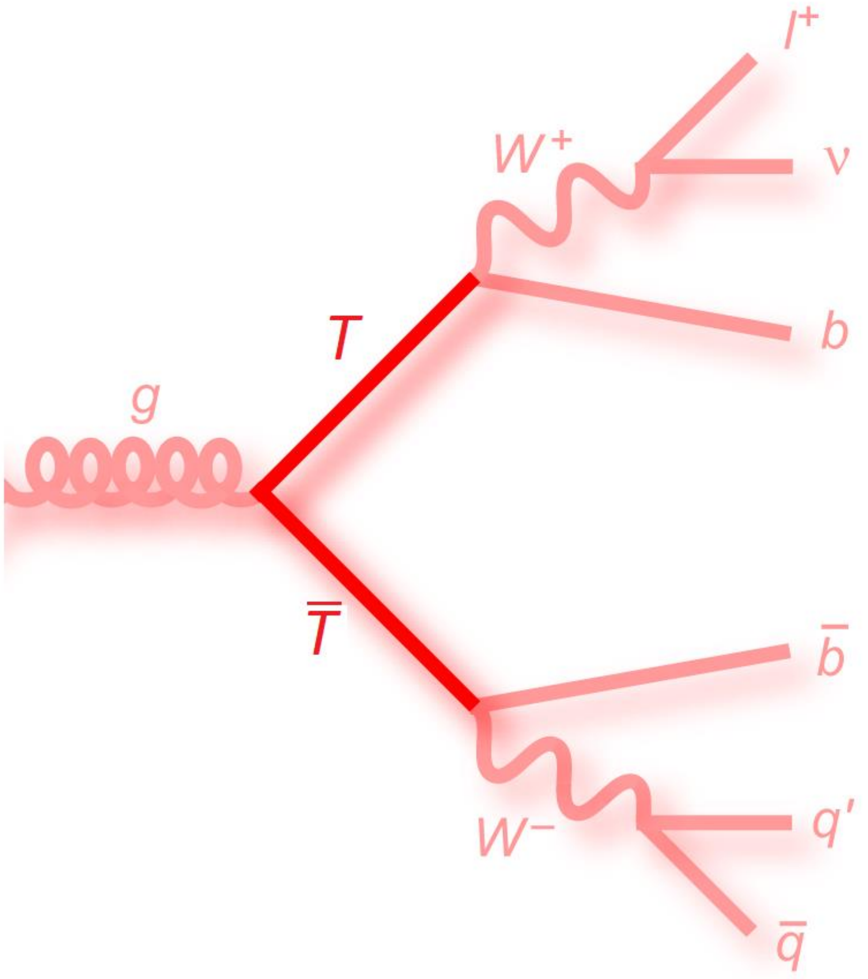
Bennett Magy

T → Wb Update: 26 March 2015

Top Partner Search
T→Wb @13 TeV

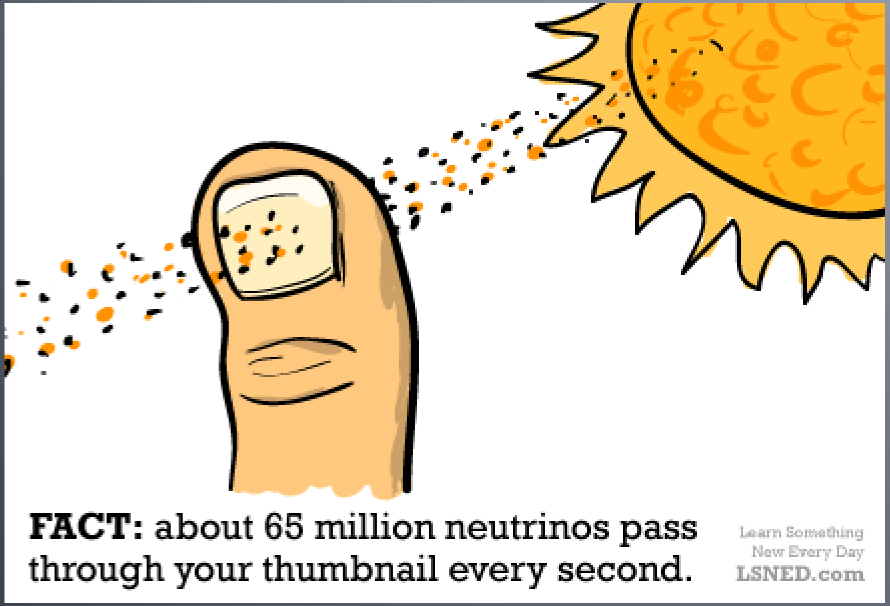
- Background Samples:
  - $t\bar{t}$
  - W + jets
  - Z + jets
  - Singletop

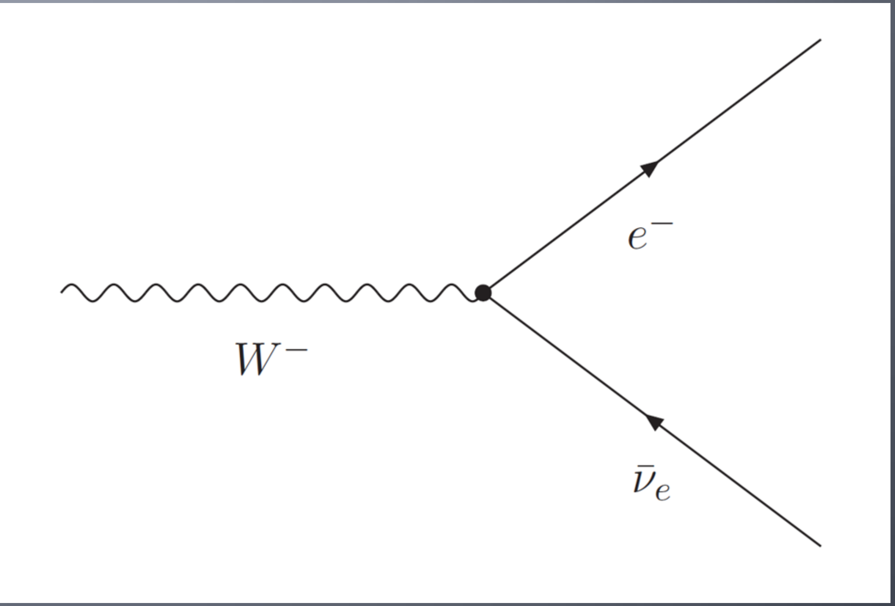
- Signal Samples:
  - 700 GeV
  - 900 GeV
  - 1100 GeV



Neutrino Reconstruction

Neutrinos can't be detected by the ATLAS detector, but we can still piece them back together





Reconstruction Equations

$$p_x = p_T \cos\phi$$
$$p_y = p_T \sin\phi$$
$$\mu = \frac{{M_W}^2}{2} + p_{x,\nu}p_{x,l} + p_{y,\nu}p_{y,l}$$
$$a = \frac{\mu p_{z,l}}{{E_l}^2 - {p_{z,l}}^2}$$
$$b = \frac{{E_l}^2 E_{T,miss}^2 - \mu^2}{{E_l}^2 - {p_{z,l}}^2}$$
$$p_{z,\nu} = a \pm \sqrt{a^2 - b}$$

- With MET, MET Phi, lepton information and what we know about the W boson, reconstruct the undetected Neutrino.
- Currently analyzing six different methods to handle the case where the neutrino solution(s) is/are complex.
- Compare how their reconstructions compare with truth

Reconstruction Methods

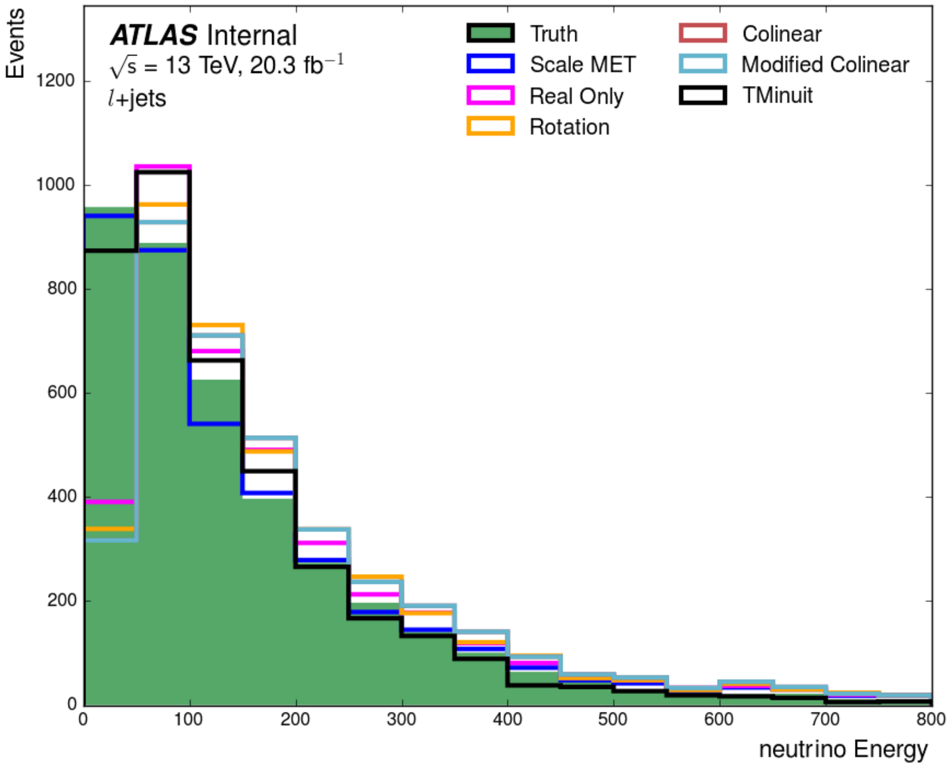
- "Real Only": $p_{z,\nu} = \mathrm{Re}\left(a \pm \sqrt{a^2 - b}\right)$
- "Colinear": $\eta_\nu = \eta_l \mid \phi_\nu = \phi_l$
- "modColinear": $\eta_\nu = \eta_l \mid \phi_\nu = \phi_{miss}$
- "TMinuit": Scale back $E_{T,miss}$ with TMinuit. The goal is to minimize difference between reconstructed M_W and standard M_W.
- "Rotation": Rotate ϕ_{miss} until the solution is real.
- "scaleMET": Scale back $E_{T,miss}$ until the solution is real.

Reconstruction Plots

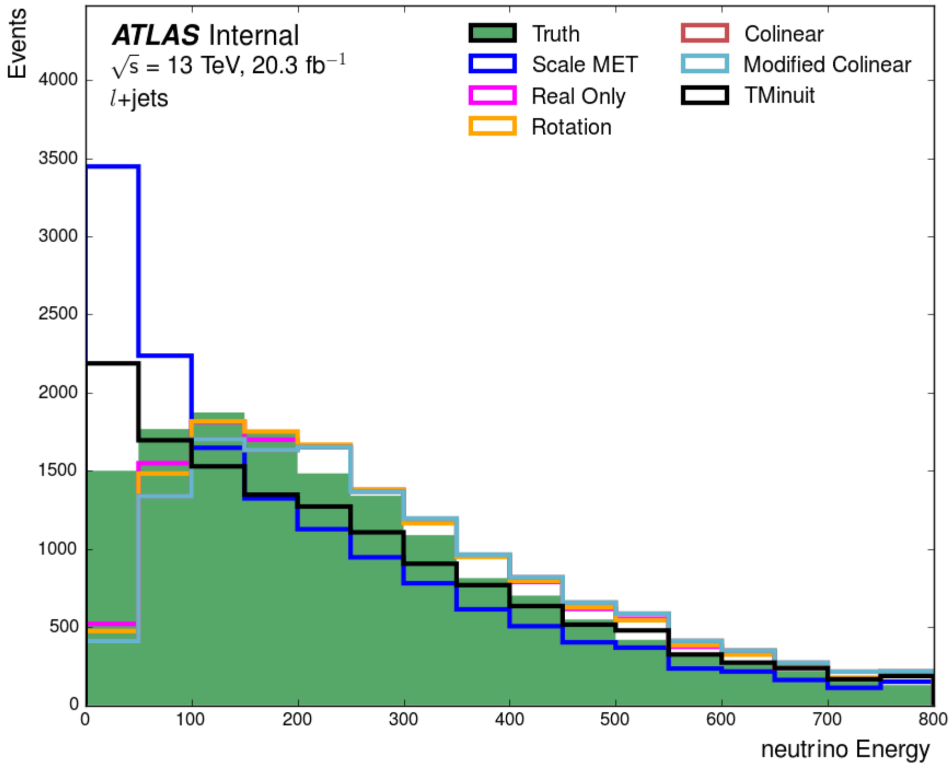
$t\bar{t}$ vs. $T\bar{T}$ (M = 900 GeV)

Neutrino Energy Comparison

$t\bar{t}$

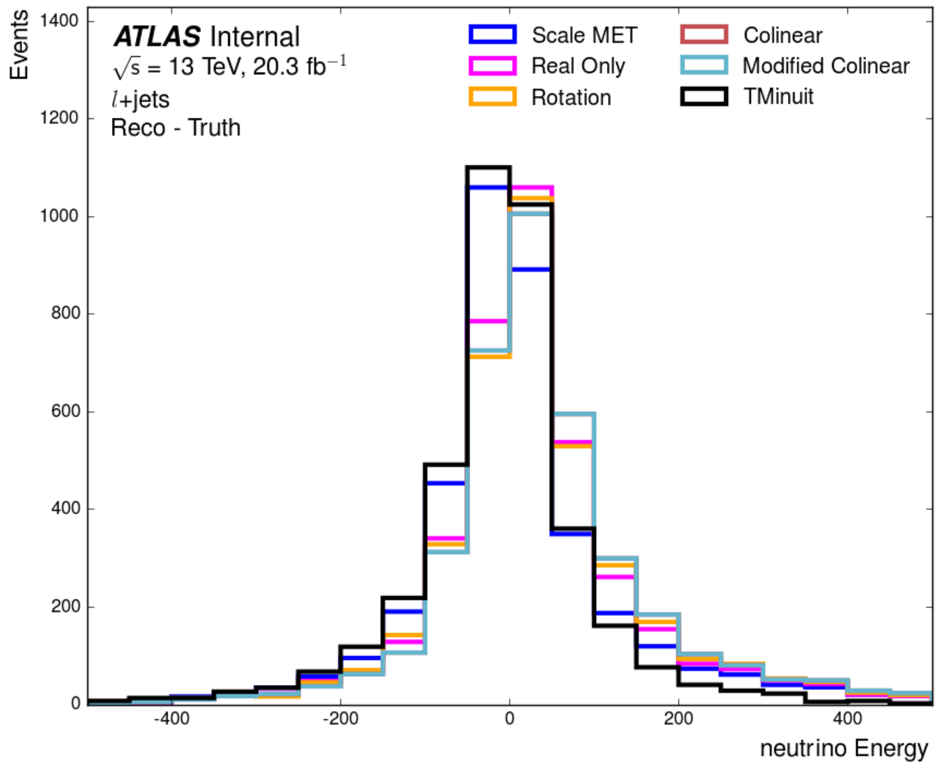


$T\bar{T}$ (M_T = 900 GeV)



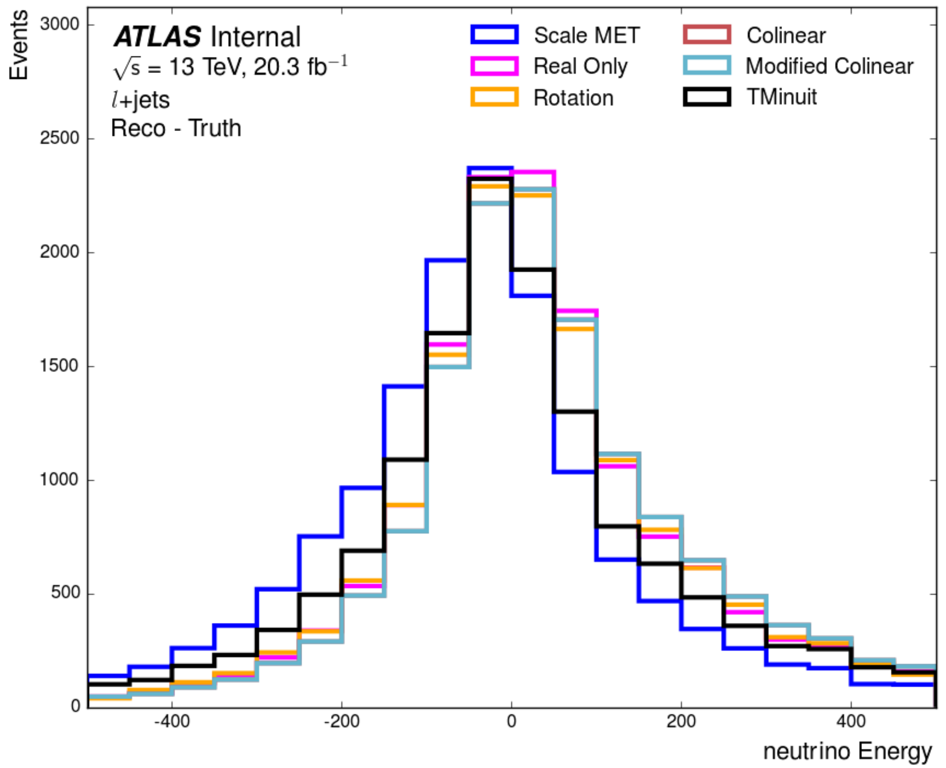
Neutrino Energy Resolution

$t\bar{t}$



Reco	Mean	Std Dev
scaleMET	24.4	189.43
realonly	71.9	848.16
rotation	79.24	866.03
colinear	86.56	882.51
modColinear	86.56	882.51
TMinuit	-8.34	187.65

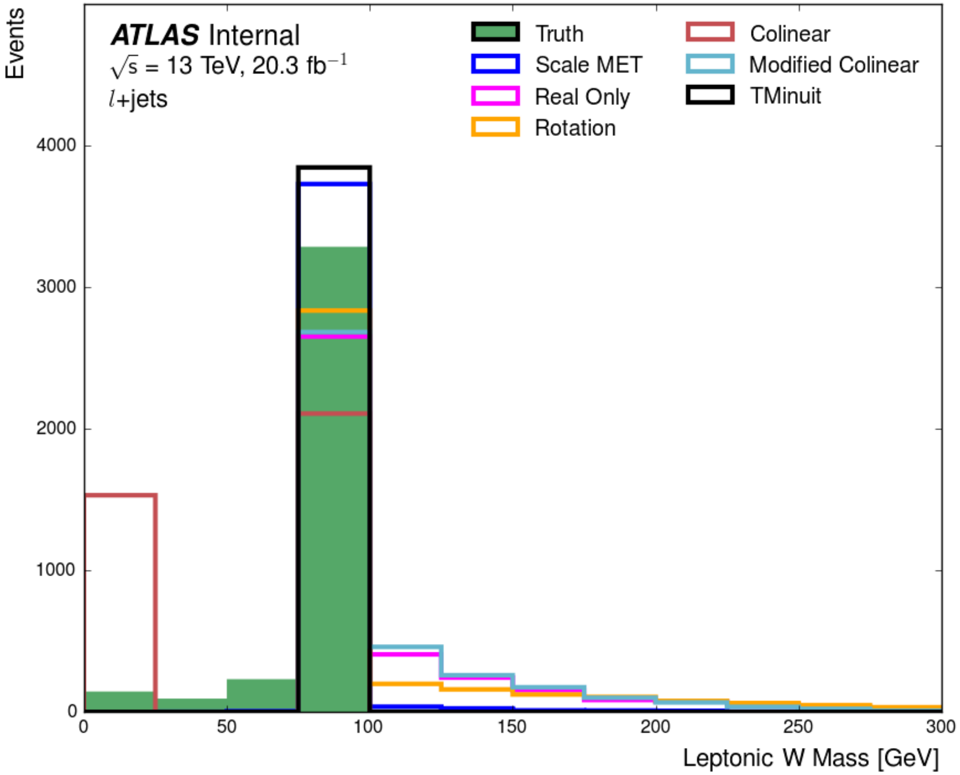
$T\bar{T}\ (M_T = 900\ \text{GeV})$



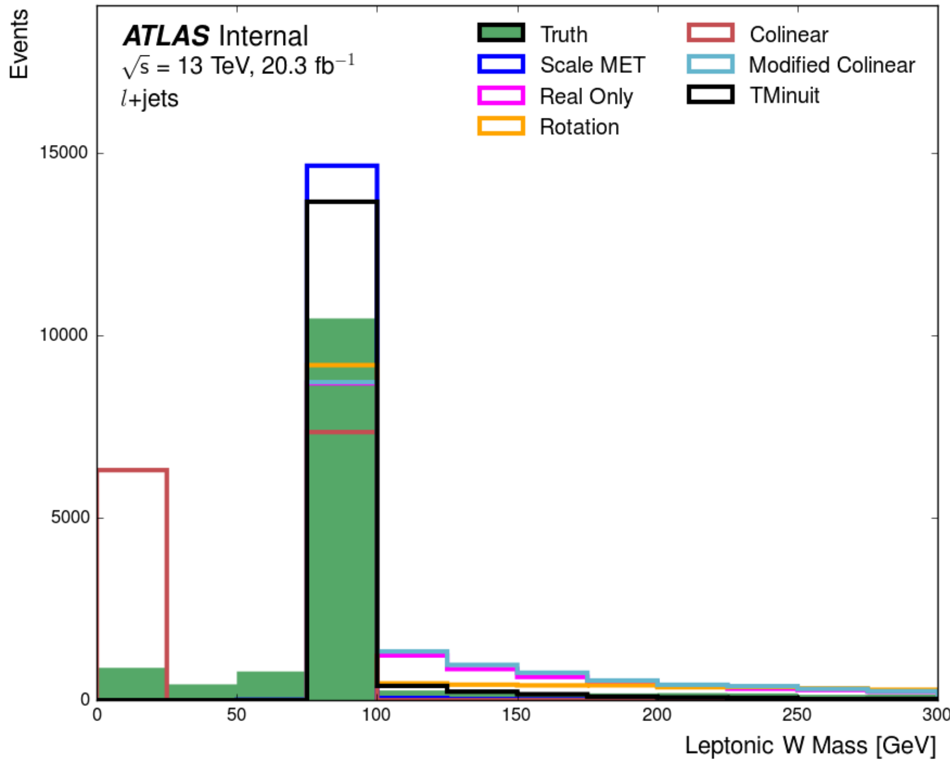
Reco	Mean	Std Dev
scaleMET	-33.18	270.11
realonly	67.3	484.17
rotation	72.35	474.29
colinear	96.65	600.39
modColinear	96.65	600.39
TMinuit	109.5	962.36

Leptonic W Mass Comparison

$t\bar{t}$

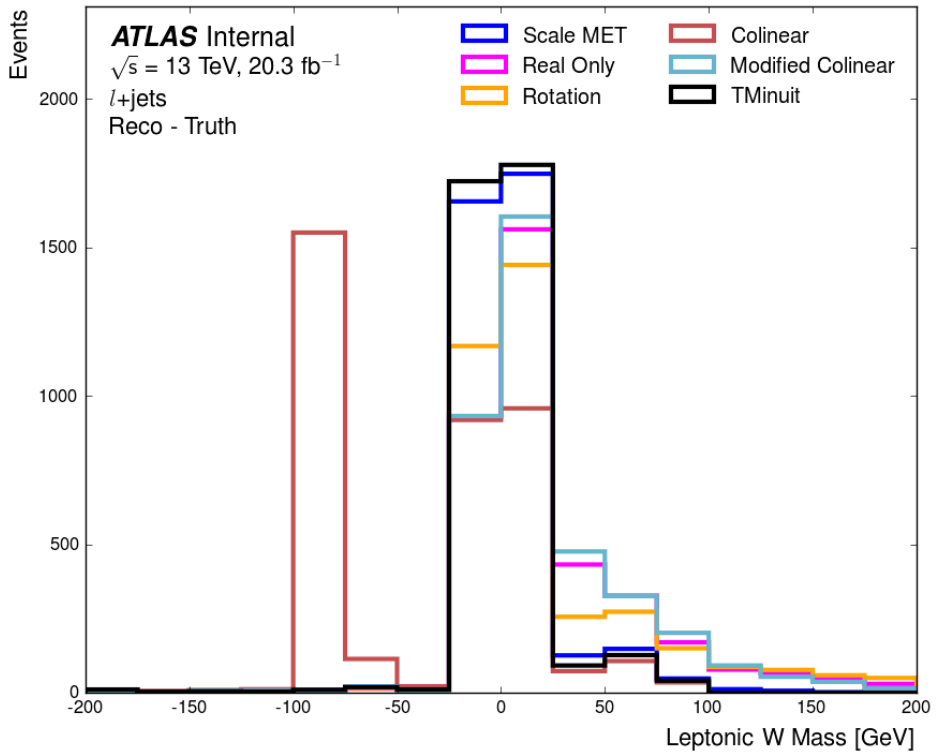


$T\bar{T}$ (M_T = 900 GeV)



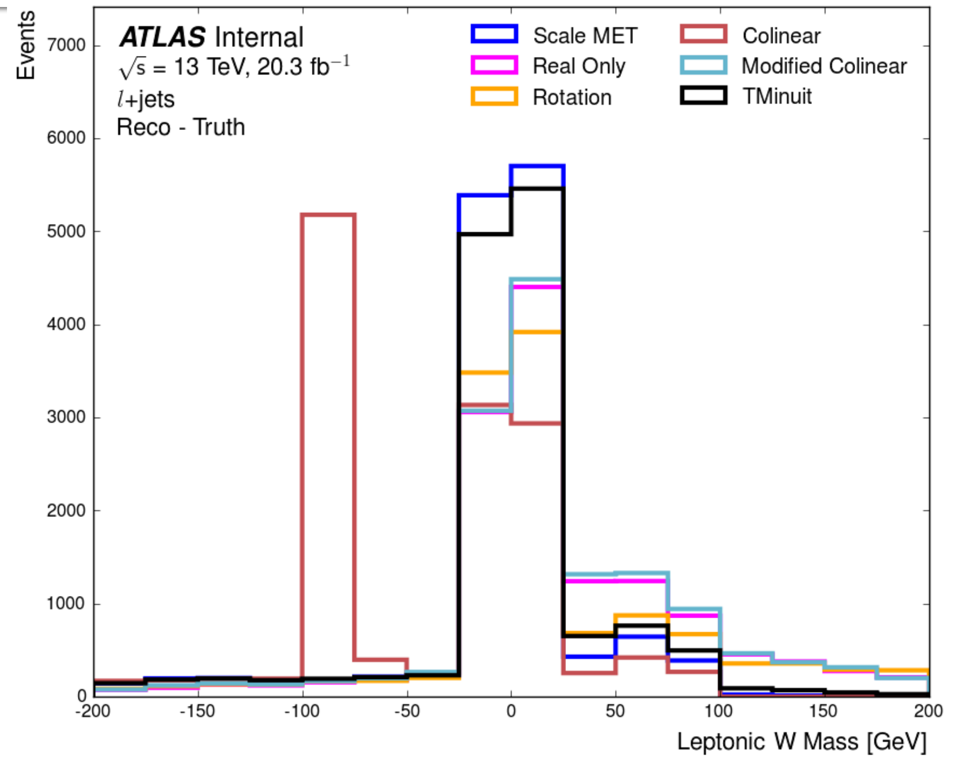
Leptonic W Mass Resolution

$t\bar{t}$



Reco	Mean	Std Dev
scaleMET	4.25	38.94
realonly	36.12	100.95
rotation	42.67	118.31
colinear	-35.17	51.96
modColinear	25.71	70.2
TMinuit	1.12	28.8

$T\bar{T}$ (M_T = 900 GeV)



Reco	Mean	Std Dev
scaleMET	-21.95	108.32
realonly	57.34	177.64
rotation	81.34	218.23
colinear	-66.35	115.91
modColinear	35.1	126.64
TMinuit	-15.38	111.45

Further Investigation

- TMinuit and scaleMET seem to be best options.
- Look at different samples (W + jets, Z + jets) for reconstruction behavior
- Investigate viability of truth information.

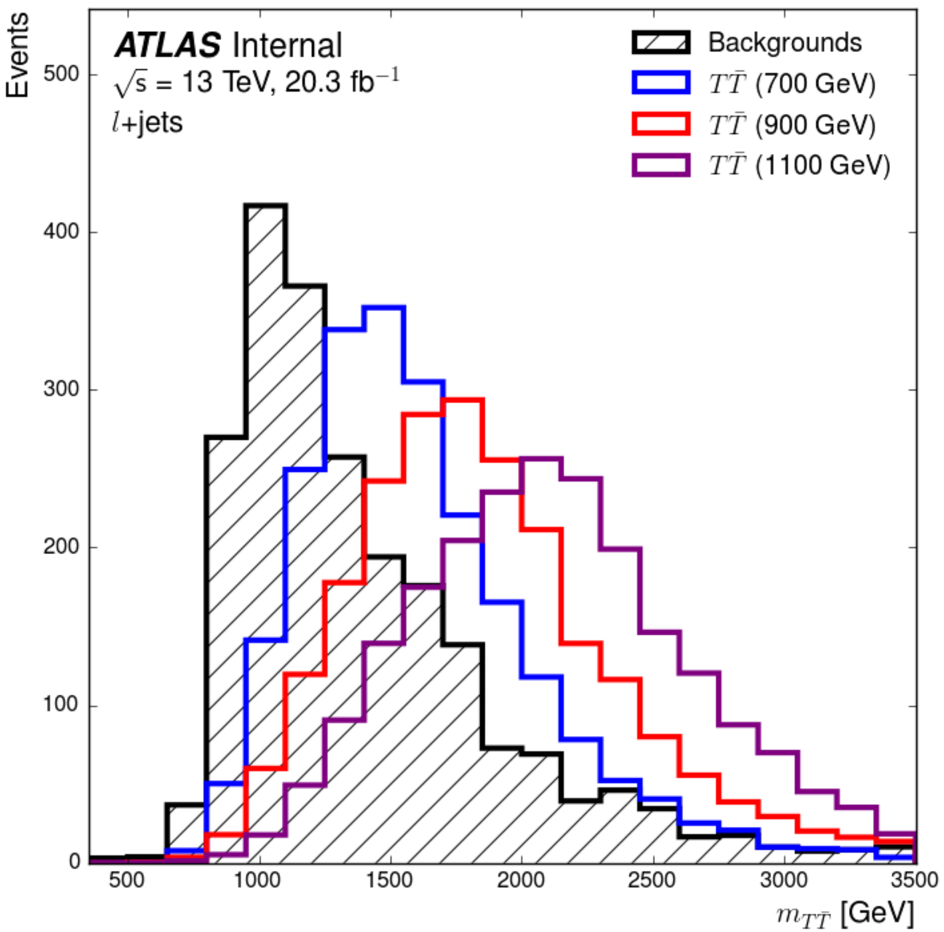
Cut Optimization

Motivation

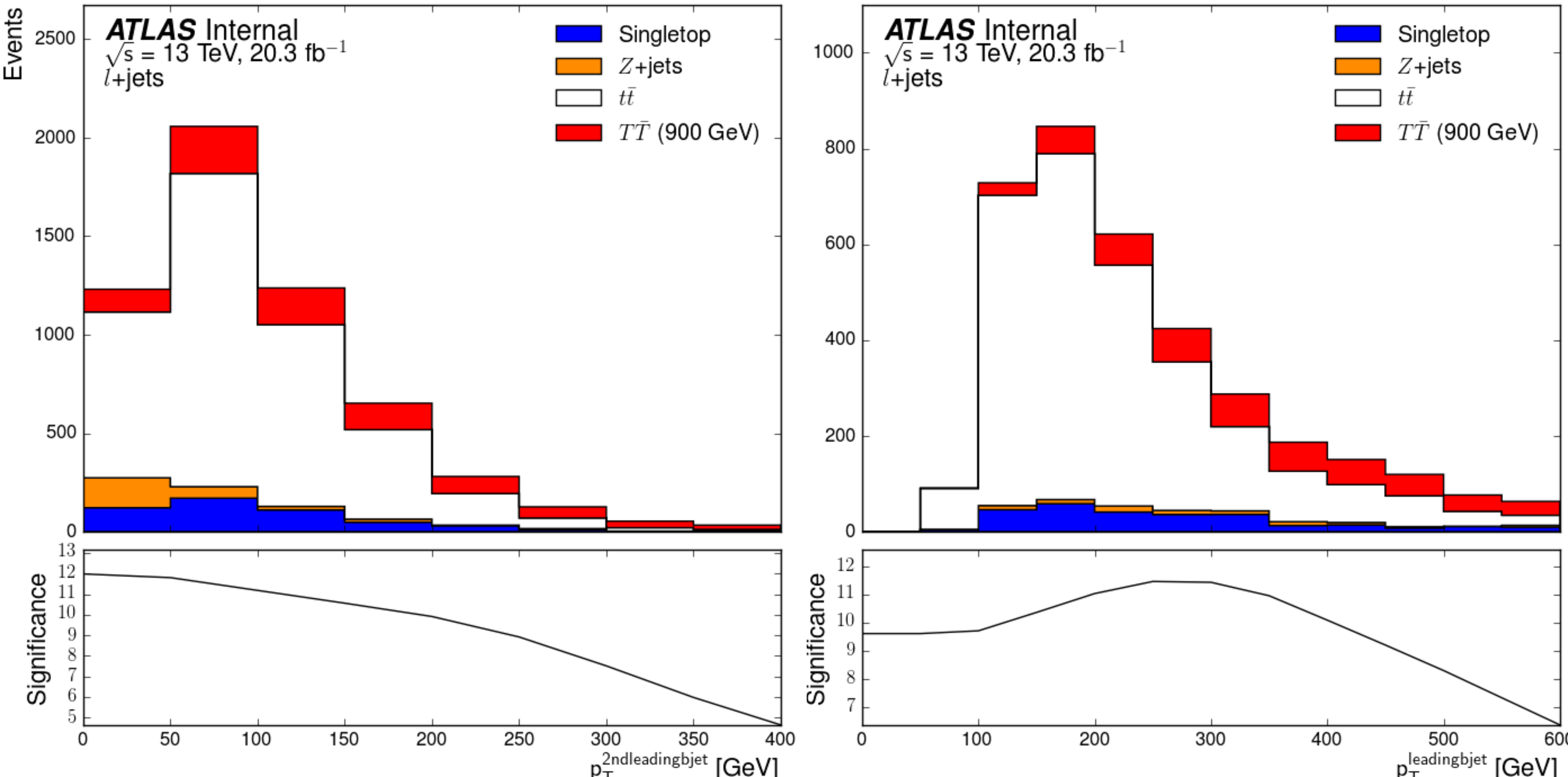
- How do we choose our events?
- Goal is to identify "Signal Region":
  - Signal: $T\bar{T}$ events
  - Background: non- $T\bar{T}$ events that pass selection.
- Maximize Significance
- Minimize Statistical Uncertainty

$$\Sigma^2 = \frac{{Y_S}^2}{Y_S + Y_B}$$

(Significance Eqn)



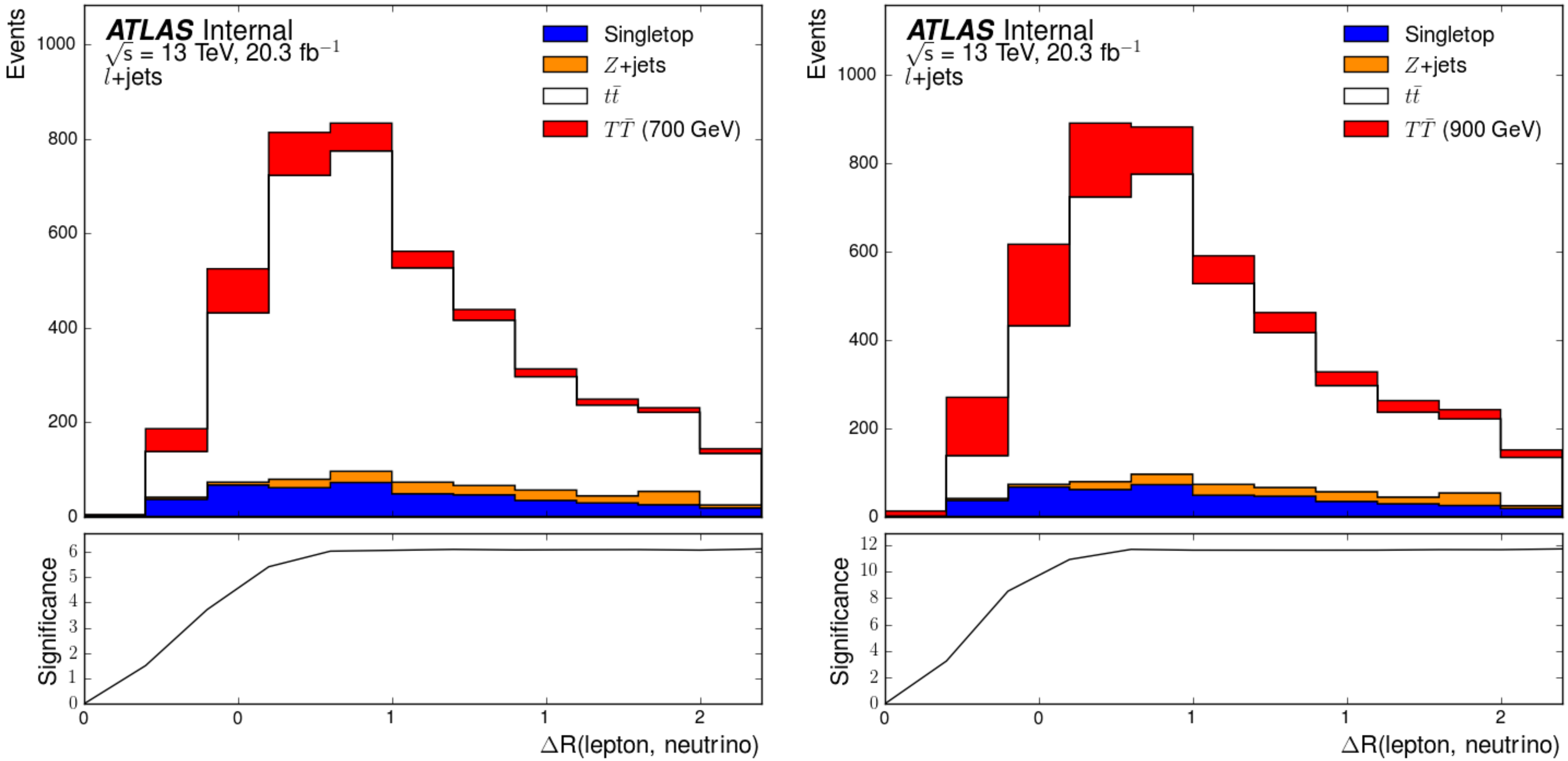
Interpreting Significance Plots



Initial Cuts: 1st Leading b jet Pt > 160 GeV,
2nd Leading bjet Pt > 80 GeV

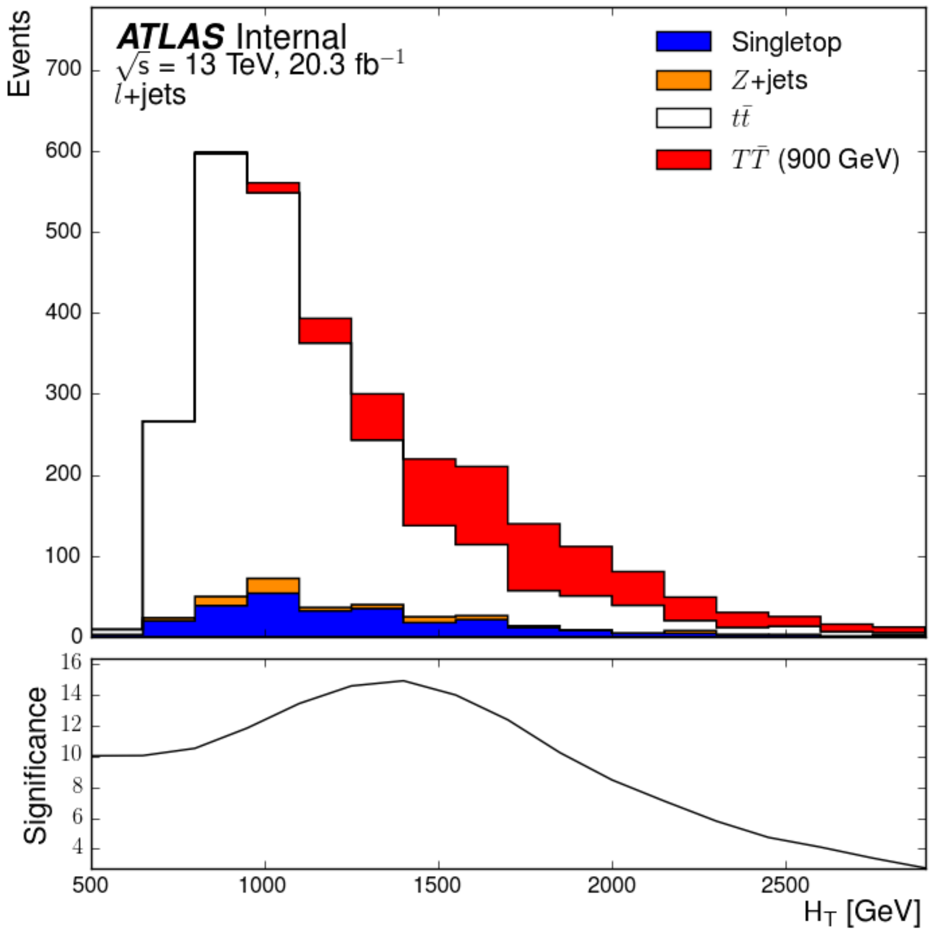
Note: Significance read as "significance associated with cutting events to the left of the specified value"

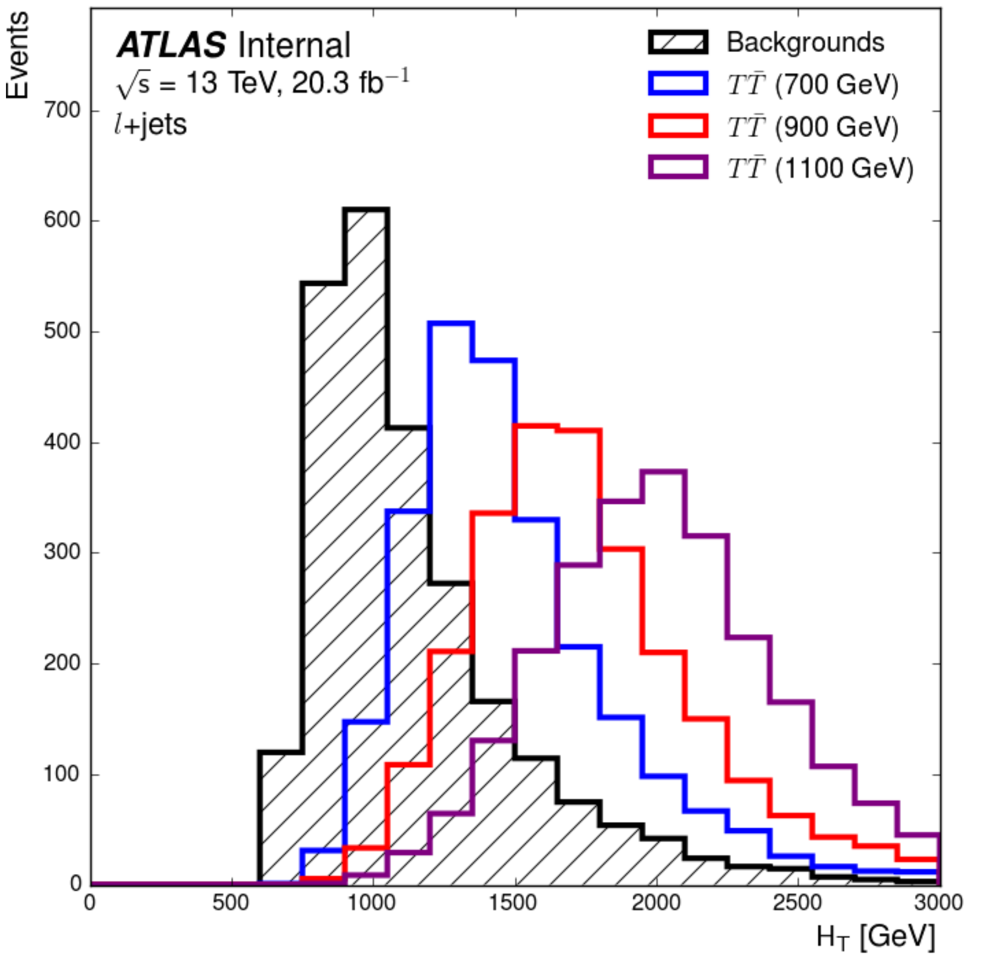
Interpreting Significance Plots (cont.)



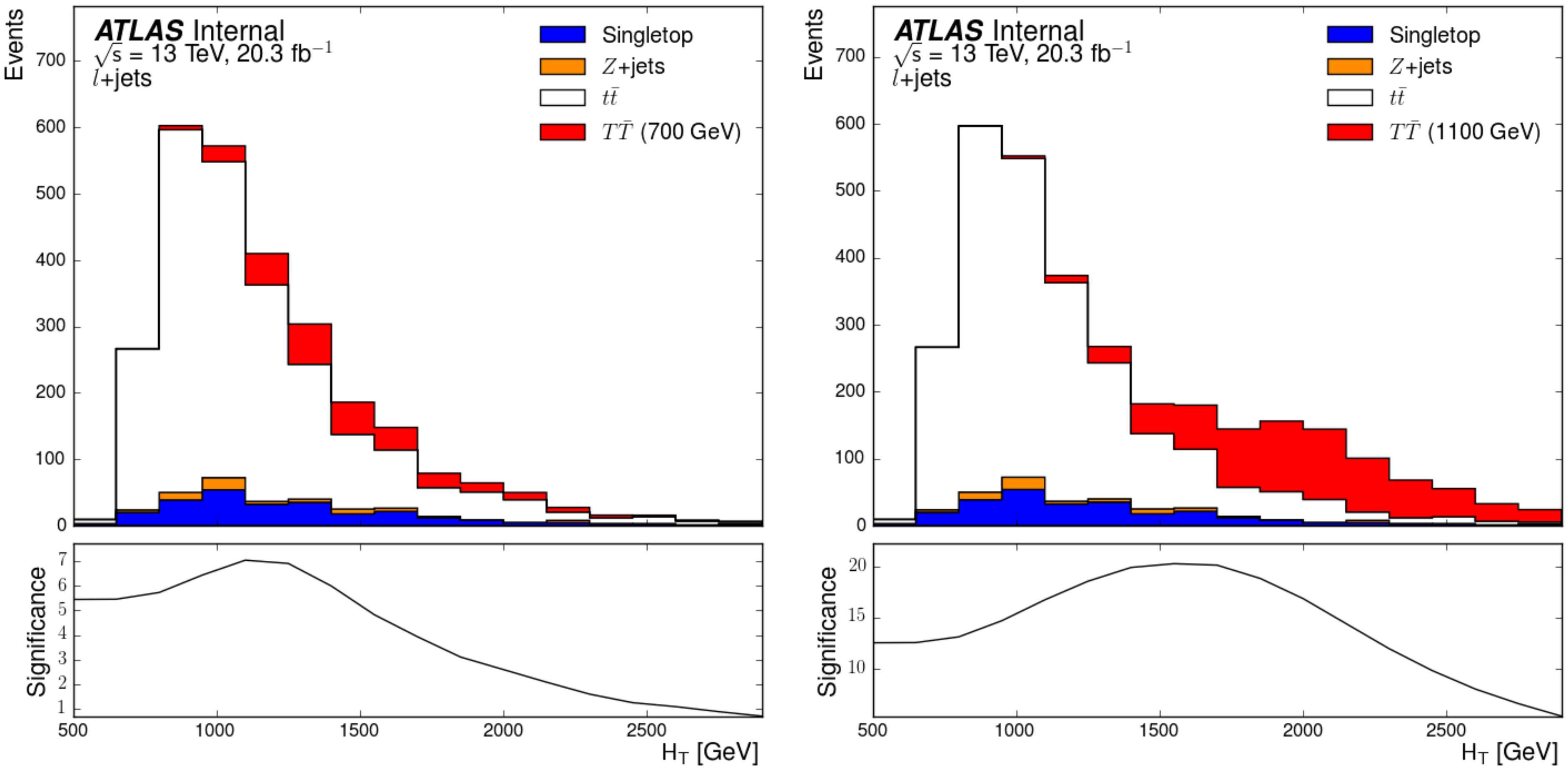
Note: This is a left hand cut, so the significance is a function of cutting all the events to the right of the specified value

Signal Sample Dependence





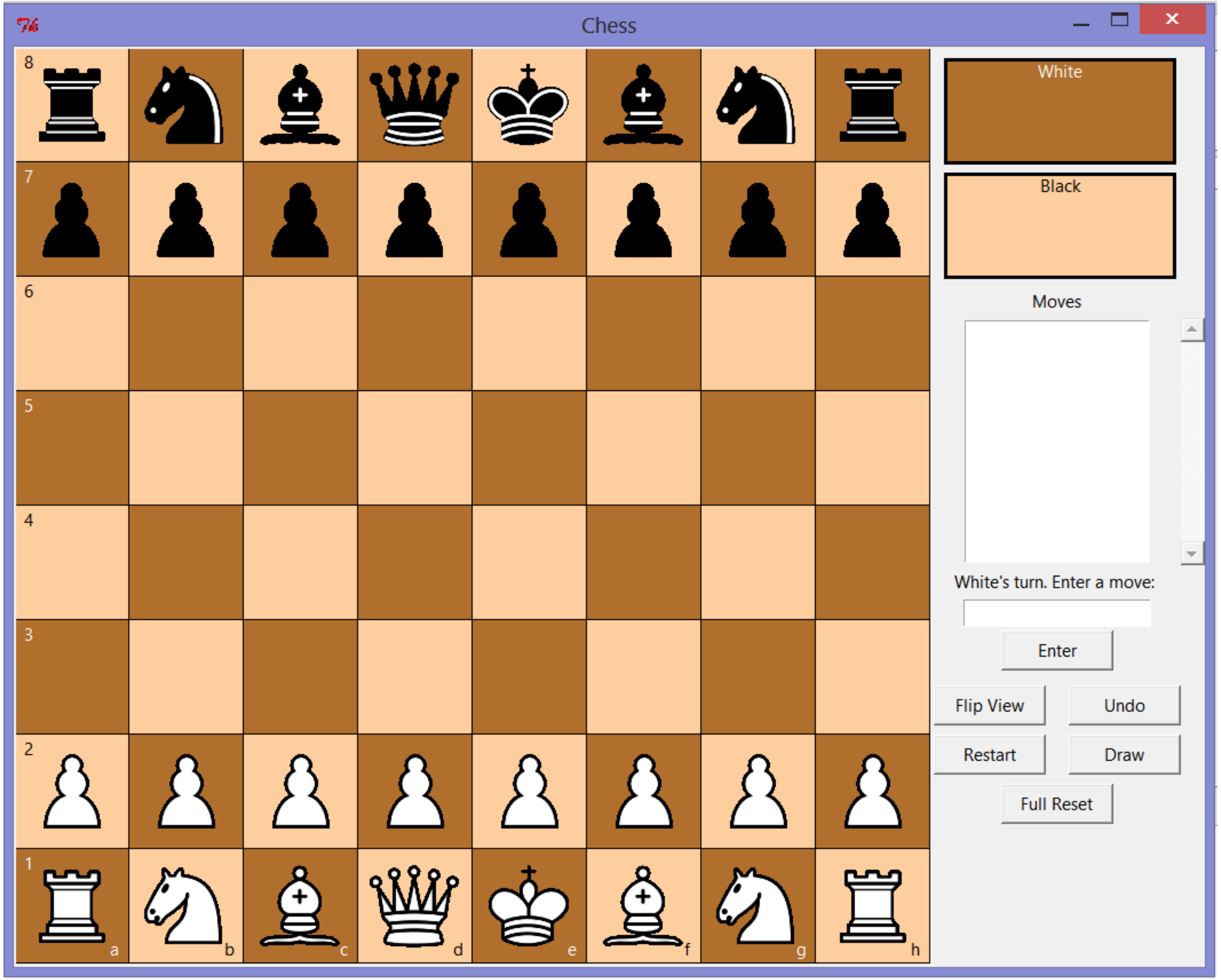
Signal Sample Dependence Cont.



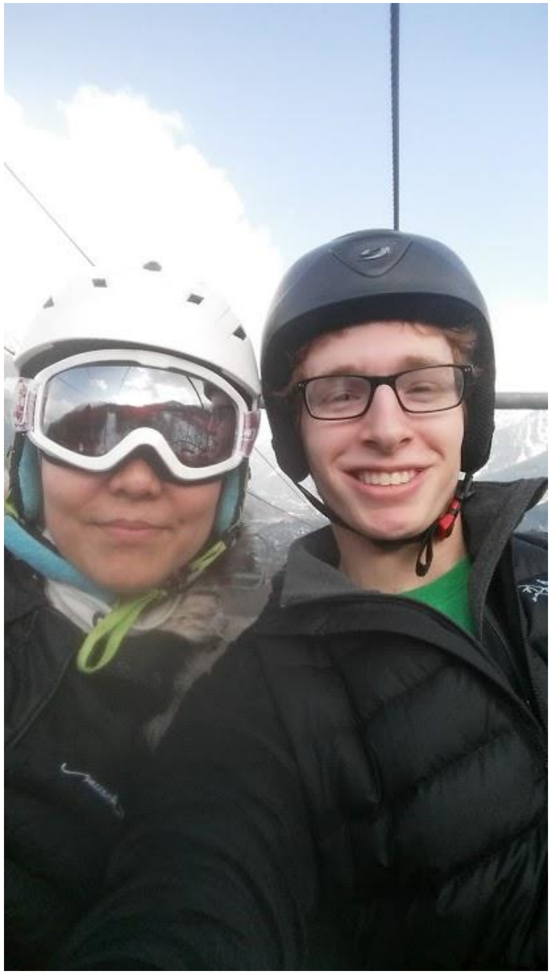
Further Investigation

- All that has been explored so far are 1-D optimization (one cut considered at a time)
- Explore TMVA for multidimensional optimization

PyChess


Chess
White
Black
Moves
White's turn. Enter a move:
Enter
Flip View
Undo
Restart
Draw
Full Reset
8
7
6
5
4
3
2
1
a
b
c
d
e
f
g
h

Cultural Activities



Special Thanks

- Thanks to Prof. Tom Schwarz, Dr. Allison McCarn, Daniel Marley, Prof. Jean Krisch, Dr. Steven Goldfarb, and Prof. Homer Neal!

THE END