Search for the Higgs Boson decaying to two b-quarks, produced in association with a pair of leptonically decaying top quarks in Run 2 at ATLAS

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IOP - 22nd March 2016

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ATLAS and the LHC

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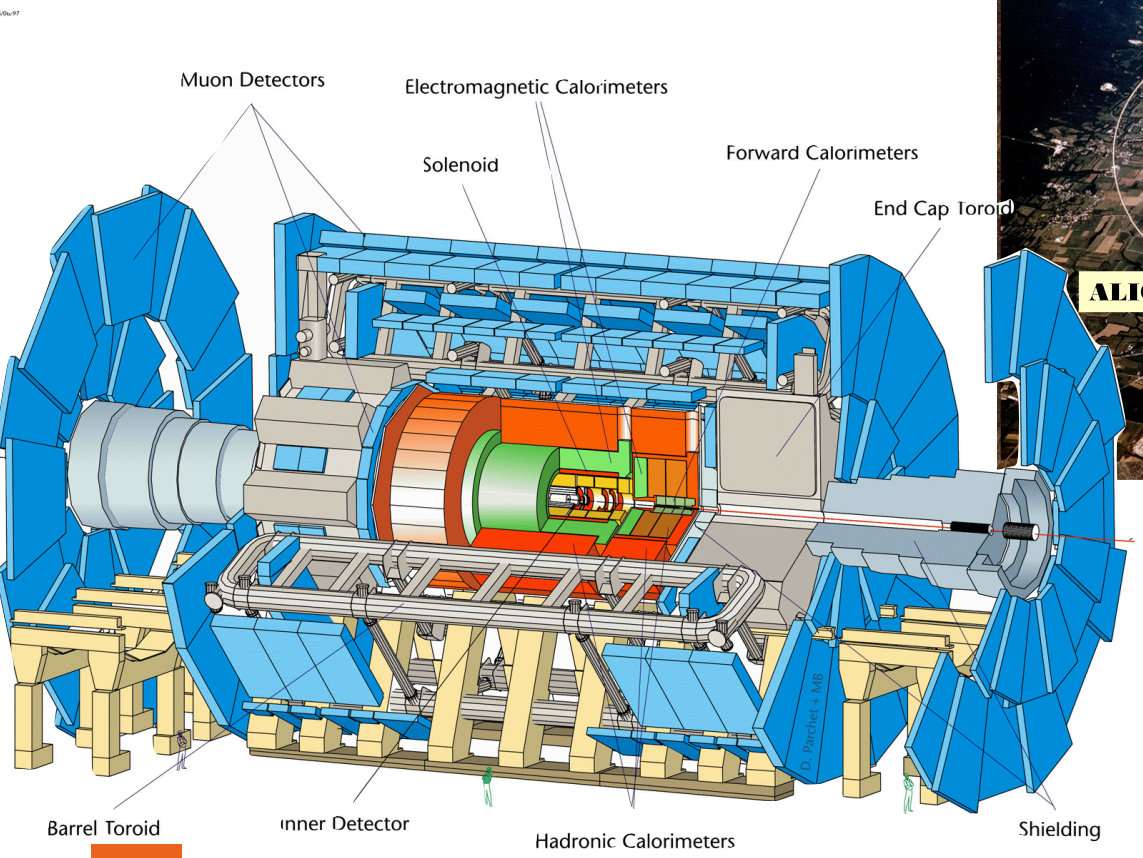

Run 2 at LHC: 8TeV -> 13TeV

~4x increase in ttH cross-section

Branching Ratios

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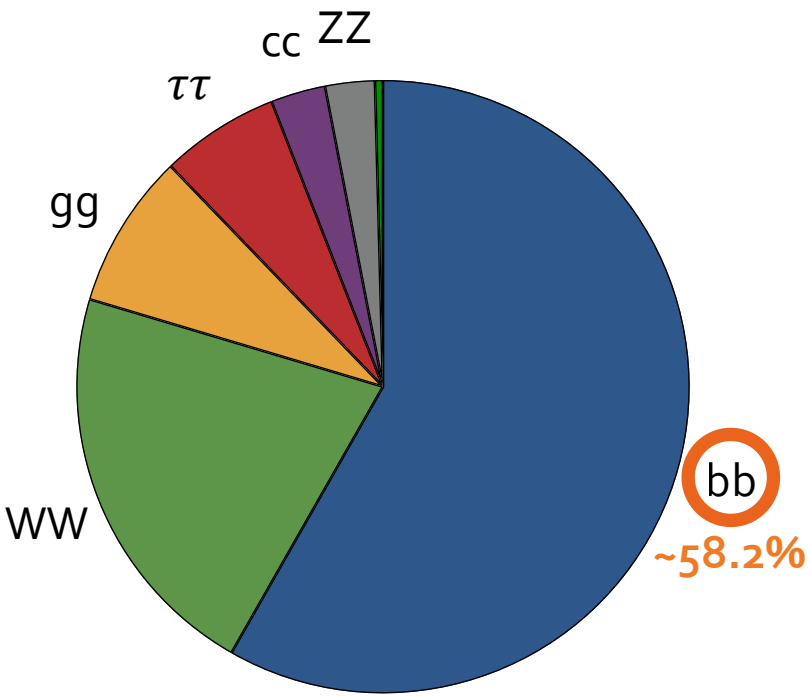
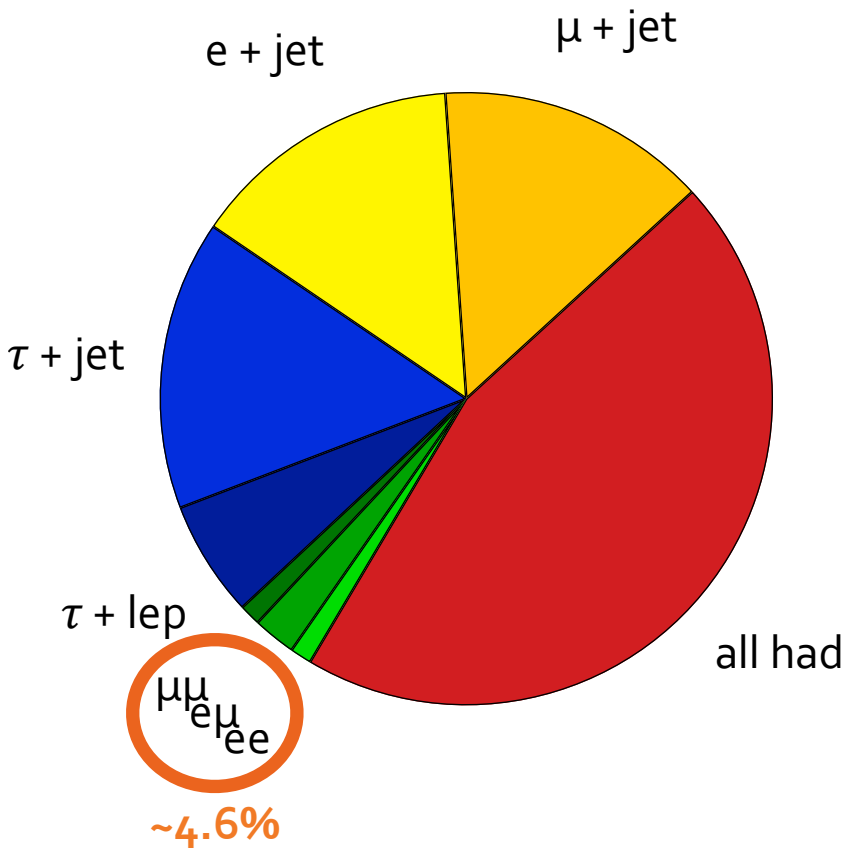
125GeV Higgs Decays

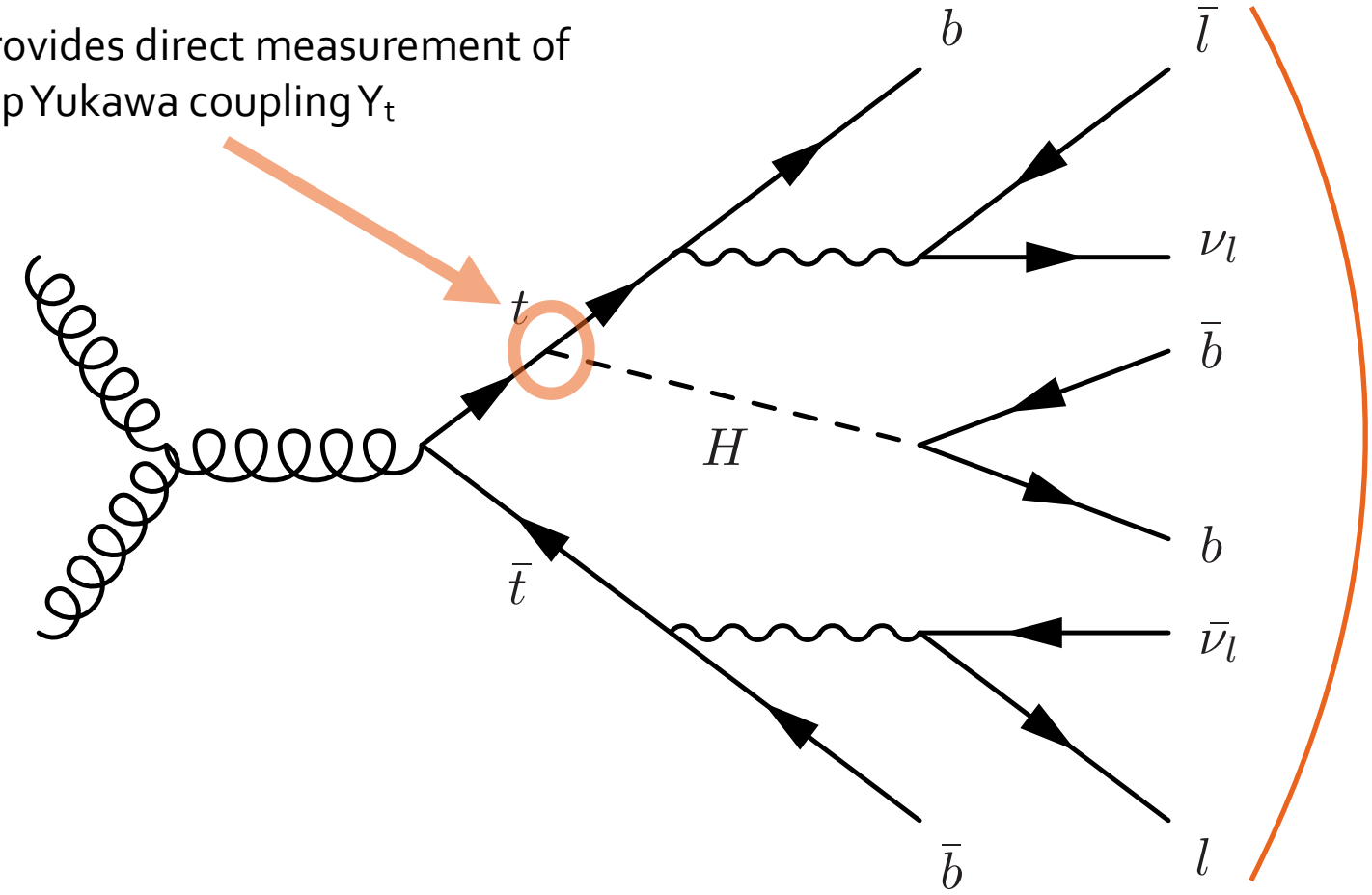


Top Pair Decays



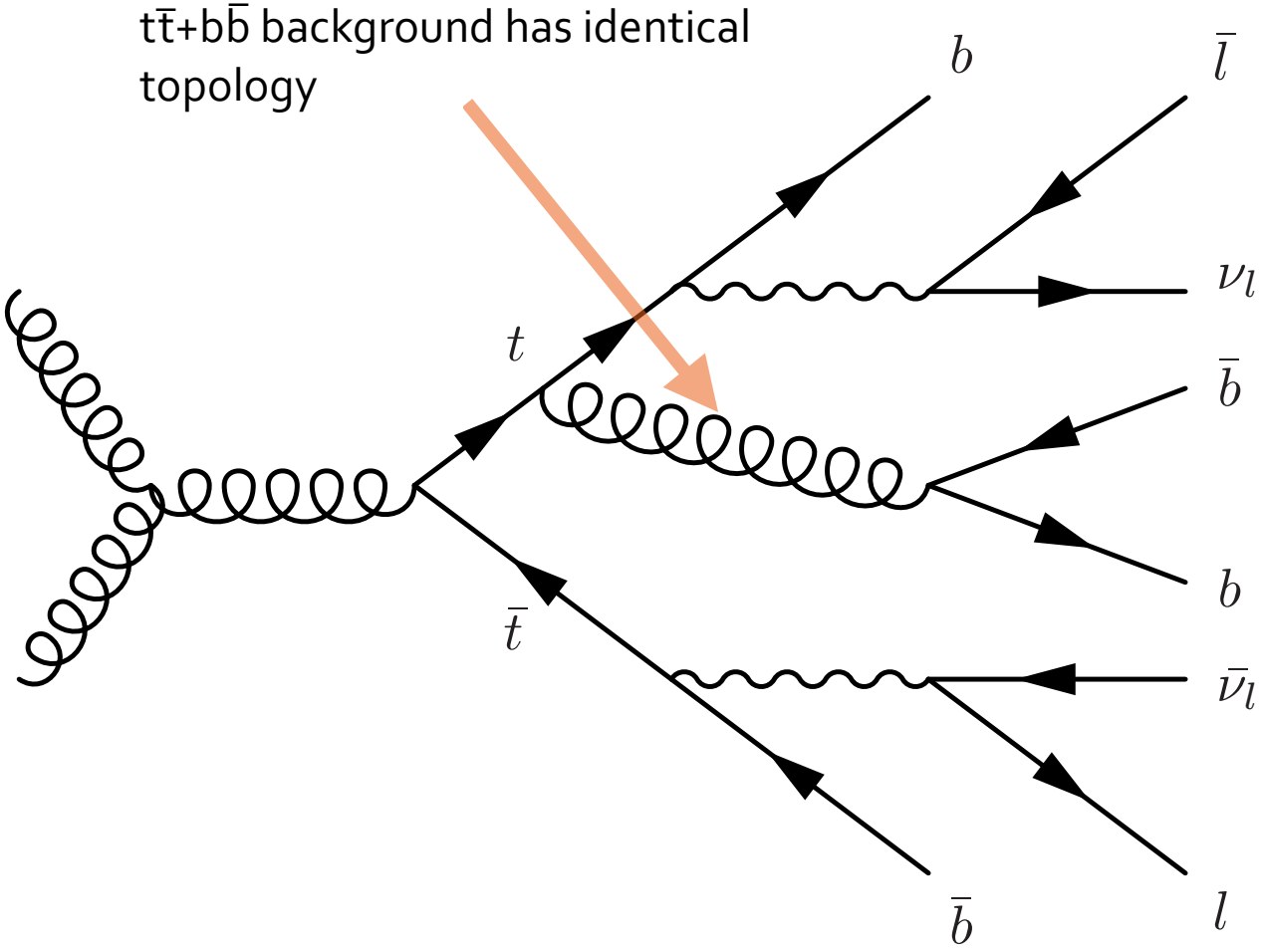
CERN Yellow Report 4

Signal Channel



Complex final state:
- 4 b-jets
- 2 leptons
- 2 neutrinos

Near Irreducible Background



Large uncertainties on heavy flavour modelling

Very large background with relatively small signal

Analysis Strategy

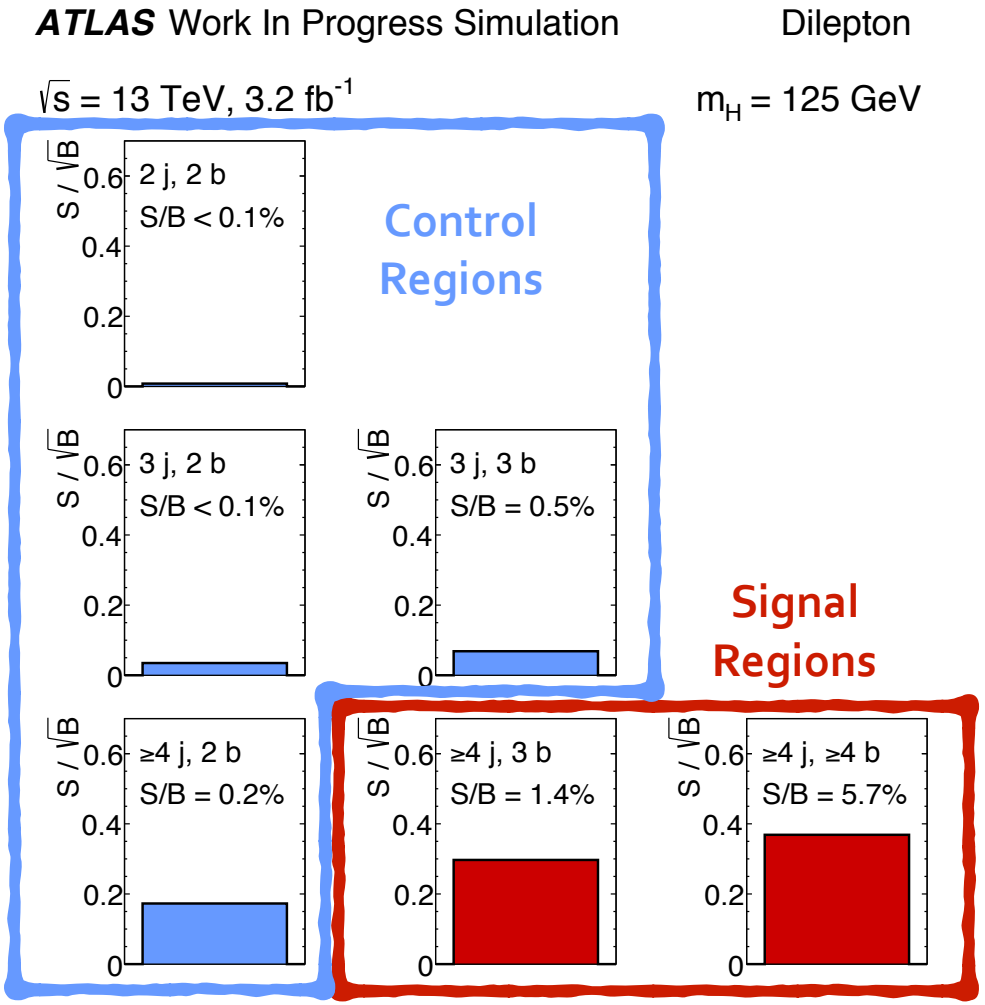
Most sensitive in high jet regions

Divide and ~~conquer~~ control - split into jet and b-jet multiplicities

Neural Networks trained in all ≥ 3 b-jet regions, H_T used elsewhere

Cross-region fit to constrain backgrounds

H_T = Scalar sum of p_T of all jets and leptons in the event



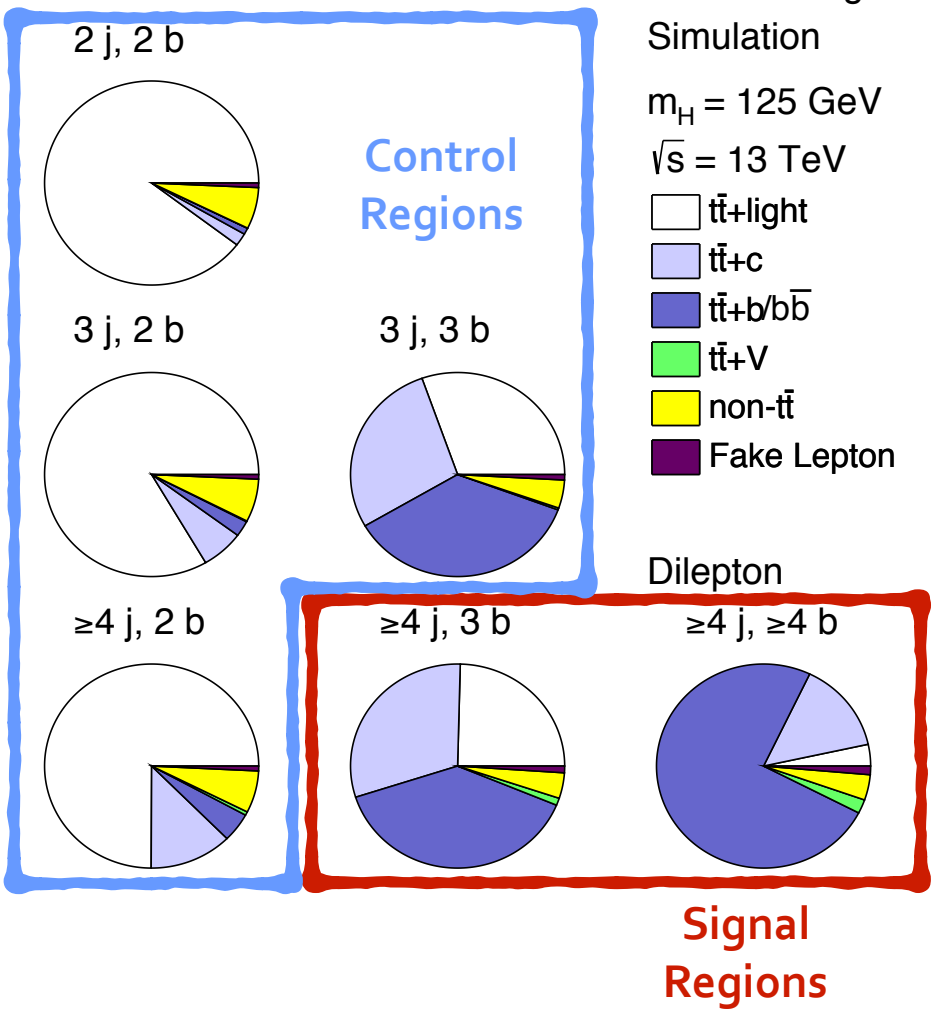
Background Composition

$t\bar{t}$ background split into additional light, c or b jet categories to constrain each cross section

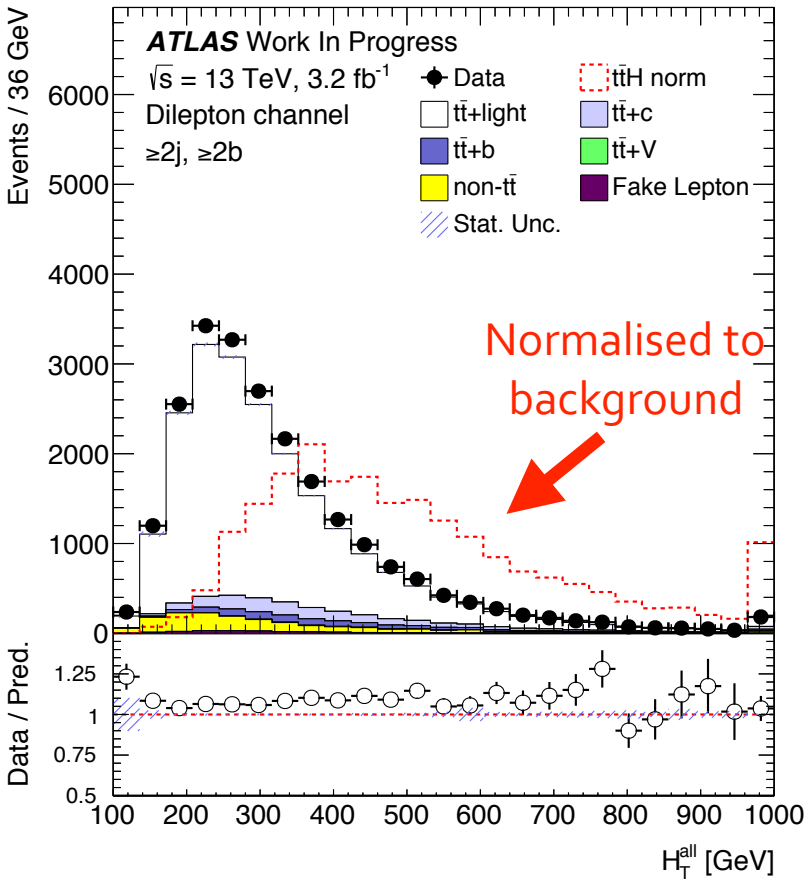
$t\bar{t}$+b/c background dominant in signal regions

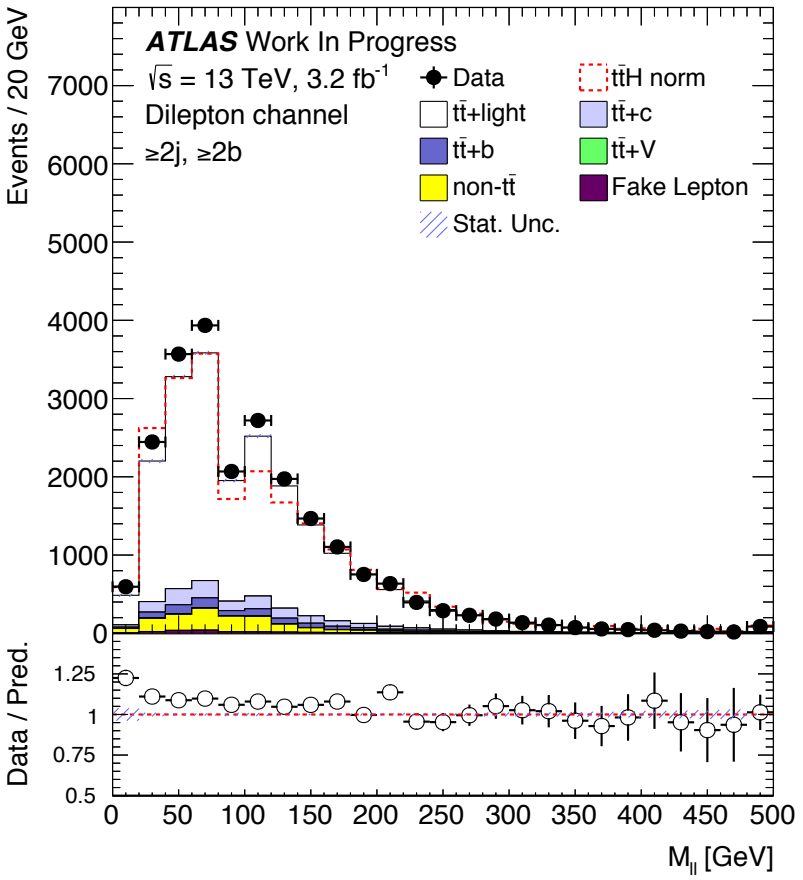
Signal and background share identical topology in this region - near irreducible

Control regions help constrain uncertainty on heavy flavour composition



Background Modelling in Control Regions

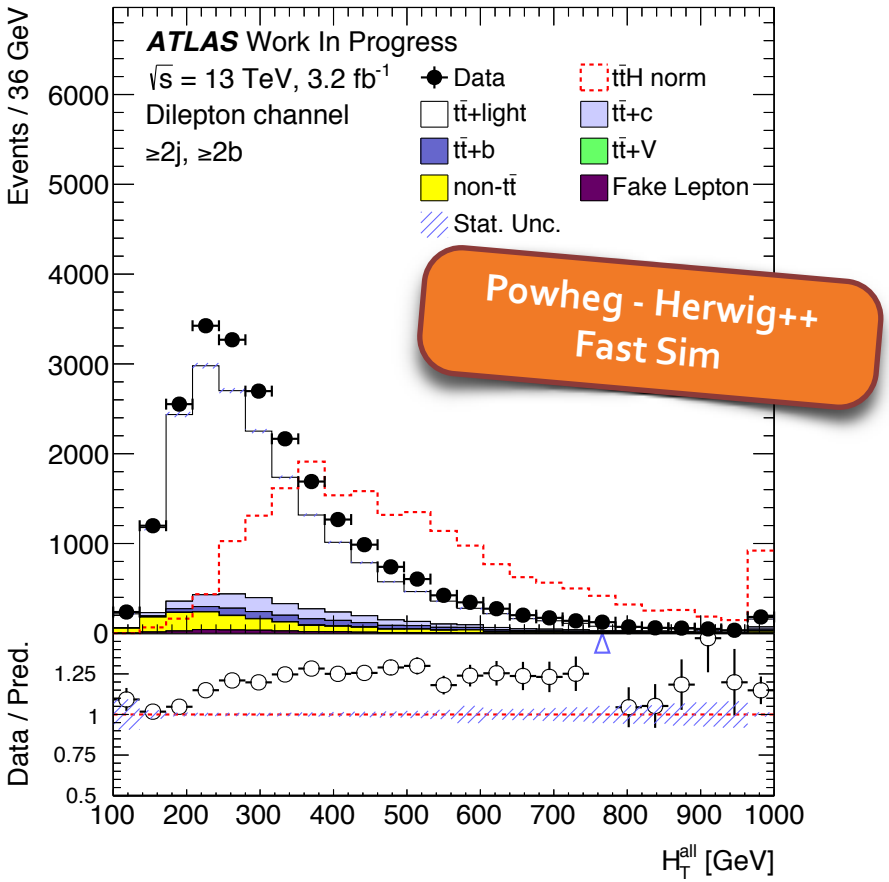


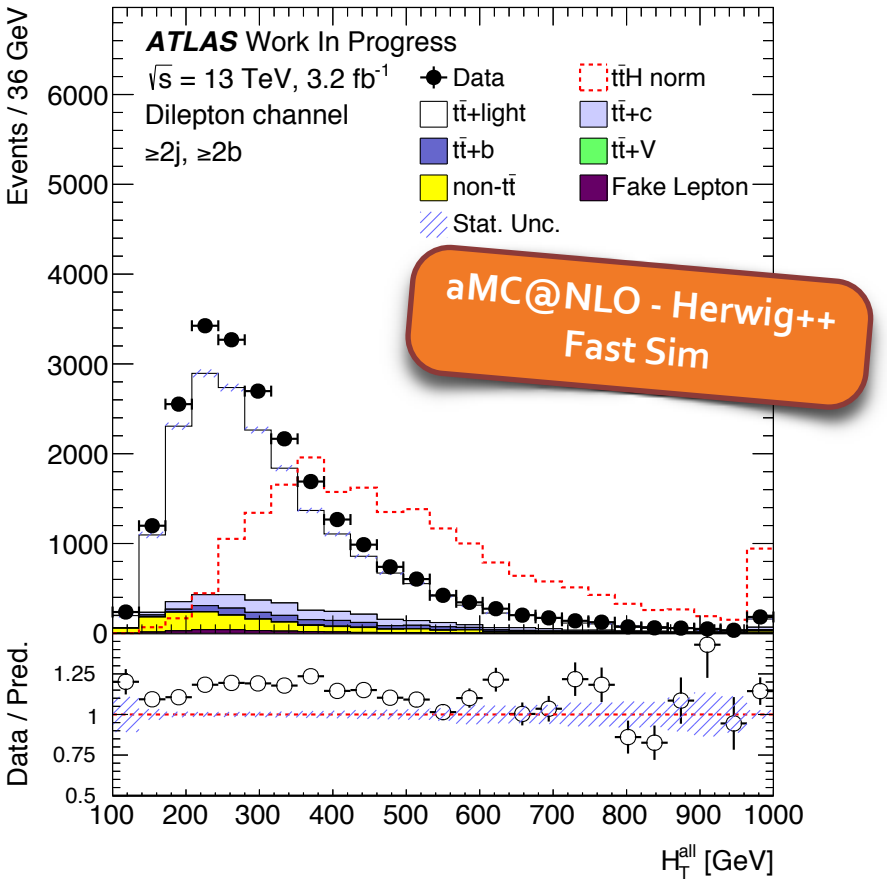


Powheg - Pythia6 is our nominal MC generator for $t\bar{t}$ events

We see very good agreement between our data and MC in control regions

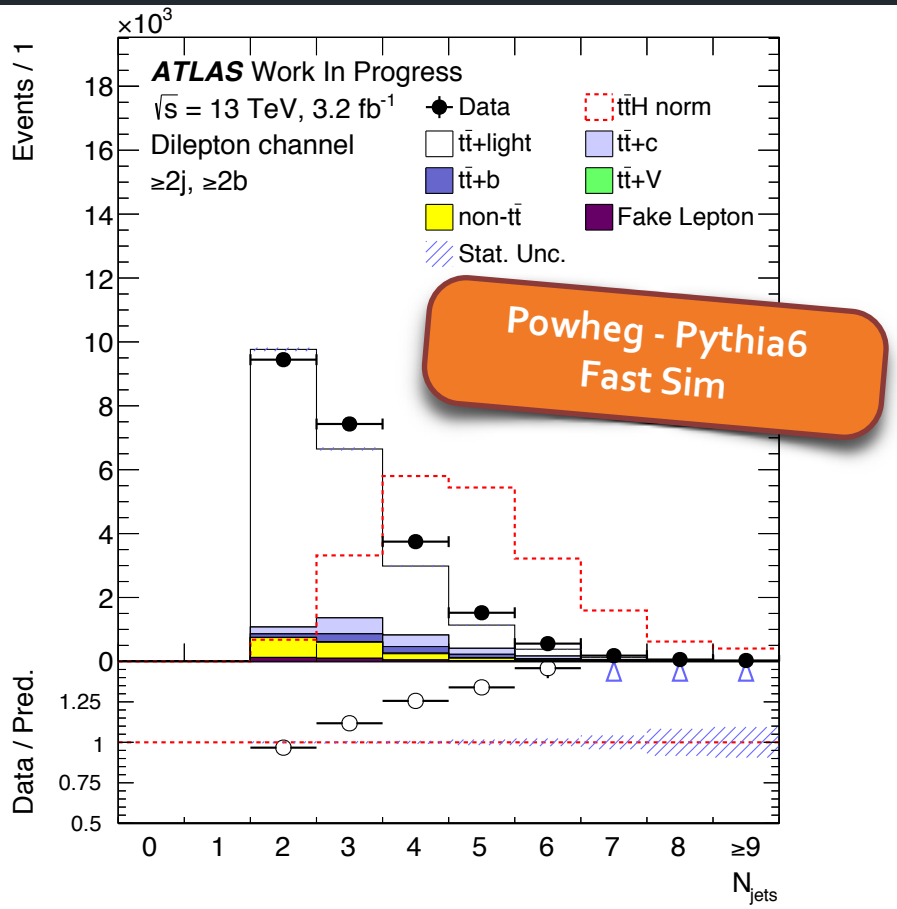
Systematic Variations - Matrix Element Variation

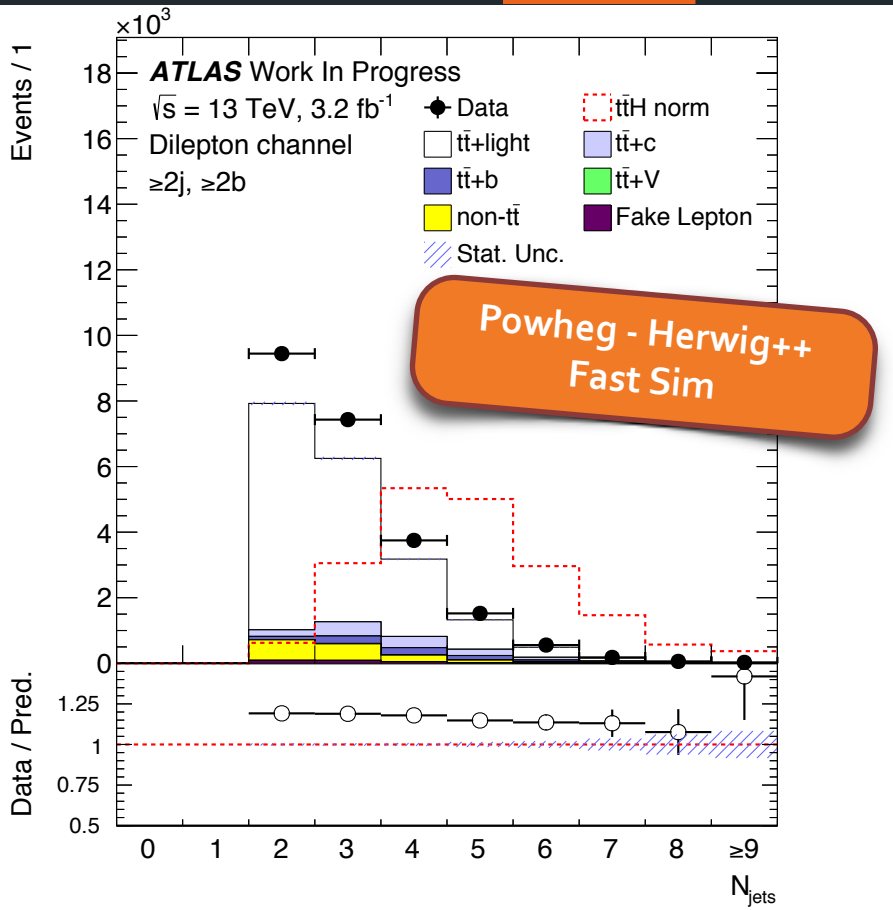




Vary the Monte Carlo generator used for the matrix element calculation

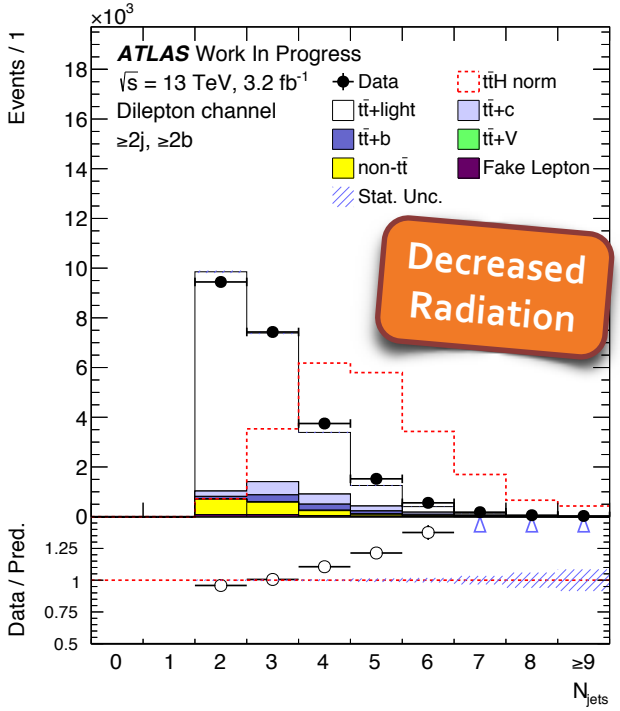
Systematic Variations - Shower Variation

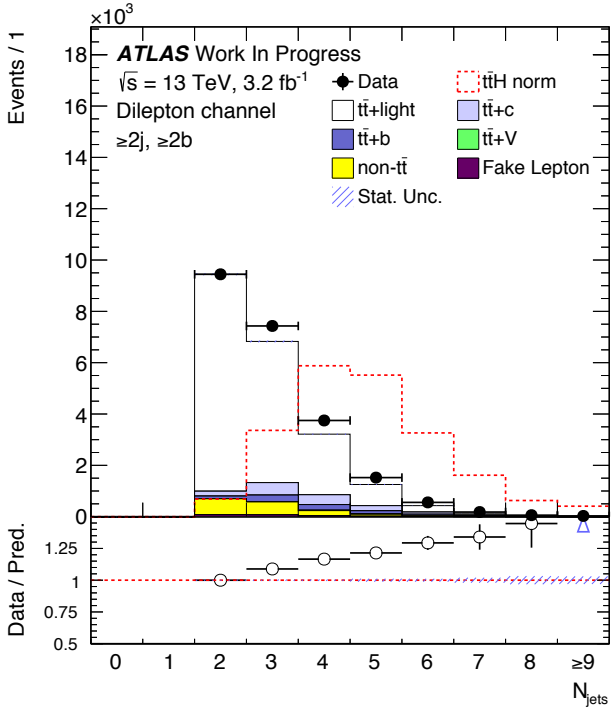


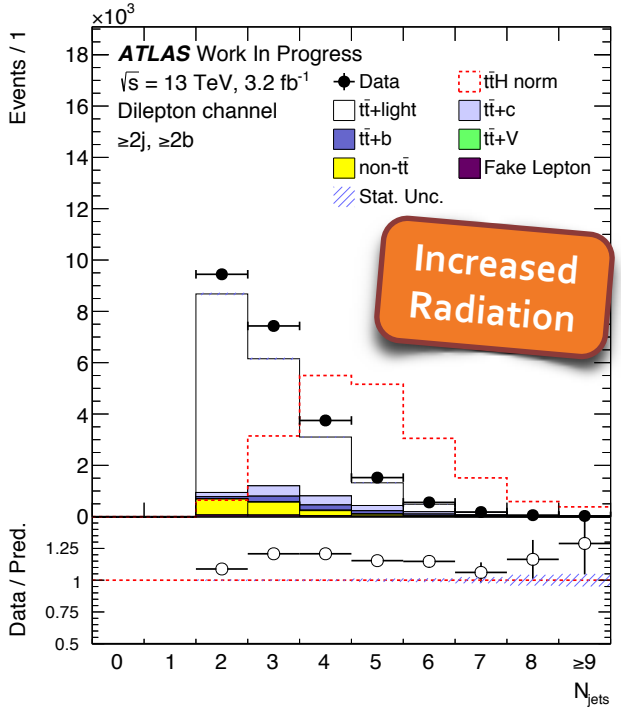


Vary the Monte Carlo generator used for the particle shower

Systematic Variations - IFSR







Vary Initial and Final State Radiation in our generator

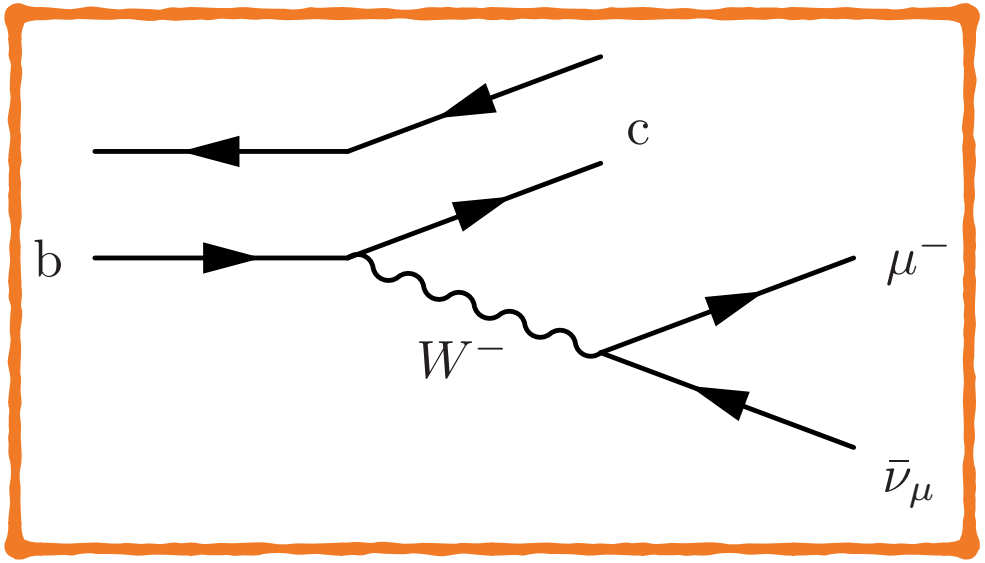
Together form an envelope around nominal sample for systematic variation

Fake Lepton Estimate - What are Fake Leptons

Lepton candidates passing our selection not from W, Z or Higgs decays

Two types:

- Non-Prompt
  - Semileptonic decays of b- and c- hadrons (e/μ)
  - Charged hadron decays (μ)
  - Photon conversions (e)



Fake Lepton Estimate - What are Fake Leptons

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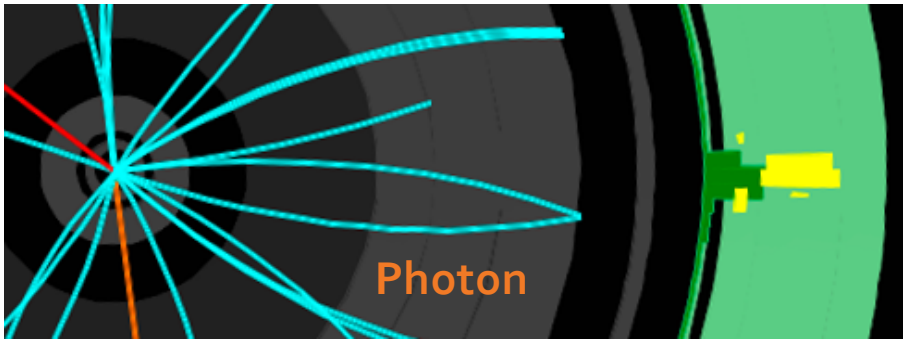
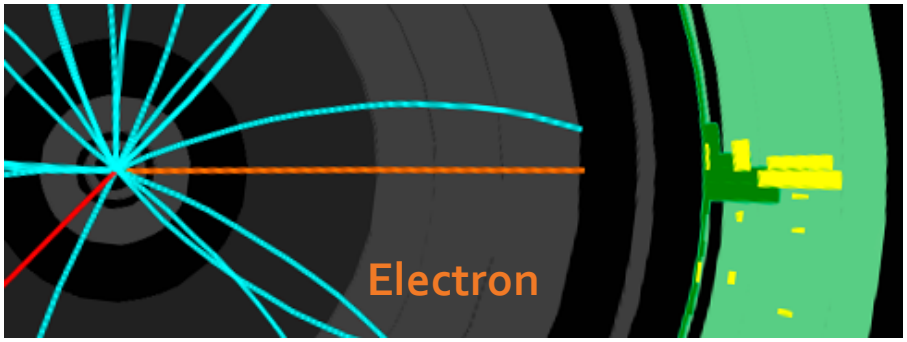
Lepton candidates passing our selection not from W, Z or Higgs decays

Two types:

- Non-Prompt
  - Semileptonic decays of b- and c- hadrons (e/μ)
  - Charged hadron decays (μ)
  - Photon conversions (e)
- Non-leptonic particles
  - Tracks overlapping photons (e)
  - Jets reconstructed as electrons (e)
  - Punch-through hadrons (μ)





Fake Lepton Estimate - How We Estimate Fakes

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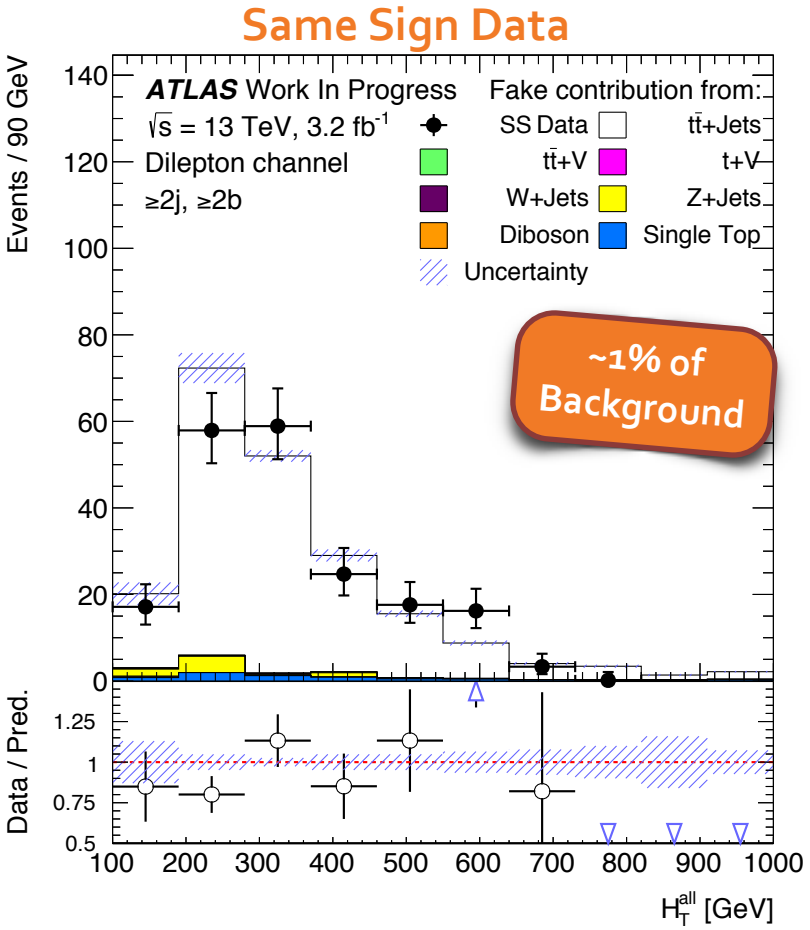
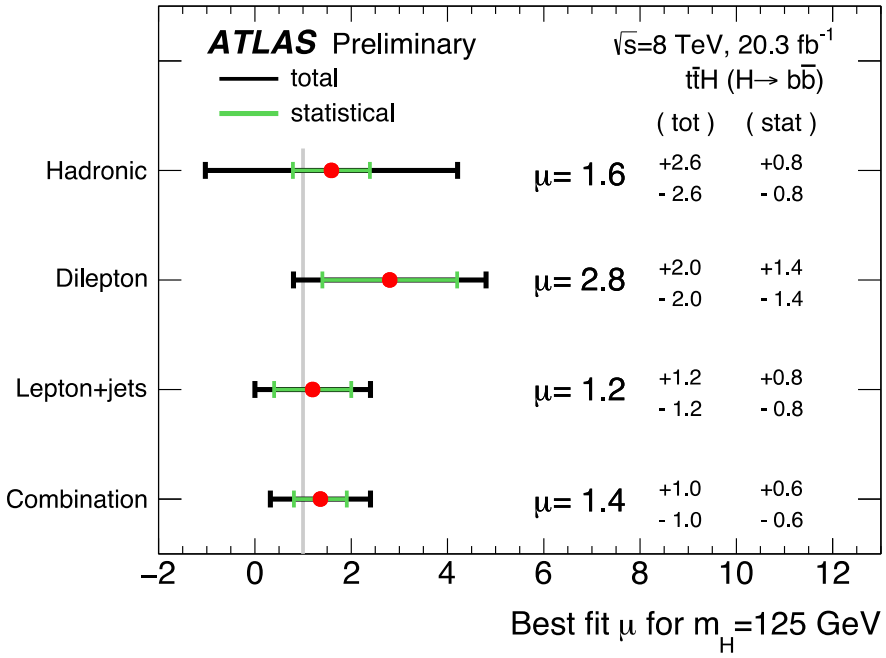
Fakes are measure differently depending on number of leptons in the final state

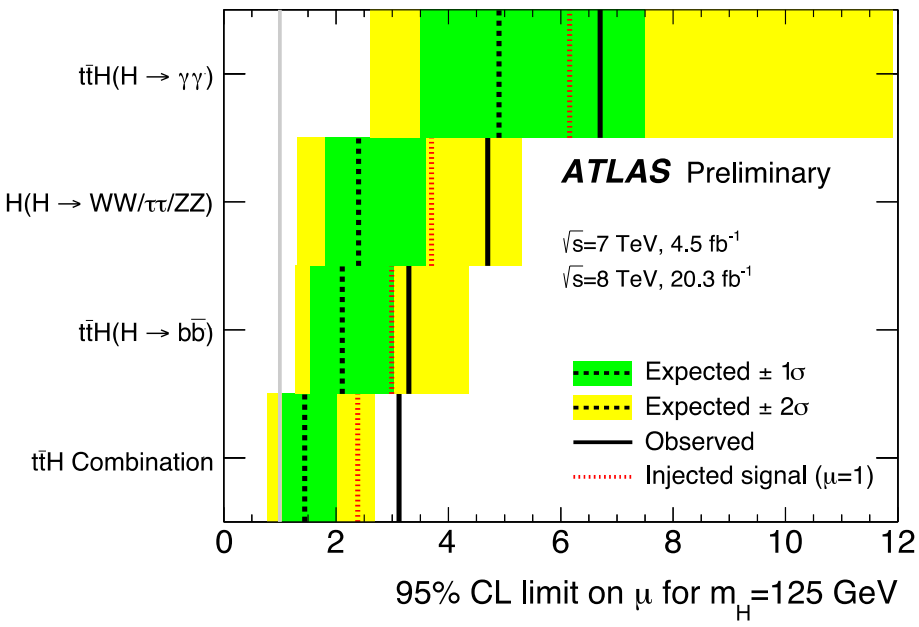
In dilepton events a Monte Carlo based fakes estimate is used:

- Lepton candidates matched to nearby truth leptons
- If event passing selection does not have two leptons matched to prompt leptons event classed as 'Fake Lepton'
- Applied for all background samples and fake only samples



Run 1 Result

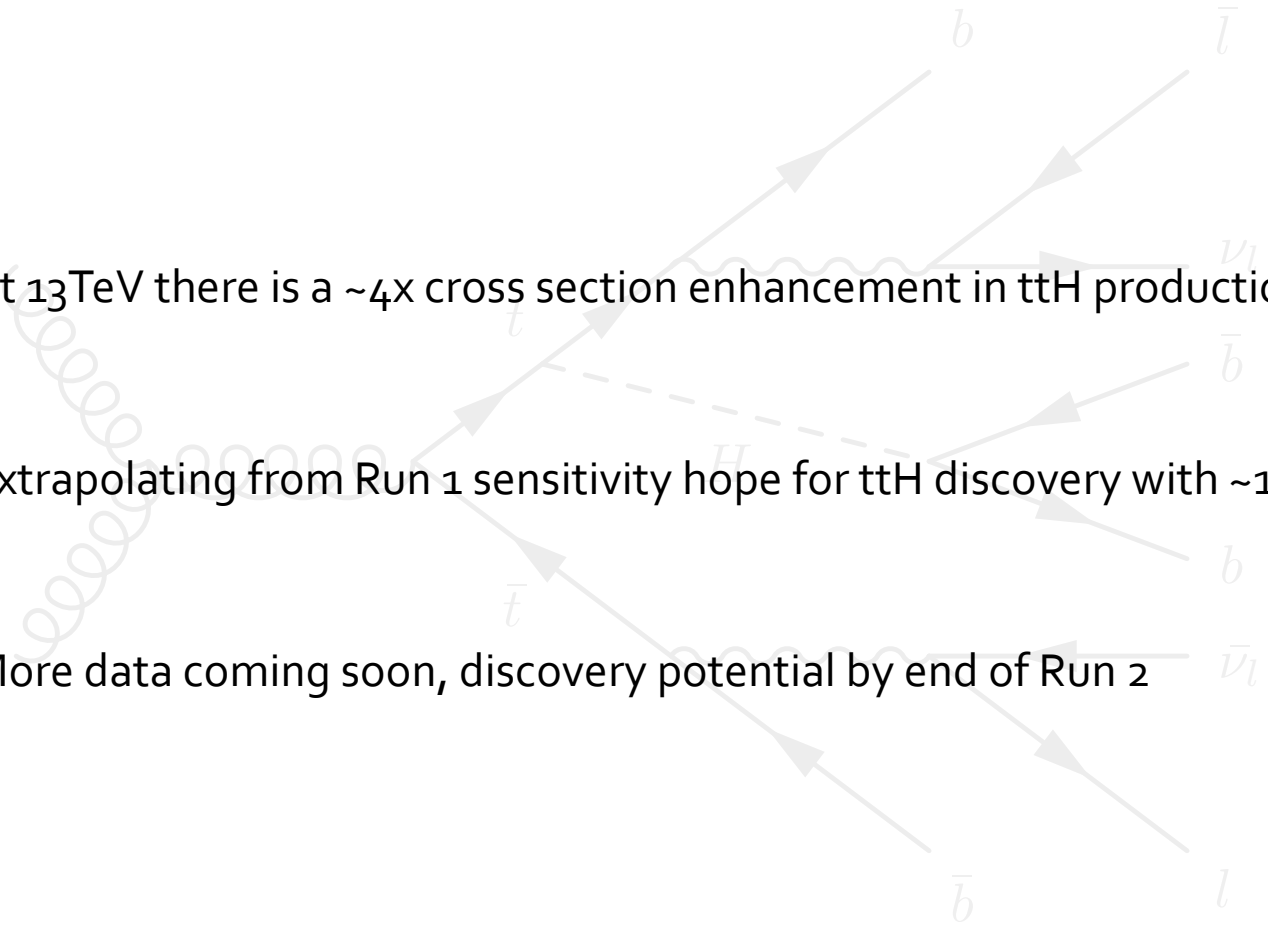




Result consistent with Standard Model

No discovery yet…

Outlook For Search



- At 13TeV there is a ~4x cross section enhancement in ttH production
- Extrapolating from Run 1 sensitivity hope for ttH discovery with ~100 fb^{-1}
- More data coming soon, discovery potential by end of Run 2

Backup