Discussion

Prospects for Exclusive measurements

Definitions, Isolation, Gaps, ZDCs

For pp:
coherent=incoherent ?

Coherent = always intact?

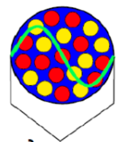
Coherent
+ Target Dissociation

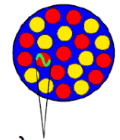
Coherent
+ Source Dissociation

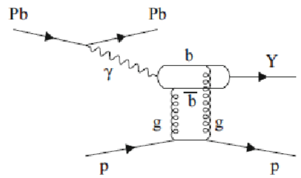
Incoherent
+ Source intact ?

Photoproduction types

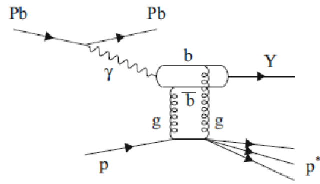
- **Coherent** Vector Meson (VM) photoproduction:
  - Photon couples coherently to all nucleons (whole nucleus)
  - $\langle p_T^{VM} \rangle \sim 1/R_{Pb} \sim 50$ MeV/c
  - Target ion stays intact
- **Incoherent** VM photoproduction:
  - Photon couples to a single nucleon
  - $\langle p_T^{VM} \rangle \sim 1/R_p \sim 400$ MeV/c
  - Target ion breaks, nucleon stays intact
  - Usually accompanied by neutron emission
- **Exclusive** VM photoproduction on target proton:
  - Photon couples to a single proton
  - $\langle p_T^{VM} \rangle \sim 1/R_p \sim 400$ MeV/c
  - Target proton stays intact (similar to coherent) in p-Pb case
- **Dissociative** (or semiexclusive) VM photoproduction:
  – Photon interacts with a single nucleon and excites it
  – $\langle p_T^{VM} \rangle \sim 1$ GeV/c
  – Target nucleon and ion break (in heavy ion collision)
  – Target proton breaks (in p-Pb)







Eur. Phys. J. C (2019) 79:277



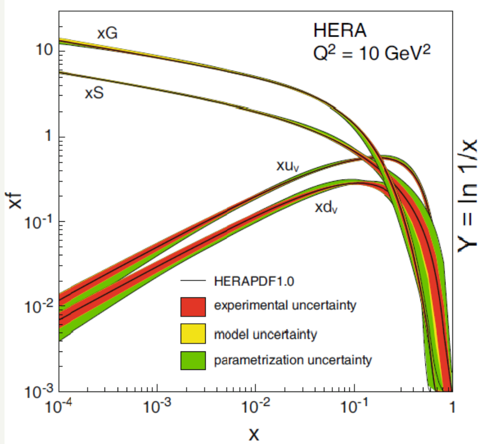
Source	Target	Comment
Coherent	Exclusive	ok
Coherent	Dissociative	nuclear excitation?
Incoherent	Exclusive	no? Nucleus must break up?
Incoherent	Dissociative	both break?

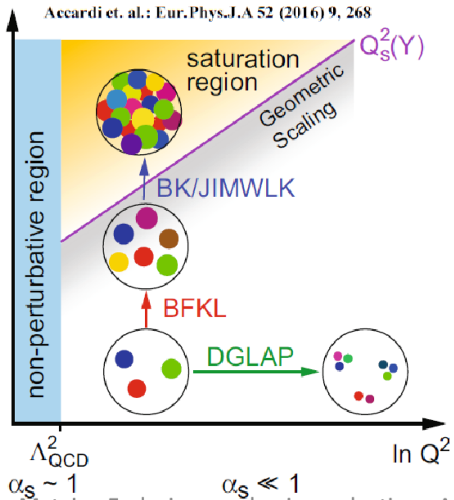
Motivation

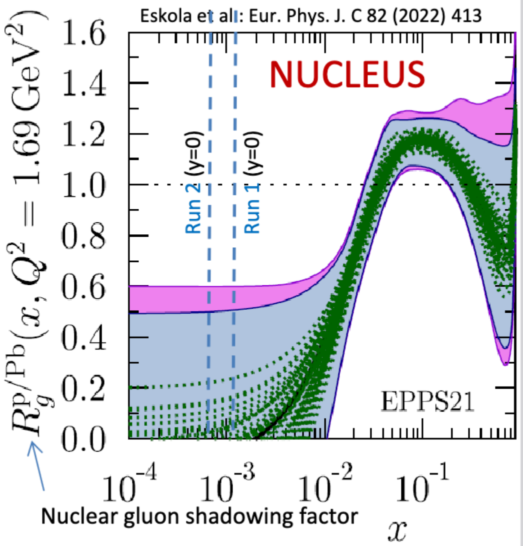
Why?

- Where is gluon **saturation**?
  - Saturation scale enhanced for nuclei by factor $A^{1/3}$: $(Q_s^A)^2 \approx cQ_0^2\,[A/x]^{1/3}$
- **Coherent** vector meson (ρ^0, J/ψ, $\psi(2S)$, $\Upsilon(nS)$) **photoproduction** particularly sensitive to the **gluon shadowing**
  - Nuclear gluon shadowing factor $R_g^A(x,Q^2)=g_A(x,Q^2)/Ag_p(x,Q^2) < 1$
  - Saturation may contribute to nuclear shadowing
  - Search for saturation at low x_B
- How well do we model **photon flux**?
- Constrain parameters of **models**
- pQCD test

Source of shadowing at high x?
Source of shadowing at low x?







Nuclear gluon shadowing factor

The photon / VM must pass through a gluon-rich region
(gluons in nucleons / gluons between nucleons)

How much is linear QCD? How much is non-linear?
Define saturation
State what would be considered proof of existence of saturation.

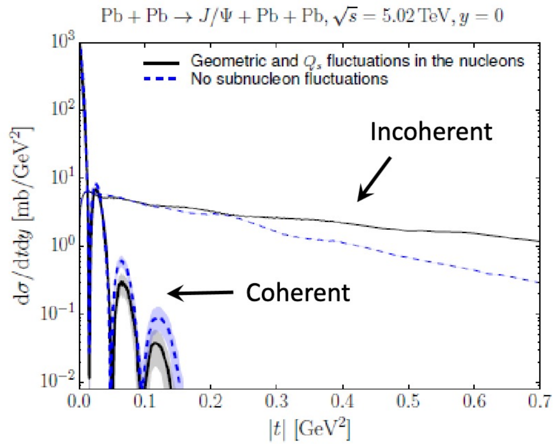
Do we really know these distributions to the indicated accuracy.

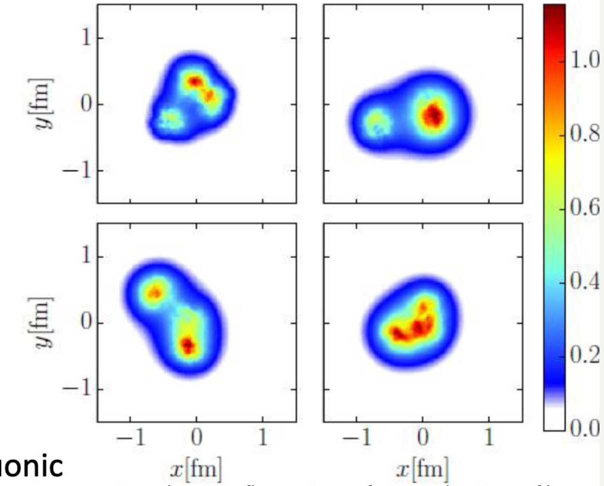
i.e. if I measure this slope in incoherent interactions, is it proof of hot-spots?

Are the relative heights of the peaks a robust prediction?

Motivation – cont.

Mantysaari, Schenke, PLB 772 (2017) 832





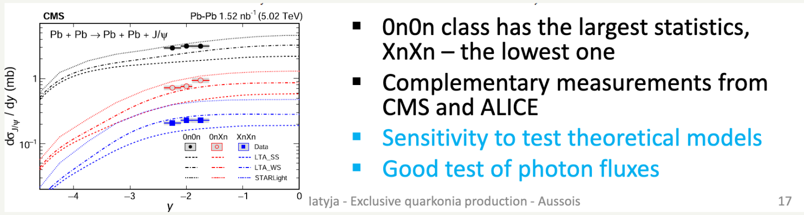
Event by event fluctuations of proton density profile

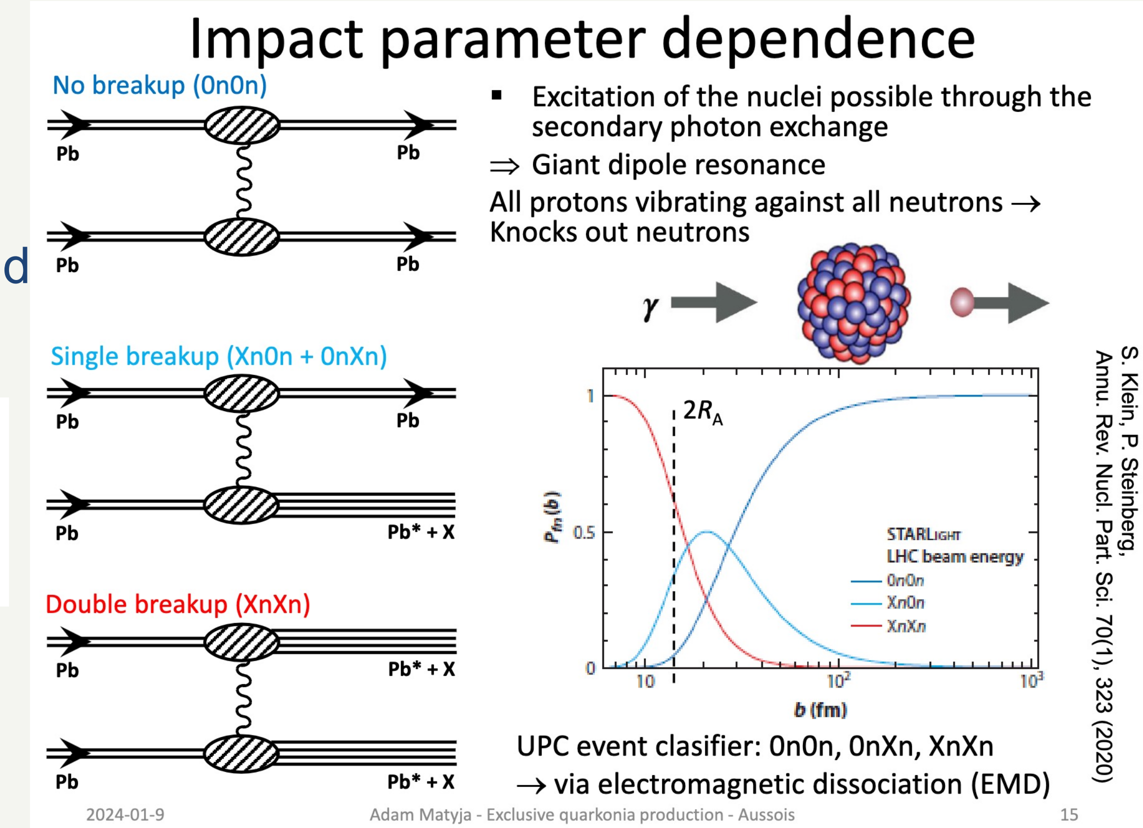
- Variations in nucleon positions and/or gluonic hot spots → **quantum fluctuations**
- Larger $|t|$ range → scatter of smaller object
- Coherent vs. Incoherent vs. Dissociative J/ψ
  - Access to **different scales**: nucleus, nucleon, hot spots

H. Mantysaari, B. Schenke, PRD 94 (2016) 034042,
J. Cepila, et al., PLB 766, 186 (2017),
S. R. Klein, PRC 107, 055203 (2023).

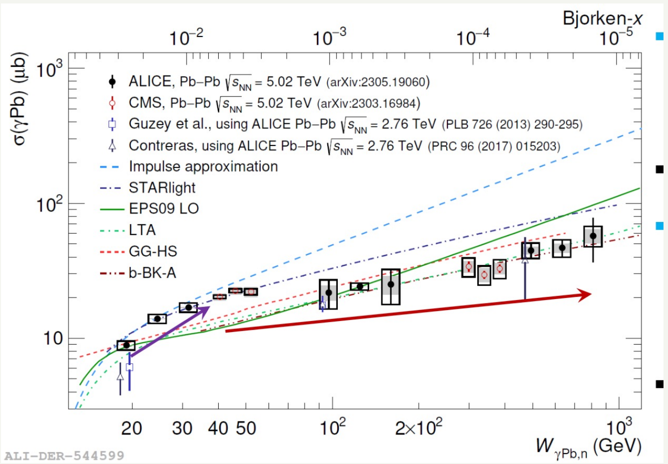
2024-01-9 Adam Matyja - Exclusive quarkonia production - Aussois 9

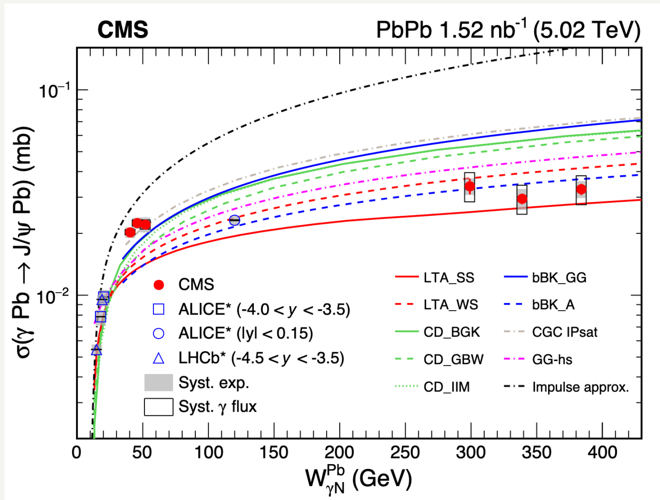
Relative modelling of
GDR (one neutron excitation) and
genuine break-up?



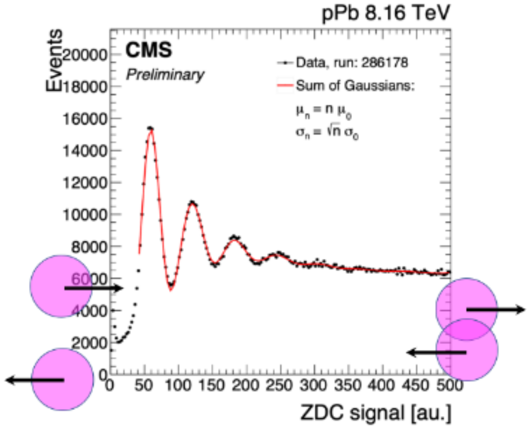


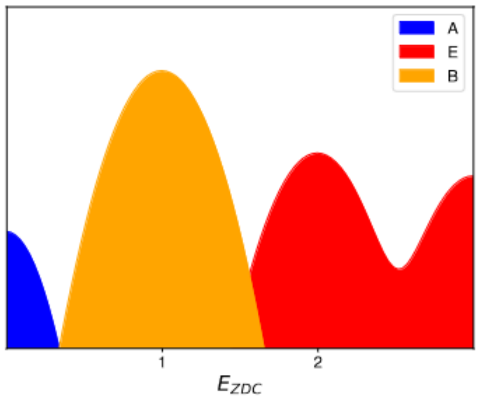
Known with sufficient
precision to separate
emitters?

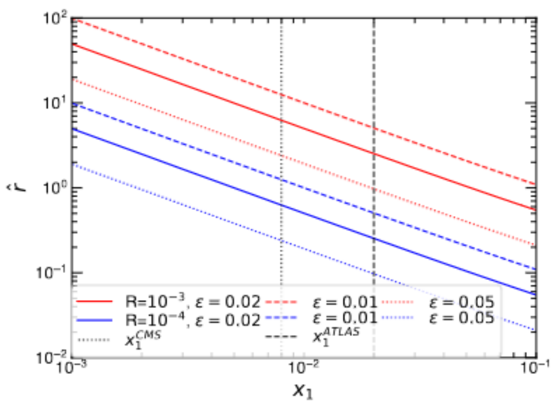




ZDCs at ALICE, ATLAS, and CMS can of resolve single to few neutron emissions.







We estimate the background reducing potential of the ZDC in a data driven way.
Assumptions:

1. Photoproduction events have no neutron emissions
2. Hadroproduction events have at least 1 neutron emission
3. Only 1-neutron events contaminate 0-neutron events with a probability ϵ
4. We assume something of the shape of the background ($x_1 = B/A$)

Kate: Modelling of these zero emissions classes needed.
Can we say anything for hadroproduction?