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Rediscovery of $D^0 \rightarrow K_S^0 \pi^+ \pi^-$ decays in early Belle II data

The Belle II Collaboration

This note presents plots for rediscovery of the $D^{*+} \rightarrow D^0 \pi^+$, $D^0 \rightarrow K_S^0 \pi^+ \pi^-$ decays, using the data collected by Belle II during 2019, which correspond to 9.6 fb^{-1} of integrated luminosity. The fit to $M(D^0)$ vs Q 2D distribution, fit to D^0 decay-time and Dalitz distributions are shown in this note.

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2 We reconstruct $D^{*+} \rightarrow D^0(\rightarrow K_s^0\pi^+\pi^-)\pi^+$ decays in data collected by Belle II in 2019,
 3 and corresponding to 9.6 fb^{-1} of integrated luminosity. A fit to the 2D distribution of
 4 $M(D^0)$ and $Q = M(D^{*+}) - M(D^0) - m_{\pi^+}$, displayed in Figure 1, gives a yield per fb^{-1}
 5 of 1230 ± 15 (*stat.*). The purity (98.3%) in the signal region is higher than at Belle
 6 (95.5%) because of the improved Q resolution. In addition, a fit to the D^0 decay-time
 7 distribution, shown in Figure 2, returns a lifetime of 408 ± 5 (*stat.*) fs, in agreement with
 8 the world-average value (410.1 ± 1.5 fs). The average decay-time resolution is estimated
 9 to be approximately 145 fs, a factor of about two better than Belle. The Dalitz-plot
 10 distributions of the data are also displayed in Figure 3, where m_+^2 indicates $M^2(K_s^0\pi^+)$
 11 for D^0 decays and $M^2(K_s^0\pi^-)$ for \bar{D}^0 decays, while m_-^2 indicates $M^2(K_s^0\pi^-)$ for D^0 decays
 12 and $M^2(K_s^0\pi^+)$ for \bar{D}^0 decays. Besides, $m_{\pi\pi}^2$ is an abbreviation for $M^2(\pi^+\pi^-)$, while $\theta_{\pi\pi}$
 13 is the helicity angle, indicating the angle between $\pi^-(\pi^+)$ and K_s^0 momenta in $\pi^+\pi^-$ -rest
 14 frame in D^0 (\bar{D}^0) decays.

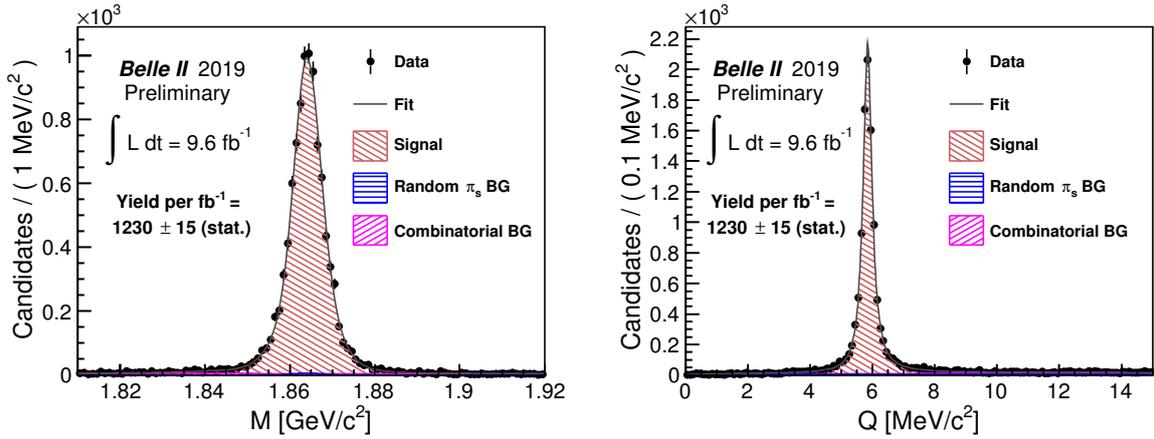


Figure 1: Distributions of (left) $M(D^0)$ and (right) $Q = M(D^{*+}) - M(D^0) - m_{\pi^+}$ for $D^0 \rightarrow K_s^0\pi^+\pi^-$ data candidates populating the Q and $M(D^0)$ signal regions, respectively, with fit projection overlaid.

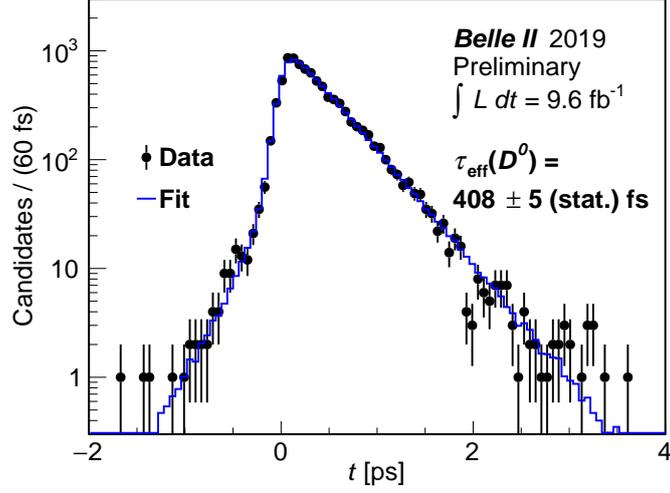


Figure 2: Phase-space-integrated decay-time distribution of $D^0 \rightarrow K_s^0 \pi^+ \pi^-$ data candidates populating the $M(D^0)$ - Q signal region, with fit projection overlaid. The D^0 effective lifetime τ_{eff} is measured to be 408 ± 5 fs, where the uncertainty is statistical only. Here the effective lifetime means the lifetime obtained when approximating the $D^0 \rightarrow K_s^0 \pi^+ \pi^-$ decay rate to be a simple exponential function, *i.e.*, without properly accounting for the effects due to D^0 - \bar{D}^0 mixing. The average decay-time resolution is estimated to be approximately 145 fs, a factor of about two better than Belle.

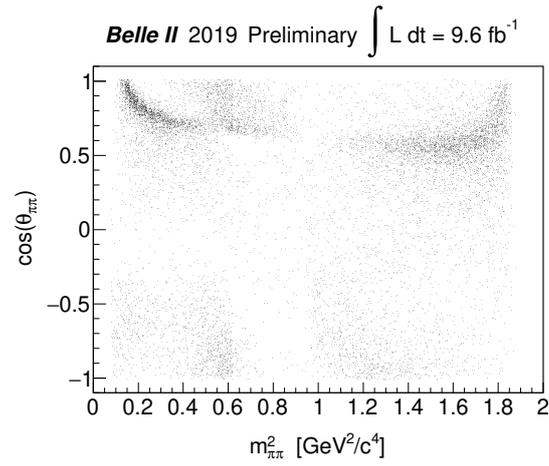
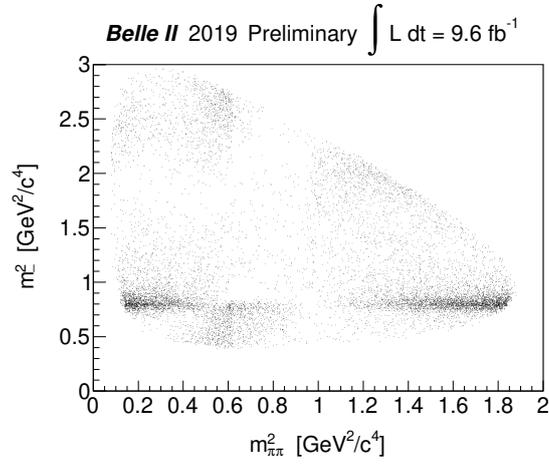
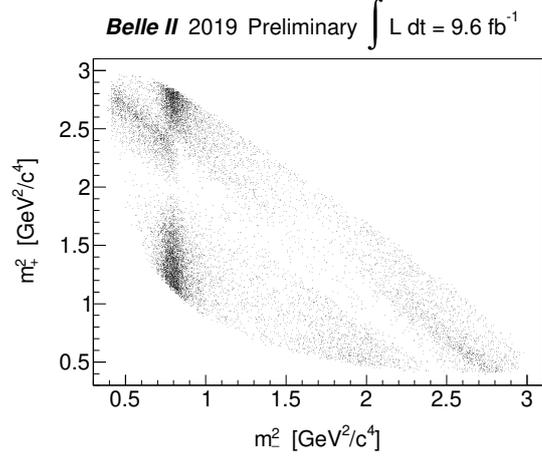


Figure 3: Dalitz-plot distributions for $D^0 \rightarrow K_S^0 \pi^+ \pi^-$ data candidates populating the $M(D^0)$ - Q signal region: (a) m_+^2 vs m_-^2 , (b) m_-^2 vs $m_{\pi\pi}^2$ and (c) $\cos(\theta_{\pi\pi})$ vs $m_{\pi\pi}^2$.