Study of $B^+ \to K^+\tau^+\tau^-$ using hadronic tagging

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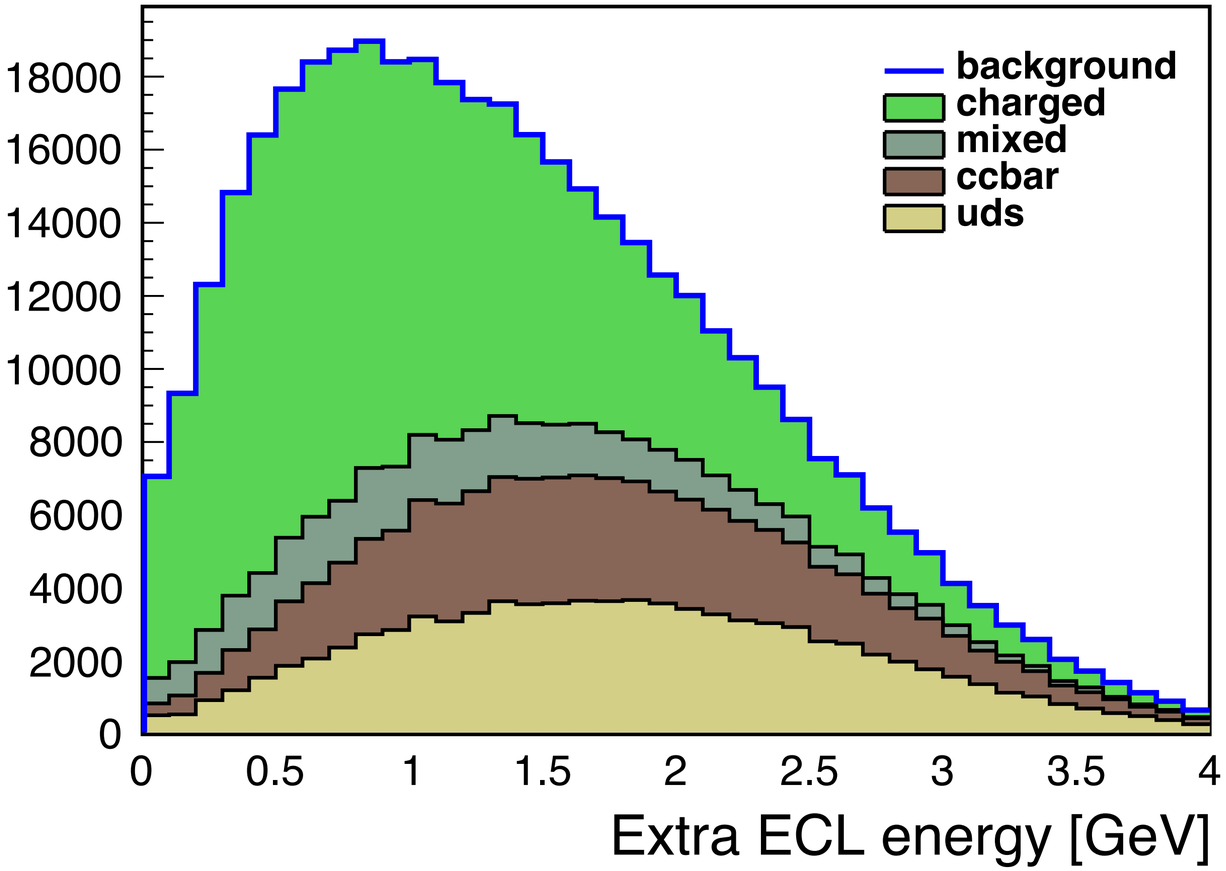
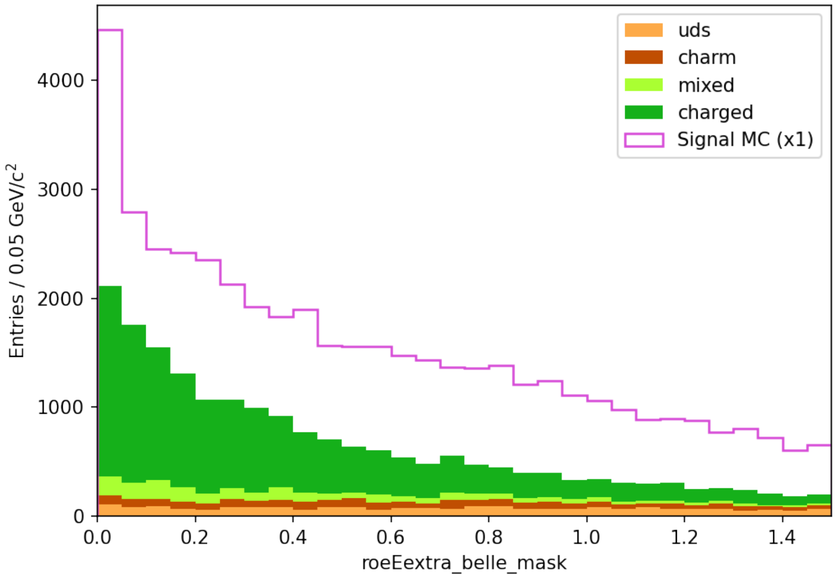
September 30, 2022

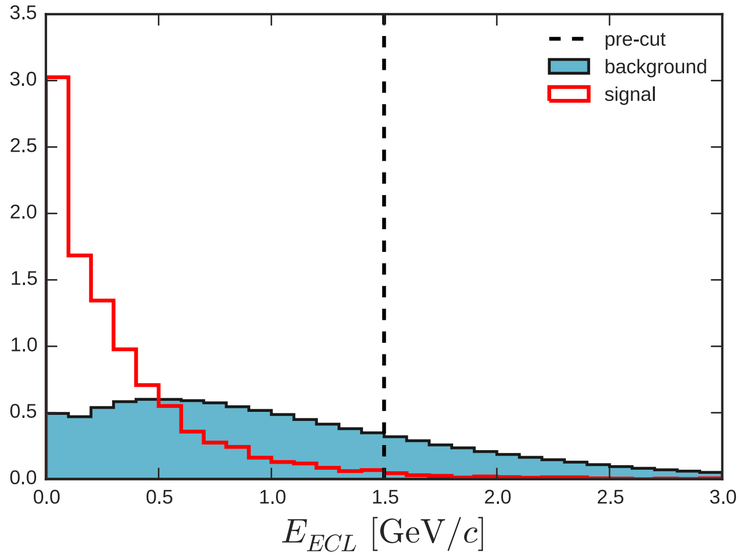
Background

genericMC (MC15rib, $400\,fb^{-1}$)





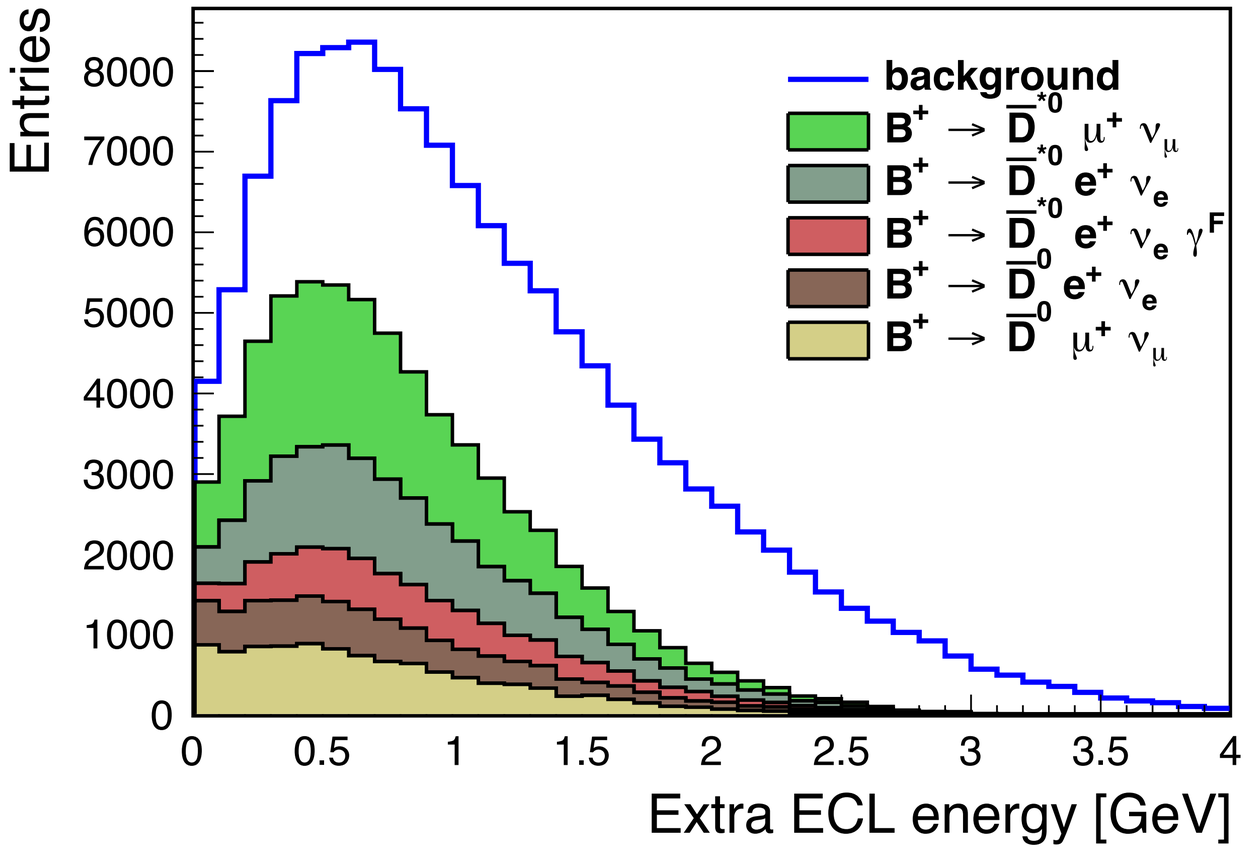
Vidya



Simon

Charged mode

background=> generic charged MC (MC15rib, $400\,fb^{-1}$)



rowNo	decay branch of B^+	iDcyBrP	nCase	nCcCase	nAllCase
1	$B^+ \to \mu^+\nu_\mu\bar{D}^{*0}$	29	11719	11766	23485
2	$B^+ \to \rho^+\bar{D}^0$	5	8053	8135	16188
3	$B^+ \to e^+\nu_e\bar{D}^{*0}$	1	8140	7724	15864
4	$B^+ \to \bar{D}^{*0}a_1^+$	32	6142	6174	12316
5	$B^+ \to \mu^+\nu_\mu\bar{D}^0$	3	5381	5415	10796
6	$B^+ \to \rho^+\bar{D}^{*0}$	24	4231	4297	8528
7	$B^+ \to e^+\nu_e\bar{D}^{*0}\gamma^F$	16	4128	4025	8153
8	$B^+ \to \pi^+\bar{D}^0$	7	3854	3943	7797
9	$B^+ \to e^+\nu_e\bar{D}^0$	31	3867	3913	7780
10	$B^+ \to \pi^+\bar{D}^{*0}$	0	3226	3258	6484
11	$B^+ \to \pi^0\pi^+\pi^+D^{*-}$	20	2902	2923	5825
12	$B^+ \to \pi^0\pi^+\pi^+\pi^-\bar{D}^{*0}$	30	2554	2417	4971
13	$B^+ \to \pi^+\pi^+\pi^-\bar{D}^0$	50	2361	2339	4700
14	$B^+ \to \rho^0\pi^+\bar{D}^0$	10	2331	2346	4677
15	$B^+ \to \bar{D}^0a_1^+$	4	2195	2202	4397
16	$B^+ \to e^+\nu_e\bar{D}^0\gamma^F$	6	1935	1849	3784
17	$B^+ \to \tau^+\nu_\tau\bar{D}^{*0}$	25	1809	1855	3664
18	$B^+ \to \mu^+\nu_\mu\bar{D}^{*0}\gamma^F$	2	1785	1799	3584
19	$B^+ \to \pi^0\rho^+\bar{D}^0$	43	1435	1403	2838
20	$B^+ \to \bar{D}^0D_s^+$	47	1319	1313	2632
21	$B^+ \to \pi^+\omega\bar{D}^0$	17	1106	1118	2224
22	$B^+ \to \rho^+\bar{D}_2^{*0}$	26	1025	1107	2132
23	$B^+ \to \tau^+\nu_\tau\bar{D}^0$	42	1065	1018	2083
24	$B^+ \to e^+\nu_e\bar{D}^{*0}\gamma^F\gamma^F$	52	1074	959	2033

*Decay modes are not mutually exclusive here

Truth match test

signalMC

- No. of events with Btag_isSignal and mother PDG index matched = 46040
- Compare the no. of events in two variations in addition to above flags:
  - with bsig_isSignalMissingNeutrino, #events = 18749
  - with our decays modes using topoana, #events = 34800

WHY?

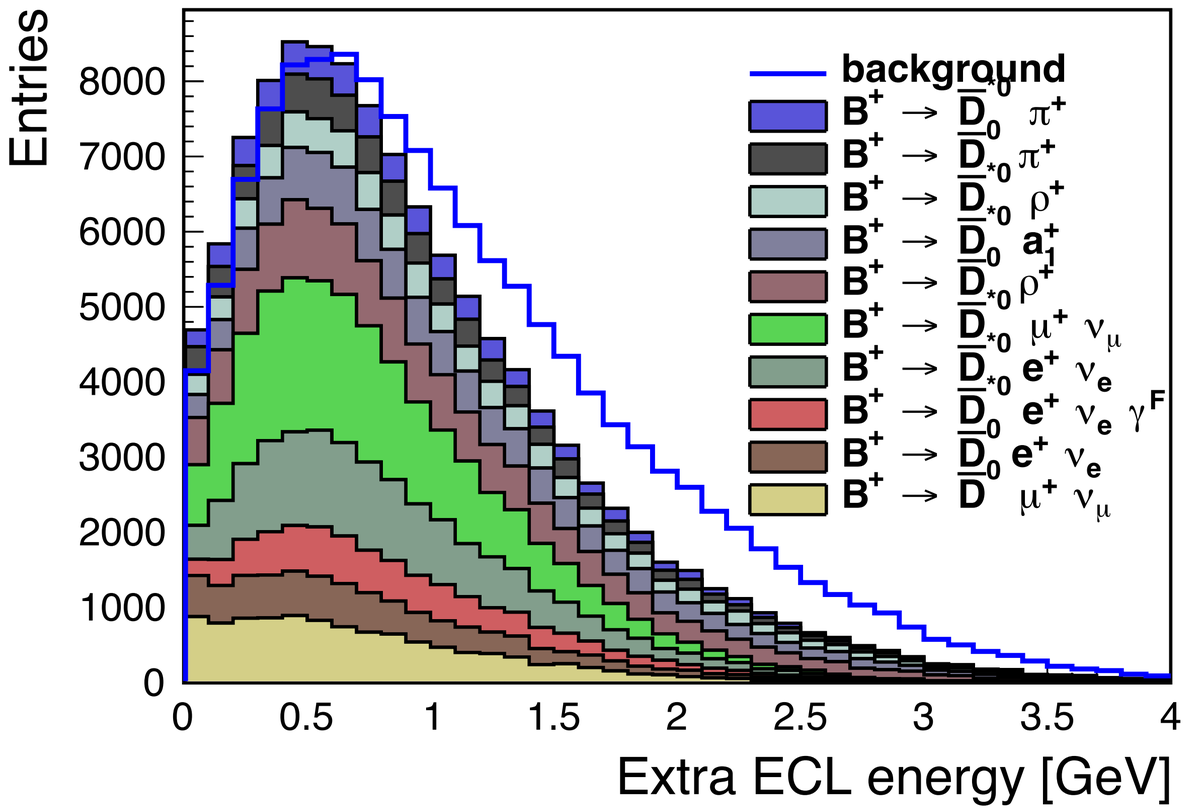
rowNo	decay branch of B^+	iDcyBrP	nCase	nCcCase	nAllCase	nCCase
1	$B^+ \to \tau^+\tau^- K^+$	0	21879	21569	43448	43448
2	$B^+ \to \rho^+ \bar{D}^0$	5	3064	3059	6123	49571
3	$B^+ \to \pi^+ \bar{D}^0$	7	1942	1999	3941	53512
4	$B^+ \to \rho^0\pi^+ \bar{D}^0$	21	1316	1331	2647	56159
5	$B^+ \to \pi^+\pi^+\pi^- \bar{D}^0$	11	1230	1300	2530	58689
6	$B^+ \to \tau^+\tau^- K^+\gamma^F$	14	1276	1245	2521	61210
7	$B^+ \to \bar{D}^{*0} a_1^+$	8	1205	1165	2370	63580
8	$B^+ \to \pi^0\pi^+\pi^+ D^{*-}$	3	1128	1148	2276	65856
9	$B^+ \to \bar{D}^0 a_1^+$	9	1071	1053	2124	67980
10	$B^+ \to \rho^+ \bar{D}^{*0}$	34	623	671	1294	69274
11	$B^+ \to \pi^+ \bar{D}^{*0}$	4	647	636	1283	70557

rowNo	decay branch of τ^+	iDcyBrP	nCase	nCcCase	nAllCase	nCCase
1	$\tau^+ \to \mu^+\nu_\mu\bar{\nu}_\tau$	0	11082	11008	22090	22090
2	$\tau^+ \to \bar{\nu}_\tau\pi^0\pi^+$	1	9434	9569	19003	41093
3	$\tau^+ \to e^+\nu_e\bar{\nu}_\tau$	4	7732	7474	15206	56299
4	$\tau^+ \to \bar{\nu}_\tau\pi^+$	2	6803	6852	13655	69954
5	$\tau^+ \to e^+\nu_e\bar{\nu}_\tau\gamma^F$	3	4130	4118	8248	78202
6	$\tau^+ \to \bar{\nu}_\tau\pi^0\pi^0\pi^+$	5	1992	2030	4022	82224
7	$\tau^+ \to \mu^+\nu_\mu\bar{\nu}_\tau\gamma^F$	9	1279	1326	2605	84829
8	$\tau^+ \to e^+\nu_e\bar{\nu}_\tau\gamma^F\gamma^F$	14	1066	1134	2200	87029
9	$\tau^+ \to \bar{\nu}_\tau\pi^+\gamma^F$	8	743	701	1444	88473
10	$\tau^+ \to \bar{\nu}_\tau\pi^0\pi^+\gamma^F$	12	675	743	1418	89891
11	$\tau^+ \to e^+\nu_e\bar{\nu}_\tau\gamma^F\gamma^F\gamma^F$	18	188	168	356	90247

Backup

Charged mode

background=> generic charged MC (MC15rib, $400\,fb^{-1}$)



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Selection

Charged tracks (e, μ, K, π) cuts:

- transverse distance from IP, $dr < 0.5$
- distance in beam direction from IP, $|dz| < 2$
- polar angle is with in CDC acceptance (thetaInCDCAcceptance)
- Kaon PID, $\mathscr{L}(K) > 0.6$
- Pion PID, $\mathscr{L}(\pi) > 0.6$
- Electron PID, $\mathscr{L}(e) > 0.9$
- Muon PID, $\mathscr{L}(\mu) > 0.9$

Continuum suppression:

- event sphericity > 0.2
- cosTBTO < 0.9

Reconstruct FEI hadronic B_{tag}:

- weight file prefix - 'FEIv4_2021_MC14_release_05_01_12'
- most probable B_{tag} candidates is accepted
- $M_{bc} > 5.27$
- $|\Delta E| < 0.1$
- FEI signal probability > 0.001
- ROE of B_{tag} has 3 charged tracks

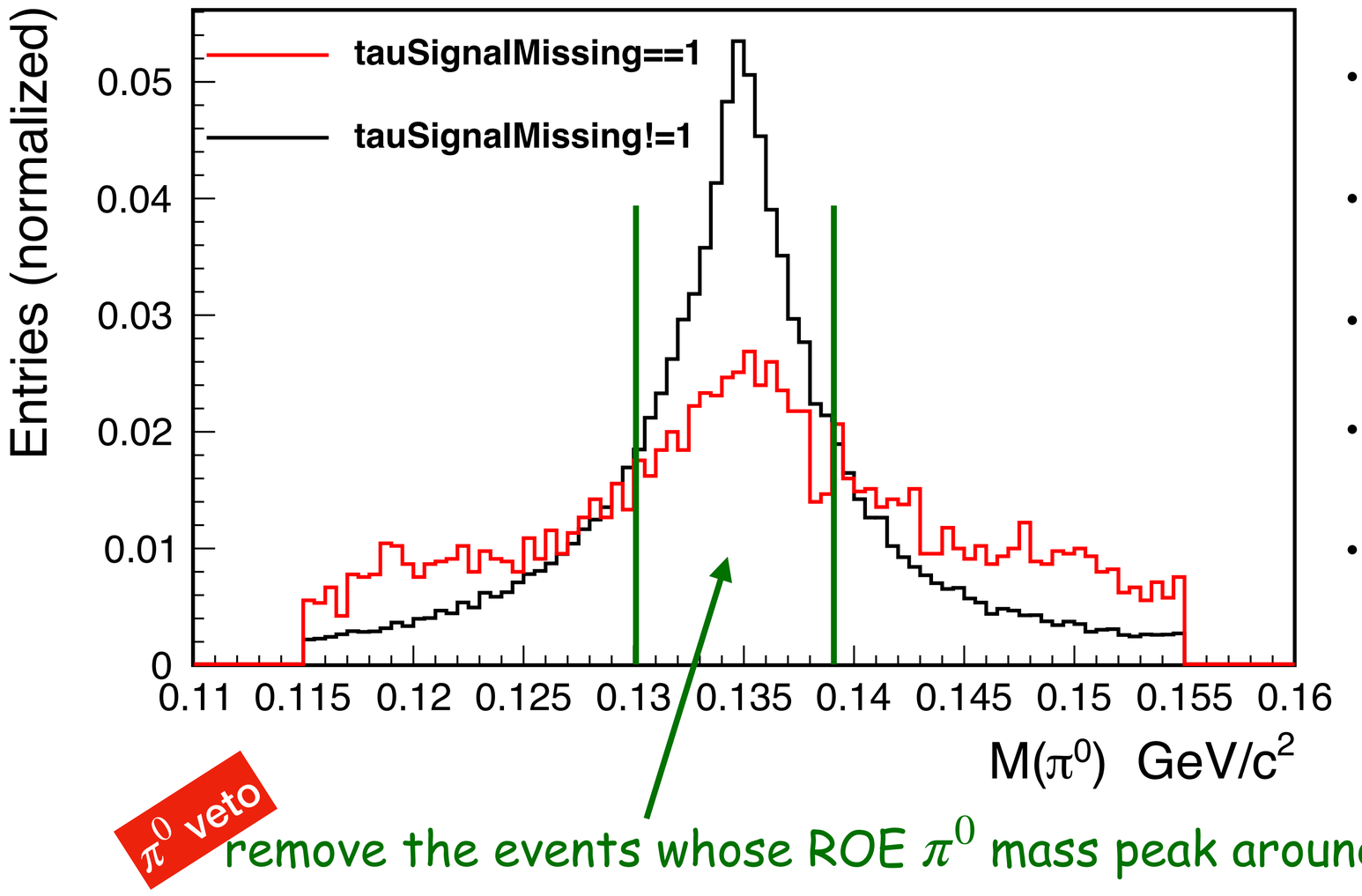
ROE mask:

- $dr < 0.5, |dz| < 2$, thetaInCDCAcceptance
- $E > 0.06$ and |cluster time| < 20

Analysis globalTag: 'analysis_tools_light-2203-zeus'

π^0 in ROE of $\Upsilon(4S)$

signalMC



- π^0 is built from ROE photons
- Cut on photons: $E > 60\,\mathrm{MeV}$
- Cut on π^0: $115 < \mathrm{M} < 155\,\mathrm{MeV/c^2}$
- Apply mass constraint
- Select one π^0 per event that has the nearest mass to the PDG mass

π^0 veto

remove the events whose ROE π^0 mass peak around π^0 actual mass: $0.130 < \mathrm{M}(\pi^0) < 0.139\,\mathrm{GeV/c^2}$