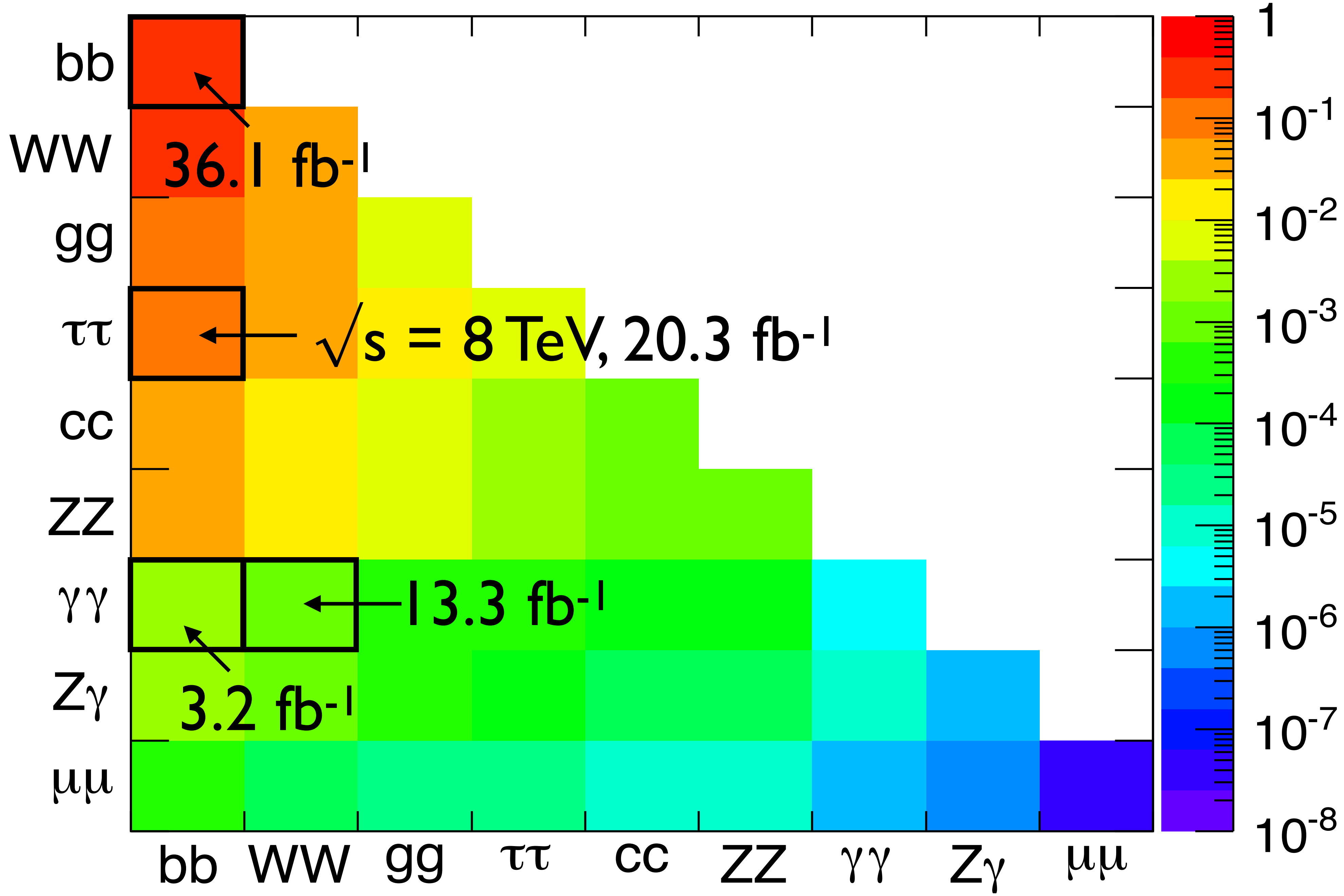
ATLAS HH Results

David Wardrope,

LHC Higgs Cross-Section Working Group Meeting,
26th March 2018

Introduction



bbbb recently updated, so will focus on that

Expect more updated results based on 2015+2016 dataset

Search for Higgs boson pairs in bbbb final state

Two complementary analyses

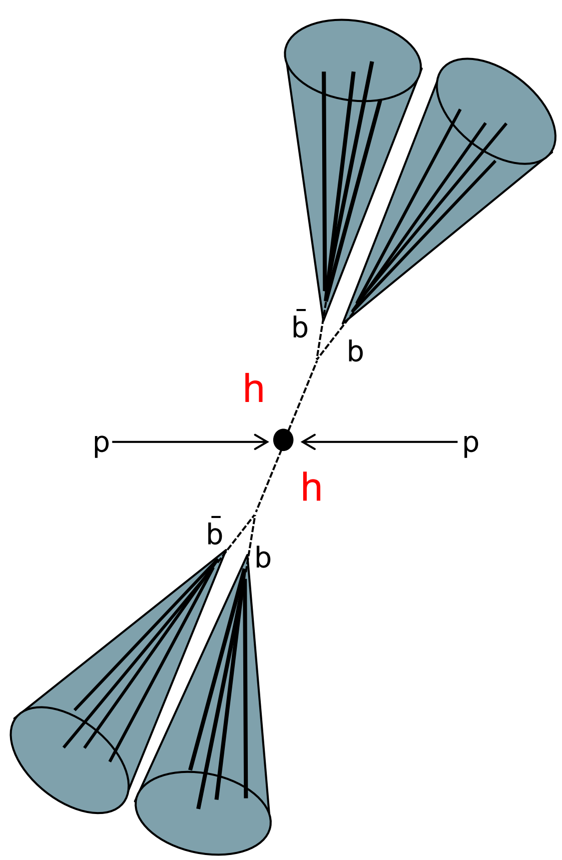
Resolved

Targets 260 GeV $\leq m_{HH} \leq$ 1500 GeV

Demands 4 b-tagged anti-k_T R=0.4 jets

$p_T > 40$ GeV, $|\eta| < 2.5$, $\varepsilon_b = 70\%$ W.P.

Combination of b-jet triggers used



Boosted

Targets 800 GeV $\leq m_{HH} \leq$ 3 TeV

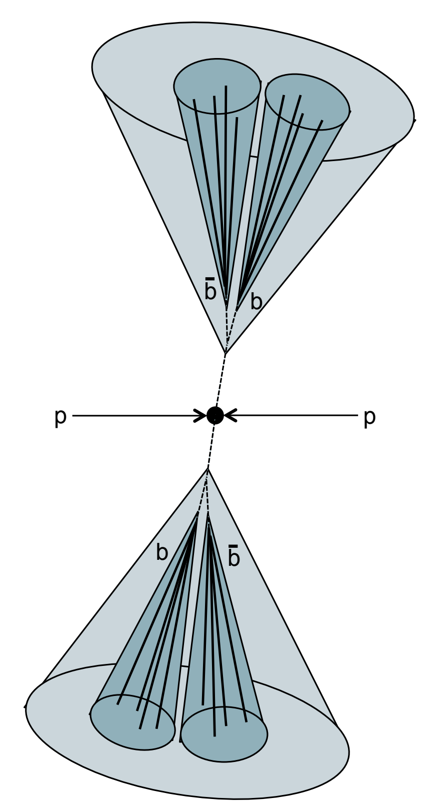
Demands 2 anti-k_T R=1.0 jets

$p_T^{l} > 450$ GeV, $p_T^{l} > 250$ GeV, $|\eta| < 2$

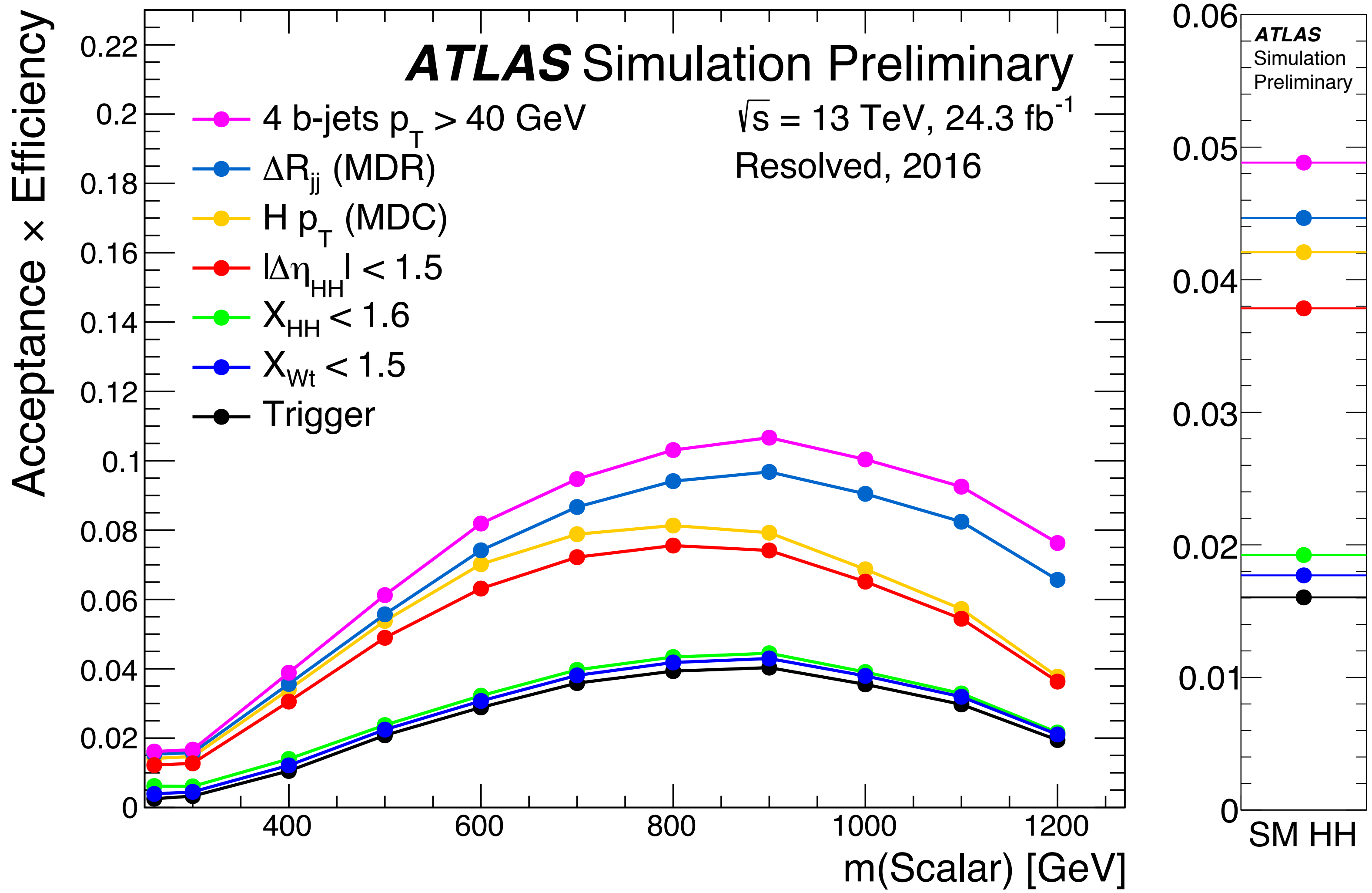
b-tagging uses anti-k_T R=0.2 track-jets

demand 1 or 2 b-tagged track-jets per large-R jet

High-p_T large-R jet trigger used



bbbb: Acceptance and Efficiency



Acceptance extends down to m_{HH} = 260 GeV, despite trigger

Good acceptance for non-resonant signal

Boosted analysis has good acceptance up to multi-TeV signals

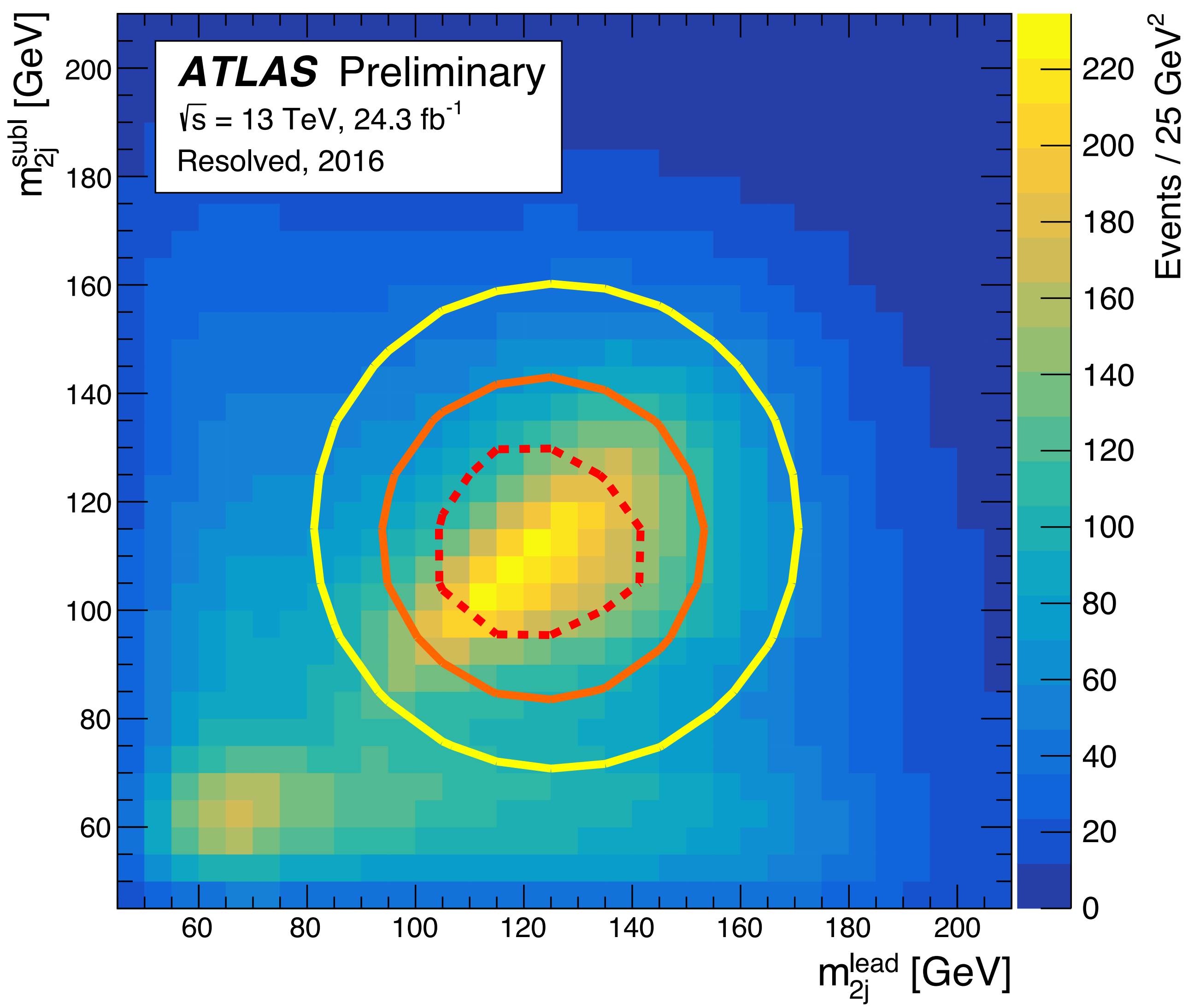
bbbb: Background Modelling

Background is 90% multijet and 10% ttbar

Model background using data samples with fewer b-tags

- e.g. 2b+2j sample to model resolved analysis 4b background

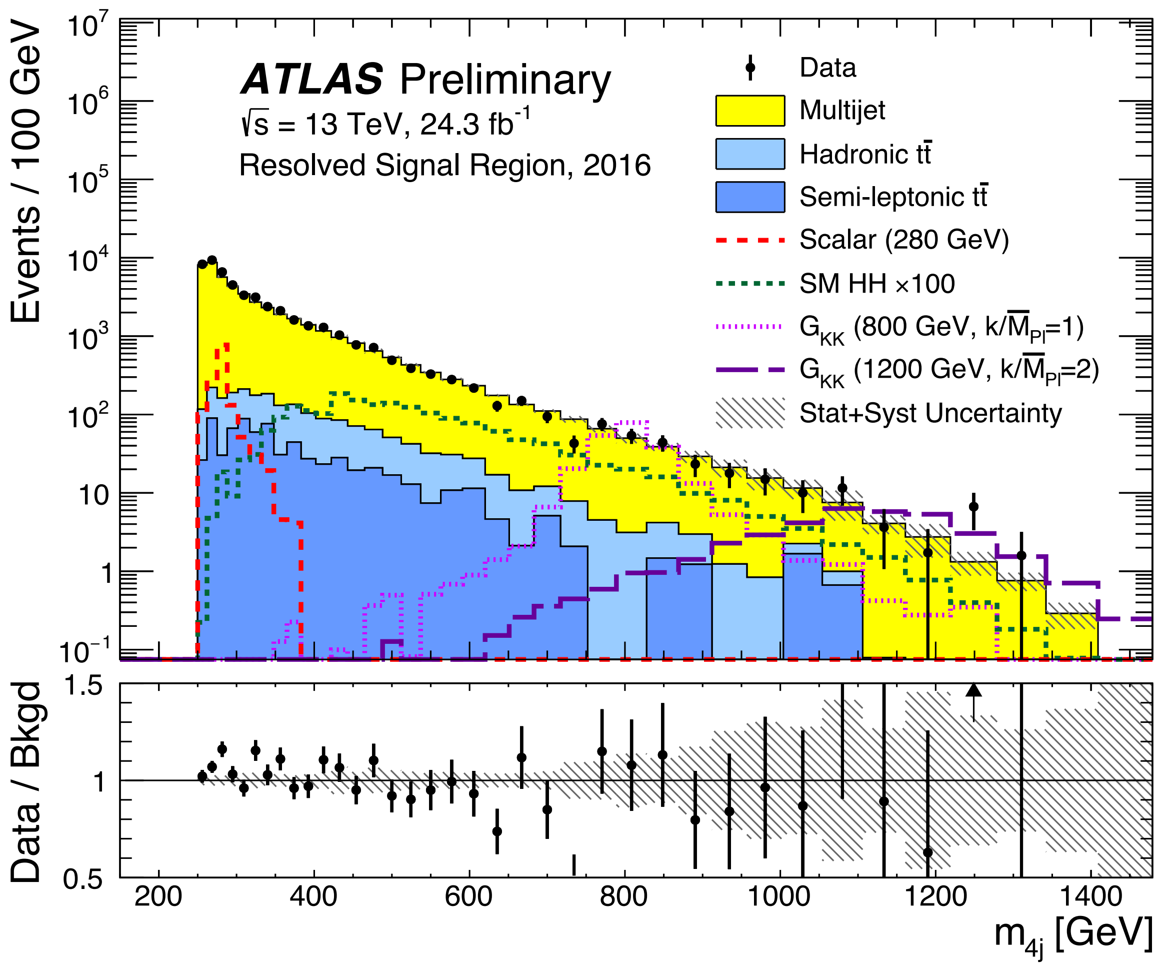
Derive normalisation factor and kinematic corrections in control regions in m_{2j}^{lead}–m_{2j}^{subl} plane

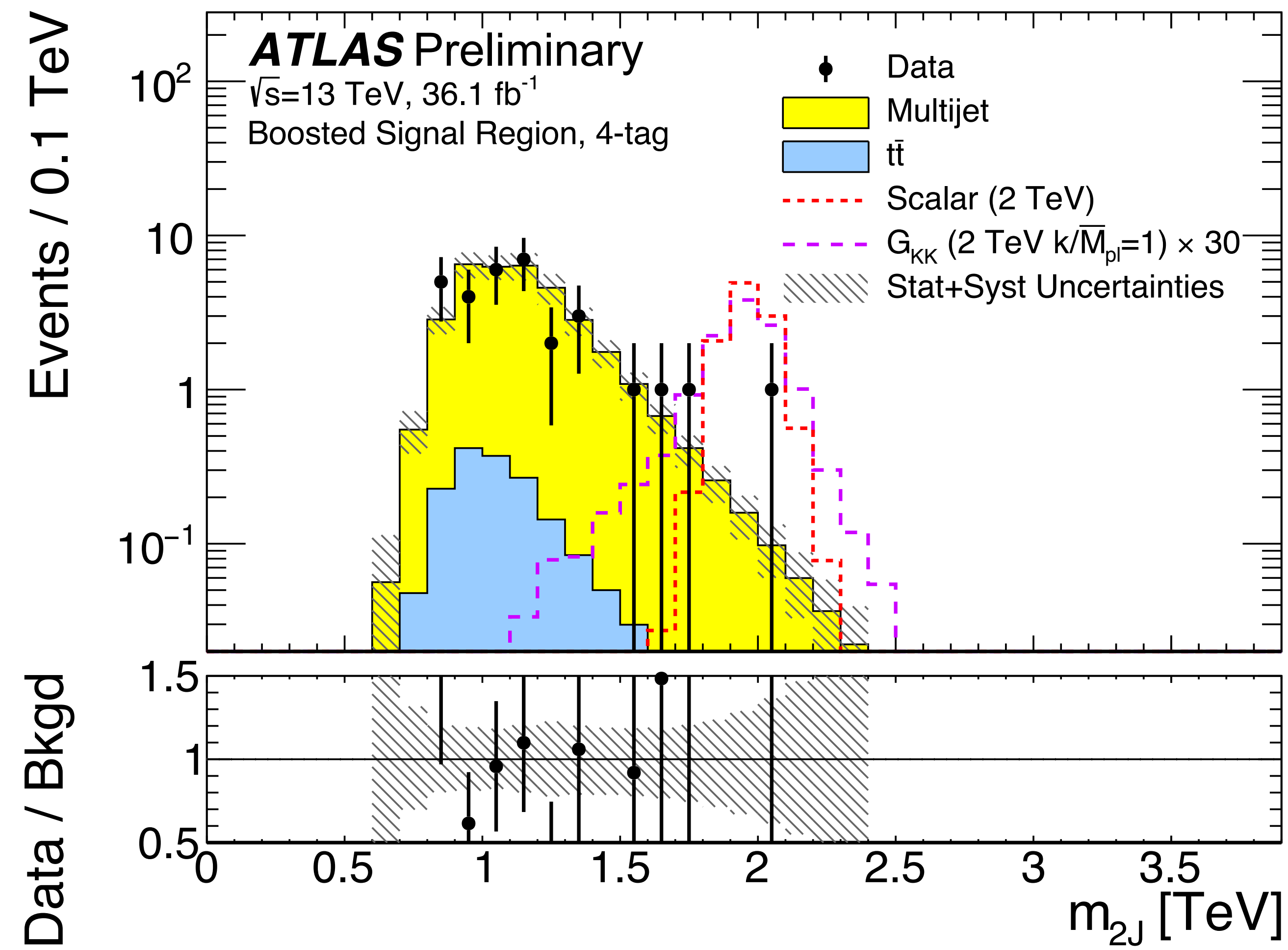


Modelling approach yields:

- an absolute prediction of background yield with small uncertainties
- with high statistical precision

bbbb: Data vs Background Results

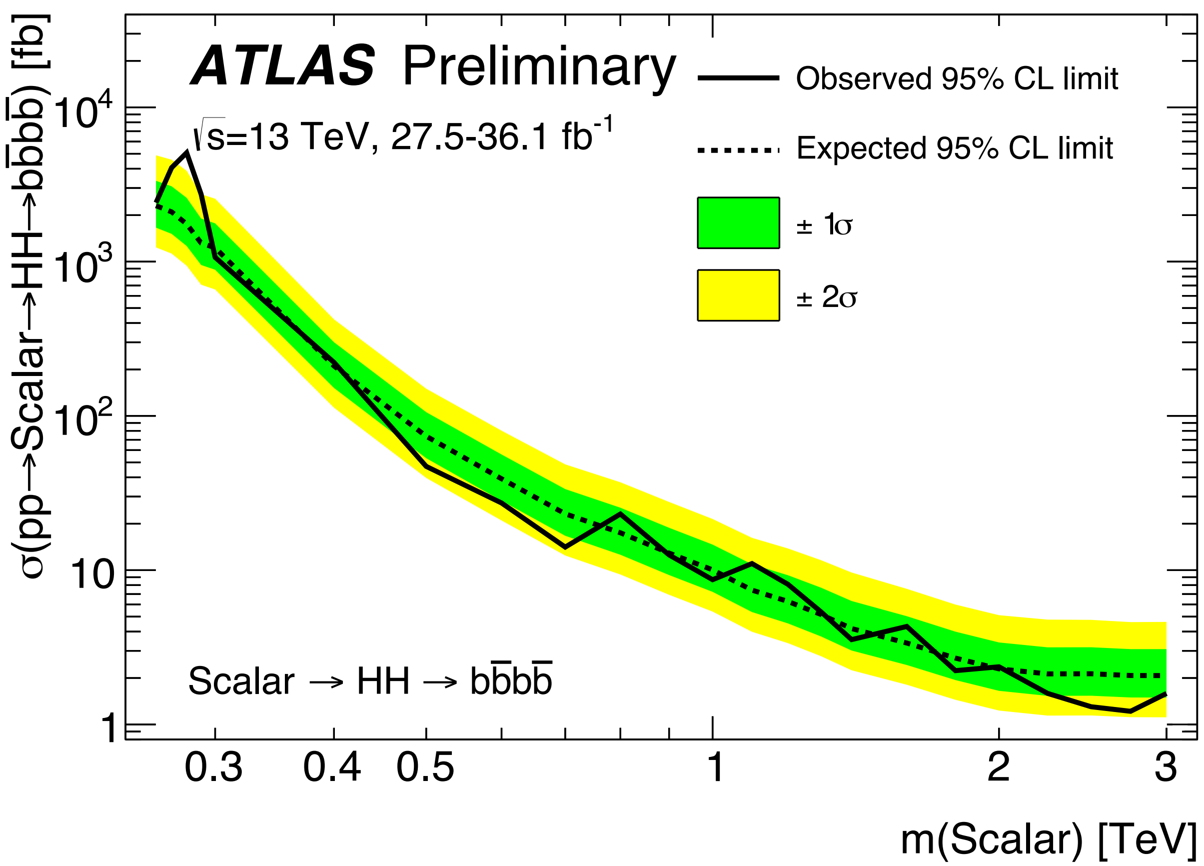


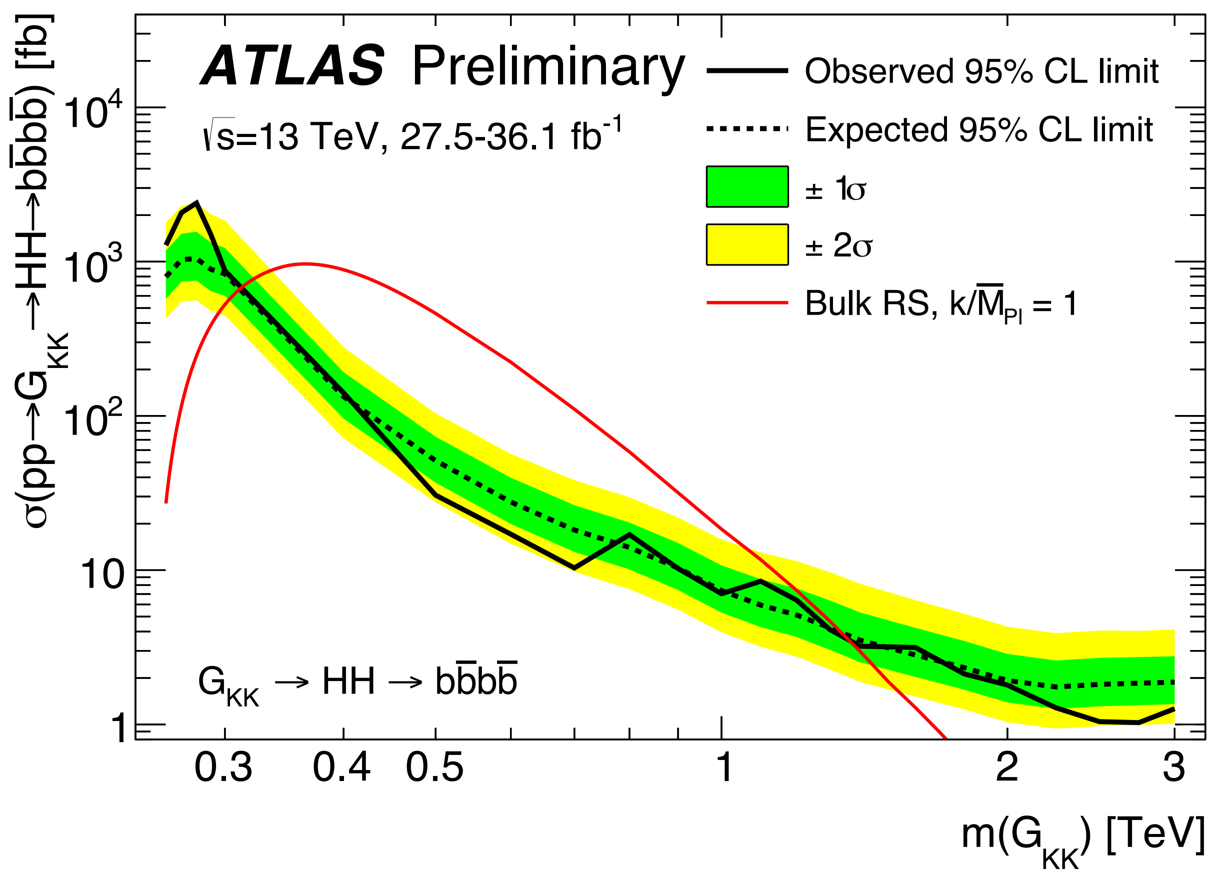


Observed data is consistent with background prediction in all signal regions

Statistically insignificant excess at m_{HH} ~ 280 GeV

bbbb: Statistical Analysis





Statistically insignificant excess at m_{HH} ~ 280 GeV

95% C.L. limits on SM non-resonant HH production:

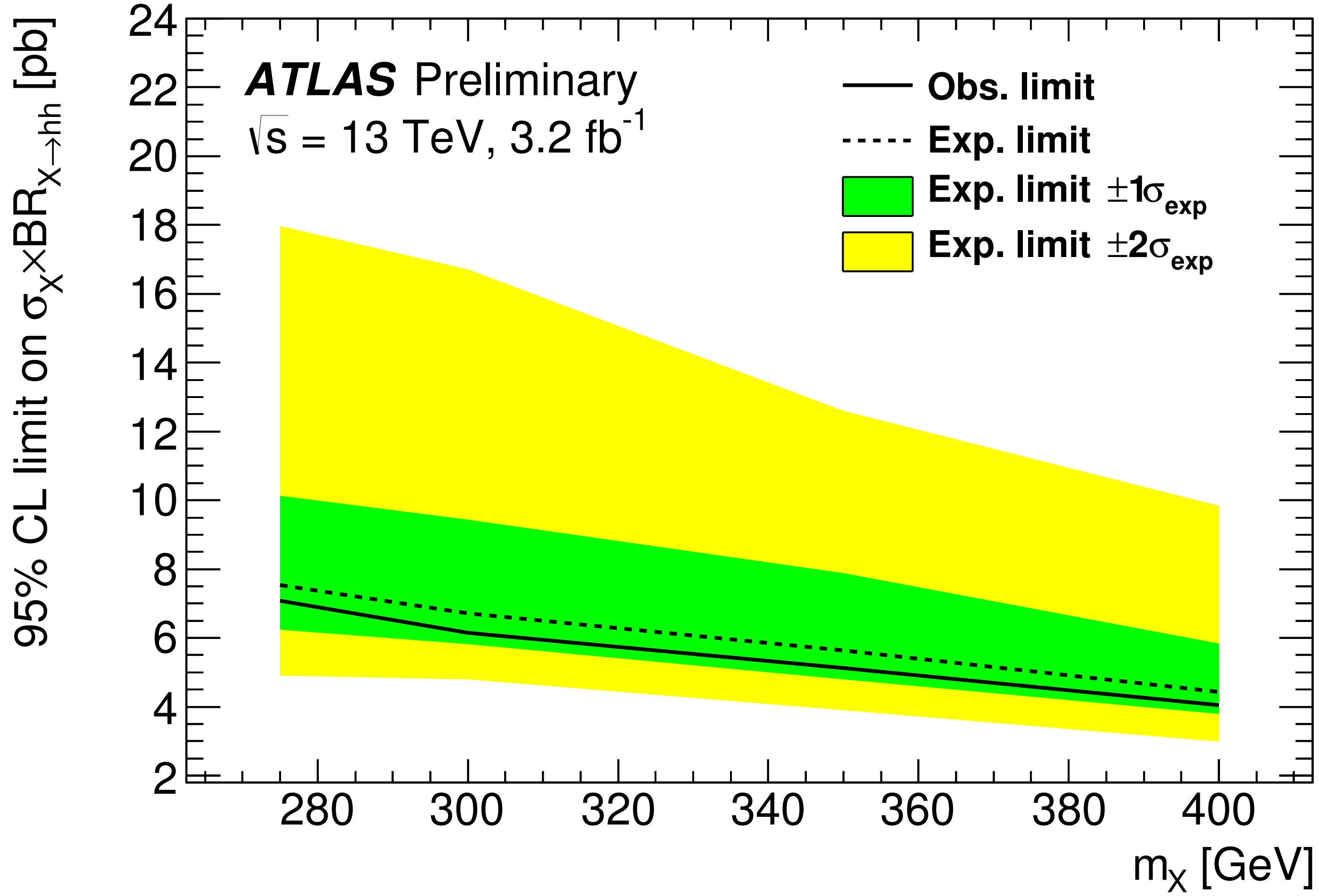
σ(pp→HH→bbbb) = 147 fb (obs.), 234 fb (exp.),

equivalently $\mu = \sigma/\sigma_{SM}$ = 13.0 (obs.), 20.7 (exp.)

Other Final States

bbγγ

ATLAS-CONF-2016-004



Sensitivity limited by small dataset analysed

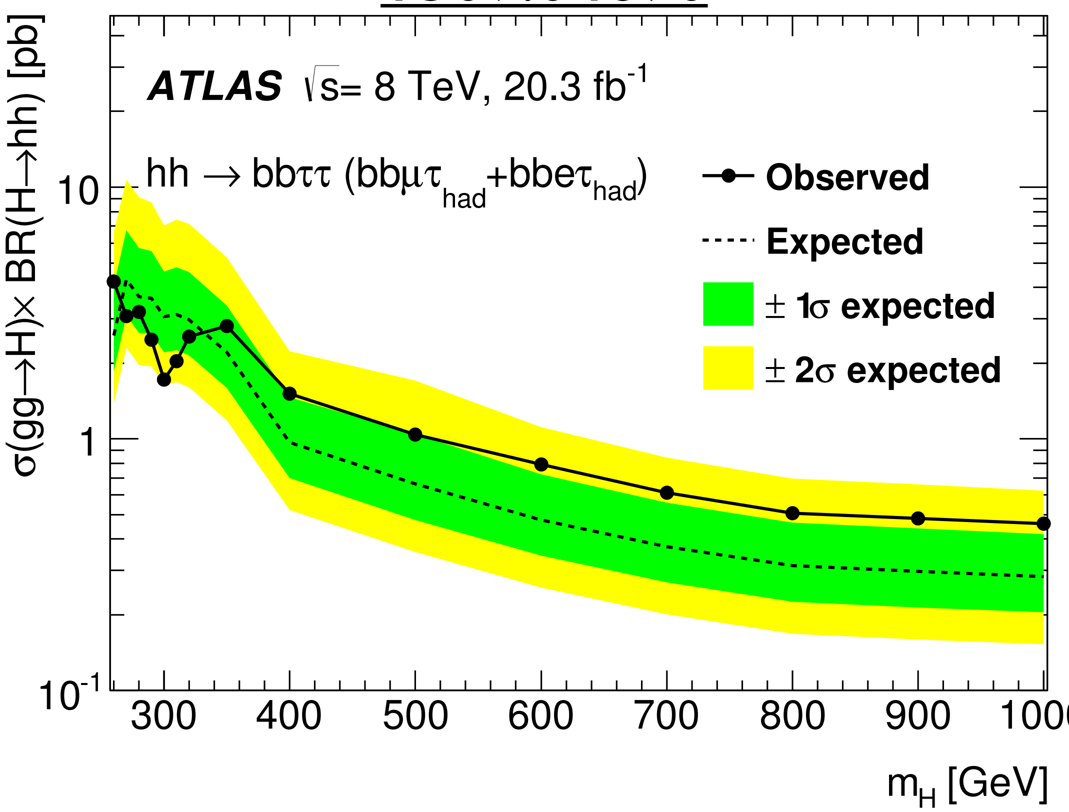
Non-resonant 95% C.L. limit is:

σ(pp→HH) = 3.9 pb (obs.), 5.4 pb (exp.),

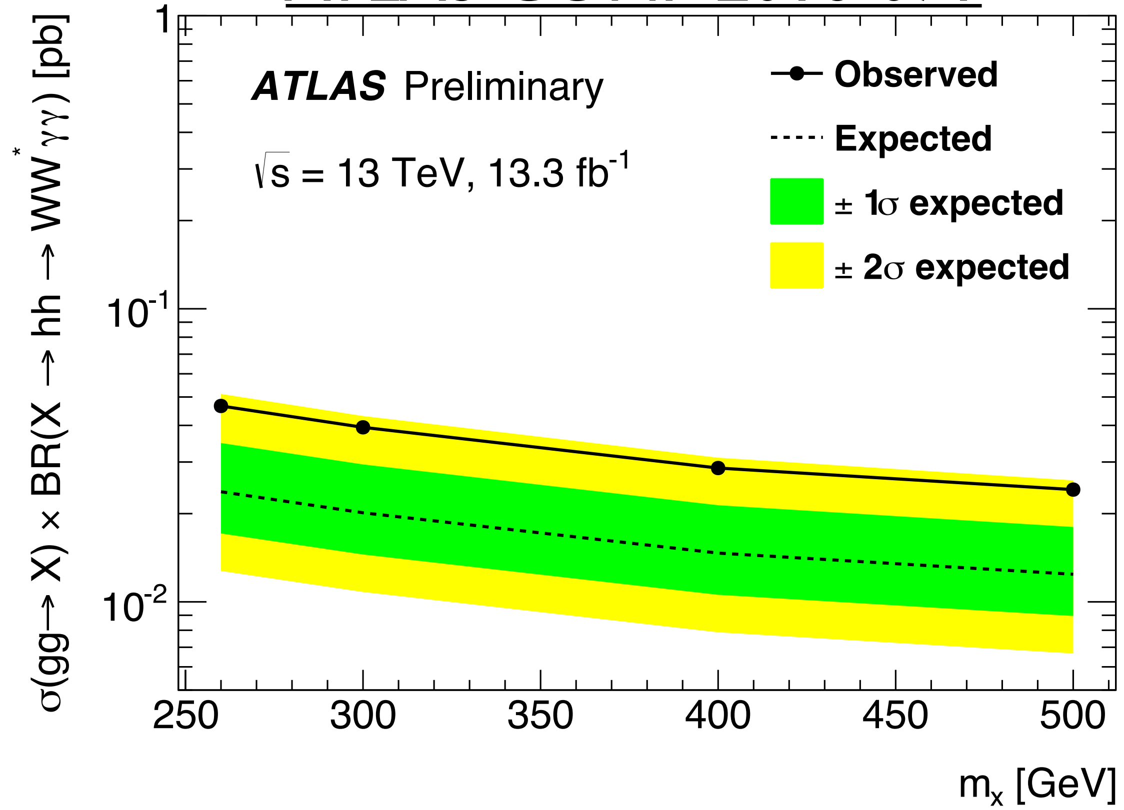
equivalent to μ = 117 (obs.), 161 (exp.)

bbττ and WWγγ

1509.04670



ATLAS-CONF-2016-071



Latest bbττ results are from Run-1 and did not use $\tau_{had}\tau_{had}$ final state ⇒ uncompetitive

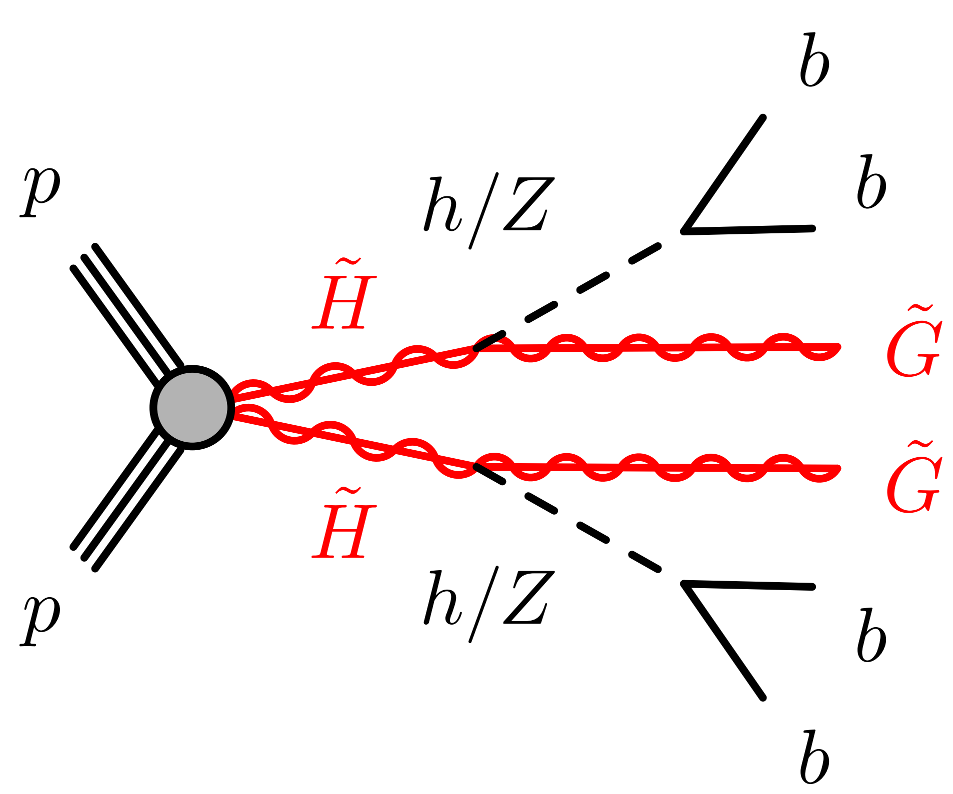
- Non-resonant limits: σ(pp→HH) = 1.6 pb (obs), 1.3 pb (exp), equivalent to μ = 157 (obs), 128 (exp)
- An updated analysis will have much more competitive sensitivity

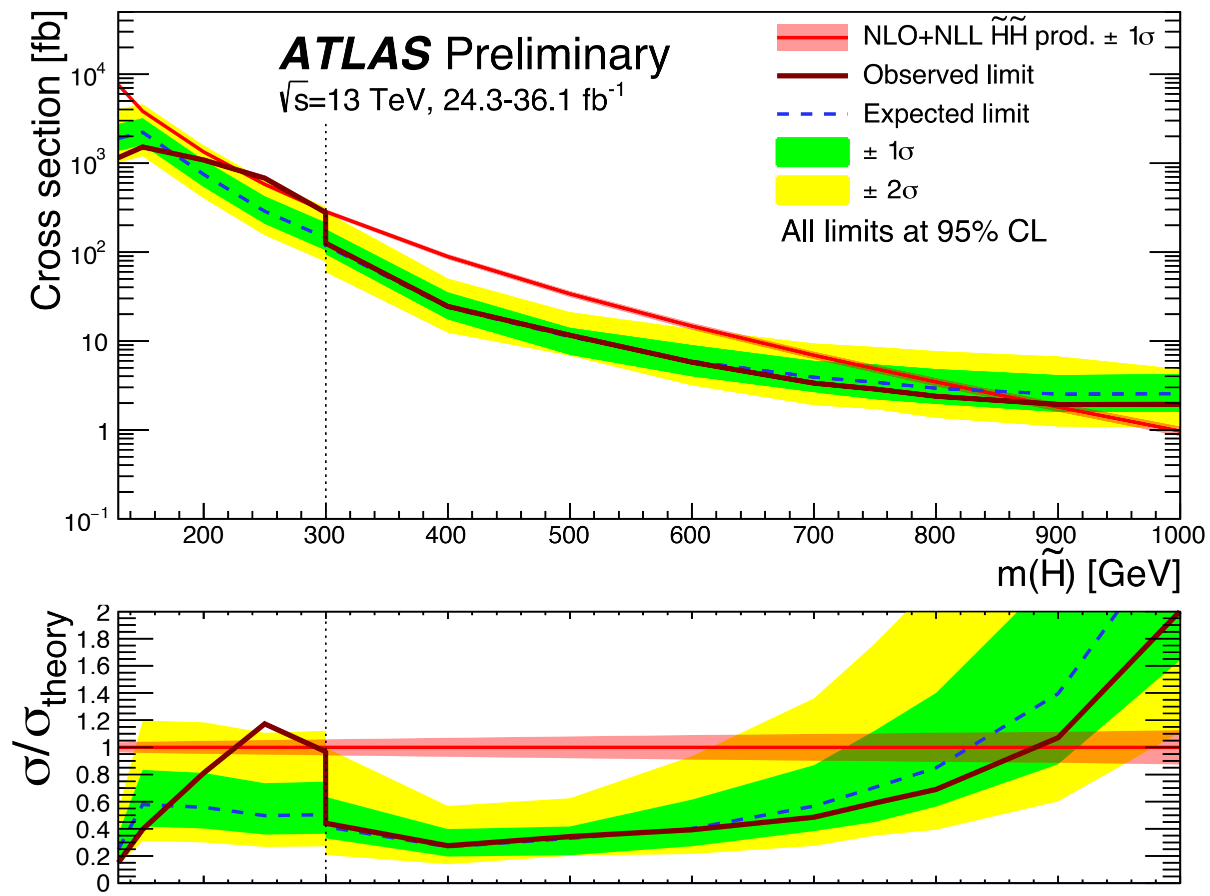
Sensitivity of WWγγ analysis fundamentally limited by small Br(H→γγ) and Br(W→lν)

- Non-res limits: σ(pp→HH) = 25.0 pb (obs), 12.9 pb (exp), equivalent to μ = 747 (obs), 386 (exp)

HH+ME$_T$

ATLAS-CONF-2017-081





Beginning to explore more exclusive final states

e.g. a search for higgsinos using the bbbb+ME$_T$ final state

With large LHC datasets, there must be other exciting possibilities to explore

Conclusions

HH→bbbb analysis has recently been updated

- paper to appear soon

Limits on non-resonant SM HH production: μ=13.0 (obs.), 20.7 (exp.)

Resonant limits range:

- 2 pb for m_{HH} = 260 GeV
- 2 fb for m_{HH} = 3 TeV

More 2015+2016 results coming soon

Interest in:

- Pursuing more exclusive final states
- More sophisticated physics interpretation, e.g. coupling analysis or EFT benchmarks

Expect sensitivity with full Run-2 dataset to be very interesting