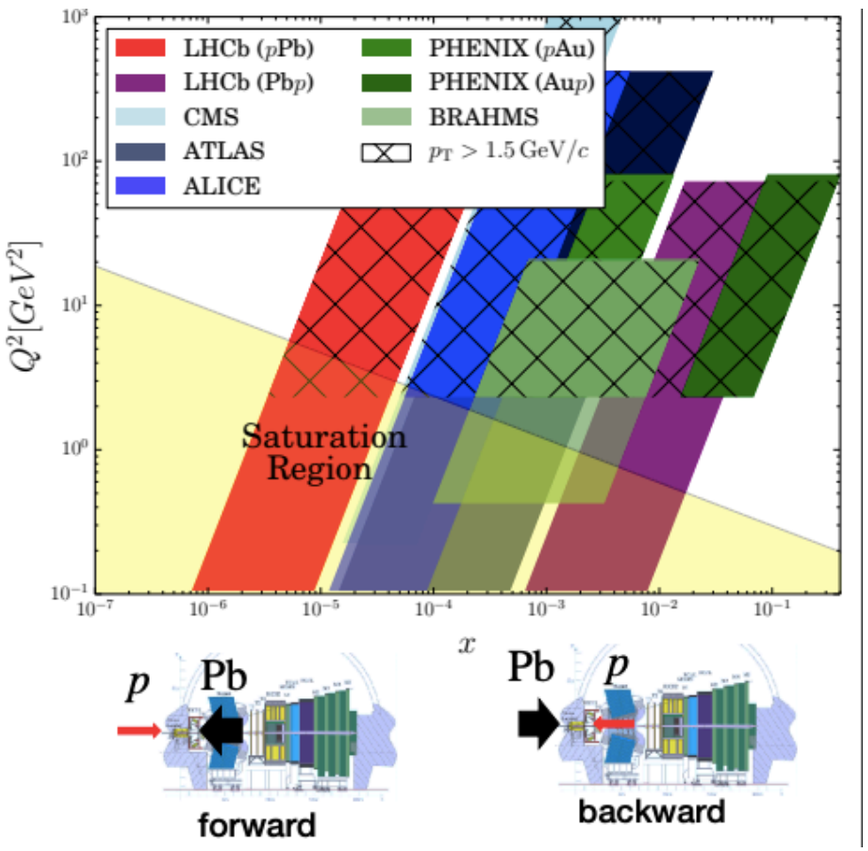
W2 Small-x, Diffraction and Vector Mesons Summary: Experimental talks

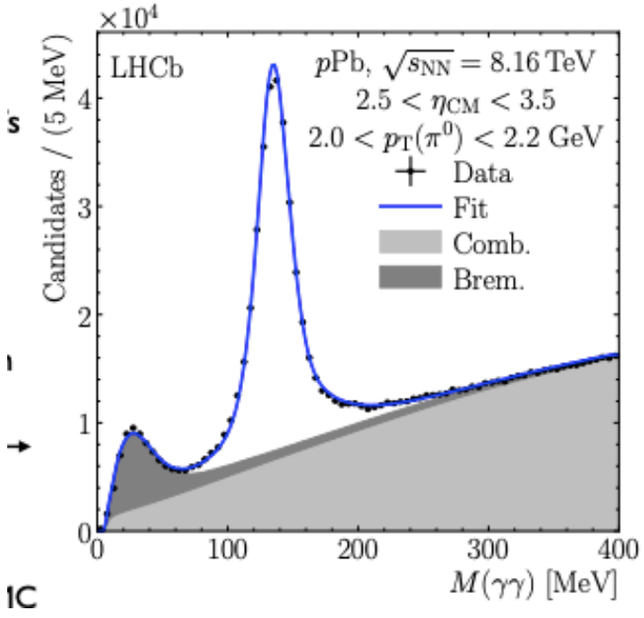
Conveners:

Guillaume Beuf, Rafał Staszewski, Daria Sokhan,
(with help from Tolga Altinoluk)

46 talks: 10 experimental, 36 theory

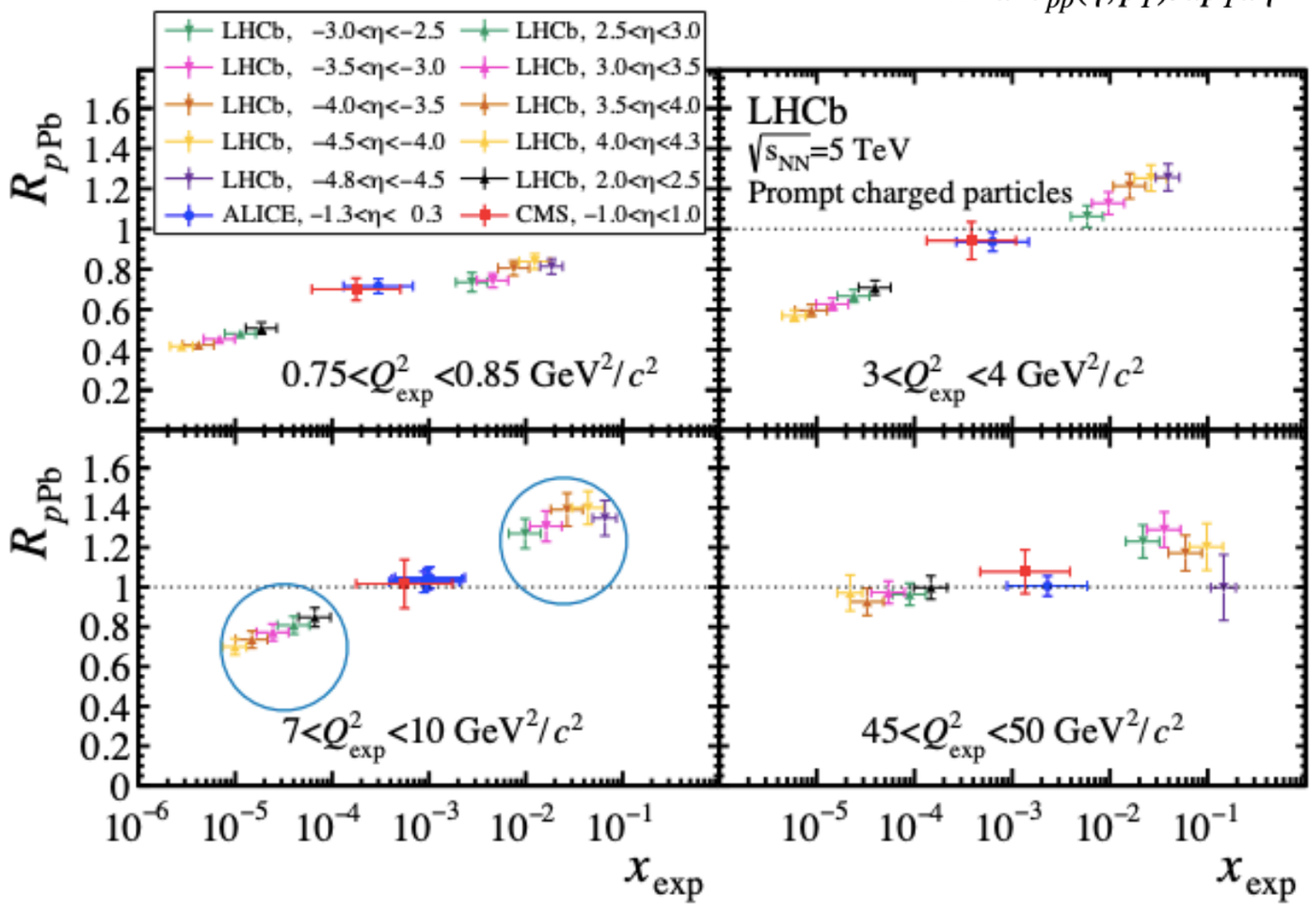
Imanol Corredoira: Studies of low-x phenomena with LHCb





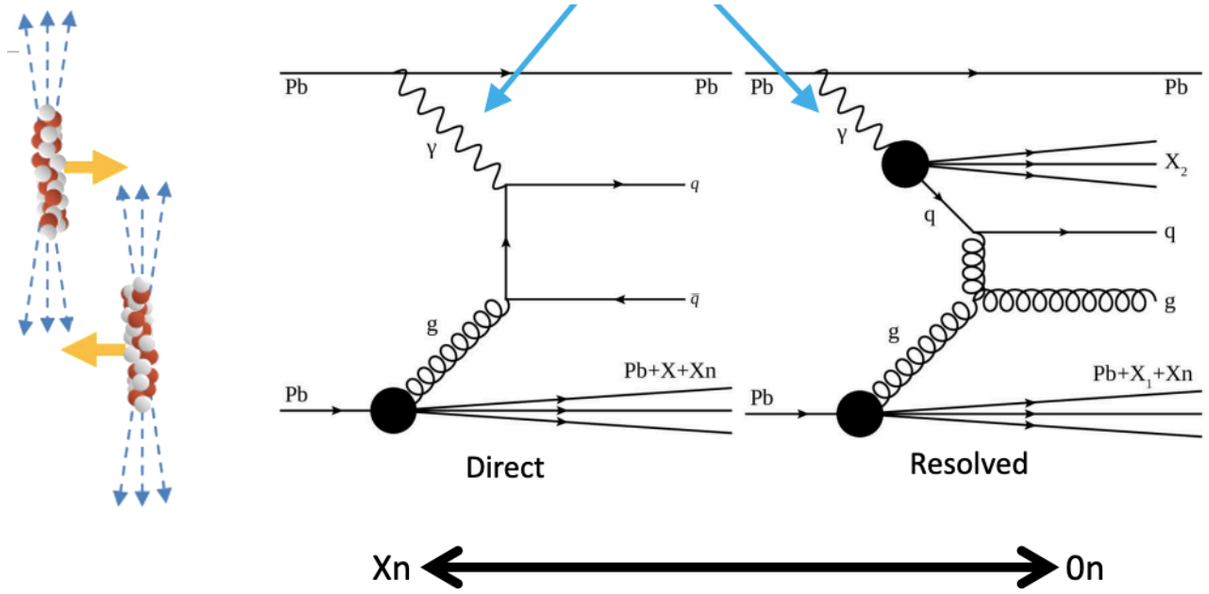
- Can study same system in forward & backward configuration: two different x-regions
- Charged hadron production, nuclear modification factor:

$$R_{pPb}(\eta, p_T) = \frac{1}{A}\frac{d^2\sigma_{pPb}(\eta, p_T)/dp_T d\eta}{d^2\sigma_{pp}(\eta, p_T)/dp_T d\eta},\ A = 208$$



- Also neutral pion production in both x-ranges.
- Measurements help to constrain nPDFs (better modelling of nuclear effects), tune saturation models and non-linear effects.

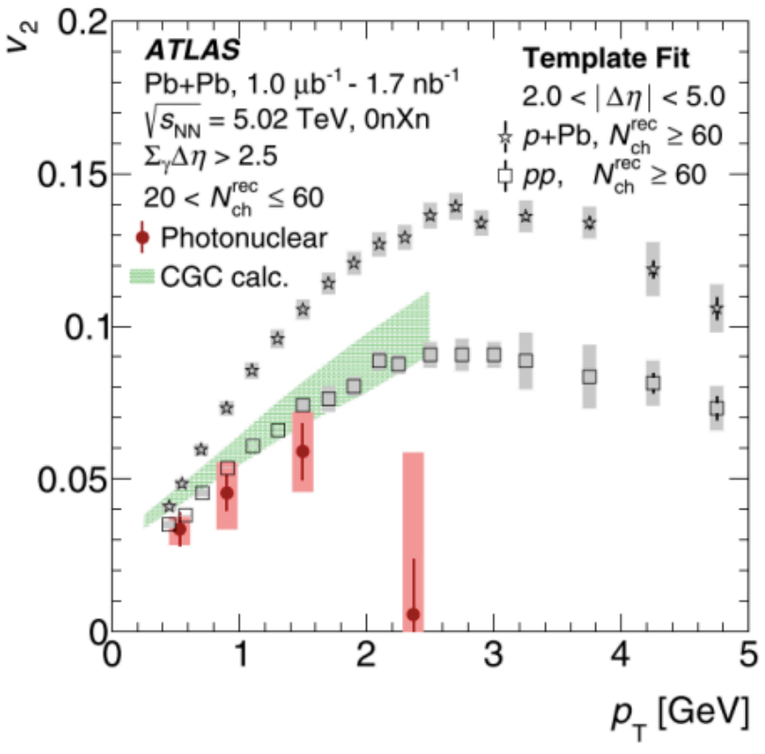
Ben Gilbert: ATLAS measurement of photo nuclear processes in UPC Pb+Pb



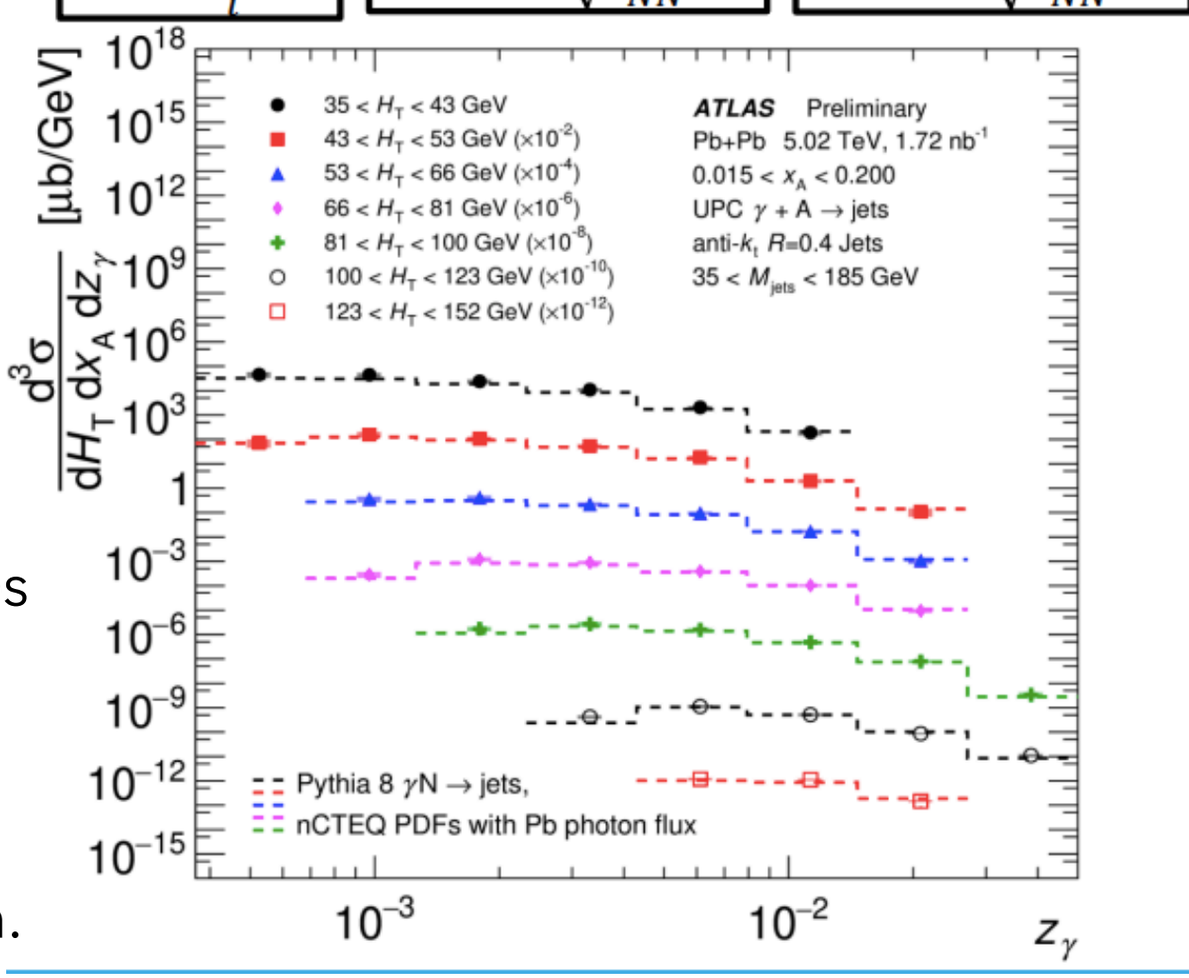
- Photonuclear can be used to study collectivity in a novel small system and inclusive jet production (hard scattering) as probe of nPDFs: saturation physics probe.

- Rapidity gaps help separate hadronic from photonuclear, which are highly asymmetric and fall quickly with multiplicity.

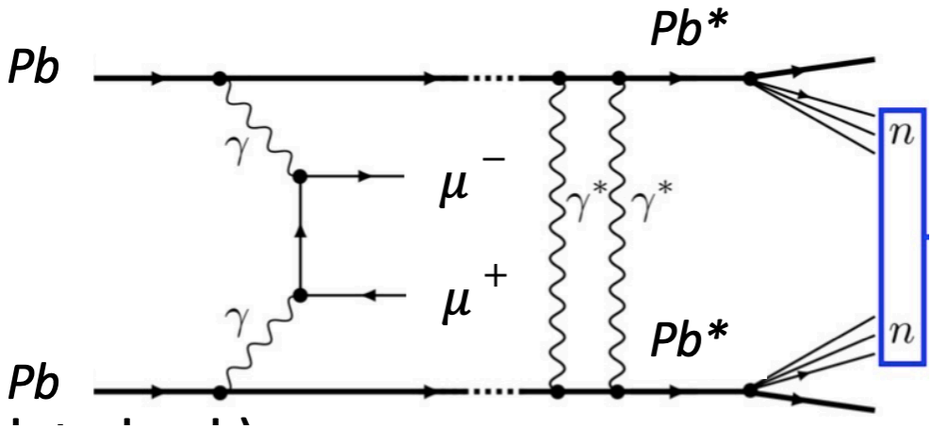
$$H_T \equiv \sum_i p_T^i \qquad x_A \equiv \frac{M_{jets} e^{-y_{jets}}}{\sqrt{s_{NN}}} \qquad z_\gamma \equiv \frac{M_{jets} e^{+y_{jets}}}{\sqrt{s_{NN}}}$$

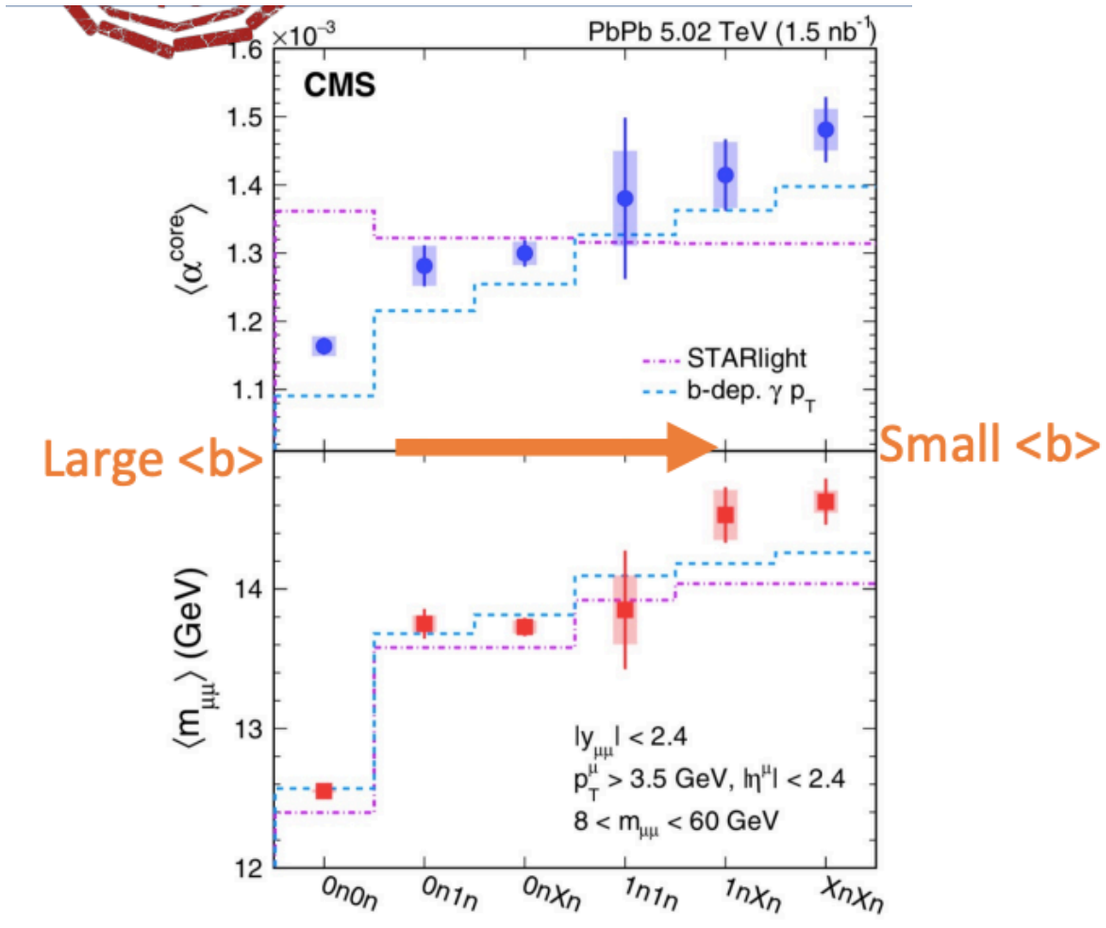


- Vector-dominance model and hydrodynamic evolution reproduces ATLAS data for flow dependence on pT: can be modelled as rho-nucleus collision.



Irais Bautista: Forward neutron multiplicity dependence of di-muon acoplanarity in UPC with PbPb at 5.02 TeV (CMS)



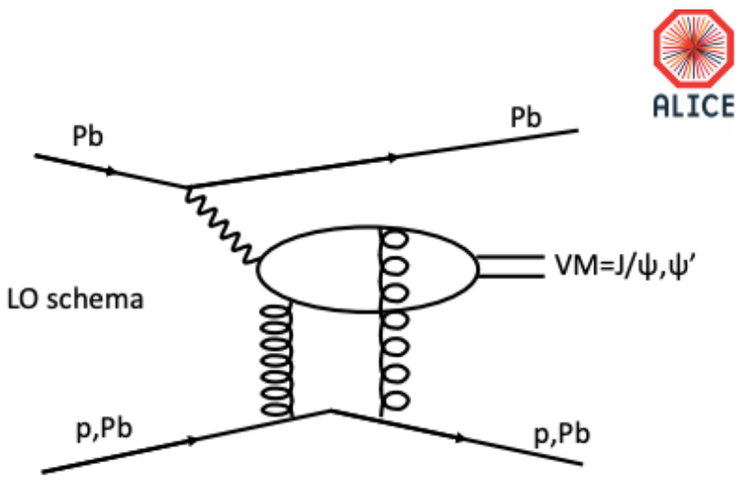


- Neutron multiplicity is a measure of impact parameter for ion collisions.
- Acoplanarity in $\gamma\gamma \rightarrow \mu^+\mu^-$ an indication of interaction of produced leptons and QGP.

$$\alpha = 1 - \frac{|\phi^+ - \phi^-|}{\pi}$$

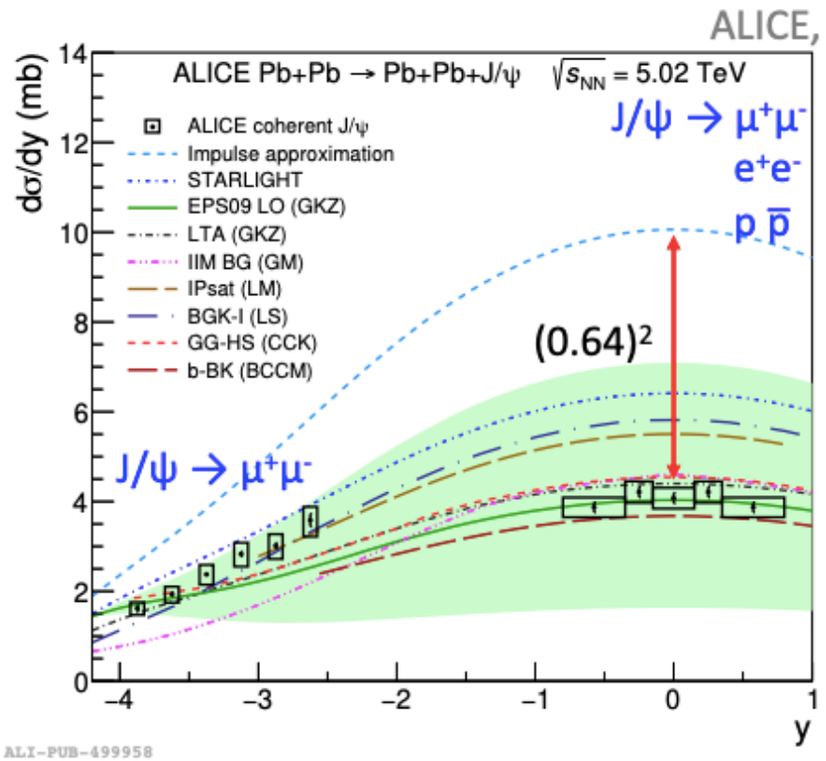
- Significant broadening of back-to-back azimuthal correlations for increasing multiplicities of emitted forward neutrons. Qualitatively reproduced by a LO QED calculation: importance of an impact-parameter-dependent photon p_T .
- First experimental demonstration that the initial energy and transverse momentum of photons exchanged in UPC depend on the impact parameter of the interaction.

Diego Stocco: Quarkonium and di-lepton photoproduction ALICE

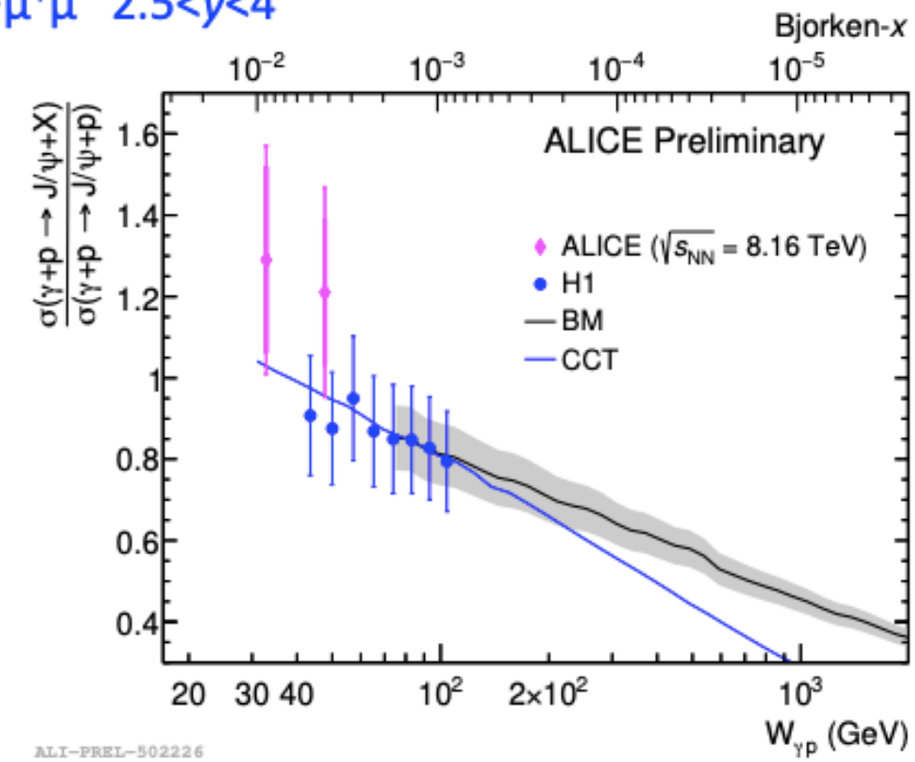


- First measurement of dissociative J/Ψ production at LHC, in p-Pb

- Photonuclear cross-section sensitive to gluon distribution at low-x
  - Moderate gluon shadowing, t-dependence described by models including saturation or shadowing



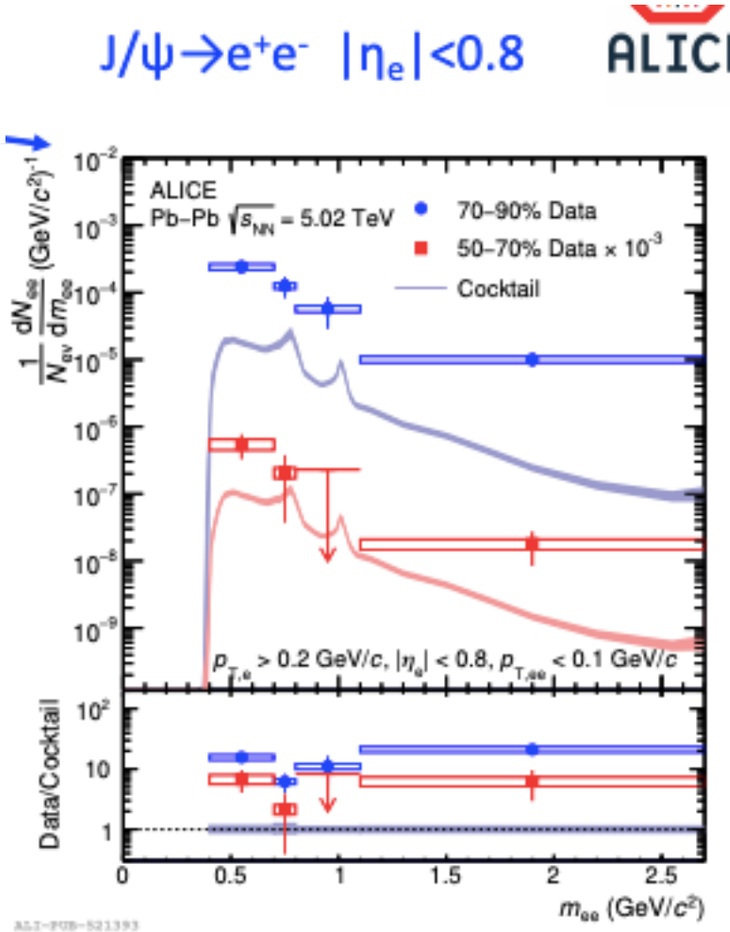
J/ψ→μ⁺μ⁻ 2.5<y<4



γγ → e⁺e⁻ in Pb–Pb collisions

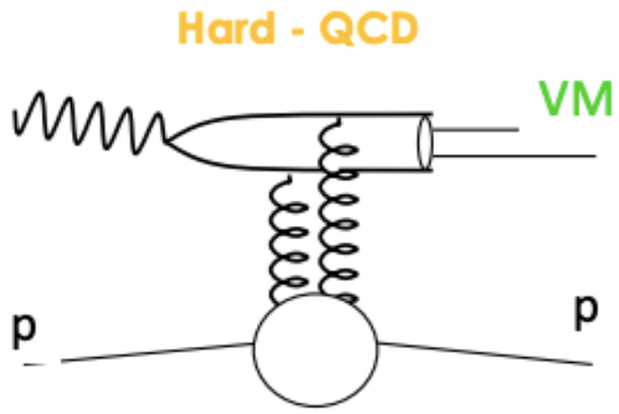
- Excess observed over known hadronic e+e- states, first measurement with low invariant mass in peripheral Pb-Pb collisions.

J/ψ→e⁺e⁻ $|\eta_e|$<0.8



Marta Ruspa: Exclusive vector meson production in p+Pb at CMS

- Exclusive Upsilon at 5 TeV

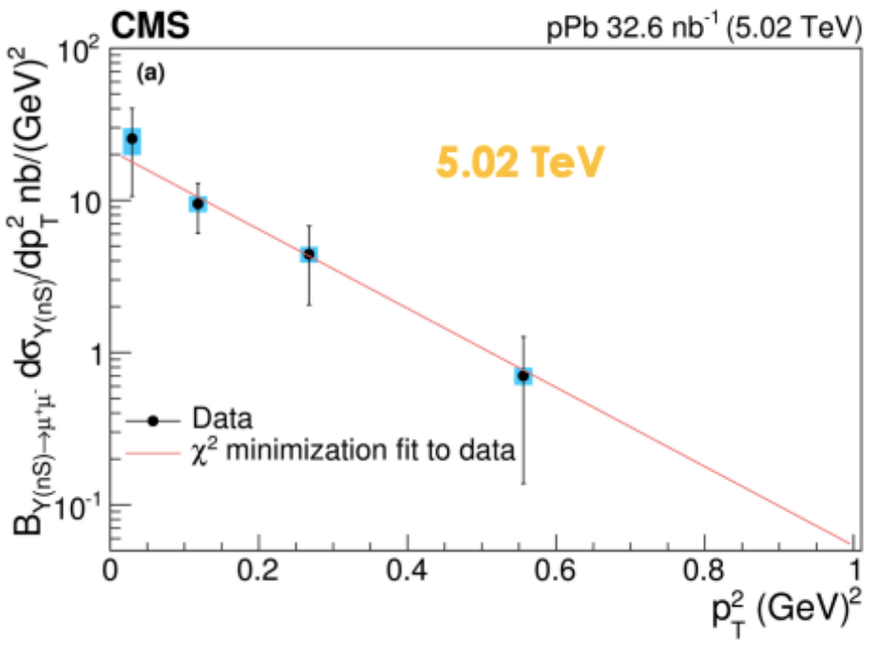


VM ($J^{PC}=1^{--}$): γ, ρ, ϕ, J/ψ,ϒ,...

b = 6.0 ± 2.1 (stat.) ± 0.3 (syst.) GeV^{-2}

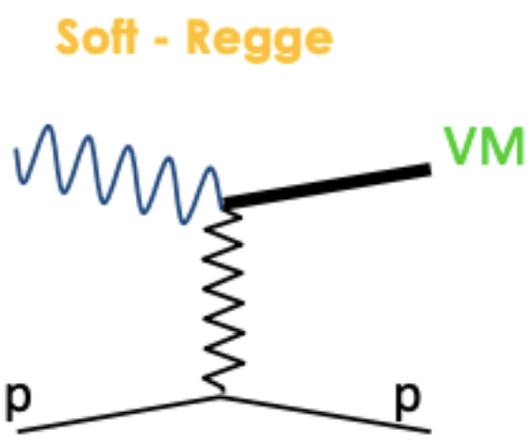
DIS22, M. Ruspa

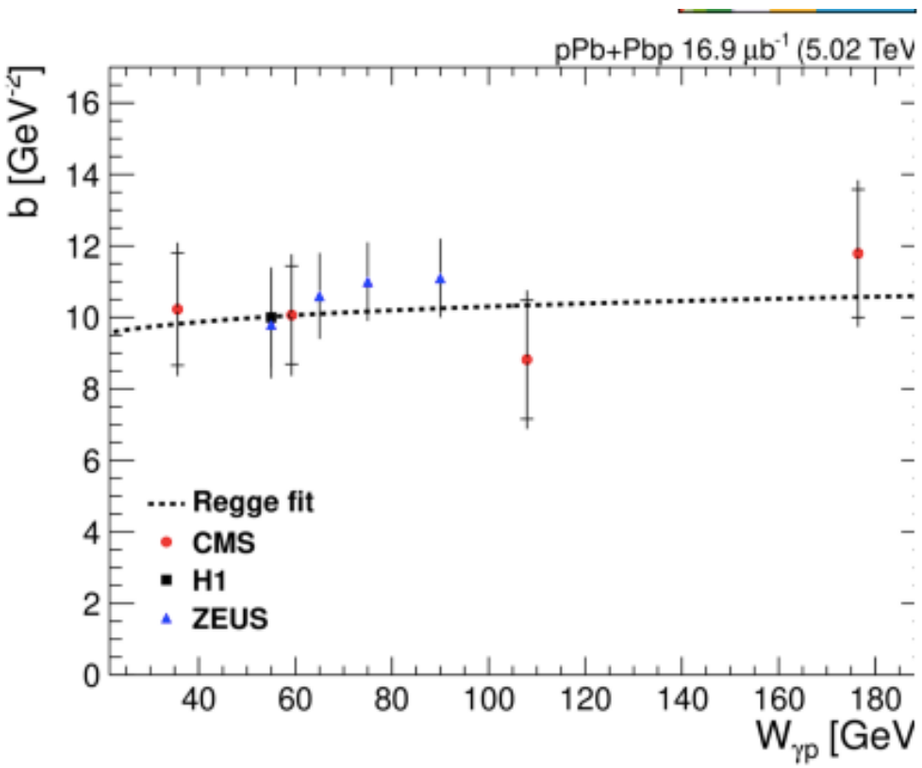
|t| dependence



- In agreement with ZEUS measurement, and predictions based on pQCD models (NLO)

- Exclusive rho (770) at 5 TeV

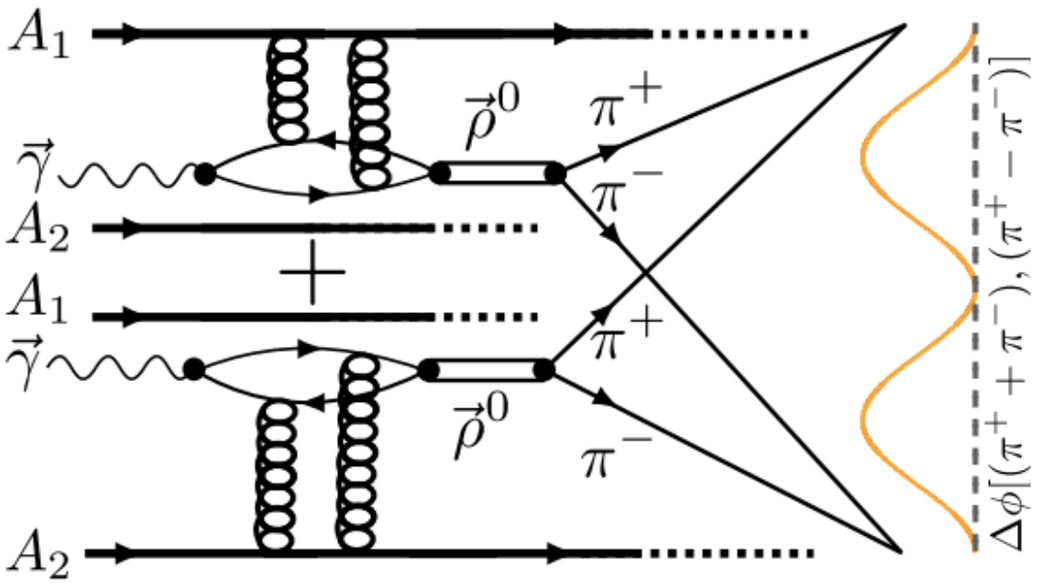




- Consistent with ZEUS measurement, and Regge model expectation

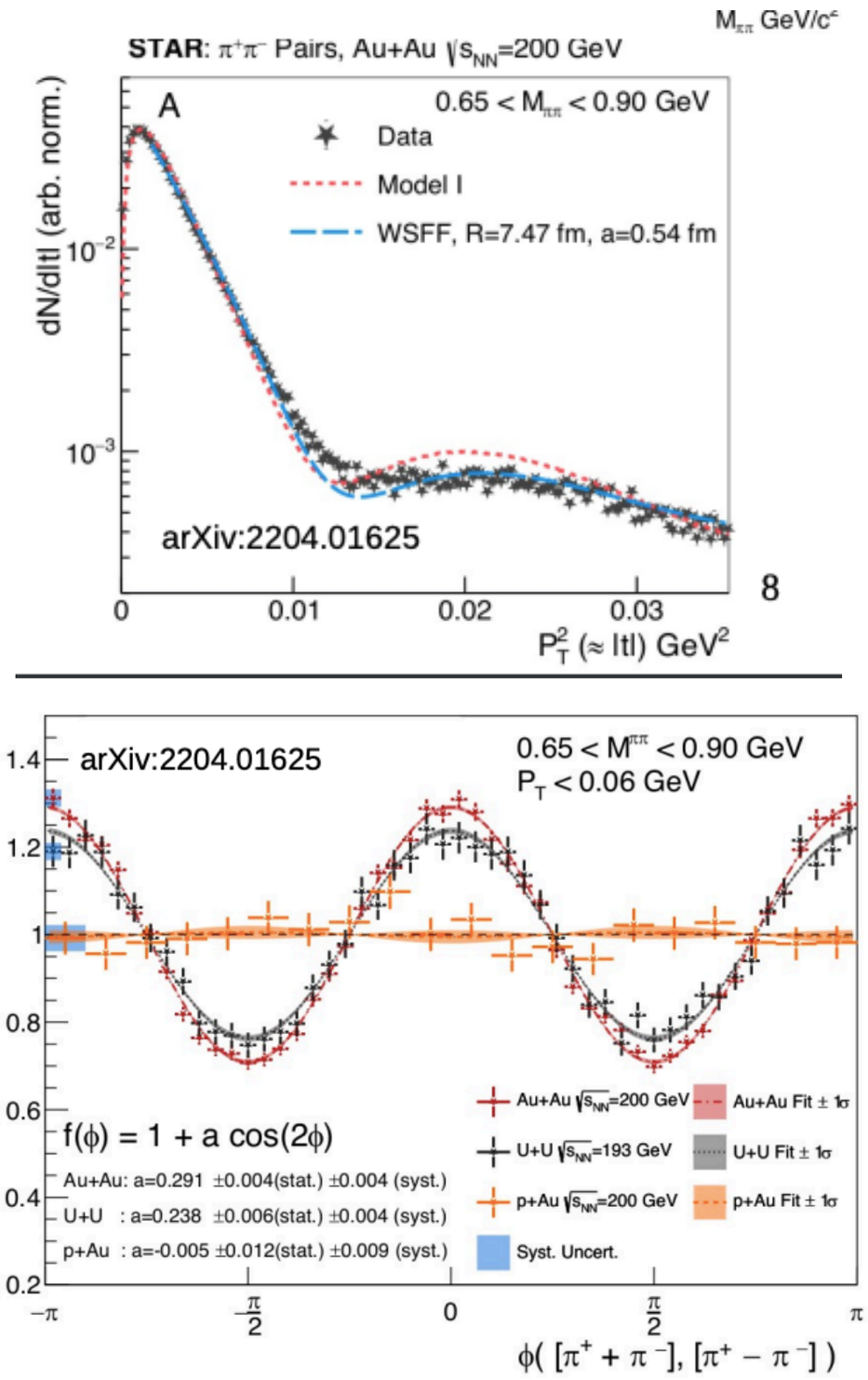
Isaac Upsal: Nuclear Tomography with polarised photon-gluon collisions at STAR

- UPC photon can fluctuate into qq-bar pair, interacts with pomeron or reggeon.
- Photon polarisation aligned with emitting source, dictates rho polarisation.
- Excess at low pT: observe diffractive production



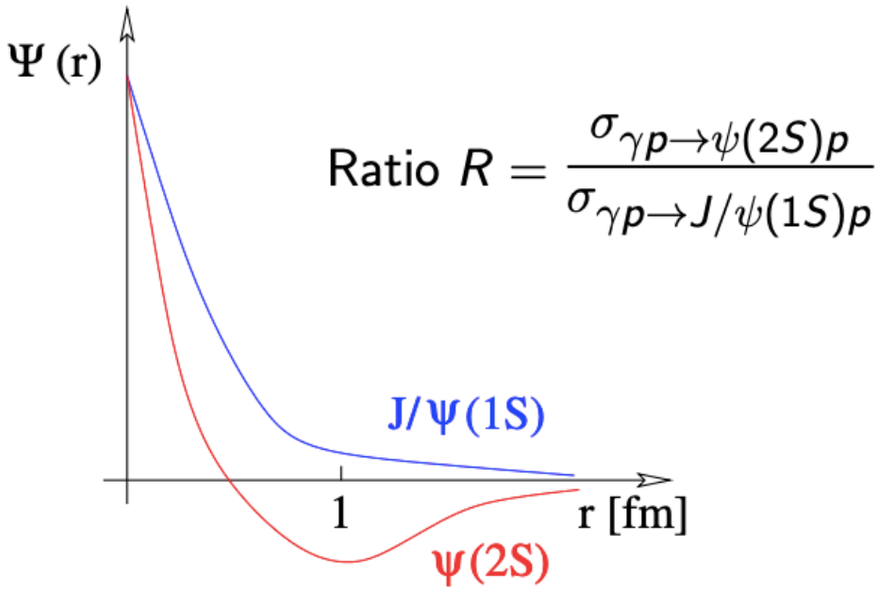
[1] Xing, H et.al. *J. High Energ. Phys.* **2020**, 64 (2020).

	Au+Au (fm)	U+U (fm)
Charge Radius	6.38 (long: 6.58, short: 6.05)	6.81 (long: 8.01, short: 6.23)
Inclusive |t| slope (STAR 2017) [1]	7.95 ± 0.03	--
Inclusive |t| slope (WSFF fit)*	7.47 ± 0.03	7.98 ± 0.03
Tomographic technique*	6.53 ± 0.03 (stat.) ±0.05 (syst.)	7.29 ± 0.06 (stat.) ± 0.05 (syst.)
DESY [2]	6.45 ± 0.27	6.90 ± 0.14
Cornell [3]	6.74 ± 0.06	--
Neutron Skin (Tomographic Technique)*	0.17 ± 0.03(stat.) ±0.08(syst.) ~ 2σ	0.44 ± 0.05 (stat.) ±0.08 (syst.) ~ 4.7σ (Note: for Pb ≈ 0.3)
		*arXiv:2204.01625



- Modulation sensitive to gluon distribution, nuclear radius

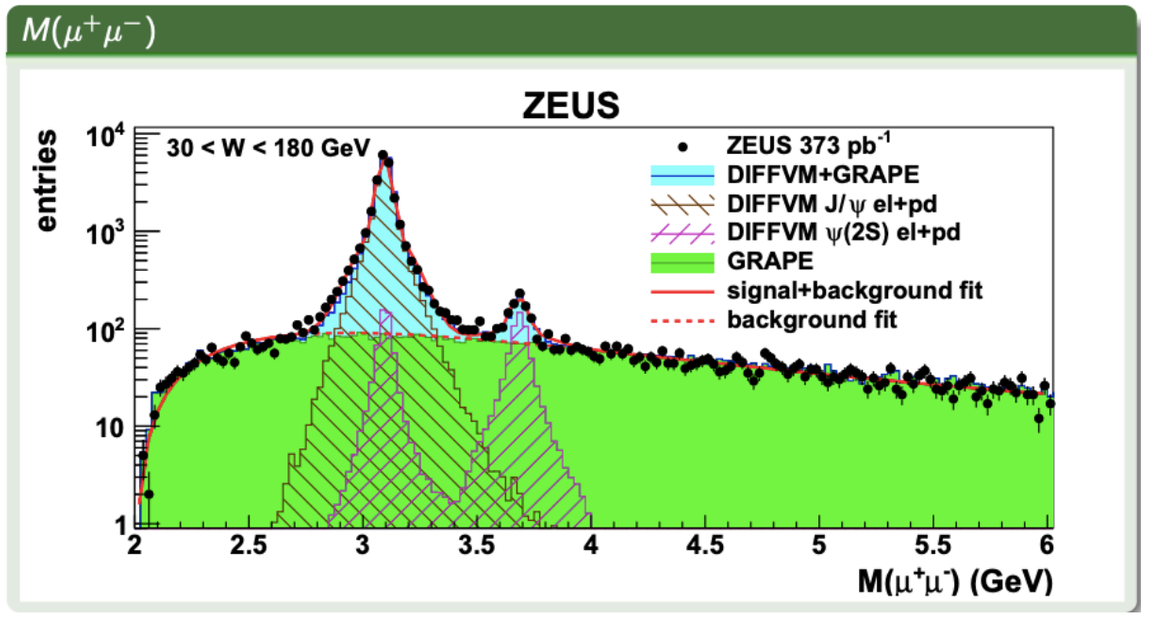
Grzegorz Grzelak : Cross-section ratio of Ψ(2S) and J/Ψ in exclusive photo-production at HERA

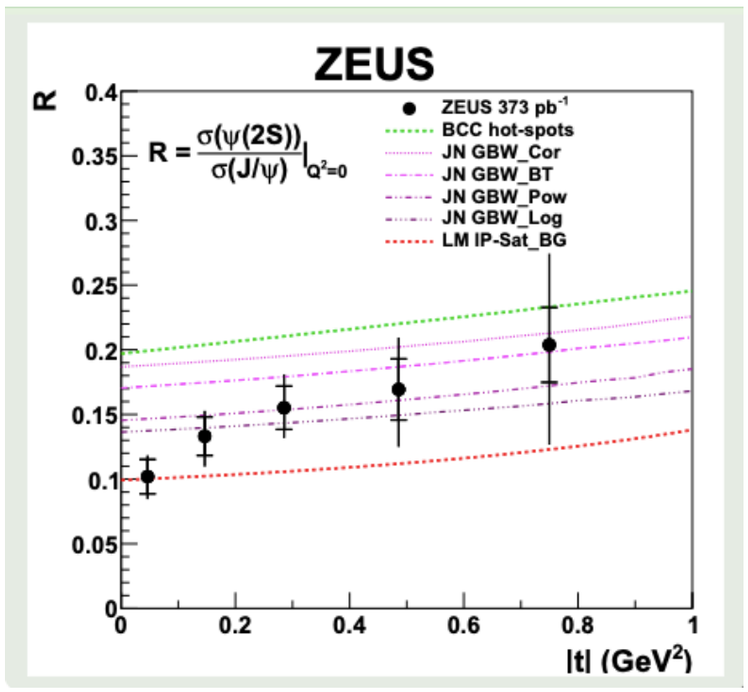


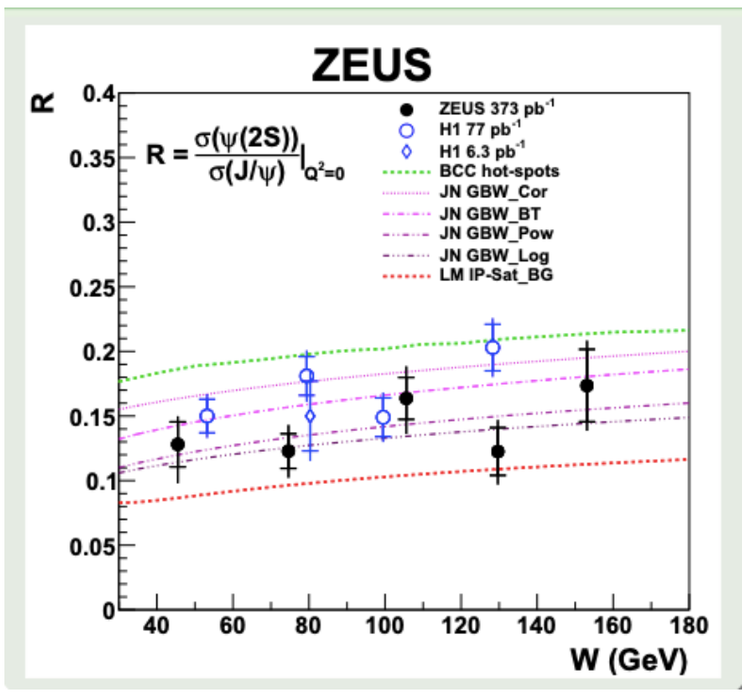
$$\text{Ratio } R = \frac{\sigma_{\gamma p \to \psi(2S) p}}{\sigma_{\gamma p \to J/\psi(1S) p}}$$

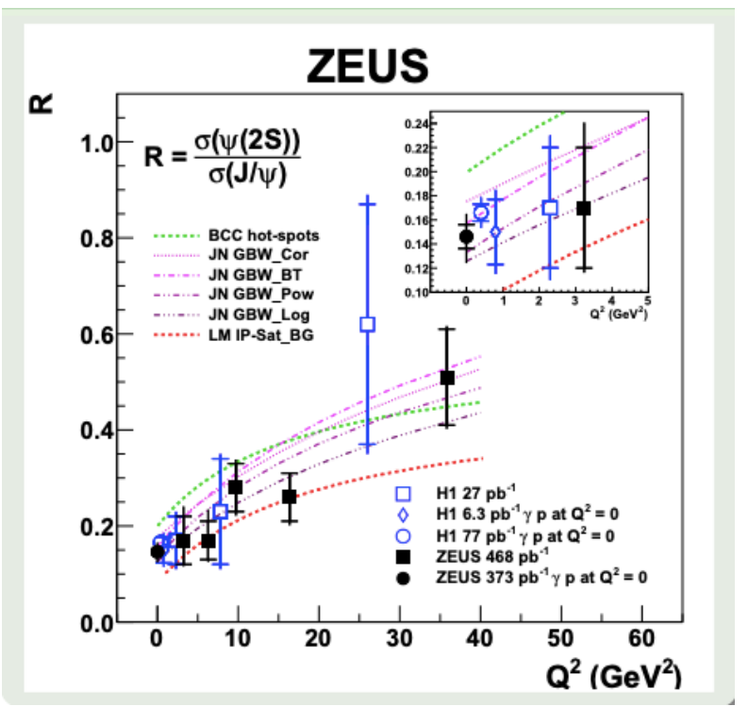
- Ratio has discriminating power for charmonium models

- HERA II data (2003 - 2007)

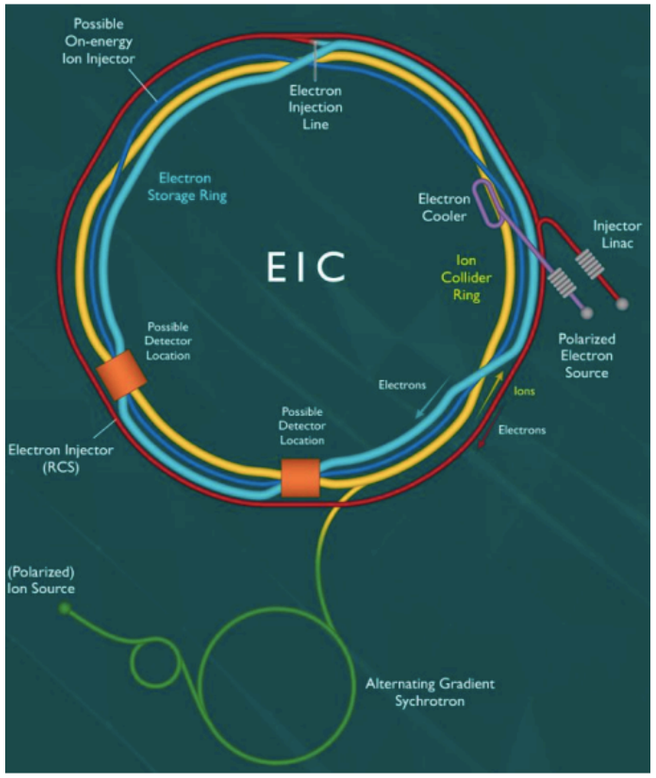




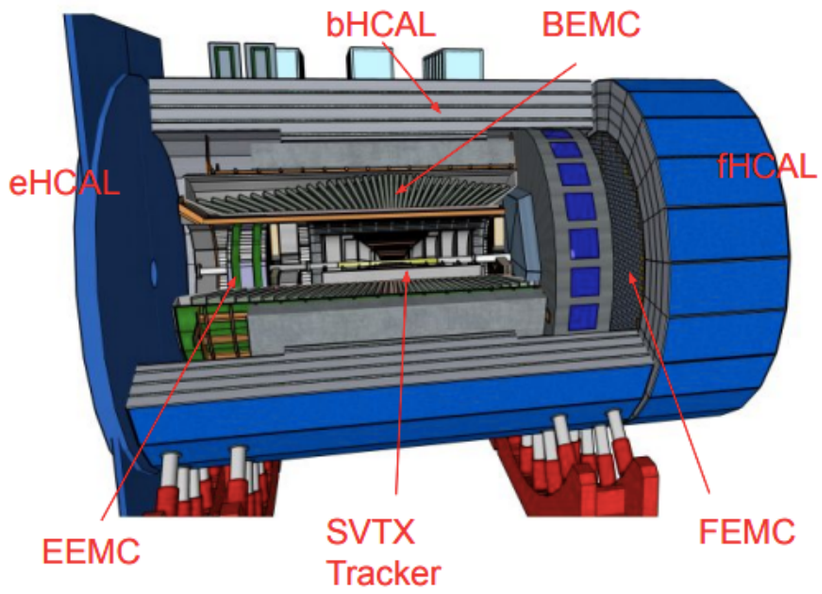




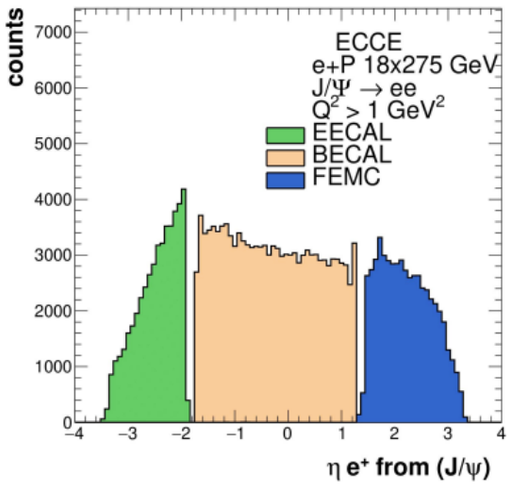
Gary Penman: 3D imaging of nucleons and nuclei with ECCE at the future EIC

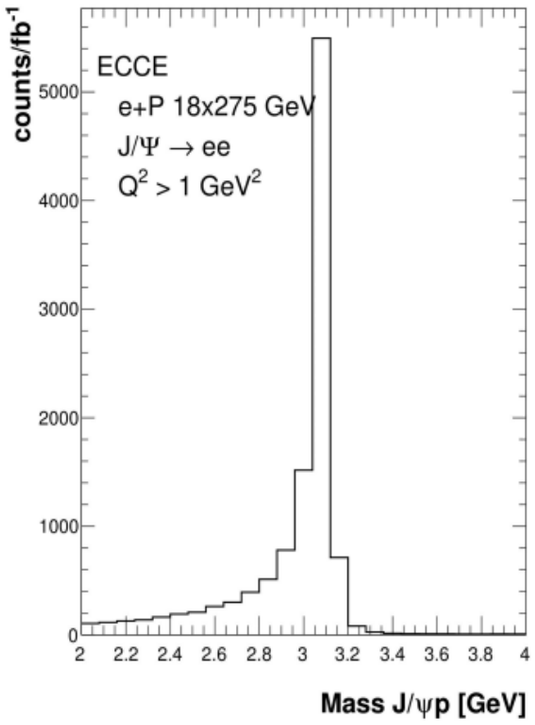


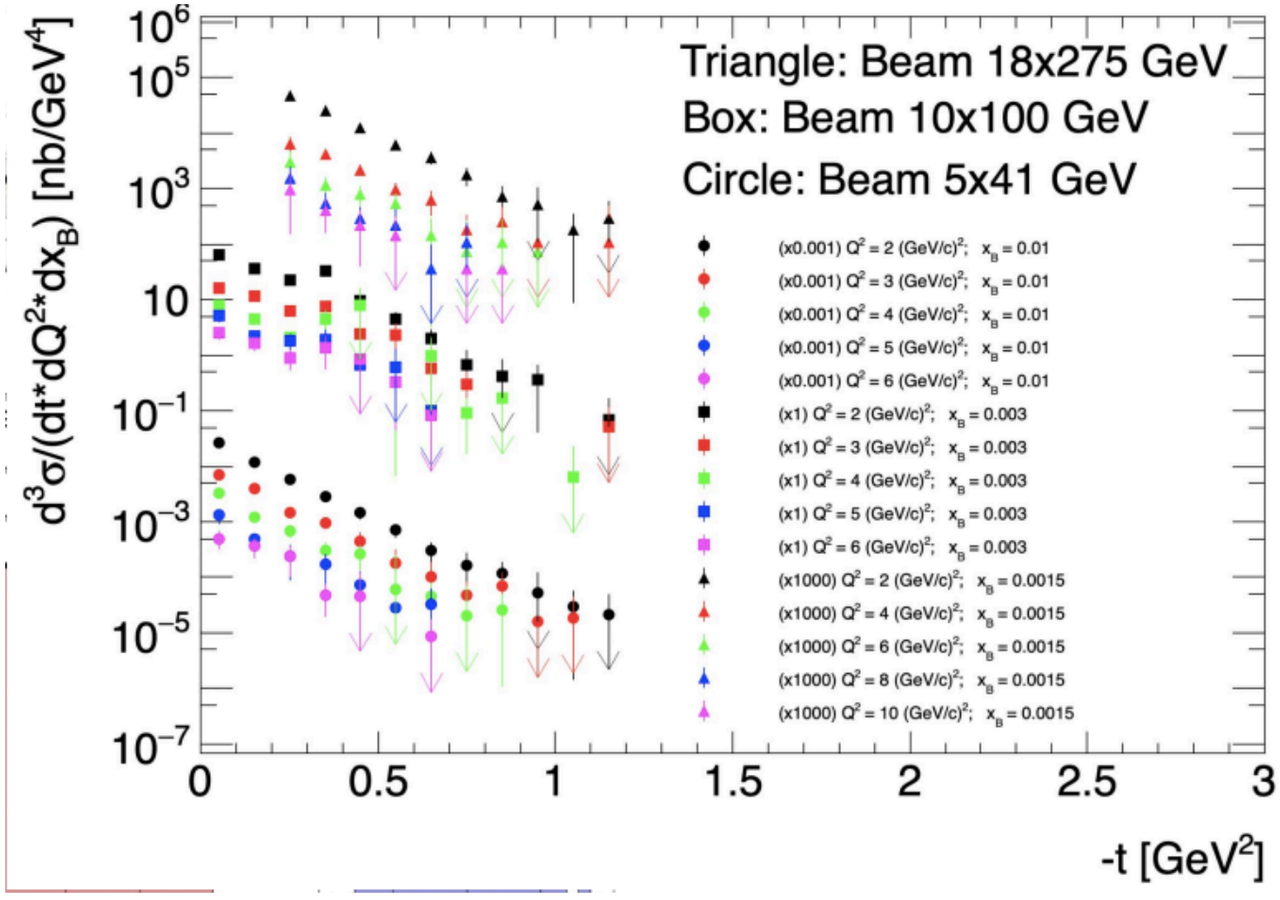
- Exclusive and diffractive processes are sensitive to Generalised Parton Distributions and gluon densities.



DVCS ep
DVCS eA (e-He4)
TCS
DVMP ep J/Ψ
DVMP eA (e-Pb) ϕ

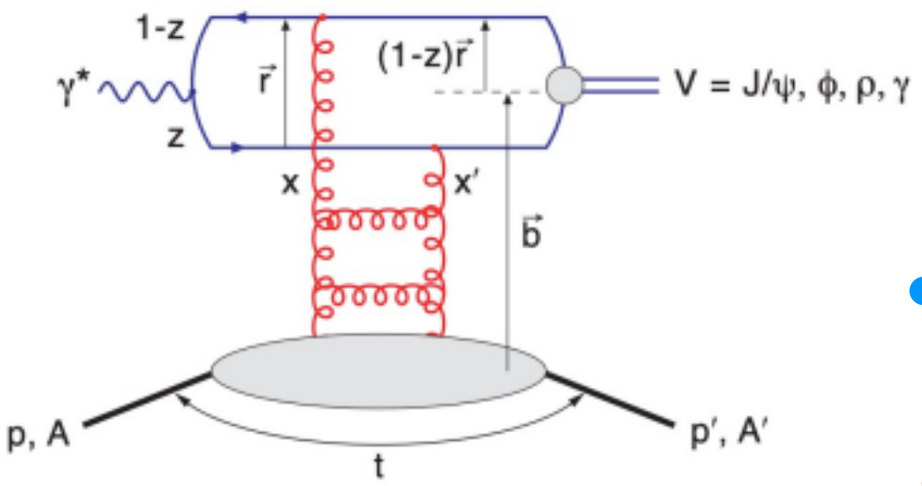






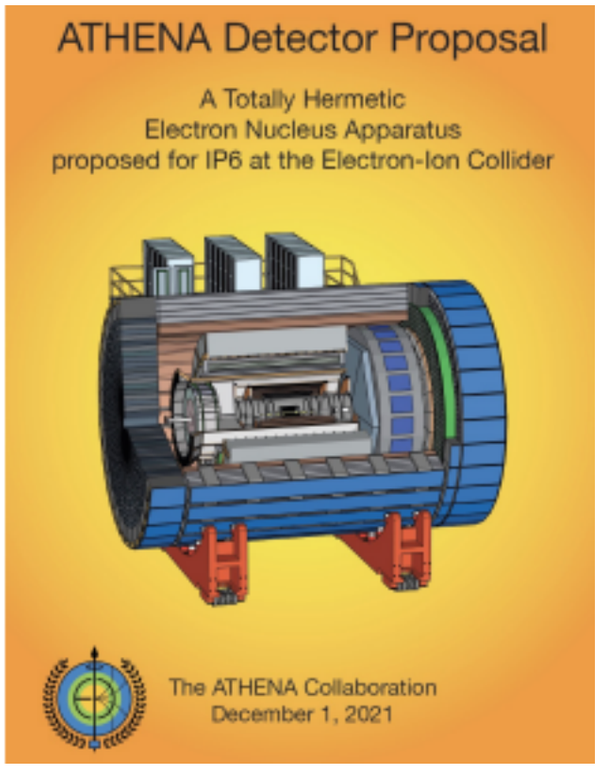
Kong Tu: Diffractive Vector Meson production at the EIC

- Probe of gluon density, spatial distributions, their fluctuations.

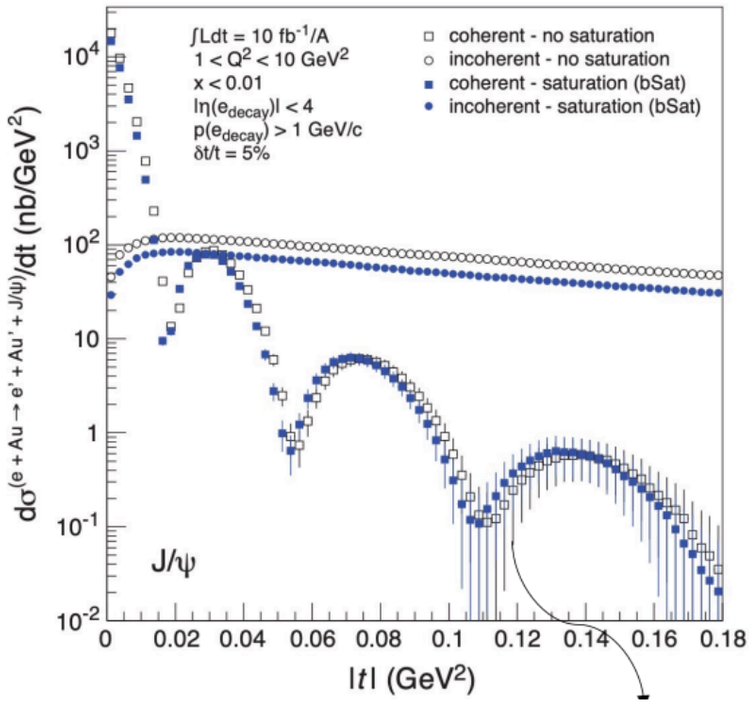


t ~ momentum transfer (kicks)

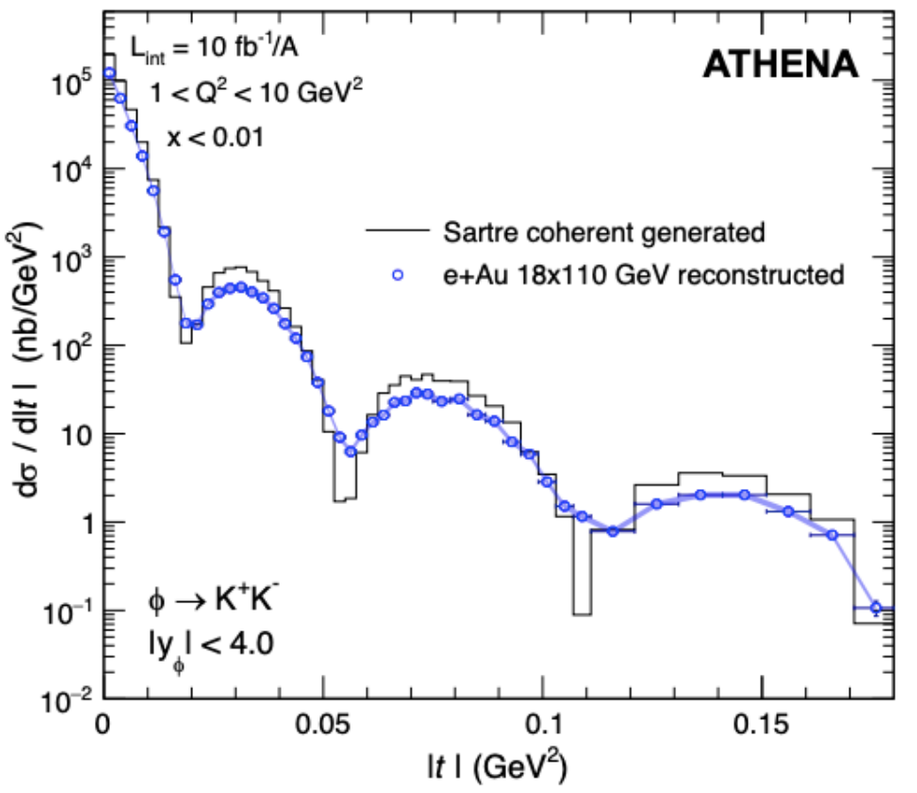
- Very large incoherent background
- Study with ATHENA detector at the EIC



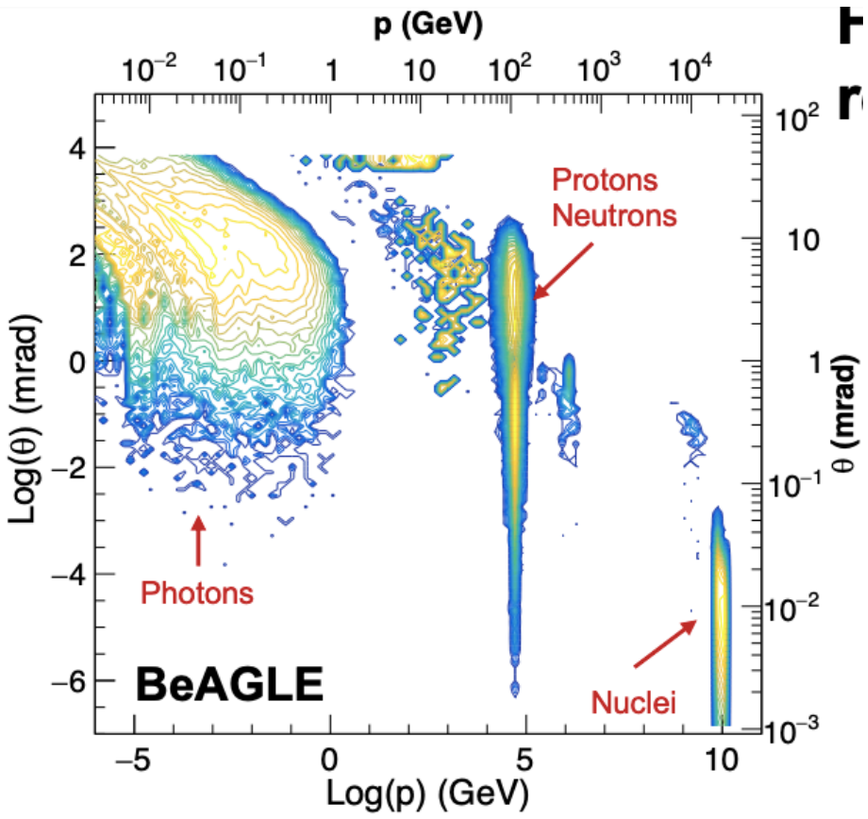
(EIC White Paper)



Gaussian smearing = 1% energy resolution

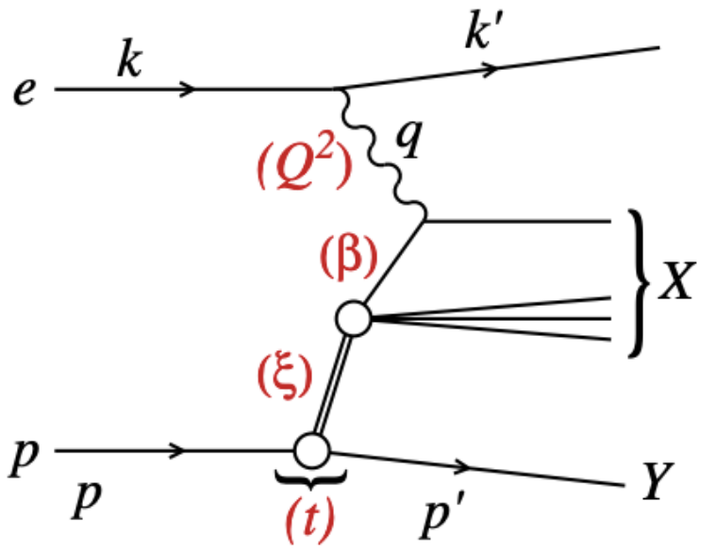


- Tracking and calorimetry can achieve background suppression and minima resolution



Incoherent backgrounds

Anna Stasto: Diffractive Longitudinal Structure Function at EIC

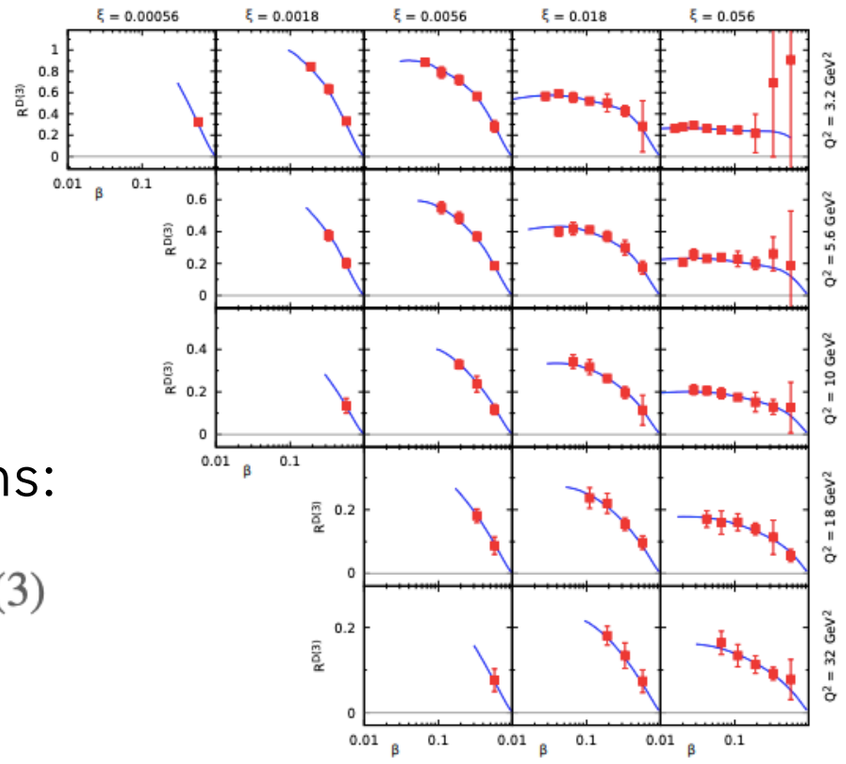


Reduced cross section depends on two structure functions:

$$\sigma_{\mathrm{r}}^{\mathrm{D}(4)}(\xi,\beta,Q^2,t) = F_2^{\mathrm{D}(4)}(\xi,\beta,Q^2,t) - \frac{y^2}{Y_+} F_L^{\mathrm{D}(4)}(\xi,\beta,Q^2,t)$$

- F_L^D: sensitive to gluon density (saturation, higher-twist effects), only measured once at HERA with large error bars.

- Five energy combinations are sufficient to extract it from EIC measurements through linear fit to reduced cross-sections.



- Also possible to extract ratios of structure functions:

$$R^{D(3)} = F_L^{D(3)} / F_T^{D(3)}$$