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Measurement of the accuracy and mixing-induced CP-violating parameters of $B_s^0 \to \phi\gamma$ at CEPC

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The $b \to s\gamma$ is a critical FCNC process that could be used to probe CP violation (CPV) and New Physics (NP), especially in the context of future Z factory. The Circular Electron-Positron Collider (CEPC) offers inherent advantages for studying flavor physics, as it offers high statistic, clean collision environment, and superior detector performance. We quantify the anticipated precision of $B_s^0 \to \phi\gamma$ measurement at the CEPC Z pole modes, showing its signal strength could be determined to a relative accuracy of 0.16%, enhanced by roughly two orders of magnitudes compared to existing measurements. Additionally, we conduct a time dependent analysis of the $B_s^0 \to \phi\gamma$ decay, accounting for $B_s^0/\bar{B}_s^0$ mixing oscillations, and extract the mixing-induced and CP-violating parameters $\mathcal{A}_{\phi\gamma}^{\Delta}$, $C_{\phi\gamma}$ and $S_{\phi\gamma}$. The result are

$$\begin{aligned}\mathcal{A}_{\phi\gamma}^{\Delta} &= -0.67 \pm 0.0283(\text{stat}) \pm 0.0408(\text{syst}),\\ C_{\phi\gamma} &= 0.11 \pm 0.097(\text{stat}) \pm 0.0092(\text{syst}),\\ S_{\phi\gamma} &= 0.34 \pm 0.095(\text{stat}) \pm 0.0384(\text{syst}).\end{aligned}$$

We also conduct a relative detector optimization study by establishing the correlation between the anticipated precision and the intrinsic resolution of the ECAL, as well as the performance of the PID system.

Primary author: WANG, Hengyu (Institute of High Energy Physics)

Presenter: WANG, Hengyu (Institute of High Energy Physics)

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