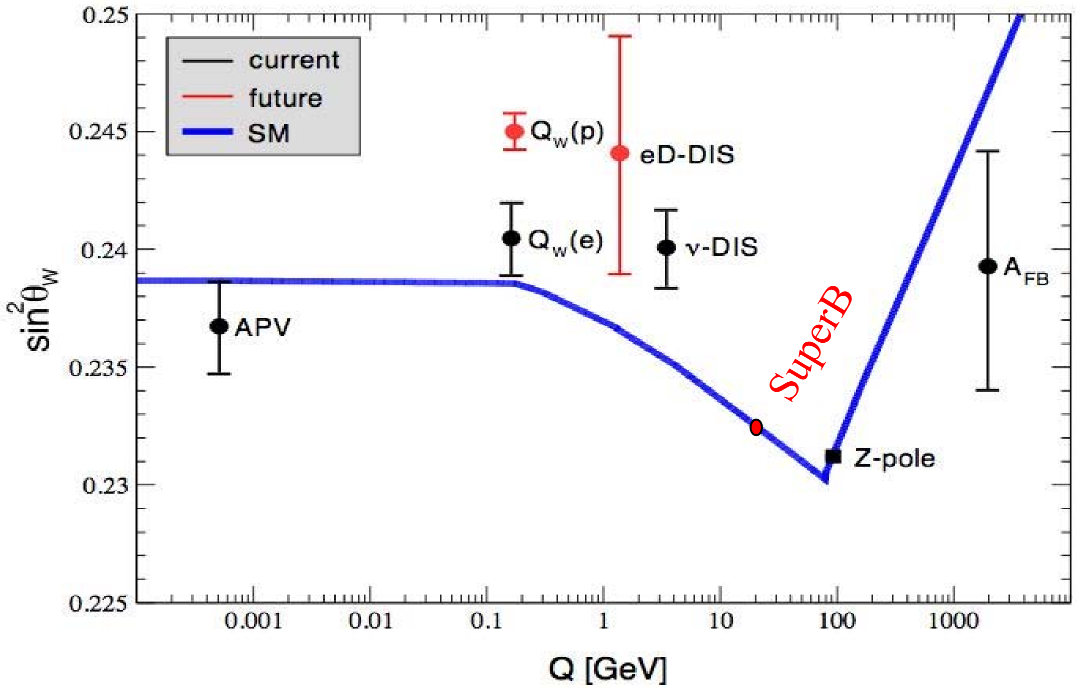
- ν mixing leads to a low level of charged LFV in the SM (BF~10^{-54})
  → Enhancements to observable levels are possible with new physics
- e^- beam polarisation helps suppress background
- Two orders of magnitude improvement at SuperB over current limits
- Hadron machines are mainly not competitive with e^+e^- machines for these measurements



Only a few modes extrapolated for SuperB so far

Precision Electroweak Measurements

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



For ongoing and future experiments, arbitrary values of $\sin^2(\theta_W)$ have been chosen to illustrate the expected experimental sensitivities

- Measure LR asymmetry in $\begin{cases} e^+e^- \rightarrow c\bar{c} \\ e^+e^- \rightarrow \mu^+\mu^- \\ e^+e^- \rightarrow \tau^+\tau^- \end{cases}$ at the $\Upsilon(4S)$ to same precision as LEP/SLC at the Z-pole
  $\rightarrow$ Can also perform crosscheck at $\psi(3770)$

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

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

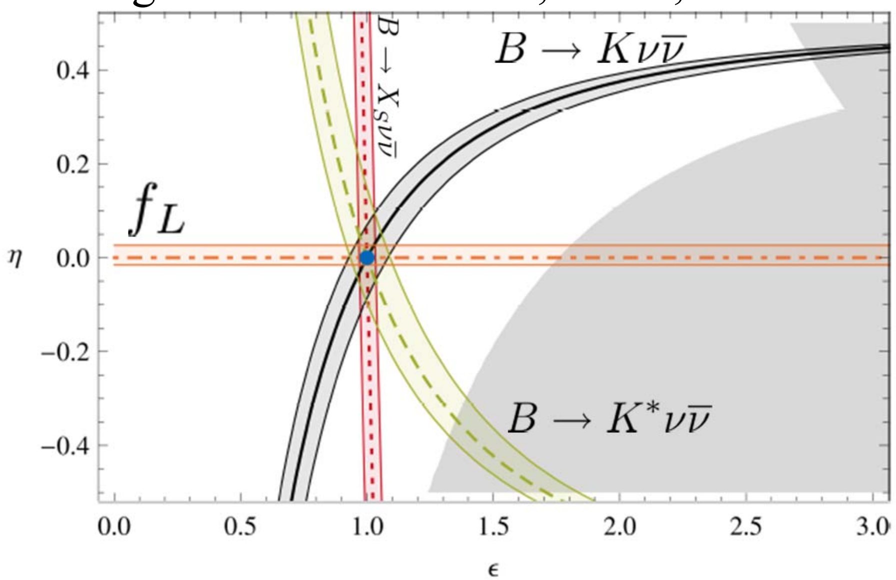
- Example: $B \to K^{(*)}\nu\bar{\nu}$
- Need 75 ab^{-1} to observe this mode
- With more than 75 ab^{-1} we could measure polarisation

Hot news: Recent BaBar update on $B \to D^{(*)}\tau\nu$ is 3.4σ away from SM

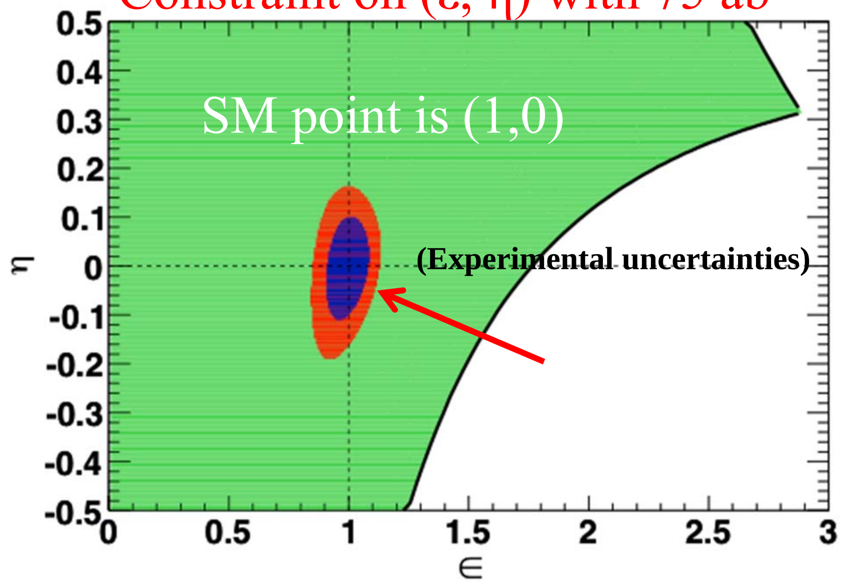
$$\epsilon = \frac{\sqrt{|C_L^\nu|^2 + |C_R^\nu|^2}}{|(C_L^\nu)^{\rm SM}|}\,, \qquad \eta = \frac{-{\rm Re}\,(C_L^\nu C_R^{\nu *})}{|C_L^\nu|^2 + |C_R^\nu|^2}$$

Sensitive to models with Z penguins and RH currents.

e.g. see Altmannshofer, Buras, & Straub

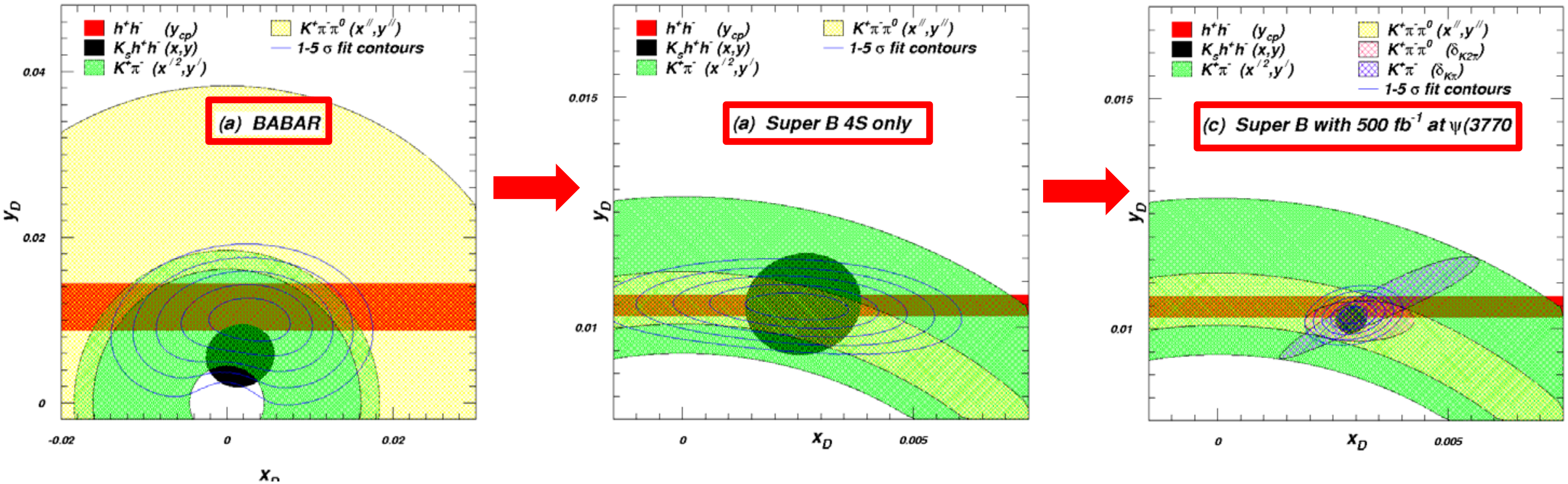


Constraint on (ϵ, η) with 75 ab^{-1}



Charm Physics

- Collect data at $\Upsilon(4S)$ and at the $D\bar{D}$ threshold
  → Benefit charm mixing and CPV measurements



- Integrating 500 fb^{-1} at the ψ(3770) provides knowledge of the average strong phases to be used in various channels and improves the DP models

- This can be achieved in ≈ 1 year with minimal modifications of the machine

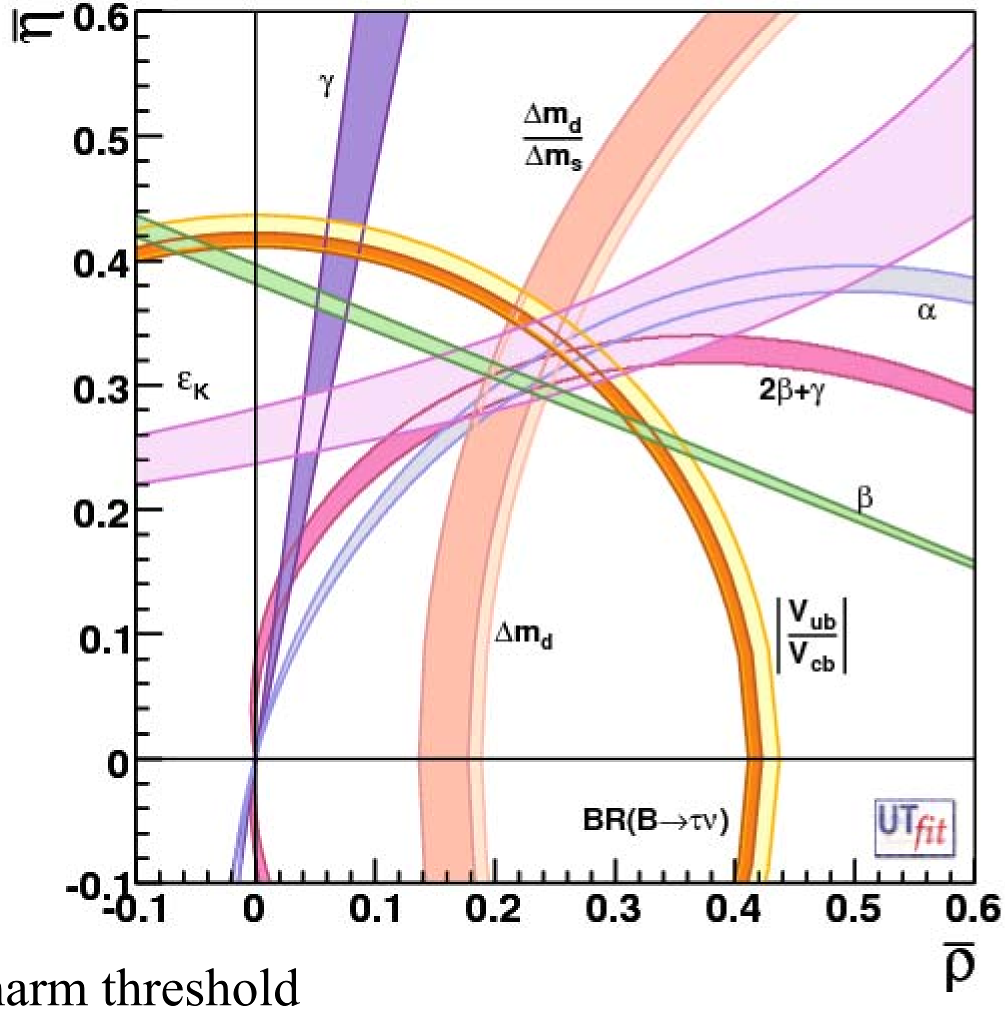
- Also useful for measuring the Unitarity triangle angle γ
  → Strong phase in D → Kππ Dalitz plot

Precision CKM constraints

- Unitarity Triangle Angles
  - $\sigma(\alpha) = 1\text{–}2°$
  - $\sigma(\beta) = 0.1°$
  - $\sigma(\gamma) = 1\text{–}2°$

- CKM Matrix Elements
  - $|V_{ub}|$
    - Inclusive $\sigma = 2\%$
    - Exclusive $\sigma = 3\%$
  - $|V_{cb}|$
    - Inclusive $\sigma = 1\%$
    - Exclusive $\sigma = 1\%$
  - $|V_{us}|$
    - → Can be measured precisely using τ decays
  - $|V_{cd}|$ and $|V_{cs}|$
    - → Can be measured at/near charm threshold

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



- SuperB measures the sides and angles of the Unitarity Triangle

Interplay between Measurements and Theory

- More information on the golden matrix can be found in arXiv:1008.1541, arXiv:0909.1333, and arXiv:0810.1312.

SuperB scope	Observable/mode	H^+ high $\tan\beta$	MFV	non-MFV	NP Z penguins	Right-handed currents	LTH	SUSY AC	SUSY RVV2	SUSY AKM	SUSY δLL	SUSY FBMSSM
✓	$\tau \to \mu\gamma$							★★★	★★★	★	★★★	★★★
✓	$\tau \to \ell\ell\ell$						★★★					
✓	$B \to \tau\nu, \mu\nu$	★★★(CKM)										
✓	$B \to K^{(*)+}\nu\overline{\nu}$			★	★★★			★	★	★	★	★
✓	S in $B \to K_S^0\pi^0\gamma$					★★★						
✓	S in other penguin modes			★★★(CKM)		★★★		★★★	★★	★	★★★	★★★
✓	$A_{CP}(B \to X_s\gamma)$			★★★		★★		★	★	★	★★★	★★★
✓	$BR(B \to X_s\gamma)$		★★★	★		★						
✓	$BR(B \to X_s\ell\ell)$			★	★	★						
✓	$B \to K^{(*)}\ell\ell$ (FB Asym)							★	★	★	★★★	★★★
	$B_s \to \mu\mu$							★★★	★★★	★★★	★★★	★★★
	β_s from $B_s \to J/\psi\phi$							★★★	★★★	★★★	★	★
✓	a_{sl}						★★★					
✓	Charm mixing							★★★	★	★	★	★
✓	CPV in Charm	★★									★★★	

NP enhancement:
★ Observable effect
★★ Moderately large effect
★★★ Very large effect

- Combine measurements to elucidate NP structure
  → Decoding NP won't be easy
  - As many measurements as possible needed

SuperB Physics Program in a Nutshell

- SuperB will probe NP observables in wide range of decays
- Pattern of deviation from SM can be used to identify structure of NP
- Clean experimental environment means clean signals in many modes
- Polarised e^- beam benefits for various searches
- Charm threshold running adds many more observables and improves potential of SuperB

} Unique features

- Measure angles and sides of the Unitarity triangle
- Physics TDR in progress

The SuperB collider

The SuperB collider in one slide

- Luminosity ≥ 10^{36} cm^{-2} s^{-1}
  → Integrated luminosity ≥ 75 ab^{-1} after five years of nominal running
- Innovative design of the interaction region: crab-waist scheme
  - Luminosity gain by squeezing the vertical size of the beams (30 nm)
  - Collisions at large Piwinski angle + crab sextupoles
    → Beams collide in the minimum waist region + machine more stable
  - Currents similar to BaBar & Belle: beam background under control
- Data taking over a large wide energy range: from ψ(3770) to ϒ(6S)
- Asymmetric collider with closer beam energies
  → Otherwise, Touschek lifetime issues
- e^- beam polarized up to ~80%
  → Resonances define the Low Energy Ring energy: 4.18 GeV
  → High Energy Ring (e^+) energy: 6.7 GeV
- Reduced $\beta\gamma = 0.24$ (was 0.56 for BaBar)
  → 1 cm beam pipe radius
  First measurement @ 1.6 cm (SVT layer 0)

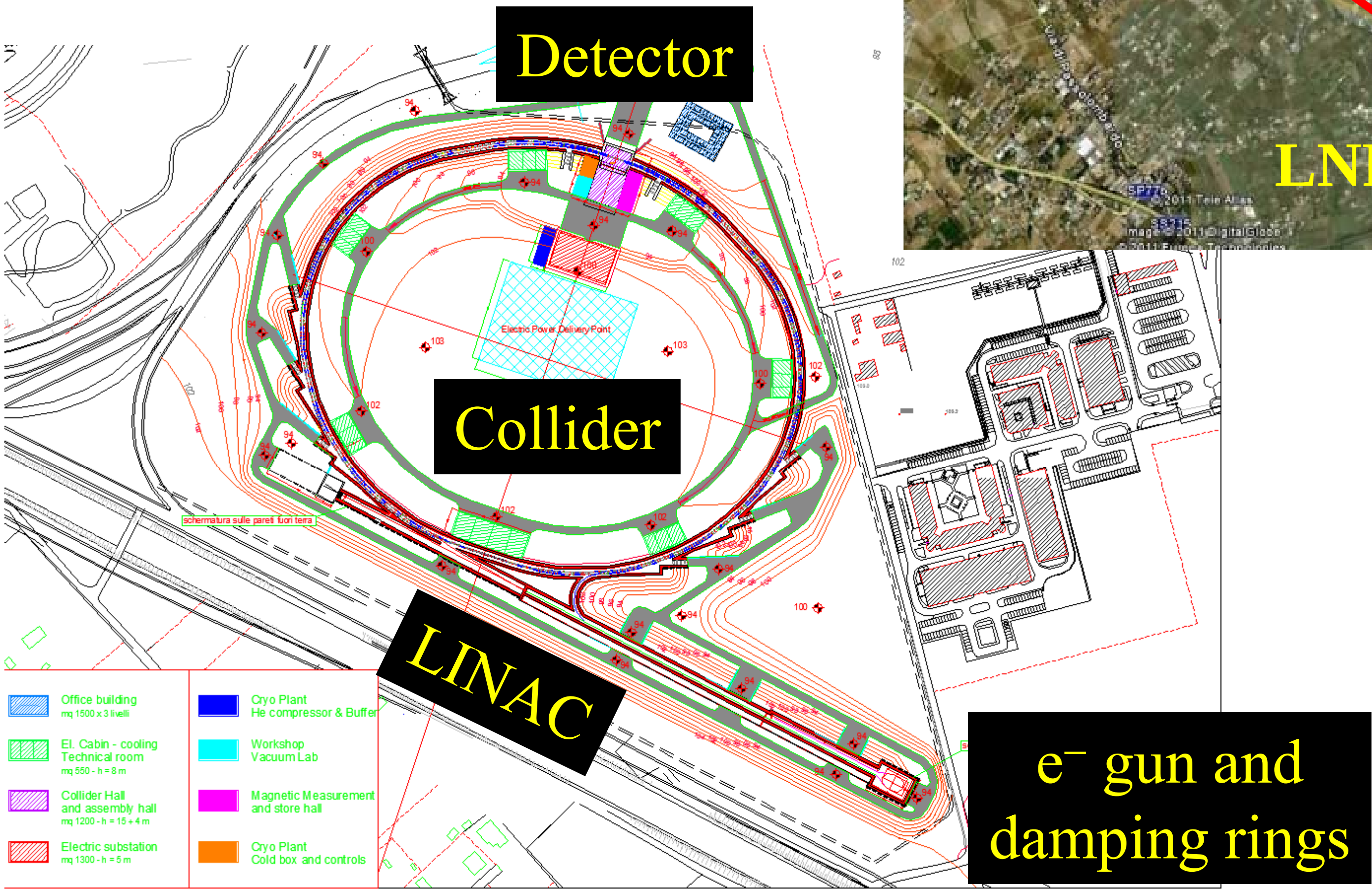
Parameter Table

- From progress report (2010)
  → Limited modifications since then
- Baseline + 2 options
  - Lower emittance
  - Higher currents
- Baseline
  - Larger emittance due to intrabeam scattering
  - Asymmetric currents
- RF power includes
  - Synchrotron radiation
  - High order modes
- Also : capability to run at $\tau/c\bar{c}$ threshold with high luminosity

		Base Line		Low Emittance		High Current	
Parameter	Units	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	
Energy	GeV	6.7	4.18	6.7	4.18	6.7	4.18
Circumference	m	1258.4		1258.4		1258.4	
X-Angle (full)	mrad	66		66		66	
β_x @ IP	cm	2.6	3.2	2.6	3.2	5.06	6.22
β_y @ IP	cm	0.0253	0.0205	0.0179	0.0145	0.0292	0.0237
Coupling (full current)	%	0.25	0.25	0.25	0.25	0.5	0.5
Emittance x (with IBS)	nm	2.00	2.46	1.00	1.23	2.00	2.46
Emittance y	pm	5	6.15	2.5	3.075	10	12.3
Bunch length (full current)	mm	5	5	5	5	4.4	4.4
Beam current	mA	1892	2447	1460	1888	3094	4000
Buckets distance	#	2		2		1	
Ion gap	%	2		2		2	
RF frequency	MHz	476.		476.		476.	
Revolution frequency	MHz	0.238		0.238		0.238	
Harmonic number	#	1998		1998		1998	
Number of bunches	#	978		978		1956	
N. Particle/bunch (10^{10})	#	5.08	6.56	3.92	5.06	4.15	5.36
σ_x effective	μm	165.22	165.30	165.22	165.30	145.60	145.78
σ_y @ IP	μm	0.036	0.036	0.021	0.021	0.054	0.0254
Piwinski angle	rad	22.88	18.60	32.36	26.30	14.43	11.74
Σ_x effective	μm	233.35		233.35		205.34	
Σ_y	μm	0.050		0.030		0.076	
Hourglass reduction factor		0.950		0.950		0.950	
Tune shift x		0.0021	0.0033	0.0017	0.0025	0.0044	0.0067
Tune shift y		0.097	0.097	0.0891	0.0892	0.0684	0.0687
Longitudinal damping time	msec	13.4	20.3	13.4	20.3	13.4	20.3
Energy Loss/turn	MeV	2.11	0.865	2.11	0.865	2.11	0.865
Momentum compaction (10^{-4})		4.36	4.05	4.36	4.05	4.36	4.05
Energy spread (10^{-4}) (full current)	dE/E	6.43	7.34	6.43	7.34	6.43	7.34
CM energy spread (10^{-4})	dE/E	5.0		5.0		5.0	
Total lifetime	min	4.23	4.48	3.05	3	7.08	7.73
Total RF Wall Plug Power	MW	16.38		12.37		28.83	

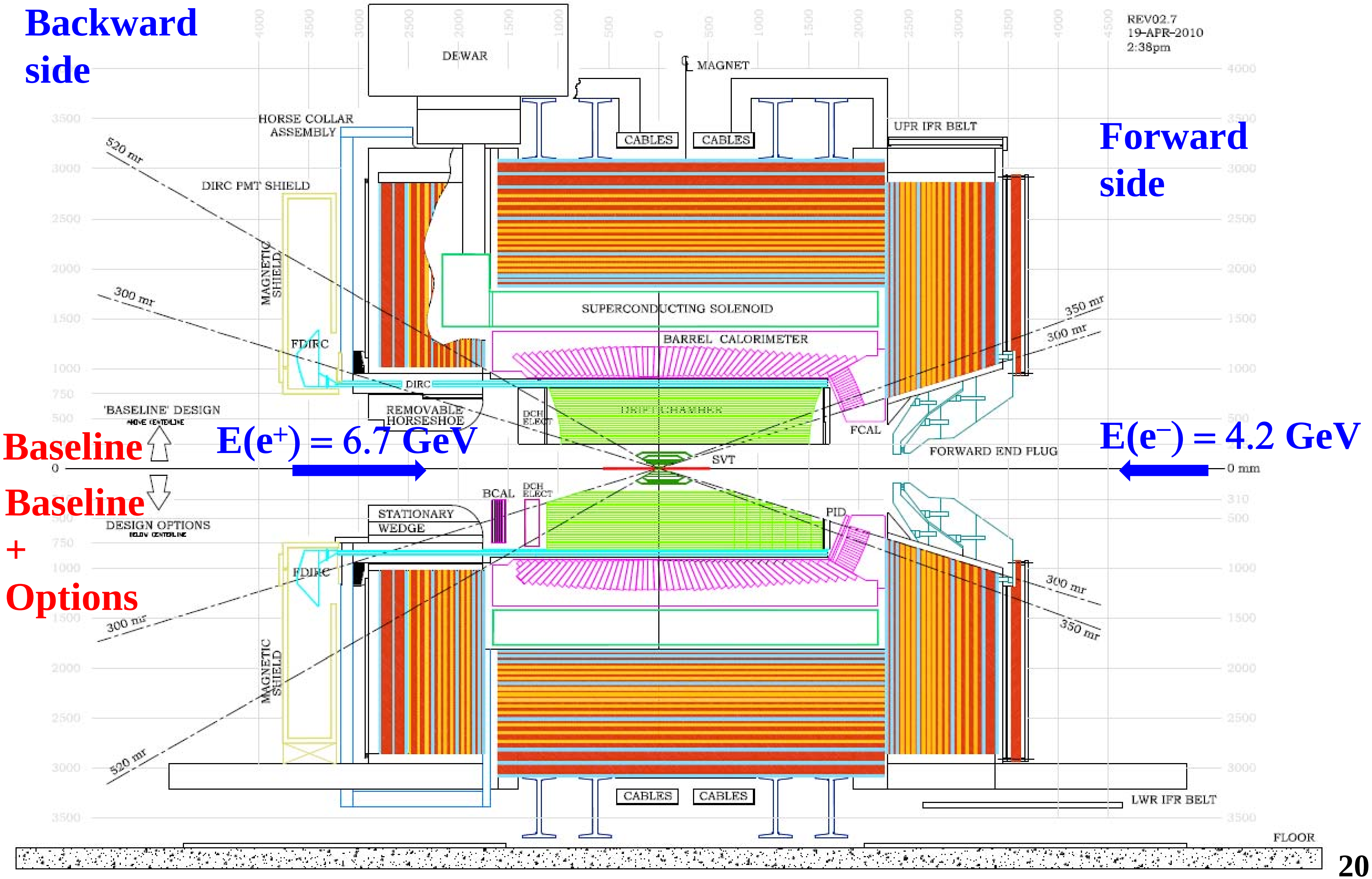
SuperB site

- Campus of the Tor Vergata University
  - Site chosen on May 29th 2011
- Excellent seismic properties
- Very close to Frascati lab



The SuperB detector

Detector Overview



The SuperB detector

- Based on the successful BaBar ‘prototype’
  → Similar design
  - Many components reused – listed below

- Fused silica bars from the PID detector (the DIRC)
- DIRC and drift chamber support structures
- Barrel calorimeter CsI(TI) crystals and mechanical structure
- Superconducting coil and flux return – with some redesign

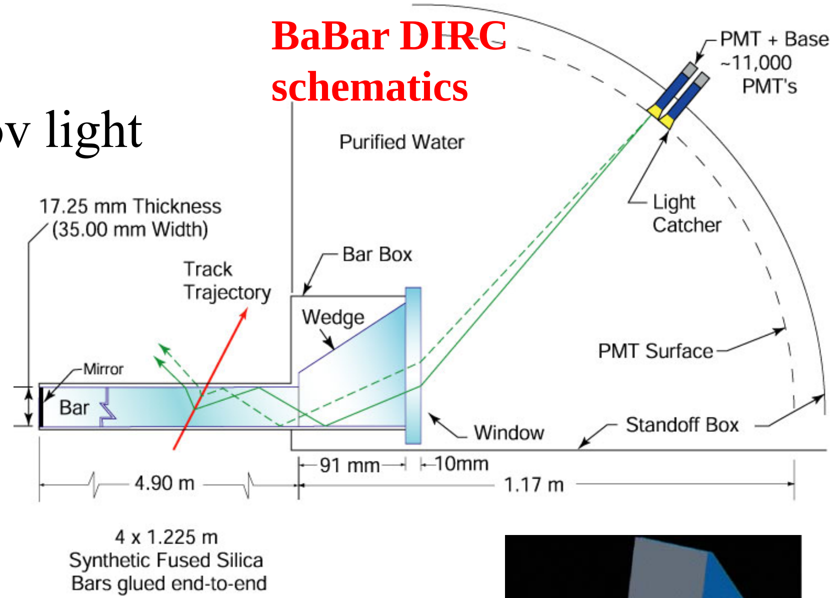
- Need to cope with new interaction region, high luminosity and background, smaller boost and higher data acquisition rates
  → Design improvements – listed below; refer to reference for additional information

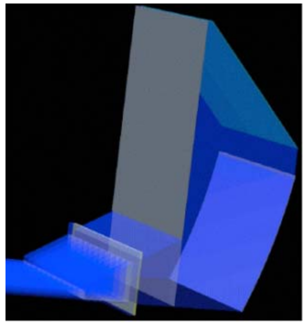
- Small beam pipe technology
- Thin first pixel layer + new 5-layer silicon vertex detector
- New drift chamber with modified gas and cell size
- New photon camera for the DIRC quartz bars
- New forward calorimeter crystals
- Extruded scintillator for flux return
- Options: a forward PID detector and a backward veto calorimeter
- Electronics, trigger, computing, etc.

The SuperB Focusing DIRC (FDIRC)

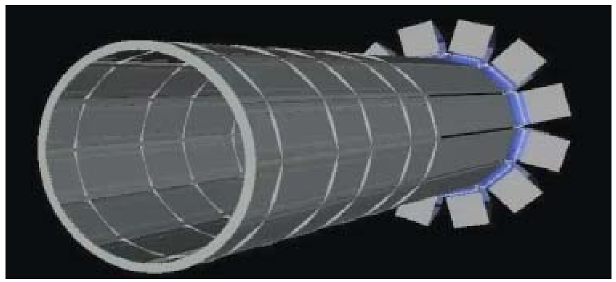
- Based on the successful BaBar DIRC:
  - Detector of Internally Reflected Cherenkov light
- Cherenkov light produced in quartz bars
- Transported by total internal reflection until array of photomultipliers
- Main PID detector for the SuperB barrel
  - K/π separation up to 3-4 GeV/c
  - Performance close to that of the BaBar DIRC

BaBar DIRC schematics





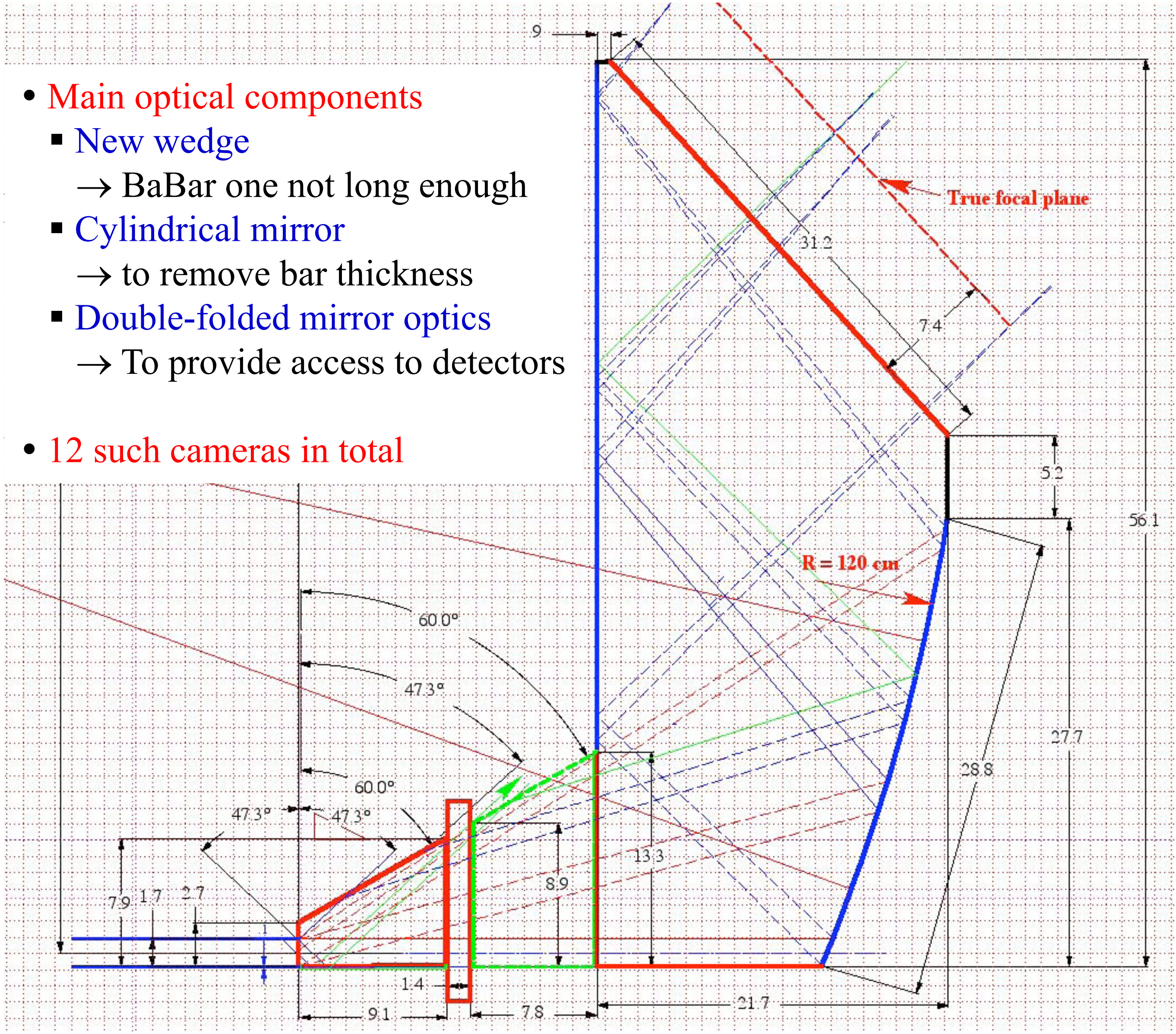
- To cope with high luminosity (10^{36} $cm^{-2}s^{-1}$) & high background
  - Complete redesign of the photon camera
  - A true 3D imaging using:
  - 25× smaller volume of the photon camera
  - 10× better timing resolution to detect single photons
  - Optical design is based entirely on Fused Silica glass
    → Avoid water or oil as optical media

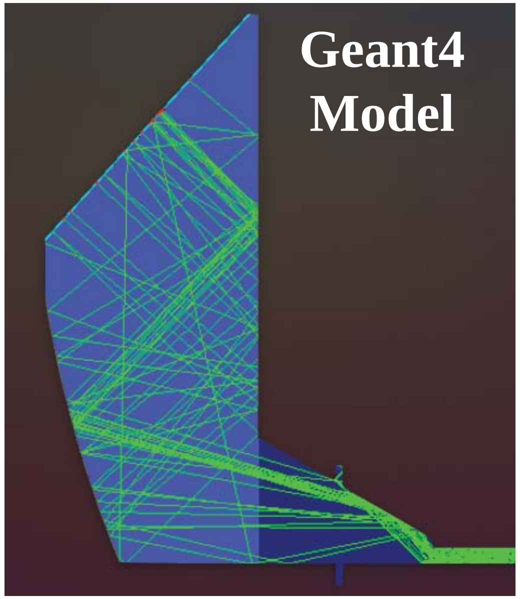


FDIRC photon camera

- Main optical components
  - New wedge
    → BaBar one not long enough
  - Cylindrical mirror
    → to remove bar thickness
  - Double-folded mirror optics
    → To provide access to detectors

- 12 such cameras in total

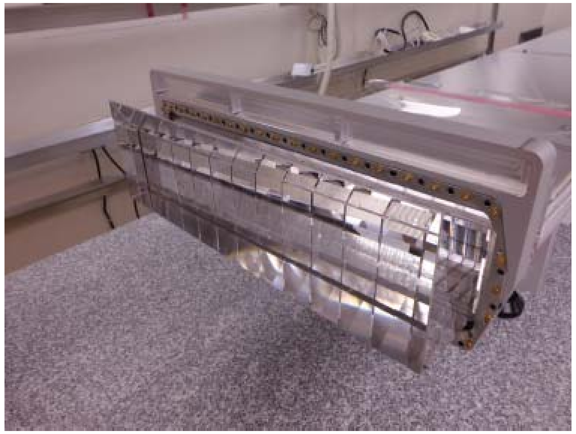




- Photon detectors: highly pixilated Hamamatsu H-8500 MaPMTs

When design turns into reality

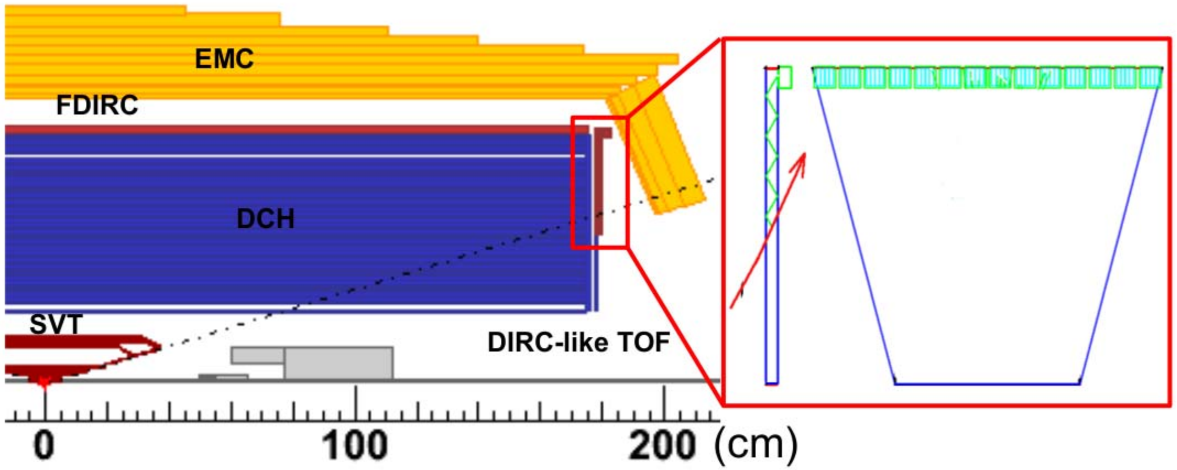
- Test of a FDIRC full size sector prototype to start next month at SLAC
  - Using the Cosmic Ray Telescope facility



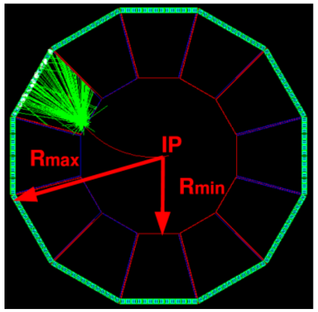
- See J. Va'vra recent talk at 12th Pisa Meeting on Advanced Detectors for details

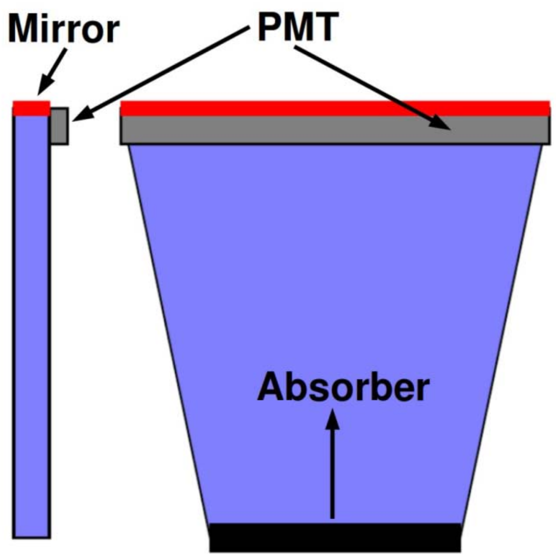
A forward PID Detector for SuperB

- Goal: to improve charged PID (based on drift chamber dE/dx only) in forward region



- 12 thin (1.5 cm width) fused silica tiles (30° in ϕ)
- Charged particles produce Cherenkov light
- γ trapped by total internal reflection are detected
- Flight path ~ 2 m ⇒ 30 ps total accuracy





- G4-based optimization of the geometry
  → Main criteria: ↑ photon yield
  ↓ timing spread
- Very fast MCP-PMTs needed (e.g. Hamamatsu SL-10)
  - 168 in total for the FTOF; 4 channel / γ detector
- New ultra-fast electronics: USB WaveCatcher (USBWC) developed jointly by LAL and CEA/Irfu
  → ~10 ps accuracy – new chip & board in development

Status of the SuperB project

The SuperB project

- SuperB was rated first in a list of 14 "flagship" projects in the Italian research plan
  → 6 projects / 14 funded, including SuperB
- Plan endorsed by "CIPE"
  → Italian institution responsible for infrastructure long term plans
- SuperB financial allocation: 256 M€ in six years
  - ~40 M€ allocated in 2010-2011
  - Early allocation of the 2012 budget soon

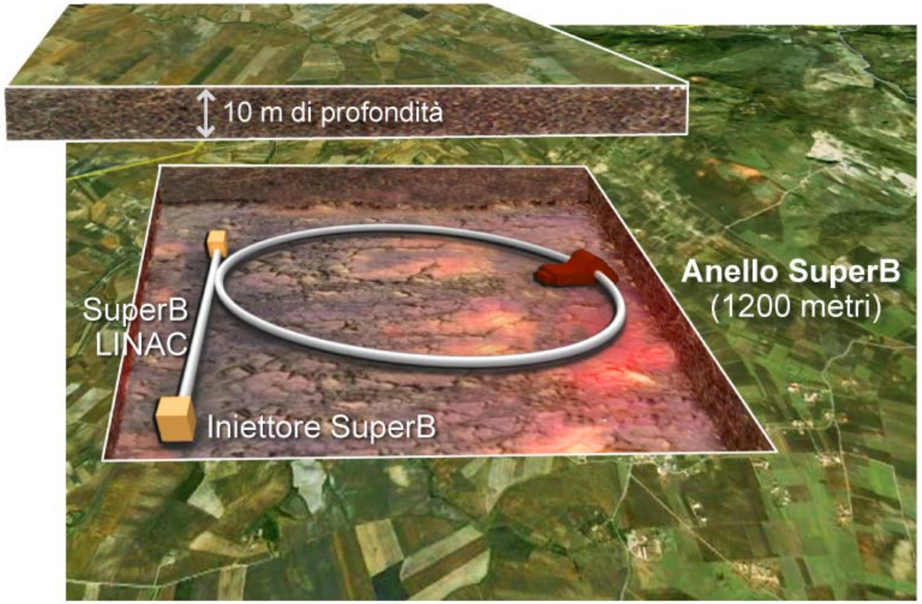
CABIBBO LAB
Laboratorio Nicola Cabibbo
http://www.cabibbolab.it

- Cabibbo Lab (consortium) created on October 7th 2011
  - INFN, Tor Vergata University, Italian Ministry for Research (→ ERIC later)
  - Management structure being defined
  → First people being hired now – see website for job offers
- Main 2012 milestones
  - Machine costing in progress
    → To be evaluated by a finance committee appointed by Italian government
    Final report expected by mid-Fall
  - Lattice completion
  - Detector Technical Design Report

Summary

For more information

- Detector Progress Report [arXiv:1007.4241]
- Physics Progress Report [arXiv:1008.1541]
- Accelerator Progress Report [arXiv:1009.6178]
- The impact of SuperB on flavour physics [arXiv: 1109.5028]
- Cabibbo lab website: http://www.cabibbolab.it
- SuperB website: http://superb.infn.it



Outlook

- SuperB has a great physics program ahead, complementary to the LHC
- The SuperB innovative collider will reach unprecedent luminosities
- We are building a detector which should exceed BaBar performances in spite of the the higher data rate and background
- It is intellectually rewarding and stimulating to work on a long-term project from the beginning, having in mind to take it until it reaches its 'super flavour factory mode'
- There are many opportunities to join SuperB in all areas – acc., det., comp., phys.
- Machine costing is ongoing
- Key Milestones
  - SuperB approval by Italy in December 2010
  - Site chosen in May 2011
  - Cabibbo lab established in October 2011
- Schedule
  - Construction in 2013-2018
  - First beams end of 2018

BACKUP

Comparing SuperB, LHCb & Belle-2

- Comparison of relative benefits of SuperB (75 ab^{-1}) / Belle-2 (50 ab^{-1}) vs. existing measurements and LHCb (5 fb^{-1}) / LHCb upgrade (50 fb^{-1})

- The impact of SuperB on flavour physics: arXiv:1109.5028
  → Document written by the SuperB physics group
  in consultation with other flavour experiments,
  in particular LHCb (upgrade) and Belle-2

- Focus on golden modes
  - Theoretical uncertainties under control
  - SuperB measurements/upper limits will be the best with the full dataset
  - Allow to test/constrain/reject some NP models

- These results will be updated in the coming years: physics TDR + physics book

- Benefit from unique features of SuperB
  - Polarization
  - Wide range of running energies
  - Larger dataset

Golden measurements: General

Experiment:	No Result	Moderately precise	Precise	Very precise
Theory:		Moderately clean	Clean, needs Lattice	Clean

Observable/mode Luminosity	Current $\sim 1\,\mathrm{fb}^{-1}$	LHCb (2017) $5\,\mathrm{fb}^{-1}$	Super$B$ (2022) $75\,\mathrm{ab}^{-1}$	LHCb upgrade $50\,\mathrm{fb}^{-1}$	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 $>75\,\mathrm{ab}^{-1}$
S in $B \to K_S^0\pi^0\gamma$	Yellow	Red	Green	Red	Yellow	Right handed currents
S (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$(B \to X_s ll)$	Yellow	Red	Green	Red	Green	
BR$(B \to K^{(*)} ll)$	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	Blue	Green	Green	Green	
D Decays						
Mixing parameters	Yellow	Blue	Green	Green	Green	
CP Violation	Red	Blue	Green	Green	Green	Clean NP search
Precision Electroweak						
$\sin^2\theta_W$ 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

Golden measurements: CKM

Experiment:	No Result	Moderately precise	Precise	Very precise
Theory:		Moderately clean	Clean, needs Lattice	Clean

Observable/mode Luminosity	Current $\sim 1\,\text{fb}^{-1}$	LHCb (2017) $5\,\text{fb}^{-1}$	Super$B$ (2022) $75\,\text{ab}^{-1}$	LHCb upgrade $50\,\text{fb}^{-1}$	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					
$\lvert V_{ub}\rvert$ inclusive					
$\lvert V_{ub}\rvert$ exclusive					
$\lvert V_{cb}\rvert$ inclusive					
$\lvert V_{cb}\rvert$ 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.

Impacts of the Polarization

- SuperB e⁻ beam polarized at ~80%
  → A unique feature of SuperB w.r.t. Belle-2

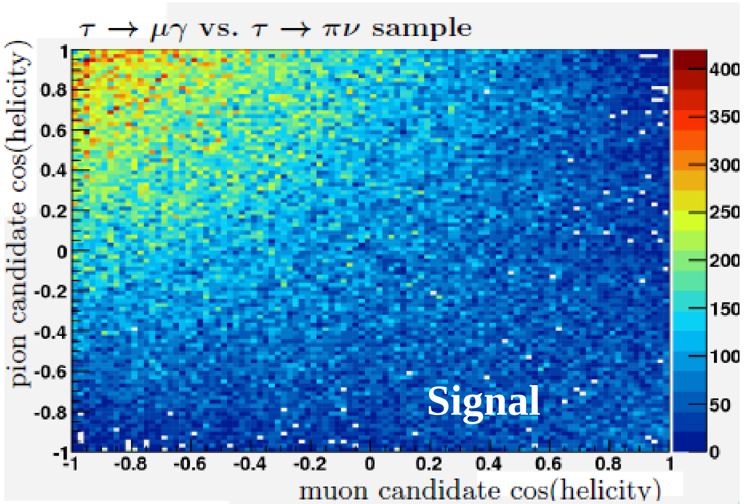
- The polarization helps suppressing the background in LFV search

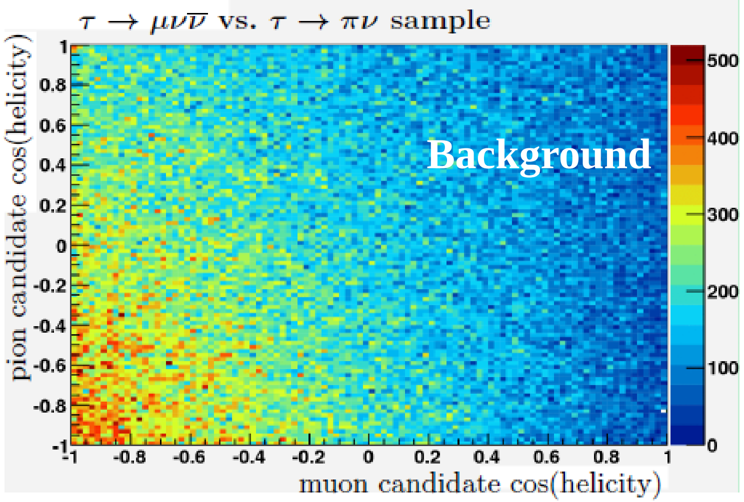
- W/o polarization, no sensitivity to

  - the Weinberg mixing angle

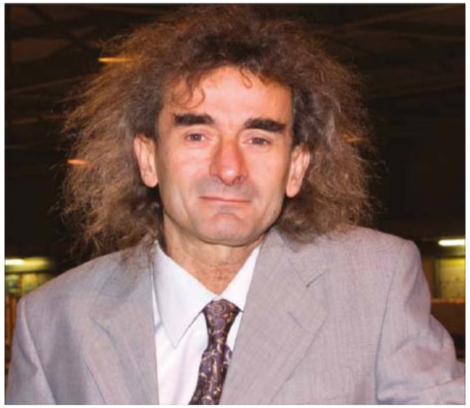
  - the τ g-2
  - the τ electric dipole moment

  ] Measurements help selecting/comparing NP models

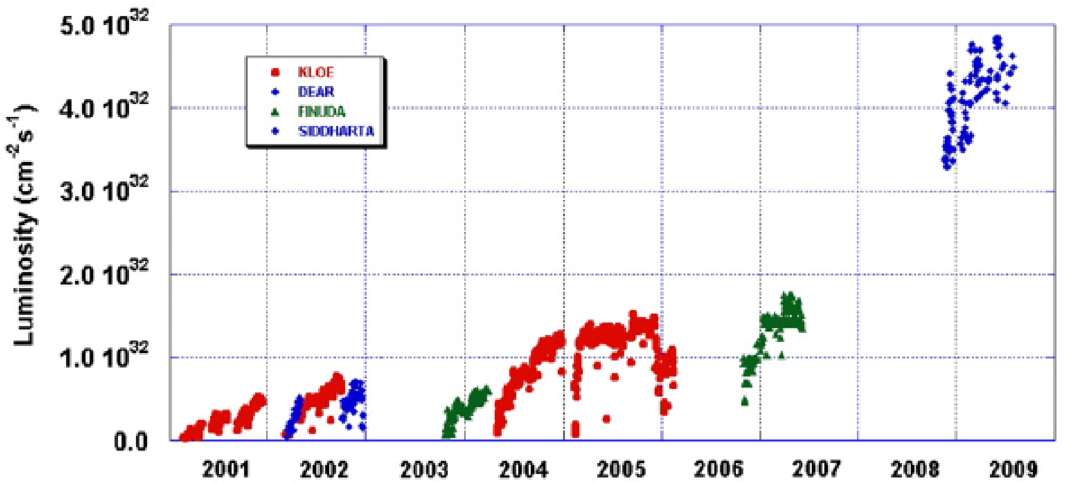




Digest of the SuperB crab waist scheme



- A superb idea from Pantaleo Raimondi
  - A variant of it is now used by Belle-2 as well: the ‘nano-beam scheme’
- Transverse beam size of nanometer scale needed to reach very high luminosity
- To benefit from this, one needs effective σ_z to be very small
- Extremely hard to do by conventionnal techniques
  → Collide at high Piwinski angle
  - Large crossing angle and long σ_z
- Creates vey large indesirable beam-beam effects
  → Get rid of them by pre-distorting the beams
- Successfully tested at DAΦNE:
  - Luminosity × ~3,
  → Consistent with expectations



Cabibbo Laboratory structure

• Director General:	Roberto Petronzio
• Director for Research:	Marcello Giorgi
• Director of Infrastructures:	Walter Scandale
• Director of the Accelerator Department:	Alessandro Variola

- Most group and area leaders identified

Comparing SuperB, LHCb & Belle-2

- With the exceptions of y_{CP} and K*μμ, there are no planned or existing experiments that will surpass SuperB precision in these modes for at least the next two decades
  → The best place to measure the other 33 golden modes is SuperB!

Observable/mode	Current now	LHCb (2017) 5 fb^{-1}	Super$B$ (2021) 75 ab^{-1}	Belle II (2021) 50 ab^{-1}	LHCb upgrade (10 years of running) 50 fb^{-1}	theory now
			τ Decays			
$\tau \to \mu\gamma$ ($\times 10^{-9}$)	< 44		< 2.4	< 5.0		
$\tau \to e\gamma$ ($\times 10^{-9}$)	< 33		< 3.0	< 3.7 (est.)		
$\tau \to \ell\ell\ell$ ($\times 10^{-10}$)	$< 150 - 270$	< 244 [a]	$< 2.3 - 8.2$	< 10	< 24 [b]	
			$B_{u,d}$ Decays			
BR($B \to \tau\nu$) ($\times 10^{-4}$)	1.64 ± 0.34		0.05	0.04		1.1 ± 0.2
BR($B \to \mu\nu$) ($\times 10^{-6}$)	< 1.0		0.02	0.03		0.47 ± 0.08
BR($B \to K^{*+}\nu\overline{\nu}$) ($\times 10^{-6}$)	< 80		1.1	2.0		6.8 ± 1.1
BR($B \to K^{+}\nu\overline{\nu}$) ($\times 10^{-6}$)	< 160		0.7	1.6		3.6 ± 0.5
BR($B \to X_s\gamma$) ($\times 10^{-4}$)	3.55 ± 0.26		0.11	0.13	0.23	3.15 ± 0.23
$A_{CP}(B \to X_{(s+d)}\gamma)$	0.060 ± 0.060		0.02	0.02		$\sim 10^{-6}$
$B \to K^{*}\mu^{+}\mu^{-}$ (events)	250[c]	8000	10-15k[d]	7-10k	100,000	-
BR($B \to K^{*}\mu^{+}\mu^{-}$) ($\times 10^{-6}$)	1.15 ± 0.16		0.06	0.07		1.19 ± 0.39
$B \to K^{*}e^{+}e^{-}$ (events)	165	400	10-15k	7-10k	5,000	-
BR($B \to K^{*}e^{+}e^{-}$) ($\times 10^{-6}$)	1.09 ± 0.17		0.05	0.07		1.19 ± 0.39
$A_{FB}(B \to K^{*}\ell^{+}\ell^{-})$	0.27 ± 0.14[e]	[f]	0.040	0.03		-0.089 ± 0.020
$B \to X_s\ell^{+}\ell^{-}$ (events)	280		8,600	7,000		-
BR($B \to X_s\ell^{+}\ell^{-}$) ($\times 10^{-6}$)[g]	3.66 ± 0.77[h]		0.08	0.10		1.59 ± 0.11
S in $B \to K^0_S\pi^0\gamma$	-0.15 ± 0.20		0.03	0.03		-0.1 to 0.1
S in $B \to \eta' K^0$	0.59 ± 0.07		0.01	0.02		± 0.015
S in $B \to \phi K^0$	0.56 ± 0.17	0.15	0.02	0.03	0.03	± 0.02
			B^0_s Decays			
BR($B^0_s \to \gamma\gamma$) ($\times 10^{-6}$)	< 8.7		0.3	$0.2 - 0.3$		0.4 - 1.0
A^s_{SL} ($\times 10^{-3}$)	-7.87 ± 1.96 [i]	[j]	4.	5. (est.)		0.02 ± 0.01
			D Decays			
x	$(0.63 \pm 0.20\%$	0.06%	0.02%	0.04%	0.02%	$\sim 10^{-2}$ [k]
y	$(0.75 \pm 0.12)\%$	0.03%	0.01%	0.03%	0.01%	$\sim 10^{-2}$ (see above).
y_{CP}	$(1.11 \pm 0.22)\%$	0.02%	0.03%	0.05%	0.01%	$\sim 10^{-2}$ (see above).
$\|q/p\|$	$(0.91 \pm 0.17)\%$	8.5%	2.7%	3.0%	3%	$\sim 10^{-3}$ (see above).
$\arg\{q/p\}$ ($^\circ$)	-10.2 ± 9.2	4.4	1.4	1.4	2.0	$\sim 10^{-3}$ (see above).
			Other processes Decays			
$\sin^2\theta_W$ at $\sqrt{s} = 10.58\,\mathrm{GeV}/c^2$			0.0002	[l]		clean

Comparing SuperB, LHCb & Belle-2

- CKM framework

Observable/mode	Current now	LHCb (2017)	Super$B$ (2021)	Belle II (2021)	LHCb upgrade (10 years of running)	theory now
		$5\,\text{fb}^{-1}$	$75\,\text{ab}^{-1}$	$50\,\text{ab}^{-1}$	$50\,\text{fb}^{-1}$	
α from $u\bar{u}d$	6.1°	$5^{\circ a}$	1°	1°	^{b}	$1-2^\circ$
β from $c\bar{c}s$ (S)	0.8° (0.020)	0.5° (0.008)	0.1° (0.002)	0.3° (0.007)	0.2° (0.003)	clean
S from $B_d \to J/\psi\pi^0$	0.21		0.014	0.021 (est.)		clean
S from $B_s \to J/\psi K_S^0$		?			?	clean
γ from $B \to DK$	11°	$\sim 4^\circ$	1°	1.5°	0.9°	clean
$\lvert V_{cb}\rvert$ (inclusive) %	1.7		0.5%	0.6 (est.)		dominant
$\lvert V_{cb}\rvert$ (exclusive) %	2.2		1.0%	1.2 (est.)		dominant
$\lvert V_{ub}\rvert$ (inclusive) %	4.4		2.0%	3.0		dominant
$\lvert V_{ub}\rvert$ (exclusive) %	7.0		3.0%	5.0		dominant

SuperB as a light source

- It is the first time a machine is developed to suit the needs of two communities:
  - High Energy Physics and Synchrotron light users

- Clear priority to the collider during its lifetime
  $\rightarrow$ Finding a design matching both sets of requirements is challenging

- Partnership with the Italian Institute of Technology

- Different solutions being studied
  - Synchrotron lines around the main ring
  - Free-electron laser in the LINAC