The SuperB factory

physics prospects and project status

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1. Introduction
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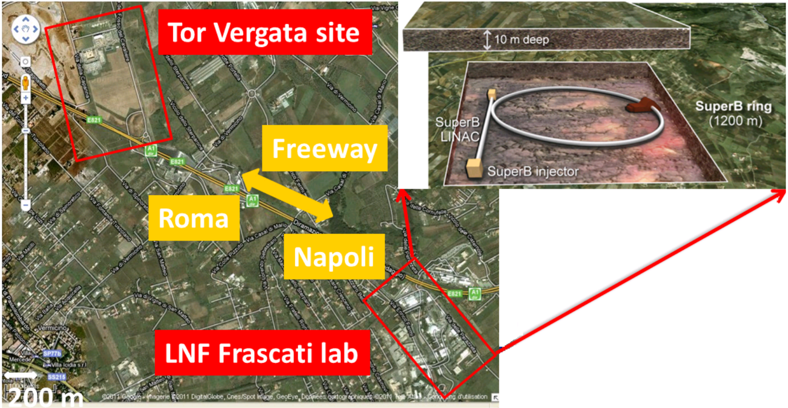
   - Accelerator
   - Luminosity
3. Detector
   - SVT
   - DCH
   - DIRC
   - EMC and IFR
4. Physics
   - Rare B Physics
   - TDCP
   - $B \to X_s \gamma$
   - LFV
   - CP violation
   - EDM

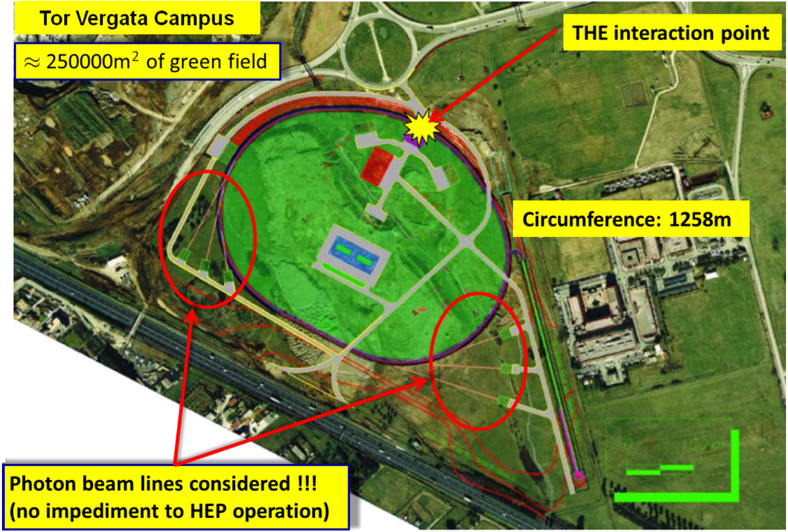
B factories

B factories achived a great success over the dozen years. A natural continuation of this project are Super Flavor Factories.

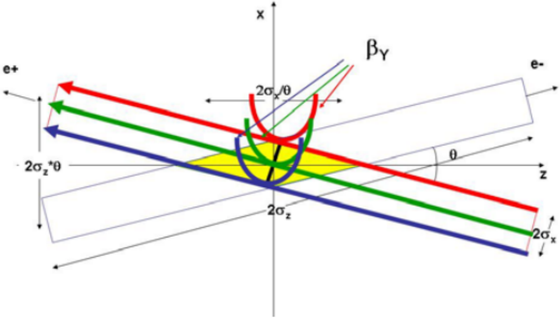
Super Flavor Factories

1. Data $75ab^{-1}$.
2. Luminosity $10^{36}cm^{-2}s^{-1}$.
3. Flexibility to run on charm threshold with luminosity $10^{35}cm^{-2}s^{-1}$.
4. Logitudanal polarization of electron beam 80%.
5. Upgradet Babar detector.
6. Start of data taking: 2018.
7. $10ab^{-1}$ peer year.

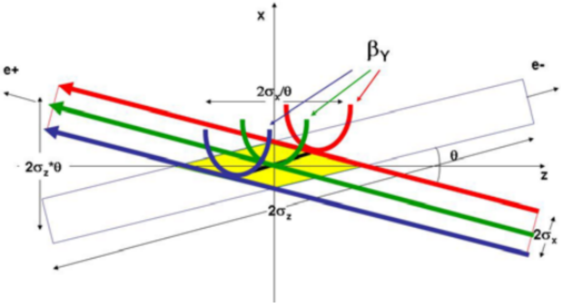

Tor Vergata site
Freeway
Roma
Napoli
LNF Frascati lab
200 m
10 m deep
SuperB ring
(1200 m)
SuperB
LINAC
SuperB injector


Tor Vergata Campus
≈ 250000m^2 of green field
THE interaction point
Circumference: 1258m
Photon beam lines considered !!!
(no impediment to HEP operation)

Quest for Luminosity



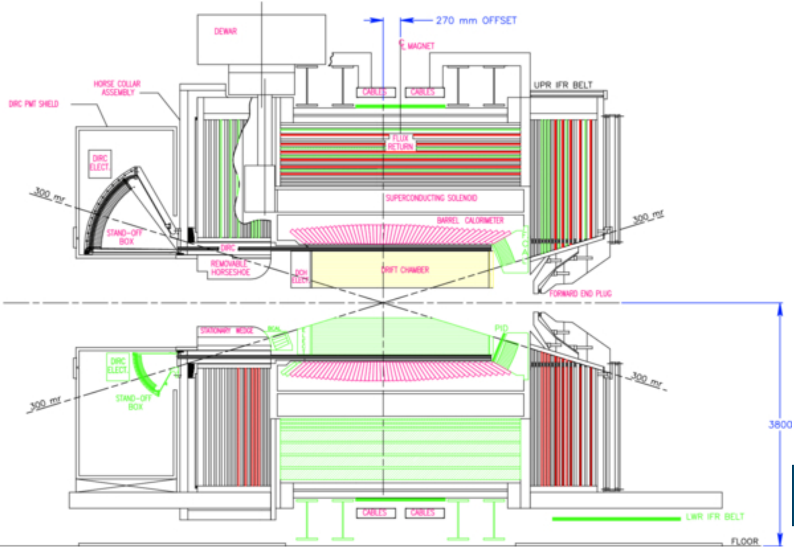
$$L \propto \frac{1}{\sqrt{\beta_y}}, \; \Phi \approx \frac{\sigma_z}{\sigma_x}\frac{\theta}{2}$$



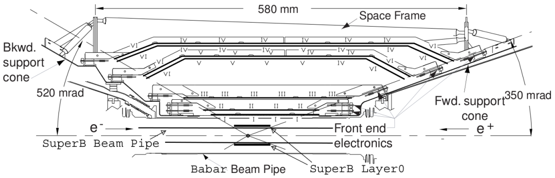
$$L \propto \frac{1}{\sqrt{\beta_y}}, \; \Phi \approx \frac{\sigma_z}{\sigma_x}\frac{\theta}{2}$$

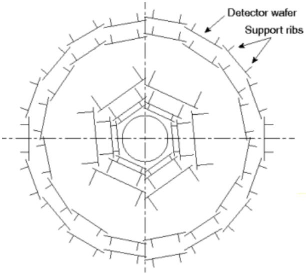
Recycling

SuperB detector is based on Babar.



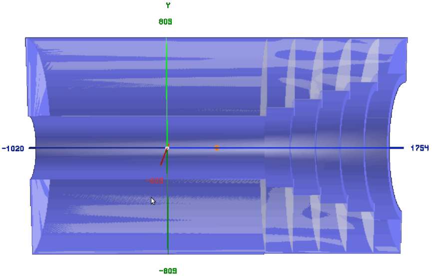
Silicon Vertex Tracker





- Five layers(1-5) of double-sided silicon strip detectors.
- Radial span $3 - 15$ cm.
- Upgrade the electronics for faster readout.
- Additional Layer 0:
  1. Radius $\approx 1.5cm$.
  2. Low material budget: $X_0 = 0.5\%$.
  3. Two possible technologies: Hybrid Pixels, Double Sided Strip detectors(Striplts).

Drift Chamber

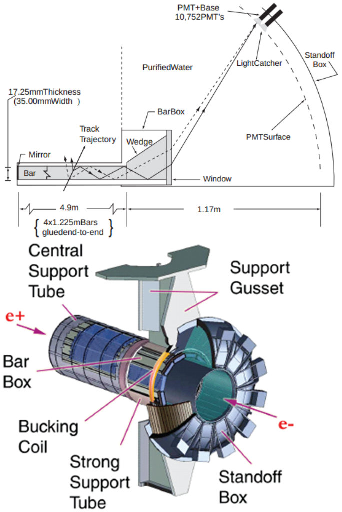


- 40 layers of $\approx 1cm$ cells parralel to beam line.
- Provide momentum and $\frac{dE}{dx}$ for low momentum particles($p < 700 MeV$).
- $\approx$ 10000 channels
- Ocuupancy

R& D:

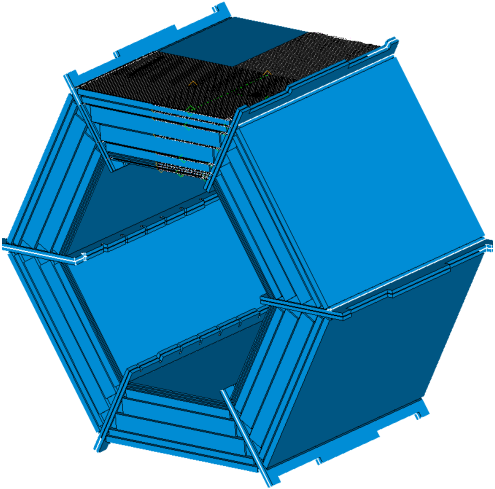
- Geometry
- Gas mixture
- aaaa

Detector of Internally Reflected Cherenkov light



- Momentum range $0.7 - 4GeV$
- Radiator: synthetic fused silica.
- Photon detectors outside field region.
- Radiatoin hard.

Electromagnetic and hadronic calorimeter



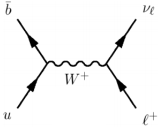
Electronamgnetic Calorimeter:

- Coverage $94\% of 4\Pi$
- CsI or LYSO cristals
- Crystal lenght $16 - 17.5X_0$
- Radiatoin hard.

Instrumented Flux Return:

- Upgrade form TDC to BIRO
- Scintilators
- Iron reused from Babar
- SiPM

$B \to \tau\nu$

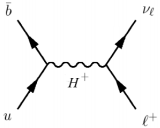


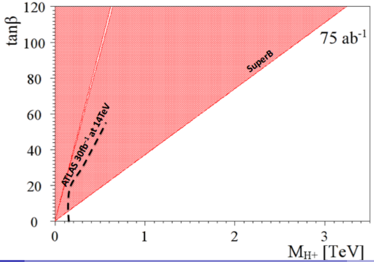
Precise SM prediction:

$$Br(B \to l\nu) = \frac{G_F^2 m_B}{8\pi} m_l^2 (1 - \frac{m_l^2}{m_B^2}) f_B^2 |V_{ub}|^2 \tau_B$$

In SUSY:

$$Br(B \to l\nu) = \frac{G_F^2 m_B}{8\pi} m_l^2 (1 - \frac{m_l^2}{m_B^2}) f_B^2 |V_{ub}|^2 \tau_B (1 - \frac{tan^2\beta}{1 + \bar{\epsilon} tan\beta} \frac{m_B^2}{m_H^2})$$





Time Depended CP

Time Depended CP can be signs of new physics. One has to study set of modes:

$b \to s\bar{s}c$, $b \to s$

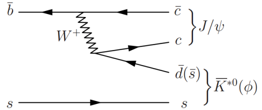
Curent experimental results(SM -observed):

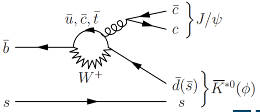
$\Delta sin(2\beta) = 2.7\sigma$, penguin

$\Delta sin(2\beta) = 2.1\sigma$, tree

Golden modes in SuperB: $B \to J/\psi K^0$, $B \to \eta' K^0$, $B \to f_0 K^0_s$

Mode	Current Precision			Predicted Precision ($75\,\mathrm{ab}^{-1}$)		
	Stat.	Syst.	ΔS^f (Th.)	Stat.	Syst.	ΔS^f (Th.)
$J/\psi K^0_S$	0.022	0.010	0 ± 0.01	0.002	0.005	0 ± 0.001
$\eta' K^0_S$	0.08	0.02	0.015 ± 0.015	0.006	0.005	0.015 ± 0.015
$\phi K^0_S \pi^0$	0.28	0.01	–	0.020	0.010	–
$f_0 K^0_S$	0.18	0.04	0 ± 0.02	0.012	0.003	0 ± 0.02
$K^0_S K^0_S K^0_S$	0.19	0.03	0.02 ± 0.01	0.015	0.020	0.02 ± 0.01
ϕK^0_S	0.26	0.03	0.03 ± 0.02	0.020	0.005	0.03 ± 0.02
$\pi^0 K^0_S$	0.20	0.03	0.09 ± 0.07	0.015	0.015	0.09 ± 0.07
ωK^0_S	0.28	0.02	0.1 ± 0.1	0.020	0.005	0.1 ± 0.1
$K^+ K^- K^0_S$	0.08	0.03	0.05 ± 0.05	0.006	0.005	0.05 ± 0.05
$\pi^0 \pi^0 K^0_S$	0.71	0.08	–	0.038	0.045	–
ρK^0_S	0.28	0.07	-0.13 ± 0.16	0.020	0.017	-0.13 ± 0.16





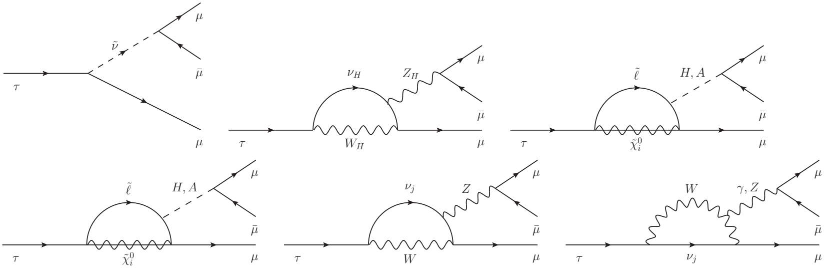
$B \to X_s\gamma$

Very important probe of new physics! Current experimental result averaged out: $Br(B \to X_s\gamma) = (3.52 \pm 0.23 \pm 0.09)10^{-4}$
Theoretical calculations on NNLO:
$Br(B \to X_s\gamma) = (3.15 \pm 0.23)10^{-4}$
Experimently chalenging to measure the inclusive decays. THere are two ways of studing this decay:

1. Exlusive:
    - The earliest results were done suing a large number of exclusive decays, which are fully reconstructed.
    - Erros rising from unseen modes.
    - Obsolete for SuperB.
2. Inclusive:
    - Use tagging to tag the other B.
    - No requirements on X_s.
    - Disadvantage: Cut on photon energy.
    - Effort to keep the cut as small as possible

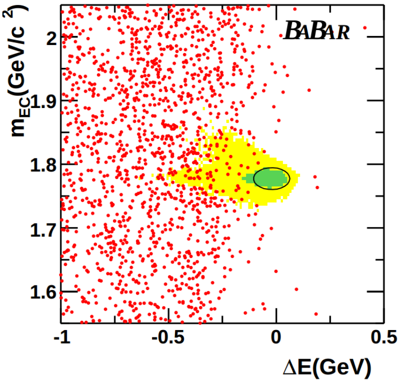
LFV

- LFV can occure in SM due to masses of the neutrinos.
- Any observation is evidence of new physics.
- Most promising channels: $\tau \rightarrow l\gamma$, $\tau \rightarrow lll$.



$\tau \to l\gamma$ sensitivity

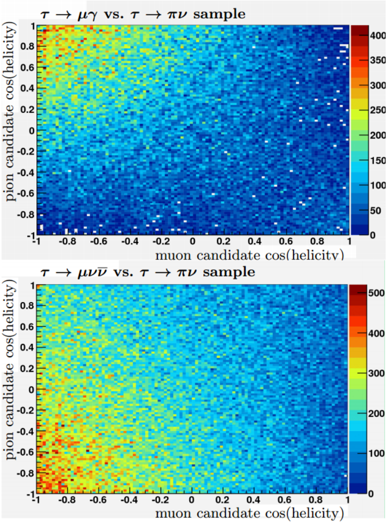
- Better tracking resolution, increase $\Delta m - \Delta E$ box, by 65%.
- Higher photon efficiency.
- Increase of geometry accepirance.
- Thicker signal peak.
- Smaller boost improves performance of the fit.



Polarization

SuperB will have polarized electron beam(80%). One can use this infromation

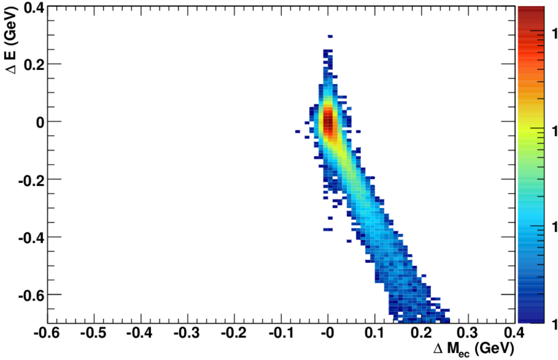
Preliminary results: Upper limit at 90%: 2.44×10^{-9} 3σ observation: 5.50×10^{-9}



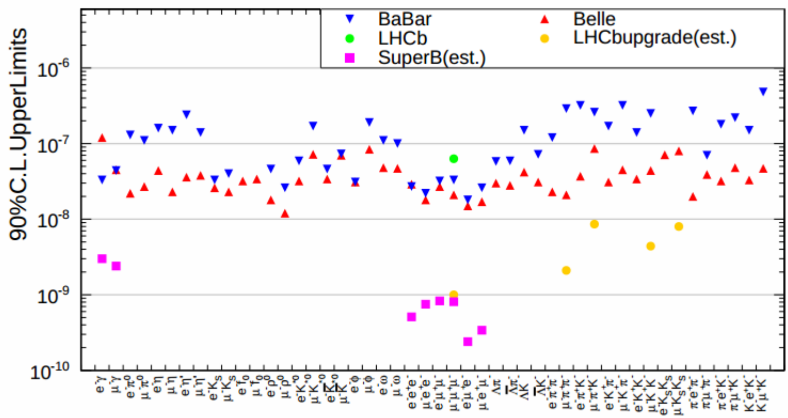
$\tau \to 3\mu$

Current analysis:

- Calculate the trust axis.
- Semi tag the second τ.
- Limit obtained(90%
  $Br(\tau \to 3\mu) = 8.1 \times 10^{-10}$



LFV Summary


BaBar
Belle
LHCb
LHCbupgrade(est.)
SuperB(est.)
90%C.L.UpperLimits
10-6
10-7
10-8
10-9
10-10

CP violation

- CP violation was never observed in τ sector.
- SM prediction is neglible small $O(10^{-12})l$ in $\tau^{\pm} \to K^{pm}\pi^{0}\nu$.
- Any observation is clear identification of NP.
- Very fiew NP models can explain this:
  1. RPV SUSY
  2. Multi Higgs models
- SuperB can improve sensitivety 75 times compared to CLEO.

EDM

EDM can be measured with single angle differential cross section $e^{+}e^{-} \rightarrow \tau^{+}\tau^{-}$.

- Improvement using polarized beam.
- Achivable sensitivety: $10^{-19} ecm$