

# BOTTOM MESONS

## ( $B = \pm 1$ )

$$B^+ = u\bar{b}, B^0 = d\bar{b}, \bar{B}^0 = \bar{d}b, B^- = \bar{u}b, \quad \text{similarly for } B^{*'}s$$

### **$B$ -particle organization**

Many measurements of  $B$  decays involve admixtures of  $B$  hadrons. Previously we arbitrarily included such admixtures in the  $B^\pm$  section, but because of their importance we have created two new sections: “ $B^\pm/B^0$  Admixture” for  $\Upsilon(4S)$  results and “ $B^\pm/B^0/B_s^0/b$ -baryon Admixture” for results at higher energies. Most inclusive decay branching fractions and  $\chi_b$  at high energy are found in the Admixture sections.  $B^0$ - $\bar{B}^0$  mixing data are found in the  $B^0$  section, while  $B_s^0$ - $\bar{B}_s^0$  mixing data and  $B$ - $\bar{B}$  mixing data for a  $B^0/B_s^0$  admixture are found in the  $B_s^0$  section.  $CP$ -violation data are found in the  $B^\pm$ ,  $B^0$ , and  $B^\pm/B^0$  Admixture sections.  $b$ -baryons are found near the end of the Baryon section.

The organization of the  $B$  sections is now as follows, where bullets indicate particle sections and brackets indicate reviews.

- $B^\pm$   
mass, mean life,  $CP$  violation, branching fractions
- $B^0$   
mass, mean life,  $B^0$ - $\bar{B}^0$  mixing,  $CP$  violation,  
branching fractions
- $B^\pm/B^0$  Admixtures  
 $CP$  violation, branching fractions
- $B^\pm/B^0/B_s^0/b$ -baryon Admixtures  
mean life, production fractions, branching fractions
- $B^*$ ,  $B_1(5721)$ ,  $B_2^*(5747)$ ,  $B_J(5970)$   
mass, width
- $B_s^0$   
mass, mean life,  $B_s^0$ - $\bar{B}_s^0$  mixing,  $CP$  violation,  
branching fractions
- $B_s^*$ ,  $B_{s1}(5830)^0$ ,  $B_{s2}^*(5840)^0$   
mass, width

- $B_c^\pm$   
mass, mean life, branching fractions
- $B_c(2S)^\pm$   
mass

At the end of Baryon Listings:

- $\Lambda_b$   
mass, mean life, branching fractions
- $\Lambda_b(5912)^0$ ,  $\Lambda_b(5920)^0$ ,  $\Lambda_b(6070)^0$ ,  $\Lambda_b(6146)^0$ ,  $\Lambda_b(6152)^0$   
mass, width
- $\Sigma_b$   
mass
- $\Sigma_b^*$ ,  $\Sigma_b(6097)^+$ ,  $\Sigma_b(6097)^-$   
mass, width
- $\Xi_b^0$ ,  $\Xi_b^-$   
mass, mean life, branching fractions
- $\Xi_b'(5935)^-$ ,  $\Xi_b(5945)^0$ ,  $\Xi_b(5955)^-$ ,  $\Xi_b(6100)^-$ ,  $\Xi_b(6227)^-$ ,  
 $\Xi_b(6227)^0$ ,  $\Xi_b(6327)^0$ ,  $\Xi_b(6333)^0$   
mass, width
- $\Omega_b^-$   
mass, mean life, branching fractions
- $\Omega_b(6316)^-$ ,  $\Omega_b(6330)^-$ ,  $\Omega_b(6340)^-$ ,  $\Omega_b(6350)^-$   
mass
- $b$ -baryon Admixture  
mean life, branching fractions

**$B^\pm$**

$$I(J^P) = \frac{1}{2}(0^-)$$

$I$ ,  $J$ ,  $P$  need confirmation. Quantum numbers shown are quark-model predictions.

$$\text{Mass } m_{B^\pm} = 5279.41 \pm 0.07 \text{ MeV}$$

$$\text{Mean life } \tau_{B^\pm} = (1.638 \pm 0.004) \times 10^{-12} \text{ s}$$

$$c\tau = 491.1 \text{ } \mu\text{m}$$

**CP violation**

$$\begin{aligned}
A_{CP}(B^+ \rightarrow J/\psi(1S)K^+) &= (1.8 \pm 3.0) \times 10^{-3} \quad (S = 1.5) \\
A_{CP}(B^+ \rightarrow J/\psi(1S)\pi^+) &= (1.8 \pm 1.2) \times 10^{-2} \quad (S = 1.3) \\
A_{CP}(B^+ \rightarrow J/\psi\rho^+) &= -0.05 \pm 0.05 \\
A_{CP}(B^+ \rightarrow J/\psi K^*(892)^+) &= -0.048 \pm 0.033 \\
A_{CP}(B^+ \rightarrow \eta_c K^+) &= 0.01 \pm 0.07 \quad (S = 2.2) \\
A_{CP}(B^+ \rightarrow \psi(2S)\pi^+) &= 0.03 \pm 0.06 \\
A_{CP}(B^+ \rightarrow \psi(2S)K^+) &= 0.012 \pm 0.020 \quad (S = 1.5) \\
A_{CP}(B^+ \rightarrow \psi(2S)K^*(892)^+) &= 0.08 \pm 0.21 \\
A_{CP}(B^+ \rightarrow \chi_{c1}(1P)\pi^+) &= 0.07 \pm 0.18 \\
A_{CP}(B^+ \rightarrow \chi_{c0}K^+) &= -0.20 \pm 0.18 \quad (S = 1.5) \\
A_{CP}(B^+ \rightarrow \chi_{c1}K^+) &= -0.009 \pm 0.033 \\
A_{CP}(B^+ \rightarrow \chi_{c1}K^*(892)^+) &= 0.5 \pm 0.5 \\
A_{CP}(B^+ \rightarrow D^0\ell^+\nu_\ell) &= (-0.14 \pm 0.20) \times 10^{-2} \\
A_{CP}(B^+ \rightarrow \bar{D}^0\pi^+) &= (-3.2 \pm 3.5) \times 10^{-3} \\
A_{CP}(B^+ \rightarrow D_{CP(+1)}\pi^+) &= -0.0088 \pm 0.0024 \\
A_{CP}(B^+ \rightarrow D_{CP(-1)}\pi^+) &= -0.003 \pm 0.012 \\
A_{CP}([K^\mp\pi^\pm\pi^+\pi^-]_D\pi^+) &= 0.070 \pm 0.020 \\
A_{CP}(B^+ \rightarrow [\pi^+\pi^+\pi^-\pi^-]_D K^+) &= 0.061 \pm 0.013 \\
A_{CP}(B^+ \rightarrow [\pi^+\pi^-\pi^+\pi^-]_D K^*(892)^+) &= 0.02 \pm 0.11 \\
A_{CP}(B^+ \rightarrow [K^+K^-\pi^+\pi^-]_D K^+) &= 0.095 \pm 0.023 \\
A_{CP}(B^+ \rightarrow [K^+K^-\pi^+\pi^-]_D \pi^+) &= -0.009 \pm 0.006 \\
A_{CP}(B^+ \rightarrow \bar{D}^0 K^+) &= -0.018 \pm 0.004 \\
A_{CP}([K^\mp\pi^\pm\pi^+\pi^-]_D K^+) &= -0.32 \pm 0.04 \\
A_{CP}(B^+ \rightarrow [\pi^+\pi^+\pi^-\pi^-]_D \pi^+) &= (-8.2 \pm 3.2) \times 10^{-3} \\
A_{CP}(B^+ \rightarrow [K^-\pi^+]_D K^+) &= -0.58 \pm 0.21 \\
A_{CP}(B^+ \rightarrow [K^-\pi^+\pi^0]_D K^+) &= -0.27 \pm 0.27 \quad (S = 2.4) \\
A_{CP}(B^+ \rightarrow [K^+\pi^-\pi^0]_D K^+) &= -0.024 \pm 0.013 \\
A_{CP}(B^+ \rightarrow [K^+K^-\pi^0]_D K^+) &= 0.07 \pm 0.07 \\
A_{CP}(B^+ \rightarrow [\pi^+\pi^-\pi^0]_D K^+) &= 0.11 \pm 0.04 \\
A_{CP}(B^+ \rightarrow \bar{D}^0 K^*(892)^+) &= -0.007 \pm 0.019 \\
A_{CP}(B^+ \rightarrow [K^-\pi^+]_{\bar{D}} K^*(892)^+) &= -0.75 \pm 0.16 \\
A_{CP}(B^+ \rightarrow [K^-\pi^+\pi^-\pi^+]_{\bar{D}} K^*(892)^+) &= -0.45 \pm 0.25 \\
A_{CP}(B^+ \rightarrow [K^-\pi^+]_D \pi^+) &= 0.00 \pm 0.09 \\
A_{CP}(B^+ \rightarrow [K^-\pi^+\pi^0]_D \pi^+) &= 0.08 \pm 0.09 \\
A_{CP}(B^+ \rightarrow [K^+K^-\pi^0]_D \pi^+) &= -0.001 \pm 0.019 \\
A_{CP}(B^+ \rightarrow [\pi^+\pi^-\pi^0]_D \pi^+) &= 0.001 \pm 0.010 \\
A_{CP}(B^+ \rightarrow [K^-\pi^+]_{(D\pi)} \pi^+) &= -0.09 \pm 0.27 \\
A_{CP}(B^+ \rightarrow [K^-\pi^+]_{(D\gamma)} \pi^+) &= -0.7 \pm 0.6 \\
A_{CP}(B^+ \rightarrow [K^-\pi^+]_{(D\pi)} K^+) &= 0.8 \pm 0.4
\end{aligned}$$

$$\begin{aligned}
A_{CP}(B^+ \rightarrow [K^- \pi^+]_{(D\gamma)} K^+) &= 0.4 \pm 1.0 \\
A_{CP}(B^+ \rightarrow [\pi^+ \pi^- \pi^0]_D K^+) &= -0.02 \pm 0.15 \\
A_{CP}(B^+ \rightarrow [K_S^0 K^+ \pi^-]_D K^+) &= 0.00 \pm 0.09 \quad (S = 1.4) \\
A_{CP}(B^+ \rightarrow [K_S^0 K^- \pi^+]_D K^+) &= 0.00 \pm 0.07 \\
A_{CP}(B^+ \rightarrow [K_S^0 K^- \pi^+]_D \pi^+) &= -0.003 \pm 0.014 \\
A_{CP}(B^+ \rightarrow [K_S^0 K^+ \pi^-]_D \pi^+) &= -0.016 \pm 0.025 \quad (S = 1.5) \\
A_{CP}(B^+ \rightarrow [K^*(892)^- K^+]_D K^+) &= 0.08 \pm 0.05 \\
A_{CP}(B^+ \rightarrow [K^*(892)^+ K^-]_D K^+) &= 0.07 \pm 0.09 \\
A_{CP}(B^+ \rightarrow [K^*(892)^+ K^-]_D \pi^+) &= 0.007 \pm 0.016 \\
A_{CP}(B^+ \rightarrow [K^*(892)^- K^+]_D \pi^+) &= -0.013 \pm 0.020 \quad (S = 1.9) \\
\mathbf{A_{CP}(B^+ \rightarrow D_{CP(+1)} K^+)} &= 0.132 \pm 0.015 \quad (S = 1.8) \\
A_{ADS}(B^+ \rightarrow D K^+) &= -0.451 \pm 0.026 \\
A_{ADS}(B^+ \rightarrow D \pi^+) &= 0.129 \pm 0.014 \\
A_{ADS}(B^+ \rightarrow [D\gamma]_{D^*} K^+) &= -0.6 \pm 1.3 \\
A_{ADS}(B^+ \rightarrow [D\pi^0]_{D^*} K^+) &= 0.72 \pm 0.29 \\
A_{ADS}(B^+ \rightarrow [D\gamma]_{D^*} \pi^+) &= 0.08 \pm 0.13 \\
A_{ADS}(B^+ \rightarrow [D\pi^0]_{D^*} \pi^+) &= -0.14 \pm 0.06 \\
A_{ADS}(B^+ \rightarrow [K^- \pi^+]_D K^+ \pi^- \pi^+) &= -0.33 \pm 0.35 \\
A_{ADS}(B^+ \rightarrow [K^- \pi^+]_D \pi^+ \pi^- \pi^+) &= -0.01 \pm 0.09 \\
A_{CP}(B^+ \rightarrow D_{CP(-1)} K^+) &= -0.14 \pm 0.05 \\
A_{CP}(B^+ \rightarrow [K^+ K^-]_D K^+ \pi^- \pi^+) &= -0.04 \pm 0.06 \\
A_{CP}(B^+ \rightarrow [\pi^+ \pi^-]_D K^+ \pi^- \pi^+) &= -0.05 \pm 0.10 \\
A_{CP}(B^+ \rightarrow [K^- \pi^+]_D K^+ \pi^- \pi^+) &= 0.013 \pm 0.023 \\
A_{CP}(B^+ \rightarrow [K^+ K^-]_D \pi^+ \pi^- \pi^+) &= -0.019 \pm 0.015 \\
A_{CP}(B^+ \rightarrow [\pi^+ \pi^-]_D \pi^+ \pi^- \pi^+) &= -0.013 \pm 0.019 \\
A_{CP}(B^+ \rightarrow [K^- \pi^+]_D \pi^+ \pi^- \pi^+) &= -0.002 \pm 0.011 \\
A_{CP}(B^+ \rightarrow [\bar{D}^0 \gamma]_{\bar{D}^*} \pi^+) &= -0.004 \pm 0.004 \\
A_{CP}(B^+ \rightarrow [\bar{D}^0 \pi^0]_{\bar{D}^*} \pi^+) &= 0.0007 \pm 0.0022 \\
A_{CP}(B^+ \rightarrow [\bar{D}^0 \gamma]_{\bar{D}_{CP(-1)}^*} \pi^+) &= 0.000 \pm 0.015 \\
A_{CP}(B^+ \rightarrow [\bar{D}^0 \pi^0]_{D_{CP(+1)}^*} \pi^+) &= 0.012 \pm 0.008 \\
A_{CP}(B^+ \rightarrow [\bar{D}^0 \pi^0]_{D_{CP(-1)}^*} \pi^+) &= -0.09 \pm 0.05 \\
A_{CP}(B^+ \rightarrow [\bar{D}^0 \gamma]_{\bar{D}^*} K^+) &= -0.004 \pm 0.014 \\
A_{CP}(B^+ \rightarrow [\bar{D}^0 \pi^0]_{\bar{D}^*} K^+) &= 0.017 \pm 0.007 \\
A_{CP}(B^+ \rightarrow [\bar{D}^0 \gamma]_{\bar{D}_{CP(-1)}^*} K^+) &= 0.12 \pm 0.06 \\
A_{CP}(B^+ \rightarrow [D^0 \pi^0]_{D_{CP(+1)}^*} K^+) &= -0.115 \pm 0.020 \\
A_{CP}(B^+ \rightarrow [D^0 \pi^0]_{D_{CP(-1)}^*} K^+) &= 0.07 \pm 0.10 \\
A_{CP}(B^+ \rightarrow D_{CP(+1)} K^*(892)^+) &= 0.08 \pm 0.06 \\
A_{CP}(B^+ \rightarrow D_{CP(-1)} K^*(892)^+) &= -0.23 \pm 0.22
\end{aligned}$$

$$\begin{aligned}
A_{CP}(B^+ \rightarrow D_s^+ \phi) &= 0.0 \pm 0.4 \\
A_{CP}(B^+ \rightarrow D_s^+ \bar{D}^0) &= (0.5 \pm 0.6)\% \\
A_{CP}(B^+ \rightarrow D_s^{*+} \bar{D}^0) &= (-0.5 \pm 1.5) \times 10^{-2} \\
A_{CP}(B^+ \rightarrow D_s^+ \bar{D}^{*0}) &= (1.1 \pm 1.1) \times 10^{-2} \\
A_{CP}(B^+ \rightarrow D_s^{*+} \bar{D}^{*0}) &= (1.3 \pm 2.6) \times 10^{-2} \\
A_{CP}(B^+ \rightarrow D^{*+} \bar{D}^0) &= (3.1 \pm 1.7) \times 10^{-2} \\
A_{CP}(B^+ \rightarrow D^+ \bar{D}^{*0}) &= (0.0 \pm 2.4) \times 10^{-2} \\
A_{CP}(B^+ \rightarrow D^+ \bar{D}^0) &= (2.4 \pm 1.1) \times 10^{-2} \\
A_{CP}(B^+ \rightarrow K_S^0 \pi^+) &= -0.003 \pm 0.015 \quad (S = 1.1) \\
A_{CP}(B^+ \rightarrow K^+ \pi^0) &= 0.027 \pm 0.012 \\
A_{CP}(B^+ \rightarrow \eta' K^+) &= 0.004 \pm 0.011 \\
A_{CP}(B^+ \rightarrow \eta' K^*(892)^+) &= -0.26 \pm 0.27 \\
A_{CP}(B^+ \rightarrow \eta' K_0^*(1430)^+) &= 0.06 \pm 0.20 \\
A_{CP}(B^+ \rightarrow \eta' K_2^*(1430)^+) &= 0.15 \pm 0.13 \\
\mathbf{A_{CP}(B^+ \rightarrow \eta K^+)} &= -0.37 \pm 0.08 \\
A_{CP}(B^+ \rightarrow \eta K^*(892)^+) &= 0.02 \pm 0.06 \\
A_{CP}(B^+ \rightarrow \eta K_0^*(1430)^+) &= 0.05 \pm 0.13 \\
A_{CP}(B^+ \rightarrow \eta K_2^*(1430)^+) &= -0.45 \pm 0.30 \\
A_{CP}(B^+ \rightarrow \omega K^+) &= -0.02 \pm 0.04 \\
A_{CP}(B^+ \rightarrow \omega K^{*+}) &= 0.29 \pm 0.35 \\
A_{CP}(B^+ \rightarrow \omega (K\pi)_0^{*+}) &= -0.10 \pm 0.09 \\
A_{CP}(B^+ \rightarrow \omega K_2^*(1430)^+) &= 0.14 \pm 0.15 \\
A_{CP}(B^+ \rightarrow K^{*0} \pi^+) &= -0.021 \pm 0.032 \quad (S = 1.5) \\
A_{CP}(B^+ \rightarrow K^*(892)^+ \pi^0) &= -0.39 \pm 0.21 \quad (S = 1.6) \\
\mathbf{A_{CP}(B^+ \rightarrow K^+ \pi^- \pi^+)} &= 0.015 \pm 0.006 \quad (S = 1.4) \\
A_{CP}(B^+ \rightarrow K^+ K^- K^+ \text{ nonresonant}) &= 0.06 \pm 0.05 \\
A_{CP}(B^+ \rightarrow f(980)^0 K^+) &= -0.08 \pm 0.09 \\
\mathbf{A_{CP}(B^+ \rightarrow f_2(1270) K^+)} &= -0.68^{+0.19}_{-0.17} \\
A_{CP}(B^+ \rightarrow f_0(1500) K^+) &= 0.28 \pm 0.30 \\
A_{CP}(B^+ \rightarrow f_2'(1525)^0 K^+) &= -0.08^{+0.05}_{-0.04} \\
\mathbf{A_{CP}(B^+ \rightarrow \rho^0 K^+)} &= 0.160 \pm 0.021 \\
A_{CP}(B^+ \rightarrow K^0 \pi^+ \pi^0) &= 0.07 \pm 0.06 \\
A_{CP}(B^+ \rightarrow K_0^*(1430)^0 \pi^+) &= 0.061 \pm 0.032 \\
A_{CP}(B^+ \rightarrow K_0^*(1430)^+ \pi^0) &= 0.26^{+0.18}_{-0.14} \\
A_{CP}(B^+ \rightarrow K_2^*(1430)^0 \pi^+) &= 0.05^{+0.29}_{-0.24} \\
A_{CP}(B^+ \rightarrow K^+ \pi^0 \pi^0) &= -0.06 \pm 0.07 \\
A_{CP}(B^+ \rightarrow K^0 \rho^+) &= -0.03 \pm 0.15 \\
A_{CP}(B^+ \rightarrow K^{*+} \pi^+ \pi^-) &= 0.07 \pm 0.08 \\
A_{CP}(B^+ \rightarrow \rho^0 K^*(892)^+) &= 0.31 \pm 0.13 \\
A_{CP}(B^+ \rightarrow K^*(892)^+ f_0(980)) &= -0.15 \pm 0.12 \\
A_{CP}(B^+ \rightarrow a_1^+ K^0) &= 0.12 \pm 0.11
\end{aligned}$$

$$\begin{aligned}
A_{CP}(B^+ \rightarrow b_1^+ K^0) &= -0.03 \pm 0.15 \\
A_{CP}(B^+ \rightarrow K^{*}(892)^0 \rho^+) &= -0.01 \pm 0.16 \\
A_{CP}(B^+ \rightarrow b_1^0 K^+) &= -0.46 \pm 0.20 \\
A_{CP}(B^+ \rightarrow K^0 K^+) &= 0.04 \pm 0.14 \\
A_{CP}(B^+ \rightarrow K_S^0 K^+) &= -0.21 \pm 0.14 \\
A_{CP}(B^+ \rightarrow K^+ K_S^0 K_S^0) &= 0.025 \pm 0.031 \\
\mathbf{A_{CP}(B^+ \rightarrow K^+ K^- \pi^+)} &= -0.115 \pm 0.008 \\
A_{CP}(B^+ \rightarrow K^+ K^- \pi^+ \text{ nonresonant}) &= -0.11 \pm 0.06 \\
A_{CP}(B^+ \rightarrow \pi^+ K^+ K^-, m_{K^+ K^-} < 1.1 \text{ GeV}) &= -0.17 \pm 0.07 \\
A_{CP}(B^+ \rightarrow K^+ \bar{K}^{*}(892)^0) &= 0.04 \pm 0.05 \\
A_{CP}(B^+ \rightarrow K^+ \bar{K}_0^{*}(1430)^0) &= 0.10 \pm 0.17 \\
A_{CP}(B^+ \rightarrow \phi \pi^+) &= 0.1 \pm 0.5 \\
A_{CP}(B^+ \rightarrow \pi^+ (K^+ K^-)_{S\text{-wave}}) &= -0.66 \pm 0.04 \\
\mathbf{A_{CP}(B^+ \rightarrow K^+ K^- K^+)} &= -0.036 \pm 0.004 \\
A_{CP}(B^+ \rightarrow \phi K^+) &= 0.017 \pm 0.017 \quad (S = 1.8) \\
A_{CP}(B^+ \rightarrow X_0(1550) K^+) &= -0.04 \pm 0.07 \\
A_{CP}(B^+ \rightarrow K^{*+} K^+ K^-) &= 0.11 \pm 0.09 \\
A_{CP}(B^+ \rightarrow \phi K^{*}(892)^+) &= -0.01 \pm 0.08 \\
A_{CP}(B^+ \rightarrow \phi (K\pi)_0^{*+}) &= 0.04 \pm 0.16 \\
A_{CP}(B^+ \rightarrow \phi K_1(1270)^+) &= 0.15 \pm 0.20 \\
A_{CP}(B^+ \rightarrow \phi K_2^{*}(1430)^+) &= -0.23 \pm 0.20 \\
A_{CP}(B^+ \rightarrow K^+ \phi \phi) &= -0.08 \pm 0.07 \\
A_{CP}(B^+ \rightarrow K^+ [\phi \phi]_{\eta_c}) &= 0.10 \pm 0.08 \\
A_{CP}(B^+ \rightarrow K^{*}(892)^+ \gamma) &= 0.014 \pm 0.018 \\
A_{CP}(B^+ \rightarrow X_S \gamma) &= 0.028 \pm 0.019 \\
A_{CP}(B^+ \rightarrow \eta K^+ \gamma) &= -0.12 \pm 0.07 \\
A_{CP}(B^+ \rightarrow \phi K^+ \gamma) &= -0.13 \pm 0.11 \quad (S = 1.1) \\
A_{CP}(B^+ \rightarrow \rho^+ \gamma) &= -0.11 \pm 0.33 \\
A_{CP}(B^+ \rightarrow \pi^+ \pi^0) &= -0.01 \pm 0.04 \quad (S = 1.1) \\
\mathbf{A_{CP}(B^+ \rightarrow \pi^+ \pi^- \pi^+)} &= 0.076 \pm 0.008 \quad (S = 1.5) \\
A_{CP}(B^+ \rightarrow \pi^+ \pi^0 \pi^0) &= (9 \pm 7) \times 10^{-2} \\
A_{CP}(B^+ \rightarrow \rho^0 \pi^+) &= 0.003 \pm 0.014 \\
A_{CP}(B^+ \rightarrow f_2(1270) \pi^+) &= 0.40 \pm 0.06 \\
A_{CP}(B^+ \rightarrow \rho^0(1450) \pi^+) &= -0.11 \pm 0.05 \\
A_{CP}(B^+ \rightarrow \rho_3(1690) \pi^+) &= -0.80 \pm 0.28 \\
\mathbf{A_{CP}(B^+ \rightarrow f_0(1370) \pi^+)} &= 0.72 \pm 0.22 \\
A_{CP}(B^+ \rightarrow \pi^+ \pi^- \pi^+ \text{ nonresonant}) &= -0.14^{+0.23}_{-0.16} \\
A_{CP}(B^+ \rightarrow \rho^+ \pi^0) &= 0.03 \pm 0.10 \\
A_{CP}(B^+ \rightarrow X \pi^+, X \rightarrow \pi^0 \pi^0) &= 0.18 \pm 0.12 \\
A_{CP}(B^+ \rightarrow \rho^+ \rho^0) &= -0.05 \pm 0.05 \\
A_{CP}(B^+ \rightarrow \omega \pi^+) &= -0.04 \pm 0.05
\end{aligned}$$

$$\begin{aligned}
A_{CP}(B^+ \rightarrow \omega \rho^+) &= -0.20 \pm 0.09 \\
A_{CP}(B^+ \rightarrow \eta \pi^+) &= -0.14 \pm 0.07 \quad (S = 1.4) \\
A_{CP}(B^+ \rightarrow \eta \rho^+) &= 0.11 \pm 0.11 \\
A_{CP}(B^+ \rightarrow \eta' \pi^+) &= 0.06 \pm 0.16 \\
A_{CP}(B^+ \rightarrow \eta' \rho^+) &= 0.26 \pm 0.17 \\
A_{CP}(B^+ \rightarrow b_1^0 \pi^+) &= 0.05 \pm 0.16 \\
A_{CP}(B^+ \rightarrow \rho \bar{\rho} \pi^+) &= 0.00 \pm 0.04 \\
A_{CP}(B^+ \rightarrow \rho \bar{\rho} K^+) &= 0.00 \pm 0.04 \quad (S = 2.2) \\
A_{CP}(B^+ \rightarrow \rho \bar{\rho} K^*(892)^+) &= 0.21 \pm 0.16 \quad (S = 1.4) \\
A_{CP}(B^+ \rightarrow \rho \bar{\Lambda} \gamma) &= 0.17 \pm 0.17 \\
A_{CP}(B^+ \rightarrow \rho \bar{\Lambda} \pi^0) &= 0.01 \pm 0.17 \\
A_{CP}(B^+ \rightarrow K^+ \ell^+ \ell^-) &= -0.02 \pm 0.08 \\
A_{CP}(B^+ \rightarrow K^+ e^+ e^-) &= 0.14 \pm 0.14 \\
A_{CP}(B^+ \rightarrow K^+ \mu^+ \mu^-) &= 0.011 \pm 0.017 \\
A_{CP}(B^+ \rightarrow \pi^+ \mu^+ \mu^-) &= -0.11 \pm 0.12 \\
A_{CP}(B^+ \rightarrow K^{*+} \ell^+ \ell^-) &= -0.09 \pm 0.14 \\
A_{CP}(B^+ \rightarrow K^* e^+ e^-) &= -0.14 \pm 0.23 \\
A_{CP}(B^+ \rightarrow K^* \mu^+ \mu^-) &= -0.12 \pm 0.24 \\
\gamma &= (65.9_{-3.1}^{+2.9})^\circ \\
\mathbf{r}_B(B^+ \rightarrow D^0 K^+) &= (9.94 \pm 0.26) \times 10^{-2} \\
\delta_B(B^+ \rightarrow D^0 K^+) &= (127.7_{-3.9}^{+3.6})^\circ \\
\mathbf{r}_B(B^+ \rightarrow D^0 \pi^+) &= (17 \pm 5) \times 10^{-3} \\
\delta_B(B^+ \rightarrow D^0 \pi^+) &= (347 \pm 9)^\circ \\
\mathbf{r}_B(B^+ \rightarrow D^0 K^{*+}) &= 0.101_{-0.034}^{+0.016} \\
\delta_B(B^+ \rightarrow D^0 K^{*+}) &= (48_{-16}^{+59})^\circ \\
\mathbf{r}_B(B^+ \rightarrow D^{*0} K^+) &= 0.104_{-0.014}^{+0.013} \\
\delta_B(B^+ \rightarrow D^{*0} K^+) &= (314.8_{-9.9}^{+7.9})^\circ
\end{aligned}$$

$B^-$  modes are charge conjugates of the modes below. Modes which do not identify the charge state of the  $B$  are listed in the  $B^\pm/B^0$  ADMIXTURE section.

The branching fractions listed below assume 50%  $B^0\bar{B}^0$  and 50%  $B^+B^-$  production at the  $\Upsilon(4S)$ . We have attempted to bring older measurements up to date by rescaling their assumed  $\Upsilon(4S)$  production ratio to 50:50 and their assumed  $D$ ,  $D_s$ ,  $D^*$ , and  $\psi$  branching ratios to current values whenever this would affect our averages and best limits significantly.

Indentation is used to indicate a subchannel of a previous reaction. All resonant subchannels have been corrected for resonance branching fractions to the final state so the sum of the subchannel branching fractions can exceed that of the final state.

For inclusive branching fractions, e.g.,  $B \rightarrow D^\pm X$ , the values usually are multiplicities, not branching fractions. They can be greater than one.

| $B^+$ DECAY MODES                                                 | Fraction ( $\Gamma_i/\Gamma$ )           | Scale factor/<br>Confidence level (MeV/c) | $p$  |
|-------------------------------------------------------------------|------------------------------------------|-------------------------------------------|------|
| <b>Semileptonic and leptonic modes</b>                            |                                          |                                           |      |
| $\ell^+ \nu_\ell X$                                               | [a] ( 10.99 $\pm$ 0.28 ) %               |                                           | —    |
| $e^+ \nu_e X_c$                                                   | ( 10.8 $\pm$ 0.4 ) %                     |                                           | —    |
| $e^+ \nu_e X$                                                     | ( 10.8 $\pm$ 2.7 ) %                     |                                           | —    |
| $\mu^+ \nu_\mu X$                                                 | ( 11.3 $\pm$ 3.5 ) %                     |                                           | —    |
| $\ell^+ \nu_\ell X_u$                                             | [a] ( 1.65 $\pm$ 0.21 ) $\times 10^{-3}$ |                                           | —    |
| $D \ell^+ \nu_\ell X$                                             | [a] ( 9.0 $\pm$ 0.6 ) %                  |                                           | —    |
| $\bar{D}^0 \ell^+ \nu_\ell$                                       | [a] ( 2.26 $\pm$ 0.07 ) %                |                                           | 2310 |
| $\tau^+ \nu_\tau X$                                               | ( 2.5 $\pm$ 0.4 ) %                      |                                           | —    |
| $\bar{D}^0 \tau^+ \nu_\tau$                                       | ( 7.7 $\pm$ 2.5 ) $\times 10^{-3}$       |                                           | 1911 |
| $\bar{D}^*(2007)^0 \ell^+ \nu_\ell$                               | [a] ( 5.26 $\pm$ 0.10 ) %                |                                           | 2258 |
| $\bar{D}^*(2007)^0 \tau^+ \nu_\tau$                               | ( 1.88 $\pm$ 0.20 ) %                    |                                           | 1839 |
| $D^{(*)} n \pi \ell^+ \nu_\ell$ ( $n \geq 1$ )                    | [a] ( 1.74 $\pm$ 0.23 ) %                |                                           | —    |
| $D^- \pi^+ \ell^+ \nu_\ell$                                       | [a] ( 3.82 $\pm$ 0.20 ) $\times 10^{-3}$ |                                           | 2306 |
| $\bar{D}_2^*(2460)^0 \ell^+ \nu_\ell$                             | [a] ( 1.59 $\pm$ 0.10 ) $\times 10^{-3}$ |                                           | 2065 |
| $\bar{D}_2^{*0} \rightarrow D^- \pi^+$                            |                                          |                                           |      |
| $\bar{D}_0^*(2420)^0 \ell^+ \nu_\ell$                             | [a] ( 9 $\pm$ 5 ) $\times 10^{-4}$       | S=2.6                                     | —    |
| $\bar{D}_0^{*0} \rightarrow D^- \pi^+$                            |                                          |                                           |      |
| $D^{*-} \pi^+ \ell^+ \nu_\ell$                                    | [a] ( 5.42 $\pm$ 0.28 ) $\times 10^{-3}$ |                                           | 2254 |
| $\bar{D}_1(2420)^0 \ell^+ \nu_\ell$ , $\bar{D}_1^0 \rightarrow$   | [a] ( 2.84 $\pm$ 0.17 ) $\times 10^{-3}$ | S=1.1                                     | 2084 |
| $D^{*-} \pi^+$                                                    |                                          |                                           |      |
| $\bar{D}_1'(2430)^0 \ell^+ \nu_\ell$ , $\bar{D}_1'^0 \rightarrow$ | [a] ( 1.7 $\pm$ 0.6 ) $\times 10^{-3}$   | S=1.8                                     | —    |
| $D^{*-} \pi^+$                                                    |                                          |                                           |      |
| $\bar{D}_2^*(2460)^0 \ell^+ \nu_\ell$                             | [a] ( 1.06 $\pm$ 0.18 ) $\times 10^{-3}$ | S=1.7                                     | 2065 |
| $\bar{D}_2^{*0} \rightarrow D^{*-} \pi^+$                         |                                          |                                           |      |
| $\bar{D}^0 \pi^+ \pi^- \ell^+ \nu_\ell$                           | [a] ( 1.73 $\pm$ 0.19 ) $\times 10^{-3}$ |                                           | 2301 |



|                                                                        |                                                      |      |
|------------------------------------------------------------------------|------------------------------------------------------|------|
| $\overline{D}_1(2420)^0 \ell^+ \nu_\ell, \overline{D}_1^0 \rightarrow$ | [a] ( 1.05 $\pm$ 0.14 ) $\times 10^{-3}$             | —    |
| $\overline{D}^{*0} \pi^+ \pi^- \ell^+ \nu_\ell$                        | [a] ( 7.0 $\pm$ 1.7 ) $\times 10^{-4}$               | 2248 |
| $D_s^{(*)-} K^+ \ell^+ \nu_\ell$                                       | [a] ( 6.1 $\pm$ 1.0 ) $\times 10^{-4}$               | —    |
| $D_s^- K^+ \ell^+ \nu_\ell$                                            | [a] ( 3.0 $\pm$ $\frac{1.4}{1.2}$ ) $\times 10^{-4}$ | 2242 |
| $D_s^{*-} K^+ \ell^+ \nu_\ell$                                         | [a] ( 2.9 $\pm$ 1.9 ) $\times 10^{-4}$               | 2185 |
| $\pi^0 \ell^+ \nu_\ell$                                                | [a] ( 7.80 $\pm$ 0.27 ) $\times 10^{-5}$             | 2638 |
| $\eta \ell^+ \nu_\ell$                                                 | [a] ( 3.5 $\pm$ 0.4 ) $\times 10^{-5}$               | 2611 |
| $\eta' \ell^+ \nu_\ell$                                                | [a] ( 2.4 $\pm$ 0.7 ) $\times 10^{-5}$               | 2553 |
| $\omega \ell^+ \nu_\ell$                                               | [a] ( 1.19 $\pm$ 0.09 ) $\times 10^{-4}$             | 2582 |
| $\rho^0 \ell^+ \nu_\ell$                                               | [a] ( 1.58 $\pm$ 0.11 ) $\times 10^{-4}$             | 2583 |
| $\pi^+ \pi^- \ell^+ \nu_\ell$                                          | [a] ( 2.3 $\pm$ 0.4 ) $\times 10^{-4}$               | 2636 |
| $p \bar{p} \ell^+ \nu_\ell$                                            | [a] ( 5.8 $\pm$ $\frac{2.6}{2.3}$ ) $\times 10^{-6}$ | 2467 |
| $p \bar{p} \mu^+ \nu_\mu$                                              | ( 5.32 $\pm$ 0.34 ) $\times 10^{-6}$                 | 2446 |
| $p \bar{p} e^+ \nu_e$                                                  | ( 8.2 $\pm$ $\frac{4.0}{3.3}$ ) $\times 10^{-6}$     | 2467 |
| $e^+ \nu_e$                                                            | < 9.8 $\times 10^{-7}$ CL=90%                        | 2640 |
| $\mu^+ \nu_\mu$                                                        | < 8.6 $\times 10^{-7}$ CL=90%                        | 2639 |
| $\tau^+ \nu_\tau$                                                      | ( 1.09 $\pm$ 0.24 ) $\times 10^{-4}$ S=1.2           | 2341 |
| $\ell^+ \nu_\ell \gamma$                                               | [a] < 3.0 $\times 10^{-6}$ CL=90%                    | 2640 |
| $e^+ \nu_e \gamma$                                                     | < 4.3 $\times 10^{-6}$ CL=90%                        | 2640 |
| $\mu^+ \nu_\mu \gamma$                                                 | < 3.4 $\times 10^{-6}$ CL=90%                        | 2639 |
| $\mu^+ \mu^- \mu^+ \nu_\mu$                                            | < 1.6 $\times 10^{-8}$ CL=95%                        | 2634 |
| <b>Inclusive modes</b>                                                 |                                                      |      |
| $D^0 X$                                                                | ( 8.6 $\pm$ 0.7 ) %                                  | —    |
| $\overline{D}^0 X$                                                     | ( 79 $\pm$ 4 ) %                                     | —    |
| $D^+ X$                                                                | ( 2.5 $\pm$ 0.5 ) %                                  | —    |
| $D^- X$                                                                | ( 9.9 $\pm$ 1.2 ) %                                  | —    |
| $D_s^+ X$                                                              | ( 7.9 $\pm$ $\frac{1.4}{1.3}$ ) %                    | —    |
| $D_s^- X$                                                              | ( 1.10 $\pm$ $\frac{0.40}{0.32}$ ) %                 | —    |
| $\Lambda_c^+ X$                                                        | ( 2.1 $\pm$ $\frac{0.9}{0.6}$ ) %                    | —    |
| $\overline{\Lambda}_c^- X$                                             | ( 2.8 $\pm$ $\frac{1.1}{0.9}$ ) %                    | —    |
| $\overline{c} X$                                                       | ( 97 $\pm$ 4 ) %                                     | —    |
| $c X$                                                                  | ( 23.4 $\pm$ $\frac{2.2}{1.8}$ ) %                   | —    |
| $c/\overline{c} X$                                                     | (120 $\pm$ 6 ) %                                     | —    |

**$D$ ,  $D^*$ , or  $D_s$  modes**

|                                           |                                          |            |
|-------------------------------------------|------------------------------------------|------------|
| $\bar{D}^0 \pi^+$                         | ( 4.61 $\pm$ 0.10 ) $\times 10^{-3}$     | 2308       |
| $D_{CP(+1)} \pi^+$                        | [b] ( 2.04 $\pm$ 0.20 ) $\times 10^{-3}$ | —          |
| $D_{CP(-1)} \pi^+$                        | [b] ( 2.1 $\pm$ 0.4 ) $\times 10^{-3}$   | —          |
| $\bar{D}^0 \rho^+$                        | ( 9.7 $\pm$ 1.1 ) $\times 10^{-3}$       | S=2.1 2237 |
| $\bar{D}^0 K^+$                           | ( 3.64 $\pm$ 0.15 ) $\times 10^{-4}$     | 2281       |
| $D_{CP(+1)} K^+$                          | [b] ( 1.81 $\pm$ 0.08 ) $\times 10^{-4}$ | —          |
| $D_{CP(-1)} K^+$                          | [b] ( 2.04 $\pm$ 0.13 ) $\times 10^{-4}$ | —          |
| $D^0 K^+$                                 | ( 3.60 $\pm$ 0.24 ) $\times 10^{-6}$     | 2281       |
| $[K^- \pi^+]_D K^+$                       | [c] < 2.8 $\times 10^{-7}$ CL=90%        | —          |
| $[K^+ \pi^-]_D K^+$                       | [c] < 1.6 $\times 10^{-5}$ CL=90%        | —          |
| $[K^- \pi^+ \pi^0]_D K^+$                 | seen                                     | —          |
| $[K^+ \pi^- \pi^0]_D K^+$                 | seen                                     | —          |
| $[K^- \pi^+ \pi^+ \pi^-]_D K^+$           | seen                                     | —          |
| $[K^+ \pi^- \pi^+ \pi^-]_D K^+$           | seen                                     | —          |
| $[K^- \pi^+]_D \pi^+$                     | [c] ( 6.3 $\pm$ 1.1 ) $\times 10^{-7}$   | —          |
| $[K^+ \pi^-]_D \pi^+$                     | ( 1.72 $\pm$ 0.30 ) $\times 10^{-4}$     | —          |
| $[K^- \pi^+ \pi^0]_D \pi^+$               | seen                                     | —          |
| $[K^+ \pi^- \pi^0]_D \pi^+$               | seen                                     | —          |
| $[K^- \pi^+ \pi^+ \pi^-]_D \pi^+$         | seen                                     | —          |
| $[K^+ \pi^- \pi^+ \pi^-]_D \pi^+$         | seen                                     | —          |
| $[\pi^+ \pi^- \pi^0]_D K^-$               | ( 4.6 $\pm$ 0.9 ) $\times 10^{-6}$       | —          |
| $[K_S^0 K^+ \pi^-]_D K^+$                 | seen                                     | —          |
| $[K_S^0 K^- \pi^+]_D K^+$                 | seen                                     | —          |
| $[K^*(892)^+ K^-]_D K^+$                  | seen                                     | —          |
| $[K_S^0 K^- \pi^+]_D \pi^+$               | seen                                     | —          |
| $[K^*(892)^+ K^-]_D \pi^+$                | seen                                     | —          |
| $[K_S^0 K^+ \pi^-]_D \pi^+$               | seen                                     | —          |
| $[K^*(892)^- K^+]_D \pi^+$                | seen                                     | —          |
| $\bar{D}^0 K^*(892)^+$                    | ( 5.3 $\pm$ 0.4 ) $\times 10^{-4}$       | 2213       |
| $D_{CP(-1)} K^*(892)^+$                   | [b] ( 2.7 $\pm$ 0.8 ) $\times 10^{-4}$   | —          |
| $D_{CP(+1)} K^*(892)^+$                   | [b] ( 6.2 $\pm$ 0.7 ) $\times 10^{-4}$   | —          |
| $D^0 K^*(892)^+$                          | ( 5.4 $\pm$ 1.8 / 4.0 ) $\times 10^{-6}$ | 2213       |
| $\bar{D}^0 K^+ \pi^+ \pi^-$               | ( 5.2 $\pm$ 2.1 ) $\times 10^{-4}$       | 2237       |
| $\bar{D}^0 K^+ \bar{K}^0$                 | ( 3.73 $\pm$ 0.34 ) $\times 10^{-4}$     | 2189       |
| $\bar{D}^0 K^+ \bar{K}^*(892)^0$          | ( 7.2 $\pm$ 0.5 ) $\times 10^{-4}$       | 2072       |
| $\bar{D}^0 \pi^+ \pi^+ \pi^-$             | ( 5.5 $\pm$ 2.0 ) $\times 10^{-3}$       | S=3.6 2289 |
| $\bar{D}^0 \pi^+ \pi^+ \pi^-$ nonresonant | ( 5 $\pm$ 4 ) $\times 10^{-3}$           | 2289       |
| $\bar{D}^0 \pi^+ \rho^0$                  | ( 4.2 $\pm$ 3.0 ) $\times 10^{-3}$       | 2208       |
| $\bar{D}^0 a_1(1260)^+$                   | ( 4 $\pm$ 4 ) $\times 10^{-3}$           | 2123       |
| $\bar{D}^0 \omega \pi^+$                  | ( 4.1 $\pm$ 0.9 ) $\times 10^{-3}$       | 2206       |
| $D^*(2010)^- \pi^+ \pi^+$                 | ( 1.35 $\pm$ 0.22 ) $\times 10^{-3}$     | 2247       |

|                                                                                        |                                               |        |      |
|----------------------------------------------------------------------------------------|-----------------------------------------------|--------|------|
| $D^*(2010)^- K^+ \pi^+$                                                                | $( 8.2 \pm 1.4 ) \times 10^{-5}$              |        | 2206 |
| $\bar{D}_1(2420)^0 \pi^+, \bar{D}_1^0 \rightarrow$<br>$D^*(2010)^- \pi^+$              | $( 8.4 \pm 1.5 ) \times 10^{-4}$              |        | 2081 |
| $D^- \pi^+ \pi^+$                                                                      | $( 1.07 \pm 0.05 ) \times 10^{-3}$            |        | 2299 |
| $D^- K^+ \pi^+$                                                                        | $( 7.7 \pm 0.5 ) \times 10^{-5}$              |        | 2260 |
| $D_0^*(2300)^0 K^+, D_0^{*0} \rightarrow$<br>$D^- \pi^+$                               | $( 6.1 \pm 2.4 ) \times 10^{-6}$              |        | —    |
| $D_2^*(2460)^0 K^+, D_2^{*0} \rightarrow$<br>$D^- \pi^+$                               | $( 2.32 \pm 0.23 ) \times 10^{-5}$            |        | —    |
| $D_1^*(2760)^0 K^+, D_1^{*0} \rightarrow$<br>$D^- \pi^+$                               | $( 3.6 \pm 1.2 ) \times 10^{-6}$              |        | —    |
| $D^+ K^0$                                                                              | $< 2 \times 10^{-6}$                          | CL=90% | 2278 |
| $D^+ K^+ \pi^-$                                                                        | $( 5.6 \pm 1.1 ) \times 10^{-6}$              |        | 2260 |
| $D^+ \eta$                                                                             | $< 1.2 \times 10^{-5}$                        | CL=90% | 2272 |
| $D_2^*(2460)^0 K^+, D_2^{*0} \rightarrow$<br>$D^+ \pi^-$                               | $< 6.3 \times 10^{-7}$                        | CL=90% | —    |
| $D^+ K^{*0}$                                                                           | $< 4.9 \times 10^{-7}$                        | CL=90% | 2211 |
| $D^+ \bar{K}^{*0}$                                                                     | $< 1.4 \times 10^{-6}$                        | CL=90% | 2211 |
| $\bar{D}^*(2007)^0 \pi^+$                                                              | $( 5.17 \pm 0.15 ) \times 10^{-3}$            |        | 2256 |
| $\bar{D}_{CP(+1)}^{*0} \pi^+$                                                          | [d] $( 2.9 \pm 0.6 ) \times 10^{-3}$          |        | —    |
| $D_{CP(-1)}^{*0} \pi^+$                                                                | [d] $( 2.6 \pm 1.0 ) \times 10^{-3}$          |        | —    |
| $\bar{D}^*(2007)^0 \omega \pi^+$                                                       | $( 4.5 \pm 1.2 ) \times 10^{-3}$              |        | 2149 |
| $\bar{D}^*(2007)^0 \rho^+$                                                             | $( 9.8 \pm 1.7 ) \times 10^{-3}$              |        | 2182 |
| $\bar{D}^*(2007)^0 K^+$                                                                | $( 4.19 \pm_{-0.28}^{+0.31} ) \times 10^{-4}$ |        | 2227 |
| $\bar{D}_{CP(+1)}^{*0} K^+$                                                            | [d] $( 2.75 \pm 0.35 ) \times 10^{-4}$        |        | —    |
| $\bar{D}_{CP(-1)}^{*0} K^+$                                                            | [d] $( 2.31 \pm 0.31 ) \times 10^{-4}$        |        | —    |
| $D^*(2007)^0 K^+$                                                                      | $( 4.5 \pm 1.2 ) \times 10^{-6}$              |        | 2227 |
| $\bar{D}^*(2007)^0 K^*(892)^+$                                                         | $( 8.1 \pm 1.4 ) \times 10^{-4}$              |        | 2156 |
| $\bar{D}^*(2007)^0 K^+ \bar{K}^0$                                                      | $( 2.9 \pm 0.6 ) \times 10^{-4}$              |        | 2132 |
| $\bar{D}^*(2007)^0 K^+ \bar{K}^*(892)^0$                                               | $( 1.23 \pm 0.14 ) \times 10^{-3}$            |        | 2009 |
| $\bar{D}^*(2007)^0 \pi^+ \pi^+ \pi^-$                                                  | $( 1.03 \pm 0.12 ) \%$                        |        | 2236 |
| $\bar{D}^*(2007)^0 a_1(1260)^+$                                                        | $( 1.9 \pm 0.5 ) \%$                          |        | 2063 |
| $\bar{D}^*(2007)^0 \pi^- \pi^+ \pi^+ \pi^0$                                            | $( 1.8 \pm 0.4 ) \%$                          |        | 2219 |
| $\bar{D}^{*0} 3\pi^+ 2\pi^-$                                                           | $( 5.7 \pm 1.2 ) \times 10^{-3}$              |        | 2196 |
| $D^*(2010)^+ \pi^0$                                                                    | $< 3.6 \times 10^{-6}$                        |        | 2255 |
| $D^*(2010)^+ K^0$                                                                      | $< 9.0 \times 10^{-6}$                        | CL=90% | 2225 |
| $D^*(2010)^- \pi^+ \pi^+ \pi^0$                                                        | $( 1.5 \pm 0.7 ) \%$                          |        | 2235 |
| $D^*(2010)^- \pi^+ \pi^+ \pi^+ \pi^-$                                                  | $( 2.6 \pm 0.4 ) \times 10^{-3}$              |        | 2217 |
| $\bar{D}^{*0} \pi^+$                                                                   | [e] $( 5.6 \pm 1.2 ) \times 10^{-3}$          |        | —    |
| $\bar{D}_1^*(2420)^0 \pi^+$                                                            | $( 1.5 \pm 0.6 ) \times 10^{-3}$              | S=1.3  | 2081 |
| $\bar{D}_1(2420)^0 \pi^+ \times B(\bar{D}_1^0 \rightarrow$<br>$\bar{D}^0 \pi^+ \pi^-)$ | $( 2.5 \pm_{-1.4}^{+1.6} ) \times 10^{-4}$    | S=3.8  | 2081 |

|                                                                                                         |                                            |      |
|---------------------------------------------------------------------------------------------------------|--------------------------------------------|------|
| $\bar{D}_1(2420)^0 \pi^+ \times B(\bar{D}_1^0 \rightarrow \bar{D}^0 \pi^+ \pi^- \text{ (nonresonant)})$ | $(2.2 \pm 0.9) \times 10^{-4}$             | 2081 |
| $\bar{D}_1(2430)^0 \pi^+, \bar{D}_1^0 \rightarrow D^*(2010)^- \pi^+$                                    | $(3.5 \pm 0.6) \times 10^{-4}$             | 2079 |
| $\bar{D}(2550)^0 \pi^+, \bar{D}^0 \rightarrow D^*(2010)^- \pi^+$                                        | $(7.2 \pm 1.4) \times 10^{-5}$             | —    |
| $\bar{D}_J^*(2600)^0 \pi^+, \bar{D}_J^{*0} \rightarrow D^*(2010)^- \pi^+$                               | $(6.8 \pm 1.3) \times 10^{-5}$             | —    |
| $\bar{D}_2^*(2462)^0 \pi^+, \bar{D}_2^{*0} \rightarrow D^- \pi^+$                                       | $(3.56 \pm 0.24) \times 10^{-4}$           | —    |
| $\bar{D}_2^*(2462)^0 \pi^+, \bar{D}_2^{*0} \rightarrow \bar{D}^0 \pi^- \pi^+$                           | $(2.2 \pm 1.0) \times 10^{-4}$             | —    |
| $\bar{D}_2^*(2462)^0 \pi^+, \bar{D}_2^{*0} \rightarrow \bar{D}^0 \pi^- \pi^+ \text{ (nonresonant)}$     | $< 1.6 \times 10^{-4}$ CL=90%              | —    |
| $\bar{D}_2^*(2462)^0 \pi^+, \bar{D}_2^{*0} \rightarrow D^*(2010)^- \pi^+$                               | $(2.1 \pm 1.0) \times 10^{-4}$             | —    |
| $\bar{D}_0^*(2400)^0 \pi^+ \times B(\bar{D}_0^*(2400)^0 \rightarrow D^- \pi^+)$                         | $(6.4 \pm 1.4) \times 10^{-4}$             | 2136 |
| $\bar{D}_1(2421)^0 \pi^+, \bar{D}_1^0 \rightarrow D^{*-} \pi^+$                                         | $(7.4 \pm 1.0) \times 10^{-4}$             | —    |
| $\bar{D}_2^*(2462)^0 \pi^+, \bar{D}_2^{*0} \rightarrow D^{*-} \pi^+$                                    | $(1.98 \pm 0.30) \times 10^{-4}$           | —    |
| $\bar{D}_1(2427)^0 \pi^+, \bar{D}_1^0 \rightarrow D^{*-} \pi^+$                                         | $(3.5 \pm 0.9) \times 10^{-4}$ S=1.5       | —    |
| $\bar{D}_1(2420)^0 \pi^+ \times B(\bar{D}_1^0 \rightarrow \bar{D}^{*0} \pi^+ \pi^-)$                    | $< 6 \times 10^{-6}$ CL=90%                | 2081 |
| $\bar{D}_1^*(2420)^0 \rho^+$                                                                            | $< 1.4 \times 10^{-3}$ CL=90%              | 1996 |
| $\bar{D}_2^*(2460)^0 \pi^+$                                                                             | $< 1.3 \times 10^{-3}$ CL=90%              | 2063 |
| $\bar{D}_2^*(2460)^0 \pi^+ \times B(\bar{D}_2^{*0} \rightarrow \bar{D}^{*0} \pi^+ \pi^-)$               | $< 2.2 \times 10^{-5}$ CL=90%              | 2063 |
| $\bar{D}_1^*(2680)^0 \pi^+, \bar{D}_1^*(2680)^0 \rightarrow D^- \pi^+$                                  | $(8.4 \pm 2.1) \times 10^{-5}$             | —    |
| $\bar{D}(2740)^0 \pi^+, \bar{D}^0 \rightarrow D^*(2010)^- \pi^+$                                        | $(3.3 \pm 1.5) \times 10^{-5}$             | —    |
| $\bar{D}_3^*(2750)^0 \pi^+, \bar{D}_3^{*0} \rightarrow D^*(2010)^- \pi^+$                               | $(1.10 \pm 0.32) \times 10^{-5}$           | 1913 |
| $\bar{D}_3^*(2760)^0 \pi^+, \bar{D}_3^*(2760)^0 \pi^+ \rightarrow D^- \pi^+$                            | $(1.00 \pm 0.22) \times 10^{-5}$           | —    |
| $\bar{D}_2^*(3000)^0 \pi^+, \bar{D}_2^*(3000)^0 \pi^+ \rightarrow D^- \pi^+$                            | $(2.0 \pm 1.4) \times 10^{-6}$             | —    |
| $\bar{D}_2^*(2460)^0 \rho^+$                                                                            | $< 4.7 \times 10^{-3}$ CL=90%              | 1977 |
| $\bar{D}_s^0 D_s^+$                                                                                     | $(9.3 \pm 0.6) \times 10^{-3}$             | 1815 |
| $D_{s0}^*(2317)^+ \bar{D}^0, D_{s0}^{*+} \rightarrow D_s^+ \pi^0$                                       | $(7.9 \pm \frac{1.5}{1.3}) \times 10^{-4}$ | 1605 |

|                                                                                                                  |                         |                  |        |      |
|------------------------------------------------------------------------------------------------------------------|-------------------------|------------------|--------|------|
| $D_{s0}(2317)^+ \bar{D}^0 \times$<br>$B(D_{s0}(2317)^+ \rightarrow D_s^{*+} \gamma)$                             | $< 7.6$                 | $\times 10^{-4}$ | CL=90% | 1605 |
| $D_{s0}(2317)^+ \bar{D}^*(2007)^0 \times$<br>$B(D_{s0}(2317)^+ \rightarrow D_s^+ \pi^0)$                         | $(9 \pm 7)$             | $\times 10^{-4}$ |        | 1511 |
| $D_{sJ}(2457)^+ \bar{D}^0$                                                                                       | $(3.1 \pm 1.0 \pm 0.9)$ | $\times 10^{-3}$ |        | —    |
| $D_{sJ}(2457)^+ \bar{D}^0 \times$<br>$B(D_{sJ}(2457)^+ \rightarrow D_s^+ \gamma)$                                | $(4.6 \pm 1.3 \pm 1.1)$ | $\times 10^{-4}$ |        | —    |
| $D_{sJ}(2457)^+ \bar{D}^0 \times$<br>$B(D_{sJ}(2457)^+ \rightarrow$<br>$D_s^+ \pi^+ \pi^-)$                      | $< 2.2$                 | $\times 10^{-4}$ | CL=90% | —    |
| $D_{sJ}(2457)^+ \bar{D}^0 \times$<br>$B(D_{sJ}(2457)^+ \rightarrow D_s^+ \pi^0)$                                 | $< 2.7$                 | $\times 10^{-4}$ | CL=90% | —    |
| $D_{sJ}(2457)^+ \bar{D}^0 \times$<br>$B(D_{sJ}(2457)^+ \rightarrow D_s^{*+} \gamma)$                             | $< 9.8$                 | $\times 10^{-4}$ | CL=90% | —    |
| $D_{sJ}(2457)^+ \bar{D}^*(2007)^0$                                                                               | $(1.20 \pm 0.30)$       | %                |        | —    |
| $D_{sJ}(2457)^+ \bar{D}^*(2007)^0 \times$<br>$B(D_{sJ}(2457)^+ \rightarrow D_s^+ \gamma)$                        | $(1.4 \pm 0.7 \pm 0.6)$ | $\times 10^{-3}$ |        | —    |
| $\bar{D}^0 D_{s1}(2536)^+ \times$<br>$B(D_{s1}(2536)^+ \rightarrow$<br>$D^*(2007)^0 K^+ +$<br>$D^*(2010)^+ K^0)$ | $(4.0 \pm 1.0)$         | $\times 10^{-4}$ |        | 1447 |
| $\bar{D}^0 D_{s1}(2536)^+ \times$<br>$B(D_{s1}(2536)^+ \rightarrow$<br>$D^*(2007)^0 K^+)$                        | $(2.2 \pm 0.7)$         | $\times 10^{-4}$ |        | 1447 |
| $\bar{D}^*(2007)^0 D_{s1}(2536)^+ \times$<br>$B(D_{s1}(2536)^+ \rightarrow$<br>$D^*(2007)^0 K^+)$                | $(5.5 \pm 1.6)$         | $\times 10^{-4}$ |        | 1339 |
| $\bar{D}^0 D_{s1}(2536)^+ \times$<br>$B(D_{s1}(2536)^+ \rightarrow D^{*+} K^0)$                                  | $(2.3 \pm 1.1)$         | $\times 10^{-4}$ |        | 1447 |
| $\bar{D}^0 D_{sJ}(2700)^+ \times$<br>$B(D_{sJ}(2700)^+ \rightarrow D^0 K^+)$                                     | $(5.6 \pm 1.8)$         | $\times 10^{-4}$ | S=1.7  | —    |
| $\bar{D}^{*0} D_{s1}(2536)^+, D_{s1}^+ \rightarrow$<br>$D^{*+} K^0$                                              | $(3.9 \pm 2.6)$         | $\times 10^{-4}$ |        | 1339 |
| $\bar{D}^0 D_{sJ}(2573)^+, D_{sJ}^+ \rightarrow$<br>$D^0 K^+$                                                    | $(8 \pm 15)$            | $\times 10^{-6}$ |        | —    |
| $\bar{D}^{*0} D_{sJ}(2573), D_{sJ}^+ \rightarrow$<br>$D^0 K^+$                                                   | $< 2$                   | $\times 10^{-4}$ | CL=90% | 1306 |
| $\bar{D}^*(2007)^0 D_{sJ}(2573), D_{sJ}^+ \rightarrow$<br>$D^0 K^+$                                              | $< 5$                   | $\times 10^{-4}$ | CL=90% | 1306 |
| $\bar{D}^0 D_s^{*+}$                                                                                             | $(7.6 \pm 1.6)$         | $\times 10^{-3}$ |        | 1734 |
| $\bar{D}^*(2007)^0 D_s^+$                                                                                        | $(7.0 \pm 1.0)$         | $\times 10^{-3}$ |        | 1737 |

|                                                                       |                                                 |      |
|-----------------------------------------------------------------------|-------------------------------------------------|------|
| $\overline{D}^*(2007)^0 D_s^{*+}$                                     | ( 1.71 $\pm$ 0.24 ) %                           | 1651 |
| $D_s^{(*)+} \overline{D}^{*0}$                                        | ( 2.7 $\pm$ 1.2 ) %                             | —    |
| $\overline{D}^*(2007)^0 D^*(2010)^+$                                  | ( 8.1 $\pm$ 1.7 ) $\times 10^{-4}$              | 1713 |
| $\overline{D}^0 D^*(2010)^+ + \overline{D}^*(2007)^0 D^+$             | < 1.30 % CL=90%                                 | 1792 |
| $\overline{D}^0 D^*(2010)^+$                                          | ( 3.9 $\pm$ 0.5 ) $\times 10^{-4}$              | 1792 |
| $\overline{D}^0 D^+$                                                  | ( 3.8 $\pm$ 0.4 ) $\times 10^{-4}$              | 1866 |
| $\overline{D}^0 D^+ K^0$                                              | ( 1.55 $\pm$ 0.21 ) $\times 10^{-3}$            | 1571 |
| $D^+ \overline{D}^*(2007)^0$                                          | ( 6.3 $\pm$ 1.7 ) $\times 10^{-4}$              | 1791 |
| $\overline{D}^*(2007)^0 D^+ K^0$                                      | ( 2.1 $\pm$ 0.5 ) $\times 10^{-3}$              | 1475 |
| $\overline{D}^0 D^*(2010)^+ K^0$                                      | ( 3.8 $\pm$ 0.4 ) $\times 10^{-3}$              | 1476 |
| $\overline{D}^*(2007)^0 D^*(2010)^+ K^0$                              | ( 9.2 $\pm$ 1.2 ) $\times 10^{-3}$              | 1362 |
| $\overline{D}^0 D^0 K^+$                                              | ( 1.45 $\pm$ 0.33 ) $\times 10^{-3}$ S=2.6      | 1577 |
| $\overline{D}^*(2007)^0 D^0 K^+$                                      | ( 2.26 $\pm$ 0.23 ) $\times 10^{-3}$            | 1481 |
| $\overline{D}^0 D^*(2007)^0 K^+$                                      | ( 6.3 $\pm$ 0.5 ) $\times 10^{-3}$              | 1481 |
| $\overline{D}^*(2007)^0 D^*(2007)^0 K^+$                              | ( 1.12 $\pm$ 0.13 ) %                           | 1368 |
| $D^- D^+ K^+$                                                         | ( 2.2 $\pm$ 0.7 ) $\times 10^{-4}$              | 1571 |
| $T_{cs0}^*(2870)^0 D^+, T_{cs0}^{*0} \rightarrow D^- K^+$             | ( 1.2 $\pm$ 0.5 ) $\times 10^{-5}$              | —    |
| $T_{cs1}^*(2900)^0 D^+, T_{cs1}^{*0} \rightarrow D^- K^+$             | ( 6.7 $\pm$ 2.3 ) $\times 10^{-5}$              | —    |
| $D^- D^+ K^+$ nonresonant                                             | ( 5.3 $\pm$ 1.8 ) $\times 10^{-5}$              | 1571 |
| $D^- D^*(2010)^+ K^+$                                                 | ( 6.3 $\pm$ 1.1 ) $\times 10^{-4}$              | 1475 |
| $D^*(2010)^- D^+ K^+$                                                 | ( 6.0 $\pm$ 1.3 ) $\times 10^{-4}$              | 1475 |
| EFF $K^+$ , EFF $\rightarrow D^*(2010)^\mp D^\pm$                     | ( 1.5 $\pm$ 0.4 ) $\times 10^{-4}$              | 1475 |
| $\eta_c(3945) K^+, \eta_c \rightarrow D^*(2010)^\mp D^\pm$            | ( 4.6 $\pm$ 2.7 $\pm$ 1.7 ) $\times 10^{-5}$    | —    |
| $\chi_{c2}(3930) K^+, \chi_{c2} \rightarrow D^*(2010)^\mp D^\pm$      | ( 2.4 $\pm$ 1.0 $\pm$ 1.7 ) $\times 10^{-5}$    | —    |
| $h_c(4000) K^+, h_c \rightarrow D^*(2010)^\mp D^\pm$                  | ( 7.0 $\pm$ 2.5 $\pm$ 1.6 ) $\times 10^{-5}$    | —    |
| $\chi_{c1}(4010) K^+, \chi_{c1} \rightarrow D^*(2010)^\mp D^\pm$      | ( 1.38 $\pm$ 0.31 $\pm$ 0.28 ) $\times 10^{-4}$ | —    |
| $\psi(4040) K^+, \psi \rightarrow D^*(2010)^\mp D^\pm$                | ( 3.8 $\pm$ 1.1 $\pm$ 0.9 ) $\times 10^{-5}$    | —    |
| $h_c(4300) K^+, h_c \rightarrow D^*(2010)^\mp D^\pm$                  | ( 1.6 $\pm$ 0.4 $\pm$ 0.7 ) $\times 10^{-5}$    | —    |
| $T_{cs0}^*(2870)^0 K^+, T_{cs0}^{*0} \rightarrow D^*(2010)^\mp D^\pm$ | ( 4.5 $\pm$ 1.2 $\pm$ 1.4 ) $\times 10^{-5}$    | —    |

|                                                                                             |                                              |      |
|---------------------------------------------------------------------------------------------|----------------------------------------------|------|
| $T_{\overline{cs}1}^*(2900)^0 K^+, T_{\overline{cs}1}^{*0} \rightarrow D^*(2010)^\mp D^\pm$ | $( 3.8 \pm 1.7 \atop - 1.6 ) \times 10^{-5}$ | —    |
| $NR K^+, NR \rightarrow D^*(2010)^\mp D^\pm$                                                | $( 2.8 \pm 0.5 \atop - 0.4 ) \times 10^{-4}$ | —    |
| $NR K^+, NR \rightarrow D^*(2010)^\mp D^\pm$                                                | $( 1.6 \pm 1.3 \atop - 0.8 ) \times 10^{-5}$ | —    |
| $NR K^+, NR \rightarrow D^*(2010)^\mp D^\pm$                                                | $( 2.4 \pm 0.6 \atop - 0.4 ) \times 10^{-4}$ | —    |
| $NR K^+, NR \rightarrow D^*(2010)^\mp D^\pm$                                                | $( 2.2 \pm 0.7 \atop - 0.5 ) \times 10^{-4}$ | —    |
| $D^*(2010)^- D^*(2010)^+ K^+$                                                               | $( 1.32 \pm 0.18 ) \times 10^{-3}$           | 1363 |
| $(\overline{D} + \overline{D}^*)(D + D^*)K$                                                 | $( 4.05 \pm 0.30 ) \%$                       | —    |
| $D_s^- D_s^+ K^+$                                                                           | $( 1.2 \pm 0.4 ) \times 10^{-4}$             | 1429 |
| $D_s^+ \pi^0$                                                                               | $( 1.6 \pm 0.5 ) \times 10^{-5}$             | 2270 |
| $D_s^{*+} \pi^0$                                                                            | $< 2.6 \times 10^{-4}$ CL=90%                | 2215 |
| $D_s^+ \eta$                                                                                | $< 1.4 \times 10^{-5}$ CL=90%                | 2235 |
| $D_s^{*+} \eta$                                                                             | $< 1.7 \times 10^{-5}$ CL=90%                | 2178 |
| $D_s^+ \rho^0$                                                                              | $< 3.0 \times 10^{-4}$ CL=90%                | 2197 |
| $D_s^{*+} \rho^0$                                                                           | $< 4 \times 10^{-4}$ CL=90%                  | 2138 |
| $D_s^+ \omega$                                                                              | $< 4 \times 10^{-4}$ CL=90%                  | 2195 |
| $D_s^{*+} \omega$                                                                           | $< 6 \times 10^{-4}$ CL=90%                  | 2136 |
| $D_s^+ a_1(1260)^0$                                                                         | $< 1.8 \times 10^{-3}$ CL=90%                | 2080 |
| $D_s^{*+} a_1(1260)^0$                                                                      | $< 1.3 \times 10^{-3}$ CL=90%                | 2015 |
| $D_s^+ K^+ K^-$                                                                             | $( 7.5 \pm 1.0 ) \times 10^{-6}$             | 2149 |
| $D_s^+ \phi$                                                                                | $< 4.2 \times 10^{-7}$ CL=90%                | 2141 |
| $D_s^{*+} \phi$                                                                             | $< 1.2 \times 10^{-5}$ CL=90%                | 2079 |
| $D_s^+ \overline{K}^0$                                                                      | $< 3 \times 10^{-6}$ CL=90%                  | 2242 |
| $D_s^{*+} \overline{K}^0$                                                                   | $< 6 \times 10^{-6}$ CL=90%                  | 2185 |
| $D_s^+ \overline{K}^*(892)^0$                                                               | $< 4.4 \times 10^{-6}$ CL=90%                | 2172 |
| $D_s^+ K^{*0}$                                                                              | $< 3.5 \times 10^{-6}$ CL=90%                | 2172 |
| $D_s^{*+} \overline{K}^*(892)^0$                                                            | $< 3.5 \times 10^{-4}$ CL=90%                | 2112 |
| $D_s^- \pi^+ K^+$                                                                           | $( 1.80 \pm 0.22 ) \times 10^{-4}$           | 2222 |
| $D_s^{*-} \pi^+ K^+$                                                                        | $( 1.45 \pm 0.24 ) \times 10^{-4}$           | 2164 |
| $D_s^- \pi^+ K^*(892)^+$                                                                    | $< 5 \times 10^{-3}$ CL=90%                  | 2138 |
| $D_s^{*-} \pi^+ K^*(892)^+$                                                                 | $< 7 \times 10^{-3}$ CL=90%                  | 2076 |
| $D_s^- K^+ K^+$                                                                             | $( 9.7 \pm 2.1 ) \times 10^{-6}$             | 2149 |
| $D_s^{*-} K^+ K^+$                                                                          | $< 1.5 \times 10^{-5}$ CL=90%                | 2088 |

**Charmonium modes**

|                                                                             |                                              |        |      |
|-----------------------------------------------------------------------------|----------------------------------------------|--------|------|
| $\eta_c K^+$                                                                | ( 1.10 $\pm$ 0.07 ) $\times 10^{-3}$         | S=1.1  | 1751 |
| $\eta_c K^*(892)^+$                                                         | ( 1.2 $\pm$ 0.5 $\pm$ 0.4 ) $\times 10^{-3}$ |        | 1646 |
| $\eta_c K^+ \pi^+ \pi^-$                                                    | < 3.9 $\times 10^{-4}$                       | CL=90% | 1684 |
| $\eta_c K^+ \omega(782)$                                                    | < 5.3 $\times 10^{-4}$                       | CL=90% | 1475 |
| $\eta_c K^+ \eta$                                                           | < 2.2 $\times 10^{-4}$                       | CL=90% | 1588 |
| $\eta_c K^+ \pi^0$                                                          | < 6.2 $\times 10^{-5}$                       | CL=90% | 1723 |
| $\eta_c(2S) K^+$                                                            | ( 4.4 $\pm$ 1.0 ) $\times 10^{-4}$           |        | 1320 |
| $\eta_c(2S) K^+, \eta_c \rightarrow p \bar{p}$                              | ( 3.5 $\pm$ 0.8 ) $\times 10^{-8}$           |        | —    |
| $\eta_c(2S) K^+, \eta_c \rightarrow K_S^0 K^\mp \pi^\pm$                    | ( 3.4 $\pm$ 2.3 $\pm$ 1.6 ) $\times 10^{-6}$ |        | —    |
| $\eta_c(2S) K^+, \eta_c \rightarrow p \bar{p} \pi^+ \pi^-$                  | ( 1.12 $\pm$ 0.18 ) $\times 10^{-6}$         |        | —    |
| $h_c(1P) K^+, h_c \rightarrow J/\psi \pi^+ \pi^-$                           | < 3.4 $\times 10^{-6}$                       | CL=90% | 1401 |
| $X(3730)^0 K^+, X^0 \rightarrow \eta_c \eta$                                | < 4.6 $\times 10^{-5}$                       | CL=90% | —    |
| $X(3730)^0 K^+, X^0 \rightarrow \eta_c \pi^0$                               | < 5.7 $\times 10^{-6}$                       | CL=90% | —    |
| $\eta_{c2}(1D) K^+, \eta_{c2} \rightarrow h_c \gamma$                       | < 3.7 $\times 10^{-5}$                       | CL=90% | —    |
| $\eta_{c2}(1D) \pi^+ K_S^0, \eta_{c2} \rightarrow h_c \gamma$               | < 1.1 $\times 10^{-4}$                       | CL=90% | —    |
| $\psi_2(3823) K^+, \psi_2 \rightarrow J/\psi \pi^+ \pi^-$                   | ( 2.8 $\pm$ 0.6 ) $\times 10^{-7}$           |        | —    |
| $\psi_2(3823) K^+, \psi_2 \rightarrow J/\psi \eta$                          | ( 1.2 $\pm$ 0.7 $\pm$ 0.5 ) $\times 10^{-6}$ |        | —    |
| $\psi_3(3842) K^+, \psi_3 \rightarrow J/\psi \eta$                          | < 6.1 $\times 10^{-7}$                       | CL=90% | —    |
| $\chi_{c1}(3872) K^+$                                                       | ( 1.9 $\pm$ 0.6 ) $\times 10^{-4}$           |        | 1141 |
| $\chi_{c0}(3915) K^+$                                                       | < 2.8 $\times 10^{-4}$                       | CL=90% | 1100 |
| $\chi_{c0}(3915) K^+, \chi_{c0} \rightarrow D^+ D^-$                        | ( 8.1 $\pm$ 3.3 ) $\times 10^{-6}$           |        | —    |
| $\chi_{c0}(3915) K^+, \chi_{c0} \rightarrow \eta_c \eta$                    | < 4.7 $\times 10^{-5}$                       | CL=90% | —    |
| $\chi_{c0}(3915) K^+, \chi_{c0} \rightarrow \eta_c \pi^0$                   | < 1.7 $\times 10^{-5}$                       | CL=90% | —    |
| $X(4014)^0 K^+, X^0 \rightarrow \eta_c \eta$                                | < 3.9 $\times 10^{-5}$                       | CL=90% | —    |
| $X(4014)^0 K^+, X^0 \rightarrow \eta_c \pi^0$                               | < 1.2 $\times 10^{-5}$                       | CL=90% | —    |
| $T_{c\bar{c}1}(3900)^0 K^+, T_{c\bar{c}1}^0 \rightarrow \eta_c \pi^+ \pi^-$ | < 4.7 $\times 10^{-5}$                       | CL=90% | —    |
| $T_{c\bar{c}1}(3900)^0 K^+, T_{c\bar{c}1}^0 \rightarrow J/\psi \eta$        | < 4.3 $\times 10^{-7}$                       | CL=90% | —    |
| $T_{c\bar{c}}(4020)^0 K^+, T_{c\bar{c}}^0 \rightarrow \eta_c \pi^+ \pi^-$   | < 1.6 $\times 10^{-5}$                       | CL=90% | —    |
| $\chi_{c1}(3872) K^*(892)^+$                                                | < 5 $\times 10^{-4}$                         | CL=90% | 940  |
| $\chi_{c1}(3872)^+ K^0, \chi_{c1}^+ \rightarrow J/\psi(1S) \pi^+ \pi^0$     | [f] < 6.1 $\times 10^{-6}$                   | CL=90% | —    |
| $\chi_{c1}(3872) K^0 \pi^+$                                                 | ( 2.4 $\pm$ 1.1 ) $\times 10^{-4}$           |        | 1085 |
| $T_{c\bar{c}1}(4430)^+ K^0, T_{c\bar{c}1}^+ \rightarrow J/\psi \pi^+$       | < 1.5 $\times 10^{-5}$                       | CL=95% | —    |
| $T_{c\bar{c}1}(4430)^+ K^0, T_{c\bar{c}1}^+ \rightarrow \psi(2S) \pi^+$     | < 4.7 $\times 10^{-5}$                       | CL=95% | —    |



|                                                                      |                                            |                  |        |      |
|----------------------------------------------------------------------|--------------------------------------------|------------------|--------|------|
| $T_{c\bar{c}1}(4430)^0 K^+, T_{c\bar{c}1}^0 \rightarrow J/\psi \eta$ | $< 1.27$                                   | $\times 10^{-6}$ | CL=90% | —    |
| $\psi(4230)^0 K^+, \psi^0 \rightarrow J/\psi \pi^+ \pi^-$            | $< 1.56$                                   | $\times 10^{-5}$ | CL=95% | —    |
| $\psi(4230) K^+, \psi \rightarrow J/\psi \eta$                       | $< 3.9$                                    | $\times 10^{-7}$ | CL=90% | —    |
| $\psi(4360) K^+, \psi \rightarrow J/\psi \eta$                       | $< 1.24$                                   | $\times 10^{-6}$ | CL=90% | —    |
| $\psi(4390) K^+, \psi \rightarrow J/\psi \eta$                       | $< 2.41$                                   | $\times 10^{-6}$ | CL=90% | —    |
| $\chi_{c0}(3915) K^+, \chi_{c0} \rightarrow J/\psi \gamma$           | $< 1.4$                                    | $\times 10^{-5}$ | CL=90% | —    |
| $\chi_{c0}(3915) K^+, \chi_{c0} \rightarrow \chi_{c1}(1P) \pi^0$     | $< 3.8$                                    | $\times 10^{-5}$ | CL=90% | —    |
| $X(3930)^0 K^+, X^0 \rightarrow J/\psi \gamma$                       | $< 2.5$                                    | $\times 10^{-6}$ | CL=90% | —    |
| $J/\psi(1S) K^+$                                                     | $(1.020 \pm 0.019) \times 10^{-3}$         |                  |        | 1684 |
| $J/\psi(1S) K^0 \pi^+$                                               | $(1.14 \pm 0.11) \times 10^{-3}$           |                  |        | 1651 |
| $J/\psi(1S) K^+ \pi^+ \pi^-$                                         | $(8.1 \pm 1.3) \times 10^{-4}$             |                  | S=2.5  | 1612 |
| $J/\psi(1S) K^+ K^- K^+$                                             | $(3.37 \pm 0.29) \times 10^{-5}$           |                  |        | 1252 |
| $\chi_{c0}(3915) K^+, \chi_{c0} \rightarrow p \bar{p}$               | $< 7.1$                                    | $\times 10^{-8}$ | CL=95% | —    |
| $J/\psi(1S) K^*(892)^+$                                              | $(1.43 \pm 0.08) \times 10^{-3}$           |                  |        | 1571 |
| $J/\psi(1S) K(1270)^+$                                               | $(1.8 \pm 0.5) \times 10^{-3}$             |                  |        | 1402 |
| $J/\psi(1S) K(1400)^+$                                               | $< 5$                                      | $\times 10^{-4}$ | CL=90% | 1308 |
| $J/\psi(1S) \eta K^+$                                                | $(1.24 \pm 0.14) \times 10^{-4}$           |                  |        | 1510 |
| $\chi_{c1-odd}(3872) K^+, \chi_{c1-odd} \rightarrow J/\psi \eta$     | $< 3.8$                                    | $\times 10^{-6}$ | CL=90% | —    |
| $\psi(4160) K^+, \psi \rightarrow J/\psi \eta$                       | $< 8.7$                                    | $\times 10^{-7}$ | CL=90% | —    |
| $J/\psi(1S) \eta' K^+$                                               | $(3.1 \pm 0.4) \times 10^{-5}$             |                  |        | 1273 |
| $J/\psi(1S) \phi K^+$                                                | $(5.0 \pm 0.4) \times 10^{-5}$             |                  |        | 1227 |
| $J/\psi(1S) K_1(1650), K_1 \rightarrow \phi K^+$                     | $(6 \pm \frac{10}{6}) \times 10^{-6}$      |                  |        | —    |
| $J/\psi(1S) K^*(1680)^+, K^* \rightarrow \phi K^+$                   | $(3.4 \pm \frac{1.9}{2.2}) \times 10^{-6}$ |                  |        | —    |
| $J/\psi(1S) K_2^*(1980), K_2^* \rightarrow \phi K^+$                 | $(1.5 \pm \frac{0.9}{0.5}) \times 10^{-6}$ |                  |        | —    |
| $J/\psi(1S) K(1830)^+, K(1830)^+ \rightarrow \phi K^+$               | $(1.3 \pm \frac{1.3}{1.1}) \times 10^{-6}$ |                  |        | —    |
| $\chi_{c1}(4140) K^+, \chi_{c1} \rightarrow J/\psi(1S) \phi$         | $(10 \pm 4) \times 10^{-6}$                |                  |        | —    |
| $\chi_{c1}(4274) K^+, \chi_{c1} \rightarrow J/\psi(1S) \phi$         | $(3.6 \pm \frac{2.2}{1.8}) \times 10^{-6}$ |                  |        | —    |
| $\chi_{c0}(4500) K^+, \chi_{c0} \rightarrow J/\psi(1S) \phi$         | $(3.3 \pm \frac{2.1}{1.7}) \times 10^{-6}$ |                  |        | —    |
| $\chi_{c0}(4700) K^+, \chi_{c0} \rightarrow J/\psi(1S) \phi$         | $(6 \pm \frac{5}{4}) \times 10^{-6}$       |                  |        | —    |

|                                                          |                                               |        |      |
|----------------------------------------------------------|-----------------------------------------------|--------|------|
| $J/\psi(1S)\omega K^+$                                   | $( 3.20 \pm_{-0.32}^{+0.60} ) \times 10^{-4}$ |        | 1388 |
| $\chi_{c0}(3915)K^+, \chi_{c0} \rightarrow J/\psi\omega$ | $( 3.0 \pm_{-0.7}^{+0.9} ) \times 10^{-5}$    |        | 1103 |
| $J/\psi(1S)\pi^+$                                        | $( 3.92 \pm 0.09 ) \times 10^{-5}$            |        | 1728 |
| $J/\psi(1S)\pi^+\pi^+\pi^+\pi^-\pi^-$                    | $( 1.17 \pm 0.13 ) \times 10^{-5}$            |        | 1635 |
| $\psi(2S)\pi^+\pi^+\pi^-$                                | $( 1.9 \pm 0.4 ) \times 10^{-5}$              |        | 1304 |
| $J/\psi(1S)\rho^+$                                       | $( 4.1 \pm 0.5 ) \times 10^{-5}$              | S=1.4  | 1612 |
| $J/\psi(1S)\pi^+\pi^0$ nonresonant                       | $< 7.3 \times 10^{-6}$                        | CL=90% | 1717 |
| $J/\psi(1S)a_1(1260)^+$                                  | $< 1.2 \times 10^{-3}$                        | CL=90% | 1415 |
| $J/\psi(1S)p\bar{p}\pi^+$                                | $< 5.0 \times 10^{-7}$                        | CL=90% | 644  |
| $J/\psi(1S)p\bar{\Lambda}$                               | $( 1.46 \pm 0.12 ) \times 10^{-5}$            |        | 568  |
| $J/\psi(1S)\bar{\Sigma}^0 p$                             | $< 1.1 \times 10^{-5}$                        | CL=90% | —    |
| $J/\psi(1S)D^+$                                          | $< 1.2 \times 10^{-4}$                        | CL=90% | 871  |
| $J/\psi(1S)\bar{D}^0\pi^+$                               | $< 2.5 \times 10^{-5}$                        | CL=90% | 665  |
| $J/\psi(1S)D_s^+$                                        | $< 2.8 \times 10^{-7}$                        | CL=90% | 727  |
| $\psi(2S)\pi^+$                                          | $( 2.44 \pm 0.30 ) \times 10^{-5}$            |        | 1348 |
| $\psi(2S)K^+$                                            | $( 6.24 \pm 0.21 ) \times 10^{-4}$            |        | 1284 |
| $\psi(2S)K^*(892)^+$                                     | $( 6.7 \pm 1.4 ) \times 10^{-4}$              | S=1.3  | 1116 |
| $\psi(2S)K^+\pi^+\pi^-$                                  | $( 4.3 \pm 0.5 ) \times 10^{-4}$              |        | 1179 |
| $\psi(2S)\phi(1020)K^+$                                  | $( 4.0 \pm 0.7 ) \times 10^{-6}$              |        | 418  |
| $\psi(3770)K^+$                                          | $( 4.3 \pm 1.1 ) \times 10^{-4}$              |        | 1218 |
| $\psi(3770)K^+, \psi \rightarrow D^0\bar{D}^0$           | $( 1.5 \pm 0.5 ) \times 10^{-4}$              | S=1.4  | 1218 |
| $\psi(3770)K^+, \psi \rightarrow D^+D^-$                 | $( 9.4 \pm 3.5 ) \times 10^{-5}$              |        | 1218 |
| $\psi(3770)K^+, \psi \rightarrow p\bar{p}$               | $< 2 \times 10^{-7}$                          | CL=95% | —    |
| $\psi(3770)K^+, \psi \rightarrow J/\psi\eta$             | $< 4.6 \times 10^{-7}$                        | CL=90% | —    |
| $\psi(4040)K^+$                                          | $( 1.6 \pm 0.5 ) \times 10^{-3}$              |        | 1002 |
| $\psi(4040)K^+, \psi \rightarrow D^+D^-$                 | $( 1.1 \pm 0.5 ) \times 10^{-5}$              |        | —    |
| $\psi(4160)K^+$                                          | $( 5.1 \pm 2.7 ) \times 10^{-4}$              |        | 869  |
| $\psi(4160)K^+, \psi \rightarrow \bar{D}^0D^0$           | $( 8 \pm 5 ) \times 10^{-5}$                  |        | —    |
| $\psi(4160)K^+, \psi \rightarrow D^+D^-$                 | $( 1.5 \pm 0.6 ) \times 10^{-5}$              |        | —    |
| $\psi(4415)K^+, \psi \rightarrow D^+D^-$                 | $( 2.0 \pm 0.8 ) \times 10^{-5}$              |        | —    |
| $\psi(4415)K^+, \psi \rightarrow J/\psi\eta$             | $< 9.6 \times 10^{-7}$                        | CL=90% | —    |
| $\chi_{c0}\pi^+, \chi_{c0} \rightarrow \pi^+\pi^-$       | $< 1 \times 10^{-7}$                          | CL=90% | 1531 |
| $\chi_{c0}\pi^+, \chi_{c0} \rightarrow \pi^0\pi^0$       | $< 5 \times 10^{-7}$                          | CL=90% | —    |
| $\chi_{c0}K^+$                                           | $( 1.51 \pm_{-0.13}^{+0.15} ) \times 10^{-4}$ |        | 1478 |
| $\chi_{c0}K^0\pi^+$                                      | $( 1.45 \pm 0.21 ) \times 10^{-3}$            |        | 1439 |
| $\chi_{c0}K^*(892)^+$                                    | $< 2.1 \times 10^{-4}$                        | CL=90% | 1341 |
| $\chi_{c1}(1P)\pi^+$                                     | $( 2.2 \pm 0.5 ) \times 10^{-5}$              |        | 1468 |
| $\chi_{c1}(1P)K^+$                                       | $( 4.74 \pm 0.22 ) \times 10^{-4}$            |        | 1412 |
| $\chi_{c1}(1P)K^*(892)^+$                                | $( 3.0 \pm 0.6 ) \times 10^{-4}$              | S=1.1  | 1265 |
| $\chi_{c1}(1P)K^0\pi^+$                                  | $( 5.8 \pm 0.4 ) \times 10^{-4}$              |        | 1370 |
| $\chi_{c1}(1P)K^+\pi^0$                                  | $( 3.29 \pm 0.35 ) \times 10^{-4}$            |        | 1373 |

|                                                                       |                                  |      |
|-----------------------------------------------------------------------|----------------------------------|------|
| $\chi_{c1}(1P)K^+\pi^+\pi^-$                                          | $(3.74 \pm 0.30) \times 10^{-4}$ | 1319 |
| $\chi_{c1}(2P)K^+, \chi_{c1}(2P) \rightarrow \pi^+\pi^-\chi_{c1}(1P)$ | $< 1.1 \times 10^{-5}$ CL=90%    | —    |
| $\chi_{c2}\pi^+, \chi_{c2} \rightarrow \pi^0\pi^0$                    | $< 7 \times 10^{-7}$ CL=90%      | —    |
| $\chi_{c2}K^+$                                                        | $(1.1 \pm 0.4) \times 10^{-5}$   | 1379 |
| $\chi_{c2}K^+, \chi_{c2} \rightarrow p\bar{p}\pi^+\pi^-$              | $< 1.9 \times 10^{-7}$           | —    |
| $\chi_{c2}K^*(892)^+$                                                 | $< 1.2 \times 10^{-4}$ CL=90%    | 1228 |
| $\chi_{c2}K^0\pi^+$                                                   | $(1.24 \pm 0.25) \times 10^{-4}$ | 1336 |
| $\chi_{c2}K^+\pi^0$                                                   | $< 6.2 \times 10^{-5}$ CL=90%    | 1339 |
| $\chi_{c2}K^+\pi^+\pi^-$                                              | $(1.34 \pm 0.19) \times 10^{-4}$ | 1284 |
| $\chi_{c2}(3930)K^+, \chi_{c2} \rightarrow D^+D^-$                    | $(1.6 \pm 0.6) \times 10^{-5}$   | —    |
| $\chi_{c2}(3930)\pi^+, \chi_{c2} \rightarrow \pi^+\pi^-$              | $< 1 \times 10^{-7}$ CL=90%      | 1437 |
| $h_c(1P)K^+$                                                          | $(3.7 \pm 1.2) \times 10^{-5}$   | 1401 |
| $h_c(1P)K^+, h_c \rightarrow p\bar{p}$                                | $< 6.4 \times 10^{-8}$ CL=95%    | —    |

**K or K\* modes**

|                                                             |                                           |      |
|-------------------------------------------------------------|-------------------------------------------|------|
| $K^0\pi^+$                                                  | $(2.39 \pm 0.06) \times 10^{-5}$          | 2614 |
| $K^+\pi^0$                                                  | $(1.32 \pm 0.04) \times 10^{-5}$          | 2615 |
| $\eta'K^+$                                                  | $(7.04 \pm 0.25) \times 10^{-5}$          | 2528 |
| $\eta'K^*(892)^+$                                           | $(4.8 \pm 1.8 \pm 1.6) \times 10^{-6}$    | 2472 |
| $\eta'K_0^*(1430)^+$                                        | $(5.2 \pm 2.1) \times 10^{-6}$            | —    |
| $\eta'K_2^*(1430)^+$                                        | $(2.8 \pm 0.5) \times 10^{-5}$            | 2346 |
| $\eta K^+$                                                  | $(2.4 \pm 0.4) \times 10^{-6}$ S=1.7      | 2588 |
| $\eta K^*(892)^+$                                           | $(1.93 \pm 0.16) \times 10^{-5}$          | 2534 |
| $\eta K_0^*(1430)^+$                                        | $(1.8 \pm 0.4) \times 10^{-5}$            | —    |
| $\eta K_2^*(1430)^+$                                        | $(9.1 \pm 3.0) \times 10^{-6}$            | 2414 |
| $\eta(1295)K^+ \times B(\eta(1295) \rightarrow \eta\pi\pi)$ | $(2.9 \pm 0.8 \pm 0.7) \times 10^{-6}$    | 2455 |
| $\eta(1405)K^+ \times B(\eta(1405) \rightarrow \eta\pi\pi)$ | $< 1.3 \times 10^{-6}$ CL=90%             | 2425 |
| $\eta(1405)K^+ \times B(\eta(1405) \rightarrow K^*K)$       | $< 1.2 \times 10^{-6}$ CL=90%             | 2425 |
| $\eta(1475)K^+ \times B(\eta(1475) \rightarrow K^*K)$       | $(1.38 \pm 0.21 \pm 0.18) \times 10^{-5}$ | 2406 |
| $f_1(1285)K^+$                                              | $< 2.0 \times 10^{-6}$ CL=90%             | 2458 |
| $f_1(1420)K^+ \times B(f_1(1420) \rightarrow \eta\pi\pi)$   | $< 2.9 \times 10^{-6}$ CL=90%             | 2420 |
| $f_1(1420)K^+ \times B(f_1(1420) \rightarrow K^*K)$         | $< 4.1 \times 10^{-6}$ CL=90%             | 2420 |
| $\phi(1680)K^+ \times B(\phi(1680) \rightarrow K^*K)$       | $< 3.4 \times 10^{-6}$ CL=90%             | 2344 |
| $f_0(1500)K^+$                                              | $(3.7 \pm 2.2) \times 10^{-6}$            | 2393 |
| $\omega K^+$                                                | $(6.5 \pm 0.4) \times 10^{-6}$            | 2558 |

|                                                                  |                                                    |        |      |
|------------------------------------------------------------------|----------------------------------------------------|--------|------|
| $\omega K^*(892)^+$                                              | $< 7.4 \times 10^{-6}$                             | CL=90% | 2503 |
| $\omega(K\pi)_0^{*+}$                                            | $(2.8 \pm 0.4) \times 10^{-5}$                     |        | —    |
| $\omega K_0^*(1430)^+$                                           | $(2.4 \pm 0.5) \times 10^{-5}$                     |        | —    |
| $\omega K_2^*(1430)^+$                                           | $(2.1 \pm 0.4) \times 10^{-5}$                     |        | 2379 |
| $a_0(980)^+ K^0 \times B(a_0(980)^+ \rightarrow \eta \pi^+)$     | $< 3.9 \times 10^{-6}$                             | CL=90% | —    |
| $a_0(980)^0 K^+ \times B(a_0(980)^0 \rightarrow \eta \pi^0)$     | $< 2.5 \times 10^{-6}$                             | CL=90% | —    |
| $K^*(892)^0 \pi^+$                                               | $(1.01 \pm 0.08) \times 10^{-5}$                   |        | 2562 |
| $K^*(892)^+ \pi^0$                                               | $(6.8 \pm 0.9) \times 10^{-6}$                     |        | 2563 |
| $K^+ \pi^- \pi^+$                                                | $(5.10 \pm 0.29) \times 10^{-5}$                   |        | 2609 |
| $K^+ \pi^- \pi^+$ nonresonant                                    | $(1.63 \pm 0.21 \text{ } ^{-0.15}) \times 10^{-5}$ |        | 2609 |
| $\omega(782) K^+$                                                | $(6 \pm 9) \times 10^{-6}$                         |        | 2558 |
| $K^+ f_0(980) \times B(f_0(980) \rightarrow \pi^+ \pi^-)$        | $(9.4 \pm 1.0 \text{ } ^{-1.2}) \times 10^{-6}$    |        | 2522 |
| $f_2(1270)^0 K^+$                                                | $(1.07 \pm 0.27) \times 10^{-6}$                   |        | —    |
| $f_0(1370)^0 K^+ \times B(f_0(1370)^0 \rightarrow \pi^+ \pi^-)$  | $< 1.07 \times 10^{-5}$                            | CL=90% | —    |
| $\rho(14500) K^+ \times B(\rho(1450)^0 \rightarrow \pi^+ \pi^-)$ | $< 1.17 \times 10^{-5}$                            | CL=90% | —    |
| $f_2'(1525) K^+ \times B(f_2'(1525) \rightarrow \pi^+ \pi^-)$    | $< 3.4 \times 10^{-6}$                             | CL=90% | 2394 |
| $K^+ \rho^0$                                                     | $(3.7 \pm 0.5) \times 10^{-6}$                     |        | 2559 |
| $K_0^*(1430)^0 \pi^+$                                            | $(3.9 \pm 0.6 \text{ } ^{-0.5}) \times 10^{-5}$    | S=1.4  | 2445 |
| $K_2^*(1430)^0 \pi^+$                                            | $(5.6 \pm 2.2 \text{ } ^{-1.5}) \times 10^{-6}$    |        | 2445 |
| $K^*(1410)^0 \pi^+$                                              | $< 4.5 \times 10^{-5}$                             | CL=90% | 2448 |
| $K^*(1680)^0 \pi^+$                                              | $< 1.2 \times 10^{-5}$                             | CL=90% | 2358 |
| $K^+ \pi^0 \pi^0$                                                | $(1.62 \pm 0.19) \times 10^{-5}$                   |        | 2610 |
| $f_0(980) K^+ \times B(f_0 \rightarrow \pi^0 \pi^0)$             | $(2.8 \pm 0.8) \times 10^{-6}$                     |        | 2522 |
| $K^- \pi^+ \pi^+$                                                | $< 4.6 \times 10^{-8}$                             | CL=90% | 2609 |
| $K^- \pi^+ \pi^+$ nonresonant                                    | $< 5.6 \times 10^{-5}$                             | CL=90% | 2609 |
| $K_1(1270)^0 \pi^+$                                              | $< 4.0 \times 10^{-5}$                             | CL=90% | 2489 |
| $K_1(1400)^0 \pi^+$                                              | $< 3.9 \times 10^{-5}$                             | CL=90% | 2451 |
| $K^0 \pi^+ \pi^0$                                                | $< 6.6 \times 10^{-5}$                             | CL=90% | 2609 |
| $K_0^*(1430)^+ \pi^0$                                            | $(1.19 \pm 0.20 \text{ } ^{-0.23}) \times 10^{-5}$ |        | —    |
| $K^0 \rho^+$                                                     | $(7.3 \pm 1.0 \text{ } ^{-1.2}) \times 10^{-6}$    |        | 2558 |
| $K^*(892)^+ \pi^+ \pi^-$                                         | $(7.5 \pm 1.0) \times 10^{-5}$                     |        | 2557 |
| $K^*(892)^+ \rho^0$                                              | $(4.6 \pm 1.1) \times 10^{-6}$                     |        | 2504 |
| $K^*(892)^+ f_0(980)$                                            | $(4.2 \pm 0.7) \times 10^{-6}$                     |        | 2466 |
| $a_1^+ K^0$                                                      | $(3.5 \pm 0.7) \times 10^{-5}$                     |        | —    |

|                                                           |                                                        |             |
|-----------------------------------------------------------|--------------------------------------------------------|-------------|
| $b_1^+ K^0 \times B(b_1^+ \rightarrow \omega \pi^+)$      | $(9.6 \pm 1.9) \times 10^{-6}$                         | —           |
| $K^{*0}(892) \rho^+$                                      | $(9.2 \pm 1.5) \times 10^{-6}$                         | 2504        |
| $K_1(1400)^+ \rho^0$                                      | $< 7.8 \times 10^{-4}$                                 | CL=90% 2388 |
| $K_2^{*0}(1430)^+ \rho^0$                                 | $< 1.5 \times 10^{-3}$                                 | CL=90% 2381 |
| $b_1^0 K^+ \times B(b_1^0 \rightarrow \omega \pi^0)$      | $(9.1 \pm 2.0) \times 10^{-6}$                         | —           |
| $b_1^+ K^{*0} \times B(b_1^+ \rightarrow \omega \pi^+)$   | $< 5.9 \times 10^{-6}$                                 | CL=90% —    |
| $b_1^0 K^{*+} \times B(b_1^0 \rightarrow \omega \pi^0)$   | $< 6.7 \times 10^{-6}$                                 | CL=90% —    |
| $K^+ \bar{K}^0$                                           | $(1.32 \pm 0.17) \times 10^{-6}$                       | S=1.2 2593  |
| $\bar{K}^0 K^+ \pi^0$                                     | $< 2.4 \times 10^{-5}$                                 | CL=90% 2578 |
| $K^+ K_S^0 K_S^0$                                         | $(1.05 \pm 0.04) \times 10^{-5}$                       | 2521        |
| $f_0(980) K^+, f_0 \rightarrow K_S^0 K_S^0$               | $(1.47 \pm 0.33) \times 10^{-5}$                       | —           |
| $f_0(1710) K^+, f_0 \rightarrow K_S^0 K_S^0$              | $(4.8 \pm 4.0 \text{ } ^{+}_{-2.6}) \times 10^{-7}$    | —           |
| $K^+ K_S^0 K_S^0$ nonresonant                             | $(2.0 \pm 0.4) \times 10^{-5}$                         | 2521        |
| $K_S^0 K_S^0 \pi^+$                                       | $< 5.1 \times 10^{-7}$                                 | CL=90% 2577 |
| $K^+ K^- \pi^+$                                           | $(5.2 \pm 0.4) \times 10^{-6}$                         | 2578        |
| $K^+ K^- \pi^+$ nonresonant                               | $(1.68 \pm 0.26) \times 10^{-6}$                       | 2578        |
| $K^+ \bar{K}^{*0}(892)$                                   | $(5.9 \pm 0.8) \times 10^{-7}$                         | 2540        |
| $K^+ \bar{K}_0^{*0}(1430)$                                | $(3.8 \pm 1.3) \times 10^{-7}$                         | 2421        |
| $\pi^+(K^+ K^-)_{S\text{-wave}}$                          | $(8.5 \pm 0.9) \times 10^{-7}$                         | 2578        |
| $\pi^+ K^+ K^-, m_{K^+ K^-} < 1.1$<br>GeV                 | $(5.4 \pm 0.5) \times 10^{-6}$                         | —           |
| $K^+ K^+ \pi^-$                                           | $< 1.1 \times 10^{-8}$                                 | CL=90% 2578 |
| $K^+ K^+ \pi^-$ nonresonant                               | $< 8.79 \times 10^{-5}$                                | CL=90% 2578 |
| $f_2'(1525) K^+$                                          | $(1.8 \pm 0.5) \times 10^{-6}$                         | S=1.1 2394  |
| $K^{*+} \pi^+ K^-$                                        | $< 1.18 \times 10^{-5}$                                | CL=90% 2524 |
| $K^{*0}(892)^+ K^{*0}(892)^0$                             | $(9.1 \pm 2.9) \times 10^{-7}$                         | 2485        |
| $K^{*+} K^+ \pi^-$                                        | $< 6.1 \times 10^{-6}$                                 | CL=90% 2524 |
| $K^+ K^- K^+$                                             | $(3.40 \pm 0.14) \times 10^{-5}$                       | S=1.4 2523  |
| $K^+ \phi$                                                | $(8.8 \pm 0.7 \text{ } ^{+}_{-0.6}) \times 10^{-6}$    | S=1.1 2516  |
| $f_0(980) K^+ \times B(f_0(980) \rightarrow K^+ K^-)$     | $(9.4 \pm 3.2) \times 10^{-6}$                         | 2522        |
| $a_2(1320) K^+ \times B(a_2(1320) \rightarrow K^+ K^-)$   | $< 1.1 \times 10^{-6}$                                 | CL=90% 2449 |
| $X_0(1550) K^+ \times B(X_0(1550) \rightarrow K^+ K^-)$   | $(4.3 \pm 0.7) \times 10^{-6}$                         | —           |
| $\phi(1680) K^+ \times B(\phi(1680) \rightarrow K^+ K^-)$ | $< 8 \times 10^{-7}$                                   | CL=90% 2344 |
| $f_0(1710) K^+ \times B(f_0(1710) \rightarrow K^+ K^-)$   | $(1.1 \pm 0.6) \times 10^{-6}$                         | 2327        |
| $K^+ K^- K^+$ nonresonant                                 | $(2.38 \pm 0.28 \text{ } ^{+}_{-0.50}) \times 10^{-5}$ | 2523        |
| $K^{*0}(892)^+ K^+ K^-$                                   | $(3.6 \pm 0.5) \times 10^{-5}$                         | 2466        |

|                                                        |                                             |        |      |
|--------------------------------------------------------|---------------------------------------------|--------|------|
| $K^*(892)^+\phi$                                       | $(10.0 \pm 2.0) \times 10^{-6}$             | S=1.7  | 2460 |
| $K^0 K^+ K^- \pi^+$                                    | $(3.40 \pm 0.33) \times 10^{-4}$            |        | 2494 |
| $J/\psi K^+, J/\psi \rightarrow K^0 K^- \pi^+$         | $(5.4 \pm 1.2) \times 10^{-6}$              |        | —    |
| $\chi_{c1} K^+, \chi_{c1} \rightarrow K^0 K^- \pi^+$   | $(2.25 \pm 0.25) \times 10^{-6}$            |        | —    |
| $\eta_c K^+, \eta_c \rightarrow K^0 K^- \pi^+$         | $(2.83 \pm 0.30) \times 10^{-5}$            |        | —    |
| $\eta_c(2S) K^+, \eta_c(2S) \rightarrow K^0 K^- \pi^+$ | $(3.3 \pm 0.4) \times 10^{-6}$              |        | —    |
| $K^0 K^+ K^+ \pi^-$                                    | $(2.80 \pm 0.30) \times 10^{-4}$            |        | 2494 |
| $J/\psi K^+, J/\psi \rightarrow K^0 K^+ \pi^-$         | $(5.4 \pm 1.3) \times 10^{-6}$              |        | —    |
| $\chi_{c1} K^+, \chi_{c1} \rightarrow K^0 K^+ \pi^-$   | $(2.06 \pm 0.32) \times 10^{-6}$            |        | —    |
| $\eta_c K^+, \eta_c \rightarrow K^0 K^+ \pi^-$         | $(3.00 \pm 0.34) \times 10^{-5}$            |        | —    |
| $\eta_c(2S) K^+, \eta_c(2S) \rightarrow K^0 K^+ \pi^-$ | $(3.1 \pm 0.6) \times 10^{-6}$              |        | —    |
| $\phi(K\pi)_0^{*+}$                                    | $(8.3 \pm 1.6) \times 10^{-6}$              |        | —    |
| $\phi K_1(1270)^+$                                     | $(6.1 \pm 1.9) \times 10^{-6}$              |        | 2380 |
| $\phi K_1(1400)^+$                                     | $< 3.2 \times 10^{-6}$                      | CL=90% | 2339 |
| $\phi K^*(1410)^+$                                     | $< 4.3 \times 10^{-6}$                      | CL=90% | —    |
| $\phi K_0^*(1430)^+$                                   | $(7.0 \pm 1.6) \times 10^{-6}$              |        | —    |
| $\phi K_2^*(1430)^+$                                   | $(8.4 \pm 2.1) \times 10^{-6}$              |        | 2332 |
| $\phi K_2^*(1770)^+$                                   | $< 1.50 \times 10^{-5}$                     | CL=90% | —    |
| $\phi K_2^*(1820)^+$                                   | $< 1.63 \times 10^{-5}$                     | CL=90% | —    |
| $a_1^+ K^{*0}$                                         | $< 3.6 \times 10^{-6}$                      | CL=90% | —    |
| $K^+ \phi \phi$                                        | $(4.2 \pm 0.8) \times 10^{-6}$              | S=2.2  | 2306 |
| $\eta' \eta' K^+$                                      | $< 2.5 \times 10^{-5}$                      | CL=90% | 2339 |
| $\omega \phi K^+$                                      | $< 1.9 \times 10^{-6}$                      | CL=90% | 2374 |
| $X(1812) K^+ \times B(X \rightarrow \omega \phi)$      | $< 3.2 \times 10^{-7}$                      | CL=90% | —    |
| $K^*(892)^+ \gamma$                                    | $(3.92 \pm 0.22) \times 10^{-5}$            | S=1.7  | 2564 |
| $K_1(1270)^+ \gamma$                                   | $(4.4 \pm_{-0.6}^{+0.7}) \times 10^{-5}$    |        | 2491 |
| $\eta K^+ \gamma$                                      | $(7.9 \pm 0.9) \times 10^{-6}$              |        | 2588 |
| $\eta' K^+ \gamma$                                     | $(2.9 \pm_{-0.9}^{+1.0}) \times 10^{-6}$    |        | 2528 |
| $\phi K^+ \gamma$                                      | $(2.7 \pm 0.4) \times 10^{-6}$              | S=1.2  | 2516 |
| $K^+ \pi^- \pi^+ \gamma$                               | $(2.58 \pm 0.15) \times 10^{-5}$            | S=1.3  | 2609 |
| $K^*(892)^0 \pi^+ \gamma$                              | $(2.33 \pm 0.12) \times 10^{-5}$            |        | 2562 |
| $K^+ \rho^0 \gamma$                                    | $(8.2 \pm 0.9) \times 10^{-6}$              |        | 2559 |
| $(K^+ \pi^-)_{NR} \pi^+ \gamma$                        | $(9.9 \pm_{-2.0}^{+1.7}) \times 10^{-6}$    |        | 2609 |
| $K^0 \pi^+ \pi^0 \gamma$                               | $(4.6 \pm 0.5) \times 10^{-5}$              |        | 2609 |
| $K_1(1400)^+ \gamma$                                   | $(10 \pm_{-4}^{+5}) \times 10^{-6}$         |        | 2453 |
| $K^*(1410)^+ \gamma$                                   | $(2.7 \pm_{-0.6}^{+0.8}) \times 10^{-5}$    |        | —    |
| $K_0^*(1430)^0 \pi^+ \gamma$                           | $(1.32 \pm_{-0.32}^{+0.26}) \times 10^{-6}$ |        | 2445 |
| $K_2^*(1430)^+ \gamma$                                 | $(1.4 \pm 0.4) \times 10^{-5}$              |        | 2447 |

|                       |                                        |        |      |
|-----------------------|----------------------------------------|--------|------|
| $K^*(1680)^+\gamma$   | $(6.7 \pm 1.7 \pm 1.4) \times 10^{-5}$ |        | 2360 |
| $K_3^*(1780)^+\gamma$ | $< 3.9 \times 10^{-5}$                 | CL=90% | 2340 |
| $K_4^*(2045)^+\gamma$ | $< 9.9 \times 10^{-3}$                 | CL=90% | 2242 |

**Light unflavored meson modes**

|                                                    |                                           |        |      |
|----------------------------------------------------|-------------------------------------------|--------|------|
| $\rho^+\gamma$                                     | $(9.8 \pm 2.5) \times 10^{-7}$            |        | 2583 |
| $\pi^+\pi^0$                                       | $(5.31 \pm 0.26) \times 10^{-6}$          |        | 2636 |
| $\pi^+\pi^+\pi^-$                                  | $(1.52 \pm 0.14) \times 10^{-5}$          |        | 2630 |
| $\rho^0\pi^+$                                      | $(8.3 \pm 1.2) \times 10^{-6}$            |        | 2581 |
| $\pi^+f_0(980), f_0 \rightarrow \pi^+\pi^-$        | $< 1.5 \times 10^{-6}$                    | CL=90% | 2545 |
| $\pi^+f_2(1270)$                                   | $(2.2 \pm 0.7 \pm 0.4) \times 10^{-6}$    |        | 2484 |
| $\rho(1450)^0\pi^+, \rho^0 \rightarrow \pi^+\pi^-$ | $(1.4 \pm 0.6 \pm 0.9) \times 10^{-6}$    |        | 2434 |
| $\rho(1450)^0\pi^+, \rho^0 \rightarrow K^+K^-$     | $(1.60 \pm 0.14) \times 10^{-6}$          |        | —    |
| $f_0(1370)\pi^+, f_0 \rightarrow \pi^+\pi^-$       | $< 4.0 \times 10^{-6}$                    | CL=90% | 2460 |
| $f_0(1370)\pi^+, f_0 \rightarrow \pi^0\pi^0$       | $< 1.1 \times 10^{-6}$                    | CL=90% | —    |
| $f_0(500)\pi^+, f_0 \rightarrow \pi^+\pi^-$        | $< 4.1 \times 10^{-6}$                    | CL=90% | —    |
| $\pi^+\pi^-\pi^+$ nonresonant                      | $(5.3 \pm 1.5 \pm 1.1) \times 10^{-6}$    |        | 2630 |
| $\pi^+\pi^0\pi^0$                                  | $(1.90 \pm 0.21) \times 10^{-5}$          |        | 2631 |
| $\rho^+\pi^0$                                      | $(1.06 \pm 0.12 \pm 0.13) \times 10^{-5}$ |        | 2581 |
| $\rho(1450)^+\pi^0, \rho^+ \rightarrow \pi^+\pi^0$ | $(1.2 \pm 0.6) \times 10^{-6}$            |        | —    |
| $\pi^+\pi^0\pi^0$ nonresonant                      | $< 6 \times 10^{-7}$                      | CL=90% | 2631 |
| $X_{pi^+}, X \rightarrow \pi^0\pi^0$               | $(6.9 \pm 1.1) \times 10^{-6}$            |        | —    |
| $\pi^+\pi^-\pi^+\pi^0$                             | $< 4.0 \times 10^{-3}$                    | CL=90% | 2622 |
| $\rho^+\rho^0$                                     | $(2.40 \pm 0.19) \times 10^{-5}$          |        | 2523 |
| $\rho^+f_0(980), f_0 \rightarrow \pi^+\pi^-$       | $< 2.0 \times 10^{-6}$                    | CL=90% | 2486 |
| $a_1(1260)^+\pi^0$                                 | $(2.6 \pm 0.7) \times 10^{-5}$            |        | 2494 |
| $a_1(1260)^0\pi^+$                                 | $(2.0 \pm 0.6) \times 10^{-5}$            |        | 2494 |
| $\omega\pi^+$                                      | $(6.9 \pm 0.5) \times 10^{-6}$            |        | 2580 |
| $\omega\rho^+$                                     | $(1.59 \pm 0.21) \times 10^{-5}$          |        | 2522 |
| $\eta\pi^+$                                        | $(4.02 \pm 0.27) \times 10^{-6}$          |        | 2609 |
| $\eta\rho^+$                                       | $(7.0 \pm 2.9) \times 10^{-6}$            | S=2.8  | 2553 |
| $\eta'\pi^+$                                       | $(2.7 \pm 0.9) \times 10^{-6}$            | S=1.9  | 2551 |
| $\eta'\rho^+$                                      | $(9.7 \pm 2.2) \times 10^{-6}$            |        | 2492 |
| $\phi\pi^+$                                        | $(3.2 \pm 1.5) \times 10^{-8}$            |        | 2539 |
| $\phi\rho^+$                                       | $< 3.0 \times 10^{-6}$                    | CL=90% | 2480 |
| $a_0(980)^0\pi^+, a_0^0 \rightarrow \eta\pi^0$     | $< 5.8 \times 10^{-6}$                    | CL=90% | —    |
| $a_0(980)^+\pi^0, a_0^+ \rightarrow \eta\pi^+$     | $< 1.4 \times 10^{-6}$                    | CL=90% | —    |
| $\pi^+\pi^+\pi^+\pi^-\pi^-$                        | $< 8.6 \times 10^{-4}$                    | CL=90% | 2608 |
| $\rho^0a_1(1260)^+$                                | $< 6.2 \times 10^{-4}$                    | CL=90% | 2433 |
| $\rho^0a_2(1320)^+$                                | $< 7.2 \times 10^{-4}$                    | CL=90% | 2410 |
| $b_1^0\pi^+, b_1^0 \rightarrow \omega\pi^0$        | $(6.7 \pm 2.0) \times 10^{-6}$            |        | —    |

|                                                |       |                  |        |      |
|------------------------------------------------|-------|------------------|--------|------|
| $b_1^+ \pi^0, b_1^+ \rightarrow \omega \pi^+$  | < 3.3 | $\times 10^{-6}$ | CL=90% | —    |
| $\pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^0$          | < 6.3 | $\times 10^{-3}$ | CL=90% | 2592 |
| $b_1^+ \rho^0, b_1^+ \rightarrow \omega \pi^+$ | < 5.2 | $\times 10^{-6}$ | CL=90% | —    |
| $a_1(1260)^+ a_1(1260)^0$                      | < 1.3 | %                | CL=90% | 2336 |
| $b_1^0 \rho^+, b_1^0 \rightarrow \omega \pi^0$ | < 3.3 | $\times 10^{-6}$ | CL=90% | —    |

**Charged particle ( $h^\pm$ ) modes**

$$h^\pm = K^\pm \text{ or } \pi^\pm$$

|                                        |                                                 |                  |        |      |
|----------------------------------------|-------------------------------------------------|------------------|--------|------|
| $h^+ \pi^0$                            | ( 1.6 $\pm$ 0.7 $\pm$ 0.6 ) $\times 10^{-5}$    |                  |        | 2636 |
| $\omega h^+$                           | ( 1.38 $\pm$ 0.27 $\pm$ 0.24 ) $\times 10^{-5}$ |                  |        | 2580 |
| $h^+ X^0$ (Familon)                    | < 4.9                                           | $\times 10^{-5}$ | CL=90% | —    |
| $K^+ X^0, X^0 \rightarrow \mu^+ \mu^-$ | < 1                                             | $\times 10^{-7}$ | CL=95% | —    |

**Baryon modes**

|                                                            |                                              |                  |        |      |
|------------------------------------------------------------|----------------------------------------------|------------------|--------|------|
| $p \bar{p} \pi^+$                                          | ( 1.62 $\pm$ 0.20 ) $\times 10^{-6}$         |                  |        | 2439 |
| $p \bar{p} \pi^+$ nonresonant                              | < 5.3                                        | $\times 10^{-5}$ | CL=90% | 2439 |
| $p \bar{p} \pi^+ \pi^0$                                    | ( 4.6 $\pm$ 1.3 ) $\times 10^{-6}$           |                  |        | 2407 |
| $p \bar{p} K^+$                                            | ( 5.9 $\pm$ 0.5 ) $\times 10^{-6}$           |                  | S=1.5  | 2348 |
| $\Theta(1710)^{++} \bar{p}, \Theta^{++} \rightarrow p K^+$ | [g] < 9.1                                    | $\times 10^{-8}$ | CL=90% | —    |
| $f_J(2220) K^+, f_J \rightarrow p \bar{p}$                 | [g] < 4.1                                    | $\times 10^{-7}$ | CL=90% | 2135 |
| $p \bar{n} \pi^0$                                          | < 6.3                                        | $\times 10^{-6}$ | CL=90% | 2440 |
| $p \bar{\Lambda}(1520)$                                    | ( 3.1 $\pm$ 0.6 ) $\times 10^{-7}$           |                  |        | 2322 |
| $p \bar{p} K^+$ nonresonant                                | < 8.9                                        | $\times 10^{-5}$ | CL=90% | 2348 |
| $p \bar{p} K^*(892)^+$                                     | ( 3.6 $\pm$ 0.8 $\pm$ 0.7 ) $\times 10^{-6}$ |                  |        | 2215 |
| $f_J(2220) K^{*+}, f_J \rightarrow p \bar{p}$              | < 7.7                                        | $\times 10^{-7}$ | CL=90% | 2059 |
| $p \bar{\Lambda}$                                          | ( 2.4 $\pm$ 1.0 $\pm$ 0.9 ) $\times 10^{-7}$ |                  |        | 2430 |
| $p \bar{\Lambda} \gamma$                                   | ( 2.4 $\pm$ 0.5 $\pm$ 0.4 ) $\times 10^{-6}$ |                  |        | 2430 |
| $p \bar{\Lambda} \pi^0$                                    | ( 3.0 $\pm$ 0.7 $\pm$ 0.6 ) $\times 10^{-6}$ |                  |        | 2402 |
| $p \bar{\Sigma}(1385)^0$                                   | < 4.7                                        | $\times 10^{-7}$ | CL=90% | 2362 |
| $\Delta^+ \bar{\Lambda}$                                   | < 8.2                                        | $\times 10^{-7}$ | CL=90% | —    |
| $p \bar{\Sigma} \gamma$                                    | < 4.6                                        | $\times 10^{-6}$ | CL=90% | 2413 |
| $p \bar{\Lambda} \pi^+ \pi^-$                              | ( 1.13 $\pm$ 0.13 ) $\times 10^{-5}$         |                  |        | 2368 |
| $p \bar{\Lambda} \pi^+ \pi^-$ nonresonant                  | ( 5.9 $\pm$ 1.1 ) $\times 10^{-6}$           |                  |        | 2368 |
| $p \bar{\Lambda} \rho^0, \rho^0 \rightarrow \pi^+ \pi^-$   | ( 4.8 $\pm$ 0.9 ) $\times 10^{-6}$           |                  |        | 2214 |
| $p \bar{\Lambda} f_2(1270), f_2 \rightarrow \pi^+ \pi^-$   | ( 2.0 $\pm$ 0.8 ) $\times 10^{-6}$           |                  |        | 2026 |
| $p \bar{\Lambda} K^+ K^-$                                  | ( 4.1 $\pm$ 0.7 ) $\times 10^{-6}$           |                  |        | 2132 |
| $p \bar{\Lambda} \phi$                                     | ( 8.0 $\pm$ 2.2 ) $\times 10^{-7}$           |                  |        | 2119 |
| $\bar{p} \Lambda K^+ K^-$                                  | ( 3.7 $\pm$ 0.6 ) $\times 10^{-6}$           |                  |        | 2132 |
| $\Lambda \bar{\Lambda} \pi^+$                              | < 9.4                                        | $\times 10^{-7}$ | CL=90% | 2358 |



|                                                              |                                        |        |      |
|--------------------------------------------------------------|----------------------------------------|--------|------|
| $\Lambda \bar{\Lambda} K^+$                                  | $(3.4 \pm 0.6) \times 10^{-6}$         |        | 2251 |
| $\Lambda \bar{\Lambda} K^{*+}$                               | $(2.2 \pm 1.2 \pm 0.9) \times 10^{-6}$ |        | 2098 |
| $\Lambda(1520) \bar{\Lambda} K^+$                            | $(2.2 \pm 0.7) \times 10^{-6}$         |        | 2126 |
| $\Lambda \bar{\Lambda}(1520) K^+$                            | $< 2.08 \times 10^{-6}$                |        | 2126 |
| $\bar{\Delta}^0 p$                                           | $< 1.38 \times 10^{-6}$                | CL=90% | 2403 |
| $\Delta^{++} \bar{p}$                                        | $< 1.4 \times 10^{-7}$                 | CL=90% | 2403 |
| $D^+ p \bar{p}$                                              | $< 1.5 \times 10^{-5}$                 | CL=90% | 1860 |
| $D^*(2010)^+ p \bar{p}$                                      | $< 1.5 \times 10^{-5}$                 | CL=90% | 1786 |
| $\bar{D}^0 p \bar{p} \pi^+$                                  | $(3.72 \pm 0.27) \times 10^{-4}$       |        | 1789 |
| $\bar{D}^{*0} p \bar{p} \pi^+$                               | $(3.73 \pm 0.32) \times 10^{-4}$       |        | 1709 |
| $D^- p \bar{p} \pi^+ \pi^-$                                  | $(1.66 \pm 0.30) \times 10^{-4}$       |        | 1705 |
| $D^{*-} p \bar{p} \pi^+ \pi^-$                               | $(1.86 \pm 0.25) \times 10^{-4}$       |        | 1621 |
| $p \bar{\Lambda}^0 \bar{D}^0$                                | $(1.43 \pm 0.32) \times 10^{-5}$       |        | —    |
| $p \bar{\Lambda}^0 \bar{D}^*(2007)^0$                        | $< 5 \times 10^{-5}$                   | CL=90% | —    |
| $\bar{\Lambda}_c^- p \pi^+$                                  | $(2.2 \pm 0.4) \times 10^{-4}$         | S=2.5  | 1980 |
| $\bar{\Lambda}_c^- p K^+$                                    | $(8.9 \pm 1.6) \times 10^{-6}$         |        | 1849 |
| $\bar{\Lambda}_c^- \Delta(1232)^{++}$                        | $< 1.9 \times 10^{-5}$                 | CL=90% | 1928 |
| $\bar{\Lambda}_c^- \Delta_X(1600)^{++}$                      | $(4.6 \pm 0.9) \times 10^{-5}$         |        | —    |
| $\bar{\Lambda}_c^- \Delta_X(2420)^{++}$                      | $(3.7 \pm 0.8) \times 10^{-5}$         |        | —    |
| $(\bar{\Lambda}_c^- p)_s \pi^+$                              | $[h] (3.1 \pm 0.7) \times 10^{-5}$     |        | —    |
| $\bar{\Sigma}_c(2520)^0 p$                                   | $< 3 \times 10^{-6}$                   | CL=90% | 1904 |
| $\bar{\Sigma}_c(2800)^0 p$                                   | $(2.6 \pm 0.9) \times 10^{-5}$         |        | —    |
| $\bar{\Lambda}_c^- p \pi^+ \pi^0$                            | $(1.8 \pm 0.6) \times 10^{-3}$         |        | 1935 |
| $\bar{\Lambda}_c^- p \pi^+ \pi^+ \pi^-$                      | $(2.2 \pm 0.7) \times 10^{-3}$         |        | 1880 |
| $\bar{\Lambda}_c^- p \pi^+ \pi^+ \pi^- \pi^0$                | $< 1.34 \%$                            | CL=90% | 1823 |
| $\Lambda_c^+ \Lambda_c^- K^+$                                | $(4.9 \pm 0.7) \times 10^{-4}$         |        | 739  |
| $\Xi_c(2930) \Lambda_c^+, \Xi_c \rightarrow K^+ \Lambda_c^-$ | $(1.7 \pm 0.5) \times 10^{-4}$         |        | —    |
| $\bar{\Sigma}_c(2455)^0 p$                                   | $(2.9 \pm 0.6) \times 10^{-5}$         |        | 1938 |
| $\bar{\Sigma}_c(2455)^0 p \pi^0$                             | $(3.5 \pm 1.1) \times 10^{-4}$         |        | 1896 |
| $\bar{\Sigma}_c(2455)^0 p \pi^- \pi^+$                       | $(3.5 \pm 1.0) \times 10^{-4}$         |        | 1845 |
| $\bar{\Sigma}_c(2455)^{--} p \pi^+ \pi^+$                    | $(2.34 \pm 0.18) \times 10^{-4}$       |        | 1845 |
| $\bar{\Lambda}_c(2593)^- / \bar{\Lambda}_c(2625)^- p \pi^+$  | $< 1.9 \times 10^{-4}$                 | CL=90% | —    |
| $\Xi_c^0 \Lambda_c^+$                                        | $(9.5 \pm 2.3) \times 10^{-4}$         |        | 1144 |
| $\Xi_c^0 \Lambda_c^+$                                        | $< 2.6 \times 10^{-5}$                 | CL=95% | 1144 |
| $\Xi_c^0 \Lambda_c^+, \Xi_c^0 \rightarrow \Xi^+ \pi^-$       | $(1.76 \pm 0.29) \times 10^{-5}$       |        | 1144 |
| $\Xi_c^0 \Lambda_c^+, \Xi_c^0 \rightarrow \Lambda K^+ \pi^-$ | $(1.14 \pm 0.26) \times 10^{-5}$       |        | 1144 |
| $\Xi_c^0 \Lambda_c^+, \Xi_c^0 \rightarrow p K^- K^- \pi^+$   | $(5.5 \pm 1.9) \times 10^{-6}$         |        | —    |
| $\Lambda_c^+ \Xi_c^0$                                        | $< 6.5 \times 10^{-4}$                 | CL=90% | 1023 |
| $\Lambda_c^+ \Xi_c(2645)^0$                                  | $< 7.9 \times 10^{-4}$                 | CL=90% | —    |
| $\Lambda_c^+ \Xi_c(2790)^0$                                  | $(1.1 \pm 0.4) \times 10^{-3}$         |        | —    |

**Lepton Family number ( $LF$ ) or Lepton number ( $L$ ) or Baryon number ( $B$ )  
violating modes, or/and  $\Delta B = 1$  weak neutral current ( $B1$ ) modes**

|                                 |      |                            |                  |        |      |
|---------------------------------|------|----------------------------|------------------|--------|------|
| $\pi^+ \ell^+ \ell^-$           | $B1$ | $[a] < 4.9$                | $\times 10^{-8}$ | CL=90% | 2638 |
| $\pi^+ e^+ e^-$                 | $B1$ | $< 5.4$                    | $\times 10^{-8}$ | CL=90% | 2638 |
| $\pi^+ \mu^+ \mu^-$             | $B1$ | $(1.78 \pm 0.23)$          | $\times 10^{-8}$ |        | 2634 |
| $\rho(770)^+ e^+ e^-$           | $B1$ | $< 4.67$                   | $\times 10^{-7}$ | CL=90% | —    |
| $\rho(770)^+ \mu^+ \mu^-$       | $B1$ | $< 3.81$                   | $\times 10^{-7}$ | CL=90% | —    |
| $\rho(770)^+ \ell^+ \ell^-$     | $B1$ | $< 1.89$                   | $\times 10^{-7}$ | CL=90% | —    |
| $\pi^+ \nu \bar{\nu}$           | $B1$ | $< 1.4$                    | $\times 10^{-5}$ | CL=90% | 2638 |
| $K^+ \ell^+ \ell^-$             | $B1$ | $[a] (4.7 \pm 0.5)$        | $\times 10^{-7}$ | S=2.3  | 2617 |
| $K^+ e^+ e^-$                   | $B1$ | $(5.6 \pm 0.6)$            | $\times 10^{-7}$ |        | 2617 |
| $K^+ \mu^+ \mu^-$               | $B1$ | $(4.53 \pm 0.35)$          | $\times 10^{-7}$ | S=1.8  | 2612 |
| $K^+ \mu^+ \mu^-$ nonresonant   | $B1$ | $(4.37 \pm 0.27)$          | $\times 10^{-7}$ |        | 2612 |
| $K^+ \tau^+ \tau^-$             | $B1$ | $< 2.25$                   | $\times 10^{-3}$ | CL=90% | 1687 |
| $K^+ \bar{\nu} \nu$             | $B1$ | $(2.3 \pm 0.7)$            | $\times 10^{-5}$ |        | 2617 |
| $\rho^+ \nu \bar{\nu}$          | $B1$ | $< 3.0$                    | $\times 10^{-5}$ | CL=90% | 2583 |
| $K^*(892)^+ \ell^+ \ell^-$      | $B1$ | $[a] (1.01 \pm 0.11)$      | $\times 10^{-6}$ | S=1.1  | 2564 |
| $K^*(892)^+ e^+ e^-$            | $B1$ | $(1.55 \pm_{0.31}^{0.40})$ | $\times 10^{-6}$ |        | 2564 |
| $K^*(892)^+ \mu^+ \mu^-$        | $B1$ | $(9.6 \pm 1.0)$            | $\times 10^{-7}$ |        | 2560 |
| $K^*(892)^+ \nu \bar{\nu}$      | $B1$ | $< 4.0$                    | $\times 10^{-5}$ | CL=90% | 2564 |
| $K^+ \pi^+ \pi^- \mu^+ \mu^-$   | $B1$ | $(4.3 \pm 0.4)$            | $\times 10^{-7}$ |        | 2593 |
| $D_s^+ \mu^+ \mu^-$             | $B1$ | $< 2.4$                    | $\times 10^{-8}$ | CL=90% | 2267 |
| $\phi K^+ \mu^+ \mu^-$          | $B1$ | $(7.9 \pm_{1.7}^{2.1})$    | $\times 10^{-8}$ |        | 2490 |
| $\bar{\Lambda} p \nu \bar{\nu}$ | $B1$ | $< 3.0$                    | $\times 10^{-5}$ | CL=90% | 2430 |
| $\pi^+ e^+ \mu^-$               | $LF$ | $< 6.4$                    | $\times 10^{-3}$ | CL=90% | 2637 |
| $\pi^+ e^- \mu^+$               | $LF$ | $< 6.4$                    | $\times 10^{-3}$ | CL=90% | 2637 |
| $\pi^+ e^\pm \mu^\mp$           | $LF$ | $< 1.7$                    | $\times 10^{-7}$ | CL=90% | 2637 |
| $\pi^+ e^+ \tau^-$              | $LF$ | $< 7.4$                    | $\times 10^{-5}$ | CL=90% | 2338 |
| $\pi^+ e^- \tau^+$              | $LF$ | $< 2.0$                    | $\times 10^{-5}$ | CL=90% | 2338 |
| $\pi^+ e^\pm \tau^\mp$          | $LF$ | $< 7.5$                    | $\times 10^{-5}$ | CL=90% | 2338 |
| $\pi^+ \mu^+ \tau^-$            | $LF$ | $< 6.2$                    | $\times 10^{-5}$ | CL=90% | 2334 |
| $\pi^+ \mu^- \tau^+$            | $LF$ | $< 4.5$                    | $\times 10^{-5}$ | CL=90% | 2334 |
| $\pi^+ \mu^\pm \tau^\mp$        | $LF$ | $< 7.2$                    | $\times 10^{-5}$ | CL=90% | 2334 |
| $K^+ e^+ \mu^-$                 | $LF$ | $< 7.0$                    | $\times 10^{-9}$ | CL=90% | 2616 |
| $K^+ e^- \mu^+$                 | $LF$ | $< 6.4$                    | $\times 10^{-9}$ | CL=90% | 2616 |
| $K^+ e^\pm \mu^\mp$             | $LF$ | $< 9.1$                    | $\times 10^{-8}$ | CL=90% | 2616 |
| $K^+ e^+ \tau^-$                | $LF$ | $< 1.53$                   | $\times 10^{-5}$ | CL=90% | 2312 |
| $K^+ e^- \tau^+$                | $LF$ | $< 1.5$                    | $\times 10^{-5}$ | CL=90% | 2312 |
| $K^+ e^\pm \tau^\mp$            | $LF$ | $< 3.0$                    | $\times 10^{-5}$ | CL=90% | 2312 |
| $K^+ \mu^+ \tau^-$              | $LF$ | $< 2.45$                   | $\times 10^{-5}$ | CL=90% | 2298 |
| $K^+ \mu^- \tau^+$              | $LF$ | $< 5.9$                    | $\times 10^{-6}$ | CL=90% | 2298 |
| $K^+ \mu^\pm \tau^\mp$          | $LF$ | $< 4.8$                    | $\times 10^{-5}$ | CL=90% | 2298 |
| $K^*(892)^+ e^+ \mu^-$          | $LF$ | $< 1.3$                    | $\times 10^{-6}$ | CL=90% | 2563 |

|                                    |        |         |                  |        |      |
|------------------------------------|--------|---------|------------------|--------|------|
| $K^*(892)^+ e^- \mu^+$             | $LF$   | $< 9.9$ | $\times 10^{-7}$ | CL=90% | 2563 |
| $K^*(892)^+ e^\pm \mu^\mp$         | $LF$   | $< 1.4$ | $\times 10^{-6}$ | CL=90% | 2563 |
| $\pi^- e^+ e^+$                    | $L$    | $< 2.3$ | $\times 10^{-8}$ | CL=90% | 2638 |
| $\pi^- \mu^+ \mu^+$                | $L$    | $< 4.0$ | $\times 10^{-9}$ | CL=95% | 2634 |
| $\pi^- e^+ \mu^+$                  | $L$    | $< 1.5$ | $\times 10^{-7}$ | CL=90% | 2637 |
| $\rho^- e^+ e^+$                   | $L$    | $< 1.7$ | $\times 10^{-7}$ | CL=90% | 2583 |
| $\rho^- \mu^+ \mu^+$               | $L$    | $< 4.2$ | $\times 10^{-7}$ | CL=90% | 2578 |
| $\rho^- e^+ \mu^+$                 | $L$    | $< 4.7$ | $\times 10^{-7}$ | CL=90% | 2582 |
| $K^- e^+ e^+$                      | $L$    | $< 3.0$ | $\times 10^{-8}$ | CL=90% | 2617 |
| $K^- \mu^+ \mu^+$                  | $L$    | $< 4.1$ | $\times 10^{-8}$ | CL=90% | 2612 |
| $K^- e^+ \mu^+$                    | $L$    | $< 1.6$ | $\times 10^{-7}$ | CL=90% | 2616 |
| $K^*(892)^- e^+ e^+$               | $L$    | $< 4.0$ | $\times 10^{-7}$ | CL=90% | 2564 |
| $K^*(892)^- \mu^+ \mu^+$           | $L$    | $< 5.9$ | $\times 10^{-7}$ | CL=90% | 2560 |
| $K^*(892)^- e^+ \mu^+$             | $L$    | $< 3.0$ | $\times 10^{-7}$ | CL=90% | 2563 |
| $D^- e^+ e^+$                      | $L$    | $< 2.6$ | $\times 10^{-6}$ | CL=90% | 2309 |
| $D^- e^+ \mu^+$                    | $L$    | $< 1.8$ | $\times 10^{-6}$ | CL=90% | 2307 |
| $D^- \mu^+ \mu^+$                  | $L$    | $< 6.9$ | $\times 10^{-7}$ | CL=95% | 2303 |
| $D^{*-} \mu^+ \mu^+$               | $L$    | $< 2.4$ | $\times 10^{-6}$ | CL=95% | 2251 |
| $D_s^- \mu^+ \mu^+$                | $L$    | $< 5.8$ | $\times 10^{-7}$ | CL=95% | 2267 |
| $\overline{D}^0 \pi^- \mu^+ \mu^+$ | $L$    | $< 1.5$ | $\times 10^{-6}$ | CL=95% | 2295 |
| $\Lambda^0 \mu^+$                  | $L, B$ | $< 6$   | $\times 10^{-8}$ | CL=90% | —    |
| $\Lambda^0 e^+$                    | $L, B$ | $< 3.2$ | $\times 10^{-8}$ | CL=90% | —    |
| $\overline{\Lambda}^0 \mu^+$       | $L, B$ | $< 6$   | $\times 10^{-8}$ | CL=90% | —    |
| $\overline{\Lambda}^0 e^+$         | $L, B$ | $< 8$   | $\times 10^{-8}$ | CL=90% | —    |

 **$B^0$** 

$$I(J^P) = \frac{1}{2}(0^-)$$

$I, J, P$  need confirmation. Quantum numbers shown are quark-model predictions.

$$\text{Mass } m_{B^0} = 5279.72 \pm 0.08 \text{ MeV}$$

$$m_{B^0} - m_{B^\pm} = 0.31 \pm 0.05 \text{ MeV}$$

$$\text{Mean life } \tau_{B^0} = (1.517 \pm 0.004) \times 10^{-12} \text{ s}$$

$$c\tau = 454.8 \text{ } \mu\text{m}$$

$$\tau_{B^+}/\tau_{B^0} = 1.076 \pm 0.004 \quad (\text{direct measurements})$$

### $B^0$ - $\overline{B}^0$ mixing parameters

$$\chi_d (B^0\text{-}\overline{B}^0 \text{ mixing probability}) = 0.1860 \pm 0.0011$$

$$\Delta m_{B^0} = m_{B_H^0} - m_{B_L^0} = (0.5069 \pm 0.0019) \times 10^{12} \text{ } \hbar \text{ s}^{-1}$$

$$= (3.336 \pm 0.013) \times 10^{-10} \text{ MeV}$$

$$x_d = \Delta m_{B^0}/\Gamma_{B^0} = 0.7697 \pm 0.0035$$

$$\text{Re}(\lambda_{CP} / |\lambda_{CP}|) \text{ Re}(z) = 0.047 \pm 0.022$$

$$\Delta\Gamma \text{ Re}(z) = -0.007 \pm 0.004 \text{ ps}^{-1}$$

$$\text{Re}(z) = (-4 \pm 4) \times 10^{-2} \quad (S = 1.4)$$

$$\text{Im}(z) = (-0.8 \pm 0.4) \times 10^{-2}$$

**CP violation parameters**

$$\text{Re}(\epsilon_{B^0})/(1+|\epsilon_{B^0}|^2) = (-0.5 \pm 0.4) \times 10^{-3}$$

$$A_{T/CP}(B^0 \leftrightarrow \bar{B}^0) = 0.005 \pm 0.018$$

$$A_{CP}(B^0 \rightarrow D^{*}(2010)^+ D^-) = 0.013 \pm 0.014$$

$$A_{CP}(B^0 \rightarrow \bar{D}^0 \pi^0) = (0.4 \pm 2.4) \times 10^{-2}$$

$$A_{CP}(B^0 \rightarrow [K^+ K^-]_D K^{*}(892)^0) = -0.05 \pm 0.06$$

$$A_{CP}(B^0 \rightarrow [K^+ \pi^-]_D K^{*}(892)^0) = 0.031 \pm 0.023$$

$$A_{CP}(B^0 \rightarrow [K^+ \pi^- \pi^+ \pi^-]_D K^{*}(892)^0) = -0.012 \pm 0.024$$

$$A_{CP}(B^0 \rightarrow [K^- \pi^+]_D K^{*}(892)^0) = 0.19 \pm 0.19$$

$$A_{CP}(B^0 \rightarrow [K^- \pi^+ \pi^+ \pi^-]_D K^{*}(892)^0) = -0.01 \pm 0.24$$

$$R_d^+ = \Gamma(B^0 \rightarrow [\pi^+ K^-]_D K^{*0}) / \Gamma(B^0 \rightarrow [\pi^- K^+]_D K^{*0}) = 0.069 \pm 0.014$$

$$R_d^- = \Gamma(\bar{B}^0 \rightarrow [\pi^- K^+]_D K^{*0}) / \Gamma(\bar{B}^0 \rightarrow [\pi^+ K^-]_D K^{*0}) = 0.093 \pm 0.014$$

$$A_{CP}(B^0 \rightarrow [\pi^+ \pi^-]_D K^{*}(892)^0) = -0.03 \pm 0.10$$

$$A_{CP}(B^0 \rightarrow [\pi^+ \pi^- \pi^+ \pi^-]_D K^{*}(892)^0) = 0.02 \pm 0.09$$

$$R_d^+ = \Gamma(B^0 \rightarrow [\pi^+ K^- \pi^+ \pi^-]_D K^{*0}) / \Gamma(B^0 \rightarrow [\pi^- K^+ \pi^+ \pi^-]_D K^{*0}) = 0.060 \pm 0.015$$

$$R_d^- = \Gamma(\bar{B}^0 \rightarrow [\pi^- K^+ \pi^+ \pi^-]_D K^{*0}) / \Gamma(\bar{B}^0 \rightarrow [\pi^+ K^- \pi^+ \pi^-]_D K^{*0}) = 0.038 \pm 0.015$$

$$\mathbf{A_{CP}(B^0 \rightarrow K^+ \pi^-)} = -0.0831 \pm 0.0031$$

$$A_{CP}(B^0 \rightarrow \eta' K^{*}(892)^0) = -0.07 \pm 0.18$$

$$A_{CP}(B^0 \rightarrow \eta' K_0^{*}(1430)^0) = -0.19 \pm 0.17$$

$$A_{CP}(B^0 \rightarrow \eta' K_2^{*}(1430)^0) = 0.14 \pm 0.18$$

$$\mathbf{A_{CP}(B^0 \rightarrow \eta K^{*}(892)^0)} = 0.19 \pm 0.05$$

$$A_{CP}(B^0 \rightarrow \eta K_0^{*}(1430)^0) = 0.06 \pm 0.13$$

$$A_{CP}(B^0 \rightarrow \eta K_2^{*}(1430)^0) = -0.07 \pm 0.19$$

$$A_{CP}(B^0 \rightarrow b_1 K^+) = -0.07 \pm 0.12$$

$$A_{CP}(B^0 \rightarrow \omega K^{*0}) = 0.45 \pm 0.25$$

$$A_{CP}(B^0 \rightarrow \omega(K\pi)_0^{*0}) = -0.07 \pm 0.09$$

$$A_{CP}(B^0 \rightarrow \omega K_2^{*}(1430)^0) = -0.37 \pm 0.17$$

$$A_{CP}(B^0 \rightarrow K^+ \pi^- \pi^0) = (0 \pm 6) \times 10^{-2}$$

$$A_{CP}(B^0 \rightarrow \rho^- K^+) = 0.20 \pm 0.11$$

$$A_{CP}(B^0 \rightarrow \rho(1450)^- K^+) = -0.10 \pm 0.33$$

$$A_{CP}(B^0 \rightarrow \rho(1700)^- K^+) = -0.4 \pm 0.6$$

$$A_{CP}(B^0 \rightarrow K^+ \pi^- \pi^0 \text{ nonresonant}) = 0.10 \pm 0.18$$

$$A_{CP}(B^0 \rightarrow K^0 \pi^+ \pi^-) = -0.01 \pm 0.05$$

$$\mathbf{A_{CP}(B^0 \rightarrow K^{*}(892)^+ \pi^-)} = -0.27 \pm 0.04$$

$$A_{CP}(B^0 \rightarrow (K\pi)_0^{*+} \pi^-) = 0.02 \pm 0.04$$

$$A_{CP}(B^0 \rightarrow K_2^{*}(1430)^+ \pi^-) = -0.29 \pm 0.24$$

$$\begin{aligned}
A_{CP}(B^0 \rightarrow K^*(1680)^+ \pi^-) &= -0.07 \pm 0.14 \\
A_{CP}(B^0 \rightarrow f_0(980) K_S^0) &= 0.28 \pm 0.31 \\
A_{CP}(B^0 \rightarrow (K\pi)_0^{*0} \pi^0) &= -0.15 \pm 0.11 \\
A_{CP}(B^0 \rightarrow K^{*0} \pi^0) &= -0.15 \pm 0.13 \\
A_{CP}(B^0 \rightarrow K^*(892)^0 \pi^+ \pi^-) &= 0.07 \pm 0.05 \\
A_{CP}(B^0 \rightarrow K^*(892)^0 \rho^0) &= -0.06 \pm 0.09 \\
A_{CP}(B^0 \rightarrow K^{*0} f_0(980)) &= 0.07 \pm 0.10 \\
A_{CP}(B^0 \rightarrow K^{*+} \rho^-) &= 0.21 \pm 0.15 \\
A_{CP}(B^0 \rightarrow K^*(892)^0 K^+ K^-) &= 0.01 \pm 0.05 \\
A_{CP}(B^0 \rightarrow a_1^- K^+) &= -0.16 \pm 0.12 \\
A_{CP}(B^0 \rightarrow K_1^0 K^0) &= -0.6 \pm 0.7 \\
A_{CP}(B^0 \rightarrow K^*(892)^0 \phi) &= 0.00 \pm 0.04 \\
A_{CP}(B^0 \rightarrow K^*(892)^0 K^- \pi^+) &= 0.2 \pm 0.4 \\
A_{CP}(B^0 \rightarrow \phi (K\pi)_0^{*0}) &= 0.12 \pm 0.08 \\
A_{CP}(B^0 \rightarrow \phi K_2^*(1430)^0) &= -0.11 \pm 0.10 \\
A_{CP}(B^0 \rightarrow K^*(892)^0 \gamma) &= -0.006 \pm 0.011 \\
A_{CP}(B^0 \rightarrow K_2^*(1430)^0 \gamma) &= -0.08 \pm 0.15 \\
A_{CP}(B^0 \rightarrow X_S \gamma) &= -0.009 \pm 0.018 \\
A_{CP}(B^0 \rightarrow \rho^+ \pi^-) &= 0.13 \pm 0.06 \quad (S = 1.1) \\
A_{CP}(B^0 \rightarrow \rho^- \pi^+) &= -0.08 \pm 0.08 \\
A_{CP}(B^0 \rightarrow \omega \omega) &= -0.4 \pm 0.4 \\
A_{CP}(B^0 \rightarrow a_1(1260)^\pm \pi^\mp) &= -0.07 \pm 0.06 \\
A_{CP}(B^0 \rightarrow b_1^- \pi^+) &= -0.05 \pm 0.10 \\
A_{CP}(B^0 \rightarrow p \bar{p} K^*(892)^0) &= 0.05 \pm 0.12 \\
A_{CP}(B^0 \rightarrow p \bar{\Lambda} \pi^-) &= 0.04 \pm 0.07 \\
A_{CP}(B^0 \rightarrow K^{*0} \ell^+ \ell^-) &= -0.05 \pm 0.10 \\
A_{CP}(B^0 \rightarrow K^{*0} e^+ e^-) &= -0.21 \pm 0.19 \\
A_{CP}(B^0 \rightarrow K^{*0} \mu^+ \mu^-) &= -0.034 \pm 0.024 \\
C_{D^{*-} D^+} (B^0 \rightarrow D^*(2010)^- D^+) &= -0.02 \pm 0.08 \\
S_{D^{*-} D^+} (B^0 \rightarrow D^*(2010)^- D^+) &= -0.83 \pm 0.09 \\
C_{D^{*+} D^-} (B^0 \rightarrow D^*(2010)^+ D^-) &= -0.03 \pm 0.09 \quad (S = 1.1) \\
S_{D^{*+} D^-} (B^0 \rightarrow D^*(2010)^+ D^-) &= -0.80 \pm 0.09 \\
C_{D^{*+} D^{*-}} (B^0 \rightarrow D^{*+} D^{*-}) &= 0.01 \pm 0.09 \quad (S = 1.6) \\
S_{D^{*+} D^{*-}} (B^0 \rightarrow D^{*+} D^{*-}) &= -0.59 \pm 0.14 \quad (S = 1.8) \\
C_+ (B^0 \rightarrow D^{*+} D^{*-}) &= 0.00 \pm 0.10 \quad (S = 1.6) \\
S_+ (B^0 \rightarrow D^{*+} D^{*-}) &= -0.73 \pm 0.09 \\
C_- (B^0 \rightarrow D^{*+} D^{*-}) &= 0.19 \pm 0.31 \\
S_- (B^0 \rightarrow D^{*+} D^{*-}) &= -1.6 \pm 0.5 \\
C (B^0 \rightarrow D^*(2010)^+ D^*(2010)^- K_S^0) &= 0.01 \pm 0.29 \\
S (B^0 \rightarrow D^*(2010)^+ D^*(2010)^- K_S^0) &= 0.1 \pm 0.4 \\
C_{D^+ D^-} (B^0 \rightarrow D^+ D^-) &= -0.06 \pm 0.18 \quad (S = 2.5)
\end{aligned}$$

$$\begin{aligned}
S_{D^+ D^-} (B^0 \rightarrow D^+ D^-) &= -0.64 \pm 0.09 \quad (S = 1.3) \\
C_{J/\psi(1S) \pi^0} (B^0 \rightarrow J/\psi(1S) \pi^0) &= 0.03 \pm 0.17 \quad (S = 1.5) \\
S_{J/\psi(1S) \pi^0} (B^0 \rightarrow J/\psi(1S) \pi^0) &= -0.88 \pm 0.32 \quad (S = 2.2) \\
C(B^0 \rightarrow J/\psi(1S) \rho^0) &= -0.06 \pm 0.06 \\
S(B^0 \rightarrow J/\psi(1S) \rho^0) &= -0.66^{+0.16}_{-0.12} \\
C_{D_{CP}^{(*)} h^0} (B^0 \rightarrow D_{CP}^{(*)} h^0) &= -0.02 \pm 0.08 \\
S_{D_{CP}^{(*)} h^0} (B^0 \rightarrow D_{CP}^{(*)} h^0) &= -0.66 \pm 0.12 \\
C_{K^0 \pi^0} (B^0 \rightarrow K^0 \pi^0) &= 0.00 \pm 0.08 \\
S_{K^0 \pi^0} (B^0 \rightarrow K^0 \pi^0) &= 0.64 \pm 0.13 \\
C_{\eta'(958) K_S^0} (B^0 \rightarrow \eta'(958) K_S^0) &= -0.04 \pm 0.20 \quad (S = 2.5) \\
S_{\eta'(958) K_S^0} (B^0 \rightarrow \eta'(958) K_S^0) &= 0.43 \pm 0.17 \quad (S = 1.5) \\
C_{\eta' K^0} (B^0 \rightarrow \eta' K^0) &= -0.08 \pm 0.04 \quad (S = 1.1) \\
S_{\eta' K^0} (B^0 \rightarrow \eta' K^0) &= 0.64 \pm 0.05 \\
C_{\omega K_S^0} (B^0 \rightarrow \omega K_S^0) &= 0.0 \pm 0.4 \quad (S = 3.0) \\
S_{\omega K_S^0} (B^0 \rightarrow \omega K_S^0) &= 0.70 \pm 0.21 \\
C(B^0 \rightarrow K_S^0 \pi^0 \pi^0) &= -0.21 \pm 0.20 \\
S(B^0 \rightarrow K_S^0 \pi^0 \pi^0) &= 0.89^{+0.27}_{-0.30} \\
C_{\rho^0 K_S^0} (B^0 \rightarrow \rho^0 K_S^0) &= -0.04 \pm 0.20 \\
S_{\rho^0 K_S^0} (B^0 \rightarrow \rho^0 K_S^0) &= 0.50^{+0.17}_{-0.21} \\
C_{f_0(980) K_S^0} (B^0 \rightarrow f_0(980) K_S^0) &= 0.29 \pm 0.20 \\
S_{f_0(980) K_S^0} (B^0 \rightarrow f_0(980) K_S^0) &= -0.50 \pm 0.16 \\
S_{f_2(1270) K_S^0} (B^0 \rightarrow f_2(1270) K_S^0) &= -0.5 \pm 0.5 \\
C_{f_2(1270) K_S^0} (B^0 \rightarrow f_2(1270) K_S^0) &= 0.3 \pm 0.4 \\
S_{f_x(1300) K_S^0} (B^0 \rightarrow f_x(1300) K_S^0) &= -0.2 \pm 0.5 \\
C_{f_x(1300) K_S^0} (B^0 \rightarrow f_x(1300) K_S^0) &= 0.13 \pm 0.35 \\
S_{K^0 \pi^+ \pi^-} (B^0 \rightarrow K^0 \pi^+ \pi^- \text{ nonresonant}) &= -0.01 \pm 0.33 \\
C_{K^0 \pi^+ \pi^-} (B^0 \rightarrow K^0 \pi^+ \pi^- \text{ nonresonant}) &= 0.01 \pm 0.26 \\
C_{K_S^0 K_S^0} (B^0 \rightarrow K_S^0 K_S^0) &= 0.0 \pm 0.4 \quad (S = 1.4) \\
S_{K_S^0 K_S^0} (B^0 \rightarrow K_S^0 K_S^0) &= -0.8 \pm 0.5 \\
C_{K^+ K^- K_S^0} (B^0 \rightarrow K^+ K^- K_S^0 \text{ nonresonant}) &= 0.06 \pm 0.08 \\
S_{K^+ K^- K_S^0} (B^0 \rightarrow K^+ K^- K_S^0 \text{ nonresonant}) &= -0.66 \pm 0.11 \\
C_{K^+ K^- K_S^0} (B^0 \rightarrow K^+ K^- K_S^0 \text{ inclusive}) &= 0.01 \pm 0.09
\end{aligned}$$

$$\begin{aligned}
S_{K^+K^-K_S^0} (B^0 \rightarrow K^+K^-K_S^0 \text{ inclusive}) &= -0.65 \pm 0.12 \\
C_{\phi K_S^0} (B^0 \rightarrow \phi K_S^0) &= -0.09 \pm 0.12 \\
S_{\phi K_S^0} (B^0 \rightarrow \phi K_S^0) &= 0.58 \pm 0.12 \\
C_{K_S K_S K_S} (B^0 \rightarrow K_S K_S K_S) &= -0.14 \pm 0.12 \\
S_{K_S K_S K_S} (B^0 \rightarrow K_S K_S K_S) &= -0.82 \pm 0.17 \\
C_{K_S^0 \pi^+ \pi^- \gamma} (B^0 \rightarrow K_S^0 \pi^+ \pi^- \gamma) &= -0.39 \pm 0.20 \\
S_{K_S^0 \pi^+ \pi^- \gamma} (B^0 \rightarrow K_S^0 \pi^+ \pi^- \gamma) &= 0.14 \pm 0.25 \\
C_{K^{*0} \gamma} (B^0 \rightarrow K^{*0} \gamma) &= 0.03 \pm 0.10 \\
S_{K^{*0} \gamma} (B^0 \rightarrow K^{*0} \gamma) &= -0.08 \pm 0.17 \\
C_{\eta K^0 \gamma} (B^0 \rightarrow \eta K^0 \gamma) &= 0.1 \pm 0.4 \quad (S = 1.4) \\
S_{\eta K^0 \gamma} (B^0 \rightarrow \eta K^0 \gamma) &= -0.5 \pm 0.5 \quad (S = 1.2) \\
C_{K^0 \phi \gamma} (B^0 \rightarrow K^0 \phi \gamma) &= -0.3 \pm 0.6 \\
S_{K^0 \phi \gamma} (B^0 \rightarrow K^0 \phi \gamma) &= 0.7^{+0.7}_{-1.1} \\
C(B^0 \rightarrow K_S^0 \rho^0 \gamma) &= -0.05 \pm 0.19 \\
S(B^0 \rightarrow K_S^0 \rho^0 \gamma) &= -0.04 \pm 0.23 \\
C(B^0 \rightarrow \rho^0 \gamma) &= 0.4 \pm 0.5 \\
S(B^0 \rightarrow \rho^0 \gamma) &= -0.8 \pm 0.7 \\
C_{\pi\pi} (B^0 \rightarrow \pi^+ \pi^-) &= -0.314 \pm 0.030 \\
S_{\pi\pi} (B^0 \rightarrow \pi^+ \pi^-) &= -0.670 \pm 0.030 \\
C_{\pi^0 \pi^0} (B^0 \rightarrow \pi^0 \pi^0) &= -0.25 \pm 0.20 \\
C_{\rho\pi} (B^0 \rightarrow \rho^+ \pi^-) &= -0.03 \pm 0.07 \quad (S = 1.2) \\
S_{\rho\pi} (B^0 \rightarrow \rho^+ \pi^-) &= 0.05 \pm 0.07 \\
\Delta C_{\rho\pi} (B^0 \rightarrow \rho^+ \pi^-) &= 0.27 \pm 0.06 \\
\Delta S_{\rho\pi} (B^0 \rightarrow \rho^+ \pi^-) &= 0.01 \pm 0.08 \\
C_{\rho^0 \pi^0} (B^0 \rightarrow \rho^0 \pi^0) &= 0.27 \pm 0.24 \\
S_{\rho^0 \pi^0} (B^0 \rightarrow \rho^0 \pi^0) &= -0.23 \pm 0.34 \\
C_{a_1 \pi} (B^0 \rightarrow a_1(1260)^+ \pi^-) &= -0.05 \pm 0.11 \\
S_{a_1 \pi} (B^0 \rightarrow a_1(1260)^+ \pi^-) &= -0.2 \pm 0.4 \quad (S = 3.2) \\
\Delta C_{a_1 \pi} (B^0 \rightarrow a_1(1260)^+ \pi^-) &= 0.43 \pm 0.14 \quad (S = 1.3) \\
\Delta S_{a_1 \pi} (B^0 \rightarrow a_1(1260)^+ \pi^-) &= -0.11 \pm 0.12 \\
C(B^0 \rightarrow b_1^- K^+) &= -0.22 \pm 0.24 \\
\Delta C(B^0 \rightarrow b_1^- \pi^+) &= -1.04 \pm 0.24 \\
C_{\rho^0 \rho^0} (B^0 \rightarrow \rho^0 \rho^0) &= 0.2 \pm 0.9 \\
S_{\rho^0 \rho^0} (B^0 \rightarrow \rho^0 \rho^0) &= 0.3 \pm 0.7 \\
C_{\rho\rho} (B^0 \rightarrow \rho^+ \rho^-) &= 0.00 \pm 0.09 \\
S_{\rho\rho} (B^0 \rightarrow \rho^+ \rho^-) &= -0.14 \pm 0.13 \\
|\lambda| (B^0 \rightarrow J/\psi K^*(892)^0) &< 0.25, \text{ CL} = 95\%
\end{aligned}$$

$$\begin{aligned}
\cos 2\beta (B^0 \rightarrow J/\psi K^*(892)^0) &= 1.7^{+0.7}_{-0.9} \quad (S = 1.6) \\
\cos 2\beta (B^0 \rightarrow [K_S^0 \pi^+ \pi^-]_{D^{(*)}} h^0) &= 0.91 \pm 0.25 \\
(S_+ + S_-)/2 (B^0 \rightarrow D^{*-} \pi^+) &= -0.039 \pm 0.011 \\
(S_- - S_+)/2 (B^0 \rightarrow D^{*-} \pi^+) &= -0.009 \pm 0.015 \\
(S_+ + S_-)/2 (B^0 \rightarrow D^- \pi^+) &= -0.046 \pm 0.023 \\
(S_- - S_+)/2 (B^0 \rightarrow D^- \pi^+) &= -0.022 \pm 0.021 \\
S_+ (B^0 \rightarrow D^- \pi^+) &= 0.058 \pm 0.023 \\
S_- (B^0 \rightarrow D^+ \pi^-) &= 0.038 \pm 0.021 \\
(S_+ + S_-)/2 (B^0 \rightarrow D^- \rho^+) &= -0.024 \pm 0.032 \\
(S_- - S_+)/2 (B^0 \rightarrow D^- \rho^+) &= -0.10 \pm 0.06 \\
C_{\eta_c K_S^0} (B^0 \rightarrow \eta_c K_S^0) &= 0.08 \pm 0.13 \\
S_{\eta_c K_S^0} (B^0 \rightarrow \eta_c K_S^0) &= 0.93 \pm 0.17 \\
C_{c\bar{c}K^{(*)0}} (B^0 \rightarrow c\bar{c}K^{(*)0}) &= (-0.5 \pm 1.5) \times 10^{-2} \\
\sin(2\beta) &= 0.709 \pm 0.011 \\
C_{J/\psi(nS)K^0} (B^0 \rightarrow J/\psi(nS)K^0) &= (-0.8 \pm 1.7) \times 10^{-2} \\
S_{J/\psi(nS)K^0} (B^0 \rightarrow J/\psi(nS)K^0) &= 0.701 \pm 0.017 \\
C_{J/\psi K^{*0}} (B^0 \rightarrow J/\psi K^{*0}) &= 0.03 \pm 0.10 \\
S_{J/\psi K^{*0}} (B^0 \rightarrow J/\psi K^{*0}) &= 0.60 \pm 0.25 \\
C_{\chi_{c0} K_S^0} (B^0 \rightarrow \chi_{c0} K_S^0) &= -0.3^{+0.5}_{-0.4} \\
S_{\chi_{c0} K_S^0} (B^0 \rightarrow \chi_{c0} K_S^0) &= -0.7 \pm 0.5 \\
C_{\chi_{c1} K_S^0} (B^0 \rightarrow \chi_{c1} K_S^0) &= 0.06 \pm 0.07 \\
S_{\chi_{c1} K_S^0} (B^0 \rightarrow \chi_{c1} K_S^0) &= 0.63 \pm 0.10 \\
\sin(2\beta_{\text{eff}})(B^0 \rightarrow \phi K^0) &= 0.22 \pm 0.30 \\
\sin(2\beta_{\text{eff}})(B^0 \rightarrow \phi K_0^*(1430)^0) &= 0.97^{+0.03}_{-0.52} \\
\sin(2\beta_{\text{eff}})(B^0 \rightarrow K^+ K^- K_S^0) &= 0.77^{+0.13}_{-0.12} \\
\sin(2\beta_{\text{eff}})(B^0 \rightarrow [K_S^0 \pi^+ \pi^-]_{D^{(*)}} h^0) &= 0.80 \pm 0.16 \\
\beta_{\text{eff}}(B^0 \rightarrow [K_S^0 \pi^+ \pi^-]_{D^{(*)}} h^0) &= (22 \pm 5)^\circ \\
2\beta_{\text{eff}}(B^0 \rightarrow J/\psi \rho^0) &= (42^{+10}_{-11})^\circ \\
|\lambda| (B^0 \rightarrow [K_S^0 \pi^+ \pi^-]_{D^{(*)}} h^0) &= 1.01 \pm 0.08 \\
|\sin(2\beta + \gamma)| &> 0.40, \text{ CL} = 90\% \\
2\beta + \gamma &= (80 \pm 60)^\circ \\
\alpha &= (84.1^{+4.5}_{-3.8})^\circ \\
x_+(B^0 \rightarrow DK^{*0}) &= 0.07 \pm 0.08 \\
x_-(B^0 \rightarrow DK^{*0}) &= -0.18 \pm 0.08 \\
y_+(B^0 \rightarrow DK^{*0}) &= -0.35 \pm 0.10 \\
y_-(B^0 \rightarrow DK^{*0}) &= -0.03 \pm 0.13 \\
r_{B^0}(B^0 \rightarrow DK^{*0}) &= 0.257^{+0.021}_{-0.023} \\
\delta_{B^0}(B^0 \rightarrow DK^{*0}) &= (194.1^{+9.6}_{-8.8})^\circ \\
a_{CP}(B^0 \rightarrow p\bar{p}K^+\pi^-) &= (0.5 \pm 0.9)\% \\
a_P(B^0 \rightarrow p\bar{p}K^+\pi^-) &= (1.5 \pm 0.9)\%
\end{aligned}$$



$\bar{B}^0$  modes are charge conjugates of the modes below. Reactions indicate the weak decay vertex and do not include mixing. Modes which do not identify the charge state of the  $B$  are listed in the  $B^\pm/B^0$  ADMIXTURE section.

The branching fractions listed below assume 50%  $B^0\bar{B}^0$  and 50%  $B^+B^-$  production at the  $\Upsilon(4S)$ . We have attempted to bring older measurements up to date by rescaling their assumed  $\Upsilon(4S)$  production ratio to 50:50 and their assumed  $D$ ,  $D_S$ ,  $D^*$ , and  $\psi$  branching ratios to current values whenever this would affect our averages and best limits significantly.

Indentation is used to indicate a subchannel of a previous reaction. All resonant subchannels have been corrected for resonance branching fractions to the final state so the sum of the subchannel branching fractions can exceed that of the final state.

For inclusive branching fractions, e.g.,  $B \rightarrow D^\pm X$ , the values usually are multiplicities, not branching fractions. They can be greater than one.

| <b><math>B^0</math> DECAY MODES</b>                      | Fraction ( $\Gamma_i/\Gamma$ )           | Scale factor/<br>Confidence level | $p$<br>(MeV/c) |
|----------------------------------------------------------|------------------------------------------|-----------------------------------|----------------|
| $\ell^+ \nu_\ell X$                                      | [a] ( 10.33 $\pm$ 0.28 ) %               |                                   | —              |
| $e^+ \nu_e X_c$                                          | ( 10.1 $\pm$ 0.4 ) %                     |                                   | —              |
| $\ell^+ \nu_\ell X_u$                                    | [a] ( 1.51 $\pm$ 0.19 ) $\times 10^{-3}$ |                                   | —              |
| $D \ell^+ \nu_\ell X$                                    | [a] ( 9.1 $\pm$ 0.8 ) %                  |                                   | —              |
| $D^- \ell^+ \nu_\ell$                                    | [a] ( 2.10 $\pm$ 0.07 ) %                |                                   | 2309           |
| $D^- \tau^+ \nu_\tau$                                    | ( 9.8 $\pm$ 2.1 ) $\times 10^{-3}$       |                                   | 1909           |
| $D^*(2010)^- \ell^+ \nu_\ell$                            | [a] ( 4.87 $\pm$ 0.09 ) %                |                                   | 2257           |
| $D^*(2010)^- \tau^+ \nu_\tau$                            | ( 1.48 $\pm$ 0.09 ) %                    | S=1.2                             | 1838           |
| $\bar{D}^{(*)} n \pi \ell^+ \nu_\ell$ ( $n \geq 1$ )     | [a] ( 2.2 $\pm$ 0.4 ) %                  |                                   | —              |
| $\bar{D}^0 \pi^- \ell^+ \nu_\ell$                        | [a] ( 3.64 $\pm$ 0.20 ) $\times 10^{-3}$ |                                   | 2308           |
| $D_0^*(2300)^- \ell^+ \nu_\ell$ ,                        | [a] < 4.4 $\times 10^{-4}$               | CL=90%                            | —              |
| $D_0^{*-} \rightarrow \bar{D}^0 \pi^-$                   |                                          |                                   |                |
| $D_2^*(2460)^- \ell^+ \nu_\ell$ ,                        | [a] ( 1.41 $\pm$ 0.20 ) $\times 10^{-3}$ | S=1.7                             | 2065           |
| $D_2^{*-} \rightarrow \bar{D}^0 \pi^-$                   |                                          |                                   |                |
| $\bar{D}^{*0} \pi^- \ell^+ \nu_\ell$                     | [a] ( 5.44 $\pm$ 0.28 ) $\times 10^{-3}$ |                                   | 2256           |
| $D_1(2420)^- \ell^+ \nu_\ell$ , $D_1^- \rightarrow$      | [a] ( 2.85 $\pm$ 0.25 ) $\times 10^{-3}$ |                                   | —              |
| $\bar{D}^{*0} \pi^-$                                     |                                          |                                   |                |
| $D_1(2420)^- \ell^+ \nu_\ell$ , $D_1^- \rightarrow$      | [a] ( 1.02 $\pm$ 0.16 ) $\times 10^{-3}$ |                                   | —              |
| $D^- \pi^+ \pi^-$                                        |                                          |                                   |                |
| $D_1'(2430)^- \ell^+ \nu_\ell$ , $D_1'^- \rightarrow$    | [a] ( 2.5 $\pm$ 0.6 ) $\times 10^{-3}$   |                                   | —              |
| $\bar{D}^{*0} \pi^-$                                     |                                          |                                   |                |
| $D_2^*(2460)^- \ell^+ \nu_\ell$ , $D_2^{*-} \rightarrow$ | [a] ( 6.6 $\pm$ 1.1 ) $\times 10^{-4}$   |                                   | 2065           |
| $\bar{D}^{*0} \pi^-$                                     |                                          |                                   |                |
| $D^- \pi^+ \pi^- \ell^+ \nu_\ell$                        | [a] ( 1.45 $\pm$ 0.22 ) $\times 10^{-3}$ |                                   | 2299           |

|                                  |                                          |      |
|----------------------------------|------------------------------------------|------|
| $D^{*-}\pi^+\pi^-\ell^+\nu_\ell$ | [a] ( 5.1 $\pm$ 2.3 ) $\times 10^{-4}$   | 2247 |
| $\rho^-\ell^+\nu_\ell$           | [a] ( 2.94 $\pm$ 0.21 ) $\times 10^{-4}$ | 2583 |
| $\pi^-\ell^+\nu_\ell$            | [a] ( 1.50 $\pm$ 0.05 ) $\times 10^{-4}$ | 2638 |
| $\pi^-\tau^+\nu_\tau$            | < 2.5 $\times 10^{-4}$ CL=90%            | 2339 |

**Inclusive modes**

|                            |                      |          |
|----------------------------|----------------------|----------|
| $K^\pm X$                  | ( 78 $\pm$ 8 ) %     | —        |
| $D^0 X$                    | ( 8.1 $\pm$ 1.5 ) %  | —        |
| $\overline{D}^0 X$         | ( 47.4 $\pm$ 2.8 ) % | —        |
| $D^+ X$                    | < 3.9 %              | CL=90% — |
| $D^- X$                    | ( 36.9 $\pm$ 3.3 ) % | —        |
| $D_s^+ X$                  | ( 10.3 $\pm$ 2.1 ) % | —        |
| $D_s^- X$                  | < 2.6 %              | CL=90% — |
| $\Lambda_c^+ X$            | < 3.1 %              | CL=90% — |
| $\overline{\Lambda}_c^- X$ | ( 5.0 $\pm$ 2.1 ) %  | —        |
| $\overline{c} X$           | ( 95 $\pm$ 5 ) %     | —        |
| $c X$                      | ( 24.6 $\pm$ 3.1 ) % | —        |
| $\overline{c}/c X$         | ( 119 $\pm$ 6 ) %    | —        |

 **$D$ ,  $D^*$ , or  $D_s$  modes**

|                                       |                                      |      |
|---------------------------------------|--------------------------------------|------|
| $D^-\pi^+$                            | ( 2.51 $\pm$ 0.08 ) $\times 10^{-3}$ | 2306 |
| $D^-\rho^+$                           | ( 7.6 $\pm$ 1.2 ) $\times 10^{-3}$   | 2235 |
| $D^-K^0\pi^+$                         | ( 4.9 $\pm$ 0.9 ) $\times 10^{-4}$   | 2259 |
| $D^-K^*(892)^+$                       | ( 4.5 $\pm$ 0.7 ) $\times 10^{-4}$   | 2211 |
| $D^-\omega\pi^+$                      | ( 2.8 $\pm$ 0.6 ) $\times 10^{-3}$   | 2204 |
| $D^-K^+$                              | ( 2.05 $\pm$ 0.08 ) $\times 10^{-4}$ | 2279 |
| $D^-K^+\pi^+\pi^-$                    | ( 3.5 $\pm$ 0.8 ) $\times 10^{-4}$   | 2236 |
| $D^-K^+\overline{K}^0$                | ( 1.64 $\pm$ 0.26 ) $\times 10^{-4}$ | 2188 |
| $D^-K^+\overline{K}^*(892)^0$         | ( 7.7 $\pm$ 0.6 ) $\times 10^{-4}$   | 2070 |
| $\overline{D}^0\pi^+\pi^-$            | ( 8.8 $\pm$ 0.5 ) $\times 10^{-4}$   | 2301 |
| $D^*(2010)^-\pi^+$                    | ( 2.66 $\pm$ 0.07 ) $\times 10^{-3}$ | 2255 |
| $\overline{D}^0K^+K^-$                | ( 6.1 $\pm$ 0.5 ) $\times 10^{-5}$   | 2191 |
| $D^-\pi^+\pi^+\pi^-$                  | ( 6.0 $\pm$ 0.6 ) $\times 10^{-3}$   | 2287 |
| ( $D^-\pi^+\pi^+\pi^-$ ) nonresonant  | ( 3.9 $\pm$ 1.9 ) $\times 10^{-3}$   | 2287 |
| $D^-\pi^+\rho^0$                      | ( 1.1 $\pm$ 1.0 ) $\times 10^{-3}$   | 2206 |
| $D^-a_1(1260)^+$                      | ( 6.0 $\pm$ 3.3 ) $\times 10^{-3}$   | 2121 |
| $D^*(2010)^-\pi^+\pi^0$               | ( 1.5 $\pm$ 0.5 ) %                  | 2248 |
| $D^*(2010)^-\rho^+$                   | ( 6.8 $\pm$ 0.9 ) $\times 10^{-3}$   | 2180 |
| $D^*(2010)^-K^+$                      | ( 2.16 $\pm$ 0.08 ) $\times 10^{-4}$ | 2226 |
| $D^*(2010)^-K^0\pi^+$                 | ( 3.0 $\pm$ 0.8 ) $\times 10^{-4}$   | 2205 |
| $D^*(2010)^-K^*(892)^+$               | ( 3.3 $\pm$ 0.6 ) $\times 10^{-4}$   | 2155 |
| $D^*(2010)^-K^+\overline{K}^0$        | ( 1.8 $\pm$ 0.4 ) $\times 10^{-4}$   | 2131 |
| $D^*(2010)^-K^+\overline{K}^*(892)^0$ | ( 1.31 $\pm$ 0.13 ) $\times 10^{-3}$ | 2007 |
| $D^*(2010)^-\pi^+\pi^+\pi^-$          | ( 7.21 $\pm$ 0.29 ) $\times 10^{-3}$ | 2235 |

|                                                                       |                                           |      |
|-----------------------------------------------------------------------|-------------------------------------------|------|
| $(D^*(2010)^- \pi^+ \pi^+ \pi^-)$ non-resonant                        | $(0.0 \pm 2.5) \times 10^{-3}$            | 2235 |
| $D^*(2010)^- \pi^+ \rho^0$                                            | $(5.7 \pm 3.2) \times 10^{-3}$            | 2150 |
| $D^*(2010)^- a_1(1260)^+$                                             | $(1.30 \pm 0.27) \%$                      | 2061 |
| $\bar{D}_1(2420)^0 \pi^- \pi^+, \bar{D}_1^0 \rightarrow D^{*-} \pi^+$ | $(1.47 \pm 0.35) \times 10^{-4}$          | —    |
| $D^*(2010)^- K^+ \pi^- \pi^+$                                         | $(4.7 \pm 0.4) \times 10^{-4}$            | 2181 |
| $D^*(2010)^- \pi^+ \pi^+ \pi^- \pi^0$                                 | $(1.76 \pm 0.27) \%$                      | 2218 |
| $D^{*-} 3\pi^+ 2\pi^-$                                                | $(4.7 \pm 0.9) \times 10^{-3}$            | 2195 |
| $D^*(2010)^- \omega \pi^+$                                            | $(2.46 \pm 0.18) \times 10^{-3}$ S=1.2    | 2148 |
| $\bar{D}_1(2430)^0 \omega, \bar{D}_1^0 \rightarrow D^{*-} \pi^+$      | $(2.7 \pm 0.8 \pm 0.4) \times 10^{-4}$    | 1992 |
| $D^{*-} \rho(1450)^+, \rho^+ \rightarrow \omega \pi^+$                | $(1.07 \pm 0.40 \pm 0.34) \times 10^{-3}$ | —    |
| $\bar{D}_1(2420)^0 \omega, \bar{D}_1^0 \rightarrow D^{*-} \pi^+$      | $(7.0 \pm 2.2) \times 10^{-5}$            | 1995 |
| $\bar{D}_2^*(2460)^0 \omega, \bar{D}_2^0 \rightarrow D^{*-} \pi^+$    | $(4.0 \pm 1.4) \times 10^{-5}$            | 1975 |
| $D^{*-} b_1(1235)^+, b_1^+ \rightarrow \omega \pi^+$                  | $< 7 \times 10^{-5}$ CL=90%               | —    |
| $\bar{D}^{*-} \pi^+$ [e]                                              | $(1.9 \pm 0.9) \times 10^{-3}$            | —    |
| $D_1(2420)^- \pi^+, D_1^- \rightarrow D^- \pi^+ \pi^-$                | $(9.9 \pm 2.0 \pm 2.5) \times 10^{-5}$    | —    |
| $D_1(2420)^- \pi^+, D_1^- \rightarrow D^{*-} \pi^+ \pi^-$             | $< 3.3 \times 10^{-5}$ CL=90%             | —    |
| $\bar{D}_2^*(2460)^- \pi^+, D_2^{*-} \rightarrow D^0 \pi^-$           | $(2.38 \pm 0.16) \times 10^{-4}$          | 2062 |
| $\bar{D}_0^*(2400)^- \pi^+, D_0^{*-} \rightarrow D^0 \pi^-$           | $(7.6 \pm 0.8) \times 10^{-5}$            | 2090 |
| $D_2^*(2460)^- \pi^+, D_2^{*-} \rightarrow D^{*-} \pi^+ \pi^-$        | $< 2.4 \times 10^{-5}$ CL=90%             | —    |
| $\bar{D}_2^*(2460)^- \rho^+$                                          | $< 4.9 \times 10^{-3}$ CL=90%             | 1974 |
| $D^0 \bar{D}^0$                                                       | $(1.4 \pm 0.7) \times 10^{-5}$            | 1868 |
| $D^{*0} \bar{D}^0$                                                    | $< 2.9 \times 10^{-4}$ CL=90%             | 1794 |
| $D^- D^+$                                                             | $(2.11 \pm 0.18) \times 10^{-4}$          | 1864 |
| $D^\pm D^{*\mp} (CP\text{-averaged})$                                 | $(6.1 \pm 0.6) \times 10^{-4}$            | —    |
| $D^- D_s^+$                                                           | $(8.1 \pm 0.6) \times 10^{-3}$ S=1.1      | 1812 |
| $D^*(2010)^- D_s^+$                                                   | $(8.2 \pm 0.8) \times 10^{-3}$            | 1735 |
| $D^- D_s^{*+}$                                                        | $(7.4 \pm 1.6) \times 10^{-3}$            | 1732 |
| $D^*(2010)^- D_s^{*+}$                                                | $(1.77 \pm 0.14) \%$                      | 1649 |
| $D_{s0}(2317)^- K^+, D_{s0}^- \rightarrow D_s^- \pi^0$                | $(4.2 \pm 1.4) \times 10^{-5}$            | 2097 |

|                                                                            |                                  |                  |        |      |
|----------------------------------------------------------------------------|----------------------------------|------------------|--------|------|
| $D_{s0}(2317)^- \pi^+, D_{s0}^- \rightarrow D_s^- \pi^0$                   | $< 2.5$                          | $\times 10^{-5}$ | CL=90% | 2128 |
| $D_{sJ}(2457)^- K^+, D_{sJ}^- \rightarrow D_s^- \pi^0$                     | $< 9.4$                          | $\times 10^{-6}$ | CL=90% | —    |
| $D_{sJ}(2457)^- \pi^+, D_{sJ}^- \rightarrow D_s^- \pi^0$                   | $< 4.0$                          | $\times 10^{-6}$ | CL=90% | —    |
| $D_s^- D_s^+$                                                              | $< 3.6$                          | $\times 10^{-5}$ | CL=90% | 1759 |
| $D_s^{*-} D_s^+$                                                           | $< 1.3$                          | $\times 10^{-4}$ | CL=90% | 1675 |
| $D_s^{*-} D_s^{*+}$                                                        | $< 2.4$                          | $\times 10^{-4}$ | CL=90% | 1584 |
| $D_{s0}^*(2317)^+ D^-, D_{s0}^{*+} \rightarrow D_s^+ \pi^0$                | $(1.05 \pm 0.16) \times 10^{-3}$ |                  | S=1.1  | 1602 |
| $D_{s0}(2317)^+ D^-, D_{s0}^+ \rightarrow D_s^{*+} \gamma$                 | $< 9.5$                          | $\times 10^{-4}$ | CL=90% | —    |
| $D_{s0}(2317)^+ D^*(2010)^-, D_{s0}^+ \rightarrow D_s^+ \pi^0$             | $(1.5 \pm 0.6) \times 10^{-3}$   |                  |        | 1509 |
| $D_{sJ}(2457)^+ D^-$                                                       | $(3.5 \pm 1.1) \times 10^{-3}$   |                  |        | —    |
| $D_{sJ}(2457)^+ D^-, D_{sJ}^+ \rightarrow D_s^+ \gamma$                    | $(6.5 \pm 1.7) \times 10^{-4}$   |                  |        | —    |
| $D_{sJ}(2457)^+ D^-, D_{sJ}^+ \rightarrow D_s^{*+} \gamma$                 | $< 6.0$                          | $\times 10^{-4}$ | CL=90% | —    |
| $D_{sJ}(2457)^+ D^-, D_{sJ}^+ \rightarrow D_s^+ \pi^+ \pi^-$               | $< 2.0$                          | $\times 10^{-4}$ | CL=90% | —    |
| $D_{sJ}(2457)^+ D^-, D_{sJ}^+ \rightarrow D_s^+ \pi^0$                     | $< 3.6$                          | $\times 10^{-4}$ | CL=90% | —    |
| $D^*(2010)^- D_{sJ}(2457)^+$                                               | $(9.3 \pm 2.2) \times 10^{-3}$   |                  |        | —    |
| $D_{sJ}(2457)^+ D^*(2010), D_{sJ}^+ \rightarrow D_s^+ \gamma$              | $(2.3 \pm 0.9) \times 10^{-3}$   |                  |        | —    |
| $D^- D_{s1}(2536)^+, D_{s1}^+ \rightarrow D^{*0} K^+ + D^{*+} K^0$         | $(2.8 \pm 0.7) \times 10^{-4}$   |                  |        | 1444 |
| $D^- D_{s1}(2536)^+, D_{s1}^+ \rightarrow D^{*0} K^+$                      | $(1.7 \pm 0.6) \times 10^{-4}$   |                  |        | 1444 |
| $D^- D_{s1}(2536)^+, D_{s1}^+ \rightarrow D^{*+} K^0$                      | $(2.6 \pm 1.1) \times 10^{-4}$   |                  |        | 1444 |
| $D^*(2010)^- D_{s1}(2536)^+, D_{s1}^+ \rightarrow D^{*0} K^+ + D^{*+} K^0$ | $(5.0 \pm 1.4) \times 10^{-4}$   |                  |        | 1336 |
| $D^*(2010)^- D_{s1}(2536)^+, D_{s1}^+ \rightarrow D^{*0} K^+$              | $(3.3 \pm 1.1) \times 10^{-4}$   |                  |        | 1336 |
| $D^{*-} D_{s1}(2536)^+, D_{s1}^+ \rightarrow D^{*+} K^0$                   | $(5.0 \pm 1.7) \times 10^{-4}$   |                  |        | 1336 |

|                                                                             |                                        |      |
|-----------------------------------------------------------------------------|----------------------------------------|------|
| $D^- D_{sJ}(2573)^+, D_{sJ}^+ \rightarrow D^0 K^+$                          | $(3.4 \pm 1.8) \times 10^{-5}$         | 1414 |
| $D^{*+}(2010)^- D_{sJ}(2573)^+, D_{sJ}^+ \rightarrow D^0 K^+$               | $< 2 \times 10^{-4}$ CL=90%            | 1304 |
| $D^- D_{sJ}(2700)^+, D_{sJ}^+ \rightarrow D^0 K^+$                          | $(7.1 \pm 1.2) \times 10^{-4}$         | —    |
| $D^+ \pi^-$                                                                 | $(7.3 \pm 1.2) \times 10^{-7}$         | 2306 |
| $D_s^+ \pi^-$                                                               | $(2.03 \pm 0.18) \times 10^{-5}$       | 2271 |
| $D_s^{*+} \pi^-$                                                            | $(2.1 \pm 0.4) \times 10^{-5}$ S=1.4   | 2215 |
| $D_s^+ \rho^-$                                                              | $< 2.4 \times 10^{-5}$ CL=90%          | 2197 |
| $D_s^{*+} \rho^-$                                                           | $(4.1 \pm 1.3) \times 10^{-5}$         | 2138 |
| $D_s^+ a_0^-$                                                               | $< 1.9 \times 10^{-5}$ CL=90%          | —    |
| $D_s^{*+} a_0^-$                                                            | $< 3.6 \times 10^{-5}$ CL=90%          | —    |
| $D_s^+ a_1(1260)^-$                                                         | $< 2.1 \times 10^{-3}$ CL=90%          | 2080 |
| $D_s^{*+} a_1(1260)^-$                                                      | $< 1.7 \times 10^{-3}$ CL=90%          | 2015 |
| $D_s^+ a_2^-$                                                               | $< 1.9 \times 10^{-4}$ CL=90%          | —    |
| $D_s^{*+} a_2^-$                                                            | $< 2.0 \times 10^{-4}$ CL=90%          | —    |
| $D_s^- K^+$                                                                 | $(2.7 \pm 0.5) \times 10^{-5}$ S=2.7   | 2242 |
| $D_s^{*-} K^+$                                                              | $(2.19 \pm 0.30) \times 10^{-5}$       | 2185 |
| $D_{s1}(2536)^{\mp} K^{\pm}, D_{s1}^- \rightarrow \bar{D}^{*+}(2007)^0 K^-$ | $(5.1 \pm 0.6) \times 10^{-6}$         | —    |
| $D_s^- K^*(892)^+$                                                          | $(3.5 \pm 1.0) \times 10^{-5}$         | 2172 |
| $D_s^{*-} K^*(892)^+$                                                       | $(3.2 \pm 1.5 \pm 1.3) \times 10^{-5}$ | 2112 |
| $D_s^- \pi^+ K^0$                                                           | $(9.7 \pm 1.4) \times 10^{-5}$         | 2222 |
| $D_s^{*-} \pi^+ K^0$                                                        | $< 1.10 \times 10^{-4}$ CL=90%         | 2164 |
| $D_s^- K^+ \pi^+ \pi^-$                                                     | $(1.7 \pm 0.5) \times 10^{-4}$         | 2198 |
| $D_s^- \pi^+ K^*(892)^0$                                                    | $< 3.0 \times 10^{-3}$ CL=90%          | 2138 |
| $D_s^{*-} \pi^+ K^*(892)^0$                                                 | $< 1.6 \times 10^{-3}$ CL=90%          | 2076 |
| $\bar{D}^0 K^0$                                                             | $(5.5 \pm 0.4) \times 10^{-5}$         | 2280 |
| $\bar{D}^0 K^+ \pi^-$                                                       | $(8.8 \pm 1.7) \times 10^{-5}$         | 2262 |
| $\bar{D}^0 K^*(892)^0$                                                      | $(4.5 \pm 0.6) \times 10^{-5}$         | 2213 |
| $\bar{D}^0 K^*(1410)^0$                                                     | $< 6.7 \times 10^{-5}$ CL=90%          | 2062 |
| $\bar{D}^0 K_0^*(1430)^0$                                                   | $(7 \pm 7) \times 10^{-6}$             | 2058 |
| $\bar{D}^0 K_2^*(1430)^0$                                                   | $(2.1 \pm 0.9) \times 10^{-5}$         | 2057 |
| $D_0^*(2300)^- K^+, D_0^{*-} \rightarrow \bar{D}^0 \pi^-$                   | $(1.9 \pm 0.9) \times 10^{-5}$         | —    |
| $D_2^*(2460)^- K^+, D_2^{*-} \rightarrow \bar{D}^0 \pi^-$                   | $(2.03 \pm 0.35) \times 10^{-5}$       | 2029 |
| $D_3^*(2760)^- K^+, D_3^{*-} \rightarrow \bar{D}^0 \pi^-$                   | $< 1.0 \times 10^{-6}$ CL=90%          | —    |
| $\bar{D}^0 K^+ \pi^-$ nonresonant                                           | $< 3.7 \times 10^{-5}$ CL=90%          | 2262 |

|                                                                        |                                    |             |
|------------------------------------------------------------------------|------------------------------------|-------------|
| $[K^+ K^-]_D K^*(892)^0$                                               | $( 3.7 \pm 0.5 ) \times 10^{-5}$   | —           |
| $[\pi^+ \pi^-]_D K^*(892)^0$                                           | $( 5.0 \pm 0.8 ) \times 10^{-5}$   | —           |
| $[\pi^+ \pi^- \pi^+ \pi^-]_D K^{*0}$                                   | $( 4.0 \pm 0.6 ) \times 10^{-5}$   | —           |
| $\overline{D}^0 \pi^0$                                                 | $( 2.67 \pm 0.09 ) \times 10^{-4}$ | 2308        |
| $\overline{D}^0 \rho^0$                                                | $( 3.21 \pm 0.21 ) \times 10^{-4}$ | 2237        |
| $\overline{D}^0 f_2$                                                   | $( 1.56 \pm 0.21 ) \times 10^{-4}$ | —           |
| $\overline{D}^0 \eta$                                                  | $( 2.56 \pm 0.12 ) \times 10^{-4}$ | 2274        |
| $\overline{D}^0 \eta'$                                                 | $( 1.38 \pm 0.16 ) \times 10^{-4}$ | S=1.3 2198  |
| $\overline{D}^0 \omega$                                                | $( 2.54 \pm 0.16 ) \times 10^{-4}$ | 2235        |
| $\overline{D}^0 \phi$                                                  | $( 7.7 \pm 2.3 ) \times 10^{-7}$   | 2183        |
| $D^0 K^+ \pi^-$                                                        | $( 5.3 \pm 3.2 ) \times 10^{-6}$   | 2262        |
| $D^0 K^*(892)^0$                                                       | $( 3.0 \pm 0.6 ) \times 10^{-6}$   | 2213        |
| $\overline{D}^{*0} \gamma$                                             | $< 2.5 \times 10^{-5}$             | CL=90% 2258 |
| $\overline{D}^*(2007)^0 \pi^0$                                         | $( 2.2 \pm 0.6 ) \times 10^{-4}$   | S=2.6 2256  |
| $\overline{D}^*(2007)^0 \rho^0$                                        | $< 5.1 \times 10^{-4}$             | CL=90% 2182 |
| $\overline{D}^*(2007)^0 \eta$                                          | $( 2.3 \pm 0.6 ) \times 10^{-4}$   | S=2.8 2220  |
| $\overline{D}^*(2007)^0 \eta'$                                         | $( 1.40 \pm 0.22 ) \times 10^{-4}$ | 2141        |
| $\overline{D}^*(2007)^0 \pi^+ \pi^-$                                   | $( 6.2 \pm 2.2 ) \times 10^{-4}$   | 2249        |
| $\overline{D}^*(2007)^0 K^+ \pi^-$                                     | $( 5.2 \pm 1.9 ) \times 10^{-5}$   | 2207        |
| $\overline{D}^*(2007)^0 K^0$                                           | $( 3.6 \pm 1.2 ) \times 10^{-5}$   | 2227        |
| $\overline{D}^*(2007)^0 K^*(892)^0$                                    | $< 6.9 \times 10^{-5}$             | CL=90% 2157 |
| $\overline{D}^*(2007)^0 \phi$                                          | $( 2.2 \pm 0.6 ) \times 10^{-6}$   | 2125        |
| $D^*(2007)^0 K^*(892)^0$                                               | $< 4.0 \times 10^{-5}$             | CL=90% 2157 |
| $D^*(2007)^0 \pi^+ \pi^+ \pi^- \pi^-$                                  | $( 2.7 \pm 0.5 ) \times 10^{-3}$   | 2219        |
| $D^*(2010)^+ D^*(2010)^-$                                              | $( 8.0 \pm 0.6 ) \times 10^{-4}$   | 1711        |
| $\overline{D}^*(2007)^0 \omega$                                        | $( 3.6 \pm 1.1 ) \times 10^{-4}$   | S=3.1 2180  |
| $D^*(2010)^+ D^-$                                                      | $( 6.1 \pm 1.5 ) \times 10^{-4}$   | S=1.6 1790  |
| $D^*(2007)^0 \overline{D}^*(2007)^0$                                   | $< 9 \times 10^{-5}$               | CL=90% 1715 |
| $D^- D^0 K^+$                                                          | $( 1.07 \pm 0.11 ) \times 10^{-3}$ | 1574        |
| $D^- D^*(2007)^0 K^+$                                                  | $( 3.5 \pm 0.4 ) \times 10^{-3}$   | 1478        |
| $D^*(2010)^- D^0 K^+$                                                  | $( 2.47 \pm 0.21 ) \times 10^{-3}$ | 1479        |
| $D^*(2010)^- D^*(2007)^0 K^+$                                          | $( 1.06 \pm 0.09 ) \%$             | 1366        |
| $D^- D^+ K^0$                                                          | $( 7.5 \pm 1.7 ) \times 10^{-4}$   | 1568        |
| $D^*(2010)^- D^+ K^0 +$<br>$D^- D^*(2010)^+ K^0$                       | $( 6.4 \pm 0.5 ) \times 10^{-3}$   | 1473        |
| $D^*(2010)^- D^*(2010)^+ K^0$                                          | $( 8.1 \pm 0.7 ) \times 10^{-3}$   | 1360        |
| $D^{*-} D_{s1}(2536)^+, D_{s1}^+ \rightarrow$<br>$D^{*+} K^0$          | $( 8.0 \pm 2.4 ) \times 10^{-4}$   | 1336        |
| $\overline{D}^0 D^0 K^0$                                               | $( 2.7 \pm 1.1 ) \times 10^{-4}$   | 1575        |
| $D^0 \overline{D}^0 K^+ \pi^-$                                         | $( 3.5 \pm 0.5 ) \times 10^{-4}$   | 1476        |
| $\overline{D}^0 D^*(2007)^0 K^0 +$<br>$\overline{D}^*(2007)^0 D^0 K^0$ | $( 1.1 \pm 0.5 ) \times 10^{-3}$   | 1478        |
| $\overline{D}^*(2007)^0 D^*(2007)^0 K^0$                               | $( 2.4 \pm 0.9 ) \times 10^{-3}$   | 1365        |
| $(\overline{D} + \overline{D}^*)(D + D^*)K$                            | $( 3.68 \pm 0.26 ) \%$             | —           |

**Charmonium modes**

|                                                              |                                         |        |      |
|--------------------------------------------------------------|-----------------------------------------|--------|------|
| $\eta_c K^0$                                                 | $(9.0 \pm 1.1) \times 10^{-4}$          |        | 1751 |
| $\eta_c(1S) K^+ \pi^-$                                       | $(6.5 \pm 0.7) \times 10^{-4}$          |        | 1722 |
| $\eta_c(1S) K^+ \pi^-$ (NR)                                  | $(6.7 \pm 1.4) \times 10^{-5}$          |        | —    |
| $T_{c\bar{c}}(4100)^- K^+, T_{c\bar{c}}^- \rightarrow$       | $(2.2 \pm 1.1) \times 10^{-5}$          |        | —    |
| $\eta_c \pi^-$                                               |                                         |        |      |
| $\eta_c(1S) K^*(1410)^0$                                     | $(2.1 \pm 1.6) \times 10^{-4}$          |        | 1395 |
| $\eta_c(1S) K_0^*(1430)^0$                                   | $(1.8 \pm 0.4) \times 10^{-4}$          |        | 1387 |
| $\eta_c(1S) K_2^*(1430)^0$                                   | $(5.4^{+2.4}_{-2.9}) \times 10^{-5}$    |        | 1386 |
| $\eta_c(1S) K^*(1680)^0$                                     | $(4 \pm 4) \times 10^{-5}$              |        | 1166 |
| $\eta_c(1S) K_0^*(1950)^0$                                   | $(4.8^{+3.2}_{-4.0}) \times 10^{-5}$    |        | —    |
| $\eta_c K^*(892)^0$                                          | $(5.3^{+0.8}_{-0.9}) \times 10^{-4}$    | S=1.7  | 1646 |
| $\eta_c(2S) K_S^0, \eta_c \rightarrow p \bar{p} \pi^+ \pi^-$ | $(4.2^{+1.4}_{-1.2}) \times 10^{-7}$    |        | —    |
| $\eta_c(2S) K^{*0}$                                          | $< 3.9 \times 10^{-4}$                  | CL=90% | 1159 |
| $h_c(1P) K_S^0$                                              | $< 1.4 \times 10^{-5}$                  |        | 1401 |
| $h_c(1P) K^{*0}$                                             | $< 4 \times 10^{-4}$                    | CL=90% | 1253 |
| $J/\psi(1S) K^0$                                             | $(8.91 \pm 0.21) \times 10^{-4}$        |        | 1683 |
| $J/\psi(1S) K^+ \pi^-$                                       | $(1.15 \pm 0.05) \times 10^{-3}$        |        | 1652 |
| $J/\psi(1S) K^*(892)^0$                                      | $(1.27 \pm 0.05) \times 10^{-3}$        |        | 1572 |
| $J/\psi(1S) \eta K_S^0$                                      | $(5.4 \pm 0.9) \times 10^{-5}$          |        | 1508 |
| $J/\psi(1S) \eta' K_S^0$                                     | $< 2.5 \times 10^{-5}$                  | CL=90% | 1271 |
| $J/\psi(1S) \phi K^0$                                        | $(4.9 \pm 1.0) \times 10^{-5}$          | S=1.3  | 1224 |
| $J/\psi(1S) \omega K^0$                                      | $(2.3 \pm 0.4) \times 10^{-4}$          |        | 1386 |
| $\chi_{c0}(3915), \chi_{c0} \rightarrow J/\psi \omega$       | $(2.1 \pm 0.9) \times 10^{-5}$          |        | 1102 |
| $J/\psi(1S) K(1270)^0$                                       | $(1.3 \pm 0.5) \times 10^{-3}$          |        | 1402 |
| $J/\psi(1S) \pi^0$                                           | $(1.65 \pm 0.08) \times 10^{-5}$        |        | 1728 |
| $J/\psi(1S) \eta$                                            | $(1.08 \pm 0.23) \times 10^{-5}$        | S=1.5  | 1673 |
| $J/\psi(1S) \pi^+ \pi^-$                                     | $(3.99 \pm 0.15) \times 10^{-5}$        |        | 1716 |
| $J/\psi(1S) \pi^+ \pi^-$ nonresonant                         | $< 1.2 \times 10^{-5}$                  | CL=90% | 1716 |
| $J/\psi(1S) f_0(500), f_0 \rightarrow \pi \pi$               | $(8.8^{+1.2}_{-1.6}) \times 10^{-6}$    |        | —    |
| $J/\psi(1S) f_2$                                             | $(3.3^{+0.5}_{-0.6}) \times 10^{-6}$    | S=1.5  | —    |
| $J/\psi(1S) \rho^0$                                          | $(2.55^{+0.18}_{-0.16}) \times 10^{-5}$ |        | 1612 |
| $J/\psi(1S) f_0(980), f_0 \rightarrow \pi^+ \pi^-$           | $< 1.1 \times 10^{-6}$                  | CL=90% | —    |
| $J/\psi(1S) \rho(1450)^0, \rho^0 \rightarrow \pi \pi$        | $(2.9^{+1.6}_{-0.7}) \times 10^{-6}$    |        | —    |
| $J/\psi \rho(1700)^0, \rho^0 \rightarrow \pi^+ \pi^-$        | $(2.0 \pm 1.3) \times 10^{-6}$          |        | —    |
| $J/\psi(1S) \omega$                                          | $(1.8^{+0.7}_{-0.5}) \times 10^{-5}$    |        | 1609 |
| $J/\psi(1S) K^+ K^-$                                         | $(2.53 \pm 0.35) \times 10^{-6}$        |        | 1534 |

|                                                                                |                                          |             |
|--------------------------------------------------------------------------------|------------------------------------------|-------------|
| $J/\psi(1S)a_0(980), a_0 \rightarrow K^+ K^-$                                  | $(4.7 \pm 3.4) \times 10^{-7}$           | —           |
| $J/\psi(1S)\phi$                                                               | $< 1.1 \times 10^{-7}$                   | CL=90% 1520 |
| $J/\psi(1S)\eta'(958)$                                                         | $(7.6 \pm 2.4) \times 10^{-6}$           | 1546        |
| $J/\psi(1S)K^0\pi^+\pi^-$                                                      | $(4.5 \pm 0.4) \times 10^{-4}$           | 1611        |
| $J/\psi(1S)K^0K^-\pi^+ + \text{c.c.}$                                          | $< 2.1 \times 10^{-5}$                   | CL=90% 1468 |
| $J/\psi(1S)K^0K^+K^-$                                                          | $(2.5 \pm 0.7) \times 10^{-5}$           | S=1.8 1249  |
| $J/\psi(1S)K^0\rho^0$                                                          | $(5.4 \pm 3.0) \times 10^{-4}$           | 1390        |
| $J/\psi(1S)K^*(892)^+\pi^-$                                                    | $(8 \pm 4) \times 10^{-4}$               | 1515        |
| $J/\psi(1S)\pi^+\pi^-\pi^+\pi^-$                                               | $(1.44 \pm 0.12) \times 10^{-5}$         | 1670        |
| $J/\psi(1S)f_1(1285)$                                                          | $(8.4 \pm 2.1) \times 10^{-6}$           | 1385        |
| $J/\psi(1S)K^*(892)^0\pi^+\pi^-$                                               | $(6.6 \pm 2.2) \times 10^{-4}$           | 1447        |
| $\eta_{c2}(1D)K_S^0, \eta_{c2} \rightarrow h_c\gamma$                          | $< 3.5 \times 10^{-5}$                   | CL=90% —    |
| $\eta_{c2}(1D)\pi^-K^+, \eta_{c2} \rightarrow h_c\gamma$                       | $< 1.0 \times 10^{-4}$                   | CL=90% —    |
| $\chi_{c1}(3872)^-K^+$                                                         | $< 5 \times 10^{-4}$                     | CL=90% —    |
| $\chi_{c1}(3872)^-K^+, [f] < 4.2 \times 10^{-6}$                               | $< 4.2 \times 10^{-6}$                   | CL=90% —    |
| $\chi_{c1}(3872)^- \rightarrow J/\psi(1S)\pi^-\pi^0$                           |                                          |             |
| $\chi_{c1}(3872)K^0$                                                           | $(1.1 \pm 0.4) \times 10^{-4}$           | 1140        |
| $\chi_{c1}(3872)K^*(892)^0$                                                    | $(9 \pm 5) \times 10^{-5}$               | 940         |
| $\chi_{c1}(3872)K^+\pi^-$                                                      | $(1.8 \pm 0.7) \times 10^{-4}$           | 1087        |
| $\chi_{c1}(3872)\gamma$                                                        | $< 1.2 \times 10^{-5}$                   | CL=90% 1220 |
| $T_{c\bar{c}1}(4430)^\pm K^\mp, T_{c\bar{c}1}^\pm \rightarrow \psi(2S)\pi^\pm$ | $(6.0 \pm_{-2.4}^{+3.0}) \times 10^{-5}$ | 583         |
| $T_{c\bar{c}1}(4430)^\pm K^\mp, T_{c\bar{c}1}^\pm \rightarrow J/\psi\pi^\pm$   | $(5.4 \pm_{-1.2}^{+4.0}) \times 10^{-6}$ | 583         |
| $T_{c\bar{c}1}(3900)^\pm K^\mp, T_{c\bar{c}1}^\pm \rightarrow J/\psi\pi^\pm$   | $< 9 \times 10^{-7}$                     | —           |
| $T_{c\bar{c}1}(4200)^\pm K^\mp, T_{c\bar{c}1}^\pm \rightarrow J/\psi\pi^\pm$   | $(2.2 \pm_{-0.8}^{+1.3}) \times 10^{-5}$ | —           |
| $J/\psi(1S)p\bar{p}$                                                           | $(4.5 \pm 0.6) \times 10^{-7}$           | 862         |
| $J/\psi(1S)\gamma$                                                             | $< 1.5 \times 10^{-6}$                   | CL=90% 1732 |
| $J/\psi\mu^+\mu^-, J/\psi \rightarrow \mu^+\mu^-$                              | $< 1.0 \times 10^{-9}$                   | CL=95% —    |
| $J/\psi(1S)\bar{D}^0$                                                          | $< 9.6 \times 10^{-7}$                   | CL=90% 877  |
| $\psi(2S)\pi^0$                                                                | $(1.17 \pm 0.19) \times 10^{-5}$         | 1348        |
| $\psi(2S)K^0$                                                                  | $(5.8 \pm 0.5) \times 10^{-4}$           | 1283        |
| $\psi(2S)K^0\pi^+\pi^-$                                                        | $(2.81 \pm 0.30) \times 10^{-4}$         | 1177        |
| $\psi(3770)K^0, \psi \rightarrow \bar{D}^0 D^0$                                | $< 1.23 \times 10^{-4}$                  | CL=90% 1217 |
| $\psi(3770)K^0, \psi \rightarrow D^- D^+$                                      | $< 1.88 \times 10^{-4}$                  | CL=90% 1217 |
| $\psi(2S)\pi^+\pi^-$                                                           | $(2.24 \pm 0.35) \times 10^{-5}$         | 1332        |
| $\psi(2S)K^+\pi^-$                                                             | $(5.8 \pm 0.4) \times 10^{-4}$           | 1239        |
| $\psi(2S)K^*(892)^0$                                                           | $(5.9 \pm 0.4) \times 10^{-4}$           | 1116        |
| $\chi_{c0}K^0$                                                                 | $(1.9 \pm 0.4) \times 10^{-4}$           | 1478        |



|                                                                             |                                          |      |
|-----------------------------------------------------------------------------|------------------------------------------|------|
| $\chi_{c0} K^*(892)^0$                                                      | $(1.7 \pm 0.4) \times 10^{-4}$           | 1342 |
| $\chi_{c1} \pi^0$                                                           | $(1.12 \pm 0.28) \times 10^{-5}$         | 1468 |
| $\chi_{c1} K^0$                                                             | $(3.95 \pm 0.27) \times 10^{-4}$         | 1411 |
| $\chi_{c1} \pi^- K^+$                                                       | $(4.97 \pm 0.30) \times 10^{-4}$         | 1372 |
| $\chi_{c1} K^*(892)^0$                                                      | $(2.38 \pm 0.19) \times 10^{-4}$ S=1.2   | 1265 |
| $T_{c\bar{c}}(4050)^- K^+, T_{c\bar{c}}^- \rightarrow$<br>$\chi_{c1} \pi^-$ | $(3.0 \pm_{-1.8}^{4.0}) \times 10^{-5}$  | —    |
| $T_{c\bar{c}}(4250)^- K^+, T_{c\bar{c}}^- \rightarrow$<br>$\chi_{c1} \pi^-$ | $(4.0 \pm_{-1.0}^{20.0}) \times 10^{-5}$ | —    |
| $\chi_{c1} \pi^+ \pi^- K^0$                                                 | $(3.2 \pm 0.5) \times 10^{-4}$           | 1318 |
| $\chi_{c1} \pi^- \pi^0 K^+$                                                 | $(3.5 \pm 0.6) \times 10^{-4}$           | 1321 |
| $\chi_{c2} K^0$                                                             | $< 1.5 \times 10^{-5}$ CL=90%            | 1379 |
| $\chi_{c2} K^*(892)^0$                                                      | $(4.9 \pm 1.2) \times 10^{-5}$ S=1.1     | 1228 |
| $\chi_{c2} \pi^- K^+$                                                       | $(7.2 \pm 1.0) \times 10^{-5}$           | 1338 |
| $\chi_{c2} \pi^+ \pi^- K^0$                                                 | $< 1.70 \times 10^{-4}$ CL=90%           | 1282 |
| $\chi_{c2} \pi^- \pi^0 K^+$                                                 | $< 7.4 \times 10^{-5}$ CL=90%            | 1286 |
| $\psi(4660) K^0, \psi \rightarrow \Lambda_c^+ \Lambda_c^-$                  | $< 2.3 \times 10^{-4}$ CL=90%            | —    |
| $\psi(4230)^0 K^0, \psi^0 \rightarrow$<br>$J/\psi \pi^+ \pi^-$              | $< 1.7 \times 10^{-5}$ CL=90%            | —    |

**K or K\* modes**

|                                                         |                                            |      |
|---------------------------------------------------------|--------------------------------------------|------|
| $K^+ \pi^-$                                             | $(2.00 \pm 0.04) \times 10^{-5}$           | 2615 |
| $K^0 \pi^0$                                             | $(1.01 \pm 0.04) \times 10^{-5}$           | 2615 |
| $\eta' K^0$                                             | $(6.6 \pm 0.4) \times 10^{-5}$ S=1.4       | 2528 |
| $\eta' K^*(892)^0$                                      | $(2.8 \pm 0.6) \times 10^{-6}$             | 2472 |
| $\eta' K_0^*(1430)^0$                                   | $(6.3 \pm 1.6) \times 10^{-6}$             | 2346 |
| $\eta' K_2^*(1430)^0$                                   | $(1.37 \pm 0.32) \times 10^{-5}$           | 2346 |
| $\eta K^0$                                              | $(1.23 \pm_{-0.24}^{0.27}) \times 10^{-6}$ | 2587 |
| $\eta K^*(892)^0$                                       | $(1.59 \pm 0.10) \times 10^{-5}$           | 2534 |
| $\eta K_0^*(1430)^0$                                    | $(1.10 \pm 0.22) \times 10^{-5}$           | 2415 |
| $\eta K_2^*(1430)^0$                                    | $(9.6 \pm 2.1) \times 10^{-6}$             | 2414 |
| $\omega K^0$                                            | $(4.8 \pm 0.4) \times 10^{-6}$             | 2557 |
| $a_0(980)^0 K^0, a_0^0 \rightarrow \eta \pi^0$          | $< 7.8 \times 10^{-6}$ CL=90%              | —    |
| $b_1^0 K^0, b_1^0 \rightarrow \omega \pi^0$             | $< 7.8 \times 10^{-6}$ CL=90%              | —    |
| $a_0(980)^\pm K^\mp, a_0^\pm \rightarrow \eta \pi^\pm$  | $< 1.9 \times 10^{-6}$ CL=90%              | —    |
| $b_1^- K^+, b_1^- \rightarrow \omega \pi^-$             | $(7.4 \pm 1.4) \times 10^{-6}$             | —    |
| $b_1^0 K^{*0}, b_1^0 \rightarrow \omega \pi^0$          | $< 8.0 \times 10^{-6}$ CL=90%              | —    |
| $b_1^- K^{*+}, b_1^- \rightarrow \omega \pi^-$          | $< 5.0 \times 10^{-6}$ CL=90%              | —    |
| $a_0(1450)^\pm K^\mp, a_0^\pm \rightarrow \eta \pi^\pm$ | $< 3.1 \times 10^{-6}$ CL=90%              | —    |
| $K_S^0 X^0$ (Familon)                                   | $< 5.3 \times 10^{-5}$ CL=90%              | —    |
| $\omega K^*(892)^0$                                     | $(2.0 \pm 0.5) \times 10^{-6}$             | 2503 |
| $\omega(K\pi)_0^{*0}$                                   | $(1.84 \pm 0.25) \times 10^{-5}$           | —    |

|                                                  |                                         |        |      |
|--------------------------------------------------|-----------------------------------------|--------|------|
| $\omega K_0^*(1430)^0$                           | $(1.60 \pm 0.34) \times 10^{-5}$        |        | 2380 |
| $\omega K_2^*(1430)^0$                           | $(1.01 \pm 0.23) \times 10^{-5}$        |        | 2380 |
| $\omega K^+ \pi^-$ nonresonant                   | $(5.1 \pm 1.0) \times 10^{-6}$          |        | 2542 |
| $K^+ \pi^- \pi^0$                                | $(3.78 \pm 0.32) \times 10^{-5}$        |        | 2610 |
| $K^+ \rho^-$                                     | $(7.0 \pm 0.9) \times 10^{-6}$          |        | 2559 |
| $K^+ \rho(1450)^-$                               | $(2.4 \pm 1.2) \times 10^{-6}$          |        | —    |
| $K^+ \rho(1700)^-$                               | $(6 \pm 7) \times 10^{-7}$              |        | —    |
| $(K^+ \pi^- \pi^0)$ nonresonant                  | $(2.8 \pm 0.6) \times 10^{-6}$          |        | 2610 |
| $(K\pi)_0^{*+} \pi^-, (K\pi)_0^{*+} \rightarrow$ | $(3.4 \pm 0.5) \times 10^{-5}$          |        | —    |
| $K^+ \pi^0$                                      |                                         |        |      |
| $(K\pi)_0^{*0} \pi^0, (K\pi)_0^{*0} \rightarrow$ | $(8.6 \pm 1.7) \times 10^{-6}$          |        | —    |
| $K^+ \pi^-$                                      |                                         |        |      |
| $K_2^*(1430)^0 \pi^0$                            | $< 4.0 \times 10^{-6}$                  | CL=90% | 2445 |
| $K^*(1680)^0 \pi^0$                              | $< 7.5 \times 10^{-6}$                  | CL=90% | 2358 |
| $K_x^{*0} \pi^0$                                 | $[i] (6.1 \pm 1.6) \times 10^{-6}$      |        | —    |
| $K^0 \pi^+ \pi^-$                                | $(4.97 \pm 0.18) \times 10^{-5}$        |        | 2609 |
| $K^0 \pi^+ \pi^-$ nonresonant                    | $(1.39_{-0.18}^{+0.26}) \times 10^{-5}$ | S=1.6  | 2609 |
| $K^0 \rho^0$                                     | $(3.4 \pm 1.1) \times 10^{-6}$          | S=2.3  | 2558 |
| $K^*(892)^+ \pi^-$                               | $(7.5 \pm 0.4) \times 10^{-6}$          |        | 2563 |
| $K_0^*(1430)^+ \pi^-$                            | $(3.3 \pm 0.7) \times 10^{-5}$          | S=2.0  | —    |
| $K_x^{*+} \pi^-$                                 | $[i] (5.1 \pm 1.6) \times 10^{-6}$      |        | —    |
| $K^*(1410)^+ \pi^-, K^{*+} \rightarrow$          | $< 3.8 \times 10^{-6}$                  | CL=90% | —    |
| $K^0 \pi^+$                                      |                                         |        |      |
| $(K\pi)_0^{*+} \pi^-, (K\pi)_0^{*+} \rightarrow$ | $(1.62 \pm 0.13) \times 10^{-5}$        |        | —    |
| $K^0 \pi^+$                                      |                                         |        |      |
| $f_0(980) K^0, f_0 \rightarrow \pi^+ \pi^-$      | $(8.1 \pm 0.8) \times 10^{-6}$          | S=1.3  | 2522 |
| $K^0 f_0(500)$                                   | $(1.6_{-1.6}^{+2.5}) \times 10^{-7}$    |        | —    |
| $K^0 f_0(1500)$                                  | $(1.3 \pm 0.8) \times 10^{-6}$          |        | 2393 |
| $f_2(1270) K^0$                                  | $(2.7_{-1.2}^{+1.3}) \times 10^{-6}$    |        | 2459 |
| $f_x(1300) K^0, f_x \rightarrow \pi^+ \pi^-$     | $(1.8 \pm 0.7) \times 10^{-6}$          |        | —    |
| $K^*(892)^0 \pi^0$                               | $(3.3 \pm 0.6) \times 10^{-6}$          |        | 2563 |
| $K_2^*(1430)^+ \pi^-$                            | $(3.65 \pm 0.34) \times 10^{-6}$        |        | 2445 |
| $K^*(1680)^+ \pi^-$                              | $(1.41 \pm 0.10) \times 10^{-5}$        |        | 2358 |
| $K^+ \pi^- \pi^+ \pi^-$                          | $[j] < 2.3 \times 10^{-4}$              | CL=90% | 2600 |
| $\rho^0 K^+ \pi^-$                               | $(2.8 \pm 0.7) \times 10^{-6}$          |        | 2543 |
| $f_0(980) K^+ \pi^-, f_0 \rightarrow \pi \pi$    | $(1.4_{-0.6}^{+0.5}) \times 10^{-6}$    |        | 2506 |
| $K^+ \pi^- \pi^+ \pi^-$ nonresonant              | $< 2.1 \times 10^{-6}$                  | CL=90% | 2600 |
| $K^*(892)^0 \pi^+ \pi^-$                         | $(5.5 \pm 0.5) \times 10^{-5}$          |        | 2557 |
| $K^*(892)^0 \rho^0$                              | $(3.9 \pm 1.3) \times 10^{-6}$          | S=1.9  | 2504 |
| $K^*(892)^0 f_0(980), f_0 \rightarrow \pi \pi$   | $(3.9_{-1.8}^{+2.1}) \times 10^{-6}$    | S=3.9  | 2466 |
| $K_1(1270)^+ \pi^-$                              | $< 3.0 \times 10^{-5}$                  | CL=90% | 2489 |

|                                                  |                                          |        |      |
|--------------------------------------------------|------------------------------------------|--------|------|
| $K_1(1400)^+ \pi^-$                              | $< 2.7 \times 10^{-5}$                   | CL=90% | 2451 |
| $a_1(1260)^- K^+$                                | [J] $(1.6 \pm 0.4) \times 10^{-5}$       |        | 2471 |
| $K^*(892)^+ \rho^-$                              | $(1.03 \pm 0.26) \times 10^{-5}$         |        | 2504 |
| $K_0^*(1430)^+ \rho^-$                           | $(2.8 \pm 1.2) \times 10^{-5}$           |        | —    |
| $K_1(1400)^0 \rho^0$                             | $< 3.0 \times 10^{-3}$                   | CL=90% | 2388 |
| $K_0^*(1430)^0 \rho^0$                           | $(2.7 \pm 0.6) \times 10^{-5}$           |        | 2381 |
| $K_0^*(1430)^0 f_0(980), f_0 \rightarrow \pi\pi$ | $(2.7 \pm 0.9) \times 10^{-6}$           |        | —    |
| $K_2^*(1430)^0 f_0(980), f_0 \rightarrow \pi\pi$ | $(8.6 \pm 2.0) \times 10^{-6}$           |        | —    |
| $K^+ K^-$                                        | $(7.8 \pm 1.5) \times 10^{-8}$           |        | 2593 |
| $K^0 \bar{K}^0$                                  | $(1.21 \pm 0.16) \times 10^{-6}$         |        | 2593 |
| $K^0 K^- \pi^+$                                  | $(6.7 \pm 0.5) \times 10^{-6}$           |        | 2578 |
| $K^*(892)^\pm K^\mp$                             | $< 4 \times 10^{-7}$                     | CL=90% | 2540 |
| $\bar{K}^{*0} K^0 + K^{*0} \bar{K}^0$            | $< 9.6 \times 10^{-7}$                   | CL=90% | —    |
| $K^+ K^- \pi^0$                                  | $(2.2 \pm 0.6) \times 10^{-6}$           |        | 2579 |
| $K_S^0 K_S^0 \pi^0$                              | $< 9 \times 10^{-7}$                     | CL=90% | 2578 |
| $K_S^0 K_S^0 \eta$                               | $< 1.0 \times 10^{-6}$                   | CL=90% | 2516 |
| $K_S^0 K_S^0 \eta'$                              | $< 2.0 \times 10^{-6}$                   | CL=90% | 2453 |
| $K^0 K^+ K^-$                                    | $(2.68 \pm 0.11) \times 10^{-5}$         |        | 2522 |
| $K^0 \phi$                                       | $(7.3 \pm 0.7) \times 10^{-6}$           |        | 2516 |
| $f_0(980) K^0, f_0 \rightarrow K^+ K^-$          | $(7.0 \pm_{-3.0}^{+3.5}) \times 10^{-6}$ |        | —    |
| $f_0(1500) K^0$                                  | $(1.3 \pm_{-0.5}^{+0.7}) \times 10^{-5}$ |        | 2393 |
| $f_2'(1525)^0 K^0$                               | $(3 \pm_{-4}^{+5}) \times 10^{-7}$       |        | —    |
| $f_0(1710) K^0, f_0 \rightarrow K^+ K^-$         | $(4.4 \pm 0.9) \times 10^{-6}$           |        | —    |
| $K^0 K^+ K^-$ nonresonant                        | $(3.3 \pm 1.0) \times 10^{-5}$           |        | 2522 |
| $K_S^0 K_S^0 K_S^0$                              | $(6.0 \pm 0.5) \times 10^{-6}$           | S=1.1  | 2521 |
| $f_0(980) K^0, f_0 \rightarrow K_S^0 K_S^0$      | $(2.7 \pm 1.8) \times 10^{-6}$           |        | —    |
| $f_0(1710) K^0, f_0 \rightarrow K_S^0 K_S^0$     | $(5.0 \pm_{-2.6}^{+5.0}) \times 10^{-7}$ |        | —    |
| $f_2(2010) K^0, f_2 \rightarrow K_S^0 K_S^0$     | $(5 \pm 6) \times 10^{-7}$               |        | —    |
| $K_S^0 K_S^0 K_S^0$ nonresonant                  | $(1.33 \pm 0.31) \times 10^{-5}$         |        | 2521 |
| $K_S^0 K_S^0 K_L^0$                              | $< 1.6 \times 10^{-5}$                   | CL=90% | 2521 |
| $K^*(892)^0 K^+ K^-$                             | $(2.75 \pm 0.26) \times 10^{-5}$         |        | 2467 |
| $K^*(892)^0 \phi$                                | $(1.00 \pm 0.05) \times 10^{-5}$         |        | 2460 |
| $K^+ K^- \pi^+ \pi^-$ nonresonant                | $< 7.17 \times 10^{-5}$                  | CL=90% | 2559 |
| $K^*(892)^0 K^- \pi^+$                           | $(4.5 \pm 1.3) \times 10^{-6}$           |        | 2524 |
| $K^*(892)^0 \bar{K}^*(892)^0$                    | $(8.3 \pm 2.4) \times 10^{-7}$           | S=1.5  | 2485 |
| $K^+ K^+ \pi^- \pi^-$ nonresonant                | $< 6.0 \times 10^{-6}$                   | CL=90% | 2559 |
| $K^*(892)^0 K^+ \pi^-$                           | $< 2.2 \times 10^{-6}$                   | CL=90% | 2524 |
| $K^*(892)^0 K^*(892)^0$                          | $< 2 \times 10^{-7}$                     | CL=90% | 2485 |
| $K^*(892)^+ K^*(892)^-$                          | $< 2.0 \times 10^{-6}$                   | CL=90% | 2485 |
| $K_1(1400)^0 \phi$                               | $< 5.0 \times 10^{-3}$                   | CL=90% | 2340 |
| $\phi(K\pi)_0^{*0}$                              | $(4.3 \pm 0.4) \times 10^{-6}$           |        | —    |

|                                                |                   |                  |        |      |
|------------------------------------------------|-------------------|------------------|--------|------|
| $\phi(K\pi)^*_0 (1.60 < m_{K\pi} < 2.15)$      | $[k] < 1.7$       | $\times 10^{-6}$ | CL=90% | —    |
| $K^*_0(1430)^0 K^- \pi^+$                      | $< 3.18$          | $\times 10^{-5}$ | CL=90% | 2404 |
| $K^*_0(1430)^0 \bar{K}^*(892)^0$               | $< 3.3$           | $\times 10^{-6}$ | CL=90% | 2360 |
| $K^*_0(1430)^0 \bar{K}^*_0(1430)^0$            | $< 8.4$           | $\times 10^{-6}$ | CL=90% | 2222 |
| $K^*_0(1430)^0 \phi$                           | $(3.9 \pm 0.8)$   | $\times 10^{-6}$ |        | 2333 |
| $K^*_0(1430)^0 K^*(892)^0$                     | $< 1.7$           | $\times 10^{-6}$ | CL=90% | 2360 |
| $K^*_0(1430)^0 K^*_0(1430)^0$                  | $< 4.7$           | $\times 10^{-6}$ | CL=90% | 2222 |
| $K^*(1680)^0 \phi$                             | $< 3.5$           | $\times 10^{-6}$ | CL=90% | 2238 |
| $K^*(1780)^0 \phi$                             | $< 2.7$           | $\times 10^{-6}$ | CL=90% | —    |
| $K^*(2045)^0 \phi$                             | $< 1.53$          | $\times 10^{-5}$ | CL=90% | —    |
| $K^*_2(1430)^0 \rho^0$                         | $< 1.1$           | $\times 10^{-3}$ | CL=90% | 2381 |
| $K^*_2(1430)^0 \phi$                           | $(6.8 \pm 0.9)$   | $\times 10^{-6}$ | S=1.2  | 2332 |
| $K^0 \phi \phi$                                | $(3.7 \pm 0.7)$   | $\times 10^{-6}$ | S=1.3  | 2305 |
| $\eta' \eta' K^0$                              | $< 3.1$           | $\times 10^{-5}$ | CL=90% | 2338 |
| $\eta K^0 \gamma$                              | $(7.6 \pm 1.8)$   | $\times 10^{-6}$ |        | 2587 |
| $\eta' K^0 \gamma$                             | $< 6.4$           | $\times 10^{-6}$ | CL=90% | 2528 |
| $K^0 \phi \gamma$                              | $(2.7 \pm 0.7)$   | $\times 10^{-6}$ |        | 2516 |
| $K^+ \pi^- \gamma$                             | $(4.6 \pm 1.4)$   | $\times 10^{-6}$ |        | 2615 |
| $K^*(892)^0 \gamma$                            | $(4.18 \pm 0.25)$ | $\times 10^{-5}$ | S=2.1  | 2565 |
| $K^*(1410) \gamma$                             | $< 1.3$           | $\times 10^{-4}$ | CL=90% | 2451 |
| $K^+ \pi^- \gamma$ nonresonant                 | $< 2.6$           | $\times 10^{-6}$ | CL=90% | 2615 |
| $K^*(892)^0 X(214), X \rightarrow \mu^+ \mu^-$ | $[l] < 2.26$      | $\times 10^{-8}$ | CL=90% | —    |
| $K^0 \pi^+ \pi^- \gamma$                       | $(1.99 \pm 0.18)$ | $\times 10^{-5}$ |        | 2609 |
| $K^+ \pi^- \pi^0 \gamma$                       | $(4.1 \pm 0.4)$   | $\times 10^{-5}$ |        | 2610 |
| $K_1(1270)^0 \gamma$                           | $< 5.8$           | $\times 10^{-5}$ | CL=90% | 2491 |
| $K_1(1400)^0 \gamma$                           | $< 1.2$           | $\times 10^{-5}$ | CL=90% | 2454 |
| $K^*_2(1430)^0 \gamma$                         | $(1.24 \pm 0.24)$ | $\times 10^{-5}$ |        | 2447 |
| $K^*(1680)^0 \gamma$                           | $< 2.0$           | $\times 10^{-3}$ | CL=90% | 2360 |
| $K^*_3(1780)^0 \gamma$                         | $< 8.3$           | $\times 10^{-5}$ | CL=90% | 2340 |
| $K^*_4(2045)^0 \gamma$                         | $< 4.3$           | $\times 10^{-3}$ | CL=90% | 2243 |

**Light unflavored meson modes**

|                                                     |                   |                  |        |      |
|-----------------------------------------------------|-------------------|------------------|--------|------|
| $\rho^0 \gamma$                                     | $(8.6 \pm 1.5)$   | $\times 10^{-7}$ |        | 2583 |
| $\rho^0 X(214), X \rightarrow \mu^+ \mu^-$          | $[l] < 1.73$      | $\times 10^{-8}$ | CL=90% | —    |
| $\omega \gamma$                                     | $(4.4 \pm 1.8)$   | $\times 10^{-7}$ |        | 2582 |
| $\phi \gamma$                                       | $< 1.0$           | $\times 10^{-7}$ | CL=90% | 2541 |
| $f_2(1270) \gamma, f_2 \rightarrow (KS)^0 (KS)^0$   | $< 3.1$           | $\times 10^{-7}$ |        | —    |
| $f'_2(1525) \gamma, f'_2 \rightarrow (KS)^0 (KS)^0$ | $< 2.1$           | $\times 10^{-7}$ |        | —    |
| $\pi^+ \pi^-$                                       | $(5.37 \pm 0.20)$ | $\times 10^{-6}$ | S=1.3  | 2636 |
| $\pi^0 \pi^0$                                       | $(1.55 \pm 0.17)$ | $\times 10^{-6}$ | S=1.1  | 2636 |

|                                                                            |                                        |        |      |
|----------------------------------------------------------------------------|----------------------------------------|--------|------|
| $\eta\pi^0$                                                                | $(4.1 \pm 1.7) \times 10^{-7}$         |        | 2610 |
| $\eta\eta$                                                                 | $< 1.0 \times 10^{-6}$                 | CL=90% | 2582 |
| $\eta'\pi^0$                                                               | $(1.2 \pm 0.6) \times 10^{-6}$         | S=1.7  | 2551 |
| $\eta'\eta'$                                                               | $< 1.7 \times 10^{-6}$                 | CL=90% | 2460 |
| $\eta'\eta$                                                                | $< 1.2 \times 10^{-6}$                 | CL=90% | 2523 |
| $\eta'\rho^0$                                                              | $< 1.3 \times 10^{-6}$                 | CL=90% | 2492 |
| $\eta'f_0(980), f_0 \rightarrow \pi^+\pi^-$                                | $< 9 \times 10^{-7}$                   | CL=90% | 2454 |
| $\eta\rho^0$                                                               | $< 1.5 \times 10^{-6}$                 | CL=90% | 2553 |
| $\eta f_0(980), f_0 \rightarrow \pi^+\pi^-$                                | $< 4 \times 10^{-7}$                   | CL=90% | 2516 |
| $\omega\eta$                                                               | $(9.4 \pm 4.0 \pm 3.1) \times 10^{-7}$ |        | 2552 |
| $\omega\eta'$                                                              | $(1.0 \pm 0.5 \pm 0.4) \times 10^{-6}$ |        | 2491 |
| $\omega\rho^0$                                                             | $< 1.6 \times 10^{-6}$                 | CL=90% | 2522 |
| $\omega f_0(980), f_0 \rightarrow \pi^+\pi^-$                              | $< 1.5 \times 10^{-6}$                 | CL=90% | 2485 |
| $\omega\omega$                                                             | $(1.40 \pm 0.25) \times 10^{-6}$       |        | 2521 |
| $\phi\pi^0$                                                                | $< 1.5 \times 10^{-7}$                 | CL=90% | 2540 |
| $\phi\eta$                                                                 | $< 5 \times 10^{-7}$                   | CL=90% | 2511 |
| $\phi\eta'$                                                                | $< 5 \times 10^{-7}$                   | CL=90% | 2448 |
| $\phi\pi^+\pi^-$                                                           | $(1.8 \pm 0.5) \times 10^{-7}$         |        | 2533 |
| $\phi\rho^0$                                                               | $< 3.3 \times 10^{-7}$                 | CL=90% | 2480 |
| $\phi f_0(980), f_0 \rightarrow \pi^+\pi^-$                                | $< 3.8 \times 10^{-7}$                 | CL=90% | 2441 |
| $\phi\omega$                                                               | $< 7 \times 10^{-7}$                   | CL=90% | 2479 |
| $\phi\phi$                                                                 | $< 2.7 \times 10^{-8}$                 | CL=90% | 2435 |
| $a_0(980)^\pm\pi^\mp, a_0^\pm \rightarrow \eta\pi^\pm$                     | $< 3.1 \times 10^{-6}$                 | CL=90% | —    |
| $a_0(1450)^\pm\pi^\mp, a_0^\pm \rightarrow \eta\pi^\pm$                    | $< 2.3 \times 10^{-6}$                 | CL=90% | —    |
| $\pi^+\pi^-\pi^0$                                                          | $< 7.2 \times 10^{-4}$                 | CL=90% | 2631 |
| $\rho^0\pi^0$                                                              | $(2.0 \pm 0.5) \times 10^{-6}$         |        | 2581 |
| $\rho^\mp\pi^\pm$                                                          | [n] $(2.30 \pm 0.23) \times 10^{-5}$   |        | 2581 |
| $\pi^+\pi^-\pi^+\pi^-$                                                     | $< 1.12 \times 10^{-5}$                | CL=90% | 2621 |
| $\rho^0\pi^+\pi^-$                                                         | $< 8.8 \times 10^{-6}$                 | CL=90% | 2575 |
| $\rho^0\rho^0$                                                             | $(9.6 \pm 1.5) \times 10^{-7}$         |        | 2524 |
| $f_0(980)\pi^+\pi^-, f_0 \rightarrow \pi^+\pi^-$                           | $< 3.0 \times 10^{-6}$                 | CL=90% | —    |
| $\rho^0 f_0(980), f_0 \rightarrow \pi^+\pi^-$                              | $(7.8 \pm 2.5) \times 10^{-7}$         |        | 2486 |
| $f_0(980)f_0(980), f_0 \rightarrow \pi^+\pi^-, f_0 \rightarrow \pi^+\pi^-$ | $< 1.9 \times 10^{-7}$                 | CL=90% | 2447 |
| $f_0(980)f_0(980), f_0 \rightarrow \pi^+\pi^-, f_0 \rightarrow K^+K^-$     | $< 2.3 \times 10^{-7}$                 | CL=90% | 2447 |
| $a_1(1260)^\mp\pi^\pm$                                                     | [n] $(2.6 \pm 0.5) \times 10^{-5}$     | S=1.9  | 2495 |
| $a_2(1320)^\mp\pi^\pm$                                                     | [n] $< 6.3 \times 10^{-6}$             | CL=90% | 2473 |
| $\pi^+\pi^-\pi^0\pi^0$                                                     | $< 3.1 \times 10^{-3}$                 | CL=90% | 2622 |
| $\rho^+\rho^-$                                                             | $(2.77 \pm 0.19) \times 10^{-5}$       |        | 2524 |
| $a_1(1260)^0\pi^0$                                                         | $< 1.1 \times 10^{-3}$                 | CL=90% | 2495 |
| $\omega\pi^0$                                                              | $< 5 \times 10^{-7}$                   | CL=90% | 2580 |

|                                                                                        |                   |                  |        |      |
|----------------------------------------------------------------------------------------|-------------------|------------------|--------|------|
| $\pi^+\pi^+\pi^-\pi^-\pi^0$                                                            | $< 9.0$           | $\times 10^{-3}$ | CL=90% | 2609 |
| $a_1(1260)^+\rho^-$                                                                    | $< 6.1$           | $\times 10^{-5}$ | CL=90% | 2433 |
| $a_1(1260)^0\rho^0$                                                                    | $< 2.4$           | $\times 10^{-3}$ | CL=90% | 2433 |
| $b_1^\mp\pi^\pm, b_1^\mp \rightarrow \omega\pi^\mp$                                    | $(1.09 \pm 0.15)$ | $\times 10^{-5}$ |        | —    |
| $b_1^0\pi^0, b_1^0 \rightarrow \omega\pi^0$                                            | $< 1.9$           | $\times 10^{-6}$ | CL=90% | —    |
| $b_1^-\rho^+, b_1^- \rightarrow \omega\pi^-$                                           | $< 1.4$           | $\times 10^{-6}$ | CL=90% | —    |
| $b_1^0\rho^0, b_1^0 \rightarrow \omega\pi^0$                                           | $< 3.4$           | $\times 10^{-6}$ | CL=90% | —    |
| $\pi^+\pi^+\pi^+\pi^-\pi^-\pi^-$                                                       | $< 3.0$           | $\times 10^{-3}$ | CL=90% | 2592 |
| $a_1(1260)^+a_1(1260)^-, a_1^+ \rightarrow 2\pi^+\pi^-, a_1^- \rightarrow 2\pi^-\pi^+$ | $(1.18 \pm 0.31)$ | $\times 10^{-5}$ |        | 2336 |
| $\pi^+\pi^+\pi^+\pi^-\pi^-\pi^-\pi^0$                                                  | $< 1.1$           | %                | CL=90% | 2572 |

**Baryon modes**

|                                                      |                          |                  |        |      |
|------------------------------------------------------|--------------------------|------------------|--------|------|
| $p\bar{p}$                                           | $(1.27 \pm 0.14)$        | $\times 10^{-8}$ |        | 2467 |
| $p\bar{p}\pi^+\pi^-$                                 | $(2.87 \pm 0.19)$        | $\times 10^{-6}$ |        | 2406 |
| $p\bar{p}K^+\pi^-$                                   | $(6.3 \pm 0.5)$          | $\times 10^{-6}$ |        | 2306 |
| $p\bar{p}K^0$                                        | $(2.66 \pm 0.32)$        | $\times 10^{-6}$ |        | 2347 |
| $\Theta(1540)^+\bar{p}, \Theta^+ \rightarrow pK_S^0$ | [o] $< 5$                | $\times 10^{-8}$ | CL=90% | 2318 |
| $f_J(2220)K^0, f_J \rightarrow p\bar{p}$             | $< 4.5$                  | $\times 10^{-7}$ | CL=90% | 2135 |
| $p\bar{p}K^*(892)^0$                                 | $(1.24^{+0.28}_{-0.25})$ | $\times 10^{-6}$ |        | 2216 |
| $f_J(2220)K_0^*, f_J \rightarrow p\bar{p}$           | $< 1.5$                  | $\times 10^{-7}$ | CL=90% | —    |
| $p\bar{p}K^+K^-$                                     | $(1.21 \pm 0.32)$        | $\times 10^{-7}$ |        | 2179 |
| $p\bar{p}\pi^0$                                      | $(5.0 \pm 1.9)$          | $\times 10^{-7}$ |        | 2440 |
| $p\bar{p}p\bar{p}$                                   | $(2.2 \pm 0.4)$          | $\times 10^{-8}$ |        | 1735 |
| $p\bar{\Lambda}\pi^-$                                | $(3.16 \pm 0.24)$        | $\times 10^{-6}$ |        | 2401 |
| $p\bar{\Lambda}\pi^-\gamma$                          | $< 6.5$                  | $\times 10^{-7}$ | CL=90% | 2401 |
| $p\bar{\Sigma}^-(1385)^-$                            | $< 2.6$                  | $\times 10^{-7}$ | CL=90% | 2363 |
| $\Delta(1232)^+\bar{p} + \Delta(1232)^-p$            | $< 1.6$                  | $\times 10^{-6}$ |        | —    |
| $\Delta^0\bar{\Lambda}$                              | $< 9.3$                  | $\times 10^{-7}$ | CL=90% | 2364 |
| $p\bar{\Lambda}K^-$                                  | $< 8.2$                  | $\times 10^{-7}$ | CL=90% | 2308 |
| $p\bar{\Lambda}D^-$                                  | $(2.5 \pm 0.4)$          | $\times 10^{-5}$ |        | 1765 |
| $p\bar{\Lambda}D^{*-}$                               | $(3.4 \pm 0.8)$          | $\times 10^{-5}$ |        | 1685 |
| $p\bar{\Sigma}^0\pi^-$                               | $(1.2 \pm 0.4)$          | $\times 10^{-6}$ |        | 2383 |
| $\bar{\Lambda}\Lambda$                               | $< 3.2$                  | $\times 10^{-7}$ | CL=90% | 2393 |
| $\bar{\Lambda}\Lambda K^0$                           | $(4.8^{+1.0}_{-0.9})$    | $\times 10^{-6}$ |        | 2250 |
| $\bar{\Lambda}\Lambda K^{*0}$                        | $(2.5^{+0.9}_{-0.8})$    | $\times 10^{-6}$ |        | 2098 |
| $\bar{\Lambda}\Lambda D^0$                           | $(1.00^{+0.30}_{-0.26})$ | $\times 10^{-5}$ |        | 1662 |
| $D^0\Sigma^0\bar{\Lambda} + \text{c.c.}$             | $< 3.1$                  | $\times 10^{-5}$ | CL=90% | 1611 |
| $\Delta^0\bar{\Delta}^0$                             | $< 1.5$                  | $\times 10^{-3}$ | CL=90% | 2335 |
| $\Delta^{++}\bar{\Delta}^{--}$                       | $< 1.1$                  | $\times 10^{-4}$ | CL=90% | 2335 |
| $\bar{D}^0 p\bar{p}$                                 | $(1.04 \pm 0.07)$        | $\times 10^{-4}$ |        | 1863 |

|                                                                                            |                                  |        |      |
|--------------------------------------------------------------------------------------------|----------------------------------|--------|------|
| $D_s^- \bar{\Lambda} p$                                                                    | $(2.8 \pm 0.9) \times 10^{-5}$   |        | 1710 |
| $\bar{D}^{*0}(2007)^0 p \bar{p}$                                                           | $(9.9 \pm 1.1) \times 10^{-5}$   |        | 1788 |
| $D^{*0}(2010)^- p \bar{n}$                                                                 | $(1.4 \pm 0.4) \times 10^{-3}$   |        | 1785 |
| $D^- p \bar{p} \pi^+$                                                                      | $(3.32 \pm 0.31) \times 10^{-4}$ |        | 1786 |
| $D^{*0}(2010)^- p \bar{p} \pi^+$                                                           | $(4.7 \pm 0.5) \times 10^{-4}$   | S=1.2  | 1708 |
| $\bar{D}^0 p \bar{p} \pi^+ \pi^-$                                                          | $(3.0 \pm 0.5) \times 10^{-4}$   |        | 1708 |
| $\bar{D}^{*0} p \bar{p} \pi^+ \pi^-$                                                       | $(1.9 \pm 0.5) \times 10^{-4}$   |        | 1623 |
| $\Theta_c \bar{p} \pi^+, \Theta_c \rightarrow D^- p$                                       | $< 9 \times 10^{-6}$             | CL=90% | —    |
| $\Theta_c \bar{p} \pi^+, \Theta_c \rightarrow D^{*-} p$                                    | $< 1.4 \times 10^{-5}$           | CL=90% | —    |
| $\bar{\Sigma}_c^{--} \Delta^{++}$                                                          | $< 8 \times 10^{-4}$             | CL=90% | 1839 |
| $\bar{\Lambda}_c^- p \pi^+ \pi^-$                                                          | $(1.01 \pm 0.14) \times 10^{-3}$ | S=1.4  | 1934 |
| $\bar{\Lambda}_c^- p$                                                                      | $(1.52 \pm 0.17) \times 10^{-5}$ |        | 2021 |
| $\bar{\Lambda}_c^- p \pi^0$                                                                | $(1.53 \pm 0.18) \times 10^{-4}$ |        | 1982 |
| $\bar{\Sigma}_c(2455)^- p$                                                                 | $< 2.4 \times 10^{-5}$           |        | —    |
| $\bar{\Lambda}_c^- p \pi^+ \pi^- \pi^0$                                                    | $< 5.07 \times 10^{-3}$          | CL=90% | 1883 |
| $\bar{\Lambda}_c^- p \pi^+ \pi^- \pi^+ \pi^-$                                              | $< 2.74 \times 10^{-3}$          | CL=90% | 1821 |
| $\bar{\Lambda}_c^- p \pi^+ \pi^-$ (nonresonant)                                            | $(5.4 \pm 1.0) \times 10^{-4}$   | S=1.3  | 1934 |
| $\bar{\Sigma}_c(2520)^{--} p \pi^+$                                                        | $(1.01 \pm 0.18) \times 10^{-4}$ |        | 1860 |
| $\bar{\Sigma}_c(2520)^0 p \pi^-$                                                           | $< 3.1 \times 10^{-5}$           | CL=90% | 1860 |
| $\bar{\Sigma}_c(2455)^0 p \pi^-$                                                           | $(1.08 \pm 0.09) \times 10^{-4}$ |        | 1895 |
| $\bar{\Sigma}_c(2455)^0 N^0, N^0 \rightarrow p \pi^-$                                      | $(6.3 \pm 1.6) \times 10^{-5}$   |        | —    |
| $\bar{\Sigma}_c(2455)^{--} p \pi^+$                                                        | $(1.89 \pm 0.15) \times 10^{-4}$ |        | 1895 |
| $\bar{\Lambda}_c^- p K^+ \pi^-$                                                            | $(3.4 \pm 0.7) \times 10^{-5}$   |        | 1786 |
| $\bar{\Sigma}_c(2455)^{--} p K^+, \bar{\Sigma}_c^{--} \rightarrow \bar{\Lambda}_c^- \pi^-$ | $(8.7 \pm 2.5) \times 10^{-6}$   |        | 1754 |
| $\bar{\Lambda}_c^- p K^*(892)^0$                                                           | $< 2.42 \times 10^{-5}$          | CL=90% | 1647 |
| $\bar{\Lambda}_c^- p K^+ K^-$                                                              | $(2.0 \pm 0.4) \times 10^{-5}$   |        | 1588 |
| $\bar{\Lambda}_c^- p \phi$                                                                 | $< 9 \times 10^{-6}$             | CL=90% | 1567 |
| $\bar{\Lambda}_c^- p \bar{p} p$                                                            | $< 2.8 \times 10^{-6}$           |        | 677  |
| $\bar{\Lambda}_c^- \Lambda K^+$                                                            | $(4.8 \pm 1.1) \times 10^{-5}$   |        | 1767 |
| $\bar{\Lambda}_c^- \Lambda_c^+$                                                            | $< 1.6 \times 10^{-5}$           | CL=95% | 1319 |
| $\bar{\Lambda}_c(2593)^- / \bar{\Lambda}_c(2625)^- p$                                      | $< 1.1 \times 10^{-4}$           | CL=90% | —    |
| $\bar{\Xi}_c^- \Lambda_c^+$                                                                | $(1.1 \pm 0.8) \times 10^{-3}$   |        | 1147 |
| $\bar{\Xi}_c^- \Lambda_c^+, \bar{\Xi}_c^- \rightarrow \bar{\Xi}^+ \pi^- \pi^-$             | $(2.3 \pm 1.0) \times 10^{-5}$   | S=1.8  | 1147 |
| $\bar{\Xi}_c^- \Lambda_c^+, \bar{\Xi}_c^- \rightarrow \bar{p} K^+ \pi^-$                   | $(5.2 \pm 1.6) \times 10^{-6}$   |        | —    |
| $\Lambda_c^+ \Lambda_c^- K^0$                                                              | $(4.0 \pm 0.9) \times 10^{-4}$   |        | 732  |
| $\bar{\Lambda}_c(2910)^- p, \bar{\Lambda}_c^- \rightarrow \bar{\Sigma}_c(2455)^{--} \pi^+$ | $(1.2 \pm 0.4) \times 10^{-5}$   |        | —    |
| $\bar{\Lambda}_c(2910)^- p, \bar{\Lambda}_c^- \rightarrow \bar{\Sigma}_c(2455)^0 \pi^-$    | $(10 \pm 4) \times 10^{-6}$      |        | —    |

|                                                                         |                                         |   |
|-------------------------------------------------------------------------|-----------------------------------------|---|
| $\Xi_c(2930)^- \Lambda_c^+, \Xi_c^- \rightarrow \Lambda_c^- K^0$        | $(2.4 \pm 0.6) \times 10^{-4}$          | — |
| $\Omega_c^0 \bar{\Lambda}, \Omega_c^0 \rightarrow \Omega^- \pi^+$       | $< 9.7 \times 10^{-8}$ CL=95%           | — |
| $\Omega_c(2770)^0 \bar{\Lambda}, \Omega_c^0 \rightarrow \Omega^- \pi^+$ | $< 3.12 \times 10^{-7}$ CL=95%          | — |
| $\Omega_c^0 \Lambda, \Omega_c^0 \rightarrow \Omega^- \pi^+$             | $< 9.5 \times 10^{-8}$ CL=95%           | — |
| $\Omega_c(2770)^0 \Lambda, \Omega_c^0 \rightarrow \Omega^- \pi^+$       | $< 1.00 \times 10^{-7}$ CL=95%          | — |
| $\Lambda\psi_{DS}$                                                      | $[p] < 0.13\text{--}5.2 \times 10^{-5}$ | — |

**Lepton Family number (LF) or Lepton number (L) or Baryon number (B)  
violating modes, or/and  $\Delta B = 1$  weak neutral current (B1) modes**

|                                                               |    |                                              |        |      |
|---------------------------------------------------------------|----|----------------------------------------------|--------|------|
| $\gamma\gamma$                                                | B1 | $< 6.4 \times 10^{-8}$                       | CL=90% | 2640 |
| $e^+e^-$                                                      | B1 | $< 2.5 \times 10^{-9}$                       | CL=90% | 2640 |
| $e^+e^-\gamma$                                                | B1 | $< 1.2 \times 10^{-7}$                       | CL=90% | 2640 |
| $\mu^+\mu^-$                                                  | B1 | $< 1.5 \times 10^{-10}$                      | CL=90% | 2638 |
| $\mu^+\mu^-\mu^+\mu^-$                                        | B1 | $< 1.8 \times 10^{-10}$                      | CL=95% | 2629 |
| $SP, S \rightarrow \mu^+\mu^-,$<br>$P \rightarrow \mu^+\mu^-$ | B1 | $[q] < 6.0 \times 10^{-10}$                  | CL=95% | —    |
| $aa, a \rightarrow \mu^+\mu^-$                                | B1 | $< 2.3 \times 10^{-10}$                      | CL=95% | —    |
| $\tau^+\tau^-$                                                | B1 | $< 2.1 \times 10^{-3}$                       | CL=95% | 1952 |
| $\pi^0 \ell^+ \ell^-$                                         | B1 | $[a] < 3.8 \times 10^{-8}$                   | CL=90% | 2638 |
| $\pi^0 e^+ e^-$                                               | B1 | $< 7.9 \times 10^{-8}$                       | CL=90% | 2638 |
| $\pi^0 \mu^+ \mu^-$                                           | B1 | $< 5.9 \times 10^{-8}$                       | CL=90% | 2634 |
| $\eta \ell^+ \ell^-$                                          | B1 | $[a] < 4.8 \times 10^{-8}$                   | CL=90% | 2611 |
| $\eta e^+ e^-$                                                | B1 | $< 1.05 \times 10^{-7}$                      | CL=90% | 2611 |
| $\eta \mu^+ \mu^-$                                            | B1 | $< 9.4 \times 10^{-8}$                       | CL=90% | 2607 |
| $\rho(770)^0 e^+ e^-$                                         | B1 | $< 4.55 \times 10^{-7}$                      | CL=90% | —    |
| $\omega e^+ e^-$                                              | B1 | $< 3.07 \times 10^{-7}$                      | CL=90% | 2582 |
| $\omega \mu^+ \mu^-$                                          | B1 | $< 2.49 \times 10^{-7}$                      | CL=90% | 2577 |
| $\omega \ell^+ \ell^-$                                        | B1 | $< 2.20 \times 10^{-7}$                      | CL=90% | 2582 |
| $\pi^0 \nu \bar{\nu}$                                         | B1 | $< 9 \times 10^{-6}$                         | CL=90% | 2638 |
| $K^0 \ell^+ \ell^-$                                           | B1 | $[a] (3.3 \pm 0.6) \times 10^{-7}$           |        | 2616 |
| $K^0 e^+ e^-$                                                 | B1 | $(2.5 \pm_{-0.9}^{+1.1}) \times 10^{-7}$     | S=1.3  | 2616 |
| $K^0 \mu^+ \mu^-$                                             | B1 | $(3.39 \pm 0.35) \times 10^{-7}$             | S=1.1  | 2612 |
| $K^0 \nu \bar{\nu}$                                           | B1 | $< 2.6 \times 10^{-5}$                       | CL=90% | 2616 |
| $\rho^0 \nu \bar{\nu}$                                        | B1 | $< 4.0 \times 10^{-5}$                       | CL=90% | 2583 |
| $K^*(892)^0 \ell^+ \ell^-$                                    | B1 | $[a] (9.9 \pm_{-1.1}^{+1.2}) \times 10^{-7}$ |        | 2565 |
| $K^*(892)^0 e^+ e^-$                                          | B1 | $(1.03 \pm_{-0.17}^{+0.19}) \times 10^{-6}$  |        | 2565 |
| $K^*(892)^0 \mu^+ \mu^-$                                      | B1 | $(9.4 \pm 0.5) \times 10^{-7}$               |        | 2560 |
| $K^*(892)^0 \tau^+ \tau^-$                                    | B1 | $< 3.1 \times 10^{-3}$                       | CL=90% | 1404 |
| $\bar{D}^0 \mu^+ \mu^-$                                       | B1 | $< 4.0 \times 10^{-8}$                       | CL=90% | 2305 |
| $\pi^+ \pi^- \mu^+ \mu^-$                                     | B1 | $(2.1 \pm 0.5) \times 10^{-8}$               |        | 2626 |
| $K^*(892)^0 \nu \bar{\nu}$                                    | B1 | $< 1.8 \times 10^{-5}$                       | CL=90% | 2565 |
| invisible                                                     | B1 | $< 2.4 \times 10^{-5}$                       | CL=90% | —    |



|                           |       |             |                  |        |      |
|---------------------------|-------|-------------|------------------|--------|------|
| $\nu\bar{\nu}\gamma$      | $B1$  | $< 1.6$     | $\times 10^{-5}$ | CL=90% | 2640 |
| $\phi\mu^+\mu^-$          | $B1$  | $< 3.2$     | $\times 10^{-9}$ | CL=90% | 2537 |
| $\phi\nu\bar{\nu}$        | $B1$  | $< 1.27$    | $\times 10^{-4}$ | CL=90% | 2541 |
| $e^\pm\mu^\mp$            | $LF$  | $[n] < 1.0$ | $\times 10^{-9}$ | CL=90% | 2639 |
| $\pi^0 e^\pm\mu^\mp$      | $LF$  | $< 1.4$     | $\times 10^{-7}$ | CL=90% | 2637 |
| $K^0 e^\pm\mu^\mp$        | $LF$  | $< 3.8$     | $\times 10^{-8}$ | CL=90% | 2615 |
| $K^*(892)^0 e^+\mu^-$     | $LF$  | $< 6.8$     | $\times 10^{-9}$ | CL=90% | 2563 |
| $K^*(892)^0 e^-\mu^+$     | $LF$  | $< 5.7$     | $\times 10^{-9}$ | CL=90% | 2563 |
| $K^*(892)^0 e^\pm\mu^\mp$ | $LF$  | $< 1.01$    | $\times 10^{-8}$ | CL=90% | 2563 |
| $K^*(892)^0 \tau^+\mu^-$  | $LF$  | $< 1.0$     | $\times 10^{-5}$ | CL=90% | 2221 |
| $K^*(892)^0 \tau^-\mu^+$  | $LF$  | $< 8.2$     | $\times 10^{-6}$ | CL=90% | 2221 |
| $e^\pm\tau^\mp$           | $LF$  | $[n] < 1.6$ | $\times 10^{-5}$ | CL=90% | 2341 |
| $\mu^\pm\tau^\mp$         | $LF$  | $[n] < 1.4$ | $\times 10^{-5}$ | CL=95% | 2340 |
| $\rho\mu^-$               | $L,B$ | $< 2.6$     | $\times 10^{-9}$ | CL=90% | 2555 |
| $\Lambda_c^+\mu^-$        | $L,B$ | $< 1.4$     | $\times 10^{-6}$ | CL=90% | 2143 |
| $\Lambda_c^+e^-$          | $L,B$ | $< 4$       | $\times 10^{-6}$ | CL=90% | 2145 |

## **$B^\pm/B^0$ ADMIXTURE**

### **$CP$ violation**

$$A_{CP}(B \rightarrow K^*(892)\gamma) = -0.003 \pm 0.011$$

$$A_{CP}(B \rightarrow s\gamma) = 0.015 \pm 0.011$$

$$A_{CP}(B \rightarrow (s+d)\gamma) = 0.010 \pm 0.031$$

$$A_{CP}(B \rightarrow X_s \ell^+ \ell^-) = 0.04 \pm 0.11$$

$$A_{CP}(B \rightarrow X_s \ell^+ \ell^-) (1.0 < q^2 < 6.0 \text{ GeV}^2/c^4) = -0.06 \pm 0.22$$

$$A_{CP}(B \rightarrow X_s \ell^+ \ell^-) (10.1 < q^2 < 12.9 \text{ or } q^2 > 14.2 \text{ GeV}^2/c^4) = 0.19 \pm 0.18$$

$$A_{CP}(B \rightarrow K^* e^+ e^-) = -0.18 \pm 0.15$$

$$A_{CP}(B \rightarrow K^* \mu^+ \mu^-) = -0.03 \pm 0.13$$

$$A_{CP}(B \rightarrow K^* \ell^+ \ell^-) = -0.04 \pm 0.07$$

$$A_{CP}(B \rightarrow \eta \text{ anything}) = -0.13^{+0.04}_{-0.05}$$

$$\Delta A_{CP}(X_s \gamma) = A_{CP}(B^\pm \rightarrow X_s \gamma) - A_{CP}(B^0 \rightarrow X_s \gamma) = 0.041 \pm 0.023$$

$$\bar{A}_{CP}(B \rightarrow X_s \gamma) = (A_{CP}(B^+ \rightarrow X_s \gamma) + A_{CP}(B^0 \rightarrow X_s \gamma))/2 = 0.009 \pm 0.012$$

$$\Delta A_{CP}(B \rightarrow K^* \gamma) = A_{CP}(B^+ \rightarrow K^{*+} \gamma) - A_{CP}(B^0 \rightarrow K^{*0} \gamma) = 0.024 \pm 0.028$$

$$\bar{A}_{CP}(B \rightarrow K^* \gamma) = (A_{CP}(B^+ \rightarrow K^{*+} \gamma) + A_{CP}(B^0 \rightarrow K^{*0} \gamma))/2 = -0.001 \pm 0.014$$

The branching fraction measurements are for an admixture of  $B$  mesons at the  $\Upsilon(4S)$ . The values quoted assume that  $B(\Upsilon(4S) \rightarrow B\bar{B}) = 100\%$ .

For inclusive branching fractions, e.g.,  $B \rightarrow D^\pm \text{ anything}$ , the treatment of multiple  $D$ 's in the final state must be defined. One possibility would be to count the number of events with one-or-more  $D$ 's and divide by the total number of  $B$ 's. Another possibility would be to count the total number of  $D$ 's and divide by the total number of  $B$ 's, which is the definition of average multiplicity. The two definitions are identical if only one  $D$  is allowed in the final state. Even though the "one-or-more" definition seems sensible, for practical reasons inclusive branching fractions are almost always measured using the multiplicity definition. For heavy final state particles, authors call their results inclusive branching fractions while for light particles some authors call their results multiplicities. In the  $B$  sections, we list all results as inclusive branching fractions, adopting a multiplicity definition. This means that inclusive branching fractions can exceed 100% and that inclusive partial widths can exceed total widths, just as inclusive cross sections can exceed total cross section.

$\bar{B}$  modes are charge conjugates of the modes below. Reactions indicate the weak decay vertex and do not include mixing.

| <b>B DECAY MODES</b>                                                                                 | Fraction ( $\Gamma_i/\Gamma$ )           | Scale factor/<br>Confidence level (MeV/c) | $p$  |
|------------------------------------------------------------------------------------------------------|------------------------------------------|-------------------------------------------|------|
| <b>Semileptonic and leptonic modes</b>                                                               |                                          |                                           |      |
| $\ell^+ \nu_\ell \text{ anything}$                                                                   | $[a,r] \quad (10.82 \pm 0.15) \%$        |                                           | —    |
| $D^- \ell^+ \nu_\ell \text{ anything}$                                                               | $[a] \quad (2.6 \pm 0.5) \%$             |                                           | —    |
| $\bar{D}^0 \ell^+ \nu_\ell \text{ anything}$                                                         | $[a] \quad (7.2 \pm 1.5) \%$             |                                           | —    |
| $\bar{D} \ell^+ \nu_\ell$                                                                            | $(2.41 \pm 0.12) \%$                     |                                           | 2311 |
| $D^{*-} \ell^+ \nu_\ell \text{ anything}$                                                            | $[s] \quad (6.7 \pm 1.3) \times 10^{-3}$ |                                           | —    |
| $\bar{D}^* \ell^+ \nu_\ell$                                                                          | $[t] \quad (4.95 \pm 0.11) \%$           |                                           | 2257 |
| $\bar{D}^{**} \ell^+ \nu_\ell$                                                                       | $[a,u] \quad (2.7 \pm 0.7) \%$           |                                           | —    |
| $\bar{D}_1(2420) \ell^+ \nu_\ell \text{ anything}$                                                   | $(3.8 \pm 1.3) \times 10^{-3}$           | S=2.4                                     | —    |
| $\bar{D} \pi \ell^+ \nu_\ell \text{ anything} +$<br>$\bar{D}^* \pi \ell^+ \nu_\ell \text{ anything}$ | $(2.6 \pm 0.5) \%$                       | S=1.5                                     | —    |
| $\bar{D} \pi \ell^+ \nu_\ell \text{ anything}$                                                       | $(1.5 \pm 0.6) \%$                       |                                           | —    |
| $\bar{D}^* \pi \ell^+ \nu_\ell \text{ anything}$                                                     | $(1.9 \pm 0.4) \%$                       |                                           | —    |
| $\bar{D}_2^*(2460) \ell^+ \nu_\ell \text{ anything}$                                                 | $(4.4 \pm 1.6) \times 10^{-3}$           |                                           | —    |
| $D^{*-} \pi^+ \ell^+ \nu_\ell \text{ anything}$                                                      | $(1.00 \pm 0.34) \%$                     |                                           | —    |
| $\bar{D} \pi^+ \pi^- \ell^+ \nu_\ell$                                                                | $(1.62 \pm 0.32) \times 10^{-3}$         |                                           | 2301 |
| $\bar{D}^* \pi^+ \pi^- \ell^+ \nu_\ell$                                                              | $(9.4 \pm 3.2) \times 10^{-4}$           |                                           | 2247 |
| $D_s^- \ell^+ \nu_\ell \text{ anything}$                                                             | $[a] < 7 \times 10^{-3}$                 | CL=90%                                    | —    |
| $D_s^- \ell^+ \nu_\ell K^+ \text{ anything}$                                                         | $[a] < 5 \times 10^{-3}$                 | CL=90%                                    | —    |
| $D_s^- \ell^+ \nu_\ell K^0 \text{ anything}$                                                         | $[a] < 7 \times 10^{-3}$                 | CL=90%                                    | —    |
| $X_c \ell^+ \nu_\ell$                                                                                | $(10.63 \pm 0.15) \%$                    |                                           | —    |
| $X_u \ell^+ \nu_\ell$                                                                                | $(1.92 \pm 0.21) \times 10^{-3}$         |                                           | —    |
| $X_u e^+ \nu_e$                                                                                      | $(1.57 \pm 0.19) \times 10^{-3}$         |                                           | —    |

|                                            |                                      |      |
|--------------------------------------------|--------------------------------------|------|
| $X_u \mu^+ \nu_\mu$                        | ( 1.62 $\pm$ 0.21 ) $\times 10^{-3}$ | —    |
| $K^+ \ell^+ \nu_\ell$ anything             | [a] ( 6.3 $\pm$ 0.5 ) %              | —    |
| $K^- \ell^+ \nu_\ell$ anything             | [a] ( 10 $\pm$ 4 ) $\times 10^{-3}$  | —    |
| $K^0 / \bar{K}^0 \ell^+ \nu_\ell$ anything | [a] ( 4.6 $\pm$ 0.5 ) %              | —    |
| $\bar{D} \tau^+ \nu_\tau$                  | ( 8.3 $\pm$ 0.8 ) $\times 10^{-3}$   | 1911 |
| $\bar{D}^* \tau^+ \nu_\tau$                | ( 1.42 $\pm$ 0.07 ) %                | 1838 |

 **$D$ ,  $D^*$ , or  $D_s$  modes**

|                                                                                                                                                                                                   |                                    |         |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|---------|
| $D^\pm$ anything                                                                                                                                                                                  | ( 23.1 $\pm$ 1.2 ) %               | —       |
| $D^0 / \bar{D}^0$ anything                                                                                                                                                                        | ( 64.6 $\pm$ 2.1 ) %               | S=1.5 — |
| $D^*(2010)^\pm$ anything                                                                                                                                                                          | ( 22.5 $\pm$ 1.5 ) %               | —       |
| $\bar{D}^*(2007)^0$ anything                                                                                                                                                                      | ( 26.0 $\pm$ 2.7 ) %               | —       |
| $D_s^\pm$ anything                                                                                                                                                                                | [n] ( 10.6 $\pm$ 0.6 ) %           | S=1.7 — |
| $D_s^{*\pm}$ anything                                                                                                                                                                             | ( 6.3 $\pm$ 1.0 ) %                | —       |
| $D_s^{*\pm} \bar{D}^*(*)$                                                                                                                                                                         | ( 3.4 $\pm$ 0.6 ) %                | —       |
| $\bar{D} D_{s0}(2317)$                                                                                                                                                                            | seen                               | 1605    |
| $\bar{D} D_{sJ}(2457)$                                                                                                                                                                            | seen                               | —       |
| $D^*(*) \bar{D}^*(*) K^0 +$<br>$D^*(*) \bar{D}^*(*) K^\pm$                                                                                                                                        | [n,v] ( 7.1 $\pm$ 2.7<br>— 1.7 ) % | —       |
| $b \rightarrow c \bar{c} s$                                                                                                                                                                       | ( 22 $\pm$ 4 ) %                   | —       |
| $D_s^*(*) \bar{D}^*(*)$                                                                                                                                                                           | [n,v] ( 5.0 $\pm$ 0.4 ) %          | —       |
| $D^* D^*(2010)^\pm$                                                                                                                                                                               | [n] < 5.9 $\times 10^{-3}$ CL=90%  | 1711    |
| $D D^*(2010)^\pm + D^* D^\pm$                                                                                                                                                                     | [n] < 5.5 $\times 10^{-3}$ CL=90%  | —       |
| $D D^\pm$                                                                                                                                                                                         | [n] < 3.1 $\times 10^{-3}$ CL=90%  | 1866    |
| $D_s^*(*)^\pm \bar{D}^*(*) X (n\pi^\pm)$                                                                                                                                                          | [n,v] ( 9 $\pm$ 5<br>— 4 ) %       | —       |
| $\bar{D}^*(2010)\gamma$                                                                                                                                                                           | < 1.1 $\times 10^{-3}$ CL=90%      | 2257    |
| $D_s^+ \pi^-, D_s^{*+} \pi^-, D_s^+ \rho^-,$<br>$D_s^{*+} \rho^-, D_s^+ \pi^0, D_s^{*+} \pi^0,$<br>$D_s^+ \eta, D_s^{*+} \eta, D_s^+ \rho^0,$<br>$D_s^{*+} \rho^0, D_s^+ \omega, D_s^{*+} \omega$ | [n] < 4 $\times 10^{-4}$ CL=90%    | —       |
| $D_{s1}(2536)^+$ anything                                                                                                                                                                         | < 9.5 $\times 10^{-3}$ CL=90%      | —       |

**Charmonium modes**

|                                   |                                      |         |
|-----------------------------------|--------------------------------------|---------|
| $J/\psi(1S)$ anything             | ( 1.094 $\pm$ 0.032 ) %              | S=1.1 — |
| $J/\psi(1S)$ (direct) anything    | ( 7.8 $\pm$ 0.4 ) $\times 10^{-3}$   | S=1.1 — |
| $\psi(2S)$ anything               | ( 3.07 $\pm$ 0.21 ) $\times 10^{-3}$ | —       |
| $\chi_{c1}(1P)$ anything          | ( 3.55 $\pm$ 0.27 ) $\times 10^{-3}$ | S=1.3 — |
| $\chi_{c1}(1P)$ (direct) anything | ( 3.08 $\pm$ 0.19 ) $\times 10^{-3}$ | —       |
| $\chi_{c2}(1P)$ anything          | ( 9.9 $\pm$ 1.7 ) $\times 10^{-4}$   | S=1.6 — |
| $\chi_{c2}(1P)$ (direct) anything | ( 7.5 $\pm$ 1.1 ) $\times 10^{-4}$   | —       |
| $\eta_c(1S)$ anything             | < 9 $\times 10^{-3}$ CL=90%          | —       |

|                                                             |                                    |      |
|-------------------------------------------------------------|------------------------------------|------|
| $K\chi_{c1}(3872)$                                          | ( 1.9 $\pm$ 0.7 ) $\times 10^{-4}$ | 1141 |
| $KX(3940), X \rightarrow D^{*0}D^0$                         | < 6.7 $\times 10^{-5}$ CL=90%      | 1084 |
| $K\chi_{c0}(3915), \chi_{c0} \rightarrow \omega J/\psi$ [x] | ( 7.1 $\pm$ 3.4 ) $\times 10^{-5}$ | 1103 |

**K or K\* modes**

|                                        |                                              |      |
|----------------------------------------|----------------------------------------------|------|
| $K^\pm$ anything                       | [n] ( 78.9 $\pm$ 2.5 ) %                     | —    |
| $K^+$ anything                         | ( 66 $\pm$ 5 ) %                             | —    |
| $K^-$ anything                         | ( 13 $\pm$ 4 ) %                             | —    |
| $K^0/\bar{K}^0$ anything               | [n] ( 64 $\pm$ 4 ) %                         | —    |
| $K^*(892)^\pm$ anything                | ( 18 $\pm$ 6 ) %                             | —    |
| $K^*(892)^0/\bar{K}^*(892)^0$ anything | [n] ( 14.6 $\pm$ 2.6 ) %                     | —    |
| $K^*(892)\gamma$                       | ( 4.2 $\pm$ 0.6 ) $\times 10^{-5}$           | 2565 |
| $\eta K\gamma$                         | ( 8.5 $\pm$ 1.8 $\pm$ 1.6 ) $\times 10^{-6}$ | 2588 |
| $K_1(1400)\gamma$                      | < 1.27 $\times 10^{-4}$ CL=90%               | 2454 |
| $K_2^*(1430)\gamma$                    | ( 1.7 $\pm$ 0.6 $\pm$ 0.5 ) $\times 10^{-5}$ | 2447 |
| $K_2(1770)\gamma$                      | < 1.2 $\times 10^{-3}$ CL=90%                | 2342 |
| $K_3^*(1780)\gamma$                    | < 3.7 $\times 10^{-5}$ CL=90%                | 2340 |
| $K_4^*(2045)\gamma$                    | < 1.0 $\times 10^{-3}$ CL=90%                | 2243 |
| $K\eta'(958)$                          | ( 8.3 $\pm$ 1.1 ) $\times 10^{-5}$           | 2528 |
| $K^*(892)\eta'(958)$                   | ( 4.1 $\pm$ 1.1 ) $\times 10^{-6}$           | 2472 |
| $K\eta$                                | < 5.2 $\times 10^{-6}$ CL=90%                | 2588 |
| $K^*(892)\eta$                         | ( 1.8 $\pm$ 0.5 ) $\times 10^{-5}$           | 2534 |
| $K\phi\phi$                            | ( 2.3 $\pm$ 0.9 ) $\times 10^{-6}$           | 2306 |
| $\bar{b} \rightarrow \bar{s}\gamma$    | ( 3.49 $\pm$ 0.19 ) $\times 10^{-4}$         | —    |
| $\bar{b} \rightarrow \bar{d}\gamma$    | ( 9.2 $\pm$ 3.0 ) $\times 10^{-6}$           | —    |
| $\bar{b} \rightarrow \bar{s}$ gluon    | < 6.8 % CL=90%                               | —    |
| $\eta$ anything                        | ( 2.6 $\pm$ 0.5 $\pm$ 0.8 ) $\times 10^{-4}$ | —    |
| $\eta'$ anything                       | ( 4.2 $\pm$ 0.9 ) $\times 10^{-4}$           | —    |
| $K^+$ gluon (charmless)                | < 1.87 $\times 10^{-4}$ CL=90%               | —    |
| $K^0$ gluon (charmless)                | ( 1.9 $\pm$ 0.7 ) $\times 10^{-4}$           | —    |

**Light unflavored meson modes**

|                           |         |                                      |        |      |
|---------------------------|---------|--------------------------------------|--------|------|
| $\rho\gamma$              |         | ( 1.39 $\pm$ 0.25 ) $\times 10^{-6}$ | S=1.2  | 2583 |
| $\rho/\omega\gamma$       |         | ( 1.30 $\pm$ 0.23 ) $\times 10^{-6}$ | S=1.2  | —    |
| $\pi^\pm$ anything        | $[n,y]$ | ( 358 $\pm$ 7 ) %                    |        | —    |
| $\pi^0$ anything          |         | ( 235 $\pm$ 11 ) %                   |        | —    |
| $\eta$ anything           |         | ( 17.6 $\pm$ 1.6 ) %                 |        | —    |
| $\rho^0$ anything         |         | ( 21 $\pm$ 5 ) %                     |        | —    |
| $\omega$ anything         | <       | 81 %                                 | CL=90% | —    |
| $\phi$ anything           |         | ( 3.43 $\pm$ 0.12 ) %                |        | —    |
| $\phi K^*(892)$           | <       | 2.2 $\times 10^{-5}$                 | CL=90% | 2460 |
| $\pi^+$ gluon (charmless) |         | ( 3.7 $\pm$ 0.8 ) $\times 10^{-4}$   |        | —    |

**Baryon modes**

|                                                       |       |      |       |                   |                    |         |
|-------------------------------------------------------|-------|------|-------|-------------------|--------------------|---------|
| $\Lambda_c^+ / \bar{\Lambda}_c^-$ anything            | (     | 3.55 | $\pm$ | 0.35              | ) %                | —       |
| $\Lambda_c^+$ anything                                | <     | 1.3  |       | %                 | CL=90%             | —       |
| $\bar{\Lambda}_c^-$ anything                          | <     | 7    |       | %                 | CL=90%             | —       |
| $\bar{\Lambda}_c^- \ell^+$ anything                   | <     | 9    |       | $\times 10^{-4}$  | CL=90%             | —       |
| $\bar{\Lambda}_c^- e^+$ anything                      | <     | 1.8  |       | $\times 10^{-3}$  | CL=90%             | —       |
| $\bar{\Lambda}_c^- \mu^+$ anything                    | < —   | 1.4  |       | $\times 10^{-3}$  | CL=90%             | —       |
| $\bar{\Lambda}_c^- p$ anything                        | (     | 2.02 | $\pm$ | 0.32              | ) %                | —       |
| $\bar{\Lambda}_c^- p e^+ \nu_e$                       | <     | 8    |       | $\times 10^{-4}$  | CL=90%             | 2021    |
| $\bar{\Sigma}_c^{--}$ anything                        | (     | 3.3  | $\pm$ | 1.7               | ) $\times 10^{-3}$ | —       |
| $\bar{\Sigma}_c^-$ anything                           | <     | 8    |       | $\times 10^{-3}$  | CL=90%             | —       |
| $\bar{\Sigma}_c^0$ anything                           | (     | 3.6  | $\pm$ | 1.7               | ) $\times 10^{-3}$ | —       |
| $\bar{\Sigma}_c^0 N (N = p \text{ or } n)$            | <     | 1.2  |       | $\times 10^{-3}$  | CL=90%             | 1938    |
| $\Xi_c^0$ anything, $\Xi_c^0 \rightarrow \Xi^- \pi^+$ | (     | 1.93 | $\pm$ | 0.30              | ) $\times 10^{-4}$ | S=1.1 — |
| $\Xi_c^+, \Xi_c^+ \rightarrow \Xi^- \pi^+ \pi^+$      | (     | 4.5  | $\pm$ | $\frac{1.3}{1.2}$ | ) $\times 10^{-4}$ | —       |
| $p/\bar{p}$ anything                                  | [n] ( | 8.0  | $\pm$ | 0.4               | ) %                | —       |
| $p/\bar{p}$ (direct) anything                         | [n] ( | 5.5  | $\pm$ | 0.5               | ) %                | —       |
| $\bar{p} e^+ \nu_e$ anything                          | <     | 5.9  |       | $\times 10^{-4}$  | CL=90%             | —       |
| $\Lambda/\bar{\Lambda}$ anything                      | [n] ( | 4.0  | $\pm$ | 0.5               | ) %                | —       |
| $\Lambda$ anything                                    | seen  |      |       |                   |                    | —       |
| $\bar{\Lambda}$ anything                              | seen  |      |       |                   |                    | —       |
| $\Xi^- / \Xi^+$ anything                              | [n] ( | 2.7  | $\pm$ | 0.6               | ) $\times 10^{-3}$ | —       |
| baryons anything                                      | (     | 6.8  | $\pm$ | 0.6               | ) %                | —       |
| $p\bar{p}$ anything                                   | (     | 2.47 | $\pm$ | 0.23              | ) %                | —       |
| $\Lambda\bar{p}/\bar{\Lambda}p$ anything              | [n] ( | 2.5  | $\pm$ | 0.4               | ) %                | —       |
| $\Lambda\bar{\Lambda}$ anything                       | <     | 5    |       | $\times 10^{-3}$  | CL=90%             | —       |

**Lepton Family number (LF) violating modes or  
 $\Delta B = 1$  weak neutral current (B1) modes**

|                          |      |       |      |       |      |                    |        |      |
|--------------------------|------|-------|------|-------|------|--------------------|--------|------|
| $s e^+ e^-$              | $B1$ | (     | 6.7  | $\pm$ | 1.7  | ) $\times 10^{-6}$ | S=2.0  | —    |
| $s \mu^+ \mu^-$          | $B1$ | (     | 4.3  | $\pm$ | 1.0  | ) $\times 10^{-6}$ |        | —    |
| $s \ell^+ \ell^-$        | $B1$ | [a] ( | 5.8  | $\pm$ | 1.3  | ) $\times 10^{-6}$ | S=1.8  | —    |
| $\pi \ell^+ \ell^-$      | $B1$ | <     | 5.9  |       |      | $\times 10^{-8}$   | CL=90% | 2638 |
| $\pi e^+ e^-$            | $B1$ | <     | 1.10 |       |      | $\times 10^{-7}$   | CL=90% | 2638 |
| $\pi \mu^+ \mu^-$        | $B1$ | <     | 5.0  |       |      | $\times 10^{-8}$   | CL=90% | 2634 |
| $K e^+ e^-$              | $B1$ | (     | 4.4  | $\pm$ | 0.6  | ) $\times 10^{-7}$ |        | 2617 |
| $K^*(892) e^+ e^-$       | $B1$ | (     | 1.19 | $\pm$ | 0.20 | ) $\times 10^{-6}$ | S=1.2  | 2565 |
| $K \mu^+ \mu^-$          | $B1$ | (     | 4.4  | $\pm$ | 0.4  | ) $\times 10^{-7}$ |        | 2612 |
| $K^*(892) \mu^+ \mu^-$   | $B1$ | (     | 1.06 | $\pm$ | 0.09 | ) $\times 10^{-6}$ |        | 2560 |
| $K \ell^+ \ell^-$        | $B1$ | (     | 4.8  | $\pm$ | 0.4  | ) $\times 10^{-7}$ |        | 2617 |
| $K^*(892) \ell^+ \ell^-$ | $B1$ | (     | 1.05 | $\pm$ | 0.10 | ) $\times 10^{-6}$ |        | 2565 |
| $K \nu \bar{\nu}$        | $B1$ | <     | 1.6  |       |      | $\times 10^{-5}$   | CL=90% | 2617 |

|                          |      |         |     |                  |        |      |
|--------------------------|------|---------|-----|------------------|--------|------|
| $K^* \nu \bar{\nu}$      | $B1$ | $<$     | 2.7 | $\times 10^{-5}$ | CL=90% | —    |
| $\pi \nu \bar{\nu}$      | $B1$ | $<$     | 8   | $\times 10^{-6}$ | CL=90% | 2638 |
| $\rho \nu \bar{\nu}$     | $B1$ | $<$     | 2.8 | $\times 10^{-5}$ | CL=90% | 2583 |
| $s e^\pm \mu^\mp$        | $LF$ | $[n] <$ | 2.2 | $\times 10^{-5}$ | CL=90% | —    |
| $\pi e^\pm \mu^\mp$      | $LF$ | $<$     | 9.2 | $\times 10^{-8}$ | CL=90% | 2637 |
| $\rho e^\pm \mu^\mp$     | $LF$ | $<$     | 3.2 | $\times 10^{-6}$ | CL=90% | 2582 |
| $K e^\pm \mu^\mp$        | $LF$ | $<$     | 3.8 | $\times 10^{-8}$ | CL=90% | 2616 |
| $K^*(892) e^\pm \mu^\mp$ | $LF$ | $<$     | 5.1 | $\times 10^{-7}$ | CL=90% | 2563 |

**$B^\pm/B^0/B_s^0/b$ -baryon ADMIXTURE**

These measurements are for an admixture of bottom particles at high energy (LHC, LEP, Tevatron,  $Sp\bar{p}S$ ).

Mean life  $\tau = (1.5673 \pm 0.0029) \times 10^{-12}$  s

Mean life  $\tau = (1.72 \pm 0.10) \times 10^{-12}$  s    Charged  $b$ -hadron admixture

Mean life  $\tau = (1.58 \pm 0.14) \times 10^{-12}$  s    Neutral  $b$ -hadron admixture

$\tau_{\text{charged } b\text{-hadron}}/\tau_{\text{neutral } b\text{-hadron}} = 1.09 \pm 0.13$

$|\Delta\tau_b|/\tau_{b,\bar{b}} = -0.001 \pm 0.014$

The branching fraction measurements are for an admixture of  $B$  mesons and baryons at energies above the  $\Upsilon(4S)$ . Only the highest energy results (LHC, LEP, Tevatron,  $Sp\bar{p}S$ ) are used in the branching fraction averages. In the following, we assume that the production fractions are the same at the LHC, LEP, and at the Tevatron.

For inclusive branching fractions, e.g.,  $B \rightarrow D^\pm$  anything, the values usually are multiplicities, not branching fractions. They can be greater than one.

The modes below are listed for a  $\bar{b}$  initial state.  $b$  modes are their charge conjugates. Reactions indicate the weak decay vertex and do not include mixing.

| $\bar{b}$ DECAY MODES | Fraction ( $\Gamma_i/\Gamma$ ) | Scale factor/<br>Confidence level | $p$<br>(MeV/c) |
|-----------------------|--------------------------------|-----------------------------------|----------------|
|-----------------------|--------------------------------|-----------------------------------|----------------|

**PRODUCTION FRACTIONS**

The production fractions for weakly decaying  $b$ -hadrons at high energy have been calculated from the best values of mean lives, mixing parameters, and branching fractions in this edition by the Heavy Flavor Averaging Group (HFLAV) as described in the note “ $B^0$ - $\bar{B}^0$  Mixing” in the  $B^0$  Particle Listings. We no longer provide world averages of the  $b$ -hadron production fractions, where results from LEP, Tevatron and LHC are averaged together; indeed the available data (from CDF and LHCb) shows that the fractions depend on the kinematics (in particular the  $p_T$ ) of the

produced  $b$  hadron. Hence we would like to list the fractions in  $Z$  decays instead, which are well-defined physics observables. The production fractions in  $p\bar{p}$  collisions at the Tevatron are also listed at the end of the section. Values assume

$$\begin{aligned} B(\bar{b} \rightarrow B^+) &= B(\bar{b} \rightarrow B^0) \\ B(\bar{b} \rightarrow B^+) + B(\bar{b} \rightarrow B^0) + B(\bar{b} \rightarrow B_s^0) + B(b \rightarrow b\text{-baryon}) &= 100\%. \end{aligned}$$

The correlation coefficients between production fractions are also reported:

$$\begin{aligned} \text{cor}(B_s^0, b\text{-baryon}) &= 0.064 \\ \text{cor}(B_s^0, B^\pm=B^0) &= -0.633 \\ \text{cor}(b\text{-baryon}, B^\pm=B^0) &= -0.813. \end{aligned}$$

The notation for production fractions varies in the literature ( $f_d$ ,  $d_{B^0}$ ,  $f(b \rightarrow \bar{B}^0)$ ,  $\text{Br}(b \rightarrow \bar{B}^0)$ ). We use our own branching fraction notation here,  $B(\bar{b} \rightarrow B^0)$ .

Note these production fractions are  $b$ -hadronization fractions, not the conventional branching fractions of  $b$ -quark to a  $B$ -hadron, which may have considerable dependence on the initial and final state kinematic and production environment.

|             |                      |   |
|-------------|----------------------|---|
| $B^+$       | ( 40.8 $\pm$ 0.7 ) % | — |
| $B^0$       | ( 40.8 $\pm$ 0.7 ) % | — |
| $B_s^0$     | ( 10.0 $\pm$ 0.8 ) % | — |
| $b$ -baryon | ( 8.4 $\pm$ 1.1 ) %  | — |

## DECAY MODES

### Semileptonic and leptonic modes

|                                                                                              |                                          |         |
|----------------------------------------------------------------------------------------------|------------------------------------------|---------|
| $\nu$ anything                                                                               | ( 23.1 $\pm$ 1.5 ) %                     | —       |
| $\ell^+ \nu_\ell$ anything                                                                   | [a] ( 10.69 $\pm$ 0.22 ) %               | —       |
| $e^+ \nu_e$ anything                                                                         | ( 10.86 $\pm$ 0.35 ) %                   | —       |
| $\mu^+ \nu_\mu$ anything                                                                     | ( 10.95 $^{+0.29}_{-0.25}$ ) %           | —       |
| $D^- \ell^+ \nu_\ell$ anything                                                               | [a] ( 2.2 $\pm$ 0.4 ) %                  | S=1.9 — |
| $D^- \pi^+ \ell^+ \nu_\ell$ anything                                                         | ( 4.9 $\pm$ 1.9 ) $\times 10^{-3}$       | —       |
| $D^- \pi^- \ell^+ \nu_\ell$ anything                                                         | ( 2.6 $\pm$ 1.6 ) $\times 10^{-3}$       | —       |
| $\bar{D}^0 \ell^+ \nu_\ell$ anything                                                         | [a] ( 6.79 $\pm$ 0.34 ) %                | —       |
| $\bar{D}^0 \pi^- \ell^+ \nu_\ell$ anything                                                   | ( 1.07 $\pm$ 0.27 ) %                    | —       |
| $\bar{D}^0 \pi^+ \ell^+ \nu_\ell$ anything                                                   | ( 2.3 $\pm$ 1.6 ) $\times 10^{-3}$       | —       |
| $D^{*-} \ell^+ \nu_\ell$ anything                                                            | [a] ( 2.75 $\pm$ 0.19 ) %                | —       |
| $D^{*-} \pi^- \ell^+ \nu_\ell$ anything                                                      | ( 6 $\pm$ 7 ) $\times 10^{-4}$           | —       |
| $D^{*-} \pi^+ \ell^+ \nu_\ell$ anything                                                      | ( 4.8 $\pm$ 1.0 ) $\times 10^{-3}$       | —       |
| $\bar{D}_j^0 \ell^+ \nu_\ell$ anything $\times$<br>$B(\bar{D}_j^0 \rightarrow D^{*+} \pi^-)$ | [a,z] ( 2.6 $\pm$ 0.9 ) $\times 10^{-3}$ | —       |

|                                                                                                                         |                                             |   |
|-------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|---|
| $D_j^- \ell^+ \nu_\ell \text{ anything} \times$<br>$B(D_j^- \rightarrow D^0 \pi^-)$                                     | $[a, z] \quad (7.0 \pm 2.3) \times 10^{-3}$ | — |
| $\bar{D}_2^*(2460)^0 \ell^+ \nu_\ell \text{ anything}$<br>$\times B(\bar{D}_2^*(2460)^0 \rightarrow$<br>$D^{*-} \pi^+)$ | $< 1.4 \times 10^{-3} \text{ CL}=90\%$      | — |
| $D_2^*(2460)^- \ell^+ \nu_\ell \text{ anything}$<br>$\times B(D_2^*(2460)^- \rightarrow$<br>$D^0 \pi^-)$                | $(4.2 \pm_{-1.8}^{+1.5}) \times 10^{-3}$    | — |
| $\bar{D}_2^*(2460)^0 \ell^+ \nu_\ell \text{ anything}$<br>$\times B(\bar{D}_2^*(2460)^0 \rightarrow$<br>$D^- \pi^+)$    | $(1.6 \pm 0.8) \times 10^{-3}$              | — |
| charmless $\ell \bar{\nu}_\ell$                                                                                         | $[a] \quad (1.7 \pm 0.5) \times 10^{-3}$    | — |
| $\tau^+ \nu_\tau \text{ anything}$                                                                                      | $(2.41 \pm 0.23) \%$                        | — |
| $D^{*-} \tau \nu_\tau \text{ anything}$                                                                                 | $(9 \pm 4) \times 10^{-3}$                  | — |
| $\bar{c} \rightarrow \ell^- \bar{\nu}_\ell \text{ anything}$                                                            | $[a] \quad (8.02 \pm 0.19) \%$              | — |
| $c \rightarrow \ell^+ \nu \text{ anything}$                                                                             | $(1.6 \pm_{-0.5}^{+0.4}) \%$                | — |

### Charmed meson and baryon modes

|                                                |                                          |   |
|------------------------------------------------|------------------------------------------|---|
| $\bar{D}^0 \text{ anything}$                   | $(58.7 \pm 2.8) \%$                      | — |
| $D^0 D_s^\pm \text{ anything}$                 | $[n] \quad (9.1 \pm_{-2.8}^{+4.0}) \%$   | — |
| $D^\mp D_s^\pm \text{ anything}$               | $[n] \quad (4.0 \pm_{-1.8}^{+2.3}) \%$   | — |
| $\bar{D}^0 D^0 \text{ anything}$               | $[n] \quad (5.1 \pm_{-1.8}^{+2.0}) \%$   | — |
| $D^0 D^\pm \text{ anything}$                   | $[n] \quad (2.7 \pm_{-1.6}^{+1.8}) \%$   | — |
| $D^\pm D^\mp \text{ anything}$                 | $[n] < 9 \times 10^{-3} \text{ CL}=90\%$ | — |
| $D^- \text{ anything}$                         | $(22.7 \pm 1.6) \%$                      | — |
| $D^*(2010)^+ \text{ anything}$                 | $(17.3 \pm 2.0) \%$                      | — |
| $D_1(2420)^0 \text{ anything}$                 | $(5.0 \pm 1.5) \%$                       | — |
| $D^*(2010)^\mp D_s^\pm \text{ anything}$       | $[n] \quad (3.3 \pm_{-1.3}^{+1.6}) \%$   | — |
| $D^0 D^*(2010)^\pm \text{ anything}$           | $[n] \quad (3.0 \pm_{-0.9}^{+1.1}) \%$   | — |
| $D^*(2010)^\pm D^\mp \text{ anything}$         | $[n] \quad (2.5 \pm_{-1.0}^{+1.2}) \%$   | — |
| $D^*(2010)^\pm D^*(2010)^\mp \text{ anything}$ | $[n] \quad (1.2 \pm 0.4) \%$             | — |
| $\bar{D} D \text{ anything}$                   | $(10 \pm_{-10}^{+11}) \%$                | — |
| $D_2^*(2460)^0 \text{ anything}$               | $(4.7 \pm 2.7) \%$                       | — |
| $D_s^- \text{ anything}$                       | $(14.7 \pm 2.1) \%$                      | — |
| $D_s^+ \text{ anything}$                       | $(10.1 \pm 3.1) \%$                      | — |
| $\Lambda_c^+ \text{ anything}$                 | $(7.6 \pm 1.1) \%$                       | — |
| $\bar{c}/c \text{ anything}$                   | $[y] \quad (116.2 \pm 3.2) \%$           | — |



**Charmonium modes**

|                                                              |                                        |   |
|--------------------------------------------------------------|----------------------------------------|---|
| $J/\psi(1S)$ anything                                        | ( 1.16 ± 0.10 ) %                      | — |
| $\psi(2S)$ anything                                          | ( 3.06 ± 0.30 ) × 10 <sup>-3</sup>     | — |
| $\chi_{c0}(1P)$ anything                                     | ( 3.0 ± 0.6 ) × 10 <sup>-3</sup>       | — |
| $\chi_{c1}(1P)$ anything                                     | ( 5.9 ± 1.5 ) × 10 <sup>-3</sup> S=1.2 | — |
| $\chi_{c2}(1P)$ anything                                     | ( 1.6 ± 1.2 ) × 10 <sup>-3</sup>       | — |
| $\chi_c(2P)$ anything, $\chi_c \rightarrow \phi\phi$         | < 2.8 × 10 <sup>-7</sup> CL=95%        | — |
| $\eta_c(1S)$ anything                                        | ( 5.7 ± 0.7 ) × 10 <sup>-3</sup>       | — |
| $\eta_c(2S)$ anything, $\eta_c \rightarrow \phi\phi$         | ( 4.1 ± 1.6 ) × 10 <sup>-7</sup>       | — |
| $\chi_{c1}(3872)$ anything, $\chi_{c1} \rightarrow \phi\phi$ | < 4.5 × 10 <sup>-7</sup> CL=95%        | — |
| $\chi_{c0}(3915)$ anything, $\chi_{c0} \rightarrow \phi\phi$ | < 3.1 × 10 <sup>-7</sup> CL=95%        | — |

**K or K\* modes**

|                          |                                  |   |
|--------------------------|----------------------------------|---|
| $\bar{S}\gamma$          | ( 3.1 ± 1.1 ) × 10 <sup>-4</sup> | — |
| $\bar{S}\bar{\nu}\nu$ B1 | < 6.4 × 10 <sup>-4</sup> CL=90%  | — |
| $K^\pm$ anything         | ( 74 ± 6 ) %                     | — |
| $K_S^0$ anything         | ( 29.0 ± 2.9 ) %                 | — |

**Pion modes**

|                    |                            |   |
|--------------------|----------------------------|---|
| $\pi^\pm$ anything | (397 ± 21 ) %              | — |
| $\pi^0$ anything   | [ $\gamma$ ] (280 ± 60 ) % | — |
| $\phi$ anything    | ( 2.82 ± 0.23 ) %          | — |

**Baryon modes**

|                                  |                  |   |
|----------------------------------|------------------|---|
| $p/\bar{p}$ anything             | ( 13.1 ± 1.1 ) % | — |
| $\Lambda/\bar{\Lambda}$ anything | ( 5.9 ± 0.6 ) %  | — |
| $b$ -baryon anything             | ( 10.2 ± 2.8 ) % | — |

**Other modes**

|                                         |                                                    |   |
|-----------------------------------------|----------------------------------------------------|---|
| charged anything                        | [ $\gamma$ ] (497 ± 7 ) %                          | — |
| hadron <sup>+</sup> hadron <sup>-</sup> | ( 1.7 $\pm$ $\frac{1.0}{0.7}$ ) × 10 <sup>-5</sup> | — |
| charmless                               | ( 7 ± 21 ) × 10 <sup>-3</sup>                      | — |

 **$\Delta B = 1$  weak neutral current (B1) modes**

|                          |                                 |   |
|--------------------------|---------------------------------|---|
| $\mu^+\mu^-$ anything B1 | < 3.2 × 10 <sup>-4</sup> CL=90% | — |
|--------------------------|---------------------------------|---|

 **$B^*$** 

$$I(J^P) = \frac{1}{2}(1^-)$$

$I, J, P$  need confirmation.

Quantum numbers shown are quark-model predictions.

$$\text{Mass } m_{B^*} = 5324.75 \pm 0.20 \text{ MeV}$$

$$m_{B^*} - m_B = 45.18 \pm 0.20 \text{ MeV}$$

$$m_{B^{*+}} - m_{B^+} = 45.34 \pm 0.20 \text{ MeV}$$

| <b><math>B^*</math> DECAY MODES</b> | Fraction ( $\Gamma_i/\Gamma$ ) | $p$ (MeV/c) |
|-------------------------------------|--------------------------------|-------------|
| $B\gamma$                           | seen                           | 45          |

$B_1(5721)$

$I(J^P) = \frac{1}{2}(1^+)$   
 $I, J, P$  need confirmation.

$B_1(5721)^+$  mass =  $5726.0^{+2.5}_{-2.7}$  MeV

$m_{B_1^+} - m_{B^{*0}} = 401.2^{+2.4}_{-2.7}$  MeV

$B_1(5721)^0$  mass =  $5726.1 \pm 1.2$  MeV (S = 1.2)

$m_{B_1^0} - m_{B^+} = 446.7 \pm 1.2$  MeV (S = 1.2)

$m_{B_1^0} - m_{B^{*+}} = 401.4 \pm 1.2$  MeV (S = 1.2)

Full width  $\Gamma(B_1(5721)^+) = 31 \pm 6$  MeV (S = 1.1)

Full width  $\Gamma(B_1(5721)^0) = 27.5 \pm 3.4$  MeV (S = 1.1)

| <b><math>B_1(5721)</math> DECAY MODES</b> | Fraction ( $\Gamma_i/\Gamma$ ) | $p$ (MeV/c) |
|-------------------------------------------|--------------------------------|-------------|
| $B^*\pi$                                  | seen                           | 365         |

$B_2^*(5747)$

$I(J^P) = \frac{1}{2}(2^+)$   
 $I, J, P$  need confirmation.

$B_2^*(5747)^+$  mass =  $5737.3 \pm 0.7$  MeV

$m_{B_2^{*+}} - m_{B^0} = 457.5 \pm 0.7$  MeV

$B_2^*(5747)^0$  mass =  $5739.6 \pm 0.7$  MeV (S = 1.4)

$m_{B_2^{*0}} - m_{B_1^0} = 13.5 \pm 1.4$  MeV (S = 1.3)

$m_{B_2^{*0}} - m_{B^+} = 460.2 \pm 0.6$  MeV (S = 1.4)

Full width  $\Gamma(B_2^*(5747)^+) = 20 \pm 5$  MeV (S = 2.2)

Full width  $\Gamma(B_2^*(5747)^0) = 24.2 \pm 1.7$  MeV

| <b><math>B_2^*(5747)</math> DECAY MODES</b> | Fraction ( $\Gamma_i/\Gamma$ ) | $p$ (MeV/c) |
|---------------------------------------------|--------------------------------|-------------|
| $B\pi$                                      | seen                           | 420         |
| $B^*\pi$                                    | seen                           | 376         |

$B_J(5970)$

$I(J^P) = \frac{1}{2}(??)$   
 $I, J, P$  need confirmation.

$B_J(5970)^+$  mass  $m = 5965 \pm 5$  MeV  
 $m_{B_J(5970)^+} - m_{B^0} = 685 \pm 5$  MeV  
 $B_J(5970)^0$  mass  $m = 5971 \pm 5$  MeV  
 $m_{B_J(5970)^0} - m_{B^+} = 691 \pm 5$  MeV  
 $B_J(5970)^+$  full width  $\Gamma = 62 \pm 20$  MeV  
 $B_J(5970)^0$  full width  $\Gamma = 81 \pm 12$  MeV

| <b><math>B_J(5970)</math> DECAY MODES</b> | Fraction ( $\Gamma_i/\Gamma$ ) | $p$ (MeV/c) |
|-------------------------------------------|--------------------------------|-------------|
| $B\pi$                                    | possibly seen                  | 633         |
| $B^*\pi$                                  | seen                           | 592         |

## NOTES

- [a] An  $\ell$  indicates an  $e$  or a  $\mu$  mode, not a sum over these modes.
- [b] An  $CP(\pm 1)$  indicates the  $CP=+1$  and  $CP=-1$  eigenstates of the  $D^0$ - $\bar{D}^0$  system.
- [c]  $D$  denotes  $D^0$  or  $\bar{D}^0$ .
- [d]  $D_{CP+}^{*0}$  decays into  $D^0\pi^0$  with the  $D^0$  reconstructed in  $CP$ -even eigenstates  $K^+K^-$  and  $\pi^+\pi^-$ .
- [e]  $\bar{D}^{**}$  represents an excited state with mass  $2.2 < M < 2.8 \text{ GeV}/c^2$ .
- [f]  $\chi_{c1}(3872)^+$  is a hypothetical charged partner of the  $\chi_{c1}(3872)$ .
- [g]  $\Theta(1710)^{++}$  is a possible narrow pentaquark state and  $G(2220)$  is a possible glueball resonance.
- [h]  $(\bar{\Lambda}_c^- p)_s$  denotes a low-mass enhancement near  $3.35 \text{ GeV}/c^2$ .
- [i] Stands for the possible candidates of  $K^*(1410)$ ,  $K_0^*(1430)$  and  $K_2^*(1430)$ .
- [j]  $B^0$  and  $B_s^0$  contributions not separated. Limit is on weighted average of the two decay rates.
- [k] This decay refers to the coherent sum of resonant and nonresonant  $J^P = 0^+ K\pi$  components with  $1.60 < m_{K\pi} < 2.15 \text{ GeV}/c^2$ .
- [l]  $X(214)$  is a hypothetical particle of mass  $214 \text{ MeV}/c^2$  reported by the HyperCP experiment, Physical Review Letters **94** 021801 (2005)
- [n] The value is for the sum of the charge states or particle/antiparticle states indicated.
- [o]  $\Theta(1540)^+$  denotes a possible narrow pentaquark state.
- [p]  $\psi_{DS}$  is a GeV-scale dark sector antibaryon (mass range  $1\text{--}4 \text{ GeV}/c^2$ ).
- [q] Here  $S$  and  $P$  are the hypothetical scalar and pseudoscalar particles with masses of  $2.5 \text{ GeV}/c^2$  and  $214.3 \text{ MeV}/c^2$ , respectively.
- [r] These values are model dependent.
- [s] Here “anything” means at least one particle observed.
- [t] This is a  $B(B^0 \rightarrow D^{*-} \ell^+ \nu_\ell)$  value.
- [u]  $D^{**}$  stands for the sum of the  $D(1^1P_1)$ ,  $D(1^3P_0)$ ,  $D(1^3P_1)$ ,  $D(1^3P_2)$ ,  $D(2^1S_0)$ , and  $D(2^1S_1)$  resonances.
- [v]  $D^{(*)}\bar{D}^{(*)}$  stands for the sum of  $D^*\bar{D}^*$ ,  $D^*\bar{D}$ ,  $D\bar{D}^*$ , and  $D\bar{D}$ .
- [x]  $X(3915)$  denotes a near-threshold enhancement in the  $\omega J/\psi$  mass spectrum.
- [y] Inclusive branching fractions have a multiplicity definition and can be greater than 100%.
- [z]  $D_j$  represents an unresolved mixture of pseudoscalar and tensor  $D^{**}$  ( $P$ -wave) states.