Epiphany 2013

W/Z physics with the CMS detector at LHC

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Outline

▸ **Inclusive W and Z boson cross section:** „*W and Z inclusive cross sections at 8 TeV*" **CMS-PAS-SMP-12-011**

  → test of QCD cross-section calculations

▸ **Electron Charge Asymmetry:** „*Measurement of the Electron Charge Asymmetry in Inclusive W Production in pp Collisions at √s=7 TeV*" **Phys. Rev. Lett. 109, 111806 (2012)**

  → constraints for parton distribution functions

▸ **Differential and double-differential Drell-Yan cross section:** „*Measurement of the differential and double-differential Drell-Yan cross section in proton-proton collisions at 7 TeV*" **CMS-PAS-EWK-11-007**

  → test of QCD and new constraints for parton distribution functions

Measurement of inclusive W and Z boson cross sections in pp collisions at √s=8 TeV

- Analysed W/Z decay channels:

$$W \rightarrow e\nu_e \quad W \rightarrow \mu\nu_\mu$$
$$Z \rightarrow ee \quad Z \rightarrow \mu\mu$$

- Low PU data sample collected in 2012
- Integrated luminosity 18.7 ± 0.9 pb^{-1}
- Dedicated LHC configuration for low pileup and CMS low transverse momentum trigger treshold:

	Level 1 p_t treshold	High level trigger p_t treshold
Electrons	12 GeV	22 GeV
Muons	7 GeV	15 GeV

Event selection

	Electron channel	Muon channel
Pseudorapidity $|\eta|$	2.5 (in endcap – barrel crack excl.)	Lower than 2.1
p_T	> 22 GeV	> 25 GeV
E_T	> 25 GeV	-
Isolation cone ΔR	0.3	0.4

$$\Delta R = \sqrt{(\Delta \eta)^2 + (\Delta \phi)^2}$$

- W extraction from MET distribution
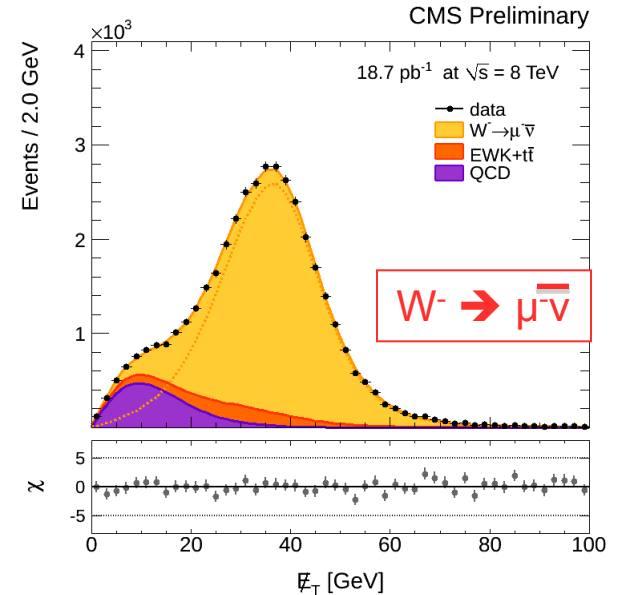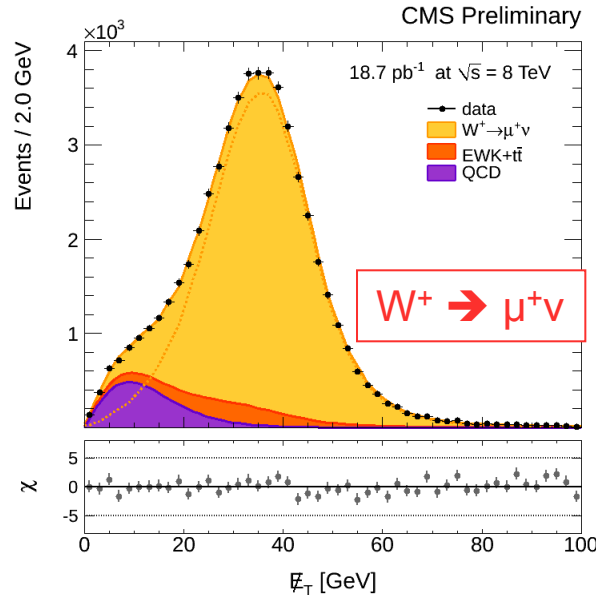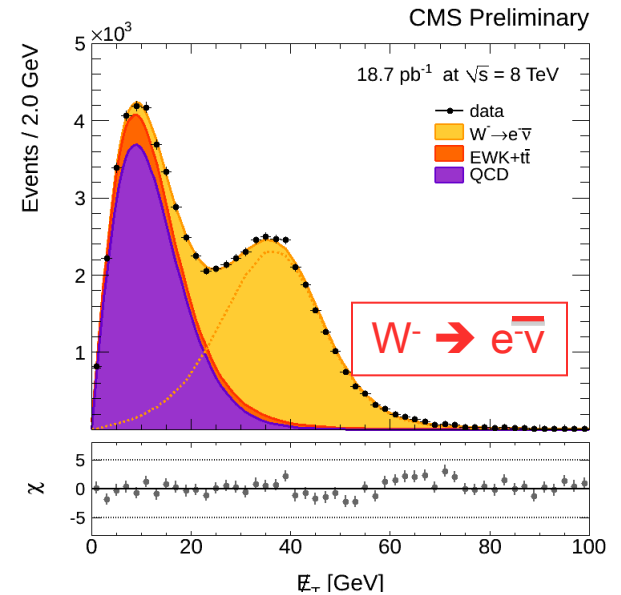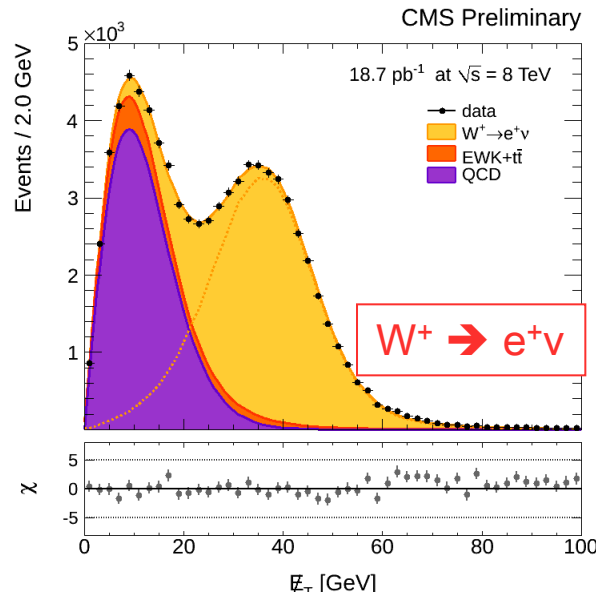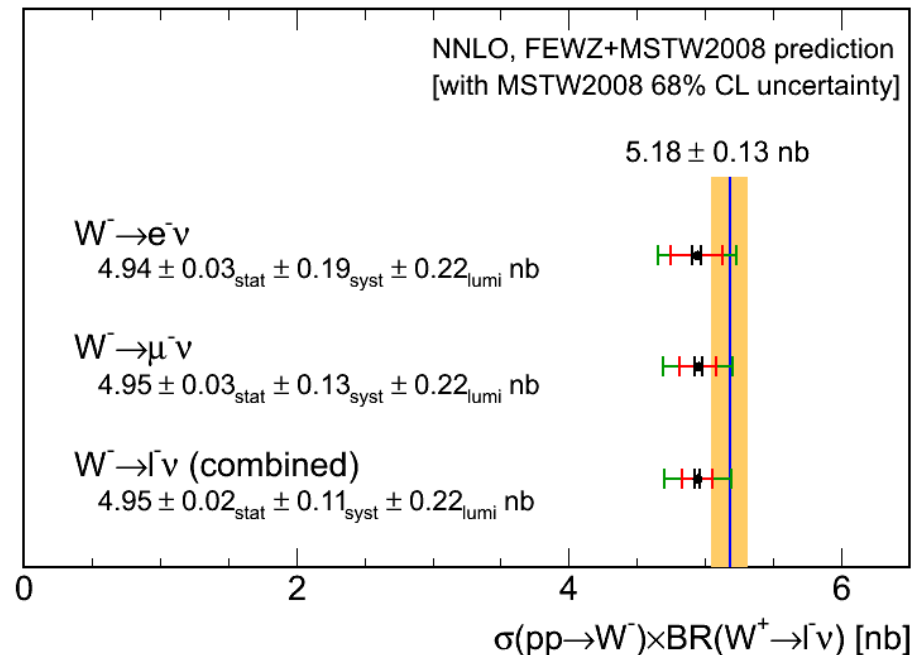
Inclusive W and Z boson cross sections

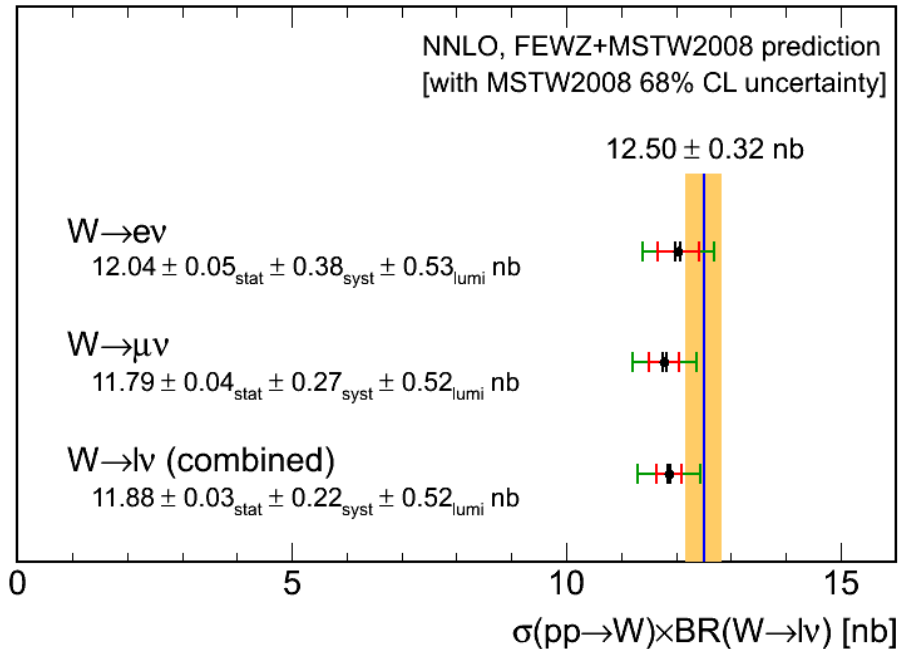**CMS Preliminary** — 18.7 pb^{-1} at $\sqrt{s}$ = 8 TeV

NNLO, FEWZ+MSTW2008 prediction
[with MSTW2008 68% CL uncertainty]

7.32 ± 0.20 nb

$W^+ \to e^+ \nu$
$7.10 \pm 0.04_{stat} \pm 0.26_{syst} \pm 0.31_{lumi}$ nb

$W^+ \to \mu^+ \nu$
$6.84 \pm 0.03_{stat} \pm 0.16_{syst} \pm 0.30_{lumi}$ nb

$W^+ \to l^+ \nu$ (combined)
$6.91 \pm 0.02_{stat} \pm 0.14_{syst} \pm 0.30_{lumi}$ nb

$\sigma(pp \to W^+) \times BR(W^+ \to l^+ \nu)$ [nb]

CMS Preliminary — 18.7 pb^{-1} at $\sqrt{s}$ = 8 TeV

NNLO, FEWZ+MSTW2008 prediction
[with MSTW2008 68% CL uncertainty]

5.18 ± 0.13 nb

$W^- \to e^- \nu$
$4.94 \pm 0.03_{stat} \pm 0.19_{syst} \pm 0.22_{lumi}$ nb

$W^- \to \mu^- \nu$
$4.95 \pm 0.03_{stat} \pm 0.13_{syst} \pm 0.22_{lumi}$ nb

$W^- \to l^- \nu$ (combined)
$4.95 \pm 0.02_{stat} \pm 0.11_{syst} \pm 0.22_{lumi}$ nb

$\sigma(pp \to W^-) \times BR(W^+ \to l^- \nu)$ [nb]
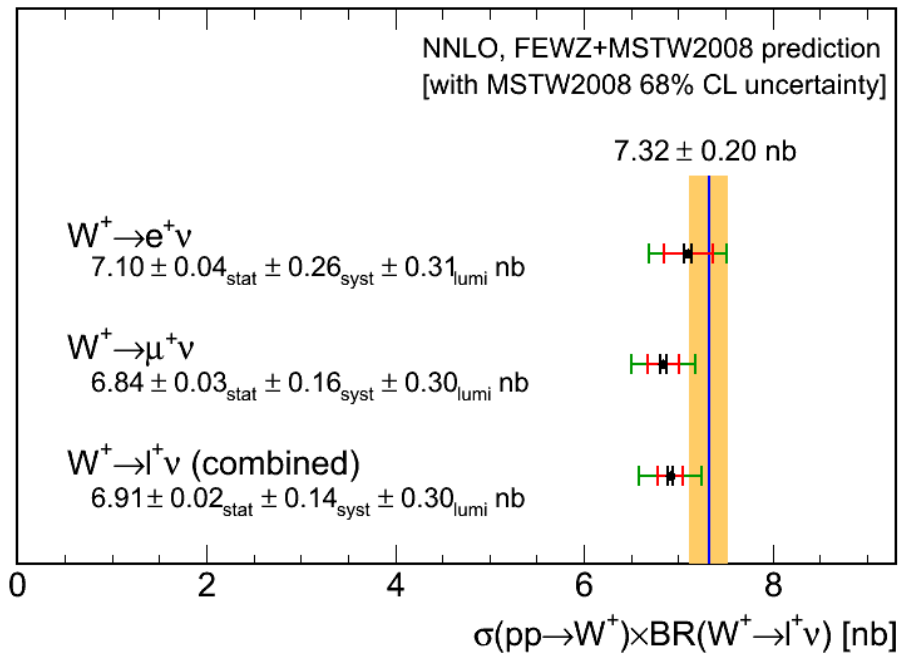
▸ <u>Good agreement with theoretical NNLO prediction</u>

Inclusive W and Z boson cross sections

▸ <u>Good agreement with theoretical NNLO prediction</u>

Ratios of W to Z and W+ to W- production cross section
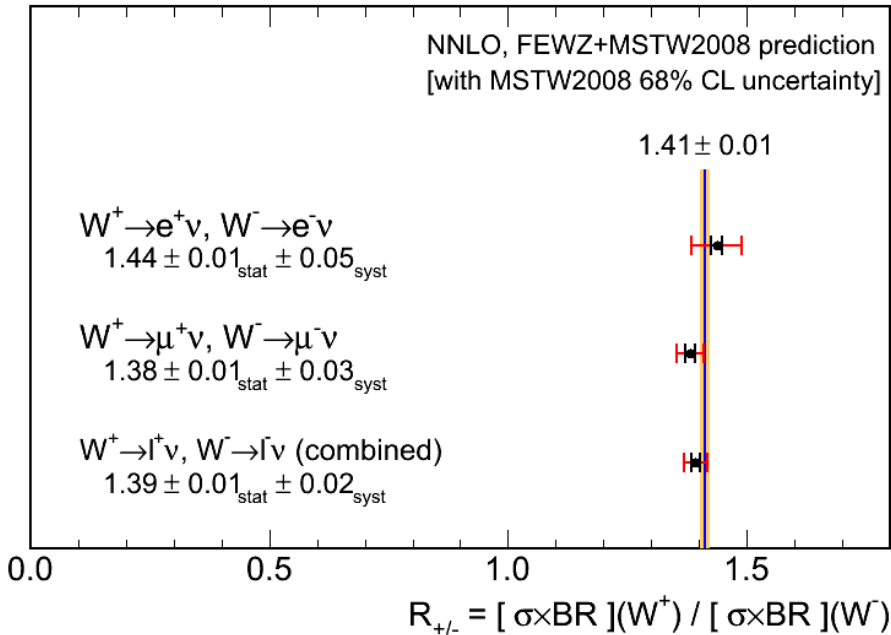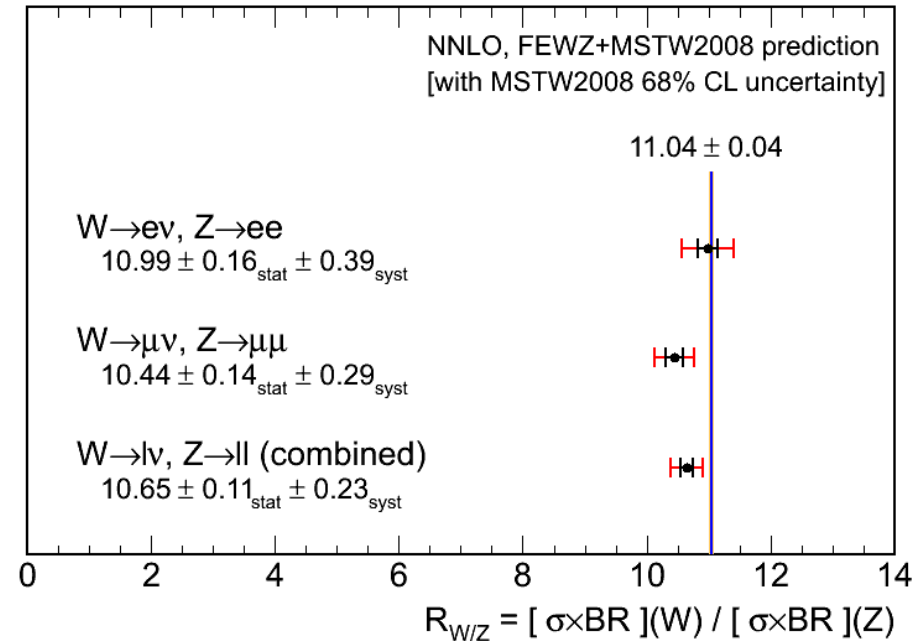
Luminosity uncertainties cancel in the ratio
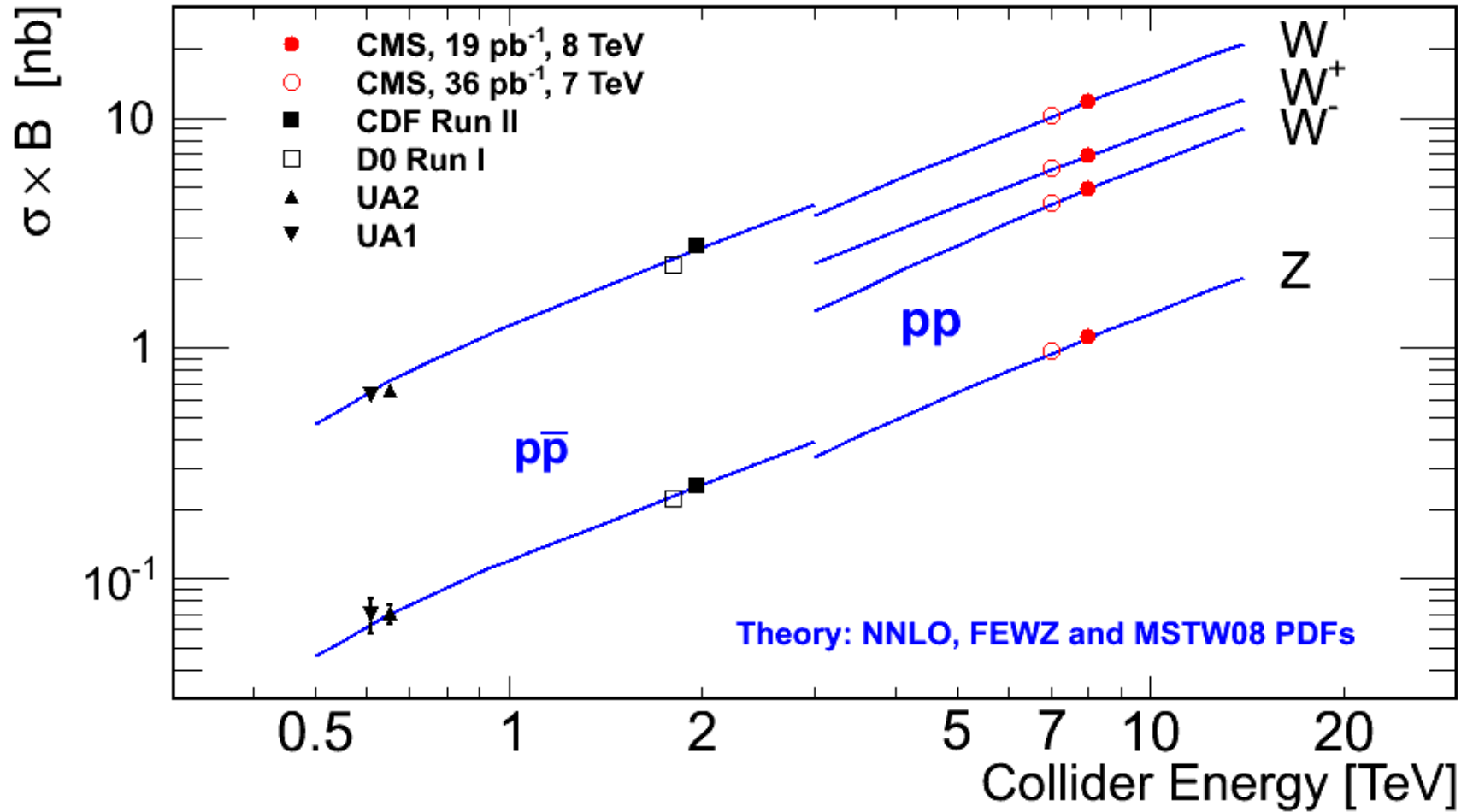
Measured and predicted W vs. Z production and W⁺ vs. W⁻ cross sections
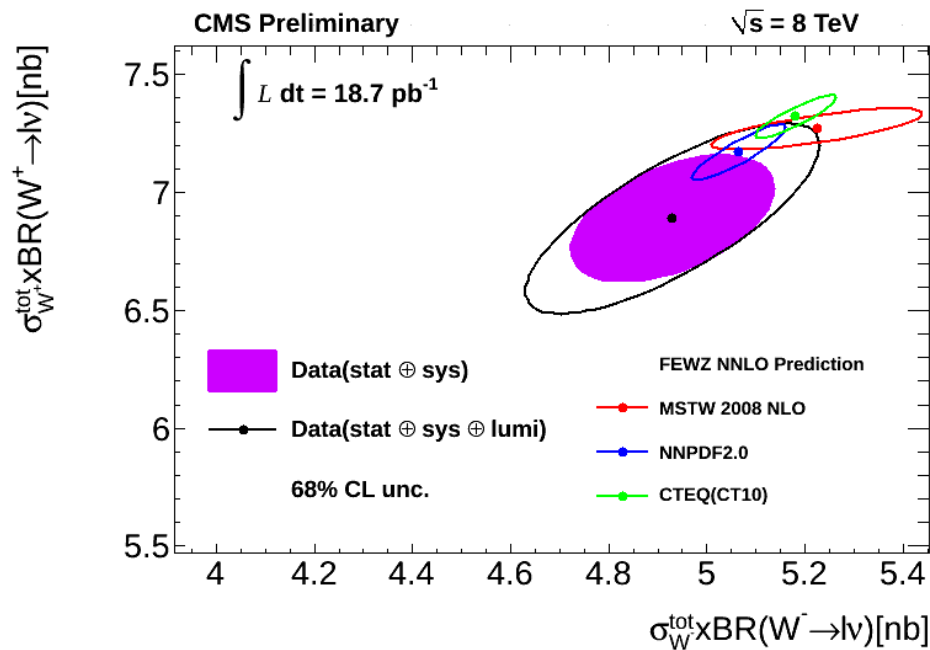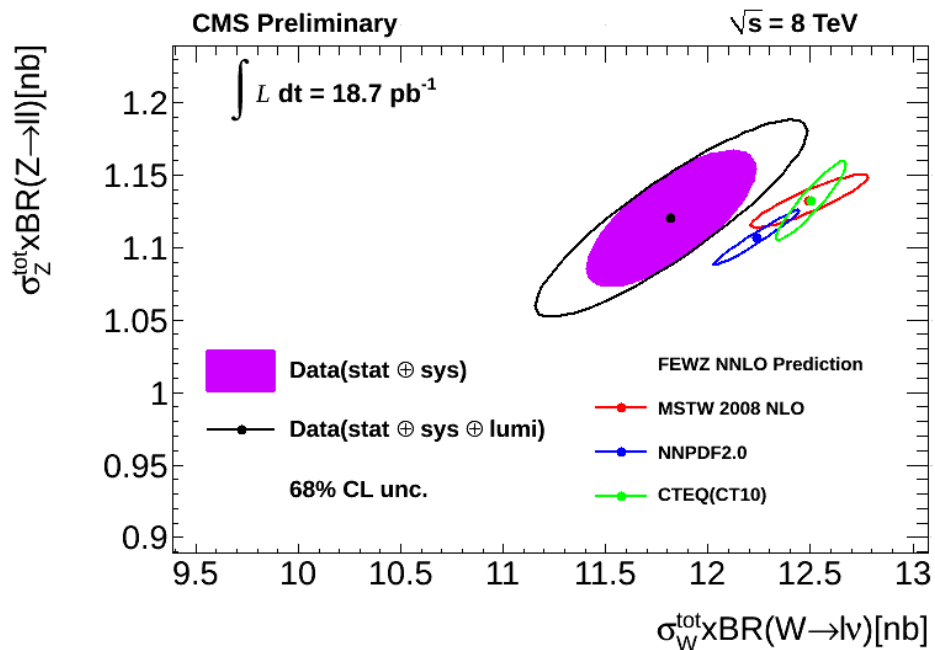
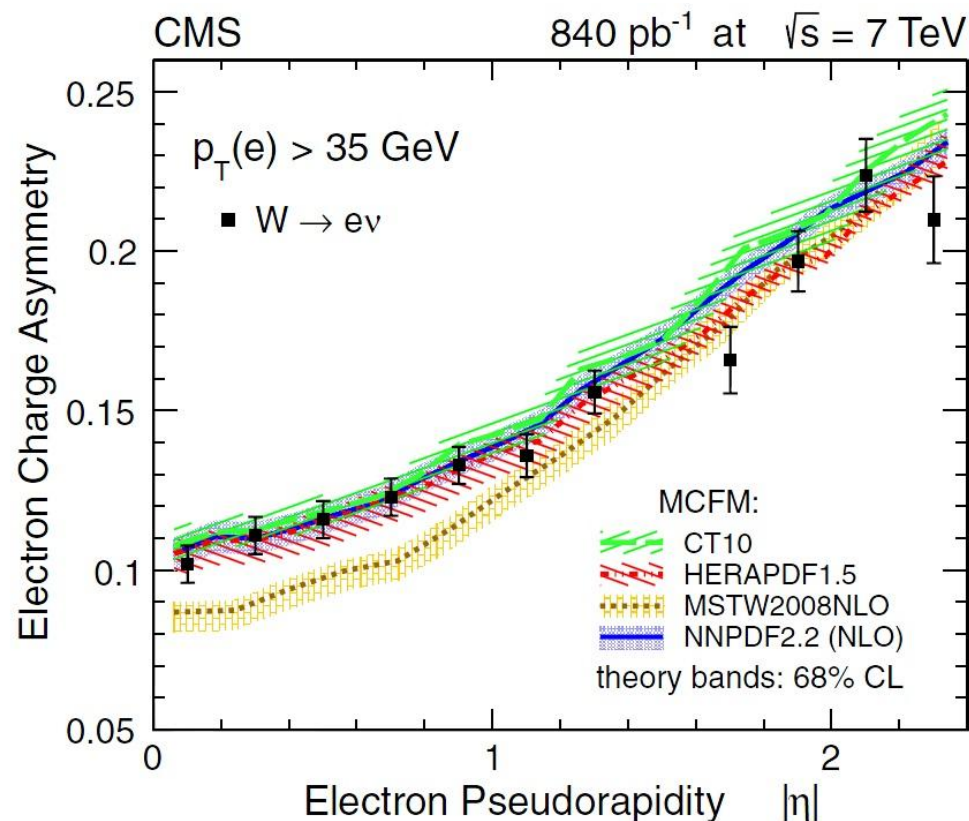# Measurements σ·B as function of center-of-mass energy for CMS and lower-energy experiments

$$A(\eta) = \frac{d\sigma/d\eta(W^+ \to e^+\nu) - d\sigma/d\eta(W^- \to e^-\bar{\nu})}{d\sigma/d\eta(W^+ \to e^+\nu) + d\sigma/d\eta(W^- \to e^-\bar{\nu})}$$
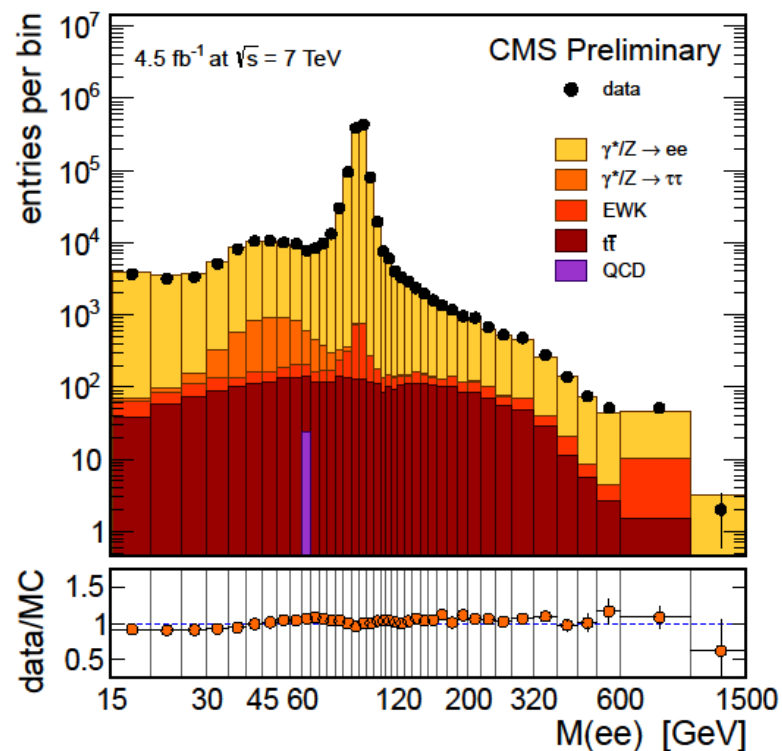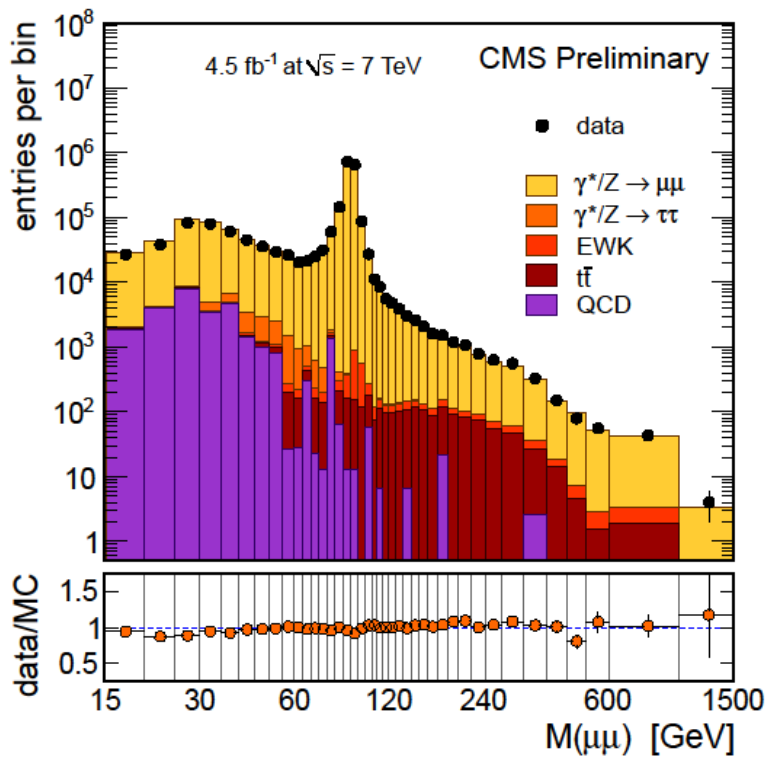
$$\eta = -\ln\tan\left(\frac{\theta}{2}\right)$$

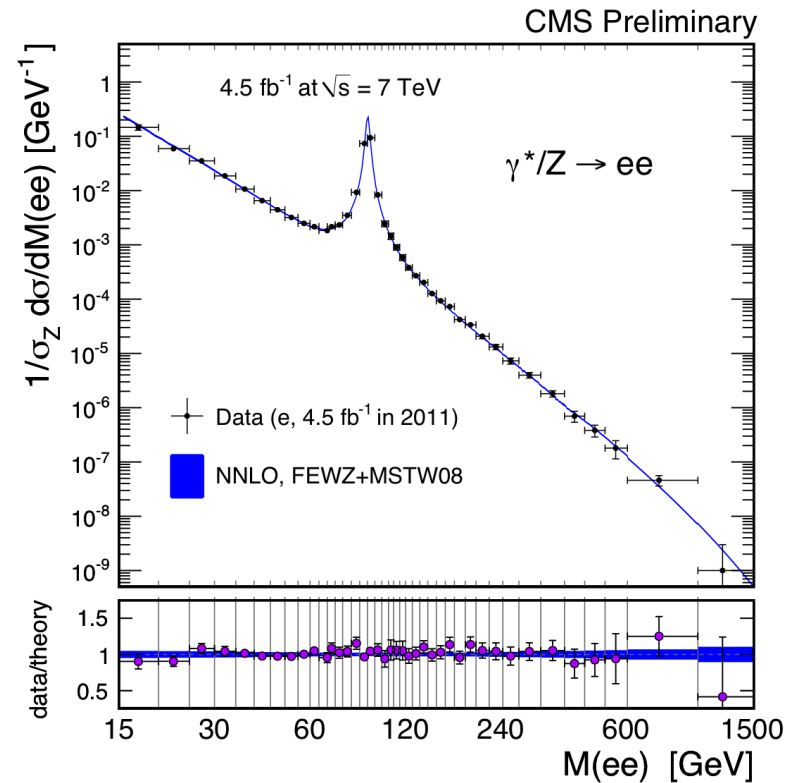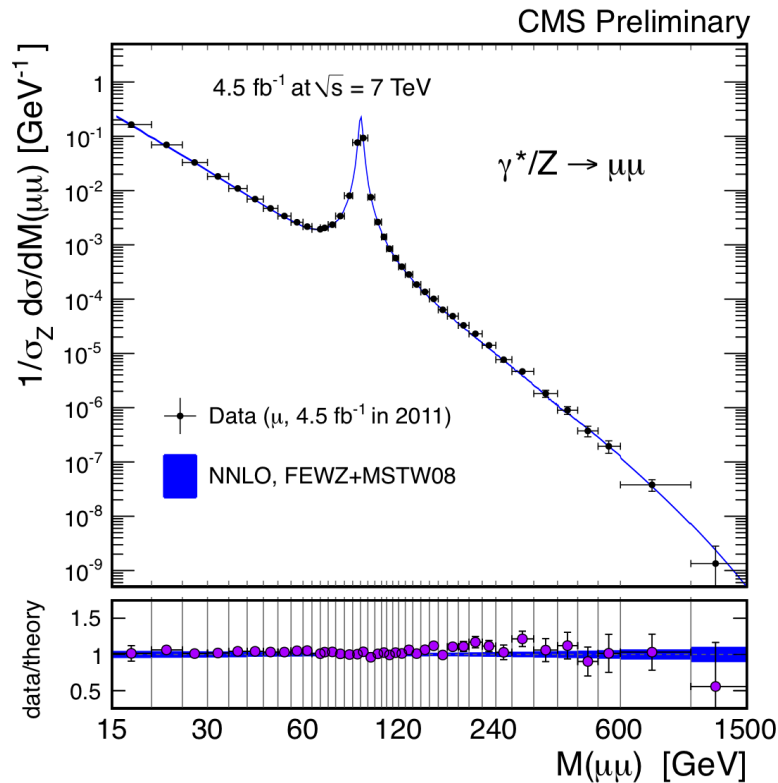Monte Carlo simulation with MSTW2008 PDF predicts faster rise of charge asymmetry than the data.

- Observed dimuon invariant mass spectrum within the detector acceptance

Measurement of the differential and double-differential Drell-Yan cross sections in proton-proton collisions at √s=7 TeV

- ▸ Drell-Yan invariant mass spectrum normalized to the Z resonance region
- ▸ Good agreement with NNLO theoretical prediction

Measurement of the differential and double-differential Drell-Yan cross sections in proton-proton collisions at √s=7 TeV
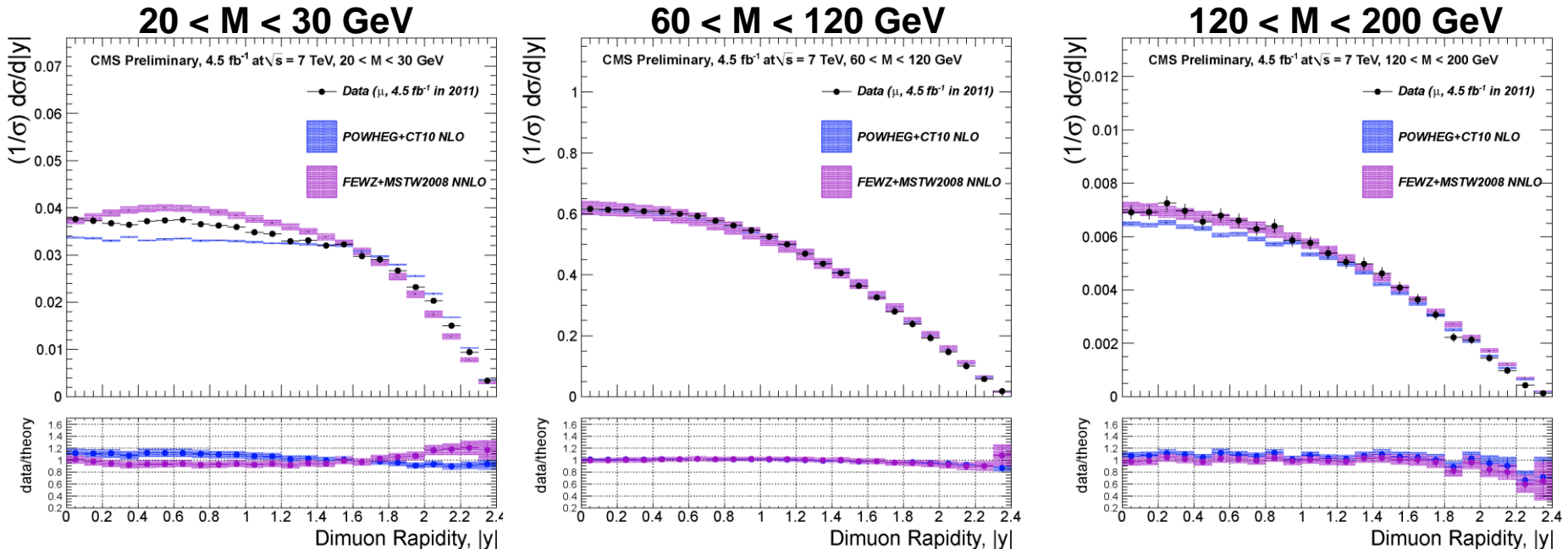
- ▸ Double differential cross section in bins of dimuon rapidity |y| and M
- ▸ Very important measurement for test and contribution to PDFs

Thank you for your attention!

The CMS Detector