

Software Working Group Priorities in 2021

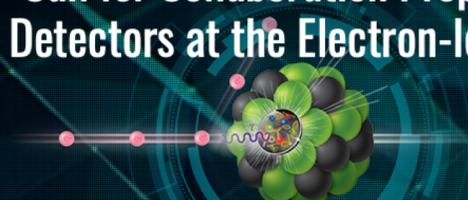
Call for Expressions of Interest for Potential Cooperation on the EIC Experimental Program



Brookhaven National Laboratory (BNL), in association with Thomas Jefferson National Accelerator Facility (TJNAF), calls for an Expression of Interest (EOI) for potential cooperation on the experimental equipment as required for a successful science program at the Electron-Ion Collider (EIC). This call emphasizes all detector components to facilitate the full EIC science program including those integrated in the interaction regions.

Realize Software Eoi

Call for Collaboration Proposals for Detectors at the Electron-Ion Collider



Brookhaven National Laboratory (BNL) and the Thomas Jefferson National Accelerator Facility (JLab) are pleased to announce the Call for Collaboration Proposals for Detectors to be located at the Electron-Ion Collider (EIC). The EIC will have the capacity to host two interaction regions, each with a corresponding detector. It is expected that each of these two detectors would be represented by a Collaboration.

Support of Collaboration Proposals

Andrea Bressan (Trieste), Markus Diefenthaler (JLab), Torre Wenaus (BNL)

EICUG Software Working Group



Electron-Ion Collider User Group

The world's most powerful microscope for studying the "glue" that binds the building blocks of visible matter.



[Home](#) » [EIC Software](#)

EIC Software

Software Working Group

The Software Working Group (SWG) is open to all members of the EICUG to work on EICUG related software tasks. It communicates via its [mailing list](#) and organizes regular [online and in-person meetings](#) that enable broad and active participation from within the EICUG as a whole.

The SWG has participated in the call for Expressions of Interest (EoI) and intends to carry its [EoI for Software](#) forward as a living document that will evolve towards a work plan for the SWG, setting priorities for the next years and goals for the next decade.

In addition to that, it will support the work on the simulation efforts for the [collaboration proposals for detectors at the EIC](#).

For questions about the Software Working Group, please [contact the conveners](#) (Andrea Bressan (Trieste), Markus Diefenthaler (JLab), and Torre Wenaus (BNL)).

Important links

Mailing list	eicug-software@eicug.org (subscribe via Google Group)
EIC organization on GitHub	https://github.com/eic
Website	https://eic.github.io

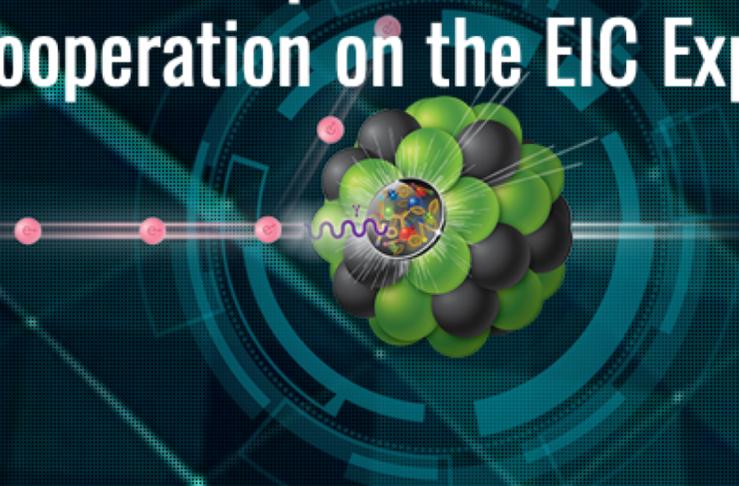
Unique software challenges for EIC Science

Scientific Problem Space

- Focus on non-perturbative QCD phenomena
- MC event generators for electron-ion collisions and **spin-dependent** measurements
 - including novel QCD phenomena (e.g., GPDs, TMDs, Wigner functions)
- **Analyses considering large number of signal events simultaneously** (or multiple times)
 - **Contrary** to separating a few events from a large number of background events
 - **Example** Search of rare events with novel topologies
 - **Example** complexity of multi-dimensional, strongly correlated relationships among data (e.g., GPDs, TMDs, Wigner functions)
 - **Example** high-precision results which require complex analyses to control systematic uncertainties
 - Require unique software and computing strategies

Work on EIC with high luminosity over a wide range of center-of-mass energies and highly polarized beams will **push R&D on these challenges.**

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Community Input for Expression of Interest

Software Needs

Requirements What software needs for EIC Software would you like to highlight **now**, in a few years, and for the completion of the EIC project?

Technologies & Techniques What software technologies and techniques should be considered for the EIC?

Meeting Software Needs

What resources can your group contribute?

Expression of Interest for Software

1

Expression of Interest (EOI) for Software

Please indicate the name of the contact person for this submission:

Conveners of the Software Working Group:

- A. Bressan, M. Diefenthaler, and T. Wenaus
- eicug-software-conveners@eicug.org

Please indicate all institutions collectively involved in this submission of interest:

ANL	Argonne National Laboratory	29 institutions
BNL	Brookhaven National Laboratory	
CEA/Irfu	IRFU at CEA /Saclay institute	
EIC-India	Akal University, Central University of Karnataka, DAV College Chandigarh, Goa University, Indian Institute of Technology Bombay, Indian Institute of Technology Delhi, Indian Institute of Technology Indore, Indian Institute of Technology Patna, Indian Institute of Technology Madras, Malaviya National Institute of Technology Jaipur, Panjab University, Ramkrishna Mission Residential College Kolkata	
IMP-CAS	Institute of Modern Physics - Chinese Academy of Sciences	
INFN	Istituto Nazionale di Fisica Nucleare	
JLab	Thomas Jefferson National Accelerator Facility	
LANL	Los Alamos National Laboratory	
LBNL and UC Berkeley	Lawrence Berkeley National Laboratory and University of California, Berkeley	
NCBJ	National Centre for Nuclear Research	
OhioU	Ohio University	
ORNL	Oak Ridge National Laboratory	
SBU	Stony Brook University	
SLAC	SLAC National Accelerator Laboratory	
SU	Shandong University	

<https://indico.bnl.gov/event/8552/contributions/43221/>

Common Projects

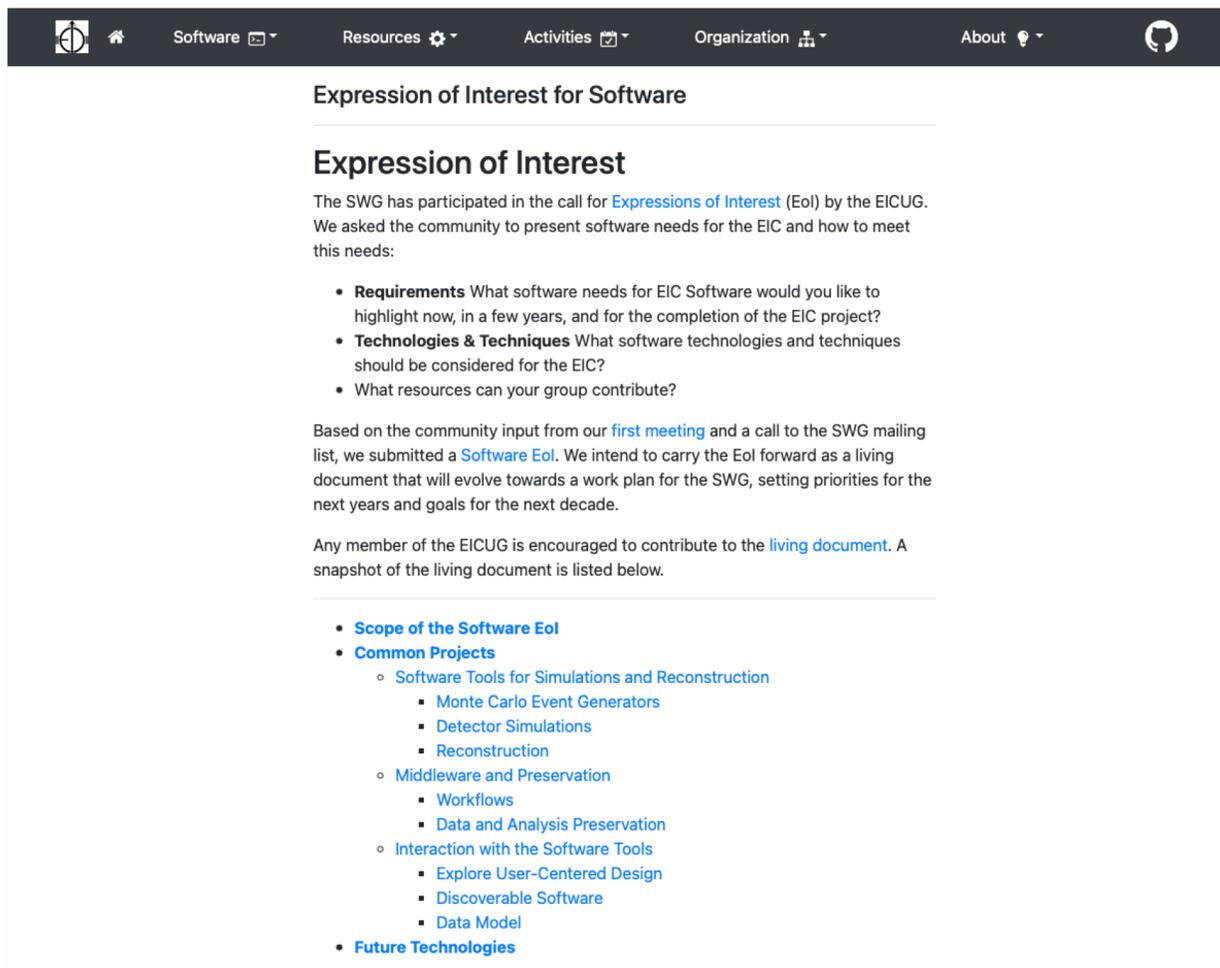
- **Software Tools for Simulations and Reconstruction**
 - Monte Carlo Event Generators
 - Detector Simulations
 - Reconstruction
 - **Validation**
- **Middleware and Preservation**
 - Workflows
 - Data and Analysis Preservation
- **Interaction with the Software Tools**
 - Explore User-Centered Design
 - Discoverable Software
 - Data Model

Future Technologies

- Artificial Intelligence
- Heterogeneous computing
- New languages and tools
- Collaborative software

Eol Evolving Towards Work Plan for the SWG

<https://eic.github.io/activities/eoi.html>



The screenshot shows the top navigation bar with links for Software, Resources, Activities, Organization, and About. The main content area is titled "Expression of Interest for Software" and contains the following text and lists:

Expression of Interest

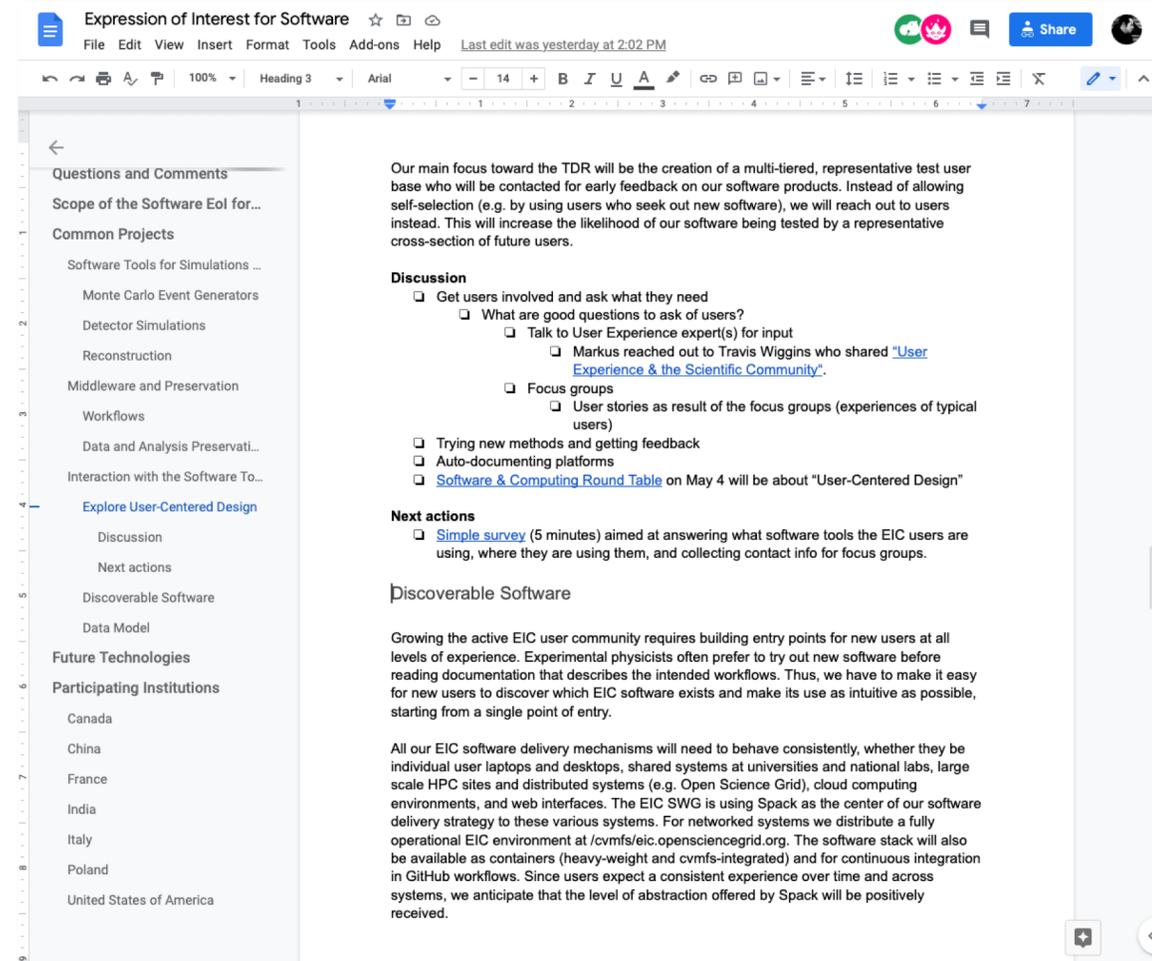
The SWG has participated in the call for [Expressions of Interest \(Eol\)](#) by the EICUG. We asked the community to present software needs for the EIC and how to meet this needs:

- **Requirements** What software needs for EIC Software would you like to highlight now, in a few years, and for the completion of the EIC project?
- **Technologies & Techniques** What software technologies and techniques should be considered for the EIC?
- What resources can your group contribute?

Based on the community input from our [first meeting](#) and a call to the SWG mailing list, we submitted a [Software Eol](#). We intend to carry the Eol forward as a living document that will evolve towards a work plan for the SWG, setting priorities for the next years and goals for the next decade.

Any member of the EICUG is encouraged to contribute to the [living document](#). A snapshot of the living document is listed below.

- **Scope of the Software Eol**
- **Common Projects**
 - [Software Tools for Simulations and Reconstruction](#)
 - [Monte Carlo Event Generators](#)
 - [Detector Simulations](#)
 - [Reconstruction](#)
 - [Middleware and Preservation](#)
 - [Workflows](#)
 - [Data and Analysis Preservation](#)
 - [Interaction with the Software Tools](#)
 - [Explore User-Centered Design](#)
 - [Discoverable Software](#)
 - [Data Model](#)
- **Future Technologies**



The screenshot shows the same content as the previous image, but in a rich text editor interface. The editor title is "Expression of Interest for Software" and it includes a menu bar with options like File, Edit, View, Insert, Format, Tools, Add-ons, and Help. The content is formatted with bold text for section headers and lists, and includes a table of contents on the left side of the editor window.

Expression of Interest for Software

Our main focus toward the TDR will be the creation of a multi-tiered, representative test user base who will be contacted for early feedback on our software products. Instead of allowing self-selection (e.g. by using users who seek out new software), we will reach out to users instead. This will increase the likelihood of our software being tested by a representative cross-section of future users.

Discussion

- Get users involved and ask what they need
 - What are good questions to ask of users?
 - Talk to User Experience expert(s) for input
 - Markus reached out to Travis Wiggins who shared "[User Experience & the Scientific Community](#)".
 - Focus groups
 - User stories as result of the focus groups (experiences of typical users)
 - Trying new methods and getting feedback
 - Auto-documenting platforms
 - [Software & Computing Round Table](#) on May 4 will be about "User-Centered Design"

Next actions

- [Simple survey](#) (5 minutes) aimed at answering what software tools the EIC users are using, where they are using them, and collecting contact info for focus groups.

Discoverable Software

Growing the active EIC user community requires building entry points for new users at all levels of experience. Experimental physicists often prefer to try out new software before reading documentation that describes the intended workflows. Thus, we have to make it easy for new users to discover which EIC software exists and make its use as intuitive as possible, starting from a single point of entry.

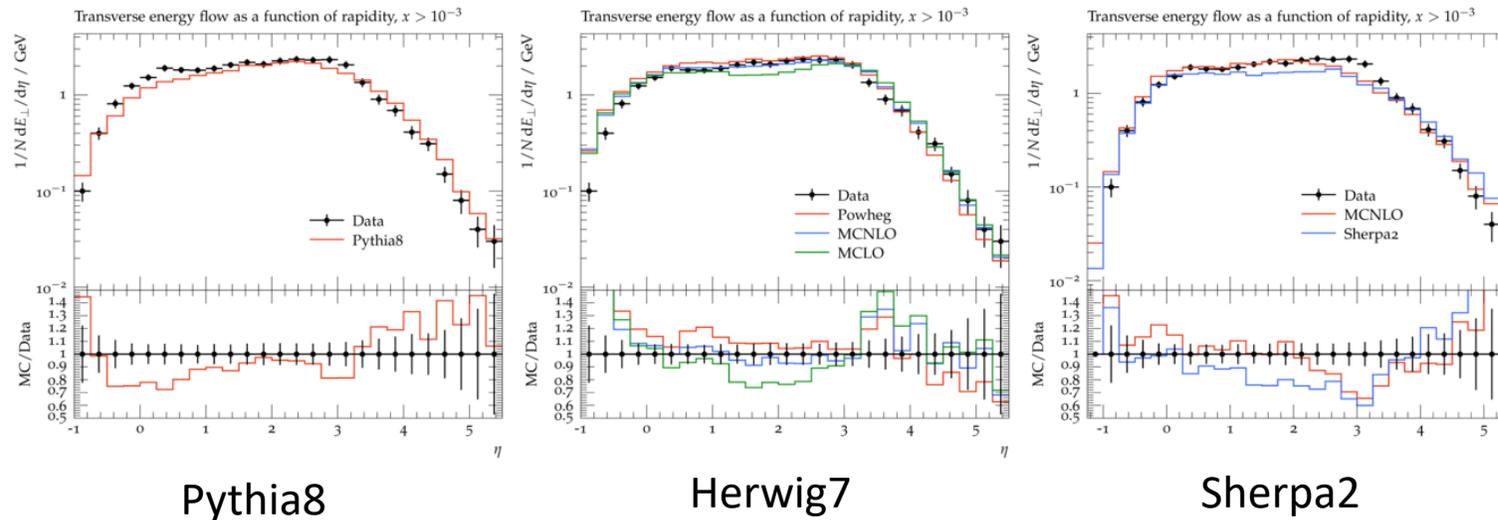
All our EIC software delivery mechanisms will need to behave consistently, whether they be individual user laptops and desktops, shared systems at universities and national labs, large scale HPC sites and distributed systems (e.g. Open Science Grid), cloud computing environments, and web interfaces. The EIC SWG is using Spack as the center of our software delivery strategy to these various systems. For networked systems we distribute a fully operational EIC environment at [/cmfms/eic.opensciencegrid.org](#). The software stack will also be available as containers (heavy-weight and cvmfs-integrated) and for continuous integration in GitHub workflows. Since users expect a consistent experience over time and across systems, we anticipate that the level of abstraction offered by Spack will be positively received.

Example Project: Compare MCEGs Results with HERA Data

EIC-India, MCnet

Current activity

- Comparison to published results using RIVET and understand differences
- **Provide initial findings and results in a EICUG report**
 - Overview of where we stand in understanding HERA data with current physics and models implement in MCEGs



Validation of Monte Carlo Event Generators for the Electron-Ion Collider

EIC-India, Software Working Group
March 2021

1 MC-data comparisons for the EIC

- Why are MC-data comparisons essential?
- data available for comparisons

2 Tools

2.1 The Rivet framework for MC/data comparison

The Rivet [?] package is in this report used for all validation against existing data, and is expected to be used for physics prediction for the EIC going forward, as the framework makes it easy to impose realistic experimental conditions on a Monte Carlo calculation. In this section we provide a brief description of Rivet, and refer to the manual cited above for a more detailed introduction.

The main purpose of the Rivet framework, is to allow for comparison to published data, under the same conditions as an experiment. An experimental analysis is often a very detailed and precise piece of work, and a brief description in a journal article, can seldom do the details full justice. Nevertheless, the details are important if the full utility of data is to be maintained even after an experiment has closed down, and the scientists responsible for the analysis have moved on. In Rivet, a data set is therefore published together with C++ code which reproduces the analysis on Monte Carlo simulated pseudo-data.

Technically, Rivet is a C++ library providing a) core functionality to write an analysis, and b) physics features which simplifies most standard operations carried out in analyses, as well as quite a few non-standard ones. On top of the framework, several (976 at the time of writing) analyses are written as plugin libraries. Historically, Rivet has its origin in HZTool [?], a FORTRAN package developed to facilitate comparisons to HERA data. Even though some analyses have been ported from the old package, $\mathcal{O}(100)$ ep analyses still exist exclusively in HZTool. An interface between the two is in its final stages of preparation, and the successful deployment of this is a high priority for the EIC software working group.

Example for Eol Planning (Work In Progress)

User-Centered Design

- Q1 Survey of software practices in the EIC community (“what was used for YR”)
- Q2 EIC SW tutorials: follow-up survey
- Q3 Develop user profiles

Discoverable Software

- Q1 CI for spack, cvmfs/spack
- Q2 Regular release of consistent environments on individual systems, cvmfs, as containers
- Q2 Increase software provided on cvmfs
- Q3 Become option for >80% of analyses

Workflows

- Q1 Template repositories for key analyses
- Q2 Cvmfs and containers, OSG job specs
- Q3 REANA on BNL / JLab resources
- Q4 Template repositories and workflows for validation

Data and Analysis Preservation

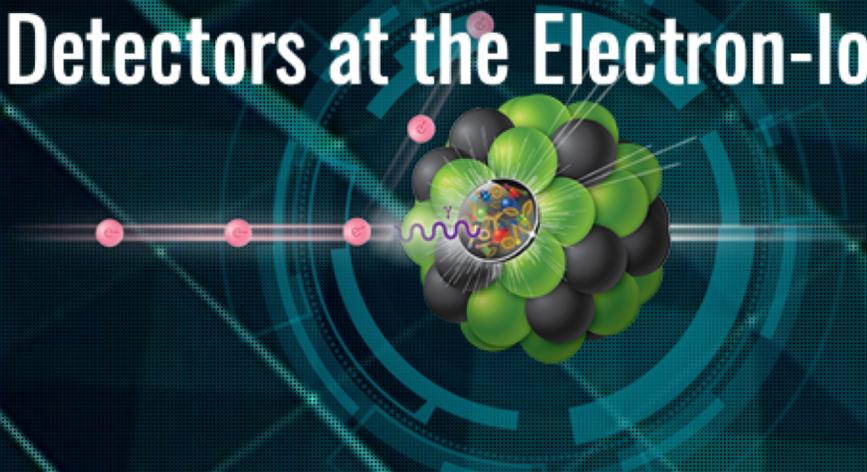
- Q1 Policy framework for github/eic
- Q2 User software/analysis code registry
- Q2 Tutorials for analysis code on git
- Q4 Tutorials on reproducible analysis

More on CI and Workflows for Validation by Whit

- ANL is part of the **Software Eol** and will share their experience with R&D on automated benchmarking workflows with the community (**Workflows and preservation**).

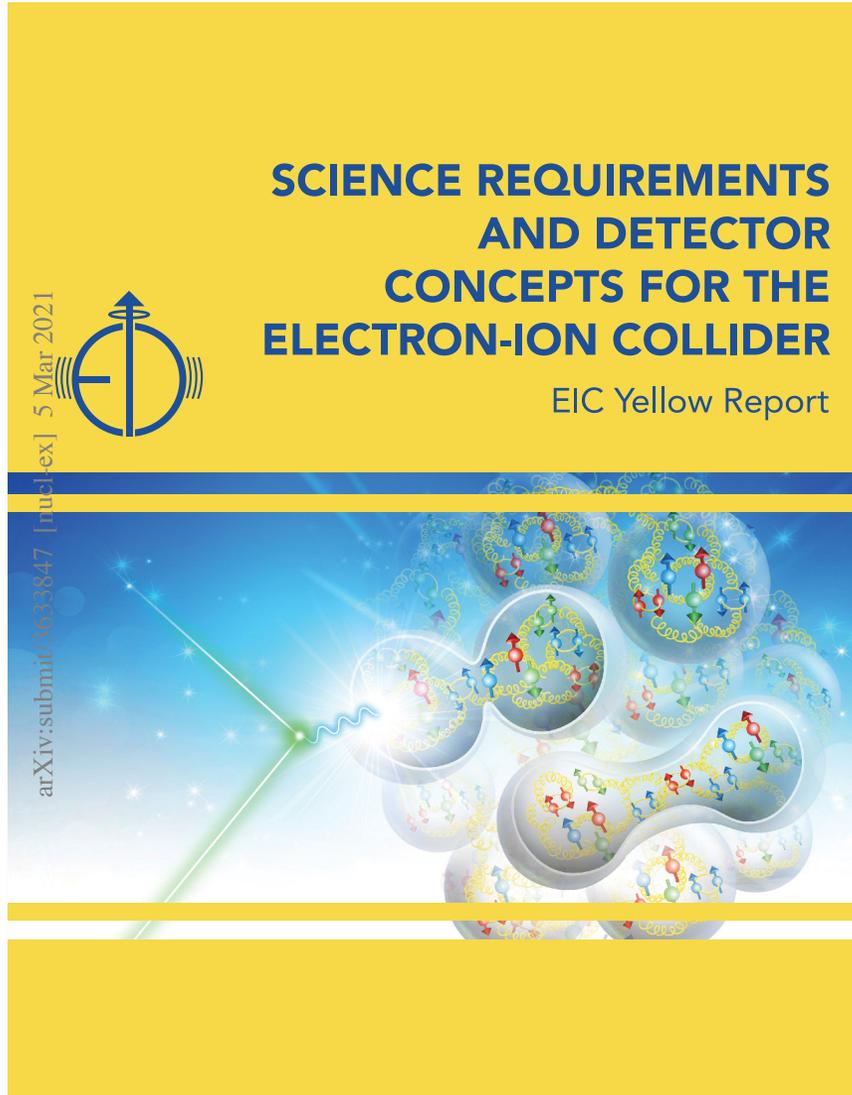
SWG Priority: Support of Collaboration Proposals

Call for Collaboration Proposals for Detectors at the Electron-Ion Collider



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Support of the Yellow Report Initiative



2nd IR for the EIC, March 19, 2021.

Software Collection

- MCEGs
- **Fast simulation tool** eic-smear, Delphes
- **Full simulation tool** EicRoot, ESCalate, Fun4All
- **Integration** EicToyModel

eic.github.io Main portal to EIC software, repositories, documentation and resources

Tutorials

EIC User Group
78 subscribers

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Uploads ▶ PLAY ALL

Video Title	Duration	Views	Time Ago
EIC Software Tutorial: Pythia 8	1:40:31	428 views	4 months ago
EIC Software Tutorial: Herwig	2:02:50	86 views	6 months ago
EIC Software Tutorial: MC-Data Comparisons in Rivet	59:52	89 views	6 months ago
EIC Software Tutorial: Sherpa	1:49:46	96 views	6 months ago
EIC Software Tutorial: Advanced Fast Simulations...	2:10:18	164 views	9 months ago
Jim Pivarski Tutorial: uproot and Awkward Array	2:37:12	373 views	11 months ago

Support of Detector Full Simulations

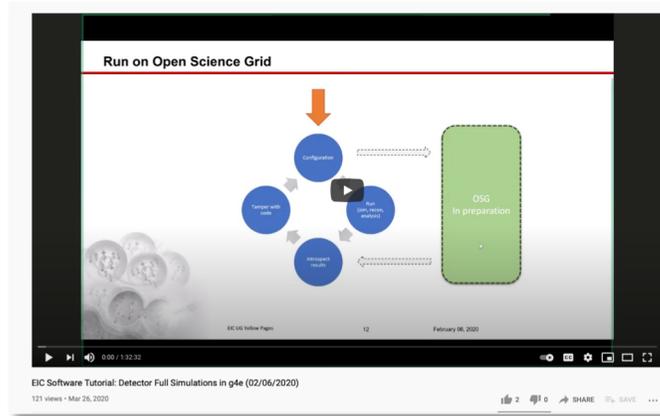
YouTube

- Tutorials on how to **integrate standalone Geant4 simulations** in ESCalate and Fun4All (January and February 2020)

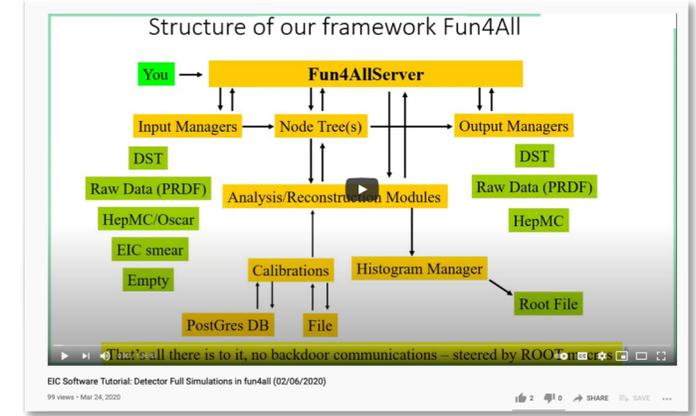
Example Detector



Integration in ESCalate (g4e)



Integration in Fun4All



- Work on **federated resources**

Introductory Meeting with Electron-Ion Collider (EIC)

Wednesday Apr 22, 2020, 3:30 PM → 4:30 PM US/Eastern

<https://indico.fnal.gov/event/24231/>

Description BlueJeans video conference: <https://bluejeans.com/993096080>.

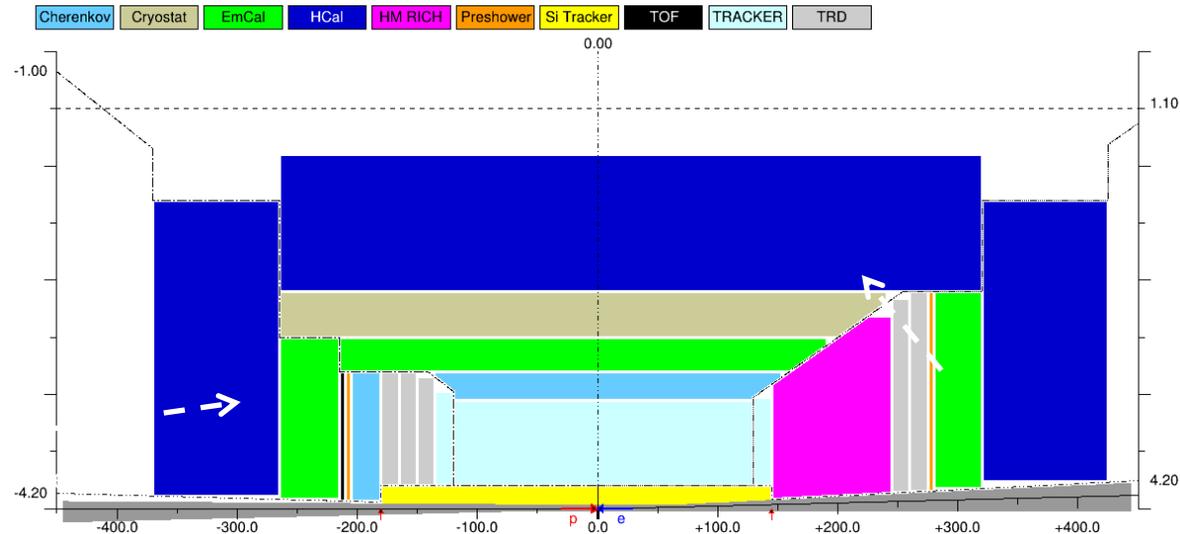
Attendees: Jerome Lauret (chair), Miron Livny, Rob Gardner, Frank Wuerthwein, Paschalis Paschos, Thomas Ullrich, Amber Boehnlein, Graham Heyes, Markus, Diefenthaler, Torre Wenaus, Andrea Bressan [Hide](#)

Meeting between EIC reps and members of the OSG ET. Good communication and productive meeting. Presentation by Markus Diefenthaler a EIC introduction.

<https://github.com/eic/EicToyModel>

A tool to model & generate EIC Central Detector *templates* in a way

- new geometries (models) can be generated, *quickly* and *by everybody*
- represented instantly in a WYSIWYG fashion
 - the sub-detector *container objects* are guaranteed to not overlap either with each other or with the IR vacuum chamber elements
 - technically they can be imported in Geant4 frameworks in a consistent way and used as wrappers to the *real* sub-detectors
 - they can be exported in a CAD format to be used in the engineering design of the detector support structures and / or laying out services



<https://eic.github.io/resources/overview.html>

Computing Resources available at BNL and JLab

BNL and JLab provide computing resources for the worldwide EIC community:

- [CPU](#)
- [Workload Management](#)
- [Storage](#)
 - [Data Storage](#)
 - [Auxiliary Data Services](#)
- [GitHub organization](#)

You can use your existing BNL or JLab account or register as new user at the host labs:

- [Request a BNL computing account](#)
- [Request a JLab computing account](#) (register as `User-remote` and state `EIC` as your sponsor)

CPU

BNL	JLab
Dedicated EIC resources: 7 machines with 64 core, 6x64 batch slots = 384 slots and one for interactive use (VMs). Each node has dual CPU AMD EPYC 7351.	JLab operates a common cluster. 25k job slots. Delivering ~ 76M core hours per year normalized to dual CPU AMD EPYC 7351.
1,000 slots allocated from a variety of CPUs (Intel® Xeon® and AMD EPYC)	EIC is currently one of ten projects sharing a 10% fair-share of the cluster. So guaranteed 7.6M core hours if the other nine are idle 0.8M if all are busy
31k slots available to all experiments that can be dynamically allocated upon priorities (358 M core hours per year).	A further 4MCH/yr dedicated to EIC will be added when demand requires it.

Software Working Group and Collaborations Proposals

Work with the EIC community

- EIC collaborations will determine for themselves what they do for software, but that will likely include **common software**.
- SWG supported Yellow Report Initiative and will **support call for detector collaborations proposals**:
 - **This includes of course the work on a detector concept for the 2nd IR.**
 - Simulation efforts by ECCE, EIC@IP6, and possible other initiatives can be part of SWG.
 - Common software projects by the SWG highly relevant for ECCE, EIC@IP6, and possible other initiatives.

Common Software

- Define requirements for EIC Software and **common software projects**:
 - Software needs of the EIC addressed in EoI.
 - Evolve with the EIC community and the EIC project.
- Work together on **common software projects** based on these requirements.
 - Avoid duplication of the effort, e.g., workflows for running on computing resources at the host labs or the OSG.
 - Team up on challenges, e.g., running on heterogenous resources.
- Continue to build a **EIC Software community** with close connections and collaborations to the experts in NP and HEP (CERN ROOT, Geant4, HEP Software Foundation, Mcnet).

What Simulation Tool(s) To Use?

- Completing the detector proposals on time will require that software efforts proceed pragmatically with maximal efficiency along already established paths.
 - This means two (or three) full simulation frameworks in use.
- Migrating either proto-collaboration fully to either framework now would inefficiently consume effort better expended on simulation studies proper.
 - There will be overlap between proto-collaborations and there will likely remain two (or three) full simulation frameworks.
- What is essential is that the subsystem simulations come together in an integrated way to a complete coherent detector model.
- The SWG has provided a software infrastructure that can support this pragmatic, efficient approach:
 - Geant4 detector subsystem models are modular enough that they can be integrated in either ESCalate or Fun4All (cf. tutorials in early 2020, slide 9) or by extension in a next-generation common framework.
 - EicToyModel exists as a starting point for detector integration across subdetector models.

Towards a Next-Generation Common Framework



ELECTRON ION COLLIDER USER GROUP STATE OF SOFTWARE SURVEY

Survey from February 16 – 23, 2021.

[report](#)

There are **too many generators and simulation tools** used at the moment.

Unify the Simulation Effort

- The SWG is preparing to launch a **common effort on next-generation simulations**:
 - building on the work done in the existing simulations,
 - unify the software community behind one common effort,
 - a requirement for the common framework is that it integrate the existing detector simulations in a modular way.



Makoto Asai (SLAC)

Our Vision Forward

Unify the Simulation Effort with the Community

- The SWG is preparing to launch a **common effort on next-generation simulations**:
 - Fast and full simulations in Geant4 for large-scale detector systems with a plug and play modular approach
 - Building on the work done in the existing simulations
 - A requirement for the common framework is that it integrate the existing detector simulations in a modular way.

Community Scenarios

1. If the proto-collaborations proceed in the context of working pragmatically with present tools now but anticipating a migration to a common framework after the current phase, in 2022, then this year's work across the proto-collaborations can be convergent, with both in their evolution targeting compatibility with one modular common framework, the architecture and APIs of which will take shape this year, in close collaboration with the existing simulation developers.
2. If however the proto-collaborations proceed with the mindset and plan that they have chosen their framework now, then the software stacks of the proto-collaborations will diverge greatly over the next year and likely make a common framework impractical for good.

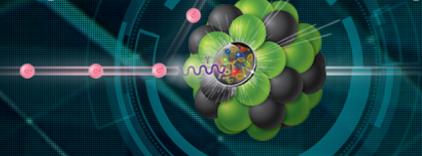
Summary

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Support of Collaboration Proposals

get work done in the short term

Weekly Meetings <https://indico.bnl.gov/category/301/>

Mailing List eicug-software@eicug.org

Realize Software Eoi

sustainable effort

Get involved