

Inclusive and differential cross-sections measurements in the single top tW $e\mu$ channel with CMS

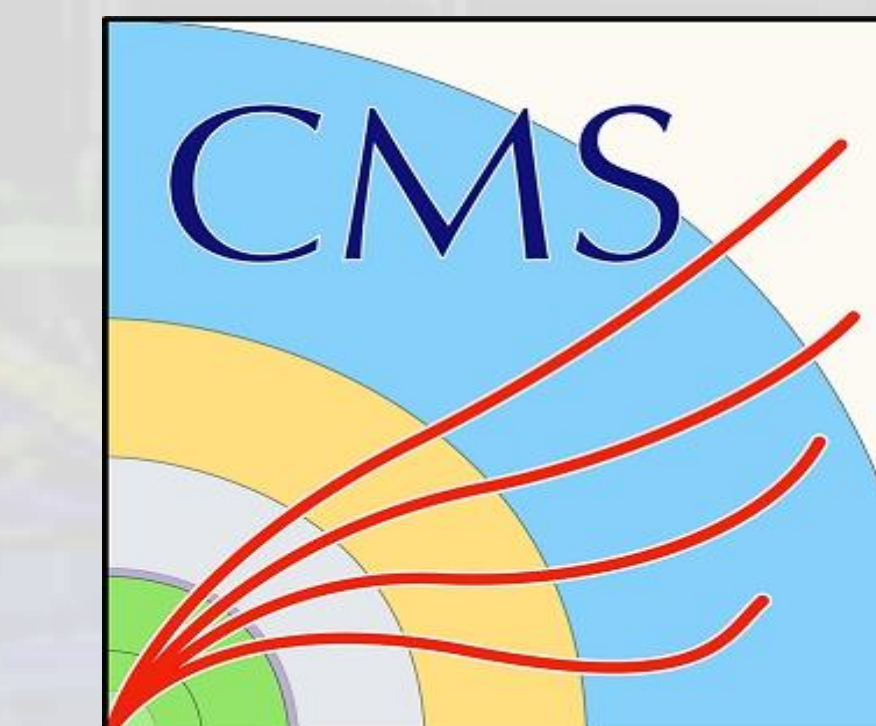
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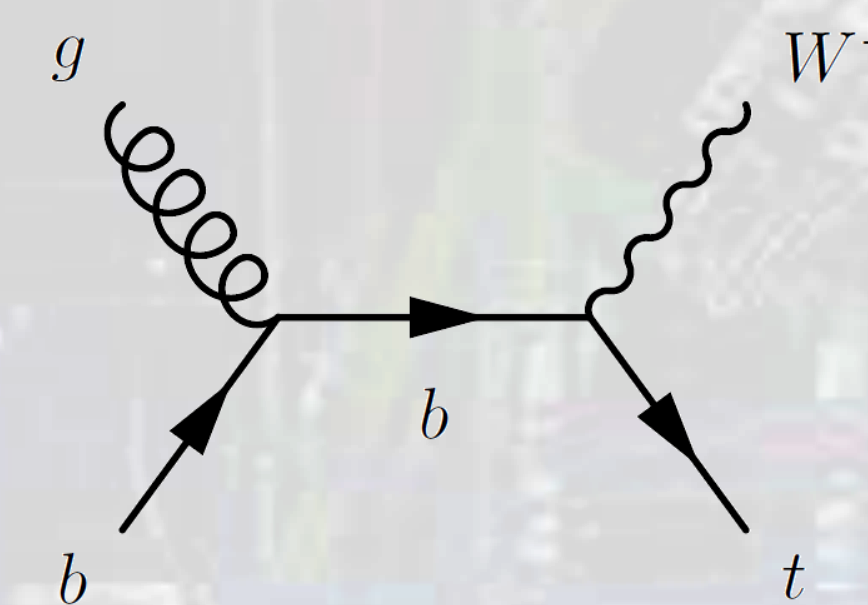


First measurement of the tW process at 13 TeV by CMS

Motivation

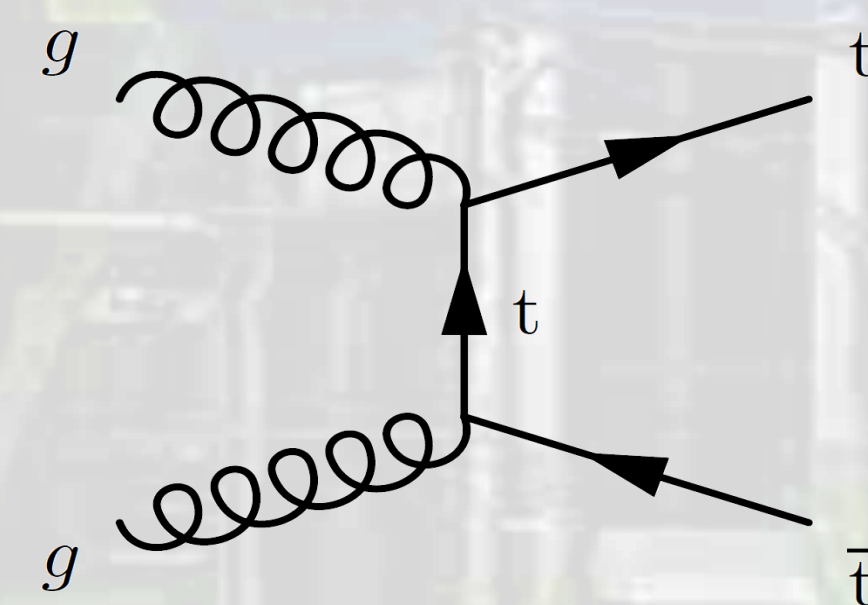
- The tW process includes the most massive elementary particle of the SM, the top quark $\rightarrow 172.5$ GeV (PTEP 2020 (2020) 8).
- It has the second biggest cross section of single top production at the LHC.

Signal $\rightarrow tW$



Electroweak production

Main background $\rightarrow t\bar{t}$



Strong production

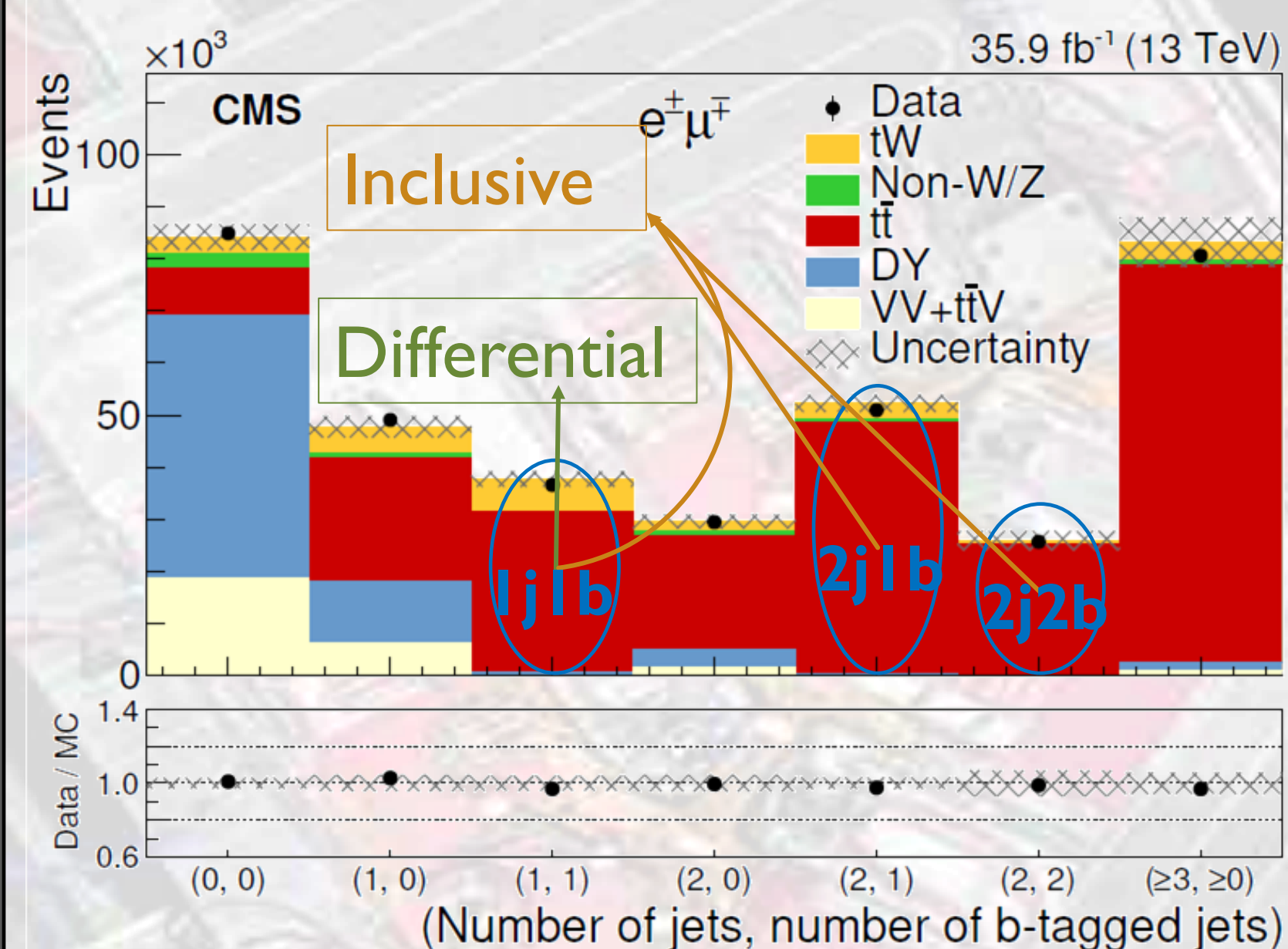
Measurement performed using the dataset recorded with the CMS detector in 2016 at $\sqrt{s} = 13$ TeV in pp collisions

- Interference between $t\bar{t}$ and tW at NLO in QCD.
- Two schemes are defined to avoid double counting issues:
 - DR:** all doubly resonant diagrams are removed from the ME calculation.
 - DS:** a gauge invariant term is introduced in the ME calculation that locally cancels the doubly resonant diagrams.

Baseline event selection

- The two first leading leptons must be an electron and a muon of opposite charge.
- Leading lepton $p_T > 25$ GeV.
- The invariant mass of the dilepton pair must be greater than 20 GeV.
- Different regions for the **inclusive** and **differential** measurements are defined based on the number of jets and **b-tagged jets**.

Challenge: background dominates signal!



Inclusive: JHEP 10 (2018) 117

Differential: CMS-PAS-TOP-19-003

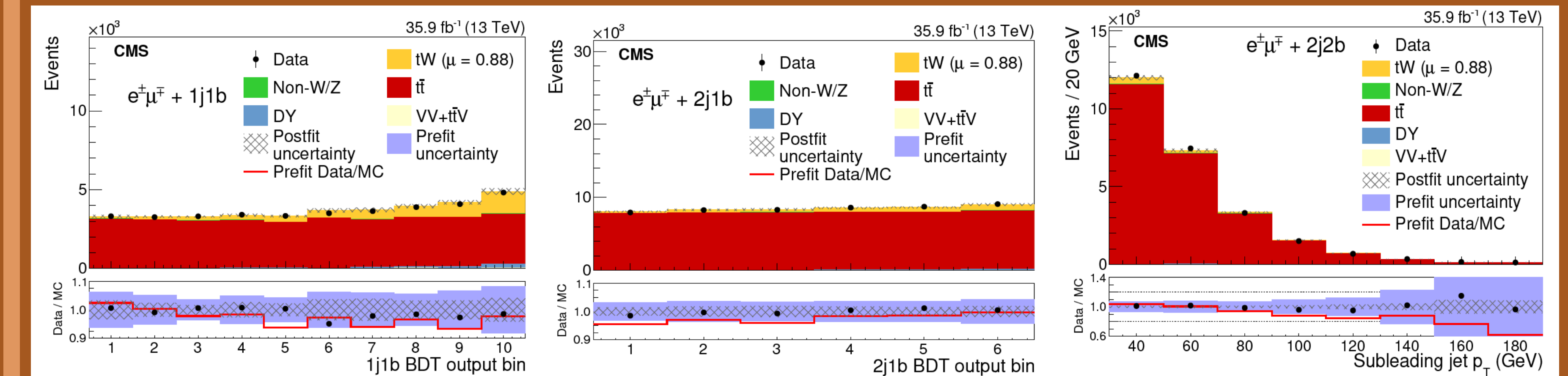
Methodology

- To discriminate between tW and $t\bar{t}$ events, two BDTs, one in the **1j1b** region and the other in the **2j1b** region, are trained using the kinematic properties of the events.
- BDTs are implemented using TMVA (arXiv:physics/0703039).
- The **2j2b** region is used as a $t\bar{t}$ control region.
- To extract the signal, a ML-fit is performed using the two BDTs output and the subleading jet p_T in the 2j2b region.

Methodology

- The **1j1b** region with a veto on the number of loose jets is chosen as the signal region.
- The differential cross sections are measured as a function of the leading lepton p_T , jet p_T , $\Delta\phi(e^\pm, \mu^\mp)$, $p_z(e^\pm, \mu^\mp, j)$, $m(e^\pm, \mu^\mp, j)$ and $m_T(e^\pm, \mu^\mp, j, p_T^{\text{miss}})$.
- Signal is extracted by subtracting background to data.
- Unfolding (implemented using TUnfold: JINST 7 (2012) T10003) is done to an equivalent fiducial region at particle level. The result is normalised to the fiducial cross section.

Results

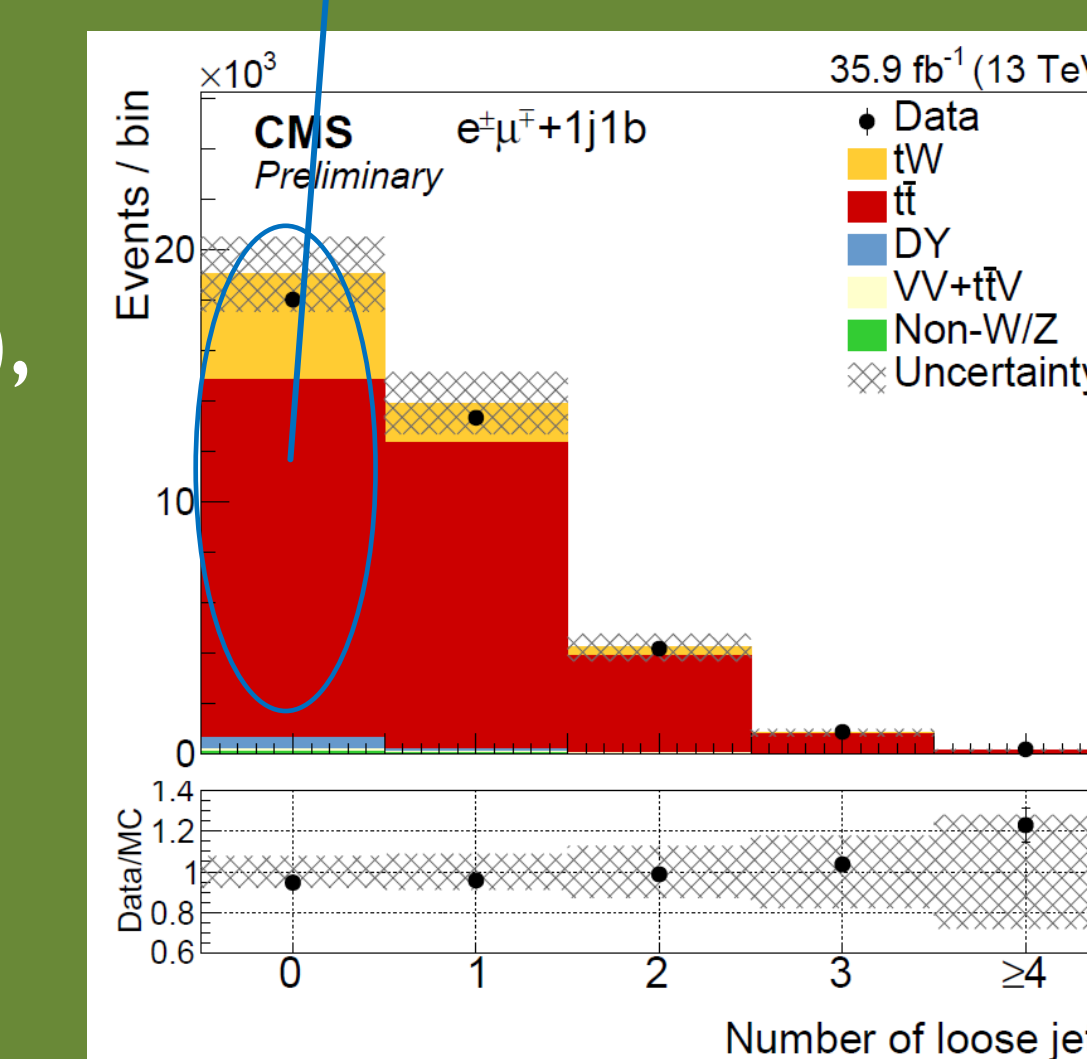


- The measured cross section is:

$$\sigma_{\text{exp}} = 63.1 \pm 1.8 \text{ (stat)} \pm 6.4 \text{ (syst)} \pm 2.1 \text{ (lumi)} \text{ pb}$$
 - Measurement dominated by **systematic uncertainties**.
- In agreement with the SM expectation (arXiv:1506.04072):

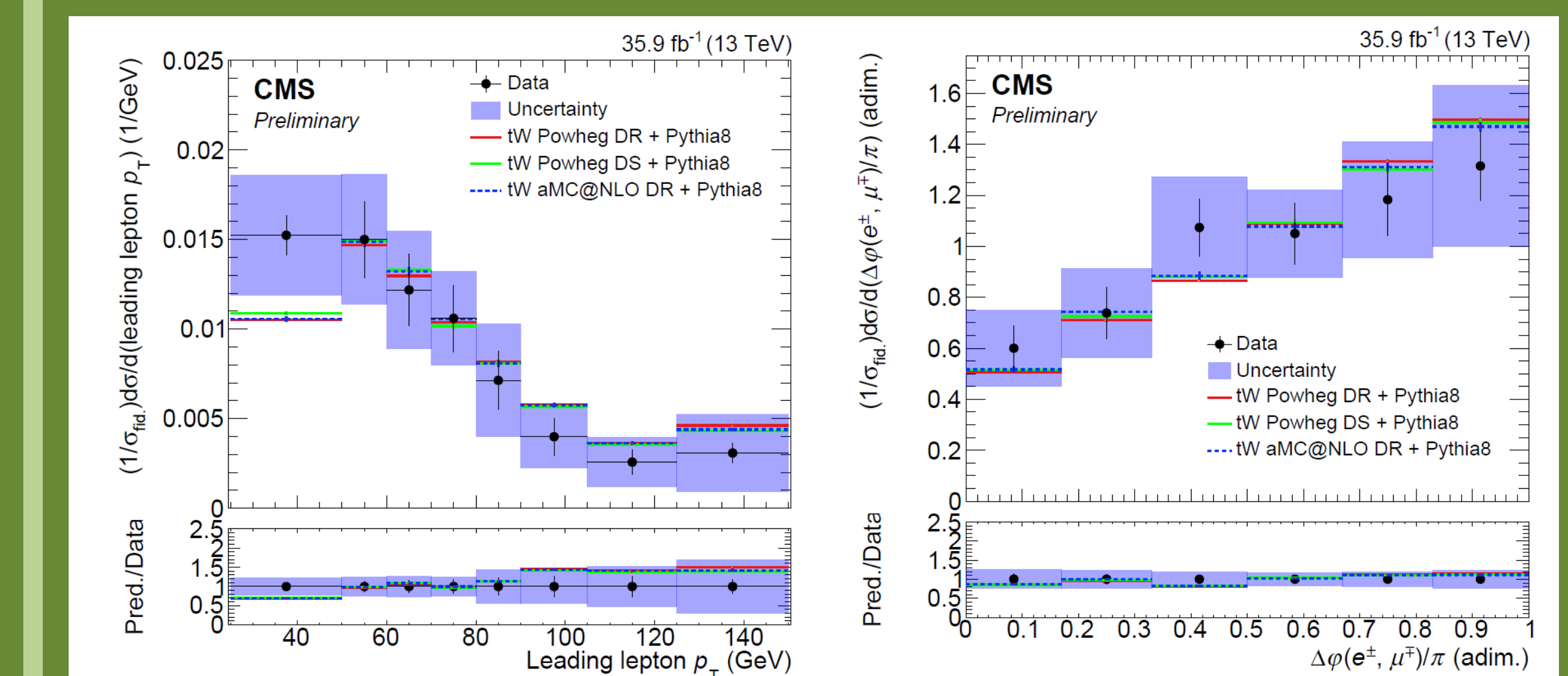
$$\sigma_{\text{theo}} = 71.7 \pm 1.8 \text{ (scale)} \pm 3.4 \text{ (PDF)} \text{ pb}$$

Signal Region



Jets with a relaxed p_T criteria

Results



- Good agreement between data and expectations.
- Compatible results between the DR and DS schemes.