H->bb: plans and EPS post-mortem

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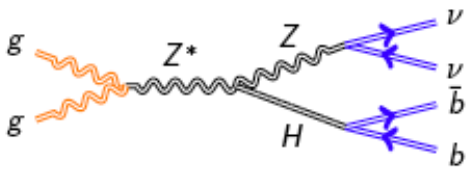
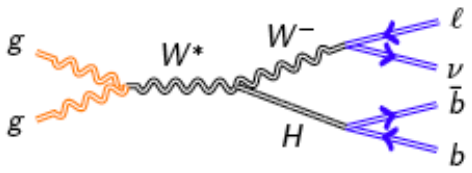
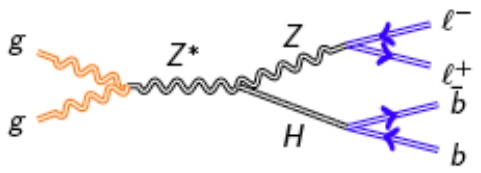
HSG5 H->bb weekly meeting, 26 July 2011

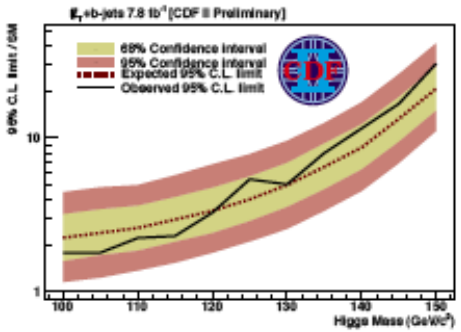
Limits throughout the mass range

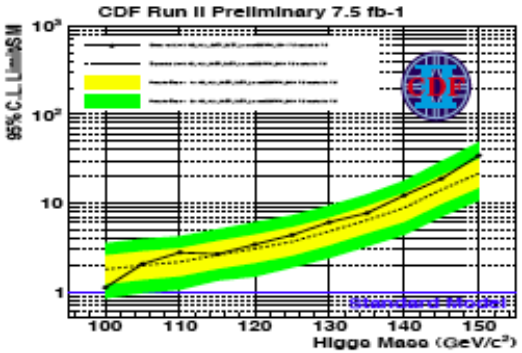
CFS+D0 H->bb Results from EPS

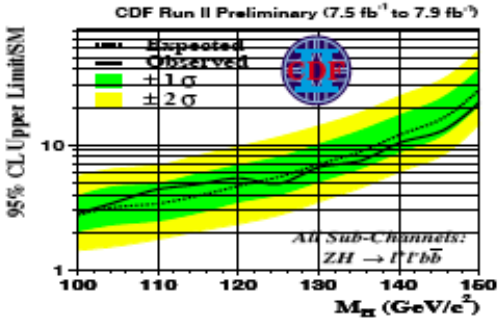


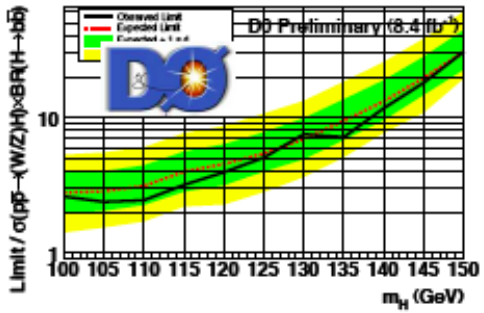


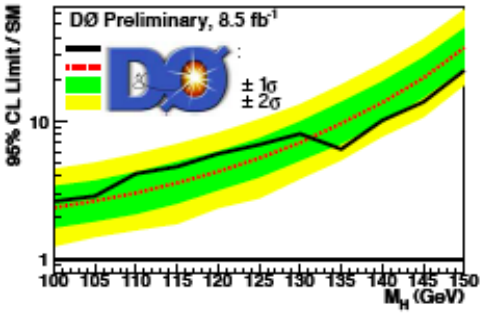


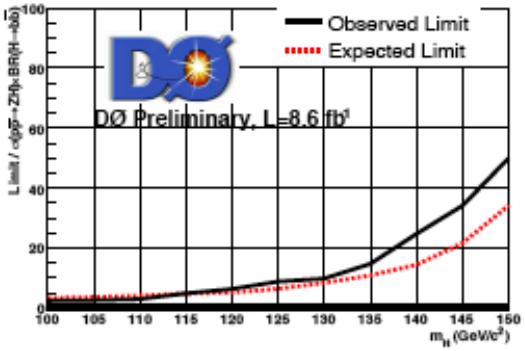








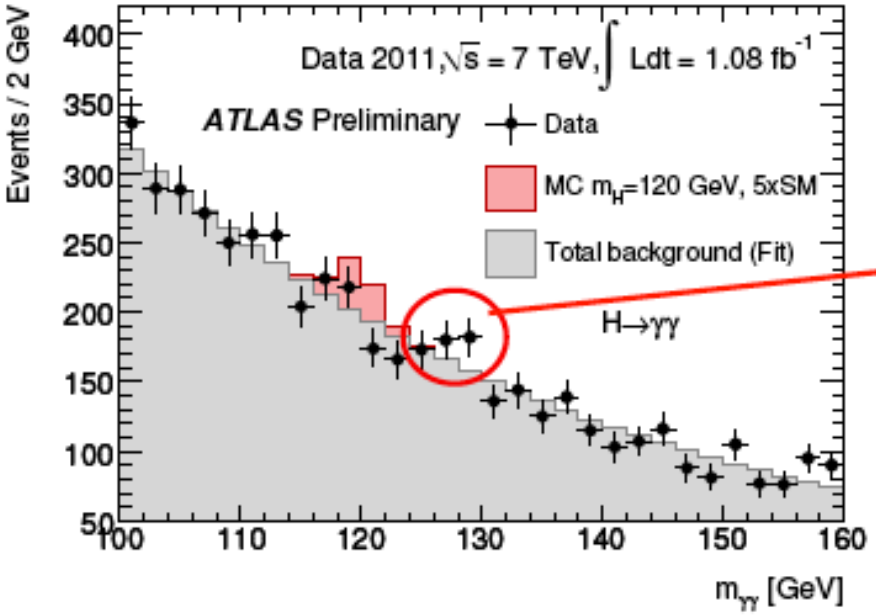


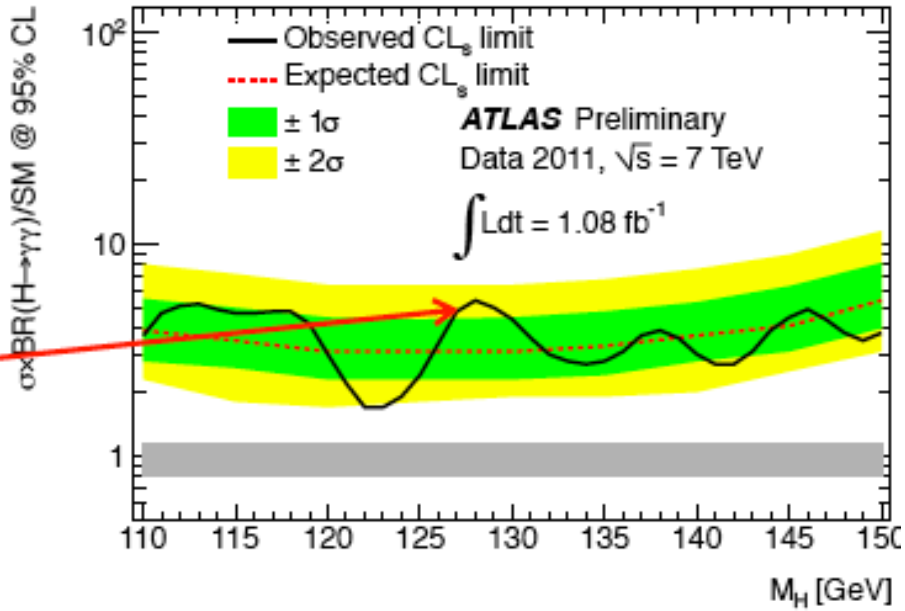


Low mass channels

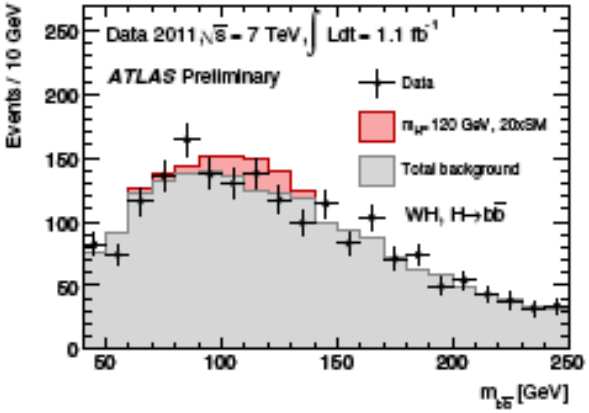
Center for Cosmology and Particle Physics

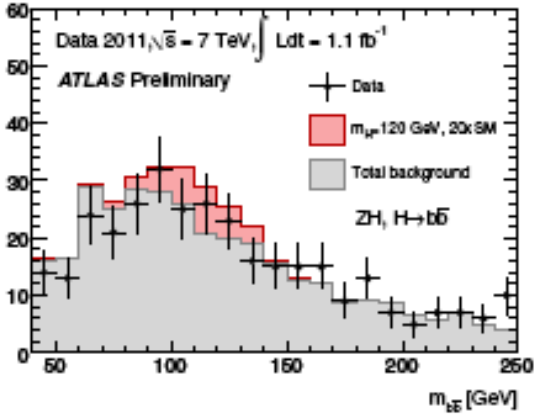
H→γγ (110-150)

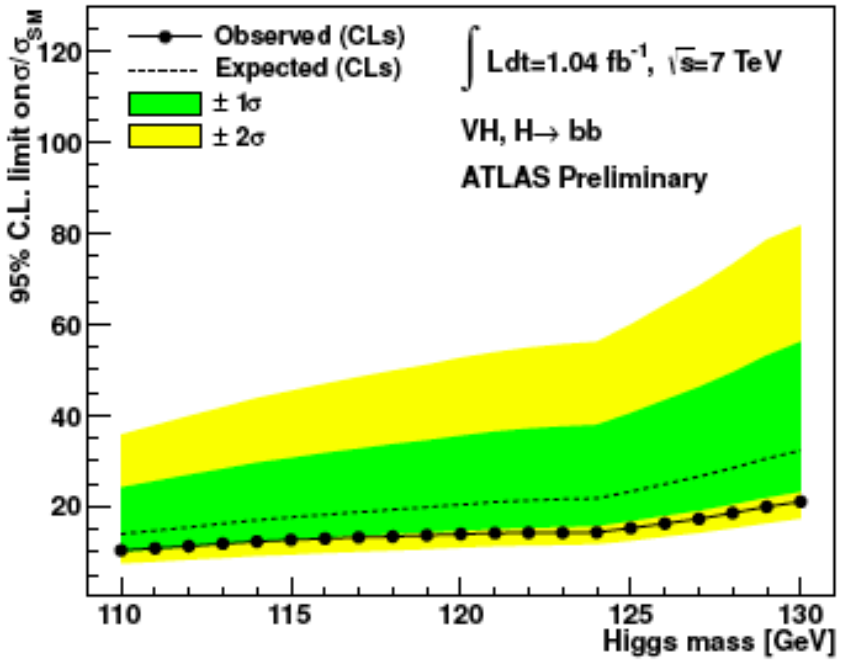




WH and ZH, H→bb (110-130)

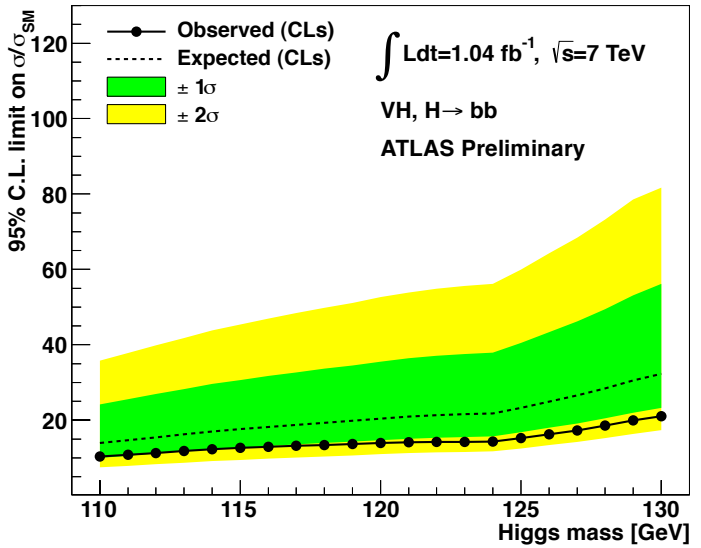


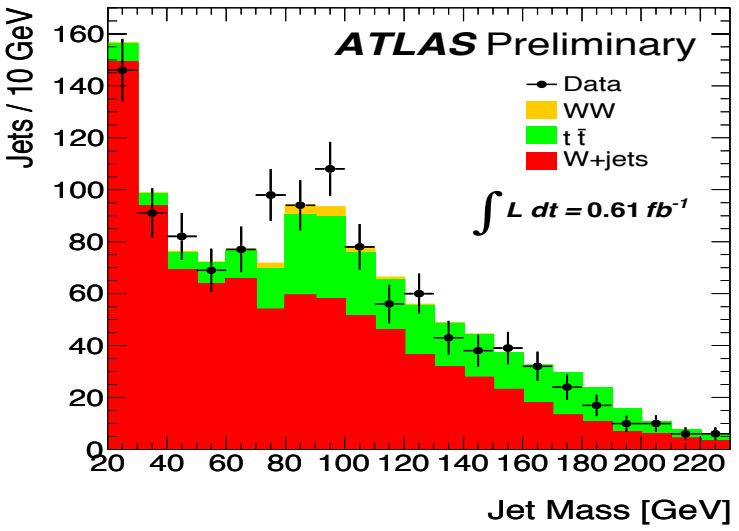




General Impressions

- Very good that we presented these results for several reasons:
  - We showed it can be done!... (first time for the LHC) And now we have baseline to build on
  - It was nicely done in several ways – data-driven estimates of worst backgrounds etc
  - We showed that boosted VH is within reach – boosted VH plot got lots of attention! Now we need to deliver on the promise
  - Important to have a cross check for H->γγ
  - Results included in ATLAS SM Higgs combination
- What is missing:
  - Real sensitivity – we're only at 10-15 times the SM
- The way forward:
  - Space for improvement in WH/ZH
  - Include other channels
  - Try to move higher in mass reach (but cannot do much)
  - See next slides…
- Concerns
  - Current results: small screw-up in limits (obs vs exp) needs to be understood
  - Near future: not much time! Waiting to see how much low mass excluded by Tevatron
  - Sociological: need to keep focused on this – need to get activity going again after EPS madness





Post-mortem of WH/ZH results

- M_{bb} resolution is extremely poor
  - Should try to get a peak, but this needs work on jet (and b-jet) energy scale
  - Try to think about this together with jet/ E_T^{miss} people
  - Could we improve other things in jet reco to improve m_{bb}?
  - In ZH->llbb could try to use ll vs bb p_T balance to do in-situ calibration?
- B-tagging systematic uncertainty dominates by far
  - 16% vs 7-9% for JES and ≈1-2% others
  - Should be possible to improve this, since the error is dominated by the statistics used in b-tagging studies
  - Would improve limits by up to 25-30%
  - Think about this with b-tagging people
- Limits: must get help from roostats experts to understand the difference between expected and observed
- WH cuts on exactly 2 jets
  - A lot of signal is lost there – can it be improved?
- WH backgrounds:
  - Top and W+jets background estimate using simultaneous template fit to m_{bb} sidebands (<80GeV and 140-250GeV)
  - Probably should try to also constrain jet energy scale from this fit
  - JES changes m_{bb} distribution and could affect normalization of backgrounds
  - In light of H->WW results, should move upper sideband to e.g. 160-250GeV – at m_H=150GeV, σ*BR already 1/10 of value at 115GeV, but H->WW and H->bb resolution is very broad
  - Can top background be reduced further?
- ZH background from Z+bb seems irreducible – can it be improved?

WH/ZH analysis plans

- We can still try to improve cut based analysis:
  - Get a m_{bb} peak, improve b-tagging systematics, constrain JES in WH, etc…
  - Reduce top background in WH:
    - Try using looser leptons or extending lepton id to forward region to veto tt->lvlvbb
    - Loosen jet η cut (at $|\eta|<2.5$ now) and maybe p_T cut to veto tt->lvjjbb/jjjjjbb
  - But… must keep pileup and JVF in mind

- Reduce Z+bb background in ZH? Would probably need a clever new variable like $\cos^{*}\theta$

- Then clearly we should include multivariate methods
  - Used intensively by Tevatron
  - e.g. use NN to target top background – may allow to relax 2-jet cut in WH
  - NN may also help in rejecting Z+bb background in ZH?
  - See if MV method can improve existing b-tagging

- Add more channels!
  - Can something be done with ZH->vvbb? Very good channel in Tevatron, but complex and mature analysis
    - Academia Sinica group plans to work on this But trigger is the crucial part
  - Boosted VH is clearly the next thing to push! WH->lvbb and ZH->llbb, but also ZH->vvbb
    - UCL and Edinburgh working on this – should be enough manpower now, but need to get results soon
  - ttH has been slowly building up in Glasgow – will push for this to happen together with Chris

Technical issues

- ZH benefitted from HSG2 DAOD skims, but WH suffered from painful running on data
- Need to push for WH skims – will follow up with Kostas & Co.
- In contrast to other groups we don't have an error due to LO/NLO on the signal. Need to get NLO signal MC
- Also need to re-do WH samples at 110 and 140 since the current ones were done with a lepton filter by mistake
- Should also other mass points:
- Get 135 for WH and ZH since we have 130 and 140
- Should we try to extend to 150 GeV in light of H->WW results? Almost no sensitivity, but could prove useful later

Limits in the low mass range

Impressive sensitivity to a Higgs boson in the mass range 135-200 GeV

Excess in $H \rightarrow WW \rightarrow l\nu l\nu$ leads to weaker-than-expected limits near M_H = 130-160 GeV