Updates on eAST developments

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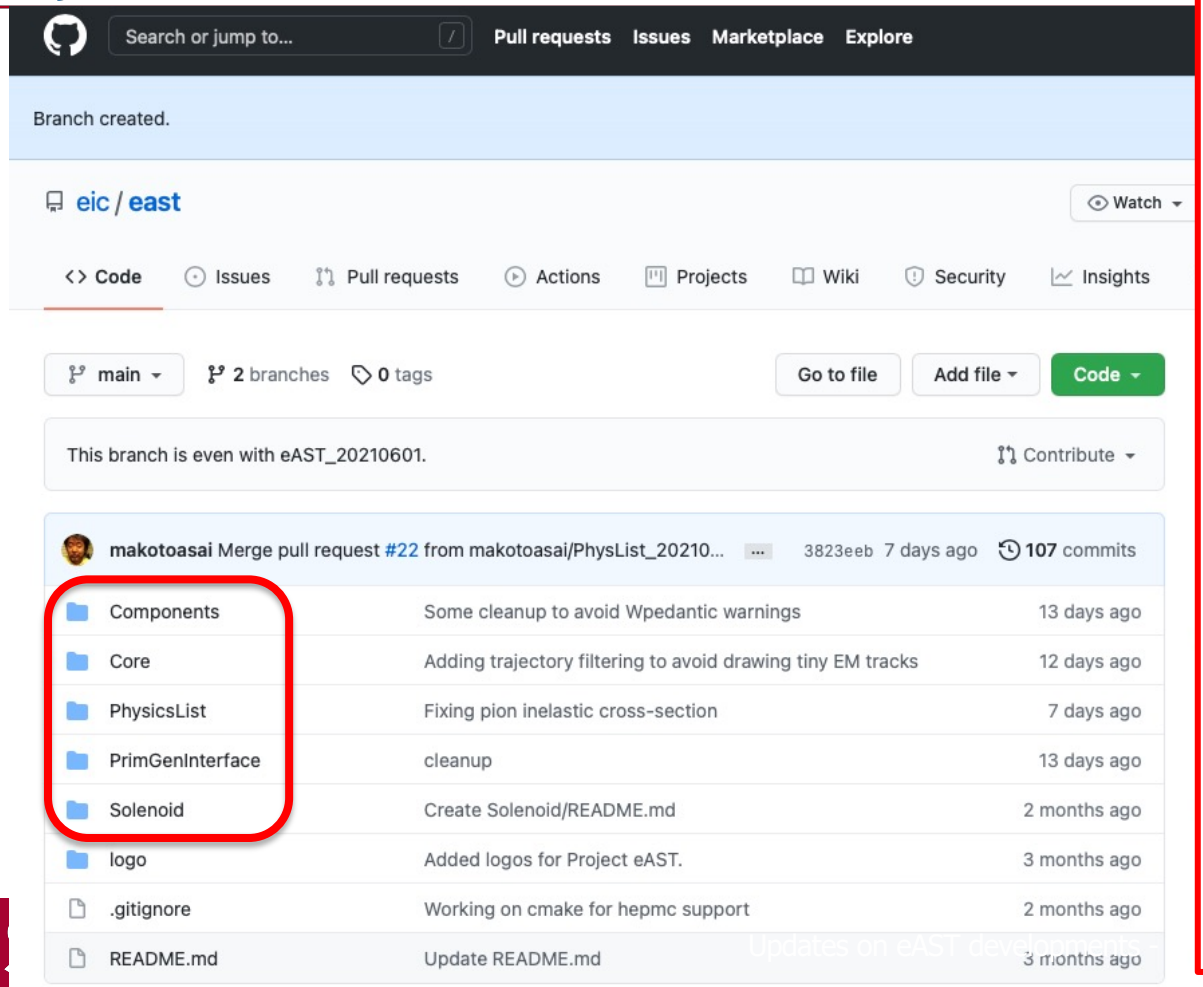
August 24th, 2021

Outline

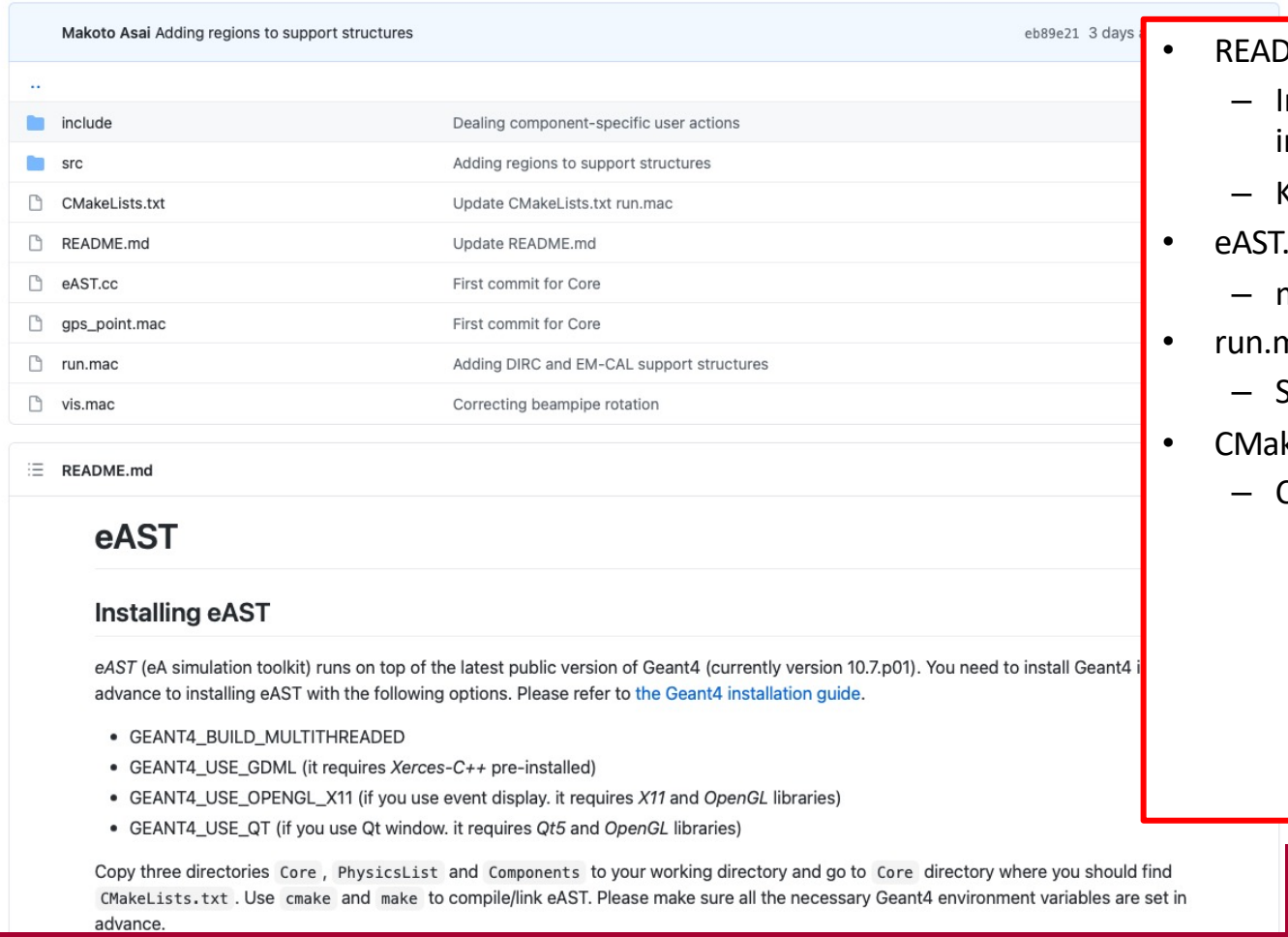
- eAST (eA Simulation Tool) project is to develop a tool for fast and full simulations built on top of Geant4.
- Updates:
  - Code repository
    - https://github.com/eic/east
    - Follow README of Core directory for installation and basic instruction
  - Importing CAD file into detector simulation
    - Two ways of importing GDML geometries
  - Centrally maintained and validated physics list
    - Baseline physics list is available
    - Need beam-test geometry/data
  - Weekly developers meeting
    - Mailing list : eicug-east@eicug.org

https://github.com/eic/east



- Core
  - eAST core classes
  - cmake and run-time macro files
  - README for installation and execution instructions
- PhysicsList
  - Physics lists
  - Currently only the baseline physics list is available
- Components
  - Description of each detector components
    - Both detectors and structures
- PrimGenInterface
  - User primary generator action
  - HepMC3 interface
- Solenoid
  - field map instruction

https://github.com/eic/east/Core/



Makoto Asai Adding regions to support structures — eb89e21 3 days

..	
include	Dealing component-specific user actions
src	Adding regions to support structures
CMakeLists.txt	Update CMakeLists.txt run.mac
README.md	Update README.md
eAST.cc	First commit for Core
gps_point.mac	First commit for Core
run.mac	Adding DIRC and EM-CAL support structures
vis.mac	Correcting beampipe rotation

README.md

eAST

Installing eAST

eAST (eA simulation toolkit) runs on top of the latest public version of Geant4 (currently version 10.7.p01). You need to install Geant4 i
advance to installing eAST with the following options. Please refer to the Geant4 installation guide.

- GEANT4_BUILD_MULTITHREADED
- GEANT4_USE_GDML (it requires *Xerces-C++* pre-installed)
- GEANT4_USE_OPENGL_X11 (if you use event display. it requires *X11* and *OpenGL* libraries)
- GEANT4_USE_QT (if you use Qt window. it requires *Qt5* and *OpenGL* libraries)

Copy three directories `Core`, `PhysicsList` and `Components` to your working directory and go to `Core` directory where you should find `CMakeLists.txt`. Use `cmake` and `make` to compile/link eAST. Please make sure all the necessary Geant4 environment variables are set in advance.

- README.md
  - Installation and execution instructions
  - Key eAST UI commands
- eAST.cc
  - main
- run.mac
  - Sample macro file
- CMakeList.txt
  - Cmake input

https://github.com/eic/east/PhysicsList/Base/src/

main ▾ east / PhysicsList / Base / src /

This branch is 3 commits ahead of eAST_20210601.

Makoto Asai Fixing pion inelastic cross-section

..		
eASTAntiBaryonPhysics.cc	First commitment	
eASTGammaLeptoNuclearPhysics.cc	First commitment	
eASTHyperonPhysics.cc	First commitment	
eASTIonPhysics.cc	First commitment	
eASTKaonPhysics.cc	Fixing pion inelastic cross-section	
eASTNeutronPhysics.cc	First commitment	
eASTPhysicsList.cc	Updating PhysicsList/Base	3 months ago
eASTPhysicsListMessenger.cc	Updating PhysicsList/Base	3 months ago
eASTPionPhysics.cc	Fixing pion inelastic cross-section	7 days ago
eASTProtonPhysics.cc	First commitment	3 months ago

- eASTPhysicsList
  - Main physics list for eAST
  - EM and other physics selections
- eASTPhysicsListMessenger
  - UI commands for physics options
- eAST***Physics
  - Granular hadronic physics lists for each particle categories
  - Intentionally hard-coded for “self-explanation”

- Pion inelastic cross-section was fixed on August 16th.

https://github.com/eic/east/Components/

main ▾ east / Components /

This branch is 3 commits ahead of eAST_20210601.

kkauder Some cleanup to avoid Wpedantic warnings

..	
Base	Adding DIRC and EM-CAL support structures
Beampipe	Some cleanup to avoid Wpedantic warnings
README.md	Update README.md

README.md

eAST detector components

Overview

eAST (eA simulation toolkit) assumes each detector component is described by a concrete class derived from *eASTVDetectoComponent* base class. Base classes and utility classes that should be used by a detector component are stored in `/Components/Base` sub-directory.

- Base
  - Every detector component must be derived from *eASTVDetectorComponent* base class
  - Each component has its dedicated *G4Region*
- README.md
  - Description of *eASTVDetectorComponent* base class
- Beampipe
  - Beampipe and support structures
  - GDML interfaces
- Other detector components will be added
  - E.g. vertex detector, tracker, calorimeter, …
  - Intend to be a collection of detector components
  - Run-time selection

https://github.com/eic/east/Components/Beampipe/src/

main ▾ east / Components / Beampipe / src /

This branch is 3 commits ahead of eAST_20210601.

Makoto Asai Adding regions to support structures

..

eASTBeamPipe.cc Rotating beampipe

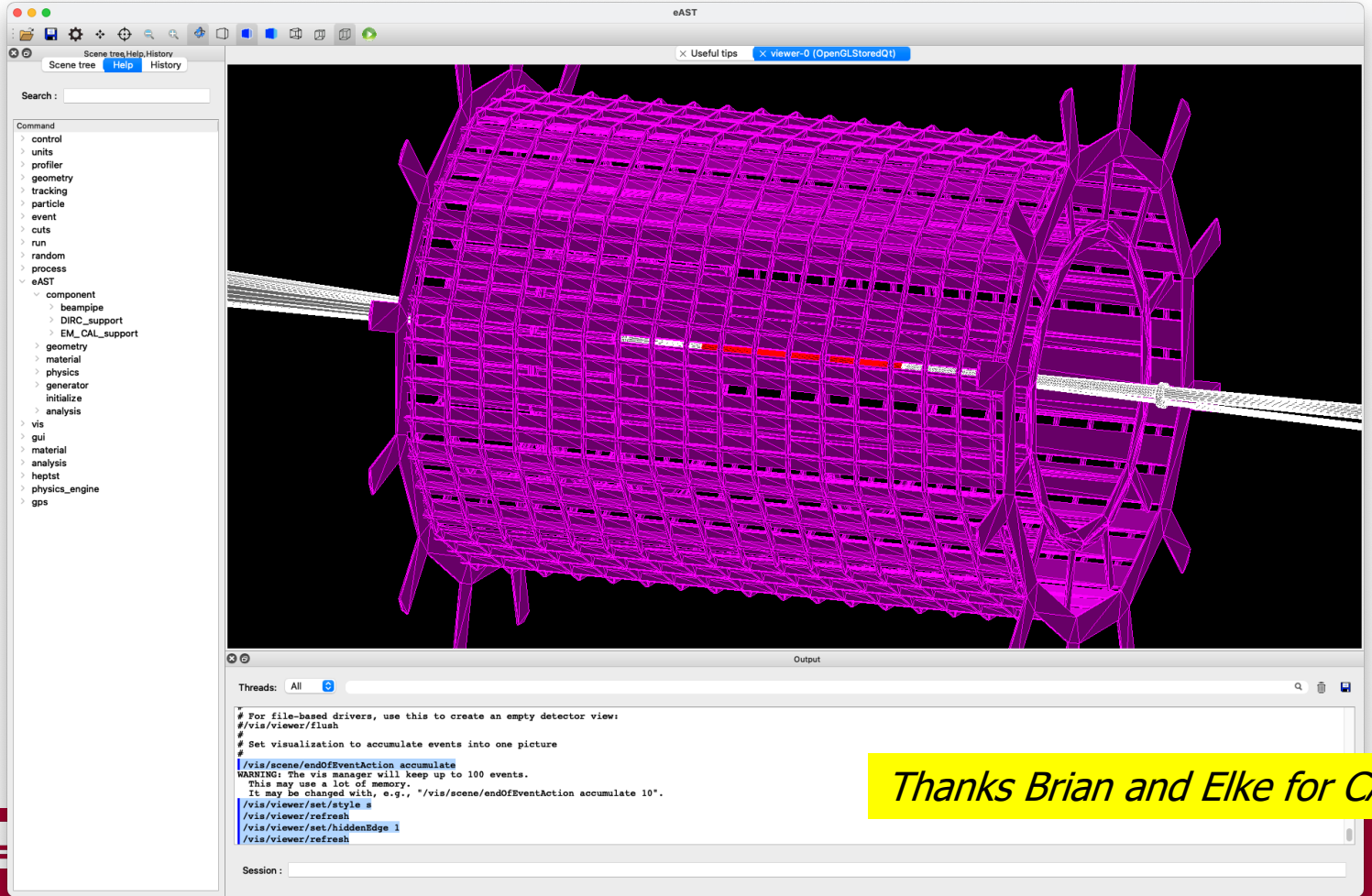
eASTSupportStructure.cc Adding regions to sup

- eASTBeamPipe
  - Reads two GDML files, envelope and contents
- eASTSupportStructure
  - Reads one GDML file, “world” is removed
- Related UI commands are automatically generated
- Optionally, material data (ASCII text of mapping volume name vs. material name) can be specified.

- Class names do not make sense – will be renamed

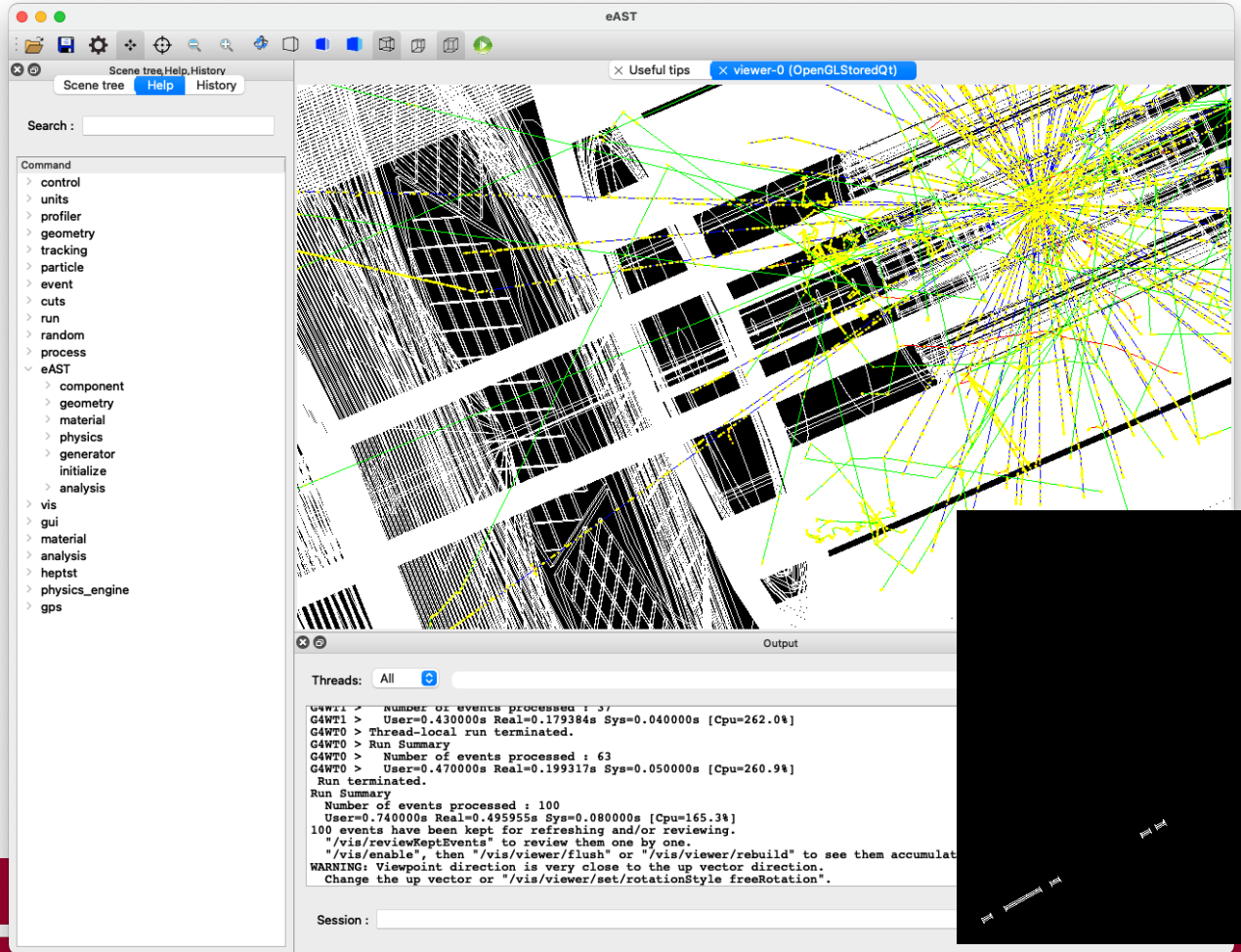
```
/eAST/component/beampipe 1
/eAST/component/beampipe/envelopeGdmlFile ../Components/Beampipe/data/Detector_chamber_210222_BG-05-21-2021_single_volume.gdml
/eAST/component/beampipe/gdmlFile ../Components/Beampipe/data/Detector_chamber_210222_test1_BG-04-07-2021.gdml
/eAST/component/beampipe/materialFile ../Components/Beampipe/data/Detector_chamber_210222_test1_BG-04-07-2021.mat
/eAST/component/beampipe/rotate x -90. deg
/eAST/component/beampipe/rotate y -90. deg

/eAST/component/DIRC_support 1
/eAST/component/DIRC_support/gdmlFile ../Components/Beampipe/data/DIRC_support_06-04-21.gdml
/eAST/component/DIRC_support/materialFile ../Components/Beampipe/data/DIRC_support_06-04-21.mat

/eAST/component/EM_CAL_support 1
/eAST/component/EM_CAL_support/gdmlFile ../Components/Beampipe/data/EM_CAL_Support_06-04-21.gdml
/eAST/component/EM_CAL_support/materialFile ../Components/Beampipe/data/EM_CAL_Support_06-04-21.mat
```

Beam pipe, DIRC and EM_CAL supports @IP6 / Athena

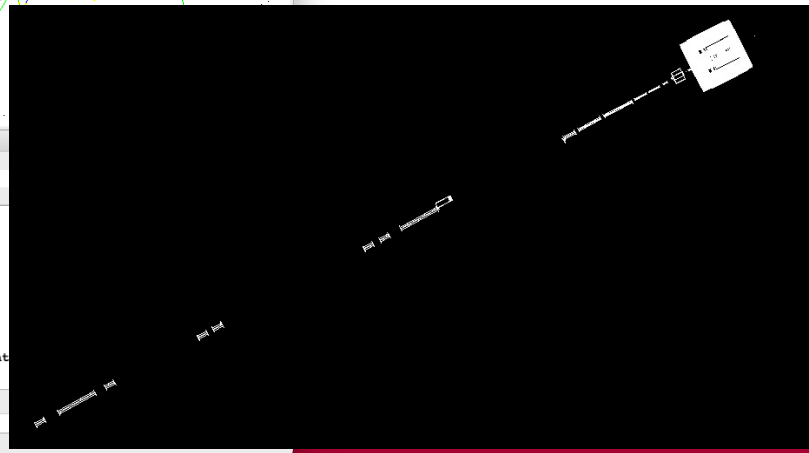


Thanks Brian and Elke for CAD files!

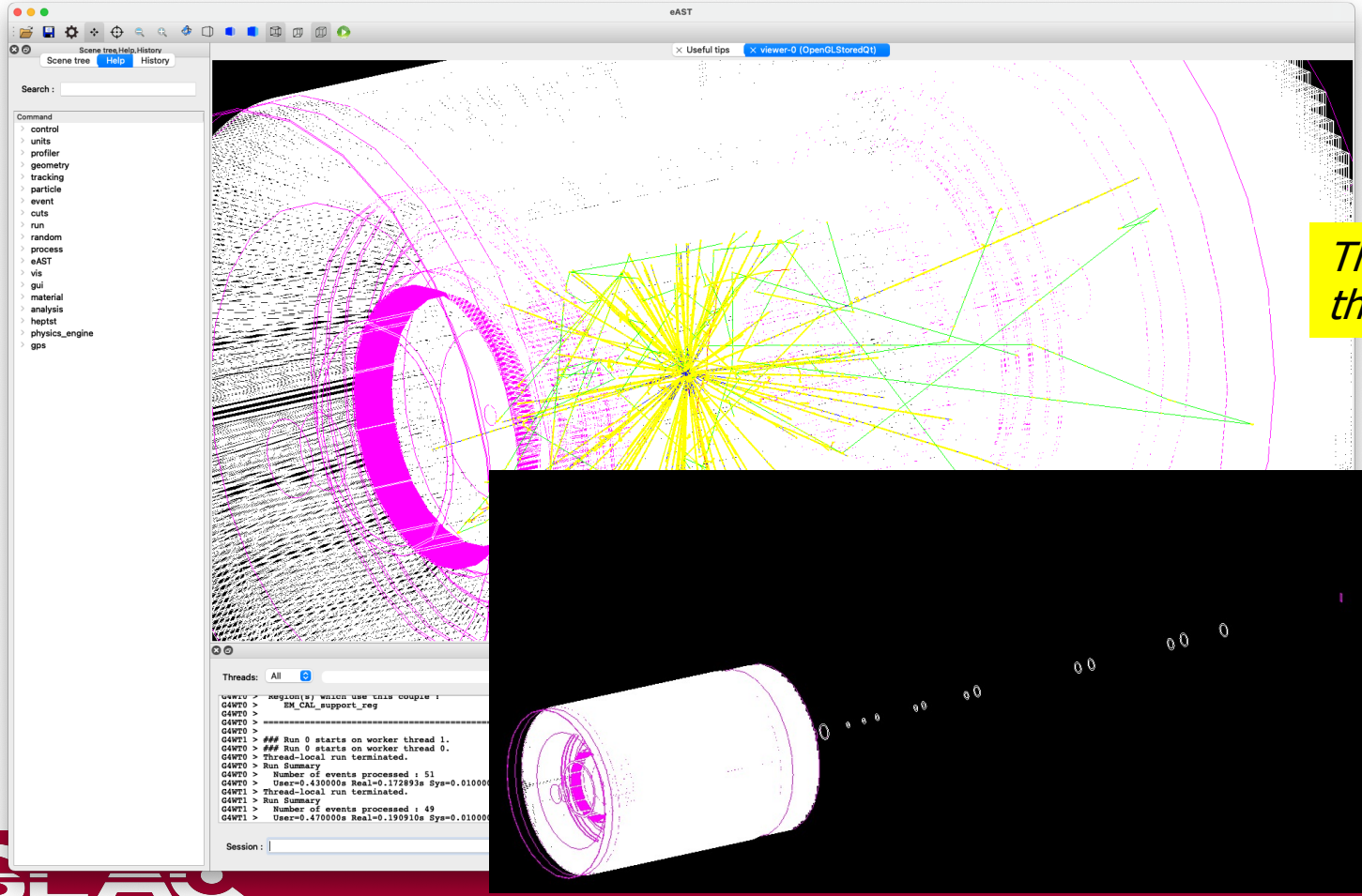
ATHENA geometry



Thanks Wouter for the CAD file!

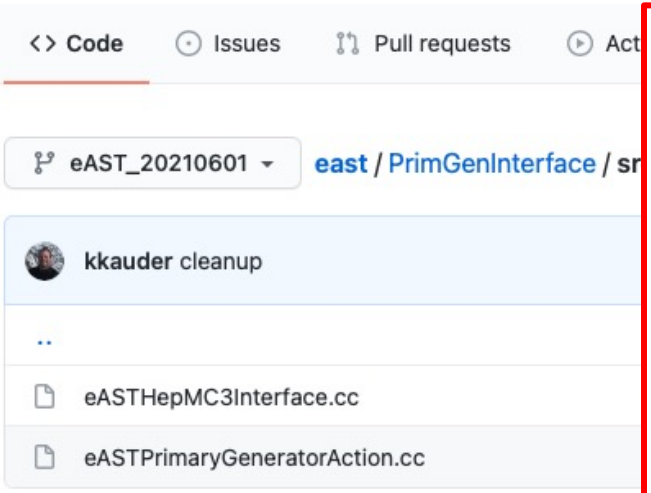


ECCE geometry



Thanks Joe for the GDML file!

https://github.com/eic/east/PrimGenInterface/src/




```
############################################################
# Selection of primary generator
############################################################
/eAST/generator/useParticleGun 0
/eAST/generator/useParticleSource 0
/eAST/generator/useHepMC3 1

############################################################
# eAST and Geant4 initialization
############################################################
/eAST/initialize

############################################################
# Set up primary generator if it is used
############################################################
/control/getVal ifGPS /eAST/generator/useParticleSource
/control/doif {ifGPS} > 0 /control/execute gps_point.mac

/control/getVal ifHepMC3 /eAST/generator/useHepMC3
/control/doif {ifHepMC3} > 0 /eAST/generator/HepMC3/verbose 2
/control/doif {ifHepMC3} > 0 /eAST/generator/HepMC3/openFile data/pythia6test.hepmc
```

README.md

Solenoid Options for the EIC

ATHENA

Please see the section on the EIC Project.

ECCE

ECCE provides magnetic field maps for var

https://github.com/ECCE-EIC/calibrations/t

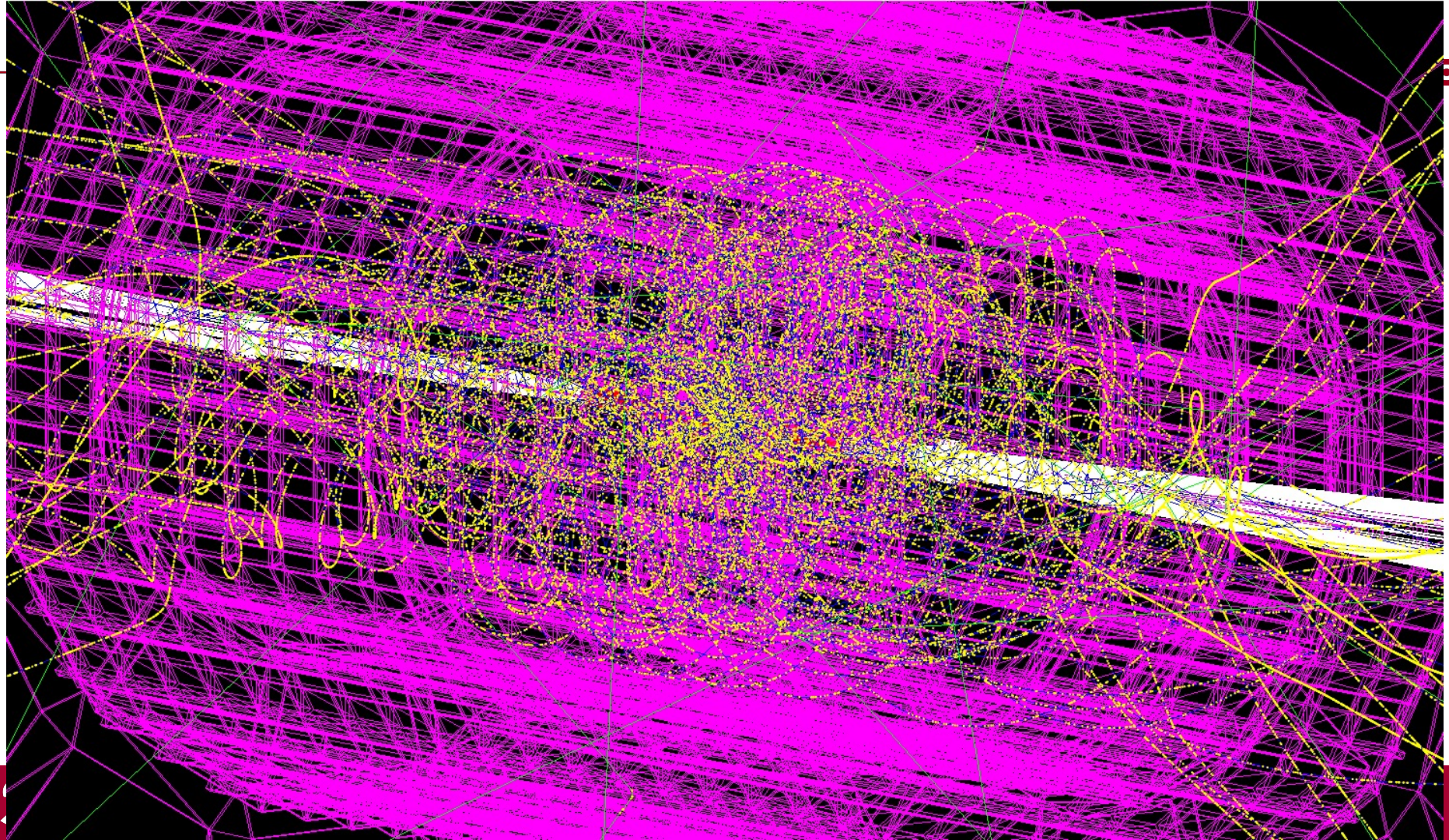
The `sPHENIX.2d.root` map appears to be

EIC Project (used in ATHENA)

The EIC Project provides a field map based

https://github.com/eic/BeastMagneticField

```
############################################################
# Magnetic fields
############################################################
/eAST/field/create central
/eAST/field/central/gridunit 0 cm
/eAST/field/central/gridunit 1 cm
/eAST/field/central/extent 0    (0.0,398.0,2.0)
/eAST/field/central/extent 1 (-600.0,598.0,2.0)
/eAST/field/central/fieldunit tesla
/eAST/field/central/type cubic
/eAST/field/central/load data/EIC_Magnetic_Field_Map_2021_
                    05_07_radial_coords__cm___T_.120000.lines.Bmap

# /eAST/field/print (0.0, 0.0, 0.0)
# /eAST/field/print (1000.0, 0.0, 0.0)
# /eAST/field/print (0.0, 1000.0, 0.0)
```



eAST has some additional utilities

- Volume overlap checker
  - More powerful than the similar tool in DD4HEP
- Particle flux measurements by UI commands
  - Including energy spectrum histogram
  - No need to write C++
- Measuring weight
  - For example, assuming all support structures in page 5 are made of stainless steel and there is no internal structure such as honeycomb, DIRC support weighs 2.5 tons and ECAL supports weigh 10.2 tons in total. The beampipe weighs 95 kg (including both stainless steel (white) and beryllium (red)).

Next to come

- Components
  - Implementation of detector components is starting
    - Both in C++ coding and interfacing to existing simulators
  - Test beam setups (either in GDML or C++ coding)
- Physics list
  - Collect test beam data / geometry and validate the common physics list
  - Physics options including fast simulation per regions
- HepMC3 interface
  - Pre-assigned decay chains
  - Afterburner
- Magnetic field
  - Global switch for not having field (for test beam setup)
- Additional UI command utilities
  - measuring thickness (in length or in radiation/absorption length)
  - Command-based histogramming (e.g. afterburner, IP profiling)
- Migration to Geant4 version 11