First Run 3 data/MC plots for the measurement of the top-quark pair production cross-section in pp collisions at centre-of-mass energy of 13.6 TeV with the ATLAS experiment at the LHC

Giovanni Guerrieri[1,2], on behalf of the ATLAS Collaboration
TOP2022, 4–9 September 2022 (Durham)

MOTIVATION

The top quark is the most massive known elementary particle. It may play a special role in the electroweak symmetry breaking. The _measurement of the production cross-section_ provides a stringent test of QCD calculations with heavy quarks and opens a window to potential new physics.

Why should we perform an early measurement?
- Important to _validate_ detector and software as soon as possible
- Find _issues_ through studies and control plots
- Run 3 is live now, opportunity to study _new data_
- Cooperation across all the ATLAS community

Why should we focus on the $t\bar{t}$ cross section?
- Can be measured with _low luminosity_
- It is _pure_ in the dilepton channel
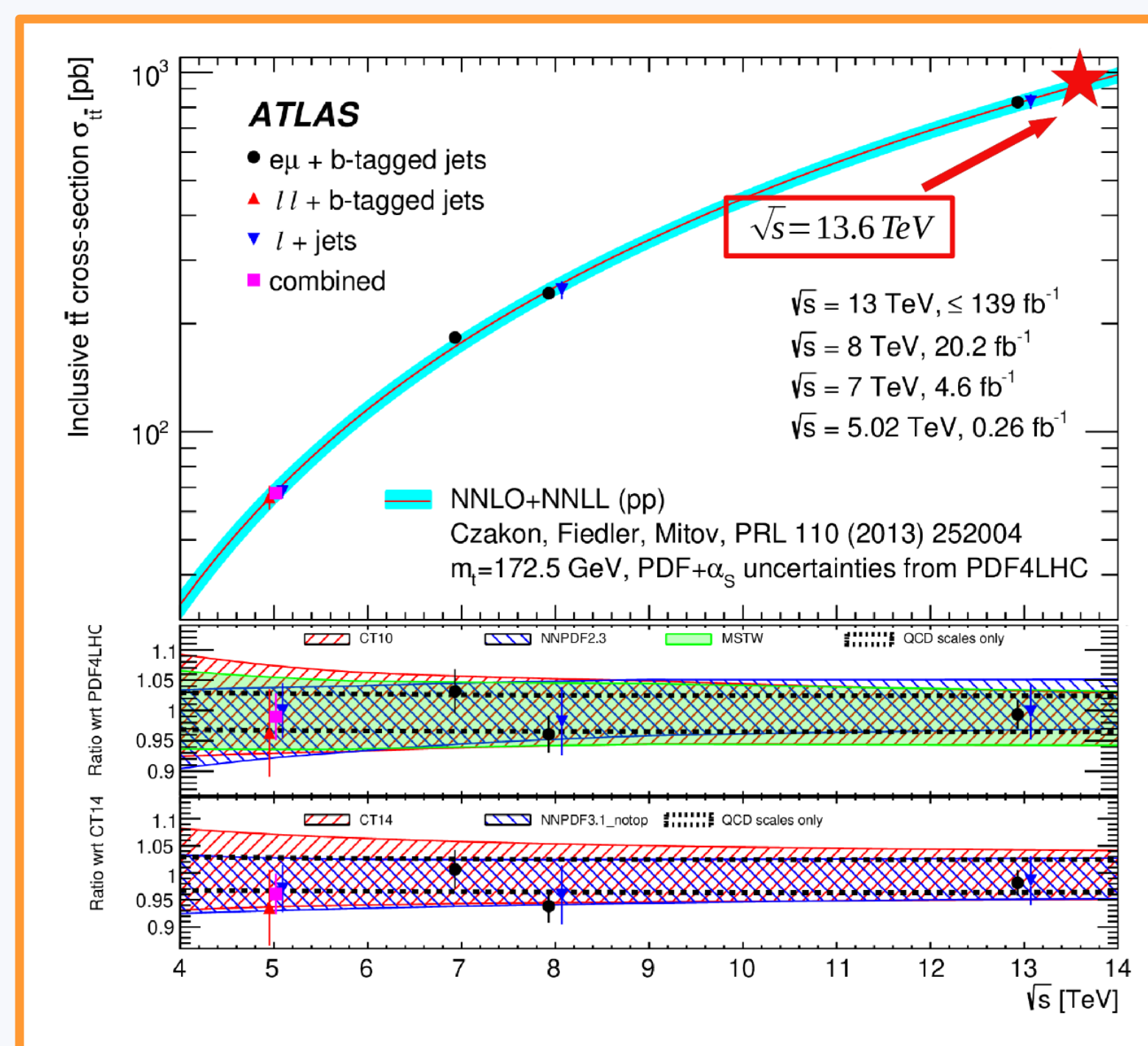
ANALYSIS STRATEGY

Dilepton channel

- Using "_b-tag counting_" method in the $e\mu$ channel
  - In-situ tagging efficiency calibration
  - Low dependence on jet uncertainties
- Smaller background wrt single lepton
- Low lepton fakes – can use MC

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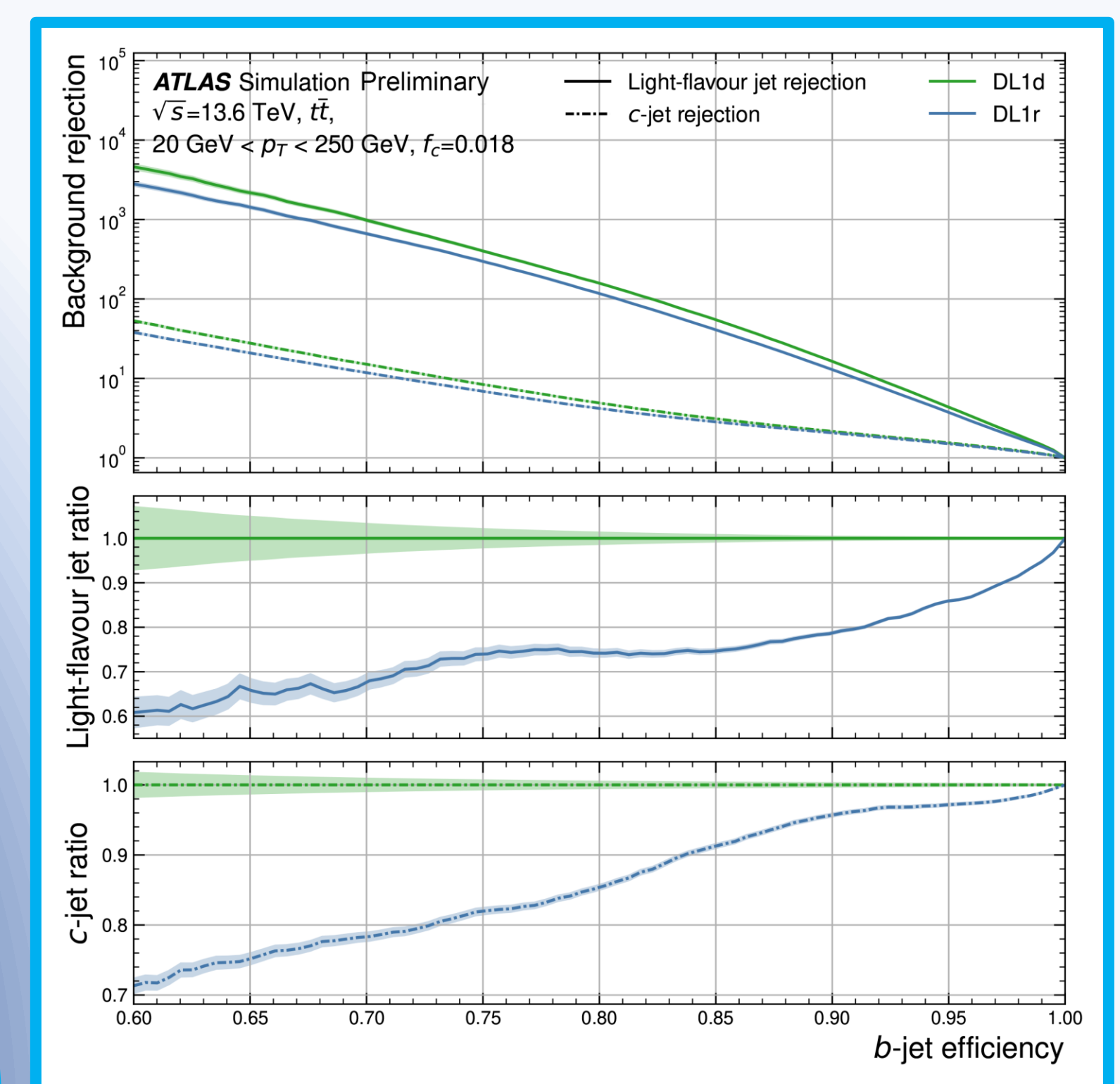$$N_1 = L\sigma_{t\bar{t}}\epsilon_{e\mu}(1 - C_b\epsilon_b) + N_1^{bkg}$$
$$N_2 = L\sigma_{t\bar{t}}\epsilon_{e\mu}C_b\epsilon_b^2 + N_2^{bkg}$$
2 b-tags

lumi   sel. eff.   tagging eff.
correction factor
background events

Dilepton selection

- 2 leptons → one electron and one muon with $p_T > 27$ GeV
- ≥ 1 jets, ≥ 1 b-tag
  (DL1d @77% [1,2])
- Jet $p_T > 30$ GeV
- Lepton fakes background estimated from MC

DL1d tagger performance

FIRST RUN 3 PLOTS

- Selected Run 3 data/MC plots of reconstructed electrons / muons / b-jets properties using a $t\bar{t}$ dilepton selection
- Plots produced with an integrated luminosity of $L{\sim}790$ pb^{-1}
- Several detector performance studies, cooperating with other working groups (_Jet&E_T^{miss}, Trigger, Flavour Tagging_...)
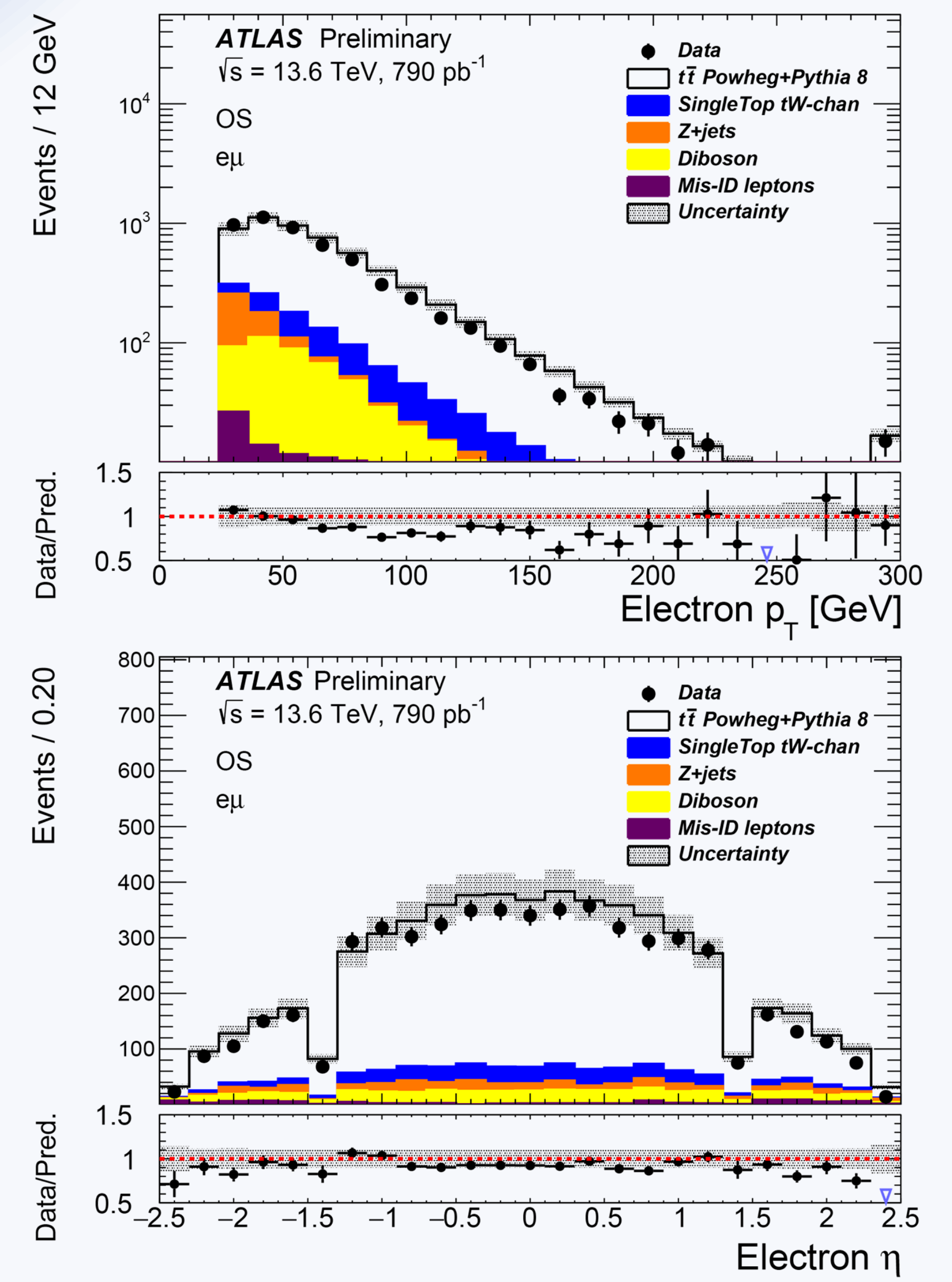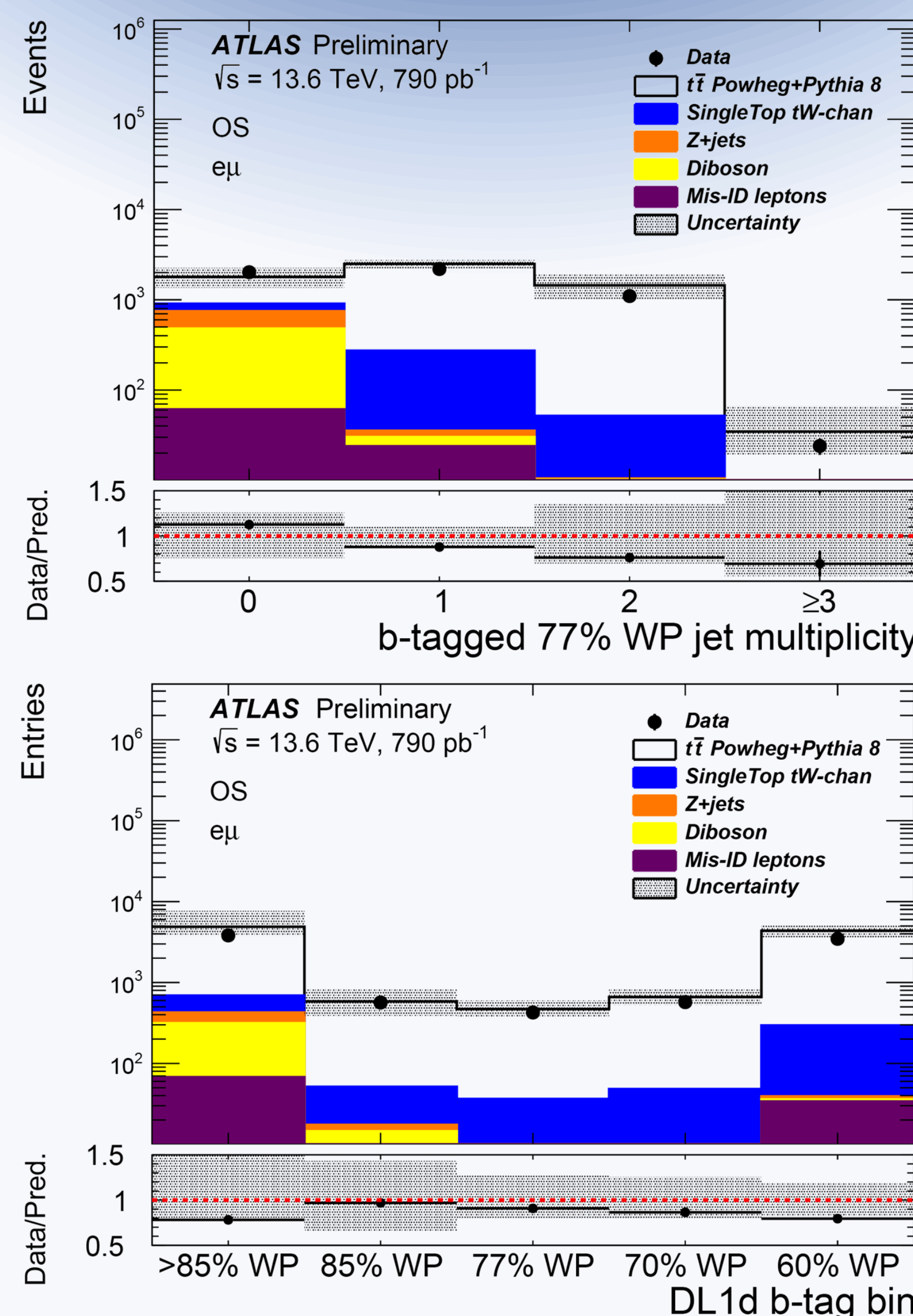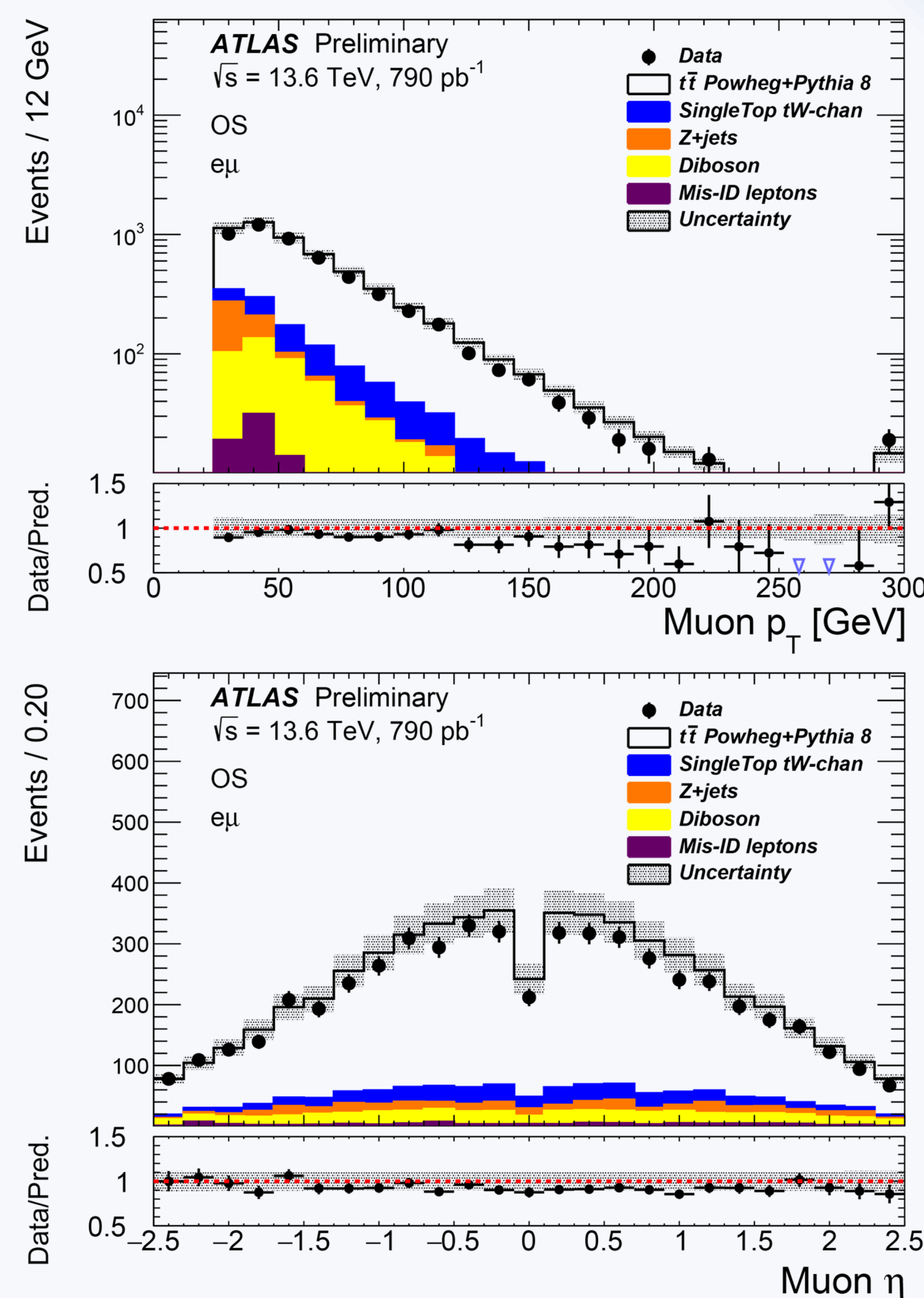
SUMMARY

Final objective for the analysis

- Extract _top-antitop pair production cross-section_ at the centre of mass-energy of $\sqrt{s} = 13.6$ TeV
- _Combine_ dilepton decay channel with the single lepton channel.
- Measure _cross-section ratio_ between top-antitop production and Z to avoid big uncertainty on luminosity for early measurement, as well as significantly contributing to PDFs constraints.

REFERENCES
[1] CERN-EP-2019-132
[2] ATL-PHYS-PUB-2020-014

More information at: https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PLOTS/FTAG-2022-003/

[1] INFN Trieste, Gruppo Collegato di Udine
[2] Università degli studi di Trieste