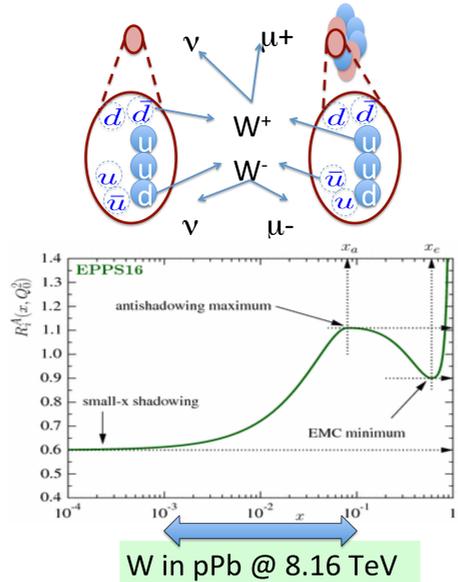


**Abstract :** The measurement of the W boson in pPb collisions at  $\sqrt{s_{NN}} = 8.16$  TeV is presented. The muon decay channel was used to study both positive and negative W bosons production as a function of muon pseudorapidity. Rapidity and charge asymmetries in the W yield are also shown, and a comparison with theoretical predictions with and without nuclear PDF (nPDF) effects is made. The measurement is sensitive to the presence of nuclear modifications to the parton distributions in the lead nucleus, and can help improve and constrain future nPDF calculations.

## Motivation

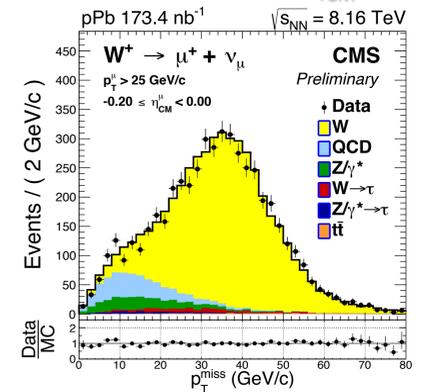
W<sup>+</sup> vs. W<sup>-</sup> production:  
probes differences between valence and sea quarks

W ( $\mu \nu$ ) bosons are produced early in the collision, and not affected by QGP:  
good probe for nuclear parton distribution functions (nPDFs) [2]



## Missing $p_T$ distributions

W yields extracted from fits of the missing  $p_T$  distribution in 24 bins of muon  $\eta_{CM}$



Signal(W)  
Z/ $\gamma^* \rightarrow \mu^+ \mu^-$   
W  $\rightarrow \tau \nu$   
Z/ $\gamma^* \rightarrow \tau^+ \tau^-$   
t-tbar  
QCD (multijet)

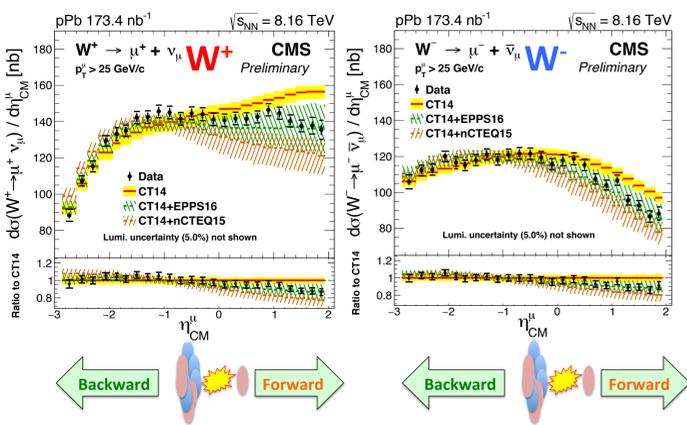
Template from simulation  
pPb NLO POWHEG v2 with  
CT14+EPPS16 nPDF  
Data-driven functional form

## Muon selection

- $p_T > 25$  GeV/c,  $|\eta_{lab}| < 2.4$
- Isolation to reduce QCD backgrounds
- Reject events with a  $\mu^+ \mu^-$  pair, with  $p_T(\mu^+) > 15$  and  $p_T(\mu^-) > 15$  GeV/c to remove Drell-Yan contribution

## Differential cross sections

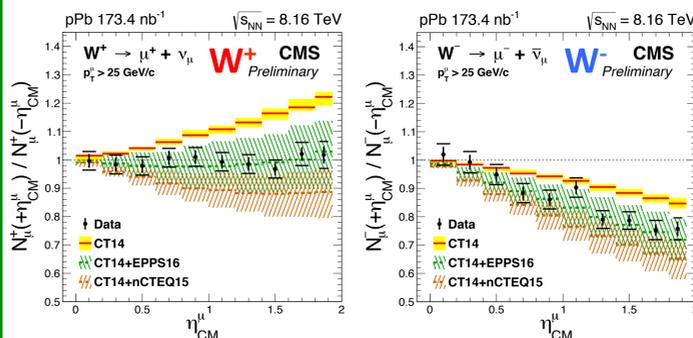
$$\frac{d\sigma(W \rightarrow \mu \nu_\mu)}{d\eta_{CM}^\mu}(\eta_{CM}^\mu) = \frac{N_\mu(\eta_{CM}^\mu)}{\mathcal{L} \Delta \eta_{CM}^\mu}$$



- Backward region (no/small nuclear effects): agreement with PDF and nPDF calculations
- Forward region (nuclear effects): nPDFs favored

## Forward-backward ratio

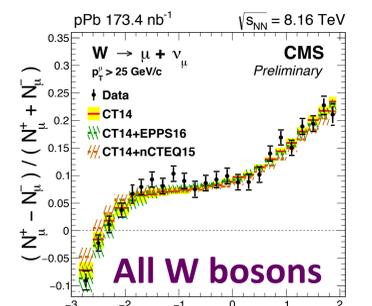
$$\frac{N_\mu(+\eta_{CM}^\mu)}{N_\mu(-\eta_{CM}^\mu)} \begin{matrix} \text{Forward} \\ \text{Backward} \end{matrix}$$



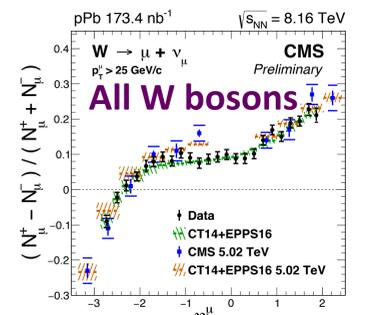
- The nPDFs calculations are favored over the CT14 PDF
- Experimental uncertainties are smaller than model uncertainties

## Muon charge asymmetry

$$\mathcal{A} \equiv \frac{(N_\mu^+ - N_\mu^-)}{(N_\mu^+ + N_\mu^-)}$$



- PDF and nPDFs reproduce the measurements



- $\eta_{ref}^\mu = \eta_{CM}^\mu \pm \ln(8.16 \text{ TeV} / \sqrt{s_{NN}})$
- Measurements at different collision energies agree [3]

## Summary and Conclusions

- CMS measured W boson production in pPb collisions at  $\sqrt{s_{NN}} = 8.16$  TeV
- The absolute cross sections and the forward-backward asymmetries show significant deviations from only proton PDF case, on the contrary showing a good agreement with nPDF sets
- The small experimental uncertainties will allow for a significant reduction of the uncertainties in the present models

## Reference and related QM talk

- CMS-PAS-HIN-17-007 : Constraints on nuclear parton distributions from W boson production in pPb collisions at  $\sqrt{s_{NN}} = 8.16$  TeV
- Eur. Phys. J C77 163
- CMS 5.02 TeV : Phys. Lett. B750 (2015) 565-586
- CT14 (only PDF) : Phys. Rev. D93 (2016), no. 3, 033006
- CT14+EPPS16 (nPDF) : Eur. Phys. J. C77 (2017), no. 3, 163
- CT14+nCTEQ15 (nPDF) : Phys. Rev. D93 (2016), no. 8, 085037

**Don't miss Andre Ståhl's talk : May. 16<sup>th</sup>(Wed.) 11:30 in Sala Casino, 1<sup>st</sup> Floor**