

Next-generation nuclear physics with JLab12 and EIC

Topical Workshop, Florida International University, 10–13 Feb 2016
W. Brooks, R. Dupre, Ch. Hyde, M. Sargsian, C. Weiss (Organizers)



- Welcome!
- Physics perspective
- Plan of meeting

 **Jefferson Lab**
Thomas Jefferson National Accelerator Facility

 **FIU**
FLORIDA INTERNATIONAL UNIVERSITY
Miami's public research university

High-energy nuclear physics

- JLab 12 GeV operations started

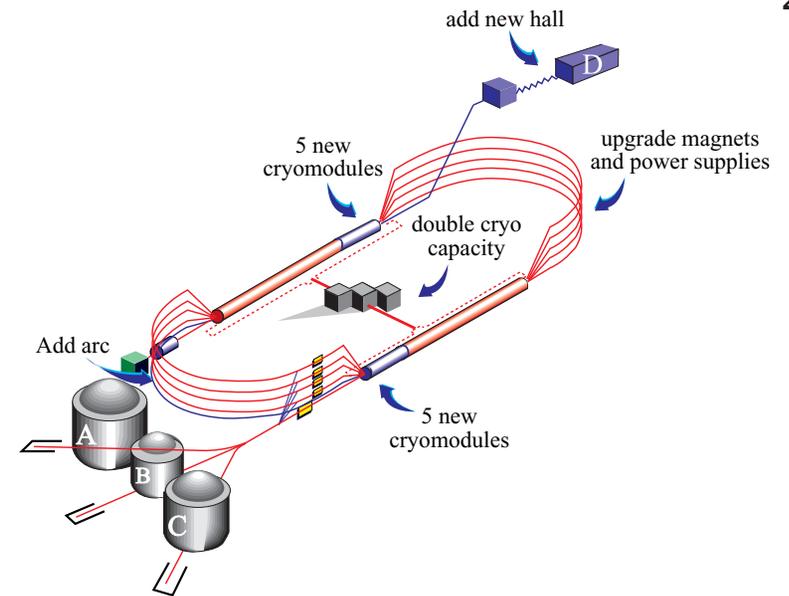
Hall A running at 11 GeV/70 μA

Hall D commissioning on-going

Hall C comm expected in few months

CLAS12 under construction

Future: Møller, SOLID, kaon beam



- EIC recommended in NSAC Long-Range Plan

Designs by BNL and JLab

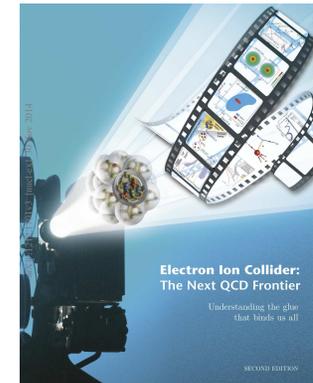
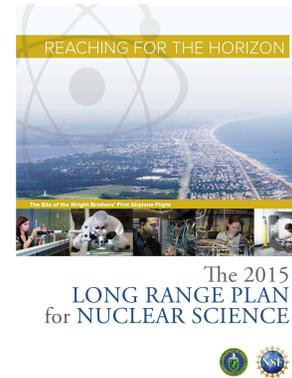
Vigorous accelerator and detector R&D

LDRD at BNL and JLab. Generic detector R& D program

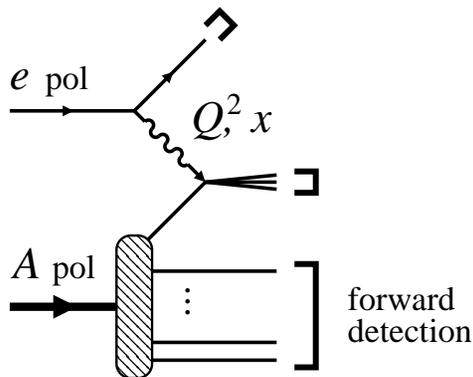
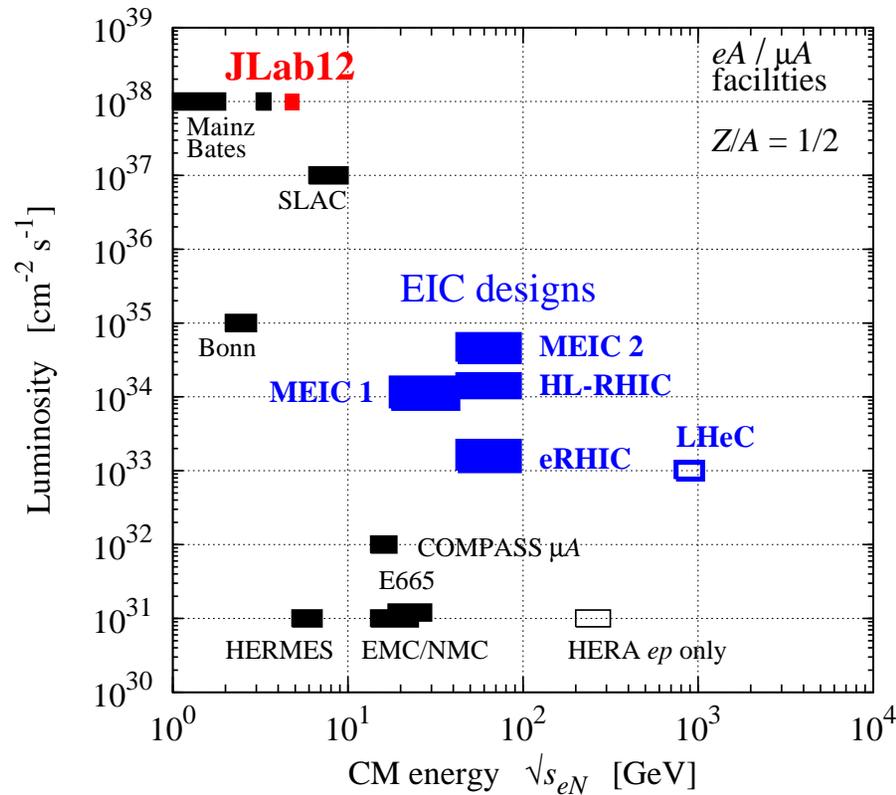
Formation of user group on-going

EIC User Group Meeting, UC Berkeley, Jan 6-9, 2016

CD0 expected in next few years



- Hadron probes: LHC, RHIC, GSI FAIR, J-PARC



- CM energy $\sqrt{s_{eN}} \sim 20\text{--}100$ GeV
 $Q^2 \sim \text{few } 10 \text{ GeV}^2$ for DIS
 $x \sim 10^{-1}\text{--}10^{-3}$ for sea quarks, gluons
- Luminosity $\sim 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$
 Exceptional configurations in target
 Multi-variable final states
 Polarization observables
- Polarized light ions
 eRHIC: pol ^3He
 MEIC: pol D and ^3He with figure-8
- Forward detection of p, n, A
 Spectator tagging
 Coherent nuclear processes

- Short-range nuclear structure

High-momentum components, short-range correlations, $x > 1$

- Neutron partonic structure and spin

Extraction of free neutron, spectator tagging, polarization

- Nuclear modifications and coherent effects

EMC effect, antishadowing, shadowing, saturation

- Parton propagation and hadronization

Color transparency, parton propagation in medium, hadronization, jets

Common perspective JLab12 \leftrightarrow EIC

Detection of nuclear final states

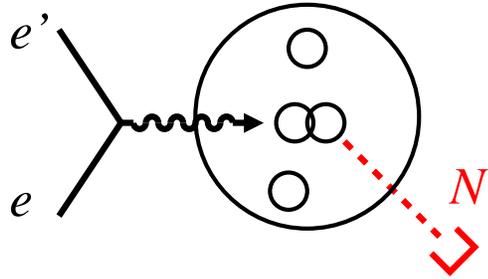
Complementarity light \leftrightarrow heavy ions



this meeting

Short-range nuclear structure

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Short-range correlations: Spin/isospin dependence, role in nuclear structure, universality? → **Piassetzky, Neff**

Short-range NN interaction, non-nucleonic DOF?

Connection with QCD?

JLab 6/12 GeV: Focused program

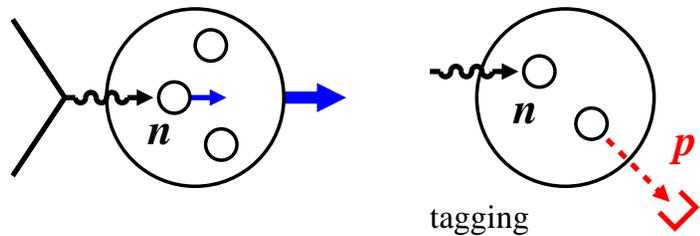
- SRCs from $(e, e'N)$ → **Hen, Cohen**
- SRCs from inclusive scattering at $x > 1$, isospin dependence → **Day, Fomin, Solvignon**
- SRCs and partonic structure: Tagged EMC effect → **Higinbotham**

EIC: New opportunities

- Partonic structure of SRCs from tagged DIS → **Hen**
- Tagging $\Delta\Delta$ component of deuteron → **Sievert**

Neutron partonic structure

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Flavor decomposition of PDFs/spin/GPDs,
singlet \leftrightarrow nonsinglet separation for QCD evolution?

Challenges in dilution from protons, nuclear binding,
neutron polarization

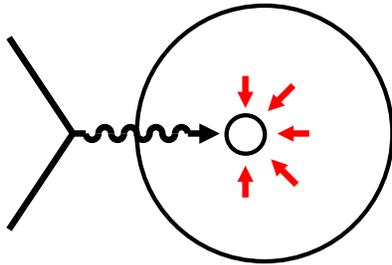
JLab 6/12 GeV: Valence region

- Neutron spin structure with inclusive DIS on $3\text{He}(\text{pol})$, $\text{D}(\text{pol})$
- Neutron structure with spectator tagging on $\text{D}(\text{unpol})$ → **Kuhn**
- Neutron GPDs with quasi-free DVCS on D → **Munoz Camacho**

EIC: Wide $x-Q^2$ range, spectator tagging

- Neutron spin structure with inclusive DIS on $3\text{He}(\text{pol})$, $\text{D}(\text{pol})$ → **Deshpande, Scopetta**
- Free neutron structure through DIS on $\text{D}(\text{pol})$
with proton tagging and on-shell extrapolation → **Park, Cosyn**
- Neutron DVCS with $\text{D}(\text{pol})$, possibly tagged

- $x > 0.2$: EMC effect



Modified nucleon structure, non-nucleonic DoF

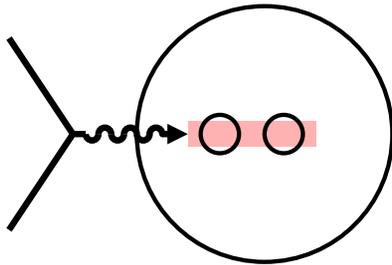
Spin/isospin dependence?

Modification of sea quarks and gluons?

→ Cloet

Connection with SRCs?

- $x \sim 0.1$: Antishadowing



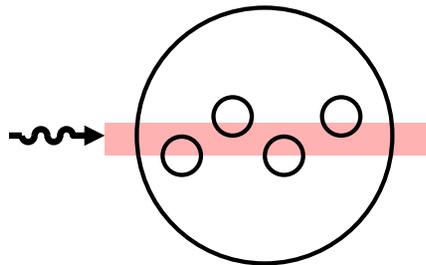
NN interactions, exchange mechanisms

Spin/isospin dependence?

Valence quarks, sea quarks, gluons?

→ Keppel

- $x \lesssim 0.01$: Coherent effects



Nuclear shadowing: Leading vs. higher twist?

Sea quarks, non-singlets?

→ Guzey

Growth of nuclear gluon density at small x ?

Unitarity limit in hard scattering: Saturation

JLab 6/12 GeV

- Valence quark EMC effect with inclusive DIS
- Spin/isospin dependence with $eA(\text{pol})$, mirror nuclei
- EMC \leftrightarrow SRC connection

→ Arrington

EIC intermediate/large x

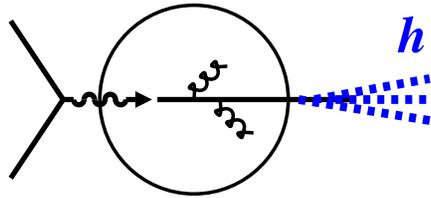
- Sea quark and gluon modifications from inclusive DIS + QCD evolution
- Gluon modification with heavy quark probes
- Flavor decomposition of quark modification with semi-inclusive DIS
- EMC effect in tagged eD DIS: Configuration dependence, SRC connection

→ Hyde

EIC small x

- Shadowing in inclusive eA : $x-Q^2$ dependence, leading vs. higher twist
- Shadowing in tagged eD : Detailed tests, configuration dependence
- High gluon densities: Black-disk regime, saturation

Parton propagation and hadronization



Color transparency: Small-size color-neutral configurations, dipole interactions

Interaction of energetic color charge with nucleus: Energy loss, p_T broadening, dynamical mechanisms?

Conversion of color charge to hadrons: Time scales, non-pert dynamics — confinement, dynamical χ SB?

JLab 6/12 GeV

- CT onset in meson production on nuclei (π , ρ) → **Hafidi**
- Hadronization in DIS at $\nu \sim$ few GeV → **El Fassi**
- J/ψ as small-size probe of nucleus → **Paolone**

EIC

- Definitive studies of CT with meson production: Appearance/disappearance, various probes, coherent regime
- Parton propagation at $\nu \sim 10^2$ – 10^3 GeV: Energy loss, p_T broadening → **Dupre, Ent**
- Hadronization inside/outside nucleus: Time scales, dynamics
- Jets in nuclei as new probe → **Blok, Vitev**

Related topics with JLab12 and EIC

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- Tensor-polarized deuteron → **Kumano, Long, Kalantarians**
- Coherent DVCS on light nuclei → **Liuti, Hattawy**
- Pion structure with tagged DIS → **Dutta, Melnitchouk**

Theoretical and experimental tools

- Light-front nuclear structure → **Miller, Boeglin**
- PDF extraction from DIS data → **Sato Gonzales, Ethier**
- Centrality selection in eA with forward tagging → **Baker**
- New experimental equipment → **Strakovsky, Somov, Meziani**