$h \to \tau^+\tau^-$ BR study
Current status

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Progress

- 500 GeV $\nu\bar{\nu}h$ analysis with aa_2f samples
  - This is the first result. There are still some rooms for improving.
  - Both Cut-based and TMVA analysis were performed to obtain the first result.

Cut-based Analysis (500 GeV $\nu\bar{\nu}h$)

Cut 0 (pre-sel): # of $\tau^{+(-)}$ >= 1, # of tracks <= 6

Cut 1: $M_{\mathrm{vis}} < 135$

Cut 2: $E_{\mathrm{vis}} < 245$

Cut 3: $P_t > 50$

Cut 4: thrust < 0.98

Cut 5: $|\cos\theta_{\mathrm{miss}}| < 0.89$

Cut 6: $20 < M_{\tau^+\tau^-} < 120$

Cut 7: $-0.76 < \cos\theta_{\tau^+\tau^-} < 0.55$

Cut 8: $\cos\theta_{\mathrm{acop}} < 0.96$

Cut 9: $\log_{10}|\min d_0\mathrm{sig}| > 0.3$

Cut 10: $\log_{10}|\min z_0\mathrm{sig}| > 0.1$

Cut Table

	$\nu\nu h$ sig	$\nu\nu h$ bkg	qqh $\ell\ell h$	2f	4f $\nu\nu\tau\tau$	4f $\nu\nu\ell\ell$	4f $\nu\nu\tau\ell$	4f other	5f	6f	aa_2f	aa_4f	sig.
none	5401	7.967e4	4.363e4	1.335e7	1.452e5	9.450e5	6.309e5	1.436e7	6.895e4	5.895e5	1.010e9	1.041e5	0.167
pre-sel	4274	2461	1126	2.649e6	9.896e4	6.522e5	4.404e5	1.364e6	1.123e4	7035	6.702e8	2.782e4	0.164
M_{vis}	4263	2438	262.9	8.235e5	5.660e4	2.064e5	1.492e5	7.964e5	7244	2775	6.693e8	2.476e4	0.165
E_{vis}	4259	2433	233.7	6.226e5	5.651e4	1.833e5	1.423e5	6.720e5	6963	2749	6.677e8	2.388e4	0.165
P_t	3052	1434	229.2	2.323e5	2.589e4	1.287e5	9.686e4	1.020e5	3845	2459	3.056e6	4845	1.60
thrust	2788	1219	224.1	1.887e5	1.569e4	1.103e5	6.142e4	9.602e4	3652	2300	2.591e6	4543	1.59
θ_{miss}	2348	1112	165.0	9803	1.181e4	6.156e4	3.787e4	2.091e4	2069	1727	1.296e5	2654	4.42
$M_{\tau^+\tau^-}$	2255	850.1	152.5	7529	1.003e4	5.244e4	3.121e4	1.497e4	1674	1363	1.212e5	2278	4.55
$\theta_{\tau^+\tau^-}$	2023	474.0	59.62	4661	6678	3.812e4	2.333e4	9625	1282	1077	7.004e4	1765	5.07
θ_{acop}	1908	462.5	58.05	851.0	6199	3.635e4	2.166e4	9230	1247	1040	4.013e4	1703	5.49
d0sig	1189	26.23	9.663	108.8	3621	1039	3201	633.6	102.8	107.0	813.5	142.4	11.3
z0sig	956.8	11.12	6.367	54.13	2878	78.63	684.6	259.0	44.59	51.00	370.0	50.52	13.0

↑ signal

↑ 4f ($\nu\nu\tau\tau$)

↑ aa_2f

Result

remained $N_{\mathrm{sig}} = 956.8, N_{\mathrm{bkg}} = 4488$

significance $= \frac{956.8}{\sqrt{956.8+4488}} = 13.0\sigma \leftrightarrow \mathbf{7.7\%}$

slightly worse than before (13.4 -> 13.0)

TMVA Analysis

I used the samples which survived after pre-selection and cuts.

pre-selection:

of $\tau^{+(-)}$ >= 1, # of tracks <= 6

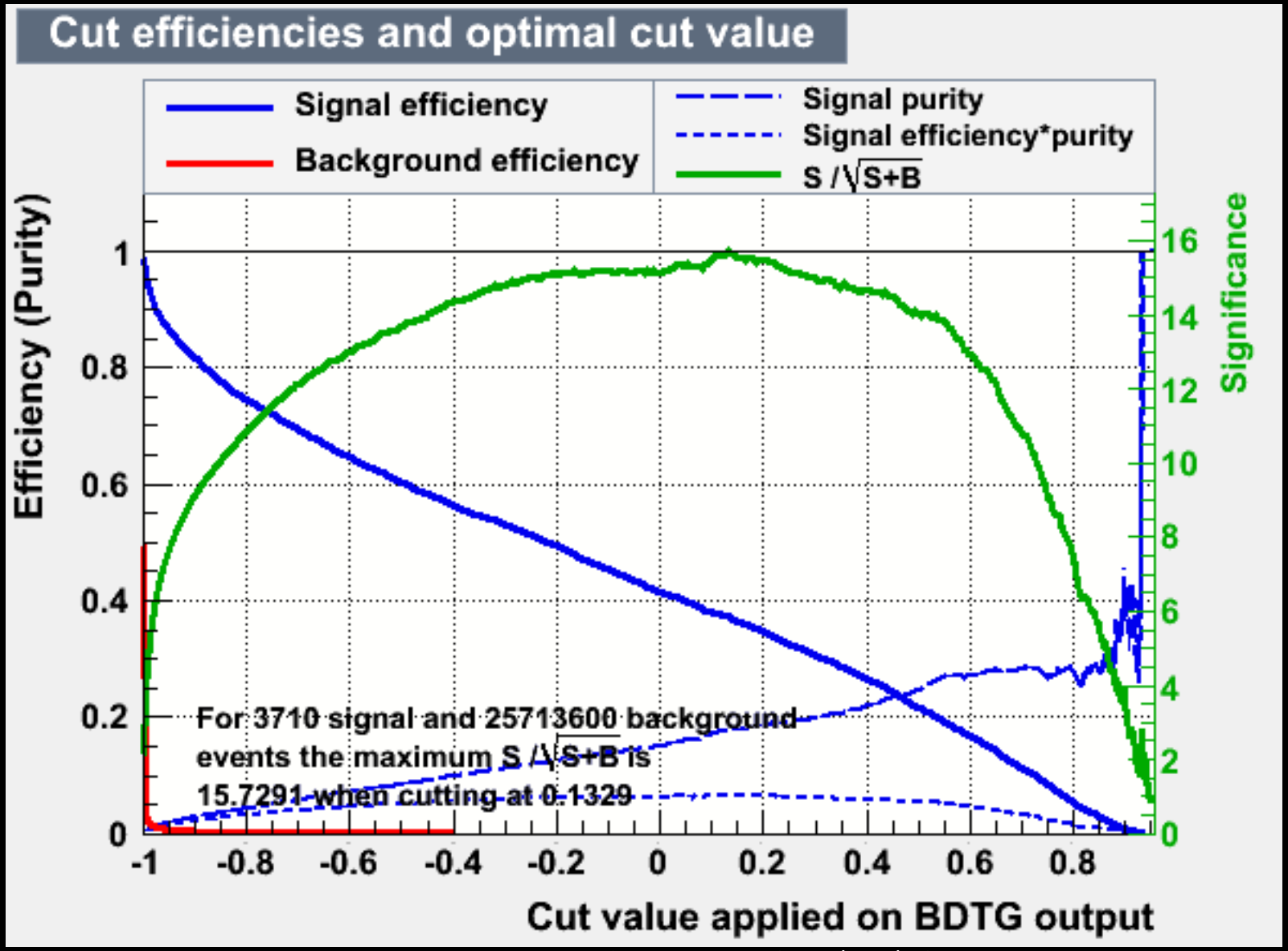
cuts:

$|\cos\theta_{\mathrm{miss}}| < 0.98, \cos\theta_{\mathrm{acop}} < 0.98, P_t > 10,$ $M_{\mathrm{vis}} < 150$, thrust > 0.7

11 parameters:

# of tracks, M_{vis}, P_t, thrust, $\cos\theta_{\mathrm{miss}}$, $M_{\tau^+\tau^-}$, $E_{\tau^+\tau^-}$, $\cos\theta_{\tau^+\tau^-}$, $\cos\theta_{\mathrm{acop}}$, $\min d_0\mathrm{sig}$, $\min z_0\mathrm{sig}$

Result of TMVA (BDTG)



Result

remained $N_{\mathrm{sig}} = 1380, N_{\mathrm{bkg}} = 6319$

significance $= \frac{1380}{\sqrt{1380+6319}} = 15.7\sigma \leftrightarrow \mathbf{6.4\%}$

slightly worse than before (16.6 -> 15.7)
relatively ~20% improved from Cut-based (13.0 -> 15.7)

Next step

- more optimization for $\nu\bar{\nu}h$ @ 500 GeV with aa_2f
  - check the maxPt (for track in an event) or number of energetic tracks
- After that:
  1. $\ell^+\ell^-h$ @ 500 GeV with aa_2f
     - try to complete the analysis in 500 GeV
  2. check MC statistics
  3. 250 GeV study