

# Jet, vector meson and photon production in pA and AA collisions in CMS



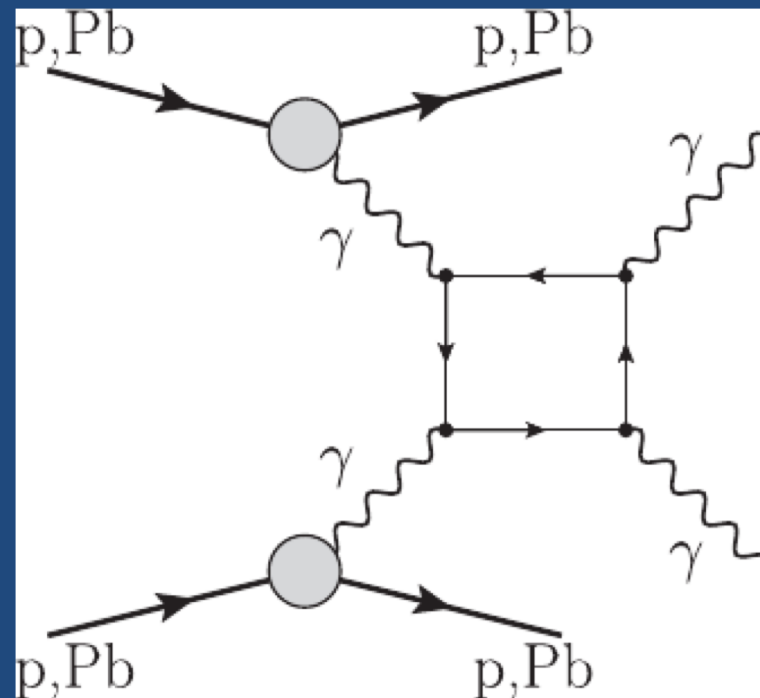
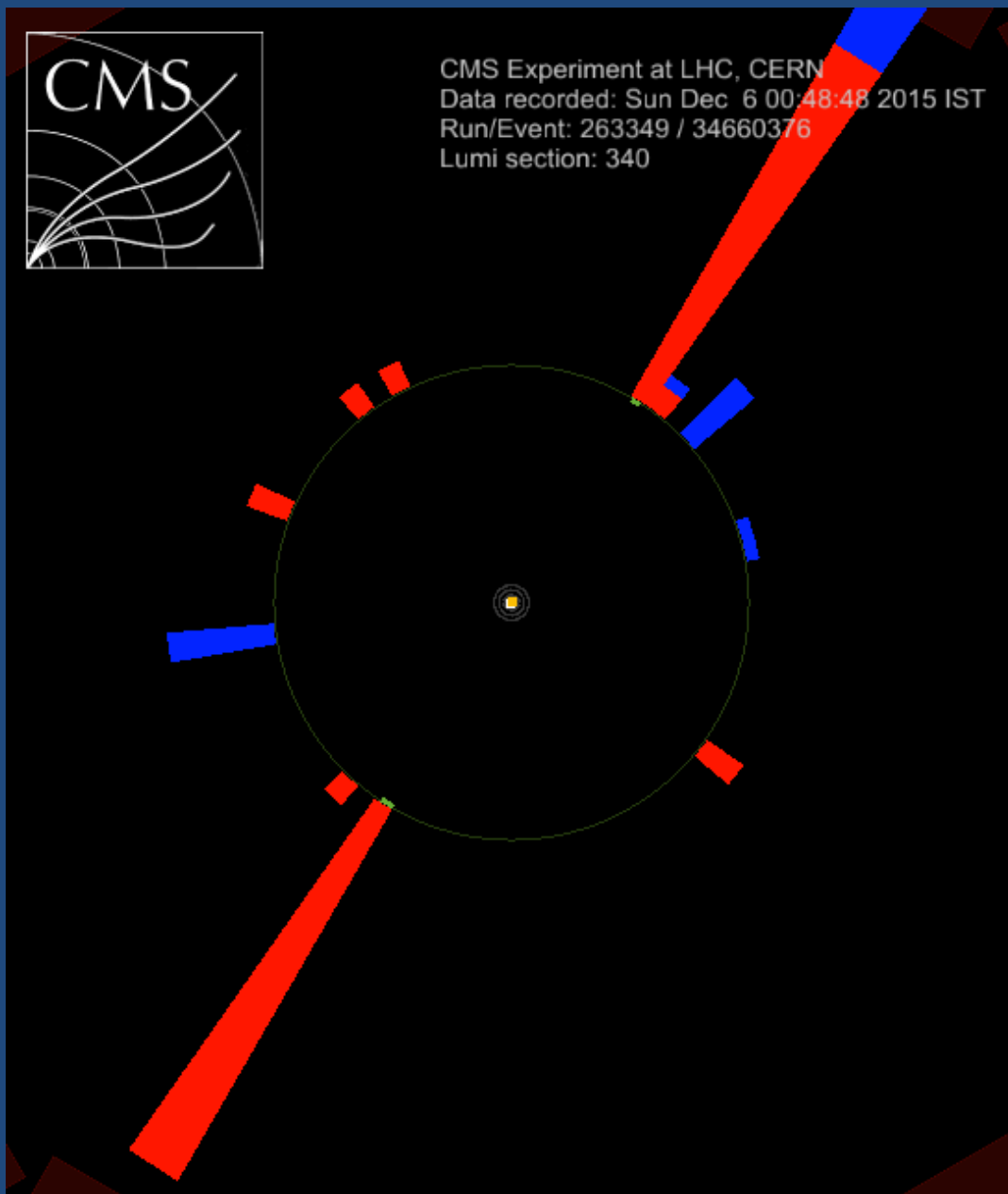
Michael Murray, University of Kansas

Diffraction & Low X 2018 1<sup>st</sup> September 2018

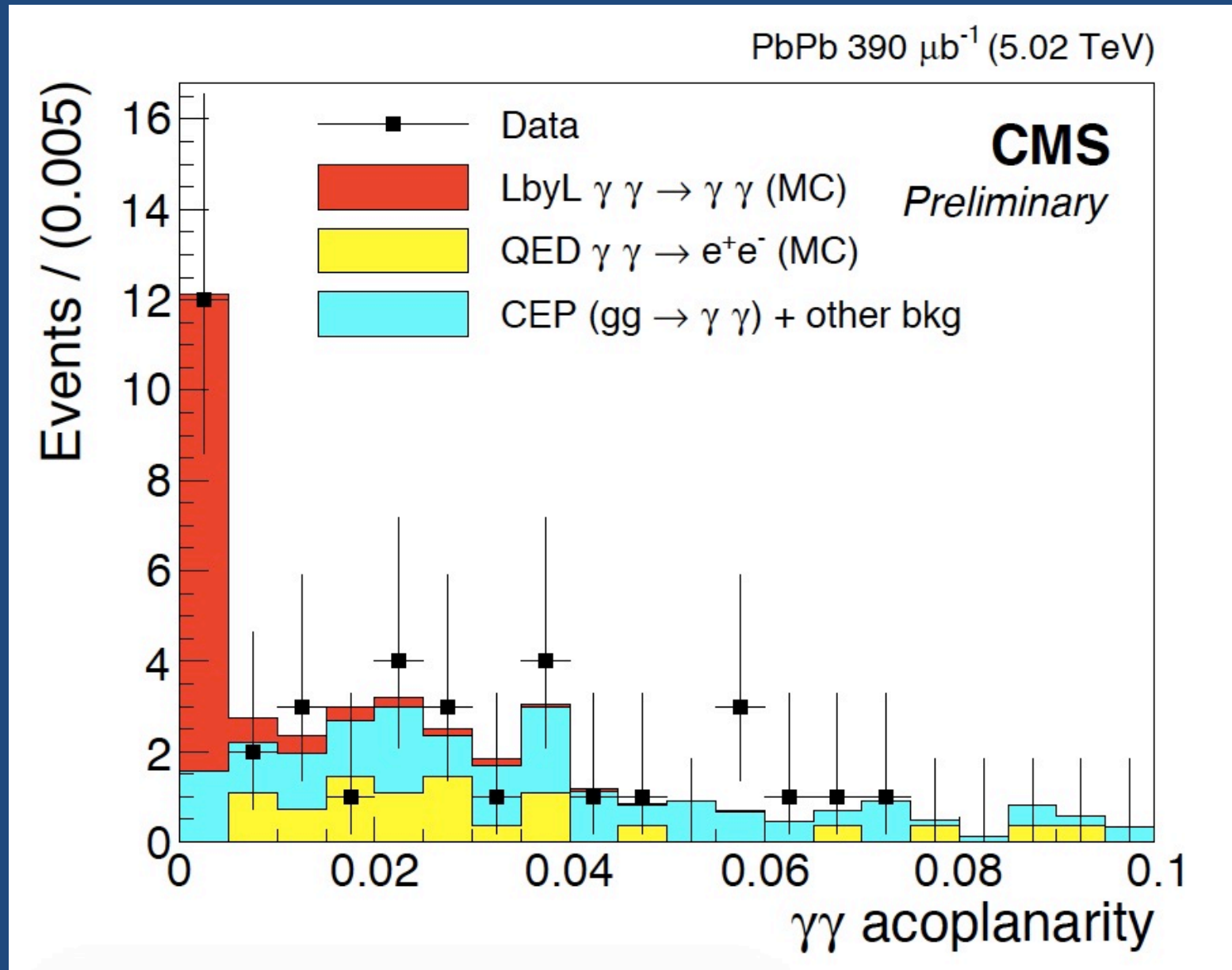
# Outline

- Search for new physics in light by light scattering [CMS PAS FSQ-16-012](#)
- Study of the lead wavefunction
  - pPb  $\Rightarrow$  J/ $\psi$  [Eur. Phys. J. C 77 \(2017\) 269](#)
  - pPb  $\Rightarrow$  Dijets [Phys. Rev. Lett. 121 \(2018\) 062002](#)
  - pPb  $\Rightarrow$  Z [Phys. Lett. B 759 \(2016\) 36](#)
  - pPb  $\Rightarrow$  W [CMS PAS HIN-17-007](#)
  - pPb  $\Rightarrow$  Top [Phys. Rev. Lett. 119 \(2017\) 242001](#)
  - $\Upsilon$ Pb  $\Rightarrow$  J/ $\psi$  [Phys. Lett. B 772 \(2017\) 489](#)

# Light by light scattering in PbPb

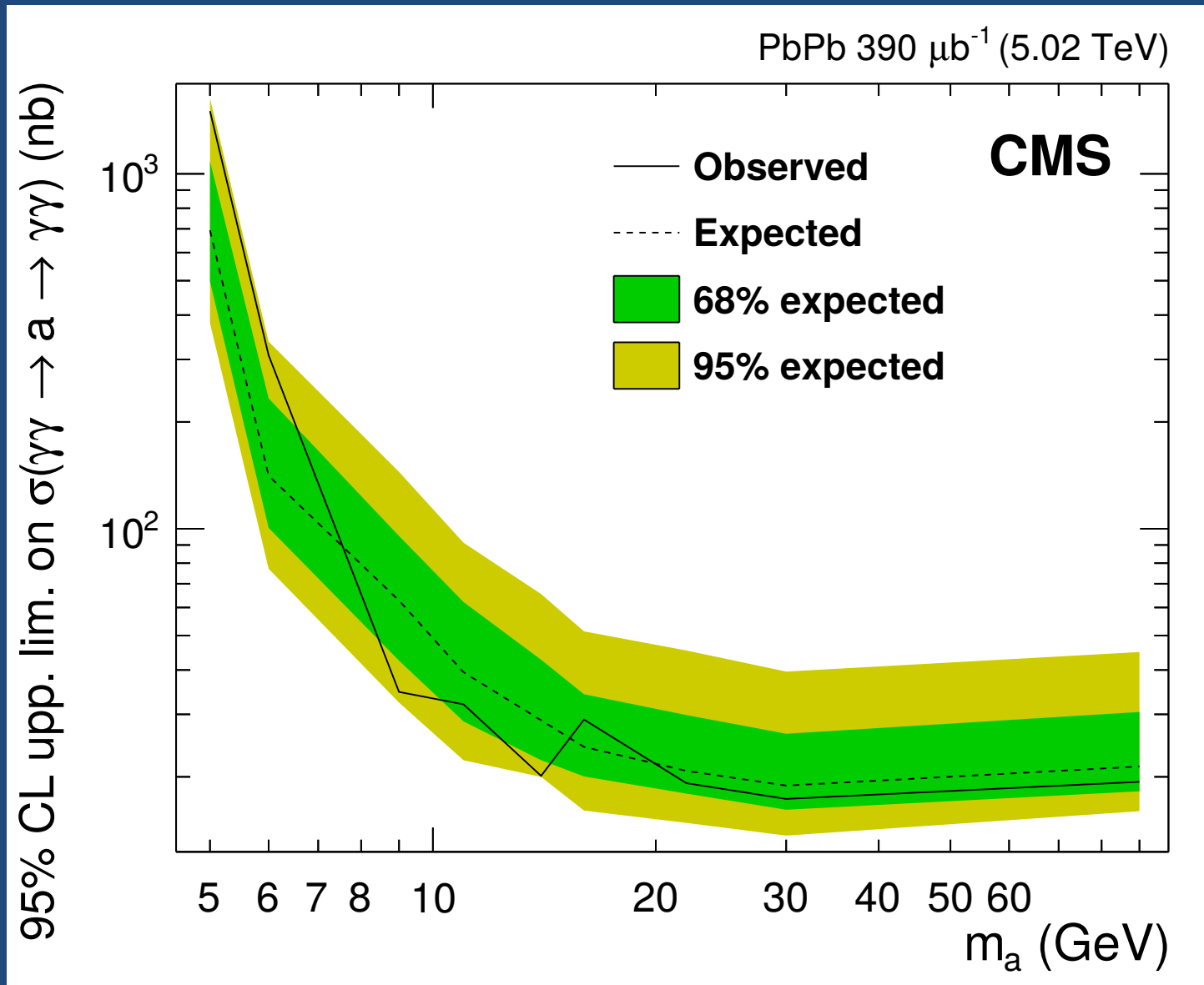


# Light by light scattering in PbPb

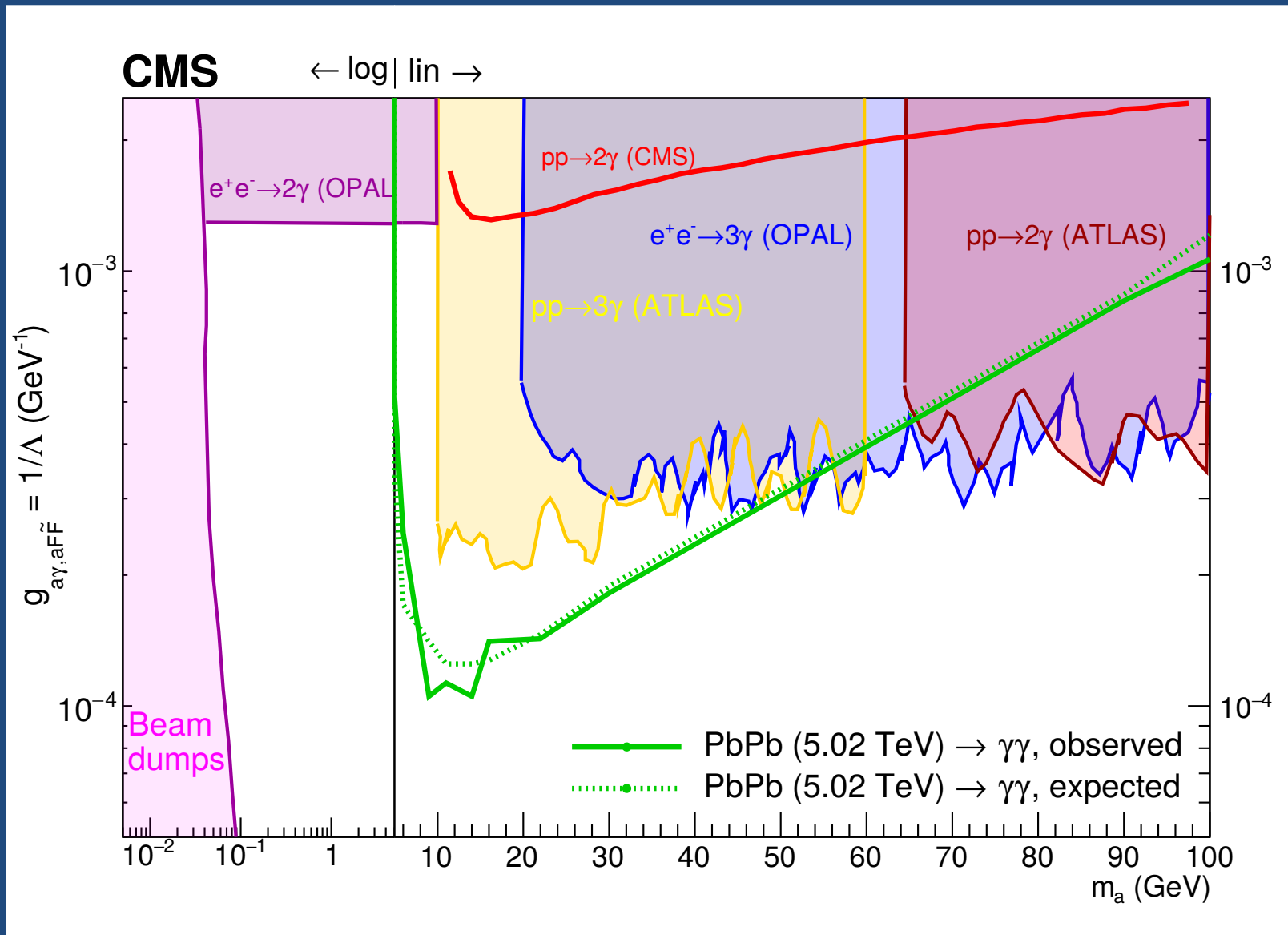




# Limits on Axion Coupling



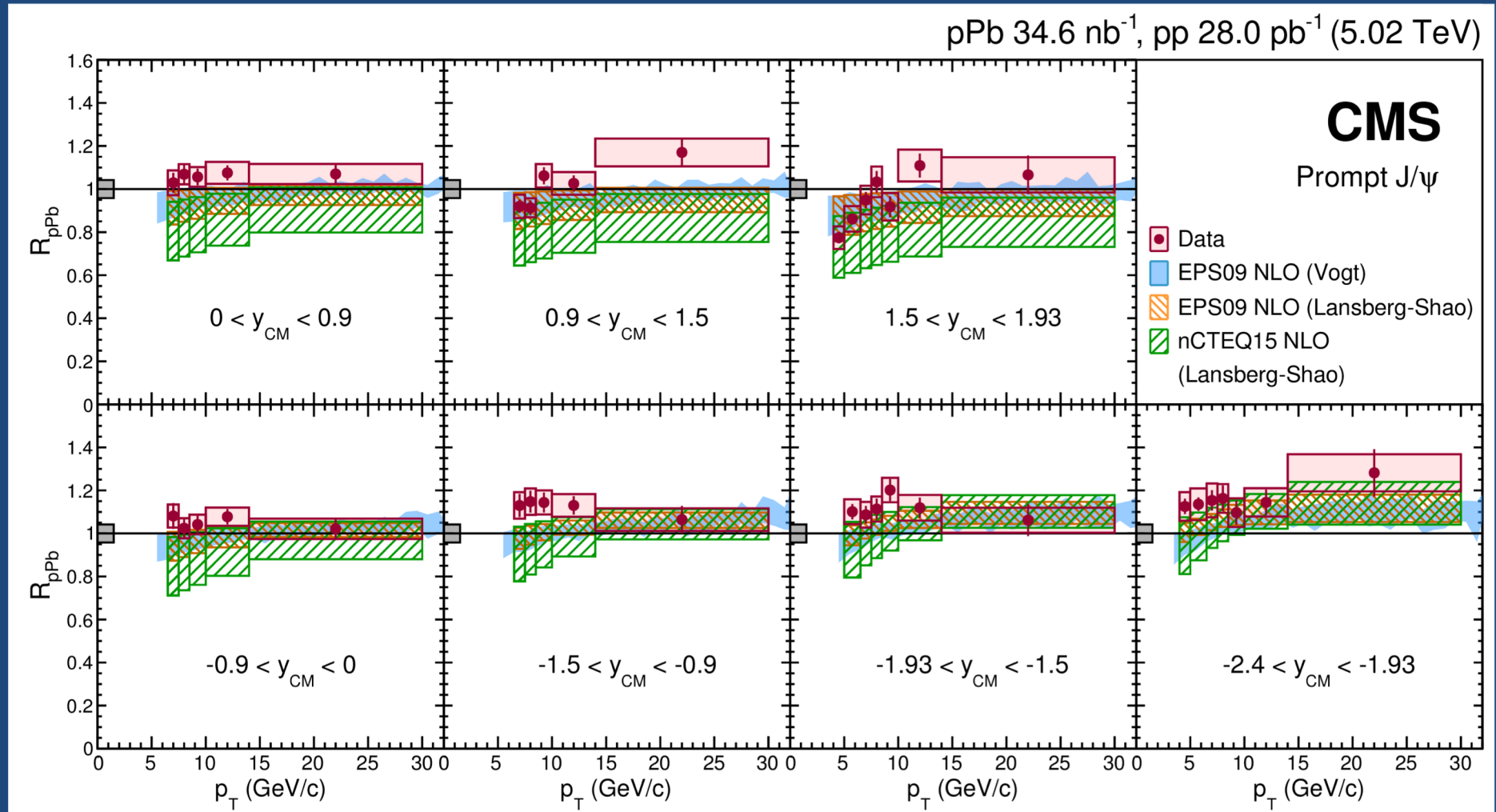
# Comparison of limits to other results



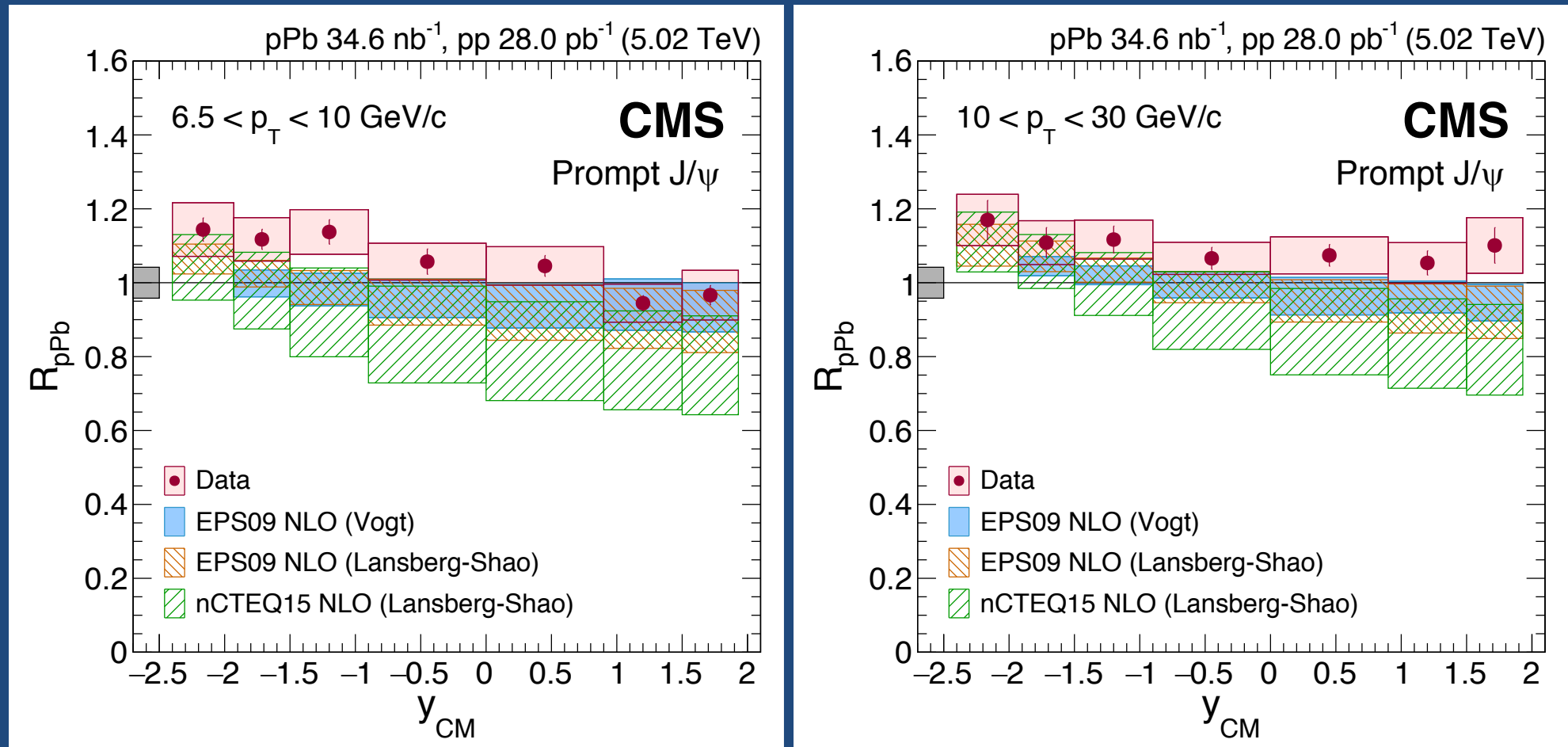
CMS PAS FSQ-16-012

# pPb => prompt J/ψ

$\frac{pPb}{pp}$

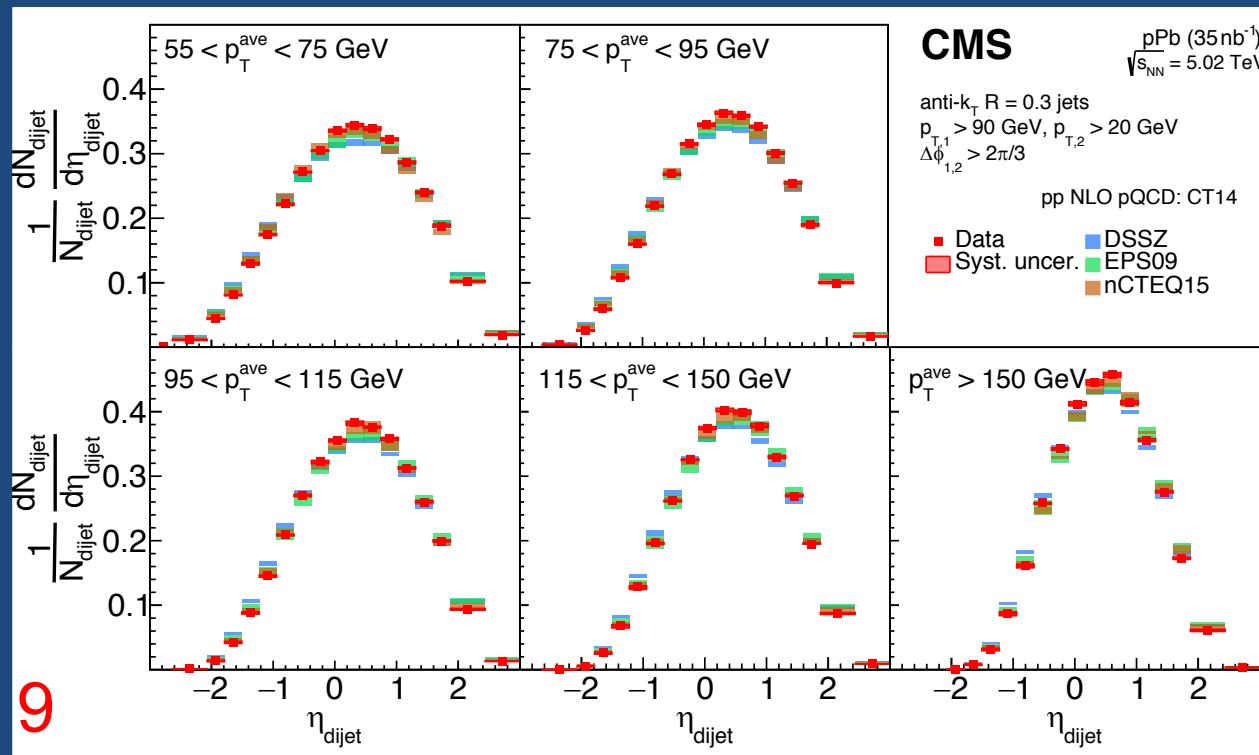
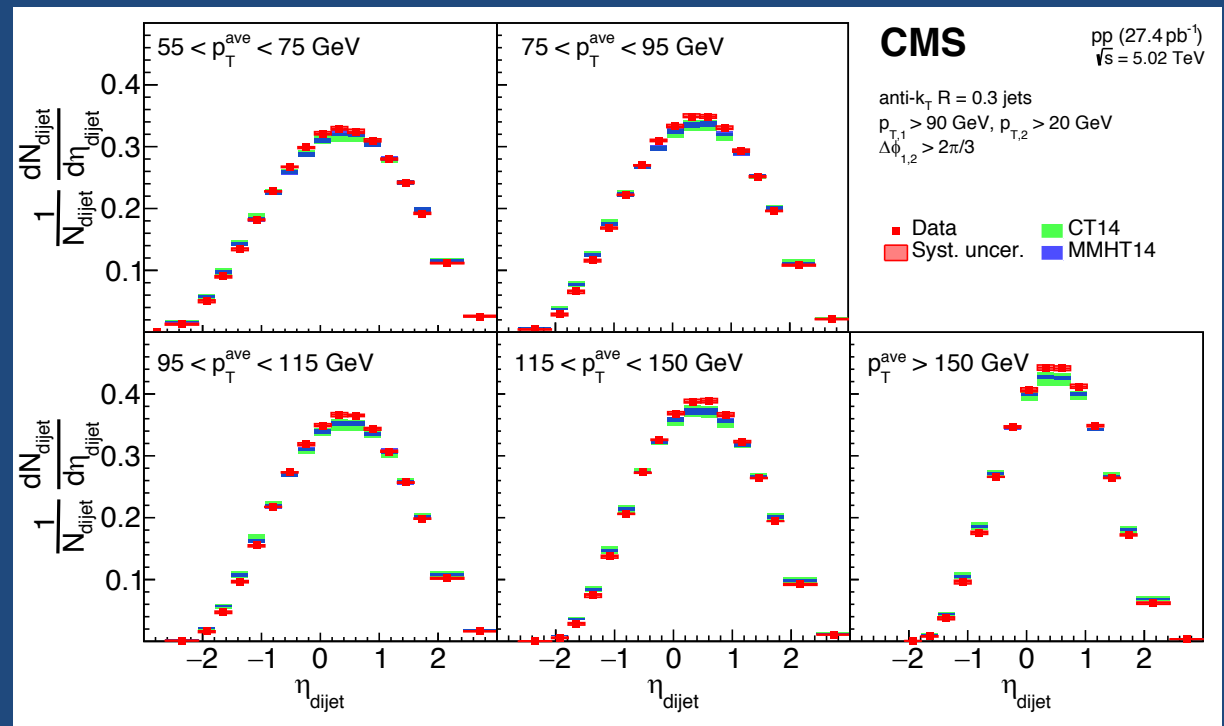


# pPb => prompt J/ψ





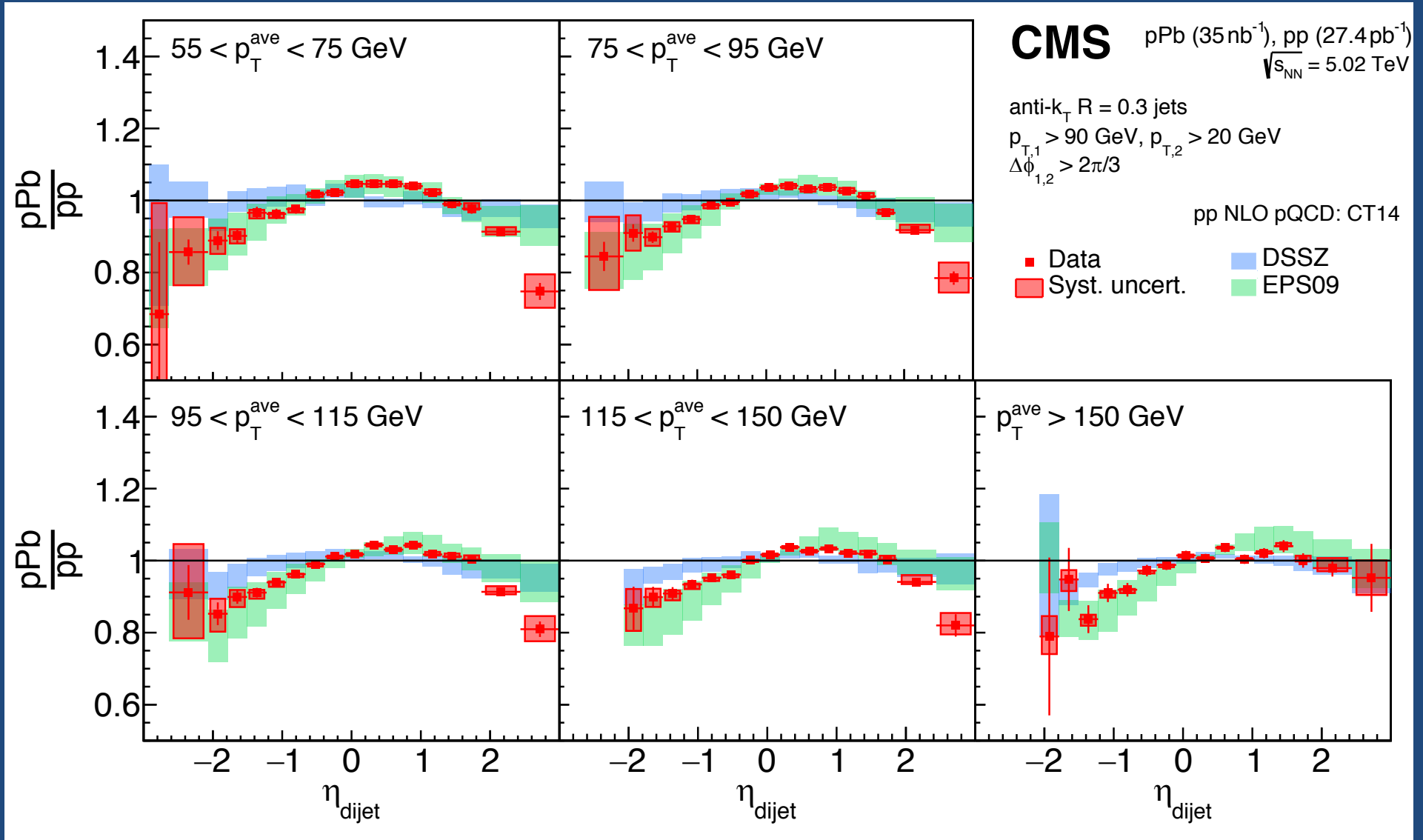
# Dijets in pp and pPb



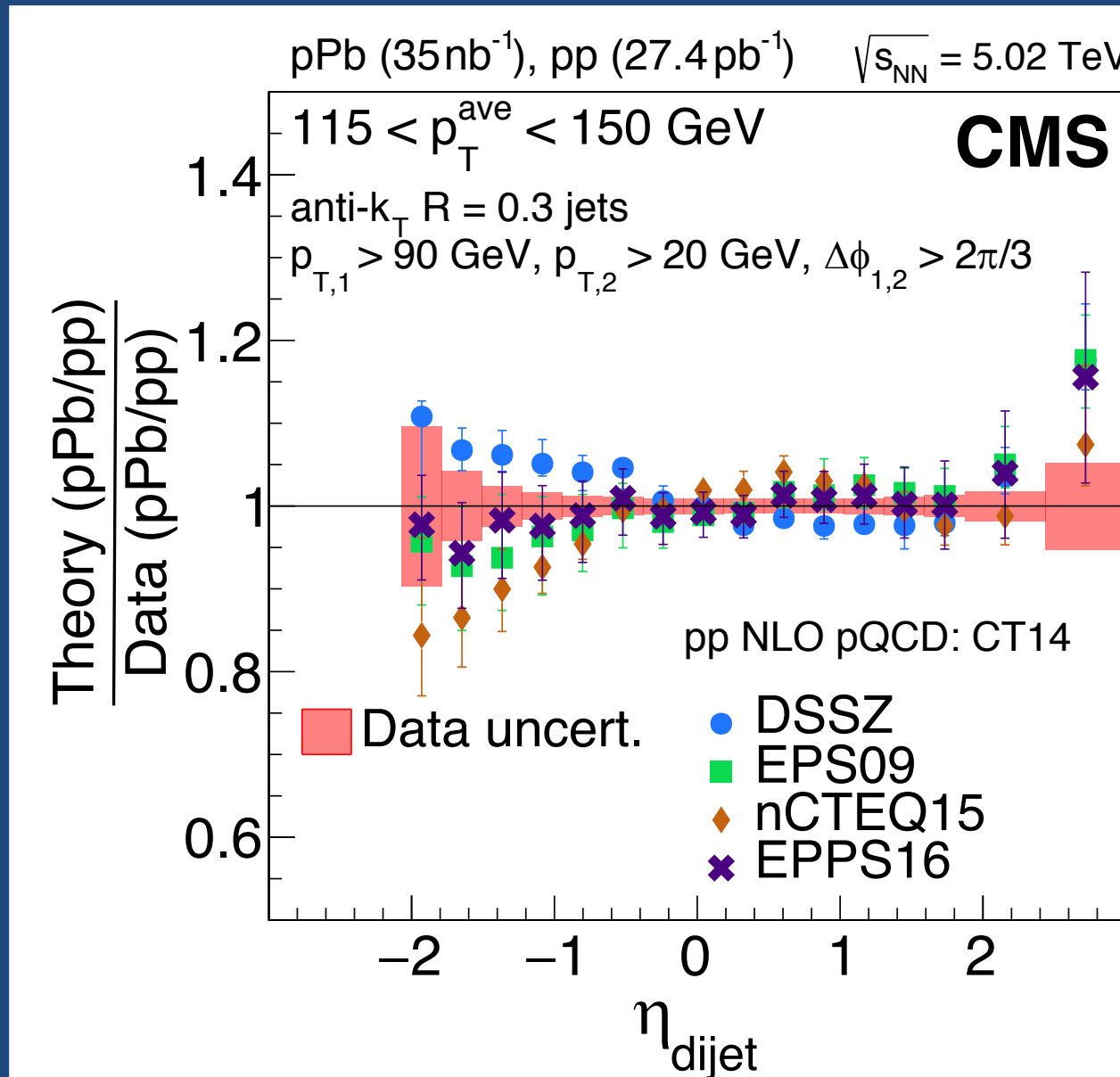
[10.1103/PhysRevLett.121.062002](https://arxiv.org/abs/10.1103/PhysRevLett.121.062002)



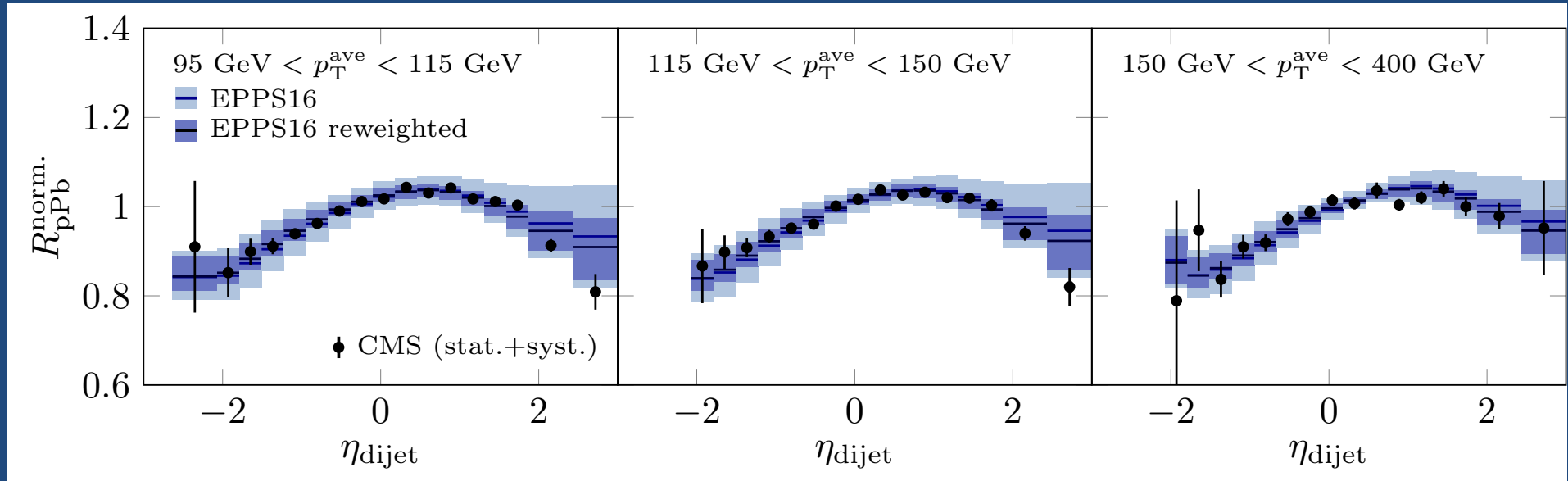
# Ratio of in dijets in pPb/pp



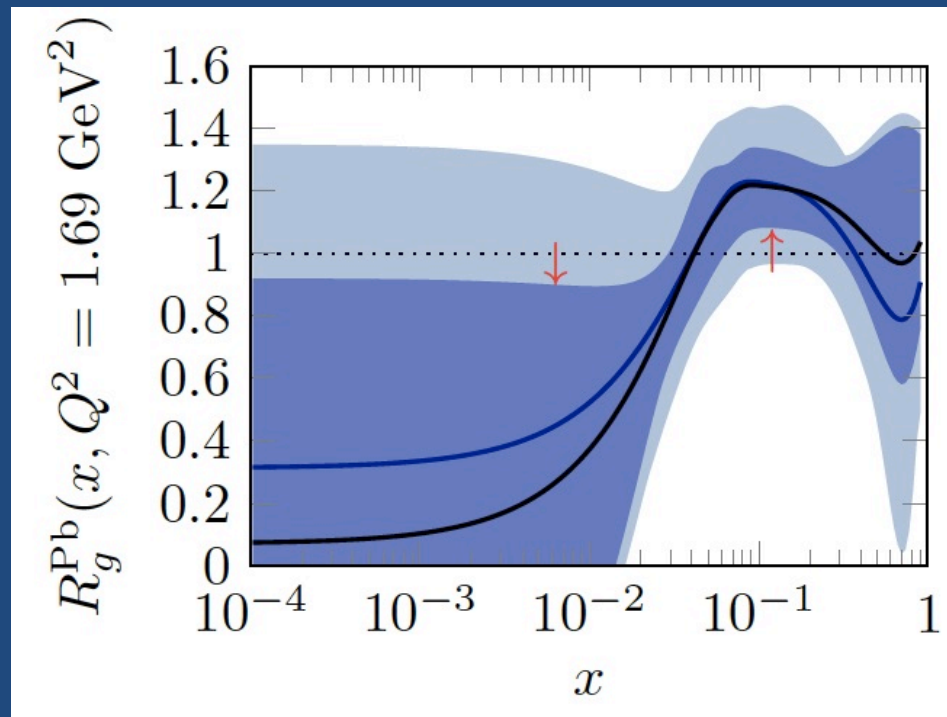
# Comparison of pPb/pp to theory



# Effect of dijet data on EPS16

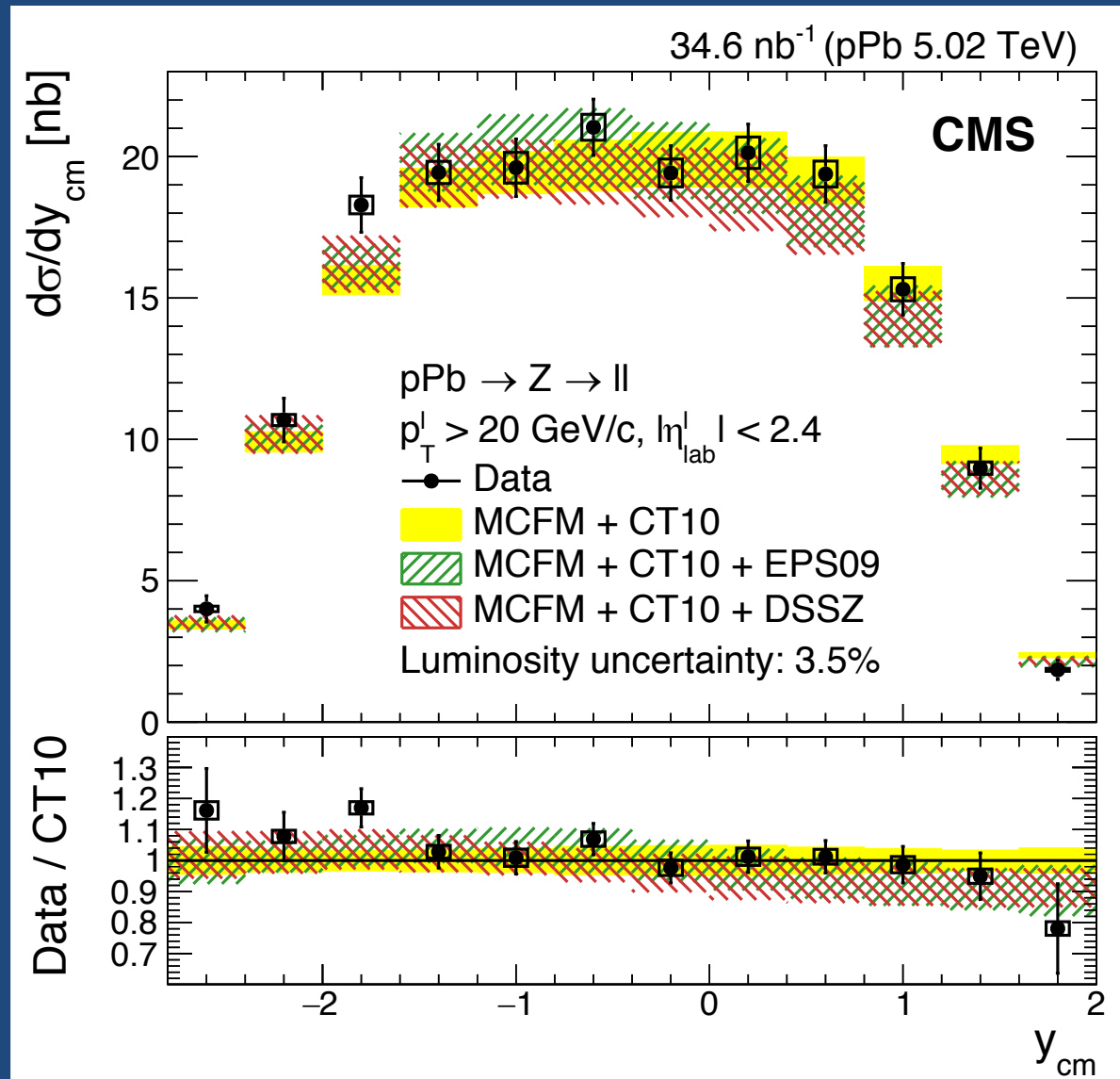


"P. Paakinen,  
talk at  
EICUGM2018".

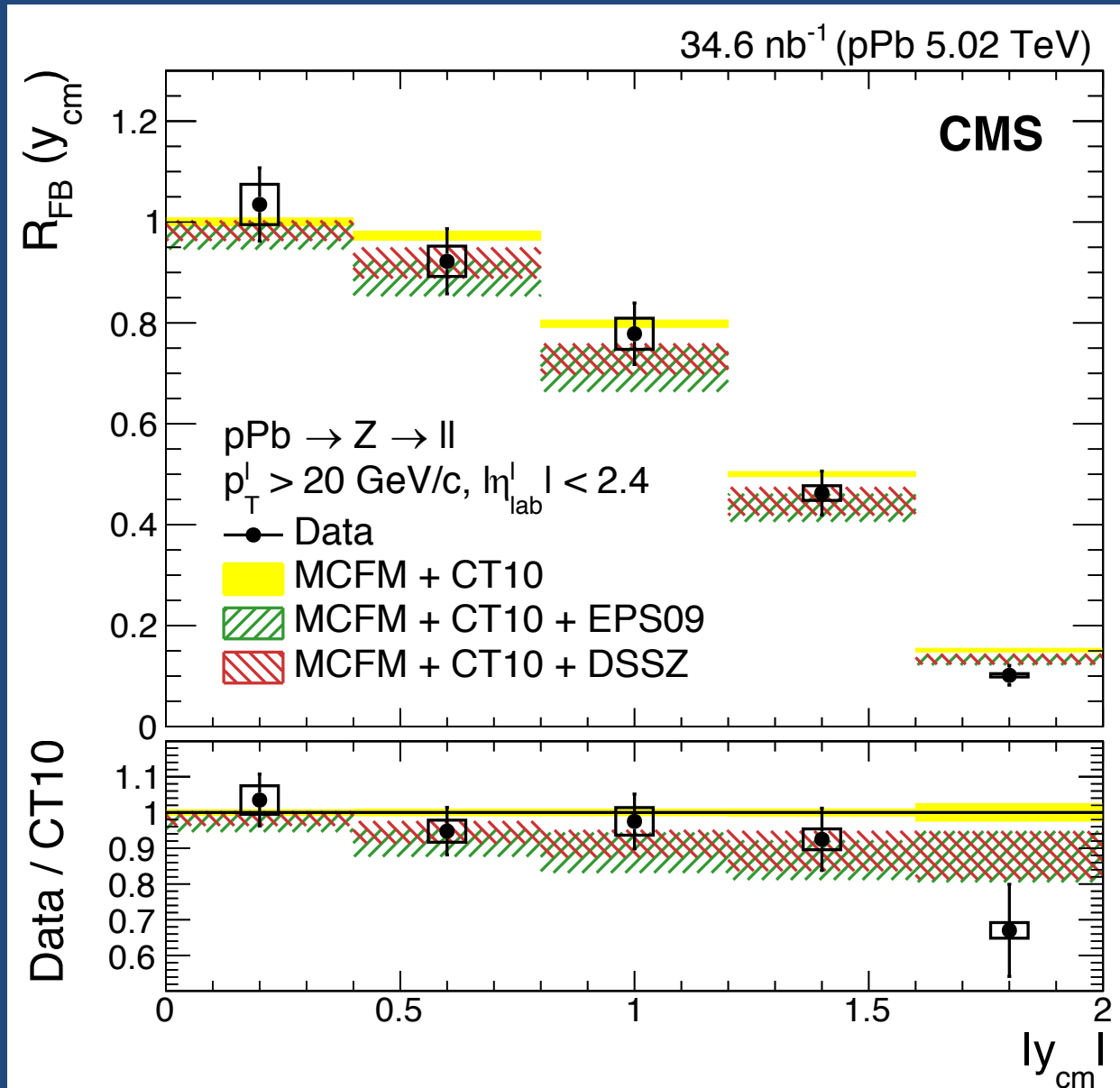




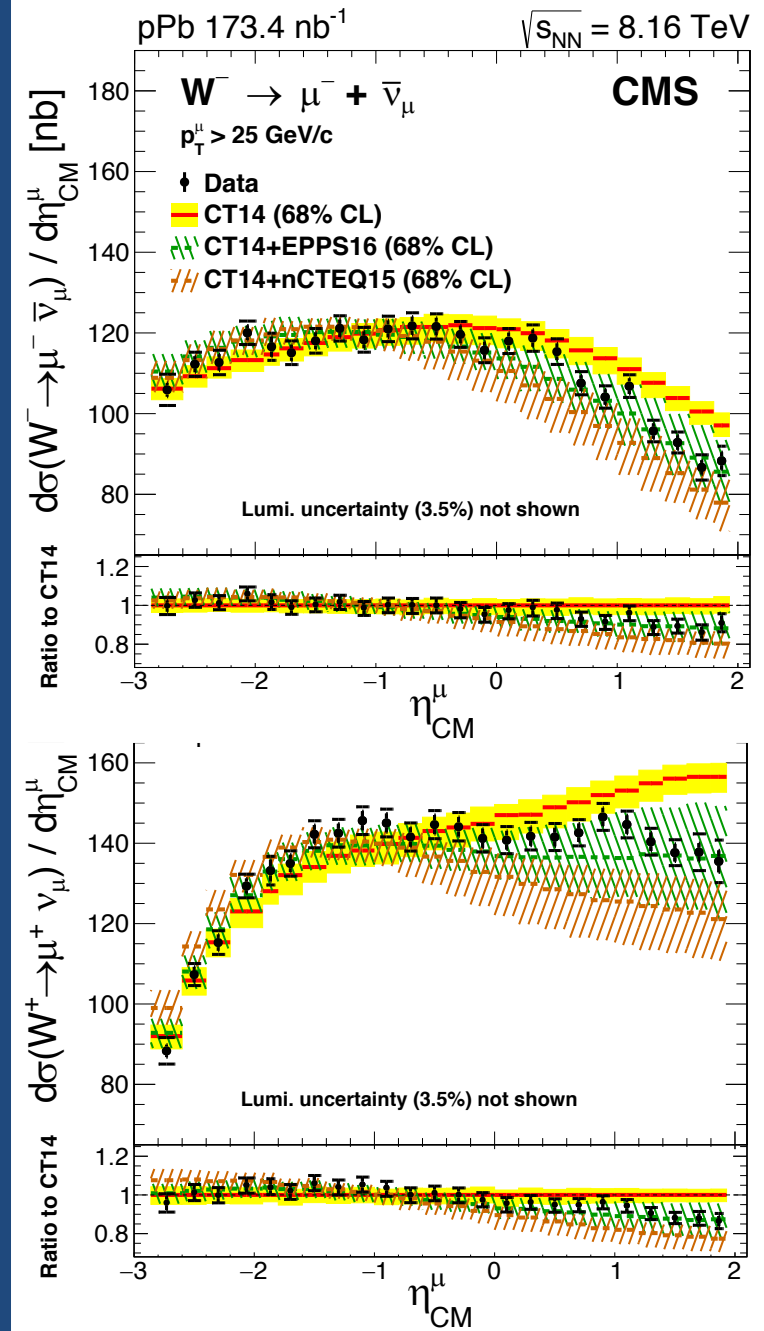
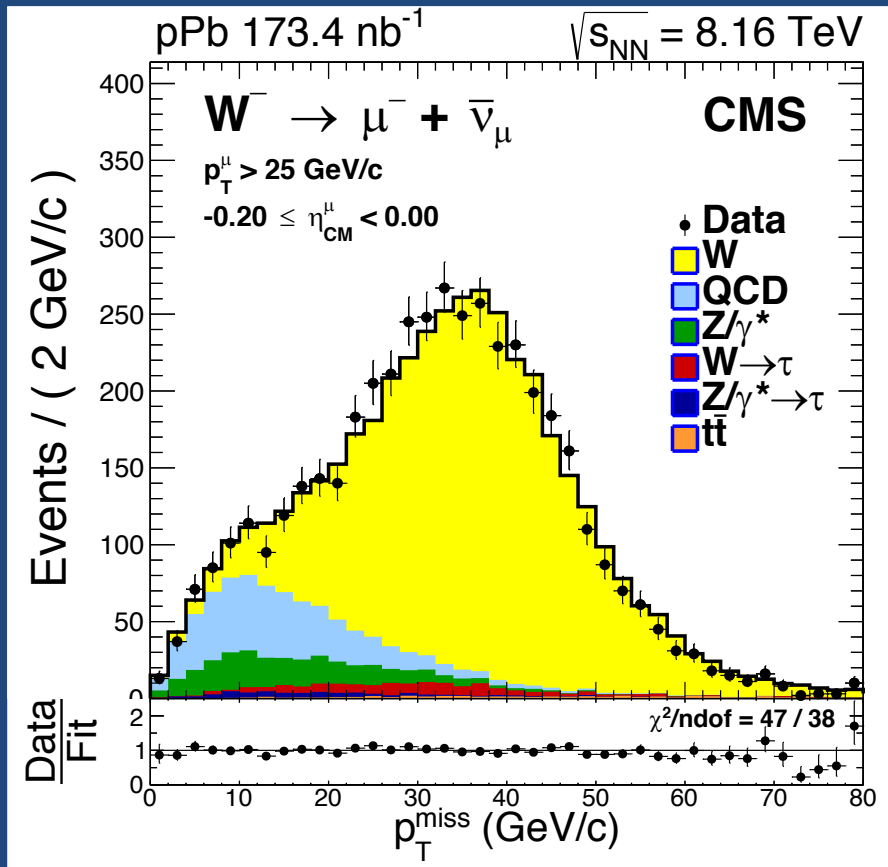
# pPb => Z



# pPb => Z



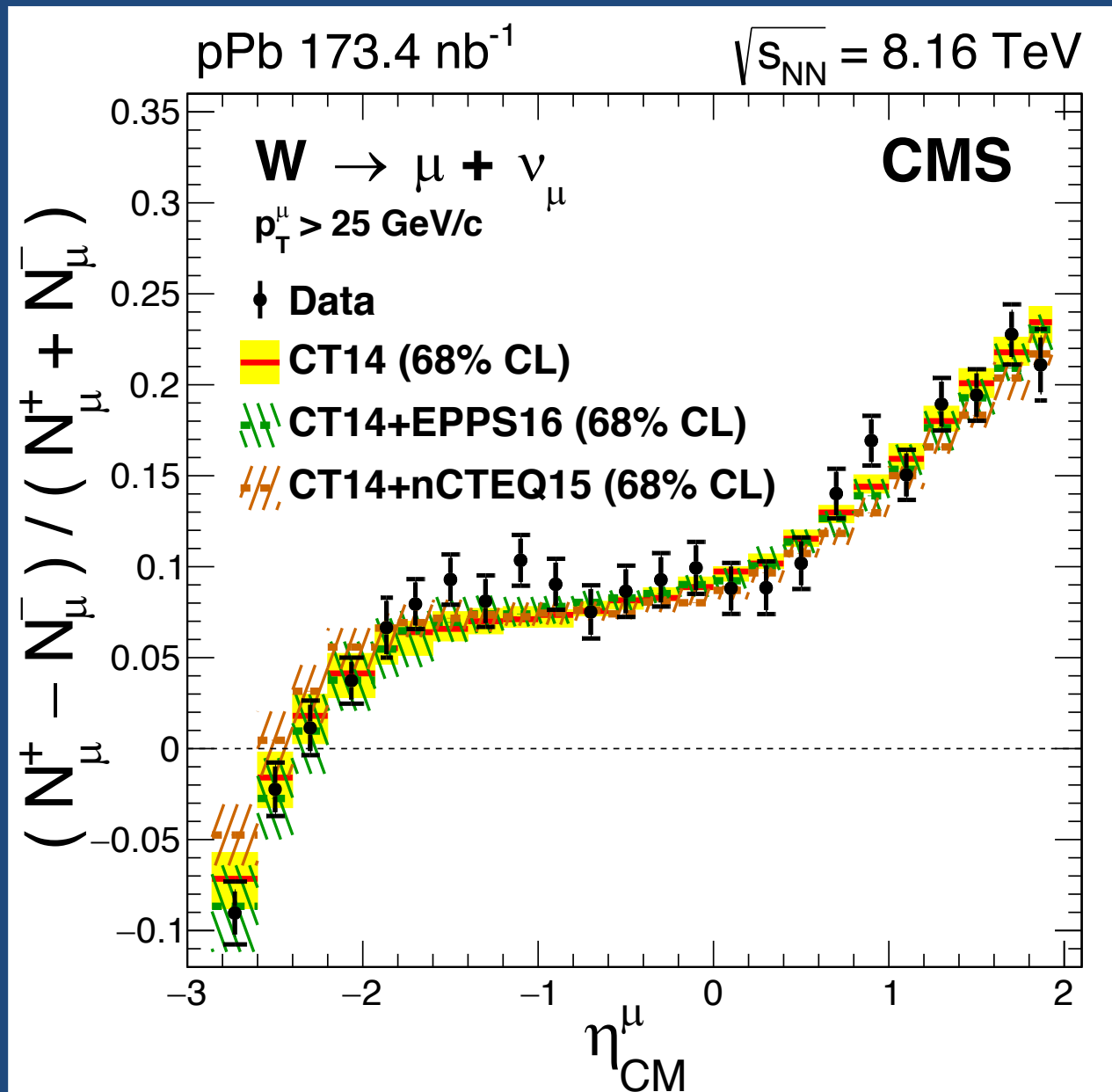
# pPb => W



W<sup>-</sup>

W<sup>+</sup>

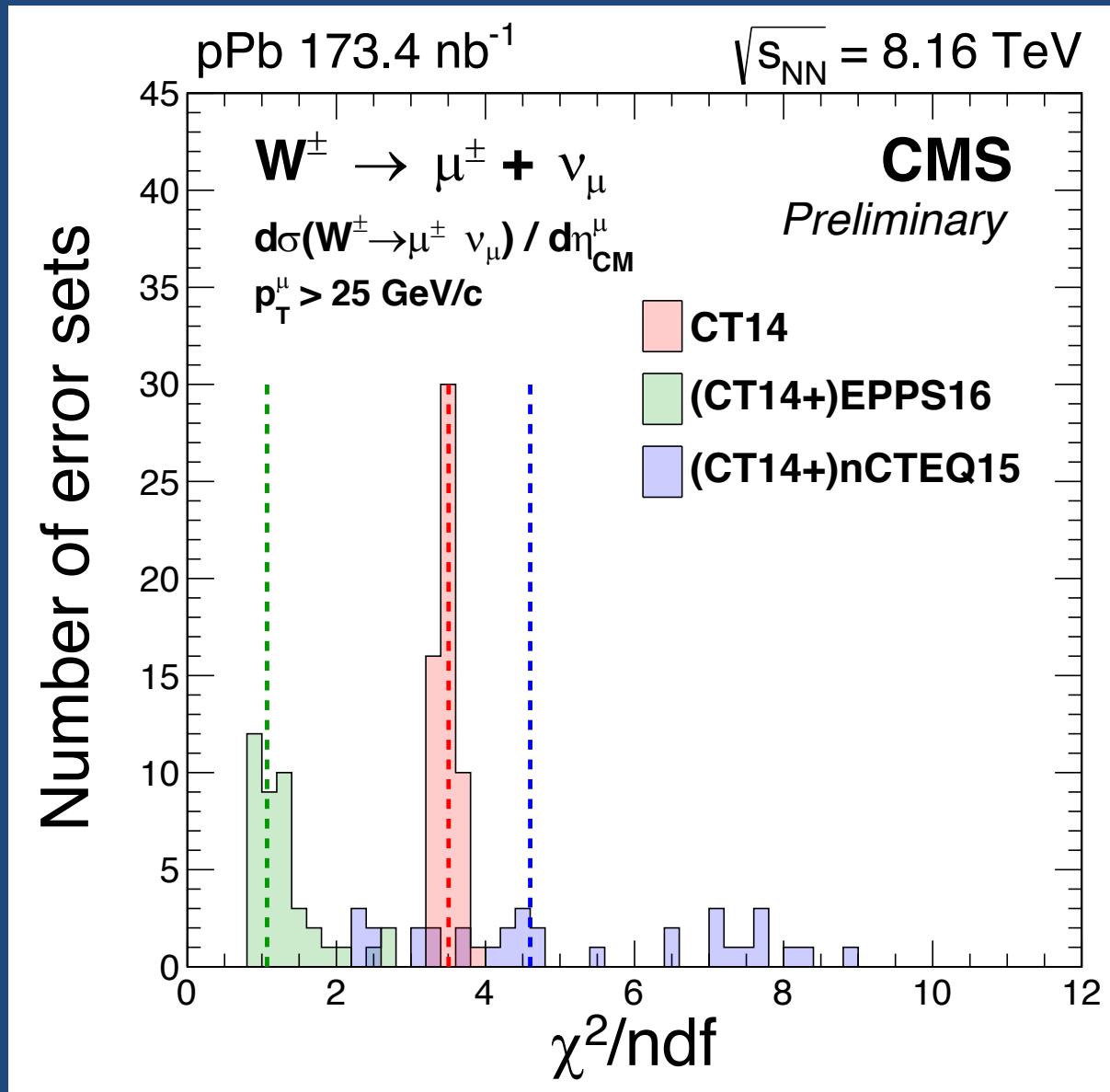
# pPb => W



CMS PAS  
HIN-17-007

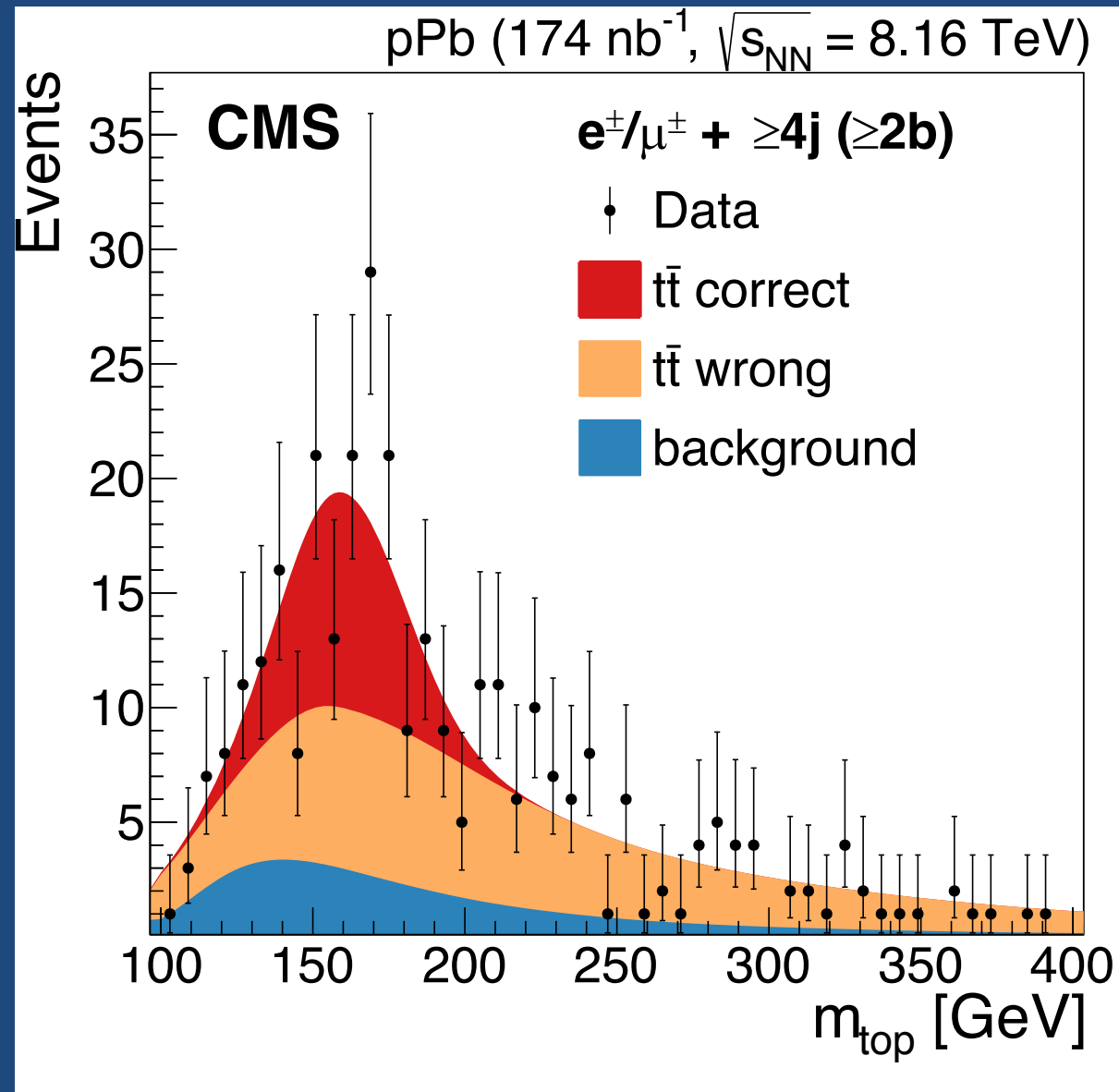


# pPb => W

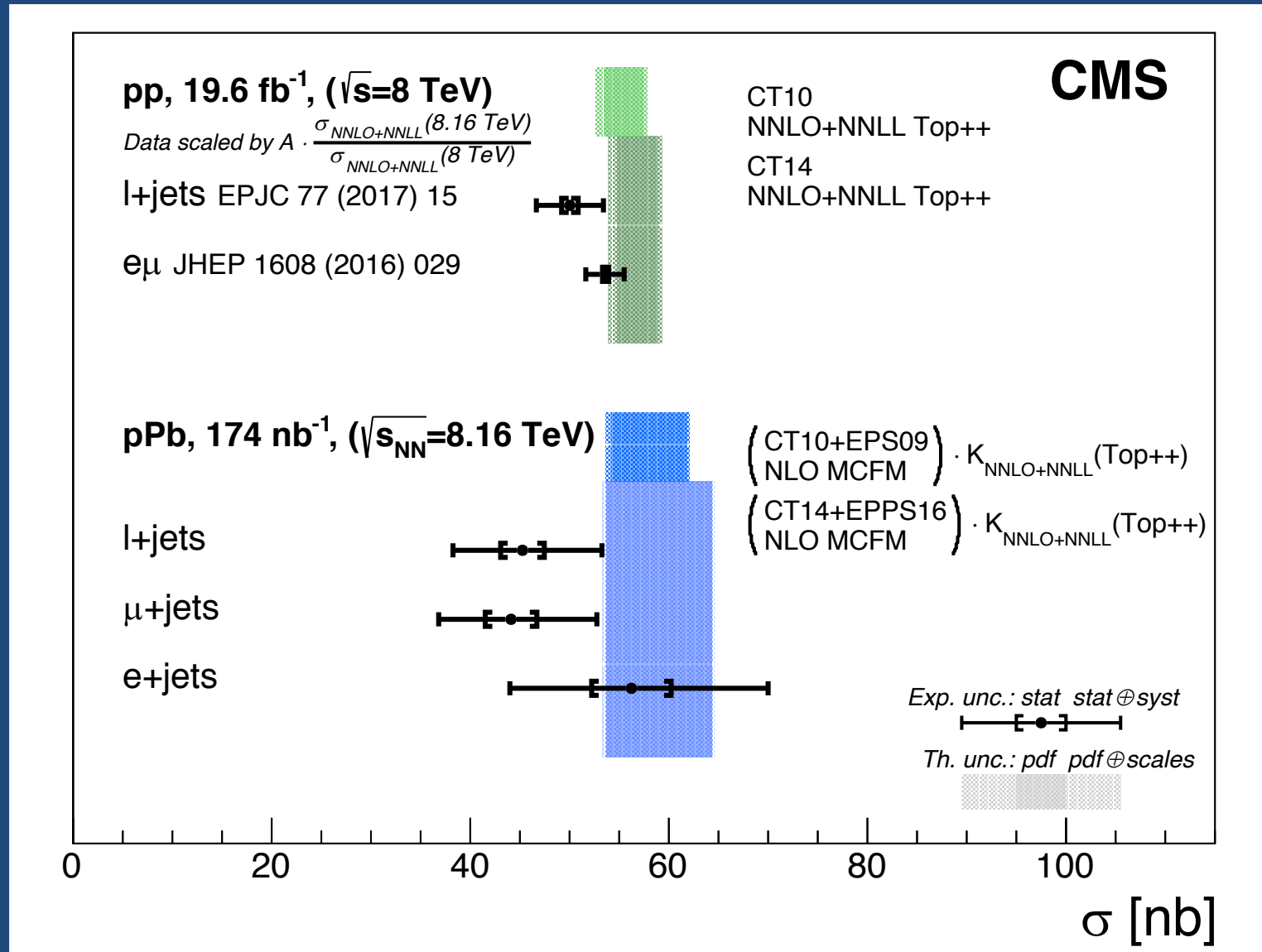


CMS PAS  
HIN-17-007

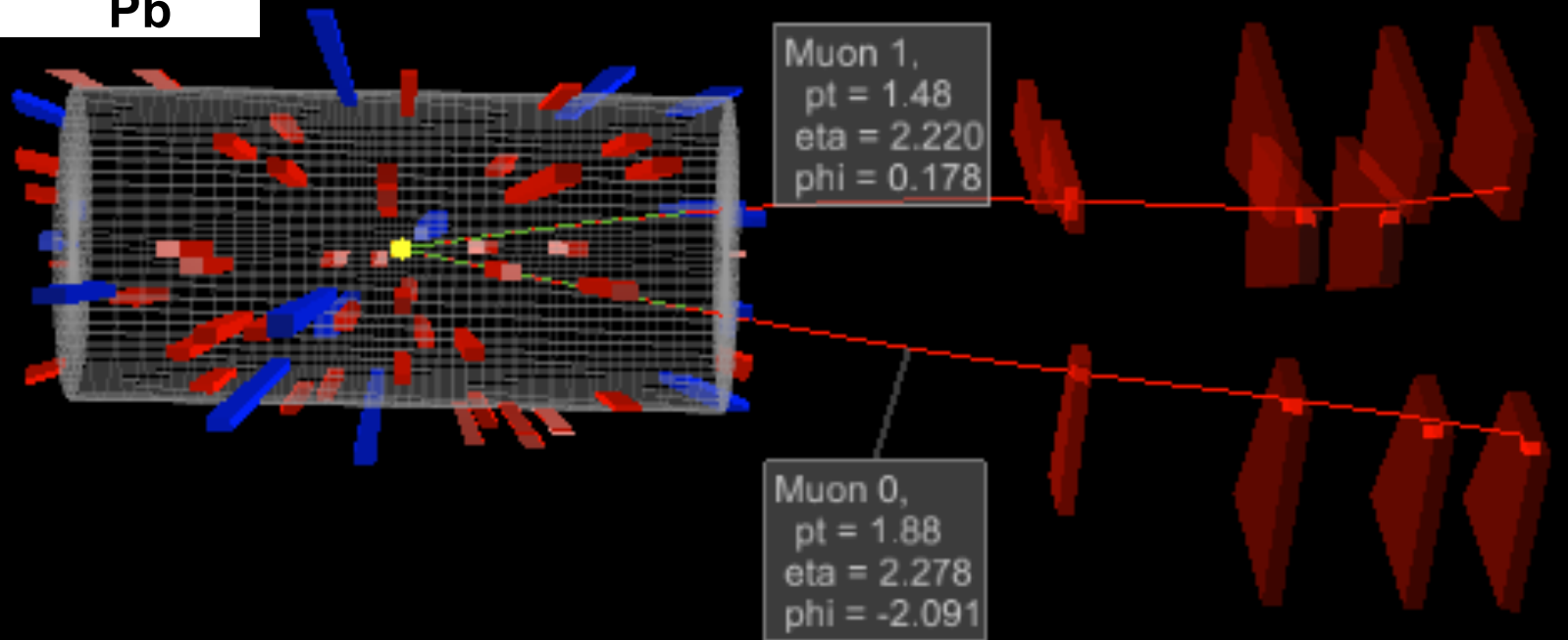
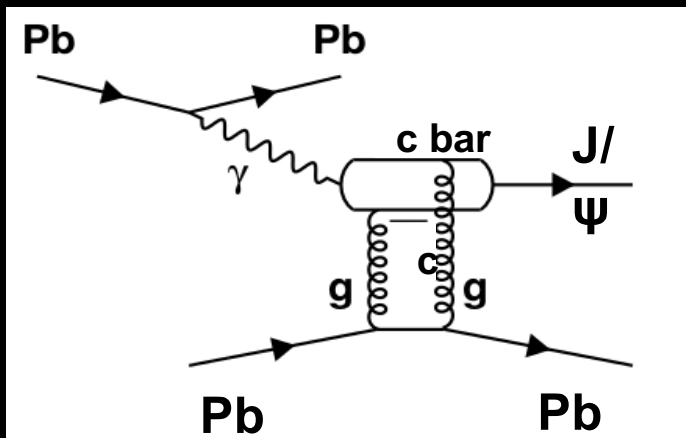
# Observation of top in pPb



# Observation of top in pPb

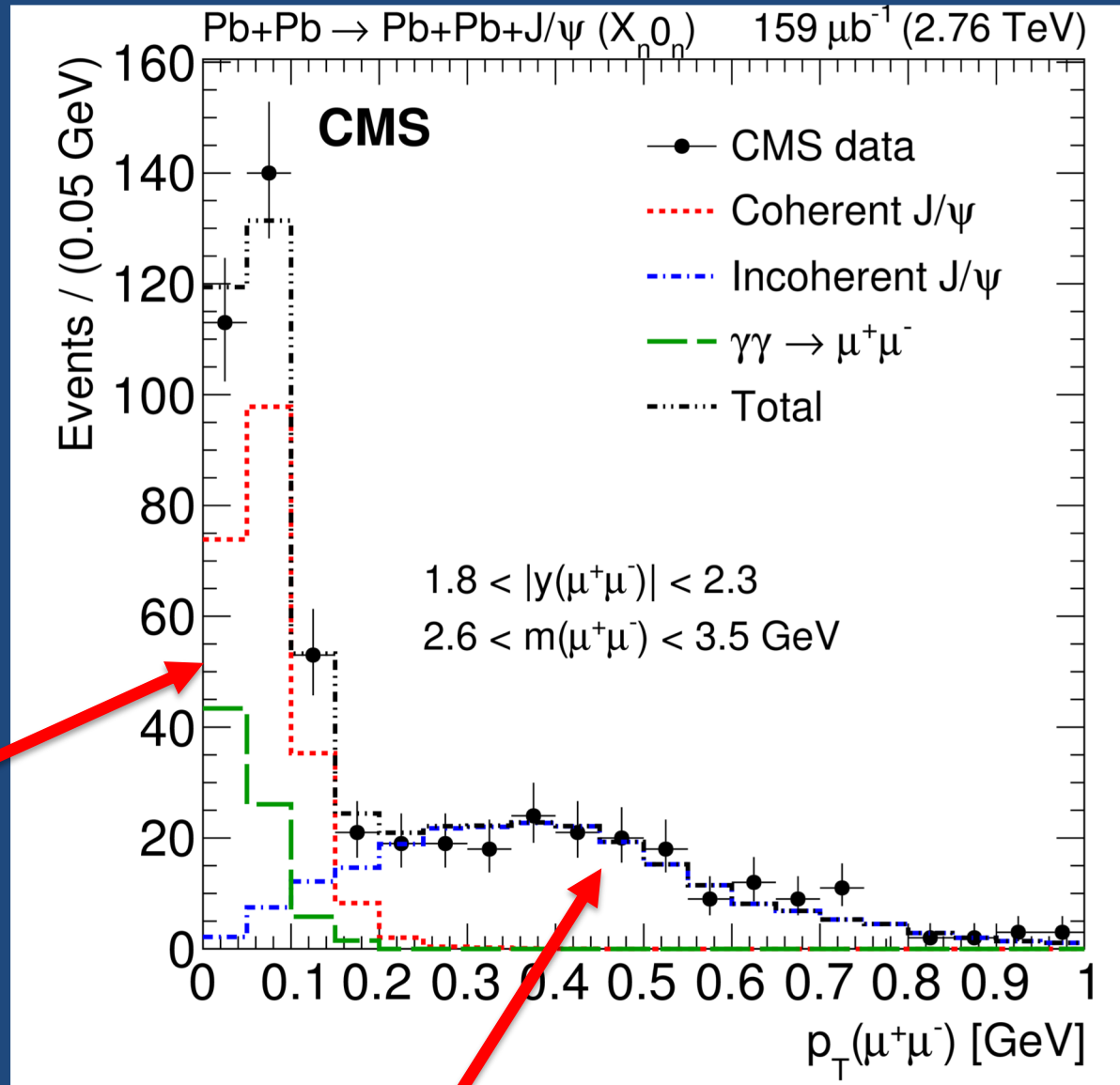


# Ultrapерipheral PbPb $\Rightarrow$ J/ $\psi$





# $\gamma\text{Pb} \Rightarrow \text{J}/\psi$

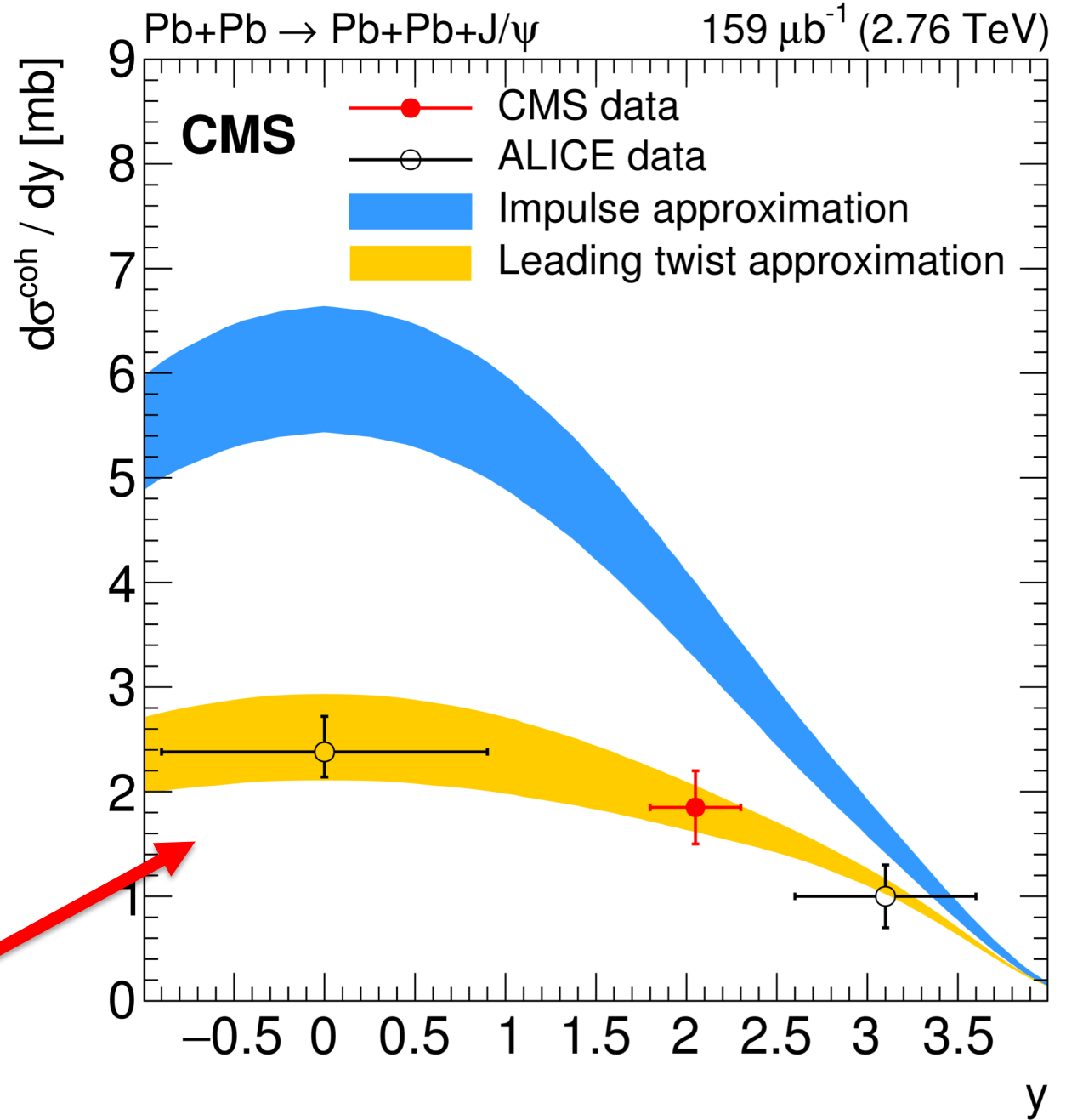


Coherent  
peak at  
 $p_T = h/R$

Incoherent region sensitive to  
fluctuations in wavefunction

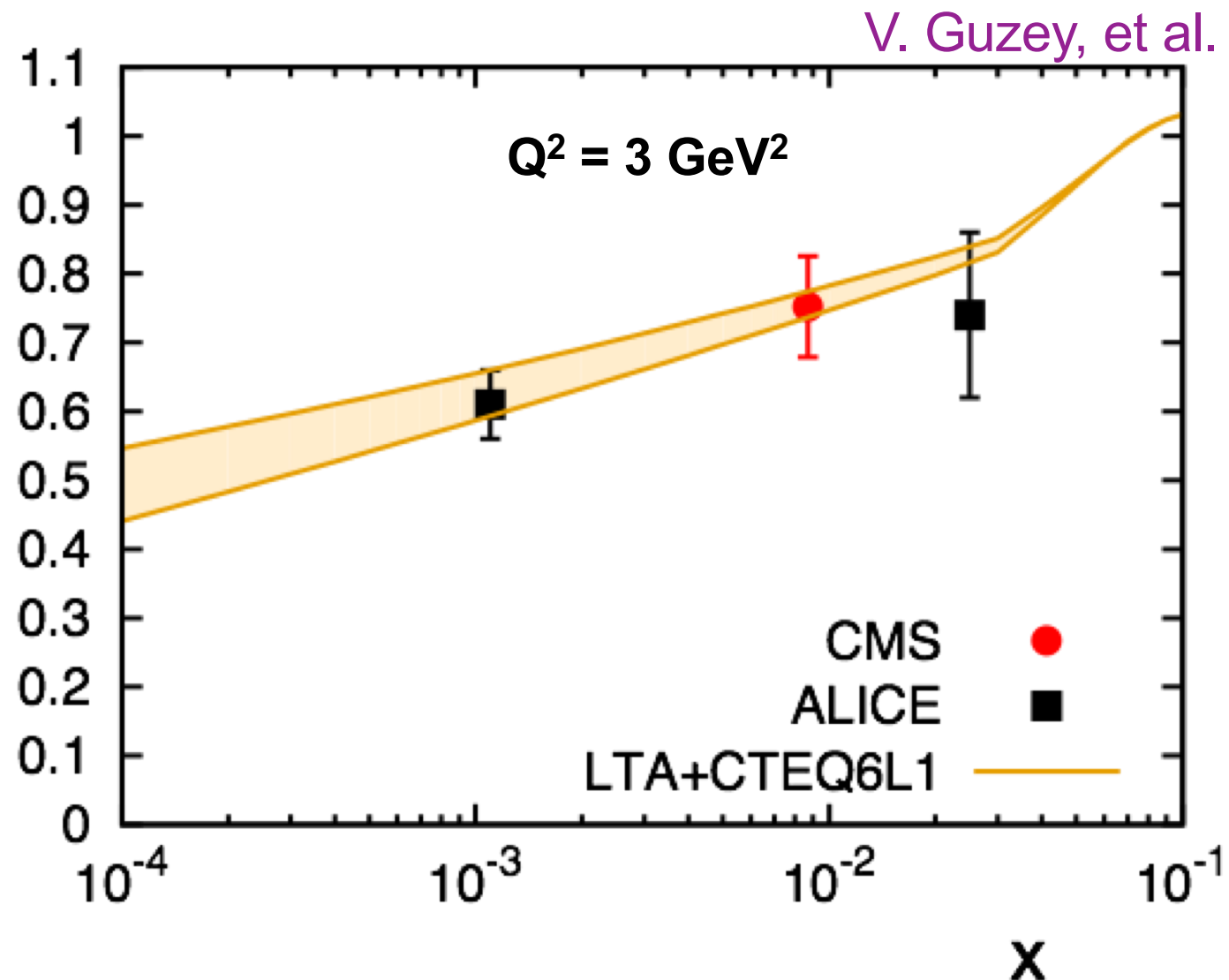
# Rapidity dependence of coherent $\gamma$ Pb $\Rightarrow$ J/ $\psi$

Data suppressed relative to simple extrapolation from pp results. This implies significant gluon shadowing



# Nuclear gluon density

$$\frac{G_A(x, \mu^2)}{AG_N(x, \mu^2)}$$

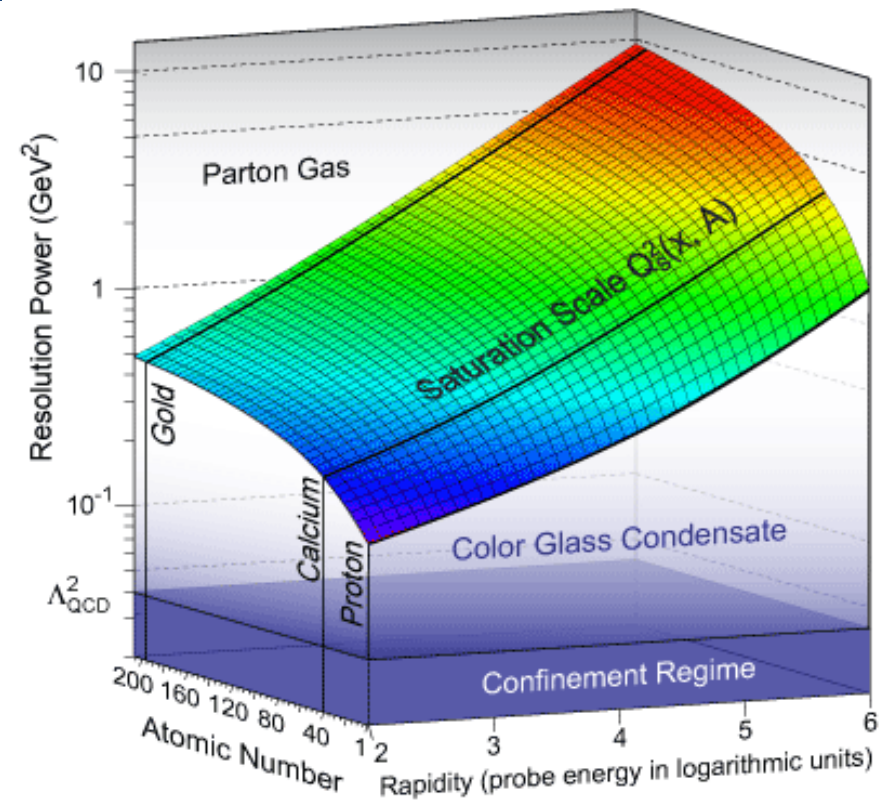
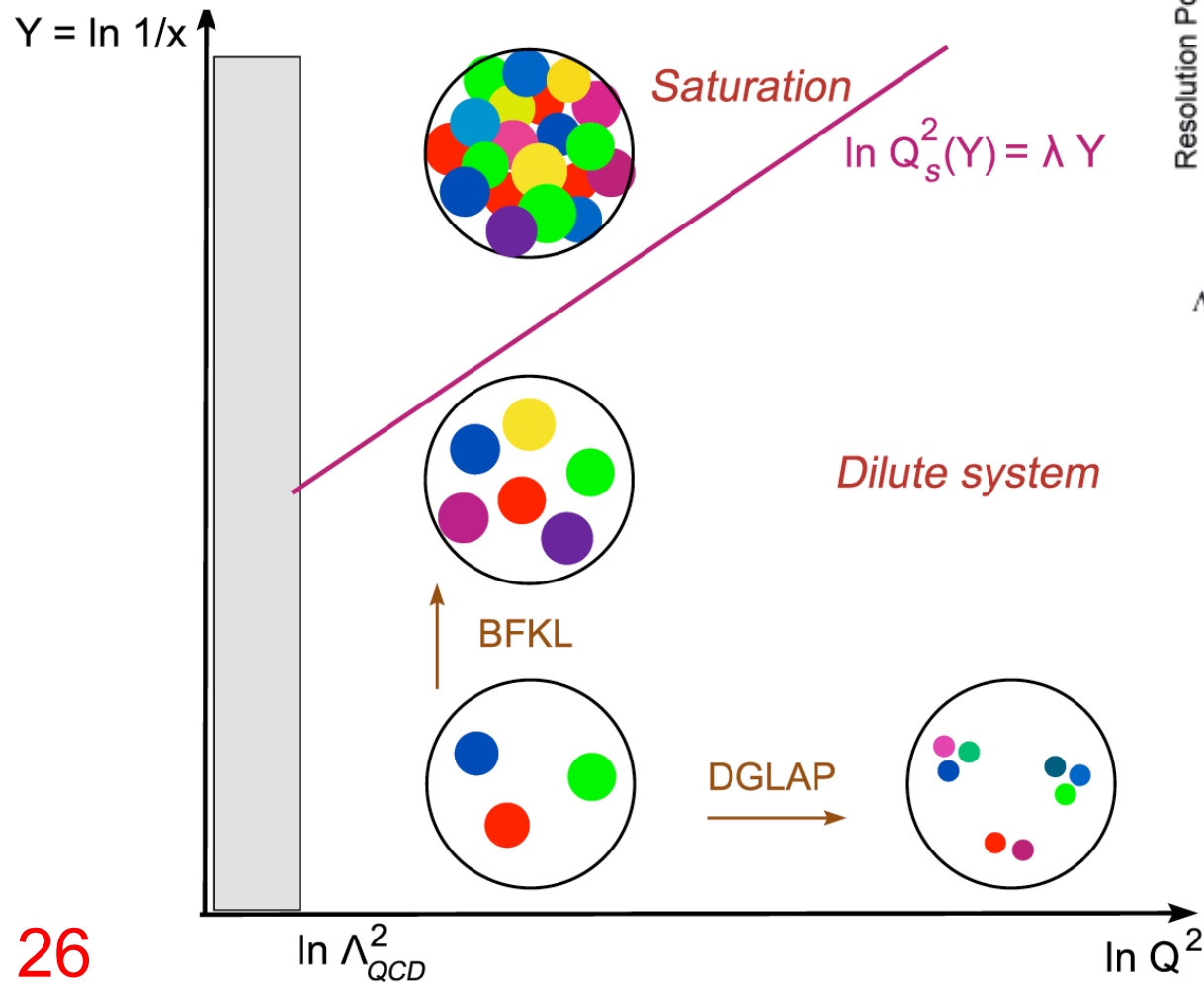


# Summary

- Photon-photon studies are competitive channels in searches for new physics at the LHC.
- A wide range of data is now probing the lead wavefunction and being used to constrain PDFs
- Moving forward, I hope theorists and experimentalist can collaborate to measure the power spectrum of fluctuations in the nucleus.

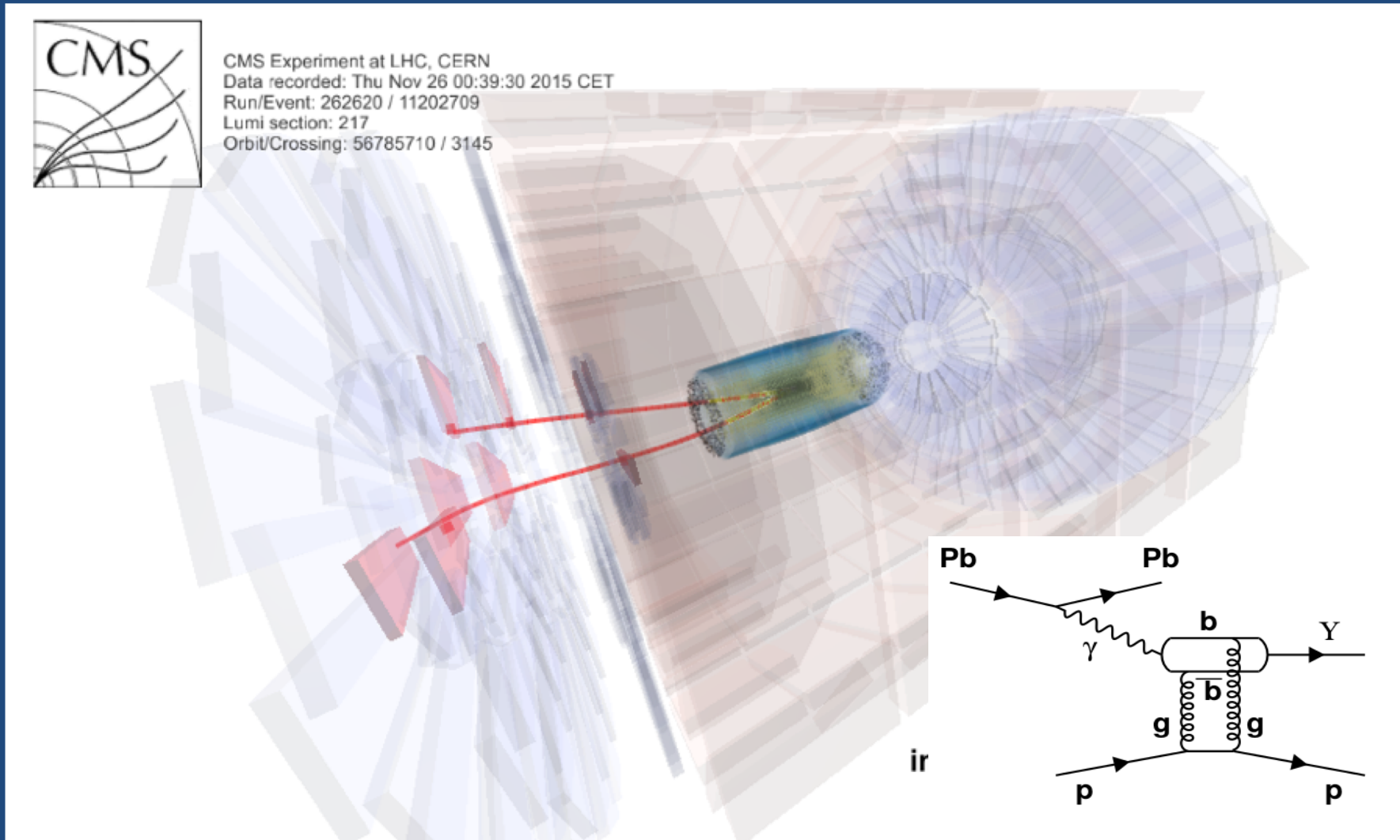
# Backup

# Searches for gluon saturation



# Cold Matter Studies

## Exclusive photo-production of quarkonia



# Exclusive photoproduction of rho

