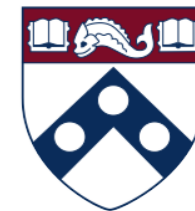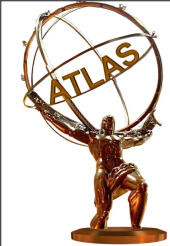# Search for Higgs→WW* at ATLAS

Chris Lester
for the Atlas Collaboration
University of Pennsylvania
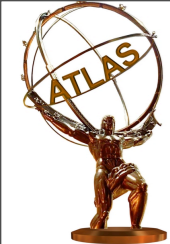USLUO Nov 8, 2013

Higgs Research: Why?

Higgs is the cornerstone of the Standard Model

Higgs is everywhere: field permeates the vacuum

Higgs is unique: scalar, couples to everything, m=125 GeV?

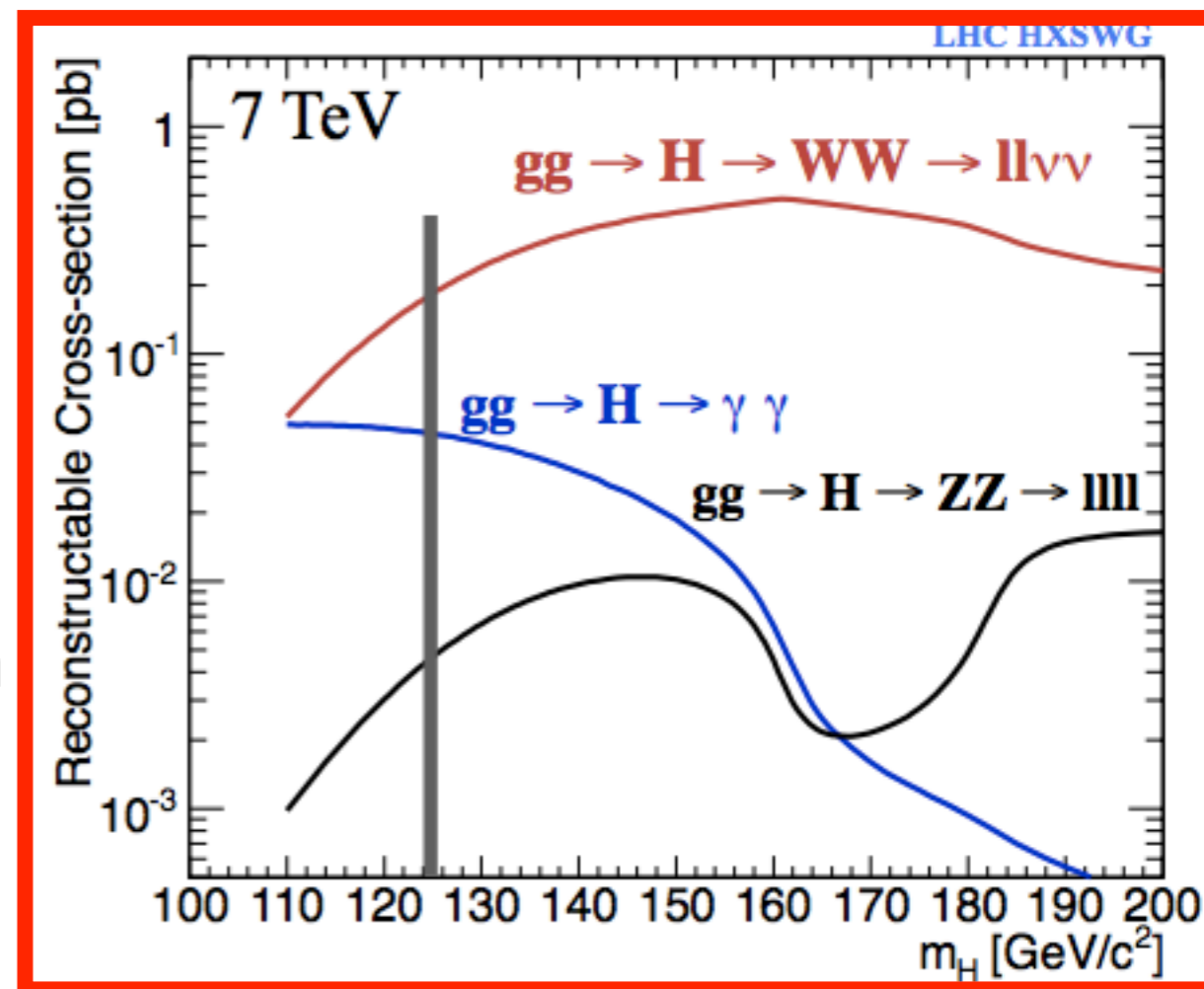Higgs can be doorway to new physics! Discovered but not well measured.

H→WW*→lνlν Final State

Motivation:

- H → WW* coupling fundamental to electroweak symmetry breaking

- large reconstructable cross-section across wide ranges of masses

Challenge:

- neutrinos, unlike H→γγ and H→ZZ→4l
- numerous backgrounds: top, WW, W+jets, Z, DiBoson
- involves understanding all nearly important objects used at ATLAS (leptons, Missing Energy, Jets, BJets)
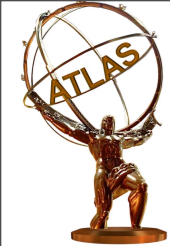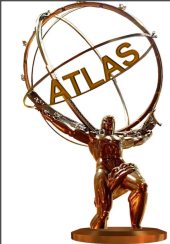
H→WW*→lνlν Strategy

1. Look for 2 OS leptons + missing energy

- focus on diff. flavor (eμ) channel - 80% of sensitivity

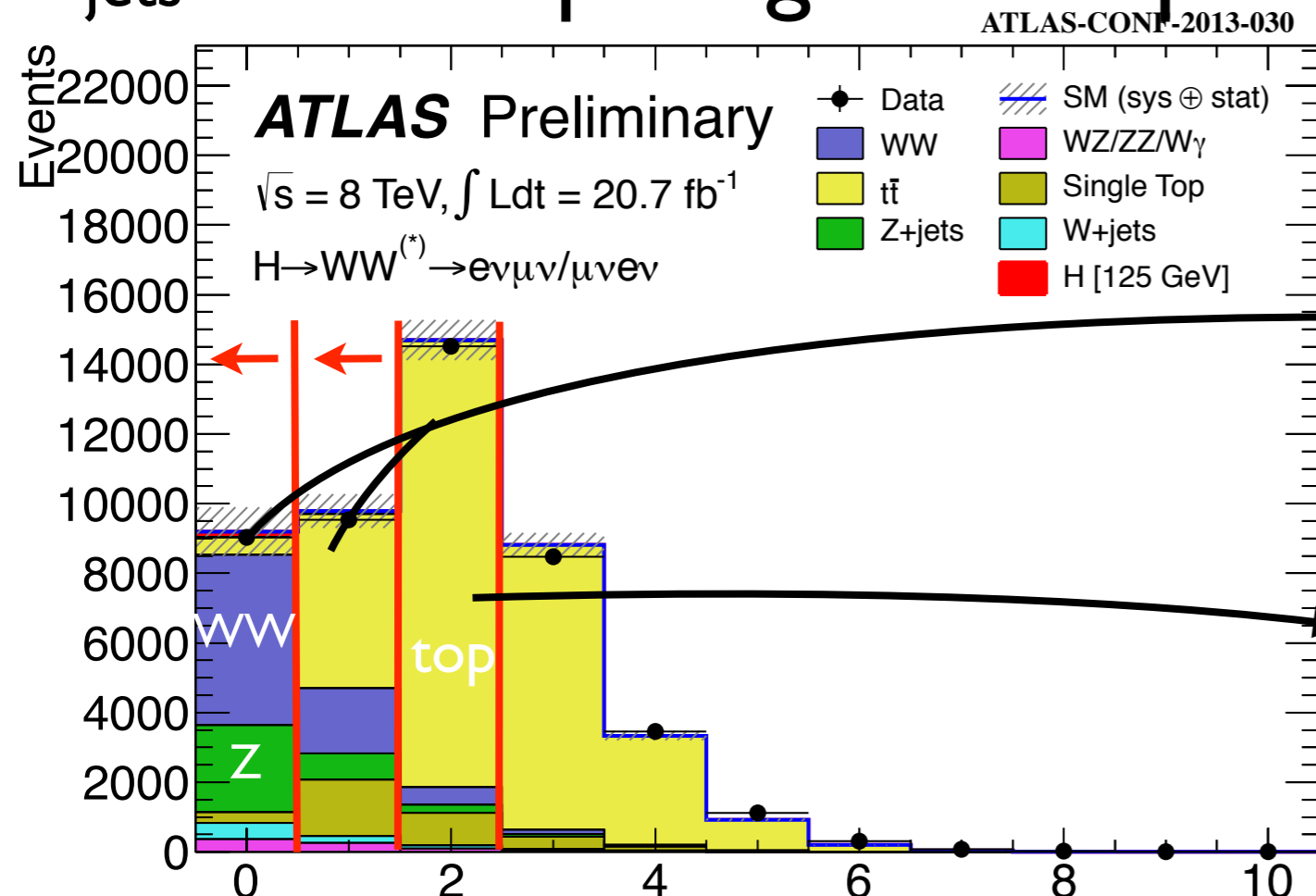## 2. Use Higgs properties (spin, resonance) to isolate signal

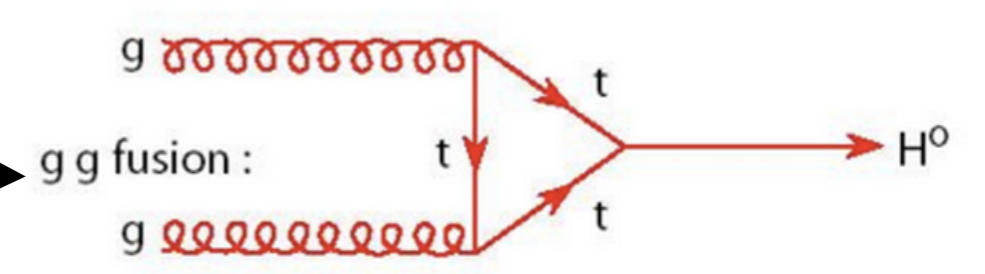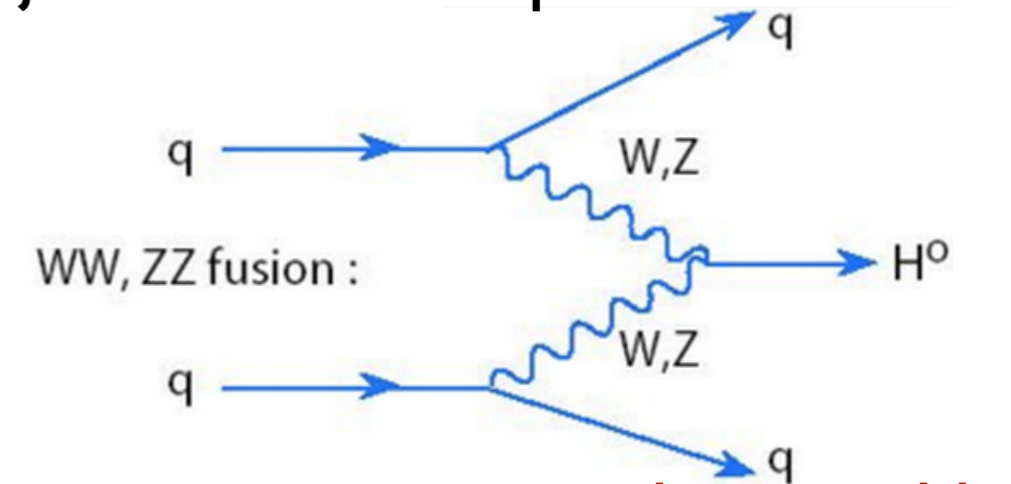## 3. Fit transverse mass (Leptons, MET) for rate measurement

Njet Spectrum

N$_{jets}$ after requiring 2 OS leptons + Missing Energy:

ATLAS-CONF-2013-030

Higgs signal too small to be seen: ~ 300 events.
Similar in shape to WW

0j, 1j Accesses ggF production mode

2j Accesses VBF production mode

not discussed here!

Separate Analysis into 0,1,2 Jet Bins
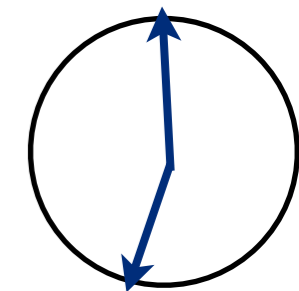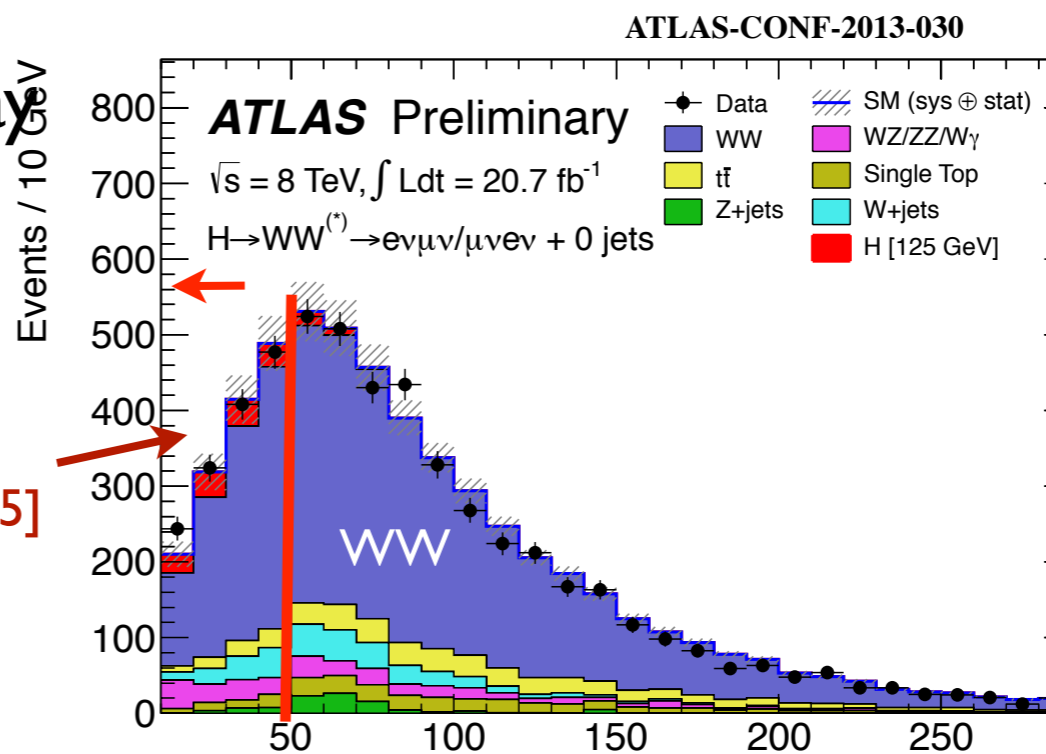- 0 jet cut greatly reduces 'jetty' top background
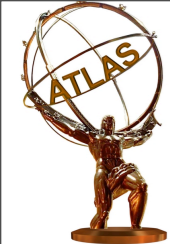
SM WW Background

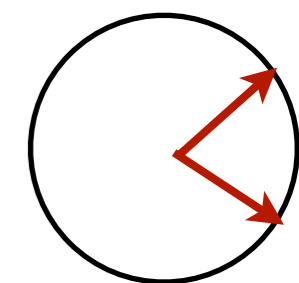## SM WW is Different Than H→WW* in 2 Ways:

1. Lepton correlations induced by Higgs spin

Higgs spin 0 + parity violating W decay
causes leptons to want to emit
in the same direction →

small lepton opening angle &
small di-lepton invariant mass

2. Resonance

Higgs [125]

m_T [GeV]

ATLAS-CONF-2013-030

ATLAS Preliminary
$\sqrt{s}$ = 8 TeV, $\int$ Ldt = 20.7 fb^{-1}
H→WW$^{(*)}$→eνμν/μνeν + 0 jets

WW

Higgs [125]
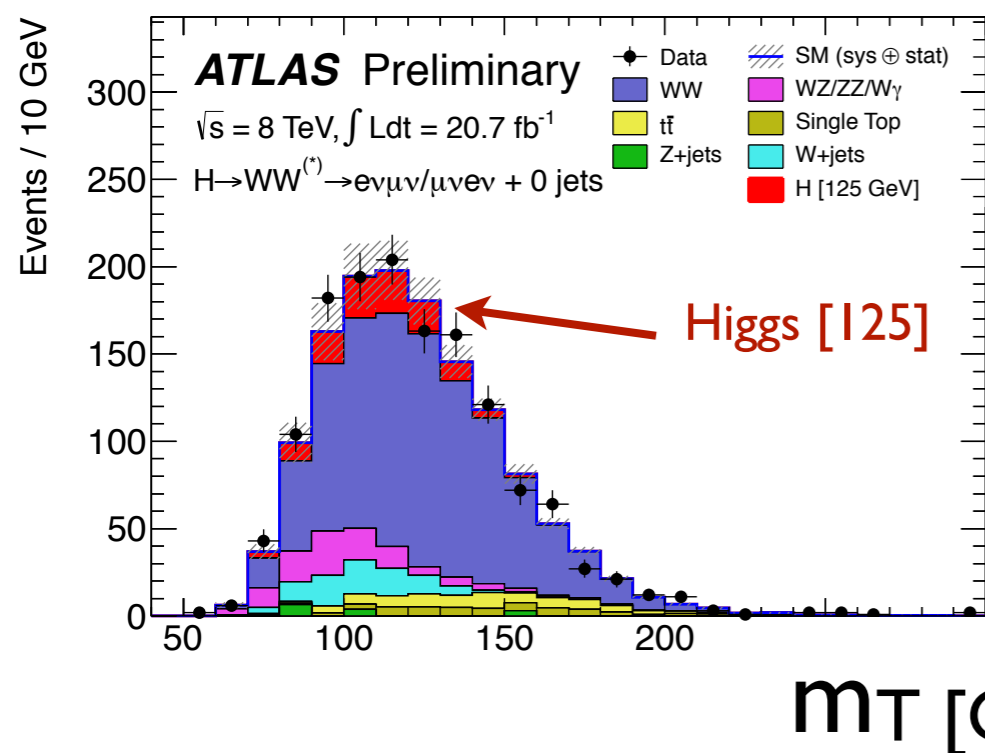
SM WW

H → WW*

m_{ll} [GeV]

Higgs peaks (broadly) in transverse mass
(leptons +MET) spectrum, use this
information in a fit to constrain signal and
backgrounds

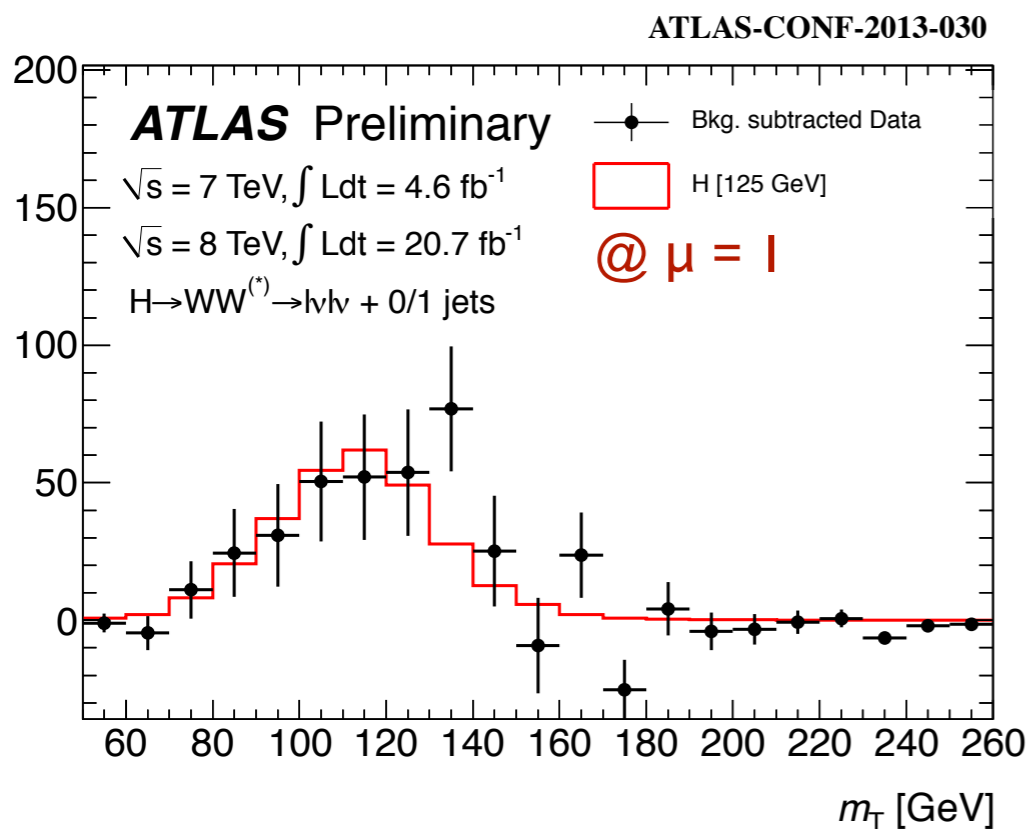## Background Subtracted Plot (after fit)

ATLAS-CONF-2013-030

ATLAS Preliminary
$\sqrt{s}$ = 7 TeV, $\int$ Ldt = 4.6 fb^{-1}
$\sqrt{s}$ = 8 TeV, $\int$ Ldt = 20.7 fb^{-1}
H→WW$^{(*)}$→lνlν + 0/1 jets

@ μ = I

Bkg. subtracted Data
H [125 GeV]

m_T [GeV]

includes of 2011+2012 data 0j,1j

Normalzation and shape consistent w/ H=125 GeV (3.8σ)

Interpret Results as a Measurement of μ (H→WW*)

μ = σxBR(measured)/σxBR(SM Higgs)

μ = 1.01 ± 0.31
± 0.21 (stat)
± 0.19 (theory)
± 0.12 (exp.)
± 0.04 (lumi)

large stat error, theory error

compared to:
H→ZZ→4l => 1.5 ± 0.4
H→γγ   => 1.6 ± 0.3
H→ττ   => 0.8 ± 0.7

ATLAS-CONF-2013-034
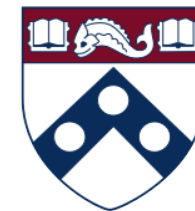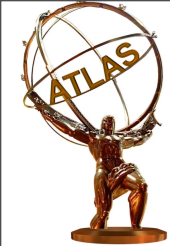
Conclusions

One of best channels to measure the Higgs production rate and properties.

7 TeV + 8 TeV measurement consistent with the Standard Model.   more in public note here

Error of 30% is still very big: expect some improvements soon but eagerly await stats from 14 TeV run in 2014.

Exciting time for Higgs Physics!

BONUS: Summary of Errors

Category	Source	Uncertainty, up (%)	Uncertainty, down (%)
Statistical	Observed data	+21	−21
Theoretical	Signal yield ($\sigma \cdot \mathcal{B}$)	+12	−9
Theoretical	WW normalisation	+12	−12
Experimental	Objects and DY estimation	+9	−8
Theoretical	Signal acceptance	+9	−7
Experimental	MC statistics	+7	−7
Experimental	W+ jets fake factor	+5	−5
Theoretical	Backgrounds, excluding WW	+5	−4
Luminosity	Integrated luminosity	+4	−4
Total		+32	−29