

THE PRODUCTION OF A HEAVY SCALAR H IN ASSOCIATION WITH TOP AND ANTI-TOP QUARKS

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Top associated Higgs production

- Small $H \rightarrow VV$ branching fraction, enhanced $p \rightarrow tH$ cross section
- Other production mechanisms are Vector Boson Fusion (VBF) and $g g \rightarrow H$



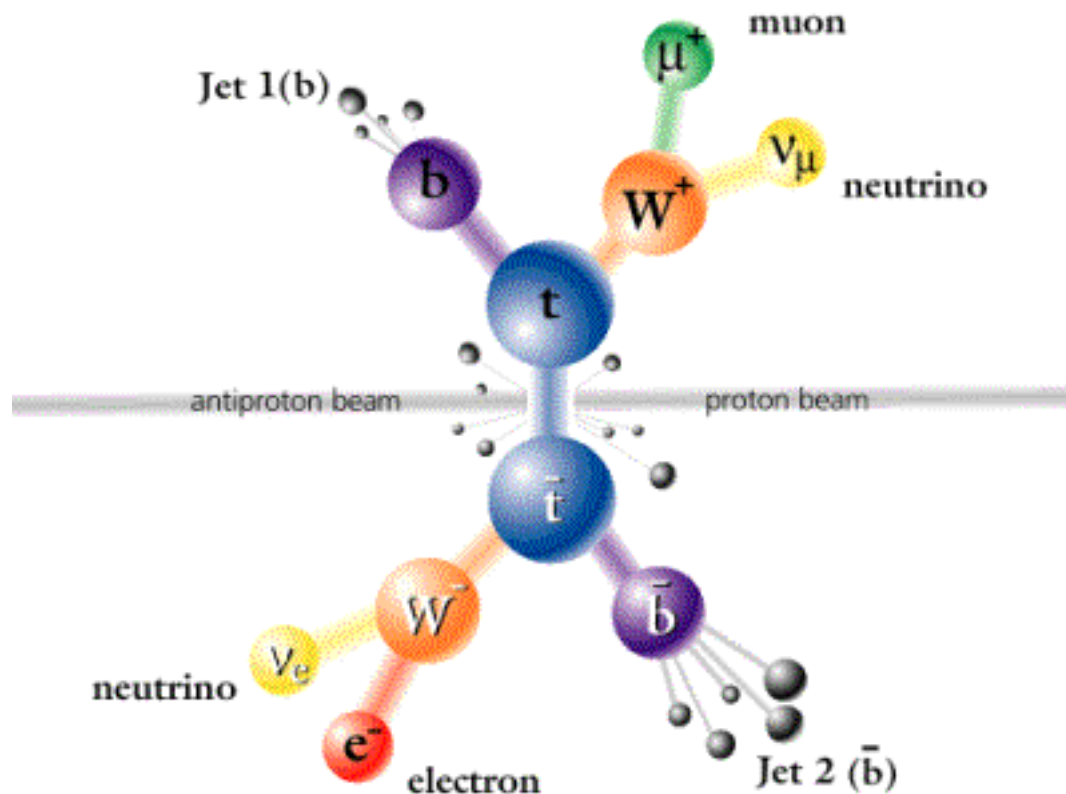
Process

- The process of interest is that of
$$p p \rightarrow t \bar{t} h$$
$$p p \rightarrow (t + \bar{t})h + \text{jets}$$
- The top quarks are heavy particles per SM
- This implies their decay before hadronization (forming of jets)



Possible decay schemes for the top quark

- The decay of the top quark



The Standard Model (SM) Higgs picture

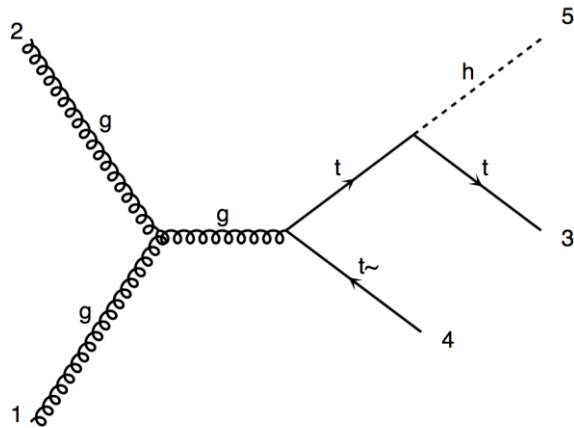


diagram 1 QCD=2, QED=1

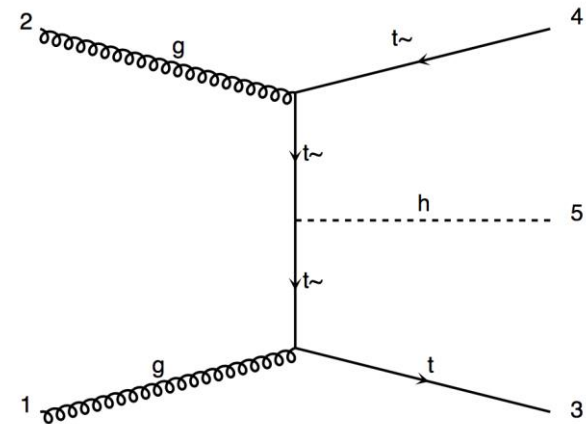


diagram 3 QCD=2, QED=1

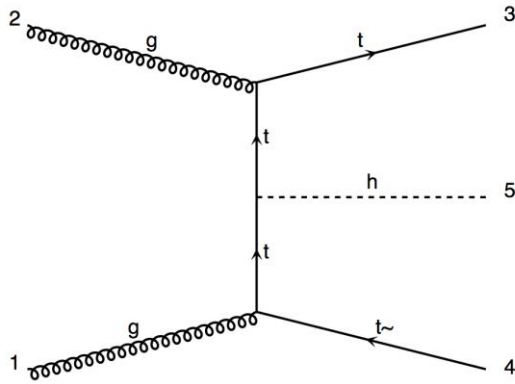


diagram 5 QCD=2, QED=1

Diagrams 1, 3 and 5 are MadGraph generated Feynman diagrams for the two-quark (4FS) higgs production



The Standard Model (SM) Higgs picture

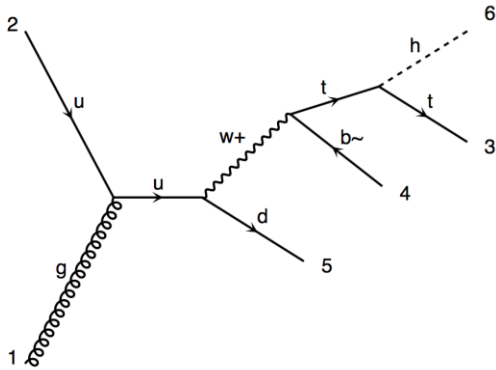


diagram 2 QCD=1, QED=3

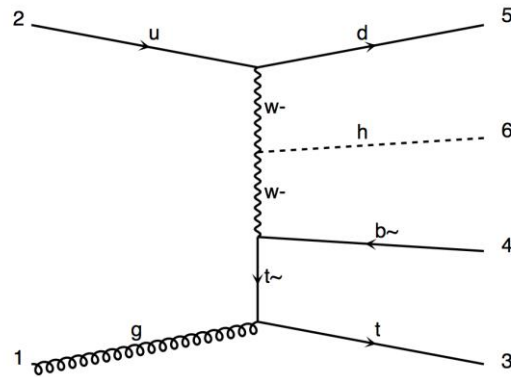


diagram 4 QCD=1, QED=3

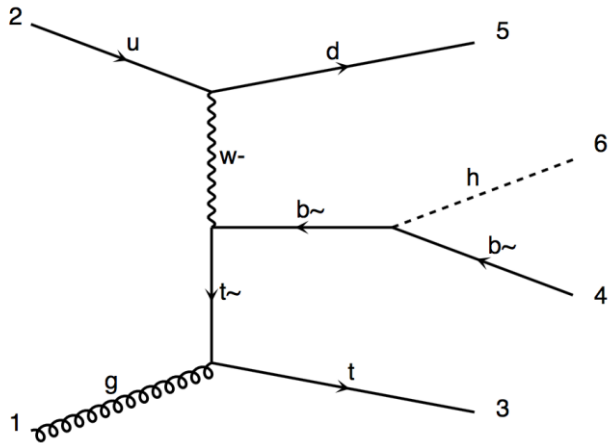


diagram 6 QCD=1, QED=3

Diagrams 2, 4 and 6 are MadGraph generated Feynman diagrams for the one-quark (5FS) higgs production



MadGraph Generated Cross Sections

Two Quark SM Higgs Production

COM Energy (GeV)	Mass (TeV)	Cross section (pb)
8	125	<u>0.1092 ± 0.00014</u>
	270	<u>$0.009557 \pm 1.4e-05$</u>
13	125	<u>0.3991 ± 0.00054</u>

One Quark SM Higgs Production

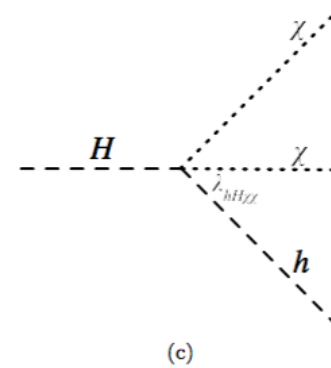
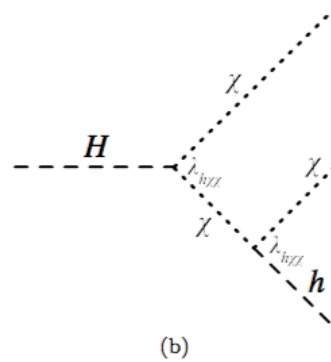
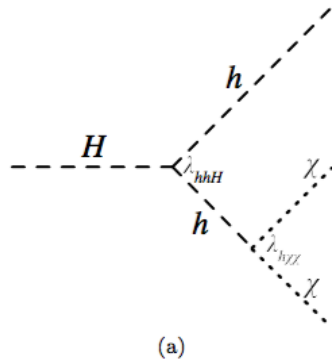
COM Energy (GeV)	Mass (TeV)	Cross section (pb)
8	125	<u>0.1091 ± 0.00026</u>
	270	<u>$0.009536 \pm 1.5e-05$</u>
13	125	<u>0.3982 ± 0.00086</u>
	270	<u>0.0432 ± 0.00018</u>

Introducing The Heavy scalar boson H

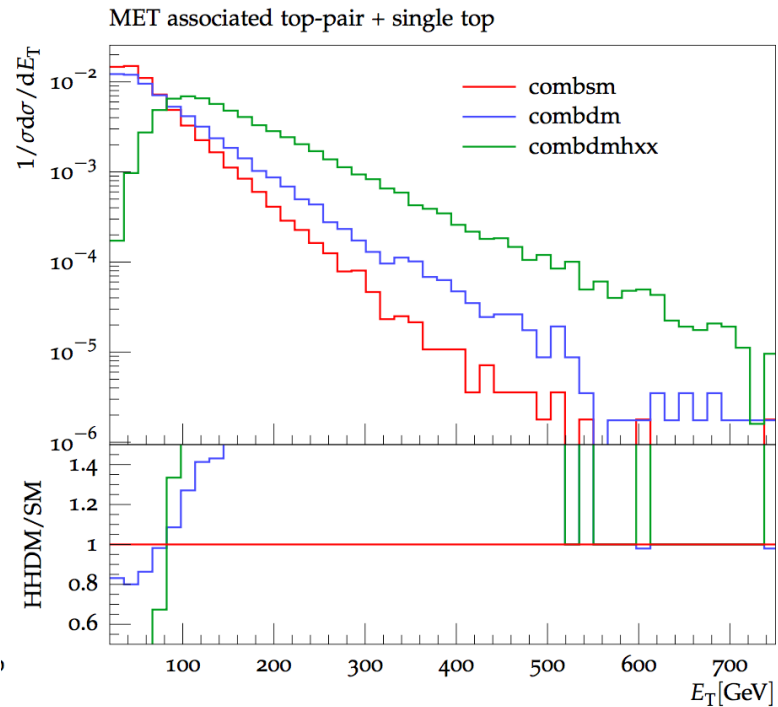
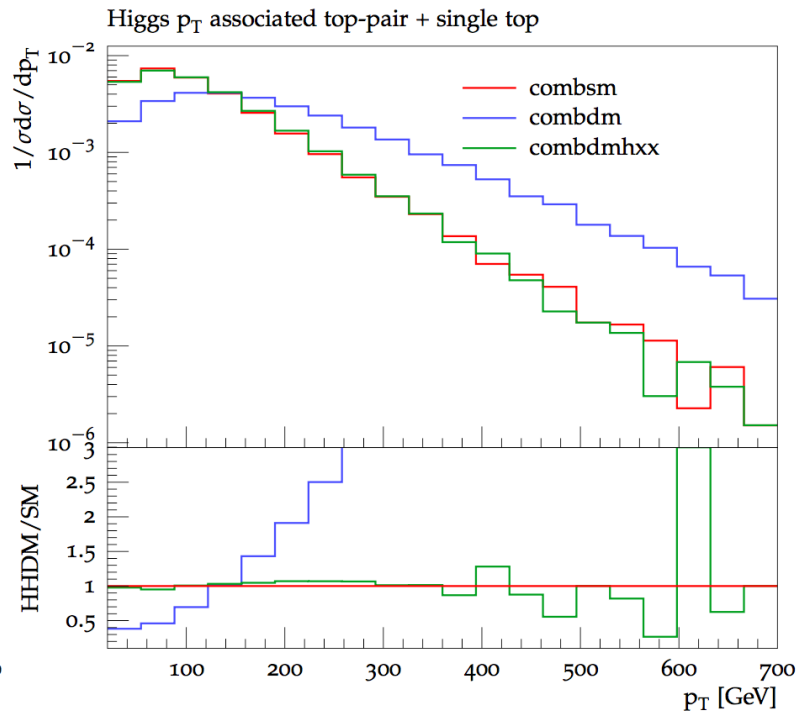
- The process of interest is the collision of
 $p p \rightarrow t \bar{t} H$
 $p p \rightarrow (t + \bar{t})H + \text{jets}$
- The Heavy scalar decays by $H \rightarrow h X X$



Feynman Diagrams of H decay



Some subsequent work on top associated Higgs production



Continued

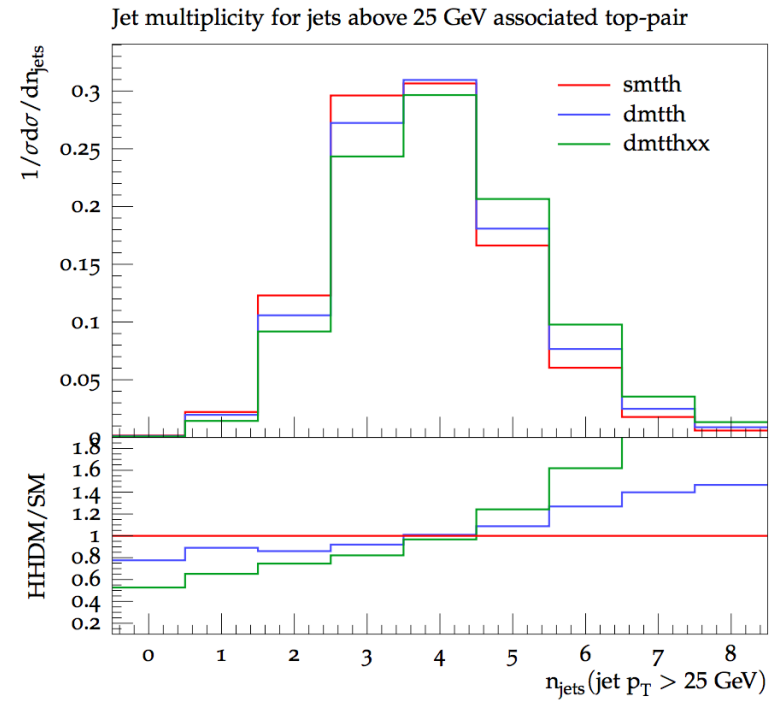
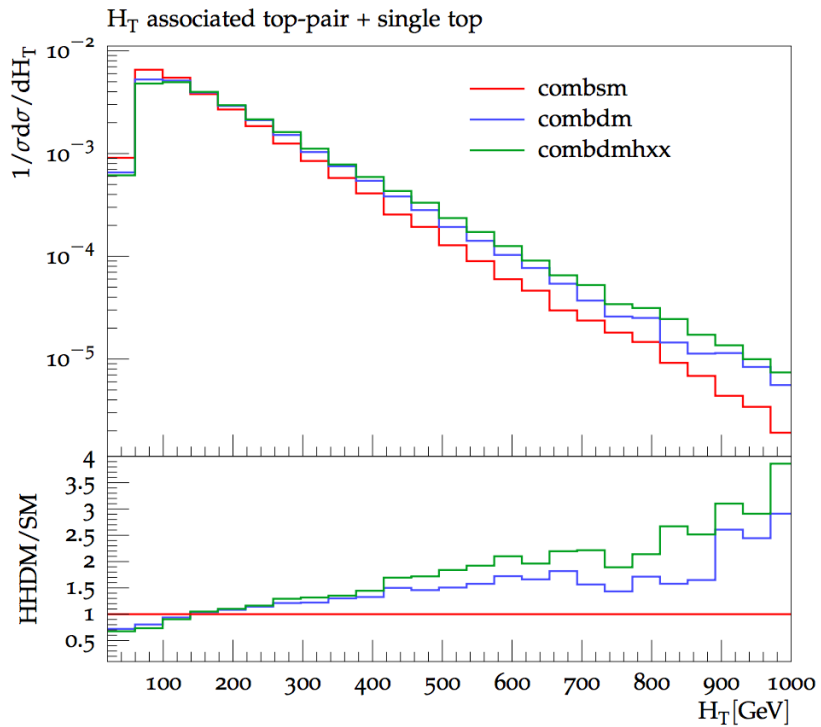


Table 1

Cut-flows all	$t\bar{t}h$	$t\bar{t}H,$ $H \rightarrow h\chi\chi$	$thj + \bar{t}hj$	$tHj + \bar{t}Hj,$ $H \rightarrow h\chi\chi$	$t\bar{t}h + thj$ $+\bar{t}hj$	$t\bar{t}H + tHj$ $+\bar{t}Hj, H \rightarrow h\chi\chi$
Total events	30000	30000	30000	30000	60000	60000
2 leptons with same sign	10933	11011	10023	10171	20956	21182
$ \eta < 2.5$ for leptons	9614	9800	7360	7652	16974	17452
p_T cut: leading lepton > 25 GeV, sub-leading lepton > 15 GeV	2305	2622	1156	1326	3461	3948
Number of jets ≥ 2 (at least 2 jets)	2301	2622	1115	1295	3461	3917
exactly 1-bTagged events	573	661	632	753	1205	1414
≥ 2 bTagged events	1682	1921	377	462	2059	2383
exactly 1-bTagged events:						
400 $< HT < 700$, MET > 40	189	291	116	265	305	556
HT ≥ 700 , 40 $< MET < 100$	26	22	16	11	42	33
700 $\geq HT$, MET ≥ 100	36	184	21	58	57	242
at least 2-bTagged events:						
400 $< HT < 700$, MET > 40	629	829	102	198	731	1027
HT ≥ 700 , 40 $< MET < 100$	151	134	19	8	170	142
700 $\geq HT$, MET ≥ 100	143	643	16	69	159	712
NJets $\in [2,4]$, bTagged ≥ 1 , $\Delta\phi_{ll} > 2.5$, HT > 450 , MET > 40	33	63	32	65	65	128

Questions

- I'm timing you



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