# Report of the 18th Electron Ion Collider Detector R&D Meeting

## *EIC Detector Advisory Committee*

January 30 – 31, 2020

M. Demarteau (ORNL), C. Haber (LBNL), P. Krizan (Ljubljana University/J. Stefan Institute),
I. Shipsey (Oxford University), R. Van Berg (U. Pennsylvania), J. Va'vra (SLAC)
and G. Young (BNL)

## Introduction

BNL, in association with Jefferson Laboratory and the DOE Office of Nuclear Physics, has established a generic detector R&D program to address the scientific requirements for measurements at a future Electron Ion Collider (EIC). The primary goals of this program are to develop detector technologies and detector concepts that are suited to experiments in an EIC environment, which will ensure that the full physics potential of an EIC can be harvested and that the resources for implementing these technologies are well established within the EIC user community.

The EIC Detector Advisory Committee meets twice a year, typically in January and in July. The current Committee members are: M. Demarteau (ORNL/Chair), C. Haber (LBNL), P. Križan (Ljubljana University/J. Stefan Institute), I. Shipsey (Oxford University), R. Van Berg (U. Pennsylvania), J. Va'vra (SLAC) and G. Young (BNL). Not able to attend this meeting was Ian Shipsey due illness. During the January meeting progress reports are reviewed and feedback is provided to the proponents. During the July meeting both progress reports and new proposals are reviewed. Funding recommendations for continuation of existing and for new proposals are provided by the Advisory Committee to the program manager in advance of the fiscal year funding cycle.

Prior to the meeting, status reports were submitted by eleven funded projects and two Letter of Intent were received. The Committee met at Brookhaven National Laboratory on January 30 and 31, 2020 to hear the status reports and discuss the progress with the proponents. The committee would like to thank all collaborations for their excellent presentations and status reports and BNL for its hospitality. The collaborations are to be commended for their progress. It is gratifying to see results being published in peer-reviewed journals, and all proponents are strongly encouraged to continue to publish their results.

## General Remarks

The EIC has received CD-0 and Brookhaven National Laboratory has been selected as the site for the project. The consortia as well as other EIC proponents are to be congratulated for this significant step. The new project is expected to engage with the detector community shortly. A notional timeline for the detectors shows that Technical Design Reports are expected to be submitted in 2023, with a seven-year construction schedule. This gives a submission of a Conceptual Design Report in 2021, which leaves little time to bring detector research to a technological readiness level to be included in a defensible way in the Conceptual Design Reports. It is also expected that the project will call for Letters of Intent for detector collaborations. The fate of this committee is at the moment uncertain. When detector collaborations have been formed most likely a new oversight committee will be formed. Our goal is to position the currently ongoing and newly proposed research on the strongest foundation to deliver a detector that can explore the full physics potential of the new and exciting project.

## eRD1: EIC Calorimetry

**O. Tsai, T. Horn and C. Woody reporting**

***Tungsten-fiber calorimeter development***

sPHENIX is now moving along steadily with construction of a W-powder SciFi electromagnetic calorimeter. The committee thanks sPHENIX for its many reports. No further reports are needed until the device has been commissioned and some large-scale operational experience has been gained to inform the future EIC detectors.

That said, there is still room for improving readout performance, as noted by the RD-1 group. Prior reports by the eRD1 group on results from FNAL test beam runs indicate that response uniformity across the matrix could be improved by better photo-sensor coverage. A solution that also avoids the radial depth lost to light guides is of interest to the EIC detector barrel region, which needs to be inside the magnet coil. The team presented a concept for a tiling of the readout face of an sPHENIX block (2x2 towers) using newly available 6x6mm$^2$ SiPMs from HPK and has now obtained the needed sensors. A 1-2mm thin 'light mixer' would be needed, replacing the few cm thick light-guides now deployed in sPHENIX. These larger SiPMs also exhibit improved noise performance compared to the (now discontinued!) series just procured for sPHENIX. An EIC detector needs an improved uniformity over that accepted for sPHENIX, and deployment of a fully 'tiled' SiPM readout presents a possible path to achieve this.

The collaboration presented further analysis of their continued measurement of the effects of radiation exposure on the long-term performance of SiPMs, with specific new information about gain loss due to a calibrated neutron dose, obtained from the University of Massachusetts Lowell reactor facility. Results were presented on gain variation as a function of temperature, and recovery of gain loss due to neutron damage by lowering of the temperature. The group also discussed means of cooling the actual junction in the current SiPMs and new SiPM devices from HPK, which provide improved cooling paths. The Committee encourages continuation of this and would be interested to know the radiation tolerance of the newer, larger 6x6mm$^2$ SiPMs. It is noted that a larger study, extended to other SiPMs including those from other manufacturers, could be of future interest.

***HCAL Studies, in particular Timing***

The collaboration has studied the time-development out to 1000 ns of the light signals from Fe/Sc/WLS calorimeters using an existing device. They have performed, in parallel, simulation studies of the performance, examined the light yield from the neutrons, determined that Pb is preferable to Fe to obtain more neutrons from the shower, and has studied the timing of existing albeit somewhat slower scintillator and WLS, and compared the results to the signal timing expected for faster fluors. The results for Fe-based devices are not particularly encouraging for event-by-event improvement of the hadronic shower response but those for a Pb (or W) based system might very well be.

Tests of a new device to examine the above were hampered by scintillator non-uniformity, traced to an issue with the manufacturer's surface finish of the plates. Light collection using tapered WLS bars did not lead to the expected performance, and a study of the light collection uniformity across the test calorimeter was made. The proponents are encouraged to look at R807 and WA80 papers on dual WLS bars to gain depth segmentation. The R807 and WA80 devices also used WLS bars on both sides of metal/scintillator plate stacks in order to compensate for the rather short light-attenuation length typical of such thin scintillator plates.  Thus one tower had 4 total WLS plates. The current concept does use a shashlik approach for the EMCal section, thus allowing a dual-WLS bar to be employed to gain depth segmentation for the hadronic compartment. Further simulation studies of shower containment, both longitudinally and transversely, are being pursued. The Committee encourages this particular aspect and would expect such work to guide the depth chosen for the forward Hadronic Calorimeters at the EIC.

***Shashlik Concept***

The Committee takes note of the continued development of the shashlik calorimeter at UTFSM using W-Cu plates to realize a compact shashlik EMCal. Nine towers are now constructed and prepared for operation in a test beam; they are readout with borrowed sPHENIX electronics. The comparisons, suggested at the last meeting, to the performance of the old PHENIX shashlik lead/scintillator EMCal towers, reconfigured to read out the individual WLS fibers, are still pending, awaiting manpower for this effort.

The Committee commends the progress shown, takes note of the concerns expressed about needed manpower. The committee would like to see the manpower needs resolved before the next review, otherwise the path to success is not obvious.

*Recommendation*

As noted in the last meeting, the timing studies for the hadron forward calorimeter are interesting, but the shashlik calorimeter effort should receive higher priority to allow a quantitative comparison with other technologies by the time of a CDR, especially given the dearth of resources.

***Crystal calorimeter development***

The Committee takes note of the ongoing effort to characterize lead-tungstate crystals from CRYTUR and SICCAS and recognizes the need to qualify a vendor in order to be able to propose a high-resolution scintillating crystal EMCal for use at forward angles at the EIC. The Committee also notes the continued progress in acquiring crystals from SICCAS and CRYTUR and was encouraged to learn that the acceptance for the last batch of crystals from CRYTUR is 100%. The concern remains about crystal handling at SICCAS. The distribution in light yield from the recent set of crystals from CRYTUR, shown earlier, has a sigma/mean of only 5% which is very good. The EIC effort benefits from work being done for the Neutral Photon Spectrometer at JLab by several of the same people. The group has a clear path to obtaining 1000 crystals.

The Committee takes note of this energetic effort and looks forward to the next report of the collaboration and their planned path forward.

***Scintillating Glasses***

The collaboration reported further results on making larger samples of scintillating glasses, with five 2x2x2 $cm^3$ samples and two 2x2x20 $cm^3$ samples prepared. These have been subjected to intense gamma radiation from $^{60}Co$ sources and 40 MeV proton bombardment from the University of Birmingham cyclotron to check radiation tolerance. Efforts have started to develop good polishing techniques and coupling to photosensors. It was reported earlier that some glasses perform well under large radiation dose, whilst other formulations were disqualified by these tests. Large fluorescence light yields relative to $PbWO_4$ were noted. Methods to control bubbles and localize them to the surface and tuning of glass composition to control radiation hardness and peak wavelength of light yield were demonstrated earlier. Densities above that of lead glass can be achieved, which makes these glasses of interest.

The group is to be congratulated on obtaining an SBIR Phase-I grant for this effort.

Near-term plans include measurement of light yield from cosmic-ray events, which is of great interest to the Committee. Having encouraging results would be a significant step forward towards further endorsement of this R&D effort. The Committee looks forward to the next reports.

## eRD6: Tracking Consortium for the EIC

**K. Gnanvo reporting**

The eRD6 collaboration reported on a broad range of efforts on Micro-Pattern Gas Detectors (MPGDs) for tracking and particle identification, which covered the TPC and cylindrical μRWELL efforts for central tracking, the triple-GEM and low-mass, large-area effort for forward tracking and particle identification with hybrid MPGDs for a RICH detector.

The team is congratulated on reestablishing the cosmic ray telescope. It is suggested to explore if an absorber can be installed to provide a momentum filter. The resolution comparison for the GEM, MicroMegas and μRWell with zig-zag readout should be understood and should lead to a conclusion what design is optimal for a central TPC for the EIC. It is also suggested to look at a single GEM-Micromegas combination.

The development of a laser line reference track system to characterize the prototype TPCs is excellent. The installation of the portable DREAM electronics is appreciated. For the TPC, a passive gating grid design has been investigated. The grid will be permanently powered and should provide a way to attract positively charged ions but leaving the path of electrons unaffected when immersed in a magnetic field. Another option is to arrange for a grid of wires separated from each other and apply a constant bias voltage between them (bi-polar grid). It was shown that at ±40V, electrons have almost full transparency, while ~80% of ions are blocked. No information on the requirements were given. It is suggested to test the gating function with a “spray” of “salt and pepper” background from an X-ray gun and investigate distortions in laser tracks as a function of this background. The danger of triggering the Malter effect on the gated wires should be studied.

The updated conceptual design of a central μRWELL-detector with five barrel segments seems very challenging to build and non-trivial to align. MC simulations comparing the tracking performance of the μRWELL and TPC tracker was performed, which showed similar performance between the two technologies for the momentum resolution. Once the μRWELL simulations are made more realistic, it is expected that this technology will not outperform a TPC, besides mechanically being very complicated to fabricate. Given the limited resources, the consortium is encouraged to redirect its efforts on more promising avenues of R&D. For instance, studying the implementation of μRWELLS in the forward region.

R&D on GEM-based forward tracker designs is progressing well. It is noted that access to damaged GEMs is not absolutely necessary. This problem can be solved by having, for example, two spare sectors. Wrinkles in GEM foils will affect the detector performance and therefore should be avoided. Wrinkles may exist even with spacers. This would speak in favor of a solution where frames are strong enough to allow stretching even if it requires a slightly larger mass around the edges. The proponents did not conclude which solution they prefer. A large table with the pros and cons of various methodologies was shown, but no decision on what the best options are was presented. It is recommended that the best options are combined in an optimized design. As proponents found, the detector's drift cathode foils collapse onto the detector's Kapton entrance window foil, which is likely related to charging of the Kapton. Aluminum coating could help this. One could also use DuPont carbon-loaded Kapton foil. However, it points to the fact that foils, including GEM foils, are not sufficiently stretched. It is not clear to us if sufficiently stretching the foils solves the problem, since there are still low efficiency spots in the results presented.

The MPGD single-photon detectors at INFN Trieste consist of three multiplication stages: two thick GEM layers, the first one with a ND coating, which acts as a photocathode, followed by a resistive MicroMegas multiplication stage. The resistive MicroMegas has a resistor in series with each pad. Tests indicate that the prototype with miniaturized pads have too high noise level, preventing a complete characterization of the proposed detector architecture. The group is handling the noise related issues with the new improved detector PCB design. A new VMM3 readout is also being implemented. The Committee is looking forward to seeing a demonstration that the new resistive MicroMegas with small pads will work.

It was not clear what QE efficiency is required for the successful operation of the detector for the new Photocathode Materials development at INFN Trieste. For example, how many photo-electrons per ring would you get with the present performance and how many are required? We would also like to know what the chromatic error contribution is to the Cherenkov angle resolution.

## eRD14: Integrated Particle Identification for a Future EIC

**P. Nadel-Turonski reporting**

The eRD14 collaboration is making progress towards the realization of particle identification for the EIC. An interim review was held in September 2019, which was very well received and demonstrated that a lot of good work is being done within the consortium. The presented results present a very good step forward and show a sizable progress on most research activities.

**Photodetectors:**

The committee is puzzled by the discrepancy in B-field performance measurements with the ones carried out by A. Lehmann, and urges the group to understand these discrepancies. The committee is pleased to hear that A. Lehmann has joined the effort. The committee recommends that the work on the LAPPD is continued but would like to see a stronger focus on fine pixelization.

**dRICH:**

A novel approach has been started for the optimization of the detector and a prototype counter is in preparation; components are being produced, and aerogel samples were ordered from Russia. The plan for 2020 is to start construction of the dRICH small-scale prototype. The committee recommends that the group thoroughly investigates the impact of two beam pipes on the design details.

**mRICH:**

The successful implementation and operation of the SiPMs for the modular RICH was a significant achievement in this R&D activity. The test clearly shows that decreasing the temperature to -30 $^{0}$C improves the thermal noise rate. The plan is that the Aerogel RICH detector provides hadron PID capability from 3 to 10 GeV/c (for π/K separation) and electron PID (for e/π separation) below 2 GeV/c. So, far, test beam results indicate a significantly worse result, which is mainly attributed to a lack of precise tracking. For the next beam test, this has to be considerably improved.

**DIRC:**

Very good progress has been made on radiation damage studies of lens materials and in the area of optical setups to study focusing properties of lenses. The committee is pleased with the progress in the transfer of the prototype to the US. The committee also agrees with pursuing the SLAC “ultimate DIRC” design, which combines the advantages of plate and bar geometries. It would provide the best possible Cherenkov angle resolution among all DIRC counters. The committee was pleased to see that the DIRC had received priority over the mini-DIRC concept.

**Electronics:**

A common read-out system is sought that would be able to read out all photosensors considered in the project. The MAROC chip was tested with SiPMs and MaPMTs, and the SiREAD read-out board (a follow-up of the TARGET-X chip used in Belle-II) has been designed and is now produced for testing. It was not clear to the committee what timing resolution is achieved with the SiREAD chips and what their power consumption is. The committee again recommends the group to re-examine options that do not rely on waveform sampling, e.g., a TOT-based design like the TOPFET2 ASIC, which is radiation hard, has low power consumption and has achieved a very good resolution per single photon with SiPMs.

*Recommendation:*

The committee appreciated the dedicated video meeting with all the subdetector leads in early September. In the preparations of the targeted R&D research activities, the committee would like to see at the July meeting short presentations by individual subprojects.

## eRD15: Compton Polarimetry

**No report**

`

## eRD16: Forward Silicon Tracking

## eRD18: Precision Central Silicon Tracking & Vertexing for the EIC

**E. Sichtermann and Laura Gonella reporting, respectively**

The committee acknowledges and supports the stated plan to merge RD16 and RD18 into a unified silicon tracking R&D effort. This section covers both efforts. Becoming a focused silicon tracking effort presents new opportunities and also challenges. It is important to make the most of this new structure by truly working together and not being just a collection of parallel efforts. In particular, the committee hopes the collaboration can also make the most of new opportunities to collaborate more widely with other emerging groups, if they have expressed interest in silicon tracking in a credible and constructive way. There are also opportunities, some already described in the review, to collaborate with outside efforts in nuclear and particle physics, which leverage ongoing and emerging technical developments. These include developments in MAPS, fast timing, and new packaging and mechanical/cooling concepts.

On the performance side, the committee acknowledges the efforts, recommended last summer, to go beyond single track performance metrics, witnessed by the charm vertex displacement study. We note that other studies could also address performance differences between all silicon and hybrid silicon-TPC trackers. Certainly, these will be needed in the process of fleshing out the layout of the EIC detector tracking system as detector collaborations form.

On the technical side, the committee has commented in the past on power requirements for different timing schemes. We note that a number of results were presented on this topic. It is also helpful to align this with explanations and data in the reports as well.

In particular, RD18 presented strong results on the characterization of the mini-MALTA sensor configuration, and on performance studies of an EIC specific DMAPS, with regard to power and timing. A variety of approaches to the time measurement (CFD, TOT/TOA…) and a new low-power front-end architecture was studied and presented with optimizations discussed for tracking versus time stamping layers, with very promising results. Finally, the possibility was presented to leave the DMAPS in favor of leveraging work in the ALICE ITS3 project, towards an EIC specific large-scale MAPS concept. A strong appeal of this approach is that it addresses multiple aspects of the tracking/timing problem in a unified way – packaging, mechanical support, cooling, etc. and points towards a larger scale MAPS implementation. The ALICE ITS3 is also an intermediate step toward a large EIC tracker, which is also very attractive. On the other hand, the proposed development has challenges which should not be minimized – yield, mechanical/electrical interference, and so forth. But with regard to challenging new approaches, if not now, when? The committee understands that the collaboration will use the next 5-6 months to more carefully analyze this proposed realignment and report back on their plans at the summer committee meeting.

We encourage the new RD25 collaboration to come back with a plan and funding request for FY21 which takes every advantage of the opportunities now available. The committee endorses the request to repurpose funds towards an RAL design effort on the aforementioned EIC MAPS.

## eRD17: EIC Calorimetry: Beagle

**M. Baker reporting**

BeAGLE is a generator to describe eA collisions for the EIC. The proponents use real data from E665 to validate the physics model. The code is being used for physics-driven refinements of detector requirements, particularly in the forward region and is essential in establishing EIC detector requirements. BeAGLE has become more widespread in the community since the group has provided good documentation and user support. Examples were given of independent use of the code, which is most encouraging.

This collaboration has provided an incredibly useful tool for the community. The committee would like to see an implementation of a selected set of benchmark channels which would be handed over to the community for designing the EIC detectors. The committee also expects that the responsibility is transferred from the eRD17 to the host lab.

## eRD20: Software Development

**Markus Diefenthaler reporting**

The committee is very pleased with the outreach activities of the EIC Software Consortium (ESC) to help ease entry of the user community into detailed simulation efforts. These efforts are conform to the goals of the group, which is to develop workflow environments for EIC simulations and to enable the user community to use the frameworks through tools, documentation and support and to grow, again with user input, through the availability and use of this infrastructure. The support is deemed to be excellent; especially having established a 'hotline' is a nice feature.

The relationship with the Software Working group of the EIC User Group is very healthy and encouraging. The downselect of the frameworks, limiting the current support to only two frameworks, is also seen as a very positive development. The group focuses on the development of simulation of physics processes through Monte Carlo event generators, the simulation of the detector response either through fast or full simulations and the physics analysis tools. The group has implemented BeAGLE (eRD17) and is actively working on the eA adaptation of JETSCAPE and the Müller dipole formalism in Pythia8. Work is also ongoing for TMD physics.

The group is currently considering the development of "greenfield event-processing software". This would be a community-wide project on event-processing software that would free the community from the legacy of existing options while leveraging everyone's experience. The project will define requirements and build up the event-processing software on these requirements. This proposed project is endorsed, and the group is encouraged to gain buy-in by the wider scientific, software and computing communities before starting the effort to ensure that the right direction is followed.

The day prior to the start of this meeting there was an EIC Software Meeting on Detector and Physics Simulations organized by the ESC with strong participation of the community, which provided valuable feedback to the ESC.

As we noted before, the group is strongly encouraged to engage with the management of the host laboratory to support the software development and its associated infrastructure.

## eRD21: Background Studies

**Charles Hyde reporting**

The eRD21 studies of beam-induced backgrounds have advanced well with notable achievements in several areas.

The eRD21 group has adapted and extended existing programs to calculate synchrotron power generation in magnet lattices and developed a methodology to generate synchrotron radiation photons by tracing the electron beam through the final focus quadrupoles while including beam emittance. A sampling method has been developed that respects the total synchrotron power, peak wavelength and the shape of the energy spectrum and generates a list of emitted photons. The output is put in event-generator format for input to GEANT4. These codes are available at JLab. It will be good to see in the future the extension of this effort to include more of the lattice magnets.

Another program has been developed to take a source of generated synchrotron photons and simulate interactions with detector elements, using the GEANT4 framework. This has progressed to yielding hit rates, energy deposits and doses in a typical silicon vertex detector planned for the EIC. Addressing in the future the design and location for masks and collimators for the synchrotron radiation is encouraged.

A third effort that is well underway is the study of neutron generation by the hadron beam using FLUKA. The model includes the Hall, beamlines/magnets and detector, plus a residual gas "line target" to interact with the hadron beam. Results can be scaled by beam current and local gas pressure along the ring to scale to hits, energy deposit and dose, as well as the number of neutrons/$cm^2$/s that are hitting all detector elements. The group noted that the upstream EMCal (i.e. in the electron direction) is actually a source of neutrons for downstream (ion-beam direction) detector elements. This may not be a complete surprise – a one lambda hadron calorimeter is actually a hadron-number amplifier. The group has also started working with the MARS code and made contact with radiation shielding and transport experts at FNAL and JLab. This is encouraged. A good description of the soft neutrons, few MeV and lower, is important.

The requested comparison to HERA-II backgrounds was included in an appendix and shows encouraging agreement, better than a factor of two. A good team has been assembled for this work, and plans are made to continue the work with people knowing their assignments.

The committee commends all this work and is happy to see the effort starting to bring in the details of the EIC lattice and magnet structures. BNL is encouraged to supply this information as soon as possible to help move along this work.

## eRD22: GEM-based Transition Radiation Detector

**Yulia Furletova reporting**

A lot of good work was carried out since summer 2019, on detectors, gas system, installation of the GEMTRD detector in GLUEX and coupling it to the GLUEX readout. This tracking setup has been installed and aligned in front of the DIRC detector right after the exit from the GlueX solenoid.

The preliminary analysis of the Fall 2019 data in JLab Hall D indicate that there was considerable RF pick-up noise. The detector should be placed in a good RF shielded box; seeking help from the local Hall D electronics expert is strongly recommended. The committee also agrees that once the shielding problem is solved, the prototype should be tested in a test beam with both electrons and pions.

The group has also started a very interesting approach for the analysis of data, where an AI based method would be trained by using pions and electrons, selected by other means, which the committee encourages.

## eRD23: Streaming Readout

**J. Bernauer reporting**

An interesting beginning of a cost-benefit analysis of possible readout architectures focusing on minimizing custom trigger hardware and relying, as much as possible, on commercial computing for data selection is being developed within this project. The group has been actively gathering data on detector needs and various possible implementations of readout strategies with a view to, once EIC detector concepts gel, being able to start to seriously compare costs (in effort and time) of triggered, streaming and hybrid DAQ schemes. The group recognizes that some sub-detector types may require new front-end electronics in an EIC implementation. It will be important for the success of an EIC detector to ensure that this evaluation process is carried out in an unbiased manner as this conceptual design drives the eventual detailed design of the front-end and DAQ systems. The next steps planned by the group are a continuation of this data gathering phase but as the Yellow report comes into focus later this year the group should be using one or more of the emerging sub-detectors as a test case to carry through the detailed cost comparison.

## eRD24: Roman Pots

**Alexander Jentsch and Alessandro Tricoli reporting**

This proposal plans to flesh out the case for far forward Roman Pots and establish the requirements for these detectors in terms of spatial and temporal resolution. LGAD sensors are being proposed. Simulation studies were presented that have sharpened the specifications significantly and the team seems to be converging on fully defining some of the important requirements for a successful detector. There has also been some progress on understanding if LGAD sensors might be suitable for use in the Roman Pots at the EIC. Going forward the committee would like to see a stronger coupling between the physics aspects and the more sensor-based R&D. For instance, while there seems to be some indication from simulation that 500-micron square pixels are sufficient to achieve the desired physics performance, there also appear to be technical efforts to achieve much finer position resolution from some of the prototype LGAD sensors. No clear specification for either a suitable sensor, or plausible readout electronics was presented although some LHC fast timing readout projects seem to be able to achieve reasonable power levels that would be plausible for 500-micron pixels. Whether those devices or variants thereof would be able to achieve the hoped-for timing resolution is not obvious. In addition, although it was claimed that 35 ps timing resolution would greatly benefit the physics, the numbers presented showed only about a 25% physics improvement with 35 ps timing vs. no timing at all. Understanding the detailed timing requirements and allocating timing errors across all the system elements (detector, front-end, $t_0$ from the accelerator, mechanical movements, thermal effects, etc.) may help clarify the actual requirements and needs for the detector and help demonstrate what is technically possible. Clearly further work is required on both simulation and detector specification and demonstration. The committee looks forward to seeing the progress achieved by the next report.

## Letter Of Intent: Compton Polarimetry Development

**D. Gaskell reporting**

There is a definite need to measure polarization of the electrons in the EIC. Compton scattering from polarized electrons is a well-developed non-destructive and arguably the best technique to do this, having been employed at SLAC, DESY, CERN and JLab for years. Longitudinal and transverse Compton-scattering asymmetries can be measured and reach precisions of a few percent. The photon source for these measurements is typically a visible-light laser, with power in the 1 kW range produced via a Fabry-Perot cavity. Two setups are currently operating at JLab in Halls A and C.

The group presented asymmetries, scattering cross sections, expected laser-electron luminosity and counting rates for typical EIC electron energies of 5, 12 and 18 GeV. With a laser power of about 1 kW, measurement times of only several seconds are possible. One would like to have the polarization measured for each bunch, which requires either a fast detector to determine which bunch was struck, or a pulsed laser synchronized to the beam revolution to fire only when a specific bunch passes the cavity.

The group plans to develop a proposal to see if a fast-pulsed laser is feasible. The Committee would like to understand from this proposal if a measurement program in this case can be carried out for each bunch before the electron ring requires a refill. It would also like to know the performance requirements for a fast-enough detector, if instead the laser needs to operate continuously in order to complete the measurement early after a refill, once beam storage conditions are met.

The Committee looks forward to a proposal.

## Letter Of Intent: Position Sensitive Zero Degree Calorimeter (ZDC)

**Yuji Goto reporting**

The proponents have made a strong case for the physics value of a zero-degree calorimeter at the EIC to measure the gluon saturation at extreme density through a set of diffractive processes and exclusive vector-meson production in e-A collisions. The requirements to access this physics is a calorimeter at very small angles to accurately measure energies of photons below 300 MeV and fully measure the energy of neutrons up to 100 GeV. A total absorption calorimeter is needed with about 1cm position resolution and 50%/sqrt(E) energy resolution. The proponents are considering several interesting techniques that seem worth pursuing, such as a plastic scintillator or crystal calorimeter, a quartz fiber calorimeter of an imaging silicon calorimeter such as the one that has been proposed for Run 4 for the ALICE experiment. Many scientists from Japanese institutions are interested as well as two US institutions. The committee urges the group to put forward a proposal focused on the most important technical questions and what physics areas it will open.