

Topology Analysis ^{*†‡§}

(v2.12.3)

August 16, 2023

^{*}Xingyu Zhou, Liaoning Normal University, zhouxy@lnnu.edu.cn

[†]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.

List of Tables

1	Decay trees and their respective initial-final states.	3
---	--	---

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

rowNo	decay tree (decay initial-final states)	iDcyTr	nEtr	nCEtr
1	$e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^-\eta\bar{K}^0\bar{K}^0K^*K^+\phi\gamma^I, \eta \rightarrow \gamma\gamma, \bar{K}^0 \rightarrow K_L^0, \bar{K}^0 \rightarrow K_L^0, K^* \rightarrow \pi^-K^+, \phi \rightarrow K^+K^-$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0K_L^0K_L^0\pi^-\pi^-K^+K^+K^+K^-\gamma^I\gamma\gamma$)	202	4	4
2	$e^+e^- \rightarrow \pi^0\pi^0\rho^0\pi^+\pi^-\rho^+\rho^-\gamma^I, \rho^0 \rightarrow \pi^+\pi^-, \rho^+ \rightarrow \pi^0\pi^+, \rho^- \rightarrow \pi^0\pi^-$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0\pi^+\pi^+\pi^-\pi^-\pi^-\gamma^I$)	228	3	7
3	$e^+e^- \rightarrow \pi^0\pi^+\pi^+\pi^-\rho^-K^+K^-, \rho^- \rightarrow \pi^0\pi^-$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^+\pi^+\pi^-\pi^-K^+K^-$)	348	3	10
4	$e^+e^- \rightarrow \pi^0\rho^-\bar{K}^0K^+K^+K^-K^{*+}K^{*-}, \rho^- \rightarrow \pi^0\pi^-, \bar{K}^0 \rightarrow K_S^0, K^{*+} \rightarrow \pi^0K^+, K^{*-} \rightarrow \pi^0K^-, K_S^0 \rightarrow \pi^+\pi^-\gamma^F$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0\pi^+\pi^-\pi^-K^+K^+K^+K^-K^-\gamma^F$)	744	3	13
5	$e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^+\pi^-\omega K^-K^{*+}\gamma^I, \omega \rightarrow \pi^0\pi^+\pi^-, K^{*+} \rightarrow \pi^0K^+$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0\pi^+\pi^+\pi^-\pi^-K^+K^-\gamma^I$)	4	2	15
6	$e^+e^- \rightarrow \pi^0\pi^-\rho^+K^+K^{*-}\phi, \rho^+ \rightarrow \pi^0\pi^+, K^{*-} \rightarrow \pi^0K^-, \phi \rightarrow K^+K^-$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^+\pi^-K^+K^+K^-K^-$)	22	2	17
7	$e^+e^- \rightarrow \pi^0\pi^0\omega\bar{K}^0K^*K^+K^-\gamma^I, \omega \rightarrow \pi^0\pi^+\pi^-\gamma^F, \bar{K}^0 \rightarrow K_L^0, K^* \rightarrow \pi^-K^+$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0K_L^0\pi^+\pi^-\pi^-K^+K^+K^-\gamma^I\gamma^F$)	36	2	19
8	$e^+e^- \rightarrow \pi^0\pi^+\pi^-\pi^-\rho^+, \rho^+ \rightarrow \pi^0\pi^+$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^+\pi^+\pi^-\pi^-$)	44	2	21
9	$e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0\pi^0\pi^0\pi^-\bar{K}^*K^{*+}, \bar{K}^* \rightarrow \pi^+K^-, K^{*+} \rightarrow \pi^+K^0, K^0 \rightarrow K_L^0$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0\pi^0\pi^0K_L^0\pi^+\pi^+\pi^-K^-$)	64	2	23
10	$e^+e^- \rightarrow \pi^0\pi^+\pi^+\pi^-\rho^-K^+K^{*-}\gamma^I\gamma^I, \rho^- \rightarrow \pi^0\pi^-, K^{*-} \rightarrow \pi^-\bar{K}^0, \bar{K}^0 \rightarrow K_L^0$ ($e^+e^- \rightarrow \pi^0\pi^0K_L^0\pi^+\pi^+\pi^-\pi^-K^+\gamma^I\gamma^I$)	71	2	25
11	$e^+e^- \rightarrow \pi^0\rho^0\pi^+\pi^-\pi^-\bar{K}^0K^+\gamma^I\gamma^I, \rho^0 \rightarrow \pi^+\pi^-\gamma^F, \bar{K}^0 \rightarrow K_S^0, K_S^0 \rightarrow \pi^+\pi^-$ ($e^+e^- \rightarrow \pi^0\pi^+\pi^+\pi^+\pi^-\pi^-\pi^-K^+\gamma^I\gamma^I\gamma^F$)	77	2	27
12	$e^+e^- \rightarrow \pi^0\pi^+\pi^+\pi^-\rho^+\rho^-K^*K^-, \rho^+ \rightarrow \pi^0\pi^+, \rho^- \rightarrow \pi^0\pi^-, K^* \rightarrow \pi^-K^+$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^+\pi^+\pi^-\pi^-K^+K^-$)	81	2	29
13	$e^+e^- \rightarrow \pi^0\pi^0\pi^+K^+K^-n\bar{p}$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^+K^+K^-n\bar{p}$)	84	2	31
14	$e^+e^- \rightarrow \pi^0\pi^+\pi^+\pi^-\rho^-\omega, \rho^- \rightarrow \pi^0\pi^-, \omega \rightarrow \pi^0\pi^+\pi^-$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^+\pi^+\pi^-\pi^-\pi^-$)	121	2	33
15	$e^+e^- \rightarrow \pi^0\pi^+\pi^-\pi^-\bar{K}^*K^+K^+K^-, \bar{K}^* \rightarrow \pi^0\bar{K}^0, \bar{K}^0 \rightarrow K_S^0, K_S^0 \rightarrow \pi^0\pi^0$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0\pi^+\pi^-\pi^-K^+K^+K^-$)	191	2	35
16	$e^+e^- \rightarrow \pi^0\pi^+\pi^-\rho^+\rho^-K^+K^-, \rho^+ \rightarrow \pi^0\pi^+, \rho^- \rightarrow \pi^0\pi^-$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^+\pi^+\pi^-\pi^-K^+K^-$)	210	2	37
17	$e^+e^- \rightarrow \pi^0\rho^0\pi^+\pi^+\pi^-\rho^-K^+K^-\gamma^I, \rho^0 \rightarrow \pi^+\pi^-, \rho^- \rightarrow \pi^0\pi^-$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^+\pi^+\pi^+\pi^-\pi^-\pi^-K^+K^-\gamma^I$)	222	2	39

rowNo	decay tree (decay initial-final states)	iDcyTr	nEtr	nCEtr
18	$e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^+\pi^-\rho^+\rho^-K^*K^-, \rho^+ \rightarrow \pi^0\pi^+, \rho^- \rightarrow \pi^0\pi^-, K^* \rightarrow \pi^-K^+$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0\pi^+\pi^+\pi^-\pi^-K^+K^-$)	235	2	41
19	$e^+e^- \rightarrow \pi^0\pi^0\rho^+\omega K^*K^-\gamma^I\gamma^I, \rho^+ \rightarrow \pi^0\pi^+, \omega \rightarrow \pi^0\pi^+\pi^-, K^* \rightarrow \pi^-K^+$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0\pi^+\pi^-\pi^-K^+K^-\gamma^I\gamma^I$)	243	2	43
20	$e^+e^- \rightarrow \pi^0\pi^+K^0K^*\phi\gamma^I\gamma^I\gamma^I, K^0 \rightarrow K_L^0, K^{*-} \rightarrow \pi^-\bar{K}^0, \phi \rightarrow K^+K^-, \bar{K}^0 \rightarrow K_S^0, K_S^0 \rightarrow \pi^0\pi^0$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0K_L^0\pi^+\pi^-K^+K^-\gamma^I\gamma^I\gamma^I$)	260	2	45
21	$e^+e^- \rightarrow \pi^0\pi^-\pi^-\rho^+\bar{K}^*K^+\gamma^I\gamma^I, \rho^+ \rightarrow \pi^0\pi^+, \bar{K}^* \rightarrow \pi^+K^-$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^+\pi^-\pi^-K^+K^-\gamma^I\gamma^I$)	276	2	47
22	$e^+e^- \rightarrow \pi^0\pi^0\rho^0\pi^+\pi^-K^+K^-\gamma^I\gamma^I, \rho^0 \rightarrow \pi^+\pi^-$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^+\pi^+\pi^-\pi^-K^+K^-\gamma^I\gamma^I$)	374	2	49
23	$e^+e^- \rightarrow \pi^0\pi^+\pi^-\pi^-\rho^+\rho^-\bar{K}^*K^+\gamma^I, \rho^+ \rightarrow \pi^0\pi^+, \rho^- \rightarrow \pi^0\pi^-, \bar{K}^* \rightarrow \pi^+K^-$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^+\pi^+\pi^-\pi^-K^+K^-\gamma^I$)	393	2	51
24	$e^+e^- \rightarrow \pi^0\pi^+\pi^-\pi^-\bar{n}p\gamma^I$ ($e^+e^- \rightarrow \pi^0\pi^+\pi^-\pi^-\bar{n}p\gamma^I$)	398	2	53
25	$e^+e^- \rightarrow \pi^0\pi^0\pi^+\pi^-\pi^-\rho^+\omega, \rho^+ \rightarrow \pi^0\pi^+, \omega \rightarrow \pi^0\pi^+\pi^-\gamma^F$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0\pi^+\pi^+\pi^-\pi^-\pi^-\gamma^F$)	400	2	55
26	$e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^+\pi^-\pi^-K^*K^-, K^* \rightarrow \pi^-K^+$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^+\pi^+\pi^-\pi^-K^+K^-$)	413	2	57
27	$e^+e^- \rightarrow \pi^-\rho^+\rho^-\bar{K}^0K^+K^+K^-, \rho^+ \rightarrow \pi^0\pi^+, \rho^- \rightarrow \pi^0\pi^-, \bar{K}^0 \rightarrow K_S^0, K_S^0 \rightarrow \pi^+\pi^-$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^+\pi^+\pi^-\pi^-K^+K^+K^-$)	430	2	59
28	$e^+e^- \rightarrow \pi^+\pi^+\pi^+\pi^-\rho^-\omega K^*K^-, \rho^- \rightarrow \pi^0\pi^-, \omega \rightarrow \pi^0\pi^+\pi^-, K^* \rightarrow \pi^-K^+$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^+\pi^+\pi^+\pi^-\pi^-\pi^-K^+K^-$)	438	2	61
29	$e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^-\bar{K}^0K^+K^-K^{*+}\gamma^I, \bar{K}^0 \rightarrow K_L^0, K^{*+} \rightarrow \pi^+K^0, K^0 \rightarrow K_L^0$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0K_L^0K_L^0\pi^+\pi^-K^+K^-\gamma^I$)	453	2	63
30	$e^+e^- \rightarrow \pi^0\pi^-\bar{K}^*K^+n\bar{n}\gamma^I\gamma^I\gamma^I, \bar{K}^* \rightarrow \pi^+K^-$ ($e^+e^- \rightarrow \pi^0\pi^+\pi^-K^+K^-n\bar{n}\gamma^I\gamma^I\gamma^I$)	495	2	65
31	$e^+e^- \rightarrow \pi^0\pi^0\rho^0\pi^+\pi^-K^0\bar{K}^*\gamma^I\gamma^I, \rho^0 \rightarrow \pi^+\pi^-, K^0 \rightarrow K_S^0, \bar{K}^* \rightarrow \pi^+K^-, K_S^0 \rightarrow \pi^+\pi^-\gamma^F$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^+\pi^+\pi^+\pi^-\pi^-\pi^-K^-\gamma^I\gamma^I\gamma^F$)	498	2	67
32	$e^+e^- \rightarrow \pi^0\pi^0\rho^0\rho^-\rho^+K^+K^-, \rho^0 \rightarrow \pi^+\pi^-, \rho^+ \rightarrow \pi^0\pi^+$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^+\pi^+\pi^-\pi^-K^+K^-$)	504	2	69
33	$e^+e^- \rightarrow \pi^0\pi^0\pi^+K^*K^-\phi\gamma^I\gamma^I\gamma^I, K^* \rightarrow \pi^-K^+, \phi \rightarrow K^+K^-$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^+\pi^-K^+K^+K^-K^-\gamma^I\gamma^I\gamma^I$)	569	2	71
34	$e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^+\eta K^*K^-\gamma^I\gamma^I, \eta \rightarrow \pi^0\pi^+\pi^-, K^* \rightarrow \pi^-K^+$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0\pi^+\pi^-\pi^-K^+K^-\gamma^I\gamma^I$)	648	2	73
35	$e^+e^- \rightarrow \rho^0\rho^0\pi^+\pi^-\eta K^+K^-\gamma^I\gamma^I, \rho^0 \rightarrow \pi^+\pi^-, \rho^0 \rightarrow \pi^+\pi^-, \eta \rightarrow \pi^0\pi^+\pi^-$ ($e^+e^- \rightarrow \pi^0\pi^+\pi^+\pi^+\pi^-\pi^-\pi^-\pi^-K^+K^-\gamma^I\gamma^I$)	701	2	75

rowNo	decay tree (decay initial-final states)	iDcyTr	nEtr	nCEtr
36	$e^+e^- \rightarrow \pi^0\pi^+\rho^+K^-\Delta^0\bar{\Sigma}^-\gamma^I\gamma^I, \rho^+ \rightarrow \pi^0\pi^+, \Delta^0 \rightarrow \pi^0n, \bar{\Sigma}^- \rightarrow \pi^-\bar{n}$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^+\pi^-K^-n\bar{n}\gamma^I\gamma^I\gamma^I$)	739	2	77
37	$e^+e^- \rightarrow \pi^0\rho^+\rho^-K^+K^-p\bar{p}, \rho^+ \rightarrow \pi^0\pi^+, \rho^- \rightarrow \pi^0\pi^-\gamma^F$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^+\pi^-K^+K^-p\bar{p}\gamma^F$)	784	2	79
38	$e^+e^- \rightarrow \pi^0\pi^0\rho^0K^*\bar{K}^*\phi, \rho^0 \rightarrow \pi^+\pi^-, K^* \rightarrow \pi^-K^+, \bar{K}^* \rightarrow \pi^+K^-, \phi \rightarrow K^+K^-$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^+\pi^+\pi^-\pi^-K^+K^+K^-K^-$)	792	2	81
39	$e^+e^- \rightarrow \pi^-\rho^+\rho^-\omega\bar{K}^0K^+, \rho^+ \rightarrow \pi^0\pi^+, \rho^- \rightarrow \pi^0\pi^-, \omega \rightarrow \pi^0\pi^+\pi^-, \bar{K}^0 \rightarrow K_L^0$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0K_L^0\pi^+\pi^+\pi^-\pi^-K^+$)	830	2	83
40	$e^+e^- \rightarrow \pi^0\rho^0\omega K^0\bar{K}^*K^+K^-\gamma^I, \rho^0 \rightarrow \pi^+\pi^-, \omega \rightarrow \pi^0\pi^+\pi^-, K^0 \rightarrow K_S^0, \bar{K}^* \rightarrow \pi^+K^-, K_S^0 \rightarrow \pi^0\pi^0$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0\pi^+\pi^+\pi^-\pi^-K^+K^-K^-\gamma^I$)	9	1	84
41	$e^+e^- \rightarrow \pi^0\rho^0\pi^-\bar{K}^0K^+K^+K^-\phi\gamma^I, \rho^0 \rightarrow \pi^+\pi^-, \bar{K}^0 \rightarrow K_S^0, \phi \rightarrow K^+K^-, K_S^0 \rightarrow \pi^+\pi^-$ ($e^+e^- \rightarrow \pi^0\pi^+\pi^+\pi^-\pi^-\pi^-K^+K^+K^-K^-\gamma^I$)	10	1	85
42	$e^+e^- \rightarrow \pi^0\rho^0\pi^-\rho^+K^+K^-\gamma^I\gamma^I, \rho^0 \rightarrow \pi^+\pi^-, \rho^+ \rightarrow \pi^0\pi^+\gamma^F$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^+\pi^+\pi^-\pi^-K^+K^-\gamma^I\gamma^I\gamma^F$)	11	1	86
43	$e^+e^- \rightarrow \pi^0\pi^0\rho^0\pi^-\pi^-\rho^+\rho^+\gamma^I, \rho^0 \rightarrow \pi^+\pi^-, \rho^+ \rightarrow \pi^0\pi^+, \rho^+ \rightarrow \pi^0\pi^+$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0\pi^+\pi^+\pi^-\pi^-\gamma^I$)	12	1	87
44	$e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^+\pi^+\pi^-\pi^-\omega\bar{K}^0K^*, \omega \rightarrow \pi^0\pi^+\pi^-, \bar{K}^0 \rightarrow K_L^0, K^* \rightarrow \pi^-K^+$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0K_L^0\pi^+\pi^+\pi^-\pi^-\pi^-\pi^-K^+$)	13	1	88
45	$e^+e^- \rightarrow \pi^0\pi^0\pi^+\pi^+\pi^-\pi^-\rho^-\bar{K}^*K^+, \rho^- \rightarrow \pi^0\pi^-, \bar{K}^* \rightarrow \pi^+K^-$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^+\pi^+\pi^-\pi^-\pi^-K^+K^-$)	14	1	89
46	$e^+e^- \rightarrow \pi^0\pi^-\rho^+\omega K^+K^-\gamma^I\gamma^I, \rho^+ \rightarrow \pi^0\pi^+, \omega \rightarrow \pi^0\pi^+\pi^-, K^{*-} \rightarrow \pi^0K^-$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0\pi^+\pi^+\pi^-\pi^-K^+K^-\gamma^I\gamma^I$)	15	1	90
47	$e^+e^- \rightarrow \pi^0\pi^0\pi^-\bar{K}^0K^+\phi\gamma^I, \bar{K}^0 \rightarrow K_S^0, \phi \rightarrow K^+K^-, K_S^0 \rightarrow \pi^+\pi^-$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^+\pi^-\pi^-K^+K^+K^-\gamma^I$)	16	1	91
48	$e^+e^- \rightarrow \pi^0\pi^+\pi^-\rho^+K^*K^-\gamma^I\gamma^I\gamma^I, \rho^+ \rightarrow \pi^0\pi^+, K^* \rightarrow \pi^-K^+$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^+\pi^+\pi^-\pi^-K^+K^-\gamma^I\gamma^I\gamma^I$)	17	1	92
49	$e^+e^- \rightarrow \pi^0\pi^+\pi^+\eta K^0K^*K^-K^-\gamma^I\gamma^I, \eta \rightarrow \pi^0\pi^+\pi^-, K^0 \rightarrow K_L^0, K^* \rightarrow \pi^-K^+$ ($e^+e^- \rightarrow \pi^0\pi^0K_L^0\pi^+\pi^+\pi^-\pi^-K^+K^-K^-\gamma^I\gamma^I$)	18	1	93
50	$e^+e^- \rightarrow \pi^0\pi^-\rho^+\rho^+\rho^-\pi\bar{n}\gamma^I\gamma^I, \rho^+ \rightarrow \pi^0\pi^+, \rho^+ \rightarrow \pi^0\pi^+, \rho^- \rightarrow \pi^0\pi^-$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0\pi^+\pi^+\pi^-\pi^-\pi^-\pi^-\pi^-\pi^-\gamma^I$)	19	1	94
51	$e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^+\pi^-\pi^-\pi^-\bar{K}^0\bar{K}^*K^+K^+\gamma^I, \bar{K}^0 \rightarrow K_L^0, \bar{K}^* \rightarrow \pi^+K^-, K_L^0 \rightarrow \pi^0\pi^0\pi^0$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0\pi^0\pi^+\pi^+\pi^-\pi^-\pi^-K^+K^+K^-\gamma^I$)	20	1	95
52	$e^+e^- \rightarrow \pi^0\pi^0\pi^0\omega K^0\bar{K}^0, \omega \rightarrow \pi^0\pi^+\pi^-, K^0 \rightarrow K_L^0, \bar{K}^0 \rightarrow K_S^0, K_S^0 \rightarrow \pi^0\pi^0$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0\pi^0K_L^0\pi^+\pi^-$)	21	1	96
53	$e^+e^- \rightarrow \pi^0\bar{K}^0K^*K^+K^-\phi\gamma^I\gamma^I, \bar{K}^0 \rightarrow K_L^0, K^* \rightarrow \pi^-K^+, \phi \rightarrow K^+K^-$ ($e^+e^- \rightarrow \pi^0K_L^0\pi^-K^+K^+K^+K^-K^-\gamma^I\gamma^I$)	1	1	97

rowNo	decay tree (decay initial-final states)	iDcyTr	nEtr	nCEtr
54	$e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^+\pi^-\pi^-\omega\omega\bar{K}^*K^+, \omega \rightarrow \pi^0\pi^+\pi^-, \omega \rightarrow \pi^0\pi^+\pi^-, \bar{K}^* \rightarrow \pi^+K^-\gamma^F$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0\pi^+\pi^+\pi^+\pi^-\pi^-\pi^-\pi^-\pi^+K^+K^-\gamma^F$)	23	1	98
55	$e^+e^- \rightarrow \rho^0\pi^-\rho^+\rho^-\bar{K}^0K^{*+}, \rho^0 \rightarrow \pi^+\pi^-\gamma^F, \rho^+ \rightarrow \pi^0\pi^+, \rho^- \rightarrow \pi^0\pi^-, \bar{K}^0 \rightarrow K_L^0, K^{*+} \rightarrow \pi^+K^0,$ $K^0 \rightarrow K_L^0$ ($e^+e^- \rightarrow \pi^0\pi^0K_L^0K_L^0\pi^+\pi^+\pi^+\pi^-\pi^-\pi^-\gamma^F$)	24	1	99
56	$e^+e^- \rightarrow \pi^0\omega K^0\bar{K}^0K^+K^-\gamma^I, \omega \rightarrow \pi^0\pi^+\pi^-, K^0 \rightarrow K_L^0, \bar{K}^0 \rightarrow K_L^0$ ($e^+e^- \rightarrow \pi^0\pi^0K_L^0K_L^0\pi^+\pi^-\pi^+K^+K^-\gamma^I$)	25	1	100
57	$e^+e^- \rightarrow \pi^+\rho^-\bar{K}^0K^*\phi, \rho^- \rightarrow \pi^0\pi^-\gamma^F, \bar{K}^0 \rightarrow K_S^0, K^* \rightarrow \pi^-K^+, \phi \rightarrow K^+K^-, K_S^0 \rightarrow \pi^+\pi^-$ ($e^+e^- \rightarrow \pi^0\pi^+\pi^+\pi^+\pi^-\pi^-\pi^+K^+K^+K^-\gamma^F$)	26	1	101
58	$e^+e^- \rightarrow \pi^0\rho^0\pi^+\pi^+\pi^-\rho^-K^+K^{*-}, \rho^0 \rightarrow \pi^+\pi^-, \rho^- \rightarrow \pi^0\pi^-\gamma^F\gamma^F, K^{*-} \rightarrow \pi^0K^-$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^+\pi^+\pi^+\pi^-\pi^-\pi^+K^+K^-\gamma^F\gamma^F$)	27	1	102
59	$e^+e^- \rightarrow \pi^0\rho^0\pi^+\pi^-\rho^+K^0\bar{K}^0K^*K^-\gamma^I\gamma^I, \rho^0 \rightarrow \pi^+\pi^-, \rho^+ \rightarrow \pi^0\pi^+, K^0 \rightarrow K_L^0, \bar{K}^0 \rightarrow K_S^0, K^* \rightarrow \pi^-K^+,$ $K_S^0 \rightarrow \pi^0\pi^0$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0K_L^0\pi^+\pi^+\pi^+\pi^-\pi^-\pi^+K^+K^-\gamma^I\gamma^I$)	28	1	103
60	$e^+e^- \rightarrow \rho^0\pi^+\pi^-\rho^+K^*K^-K^{*+}K^{*-}\gamma^I, \rho^0 \rightarrow \pi^+\pi^-\gamma^F, \rho^+ \rightarrow \pi^0\pi^+, K^* \rightarrow \pi^-K^+, K^{*+} \rightarrow \pi^+K^0, K^{*-} \rightarrow \pi^-\bar{K}^0,$ $K^0 \rightarrow K_L^0, \bar{K}^0 \rightarrow K_L^0$ ($e^+e^- \rightarrow \pi^0K_L^0K_L^0\pi^+\pi^+\pi^+\pi^+\pi^-\pi^-\pi^-\pi^+K^+K^-\gamma^I\gamma^F$)	29	1	104
61	$e^+e^- \rightarrow \pi^0\pi^0\pi^+\rho^-\omega\bar{K}^0K^*p\bar{p}\gamma^I, \rho^- \rightarrow \pi^0\pi^-, \omega \rightarrow \pi^0\pi^+\pi^-, \bar{K}^0 \rightarrow K_L^0, K^* \rightarrow \pi^-K^+$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0K_L^0\pi^+\pi^+\pi^-\pi^-\pi^+K^+p\bar{p}\gamma^I$)	30	1	105
62	$e^+e^- \rightarrow \pi^0\pi^+\bar{K}^*\Delta^-\bar{\Lambda}\gamma^I\gamma^I\gamma^I, \bar{K}^* \rightarrow \pi^+K^-, \Delta^- \rightarrow \pi^-n, \bar{\Lambda} \rightarrow \pi^0\bar{n}$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^+\pi^+\pi^+K^-n\bar{n}\gamma^I\gamma^I\gamma^I$)	31	1	106
63	$e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0\rho^0\pi^-\bar{K}^*K^+\gamma^I, \rho^0 \rightarrow \pi^+\pi^-, \bar{K}^* \rightarrow \pi^+K^-$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0\pi^+\pi^+\pi^-\pi^+K^+K^-\gamma^I$)	32	1	107
64	$e^+e^- \rightarrow \pi^0\pi^0\rho^0\pi^+K^0K^-\eta'\gamma^I, \rho^0 \rightarrow \pi^+\pi^-, K^0 \rightarrow K_S^0, \eta' \rightarrow \pi^0\pi^0\eta, K_S^0 \rightarrow \pi^0\pi^0, \eta \rightarrow \pi^0\pi^0\pi^0$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0\pi^0\pi^0\pi^0\pi^+\pi^+\pi^+K^+K^-\gamma^I$)	33	1	108
65	$e^+e^- \rightarrow \rho^0\rho^-K^0\bar{K}^0\bar{K}^*K^+, \rho^0 \rightarrow \pi^+\pi^-, \rho^- \rightarrow \pi^0\pi^-, K^0 \rightarrow K_S^0, \bar{K}^0 \rightarrow K_S^0, \bar{K}^* \rightarrow \pi^+K^-,$ $K_S^0 \rightarrow \pi^+\pi^-, K_S^0 \rightarrow \pi^0\pi^0$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^+\pi^+\pi^+\pi^-\pi^-\pi^+K^+K^-$)	34	1	109
66	$e^+e^- \rightarrow \pi^-\rho^-\omega\omega\bar{\Delta}^+p, \rho^- \rightarrow \pi^0\pi^-, \omega \rightarrow \pi^0\gamma, \omega \rightarrow \pi^0\pi^+\pi^-, \bar{\Delta}^+ \rightarrow \pi^+\bar{n}$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^+\pi^+\pi^-\pi^-\pi^-\bar{n}p\gamma$)	35	1	110
67	$e^+e^- \rightarrow \pi^0\pi^0\pi^-\pi^-\rho^+\rho^+, \rho^+ \rightarrow \pi^0\pi^+, \rho^+ \rightarrow \pi^0\pi^+$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0\pi^+\pi^+\pi^-\pi^-$)	2	1	111
68	$e^+e^- \rightarrow \pi^0\pi^-\rho^+\rho^+\omega K^*K^-\gamma^I\gamma^I, \rho^+ \rightarrow \pi^0\pi^+, \rho^+ \rightarrow \pi^0\pi^+, \omega \rightarrow \pi^0\pi^+\pi^-, K^* \rightarrow \pi^-K^+$ ($e^+e^- \rightarrow \pi^0\pi^0\pi^0\pi^0\pi^+\pi^+\pi^-\pi^-\pi^+K^+K^-\gamma^I\gamma^I$)	37	1	112
69	$e^+e^- \rightarrow \pi^0\pi^0\pi^-\bar{K}^0K^*\bar{K}^*K^{*+}\gamma^I\gamma^I, \bar{K}^0 \rightarrow K_L^0, K^* \rightarrow \pi^-K^+, \bar{K}^* \rightarrow \pi^+K^-\gamma^F, K^{*+} \rightarrow \pi^+K^0, K^0 \rightarrow K_S^0,$ $K_S^0 \rightarrow \pi^+\pi^-$ ($e^+e^- \rightarrow \pi^0\pi^0K_L^0\pi^+\pi^+\pi^+\pi^-\pi^-\pi^+K^+K^-\gamma^I\gamma^I\gamma^F$)	38	1	113

rowNo	decay tree (decay initial-final states)	iDcyTr	nEtr	nCEtr
70	$e^+e^- \rightarrow \pi^0 \rho^0 \pi^+ \pi^- \rho^+ \rho^- \bar{K}^0 K^* \gamma^I, \rho^0 \rightarrow \pi^+ \pi^-, \rho^+ \rightarrow \pi^0 \pi^+, \rho^- \rightarrow \pi^0 \pi^-, \bar{K}^0 \rightarrow K_L^0, K^* \rightarrow \pi^- K^+$ ($e^+e^- \rightarrow \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+ \gamma^I$)	39	1	114
71	$e^+e^- \rightarrow \pi^0 \bar{K}^* K^{*+} \Delta \bar{\Sigma}^- \gamma^I, \bar{K}^* \rightarrow \pi^+ K^-, K^{*+} \rightarrow \pi^0 K^+, \Delta \rightarrow \pi^- p, \bar{\Sigma}^- \rightarrow \pi^0 \bar{p}$ ($e^+e^- \rightarrow \pi^0 \pi^0 \pi^0 \pi^+ \pi^- K^+ K^- p \bar{p} \gamma^I$)	40	1	115
72	$e^+e^- \rightarrow \rho^0 \pi^+ \pi^- \pi^- \omega \bar{n} p, \rho^0 \rightarrow \pi^+ \pi^- \gamma^F, \omega \rightarrow \pi^0 \pi^+ \pi^-$ ($e^+e^- \rightarrow \pi^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \bar{n} p \gamma^F$)	41	1	116
73	$e^+e^- \rightarrow \pi^+ \pi^- \rho^- \omega \bar{K}^0 K^+, \rho^- \rightarrow \pi^0 \pi^-, \omega \rightarrow \pi^0 \pi^+ \pi^-, \bar{K}^0 \rightarrow K_S^0, K_S^0 \rightarrow \pi^+ \pi^-$ ($e^+e^- \rightarrow \pi^0 \pi^0 \pi^+ \pi^+ \pi^- \pi^- \pi^- K^+$)	42	1	117
74	$e^+e^- \rightarrow \pi^0 \rho^0 \pi^+ \pi^- K^0 \bar{K}^* \phi \gamma^I \gamma^I, \rho^0 \rightarrow \pi^+ \pi^- \gamma^F, K^0 \rightarrow K_S^0, \bar{K}^* \rightarrow \pi^+ K^-, \phi \rightarrow K^+ K^-, K_S^0 \rightarrow \pi^+ \pi^-$ ($e^+e^- \rightarrow \pi^0 \pi^+ \pi^+ \pi^+ \pi^- \pi^- K^+ K^- K^- \gamma^I \gamma^I \gamma^F$)	43	1	118
75	$e^+e^- \rightarrow \pi^+ K^0 \bar{K}^* \Delta^- \bar{n} \gamma^I, K^0 \rightarrow K_L^0, \bar{K}^* \rightarrow \pi^+ K^-, \Delta^- \rightarrow \pi^- n, K_L^0 \rightarrow \mu^+ \nu_\mu \pi^-$ ($e^+e^- \rightarrow \mu^+ \nu_\mu \pi^+ \pi^+ \pi^- \pi^- K^- n \bar{n} \gamma^I$)	3	1	119
76	$e^+e^- \rightarrow \pi^0 \pi^0 \pi^+ \rho^- \eta K^* \bar{K}^* \gamma^I, \rho^- \rightarrow \pi^0 \pi^-, \eta \rightarrow \gamma \gamma, K^* \rightarrow \pi^- K^+, \bar{K}^* \rightarrow \pi^+ K^-$ ($e^+e^- \rightarrow \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- \pi^- K^+ K^- \gamma^I \gamma \gamma$)	45	1	120
77	$e^+e^- \rightarrow \pi^0 \pi^+ \pi^- \rho^- \omega \bar{K}^0 K^+ K^- K^{*+} \gamma^I, \rho^- \rightarrow \pi^0 \pi^-, \omega \rightarrow \pi^0 \pi^+ \pi^-, \bar{K}^0 \rightarrow K_L^0, K^{*+} \rightarrow \pi^0 K^+$ ($e^+e^- \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 K_L^0 \pi^+ \pi^+ \pi^- \pi^- K^+ K^+ K^- \gamma^I \gamma^F$)	46	1	121
78	$e^+e^- \rightarrow \pi^0 \pi^- \eta \bar{K}^* K^+ n \bar{n}, \eta \rightarrow \gamma \gamma, \bar{K}^* \rightarrow \pi^+ K^-$ ($e^+e^- \rightarrow \pi^0 \pi^+ \pi^- K^+ K^- n \bar{n} \gamma \gamma$)	47	1	122
79	$e^+e^- \rightarrow \pi^- \omega K^0 \bar{K}^0 \bar{K}^* K^+ \gamma^I, \omega \rightarrow \pi^0 \pi^+ \pi^-, K^0 \rightarrow K_S^0, \bar{K}^0 \rightarrow K_S^0, \bar{K}^* \rightarrow \pi^+ K^-, K_S^0 \rightarrow \pi^0 \pi^0,$ $K_S^0 \rightarrow \pi^+ \pi^- \gamma^F$ ($e^+e^- \rightarrow \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- \pi^- K^+ K^- \gamma^I \gamma^F$)	48	1	123
80	$e^+e^- \rightarrow \pi^0 \rho^0 \pi^+ \pi^- \rho^+ K^* K^-, \rho^0 \rightarrow \pi^+ \pi^- \gamma^F, \rho^+ \rightarrow \pi^0 \pi^+, K^* \rightarrow \pi^- K^+$ ($e^+e^- \rightarrow \pi^0 \pi^0 \pi^+ \pi^+ \pi^- \pi^- K^+ K^- \gamma^F$)	49	1	124
81	$e^+e^- \rightarrow \pi^0 \rho^0 \pi^+ \pi^- \rho^+ \rho^- K^+ K^- \gamma^I, \rho^0 \rightarrow \pi^+ \pi^- \gamma^F, \rho^+ \rightarrow \pi^0 \pi^+, \rho^- \rightarrow \pi^0 \pi^-$ ($e^+e^- \rightarrow \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- \pi^- K^+ K^- \gamma^I \gamma^F$)	50	1	125
82	$e^+e^- \rightarrow \pi^+ \pi^- \pi^- \eta \bar{K}^* K^+ \phi, \eta \rightarrow \gamma \gamma, \bar{K}^* \rightarrow \pi^0 \bar{K}^0, \phi \rightarrow K^+ K^-, \bar{K}^0 \rightarrow K_L^0, K_L^0 \rightarrow \pi^0 \pi^0 \pi^0$ ($e^+e^- \rightarrow \pi^0 \pi^0 \pi^0 \pi^+ \pi^- \pi^- K^+ K^+ K^- \gamma \gamma$)	51	1	126
83	$e^+e^- \rightarrow \pi^0 \pi^+ \omega K^+ K^- n \bar{p} \gamma^I, \omega \rightarrow \pi^0 \gamma$ ($e^+e^- \rightarrow \pi^0 \pi^0 \pi^+ K^+ K^- n \bar{p} \gamma^I \gamma$)	52	1	127
84	$e^+e^- \rightarrow \pi^0 \pi^0 \rho^0 \rho^- \bar{K}^* K^+, \rho^0 \rightarrow \pi^+ \pi^- \gamma^F, \rho^- \rightarrow \pi^0 \pi^-, \bar{K}^* \rightarrow \pi^+ K^-$ ($e^+e^- \rightarrow \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- \pi^- K^+ K^- \gamma^F$)	53	1	128
85	$e^+e^- \rightarrow \pi^0 \pi^0 \pi^+ \rho^+ \rho^- \rho^- K^+ K^- \gamma^I \gamma^I, \rho^+ \rightarrow \pi^0 \pi^+, \rho^- \rightarrow \pi^0 \pi^-, \rho^- \rightarrow \pi^0 \pi^-$ ($e^+e^- \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^+ \pi^- \pi^- K^+ K^- \gamma^I \gamma^I$)	54	1	129
86	$e^+e^- \rightarrow \pi^0 \pi^0 \pi^+ \rho^+ \rho^- K^0 K^- \gamma^I, \rho^+ \rightarrow \pi^0 \pi^+, \rho^- \rightarrow \pi^0 \pi^-, K^0 \rightarrow K_S^0, K_S^0 \rightarrow \pi^0 \pi^0$ ($e^+e^- \rightarrow \pi^0 \pi^0 \pi^0 \pi^0 \pi^0 \pi^+ \pi^- K^- \gamma^I$)	55	1	130

[illegible]