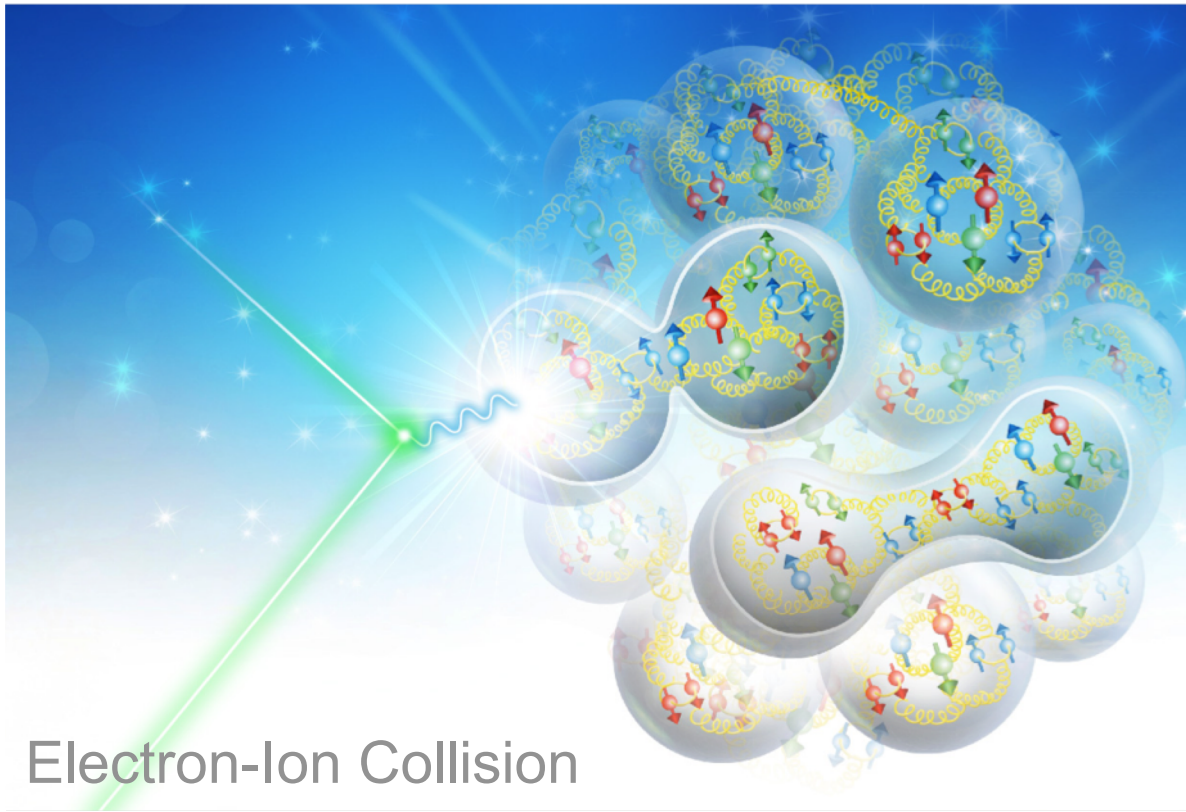
Requirements for initial EIC Software

Markus Diefenthaler (EIC^2 Jefferson Lab)
PI EIC Software Consortium
Convener EICUG Software Working Group



Electron-Ion Collision

Initial steps

EIC Software Consortium

Existing EIC Software

ANL TOPSiDE detector concept (ILC software variant)

BNL BeAST detector concept: EICroot (FairRoot variant)

BNL ePHENIX detector concept (fun4all)

JLAB JLEIC detector concept (GEMC → eJANA)

Software Review by EIC Community in November 2017

- Actively maintained: ANL software, fun4All , EicRoot, then GEMC and now eJANA
- The analysis environments for the EIC will be chosen when the EIC experimental collaborations will form.
- Until then, we will examine the **requirements** for the EIC analysis environment and work on the **R&D** aspects of the EIC analysis environment.

EIC Software Consortium

EIC SOFTWARE CONSORTIUM

Goals and focus

- work on common interfaces among EIC simulation tools
- explore new avenues of software development (e.g., AI)
- **reach out to the EIC community**
  - communicate present status of EIC software
  - bring existing EIC software to end users
  - produce publicly available consensus-based documents on critical subjects
  - provide vision for the future

ESC members

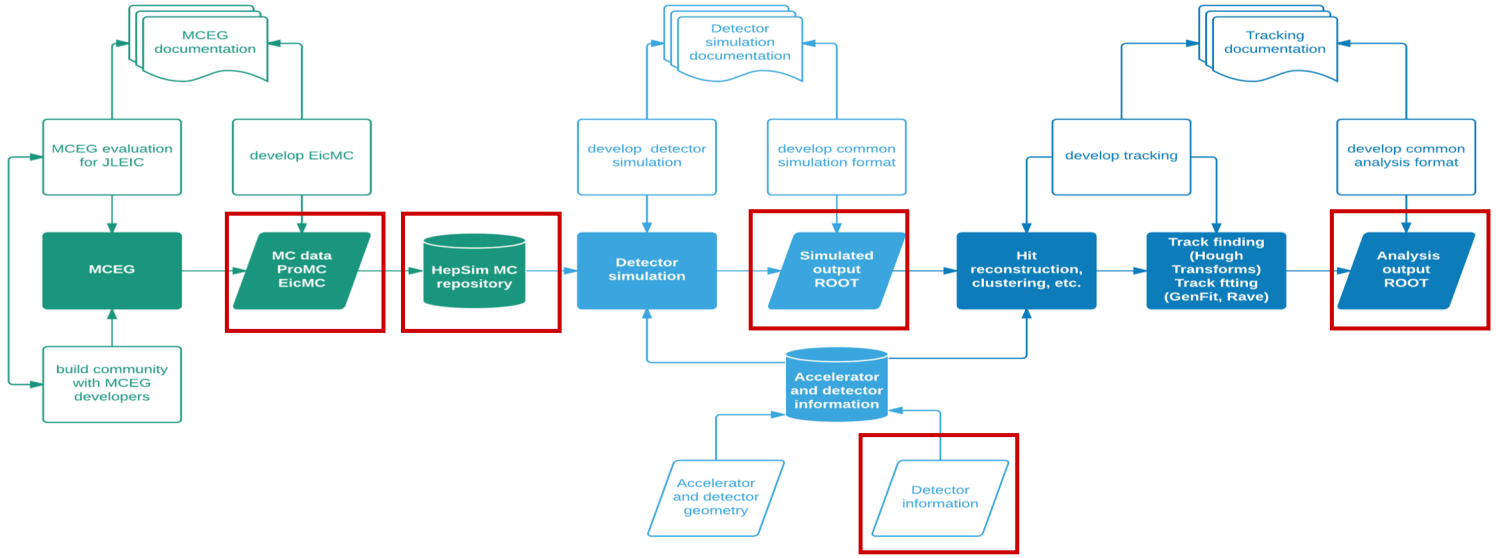
ANL, BNL, JLAB, LUND, INFN, SLAC, Trieste, W&M

Part of EIC Generic Detector R&D program

Common interfaces

Advice from ILC effort

- facilitate interoperability
- focus on exchange detector designs and data
  - get the event data model right and keep it open
  - pick a detector definition which is exchangeable



Norman Graf (SLAC)

"It's very difficult to ~~herd cats~~ keep physicists from re-inventing the wheel and writing new software packages."

MCEG

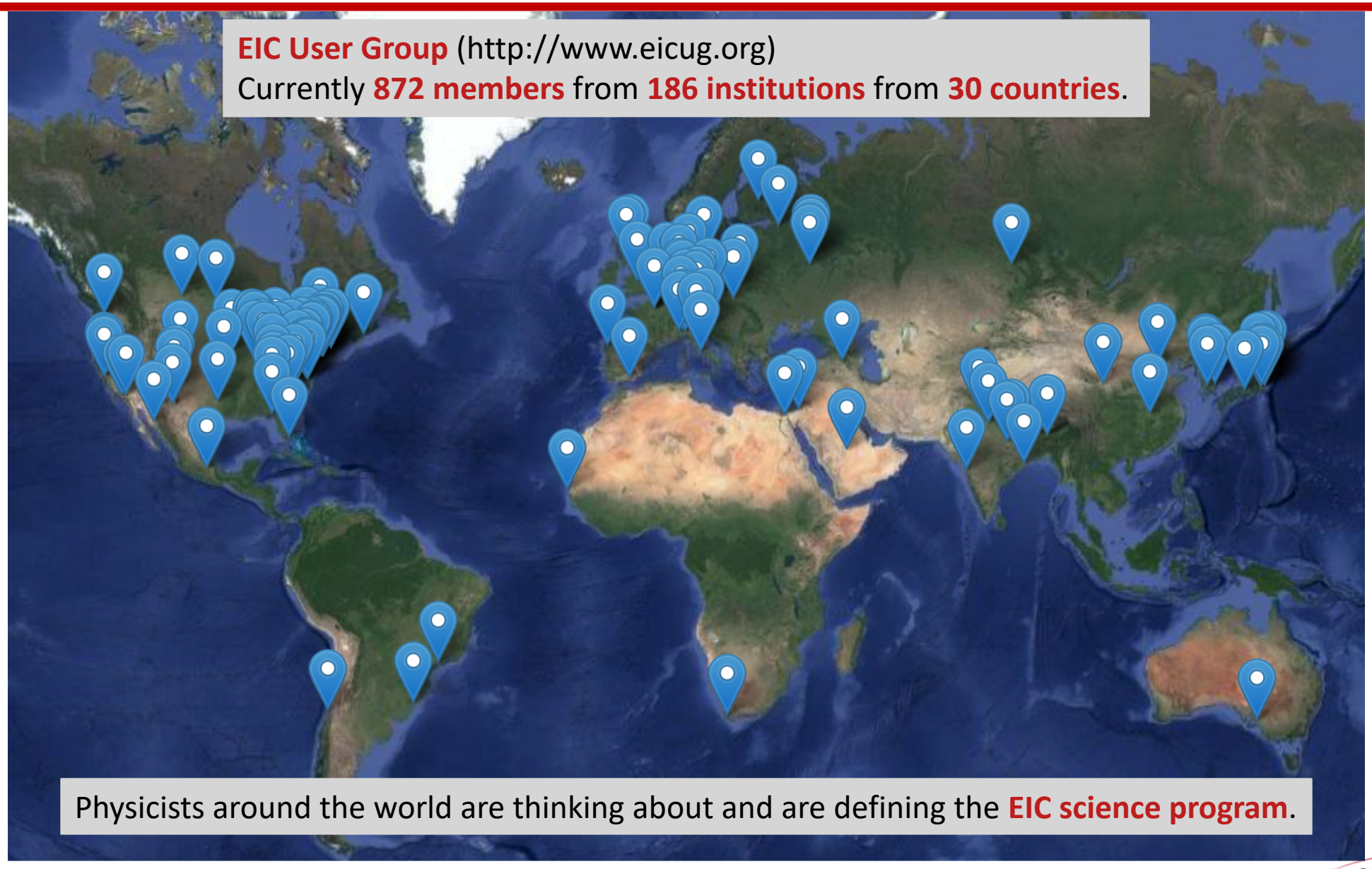
- BeAST container (EICroot)
- ePHENIX container (fun4all)
- JLEIC container
- TOPSiDE container

reconstruction

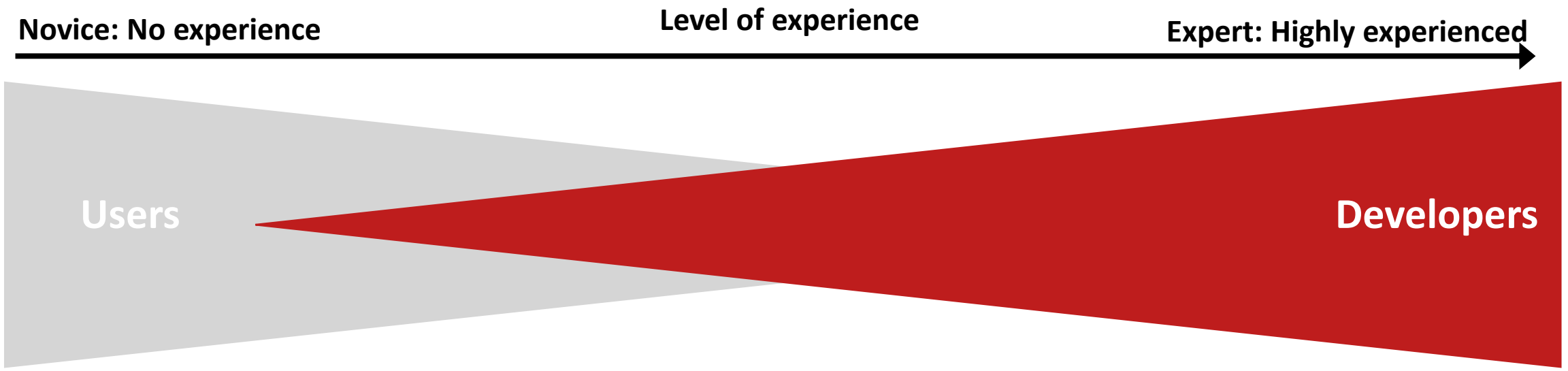
Engaging with the wider community

EICUG Software Working Group

The worldwide EIC community



EIC Software Users



User involved in

Ongoing EIC project
Software ✓
Documentation ✓
Requests none

EIC User Group
Common Software ✗
Common Documentation ✗
Requests software, documentation

EIC Generic Detector R&D projects
Software ✓
Documentation ✗ - ✓
Requests common software

User requests

Ongoing EIC project
Software ✓
Documentation ✓
Requests none

EIC User Group
Common Software ✗
Common Documentation ✗
Requests software, documentation

EIC Generic Detector R&D projects
Software ✓
Documentation ✗ - ✓
Requests common software

Focus on (pre)**CDRs and site selection as part of CD1**

Focus on preparation of EIC collaborations

- further develop EIC Science
- examine detector requirements
- work on detector designs
- work on detector concepts

requires simulations of physics processes and detector response

Request from Thomas Ullrich, manager of the R&D program:

- in most cases only GEANT simulations are needed:
  - no need for sophisticated framework
  - no need for elaborate tracking
- a simple *lite setup* with a well defined geometry description standard might get them a long way as long if it is EIC wide and easy to use

EIC Software Groups (beyond the simulation effort at the labs)

High Energy Physics

CERN ROOT
Possible collaboration

Geant4
Established collaboration

HEP Software Foundation
Possible collaboration

MCnet
Started collaboration

Nuclear Physics

EIC Software Consortium
Community Endorsement ✗
Funding ✓

Same software suite Seamless data processing from DAQ to data analysis using AI

EIC Streaming Readout Consortium
Community Endorsement ✗
Funding ✓

EICUG Software Working Group
Community Endorsement ✓
Funding ✗

Charge for EICUG Software Working Group

The EICUG Software Working Group's **initial focus** will be on **simulations of physics processes and detector response to enable quantitative assessment of measurement capabilities and their physics impact**. This will be pursued in a manner that is **accessible**, **consistent**, and **reproducible** to the EICUG as a whole.

It will embody simulations of all processes that make up the EIC science case as articulated in the white paper, eventually integrating new processes under request and with the help of interested communities within the EICUG. The Software working group is to engage with new major initiatives that aim to further develop the EIC science case, including for example the upcoming INT program(s), and is anticipated to play key roles also in the preparations for the EIC project(s) and its critical decisions. The working group will build on the considerable progress made within the EIC Software Consortium (eRD20) and other efforts. The evaluation or development of experiment-specific technologies, e.g. mass storage, clusters or other, are outside the initial scope of this working group until the actual experiment collaborations are formed.

The working group will be open to all members of the EICUG to work on EICUG related software tasks. It will communicate via a new mailing list and organize regular online and in-person meetings that enable broad and active participation from within the EICUG as a whole.

Initial requirements

Simulations of physics processes and detector response

Monte Carlo event generators (MCEGs)

Requirement (charge) MCEG for all physics processes that make up the EIC science case as articulated in the white paper and as further developed by the EICUG.

Related requirements:

- requires organization with theory community in NP and HEP (where most of the MCEG are being developed)
- requires integration of RC effects in MCEGs for the different processes
- CPU usage will be dominated by MC (mainly for detector simulation, but the higher MCEG complexity will also impact on resources): Requires organization on how to handle MC, how to keep track of MC data, and how to validate MC.

Detector simulations

Requirement Geant4

Discussion on fast simulations beyond eic-smear

- Are these needed at all?
- these detectors specific, or a common system could be developed?
- What is the needed speedup?
- If is a factor 2-10 technologies already exist (e.g. gflash or biasing in G4), if more one needs to think how to develop these.

Benchmarks and validation

Requirement (charge) quantitative assessment of measurement capabilities and their physics impact

Related requirements:

- benchmark processes (→ MCEGs)
- validation tools (intrinsic part of simulation tools?)
- benchmark workflow (intrinsic part of simulation workflow?)

Accessible

Requirement (charge) accessible to the EICUG

Related requirements:

- repository
- **User-centered design**: “Experience in HEP has been that as the complexity and size of the experiments grew, the complexity of analysis environment grew. The time spent by physicists in dealing with the analysis infrastructure rather than on doing physics also grew. Currently, the anecdotal data is that a typical LHC student of post-doc spends up to 50 % of his/her time dealing with computing issues. This seems to most of us to be too much. One key idea in beginning to think about the EIC analysis environments is to understand the user requirements of the analysis environment first and foremost. This requires the engagement of the wider community of physicists whose primary (and perhaps not even secondary) interest is not in computing. All design decisions must serve these requirements.” (Future Trends in Nuclear Physics Computing in 2016)

Consistency

Requirement (charge) consistent to the EICUG

Related requirements:

- simulation tools to be used on all detector concepts
- geometry exchange

Reproducibility

Requirement (charge) reproducible to the EICUG

Related requirements:

- documentation for simulation and validation tools and the related workflow
- self-descriptive data
- self-descriptive analysis

Concurrency

Requirement EIC software should be designed with concurrency in mind from the very beginning

Modularity

Requirement "We need to think about structures that are robust against likely changes in computing environment both hardware and software. Modularity is important, and careful thought has to be given to how exactly to modularize so that changes in underlying code, database structure, etc. can be handled without an entire overhaul of the structure. This is important also in that most powerful future computers will likely be very different from the kind of computers that are currently most often used in HEP and NP." (Future Trends in Nuclear Physics Computing in 2016)

Related requirements:

- modular also for simulation of detector effects, digitization, and event reconstruction
- requires geometry exchange between simulation, digitization, and the event reconstruction

Markus Diefenthaler

mdiefent@jlab.org

Discussion

What are the requirements for the initial EIC simulation software? Write them up as community document. Ask EICUG for input.

How does the existing and currently being developed software met these requirements?

How can we met these requirements in FY19/20? To what extent can we (re-)use existing and currently being developed software? Write up plan and share task list with EICUG, share status updates on regular basis