SuperB prospective of time-dependent analysis of $B^0 \rightarrow K_S K_S K_S$ decays

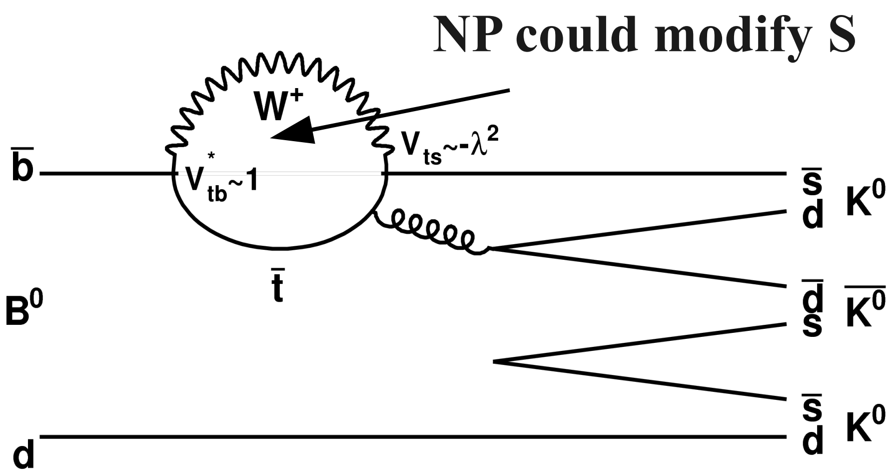
Eli Ben-Haim, **Simon Sitt**

Overview

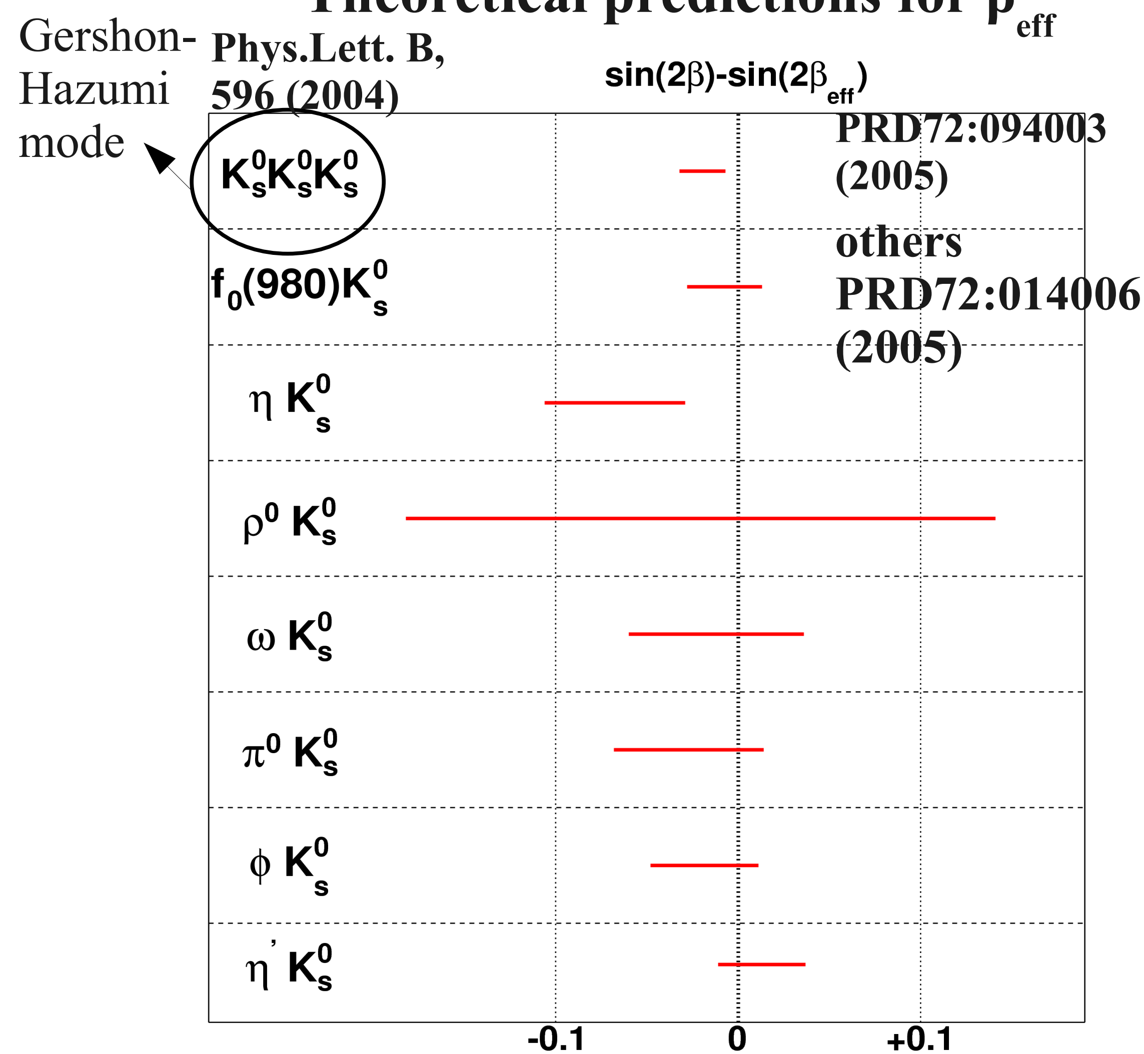
- Motivation
- Current experimental status
- Feasibility study at SuperB
  - Vertex precision
  - Beam backgrounds
- Error projection

Physics motivations

$S=(1-C^2)^{1/2}\,\eta\sin(2\beta_{eff})$



Theoretical predictions for β_{eff}



Prediction: "tree pollution" and final state rescattering (pQCD)

- Pure penguin decay, SM prediction is $S=-\sin(2\beta)$ that has been measured to high precision in $B^0 \rightarrow c\bar{c}K^{(*)}$ decays.
- Theoretically very clean, other contributions suppressed by at least λ^2.
- CP definite final state allows to measure S and C inclusively

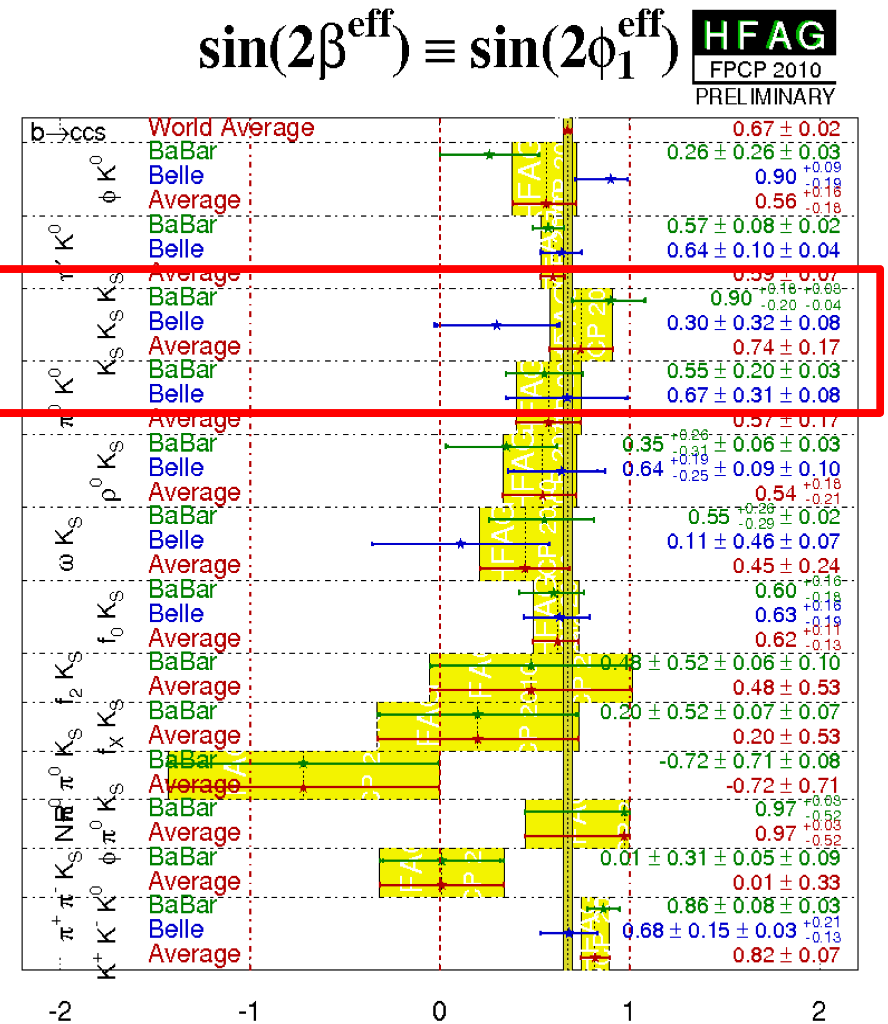
Currents status

$$\mathcal{S} = -0.935^{+0.238}_{-0.214} \pm 0.063$$

$$\mathcal{C} = -0.166^{+0.180}_{-0.178} \pm 0.038$$

stat sys

Statistics dominated



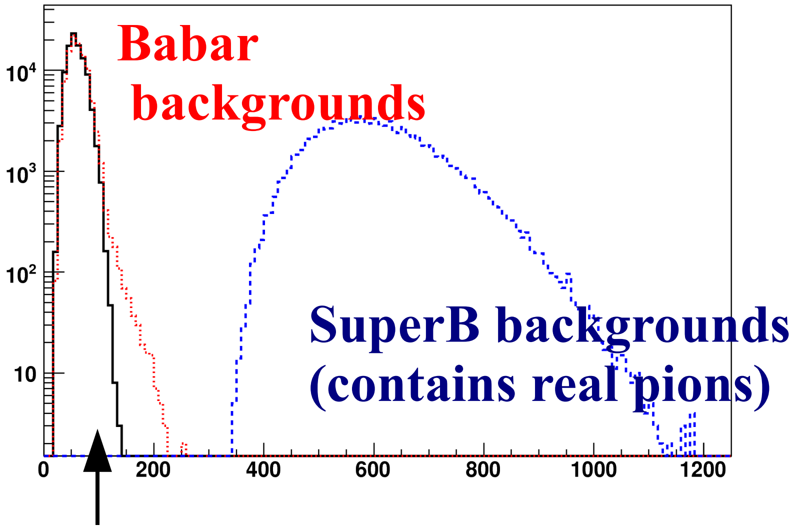
Comment: Preliminary results are shown, publication underway

Feasibility study using FastSim

- Release V0.2.5
- Reconstruct K_S using KsDefault list (charged pion daughters only)
- TreeFitter for vertexing

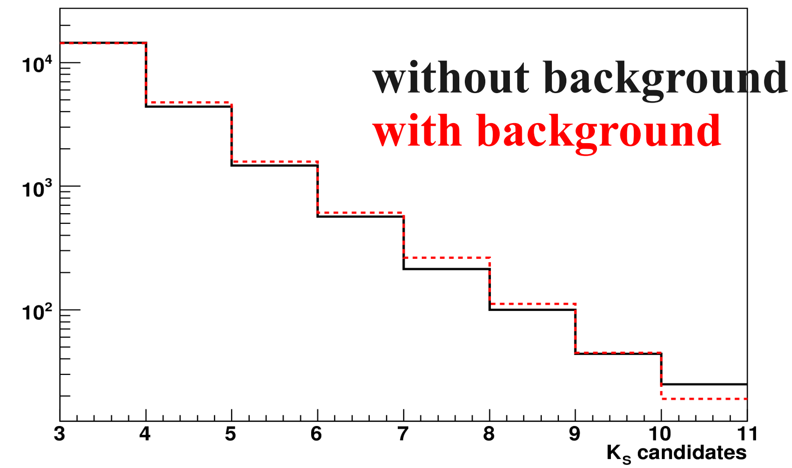
Beam backgrounds

Number of generated particles in event



No background

Number of reconstructed KS per event with and without SuperB-like backgrounds



Strongly geometrically constrained reconstruction insensitive to beam backgrounds

Efficiencies and vertex resolution

- The boost in SuperB is approximately half the boost of BaBar ($\beta\gamma=0.24$ vs $\beta\gamma=0.56$)
- We use FastSim for the following investigations:
  - We investigate how this reduced boost and additional detector components improve the reconstruction efficiency
  - To do time-dependent analysis with a reduced boost we need an improved vertex resolution. We check if the proposed Layer0 of the SVT provides a sufficient improvement

Efficiencies for different detector compositions

Detector	no background	*BABAR* backgrounds	SuperB backgrounds
BABAR	0.188 ± 0.001	0.186 ± 0.001	0.187 ± 0.001
DG0	0.213 ± 0.002	0.216 ± 0.002	0.218 ± 0.002
DG1	0.219 ± 0.002	0.216 ± 0.002	0.220 ± 0.002
DG2	0.217 ± 0.002	0.219 ± 0.002	0.218 ± 0.002
DG3	0.214 ± 0.002	0.217 ± 0.002	0.216 ± 0.002
DG4	0.212 ± 0.002	0.217 ± 0.002	0.216 ± 0.002

The reconstruction efficiency increases by 13% wrt BaBar (one third due to reduced boost). Detector components additional to the baseline concept do not significantly improve the efficiency.

Reminder
Detector **G**eometries

DG	SVT	DCH	PID	EMC	IFR
BABAR	"*BABAR*"	"*BABAR*"	"*BABAR*"	"*BABAR*"	"*BABAR*"
DG0	5 layers+L0	"*BABAR*"	DIRC	"*BABAR*"+fwdLYSO	baseline
DG1	5 layers+L0	"*BABAR*"+bwdDCH+fwdDCH	DIRC	"*BABAR*"+fwdLYSO	baseline
DG2	5 layers+L0	"*BABAR*"+bwdDCH	DIRC+fwdPID	"*BABAR*"+fwdLYSO	baseline
DG3	5 layers+L0	"*BABAR*"+fwdDCH	DIRC	"*BABAR*"+fwdLYSO+bwdEMC	baseline
DG4	5 layers+L0	"*BABAR*"	DIRC+fwdPID	"*BABAR*"+fwdLYSO+bwdEMC	baseline

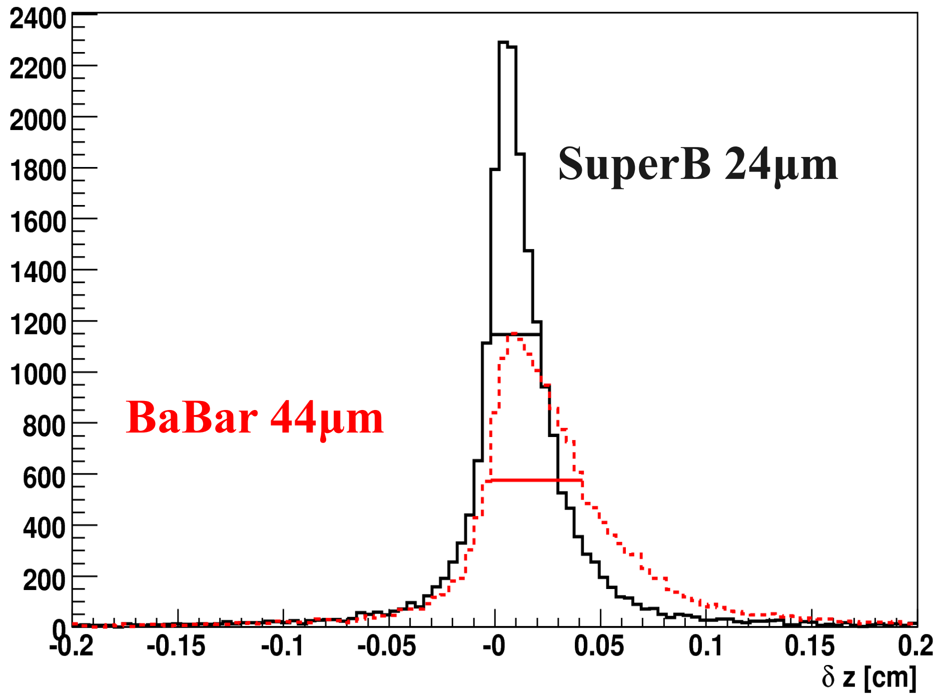
Vertex resolution

Particularity: no charged track from signal B decay

It was already shown that TD-analysis with direct charged tracks on the signal side is possible.

Here: look at the position resolution on the signal side only

$$\delta z = z_{gen} - z_{rec}$$

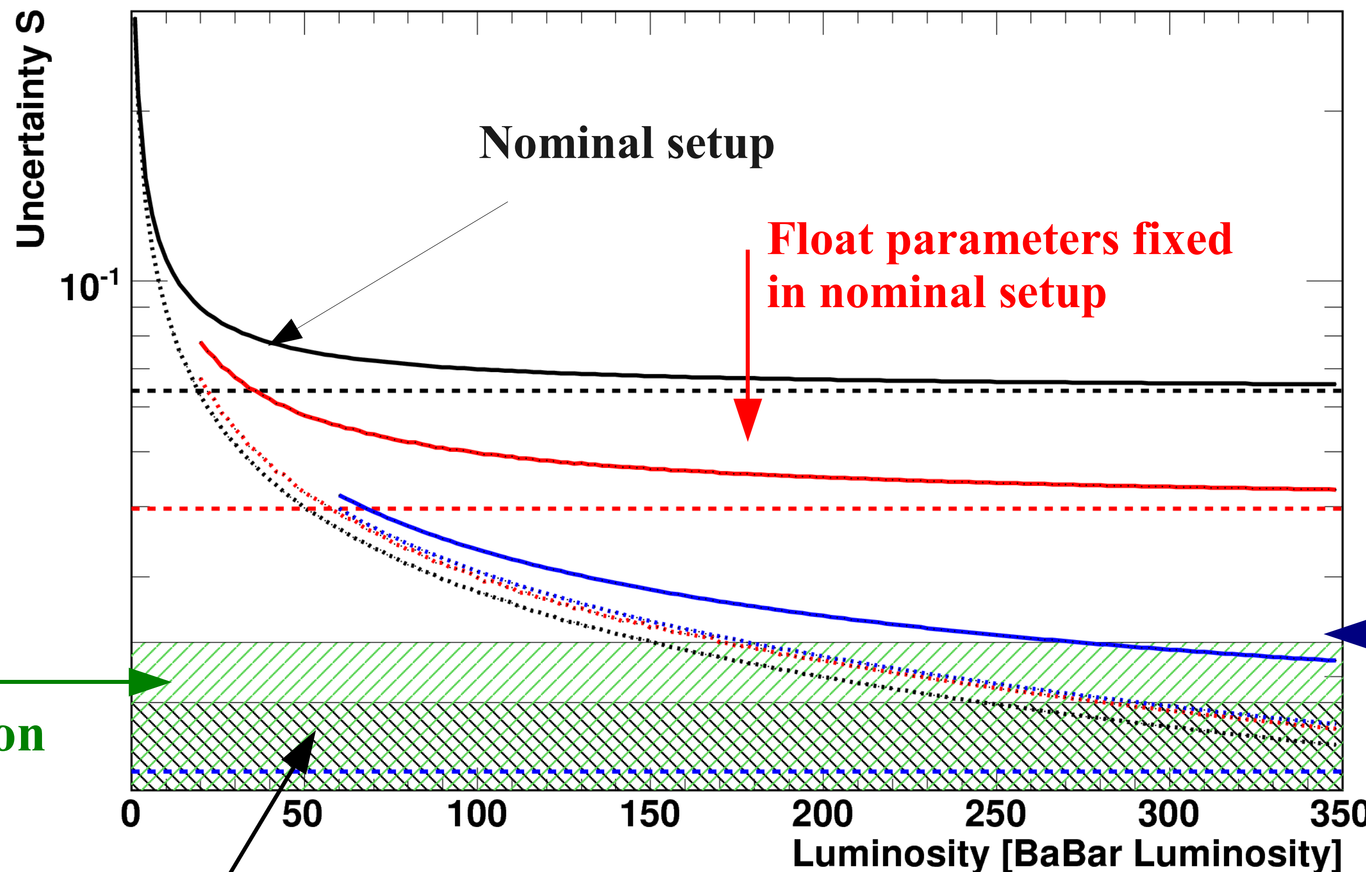


Vertex resolution in z improves by a factor of ~2 wrt BaBar → sufficient for time-dependent measurement

Error projection (1/2)

- Right now the **statistical error dominates** the total uncertainty. With increased statistics (~20 x BaBar), the **systematic uncertainty will dominate**.
- We use toy studies to estimate **how the total error can be reduced** at luminosities expected at SuperB
- The most **straight-forward way** to reduce systematic uncertainties is to **free parameters** that have been fitted on simulation or are taken from other measurements (This increases the statistical error).
- Systematics from **backgrounds from B decays** can be **reduced by better knowledge of their BF and CP content (we assume 10%-measurements for the exclusive contributions in the future).** For sizable contributions (in particular the generic component) the S and C parameters can be allowed to vary in the fit.

Error projection (2/2)



Dotted: Statistical error

Dashed: Systematic uncertainty

Solid: Total error

Current uncertainty on sin(2β)

Assume 10%-measurements (BF and CP) for exclusive modes in background

Theoretical uncertainty in prediction for S in $B^0 \rightarrow K_S K_S K_S$

After ten years of running the measurement becomes competitive with the theoretical uncertainty and the current on sin(2β)

Summary

- The time-dependent measurement is feasible and can be competitive with the current sin(2β) measurements using $B^0 \rightarrow c\bar{c}K^{(*)}$ events after 10 years of running
- The reconstruction efficiency increases by ~13% wrt to BaBar
- Beam backgrounds are not an issue for $B^0 \rightarrow K_S K_S K_S$