Study of the decay of $B \to \omega K_s$ at Belle

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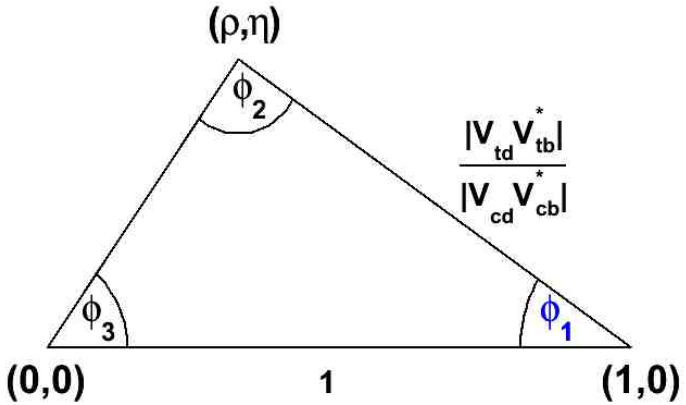
Physical Motivation

CKM Matrix

$$\begin{pmatrix} d \\ s \\ b \end{pmatrix}_{\text{weak}} = V_{\text{CKM}} \begin{pmatrix} d \\ s \\ b \end{pmatrix}_{\text{mass}} \equiv \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} \begin{pmatrix} d \\ s \\ b \end{pmatrix}_{\text{mass}}$$

CKM matrix is unitary $\Rightarrow V_{ud} \cdot V_{ub}^* + V_{cd} \cdot V_{cb}^* + V_{td} \cdot V_{tb}^* = 0$



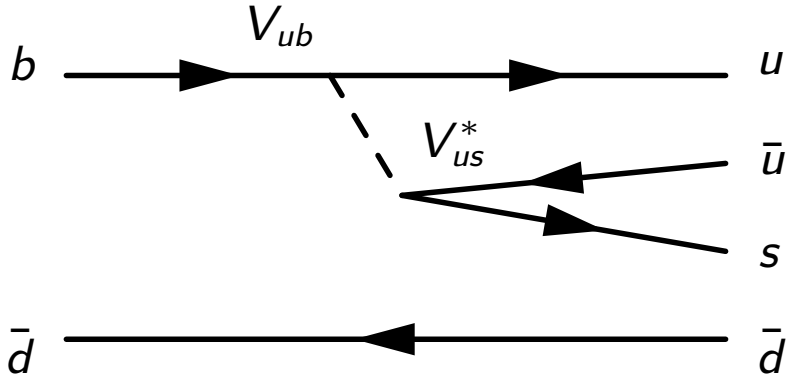
Decays via charmless $b \to sq\bar{q}$ (like $B \to \omega K_s$) transitions sensitive to ϕ_1

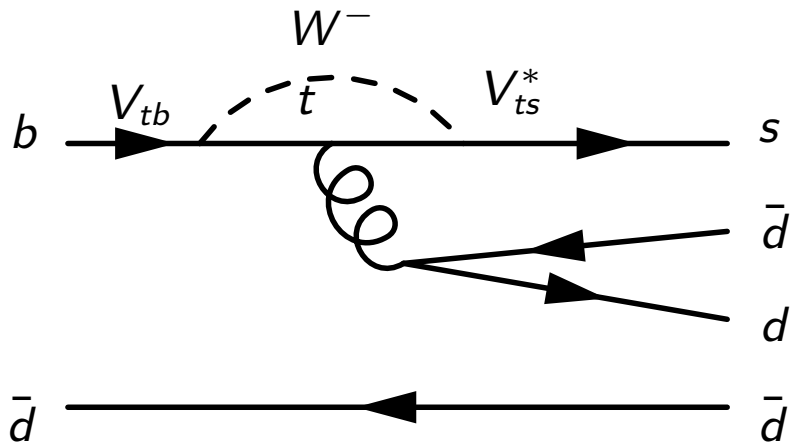
Physical Motivation

Wolfenstein parametrisation

$$V_{\mathrm{CKM}} = \begin{pmatrix} 1 & \lambda & \lambda^3(\rho - i\eta) \\ \lambda & 1 & \lambda^2 \\ \lambda^3(1 - \rho - i\eta) & \lambda^2 & 1 \end{pmatrix} + \mathcal{O}(\lambda^4)$$

$\lambda = \sin\theta_C \approx 0.22$, θ_C: Cabibbo angle





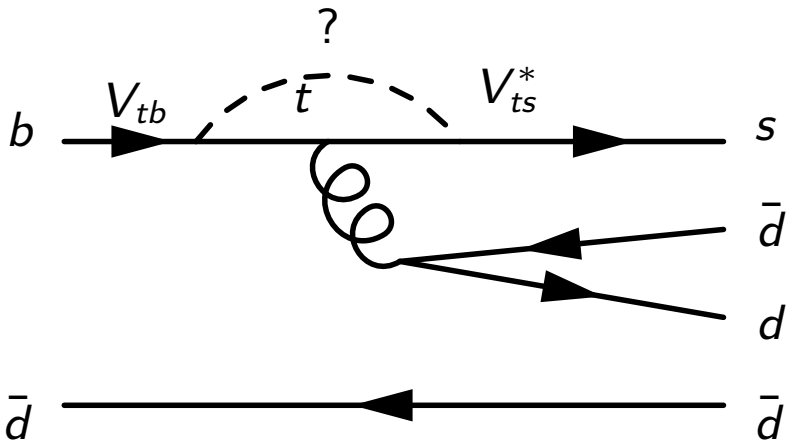
Matrix elements for the two Feynman diagrams:

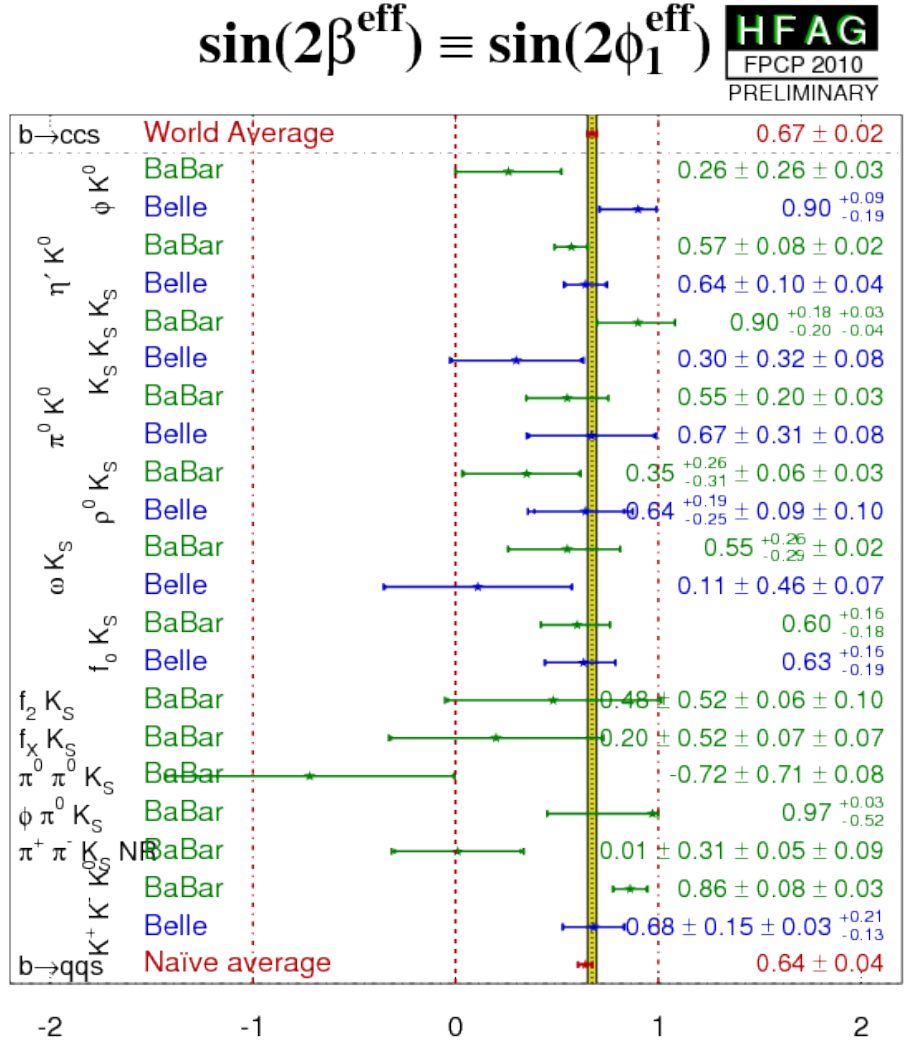
- $M_{tree} \propto \frac{V_{ub} \cdot V_{us}^*}{3} \propto \frac{\lambda^3 \cdot \lambda}{3} \propto \frac{\lambda^4}{3}$
- $M_{penguin} \propto V_{tb} \cdot V_{ts}^* \propto 1 \cdot \lambda^2 \propto \lambda^2$

$\Rightarrow$ Decay is penguin-dominated

Physical Motivation

- Theory predicts in SM that $\sin 2\phi_1$ from $b \to sq\bar{q}$ should be larger than for $b \to c\bar{c}s$ ($S_f - \sin 2\phi_1 \ \epsilon \ (0.0; 0.2)$)
- But measurements could be systematically lower (hint of New Physics)
- Unknown particle in the loop could change measured $\sin 2\phi_1$
- Discovery of $A_{cp} \neq 0$ for B^+ decay could give evidence of another Feynmann diagramm and an unknown particle





Analysis at MPI

- Ongoing analysis for two decays with the same kinematics: $B^0 \to \omega K_s$ and $B^+ \to \omega K^+$
- B^+: No mixing-induced CP-Violation, can give us the value for A_{cp}
- The analysis consists of the following steps:
  - Generating Monte Carlo events for signal and background
  - Reconstruction of the particles B, ω, K_s
  - Fitting the observables ΔE, $F_{BB/qq}$, ω mass, ω helicity, Δt, q
  - Extracting the branching fraction

B Reconstruction

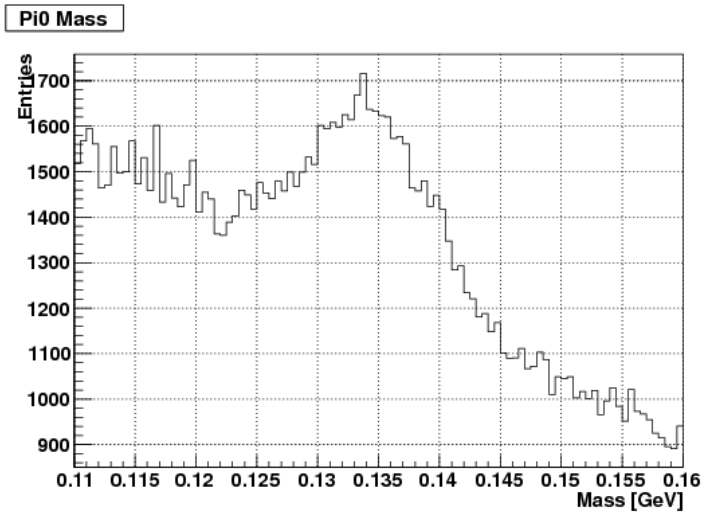
$B^0 \to \omega K_s \to \pi^+\pi^-\pi^0 K_s \to \pi^+\pi^-\pi^0\pi^+\pi^-$
$\pi^0 \to \gamma\gamma$

General selection criteria for the reconstruction

- For charged pions: $L_{K/\pi} < 0.9$ in order to separate them from the kaons
- For charged kaons (only B^+ decay): $L_{K/\pi} > 0.6$

π^0*candidates*

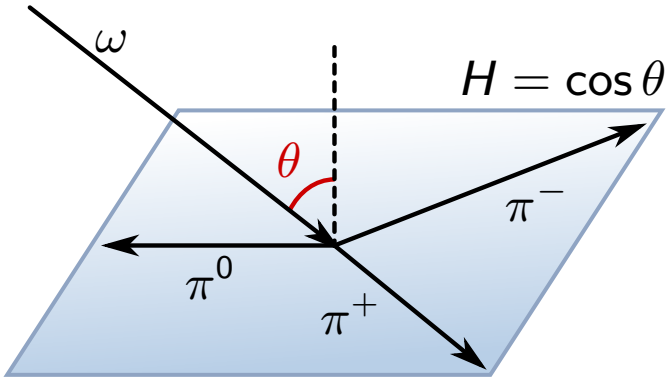
- $118\,MeV/c^2 < m(\gamma\gamma) < 150\,MeV/c^2$, mass fit $\chi^2 < 50$
- $E_\gamma > 50MeV$ in ECL barrel, $E_\gamma > 100MeV$ in ECL endcap



B reconstruction

ω candidates

$0.73\,GeV/c^2 < m(\pi^+\pi^-\pi^0) < 0.83\,GeV/c^2$ $(m(\omega) \pm 50\,MeV))$



K_s candidates

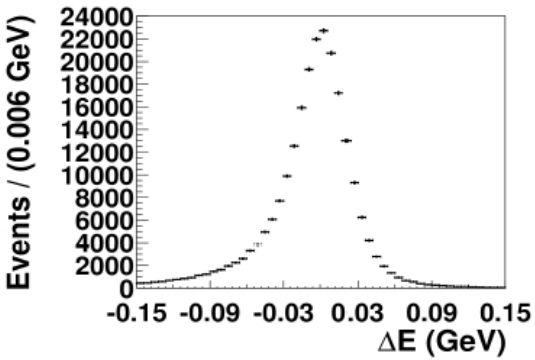
- The reconstructed vertex must be shifted from the e^+e^- collision point, as the kaon decays much later than the ω
- $0.482\,GeV/c^2 < m(\pi^+\pi^-) < 0.514\,GeV/c^2$ $(m(K_s) \pm 16\,MeV))$

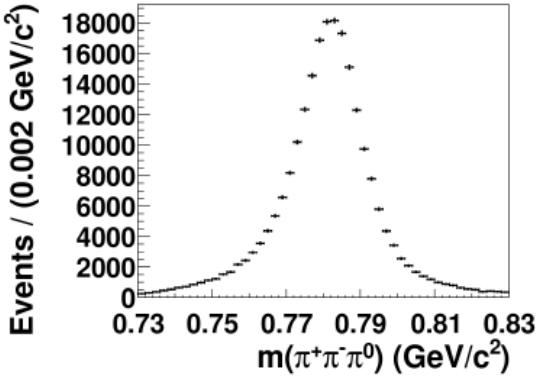
B reconstruction

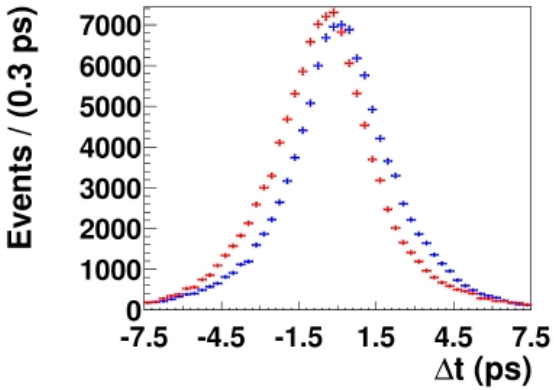
B^0 candidates

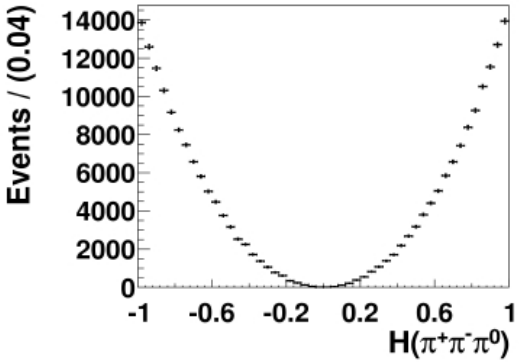
- Best B selected with the beam-energy constrained mass ($M_{bc} = \sqrt{E_{beam}^{cms} - p_B^{cms}}$ with E_{beam}^{cms} the beam energy and p_B^{cms} the reconstructed momentum of the B) closest to the nominal B mass ($5.28\ GeV/c^2$)
- Additionally, $M_{bc} > 5.27\ GeV/c^2$
- $|\Delta E| < 0.15\ GeV$ with $\Delta E = E_B^{cms} - E_{beam}^{cms}$
- Vertex determined from $\pi^+\pi^-$ tracks of the ω
- Flavour tagging and tag-side vertexing algorithm applied for determination of the B flavour

Efficiency of the reconstruction module: 14.2% Misreconstruction fraction: 10%









Red: B^0 tags, Blue: B^0-bar tags

Summary and outlook

- $B^0 \to \omega K_s$ is an interesting decay channel, which can reveal knowledge about New Physics
- In progress: Study of the different backgrounds
- To do:
  - Fit to the variables ΔE, $F_{BB/qq}$, ω mass, ω helicity, Δt, q
  - Extracting the CP parameters S_{cp}, A_{cp}
  - Extracting the branching fraction for the decay channel

Thank you
for your attention