

# EIC Polarimetry Technical Subsystem Status Review Close-Out

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














Organization: Elke-Caroline Aschenauer (BNL) and Rolf Ent (JLab)

**via zoom**

Jan 17 – 18, 2023

<https://indico.bnl.gov/event/17816>

## Day 1: January 17

EIC Polarimetry Technical Subsystem Status Review		
<div>  Jan 17, 2023, 2:00 PM         --          Jan 19, 2023, 5:30 AM         Europe/Berlin       </div>		
<div> <b>Description</b> <a href="https://ford.zoemg.com/files/1612136157/pwd-LyKcmF6MzC3R0u4WwWvGJ2VXJyU7G9">https://ford.zoemg.com/files/1612136157/pwd-LyKcmF6MzC3R0u4WwWvGJ2VXJyU7G9</a>        Meeting ID: 161 213 8157        Passcode: 281385     </div> <div>  <a href="#">Change_Polarity...</a>  <a href="#">Pls-Schedule_206F...</a>  <a href="#">PrelimMaterial.pdf</a>  <a href="#">Reports</a>   </div>		
TUESDAY, JANUARY 17		
2:00 PM	<b>Executive Session (Closed Session)</b> EIC Polarimetry Status Review Closed Session Join Zoom Meeting <a href="https://ford.zoemg.com/files/1618037888/pwd-V3pQVkvuMCFMjHhUgZKXyU7G9">https://ford.zoemg.com/files/1618037888/pwd-V3pQVkvuMCFMjHhUgZKXyU7G9</a> Meeting ID: 160 899 7888 Passcode: 936449 <div>  <a href="#">PolarityReview...</a> </div>	20m
2:30 PM	<b>Welcome and introduction to the EIC Project</b> Speakers: E. C. Aschenauer (JHU), Rolf EH (Lawrence Lab) <div>  <a href="#">eica.PolarityIntro...</a>  <a href="#">eica.PolarityIntro...</a> </div>	20m
3:00 PM	<b>Polarized Beams at the EIC</b> Speaker: Vladimir Pitschik (JHU) <div>  <a href="#">EIC_Polarized_Bea...</a>  <a href="#">EIC_Polarized_Bea...</a> </div>	20m
3:30 PM	<b>Hadron Polarimeter Overview</b> Speaker: Greg Eyster (JHU) <div>  <a href="#">hadronPolarity...</a>  <a href="#">hadronPolarity...</a> </div>	40m
4:10 PM	<b>R&amp;D for Hadron Polarimetry</b> Speaker: William Schroeder (JHU) <div>  <a href="#">EICHadron_Techni...</a> </div>	30m
4:40 PM	Coffee Break	
5:00 PM	<b>Electron Polarimeter Overview</b> Speaker: David Gaskell (Lawrence Lab) <div>  <a href="#">electron_polarime...</a> </div>	40m
5:40 PM	<b>Backgrounds for Compton Polarimetry</b> Speaker: Mike Sullivan <div>  <a href="#">SR Calculations and...</a>  <a href="#">SR Calculations and...</a> </div>	20m
6:15 PM	<b>Laser System for Compton Polarimetry</b> Speaker: Ciprian Gai (Brookhaven Laboratory) <div>  <a href="#">230117_EIC-Gai...</a> </div>	30m
6:40 PM	Lunch Break	

## Day 2: January 18

[illegible]

We would like to thanks all participants for

- the efficient preparation/organization of the review,
- the excellent presentations of the team, and
- the open and fruitful discussions.

We will be happy to help you with your next steps.

## Review Charge Questions I

1. Are the technical performance requirements of the electron and hadron polarimetry systems appropriately defined and complete for this stage of the project?

The requirements for both electron and proton polarimetry are adequately defined for the present stage of the project. Regarding  $^3\text{He}$  polarimetry, the requirements appear to be not yet clearly defined.

2. Are the plans for achieving polarimetry performance and construction sufficiently developed and documented for the present phase of the project?

Critical issues have been identified and are properly addressed for proton and electron polarimetry at the present stage of the project. Regarding  $^3\text{He}$  polarimetry, we did not receive sufficient information to judge this aspect. The transverse electron polarimetry in the ESR and in the RCS seem to still require more attention.

3. Are the current designs and plans for detector and electronics readout likely to achieve the performance requirements with a low risk of cost increases, schedule delays, and technical problems?

Although at this stage, the risks can not be completely evaluated, it seems that the performance requirements for the proton HSR and ESR polarimetry on detector and electronics are not excessive and can be achieved with state-of-the-art systems. In the RCS, however, details are still lacking in order to judge this.

## Review Charge Questions II

4. Are the polarimetry fabrication and assembly plans consistent with the overall project and detector schedule?

For electron and proton polarimetry, the time schedules match the overall project schedule.

5. Are the plans for polarimetry integration in the EIC accelerator and detector appropriately developed for the present phase of the project?

The plans for proton polarimetry integration in the EIC are adequately developed for the present stage of the project. In the ESR, the polarimeter region design needs to be detailed further, taking into account synchrotron radiation, other backgrounds, higher-order modes, and wake fields.

6. Have ES&H and QA considerations been adequately incorporated into the designs at their present stage?

We assume that radiation protection and laser safety issues regarding polarimetry will be incorporated into the general ES&H scheme of the facility.

## 1. HJET polarimeter:

- ▶ Findings
  - ★ After RHIC shutdown in 06/2025, the existing HJET will be moved from IR-12 to IR-4.
- ▶ Comments/Concerns
  - ★ The plans presented for refurbishing elements and upgrading the detector readout appear sound.
  - ★ The issue that signals from recoil protons and punch-through particles overlap from different bunches can be addressed by adding a second detector layer.
  - ★ Thought should be given to upgrade the magnetic holding field system of the HJET to enable also measurements with sideways and/or longitudinal target polarization. This may provide a unique opportunity to truly determine all components of the beam polarization vector  $\vec{p}$  at one location in the EIC.
- ▶ Recommendations
  - ★ A target gas analyzer, i.e., a quadrupole mass spectrometer should be installed to be able to determine the molecular fraction in the jet beam.
  - ★ The option of using thinner SI detectors should be investigated, as this allows to veto punch through events more efficiently.

## 2. pC polarimetry:

- ▶ Findings
  - ★ The two available pC polarimeters (double and single chambers) will be relocated after RHIC shutdown to IR 4 and IR 6.
- ▶ Comments/Concerns

- ★ In particular the placement of a pC polarimeter in front of the main detector at IR 6 is highly appreciated, as this allows to study the beam spin evolution of the transverse components ( $p_x$  and  $p_y$ ) from IR 4 to IR 6.
- ★ Due to the higher beam current at EIC compared to RHIC, heating of the C fiber targets beyond the sublimation temperature is a concern.
- ★ As already mentioned above regarding the HJET, also here the issue that signals from recoils and punch-through particles overlap from different bunches can be addressed by adding a second detector layer.

## ► Recommendations

- ★ Besides further investigation of other potential target materials, the possibilities to mitigate the issue by increasing the beam size through reduced focusing at the IR4 should be studied.
- ★ As already mentioned in the section on the HJET, also here the option of using thinner SI detectors should be investigated, as this allows to veto punch through events more efficiently.
- ★ As an additional pC polarimeter is installed in the AGS, an effort should be made to obtain beam time at the AGS for further R&D studies to test and improve the SI detectors.

## 3. $^3\text{He}$ polarimetry:

### ► Findings

- ★ Absolute polarimetry requires detection of elastic scattering, i.e., here  $^3\text{He} - ^3\text{He}$  scattering. The calibration would entail using in a first step a polarized  $^3\text{He}$  target and to measure the analyzing powers and cross sections of the elastic process. Once this is established,  $^3\text{He}$  ( $h$ ) beam polarimetry can be performed on an unpolarized  $^3\text{He}$  target.
- ★ The issue is to find out how to veto the inelastic reactions involving breakup of  $h$ , i.e.,  $hh \rightarrow h + dp$  or  $hh \rightarrow h + npp$ . The available detectors at the pC polarimeters lack the resolution to distinguish elastic  $hh$  from  $hh$  involving breakup.
- ★ The concept presented for the EIC would rely on the use of an additional dipole magnet and a drift space.

# Hadron polarimetry III

- ★ A test has been performed using Taggers installed near the HJET, and beam HJET target interactions were observed.
- ▶ Comments/Concerns
  - ★ The development of  $^3\text{He}$  polarimetry is not yet as advanced as the one for protons or electrons. In addition, information about the performance requirements appear to be missing.
- ▶ Recommendations
  - ★ It would be useful to have available a theoretical assessment of  $hh$  elastic analyzing power and cross sections, and further information on feasibility/simulation studies for  $^3\text{He}$  polarimetry.
  - ★ We encourage further studies regarding  $^3\text{He}$  polarimetry R&D during the remaining RHIC runs.

## 4. (Deuteron beams):

- ▶ Comments/Concerns:
  - ★ Albeit not being part of the baseline, the work on the polarized deuteron source should not be postponed too much, as the international expertise is likely to fade away during the next years.
  - ★ The polarimetry for  $d$  beams needs to be addressed.

- ESR polarimetry

- ▶ Findings

- ★ The longitudinal polarimeter planning and design is advanced and in good shape. Some of the details of the implementation into the electron ring needs to be worked out.
    - ★ The detector concept for the longitudinal polarimeter has been chosen and the design of the laser system needs to be tested and implemented.
    - ★ The detector concept for the transverse polarimeter is not yet well defined.
    - ★ The planned program on the laser transport and diagnostics is excellent, beyond the application in the EIC polarimeter.

- ▶ Comments/Concerns

- ★ The chosen detector concept using diamond strip detectors appears reasonable, but unlike silicon, the commercial availability may be more challenging.
    - ★ R&D on the laser transport and diagnostics should be continued and fully supported with personnel and financial resources.
    - ★ The implementation of the polarimeter system in the electron ring of EIC appears to be more challenging compared to JLAB, also regarding synchrotron power and rf loading.
    - ★ The transverse polarimetry detector requires both more simulations and R&D.
    - ★ The cost estimates shown seem reasonable for this stage of the project.

- ▶ Recommendations

- ★ An alternative detector concept based on Silicon strip detector should be developed.
    - ★ Perform detailed simulation studies of the polarimeter region including background, shielding, rf shielding, etc. Once available, the design should be reviewed again.
    - ★ Explore transverse polarization measurement with spin-dependent synchrotron radiation using the existing ESR lattice.

# Electron polarimetry II

- RCS polarimeter

- ▶ Findings

- ★ Expect to copy the ESR polarimetry, but challenges of the implementation in the EIC tunnel need to be explored.
    - ★ The measurement concept and the detector requirements seem quite different from the ones in the ESR. No details were presented.

- ▶ Comments/Concerns

- ★ The concerns regarding transverse polarimetry mentioned above apply here as well.
    - ★ Regarding the RCS polarimeter, there were too few details given, in order to be able to critically review its aspects and costs.
    - ★ We suggest to study whether in addition, monitoring of longitudinal polarization in the RCS appears feasible.

- ▶ Recommendations

- ★ Carry out a detailed study of the detector requirements to measure the transverse polarization in multi-photon mode in the RCS from different bunches.
    - ★ The RCS polarimeter may be the ideal place to exploit spin-dependent synchrotron radiation.