The Super*B* detector and its Physics reach

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(on behalf of the Super*B* collaboration)

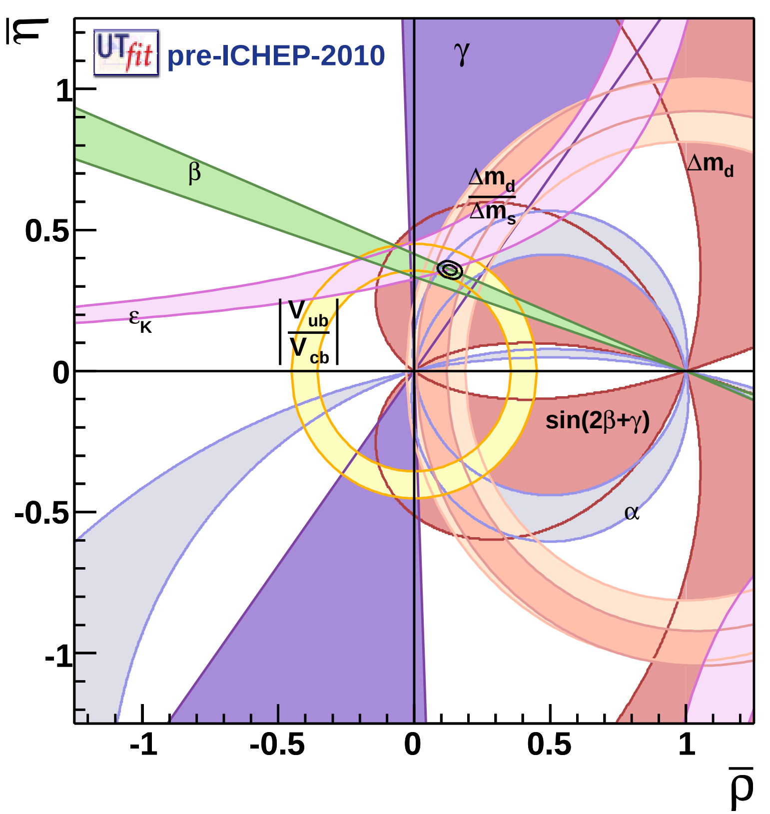
Epiphany Conference

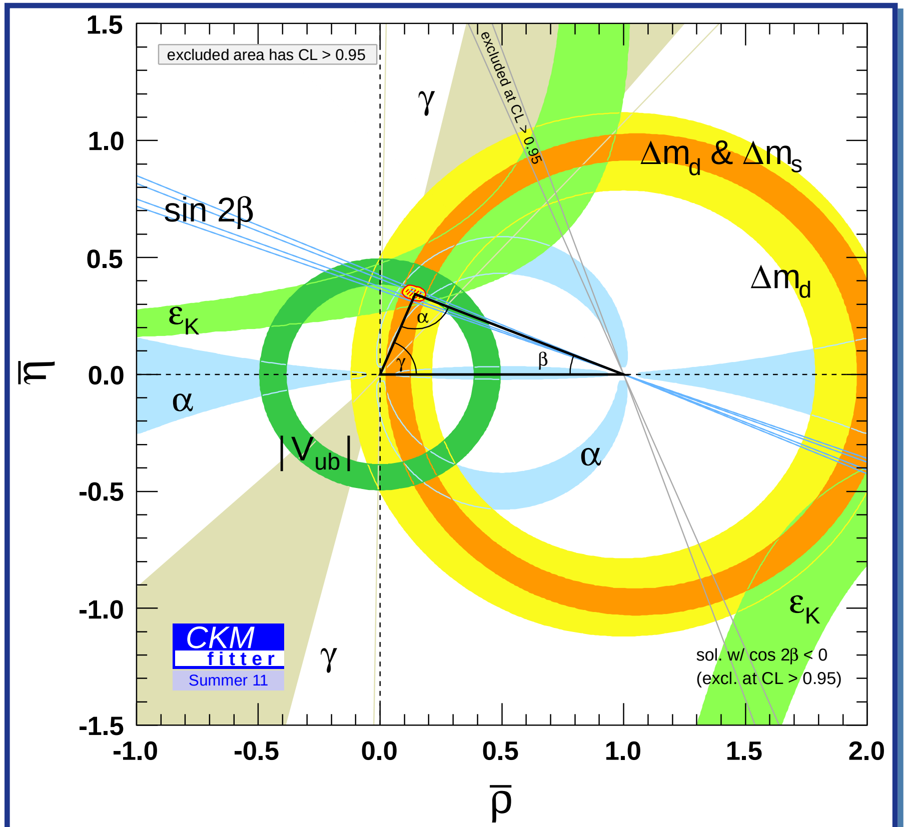
Cracow, 9-12 January 2012

Outline

- Super*B* introduction and physics motivation
- Super*B* detector (very shortly)
- Super*B* physics reach
- recent progress in funding, schedules, organization

B-factories overconstrained Standard Model & searched for New Physics





- **CKM matrix phase main source of CP violation** (2008 Nobel prize to M.Kobayashi & T.Maskawa)
- no evidence (but perhaps few glimpses) of Physics beyond the Standard Model

The intensity & precision frontier

- energy frontier
  - NP existence & **scale** through effects of **~on-shell amplitudes** with definite energy threshold
- intensity & precision frontier (low-energy)
  - NP existence & **flavour structure** through effects of **off-shell amplitudes**
  - processes very suppressed or even forbidden in the SM
    - FCNC processes ($b \to s\gamma$, $B_{s,d} \to \mu^+\mu^-$, $\mu \to e\gamma$, $\tau \to \mu\gamma$, $K \to \pi\nu\nu$)
    - FCNC & CPV in $B_{s,d}$ and D decay/mixing
    - CPV effects in the electron/neutron EDMs, $d_{e,n}$,...
  - processes predicted with high precision in the SM
    - EW observables like $(g-2)_\mu$
    - Lepton Universality & helicity suppression in $R_M^{e/\mu} = \Gamma(M \to e\nu)/\Gamma(M \to \mu\nu)$ with $M = \pi, K$

Intensity & precision frontier experimental options

- **light leptons & hadrons**
  - e.g. MEG, NA62
  - lower energy, lower cost, higher intensity & precision
  - less variety of processes, no access to heavy-flavour physics
  - smaller size NP effects
- **heavy leptons & hadrons**
  - BES, LHCb, Belle2, **Super*B***
  - higher energy, higher cost, statistics limited by power consumption & cost
  - larger variety of processes (especially in e^+e^-), access also to heavy-flavour physics
  - larger size NP effects

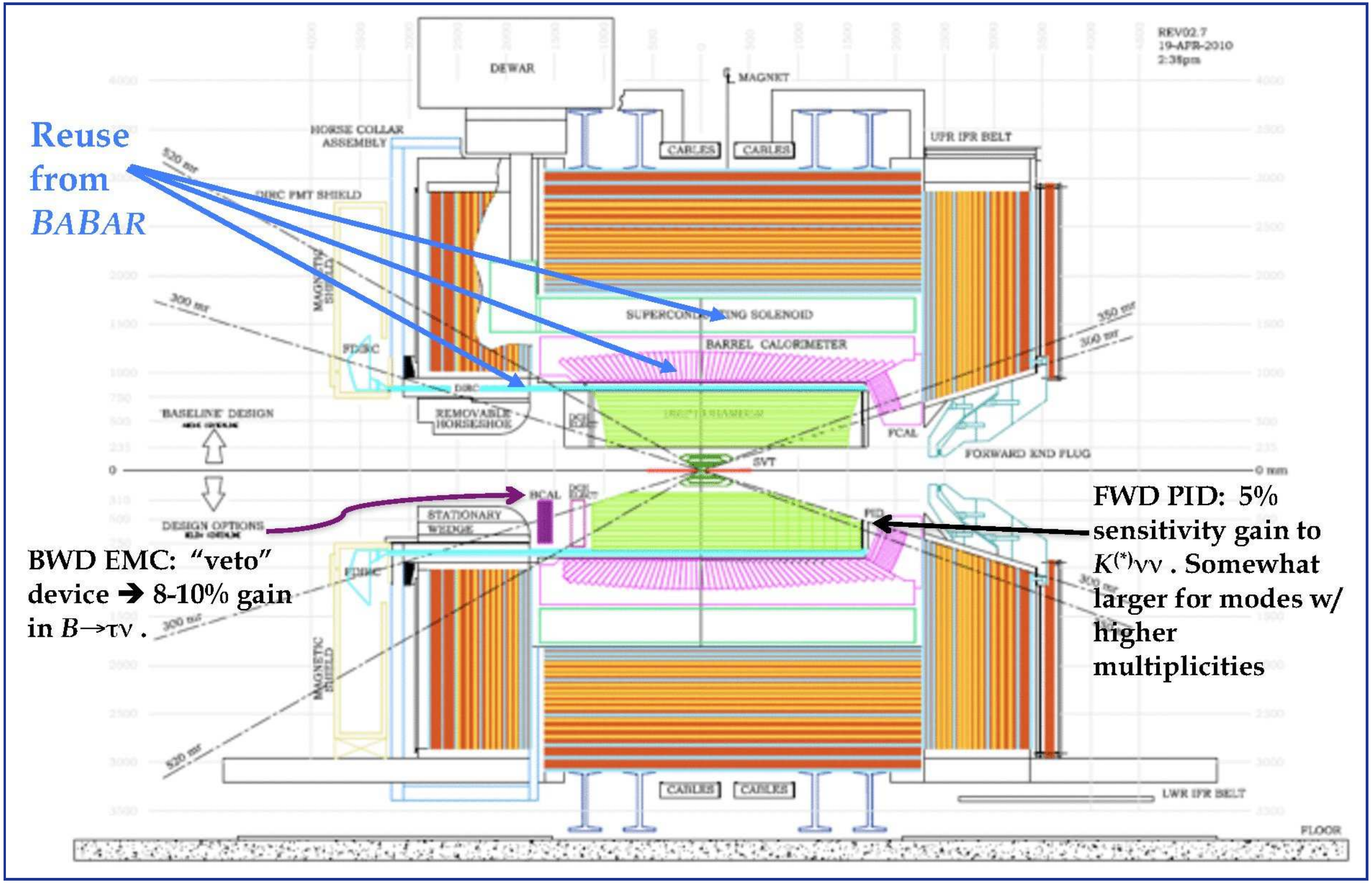
NP signals in hadrons and leptons at the intensity frontier

- hadrons
  - NP amplitudes compete with SM amplitudes in forbidden / suppressed / mixing&CPV processes
  - CPV in B mesons ideal because CKM matrix makes it maximal and relatively well calculable
  - in SM, D mixing and CPV are smaller and less precisely predicted
  - theory QCD-related uncertainties
    - important is several cases (D's, $b \to s\gamma$, ϵ_K) (lattice QCD progress dependence)
    - quite small in some cases (CPV in $B \to J/\psi K_S$, $K \to \pi\nu\nu$)
- (charged) leptons
  - (charged) Lepton Flavour Violation
    - clean, mostly QCD-free SM prediction, unambigous NP signal detection
    - NP effects less direct than for hadrons (typically, unknown mass-scale heavy neutrino sector)
    - possibly related to neutrino mixing, esp. θ_{13}
- asymmetric $\Upsilon(4S)$ Super-Flavour-Factories best for most measurements (tau leptons included)
- additional valuable option is running at the charm / tau production threshold

The Super*B* project

- $\Upsilon(4S)$-peak asymmetric energy e^+e^- **Super Flavor Factory**
- flexible design will also allow **running at the charm threshold**
- **80% polarized electron beam** further defines the already clean initial e^+e^- state
- accelerator: **100× B-factories luminosity** with same power by squeezing beams (ILC)
- detector: moderately improved *BABAR* detector (e.g. vertex detector closer to the beam)
- $\boldsymbol{L \approx 10^{36}\,\mathrm{cm^{-2}s^{-1}}}$ around $\Upsilon(4S)$ peak, $\boldsymbol{L \approx 10^{35}\,\mathrm{cm^{-2}s^{-1}}}$ at tau/charm threshold
  - $\Upsilon(4S)$: **coherent *B* mesons** & time-dep. measurements, charm hadrons, **tau leptons**
  - charm threshold: **coherent *D* mesons** & time-dep. measurements, tau leptons
- Physics program
  - topics: bottom and charm physics, tau LFV, precision EW, light new physics
  - emphasis: new physics sensitivity **competitive** and **complementary** with LHC experiments
  - don't forget: e^+e^- clean data for precision measurements in almost every energy-accessible topic
- data-taking: **beginning of 2017**
  - plan: $75\,\mathrm{ab}^{-1}$ around $\Upsilon(4S)$ (+ continuum), $0.5\,\mathrm{ab}^{-1}$ at charm threshold, $1\,\mathrm{ab}^{-1}$ at $\Upsilon(5S)$

Super*B* Detector sketch



Super*B* Detector requirements

- similar requirement as B-factories
  - Large solid angle coverage, good lepton ID, $\pi - K$ PID up to 4 GeV
  - resolve B mesons decay time difference
  - good low momentum resolution, good low energy photon energy resolution
- main differences w.r.t. *BABAR*
  - lower machine boost to maximize luminosity ($\beta\gamma$ = 0.24 vs. $\beta\gamma$ = 0.56 in *BABAR*)
    - ⟶ need **twice better tracking resolution to compensate**
    - ⟶ **SVT layer 0** in addition to 5 *BABAR*-like layers
  - 100x higher luminosity (and both $\sqrt{L}$ and L-scaling backgrounds)
    - ⟶ faster & more robust detectors
    - ⟶ open, 100% efficient trigger
  - emphasis on **hermeticity** (helped by lower boost)
    - ⟶ advantage over LHCb is channels with neutrals/neutrinos, or inclusive final states
    - ⟶ forward EMC, studies on forward PID and backward EMC
- thanks to low beam currents, can re-use parts of *BABAR* detector (CsI, DIRC quartz bars)

Super*B* Detector, major changes w.r.t. *BABAR*

- **SVT layer 0**, several options
  - striplets: baseline, reliable technology but occupancy may become a problem eventually
  - hybrid pixels: R&D is completing, can sustain large occupancies
  - MAPS (Monolithic Active Pixels): very thin Si but need active liquid cooling
  - IPHC-Strasbourg CMOS pixels
- **forward EMC** with LYSO
- impact of **backward EMC** and **forward PID** evaluated for hermeticity-demanding channels
  - none is critically needed, moderate improvements on physics output
  - will include only if budget and collaborating institutions allow
- solid baseline design is becoming finalized, TDR by ~end of Feb 2012

Super*B* Physics Aims

New Physics (NP) expected beyond Standard Model, perhaps at $\Lambda \sim 1\,\mathrm{TeV}$

Super*B* can search for NP, in a complementary & competivive way with LHC, MEG and other expts

case 1 **LHC finds New Physics (therefore determining Λ)**

- ▶ Super*B* can study NP flavour structure, but can also be sensitive to larger scales than LHC

case 2 **the NP scale is beyond the LHC reach**

- ▶ Super*B* can look for indirect NP signals up to $\Lambda \sim 10\,\mathrm{TeV}$ and more

◆ **Super*B* vs. Belle2**

- ▶ **beam polarization**, **charm threshold ability**, **larger design luminosity**, **starts ~2 years later**
- ▶ competition worked fine for *BABAR* and Belle

◆ **LHCb and MEG** partly competitive and partly complementary

- ▶ some *B* final states are only measurable by Super*B* (with neutrals or missing momentum)
- ▶ Super*B* can test tau LFV, *CPV*, EDM, $g-2$, can search for light new physics
- ▶ Super*B* can do useful measurements on entangled charm mesons decays

Super*B* physics studies initiated in ~2005

2005	Hewett et al., The Discovery Potential of a Super B factory, **hep-ph/0503261**
2007	Conceptual Design Report, **arXiv:0709.0451 [hep-ex]**
2008	Valencia retreat proceedings, **arXiv:0810.1312 [hep-ex]**
2010	SuperB white paper: Physics, **arXiv:1008.1541 [hep-ex]**
2011	The impact of SuperB on flavour physics, **arXiv:1109.5028v2 [hep-ex]**

Two recent workshops on high intensity frontier measurements

- Workshop on charm physics at threshold (21 - 23, October, 2011, IHEP, China)
  `http://bes3.ihep.ac.cn/conference/threshold2011/index.html`
- Fundamental Physics at the Intensity Frontier (Nov 30-Dec 2, 2011, Rockville, MD USA)
  `http://www.intensityfrontier.org/`

Super*B* golden modes

(indirect searches for NP need 1) good exp. precision & 2) good theory understanding)

$B_{u,d}$ Physics

- $B^+ \to \tau^+\nu$, $B^+ \to \mu^+\nu$, $B^+ \to K^{(*)+}\nu\bar{\nu}$, $b \to s\gamma$, $b \to s\ell\ell$
- precision $\sin 2\beta$ measurements, in particular $B \to \eta' K^0_S, \to K^0_S\pi^0\gamma$

τ Physics

- Lepton flavour violation in tau decays: especially $\tau \to \mu\gamma$ and $\tau \to 3\ell$

Charm Physics

- mixing parameters and *CP* violation

B_s Physics

- Semi-leptonic *CP* asymmetry A^s_{SL}
- $B_s \to \gamma\gamma$

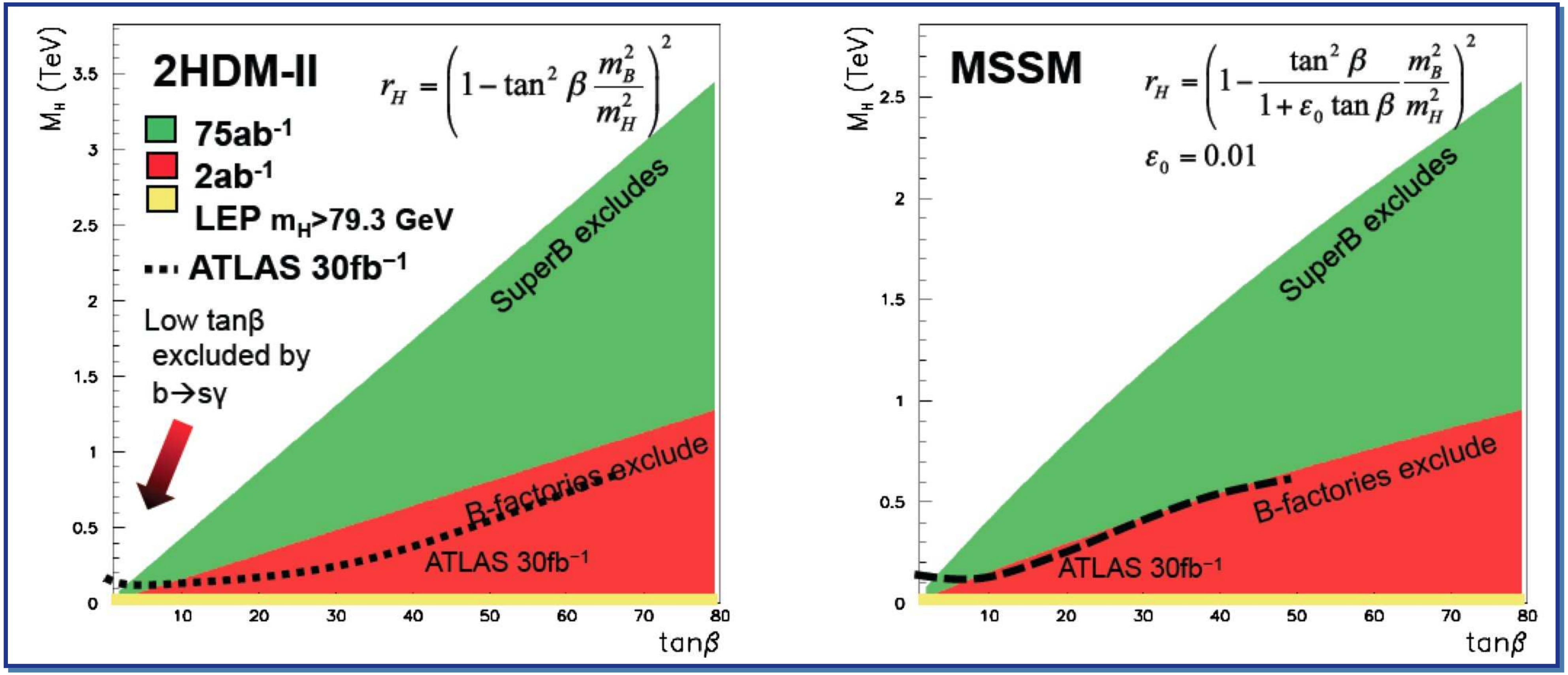
Other Physics

- Precision EW measurement at $\sqrt{s} = 10.58\ \text{GeV}/c^2$ with polarized beams
- Direct searches for non-standard light Higgs bosons, Dark Matter and Dark Forces

$\mathcal{B}(B \to \tau\nu)$

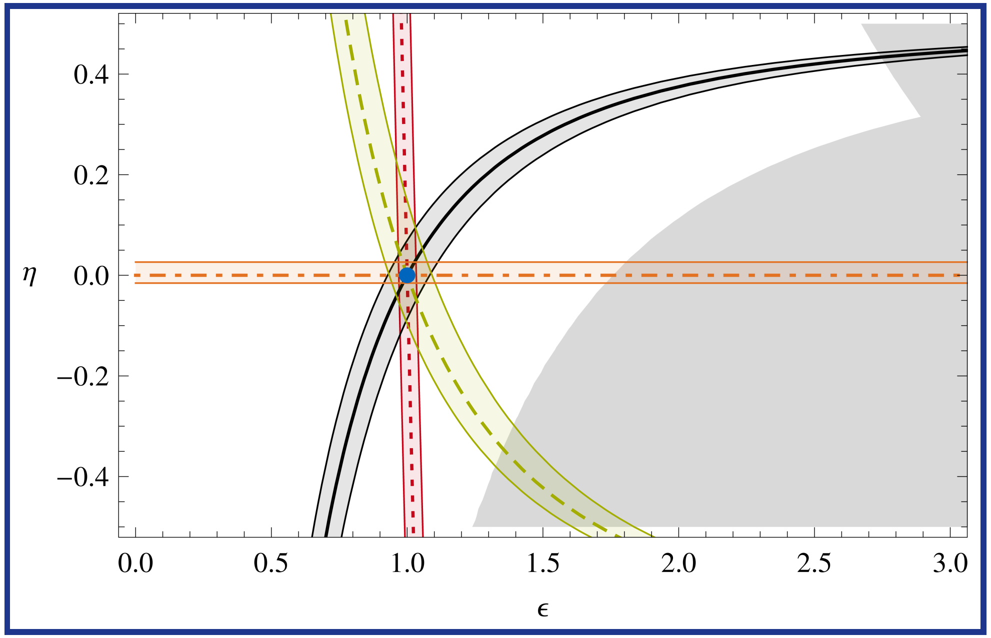
- helicity suppressed, reasonably clean SM prediction
  - (within the SM, BR proportional to $|V_{ub}|^2$ and f_B^2. Now tension with other $|V_{ub}|$ determinations)
- negative interference from charged Higgs amplitude (favoring tau over muon)
- non trivial selection and bkg suppression because of neutrinos in final state
- Super*B* offers ideal conditions
  - clean events, hermetic detector, well defined initial state, just 2 *B*s
  - → tag other side with reconstructed *B*
  - → study "extra-energy" distribution with data for bkg subtraction
- 3% measurement is possible

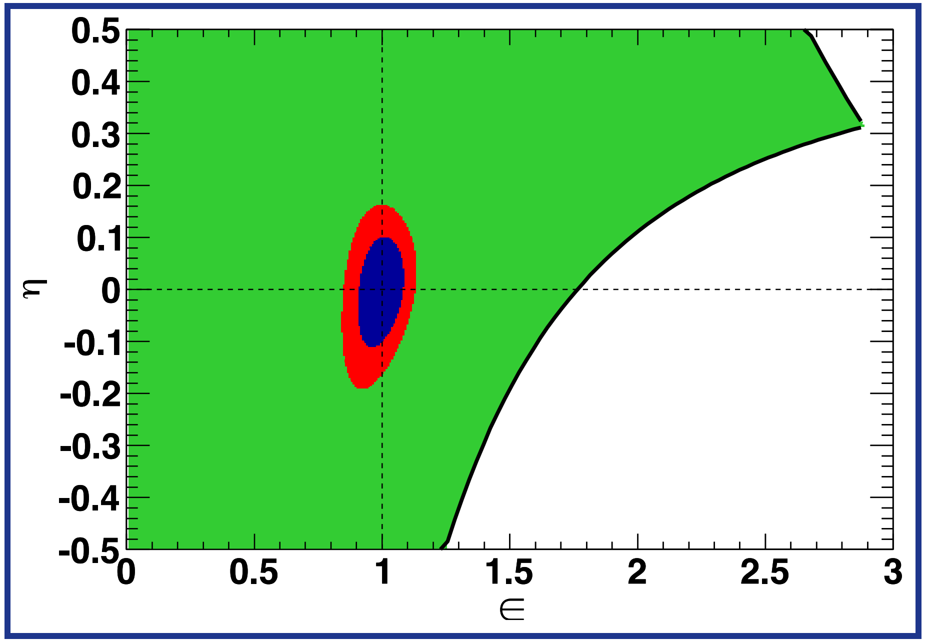
$\mathcal{B}(B \to \tau\nu)$ effective constraint on charged Higgs NP



- $r_H = \mathcal{B}(B \to \tau\nu)/\mathcal{B}_{SM}(B \to \tau\nu)$ limits assuming the SM value is measured
- ATLAS exclusion limit for 30 fb^{-1} at 14 TeV computed using arXiv:0901.0512

Constraints from $B \to K^0 \nu\nu$, $B \to K^* \nu\nu$, $B \to X_s \gamma$ inclusive

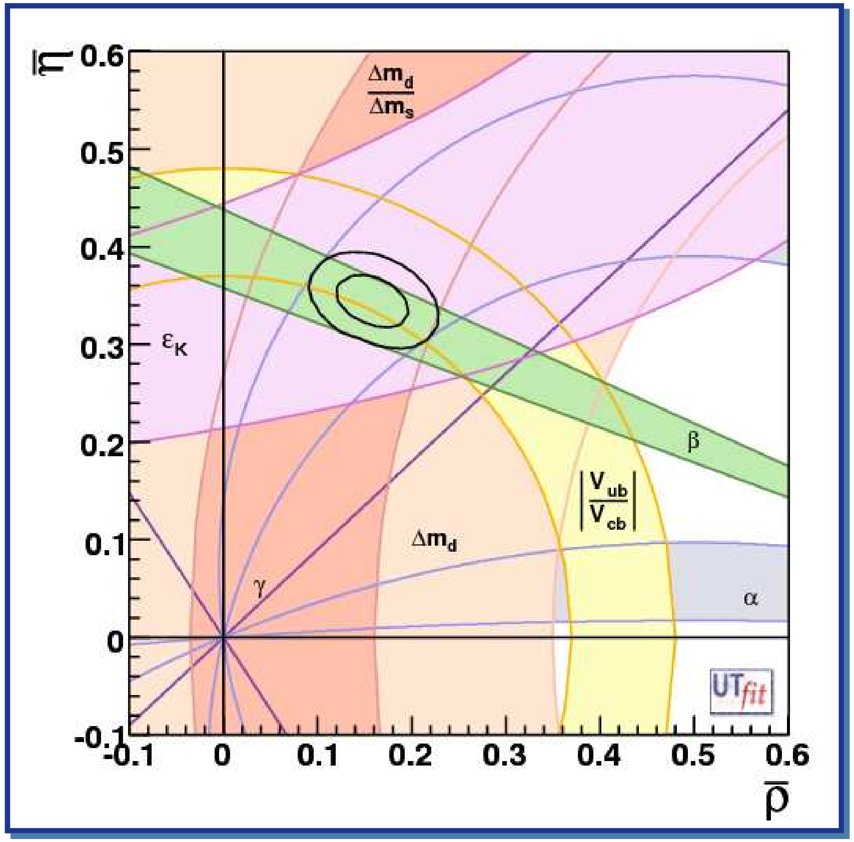




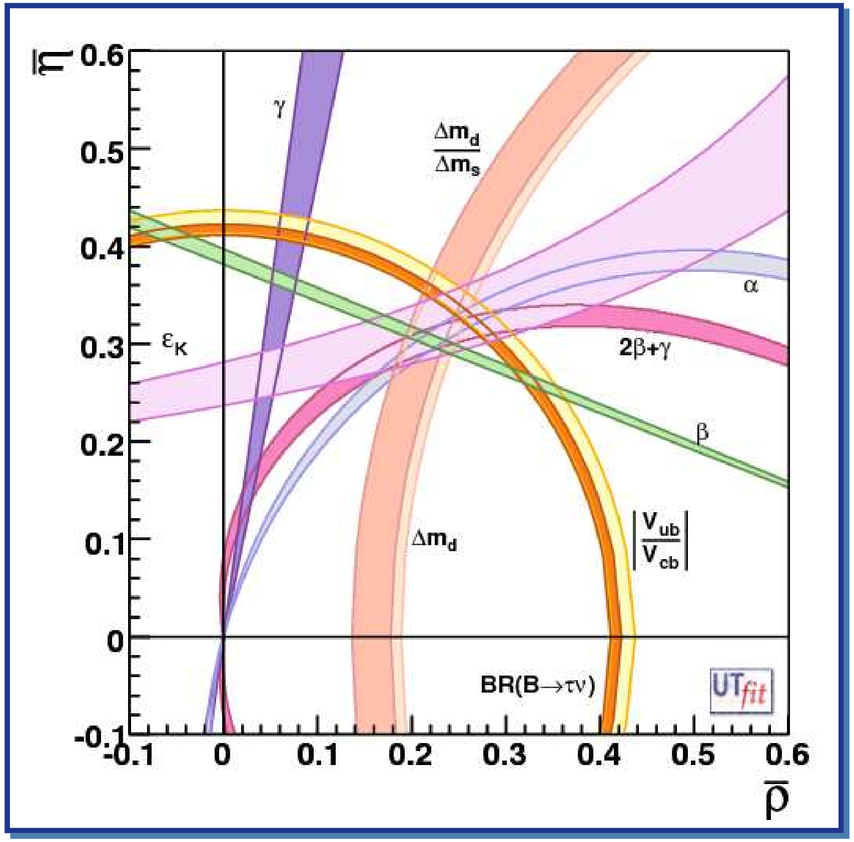
- W.Altmannshofer, A.J.Buras, and P.Paradisi, Phys.Lett.B688, 202 (2010), arXiv:1001.3835 [hep-ph]
- left: ϵ, η bounds from measurements
- right: overall ϵ, η bounds now vs. Super*B* with 75 ab^{-1}

From ∼10% to ∼1% experimental precision on CKM

CKM fit in 2006



possible fit with Super*B* & improved lattice QCD

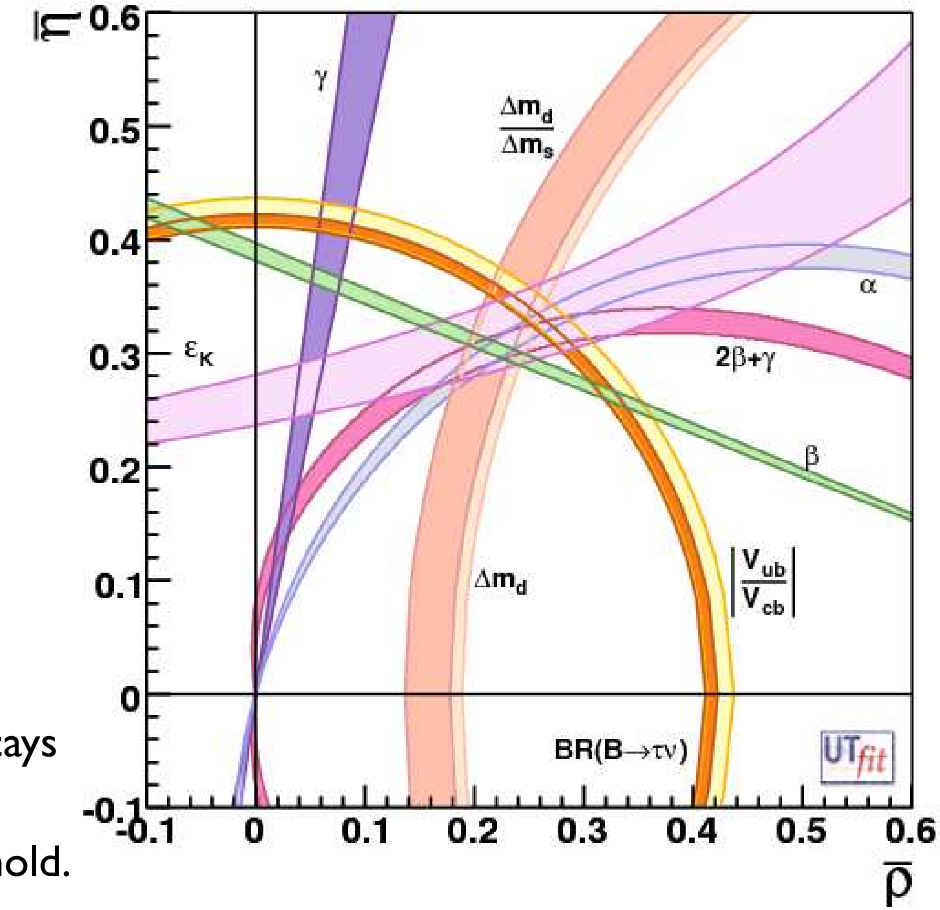


- bands show 95% constraints, 2006 values assumed for the Super*B* fit

From ~10% to ~1% experimental precision on CKM

- 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.

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

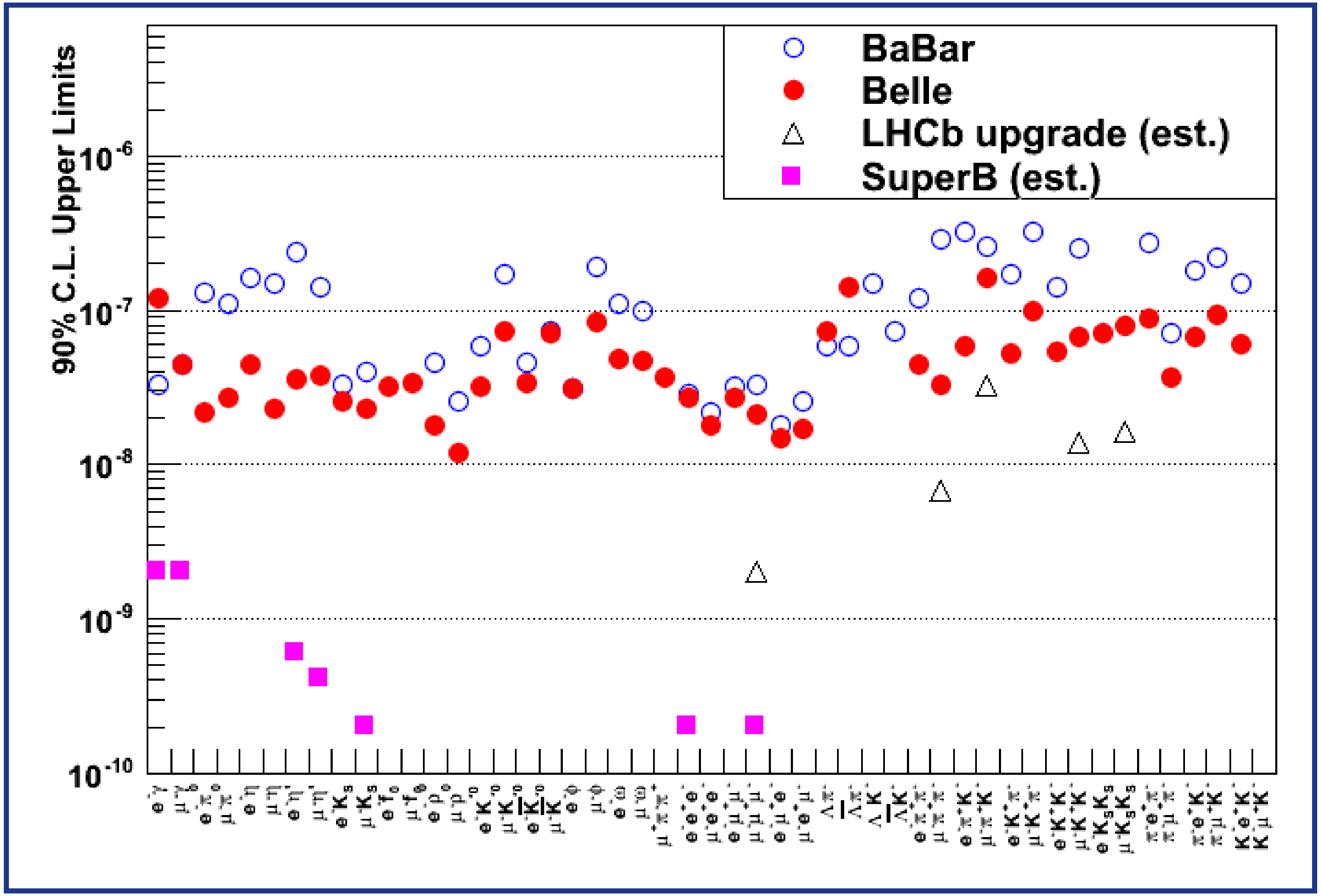


- SuperB Measures the sides and angles of the Unitarity Triangle

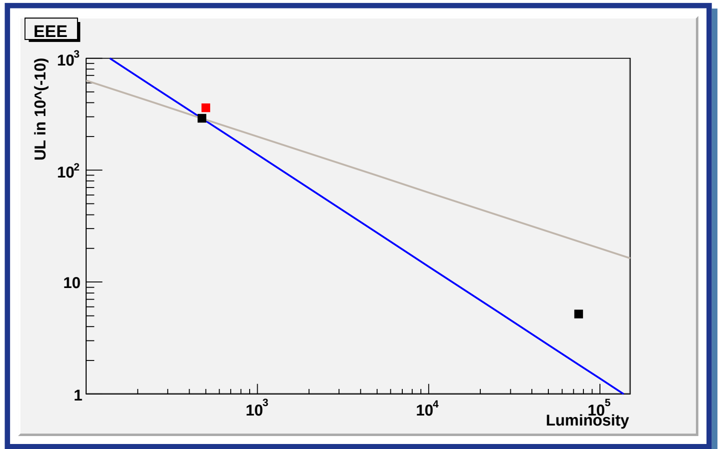
Super*B* Tau Physics NP probes

- Lepton Flavor violation in tau decays
  - many NP models predict tau LFV within Super*B* sensitivity
  - unambiguous NP probe, negligible theory uncertainties
  - Super*B* is complementary with MEG
    ($\mu \to e\gamma$ can be accidentally suppressed, tau measurements are complementary)
  - best channels: $\boldsymbol{\tau \to \mu\gamma, \tau \to 3\ell, \tau \to \mu\rho, \tau \to \mu\eta}$
- Tau g–2
  - if MSSM explains today's $\Delta a_\mu \approx 3{\cdot}10^{-9}$ discrepancy ⟶ $\boldsymbol{\Delta a_\tau \approx m_\tau^2/m_\mu^2 \cdot \Delta a_\mu \approx 1{\cdot}10^{-6}}$
  - Super*B* sensitivity is in the range of such prediction
- Tau EDM and CPV
  - Super*B* sensitive to some few NP model CPV effects
  - tau EDM constrained by electron EDM upper limit to a range inaccessible by Super*B*
    anyway, Super*B* can substantially improve the existing limits
- all: **beam polarization improves precision & helps discriminating NP models**

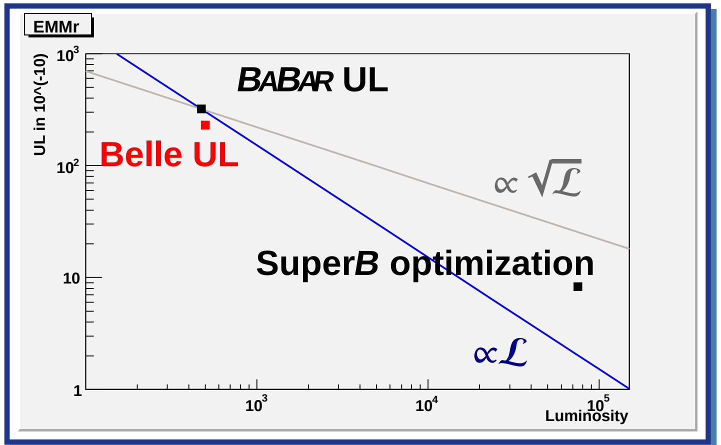
Super*B* 10–100 times more sensitive than *BABAR* to tau LFV modes



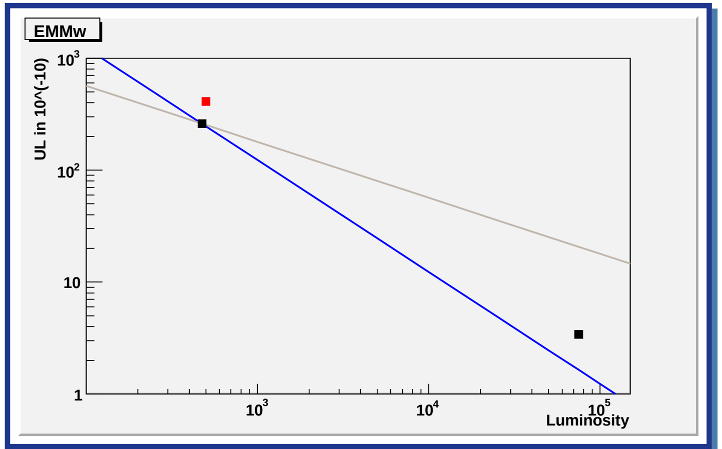
$\tau \to 3\ell$ 90% CM upper limit extrapolations: $\propto \mathcal{L}$ vs. $\propto \sqrt{\mathcal{L}}$ vs. re-optimization



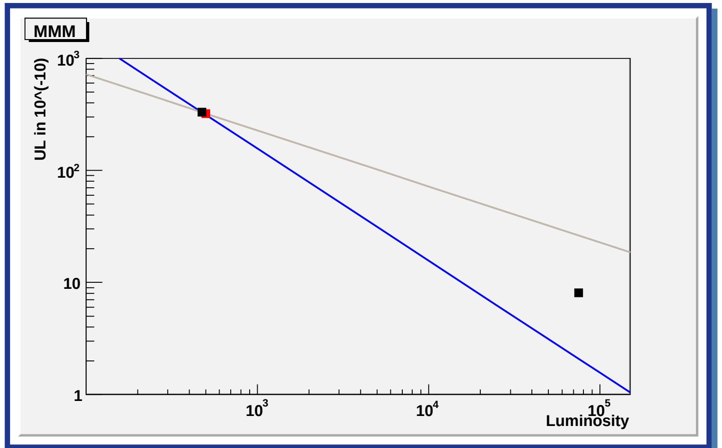
$\tau \to eee$



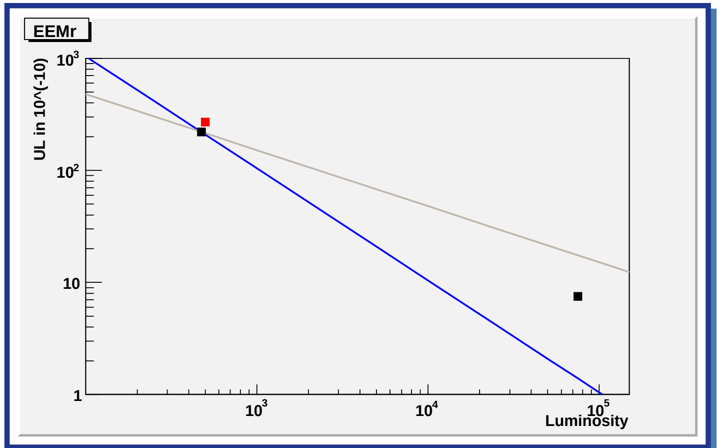
$\tau \to e\mu{+}\mu{-}$



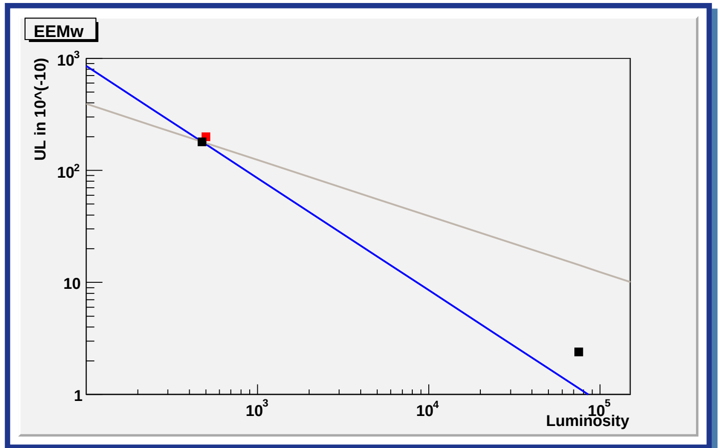
$\tau{-} \to e{+}\mu{-}\mu{-}$



$\tau \to \mu\mu\mu$

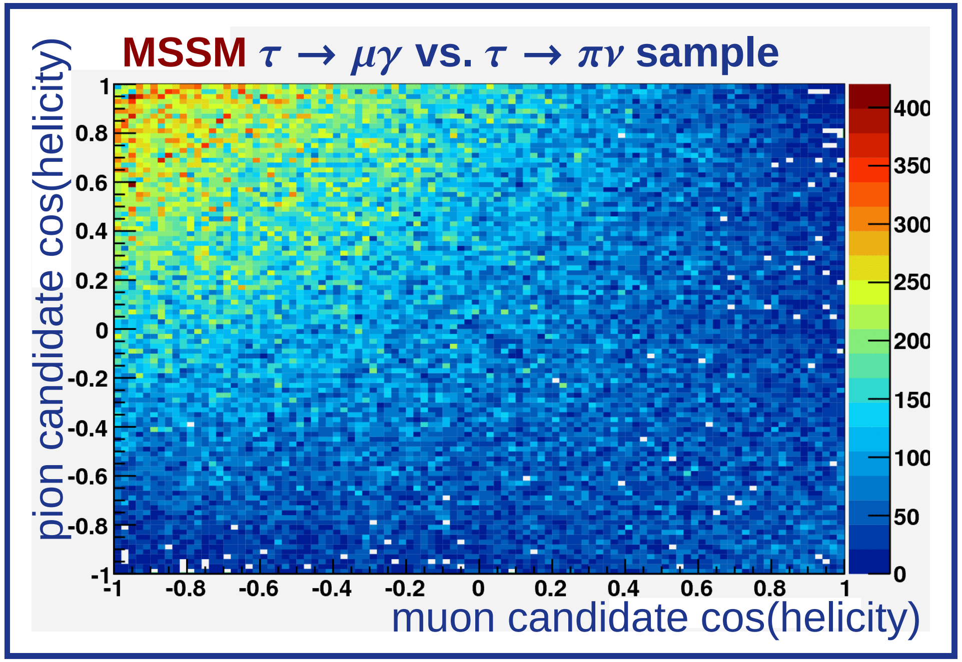


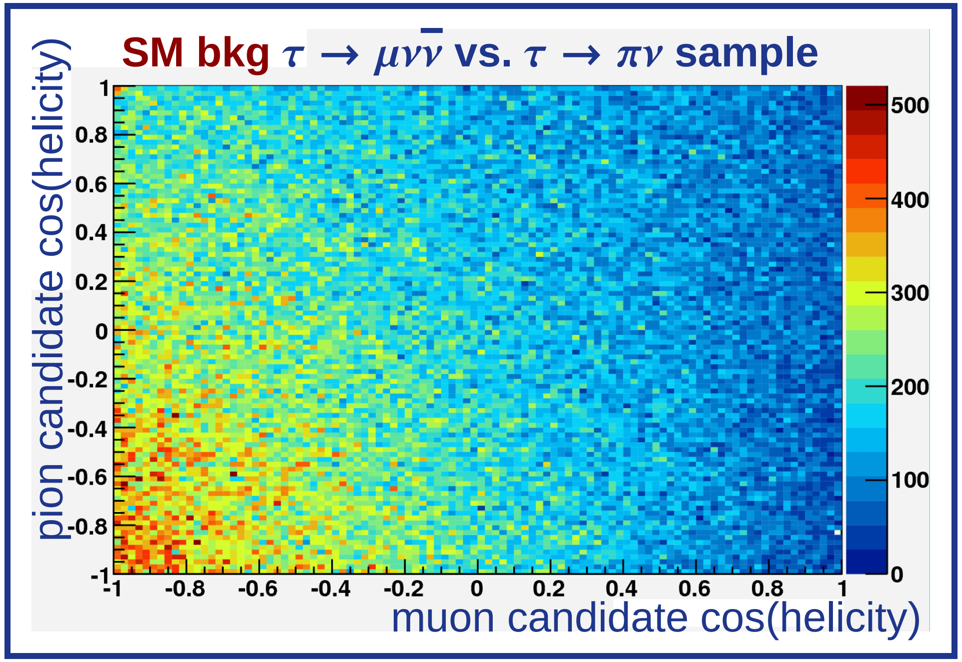
$\tau \to \mu e{+}e{-}$



$\tau{-} \to \mu{+}e{-}e{-}$

Super*B* beam polarization effects on $\tau \to \mu\gamma$ LFV search

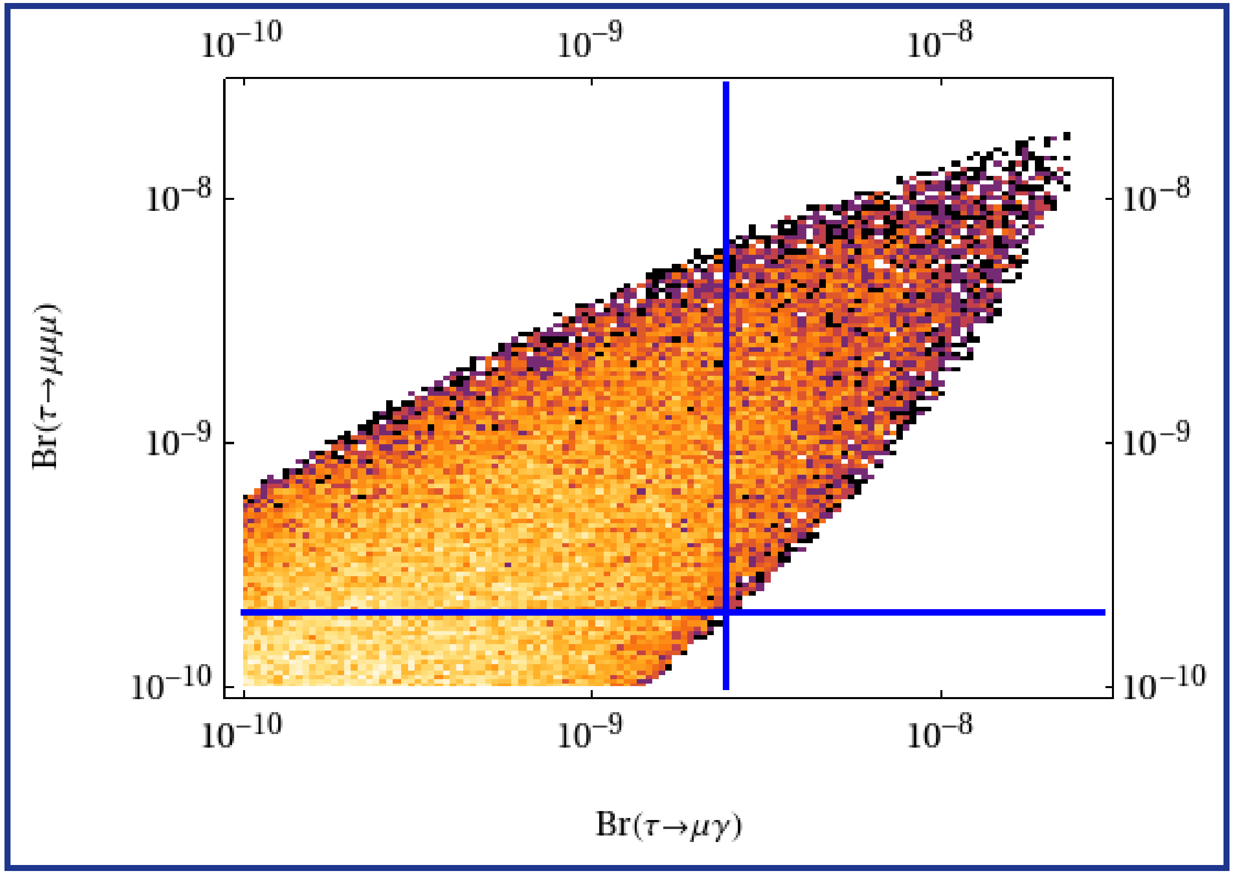




- 80% polarized electron beam
- SUSY LFV spin correlations Tauola decay mode added by S.Banerjee
- Super*B* fast simulation

- can improve S/N ratio (assuming LFV NP model)
  - sensitivity improvements being evaluated
- can discriminate between NP models

Super*B* $\tau \to \ell\gamma$ constraints on LHT model with breaking scale at 500 GeV



- Super*B* reach from arXiv:1109.5028v2 [hep-ex] The impact of SuperB on flavour physics
- predictions from M. Blanke et al. arXiv:0906.5454

Tau g–2 at Super*B* with beam polarization

- MSSM would shift muon g–2 by about the presently observed discrepancy $\Delta a_\mu \approx 3{\cdot}10^{-9}$

Δa_μ and Δa_τ for various SPS points

SPS	1 a	1 b	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

(specific parameters can produce Δa_τ as high as $1{\cdot}10^{-5}$)

- J.Bernabeu et al., JHEP098P1108 estimate Super*B* $\sigma(a_\tau)$ = $[0.75 - 1.7]{\cdot}10^{-6}$
  - Super*B* actually measures $\boldsymbol{a_\tau(q^2)}$ from final state distributions of $e^+e^- \to \tau^+\tau^-$
    - however, Δa_τ from high energy NP contributions is constant for small q^2
  - real part from τ polar angle distribution or transv.&long. polarization
- from tau EDM studies (see next slides) with more realistic assumptions ⟶ Super*B* $\sigma(a_\tau) \sim 2.4{\cdot}10^{-6}$

Tau EDM at Super*B*

- $|d_e| < 1.6{\cdot}10^{-27}\,e\,\text{cm}$ at 90% CL, 10.1103/PhysRevLett.88.071805 / PDG10
- most NP models expect $|d_\tau| \propto (m_\tau/m_e)|d_e|$
- Super*B* 2010 Physic Report reviews NP models expectations and concludes that:
  $|d_e|$ upper limit → $|d_\tau^{NP}| < 10^{-22}\,e\,\text{cm}$
- Super*B* actually measures **$d_\tau(q^2)$ form factor** from final state distributions of $e^+e^- \to \tau^+\tau^-$
  - however, high energy NP contributions are constant for small q^2
- beam polarization permits measurements based on single tau distributions
- J.Bernabeu et al., arXiv:0707.1658v1 [hep-ph], estimate Super*B* $\sigma(d_\tau) \approx 7.2{\cdot}10^{-20}\,e\,\text{cm}$
  - 100% electron beam polarization, no uncertainty
  - only $\tau \to \pi\nu$, $\tau \to \rho\nu$, no reconstruction uncertainty
- with more realistic assumptions, Super*B* $\sigma(d_\tau) \approx 10{\cdot}10^{-20}\,e\,\text{cm}$
  (note that information can be obtained also from the other decay channels)
- extrapolate Belle EDM search, **Phys. Lett. B551, 16 (2003), hep-ex/0210066**
  → Super*B* $\sigma(d_\tau) \approx 17\text{–}34{\cdot}10^{-20}\,e\,\text{cm}$ (both real and imaginary parts)

Tau *CPV* at Super*B*

- SM predictions in general very small
  ($\tau^\pm \to K^\pm \pi^0 \nu$ *CP* asymmetry $\mathcal{O}(10^{-12})$, D. Delepine et al., PRD 72, 033009 (2005), hep-ph/0503090)
- small SM *CP* asymmetry in $\tau^\pm \to K_S \pi^\pm \nu$ from *CPV* in $K^0\overline{K}^0$
  $3.3{\cdot}10^{-3} \pm 2\%$ relative, I.I.Bigi & A. I. Sanda, PLB 625, 47 (2005), hep-ph/0506037
- most NP models do not induce measurable tau CPV
- R-parity violating SUSY ⟶ CPV related asymmetries up to 10%, saturating existing limits
  - sizable asymmetries in $\tau \to K\pi\nu_\tau$, $\tau \to K\eta^{(\prime)}\nu_\tau$, and $\tau \to K\pi\pi\nu_\tau$
- CLEO, PRL 88, 111803 (2002), hep-ex/0111095, 13.3 fb^{-1}, $\tau \to K_S\pi\nu$

⟶ optimal asymmetry observable $\langle\xi\rangle$ **= (–2.0 ± 1.8)·10^{-3}**

  - data calibration with $\tau \to \pi\pi\pi\nu$
- extrapolating at Super*B*, $\sigma_{\langle\xi\rangle} \approx 2.4{\cdot}10^{-5}$
- beam polarization can provide extra equivalent luminosity (to be studied)

Super*B* D^0–mixing reach using $\Upsilon(4S)$ data

Super*B* 75 ab^{-1} at $\Upsilon(4S)$

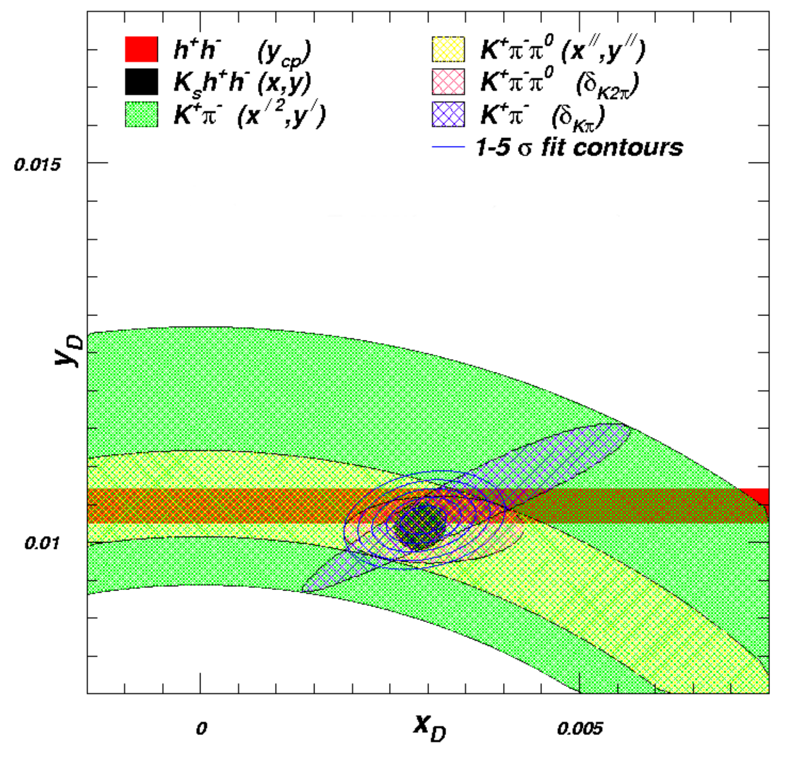
Parameter	$x \times 10^3$	$y \times 10^3$	$\delta_{K\pi}$ (°)	$\delta_{K\pi\pi}$ (°)
σ (stat)	0.18	0.11	1.3	2.7
σ (stat) +(syst)	0.42	0.17	2.2	$^{+3.3}_{-3.4}$

Super*B* 75 ab^{-1} at $\Upsilon(4S)$ with 0.5 ab^{-1} charm threshold run

(measure *D* strong phases on entangled *D*'s at charm threshold)

Parameter	$x \times 10^3$	$y \times 10^3$	$\delta_{K\pi}$ (°)	$\delta_{K\pi\pi}$ (°)
σ (stat)	0.17	0.10	0.9	1.1
σ (stat) +(syst)	0.20	0.12	1.0	1.1

(SuperB white paper: Physics, **arXiv:1008.1541 [hep-ex]**)



D^0 mixing and CPV measurements on entangled *D*'s at charm threshold

M.Rama, Workshop on Charm Physics at threshold, Beijing 21-23 October 2011

- Flavor tag at $D\bar{D}$ threshold provides identical time-dependence than at $\Upsilon(4S)$ using D* tagging, and less events, although in a different environment
- $D\bar{D}$ threshold is unique to provide CP, $K\pi$ and $Ks\pi\pi$ tags
- Variation of Δt resolution and geometrical acceptance vs CM boost was evaluated
- Estimated the impact on physics with 2-body decays
  - Combined fit to all 2-body double-tags allows determination of x, y, arg(q/p), |q/p|
  - Best sensitivity at $\Psi(3770)$ for intermediate boost, $\beta\gamma \approx 0.3\text{-}0.6$

Parameter	Sensitivity @ $\Upsilon(4S)$ with time resolution, no mistag. 75 ab^{-1}	Best sensitivity @ $\psi(3770)$ with time resolution ($\beta\gamma$=0.56), no mistag. 0.5 ab^{-1}
x	0.017%	0.11%
y	0.008%	0.05%
Arg(q/p)	0.8 deg	4.8 deg
|q/p|	0.5%	3.7%

Relative effect of flavor mistag similar at $\Psi(3770)$ and $\Upsilon(4S)$

- error per ab^{-1} at $\Upsilon(3770)$ ~ ½ error per ab^{-1} at $\Upsilon(4S)$ (2-body only, no mistag)
- error at $\Psi(3770)$ [0.5ab^{-1}] ~ 6x error at $\Upsilon(4S)$ [75ab^{-1}] (2-body only, no mistag)

Precise EW tests with polarized beams (M.Roney, Super*B* Dec 2011 meeting)

Polarised e- beam yields product of the neutral axial-vector coupling of the electron and vector coupling of the final-state fermion via Z-γ interference:

$$A_{LR} = \frac{4}{\sqrt{2}}\left(\frac{G_F s}{4\pi\alpha Q_f}\right) g_A^e g_V^f \langle Pol \rangle$$

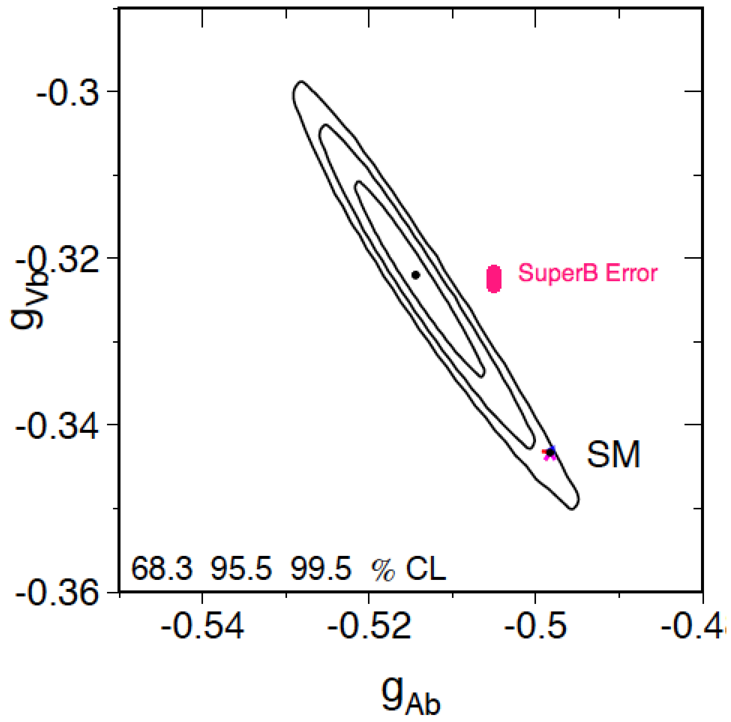
$$\langle Pol \rangle = 0.5\left\{\left(\frac{N_R^{e-} - N_L^{e-}}{N_R^{e-} + N_L^{e-}}\right)_R - \left(\frac{N_R^{e-} - N_L^{e-}}{N_R^{e-} + N_L^{e-}}\right)_L\right\}$$

$$g_A^e = T_3^e = 1/2 \qquad\qquad g_V^f = T_3^f - 2Q_f \sin^2\theta_W$$

Measure g_{Vb} and test LEP A^b_{FB} anomaly

Measurement of g_V^b

- SM: -0.34372 +0.00049-.00028
- A_{FB}^b: -0.3220±0.0077



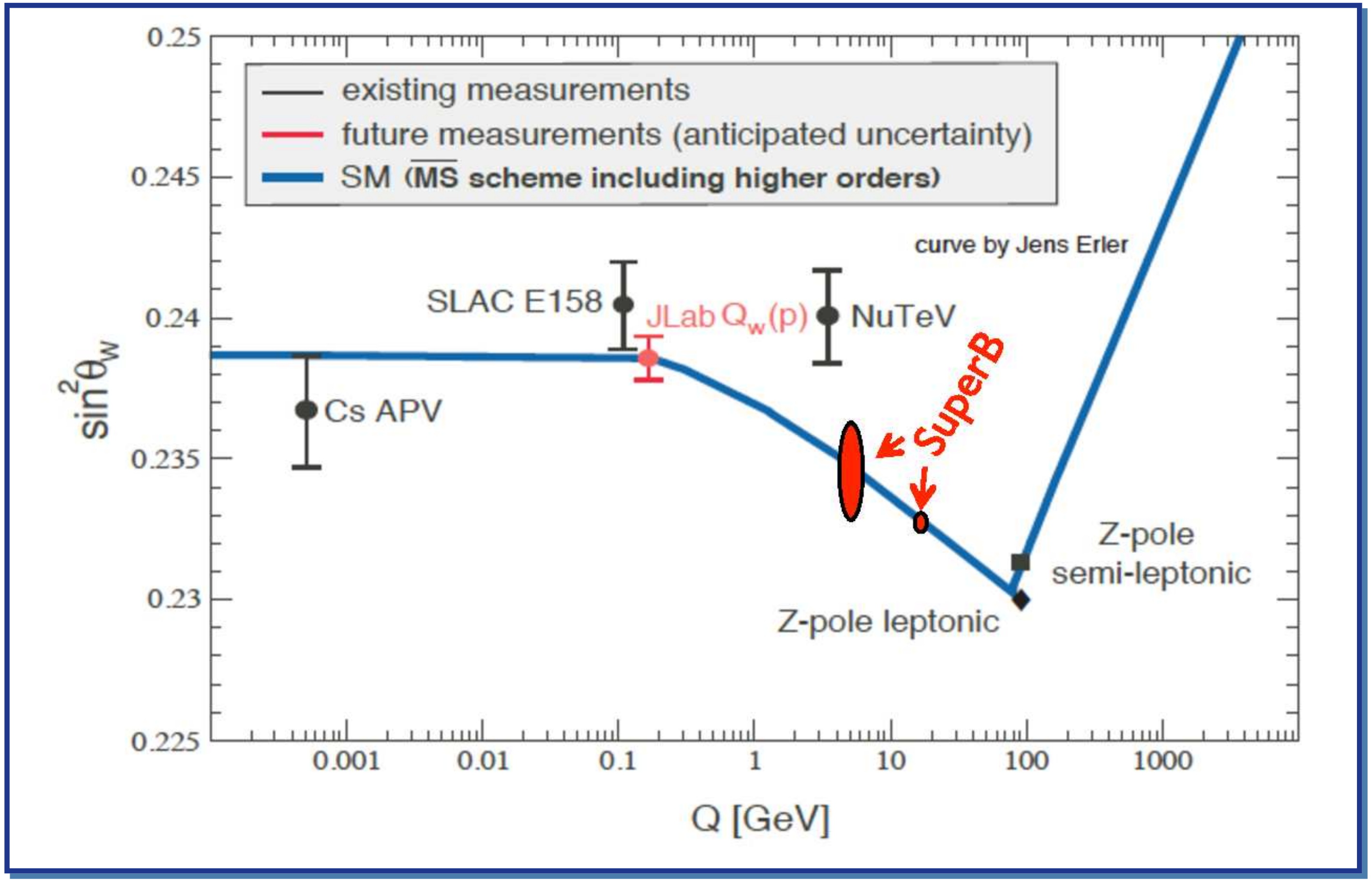
- with 0.5% polarization systematic and 0.3% stat error, SuperB can have an error of ±0.0021

Measure weak charged vector couplings ratios

take ratios of μ,τ,c,b A_{LR} so that of the electron cancels polarisation systematic errors and the electron axial-vector coupling: stat. error dominated

	SM (Mh=125GeV)	LEP	SuperB error
g_V^{μ} / g_V^{τ}	1	0.997 +/- 0.068	~2% from tau stats
g_V^{c} / g_V^{lepton}	5.223 +/-	-4.991 +/- 0.074	~1% muon stats +/-0.05
g_V^{b} / g_V^{lepton}	9.357 +/-	8.58+/- 0.16	~1% from mu stats +/- 0.08

Measure sin θ_W energy evolution with σ_{LR} for μ, τ, charm and *b*



- plot adapted by A.Bevan from QWeak proposal (JLAB E02-020)
- precition not yet evaluated at charm threshold

Sensitivity of Super*B* to specific NP models

list of NP models, full description in

- W.Altmannshofer, A.J.Buras, S.Gori, P.Paradisi, D.M.Straub, Anatomy and Phenomenology of FCNC and CPV Effects in SUSY Theories, arXiv:0909.1333 [hep-ph]
- arXiv:1109.5028v2 [hep-ex] The impact of SuperB on flavour physics

AC	(SUSY) abelian model by Agashe and Carone based on a U(1) flavour symmetry
RVV2	(SUSY) non-abelian model by Ross, Velasco-Sevilla and Vives
AKM	(SUSY) non-abelian model by Antusch, King and Malinsky
δLL	(SUSY) purely left-handed currents with CKM-like mixing angles
FBMSSM	flavour-blind MSSM
GUT-CMM	SUSY GUT
SSU(5)	SUSY GUT SU(5)
LHT	Littlest Higgs with T-parity
RS	Randall-Sundrum

Sensitivity of Super*B* golden modes to specific NP models

Observable/mode	H^+ high $\tan\beta$	MFV NP low $\tan\beta$	non-MFV 2-3 sector	NP in Z peng.	RH currents	LHT	SUSY					
							AC	RVV2	AKM	δLL	FBMSSM	GUT-CMM
$\tau \to \mu\gamma$							★★★	★★★	★	★★★	★★★	★★★
$\tau \to \ell\ell\ell$						★★★						?
$B \to \tau\nu, \mu\nu$	★★★(CKM)											
$B \to K^{(*)+}\nu\bar{\nu}$			★	★★★			★	★	★	★	★	?
S in $B \to K_S^0\pi^0\gamma$			★★		★★★							
S in other penguins			★★★(CKM)		★★★		★★★	★★	★	★★★	★★★	?
$A_{CP}(B \to X_s\gamma)$			★★★		★★		★	★	★	★★★	★★★	?
$BR(B \to X_s\gamma)$		★	★★		★							★★
$BR(B \to X_s\ell\ell)$			★★	★	★							?
$B \to K^{(*)}\ell\ell$ (FBA)							★	★	★	★★★	★★★	?
a_{sl}^s			★★★			★★★						★★★
Charm mixing							★★★	★	★	★	★	
CPV in Charm	★★									★★★		

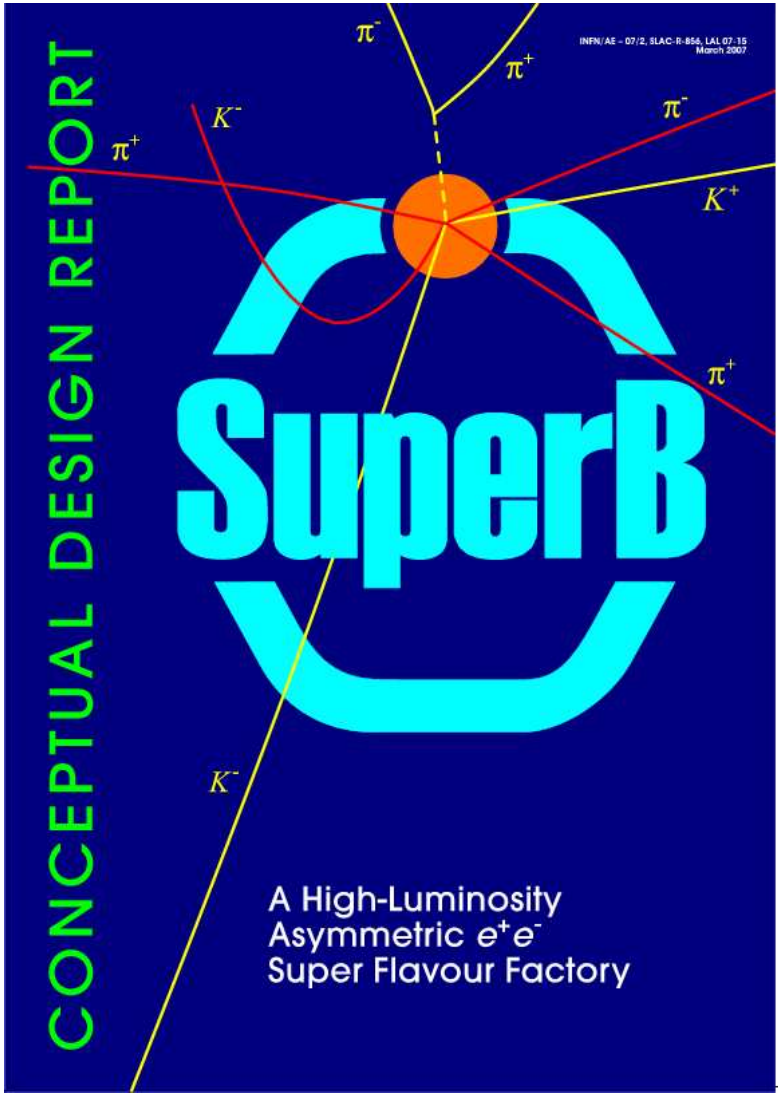
- arXiv:1109.5028v2 [hep-ex] The impact of SuperB on flavour physics

Super*B* vs. LHCb for 5 NP models (P.Paradisi, Super*B* meeting, Dec 2011)

	SSU(5)	AC	RVV2	AKM	δLL	FBMSSM	
$S_{\phi K_S}$	★★★	★★★	●●	■	★★★	★★★	
$A_{CP}(B \to X_s\gamma)$	■	■	■	■	★★★	★★★	
$B \to K^{(*)}\nu\bar{\nu}$	■	■	■	■	■	■	
$\tau \to \mu\gamma$	★★★	★★★	★★★	■	★★★	★★★	
$D^0 - \bar{D}^0$	■	★★★	■	■	■	■	
$A_{7,8}(B \to K^*\mu^+\mu^-)$	■	■	■	■	★★★	★★★	vs.
$A_9(B \to K^*\mu^+\mu^-)$	■	■	■	■	■	■	
$S_{\psi\phi}$	★★★	★★★	★★★	★★★	■	■	
$B_s \to \mu^+\mu^-$	★★★	★★★	★★★	★★★	★★★	★★★	
ϵ_K	★★★	■	★★★	★★★	■	■	
$K^+ \to \pi^+\nu\bar{\nu}$	■	■	■	■	■	■	
$K_L \to \pi^0\nu\bar{\nu}$	■	■	■	■	■	■	
$\mu \to e\gamma$	★★★	★★★	★★★	★★★	★★★	★★★	
$\mu + N \to e + N$	★★★	★★★	★★★	★★★	★★★	★★★	
d_n	★★★	★★★	★★★	★★★	●●	★★★	
d_e	★★★	★★★	★★★	●●	■	★★★	
$(g-2)_\mu$	★★★	★★★	★★★	●●	★★★	★★★	

elaboration using information in W.Altmannshofer, A.J.Buras, S.Gori, P.Paradisi, D.M.Straub, Anatomy and Phenomenology of FCNC and CPV Effects in SUSY Theories, arXiv:0909.1333 [hep-ph]

Super*B* project progress 1



Conceptual Design Report (2007)

- arXiv:0709.0451v2 [hep-ex]
- 440 pages: Accelerator, Detector, Physics
- cost and schedule of accelerator & detector
- 320 signers from ~80 institutions

White paper

- accelerator: arXiv:1009.6178v1 [physics.acc-ph]
- detector: arXiv:1007.4241v1 [physics.ins-det]
- physics: arXiv:1008.1541v1 [hep-ex]
- **updated costs and schedules**

Super*B* project progress 2

- Dec 2010 **Italian government funds Super*B*** as flaghship national research project
  - funds match preliminary estimates in INFN 2010-2012 3-year plan
  - funds allocated for 6 years (2010-2015), given as planned in 2010 and 2011
- May 2011 Super*B* Kick Off Meeting → collaboration formation begins
  - Tor Vergata accelerator **site selected**
- Sep 2011 1st Super*B* collaboration meeting in London
- Oct 2011 **Cabibbo Lab** Consortium established
  - INFN & Rome Tor Vergata University agreement in July
  - IIT (Italian Institute of Technology) expected to join in near future
- Dec 2011 2nd Super*B* collaboration meeting in Frascati
  - progress in both Super*B* collaboration and Cabibbo Lab organization
- short term goals
  - Detector and Accelerator TDR (Super*B* Physics Book will follow later in 2013)
  - Cabibbo Lab management and team recruiting (president is R.Petronzio)

Yearly funding profile (INFN 2010-2012 plan)

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

Accelerator cost (accelerator white paper, 2010)

Table 26.1: Accelerator budget estimate

WBS	Item	Number of units	EDIA (mm)	Labor (mm)	M&S (k€)	Total (k€)	Repl. Value (k€) (not in total)
2.00	Overall SuperB Accelerator total		3159	2852	285350	357476	85760
2.01	Contingency and VAT (50%)		1053	951	95117	119159	0
2.02	Overall Super B Project Sub-total		2106	1901	190233	238317	85760

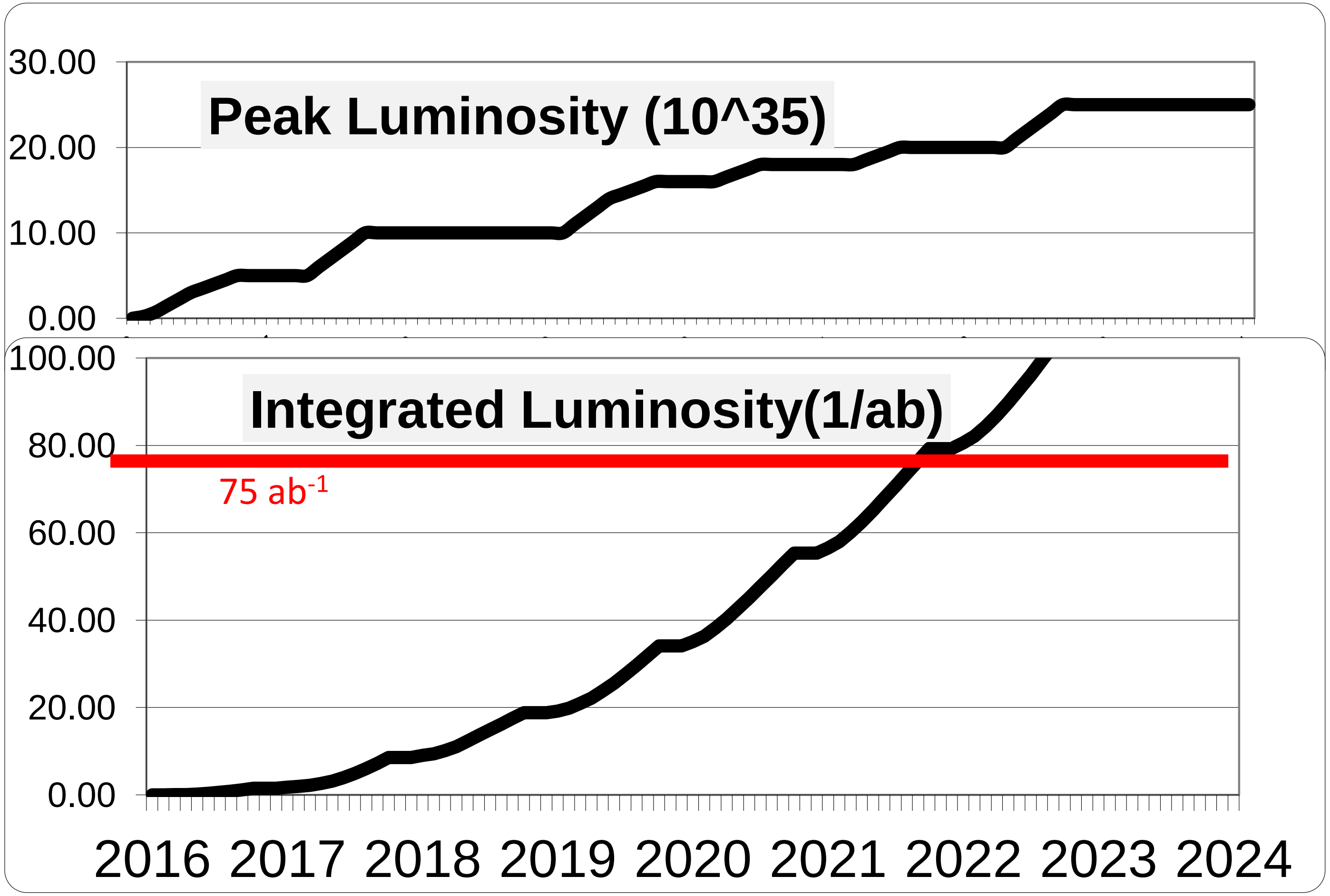
- Italian 6-years funding of 270 MEuro in correct range
  (but was based on preliminary estimates in INFN 2010-2012 plan)
- VAT won't be due if an ERIC is established, as planned

Accelerator schedule, 5 years to operations (accelerator white paper, 2010)

Table 25.1: Construction schedule

Year	Quarter 1	Quarter 2	Quarter 3	Quarter 4
1	▪ Tunnel design completed ▪ Injector components designed ▪ Ring component studied ▪ Tunnel contracts awarded ▪ Injector components ordered ▪ Ring components designed		▪ Ring tunnel digging started ▪ Injector tunnel digging started ▪ Injector components started manufacturing ▪ Ring components designed ▪ Tunnel digging continued ▪ Injector components are in manufacturing ▪ Ring components orders started	
2	▪ Ring tunnel digging continues ▪ Injector tunnel finished ▪ Injector components start to arrive ▪ Ring components orders finished		▪ Ring tunnel is completed ▪ Injector installation starts ▪ Ring components start to arrive for installation ▪ PEP-II components shipped from SLAC	
3	▪ Injector installation continues ▪ Ring component installation starts		▪ Injector installation is completed ▪ Ring installation continues	
4	▪ Injector checkout starts ▪ Ring installation continues		▪ Injector beam commissioning starts ▪ Ring installation is completed ▪ Ring checkout starts	
5	▪ Ring beam commissioning starts		▪ SuperB beam delivery to detector starts	

Planned Super*B* integrated luminosity (M.Giorgi, Frascati, 13/12/2011)



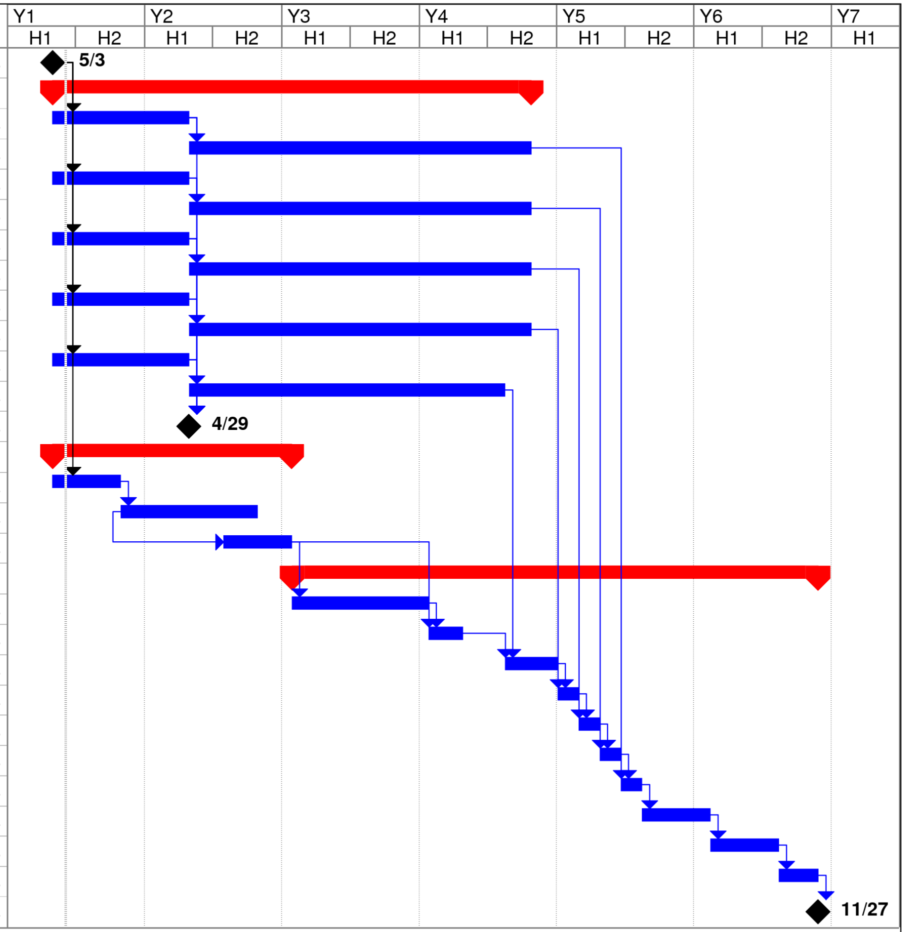
Detector cost estimated at ~50 M Euro (detector white paper, September 2010)

arXiv:1007.4241v1 [physics.ins-det], Table 9: SuperB detector budget

WBS	Item	EDIA mm	Labor mm	M&S kEuro	Rep.Val. kEuro
1	Super*B* detector	4037	2422	52953	48922
1.0	Interaction region	21	12	860	0
1.0.1	Be Beampipe	10	4	260	0
1.0.2	Tungsten Shield	9	6	540	0
1.0.3	Radiation monitors	2	2	60	0
1.1	Tracker (SVT + Strip + MAPS)	408	442	6444	0
1.1.1	SVT	222	309	4326	0
1.1.2	L0 Striplet option	36	55	542	0
1.1.3	L0 MAPS option	150	78	1576	0
1.1.4	L0 Hybrid Pixel option	156	84	1684	0
1.2	DCH	165	139	3421	0
1.3	PID	116	236	5820	7138
1.3.1	DIRC Barrel (Focusing DIRC)	116	236	5820	7138
1.4	EMC	219	360	12147	31574
1.4.1	Barrel EMC	20	5	205	31574
1.4.2	Forward EMC	171	312	11565	0
1.4.3	Backward EMC	28	43	377	0
1.5	IFR	37	184	1374	0
1.6	Magnet	93	59	3767	10210
1.7	Electronics	994	342	9234	0
1.8	Online System	912	24	2074	0
1.9	Installation and integration	353	624	7596	0
1.A	Project Management	720	0	216	0

Detector schedule, *y*1 = 2010 (detector white paper, September 2010)

ID	Task Name	Duration
1	Approval	0 wks
2	**Detector Design & Construction**	**182 wks**
3	Design SVT	52 wks
4	Construct SVT	130 wks
5	Design DCH	52 wks
6	Construct DCH	130 wks
7	Design PID	52 wks
8	Construct PID	130 wks
9	Design forward EMC	52 wks
10	Construct forward EMC	130 wks
11	Design IFR	52 wks
12	Construct IFR	120 wks
13	Detector Technical Design Report	0 wks
14	**Dismantle & Move Babar**	**91 wks**
15	Design Tooling	26 wks
16	Dismantle Babar	52 wks
17	Component transportation	26 wks
18	**Detector Installation & Commissioning**	**200 wks**
19	Installation steel	52 wks
20	Installation magnet	13 wks
21	Installation IFR	20 wks
22	Installation EMC	8 wks
23	Installation PID	8 wks
24	Installation DCH	8 wks
25	Installation SVT	8 wks
26	Commissioning	26 wks
27	Cosmic Ray test	26 wks
28	Commissioning on beam	15 wks
29	**Detector ready for collision**	0 wks



Project: SBF_schedule_v1.2
Date: Fri 6/4/10

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

Summary

- the Super Flavour Factories Belle2 and Super*B* are well motivated
- Super*B* will start data-taking later than Belle2 but is designed to be:
  - more luminous
  - more flexible, with ability or running at the charm threshold
  - more versatile, providing beam polarization
- Super*B* will be complementary to LHC, LHCb and other experiments like MEG
- with $75\,\text{ab}^{-1}$ of clean e^+e^- events, a large variety of physics measurements will be possible
- Super*B* detector will be an improved *BABAR* detector for high luminosity and smaller boost
- the Super*B* collaboration is becoming more formally organized
- the Super*B* detector TDR is bein prepared and is due to appear in the first months of 2012