HSG5 Report: ongoing activity and 2012 plans

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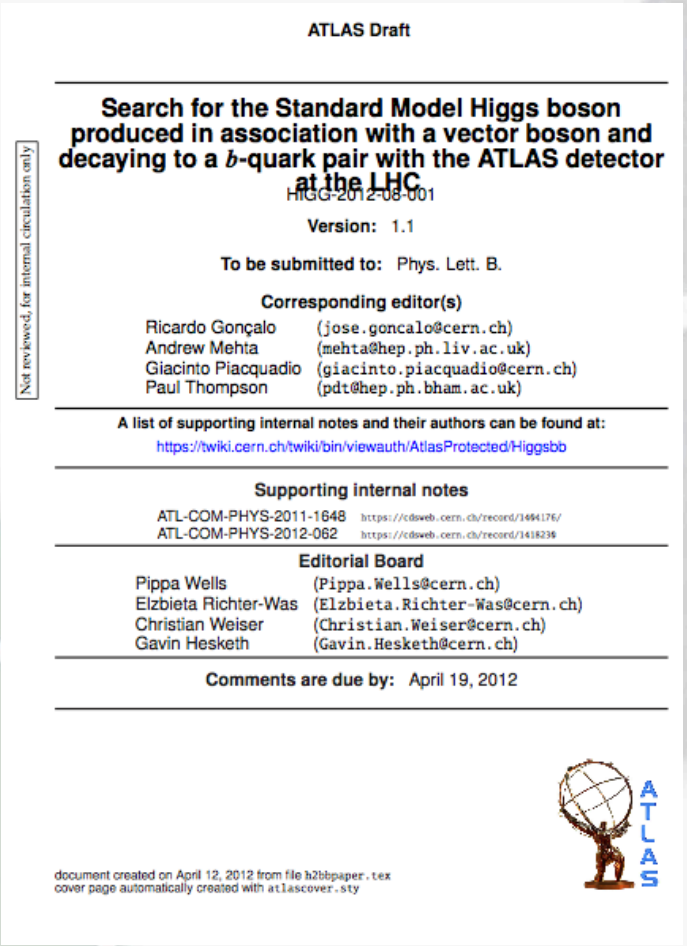
Higgs Working Group Meeting – 10 May 2012

H->bb 2011 paper

- H->bb 2011 paper near second circulation https://cdsweb.cern.ch/record/1440266
- 3 channels: ZH->llbb, WH->lvbb, ZH->vvbb



ATLAS Draft

Search for the Standard Model Higgs boson produced in association with a vector boson and decaying to a b-quark pair with the ATLAS detector at the LHC

HIGG-2012-08-001

Version: 1.1

To be submitted to: Phys. Lett. B.

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A list of supporting internal notes and their authors can be found at:
https://twiki.cern.ch/twiki/bin/viewauth/AtlasProtected/Higgsbb

Supporting internal notes

ATL-COM-PHYS-2011-1648 https://cdsweb.cern.ch/record/1464176/
ATL-COM-PHYS-2012-062 https://cdsweb.cern.ch/record/1418236

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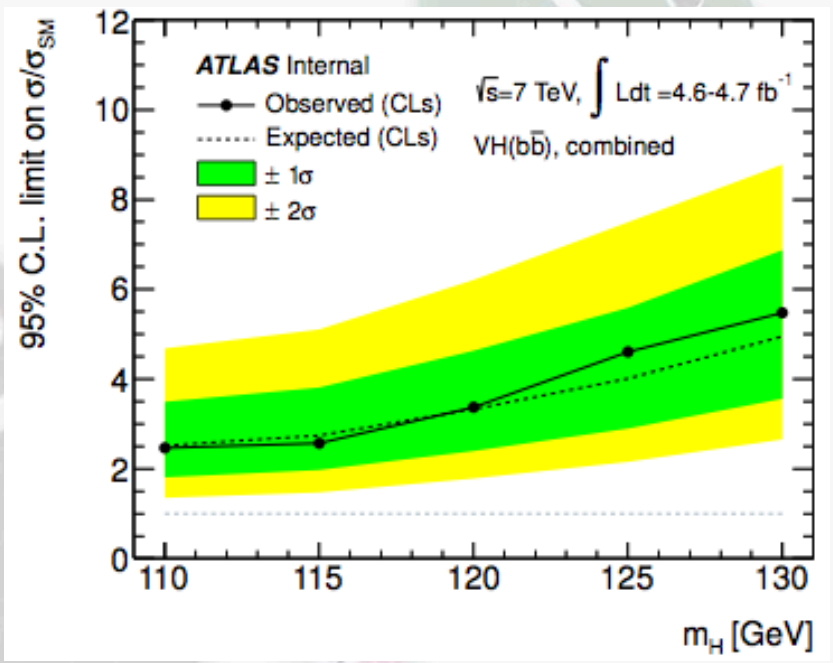
Comments are due by: April 19, 2012

document created on April 12, 2012 from file h2bbpaper.tex
cover page automatically created with atlascover.sty

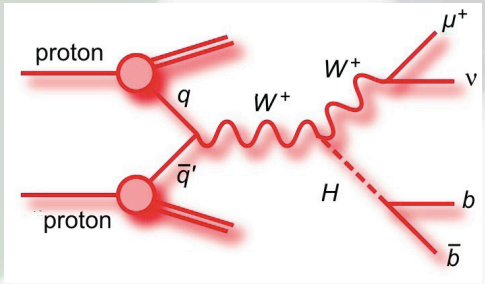
Not reviewed, for internal circulation only

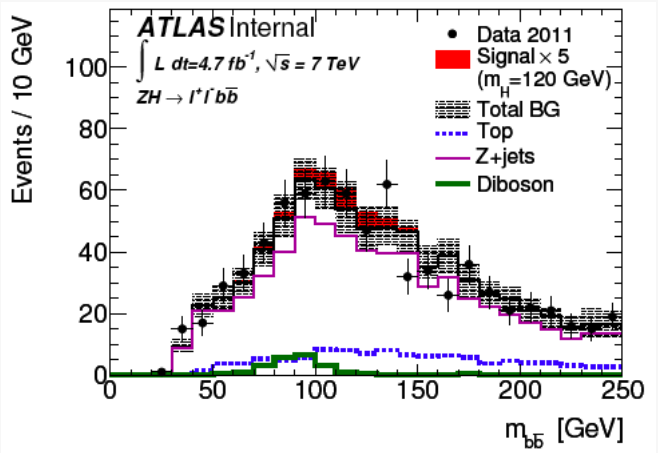


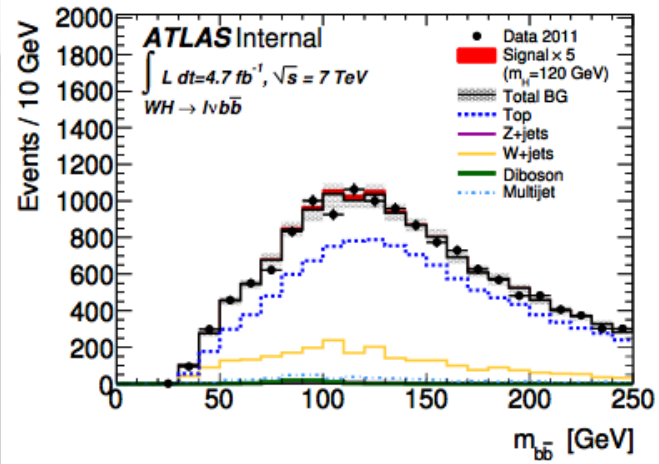
Mass [GeV]	$ZH \to \ell^+\ell^- b\bar{b}$ Obs.	Exp.	$WH \to \ell\nu b\bar{b}$ Obs.	Exp.	$ZH \to \nu\bar{\nu} b\bar{b}$ Obs.	Exp.	Combined Obs.	Exp.
110	7.7	6.0	3.3	4.2	3.7	4.0	2.5	2.5
115	7.7	6.2	4.0	4.9	3.6	4.2	2.6	2.7
120	10.4	8.0	4.9	5.9	4.8	5.0	3.4	3.3
125	11.6	9.1	5.5	7.5	7.3	6.0	4.6	4.0
130	14.4	11.6	5.9	9.2	10.3	7.6	5.5	4.9

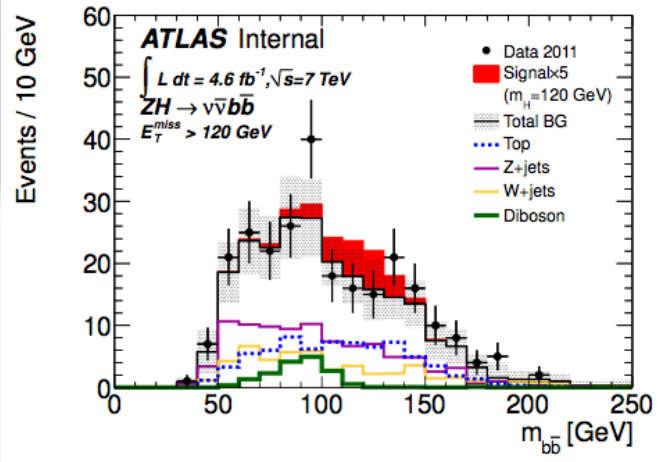
H->bb 2011 analyses

- "Simple" cut-based analyses
  - Search for a good W or Z, then search for 2 b-tagged jets
- Main difficulties:
  - Determination of main backgrounds from control regions
  - Long discussions on b-tagging and JES systematics – often just before deadlines
  - MC description of data (N_{jets}, p_T^W …) not ideal => higher systematic uncertainties
- Plenty of lessons learned for future…









Bin	$ZH \to \ell^+\ell^- b\bar{b}$ p_T^Z [GeV]				$WH \to \ell\nu b\bar{b}$ p_T^W [GeV]				$ZH \to \nu\bar{\nu} b\bar{b}$ E_T^{miss} [GeV]		
	0-50	50-100	100-200	>200	0-50	50-100	100-200	>200	120-160	160-200	>200
Number of events for $80 < m_{b\bar{b}} < 150$ [GeV]											
Signal	1.3 ± 0.1	1.8 ± 0.2	1.6 ± 0.2	0.4 ± 0.1	5.0 ± 0.6	5.1 ± 0.6	3.7 ± 0.4	1.2 ± 0.2	2.0 ± 0.2	1.2 ± 0.1	1.5 ± 0.2
Top	17.4	24.1	7.3	0.2	229.9	342.7	201.3	8.2	35.2	8.3	4.1
W+jets	0.0	0.0	0.0	0.0	285.9	193.6	85.8	17.5	13.2	7.8	4.8
Z+jets	123.2	119.9	55.9	6.1	11.1	10.5	2.8	0.0	31.5	11.9	7.1
Diboson	7.2	5.6	3.6	0.7	12.6	11.9	7.8	1.4	4.6	4.3	3.6
Multijet	0.0	0.0	0.0	0.0	55.5	38.2	3.6	0.2	0.85	0.04	0.26
Total Bkg	148 ± 10	150 ± 6	67 ± 4	6.9 ± 1.2	596 ± 23	598 ± 16	302 ± 10	27 ± 5	85 ± 8	32 ± 3	20 ± 3
Data	141	163	61	13	614	588	271	15	105	22	25
Components of the Background Relative Systematic Uncertainties [%]											
B-tag Eff	1.4	1.0	0.3	4.8	0.9	1.3	0.9	7.2	4.1	4.2	5.5
Bkg Norm	3.6	3.4	3.6	3.8	2.7	1.8	1.8	4.5	2.7	2.2	3.2
Jets/E_T^{miss}	2.1	1.2	2.7	5.1	1.5	1.4	2.1	9.5	7.7	8.2	12.1
Leptons	0.2	0.3	1.1	3.4	0.1	0.2	0.2	1.7	0.0	0.0	0.0
Luminosity	0.2	0.1	0.2	0.4	0.1	0.1	0.1	0.2	0.2	0.5	0.7
Pile Up	0.9	1.6	0.5	1.3	0.1	0.2	0.8	0.5	1.6	2.5	3.0
Theory	5.2	1.3	4.7	14.9	2.2	0.3	1.6	14.8	2.9	4.0	7.7
Total Bkg	6.9	4.3	6.6	17.3	3.9	2.7	3.4	19.6	9.7	10.6	16.0
Components of the Signal Relative Systematic Uncertainties [%]											
B-tag Eff	6.4	6.4	7.0	13.7	6.4	6.4	7.0	12.1	7.1	8.2	9.2
Jets/E_T^{miss}	4.9	3.2	3.5	5.5	5.8	4.6	3.7	3.3	7.3	5.1	6.3
Leptons	0.9	1.2	1.7	2.6	3.0	3.0	3.0	3.2	0.0	0.0	0.0
Luminosity	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
Pile Up	0.5	1.1	1.8	2.2	1.2	0.3	0.3	1.6	0.2	0.2	0.0
Theory	4.6	3.6	3.3	5.3	4.4	4.7	5.0	8.0	3.3	3.3	5.6
Total Signal	10.1	9.1	9.6	16.5	11.4	10.8	11.0	16.0	11.8	11.4	13.4

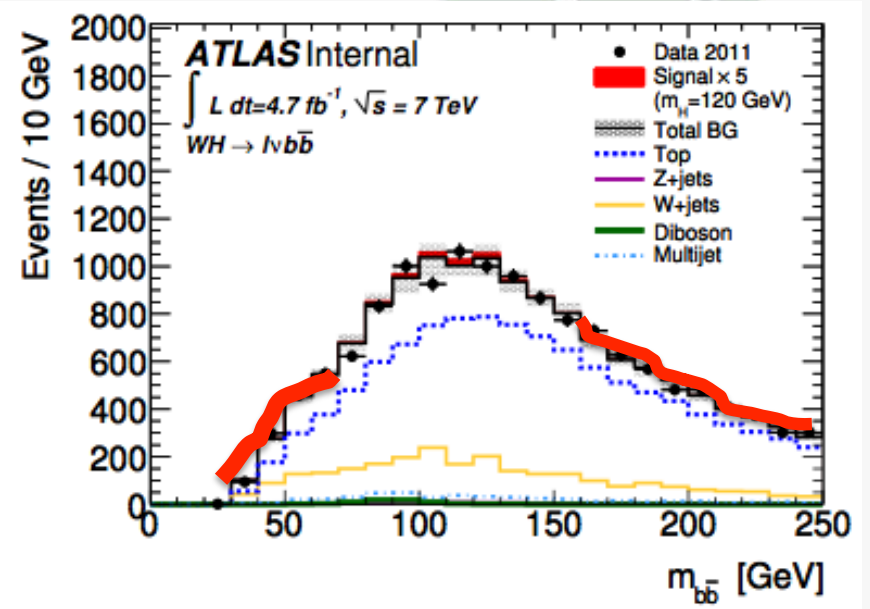
Improvements…

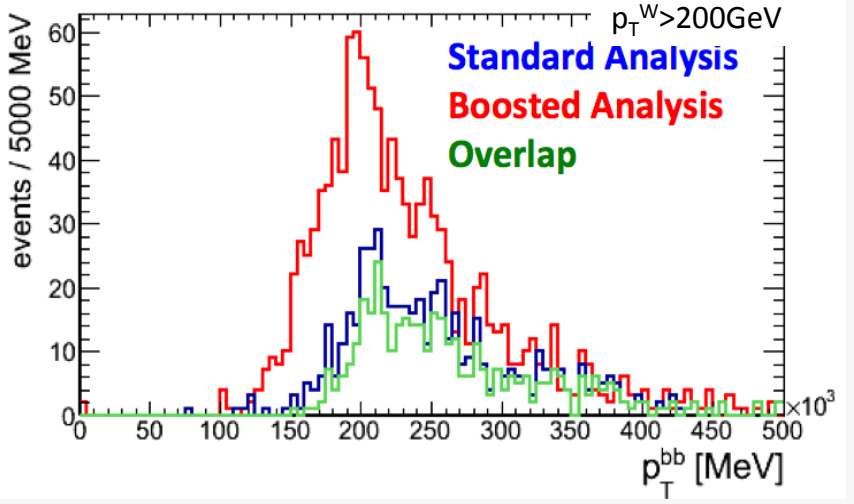
- Systematics already playing a very big role:
- 1st p_T bin systematics-dominated
- degradation of limits: 25% to 40%
- Adding more data will help… but improving systematics will help more (plus adding more data…)
- Concerns:
  - Monte Carlo
  - Theory uncertainties
  - JES (happy with new developments, but waiting for convergence)
  - B-tagging

llbb	**0-50**	**50-100**	**100-200**	**>200**
Data stat (%)	8.4	7.8	12.8	27.7
BG syst (%)	6.9	4.3	6.6	17.3
lvbb	**0-50**	**50-100**	**100-200**	**>200**
Data stat (%)	4.0	4.1	6.1	25.8
BG syst (%)	3.9	2.7	3.4	19.6
vvbb	**120-160**	**160-200**	**>200**	
Data stat (%)	9.8	21.3	20.0	
BG syst (%)	9.7	10.6	16.0	

Planned improvements

- Fitting the backgrounds:
  - Plan to fit backgrounds in the limit code together with profiling uncertainties
  - Instead of sidebands and control regions
- b-jet energy corrections:
  - Semileptonic B decays
  - Inclusive b-JES?
- Improve background rejection
- Adjust to new pileup conditions
- Add substructure analysis
  - Ongoing: recent progress
  - …but CMS will have this for ICHEP
- …



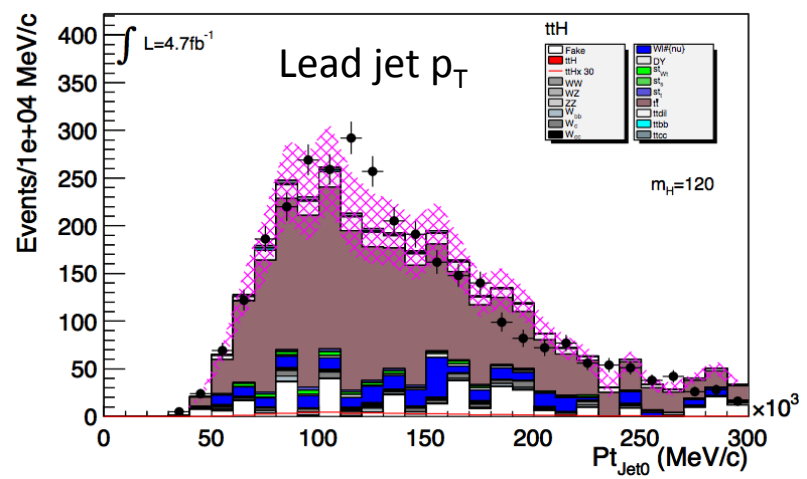


Ongoing 2011 analyses

- Some 2011 analyses in new channels are progressing:
  - ttH, H->bb analysis
  - Boosted VH analyses: same channels as existing H->bb analyses
  - Common with Exo: Minimal Walking Technicolor interpretation of existing analyses
  - Z->bb in diboson production – a standard candle for H->bb search
- More exploratory for now:
  - bH/A -> bbb
  - VBF H->bb interest from Victoria and Waseda

ttH analysis

- Analysis is progressing fast! Single-lepton channel looks promising
- Control regions to evaluate background/check data description
- Evaluating systematics: b-tagging dominant
- Complementary analyses: cut-based NN and kinematic fit

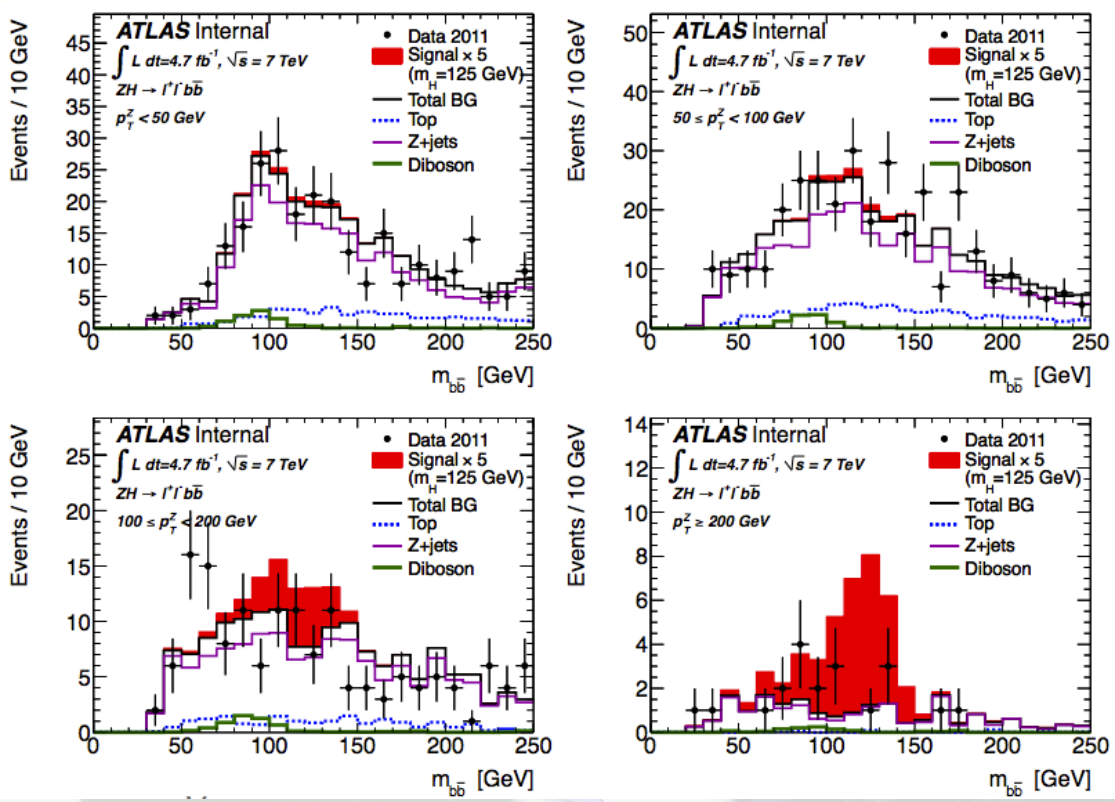


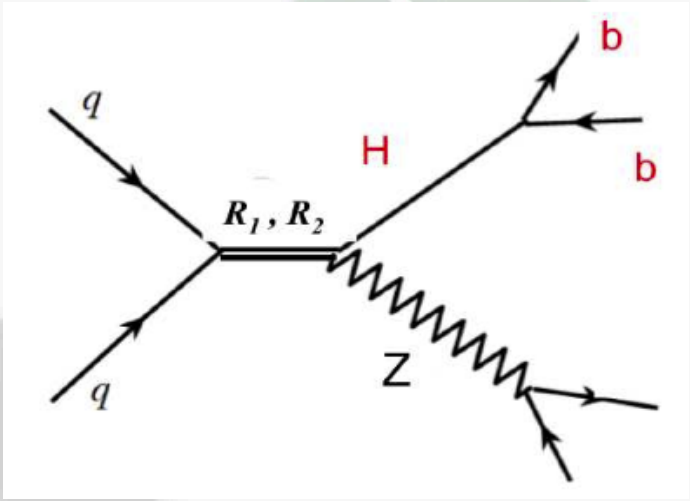
	Region	Type
A	= 4 jets and = 1 b-tag	Control
B	= 5 jets and = 1 b-tag	Control
C	≥ 6 jets and = 1 b-tag	Control
	≥ 6 jets and ≥ 3 b-tag	Signal

	-2σ	-1σ	median	$+1\sigma$	$+2\sigma$
Including QCD					
Electron	5.14226	8.5868	16.1312	37.9869	103.052
Muon	5.82686	8.15905	11.6698	17.167	24.2744
Combined = 6j	4.91948	6.89772	9.84857	13.8302	19.0837
Combined ≥ 6j	2.16559	3.67978	**6.74333**	13.0062	29.0718
Excluding QCD					
Electron	8.29638	11.6077	15.994	22.828	31.3265

No shape uncertainties

Minimal Walking Technicolor



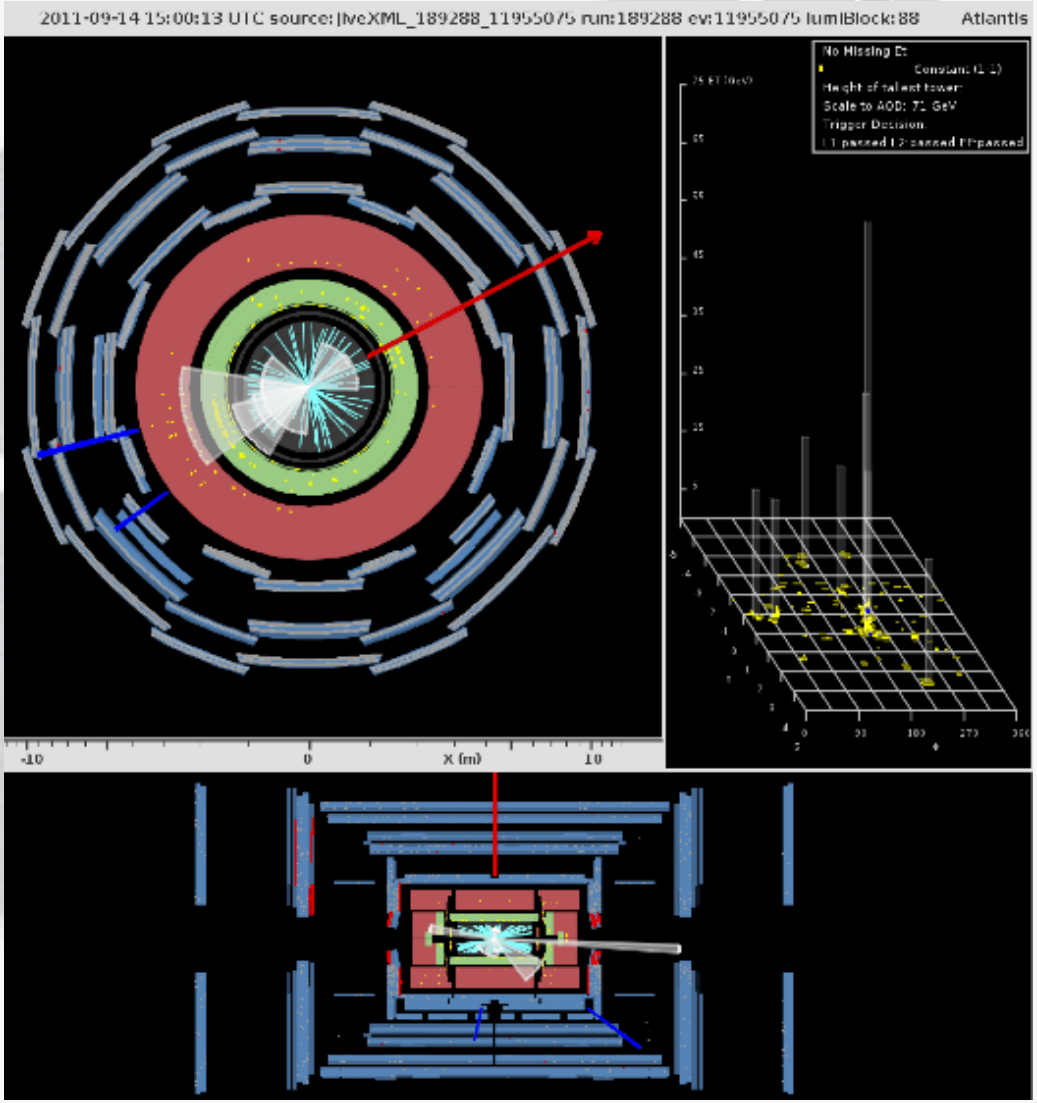


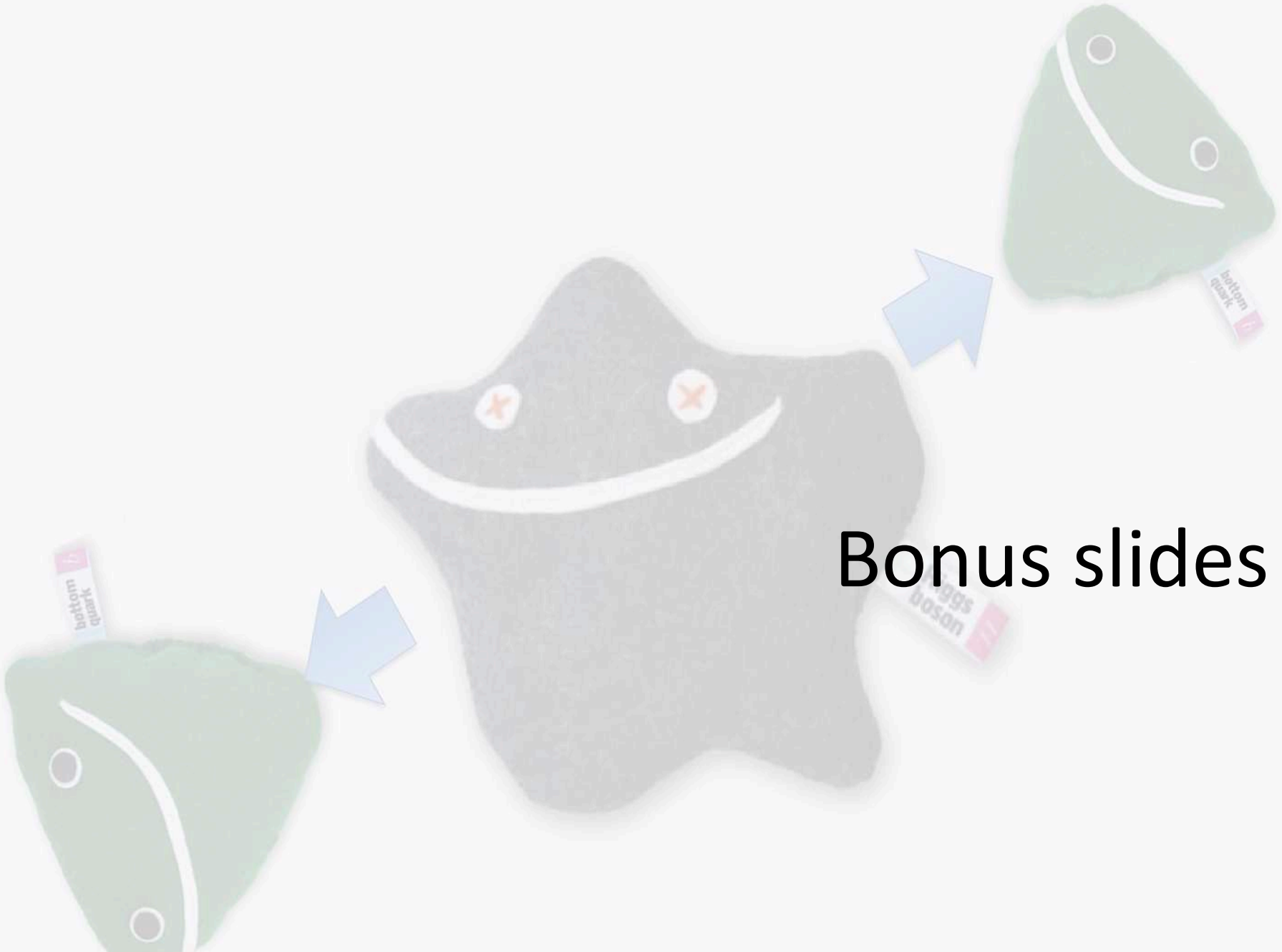
m_H (GeV)	Observed μ/μ_{SM}	Expected μ/μ_{SM} -2σ	-1σ	Median	$+1\sigma$	$+2\sigma$
125	**1.92**	0.66	0.89	**1.24**	1.72	2.30
140	**2.02**	0.81	1.09	**1.51**	2.10	2.82

- The idea is to see if we exclude some part of MWT parameter space using current WH/ZH analyses - proposed by Georges Azuelos
- Simply using existing ZH->llbb analysis obtained reasonable limits
- Will investigate reach with new signal MC

Conclusions

- Lots of activity ongoing
- Plans not yet crystalized
- Sorry I couldn't make justice to all





Bonus slides