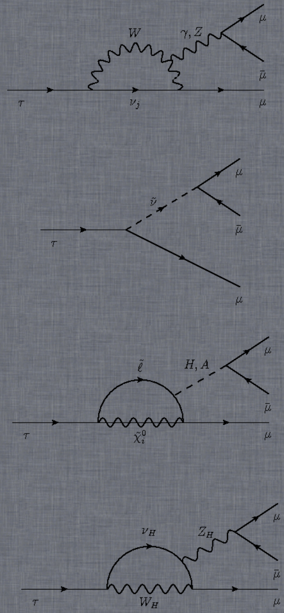
The SuperB factory

physics prospects and project status

Marcin Chrząszcz

Institute of Nuclear Physics,
Polish Academy of Science,
on behave of SuperB collaboration

21^{st} September 2012



Introduction

SuperB Infrasctructure

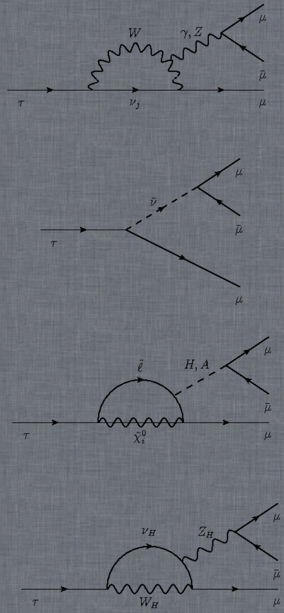
- Accelerator
- Luminosity

Detector

- SVT
- DCH
- DIRC
- EMC and IFR

Physics

- Rare B Physics
- TDCP
- $B \to X_s\gamma$
- LFV
- CP violation
- EDM



B factories

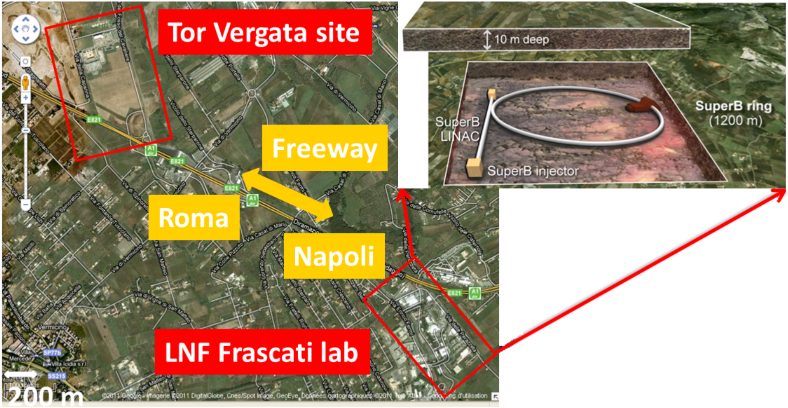
B factories achived a great success over the dozen years. A natural continuation of this project are Super Flavor Factories.

Super Flavor Factories

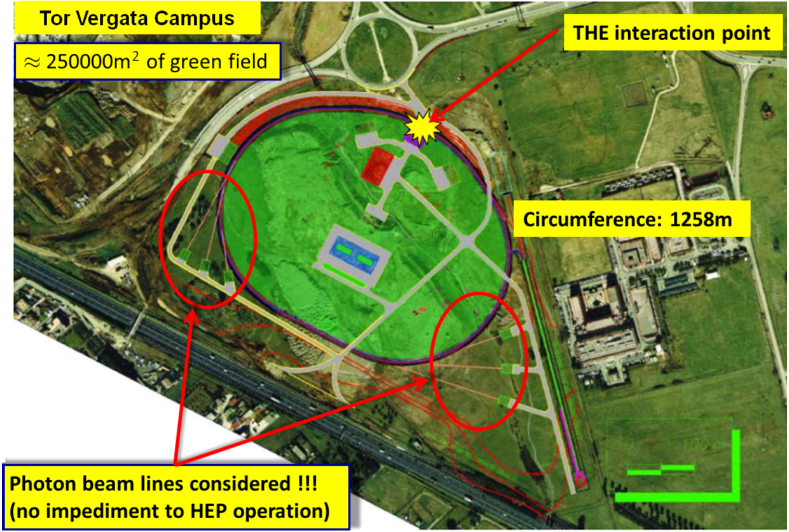
1. Data $75ab^{-1}$.
2. Luminosity $10^{36}cm^{-2}s^{-1}$.
3. Flexibility to run on charm threshold with luminosity $10^{35}cm^{-2}s^{-1}$.
4. Logitudanal polarization of electron beam 80%.
5. Upgradet Babar detector.
6. Start of data taking: 2018.
7. $10ab^{-1}$ peer year.

we have in 200 metres 3 shops selling tissot

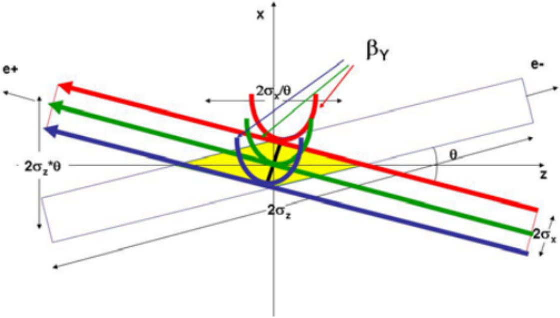
TorVegata Site



TorVegata Site

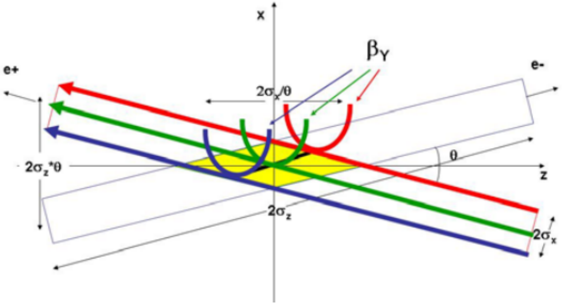


Quest for Luminosity



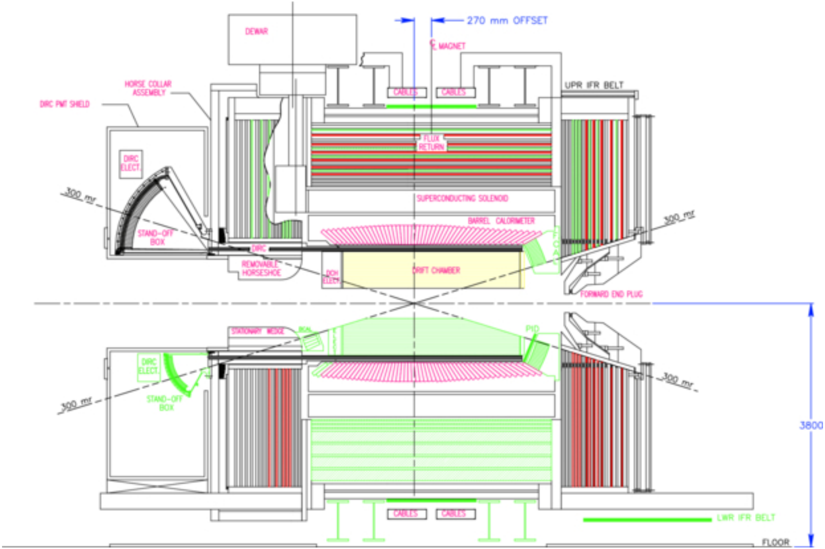
$$L \propto \frac{1}{\sqrt{\beta_y}}, \Phi \approx \frac{\sigma_z}{\sigma_x}\frac{\theta}{2}$$

Quest for Luminosity

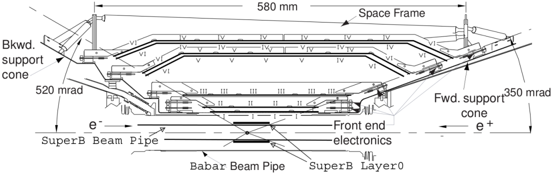


$$L \propto \frac{1}{\sqrt{\beta_y}}, \Phi \approx \frac{\sigma_z}{\sigma_x}\frac{\theta}{2}$$

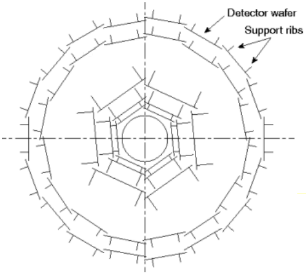
Recycling, Babar



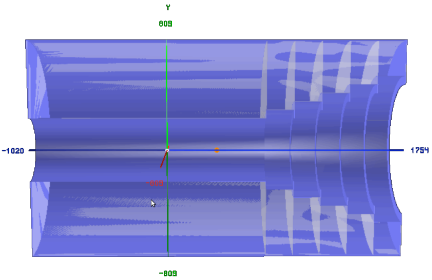
Silicon Vertex Tracker



- Five layers(1-5) of double-sided silicon strip detectors.
- Radial span $3 - 15\,\mathrm{cm}$.
- 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(Striplets).



Drift Chamber

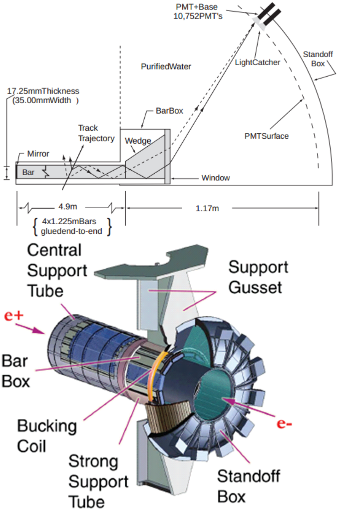


- 40 layers of $\approx 1cm$ cells parralel to beam line.
- Provide momentum and $\frac{dE}{dx}$ for low momentum particles($p < 700MeV$).
- $\approx$ 10000 channels
- Ocuupancy($3.5\% - 5\%$).

R&D:

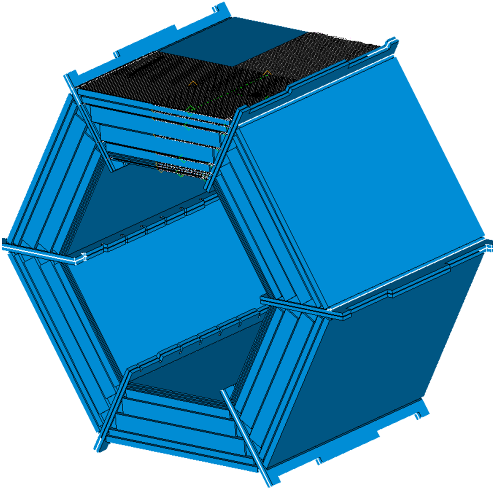
- Geometry
- Gas mixture
- aaaa

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

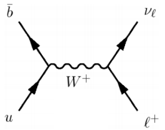
$B \to \tau\nu$

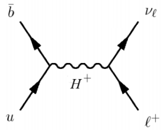
Precise SM prediction:

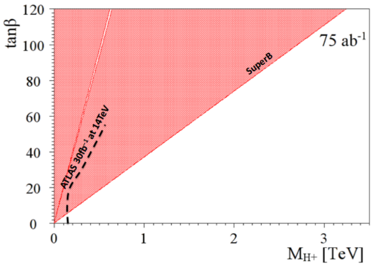
$$Br(B \to l\nu) = \frac{G_F^2 m_B}{8\pi} m_l^2 (1 - \frac{m_l^2}{m_B^2}) f_B^2 |V_{ub}|^2 \tau_B$$

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:

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

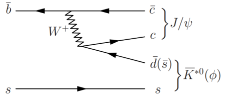
Curent experimental results(SM -observed):

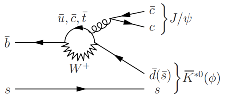
$\Delta sin(2\beta) = 2.7\sigma$, penguin

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





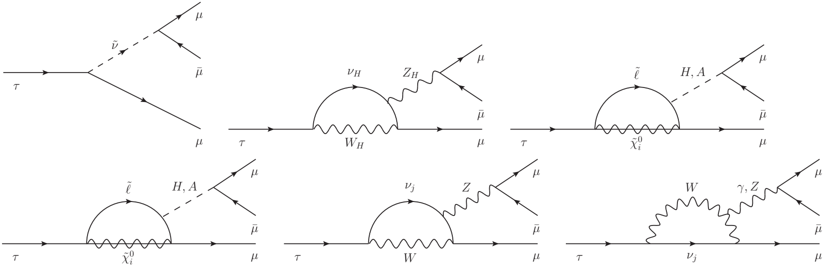
$B \to X_s\gamma$

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

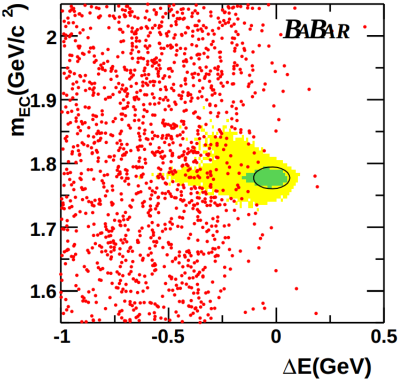
LFV

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

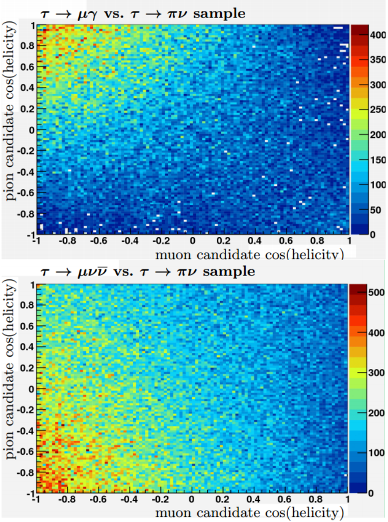


$\tau \to l\gamma$ sensitivity

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



Polarization



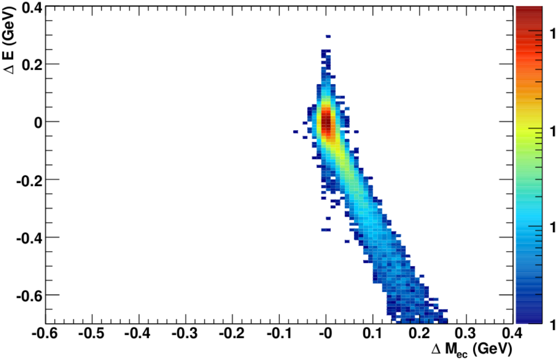
1. SuperB will have polarized electron beam(80%).
2. One can use this infromation in serching for NP.
3. Preliminary results:

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

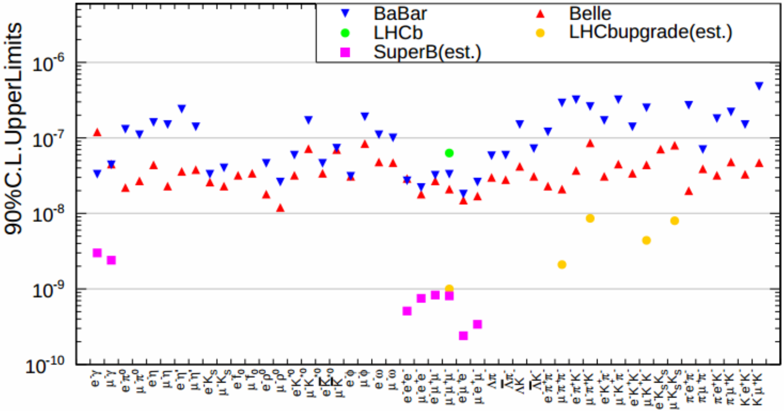
$\tau \to 3\mu$

Current analysis:

- Calculate the trust axis.
- Semi tag the second τ.
- Limit obtained(90%
  Br($\tau \to 3\mu$) = 8.1×10^{-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 $\tau^{\pm} \rightarrow K^{pm}\pi^{0}\nu$.
- Any obserwation 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 $e^+e^- \to \tau^+\tau^-$.

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