INCLUSIVE SEARCHES FOR SQUARKS AND GLUINOS WITH THE ATLAS DETECTOR

Tova Holmes, on behalf of the ATLAS Collaboration

May 9, 2016

BERKELEY LAB

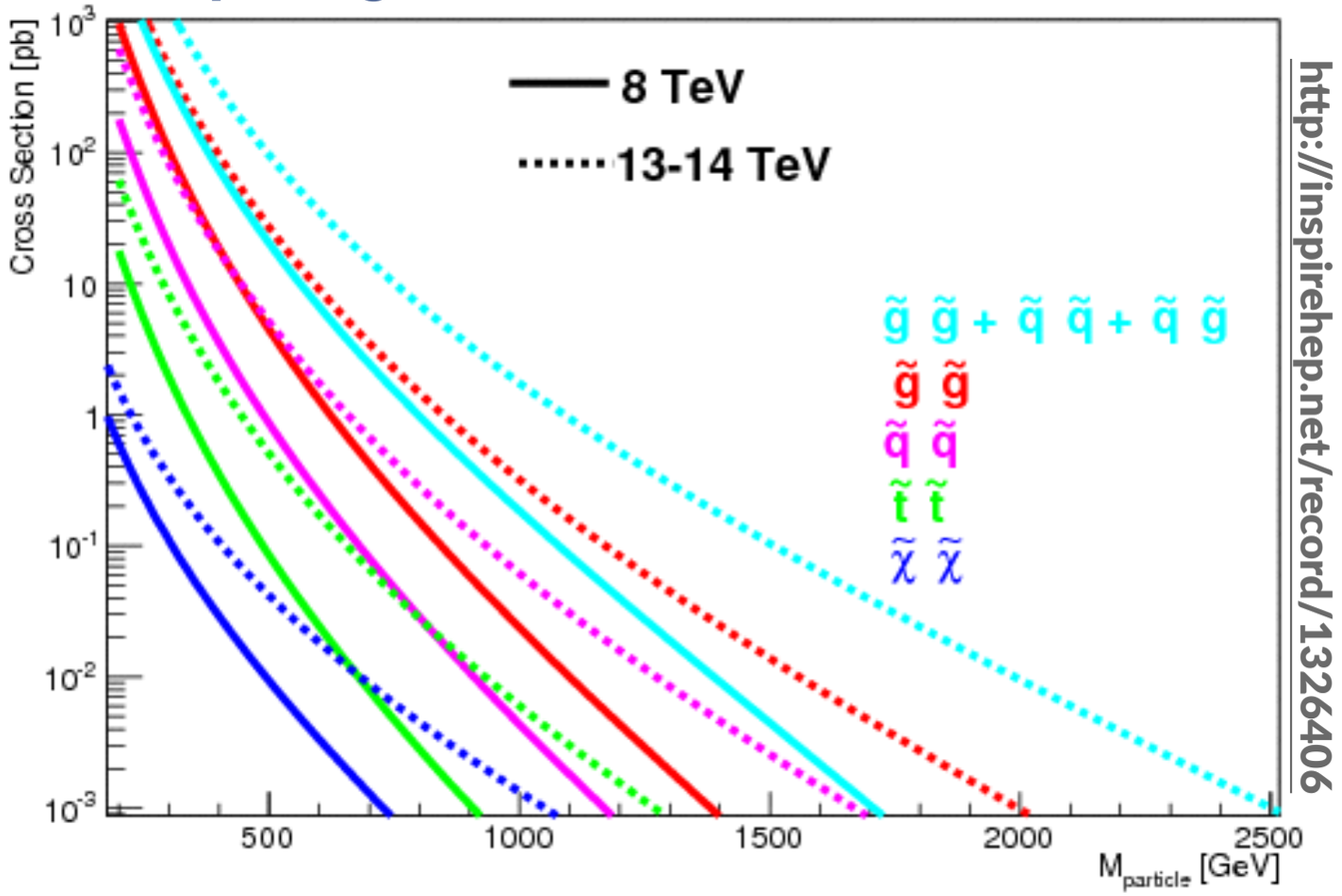
ATLAS EXPERIMENT

EARLY RUN 2 DATA

- squark and gluino production can increase by more than an order of magnitude

- even with a small fraction of the Run 1 luminosity, can have better sensitivity

squark/gluino cross-sections from NLL-fast



with 3.2 fb^{-1} of 13 TeV data…

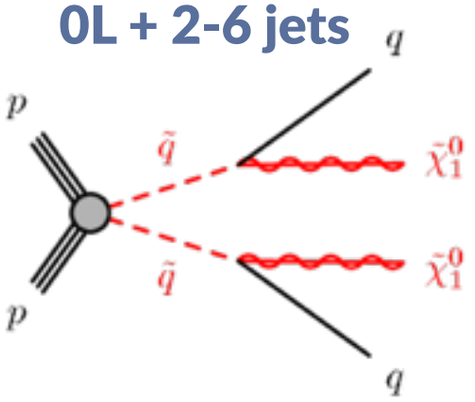
- ttbar → 1/2 amount in 20 fb^{-1} of 8 TeV data
- gluino pair production (1.5 TeV) → 7x amount in 8 TeV

ANALYSES COVERING AS MANY FINAL STATES AS POSSIBLE

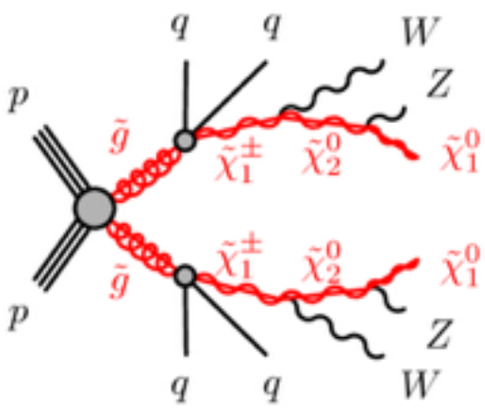
largest branching ratio ⟷ smallest SM background

0 leptons

0L + 2-6 jets

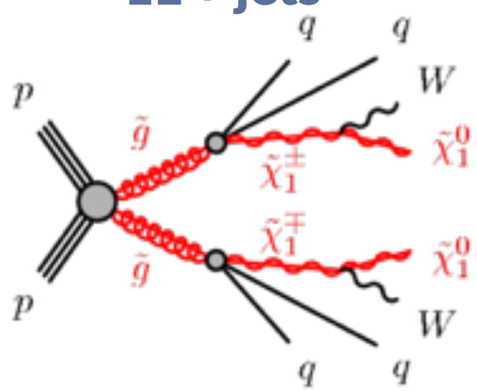


0L + 7-10 jets

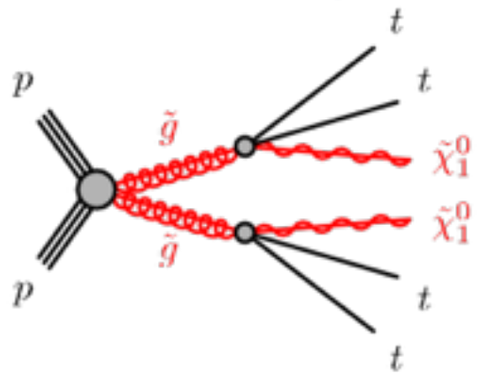


1 lepton

1L + jets

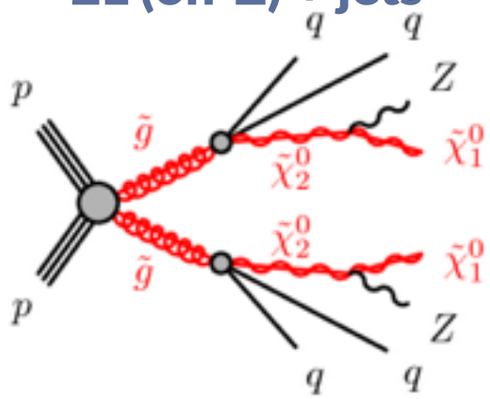


0/1L + 3 b-jets



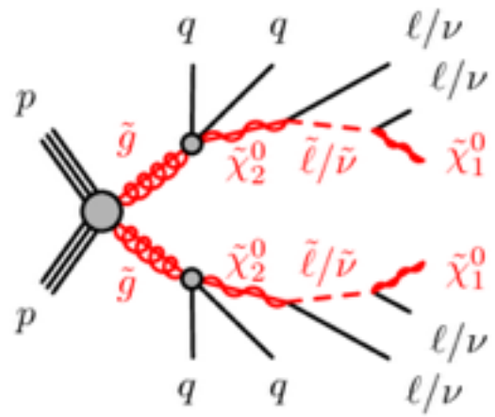
2 leptons

2L (on-Z) + jets



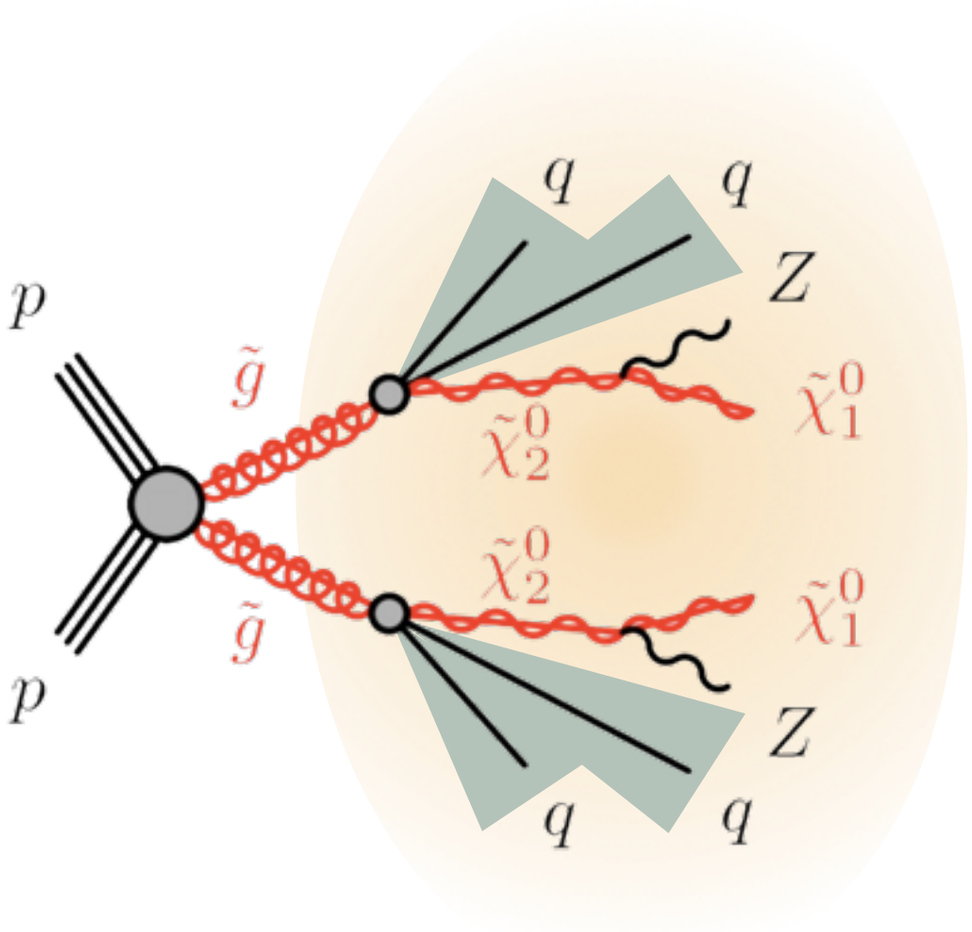
2 SS/3 leptons

2 SS / 3L + jets



- complementary final states cover large areas of phase space and large range of models

COMMON THEMES



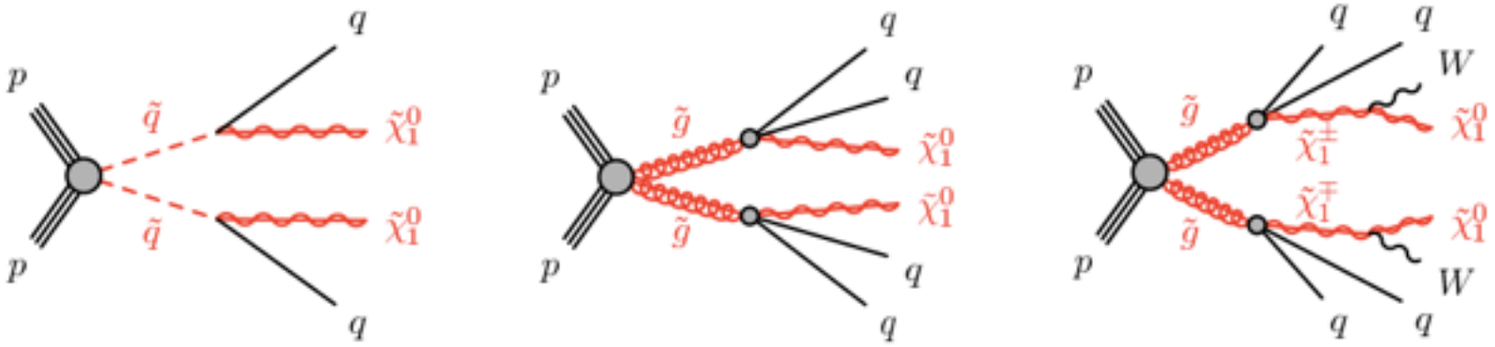
- large E_T^{miss} requirements
  - R-parity conserving SUSY models typically give decay chains that result in a neutral LSP that escapes the detector
- large n_{jets}
  - color-charged SUSY particles emit jets as they go through decay chains
- large total energies
  - variables that sum the total energy of the event (m_{eff}, H_T) can be used to isolate events that are likely to contain very massive particles

m_{eff} : scalar sum of E_T^{miss} and jet p_Ts

H_T : scalar sum of p_T of visible objects (sometimes just jets)

0L, 2-6 JETS

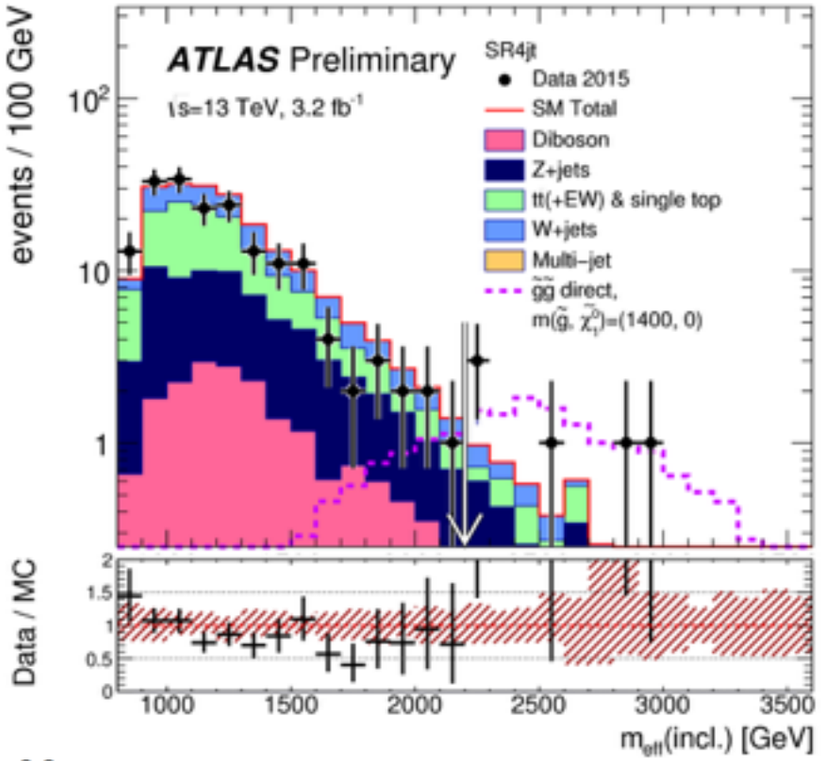
all hadronic states, likely to be dominant decay mode

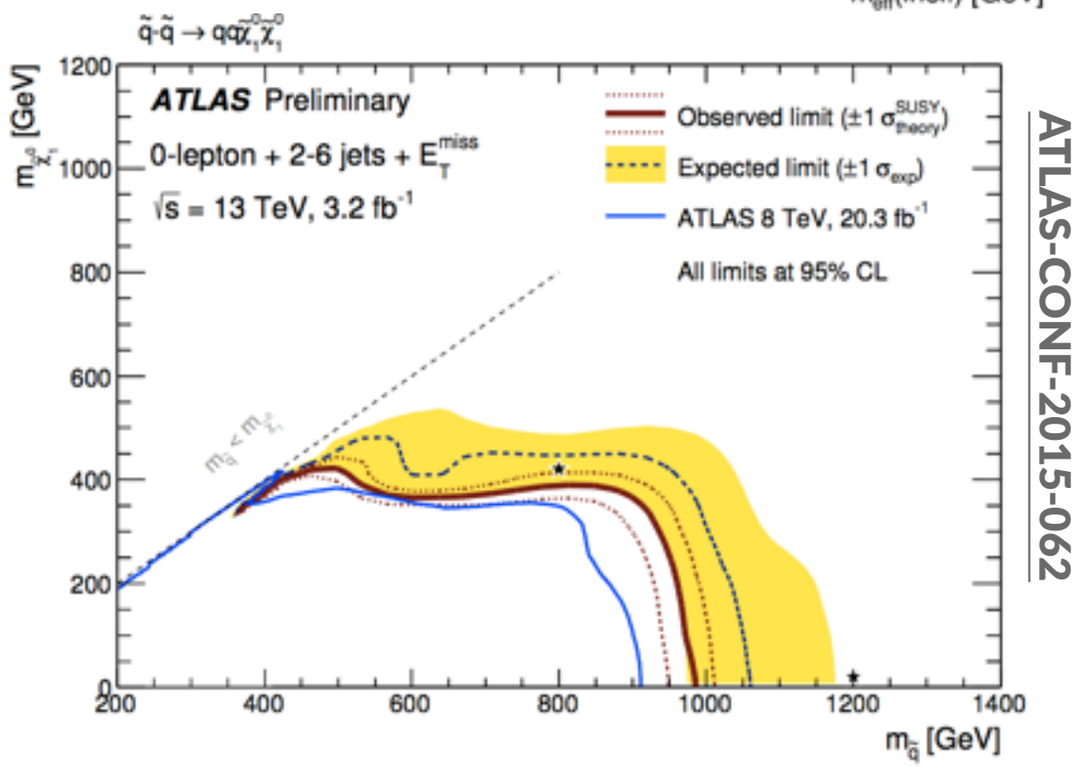


- 7 signal regions with different numbers of jets
- all require E_T^{miss}
- require large m_{eff}

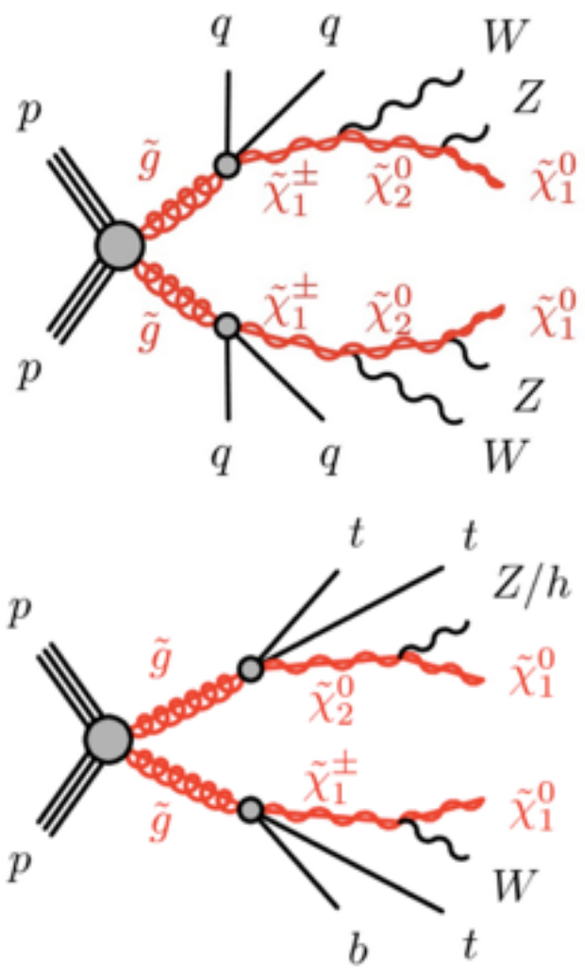
major backgrounds

- Z + jets
  - Z→νν estimated with photon events
- W + jets and ttbar
  - 1L CR regions with/without b-jets used to normalize MC
- multijet
  - invert SR cuts for CR



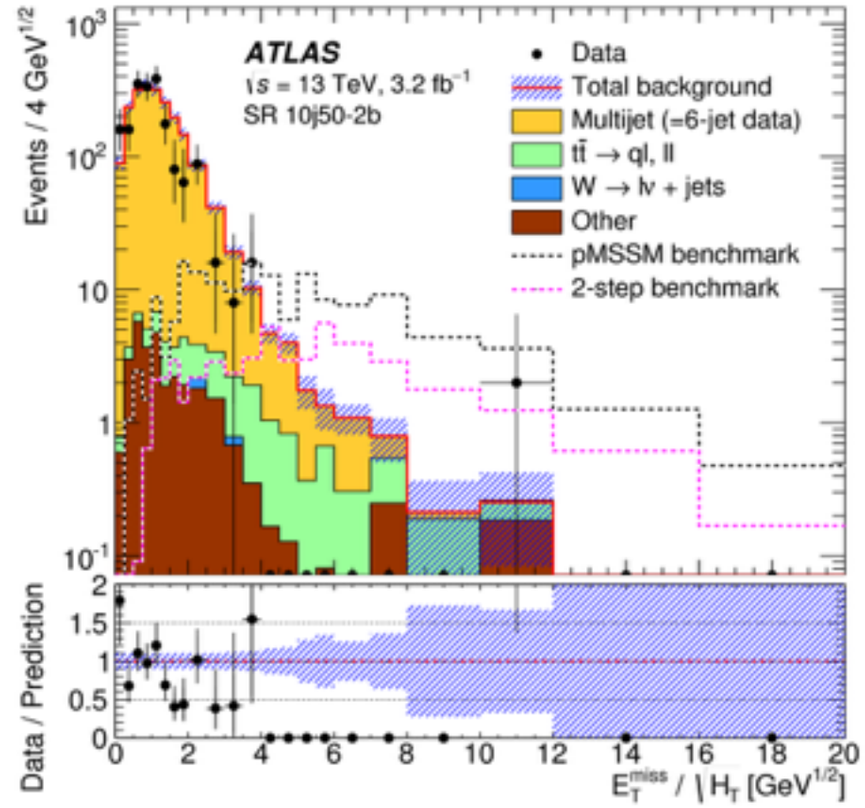


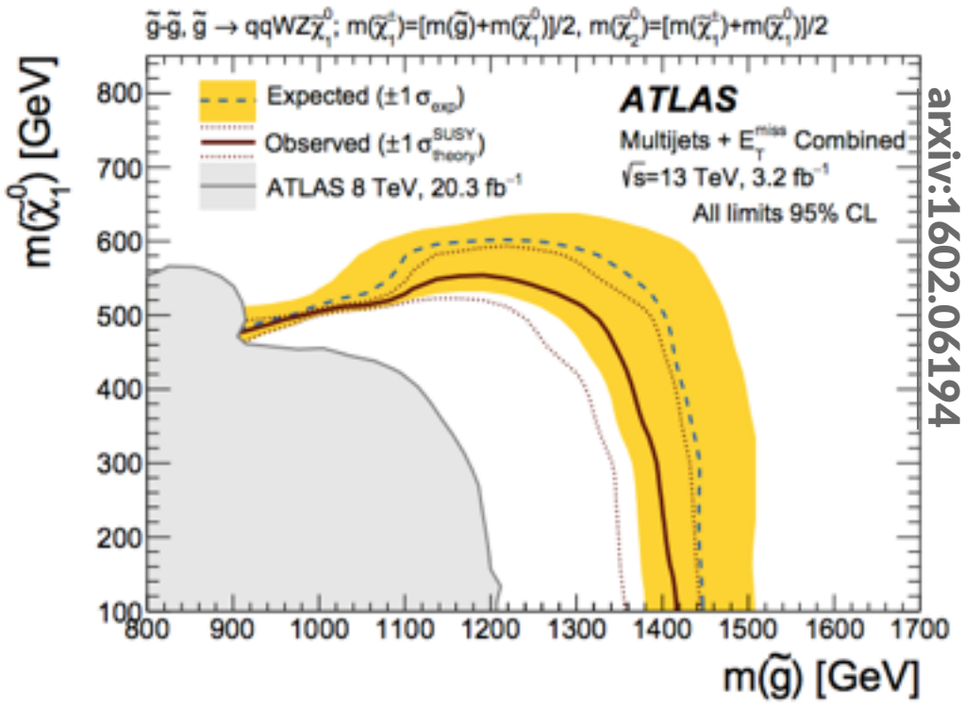
0L, 7-10 JETS



major backgrounds

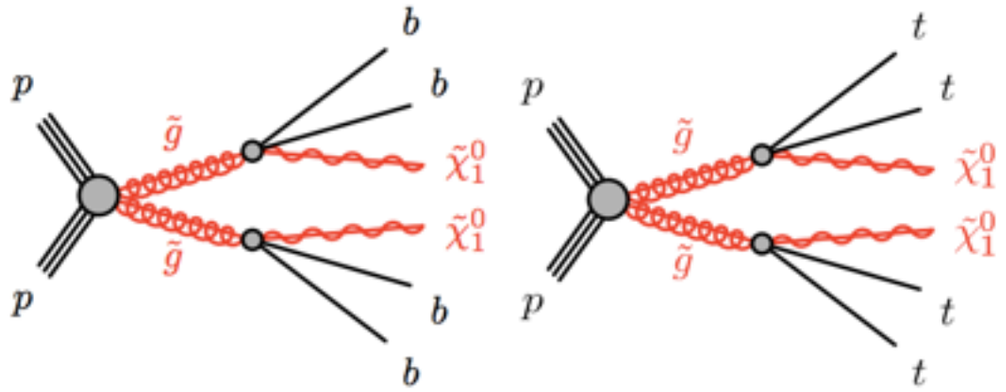
- multijet
  - E_T^{miss} significance and n_{jets} uncorrelated → use template from lower n_{jets}
- leptonic
  - ttbar and W+jets can produce 0 leptons, or a lepton can be missed
  - construct 1L CR



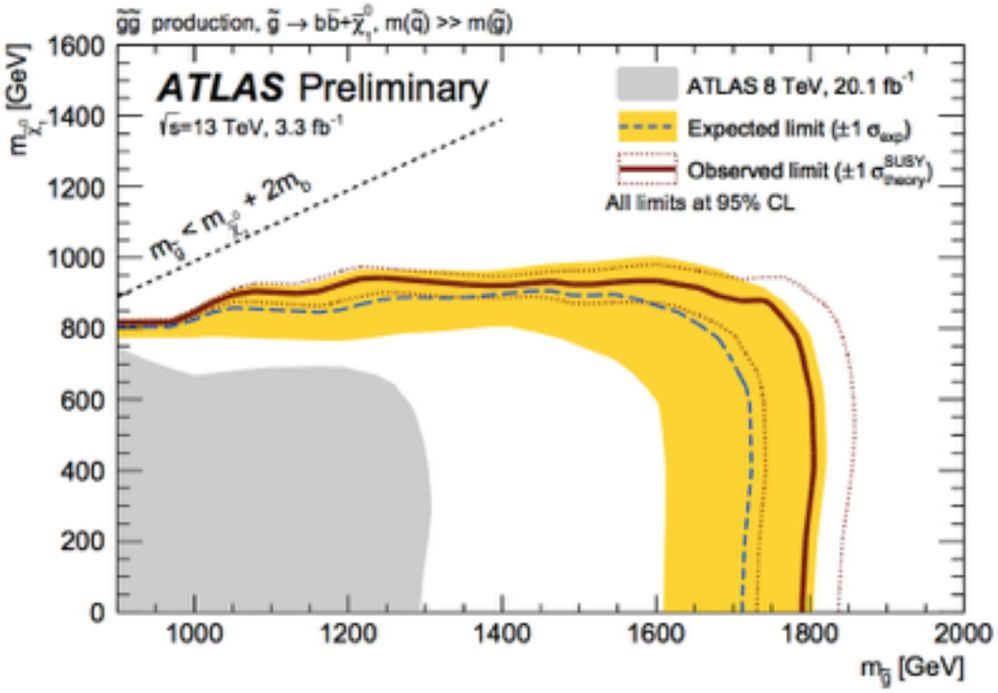


- targeting models which produce many jets through cascades of SUSY particles
- additional SRs requiring b-tags
- use E_T^{miss} significance (E_T^{miss} / $\sqrt{H_T}$) as main discrimination variable (background E_T^{miss} from jet mis-measurement)

0/1L, 3B JETS

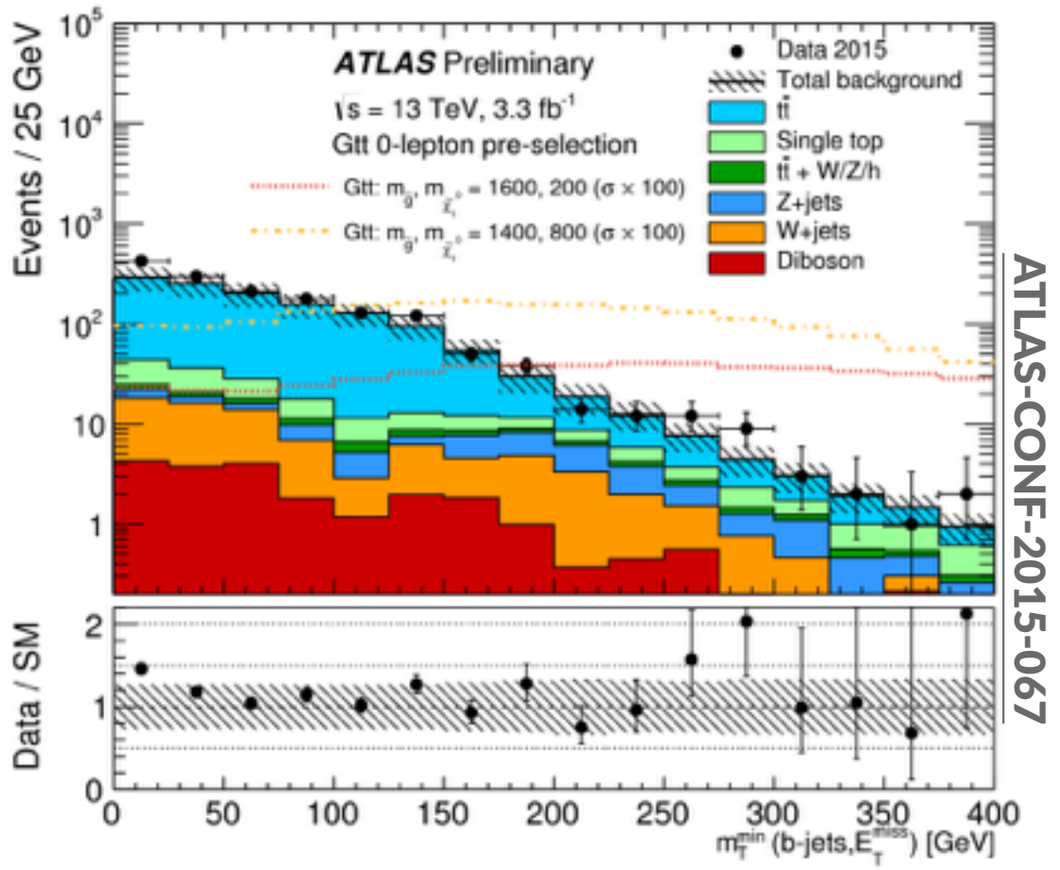


- looks for gluino decays via sbottoms and stops
- require at least 3 b-jet tags
- SRs with 0 and 1 L
- uses m_{eff} and m_T (transverse mass of lepton and E_T^{miss}) to reduce background



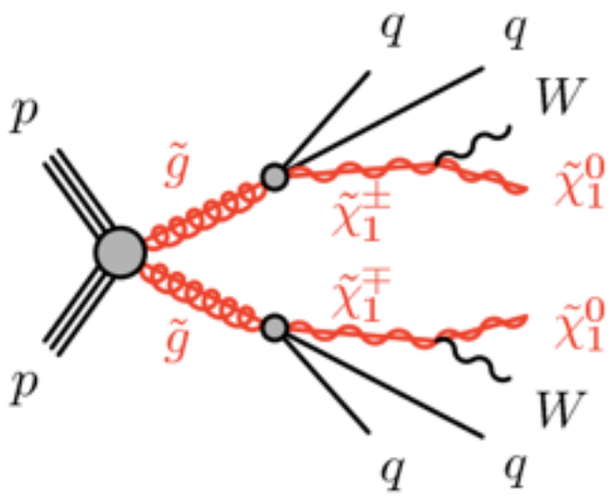
major backgrounds

- dominant background is ttbar
  - normalization factors acquired from kinematically similar CRs for each SR
  - use 1L regions and invert m_T for 0L SRs, just invert m_T for 1L SRs
- all other backgrounds taken from MC



ATLAS-CONF-2015-067

1L + JETS



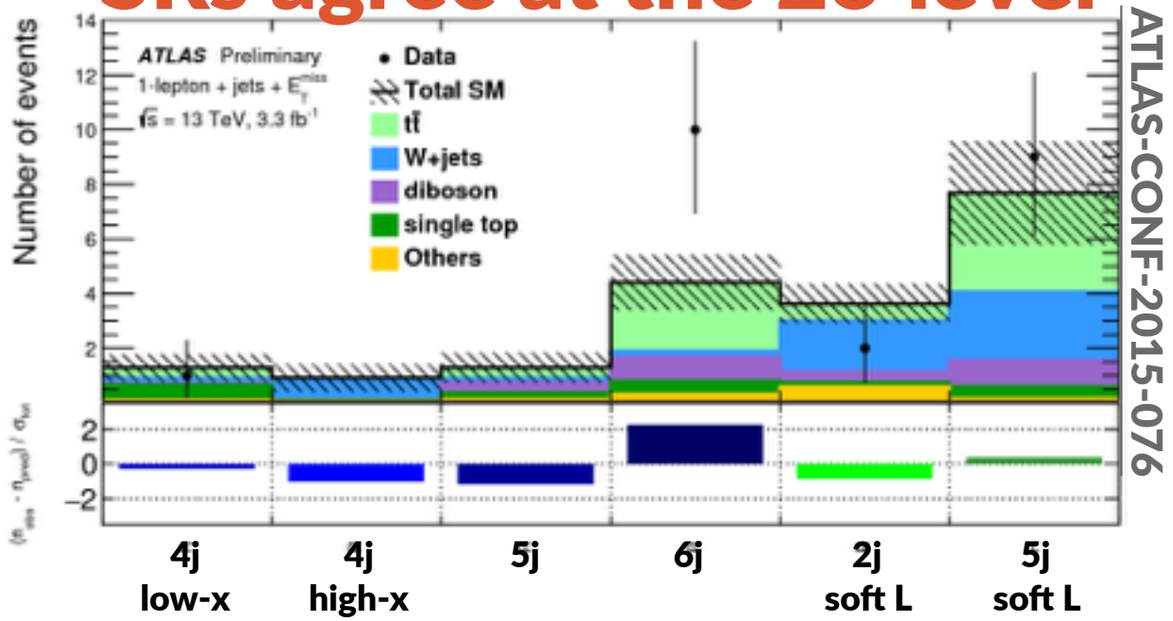
$$x = \frac{m_{\tilde{\chi}_1^{\pm}} - m_{\tilde{\chi}_1^0}}{m_{\tilde{g}} - m_{\tilde{\chi}_1^0}}$$

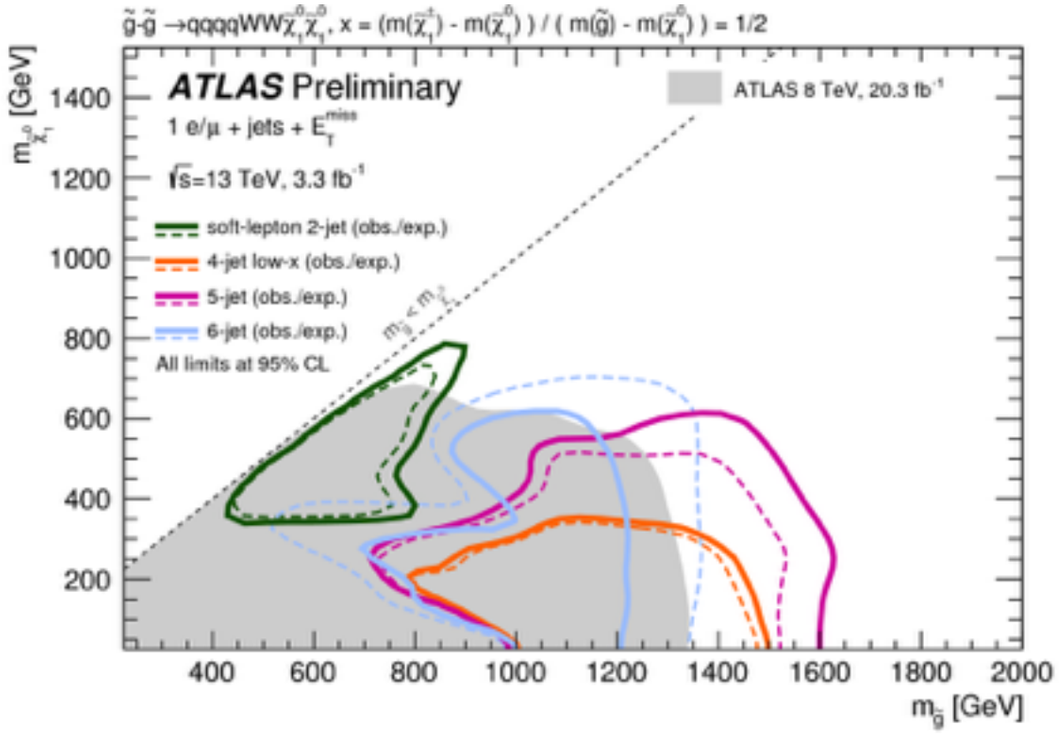
- signal regions targeting different mass hierarchies
  - "soft" selections with low lepton pT and few jets targets close to diagonal
  - "hard" selections with higher lepton pT
  - varying chargino mass explored with regions optimized in lepton p_T cuts, jet cuts, and E_T^{miss} cuts, m_T, m_{eff}, and shape variables

major backgrounds

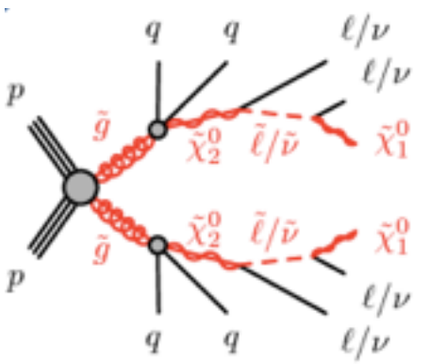
- ttbar and W+jets are dominant
  - normalized in CRs defined at lower m_T and E_T^{miss}/m_{eff} or aplanarity

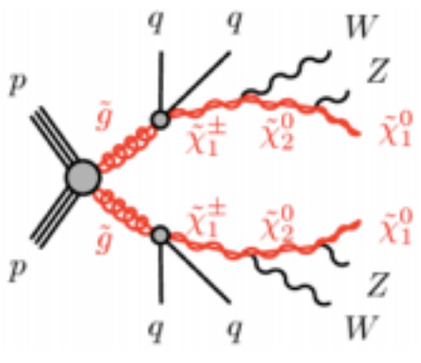
SRs agree at the 2σ level

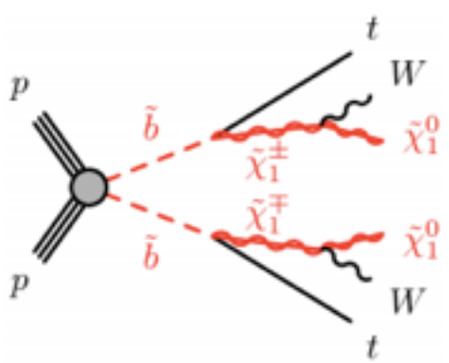




2 SS L / 3L + JETS



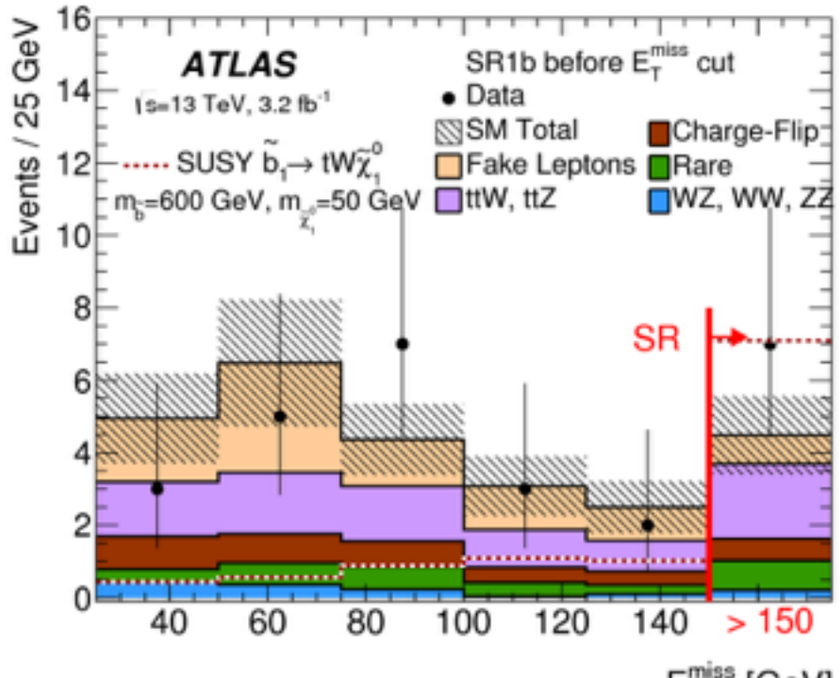


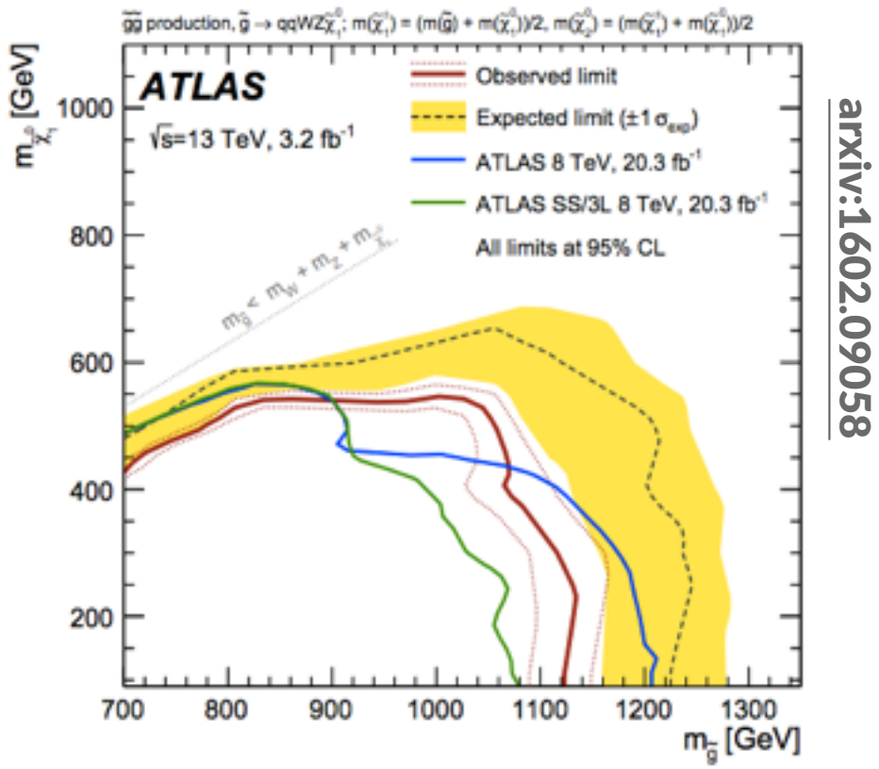


- very few SM processes that produce same-sign leptons, but fairly common in BSM
- all signal regions require large E_T^{miss} and m_{eff} to further reduce SM background

major backgrounds

- ttV and diboson
  - taken from MC with VRs
- mis-measured charge
  - probabilities measured in data from Z→ee events
- fake/non-prompt leptons
  - taken from a data-driven matrix method

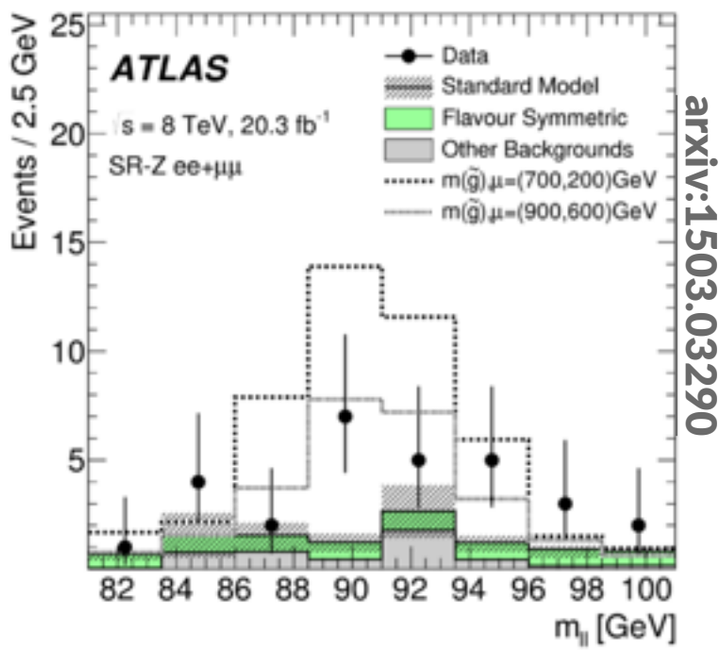


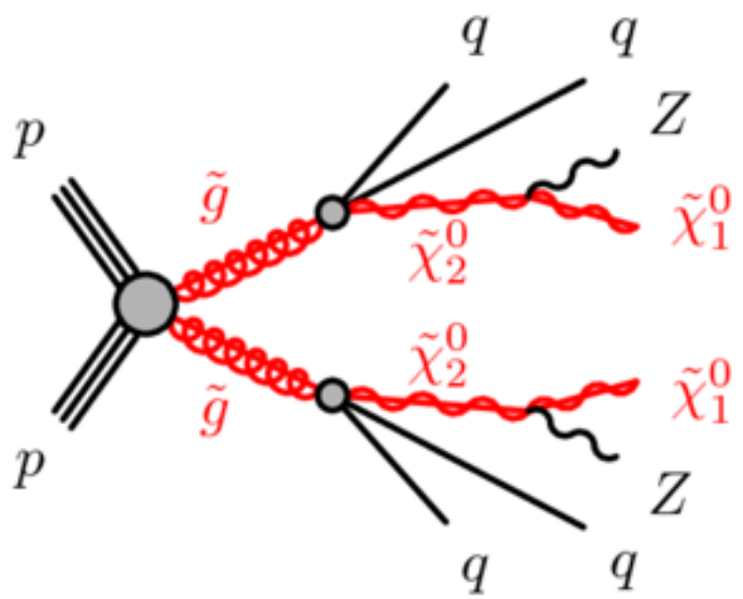


arxiv:1602.09058

2L (ON-Z) + JETS

3σ excess in Run 1

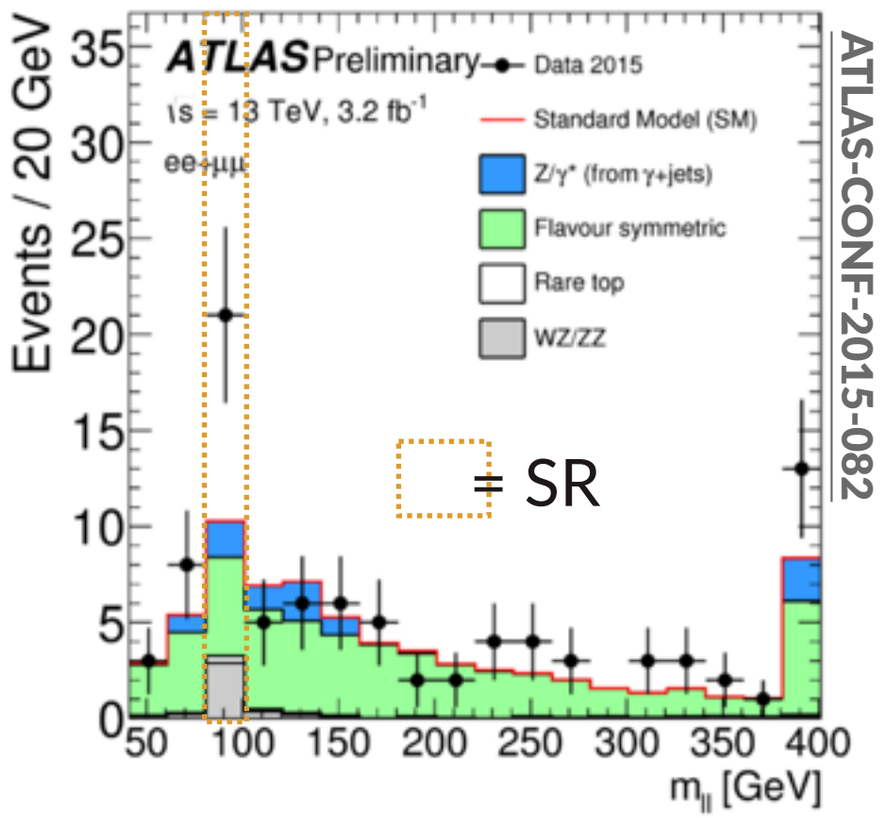




- same cuts as Run 1:
- looking for 2L that reconstruct to the Z mass
- additionally require E_T^{miss} and H_T (sum of jet and lepton p_T)
- loose jet requirement (only 2)

major backgrounds

- dominant background is ttbar
  - determined from an eμ control region
- Z+jets taken from photon data
  - reweighted and smeared to match Z→ℓℓ

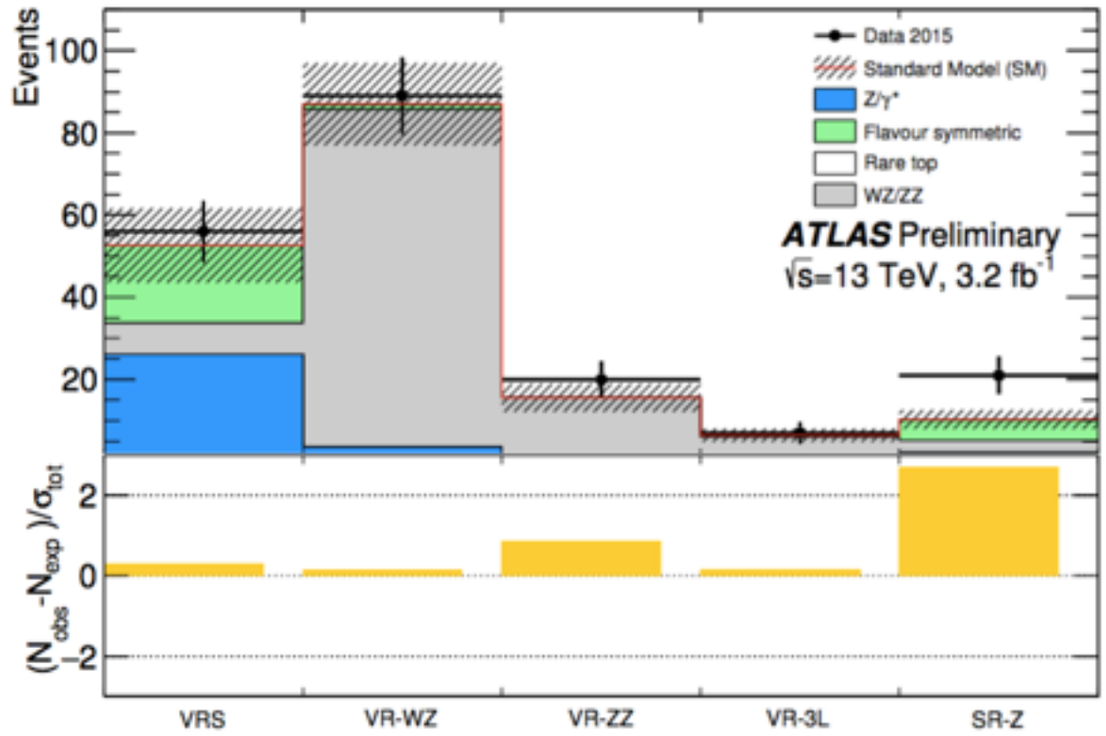


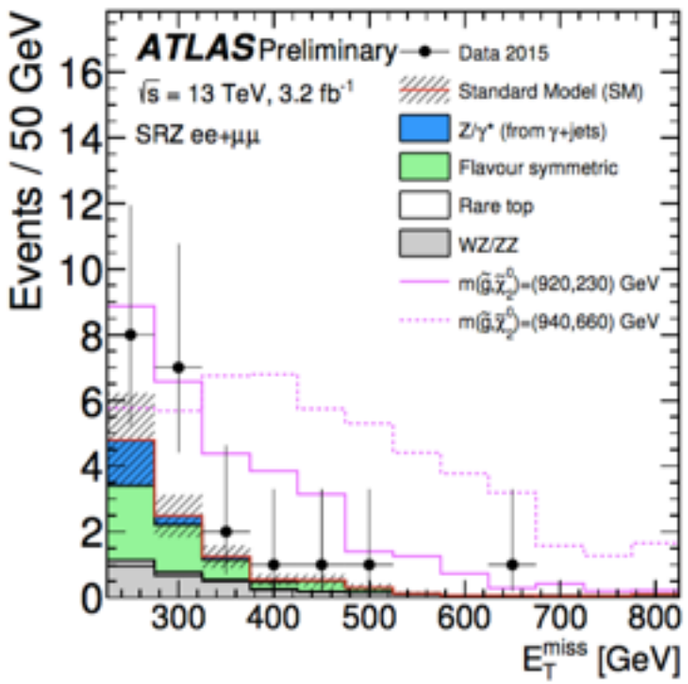
2.2σ excess

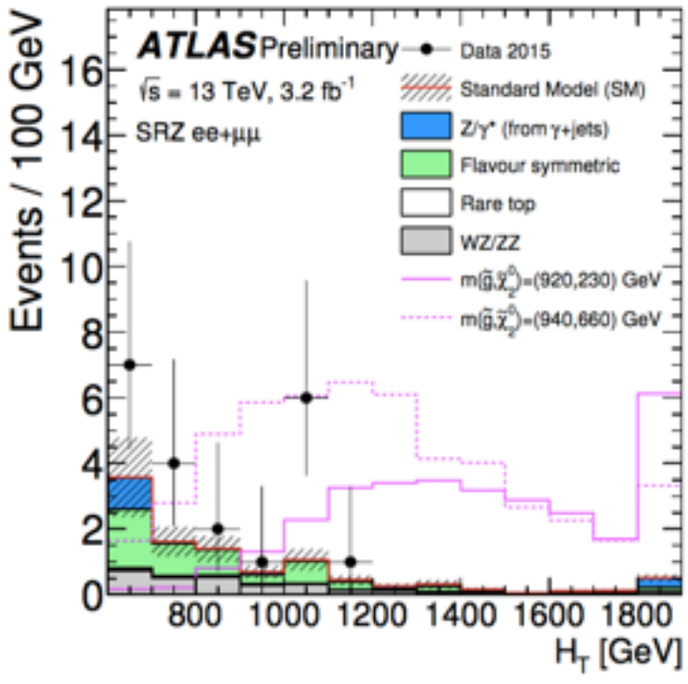
(11 μμ/ 10 ee)

2L (ON-Z) + JETS

- excellent agreement in all VRs
- extensive checks/cross-checks of background estimates
- SR distributions look background-like in shape
- would also fit signals with compressed mass spectra + massive LSP
- no evidence of underestimate of background (like E_T^{miss} aligned with leptons or jets)







SUMMARY

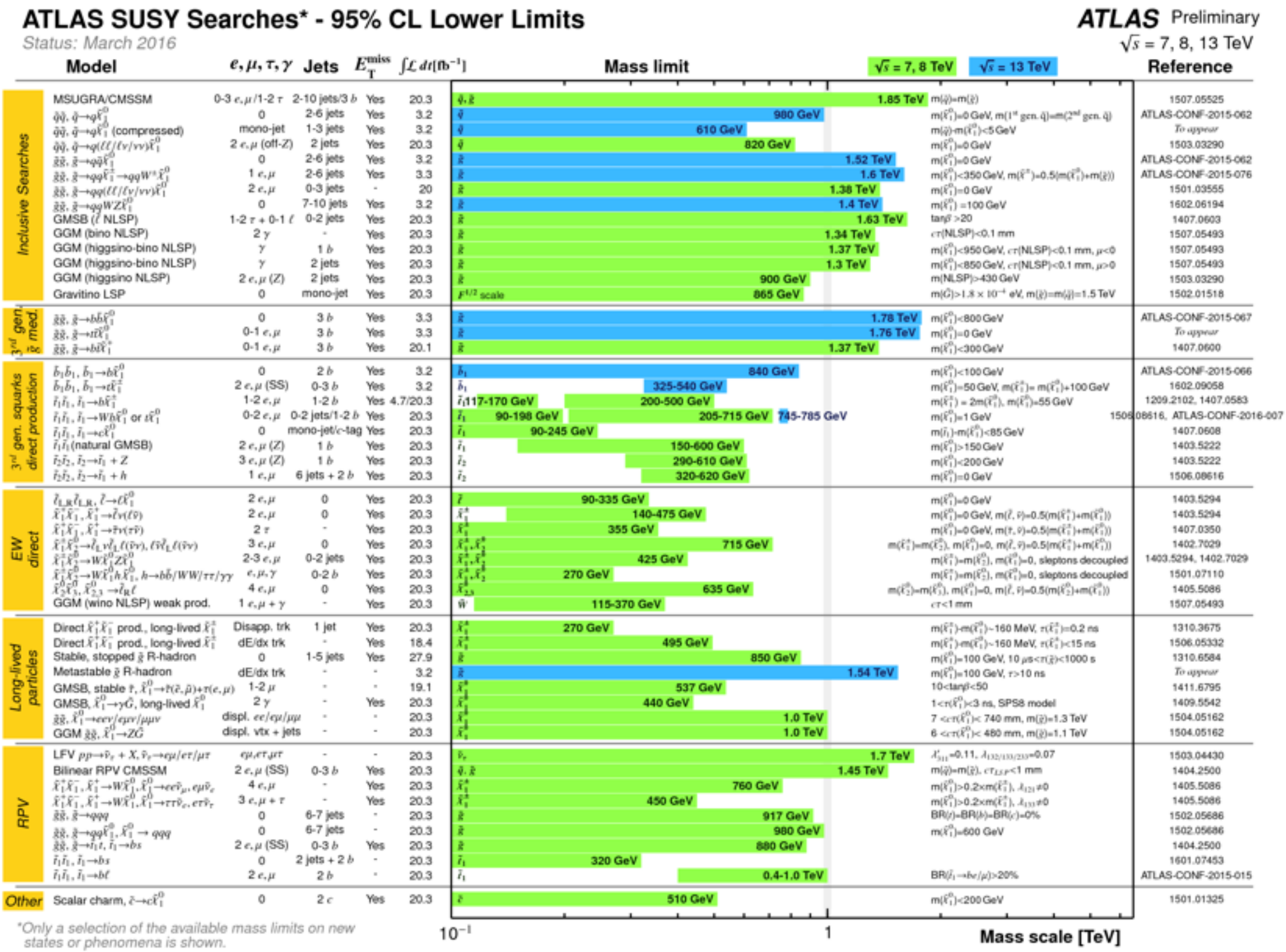
- even with the small amount of 13 TeV data, all analyses presented have been able to significantly improve their limits

- no new physics yet, but repeated modest excess in 2L search is interesting!
    - just starting data-taking again for 2016, and should have much better statistics to look in this and all other regions

- for more info, see: https://twiki.cern.ch/twiki/bin/view/AtlasPublic/SupersymmetryPublicResults

BACK-UP

SUMMARY


ATLAS SUSY Searches* - 95% CL Lower Limits
Status: March 2016
ATLAS Preliminary
√s = 7, 8, 13 TeV
Model
e, μ, τ, γ
Jets
E_T^miss
∫L dt[fb⁻¹]
Mass limit
√s = 7, 8 TeV
√s = 13 TeV
Reference
Inclusive Searches
MSUGRA/CMSSM 0-3 e,μ/1-2 τ 2-10 jets/3 b Yes 20.3 1.85 TeV m(q̃)=m(g̃) 1507.05525
q̃q̃, q̃→qχ̃₁⁰ 0 2-6 jets Yes 3.2 980 GeV m(χ̃₁⁰)=0 GeV, m(1st gen. q̃)=m(2nd gen. q̃) ATLAS-CONF-2015-062
q̃q̃, q̃→qχ̃₁⁰ (compressed) mono-jet 1-3 jets Yes 3.2 610 GeV m(q̃)-m(χ̃₁⁰)<5 GeV To appear
q̃q̃, q̃→qℓ(ℓℓ/ℓν/νν)χ̃₁⁰ 2 e,μ (off-Z) 2 jets Yes 20.3 820 GeV m(χ̃₁⁰)=0 GeV 1503.03290
g̃g̃, g̃→qqq̄q̄χ̃₁⁰ 0 2-6 jets Yes 3.2 1.52 TeV m(χ̃₁⁰)=0 GeV ATLAS-CONF-2015-062
g̃g̃, g̃→qqχ̃₁±→qqW±χ̃₁⁰ 1 e,μ 2-6 jets Yes 3.3 1.6 TeV m(χ̃₁⁰)<350 GeV, m(χ̃±)=0.5(m(χ̃₁⁰)+m(g̃)) ATLAS-CONF-2015-076
g̃g̃, g̃→qqℓ(ℓℓ/ℓν/νν)χ̃₁⁰ 2 e,μ 0-3 jets - 20 1.38 TeV m(χ̃₁⁰)=0 GeV 1501.03555
g̃g̃, g̃→qqWZχ̃₁⁰ 0 7-10 jets Yes 3.2 1.4 TeV m(χ̃₁⁰) =100 GeV 1602.06194
GMSB (l̃ NLSP) 1-2 τ + 0-1 ℓ 0-2 jets Yes 20.3 1.63 TeV tanβ >20 1407.0603
GGM (bino NLSP) 2 γ - Yes 20.3 1.34 TeV cτ(NLSP)<0.1 mm 1507.05493
GGM (higgsino-bino NLSP) γ 1 b Yes 20.3 1.37 TeV m(χ̃₁⁰)<950 GeV, cτ(NLSP)<0.1 mm, μ<0 1507.05493
GGM (higgsino-bino NLSP) γ 2 jets Yes 20.3 1.3 TeV m(χ̃₁⁰)<850 GeV, cτ(NLSP)<0.1 mm, μ>0 1507.05493
GGM (higgsino NLSP) 2 e,μ (Z) 2 jets Yes 20.3 900 GeV m(NLSP)>430 GeV 1503.03290
Gravitino LSP 0 mono-jet Yes 20.3 865 GeV F^1/2 scale m(G̃)>1.8 × 10⁻⁴ eV, m(g̃)=m(q̃)=1.5 TeV 1502.01518
3rd gen. g̃ med.
g̃g̃, g̃→bb̄χ̃₁⁰ 0 3 b Yes 3.3 1.78 TeV m(χ̃₁⁰)<800 GeV ATLAS-CONF-2015-067
g̃g̃, g̃→tt̄χ̃₁⁰ 0-1 e,μ 3 b Yes 3.3 1.76 TeV m(χ̃₁⁰)=0 GeV To appear
g̃g̃, g̃→bt̄χ̃₁⁺ 0-1 e,μ 3 b Yes 20.1 1.37 TeV m(χ̃₁⁰)<300 GeV 1407.0600
3rd gen. squarks direct production
b̃₁b̃₁, b̃₁→bχ̃₁⁰ 0 2 b Yes 3.2 840 GeV m(χ̃₁⁰)<100 GeV ATLAS-CONF-2015-066
b̃₁b̃₁, b̃₁→tχ̃₁± 2 e,μ (SS) 0-3 b Yes 3.2 325-540 GeV m(χ̃₁⁰)=50 GeV, m(χ̃₁±)= m(χ̃₁⁰)+100 GeV 1602.09058
t̃₁t̃₁, t̃₁→bχ̃₁± 1-2 e,μ 1-2 b Yes 4.7/20.3 117-170 GeV 200-500 GeV m(χ̃₁±) = 2m(χ̃₁⁰), m(χ̃₁⁰)=55 GeV 1209.2102, 1407.0583
t̃₁t̃₁, t̃₁→Wbχ̃₁⁰ or tχ̃₁⁰ 0-2 e,μ 0-2 jets/1-2 b Yes 20.3 90-198 GeV 205-715 GeV 745-785 GeV m(χ̃₁⁰)=1 GeV 1506.08616, ATLAS-CONF-2016-007
t̃₁t̃₁, t̃₁→cχ̃₁⁰ 0 mono-jet/c-tag Yes 20.3 90-245 GeV m(t̃₁)-m(χ̃₁⁰)<85 GeV 1407.0608
t̃₁t̃₁(natural GMSB) 2 e,μ (Z) 1 b Yes 20.3 150-600 GeV m(χ̃₁⁰)>150 GeV 1403.5222
t̃₂t̃₂, t̃₂→t̃₁ + Z 3 e,μ (Z) 1 b Yes 20.3 290-610 GeV m(χ̃₁⁰)<200 GeV 1403.5222
t̃₂t̃₂, t̃₂→t̃₁ + h 1 e,μ 6 jets + 2 b Yes 20.3 320-620 GeV m(χ̃₁⁰)=0 GeV 1506.08616
EW direct
l̃L,Rl̃L,R, l̃→ℓχ̃₁⁰ 2 e,μ 0 Yes 20.3 90-335 GeV m(χ̃₁⁰)=0 GeV 1403.5294
χ̃₁±χ̃₁∓, χ̃₁±→l̃ν(ℓν̃) 2 e,μ 0 Yes 20.3 140-475 GeV m(χ̃₁⁰)=0 GeV, m(l̃, ν̃)=0.5(m(χ̃₁±)+m(χ̃₁⁰)) 1403.5294
χ̃₁±χ̃₁∓, χ̃₁±→τ̃ν(τν̃) 2 τ - Yes 20.3 355 GeV m(χ̃₁⁰)=0 GeV, m(τ̃, ν̃)=0.5(m(χ̃₁±)+m(χ̃₁⁰)) 1407.0350
χ̃₁±χ̃₂⁰→l̃Lνl̃Ll(ν̃ν), ℓν̃l̃Ll(ν̃ν) 3 e,μ 0 Yes 20.3 715 GeV m(χ̃₁±)=m(χ̃₂⁰), m(χ̃₁⁰)=0, m(l̃, ν̃)=0.5(m(χ̃₁±)+m(χ̃₁⁰)) 1402.7029
χ̃₁±χ̃₂⁰→Wχ̃₁⁰Zχ̃₁⁰ 2-3 e,μ 0-2 jets Yes 20.3 425 GeV m(χ̃₁±)=m(χ̃₂⁰), m(χ̃₁⁰)=0, sleptons decoupled 1403.5294, 1402.7029
χ̃₁±χ̃₂⁰→Wχ̃₁⁰hχ̃₁⁰, h→bb̄/WW/ττ/γγ e,μ,γ 0-2 b Yes 20.3 270 GeV m(χ̃₁±)=m(χ̃₂⁰), m(χ̃₁⁰)=0, sleptons decoupled 1501.07110
χ̃₂⁰χ̃₃⁰, χ̃₂,₃⁰→l̃Rℓ 4 e,μ 0 Yes 20.3 635 GeV m(χ̃₂⁰)=m(χ̃₃⁰), m(χ̃₁⁰)=0, m(l̃, ν̃)=0.5(m(χ̃₂⁰)+m(χ̃₁⁰)) 1405.5086
GGM (wino NLSP) weak prod. 1 e,μ + γ - Yes 20.3 115-370 GeV cτ<1 mm 1507.05493
Long-lived particles
Direct χ̃₁±χ̃₁∓ prod., long-lived χ̃₁± Disapp. trk 1 jet Yes 20.3 270 GeV m(χ̃₁±)-m(χ̃₁⁰)~160 MeV, τ(χ̃₁±)=0.2 ns 1310.3675
Direct χ̃₁±χ̃₁∓ prod., long-lived χ̃₁± dE/dx trk - Yes 18.4 495 GeV m(χ̃₁±)-m(χ̃₁⁰)~160 MeV, τ(χ̃₁±)<15 ns 1506.05332
Stable, stopped g̃ R-hadron 0 1-5 jets Yes 27.9 850 GeV m(χ̃₁⁰)=100 GeV, 10 μs<τ(g̃)<1000 s 1310.6584
Metastable g̃ R-hadron dE/dx trk - - 3.2 1.54 TeV m(χ̃₁⁰)=100 GeV, τ>10 ns To appear
GMSB, stable τ̃, χ̃₁⁰→τ̃(ẽ, μ̃)+τ(e, μ) 1-2 μ - - 19.1 537 GeV 10<tanβ<50 1411.6795
GMSB, χ̃₁⁰→γG̃, long-lived χ̃₁⁰ 2 γ - Yes 20.3 440 GeV 1<τ(χ̃₁⁰)<3 ns, SPS8 model 1409.5542
g̃g̃, χ̃₁⁰→eeν/eμν/μμν displ. ee/eμ/μμ - - 20.3 1.0 TeV 7 <cτ(χ̃₁⁰)< 740 mm, m(g̃)=1.3 TeV 1504.05162
GGM g̃g̃, χ̃₁⁰→ZG̃ displ. vtx + jets - - 20.3 1.0 TeV 6 <cτ(χ̃₁⁰)< 480 mm, m(g̃)=1.1 TeV 1504.05162
RPV
LFV pp→ν̃τ + X, ν̃τ→eμ/eτ/μτ eμ,eτ,μτ - - 20.3 1.7 TeV λ'311=0.11, λ132/133/233=0.07 1503.04430
Bilinear RPV CMSSM 2 e,μ (SS) 0-3 b Yes 20.3 1.45 TeV m(q̃)=m(g̃), cτLSP<1 mm 1404.2500
χ̃₁±χ̃₁∓, χ̃₁±→Wχ̃₁⁰, χ̃₁⁰→eeν̃μ, eμν̃e 4 e,μ - Yes 20.3 760 GeV m(χ̃₁⁰)>0.2×m(χ̃₁±), λ121≠0 1405.5086
χ̃₁±χ̃₁∓, χ̃₁±→Wχ̃₁⁰, χ̃₁⁰→ττν̃e, eτν̃τ 3 e,μ + τ - Yes 20.3 450 GeV m(χ̃₁⁰)>0.2×m(χ̃₁±), λ133≠0 1405.5086
g̃g̃, g̃→qqq 0 6-7 jets - 20.3 917 GeV BR(t)=BR(b)=BR(c)=0% 1502.05686
g̃g̃, g̃→qqχ̃₁⁰, χ̃₁⁰ → qqq 0 6-7 jets - 20.3 980 GeV m(χ̃₁⁰)=600 GeV 1502.05686
g̃g̃, g̃→t̄t, t̃₁→bs 2 e,μ (SS) 0-3 b Yes 20.3 880 GeV 1404.2500
t̃₁t̃₁, t̃₁→bs 0 2 jets + 2 b - 20.3 320 GeV 1601.07453
t̃₁t̃₁, t̃₁→bℓ 2 e,μ 2 b - 20.3 0.4-1.0 TeV BR(t̃₁→be/μ)>20% ATLAS-CONF-2015-015
Other
Scalar charm, c̃→cχ̃₁⁰ 0 2 c Yes 20.3 510 GeV m(χ̃₁⁰)<200 GeV 1501.01325
*Only a selection of the available mass limits on new states or phenomena is shown.
10⁻¹
1
Mass scale [TeV]

0L, 2-6 JETS

0L, 2-6 JETS

signal regions

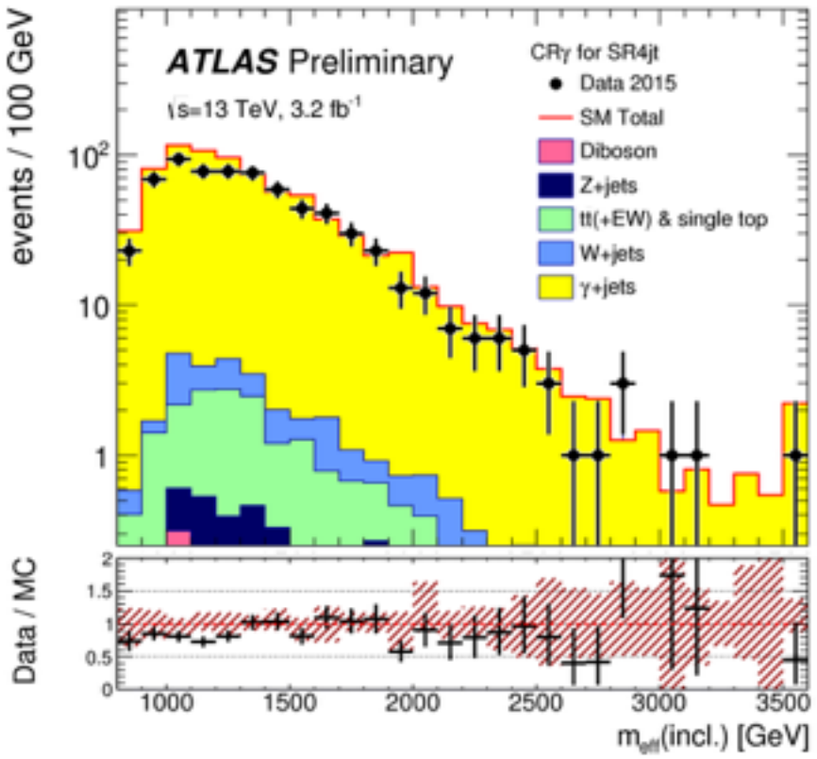
Requirement	Signal Region						
	2jl	**2jm**	**2jt**	**4jt**	**5j**	**6jm**	**6jt**
$E_{\mathrm{T}}^{\mathrm{miss}}$ [GeV] >	200						
$p_{\mathrm{T}}(j_1)$ [GeV] >	200	300	200				
$p_{\mathrm{T}}(j_2)$ [GeV] >	200	50	200	100			
$p_{\mathrm{T}}(j_3)$ [GeV] >	–			100			
$p_{\mathrm{T}}(j_4)$ [GeV] >	–			100			
$p_{\mathrm{T}}(j_5)$ [GeV] >	–				100		
$p_{\mathrm{T}}(j_6)$ [GeV] >	–					100	
$\Delta\phi(\mathrm{jet}_{1,2,(3)}, \boldsymbol{E}_{\mathrm{T}}^{\mathrm{miss}})_{\mathrm{min}}$ >	0.8	0.4	0.8	0.4			
$\Delta\phi(\mathrm{jet}_{i>3}, \boldsymbol{E}_{\mathrm{T}}^{\mathrm{miss}})_{\mathrm{min}}$ >	–			0.2			
$E_{\mathrm{T}}^{\mathrm{miss}}/\sqrt{H_{\mathrm{T}}}$ [GeV$^{1/2}$] >	15		20	–			
Aplanarity >	–			0.04			
$E_{\mathrm{T}}^{\mathrm{miss}}/m_{\mathrm{eff}}(N_{\mathrm{j}})$ >	–			0.2	0.25		0.2
m_{eff}(incl.) [GeV] >	1200	1600	2000	2200	1600	1600	2000

0L, 2-6 JETS

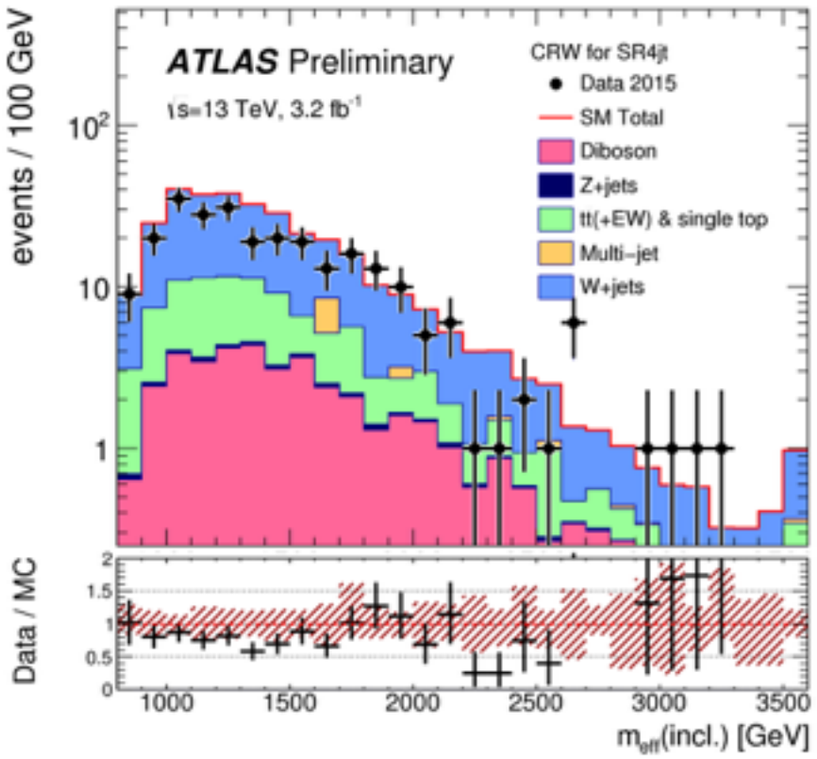
CRs

CR	SR background	CR process	CR selection
CRγ	$Z(\to \nu\bar{\nu})$+jets	γ+jets	Isolated photon
CRQ	Multi-jet	Multi-jet	SR with reversed requirements on (i) (jet, $\boldsymbol{E}_{\mathrm{T}}^{\mathrm{miss}}$)$_{\mathrm{min}}$ and (ii) $E_{\mathrm{T}}^{\mathrm{miss}}/m_{\mathrm{eff}}(N_{\mathrm{j}})$ or $E_{\mathrm{T}}^{\mathrm{miss}}/\sqrt{H_{\mathrm{T}}}$
CRW	$W(\to \ell\nu)$+jets	$W(\to \ell\nu)$+jets	30 GeV $< m_{\mathrm{T}}(\ell, E_{\mathrm{T}}^{\mathrm{miss}}) <$ 100 GeV, b-veto
CRT	$t\bar{t}$(+EW) and single top	$t\bar{t} \to b\bar{b}qq'\ell\nu$	30 GeV $< m_{\mathrm{T}}(\ell, E_{\mathrm{T}}^{\mathrm{miss}}) <$ 100 GeV, b-tag

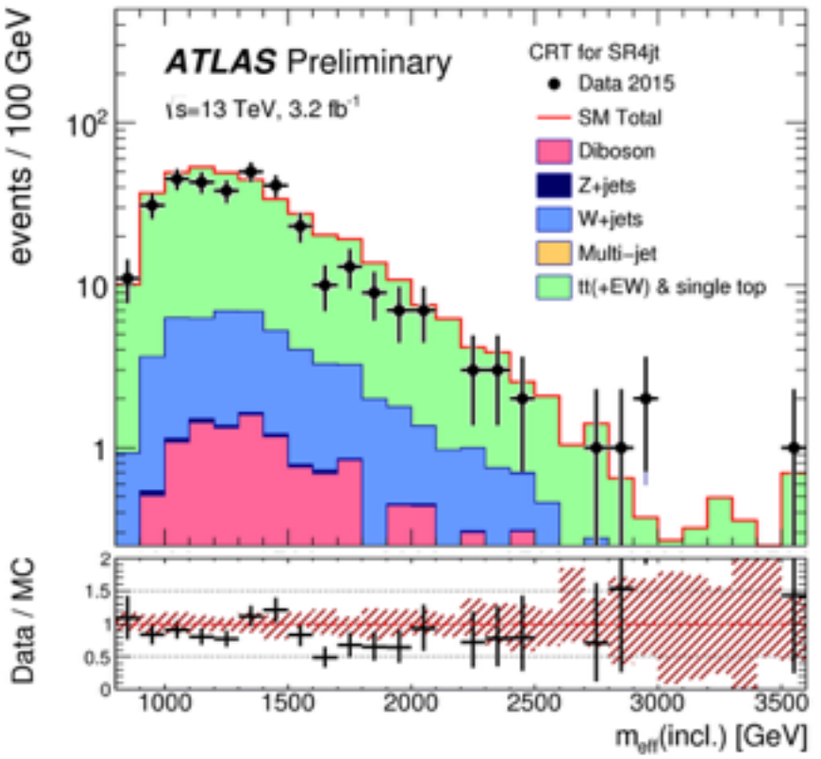
CRY



CRW



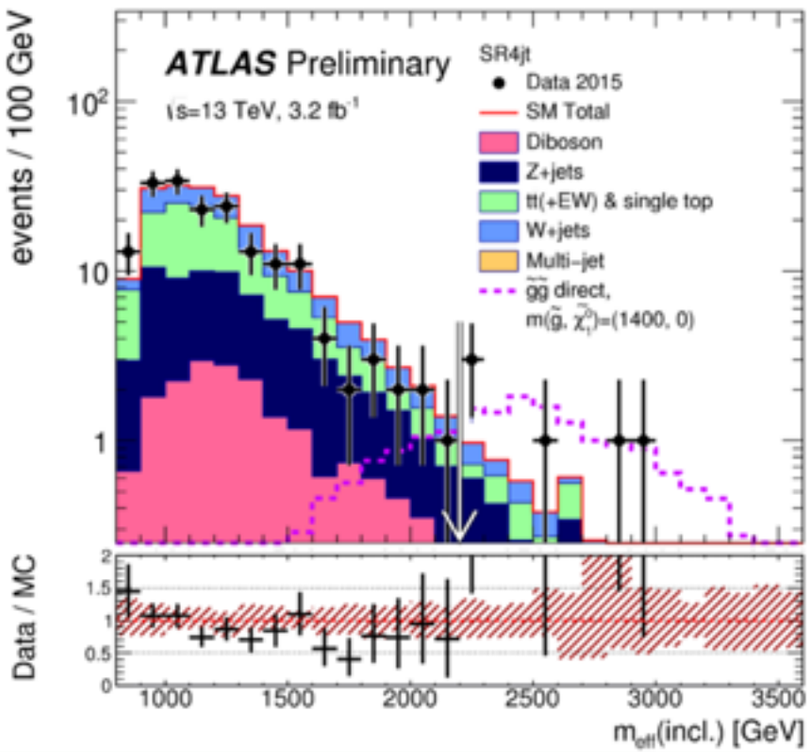
CRT



0L, 2-6 JETS

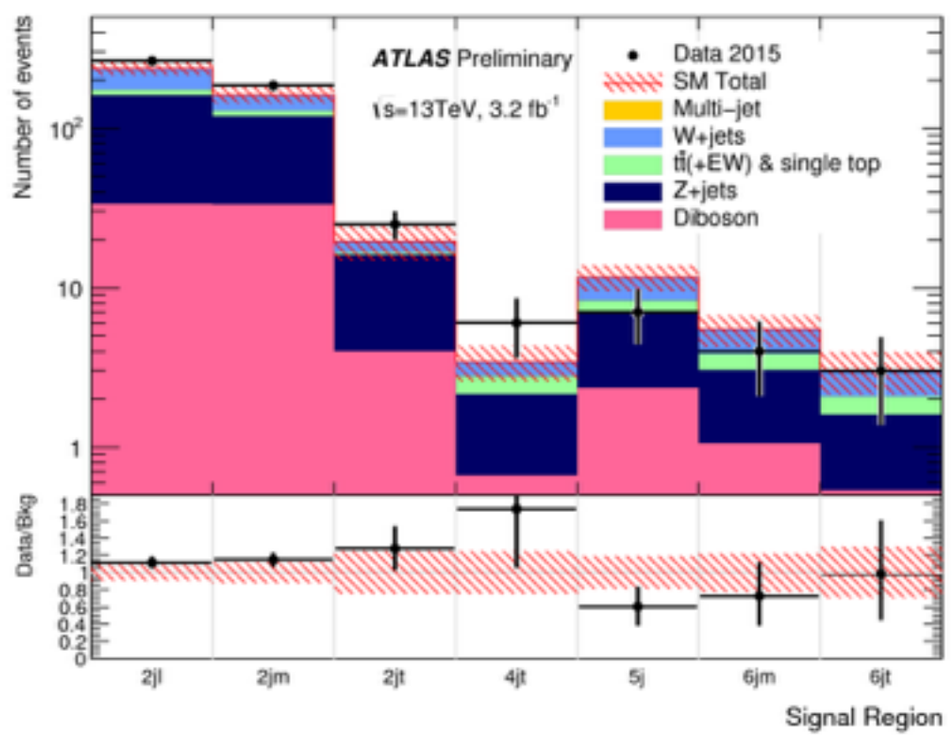
uncertainties

Channel	2jl	2jm	2jt	4jt	5j	6jm	6jt
Total bkg	237	163	20	3.5	11.7	5.5	3.1
Total bkg unc.	±22 [9%]	±20 [12%]	±5 [25%]	±0.8 [23%]	±2.2 [19%]	±1.2 [22%]	±0.9 [29%]
MC statistics	–	±1.8 [1%]	±0.5 [3%]	±0.26 [7%]	±0.5 [4%]	±0.35 [6%]	±0.27 [9%]
$\Delta\mu_{Z+\text{jets}}$	±6 [3%]	±5 [3%]	±2.0 [10%]	±0.5 [14%]	±0.8 [7%]	±0.6 [11%]	±0.4 [13%]
$\Delta\mu_{W+\text{jets}}$	±4 [2%]	±4 [2%]	±0.7 [3%]	±0.32 [9%]	±0.7 [6%]	±0.5 [9%]	±0.4 [13%]
$\Delta\mu_{\text{Top}}$	±1.2 [1%]	±1.6 [1%]	±0.21 [1%]	±0.26 [7%]	±0.32 [3%]	±0.21 [4%]	±0.24 [8%]
$\Delta\mu_{\text{Multi-jet}}$	±0.05 [0%]	±0.09 [0%]	–	–	–	–	–
CRγ corr. factor	±8 [3%]	±6 [4%]	±0.8 [4%]	±0.1 [3%]	±0.29 [2%]	±0.13 [2%]	±0.07 [2%]
Theory W	±1.4 [1%]	±2.3 [1%]	±0.4 [2%]	±0.22 [6%]	±0.7 [6%]	±0.4 [7%]	±0.34 [11%]
Theory Z	±6 [3%]	±3.2 [2%]	±4 [20%]	±0.32 [9%]	±0.9 [8%]	±0.32 [6%]	±0.3 [10%]
Theory Top	±2.7 [1%]	±2.1 [1%]	±0.5 [3%]	±0.24 [7%]	±0.2 [2%]	±0.27 [5%]	±0.2 [6%]
Theory Diboson	±16 [7%]	±16 [10%]	±2.0 [10%]	–	±1.0 [9%]	–	–
Jet/$E_{\text{T}}^{\text{miss}}$	±1.5 [1%]	±2.1 [1%]	±0.29 [1%]	±0.14 [4%]	±0.8 [7%]	±0.4 [7%]	±0.27 [9%]



4j - tight SR

all SRs



0L, 2-6 JETS

results

Signal Region	2jl	2jm	2jt	4jt	5j	6jm	6jt
MC expected events							
Diboson	33	33	4.0	0.7	2.4	1.1	0.5
Z/γ^*+jets	151	94	12	1.8	4.9	2.5	1.3
W+jets	72	42	4.5	0.9	3.0	1.6	0.9
$t\bar{t}$(+EW) + single top	18	17	1.2	0.9	2.7	1.6	1.1
Multi-jet	0.6	0.8	0.03	–	–	–	–
Total MC	275	188	22	4.3	13	6.7	3.8
Fitted background events							
Diboson	33 ± 17	33 ± 17	4.0 ± 2.0	0.67 ± 0.35	2.4 ± 1.3	1.1 ± 0.6	0.5 ± 0.4
Z/γ^*+jets	127 ± 12	85 ± 8	12 ± 4	1.5 ± 0.6	4.5 ± 1.3	2.0 ± 0.7	1.1 ± 0.6
W+jets	61 ± 4	32 ± 5	2.9 ± 0.8	0.7 ± 0.4	3.3 ± 1.0	1.7 ± 0.7	1.0 ± 0.6
$t\bar{t}$(+EW) + single top	14.6 ± 2.9	10.5 ± 2.6	0.7 ± 0.5	0.6 ± 0.4	1.4 ± 0.5	0.8 ± 0.4	0.46 ± 0.33
Multi-jet	0.51 ± 0.06	0.6 ± 0.5	–	–	–	–	–
Total bkg	237 ± 22	163 ± 20	20 ± 5	3.5 ± 0.8	11.7 ± 2.2	5.5 ± 1.2	3.1 ± 0.9
Observed	264	186	25	6	7	4	3
$\langle\epsilon\sigma\rangle^{95}_{\rm obs}$ [fb]	24	21	5.9	2.5	2.0	1.6	1.6
$S^{95}_{\rm obs}$	76	67	19	8.2	6.3	5.3	5.0
$S^{95}_{\rm exp}$	52^{+22}_{-15}	46^{+19}_{-12}	$14.1^{+5.1}_{-3.1}$	$5.7^{+2.2}_{-1.6}$	$8.5^{+3.3}_{-2.1}$	$6.5^{+2.5}_{-1.6}$	$5.0^{+2.3}_{-1.4}$
p_0 (Z)	0.11 (1.20)	0.12 (1.15)	0.18 (0.93)	0.14 (1.08)	0.5 (0.0)	0.5 (0.0)	0.5 (0.0)

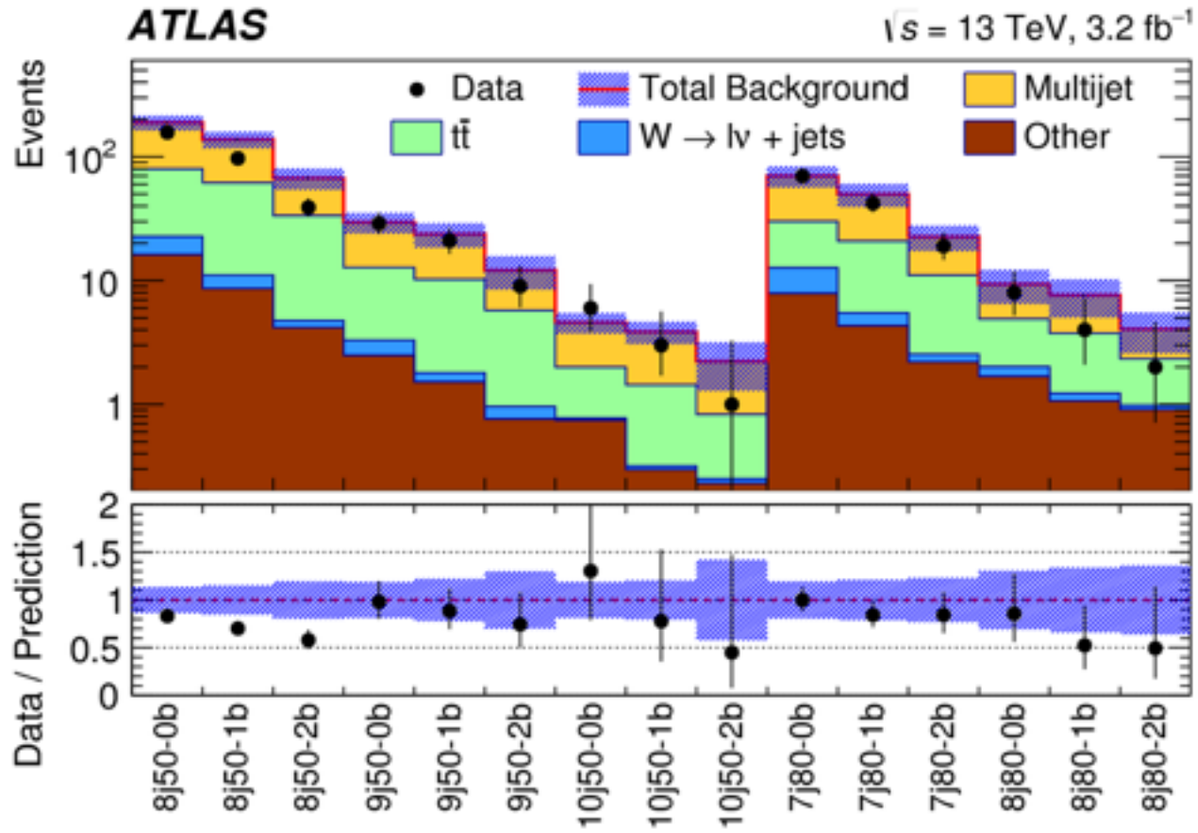
OL, 7-10 JETS

0L, 7-10 JETS

SRs

	8j50	8j50-1b	8j50-2b	9j50	9j50-1b	9j50-2b	10j50	10j50-1b	10j50-2b
n_{50}	≥ 8			≥ 9			≥ 10		
$n_{b-\text{jet}}$	—	≥ 1	≥ 2	—	≥ 1	≥ 2	—	≥ 1	≥ 2
$E_{\text{T}}^{\text{miss}}/\sqrt{H_{\text{T}}}$	$> 4\,\text{GeV}^{1/2}$								

	7j80	7j80-1b	7j80-2b	8j80	8j80-1b	8j80-2b
n_{80}	≥ 7			≥ 8		
$n_{b-\text{jet}}$	—	≥ 1	≥ 2	—	≥ 1	≥ 2
$E_{\text{T}}^{\text{miss}}/\sqrt{H_{\text{T}}}$	$> 4\,\text{GeV}^{1/2}$					



0L, 7-10 JETS

CRs

SR name	nj50 or nj50-1b or nj50-2b		nj80 or nj80-1b or nj80-2b	
CR name	CR$(n-1)$j50-0b	CR$(n-1)$j50-1b	CR$(n-1)$j80-0b	CR$(n-1)$j80-1b
p_{T}^{ℓ} $(\ell \in \{e\,\mu\})$	> 20 GeV			
m_{T}	< 120 GeV			
$E_{\mathrm{T}}^{\mathrm{miss}}/\sqrt{H_{\mathrm{T}}}$	$> 3\,\mathrm{GeV}^{1/2}$			
n_{50}^{CR}	$\geq n_{50} - 1$		—	
n_{80}^{CR}	—		$\geq n_{80} - 1$	
$n_{b-\mathrm{jet}}$	0	≥ 1	0	≥ 1

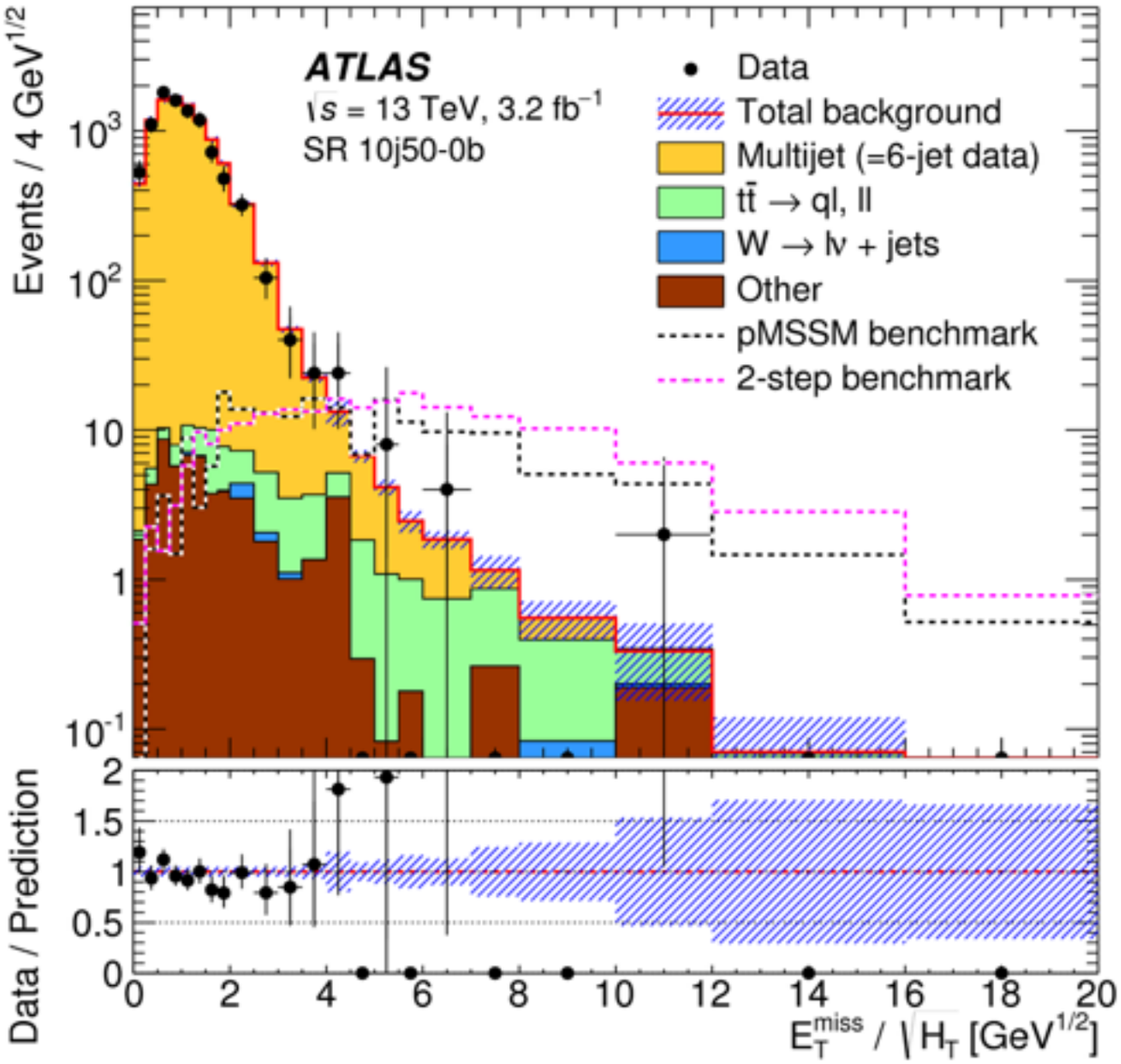
0L, 7-10 JETS

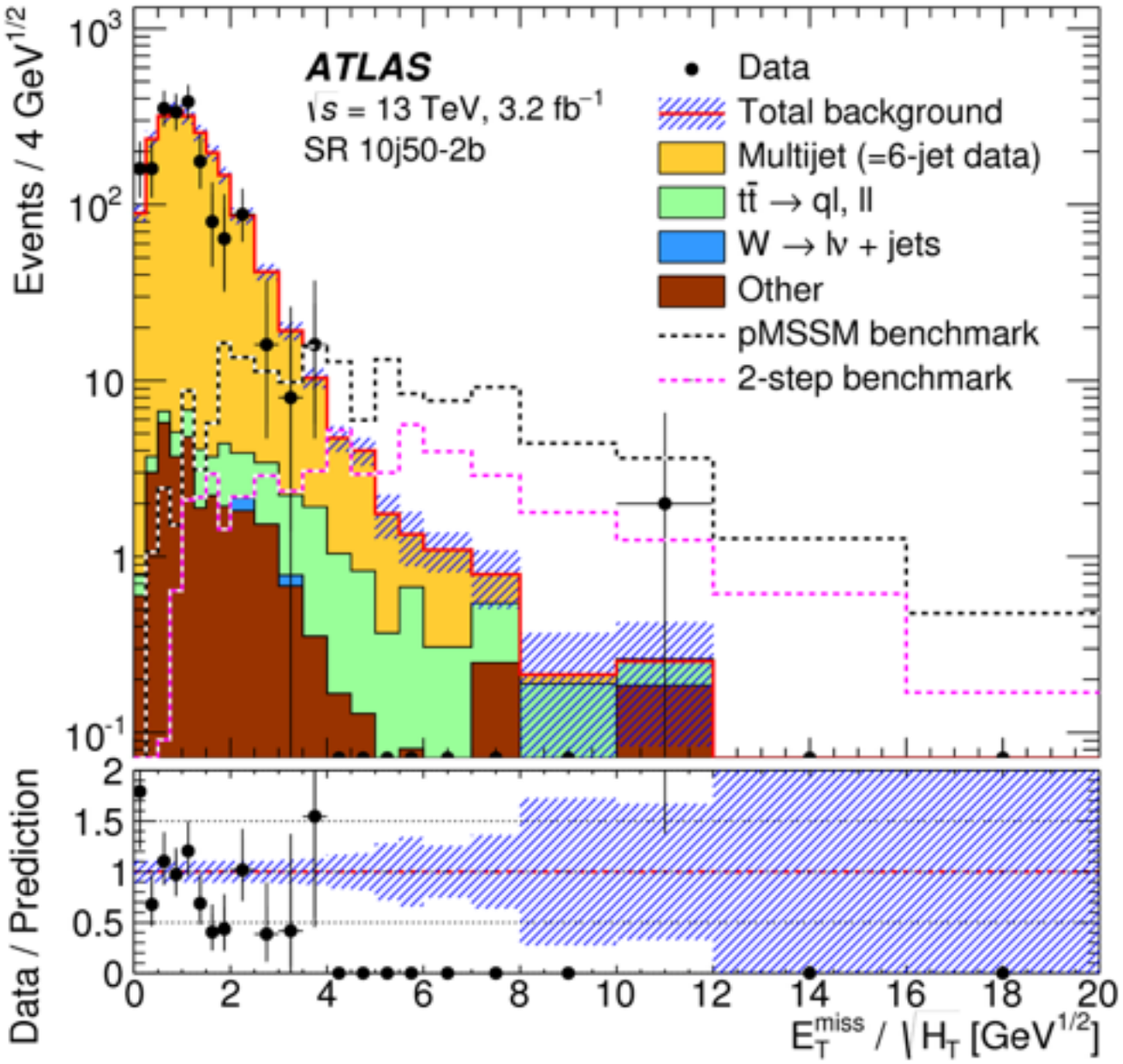
results

Signal region	Fitted background			Obs events
	Multijet	Leptonic	Total	
8j50	109.3 ± 6.9	80 ± 25	189 ± 26	157
8j50-1b	76.7 ± 2.7	62 ± 21	138 ± 21	97
8j50-2b	33.8 ± 2.1	33 ± 13	67 ± 13	39
9j50	16.8 ± 1.3	12.8 ± 5.4	29.6 ± 5.6	29
9j50-1b	13.5 ± 2.0	10.2 ± 4.9	23.8 ± 5.3	21
9j50-2b	6.4 ± 1.6	5.8 ± 3.3	12.1 ± 3.6	9
10j50	2.61 ± 0.61	1.99 ± 0.62	4.60 ± 0.87	6
10j50-1b	2.42 ± 0.62	1.44 ± 0.49	3.86 ± 0.79	3
10j50-2b	1.40 ± 0.87	0.83 ± 0.37	2.23 ± 0.94	1
7j80	40.0 ± 5.3	30 ± 13	70 ± 14	70
7j80-1b	29.1 ± 3.4	20.8 ± 10	50 ± 11	42
7j80-2b	11.5 ± 1.6	11.0 ± 5.0	22.5 ± 5.2	19
8j80	4.5 ± 1.9	4.9 ± 2.2	9.3 ± 2.9	8
8j80-1b	3.9 ± 1.5	3.8 ± 2.1	7.6 ± 2.6	4
8j80-2b	1.72 ± 0.93	2.3 ± 1.1	4.1 ± 1.5	2

0L, 7-10 JETS

results





0/1L + 3 B-JETS

0/1L + 3 B-JETS

Criteria common to all Gbb regions: ≥ 4 signal jets, ≥ 3 b-jets				
	Variable	Signal region	Control region	Validation region
Criteria common to all regions of the same type	Lepton	Candidate veto	$= 1$ signal	Candidate veto
	$\Delta\phi_{\text{min}}^{\text{4j}}$	> 0.4	–	> 0.4
	$\text{m}_{\text{T,min}}^{b-\text{jets}}$	–	–	< 160
	m_{T}	–	< 150	–
Region A (Large mass splitting)	$p_{\text{T}}^{\text{jet}}$	> 90	> 90	> 90
	$E_{\text{T}}^{\text{miss}}$	> 350	> 250	> 250
	$\text{m}_{\text{eff}}^{\text{4j}}$	> 1600	> 1200	< 1400
Region B (Moderate mass splitting)	$p_{\text{T}}^{\text{jet}}$	> 90	> 90	> 90
	$E_{\text{T}}^{\text{miss}}$	> 450	> 300	> 300
	$\text{m}_{\text{eff}}^{\text{4j}}$	> 1400	> 1000	< 1400
Region C (Small mass splitting)	$p_{\text{T}}^{\text{jet}}$	> 30	> 30	> 30
	$E_{\text{T}}^{\text{miss}}$	> 500	> 400	> 400
	$\text{m}_{\text{eff}}^{\text{4j}}$	> 1400	> 1200	< 1400

0/1L + 3 B-JETS

Criteria common to all Gtt 0-lepton regions: $p_{\mathrm{T}}^{\mathrm{jet}} > 30$ GeV					
	Variable	Signal region	Control region	VR1L	VR0L
Criteria common to all regions of the same type	Lepton	0 signal	= 1 signal	= 1 signal	0 signal
	$\Delta\phi_{\mathrm{min}}^{\mathrm{4j}}$	> 0.4	–	–	> 0.4
	$\mathrm{N}^{\mathrm{jet}}$	≥ 8	≥ 7	≥ 7	≥ 8
	$\mathrm{m}_{\mathrm{T,min}}^{b-\mathrm{jets}}$	> 80	–	> 80	< 80
	m_{T}	–	< 150	< 150	–
Region A (Large mass splitting)	$E_{\mathrm{T}}^{\mathrm{miss}}$	> 400	> 250	> 250	> 200
	$\mathrm{m}_{\mathrm{eff}}^{\mathrm{incl}}$	> 1700	> 1350	> 1350	> 1400
	$\mathrm{N}^{b-\mathrm{jet}}$	≥ 3	≥ 3	≥ 3	≥ 2
	$\mathrm{N}^{\mathrm{top}}$	≥ 1	≥ 1	≥ 1	≥ 1
Region B (Moderate mass splitting)	$E_{\mathrm{T}}^{\mathrm{miss}}$	> 350	> 200	> 200	> 200
	$\mathrm{m}_{\mathrm{eff}}^{\mathrm{incl}}$	> 1250	> 1000	> 1000	> 1100
	$\mathrm{N}^{b-\mathrm{jet}}$	≥ 4	≥ 4	≥ 4	≥ 3
	$\mathrm{N}^{\mathrm{top}}$	≥ 1	≥ 1	≥ 1	≥ 1
Region C (Small mass splitting)	$E_{\mathrm{T}}^{\mathrm{miss}}$	> 350	> 200	> 200	> 200
	$\mathrm{m}_{\mathrm{eff}}^{\mathrm{incl}}$	> 1250	> 1000	> 1000	> 1250
	$\mathrm{N}^{b-\mathrm{jet}}$	≥ 4	≥ 4	≥ 4	≥ 3

0/1L + 3 B-JETS

Criteria common to all Gtt 1-lepton regions: ≥ 1 signal lepton, $p_{\mathrm{T}}^{\mathrm{jet}} > 30$ GeV					
	Variable	Signal region	Control region	VR-m_{T}	VR-$\mathrm{m}_{\mathrm{T,min}}^{b-\mathrm{jets}}$
Criteria common to all regions of the same type	m_{T}	> 150	< 150	> 150	< 150
	$\mathrm{N}^{\mathrm{jet}}$	≥ 6	≥ 6	≥ 5	≥ 6
	$\mathrm{N}^{b-\mathrm{jet}}$	≥ 3	≥ 3	$= 3$	$= 3$
Region A (Large mass splitting)	$E_{\mathrm{T}}^{\mathrm{miss}}$	> 200	> 200	> 200	> 200
	$\mathrm{m}_{\mathrm{eff}}^{\mathrm{incl}}$	> 1100	> 1100	> 600	> 600
	$\mathrm{m}_{\mathrm{T,min}}^{b-\mathrm{jets}}$	> 160	–	< 160	> 140
	$\mathrm{N}^{\mathrm{top}}$	≥ 1	≥ 1	≥ 1	≥ 1
Region B (Moderate to small mass splitting)	$E_{\mathrm{T}}^{\mathrm{miss}}$	> 300	> 300	> 200	> 200
	$\mathrm{m}_{\mathrm{eff}}^{\mathrm{incl}}$	> 900	> 900	> 600	> 600
	$\mathrm{m}_{\mathrm{T,min}}^{b-\mathrm{jets}}$	> 160	–	< 160	> 160

0/1L + 3 B-JETS

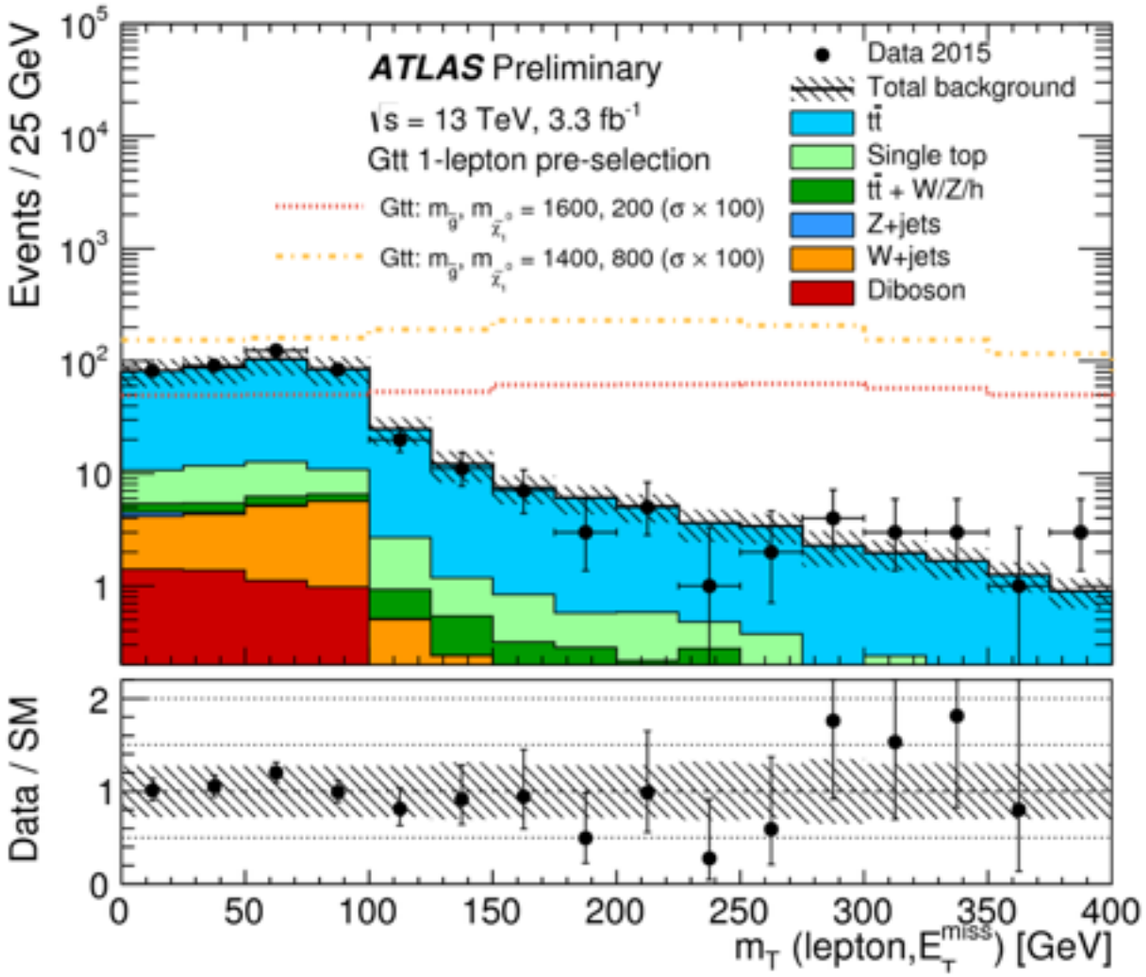
	SR-Gbb-A	SR-Gbb-B	SR-Gbb-C
Observed events	0	1	5
Fitted background events	1.4 ± 0.7	1.5 ± 0.5	7.5 ± 1.4
$t\bar{t}$	0.7 ± 0.5	0.83 ± 0.32	3.9 ± 1.0
Z+jets	0.25 ± 0.26	0.25 ± 0.22	1.4 ± 0.6
W+jets	0.19 ± 0.10	0.15 ± 0.06	0.95 ± 0.34
Single-top	0.22 ± 0.10	0.16 ± 0.15	0.67 ± 0.33
$t\bar{t}W$, $t\bar{t}Z$, $t\bar{t}H$, $t\bar{t}t\bar{t}$	< 0.1	< 0.1	0.18 ± 0.10
Diboson	–	< 0.1	0.43 ± 0.25
MC-only prediction	1.7	1.6	7.1
$\mu_{t\bar{t}}$	0.7 ± 0.3	0.9 ± 0.4	1.1 ± 0.4

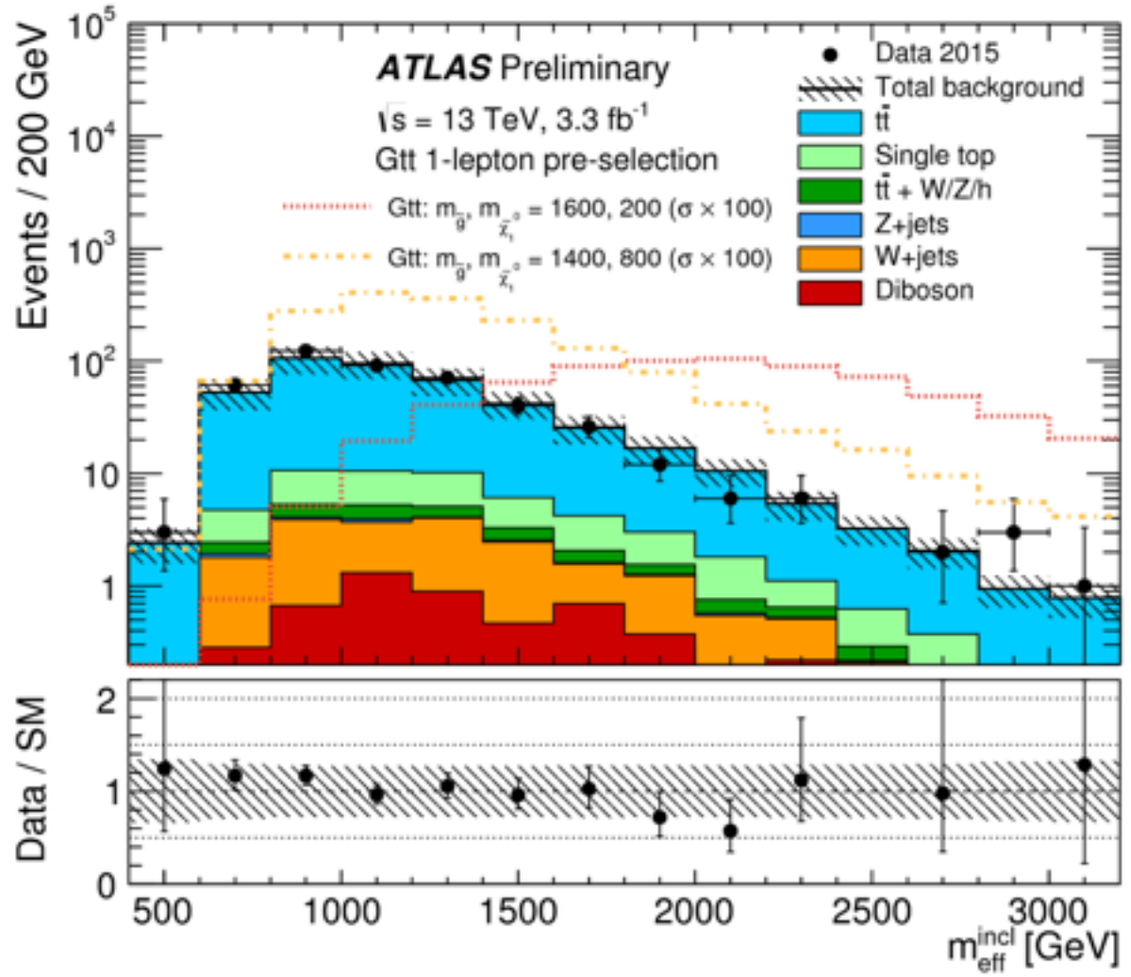
0/1L + 3 B-JETS

	SR-Gtt-0l-A	SR-Gtt-0L-B	SR-Gtt-0L-C
Observed events	1	1	1
Fitted background events	2.0 ± 0.7	2.8 ± 1.7	3.2 ± 1.7
$t\bar{t}$	1.3 ± 0.6	2.2 ± 1.6	2.4 ± 1.7
Z+jets	0.24 ± 0.17	0.13 ± 0.13	0.16 ± 0.09
W+jets	0.21 ± 0.14	0.15 ± 0.16	0.20 ± 0.21
Single-top	0.14 ± 0.16	0.15 ± 0.13	0.18 ± 0.16
$t\bar{t}W$, $t\bar{t}Z$, $t\bar{t}h$, $t\bar{t}t\bar{t}$	< 0.1	0.10 ± 0.06	0.11 ± 0.06
Diboson	< 0.1	< 0.1	0.18 ± 0.18
MC-only prediction	1.8	1.9	2.6
$\mu_{t\bar{t}}$	1.2 ± 0.4	1.7 ± 0.7	1.4 ± 0.6

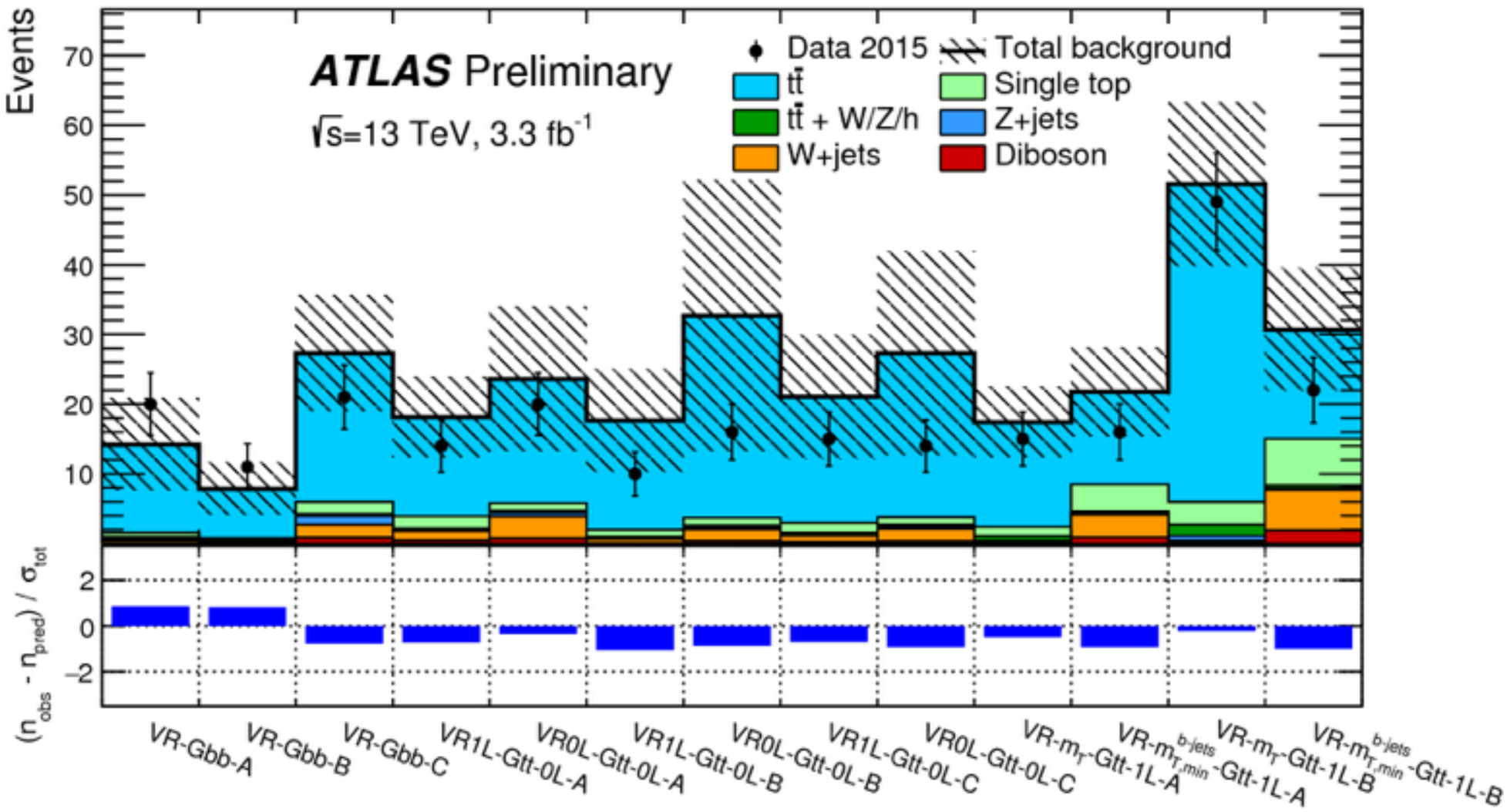
	SR-Gtt-1L-A	SR-Gtt-1L-B
Observed events	2	0
Fitted background events	1.3 ± 0.4	1.1 ± 0.6
$t\bar{t}$	0.91 ± 0.33	0.8 ± 0.5
Z+jets	–	–
W+jets	< 0.1	< 0.1
Single-top	0.19 ± 0.15	0.15 ± 0.13
$t\bar{t}W$, $t\bar{t}Z$, $t\bar{t}h$, $t\bar{t}t\bar{t}$	0.18 ± 0.10	0.18 ± 0.10
Diboson	–	–
MC-only prediction	1.3	1.2
$\mu_{t\bar{t}}$	1.0 ± 0.3	0.9 ± 0.3

0/1L + 3 B-JETS


ATLAS Preliminary
√s = 13 TeV, 3.3 fb-1
Gtt 1-lepton pre-selection
Gtt: mg̃, mχ̃1⁰ = 1600, 200 (σ × 100)
Gtt: mg̃, mχ̃1⁰ = 1400, 800 (σ × 100)
Data 2015
Total background
tt̄
Single top
tt̄ + W/Z/h
Z+jets
W+jets
Diboson
Events / 25 GeV
Data / SM
mT (lepton,ETmiss) [GeV]


ATLAS Preliminary
√s = 13 TeV, 3.3 fb-1
Gtt 1-lepton pre-selection
Gtt: mg̃, mχ̃1⁰ = 1600, 200 (σ × 100)
Gtt: mg̃, mχ̃1⁰ = 1400, 800 (σ × 100)
Data 2015
Total background
tt̄
Single top
tt̄ + W/Z/h
Z+jets
W+jets
Diboson
Events / 200 GeV
Data / SM
meffincl [GeV]

0/1L + 3 B-JETS


ATLAS Preliminary
√s=13 TeV, 3.3 fb-1
Data 2015
Total background
tt̄
Single top
tt̄ + W/Z/h
Z+jets
W+jets
Diboson
Events
70
60
50
40
30
20
10
2
0
-2
(nobs - npred) / σtot
VR-Gbb-A
VR-Gbb-B
VR-Gbb-C
VR1L-Gtt-0L-A
VR0L-Gtt-0L-A
VR1L-Gtt-0L-B
VR0L-Gtt-0L-B
VR1L-Gtt-0L-C
VR0L-Gtt-0L-C
VR-mT-Gtt-1L-A
VR-mTb-jets,min-Gtt-1L-A
VR-mT-Gtt-1L-B
VR-mTb-jets,min-Gtt-1L-B

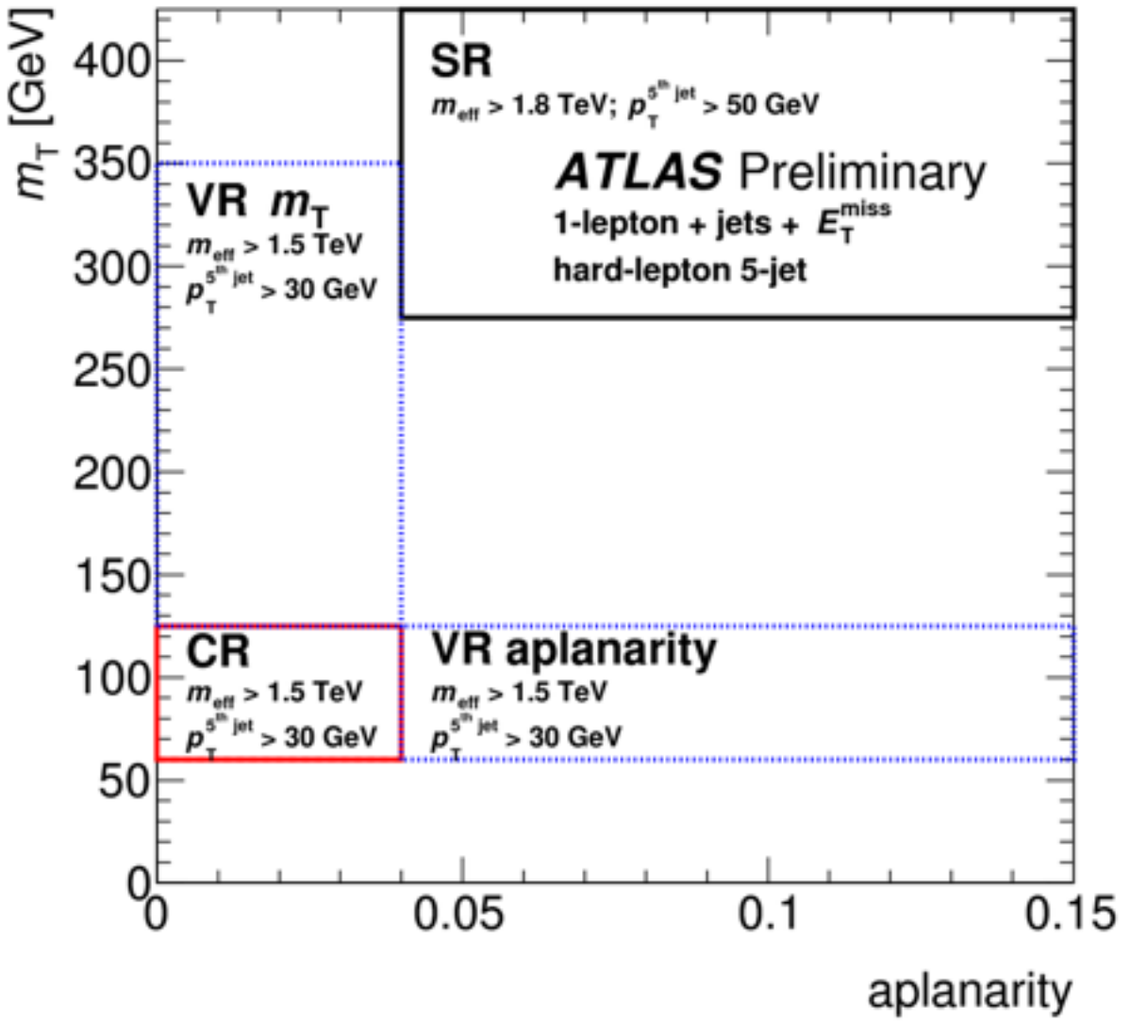
1L + JETS

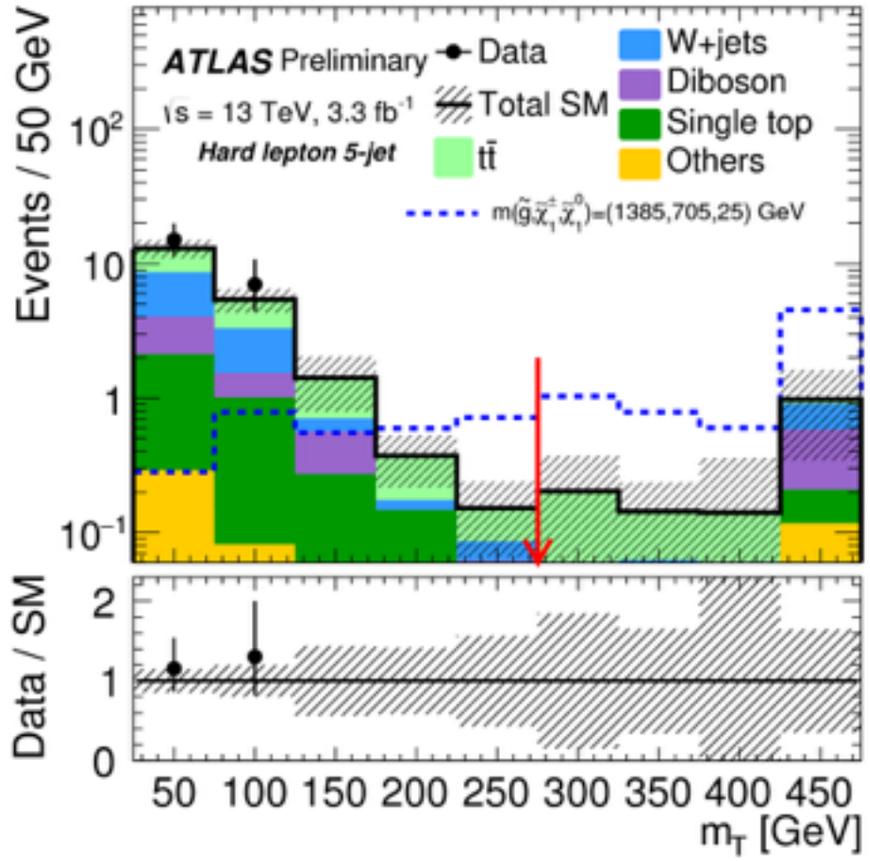
1L + JETS

	2-jet soft-lepton SR	**5-jet soft-lepton SR**
N_{lep}	$= 1$	$= 1$
$p_{\text{T}}^{\ell\, e(\mu)}$ (GeV)	7(6) - 35	7(6) - 35
$p_{\text{T}}^{\ell_2\, e(\mu)}$ (GeV)	$< 7(6)$	$< 7(6)$
N_{jet}	≥ 2	≥ 5
$p_{\text{T}}^{\text{jet}}$ (GeV)	> 180, 30	> 200, 200, 200, 30, 30
$E_{\text{T}}^{\text{miss}}$ (GeV)	> 530	> 375
m_{T} (GeV)	> 100	-
$E_{\text{T}}^{\text{miss}}/m_{\text{eff}}^{\text{incl}}$	> 0.38	-
H_{T} (GeV)	-	> 1100
Jet aplanarity	-	> 0.02

	4-jet high-x SR	**4-jet low-x SR**	**5-jet SR**	**6-jet SR**
N_{lep}	$= 1$	$= 1$	$= 1$	$= 1$
p_{T}^{ℓ} (GeV)	> 35	> 35	> 35	> 35
$p_{\text{T}}^{\ell 2}$ (GeV)	< 10	< 10	< 10	< 10
N_{jet}	≥ 4	≥ 4	≥ 5	≥ 6
$p_{\text{T}}^{\text{jet}}$ (GeV)	> 325, 30,... , 30	> 325, 150,... , 150	> 225, 50,... , 50	> 125, 30,... , 30
$E_{\text{T}}^{\text{miss}}$ (GeV)	> 200	> 200	> 250	> 250
m_{T} (GeV)	> 425	> 125	> 275	> 225
$E_{\text{T}}^{\text{miss}}/m_{\text{eff}}^{\text{incl}}$	> 0.3	-	> 0.1	> 0.2
$m_{\text{eff}}^{\text{incl}}$ (GeV)	> 1800	> 2000	> 1800	> 1000
Jet aplanarity	-	> 0.04	> 0.04	> 0.04

1L + JETS

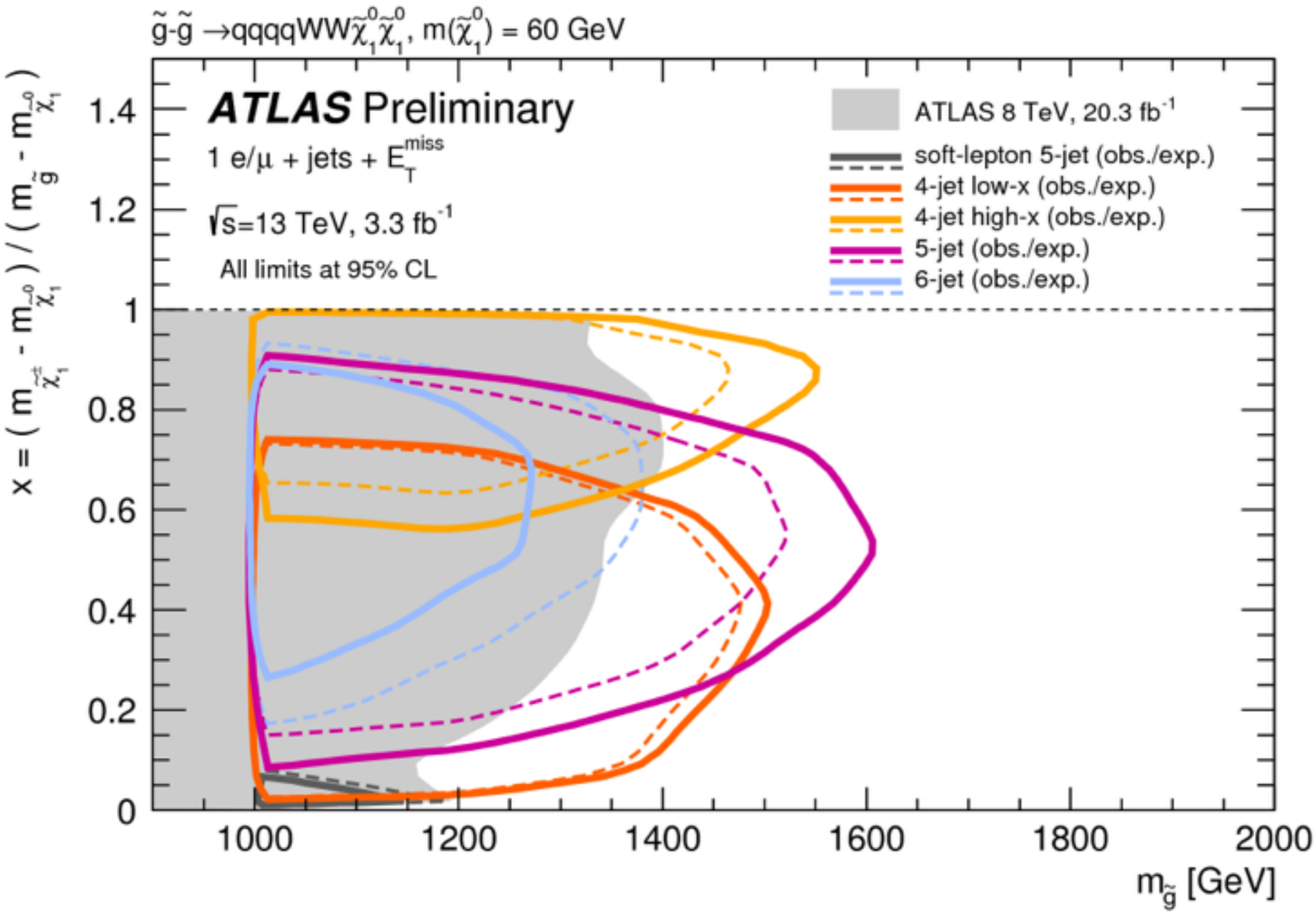

SR
m_{eff} > 1.8 TeV; $p_T^{5^{th}\ jet}$ > 50 GeV
ATLAS Preliminary
1-lepton + jets + E_T^{miss}
hard-lepton 5-jet
VR m_T
m_{eff} > 1.5 TeV
$p_T^{5^{th}\ jet}$ > 30 GeV
CR
m_{eff} > 1.5 TeV
$p_T^{5^{th}\ jet}$ > 30 GeV
VR aplanarity
m_{eff} > 1.5 TeV
$p_T^{5^{th}\ jet}$ > 30 GeV
m_T [GeV]
aplanarity


ATLAS Preliminary
Data
Total SM
tt̄
W+jets
Diboson
Single top
Others
√s = 13 TeV, 3.3 fb⁻¹
Hard lepton 5-jet
m(g̃χ̃₁±χ̃₁⁰)=(1385,705,25) GeV
Events / 50 GeV
Data / SM
m_T [GeV]

1L + JETS

	Hard-lepton				Soft-lepton	
	4-jet low x	4-jet high x	5-jet	6-jet	2-jet	5-jet
Observed events	1	0	0	10	2	9
Fitted background events	1.3 ± 0.5	0.9 ± 0.5	1.3 ± 0.6	4.4 ± 1.0	3.6 ± 0.7	7.7 ± 1.9
$t\bar{t}$	0.40 ± 0.31	0.08 ± 0.07	0.39 ± 0.24	2.5 ± 0.9	0.64 ± 0.33	3.6 ± 1.2
W+jets	0.19 ± 0.12	0.7 ± 0.5	0.16 ± 0.12	0.22 ± 0.15	1.9 ± 0.5	2.5 ± 1.3
Z+jets	0.046 ± 0.024	0.029 ± 0.028	0.08 ± 0.04	0.08 ± 0.08	0.49 ± 0.13	0.09 ± 0.05
Single-Top	0.5 ± 0.5	$0.04^{+0.10}_{-0.04}$	$0.22^{+0.23}_{-0.22}$	0.5 ± 0.4	0.16 ± 0.14	0.43 ± 0.34
Diboson	$0.06^{+0.20}_{-0.06}$	$0.002^{+0.014}_{-0.002}$	0.38 ± 0.24	0.9 ± 0.5	0.39 ± 0.17	1.0 ± 0.7
$t\bar{t}$+V	0.050 ± 0.022	0.025 ± 0.013	0.060 ± 0.030	0.24 ± 0.08	0.088 ± 0.029	0.067 ± 0.025
Background yield from simulation	1.7	1.1	1.6	5.2	4.0	9.4
$t\bar{t}$	0.80	0.26	0.63	3.2	0.93	4.1
W+jets	0.20	0.7	0.22	0.32	1.9	3.8
Z+jets	0.046	0.029	0.08	0.08	0.49	0.09
Single-t	0.5	0.04	0.22	0.5	0.16	0.43
Diboson	0.06	0.002	0.38	0.9	0.39	1.0
$t\bar{t}$+V	0.050	0.025	0.060	0.24	0.088	0.067

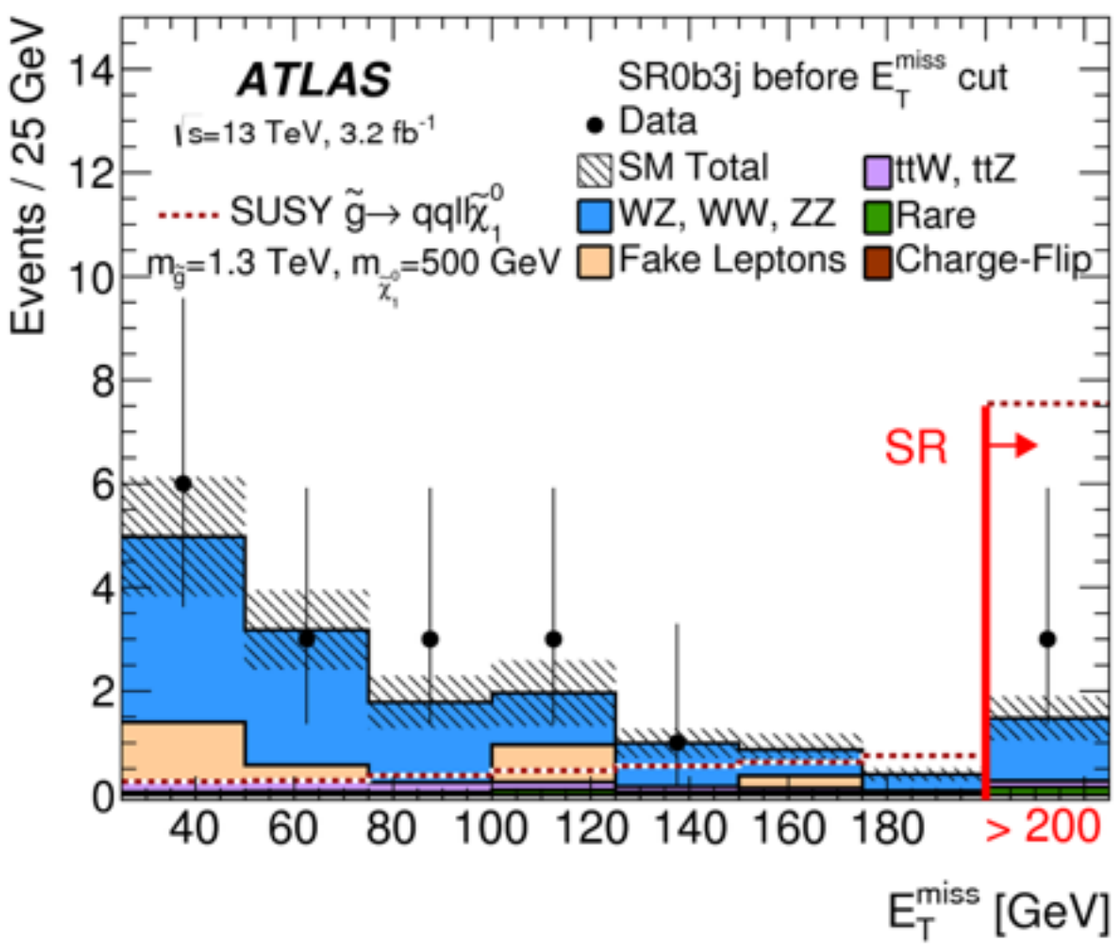
1L + JETS

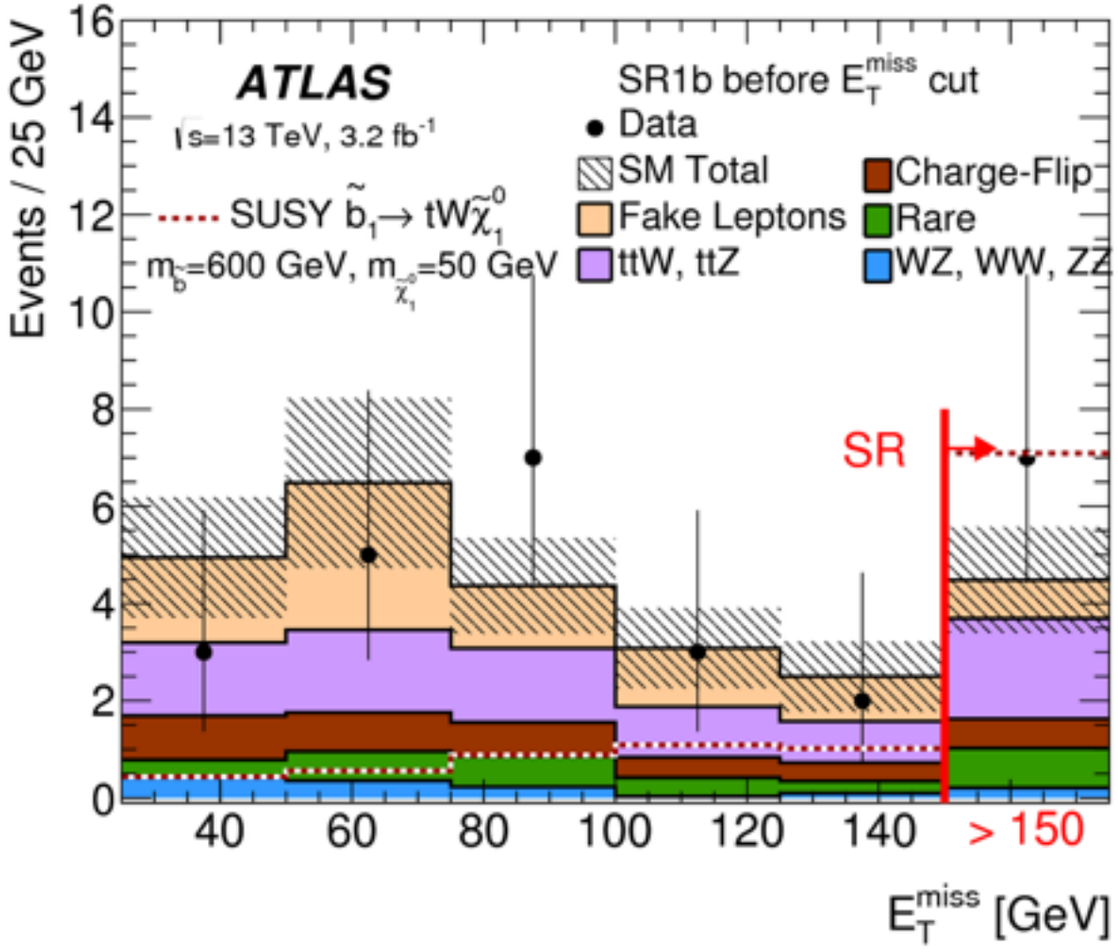

$\tilde{g}$-$\tilde{g}$ →qqqqWW$\tilde{\chi}_1^0\tilde{\chi}_1^0$, m($\tilde{\chi}_1^0$) = 60 GeV
ATLAS Preliminary
1 e/μ + jets + E_T^{miss}
$\sqrt{s}$=13 TeV, 3.3 fb^{-1}
All limits at 95% CL
ATLAS 8 TeV, 20.3 fb^{-1}
soft-lepton 5-jet (obs./exp.)
4-jet low-x (obs./exp.)
4-jet high-x (obs./exp.)
5-jet (obs./exp.)
6-jet (obs./exp.)
x = ($m_{\tilde{\chi}_1^\pm}$ - $m_{\tilde{\chi}_1^0}$) / ($m_{\tilde{g}}$ - $m_{\tilde{\chi}_1^0}$)
$m_{\tilde{g}}$ [GeV]

2SS / 3L + JETS

2SS / 3L + JETS

Signal region	$N_{\text{lept}}^{\text{signal}}$	$N_{b-\text{jets}}^{20}$	N_{jets}^{50}	$E_{\text{T}}^{\text{miss}}$ [GeV]	m_{eff} [GeV]
SR0b3j	$\geq$3	=0	$\geq$3	>200	>550
SR0b5j	$\geq$2	=0	$\geq$5	>125	>650
SR1b	$\geq$2	$\geq$1	$\geq$4	>150	>550
SR3b	$\geq$2	$\geq$3	-	>125	>650

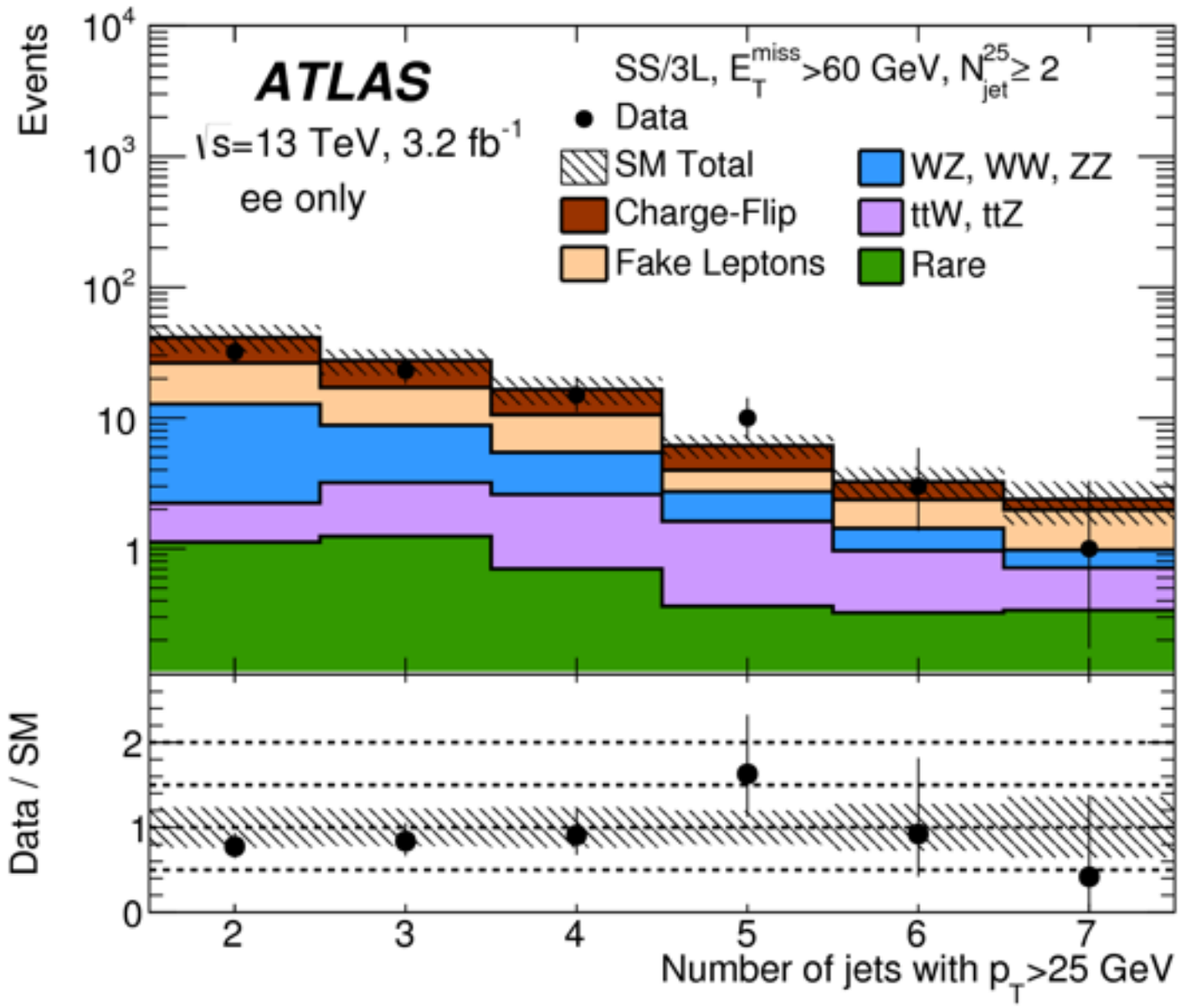




2SS / 3L + JETS

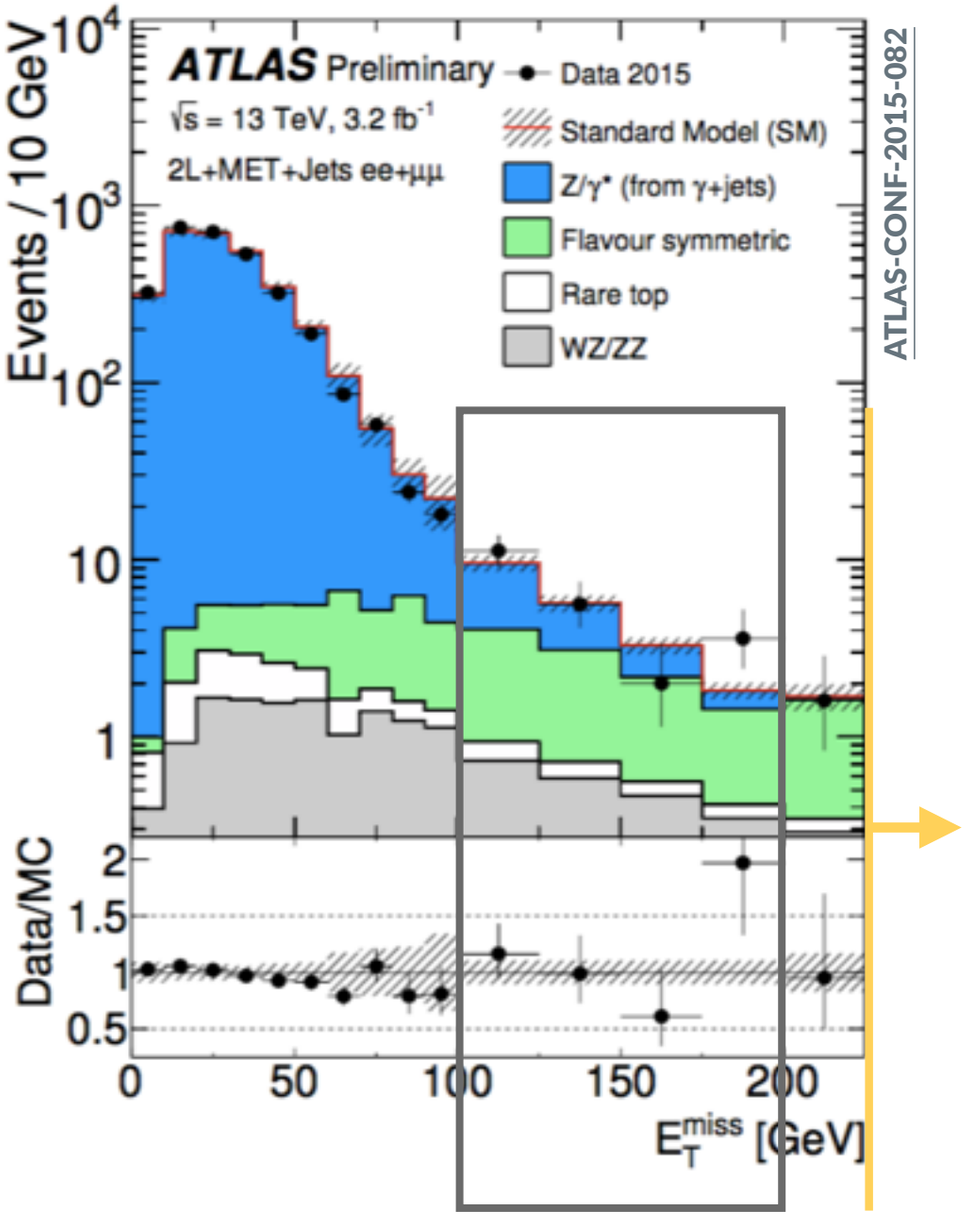
	SR0b3j	SR0b5j	SR1b	SR3b
Observed events	3	3	7	1
Total background events	1.5 ± 0.4	0.88 ± 0.29	4.5 ± 1.0	0.80 ± 0.25
$p(s = 0)$	0.13	0.04	0.15	0.36
Fake/non-prompt leptons	< 0.2	0.05 ± 0.18	0.8 ± 0.8	0.13 ± 0.17
Charge-flip	–	0.02 ± 0.01	0.60 ± 0.12	0.19 ± 0.06
$t\bar{t}W$	0.02 ± 0.01	0.08 ± 0.04	1.1 ± 0.4	0.10 ± 0.05
$t\bar{t}Z$	0.10 ± 0.04	0.05 ± 0.03	0.92 ± 0.31	0.14 ± 0.06
WZ	1.2 ± 0.4	0.48 ± 0.20	0.18 ± 0.11	< 0.02
$W^{\pm}W^{\pm}jj$	–	0.12 ± 0.07	0.03 ± 0.02	< 0.01
ZZ	< 0.03	< 0.04	< 0.03	< 0.03
Rare	0.14 ± 0.08	0.07 ± 0.05	0.8 ± 0.4	0.24 ± 0.14

2SS / 3L + JETS


ATLAS
√s=13 TeV, 3.2 fb-1
ee only
SS/3L, E_T^miss>60 GeV, N_jet^25≥ 2
Data
SM Total
Charge-Flip
Fake Leptons
WZ, WW, ZZ
ttW, ttZ
Rare
Events
Data / SM
Number of jets with p_T>25 GeV

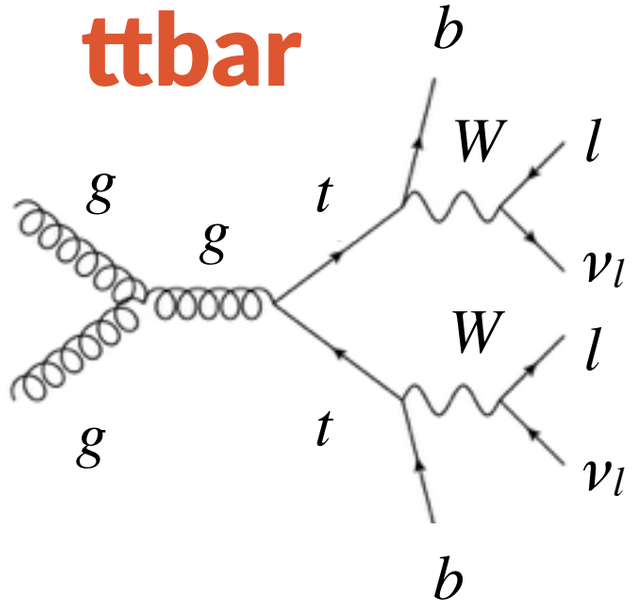
2L (ON-Z) + JETS

THE BACKGROUNDS

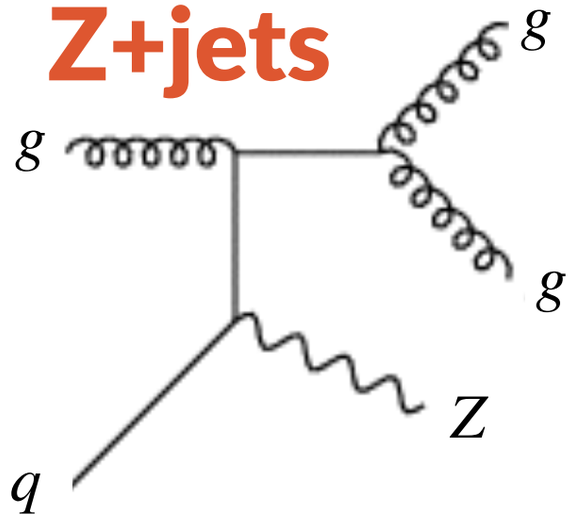


data-driven

ttbar

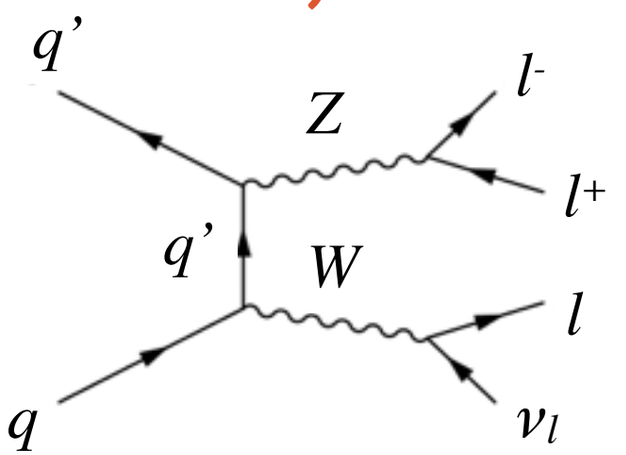


Z+jets

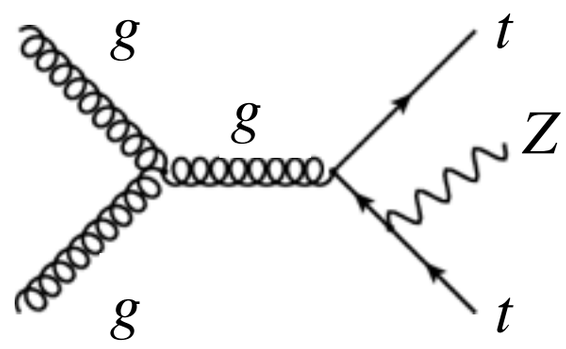


from MC

WZ, ZZ



rare top

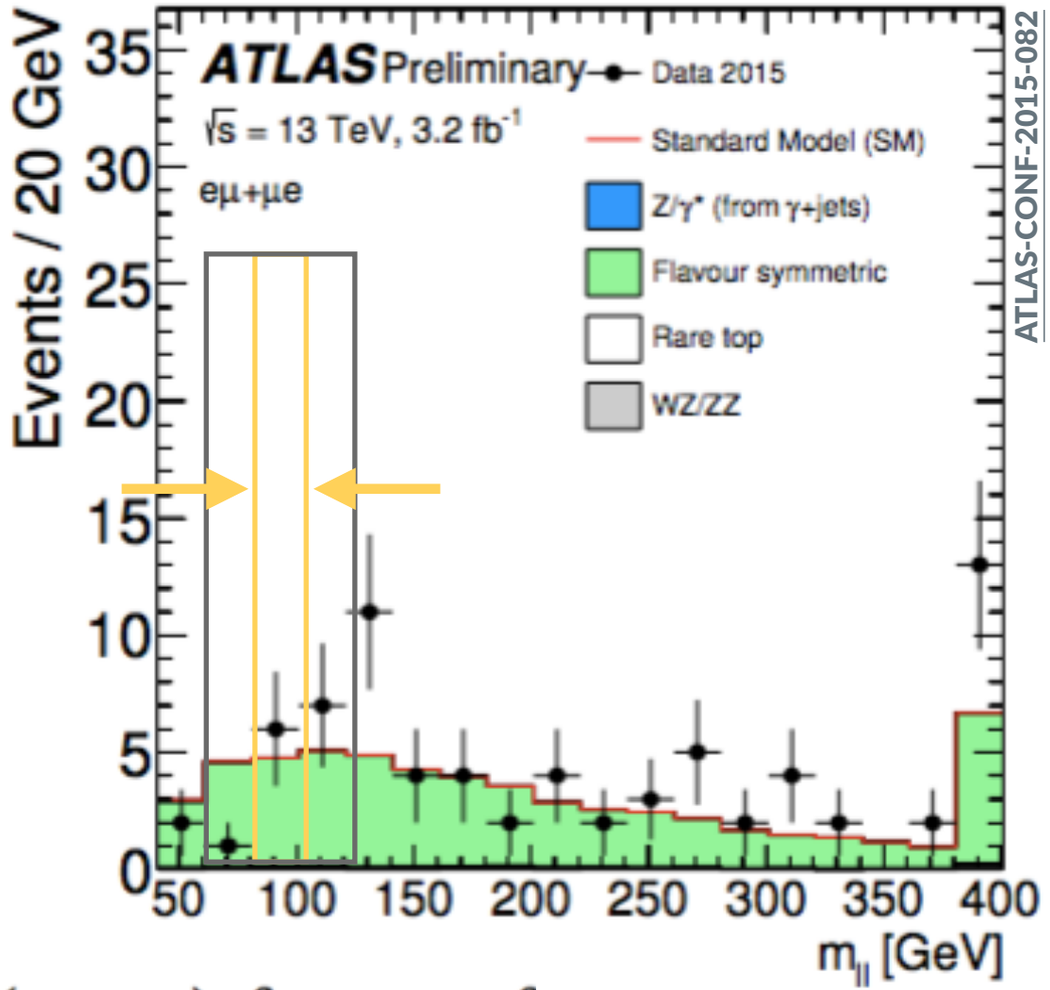


FLAVOR SYMMETRIC

- 2:1:1 ratio of eμ:ee:μμ events
- measure number of events in CR:
  - eμ version of SR, with expanded mll window
- apply correction factors to predict ee/μμ:

$$N_{ee}^{\text{est}} = \frac{1}{2} \times N_{e\mu}^{\text{data}} \times k_{ee}(p_{\text{T}}, \eta) \times \alpha(p_{\text{T}}, \eta) f_{Z-\text{mass}} f_{\text{FS}}$$

- test in VR and cross-check with a sideband fit

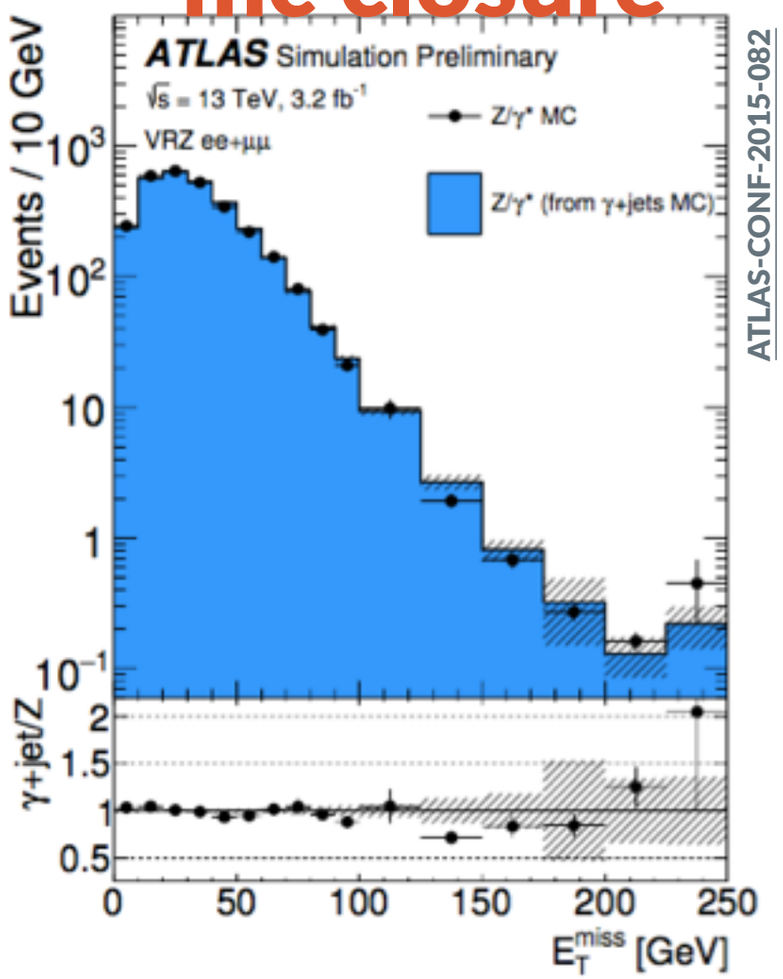


Region	Flavour-symmetry	Sideband fit
SRZ	5.1 ± 2.0	6.1 ± 1.7
VRS	18.9 ± 4.8	20.5 ± 5.6

Z+JETS

- small but peaks on-Z
- fake MET from muon and jet mis-measurement
- estimated using photon + jets
- reweight photon events to match Z p_T
- smear photons to match μ resolution for μμ channel
- normalize at low MET and make a prediction in the SR

mc closure



UNCERTAINTIES

Source	Relative systematic uncertainty [%]
	SRZ
Total systematic uncertainty	22
Flavour symmetry (statistical)	14
Flavour symmetry (systematic)	12
Z/γ^* + jets (systematic)	7.8
WZ generator uncertainty	7.6
Z/γ^* + jets (statistical)	2.2

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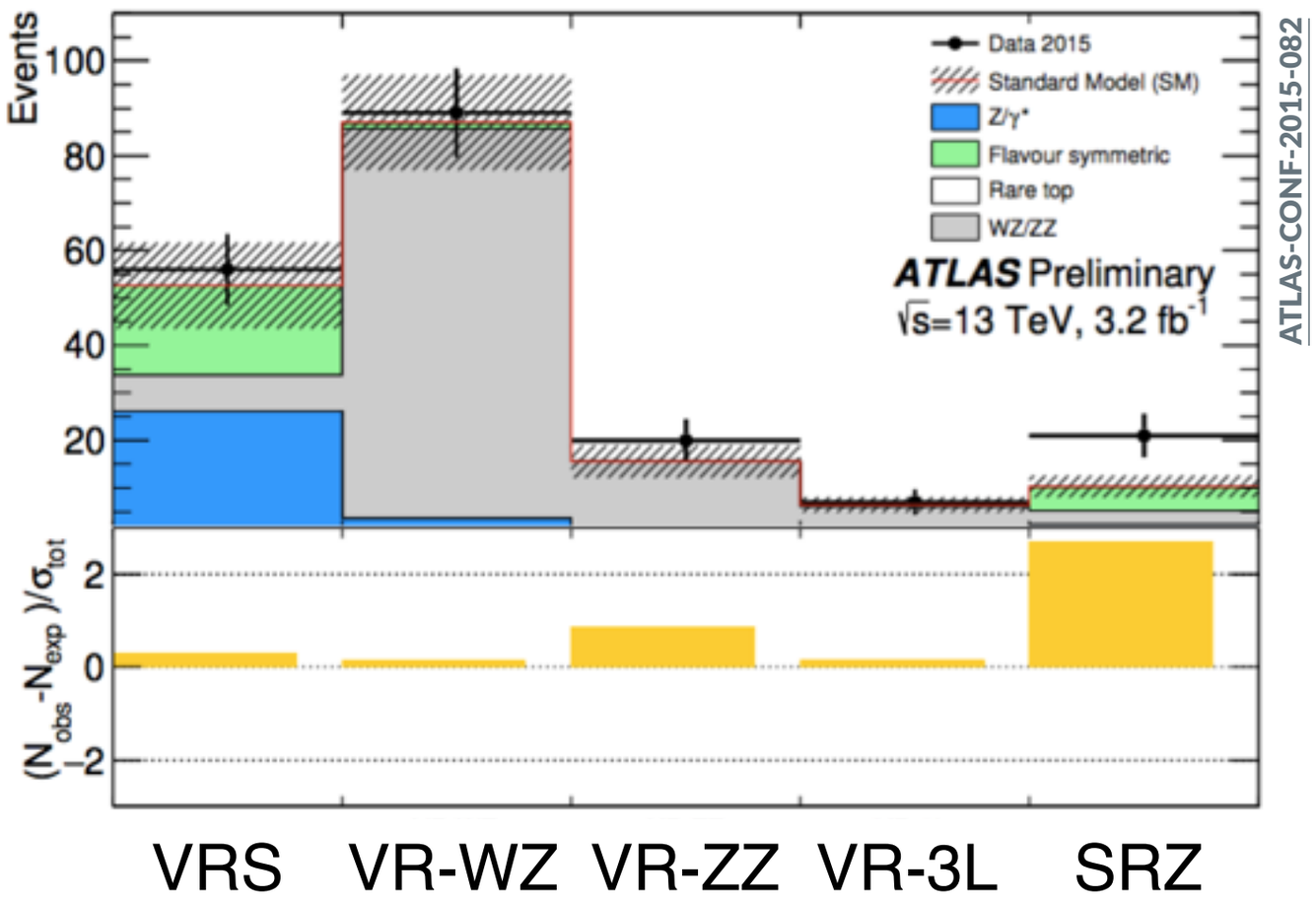
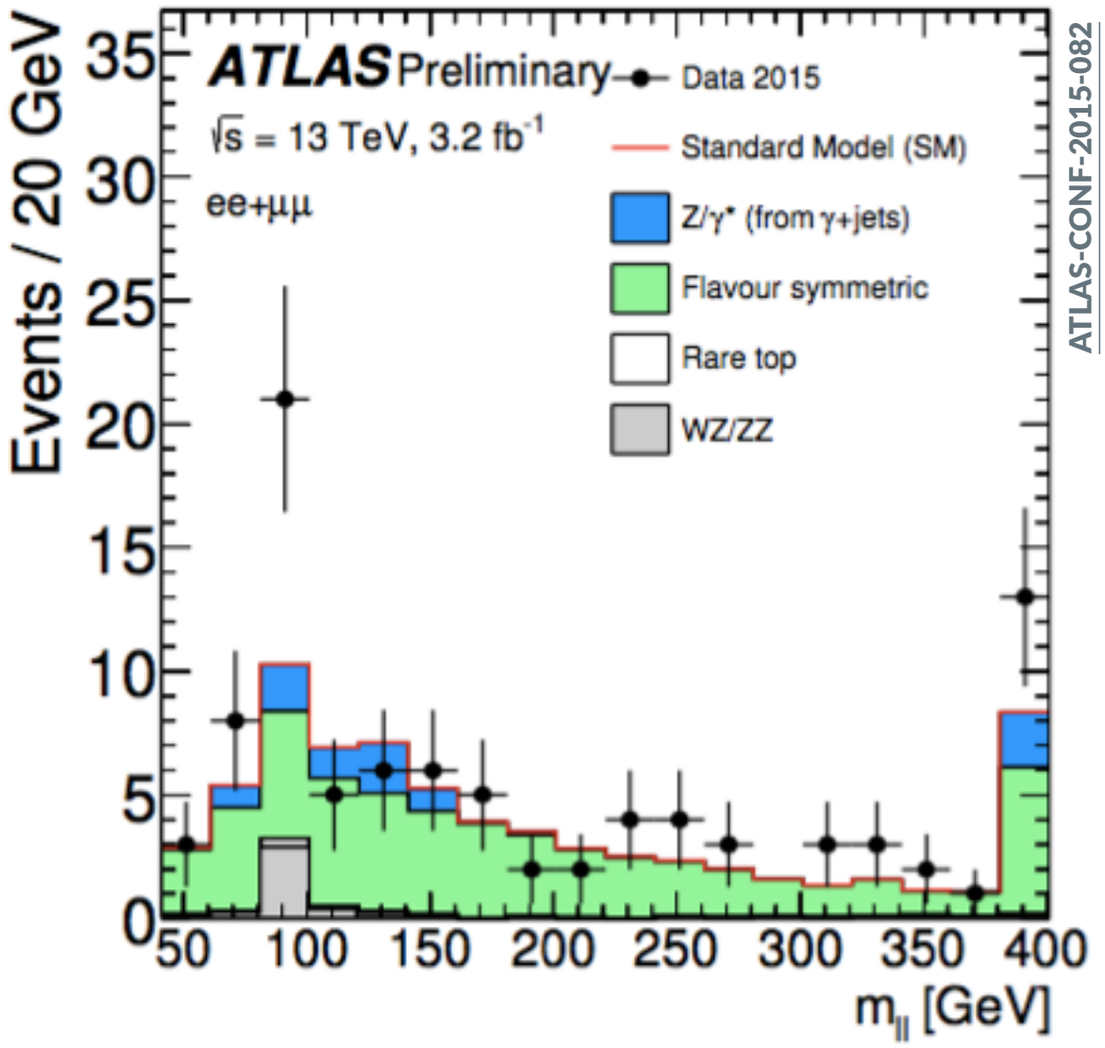
RESULTS

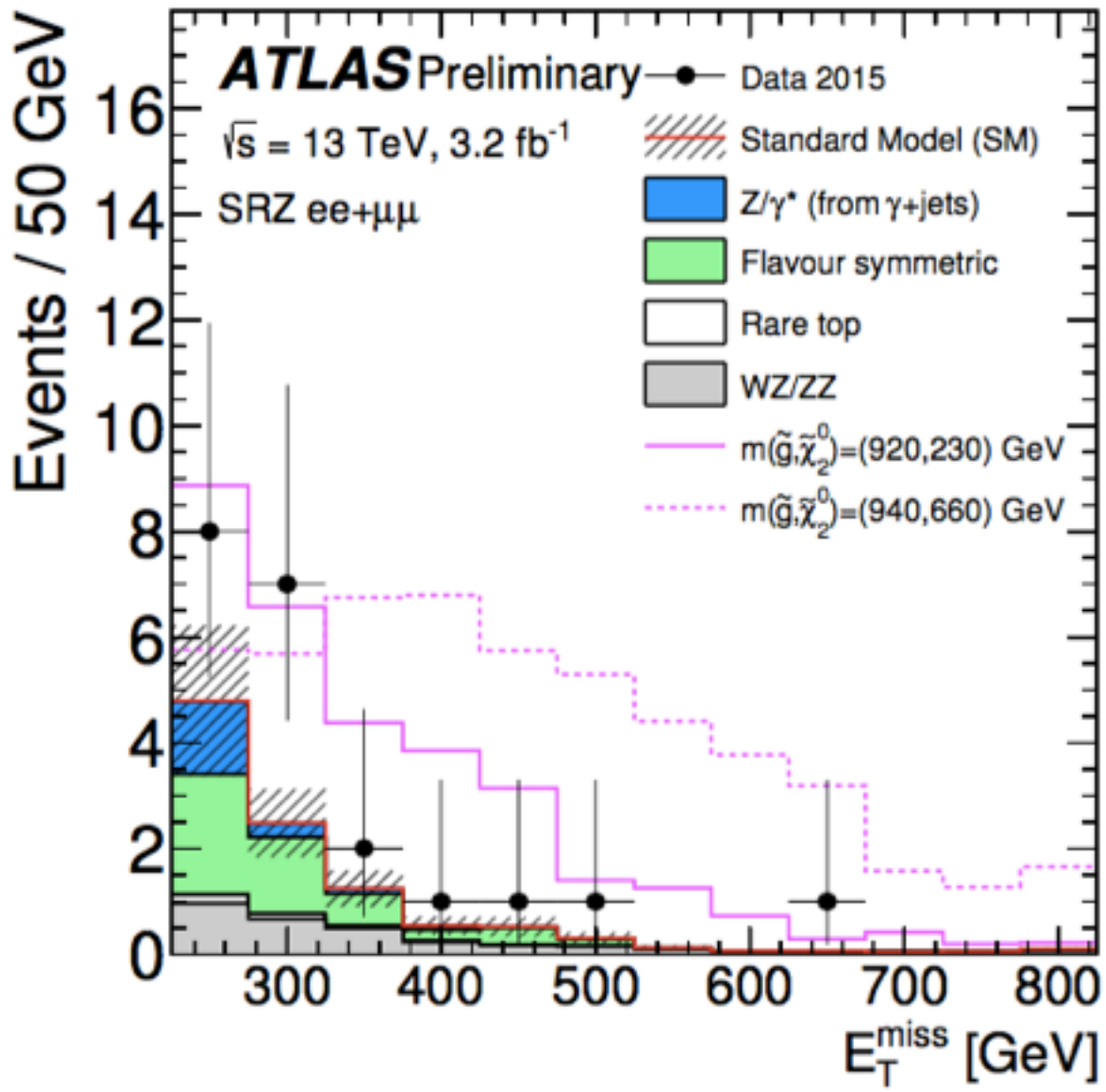
- expected background is 10.3 ± 2.3 events

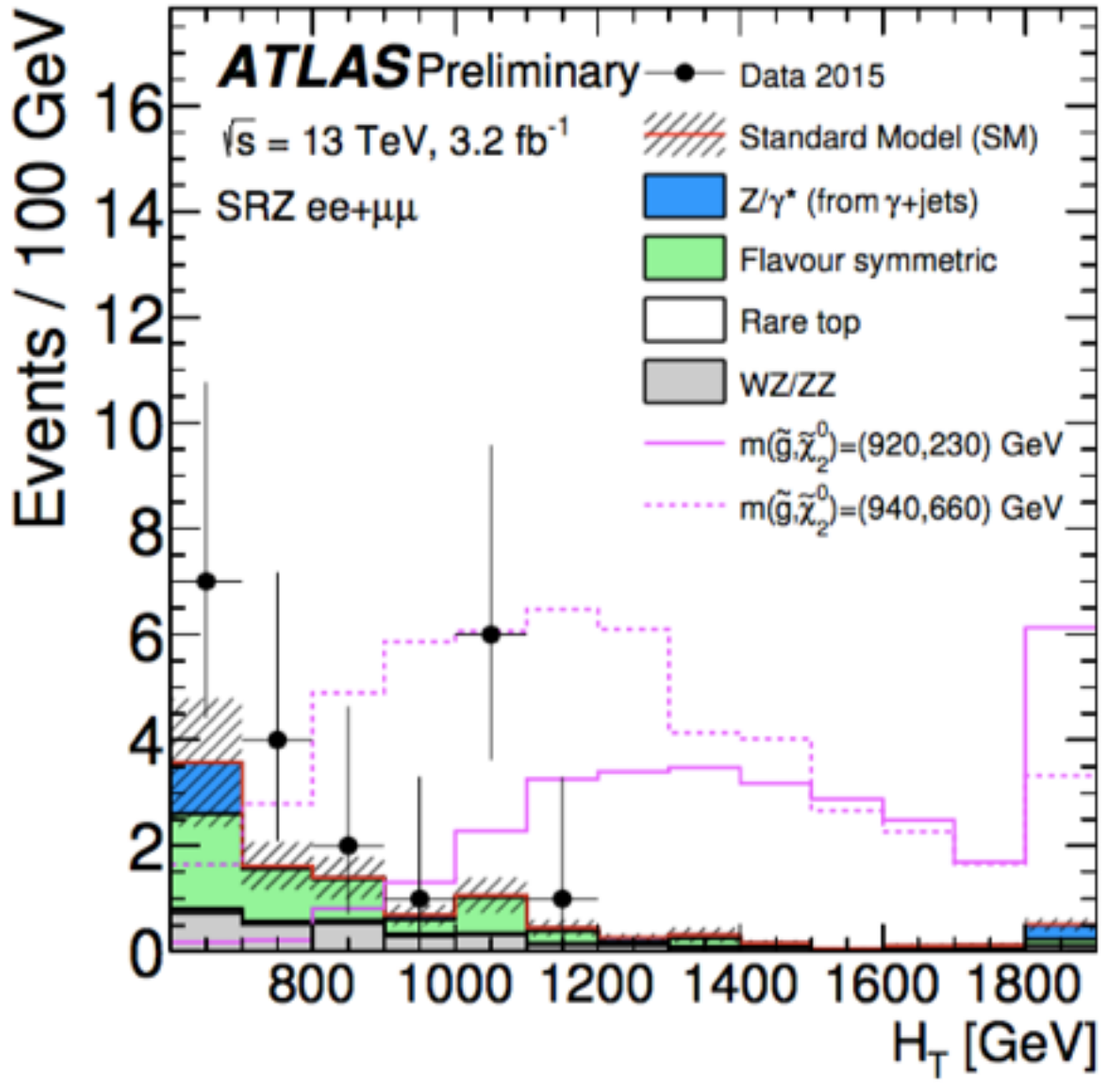




- 2.2σ excess with 10 ee and 11 μμ events

SR-Z CHARACTERISTICS OF THE EXCESS





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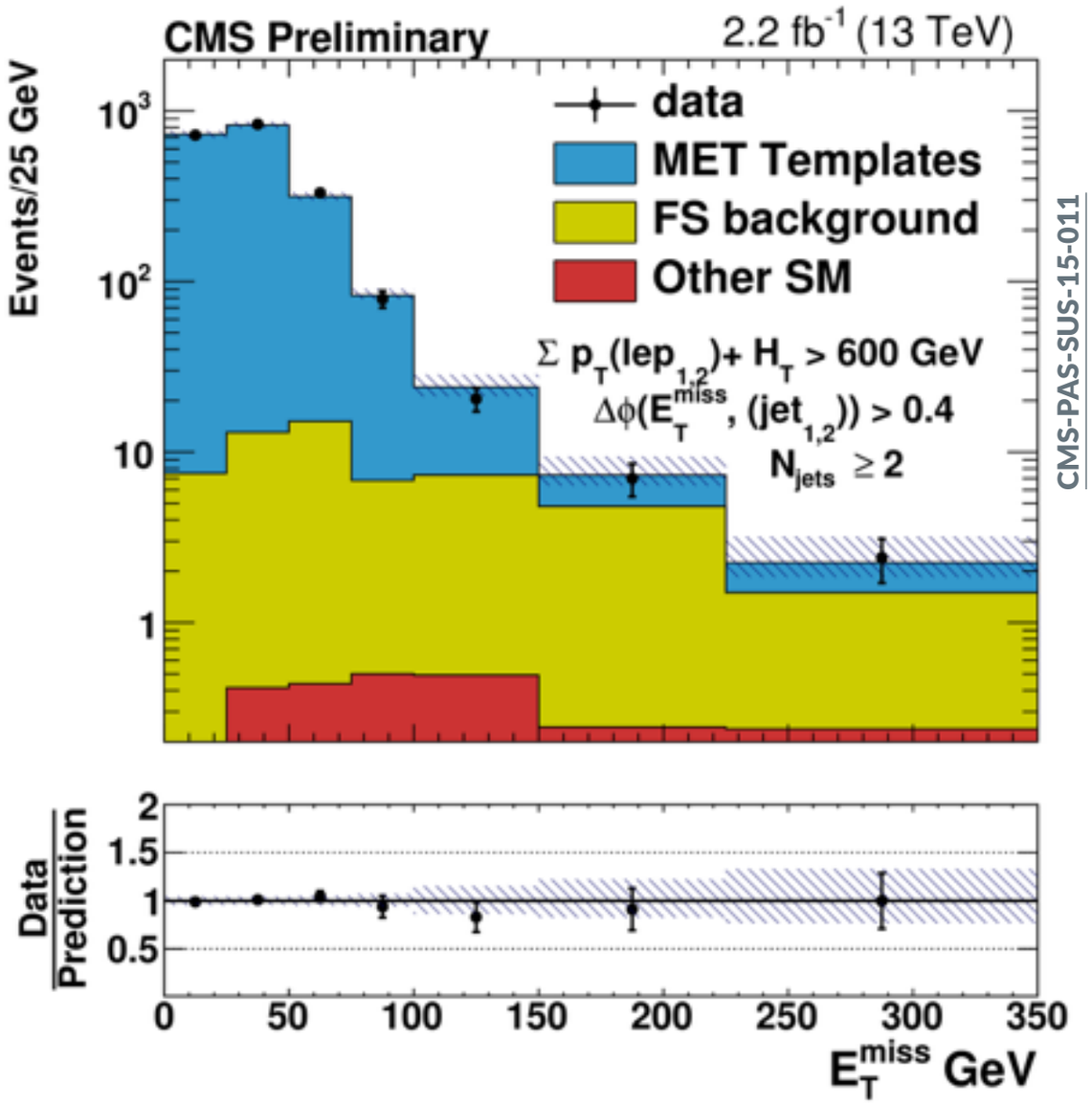
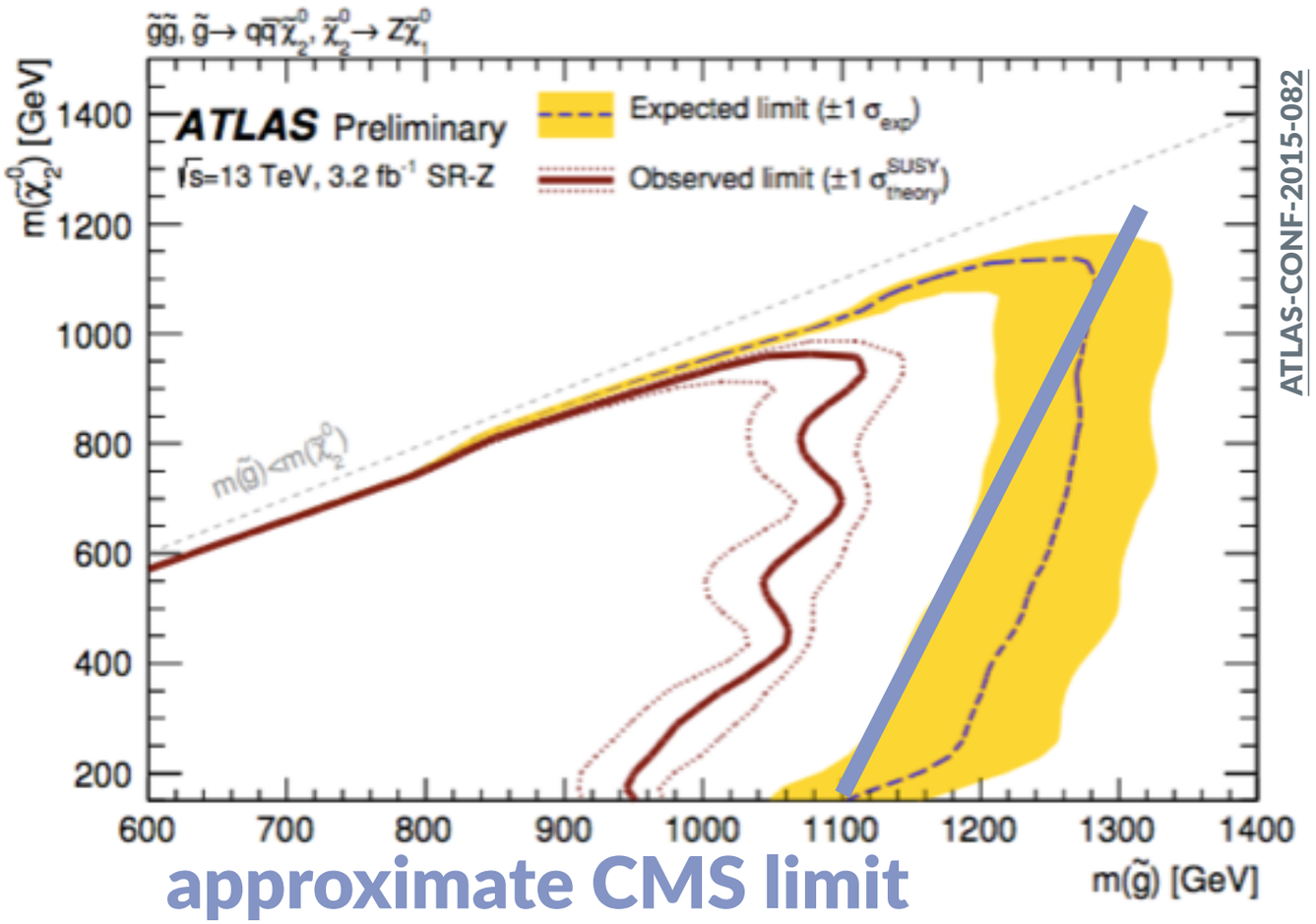
- events have MET and H_T shapes consistent with background
- many checks in SR (phi distributions, numbers of b-jets, number of 3-lepton events) but no clear source of underestimate

CMS SEES NOTHING





approximate CMS limit

- CMS sees 12 events, expect 12.0 + 4.0 - 2.8
- similar limit to ATLAS expected limit on simplified models