Branching Ratio $\times$ Cross Section for $h \longrightarrow \tau\tau$ @ 3 TeV

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Introduction

Previous analysis at 1.4 TeV: LCD-Note-2012-010

Repeat the same analyis at 3 TeV:

- Same channels
- Same sthep cuts
- Same analysis cuts
- Same proceedure

New:

- $m(\mathrm{H}) = 126\mathrm{GeV}$
- Channels with γ seperated into BS and EPA
  $\longrightarrow$ different scaling factors

- Final state: ττνν via Hνν
- $\sqrt{s} = 3000$ GeV
- $L = 2000$ fb^{-1}

Part of process list (39 in total):

Process	σ [fb]	Cut eff.	BR/Scaling	σ_{eff} [fb]	Events	Luminosity [ab^{-1}]
h_nunu_dst_2671	415.05	1.0000	0.61	255.26	197703	774.53
qq_nunu_dst_2660	1317.51	1.0000	1.00	1317.51	207801	157.72
qq_ll_dst_3048	3319.61	1.0000	1.00	3319.61	63161	19.03
e3e3_dst_2848	243.11	0.0372	1.00	9.04	20000	2211.38
e3e3nn_dst_2851	95.54	0.4106	1.00	39.23	99400	2533.72
e1e1e3e3_o_dst_2854	2373.83	0.0331	1.00	78.61	203600	2590.02
e2e2e3e3_o_dst_2857	0.96	0.1529	1.00	0.15	20000	136023.19
aa_e3e3nn_dst_2836	11.69	0.4219	1.00	4.93	50700	10279.70
aa_e3e3nn_dst_2845	389.16	0.3674	0.69	98.67	201500	2042.23
aa_e3e3nn_dst_2842	72.46	0.3950	0.79	22.61	101700	4497.98
aa_e3e3nn_dst_2839	72.54	0.3949	0.79	22.63	101200	4472.28
aa_e3e3ll_dst_2824	40.03	0.1350	1.00	5.40	50800	9402.02
aa_e3e3ll_dst_2833	1106.80	0.1362	0.69	104.05	201400	1935.64
aa_e3e3ll_dst_2830	235.48	0.1308	0.79	24.33	101400	4167.46
aa_e3e3ll_dst_2827	235.64	0.1308	0.79	24.35	101900	4185.19

Parameter scan of TauFinder (LCD-Note-2010-009) settings for

- $\tau\tau\nu\nu \rightarrow$ single τ reco efficiency
- $qq\nu\nu \rightarrow$ fake rate to reconstruct q as τ

Chosen point:
p_T=1, $p_{T,seed}$=5, sC= 0.07, iC= 0.3, iE= 5, minv=2.5

$\sqrt{s}$	350 GeV	1.4 TeV	3 TeV
Efficiency [%]	73	70	60
Fake rate [%]	5	7	9

The higher the energy the harder it is to find τs and keep fake rate from quarks low.

Cuts: Same as at 1.4 TeV

Stdhep level

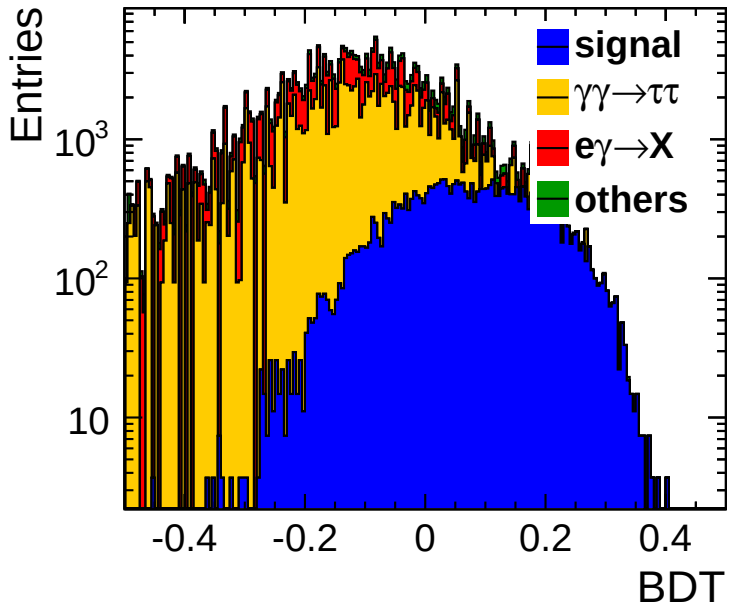
- $10 < \theta_\tau < 170$ deg, where θ_τ is the polar angle of the τ candidate
- $p_T > 20$ GeV
- $\Delta\phi < 178$ deg
- angle of τ system $>$ 0.4 rad (23 deg)
- $40 <$ invariant mass of τ system < 650 GeV

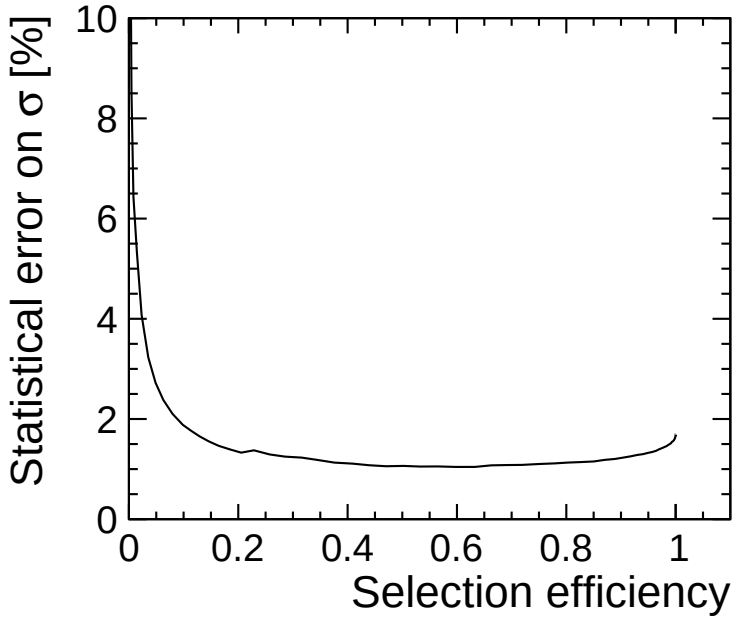
Analysis

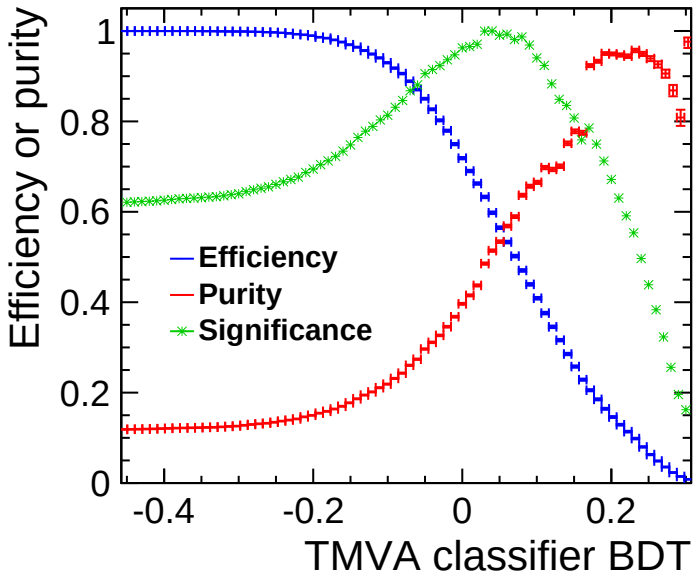
- no leptons in τ
- $15 < \theta_\tau < 165$ deg
- p_T of $\tau > 25$ GeV
- $\Delta\phi < 177$ deg
- angle between the two τs > 0.5
- $45 <$ invariant mass of τ system $<$ 130 GeV
- Thrust < 0.99
- $20 <$ transverse mass of τ system $<$ 400 GeV
- Number of tracks in τ candidate either 1 or 3

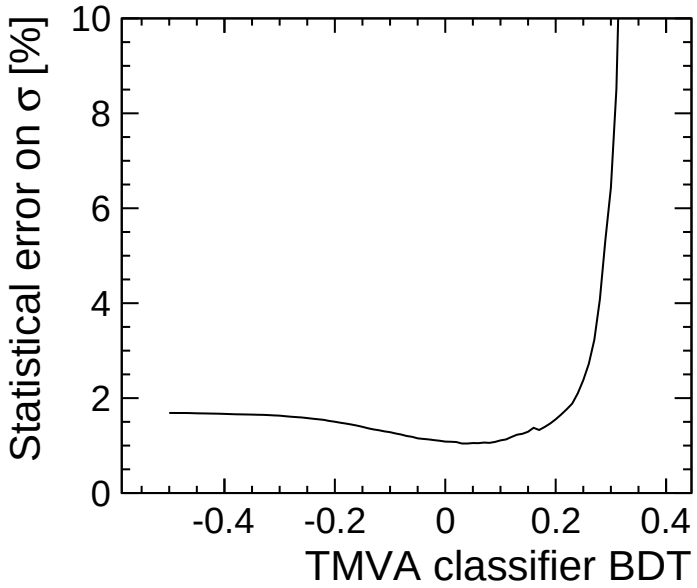
TMVA for training of BDT based on 30% of statistics.

Signal Selection









Calculating error on cross section

- **Method 1:**

$$\frac{\Delta\sigma}{\sigma} = \frac{\sqrt{S+B}}{S}$$

  where S and B are summed over all bins above BDT cut

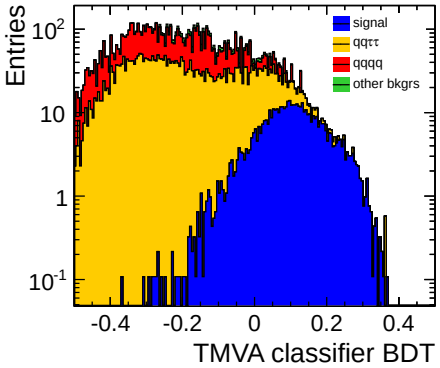
- **Method 2:**
  Calculate $\frac{\Delta\sigma}{\sigma}$ for each BDT bin with signal.
  Then sum up the errors:

$$x_i = \frac{\sqrt{S_i + B_i}}{S_i}$$

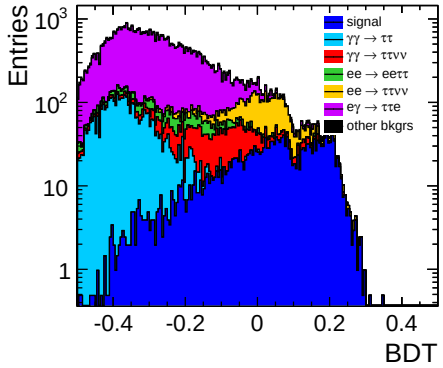
$$\frac{\Delta\sigma}{\sigma} = \sqrt{\frac{1}{\sum_i \frac{1}{x_i^2}}}$$

Results: Branching Ratio $\times$ Cross Section

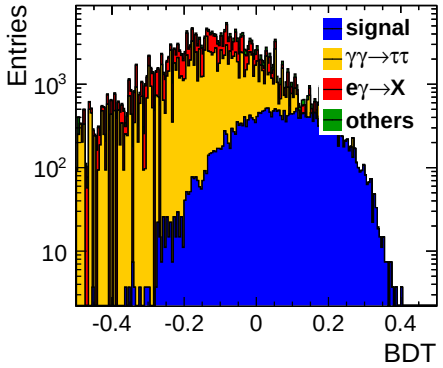
350 GeV



1400 GeV



3000 GeV



$\sqrt{s}$	350 GeV	1.4 TeV	3 TeV
$\sqrt{S+B}/S$ (Method 1)	6.9%	4.2%	0.9%
$\sqrt{S+B}/S$ (Method 2)	6.2%	3.6%	1.0%

Very preliminary result at 3 TeV.
Statistics missing for proper training.
Main background has sclaing factor of $\sim$ 150.

Outlook

More statistics needed on signal.
More files on $ee \to qq\nu\nu$ and $qqll$ available but trouble with staging.

More statistics needed for:

Process	σ_{eff} [fb]	reco Events	scale factor
h_nunu_dst_2671	255	11571	2.6
qq_nunu_dst_2660	1317	26	12.7
qq_ll_dst_3048	3319	2	105.1
aa_e3e3_o_dst_3132	268	37	141.4
aa_e3e3_o_dst_3129	1649	304	169.1
aa_e3e3_o_dst_3126	1632	283	174.9
aa_e3e3_o_dst_3123	633	339	65.4
ea_qqe_dst_3222	1090	5	122.2
ae_qqe_dst_3228	1088	6	114.8
ea_qqe_dst_3219	553	7	61.4
ae_qqe_dst_3225	554	0	58.9
e1a_e1e3e3_o_dst_3162	706	330	72.5
ae1_e1e3e3_o_dst_3168	709	357	73.5
e1a_e1e3e3_o_dst_3159	385	345	39.8
ae1_e1e3e3_o_dst_3165	385	359	39.9

Especially $\gamma\gamma \to \tau\tau$ and $eq \to \tau\tau e$ make it into the analysis.