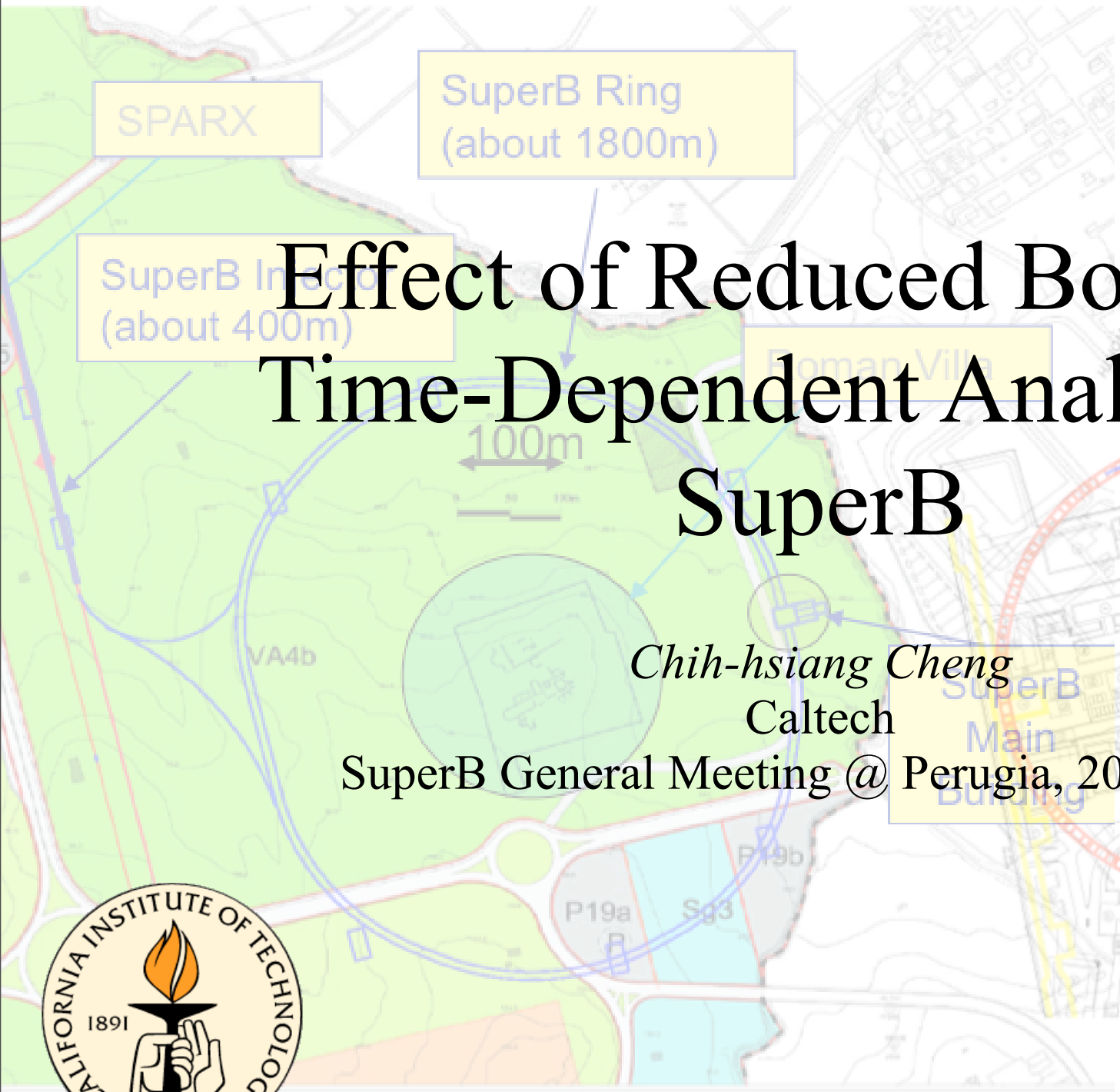

Effect of Reduced Boost on Time-Dependent Analysis in SuperB

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SuperB General Meeting @ Perugia, 2009/06/18

Introduction

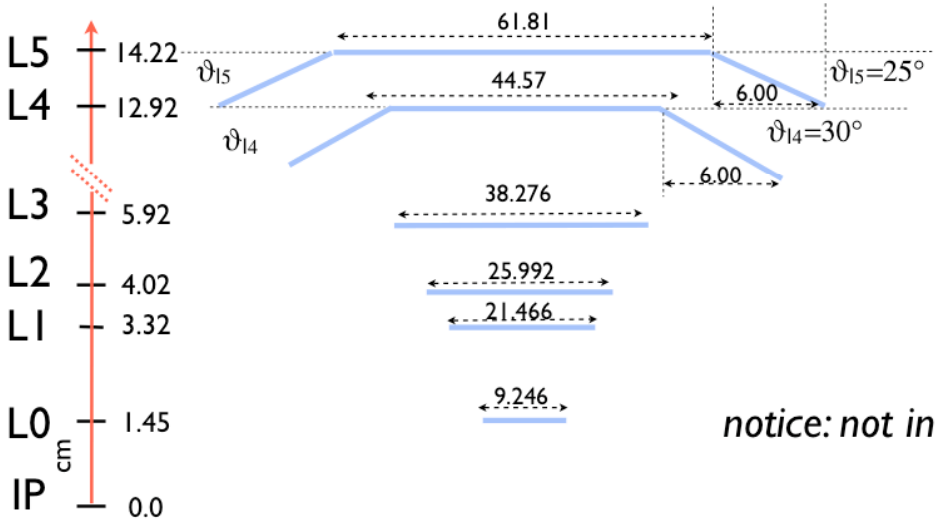
- It was recently proposed to reduce the asymmetry of the HER/LER energies from 7.0/4.0 GeV to 6.7/4.18 GeV, in order to reduce the storage ring size to fit to the potential site at LNF as an alternative to Tor Vergata site.
- The boost would be reduced from $\beta\gamma = 0.283$ to $\beta\gamma = 0.238$.
- We must study the loss of sensitivity to time-dependent analysis to understand the compromise.

Set up

- Study the S and C terms in time-dependent CP fit to $B^0 \to \varphi K_S$ decays using the two beam energy configurations.
- Tool: fast simulation V0.0.9 + development up to ~June10.
- Mode: signal only; $B^0 \to \varphi K_S$, $\varphi \to K^+K^-$, $K_S \to \pi^+\pi^-$.
  - BF= 1.45×10^{-6}.
  - Generator at: $\sin 2\beta = 0.7033$, C=0, τ= 1.541 ps, Δm= 0.489 ps^{-1}.
- Layer 0: Si hybrid pixels at R=1.455 cm, 200 μm thick, z_resolution= 10 μm.
- Beam spot σ_x= 5.7 μm, σ_y= 35 nm, σ_z= 330 μm.

SVT configuration

SVT layer geometry for baseline

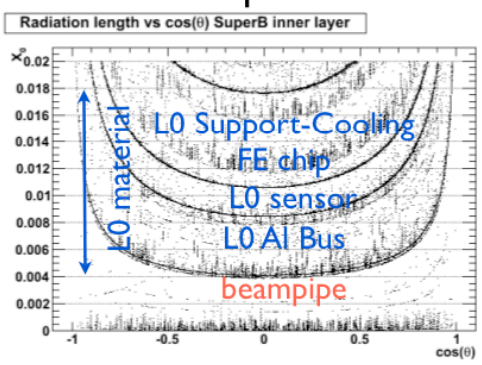


notice: not in sc

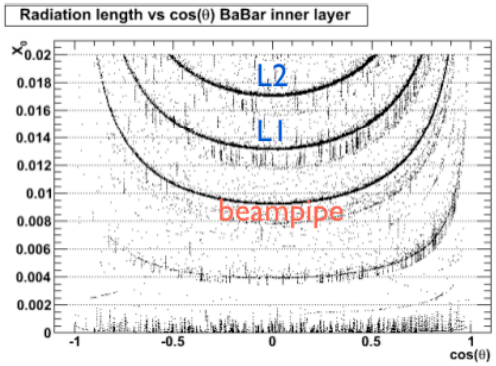
Coverage down to 300 mrad FW and BW

Radiation length vs cos(theta) in FastSim

SuperB



BaBar



Total amount of L0 material is ~1.36% X_0 considering overlap of passive material.
Relative amount of material for Al bus and support-cooling requires small adjustments.

7

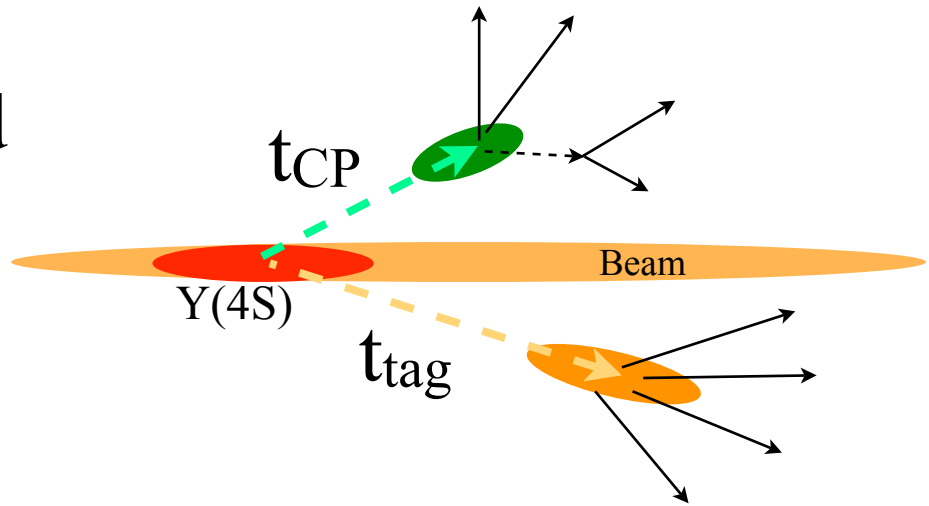
Nicola Neri, Wednesday Parallel - Tracking (DGWG)

Event selection

- $\varphi \rightarrow K^+K^-$ from two GoodTracksLoose; $|m_{KK}-m_{\varphi}|<20$MeV.
  - No Particle ID
- $K_S \rightarrow \pi^+\pi^-$ from two ChargedTracks; $|m_{\pi\pi}-m_{Ks}|<25$ MeV; $P(\chi^2)>0.001$.
- B^0 : $5.27<m_{ES}<5.29$ GeV; $|\Delta E|<50$ MeV.
- Truth-matched: (use older χ^2-based match)
- Reconstruction efficiency:
  - $\beta\gamma = 0.283$: $\varepsilon = 65.22\%$
  - $\beta\gamma = 0.238$: $\varepsilon = 65.39\%$

Vertexing and tagging

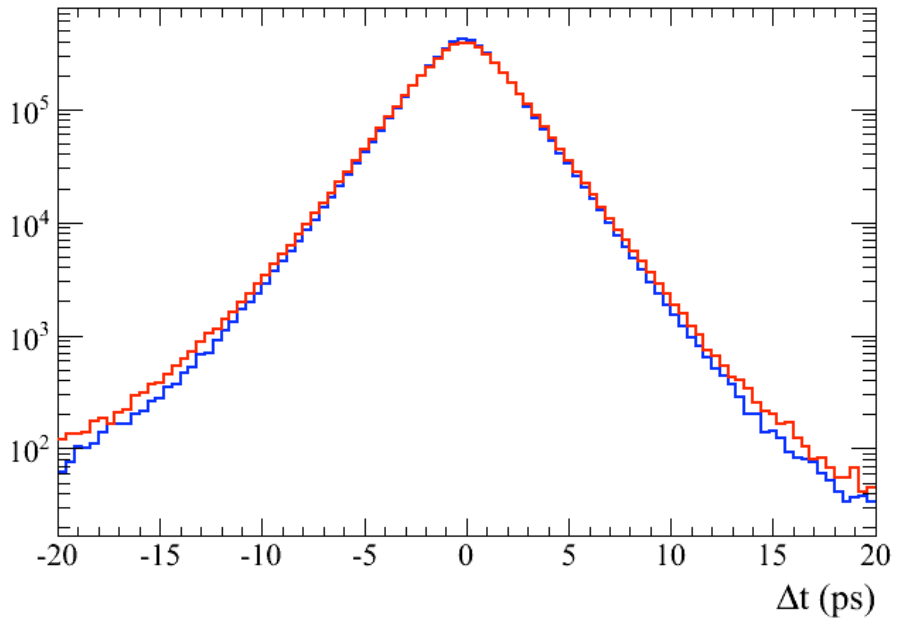
- Tag-vertex is determined by standard BaBar algorithm.
- Reco-vertex and tag-vertex are fed to a TreeFitter to fit an "Y(4S)→BB" candidate with the Beam constraint.
  - $\Delta t = t_{CP} - t_{tag}$.
- Flavor tagging is not validated yet due to PID. So here I will use the true tag flavor.
  - In BaBar, Q~33%, so each event here has ~3x stat. power.
  - The potential correlation between flavor tagging and boost is ignored.

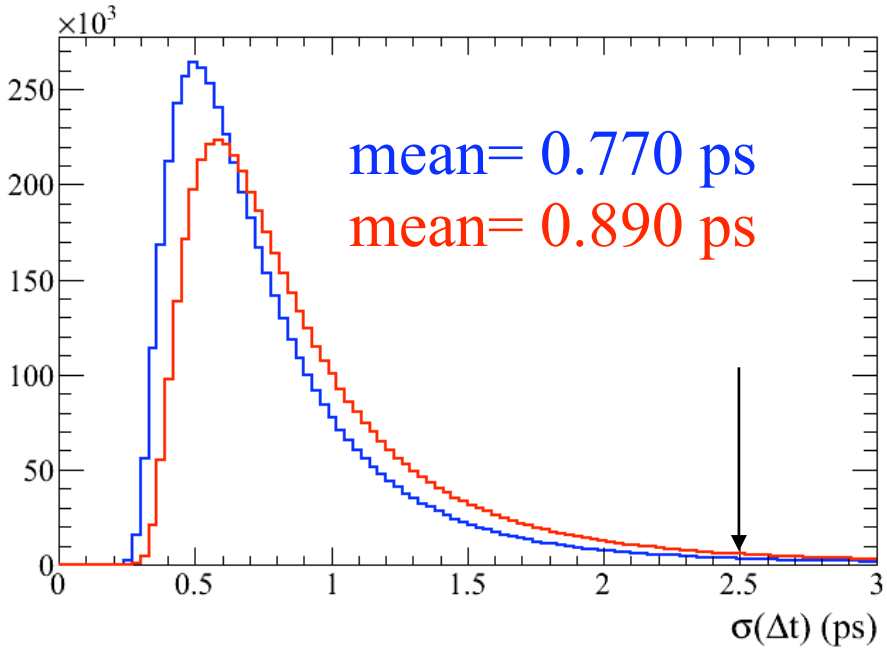


t_{CP} and t_{tag} have large uncertainties because the large error in Y(4S) vertex. But they are positively correlated and error due to Y(4S) vertex is canceled in Δt.

Δt and its uncertainty

- $|\Delta t| < 20$ ps; $0.1 < \sigma(\Delta t) < 2.5$ ps
  - $\beta\gamma = 0.283$: $\varepsilon = 63.10\%$
  - $\beta\gamma = 0.238$: $\varepsilon = 62.33\%$





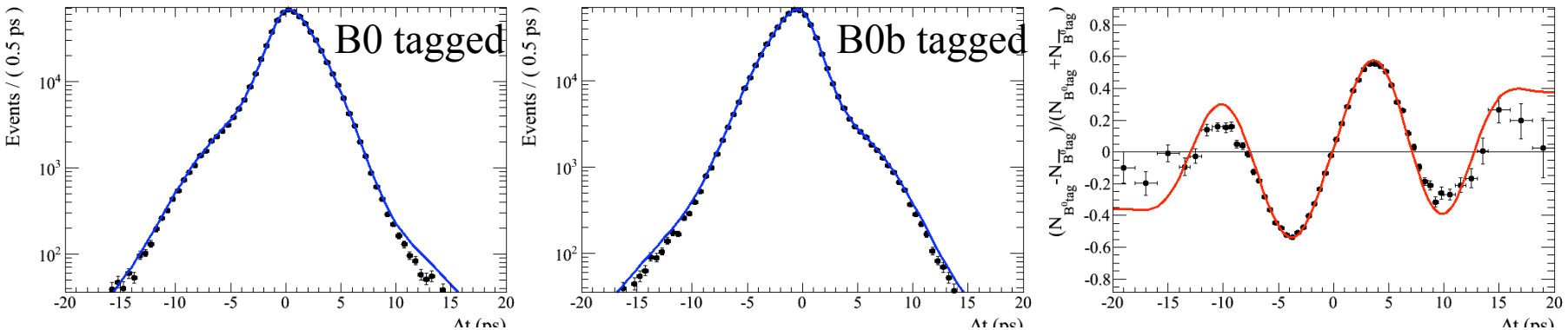
CP fit

- Δt resolution function: standard BaBar triple Gaussian.
  - core, tail Gaussians: bias and width scaled by per-event error.
  - tail Gaussian width scale factor fixed at 3.
  - outlier Gaussian fixed at b= 0 ps, σ= 8 ps.
  - 5 free parameters (plus S and C, total of 7 free parameters).
  - No splitting by tagging category because we don't have it.
- First fit to a sample generated with 2M events to obtain resolution function.
- Then fit to 400 samples each generated with 20000 events with resolution fixed from the large sample fit.

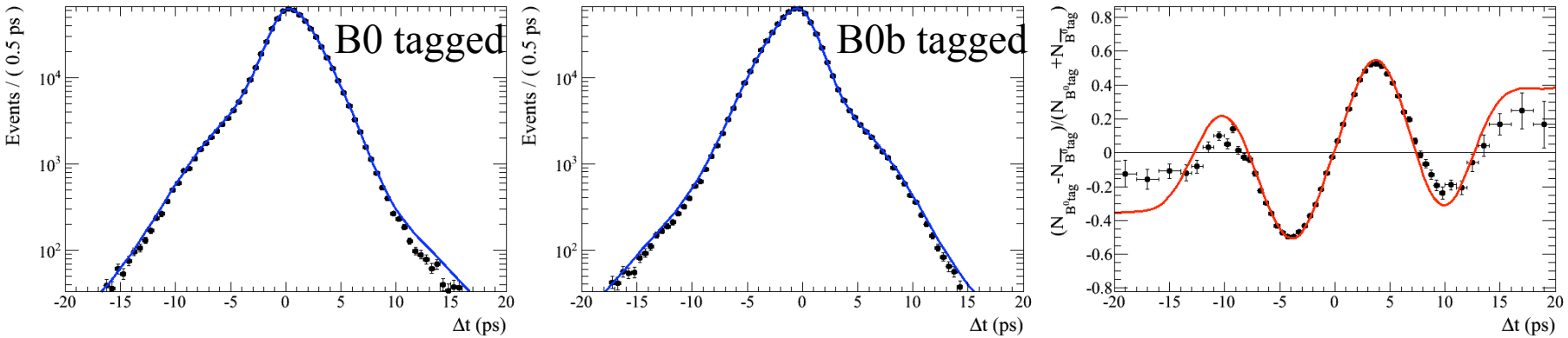
2M-event fits

~1.25 M events in the fit

βγ= 0.283



βγ= 0.238



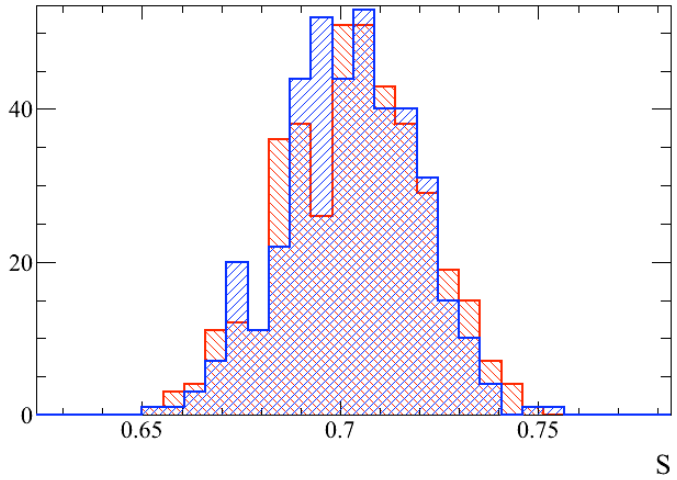
βγ	0.283	0.238
S	0.70414 ± 0.00175	0.70325 ± 0.00187
C	-0.00105 ± 0.00122	-0.00289 ± 0.00125
b_core	-0.1158 ± 0.0038	-0.0929 ± 0.0034
b_tail	-0.8376 ± 0.0241	-0.7653 ± 0.0204
f_out	0.0078 ± 0.0004	0.0100 ± 0.0002
f_tail	0.1773 ± 0.0027	0.1779 ± 0.0023
s_core	1.1230 ± 0.0056	1.1314 ± 0.0049

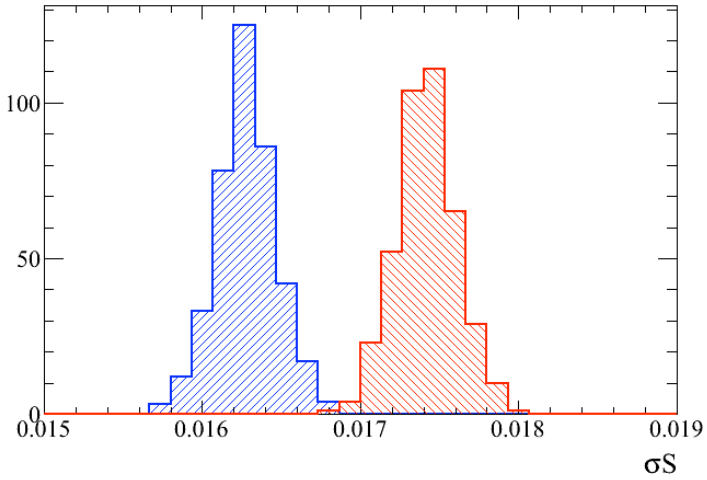
- Resolution function is not perfect, but does not cause bias in uncertainty comparison.
- Error on S changes by **+6.9%**.

It does not change the result if we relax σ(Δt) cut in reduced boost so that #events in the fit are the same.

Fits to samples of 20k (generated)

- 400 samples, each has ~12.5k events in the fit (fix resolution).
  - This has roughly the same statistical power of 75 ab^{-1} for this particular mode after (tighter) reconstruction efficiency and flavor tagging for real data are taken into account.





βγ	0.283	0.238	ratio	1/ratio	ratio^2
S mean	0.70231 ± 0.00081	0.70335 ± 0.00089			
S RMS	0.01627 ± 0.00058	0.01779 ± 0.00063	0.915	1.093	0.836
σS mean	0.01628 ± 0.00001	0.01742 ± 0.00001	0.935	1.070	0.873

Conclusions

- Using $B^0 \to \varphi K_S$, $\varphi \to K^+K^-$, $K_S \to \pi^+\pi^-$ and fast simulation in SuperB under two beam energy configurations (7/4 vs. 6.7/4.18) assuming layer 0 at R=1.455 cm and 10 μm z resolution, we find that reducing the boost is equivalent to losing ~15% of data in terms of the S measurement in a typical time-dependent analysis.