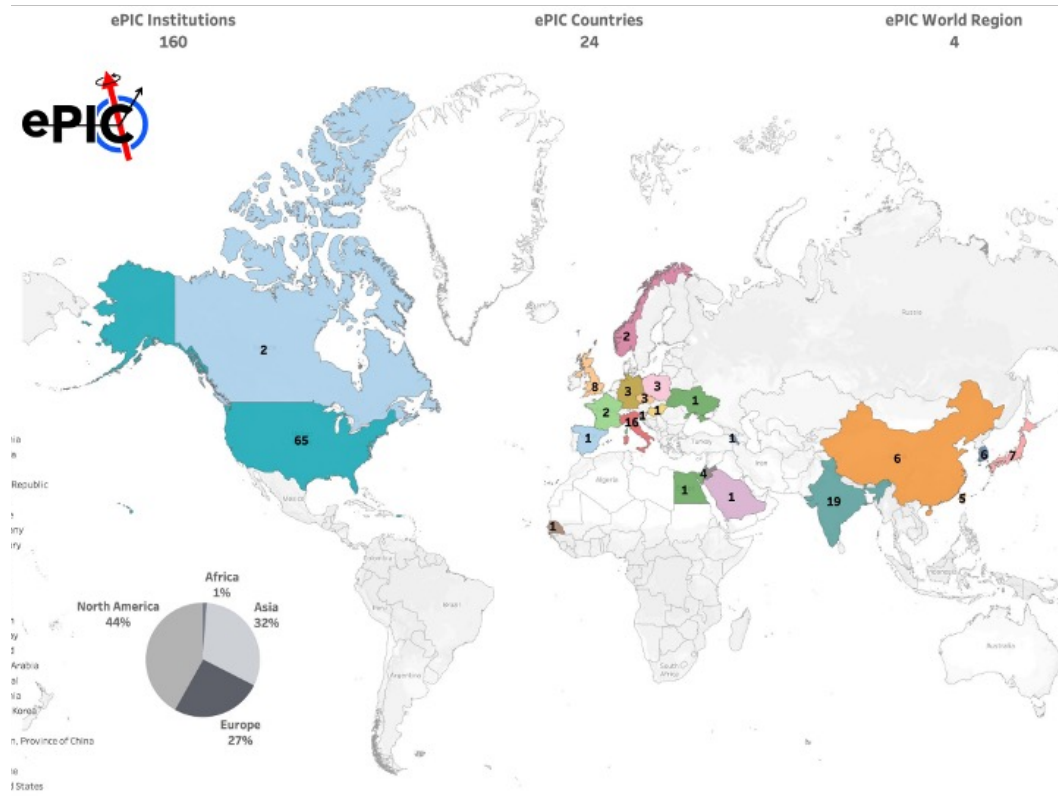


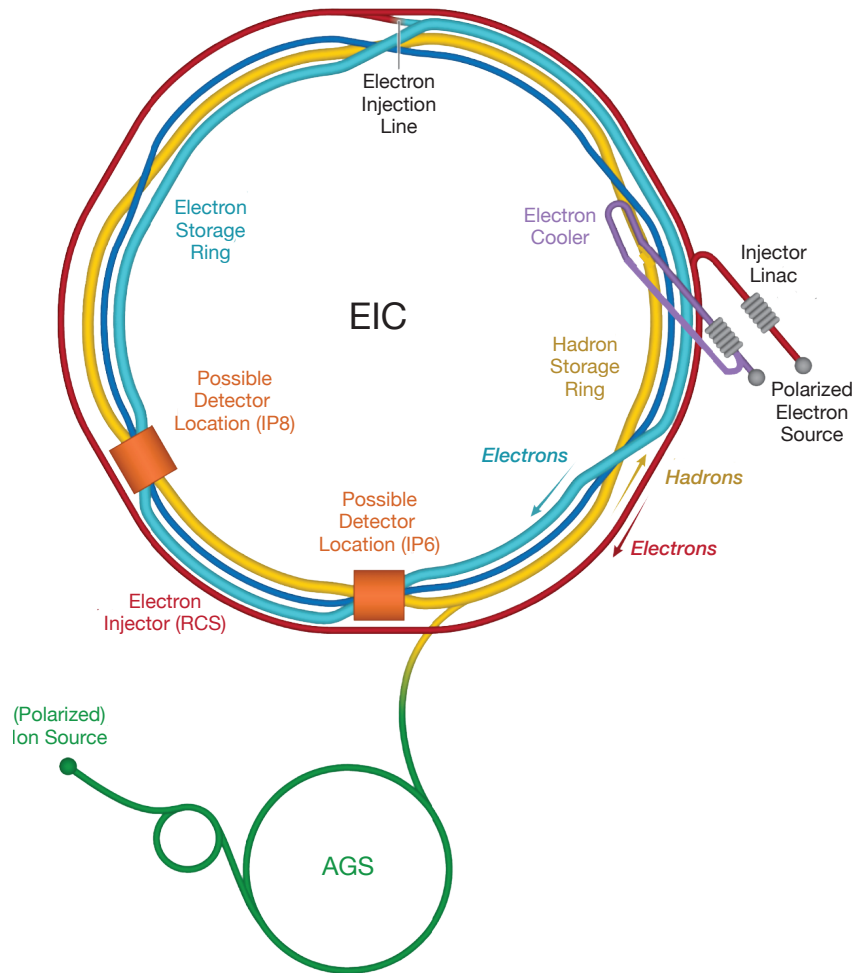
User-Centered Design for the Electron-Ion Collider



ePIC Collaboration Meeting at Jefferson Lab

Markus Diefenthaler EIC² at Jefferson Lab, ePIC

The Electron-Ion Collider (EIC)



Frontier accelerator facility in the U.S.

- **World's first collider of:**

- Polarized electrons and polarized protons,
- Polarized electrons and light ions (d, ^3He),
- Electrons and heavy ions (up to Uranium).

- The EIC will enable us to embark on a **precision study of the nucleon and the nucleus at the scale of sea quarks and gluons**, over all of the kinematic range that is relevant.
- The **EIC Yellow Report** ([Nucl.Phys.A 1026 \(2022\) 122447](#)) describes the physics case, the resulting detector requirements, and the evolving detector concepts for the experimental program at the EIC.
- BNL and Jefferson Lab will be host laboratories for the EIC Experimental Program. Leadership roles in the EIC project are shared.
- EIC operations will start in about a decade.

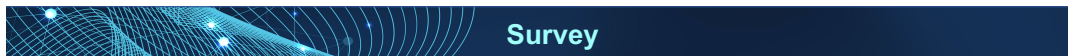
Our Vision for Software & Computing at the EIC

“The purpose of computing is insight, not numbers.” Richard Hamming (1962)

Rapid turnaround of data for the physics analysis and to start the work on publications:

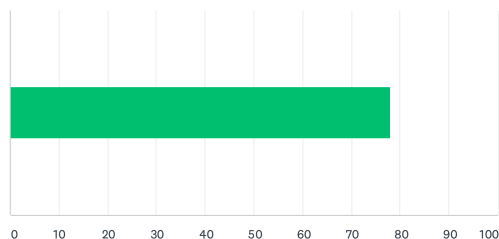
- **Goal:** Analysis-ready data from the DAQ system.
- **Compute-detector integration** using streaming readout, AI/ML, and heterogeneous computing.

Software & computing are an integral part of our research:



Q1 What fraction of your time do you spend on the software and computing aspects of your research, such as programming, analysis jobs, etc.?

Answered: 44 Skipped: 0



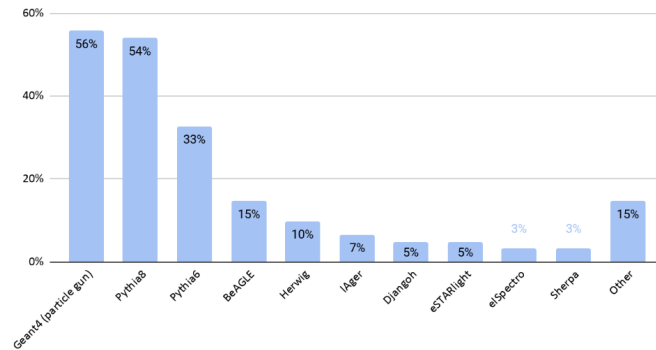
Survey among NP Ph.D. students and postdocs in preparation of “Future Trends in NP Computing”

- **Goal** We would like to ensure that scientists of all levels worldwide can participate in EIC analysis actively.
- **User-Centered Design:** Engage the world community in the development. Listen to users, then develop software.

- **State of Software Survey in 2021 and 2022**: Collected information on software tools and practices

Over the past year, which physics event generation tools did you use for EIC simulations?

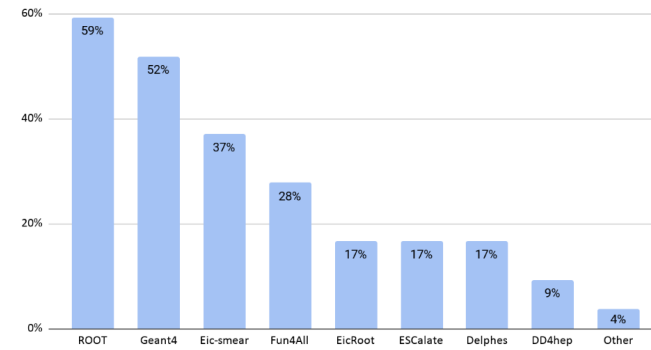
N = 61, average number of selected options = 2.0



Other (N = 9): personal computer codes (N = 2), ACT, CLASDIS, ComptonRad, GRAPE-DILEPTON, MADX, MILOU, OPERA, RAYTRACE, Sartre, Topeg, ZGOUBI

Over the past year, which detector simulation tools did you use for EIC simulations?

N = 54, average number of selected options = 2.4



Other (N = 2): GEMC, RAYTRACE

- The regular software census will be essential to better understand and quantify software usage throughout the EIC community.
- As part of the State of Software Survey, we asked for volunteers for **focus-group discussions**:
 - Students (2f, 2m), Junior Postdocs (2f, 3m), Senior Postdocs (2f, 3m), Professors (5m), Staff Scientists (2f, 3m), Industry (2f, 2m)
 - Extremely valuable feedback, documented many suggestions and ideas.
 - Developed user archetypes based on the feedback.

- Based on feedback from focus group discussions.
- Developed with Communication Office at Jefferson Lab and UX Design Consultant.
- Input to software developers as to which users they are writing software for:



DREW – Software as Part of My Research

#Independent, #Invested, #StatusQuo, #LateAdopter

"You cannot participate in research in our field without spending a significant amount of time on software. That's just how it is. I feel comfortable using the software and modifying it for my needs. I sometimes share my modifications but software development is not my priority."

CHARACTERISTICS



Independent as long as things work.



Invested in status quo. Won't push for new approaches but rather for maintaining old ones.



Late adopter will change from status quo only when others already have.

ATTRIBUTE METRICS – All sliders are ranging from low to high.



SOFTWARE EXPERIENCE



SOFTWARE EXPERTISE



EMOTIONAL INVESTMENT



OPENNESS TO NEW EXPERIENCES



ABILITY TO COMPROMISE



INFLUENCE

User Archetypes

Software is not my strong suit.

Software as a necessary tool.

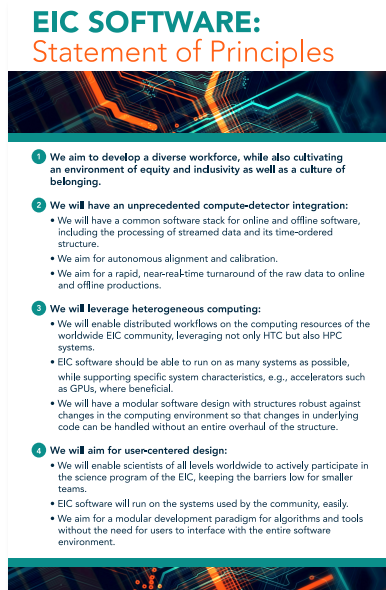
Software as part of my research.

Software is a social activity.

Software emperors.

Major Outcome of Surveys: One Software Stack for the EIC

- **How to decide on our software stack?**
 - How do we ensure we work towards to our vision for EIC Software?
 - How do we ensure we meet the needs of the EIC community?
- **Solution: Statement of Principles**
 - Community process to define guiding principles for EIC Software.
 - Guiding principles define the requirements for EIC Software.
 - Endorsement by the international EIC community.



PDF version, Webpage

Principle 4: User-Centered Design

4 We will aim for user-centered design:

- We will enable scientists of all levels worldwide to actively participate in the science program of the EIC, keeping the barriers low for smaller teams.
- EIC software will run on the systems used by the community, easily.
- We aim for a modular development paradigm for algorithms and tools without the need for users to interface with the entire software environment.

Users should not need to know the entire toolchain to make meaningful contributions to a single component.

Principle 7: Community

7 We will embrace our community:

- EIC software will be open source with attribution to its contributors.
- We will use publicly available productivity tools.
- EIC software will be accessible by the whole community.
- We will ensure that mission critical software components are not dependent on the expertise of a single developer, but managed and maintained by a core group.
- We will not reinvent the wheel but rather aim to build on and extend existing efforts in the wider scientific community.
- We will support the community with active training and support sessions where experienced software developers and users interact with new users.
- We will support the careers of scientists who dedicate their time and effort towards software development.

User-Centered Design for the Electron-Ion Collider

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- **Reality:** On average, 78% of students' and postdocs' research time is devoted to software and computing.
 - **Goal:** Enable active participation in physics analysis, regardless of career stage, beyond just students and postdocs.
 - **Solution via User-Centered Design:** Engage community in development. Listen to users, then develop software.
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- Started projects on User-Centered Design in ePIC.
 - User-Centered Design is part of our software principles.

