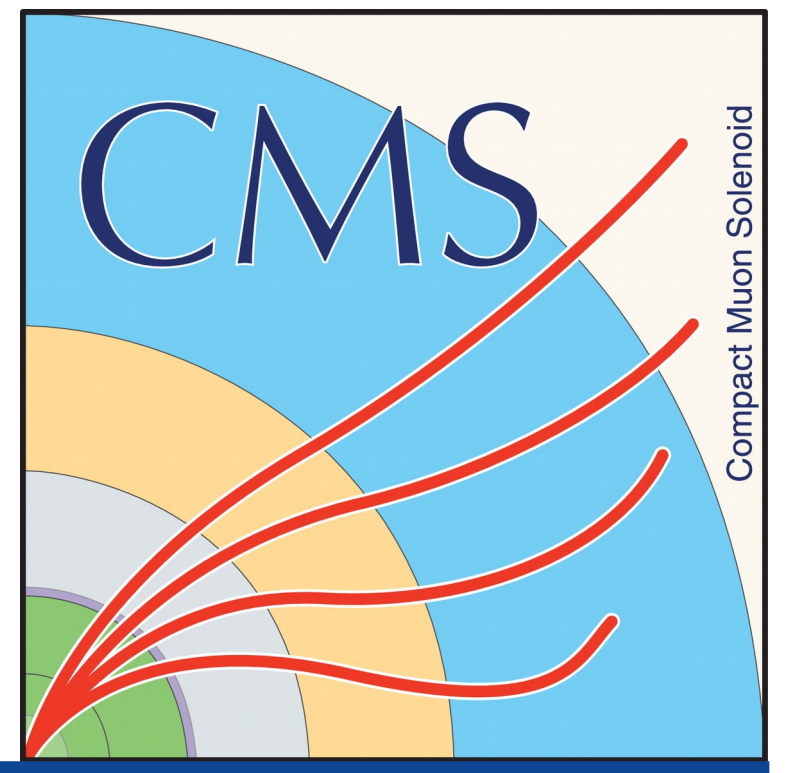# Single top quark production in association with a W boson in CMS

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Víctor Rodríguez Bouza (Universidad de Oviedo–ICTEA)*, on behalf of the CMS Collaboration*

Universidad de Oviedo
Universidá d'Uviéu
University of Oviedo

ICTEA — Instituto Universitario de Ciencias y Tecnologías del Espacio de Asturias

CMS — Compact Muon Solenoid

Introduction

The tW process is one of the main channels for single top quark production.

- At NLO shows **quantum interference** due to shared final states with the pair production diagrams of top quarks.

- Allows to **probe the V_{tb} element** of the CKM matrix.

- Is sensitive to **beyond Standard Model** (BSM) physics.

$$\sigma_{tW} = 71.7 \pm 1.8(\text{scale}) \pm 3.4(\text{PDF},\alpha_S)\,\text{pb}\quad [2]$$
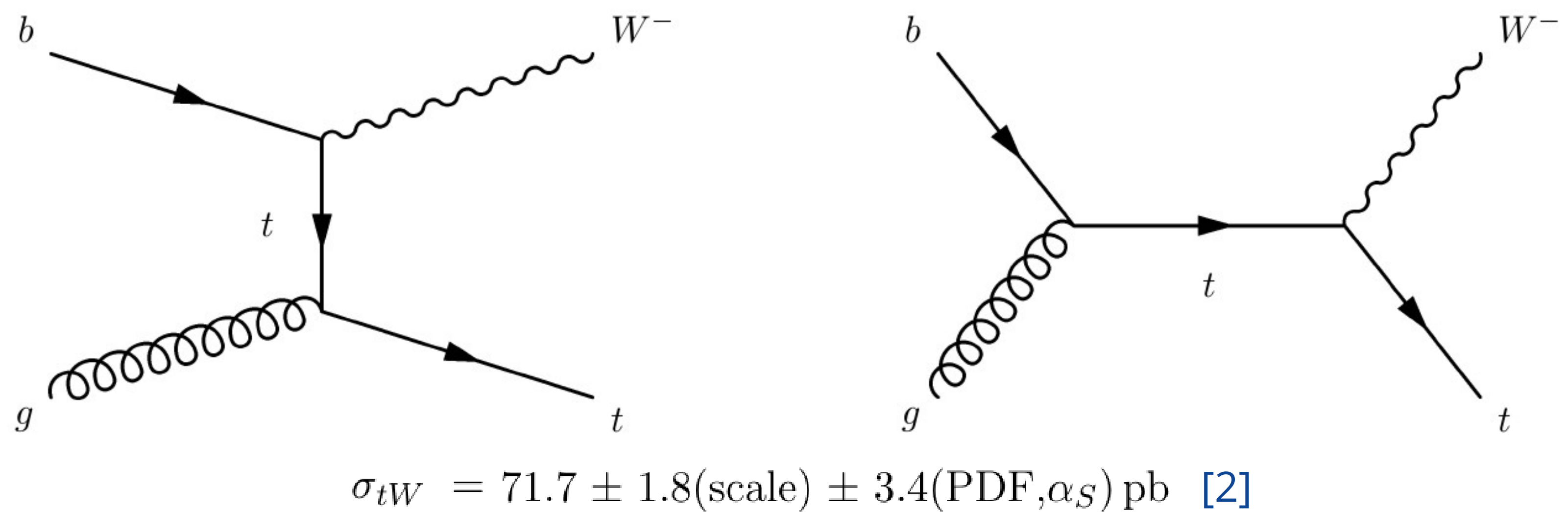
Methodology

- Analysis fully **dominated by the overwhelming top pair production**.

- Event **selection**:

  - Dileptonic channel ($e^{\pm}\mu^{\mp}$).

  - Signal and control regions defined taking advantage of n_{jet} and $n_{b\text{-tag}}$ distribution (see left fig.).

    - Signal regions: 1j1b and 2j1b.

    - Control region: 2j2b.

- A **maximum likelihood fit** is performed to the discriminant of a BDT built from events from the signal regions in addition to the p_T of the subleading jet in the control region (see bottom figs.).

 - Systematic uncertainties are taken into account using nuisance parameters in the fit.
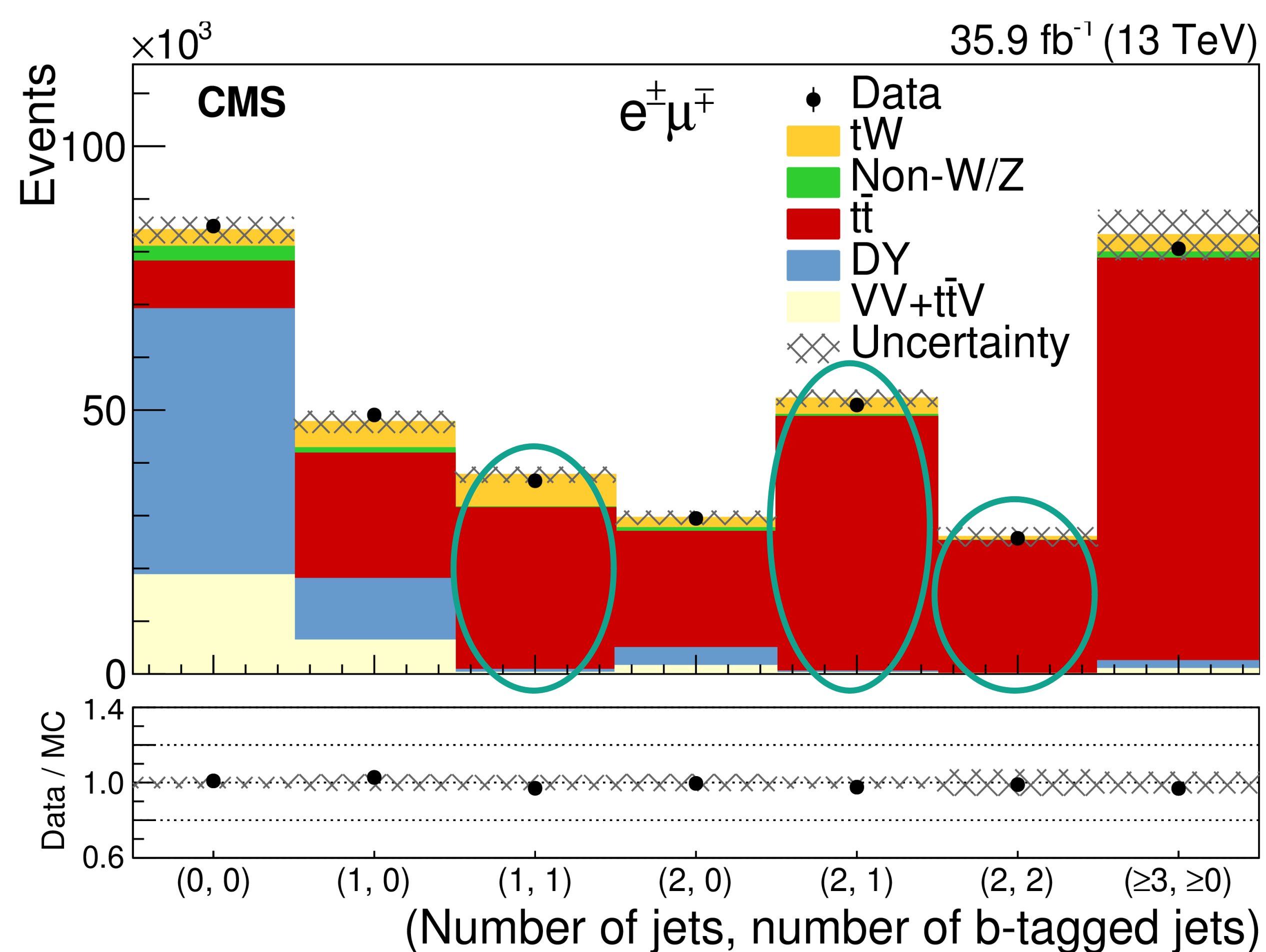
Results

- The signal contribution is extracted from the ML fit and used to calculate the experimental cross section:

$$\sigma_{exp.} = 63.1 \pm 1.8(\text{stat.}) \pm 6.4(\text{syst.}) \pm 2.1(\text{lumi.})$$

- The result yields a **11%** relative total uncertainty. Dominant sources are mainly **experimental**, and affect the measurement through the estimation of the top pair production background.

Source	Uncertainty (%)	Source	Uncertainty (%)
Experimental		Modeling	
Trigger efficiencies	2.7	$t\bar{t}$ μ_R and μ_F scales	2.5
Electron efficiencies	3.2	tW μ_R and μ_F scales	0.9
Muon efficiencies	3.1	Underlying event	0.4
JES	3.2	Matrix element/PS matching	1.8
Jet energy resolution	1.8	Initial-state radiation	0.8
b tagging efficiency	1.4	Final-state radiation	0.8
Mistag rate	0.2	Color reconnection	2.0
Pileup	3.3	B fragmentation	1.9
		Semileptonic B decay	1.5
Background normalization		PDFs	1.5
$t\bar{t}$	2.8	DR-DS	1.3
VV	0.4		
Drell–Yan	1.1	Total systematic	10.1
Non-W/Z leptons	1.6	(excluding integrated luminosity)	
$t\bar{t}$V	0.1	Integrated luminosity	3.3
MC finite sample size	1.6	Statistical	2.8
Full phase space extrapolation	2.9	Total	11.1
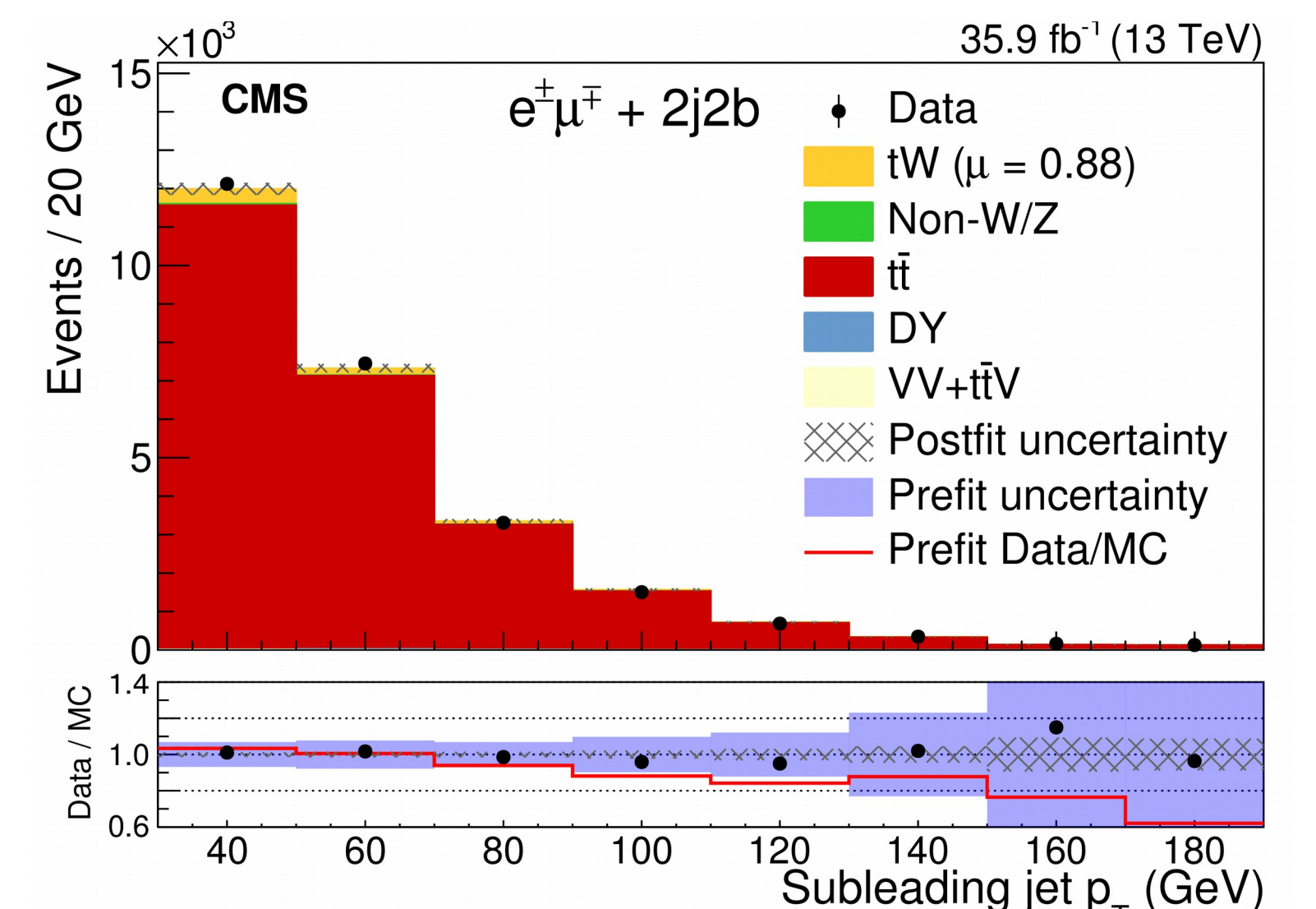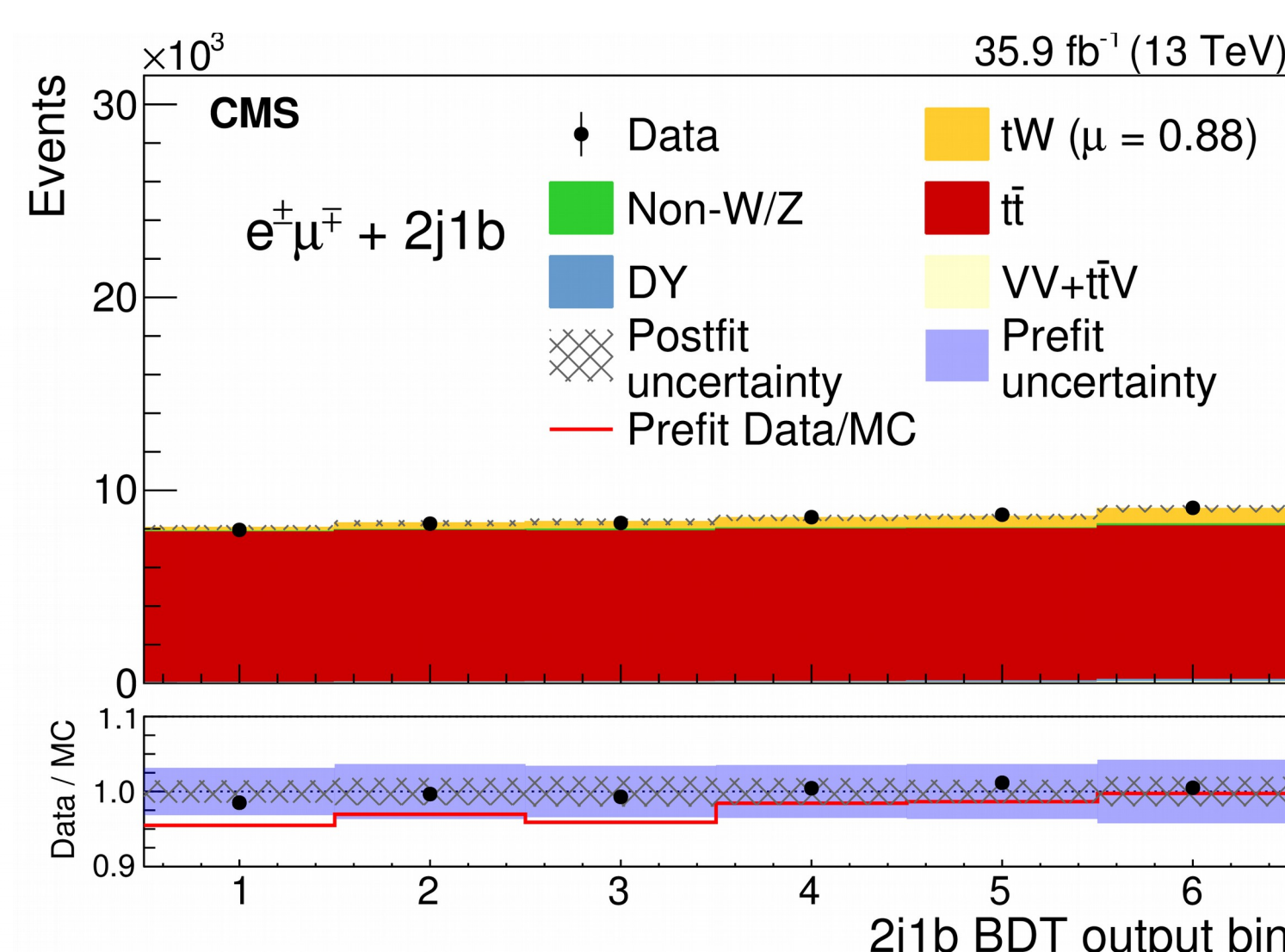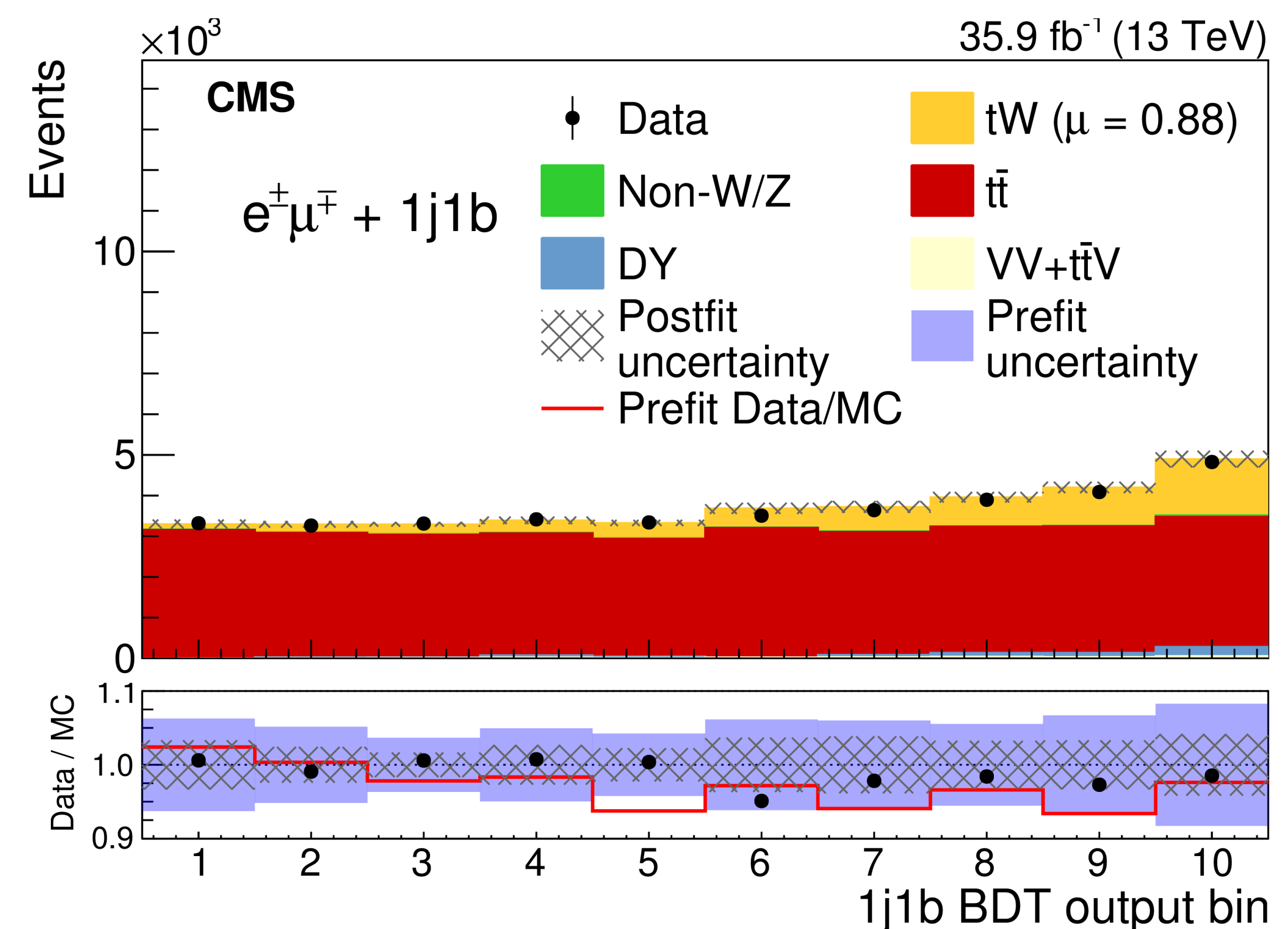
References

[1] **CMS Collab. (2018).** *Measurement of the production cross section for single top quarks in association with W bosons in proton-proton collisions at √s = 13 TeV, J. High Energ. Phys. (2018) 2018: 117; arXiv:1805.07399.*

[2] **N. Kidonakis (2015).** *"Theoretical results for electroweak-boson and single-top production", in* Proceedings, 23rd International Workshop on Deep-Inelastic Scattering and Related Subjects (DIS 2015): Dallas, Texas, USA, April 27-May 01, 2015, *volume DIS2015, p. 170. 2015; arXiv:1506.04072.*