Approved INT Proposal

Towards Realizing the Experimental Program with Polarized Ion Beams at the Electron-Ion Collider

March 22 to April 2, 2027

- *Organizers info: names, institutions, and email addresses*

  Zein-Eddine Meziani (ANL), zmeziani@anl.gov
  Richard Milner (MIT), milner@mit.edu
  Frank Rathmann (BNL), frathmann@bnl.gov
  Phiala Shanahan (MIT), pshana@mit.edu

- *How many program/ workshop weeks requested*
  Two weeks

- *Information on embedded workshop (if applicable)*
  N/A

- *Dates*
  Week 1: March 22 to 26, 2027
  Week 2: March 29 to April 2, 2027

- *Designated lead organizer and workforce development plan*
  Richard Milner

A primary purpose of the two-week program is to attract young researchers into the EIC scientific endeavor. We have chosen several participants who will give motivational presentations early in week 1. In the second week, where several measurements are studied in detail, we will aim to involve young physicists in the detailed simulations and uncertainty projections. We would like to have about five graduate students and their advisors as participants. With the deliverables being scientific papers, the young people who participated would be lead authors. During week 2, we would arrange an interactive mentoring lunch session, to create a cohort of junior researchers at this intersection and to provide a venue for senior physicists to answer questions from the junior physicists on career trajectory and other issues.

- *Why the event topic is important and timely*
  Polarized ion beams are essential for some of the most important science questions addressed by EIC. To date, the accelerator and detector have received considerable attention and resources. It is timely to begin serious consideration of the polarized ion beams in the context of the scientific motivation, and the current accelerator and detector designs. The goal is to simulate a suite of the most important EIC measurements that use polarized ion beams employing realistic accelerator and ePIC detector characterizations. The proposed program will add real value to the EIC scientific enterprise.

- *Key goals for the event*

  – To raise the visibility of EIC science with polarized ion beams

  – To attract the interest of young physicists to this science

  – To work out in detail a suite of the most important EIC measurements that use polarized ion beams. After the INT program, it is planned that these will be published.

In the first week, we aim to identify the most compelling scientific opportunities through presentations by both theorists and experimentalists, followed by discussion. The program will also feature overview talks on the EIC accelerator, the ePIC detector, the current status of polarized ion source development, and advances in polarimetry. This foundation will build upon the findings of the Yellow Report. We plan to include the following topics:

- Spin Structure of the Nucleon
- 3D Partonic Structure of the Nucleon and Light Nuclei
- Modification of Spin Structure of Nucleon in the Nucleus
- Exotic Gluon States in the Nucleus
- Overview of EIC
- Overview of Polarized Ion Sources
- Overview of Polarimetry
- Overview of ePIC detector

At the end of the first week, there will be an overview presentation describing the highlights and the measurements to be studied in detail in the second week.

The second week will be dedicated to identifying and developing the most important measurements to be pursued at the EIC. The attendees would break up into parallel working groups to work on simulation of these measurements. The organizing committee will prepare a core set of experimental priorities based on the EIC White Paper and Yellow Report, while remaining receptive to new, scientifically well-justified proposals. Activities will center on detailed and realistic simulations of the beam conditions, interaction region, and ePIC detector configuration. Key topics will include background characterization, polarimetry, and other instrumental considerations, with particular emphasis on the evaluation and mitigation of systematic uncertainties.

At the end of the second week, there will be an overview presentation describing the achievements of the different working groups in evaluating the selected measurements. It is planned that these evaluations be brought to completion after the INT program and be published.

Feedback

Kimberlee Choe October 3, 2025 at 11:52 AM

INT Program: "Towards Realizing the Program with Polarized Ion Beams at EIC"

To: Richard Milner, zmeziani@anl.gov, pshana@mit.edu, frathmann@bnl.gov, Cc: Sanjay K. Reddy Details

Dear Richard, Zein-Eddine, Phiala, and Frank:

I am delighted to inform you that, following review, the National Advisory Committee (NAC) has recommended that the Institute for Nuclear Theory (INT) host your program, "**Towards Realizing the Program with Polarized Ion Beams at EIC**." We sincerely thank you for submitting such an excellent and timely proposal on this important topic.

Kim will be in touch within the next two months to schedule your program. Should you not hear from her by the end of November, please follow up directly.

The NAC has provided the following feedback on your proposal:
"The committee is pleased to recommend approval of the program proposal Towards Realizing the Program with Polarized Ion Beams at EIC. The two-week structure represents a timely and valuable opportunity to advance the science case for polarized beams at the EIC and to engage the next generation of researchers in this critical endeavor, spanning both experiment and theory, and to foster a community capable of leading this effort for decades to come. The NAC especially commends the emphasis on workforce development and the plan to include graduate students and postdocs as lead contributors to the scientific outcomes. At the same time, the NAC recommends that the organizers take additional steps to ensure that the second week is structured inclusively, providing clear avenues for groups and individuals not yet involved in this program to get up to speed and begin contributing meaningfully. Furthermore, broadening participation beyond the currently listed institutions will significantly strengthen both the scientific and community impact of the program. In particular, the committee encourages the inclusion of groups pursuing complementary target development and polarization efforts, even if not yet focused directly on the EIC, such as the New Hampshire team on tensor-polarized deuteron targets, the Tennessee group working on polarized 3He, as well as colleagues from UVA, William & Mary, and other institutions. In addition, in recent decades the theory community working on spin physics has expanded greatly, and includes additional experts to the ones listed in the proposal working on a broad range of observables and distributions such as various spin asymmetries and spin-dependent PDFs, GPDs, and TMDs. The NAC suggests those researchers be invited and engaged in the program as well. Expanding participation in this way will maximize the program's reach, ensure multiple perspectives are represented, and lay the foundation for a truly collaborative community effort."

We trust that this feedback will serve as constructive guidance and support your planning as the program develops.

Finally, please note that while the INT welcomes programs with more than three organizers, the organizers' office space can only accommodate three individuals. Additional organizers will be assigned to offices shared with program participants. In addition, travel support will be provided for up to three organizers.

Sincerely,
Sanjay Reddy
Director, Institute for Nuclear Theory

Communicated to ePIC Collaboration

- Description of planned two week program
  - week 1 focus on science
  - week 2 break into working groups focused on measurements
- Emphasize importance of having engagement of ePIC collaboration.
- Dates
- Positive response from leadership

We have reached out to University Groups

UNH - Elena Long, Karl Slifer

U Tennessee - Nadia Fomin, Dien Nguyen

Duke U - Haiyan Gao

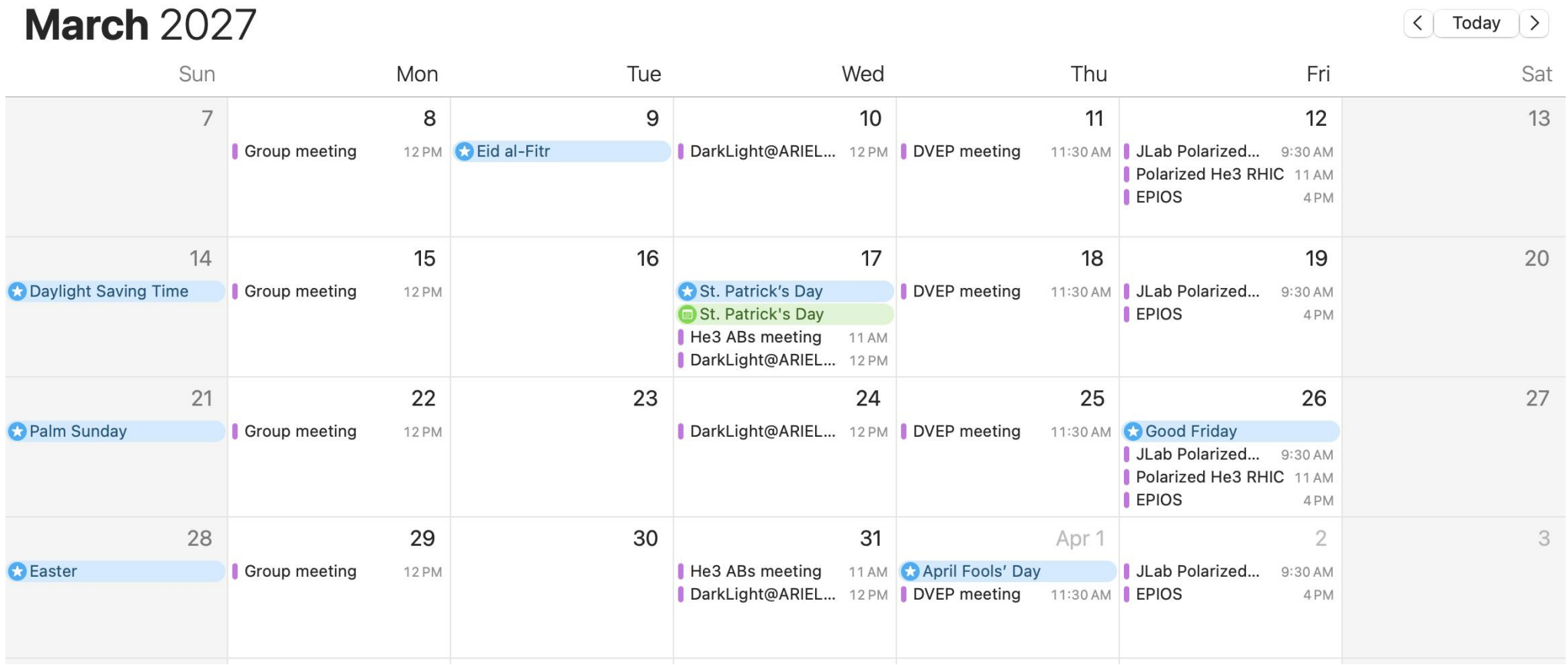
UVA - Gordon Cates, Dustin Keller, Kent Paschke

Wm & Mary - David Armstrong, Todd Averett

ODU - Stephen Bueltmann, Sebastian Kuhn

Towards Realizing the Program with Polarized Ion Beams at EIC*

March 22 to April 2, 2027



*** Subject to funding.**

Physics with Polarized Ions in the EIC Yellow Report

- Nucleon spin
  EIC-YR Section 7.1.2, Fig. 7.12, ΔG from dijet and heavy quark A_{LL} p. 73

- Multiparton correlations, TMDs
  EIC-YR Section 7.1.5, transverse nucleon polarization

- Multi-dimensional Imaging
  EIC-YR Fig. 7.46: Fourier Transform of GPDs from DVCS with polarized proton, Section 7.2.3, Sivers and Collins effects, polarized proton and He-3, Fig. 7.54, Gluon TMDs, tensor charge Fig. 7.56., Section 7.2.5 Light Polarized Nuclei

- **I could not find any discussion of modified quark polarizations or search for $\Delta(x, Q^2)$**

Issues for Consideration in Week 1

- Nuclear generators for ^{2}H, ^{3}He, ^{6}Li and ^{7}Li as input for the ePIC simulation
- Spin formalism for spin-3/2 target
- Calculating spin observables in collider frame
- Determining the gluon contribution to proton spin
- Testing the Bjorken Sum Rule
- Consistent calculation of nuclear modification of quark distributions for different ion species
- Calculation of exotic gluon effects vs. A

Table 1: Scientific focus vs. polarized ion species.

Polarized Ion	**Spin** $\hbar$	**Quark/gluon spin**	**3D Imaging**	**Modified quark/gluon spin**	**Search for Exotic Gluons**
^{1}H	1/2	$g_p^1(x,Q^2)$	Spin-dependent SIDIS & DVEP		N/A
^{2}H	1	$g_d^1(x,Q^2)$	Spin-dependent SIDIS & DVEP	$g_{N,bound}^1(x,Q^2)$ with tagging	Trans. poln.
^{3}He	1/2	$g_n^1(x,Q^2)$	Spin-dependent SIDIS & DVEP	$g_{p,bound}^1(x,Q^2)$ with tagging	N/A
^{6}Li	1	$g_{d,bound}^1(x,Q^2)$	Spin-dependent SIDIS & DVEP	^{2}H vs. ^{6}Li comparison	Trans. poln.
^{7}Li	3/2		Spin-dependent SIDIS & DVEP		Trans. poln.

Candidate Golden Measurements

- Determination of $\Delta G(x, Q^2)$ and the gluon contribution to nucleon spin
- Search for modification of $g_p^1(x, Q^2)$, $g_d^1(x, Q^2)$ in light nuclei
- Measurement of GPDs, TMDs using a polarized nucleon beam
- Measurement of $\Delta(x, Q^2)$ using a transversely polarized nucleus of $I \geq 1$

Path forward

- We should proceed to organize a two week meeting as proposed in spring 2027
- CFNS at Stony Brook University is a great location if INT falls through
- We should start to organize:

By ion:

^{2}H: Frank Rathman ^{3}He: Richard Milner ^{6}Li, ^{7}Li: Zein-Eddine Meziani

- For example, spin-dependent generators for ePIC Monte-Carlo

By physics measurement:

- Identify leaders (theorists and experimenters) for the working groups
- Connect with ePIC physics conveners
- Connect with ePIC simulation

- Initiate a regular meeting of the four co-organizers immediately to stand up the working groups: attract postdocs and graduate students.
- Aim to initiate a regular broader organizational meeting via Zoom by the summer 2026.