

Topology Analysis ^{*†‡§}

(v2.12.3)

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[†]This package is implemented referring to a program called TOPO, which is first developed by Prof. Shuxian Du from Zhengzhou University and later extended and maintained by Prof. Gang Li from Institute of High Energy Physics, Chinese Academy of Sciences. The TOPO program has been widely used by colleagues in BESIII collaboration. Several years ago, when I was a Ph.D. student working on the BESIII experiment, I learned the idea of topology analysis and a lot of programming techniques from the TOPO program. So, I really appreciate the original works of Prof. Du and Prof. Li very much. To meet my own needs and to practice developing analysis tools with C++, ROOT, and LaTeX, I wrote the package from scratch. At that time, the package functioned well but was relatively simple. At the end of 2017, when I just started my post-doctoral research at Beihang University, my co-supervisor Prof. Chengping Shen reminded me that it could be a useful tool for the Belle II experiment as well. So, I revised and extended it, making it more well-rounded and suitable for the Belle II experiment. Now, it also applies to many other similar high energy physics experiments. Here, I would like to thank Prof. Du and Prof. Li for their original works, and Prof. Shen for his suggestion, guidance, support, and encouragement.

[‡]Besides, I would like to thank all of the people who have helped me in the development of the program. I am particularly grateful to Prof. Xingtao Huang for his comments on the principles and styles of the program, to Remco de Boer for his suggestions on the tex output and the use of GitHub, and to Xi Chen for his discussions on the core algorithms. I am especially indebted to Prof. Xiqing Hao, Longke Li, Xiaoping Qin, Ilya Komarov, Yubo Li, Guanda Gong, Suxian Li, Junhao Yin, Prof. Xiaolong Wang, Yeqi Chen, Hannah Wakeling, Hongrong Qi, Hui Li, Ning Cao, Sanjeeda Bharati Das, Kazuki Kojima, Tingting Han, Fang Yan, Lin Wang, Meiru An, and Noreen Rauls for their advice in extending and perfecting the program. Also, I thank Xi'an Xiong, Runqiu Ma, Wencheng Yan, Sen Jia, Lu Cao, Dong Liu, Hongpeng Wang, Jiawei Zhang, Jiajun Liu, Maoqiang Jing, Yi Zhang, Wei Shan, and Yadi Wang for their efforts in helping me test the program.

[§]The paper on the tool has been published by *Computer Physics Communications*. You can find this paper and the preprint corresponding to it in the links [Comput. Phys. Commun. 258 \(2021\) 107540](#) and [arXiv:2001.04016](#), respectively. If the tool really helps your researches, we would appreciate it very much if you could cite the paper in your publications.

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Table 1: Decay trees and their respective initial-final states.

| rowNo | decay tree (decay initial-final states) | iDcyTr | nEtr | nCEtr |
|-------|---|--------|------|-------|
| 1 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow K^+ \Lambda \bar{\Sigma}_c^-, \bar{B}^0 \rightarrow \pi^+ K_0^{*-}, \Lambda \rightarrow \pi^- p, \bar{\Sigma}_c^- \rightarrow \pi^0 \bar{\Lambda}_c^-, K_0^{*-} \rightarrow \pi^0 K^-,$ $\bar{\Lambda}_c^- \rightarrow \eta \bar{\Sigma}^-, \eta \rightarrow \pi^0 \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^- K^+ K^- p \bar{\Sigma}^-)$ | 36409 | 26 | 26 |
| 2 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow K^- K^{*+}, \bar{B}^0 \rightarrow \pi^+ \pi^- \bar{K}^0 K^+ D^-, K^{*+} \rightarrow \pi^0 K^+, \bar{K}^0 \rightarrow K_S^0, D^- \rightarrow \pi^0 \pi^0 \pi^0 \pi^- \eta,$ $K_S^0 \rightarrow \pi^+ \pi^-, \eta \rightarrow \pi^0 \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^- \pi^- \pi^- K^+ K^+ K^-)$ | 41078 | 22 | 48 |
| 3 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow K^{*+} D^{*-} \bar{D}^0, \bar{B}^0 \rightarrow K^+ K^* (1680)^-, K^{*+} \rightarrow \pi^0 K^+, D^{*-} \rightarrow \pi^- \bar{D}^0, \bar{D}^0 \rightarrow \pi^0 \pi^+ K^-,$ $K^* (1680)^- \rightarrow \pi^0 K^-, \bar{D}^0 \rightarrow \pi^0 \eta \eta, \eta \rightarrow \gamma \gamma, \eta \rightarrow \pi^0 \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^- K^+ K^+ K^- K^- \gamma \gamma)$ | 20011 | 21 | 69 |
| 4 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^0 \rho^0 \pi^+ \pi^- \rho^- \omega \omega D^-, \bar{B}^0 \rightarrow \pi^+ K_0^{*-} \gamma^F, \rho^0 \rightarrow \pi^+ \pi^-, \rho^- \rightarrow \pi^0 \pi^-, \omega \rightarrow \pi^0 \pi^+ \pi^-,$ $\omega \rightarrow \pi^0 \pi^+ \pi^-, D^- \rightarrow \pi^0 \pi^- K_S^0, K_0^{*-} \rightarrow \pi^0 K^-, K_S^0 \rightarrow \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^- \pi^+ \pi^- \pi^- \pi^- \pi^- \pi^- K^- \gamma^F)$ | 2573 | 20 | 89 |
| 5 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow K^- K^{*+}, \bar{B}^0 \rightarrow \eta K^0 \bar{K}^0 K^* K^- D^{*+}, K^{*+} \rightarrow \pi^0 K^+, \eta \rightarrow \pi^0 \pi^+ \pi^-, K^0 \rightarrow K_S^0,$ $\bar{K}^0 \rightarrow K_L^0, K^* \rightarrow \pi^0 K^0, D^{*+} \rightarrow \pi^+ D^0, K_S^0 \rightarrow \pi^+ \pi^-, K_L^0 \rightarrow e^- \nu_e \pi^+ \gamma^F, K^0 \rightarrow K_S^0,$ $D^0 \rightarrow \pi^0 \pi^0 \pi^+ \pi^-, K_S^0 \rightarrow \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow e^- \nu_e \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^- \pi^+ \pi^- \pi^- \pi^- K^+ K^- K^- \gamma^F)$ | 4671 | 20 | 109 |
| 6 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^- K^{*+}, \bar{B}^0 \rightarrow \pi^0 \pi^0 \pi^+ K^{*-} D^0 p \bar{p}, K^{*+} \rightarrow \pi^0 K^+, K^{*-} \rightarrow \pi^- \bar{K}^0, D^0 \rightarrow \rho^+ K^{*-},$ $\bar{K}^0 \rightarrow K_S^0, \rho^+ \rightarrow \pi^0 \pi^+, K^{*-} \rightarrow \pi^- \bar{K}^0, K_S^0 \rightarrow \pi^0 \pi^0, \bar{K}^0 \rightarrow K_L^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+ p \bar{p})$ | 31911 | 20 | 129 |
| 7 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^- a_1^+, \bar{B}^0 \rightarrow \pi^0 \bar{K}^0 D^{*+} D^{*-}, a_1^+ \rightarrow \pi^0 \rho^+, \bar{K}^0 \rightarrow K_L^0, D^{*+} \rightarrow \pi^0 D^+,$ $D^{*-} \rightarrow \pi^0 D^-, \rho^+ \rightarrow \pi^0 \pi^+, D^+ \rightarrow e^+ \nu_e \bar{K}^*, D^- \rightarrow \pi^0 \pi^0 \pi^- \eta, \bar{K}^* \rightarrow \pi^+ K^-, \eta \rightarrow \pi^0 \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow e^+ \nu_e \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^- \pi^- \pi^- K^-)$ | 25672 | 19 | 148 |
| 8 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^0 \pi^+ \eta K^* D^{*-}, \bar{B}^0 \rightarrow \rho^+ \rho^- \gamma, \eta \rightarrow \pi^0 \pi^0 \pi^0, K^* \rightarrow \pi^- K^+, D^{*-} \rightarrow \pi^- \bar{D}^0,$ $\rho^+ \rightarrow \pi^0 \pi^+, \rho^- \rightarrow \pi^0 \pi^-, \bar{D}^0 \rightarrow \pi^0 \pi^0 K^*, K^* \rightarrow \pi^- K^+ \gamma^F$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^- \pi^- \pi^- \pi^- K^+ K^+ \gamma^F \gamma)$ | 38650 | 19 | 167 |
| 9 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^+ \pi^+ \pi^- \pi^- \omega \bar{D}^0, \bar{B}^0 \rightarrow \rho^+ K^- \gamma^F \gamma^F, \omega \rightarrow \pi^0 \pi^+ \pi^-, \bar{D}^0 \rightarrow \rho^- K^{*+} \gamma, \rho^+ \rightarrow \pi^0 \pi^+,$ $\rho^- \rightarrow \pi^0 \pi^-, K^{*+} \rightarrow \pi^0 K^+$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- K^+ K^- \gamma^F \gamma^F \gamma)$ | 7746 | 18 | 185 |
| 10 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^0 \pi^+ \eta D^-, \bar{B}^0 \rightarrow \pi^0 \pi^0 \bar{K}_0^{*0}, \eta \rightarrow \gamma \gamma, D^- \rightarrow \pi^0 K_L^0 \pi^- \gamma^F, \bar{K}_0^{*0} \rightarrow \pi^+ K^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^- K^- \gamma^F \gamma \gamma)$ | 16539 | 18 | 203 |
| 11 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow K^- K^{*+}, \bar{B}^0 \rightarrow \pi^0 \pi^- \eta \omega D^+, K^{*+} \rightarrow \pi^0 K^+, \eta \rightarrow \pi^0 \pi^+ \pi^-, \omega \rightarrow \pi^0 \pi^+ \pi^-,$ $\omega \rightarrow \pi^0 \pi^+ \pi^-, D^+ \rightarrow \pi^0 \pi^+ \pi^+ \pi^- \eta, \eta \rightarrow \pi^0 \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- K^+ K^-)$ | 41784 | 18 | 221 |

| rowNo | decay tree (decay initial-final states) | iDcyTr | nEtr | nCEtr |
|-------|---|--------|------|-------|
| 12 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow K^- K_0^{*+}, \bar{B}^0 \rightarrow \pi^+ K^- D^+ D^{*-}, K_0^{*+} \rightarrow \pi^0 K^+, D^+ \rightarrow \pi^0 \pi^0 \pi^+ \pi^- \eta \gamma^F, D^{*-} \rightarrow \pi^- \bar{D}^0,$ $\eta \rightarrow \pi^0 \pi^+ \pi^-, \bar{D}^0 \rightarrow \rho^- K^{*+}, \rho^- \rightarrow \pi^0 \pi^-, K^{*+} \rightarrow \pi^+ K^0, K^0 \rightarrow K_S^0, K_S^0 \rightarrow \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- K^+ K^- K^- \gamma^F)$ | 4579 | 17 | 238 |
| 13 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^- K_0^{*+}, \bar{B}^0 \rightarrow \bar{K}^* \eta_c(2S), K_0^{*+} \rightarrow \pi^0 K^+, \bar{K}^* \rightarrow \pi^+ K^-, \eta_c(2S) \rightarrow \pi^0 \rho^0 \pi^+ \omega K^0 K^{*-},$ $\rho^0 \rightarrow \pi^+ \pi^-, \omega \rightarrow \pi^0 \pi^+ \pi^-, K^0 \rightarrow K_S^0, K^{*-} \rightarrow \pi^- \bar{K}^0, K_S^0 \rightarrow \pi^0 \pi^0, \bar{K}^0 \rightarrow K_L^0,$ $K_L^0 \rightarrow \pi^0 \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- K^+ K^-)$ | 11965 | 17 | 255 |
| 14 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^0 \eta \bar{K}^0 K^{*+} \eta' D^{*-}, \bar{B}^0 \rightarrow \rho^0 \bar{K}_0^{*0}, \eta \rightarrow \gamma \gamma, \bar{K}^0 \rightarrow K_L^0, K^{*+} \rightarrow \pi^+ K^0,$ $\eta' \rightarrow \pi^+ \pi^- \eta, D^{*-} \rightarrow \pi^- \bar{D}^0, \rho^0 \rightarrow \pi^+ \pi^-, \bar{K}_0^{*0} \rightarrow \pi^+ K^-, K_L^0 \rightarrow \pi^0 \pi^0 \pi^0, K^0 \rightarrow K_S^0,$ $\eta \rightarrow \gamma \gamma, \bar{D}^0 \rightarrow \rho^0 K^*, K_S^0 \rightarrow \pi^0 \pi^0, \rho^0 \rightarrow \pi^+ \pi^- \gamma^F, K^* \rightarrow \pi^0 K^0, K^0 \rightarrow K_S^0,$ $K_S^0 \rightarrow \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- K^- \gamma^F \gamma \gamma \gamma \gamma)$ | 21479 | 17 | 272 |
| 15 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \rho^- K^{*+}, \bar{B}^0 \rightarrow \pi^0 \rho^- D^{*+} n \bar{n}, \rho^- \rightarrow \pi^0 \pi^-, K^{*+} \rightarrow \pi^0 K^+, \rho^- \rightarrow \pi^0 \pi^-,$ $D^{*+} \rightarrow \pi^+ D^0, D^0 \rightarrow K_S^0 \eta', K_S^0 \rightarrow \pi^0 \pi^0, \eta' \rightarrow \pi^+ \pi^- \eta, \eta \rightarrow \gamma \gamma$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+ n \bar{n} \gamma \gamma)$ | 23068 | 17 | 289 |
| 16 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^0 D^- D_s^+, \bar{B}^0 \rightarrow K^+ K^{*-}, D^- \rightarrow \pi^+ \pi^- \pi^- K_S^0, D_s^+ \rightarrow \tau^+ \nu_\tau, K^{*-} \rightarrow \pi^0 K^-,$ $K_S^0 \rightarrow \pi^0 \pi^0, \tau^+ \rightarrow \bar{\nu}_\tau \pi^0 \pi^+$ $(\Upsilon(4S) \rightarrow \nu_\tau \bar{\nu}_\tau \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- \pi^- K^+ K^-)$ | 30720 | 17 | 306 |
| 17 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \rho^- \Delta^+ \bar{\Sigma}_c^0, \bar{B}^0 \rightarrow \pi^+ K^{*-} \gamma^F, \rho^- \rightarrow \pi^0 \pi^-, \Delta^+ \rightarrow \pi^0 p, \bar{\Sigma}_c^0 \rightarrow \pi^+ \bar{\Lambda}_c^-,$ $K^{*-} \rightarrow \pi^0 K^-, \bar{\Lambda}_c^- \rightarrow \pi^0 \rho^- \bar{\Lambda}, \rho^- \rightarrow \pi^0 \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- \pi^- K^- p \bar{\Lambda} \gamma^F)$ | 17 | 16 | 322 |
| 18 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow e^+ \nu_e D_1^- \gamma^F \gamma^F, \bar{B}^0 \rightarrow K^+ K_0^{*-}, D_1^- \rightarrow \pi^0 \pi^0 D^-, K_0^{*-} \rightarrow \pi^0 K^-, D^- \rightarrow \pi^0 \pi^0 \pi^0 \pi^- \eta,$ $\eta \rightarrow \pi^0 \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow e^+ \nu_e \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^- K^+ K^- \gamma^F \gamma^F)$ | 4051 | 15 | 337 |
| 19 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^- K_0^{*+}, \bar{B}^0 \rightarrow \pi^0 \pi^+ \pi^+ \pi^- \pi^- \bar{K}^0 D^{*0}, K_0^{*+} \rightarrow \pi^0 K^+, \bar{K}^0 \rightarrow K_L^0, D^{*0} \rightarrow D^0 \gamma,$ $D^0 \rightarrow \pi^+ K_S^0 K^-, K_S^0 \rightarrow \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- K^+ K^- \gamma)$ | 7760 | 15 | 352 |
| 20 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \rho^+ \omega K^0 \bar{K}^0 D^-, \bar{B}^0 \rightarrow \rho^+ K^- \gamma^F, \rho^+ \rightarrow \pi^0 \pi^+, \omega \rightarrow \pi^0 \pi^+ \pi^-, K^0 \rightarrow K_S^0,$ $\bar{K}^0 \rightarrow K_S^0, D^- \rightarrow e^- \bar{\nu}_e K^0, \rho^+ \rightarrow \pi^0 \pi^+, K_S^0 \rightarrow \pi^0 \pi^0, K_S^0 \rightarrow \pi^+ \pi^-, K^0 \rightarrow K_L^0$ $(\Upsilon(4S) \rightarrow e^- \bar{\nu}_e \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- K^- \gamma^F)$ | 26977 | 15 | 367 |
| 21 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^- K_0^{*+}, \bar{B}^0 \rightarrow \pi^0 \rho^0 \rho^0 \pi^+ \pi^- K^{*-} D_s^{*+}, K_0^{*+} \rightarrow \pi^0 K^+, \pi^0 \rightarrow e^+ e^- \gamma^F, \rho^0 \rightarrow \pi^+ \pi^-,$ $\rho^0 \rightarrow \pi^+ \pi^-, K^{*-} \rightarrow \pi^0 K^-, D_s^{*+} \rightarrow D_s^+ \gamma, D_s^+ \rightarrow \pi^0 \pi^0 \pi^0 \pi^+ \eta, \eta \rightarrow \pi^0 \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow e^+ e^- \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- K^+ K^- \gamma^F \gamma)$ | 6347 | 14 | 381 |
| 22 | $\Upsilon(4S) \rightarrow \bar{B}^0 \bar{B}^0, \bar{B}^0 \rightarrow \pi^0 \pi^+ \pi^-, \bar{B}^0 \rightarrow \pi^- D^{*+} \Sigma^+ \bar{\Sigma}^-, D^{*+} \rightarrow D^+ \gamma, \Sigma^+ \rightarrow \pi^0 p, \bar{\Sigma}^- \rightarrow \pi^0 \bar{p},$ $D^+ \rightarrow \pi^+ \pi^+ K^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- K^- p \bar{p} \gamma)$ | 8018 | 14 | 395 |

| rowNo | decay tree (decay initial-final states) | iDcyTr | nEtr | nCEtr |
|-------|---|--------|------|-------|
| 23 | $\Upsilon(4S) \rightarrow B^0 B^0, B^0 \rightarrow \pi^0 \pi^+ \pi^-, B^0 \rightarrow \pi^+ \rho^- \omega K^0 \bar{K}^0 K^+ D_s^-, \rho^- \rightarrow \pi^0 \pi^-, \omega \rightarrow \pi^0 \pi^+ \pi^-, K^0 \rightarrow K_S^0,$ $\bar{K}^0 \rightarrow K_L^0, D_s^- \rightarrow \pi^- \eta', K_S^0 \rightarrow \pi^+ \pi^-, \eta' \rightarrow \pi^0 \pi^0 \eta, \eta \rightarrow \gamma \gamma$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- K^+ \gamma \gamma)$ | 12734 | 14 | 409 |
| 24 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^0 \rho^0 \pi^+ \pi^- \rho^+ D^{*-}, \bar{B}^0 \rightarrow \rho^+ K_0^{*-}, \rho^0 \rightarrow \pi^+ \pi^-, \rho^+ \rightarrow \pi^0 \pi^+, D^{*-} \rightarrow \pi^0 D^-,$ $\rho^+ \rightarrow \pi^0 \pi^+, K_0^{*-} \rightarrow \pi^0 K^-, D^- \rightarrow e^- \bar{\nu}_e K^0 \gamma^F, K^0 \rightarrow K_S^0, K_S^0 \rightarrow \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow e^- \bar{\nu}_e \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- K^- \gamma^F)$ | 13156 | 14 | 423 |
| 25 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^0 \pi^+ \rho^- \bar{K}^0 K^+ D^-, \bar{B}^0 \rightarrow \pi^0 \pi^+ \pi^-, \rho^- \rightarrow \pi^0 \pi^-, \bar{K}^0 \rightarrow K_L^0, D^- \rightarrow K_S^0 a_1^-,$ $K_S^0 \rightarrow \pi^0 \pi^0, a_1^- \rightarrow \pi^0 \rho^-, \rho^- \rightarrow \pi^0 \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+)$ | 18003 | 14 | 437 |
| 26 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \rho^- K_0^{*+}, \bar{B}^0 \rightarrow D^+ D_s^{*-}, \rho^- \rightarrow \pi^0 \pi^-, K_0^{*+} \rightarrow \pi^0 K^+, D^+ \rightarrow \pi^0 K_L^0 \pi^+,$ $D_s^{*-} \rightarrow D_s^- \gamma, D_s^- \rightarrow \rho^- \eta', \rho^- \rightarrow \pi^0 \pi^-, \eta' \rightarrow \pi^0 \pi^0 \eta, \eta \rightarrow \pi^0 \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+ \gamma)$ | 19364 | 14 | 451 |
| 27 | $\Upsilon(4S) \rightarrow \bar{B}^0 \bar{B}^0, \bar{B}^0 \rightarrow \pi^+ K_0^{*-}, \bar{B}^0 \rightarrow D_2^{*+} D_s^{*-}, K_0^{*-} \rightarrow \pi^0 K^-, D_2^{*+} \rightarrow \pi^0 D^+, D_s^{*-} \rightarrow D_s^- \gamma,$ $D^+ \rightarrow \pi^0 \pi^+ K_S^0, D_s^- \rightarrow \rho^- \eta, K_S^0 \rightarrow \pi^+ \pi^-, \rho^- \rightarrow \pi^0 \pi^-, \eta \rightarrow \pi^0 \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- \pi^- K^- \gamma)$ | 19602 | 14 | 465 |
| 28 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^0 \pi^+ \pi^- \rho^- K^0 \bar{K}^0 K^{*+} \bar{D}^0, \bar{B}^0 \rightarrow K^+ K^{*-}, \rho^- \rightarrow \pi^0 \pi^-, K^0 \rightarrow K_L^0, \bar{K}^0 \rightarrow K_S^0,$ $K^{*+} \rightarrow \pi^+ K^0, \bar{D}^0 \rightarrow \pi^0 \pi^0 \pi^0 \pi^- K^+, K^{*-} \rightarrow \pi^0 K^-, K_L^0 \rightarrow e^- \nu_e \pi^+, K_S^0 \rightarrow \pi^0 \pi^0, K^0 \rightarrow K_L^0$ $(\Upsilon(4S) \rightarrow e^- \nu_e \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+ K^+ K^-)$ | 19789 | 14 | 479 |
| 29 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^0 \pi^+ \pi^- D^{*-} \gamma^F, \bar{B}^0 \rightarrow K^- a_1^+, D^{*-} \rightarrow \pi^- \bar{D}^0, a_1^+ \rightarrow \pi^0 \rho^+, \bar{D}^0 \rightarrow \pi^+ \pi^- K_S^0,$ $\rho^+ \rightarrow \pi^0 \pi^+, K_S^0 \rightarrow \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- K^- \gamma^F)$ | 20983 | 14 | 493 |
| 30 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^0 \rho^0 \pi^+ \eta D^{*-}, \bar{B}^0 \rightarrow \pi^0 \pi^+ \pi^-, \rho^0 \rightarrow \pi^+ \pi^-, \eta \rightarrow \pi^0 \pi^0 \pi^0, D^{*-} \rightarrow \pi^- \bar{D}^0,$ $\bar{D}^0 \rightarrow \rho^- K^{*+}, \rho^- \rightarrow \pi^0 \pi^-, K^{*+} \rightarrow \pi^0 K^+$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- K^+)$ | 26686 | 14 | 507 |
| 31 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^- K^*(1680)^+, \bar{B}^0 \rightarrow \pi^0 \pi^0 \rho^0 \rho^- D^+, K^*(1680)^+ \rightarrow \pi^+ K^0, \rho^0 \rightarrow \pi^+ \pi^- \gamma^F \gamma^F, \rho^- \rightarrow \pi^0 \pi^-,$ $D^+ \rightarrow \pi^+ \pi^+ K^- \gamma^F, K^0 \rightarrow K_S^0, K_S^0 \rightarrow \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- K^- \gamma^F \gamma^F \gamma^F)$ | 30435 | 14 | 521 |
| 32 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^- K_0^{*+}, \bar{B}^0 \rightarrow \pi^0 \rho^- \eta \omega D^{*+}, K_0^{*+} \rightarrow \pi^0 K^+, \rho^- \rightarrow \pi^0 \pi^-, \eta \rightarrow \pi^0 \pi^0 \pi^0,$ $\omega \rightarrow \pi^0 \pi^+ \pi^-, D^{*+} \rightarrow \pi^0 D^+, D^+ \rightarrow \mu^+ \nu_\mu \bar{K}^*, \bar{K}^* \rightarrow \pi^+ K^-$ $(\Upsilon(4S) \rightarrow \mu^+ \nu_\mu \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+ K^-)$ | 32233 | 14 | 535 |
| 33 | $\Upsilon(4S) \rightarrow \bar{B}^0 \bar{B}^0, \bar{B}^0 \rightarrow \omega K_2^{*0}, \bar{B}^0 \rightarrow \pi^0 \pi^0 \rho^0 \pi^- \eta D^+, \omega \rightarrow \pi^+ \pi^-, K_2^{*0} \rightarrow \pi^+ K^-, \rho^0 \rightarrow \pi^+ \pi^-,$ $\eta \rightarrow \pi^0 \pi^0 \pi^0, D^+ \rightarrow \pi^0 \pi^+ K_S^0, \pi^0 \rightarrow e^+ e^- \gamma^F, K_S^0 \rightarrow \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow e^+ e^- \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- K^- \gamma^F)$ | 36486 | 14 | 549 |
| 34 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow K^{*+} D^- D^{*0}, \bar{B}^0 \rightarrow e^- \bar{\nu}_e D_0^{*+}, K^{*+} \rightarrow \pi^+ K^0 \gamma^F, D^- \rightarrow \pi^- \omega K^*, D^{*0} \rightarrow \pi^0 D^0,$ $D_0^{*+} \rightarrow \pi^+ D^0, K^0 \rightarrow K_S^0, \omega \rightarrow \pi^0 \pi^+ \pi^-, K^* \rightarrow \pi^0 K^0, D^0 \rightarrow \pi^0 K_L^0 \eta, D^0 \rightarrow \pi^+ K^-,$ $K_S^0 \rightarrow \pi^0 \pi^0, K^0 \rightarrow K_S^0, \eta \rightarrow \pi^0 \pi^0 \pi^0, K_S^0 \rightarrow \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow e^- \bar{\nu}_e \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- K^- \gamma^F)$ | 978 | 13 | 562 |

| rowNo | decay tree (decay initial-final states) | iDcyTr | nEtr | nCEtr |
|-------|--|--------|------|-------|
| 35 | $\Upsilon(4S) \rightarrow \bar{B}^0 \bar{B}^0, \bar{B}^0 \rightarrow \pi^- D^+, \bar{B}^0 \rightarrow \pi^- \rho^+ \omega K^* K^- D^{*+}, D^+ \rightarrow \pi^0 \pi^0 \pi^+, \rho^+ \rightarrow \pi^0 \pi^+, \omega \rightarrow \pi^0 \gamma,$ $K^* \rightarrow \pi^- K^+, D^{*+} \rightarrow \pi^0 D^+, D^+ \rightarrow \pi^+ \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- K^+ K^- \gamma)$ | 4618 | 13 | 575 |
| 36 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^0 \pi^+ \rho^- \omega \bar{D}^0, \bar{B}^0 \rightarrow \rho^+ K^{*-}, \rho^- \rightarrow \pi^0 \pi^-, \omega \rightarrow \pi^0 \pi^+ \pi^-, \bar{D}^0 \rightarrow \pi^0 \pi^- K^+ \gamma^F,$ $\rho^+ \rightarrow \pi^0 \pi^+, K^{*-} \rightarrow \pi^0 K^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- K^+ K^- \gamma^F)$ | 5492 | 13 | 588 |
| 37 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \eta \eta D^- D_s^+, \bar{B}^0 \rightarrow \pi^+ K^- \gamma^F \gamma^F, \eta \rightarrow \pi^0 \pi^0 \pi^0, \eta \rightarrow e^+ e^- \gamma^F \gamma^F, D^- \rightarrow \mu^- \bar{\nu}_\mu K^*,$ $D_s^+ \rightarrow \rho^+ \phi, K^* \rightarrow \pi^- K^+, \rho^+ \rightarrow \pi^0 \pi^+ \gamma^F, \phi \rightarrow K_L^0 K_S^0, K_S^0 \rightarrow \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow e^+ e^- \mu^- \bar{\nu}_\mu \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- K^+ K^- \gamma^F \gamma^F \gamma^F \gamma^F \gamma^F)$ | 6383 | 13 | 601 |
| 38 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^+ \rho^- \eta K^+ D_s^-, \bar{B}^0 \rightarrow \bar{K}^0 K^+ K^- \gamma^F, \rho^- \rightarrow \pi^0 \pi^-, \eta \rightarrow \pi^0 \pi^0 \pi^0, D_s^- \rightarrow \pi^- \omega,$ $\bar{K}^0 \rightarrow K_L^0, \omega \rightarrow \pi^0 \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+ K^- \gamma^F)$ | 8396 | 13 | 614 |
| 39 | $\Upsilon(4S) \rightarrow \bar{B}^0 \bar{B}^0, \bar{B}^0 \rightarrow \pi^+ K^* (1410)^-, \bar{B}^0 \rightarrow D^+ D_s^-, K^* (1410)^- \rightarrow \pi^0 K^-, D^+ \rightarrow \pi^0 \pi^+ \bar{K}^*, D_s^- \rightarrow K^0 K^{*-},$ $\bar{K}^* \rightarrow \pi^+ K^-, K^0 \rightarrow K_S^0, K^{*-} \rightarrow \pi^- \bar{K}^0, K_S^0 \rightarrow \pi^0 \pi^0, \bar{K}^0 \rightarrow K_S^0, K_S^0 \rightarrow \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- K^- K^-)$ | 18067 | 13 | 627 |
| 40 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^+ D^-, \bar{B}^0 \rightarrow D^{*+} D_s^{*-} \gamma, D^- \rightarrow K_L^0 \pi^- \gamma^F, D^{*+} \rightarrow \pi^+ D^0, D_s^{*-} \rightarrow D_s^- \gamma,$ $D^0 \rightarrow \pi^0 K_L^0 \eta, D_s^- \rightarrow \mu^- \bar{\nu}_\mu \eta, \eta \rightarrow \pi^0 \pi^0 \pi^0, \eta \rightarrow \gamma \gamma$ $(\Upsilon(4S) \rightarrow \mu^- \bar{\nu}_\mu \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 K_L^0 \pi^+ \pi^+ \pi^- \gamma^F \gamma \gamma \gamma \gamma)$ | 19993 | 13 | 640 |
| 41 | $\Upsilon(4S) \rightarrow B^0 B^0, B^0 \rightarrow K^{*+} D^{*-} D^{*0}, B^0 \rightarrow \pi^- \eta K^+ \gamma^F, K^{*+} \rightarrow \pi^+ K^0, D^{*-} \rightarrow \pi^- \bar{D}^0, D^{*0} \rightarrow \pi^0 D^0,$ $\eta \rightarrow \pi^0 \pi^0 \pi^0, K^0 \rightarrow K_S^0, \bar{D}^0 \rightarrow \rho^- K^{*+}, D^0 \rightarrow \rho^+ K^{*-}, K_S^0 \rightarrow \pi^+ \pi^-, \rho^- \rightarrow \pi^0 \pi^-,$ $K^{*+} \rightarrow \pi^+ K^0, \rho^+ \rightarrow \pi^0 \pi^+, K^{*-} \rightarrow \pi^- \bar{K}^0, K^0 \rightarrow K_L^0, \bar{K}^0 \rightarrow K_L^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 K_L^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- \pi^- K^+ \gamma^F)$ | 20530 | 13 | 653 |
| 42 | $\Upsilon(4S) \rightarrow B^0 B^0, B^0 \rightarrow D_2^{*-} D_s^+, B^0 \rightarrow \rho^+ \rho^- \gamma, D_2^{*-} \rightarrow \pi^0 D^-, D_s^+ \rightarrow \rho^+ \phi, \rho^+ \rightarrow \pi^0 \pi^+,$ $\rho^- \rightarrow \pi^0 \pi^-, D^- \rightarrow \pi^- K^+ K^-, \rho^+ \rightarrow \pi^0 \pi^+, \phi \rightarrow K_L^0 K_S^0, K_S^0 \rightarrow \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+ K^- \gamma)$ | 27775 | 13 | 666 |
| 43 | $\Upsilon(4S) \rightarrow \bar{B}^0 \bar{B}^0, \bar{B}^0 \rightarrow \pi^0 \pi^+ \pi^-, \bar{B}^0 \rightarrow \pi^0 \pi^- \omega D^{*+}, \omega \rightarrow \pi^0 \pi^+ \pi^-, D^{*+} \rightarrow \pi^+ D^0, D^0 \rightarrow \rho^+ K^{*-},$ $\rho^+ \rightarrow \pi^0 \pi^+, K^{*-} \rightarrow \pi^- \bar{K}^0, \bar{K}^0 \rightarrow K_S^0, K_S^0 \rightarrow \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^-)$ | 31300 | 13 | 679 |
| 44 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^- K_1'^+, \bar{B}^0 \rightarrow \omega \bar{K}^0 \bar{K}^0 \Sigma^0 \Xi^0, K_1'^+ \rightarrow \pi^+ K^*, \omega \rightarrow \pi^0 \pi^+ \pi^-, \bar{K}^0 \rightarrow K_L^0,$ $\bar{K}^0 \rightarrow K_S^0, \Sigma^0 \rightarrow \Lambda \gamma, \Xi^0 \rightarrow \pi^0 \bar{\Lambda}, K^* \rightarrow \pi^- K^+, K_S^0 \rightarrow \pi^+ \pi^-, \Lambda \rightarrow \pi^- p,$ $\bar{\Lambda} \rightarrow \pi^+ \bar{p}$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- \pi^- K^+ p \bar{p} \gamma)$ | 151 | 12 | 691 |
| 45 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow K^- K^* (1680)^+, \bar{B}^0 \rightarrow \rho^0 \pi^- \eta K^0 \bar{K}^0 D^{*+}, K^* (1680)^+ \rightarrow \pi^0 K^+, \rho^0 \rightarrow \pi^+ \pi^-, \eta \rightarrow \pi^+ \pi^- \gamma^F,$ $K^0 \rightarrow K_L^0, \bar{K}^0 \rightarrow K_S^0, D^{*+} \rightarrow \pi^0 D^+, K_S^0 \rightarrow \pi^0 \pi^0, D^+ \rightarrow \pi^0 \pi^+ \bar{K}^*, \bar{K}^* \rightarrow \pi^+ K^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+ K^- K^- \gamma^F)$ | 2998 | 12 | 703 |

| rowNo | decay tree (decay initial-final states) | iDcyTr | nEtr | nCEtr |
|-------|--|--------|------|-------|
| 46 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \rho^- K^+ \gamma^F, \bar{B}^0 \rightarrow \pi^0 \rho^- \eta \eta D^{*+}, \rho^- \rightarrow \pi^0 \pi^-, \rho^- \rightarrow \pi^0 \pi^-, \eta \rightarrow \gamma \gamma,$ $\eta \rightarrow \pi^0 \pi^+ \pi^-, D^{*+} \rightarrow \pi^+ D^0, D^0 \rightarrow \pi^+ \pi^+ \pi^- K^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- K^+ K^- \gamma^F \gamma \gamma)$ | 3795 | 12 | 715 |
| 47 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^+ \pi^- \eta \omega K^0, \bar{B}^0 \rightarrow \pi^+ K_1^-, \eta \rightarrow \pi^0 \pi^+ \pi^-, \omega \rightarrow \pi^0 \pi^+ \pi^-, K^0 \rightarrow K_L^0,$ $K_1^- \rightarrow \pi^0 \pi^0 K^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- K^-)$ | 9025 | 12 | 727 |
| 48 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^- \bar{D}^0 D_s^+, \bar{B}^0 \rightarrow \rho^+ K^{*-}, \bar{D}^0 \rightarrow \pi^0 \pi^0 K^*, D_s^+ \rightarrow \rho^+ \phi, \rho^+ \rightarrow \pi^0 \pi^+,$ $K^{*-} \rightarrow \pi^0 K^-, K^* \rightarrow \pi^0 K^0, \rho^+ \rightarrow \pi^0 \pi^+, \phi \rightarrow K^+ K^-, K^0 \rightarrow K_S^0, K_S^0 \rightarrow \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+ K^- K^-)$ | 9245 | 12 | 739 |
| 49 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^0 \pi^- \eta \bar{K}^0 K^{*+} \bar{D}^{*0}, \bar{B}^0 \rightarrow \rho^0 D^0, \eta \rightarrow \pi^0 \pi^+ \pi^-, \bar{K}^0 \rightarrow K_S^0, K^{*+} \rightarrow \pi^0 K^+,$ $\bar{D}^{*0} \rightarrow \bar{D}^0 \gamma, \rho^0 \rightarrow \pi^+ \pi^-, D^0 \rightarrow \pi^+ K^-, K_S^0 \rightarrow \pi^+ \pi^-, \bar{D}^0 \rightarrow \pi^0 \pi^0 \pi^0 K_S^0, K_S^0 \rightarrow \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- K^+ K^- \gamma)$ | 14047 | 12 | 751 |
| 50 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \rho^+ \Delta^0 \bar{\Lambda}_c^-, \bar{B}^0 \rightarrow \pi^+ K_0^{*-}, \rho^+ \rightarrow \pi^0 \pi^+, \Delta^0 \rightarrow \pi^0 n, \bar{\Lambda}_c^- \rightarrow \pi^+ \pi^- \eta \bar{p},$ $K_0^{*-} \rightarrow \pi^0 K^-, \eta \rightarrow \pi^0 \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- K^- n \bar{p})$ | 14934 | 12 | 763 |
| 51 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^- K_0^{*+}, \bar{B}^0 \rightarrow \pi^0 \pi^+ \pi^- \rho^- D^{*+}, K_0^{*+} \rightarrow \pi^0 K^+, \rho^- \rightarrow \pi^0 \pi^-, D^{*+} \rightarrow \pi^+ D^0,$ $D^0 \rightarrow K_L^0 K_L^0 \pi^+ K^-, K_L^0 \rightarrow \pi^0 \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+ K^-)$ | 15315 | 12 | 775 |
| 52 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^0 \rho^+ \rho^- \omega \omega K^0 \bar{K}^0 K^*, \bar{B}^0 \rightarrow \bar{K}^0 K^+ K^-, \rho^+ \rightarrow \pi^0 \pi^+, \rho^- \rightarrow \pi^0 \pi^-, \omega \rightarrow \pi^0 \pi^+ \pi^-,$ $\omega \rightarrow \pi^0 \pi^+ \pi^-, K^0 \rightarrow K_S^0, \bar{K}^0 \rightarrow K_S^0, K^* \rightarrow \pi^0 K^0, \bar{K}^0 \rightarrow K_S^0, K_S^0 \rightarrow \pi^+ \pi^-,$ $K_S^0 \rightarrow \pi^+ \pi^-, K^0 \rightarrow K_L^0, K_S^0 \rightarrow \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- \pi^- K^+ K^-)$ | 15356 | 12 | 787 |
| 53 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^- K_0^{*+}, \bar{B}^0 \rightarrow \pi^0 \pi^+ D^0 D_s^{*-}, K_0^{*+} \rightarrow \pi^0 K^+, D^0 \rightarrow \pi^0 \pi^0 \pi^0 \pi^+ \pi^- K_S^0, D_s^{*-} \rightarrow D_s^- \gamma,$ $K_S^0 \rightarrow \pi^+ \pi^-, D_s^- \rightarrow \mu^- \bar{\nu}_\mu \eta', \eta' \rightarrow \pi^+ \pi^- \eta, \eta \rightarrow \pi^0 \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \mu^- \bar{\nu}_\mu \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- K^+ \gamma)$ | 20476 | 12 | 799 |
| 54 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^0 \pi^+ \rho^- K^+ D^{*-}, \bar{B}^0 \rightarrow \rho^+ K^-, \rho^- \rightarrow \pi^0 \pi^-, D^{*-} \rightarrow \pi^0 D^-, \rho^+ \rightarrow \pi^0 \pi^+,$ $D^- \rightarrow \pi^- K_S^0 \gamma^F, K_S^0 \rightarrow \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- \pi^- K^+ K^- \gamma^F)$ | 21571 | 12 | 811 |
| 55 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^- K^*(1680)^+, \bar{B}^0 \rightarrow \pi^- \eta \omega \bar{K}^0 K^* D^{*+}, K^*(1680)^+ \rightarrow \pi^0 K^+ \gamma^F, \eta \rightarrow \pi^0 \pi^0 \pi^0, \omega \rightarrow \pi^+ \pi^-,$ $\bar{K}^0 \rightarrow K_S^0, K^* \rightarrow \pi^- K^+, D^{*+} \rightarrow \pi^+ D^0, K_S^0 \rightarrow \pi^+ \pi^-, D^0 \rightarrow \pi^0 \pi^+ \pi^- K_S^0, K_S^0 \rightarrow \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- \pi^- \pi^- K^+ K^+ \gamma^F)$ | 22197 | 12 | 823 |
| 56 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^0 \pi^- \rho^+ \omega \bar{D}^{*0}, \bar{B}^0 \rightarrow \pi^- a_1^+ \gamma^F, \rho^+ \rightarrow \pi^0 \pi^+, \omega \rightarrow \pi^0 \pi^+ \pi^-, \bar{D}^{*0} \rightarrow \bar{D}^0 \gamma,$ $a_1^+ \rightarrow \pi^+ f_0(600), \bar{D}^0 \rightarrow \pi^0 \pi^- K^+, f_0(600) \rightarrow \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- K^+ \gamma^F \gamma)$ | 24045 | 12 | 835 |

| rowNo | decay tree (decay initial-final states) | iDcyTr | nEtr | nCEtr |
|-------|---|--------|------|-------|
| 57 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^- K^{*+}, \bar{B}^0 \rightarrow \pi^0 \rho^- \omega K^- K^{*+} D^+, K^{*+} \rightarrow \pi^+ K^0, \rho^- \rightarrow \pi^0 \pi^-, \omega \rightarrow \pi^0 \pi^+ \pi^-,$ $K^{*+} \rightarrow \pi^+ K^0 \gamma^F, D^+ \rightarrow e^+ \nu_e \bar{K}^*, K^0 \rightarrow K_L^0, K^0 \rightarrow K_S^0, \bar{K}^* \rightarrow \pi^0 \bar{K}^0, K_S^0 \rightarrow \pi^0 \pi^0,$ $\bar{K}^0 \rightarrow K_S^0, K_S^0 \rightarrow \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow e^+ \nu_e \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- K^- \gamma^F)$ | 24294 | 12 | 847 |
| 58 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^- K^{*+}, \bar{B}^0 \rightarrow \pi^0 \rho^0 \pi^- D^+, K^{*+} \rightarrow \pi^0 K^+, \rho^0 \rightarrow \pi^+ \pi^-, D^+ \rightarrow \mu^+ \nu_\mu \bar{K}^*,$ $\bar{K}^* \rightarrow \pi^0 \bar{K}^0, \bar{K}^0 \rightarrow K_L^0$ $(\Upsilon(4S) \rightarrow \mu^+ \nu_\mu \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^- \pi^- \pi^- K^+)$ | 25236 | 12 | 859 |
| 59 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \rho^- K^{*+}, \bar{B}^0 \rightarrow D^{*+} D_{s1}^{\prime-}, \rho^- \rightarrow \pi^0 \pi^-, K^{*+} \rightarrow \pi^0 K^+, D^{*+} \rightarrow \pi^+ D^0,$ $D_{s1}^{\prime-} \rightarrow \pi^0 D_s^{*-}, D^0 \rightarrow K_S^0 \eta', D_s^{*-} \rightarrow D_s^- \gamma, K_S^0 \rightarrow \pi^+ \pi^-, \eta' \rightarrow \pi^0 \pi^0 \eta, D_s^- \rightarrow e^- \bar{\nu}_e \eta,$ $\eta \rightarrow \pi^0 \pi^0 \pi^0, \eta \rightarrow \gamma \gamma$ $(\Upsilon(4S) \rightarrow e^- \bar{\nu}_e \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- \pi^- K^+ \gamma \gamma \gamma)$ | 27300 | 12 | 871 |
| 60 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^- K^*(1410)^+, \bar{B}^0 \rightarrow D^{*+} D_s^{*-}, K^*(1410)^+ \rightarrow \pi^0 K^{*+}, D^{*+} \rightarrow \pi^+ D^0, D_s^{*-} \rightarrow D_s^- \gamma,$ $K^{*+} \rightarrow \pi^0 K^+, D^0 \rightarrow K^- a_1^+, D_s^- \rightarrow \pi^- \eta', a_1^+ \rightarrow \pi^0 \rho^+, \eta' \rightarrow \pi^0 \pi^0 \eta, \rho^+ \rightarrow \pi^0 \pi^+,$ $\eta \rightarrow \pi^0 \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+ K^- \gamma)$ | 27928 | 12 | 883 |
| 61 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \rho^- \eta \bar{D}^0 D_s^+, \bar{B}^0 \rightarrow \rho^+ K^-, \rho^- \rightarrow \pi^0 \pi^-, \eta \rightarrow \pi^0 \pi^0 \pi^0, \bar{D}^0 \rightarrow \pi^0 \pi^0 \eta,$ $D_s^+ \rightarrow \tau^+ \nu_\tau, \rho^+ \rightarrow \pi^0 \pi^+, \eta \rightarrow \pi^0 \pi^0 \pi^0, \tau^+ \rightarrow \bar{\nu}_\tau \pi^+$ $(\Upsilon(4S) \rightarrow \nu_\tau \bar{\nu}_\tau \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- K^-)$ | 29790 | 12 | 895 |
| 62 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^- K_2^{*+}, \bar{B}^0 \rightarrow \bar{K}^* D^0 \bar{D}^0, K_2^{*+} \rightarrow \pi^0 K^+, \bar{K}^* \rightarrow \pi^+ K^-, D^0 \rightarrow \pi^0 \eta K_S^0,$ $\bar{D}^0 \rightarrow K^+ K^{*-}, \eta \rightarrow \pi^0 \pi^0 \pi^0, K_S^0 \rightarrow \pi^0 \pi^0, K^{*-} \rightarrow \pi^- \bar{K}^0, \bar{K}^0 \rightarrow K_S^0, K_S^0 \rightarrow \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+ K^+ K^-)$ | 30467 | 12 | 907 |
| 63 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^- K_1^+ \gamma^F, \bar{B}^0 \rightarrow \pi^0 \pi^0 \pi^0 \pi^+ \pi^- \pi^- \eta \omega D^+, K_1^+ \rightarrow \pi^0 K^{*+}, \eta \rightarrow \pi^0 \pi^0 \pi^0, \omega \rightarrow \pi^0 \gamma,$ $D^+ \rightarrow e^+ \nu_e \bar{K}^*, K^{*+} \rightarrow \pi^0 K^+, \bar{K}^* \rightarrow \pi^+ K^-$ $(\Upsilon(4S) \rightarrow e^+ \nu_e \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+ K^- \gamma^F \gamma)$ | 30708 | 12 | 919 |
| 64 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow D_s^{*+} D_1^-, \bar{B}^0 \rightarrow \pi^+ K^*(1410)^- \gamma^F, D_s^{*+} \rightarrow D_s^+ \gamma, D_1^- \rightarrow \pi^+ \pi^- D^- \gamma^F, K^*(1410)^- \rightarrow \pi^- \bar{K}^*,$ $D_s^+ \rightarrow \rho^+ \eta', D^- \rightarrow \pi^0 \pi^0 \pi^- \pi^- K^+, \bar{K}^* \rightarrow \pi^+ K^-, \rho^+ \rightarrow \pi^0 \pi^+, \eta' \rightarrow \pi^+ \pi^- \eta, \eta \rightarrow \pi^0 \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- \pi^- K^+ K^- \gamma^F \gamma^F \gamma)$ | 32052 | 12 | 931 |
| 65 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^- \eta K^+, \bar{B}^0 \rightarrow \rho^0 \rho^+ \rho^- \rho^- D^{*+}, \eta \rightarrow \pi^0 \pi^0 \pi^0, \rho^0 \rightarrow \pi^+ \pi^-, \rho^+ \rightarrow \pi^0 \pi^+ \gamma^F,$ $\rho^- \rightarrow \pi^0 \pi^-, \rho^- \rightarrow \pi^0 \pi^- \gamma^F, D^{*+} \rightarrow \pi^+ D^0, D^0 \rightarrow \eta \eta, \eta \rightarrow \pi^0 \pi^+ \pi^-, \eta \rightarrow \pi^0 \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- \pi^- \pi^- K^+ \gamma^F \gamma^F)$ | 32395 | 12 | 943 |
| 66 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^- K_1^+ \gamma^F, \bar{B}^0 \rightarrow K^{*-} D^{*+} \bar{D}^{*0}, K_1^+ \rightarrow \pi^0 \pi^0 K^+, K^{*-} \rightarrow \pi^- \bar{K}^0 \gamma^F, D^{*+} \rightarrow \pi^+ D^0,$ $\bar{D}^{*0} \rightarrow \pi^0 \bar{D}^0, \bar{K}^0 \rightarrow K_S^0, D^0 \rightarrow \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^-, \bar{D}^0 \rightarrow \pi^+ \pi^- K_S^0, K_S^0 \rightarrow \pi^+ \pi^-, K_S^0 \rightarrow \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- \pi^- K^+ \gamma^F \gamma^F)$ | 32992 | 12 | 955 |
| 67 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^- K_0^{*+}, \bar{B}^0 \rightarrow \pi^0 \bar{K}^* K^+ K^- D^0, K_0^{*+} \rightarrow \pi^0 K^+, \bar{K}^* \rightarrow \pi^0 \bar{K}^0, D^0 \rightarrow \pi^+ K^-,$ $\bar{K}^0 \rightarrow K_L^0, K_L^0 \rightarrow \pi^0 \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^- \pi^- K^+ K^+ K^- K^-)$ | 35981 | 12 | 967 |

| rowNo | decay tree (decay initial-final states) | iDcyTr | nEtr | nCEtr |
|-------|--|--------|------|-------|
| 68 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \rho^- K_0^{*+} \gamma, \bar{B}^0 \rightarrow \pi^0 \pi^0 \pi^- \eta \eta D^{*+}, \rho^- \rightarrow \pi^0 \pi^-, K_0^{*+} \rightarrow \pi^0 K^+, \eta \rightarrow \gamma \gamma,$ $\eta \rightarrow \gamma \gamma, D^{*+} \rightarrow \pi^0 D^+, D^+ \rightarrow \pi^0 \pi^+ K_S^0 \gamma^F, K_S^0 \rightarrow \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^- \pi^- K^+ \gamma^F \gamma \gamma \gamma \gamma)$ | 36349 | 12 | 979 |
| 69 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^0 K^+ K^-, \bar{B}^0 \rightarrow \pi^0 \pi^- \eta \eta D^{*+}, \eta \rightarrow \pi^0 \pi^0 \pi^0, \eta \rightarrow \pi^0 \pi^0 \pi^0, D^{*+} \rightarrow \pi^0 D^+,$ $D^+ \rightarrow \pi^+ \bar{K}_1^{0'}, \bar{K}_1^{0'} \rightarrow \pi^0 \bar{K}^*, \bar{K}^* \rightarrow \pi^+ K^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^- \pi^- K^+ K^- K^-)$ | 37557 | 12 | 991 |
| 70 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^0 \pi^0 K^0 D^{*0} \bar{D}^{*0}, \bar{B}^0 \rightarrow \pi^- D^+, K^0 \rightarrow K_L^0, D^{*0} \rightarrow D^0 \gamma, \bar{D}^{*0} \rightarrow \pi^0 \bar{D}^0,$ $D^+ \rightarrow \pi^0 K^+ \gamma^F, D^0 \rightarrow \rho^+ K^{*-}, \bar{D}^0 \rightarrow K^+ a_1^-, \rho^+ \rightarrow \pi^0 \pi^+, K^{*-} \rightarrow \pi^0 K^-, a_1^- \rightarrow \pi^- f_0(600),$ $f_0(600) \rightarrow \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+ K^+ K^- \gamma^F \gamma)$ | 39773 | 12 | 1003 |
| 71 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^+ D^-, \bar{B}^0 \rightarrow D^+ D_{s0}^{*-}, D^- \rightarrow K_S^0 K^-, D^+ \rightarrow \pi^0 \pi^+ K_S^0, D_{s0}^{*-} \rightarrow \pi^0 D_s^-,$ $K_S^0 \rightarrow \pi^+ \pi^-, K_S^0 \rightarrow \pi^+ \pi^-, D_s^- \rightarrow e^- \bar{\nu}_e \eta' \gamma^F, \eta' \rightarrow \pi^0 \pi^0 \eta, \eta \rightarrow \pi^0 \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow e^- \bar{\nu}_e \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- K^- \gamma^F)$ | 40683 | 12 | 1015 |
| 72 | $\Upsilon(4S) \rightarrow \bar{B}^0 \bar{B}^0, \bar{B}^0 \rightarrow \pi^+ \bar{K}_1^{0'}, \bar{B}^0 \rightarrow \pi^0 \pi^0 \pi^- \pi^- \rho^+ \omega \omega D^{*+}, \bar{K}_1^{0'} \rightarrow \pi^0 K^{*-}, \rho^+ \rightarrow \pi^0 \pi^+, \omega \rightarrow \pi^0 \pi^+ \pi^-,$ $\omega \rightarrow \pi^0 \pi^+ \pi^-, D^{*+} \rightarrow \pi^0 D^+, K^{*-} \rightarrow \pi^0 K^-, D^+ \rightarrow K_L^0 a_1^+, a_1^+ \rightarrow \pi^+ \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- K^-)$ | 41060 | 12 | 1027 |
| 73 | $\Upsilon(4S) \rightarrow \bar{B}^0 \bar{B}^0, \bar{B}^0 \rightarrow K^* \bar{K}^*, \bar{B}^0 \rightarrow \pi^0 K^0 K^{*-} D^+, K^* \rightarrow \pi^- K^+ \gamma^F, \bar{K}^* \rightarrow \pi^+ K^-, K^0 \rightarrow K_S^0,$ $K^{*-} \rightarrow \pi^- \bar{K}^0, D^+ \rightarrow \pi^0 \pi^0 \pi^0 \pi^+ \eta, K_S^0 \rightarrow \pi^0 \pi^0, \bar{K}^0 \rightarrow K_S^0, \eta \rightarrow \pi^0 \pi^0 \pi^0, K_S^0 \rightarrow \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+ K^- \gamma^F)$ | 41158 | 12 | 1039 |
| 74 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^+ \eta D^-, \bar{B}^0 \rightarrow \pi^- D^+ \gamma^F, \eta \rightarrow \pi^0 \pi^0 \pi^0, D^- \rightarrow \pi^- \pi^- K^+, D^+ \rightarrow \pi^+ K_S^0,$ $K_S^0 \rightarrow \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+ \gamma^F)$ | 41878 | 12 | 1051 |
| 75 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^- K_0^{*+} \gamma^F, \bar{B}^0 \rightarrow \bar{K}^* D^- D^{*+}, K_0^{*+} \rightarrow \pi^0 K^+, \bar{K}^* \rightarrow \pi^0 \bar{K}^0, D^- \rightarrow K_L^0 a_1^-,$ $D^{*+} \rightarrow \pi^+ D^0, \bar{K}^0 \rightarrow K_S^0, K_L^0 \rightarrow \mu^- \nu_\mu \pi^+, a_1^- \rightarrow \pi^0 \rho^-, D^0 \rightarrow K_L^0 \eta', K_S^0 \rightarrow \pi^0 \pi^0,$ $\rho^- \rightarrow \pi^0 \pi^-, \eta' \rightarrow \pi^0 \pi^0 \eta, \eta \rightarrow \pi^0 \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \mu^- \nu_\mu \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^- \pi^- K^+ \gamma^F)$ | 177 | 11 | 1062 |
| 76 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^+ \eta \omega D^{*-}, \bar{B}^0 \rightarrow \pi^+ K^- \gamma^F, \eta \rightarrow \pi^0 \pi^0 \pi^0, \omega \rightarrow \pi^0 \pi^+ \pi^-, D^{*-} \rightarrow \pi^0 D^-,$ $D^- \rightarrow \pi^0 K_L^0 \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- K^- \gamma^F)$ | 1193 | 11 | 1073 |
| 77 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow K^* D^+ D^{*-}, \bar{B}^0 \rightarrow \pi^+ K^* (1410)^-, K^* \rightarrow \pi^- K^+, D^+ \rightarrow \pi^0 \pi^+ \pi^+ \pi^- \eta, D^{*-} \rightarrow \pi^- \bar{D}^0,$ $K^* (1410)^- \rightarrow \pi^0 K^-, \eta \rightarrow \pi^0 \pi^0 \pi^0, \bar{D}^0 \rightarrow \pi^0 K_L^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+ K^-)$ | 3849 | 11 | 1084 |
| 78 | $\Upsilon(4S) \rightarrow B^0 B^0, B^0 \rightarrow K^- K^{*+}, B^0 \rightarrow D^{*-} D_{s1}^{'+} \gamma, K^{*+} \rightarrow \pi^0 K^+, D^{*-} \rightarrow \pi^0 D^-, D_{s1}^{'+} \rightarrow D_s^+ \gamma,$ $D^- \rightarrow \pi^- \pi^- K^{*+}, D_s^+ \rightarrow K_S^0 K^+, K^{*+} \rightarrow \pi^+ K^0, K_S^0 \rightarrow \pi^0 \pi^0, K^0 \rightarrow K_S^0, K_S^0 \rightarrow \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+ K^+ K^- \gamma \gamma)$ | 5444 | 11 | 1095 |

| rowNo | decay tree (decay initial-final states) | iDcyTr | nEtr | nCEtr |
|-------|---|--------|------|-------|
| 79 | $\Upsilon(4S) \rightarrow B^0 B^0, B^0 \rightarrow \rho^- K^+, B^0 \rightarrow \pi^- K^+ D^{*-} \bar{\Sigma}^+ \Sigma^0, \rho^- \rightarrow \pi^0 \pi^-, D^{*-} \rightarrow \pi^- \bar{D}^0, \bar{\Sigma}^+ \rightarrow \pi^+ \bar{n},$ $\Sigma^0 \rightarrow \Lambda \gamma, \bar{D}^0 \rightarrow \pi^0 \pi^- K^+, \Lambda \rightarrow \pi^- p$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^+ \pi^- \pi^- \pi^- \pi^- K^+ K^+ K^+ \bar{n} p \gamma)$ | 6464 | 11 | 1106 |
| 80 | $\Upsilon(4S) \rightarrow B^0 B^0, B^0 \rightarrow K^+ a_1^-, B^0 \rightarrow \pi^0 \pi^+ D^{*-}, a_1^- \rightarrow \pi^- f_0(600), D^{*-} \rightarrow \pi^0 D^-, f_0(600) \rightarrow \pi^+ \pi^-,$ $D^- \rightarrow \pi^0 K_L^0 \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^- \pi^- \pi^- K^+)$ | 6923 | 11 | 1117 |
| 81 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \mu^+ \nu_\mu \eta D^-, \bar{B}^0 \rightarrow \pi^+ K^*(1410)^-, \eta \rightarrow \gamma \gamma, D^- \rightarrow \pi^0 \pi^+ \pi^- \pi^- \eta, K^*(1410)^- \rightarrow \pi^0 K^{*-},$ $\eta \rightarrow \pi^0 \pi^0 \pi^0, K^{*-} \rightarrow \pi^0 K^-$ $(\Upsilon(4S) \rightarrow \mu^+ \nu_\mu \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^- \pi^- K^- \gamma \gamma)$ | 9402 | 11 | 1128 |
| 82 | $\Upsilon(4S) \rightarrow \bar{B}^0 \bar{B}^0, \bar{B}^0 \rightarrow \rho^+ K^-, \bar{B}^0 \rightarrow \pi^0 \bar{K}^* \eta' D^{*0}, \rho^+ \rightarrow \pi^0 \pi^+, \bar{K}^* \rightarrow \pi^+ K^-, \eta' \rightarrow \pi^0 \pi^0 \eta,$ $D^{*0} \rightarrow \pi^0 D^0, \eta \rightarrow \pi^0 \pi^0 \pi^0, D^0 \rightarrow \pi^+ \pi^+ \pi^- \pi^-$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- K^- K^-)$ | 10470 | 11 | 1139 |
| 83 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^+ D^-, \bar{B}^0 \rightarrow \pi^0 \pi^+ \pi^- \rho^- \eta D^{*+} \gamma^F, D^- \rightarrow K_L^0 K^-, \rho^- \rightarrow \pi^0 \pi^-, \eta \rightarrow \pi^0 \pi^0 \pi^0,$ $D^{*+} \rightarrow \pi^0 D^+, K_L^0 \rightarrow \mu^+ \nu_\mu \pi^-, D^+ \rightarrow K_L^0 \pi^+$ $(\Upsilon(4S) \rightarrow \mu^+ \nu_\mu \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- K^- \gamma^F)$ | 12294 | 11 | 1150 |
| 84 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow e^+ \nu_e D^-, \bar{B}^0 \rightarrow K^- \rho^+(1450), D^- \rightarrow e^- \bar{\nu}_e K^0, \rho^+(1450) \rightarrow \pi^0 \pi^+, K^0 \rightarrow K_S^0,$ $K_S^0 \rightarrow \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow e^+ e^- \nu_e \bar{\nu}_e \pi^0 \pi^+ \pi^+ \pi^- K^-)$ | 12389 | 11 | 1161 |
| 85 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow K^- K^{*+}, \bar{B}^0 \rightarrow D^{*+} \Delta^- \bar{\Delta}^0, K^{*+} \rightarrow \pi^0 K^+, D^{*+} \rightarrow \pi^+ D^0, \Delta^- \rightarrow \pi^- n,$ $\bar{\Delta}^0 \rightarrow \pi^+ \bar{p}, D^0 \rightarrow \pi^0 \pi^+ K^- \gamma^F$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^+ \pi^+ \pi^- K^+ K^- K^- n \bar{p} \gamma^F)$ | 16109 | 11 | 1172 |
| 86 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \rho^- K^{*+}, \bar{B}^0 \rightarrow \bar{K}^0 D^{*+} D^{*-}, \rho^- \rightarrow \pi^0 \pi^-, K^{*+} \rightarrow \pi^0 K^+, \bar{K}^0 \rightarrow K_L^0,$ $D^{*+} \rightarrow \pi^+ D^0, D^{*-} \rightarrow \pi^- \bar{D}^0, D^0 \rightarrow \pi^0 \pi^0 \pi^0 \pi^+ \pi^- K_S^0, \bar{D}^0 \rightarrow \mu^- \bar{\nu}_\mu K^+, K_S^0 \rightarrow \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \mu^- \bar{\nu}_\mu \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^- \pi^- K^+ K^+)$ | 16123 | 11 | 1183 |
| 87 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow K^- K^{*+}, \bar{B}^0 \rightarrow D^+ D_s^{*-}, K^{*+} \rightarrow \pi^0 K^+, D^+ \rightarrow \pi^+ \bar{K}_1^{*0}, D_s^{*-} \rightarrow \pi^0 D_s^-,$ $\bar{K}_1^{*0} \rightarrow \pi^0 \bar{K}^*, D_s^- \rightarrow \mu^- \bar{\nu}_\mu \phi, \bar{K}^* \rightarrow \pi^0 \bar{K}^0, \phi \rightarrow K^+ K^-, \bar{K}^0 \rightarrow K_S^0, K_S^0 \rightarrow \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \mu^- \bar{\nu}_\mu \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ K^+ K^+ K^- K^-)$ | 18322 | 11 | 1194 |
| 88 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow K^- K_0^{*+}, \bar{B}^0 \rightarrow \bar{K}^* D^+ D^-, K_0^{*+} \rightarrow \pi^+ K^0, \bar{K}^* \rightarrow \pi^0 \bar{K}^0, D^+ \rightarrow \pi^0 \pi^0 \pi^0 \pi^+ \eta,$ $D^- \rightarrow \pi^- \pi^- K^{*+}, K^0 \rightarrow K_S^0, \bar{K}^0 \rightarrow K_S^0, \eta \rightarrow \pi^0 \pi^0 \pi^0, K^{*+} \rightarrow \pi^+ K^0, K_S^0 \rightarrow \pi^+ \pi^-,$ $K_S^0 \rightarrow \pi^+ \pi^-, K^0 \rightarrow K_L^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- K^-)$ | 19712 | 11 | 1205 |
| 89 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \rho^+ D^{*-} \Sigma^+ \bar{\Sigma}^-, \bar{B}^0 \rightarrow \pi^- D^+, \rho^+ \rightarrow \pi^0 \pi^+ \gamma^F, D^{*-} \rightarrow \pi^- \bar{D}^0, \Sigma^+ \rightarrow \pi^0 p,$ $\bar{\Sigma}^- \rightarrow \pi^0 \bar{p}, D^+ \rightarrow \pi^0 K^+, \bar{D}^0 \rightarrow \pi^- \eta K^+ \gamma^F, \eta \rightarrow \gamma \gamma$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^- \pi^- \pi^- K^+ K^+ p \bar{p} \gamma^F \gamma^F \gamma \gamma)$ | 22857 | 11 | 1216 |
| 90 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \rho^0 \pi^+ \eta \omega \omega D^-, \bar{B}^0 \rightarrow K^+ K^{*-}, \rho^0 \rightarrow \pi^+ \pi^-, \eta \rightarrow \gamma \gamma, \omega \rightarrow \pi^0 \pi^+ \pi^-,$ $\omega \rightarrow \pi^0 \pi^+ \pi^-, D^- \rightarrow \pi^0 \pi^- K^*, K^{*-} \rightarrow \pi^0 K^-, K^* \rightarrow \pi^- K^+$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- K^+ K^+ K^- \gamma \gamma)$ | 23398 | 11 | 1227 |

| rowNo | decay tree (decay initial-final states) | iDcyTr | nEtr | nCEtr |
|-------|--|--------|-------|-------|
| 91 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow D_2^{*-} D_s^+, \bar{B}^0 \rightarrow K^- D^+, D_2^{*-} \rightarrow \pi^0 D^-, D_s^+ \rightarrow \pi^0 \pi^0 \pi^0 \pi^+ \eta, D^+ \rightarrow K_L^0 \pi^+,$ $D^- \rightarrow K_L^0 \pi^+ \pi^- \pi^-, \eta \rightarrow \pi^0 \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 K_L^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- K^-)$ | 23556 | 11 | 1238 |
| 92 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^0 \pi^+ \pi^- \gamma^F, \bar{B}^0 \rightarrow \pi^0 \omega K^0 \bar{K}^0 D^{*0}, \omega \rightarrow \pi^0 \pi^+ \pi^-, K^0 \rightarrow K_S^0, \bar{K}^0 \rightarrow K_L^0,$ $D^{*0} \rightarrow \pi^0 D^0, K_S^0 \rightarrow \pi^+ \pi^-, K_L^0 \rightarrow \mu^+ \nu_\mu \pi^-, D^0 \rightarrow K^- a_1^+, a_1^+ \rightarrow \pi^0 K^0 K^+, K^0 \rightarrow K_L^0$ $(\Upsilon(4S) \rightarrow \mu^+ \nu_\mu \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 K_L^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+ K^- \gamma^F)$ | 24974 | 11 | 1249 |
| 93 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow K^+ a_1^-, \bar{B}^0 \rightarrow \pi^0 \omega K^- \Xi^+ \Xi_c^0, a_1^- \rightarrow \rho^0 \pi^-, \omega \rightarrow \pi^0 \gamma, \Xi^+ \rightarrow \pi^+ \bar{\Lambda},$ $\Xi_c^0 \rightarrow \pi^+ K^- K^- p, \rho^0 \rightarrow \pi^+ \pi^- \gamma^F, \bar{\Lambda} \rightarrow \pi^0 \bar{n}$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- K^+ K^- K^- K^- \bar{n} p \gamma^F \gamma)$ | 25727 | 11 | 1260 |
| 94 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \tau^+ \nu_\tau D_1'^-, \bar{B}^0 \rightarrow K^+ K^{*-}, \tau^+ \rightarrow e^+ \nu_e \bar{\nu}_\tau \gamma^F \gamma^F, D_1'^- \rightarrow \pi^- \bar{D}^{*0}, K^{*-} \rightarrow \pi^0 K^-,$ $\bar{D}^{*0} \rightarrow \pi^0 \bar{D}^0, \bar{D}^0 \rightarrow \pi^0 \pi^0 \pi^0 K_S^0, K_S^0 \rightarrow \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow e^+ \nu_e \bar{\nu}_\tau \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^- K^+ K^- \gamma^F \gamma^F)$ | 26318 | 11 | 1271 |
| 95 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^+ \pi^- K^*, \bar{B}^0 \rightarrow \pi^+ \eta K^0 \bar{K}^0 D^-, K^* \rightarrow \pi^- K^+, \eta \rightarrow \pi^0 \pi^0 \pi^0, K^0 \rightarrow K_L^0,$ $\bar{K}^0 \rightarrow K_L^0, D^- \rightarrow \pi^- \pi^- K^+$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 K_L^0 K_L^0 \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- K^+ K^+)$ | 26499 | 11 | 1282 |
| 96 | $\Upsilon(4S) \rightarrow \bar{B}^0 \bar{B}^0, \bar{B}^0 \rightarrow \pi^0 \pi^+ K^- \gamma^F, \bar{B}^0 \rightarrow \pi^+ \pi^+ \eta K^{*-} \eta' D^{*-}, \eta \rightarrow \pi^0 \pi^+ \pi^- \gamma^F, K^{*-} \rightarrow \pi^- \bar{K}^0, \eta' \rightarrow \pi^0 \pi^0 \eta,$ $D^{*-} \rightarrow \pi^- \bar{D}^0, \bar{K}^0 \rightarrow K_S^0, \eta \rightarrow \pi^0 \pi^+ \pi^-, \bar{D}^0 \rightarrow \pi^0 \pi^+ \pi^- K^*, K_S^0 \rightarrow \pi^0 \pi^0, K^* \rightarrow \pi^- K^+$ $(\Upsilon(4S) \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^- K^+ K^- \gamma^F \gamma^F)$ | 27693 | 11 | 1293 |
| 97 | $\Upsilon(4S) \rightarrow \bar{B}^0 \bar{B}^0, \bar{B}^0 \rightarrow \pi^+ K^* (1410)^-, \bar{B}^0 \rightarrow \pi^- \bar{K}^0 D^+ \bar{D}^{*0}, K^* (1410)^- \rightarrow \pi^0 K^{*-}, \bar{K}^0 \rightarrow K_L^0, D^+ \rightarrow \mu^+ \nu_\mu \bar{K}^0,$ $\bar{D}^{*0} \rightarrow \pi^0 \bar{D}^0, K^{*-} \rightarrow \pi^0 K^-, \bar{K}^0 \rightarrow K_S^0, \bar{D}^0 \rightarrow \pi^0 \pi^- K^{*+}, K_S^0 \rightarrow \pi^+ \pi^-, K^{*+} \rightarrow \pi^0 K^+$ $(\Upsilon(4S) \rightarrow \mu^+ \nu_\mu \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+ K^-)$ | 28205 | 11 | 1304 |
| 98 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^+ \pi^- K^0 \chi_{c1}, \bar{B}^0 \rightarrow \pi^+ K_1^-, K^0 \rightarrow K_S^0, \chi_{c1} \rightarrow \pi^0 \pi^0 \pi^0 \pi^- K^0 \bar{K}^0 \bar{n} p, K_1^- \rightarrow \pi^+ \pi^- K^-,$ $K_S^0 \rightarrow \pi^+ \pi^-, K^0 \rightarrow K_L^0, \bar{K}^0 \rightarrow K_S^0, K_L^0 \rightarrow \mu^- \nu_\mu \pi^+, K_S^0 \rightarrow \pi^0 \pi^0$ $(\Upsilon(4S) \rightarrow \mu^- \nu_\mu \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- K^- \bar{n} p)$ | 29633 | 11 | 1315 |
| 99 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^- K^0 D^+ \bar{D}^{*0}, \bar{B}^0 \rightarrow \pi^+ \bar{K}_1'^-, K^0 \rightarrow K_S^0, D^+ \rightarrow \pi^0 \pi^+ \bar{K}^*, \bar{D}^{*0} \rightarrow \bar{D}^0 \gamma,$ $\bar{K}_1'^- \rightarrow \pi^0 K^{*-}, K_S^0 \rightarrow \pi^0 \pi^0, \bar{K}^* \rightarrow \pi^0 \bar{K}^0, \bar{D}^0 \rightarrow e^- \bar{\nu}_e K^+, K^{*-} \rightarrow \pi^0 K^-, \bar{K}^0 \rightarrow K_L^0$ $(\Upsilon(4S) \rightarrow e^- \bar{\nu}_e \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^- K^+ K^- \gamma)$ | 31205 | 11 | 1326 |
| 100 | $\Upsilon(4S) \rightarrow B^0 \bar{B}^0, B^0 \rightarrow \pi^- K^+ \chi_{c1}, \bar{B}^0 \rightarrow \pi^+ K^{*-}, \chi_{c1} \rightarrow \pi^0 \pi^0 \pi^+ \pi^- \eta \eta \omega, K^{*-} \rightarrow \pi^0 K^-, \eta \rightarrow e^+ e^- \gamma^F,$ $\eta \rightarrow \pi^0 \pi^+ \pi^-, \omega \rightarrow \pi^0 \pi^+ \pi^-$ $(\Upsilon(4S) \rightarrow e^+ e^- \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+ K^- \gamma^F)$ | 31929 | 11 | 1337 |
| rest | $\Upsilon(4S) \rightarrow \text{others (41864 in total)}$ $(\Upsilon(4S) \rightarrow \text{corresponding to others})$ | — | 55090 | 56427 |

Table 2: Decay branches of B^0 .

| rowNo | decay branch of B^0 | iDcyBrP | nCase | nCCase |
|-------|--|---------|-------|--------|
| 1 | $B^0 \rightarrow \pi^0 \bar{D}^0$ | 3 | 2647 | 2647 |
| 2 | $B^0 \rightarrow \rho^+ D^{*-}$ | 36 | 1684 | 4331 |
| 3 | $B^0 \rightarrow \rho^+ D^-$ | 43 | 1668 | 5999 |
| 4 | $B^0 \rightarrow \pi^- K_0^{*+}$ | 8 | 1603 | 7602 |
| 5 | $B^0 \rightarrow K^0 K^+ K^-$ | 2 | 1461 | 9063 |
| 6 | $B^0 \rightarrow \pi^0 \bar{D}^{*0}$ | 24 | 1310 | 10373 |
| 7 | $B^0 \rightarrow \pi^+ D^-$ | 23 | 1224 | 11597 |
| 8 | $B^0 \rightarrow \rho^- K^+$ | 67 | 961 | 12558 |
| 9 | $B^0 \rightarrow \pi^- K^*(1410)^+$ | 25 | 898 | 13456 |
| 10 | $B^0 \rightarrow \mu^+ \nu_\mu D^{*-}$ | 38 | 880 | 14336 |
| 11 | $B^0 \rightarrow K^- K^{*+}$ | 6 | 756 | 15092 |
| 12 | $B^0 \rightarrow e^+ \nu_e D^{*-}$ | 70 | 712 | 15804 |
| 13 | $B^0 \rightarrow K^- K_0^{*+}$ | 42 | 676 | 16480 |
| 14 | $B^0 \rightarrow \pi^0 K^+ K^-$ | 20 | 618 | 17098 |
| 15 | $B^0 \rightarrow \pi^+ D^{*-}$ | 63 | 567 | 17665 |
| 16 | $B^0 \rightarrow K^+ D^-$ | 151 | 550 | 18215 |
| 17 | $B^0 \rightarrow \pi^0 \pi^+ D^{*-}$ | 11 | 528 | 18743 |
| 18 | $B^0 \rightarrow D^{*-} D_{s0}^{*+}$ | 14 | 518 | 19261 |
| 19 | $B^0 \rightarrow D^{*-} D_s^{*+}$ | 15 | 509 | 19770 |
| 20 | $B^0 \rightarrow K^+ D^{*-} D^{*0}$ | 65 | 482 | 20252 |
| 21 | $B^0 \rightarrow \pi^- K^{*+}$ | 53 | 478 | 20730 |
| 22 | $B^0 \rightarrow K^+ a_1^-$ | 256 | 459 | 21189 |
| 23 | $B^0 \rightarrow \pi^- K_0^{*+} \gamma^F$ | 10 | 374 | 21563 |
| 24 | $B^0 \rightarrow D^{*-} a_1^+$ | 147 | 366 | 21929 |
| 25 | $B^0 \rightarrow \pi^0 \pi^+ \pi^+ \pi^- D^{*-}$ | 57 | 355 | 22284 |
| 26 | $B^0 \rightarrow \pi^0 \pi^+ \pi^-$ | 379 | 331 | 22615 |
| 27 | $B^0 \rightarrow e^+ \nu_e D^{*-} \gamma^F$ | 55 | 326 | 22941 |
| 28 | $B^0 \rightarrow D^{*-} D_{s1}^{'+}$ | 1 | 315 | 23256 |
| 29 | $B^0 \rightarrow \pi^- K^*(1680)^+$ | 209 | 315 | 23571 |
| 30 | $B^0 \rightarrow \pi^- K_1^{'+}$ | 85 | 312 | 23883 |
| 31 | $B^0 \rightarrow \mu^+ \nu_\mu D^-$ | 29 | 301 | 24184 |
| 32 | $B^0 \rightarrow \tau^+ \nu_\tau D^{*-}$ | 39 | 278 | 24462 |
| 33 | $B^0 \rightarrow K^0 K^+ K^- \gamma^F$ | 45 | 275 | 24737 |

| rowNo | decay branch of B^0 | iDcyBrP | nCase | nCCase |
|-------|---|---------|-------|--------|
| 34 | $B^0 \rightarrow \pi^0 K^{*+}(1410)^0$ | 26 | 260 | 24997 |
| 35 | $B^0 \rightarrow D^{*-} D_s^+$ | 33 | 255 | 25252 |
| 36 | $B^0 \rightarrow K^+ D^{*-}$ | 404 | 255 | 25507 |
| 37 | $B^0 \rightarrow \pi^0 \pi^- K^+$ | 150 | 239 | 25746 |
| 38 | $B^0 \rightarrow e^+ \nu_e D^-$ | 90 | 222 | 25968 |
| 39 | $B^0 \rightarrow \pi^+ D^- \gamma^F$ | 30 | 217 | 26185 |
| 40 | $B^0 \rightarrow K^{*+} D^{*-} D^{*0}$ | 189 | 216 | 26401 |
| 41 | $B^0 \rightarrow K^0 D^{*+} D^{*-}$ | 76 | 213 | 26614 |
| 42 | $B^0 \rightarrow \rho^- K^{*+}$ | 183 | 210 | 26824 |
| 43 | $B^0 \rightarrow \pi^- K^*(1410)^+ \gamma^F$ | 132 | 208 | 27032 |
| 44 | $B^0 \rightarrow D^- D_s^+$ | 82 | 205 | 27237 |
| 45 | $B^0 \rightarrow D^- D_{s0}^{*+}$ | 124 | 198 | 27435 |
| 46 | $B^0 \rightarrow D^- D_s^{*+}$ | 78 | 191 | 27626 |
| 47 | $B^0 \rightarrow \rho^+ D^- \gamma$ | 283 | 191 | 27817 |
| 48 | $B^0 \rightarrow K^* D^{*+} D^{*-}$ | 267 | 188 | 28005 |
| 49 | $B^0 \rightarrow K^+ D_s^-$ | 110 | 187 | 28192 |
| 50 | $B^0 \rightarrow X_{sd} \gamma$ | 154 | 184 | 28376 |
| 51 | $B^0 \rightarrow \pi^- \eta K^+$ | 117 | 180 | 28556 |
| 52 | $B^0 \rightarrow D^- a_1^+$ | 35 | 177 | 28733 |
| 53 | $B^0 \rightarrow \rho^- K_0^{*+}$ | 213 | 175 | 28908 |
| 54 | $B^0 \rightarrow \rho^+ D^{*-} \gamma$ | 51 | 165 | 29073 |
| 55 | $B^0 \rightarrow \rho^- K^+ \gamma^F$ | 84 | 165 | 29238 |
| 56 | $B^0 \rightarrow \pi^- K_1^+$ | 100 | 158 | 29396 |
| 57 | $B^0 \rightarrow \pi^0 \rho^- K^+$ | 34 | 156 | 29552 |
| 58 | $B^0 \rightarrow D_2^{*-} D_s^+$ | 69 | 149 | 29701 |
| 59 | $B^0 \rightarrow \rho^+ \rho^-$ | 118 | 149 | 29850 |
| 60 | $B^0 \rightarrow \mu^+ \nu_\mu D^{*-} \gamma^F$ | 49 | 148 | 29998 |
| 61 | $B^0 \rightarrow \pi^0 K^*$ | 361 | 147 | 30145 |
| 62 | $B^0 \rightarrow \rho^0 \bar{D}^0$ | 347 | 144 | 30289 |
| 63 | $B^0 \rightarrow K^- K_0^{*+} \gamma^F$ | 309 | 142 | 30431 |
| 64 | $B^0 \rightarrow \mu^+ \nu_\mu D_1^-$ | 41 | 140 | 30571 |
| 65 | $B^0 \rightarrow \rho^0 \pi^+ D^{*-}$ | 225 | 135 | 30706 |
| 66 | $B^0 \rightarrow K^+ D^- D^{*0}$ | 288 | 135 | 30841 |
| 67 | $B^0 \rightarrow K^0 D^- D^{*+}$ | 125 | 133 | 30974 |
| 68 | $B^0 \rightarrow \pi^- K^+ \gamma^F$ | 493 | 132 | 31106 |

| rowNo | decay branch of B^0 | iDcyBrP | nCase | nCCase |
|-------|---|---------|-------|--------|
| 69 | $B^0 \rightarrow K^- K^{*+} \gamma^F$ | 254 | 129 | 31235 |
| 70 | $B^0 \rightarrow K^- K^* (1680)^+$ | 152 | 128 | 31363 |
| 71 | $B^0 \rightarrow \pi^- \bar{D}^0 D_s^+$ | 634 | 128 | 31491 |
| 72 | $B^0 \rightarrow \tau^+ \nu_\tau D^-$ | 327 | 119 | 31610 |
| 73 | $B^0 \rightarrow \pi^- K^{*+} \gamma^F$ | 178 | 117 | 31727 |
| 74 | $B^0 \rightarrow \pi^0 \pi^+ \pi^- \gamma^F$ | 168 | 115 | 31842 |
| 75 | $B^0 \rightarrow K^+ \rho^- (1450)$ | 685 | 115 | 31957 |
| 76 | $B^0 \rightarrow \pi^+ D^{*-} \gamma^F$ | 28 | 114 | 32071 |
| 77 | $B^0 \rightarrow D^- D_{s1}^+$ | 310 | 112 | 32183 |
| 78 | $B^0 \rightarrow e^+ \nu_e D_1^-$ | 265 | 110 | 32293 |
| 79 | $B^0 \rightarrow \pi^- K_2^{*+}$ | 440 | 110 | 32403 |
| 80 | $B^0 \rightarrow \pi^0 \pi^+ \pi^+ \pi^- D^{*-} \gamma^F$ | 500 | 110 | 32513 |
| 81 | $B^0 \rightarrow \pi^+ \eta D^-$ | 75 | 108 | 32621 |
| 82 | $B^0 \rightarrow \pi^- K^* (1680)^+ \gamma^F$ | 173 | 106 | 32727 |
| 83 | $B^0 \rightarrow \pi^- \bar{D}^0 D_s^{*+}$ | 315 | 106 | 32833 |
| 84 | $B^0 \rightarrow f_2(1270) K^*$ | 140 | 105 | 32938 |
| 85 | $B^0 \rightarrow e^+ \nu_e D^- \gamma^F$ | 498 | 104 | 33042 |
| 86 | $B^0 \rightarrow K^{*+} D^{*-} D^0$ | 245 | 103 | 33145 |
| 87 | $B^0 \rightarrow K^* D^+ D^{*-}$ | 260 | 103 | 33248 |
| 88 | $B^0 \rightarrow \pi^+ \pi^+ \pi^+ \pi^- \pi^- D^{*-}$ | 62 | 102 | 33350 |
| 89 | $B^0 \rightarrow e^+ \nu_e D_1'^-$ | 239 | 101 | 33451 |
| 90 | $B^0 \rightarrow D_2^{*-} D_s^{*+}$ | 9 | 100 | 33551 |
| 91 | $B^0 \rightarrow \pi^+ \eta D^{*-}$ | 180 | 100 | 33651 |
| 92 | $B^0 \rightarrow \pi^0 K_2^{*0}$ | 201 | 100 | 33751 |
| 93 | $B^0 \rightarrow K^* K^+ K^-$ | 77 | 99 | 33850 |
| 94 | $B^0 \rightarrow \mu^+ \nu_\mu D_1'^-$ | 345 | 98 | 33948 |
| 95 | $B^0 \rightarrow e^+ \nu_e D^{*-} \gamma^F \gamma^F$ | 385 | 93 | 34041 |
| 96 | $B^0 \rightarrow K^{*+} D^- D^{*0}$ | 414 | 93 | 34134 |
| 97 | $B^0 \rightarrow \pi^+ \pi^- D^- D_s^{*+}$ | 92 | 92 | 34226 |
| 98 | $B^0 \rightarrow \pi^0 K^+ K^- \gamma^F$ | 266 | 92 | 34318 |
| 99 | $B^0 \rightarrow \rho^0 K_0^0$ | 368 | 92 | 34410 |
| 100 | $B^0 \rightarrow \pi^- K^+$ | 54 | 89 | 34499 |
| rest | $B^0 \rightarrow \text{others (5057 in total)}$ | — | 22217 | 56716 |

Table 3: Cascade decay branches of B^0 (only the first ten hierarchies are involved).

| rowNo | cascade decay branch of B^0 | iCascDcyBrP | nCase | nCCase |
|-------|--|-------------|-------|--------|
| 1 | $B^0 \rightarrow \pi^- K_0^{*+}, K_0^{*+} \rightarrow \pi^0 K^+$ | 8 | 1448 | 1448 |
| 2 | $B^0 \rightarrow \rho^- K^+, \rho^- \rightarrow \pi^0 \pi^-$ | 82 | 909 | 2357 |
| 3 | $B^0 \rightarrow \pi^0 \bar{D}^0, \bar{D}^0 \rightarrow \pi^0 \pi^- K^+$ | 3 | 786 | 3143 |
| 4 | $B^0 \rightarrow K^- K^{*+}, K^{*+} \rightarrow \pi^0 K^+$ | 6 | 735 | 3878 |
| 5 | $B^0 \rightarrow K^0 K^+ K^-, K^0 \rightarrow K_S^0, K_S^0 \rightarrow \pi^0 \pi^0$ | 86 | 646 | 4524 |
| 6 | $B^0 \rightarrow \pi^0 K^+ K^-$ | 20 | 618 | 5142 |
| 7 | $B^0 \rightarrow \rho^+ D^{*-}, \rho^+ \rightarrow \pi^0 \pi^+, D^{*-} \rightarrow \pi^- \bar{D}^0, \bar{D}^0 \rightarrow \pi^- K^+$ | 49 | 603 | 5745 |
| 8 | $B^0 \rightarrow K^- K_0^{*+}, K_0^{*+} \rightarrow \pi^0 K^+$ | 48 | 596 | 6341 |
| 9 | $B^0 \rightarrow \pi^0 \bar{D}^0, \bar{D}^0 \rightarrow \pi^- K^+$ | 76 | 581 | 6922 |
| 10 | $B^0 \rightarrow \rho^+ D^-, \rho^+ \rightarrow \pi^0 \pi^+, D^- \rightarrow \pi^- \pi^- K^+$ | 78 | 523 | 7445 |
| rest | $B^0 \rightarrow \text{others (21160 in total)}$ | — | 49271 | 56716 |

Table 4: Cascade decay branches of \bar{B}^0 (only the first ten hierarchies are involved).

| rowNo | cascade decay branch of \bar{B}^0 | iCascDcyBrP | nCase | nCCase |
|-------|--|-------------|-------|--------|
| 1 | $\bar{B}^0 \rightarrow \pi^+ K_0^{*-}, K_0^{*-} \rightarrow \pi^0 K^-$ | 10 | 1189 | 1189 |
| 2 | $\bar{B}^0 \rightarrow \rho^+ K^-, \rho^+ \rightarrow \pi^0 \pi^+$ | 38 | 836 | 2025 |
| 3 | $\bar{B}^0 \rightarrow \pi^0 D^0, D^0 \rightarrow \pi^0 \pi^+ K^-$ | 59 | 785 | 2810 |
| 4 | $\bar{B}^0 \rightarrow \bar{K}^0 K^+ K^-, \bar{K}^0 \rightarrow K_S^0, K_S^0 \rightarrow \pi^0 \pi^0$ | 11 | 666 | 3476 |
| 5 | $\bar{B}^0 \rightarrow K^+ K^{*-}, K^{*-} \rightarrow \pi^0 K^-$ | 116 | 644 | 4120 |
| 6 | $\bar{B}^0 \rightarrow \pi^0 K^+ K^-$ | 30 | 591 | 4711 |
| 7 | $\bar{B}^0 \rightarrow \rho^- D^{*+}, \rho^- \rightarrow \pi^0 \pi^-, D^{*+} \rightarrow \pi^+ D^0, D^0 \rightarrow \pi^+ K^-$ | 24 | 590 | 5301 |
| 8 | $\bar{B}^0 \rightarrow \pi^0 D^0, D^0 \rightarrow \pi^+ K^-$ | 98 | 586 | 5887 |
| 9 | $\bar{B}^0 \rightarrow \rho^- D^+, \rho^- \rightarrow \pi^0 \pi^-, D^+ \rightarrow \pi^+ \pi^+ K^-$ | 115 | 528 | 6415 |
| 10 | $\bar{B}^0 \rightarrow K^+ K_0^{*-}, K_0^{*-} \rightarrow \pi^0 K^-$ | 83 | 468 | 6883 |
| rest | $\bar{B}^0 \rightarrow \text{others (21376 in total)}$ | — | 49255 | 56138 |