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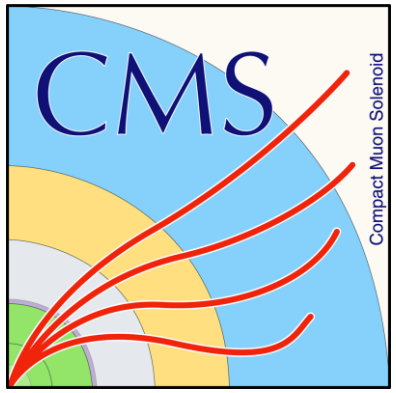

Inclusive and differential cross-sections measurements in the single top tW eμ channel with CMS

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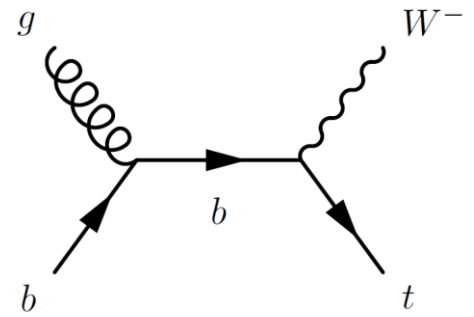
Introduction

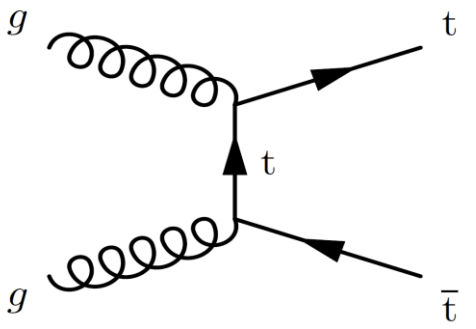
- A measurement of the tW inclusive and differential cross sections using data recorded with the CMS detector at $\sqrt{s} = 13$ TeV in 2016 is presented (JHEP 10 (2018) 117, CMS-PAS-TOP-19-003).
- The tW process includes the most massive elementary particle of the SM, the top quark → 172.5 GeV (PTEP 2020 (2020) 8).
- The study of the production and properties of the top quark is one of the core elements of the LHC physics programme.
- Main challenge of the analysis: background (being the most important $t\bar{t}$) largely dominates signal.

Interference between $t\bar{t}$ and tW

- It is a consequence of its similarity on their final states.
- They interfere at NLO in perturbative QCD.
- In order to resolve both processes' definitions, and avoid double counting issues, two approaches (JHEP 07 (2008) 029) are used to obtain the tW simulation samples:
  - Diagram removal (**DR**): all doubly resonant diagrams are removed from the ME calculation.
  - Diagram subtraction (**DS**): a gauge invariant term is introduced in the ME calculation that locally cancels the doubly resonant diagrams.
- In this analysis the DR method is used, and it has been verified that the number of predicted events after the full selection is comparable with that obtained from the DS approach.



tW



$t\bar{t}$

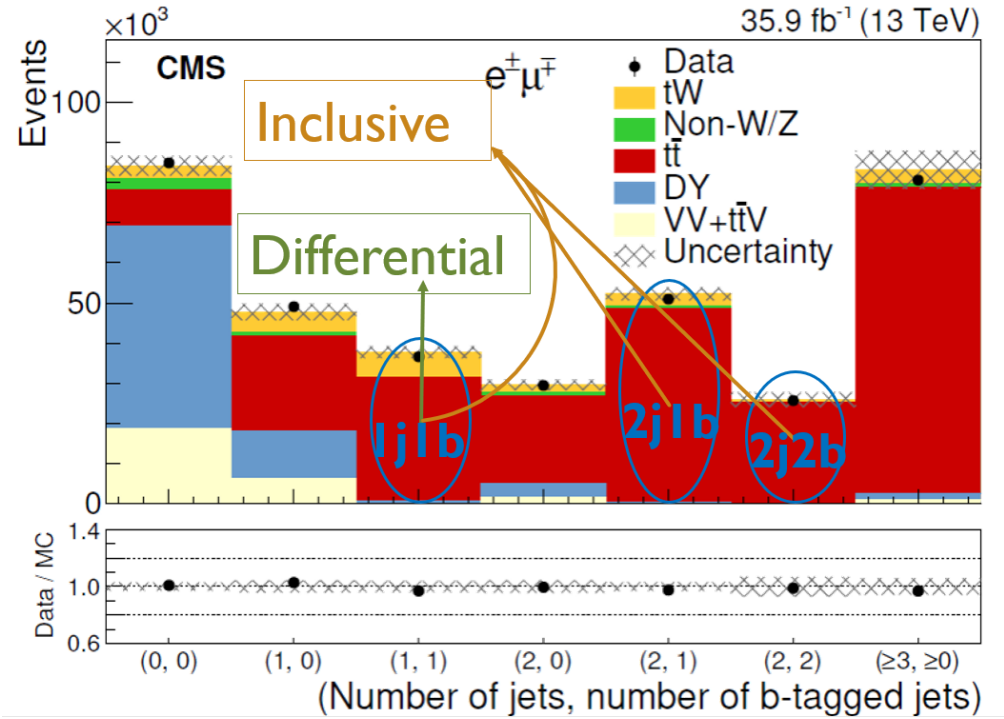
Methodology

- The analysis is performed using the complete 2016 dataset (35.9 fb^{-1}).
- The trigger strategy uses a combination of single and double lepton triggers to maximise efficiency.

Event selection:

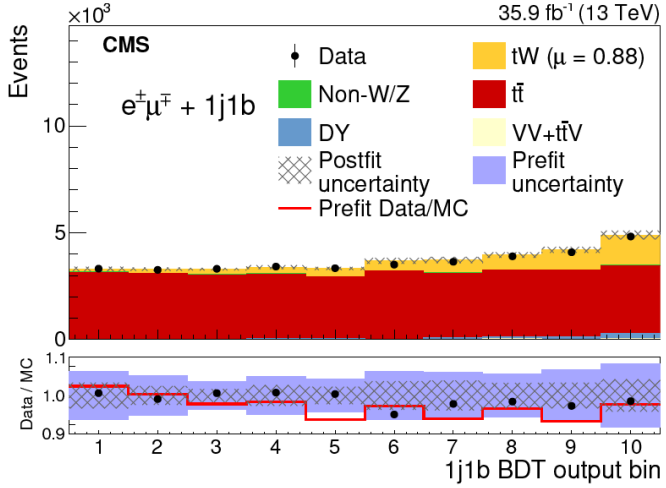
- The two first leading leptons must be an electron and a muon of opposite charge.
- Leading lepton p_T>25 GeV.
- The invariant mass of the dilepton pair must be greater than 20 GeV.

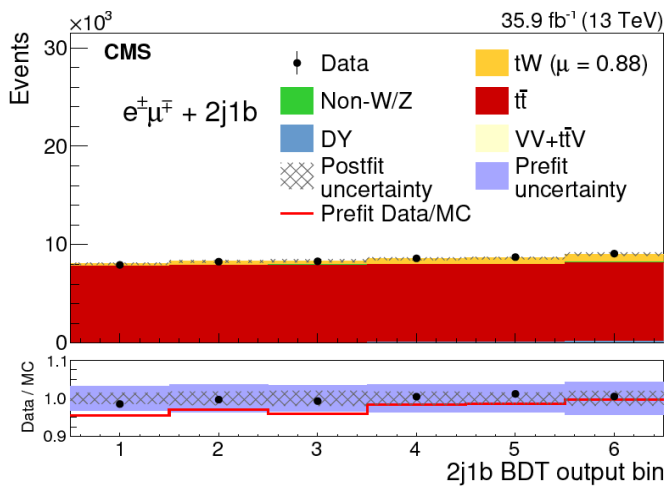
Different regions for the inclusive and differential measurements are defined based on the number of jets and b-tagged jets.

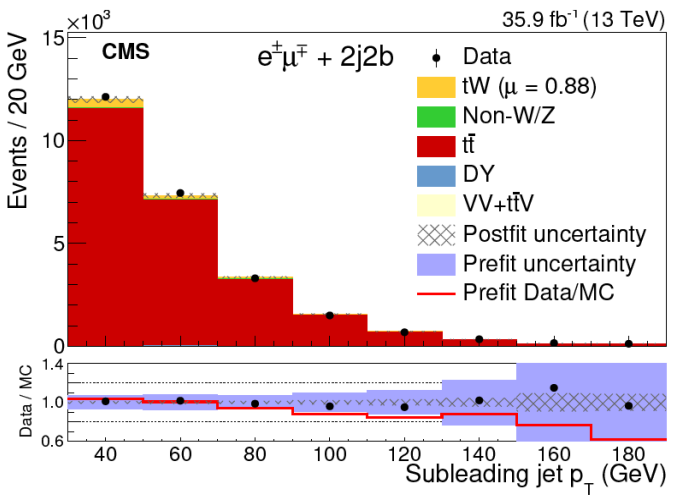


Inclusive cross section measurement

- 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.
- 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.





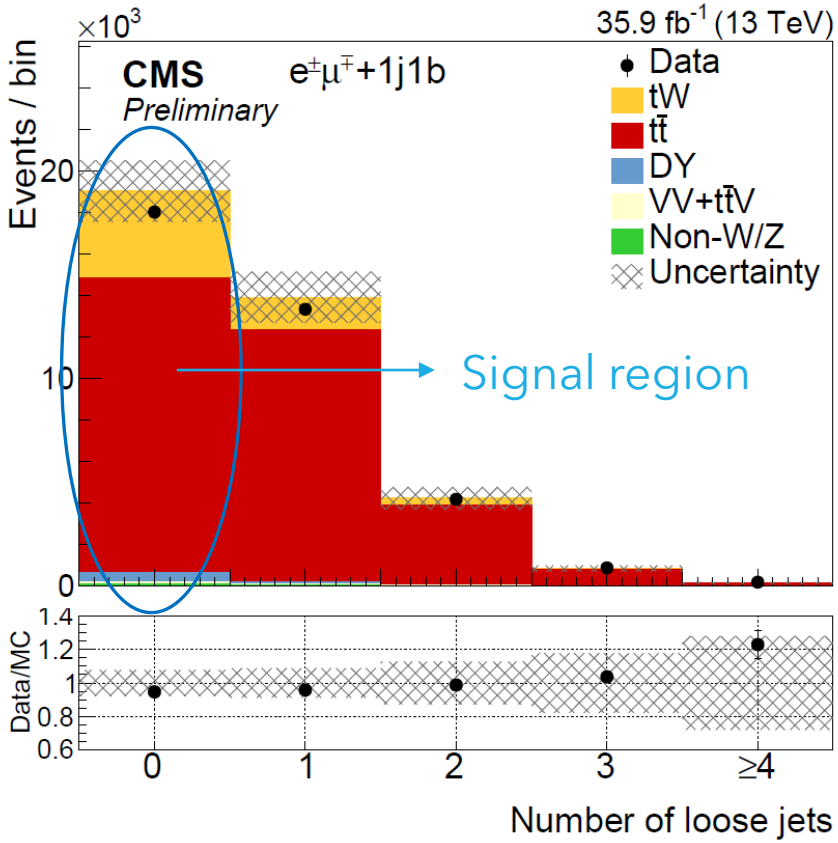


The measured cross section is: $\sigma_{\text{exp}} = 63.1 \pm 1.8\ (\text{stat}) \pm 6.4\ (\text{syst}) \pm 2.1\ (\text{lumi})\ \text{pb}.$

Dominated by systematic uncertainties.

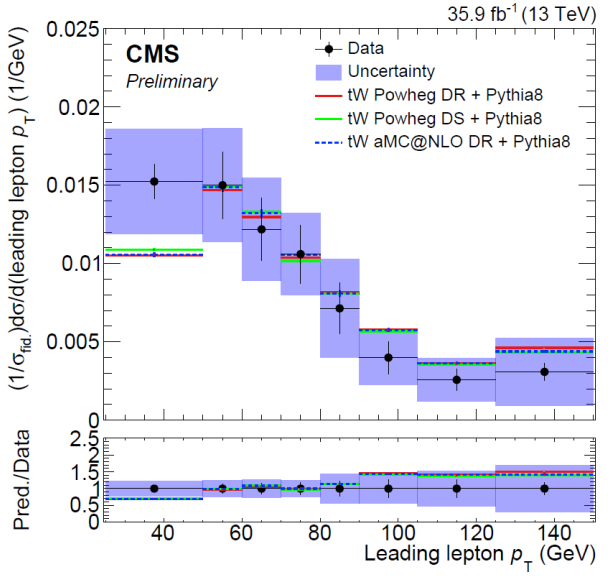
Differential cross section measurement

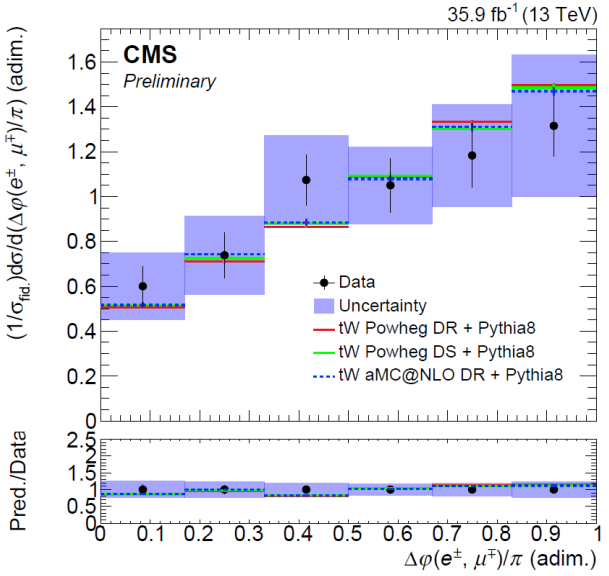
- The 1j1b region with a veto on the number of loose jets is chosen as the signal region.
- The differential cross sections are measured as a function of the leading lepton p_T, jet p_T, $\Delta\phi(e^{\pm}\mu^{\pm})$, $\mathrm{p_z}(e^{\pm}\mu^{\pm}, j)$, $m(e^{\pm}\mu^{\pm}, j)$ and $\mathrm{m_T}\left(e^{\pm}\mu^{\pm}, j, p_T^{miss}\right)$.
- **Signal is extracted by subtracting background from 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.

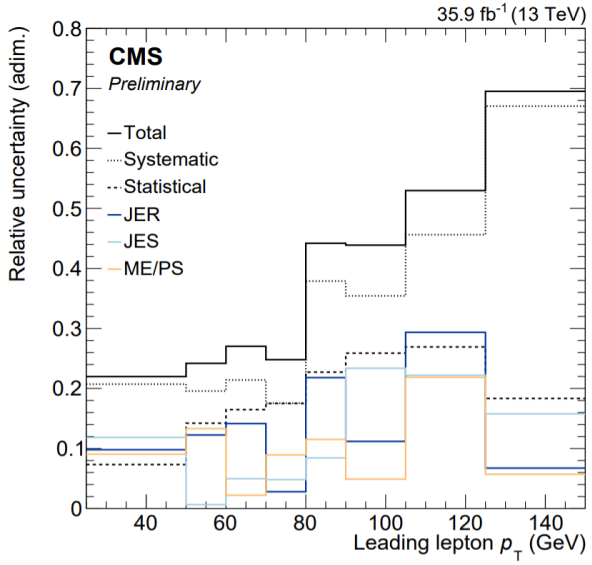


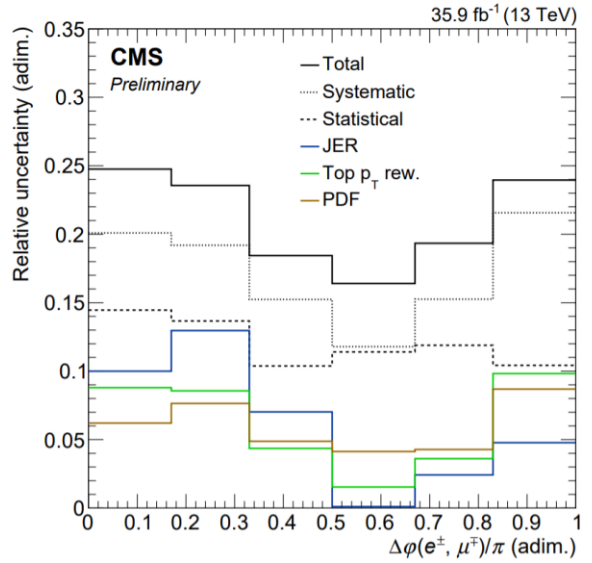
Differential cross section measurement

- Agreement between data and expectations (with the two generators, POWHEG and MADGRAPH5_aMC@NLO) is fairly good.
- Analysis largely dominated by systematic sources of uncertainties, whose main origin is the overwhelming background.
- Compatible results between the DR and DS schemes of the signal process.









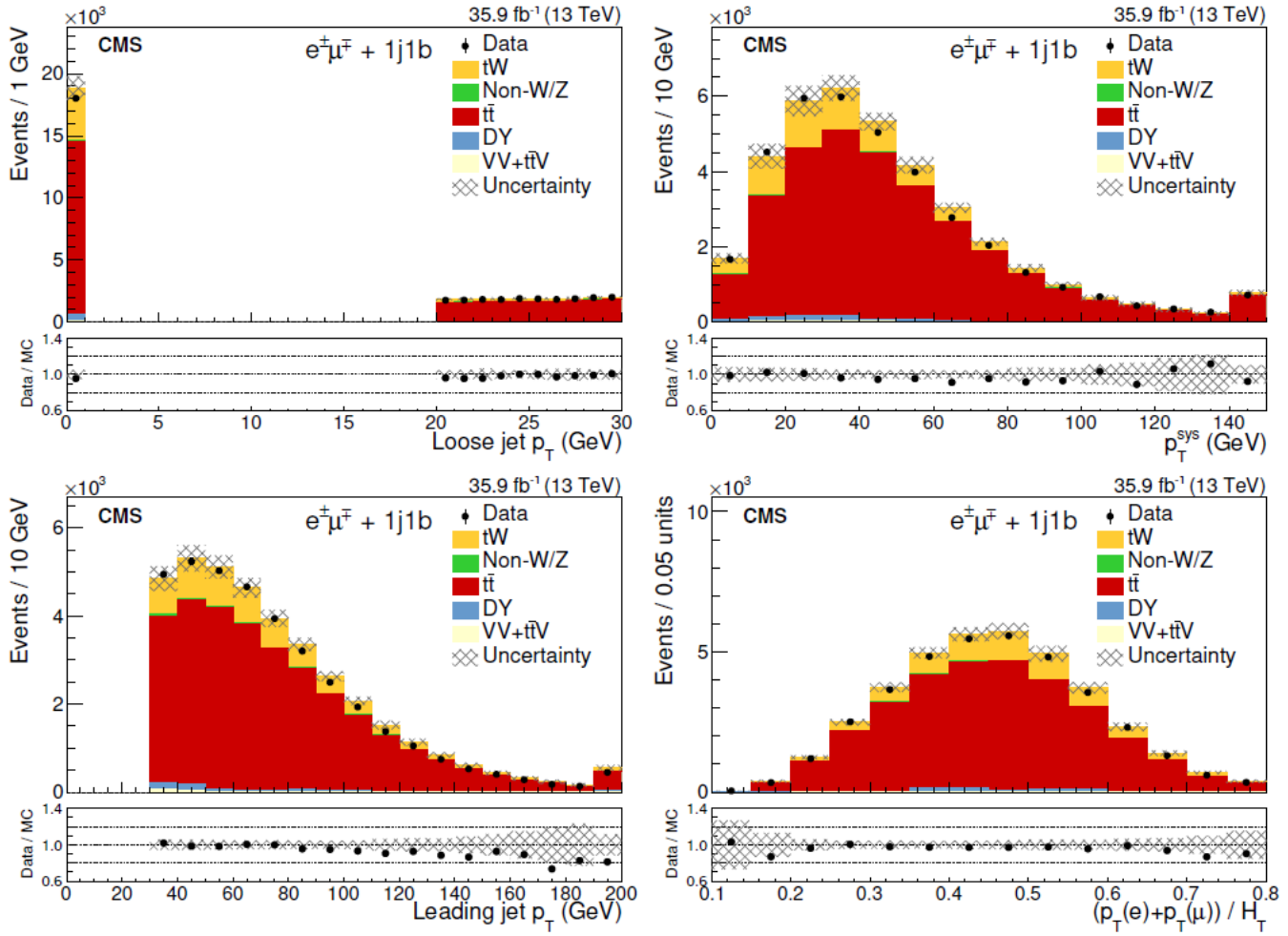
Conclusions

- An inclusive and differential cross section measurements of the tW process have been presented.
- For the inclusive measurement two BDTs are used to separate signal and background events.
- The measured inclusive cross section $\sigma_{\mathrm{exp}} = 63.1 \pm 1.8\ (\mathrm{stat}) \pm 6.4\ (\mathrm{syst}) \pm 2.1\ (\mathrm{lumi})\ \mathrm{pb}$ is compatible with the SM prediction $\sigma_{\mathrm{theo}} = 71.7 \pm 1.8\ (\mathrm{scale}) \pm 3.4\ (\mathrm{PDF})$ pb (arXiv:1506.04072).
- With respect to the differential measurement, compatible results between the SM expectations and the measured cross sections is also observed.

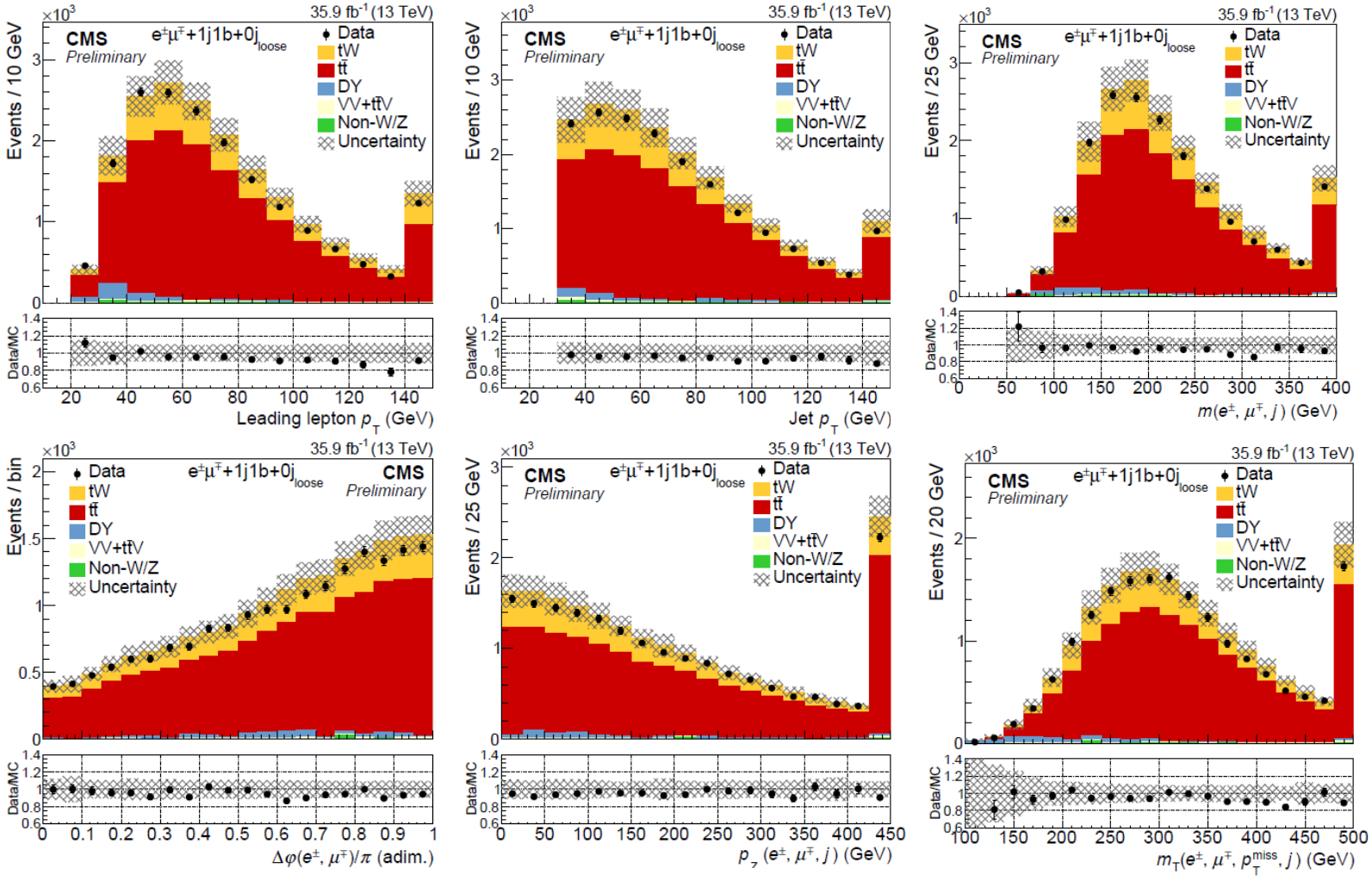
Thanks for your attention

Backup

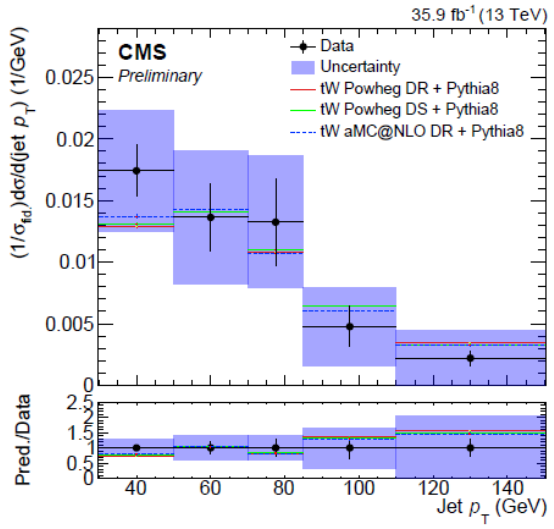
Input variables BDT 1j1b

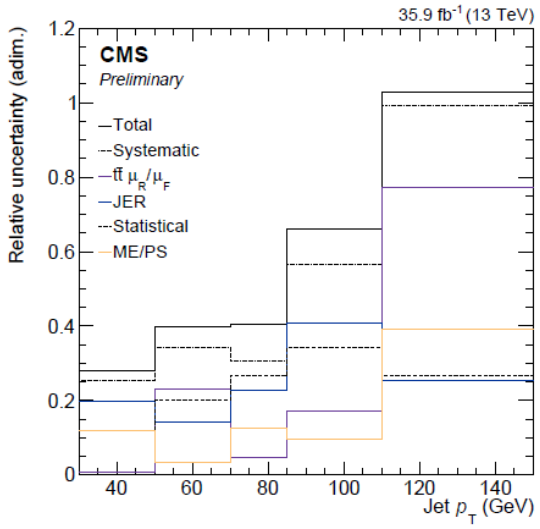


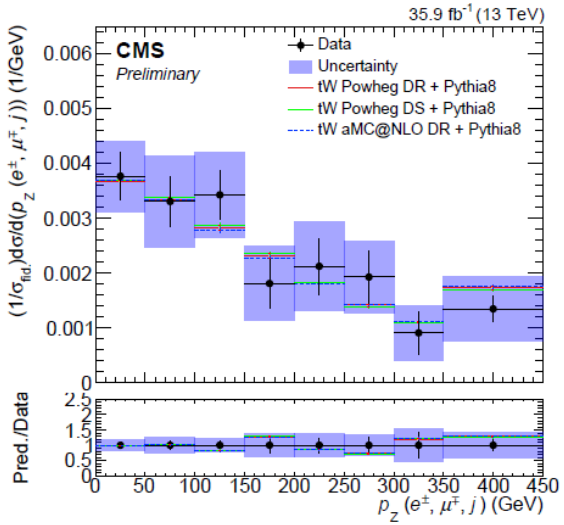
Data/MC comparison unfolding var.

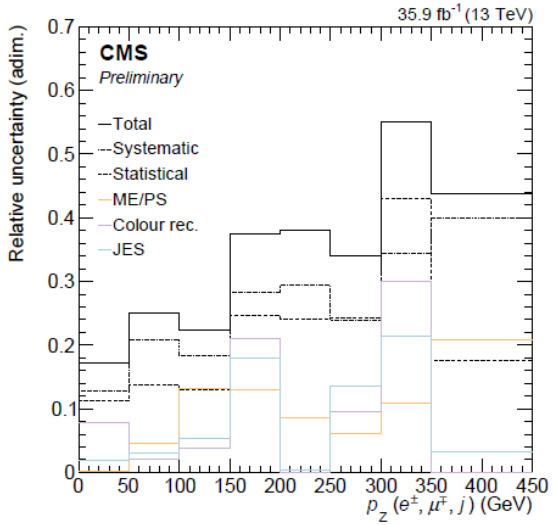


Differential measurement









Differential measurement