ttH, H->bb at 14 and 33 TeV

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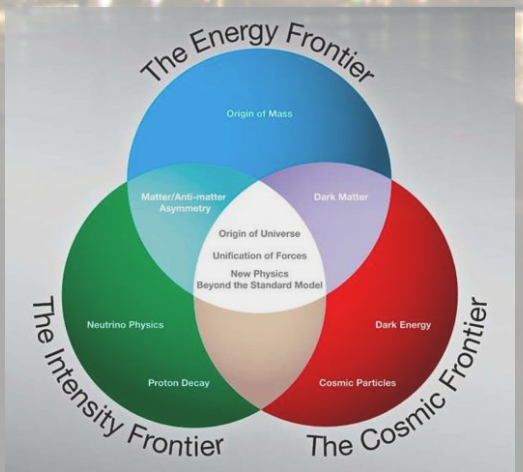

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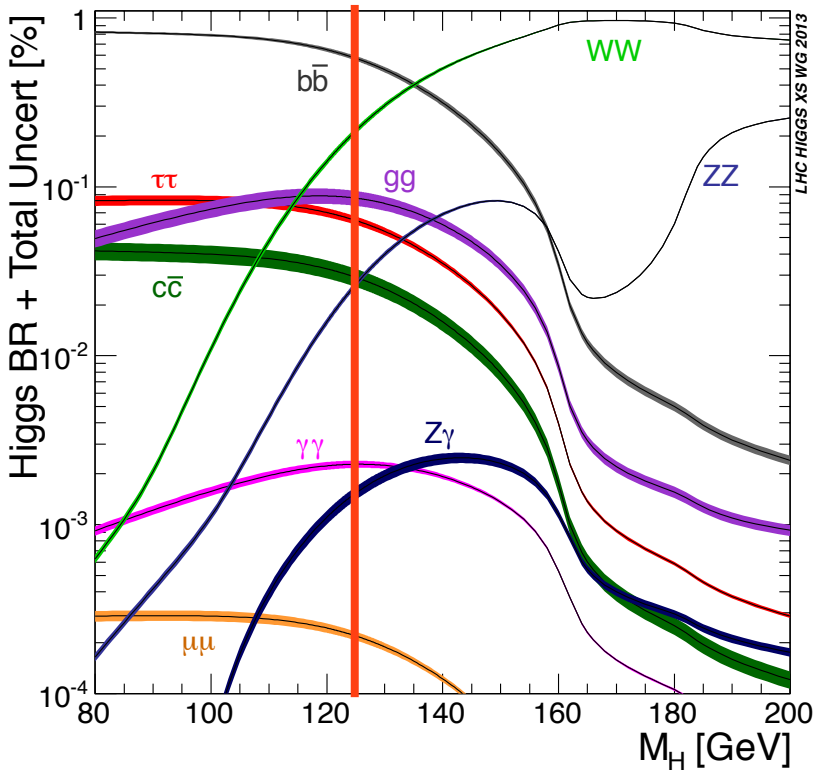
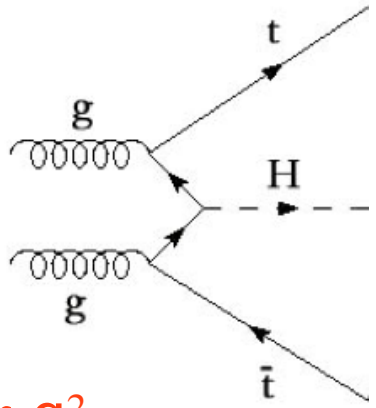
Importance of a ttH Measurement

- ttH is a direct measurement of the top-Yukawa coupling
- A parameter of great interest
  - Implications in new physics
- Signal is found in same region (tt + heavy flavour) as vast amount of searches



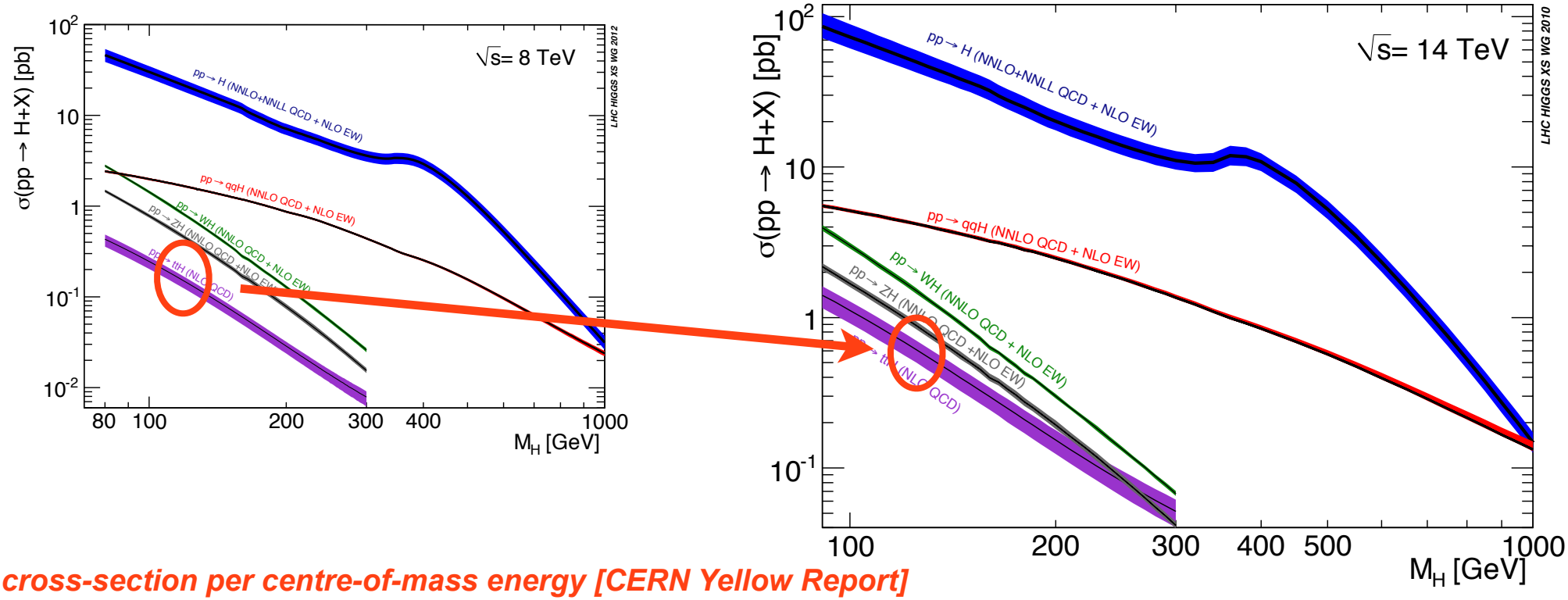


$\sigma(ttH) \propto g^2_{ttH}$

- Focus on Higgs decays: H->bb
- Largest BR at m_H of 125 GeV (58 %)

Gain in ttH Cross-section

- Moving from 8 TeV to 14 TeV, the ttH cross-section significantly increases



ttH cross-section per centre-of-mass energy [CERN Yellow Report]

7 TeV	8 TeV	14 TeV	33 TeV
0.0863 pb	0.1302 pb	0.6113 pb	4.4 pb

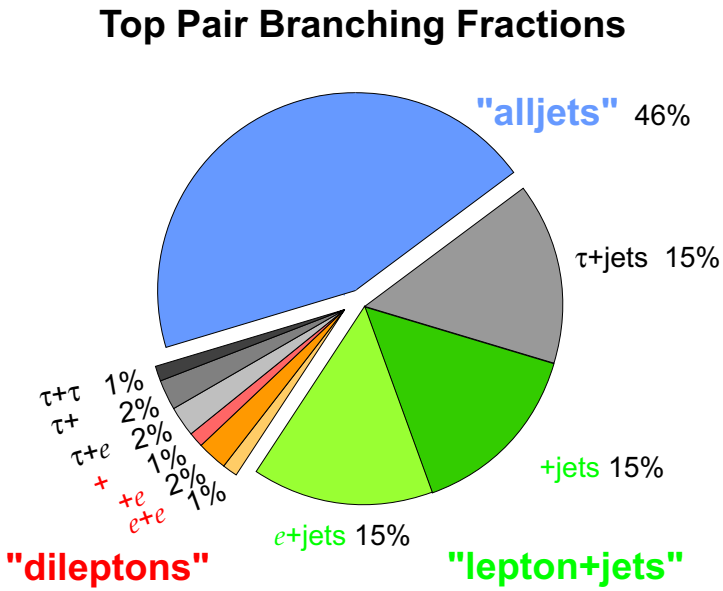
ttbar cross-section per centre-of-mass energy [Kidonakis, DIS 2012]

7 TeV	8 TeV	14 TeV	33 TeV
163 pb	234 pb	920 pb	5.6 nb

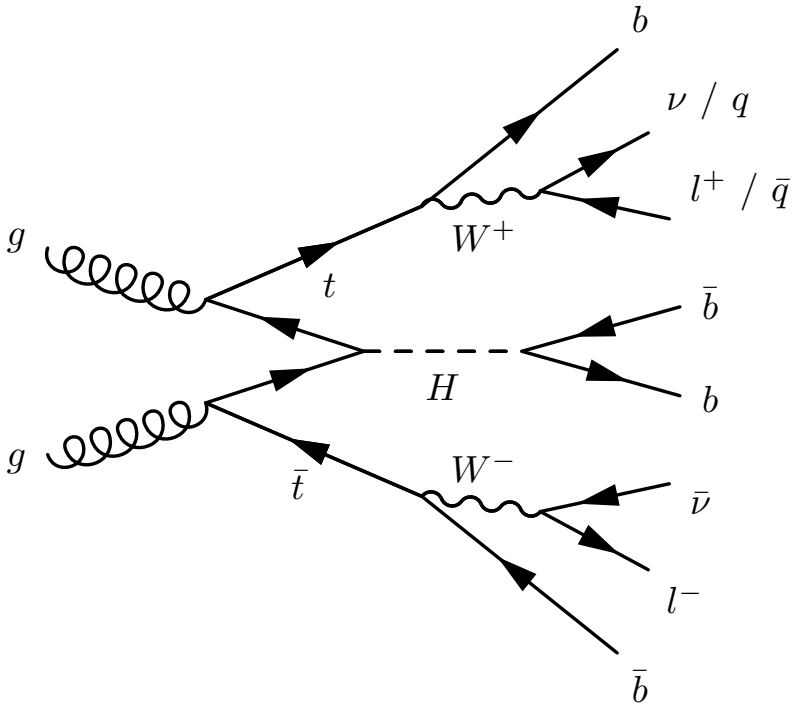
- ttH cross-section increases over ttbar cross-section

ttH Measurement

- Overview of decay modes of ttbar pair
- Analyses in all three top pair decay modes



- Alljets: largest BF (~ 46 %), 8 jets (4 b and 4 light) with large QCD background
- Lepton+jets: (~ 34 % BF), 6 jets (4 b and two light), 1 charged lepton, still significant QCD background



- Dilepton: Smallest BF (~ 6 %), 4 jets, all 4 are b quarks, two charged leptons, small QCD background rate
- *Dilepton channel used for this measurement*

ATLAS Measurement

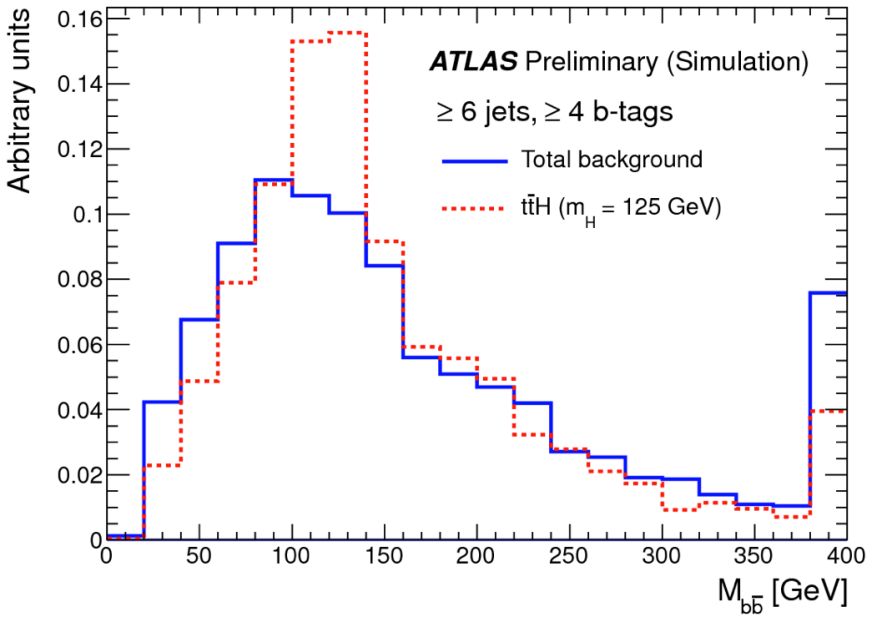
ATLAS-CONF-2012-135

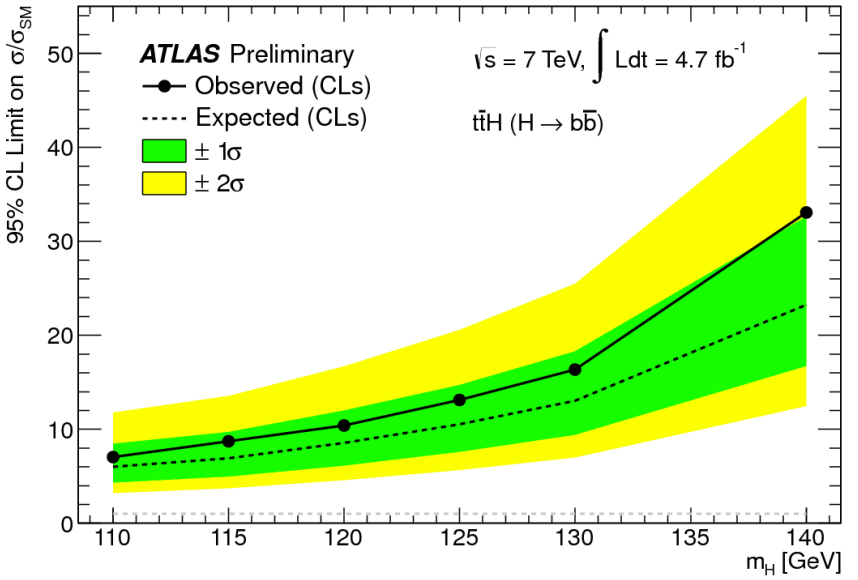
- 7 TeV 2011 Analysis using 5 fb^{-1}
- lepton + jets channel only
- H -> bb signal

- Two variables used in fit:
  - H_T of jets
  - m_{bb} from a kinematic fitting tool

- Nine region fit, separated by 5 background and 4 signal regions based on number of jets / b-tags per event

- Observed (expected) limits for mH = 125 GeV
  - 13.1 (10.2) x SM





CMS Measurement

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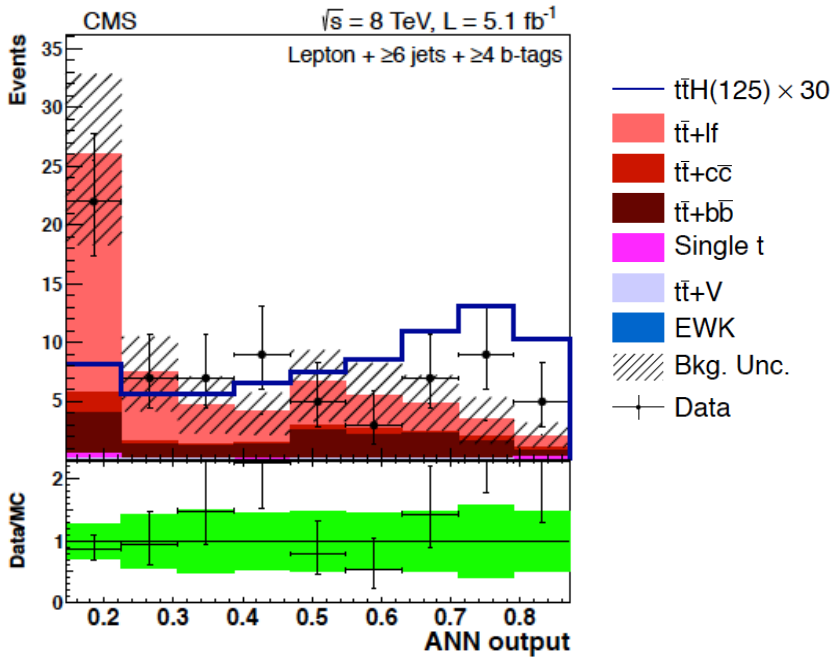
arXiv:1303.0763

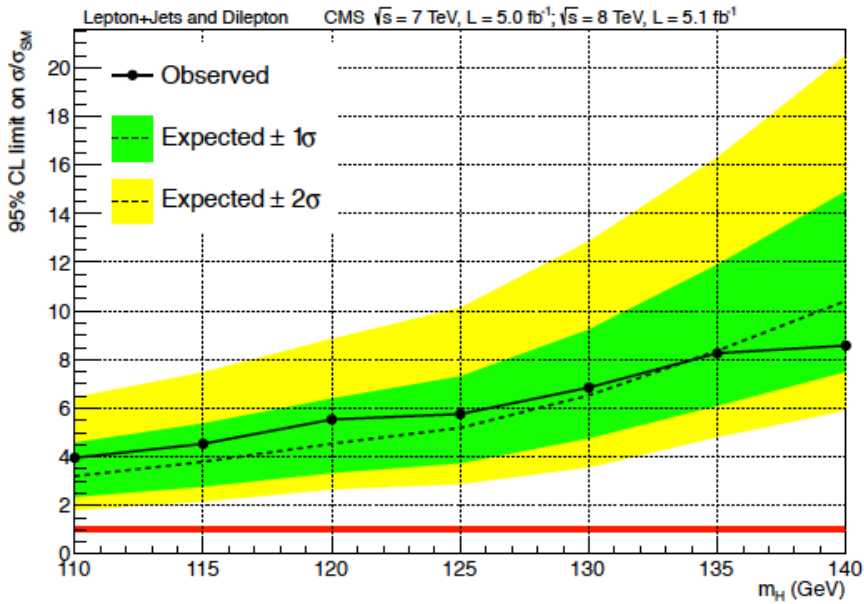
- 7 + 8 TeV 2011 Analysis using 5.0 + 5.1 fb^{-1}
- lepton + jets and dilepton channels only
- All SM Higgs considered signal

- NN is used in both lepton + jets and dilepton channels
  - 10 Variables used as input

- 7 region fit in lepton + jets
- 2 region fit in dilepton channel

- Observed (expected) limits for mH = 125 GeV
  - 5.8 (5.2) x SM



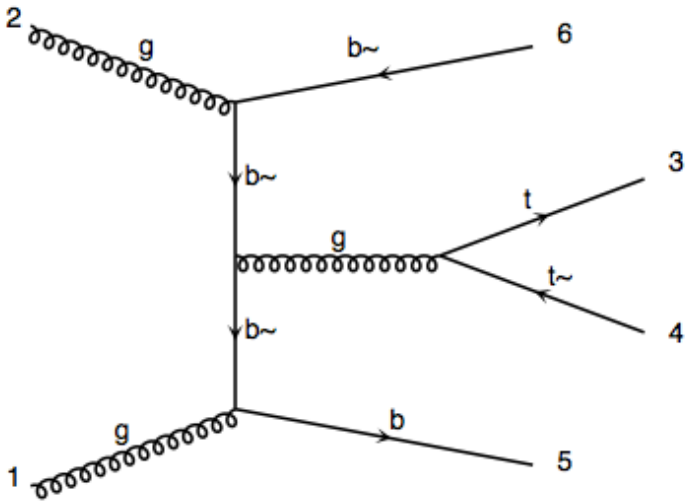


Measurement Strategy

- Focus on a dilepton ttH,H -> bb measurement: 2 oppositely signed leptons and 4 b jets

- Main task: Reduce uncertainty on irreducible tt+HF background

ttbb ME Contribution



- At 8 TeV, S/√B ~ 0.2, largest background from tt+HF

Background Signal

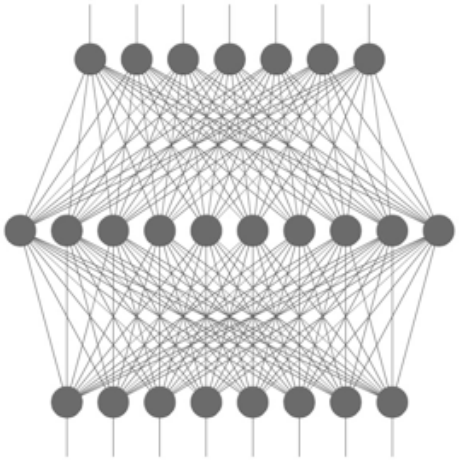
	1 + 2 b-tags	3 b-tags	≥ 4 b-tags
2 jets	HT		
≥ 3 jets	NN		

- Split fit regions in two for control of ttbar background

- Build a Neural Network to further separate signal from background in signal regions

Neural Network

- Use *NeuroBayes* to build a Neural Network to better distinguish signal from background
- Exploit kinematic information of the event, as well as b-tagging performance



Variable	Definition
b-tag WP	Pseudo-Continuous b-tagging variable based on loose and tight WP
H_T^{tot}	Scalar sum of jet p_T and lepton p_T
Jet p_T^{1st}	Leading jet p_T
N_{jets}	Number of Jets
$\Delta R(l,j)$	Closest distance of a lepton and jet per event
$\Delta R(j,j)$	Closest distance of two tagged jets per event

Table 1: The variables considered for use within the Neural Network analysis.

- Try to use variables which are un-correlated and contain the maximum amount of event information

Variables Considered in NN

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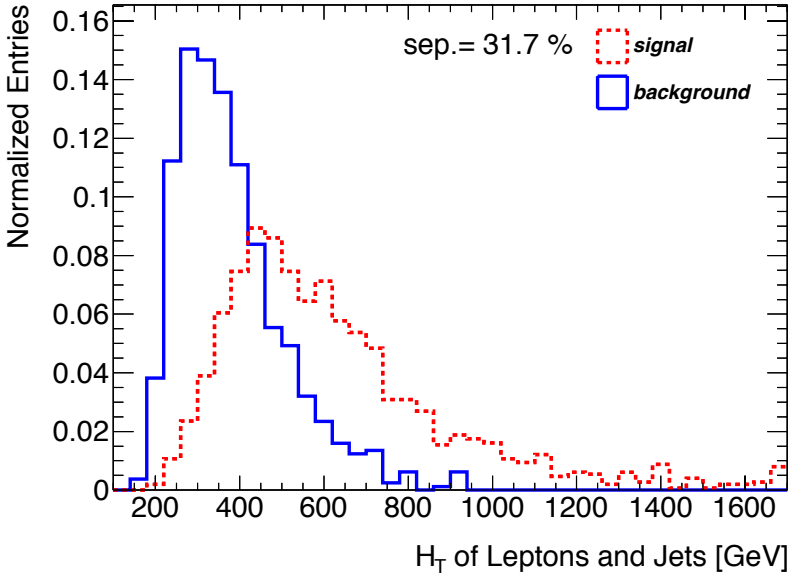
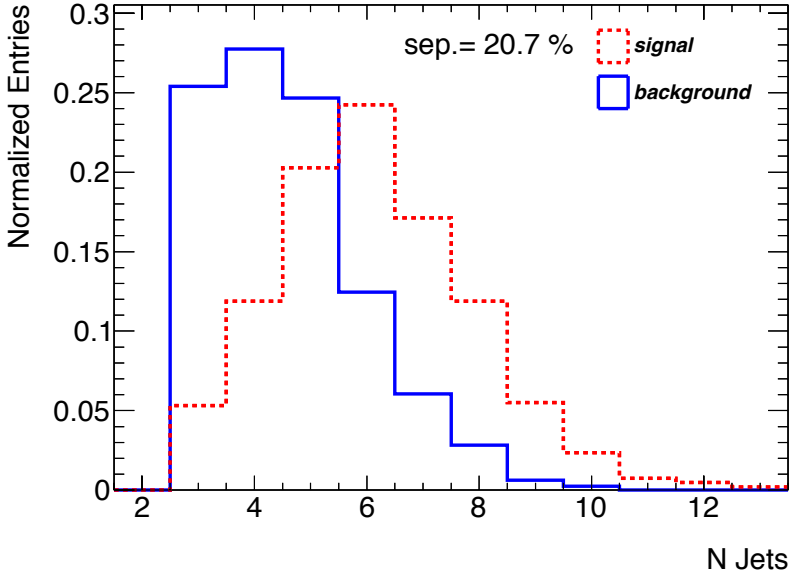
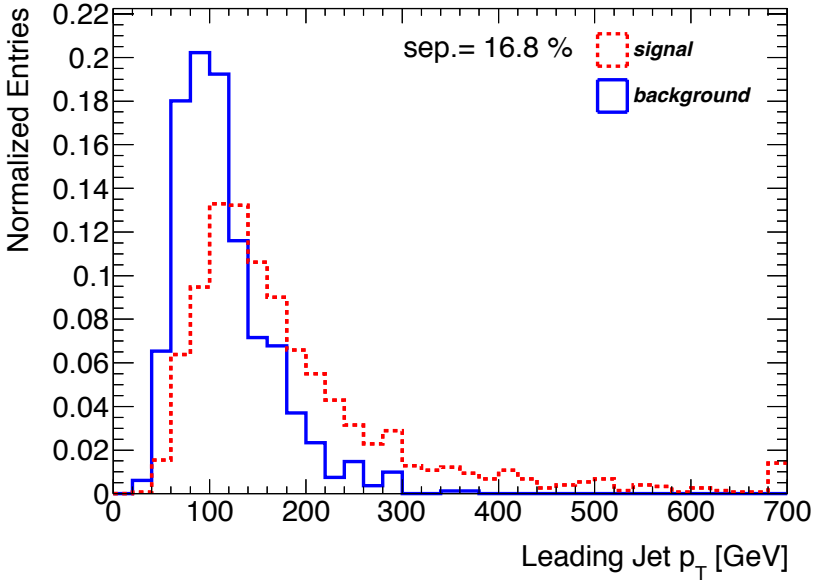
- Highest ranking variables in order of their separation

test sample stat. only (mu50)







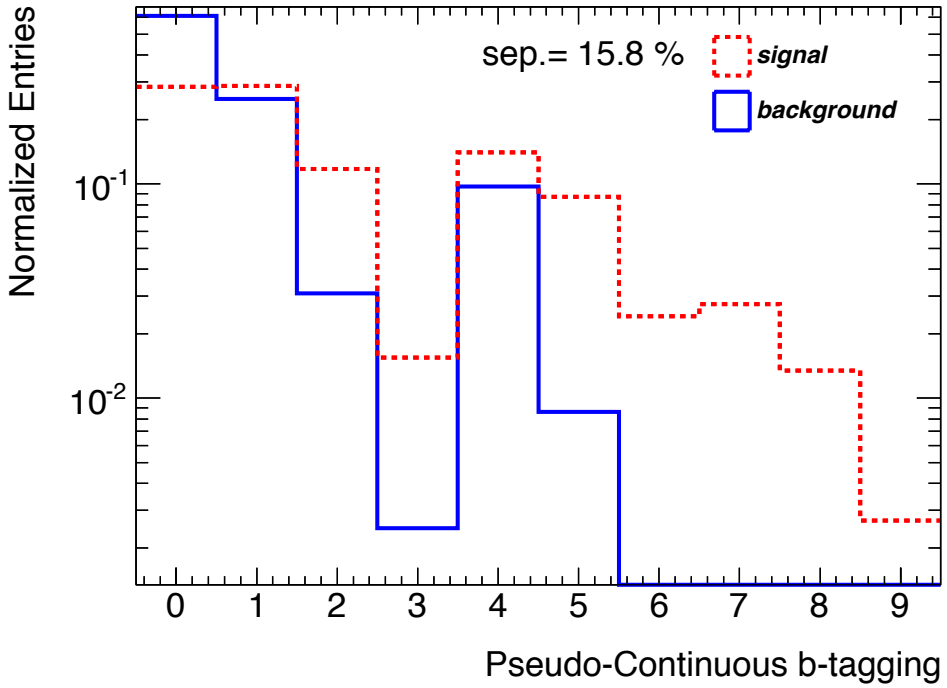
- Largest separation obtained using H_T variable

Separation defined as:

$$S = \frac{1}{2} \cdot \sum_i \frac{(N_i^{signal} - N_i^{background})^2}{(N_i^{signal} + N_i^{background})^2}$$

Pseudo-Continuous b-tagging

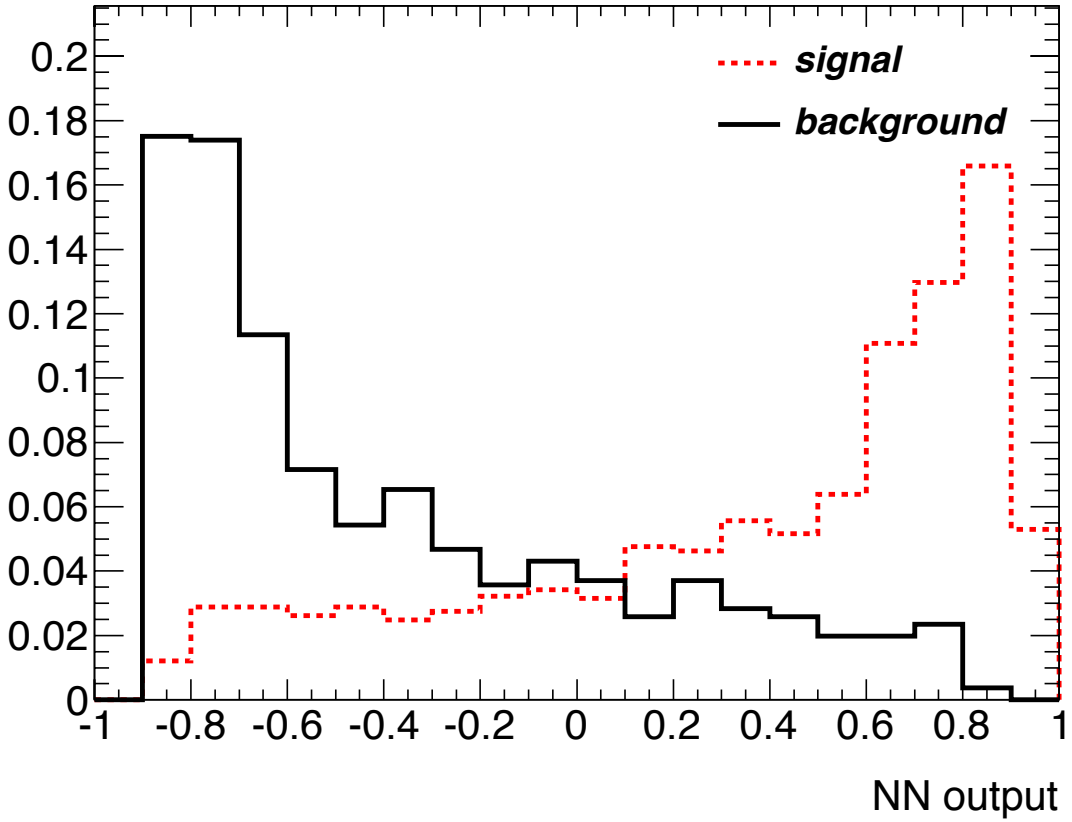
- Potentially very powerful variable is pseudo-continuous b-tagging
- Per event: Separate signal region events by number of loose and tight b-tags
- 10 possible options



Value	# of Loose	# of Tight
0	1	1
1	2	1
2	3	1
3	4 or more	1
4	2	2
5	3	2
6	4 or more	2
7	3	3
8	4 or more	3
9	4 or more	4 or more

- Tight must be also loose tag

Discriminant of NN



- Final discriminant of the NN
- Only training on the test samples:
  - ttbar background
  - ttH signal
- Very good separation
- Limited amount of signal

- Next steps: Look into full dataset variables using Delphes 3.0.9

Many thanks to the entire production team!

Initial Projections at 8 TeV

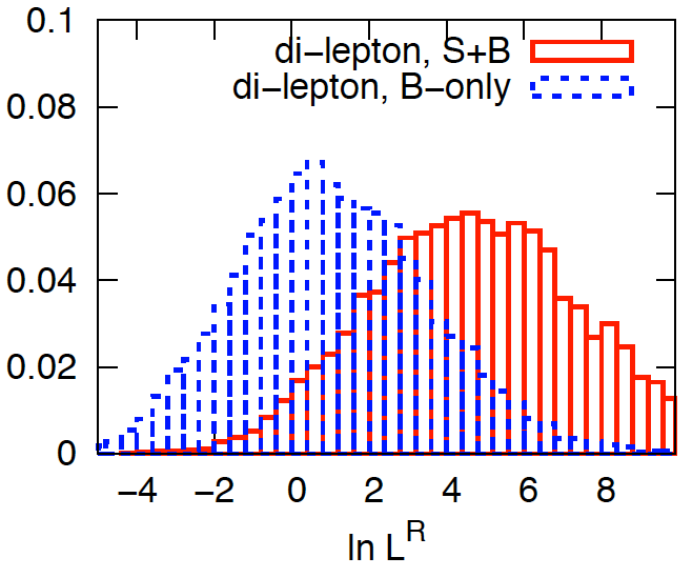
- Initial 8 TeV limit projections (σ/σ_{SM} at 95 % C.L.), absence of signal
- Performed with single variable H_T and conservative systematics estimate

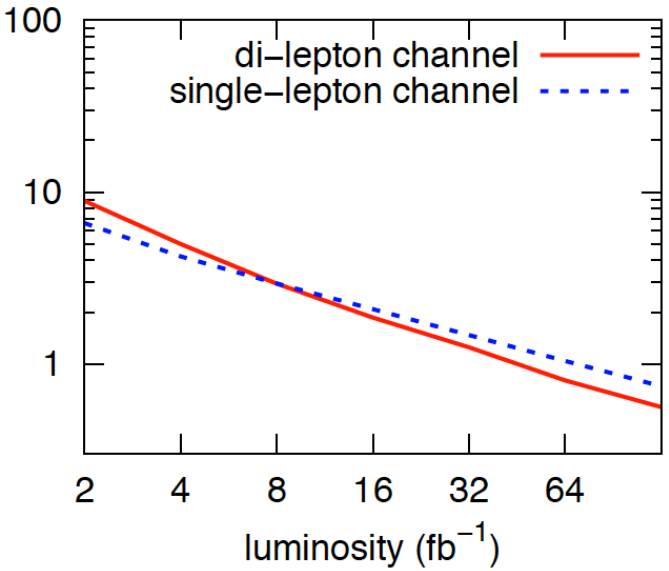
- *σ/σ_{SM} at 95 % C.L. at 8 TeV*

20 /fb	300 /fb	3000 /fb
8.0	1.7	0.2

- Much better at 14 TeV
- Should expect discovery around 50 - 300 /fb with only the dilepton channel using a NN

Artoisenet et al., arXiv:1304.6414





- MEM in dilepton channel: S+B excluded at ~ 32 /fb

Conclusions and Outlook

- Overview of ttH, H->bb measurement for the Snowmass effort
- ttH measurement is important for the understanding of top-Yukawa coupling
  - Will be an important measurement in Phase-II LHC upgrade
  - Potential for direct couplings measurement

- Measurement is performed in the ttbar dilepton decay mode
- Looking at event and kinematic variables to distinguish signal from ttbar background in a Neural Network

- First draft of paper being prepared, ready early next week
- Final report expected by end of July / early August