Le redémarrage de l'Expérience Atlas au LHC

Camilla Maiani pour l'expérience Atlas

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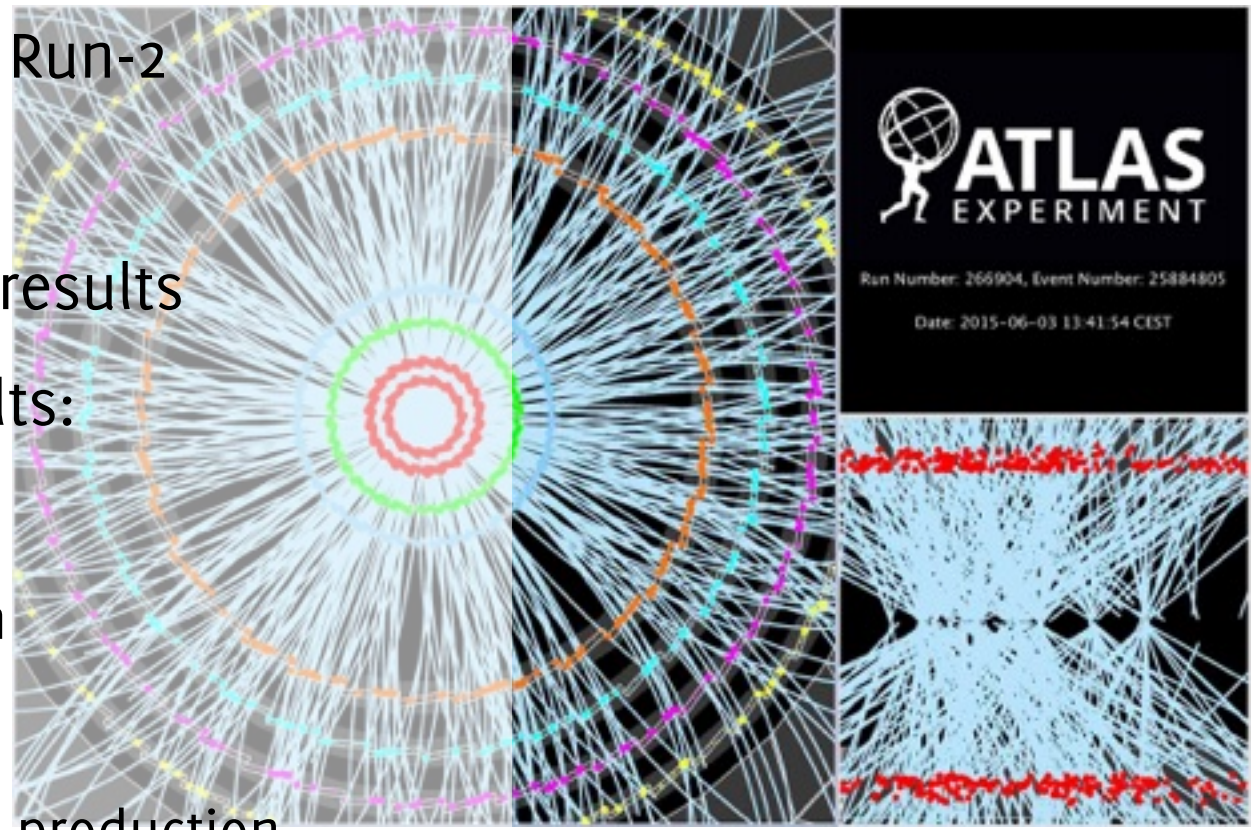
Strasbourg, 24.08.2015

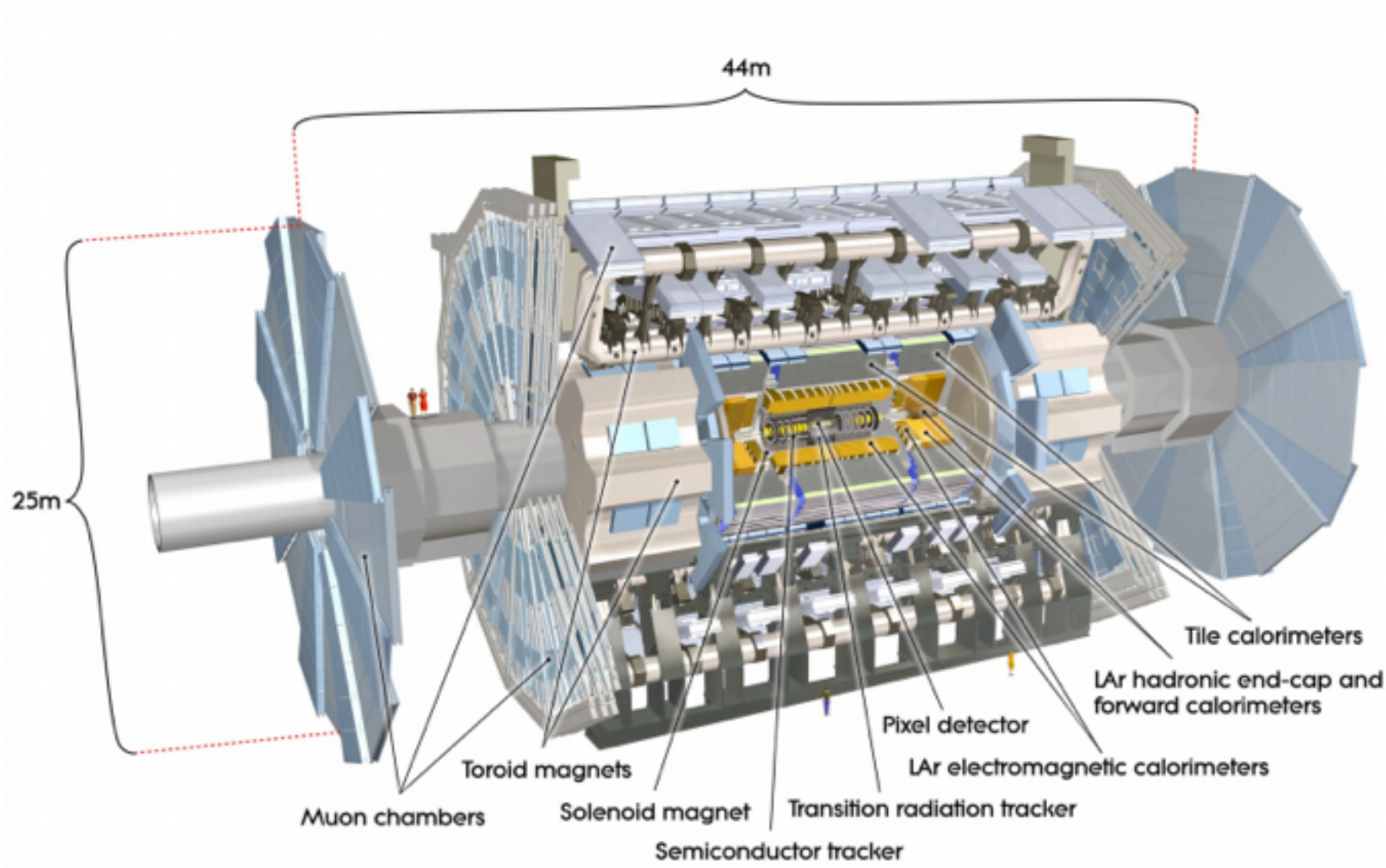
Outlook

- Introduction: ATLAS Run-1 Overview
- ATLAS upgrade for Run-2
- Run-2 data taking
- First performance results
- First analysis results:
  - J/ψ production
  - W and Z production
  - $t\bar{t}$ production
  - High-mass dilepton production

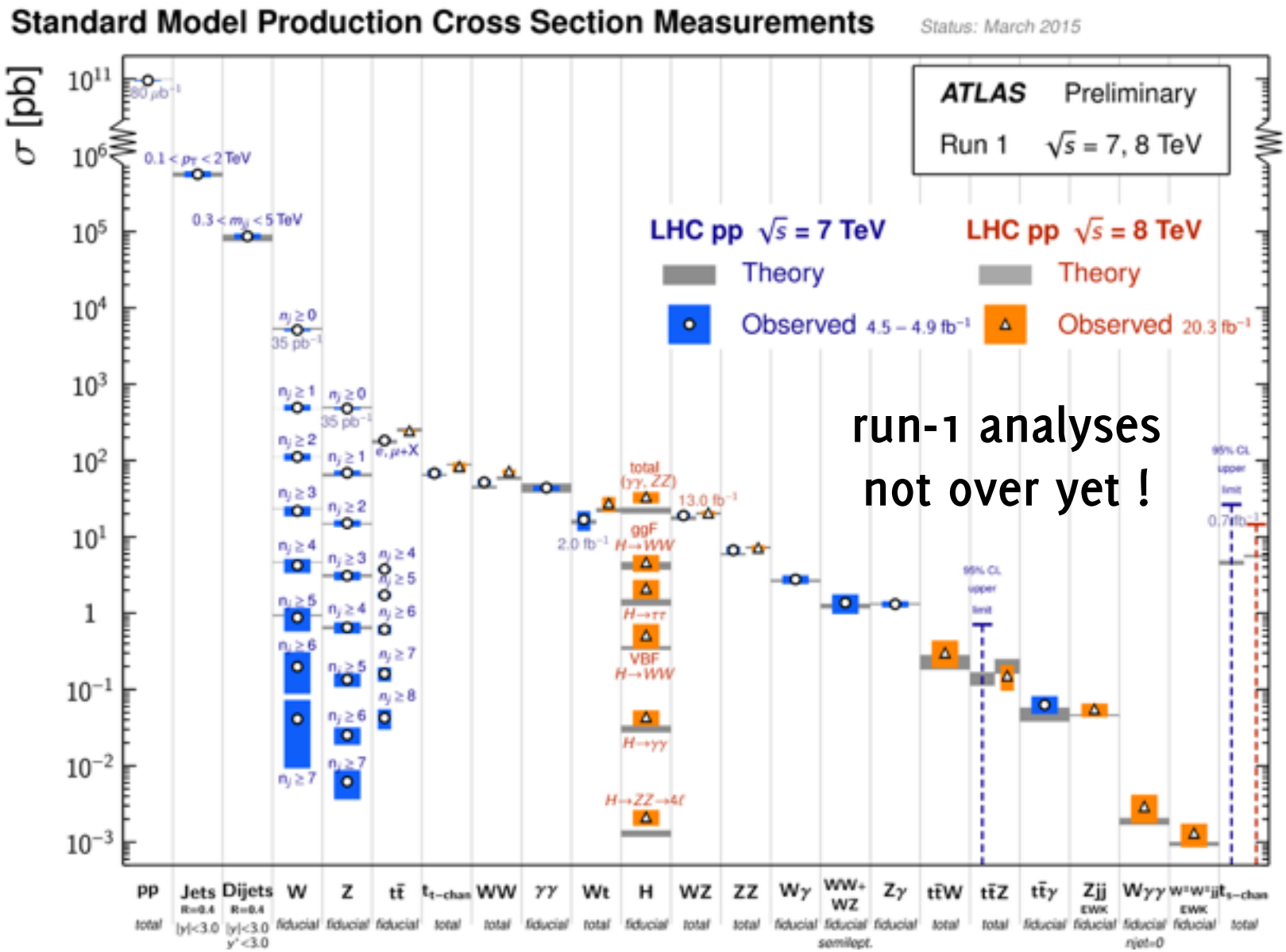


arbitrary choice ! full list of 13 TeV results here

ATLAS OVERVIEW DURING RUN-1



Introduction: LHC Run 1 Findings

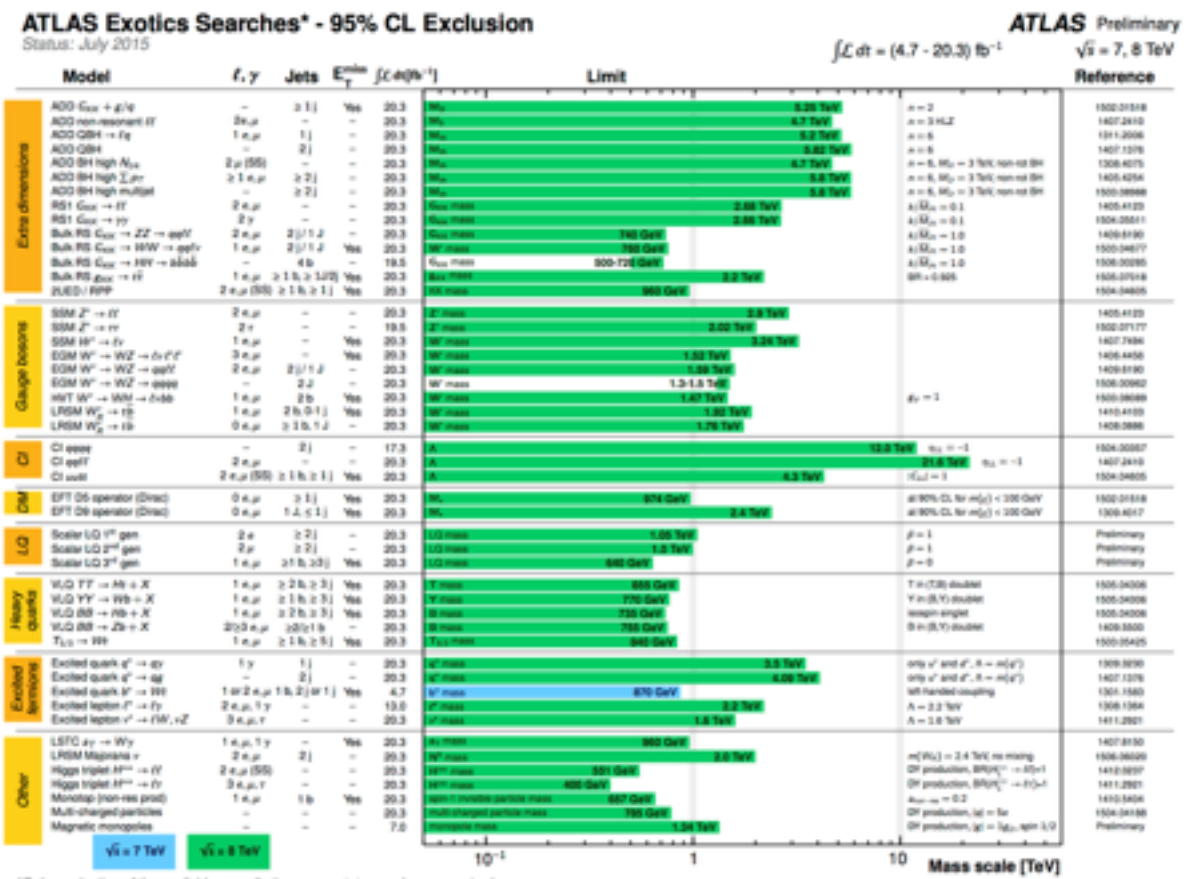


Saclay

http://atlas.ch

Introduction: LHC Run 1 Findings

limits up to ~1 TeV or above



no significant anomaly seen so far

Atlas Upgrade

Atlas Upgrade

- Infrastructure upgrades:
  - ★ magnet & cryogenic systems
  - ★ additional muon chambers shielding
  - ★ new beam pipes

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to cope with 100 kHz trigger rate

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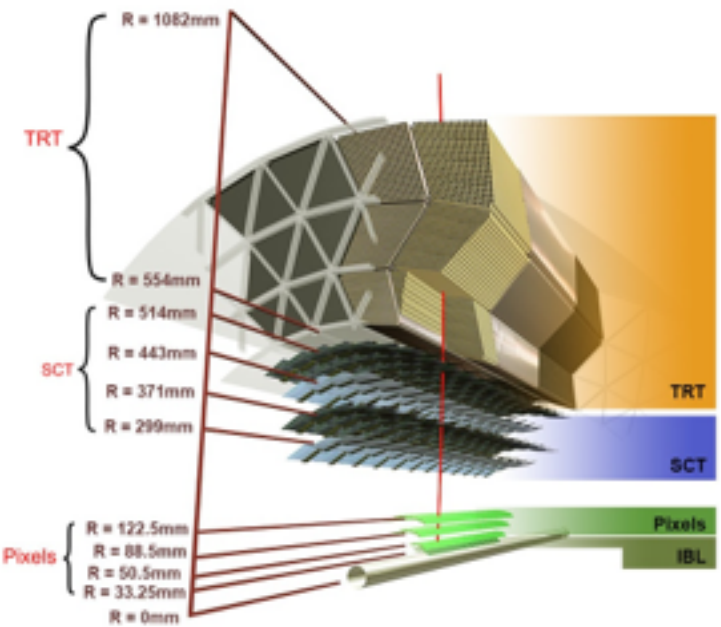

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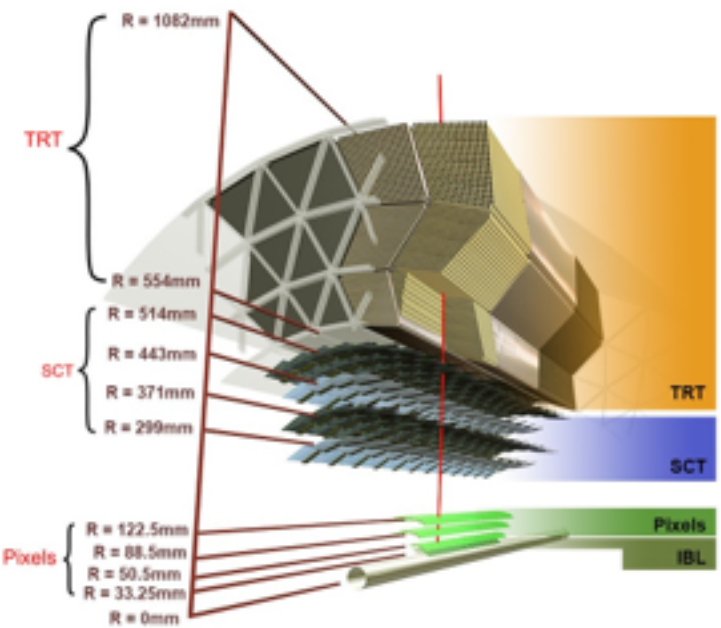

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- ★ new central trigger processor

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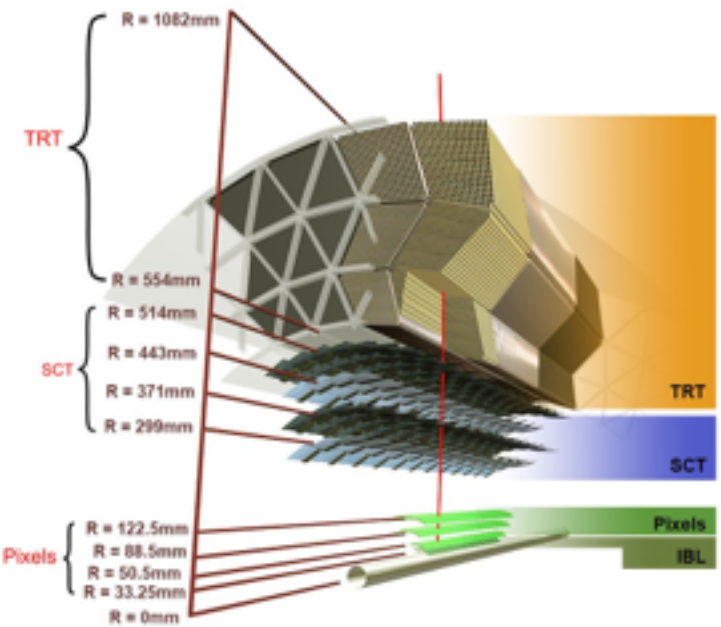

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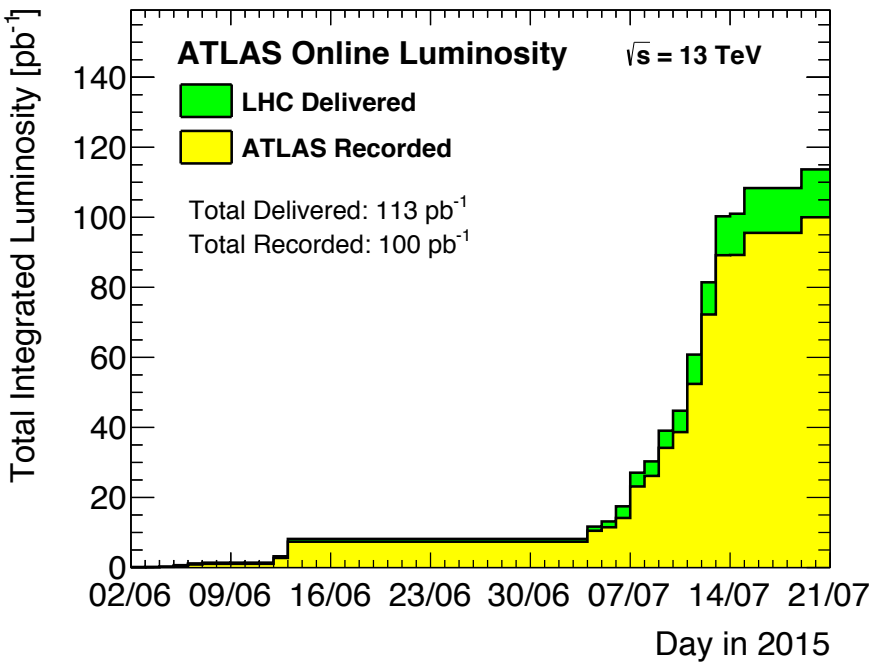
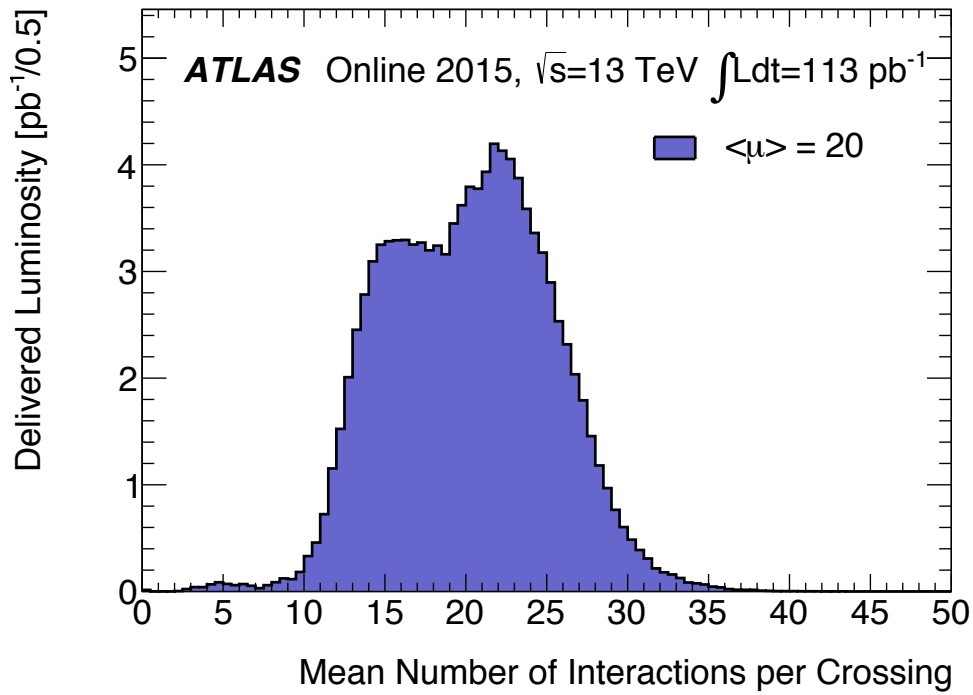
→ to cope with 100 kHz trigger rate → restructured high-level trigger

+ New software, new reconstruction framework, new analysis model…

13 TeV Data Taking



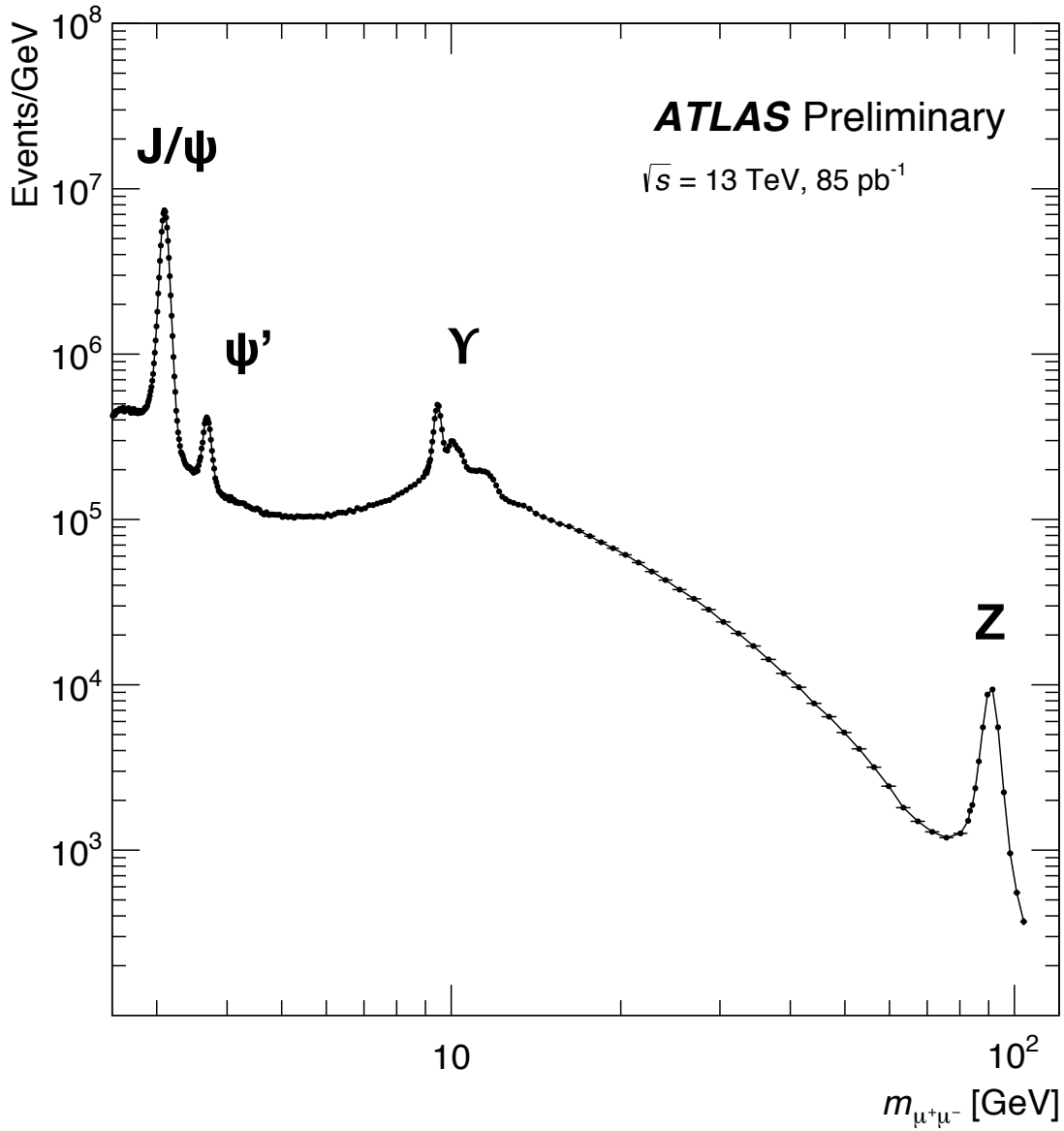


peak luminosity: $L = 1.6 \cdot 10^{33}\ cm^{-2}s^{-1}$

9% systematic uncertainty on current luminosity measurement

June-July 2015 → 93.3% data taken is "good for physics"

Exploring 50 Years of Particle Physics in a Few Months



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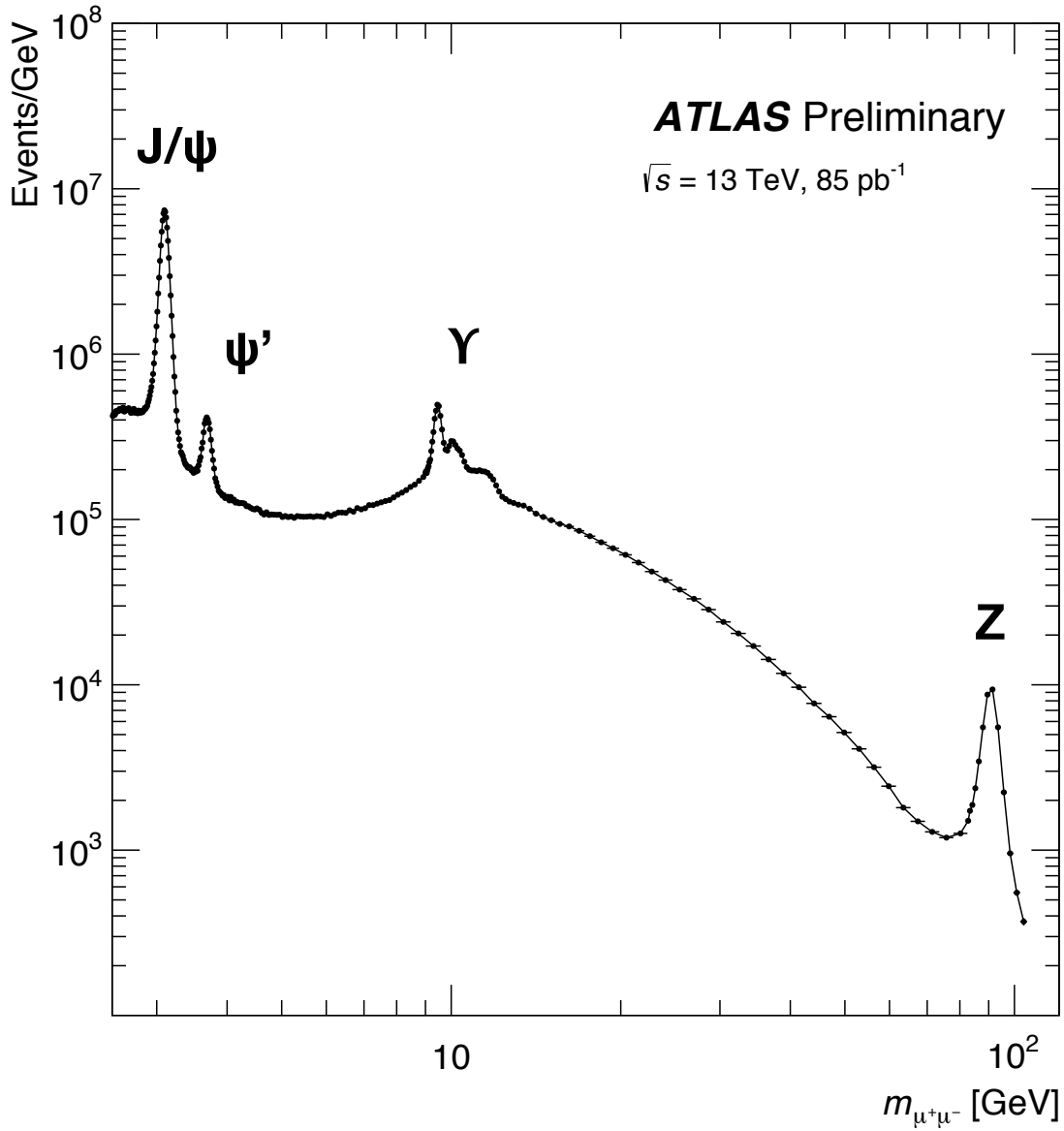
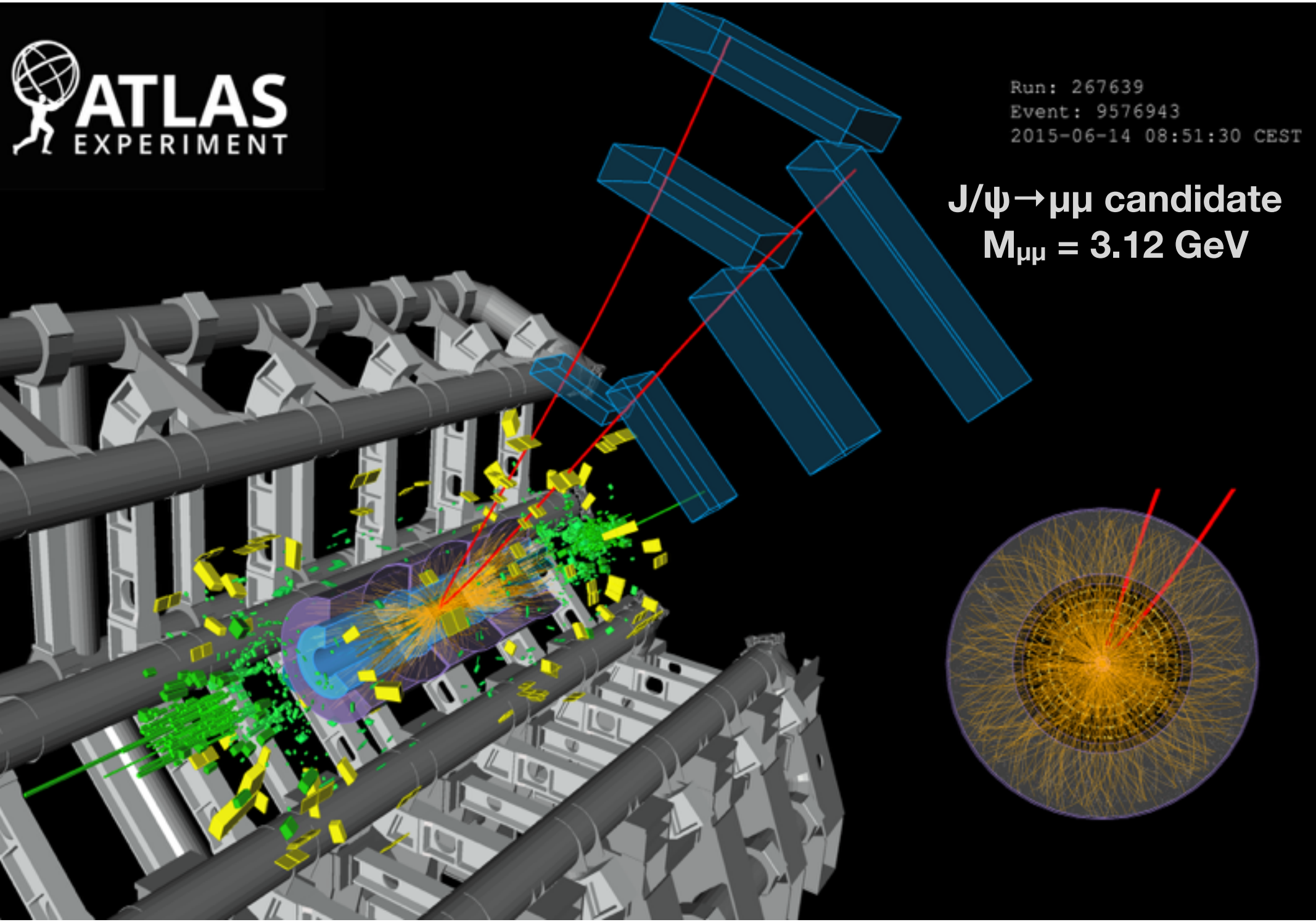
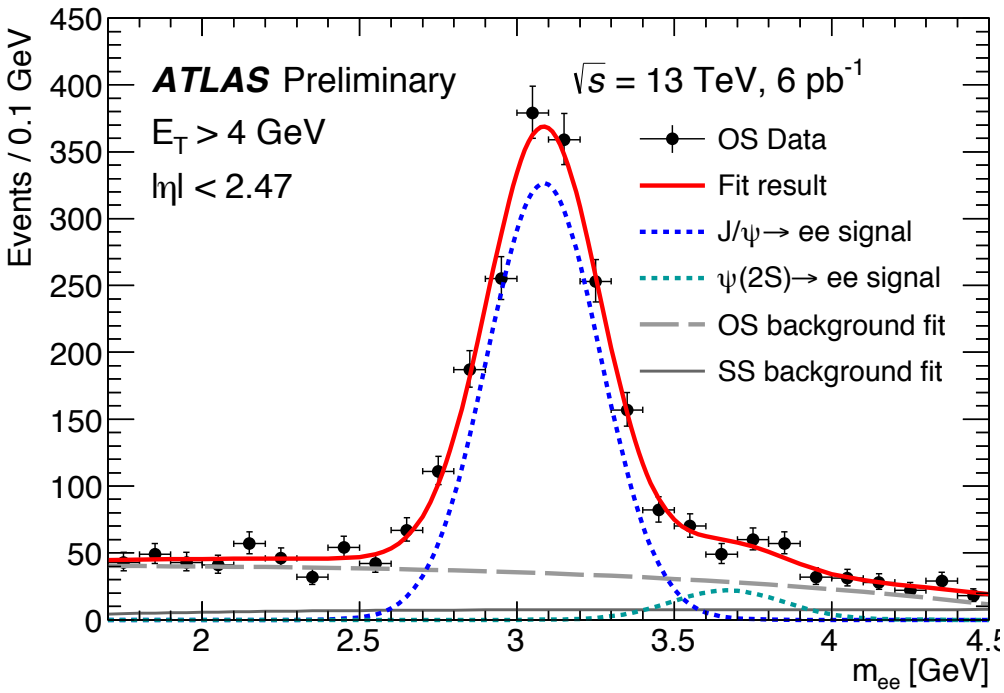


dimuon invariant mass spectrum

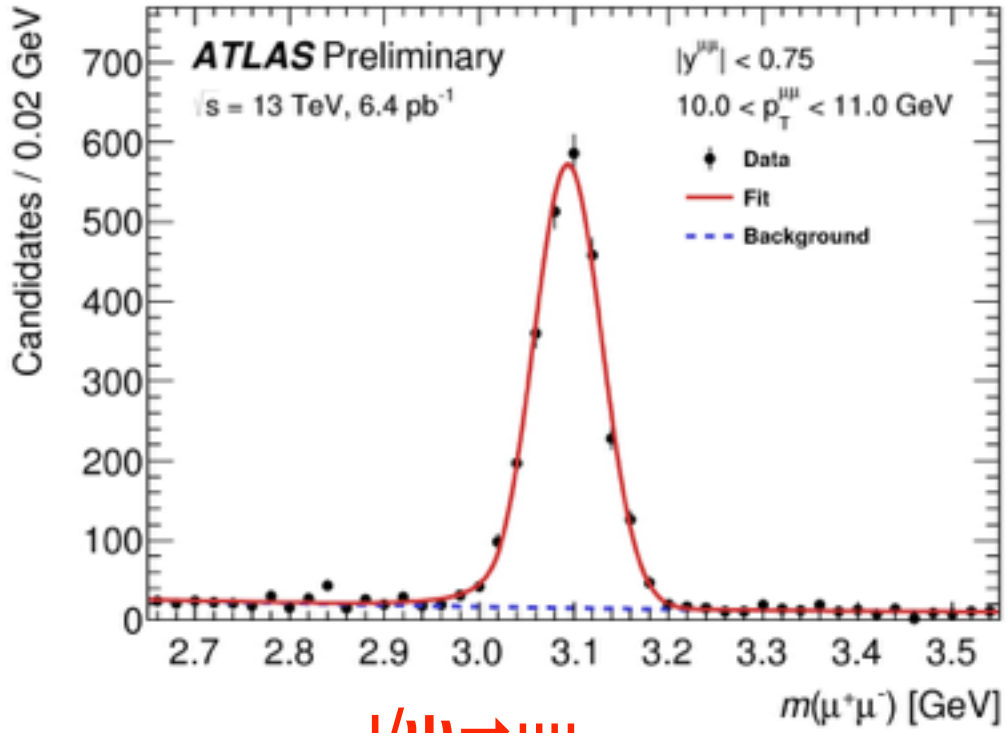

ATLAS
EXPERIMENT
Run: 267639
Event: 9576943
2015-06-14 08:51:30 CEST
J/ψ→μμ candidate
$M_{\mu\mu}$ = 3.12 GeV

[ATLAS-CONF-2015-030]
[EGAM-2015-003]

J/ψ Production



J/ψ→ee

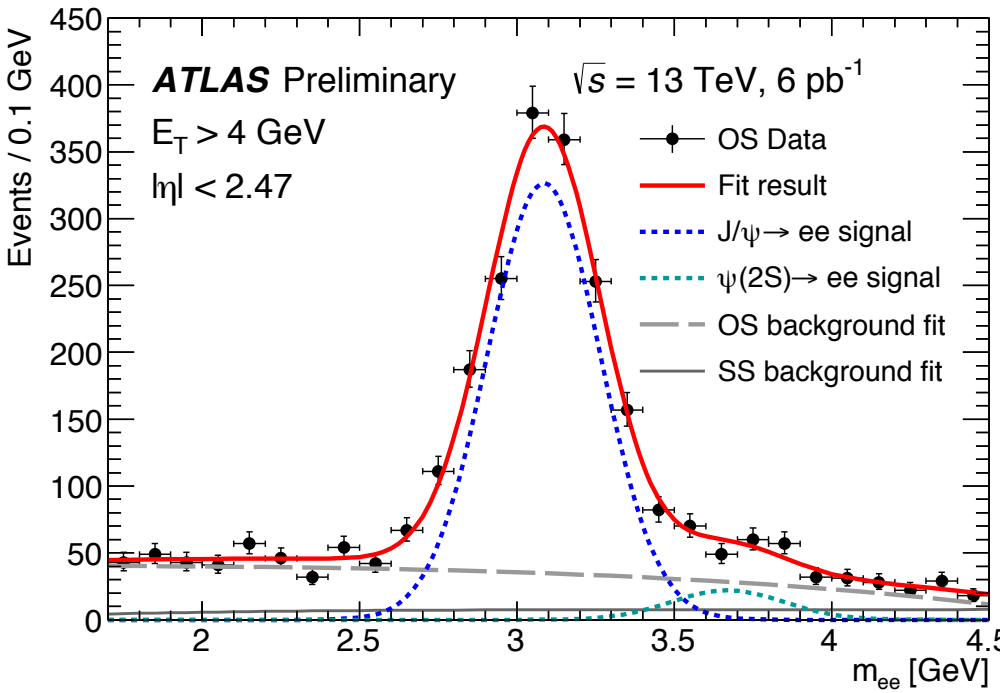


J/ψ→μμ

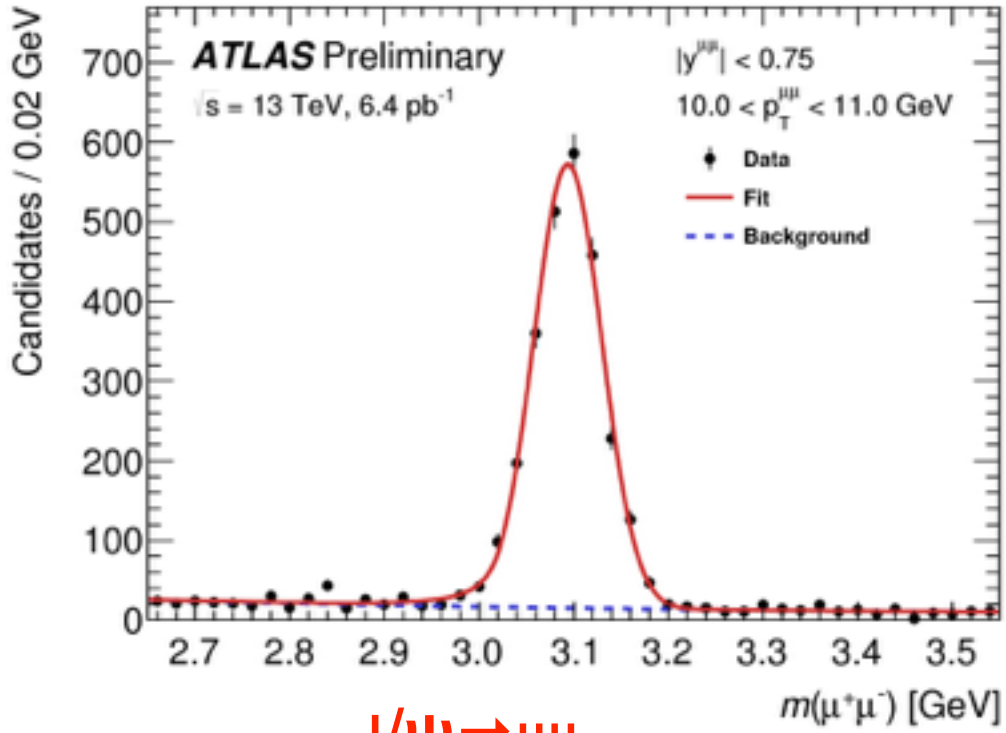
→ first resonance encountered at a collider, very small width: calibration
→ test of QCD calculations

[ATLAS-CONF-2015-030]
[EGAM-2015-003]

J/ψ Production



J/ψ→ee



J/ψ→μμ

→ first resonance encountered at a collider, very small width: calibration

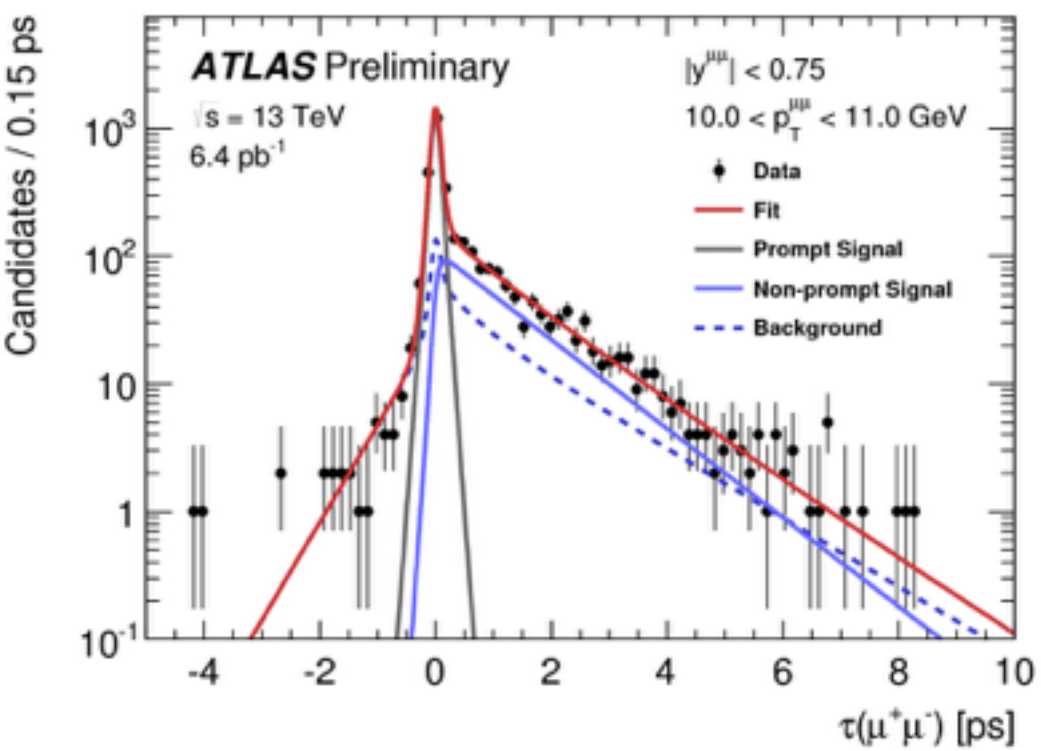
→ test of QCD calculations

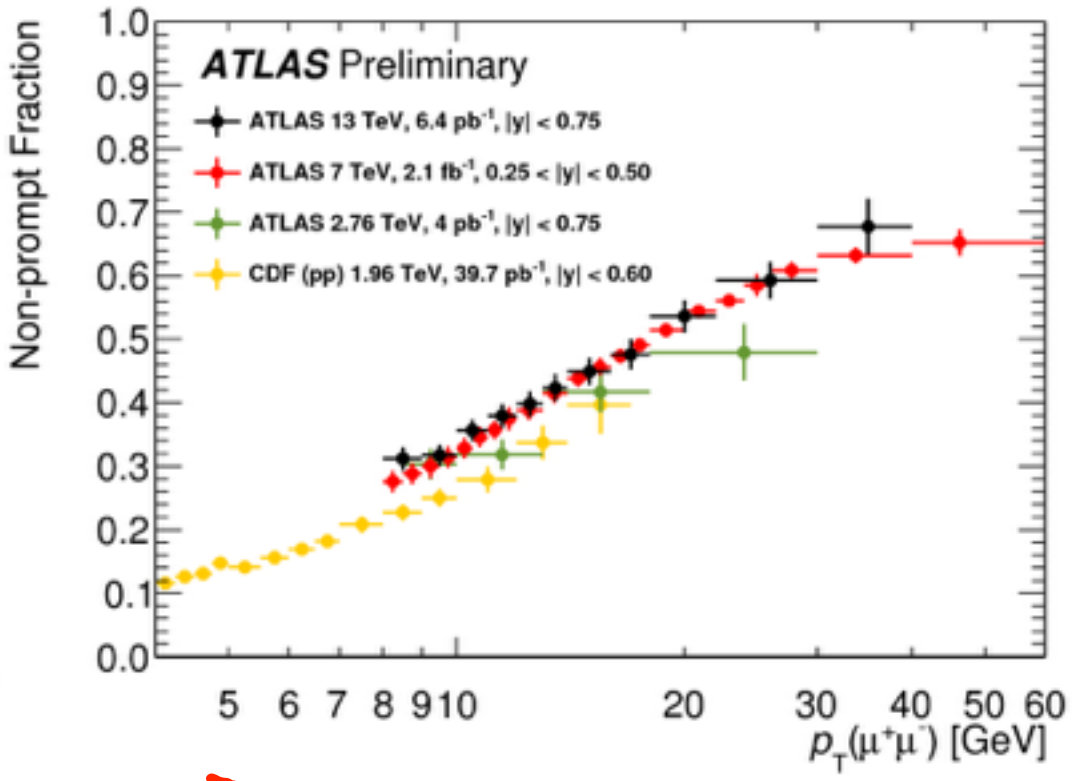
J/ψ can be produced directly from the pp interaction (promptly) or from b-mesons decays (non-promptly)

[ATLAS-CONF-2015-030]

J/ψ Production: Measuring Non-Prompt Fraction

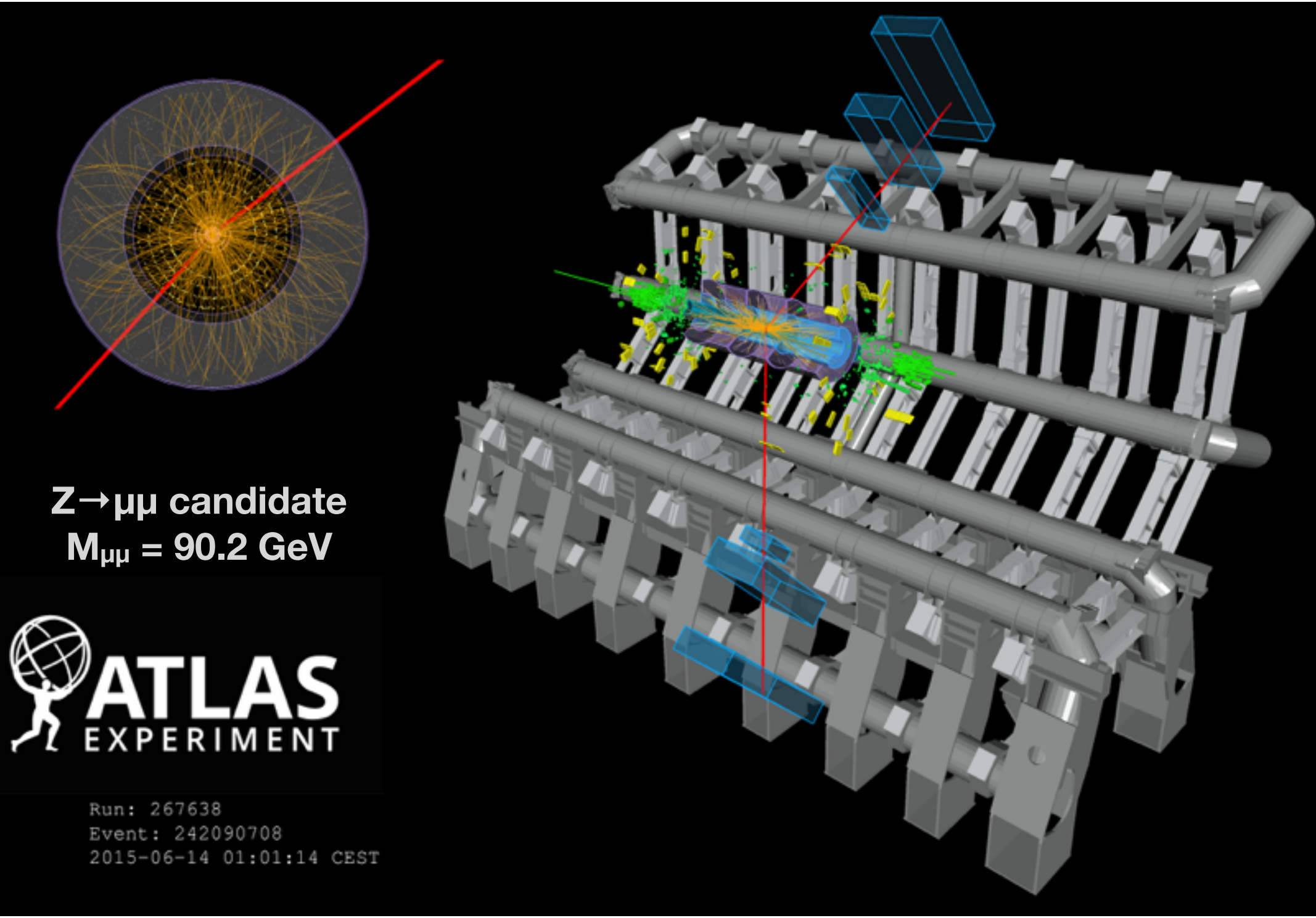
non-prompt to prompt fraction defined as $R = \frac{d\sigma(pp \to b\bar{b}X \to J/\Psi X')}{d\sigma(pp \to J/\Psi X'')}$





simultaneous invariant mass and pseudo-proper time fit

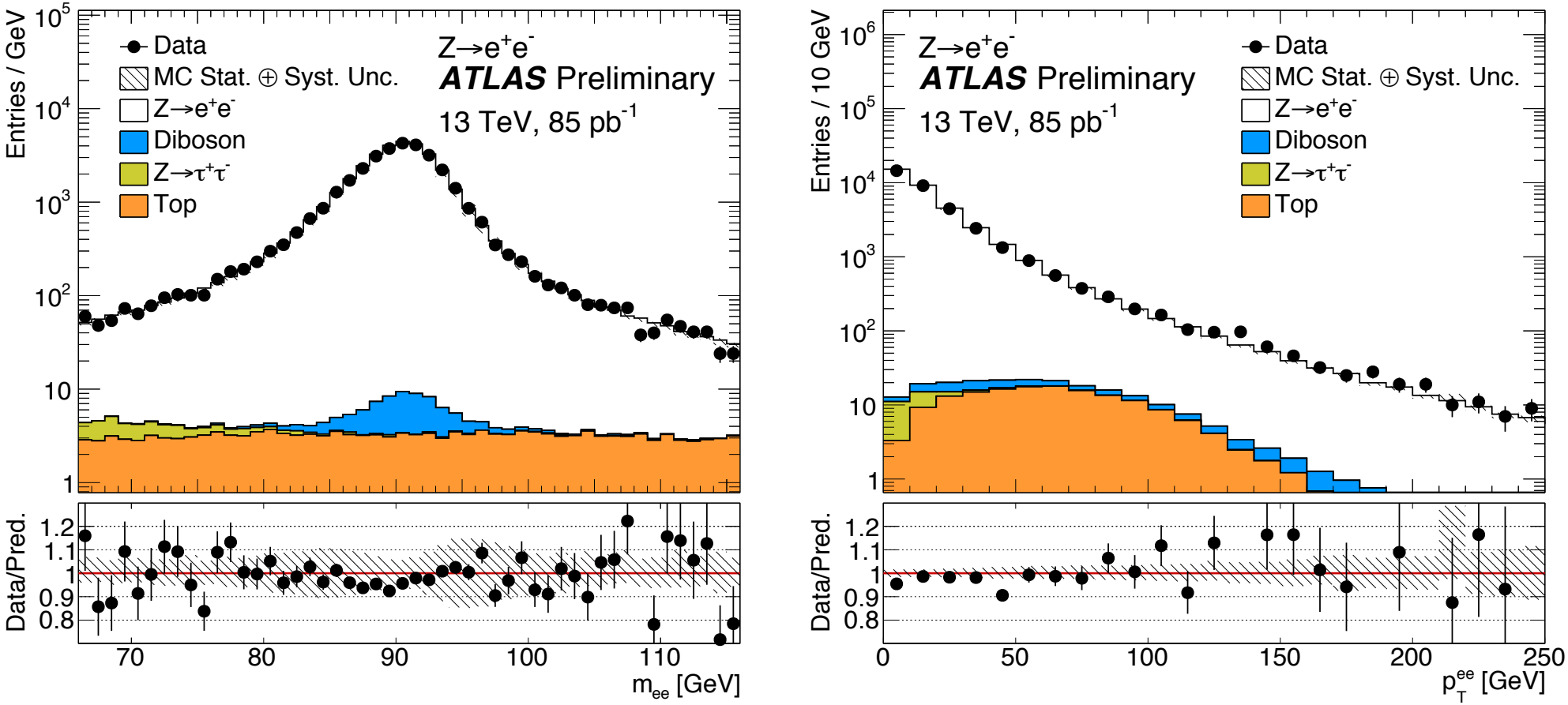
$\tau = \frac{L_{xy} m^{J/\Psi}}{p_T^{J/\Psi}}$


Z→μμ candidate
$M_{\mu\mu}$ = 90.2 GeV
ATLAS
EXPERIMENT
Run: 267638
Event: 242090708
2015-06-14 01:01:14 CEST

[ATL-PHYS-PUB-2015-021]

W and Z Production at 13 TeV

W and Z leptonic decays are 'standard candles' for e/μ reconstruction



Z→ee events

[ATL-PHYS-PUB-2015-021]

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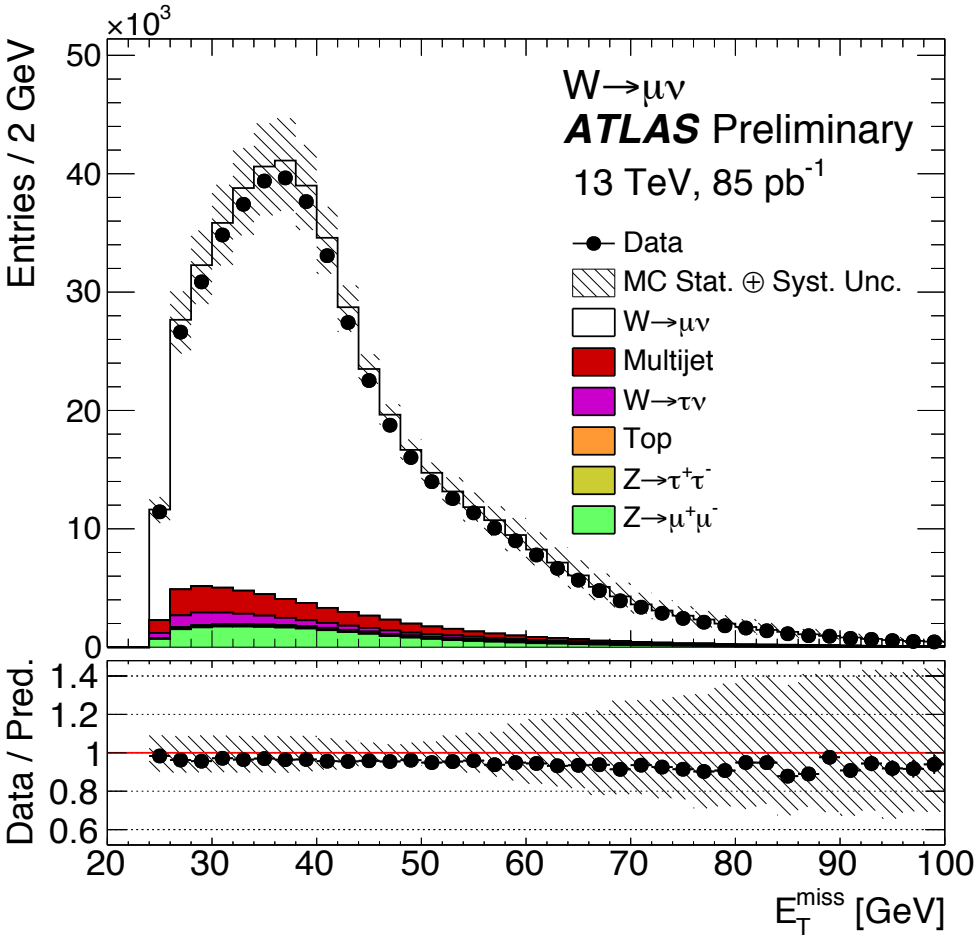
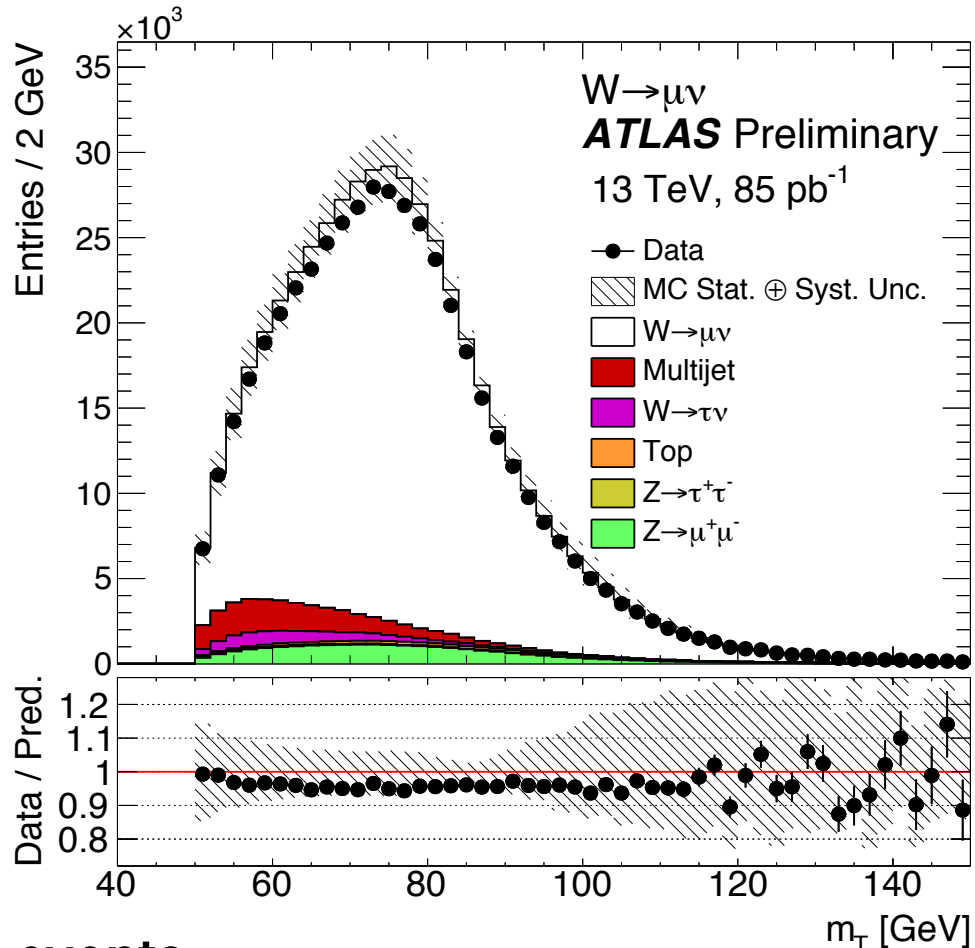


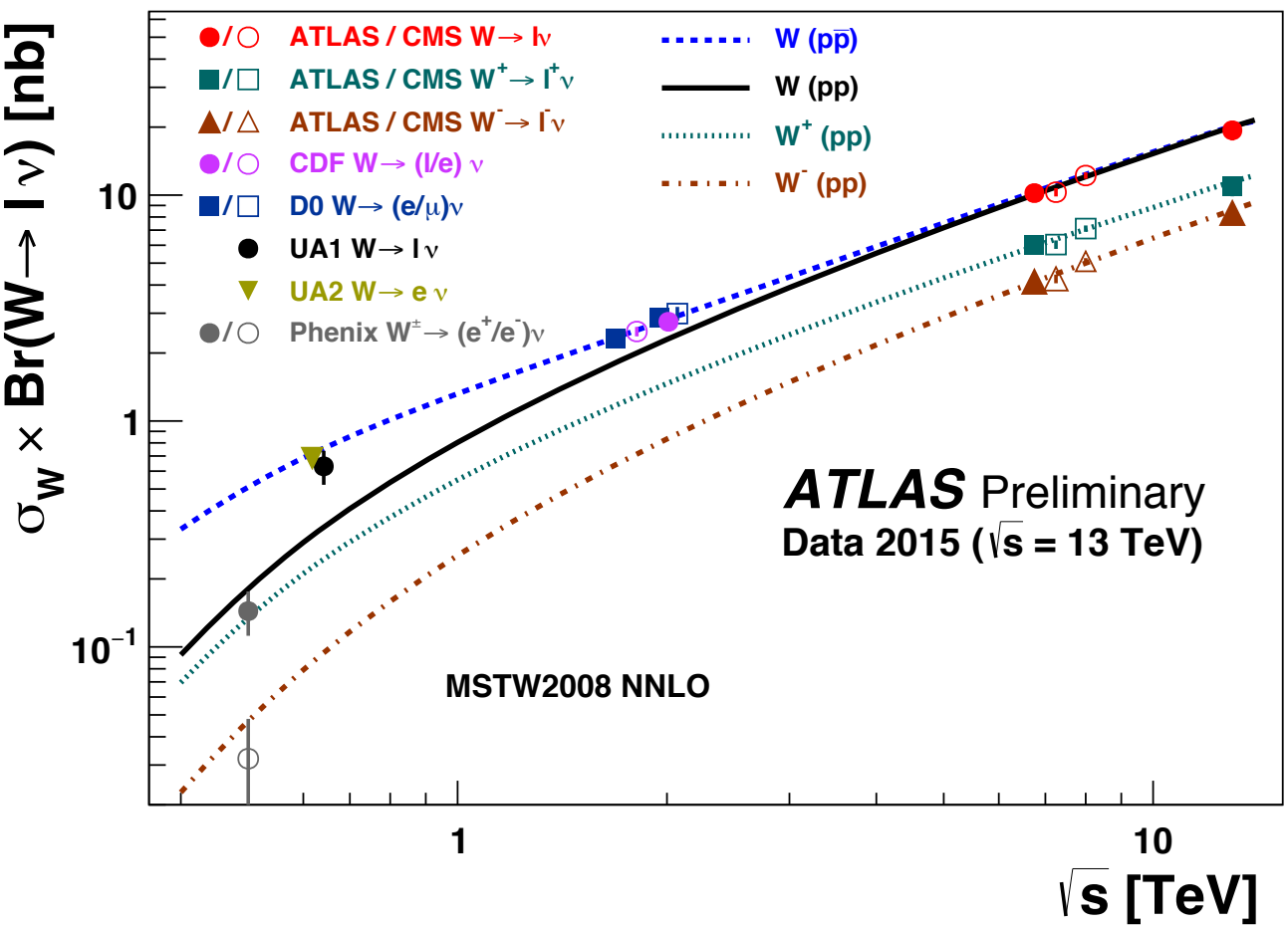


W→μν events

[ATLAS-CONF-2015-039]

W Cross-Section at 13 TeV

8 to 13 TeV → increase of a factor 1.6 of the cross-section

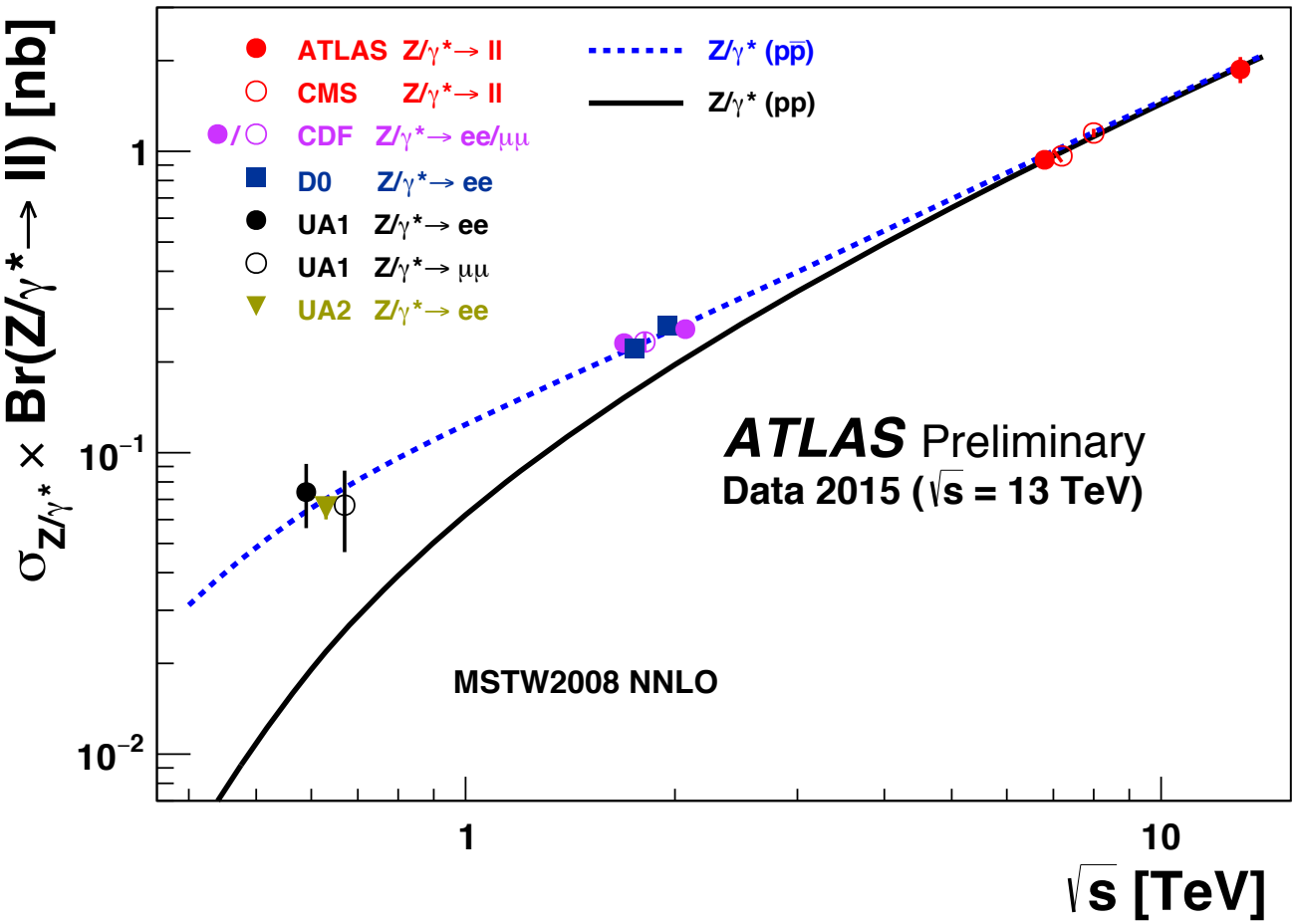


good agreement with NNLO QCD predictions up to 13 TeV !

[ATLAS-CONF-2015-039]

Z Cross-Section at 13 TeV

8 to 13 TeV → increase of a factor 1.7 of the cross section



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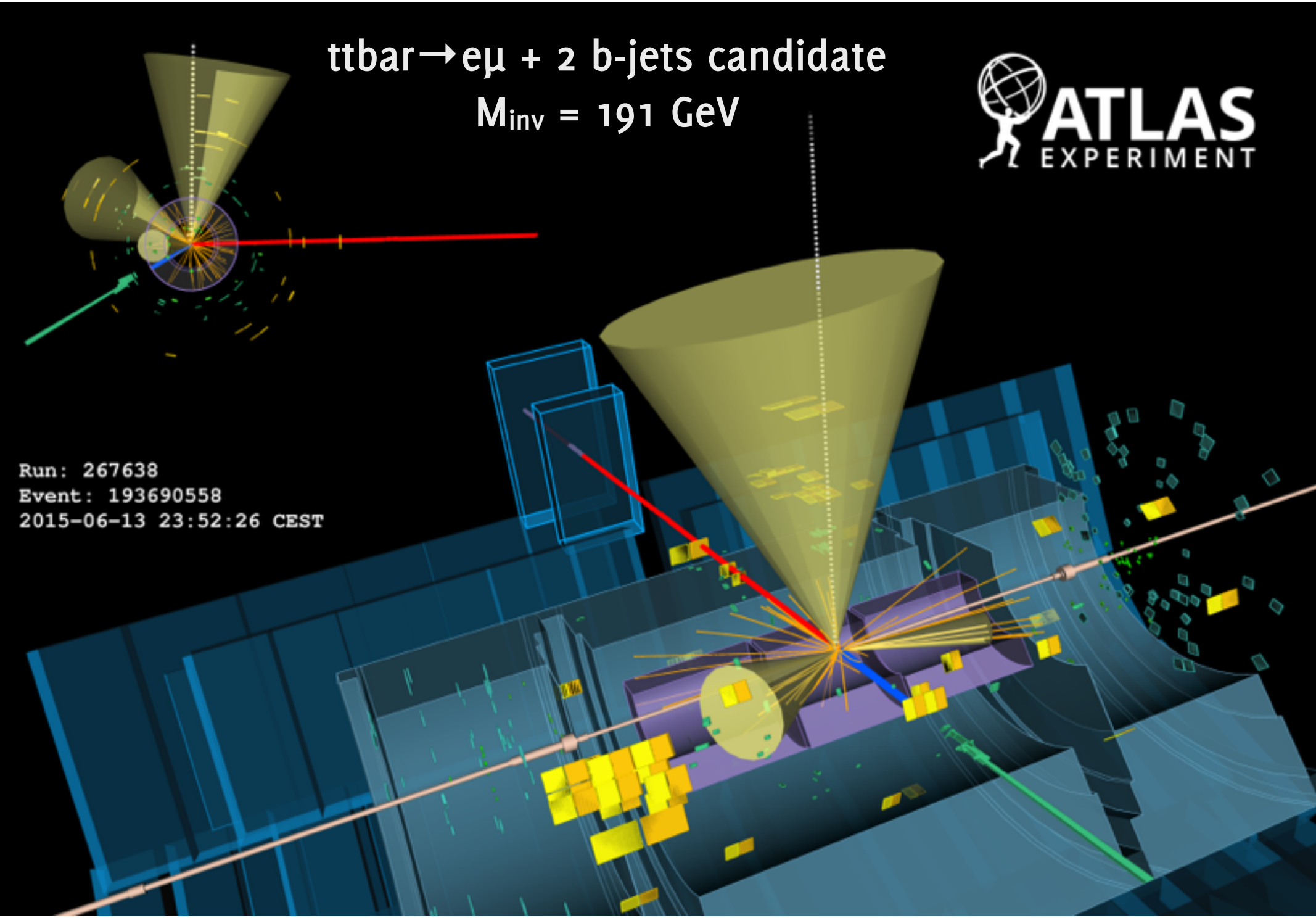

ttbar→eμ + 2 b-jets candidate
M_{inv} = 191 GeV
ATLAS EXPERIMENT
Run: 267638
Event: 193690558
2015-06-13 23:52:26 CEST

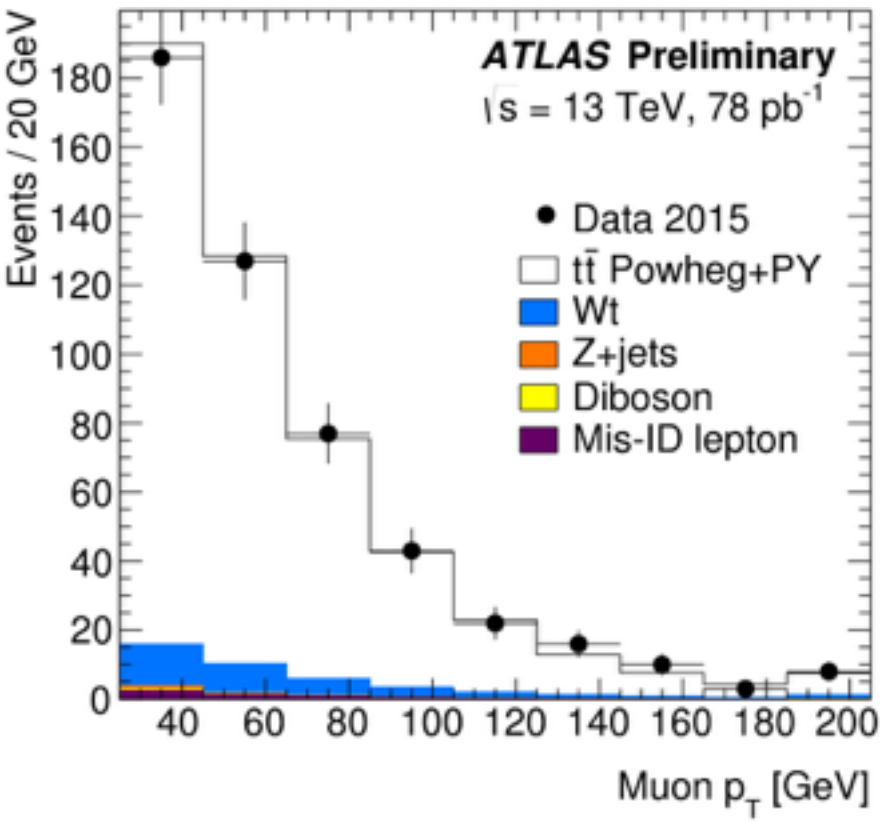
[ATLAS-CONF-2015-033]

ttbar Production

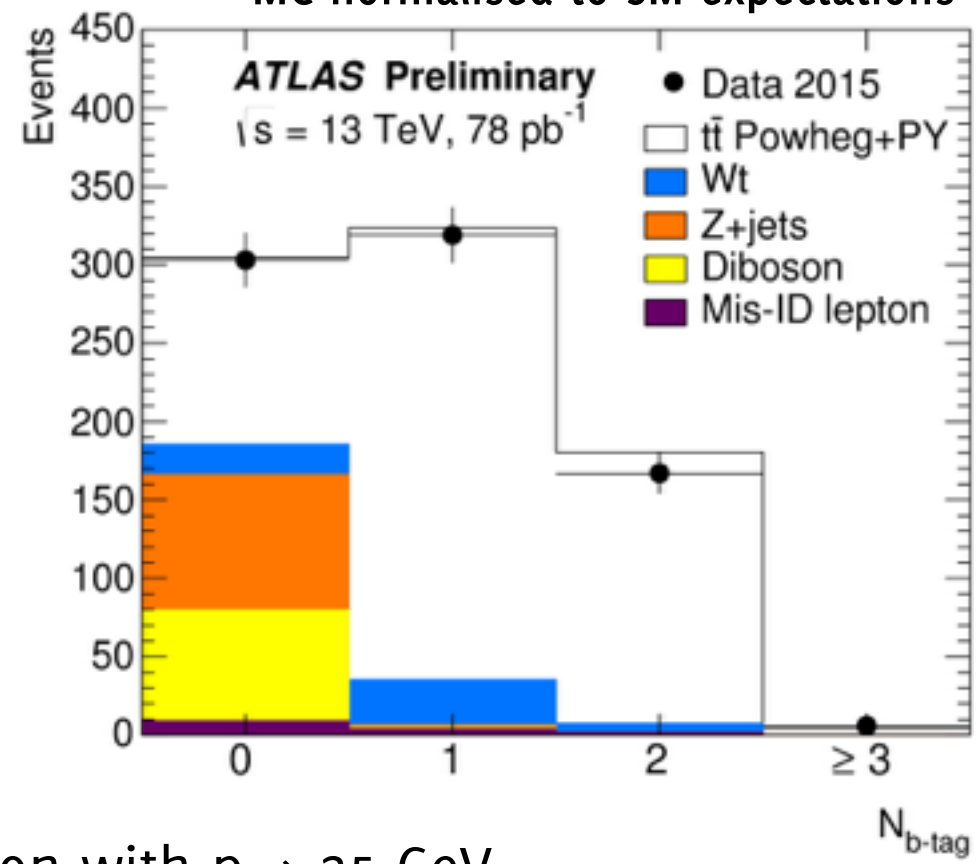
using the cleanest decay channel:

$tt \rightarrow (e + \nu + b\text{-jet}) + (\mu + \nu + b\text{-jet}) = e\mu + 2b\text{-jet} + E_T^{miss}$

MC normalised to data



MC normalised to SM expectations

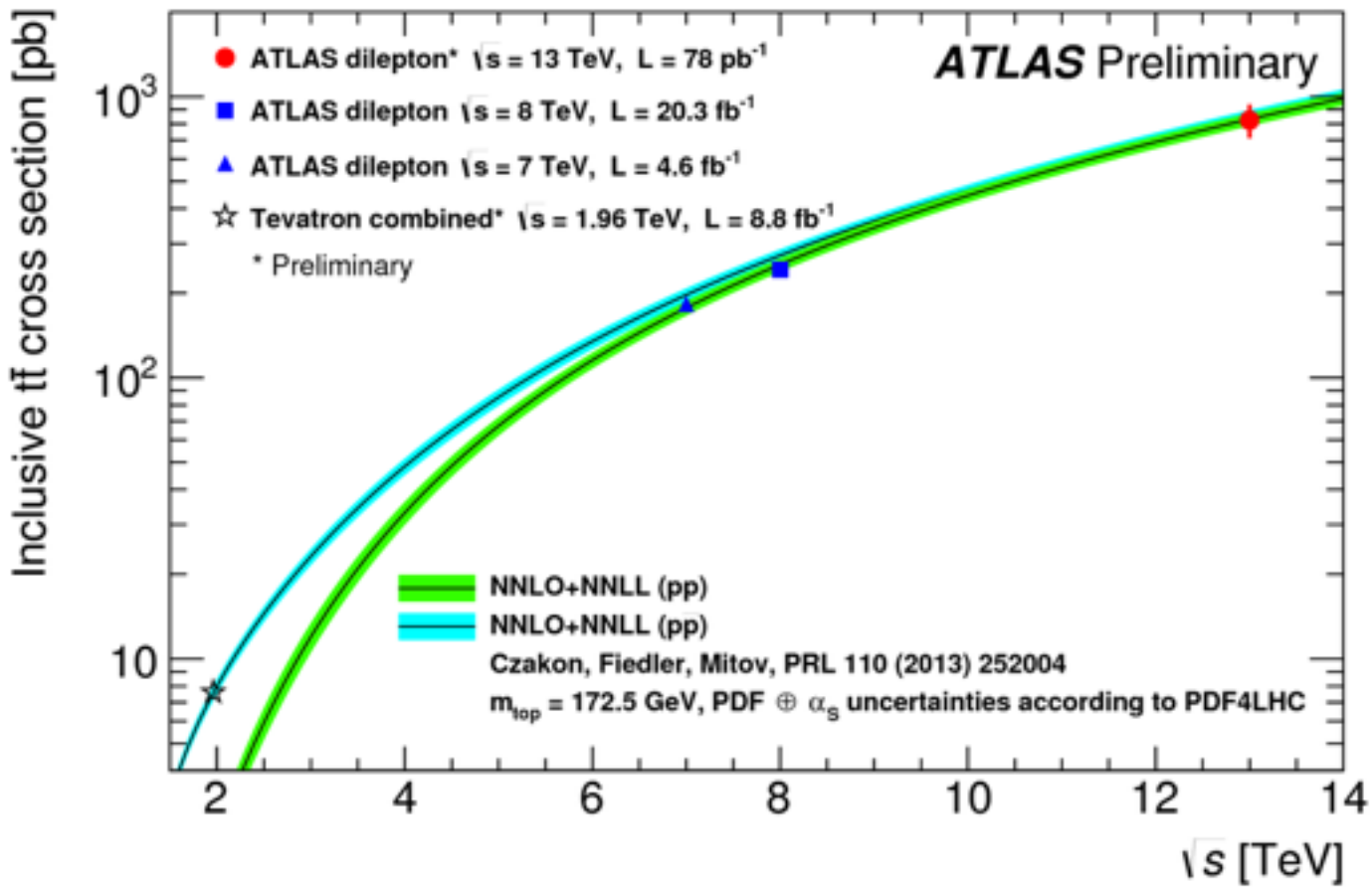


OS electron and muon with p_T > 25 GeV

at least one b-tagged jet with p_T > 25 GeV

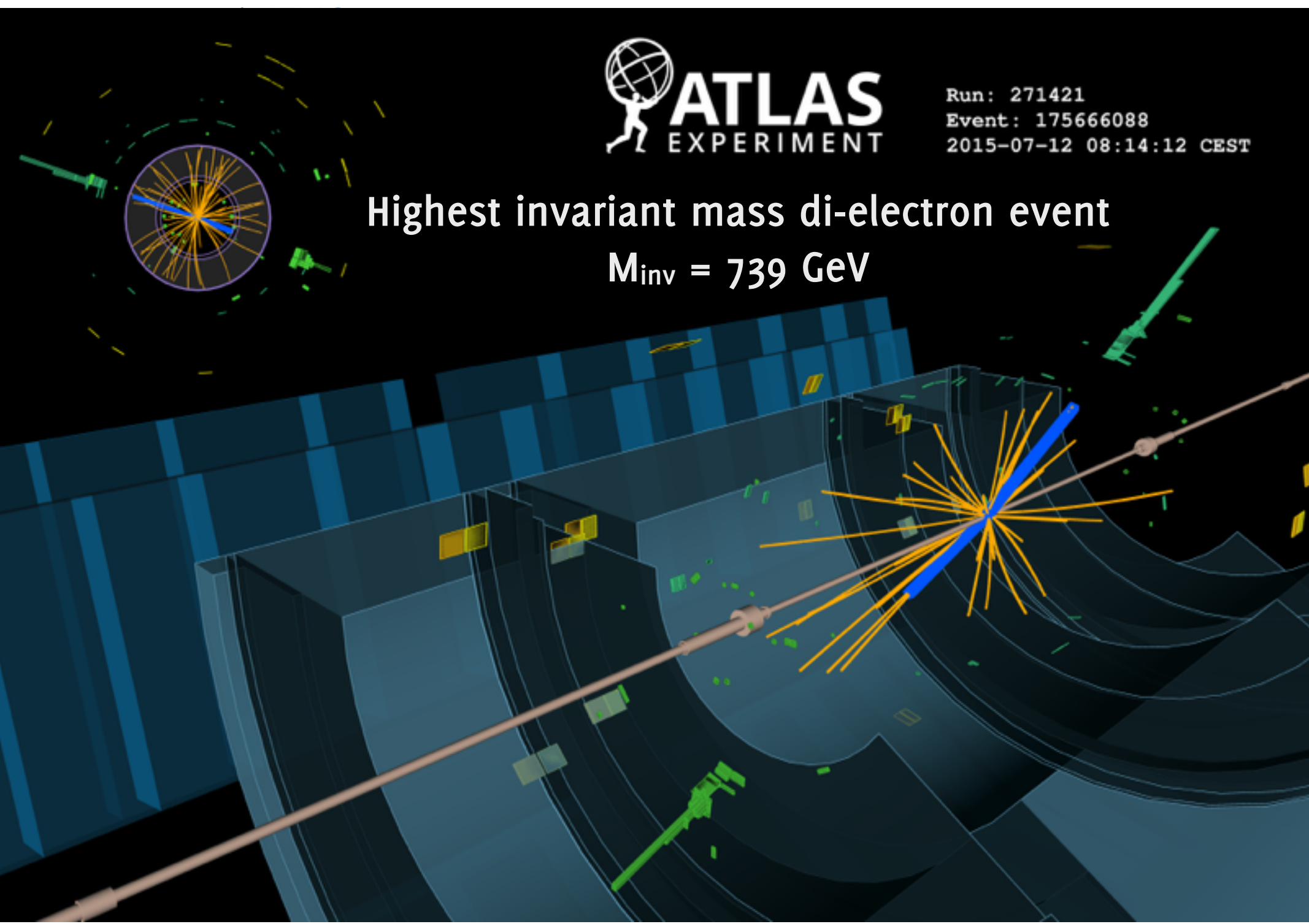
[ATLAS-CONF-2015-033]

ttbar Cross-Section Measurement



8 to 13 TeV → expected increase of the cross-section of a factor 3.3

good agreement with NNLO calculations !



Highest invariant mass di-electron event

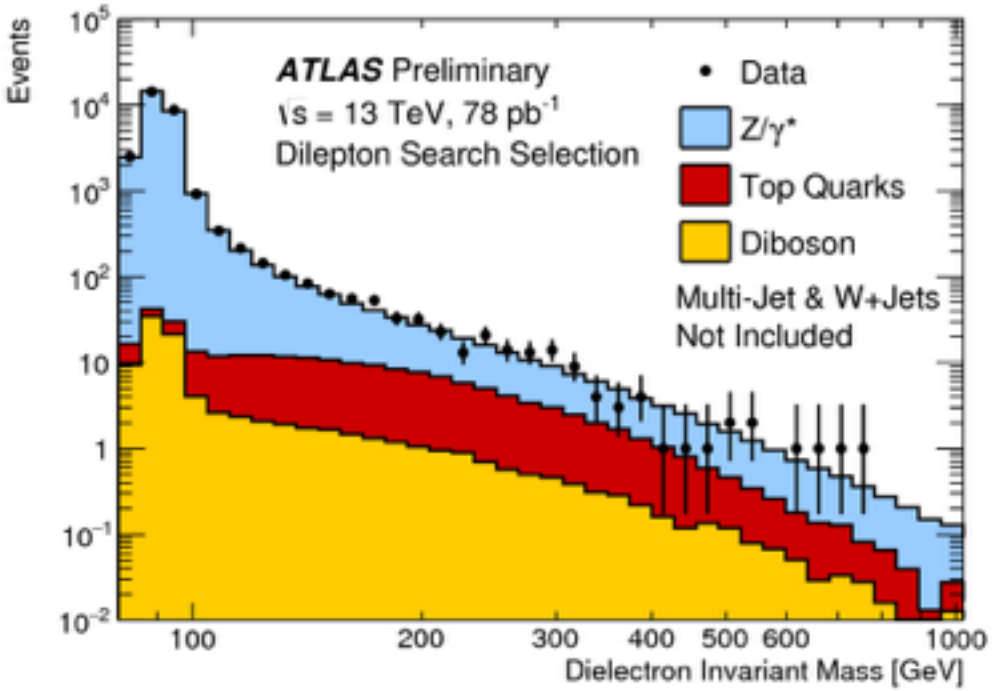
M_{inv} = 739 GeV

[EXOT-2015-001]

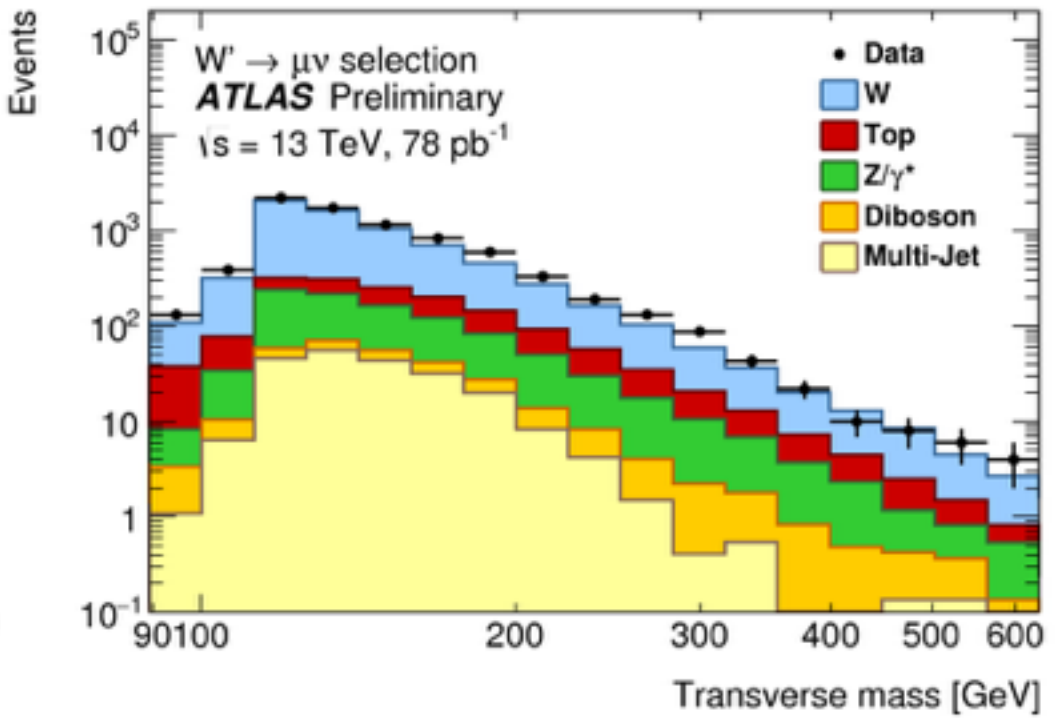
[EXOT-2015-002]

Searches for Z' and W'

pp→ee + X



pp→μν + X



multi-jet background data-driven

first performance plots produced
insufficient luminosity to challenge Run-1 sensitivities

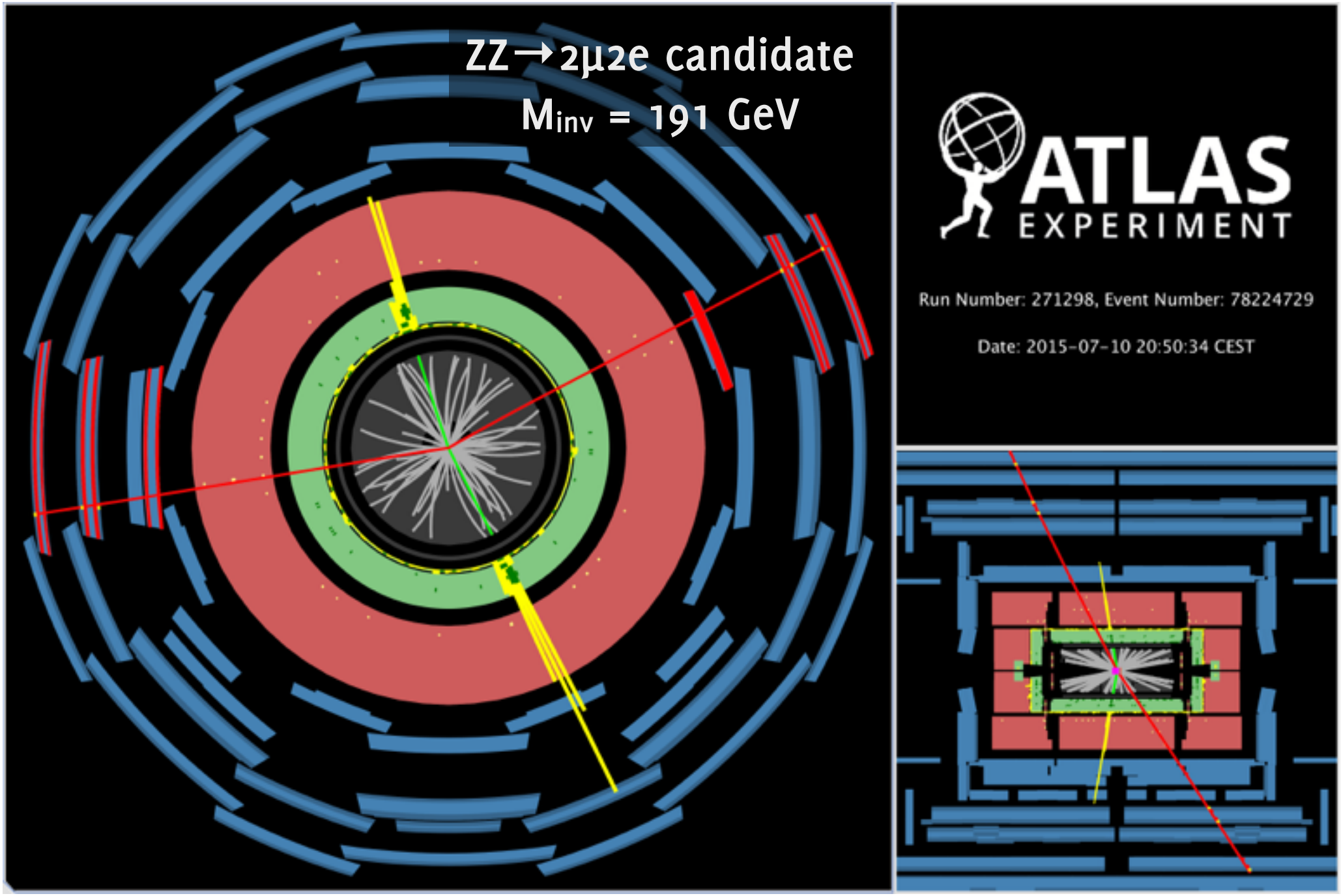
Conclusions

- The LHC is back ! Already providing pp data at 13 TeV
- ATLAS has integrated and commissioned new detector systems, software and analysis frameworks successfully
- **Remarkable understanding of 13 TeV data !** First measurements of J/ψ, W, Z, and ttbar shown today → good agreement with expectations
- Need to integrate more statistics for searches, some preliminary studies are already out !

ATLAS is fully operational, only a very small (and arbitrary !) selection of material shown here, full list of summer conference results:

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

Backup

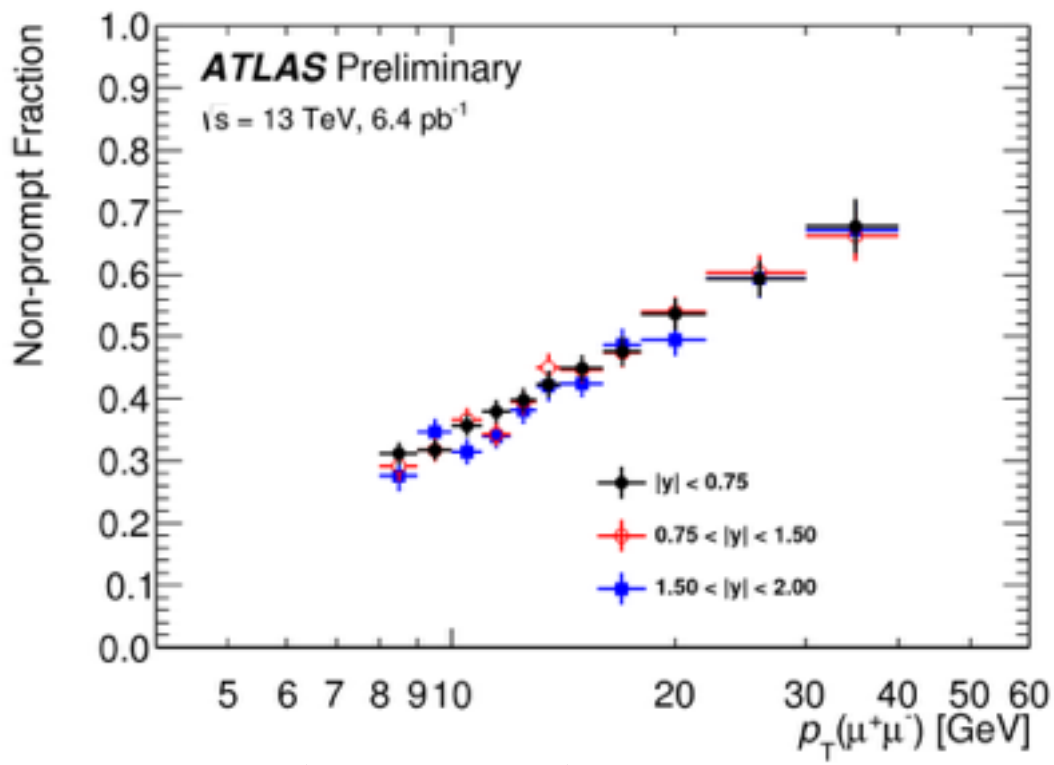


we also have already seen diboson production !

J/ψ Production: Measuring Non-Prompt Fraction

non-prompt to prompt fraction defined as

$$R = \frac{d\sigma(pp \to b\bar{b}X \to J/\Psi X')}{d\sigma(pp \to J/\Psi X'')}$$

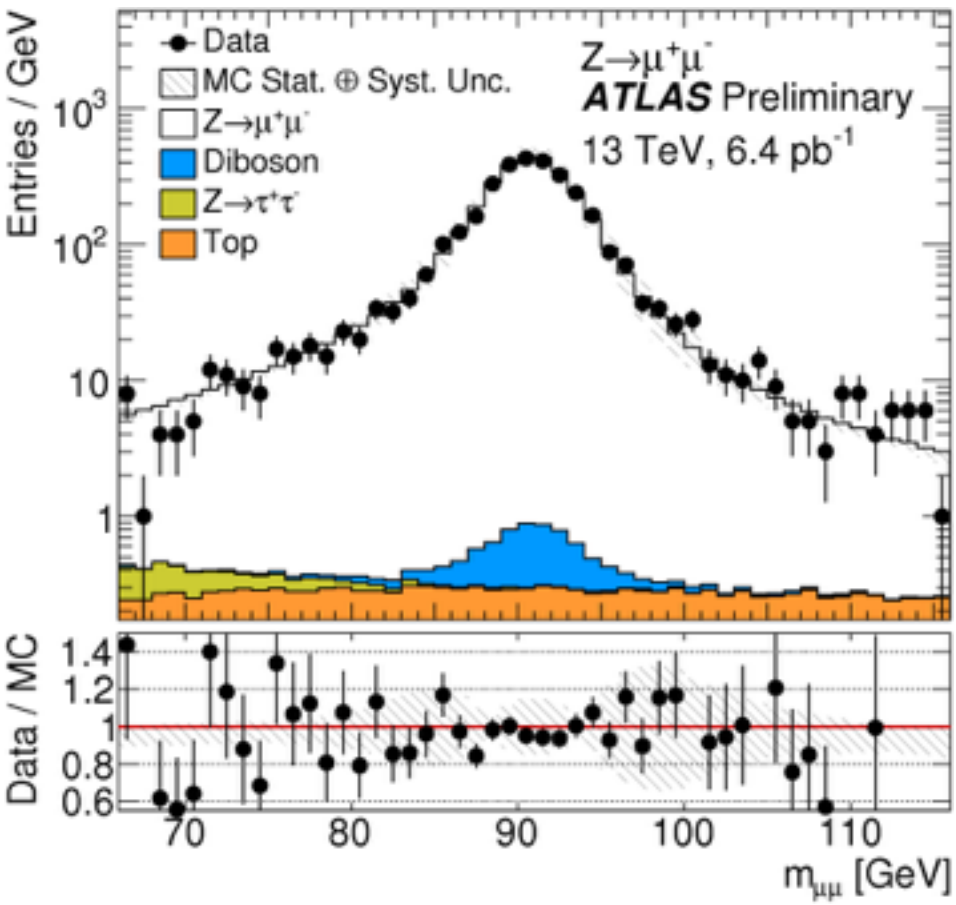


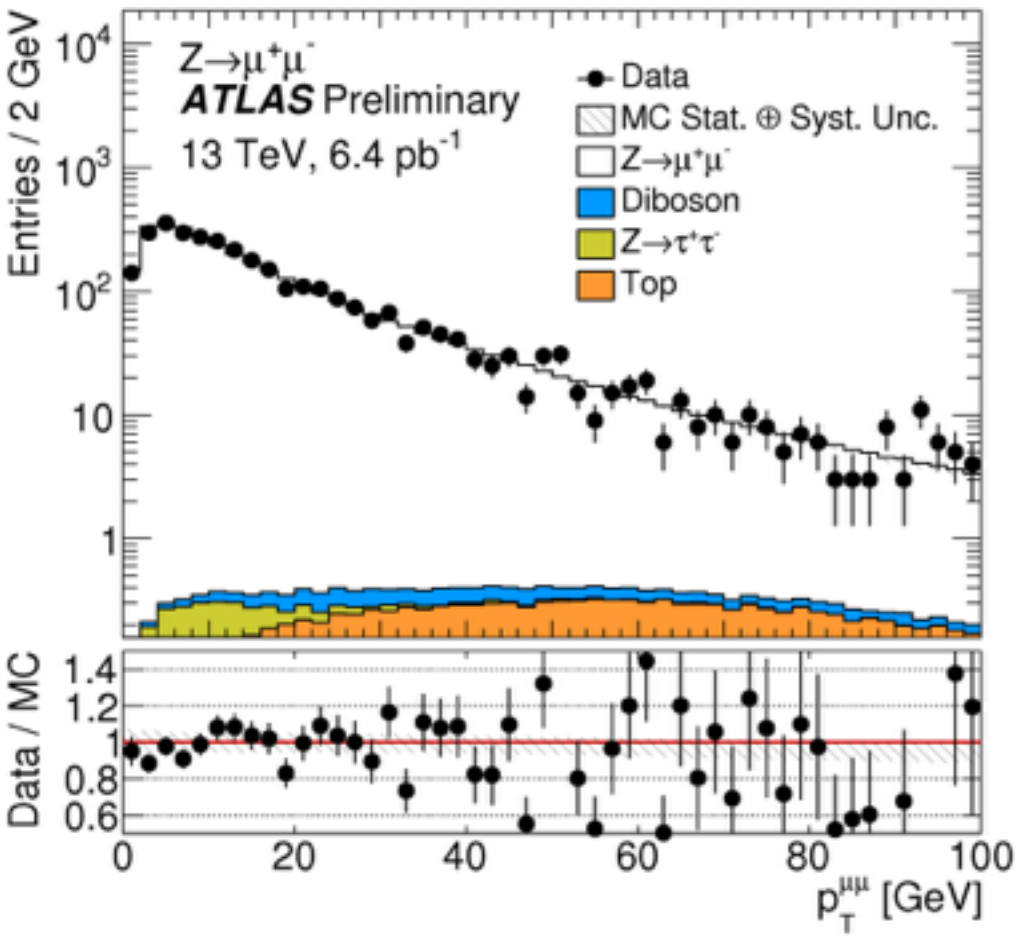
as a function of rapidity

[ATL-PHYS-PUB-2015-021]

Z Production at 13 TeV

Z→μμ events

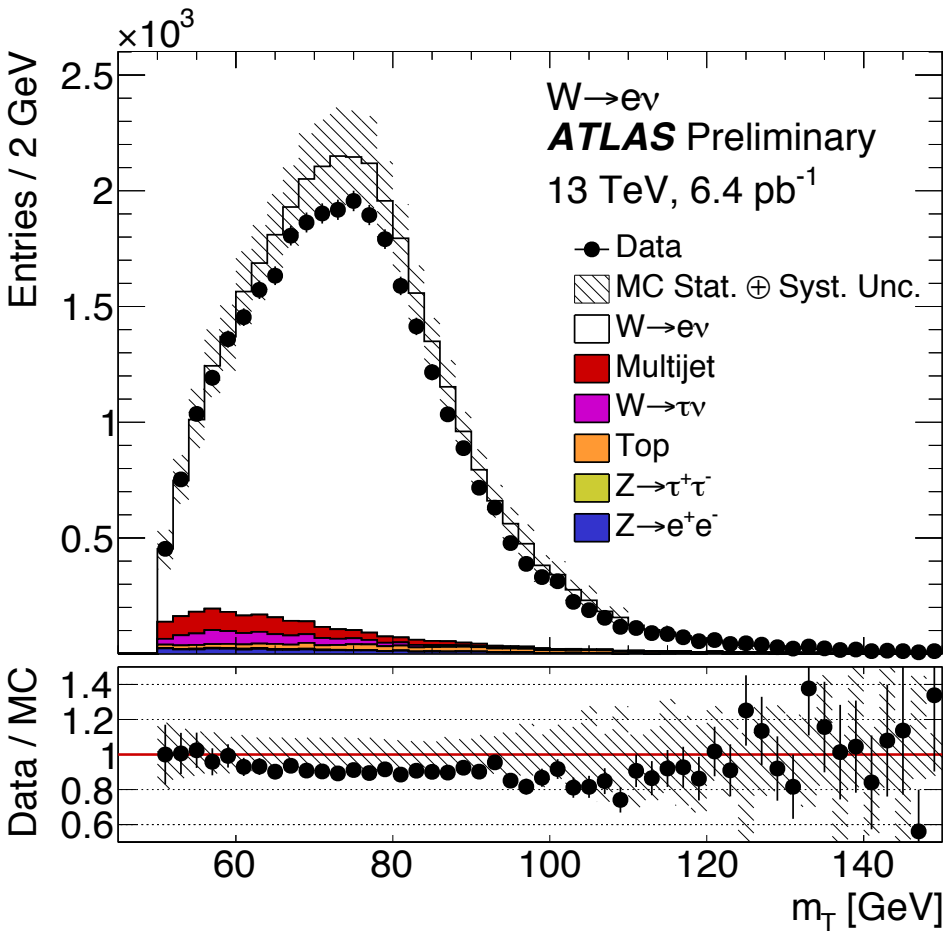


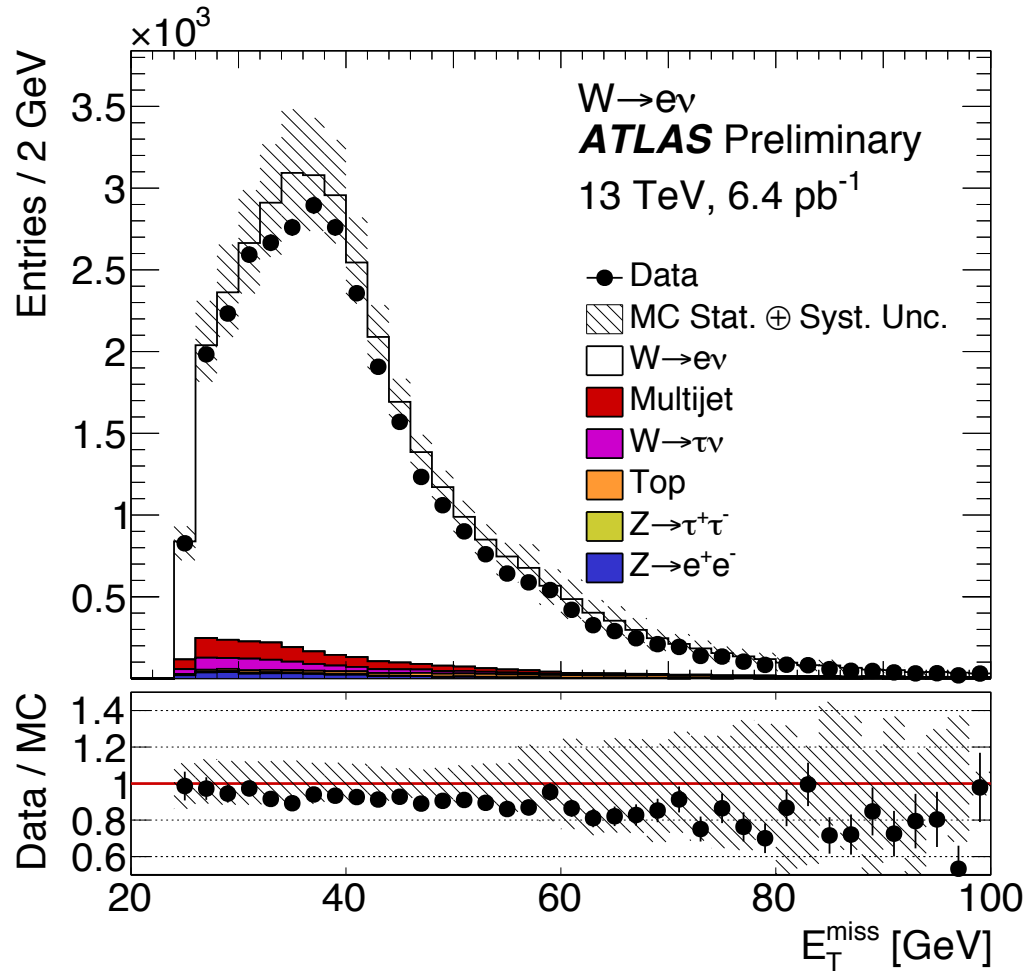


[ATL-PHYS-PUB-2015-021]

W Production at 13 TeV

W→eν events





ttbar Cross-Section Measurement Systematics

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

Total relative uncertainty of 14% (4.3% at 8 TeV)

σ_{tt}[SM] (13 TeV) = 832^{+40}_{-46} pb (at NNLO + NNLL accuracy, m_t = 172.5 GeV, Top++ 2.0)

Systematic uncertainty (7.3%) dominated by

- tt hadronisation (4.5%) → large Pythia8 / Herwig++ parton shower effect, to be further studied
- tt NLO modelling, ISR/FSR radiation & PDF (2.9%)
- Electron ID + isolation (4.2%)
- Muon ID + isolation (1.6%)
- Lepton mis-identification (1.3%)
- Lepton triggers (1.3%)

→ will improve with more data

Overall uncertainty dominated by luminosity (9%) → will improve with full van-der-Meer luminosity scan

We also measure: ε_b = 0.527 ± 0.026 ± 0.006, in good agreement with simulation: 0.543