Initial-state in heavy-ion collisions at colliders: Experimental summary

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Hard Probes 2018

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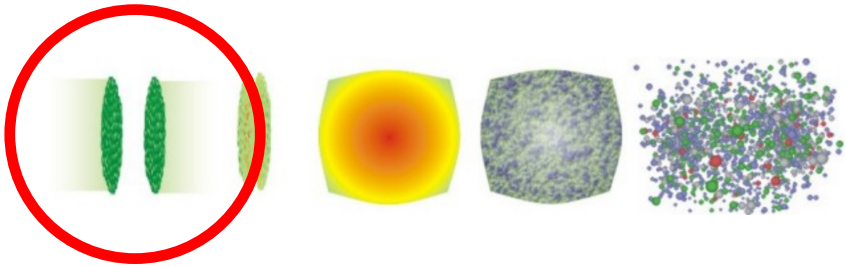
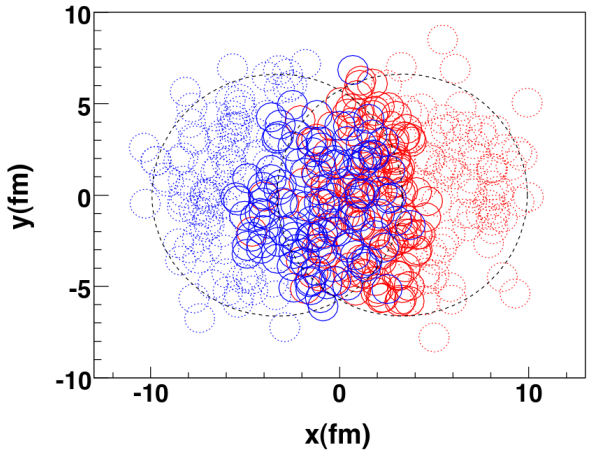
Initial state



Characterising the initial state of heavy-ion collisions:

- Spatial distribution: geometry (Glauber...)



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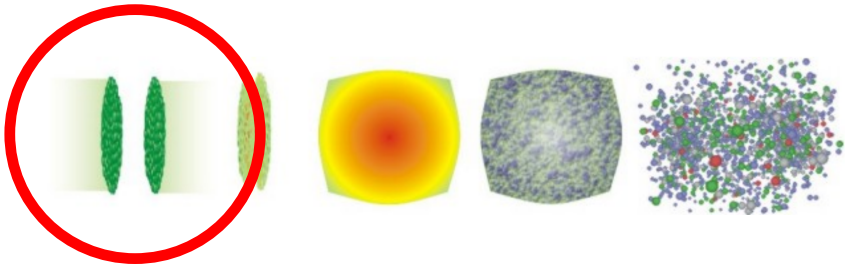
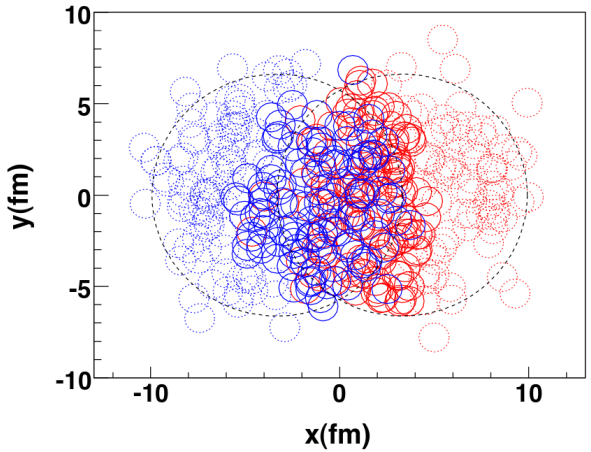
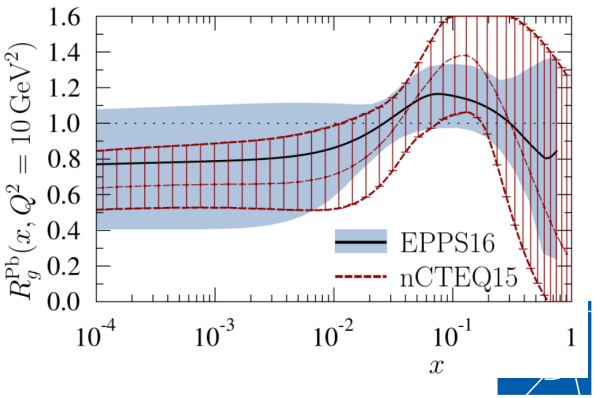


Characterising the initial state of heavy-ion collisions:

- Spatial distribution: geometry (Glauber...)
- Momentum distribution: nuclear parton distribution functions





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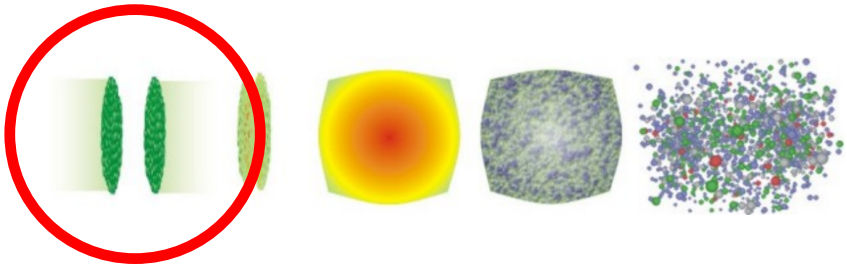

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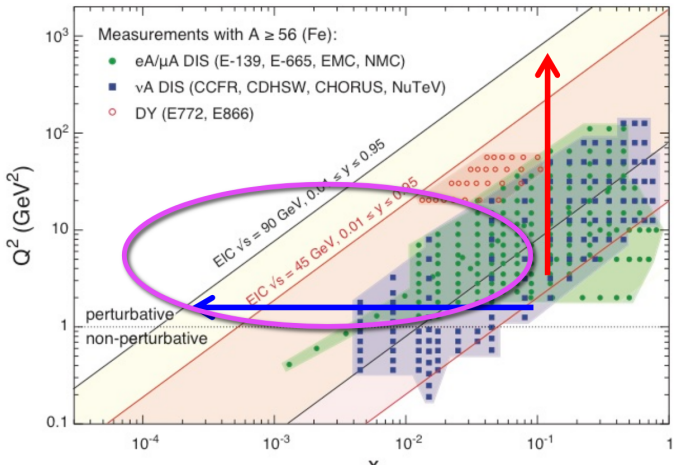
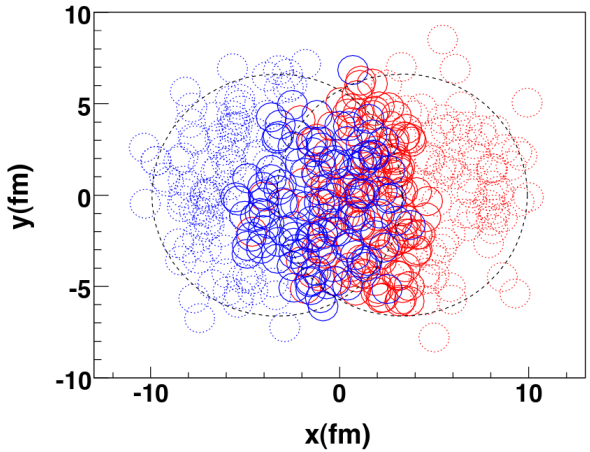
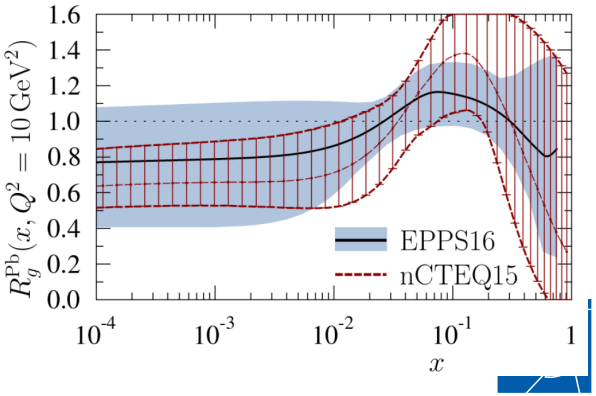
Future experimental input



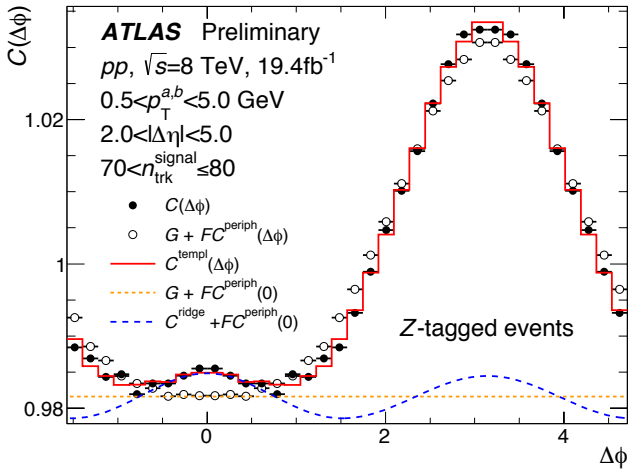


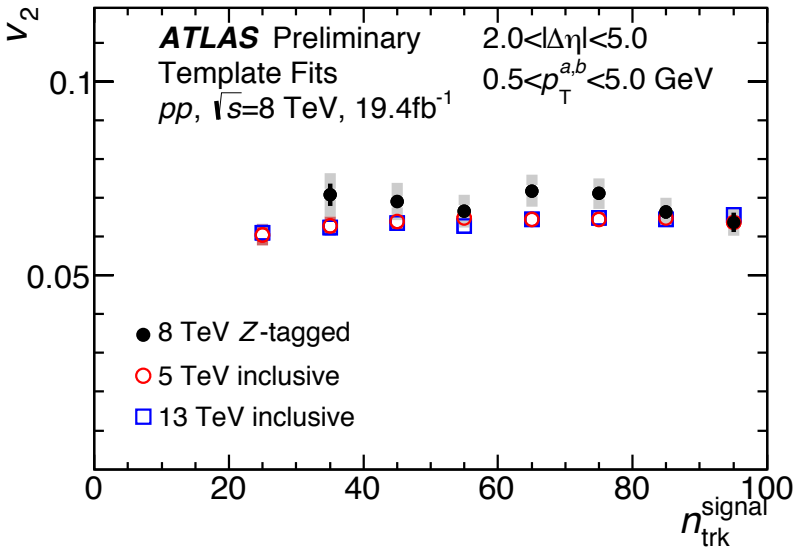


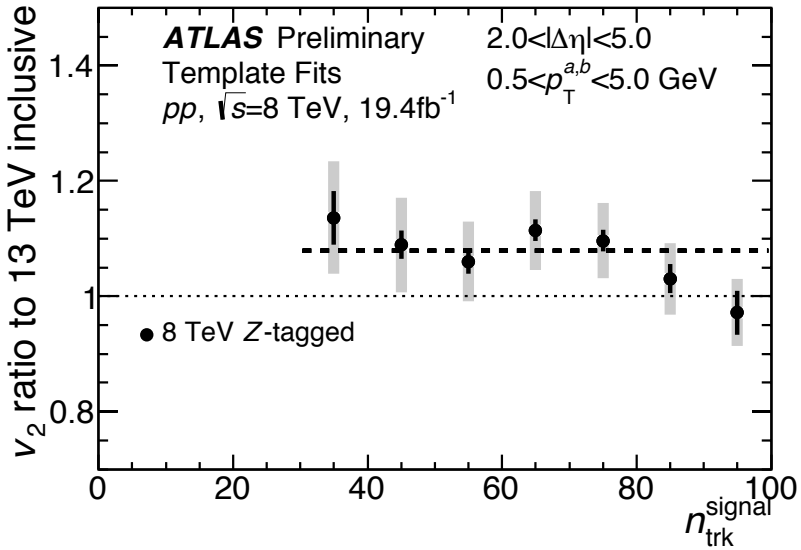
v_2 in Z-tagged events in pp

A. Trzupek (ATLAS)

- Select higher Q^2 (smaller b? different ϵ_2?) with Z bosons
- First measurement of 2-particle correlations in high-pileup samples (up to 20% PU correction)
- v_2 in Z-tagged events shows no dependence on multiplicity
- $8 \pm 6\%$ larger than inclusive 13 TeV pp (but different p_T spectrum)



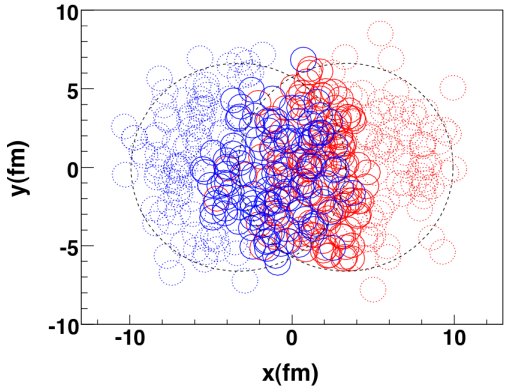


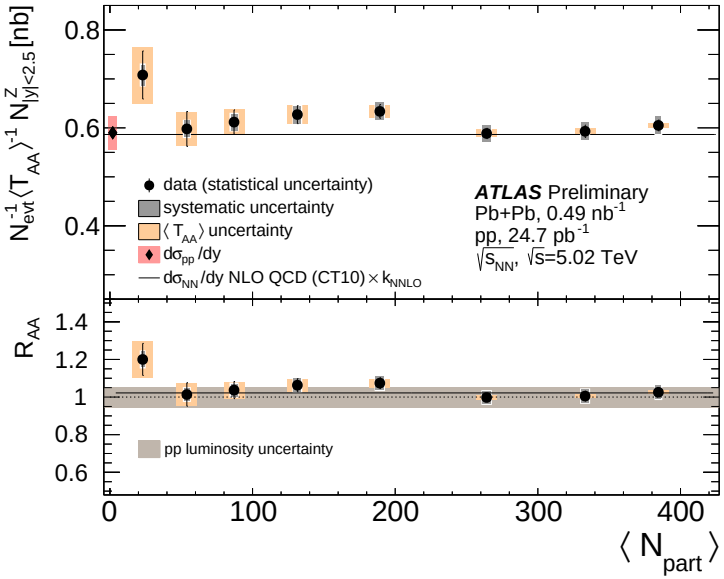


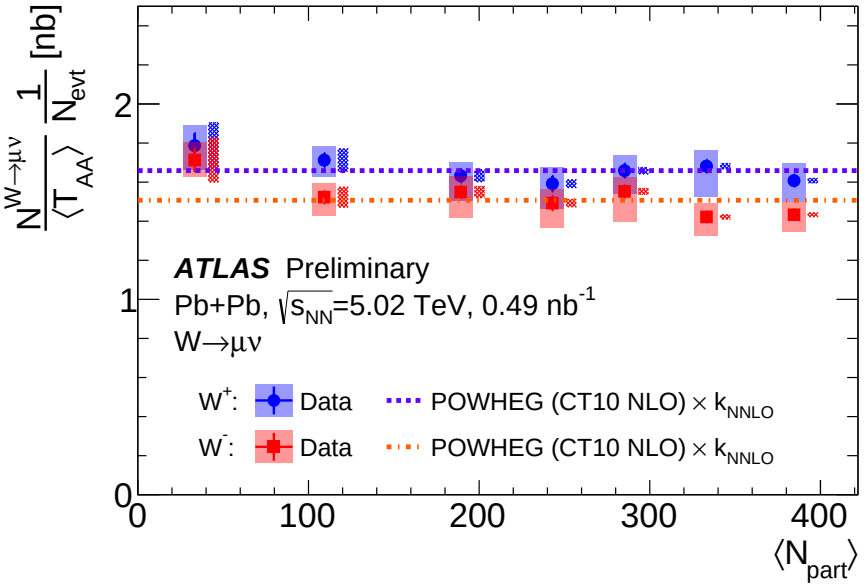
Collision geometry in PbPb: W and Z bosons

J. Kremer (ATLAS), A. Sarkar (ALICE)

- W and Z bosons not expected to be affected by the strongly interacting QGP
- Use them for testing the initial state geometry (Glauber model)
- Measurement uncertainties smaller than normalisation (T_{AA}) ones! Could define $Z_{AA} = \frac{N^X_{AA} \cdot \sigma^Z_{pp}}{N^X_{pp} \cdot \sigma^Z_{AA}}$?
- Similar hint of excess in peripheral collisions for both W and Z







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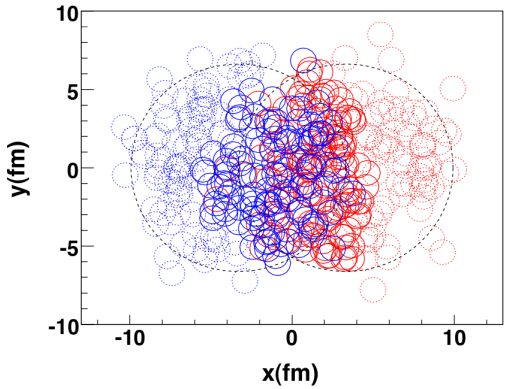
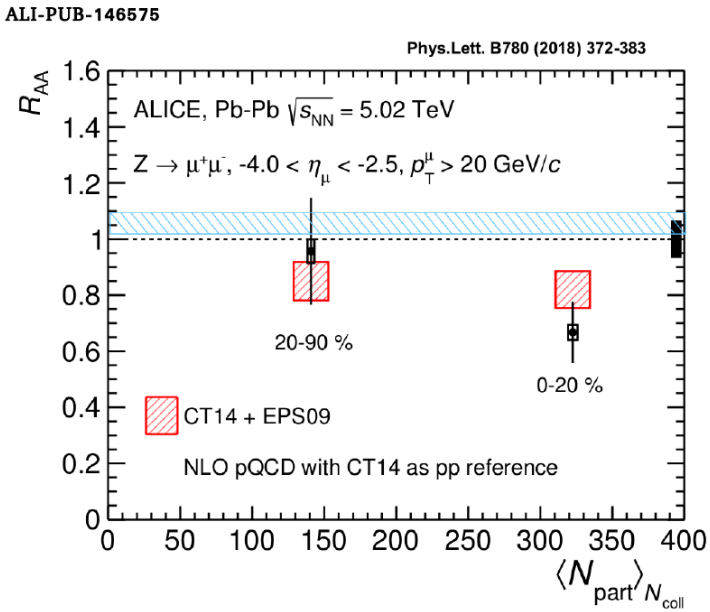
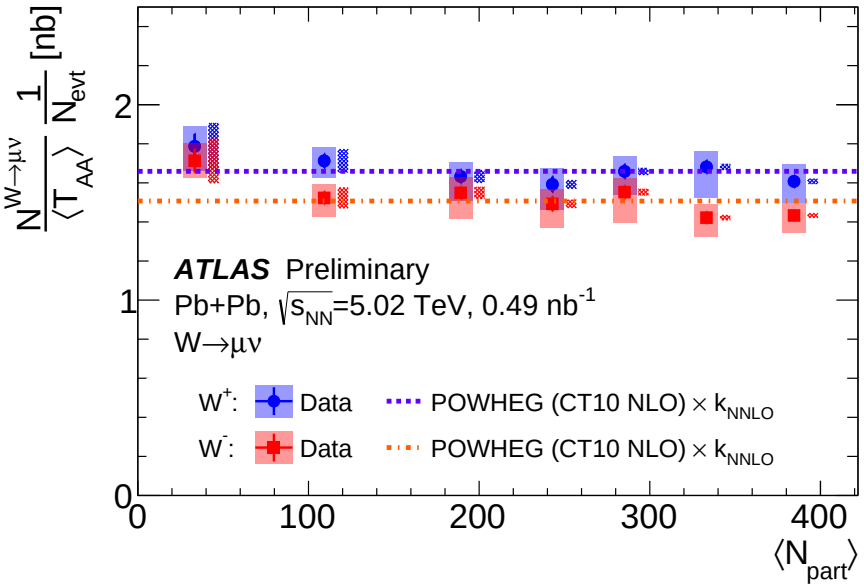


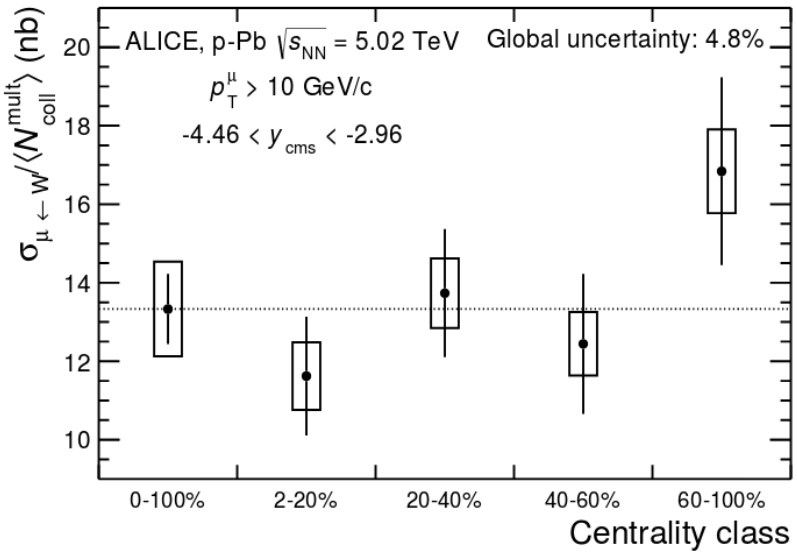


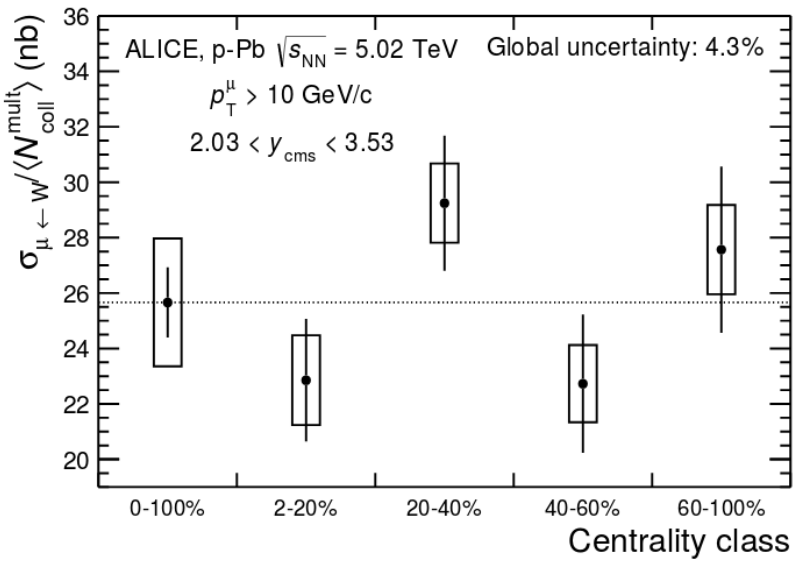


Glauber in pPb

A. Sarkar (ALICE)

- Can also use W bosons to test Glauber in pPb
- Centrality and $\langle N_{\mathrm{coll}} \rangle$ estimated using neutron zero degree calorimeters + Glauber model with an "hybrid method"
- W boson production consistent with geometric expectation

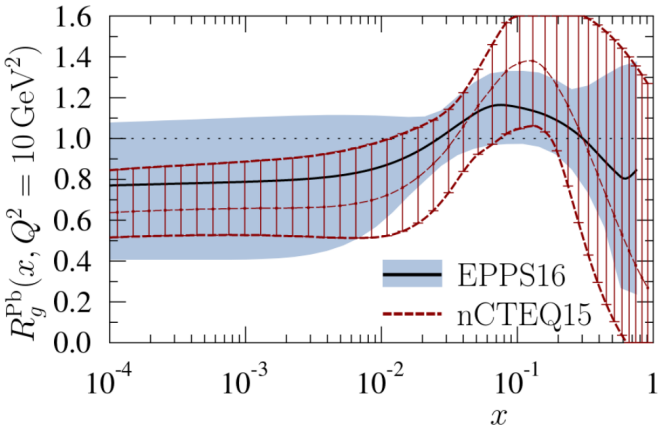


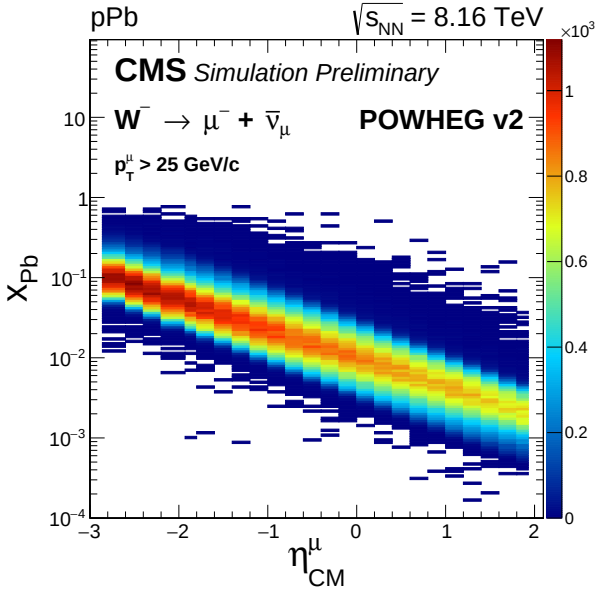


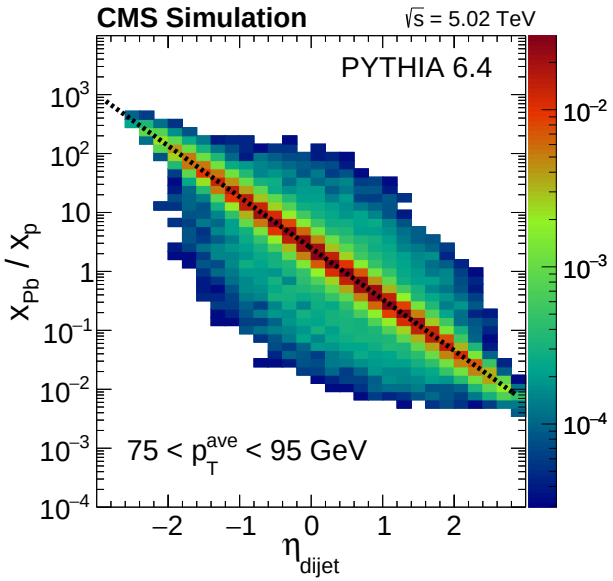
Nuclear PDF

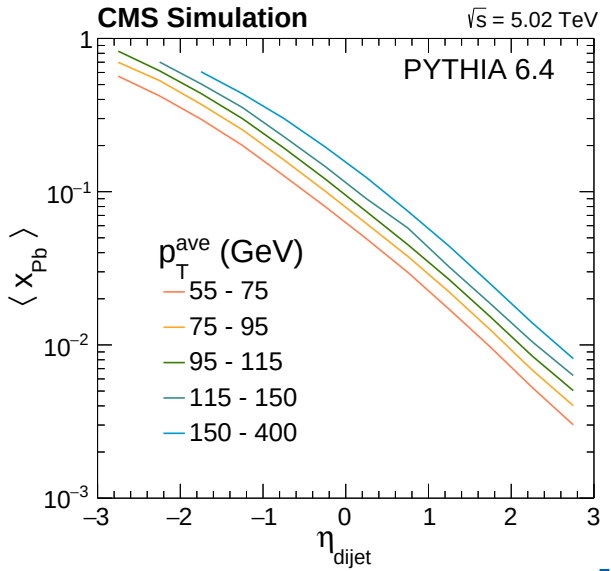
Partonic content in the initial state

- Needed for $\sim$ any cross section or R_{AB} prediction
- In pPb: correlation between measured kinematics and probed x_{Pb}
- PbPb can add some information





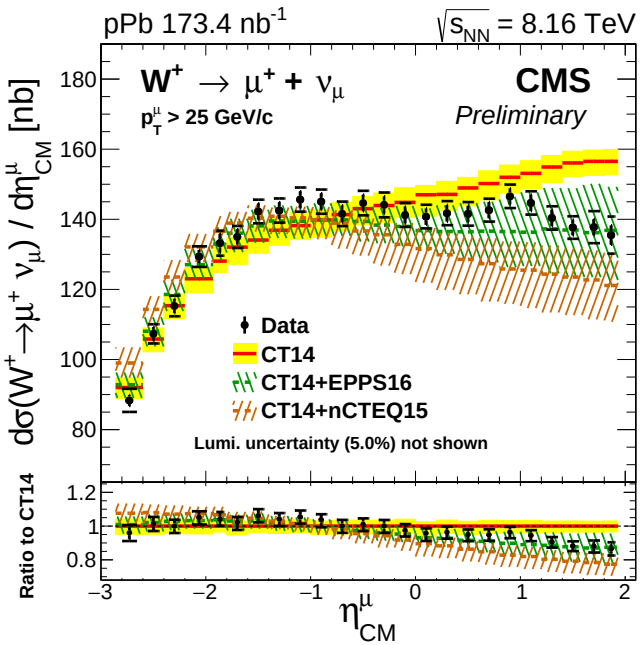


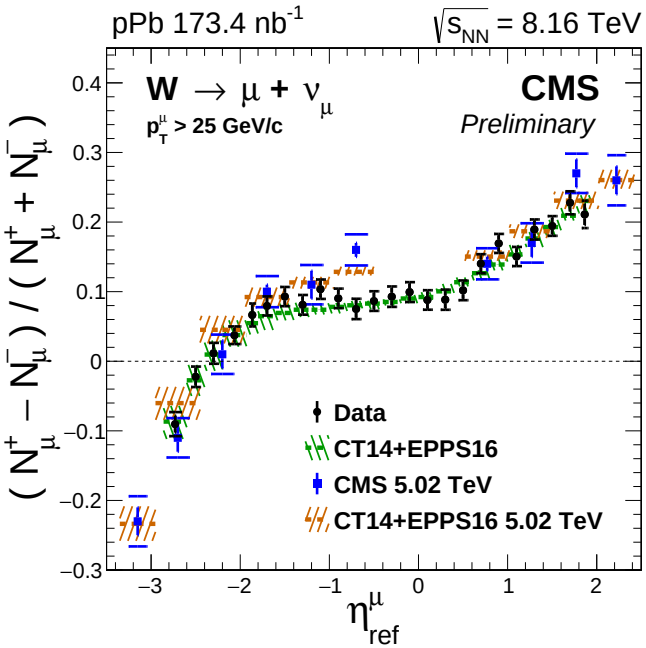


W and Z bosons in pPb

H. Kim (CMS), A. Sarkar (ALICE)

- CMS W bosons (8.16 TeV):
  - Experimental uncertainties smaller than nPDF ones
  - Inconsistent with free proton PDF, better agreement with EPPS16 than nCTEQ15 (amount of shadowing)
  - Consistency with 5.02 TeV data checked





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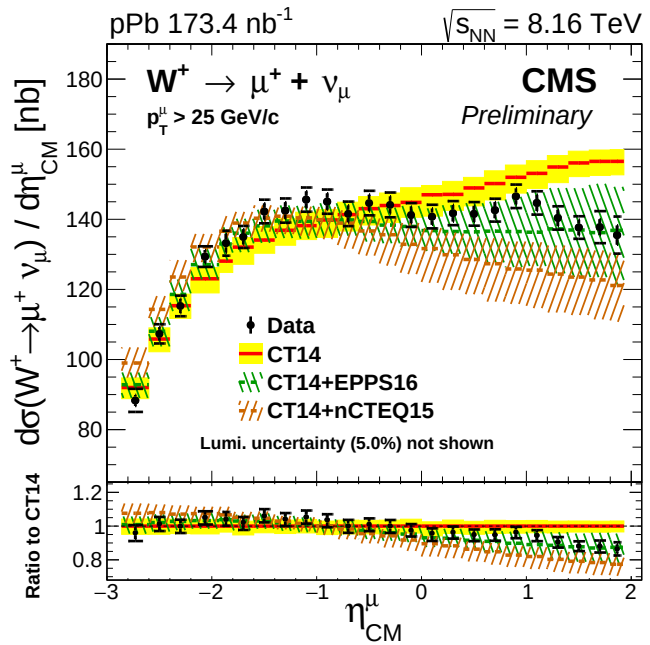
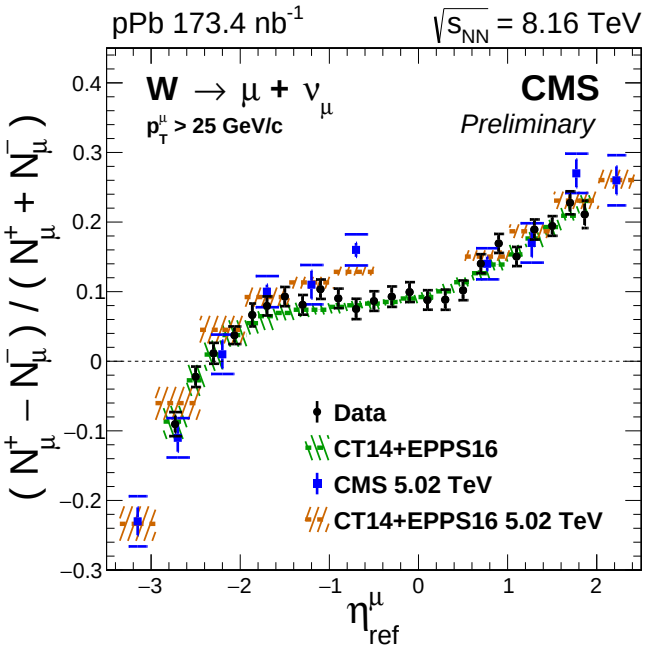
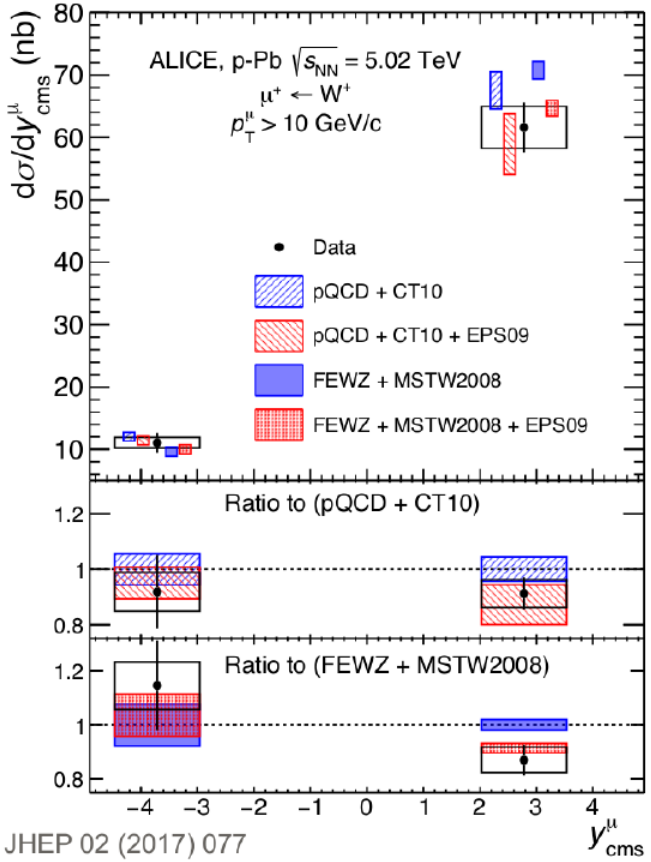
  - Consistency with 5.02 TeV data checked
- ALICE W and Z bosons (5.02 TeV):
  - Inconclusive given current uncertainties



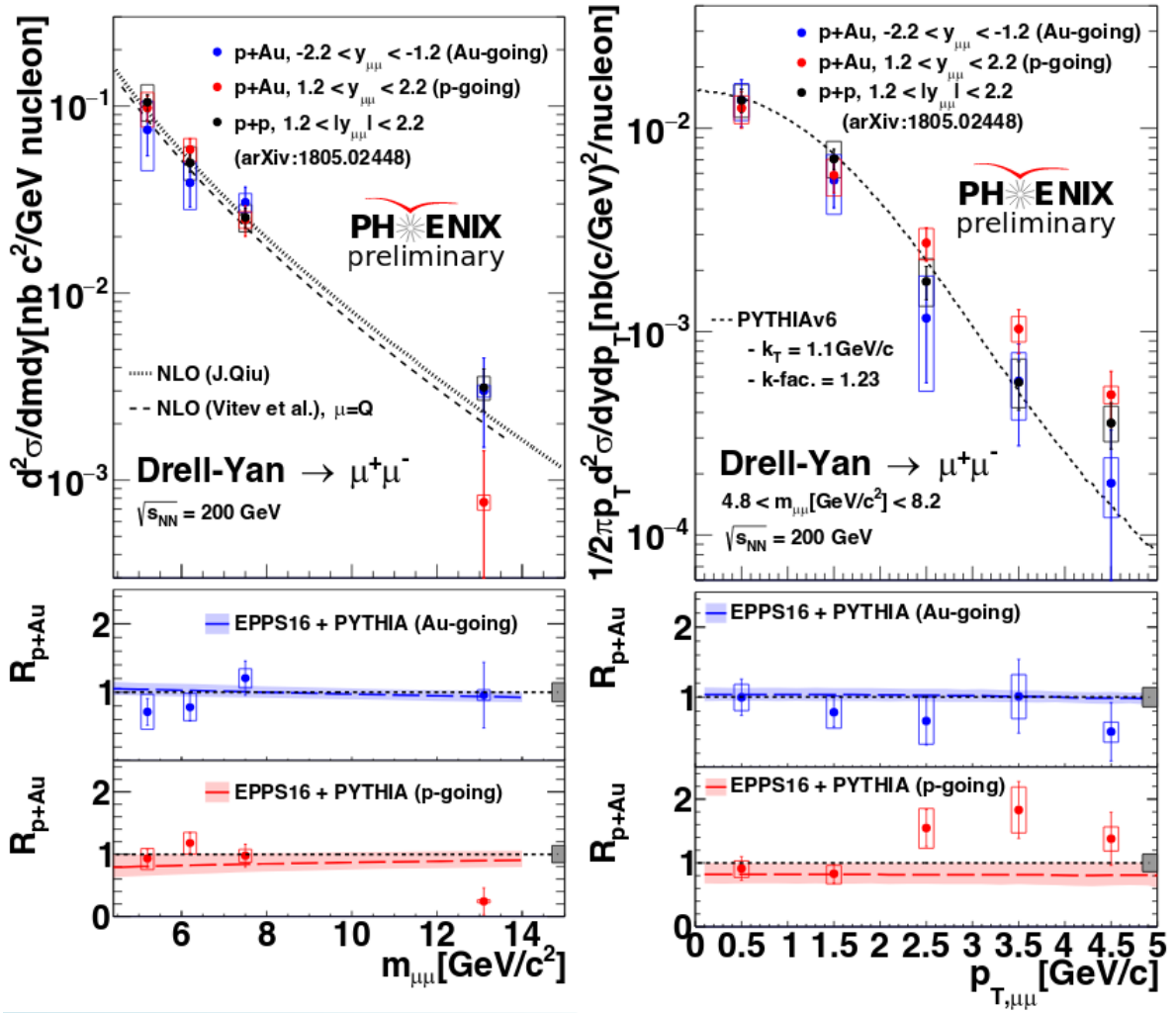




Drell-Yan in pAu

Y.H. Leung (PHENIX)

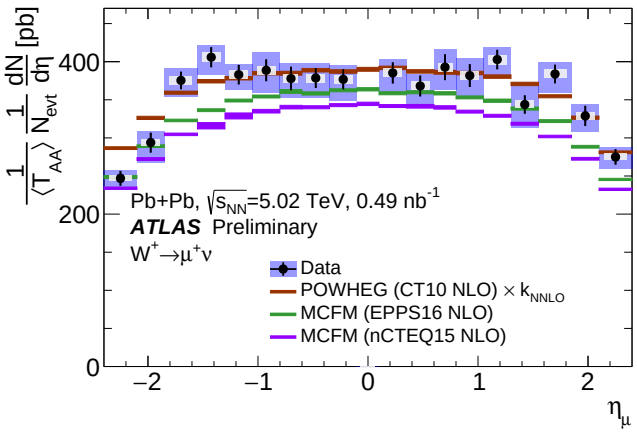
- R_{pAu} consistent with unity and EPPS16
- Inconclusive due to large uncertainties in the data

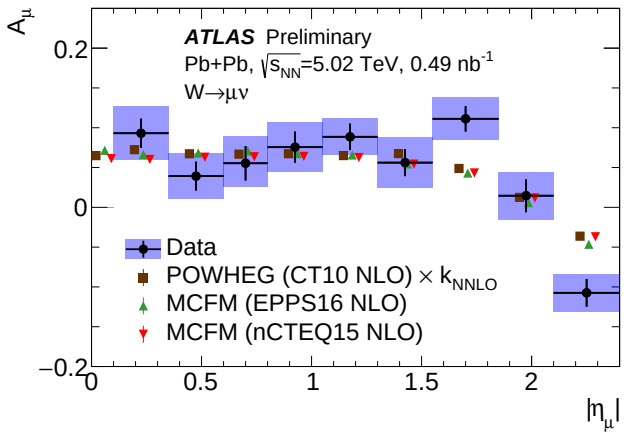


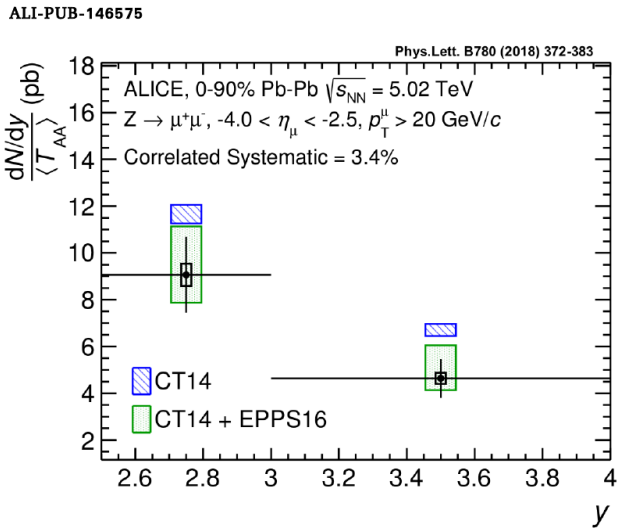
W and Z bosons in PbPb

J. Kremer (ATLAS), A. Sarkar (ALICE)

- ATLAS W bosons: inconclusive (note also: NLO vs NNLO)
- ALICE Z bosons: hint of nuclear effects



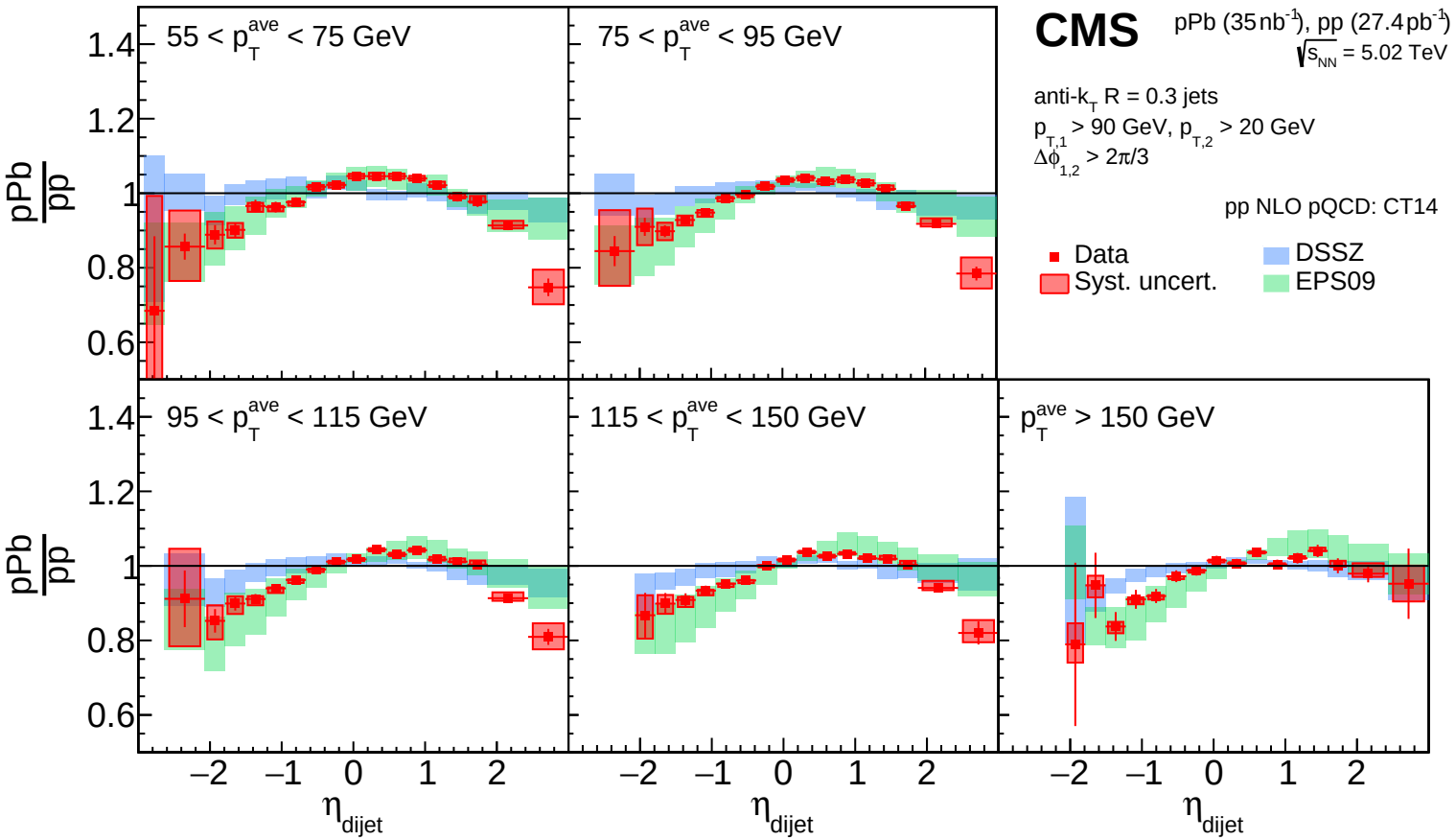




Dijets in pPb

Y. Go (CMS)

- Probing gluon nPDF over a wide range of x_{Pb}, from shadowing to anti-shadowing and EMC
- pPb data already included in EPPS16
- pPb/pp less sensitive to pp modelling

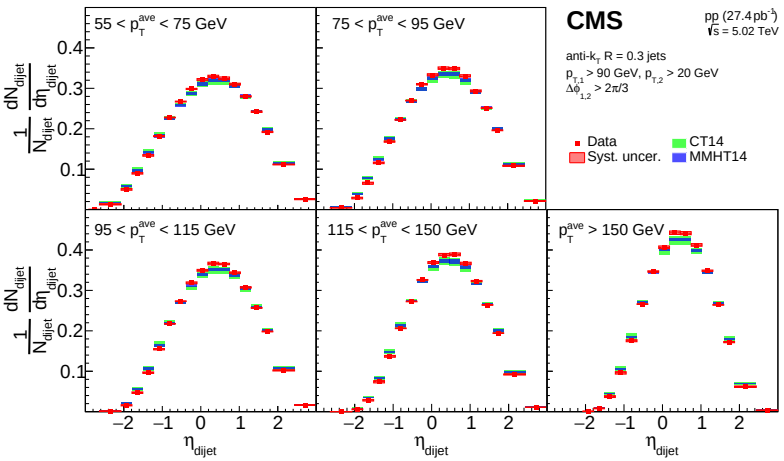


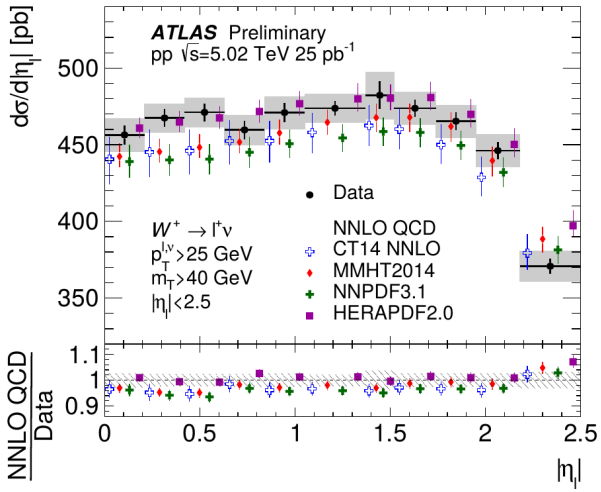
Interlude: free proton PDF

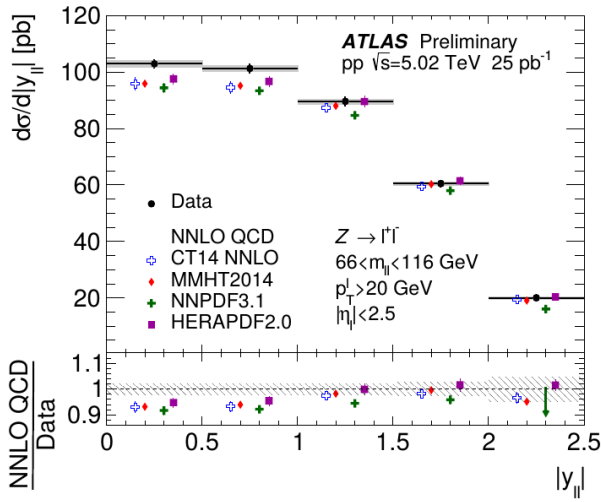
J. Kremer (ATLAS), Y. Go (CMS)

Free protons are the reference! But are they that well known?

- Some tension between dijet data and NLO pQCD
- NNLO pQCD with recent PDFs fails to reproduce ATLAS W/Z data at 5.02 TeV
  - Note1: 1.9% luminosity uncertainty!







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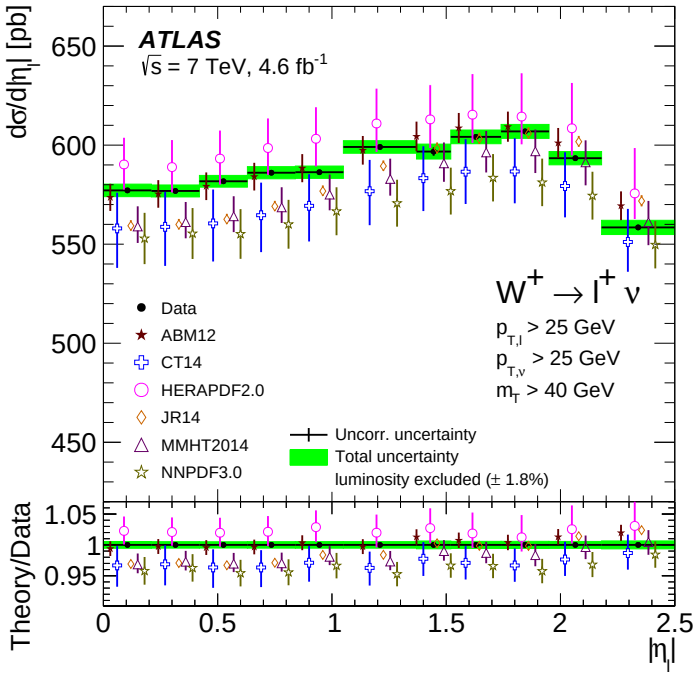
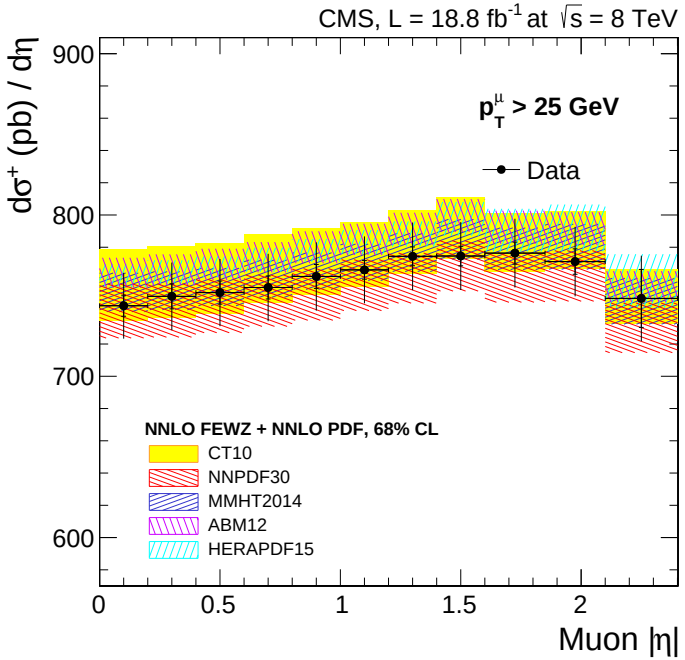
- NNLO pQCD with recent PDFs fails to reproduce ATLAS W/Z data at 5.02 TeV
  - Note1: 1.9% luminosity uncertainty!
  - Note2: consistent ATLAS 5.02 and 7 TeV... but not CMS 8 TeV? Puzzle

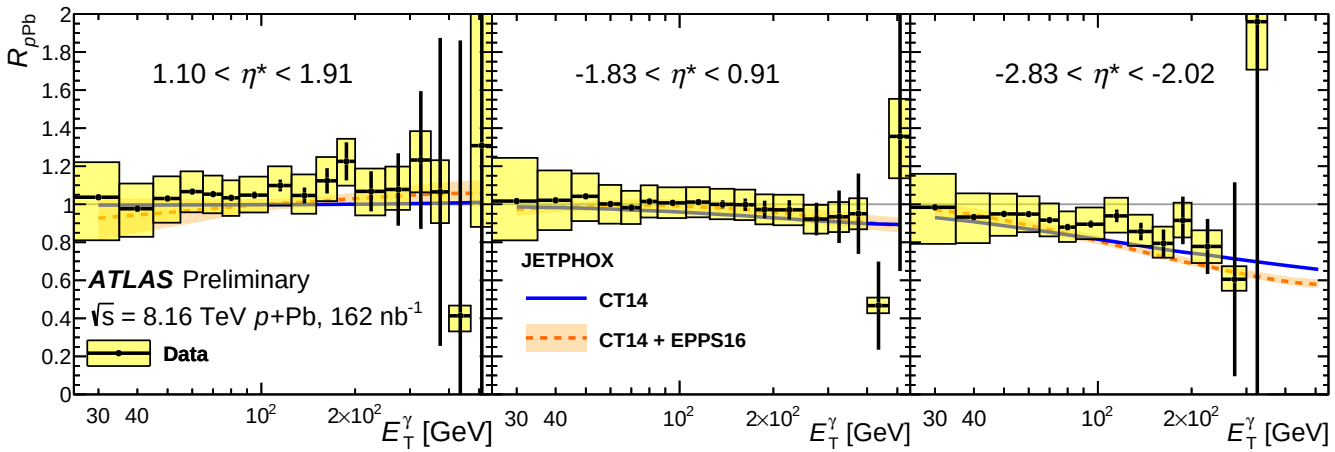


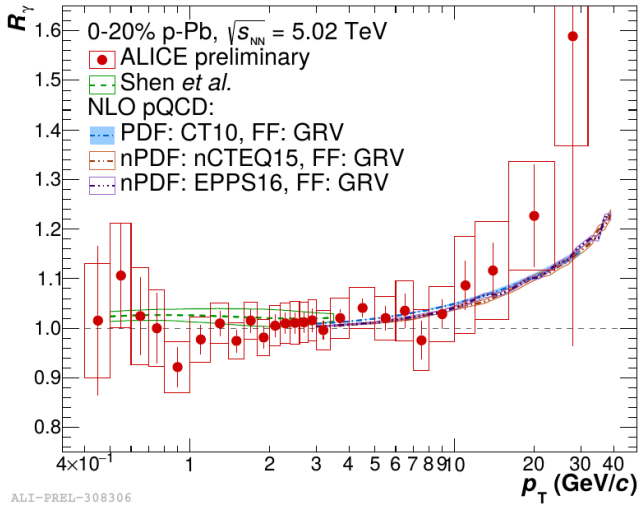


Photons in pPb

M. Spousta (ATLAS), N. Schmidt (ALICE)

- Photons also expected to be sensitive to initial state (isospin + nPDF)
- No nPDF constraints within current precision
- Also differential in multiplicity in ALICE



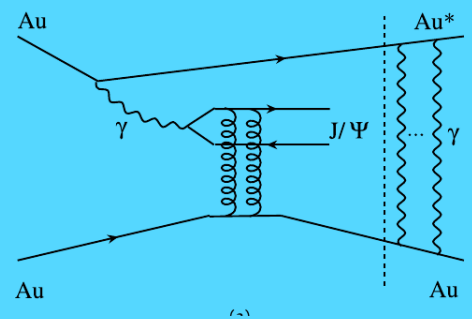


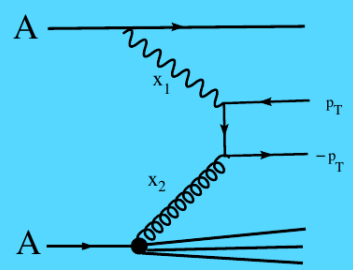
Ultra-peripheral collisions

Using the lead ions as a source of quasi-real photons

- Can be used as a probe of the projectile structure
- Sensitivity to nPDF

P. Steinberg





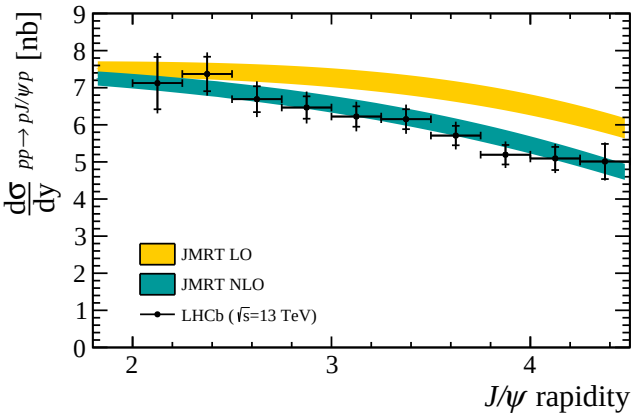
***Photon-pomeron**:*
production of vector mesons
(sensitivity to nPDF)

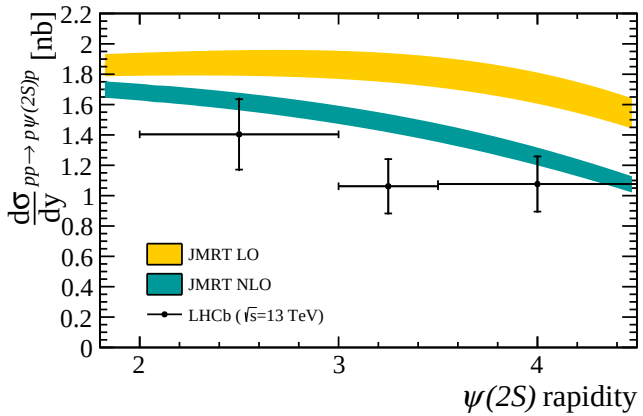
***Photo-nuclear**:*
jet photoproduction
(probe nPDF directly)

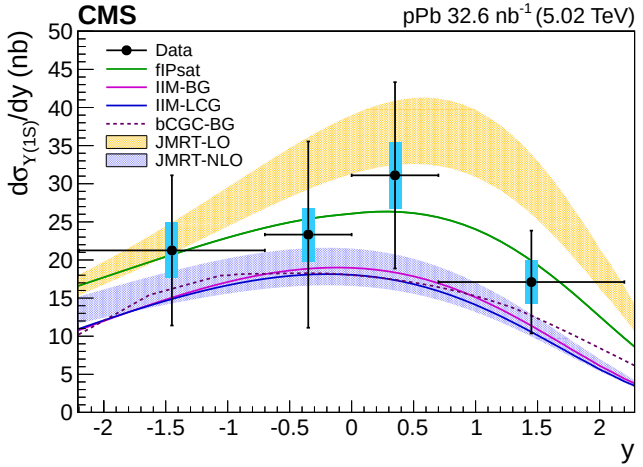
Quarkonia in γp collisions

S. Belin (LHCb), K. Naskar (CMS)

- Exclusive J/ψ and ψ(2S) in 13 TeV pp (LHCb)
- Exclusive Υ(1S) in 5.02 TeV pPb (CMS)
- Good agreement with models (NLO pQCD, gluon saturation)



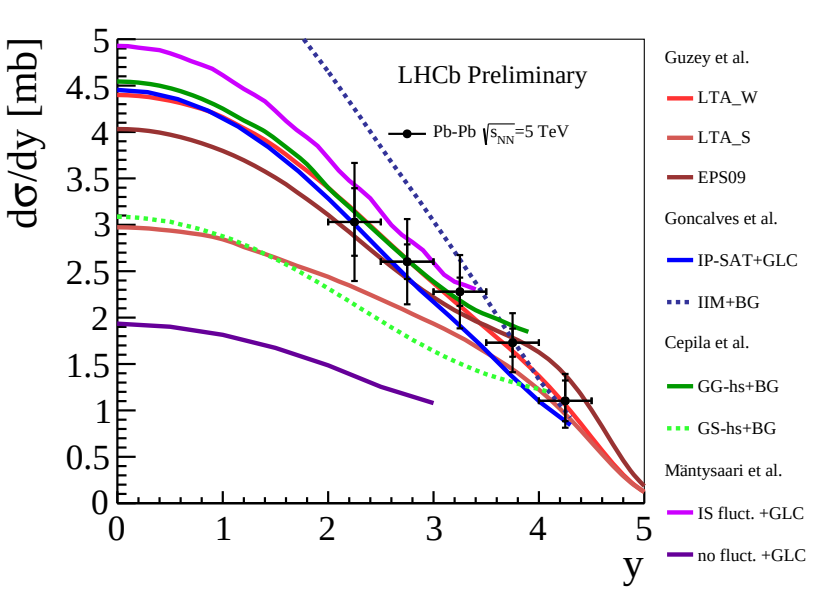


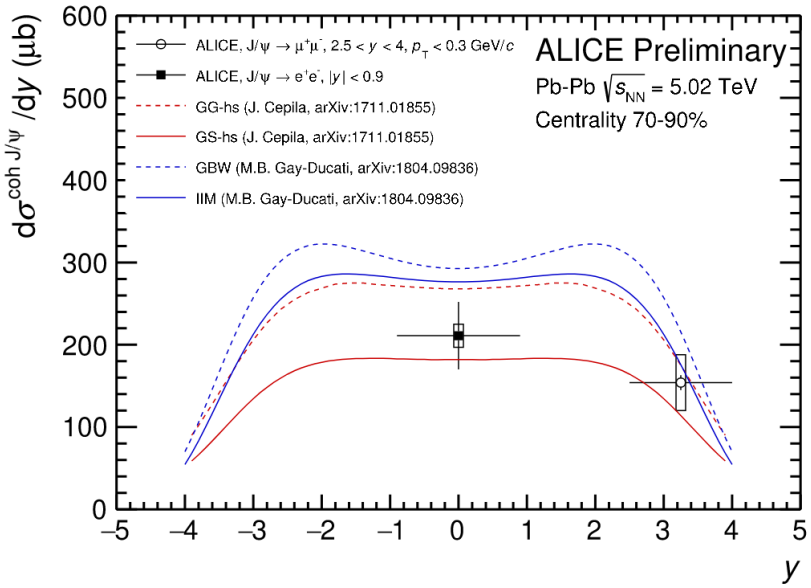


γPb collisions

S. Belin (LHCb), L. Massacrier (ALICE)

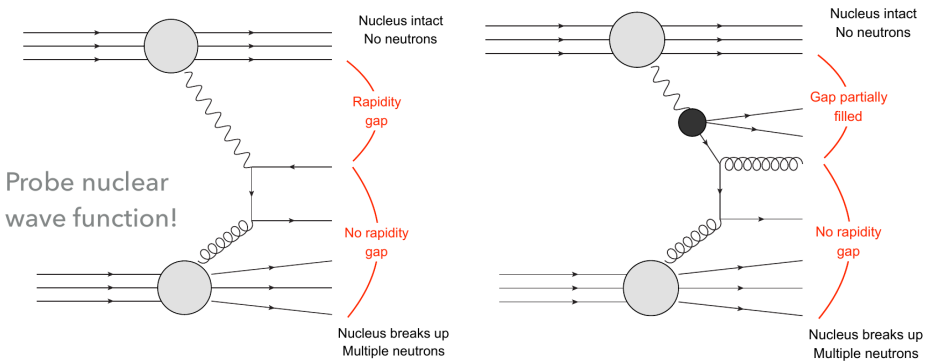
- LHCb: coherent J/ψ production
- ALICE: coherent J/ψ production with nuclear overlap (in two centrality bins)
- Models implement different initial state (gluon saturation...) and quarkonium production mechanisms



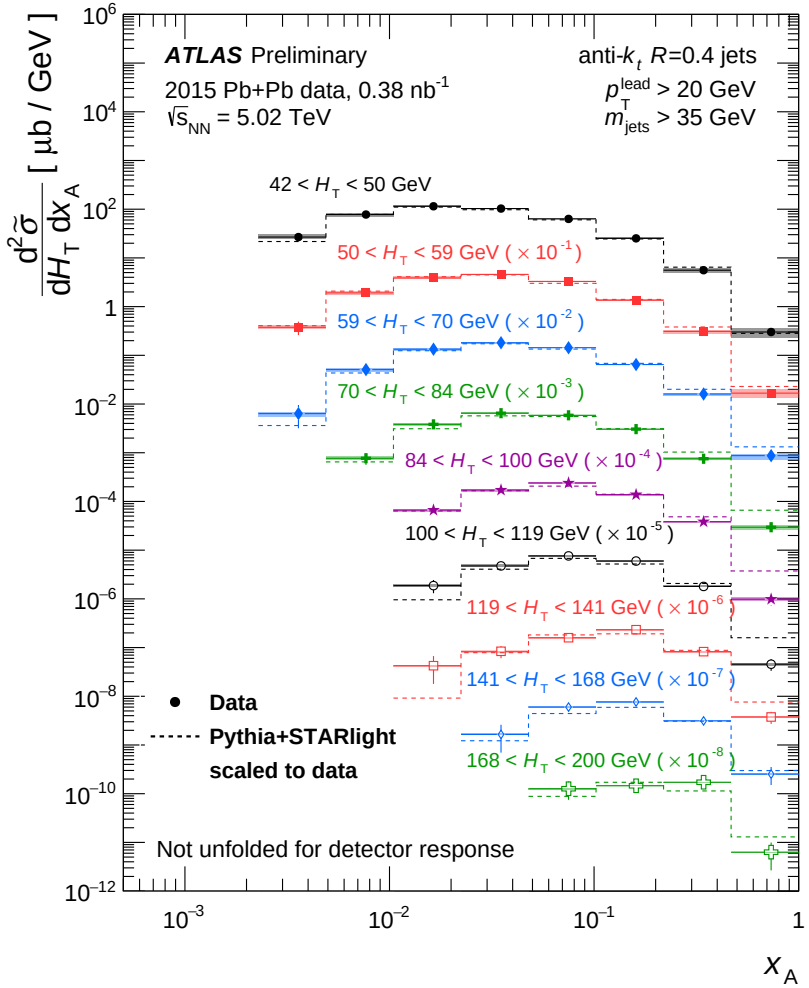


Photonuclear dijets

P. Steinberg (ATLAS)



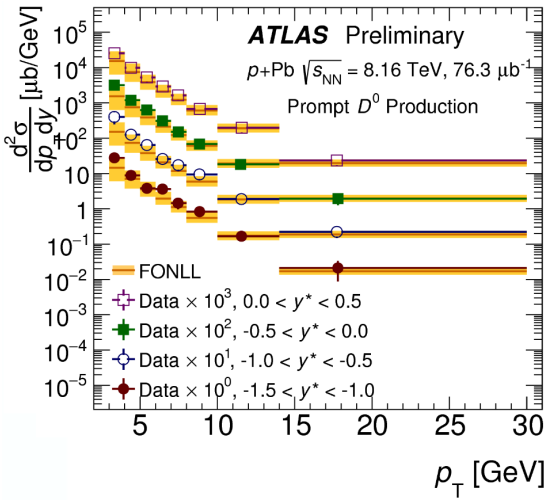
- Selecting γPb interactions using ZDC + rapidity gaps
- Comparison with PYTHIA (γ spectrum reweighted to STARLIGHT)
- Sensitivity to nPDF

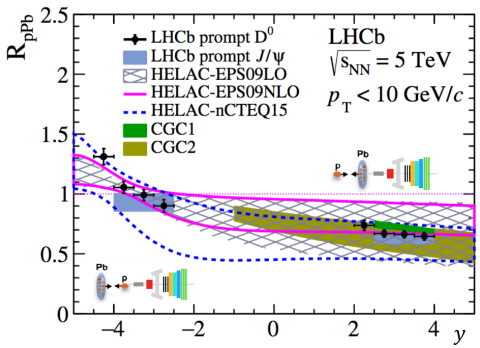


Open heavy flavour hadrons

C. Terrevoli (ALICE), Y. Zhang (LHCb), M. Dumancic (ATLAS)

- Many precise open heavy flavour measurements
  - D^0,

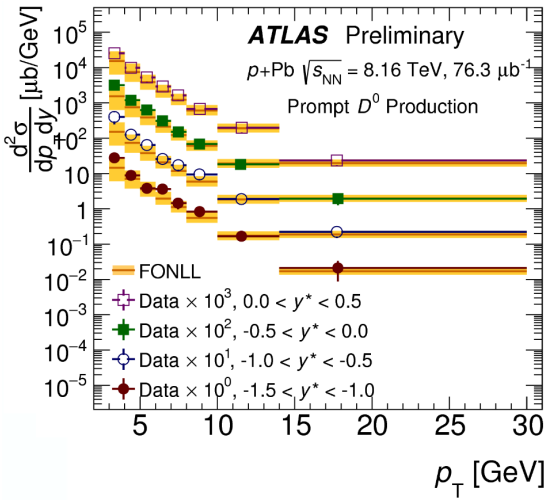


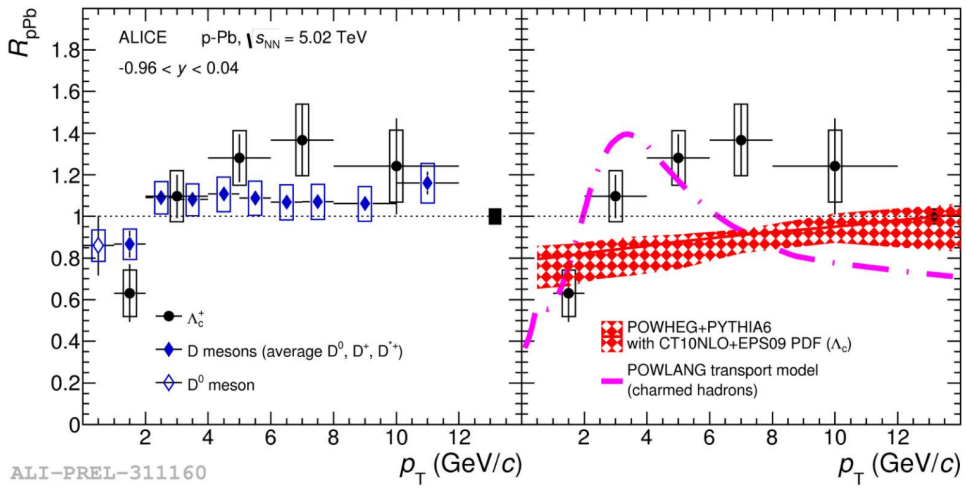


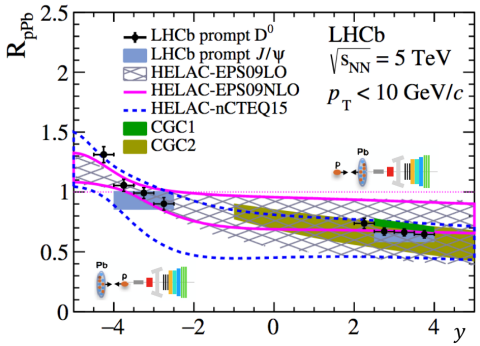
Open heavy flavour hadrons

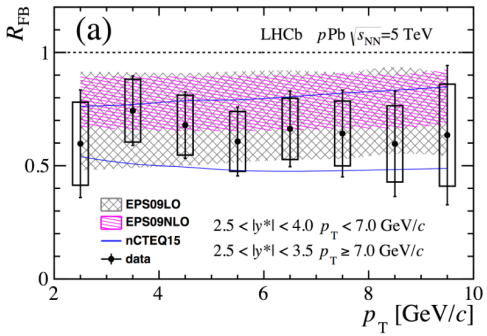
C. Terrevoli (ALICE), Y. Zhang (LHCb), M. Dumancic (ATLAS)

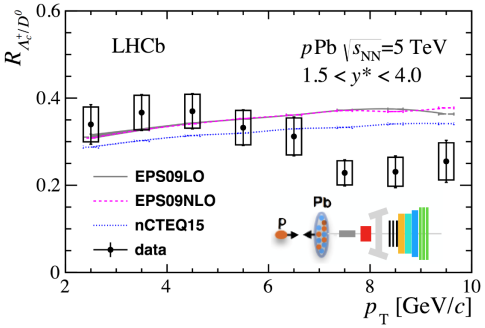
- Many precise open heavy flavour measurements
  - D^0, Λ_c^+,







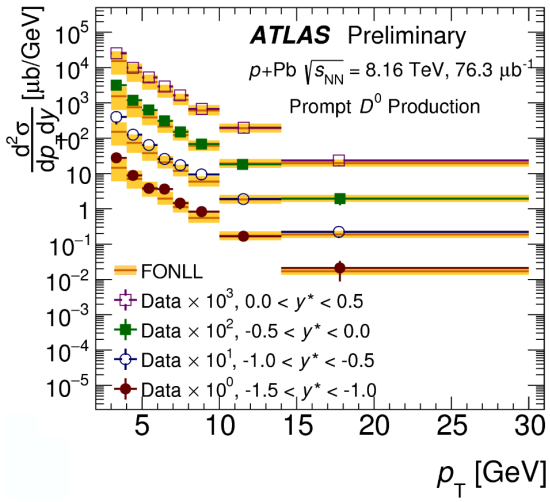


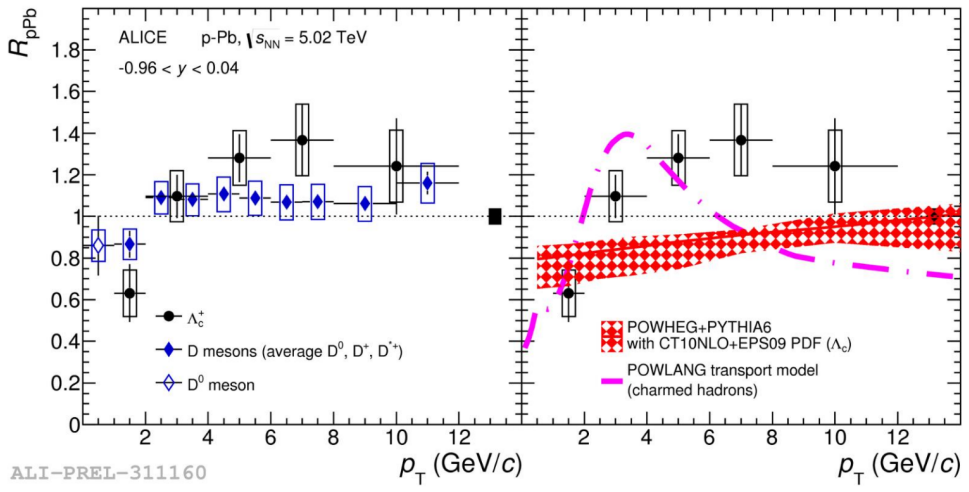


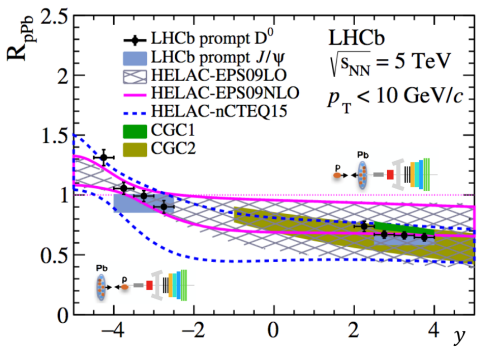
Open heavy flavour hadrons

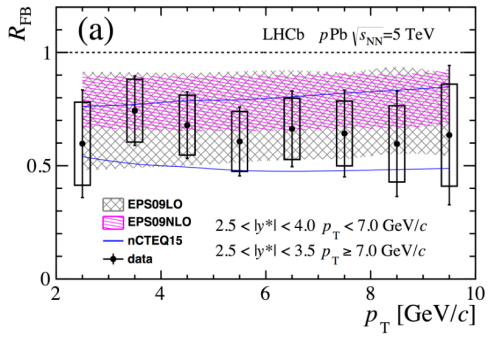
C. Terrevoli (ALICE), Y. Zhang (LHCb), M. Dumancic (ATLAS)

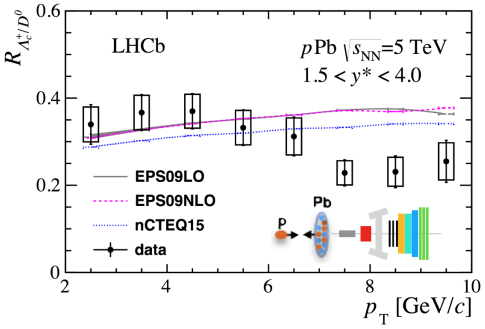
- Many precise open heavy flavour measurements
  - D^0, Λ_c^+, B^+, $J/\psi \leftarrow$ b...

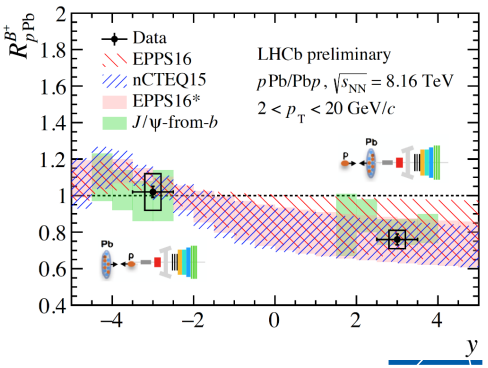








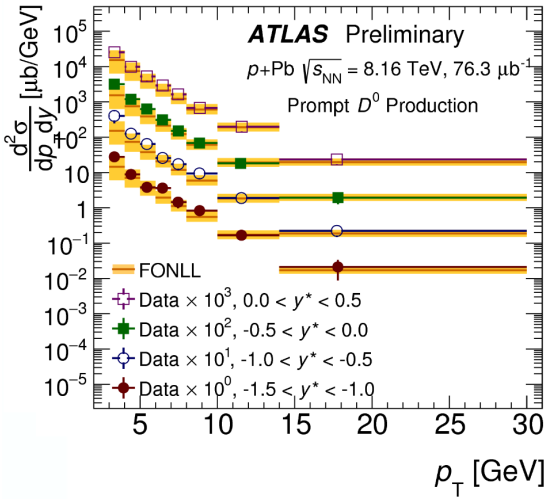


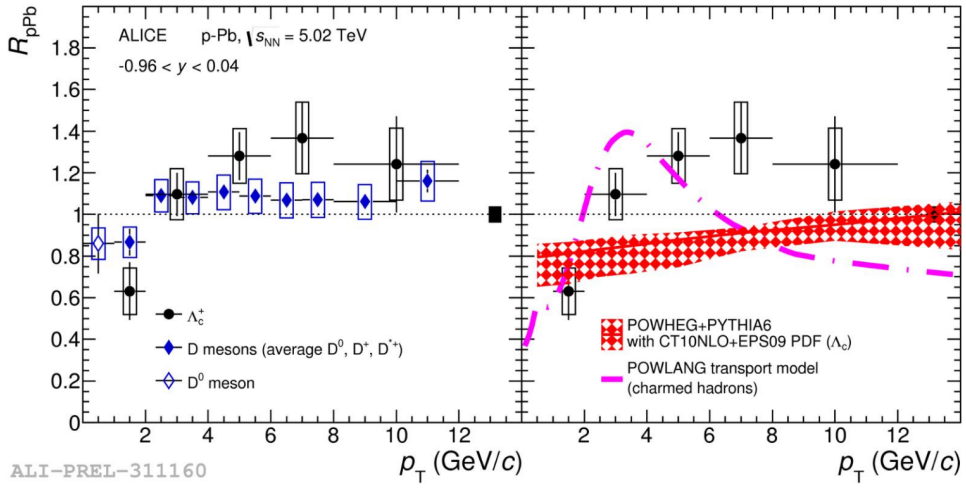


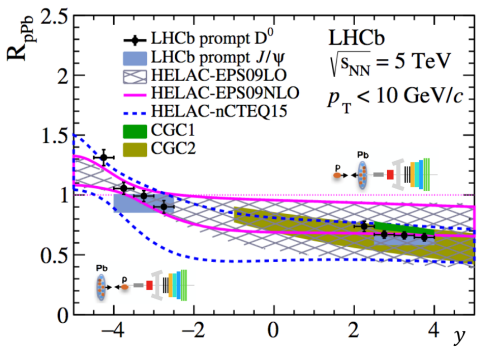
Open heavy flavour hadrons

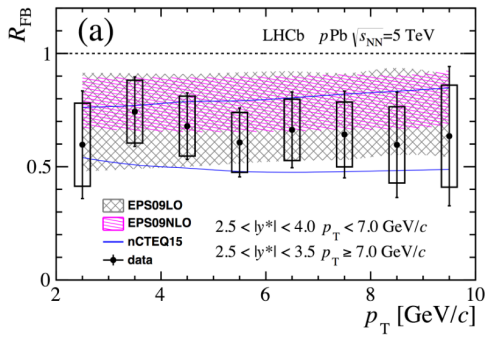
C. Terrevoli (ALICE), Y. Zhang (LHCb), M. Dumancic (ATLAS)

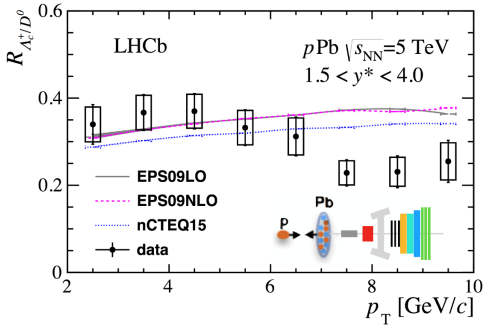
- Many precise open heavy flavour measurements
  - D^0, Λ_c^+, B^+, $J/\psi \leftarrow$ b...
- Being considered for constraining nPDF
  - Precise measurements, access to low x (down to $< 10^{-6}$)!
  - Some theoretical issues being discussed

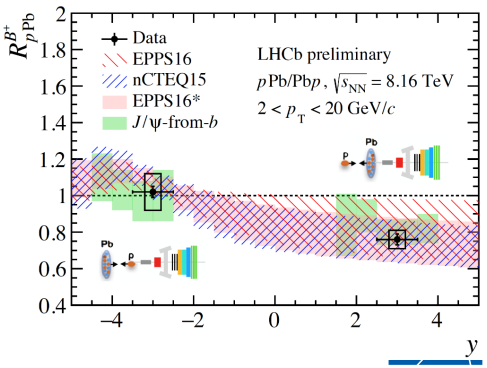










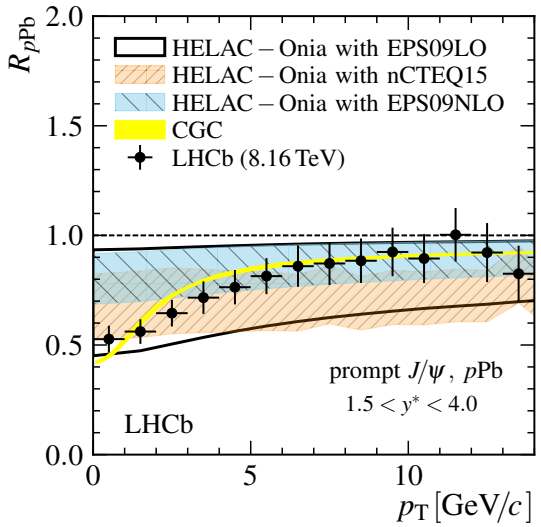


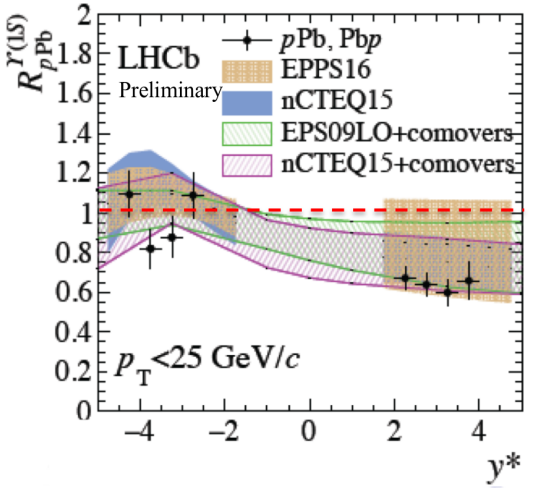
Quarkonia

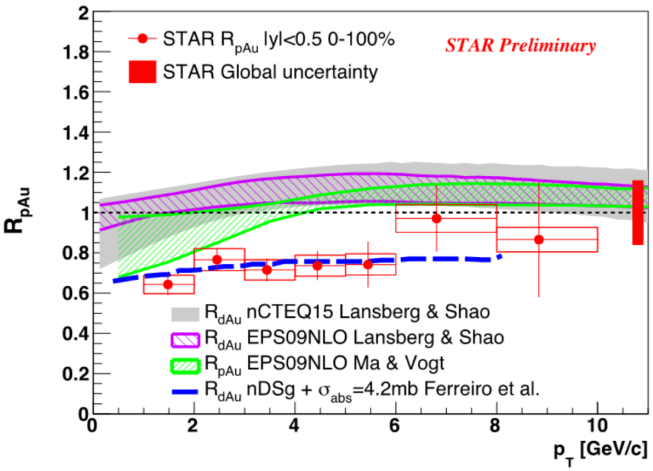
A. Lardeux (ALICE), G. Manca (LHCb), Z. Liu (STAR)

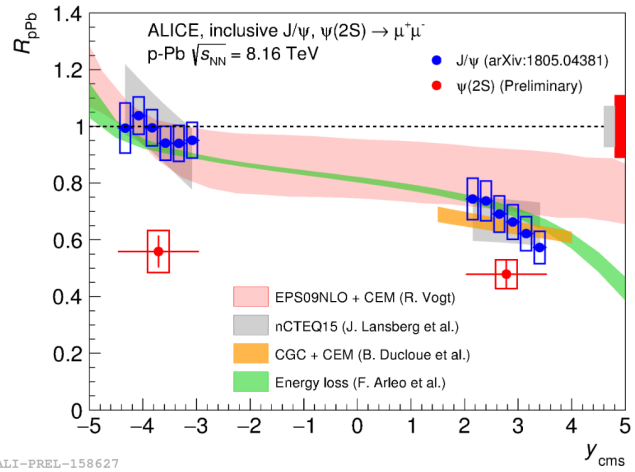
Also quarkonia:

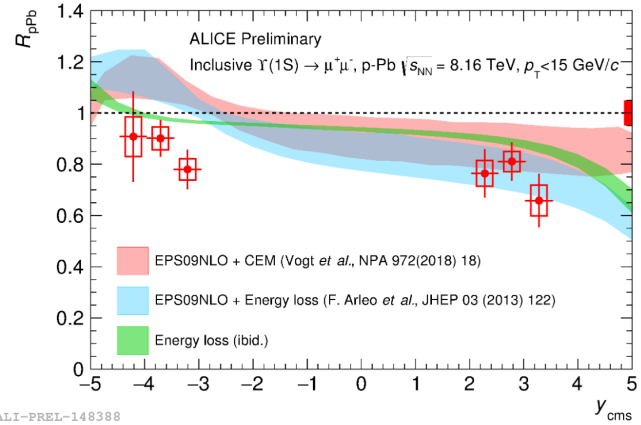
- Many precise quarkonium measurements
- Some theoretical complications







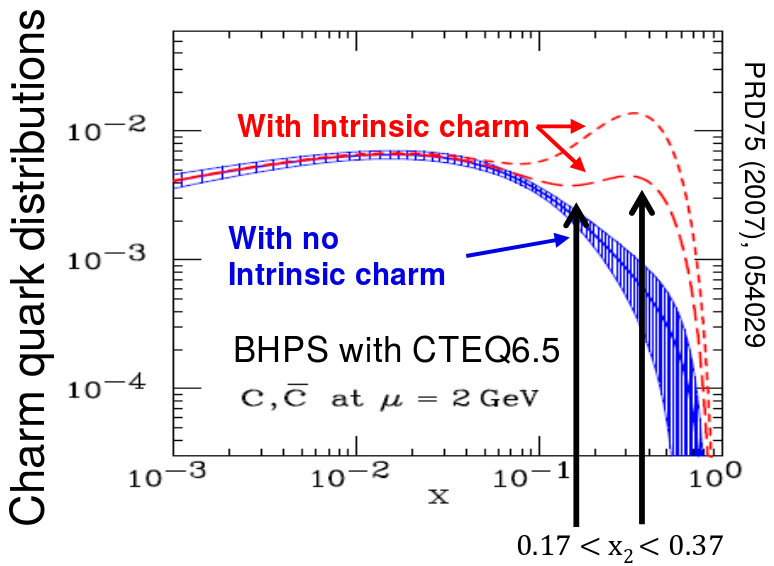


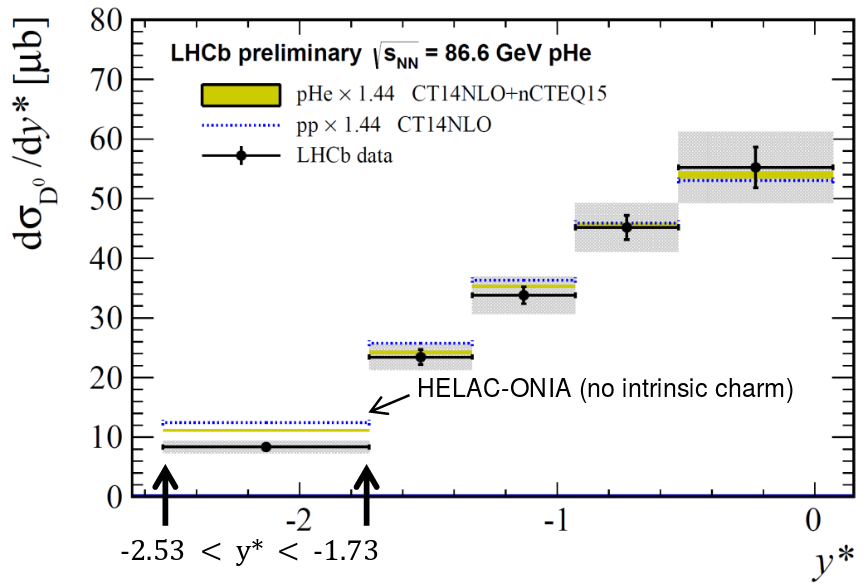


Large-x: intrinsic charm

F. Fleuret (LHCb)

- Probing large x with LHCb in fixed-target mode (SMOG)
- No evidence for substantial valence-like intrinsic charm contribution

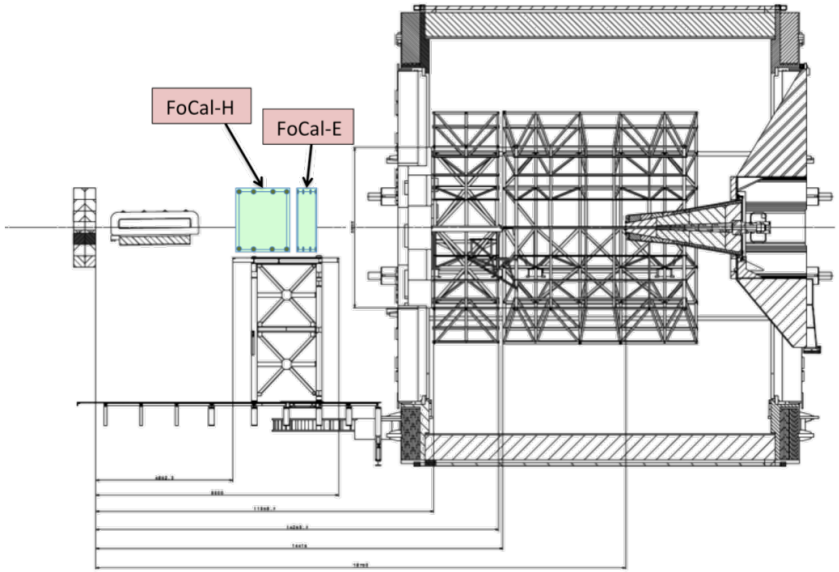




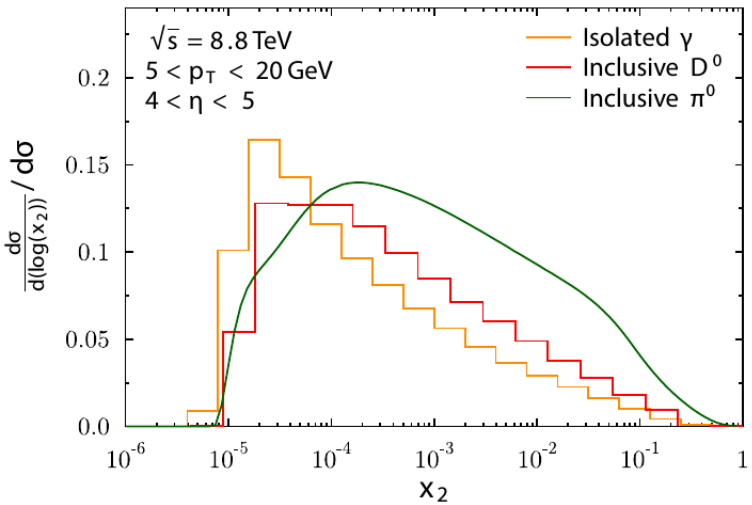
Forward photons in ALICE

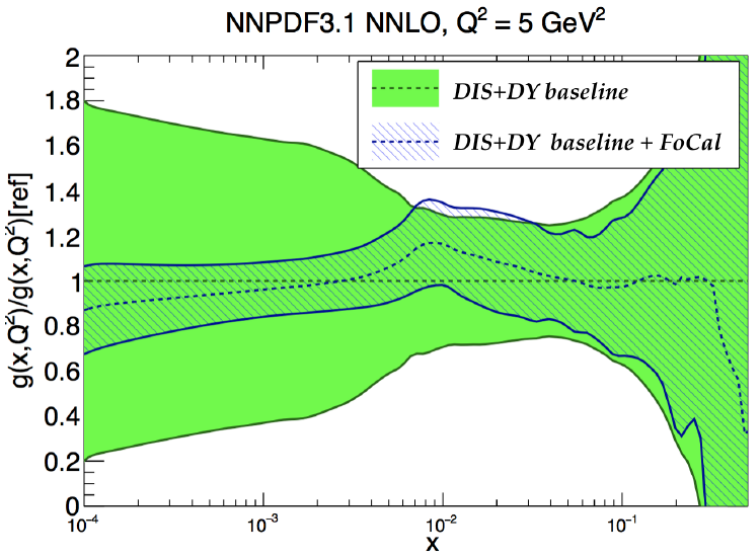
T. Peitzmann (ALICE)

- FoCal: new forward calorimeters for installation in 2024-2025
- Probing low x nPDF using photons
- Complementary to forward heavy flavour measurements



- x-distributions from NLO pQCD



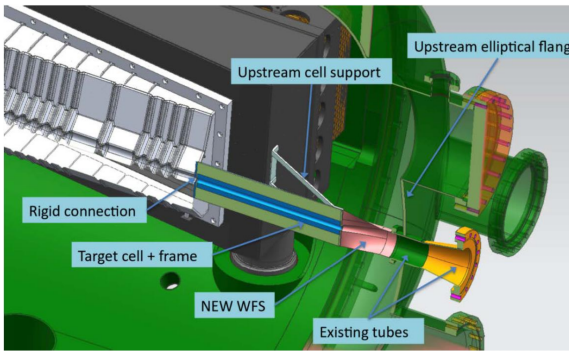


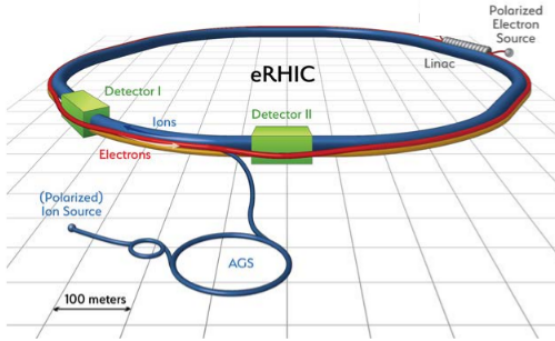
Future facilities

A. Kusina, C. Hadjidakis, J.-P. Lansberg (AFTER), A. Deshpande, R. Yoshida (eIC), A. Dainese (FCC-AA)

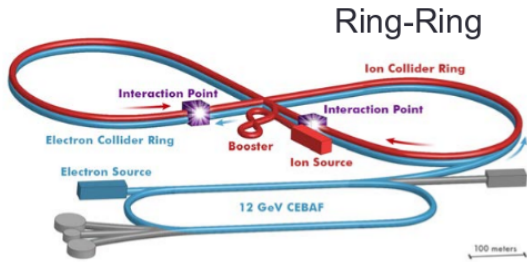
Uncharted kinematic territory and precision:

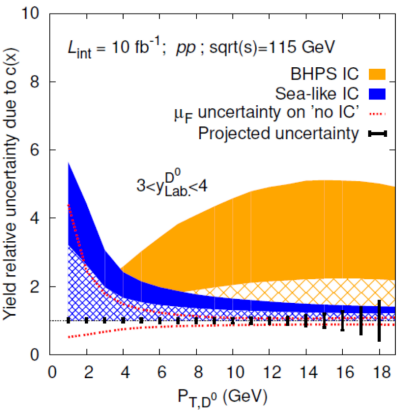
- AFTER@LHC (fixed target with ALICE or LHCb): high-x frontier
- eIC, LHeC, FCC-eh: large (x, Q^2) coverage, high precision

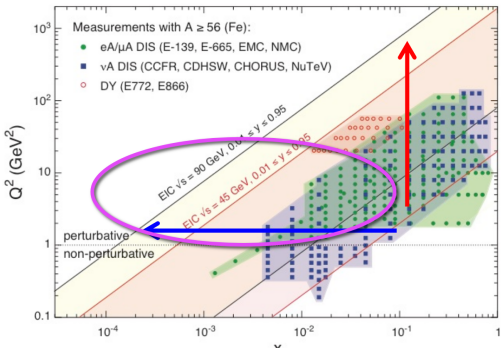


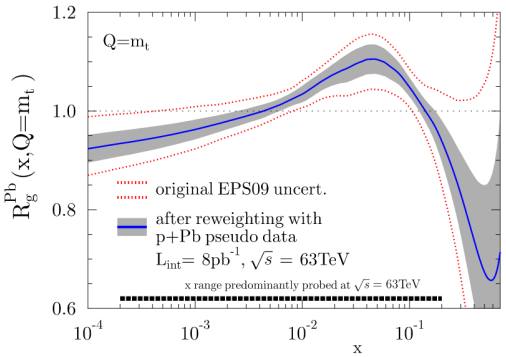


Not to scale

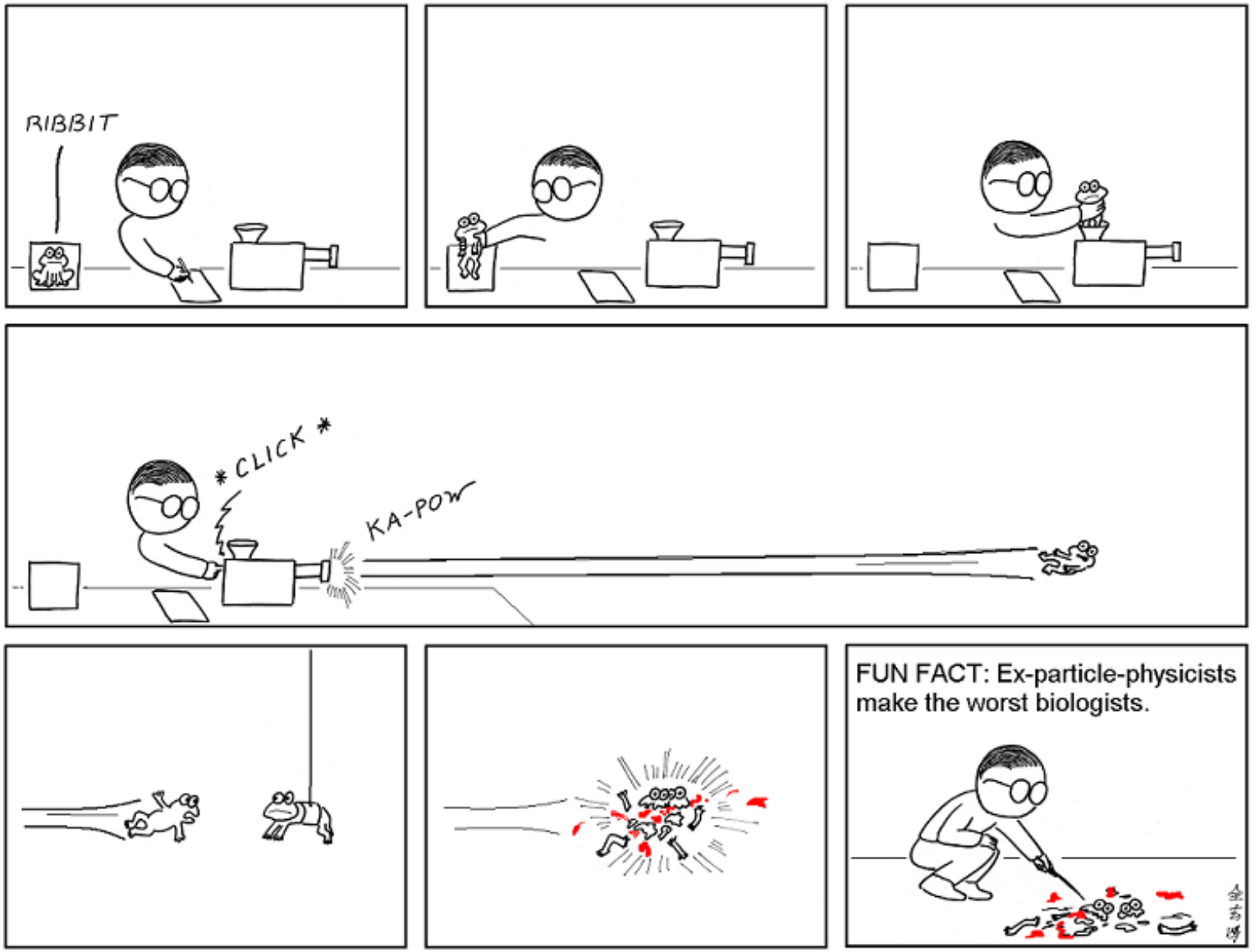








Initial-state in ~~heavy-ion~~ frog collisions



https://abstrusegoose.com/156