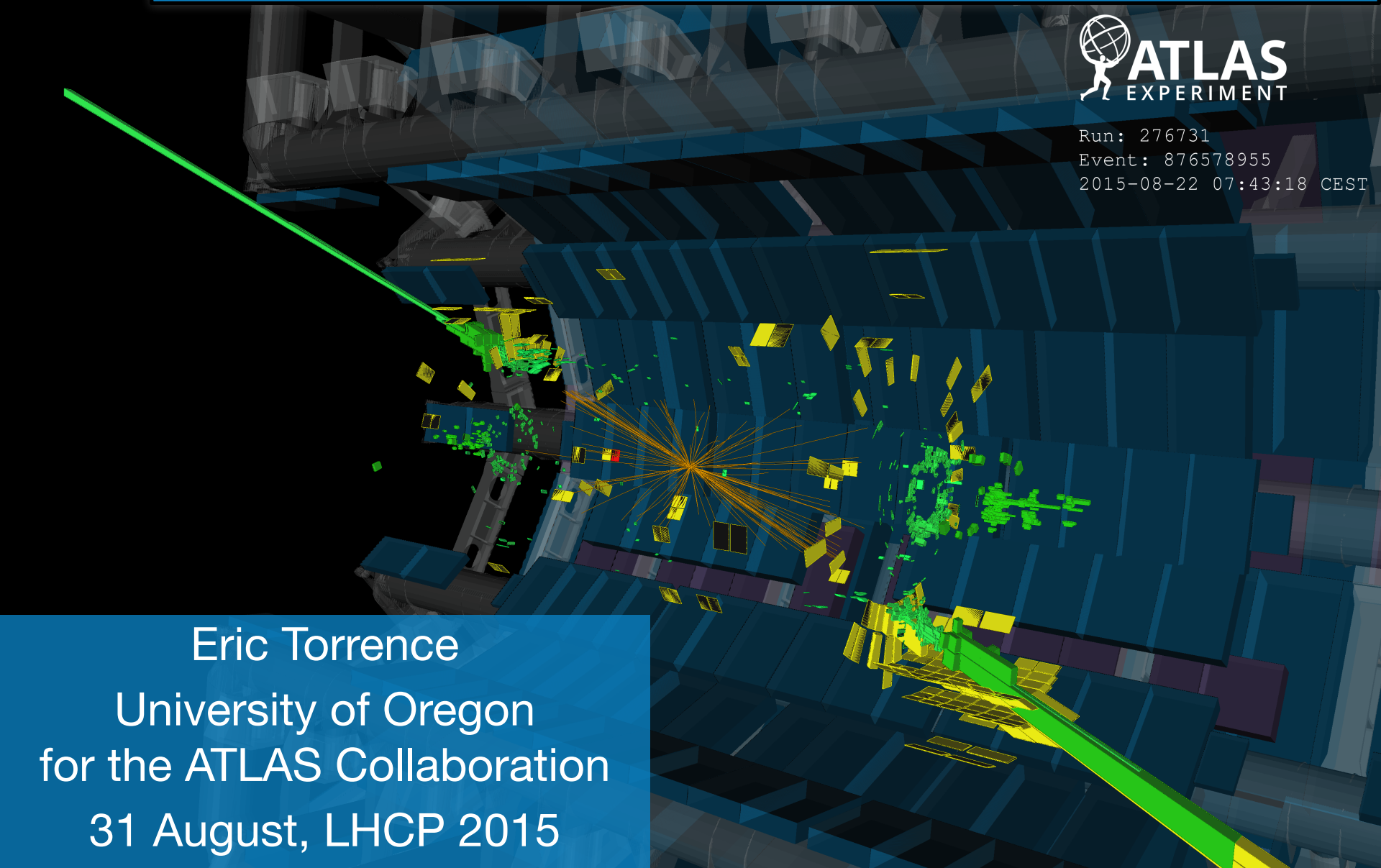
ATLAS: First Results with 13 TeV Data

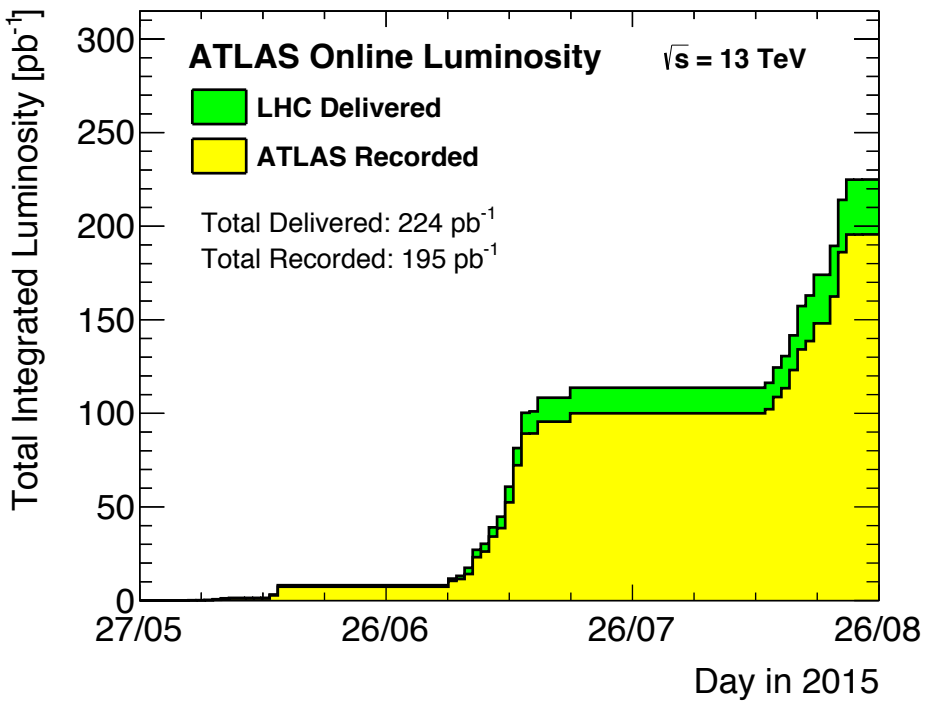


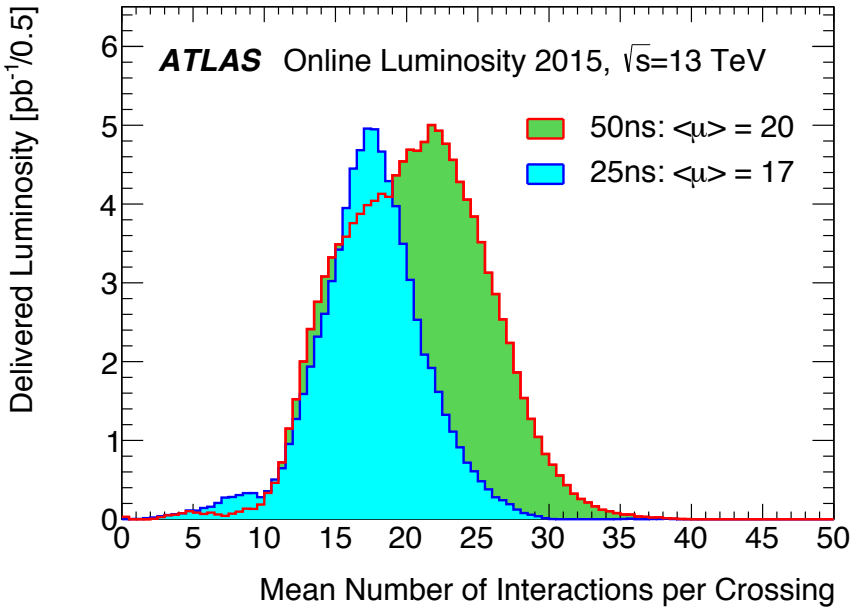
Eric Torrence

University of Oregon
for the ATLAS Collaboration

31 August, LHCP 2015

2015 Data So Far

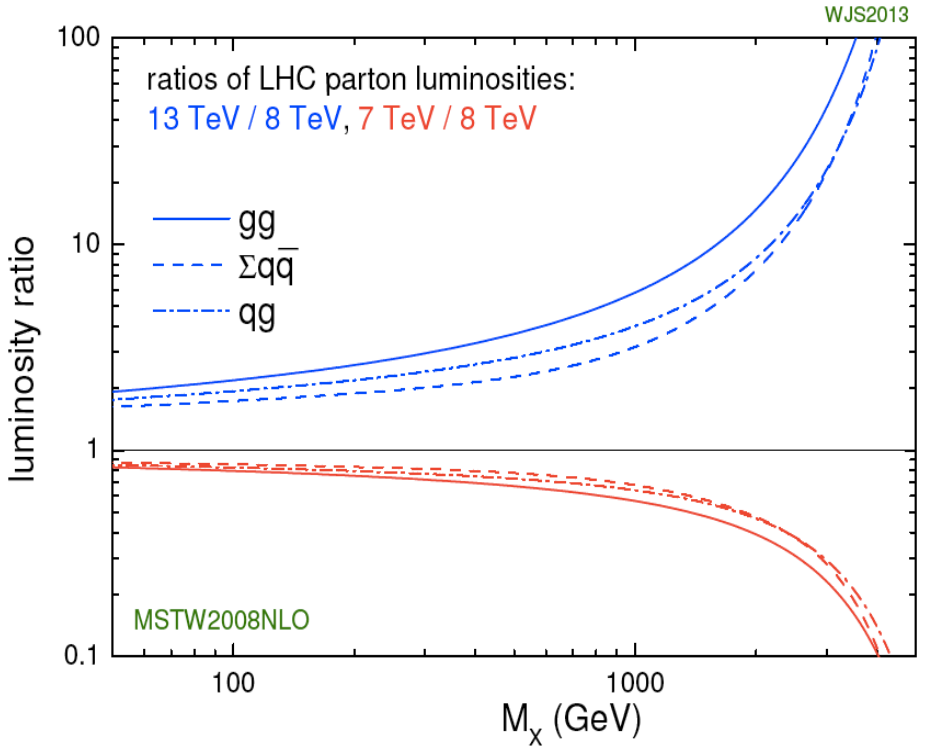




- 195 pb^{-1} recorded so far in 2015 (25ns + 50ns bunch spacing)
- Full sample processed and available for analysis
- Average Pileup around 20 interactions/crossing
  - Special low pileup sample also collected ($\mu < 0.05$, 15 nb^{-1})
- Early mini-scan ($\pm 6\sigma$) in June to determine Luminosity scale
  - Current preliminary uncertainty $\delta L/L$: ±9%
  - Improved scan taken last week, analysis underway

Program with 200 pb^{-1}?

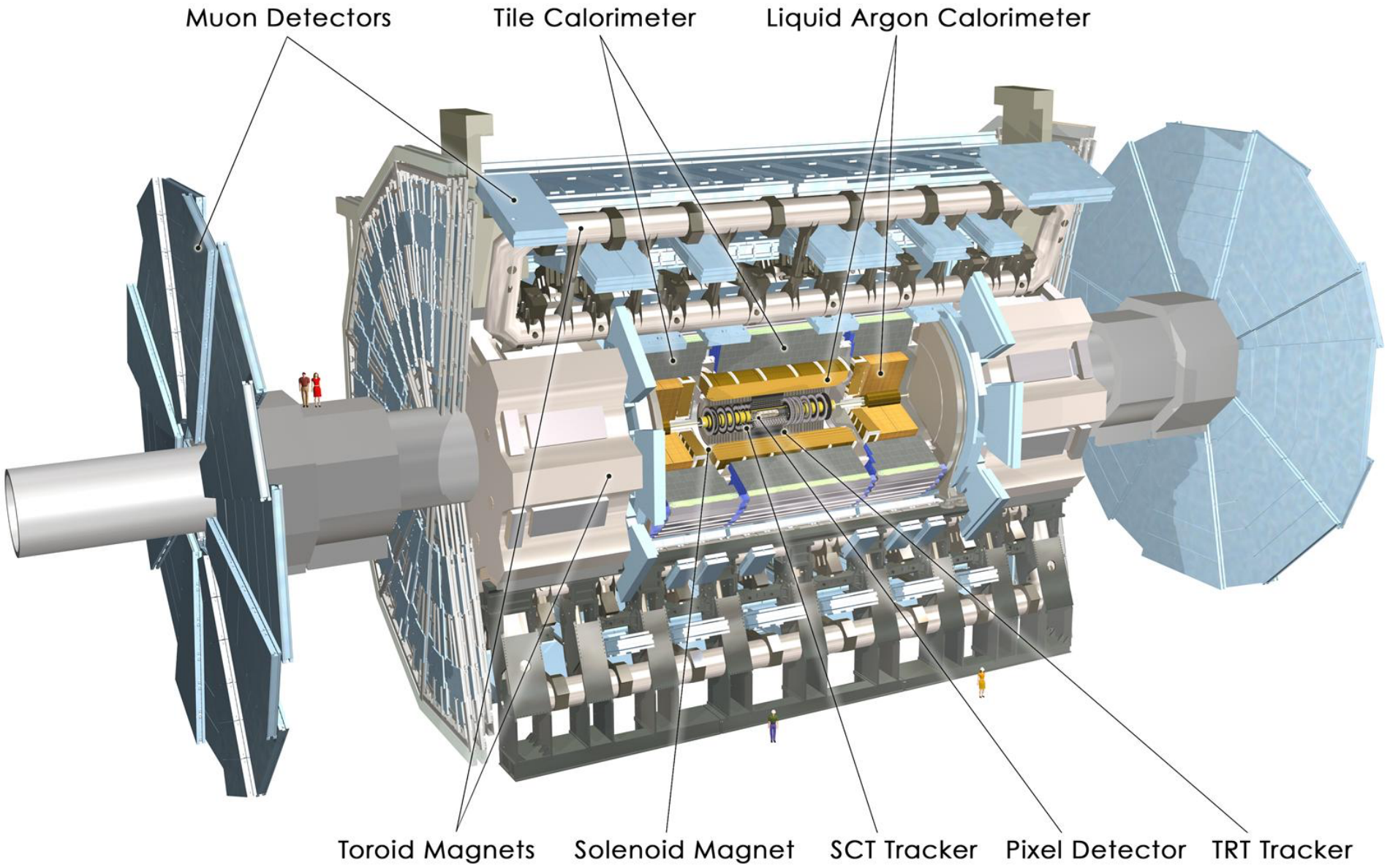
4.3 times 2010 data set!



- Re-commission detector and establish performance
- Measure high cross-section SM processes
- Search for high-mass final states exploiting parton luminosities at $\sqrt{s}$ = 13 TeV

Prepare for more data to come!

The ATLAS Detector

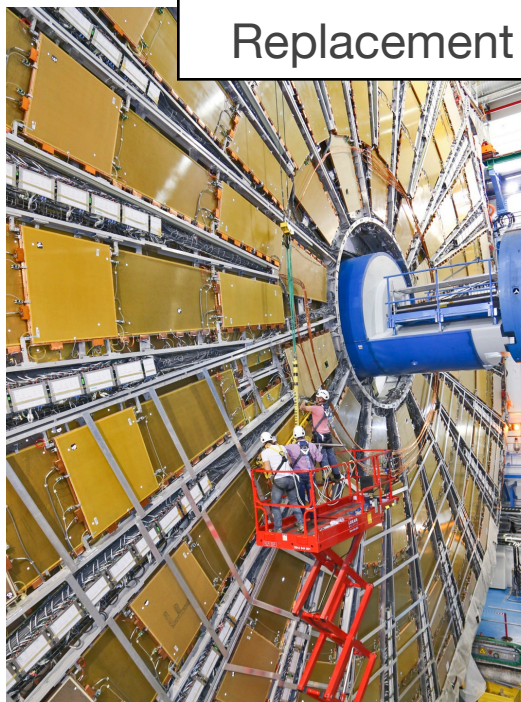


Updates for Run2

- 4th silicon pixel layer (IBL)
  - Innermost layer at r=3.3 cm
- Infrastructure
  - New beam pipe, improvements to magnet & cryo system
- Detector consolidation
  - Muon chamber completion and repairs, improved readout for 100kHz L1 rate, repair of various systems, new pixel services, new lumi detectors, new MBTS
- Trigger improvements
  - New Topological L1 trigger, new central trigger processor, Tile-muon coincidence, restructured high-level trigger, Fast TracK Trigger (FTK), improved L1Calo
- Software and Reco
  - New analysis model, event data model, production workflow, improved tracking code, grid software, monitoring

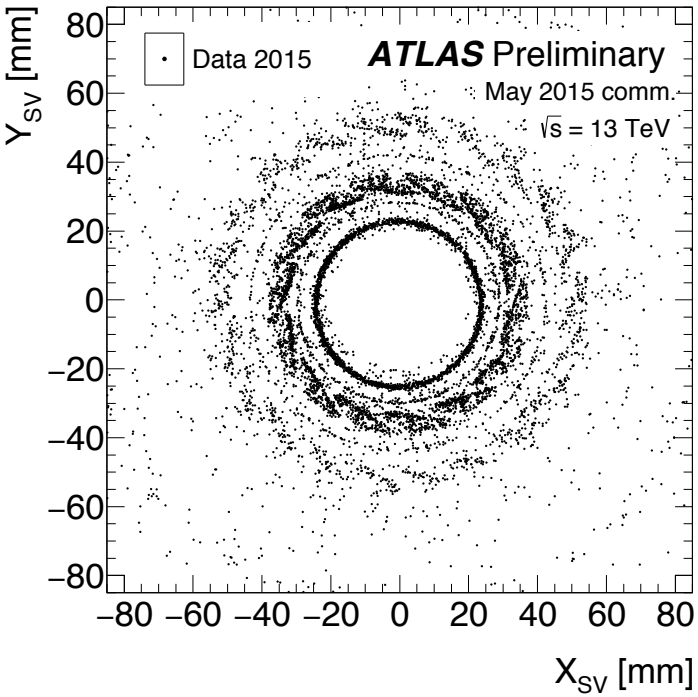
IBL Installation

TGC Chamber Replacement

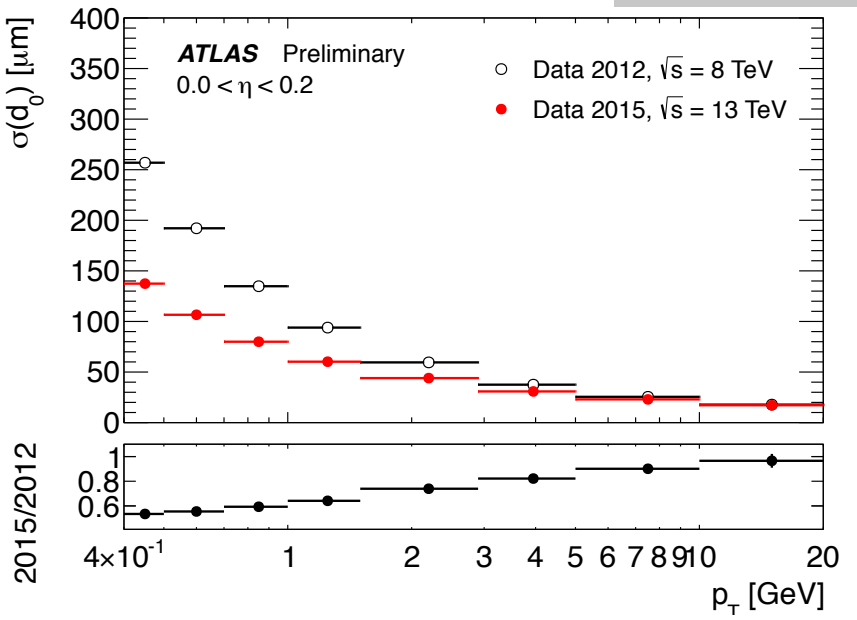


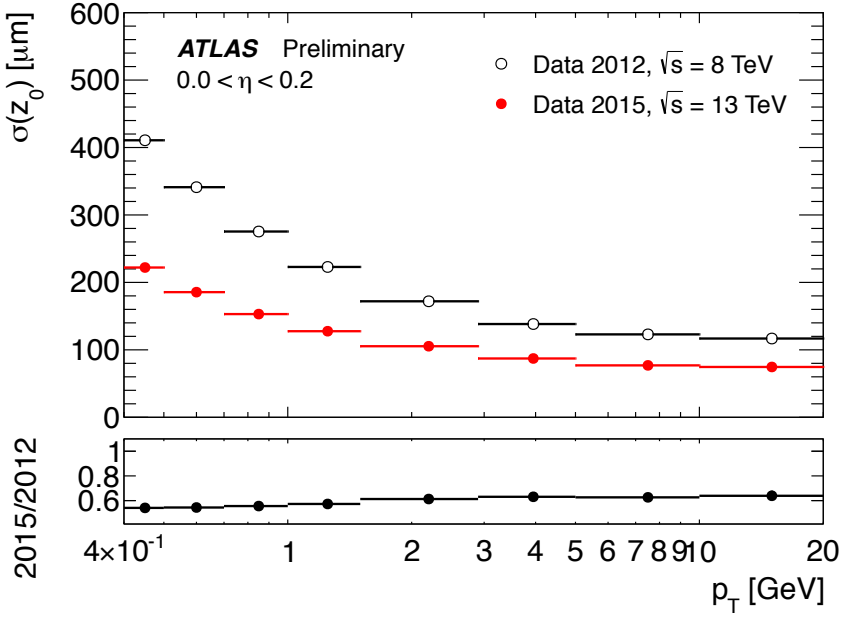
IBL Commissioning

- IBL fully operational
- Material mapping
  - e.g.: conversions, had. interactions
- Improved impact parameter resolution
- Expect ~4x improvement in light-flavor rejection



IDTR-2015-007





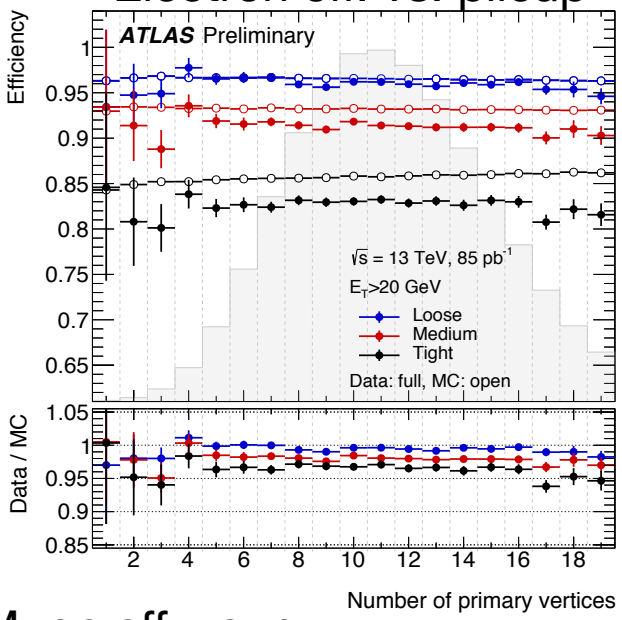
Physics Performance

https://twiki.cern.ch/twiki/bin/view/AtlasPublic/Summer2015-13TeV

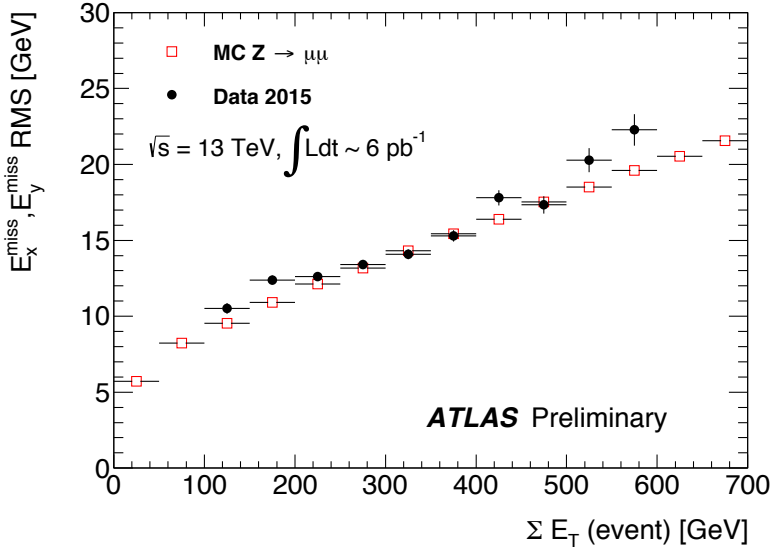
- Initial extrapolation from Run1 by MC
- Validated in early data, or measured directly (e/μ)
- Systematic uncertainties available for preliminary results

- Trigger
- Tracking
- Electrons/photons
- Muons
- Taus
- Jets
- Missing Energy
- b-tagging

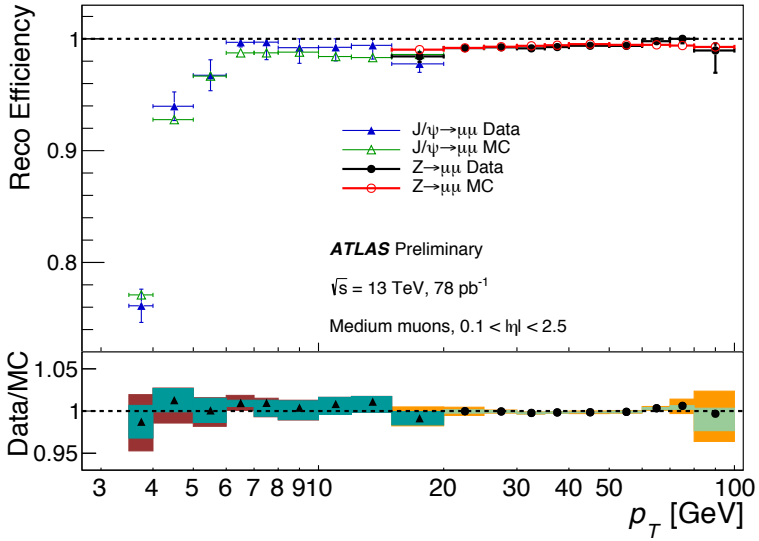
Electron eff. vs. pileup



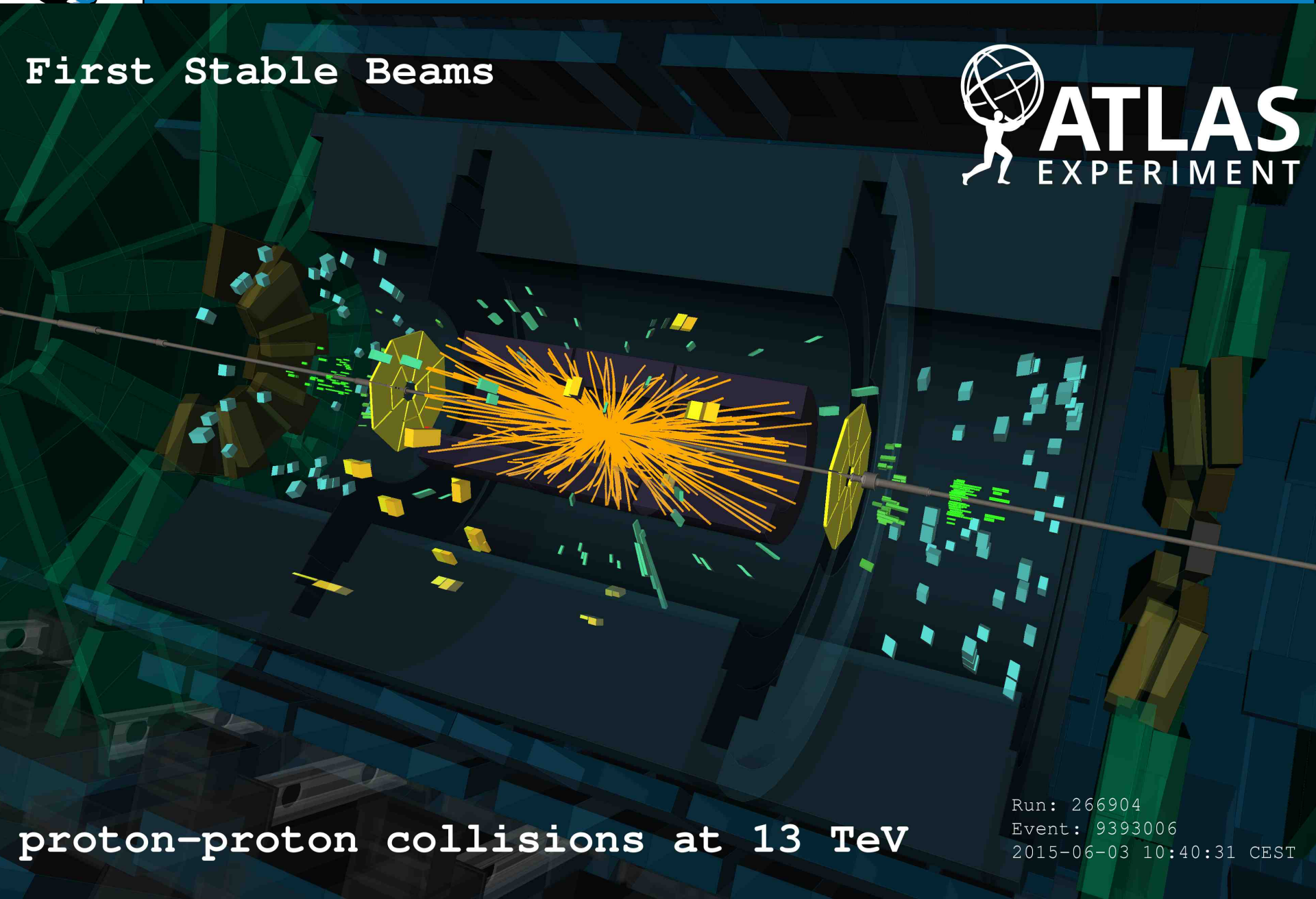
MET resolution



Muon eff. vs. p_T



Soft QCD


First Stable Beams
ATLAS
EXPERIMENT
proton-proton collisions at 13 TeV
Run: 266904
Event: 9393006
2015-06-03 10:40:31 CEST

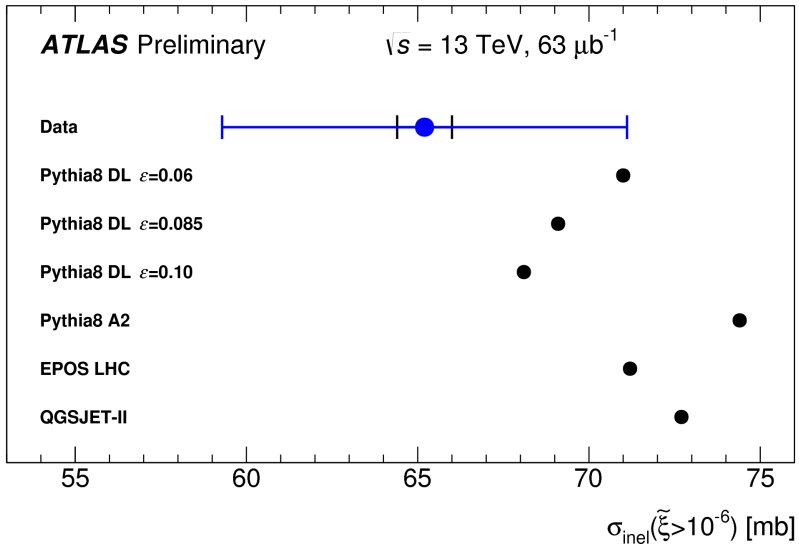
Inelastic pp Cross-Section

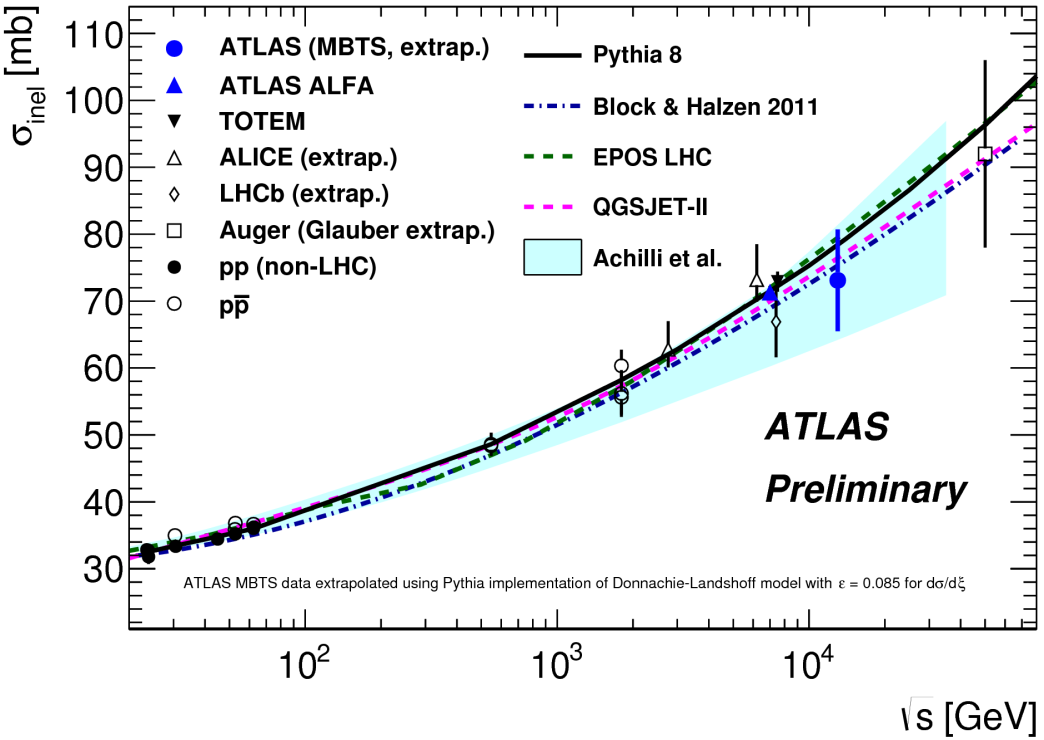
ATLAS-CONF-2015-038

- Using low-pileup data set ($\mu < 0.05$)
- Analysis w/ new MBTS scintillators ($2.1 < |\eta| < 3.9$)
- Result dominated by luminosity uncertainty

Fiducial cross-section:
65.2 ± 0.8 (exp) ± 5.9 (lum) mb

4.2M events selected in 63 μb^{-1}
Estimated 1% background

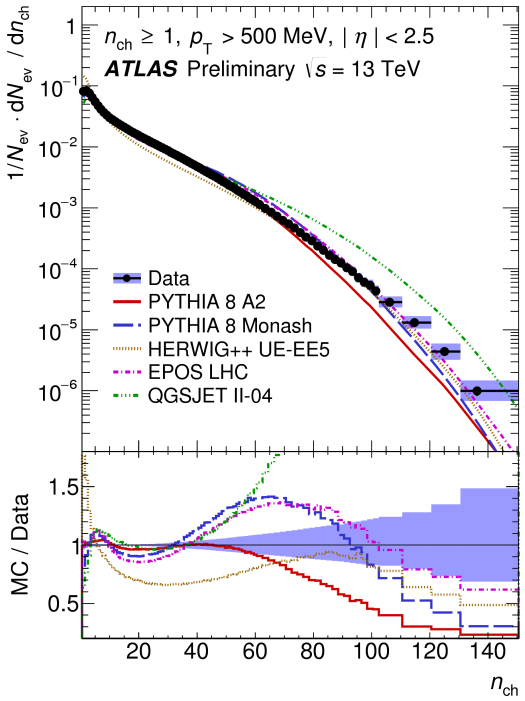


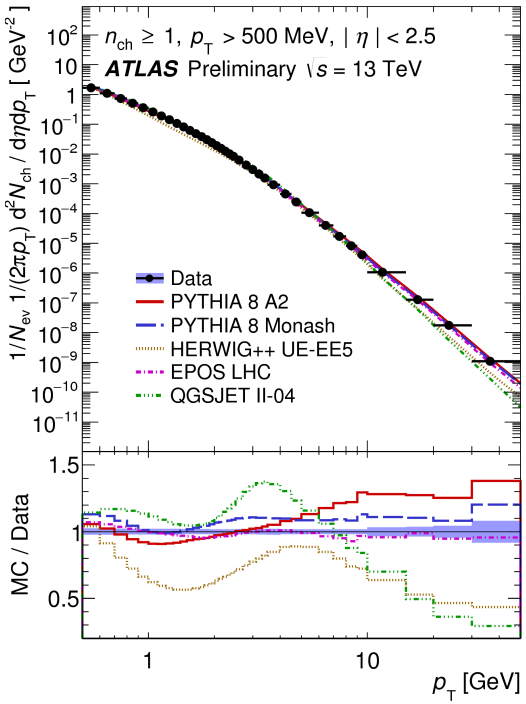


Inelastic pp Event Properties

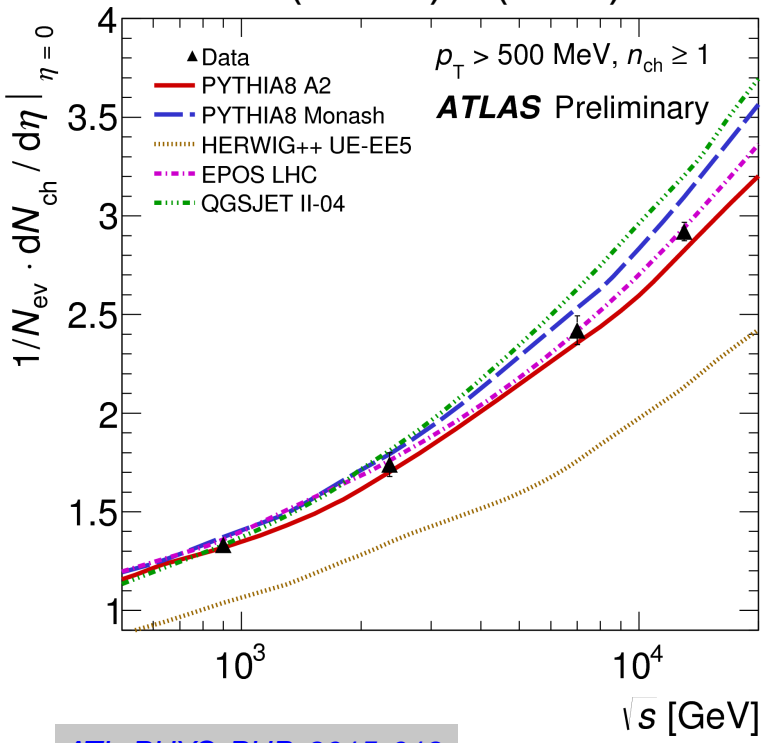
ATLAS-CONF-2015-028

- Triggered by MBTS (ε > 99%) in low-pileup data
- Unfolded distributions
- Uncertainties from tracking efficiency, unfolding
- Adequate modeling from Pythia and EPOS
- Validates pileup modeling for early analysis





N(13TeV)/N(8TeV) ~ 1.2



31 August, LHCP 2015

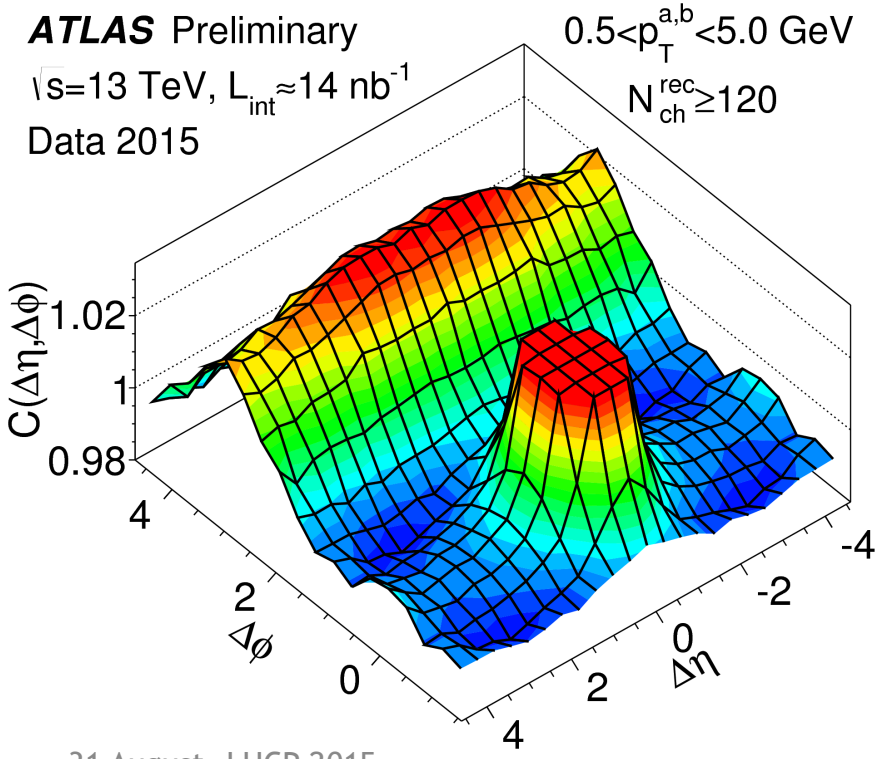
Also underlying event studies: ATL-PHYS-PUB-2015-019

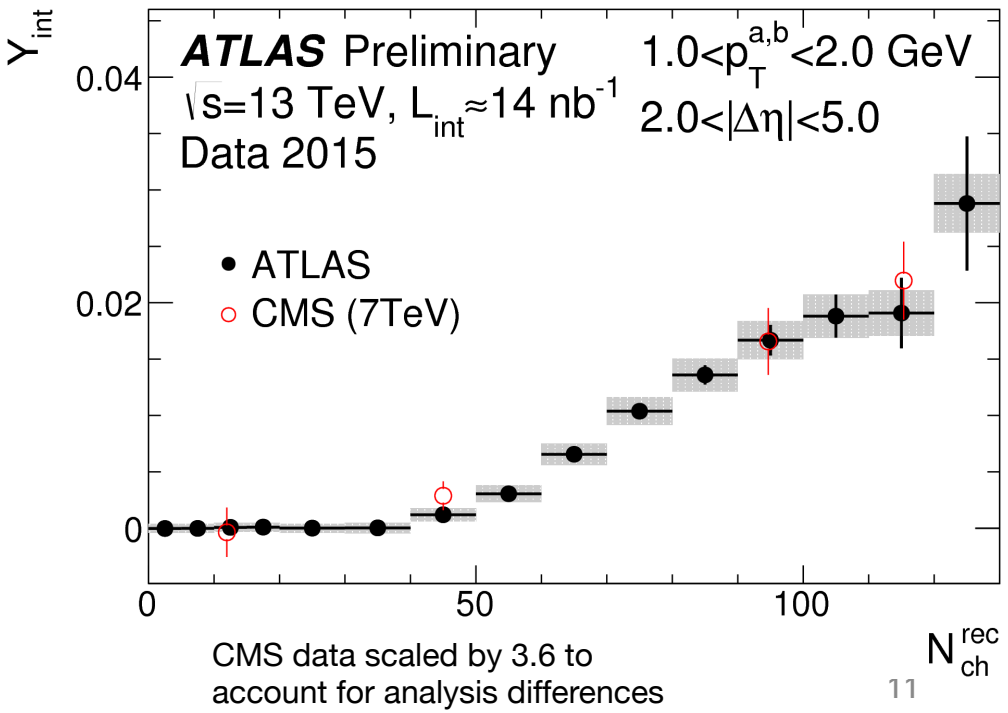
Long-range Correlations

ATLAS-CONF-2015-027

- High-multiplicity events show long-range correlations at ΔΦ ~ 0 (near-side ridge)
- Dedicated MBTS + high multiplicity trigger in low-pileup data
- Tracks with $p_T > 0.4$ GeV $|\eta| < 2.5$
- Strength consistent with 7 TeV CMS data

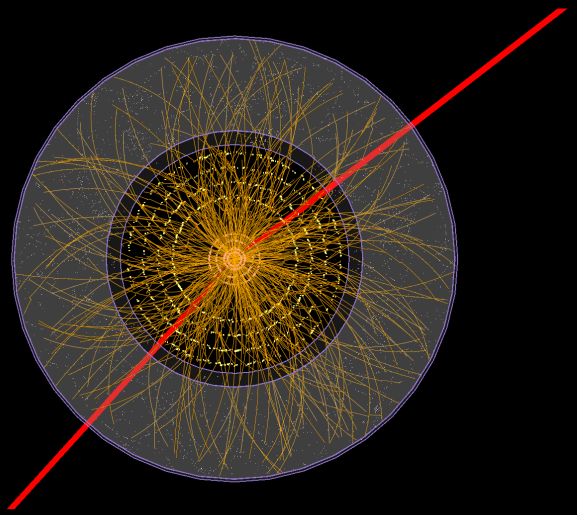
$$Y(\Delta\phi) = \left(\frac{\int B(\Delta\phi)\mathrm{d}\Delta\phi}{N^a \int \mathrm{d}\Delta\phi} \right) C(\Delta\phi),$$

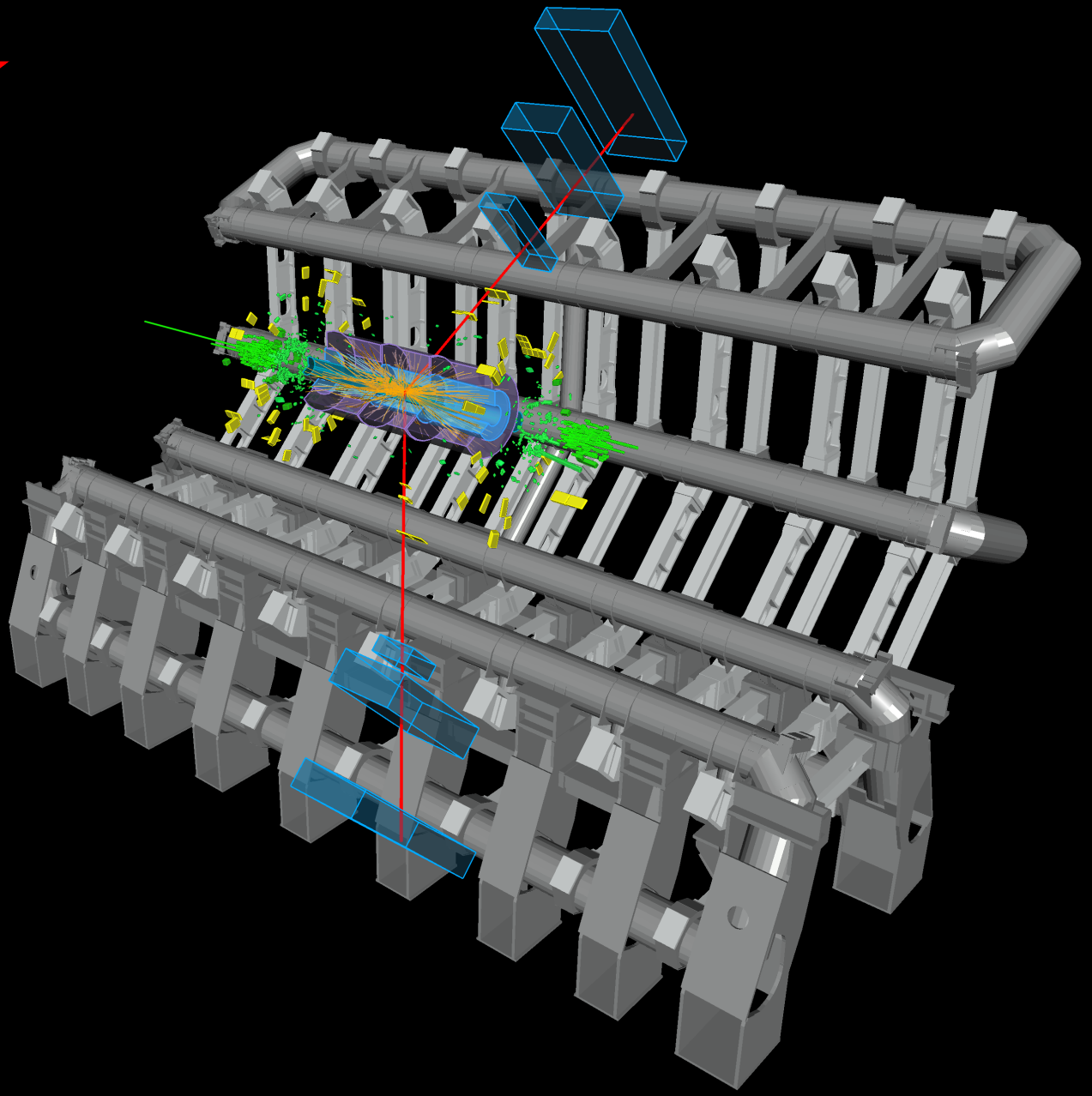




CMS data scaled by 3.6 to account for analysis differences

Electroweak Bosons



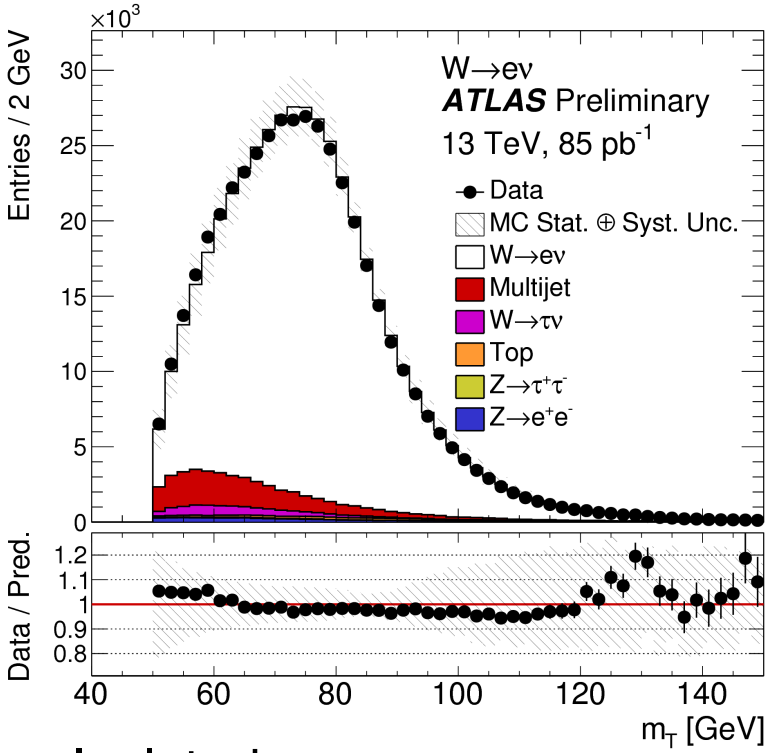


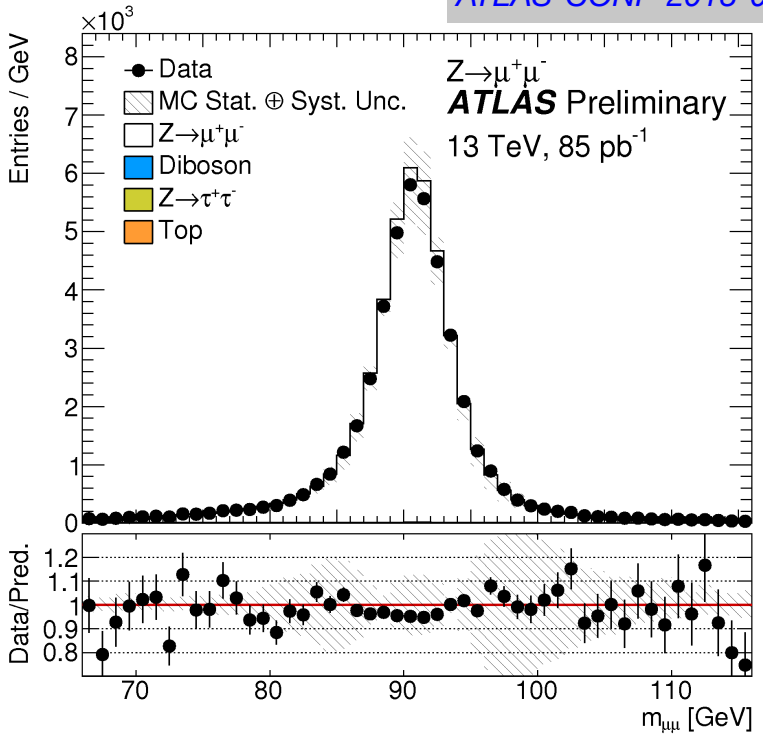
ATLAS EXPERIMENT

Run: 267638
Event: 242090708
2015-06-14 01:01:14 CEST

W/Z Cross-Section

ATLAS-CONF-2015-039



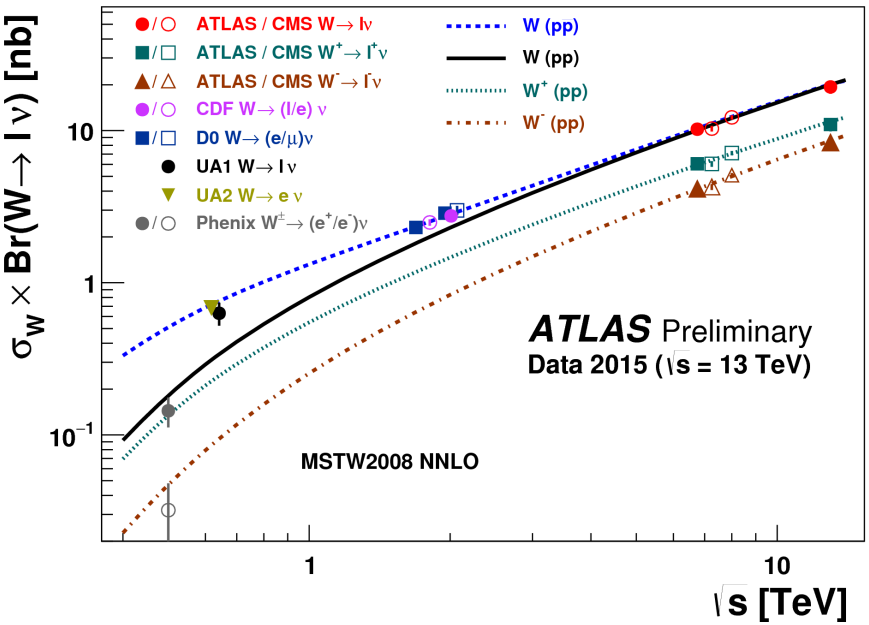


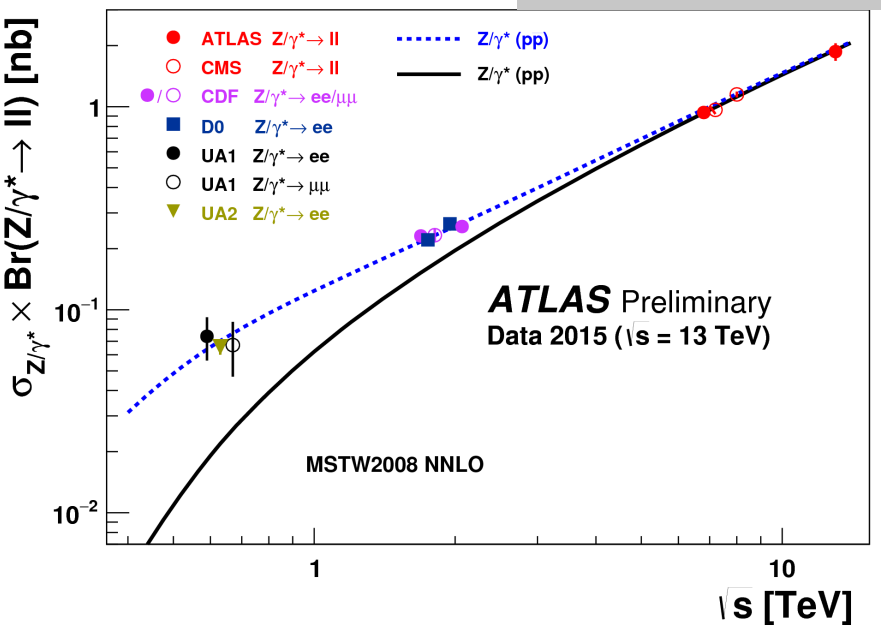
- Isolated e or μ
  - p_T > 25 GeV
- W bosons
  - E_T^{miss} > 25 GeV, m_T > 50 GeV
- Z bosons
  - Opp. charge, 66 < m(ll) < 116 GeV

	Number of events	Background
W->eν	463,063	11%
W->μν	487,090	13%
Z->ee	34,955	0.7%
Z->μμ	44,899	0.7%

W/Z Cross-Section

ATLAS-CONF-2015-039



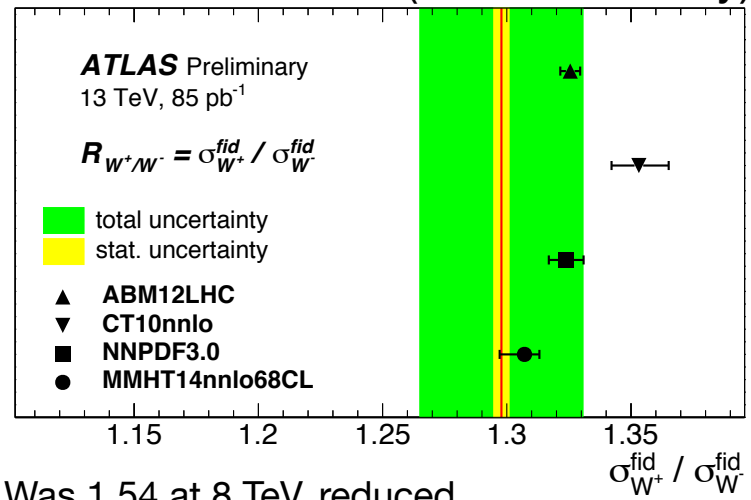


Fiducial cross-sections

Channel	value ± stat ± syst ± lumi [pb]
W^-	$3344 \pm 6 \pm 113 \pm 301$
W^+	$4340 \pm 7 \pm 138 \pm 391$
$W^\pm$	$7684 \pm 9 \pm 232 \pm 692$
Z	$746 \pm 3 \pm 13 \pm 67$

Currently dominated by lumi uncertainty

W+/W- Fiducial Ratio (2.5% accuracy)

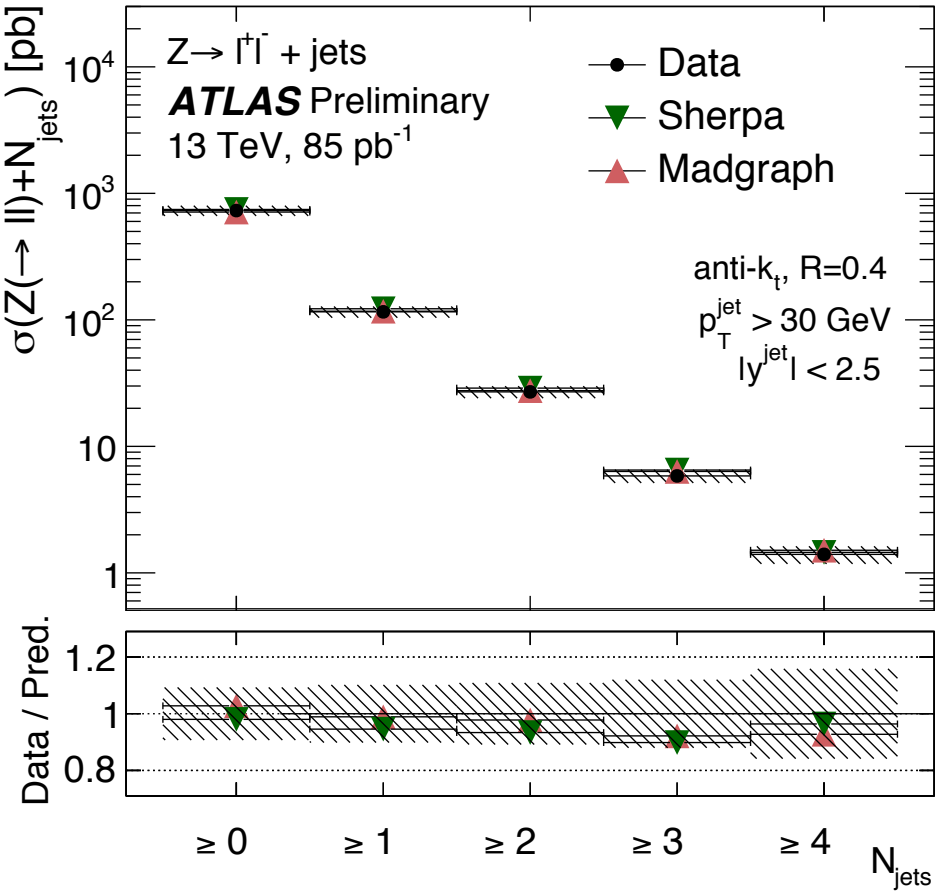


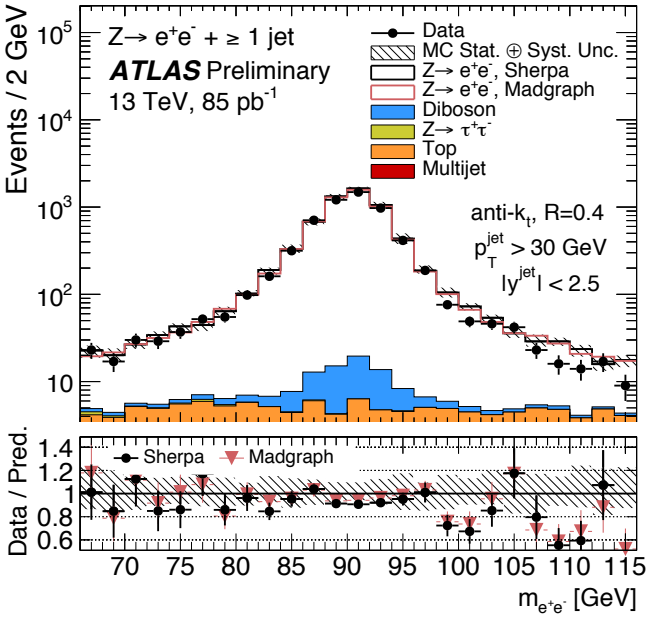
Was 1.54 at 8 TeV, reduced valence quark asymmetry at 13 TeV

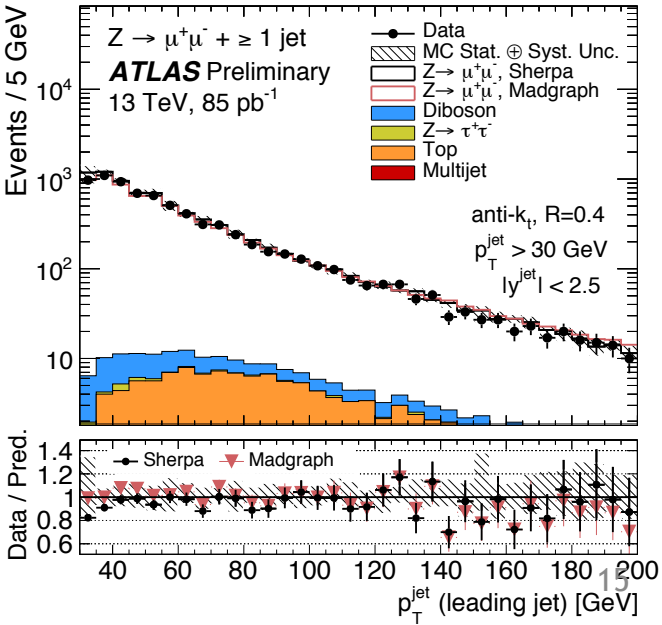
Z+jets

ATLAS-CONF-2015-041

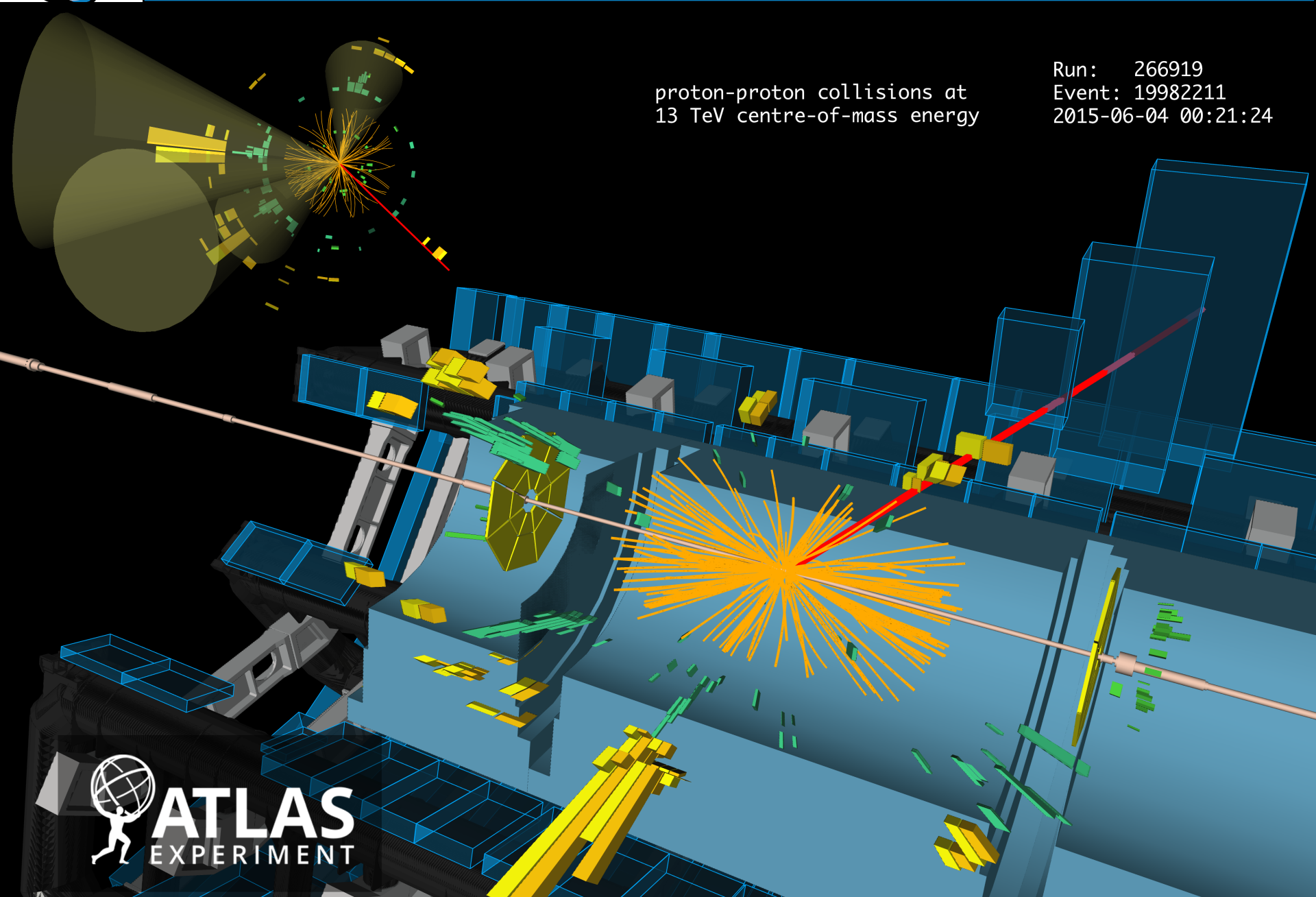
- Inclusive Z event selection
- Particle-level fiducial cross-sections
  - Jet $p_T > 30$ GeV, $|y| < 2.5$
- Backgrounds from top, diboson
- Syst. dominated by Lumi, Jets







Top Quark Production



Top Cross-Section

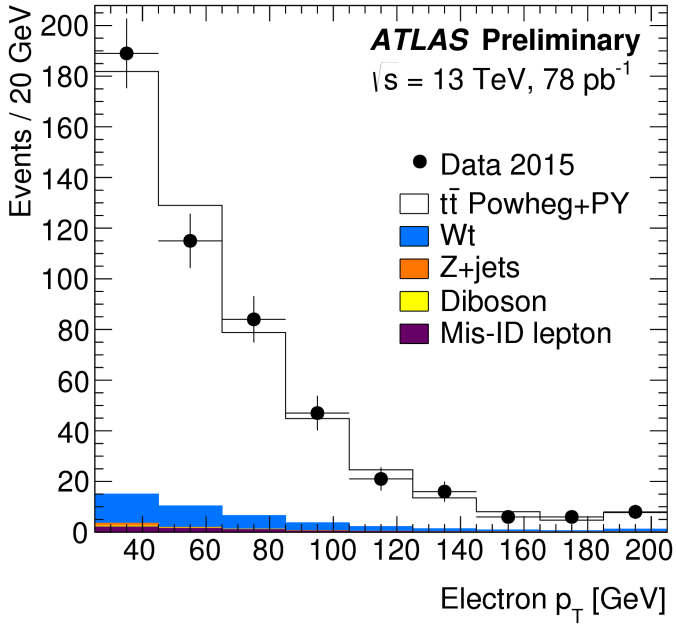
ATLAS-CONF-2015-033

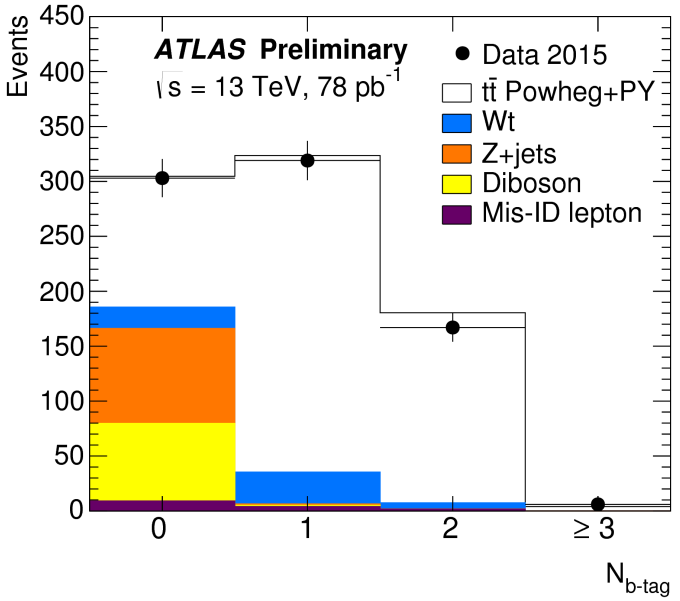
- Dilepton selection
  - Isolated e & μ, p_T > 25 GeV
  - One or 2 b-jets
- Extract b-tag yield and cross-section simultaneously
- Syst. dominated by Luminosity

$$N_1 = L\sigma_{t\bar{t}}\,\epsilon_{e\mu} 2\epsilon_b(1 - C_b\epsilon_b) + N_1^{\text{bkg}}$$
$$N_2 = L\sigma_{t\bar{t}}\,\epsilon_{e\mu} C_b\epsilon_b{}^2 + N_2^{\text{bkg}}$$

ϵ_b = 52.7 ± 2.6 (stat) ± 0.6 (syst) %
MC expectation: 54.3 %

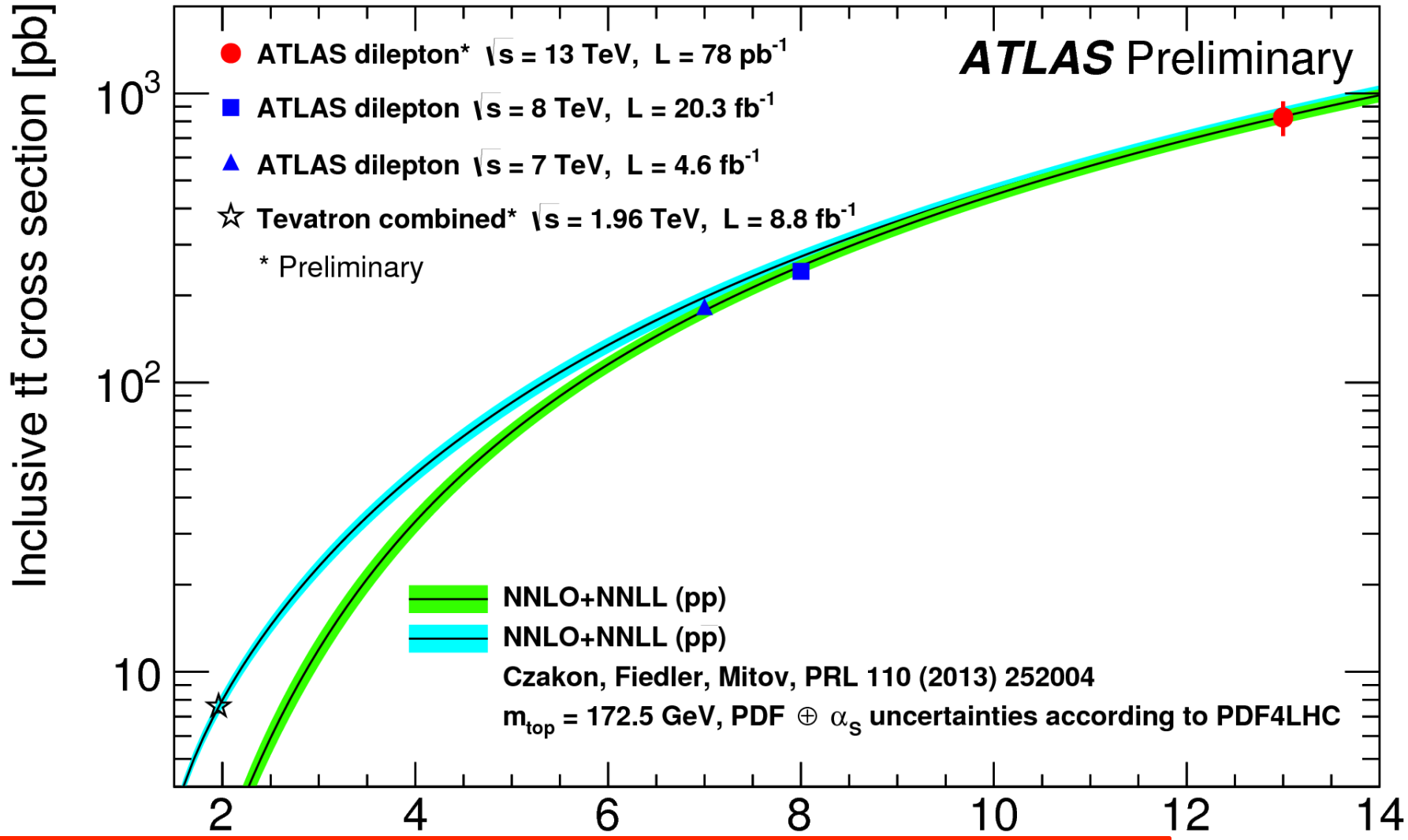
Event counts	N_1	N_2
Data	319	167
Wt single top	29.0 ± 3.8	5.6 ± 2.0
Dibosons	1.1 ± 0.2	0.0 ± 0.0
$Z(\to \tau\tau \to e\mu)$+jets	1.3 ± 0.7	0.1 ± 0.1
Misidentified leptons	6.0 ± 3.9	2.8 ± 2.9
Total background	37.3 ± 5.5	8.5 ± 3.5





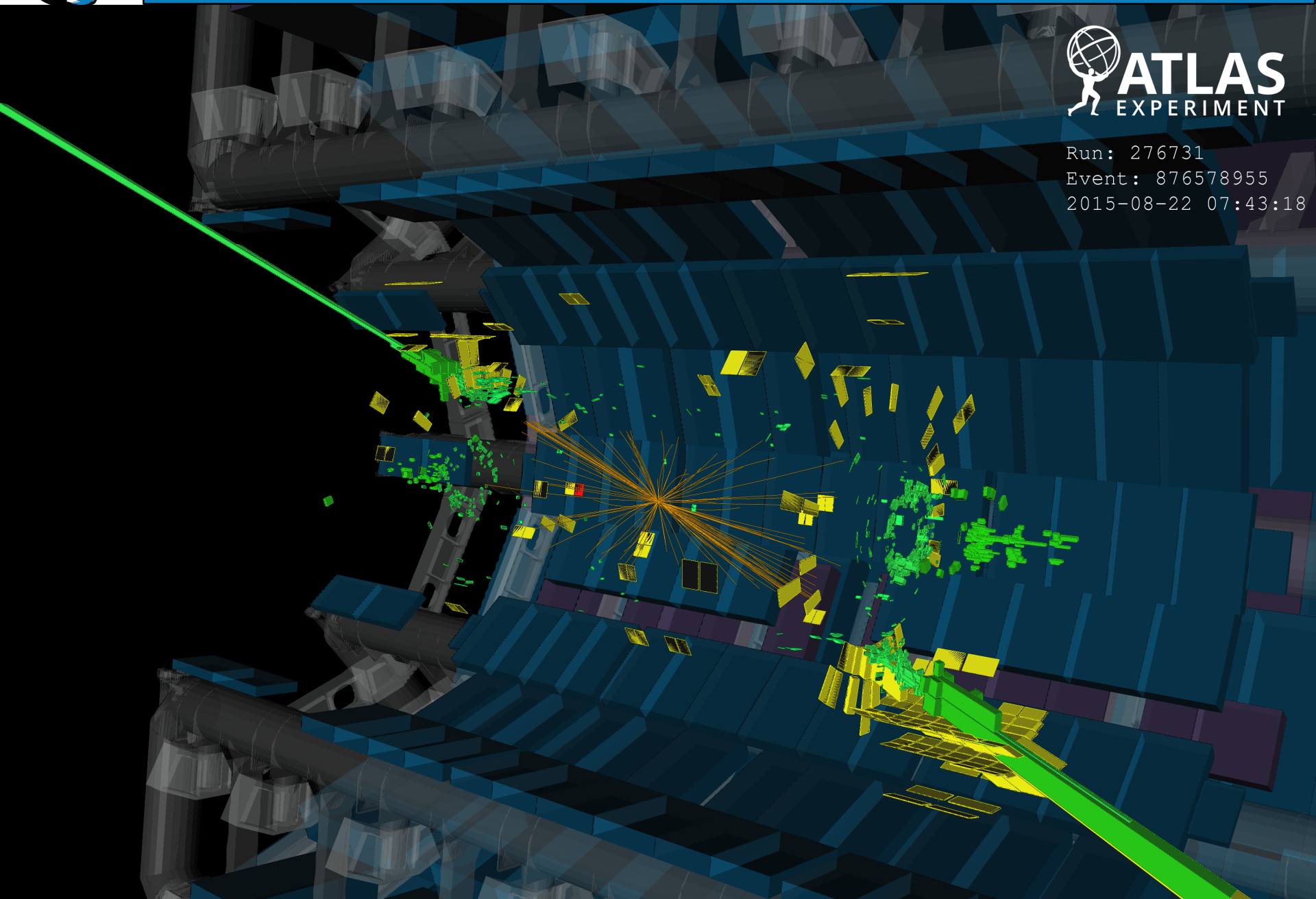
Top Cross-Section

ATLAS-CONF-2015-033



σ_{tt} (13 TeV) = 825 ± 49 (stat) ± 60 (syst) ± 83 (lumi) pb

High-mass searches

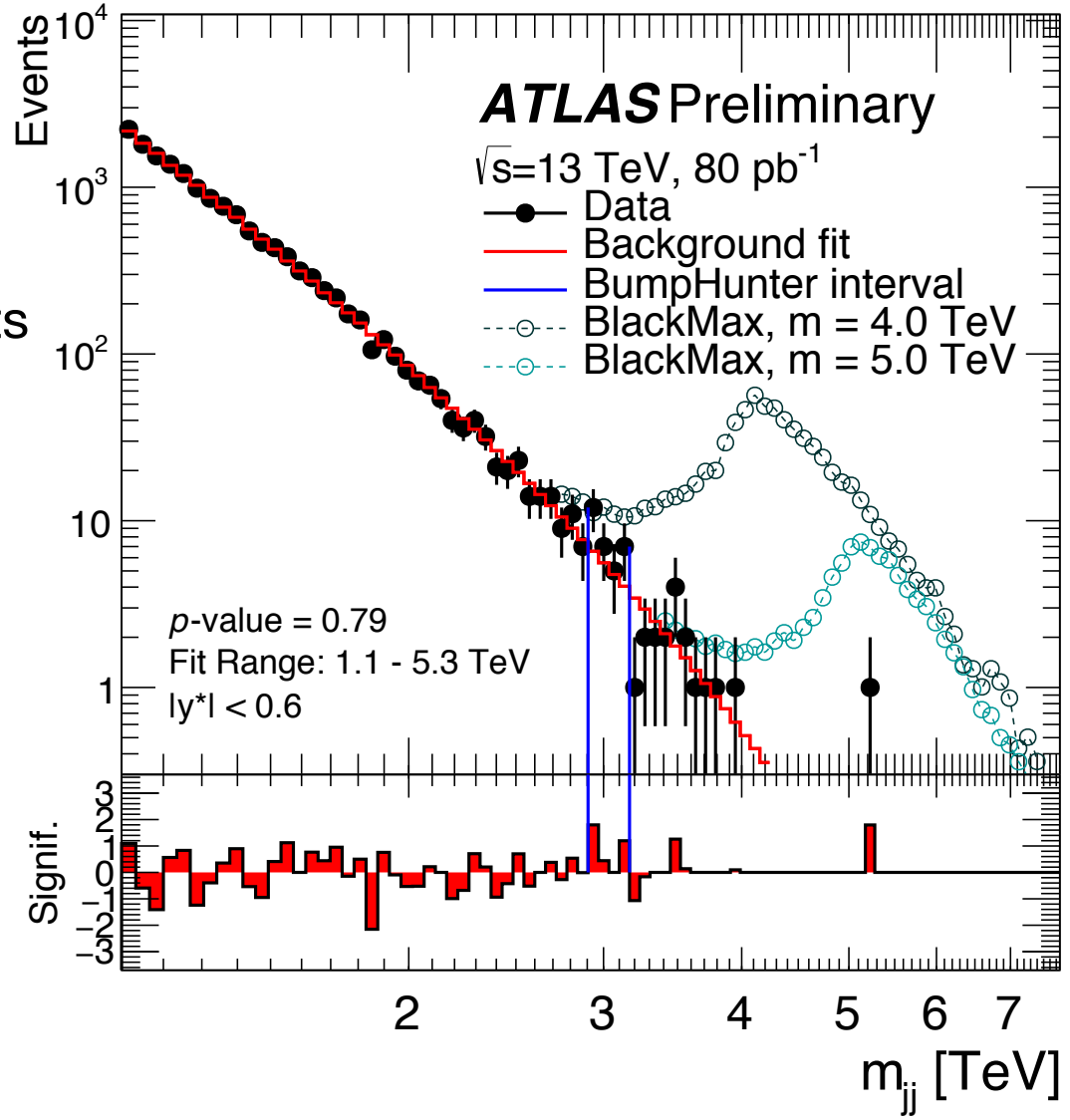


Resonant Di-jet Search

ATLAS-CONF-2015-042

- Resonance search
- Jet trigger, dijet selection
  - $|y_1-y_2| < 1.2$, reduces QCD dijets
  - $m_{jj} > 1.2$ TeV
- Data-driven background fits
  - $f(z) = p_1 (1-z)^{p2} z^{p3 + p4 \log(z)}$
  - $z = m_{jj} / \sqrt{s}$
- 'Bumphunter' to find most significant local excess
- Uncertainty dominated by jet energy scale

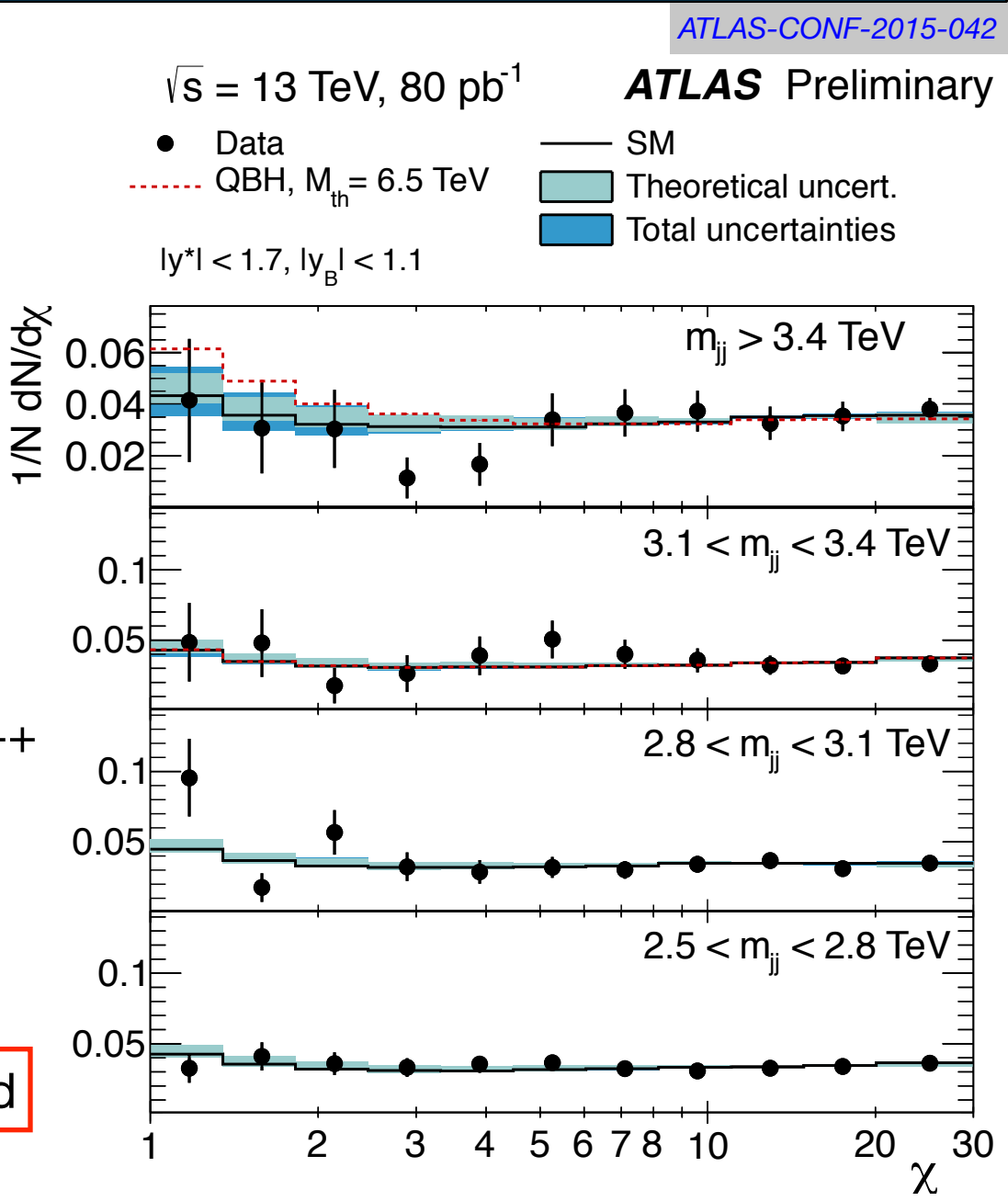
No significant excess found

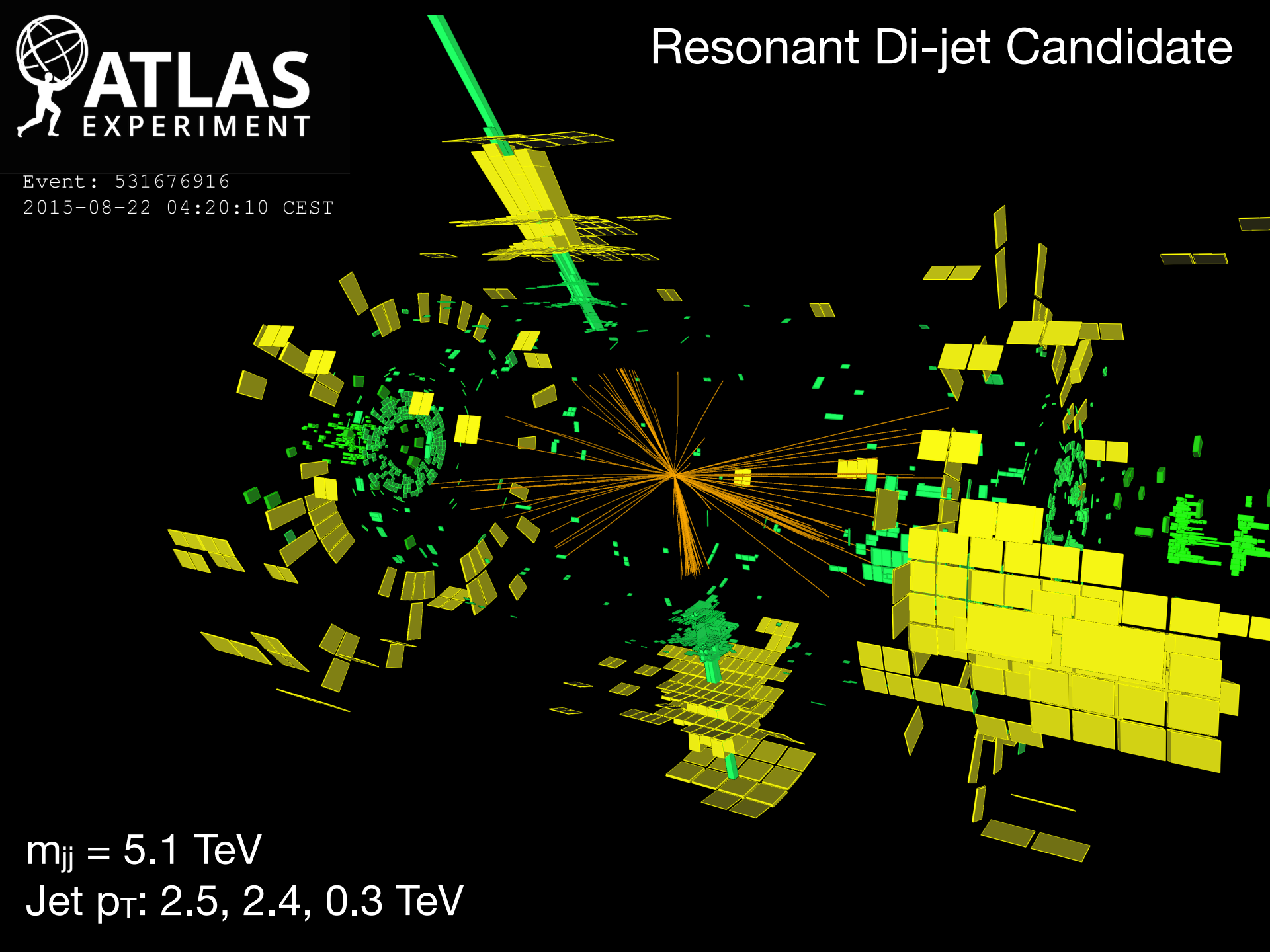


Non-resonant Di-jet Search

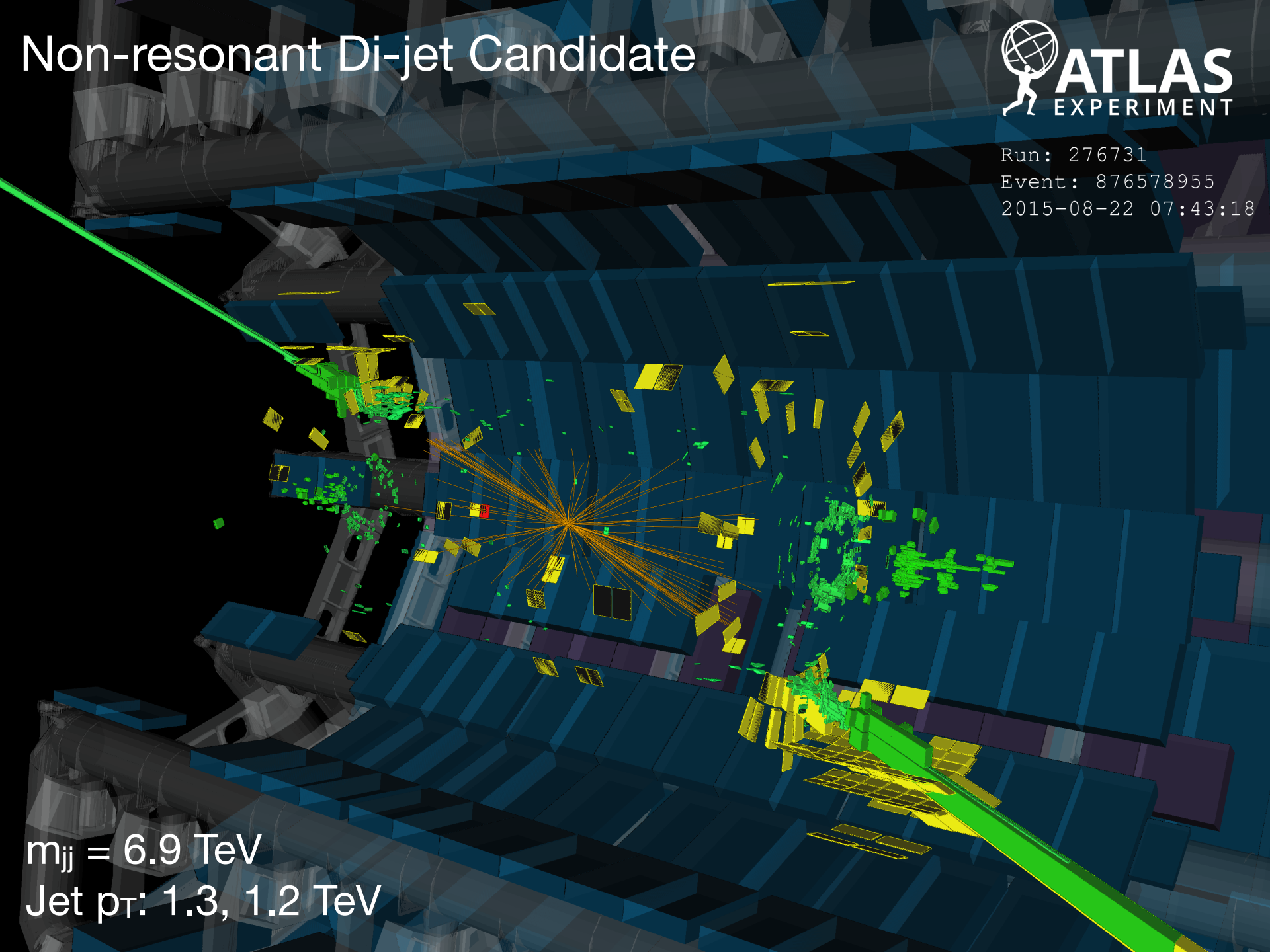
- Non-resonant search
- Look for anomalies in shapes and rates at high mass
- $\chi = \exp|y_1 - y_2|$
  - ~independent of m_{12} for t-channel LO QCD
  - $|y_1 - y_2| < 3.4$ ($\chi < 30$)
    $|y_B| = |y_1 + y_2|/2 < 1.1$
    $m_{jj} > 2.5$ TeV
- Prediction from NLOJET++ including EW effects
- Systematics dominated by QCD prediction and jet energy scale

No significant deviation found



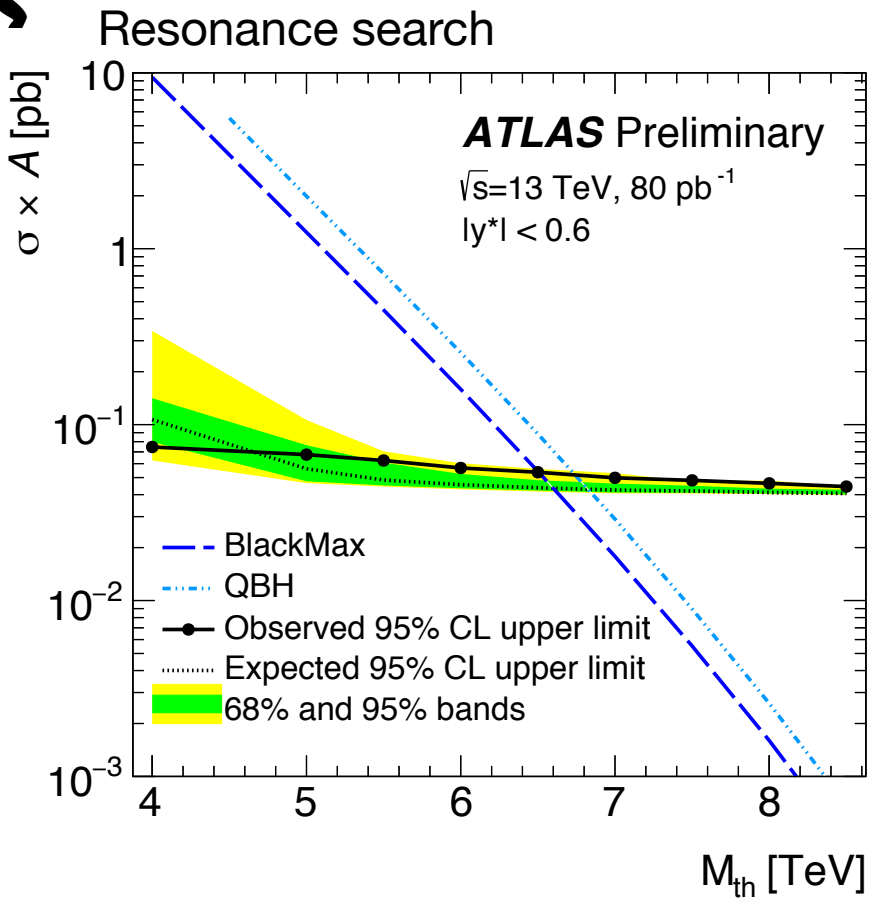

ATLAS
EXPERIMENT
Event: 531676916
2015-08-22 04:20:10 CEST
Resonant Di-jet Candidate
m_{jj} = 5.1 TeV
Jet p_T: 2.5, 2.4, 0.3 TeV

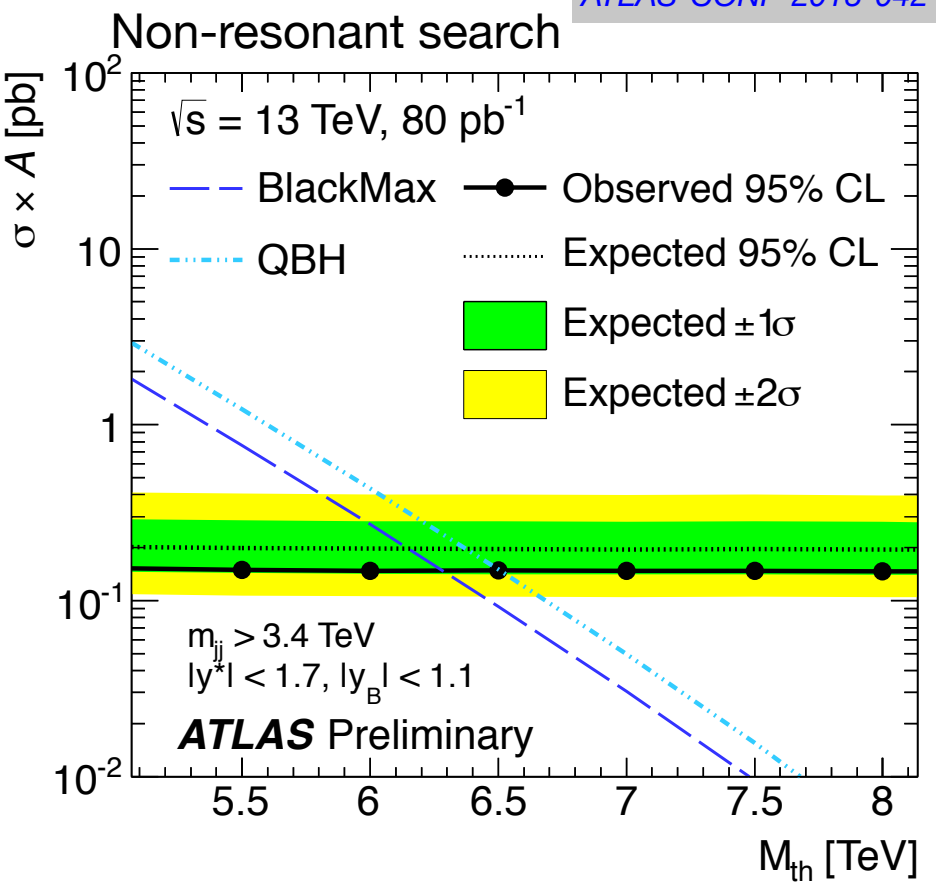
Non-resonant Di-jet Candidate



Di-jet Search Results

ATLAS-CONF-2015-042





Sensitive to strong gravity models

Compare to quantum BH production at threshold

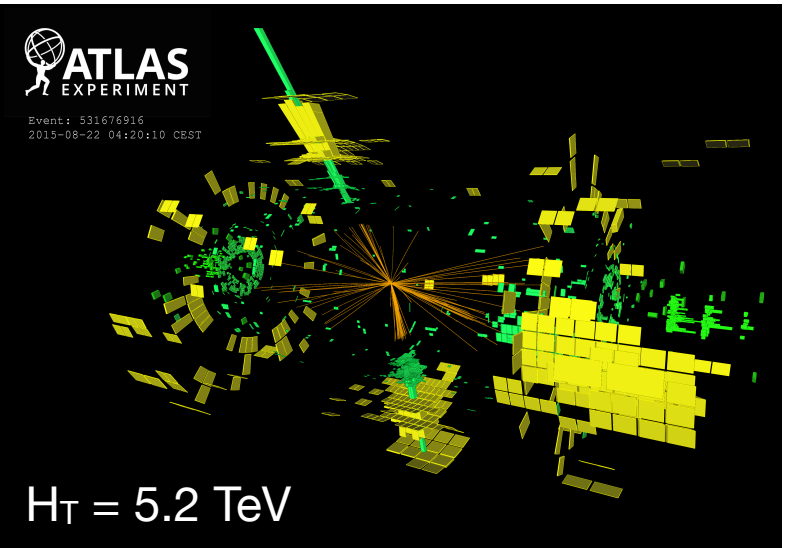
(ADD scenario, n = 6, $M_D = M_{th}$)

Threshold mass limit (QBH): $m_{Th} > 6.8$ TeV @ 95% CL

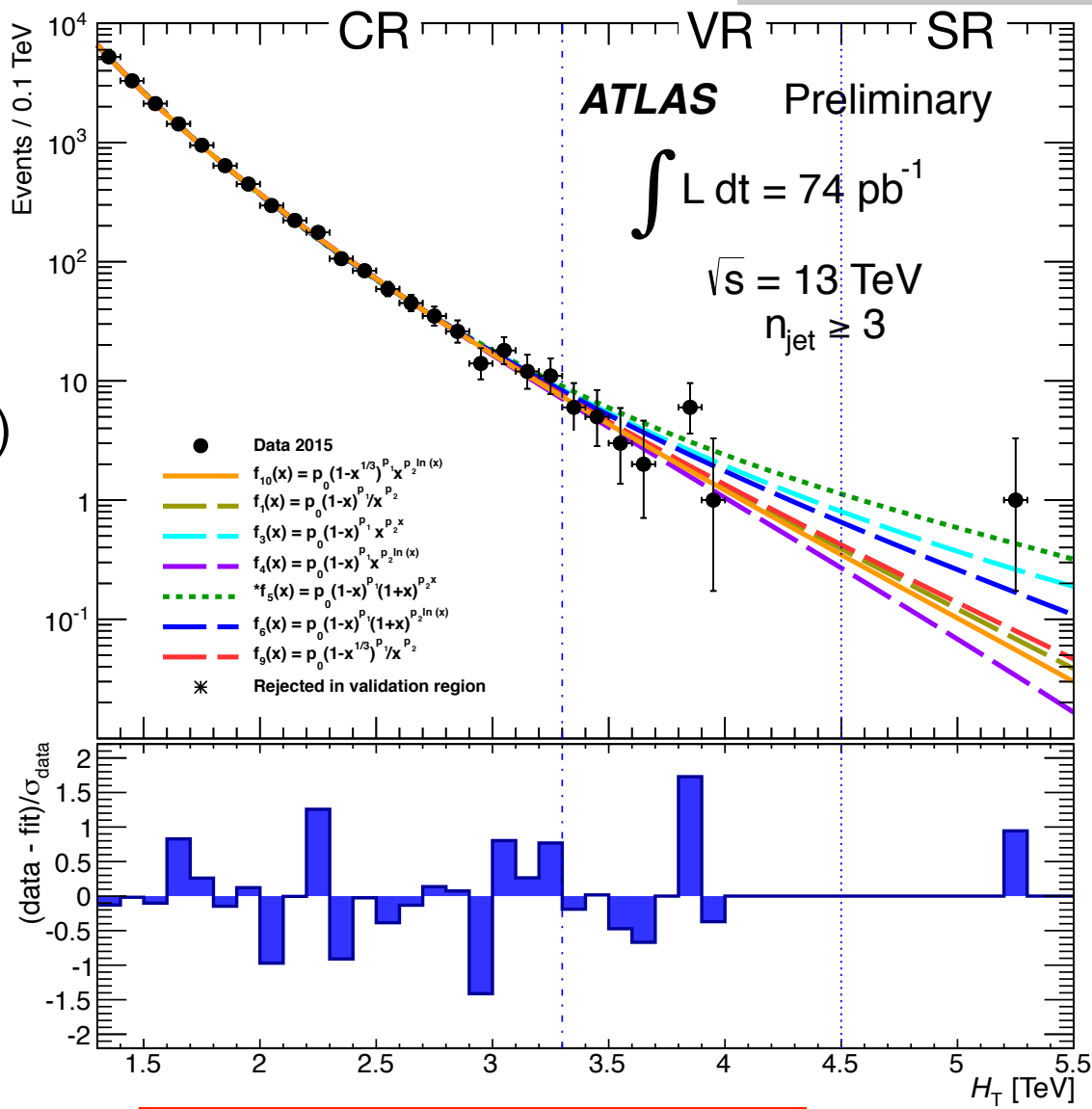
Run1 limit: $m_{Th} > 5.7$ TeV

Multi-jet Search

- Non-resonant search
- H_T trigger (0.85 TeV)
- $N_{jet} \geq 3$, $p_T > 50$ GeV
- Look for excess in $H_T = \sum p_T$ (jets)
- Data-driven background fits in control region (CR)
- Check in validation (VR)
- Compared to events in signal region (SR)



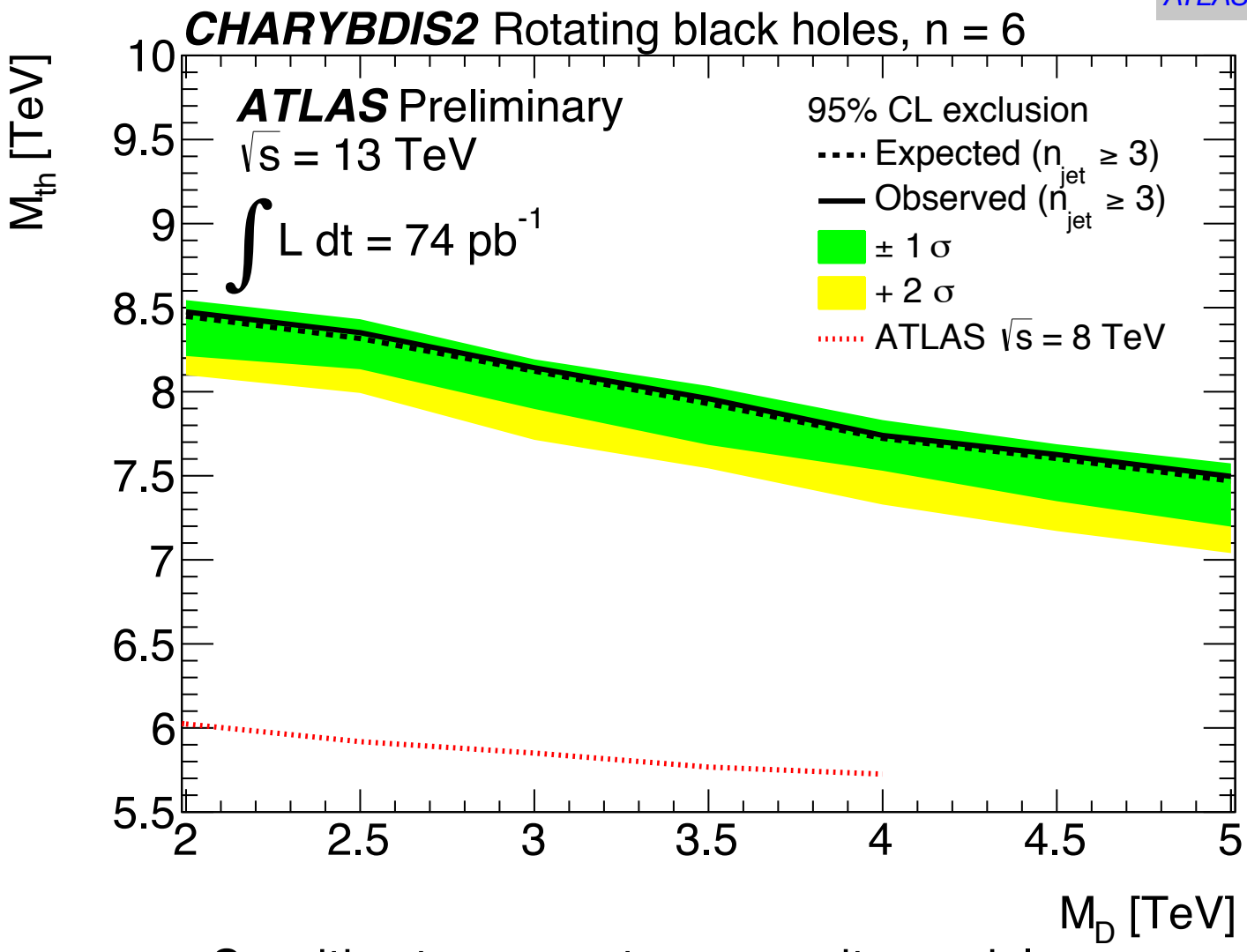
ATLAS-CONF-2015-043



No significant excess found

Multi-jet search results

ATLAS-CONF-2015-043



Sensitive to many strong-gravity models

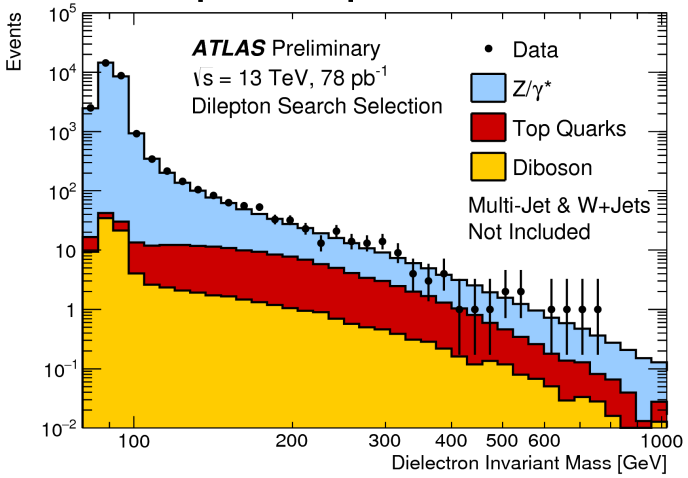
Limits set for thermal black hole model (Charybdis2)

Improvement over Run1 limit

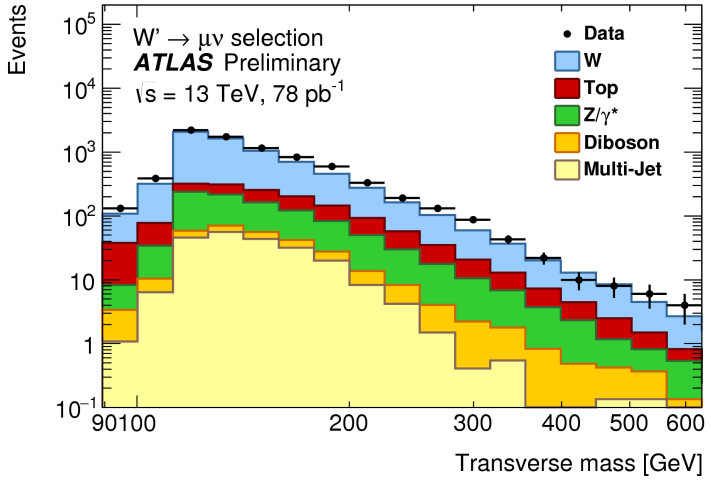
Preparations for Higher Luminosity

https://twiki.cern.ch/twiki/bin/view/AtlasPublic/Summer2015-13TeV

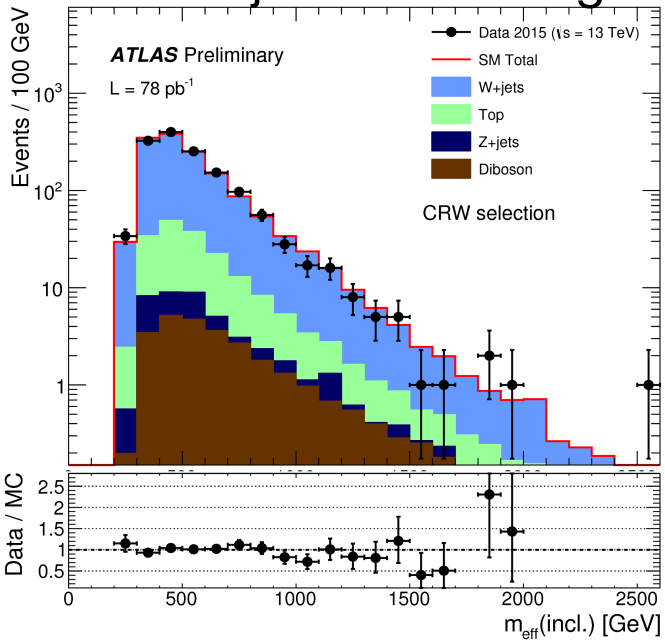
di-lepton spectrum



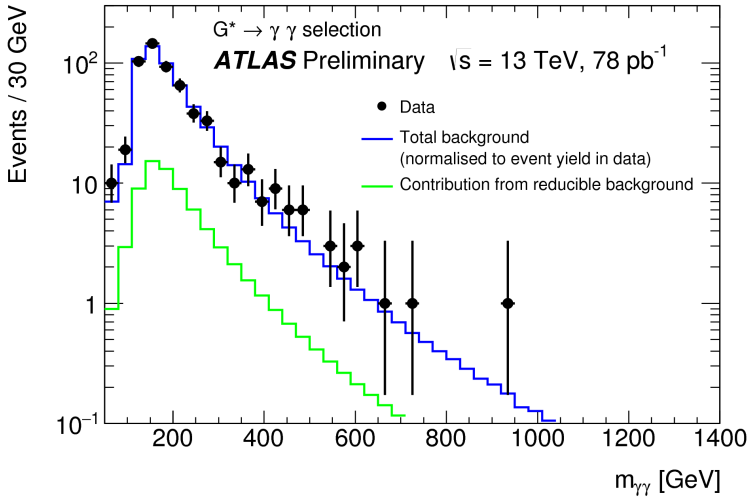
lepton+MET mass (W')



SUSY l+jets control region



di-photon spectrum



Preparation for higher luminosity

Conclusions and Outlook

- ATLAS would like to thank the LHC for their efforts to provide this first 13 TeV data
- ATLAS is working well at 13TeV
  - Upgraded components have been commissioned
  - Performance already close to (or exceeding!) Run1
- Many first measurements made with early data
  - Prelim. uncertainties ready for physics object performance
  - SM processes from inclusive pp to ttbar cross-section
  - Many measurements limited by luminosity uncertainty
    - Will improve with vdM scan taken last week
- First competitive searches at 13TeV
  - Nothing found yet
- ATLAS is excited and ready for more data to come

Many more details (and Run1!) to be shown this week

https://twiki.cern.ch/twiki/bin/view/AtlasPublic/Summer2015-13TeV