4th gen quarks at ATLAS

Direct Searches

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4th gen

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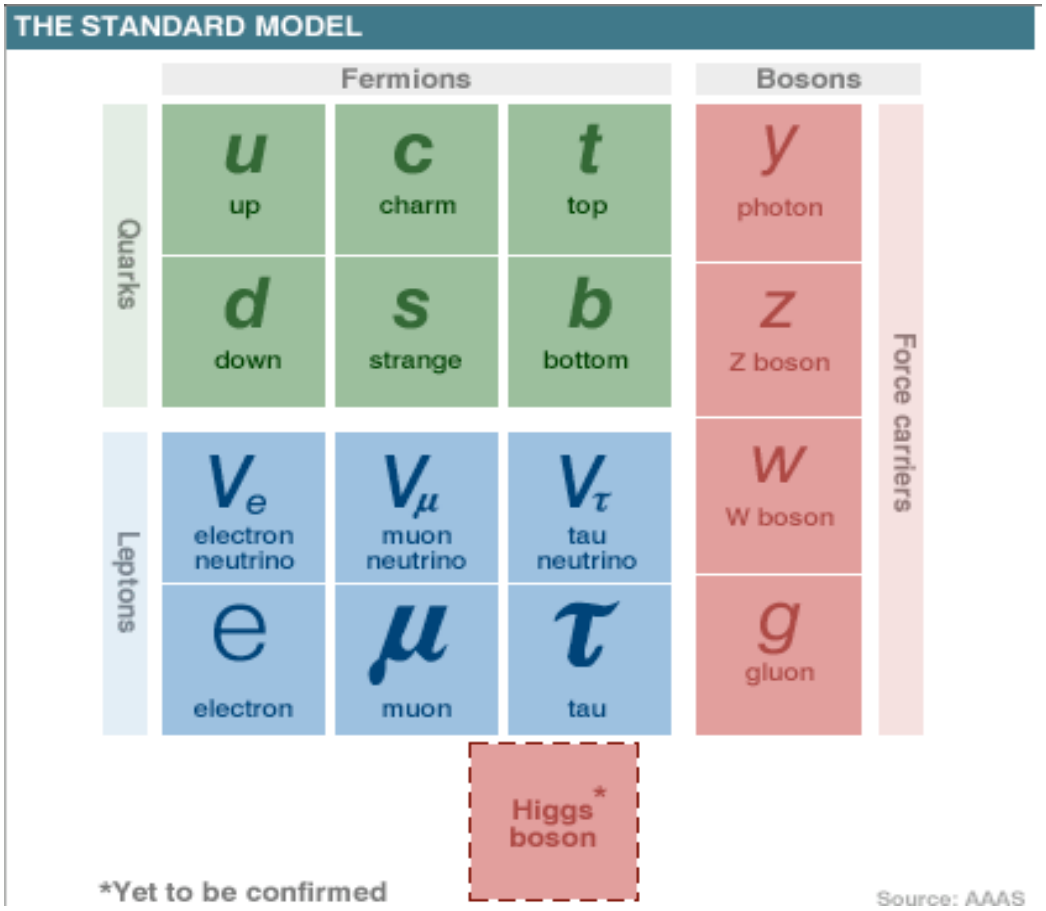
Motivation



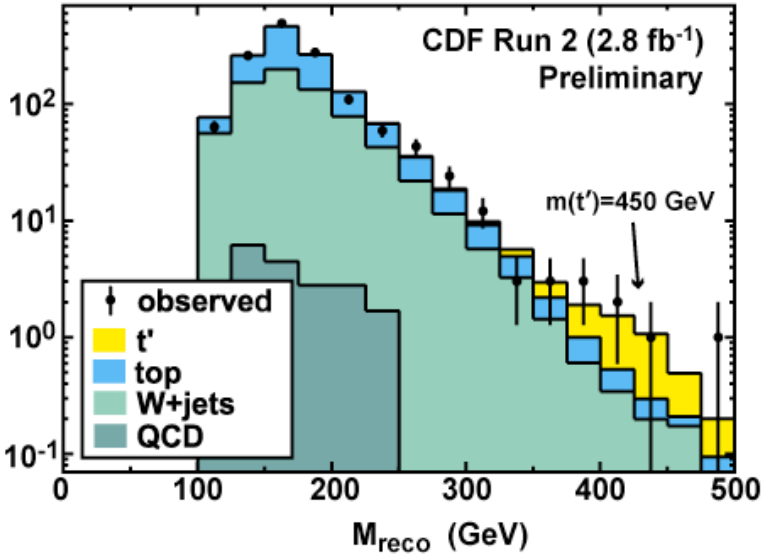
4th generation

A Natural SM extension.

Tevatron searches

t′

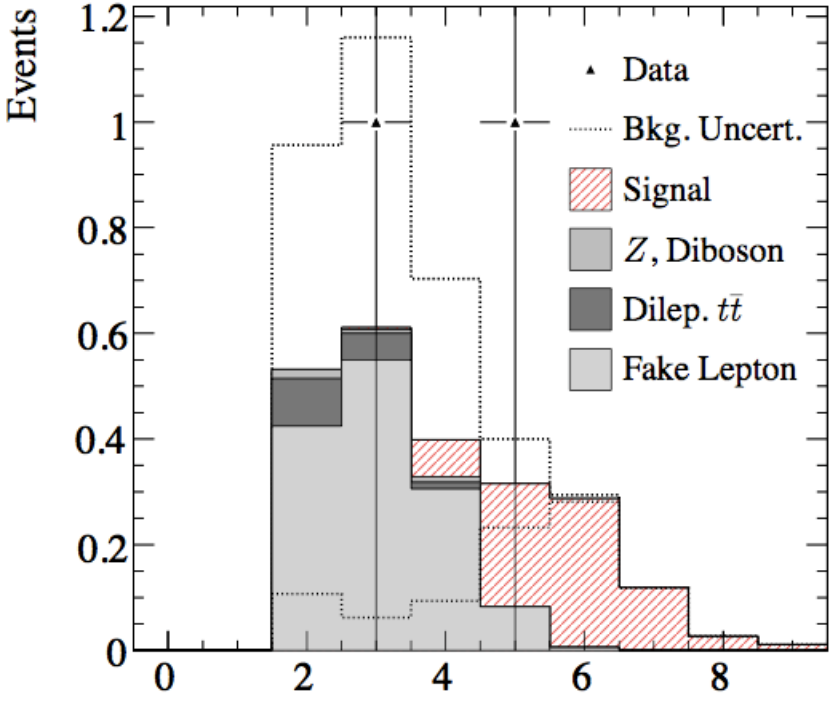
m > 311 GeV



2 TeV, 2.8/fb
CDF9446

b′

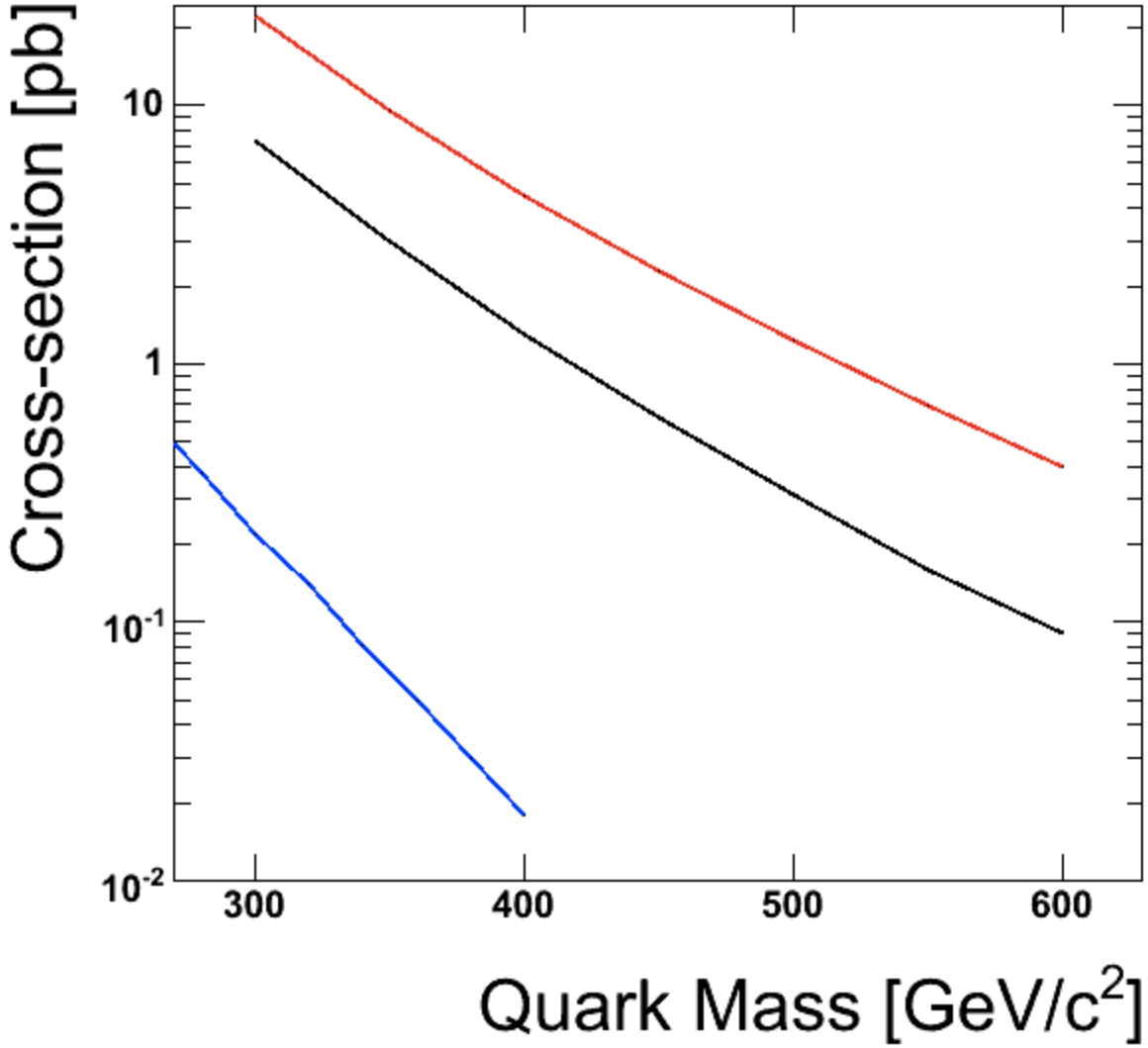
m > 338 GeV



2 TeV, 2.7/fb
arxiv:0912.1057

Cross-sections

LHC has much larger rates for heavy quarks



pp 10 TeV

pp 7 TeV

p$\bar{p}$ 2 TeV

From
arXiv: 0804.2800v1

Outline

I. Decays & Signatures
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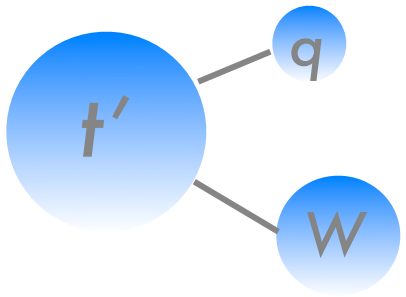
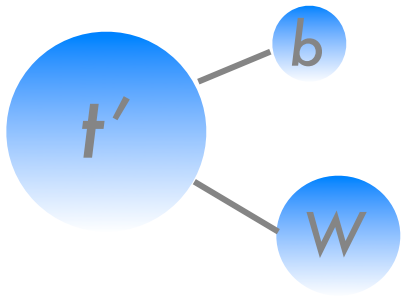
t′ topologies

1st/2nd gen decay



3rd gen decay



Mixing possibilities

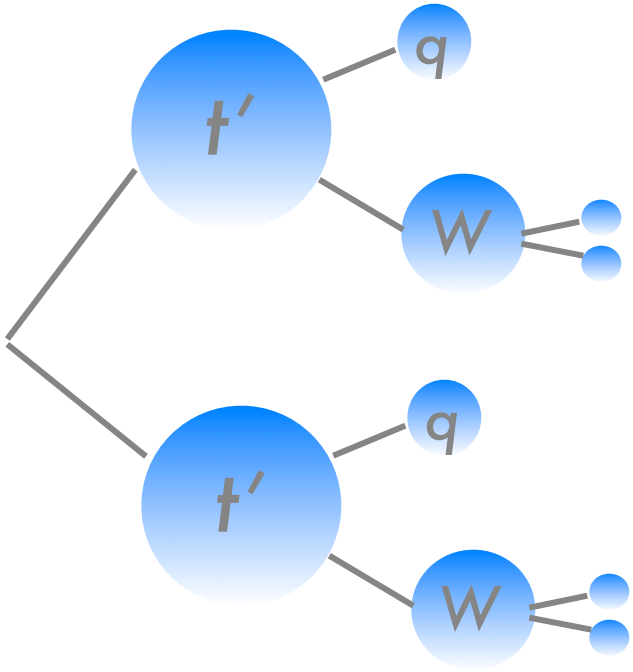
What does the CKM tell us?

$$\mathrm{CKM}_{4\times4} = \begin{bmatrix} 0.97377 \pm 0.00027 & 0.2257 \pm 0.0021 & 0.00431 \pm 0.00030 & < 0.044 \\ 0.230 \pm 0.011 & 0.957 \pm 0.095 & 0.0416 \pm 0.0006 & < 0.46 \\ 0.0074 \pm 0.0008 & 0.0406 \pm 0.0027 & > 0.78 & < 0.47 \\ < 0.063 & < 0.46 & < 0.47 & > 0.57 \end{bmatrix}$$

From ATLAS SN-ATLAS-2008-069

Constraints on 4th gen mixing are fairly weak!

Signatures

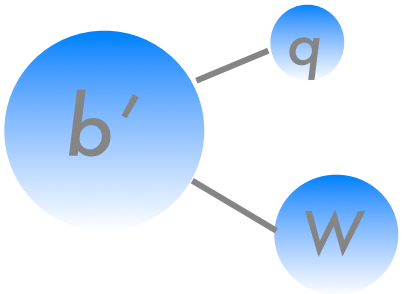


Top-like:	Wq	Wq
Dilepton:	*lνq*	*lνq*
Lepton+jets:	*lνq*	*qqq*
All-hadronic:	*qqq*	*qqq*

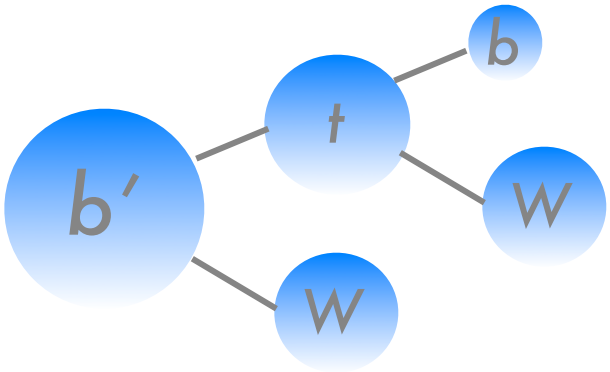
b-tags can probe flavor mixing

b′ topologies

1st/2nd gen decay

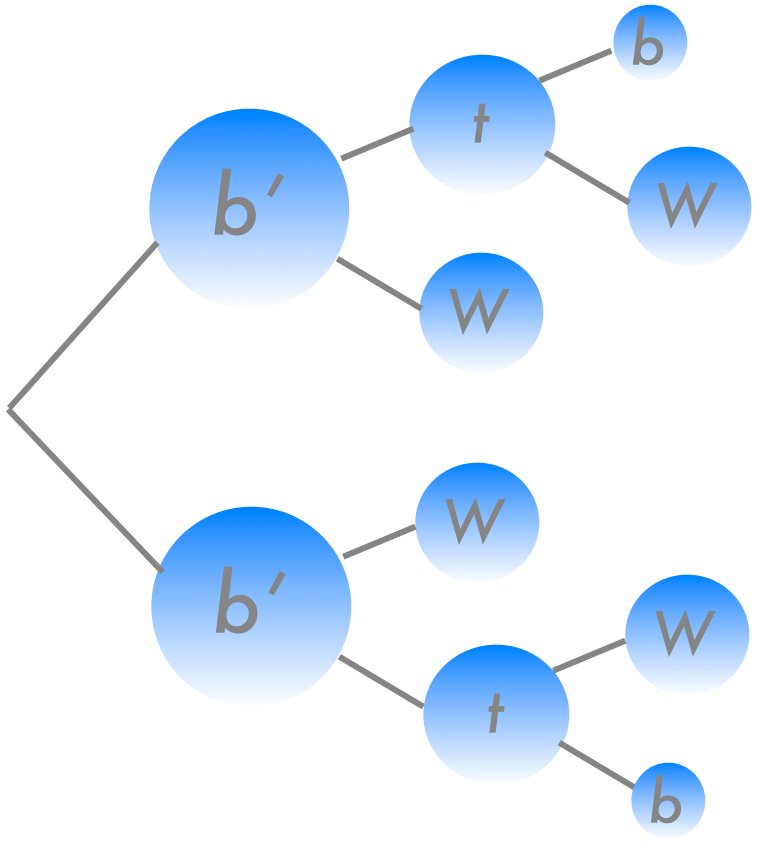


3rd gen decay



Top-like: WqWq

Signatures



Top-like+2W: WWb WWb

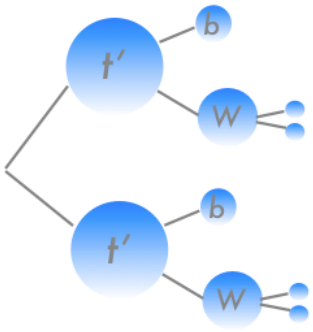
Dilepton: *lνqqb lνqqb*

half-time same-charge!

Lepton+jets: *lνqqb qqqqb*

All-hadronic: *qqqqb qqqqb*

backgrounds



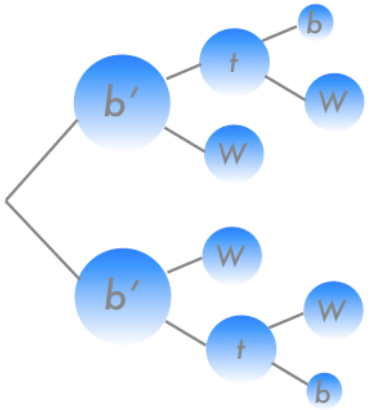
t′,b′: Top-like l+jets

top pairs

W+jets

Misidentified leptons

(from multi-jets)



t′,b′: Top-like dilepton

top pairs

Z+jets

WW,WZ,ZZ,Wγ

Misidentified leptons

(from W+jets)

b′: same-charge lepton

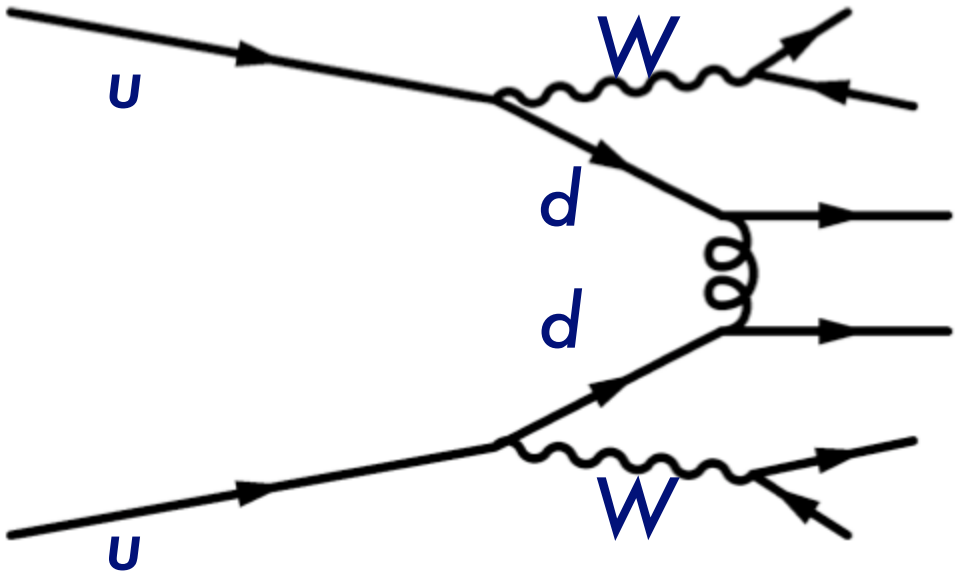
WZ,ZZ,Wγ

Misidentified lepton

(from W/Z+jets)

LHC-specific backgrounds

At Tevatron, true same-charge leptons are rare
Primarily from trilepton processes



pp nature of LHC beams offers new background with true same-sign dileptons

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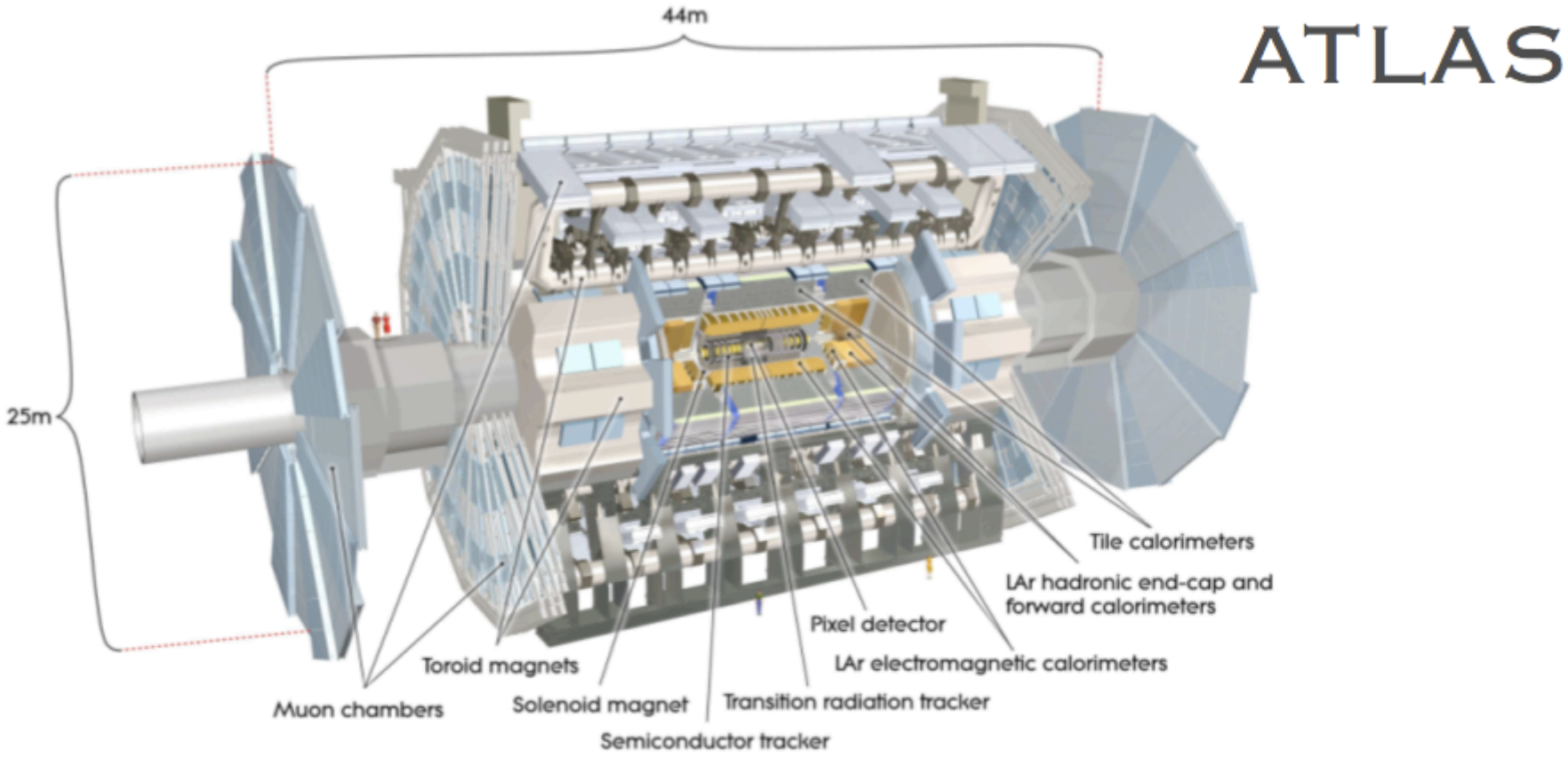
ATLAS


ATLAS
44m
25m
Tile calorimeters
LAr hadronic end-cap and
forward calorimeters
Pixel detector
LAr electromagnetic calorimeters
Toroid magnets
Muon chambers
Solenoid magnet
Transition radiation tracker
Semiconductor tracker

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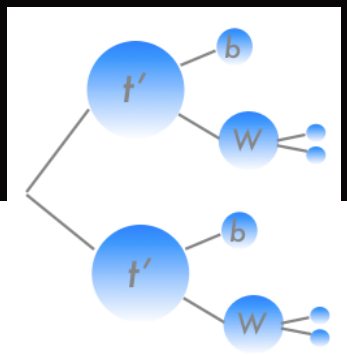
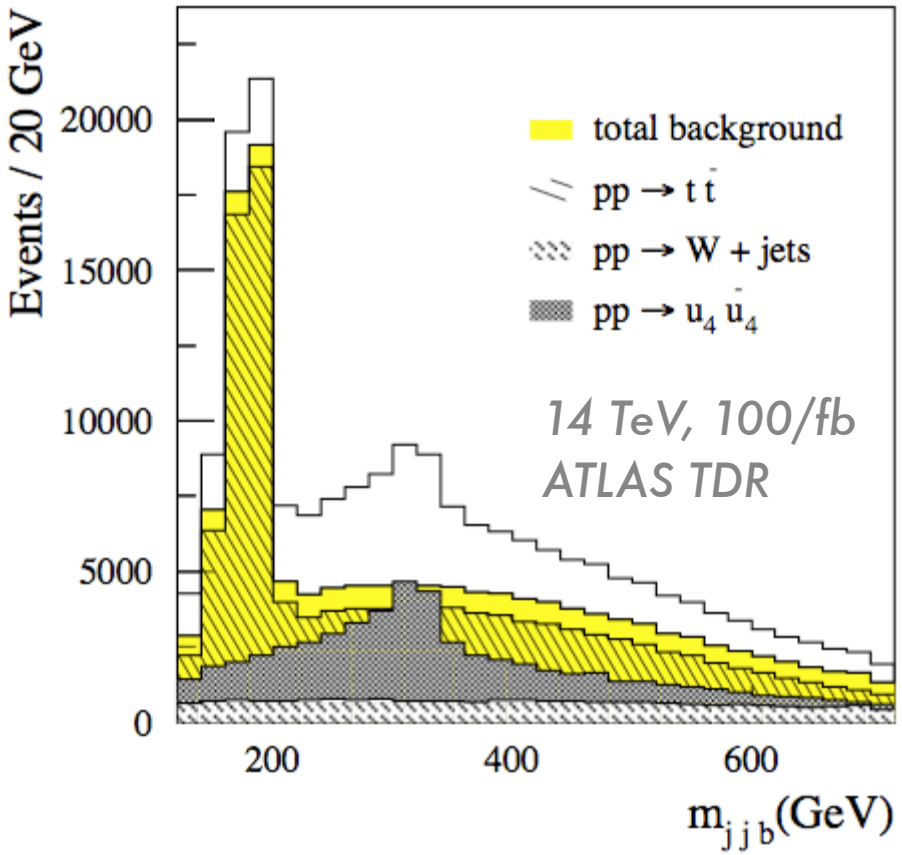
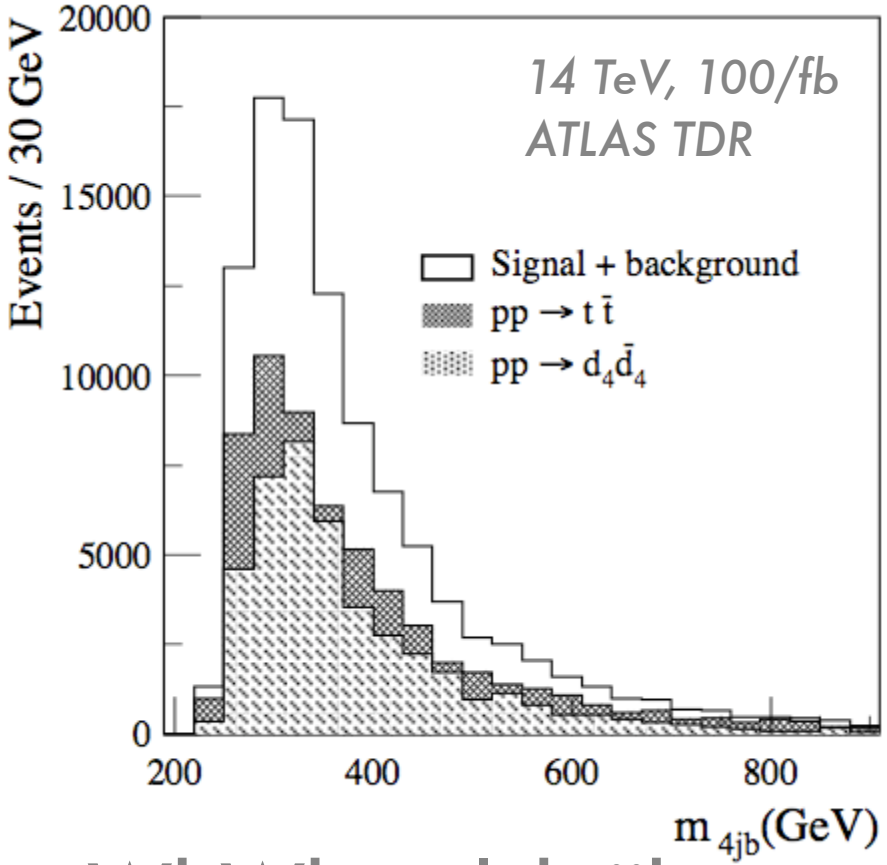


ATLAS TDR

Mixing to 3rd generation





Lepton+jets top-like mode: WbWb to lvb jjb

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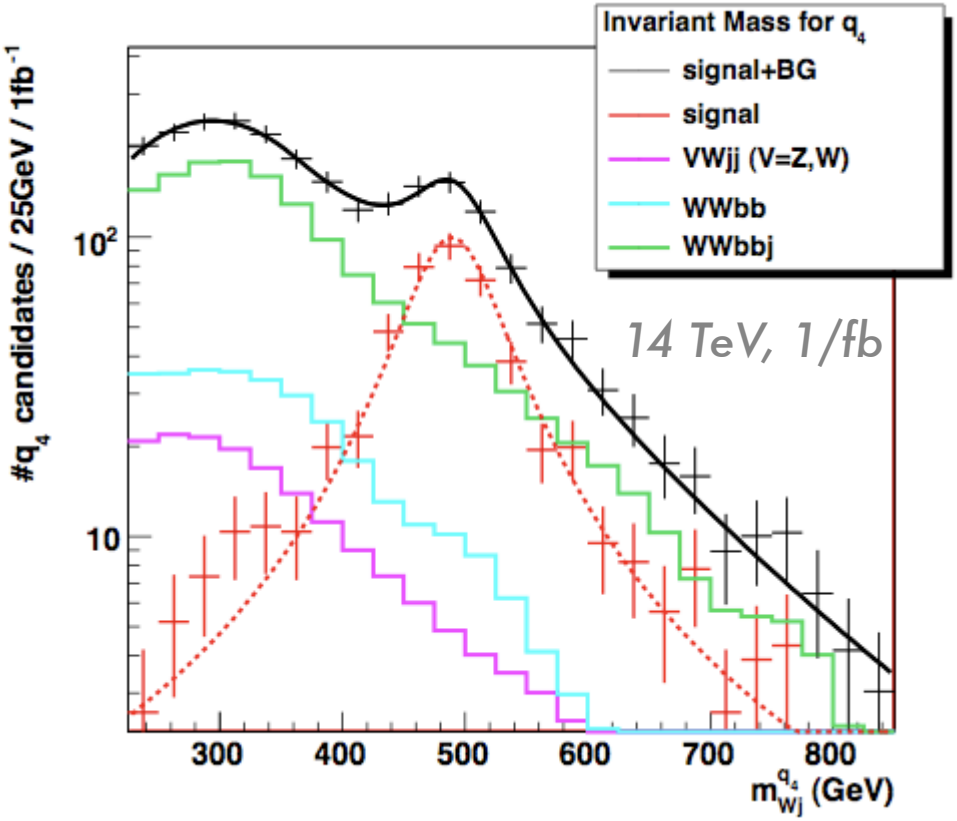
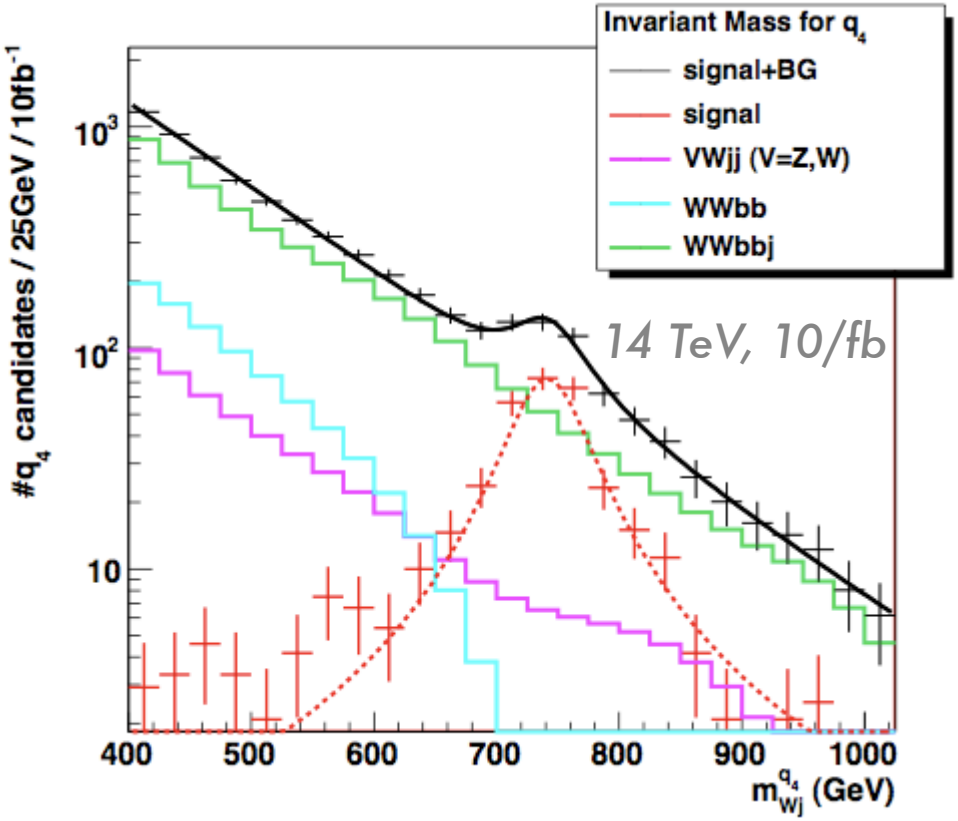
Light jet decays

Studies with parametric detector simulation.

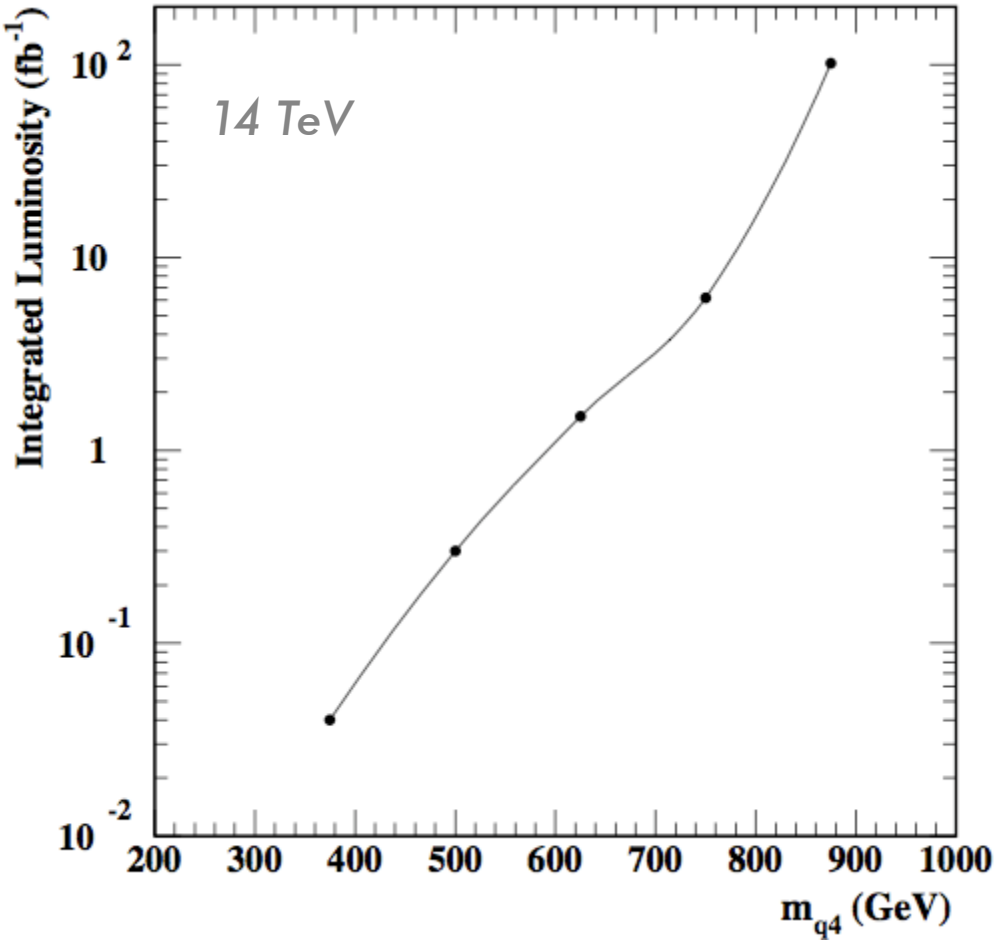




From ATLAS SN-ATLAS-2008-069

Sensitivity

5σ discovery



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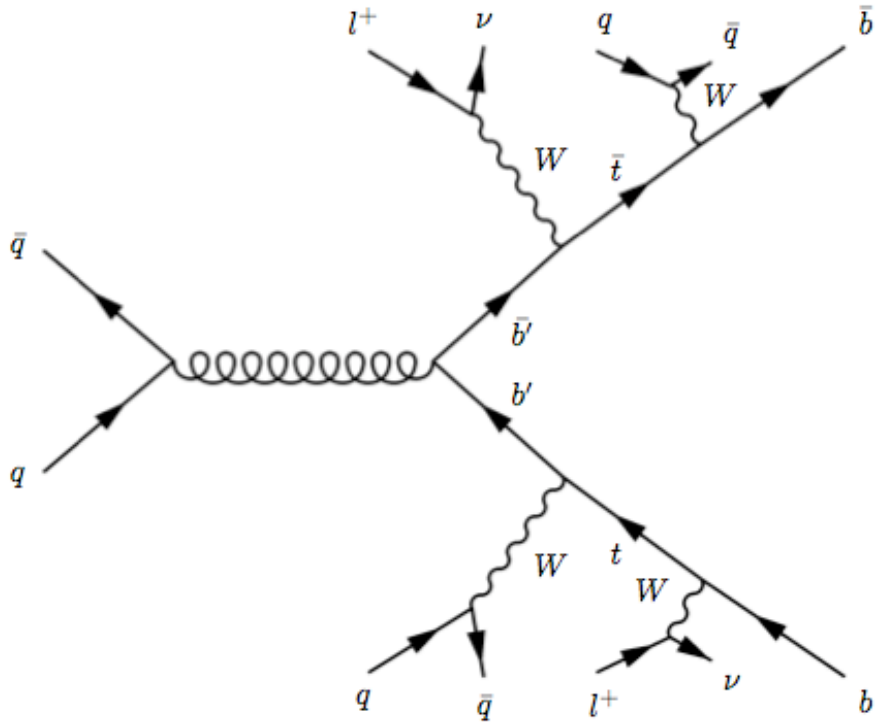
b′



Same-charge dileptons

Extend CDF approach

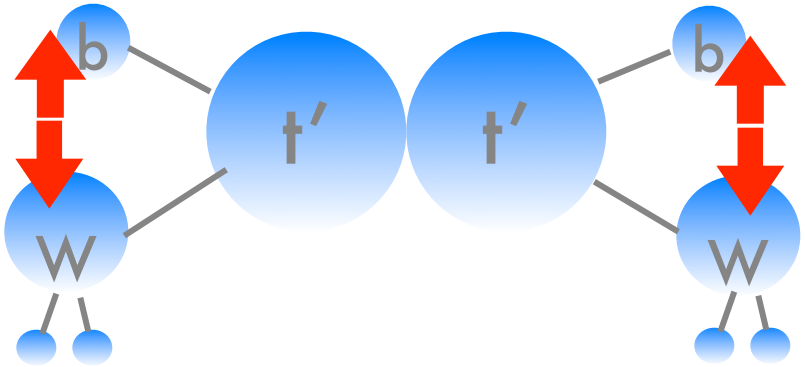
Use W,t mass fitting

t′

Useful difference in top and t′ topologies:

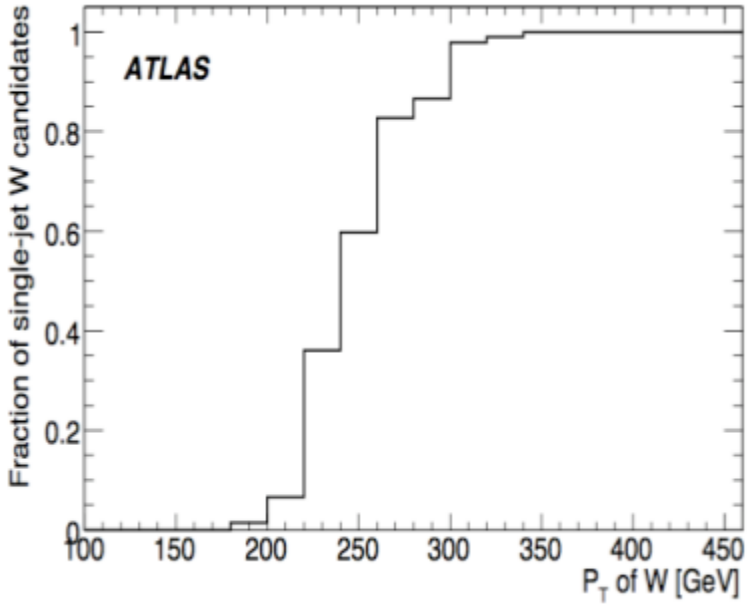
Boosted tops

Boosted Ws!



Hadronic W's

Angles between decay products becomes small

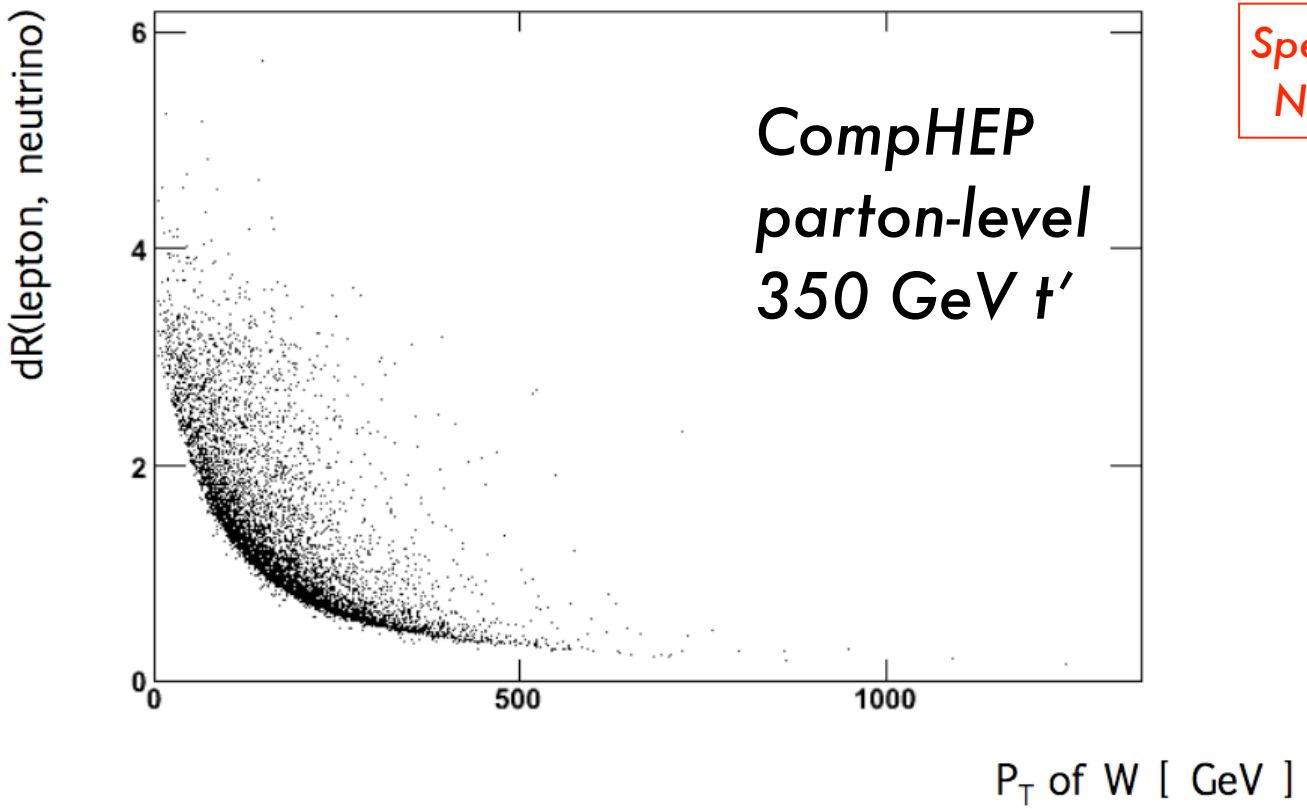


From arXiv:0901.0512
CERN-OPEN-2008-020

In hadronic mode, jets merge into one.

Leptonic W's

Similarly small angles for leptonic decay

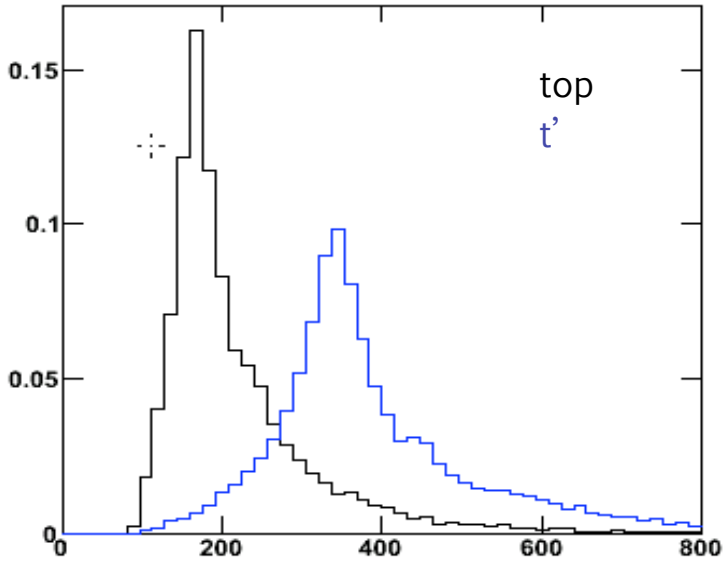


Speaker's own plot
Not ATLAS result

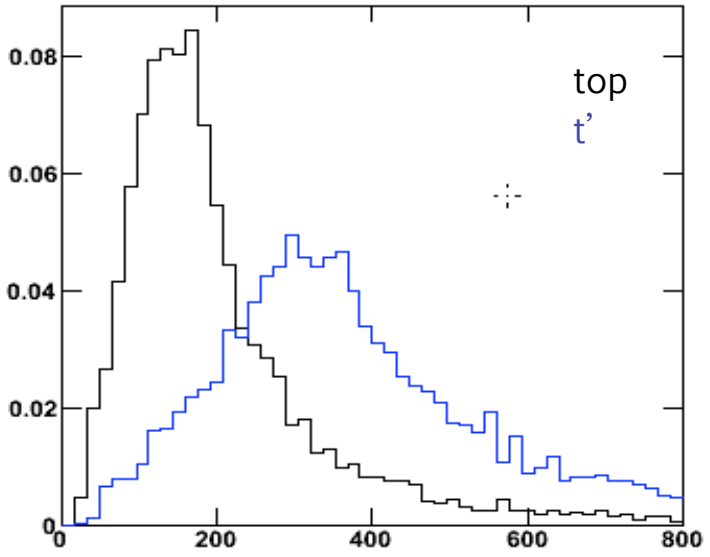
Collinear approximation

Use lepton angle to resolve t′ mass underconstraint in dilepton channel

lepton+jets



dileptons



CompHEP 350 GeV t′
10 TeV pp
PGS detector simulation

Speaker's own plots
Not ATLAS result

Conclusions

Fourth generation quark searches are important

ATLAS will have great discovery/exclusion power

Expect results competitive with Tevatron soon.