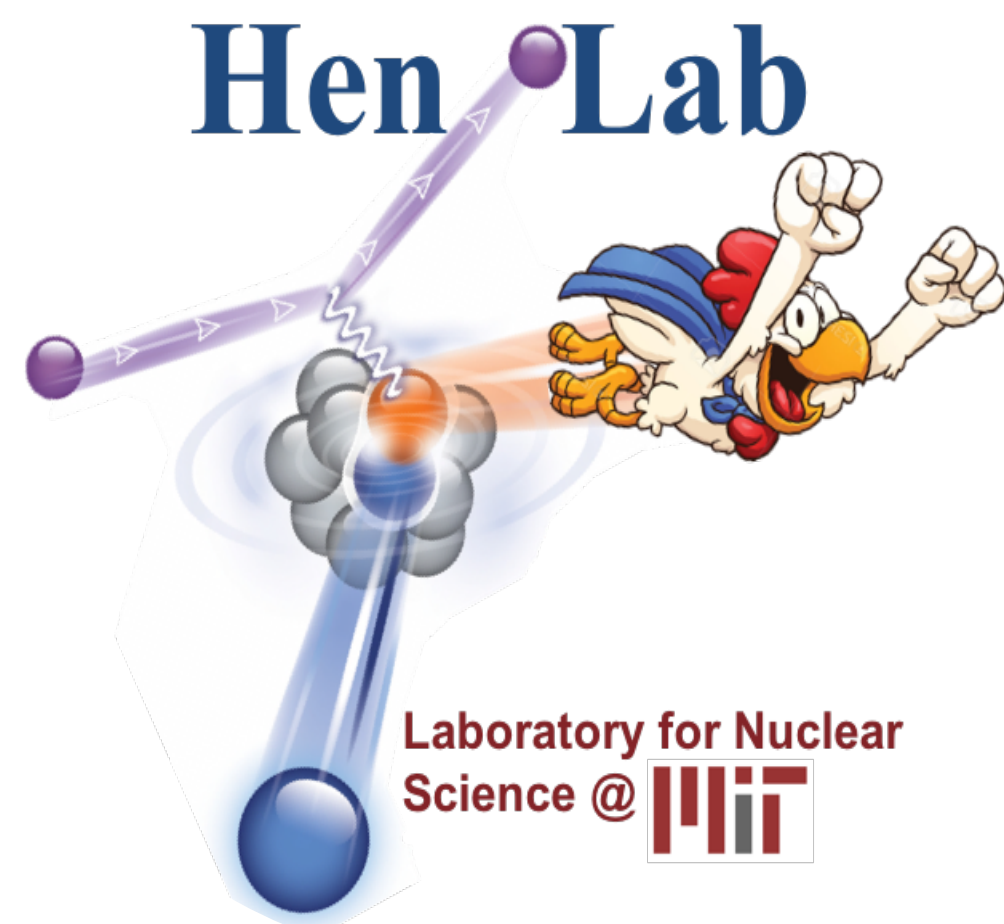
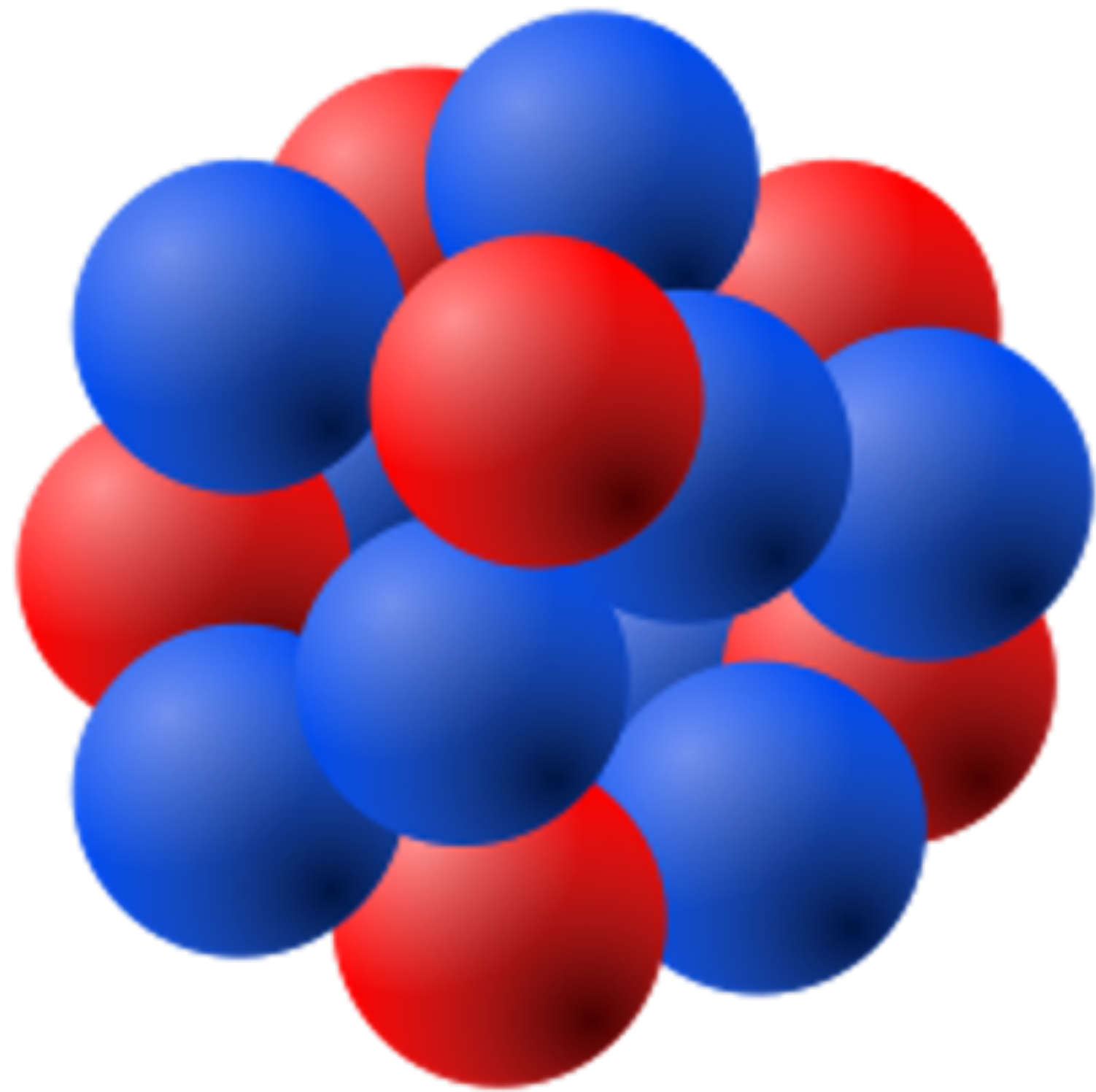


Threshold J/ψ Photoproduction as a Probe of Nuclear Gluon Structure

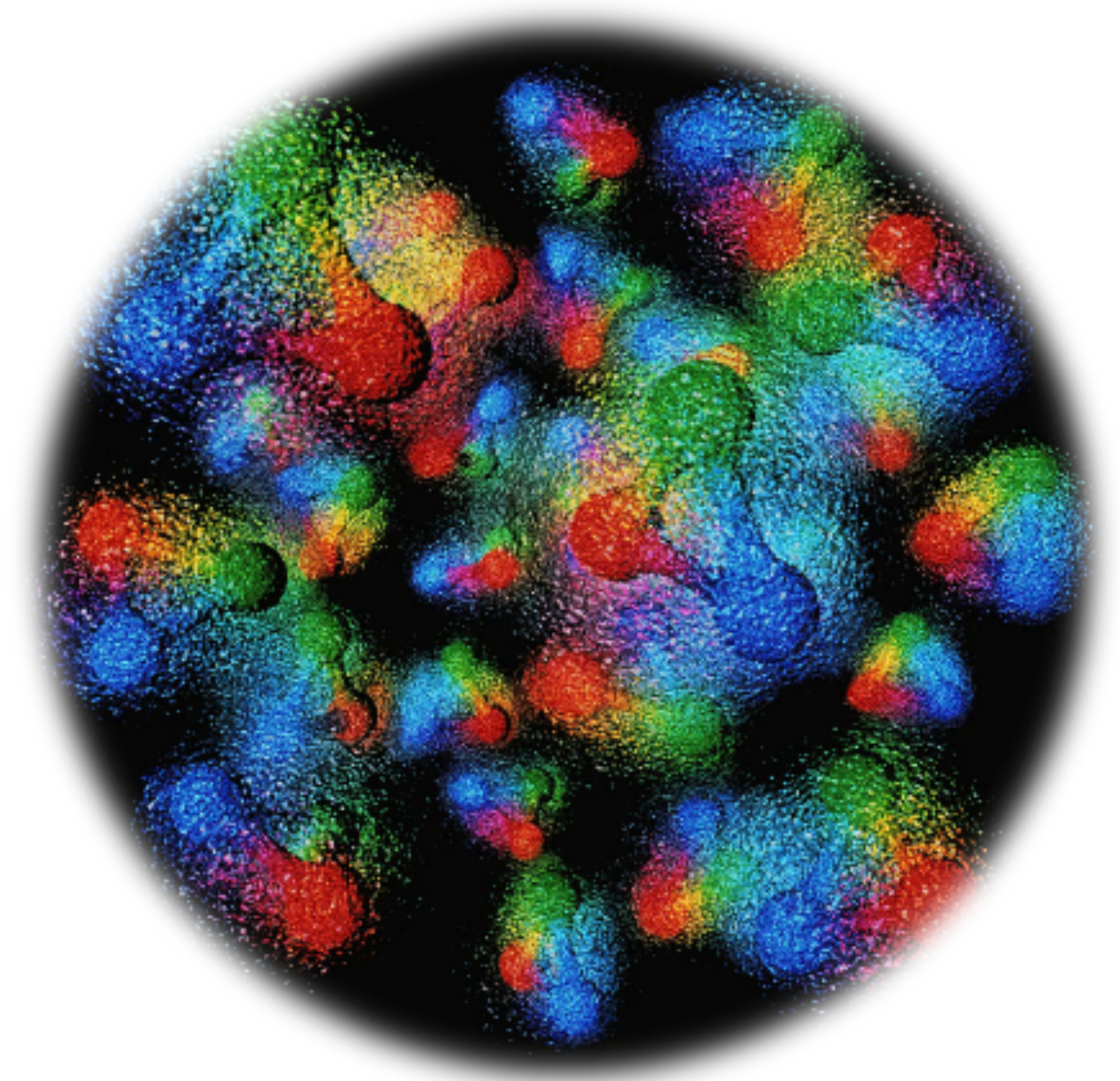
Jackson Pybus
April 3, 2024



Nuclear and parton dynamics are linked

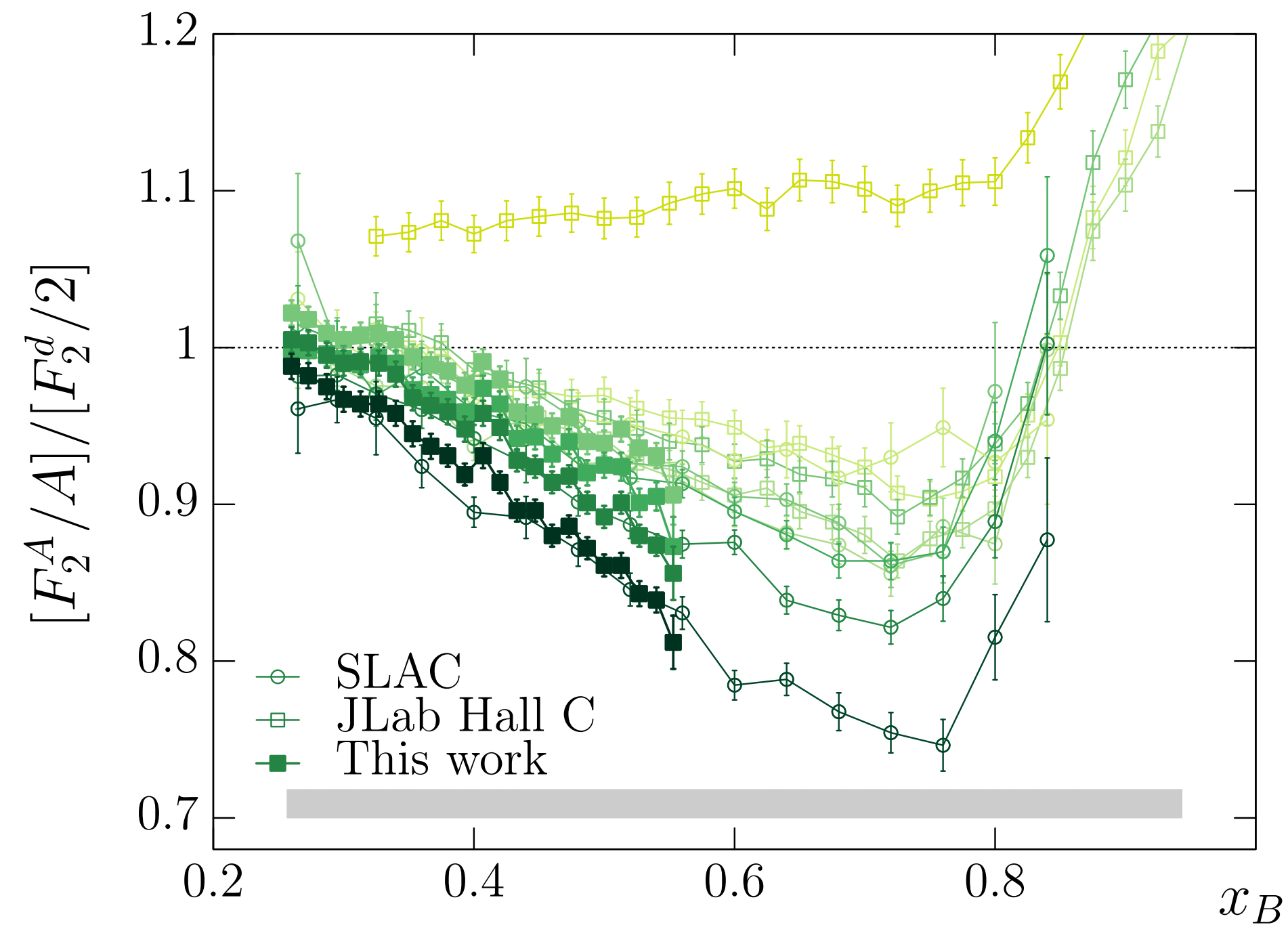


We describe nuclei as collections of protons and neutrons...

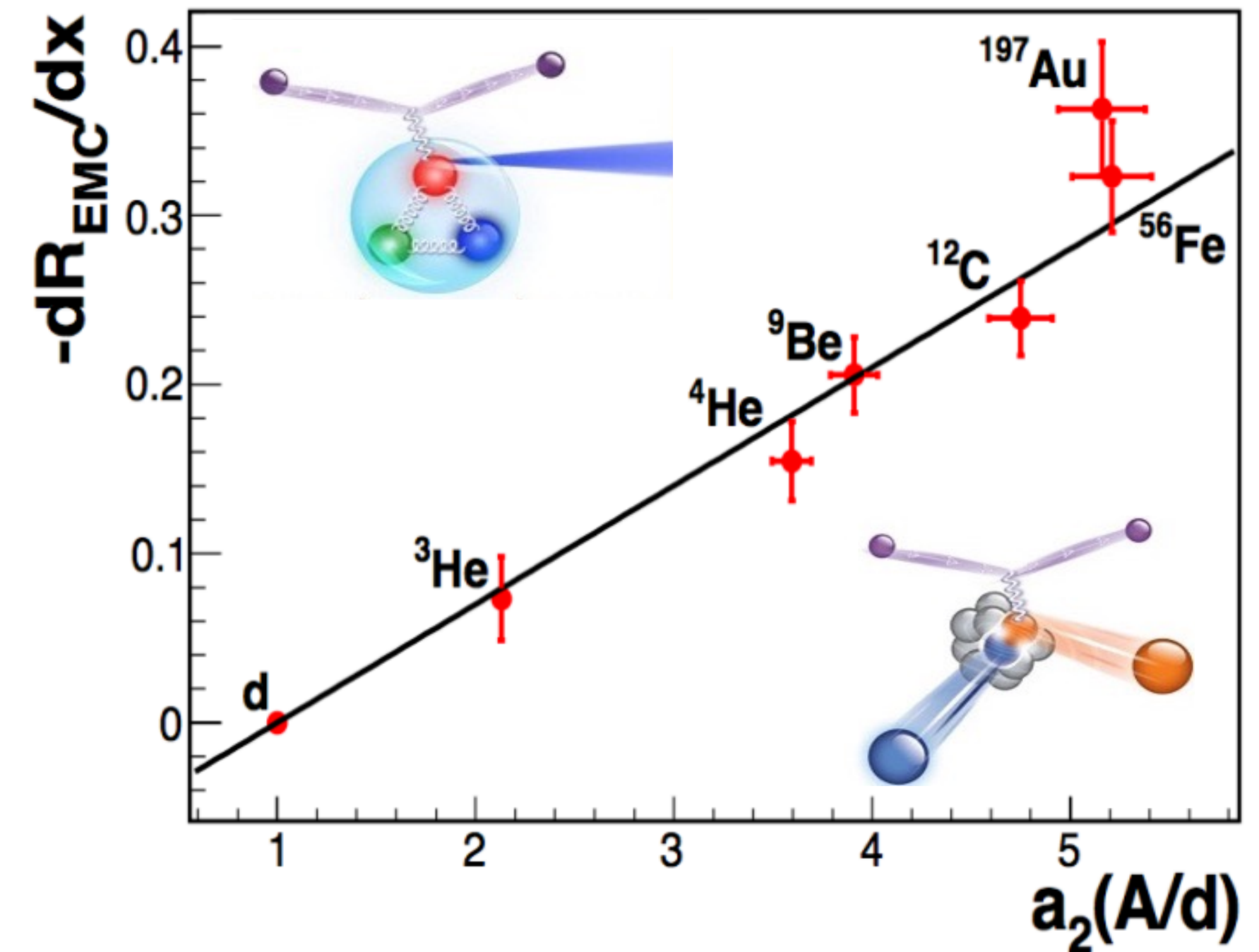


... but the reality is more complicated (quarks + gluons)

EMC Effect: Modification of quark content in nuclei



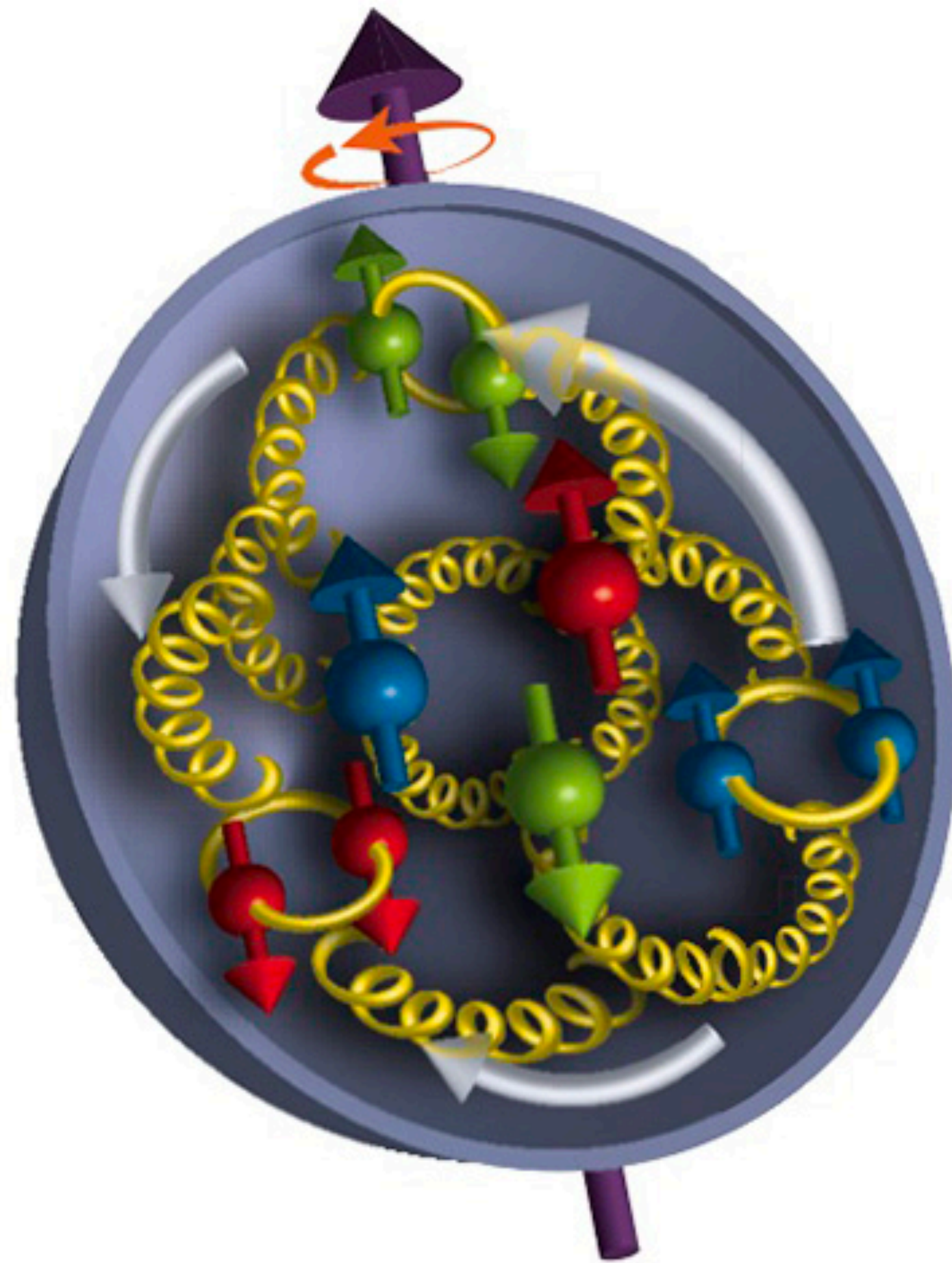
Fewer high-momentum quarks in nuclei



EMC effect correlated with SRCs

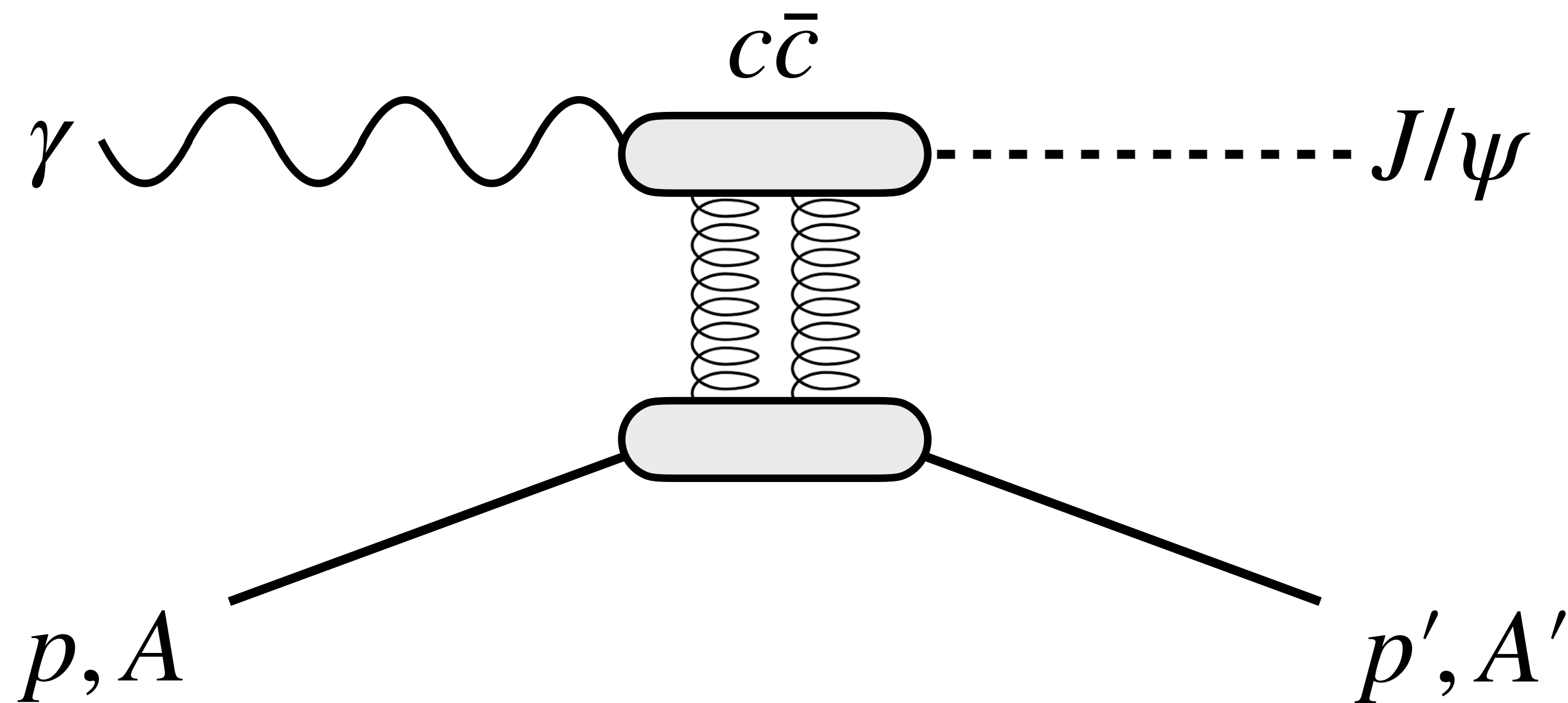
But what about the gluon content?

Quark sector:
EMC Effect



Gluon sector:
?

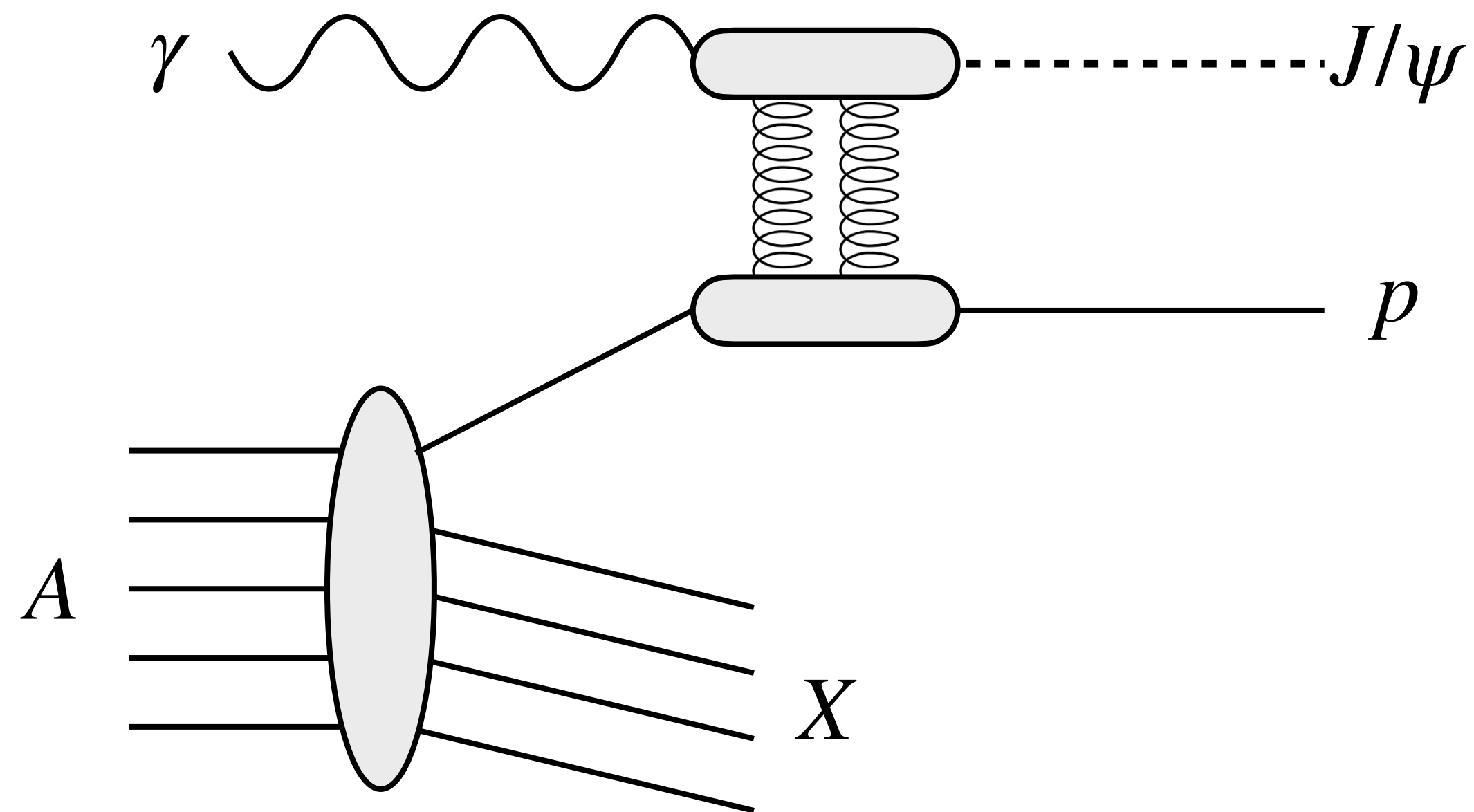
J/ψ is key probe of gluon physics



J/ψ is "color dipole", interacts by exchanging gluons

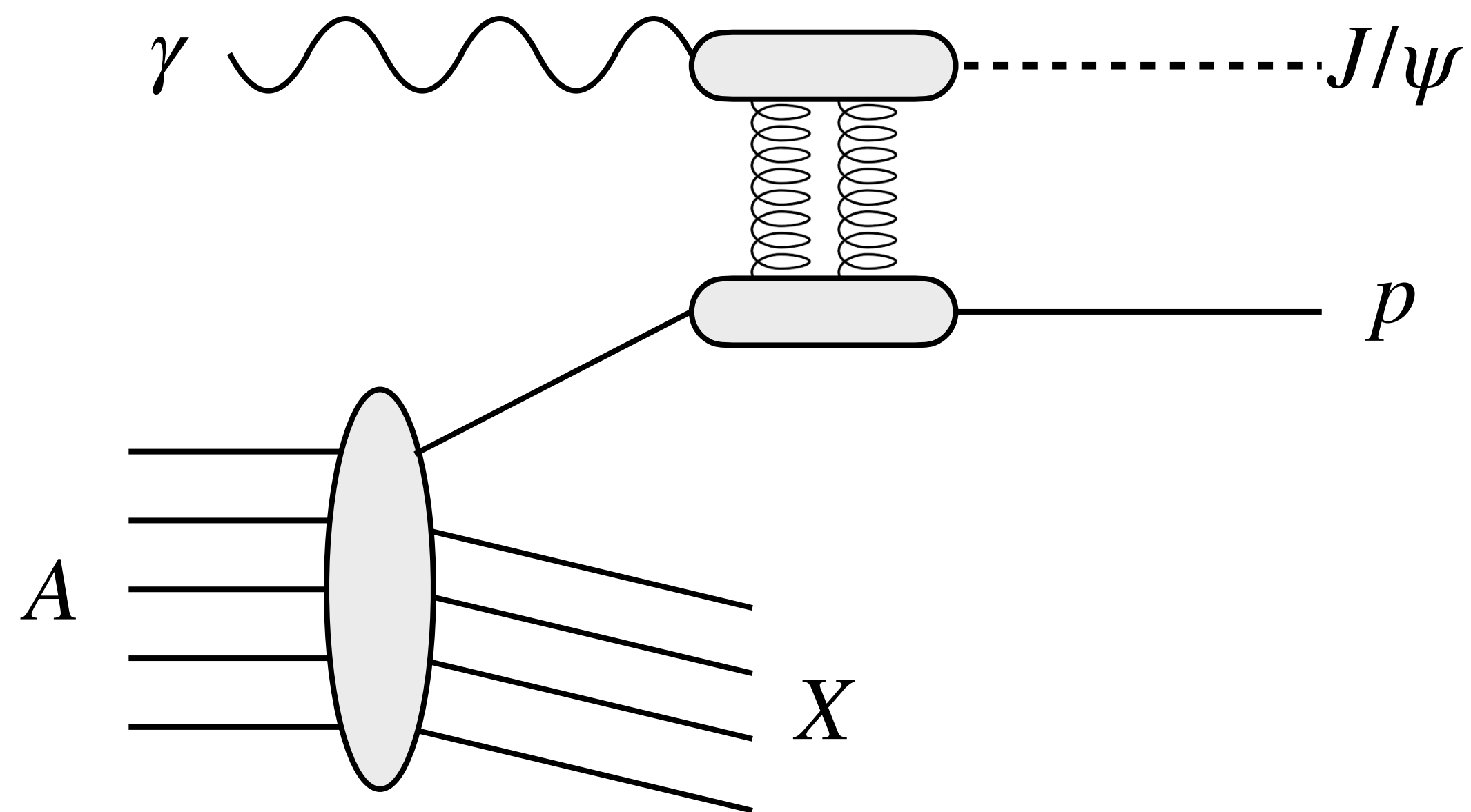
Sensitive to gluon densities and spatial distributions within the target

Photoproduction of J/ψ from bound protons

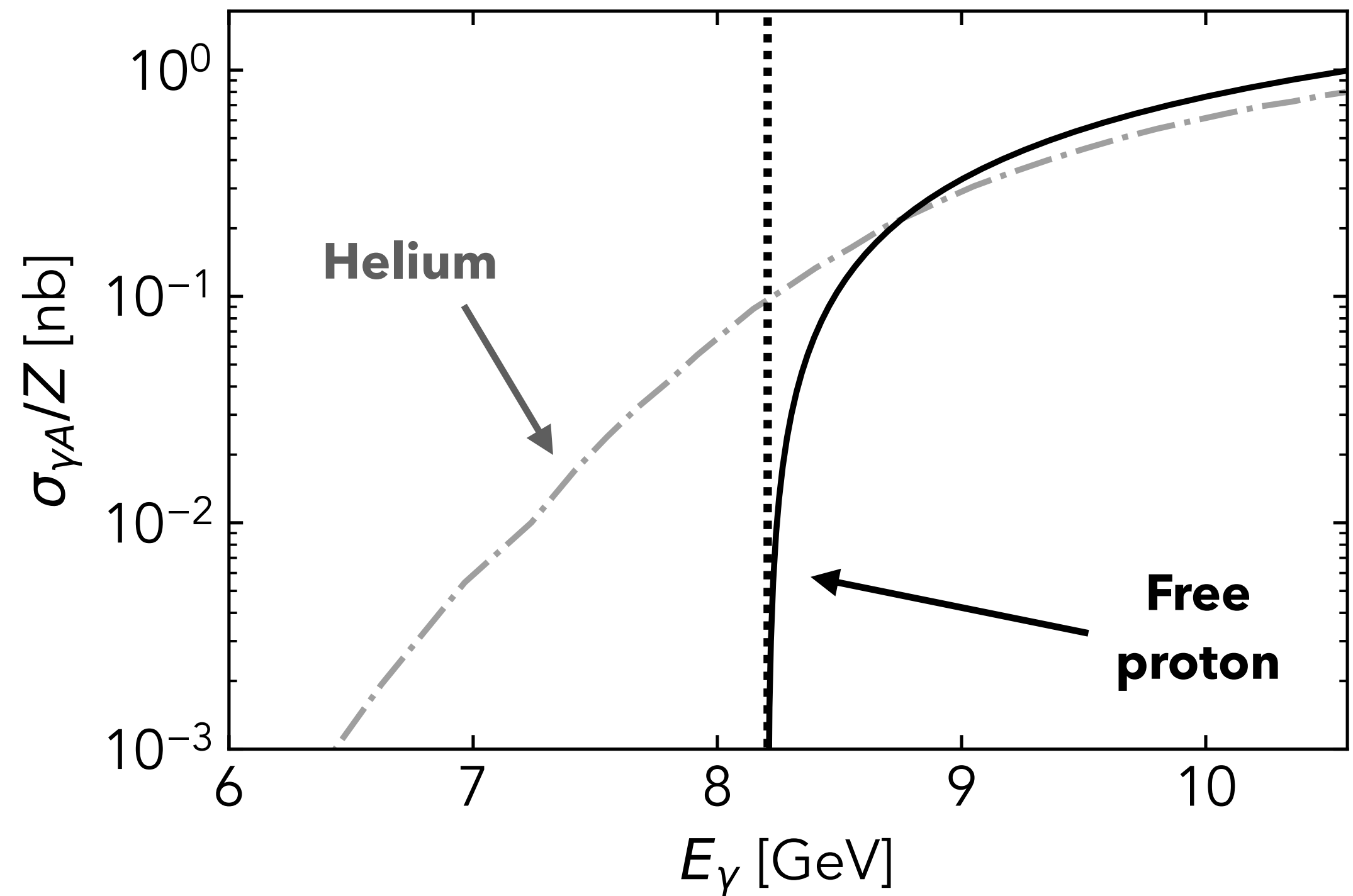


Incoherent J/ψ photoproduction near threshold sensitive to both nuclear and partonic effects

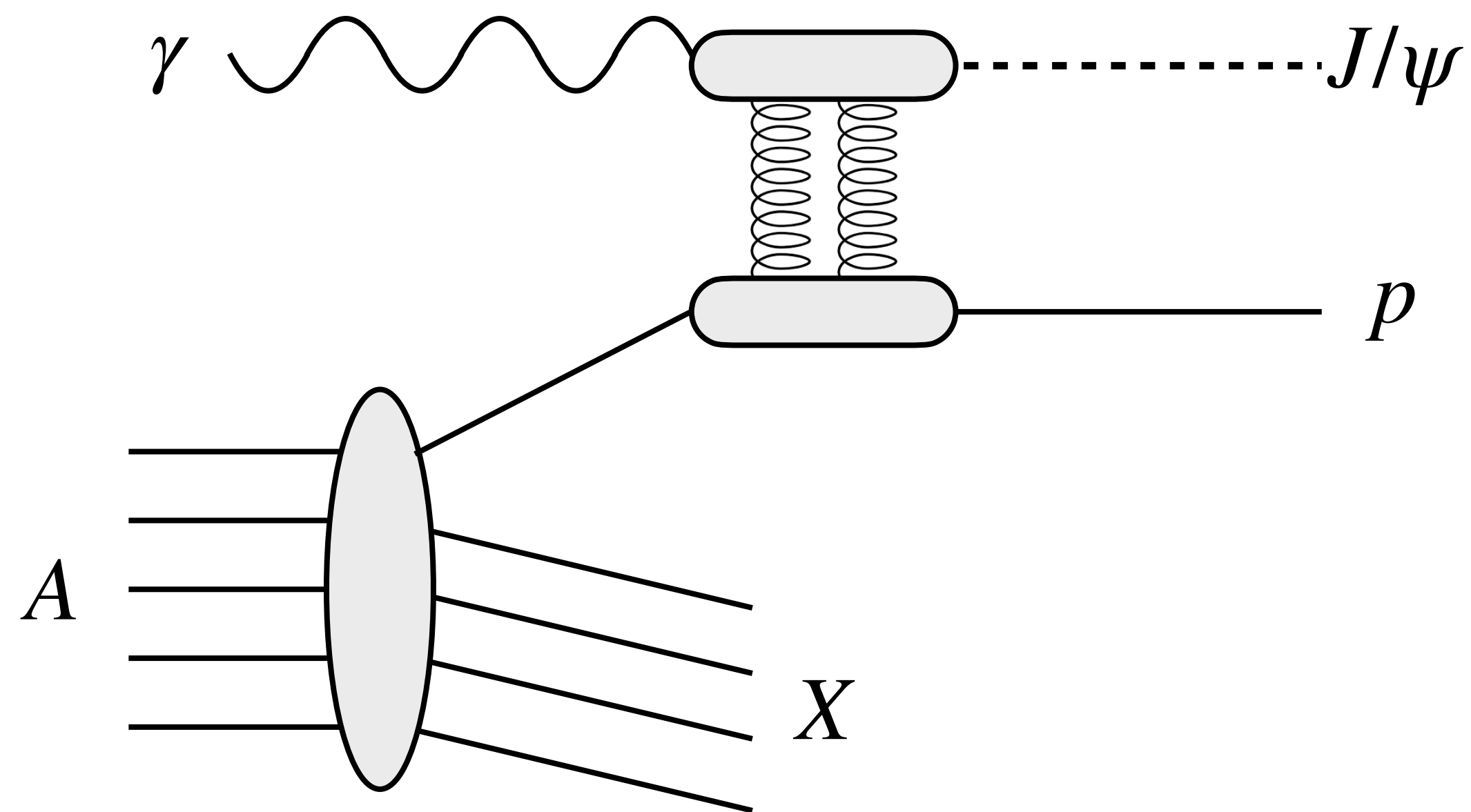
Photoproduction of J/ψ from bound protons



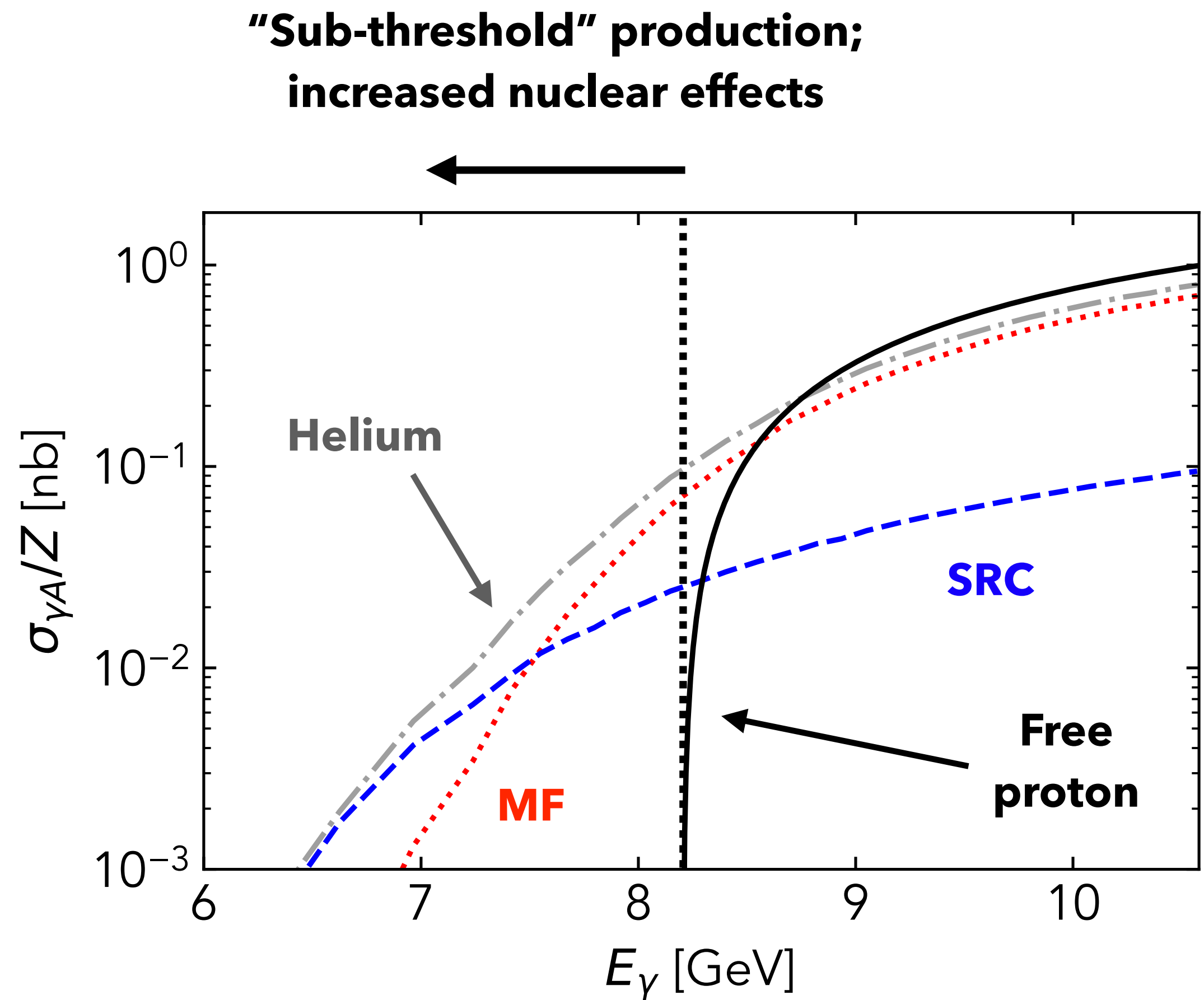
Incoherent J/ψ photoproduction near threshold sensitive to both nuclear and partonic effects



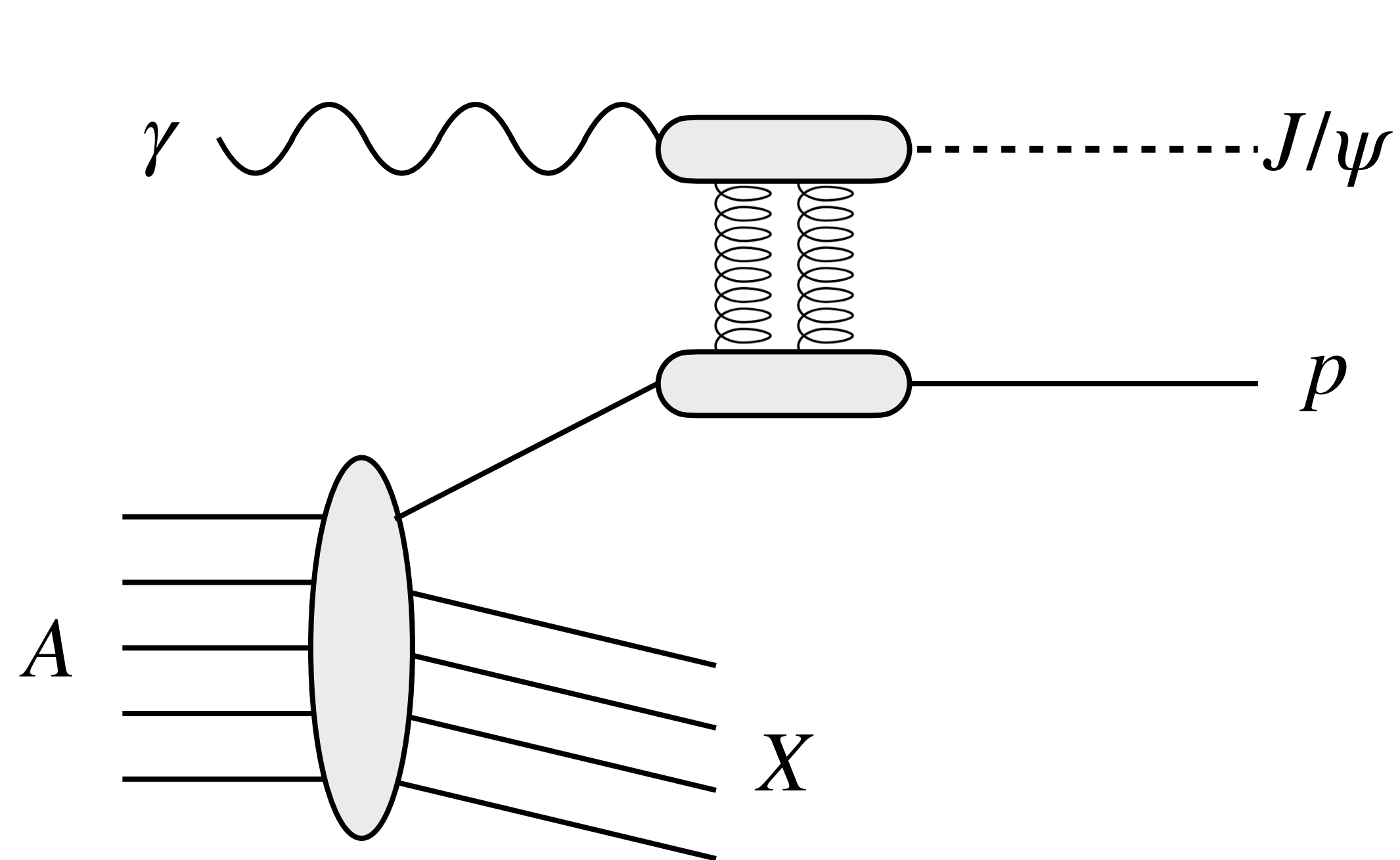
Photoproduction of J/ψ from bound protons



Incoherent J/ψ photoproduction near threshold sensitive to both nuclear and partonic effects

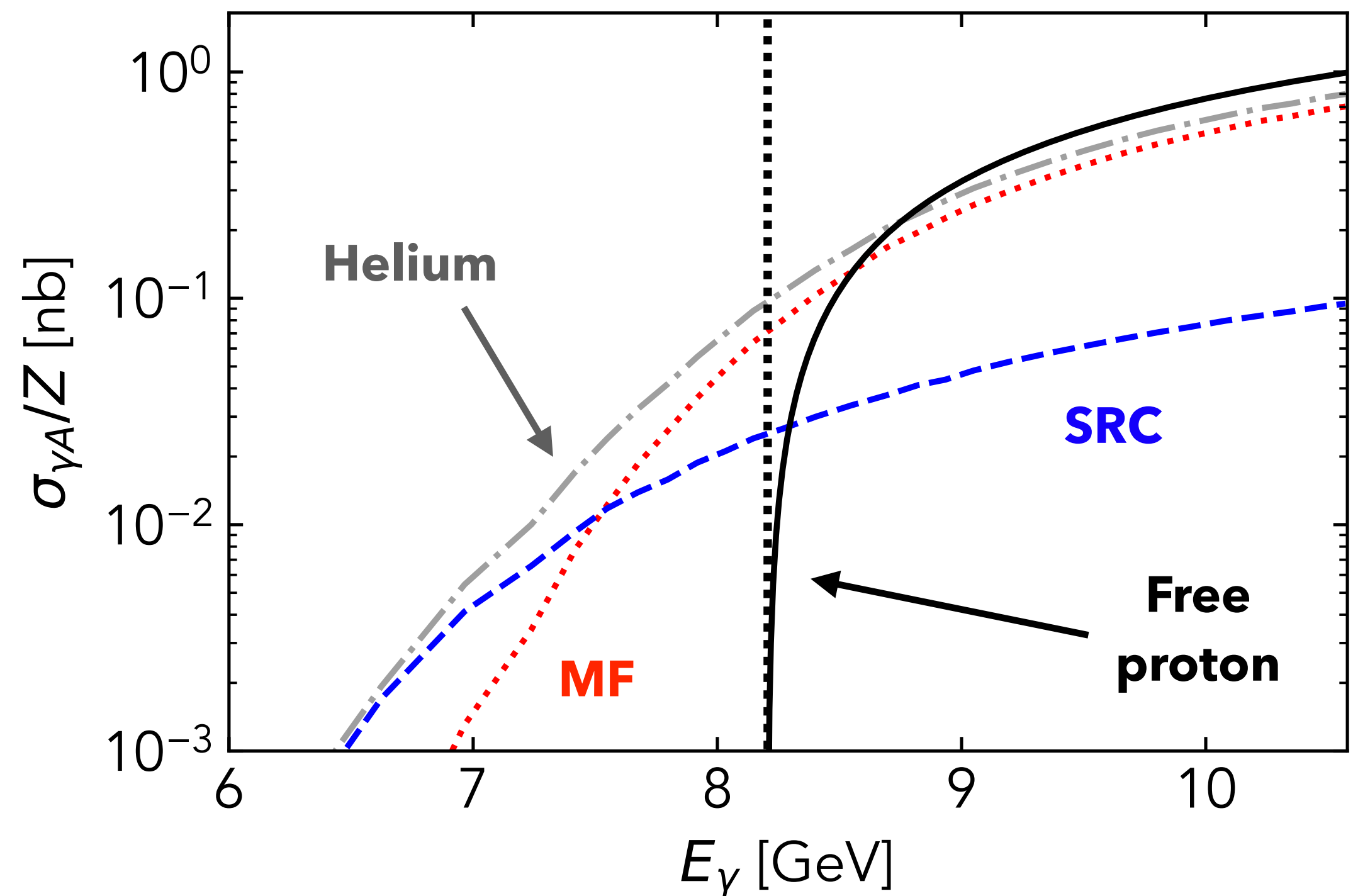


Photoproduction of J/ψ from bound protons

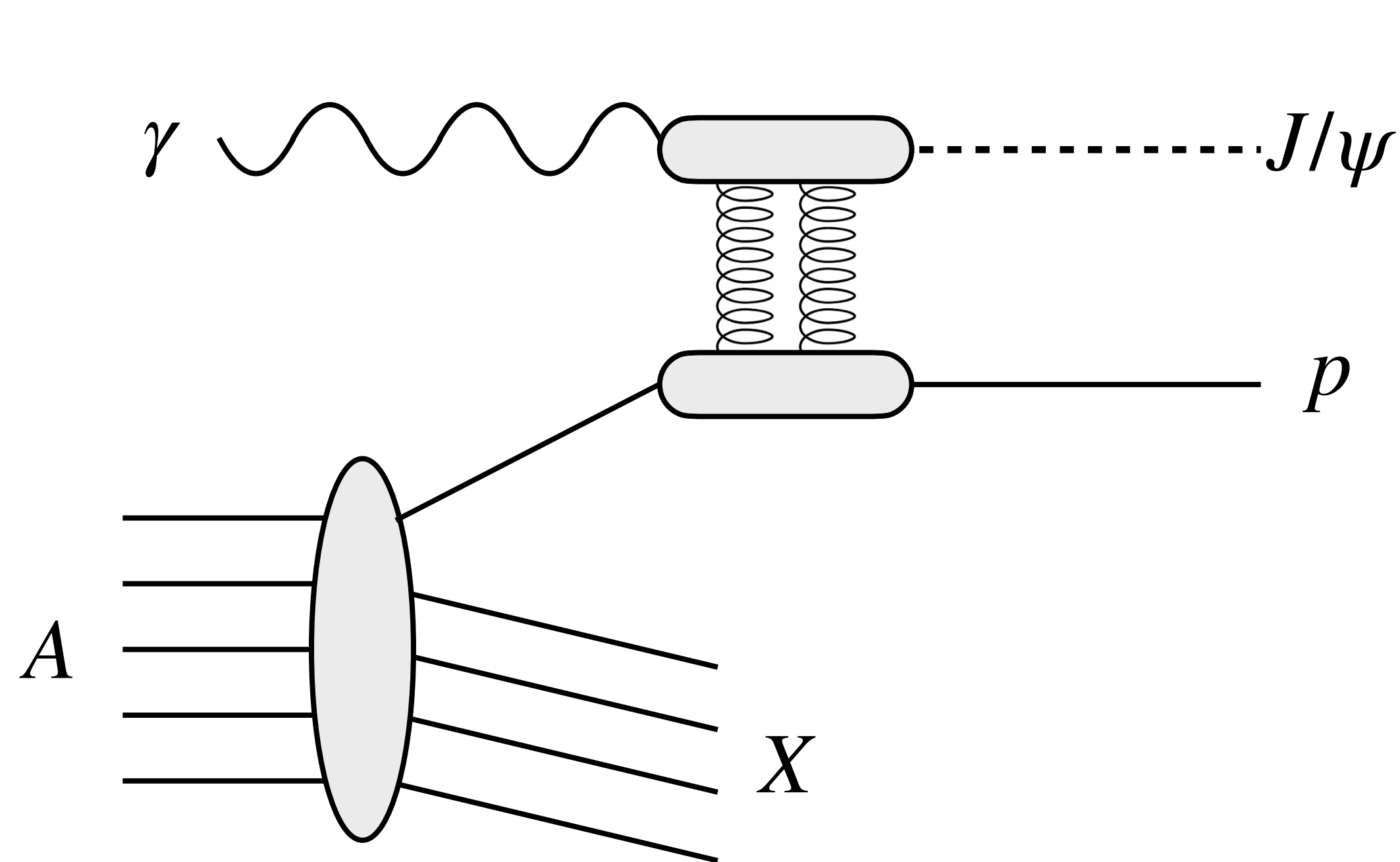


Incoherent J/ψ photoproduction near threshold sensitive to both nuclear and partonic effects

$$\frac{d\sigma(\gamma A \rightarrow J/\psi p X)}{dt d^3p_{miss} dE_{miss}} = v_{\gamma i} \cdot \frac{d\sigma}{dt}(\gamma p \rightarrow J/\psi p) \cdot S(p_{miss}, E_{miss})$$



Photoproduction of J/ψ from bound protons



Incoherent J/ψ photoproduction near threshold sensitive to both nuclear and partonic effects

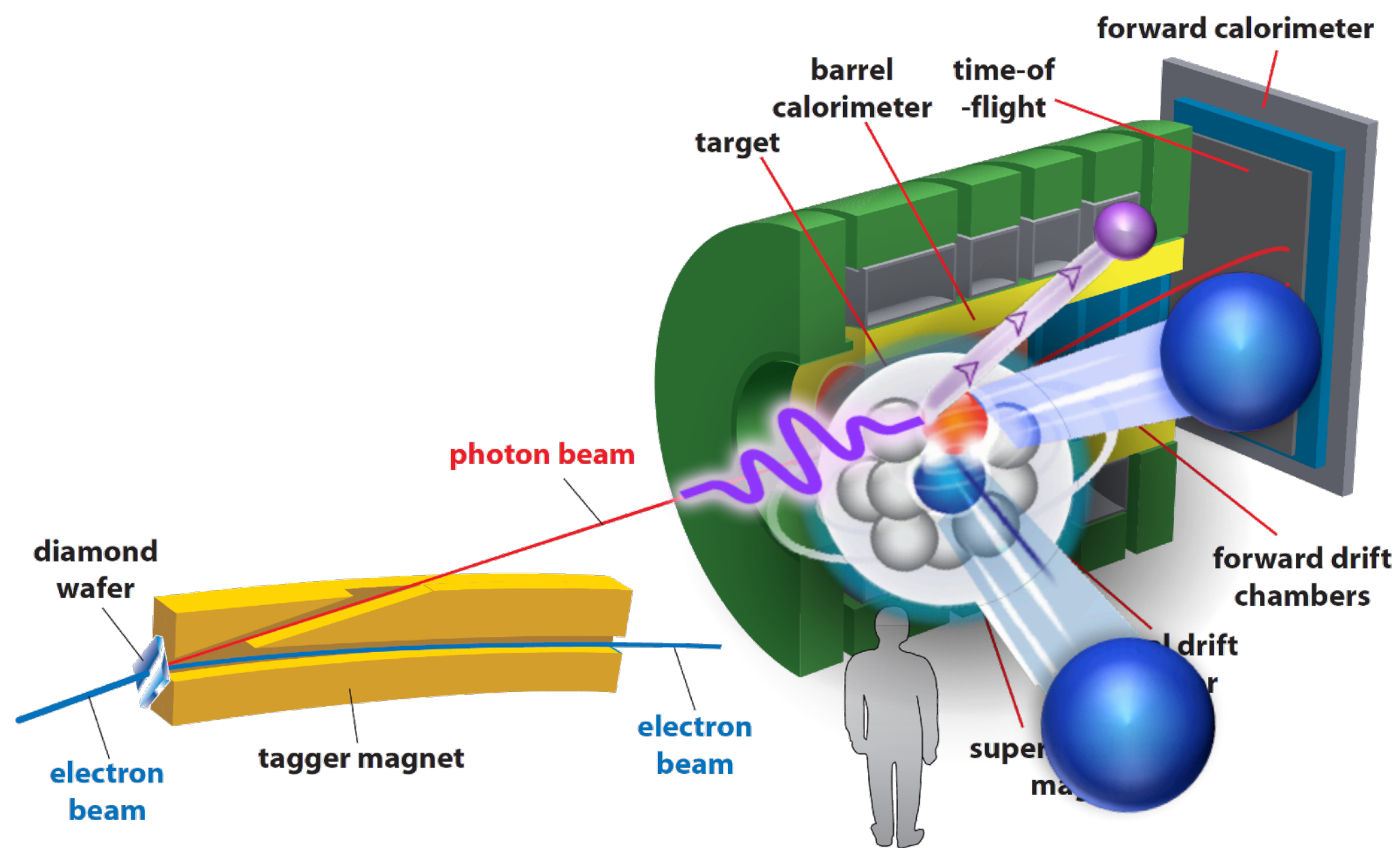
$$\frac{d\sigma(\gamma A \rightarrow J/\psi p X)}{dt d^3p_{miss} dE_{miss}} = v_{\gamma i} \cdot \frac{d\sigma}{dt}(\gamma p \rightarrow J/\psi p) \cdot S(p_{miss}, E_{miss})$$

$$\frac{d\sigma}{dt}(\gamma p \rightarrow J/\psi p) = \left. \frac{d\sigma}{dt} \right|_{t=0} (s_{\gamma p}) \times F^2(t)$$

Forward cross section

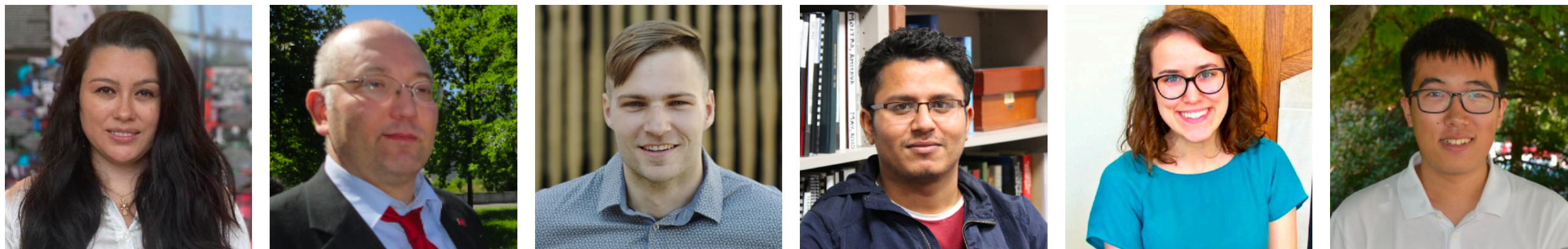
Gravitational form factor

Hall D SRC-CT Experiment

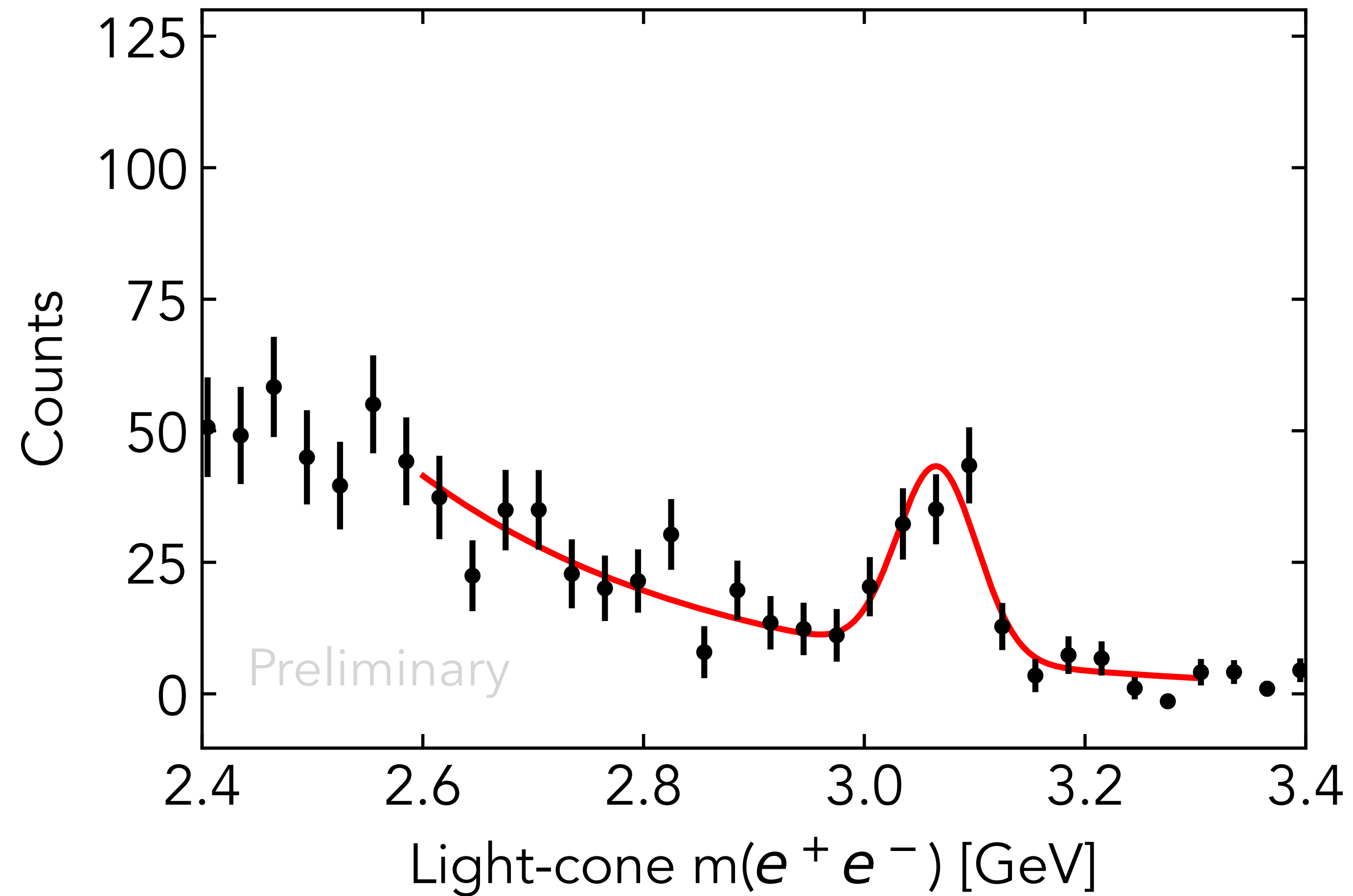


- Dedicated high-energy photonuclear measurement
- ~40-day measurement of targets ^2H , ^4He , ^{12}C
- 10.8-GeV electron beam – **tagged** coherent bremsstrahlung
- Final-state (e^+e^-p) detected in large-acceptance GlueX spectrometer

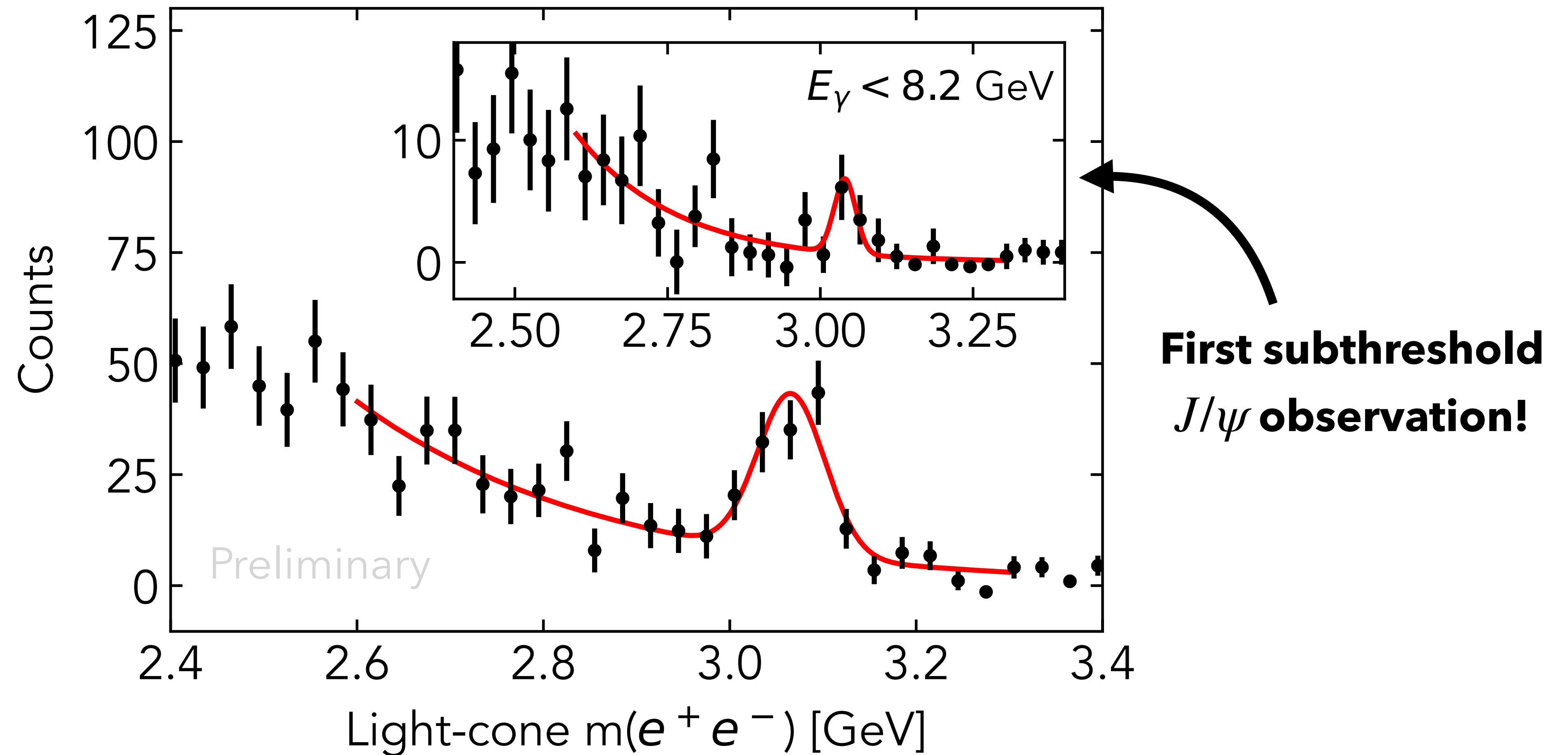
• • •



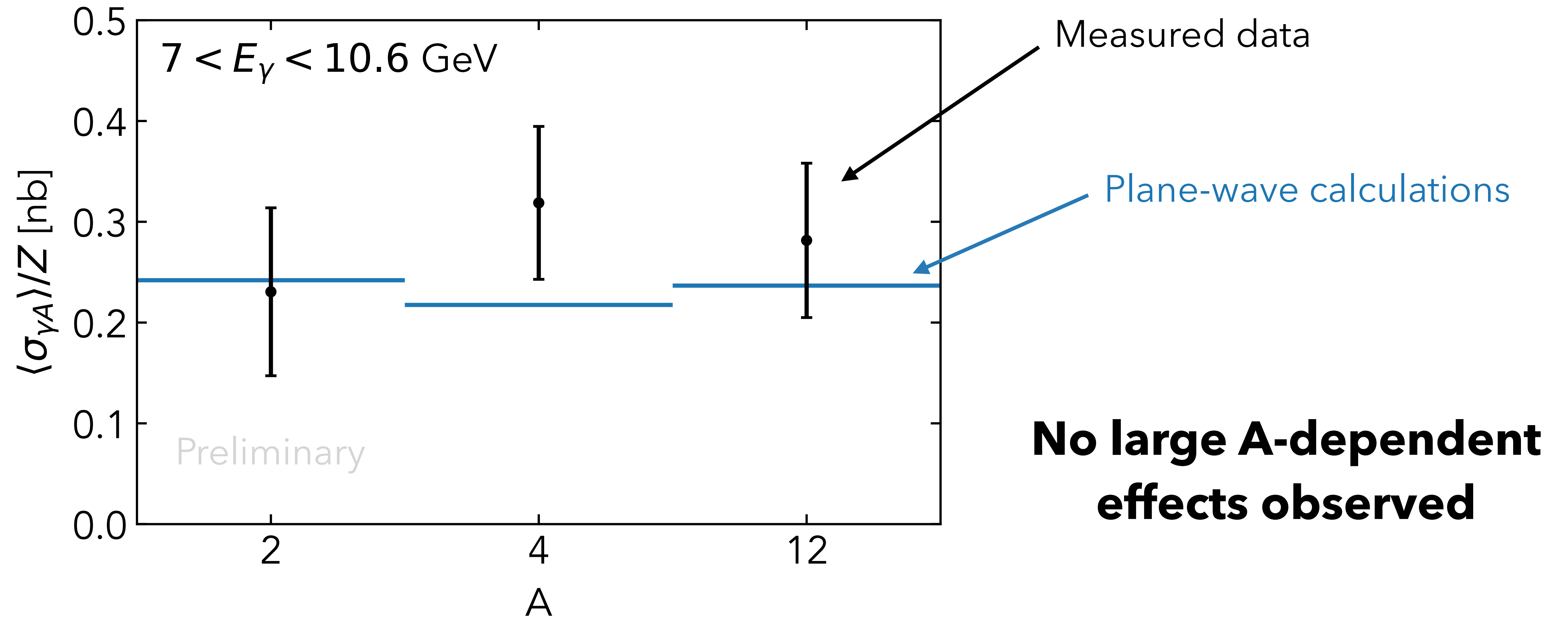
Invariant mass shows $J/\psi \rightarrow e^+e^-$ decay



Invariant mass shows $J/\psi \rightarrow e^+e^-$ decay

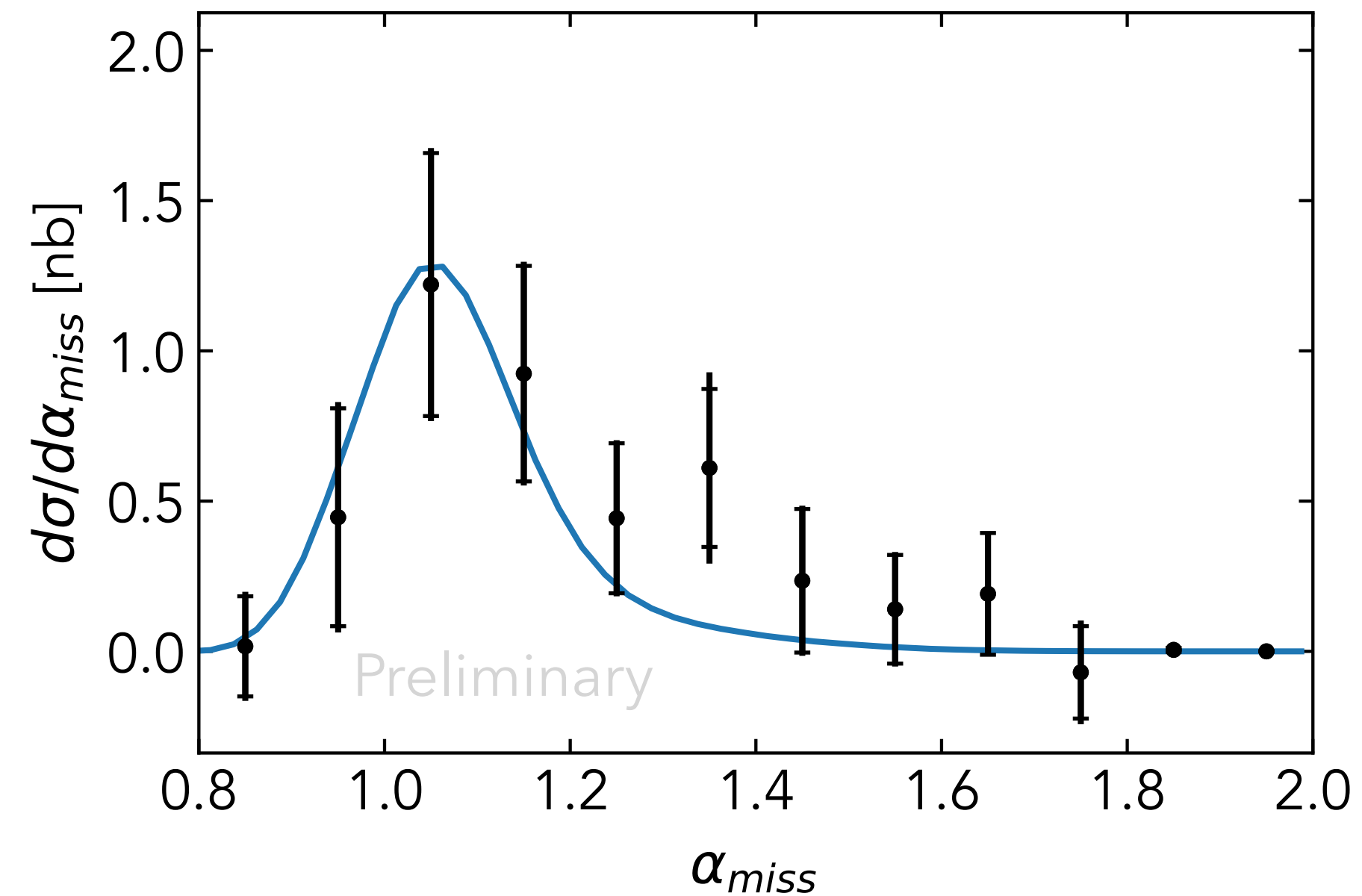


Energy-averaged cross section across nuclei

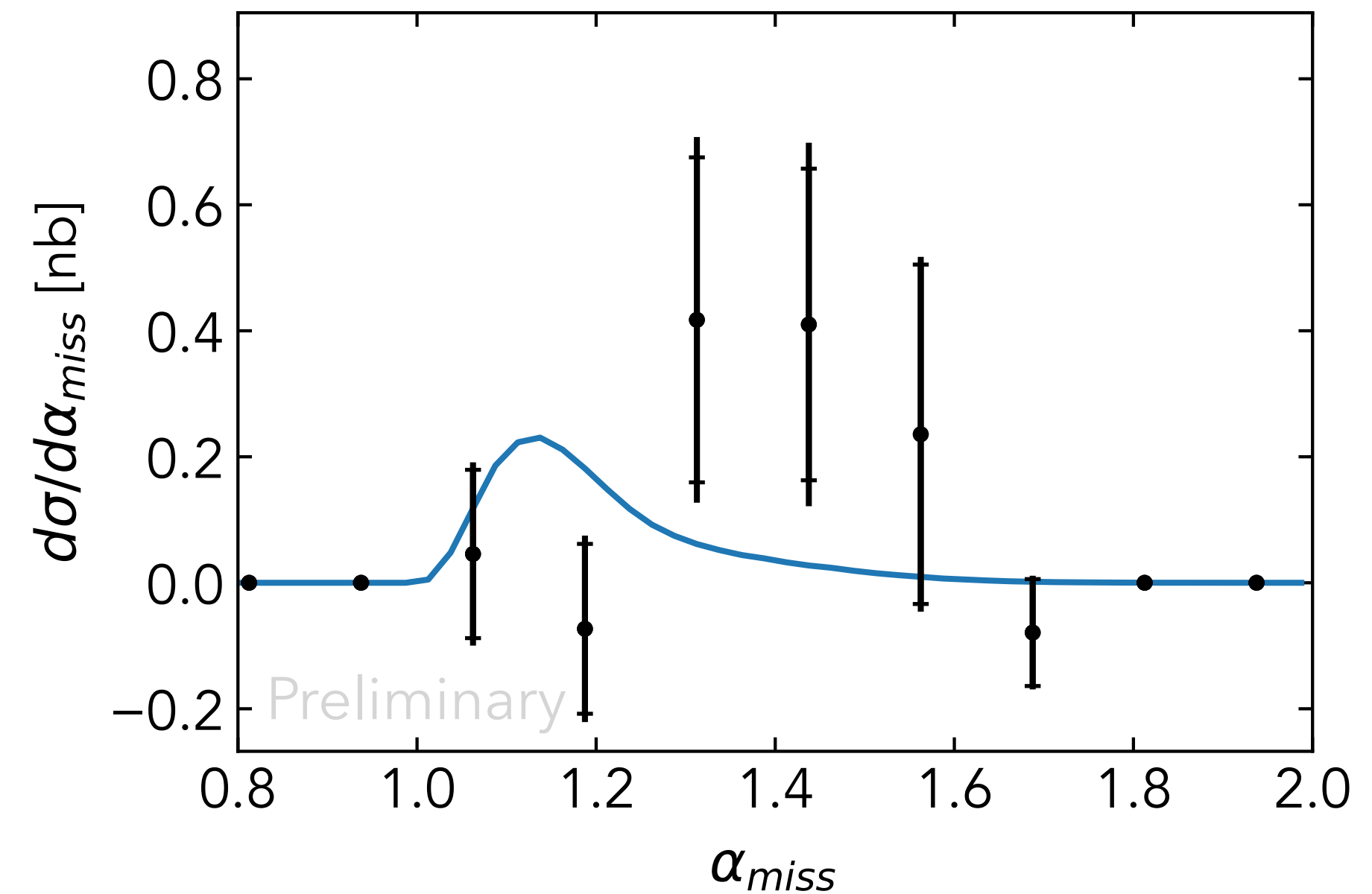


Kinematics give insight into reaction mechanisms

Above threshold: $E_\gamma > 8.2$ GeV

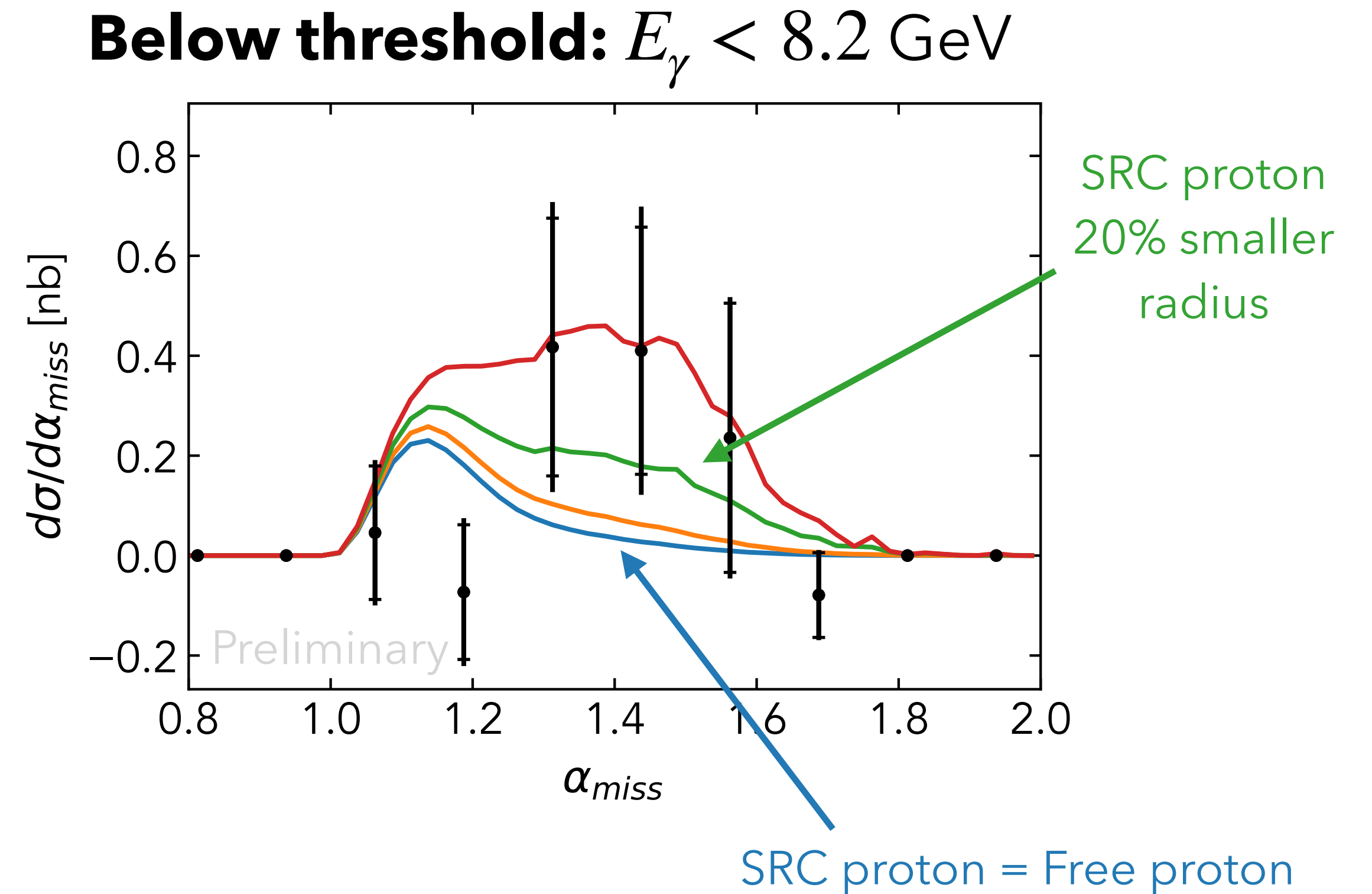
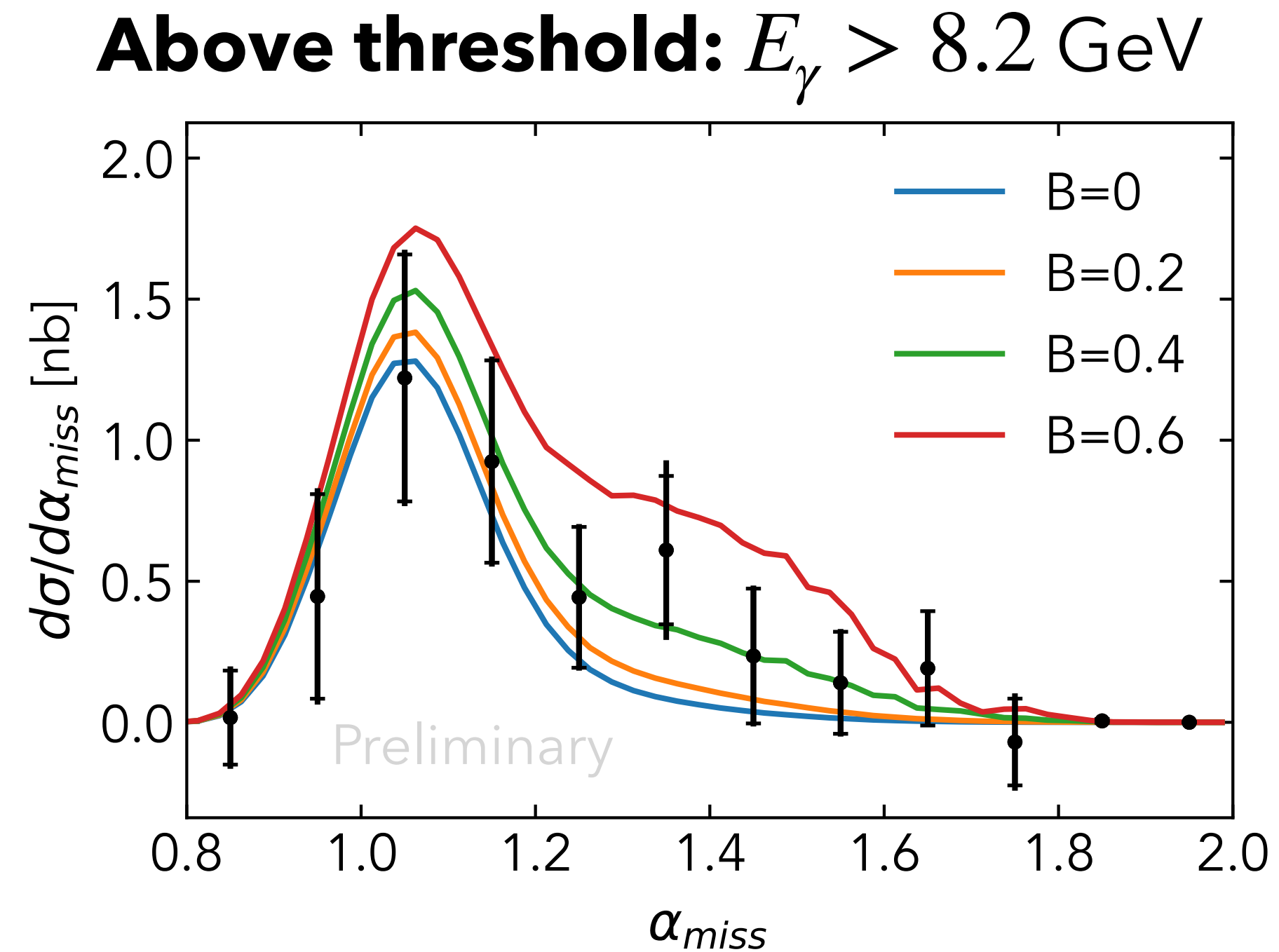


Below threshold: $E_\gamma < 8.2$ GeV



Lightcone momentum fraction $\alpha_{miss} = \frac{E_{miss} - p_{z,miss}}{m_A/A}$

Smaller-size proton could enhance large- α cross section



Modified gluon radius: $\langle r \rangle_g \rightarrow (1 + Bv)\langle r \rangle_g$

Conclusions

- New photonuclear measurement gives first measurement of incoherent J/ψ production at and below threshold energy
- Kinematic distributions indicate possible modification of gluons in bound proton
- Proposed high-statistics measurement **PR12-23-009** will shine more light on mechanisms of large- x nuclear gluons

