Observation of top-quark pair production in heavy-ion collisions in the ATLAS experiment

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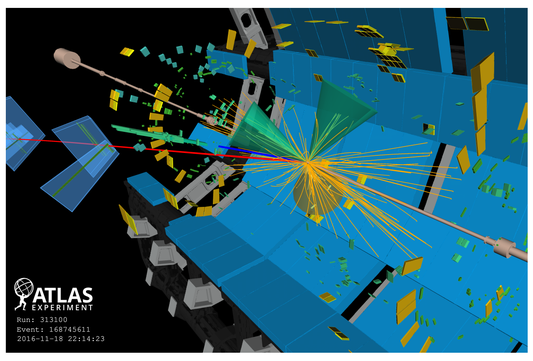
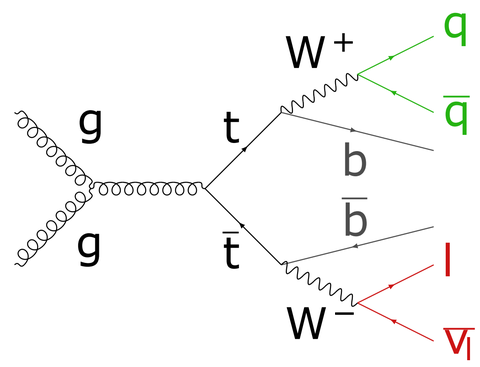
AGH

1 Top-quark pair production

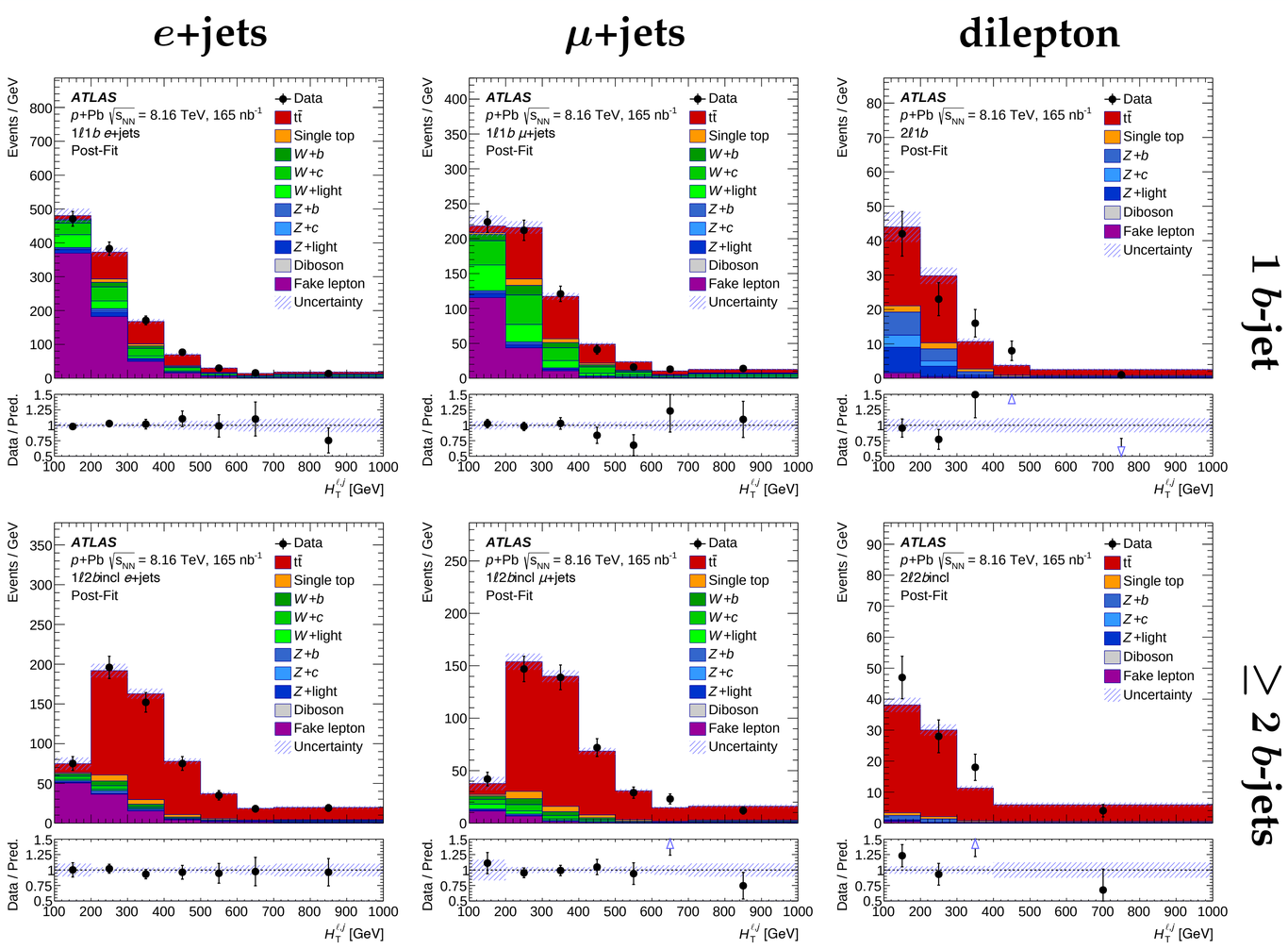


- Top quarks in heavy-ion collisions provide novel probes of **nuclear modifications** to parton distribution functions (nPDF).
- Top quarks are sensitive to **gluon nPDFs** in the high Bjorken-x region.
- Top quarks are more likely produced in **pairs ($t\bar{t}$)** and decay before hadronisation.
- **165 nb^{-1}** of p+Pb data at $\sqrt{s_{\mathrm{NN}}} = 8.16$ TeV were collected in 2016 by ATLAS.



2 $t\bar{t}$ measurement in p+Pb collisions

e+jets **μ+jets** **dilepton**



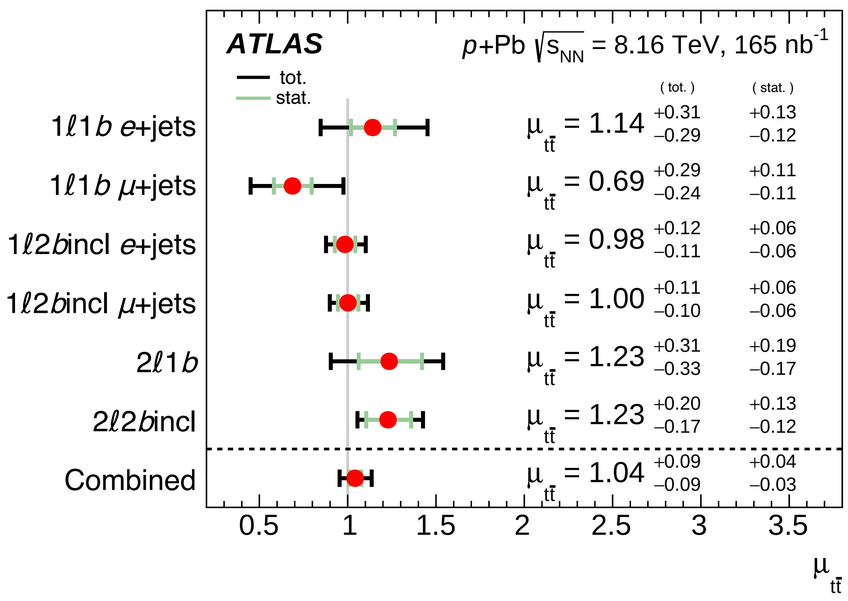
1 b-jet

≥ 2 b-jets

- **Electrons** must have $p_{\mathrm{T}} > 18$ GeV and $|\eta| < 2.47$ and pass Medium identification.
- **Muons** must have $p_{\mathrm{T}} > 18$ GeV and $|\eta| < 2.5$ and pass Medium requirements.
- **Jets** are required to have $p_{\mathrm{T}} > 20$ GeV and $|\eta| < 2.5$.
- A **profile-likelihood fit** is performed using $H_{\mathrm{T}}^{\ell,j}$ distributions in six signal regions.
- $H_{\mathrm{T}}^{\ell,j}$ is defined as the scalar sum of lepton and jet transverse momenta.
- A good agreement between data and predictions.

3 $t\bar{t}$ signal strength

- **Signal strength** definition: $\mu_{t\bar{t}} = \sigma_{t\bar{t}}^{\mathrm{measured}} / \sigma_{t\bar{t}}^{\mathrm{theory}}$.
- $\mu_{t\bar{t}}$ is extracted in each signal region separately and combined.
- The significance exceeds **5 σ** separately in the ℓ+jets and dilepton channels.
- The **first observation** in the dilepton channel in p+Pb collisions.

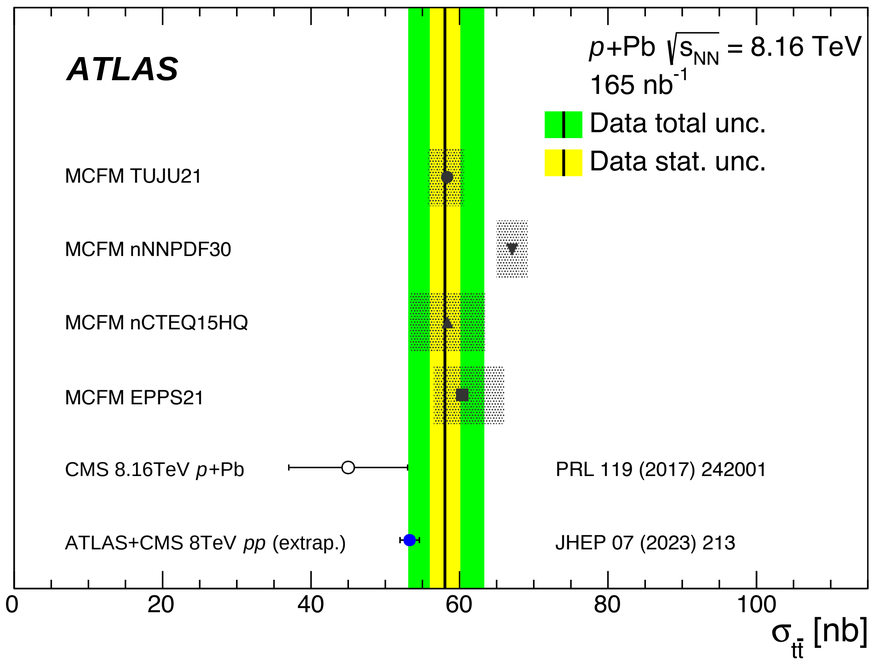


4 $t\bar{t}$ cross-section

- Measured $t\bar{t}$ production cross section:

$$\sigma_{t\bar{t}} = 58.1 \pm 2.0\ (\mathrm{stat.})\ ^{+4.8}_{-4.4}\ (\mathrm{syst.})\ \mathrm{nb}.$$

- The **most precise** $t\bar{t}$ cross-section measurement in heavy-ion collisions.
- A good agreement with the **CMS measurement** and the cross section in ***pp* collisions** scaled by $A_{\mathrm{Pb}} = 208$.

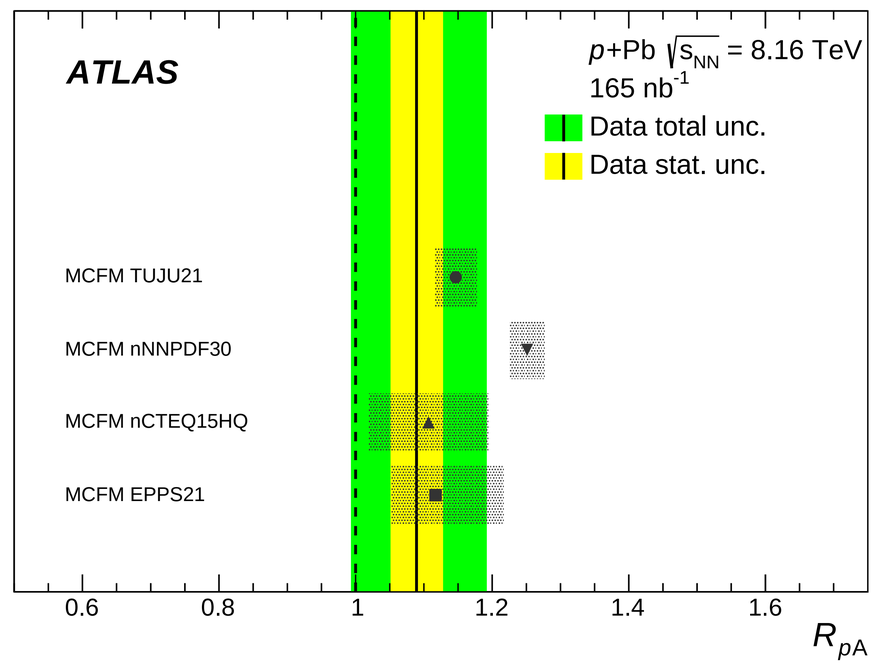


5 $t\bar{t}$ nuclear modification factor

- A **nuclear modification factor** in p+Pb collisions is defined as $R_{p\mathrm{A}} = \sigma_{t\bar{t}}^{p+\mathrm{Pb}} / (A_{\mathrm{Pb}} \cdot \sigma_{t\bar{t}}^{pp})$.
- Measured nuclear modification factor:

$$R_{p\mathrm{A}} = 1.090 \pm 0.039\ (\mathrm{stat.})\ ^{+0.094}_{-0.087}\ (\mathrm{syst.}).$$

- A good agreement is found with NNLO calculations based on **four nPDF sets**.



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References

[1] ATLAS Collaboration, arXiv:2405.05078