



Project eAST

A Unified Fast/Full Simulation

Makoto Asai, Wouter Deconinck, Markus Diefenthaler,
and the entire eAST developer team of 18+ developers,
with members from ATHENA and ECCE

Recall...



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?

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

Project eAST: Unify the Simulation Effort with the Community

The SWG is launching **eAST**, a **common effort on next-generation simulations**:

- building on the work done in the existing simulations,
- a requirement for the common toolkit is that it integrates existing detector simulations in a modular way.
 - **Community Scenario** Members of ATHENA and ECCE involved. Possible migration to common tool after the current phase, in 2022.



eA Simulation Toolkit

Meetings on Project eAST with wider EIC community

- including many representatives from ATHENA, CORE, ECCE

03/25 Discussion of proposal and possible work plan

03/31 Discussion for anyone who could not attend on 03/25

Material

- [Introduction to Project eAST](#)
- [Writeup on Project eAST](#), including community feedback

04/05 Update at SWG meeting

05/05 Update at SWG meeting

05/20 Update at EIC Remote Meeting

06-07 Regular development team meetings

Project eAST in a nutshell

Detector Simulation

- **comprehensive, centrally maintained application**
- **based on Geant4 for fast and full simulations**
- **with library of potential detector options**

Requirements

- ability to **reuse existing simulation work**
- ease of **switching detector options**
- ease of switching between **detailed and coarse** detector descriptions
- ease of **leveraging new and rapidly evolving technologies**,
 - e.g., AI/ML
 - computing hardware, e.g., heterogeneous architectures

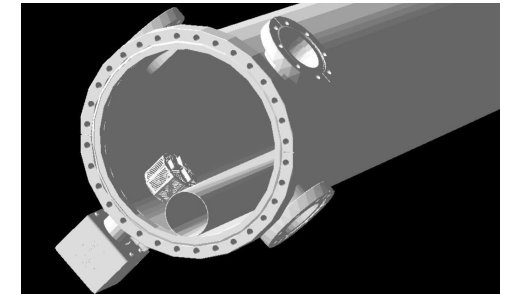
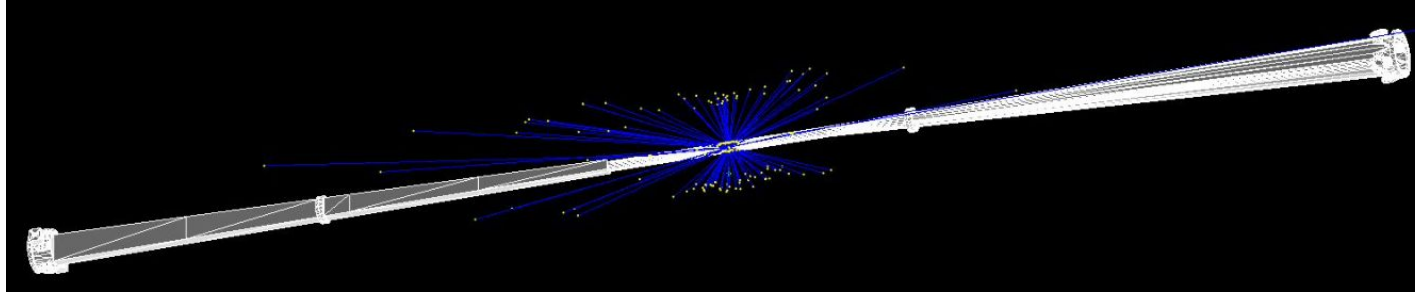
Project Leader

- Makoto Asai (SLAC), Geant4 project leader and deep technical expert for >20yrs.



Project eAST: First Achievements

CAD Interface



EIC Project

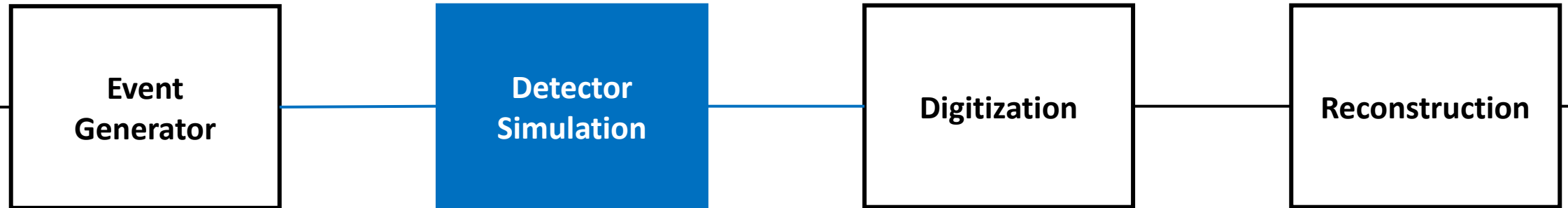
- Simulation based (in part) on CAD files provided by EIC project engineering teams, rather than a bottoms-up reliance on constructive solid geometry

High priority request of community:

Physics List

- “Baseline” physics list available (<https://github.com/eic/east/tree/main/PhysicsList>):
- It can be used for every EIC detector component as a baseline.
 - It needs tuning / optimization / specialization for each detector component.
 - It works with Geant4 version 10.7-patch01. Can be integrated in other simulation efforts.
 - Basic validation within Geant4 validation suite under preparation. Test beam data needed.

Towards a detector simulation tool



- Comprehensive, centrally maintained
- Based on Geant4 for fast and full simulations
- With library of potential detector options

The point of commonality before collaborations branch to their specialized software.

Of course in 2021, for the proto-collaborations developing the detector proposals, using some newfangled non-existent common simulation tool is not an option.

But if we develop this tool in 2021, with its interfaces, the proto-collaborations have their convergence target.

So post-proposals in 2022, we can come together.

Detector Simulation

- **comprehensive, centrally maintained application**
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- **with library of potential detector options**

Requirements

- ability to **reuse existing simulation work**
- ease of **switching detector options** with comparable levels of detail
- ease of switching between **detailed and coarse** detector descriptions
- ease of **leveraging new and rapidly evolving**
 - technologies, e.g., AI/ML
 - computing hardware, e.g., heterogeneous architectures

Initial Focus

- interface to MCEG output (but no further work on MCEGs)
- clear separation of detector effects and responses (digitization)
- common geometry interface between detector simulation tool and reconstruction tools

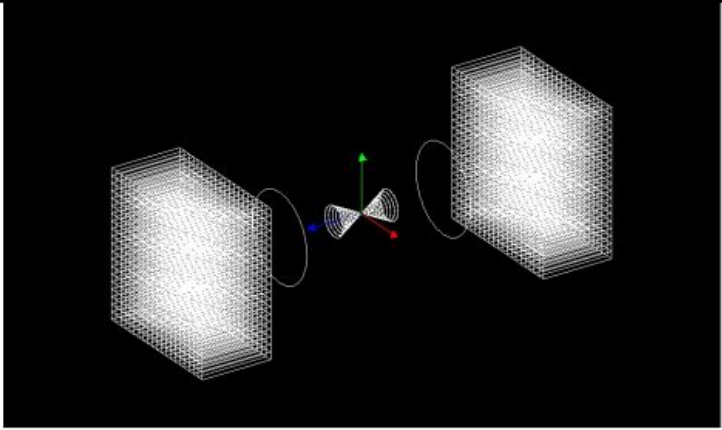
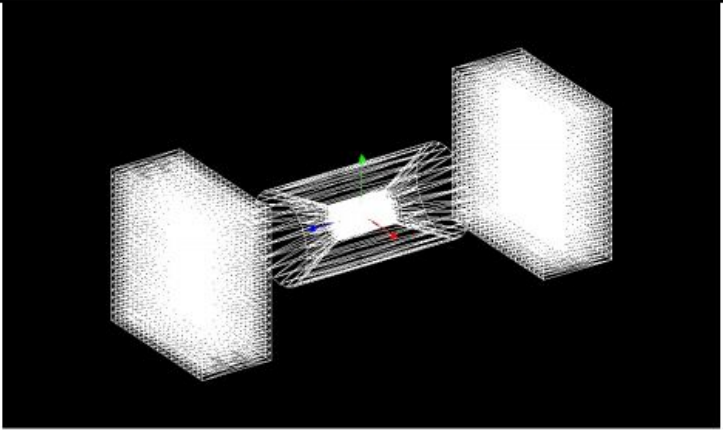
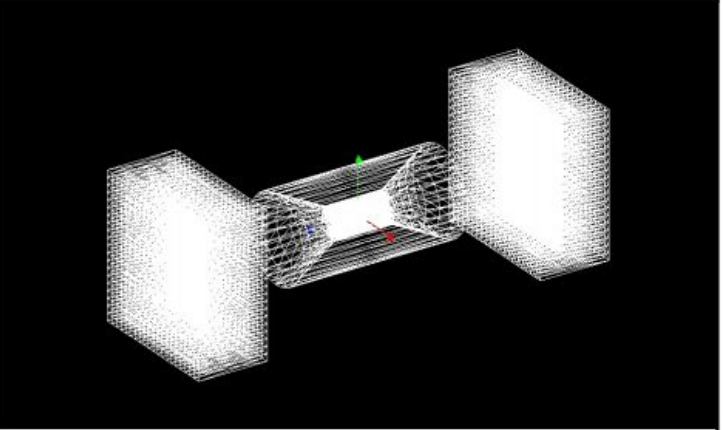

Detector Simulation

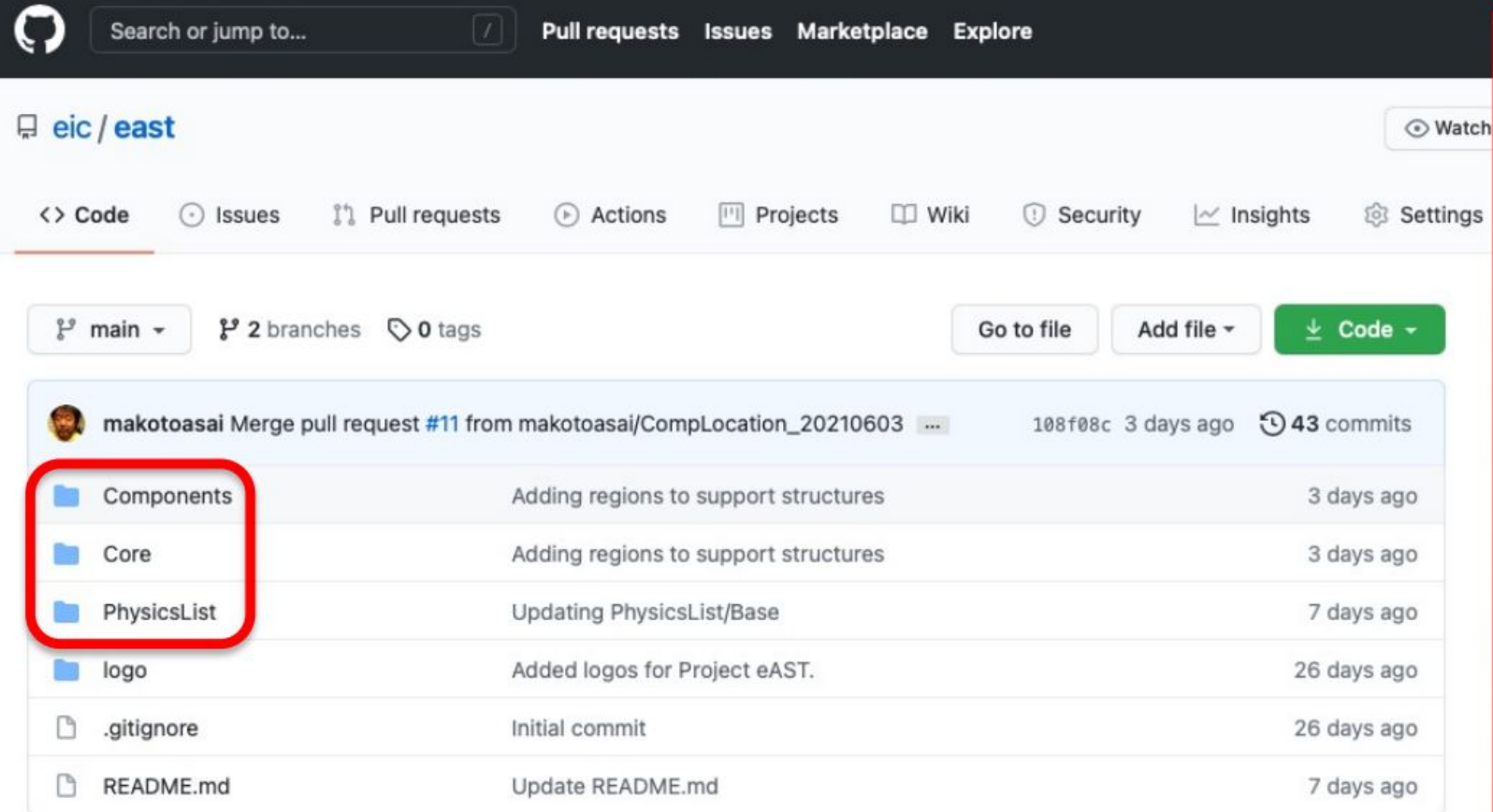
- comprehensive, centrally maintained application
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Deliverables

- Create CAD interface to the simulation (a distinct project that occupied June into July).
-
- Create an **initial version of the fast and full simulation tool**.
 - Produce a documented **prototype of an existing simulation integrated** in the new tool.
 - Develop and deliver a documented common **physics list for EIC detectors**.
 - Deliver a framework extensible to **heterogeneous architectures** using Geant4's new task-based concurrency and sub-event level parallelism

- Motivation
 - Because of the complexity of the detector - accelerator integration we need to convert the output of the CAD program to Geant4-readable geometry.
 - We need to do this for full 3D design drawings with parametric surfaces, not some simple EIC IR toy models of CSG shapes, that is not good enough for detailed simulation.
- Key work items
 1. Conversion of CAD STEP file to GDML file
 2. Material composition
 3. Vacuum volume
- We launched the effort
 - Starting with the work item #1
 - Studying items #2 and #3 in parallel

File	CSG (hand-written)	Tessellated solids (Commercial converter)	Tessellated solids (MRADSIM converter)
			
File size	2,423 Byte	2,575,524 Byte	3,427,771 Byte
200,000 geantino's 12 threads			Many warning messages from GDML Parser 
Total time (within event loop)	User=9.120000s Real=0.822846s Sys=0.060000s [Cpu=1115.6%]	User=44.090000s Real=3.821735s Sys=0.120000s [Cpu=1156.8%]	User=47.060000s Real=4.059320s Sys=0.110000s [Cpu=1162.0%]
Total memory	120 MB	107 MB	122 MB



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main 2 branches 0 tags Go to file Add file Code

makotoasai Merge pull request #11 from makotoasai/CompLocation_20210603 108f08c 3 days ago 43 commits

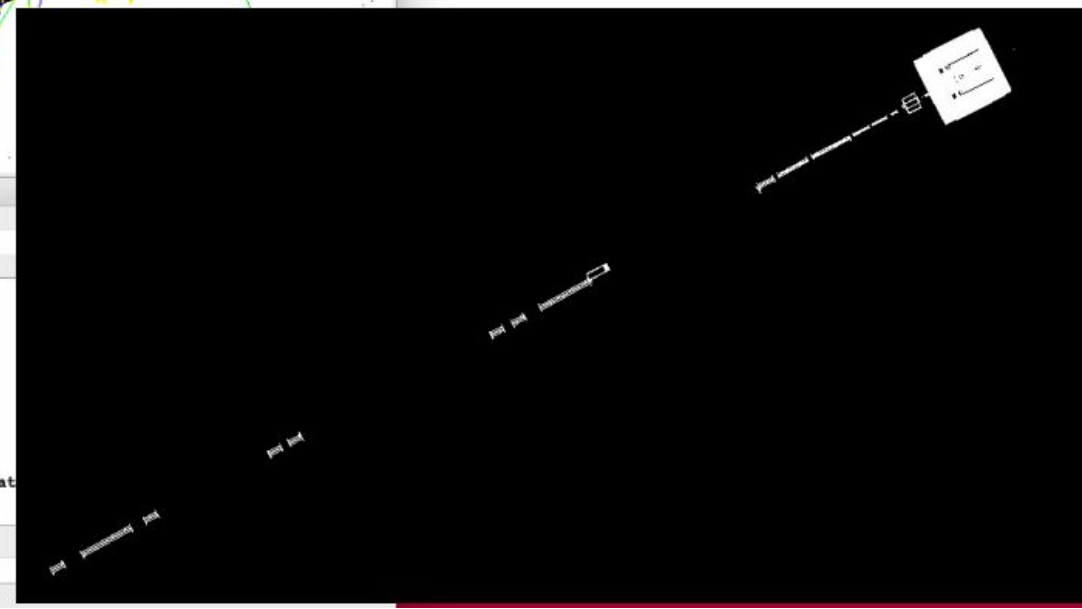
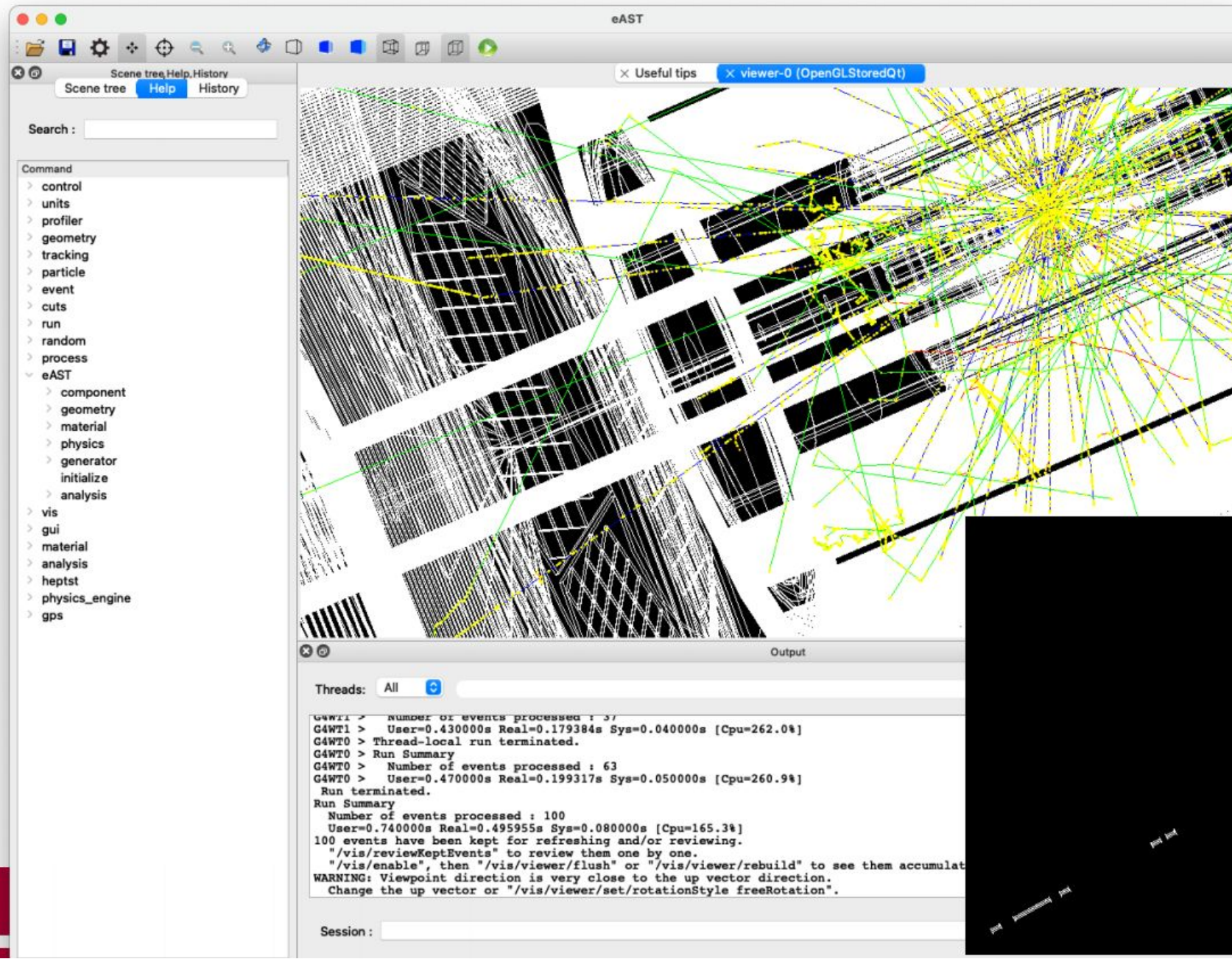
Components	Adding regions to support structures	3 days ago
Core	Adding regions to support structures	3 days ago
PhysicsList	Updating PhysicsList/Base	7 days ago
logo	Added logos for Project eAST.	26 days ago
.gitignore	Initial commit	26 days ago
README.md	Update README.md	7 days ago

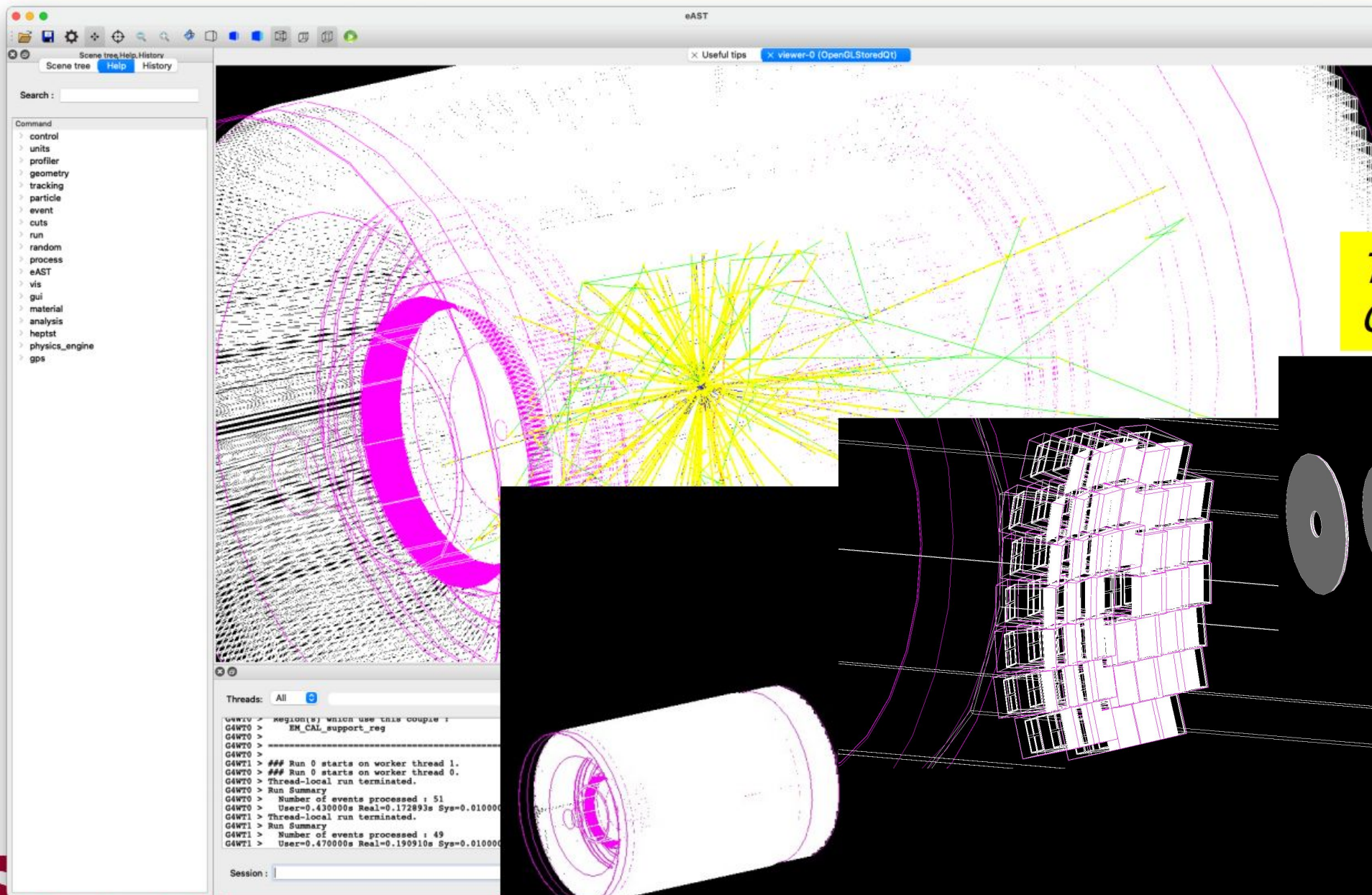
- Core
 - eAST core classes
 - **README for installation and execution instructions**
- PhysicsList
 - Physics lists
 - Currently only the baseline physics list is available
 - In the future, alternative options including fast simulation will be populated
- Components
 - Description of each detector components
 - Both detectors and structures
 - Meant to be a collection
 - eAST Core makes run-time selection

Project eAST

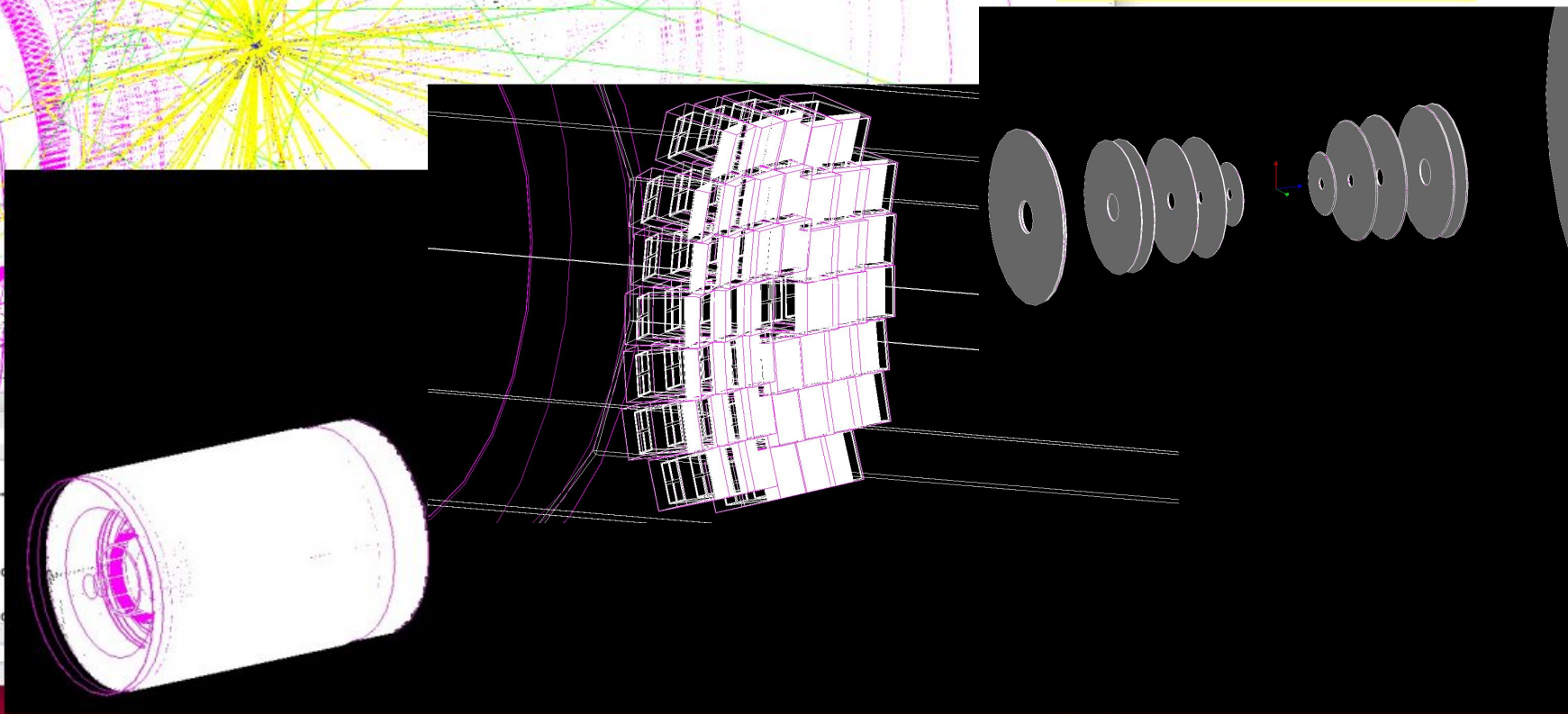
Overview

Project eAST (eA simulation toolkit) is led by Makoto Asai (SLAC) and builds on the work done in existing detector





Thanks Joe for
GDML file!



Detector Simulation

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Conclusion

- Central EIC-wide effort
- Taking advantage of the latest in Geant4 technology
- Developed with heterogeneous computing, AI/ML support, and adjustable fast and full simulations in Geant4 in mind.
- Immediately useful deliverables in physics list and CAD interface

Other Useful Resource from the eAST Team

Up-to-date [Geant4 Tutorial](#)

- [Documents & Examples](#)
- [Kernel - part I](#)
- [Geometry](#)
- [Kernel - part II](#)
- [Installation](#)
- [Hands-on](#)

Targeting Geant4 10.7

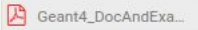



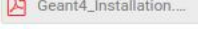
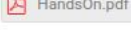
An excellent resource!

eAST Tutorial

Tuesday 29 Jun 2021, 09:00 → 11:00 US/Eastern

Description We will use Zoom for the remote tutorial

<https://stanford.zoom.us/j/93252217686?pwd=dk95d1NwWHpaVk5MMHJOTEFRcnYrUT09>

09:00 → 09:20	Geant4 Documents and Examples Speaker: Makoto Asai (SLAC) 	🕒 20m
09:20 → 09:40	Geant4 Kernel - part I Speaker: Makoto Asai (SLAC) 	🕒 20m
09:40 → 10:00	Geant4 Geometry Speaker: Makoto Asai (SLAC) 	🕒 20m
10:00 → 10:20	Geant4 Kernel - part II Speaker: Makoto Asai (SLAC) 	🕒 20m
10:20 → 10:40	Geant4 Installation Speaker: Makoto Asai (SLAC) 	🕒 20m
10:40 → 11:00	Geant4 Hands-on Speaker: Makoto Asai (SLAC) 	🕒 20m