$D^0$ Lifetime Plots with 2019 Data

The Belle II Collaboration

Preliminary plots of the $D^0$ lifetime for the $D^0 \rightarrow K^-\pi^+$, $D^0 \rightarrow K^-\pi^+\pi^0$ and $D^0 \rightarrow K^-\pi^+\pi^+\pi^-$ decays reconstructed in the data collected by Belle II during 2019, corresponding to 9.6 fb$^{-1}$ of integrated luminosity. More details in BELLE2-NOTE-PH-2020-033.
We reconstruct $D^0 \rightarrow K^-\pi^+$, $D^0 \rightarrow K^-\pi^+\pi^0$ and $D^0 \rightarrow K^-\pi^+\pi^+\pi^-$ candidates from $D^{*+} \rightarrow D^0\pi^+_s$ decays in data collected by Belle II in 2019, and corresponding to a luminosity of $9.6 \text{ fb}^{-1}$ of integrated luminosity. We extract the $D^0$ lifetime in each of the three signal channels with an unbinned maximum likelihood 2D fit to the proper time and proper time uncertainty distribution. The average lifetime is $\tau_{D^0} = (412.3 \pm 2.0) \text{ fs}$, in agreement with the world-average value of $(410.1 \pm 1.5) \text{ fs}$. A summary plot is shown in Figure 1. The proper-time projections of the three fits are shown in Figures 2, 3 and 4. The average decay-time resolution is estimated to be $(97 \pm 8) \text{ fs}$ for the $D^0 \rightarrow K^-\pi^+$ channel, $(128 \pm 9) \text{ fs}$ for the $D^0 \rightarrow K^-\pi^+\pi^0$ channel and $(82 \pm 9) \text{ fs}$ for the $D^0 \rightarrow K^-\pi^+\pi^+\pi^-$ channel.

![Figure 1: Comparison of the extracted lifetime in the three signal channels, compared to the world average. The average of the three extracted lifetimes is $(412.3 \pm 2.0) \text{ fs}$.

Belle II (preliminary)\[
\int L \, dt = 9.6 \text{ fb}^{-1}
\]
Figure 2: Fit to the proper-time distributions of $D^*\text{-tagged } D^0 \rightarrow K^-\pi^+$ candidates reconstructed with 2019 Belle II data. The extracted lifetime in this channel is $(412.4 \pm 3.4)$ fs, the estimated average proper time resolution is $(97 \pm 8)$ fs.
Figure 3: Fit to the proper-time distributions of $D^*$-tagged $D^0 \to K^-\pi^+\pi^0$ candidates reconstructed with 2019 Belle II data. The extracted lifetime in this channel is $(413.3 \pm 2.9)$ fs, the estimated average proper time resolution is $(128 \pm 9)$ fs.
Figure 4: Fit to the proper-time distributions of $D^*$-tagged $D^0 \to K\pi\pi\pi$ candidates reconstructed with 2019 Belle II data. The extracted lifetime in this channel is $(410.2 \pm 4.1) \text{ fs}$, the estimated average proper time resolution is $(82 \pm 9) \text{ fs}$.