Introduction

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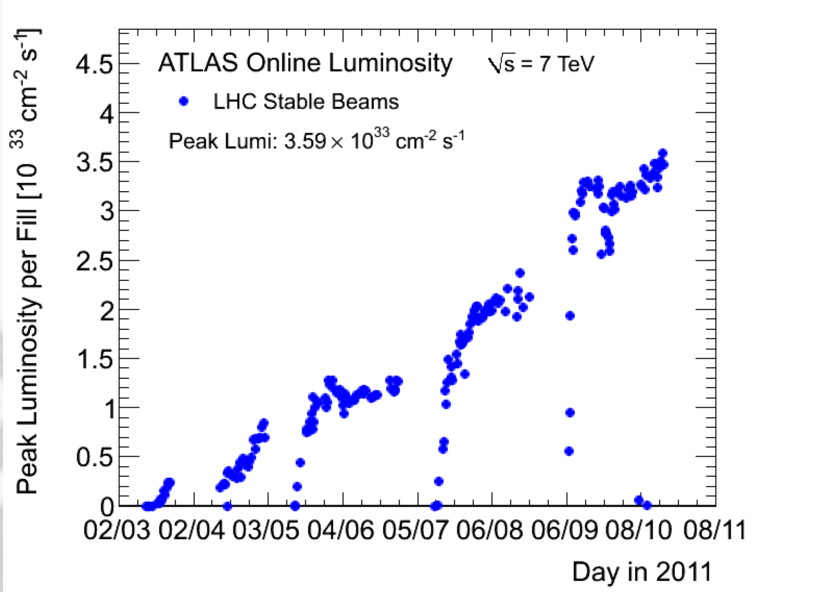
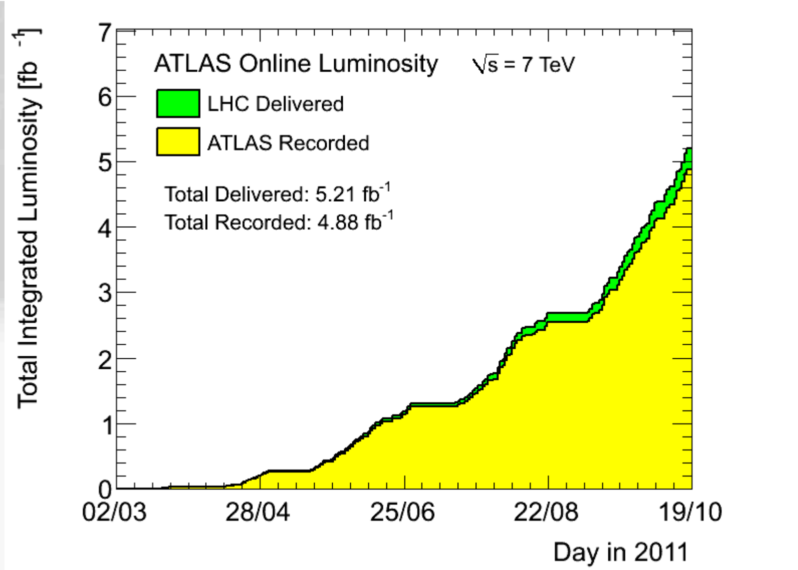
HSG5 H->bb weekly meeting, 18 October 2011

News! News! News!

- Peak stable lumi $3.59 \times 10^{33} cm^{-2} s^{-1}$
- 4.88 fb^{-1} with stable beams collected so far – 5.21 fb^{-1} delivered!!





News! News! News!

- Due to the high load and diverse nature of HSG5 which is responsible for Charged Higgs analysis and Hbb analysis, Physics coordination and the Higgs conveners decided to split HSG5 in two
- The new HSG5 will lead the search for bb final states, such as Vbb and ggH, vbf with H->bb.
- Nominations for a new subconvener for HSG5 requested by Oct 21st.

Plans for December

- It would be ideal to update results for December CERN Council meeting
- Currently being by Higgs convenors and Physics Coordination
- Depends on availability of high-priority MC sample and on combined performance estimates of scaling factors, calibrations etc

ATLAS-CMS comparisons

- Jonas and Jike have emulated CMS's cuts in WH->lvbb and ZH->vvbb
- Differences not yet clear – need to continue to pursue this
- Similar significances in WH ->lvbb when applying mass window cut
  - But very different event numbers – by factor 10-100 depending on channel
- CMS seems to get a lower QCD background than us in ZH->vvbb

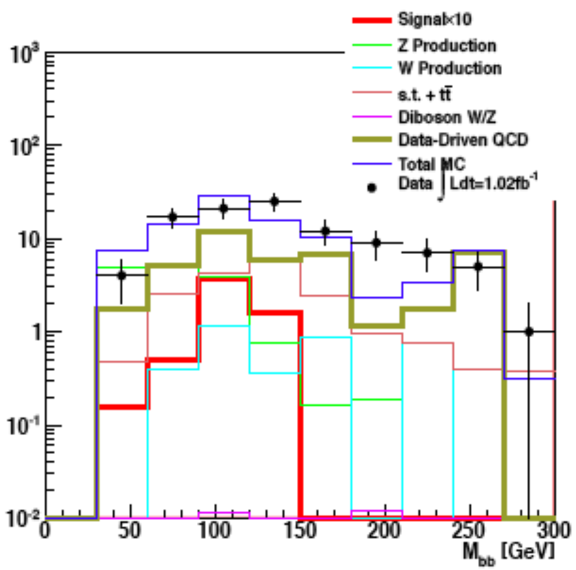
WH->lvbb

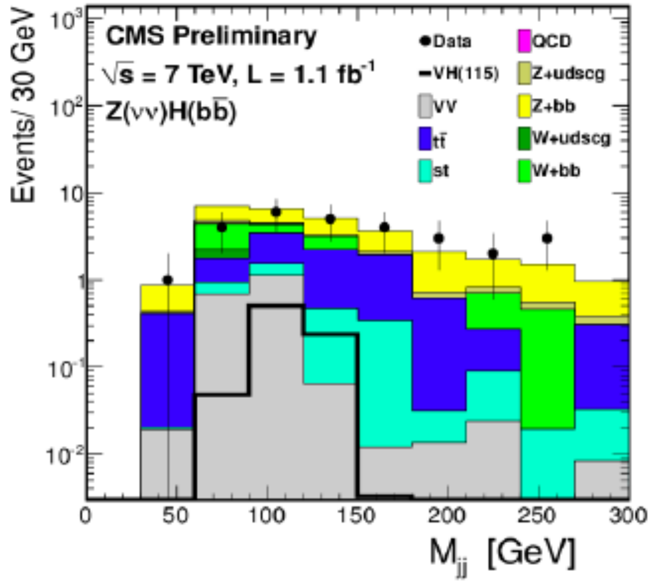
S/sqrt(B) for 40<m(bb)/GeV<240

	ATLAS-EPS	CMS-like
WH_115	0.163686	0.157101
WH_120	0.148339	0.116313
WH_130	0.0925769	0.0926334

S/sqrt(B) for sliding window (30 GeV)

	ATLAS-EPS	CMS-like
WH_115	0.198323	0.260037
WH_120	0.174354	0.213981
WH_130	0.0975579	0.148665





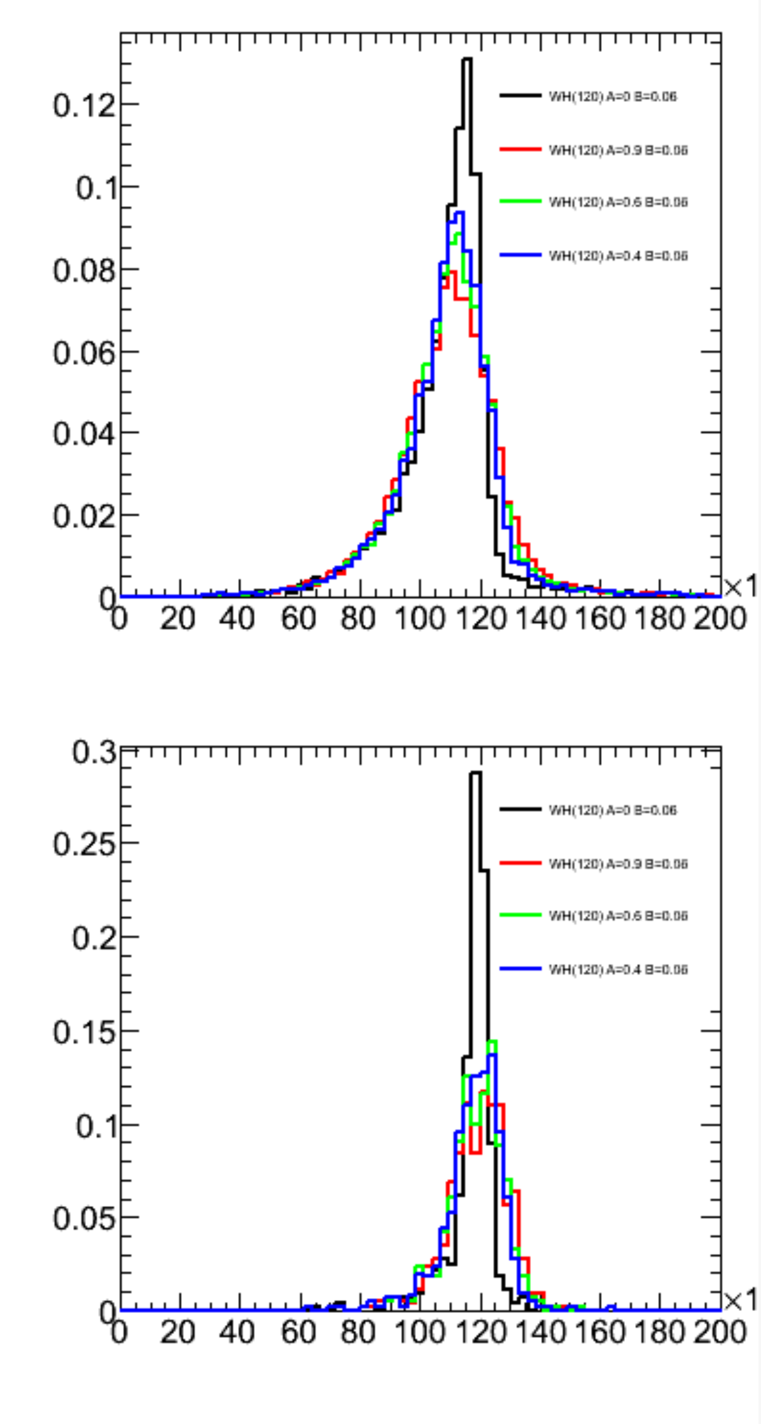
Mass Range	Mine : $90GeV < M_{bb} < 150GeV$	CMS : $100GeV < M_{bb} < 130GeV$
$S/\sqrt{S+B}$	$0.53/\sqrt{0.53+58.60} = 0.07$	$0.59/\sqrt{0.59+4.79} = 0.25$

Performance studies

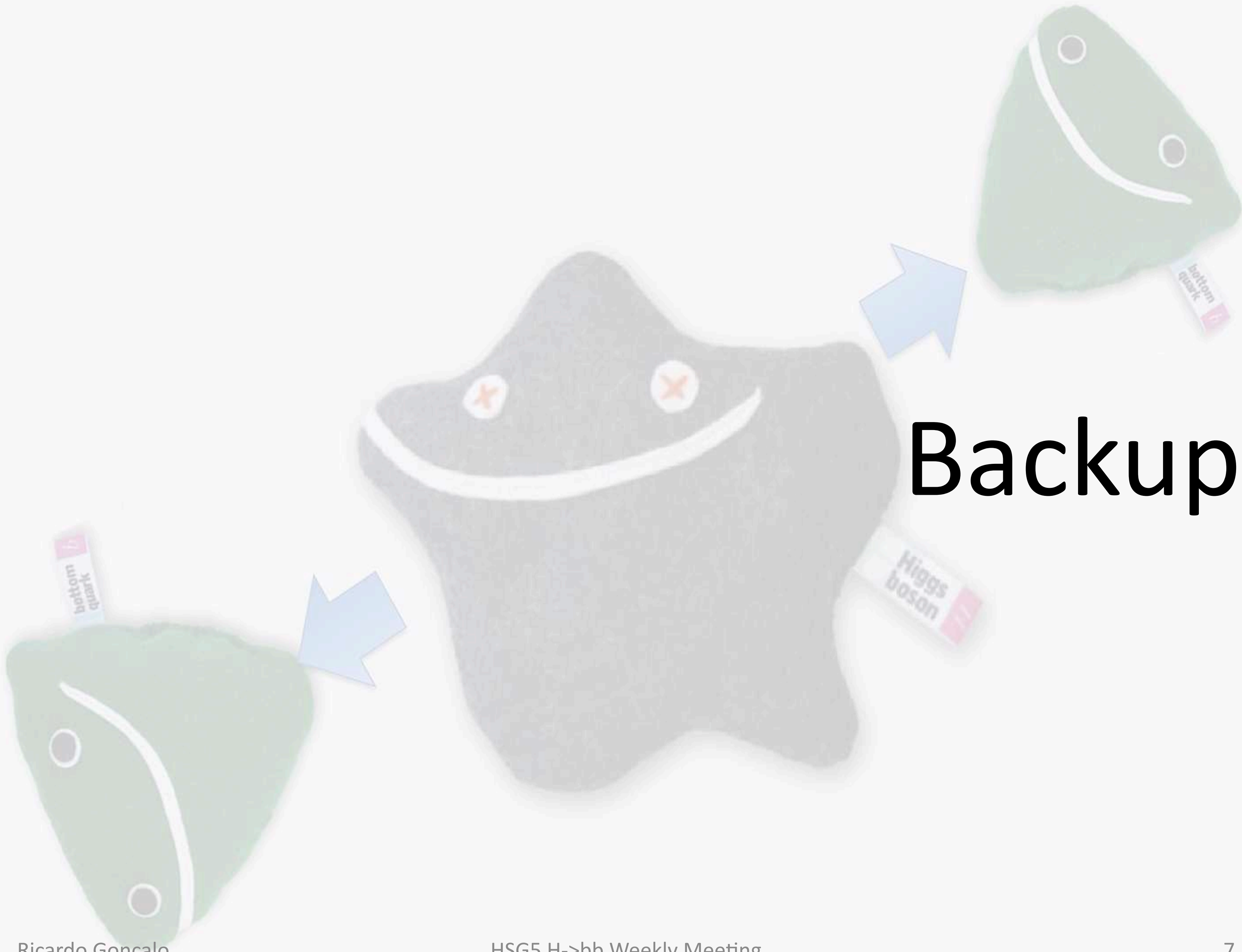
- Main systematics are jet and b-tagging related

- Current tasks listed in [Wiki]

- More questions than answers at the moment, but pursuing several threads:
- Jet resolution:
  - We seem to be affected by out-of-cone losses
  - Will try different jets
- B-tagging:
  - Find how much improvement needed to reduce syst
  - Improve MC statistics term of b-tagging uncertainty with AFII – requesting some AFII validation samples
  - Differences between hadronic and semileptonic b-jets

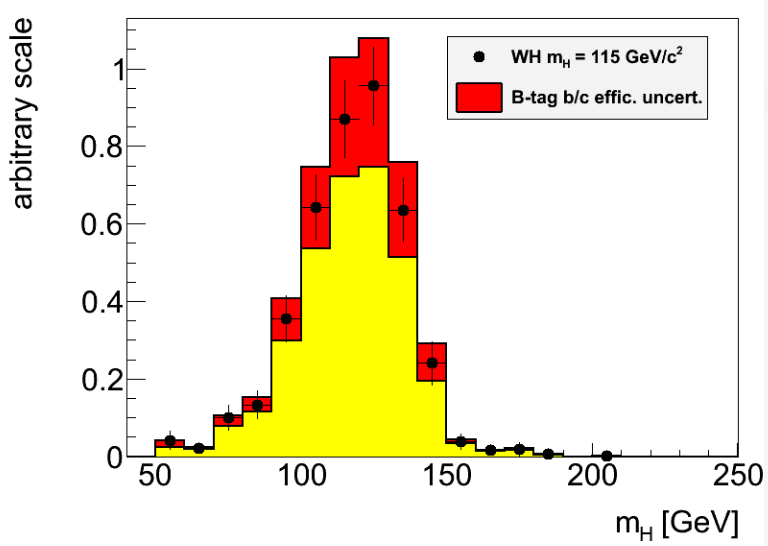


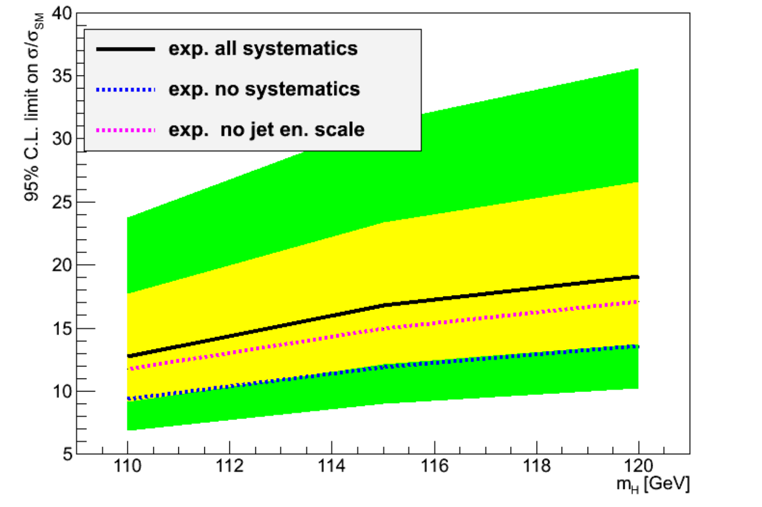
Backup



H→bb – Reconstruction Performance

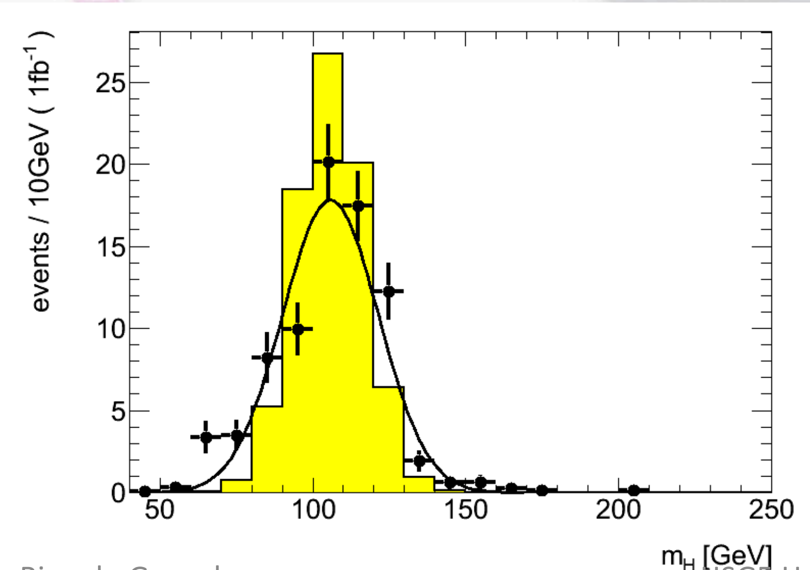
- Main limitations from jet reconstruction and b-tagging uncertainties
- Try to improve b-tagging efficiency/ fake rate uncertainty:
  - Dominant uncertainty on signal yield in EPS analyses
- Try to optimize di-jet mass resolution:
  - A sharper peak improves analysis sensitivity (10% width reduction ≈4% limit improvement)
- Try to reduce jet energy scale uncertainty:
  - Large effect in limit through changes in m_{bb} shape

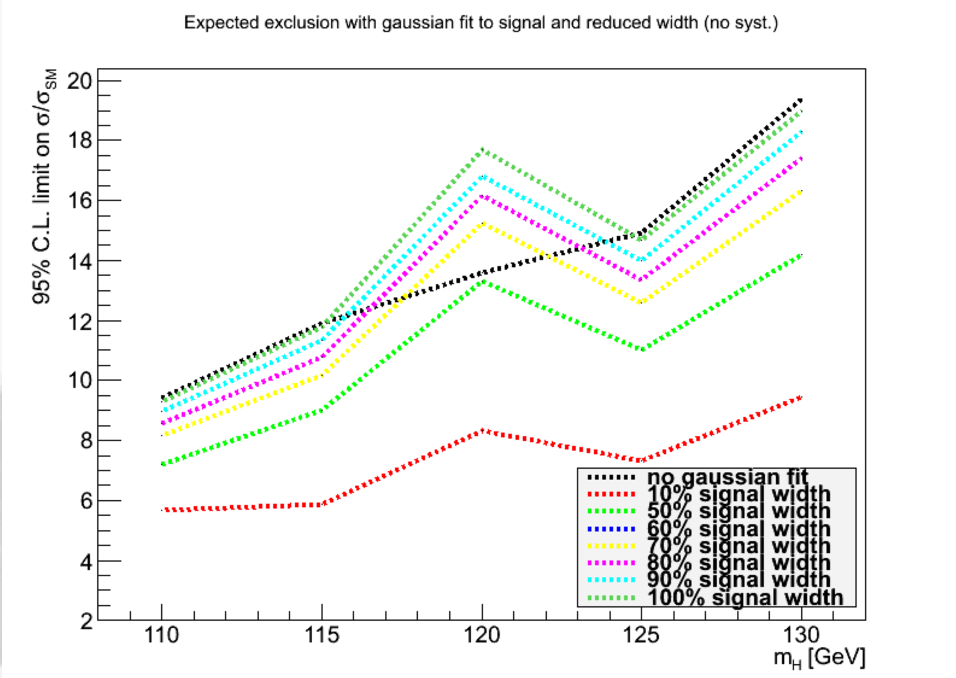


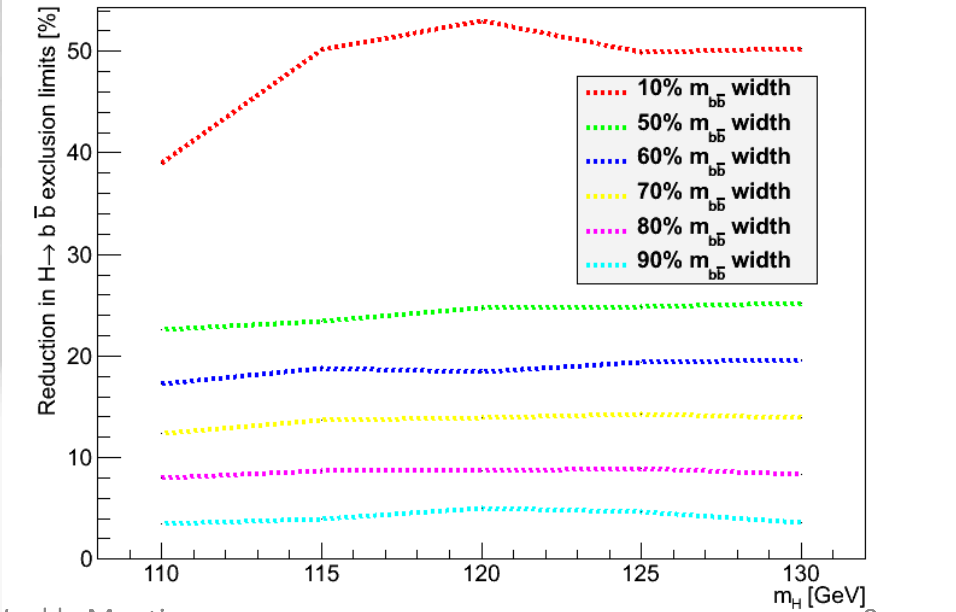


Backup

- Replaced signal with fitted Gaussian to manipulate signal width
- Estimated improvement in limits ($1fb^{-1}$) with reduced signal width
- Reduction to 80% gives 8% improved limits (magenta line, bottom left)







1. Di-jet mass resolution:

- Truth-level study, using partons (a similar study using truth jets would also be interesting). To be done for either WH or ZH channels, signal only would be enough.The idea is: 1. apply kinematic cuts to leptons and quarks similar to the analysis cuts - to look at a similar region of phase space 2. calculate the invariant mass of the two b quarks coming from the Higgs boson decay 3. determine the bb mass resolution 4. smear the parton transverse energies by some amount and go back to 2. The aim is to find by the (b-jet) energy scale uncertainty corresponding to a given value of the bb mass uncertainty. To define some numbers: the m(bb) uncertainty is around 20GeV. It would be interesting to know how much the jet energy resolution would need to decrease to make this 5%, 10%, 20% and 30% better.It would also be interesting to smear the quark directions. This should be a second-order effect for the un-boosted case but should be relevant for the boosted case.

2. B-tagging efficiency uncertainty:

- Analysis-level study. Find how much the b-tagging efficiency uncertainty should be, to make the systematic uncertainty comparable to other systematic uncertainties.In the EPS analysis, the systematic uncertainty in the number of selected events, arising from the b-tagging (b/c efficiency & light fake rate), was 17% for WH and 16 for ZH. This was the dominant systematic uncertainty in both cases and the sub-leading systematic was 3% and 9%, respectively for WH and ZH.The idea is to run the analysis a few times with different values of the b/c efficiency uncertainty and the light fake rates (say, 80%, 60%, 40% of the official values to make it simple) and find what the corresponding systematic uncertainty would be on the signal yield.

3. Validate Atlfast II description of pTrel for b-tagging improvements

- The b-tagging uncertainty is the one of the dominant uncertainties affecting the H->bb analyses. The estimated uncertainty itself is affected by several systematic uncertainties, and crucially by the MC statistics in the mu+jet samples used to determine the b-tagging scale factors. A solution for this would be to use fast simulation (Atlfast II) to get enough statistics. But this simulation needs to be verified against full simulation.So, this task aims to: compare the description of important quantities in AFII files against the same variable in full simulation files. The most important variable is "pTrel" for muons found inside a jet cone. This is the relative transverse momentum of muons with respect to the jet they belong to. of the The files to use are Jx samples filtered with a muon filter ("Jx*mufixed", with a filter selecting muons with pT>3GeV). Equivalent files need to be requested with AFII (to be done soon by Ricardo).

4. Differences between hadronic and semileptonic B decays

- This is another of the important uncertainties affecting the b-tagging efficiency determination (as the study above). A term of the b-tagging efficiency uncertainty accounts for differences between jets arising from hadronic and semileptonic B decays. But this area remains under studied. It would be important to identify variables which show marked differences between these two types of jets, and could lead to differences in b-tagging efficiency. And to quantify the differences. Examples of possible variables to examine are the number of tracks, leading track pT fraction, Sum(pTtrack)/ET, etc.This task is not very well defined. Please get in touch with Ricardo

MC requests

Inclusive and boosted H->bb samples for MC11b:

- Herwig++ in Powheg
- Mass points: M_H = 110, 115, 120, 125, 130, 135, 140, 145, 150 GeV
- WH->lvbb, ZH->llbb, ZH->vvbb
- Both boosted and inclusive for each mass

- Approved for production – still in waiting list for MC11b production (delays in MC11a)

- Other samples:
  - Wbb, Zbb
  - ZH, WZ, WW -> lljj and llbb final states
  - Gluon-fusion H->bb

- See Junichi's page: https://twiki.cern.ch/twiki/bin/view/AtlasProtected/HSG5Higgs2bbFinalState#H_bb_MC_samples