

# Nuclear structure theory for an Electron–Ion Collider

- High–luminosity polarized  $ep/eA$  collider (JLab, BNL)

CM energy  $\sqrt{s} \sim 10\text{-}40$  GeV/nucleon, luminosity  $\sim 10^{34}$  cm<sup>-2</sup>s<sup>-1</sup>

Polarized light ions: Deuterium D(pol), <sup>3</sup>He(pol), <sup>4</sup>He, Li, Be, . . .

- Deep-inelastic scattering from light ions

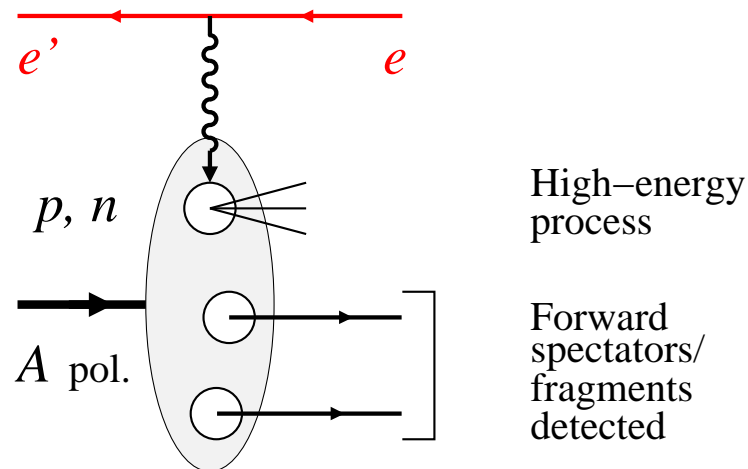
Physics objectives: Neutron partonic structure, bound nucleon in QCD, coherent nuclear phenomena

- Spectator nucleon tagging

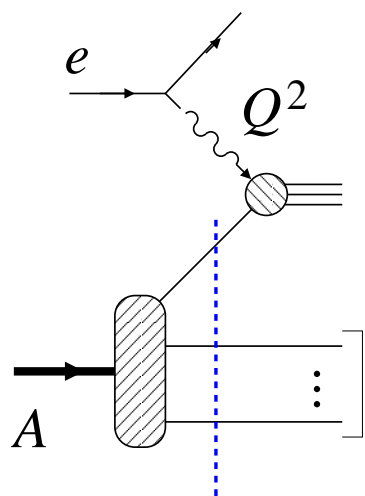
Identify active nucleon,  
control its quantum state

Next–generation measurements:  
Precision, theoretical control

Uniquely suited for collider:  
Forward detectors, spectator momenta  
measured, no target material



- Nuclear structure in high-energy scattering



Light-front time  $x^+$

Factorize deep-inelastic process — nuclear structure.  
Impulse approximation, final-state interactions

Nucleus probed at fixed light-front time  $x^+ = t + z$ .  
Low-energy structure, just viewed differently!

- Theory input for spectator tagging

Light-front wave functions of light nuclei  $D(\text{pol})$ ,  ${}^3\text{He}(\text{pol})$ , ...  
in nucleon degrees of freedom  $\langle N..N|A \rangle$

Light-front spectral functions  $A \rightarrow N(p^+, \mathbf{p}_T) + \text{spectators}$ ,  
including components with  $p \gg p_F$  from correlations

Estimates of final-state interactions using phenomenological models,  
identification of configurations minimizing FSI

- Applications of spectator tagging

Free neutron structure from  $D$  with proton tagging and on-shell extrapolation  $p_{\text{Recoil}} \rightarrow 0$ . Eliminate Fermi motion and binding effects

Quark/gluon structure of short-range  $NN$  correlations from tagging deep-inelastic processes with  $p_{\text{Recoil}} \gg p_F$

- R&D status and needs

Joint theoretical-experimental R&D for spectator nucleon tagging on-going. Focus on polarized  $D$  – simple! Simulations, detector development.

JLab 2014 LDRD project “Physics potential of polarized light ions with EIC@JLab”

$A > 2$  nuclei need dedicated theoretical effort. Expert groups, several years

- Intellectual challenges

Light-front nuclear structure from NMBT – new formulation!  
Use of EFT-constrained interactions for light-front structure?

**Nuclear theory input needed to realize full potential of next-generation experiments at EIC with spectator tagging**