

EIC Software Status and Plans

Amber Boehnlein (JLab)

Markus Diefenthaler (JLab)

Torre Wenaus (BNL)

November 12, 2021

EIC R&D For Computing and Software

EIC Computing and Software is in a very early life stage

- The current focus is supporting detector design
- Software Working Group within the EIC Users Group works with the community and proto-collaborations to address software needs and evolving R&D
- Legacy codes and frameworks are in use
- Distributed Computing approach to supply resources for studies
- At the pre-requirements stage for production computing and software activities

Driven by community need, 'bottom up'



ELECTRON ION COLLIDER USER GROUP STATE OF SOFTWARE SURVEY

The Software Working Group collected information on the community's specific software tools and practices during the Yellow Report Initiative.

Q7. Do you have any comments on your current experience with EIC Software?

Common message:
Priorities for consolidating around
common software are in MC
generators and detector simulation

MC event generators for EIC

EIC community has been organized around its MC generator needs already for several years

Precision measurements at the EIC require advancements in QCD theory and computational methods.



MC4EIC

CTEQ-EICUG workshop on MC event simulation for the EIC

November 18-19, 2021 <https://indico.bnl.gov/event/13298/>

- eAST is **toolkit** for Electron-Ion Collider simulation studies built on top of Geant4.
- It is a **turn-key application**.
- Requirements:
 - ability to **reuse existing simulation works**
 - ease of **switching detector options** with comparable levels of detail
 - ease of switching between **detailed and coarse** detector descriptions
 - ease of switching between **full Monte Carlo and fast simulation** at component level
 - ability to **integrate beam test setups** for physics validation and parameter optimization and
 - ease of **leveraging new and rapidly evolving** computing architectures
- Strong tie-up
 - EIC user community
 - eAST development team
 - Geant4 core developers
 - eAST lead by Makoto Asai

- Modularity
 - integrability / flexibility at the level of detector component
 - choice of CAD/GDML or hard-coding geometries
 - physics options per detector components
- Thinnest wrapper
 - use native Geant4 functionalities as much as possible
 - quick catchup of Geant4 evolutions
- Controllability
 - everything to be controlled by GUI / macro file
 - e.g. particle flux scoring and plotting histograms and n-tuples

Side note:

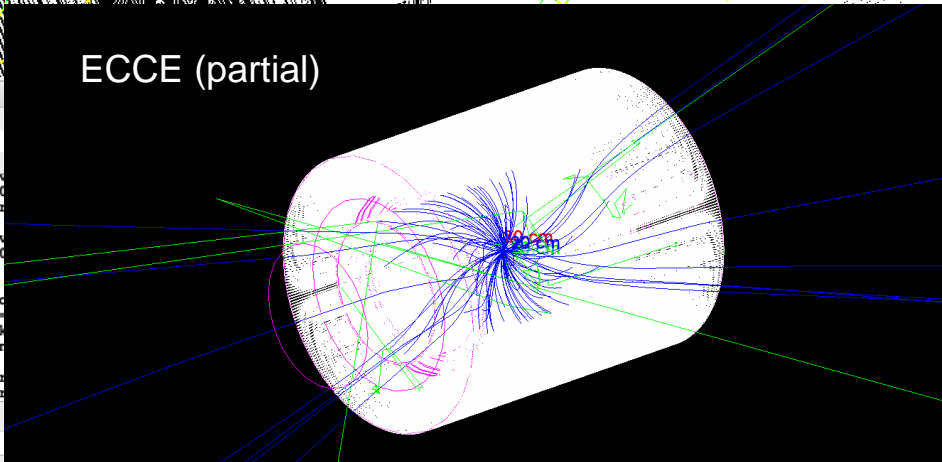
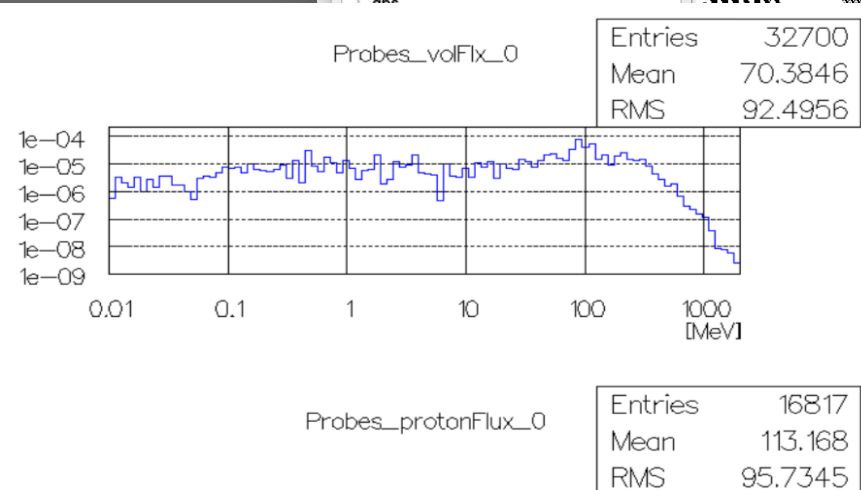
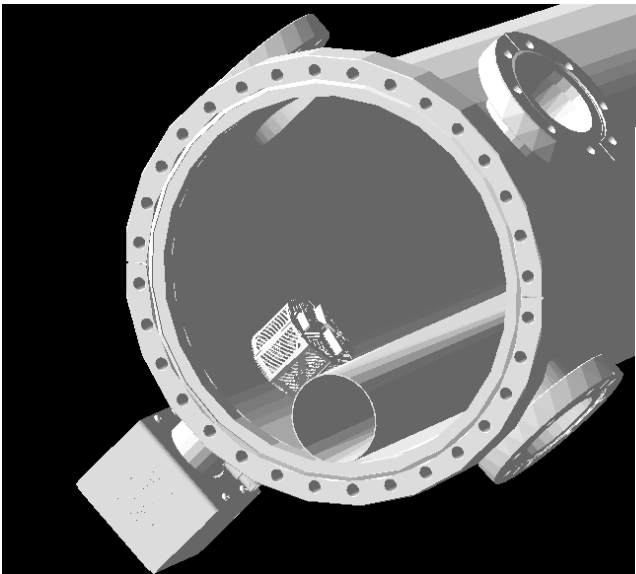
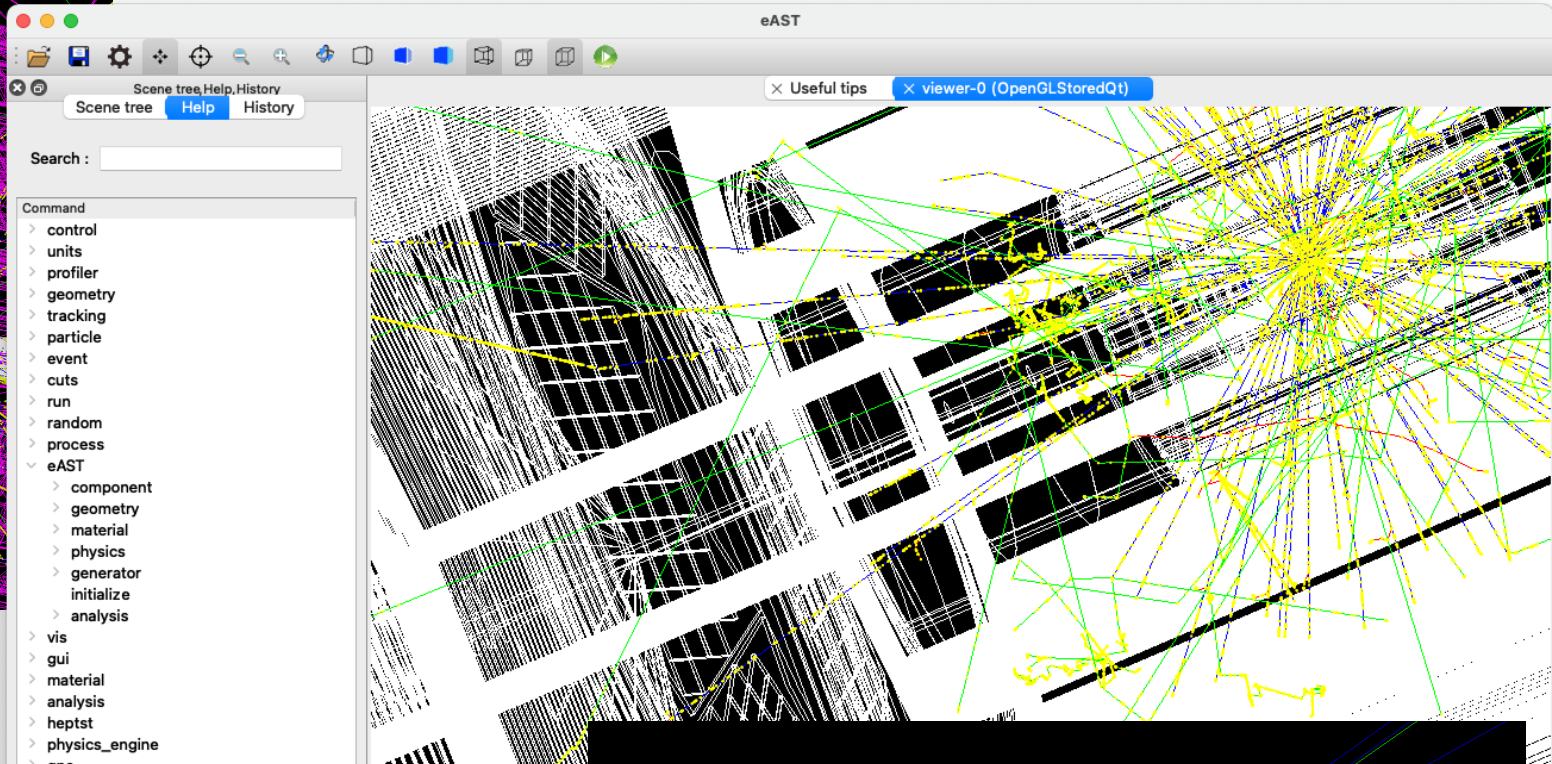
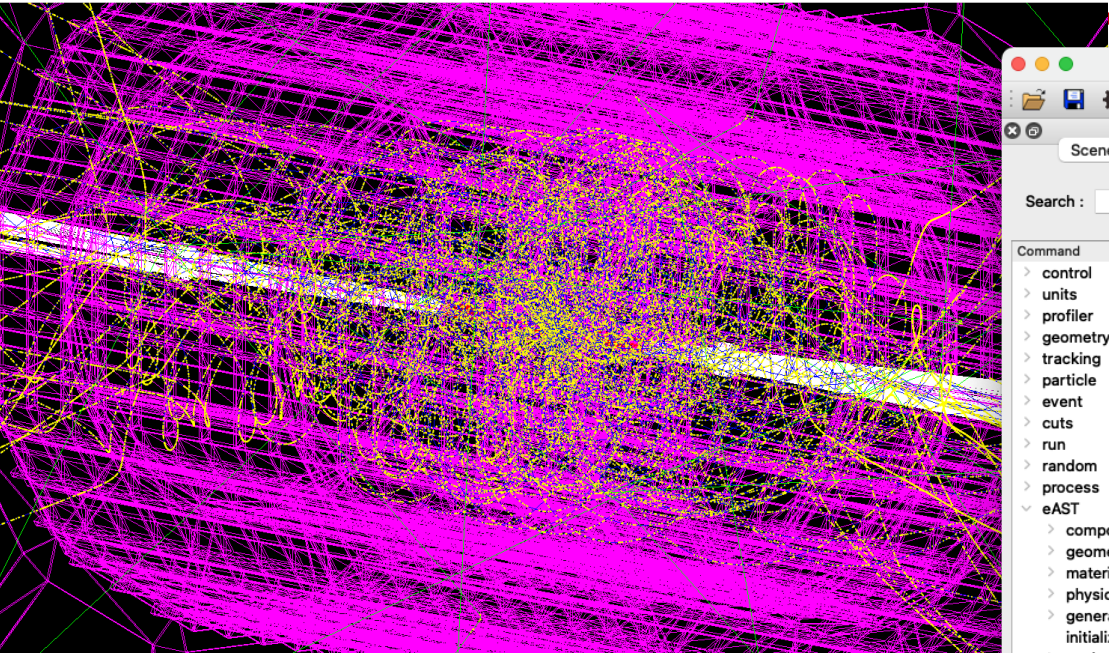
Geant4 version 11.0 (Dec.2021) includes

- Task-based event parallelism
- New set of EM physics specialized to HENP calorimeter
- Integrated filling and drawing of histogram / 2D-plot

Near future Geant4 (2022~) will include

- Task-based sub-event parallelism suitable for heterogeneous computing architecture

eAST in action (early days)



EIC Common Software: The Software EOI (and 'living' planning document)

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

Brookhaven National Laboratory
Expression of Interest (EOI) for
Electron-Ion Collider (EIC). The
integrated in the interaction region

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
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, Punjab 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

- **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 cvmfs/spack
 - Data Model Common data format
- **Future Technologies**
 - Artificial Intelligence
 - Heterogeneous computing
 - New languages and tools
 - Collaborative software

AI/ML for EIC

AI/ML already has an important presence in EIC, with one of the proto-collaborations (ECCE) applying it to detector design optimization, as well as applications such as streaming DAQ, and a community-level AI/ML working group being established to explore and develop AI/ML's potential

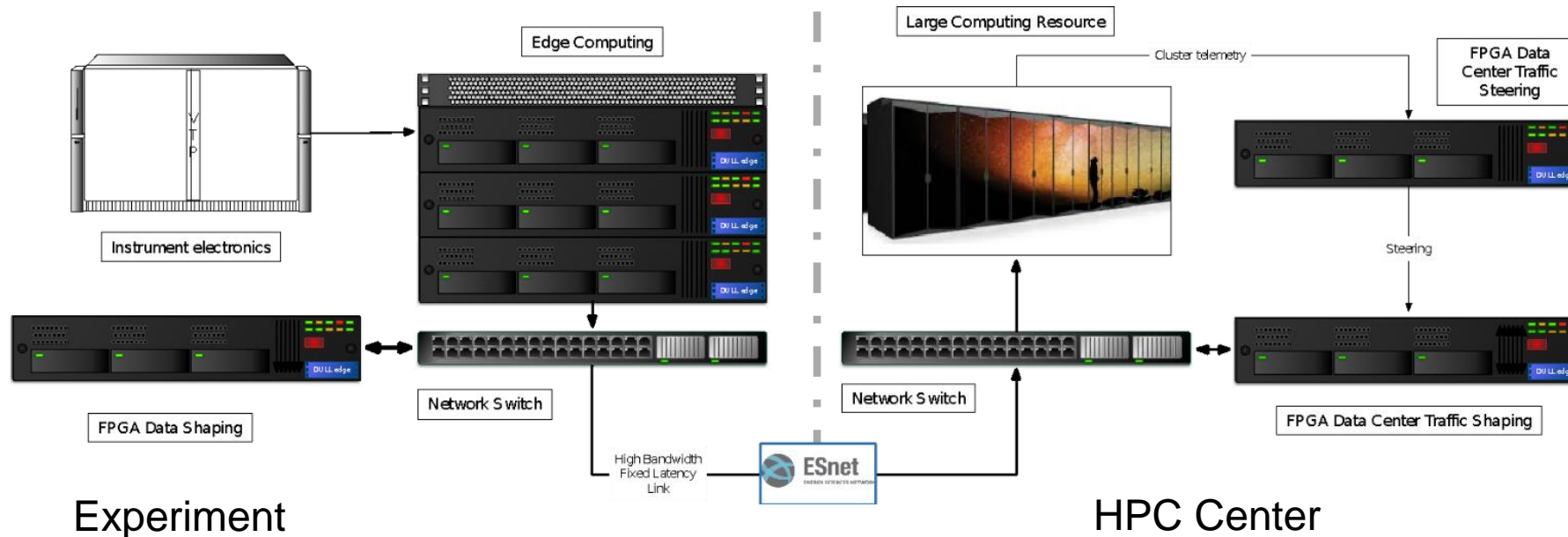


The image features a logo for 'AI4EIC' on a dark blue background. The 'AI' is rendered in a large, white, outlined font, with a white triangle inside the 'A'. The '4' is a small white number, and 'EIC' is in a large, white, outlined font. To the right of the text is a diagram of an electron-ion collider. It shows a blue circular ring with a central core of blue spheres. A wavy line labeled γ (photon) is shown interacting with the core. Several pink circles labeled e^- (electrons) are shown entering the ring from the left. The background of the logo is a grid of blue squares of varying sizes and opacities.

Workshop: AI4EIC-Exp - Experimental Applications of Artificial Intelligence
for the Electron Ion Collider

• EJFAT - ESnet / JLab FPGA Accelerated Transport:

- Pilot Project funded Advanced Scientific Computing Research (ASCR), Office of Science in DOE
- Purpose: Demonstrate seamless integration of edge / core computing to support direct experiment data processing at HPC Centers
 - Support High Data Rates (100Gbs) with guaranteed Quality of Service (QoS)
 - Dynamic Compute Work Load Balancing via AI/ML
 - Workflow Support:
 - Streamed Data Processing / Storage
 - real time researcher feedback
 - Explore with ESnet next generation networking fabric / control



Thanks

EIC Software and Computing Vision:

- Seamless data processing from detector readout to analysis
- Common, community software where possible
- Leverage tools and applications from related activities
 - Collaborating institutions
 - WP7 activities
- Distributed Computing Model that includes HPC centers
- Use AI/ML to maximize the physics potential of the EIC from design to physics results

The EIC has a vibrant software community

- Organizing effectively around essential needs like MC
- Organizing early and actively for the long term