

update tth study @  $\sqrt{s} = 500$  GeV

2014.05.09

Physics meeting

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# optimize parameters

## analyze at 500 fb<sup>-1</sup> and 1600 fb<sup>-1</sup>

### Changes

- tth → 8 jets channel
  - $Y_{87} > 0.00082$ ,  $Y_{76} > 0.0021$  &&  $Y_{87} < 0.00082$  (old  $y_{87} > 0.0009$ ,  $Y_{76} > 0.0025$ )
  - highest 2 jets E Sum < 208 GeV (old 207)
  - lowest 3 jets E Sum > 104 GeV (old 86)
- tth → ln + 6 jets channel
  - $Y_{65} > 0.00045$ ,  $Y_{54} > 0.006$  &&  $Y_{65} < 0.00045$  (old  $Y_{65} > 0.002$ ,  $Y_{54} > 0.036$ )
  - $\chi^2 < 34.5$  (old 19)
  - highest 2 jets E Sum < 195 GeV (old 210)
  - lowest 2 jets E Sum > 66 GeV (old ---)
- with low Pt background overlay
- Integrated luminosity and polarization  
500 fb<sup>-1</sup> and 1600 fb<sup>-1</sup>, Pol(e<sup>-</sup>,e<sup>+</sup>)=(-0.8,+0.3)  
Pol (-1,+1) and Pol(+1,-1) at 500 fb<sup>-1</sup>

# Systematic Uncertainties

- luminosity : 0.1 %
- polarization : 0.1 %
- Branching ratio of  $h \rightarrow bb$  : 3.3 %

- b likeness value  
1%, 5%

- total Jet energy calibration  
1%, 3%, 5%

$$|\Delta\sigma/\sigma|^2 = (S+B)/S^2 + (\text{Lumi.})^2 + (\text{Pol.})^2 + (\text{BR})^2 + (\text{b likeness})^2 + (\text{JEC})^2$$

- systematic uncertainties related to shape is not included.

# $t\bar{t}h \rightarrow 8 \text{ jets } (h \rightarrow b\bar{b}) @ \sqrt{s} = 500 \text{ GeV}$

500 fb<sup>-1</sup>, N<sub>sig</sub> ~ 11.6, N<sub>bkgd</sub> ~ 20

Selection	$t\bar{t}h(tt6j \text{ hbb})$	$t\bar{t}h(ttall \text{ hnob})$	$t\bar{t}h(ttl4j \text{ hbb})$	$t\bar{t}h(tt2l2n2j \text{ hbb})$	$t\bar{t}Z$	$t\bar{t}g^*(bb)$	$t\bar{t}W$
No Cut	63.9	102.6	61.3	14.6	987.3	529.3	489902.1
No Isolated Lepton	59.1	48.0	8.3	0.34	517.8	308.2	291330.0
Y cut for 8 jets	52.7	42.8	4.3	0.05	354.0	174.5	51265.1
b jet candidate $\geq 4$	30.6	1.1	2.5	0.03	43.1	78.7	941.5
$ \text{Jet } \cos\theta  \leq 0.99$	24.3	0.8	1.5	0.01	32.6	56.6	390.8
$\chi^2 \leq 9.5$	17.2	0.4	0.4	0	20.5	21.5	99.7
h Candidate $M_{jj} \geq 80 \text{ (GeV)}$	16.0	0.3	0.2	0	17.2	12.1	47.9
Leading 2 JetEnergySum < 208 GeV	15.0	0.3	0.2	0	15.9	8.0	29.7
Lowest 3 JetEnergySum > 104 GeV	13.5	0.3	0.1	0	13.1	5.8	14.3
$M_{top} \geq 140 \text{ (GeV)}$	13.2	0.3	0.1	0	12.6	5.3	10.2
$95 \leq h \text{ Candidate } M_{jj} \leq 170 \text{ (GeV)}$	11.6	0.2	0.1	0	9.1	3.7	6.9

Significance	500 fb-1 (baseline)	1600 fb-1 (lumi up)
stat only	2.067	3.71
with syst.		
blikeness1%, JEC1%	2.055	3.64
blikeness1%, JEC3%	2.027	3.49
blikeness5%, JEC5%	2.010	3.40

$\Delta$ significance  
b likeness value  
 $\pm 1\%$

luminosity : 0.1 %  
polarization : 0.1 %  
Branching ratio  
 $h \rightarrow b\bar{b}$  : 3.3 %

total Jet energy  
calibration (JEC)  
-4% ( $\Delta$  JEC=1%)  
-9% ( $\Delta$  JEC=3%)  
-11% ( $\Delta$  JEC=5%)

# tth $\rightarrow$ ln+ 6jets (h $\rightarrow$ bb) @ $\sqrt{s} = 500$ GeV

500 fb<sup>-1</sup>, Nsig  $\sim$  11.9, Nbkgd  $\sim$  11.1

Selection	<i>tth(tln4j hbb)</i>	<i>tth(ttall hnobb)</i>	<i>tth(tt6j hbb)</i>	<i>tth(tt2l2n2j hbb)</i>	<i>ttZ</i>	<i>ttg*(bb)</i>	<i>tbW</i>
No Cut	61.3	102.6	63.9	14.6	987.3	529.3	
One Isolated Lepton	50.2	38.6	4.7	3.0	344.4	188.6	
<i>Y cut</i> (6 jets)	49.9	38.4	4.7	2.4	314.3	175.6	
b jet candidate $\geq$ 4	27.0	0.8	2.3	1.3	29.3	64.0	
Jet $\cos\theta$   $\leq$ 0.99	23.2	0.7	2.1	0.8	24.0	50.2	
Missing P > 20	22.9	0.6	0.8	0.8	22.3	46.1	
$\chi^2 \leq 34.5$	21.8	0.5	0.6	0.5	21.0	40.1	
<i>h</i> Candidate $M_{jj} \geq 80$ (GeV)	18.9	0.4	0.5	0.3	16.3	17.2	
Leading 2 JetEnergySum < 195 GeV	15.8	0.3	0.1	0.3	11.8	8.1	
lowest 2 JetEnergySum > 66 GeV	14.5	0.3	0.1	0.1	9.8	4.0	
$M_{top} \geq 140$ (GeV)	13.3	0.3	0.07	0.1	8.3	3.1	
$95 \leq h$ Candidate $M_{jj} \leq 175$ (GeV)	11.9	0.2	0.06	0.06	5.9	2.2	2.7

Significance	500 fb-1 (baseline)	1600 fb-1 (lumi up)
stat only	2.485	4.44
with syst.		
blikeness1%, JEC1%	2.466	4.34
blikeness1%, JEC3%	2.440	4.2
blikeness5%, JEC5%	2.392	3.97

$\Delta$ significance

b likeness value

$\pm 0.5\%$  ( $\Delta$ b likeness 1%)

$\pm 1.7\%$  ( $\Delta$ b likeness 5%)

total Jet energy calibration  
(JEC)

-4% ( $\Delta$  JEC=1%)

-7% ( $\Delta$  JEC=3%)

-10.6% ( $\Delta$  JEC=5%)

# Pol (-1,+1), (+1,-1)

$\sqrt{s} = 500 \text{ GeV}, 500 \text{ fb}^{-1}$   
Significance (stat only)

(Pe-,Pe+)	(-1,+1)	(+1,-1)	(-8,+0.3)
8jet	2.688	1.528	2.067
ln+ 6jet	3.214	1.953	3.71

Backup  
1000 fb-1

# Result of event selection ( $t\bar{t}h \rightarrow 8\text{jets}$ )

select a range of higgs candidate  $M_{jj}$  to maximize  $S/\sqrt{S+B}$

✓  $100 \text{ GeV} \leq \text{higgs candidate } M_{jj} \leq 160 \text{ GeV}$

## Preliminary

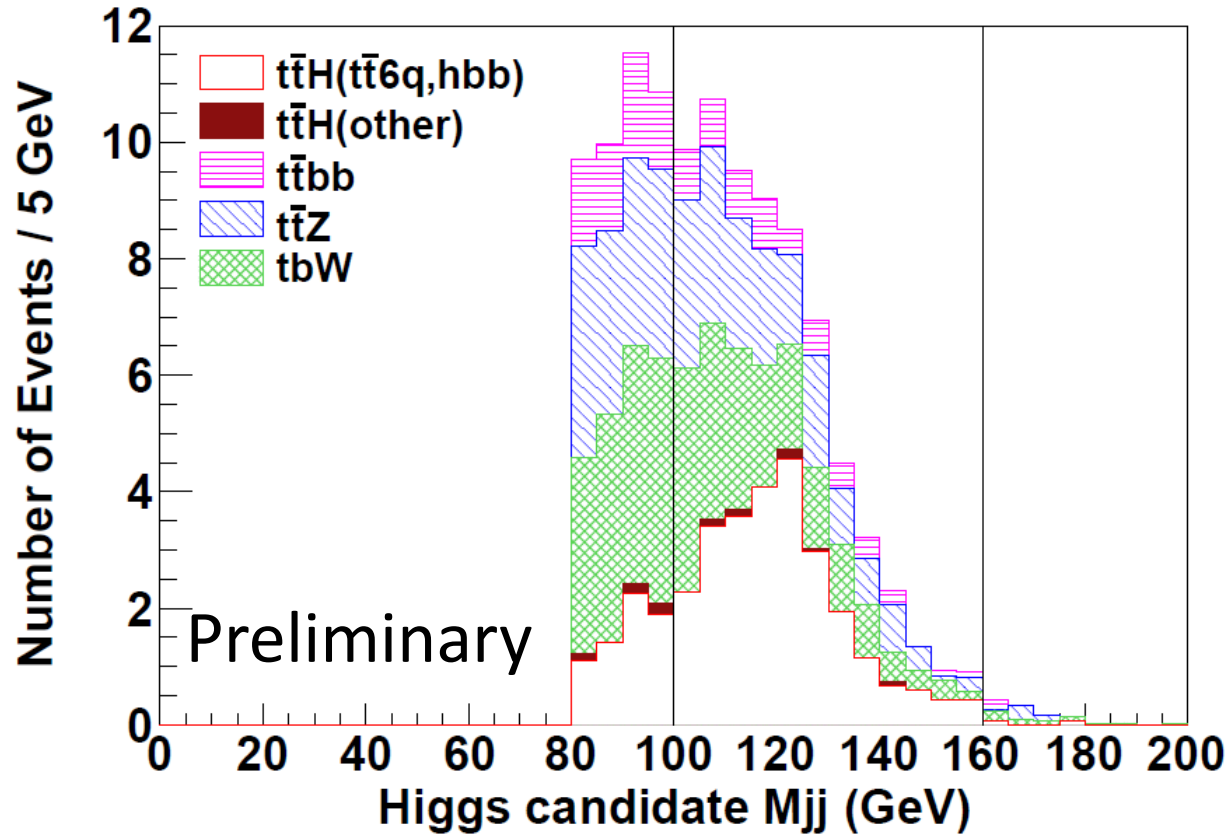
Selection	$t\bar{t}h(tt6j \text{ hbb})$	$t\bar{t}h(ttall \text{ hnob})$	$t\bar{t}h(t\bar{t}ln4j \text{ hbb})$	$t\bar{t}h(t\bar{t}l2l2n2j \text{ hbb})$	$t\bar{t}Z$	$t\bar{t}g^*(bb)$	$t\bar{t}bW$
No Cut	127.9	205.2	122.6	29.4	1974.6	1058.6	979807.7
$Y_{8 \rightarrow 7}$ (8 jets)	118.7	96.4	17.6	0.412	1030.4	613.3	582660.8
No Isolated Lepton	97.3	80.8	6.8	0.060	602.2	264.7	83102.9
b jet candidate $\geq 4$	57.0	2.1	3.5	0.003	71.3	111.3	1657.2
$ \text{Jet } \cos \theta  \leq 0.99$	54.1	2.0	3.1	0	67.3	104.8	698.2
$\chi^2 \leq 9.5$	38.1	0.9	0.9	0	42.3	38.3	178.8
$h$ Candidate $M_{jj} \geq 80$ (GeV)	34.9	0.7	0.4	0	34.2	20.2	89.0
Leading 2 JetEnergySum < 207.5 GeV	34.0	0.7	0.4	0	32.6	14.6	52.6
Lowest 3 JetEnergySum > 86.65 GeV	33.8	0.7	0.4	0	31.6	13.0	52.6
$M_{top} \geq 140$ (GeV)	32.8	0.7	0.3	0	30.5	11.8	34.7
$100 \leq h$ Candidate $M_{jj} \leq 160$ (GeV)	26.0	0.5	0.06	0	16.9	5.6	18.7

- no overlay of low Pt background

- $t\bar{t}h \rightarrow 8\text{jet}$ :  $N_{sig} = 26.0$
- $N_{bkgd} = 41.74$



# Significance ( $t\bar{t}H \rightarrow 8\text{jets}$ )



- $\sqrt{s} = 500 \text{ GeV}, 1000 \text{ fb}^{-1}$
- Cut base + counting analysis
- $N_{\text{sig}}/\sqrt{N_{\text{sig}} + N_{\text{bkgd}}} = \underline{3.16}, |\Delta g_t/g_t| \sim 15.8\%$
- no overlay of low Pt background

# Result of event selection ( $t\bar{t}h \rightarrow l n + 6 \text{jets}$ )

At last, We select a range of higgs candidate  $M_{jj}$  to maximize  $S/\sqrt{S+B}$

✓  $90 \text{ GeV} \leq \text{higgs candidate } M_{jj} \leq 150 \text{ GeV}$

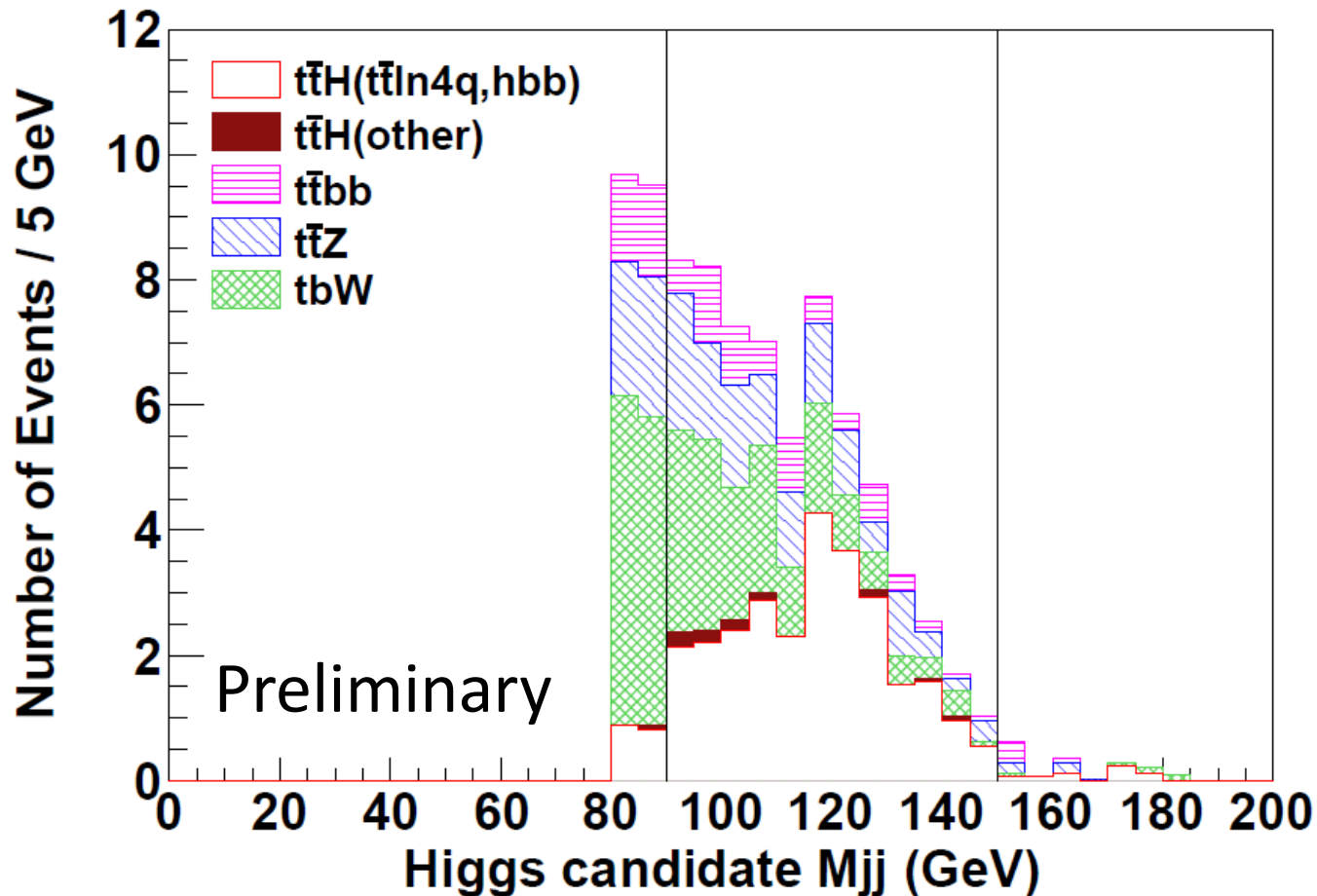
Preliminary

Selection	$t\bar{t}h(t\bar{t}l n 4j \text{ } hbb)$	$t\bar{t}h(t\bar{t}all \text{ } hnobb)$	$t\bar{t}h(t\bar{t}6j \text{ } hbb)$	$t\bar{t}h(t\bar{t}2l2n2j \text{ } hbb)$	$t\bar{t}Z$	$t\bar{t}g^*(bb)$	$t\bar{t}W$
No Cut	122.6	205.2	127.9	29.3	1974.6	1058.6	979807.7
$Y_{cut}$ (6 jets)	99.6	76.9	8.9	6.3	695.4	378.5	342027.9
One Isolated Lepton	82.3	67.5	8.7	1.8	419.9	176.7	49812.8
b jet candidate $\geq 4$	45.4	1.2	4.6	1.0	41.4	76.6	806.3
$ \text{Jet } \cos \theta  \leq 0.99$	44.4	1.2	4.2	1.0	40.2	73.4	339.8
Missing P $> 20$	44.1	1.2	1.1	1.0	36.8	66.2	311.6
$\chi^2 \leq 19$	39.1	1.0	0.6	0.7	30.5	46.5	185.8
$h$ Candidate $M_{jj} \geq 80$ (GeV)	34.0	0.6	0.4	0.3	21.2	19.7	72.1
Leading 2 JetEnergySum $< 210$ GeV	33.5	0.6	0.3	0.3	20.0	15.5	49.3
$M_{top} \geq 140$ (GeV)	29.6	0.6	0.06	0.17	17.1	9.2	26.8
$90 \leq h$ Candidate $M_{jj} \leq 150$ (GeV)	27.4	0.5	0.06	0.17	12.4	6.0	16.4

- no overlay of low Pt background

- $t\bar{t}h \rightarrow l n + 6 \text{jet}$ :  $N_{sig} = 27.4$
- $N_{bkgd} = 35.64$

# Significance ( $t\bar{t}H \rightarrow l n + 6\text{jets}$ )



- $\sqrt{s} = 500 \text{ GeV}, 1000 \text{ fb}^{-1}$
- no overlay of low Pt background
- Cut base + counting analysis
- $N_{\text{sig}}/\sqrt{N_{\text{sig}} + N_{\text{bkgd}}} = \underline{3.45}, |\Delta g_t/g_t| \sim 14.5\%$

# Rough estimation of significance and $|\Delta g_t/g_t|$

$$\sqrt{s} = 480-610 \text{ GeV}$$

1000fb<sup>-1</sup>, tth → 8jets & ln6jets

$\sqrt{s}$  :  $S/\sqrt{S+B}$  :  $|\Delta g_t/g_t|$  %

490 : 3.00 : 16.6

**500 : 4.67 : 10.6**

510 : 6.25 : 7.99

520 : 7.68 : 6.50

530 : 8.98 : 5.56

540 : 10.1 : 4.93

550 : 11.1 : 4.50

cross section (fb)

$\sqrt{s}$  : tth(total) : ttz : ttbb : tbw

490 : 0.272 : 1.569 : 1.009 : 991.1

**500 : 0.485 : 1.974 : 1.058 : 979.8**

510 : 0.725 : 2.373 : 1.105 : 967.0

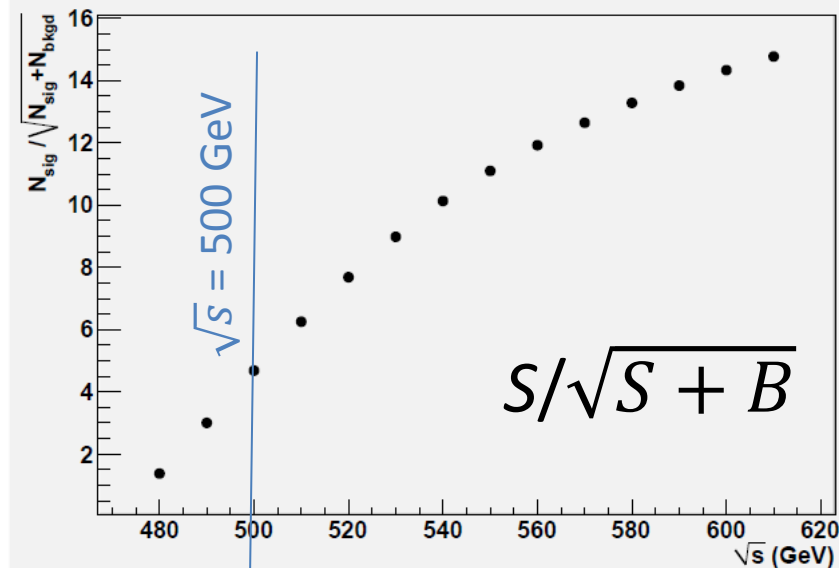
520 : 0.981 : 2.753 : 1.151 : 953.5

530 : 1.244 : 3.118 : 1.199 : 939.4

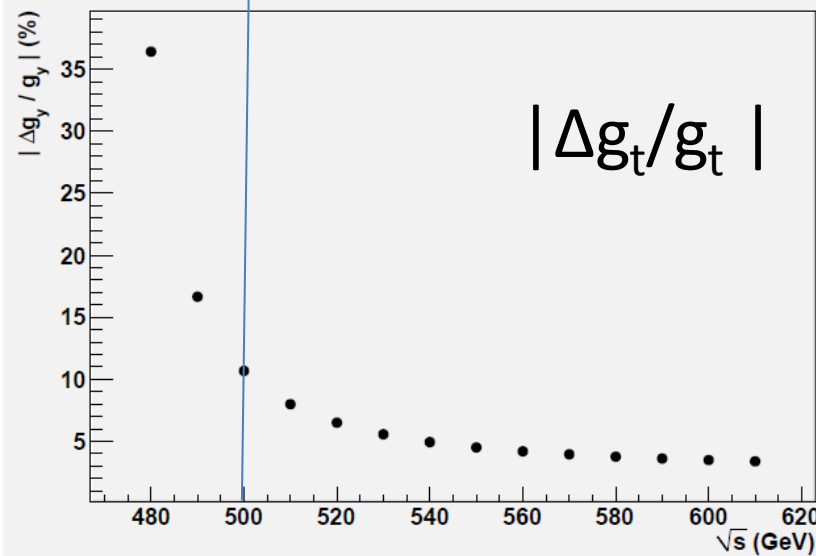
540 : 1.504 : 3.469 : 1.243 : 924.5

550 : 1.743 : 3.806 : 1.285 : 909.5

Graph



Graph



(low Pt background is not overlaid.)