We combine the results presented in this Letter with current knowledge of charm-mixing parameters to assess their impact on the world average. The combination procedure follows closely the methods of the Heavy Flavor Averaging Group. In addition to the results presented in this Letter, the following measurements are included in the combination:

- LHCb collaboration, R. Aaij et al., Updated determination of \(D^0 - \bar{D}^0\) mixing and CP violation parameters with \(D^0 \to K^+\pi^-\) decays, Phys. Rev. D97 (2018) 031101, arXiv:1712.03220.
- CLEO collaboration, D. M. Asner et al., Updated measurement of the strong phase in \(D^0 \to K^+\pi^-\) decay using quantum correlations in \(e^+e^- \to D^0\bar{D}^0\) at CLEO, Phys. Rev. D86 (2012) 112001, arXiv:1210.0939.
- LHCb collaboration, R. Aaij et al., Measurement of the CP violation parameter \(A_\Gamma\) in \(D^0 \to K^+K^-\) and \(D^0 \to \pi^+\pi^-\) decays, Phys. Rev. Lett. 118 (2017) 261803, arXiv:1702.06490.
- Belle collaboration, M. Starič et al., Measurement of \(D^0 - \bar{D}^0\) mixing and search for CP violation in \(D^0 \to K^+K^-, \pi^+\pi^-\) decays with the full Belle data set, Phys. Lett B753 (2016) 412, arXiv:1509.08266.
- LHCb collaboration, R. Aaij et al., Measurement of indirect CP asymmetries in \(D^0 \to K^-K^+\) and \(D^0 \to \pi^-\pi^+\) decays using semileptonic B decays, JHEP 04 (2015) 043, arXiv:1501.06777.
- CDF collaboration, T. Aaltonen et al., Measurement of indirect CP-violating asymmetries in \(D^0 \to K^+K^-\) and \(D^0 \to \pi^+\pi^-\) decays at CDF, Phys. Rev. D90 (2014) 111103, arXiv:1410.5435.
- LHCb collaboration, R. Aaij et al., Model-independent measurement of mixing parameters in \(D^0 \to K_S^0\pi^+\pi^-\) decays, JHEP 04 (2016) 033, arXiv:1510.01664.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Allowed interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x \times 10^{-2}$</td>
<td>$0.38 \pm 0.12$</td>
<td>[0.26, 0.50] [0.14, 0.61] [0.02, 0.71]</td>
</tr>
<tr>
<td>$y \times 10^{-2}$</td>
<td>$0.655 \pm 0.062$</td>
<td>[0.588, 0.717] [0.52, 0.78] [0.44, 0.84]</td>
</tr>
<tr>
<td>$</td>
<td>q/p</td>
<td>$</td>
</tr>
<tr>
<td>$\phi$</td>
<td>$-0.070 \pm 0.079$</td>
<td>$[-0.151, 0.009]$ $[-0.24, 0.09]$ $[-0.33, 0.19]$</td>
</tr>
</tbody>
</table>

- Belle collaboration, T. Peng et al., *Measurement of $D^0$–$\bar{D}^0$ mixing and search for indirect CP violation using $D^0 \to K_S^0 \pi^+ \pi^-$ decays*, Phys. Rev. D89 (2014) 091103, arXiv:1404.2412;

- BaBar collaboration, P. del Amo Sanchez et al., *Measurement of $D^0$–$\bar{D}^0$ mixing parameters using $D^0 \to K_S^0 \pi^+ \pi^-$ and $D^0 \to K_S^0 K^+ K^-$ decays*, Phys. Rev. Lett. 105 (2010) 081803, arXiv:1004.5053;


- LHCb collaboration, R. Aaij et al., *First observation of $D^0$–$\bar{D}^0$ oscillations in $D^0 \to K^+ \pi^- \pi^+ \pi^-$ decays and measurement of the associated coherence parameters*, Phys. Rev. Lett. 116 (2016) 241801, arXiv:1602.07224;

- BaBar collaboration, J. P. Lees et al., *Measurement of the neutral $D$ meson mixing parameters in a time-dependent amplitude analysis of the $D^0 \to \pi^+ \pi^- \pi^0$ decay*, Phys Rev. D93 (2016) 112014, arXiv:1604.00857;

- BaBar collaboration, B. Aubert et al., *Measurement of $D^0$–$\bar{D}^0$ mixing from a time-dependent amplitude analysis of $D^0 \to K^+ \pi^- \pi^0$ decays*, Phys. Rev. Lett. 103 (2009) 211801, arXiv:0807.4544;


The results are reported in Table 5 and Figure 5.
Figure 5: Impact of the results reported in this Letter on current global averages of charm-mixing parameters. The hatched and shaded areas in the bottom panels indicate the 68% and 95% confidence regions, respectively.
Table 6: Summary of the uncertainties in units of $10^{-3}$. Numbers outside parentheses refer to the combined fit to prompt and semileptonic data, those inside the first (second) parentheses refer to the fit to the prompt-only (semileptonic-only) data. The total systematic uncertainty is the sum in quadrature of the individual components. The uncertainties due to the CLEO inputs are included in the statistical uncertainty. We also report separately the contributions due to the CLEO inputs and to our sample size to ease comparison with other sources.

<table>
<thead>
<tr>
<th>Source</th>
<th>$x_{CP}$</th>
<th>$y_{CP}$</th>
<th>$\Delta x$</th>
<th>$\Delta y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary charm decays</td>
<td>0.24(0.44)</td>
<td>0.36(0.65)</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Unrelated $D^0\mu^-$ combinations</td>
<td>0.34(0.00)</td>
<td>0.31(0.00)</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Reconstruction and selection biases</td>
<td>0.08(0.24)</td>
<td>0.94(1.37)</td>
<td>0.22(0.24)</td>
<td>0.25(0.29)</td>
</tr>
<tr>
<td>Mass-fit model</td>
<td>0.04(0.02)</td>
<td>0.03(0.08)</td>
<td>&lt; 0.01</td>
<td>0.03(0.04)</td>
</tr>
<tr>
<td>VELO length scale</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Input $D^0$ lifetime</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Total systematic</td>
<td>0.43(0.50)</td>
<td>1.05(1.52)</td>
<td>0.22(0.24)</td>
<td>0.25(0.29)</td>
</tr>
</tbody>
</table>

CLEO inputs                        | 0.70(0.65) | 1.22(1.54) | 0.19(0.25) | 0.26(0.36) |

Statistical (w/o CLEO inputs)      | 1.46(1.76) | 3.35(4.02) | 0.68(0.74) | 1.58(1.76) |

Statistical                        | 1.62(1.87) | 3.57(4.30) | 0.70(0.78) | 1.60(1.80) |
Figure 6: (Left) Example fit to the distribution of the $D^0 \log(\chi^2_{IP})$ of background-subtracted $D^{+} \rightarrow D^{0}(\rightarrow K_{S}^{0}\pi^{+}\pi^{-})\pi^{+}$ candidates selected by an inclusive $D^{+}$ trigger; the distribution for the secondary decays is determined from prompt candidates that are also reconstructed as $B \rightarrow D^{*+}\mu^{-}X$ decays. (Right) Observed fraction of secondary $D^{*+}$ decays as a function of decay time, for candidates selected by the inclusive $D^{*+}$ trigger; in the evaluation of the systematic uncertainties, the larger secondary fraction indicated by the red line is considered to account for uncertainties in the extrapolation of the contamination fraction to the full sample.

Figure 7: (Left) Example distribution of the visible $B$ mass for $B \rightarrow D^{0}(\rightarrow K_{S}^{0}\pi^{+}\pi^{-})\mu^{-}X$ candidates. The unphysical region on the right of the dashed line is fitted with an exponential function (red) to extract the fraction of random $D^{0}\mu^{-}$ combinations in the signal region. The background in $D^{0}$ mass is statistically subtracted. (Right) Example fit to the $\Delta m$ distribution of $B \rightarrow D^{*+}(\rightarrow D^{0}\pi^{+})\mu^{+}X$ candidates where the muon and soft-pion charges have the same sign. The fraction of these candidates is a measure of the fraction of random $D^{0}\mu^{-}$ combinations.
Figure 8: Two-dimensional 68.3%, 95.5%, and 99.7% confidence-level (CL) contours in the (left) $(x_{CP}, y_{CP})$ and (right) $(\Delta x, \Delta y)$ planes, as determined from the fit to the combined prompt and semileptonic data. The no-mixing hypothesis (indicated by the cross in the left plot) has a $p$ value of 1% and the no-$CP$-violation hypothesis (indicated by the cross in the right plot) has a $p$ value of 72%.

Figure 9: Distribution of $1 - CL$ for the derived parameters $x$, $y$, $|q/p|$, $\phi$. 
Figure 10: Efficiency (normalized to unity at its maximum) as a function of decay time as determined from simulation for the (solid blue) prompt and (dashed red) semileptonic samples. The samples reconstructed with long and downstream $K_S^0$ candidates have been combined.

Figure 11: Efficiency as a function of the Dalitz-plot position, as determined from simulation for the (left) prompt and (right) semileptonic samples. The samples reconstructed with long and downstream $K_S^0$ candidates have been combined.
Figure 12: Smoothed distribution of the efficiency as a function of decay time and $m^2(\pi^+\pi^-)$ in $D^{*+} \to D^0(\to K^0_S\pi^+\pi^-)\pi^+$ decays, as determined from the data with (left) downstream and (right) long $K^0_S$ candidates.

Figure 13: Smoothed distribution of the efficiency as a function of decay time and $m^2(\pi^+\pi^-)$ in $B \to D^0(\to K^0_S\pi^+\pi^-)\mu^-X$ decays, as determined from the data with (left) downstream and (right) long $K^0_S$ candidates.