Jet fragmentation, electro-weak boson, and charmonium production in pp and p-Pb

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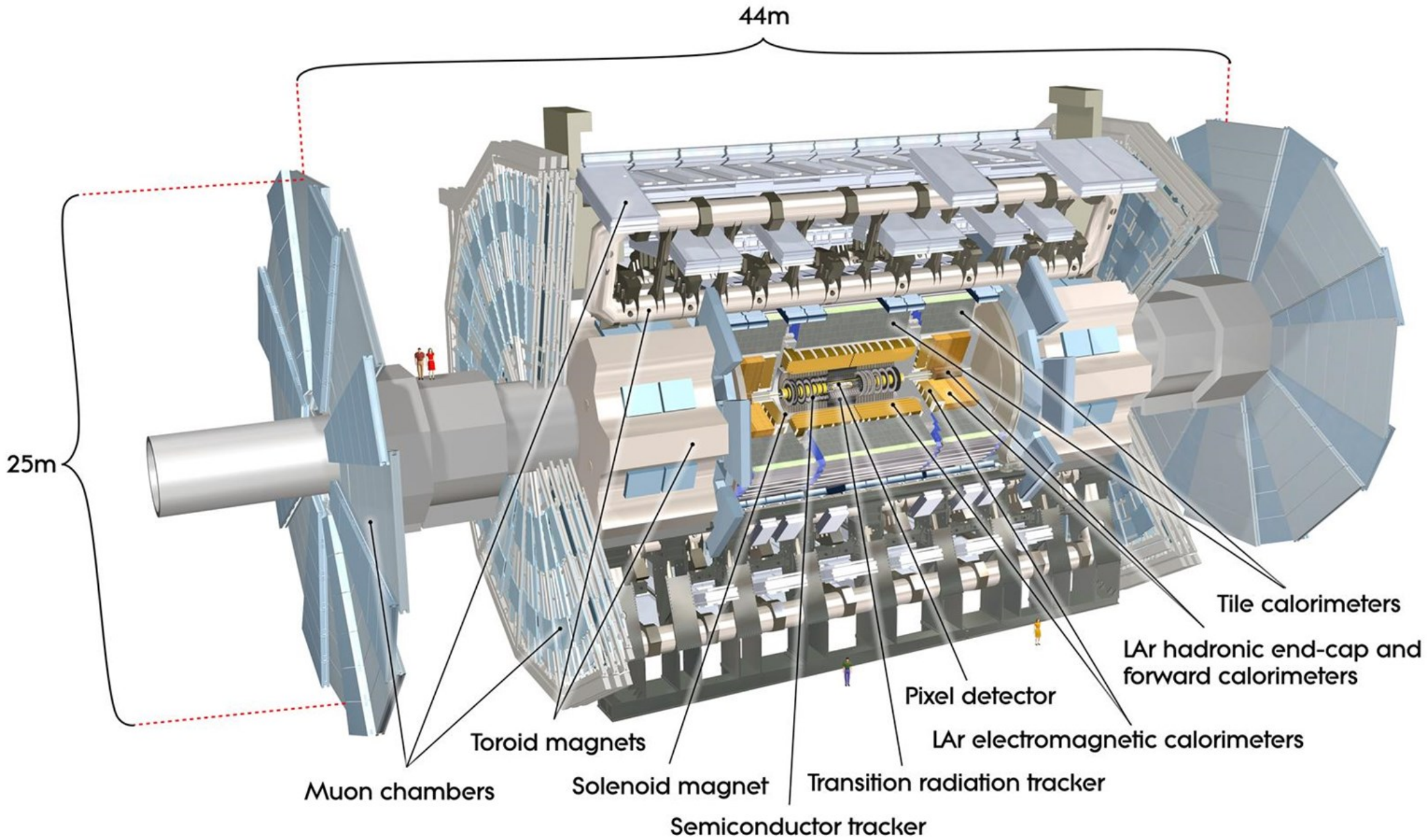
Initial Stages 2016, Instituto Superior Técnico, Lisboa

ATLAS EXPERIMENT

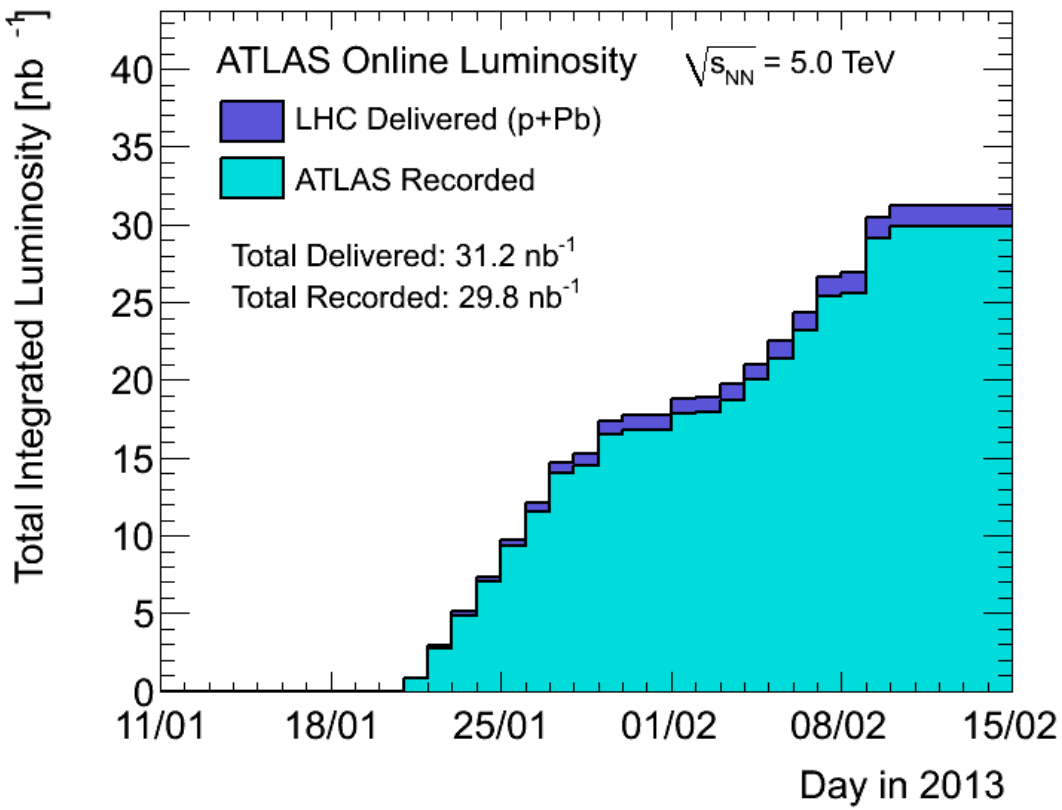
Motivation

- Study nuclear modification of PDFs
- Benchmark for studies of AA collisions
- Search for final state effects, normally attributed to QGP (?)


44m
25m
Tile calorimeters
LAr hadronic end-cap and forward calorimeters
Pixel detector
LAr electromagnetic calorimeters
Toroid magnets
Transition radiation tracker
Muon chambers
Solenoid magnet
Semiconductor tracker

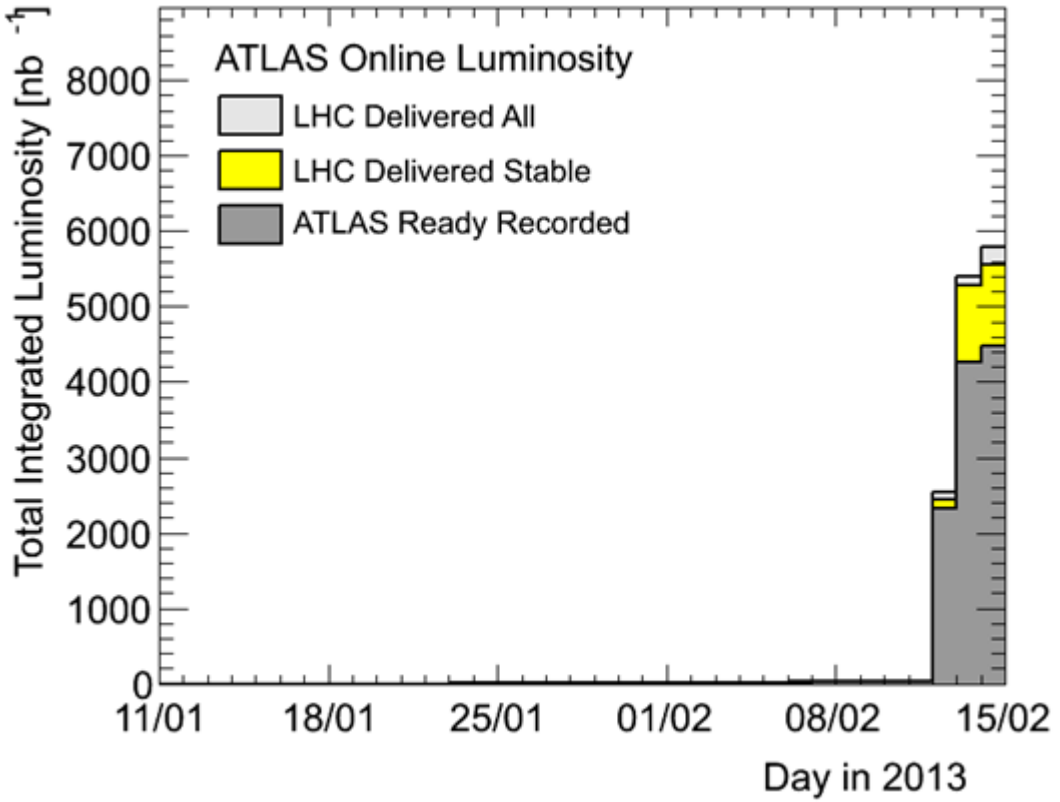
Datasets

p-Pb @ 5 TeV



$28.1\ \mathrm{nb}^{-1} \pm 2.7\%$

pp @ 2.76 TeV



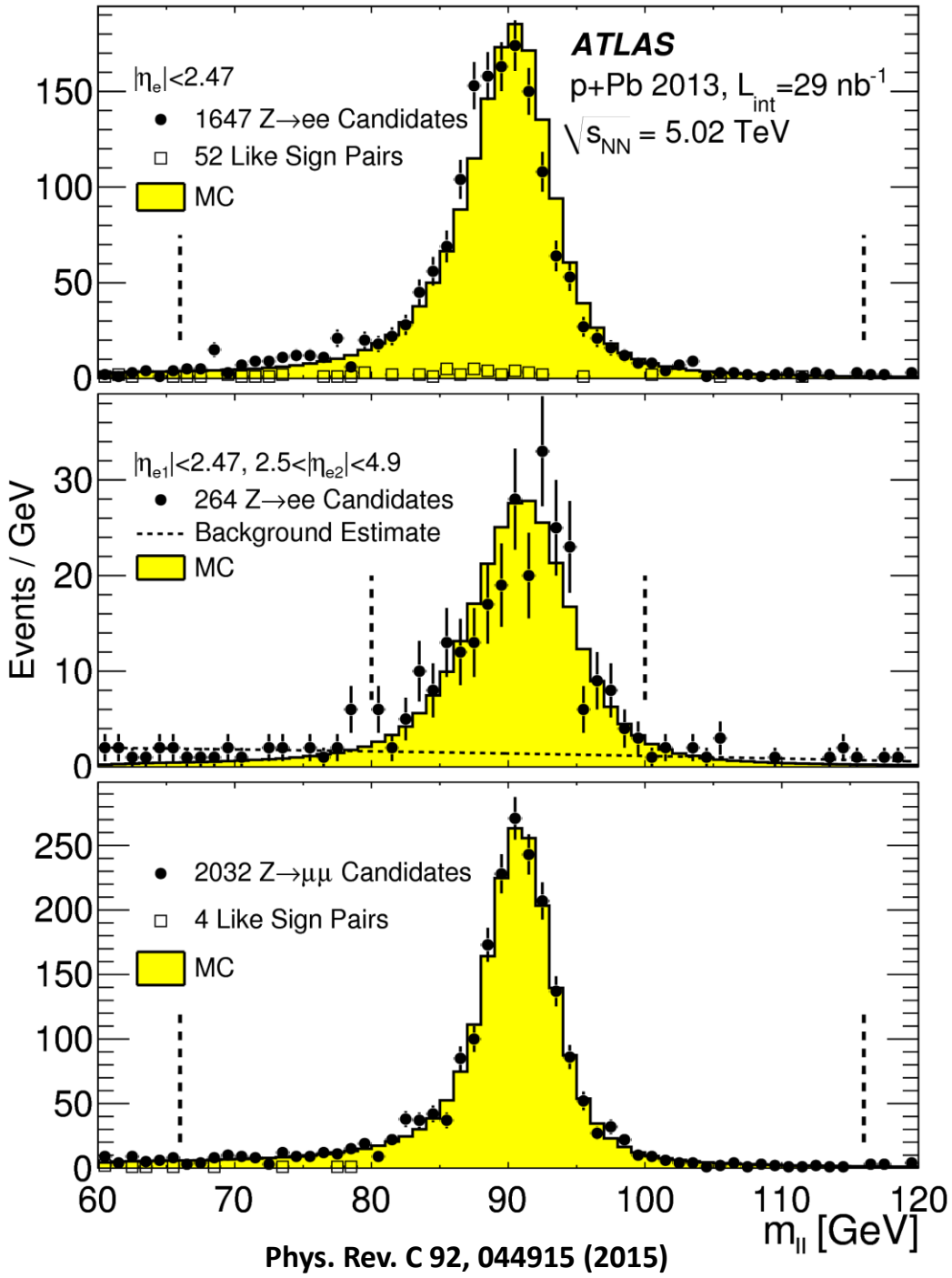
$3.9\ \mathrm{pb}^{-1} \pm 3.1\%$

Electroweak Bosons

W and Z bosons

W measured in muon channel

Z measured in electron and muon channels.



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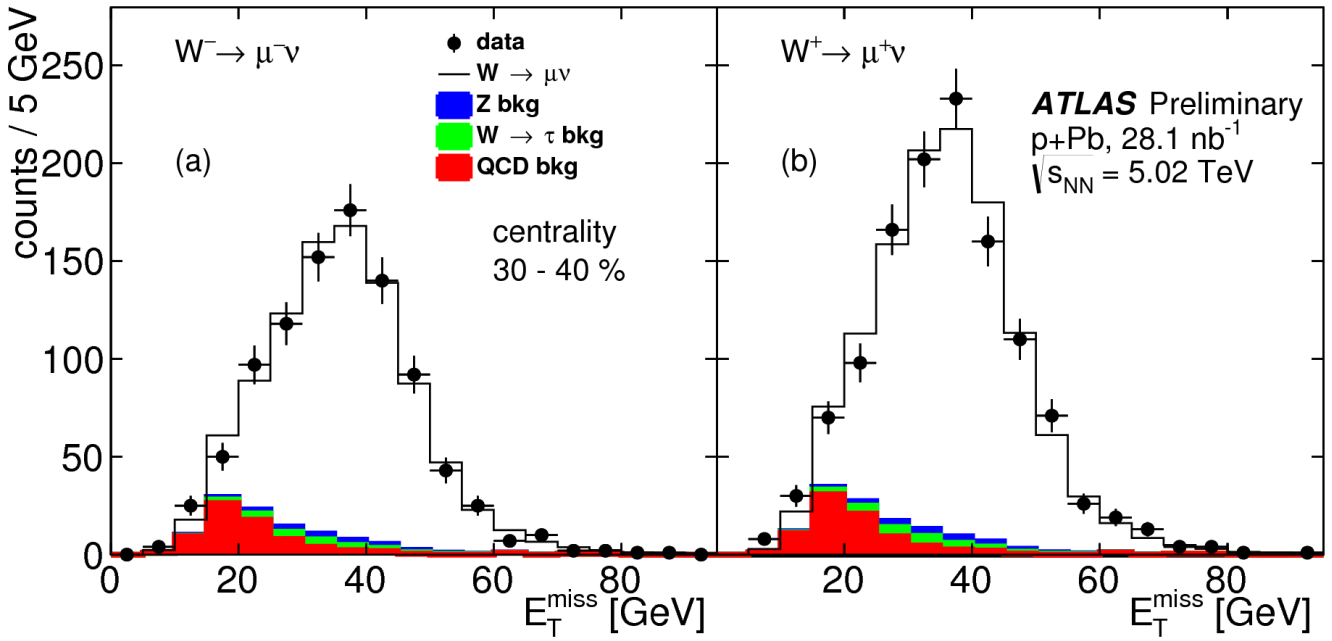

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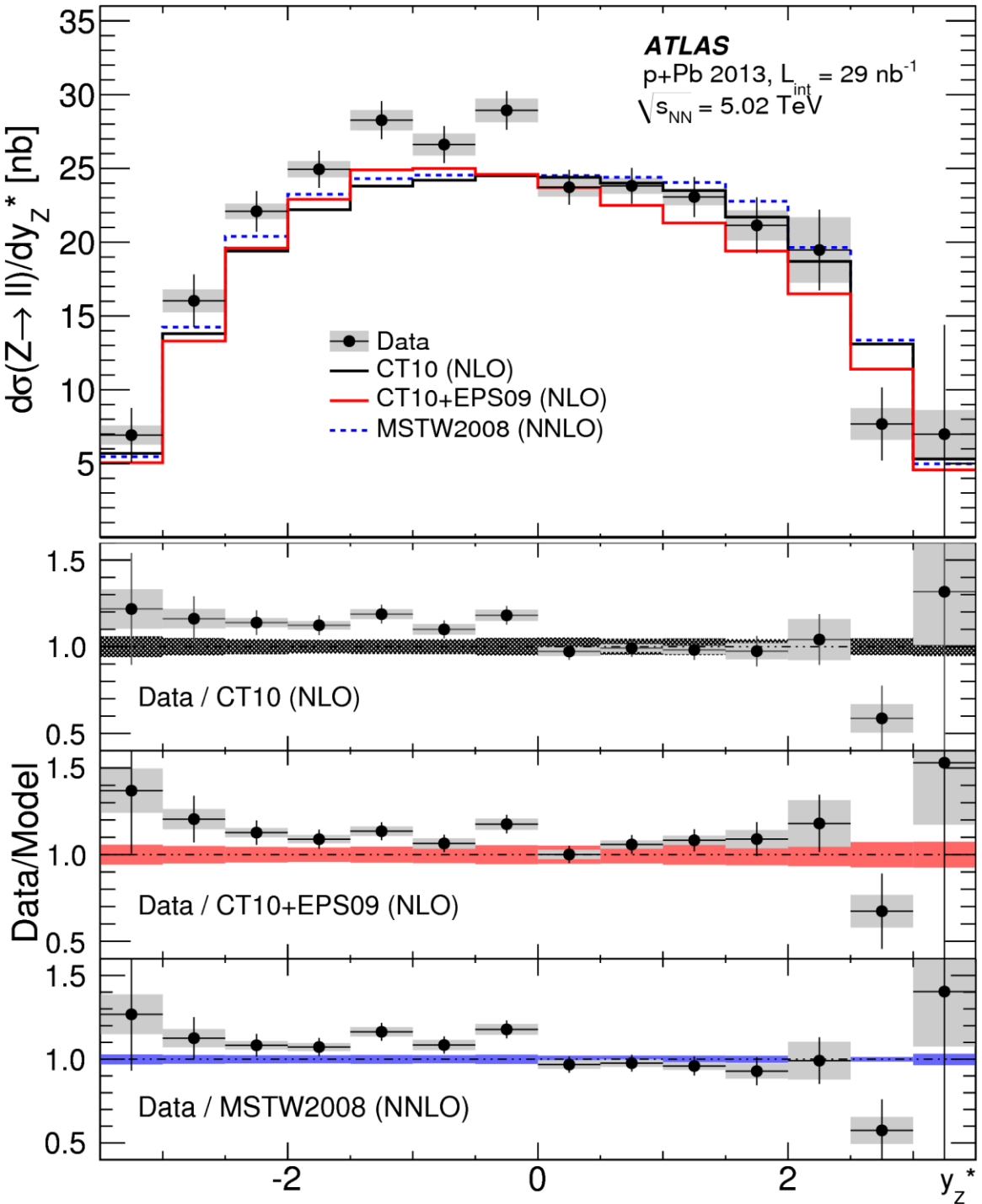
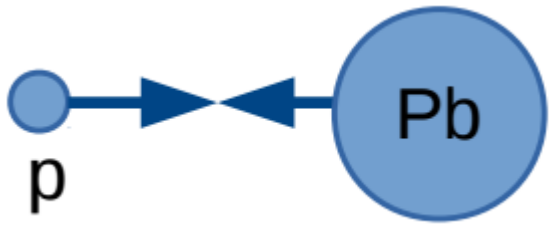
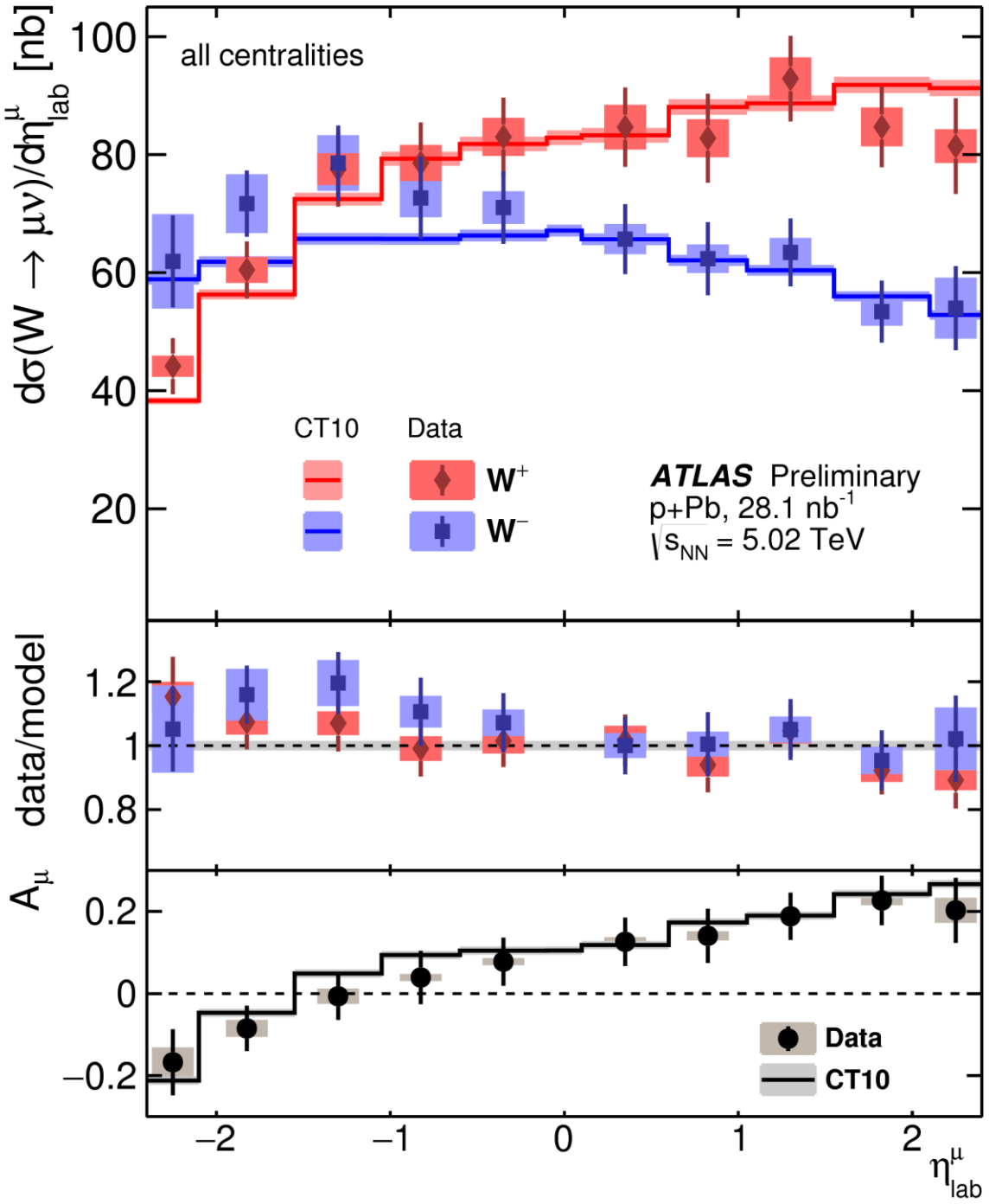


Z boson cross-section

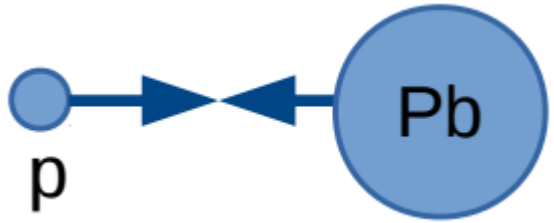
- Hints of excess on Pb-going side
- Otherwise consistent with calculations
- Uncertainties limit discrimination power of different PDFs and nuclear effects





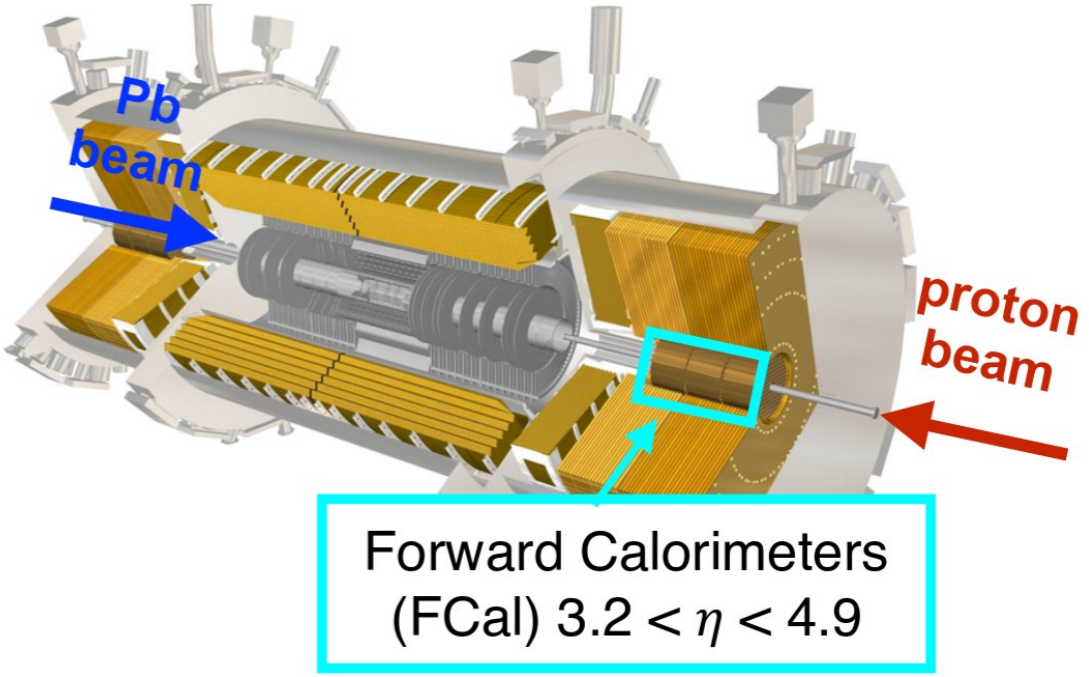
W boson cross-section

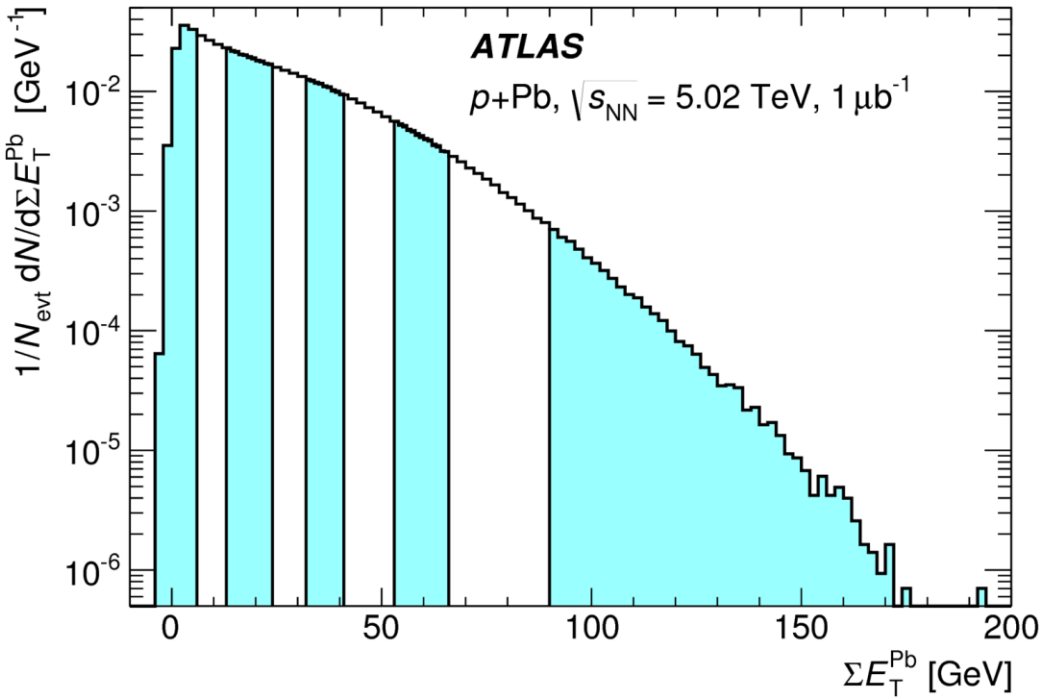
- Hints of excess on the Pb-going side (specially W-)
- Otherwise consistent with calculations with CT10 PDF
- Asymmetry well reproduced

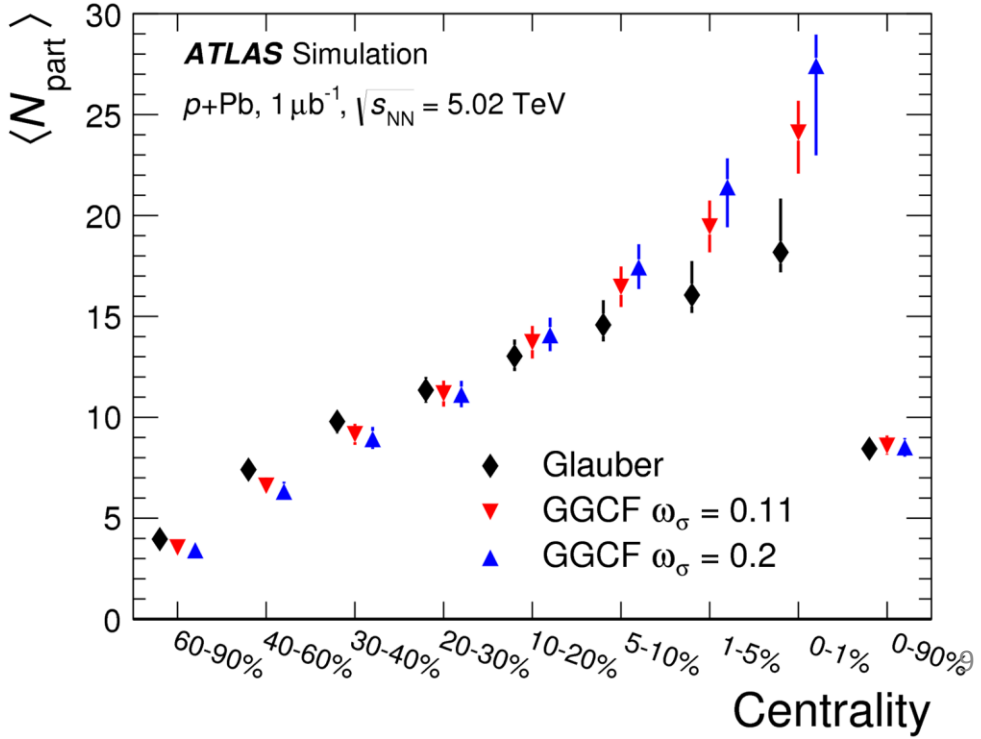


Centrality determination

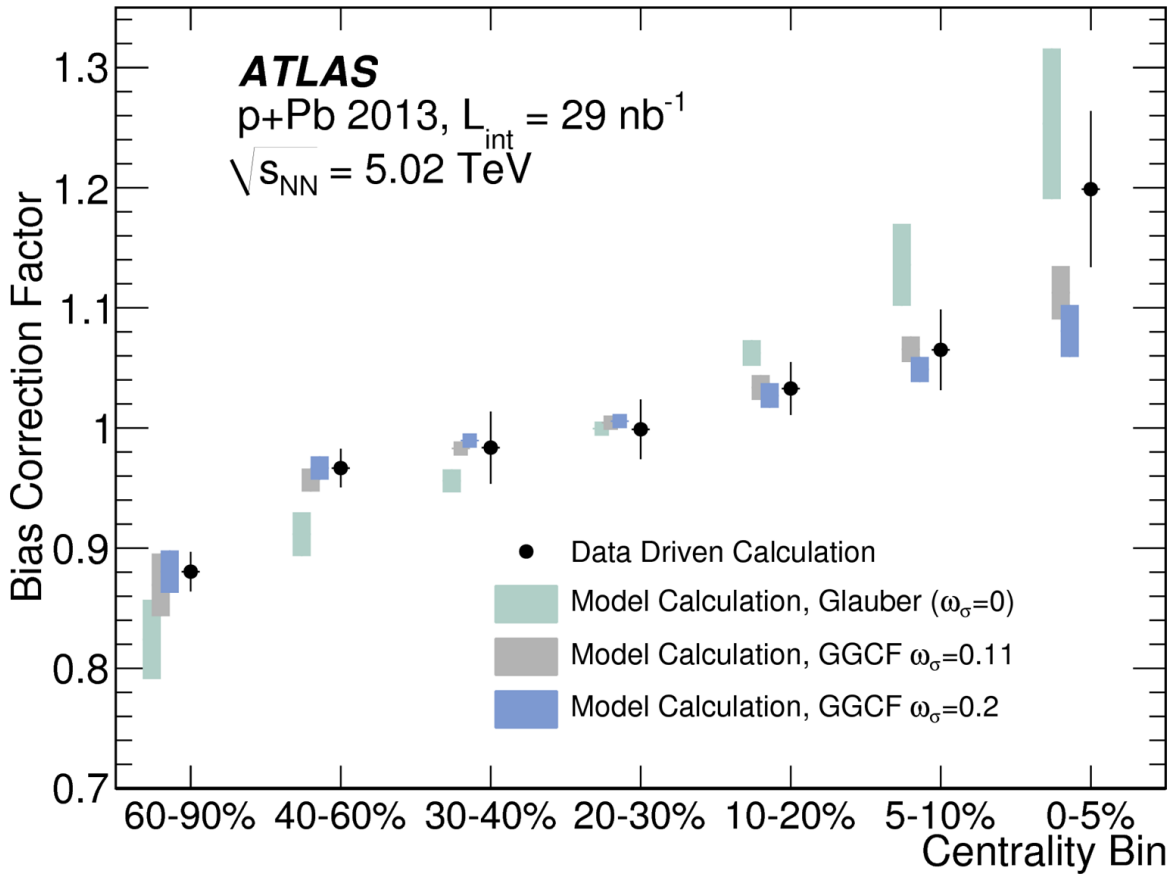
- Uses forward calorimeters on the Pb-going side
- Glauber model, and extensions used to determine mean number of participants
- Analysis assumes no correlation between hard scattering and soft underlying activity







Centrality bias correction



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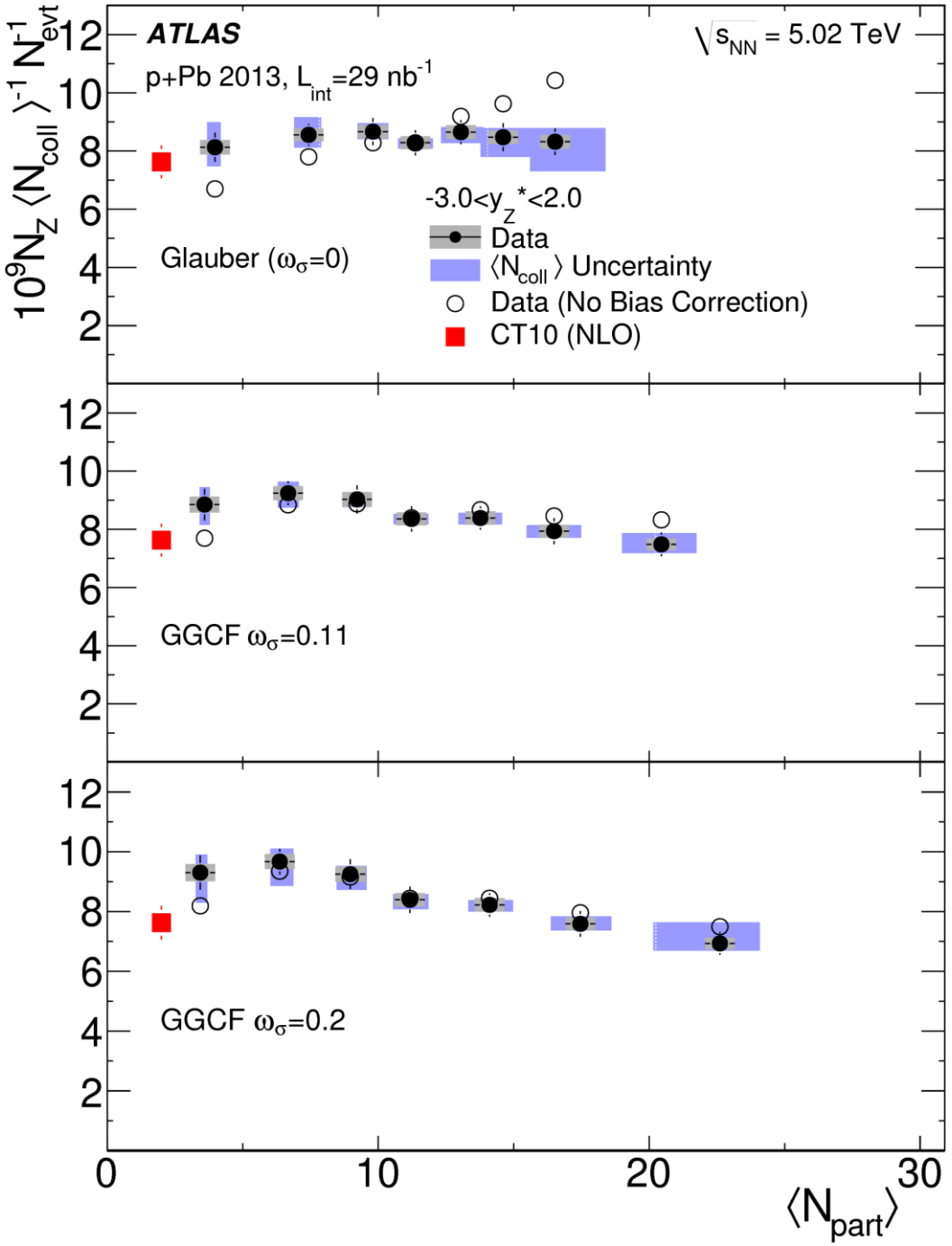
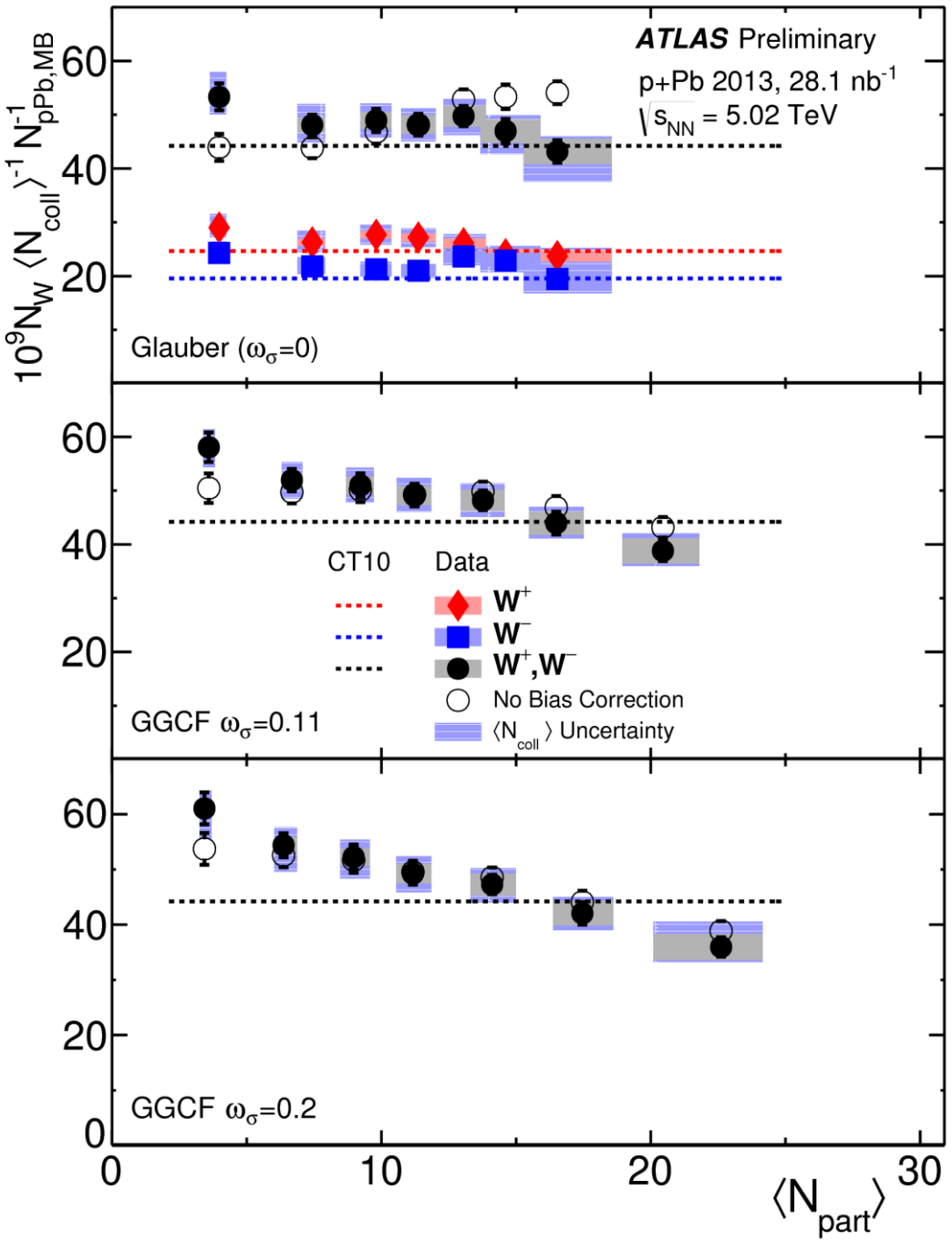
- Estimate of impact of correlation between hard scattering and soft underlying event from model [arXiv:1412.0976] and data.



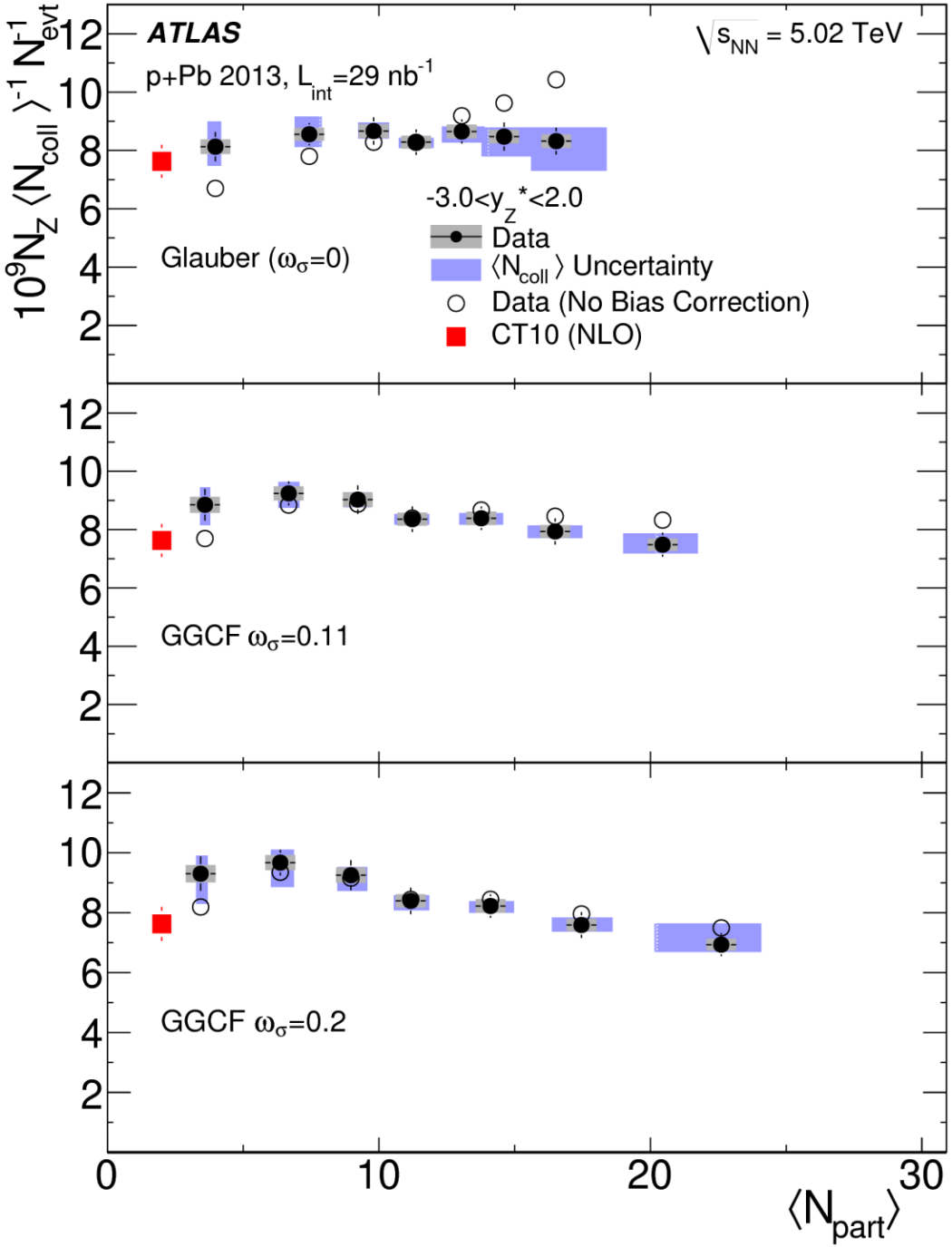
Z boson, centrality dependence

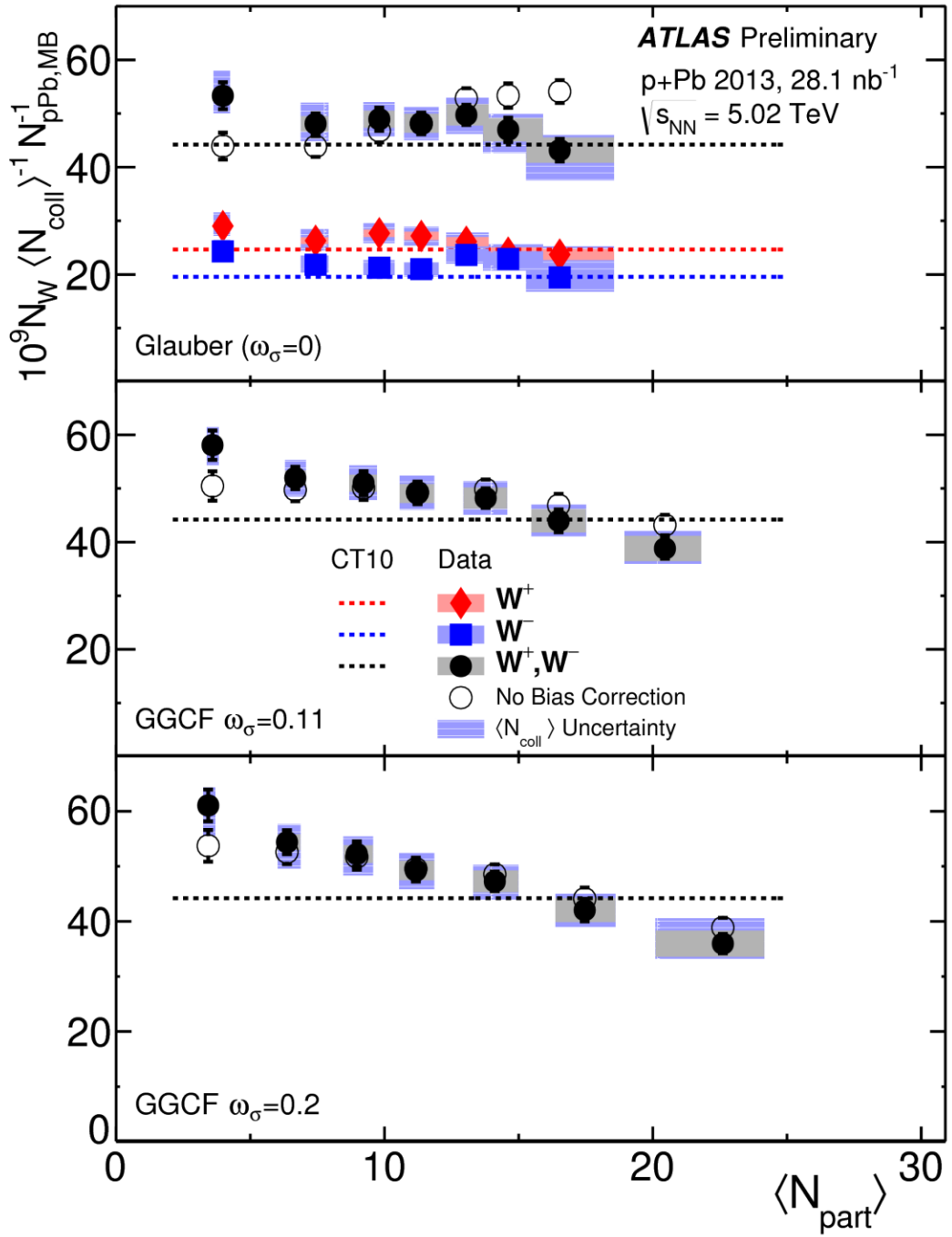
- Reasonable scaling observed with standard Glauber model + centrality bias correction
- Some hints of slope in Glauber-Gribov extensions that include colour fluctuations



W boson, centrality dependence

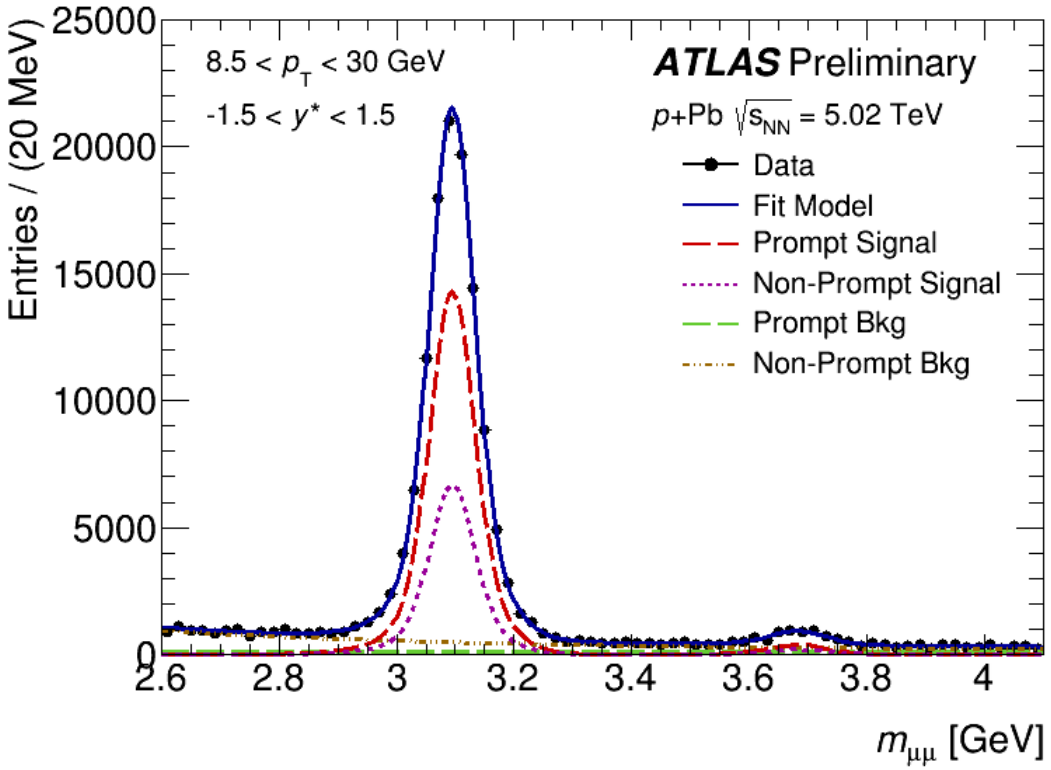
- Reasonable scaling observed with standard Glauber model + centrality bias correction
- Some hints of slope in Glauber-Gribov extensions that include colour fluctuations

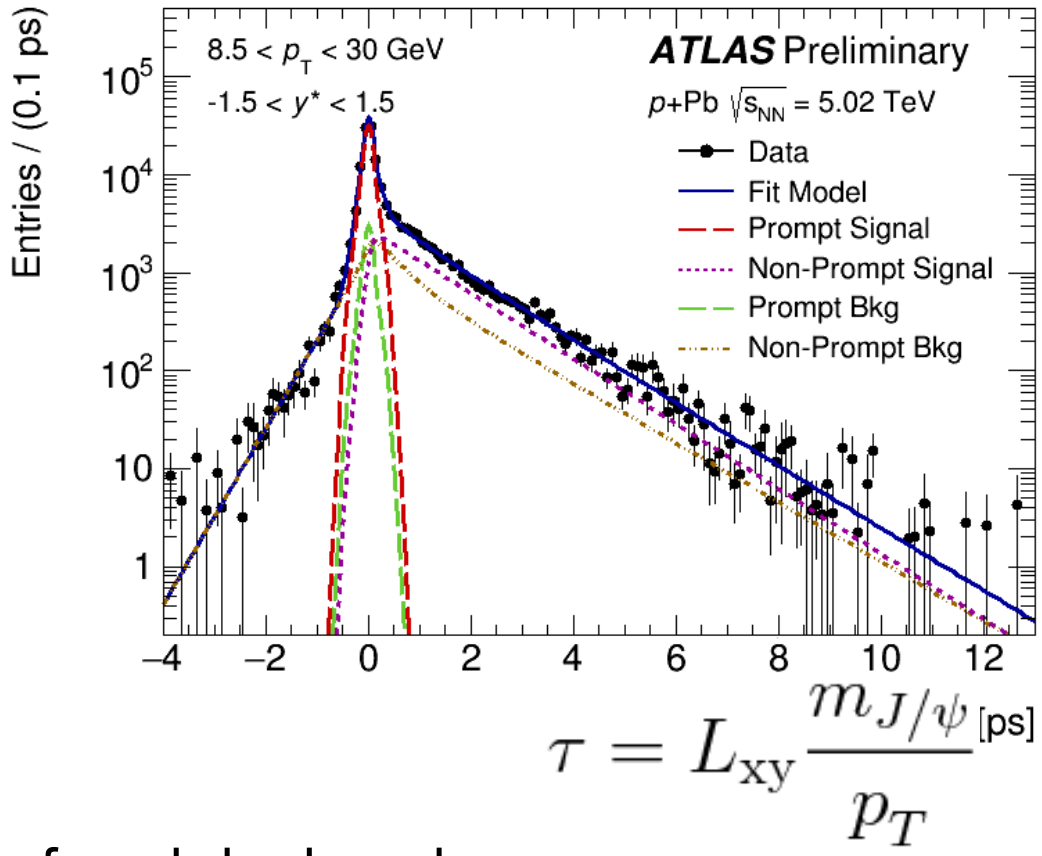

ATLAS
p+Pb 2013, L_int=29 nb^-1
√s_NN = 5.02 TeV
-3.0<y_Z*<2.0
Data
⟨N_coll⟩ Uncertainty
Data (No Bias Correction)
CT10 (NLO)
Glauber (ω_σ=0)
GGCF ω_σ=0.11
GGCF ω_σ=0.2
10^9 N_Z ⟨N_coll⟩^-1 N_evt^-1
⟨N_part⟩


ATLAS Preliminary
p+Pb 2013, 28.1 nb^-1
√s_NN = 5.02 TeV
CT10
Data
W+
W−
W+,W−
No Bias Correction
⟨N_coll⟩ Uncertainty
Glauber (ω_σ=0)
GGCF ω_σ=0.11
GGCF ω_σ=0.2
10^9 N_W ⟨N_coll⟩^-1 N_pPb,MB^-1
⟨N_part⟩

Charmonium

2D fit to mass and pseudo-lifetime

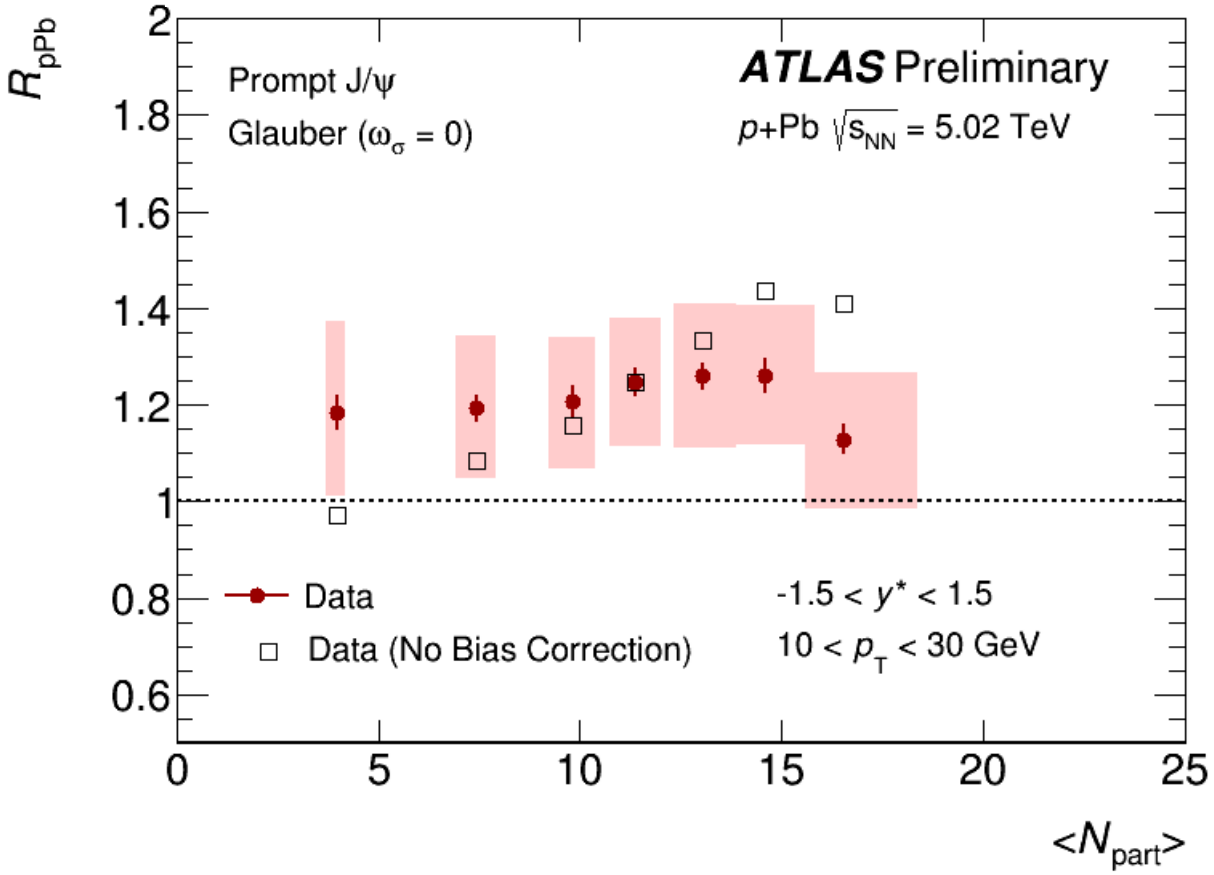




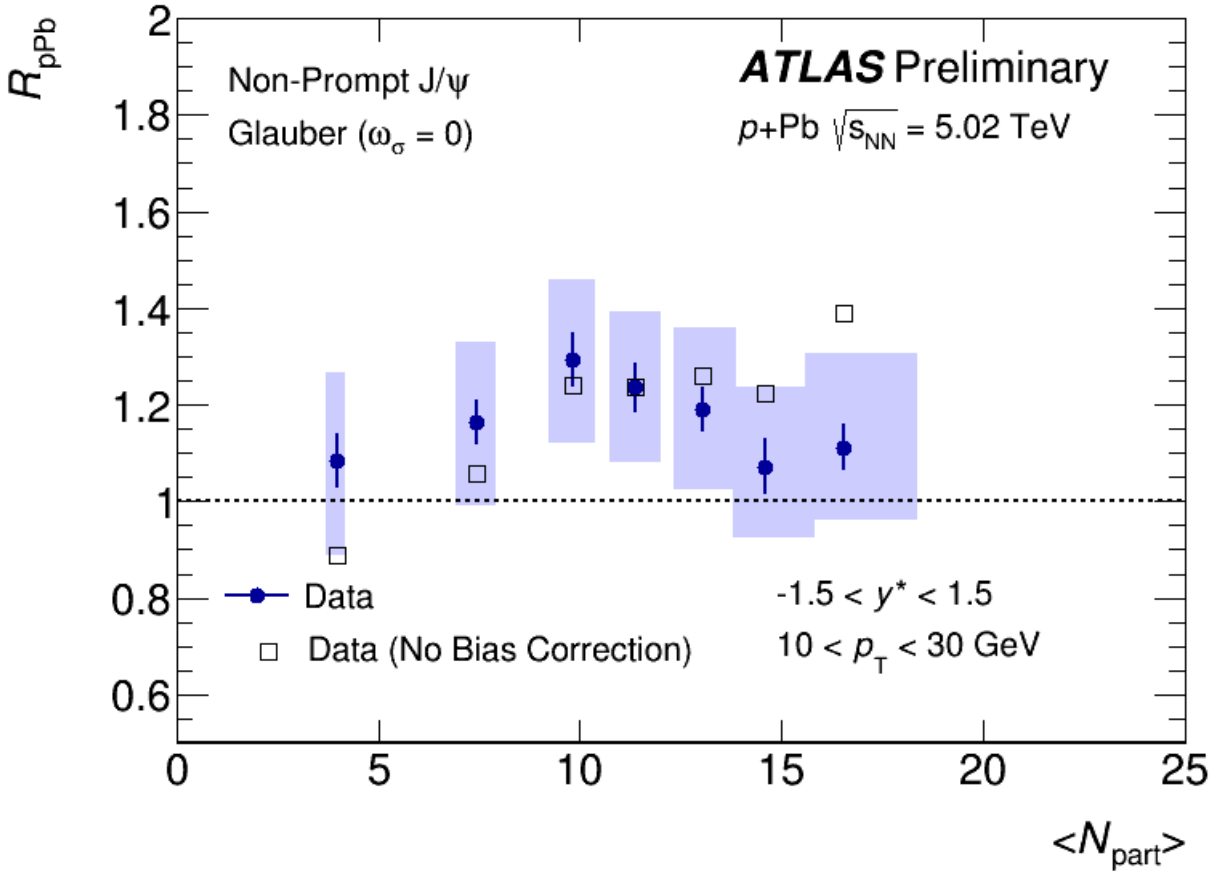
- Maximum likelihood fit to extract yields and fraction from b-hadron decays
- Event-by-event weighting for acceptance, reconstruction, and trigger efficiencies $w_{\text{total}}^{-1} = A \cdot \varepsilon_{\text{reco}} \cdot \varepsilon_{\text{trig}}$

$$R_{p\mathrm{Pb}} = \frac{1}{\langle T_{p\mathrm{Pb}} \rangle_{\mathrm{cent}}} \frac{1/N_{\mathrm{evt}}\, d^2 N_{\psi}^{p+\mathrm{Pb}}/dy^* dp_{\mathrm{T}} \Big|_{\mathrm{cent}}}{d^2\sigma_{\psi}^{pp}/dy dp_{\mathrm{T}}}$$

Prompt J/ψ



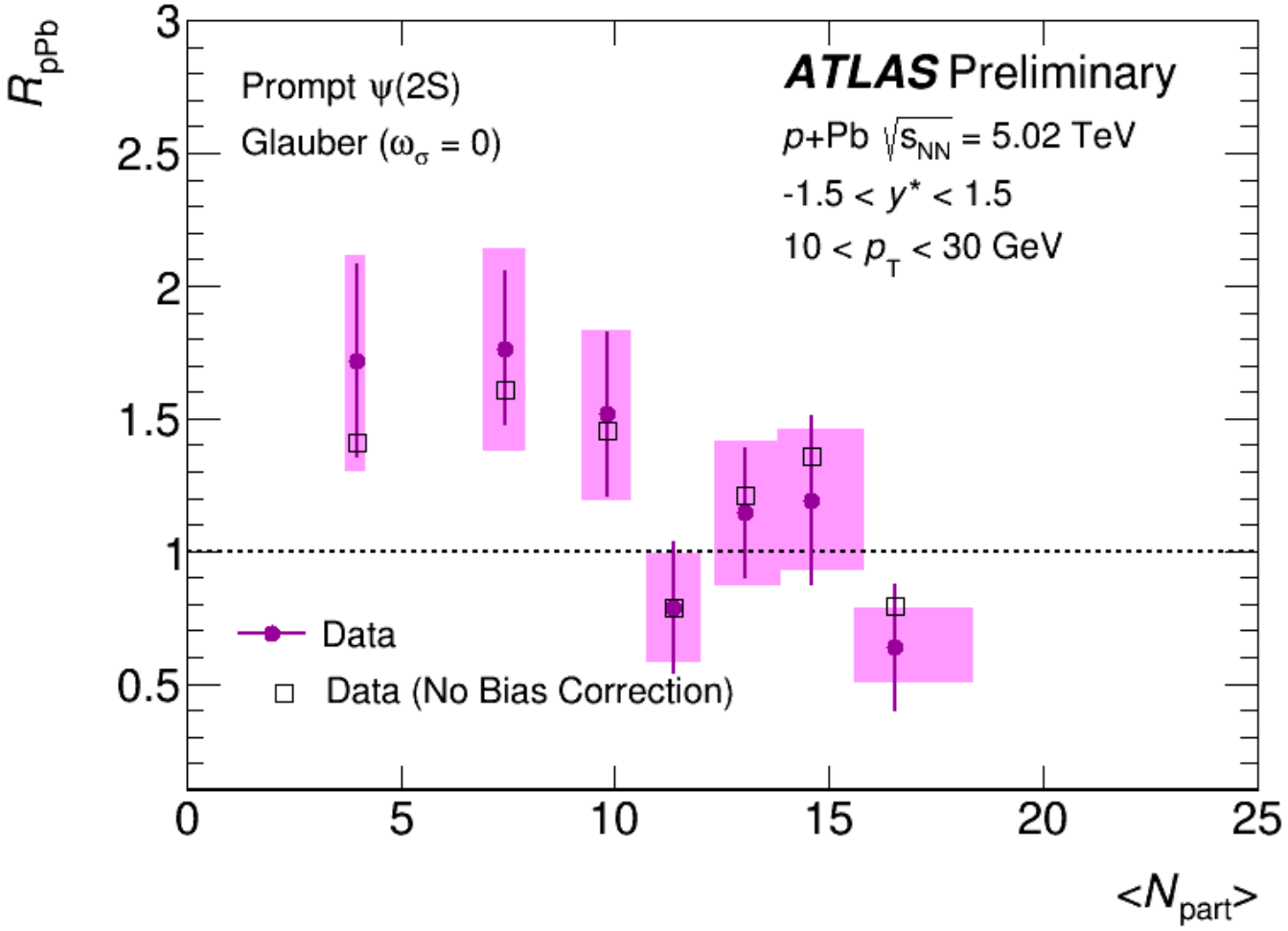
J/ψ from b



After centrality bias correction, ratio is flat

$\psi(2S)$

$$R_{p\mathrm{Pb}} = \frac{1}{\langle T_{p\mathrm{Pb}} \rangle_{\mathrm{cent}}} \frac{1/N_{\mathrm{evt}}\, d^2N_{\psi}^{p+\mathrm{Pb}}/dy^* dp_{\mathrm{T}} \Big|_{\mathrm{cent}}}{d^2\sigma_{\psi}^{pp}/dy dp_{\mathrm{T}}}$$



Hint of centrality dependence

Standard candle: the Z boson

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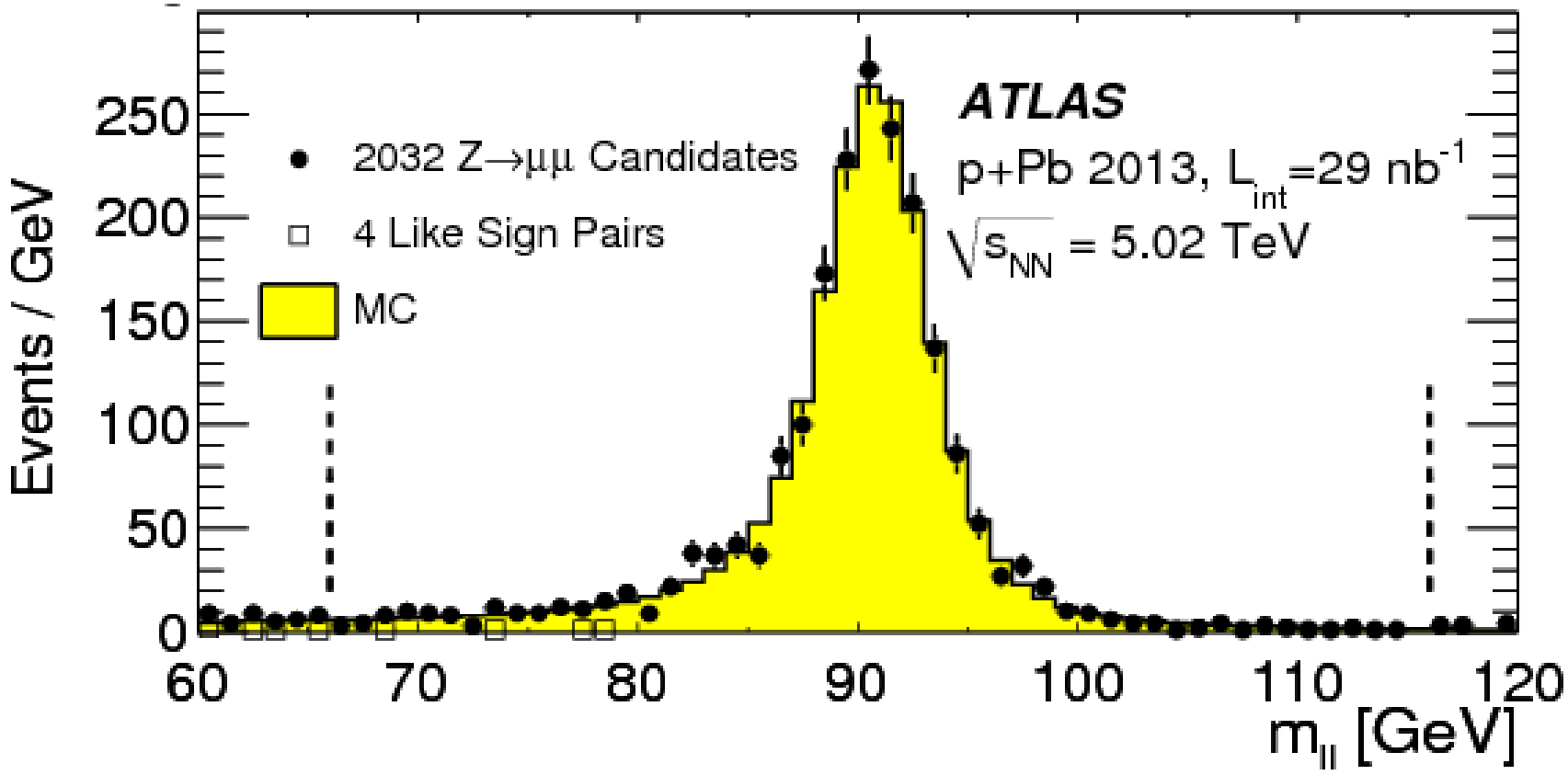
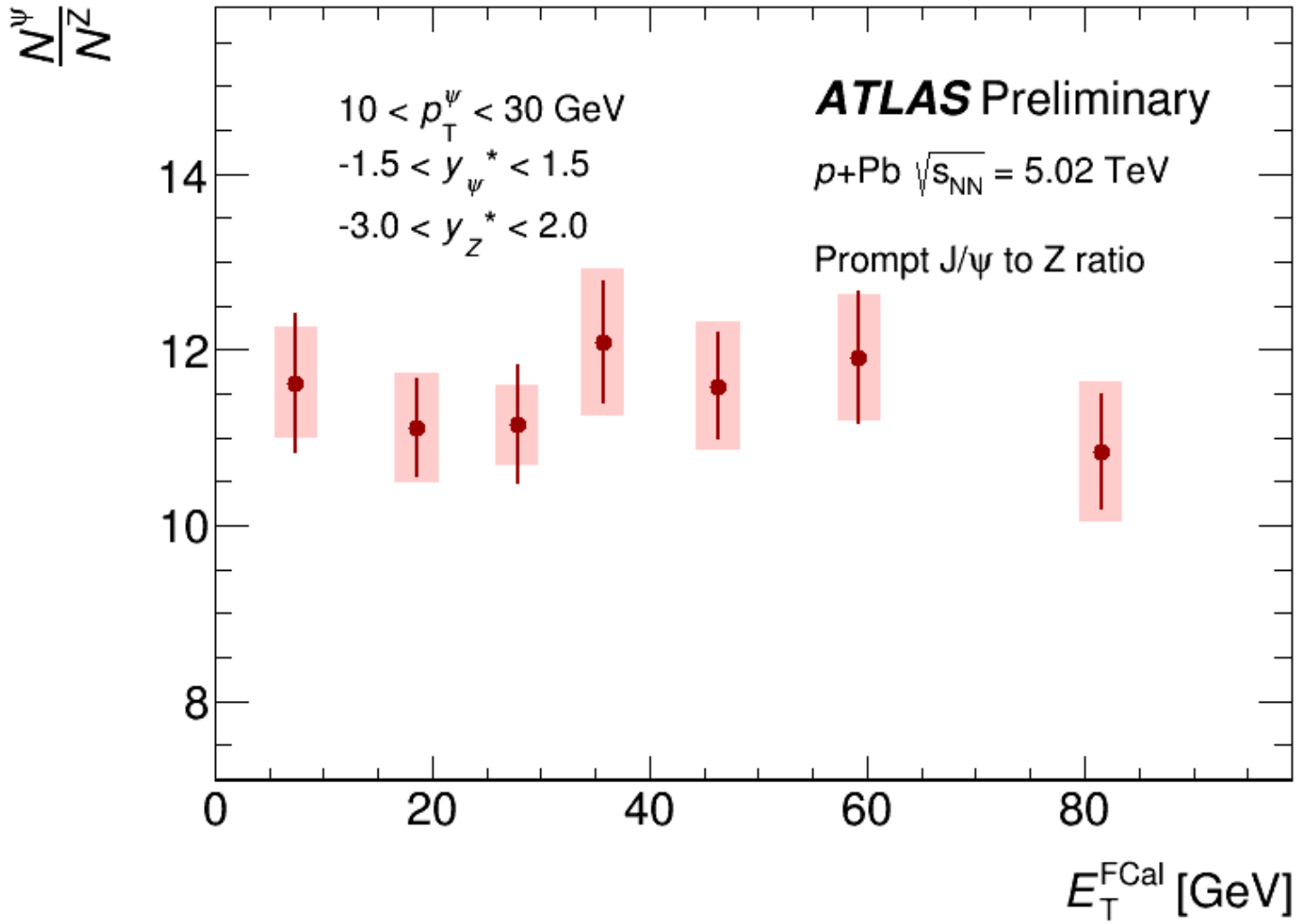


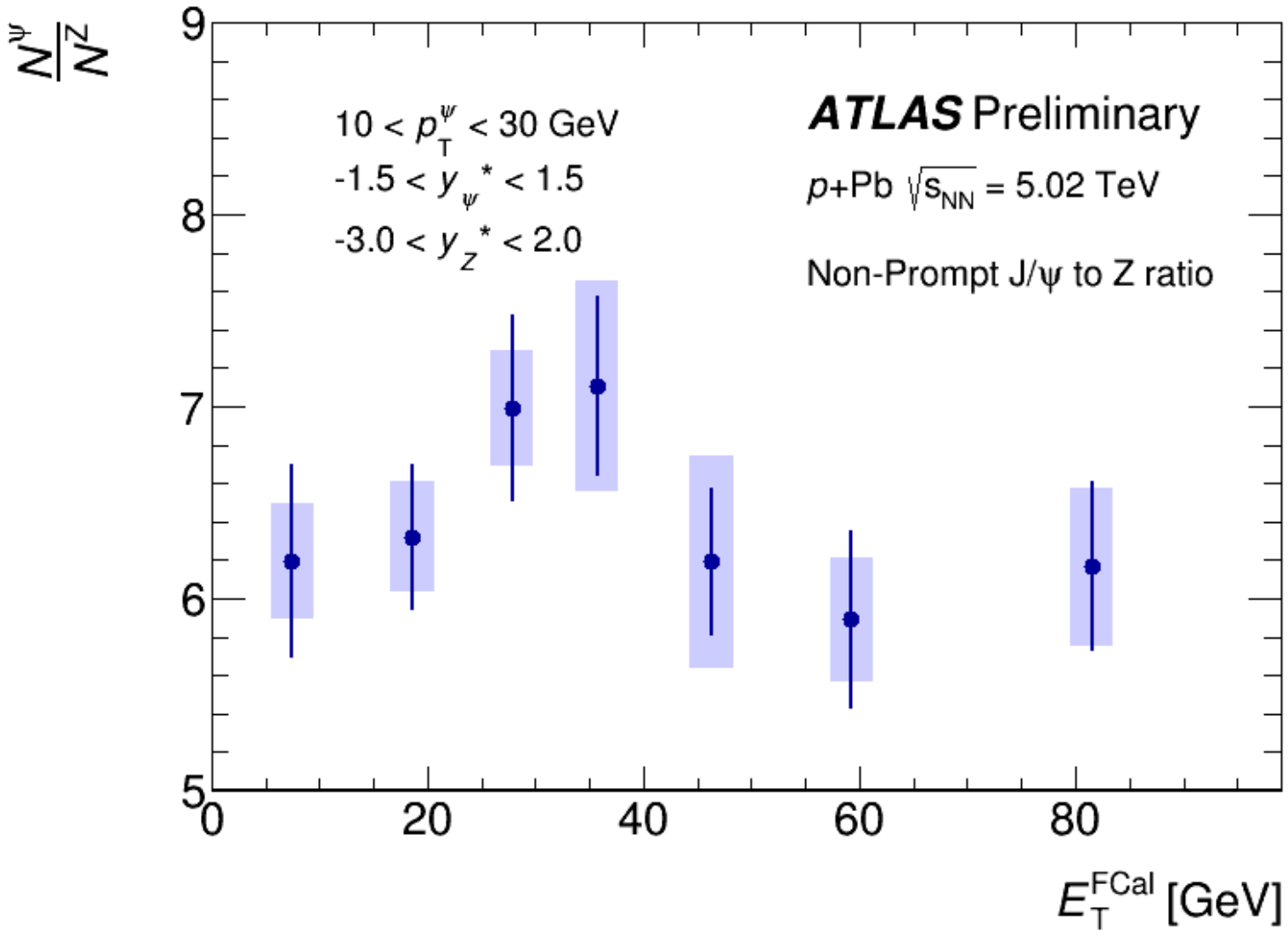
Use Z boson as a model independent reference of centrality

Prompt J/ψ to Z ratio vs multiplicity



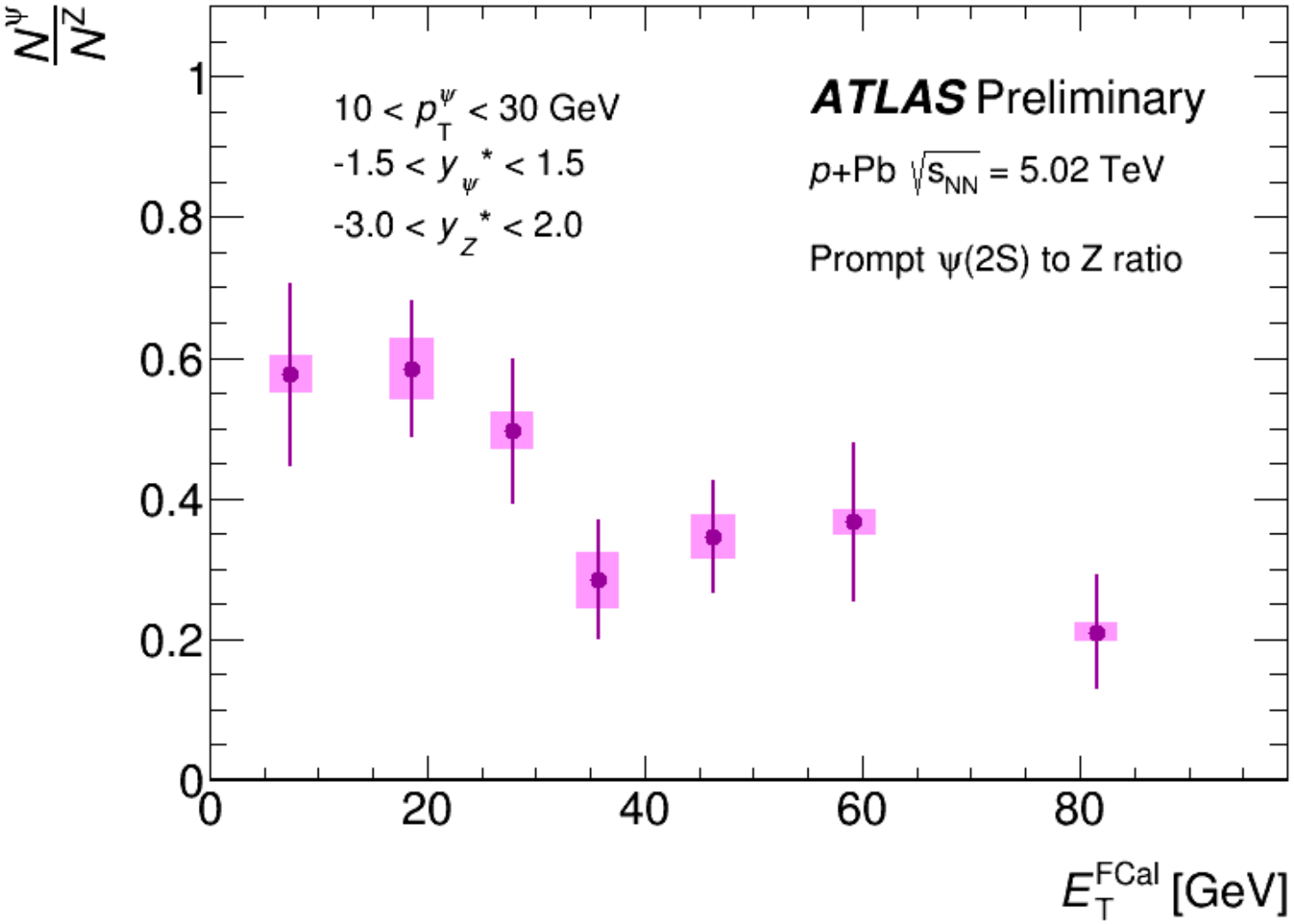
Flat ratio suggests no strong modification

J/ψ from *b* to Z ratio vs multiplicity



Flat ratio suggests no strong modification

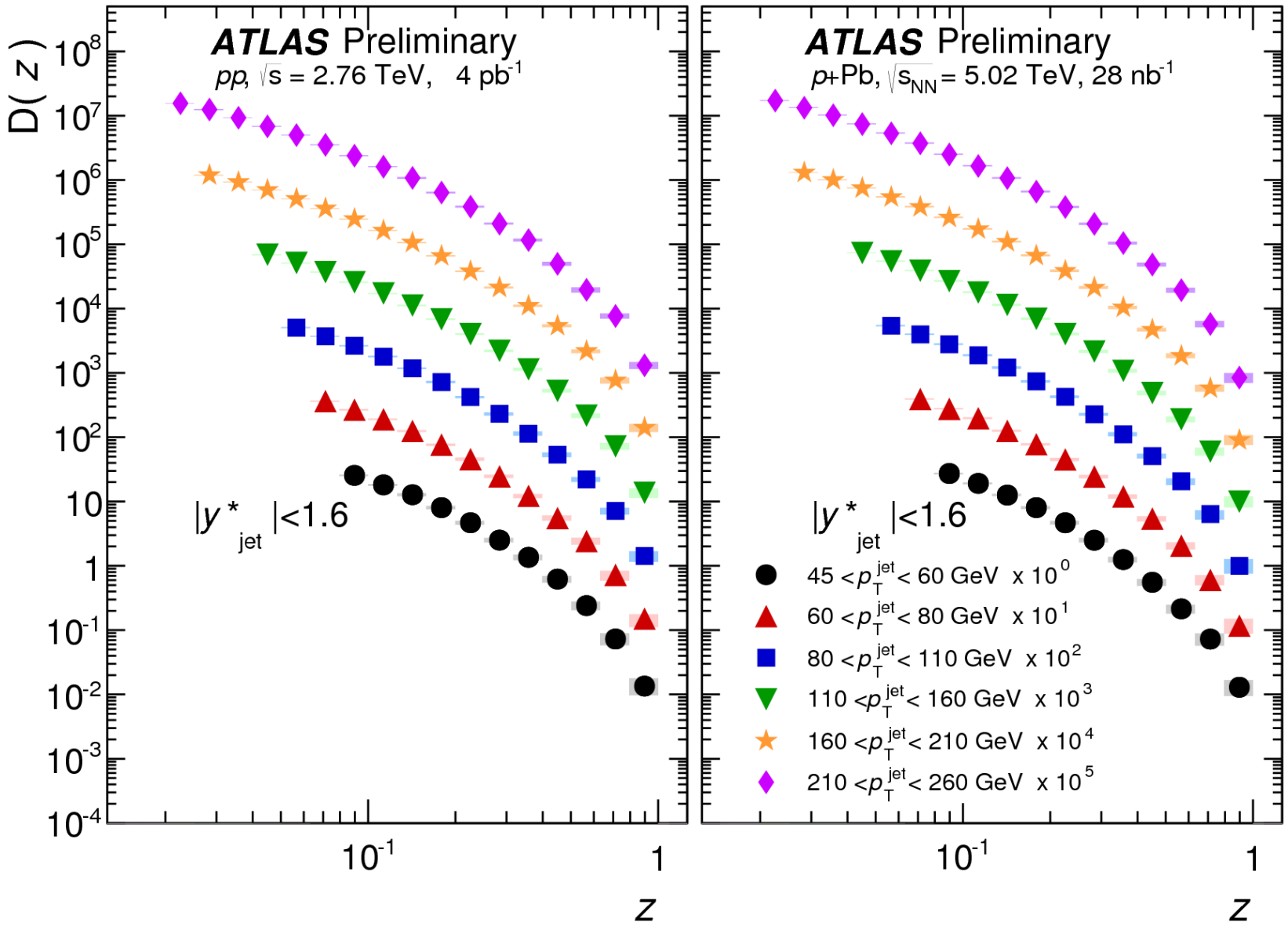
Prompt $\psi(2S)$ to Z ratio vs multiplicity



Hint of suppression at high multiplicities

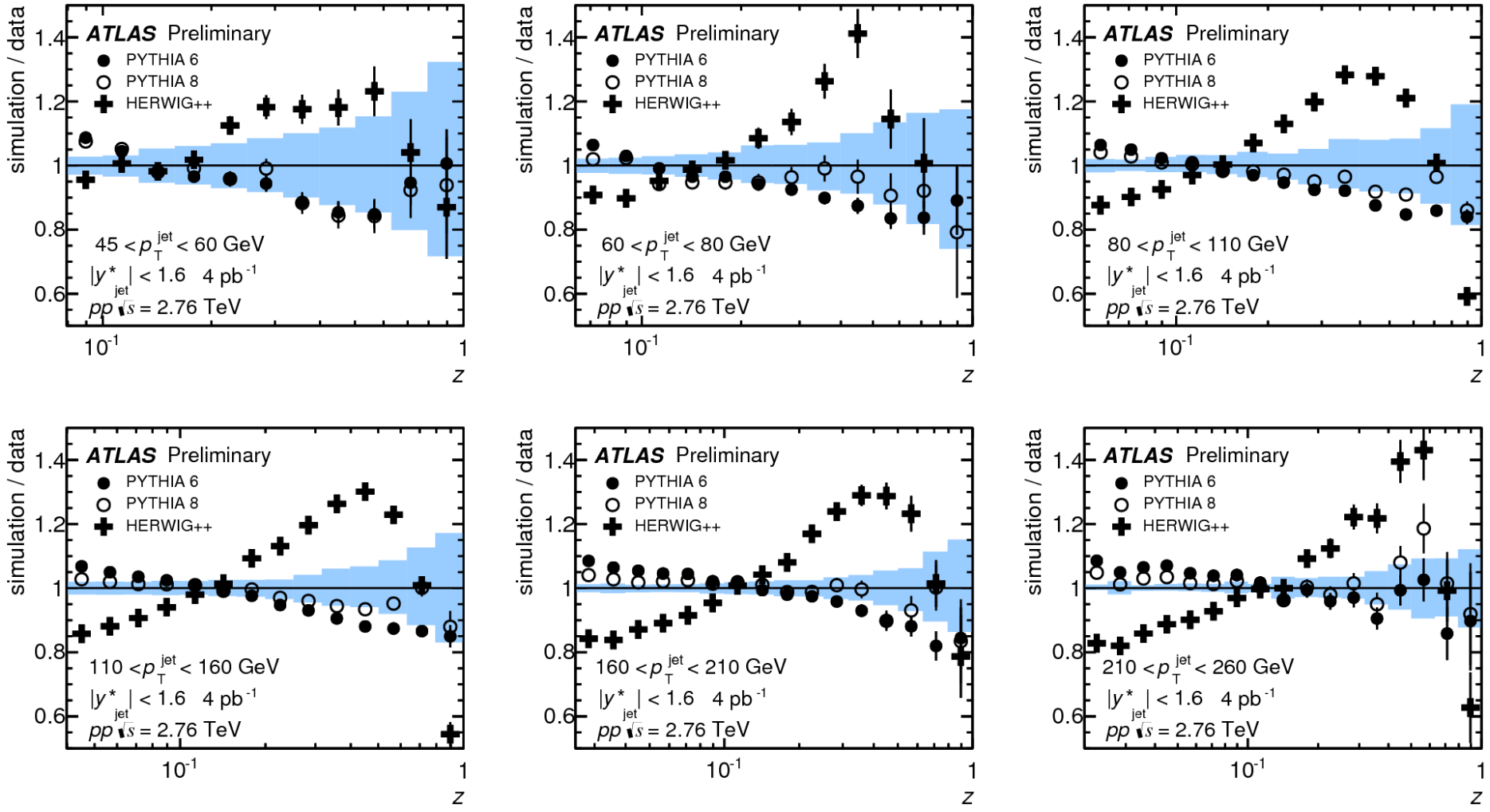
Jet fragmentation

Fragmentation functions in pp and pA collisions



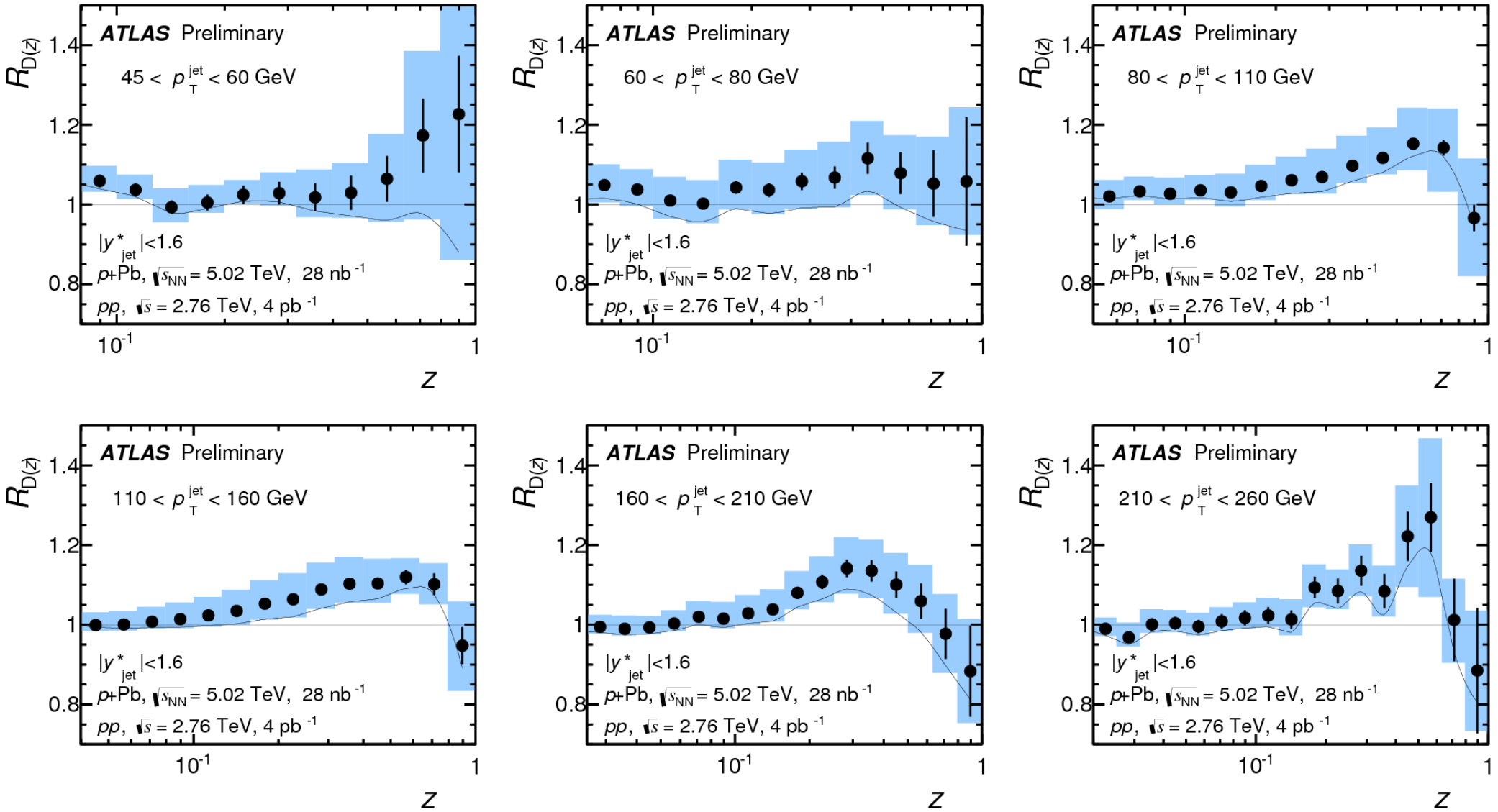
- Jets reconstructed with anti-kT algorithm
- Fragmentation functions measured over wide jet pT range for charged particles with pT > 3.5 GeV

Ratio of pp data to Pythia and Herwig++



The ability of these generators to describe the data is in qualitative agreement with the comparisons of fragmentation functions at 7 TeV

Ratio of p-Pb data to (extrapolated) pp reference



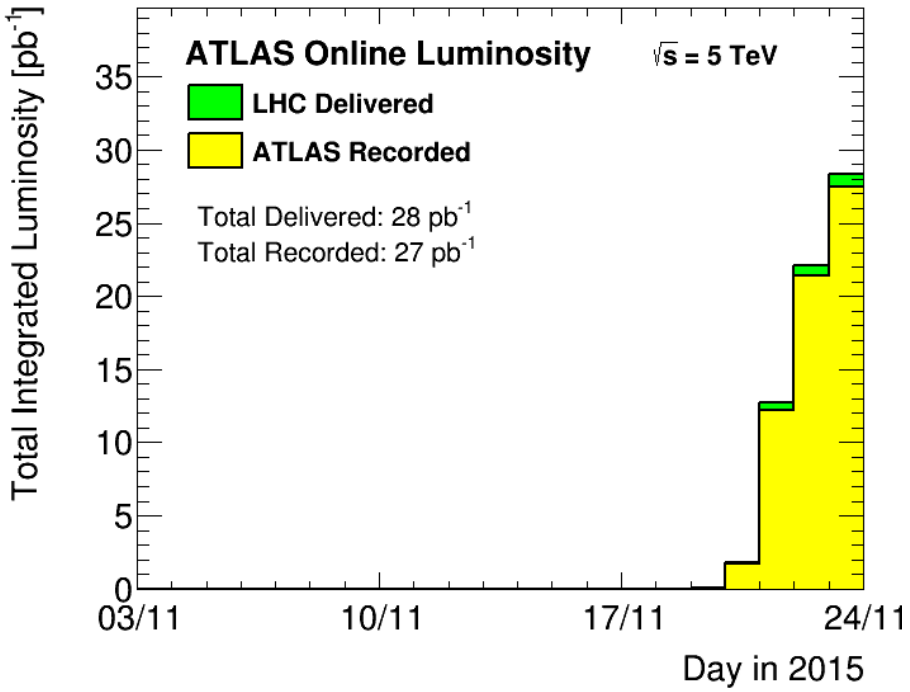
Clear enhacement at high-z for high-pT jets

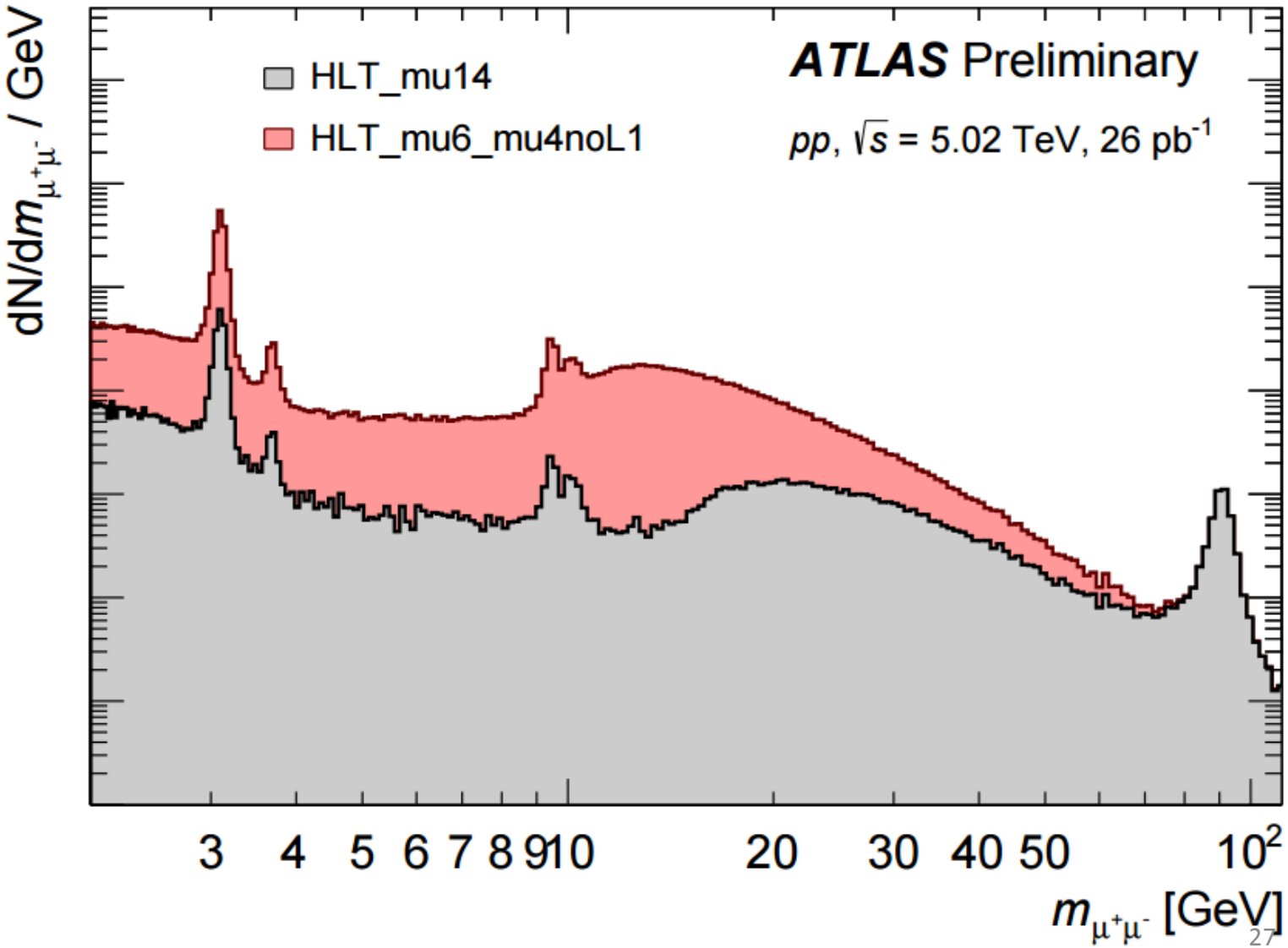
Conclusions

- Electroweak bosons
  - Hints of excess on the Pb-going side
  - Reasonable scaling with Ncoll in the standard Glauber model, once bias correction applied
- Charmonium
  - Hint of suppression of excited state
- Jet fragmentation
  - Excess at high-z

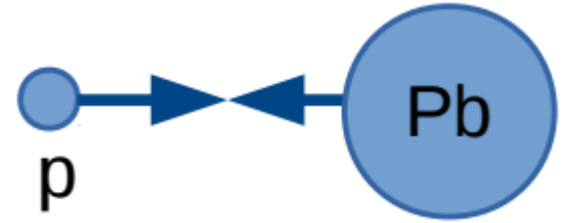
Stay tuned: ***https://twiki.cern.ch/twiki/bin/view/AtlasPublic/HeavyIonsPublicResults***

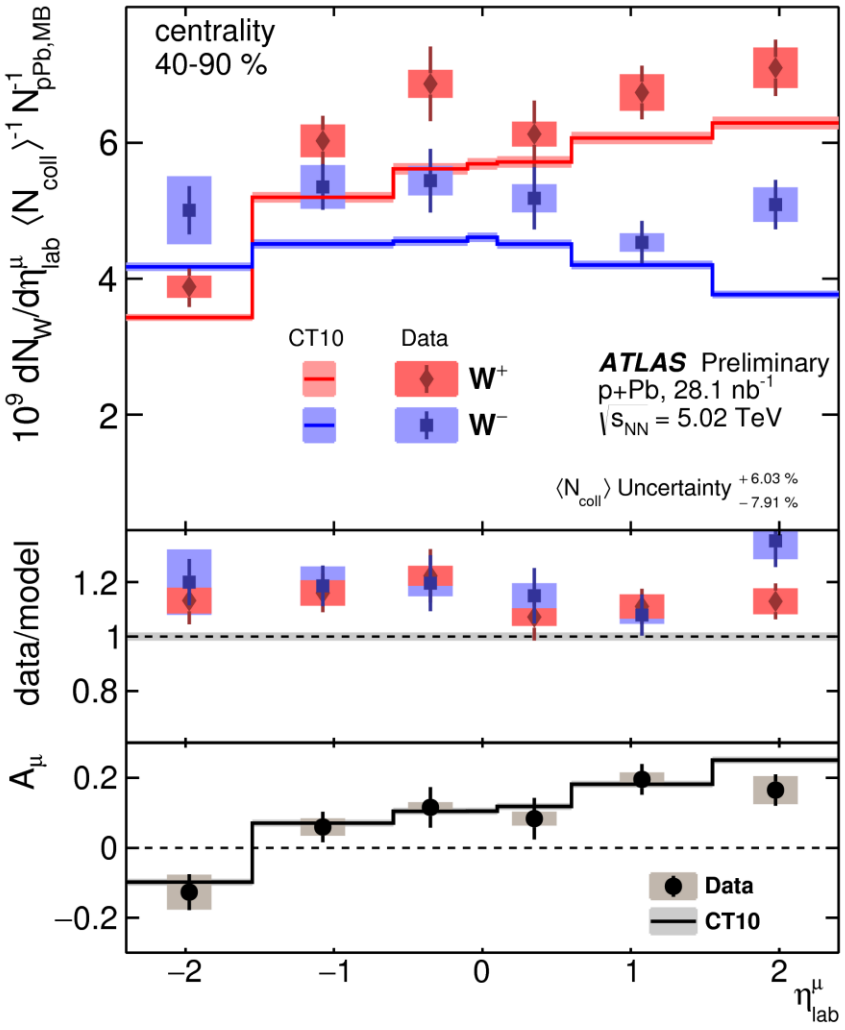
Looking forward for updated results with 5 TeV pp data!

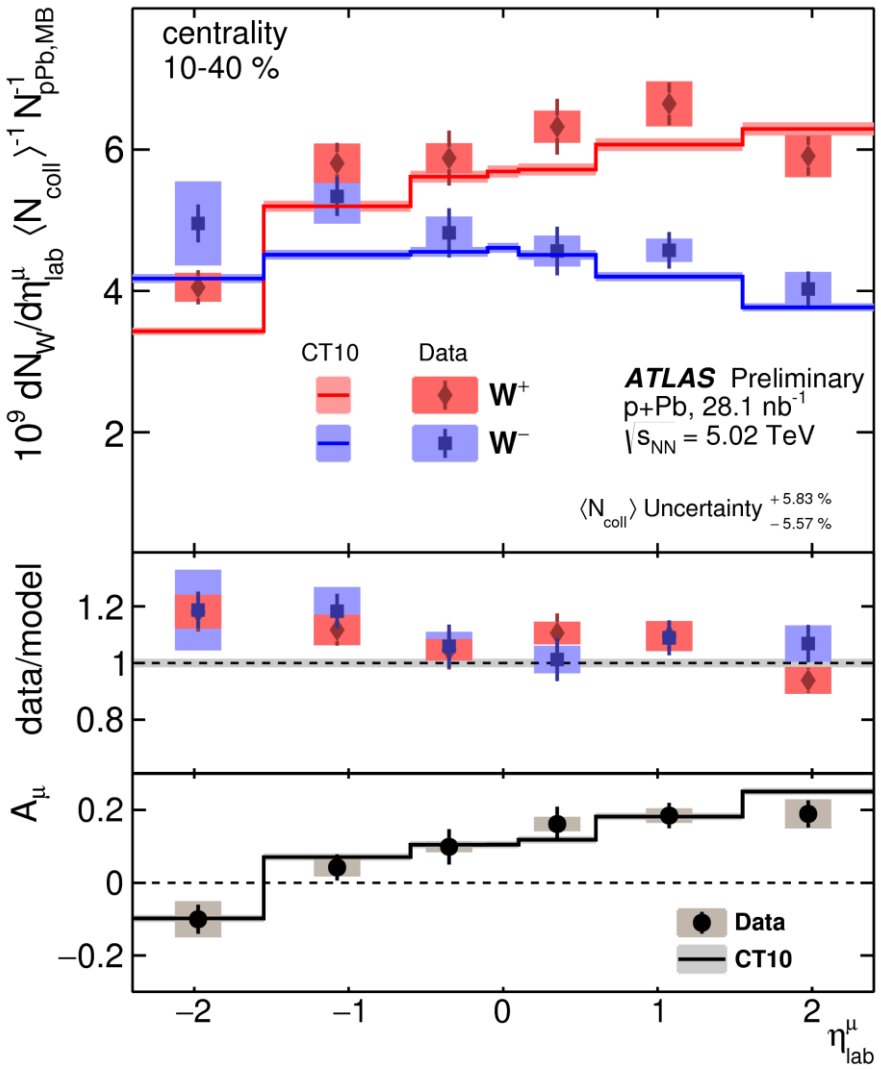


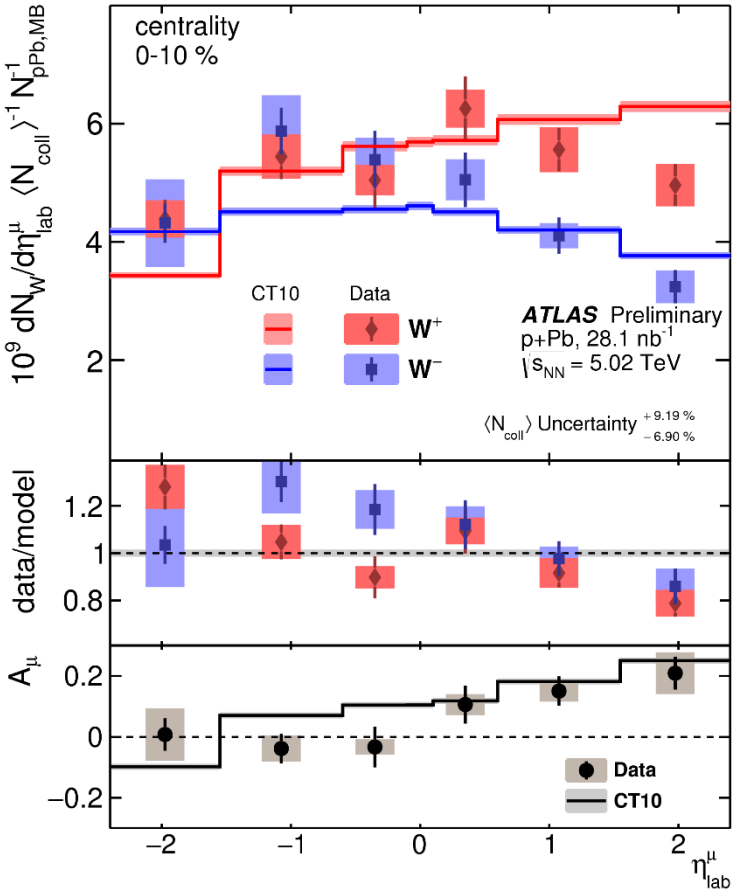


BACKUP SLIDES


p
Pb


centrality
40-90 %
CT10
Data
W+
W−
ATLAS Preliminary
p+Pb, 28.1 nb-1
√sNN = 5.02 TeV
⟨Ncoll⟩ Uncertainty +6.03 % −7.91 %
10^9 dNW/dη^μ_lab ⟨Ncoll⟩^-1 N^-1_pPb,MB
data/model
Aμ
Data
CT10
η^μ_lab


centrality
10-40 %
CT10
Data
W+
W−
ATLAS Preliminary
p+Pb, 28.1 nb-1
√sNN = 5.02 TeV
⟨Ncoll⟩ Uncertainty +5.83 % −5.57 %
10^9 dNW/dη^μ_lab ⟨Ncoll⟩^-1 N^-1_pPb,MB
data/model
Aμ
Data
CT10
η^μ_lab

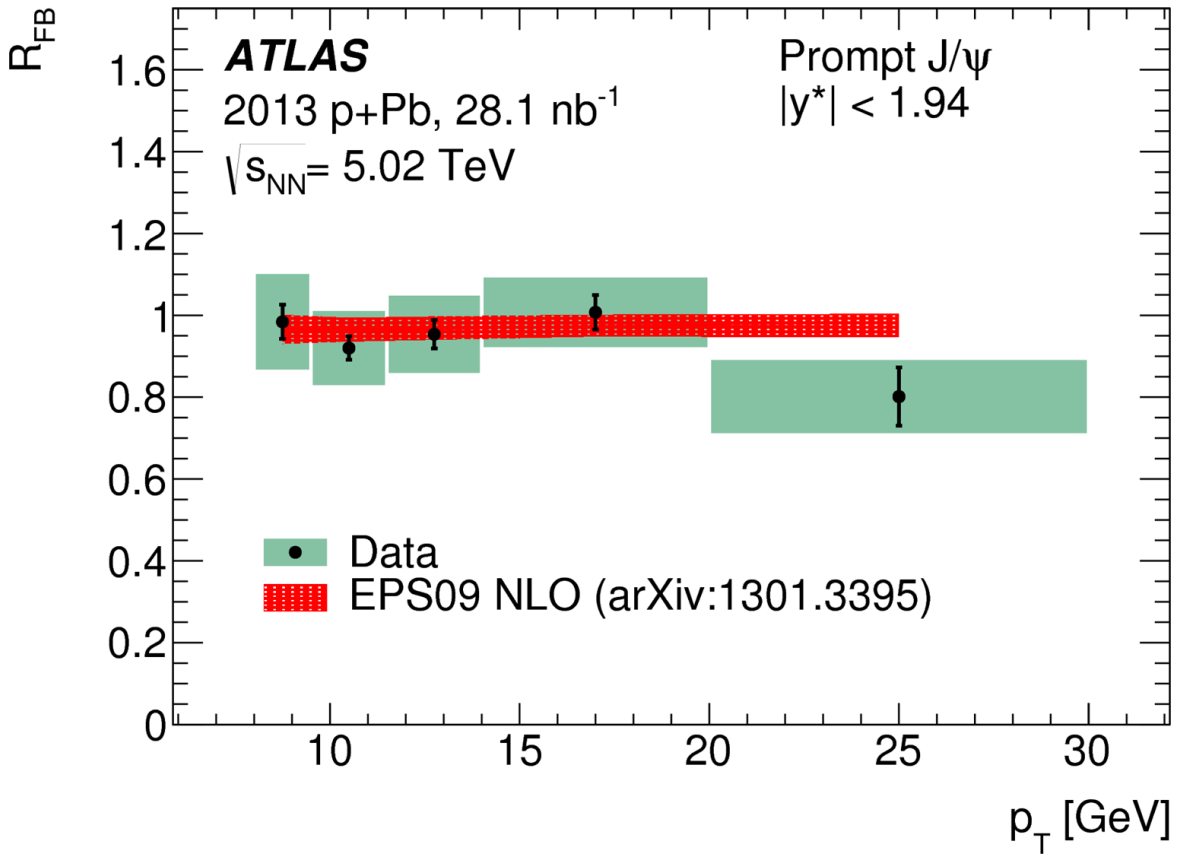

centrality
0-10 %
CT10
Data
W+
W−
ATLAS Preliminary
p+Pb, 28.1 nb-1
√sNN = 5.02 TeV
⟨Ncoll⟩ Uncertainty +9.19 % −6.90 %
10^9 dNW/dη^μ_lab ⟨Ncoll⟩^-1 N^-1_pPb,MB
data/model
Aμ
Data
CT10
η^μ_lab

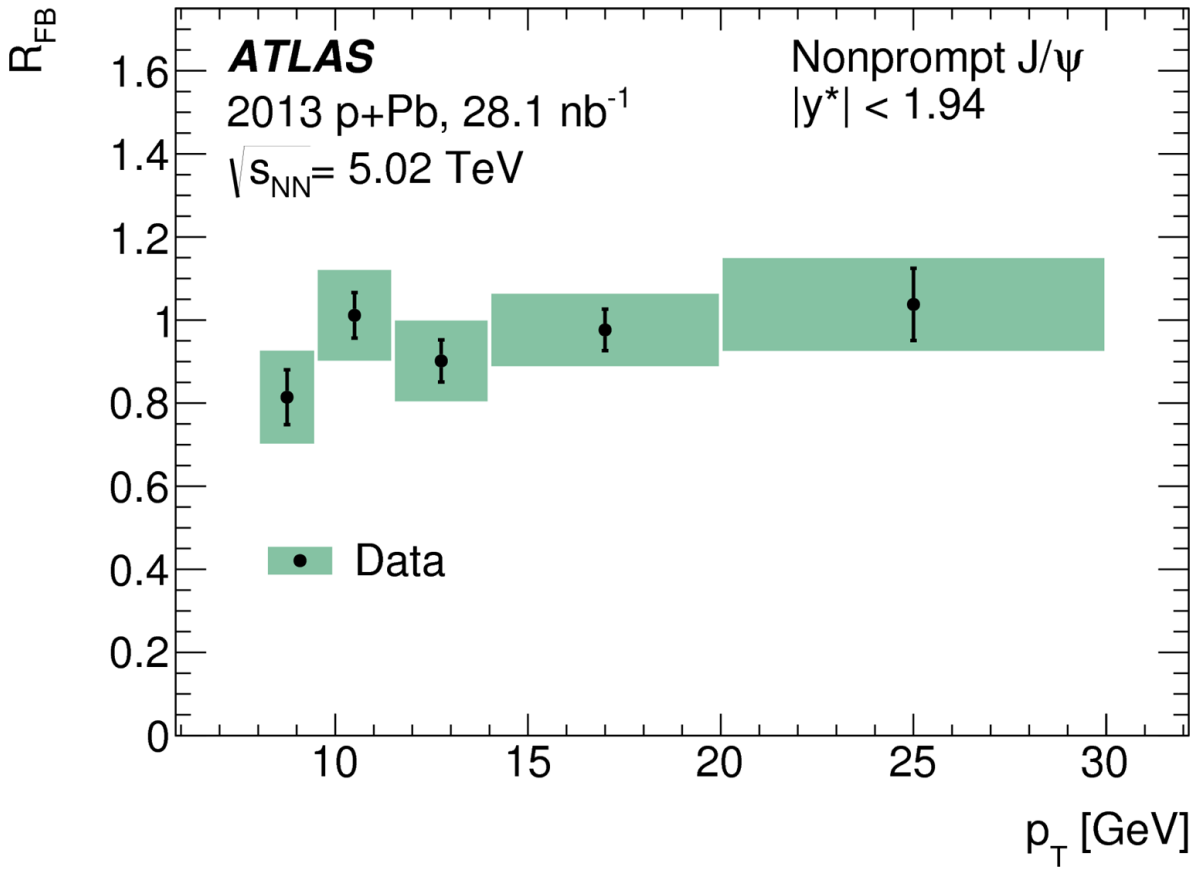
Extrapolation

$$D_{pp}(z)_{5.02\text{TeV}} = D_{pp}(z)_{2.76\text{TeV}} \times \frac{D_{\text{PYTHIA6}}(z)_{5.02\text{TeV}}}{D_{\text{PYTHIA6}}(z)_{2.76\text{TeV}}}$$

Forward-to-backward ratio

$$R_{\mathrm{FB}}(p_{\mathrm{T}}, y^*) \equiv \frac{d^2\sigma(p_{\mathrm{T}}, y^* > 0)/dp_{\mathrm{T}}dy^*}{d^2\sigma(p_{\mathrm{T}}, y^* < 0)/dp_{\mathrm{T}}dy^*}$$

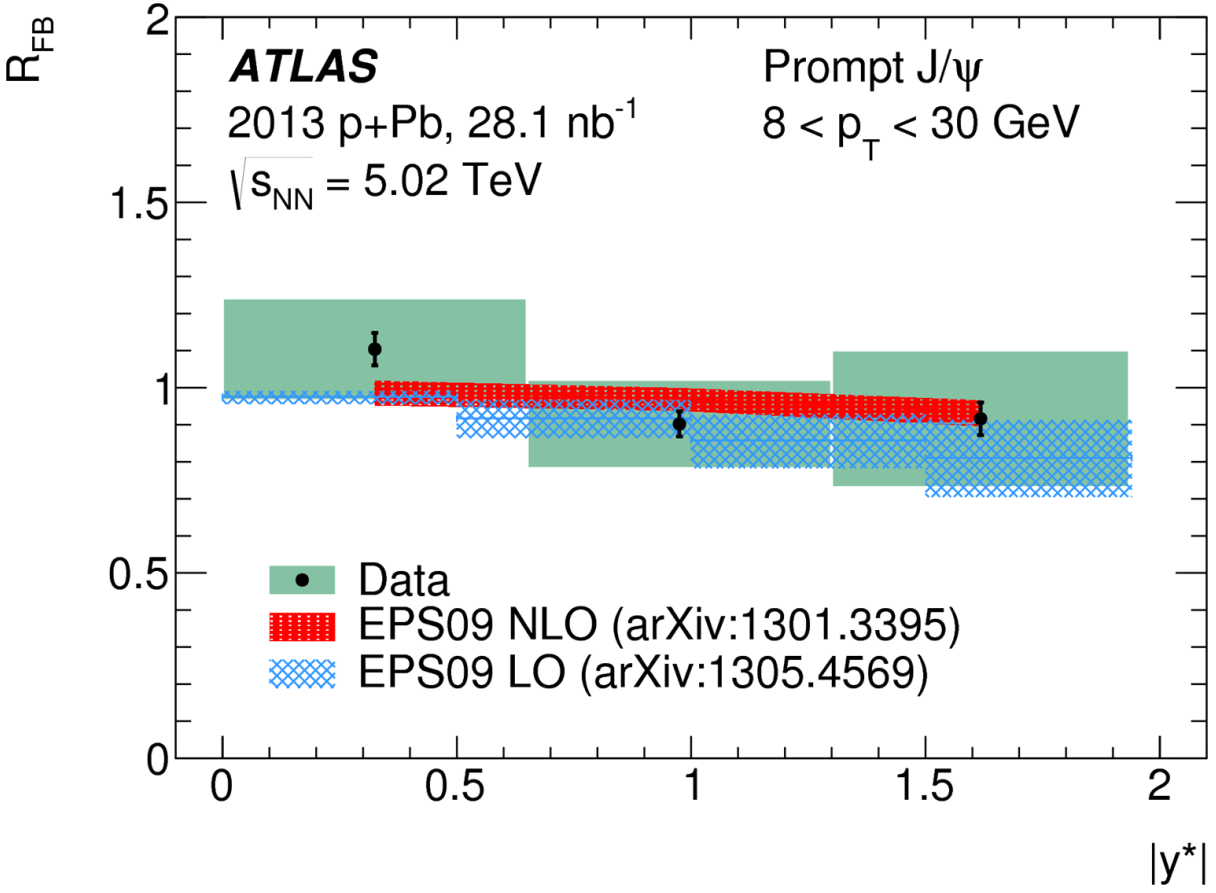


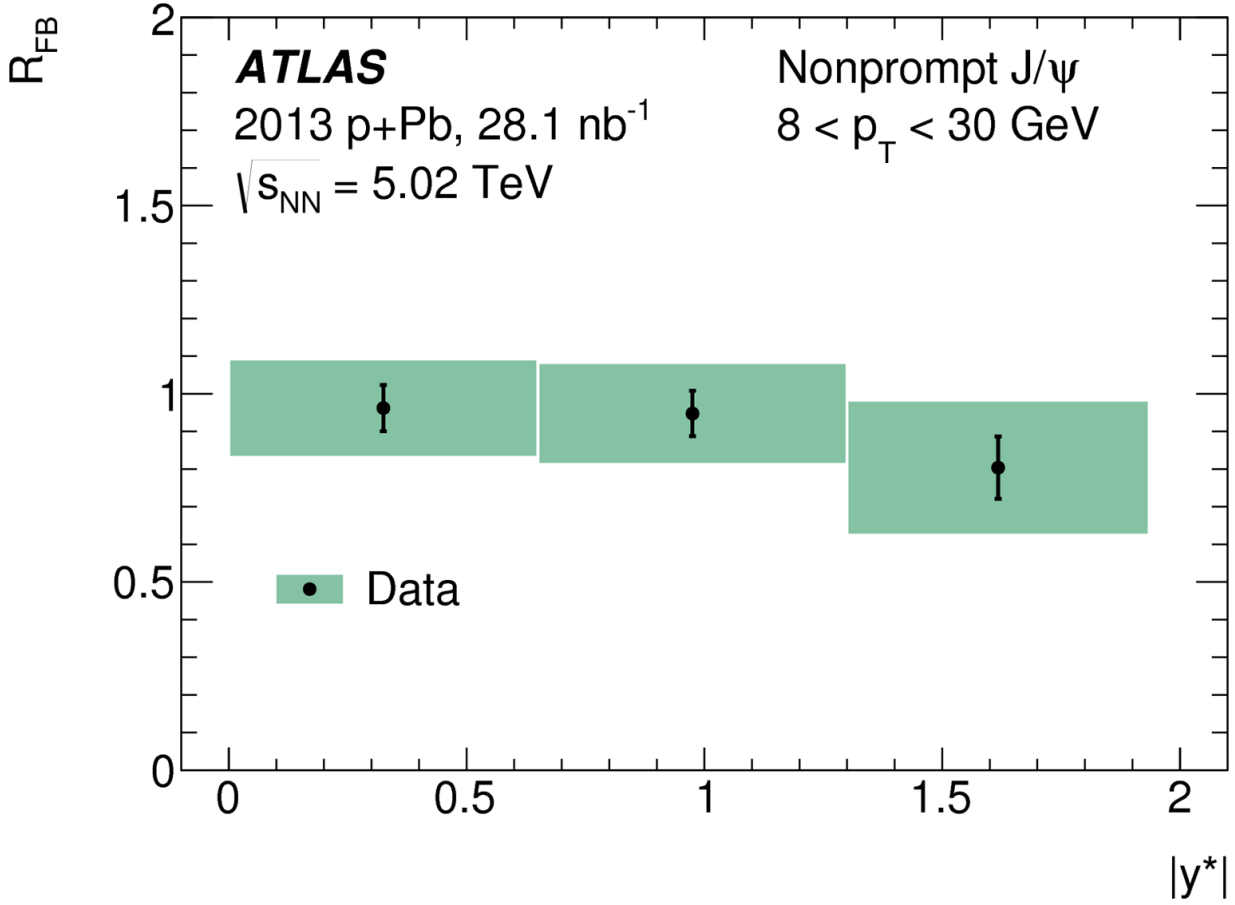


- Consistent with unity within uncertainties in both cases
- Consistent with expectations from calculations that include shadowing

Forward-to-backward ratio

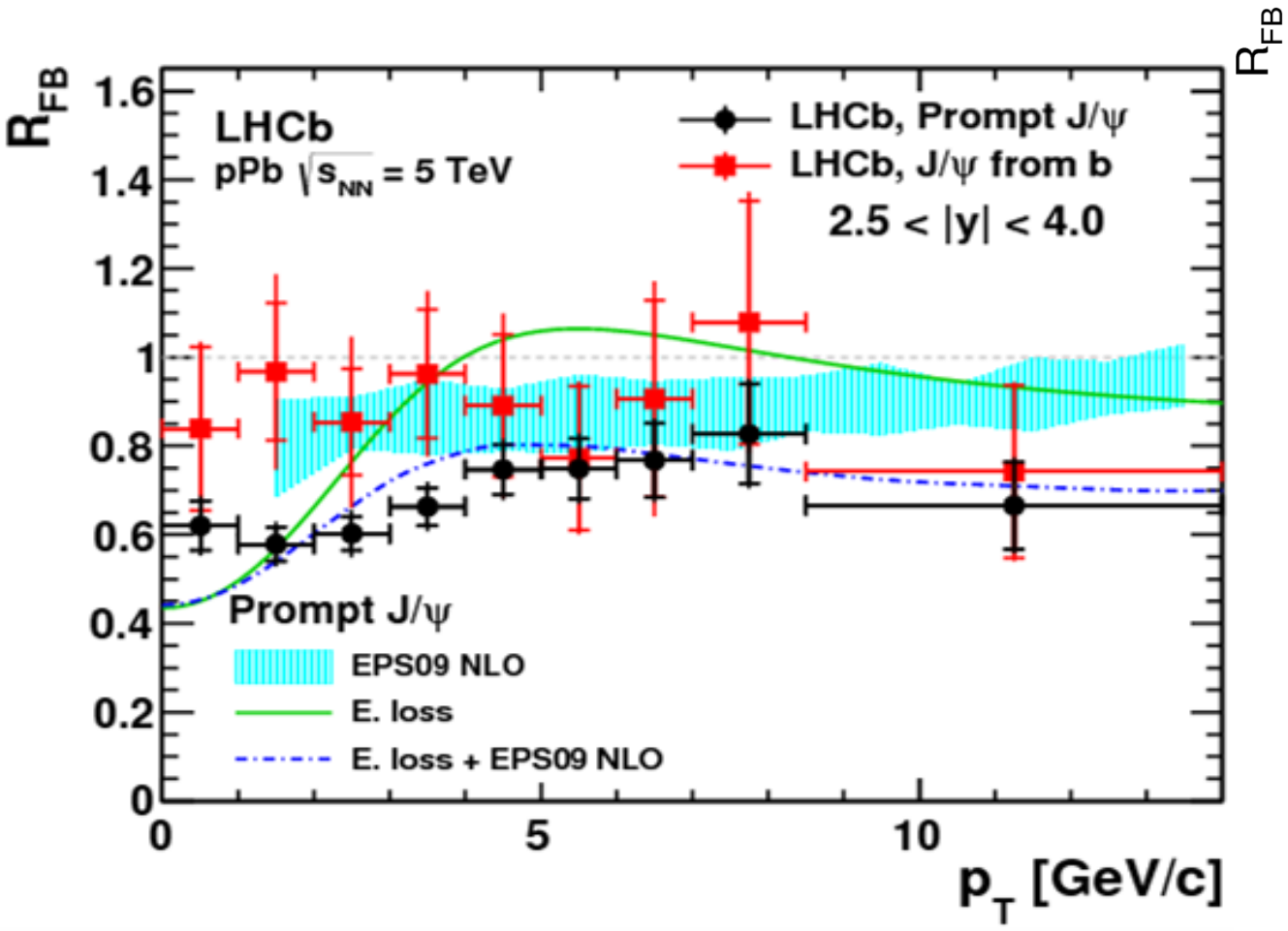
$$R_{\mathrm{FB}}(p_{\mathrm{T}}, y^*) \equiv \frac{d^2\sigma(p_{\mathrm{T}}, y^* > 0)/dp_{\mathrm{T}}dy^*}{d^2\sigma(p_{\mathrm{T}}, y^* < 0)/dp_{\mathrm{T}}dy^*}$$

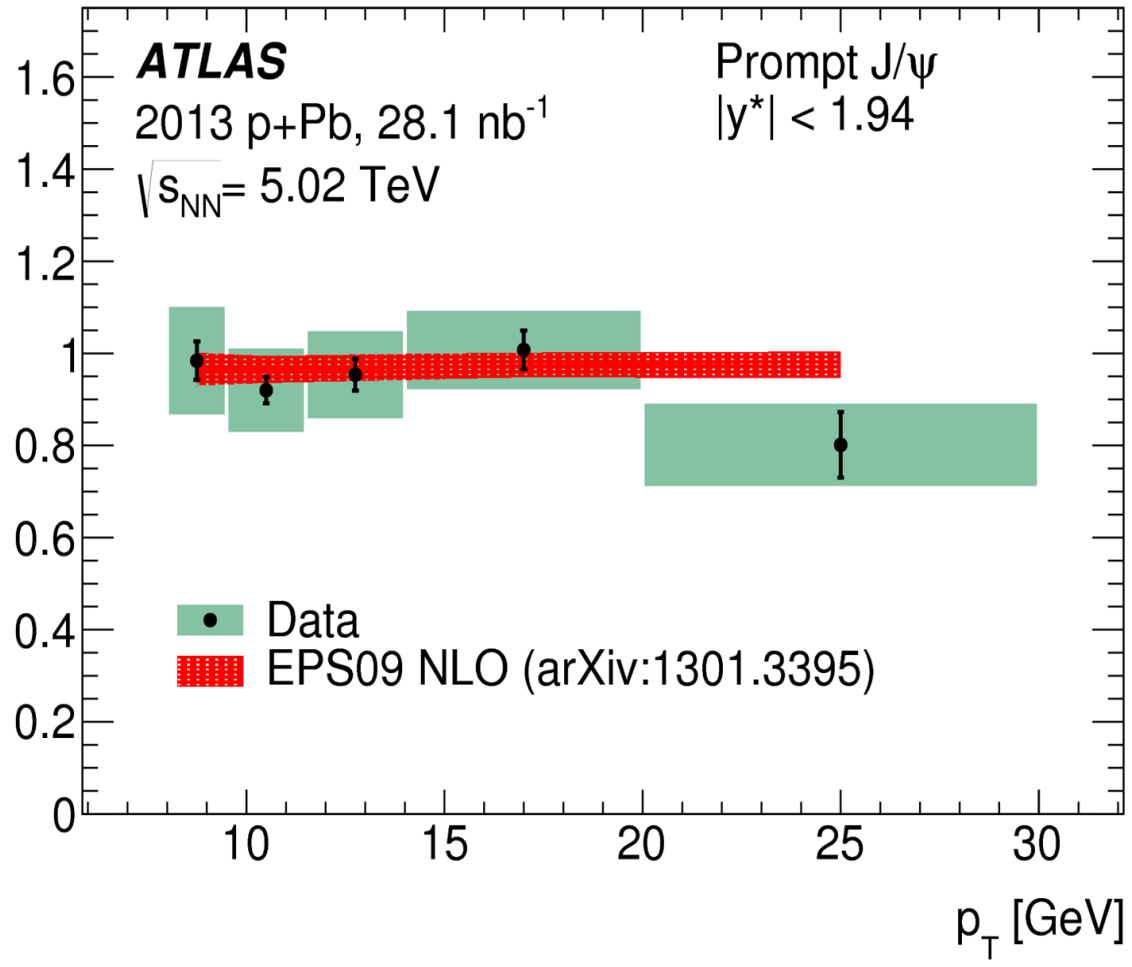




- Consistent with unity within uncertainties in both cases
- Consistent with expectations from calculations that include shadowing

Comparison with LHCb





- Combined data suggest strong kinematic dependence of nuclear effects