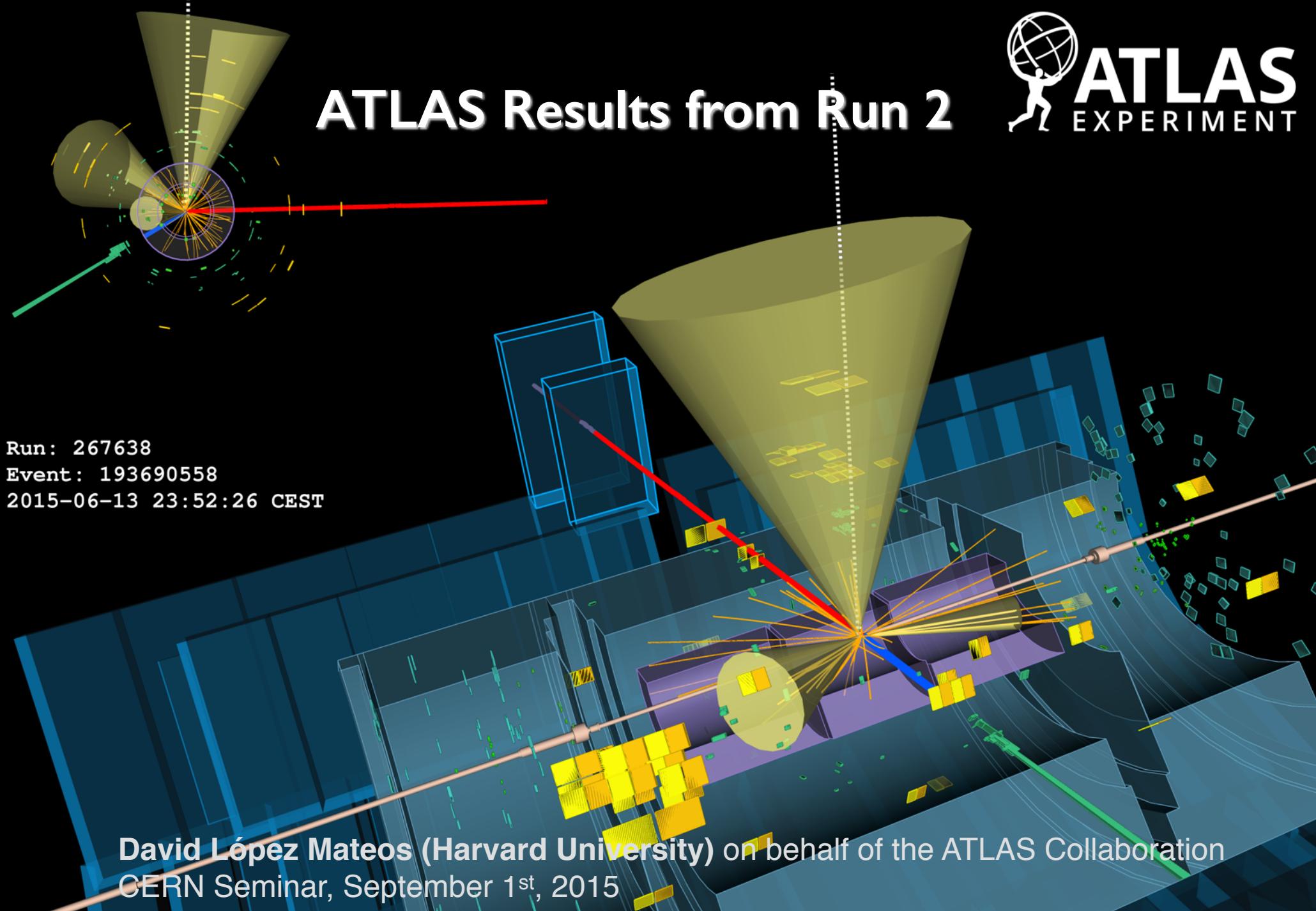




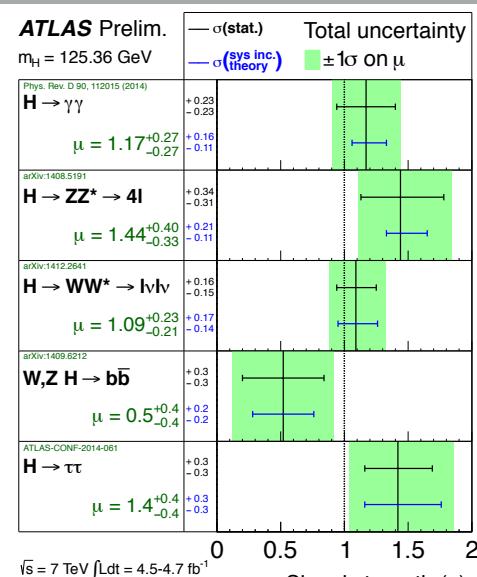
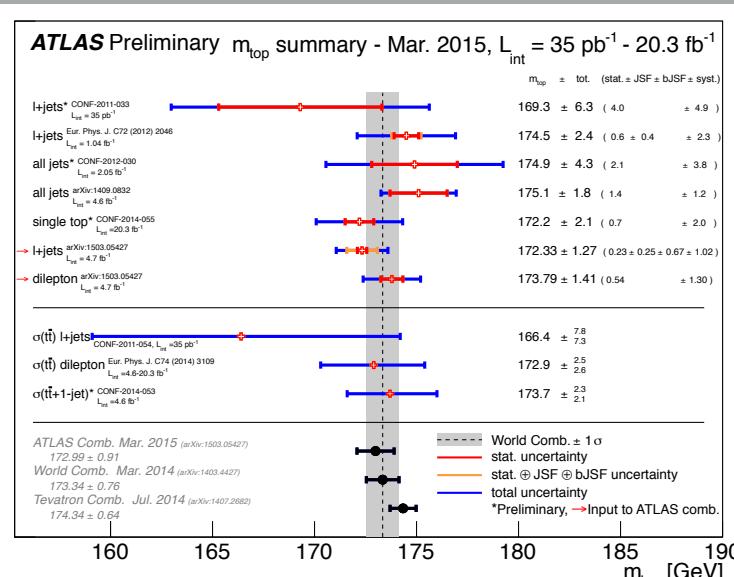
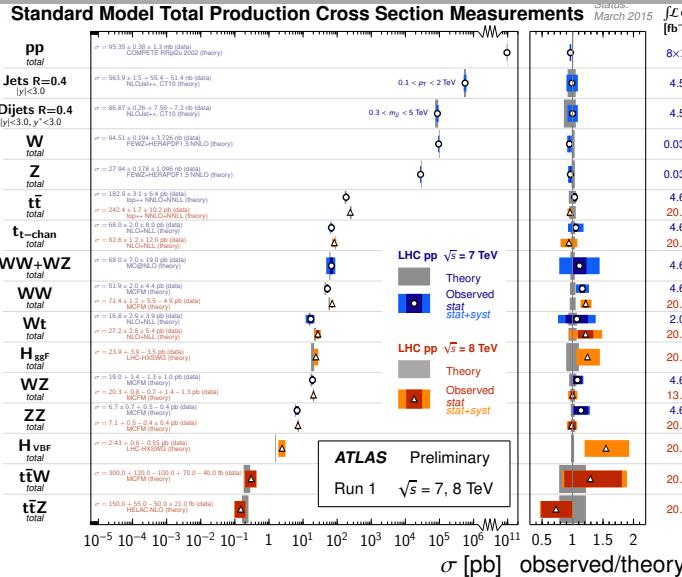
ATLAS Results from Run 2



Run: 267638
Event: 193690558
2015-06-13 23:52:26 CEST

David López Mateos (Harvard University) on behalf of the ATLAS Collaboration
CERN Seminar, September 1st, 2015

The Run I Legacy



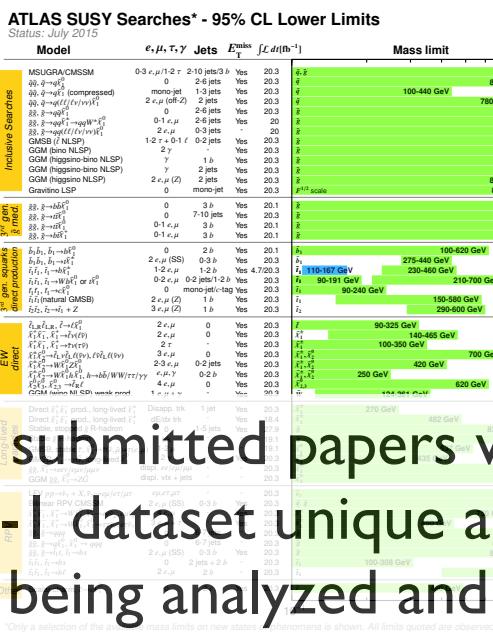
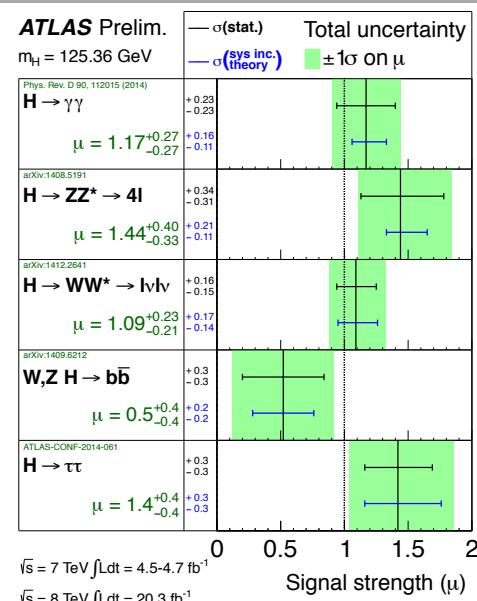
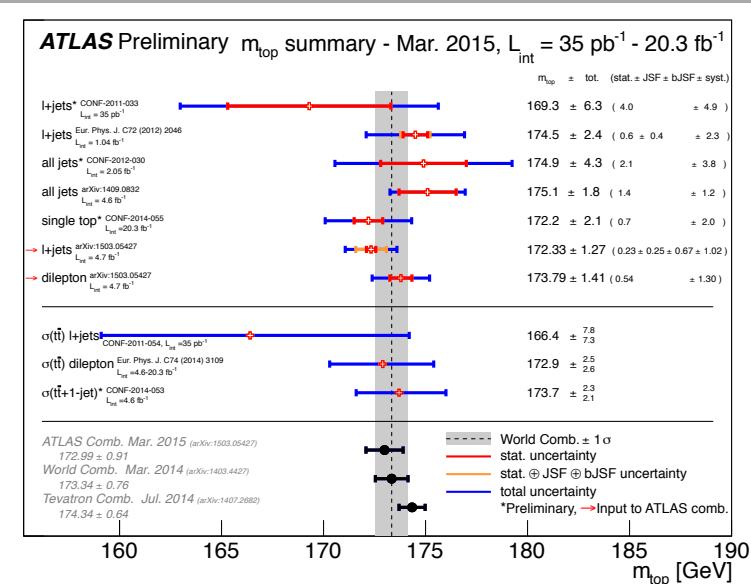
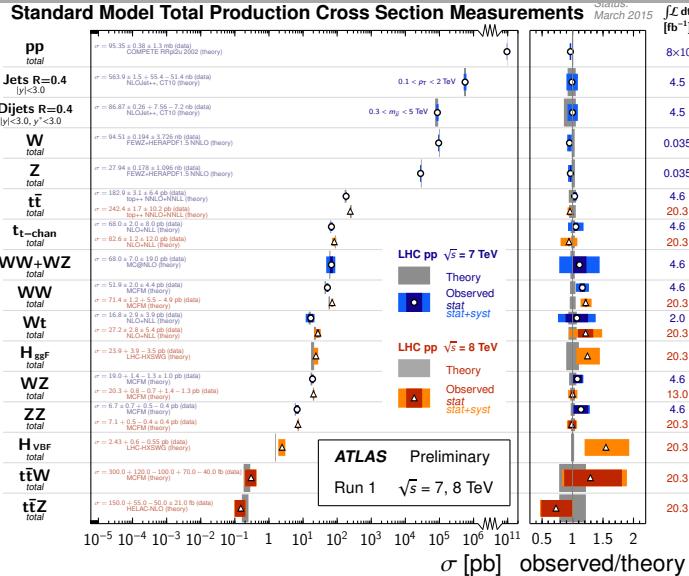
ATLAS SUSY Searches* - 95% CL Lower Limits

ATLAS SUSY

**Only a selection of the available mass limits on new states or phenomena is shown. All limits quoted are observed minus 1 σ theoretical signal cross section uncertainty.*

D. López Mateos

The Run I Legacy



ATLAS Preliminary Exotics Searches* - 95% CL Exclusion

Status: July 2015

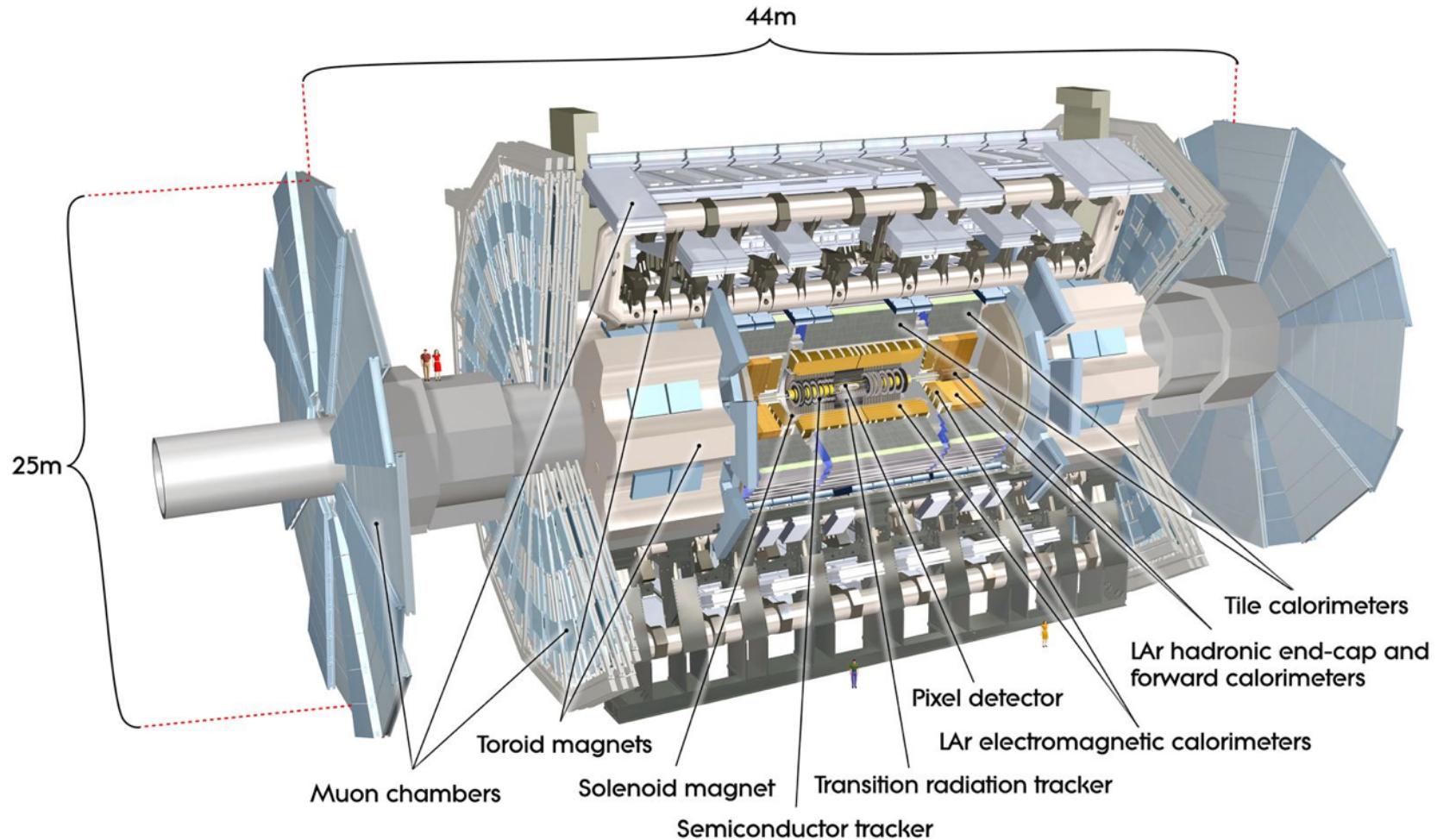
$\sqrt{s} = 7, 8 \text{ TeV}$

$\int L dt = (4.7 - 20.3) \text{ fb}^{-1}$

Limit

Model	ℓ, γ	Jets	$E_{\text{T}}^{\text{miss}}$	$fL dt (\text{fb}^{-1})$
ADD $G_{KK} \rightarrow g/g$	-	-	-	4.25 TeV
ADD non-resonant $\ell\ell$	≥ 1	Yes	20.3	$M_{\text{KK}} = 3 \text{ THZ}$
$\tilde{g}, \tilde{g} \rightarrow g(g)$ (compressed)	≥ 2	Yes	20.3	$M_{\text{KK}} = 3 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\gamma/\nu\gamma)$	≥ 2	Yes	20.3	$M_{\text{KK}} = 3.5 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 4 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 4.5 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 5 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 6 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 7 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 8 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 9 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 10 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 11 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 12 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 13 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 14 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 15 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 16 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 17 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 18 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 19 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 20 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 21 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 22 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 23 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 24 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 25 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 26 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 27 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 28 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 29 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 30 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 31 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 32 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 33 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 34 \text{ TeV}$
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$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 37 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 38 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 39 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 40 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 41 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 42 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 43 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 44 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 45 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 46 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 47 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 48 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 49 \text{ TeV}$
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$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 54 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 55 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 56 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 57 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 58 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 59 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 60 \text{ TeV}$
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$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 65 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 66 \text{ TeV}$
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$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 69 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 70 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 71 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 72 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 73 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 74 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 75 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 76 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 77 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 78 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 79 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 80 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 81 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 82 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 83 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 84 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 85 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 86 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 87 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 88 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 89 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 90 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 91 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 92 \text{ TeV}$
$\tilde{g}, \tilde{g} \rightarrow \ell\ell(\ell\ell)/\nu\gamma$	≥ 2	Yes	20.3	$M_{\text{KK}} = 93 \text{ TeV}$

The ATLAS Detector



- ▶ High precision silicon and micro-tube tracking
- ▶ Fine-granularity/longitudinally segmented calorimeter
- ▶ Air-core toroid muon spectrometer

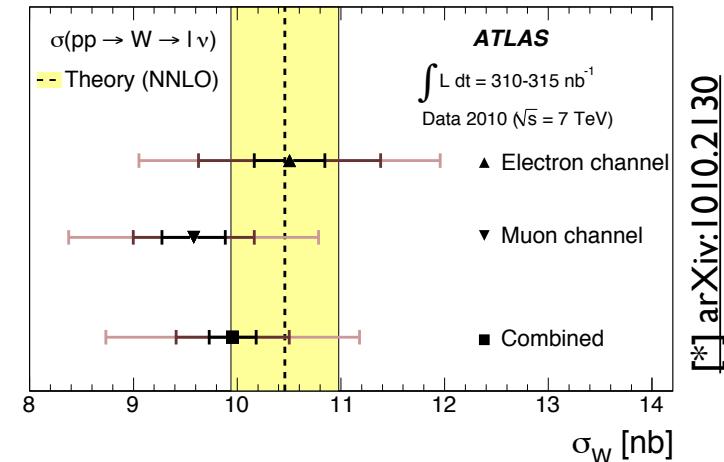
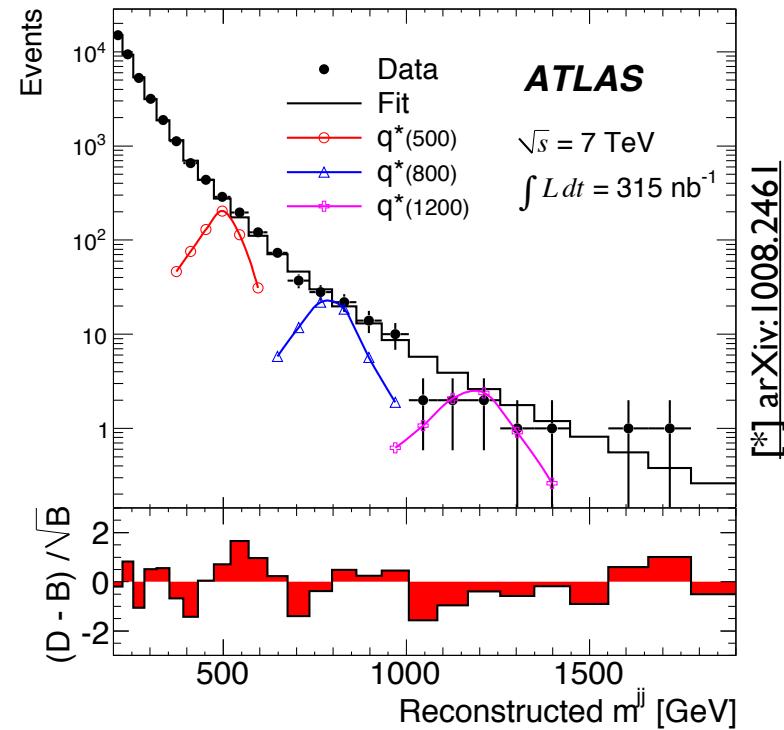
What to Expect in the Early Run 2 Data

► Early Run I dataset

- 2010 at $\sqrt{s}=7 \text{ TeV}$, $L=36 \text{ pb}^{-1}$
- Over 50 measurements of SM processes published
- First measurements and searches submitted for publication within 2-3 months of start of data taking

► So, what to expect with early Run 2 dataset?

- Measurements of SM processes interesting theoretically and to understand backgrounds for searches with not much data
- Searches can already extend 2012 results with $\mathcal{O}(100 \text{ pb}^{-1})$ in some cases, $\mathcal{O}(5 \text{ fb}^{-1})$ in most cases
- And we know much more about our detector now than we did in 2010!



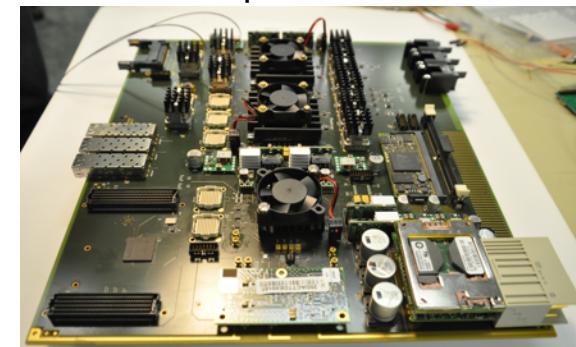
ATLAS Upgrades During LSI

- ▶ **Infrastructure upgrades**
 - new beam pipe, improvements to cryogenic systems
- ▶ **Detector consolidation**
 - Completion and repair of muon chambers, repair of pixel modules and calorimeter electronics, new luminosity detectors, improved read-out for 100 kHz L1 rate
- ▶ **Insertable B-layer (IBL)**
 - New innermost pixel layer at $R=3.3\text{cm}$ from beam
- ▶ **Trigger**
 - New topological L1 trigger, new central trigger processor, restructured high-level trigger
- ▶ **Reconstruction and calibration**
 - Reconstruction software rewritten ($\times 3\text{-}4$ faster reconstruction), new analysis model, production system

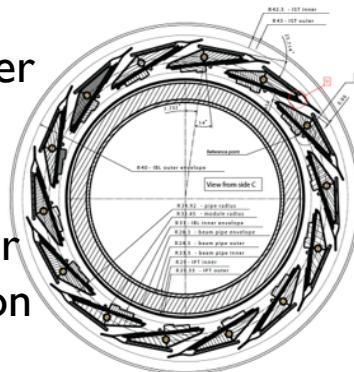
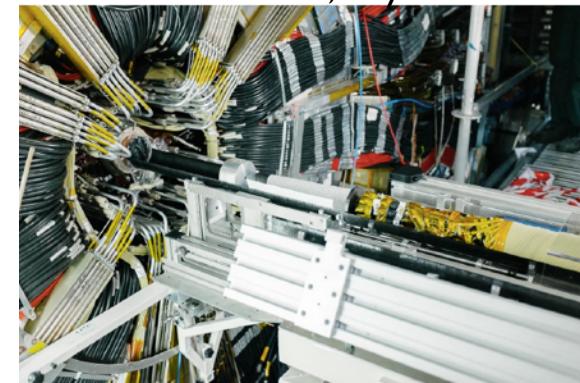
Replacement of TGC chambers



L1 Topo board

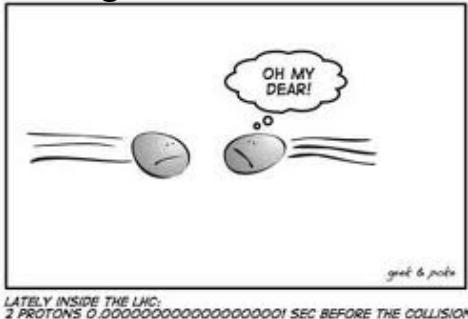


IBL insertion, May 2014

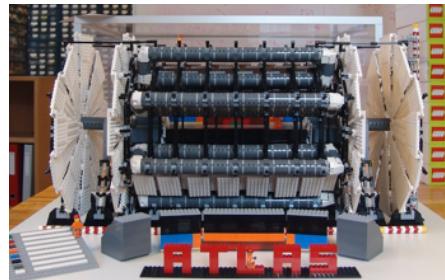


Getting to the Physics

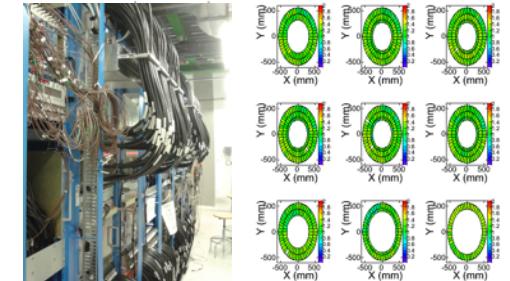
Large Hadron Collider



ATLAS detector



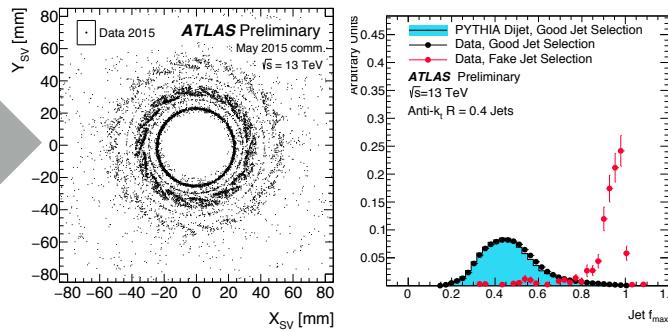
trigger & online monitoring



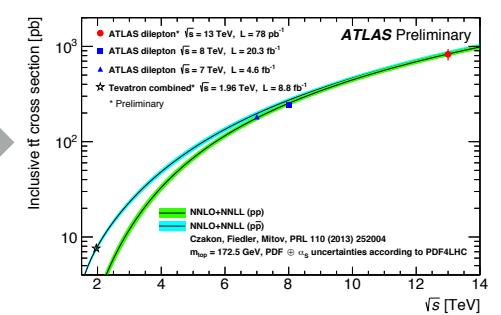
prompt calibration & reconstruction



physics object calibration & uncertainties



measurements & searches



- Here I will focus mostly in the two last parts of this chain, but huge efforts involved in all parts
 - A special thanks from the ATLAS collaboration to the LHC team for a successful start of Run 2!

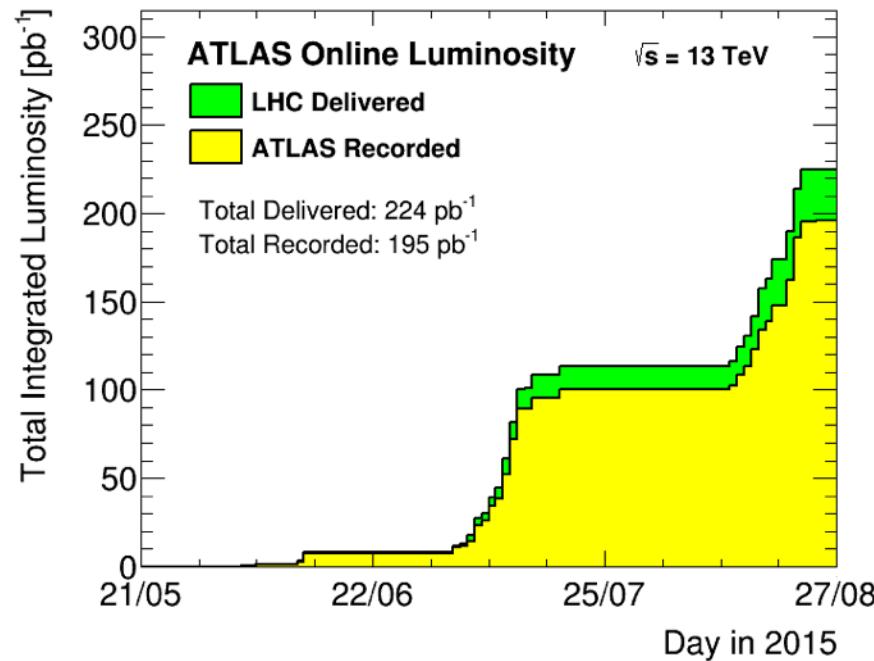
Run 2 Operations

Detector Status: April

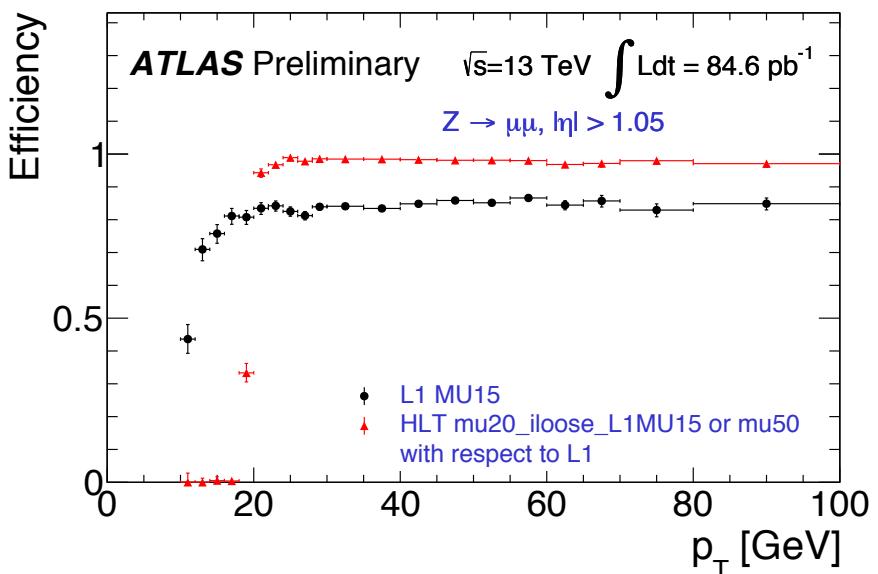
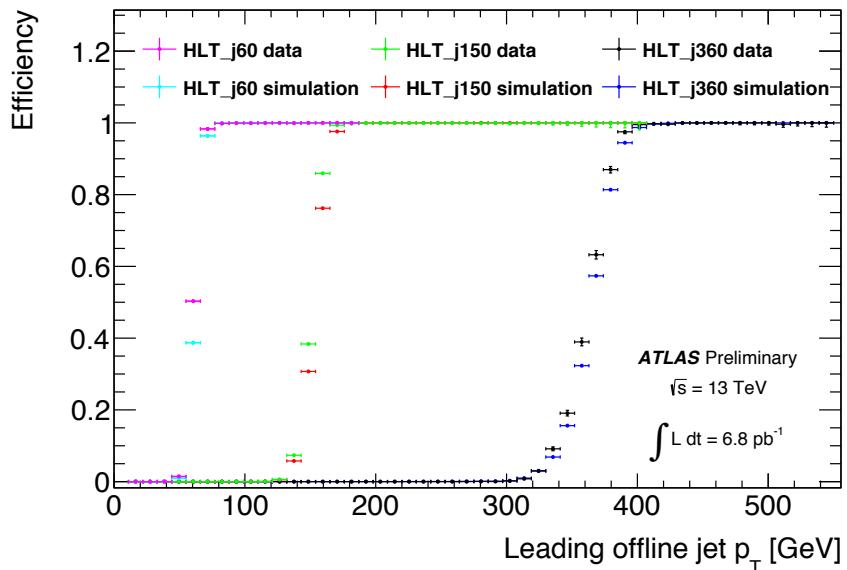
Subdetector	Number of Channels	Approximate Operational Fraction
Pixels	92 M	99.0%
SCT Silicon Strips	6.3 M	98.9%
TRT Transition Radiation Tracker	350 k	97.3%
LAr EM Calorimeter	170 k	100%
Tile calorimeter	4900	99.2%
Hadronic endcap LAr calorimeter	5600	99.6%
Forward LAr calorimeter	3500	99.8%
LVL1 Calo trigger	7160	100%
LVL1 Muon RPC trigger	370 k	98.7%
LVL1 Muon TGC trigger	320 k	100%
MDT Muon Drift Tubes	357 k	99.8%
CSC Cathode Strip Chambers	31 k	98.4%
RPC Barrel Muon Chambers	370 k	97.1%
TGC Endcap Muon Chambers	320 k	99.8%

- ▶ Up to 85 pb^{-1} used in analyses in June-July at 50 ns
- ▶ 80 pb^{-1} collected in August, most of which at 25 ns (25 pb^{-1} at 50 ns)
- ▶ Measurements in this talk use the first dataset, searches the second
- ▶ Luminosity calibration from July 6σ VdM scan: luminosity uncertainty of 9%
- ▶ Thorough VdM scan from last week not propagated to analyses yet

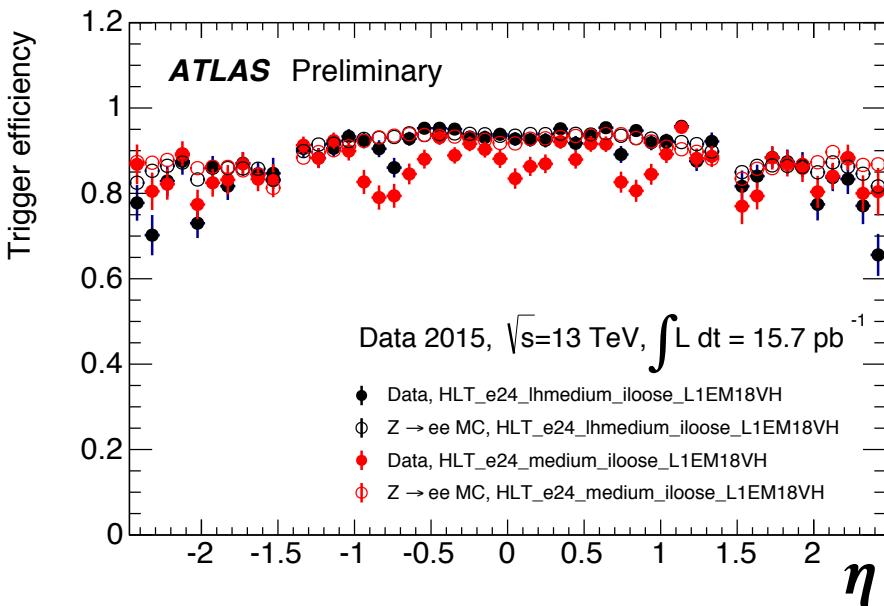
ATLAS pp run: June-August 2015										
Inner Tracker			Calorimeters		Muon Spectrometer			Magnets		
Pixel	SCT	TRT	LAr	Tile	MDT	RPC	CSC	TGC	Solenoid	Toroid
98.5	99.7	100	99.1	100	100	99.3	100	100	100	99.6
Luminosity weighted relative detector uptime (in percent) and good quality data delivery during the stable beams in pp collisions at 13 TeV between June-August 2015, corresponding to 173 pb^{-1} recorded luminosity.										



Trigger Commissioning

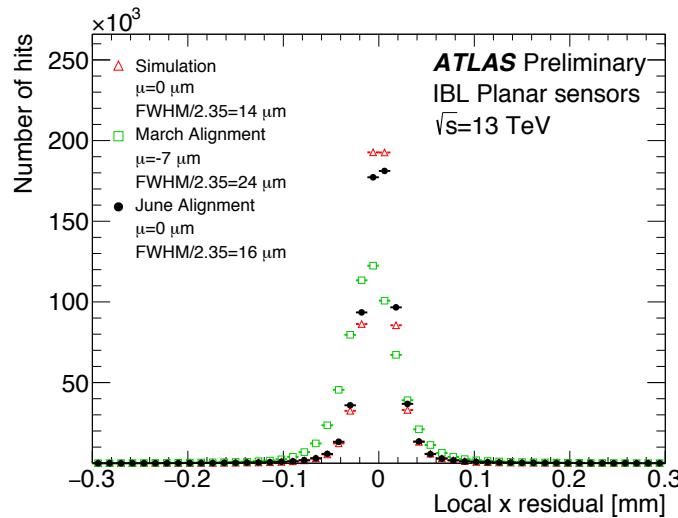
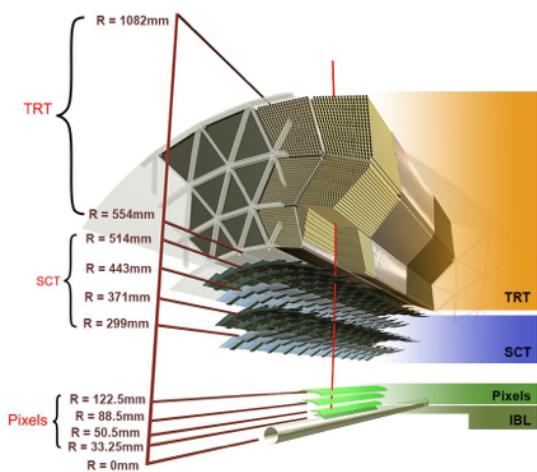


- ▶ Good understanding of trigger turn-on curves and efficiencies for jets, muons and electrons
- ▶ Scale factors for lepton triggers derived and used in analyses throughout this talk

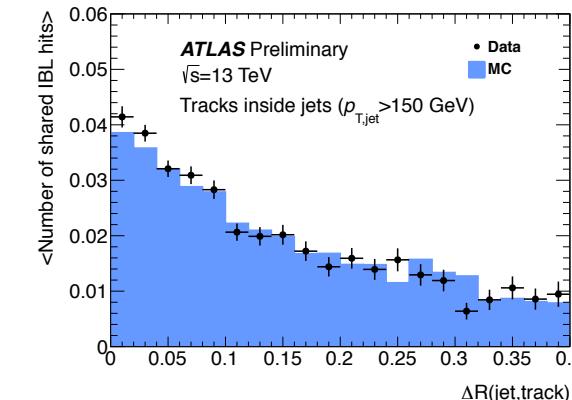
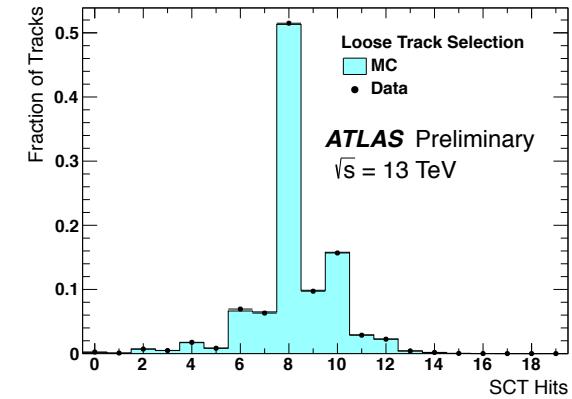
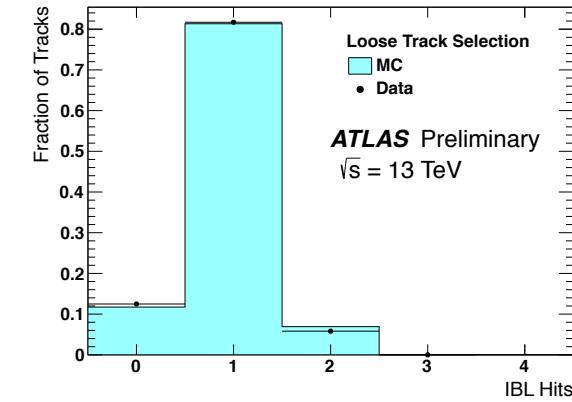


OBJECT RECONSTRUCTION AND PERFORMANCE

Tracking and Vertexing Commissioning

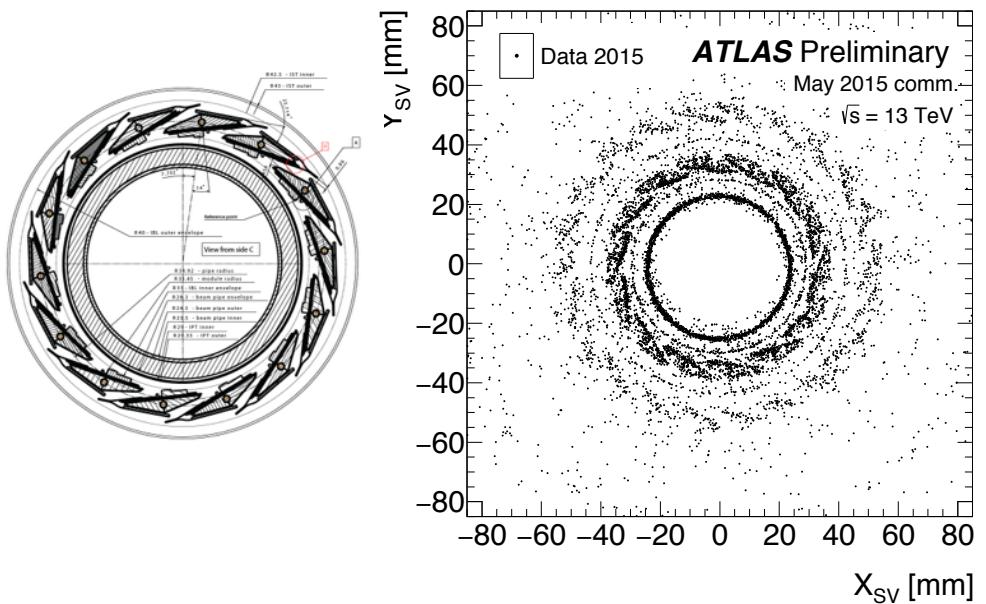


[*] ATL-PHYS-PUB-2015-031

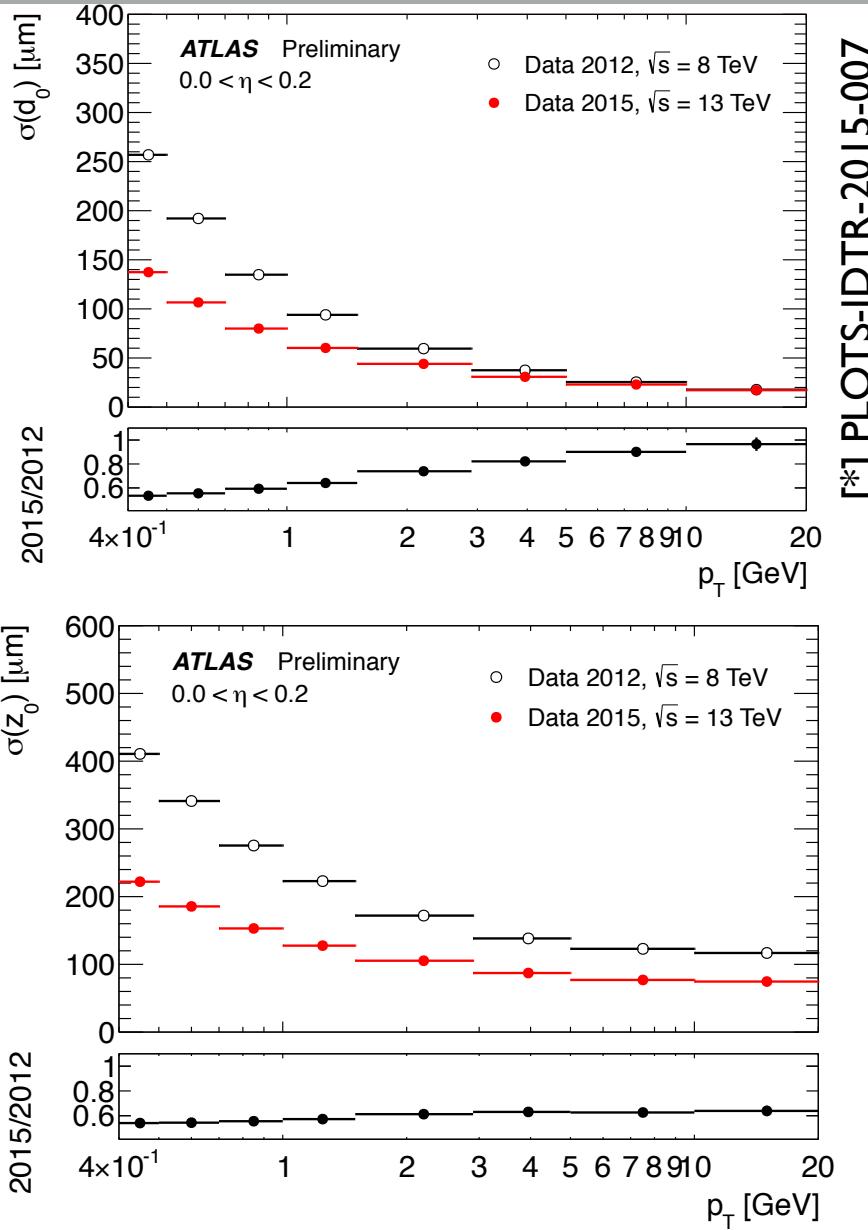


- ▶ Use early runs to perform alignment
- ▶ Basic track properties are described by the MC simulation
- ▶ Properties of tracks inside jets of importance for b-tagging and jet calibration also well described

Tracking and Vertexing Performance

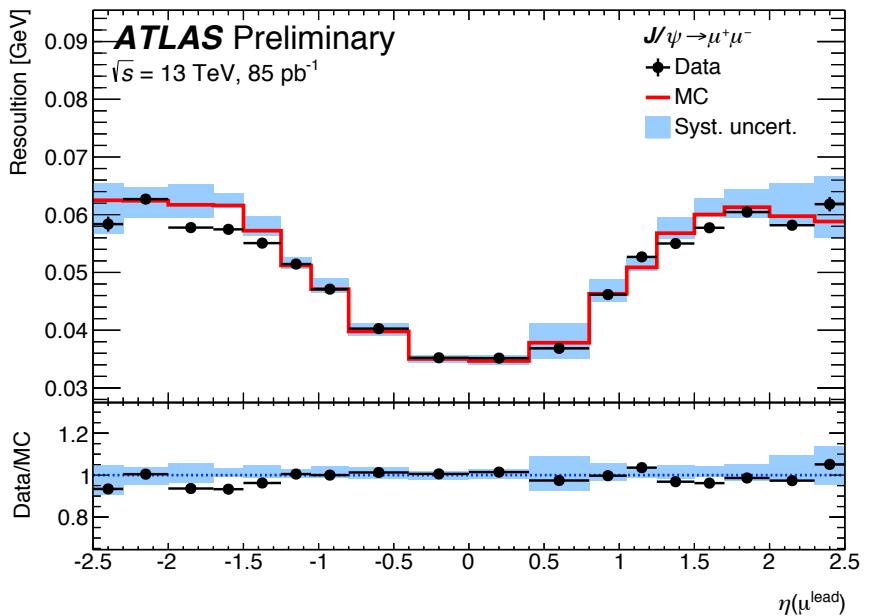
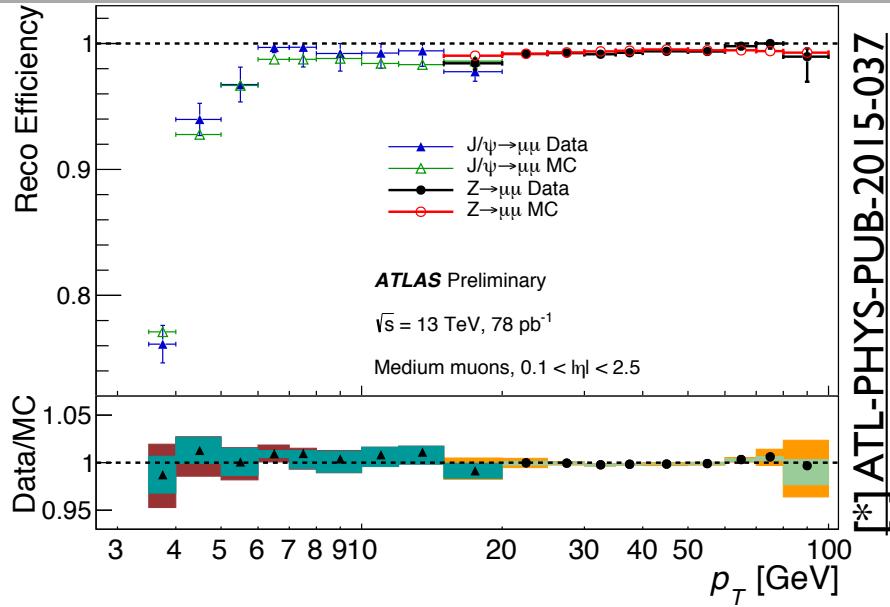


- ▶ Measure tracking performance in-situ
 - Material mapping of new IBL
 - Impact parameter resolution
(improved due to IBL)
 - ▶ Used in first data measurements,
performance improvements important for
b-tagging

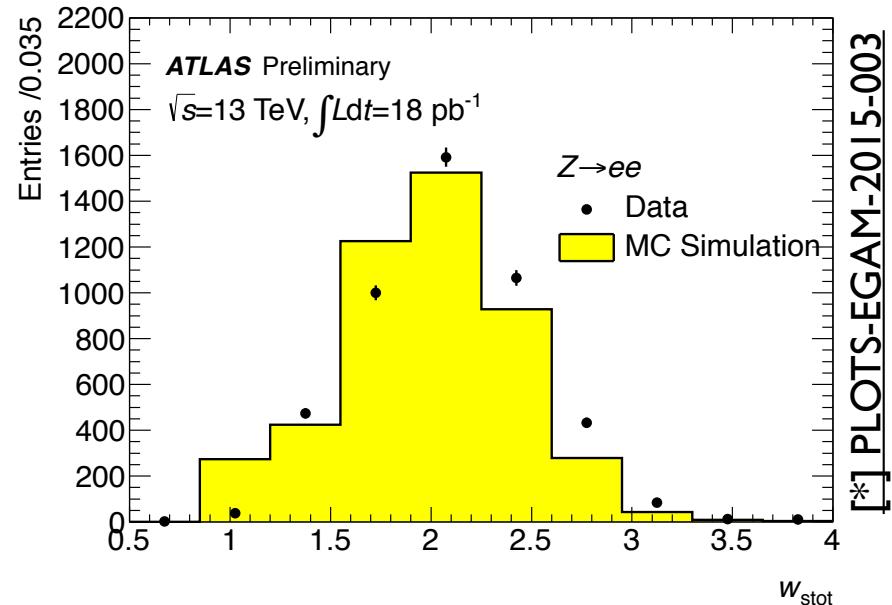
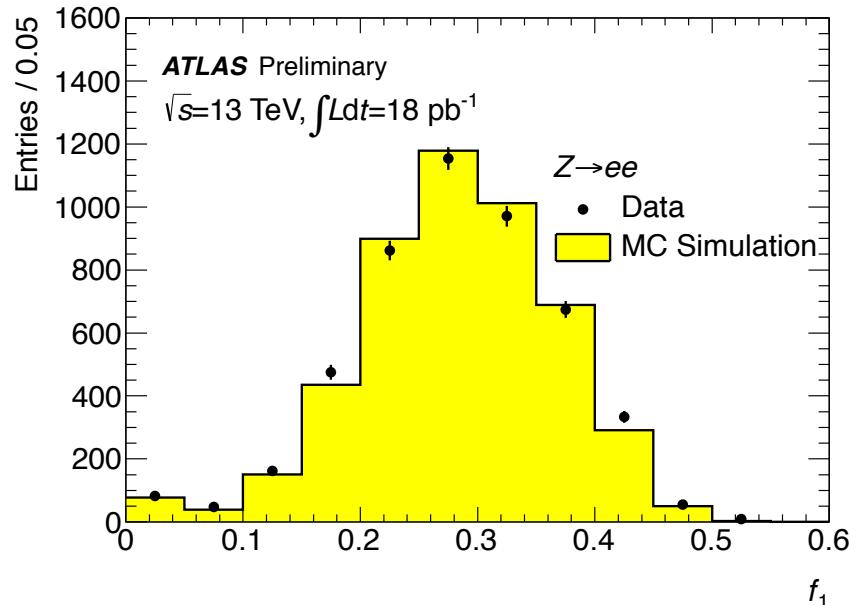


Muon Commissioning and Performance

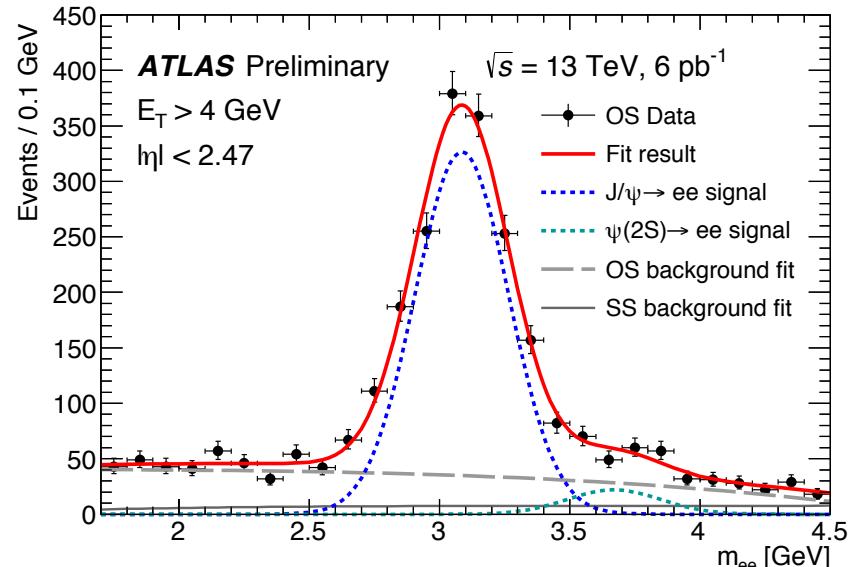
- ▶ Dedicated runs with 22 pb^{-1} with the toroid off used for muon alignment
- ▶ Muon reconstruction and identification efficiency measured in data using Z and J/Ψ events
- ▶ Resolution and scale extracted in data using Z and J/Ψ peak
- ▶ Excellent agreement between data and MC simulation



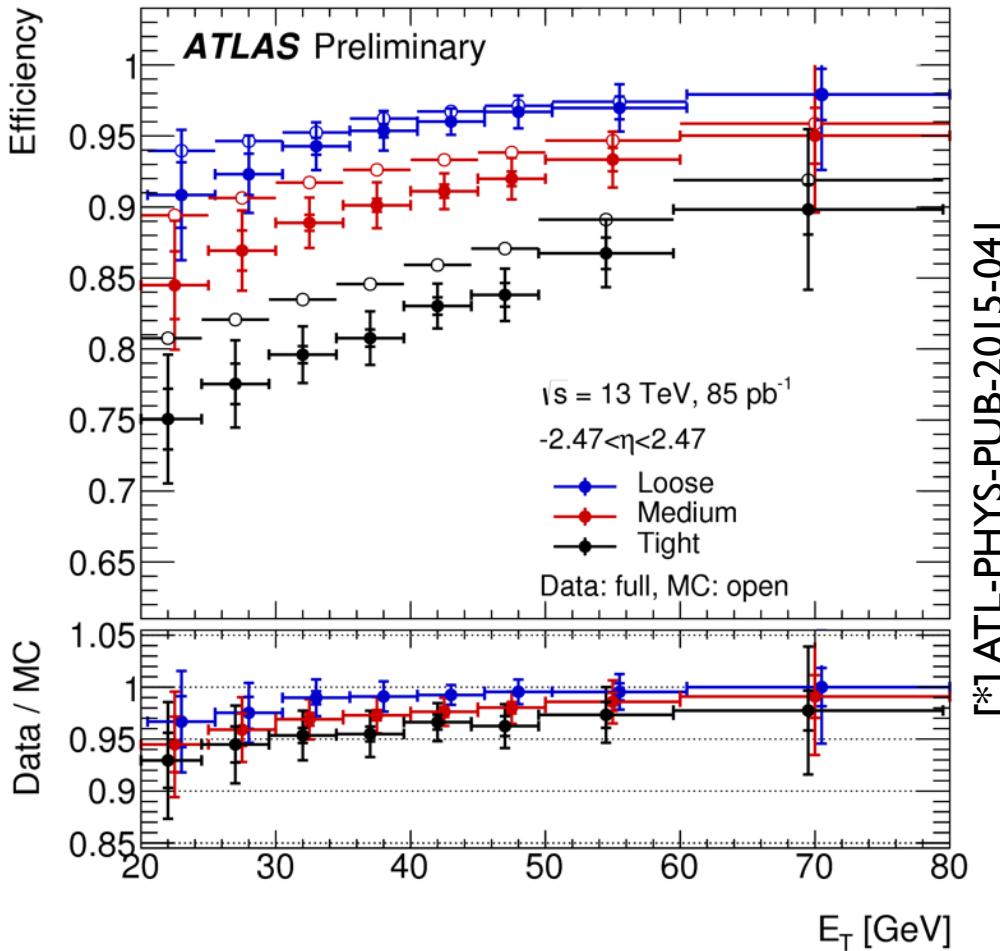
Electron Commissioning and Performance



- ▶ Shower shapes used in electron identification studied in detail
- ▶ Differences found consistent with what was observed in Run I
- ▶ Electron energy scale and resolution studied using 2015 Z → ee and reprocessed 2012 data



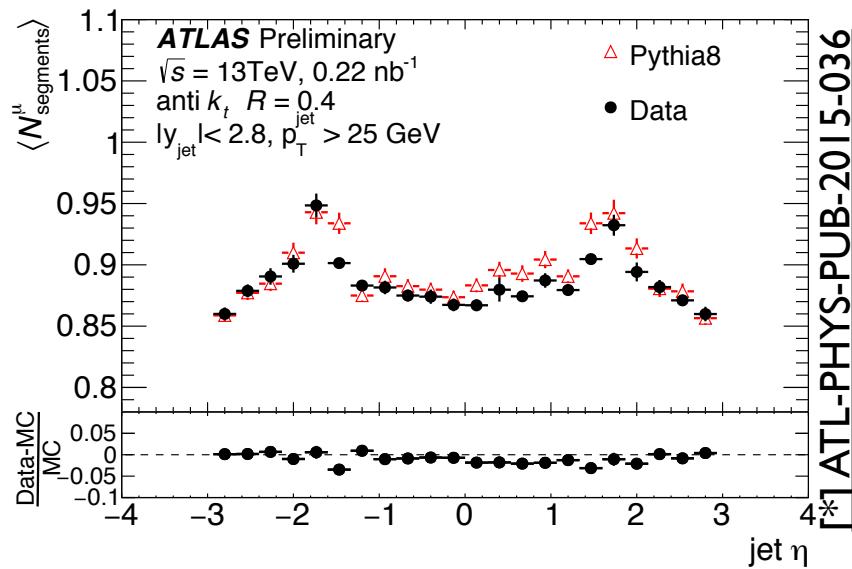
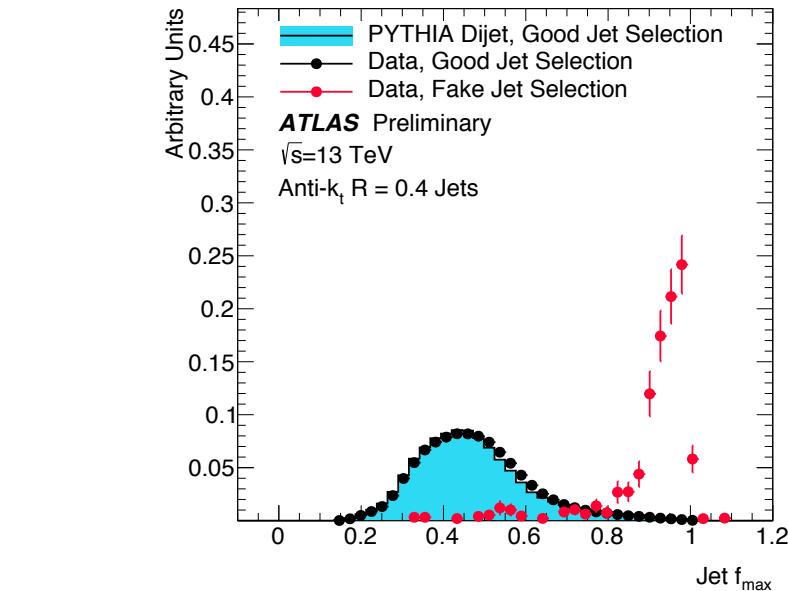
Electron Commissioning and Performance



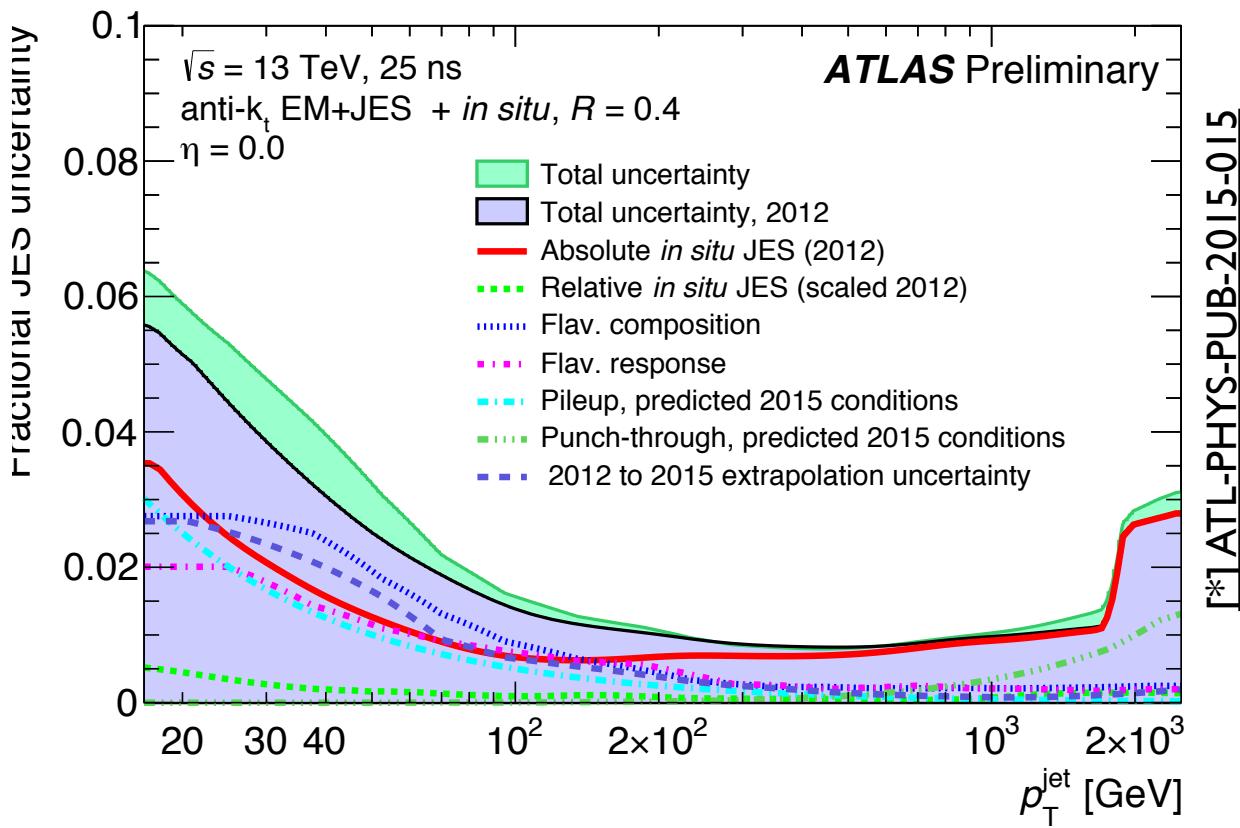
- ▶ Shower shape differences translate into MC/data differences in identification efficiencies
- ▶ Identification efficiencies measured in data and scale factors derived for MC

Jet Commissioning

- ▶ High- p_T kinematics key for discovery
 - ▶ Non-collision backgrounds studied using dedicated selections
 - ▶ “Jet cleaning” selection cuts very similar to those used in Run I, essentially fully efficient both at low and high p_T
 - ▶ Muon segments behind jets used as proxy for jet energy not contained in the calorimeter
 - ▶ Many other variables, relevant for low and high p_T jets studied
- ➡ Results show consistency with Run I observations

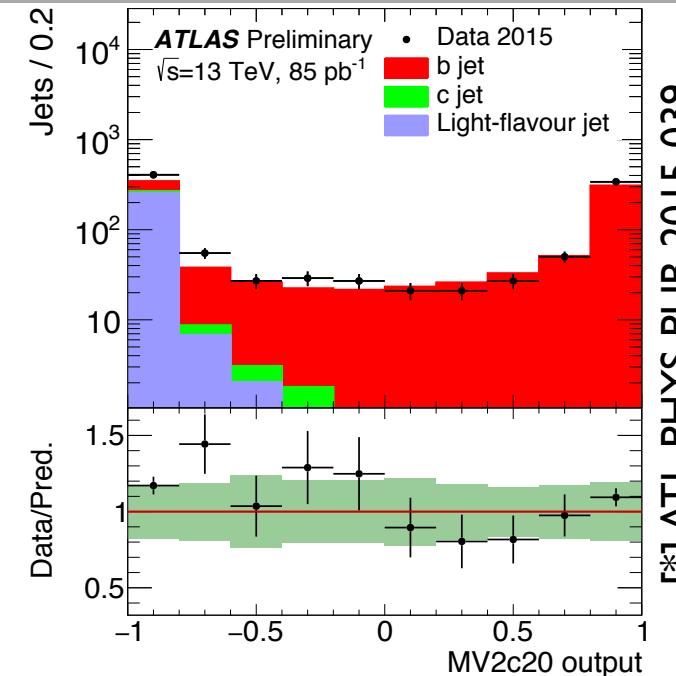
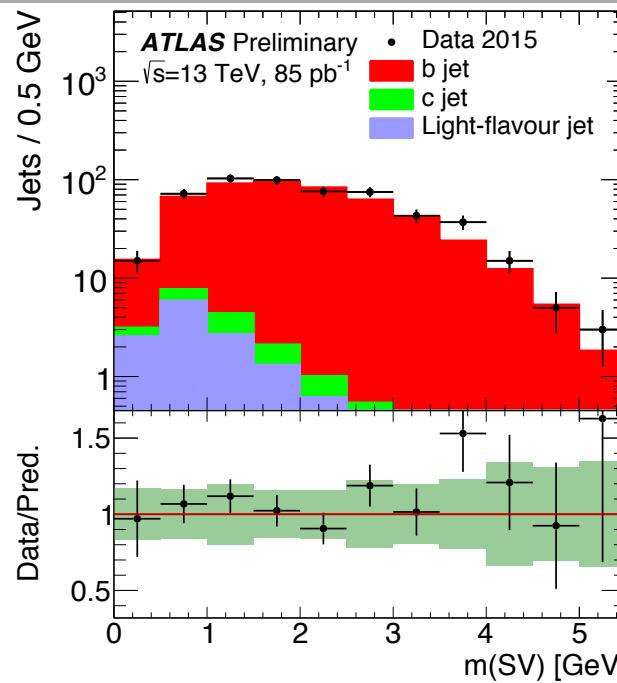
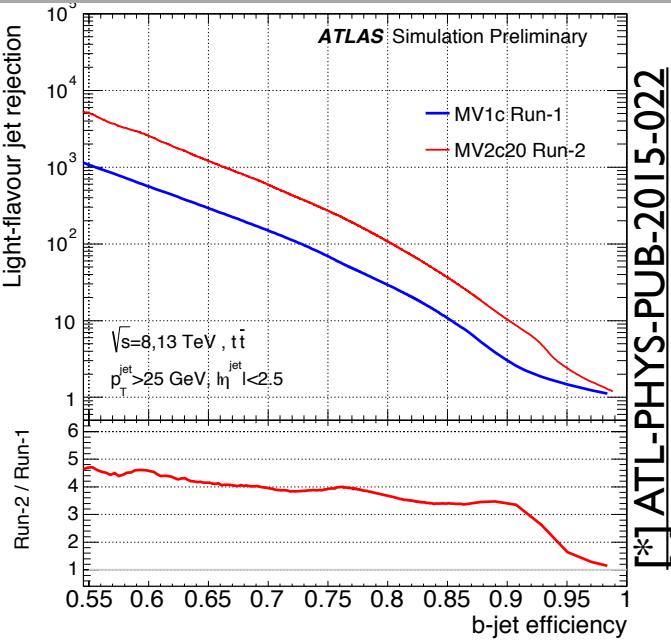


Jet Reconstruction Performance



- ▶ Use knowledge of calibration and performance in Run 1 to extrapolate systematic uncertainties to Run 2
- ▶ Effects of known changes in the detector are conservatively accounted for as additional systematic uncertainties

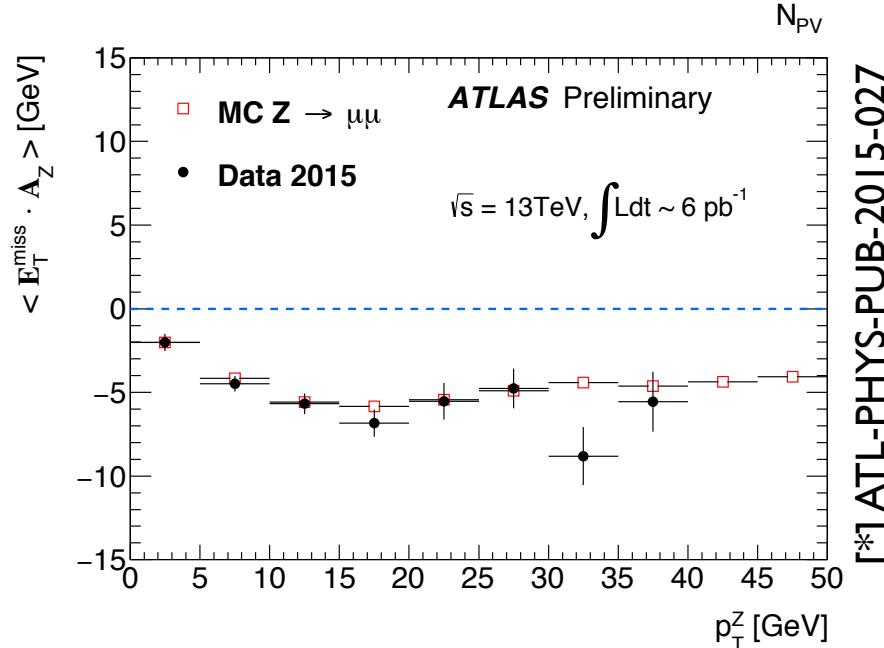
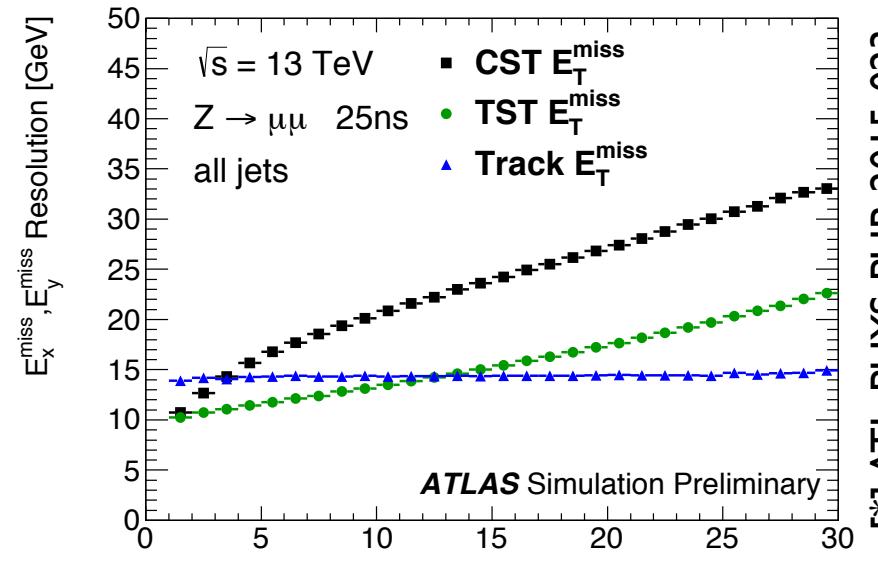
b-tagging Commissioning and Performance



- ▶ Algorithmic improvements and IBL yield a 4x increase in light-jet rejection in b-tagging algorithms
- ▶ Variables input to the b-tagging algorithm as well as output discriminant well described in top quark pair events

Reconstructing Missing Energy

- ▶ New way of reconstructing E_T^{miss} to reduce sensitivity of pile-up
- ▶ Use tracks for part of the event not associated to the hard objects (soft terms)
- ▶ Improved resolution without increasing bias on E_T^{miss} reconstruction
- ▶ Systematic uncertainties use MC simulations, but verifications in data show good agreement with MC

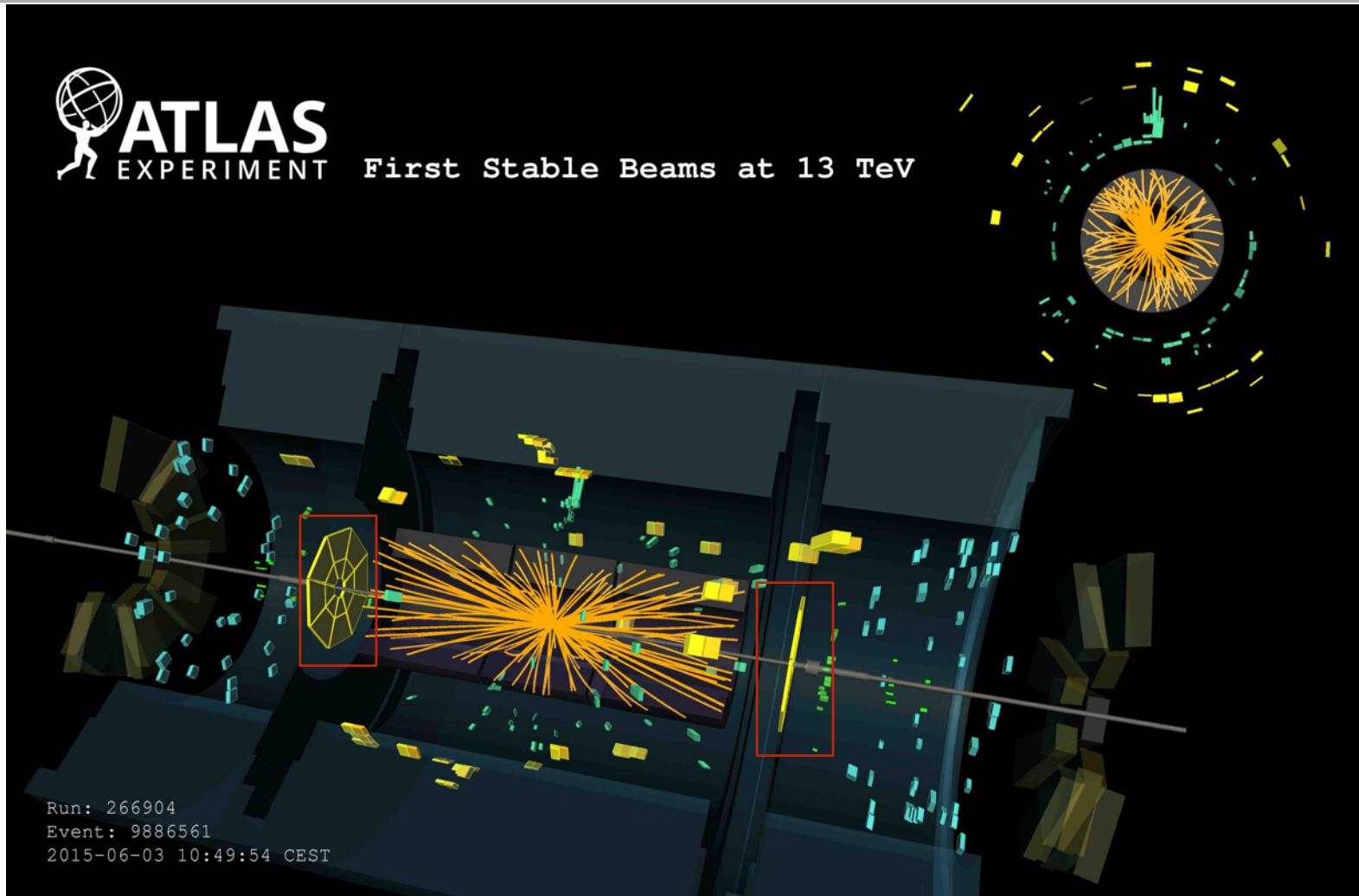


[*] ATL-PHYS-PUB-2015-023

[*] ATL-PHYS-PUB-2015-027

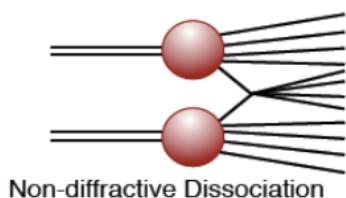
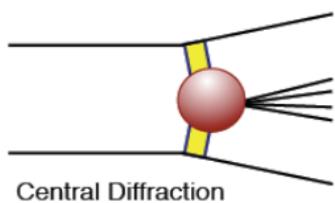
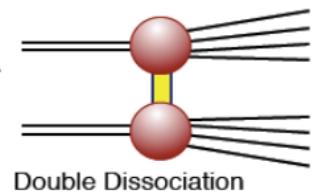
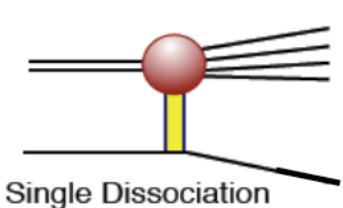
MEASUREMENTS

pp Cross Section and Soft QCD Measurements



- ▶ Trigger using one MBTS hit
- ▶ They use low luminosity run in June

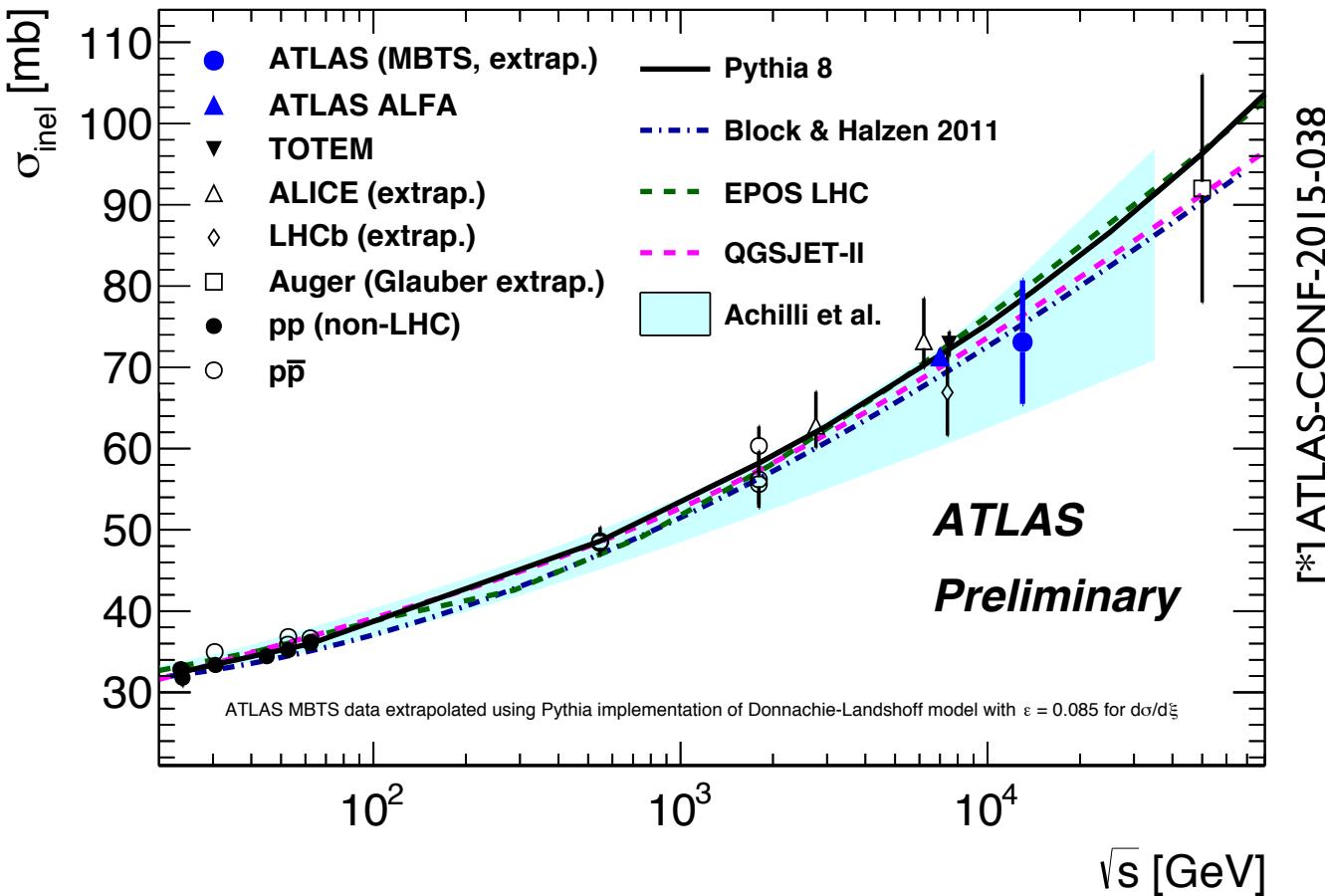
Inelastic pp Cross Section



$$\sigma_{\text{inel}}(\tilde{\xi} > 10^{-6}) = \frac{N - N_{\text{BG}}}{\epsilon_{\text{trig}} \times L} \times \frac{1 - f_{\tilde{\xi} < 10^{-6}}}{\epsilon_{\text{sel}}}$$

- ▶ MBTS coverage ($2.08 < |\eta| < 3.86$) defines fiducial region of the measurement ($M_X > 13 \text{ GeV}$)
- ▶ Measurement also extrapolated to $M_X = m_p$
- ▶ Counting experiment with highly efficient trigger
- ▶ Diffractive component estimated using events triggered by one side MBTS hits only (affects ϵ_{sel} and extrapolation out of fiducial region)

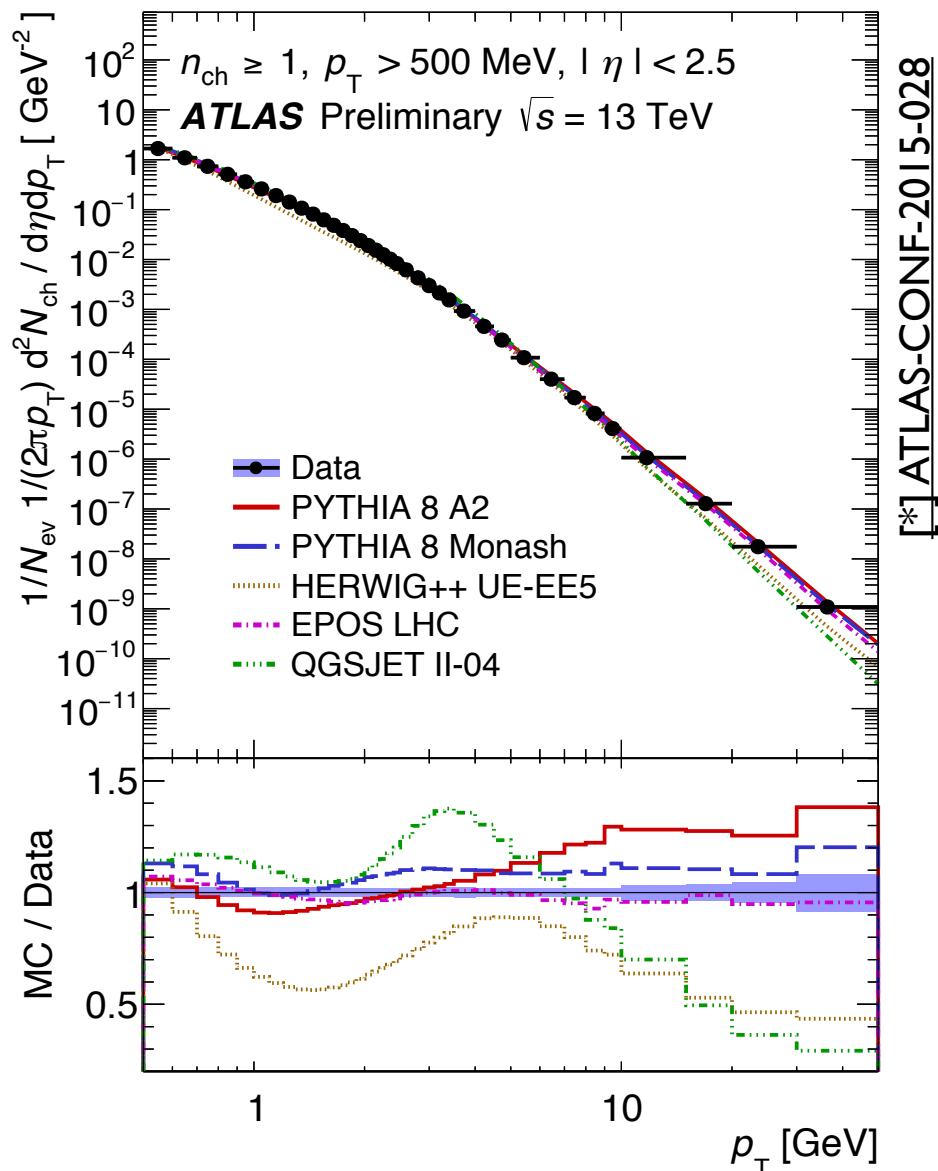
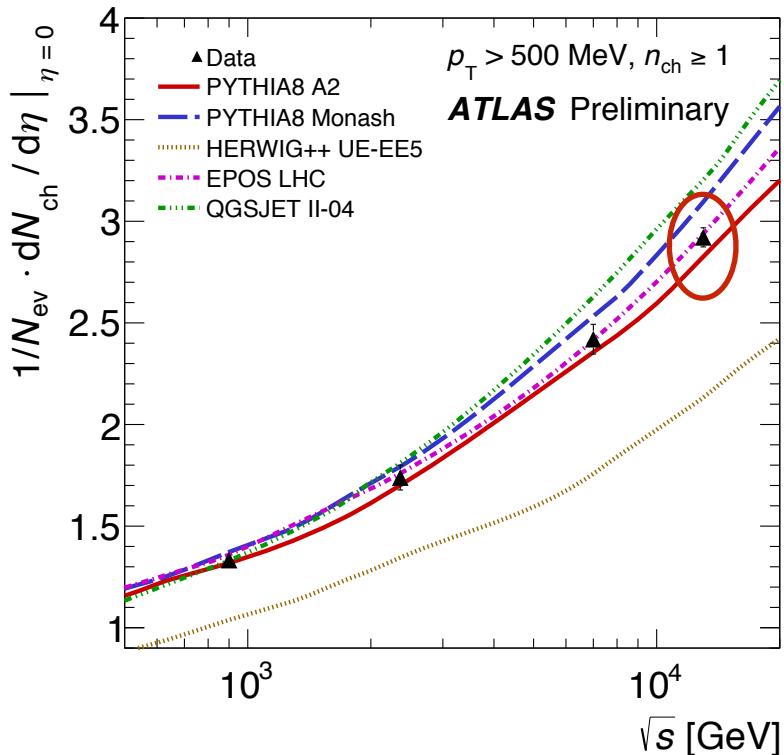
Inelastic pp Cross Section



$$\sigma_{\text{fid}} = 65.2 \pm 0.8 \text{ (exp.)} \pm 5.9 \text{ (lum.) mb}$$

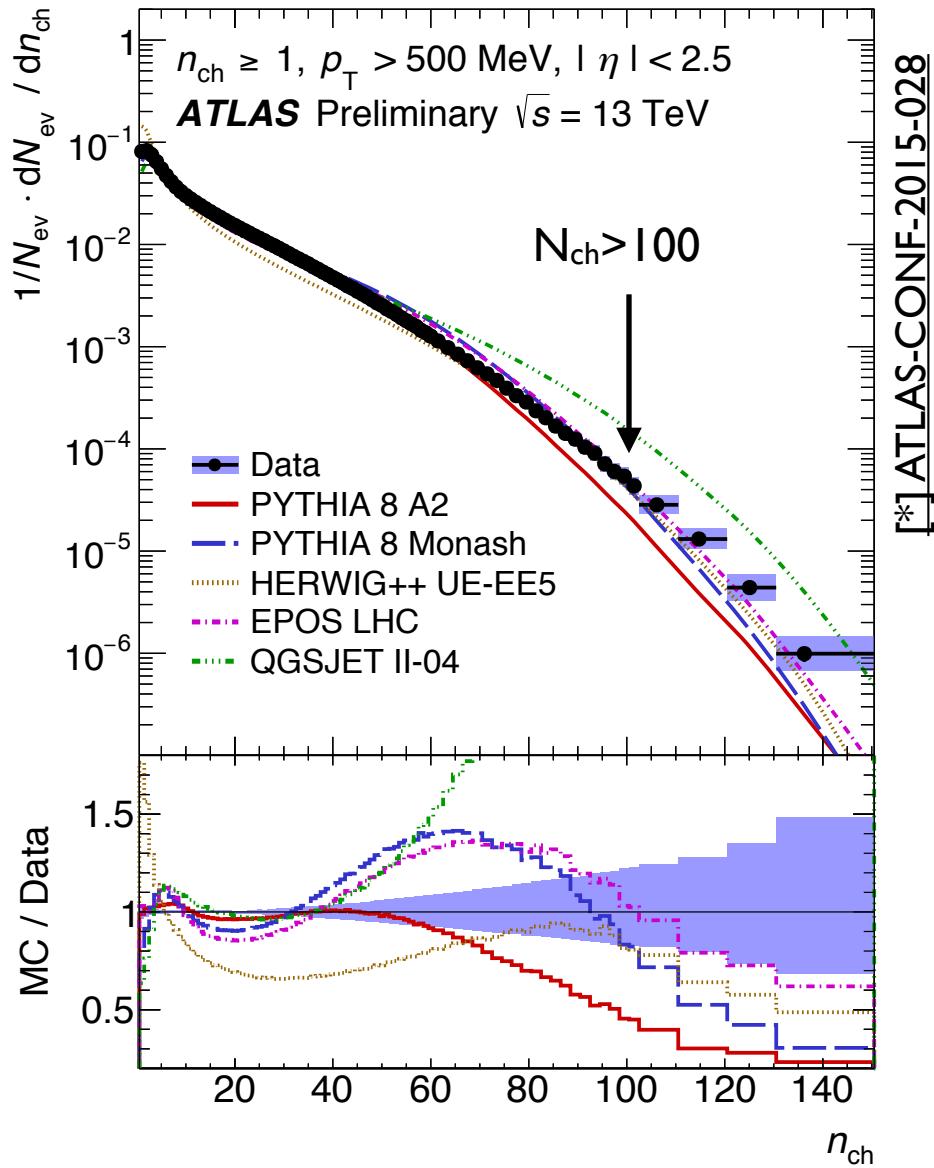
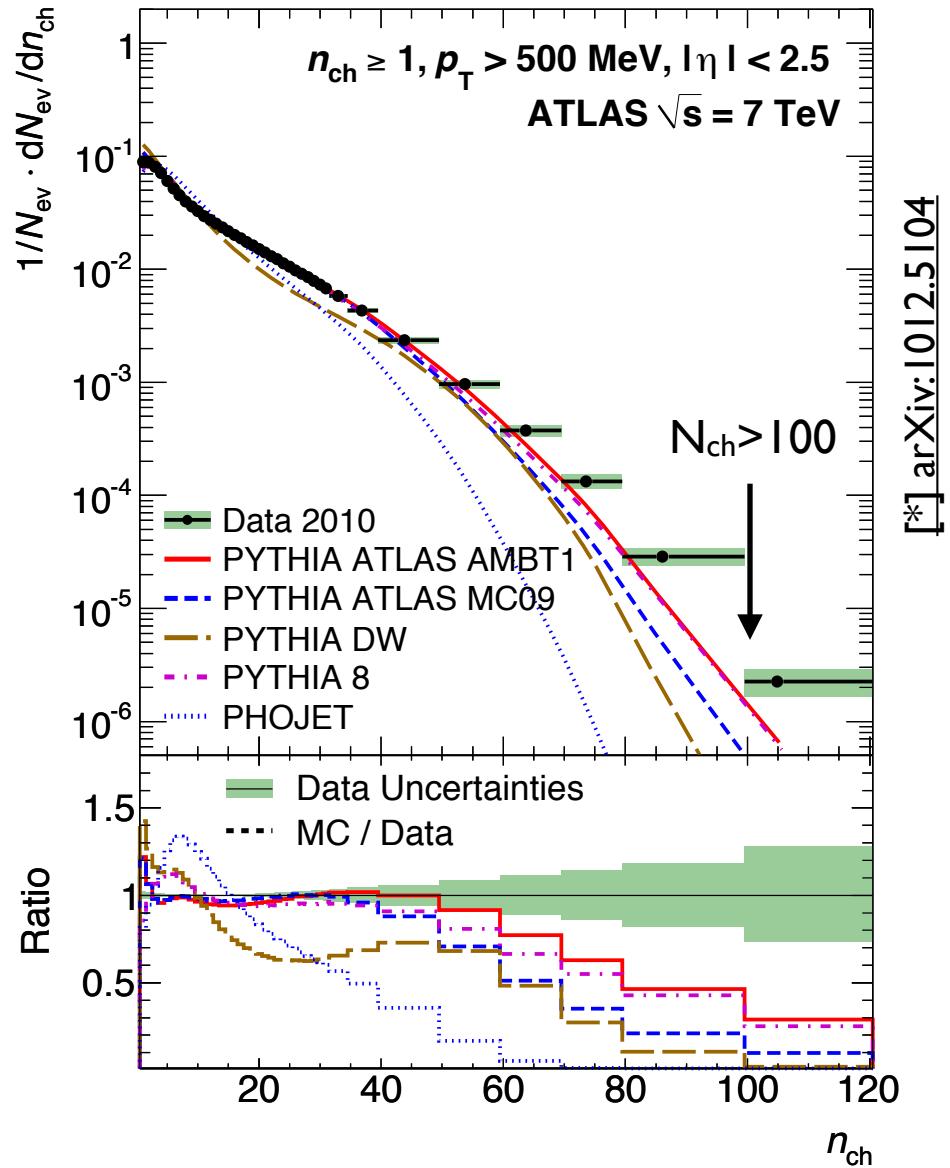
$$\sigma_{\text{inel}} = 73.1 \pm 0.9 \text{ (exp.)} \pm 6.6 \text{ (lum.)} \pm 3.8 \text{ (extr.) mb}$$

Minimum Bias Charged Particle Multiplicities

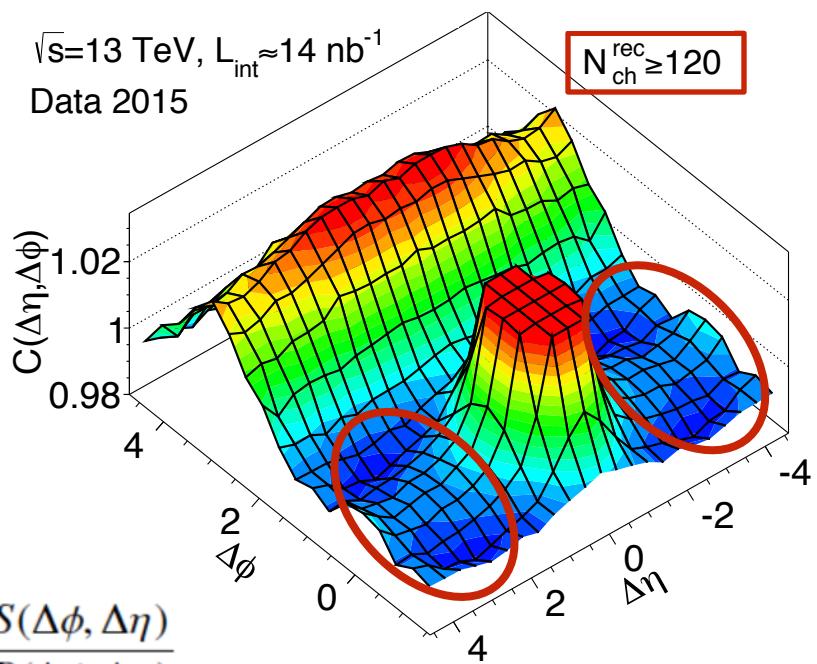
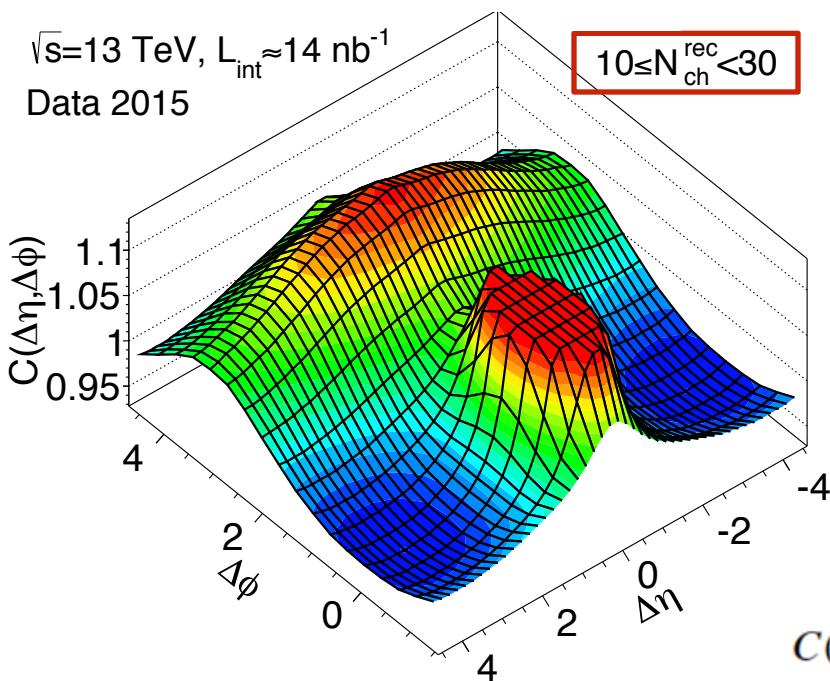


- ▶ Tracking requirements:
 - At least one track with $p_T > 500 \text{ MeV}$
 - Exactly one vertex with 2 tracks of $p_T > 100 \text{ MeV}$
- ▶ Data reasonably described by EPOS and Pythia tunes
- ▶ Additional measurements of underlying event (ATL-PHYS-PUB-2015-019)

Minimum Bias Charged Particle Multiplicities



Long-range Correlations: the “Ridge”



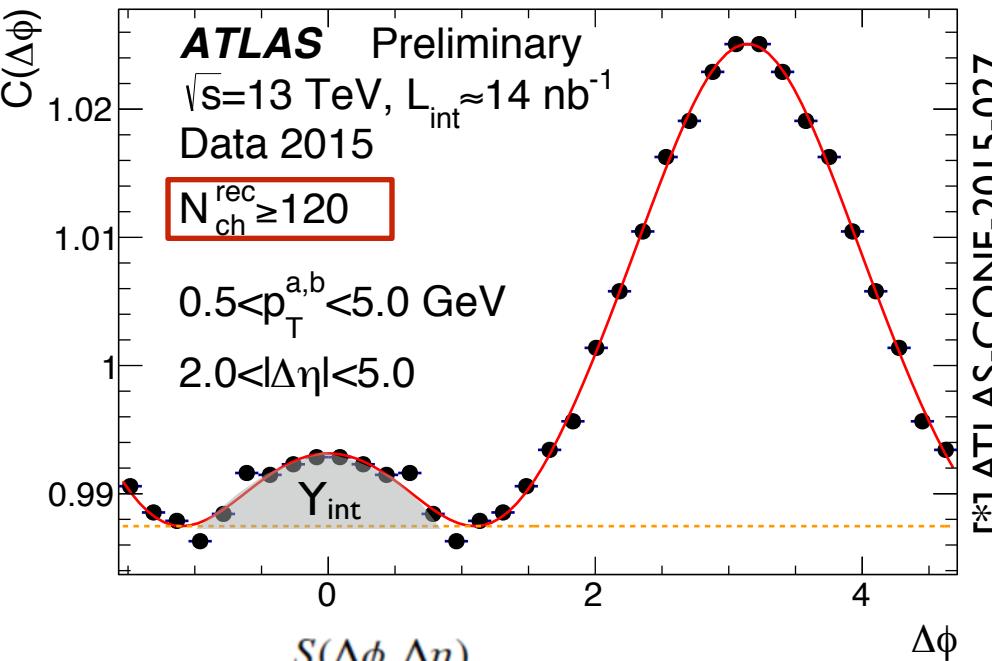
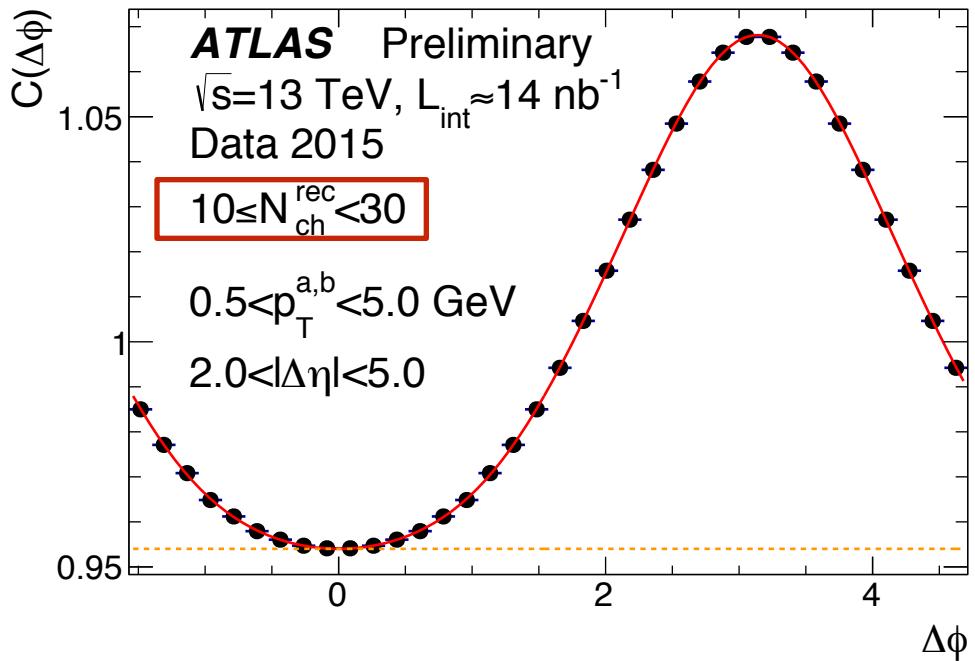
$$C(\Delta\eta, \Delta\phi) = \frac{S(\Delta\phi, \Delta\eta)}{B(\Delta\phi, \Delta\eta)}$$

S=same event

B=mixed event (proxy for no correlation)

- ▶ High N_{ch} events show correlations at large $\Delta\eta$ and $\Delta\phi=0$
- ▶ Effect present strongly in p-A and A-A collisions
- ▶ First observed on p-p collisions by CMS at $\sqrt{s}=7 \text{ TeV}$

Long-range Correlations: the “Ridge”



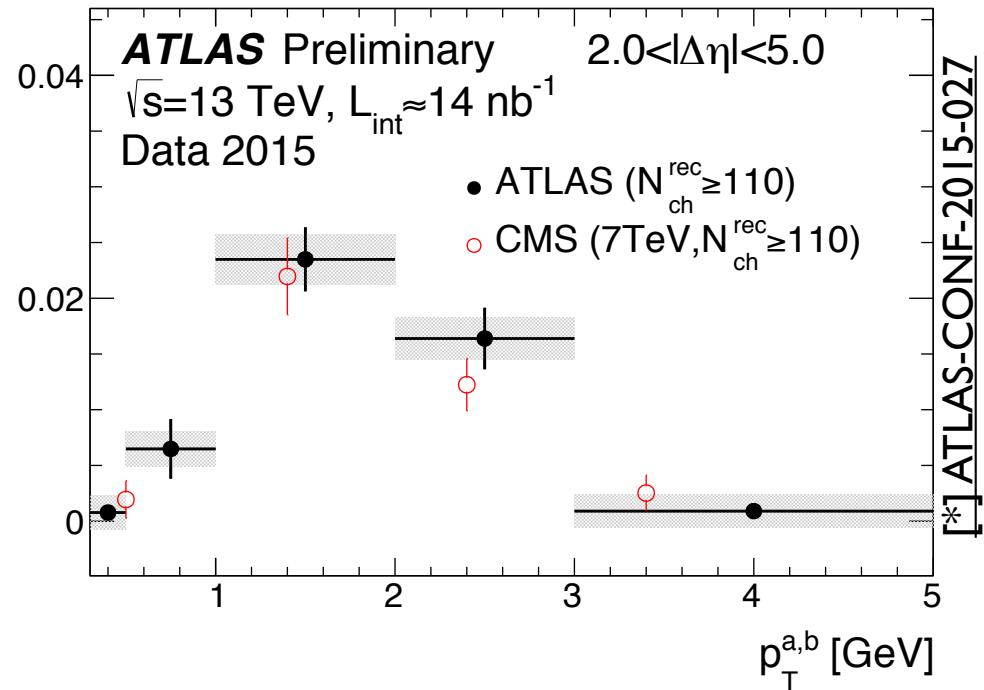
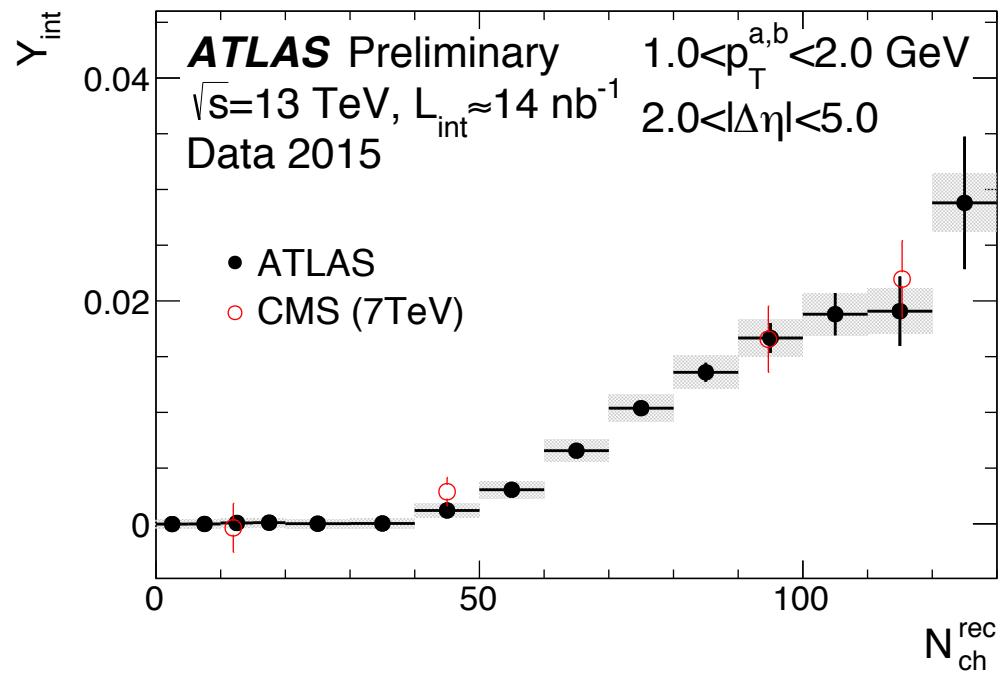
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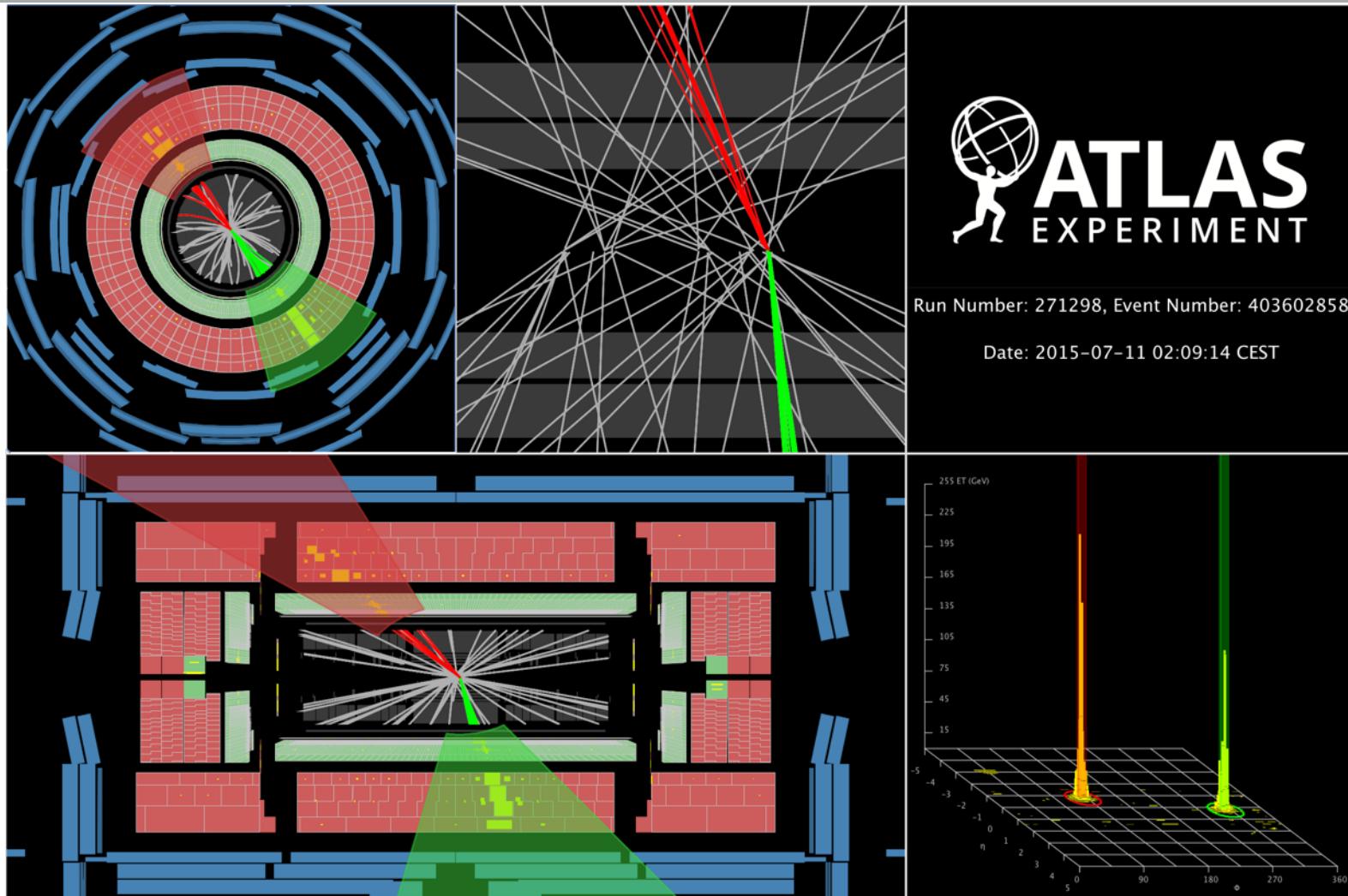
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The Ridge at $\sqrt{s}=13$ TeV



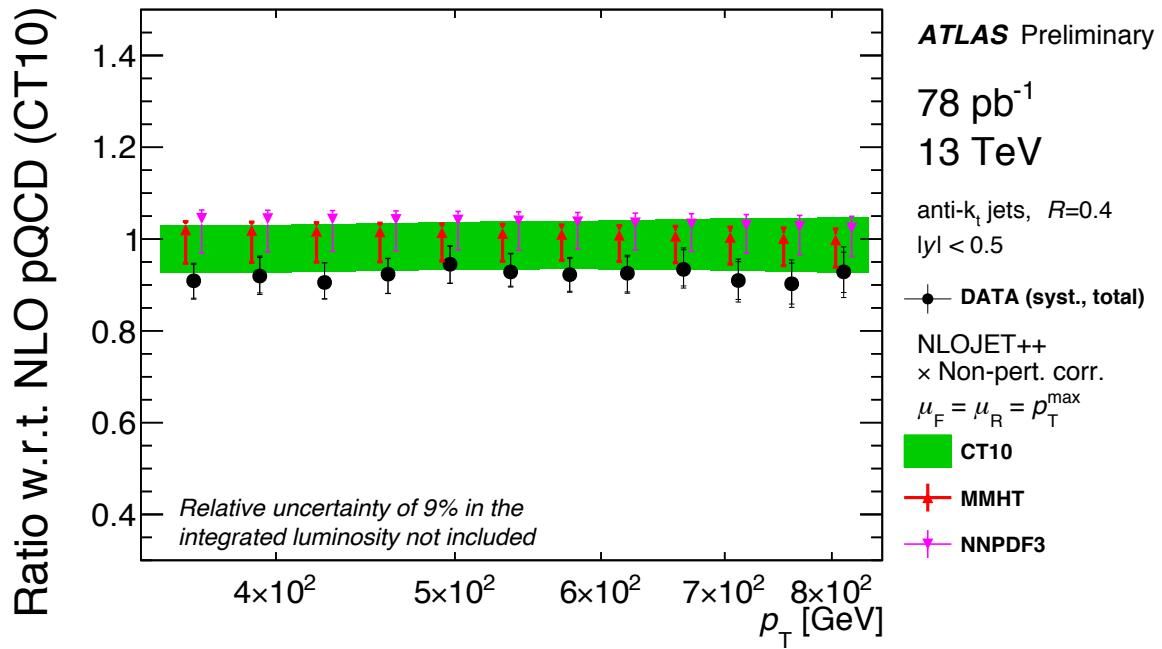
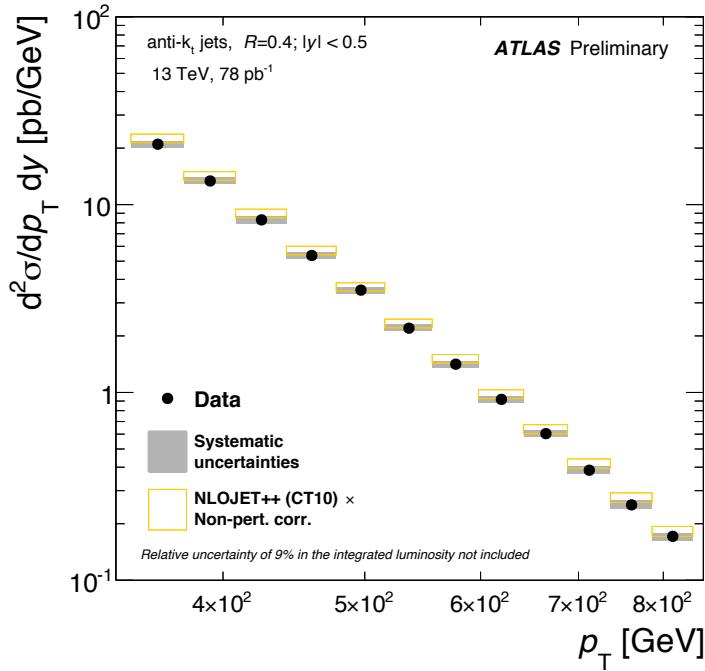
- ▶ Very large increase in statistics
- ▶ Size of ridge independent of center-of-mass energy, only dependent on N_{ch}

Inclusive Jet Cross Section Measurement



- ▶ Counting experiment using lowest- p_T unprescaled single-jet trigger
- ▶ Focus on area of the detector with lowest jet uncertainties ($|y|<0.5$)

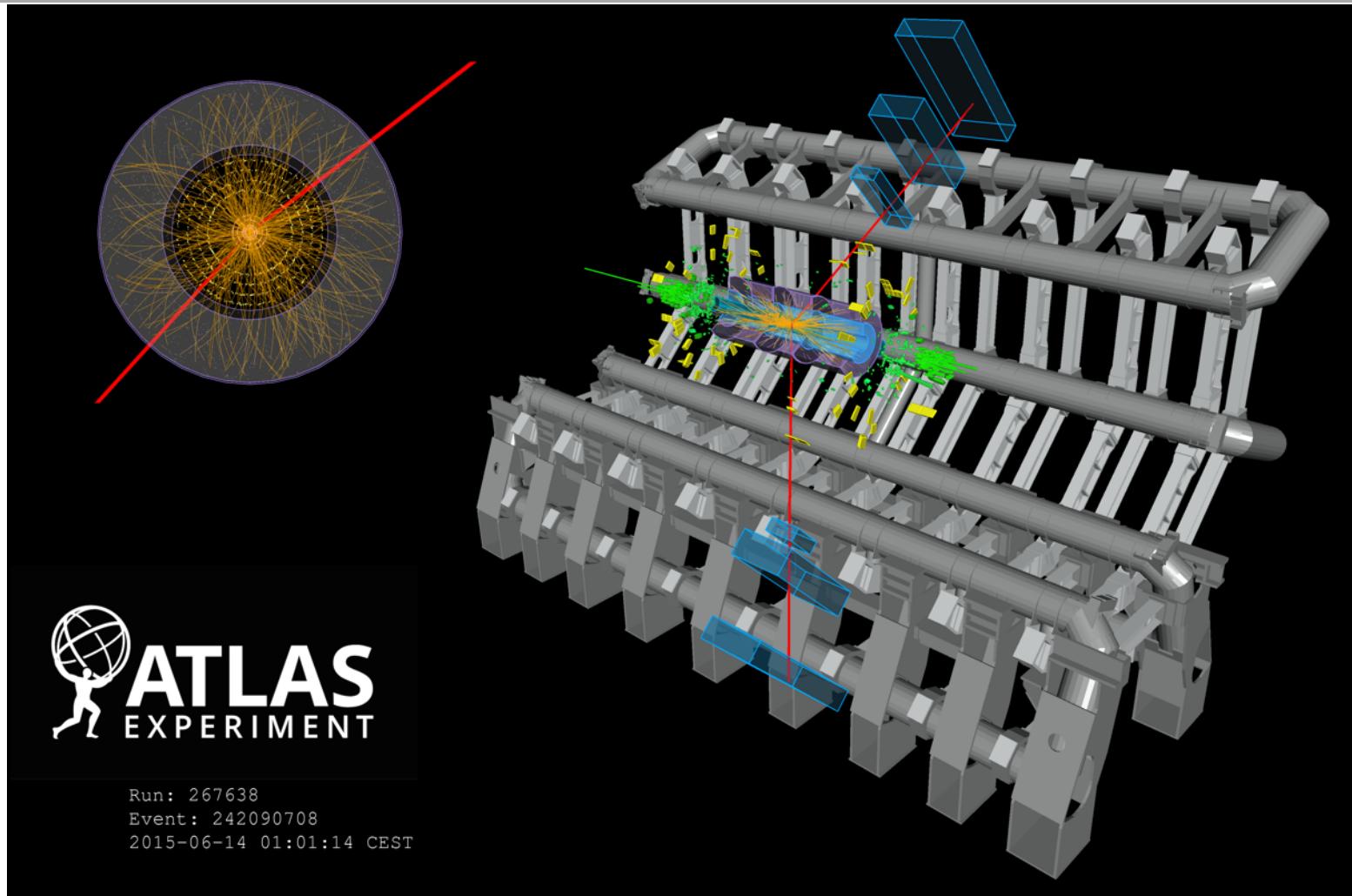
Inclusive Jet Cross Section Measurement



[*] ATLAS-CONF-2015-034

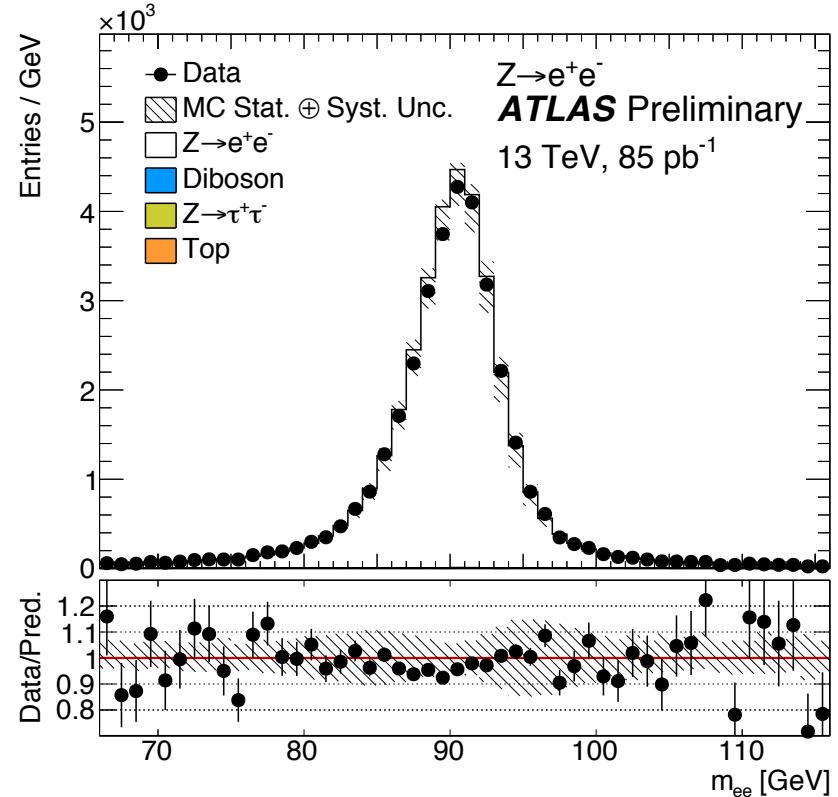
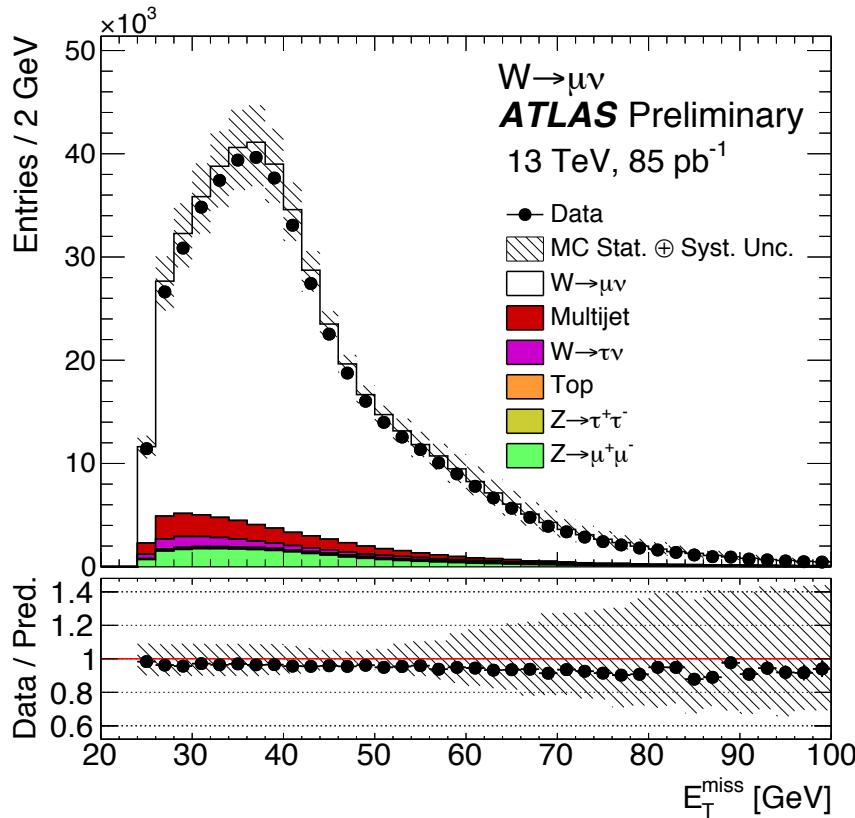
- ▶ Good agreement with fixed-order NLO calculation and several PDFs
- ▶ Systematic uncertainties dominated by luminosity (9%) and already comparable to uncertainties in fixed-order calculation
- ▶ Measurements of photon+jet production also in progress (see [ATL-PHYS-PUB-2015-016](#))

W and Z Cross Section Measurements



- ▶ Isolated electrons or muons, $p_T > 25 \text{ GeV}$
- ▶ W bosons
 - $E_T^{\text{miss}} > 25 \text{ GeV}$
 - $m_T > 50 \text{ GeV}$
- ▶ Z bosons: opposite-sign leptons with $66 < m_{\ell\ell} < 116 \text{ GeV}$

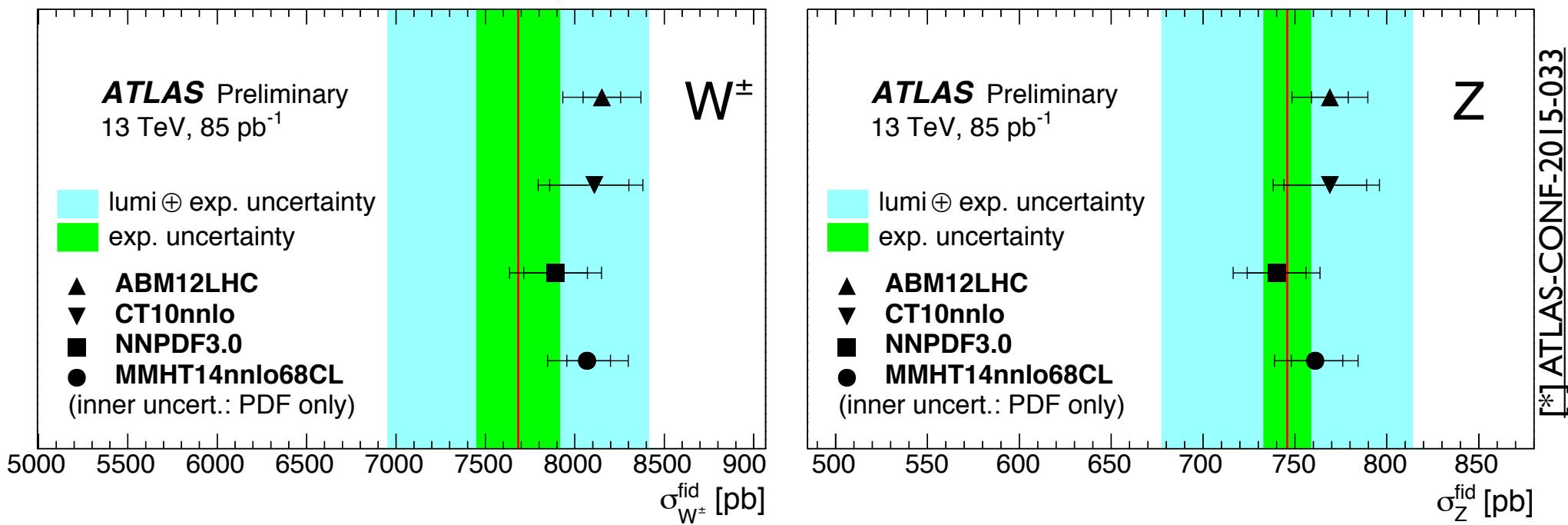
W and Z Cross Section Measurements



[*]ATLAS-CONF-2015-039

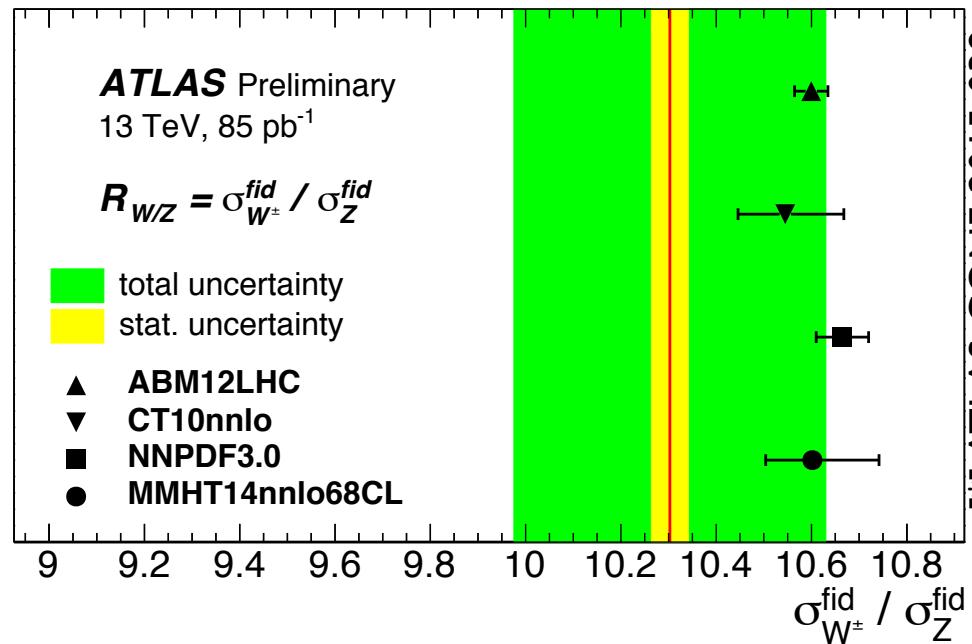
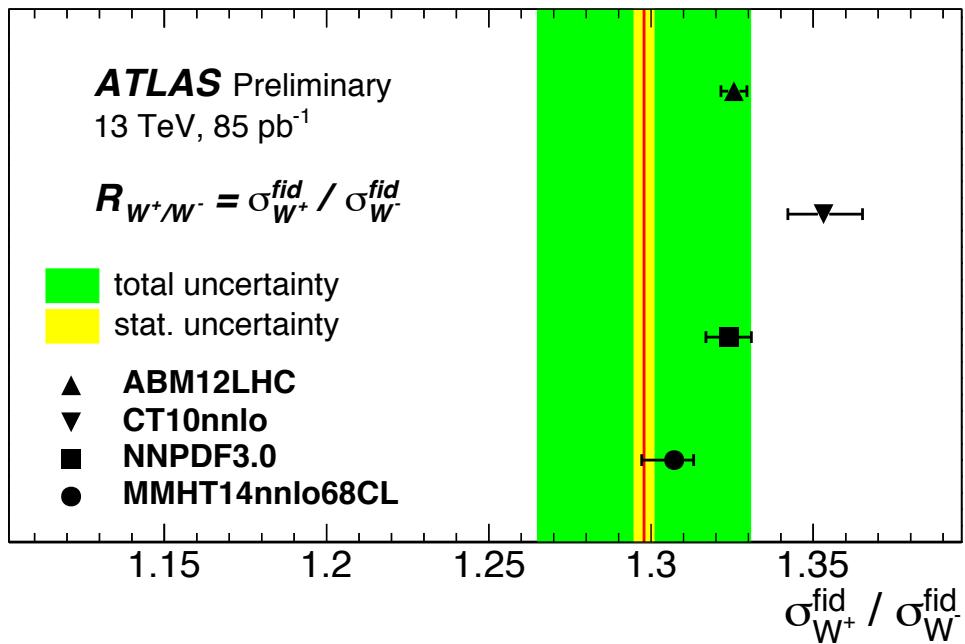
- ▶ About 1 million W candidates selected and 100k Z candidates
- ▶ Measure fiducial cross section and total cross section
- ▶ Systematic uncertainties dominated by luminosity (and then lepton efficiencies and backgrounds and jet energy scale for the W measurement)

W and Z Cross Section Measurements



- ▶ Measurements consistent with NNLO predictions with different PDFs
- ▶ Measurement uncertainties without luminosity already of the same magnitude as theoretical uncertainties!

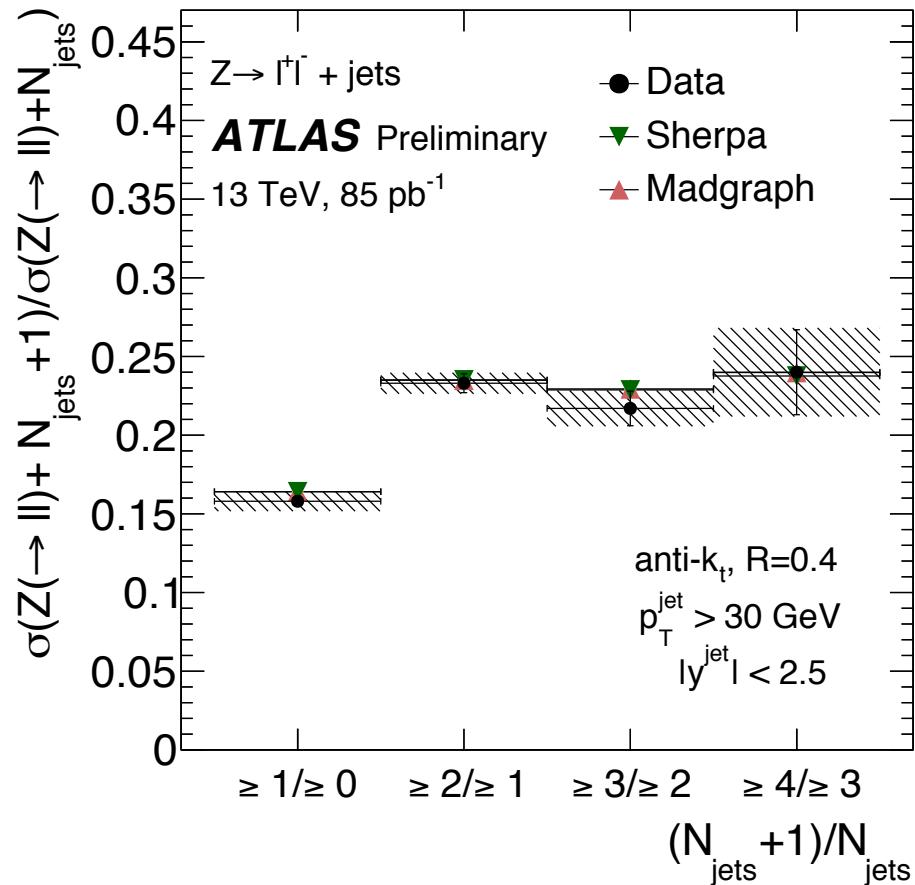
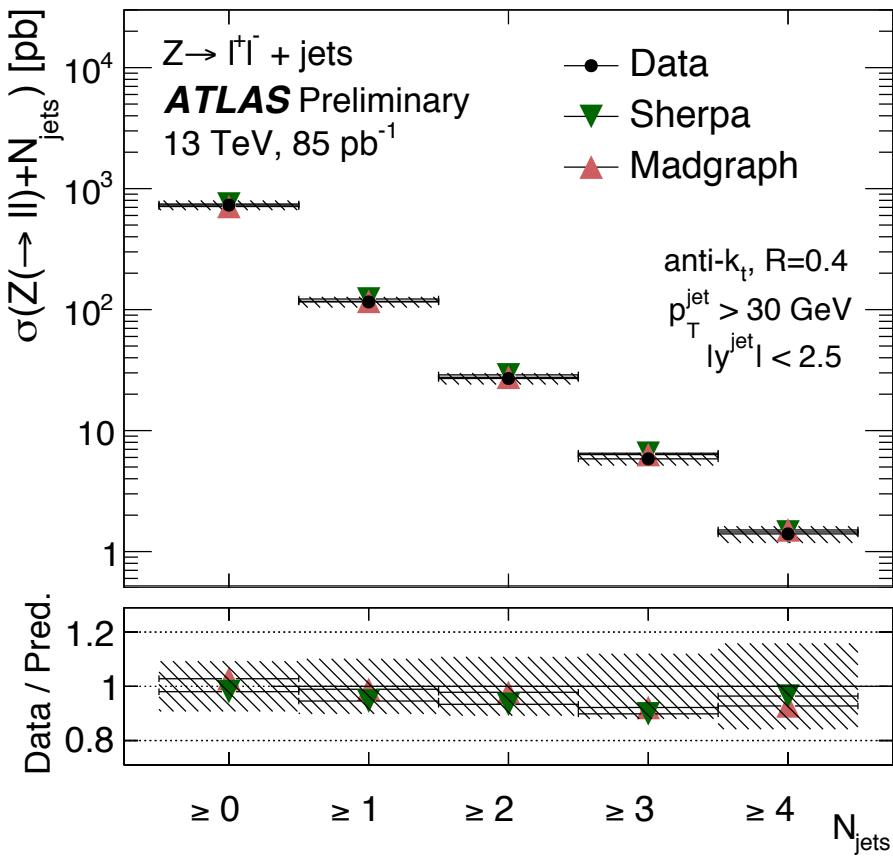
W/Z Cross Section Ratios



[*] ATLAS-CONF-2015-039

- ▶ Cross section ratios cancel main systematic uncertainty (luminosity)
- ▶ Statistical uncertainties much smaller than systematics, uncertainties of ~3%
- ▶ Measurements agree with various PDFs

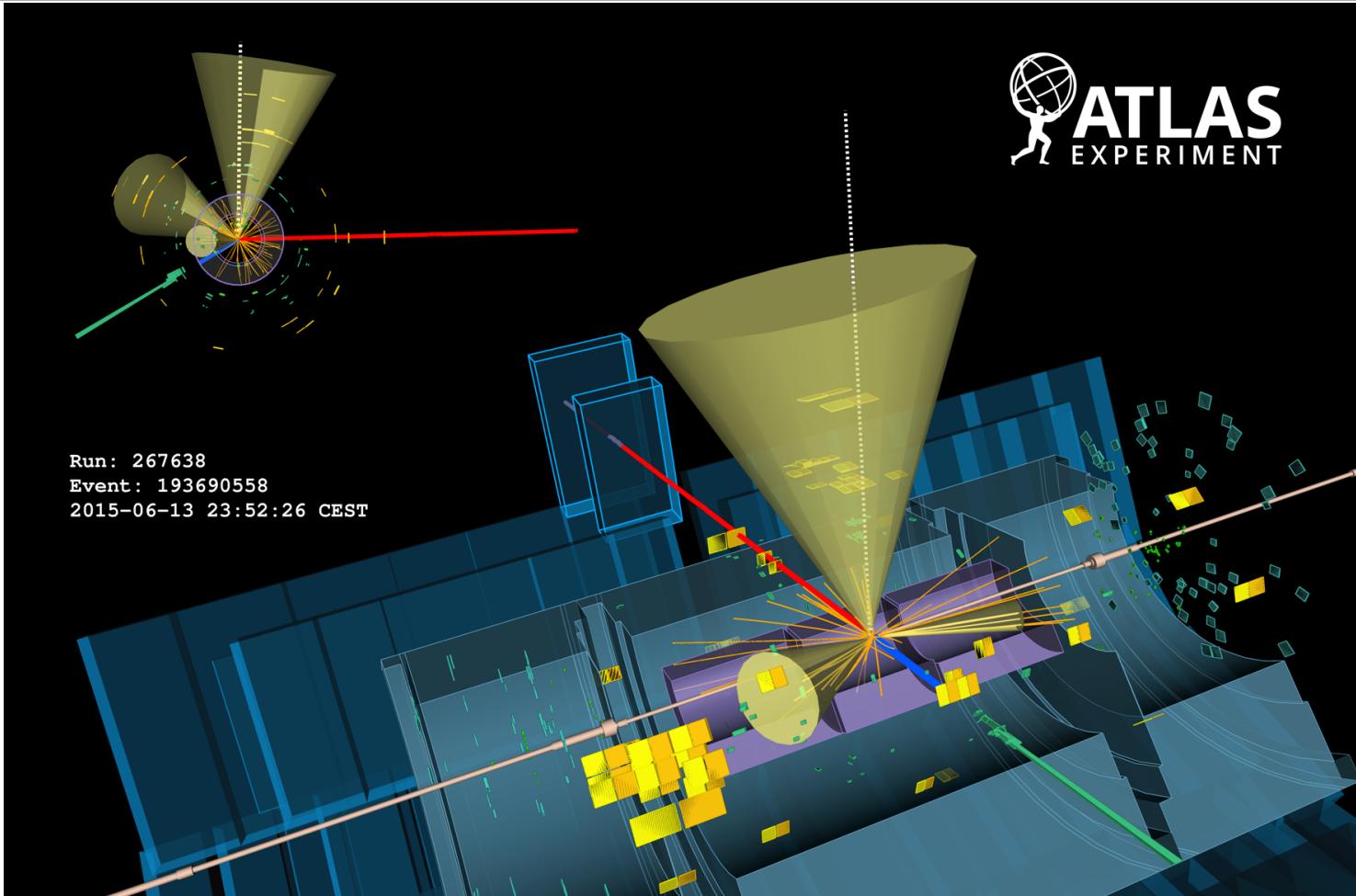
Z+jets Cross Section



[*] ATLAS-CONF-2015-041

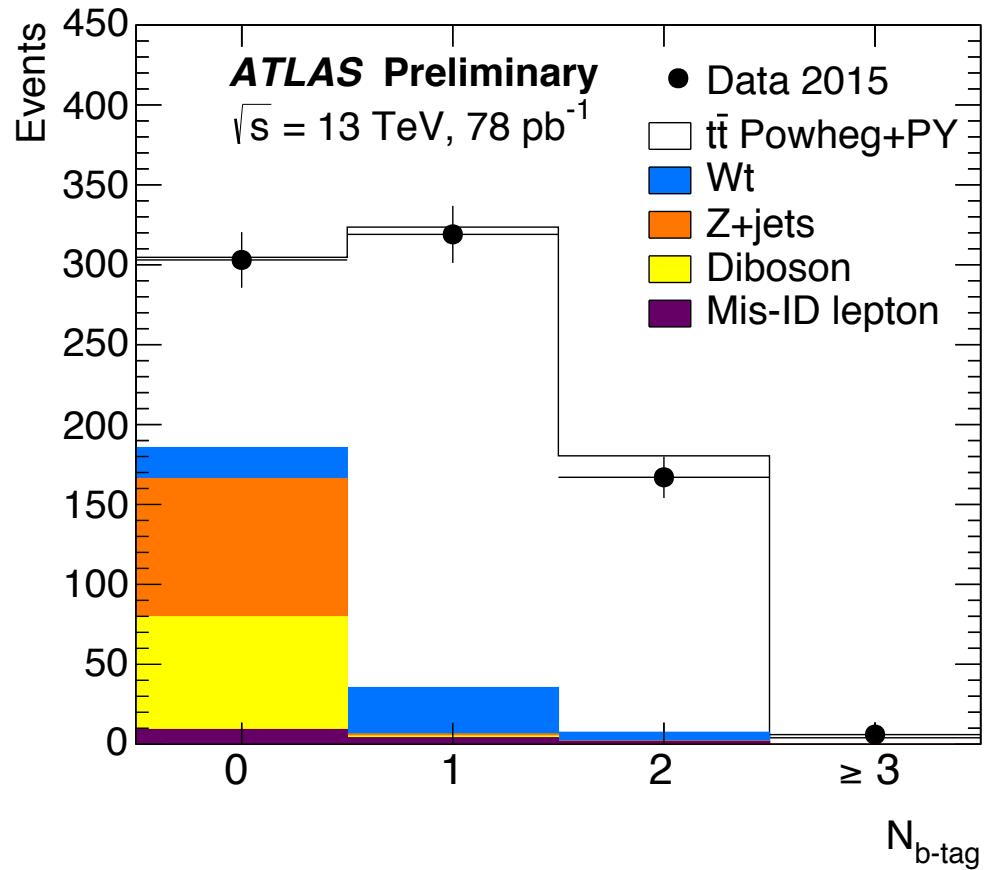
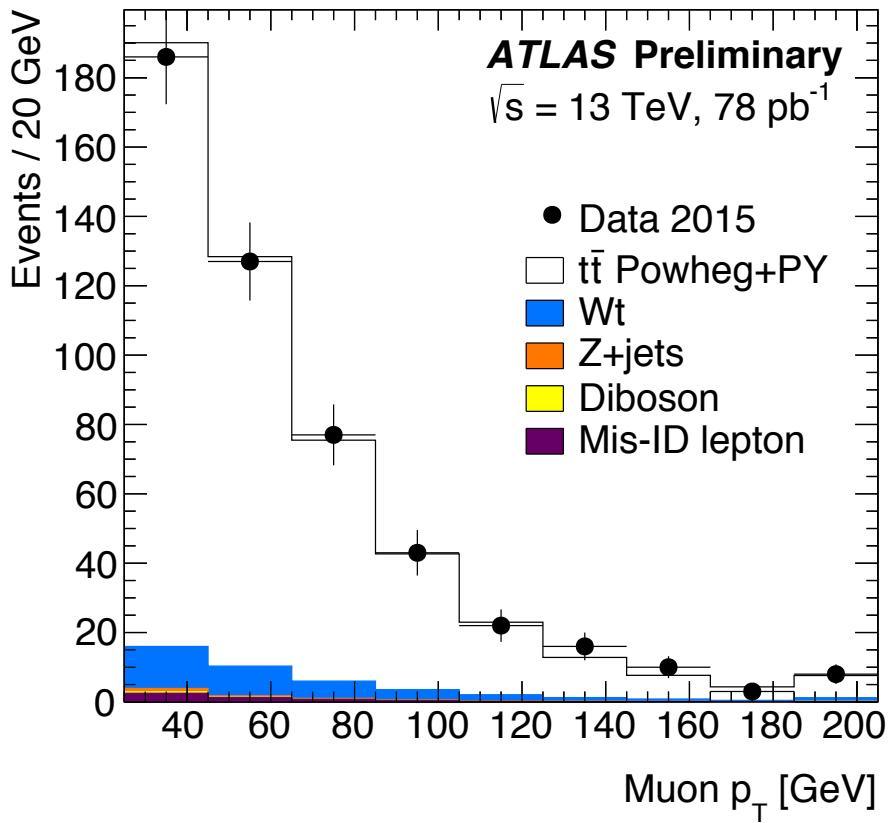
- ▶ Cross section measured with uncertainty of 10-15% up to $N_{\text{jet}} \geq 4$, luminosity is the dominant uncertainty
- ▶ Cross section ratios measured within less than 5%, where enough statistical power

$t\bar{t}$ Production



- ▶ Isolated electron and muon, $p_T > 25$ GeV
- ▶ 1 or 2 b-jets, $p_T > 25$ GeV

t̄t Production



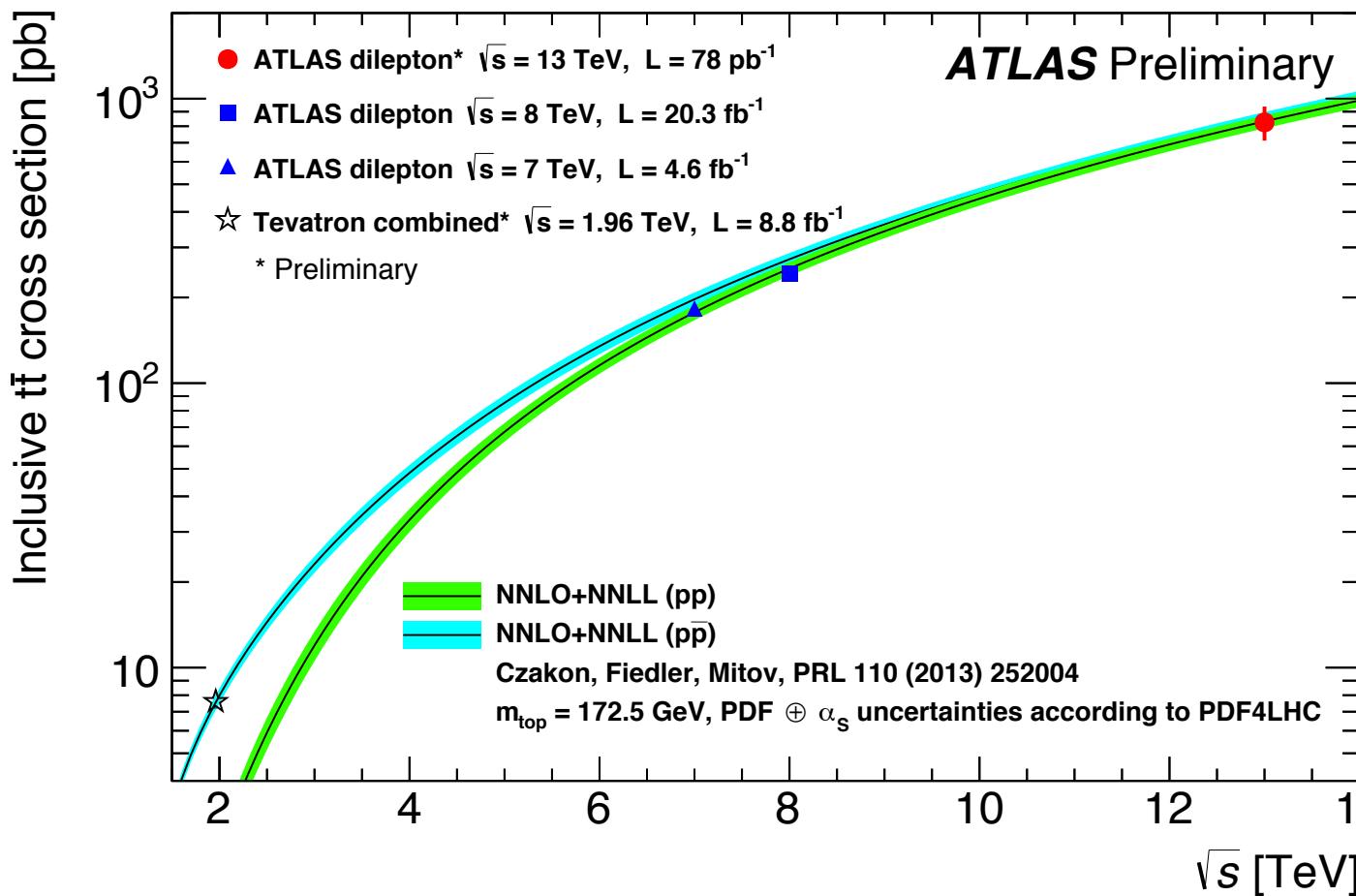
[*]ATLAS-CONF-2015-033

- ▶ Very low background
- ▶ Use of 1 b-jet and 2 b-jet regions allows to measure b-tagging efficiency times acceptance (ϵ_b) at the same time

$$\epsilon_b^{\text{data}} = 52.7 \pm 2.6(\text{stat.}) \pm 0.6(\text{syst.})\%$$

$$\epsilon_b^{\text{MC}} = 54.3\%$$

t̄t Cross Section Measurement

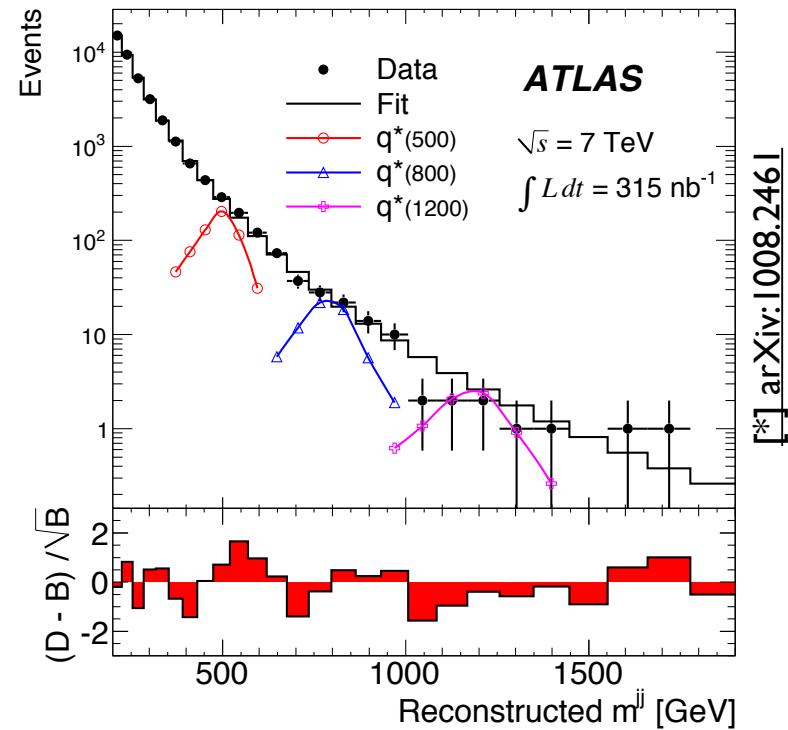


$$\sigma_{tt} = 825 \pm 49 \text{ (stat.)} \pm 60 \text{ (syst.)} \pm 83 \text{ (lumi.) pb}$$

SEARCHES

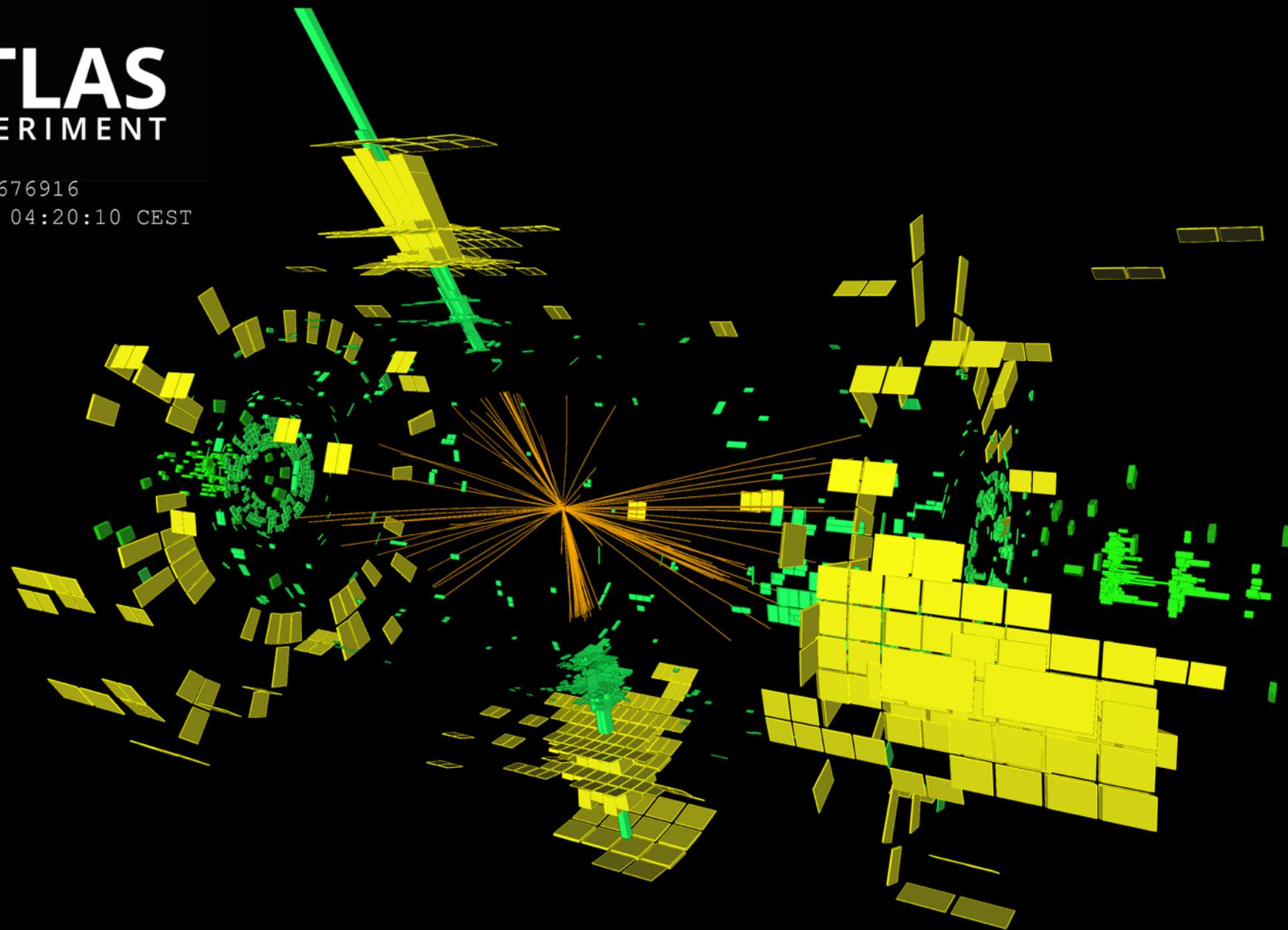
Early Searches and Models

- ▶ Good understanding of detector and backgrounds builds confidence that we can find new physics
- ▶ Black hole production in models with extra dimensions see a very large increase in production cross section
- ▶ Sensitivity to excited quarks and contact interactions does not yet extend beyond our Run I limits

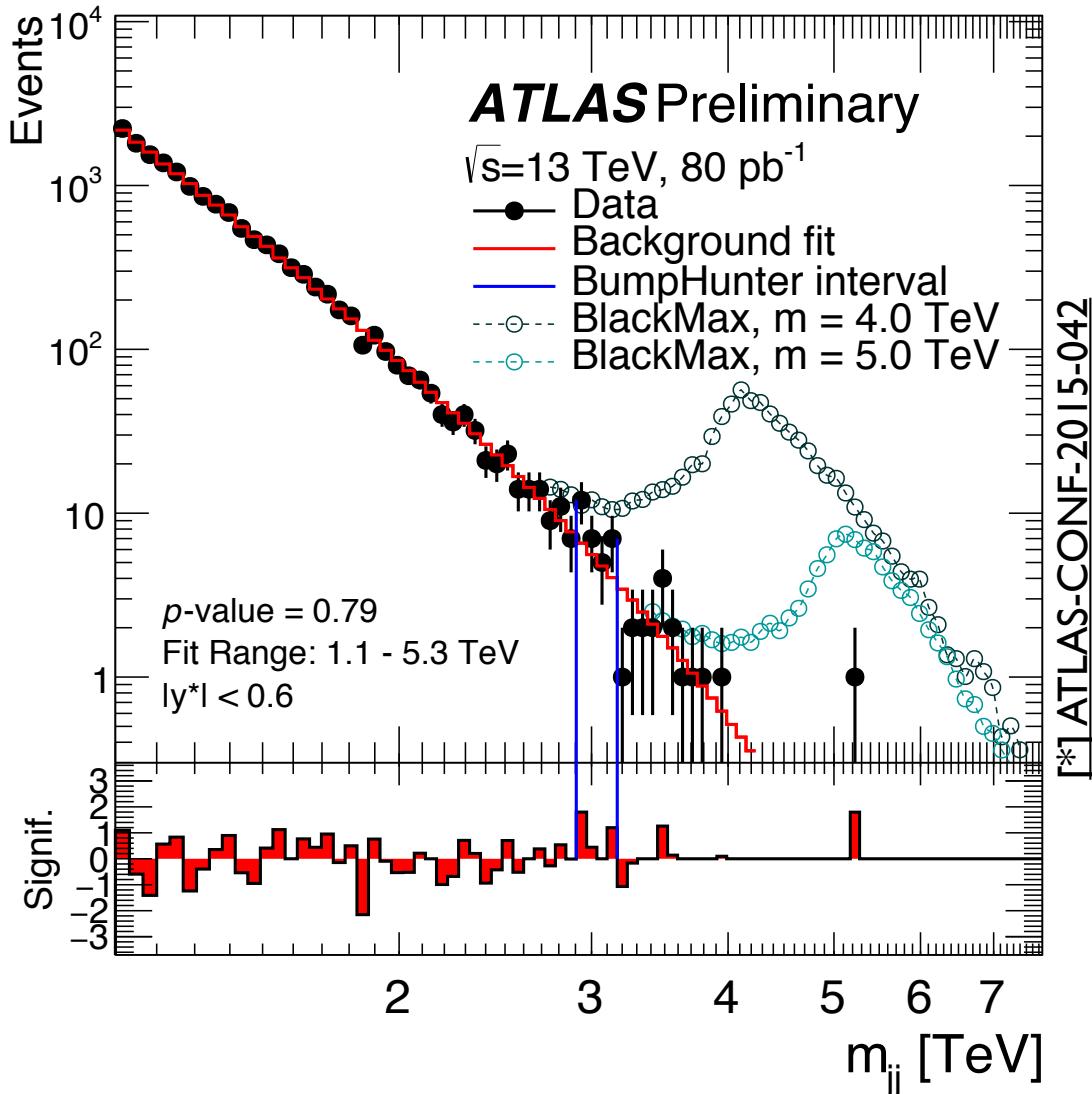




Event: 531676916
2015-08-22 04:20:10 CEST



Searches in Dijet Final States (Resonant)



- ▶ Use m_{jj} distribution
 - ▶ $|y^*| = |y_1 - y_2|/2 < 0.6$
 - ▶ $m_{jj} > 1100 \text{ GeV}$
 - ▶ Fit bkg to: $p_1(1-x)^{p_2}x^{p_3}$
- No significant deviations observed

Searches in Dijet Final States (Non-Resonant)

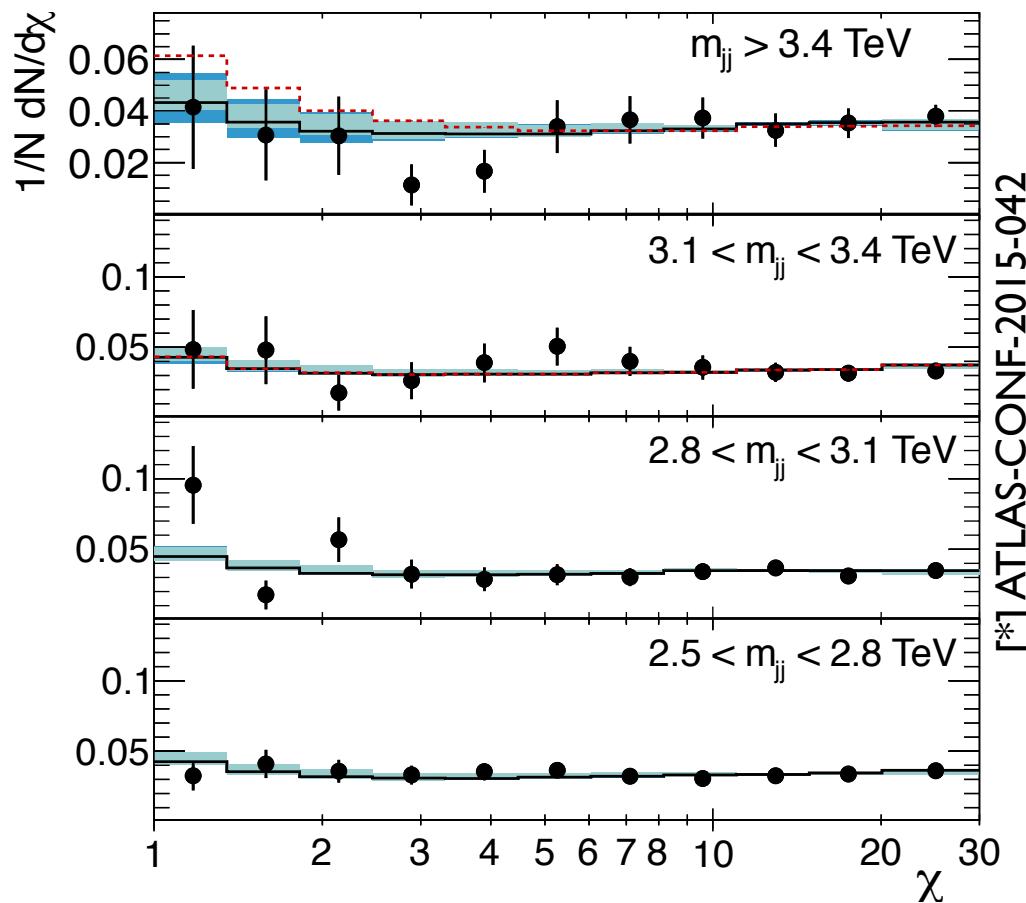
$\sqrt{s} = 13 \text{ TeV}, 80 \text{ pb}^{-1}$

- Data
- QBH, $M_{\text{th}} = 6.5 \text{ TeV}$

ATLAS Preliminary

- SM
- Theoretical uncert.
- Total uncertainties

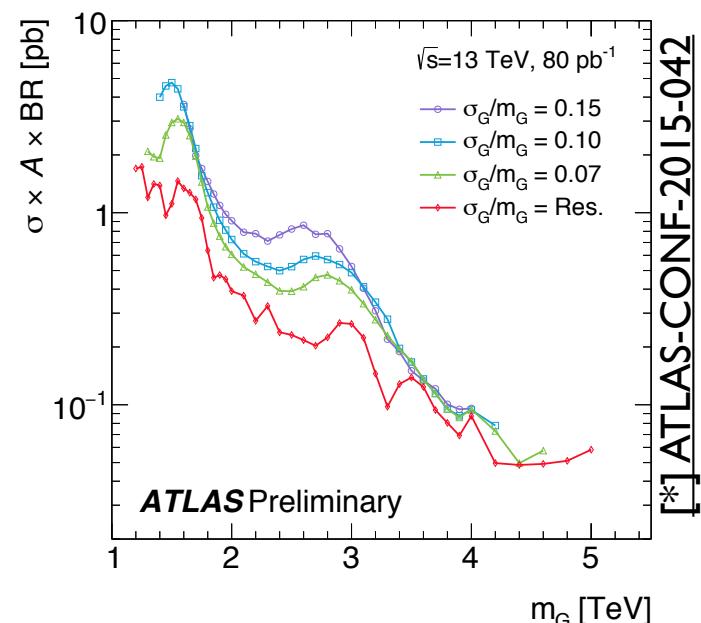
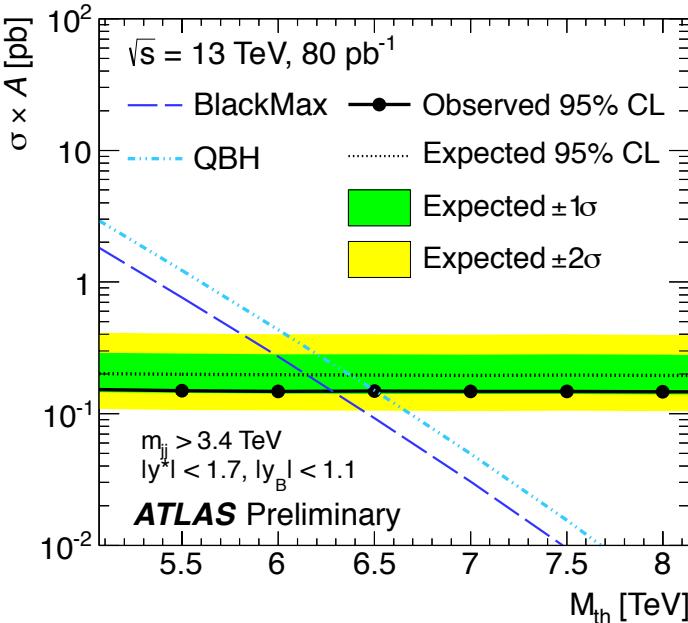
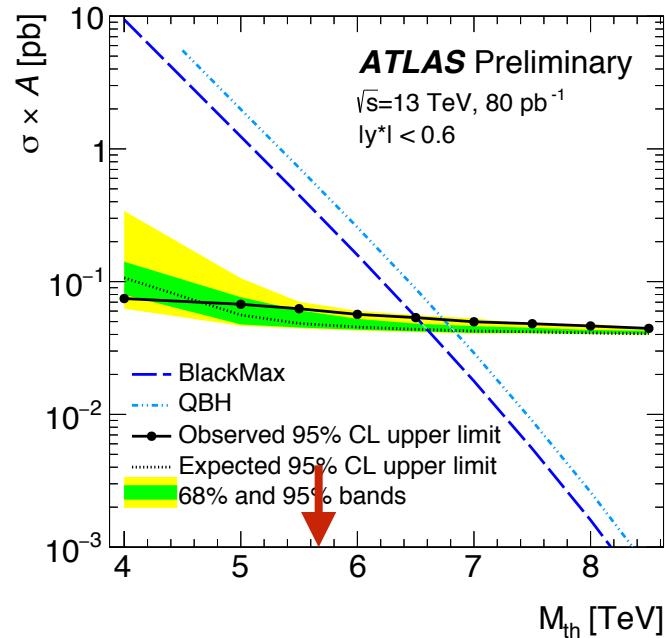
$|y^*| < 1.7, |y_B| < 1.1$



$$\chi = e^{2|y^*|}$$

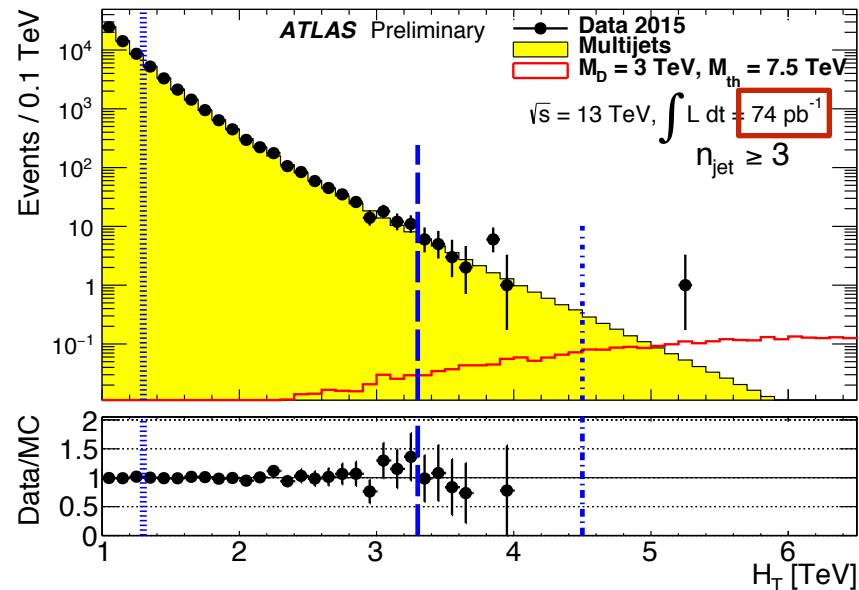
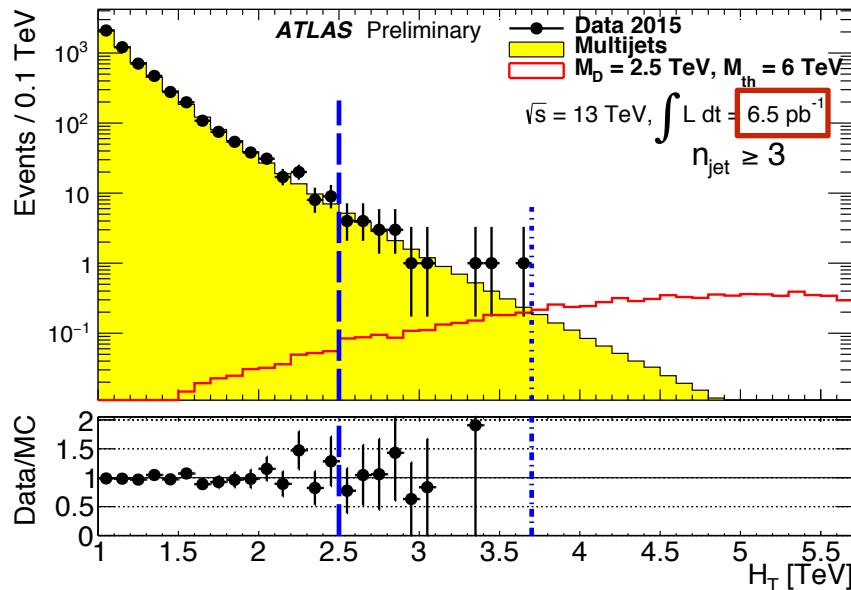
- ▶ Use χ distribution
- ▶ $|y^*| < 1.7, |y_B| = (y_1 + y_2)/2 < 1.1$
- ▶ $m_{jj} > 2500 \text{ GeV}$
- ▶ Bkg estimate from NLO prediction+EW corrections
- ▶ No significant deviations observed

Summary of Limits (Dijet Searches)



- ▶ Limits on M_{th} of about 6.5 TeV, depending on model, a 1 TeV improvement with respect to Run I limits
- ▶ Model-independent limits on resonant cross section weaker than in Run I, but extending to masses of up to 1 TeV higher ($\sim 5 \text{ TeV}$)

Search in Multijet Final States

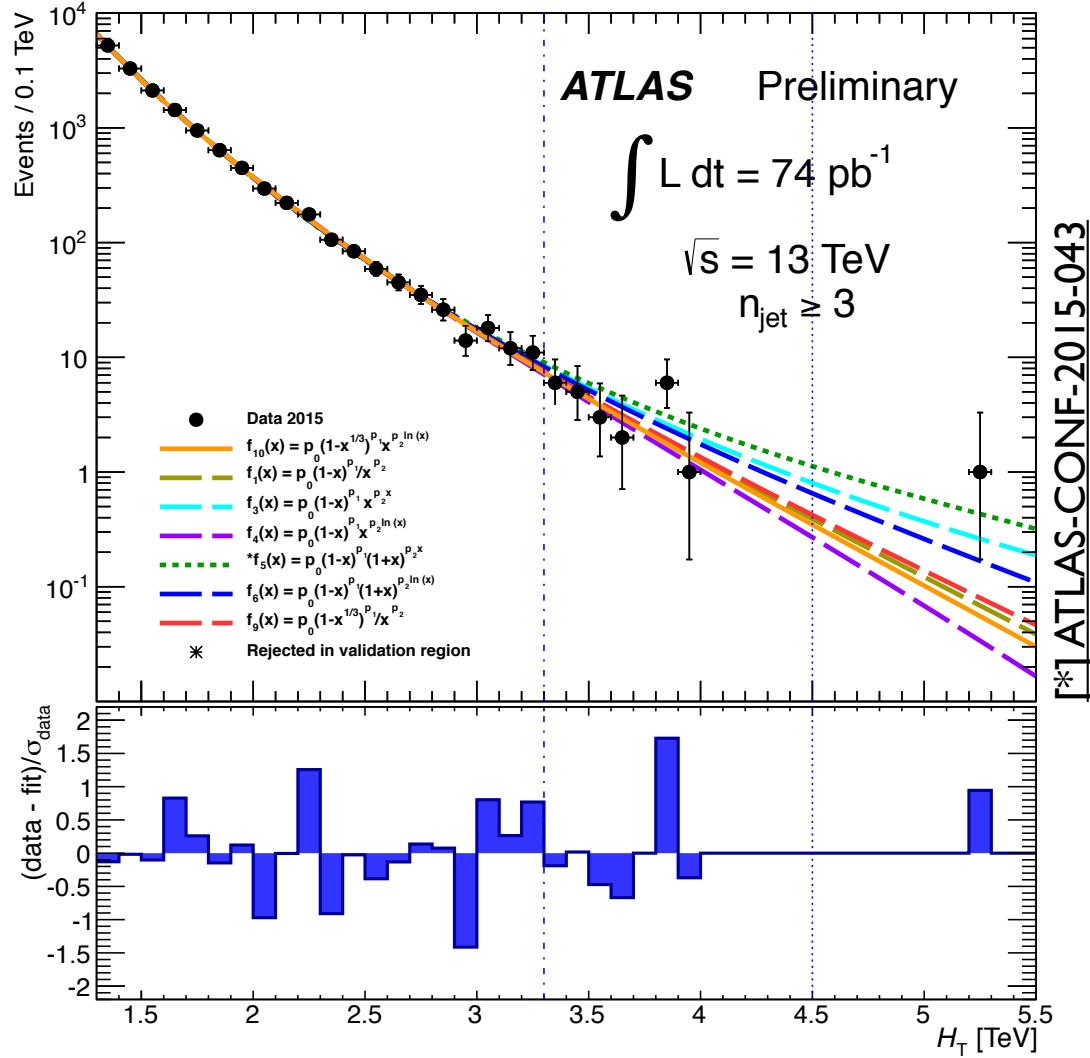


[*] ATLAS-CONF-2015-043

- Analysis uses H_T (scalar sum of p_T of all jets of $p_T > 50 \text{ GeV}$) and fit to the data in bins of $N_{\text{jets}} \geq 3, 4, 5, 6, 7$ and 8
- Control region defined in small set of data (6 pb^{-1}) according to exclusion limits from Run I, then expanded on the rest of the data (74 pb^{-1}), based on exclusion obtained on 6 pb^{-1}

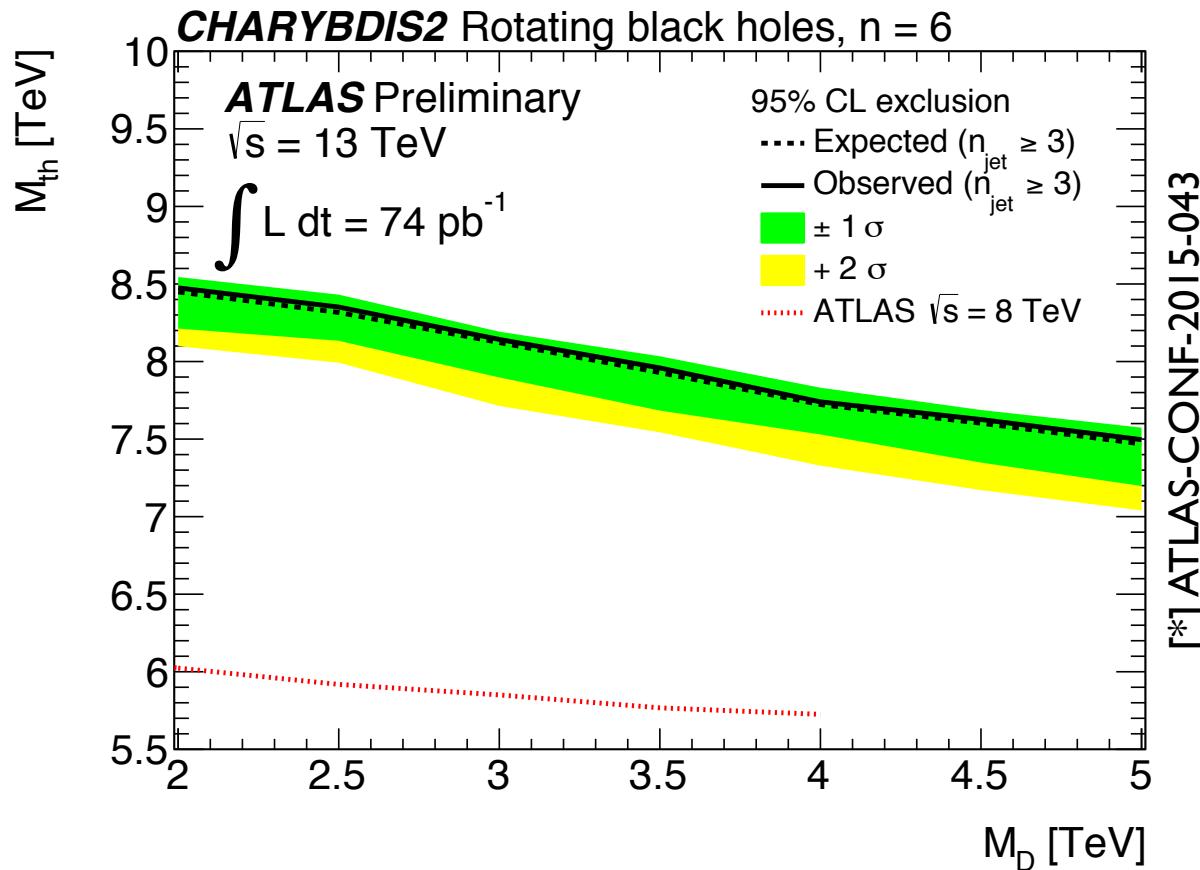
Search in Multijet Final States

- Validation region defined to test different fit functions to the data



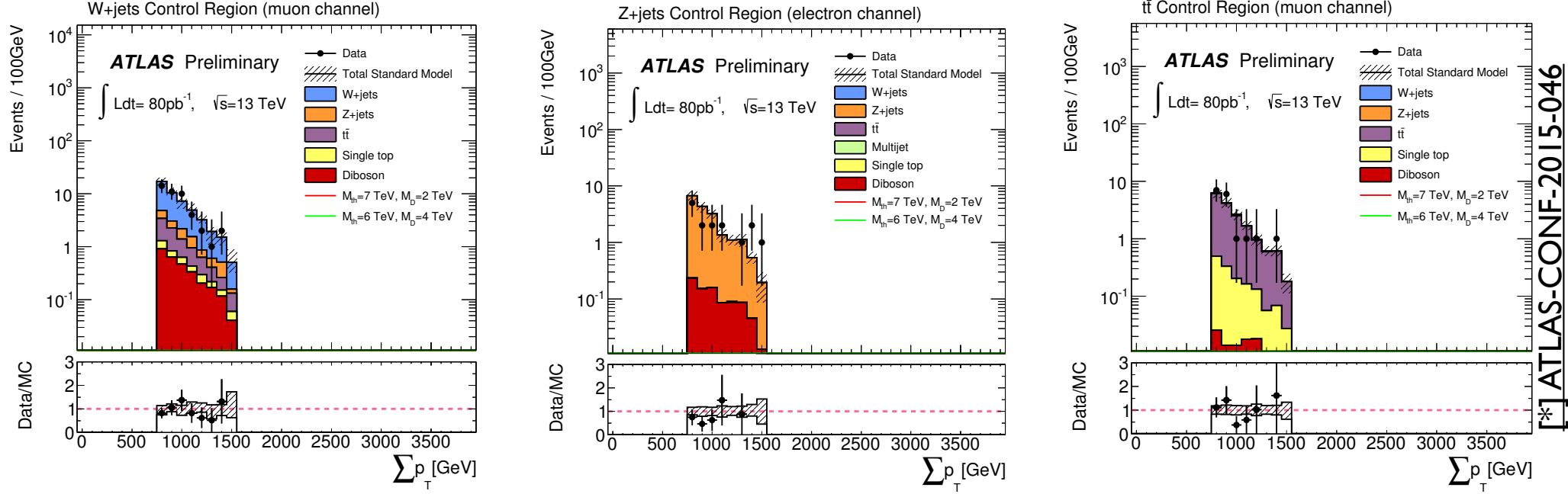
- No significant deviations observed in any signal region

Summary of Limits (Multijet)



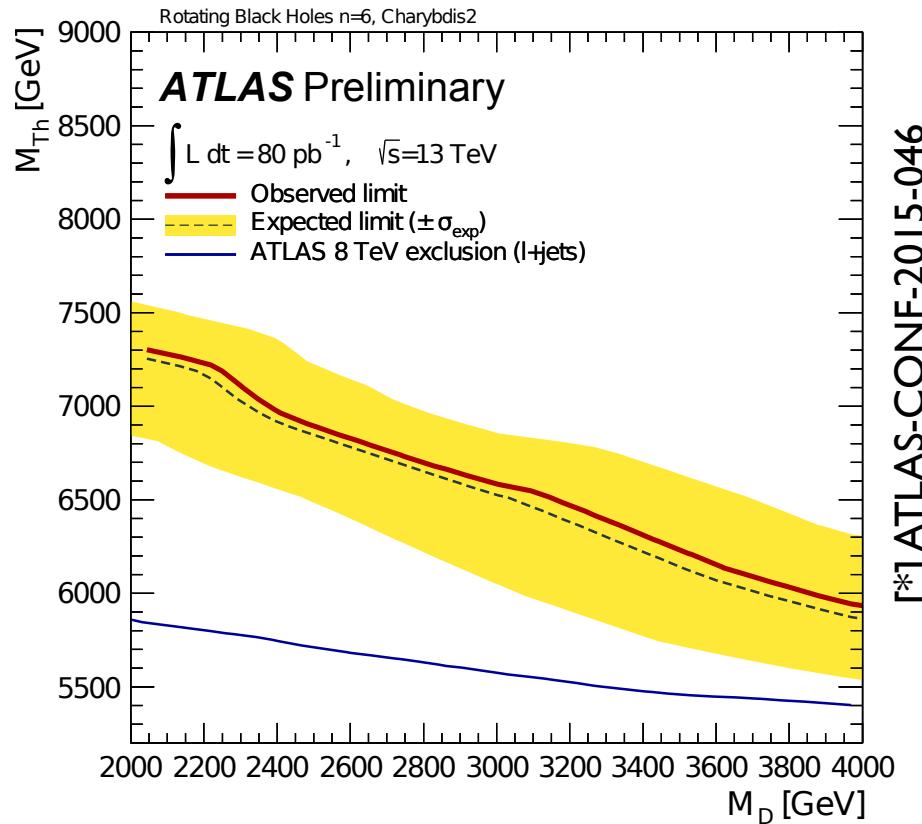
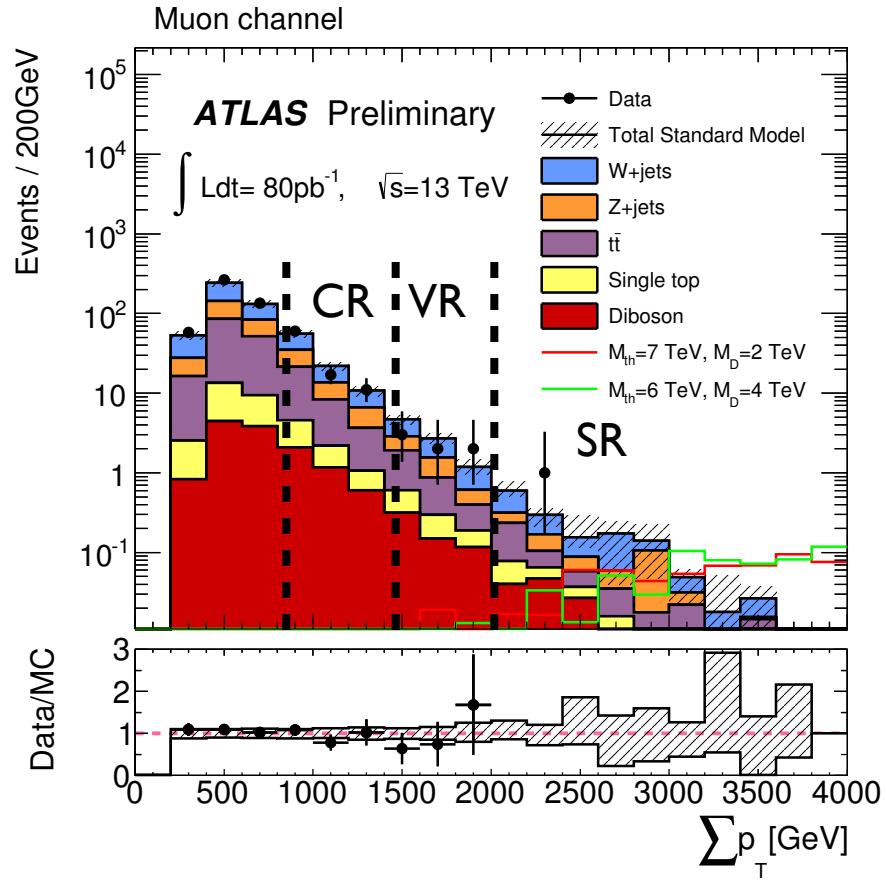
- ▶ Use $N_{\text{jets}} \geq 3$ signal region (most powerful)
- ▶ Improvement of 2-2.5 TeV on exclusion limit with respect to Run-I result

Search in Lepton+jet Final States



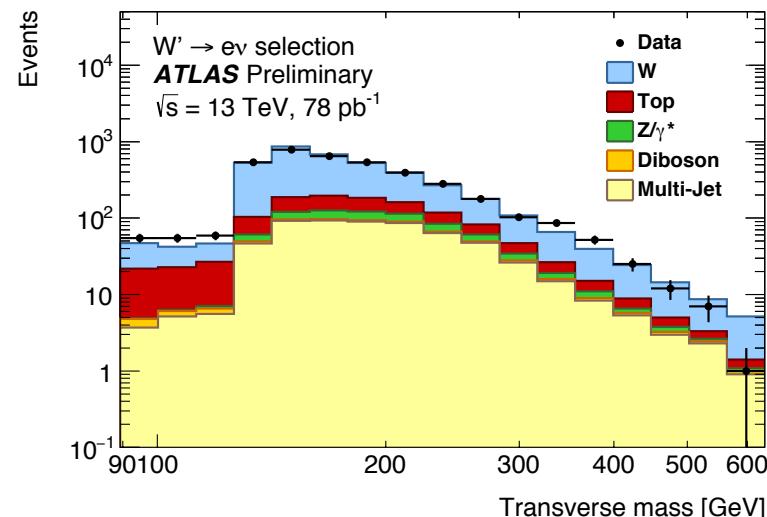
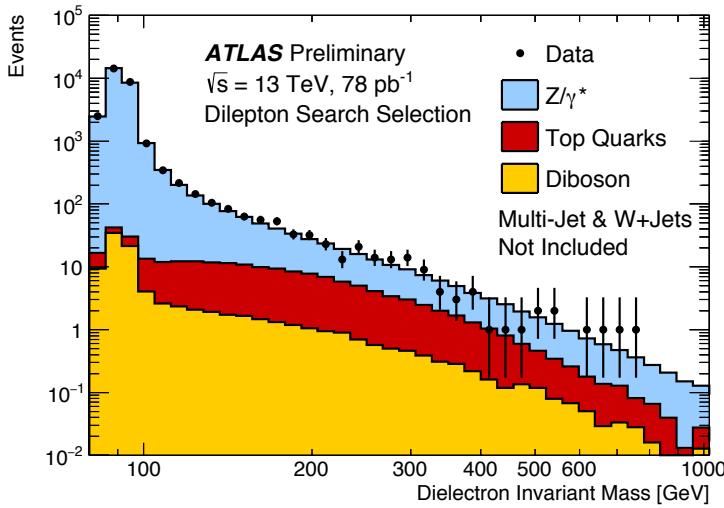
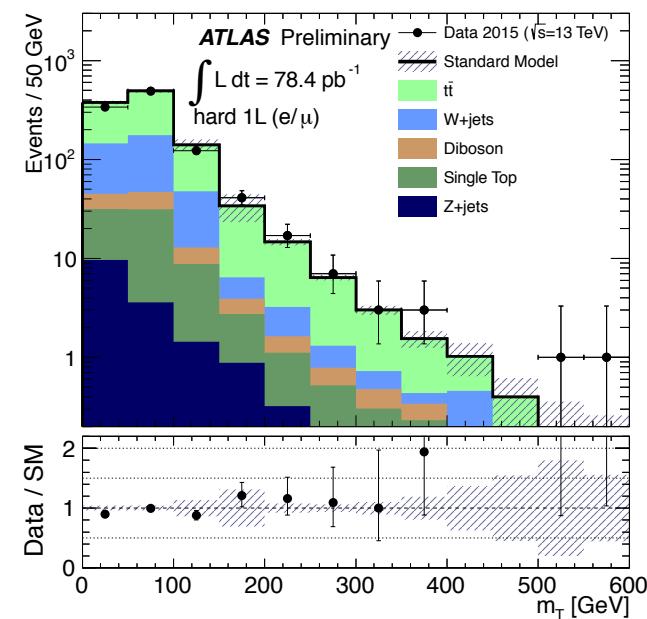
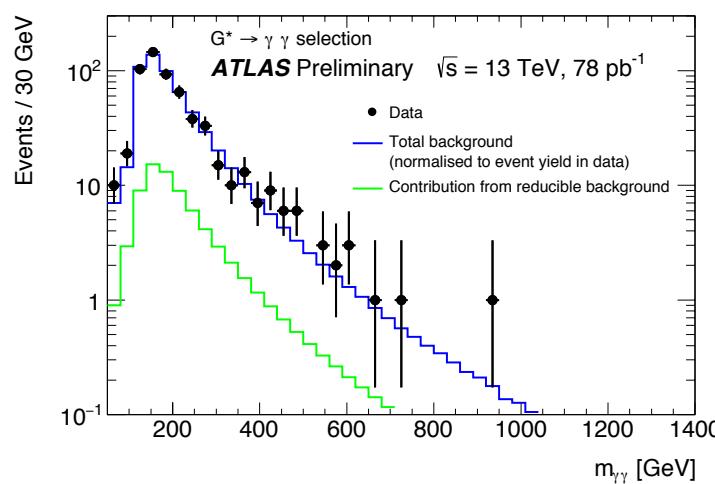
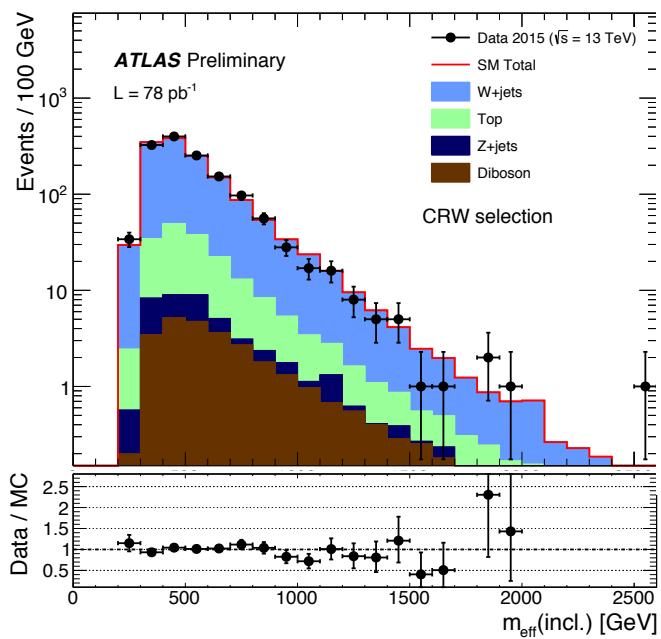
- ▶ Strategy and models similar to multijet final states
- ▶ Several control regions enriched in primary backgrounds (W+jets, Z+jets, tt) determine their normalization
- ▶ Systematics on extrapolation to high p_T obtained in situ in control regions

Search in Lepton+jet Final States

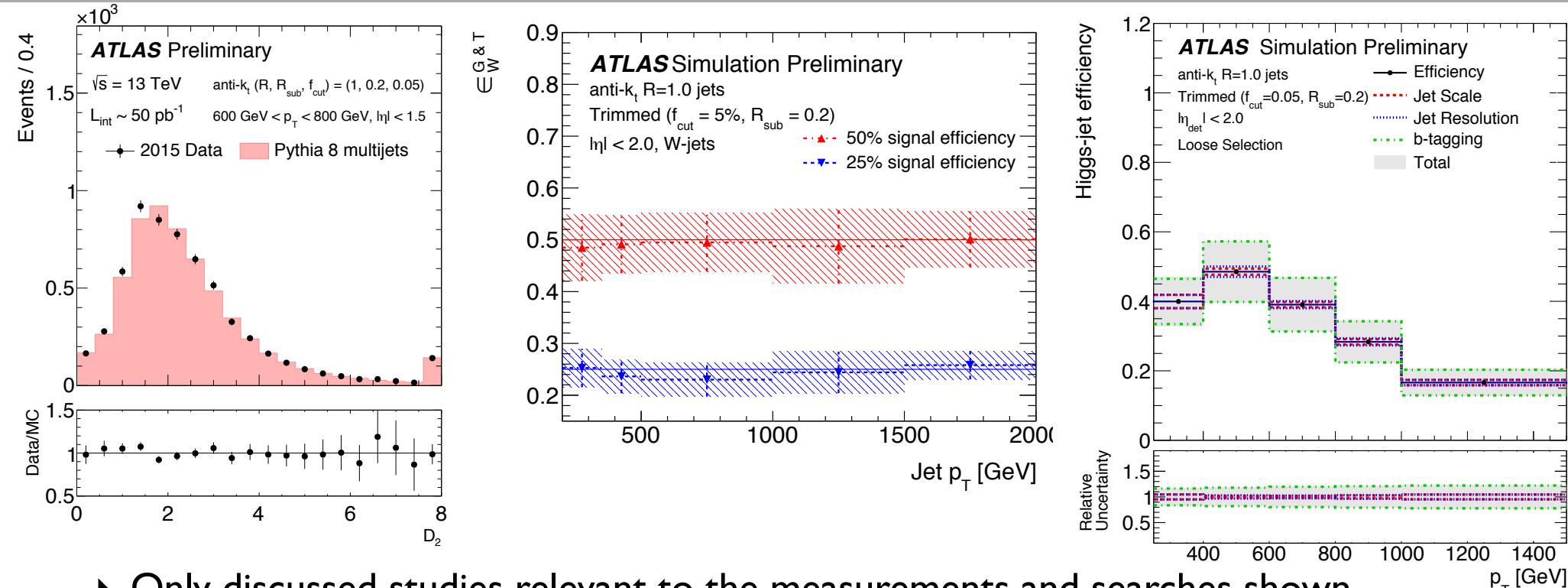


- No significant deviations observed in signal region, improvement of 1.5 TeV on Run-I limit

Other Searches



Commissioning of Objects for the Rest of 2015



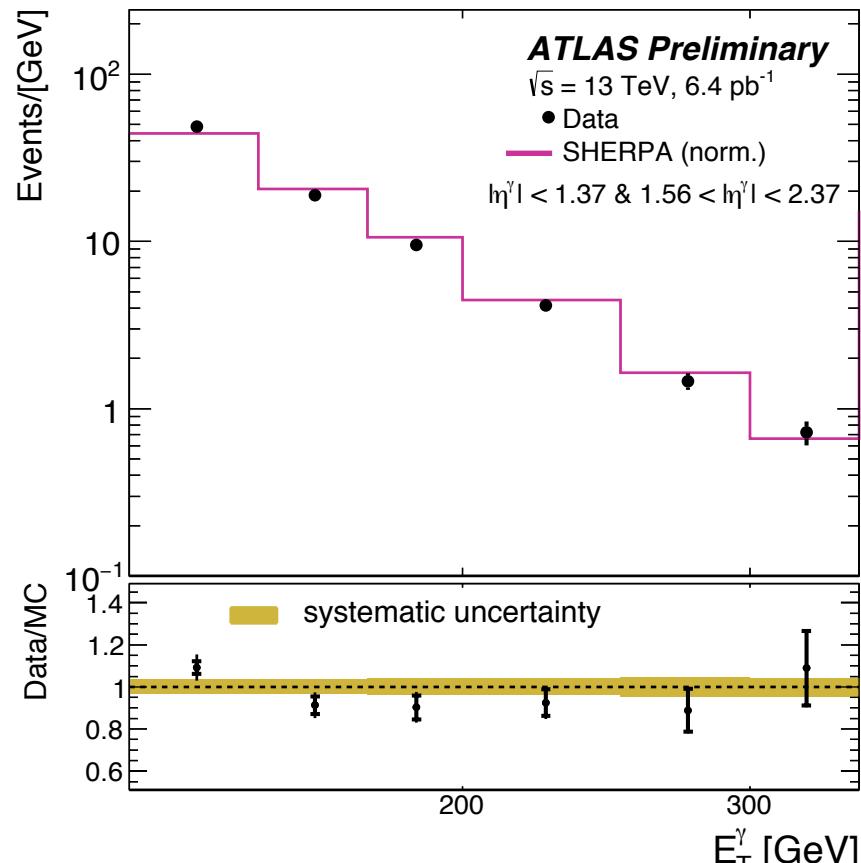
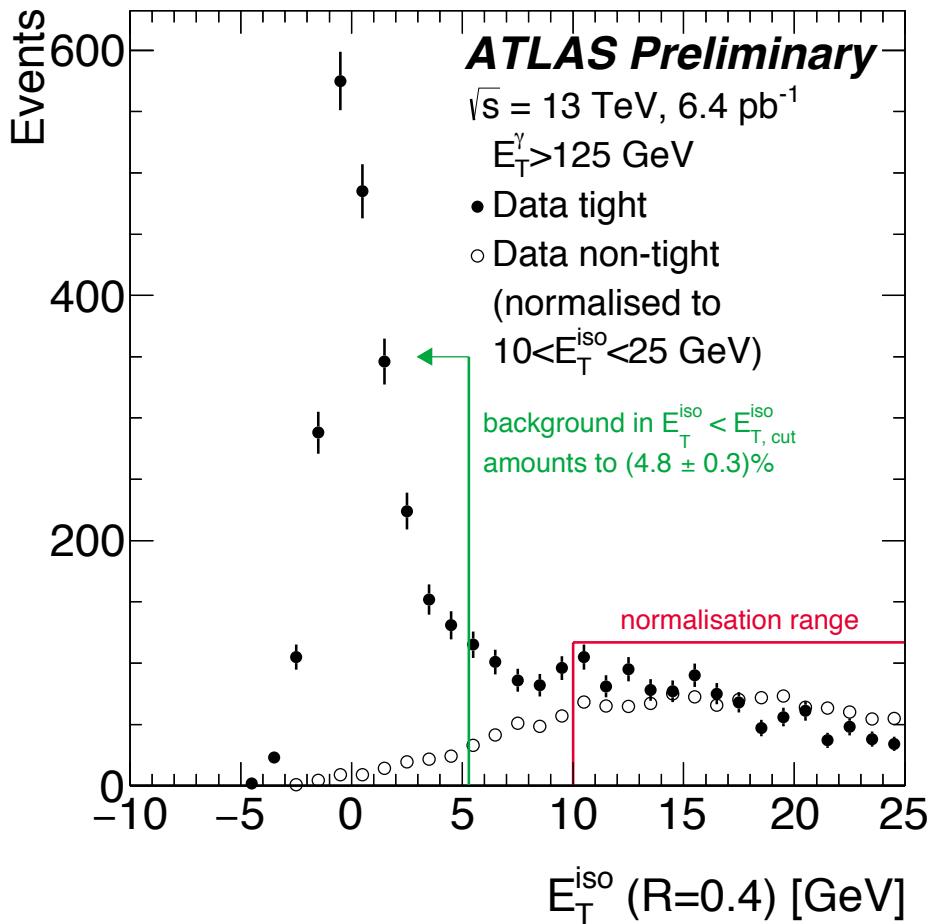
- Only discussed studies relevant to the measurements and searches shown
- However, using data and MC simulations to commission techniques of relevance in the next couple of months:
 - τ tagging ([ATL-PHYS-PUB-2015-025](#))
 - boosted hadronic W/Z tagging ([ATL-PHYS-PUB-2015-033](#), [ATLAS-CONF-2015-035](#))
 - boosted $H \rightarrow bb$ tagging ([ATL-PHYS-PUB-2015-035](#))
 - ...

Conclusions and Outlook

- ▶ ATLAS has successfully commissioned several upgrades to the detector and reconstruction
- ▶ Physics objects have been understood with detailed MC simulations and in situ analyses, reaching already small systematic uncertainties
- ▶ First measurements performed at 13 TeV on:
 - soft QCD (inelastic cross section, minimum bias, underlying event and 2-particle correlations)
 - hard processes (inclusive jet cross section, W/Z and top pair production)
- ▶ First searches are capable of improving Run I limits on black hole production
- ▶ Understanding of backgrounds for many other searches well underway
- ▶ Physics objects necessary for the rest of the year such as boosted bosons well on their way to being commissioned
- ➡ ATLAS is ready for discoveries and precision physics with more 13 TeV data!
All the material from today's talk and more can be found [here](#)

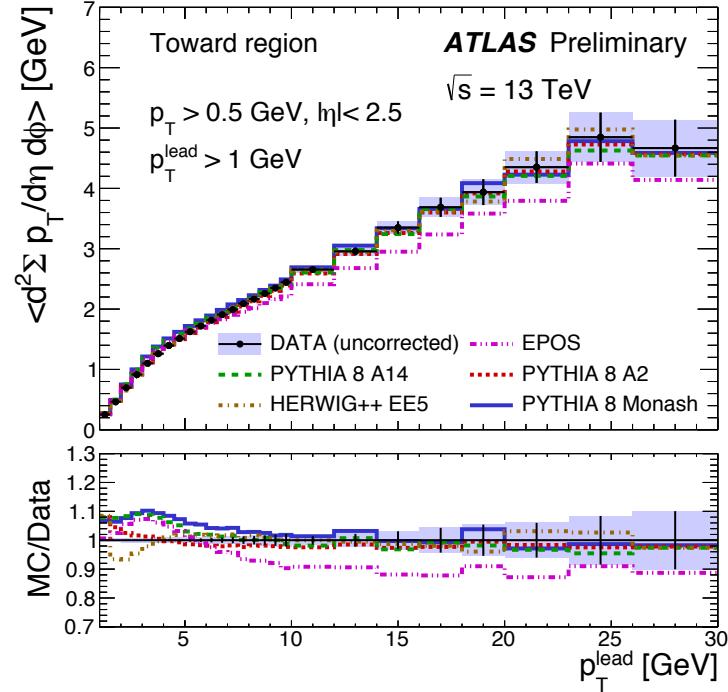
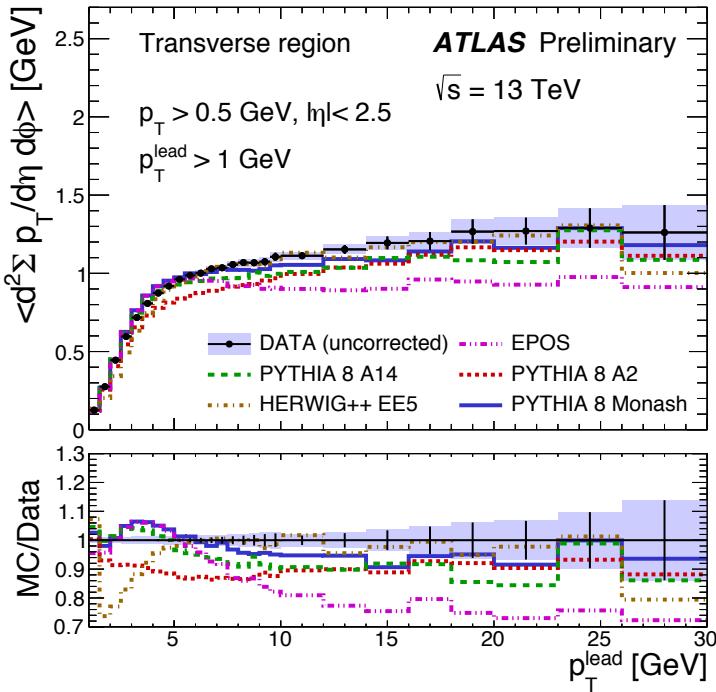
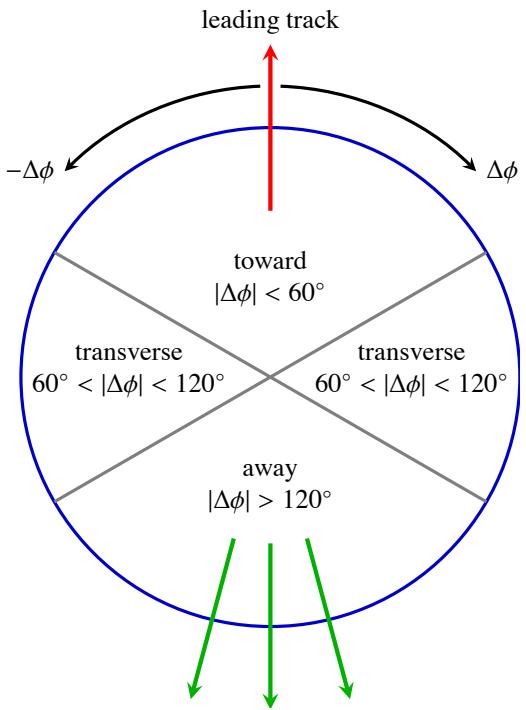
BACK-UP SLIDES

Photon+jet results



[*] ATLAS-PHYS-PUB-2015-016

Underlying Event Measurements



[*] ATL-PHYS-PUB-2015-019