Mono-Higgs

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USLUA Lighting Round Talks
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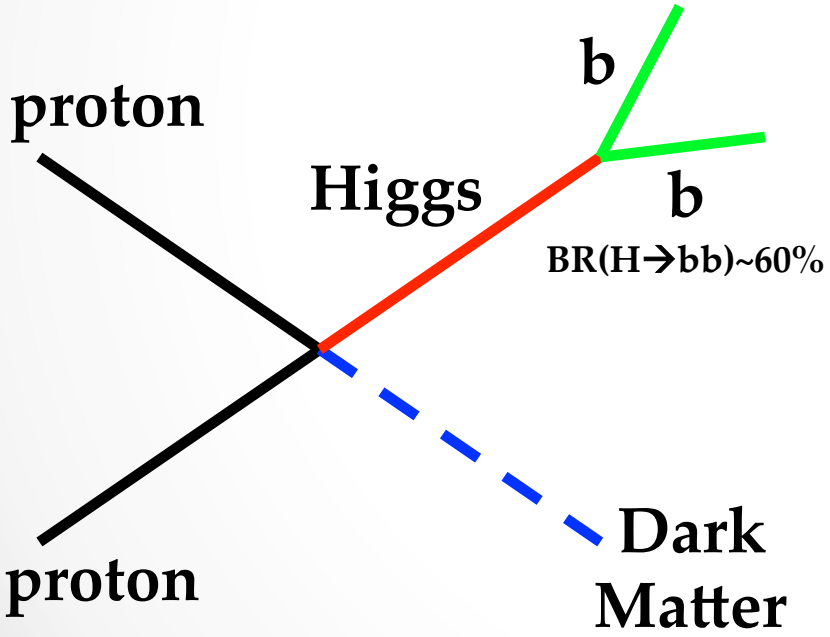
ArXiV : 1609.04572
ATLAS-CONF-2016-019

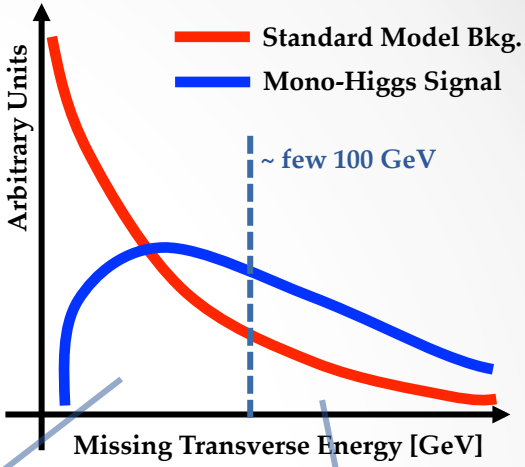
What more could you want?

- Hits 60% of the P5 "science-drivers"
  - Higgs boson as a tool / dark matter / new particles and interactions
- Leans heavily on fatjets and substructure
  - Run1 – "fringe" → Run2 – "standard recommendations"



The Search

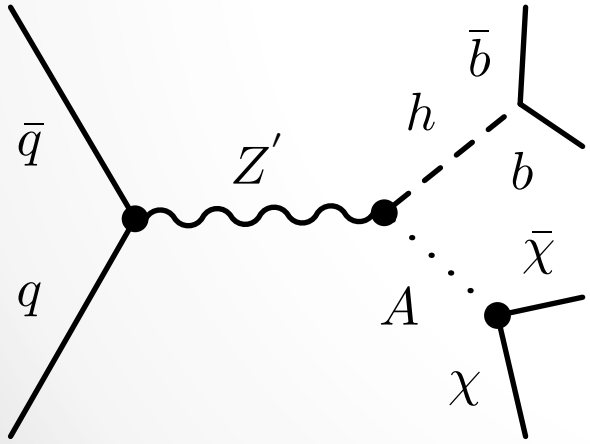
- [1] Trigger on high Missing Transverse Energy (>150 GeV)
- [2] Identify H→bb decay with jets
  - Two topologies based on hadronic final state



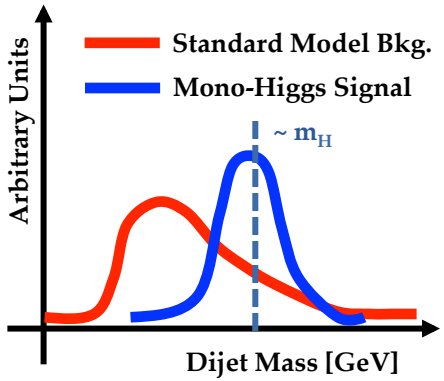
Simplified Model

ArXiv : 1402.7074

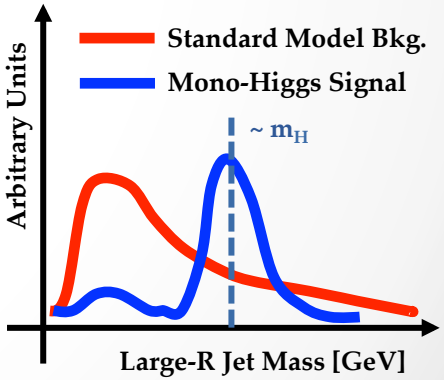
ArXiv : 1312.2592



Resolved

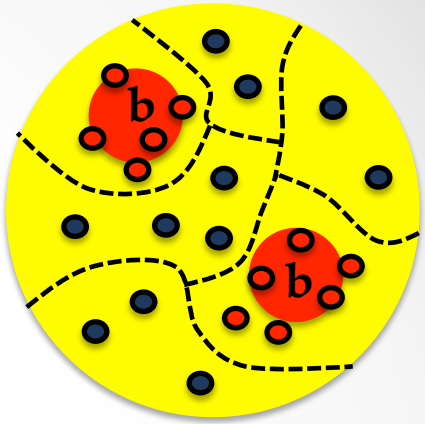


Merged

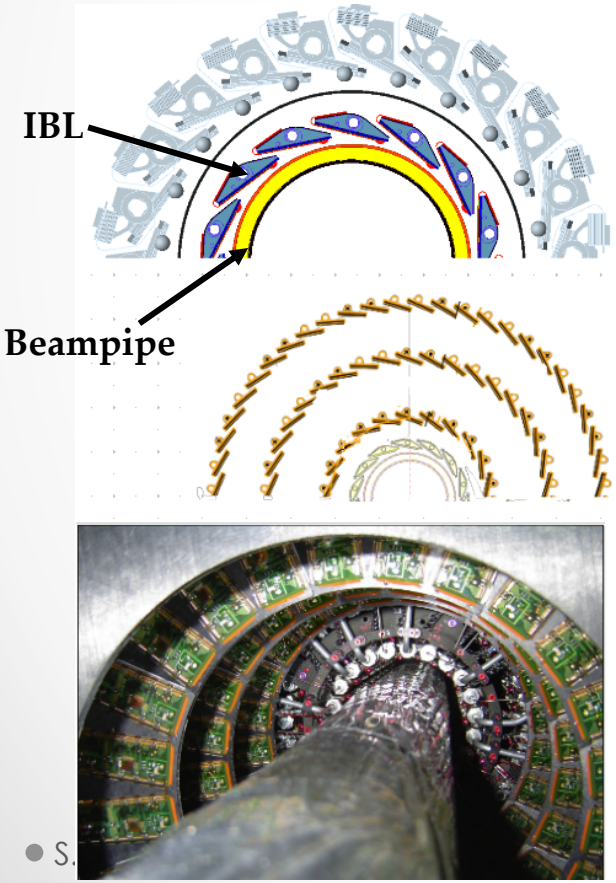


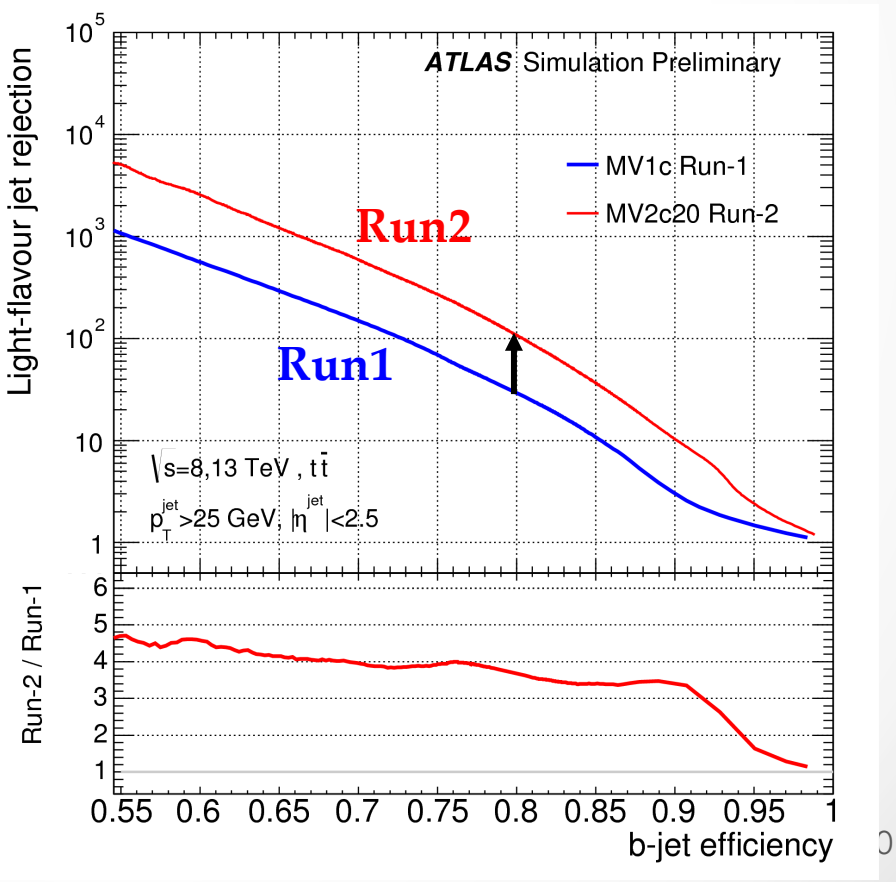
Higgs Tagging

- Higgs(bb) Tag ~ "closeby double b-tag"
- Run 2 = IBL → 400% gain in performance



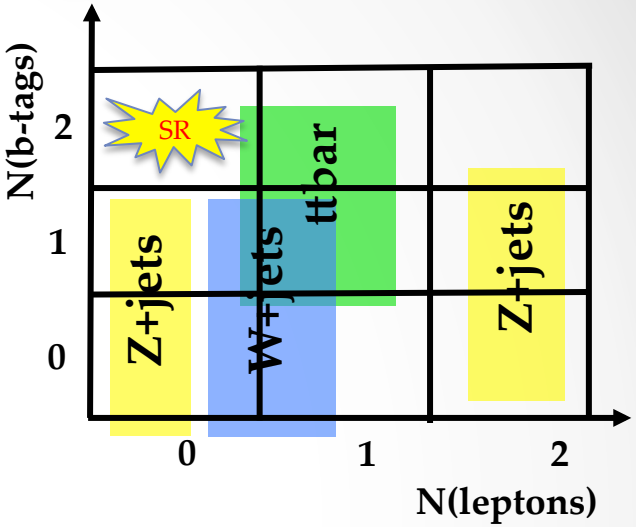
Insertible B-Layer



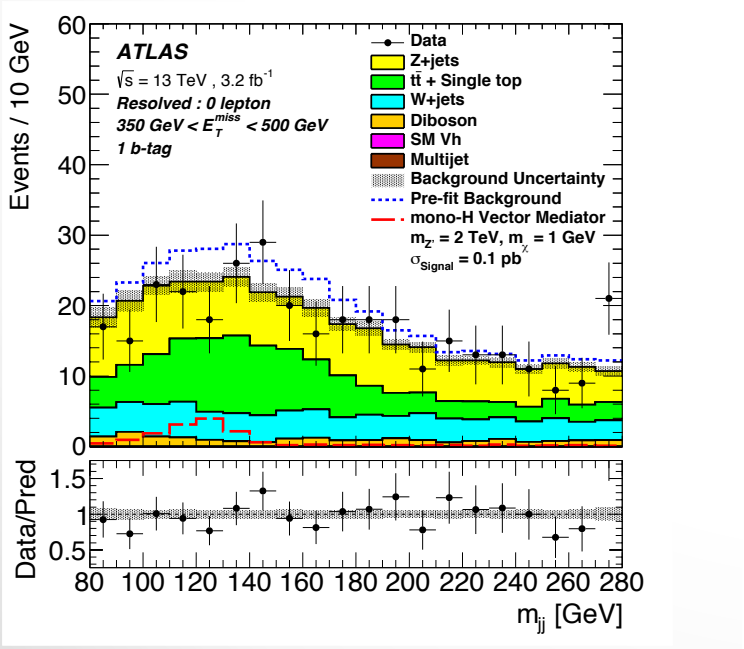


Control Those Backgrounds!

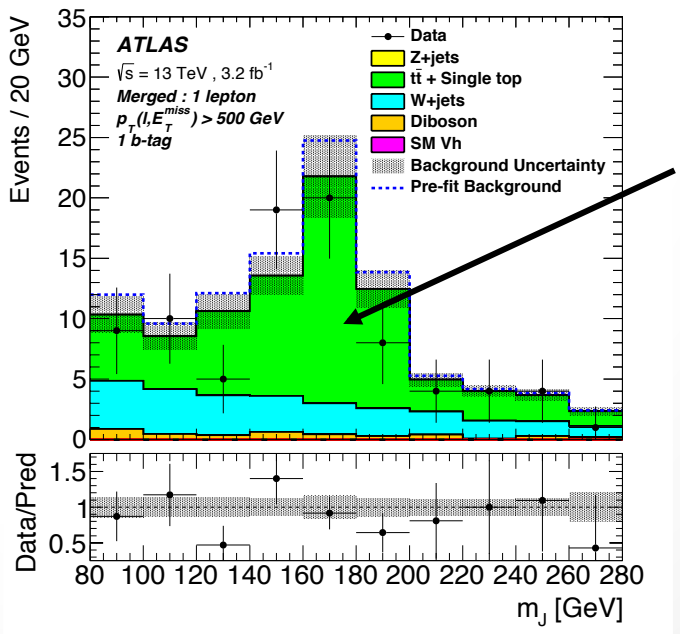
- Profile likelihood fit with all backgrounds from Monte Carlo
  - Exception = multijet (~1%) is data-driven
- Control regions used for constraints
  - Topologies → ~ pure bkg. samples
  - Kinematics → [MET, m(bb)]



Resolved (0-lepton / 1-btag)



Merged (1-lepton / 1-btag)

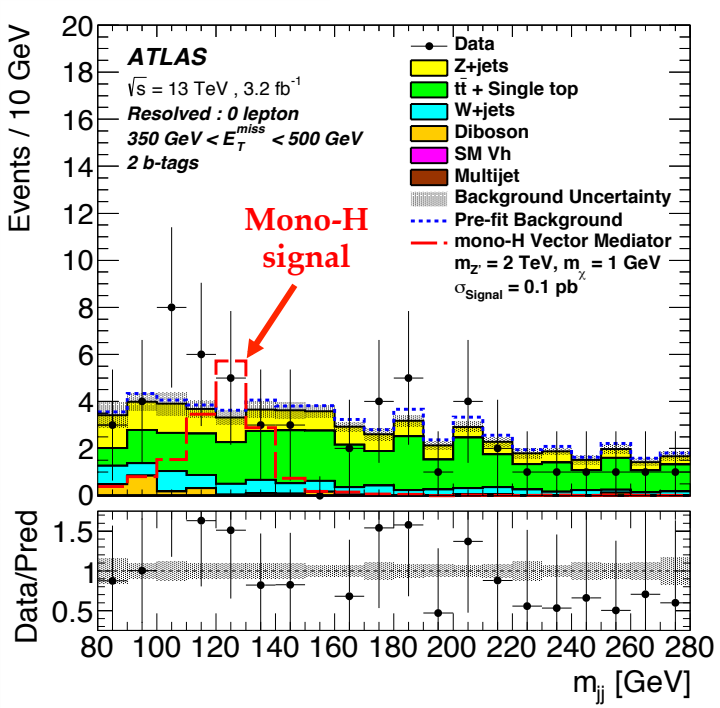


FatJets @ Work : Top-quark peak

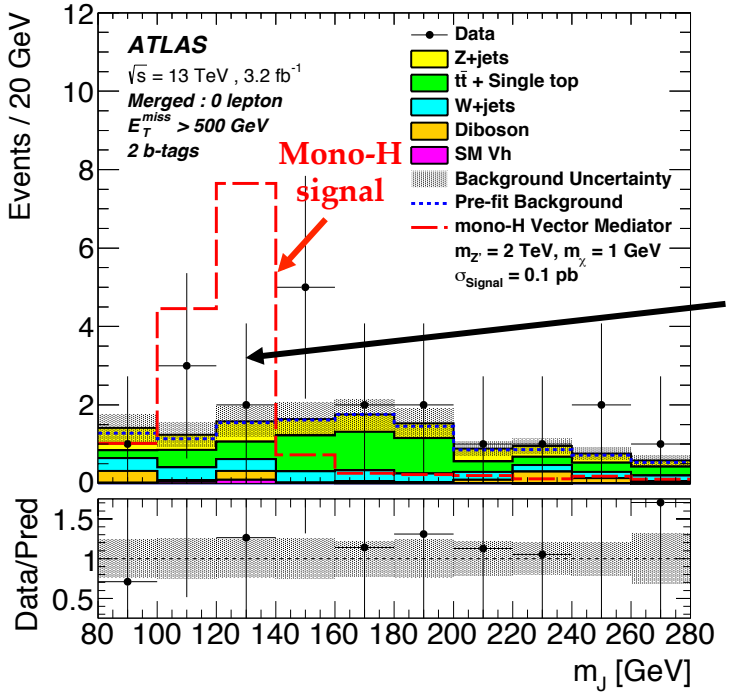
The Open Box

- No clear excess ☹ … ok, its still early days
- Main takeaway messages
  - Sensitivity statistics limited – same in 2016?
  - Merged region is key – how low can you go?

Resolved Region



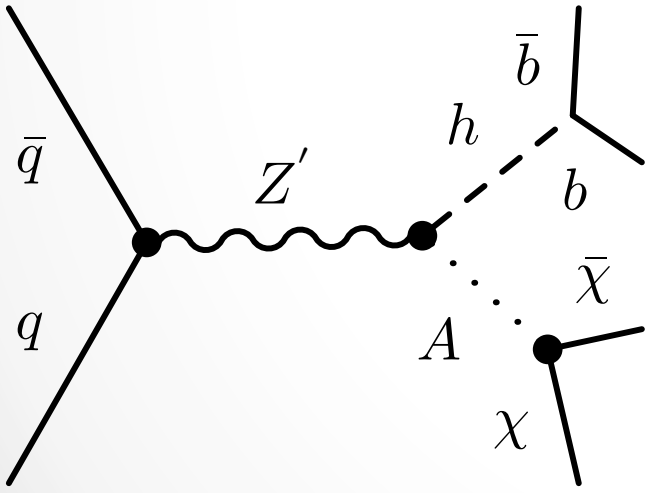
Merged Region

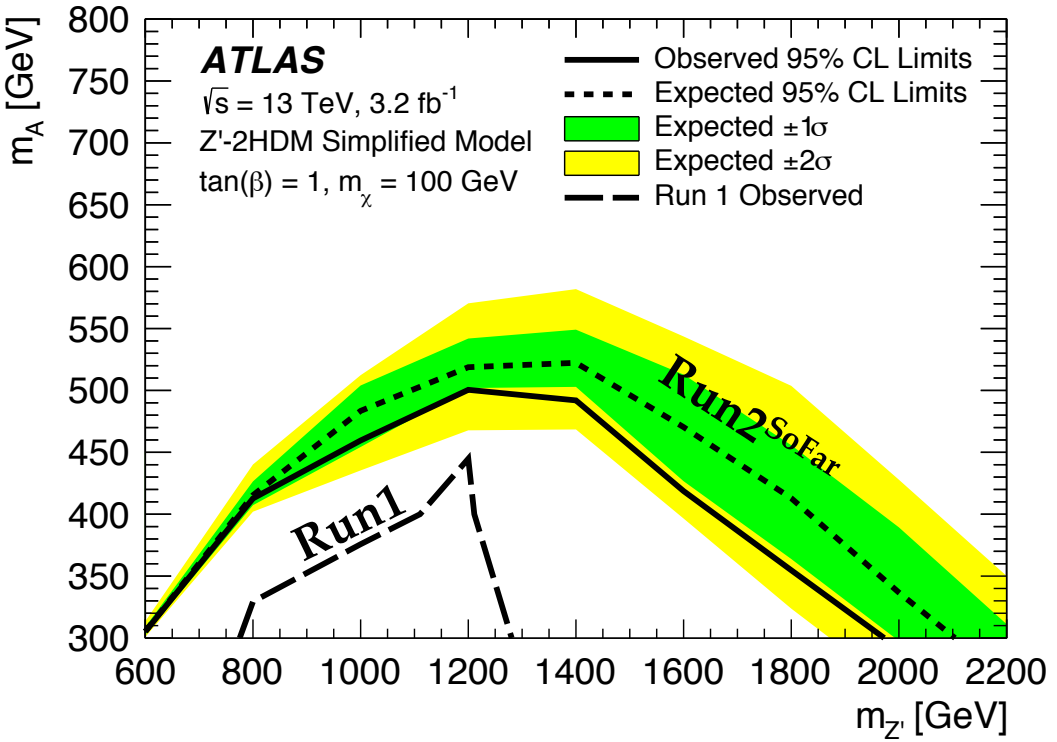


FatJets @ Work : Higher S/B than in resolved region

Interpretations

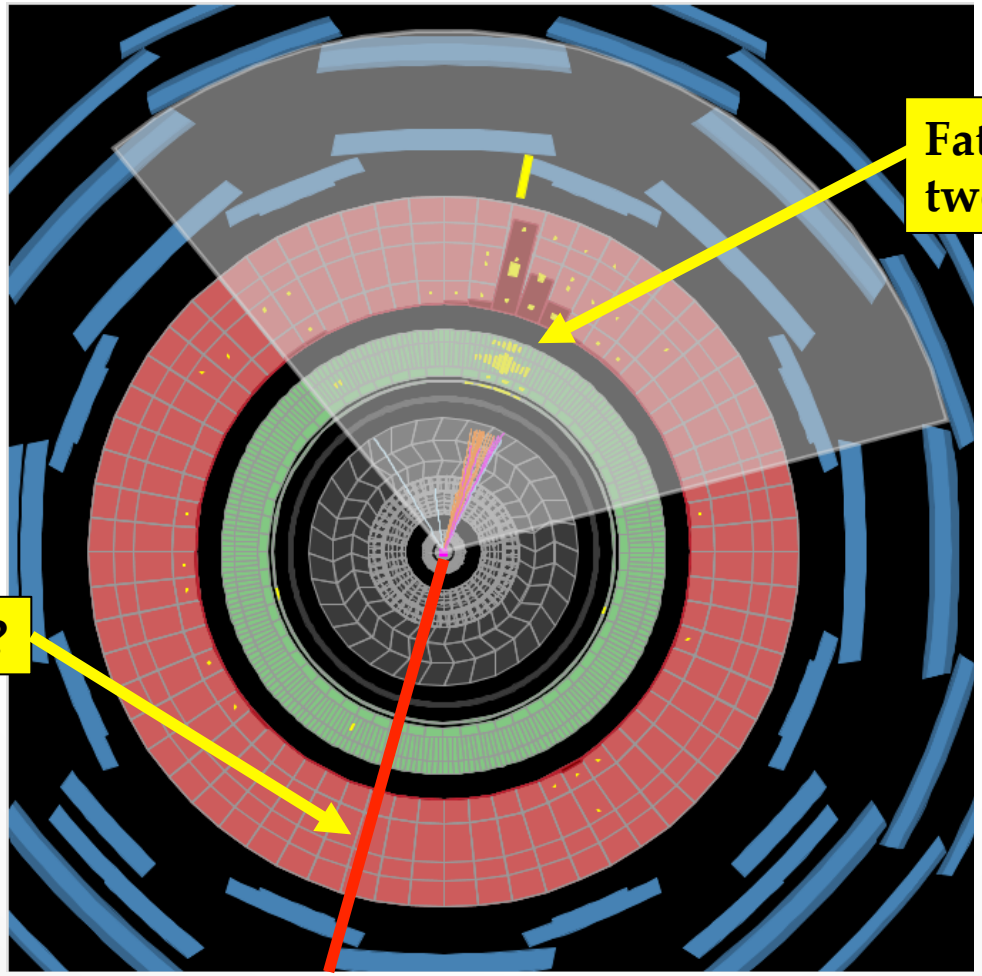
- Constraints mapped onto two simplified models
- Current big question in LHC DarkMatter-WG :
  - How does mono-H fit into the larger picture?
  - How can we best draw a coherent picture for scalar mediator?





The Future

- Full 2015/16 dataset aiming at #moriond2017
- Discussing closely with CMS team
  - Learning a lot on both sides … "teamwork makes the dreamwork"



BACKUPS

Nitty Gritty : Objects

- Electrons
  - Loose
    - ID : Loose likelihood WP
    - Iso. : loose track only
    - |eta|<2.47
    - pT>7 GeV
    - Sig(d0)>5
    - Z0*sin(Theta)<0.5 mm
    - isGoodOQ criteria
  - Signal electrons :
    - Loose
    - ++ pT>25 GeV
- Muons
  - Loose
    - ID : acceptMuon tool
    - Iso. : loose track only
    - |eta|<2.7
    - pT>7 GeV
    - Sig(d0)>3
    - Z0*sin(Theta)<0.5 mm
  - Signal electrons :
    - ++ |eta|<2.5
    - ++ pT>25 GeV

- Small-R Jets
  - Anti-kT R=0.4 EMTopo
  - pT>30 GeV if |eta|=[2.5, 4.5]
  - pT>20 GeV if |eta|<2.5
  - JVT>0.59 if pT<60 and |eta|<2.4
  - Signal jets for Higgs reco
    - ++ |eta|<2.5
    - B-tagging MV2c10 @ 70% WP
- Large-R Jets
  - Anti-kT R=1.0 LCTopo + Trimmed
  - pT>200 GeV
  - |eta|<2.0
  - Track jets
    - pT>10 GeV
    - |eta|<2.5
    - B-tagging MV2c10 @ 70% WP
- MET
  - Reconstructed with
    - Jets
    - Electrons
    - Muons
    - Photons
  - Using track soft term

Nitty Gritty : SR's

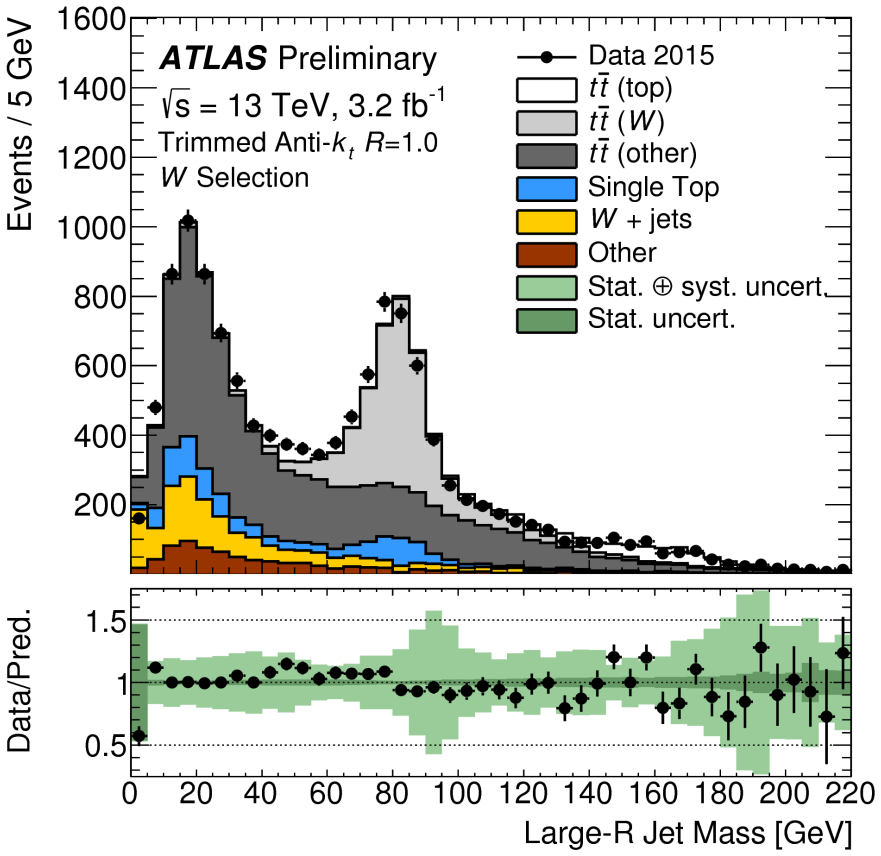
- Trigger
  - xe70 [2015]
- Lepton veto
  - N(electrons)==0, N(muons)==0
- Resolved Selection
  - MET=[150,500] GeV
  - MPT>30 GeV (not in 2 tag region)
  - Min[dPhi(MET , jets)]>20°
  - dPhi(MET,MPT)<90°
  - N(signal jets)>=2
  - pT(j0) or pT(j1) > 45 GeV
  - sum[pT(jets)]>120 (150) GeV
    - 2 jets or (3 jets)
  - dPhi(j0,j1) < 140°
  - dPhi(MET, j0+j1) > 120°
  - B-tagging division
    - based on N(b-tagged central jets)
- Merged Selections
  - MET>500 GeV
  - MPT>30 GeV (not in 2 tag region)
  - Min[dPhi(MET , jets)]>20°
  - dPhi(MET,MPT)<90°
  - N(large-R jets)>=1
  - B-tagging division
    - Based on whether 0,1,2 of the leading two track jets associated to the large-R jet is b-tagged

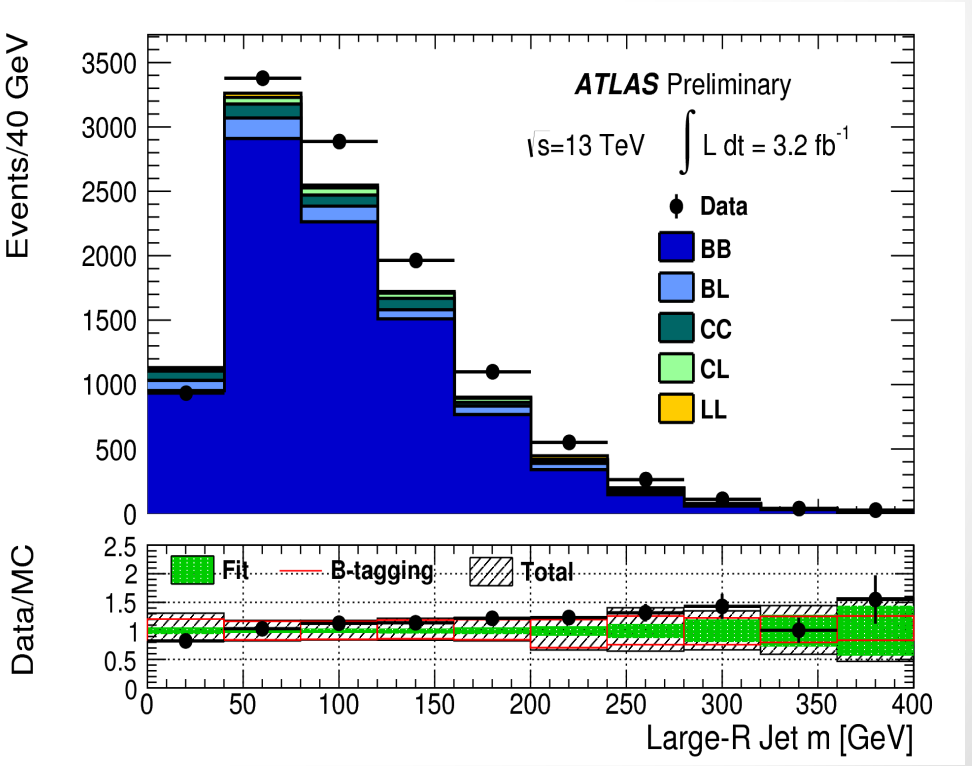
Hbb : Control Regions

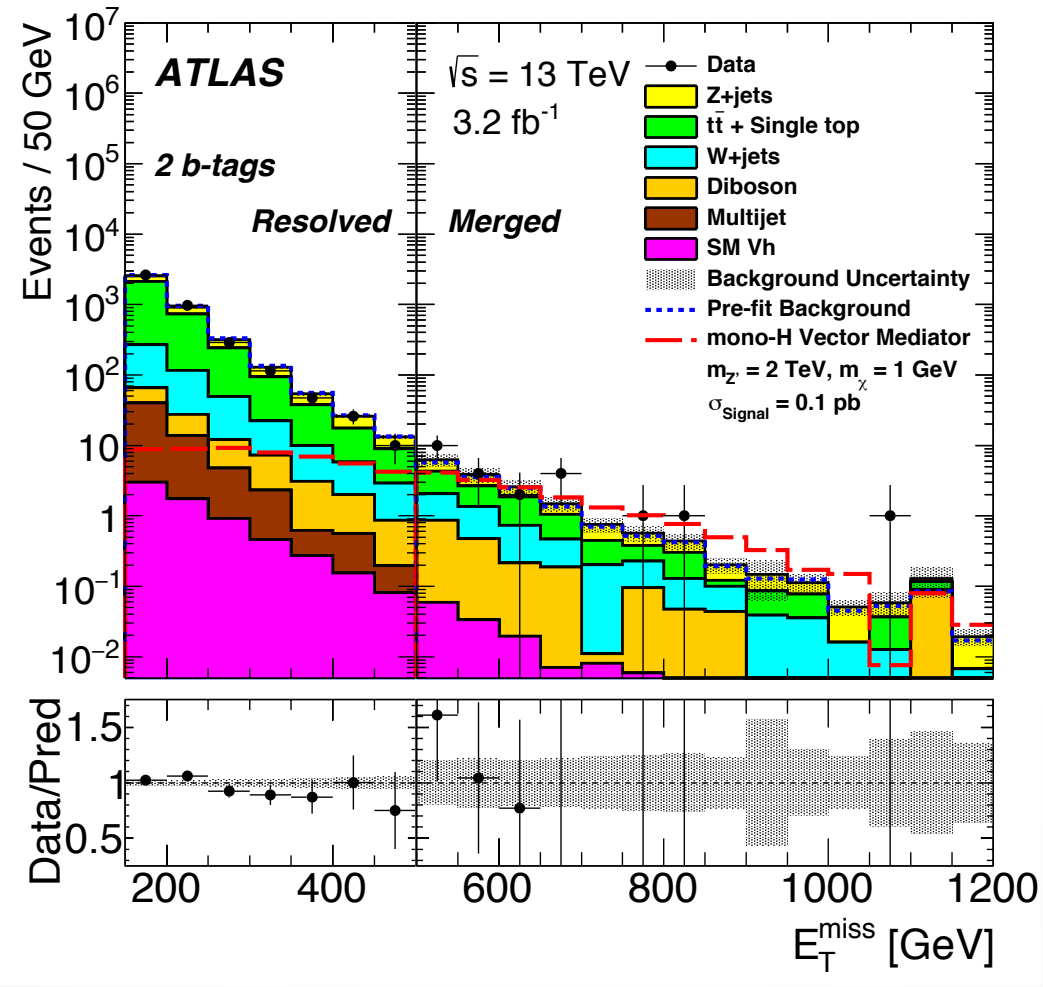
- One Lepton : W+jets and ttbar
  - Triggers : MET (same as signal region)
  - Veto on additional ***"loose"*** category electrons and muons
  - Exactly 1 ***"signal"*** muon
  - MET → pT(muon, MET) and MPT → pT(muon, MPT) for kinematic divisions
  - Same selection as signal region otherwise
- Two Lepton : Z+jets
  - Triggers : OR of the following
    - Elec : 24/60/120 mediumLH
    - Muon : 20/50
  - pT(ll)>150 GeV
  - MPT > 30 GeV
  - M(ee)=[83,99] GeV or m(mumu) = [71,106]
  - pT(j1) > 45 GeV
  - "MET significance" : MET/sqrt(sum[pt(jets)]) < 3.5

JSS Validation

- Two prong decays validated in data using W bosons from ttbar and gluon→bb topologies





The MET Spectrum

- No tail like excess here …