Weekly report

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20-10-2015

IHEP

HH combination paper is approved!

- Approved by PRD last week
- This week we got some proof checks to do

PRD DJ11717

Paper Final Publication

Referee Report On	2015/09/24	PGC PC Pub EdB
Journal Acceptance Date	2015/10/13	PGC PC Pub EdB
Proofs On		PGC PC Pub EdB
Final Journal Publication		

Inspire

https://atglance.web.cern.ch/atglance/analysis/detailAnalysis.php?readonly=true&id=4783

Searches for Higgs boson pair production in the $hh \to bb\tau\tau$, $\gamma\gamma WW^*$, $\gamma\gamma bb$, $bbbb$ channels with the ATLAS detector

The ATLAS Collaboration

RUN II HH comb - Introduction

- In RUN I four channels (bbyy, bbbb, bbtautau, wwyy) entered combination for hh non-resonance / resonance searches
- Interpretations were done for hMSSM and low-tb-high MSSM instead of 2HDM due to width issue
- RUN I publication (PRD):
  - https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/HIGG-2013-33/
- we learn a lot from RUN I experience and get well prepared across all channels in a more coordinated way
- A ***twiki*** is set up in order to coordinate on relevant issues of combination: *object definitions, signal regions, control regions, systematic uncertainties* etc.
  - https://twiki.cern.ch/twiki/bin/view/AtlasProtected/HHCombinationRUNII

RUN II channels

- For RUN II, six channels are involved ***so far***
  - bbyy: https://twiki.cern.ch/twiki/bin/viewauth/AtlasProtected/HGam_run2_ggbb
  - bbbb: https://twiki.cern.ch/twiki/bin/view/AtlasProtected/XtoYYtobbbbRun2
  - bbtautau: lephad and hadhad
  - wwyy: lvjj+yy and jjjj+yy
  - bbww: lvjj+bb https://twiki.cern.ch/twiki/bin/view/AtlasProtected/HHtoWWbb
  - yytautau: lephad and hadhad

Signal samples

- In RUN I we used LO HeavyScalar package with MG5
  - https://cp3.irmp.ucl.ac.be/projects/madgraph/wiki/HiggsPairProduction
- For RUN II, we had requested
  - non-resonance: NLO samples for all
  - resonance: LO for bbyy bbww bbtautau
  - resonance: NLO under studies ... took **too long** from theorists' side ... may go **back to LO**
- **Missing samples: resonance bbbb,wwyy,yytautau**
- Special background requests:
  - bbyy continuum bkg: jjyy bbyy etc.
  - wwyy continuum bkg: lvjjyy, jjjjyy
- Anything else needed, please speak out!

Mass range

- In RUN I four channels entered combination foss r hh searches
  - non-resonance: bbbb, bbyy, bbtautau, wwyy
  - resonance (260-500): bbyy, bbtautau, wwyy
  - resonance (500-1000): bbtautau, wwyy
- For RUN II, we have requested
  - bbyy: 275, 300, 325, 350, 400
  - bbww: 700, 2000, 5000
  - bbtautau: 260,300,400,500,600,700,800,900,1000
  - the rests:
    - bbbb: high mass
    - wwyy: low mass
    - yytautau: ?

SM Higgs mass

- In RUN I, we struggled to converge the **SM Higgs mass** that is used on Higgs-mass constraint in each channel; that was realized at a quite late stage in the analysis, so additional systematic uncertainties were assigned due to moving from channel-specific Higgs masses to the agreed one (latest combined value 125.4GeV)
- For RUN II, it would be good to define the SM Higgs mass in the early stage of all analyses
  - 125.4GeV

    ATLAS Collaboration, Measurement of the Higgs boson mass from the $H \to \gamma\gamma$ and $H \to ZZ^* \to 4$ channels in pp collisions at center-of-mass energies of 7 and 8 TeV with the ATLAS detector,

    – Phys. Rev. D90 (2014) 052004, arXiv: 1406.3827 [hep-ex].

Interpretations

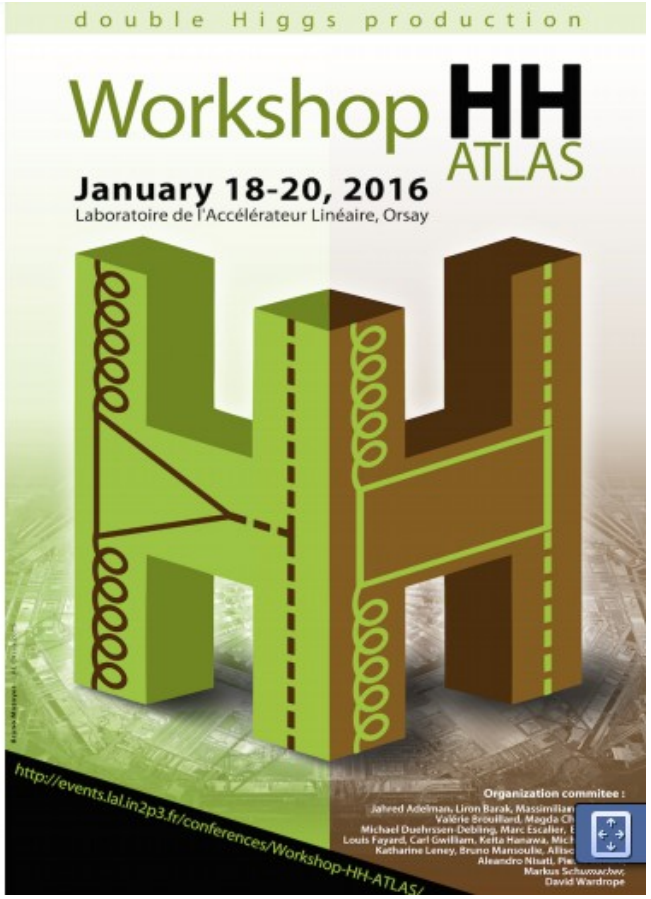
- In RUN I, two MSSM models were interpreted instead of 2HDM only due to the width issue
- For RUN II, we may start to study the width issue with non-NWA samples that allows to have more freedom on the models that we would like to interpret
- Proposals:
  - MSSM: hMSSM, low-tb-high MSSM
  - 2HDM: four types
  - Others ... Singlet ?

Backup

HH workshop registration

- HH Workshop registration is open now
  - http://events.lal.in2p3.fr/conferences/Workshop-HH-ATLAS/

- Planning to have a dedicated ATLAS workshop on hh
  - Will focus on BSM but also cover longer-term SM hh
  - 18th – 20th Jan 2016 in Orsay, Paris
- Doodle to get a rough idea of numbers who may attend
  - http://doodle.com/poll/s6qevubdgv2pbrzp
  - Not a registration yet



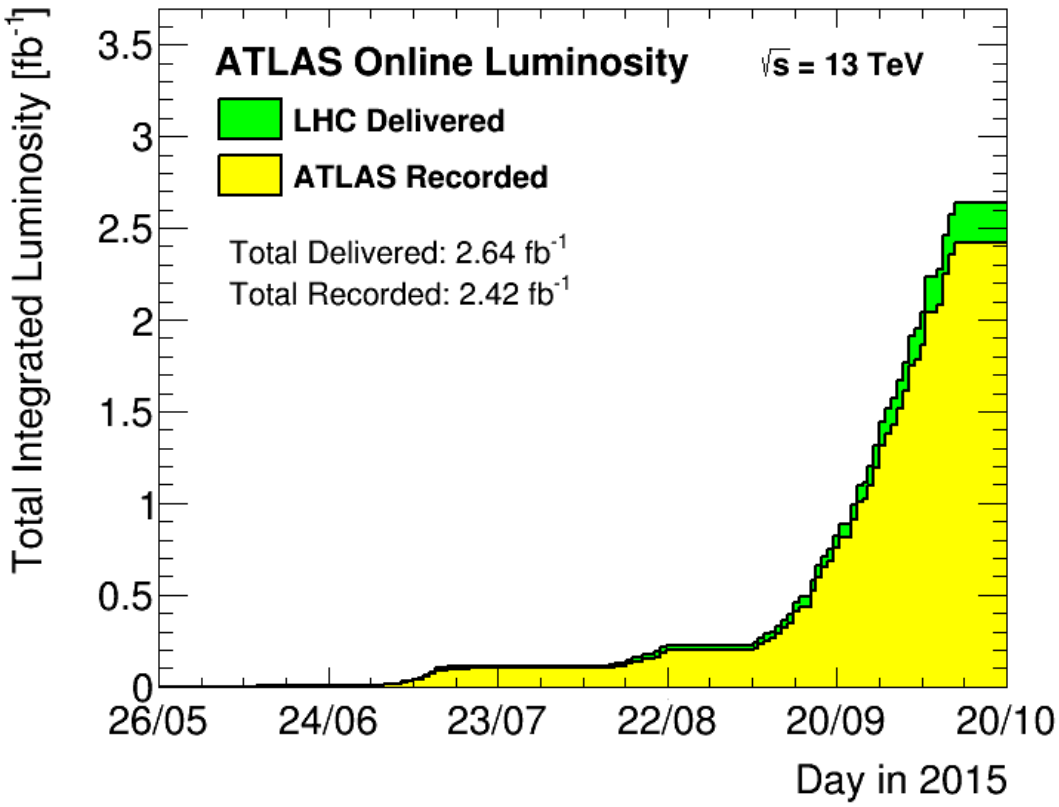
Data in wwyy categories

- Run with HGam h008 MxAOD from eos system
  - /eos/atlas/atlasgroupdisk/phys-higgs/HSG1/MxAOD/h008/data_25ns/
- In total, 286.9 /pb 25ns was processed to MxAOD
- In total, 1.6M events
- With HGam sel:
- Previously, 50ns

  668 evts ~ **84.6**/pb
- Now, 25 ns

  6814 evts ~ **1.01**/fb

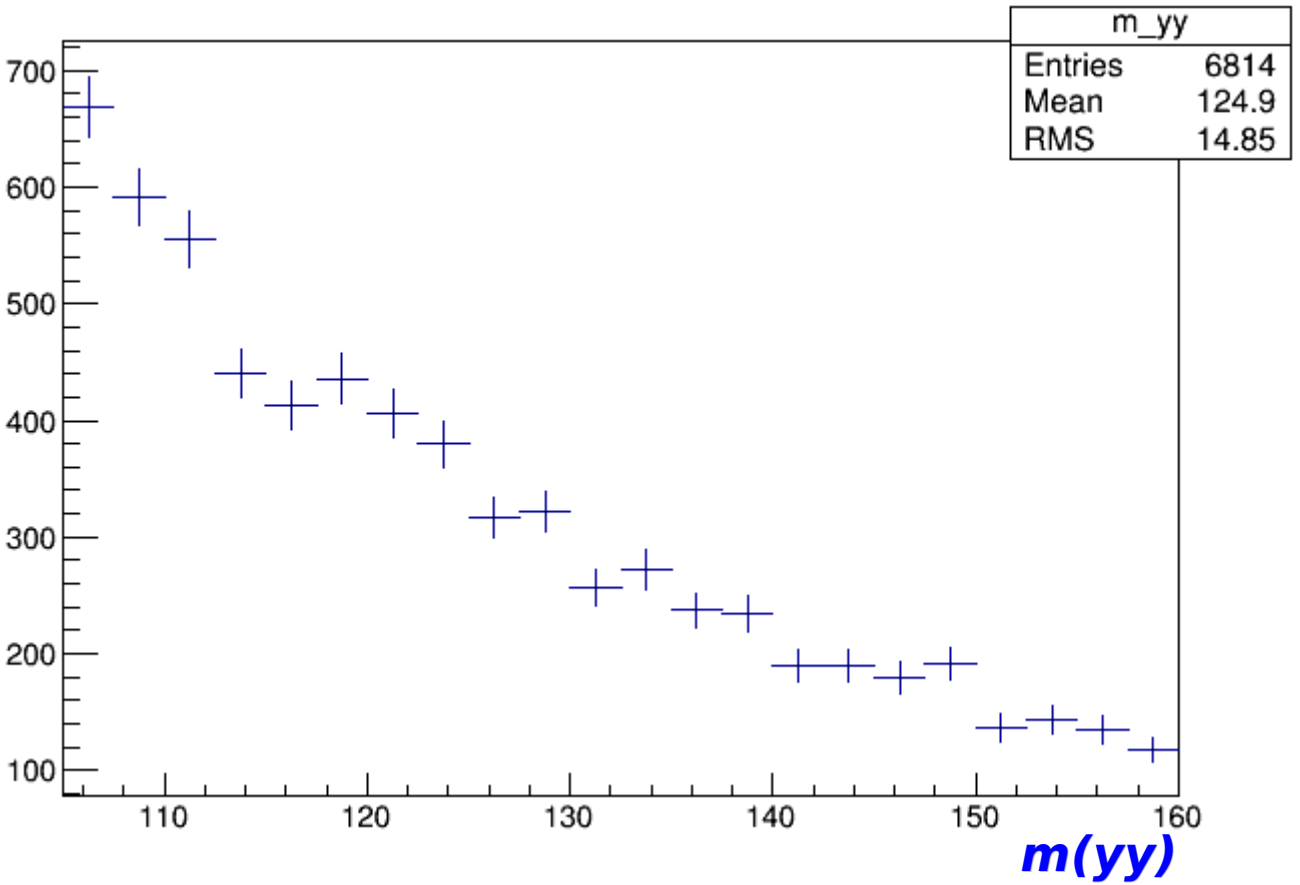
X10.2



yy events

- Selected yy events

X10.2



pre-sel

1: all events
2: trigger
3: GRL
4: detector DQ
5: hasPV
6: 2 loose photons
7: e/γ ambiguity

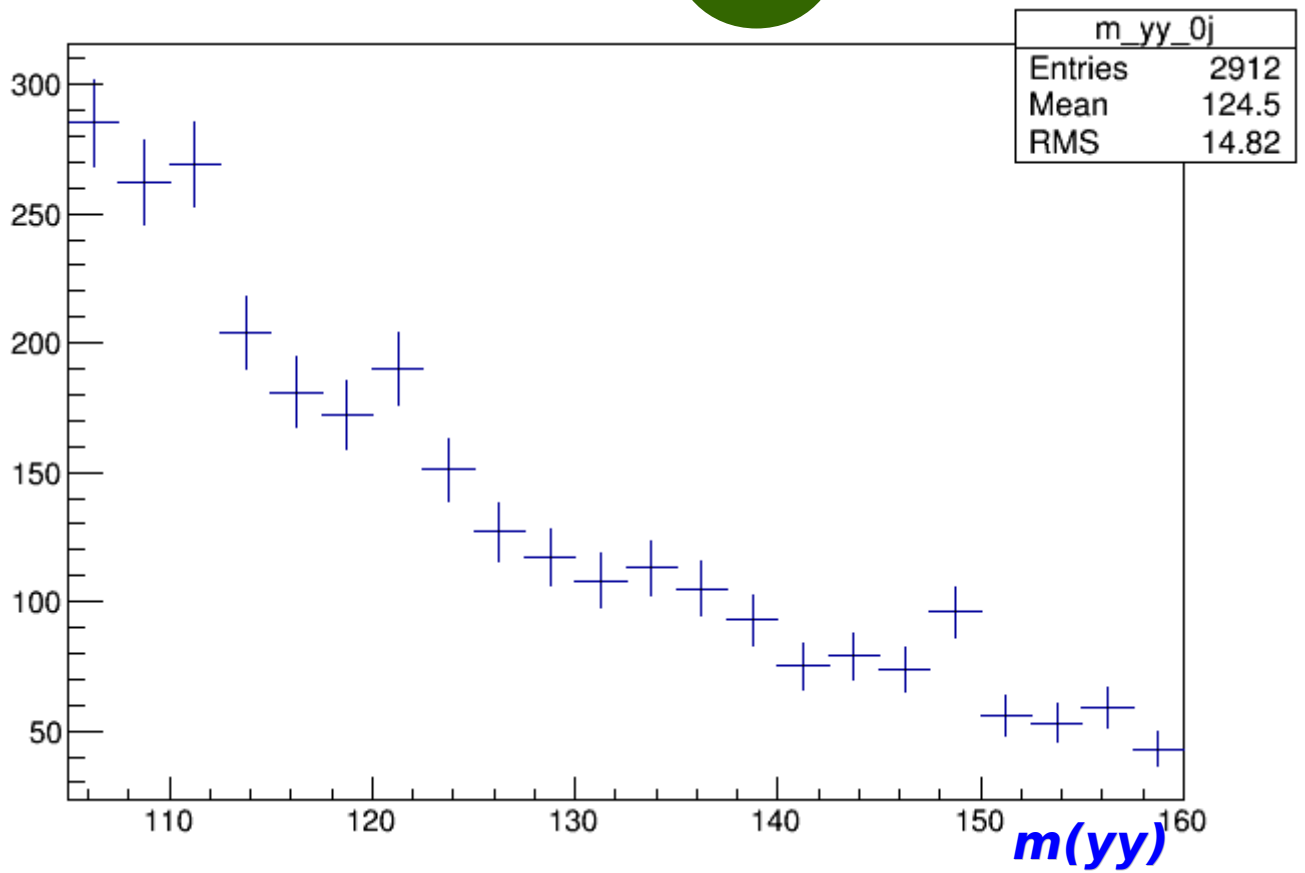
full-sel

8: tight
9: isolation
10: rel ET cuts
11: myy in 105-160 GeV

yy + 0jet

- yy+0jet events
- Previously 281, now 2912

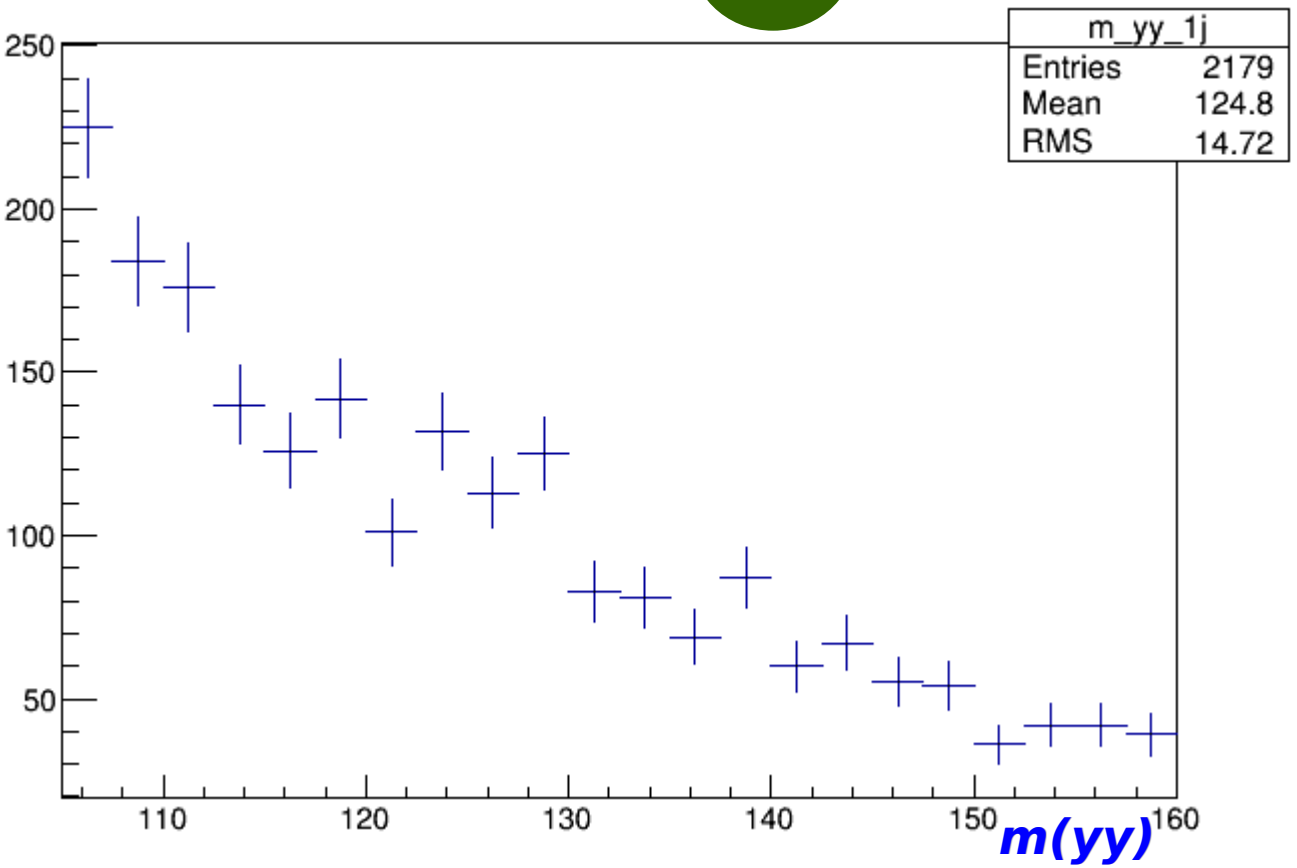
X10.4



yy + 1jet

- yy+1jet events
- Previously 208, now 2179

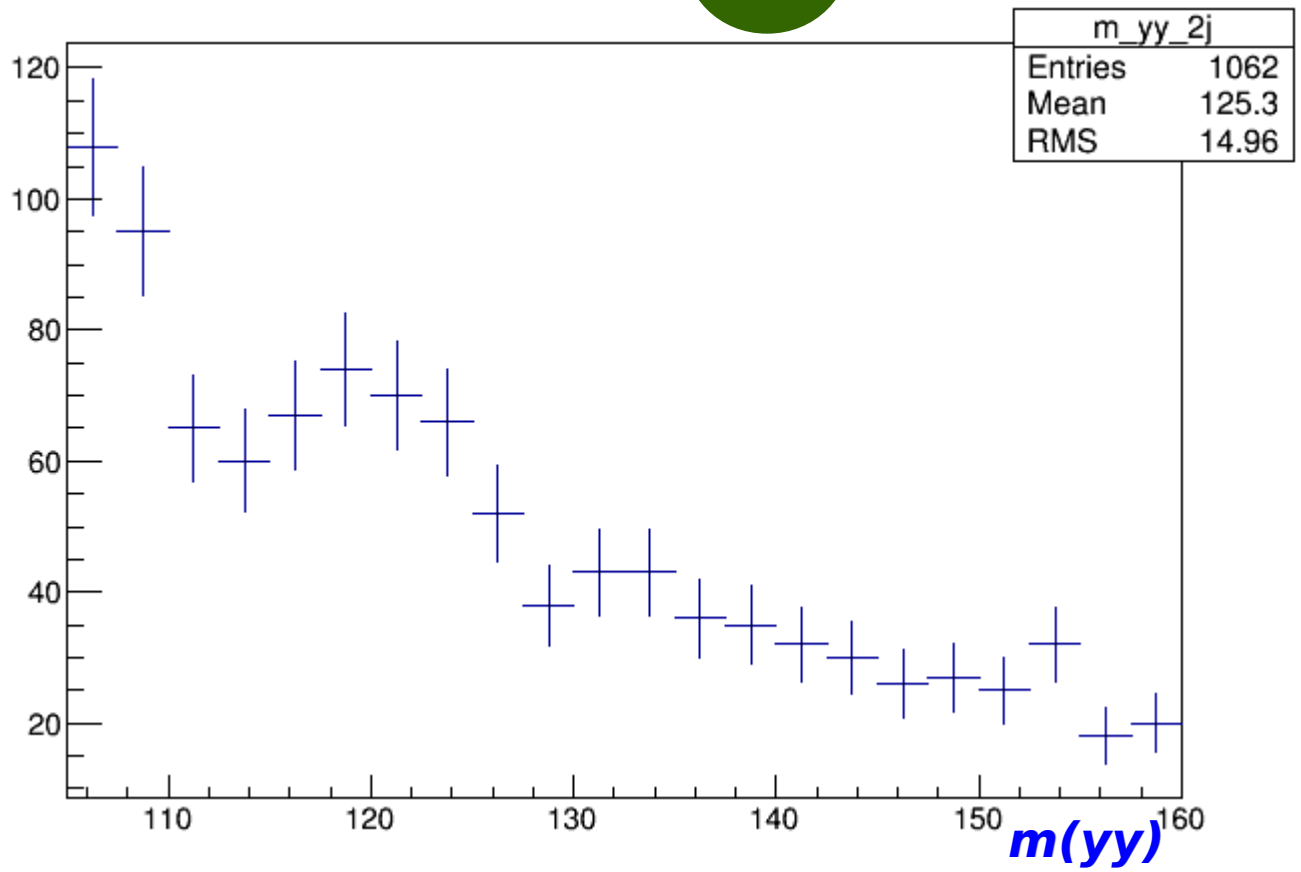
X10.5



yy + 2jet

- yy+2jet events
- Previously 108, now 1062

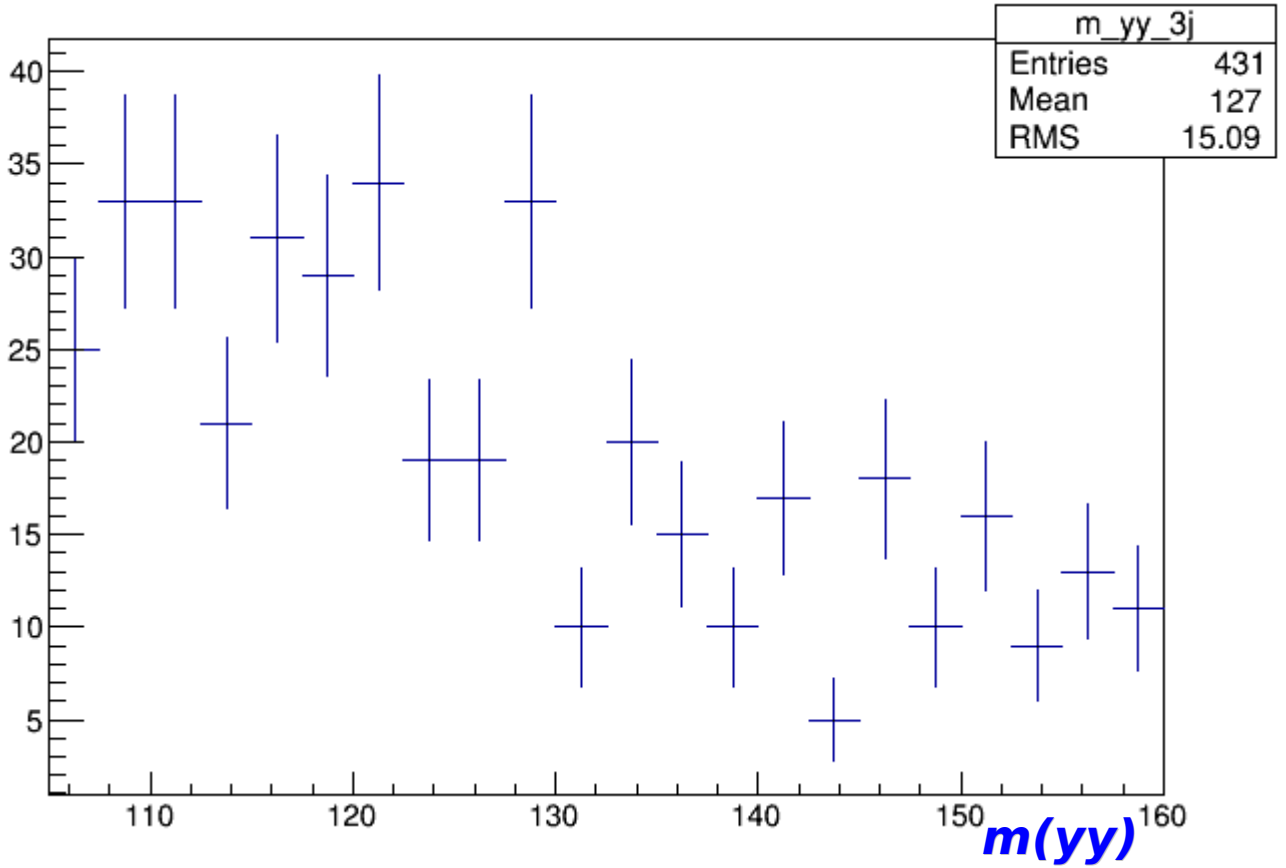
X9.83



yy + 3jet

- yy+3jet events
- Previously 46, now 431

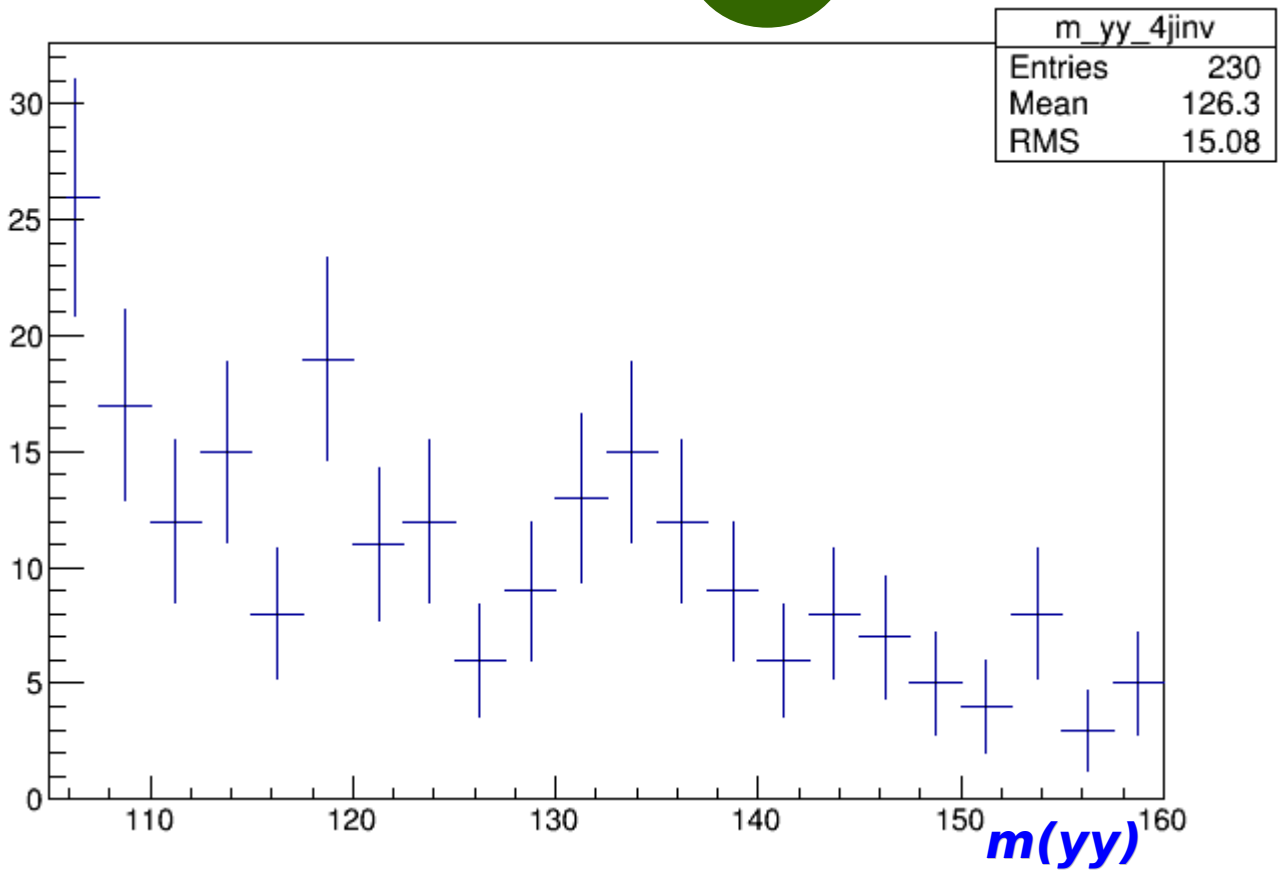
X9.37



yy + 4jet inclusively

- yy+4jet inclusively events
- Previously 27, now 230

X8.51

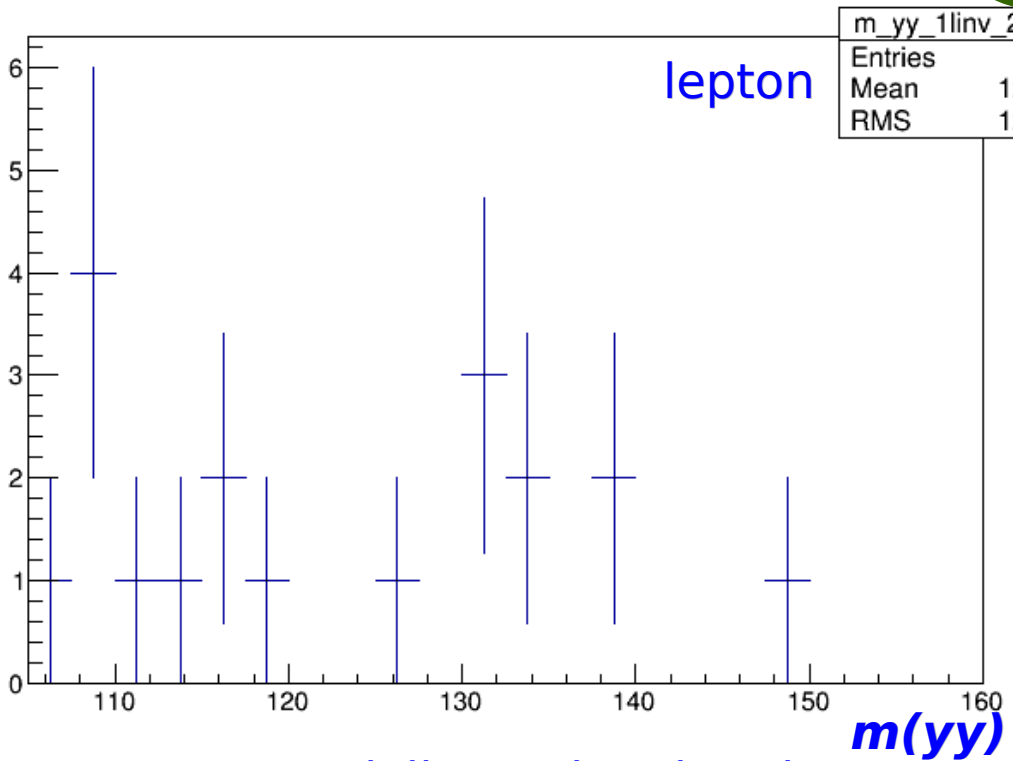


wwyy jjjj+yy signal region

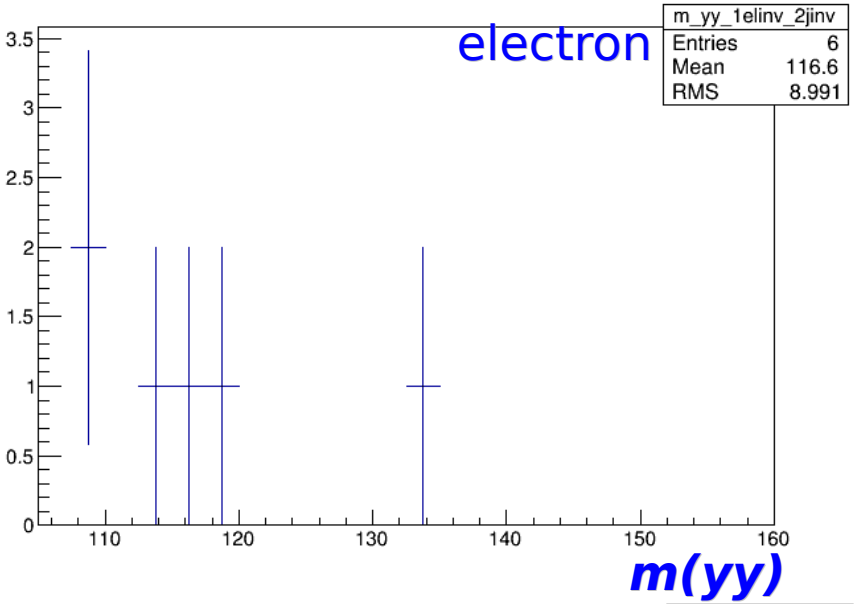
yy + 1lep + 2jet inclusively

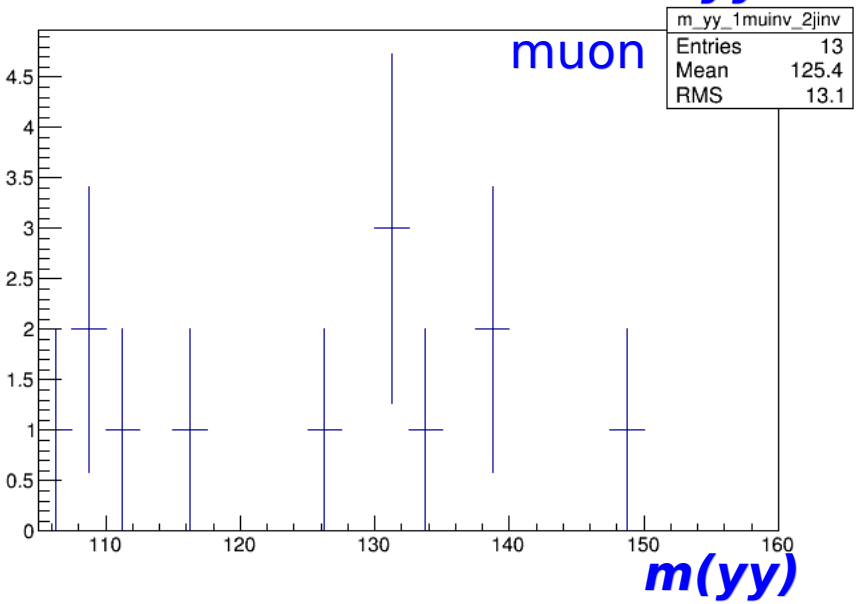
- yy+ 1lep+ 2jet inclusively events
- Previously 2, now 19

X9.5



wwyy lvjj+yy signal region



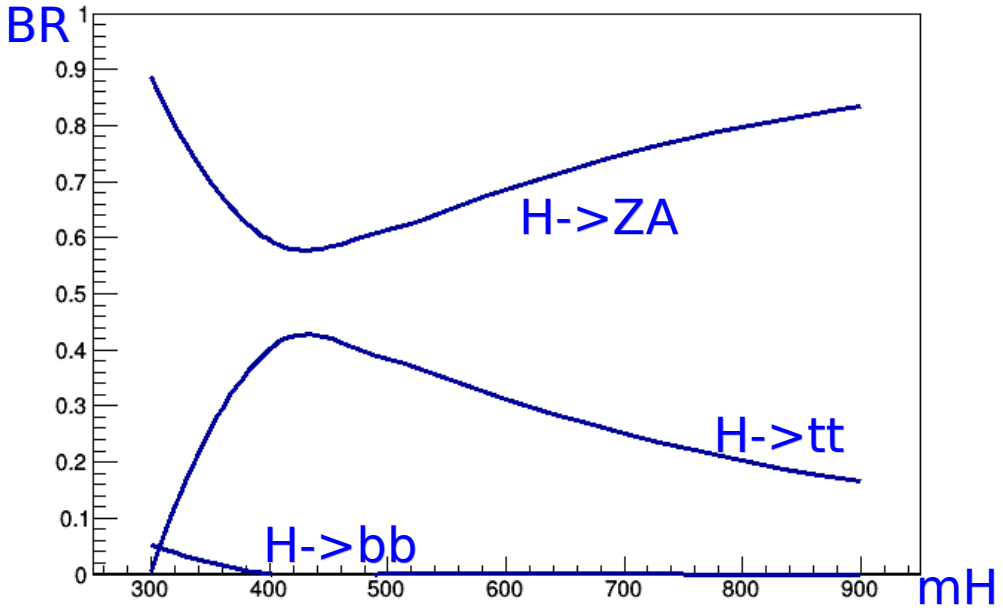


2HDM xsec calculation

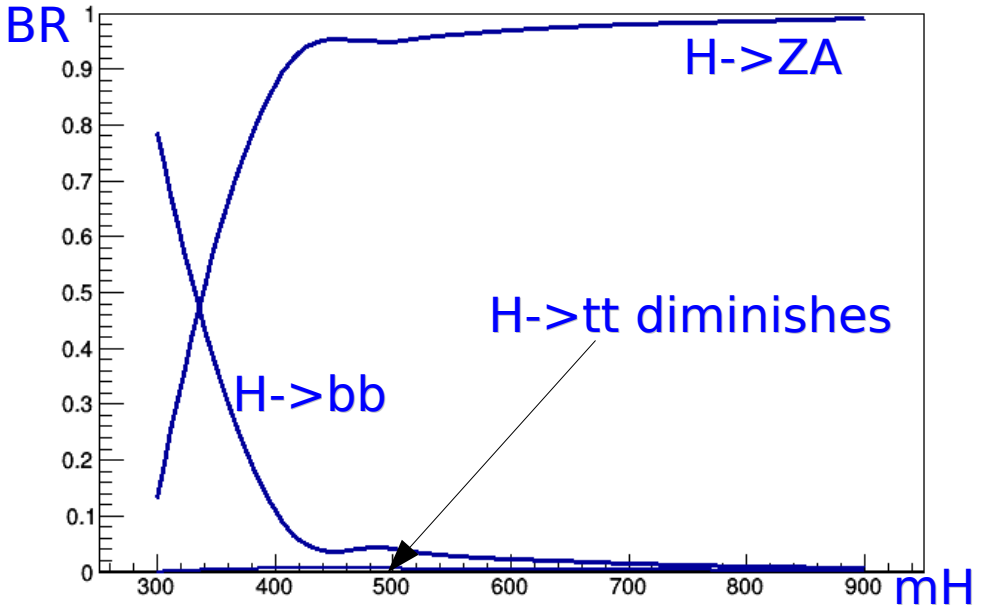
- Having produced series of 2HDM xsec for RUN I analyses, I continued to take responsibility of **2HDM ntuple production for RUN II** for both ATLAS and the LHC
- https://twiki.cern.ch/twiki/bin/viewauth/AtlasProtected/HiggsBSM2HDMRecommendations
- https://twiki.cern.ch/twiki/bin/view/LHCPhysics/LHCHXSWG2HDM
- ***13TeV Update:***
  - **SM** parameters follow latest recommendation from LHC Higgs working group: https://cds.cern.ch/record/2047636/files/LHCHXSWG-INT-2015-006.pdf
  - Latest sw versions: 2HDMC version 1.7.0, SusHi version 1.5.0
  - Latest SM WH/ZH xsec that will be rescaled to BSM
  - Latest 4FS (gb+gt interference) + 5FS matching for b-associated productions

2HDM AZH HZA (mCh=max{mA,mH})

- Type II, both close in SM alignment, different tb
- Look at ***H -> XX*** **BRs**



type II, tb=1.0 cos(b-a)=0
mA=200GeV



type II, tb=10.0 cos(b-a)=0
mA = 200GeV

$$c_{\beta-\alpha} - s_{\beta-\alpha}/t_\beta$$

coupling between A and up-type quark

cos(b-a)=0, sin(b-a)=1, coupling ~ 1/tb
low tb, high coupling, A/H->tt contributes after m(tt) threshold
high tb, low coupling A/H->tt diminishes

bak

- bak