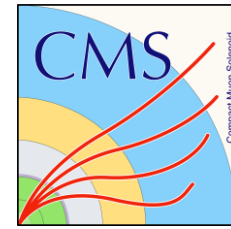
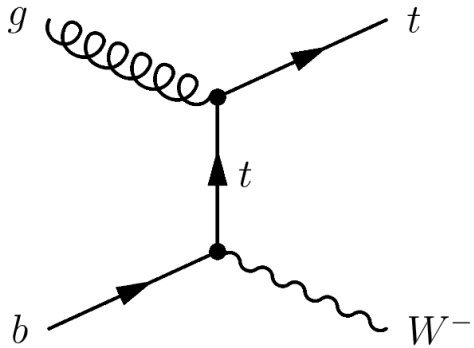




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tW inclusive and differential cross section measurements at 13.6 TeV



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ON BEHALF OF THE CMS COLLABORATION

Moriond EW, La Thuille (Italy)

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Introduction and analysis overview

- **First** measurement of the **tW** process at **13.6 TeV** and one of the first measurements done in **Run 3** using the full **2022** dataset with **34.7 fb⁻¹** of int. luminosity.

- Reference: CMS-PAS-TOP-23-008.

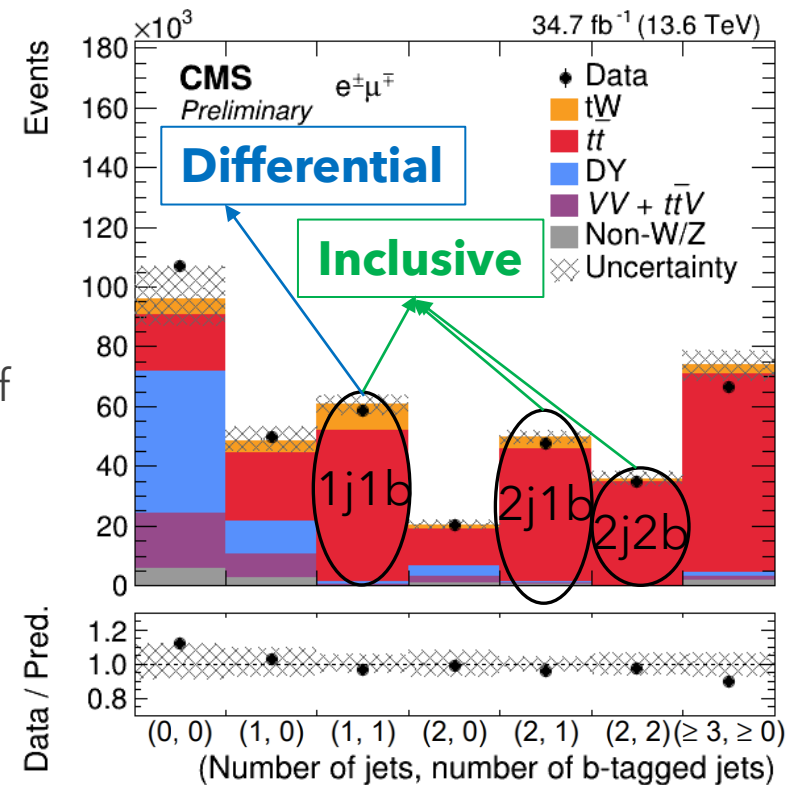
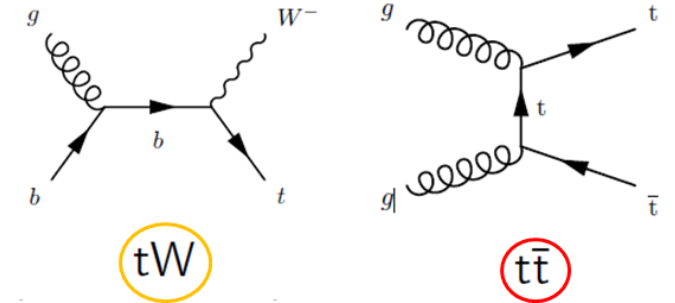
- **Objectives:**

- Measure the **inclusive** cross section of **tW**.
- Measure the **differential** cross sections as a function of several observables.

- **Main challenge:** irreducible **t \bar{t}** background largely dominates signal contribution.

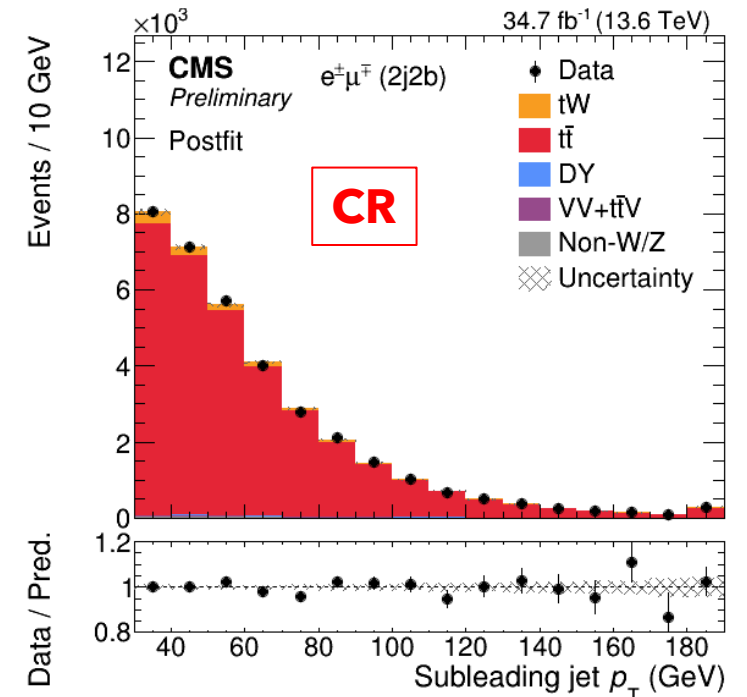
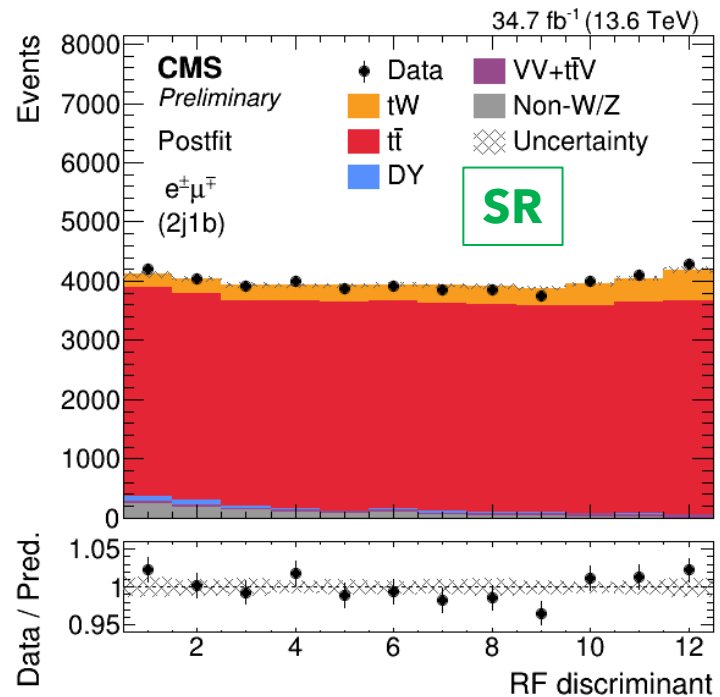
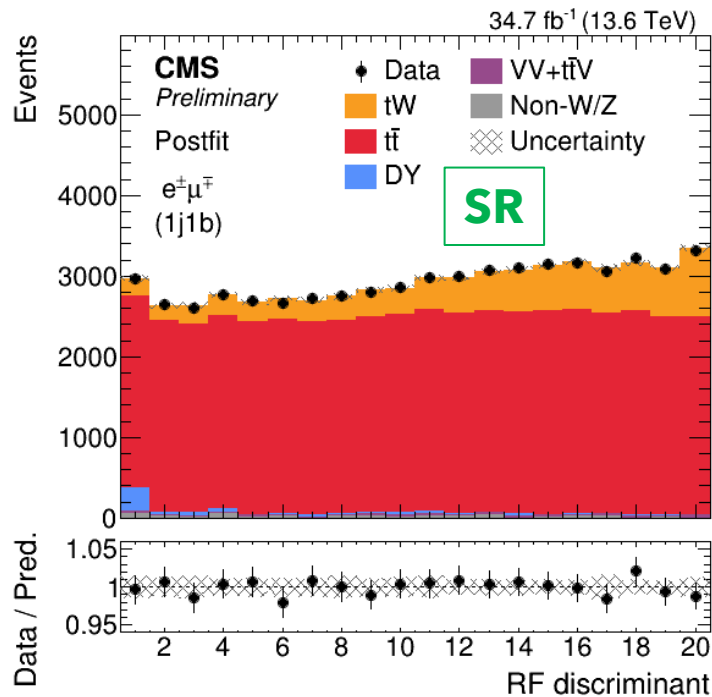
- **Event selection:**

- **e $^{\pm}$ μ^{\mp}** : the two leading leptons must be an electron and a muon of opposite charge.
- Leading lepton $p_T > 25$ GeV and subleading lepton $p_T > 20$ GeV.
- All lepton pairs must satisfy $m(\ell_1, \ell_2) > 20$ GeV.



Inclusive cross section measurement

- To discriminate between tW and $t\bar{t}$ events, two Random Forest (RF), one in the **1j1b** region and the other in the **2j1b** region, are trained using the kinematic properties of the events.
- To extract the signal, a ML fit is performed using the two RF output and the subleading jet p_T in the **2j2b** region.



aN³LO

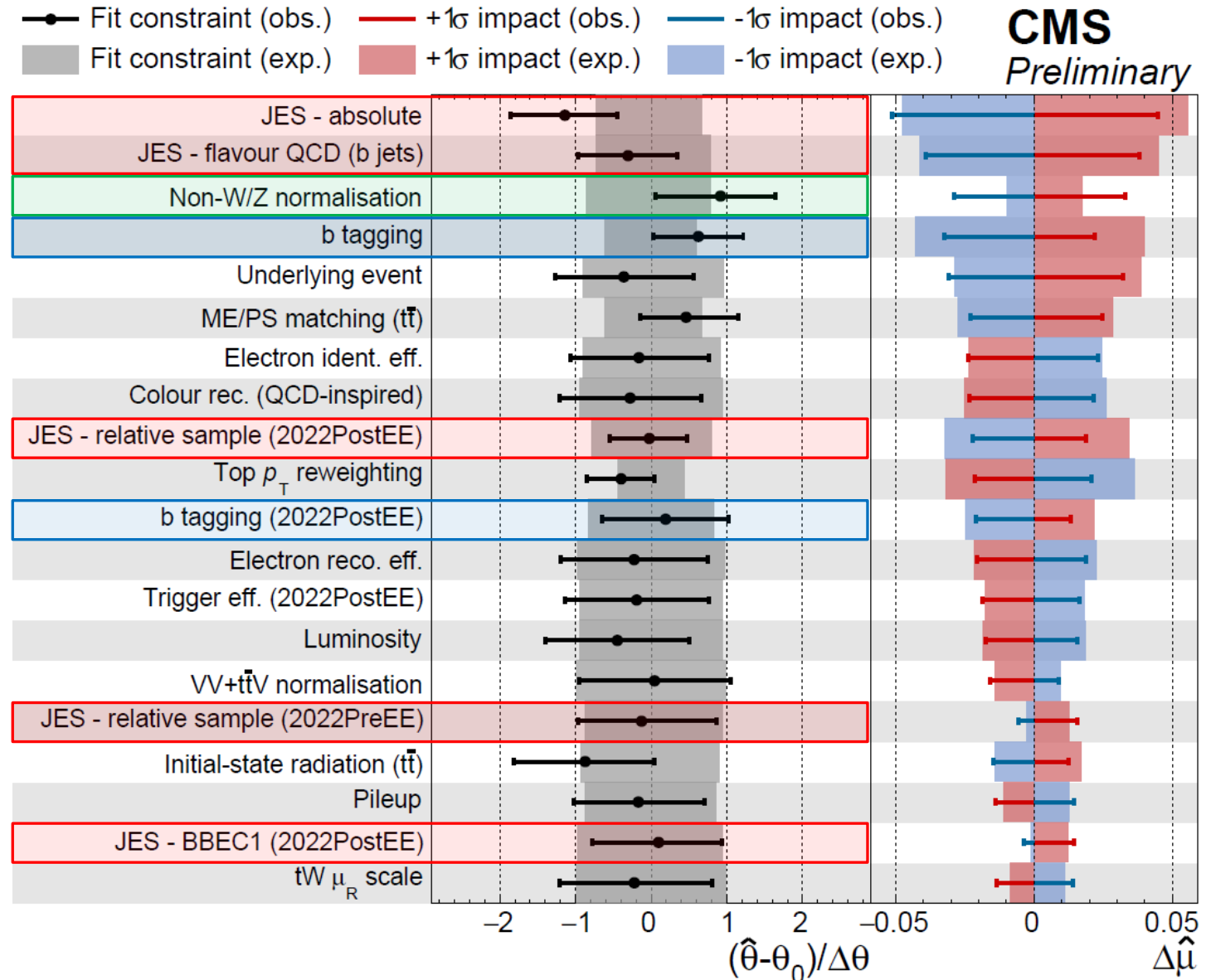
[JHEP05 \(2021\) 278](#)

$$\sigma_{tW}^{SM} = 87.9_{-1.9}^{+2.0}(\text{scale}) \pm 2.4(\text{PDF} + \alpha_s) \text{ pb}$$

$$\sigma_{tW}^{obs} = 84.1 \pm 2.1(\text{stat})_{-10.2}^{+9.8}(\text{syst}) \pm 3.3(\text{lum}) \text{ pb}$$

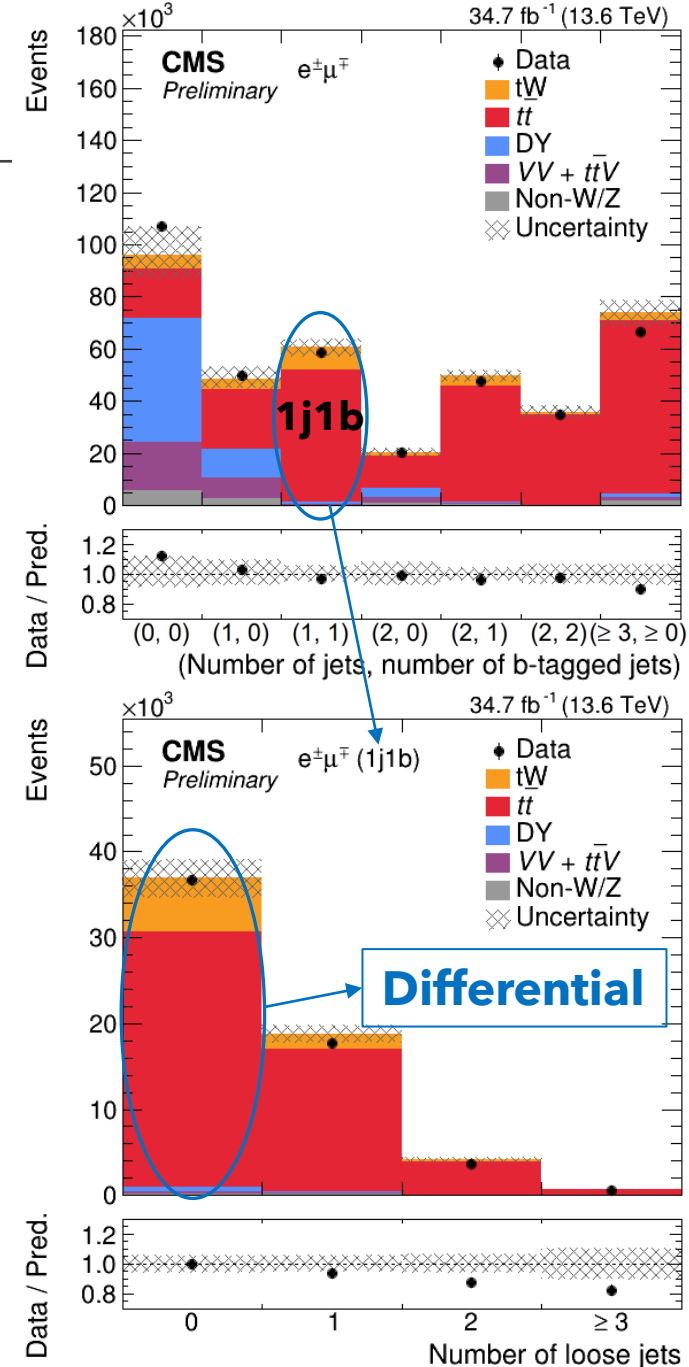
Inclusive cross section measurement

- Measurement dominated by **systematic** uncertainties.
- The main difference between $t\bar{t}$ and tW is the **additional b jet** that is present in $t\bar{t}$, thus:
 - The leading uncertainties are the ones associated with the **jets energy** and **b tagging**. But also, the normalisation of the second leading background: **Non-W/Z (misidentified leptons)**.



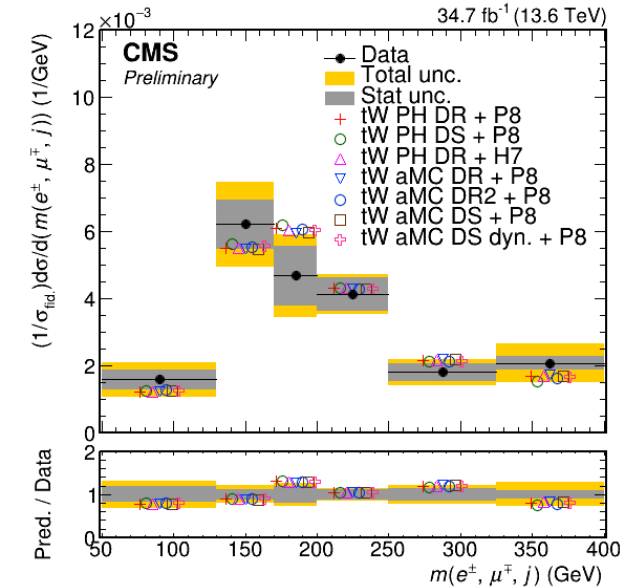
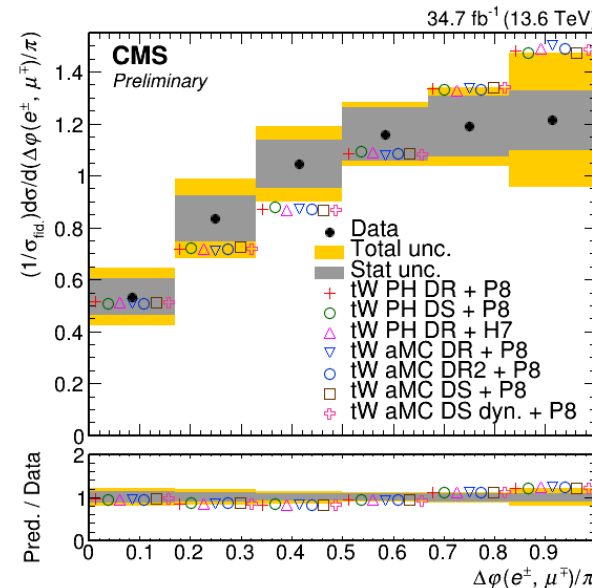
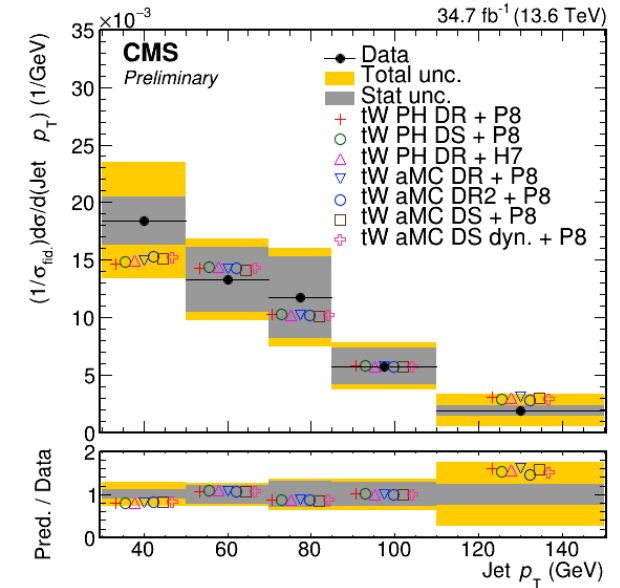
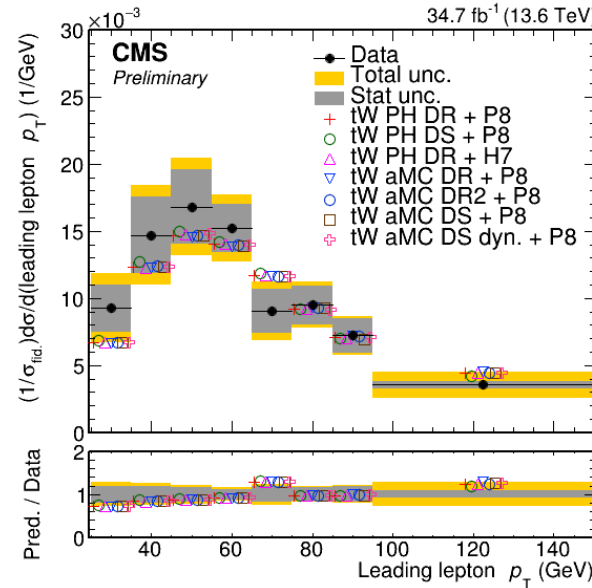
Differential measurements

- Measurement performed in the **1j1b** region **vetoing events with low energy jets (loose jets)**.
- Signal extraction is performed by **background subtraction**.
- Unfolding from detector level to particle level is performed using **TUnfold** ([JINST 7 \(2012\) T10003](#)).
- We measure the following observables:
 - p_T of the leading lepton.
 - p_T of the jet.
 - $\Delta\phi(e, \mu)$.
 - $p_z(e, \mu, \text{jet})$.
 - $m(e, \mu, \text{jet})$.
 - $m_T(e, \mu, \text{jet}, p_T^{\text{miss}})$.



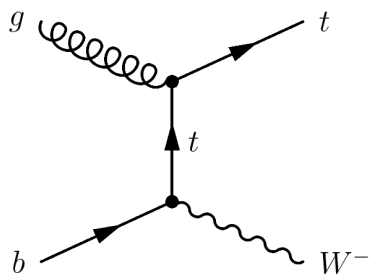
Differential measurements

- Results are normalised to the fiducial cross section and bin width.
- There is **good agreement** between the measurements and the predictions from the different event generators:
 - POWHEG vs MADGRAPH5_aMC@NLO.
 - PYTHIA8 vs HERWIG7.
 - Different schemes to treat the interference between tW and $t\bar{t}$.

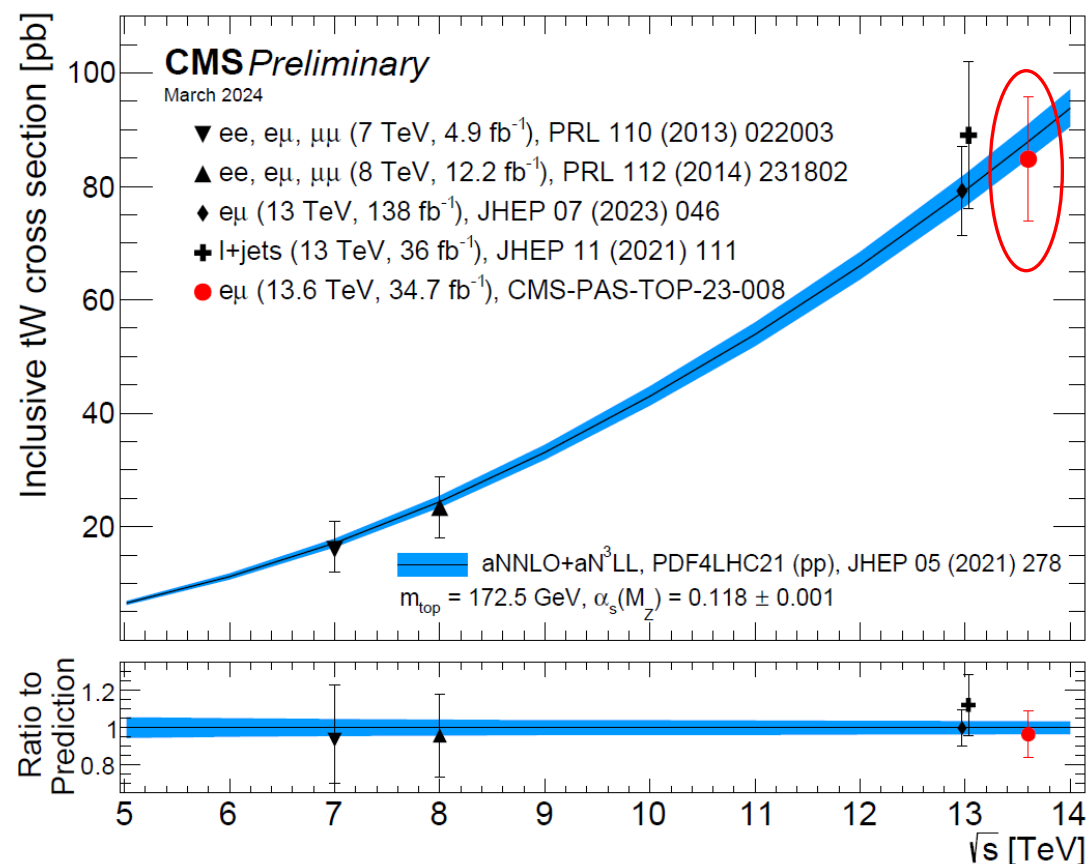


Summary

- The **first inclusive** and **differential** cross section measurements of the **tW** process at **13.6 TeV** have been presented: CMS-PAS-TOP-23-008.
- The measured **inclusive** cross section $\sigma_{tW}^{obs} = 84.1 \pm 2.1(stat)_{-10.2}^{+9.8}(syst) \pm 3.3(lum)$ pb is compatible with the SM prediction $\sigma_{tW}^{SM} = 87.9_{-1.9}^{+2.0}(scale) \pm 2.4(PDF + \alpha_s)$ pb ([JHEP05 \(2021\) 278](#)).
- With respect to the **differential** measurements, compatible results between the SM expectations and the measured cross sections are also observed.

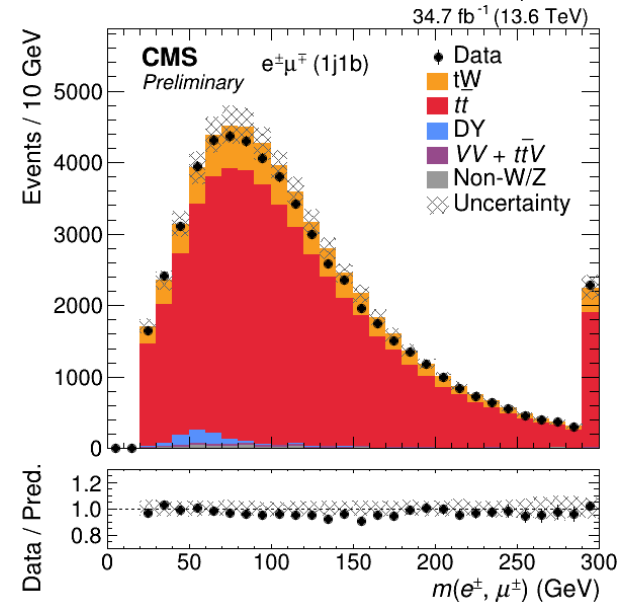
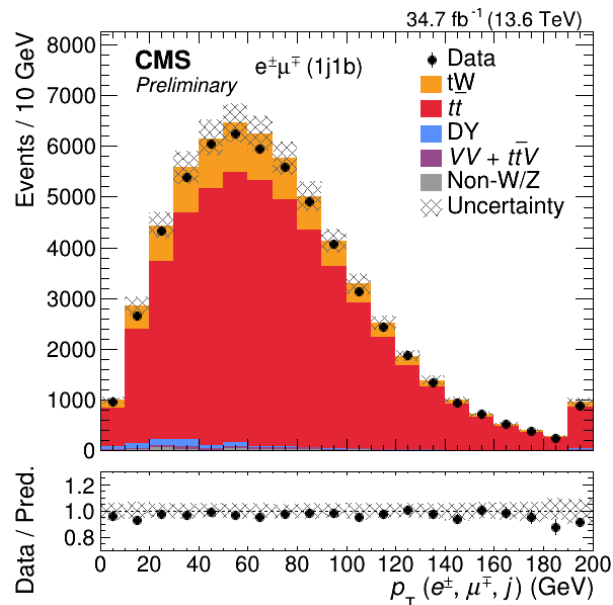
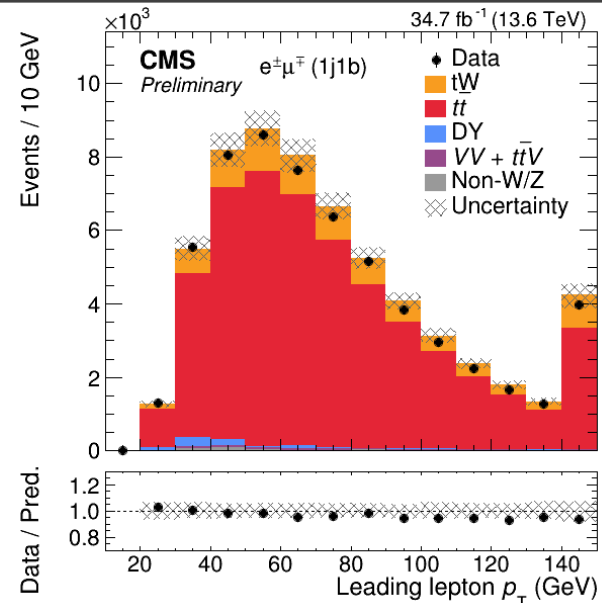
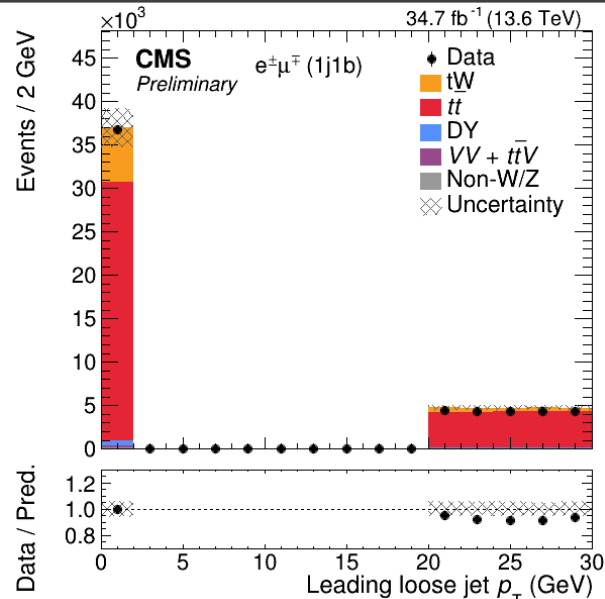


Thanks!

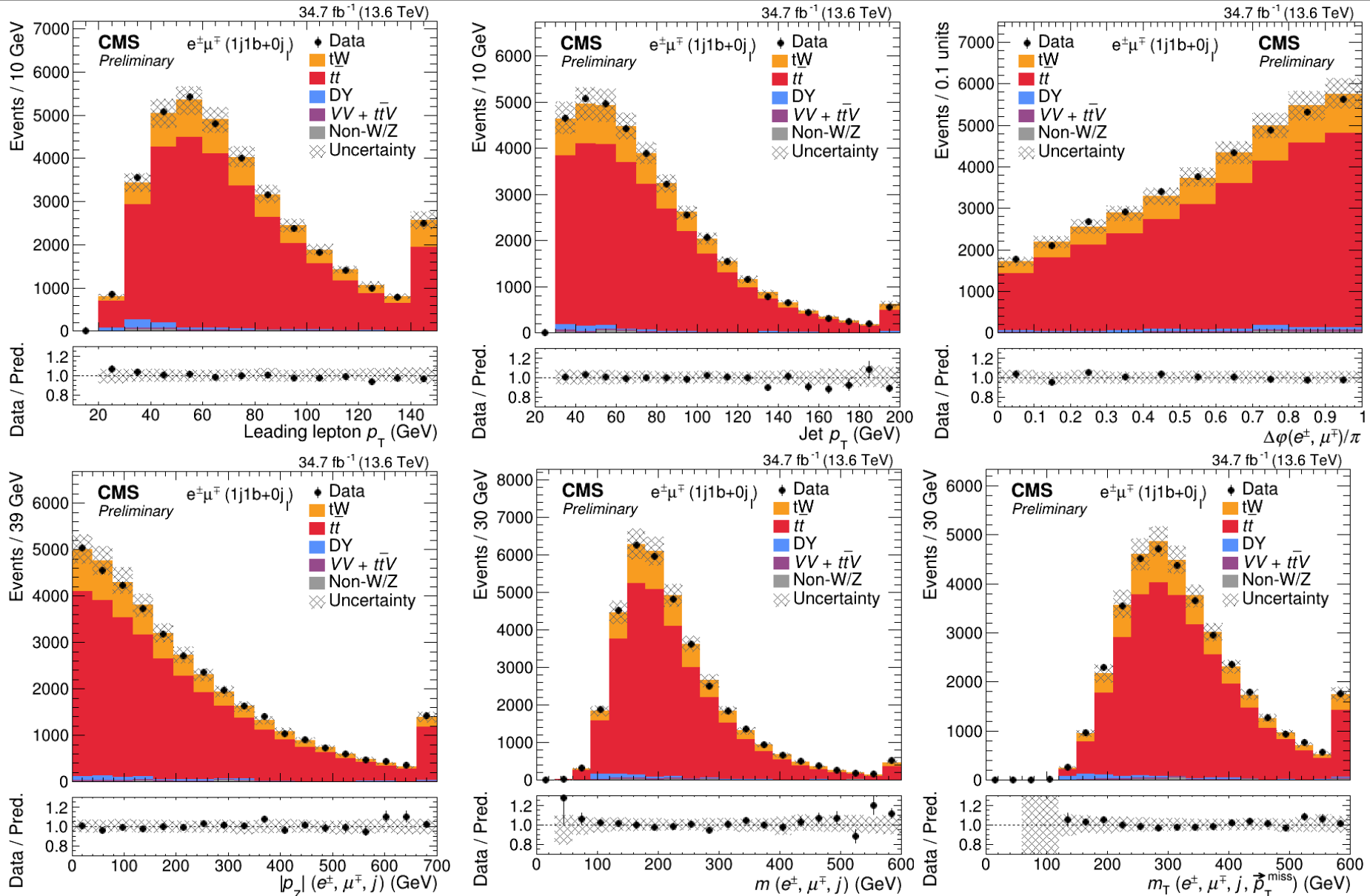


Back up

Inclusive measurement - 1j1b MVA training variables



Differential measurement – data/MC comparison



Differential measurements

