SuperB Physics & Detector overview

SuperB Miniworkshop, Oxford 18/19th May 2011

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Overview

- Introduction
- Data samples available at SuperB
- Topics
  - τ physics
  - $B_{u,d,s}$ physics
  - D physics
  - Precision EW
  - Spectroscopy
- Interplay
  - Precision CKM
  - Golden modes
- A brief tour of the detector
- Summary

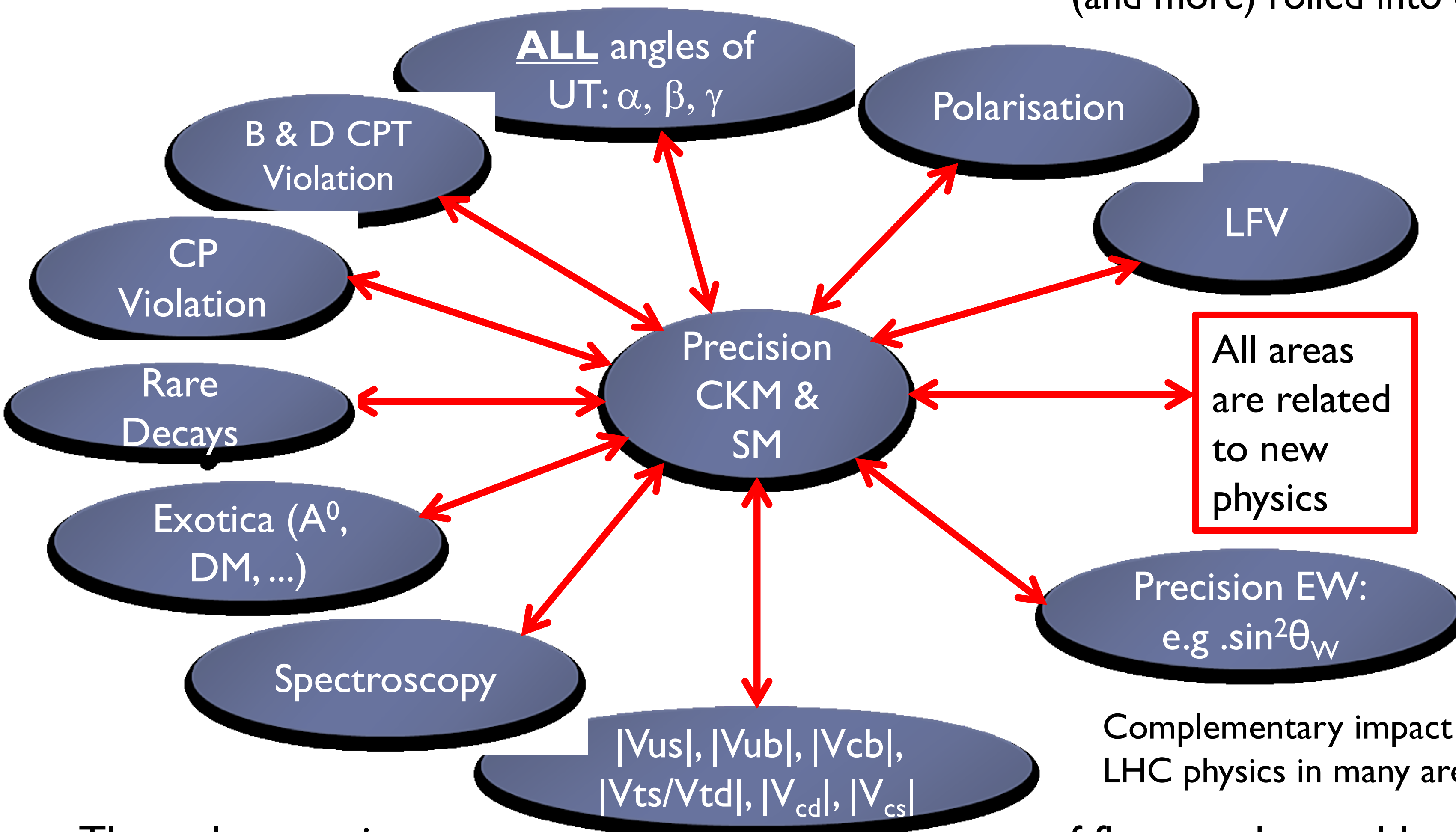
Introduction

- Current flavour physics landscape is defined by BaBar, Belle and the Tevatron.
  - We learned that CKM is correct at leading order.
  - Placed indirect constraints on NP that will last well into the LHC era. (e.g. H^+ searches).
- SuperB will start taking data in 2016, and the first full run is expected in 2017.
  - LHCb will have re-defined some areas of flavour physics on that timescale [and take data through to 2017 shutdown].
  - LHC may (or may not) have found new particles.
  - In both scenarios SuperB can be used to constrain flavour dynamics at high energy.

SuperB: Physics

Operate between Charm threshold and $\Upsilon(6S)$.

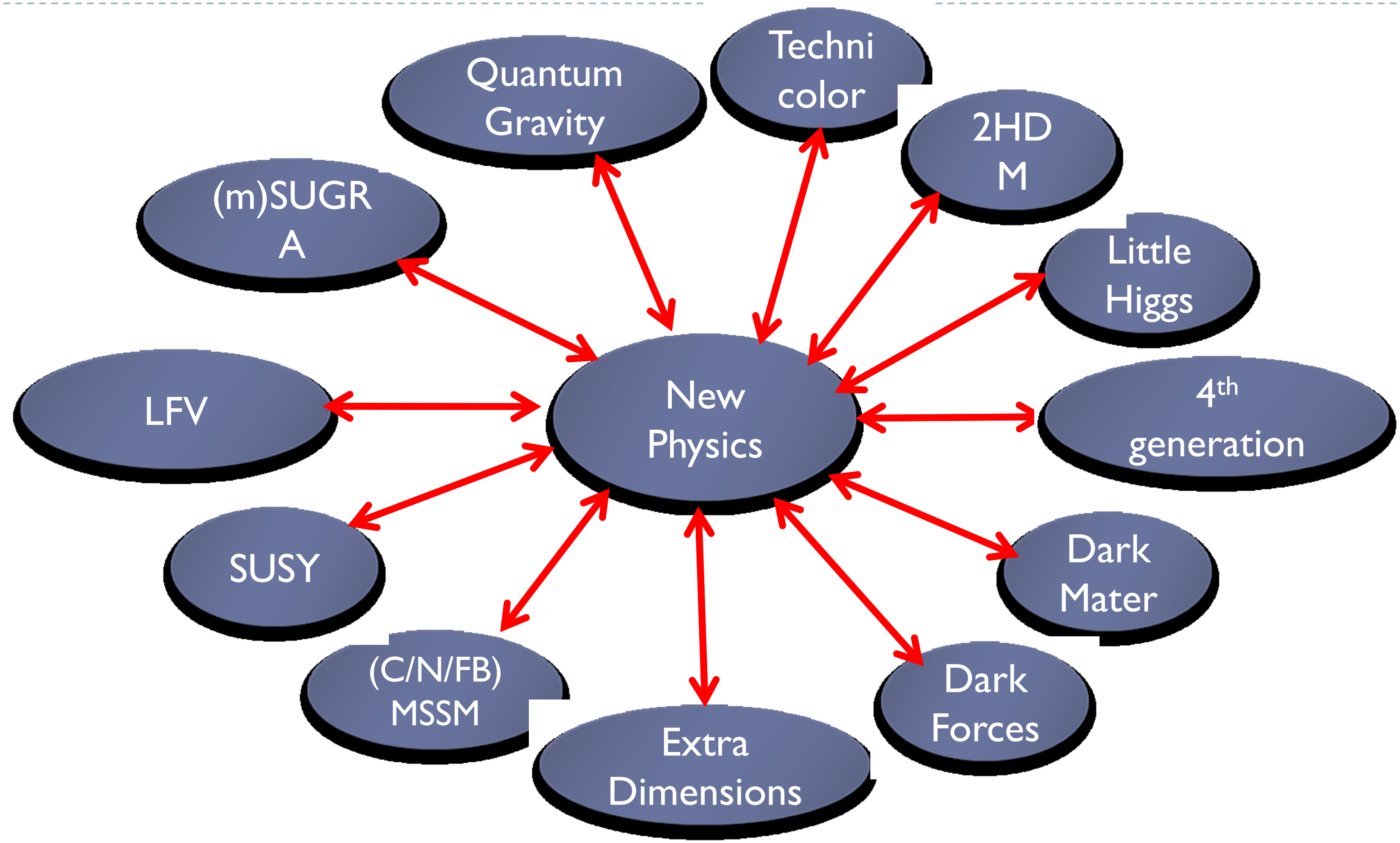
Is a Super-CLEO/B/τ-charm (and more) rolled into one!



Complementary impact on LHC physics in many areas.

- The only experiment with access such a wide range of flavour observables.
- (theoretically cleaner) inclusive measurements only in e^+e^- environment.

SuperB: Physics



- Data from SuperB will be used to reconstruct the new physics Lagrangian.
- Can learn something unique about NP irrespective of any NP discovery at LHC.

- Aims to constrain flavour couplings of new physics at high energy:
  - Refine understanding of nature if new physics exists at high energy.
    - We need to test the anzatz that new physics might be flavour blind:
      - Case 1: trivial solution → Reject more complicated models.
      - Case 2: non-trivial solution → Reject flavour blind models.
  - If the LHC doesn't find new physics: SuperB indirectly places constraints beyond the reach of the LHC and SLHC.

Quarks and neutrinos have non-trivial couplings. e,g, the CKM matrix in the Standard Model of particle physics. How far fetched is a trivial flavour blind new physics sector?

$$J^\mu = (\overline{u}, \overline{c}, \overline{t}) \frac{\gamma^\mu (1-\gamma^5)}{2} \begin{pmatrix} c_{12}c_{13} & s_{12}c_{13} & s_{13}e^{-i\delta} \\ -s_{12}c_{23} - c_{12}s_{23}s_{13}e^{i\delta} & c_{12}c_{23} - s_{12}s_{23}s_{13}e^{i\delta} & s_{23}c_{13} \\ s_{12}s_{23} - c_{12}c_{23}s_{13}e^{i\delta} & -c_{12}s_{23} - s_{12}c_{23}s_{13}e^{i\delta} & c_{23}s_{13} \end{pmatrix} \begin{pmatrix} d \\ s \\ b \end{pmatrix}$$

SuperB

- Aims to constrain flavour couplings of new physics at high energy:
  - Refine understanding of nature if new physics exists at high energy.
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      - Case 1: trivial solution → Reject more complicated models.
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  - If the LHC doesn't find new physics: SuperB indirectly places constraints beyond the reach of the LHC and SLHC.

e.g. MSSM: 124 (160 with ν_R) couplings, most are flavour related.

Δ's are related to NP mass scale.

LHCb, SuperB

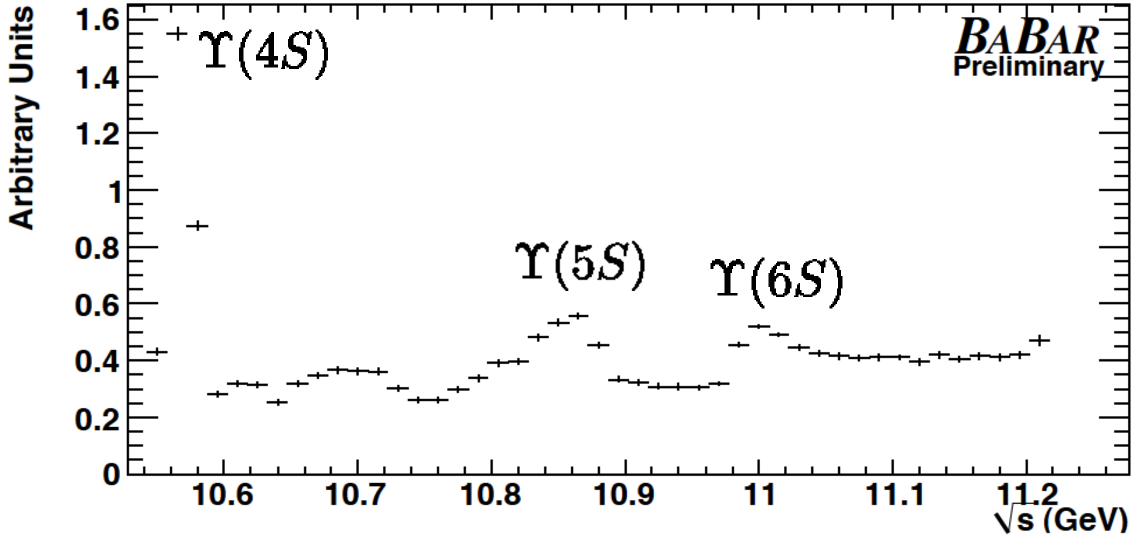
LHC, ILC - HE frontier

$$M^2_{\tilde d} \approx \begin{pmatrix} m^2_{\tilde d_L} & m_d(A_d - \mu\tan\beta) & (\Delta^d_{12})_{LL} & (\Delta^d_{12})_{LR} & (\Delta^d_{13})_{LL} & (\Delta^d_{13})_{LR} \\ & m^2_{\tilde d_R} & (\Delta^d_{12})_{RL} & (\Delta^d_{12})_{RR} & (\Delta^d_{13})_{RL} & (\Delta^d_{13})_{RR} \\ & & m^2_{\tilde s_L} & m_s(A_s - \mu\tan\beta) & (\Delta^d_{23})_{LL} & (\Delta^d_{23})_{LR} \\ & & & m^2_{\tilde s_R} & (\Delta^d_{23})_{RL} & (\Delta^d_{23})_{RR} \\ & & & & m^2_{\tilde b_L} & m_b(A_b - \mu\tan\beta) \\ & & & & & m^2_{\tilde b_R} \end{pmatrix}$$

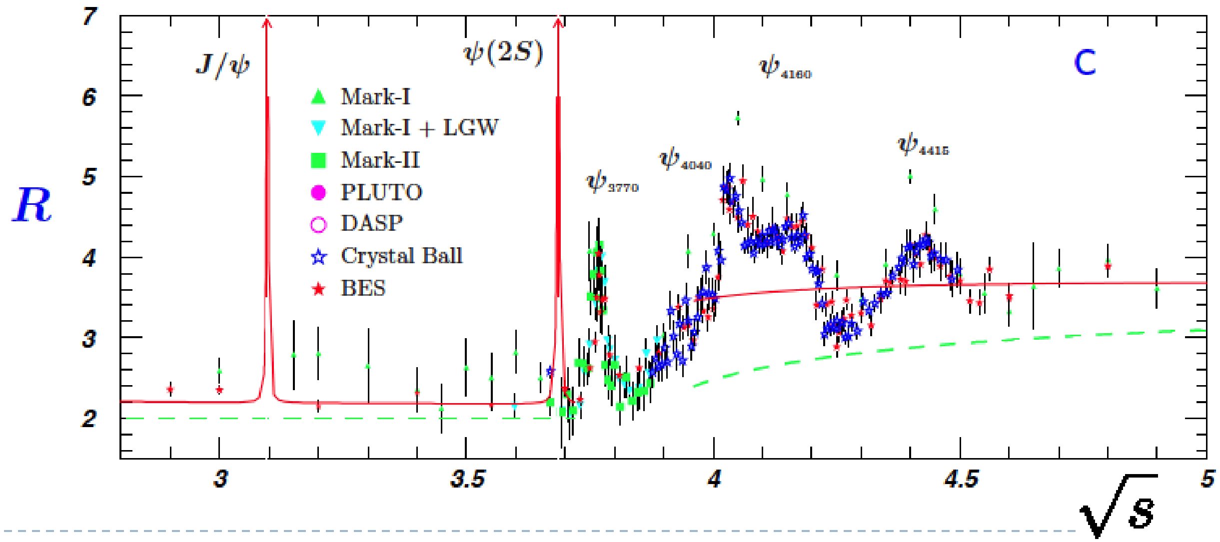
and similarly for $M^2_{\tilde u}$

Data sample

- Υ(4S) region:
  - 75ab−1 at the 4S
  - Also run above / below the 4S
  - ~75 x10⁹ B, D and τ pairs



- ψ(3770) region:
  - 500fb^{-1} at threshold
  - Also run at nearby resonances
  - ~2 x 10^9 D pairs at threshold in a few months of running.

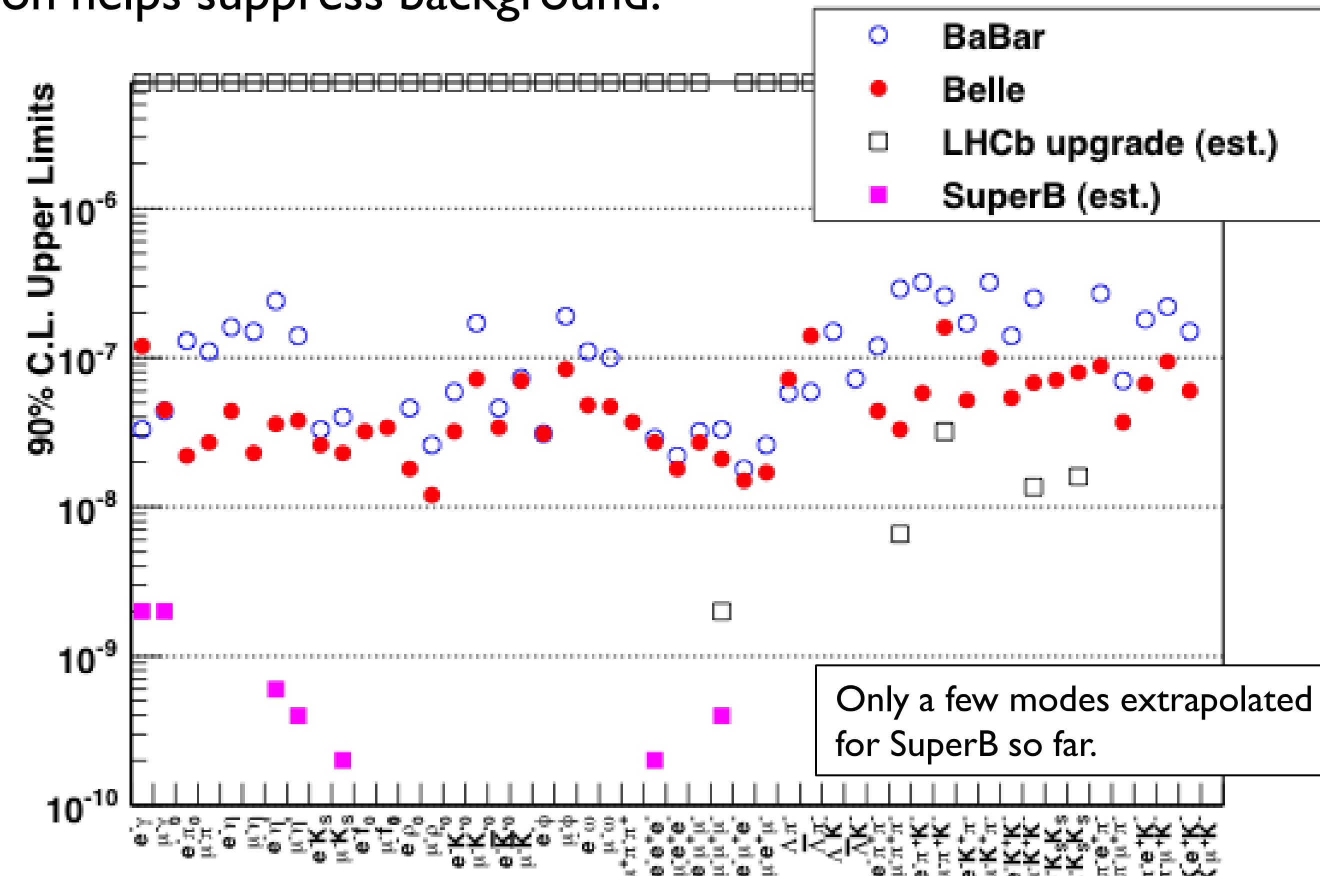


τLepton Flavor Violation (LFV)

- νmixing leads to a low level of charged LFV ($B \sim 10^{-54}$).
  - 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 not competitive with e^+e^- machines for these measurements.



Only a few modes extrapolated for SuperB so far.

Specific example: $\tau \to \mu\gamma$

- Only accessible in e^+e^- (golden modes: $\mu\gamma$, 3 lepton)
- Expect to retain background free searches with polarised electron beam.

[redacted] BLUE

[redacted] RED

Model dependent NP constraint.

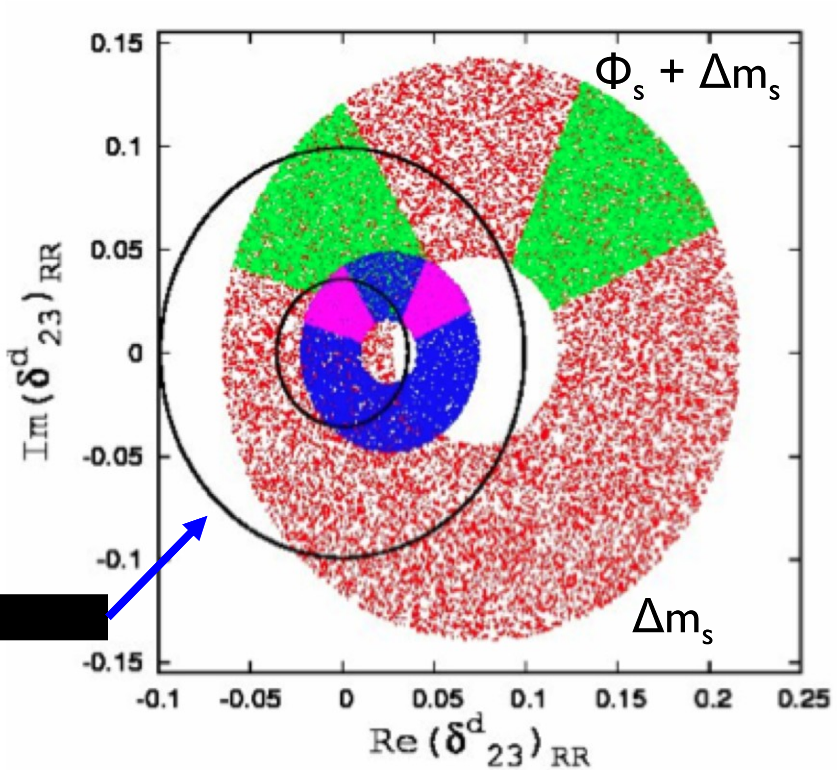
Golden channel for finding LFV.

Correlated with other flavour observables: MEG, LHCb etc.

TABLE III: Expected 90% CL upper limits and 3σ evidence reach on LFV decays with 75 ab^{-1} with a polarized electron beam.

Process	Expected 90% CL upper limit	3σ evidence reach
$\mathcal{B}(\tau \to \mu\gamma)$	2.4×10^{-9}	5.4×10^{-9}
$\mathcal{B}(\tau \to e\gamma)$	3.0×10^{-9}	6.8×10^{-9}
$\mathcal{B}(\tau \to \ell\ell\ell)$	$2.3\text{–}8.2 \times 10^{-10}$	$1.2\text{–}4.0 \times 10^{-9}$

[redacted]

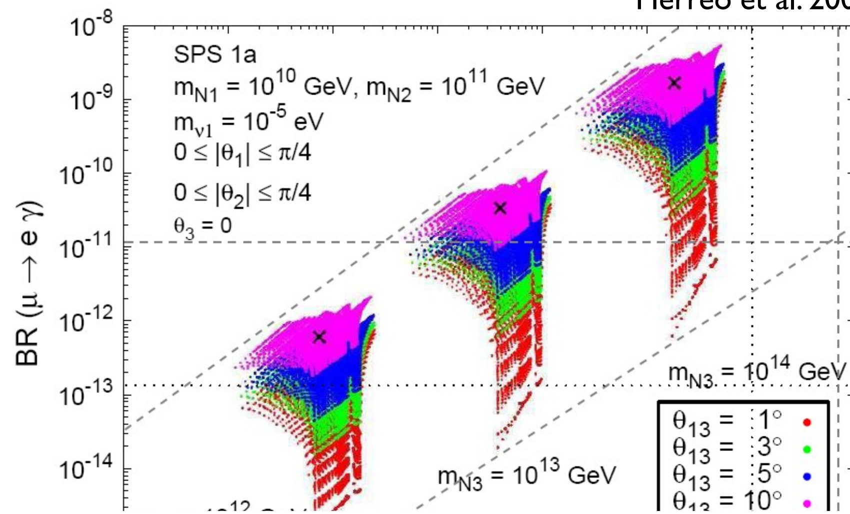


Lepton Flavour Violation (τ decay)

- $\tau \to \mu\gamma$ upper limit can be correlated to θ_{13} (neutrino mixing/CPV, T2K etc.) and also to $\mu \to e\gamma$.
- Complementary to flavour mixing in quarks.
- Golden modes:
  - $\tau \to \mu\gamma$ and 3μ.
- e^- beam polarization:
  - Lower background
  - Better sensitivity than competition!
- e^+ polarization may be used later in programme.
- CPV in $\tau \to K_S \pi \nu$ at the level of $\sim 10^{-5}$.
- Added Bonus:
  - Can also measure τ g-2 (polarization is crucial).
  - $\sigma(g-2) \sim 2.4 \times 10^{-6}$ (statistically dominated error).

SUSY seasaw = CMSSM + $3\nu_R$ + ν

Herreo et al. 2006



Process	Expected 90%CL upper limited	4σ Discovery Reach
$\mathcal{B}(\tau \to \mu\gamma)$	2×10^{-9}	5×10^{-9}
$\mathcal{B}(\tau \to \mu\mu\mu)$	2×10^{-10}	8.8×10^{-10}

Use $\mu\gamma/3l$ to distinguish SUSY vs. LHT.

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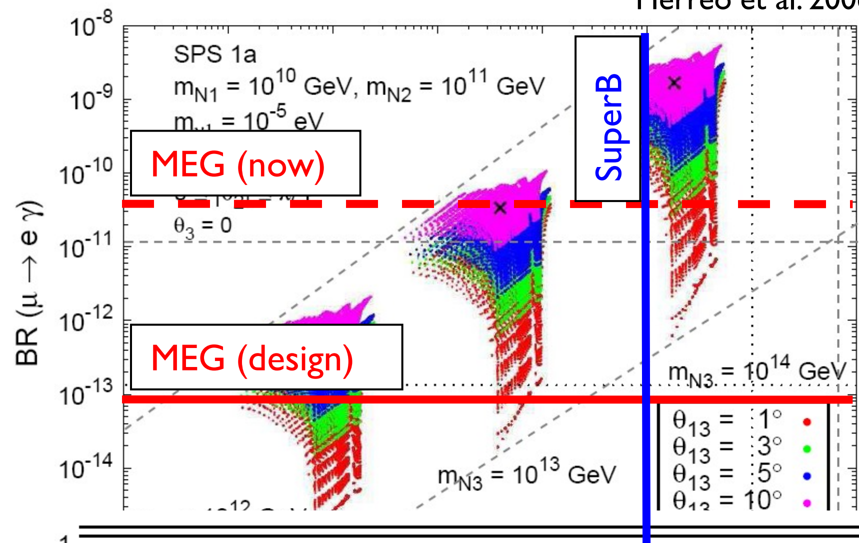

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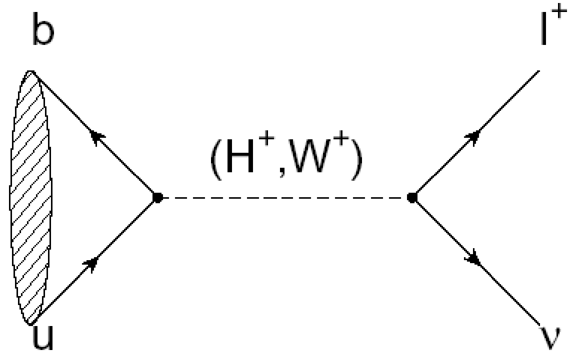
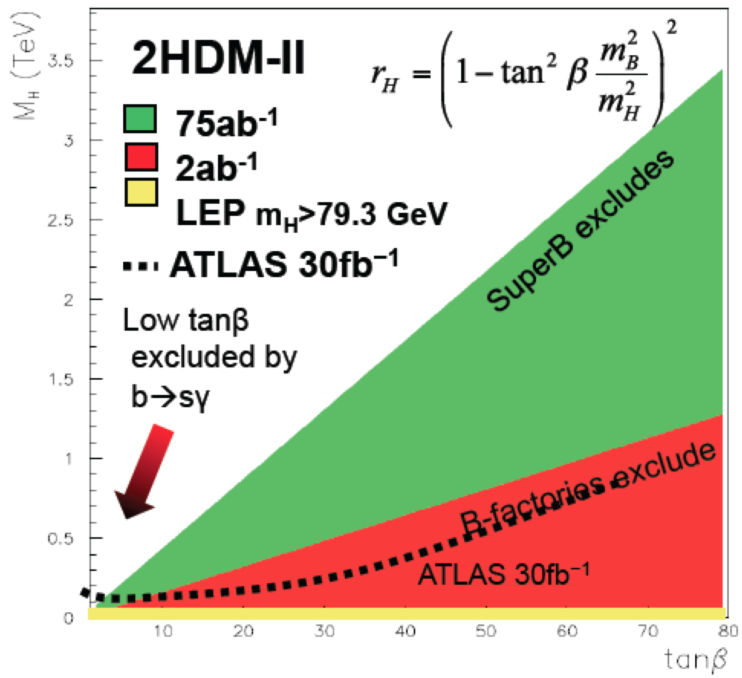
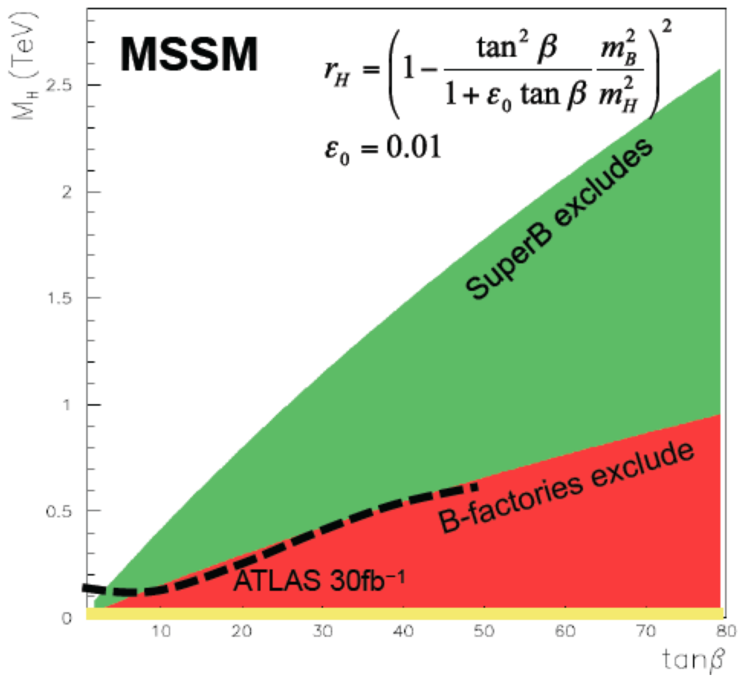
$B_{u,d}$ physics: Rare Decays

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

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







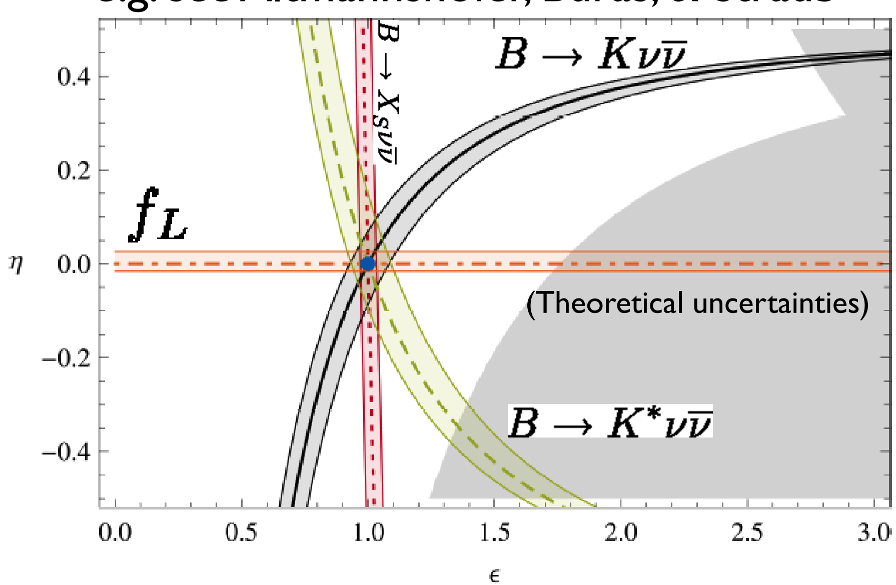
$B_{u,d}$ physics: Rare Decays

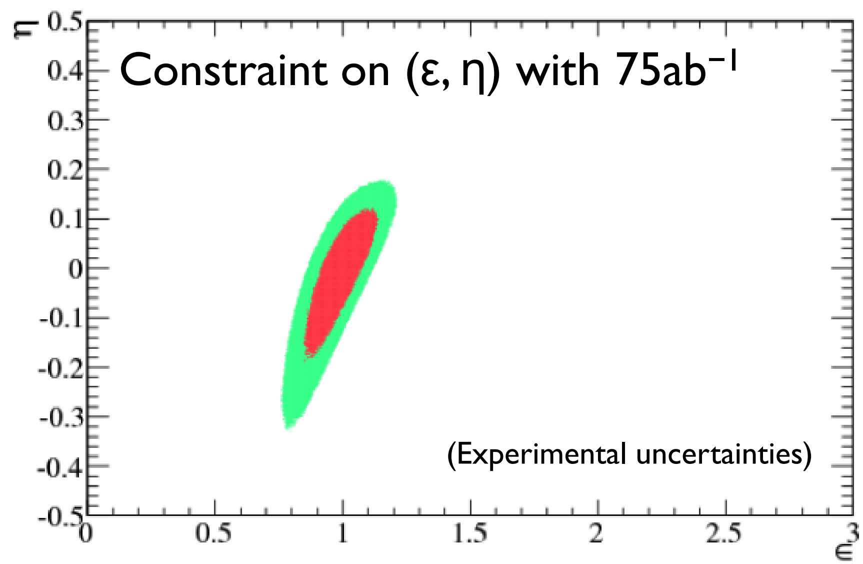
- Example: $B \to K^{(*)}\nu\overline{\nu}$
  - Need 75ab^{-1} to observe this mode.
  - With more than 75ab^{-1} we could measure polarisation.

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

Sensitive to models with Z penguins and RH currents.

e.g. see Altmannshofer, Buras, & Straub





$b \rightarrow s l^+ l^-$

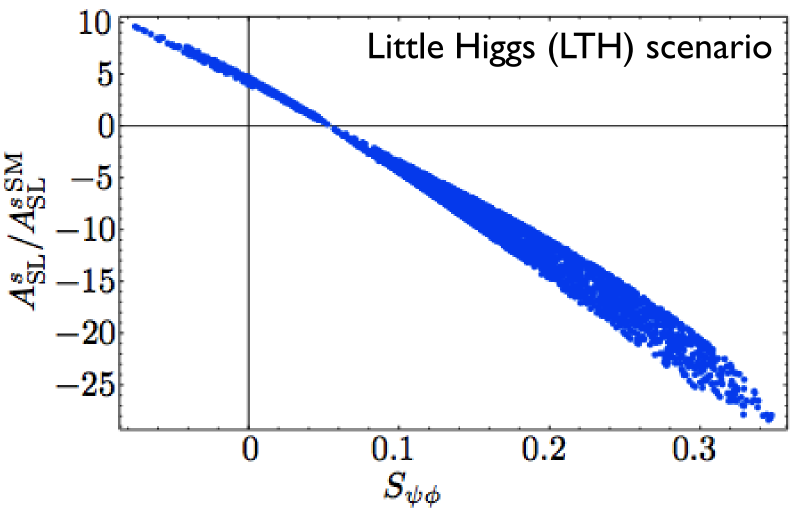
- SuperB can measure inclusive and exclusive modes.
  - Crosscheck results to understand NP constraints using different approaches.
  - Important as opinions on theory uncertainties differ, and this is a complicated area (nothing is perfectly clean).
    - Actively engaging the community to review this issue.
- SuperB can measure all lepton flavours
  - Equal amounts of μ and e final states can be measured.
    - Need both of these to measure all NP sensitive observables.
    - LHCb will accumulate slight more events in the μμ mode.
    - Expect superior statistics wrt LHCb for ee mode.
    - S/B~ 0.3, c.f. S/B~1.0 for LHCb.
  - Can also search for $K^{(*)}\tau^+\tau^-$ decay.
  - ... and constrain Majorana ν's using like sign final states.
    - Also of interest for D_s decays to $K^{(*)}ll$ final states near charm threshold.

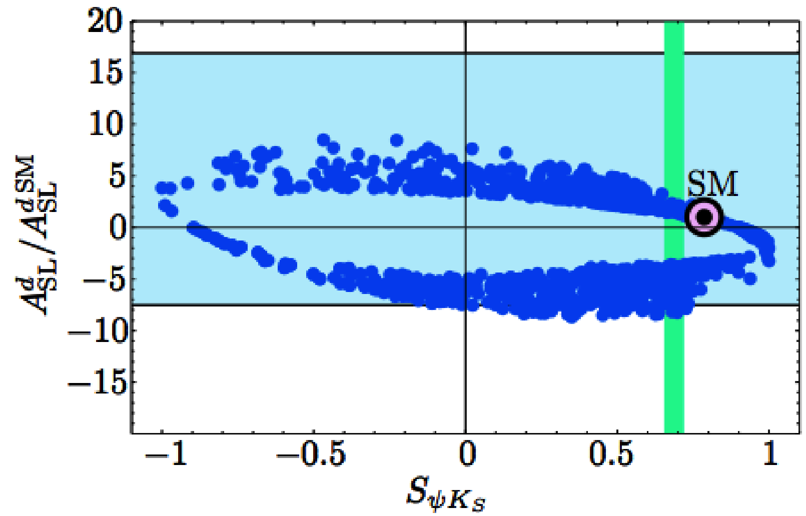
B_s physics

- Can cleanly measure A^s_{SL} using 5S data

$$A^s_{SL} = \frac{\mathcal{B}(B_s \to \overline{B}_s \to X^- \ell^+ \nu_\ell) - \mathcal{B}(\overline{B}_s \to B_s \to X^- \ell^+ \nu_\ell)}{\mathcal{B}(B_s \to \overline{B}_s \to X^- \ell^+ \nu_\ell) + \mathcal{B}(\overline{B}_s \to B_s \to X^- \ell^+ \nu_\ell)} = \frac{1 - |q/p|^4}{1 - |q/p|^4}$$

$$\sigma(A^s_{SL}) \sim 0.004 \text{ with a few } ab^{-1}$$

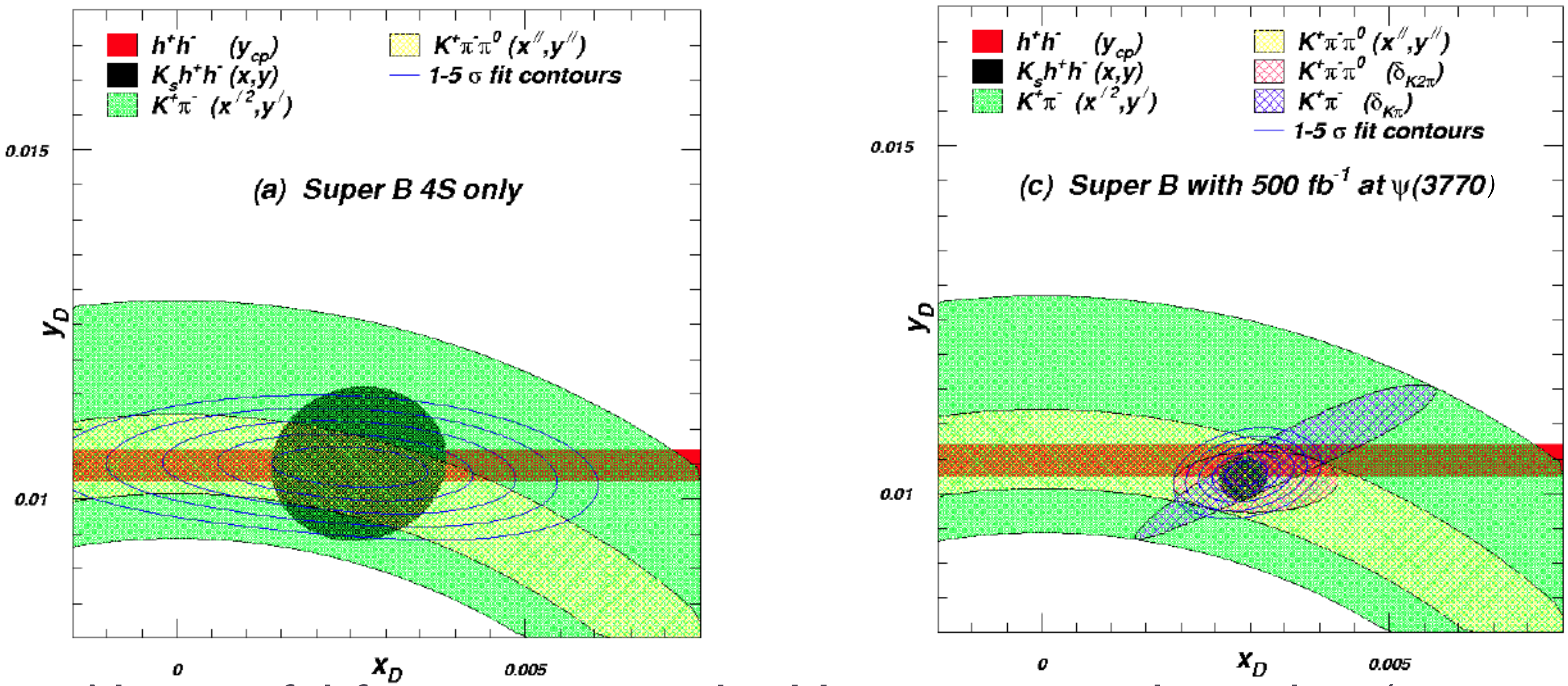




- SuperB can also study rare decays with many neutral particles, such as $B_s \to \gamma\gamma$, which can be enhanced by SUSY.

Charm

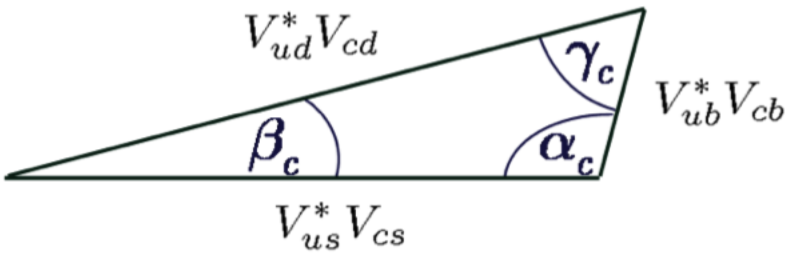
- Collect data at threshold and at the 4S.
  - Benefit charm mixing and CPV measurements.



  - Also useful for measuring the Unitarity triangle angleγ (strong phase in D→Kππ Dalitz plot).

Work in progress: The quest for the final angle of the CKM matrix: β_c

- The charm cu triangle has one unique element: β_c



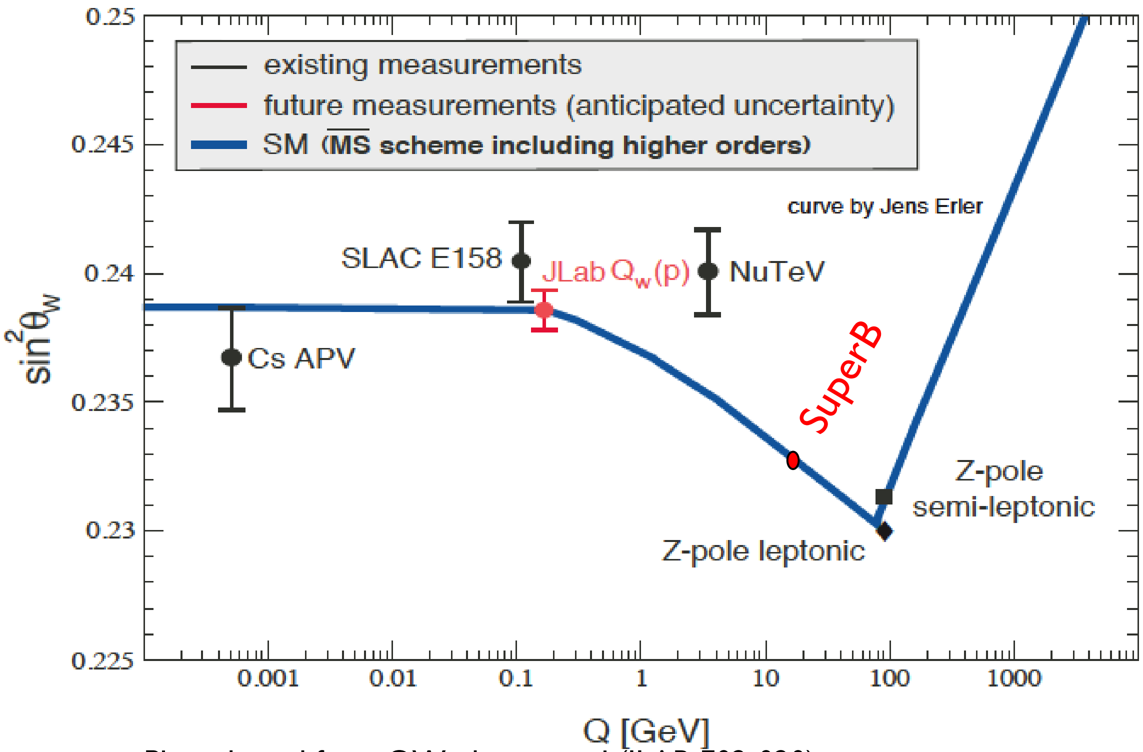
$$\begin{aligned}
\alpha_c &= \arg\left[-V_{ub}^* V_{cb}/V_{us}^* V_{cs}\right] . \\
\beta_c &= \arg\left[-V_{ud}^* V_{cd}/V_{us}^* V_{cs}\right] , \\
\gamma_c &= \arg\left[-V_{ub}^* V_{cb}/V_{ud}^* V_{cd}\right] ,
\end{aligned}$$

- Can measure this angle using a $D \to \pi\pi$ Isospin analysis (ignoring long distance and exchange amplitudes).
  - This is only possible in an e^+e^- environment.
  - Data from the charm threshold region completes the set of 5 $|V_{ij}|$ to measure: needs SuperB to perform an indirect test of the triangle.
- CPV can be measured in many places, but β_c will have smaller systematic errors using $\psi(3770)$ data, and $\Upsilon(4S)$ data than at a hadronic machine.
  - There is essentially no dilution at $\psi(3770)$ [negligible systematic error]

Bevan, Inguglia, Meadows, to appear soon

Precision Electroweak

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



Plot adapted from QWeak proposal (JLAB E02-020)

Measure LR asymmetry in

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

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

Can also perform crosscheck at $\psi(3770)$.

Spectroscopy

- Wide range of searches that can be made
  - SM searches, and understanding the properties particles, e.g. of X, Y, Z (establishing quantum numbers and resolving issues in the field).
  - Searching for light scalar particles (Higgs and Dark Matter candidates)
  - Di-lepton and 4-lepton final states can be used to test
    - lepton universality (c.f. NA62, many possible measurements in this area)
    - models of Dark Forces (few GeV scalar field in the dark sector)
  - Remember that BaBar's most cited paper is the discovery of the D_{sJ}

Interplay

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

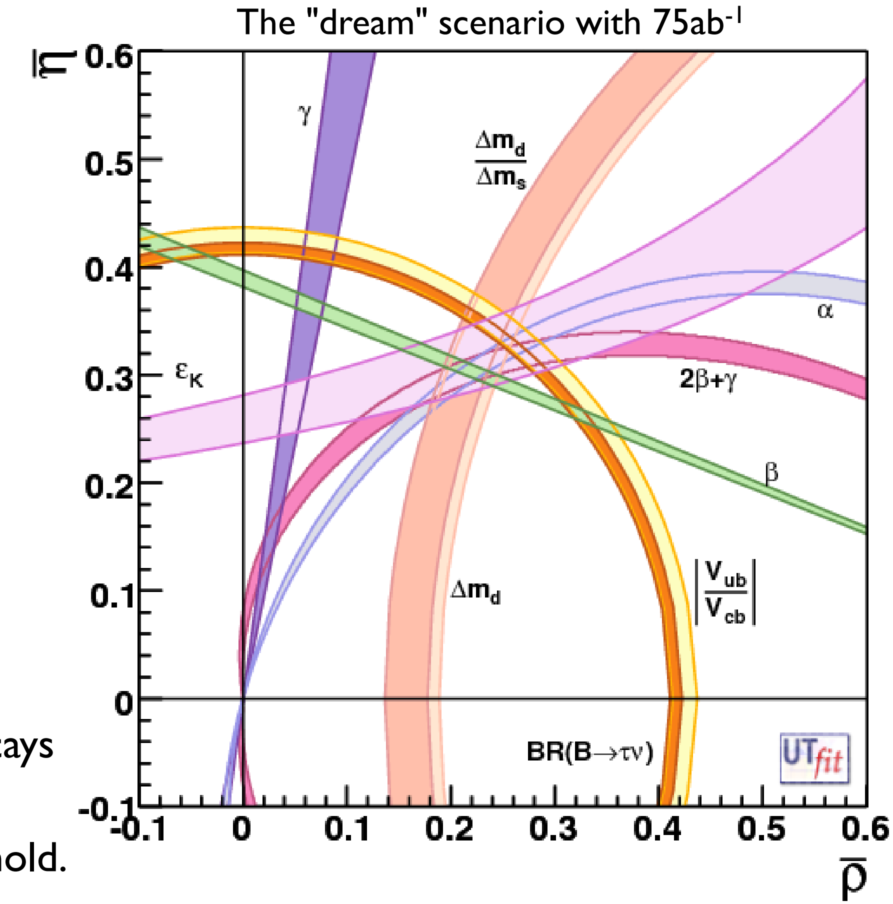
- Combine measurements to elucidate structure of new physics.

	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 $B \to K^0_S\pi^0\gamma$					★★★						
✓	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	★★									★★★	

✓ = SuperB can measure this

Precision CKM constraints

- Unitarity Triangle Angles
  - σ(α) = 1−2°
  - σ(β) = 0.1°
  - σ(γ) = 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

Golden Measurements: CKM

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

Observable/mode	Current (now)	LHCb (2017)	Super$B$ (2021)	LHCb upgrade (2030?)	Theory
α	Blue	Blue	Green	Blue	Yellow
β from $b \to c\bar{c}s$	Blue	Blue	Green	Green	Green
$B_d \to J/\psi \pi^0$	Yellow	Red	Green	Red	Green
$B_s \to J/\psi K_S^0$	Red	Yellow	Red	Blue	Green
γ	Yellow	Blue	Green	Green	Green
$\|V_{ub}\|$ inclusive	Blue	Yellow	Green	Blue	Blue
$\|V_{ub}\|$ exclusive	Blue	Yellow	Green	Blue	Blue
$\|V_{cb}\|$ inclusive	Blue	Yellow	Green	Blue	Blue
$\|V_{cb}\|$ exclusive	Blue	Yellow	Green	Blue	Blue

LHCb can only use $\rho\pi$

βtheory error B_d

βtheory error B_s

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

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

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

Golden Measurements: CKM

Observable/mode	Current now	LHCb (2017)	Super$B$ (2021)	Belle II (2021)	LHCb upgrade (2030)	theory now
α from $u\bar{u}d$	6.1°	$5^{\circ\,a}$	1°	1°	^{b}	$1-2^\circ$
β from $c\bar{c}s$ (S)	0.9° (0.024)	0.5° (0.008)	0.1° (0.002)	0.5° (0.012)	0.2° (0.003)	clean
S from $B_d \to J/\psi\pi^0$	0.21		0.014	0.021 (est)		clean
S from $B_s \to J/\psi K^0_S$		?			?	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

- Angles:
  - Unitarity Triangle: SuperB covers all angles: α, β, γ(with redundant measurements).
  - cu Triangle: SuperB covers β_c (γ_c needs "infinite" statistics to measure).
- Sides:
  - Only SuperB can measure all of $|V_{ub}|$, $|V_{cb}|$, $|V_{us}|$, $|V_{cs}|$, $|V_{cd}|$. Need $|V_{ud}|$ (already precisely known) to complete set of constraints to indirectly test bd and cu triangles.
- Only SuperB can provide direct and indirect constraints of bd and cu triangles.

Golden Measurements: General

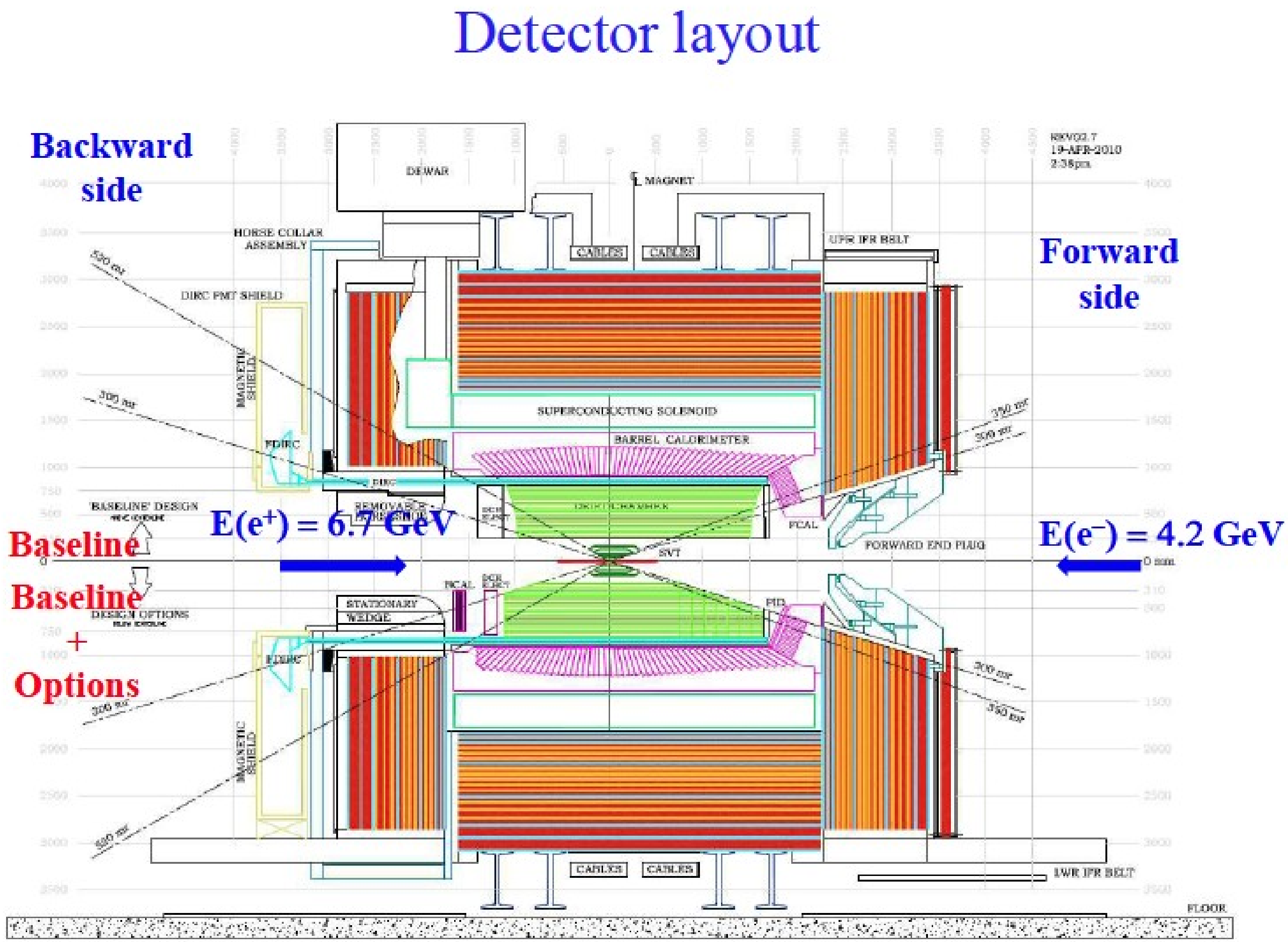
Experiment: Red = No Result, Yellow = Moderate Precision, Blue = Precise, Green = Very Precise

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 $B \to K_S^0\pi^0\gamma$	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

Observable/mode	Current now	BES III (2016) 20 fb^{-1}	LHCb (2017) 5 fb^{-1}	Super$B$ (2021) 75 ab^{-1}	Belle II (2021) 50 ab^{-1}	LHCb upgrade (2030) 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($B \to \tau\nu$) ($\times 10^{-4}$)	0.34			4%	0.05		
BR($B \to \mu\nu$) ($\times 10^{-6}$)	< 1.0			5%	$> 5\sigma$ observation		
BR($B \to K^{*+}\nu\bar{\nu}$) ($\times 10^{-6}$)	< 80			1.1	2.0		~ 1
BR$B \to K^{+}\nu\bar{\nu}$) ($\times 10^{-6}$)	< 160			0.7	1.6		≤ 0.7
BR($B \to X_s\gamma$) ($\times 10^{-4}$)	0.26			0.11	0.13	0.23	
BR($B \to X_s\ell^+\ell^-$) ($\times 10^{-6}$)	0.77			0.18	0.22		
$B \to K^*\mu^+\mu^-$ (events)	X		14,000	10,000	6,700	140,000	
$B \to K^*e^+e^-$ (events)	X		1,400[c]	10,000	6,700	14,000[d]	
S in $B \to K^0_S\pi^0\gamma$	0.20			0.03	0.04 (est.)		
S in $B \to \eta' K^0$	0.07			0.01	0.02		± 0.015
S in $B \to \phi K^0$	0.17		0.15	0.02	0.03	0.03	± 0.02
			B^0_s Decays				
BR($B_s \to \mu\mu$) [e] ($\times 10^{-9}$)	< 51		± 1			± 0.3	± 0.4
$2\beta_s$ from $B^0_s \to J/\psi\phi$	0.35		0.019			0.006	0.003
BR($B^0_s \to \gamma\gamma$) ($\times 10^{-6}$)	< 8.7			0.3 [f]			0.4 - 1.0
A^s_{SL}				0.004			
			D Decays				
x	0.21%			0.02%	0.09%		
y	0.19%			0.01%	0.05%		
y_{CP}	0.22%		0.05%	0.04%	0.05% (est.)	0.02%	
			Other processes Decays				
$\sin^2\theta_W$ at $\sqrt{s} = 10.58\,\mathrm{GeV}/c^2$				0.0002	0.0005		clean

The detector



SVT

- Contact: Giuliana Rizzo (Pisa)
- 1 layer of pixels, 5 layers of double sided strips
  - See Fergus' talk this afternoon on pixels
  - AB's talk on mechanics and strips

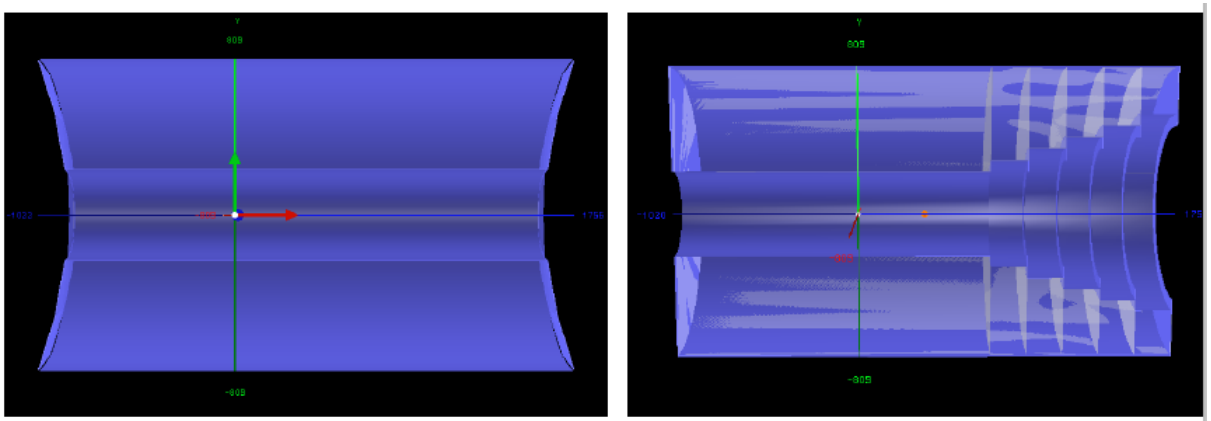
for more details.

Countries involved: UK (QM, RAL), Italy (Bologna, Milano, Pavia, Pisa, Roma III, Torino, Trento, Trieste)

- UK interest: sensors and mechanics
- Plenty of open areas for interested newcomers

DCH

- Contacts: Mike Roney (UVic), Giuseppe Finocchiaro (LNF)
- Canada, Italy and France working on this system



(a) Spherical endplates design. (b) Stepped endplates design.

- The DCH outer radius is constrained to 809mm by the DIRC quartz bars
- the nominal BABAR DCH inner radius of 236mm currently used until final focus cooling system constraints finalized
- chamber length of 2764mm at the outer radius: depends on forward PID and backward EMC
- 28 sense wire prototype under construction

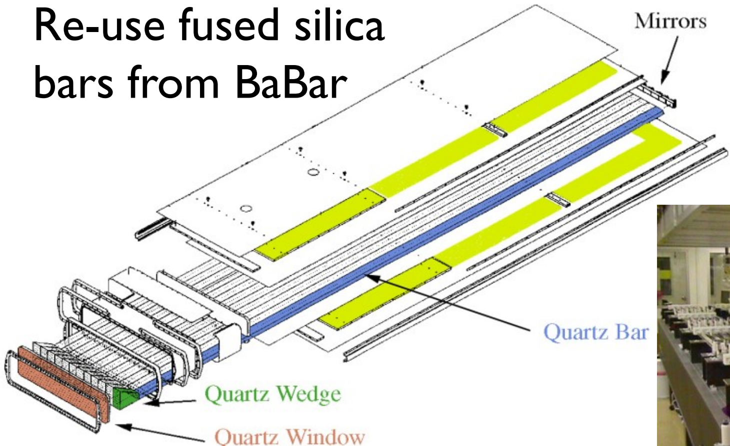
FDIRC

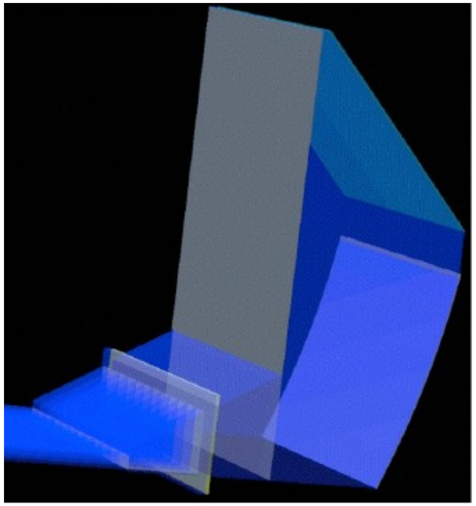
Contacts: J Vavra (SLAC), N Arnaud (LAL)

US+France

- Next generation iteration of the BaBar DIRC system

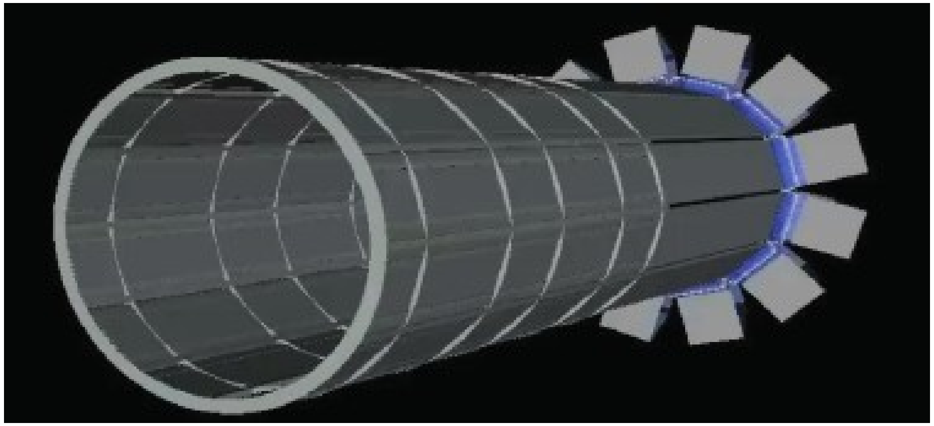
Re-use fused silica bars from BaBar

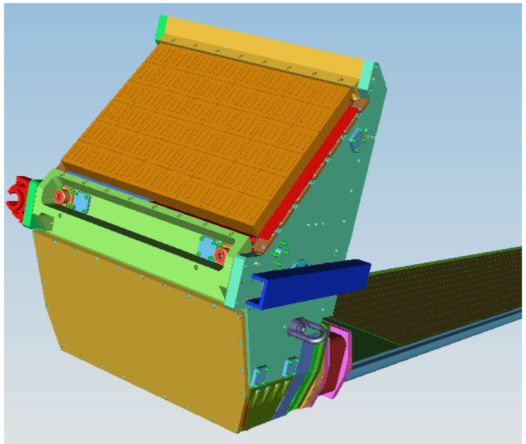




Geant4 simulation

Photon cameras at the end of bar boxes

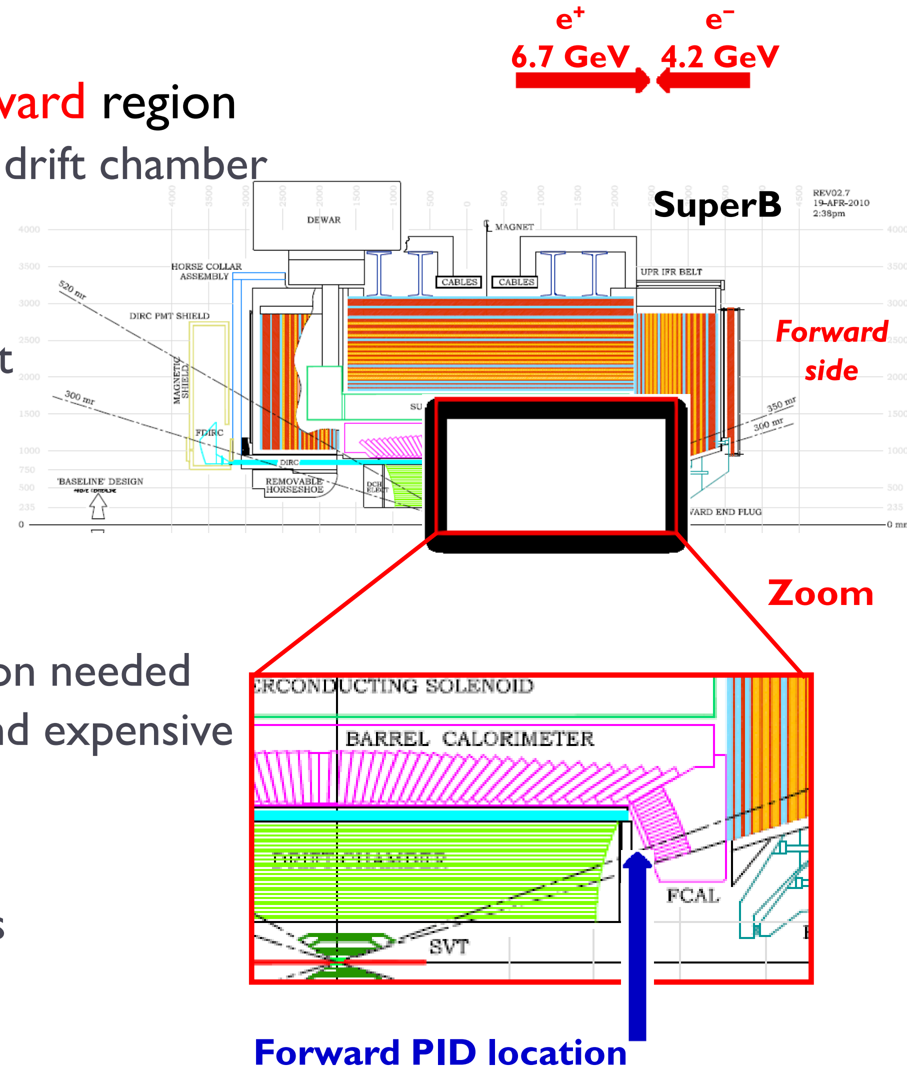




Current mechanical design

Forward PID (option)

- Goal: improve PID in the SuperB forward region
  - In BaBar: only dE/dx information from drift chamber
- Challenges
  - space limitation, low X_0, cheap, efficient
  - Gain limited by the small solid angle [θ_{polar}~15÷25 degrees]
- Different technologies being studied
  - Time-Of-flight: ~100ps timing resolution needed
  - RICH: great performances but thick and expensive
- Decision by the TDR time
  - Internal task force reviewing proposals



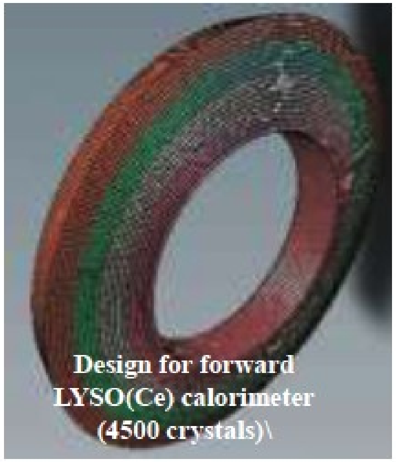
Electromagnetic Calorimeter

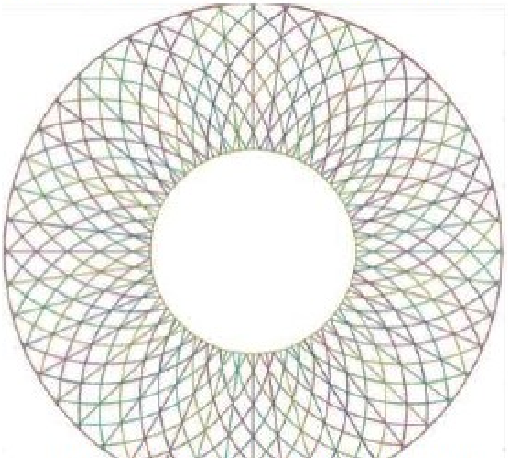
- Contacts: Frank Porter (Caltech), Claudia Cecchi (Perugia)

The SuperB ElectroMagnetic Calorimeter (EMC)

- System to measure electrons and photons, assist in particle identification
- Three components
  - Barrel EMC: CsI(Tl) crystals with PiN diode readout (Re-use BaBar barrel crystals)
  - Forward EMC: LYSO(Ce) crystals with APD readout
  - Backward EMC: Pb scintillator with WLS fiber to SiPM/MPPC readout [*option*]
- Groups: Bergen, Caltech, Perugia, Rome
  → New groups welcome to join!


CsI(Tl) barrel calorimeter (5760 crystals)


Design for forward LYSO(Ce) calorimeter (4500 crystals)\


Sketch of backward Pb-scintillator calorimeter, showing both radial and logarithmic spiral strips (24 Pb-scint layers, 48 strips/layer, total 1152 scintillator strips)

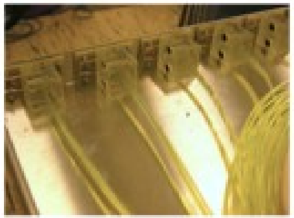
IFR

- Contact: Roberto Calabrese (Ferrara)

The Beam test of the Prototype

- A detector prototype has been built to test the technology on large scale and to validate simulation results
- Iron: *60x60x92 cm*^{3}, 3cm gaps for the active layers

- Up to *9 active layers* readout together (about 230 independent electronic channels)
- Active modules housed in light tightened boxes (aka Pizza Box)
    - *4 Time Readout modules*
    - *4 Binary Readout modules*
    - *4 special modules* to study different fibers or SiPM geometry
- Tested in Dec. 2010 at *the Fermilab Test Beam Facility* with muon/pion (4-8GeV)



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.
    - Polarised 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.
- Working on a TDR for 2012, followed by a physics book some time later.
  - Plenty of open areas for newcomers to work on

Detector programme in a nutshell

- All subsystems have a strong core of people working on them
- However all have open areas of interest to newcomers to the effort.
  - Very little is frozen (e.g. inner/outer radii of DCH is fixed, but flexibility in technology choice and design)
  - Focussed active groups can still make a strong impact in a given sub-system
- Re-use of EMC barrel, DIRC fused silica, Solenoid and flux-return iron save a lot from the budget.
  - The SuperB detector is extremely cheap: 50M€ split 50/50 between INFN and overseas contributors such as ourselves.
- Working toward a TDR for 2012