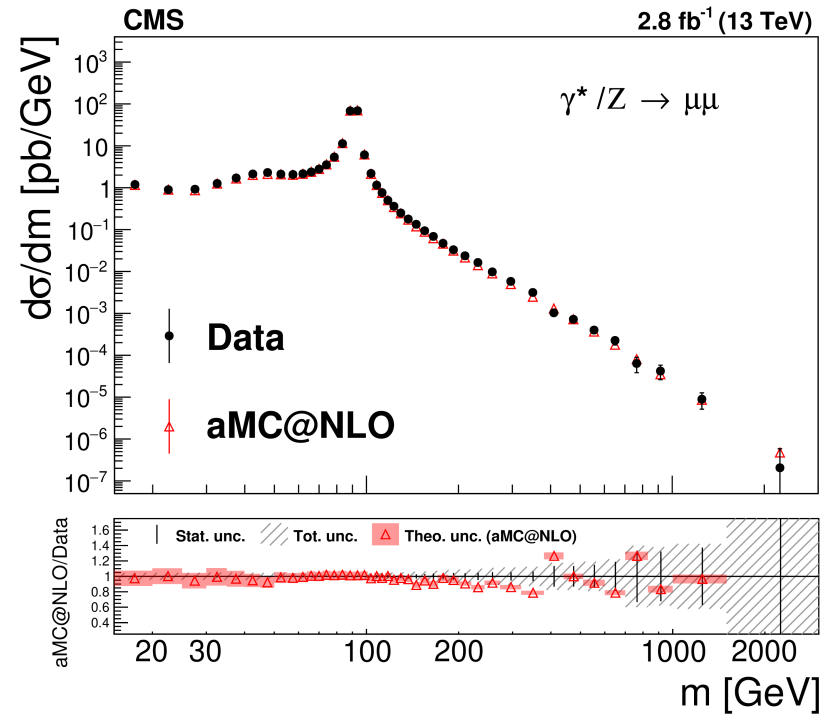
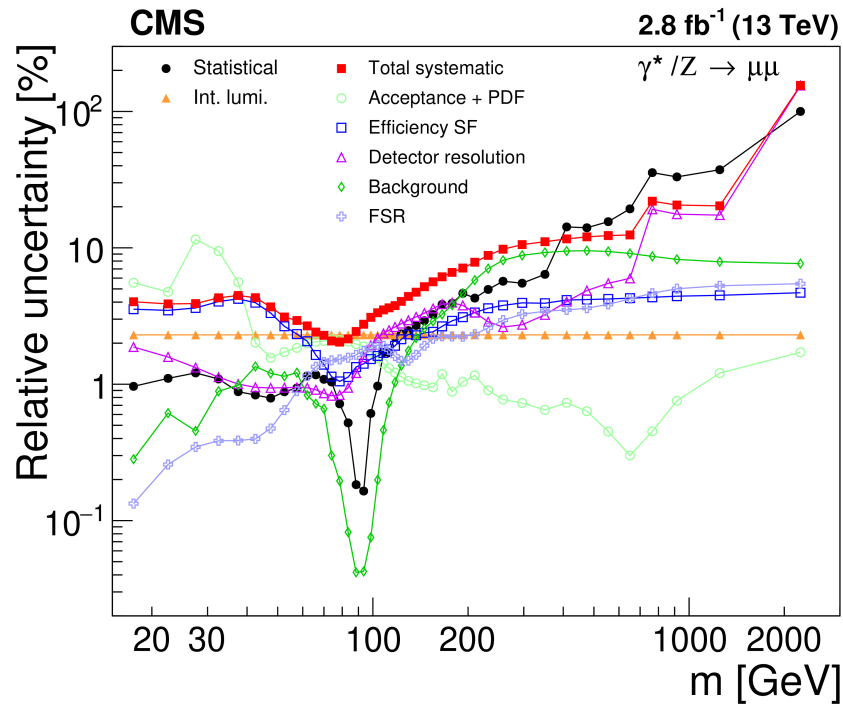

Recent EWK results

Highlights from CMS

Lorenzo Bianchini
INFN, Sezione di Pisa



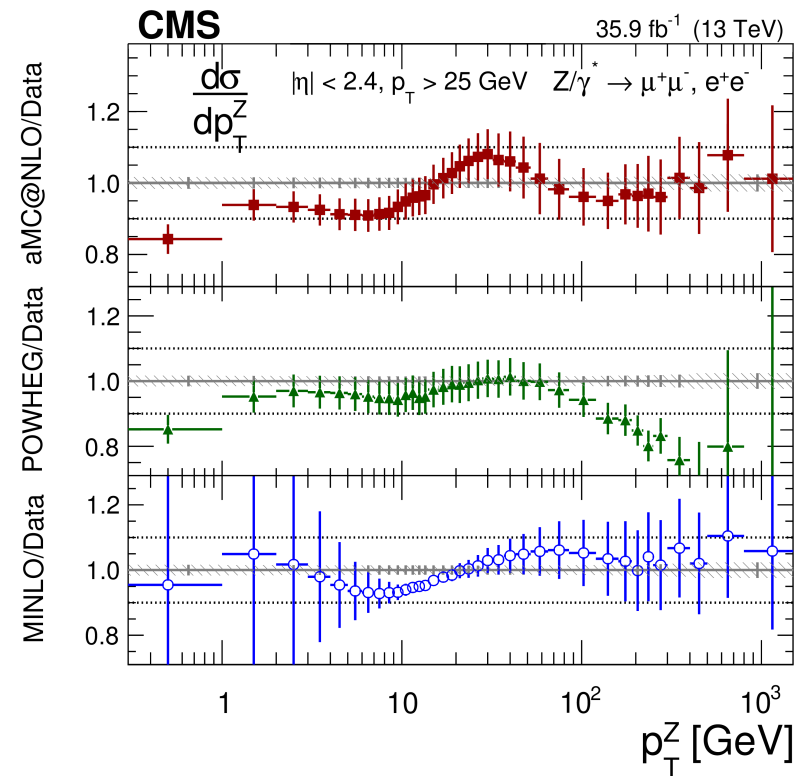
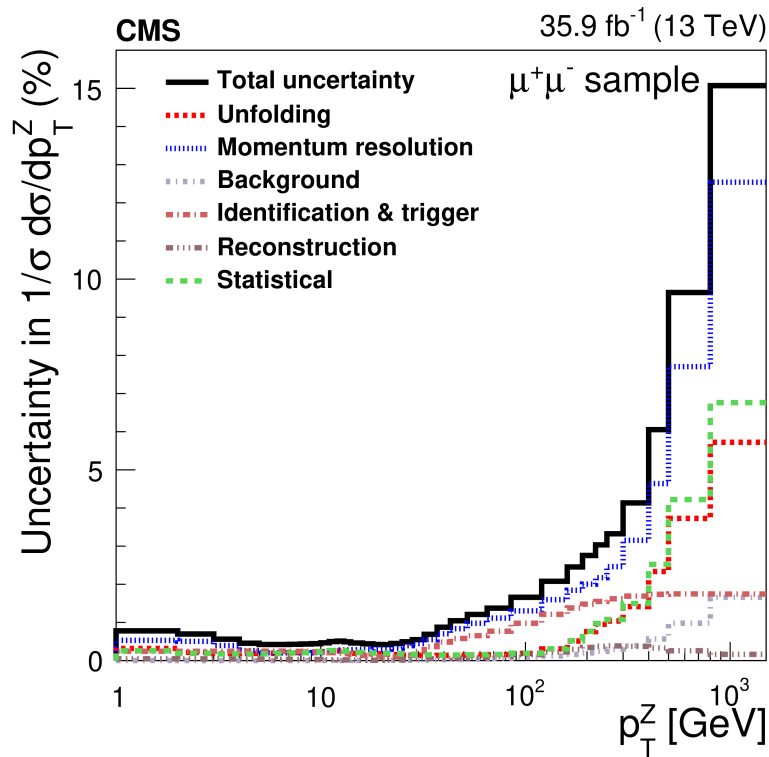
Dilepton mass with $\sim 3/\text{fb}$ at 13 TeV



Z p_T and φ^* with $\sim 36/\text{fb}$ at 13 TeV

JHEP 12 (2019) 061

New measurement at 13 TeV. Precision similar to 8 TeV measurement and limited by systematics



SMP-18-012: 36/fb @ 13 TeV

<https://cds.cern.ch/record/270849>

See also JHEP 12 (2017) 130

New CMS measurement of single-lepton events at 13 TeV.

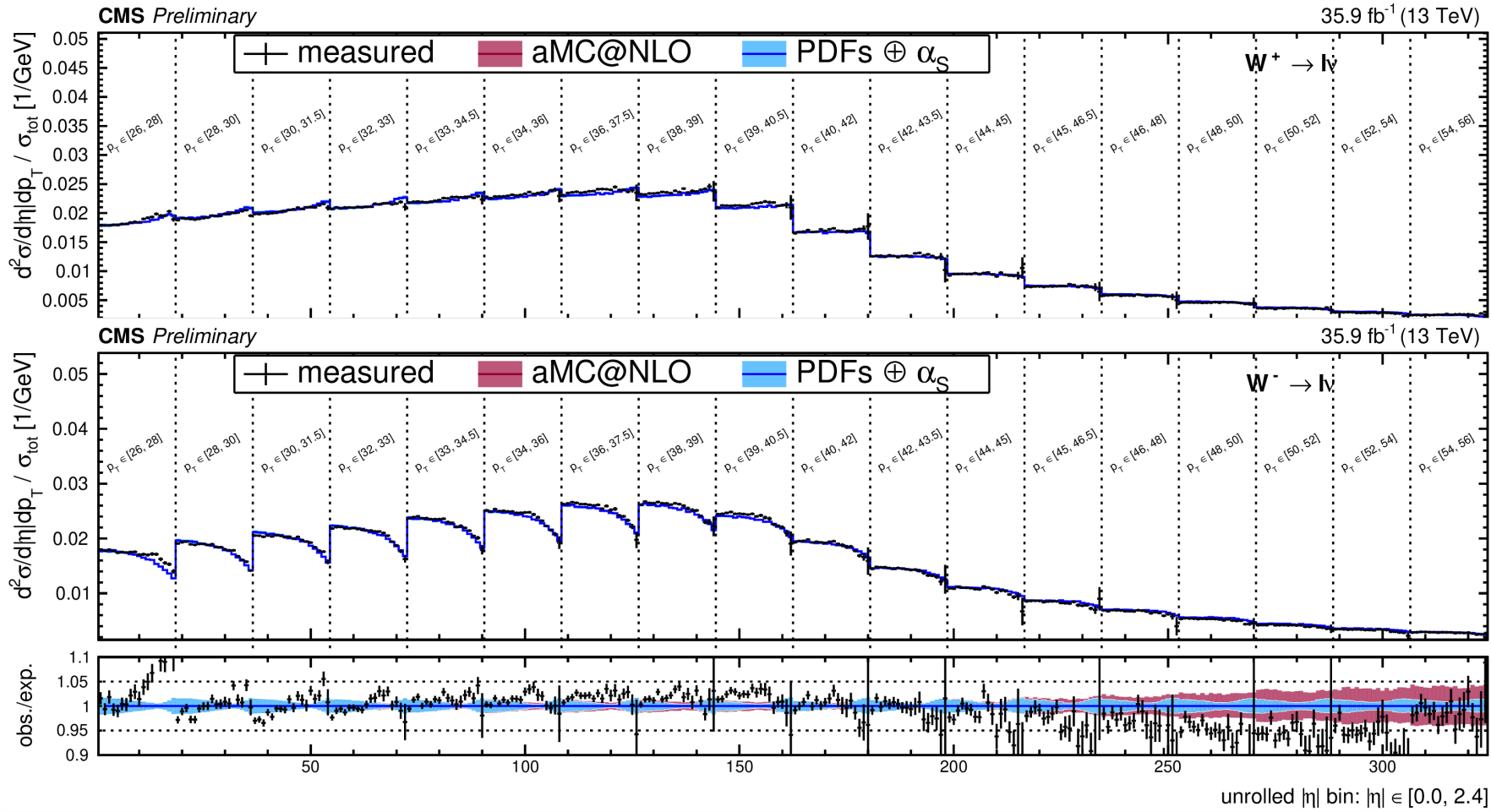
SMP-18-012: 36/fb @ 13 TeV

New CMS measurement of single-lepton events at 13 TeV.

Main results are:

- Unfolded 2D cross section (p_T, η): $\frac{d^2\sigma_l}{d\eta dp_T}$

SMP-18-012: 2D cross section



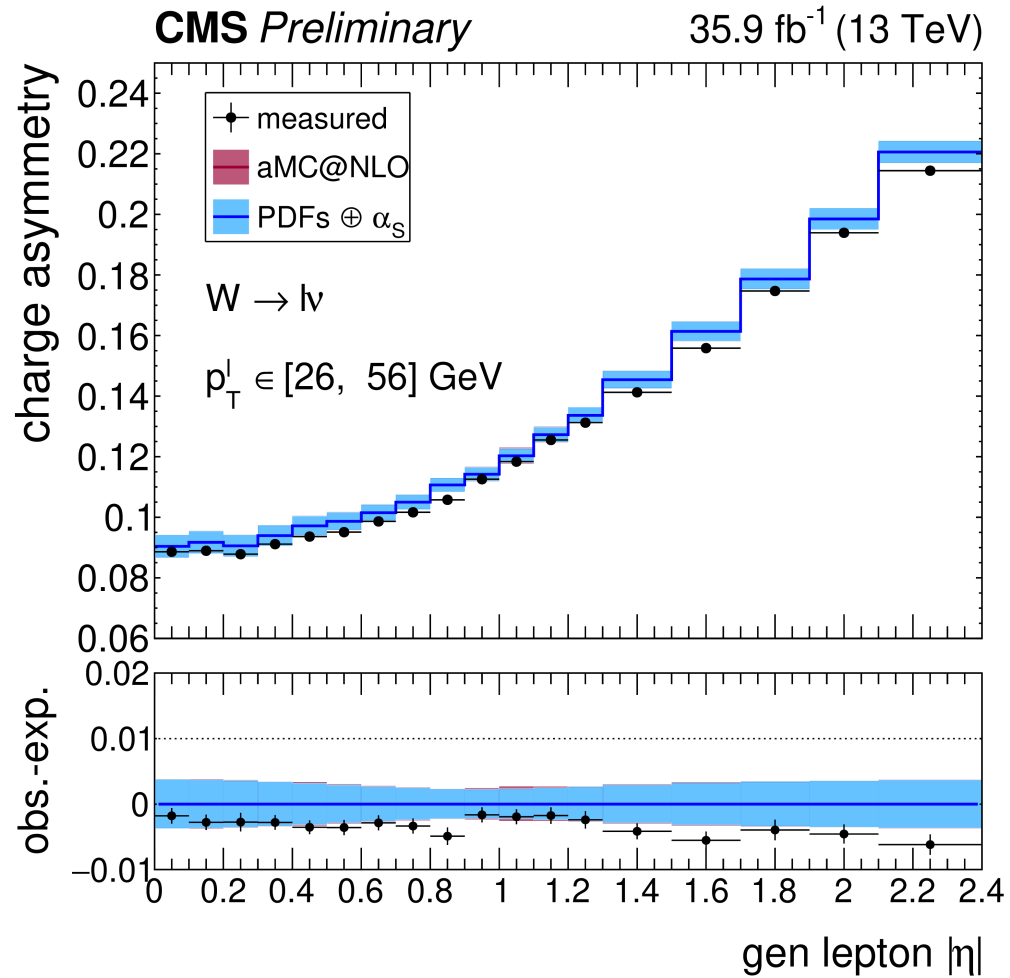
SMP-18-012: 36/fb @ 13 TeV

New CMS measurement of single-lepton events at 13 TeV.

Main results are:

- unfolded 2D cross section (p_T, η): $\frac{d^2\sigma_l}{d\eta dp_T}$
- Charge asymmetry vs η : $\left(\frac{d\sigma_+}{d\eta} - \frac{d\sigma_-}{d\eta}\right) / \left(\frac{d\sigma_+}{d\eta} + \frac{d\sigma_-}{d\eta}\right)$

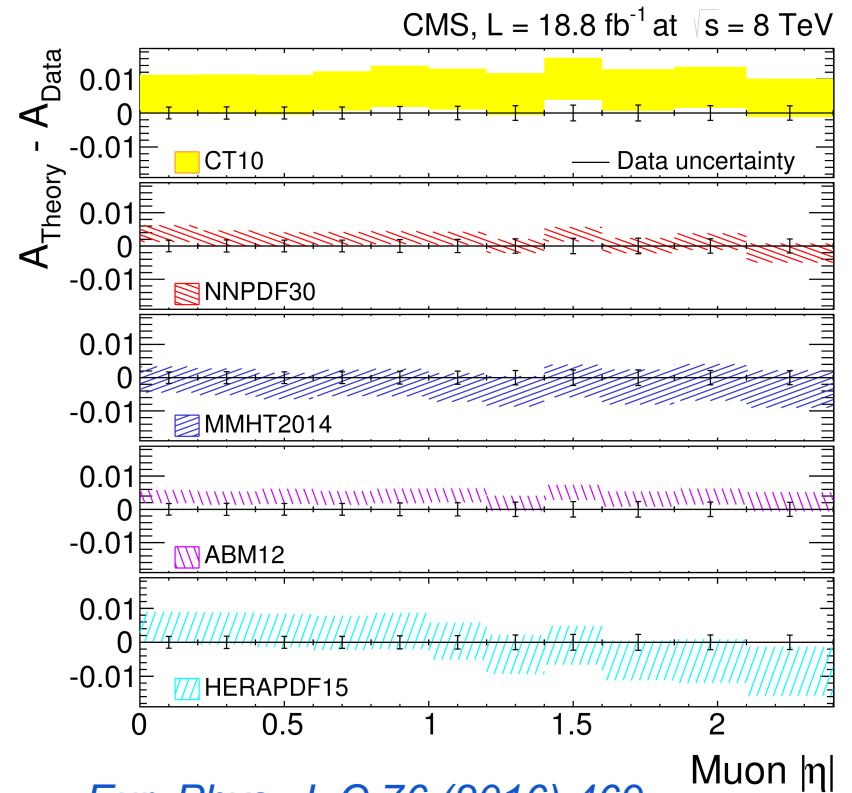
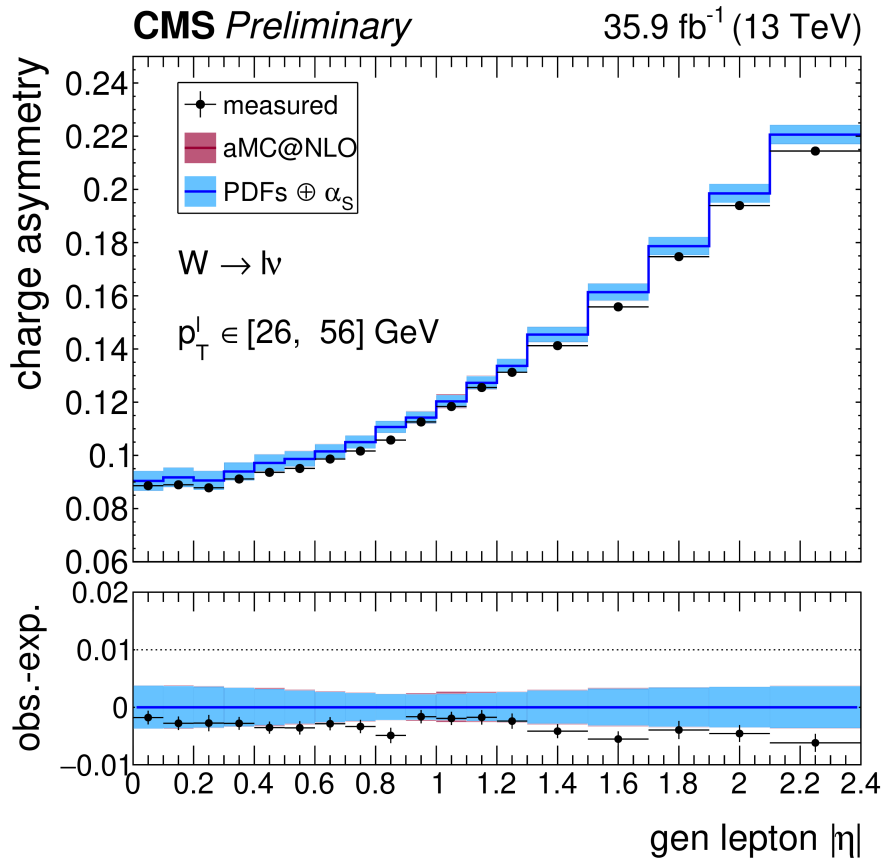
SMP-18-012: charge asymmetry



SMP-18-012 vs charge asymmetry @ 8 TeV

110M (μ^+) / 90M (μ^-), 50M (e^+) / 40M (e^-)

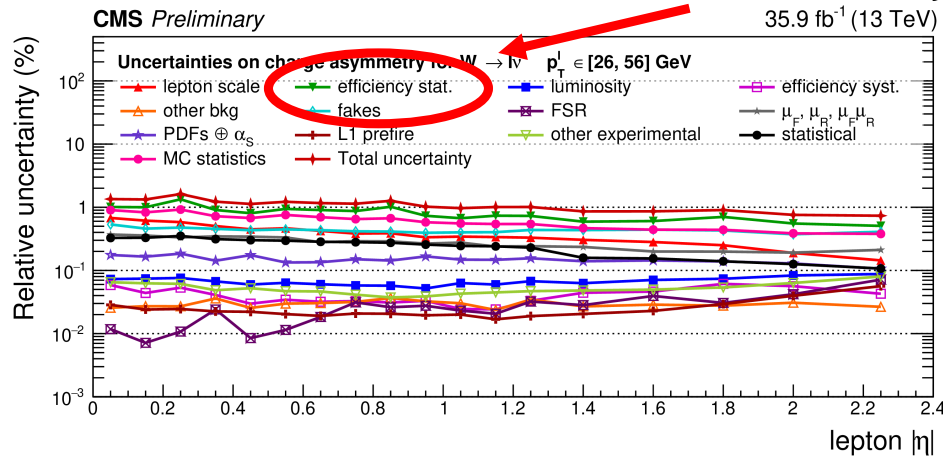
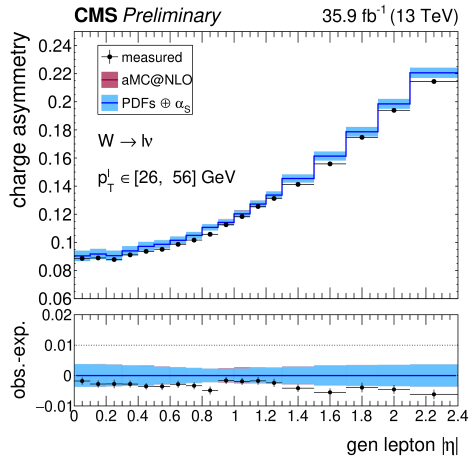
50M (μ^+) / 35M (μ^-)



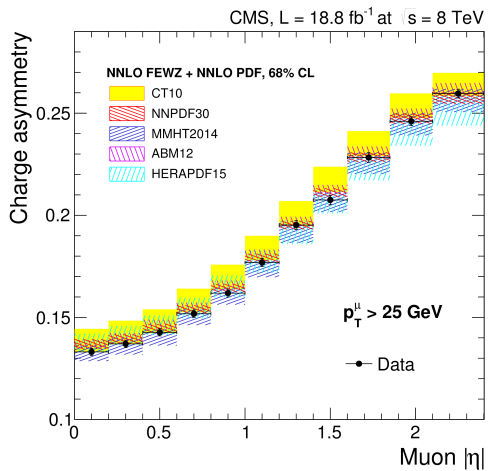
[Eur. Phys. J. C 76 \(2016\) 469](#)

SMP-18-012 vs charge asymmetry @ 8 TeV

Limited by MC stat. & lepton eff.



	$\eta = 0$	$\eta = 2.2$
$\delta A \times 100$	0.13	0.22
$\delta A/A$	1.5%	1%



	$\delta A \times 100$										
Efficiency	0.06	0.07	0.06	0.06	0.09	0.09	0.10	0.09	0.09	0.08	0.14
Muon scale	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.03	0.03
QCD +/-	0.15	0.15	0.15	0.15	0.15	0.15	0.16	0.18	0.17	0.14	0.10
QCD shape	0.02	0.03	0.03	0.03	0.04	0.04	0.05	0.06	0.07	0.05	0.04
EW+tt bkg	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.05
E _T shape	0.03	0.04	0.04	0.04	0.05	0.06	0.06	0.09	0.09	0.09	0.07
PDF	0.03	0.02	0.02	0.02	0.02	0.03	0.04	0.05	0.05	0.09	0.08
FSR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Total syst.	0.17	0.18	0.18	0.18	0.19	0.20	0.22	0.23	0.23	0.22	0.21
Stat.	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.06	0.06	0.07
Total unc.	0.18	0.19	0.19	0.19	0.20	0.21	0.23	0.24	0.24	0.23	0.22

	$\eta = 0$	$\eta = 2.2$
$\delta A \times 100$	0.18	0.22
$\delta A/A$	1.4%	0.9%

Limited by multijet bkg & lepton eff.

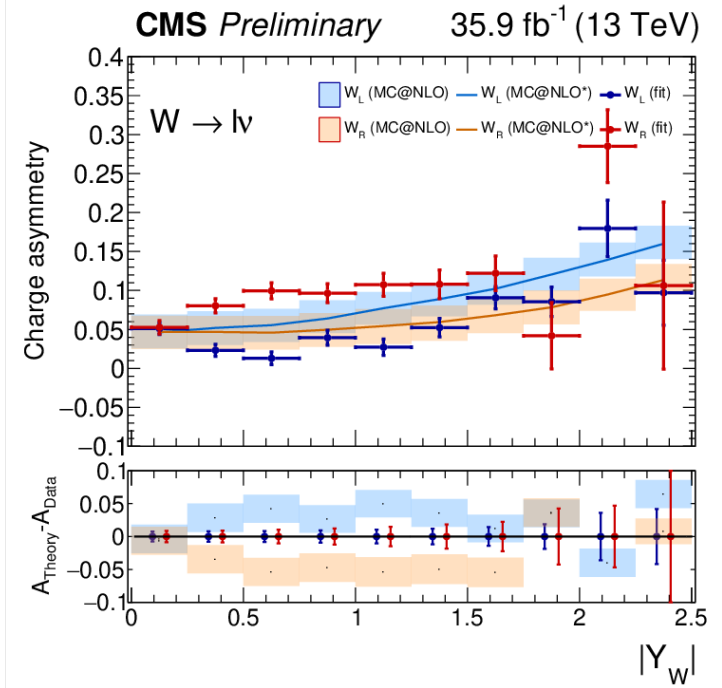
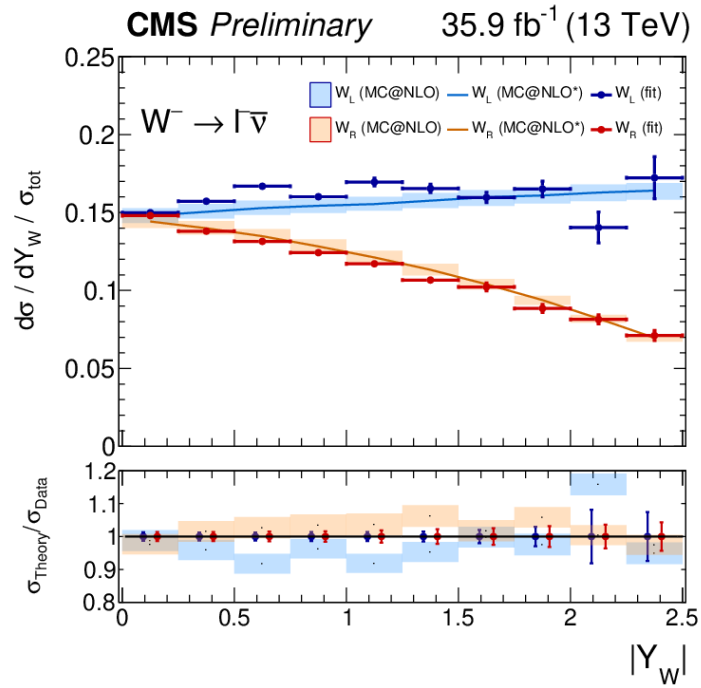
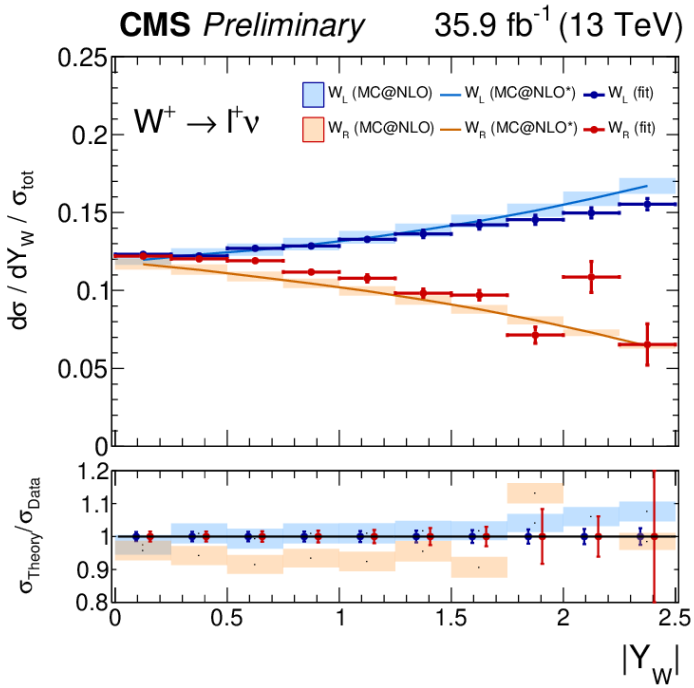
SMP-18-012: 36/fb @ 13 TeV

New CMS measurement of single-lepton events at 13 TeV.

Main results are:

- unfolded 2D cross section (p_T, η): $\frac{d^2\sigma_l}{d\eta dp_T}$
- Charge asymmetry vs η : $\left(\frac{d\sigma_+}{d\eta} - \frac{d\sigma_-}{d\eta}\right) / \left(\frac{d\sigma_+}{d\eta} + \frac{d\sigma_-}{d\eta}\right)$
- $|y|$ cross section in helicity states: $\frac{d\sigma_V}{d|y_V|}, V = W_L^+, W_R^+, W_L^-, W_R^-$

SMP-18-012: helicity cross sections



SMP-18-012: 36/fb @ 13 TeV

New CMS measurement of single-lepton events at 13 TeV.

Main results are:

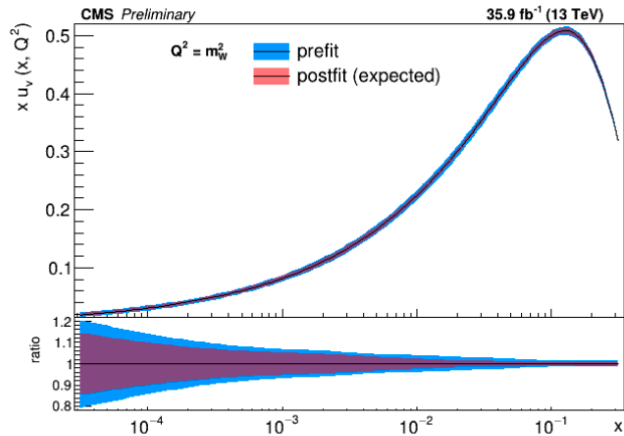
- unfolded 2D cross section (p_T, η): $\frac{d^2\sigma_l}{d\eta dp_T}$
- Charge asymmetry vs η : $\left(\frac{d\sigma_+}{d\eta} - \frac{d\sigma_-}{d\eta}\right) / \left(\frac{d\sigma_+}{d\eta} + \frac{d\sigma_-}{d\eta}\right)$
- $|y|$ cross section in helicity states: $\frac{d\sigma_V}{d|y_V|}, V = W_L^+, W_R^+, W_L^-, W_R^-$

Large constraining power on u/d/s valence & sea PDFs.

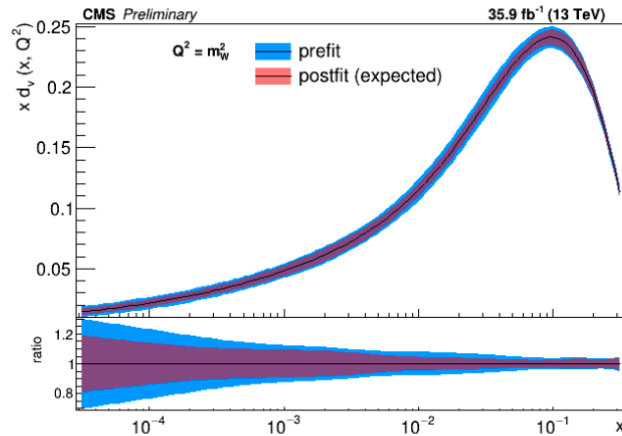
No QCD analysis carried out. Post-fit constraint of NNPDF3.0 eigenvectors used as a proxy

SMP-18-012: PDF constraints

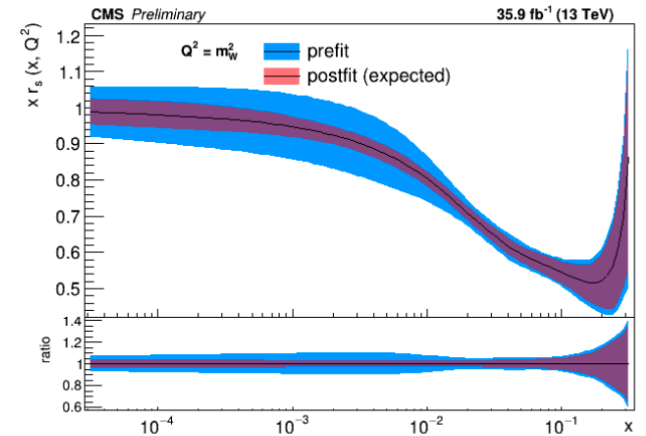
u valence



d valence



$r_s = (s+\bar{s})/(\bar{u}+\bar{d})$



No QCD analysis carried out. Post-fit constraint of NNPDF eigenvectors used as a proxy

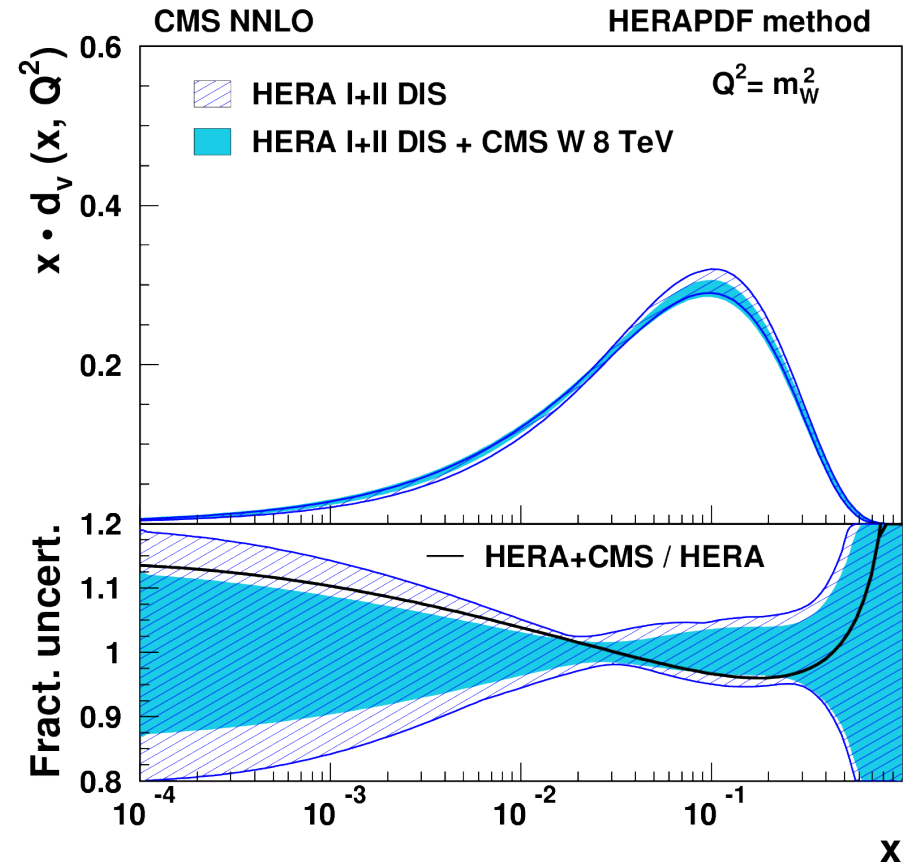
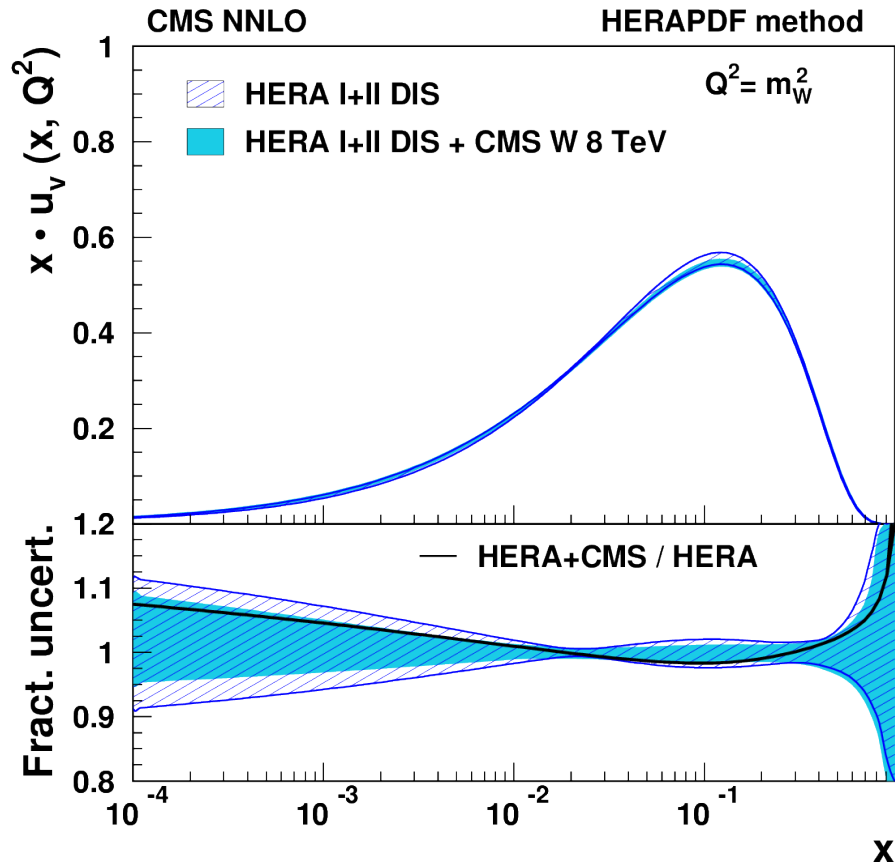
NNPDF3.0

[JHEP04\(2015\)040](#)

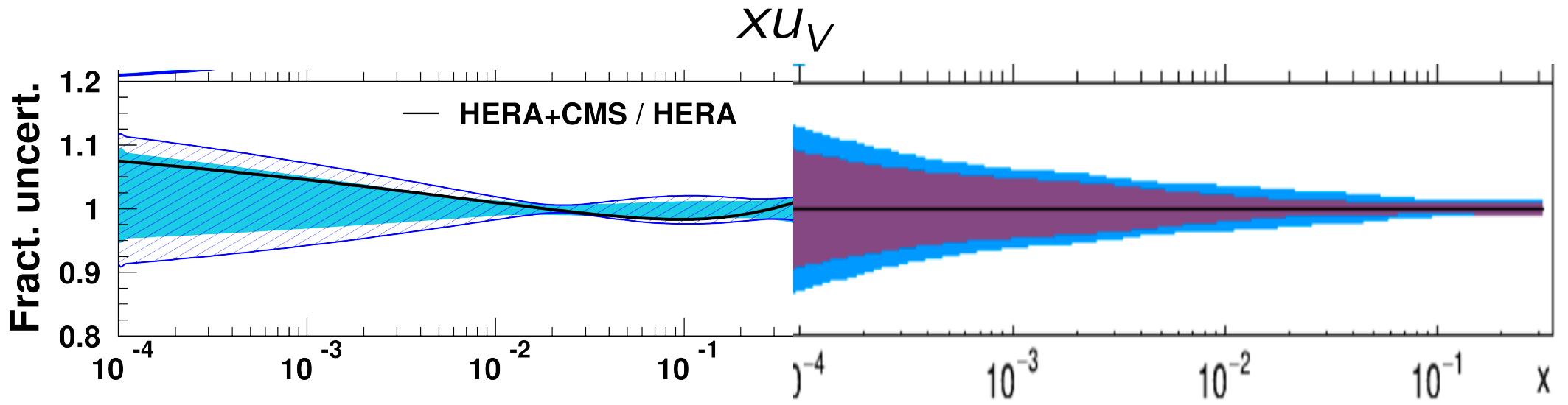
ATLAS	ATLAS W, Z 2010	[47]	M	full	i	30 (30/30)	$20 \leq p_T^{\text{jet}} \leq 200 \text{ GeV}$ $0 \leq \eta^{\text{jet}} \leq 4.4$ $116 \leq M_{ll} \leq 1500 \text{ GeV}$ $0 \leq p_T^W \leq 300 \text{ GeV}$
	ATLAS 7 TeV jets 2010	[50]	M	full	i,j	90 (90/9)	
	ATLAS 2.76 TeV jets	[63]	M	full	j	59 (59/3)	
	ATLAS high-mass DY	[56]	M	full		11 (5/5)	
	ATLAS $W p_T$	[57]	M	full		11 (9/-)	
CMS 7 TeV	CMS W electron asy	[48]	M	cov		11 (11/11)	$0 \leq \eta_l \leq 2.4$ $114 \leq p_T^{\text{jet}} \leq 2116 \text{ GeV}$ $0 \leq \eta^{\text{jet}} \leq 2.5$ $0 \leq \eta_l \leq 2.1$ $0 \leq \eta_l \leq 2.1$ $20 \leq M_{ll} \leq 1200 \text{ GeV}$ $0 \leq \eta_{ll} \leq 2.4$
	CMS W muon asy	[58]	M	cov		11 (11/11)	
	CMS jets 2011	[62]	M	full		133 (133/83)	
	CMS $W + c$ total	[60]	M	cov		5 (5/5)	
	CMS $W + c$ ratio	[60]	M	cov		5 (5/5)	
	CMS 2D DY 2011	[59]	M	cov		124 (88/110)	

SMP-18-012 vs charge asymmetry @ 8 TeV

[Eur. Phys. J. C 76 \(2016\) 469](#)



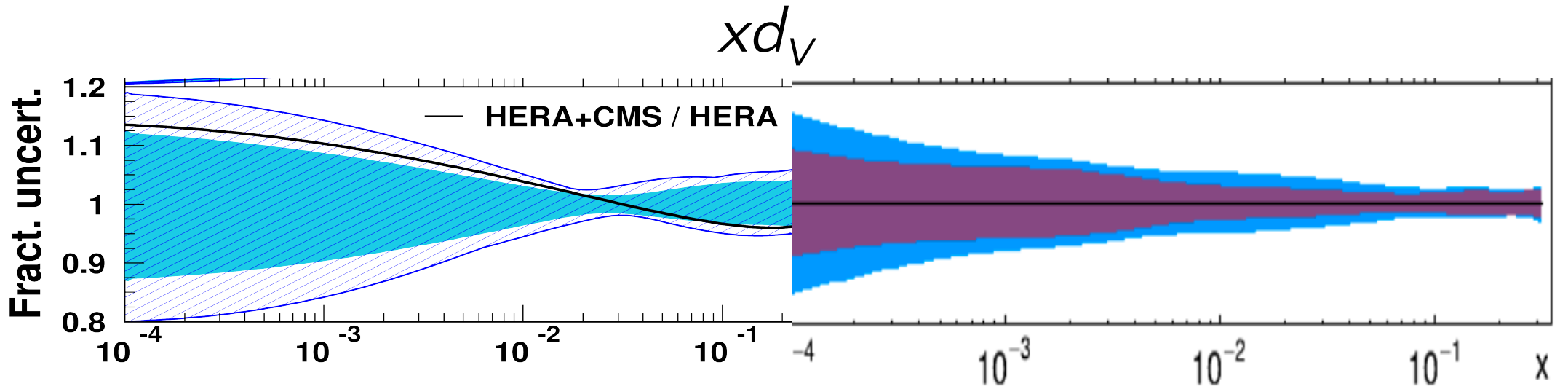
SMP-18-012 vs charge asymmetry @ 8 TeV



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SMP-18-012

SMP-18-012 vs charge asymmetry @ 8 TeV



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SMP-18-012

Moving ahead

Our goal is to perform the first **5-fold differential cross section** measurement of CC Drell-Yan.

This implies a major extension of SMP-18-012 :

- Adding one more dimension: $d\sigma/dq_T \rightarrow d^2\sigma/d|y|dq_T$
- Full breakdown of helicity cross sections: $A_4(y) \rightarrow A_{0,1,2,3,4}(y, q_T)$
- Adding a **regularization scheme** to fit the A_k as continuous functions

In this fit model, the impact of theory uncertainty is minimized (modulo the detector acceptance):

- The complete, fully differential (lv) x-section would be measured in one shot

In the future

A number of important precision SM results with Run2 to appear in the next months:

- $W p_T$ at low-PU
- M_W (!)
- DY double-differential (M, y) , (M, p_T, N_{jet})
- AFB at high-mass
- $\sin\theta_1^{\text{eff}}$ from AFB

—◆ Backup