Results with the Full 2015 Data Sample from the ATLAS Experiment

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On behalf of the ATLAS Collaboration

Outline and Disclaimer

This talk will present **only new results** based on the full 2015 13 TeV pp collision data

- **ATLAS in Run-2**
- **Performance with the full 2015 Data**
- **New Measurements**
  - SM and Top Measurements
  - First look at the Higgs boson at Run-2
- **Searches**
  - Search for Additional Higgs bosons
  - Searches for SUSY
  - Searches at very high mass
  - Dibosons searches with boosted topologies

Many Run-1 new results recently released, but will not be discussed

See: https://twiki.cern.ch/twiki/bin/view/AtlasPublic

- 491 Run-1 papers submitted
- 3 Run-2 papers submitted

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Main Improvements for the Run-2

Important changes in all areas of the experiment

Detector

- 4th innermost layer of pixels (3.3 cm, 2nd layer at 5.05 cm)
- Consolidation: Complete muon coverage, Luminosity detectors, Repairs (LAr and Tile), Beam Condition. Monitors

Infrastructure

New Beam Pipe, Magnets and Cryogenic system, Muon Chamber shielding, New pixel services

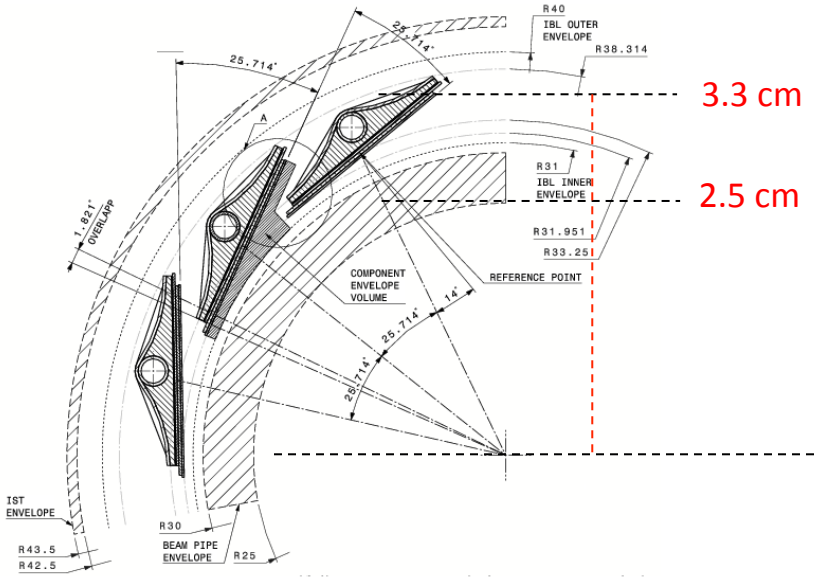
Trigger/DAQ

- Increase max L1 rate from 75kHz to 100kHz
- New Central Trigger Processor
- Merge L2 and HLT farms, Additional SFOs allowing for higher output rate (limited by storage capacity to **1.1-1.5 kHz**)

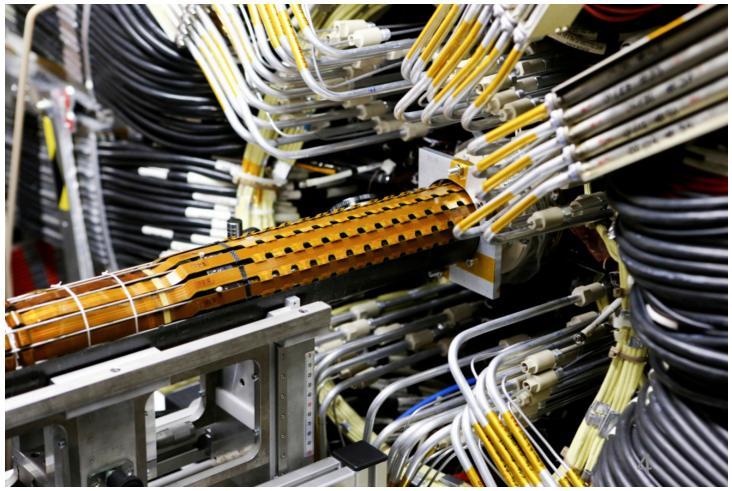
Software and Computing

Improved reconstruction software, New analysis framework with new data format

For a complete ATLAS Status: see A. Polini talk at LHCC Open Session (Dec 2, 2015)
http://indico.cern.ch/event/460278



IBL TDR: http://cds.cern.ch/record/1291633



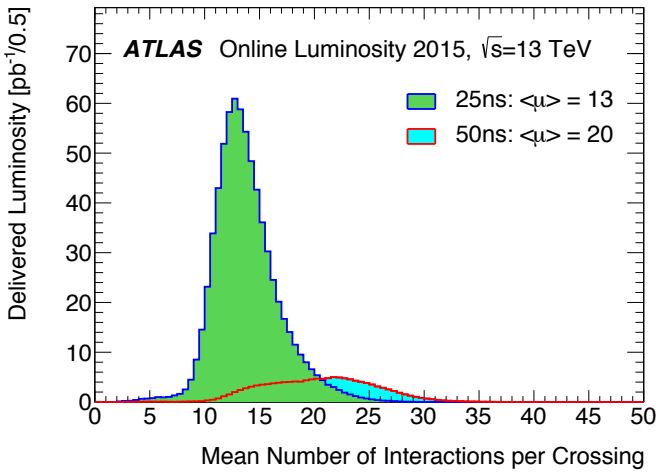
2015 Brief Year in Review

13 TeV pp 2015 Dataset

- **50 ns data**: 100 pb-1 good for physics *(mu ~ 20)*
- **25 ns data**: 4 fb-1 recorded *(mu ~ 13)*
- **Highest instantaneous Luminosity**

  reached 5.1 10^{33} cm^2s^{-1} *(Run 1: 7-8 10^{33} cm^2s^{-1})*

- **Special runs**:
  - 90m elastic run with 10 μb-1 collected
  - 170 μb-1 of "low mu" data (special runs with LHCf)
- **Heavy Ion** running with 680 μb^{-1} collected and corresponding pp reference at 5 TeV with 27 pb^{-1} (mu~1.5)

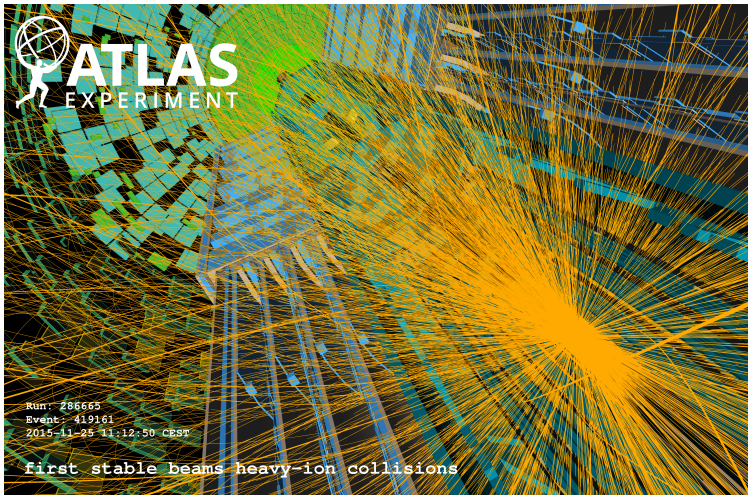


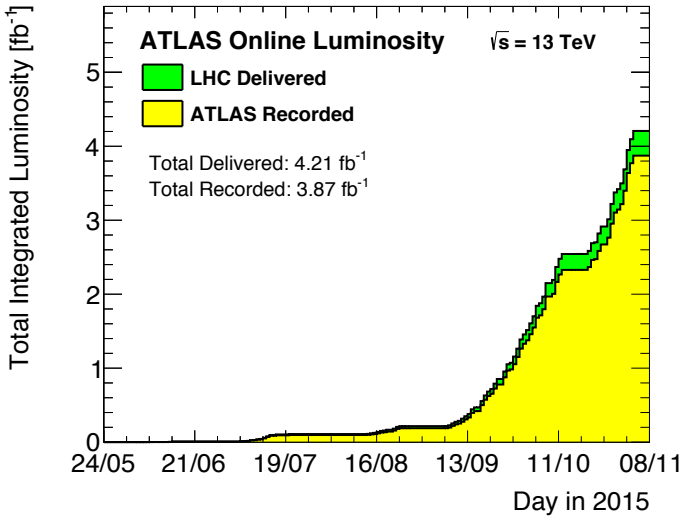
***Run 1**: 8 TeV (mu~21) and 7 TeV (mu~9)*

***ATLAS**: Pileup at Run-2 less difficult than at Run-1*

PbPb Collision at **1.1 PeV**

Events with charged track multiplicities of up to 10k tracks





Data taking efficiency of 92%

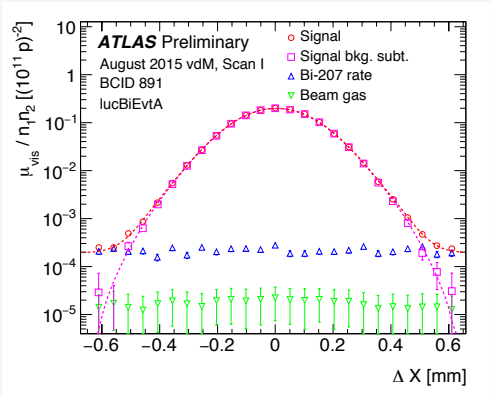
Data Quality Efficiencies, Luminosity and Trigger

Data Quality efficiency

- Average 93% (Run 1 Average 94%)
- Requiring IBL as well 87%

Luminosity Measurement

- Preliminary uncertainty from complete scan (Valid for entire 2015 dataset) **5%**



"All Good" dataset :

$3.2 \pm 0.2 \ \ fb^{-1}$

With IBL Off runs

$3.5 \pm 0.2 \ \ fb^{-1}$

Trigger

- **Run-2 Menu**: Approximately 1500 HLT selections seeded by about 400 L1 items
  - Primary triggers, typically unprescaled;
  - Numerous other triggers for Support, Background, Alternative algorithms, Backup and Calibration
- **Continued excellent performance** and stability of trigger throughout the run
- Rates for typical lowest unprescaled single object triggers:

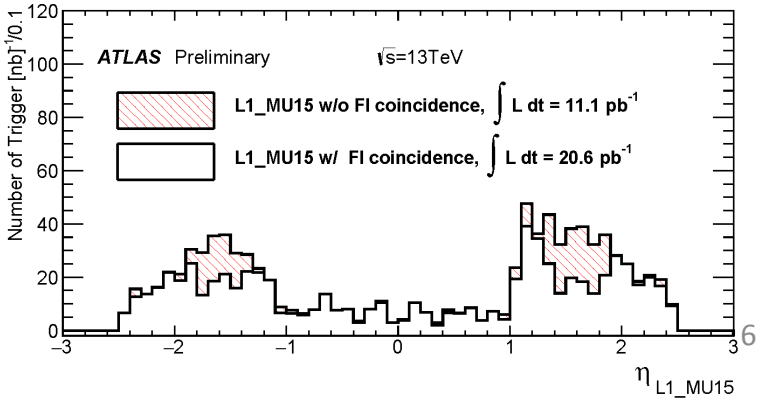
Trigger	p_T Threshold (GeV)		Rate (Hz) *	
	Run 1	Run 2	Run 1	Run 2
Inclusive e	24	24	70	97
Inclusive μ	24	20	45	130
E_T^{mis}	80	70	18	55

Improvements at Run-2

L1 Calo Per bunch baseline subtraction large reduction in MET trigger rates

L1 Muon triggering Use of FI coincidences **50%**

Rate reduction (in $1.0 < \eta < 1.9$ at p_T 20 GeV)



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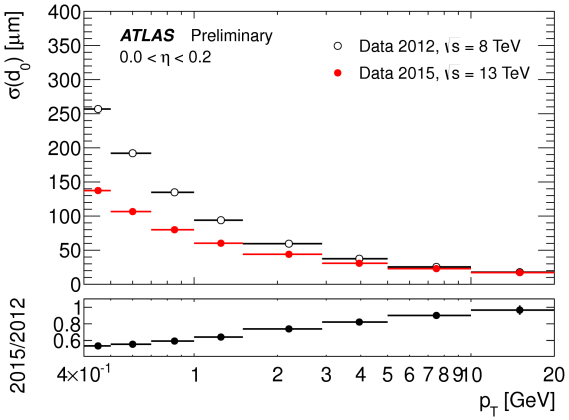
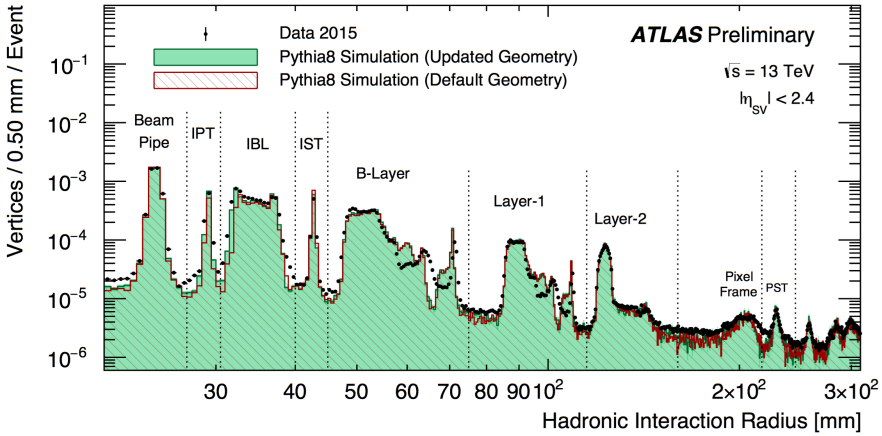
Combined Performance - **Tracking**

IBL: Improved Tracking performance



IBL, new Beam Pipe and Services: Additional material (and main systematic uncertainty for tracking)



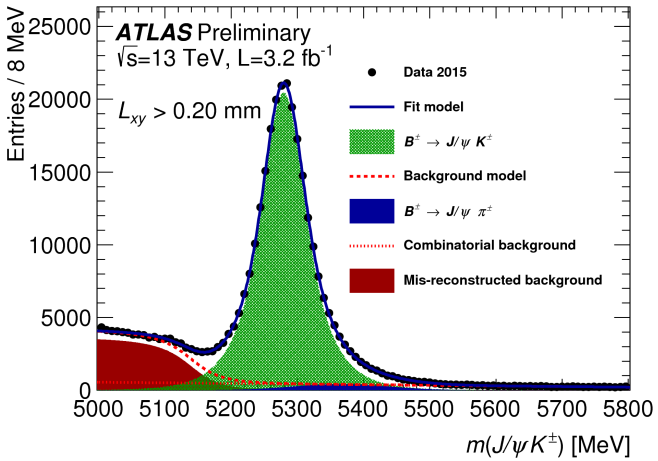
Material studies using hadronic interactions and conversions have led to a new geometry for simulations

Alignment and Tracking Performance check with $B^{\pm}$ mass

$$B^{\pm} \rightarrow J/\psi K^{\pm}$$

No specific trigger selection

Selection of J/Psi(μμ) and a track (assume Kaon), J/Psi π background from MC



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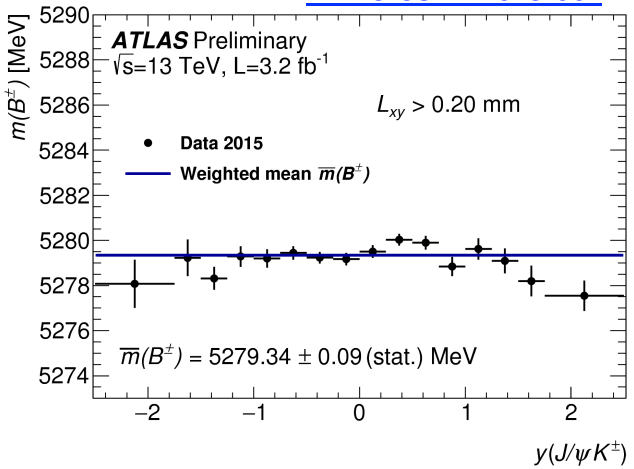


$$m(B^{\pm}) = 5279.32 \pm 0.10(stat) \pm 0.22(fit\ syst)\ MeV$$

$$m(B^{\pm}) = 5279.29 \pm 0.15\ \text{MeV}\ (World\ Average)$$

Cross check: Systematics on peaking background and fit, but not on momentum scale and vertexing

Combined Performance (III)

Electrons and Photons

Electron Efficiency: Full 2015 data driven measurements

Long-standing lateral shower shape difference in G4 simulation present at Run 1 – Taken into account in ID optimization

Photon Efficiency: From Run-1 and MC extrapolation

Calibration: based on Run-1 with MC extrapolation
Checked with Run-2 data to be well within uncertainties

Muons

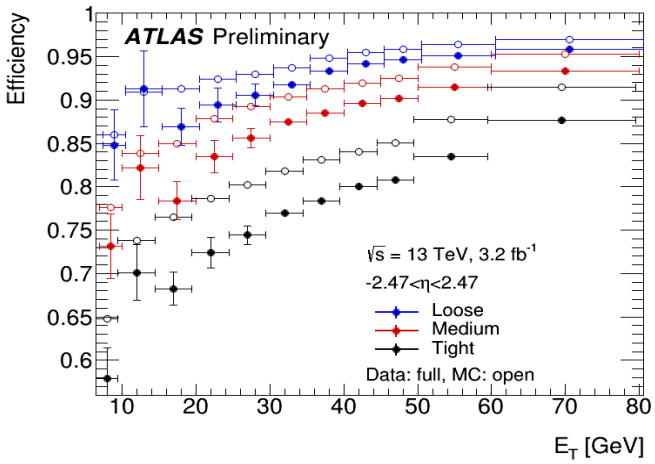
Efficiency: Full 2015 data driven trigger and reco efficiencies using Tag and Probe (with Z and J/Psi)

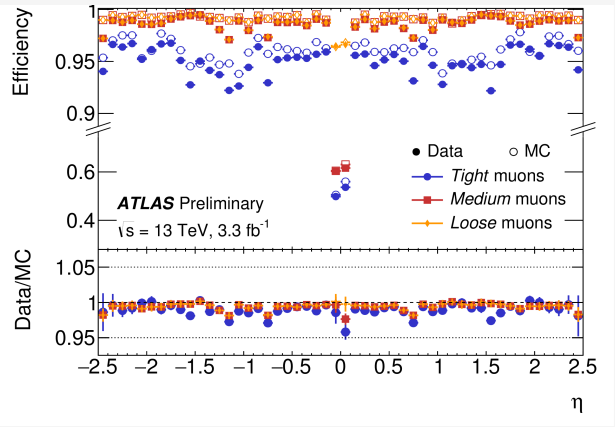
Energy scale and resolution: calibration on full 2015 dataset (using Z and J/Psi)

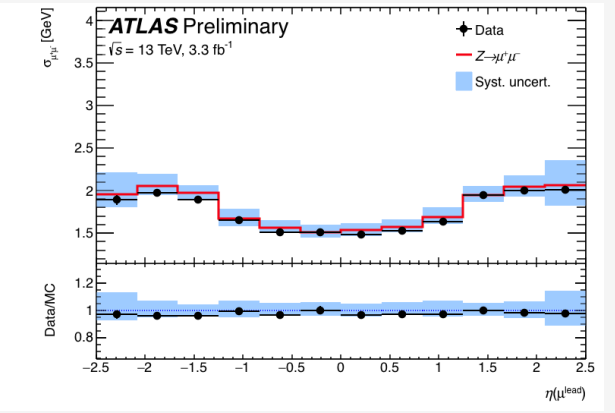
Using preliminary Toroid Off Alignment

(Alignment close to final O(50μm) in the barrel and O(100μm) in the Endcap)

Close to nominal performance of O(10%) relative resolution in (1/pT) for TeV muons







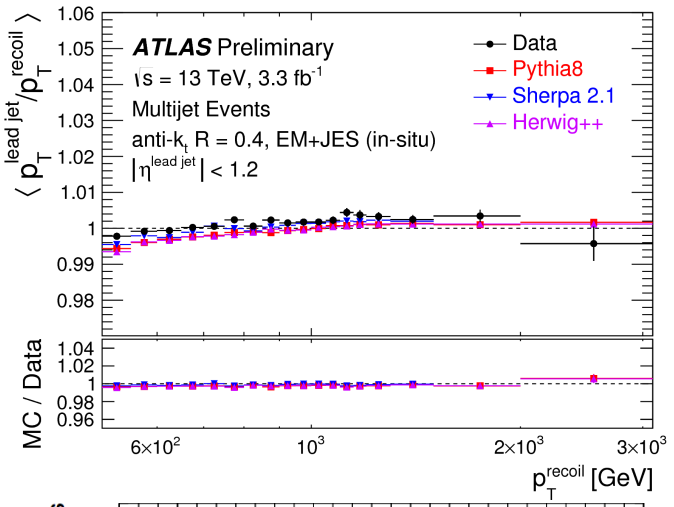
Combined Performance (IV)

Jets

MC extrapolated Run 1 Performance and Jet η-inter-calibration with balanced di-jet events.

Many checks with Run-2 data in particular

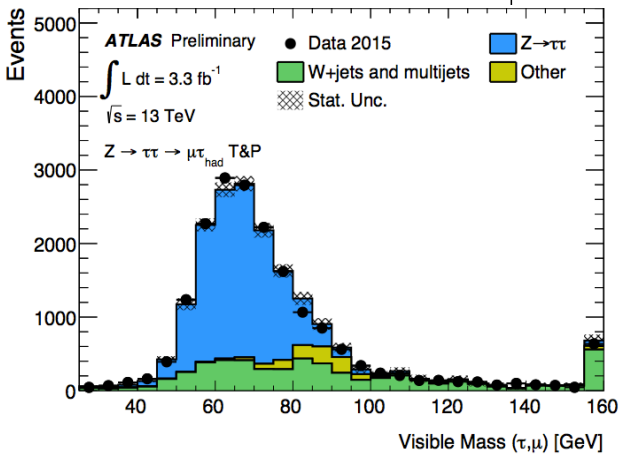
- JES balance in photon-Jet events
- ***JES balance with Multi Jet*** (Highest pT reach)



MET

Based on Tracking Soft Term, Performance and uncertainties extrapolated with MC from Run-1

Multiple checks in data



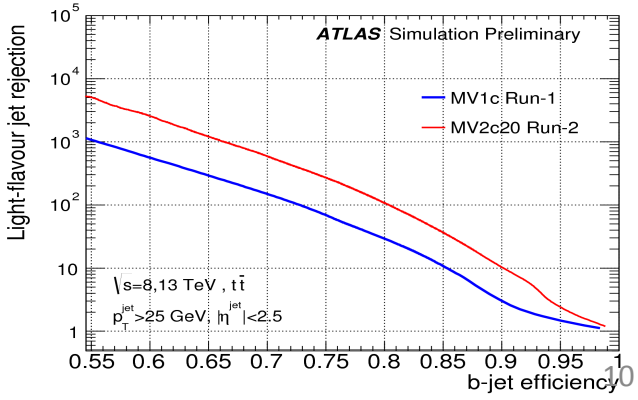
Taus

extrapolated with MC from Run-1

Many checks with full dataset for fakes and efficiency (using Tag and probe with Z events)

Flavor Tagging [ATL-PHYS-PUB-2015-022]

- Improvement from IBL and new algorithms
- Improved light jet rejection of a factor of 4 (precise data driven light jet rejection is becoming challenging)
- MC calibration checked with top events in data (fully consistent with current MC within uncertainties)



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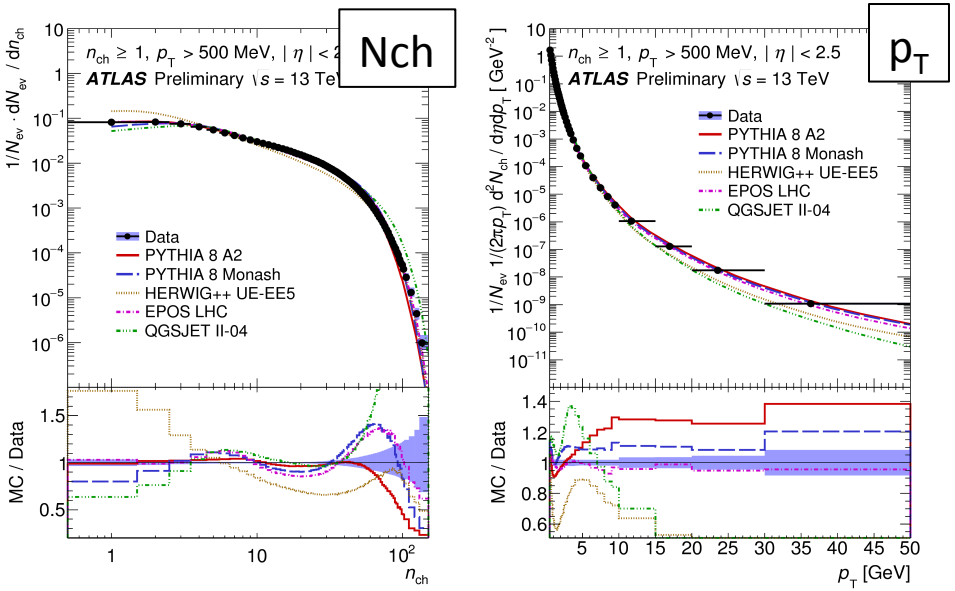
Physics Modelling

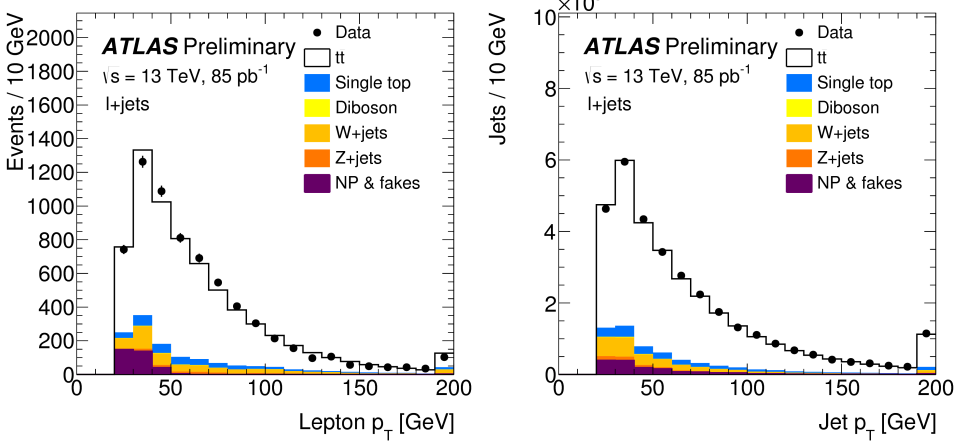
A2 Minbias tune (for PU)

Pythia 6 and 8 (using 7 TeV ATLAS data only)



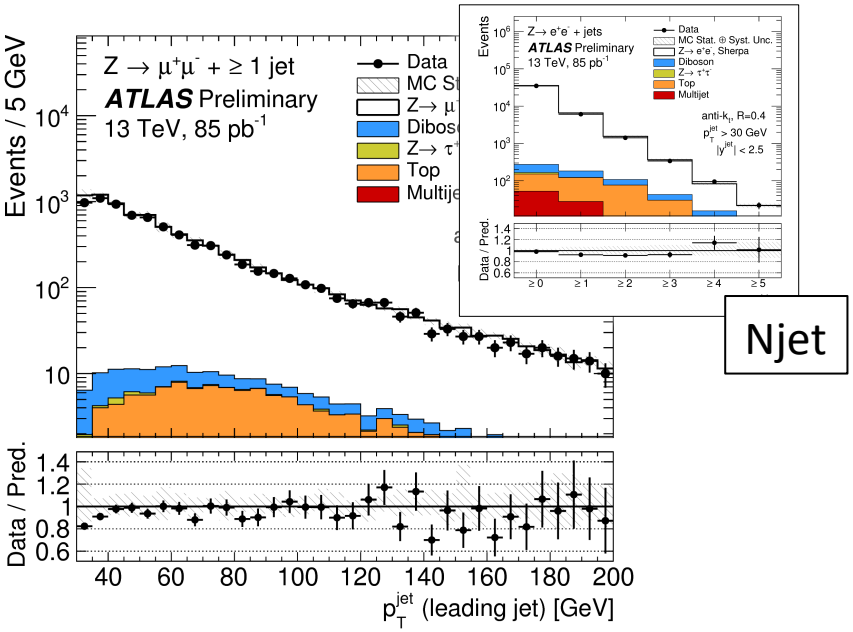
Top pair production

Powheg-Box v2 (hdamp =m_t) – Pythia 6.428 – EvtGen (HF decays) - CT10 PDFs – Perugia 2012 tune



V+Jets , Dibosons, Tribosons

Sherpa NLO (2partons) and LO (up to 4 partons) 2.1.1



Additional samples

(main backgrounds and signals)

e.g. Pythia 8, Sherpa LO, MG5_aMC@NLO

PDFs: CT10, CTEQ6L1, NNPDF3.0

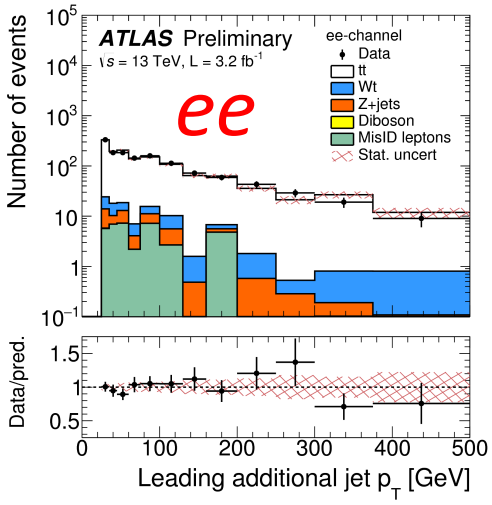
Higher order cross sections used where calculations available

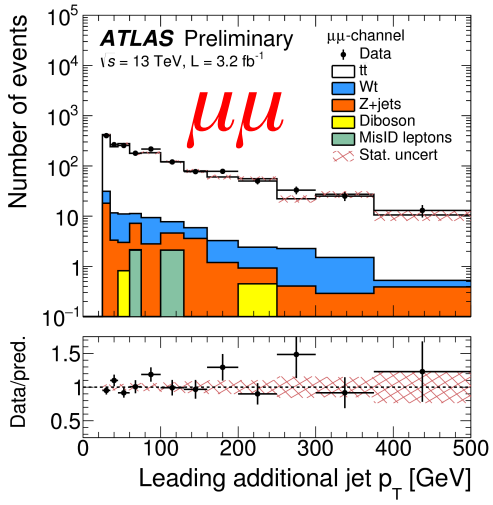
Thanks to the fruitful interactions with theory Community

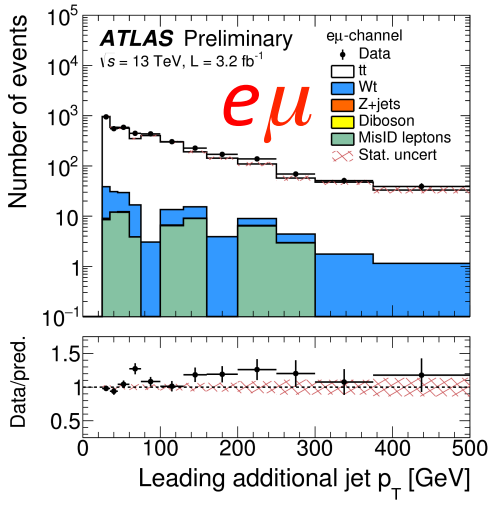
Differential Fiducial and Unfolded tt+Jets Cross Sections

Di-lepton channels (including Same Flavor - ee, μμ and eμ)

ATLAS-CONF-2015-065



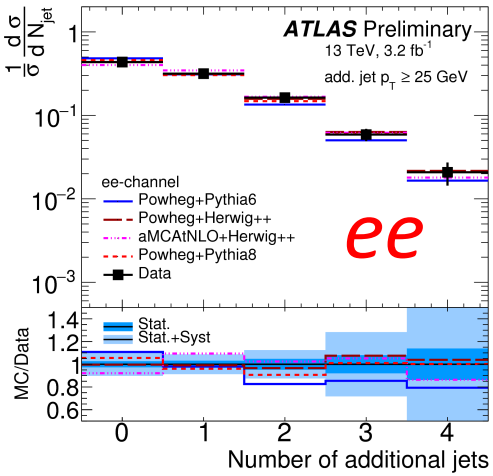


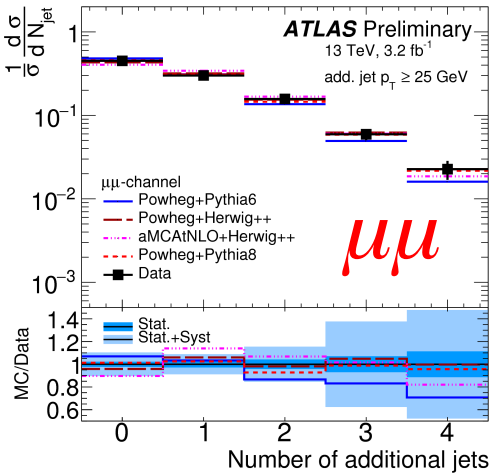


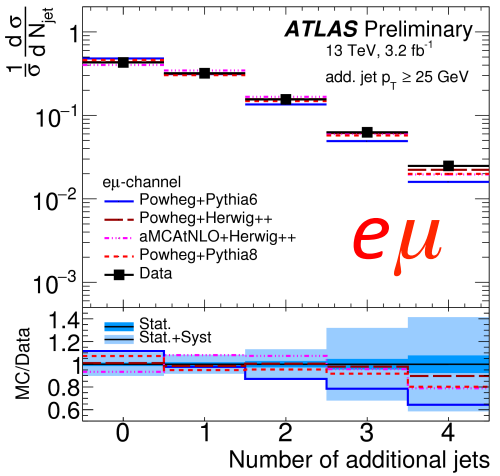
Good agreement of Jet kinematics with higher statistics

Unfolded Jet Multiplicity to particle-level Jets

In good agreement with other MC prediction (Powheg-Pythia8, Powheg-Herwig++ and aMC@NLO-Herwig ++)







Good agreement Data-MC within uncertainties

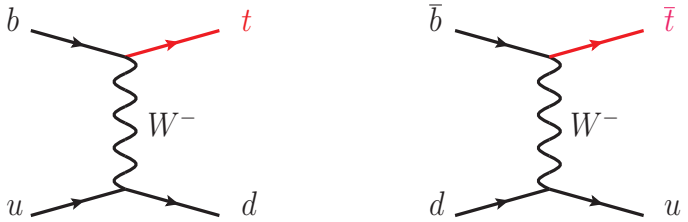
Measurement of the Single Top Cross Section

ATLAS-CONF-2015-079

Electroweak production of (single) Top quark

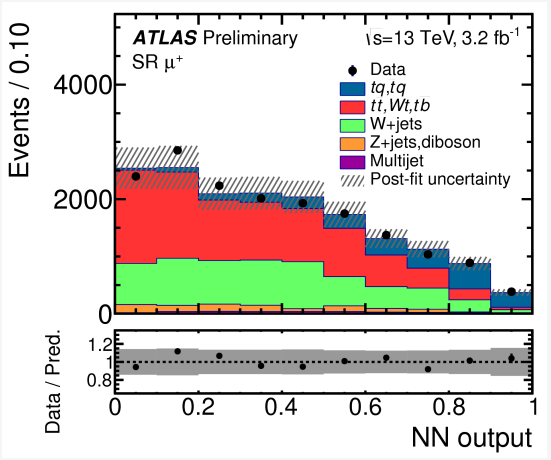
Muon decay channel only in events with 2jets and 1b-tag

Separating μ^+ and μ^-



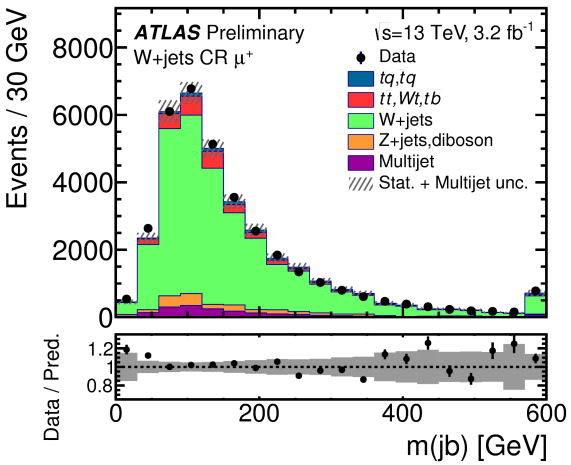
Signal region

NN output



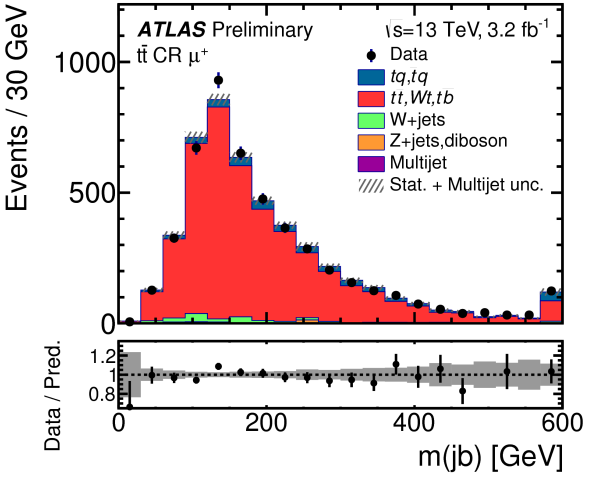
W+jets Control Region

1 loose b-Tag exclusively



tt Control Region

3 jets and 2 b-Tags



$$\sigma_{tq} = 130.3 \pm 5.8(stat) \pm 16.5(syst) \pm 7.7(lumi)\ pb$$

$$\sigma_{\bar{t}q} = 90.2.3 \pm 5.3(stat) \pm 18.4(syst) \pm 5.3(lumi)\ pb$$

NLO prediction $\sigma_{ttq} = 136.0.2.3 \pm 5.4(stat)\ pb$

$\sigma_{\bar{t}q} = 81.4 \pm 4.1(stat)\ pb$

Direct measurement of V_{tb}

(assuming Vtb>>Vts,Vtd, left chiral coupling)

$$\left| f_{LV} V_{tb} \right| = 0.98 \pm 0.08$$

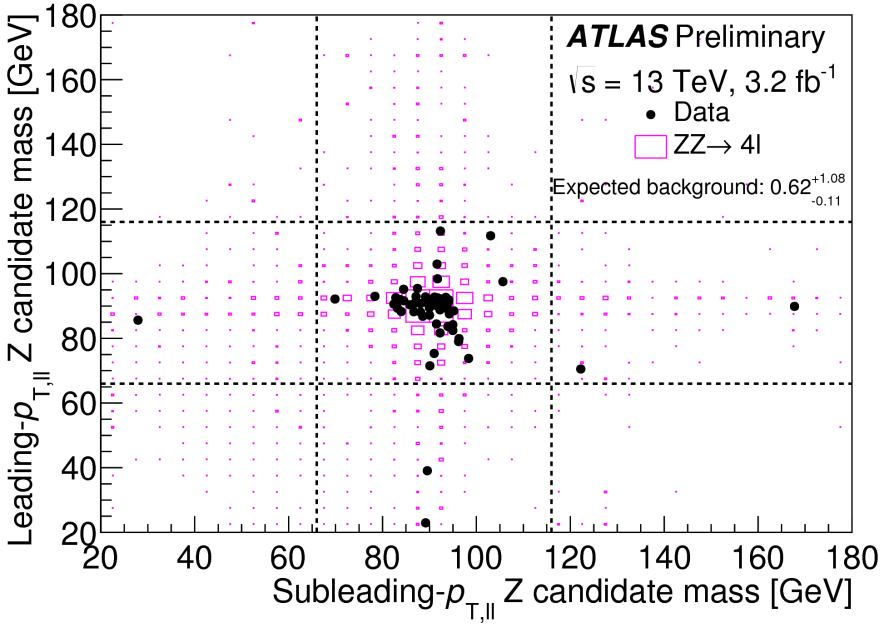
Measurement of the ZZ Cross Section

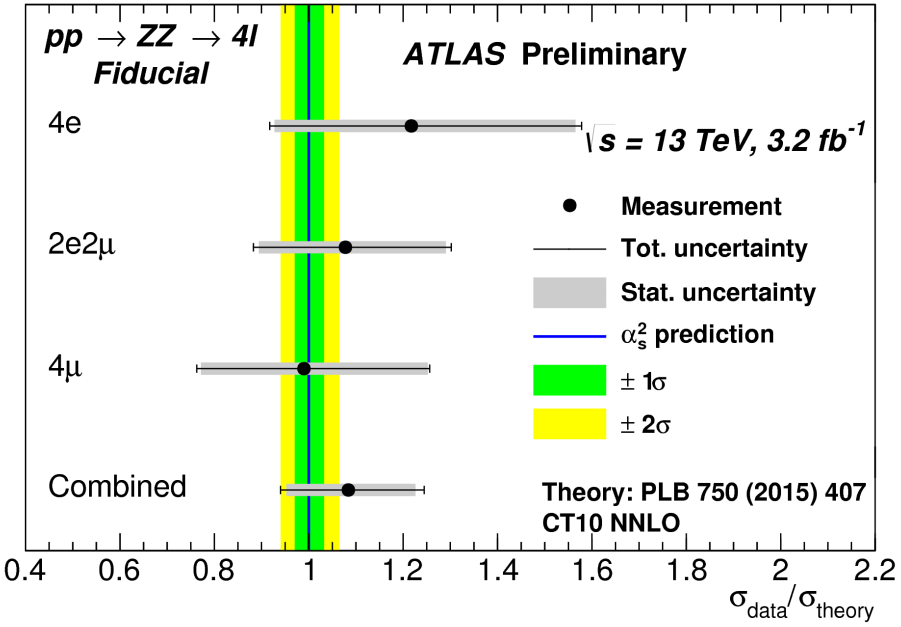
Measurement in the 4-leptons channel

Two OS and SF pairs of leptons with mass consistent with the Z ($66 < m_{ll} < 116$ GeV)

Contributions from Tau, tri-boson and ttZ from MC

Fakes data driven: Fake factor method.





$$\sigma_{ZZ} = 16.7 \pm 2.0(stat)^{+0.9}_{-0.7}(syst)^{+1.0}_{-0.7}(lumi)\ pb$$

NNLO Prediction $\sigma_{ZZ} = 15.6^{+0.4}_{-0.4}\ pb$

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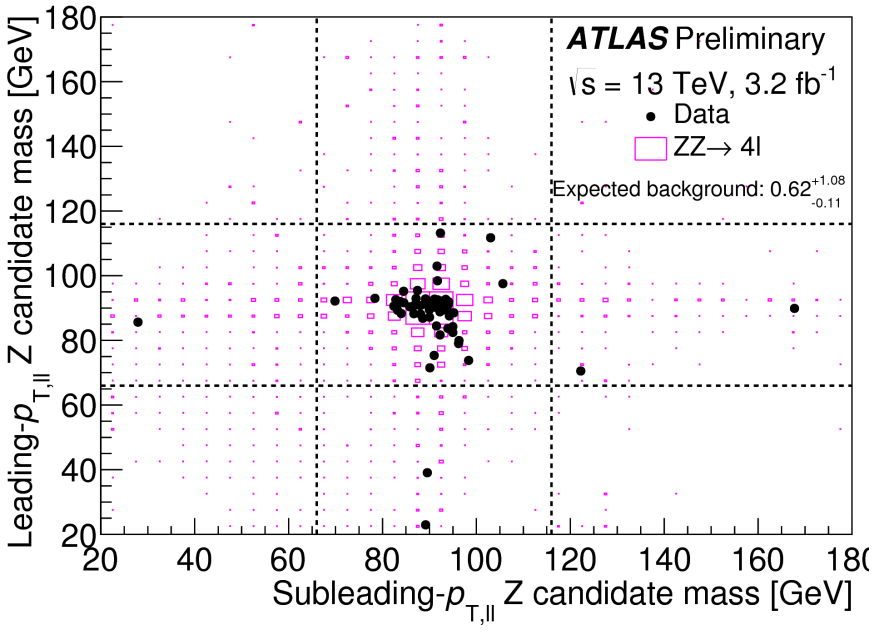

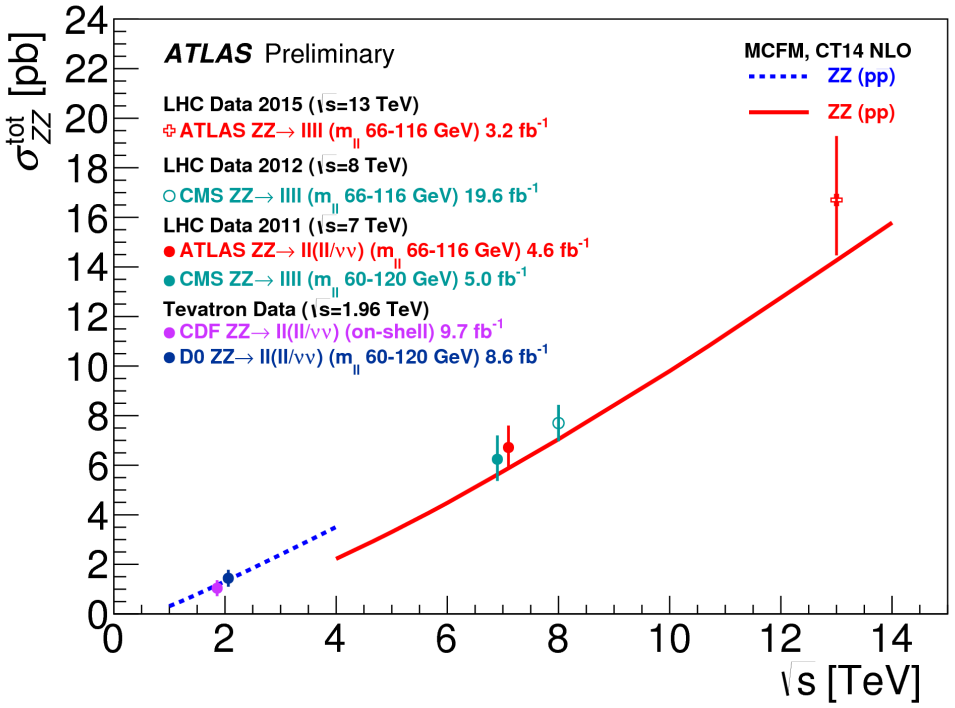

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NNLO Prediction $\sigma_{ZZ} = 15.6^{+0.3}_{-0.3}\ pb$

Glimpse at the Higgs in the Discovery Channels

Mass taken to be ATLAS-CMS Combined value (***PRL 114, 191803***): $m_H = 125.09 \pm 0.24\ GeV$

Diphoton Channel

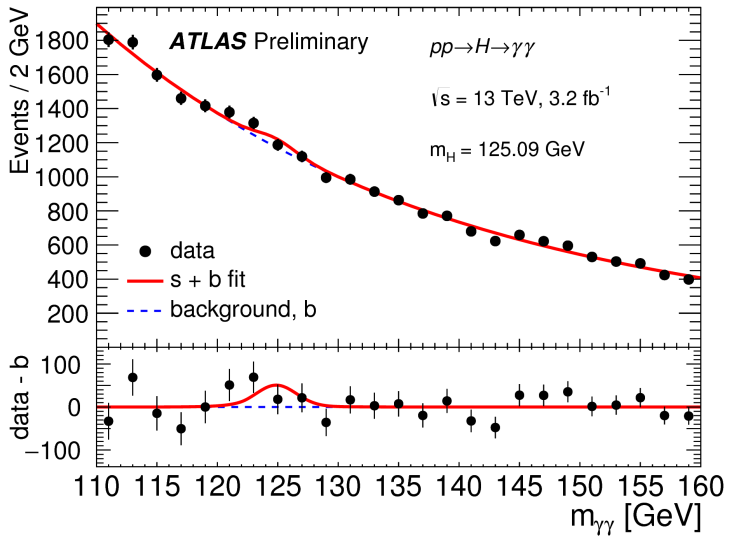
Fully inclusive analysis

- Photon ET thresholds: 0.25 $m_{\gamma\gamma}$ and 0.35 $m_{\gamma\gamma}$
- Track and Calorimeter based isolation criteria
- Simple fit function for background estimate
- **Number of candidate events fitted**:

  113 ± 74 (stat) +43/-25 (syst)

Sensitivity to SM Higgs: **1.9σ** (Observed **1.5σ**)

ATLAS-CONF-2015-060



Four lepton Channel

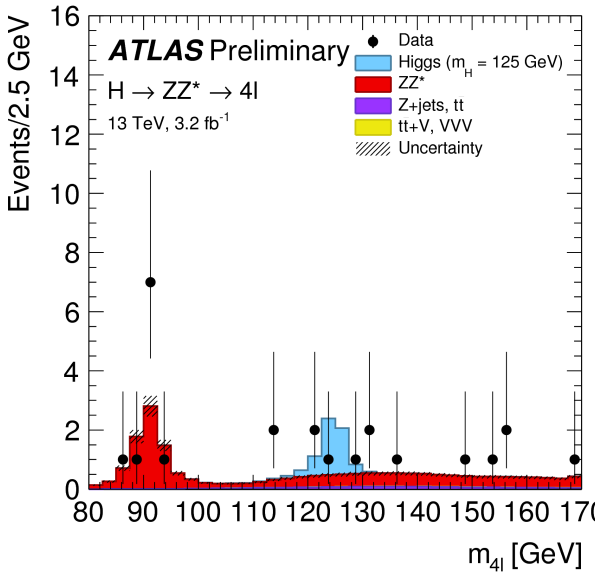
Fully Inclusive analysis

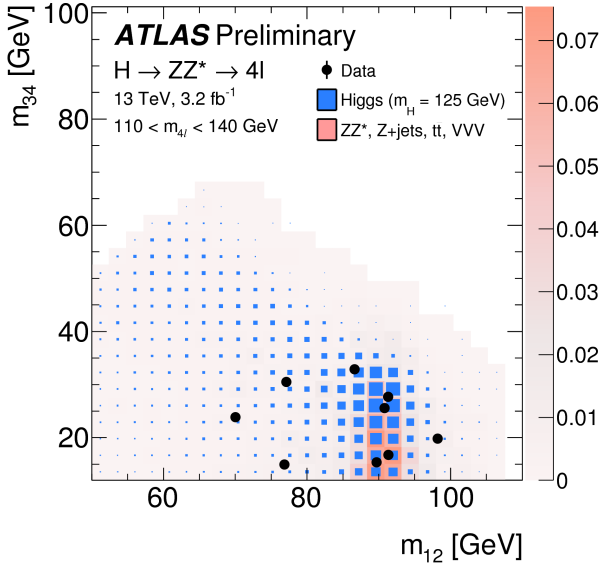
- Electron pT thresholds: 6, 10, 15, 20 GeV
- Muon pT thresholds: 7, 10, 15, 20 GeV
- Irreducible background (ZZ) from MC
- Reducible from CRs (from Isolation and IP)
- **Nb of candidates in [120,130] GeV**: **4**
- **From fit**:

  1.0 +2.3/-1.5

Sensitivity to SM Higgs: **2.8σ**
(Observed **0.7σ**)

ATLAS-CONF-2015-059



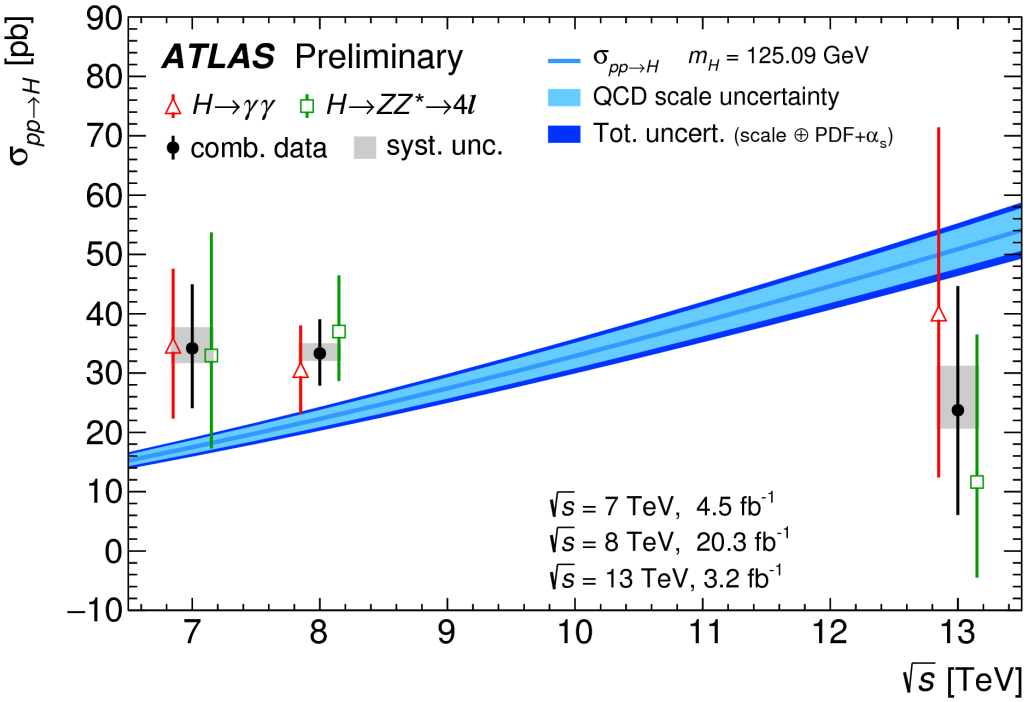


Measurement of the **Higgs Cross Section** (Combination)

From **Fiducial** to **Total** Inclusive Higgs production cross sections

	13 TeV
Acceptance factor	
$H \to \gamma\gamma$	0.570 ± 0.006
$H \to ZZ^* \to 4\ell$	0.427 ± 0.006
Fiducial cross section [fb]	
$H \to \gamma\gamma$	52^{+40}_{-37}
$H \to ZZ^* \to 4\ell$	$0.6^{+1.3}_{-0.9}$
Total cross section [pb]	
$H \to \gamma\gamma$	40^{+31}_{-28}
$H \to ZZ^* \to 4\ell$	12^{+25}_{-16}
Combination	24^{+20}_{-17} (stat.) $^{+7}_{-3}$ (syst.)
LHC-XS	$50.9^{+4.5}_{-4.4}$

ATLAS-CONF-2015-069

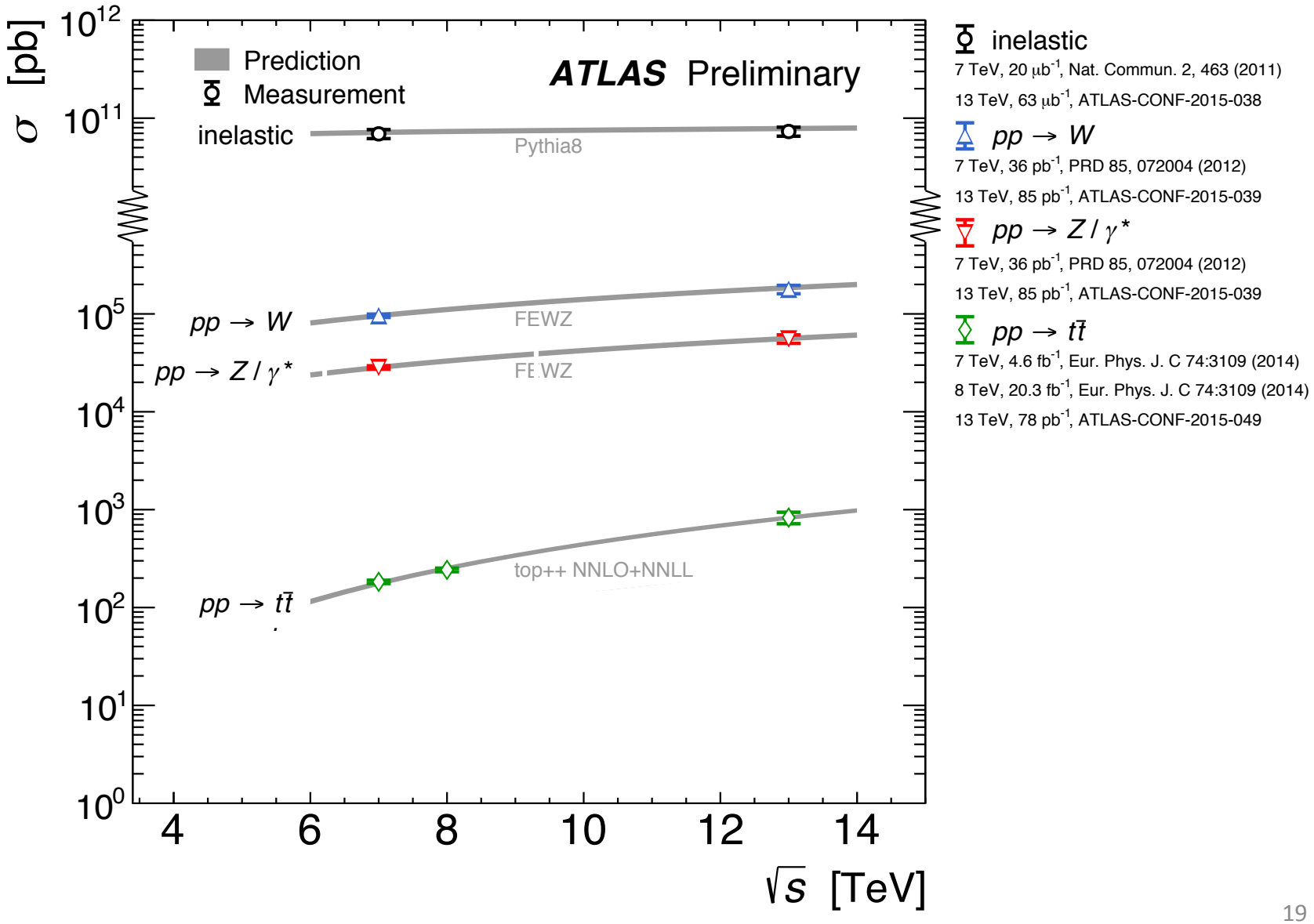


Combined observation significance:

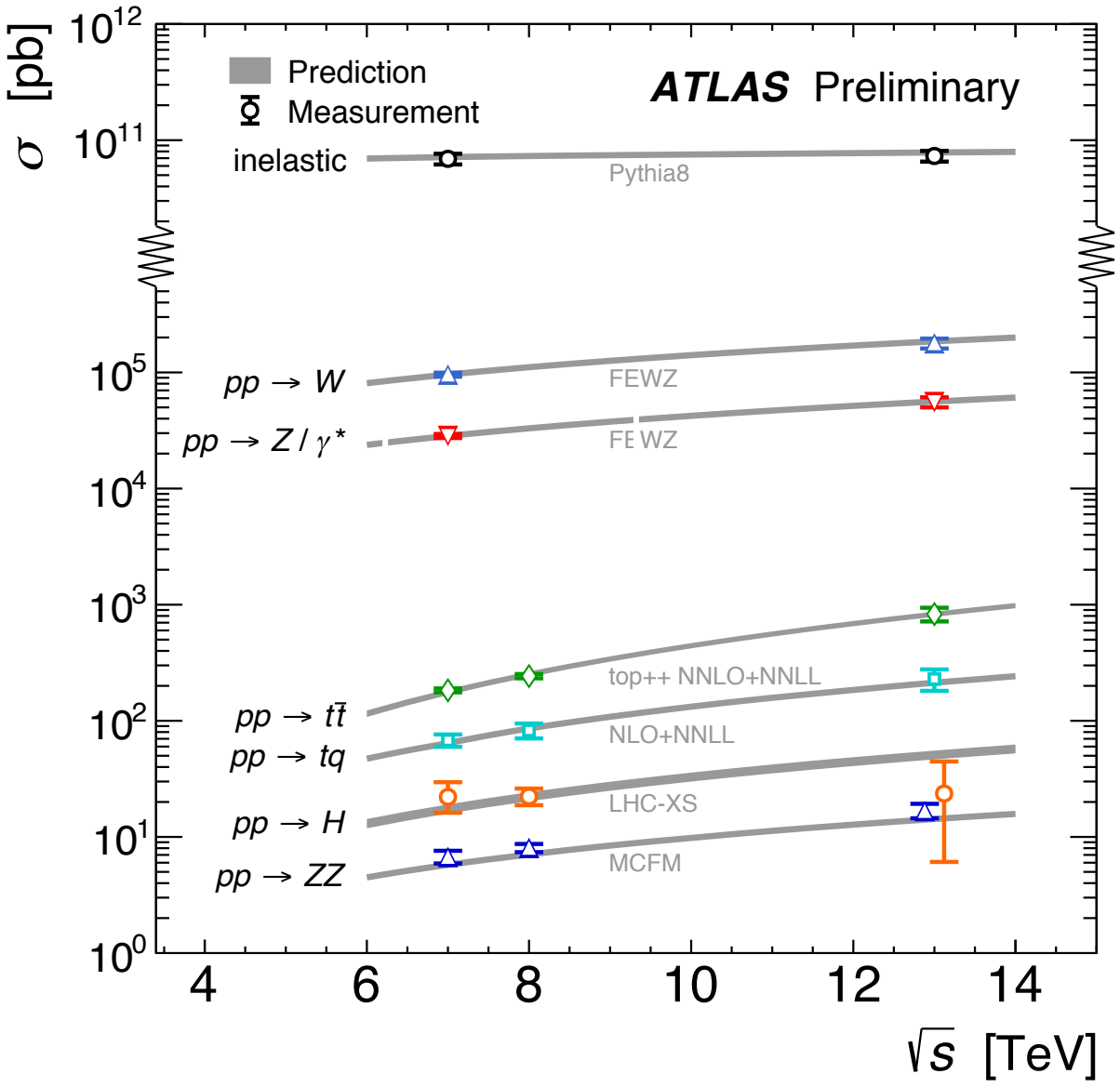
- Expected: **3.4σ**
- Observed: **1.4σ**

Compatibility with SM: **1.3σ**

Summary of Run-2 Total Cross Section Measurements



Summary of Run-2 Total Cross Section Measurements



inelastic
7 TeV, 20 μb^{-1}, Nat. Commun. 2, 463 (2011)
13 TeV, 63 μb^{-1}, ATLAS-CONF-2015-038

$pp \rightarrow W$
7 TeV, 36 pb^{-1}, PRD 85, 072004 (2012)
13 TeV, 85 pb^{-1}, ATLAS-CONF-2015-039

$pp \rightarrow Z / \gamma^*$
7 TeV, 36 pb^{-1}, PRD 85, 072004 (2012)
13 TeV, 85 pb^{-1}, ATLAS-CONF-2015-039

$pp \rightarrow t\bar{t}$
7 TeV, 4.6 fb^{-1}, Eur. Phys. J. C 74:3109 (2014)
8 TeV, 20.3 fb^{-1}, Eur. Phys. J. C 74:3109 (2014)
13 TeV, 78 pb^{-1}, ATLAS-CONF-2015-049

$pp \rightarrow tq$
7 TeV, 4.6 fb^{-1}, PRD 90, 112006 (2014)
8 TeV, 20.3 fb^{-1}, ATLAS-CONF-2014-007
13 TeV, 3.2 fb^{-1}, ATLAS-CONF-2015-079

$pp \rightarrow H$
7 TeV, 4.5 fb^{-1}, arXiv:1507.04548
8 TeV, 20.3 fb^{-1}, arXiv:1507.04548
13 TeV, 3.2 fb^{-1}, ATLAS-CONF-2015-069

$pp \rightarrow ZZ$
7 TeV, 4.6 fb^{-1}, JHEP 03, 128 (2013)
8 TeV, 20.3 fb^{-1}, ATLAS-CONF-2013-020
13 TeV, 3.2 fb^{-1}, STDM-2015-13

Outline

This talk presents **only new results** based on the full 2015 13 TeV pp collision data

- **ATLAS in Run-2**
- **Performance with the full 2015 Data**
- **New Measurements**
  - SM and Top Measurements
  - First look at the Higgs boson at Run-2
- **Searches**
  - Search for Additional Higgs bosons
  - Searches for SUSY
  - Searches at very high mass
  - Dibosons searches with boosted topologies

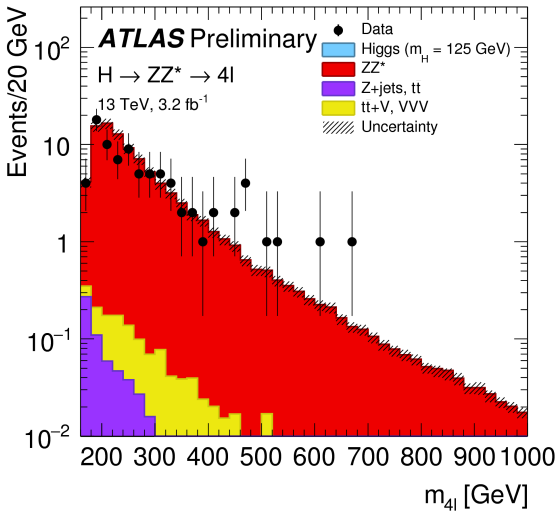
Search in the 4-lepton Channel

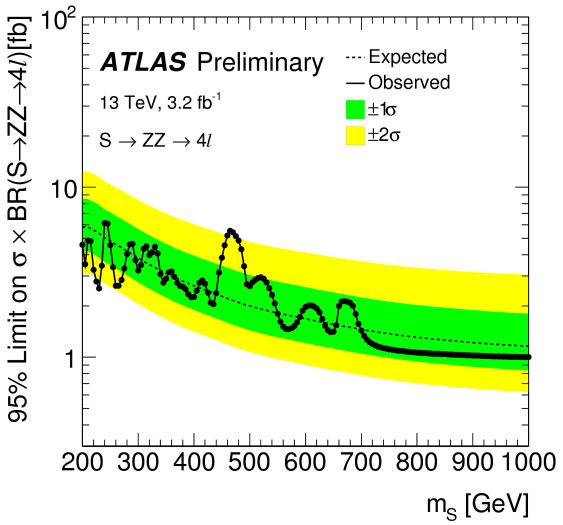
Mass dependent EW k-factor applied

ATLAS-CONF-2015-059

High Mass Search

- Region where two Z on shell
- No significant excess (large LEE)
- Total cross sec. limits in the NWA
  (acceptance assumes ggF ~ for VBF)

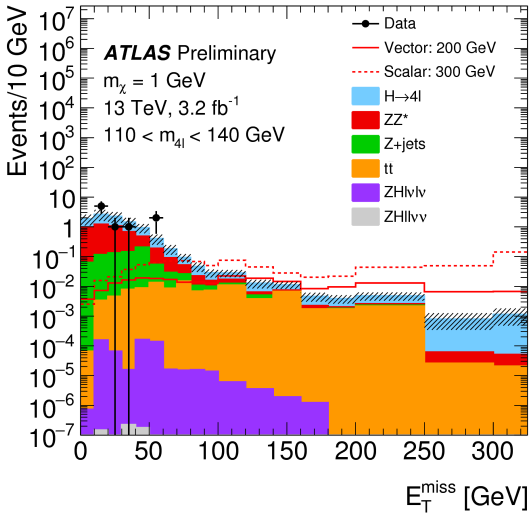


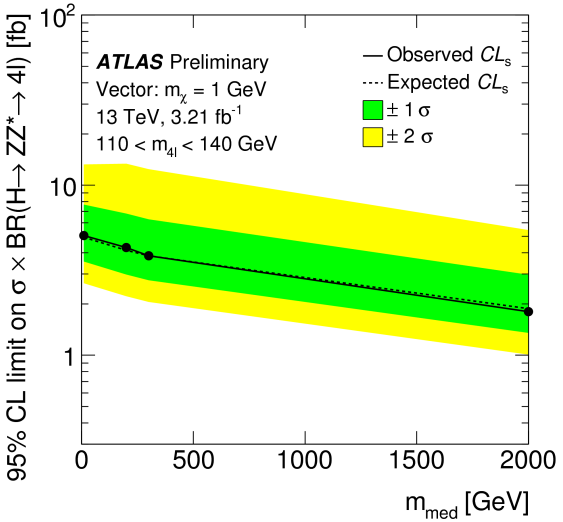


Higgs-MET search for Dark Matter

Benchmark scenarios (from DM Forum, LHC Exp. And Theory):
http://arxiv.org/pdf/1507.00966.pdf

- 4-leptons and MET>100 GeV
- SM Higgs prod. as background
- Total background: 0.06 Events
- No events **observed 0**



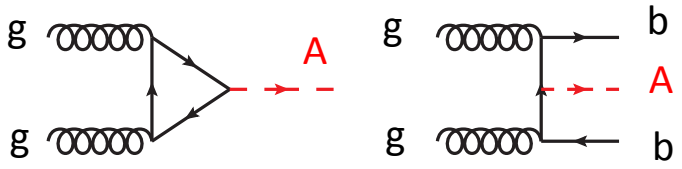


Interpretation in Scalar (and Vector) Mediated simplified model

Search for Higgs boson H/A in ττ Decays

Analysis done in two channels: $\tau_{lep}\tau_{had}$ and $\tau_{had}\tau_{had}$

Aiming at all production modes inclusively:



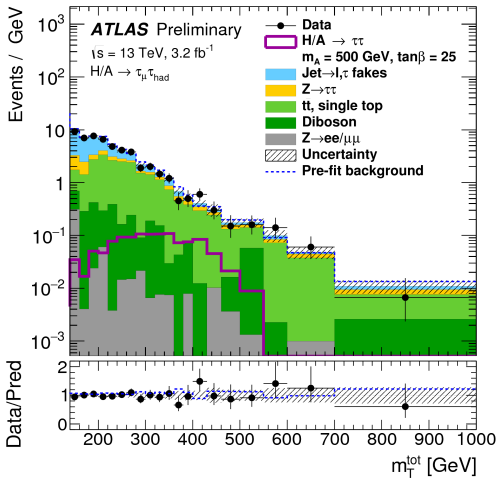
$\tau_{lep}\tau_{had}$ Channel

- Z and top backgrounds from MC
- W+jets and MJ background from Fake Factor (tau ID)

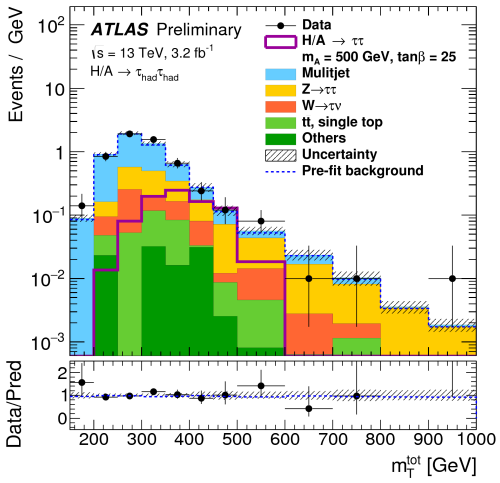
$\tau_{had}\tau_{had}$ Channel

Dominant MJ background from fake factor method
(checks in Same Sign Validation region)

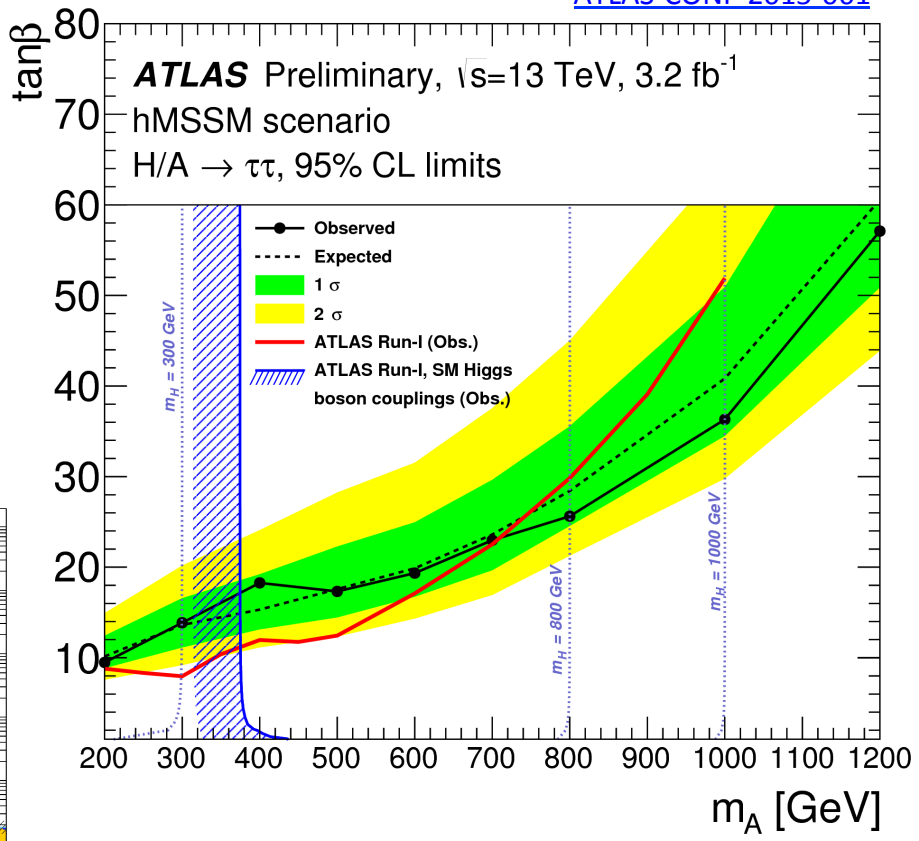
$\tau_{lep}\tau_{had}$ final selection level



$\tau_{had}\tau_{had}$ Final selection level



ATLAS-CONF-2015-061



New exclusion at intermediate tanβ from approx. 600 GeV up to 1.2 TeV

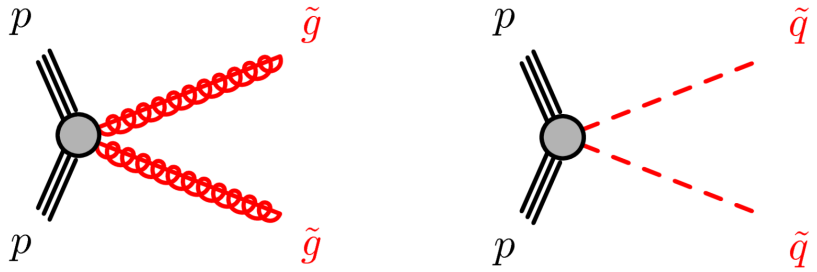
Early Searches for SUSY

At this early stage of the Run-2 main focus of SUSY searches:
Strong production of Guinos and (to lesser extent) Squarks

Ratio of 13 TeV / 8 TeV Cross sections:

- Squarks and Gluinos 1.5 TeV: **35**
- Squarks and Gluinos 1 TeV: **15**

44 Signal regions to cover large number of decay chains (Jets, MET, Leptons, b-Jets)

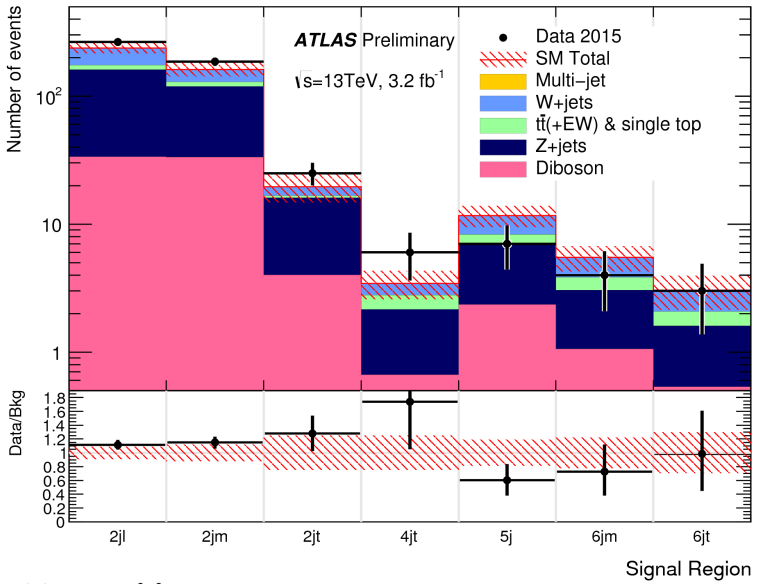


Strongly Produced SUSY Searches (I)

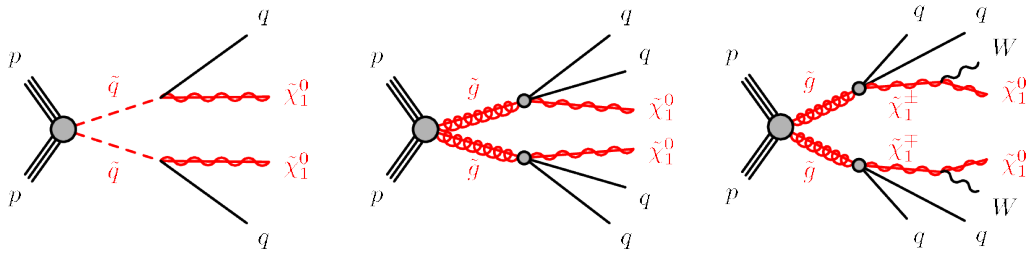
2-6 Jets-MET

ATLAS-CONF-2015-062

No significant excess found

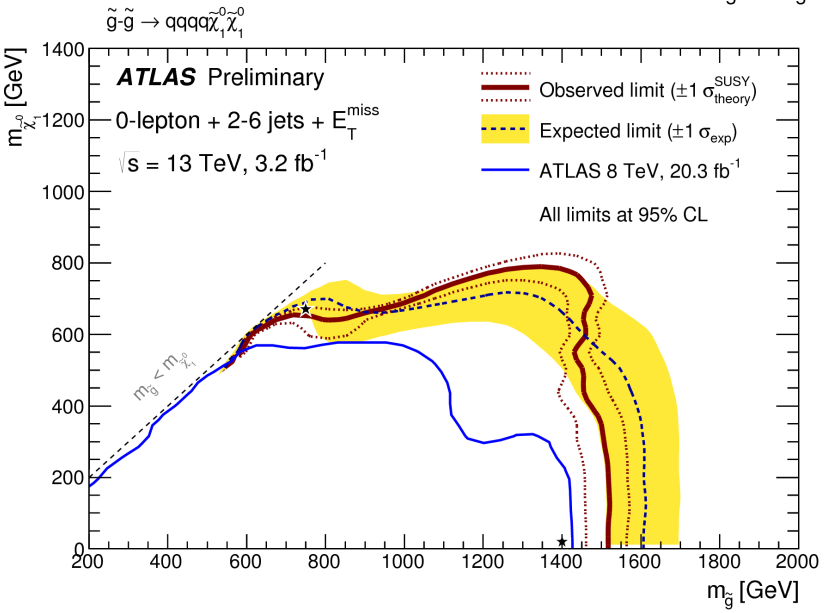


- **Search for squarks and gluinos** in 6 signal regions aiming at simplest production and decay modes



- **Signal categories**
  - 2-4-5-6 Jets
  - With different selection tightness in MET (loose, medium and tight)

- **Background estimates**
  - CR Z (to vv)-Jets from γ-jet events
  - CR Top pair from lepton, b-tag, MET region
  - CR W-jets from lepton, MET, b-veto
  - CR Multijet (from MET aligned with jets)



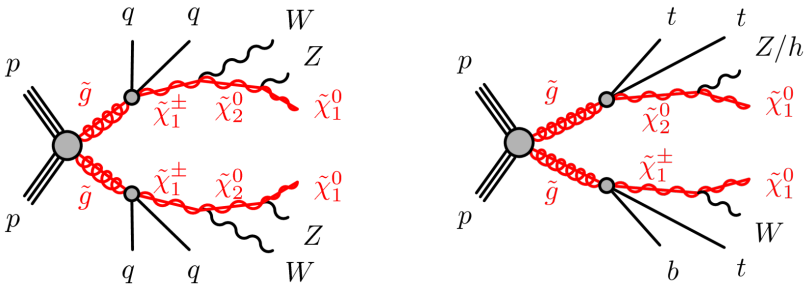
Limits on gluino mass reach 1.5 TeV

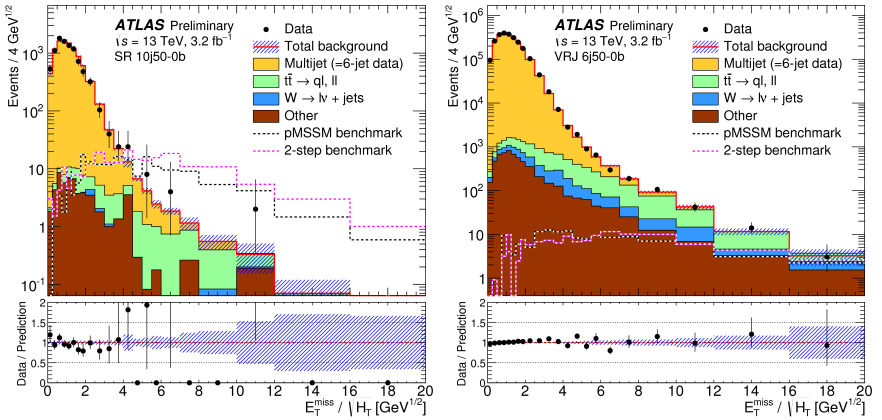
Strongly Produced SUSY Searches (II)

7-10 Jets-MET Signatures

ATLAS-CONF-2015-077 *No significant excess found*

Search for gluino production in 15 signal regions aiming at more complex decay chains





Signal categories

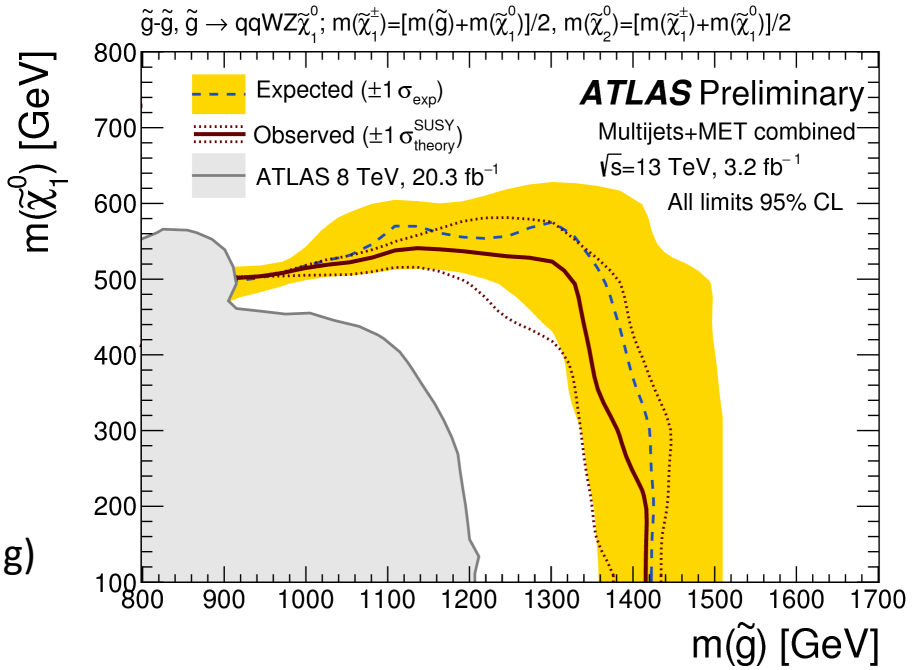
- Lower MET cuts
- 7-8-9-10 Jets
- With up to 2 b-tagged jets

Backgrounds

- Multijet based on invariance of MET significance distribution estimated in events with 6-jets (1 b-tag)

$$E_T^{Miss} / \sqrt{H_T}$$

- Top and W backgrounds estimated using MC



Limits on Gluino mass reach 1.4 TeV

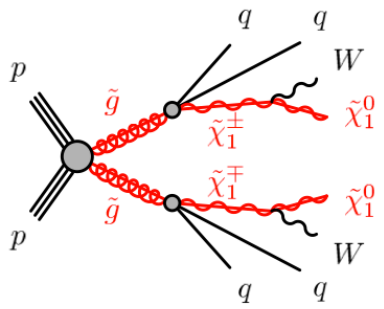
Strongly Produced SUSY Searches (III)

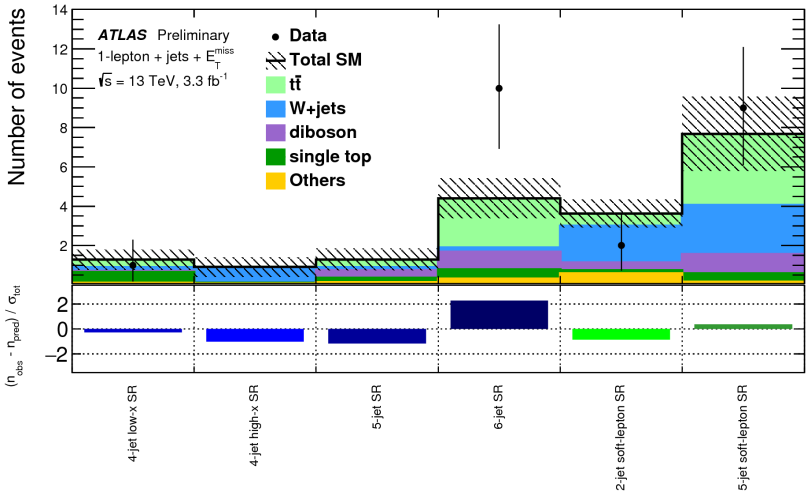
1 Lepton-Jets and MET Signatures

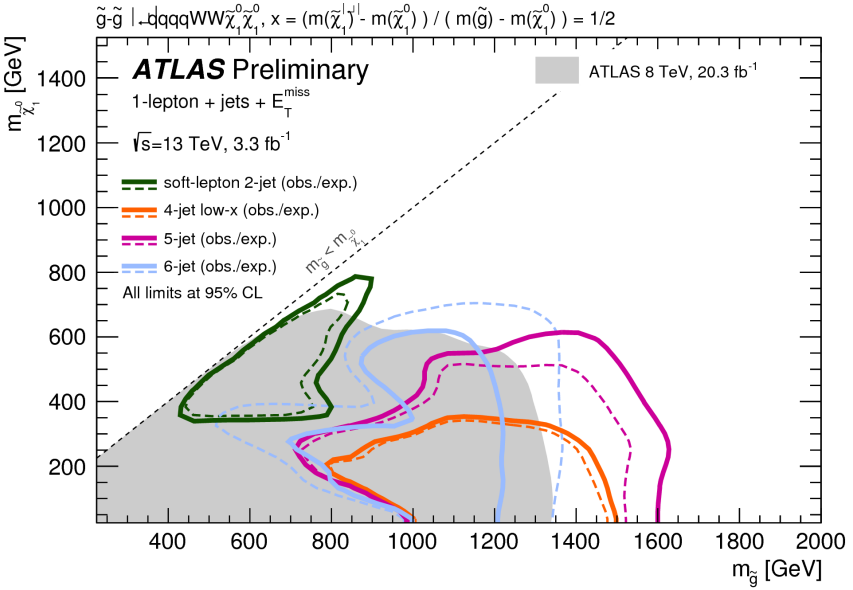
No significant excess found

ATLAS-CONF-2015-076

Search for gluino production in 6 signal regions instead of vetoing 1-lepton is required(e or μ)







Signal categories

- In 1L and 2-4-5-6 Jets
- Including soft leptons for compressed scenarios

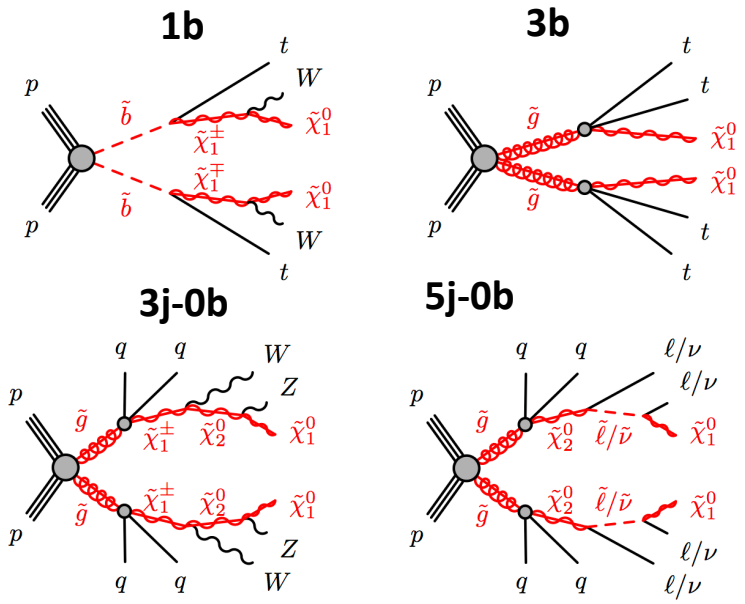
Backgrounds

- W CR lower MT or HT and lower MET w/b-veto
- Top CR in lower MT or HT and lower MET w/ 1 b-tag

Gluino exclusion up to 1.6 TeV

Strongly Produced SUSY Searches (IV)
SS di-leptons and 3-leptons signatures

Search for gluino and squarks production in 4 signal regions aiming at decay chains involving one W decaying to lepton (e or μ)

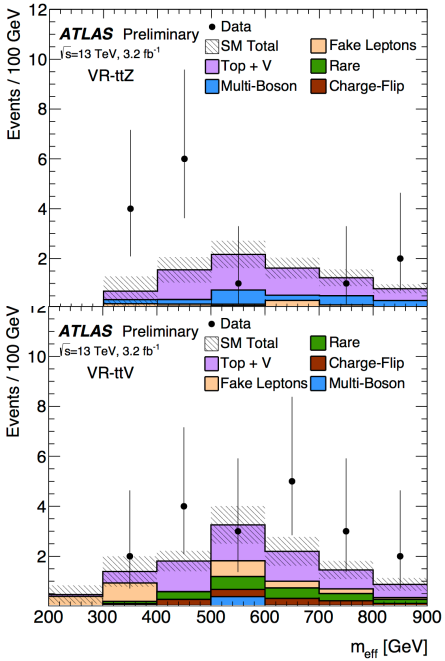


Backgrounds

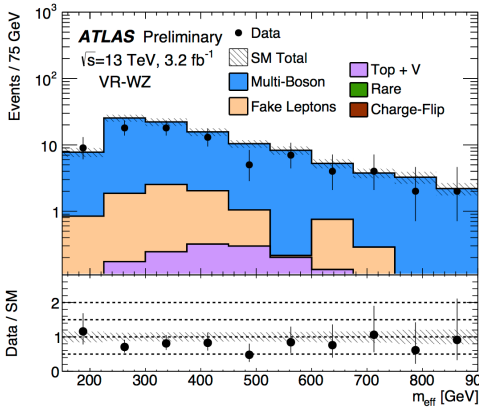
- Charge flip from Z events
- Fake leptons from Matrix method based on lepton-ID.
- Other backgrounds from MC

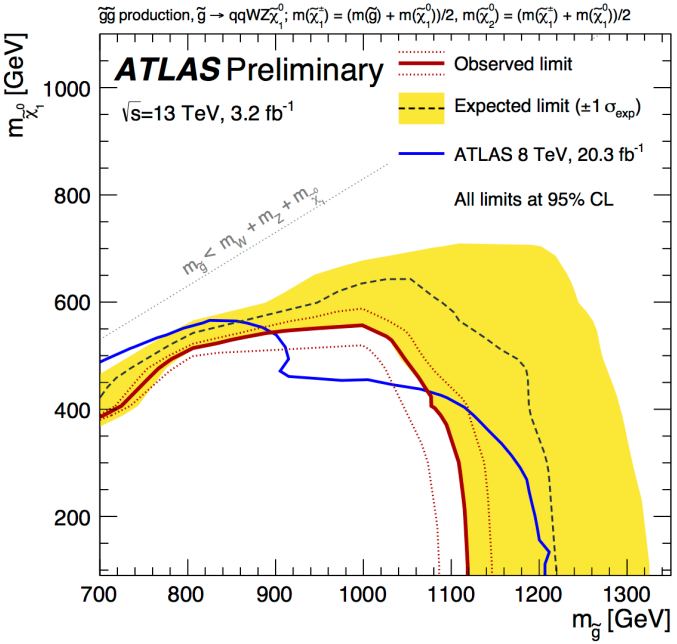
ATLAS-CONF-2015-078

ttV validation regions



3L-WZ validation region



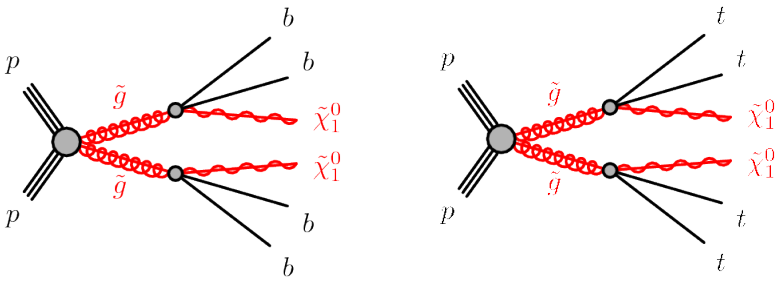


Gluino exclusion up to 1.2 TeV

Strongly Produced SUSY Searches (VI)
Multi-b Jets Signatures

ATLAS-CONF-2015-067

Search for gluino production in 8 signal regions with multiple b-jets aiming at decays with b and top quarks



Signal categories

- 0L and 1L (specific for multi-top signals)
- Number of jets, b-jets and MET

Improvements to the analysis

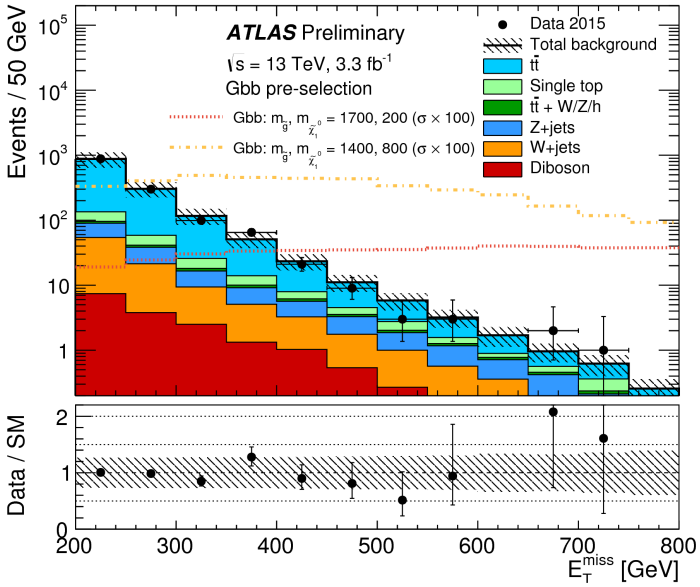
Use of boosted tops, New selection cuts

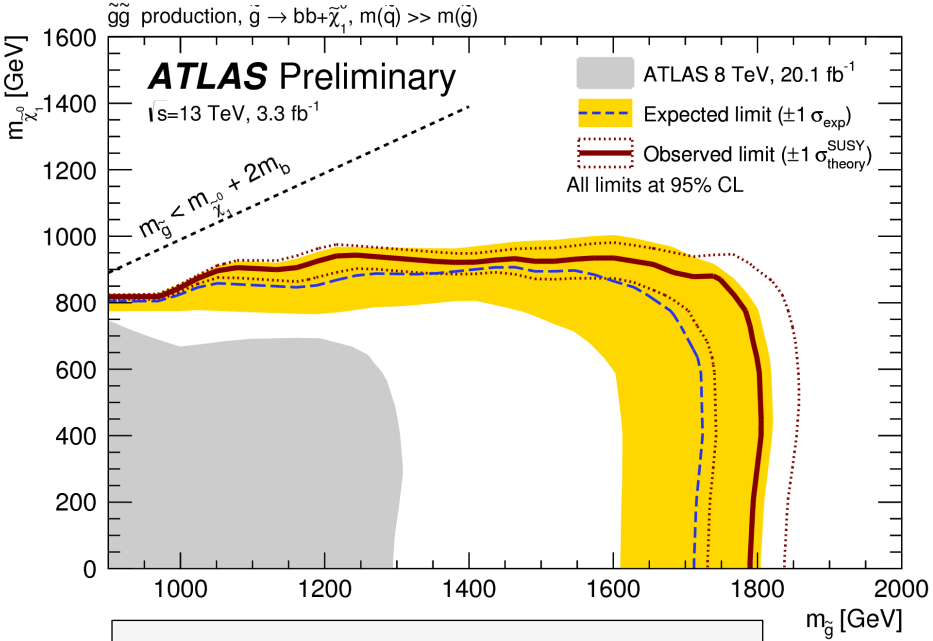
Backgrounds

Top background (dominant) from CRs (in MET)

Other backgrounds from MC

Preselection level distribution



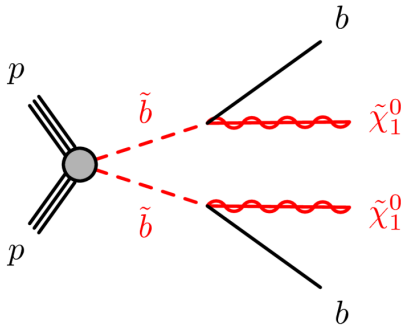


Gluino exclusion reach 1.8 TeV

Strongly Produced SUSY Searches (V)
Sbottom pair production

ATLAS-CONF-2015-066

Search for sbottom production in 4 signal regions aiming at (A) low neutralino mass or (B) more compressed scenarios



Signal categories

Selection of 2 b-jets and MET>250 (A) 400 (B) GeV

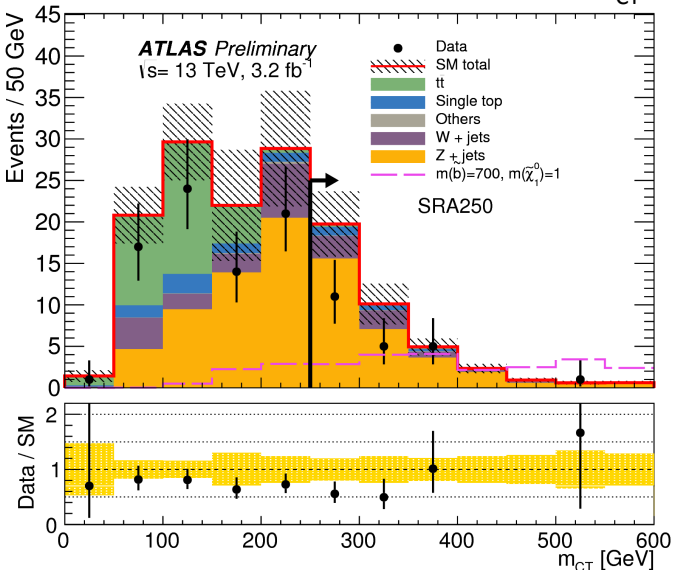
Categories in (A) based on (contransverse mass)

Backgrounds

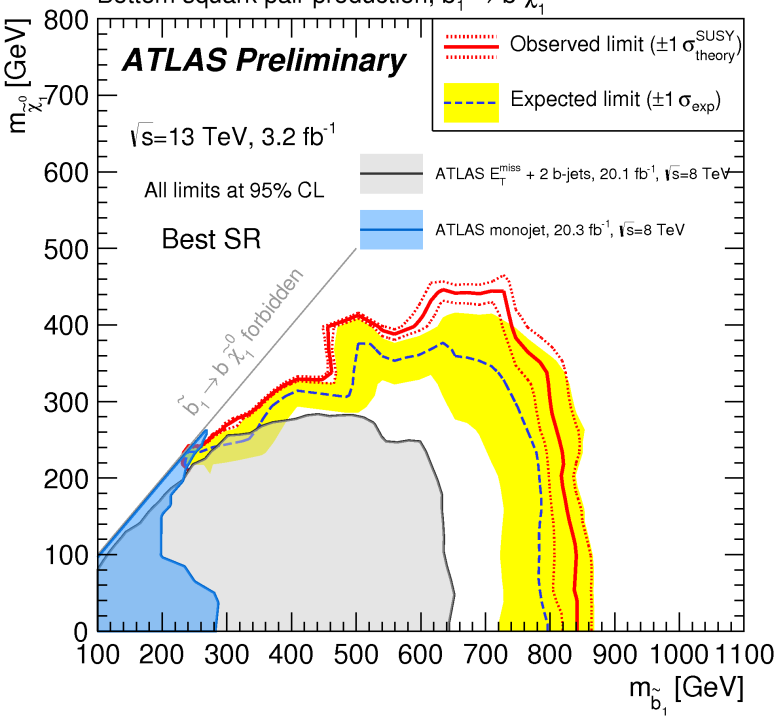
W, Z and top estimated from regions with 1 or 2 identified leptons

Limits on Sbottom up to 850 GeV

SR-A without cut on m_{CT}



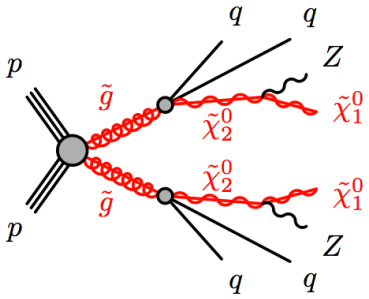
Bottom squark pair production, $\tilde{b}_1 \rightarrow b\,\tilde{\chi}_1^0$



Strongly Produced SUSY Searches (VII)
Z+MET Signature

ATLAS-CONF-2015-082

Search for gluino production in events with a Z, jets and MET in one Signal region



Event selection

Z, 2 jets, MET>225 GeV, HT>600 GeV

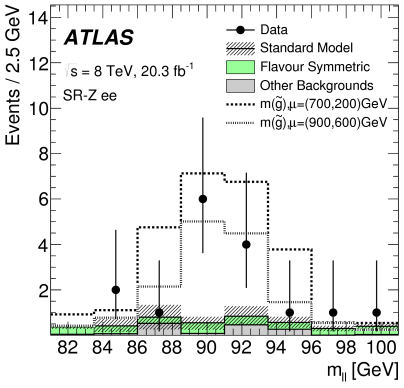
Main Backgrounds

- Z background from γ-jet events
- Top and diboson from DF events (eμ) – mainly top (70% of DF events)

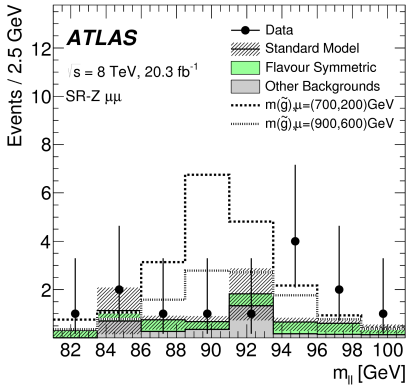
Check of an excess seen in ATLAS (not in CMS) at Run-1

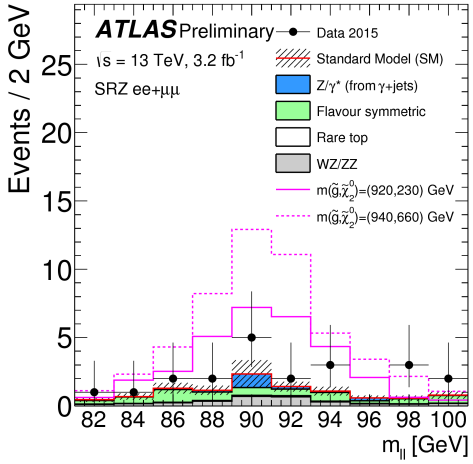
29 events *obs* **10.8±2.2** *exp* (3σ excess)

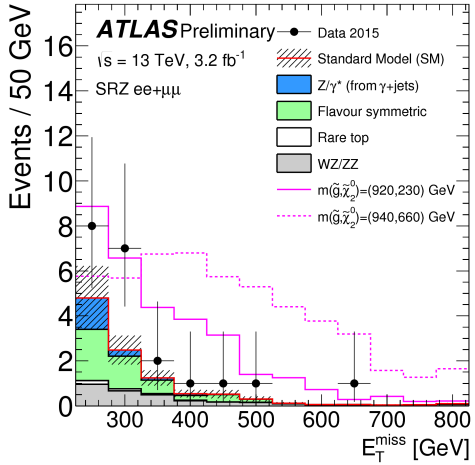
Run-1



Run-1

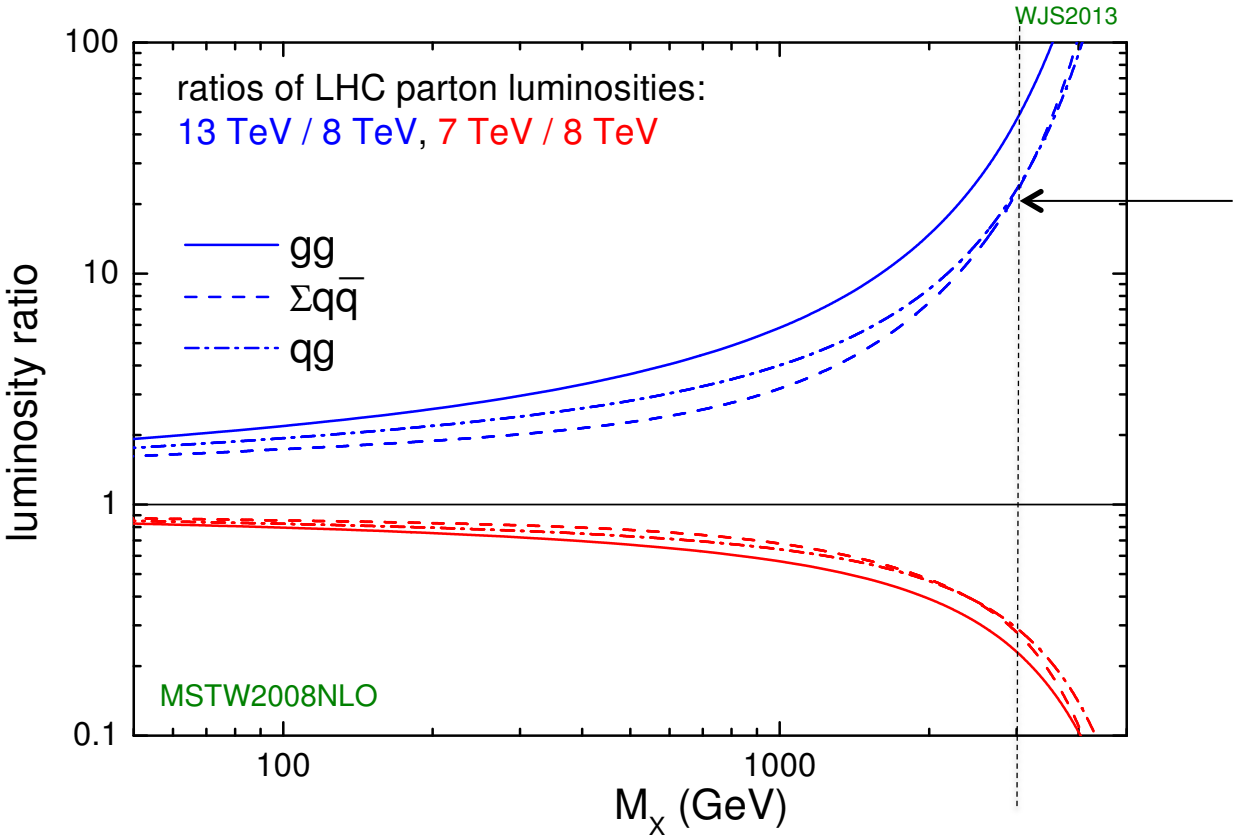






21 events *obs* (e ~ μ) and **10.4±2.4** *exp* (**2.2σ excess** at intermediate MET)

Early Searches for New Phenomena



Ratio of 13 TeV / 8 TeV
Cross sections:

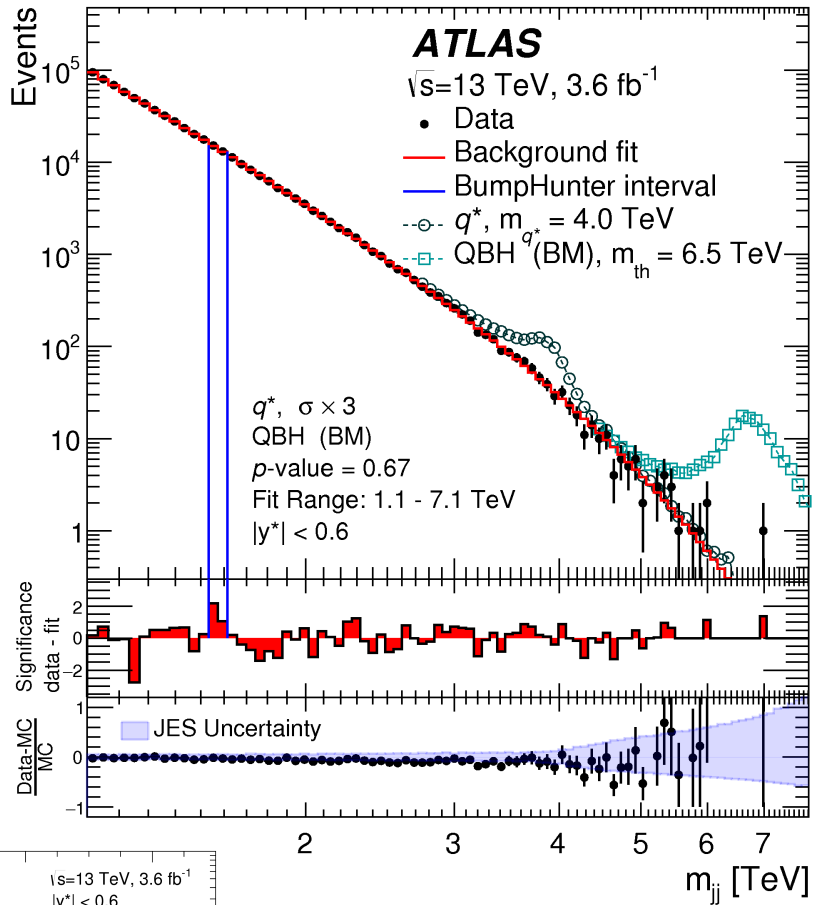
- Z' at 3 TeV: **20**
- q* at 4 TeV: **56**
- QBH at 5 TeV: **370**
- QBH at 6 TeV: **9000**

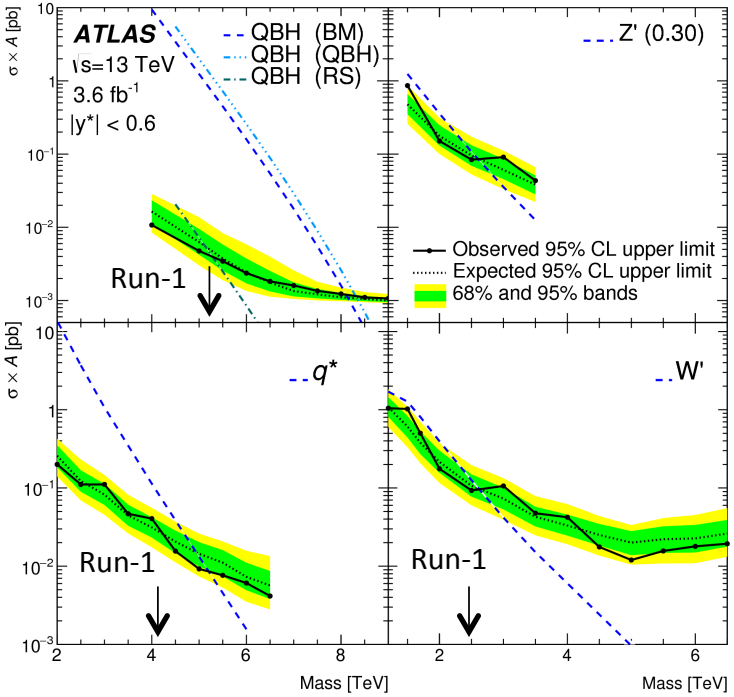
Update on **Dijet Resonant** Searches

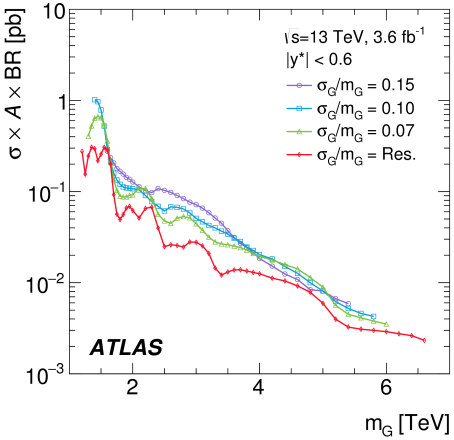
1512.01530

Dijet search for a peaking signal in invariant mass spectrum

- **Models**: Sensitive to Quantum Black Holes (Close to Mass Scale), Excited quarks, W' and Z'
- **Background**: Using simple analytic fit function
- Using Bump Hunter technique to identify most significant excess (global p-value of 70%)
  No significant excess found

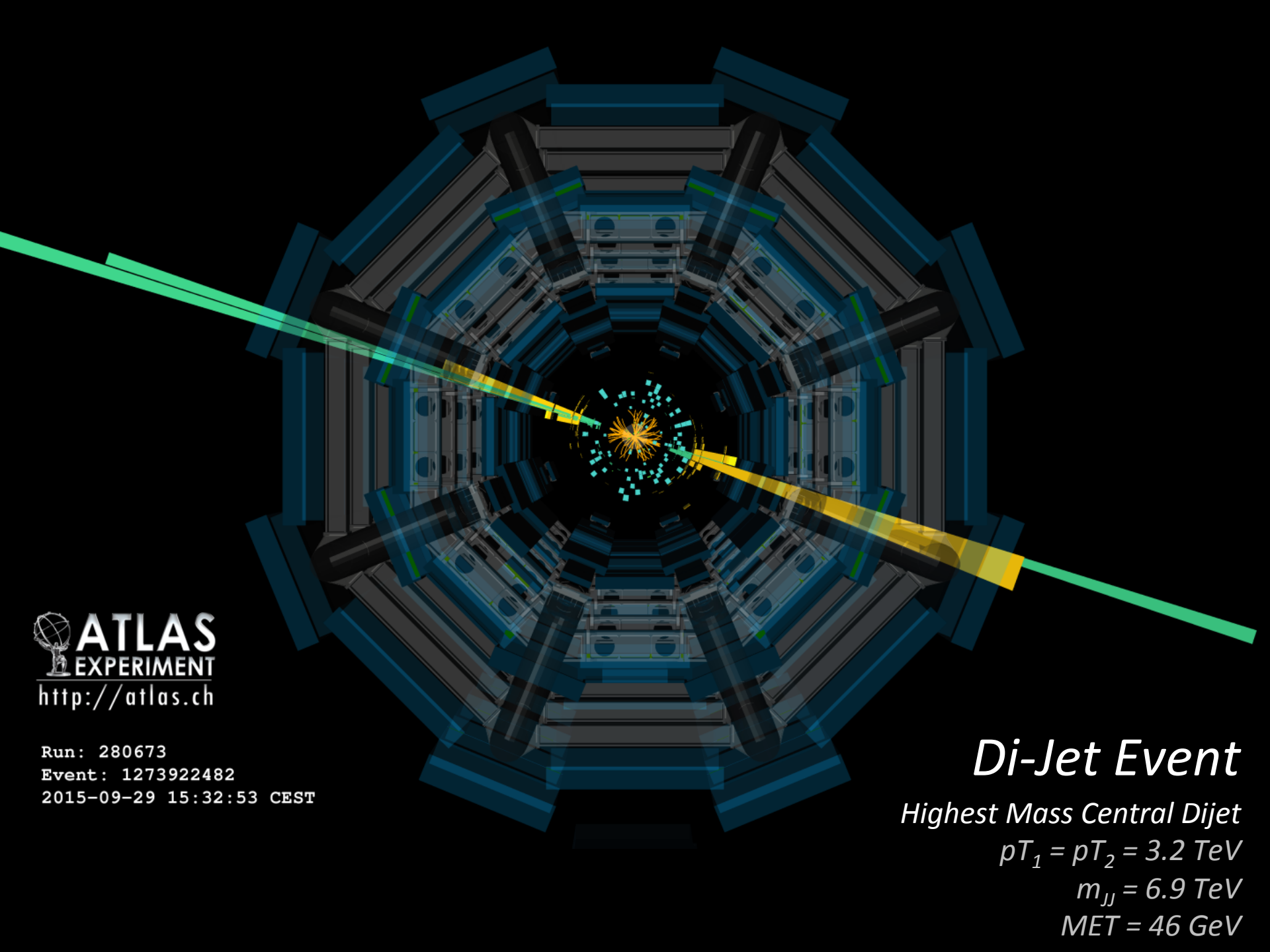






Model independent limits (based on Gaussian signal shape)

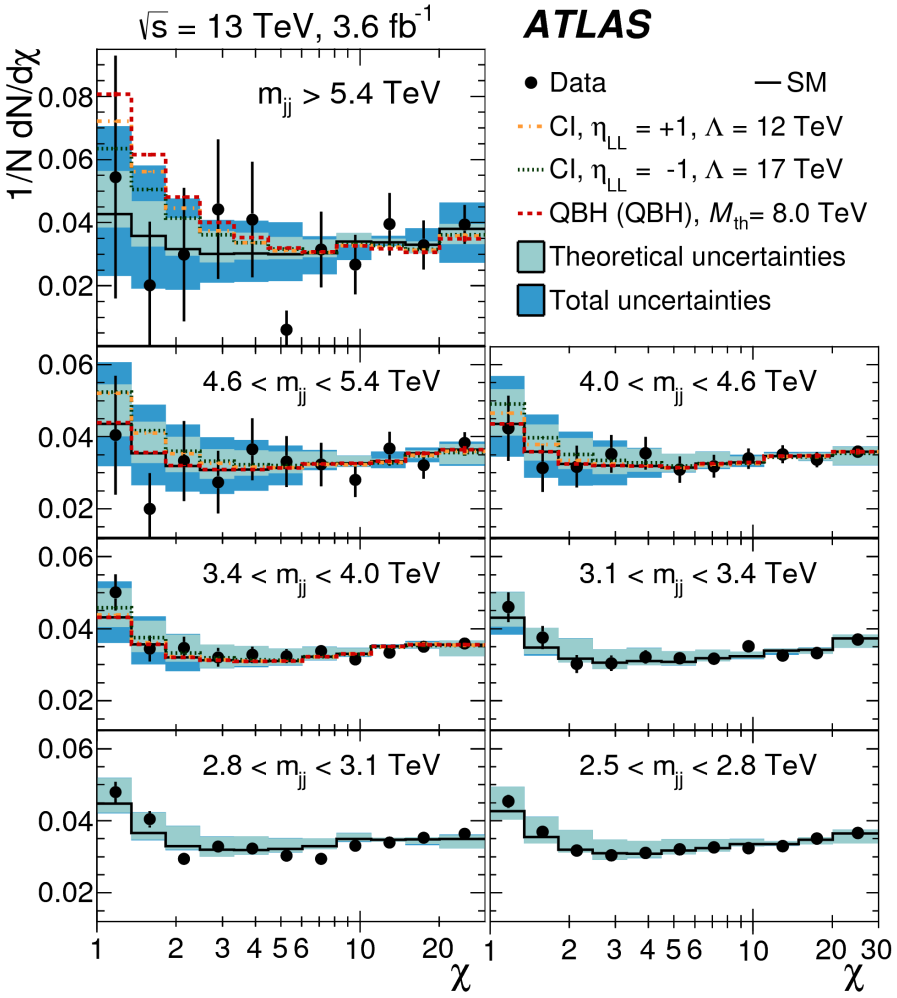
Limits on QBH reaching 8 TeV


ATLAS
EXPERIMENT
http://atlas.ch
Run: 280673
Event: 1273922482
2015-09-29 15:32:53 CEST
Di-Jet Event
Highest Mass Central Dijet
$pT_1 = pT_2 = 3.2$ TeV
$m_{JJ} = 6.9$ TeV
MET = 46 GeV

Update on **Dijet Angular** Searches

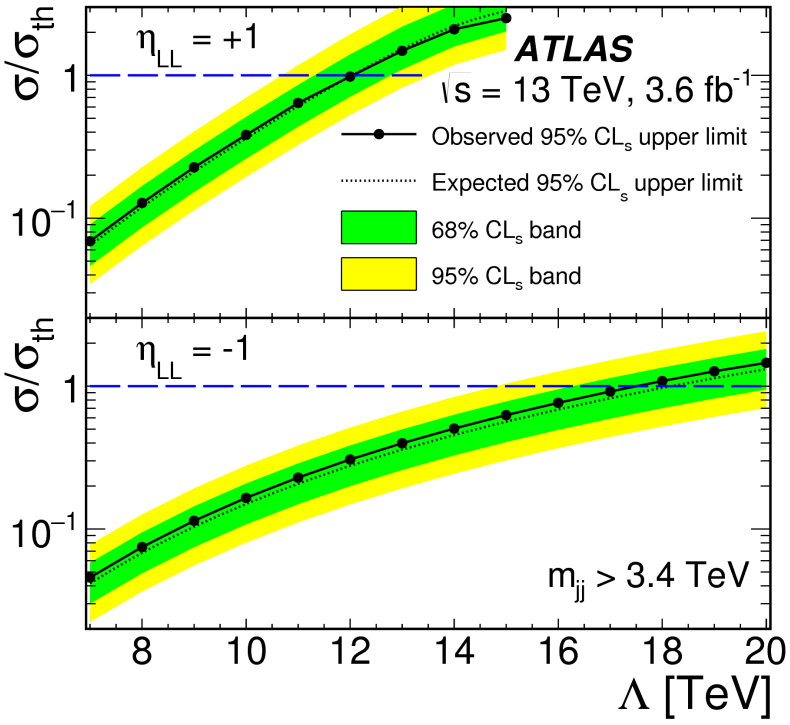
Search in dijet mass bins using angular distribution

$$\chi = e^{2|y^*|} \sim \frac{1+\cos\theta^*}{1-\cos\theta^*}$$



Search for distortions of the dijet angular distribution from Contact Interactions of particles at much higher masses O(Λ) with color-singlet left-handed chiral couplings (in 4-fermion effective field theory)

1512.01530



No deviations observed, limits set at 12 TeV on Λ (for $\eta_{LL} = 1$)

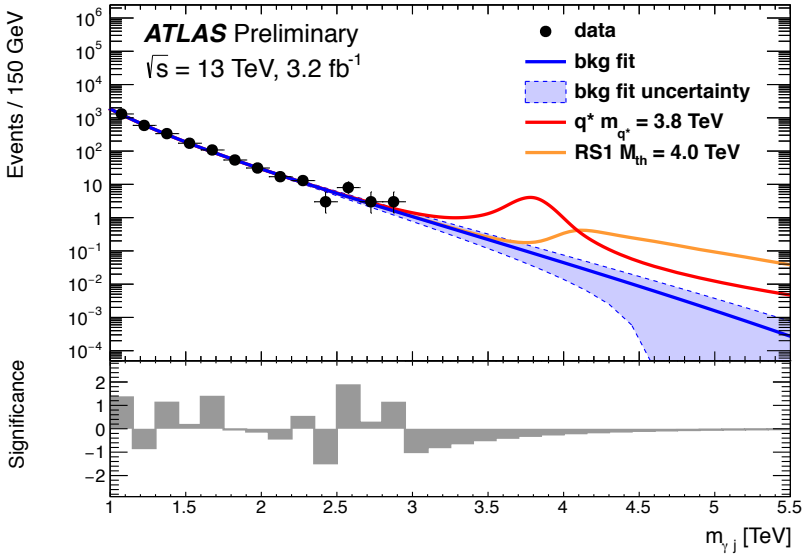
Searches for New Phenomena in **Photon-Jet** Events

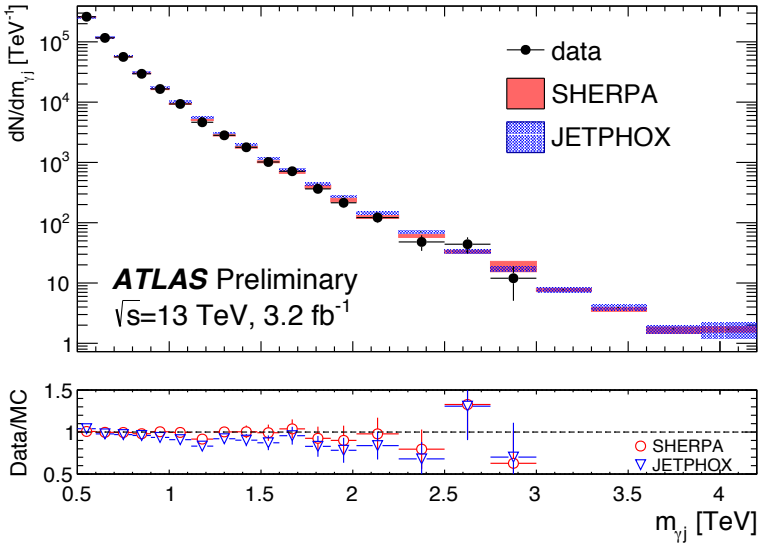
Search for q* or **QBH** decaying to a photon and a parton

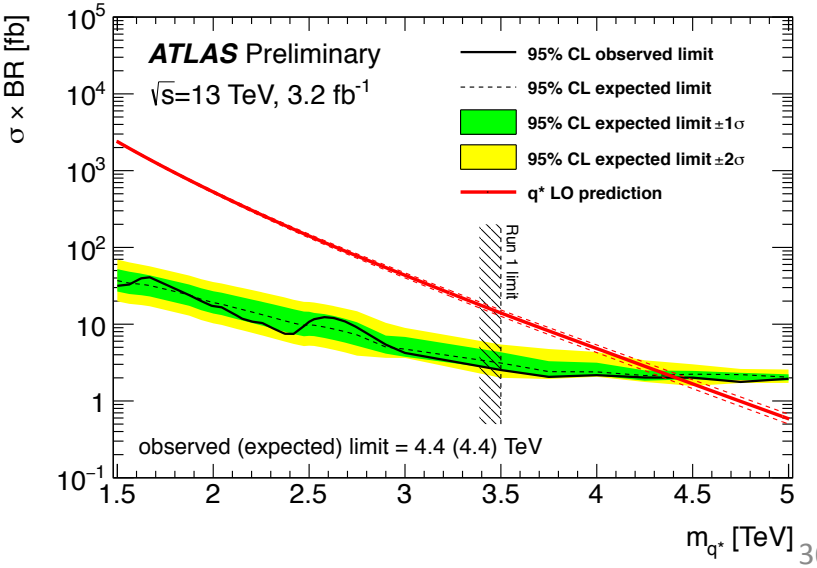
- **Background** estimated using a simple fit function similar to dijet search and extrapolate in the high mass domain

$$f_{bkg}(x \equiv m_{\gamma j} / \sqrt{s}) = p_0 (1-x)^{p_1} x^{-p_2 - p_3 \log x}$$

- **Background modeling systematics** estimated using the *spurious signal* method similarly to the diphoton Higgs channel

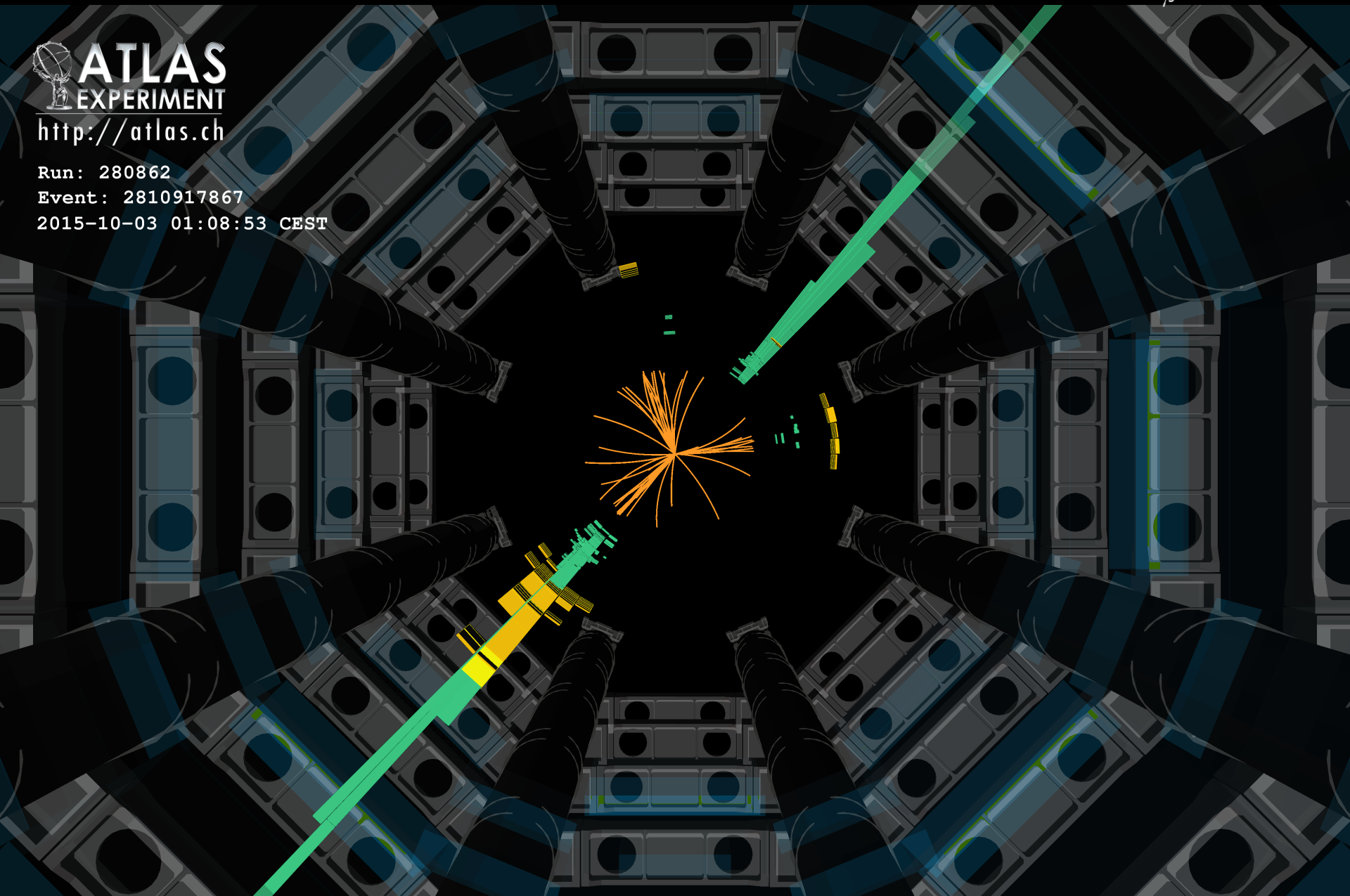






Photon-Jet Event

High Mass Photon-Jet
ET_1 =1.23 GeV ET_2 = 1.26 GeV
$m_{\gamma J}$ = 2.9TeV

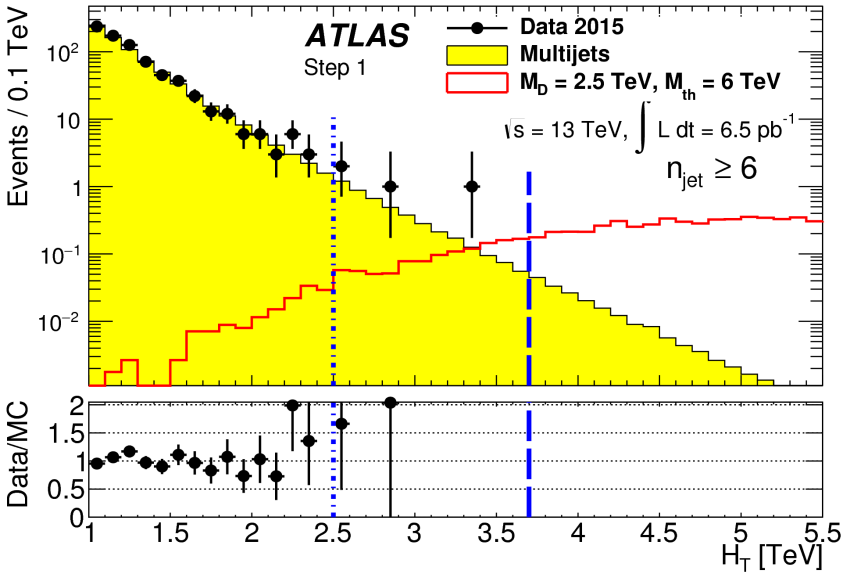


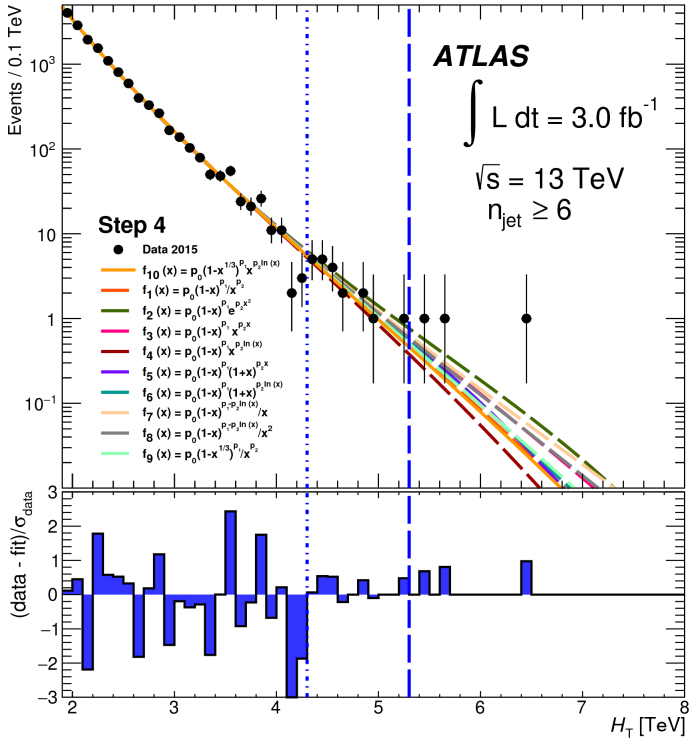
Update on Searches for New Phenomena in **Multijet** Events

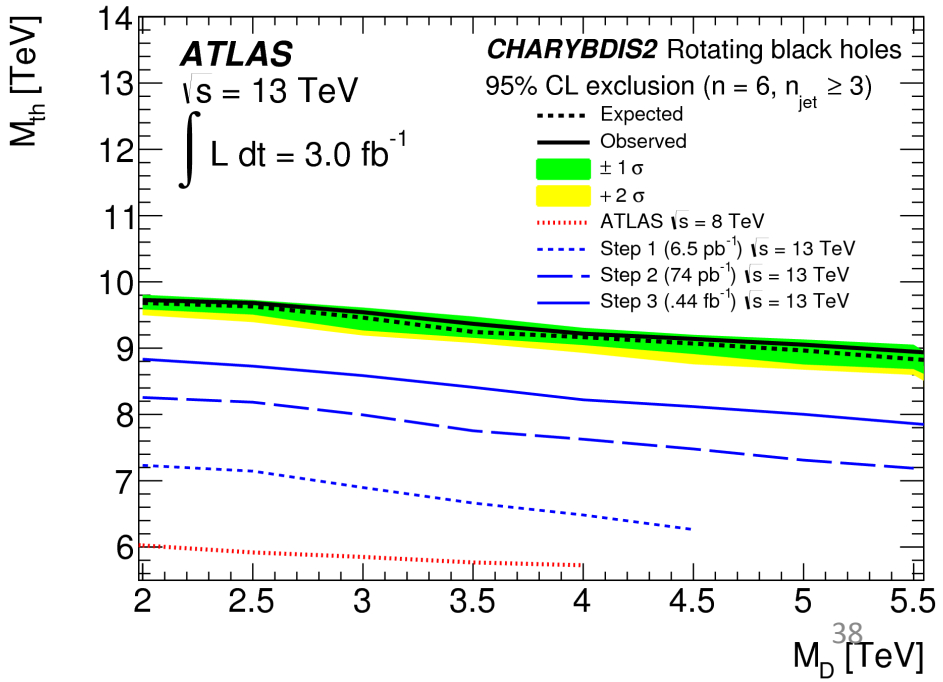
1512.02586

Search for thermal black holes in multijet events (in 3-8 jets signal regions), signal at high HT

- **Fit low HT** and **validate** and choose in medium **HT** (among 10 functions)
- **Bootstrap**: use incremental datasets to define Control Regions (6.5pb-1, 74pb-1, 440pb-1 and 3.0 fb-1)







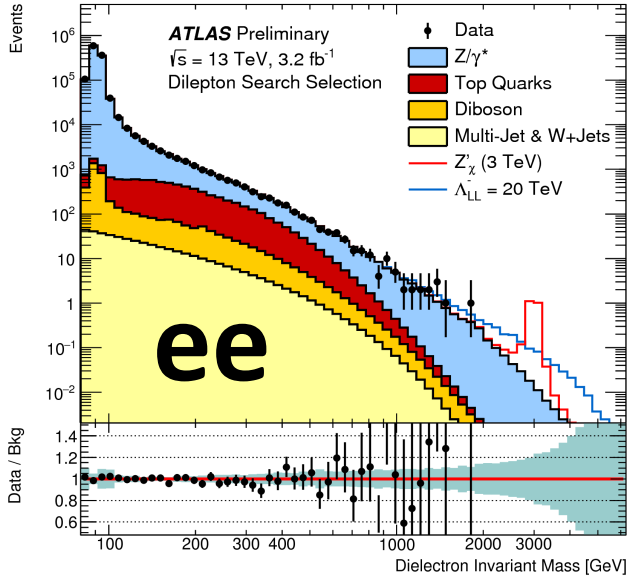
Searches for **Dilepton Resonances (LFC** and **LFV)** (I)

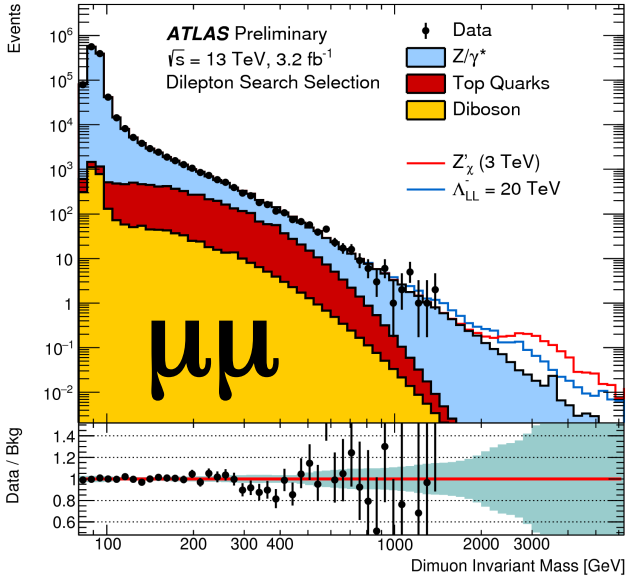
Search for Z' in dilepton (LFC) and (LFV) *(in eμ decays)*

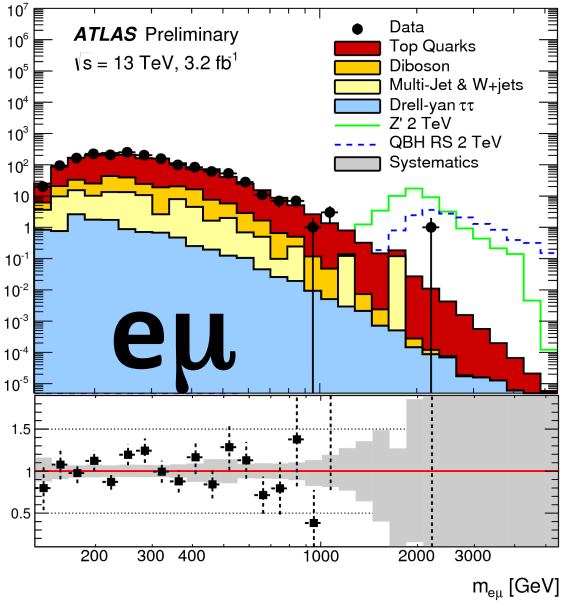
[ATLAS-CONF-2015-070](#)

[ATLAS-CONF-2015-072](#)

- Main background DY is taken from MC
- Top and diboson extrapolated at very high masses using a functional form
- Background from MC except for MJ in dielectron uses Matrix method (based on electron ID)







Highest di-electron mass event at 1.8 TeV

Highest di-muon mass event at 1.4 TeV

Highest eμ mass event at 2.1 TeV

No Excess found !

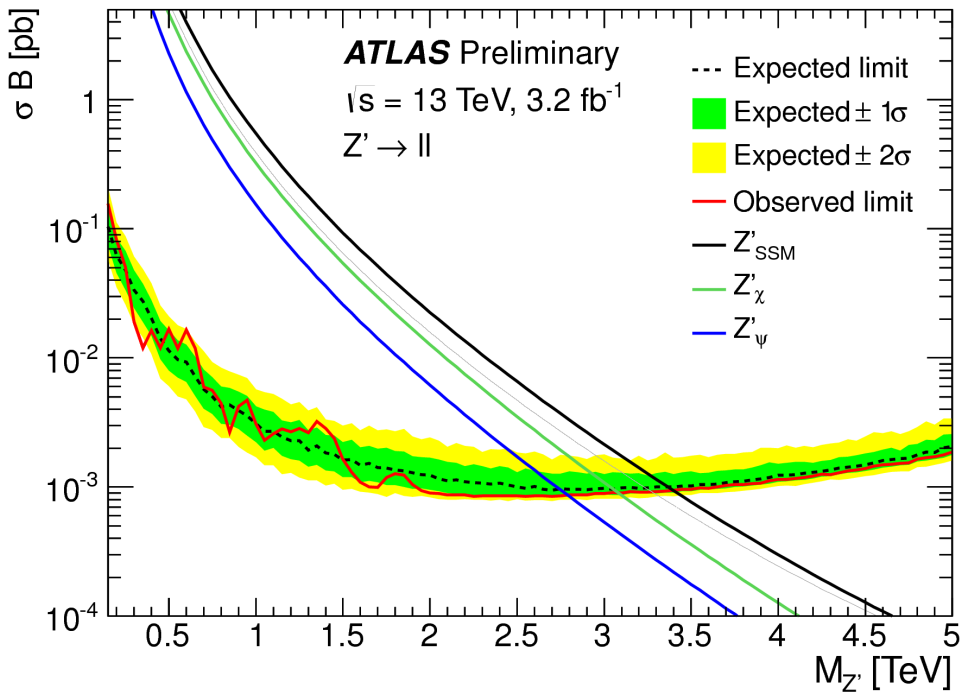
95% CL Limit on SSM Z' at 3.4 TeV (2.9 TeV from Run-1)

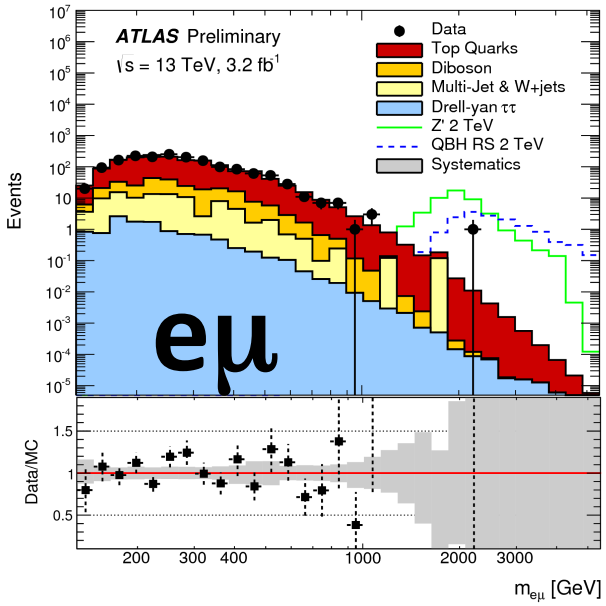
95% CL Limit on SSM LFV Z' at 3.0 TeV (2.5 TeV from Run-1)

Searches for **Dilepton Resonances (LFC** and **LFV)** (I)

Search for Z' in dilepton (LFC) and (LFV) *(in eμ decays)*

- Main background DY is taken from MC
- Top and diboson extrapolated at very high masses using a functional form
- Background from MC except for MJ in dielectron uses Matrix method (based on electron ID)





Highest eμ mass event at 2.1 TeV

No Excess found !

95% CL Limit on SSM Z' at 3.4 TeV (2.9 TeV from Run-1)

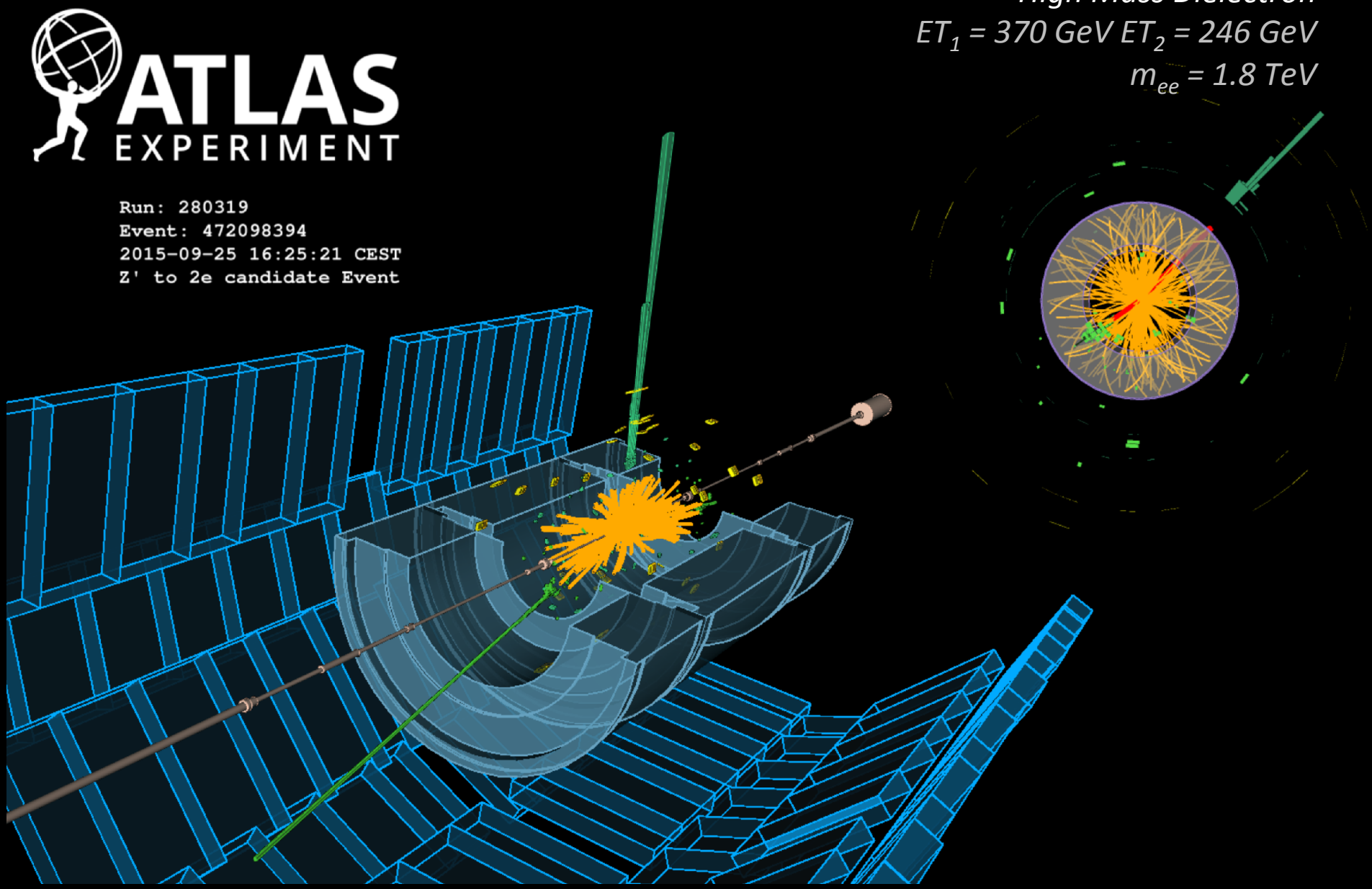
95% CL Limit on SSM LFV Z' at 3.0 TeV (2.5 TeV from Run-1)

Di-Electron Event

High Mass Dielectron

ET_1 = 370 GeV ET_2 = 246 GeV

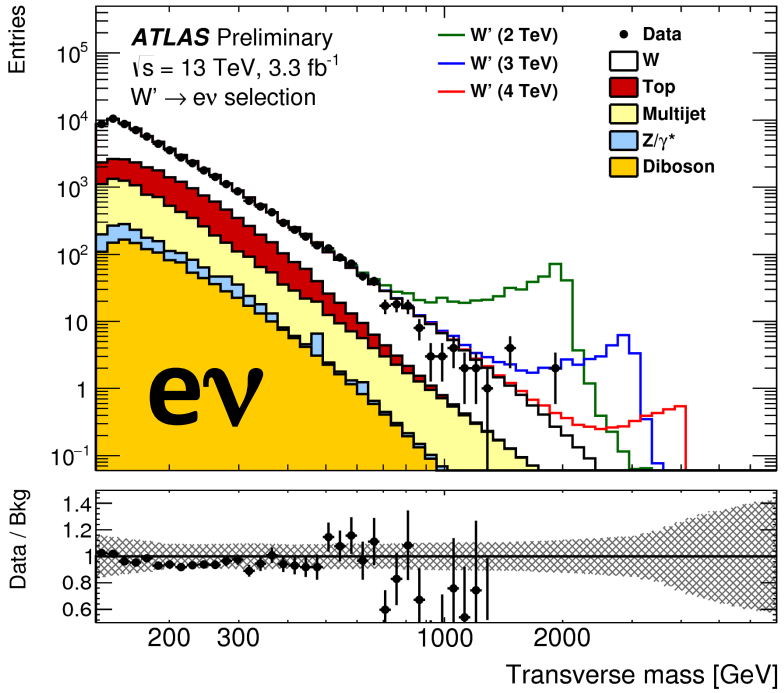
m_{ee} = 1.8 TeV

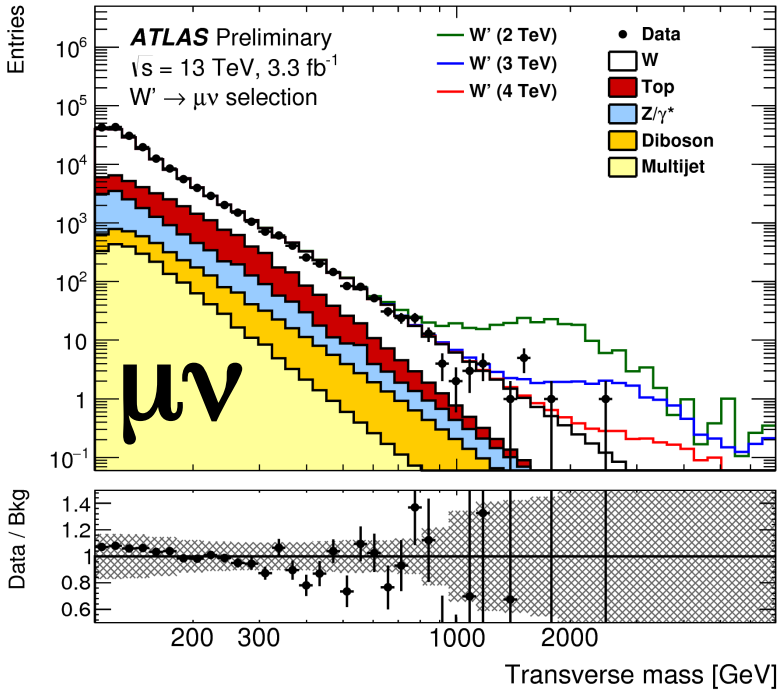


Search for **Resonant Lepton-MET**

ATLAS-CONF-2015-063

- Search for W' in lepton-MET final states
- Background from MC except for Multijet estimated with matrix method
- Top and diboson extrapolated at very high masses using a functional form





Highest electron-MET mass event at 1.95 TeV

Highest muon-MET mass event at 2.2 TeV

No Excess found !

95%CL Limit on SSM W' at 4.1 TeV (3.2 TeV at Run-1)

Search for a **Two Photons Resonance** (I)

ATLAS-CONF-2015-081

Inclusive search for two photon resonance
(optimized for a scalar resonance)

- Selection of two photons with pT/m thresholds of 0.3 and 0.4 and pT dependent calorimeter and track isolation criteria
- Typical prompt photon purity 90%

Background from a functional

Similar to the dijet search but chosen using the Fisher F-test and the spurious signal method measured in events from Sherpa, Diphox and Jetphox:

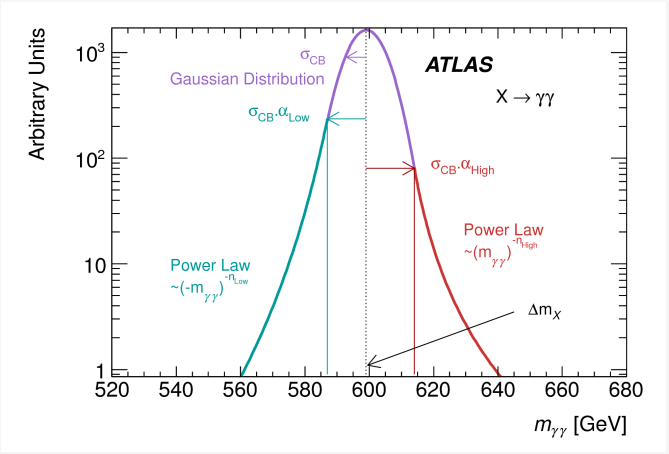
$$f_{bkg}(x;b,\{a_k\}) = (1-x^{1/3})^b\, x^{\sum_{j=0}^{k} a_j \log(x)^j}$$

$$x \equiv \frac{m_{\gamma\gamma}}{\sqrt{s}}$$

Here a simple form with k=0 is used

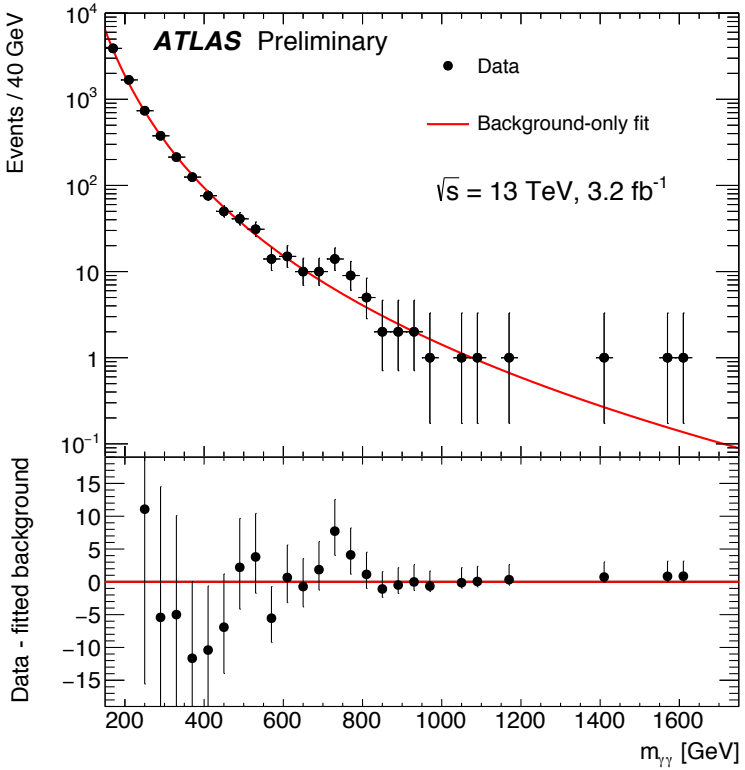
Signal Model

- **NWA**: Use Double Sided Crystal Ball function
- **LW**: Use DSCB fitted from simulated samples with different widths with up to 25% of the resonance mass



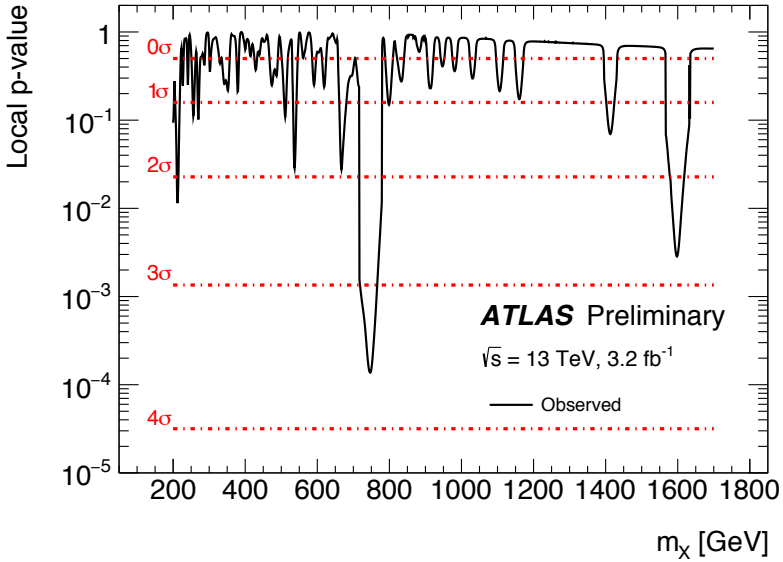
Search for a **Two Photons Resonance** (II)

Results: Events with mass in excess of 200 GeV are included in **unbinned fit**



- **In the NWA search**, an excess of **3.6σ** (local) is observed at a mass hypothesis of minimal p_0 of 750 GeV

- Taking a LEE in a mass range (fixed before unblinding) **of 200 GeV to 2.0 TeV** the global significance of the excess is **2.0σ**



In the NWA fit the resolution uncertainty is profiled in the NWA fit and is pulled by 1.5σ

The data was then fit under a **LW hypothesis** yielding a width of approximately 45 GeV
(Approx. 6% of the best fit mass of approximately 750 GeV)

- As expected the local significance increases to **3.9σ**

- Taking into account a LEE in mass and width of up to **10%** of the mass hypothesis of **2.3σ** (Note: upper range in resolution fixed after unblinding)

Searches in Diboson Final States using **Jet Substructure**

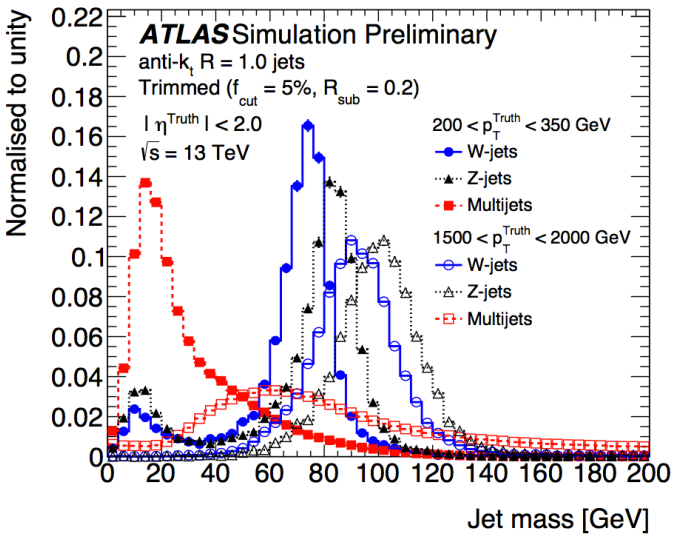
Searches for VV or VH resonances in several topologies involving boson (W, Z and H) tagging

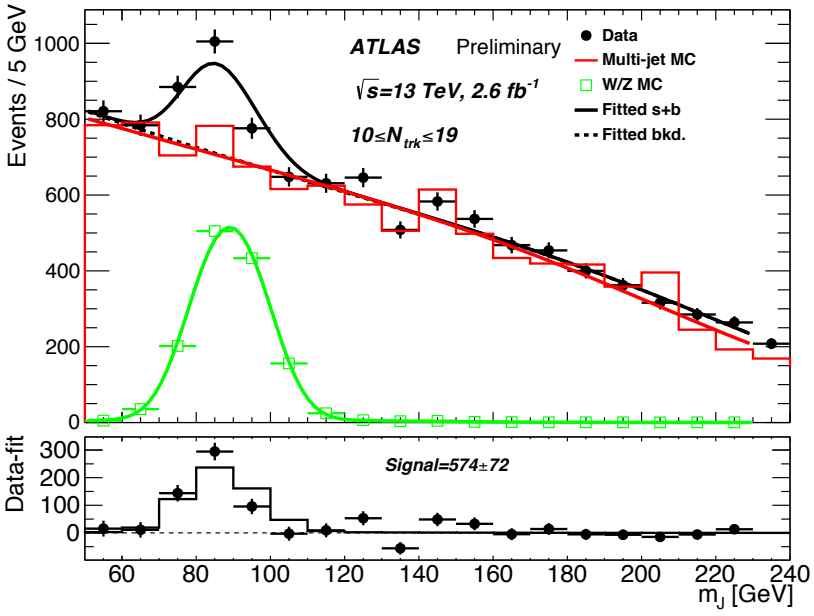
Nominal boson tagging algorithm

- Anti-kT R=1.0
- Trimming: fcut = 5% and Rsub = 0.2
- pT dependent (energy correlation ratio) D2 selections for W and Z separately (Multijet reduction by 40 – 70)

Boson tagging at work

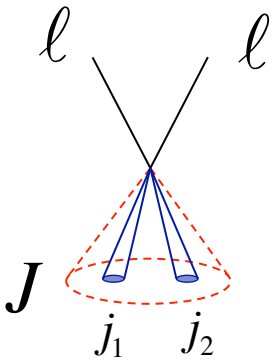
W and Z peak in the data from dijet events applying the nominal boson tagging algorithm





Searches for a **Resonance** in **Diboson VV** Final States

ZV (with Z to **dilepton**)

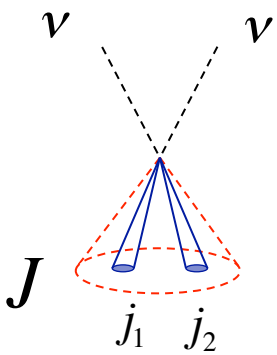


Backgrounds

Z-jets is the main background, estimated using MC and normalised to mJ sidebands

Diboson and top from MC

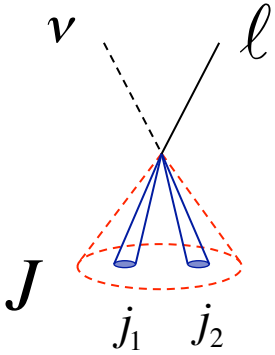
ZV (with Z to **νν**)



Backgrounds

Z-jets, W-jets and top are main backgrounds, these are estimated using CRs with 1 or 2 muons and one b-tag for the Top CR.

WV (with W to **lν**)



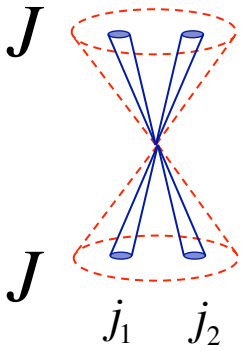
Backgrounds

Z, W and top shapes from MC

Diboson fully from MC

Multijet shape from loose lepton ID

VV to **JJ**

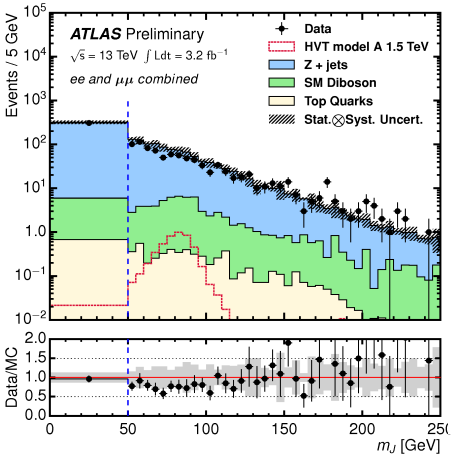


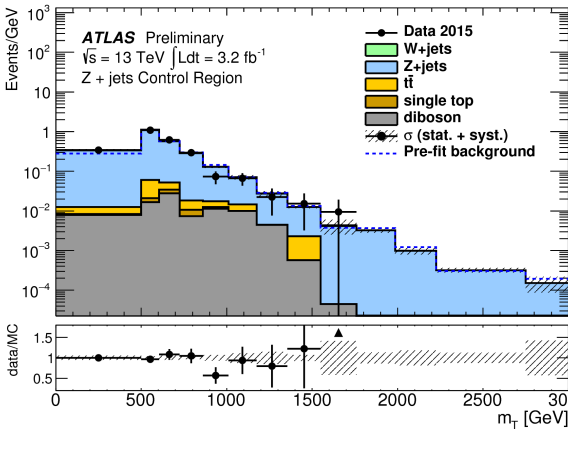
Modest excess Run-1

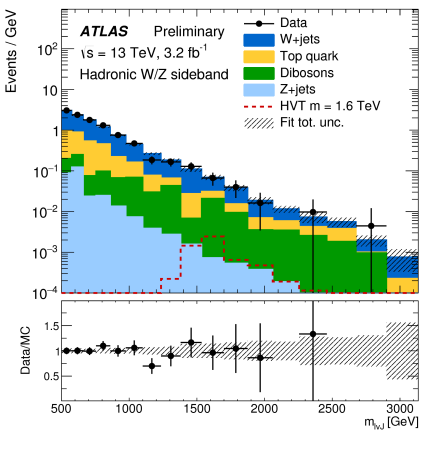
observed at Run 1 to be checked

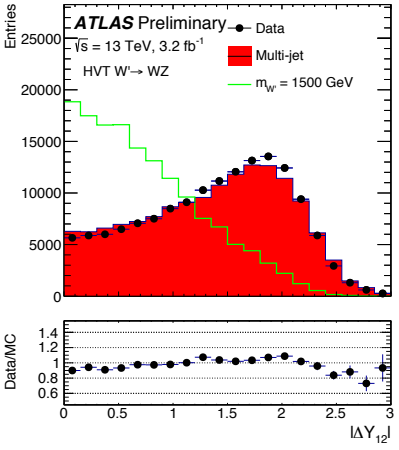
Background

Estimated using a functional form







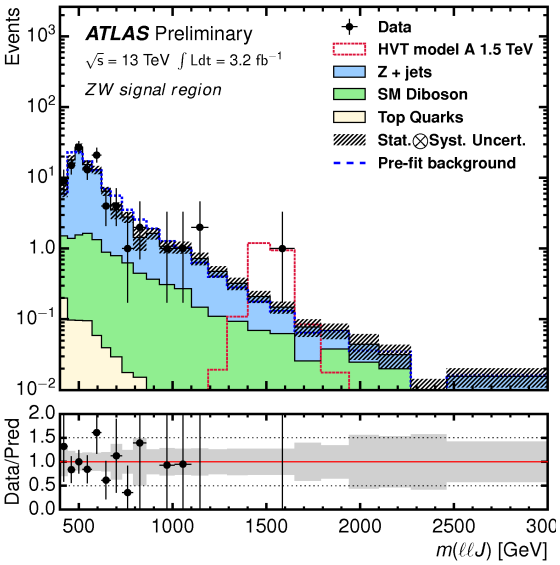


Searches in **Resonant Diboson VV** Final States

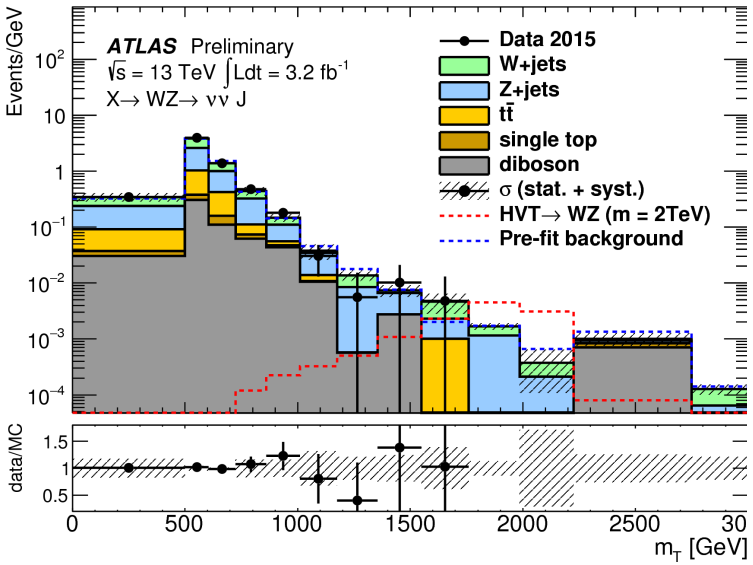
[ATLAS-CONF-2015-075](#)
[ATLAS-CONF-2015-068](#)
[ATLAS-CONF-2015-071](#)

Signal regions (WZ) distributions in m_{VV}

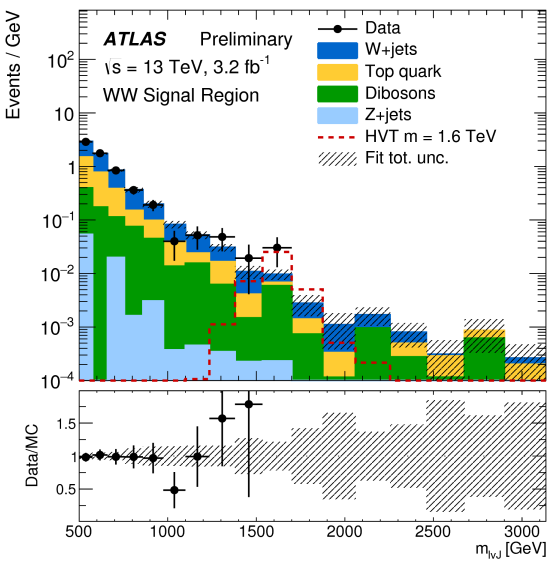
ZV (with Z to **dilepton**)



ZV (with Z to **vv**)



WV (with W to **lv**)

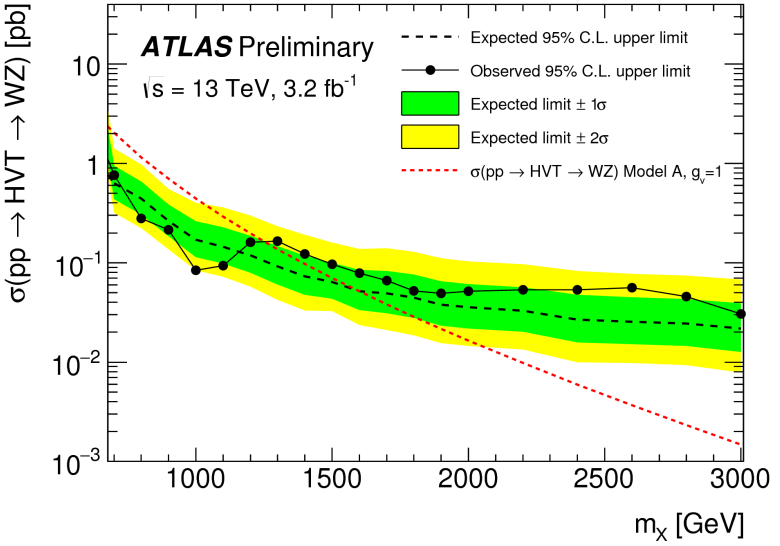


Results

All analyses have similar sensitivities ranging between **1.4 TeV** and **1.6 TeV** for HVT additional vector bosons

- No significant excess observed, limits are set in these scenarios

- Interpretations also in Higgs and Graviton hypotheses



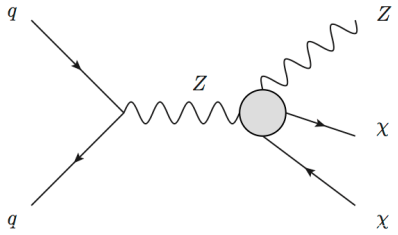
Searches in the **DM-V Final** States

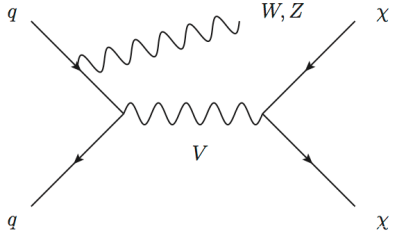
ATLAS-CONF-2015-080

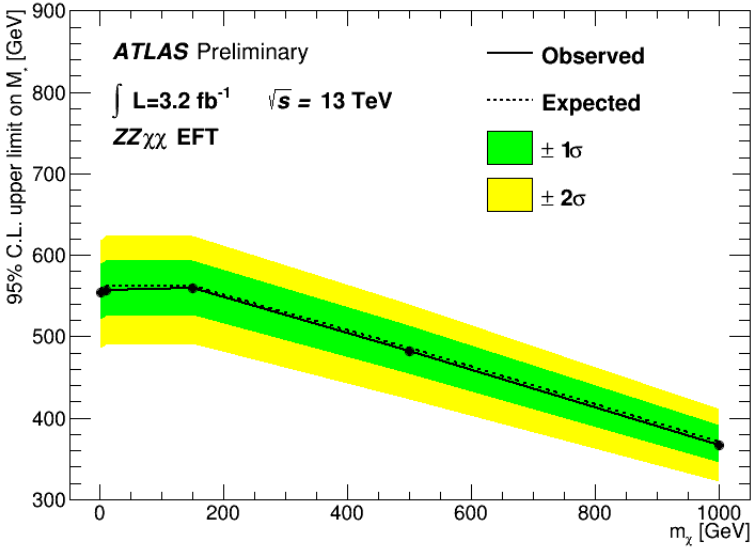
Same selection as for the **VZ-Jvv** selection with the use of the MET shape in the fit

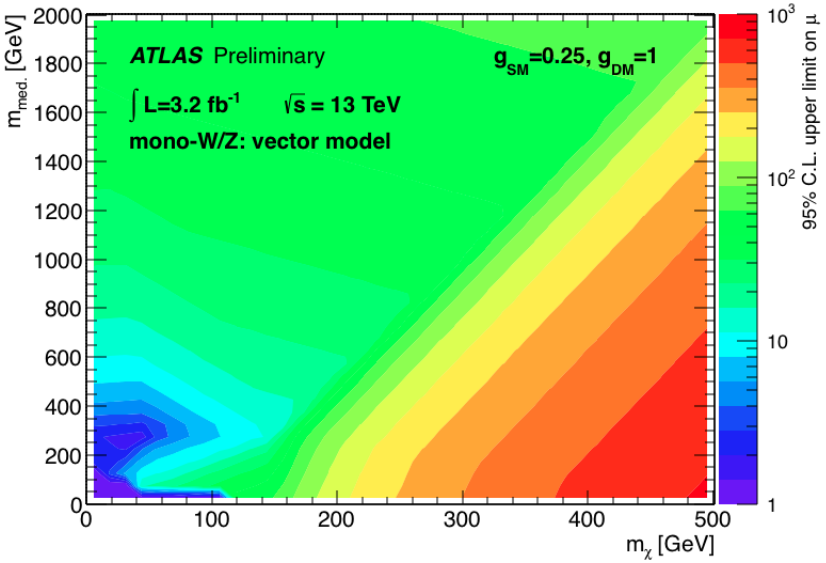
- (A) Interpretation in Vector mediated simplified model
- (B) Interpretation in EFT favorable for the Z

DM Forum benchmarks (LHC Exp. and Theory):
http://arxiv.org/pdf/1507.00966.pdf







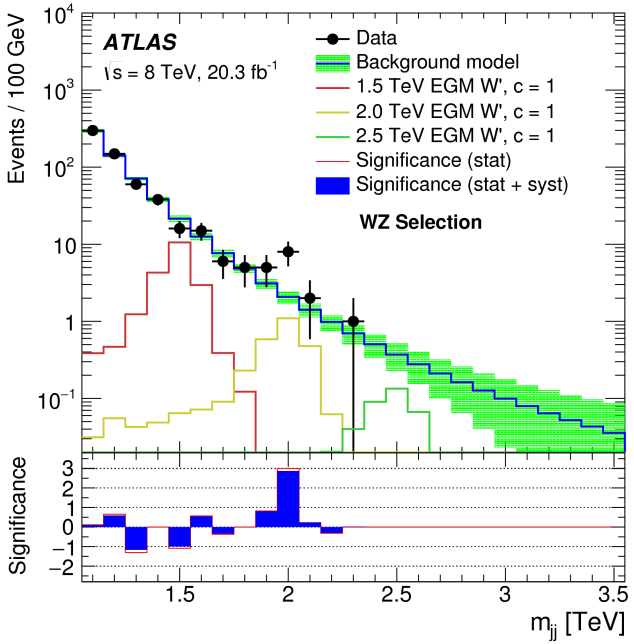


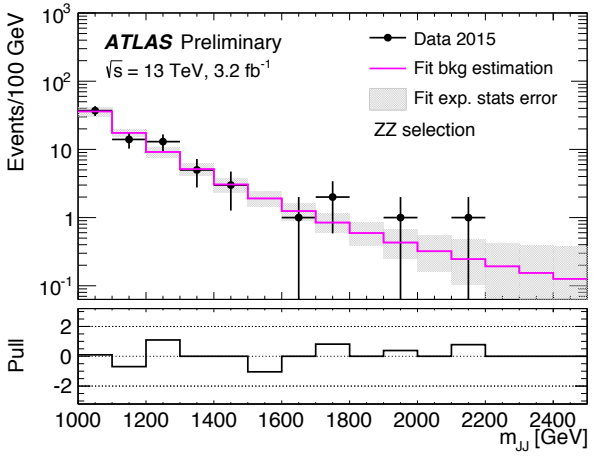
ATLAS-CONF-2015-073

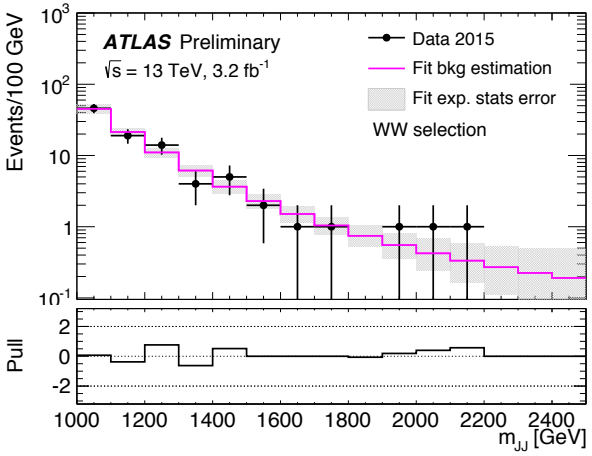
Fully Hadronic **JJ Diboson** searches

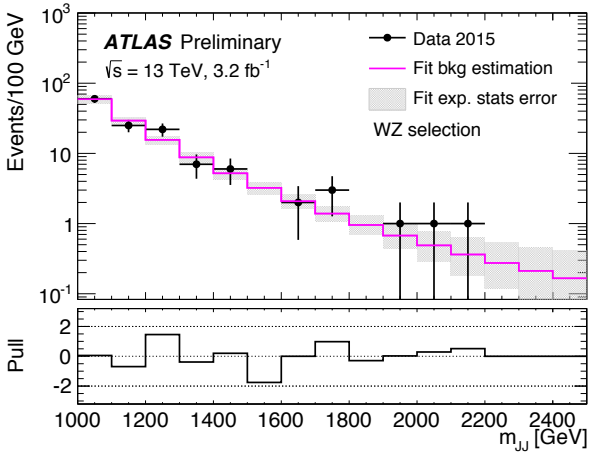
Run-1

- **Modest excess at Run-1**: **3.4σ** local / **2.5σ global**
- **Analysis very similar to Run 1**, with functional fit of the background
- **No significant excess is observed**
  however sensitivity not high enough for conclusive probe of the Run 1 excess









Searches in **Diboson VH** Final States

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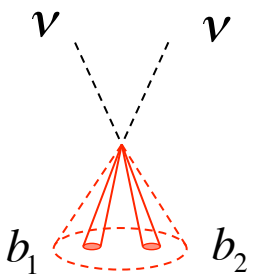
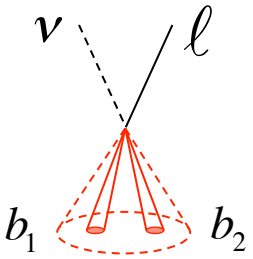
Analysis Strategy: 6 regions 0L, 1L-MET and 2L-MET with at least two jets and 1 or 2 b-tags (2 b-tags harder to distinguish at high pT)

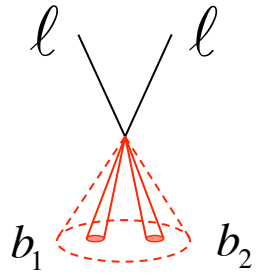
Analysis Strategy: Global fit of 6 regions simultaneously (similar to SM VH analysis at Run-1)



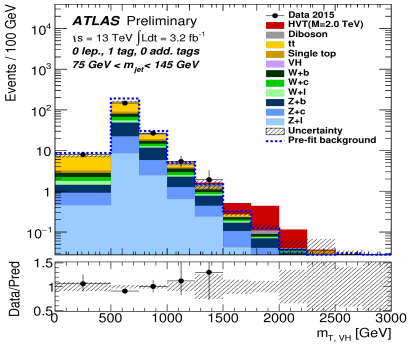
ZH (with **Z to νν**)

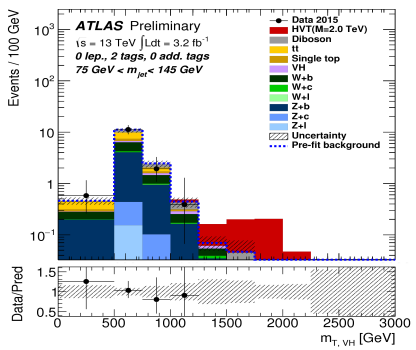


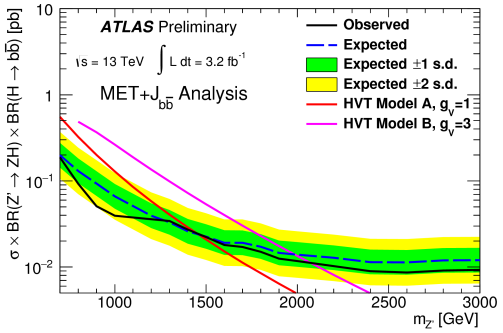
WH (with **W to lν**)

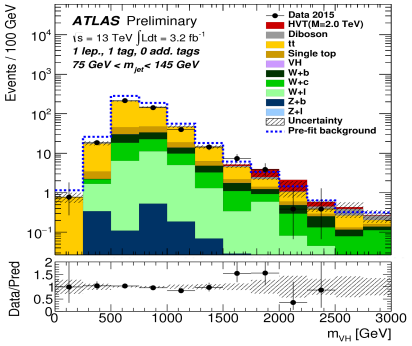


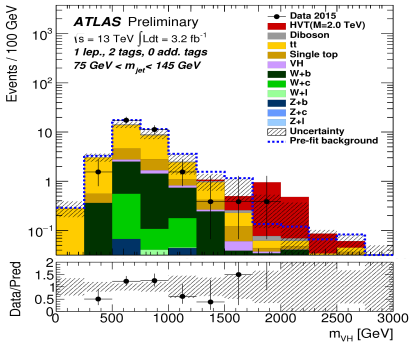
ZH (with **Z to dilepton**)

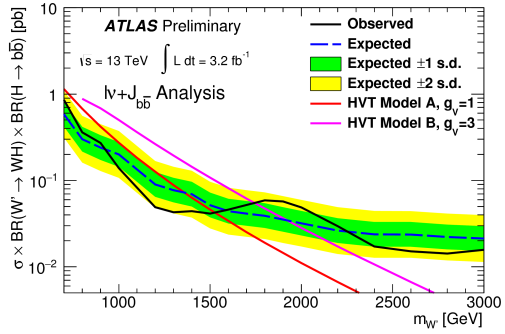


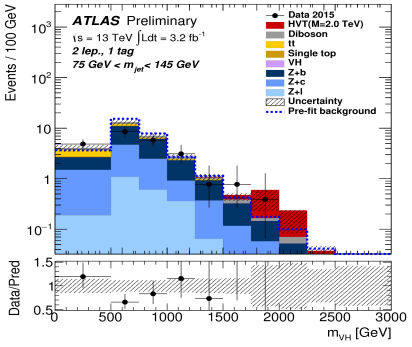


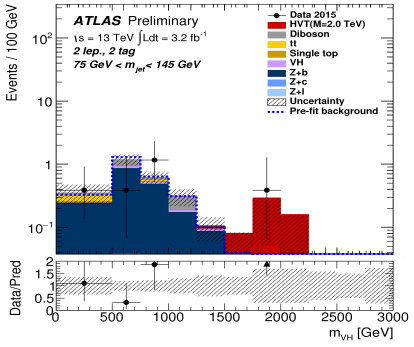


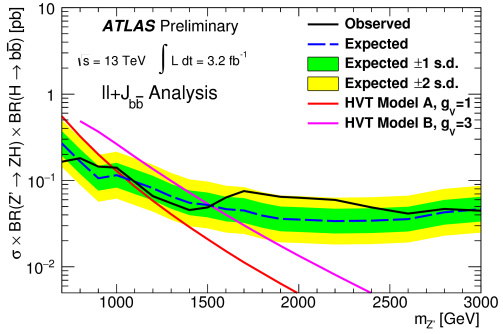












Summary

- ATLAS made major changes to detector, DAQ, trigger, software and analysis frameworks during LS1, **Including new IBL**

- ATLAS is working very well at 13 TeV with 25ns collisions

- Host of new results presented here with full 2015 data sample

- The ATLAS Collaboration has released a host of new results with the full 2015 13 TeV dataset, *in* ***24 Conference Notes*** *and* ***4 Journal Papers***
  (Available at the following location: https://twiki.cern.ch/twiki/bin/view/AtlasPublic/December2015-13TeV)

  - New measurements of single top and diboson cross sections
  - First look at H(125 GeV) production
  - Many searches for new physics with sensitivity exceeding the Run 1 reach, investigating a vast number of topologies and event characteristics
  - Modest excesses begging for more data

- Eagerly awaiting a much larger haul of data in 2016!

Summary

Huge thanks and Congratulations to the LHC operations team