Introduction

Ricardo Goncalo

ATLAS-UK Higgs Meeting, 3 November 2011

The New HSG5 Group

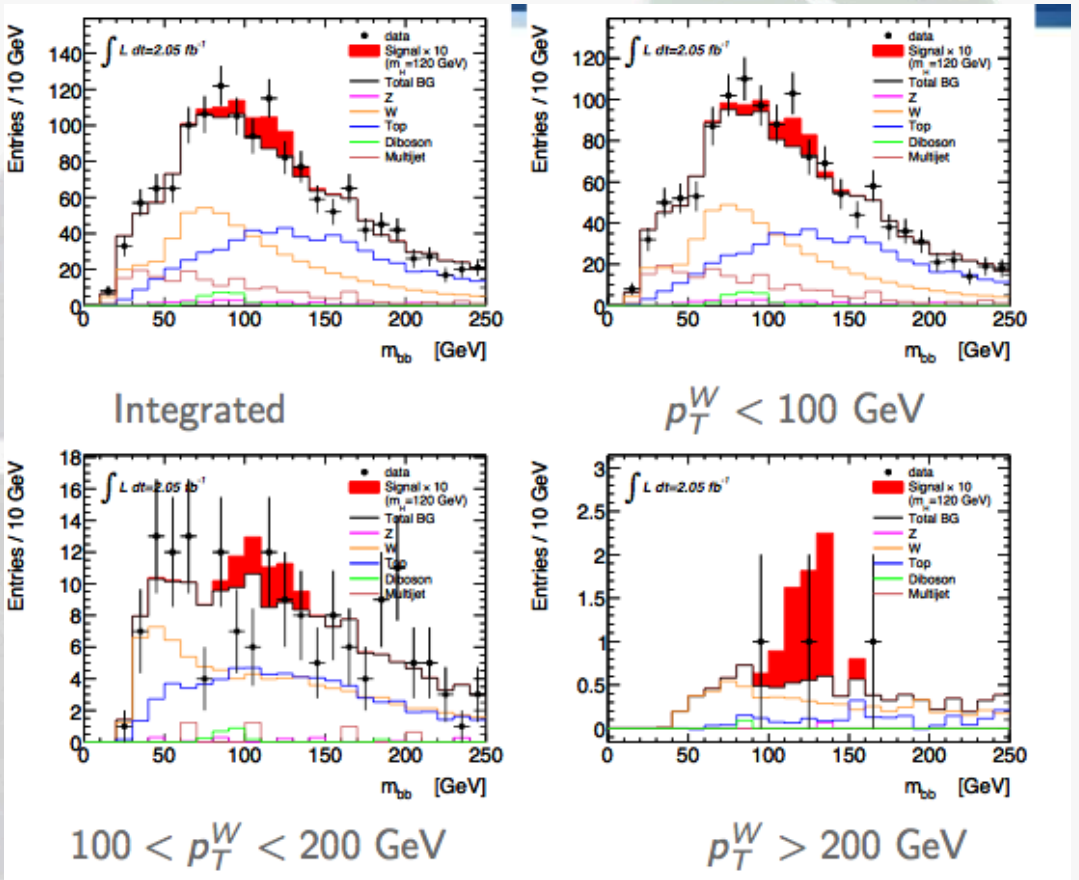
- The old Higgs Subgroup 5 was split into:
  - HSG5 dedicated to H->bb (SM and BSM)
  - HSG6 dedicated to H+
- Two week old organisation, but lots of work already done and ongoing
  - CONF note from July, shown at EPS and later conferences
  - Several active channels:
    - Inclusive WH->lvbb and ZH->llbb
    - Boosted Higgs VH analyses (jet substructure techniques)
    - ZH->vvbb
    - ttH, H->bb
    - VBF H->bb (and even a gluon-fusion analysis)
    - MSSM b(b)H
- Near-term goals:
  - Update WH/ZH results for December CERN Council Meeting
  - Several other analyses to converge for Moriond 2012
  - Publication (refereed paper) on this timescale

HSG5 Composition

- Good and active UK participation:
  - Birmingham
  - Edinburgh
  - Glasgow
  - Liverpool
  - RHUL
  - UCL
- Also work or interest from:
  - Canada: Victoria
  - France: CPPM Marseille
  - Germany: Bonn, LMU, Würzburg
  - Portugal: LIP Lisbon
  - Russia: JINR Dubna
  - Spain: IFAE
  - Taiwan: Academia Sinica
  - USA: Argonne, Harvard, Iowa, SLAC, Wisconsin

WH->lvbb and ZH->llbb

- First attempt at this analysis with $1fb^{-1}$
- ATLAS-CONF-2011-103
- Analysis optimized to reject main backgrounds and increase acceptance
- Separated into p_T^V bins
- Latest results ($2fb^{-1}$, rel.16) very promising!



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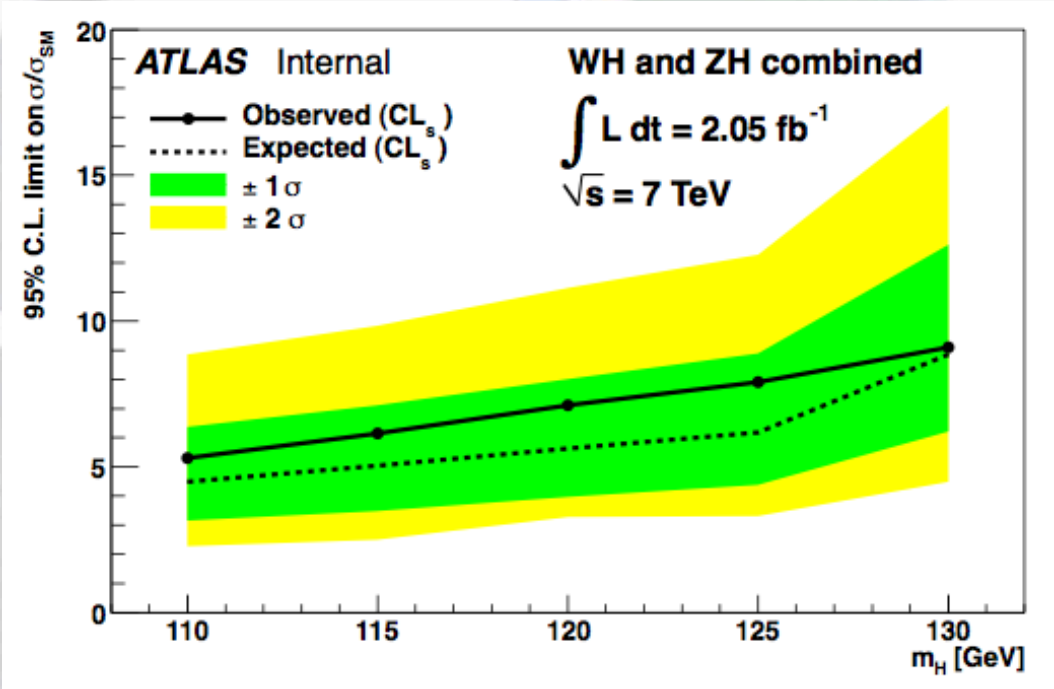
- More details on Benedict's talk

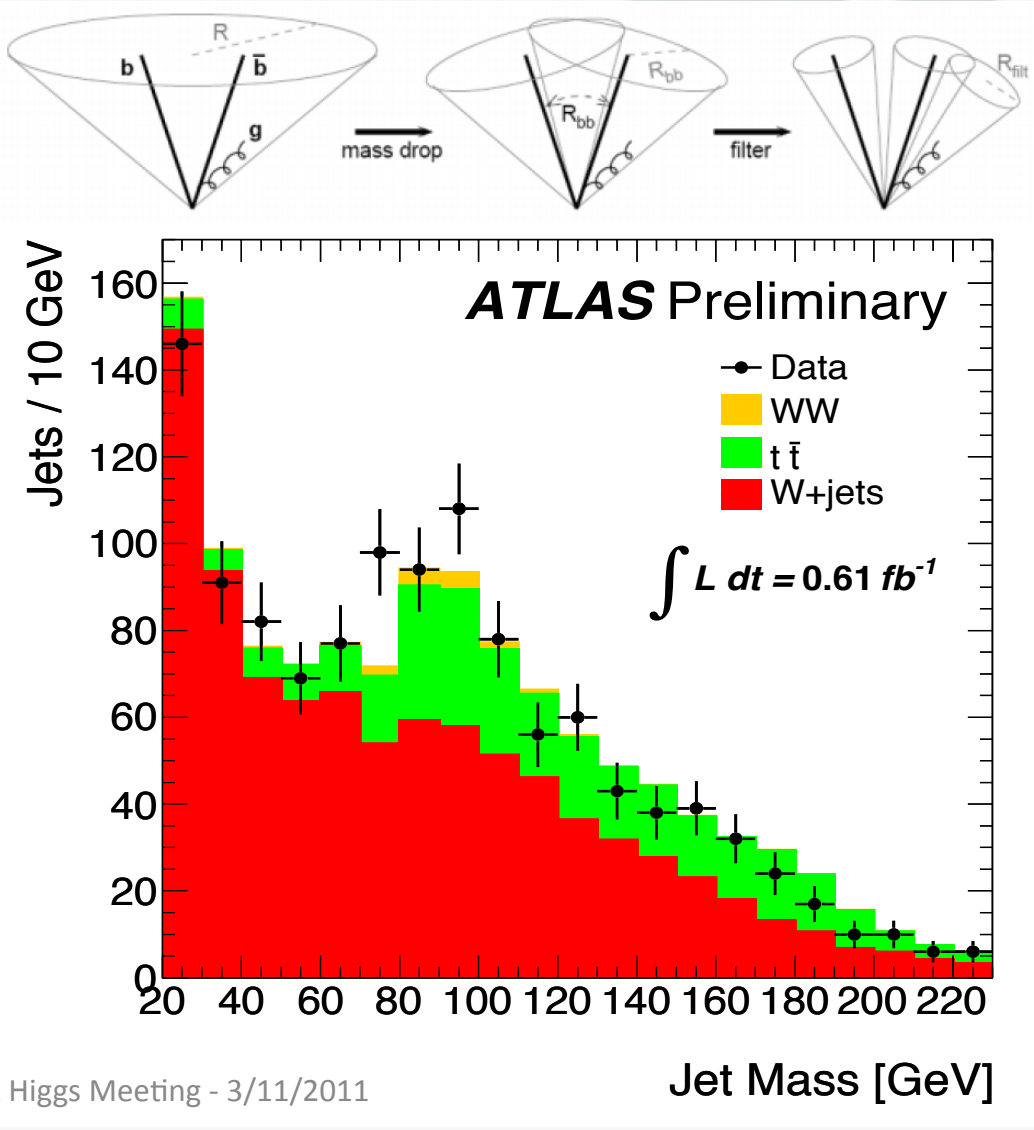


- Alternative to inclusive channels: search for high-pT Higgs to bb:
  - J. M. Butterworth, A. R. Davison, M. Rubin, and G. P. Salam, Phys. Rev. Lett. 100 (2008) 242001, arXiv:0802.2470 [hep-ph]
- $p_T^H > 200\text{GeV} \approx 5\%$ of inclusive cross section but improved significance

- Select $W \rightarrow l\nu$ events and search for a $H \rightarrow bb$ jet
  1. Search for high-p_T jet (Cambridge-Aachen algorithm, R=1.2)
  2. Search jet clustering history in reverse and look for large mass drop
  3. Re-cluster with small R parameter to find sub jets

- Peak consistent with $W \rightarrow jj$ in tt events
- Proof of principle for future analysis

See talk by Wahid



The future

- Main candidates for CERN Council meeting are WH->lvbb and ZH->llbb
- Moriond is our real goal - aiming for results from:
  - WH->lvbb
  - ZH->llbb
  - ZH->vvbb
  - plus jet substructure VH analyses
  - ttH

- H->bb UK activity reflected in today's agenda
- New results shown today (and there's more…)

14:15 - 14:25	H->bbbar Overview *10'*	
	Speaker:	Ricardo Jose Morais Silva Goncalo (University of London (GB))
14:25 - 14:45	WH, H->b bbar *20'*	
	Speaker:	Benedict Allbrooke (University of Birmingham (GB))
14:45 - 15:05	Boosted WH, H->bbbar *20'*	
	Speakers:	Wahid Bhimji (University of Edinburgh (GB)), Dr. Victoria Jane Martin (University of Edinburgh (GB))
15:05 - 15:35	Tea	
15:35 - 15:55	ZH->nu nu b bbar *20'*	
	Speaker:	Matthew Jackson (University of Liverpool (GB))
	Material:	**Slides**
15:55 - 16:15	ttH, H->b bbar *20'*	
	Speaker:	Donny Quilty (University of Glasgow (GB))
	Material:	**Slides**

BACKUP

- Common event selection:

	$ZH \to \ell\ell b\bar{b}$	$WH \to \ell\nu b\bar{b}$
Trigger	single/dilepton	single lepton
Primary vertex	primary vertex with > 3 tracks	
Number of leptons	exactly two	exactly one
Invariant/transverse mass	$76 < m_{ll} < 106$ GeV	$m_T > 40$ GeV
$E_{\mathrm{T}}^{\mathrm{miss}}$	$E_{\mathrm{T}}^{\mathrm{miss}} < 50$ GeV	$E_{\mathrm{T}}^{\mathrm{miss}} > 25$ GeV
Jets	at least two	exactly two
b-tagged jets	exactly two	exactly two

- Lepton Identification:

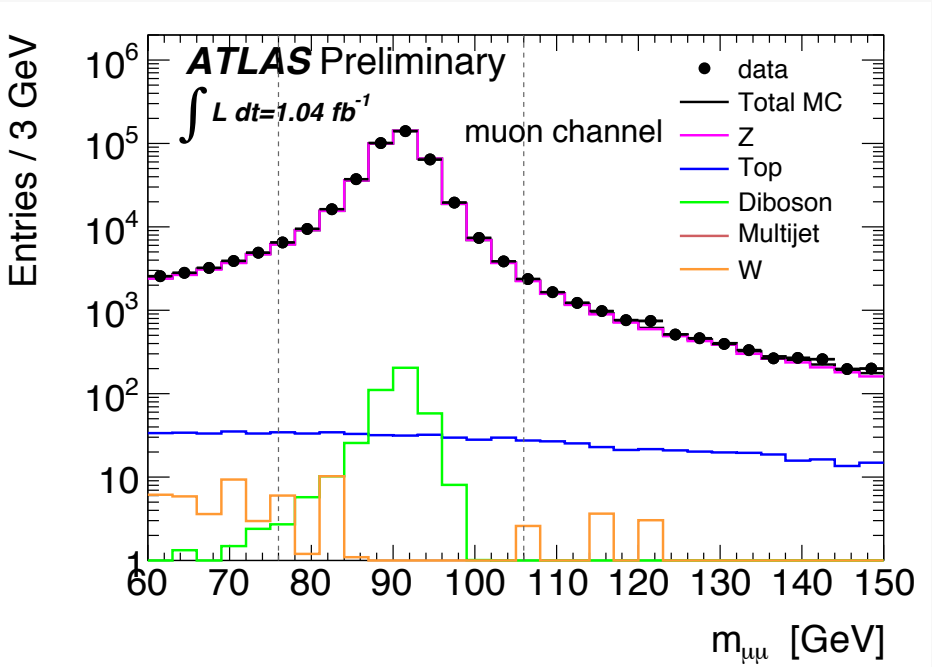
	$ZH \to \ell\ell b\bar{b}$		$WH \to \ell\nu b\bar{b}$	
	e **channel**	μ **channel**	e **channel**	μ **channel**
Kinematic cuts	$E_T^e > 20$ GeV $\lvert\eta^e_{cluster}\rvert < 2.47$	$P_T^\mu > 20$ GeV $\lvert\eta^\mu\rvert < 2.5$	$E_T^e > 25$ GeV $\lvert\eta^e_{cluster}\rvert < 2.47$	$P_T^\mu > 25$ GeV $\lvert\eta^\mu\rvert < 2.4$
impact parameter	$\lvert d_0\rvert < 1$ mm $\lvert z_0\rvert < 10$ mm		$\lvert d_0\rvert < 0.1$ mm $\lvert z_0\rvert < 10$ mm	
Track isolation	$\sum_{tracks} P_T^{track}(\Delta R < 0.2)/p_T^\mu < 0.1$			

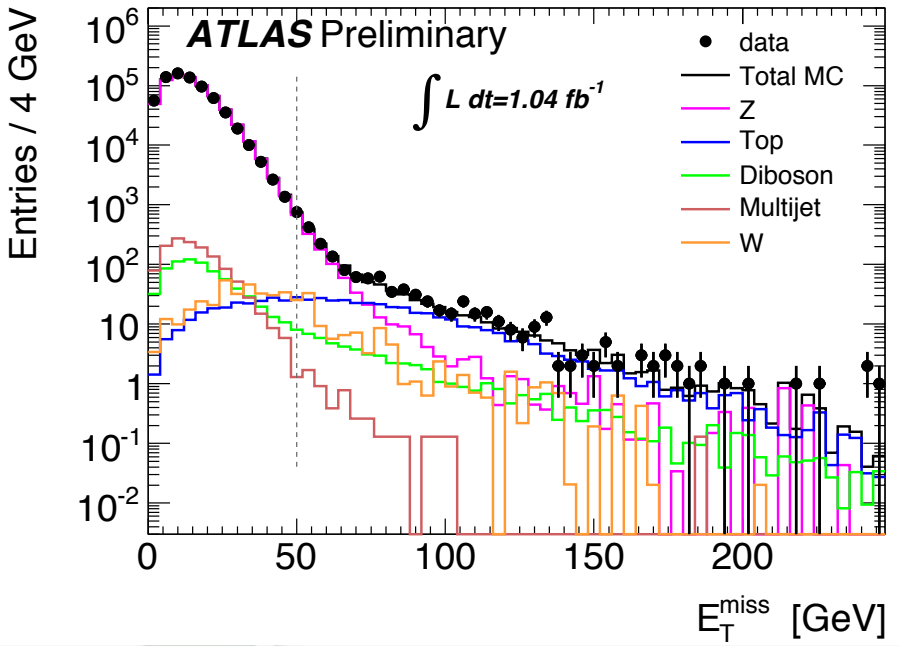
- Jet reconstruction:

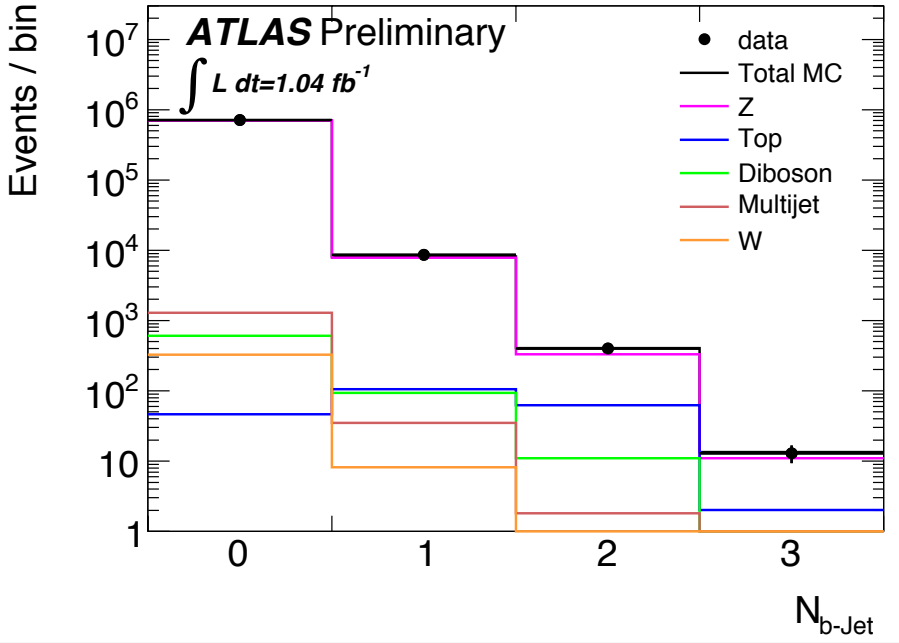
Constituents	Topological jets
Identification	Anti-K_T $R = 0.4$
Kinematic cuts	$P_T^{jet} > 25$ GeV $\lvert\eta^{jet}\rvert < 2.5$
Pile-Up conditions	$\lvert JVF\rvert > 0.75$

ZH→llbb Selection

- Trigger:
  - e (p_T^e>20GeV) or μ (p_T^μ>18GeV)
  - 2e/2μ trigger (p_T>12GeV)
- Exactly 2 leptons p_T > 20GeV
  - Opposite charge for μ
- Z mass cut: 76 < m_{ll} < 106 GeV
- E_T^{miss} < 50GeV
- Two leading jets b tagged

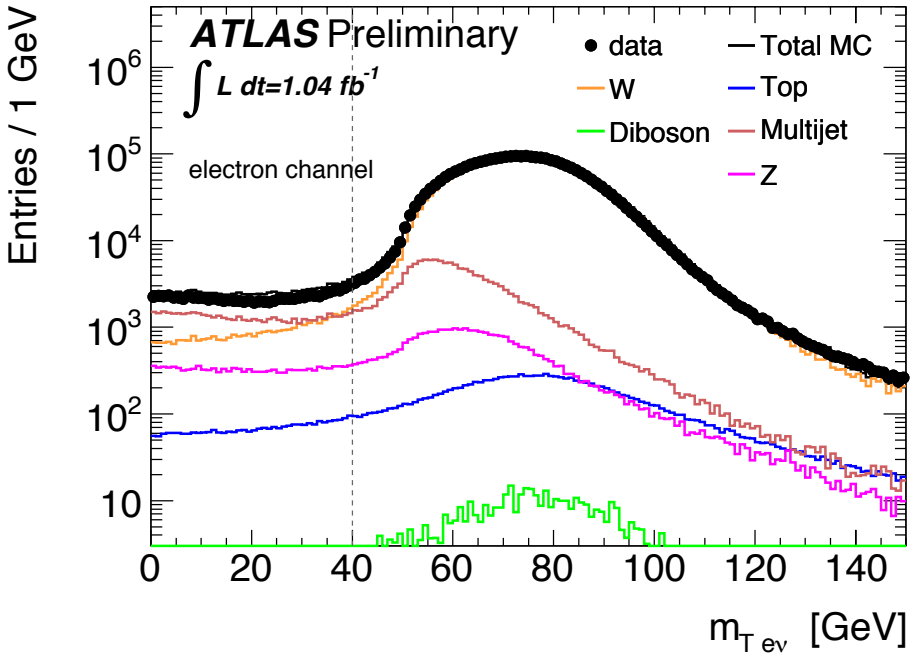


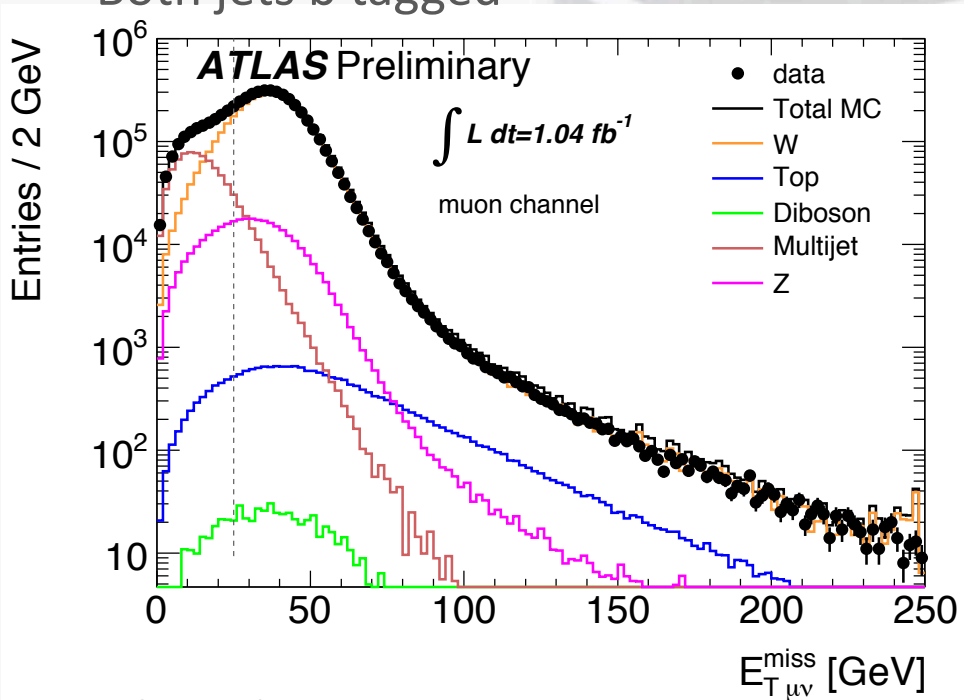


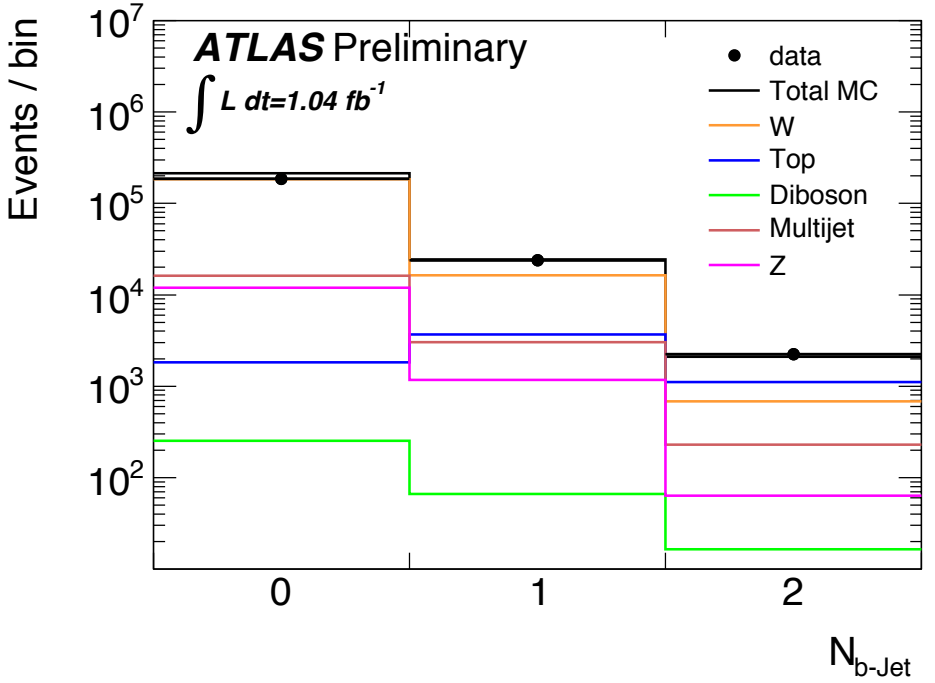


WH→lνbb Selection

- Trigger: e (p_T^e>20GeV) or μ (p_T^μ>18GeV)
- Exactly 1 lepton – p_T > 25GeV
- $M_T = \sqrt{2 p_T^l p_T^\nu (1 - \cos \Delta\phi_{l\nu})} > 40$ GeV
- E_T^{miss} > 25GeV
- Exactly 2 jets (anti-k_T 0.4; E_T > 25GeV) to reduce top background
- Both jets b tagged

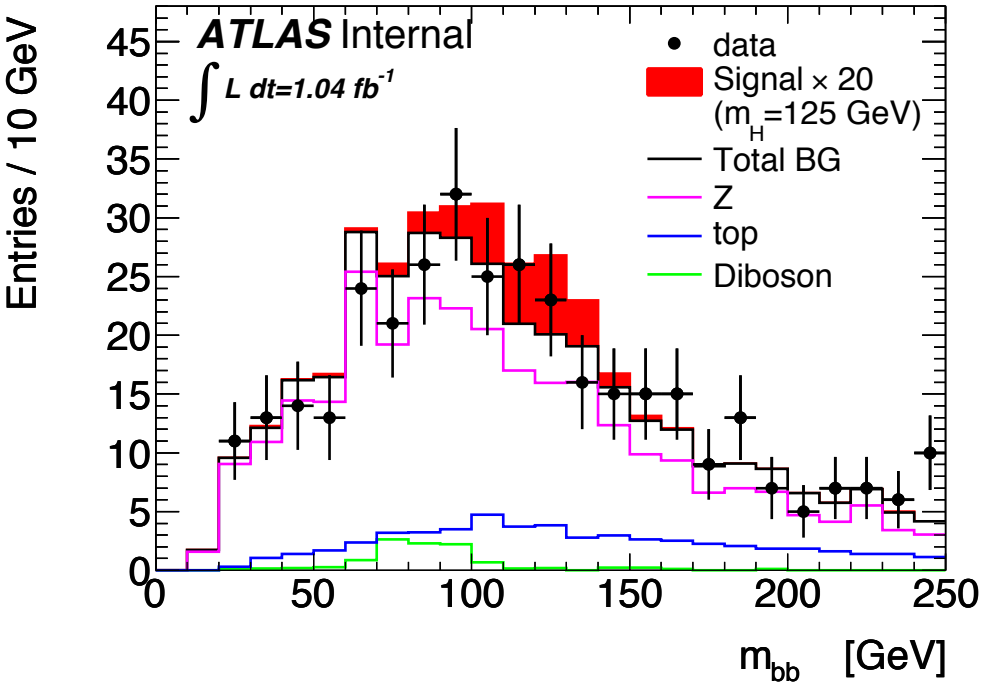


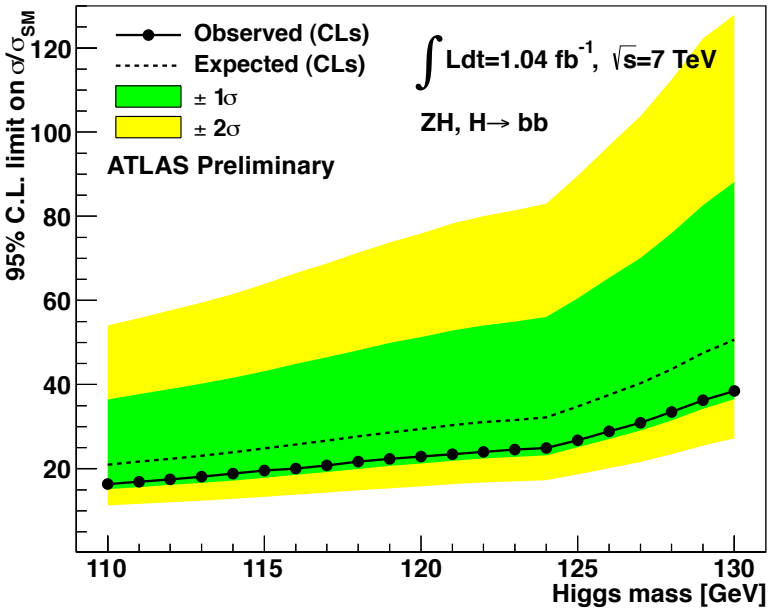




ZH→llbb

- Good description of the background
- No excess observed
- Single-channel exclusion of ≈20x Standard Model

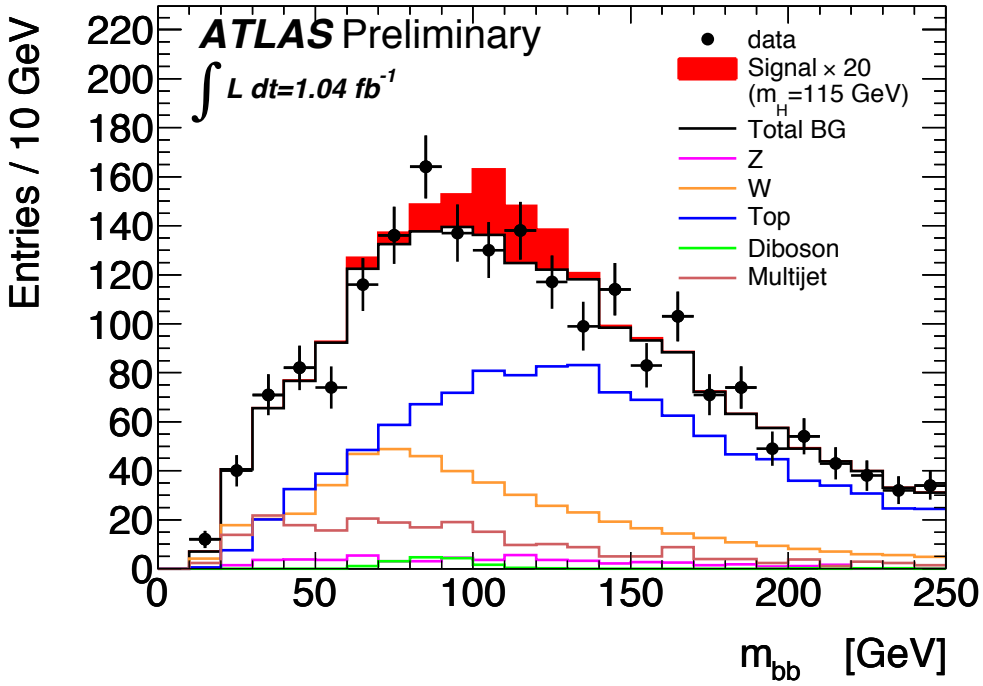


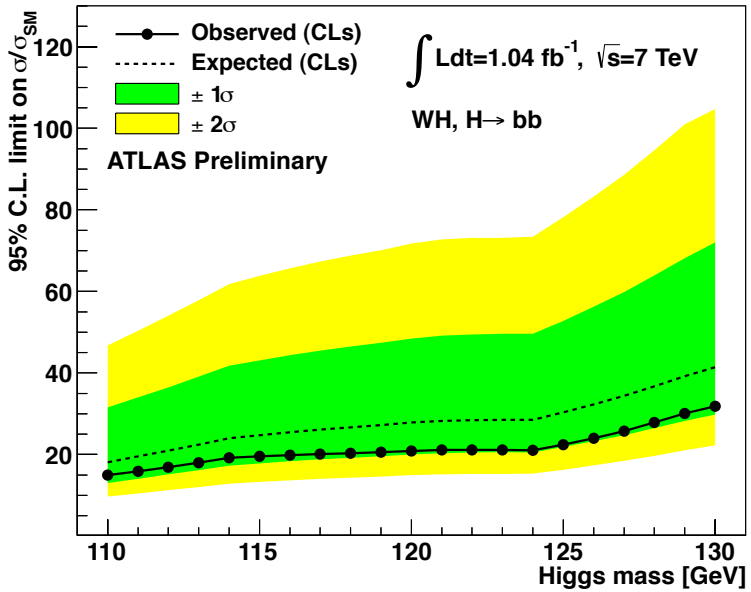


Source	expected events		(stat.)		(sys.)
Z+jets	261.0	±	7.8	±	24.6
Top-quark	52.0	±	1.3	±	10.6
Multijet	1.4	±	0.4	±	1.4
ZZ	9.2	±	1.1	±	2.3
WZ	1.1	±	0.3	±	0.3
Total background	324.8	±	8.0	±	27.9
Data	329				
Signal m_H = 110 GeV	2.22	±	0.09	±	0.43
Signal m_H = 115 GeV	1.91	±	0.07	±	0.38
Signal m_H = 120 GeV	1.58	±	0.06	±	0.32
Signal m_H = 125 GeV	1.44	±	0.05	±	0.28
Signal m_H = 130 GeV	1.02	±	0.04	±	0.20

WH→lνbb

- Good description of the background
- No excess observed
- Single-channel exclusion of ≈20-30x Standard Model





Source	expected events		(stat.)		(sys.)
Z+jets	54.4	±	3.9	±	12.3
W+jets	466.7	±	1.4	±	67.1
Top-quark	1141.8	±	8.8	±	81.2
Multijet	193.0	±	9.4	±	96.5
WZ	16.1	±	2.2	±	3.5
WW	4.8	±	1.1	±	1.4
Total background	1876.6	±	13.7	±	150.7
Data	1888				
Signal m_H = 110 GeV	6.72	±	0.31	±	1.20
Signal m_H = 115 GeV	5.25	±	0.30	±	0.97
Signal m_H = 120 GeV	4.54	±	0.25	±	0.83
Signal m_H = 125 GeV	4.08	±	0.21	±	0.77
Signal m_H = 130 GeV	3.28	±	0.17	±	0.62

- First direct search for H→bb at the LHC in WH and ZH channels
- Combined sensitivity to ≈10-20x Standard Model
- Room for improvement!
  - Reduce systematics
  - New channels to explore
  - Multivariate analyses
  - Lots of data expected!
- Proof of principle for boosted Higgs analysis
- **Watch this space!**

Ref.: ATLAS-CONF-2011-103