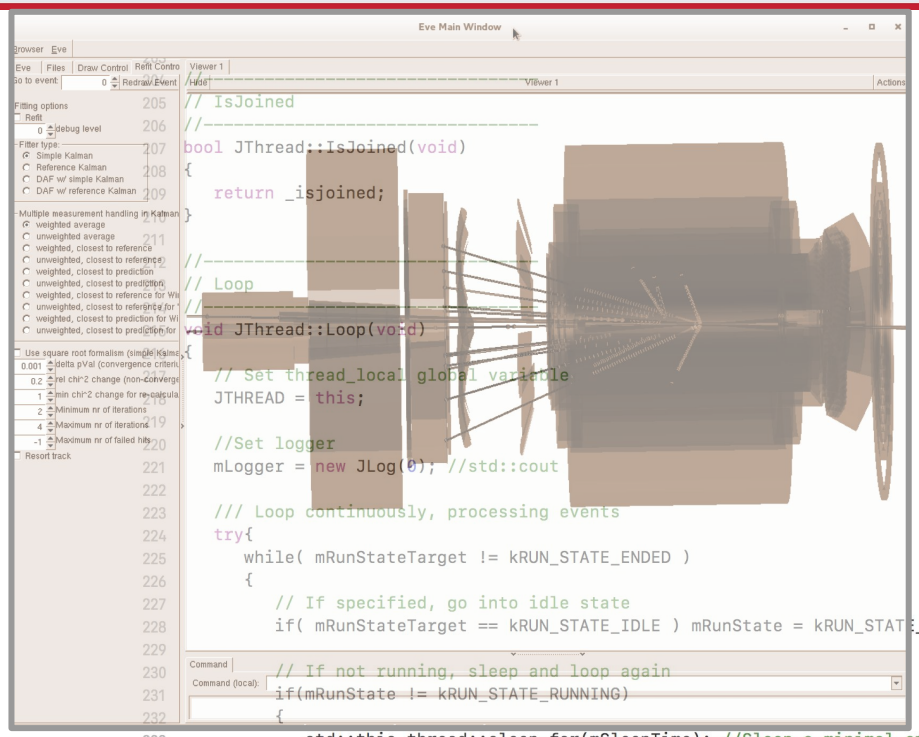
JLEIC Software Status

Status of Simulation and Reconstruction Software at JLEIC



David Lawrence (JLab)

on behalf of the JLEIC Detector and IR Study Group
https://www.eiccenter.org/content/jleic-detector-and-ir-study-group

Simulation and Reconstruction

Near Term Goals/Purpose:

1. Study ability to measure Physics Processes
   a. Interface to MC Event Generators
   b. Provide detector responses (Fast MC for acceptance/resolution, ab initio for resolution/backgrounds)

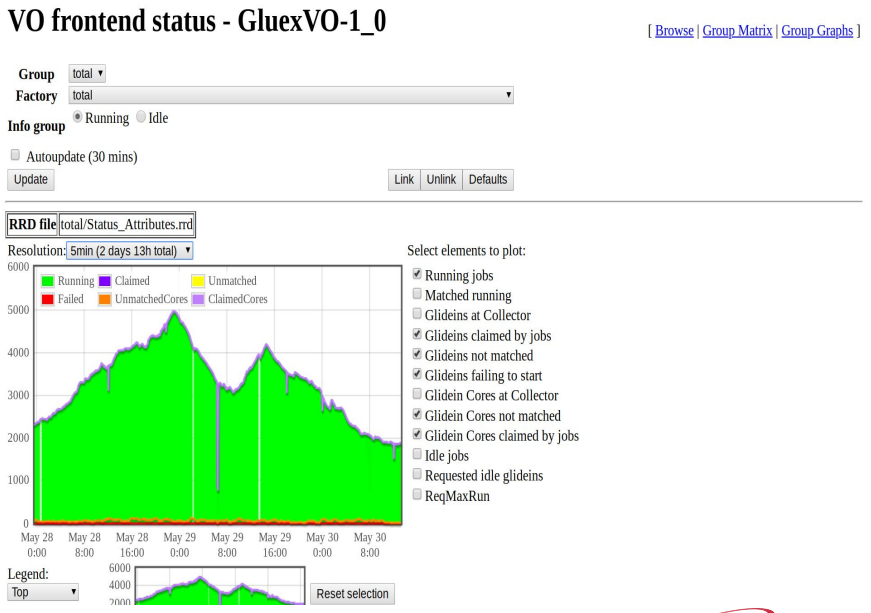
2. Study/Refine Detector Design
   a. Interface to MC Event Generators
   b. Access to simulation from alternative designs
   c. Provide detector responses (Fast MC for acceptance/resolution, ab initio for resolution/backgrounds)

(JLab) Experimental Computing Performance Plan

- **Insure adequate computing resources with $850K investment in FY18**
  - Use local farm for reconstruction, calibration and analysis
  - Use distributed resources for MC
  - Storage and associated bandwidth scaled to support all resources
- **Open Science Grid**
  - GlueX -6 institutions contribute resources
  - In a recent 2 week period ~1M core-hours
  - Expect yearly 35M-50M core-hours
  - Investigating options for CLAS12
- **GlueX reconstruction code at NERSC**
  - Scale test in July
  - Anticipate 70M core-hours/year
- **Cloud Computing available for bursts**

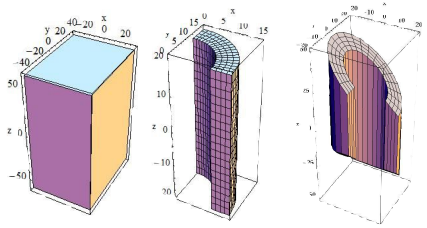
	Current	FY19	FY20
CPU (M-core-hours/year)	37	70	90
Scratch Disk & Cache Disk (PB)	0.65	1.1	2
Tape (GB/s)	3	5	7
WAN bandwidth (Gbps)	10	10	10

Current and Projected Capacity

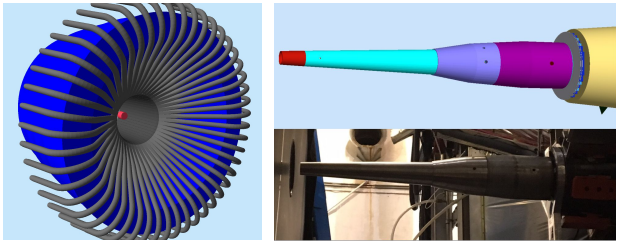


GEMC Framework

Maurizio Ungaro

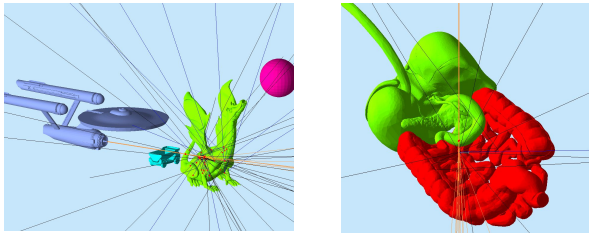


Native Geant4

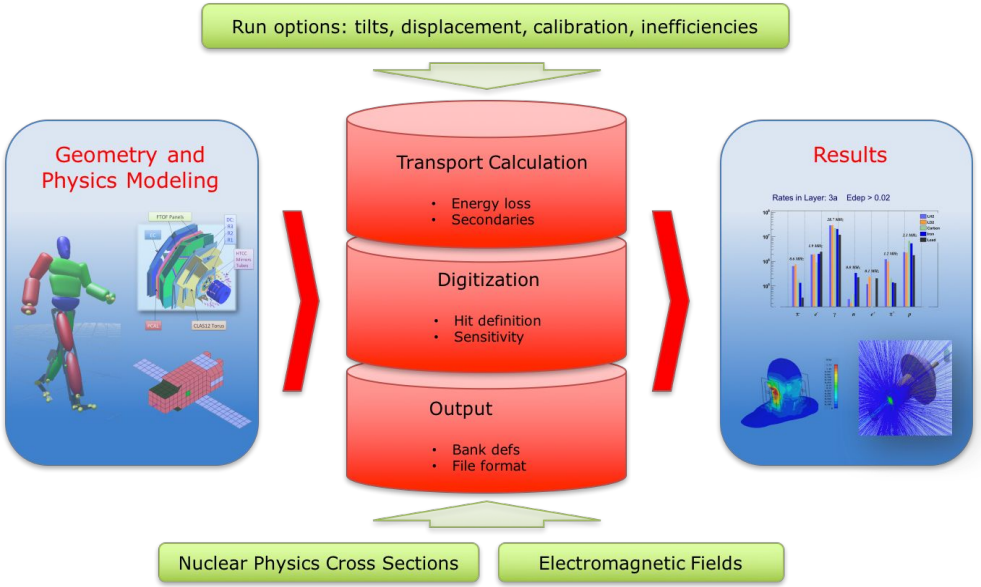


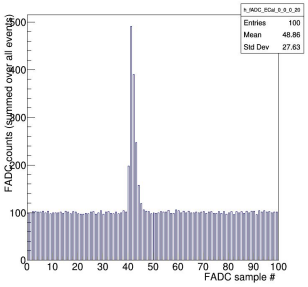
CAD

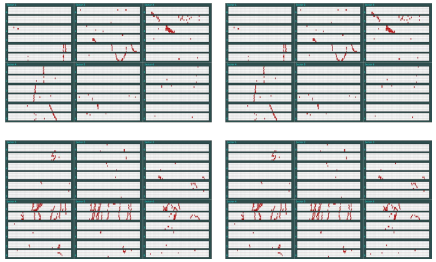
Many CLAS12 detectors use actual engineering models (STL)



GDML







- Input: Native, CAD, GDML, can be mixed and matched.
- FADC Mode 1 (crate, slot channel)
- Background Merging.
- FAST MC Mode.
- Digitization uses actual CCDB calibration constants.
- Used for CLAS12

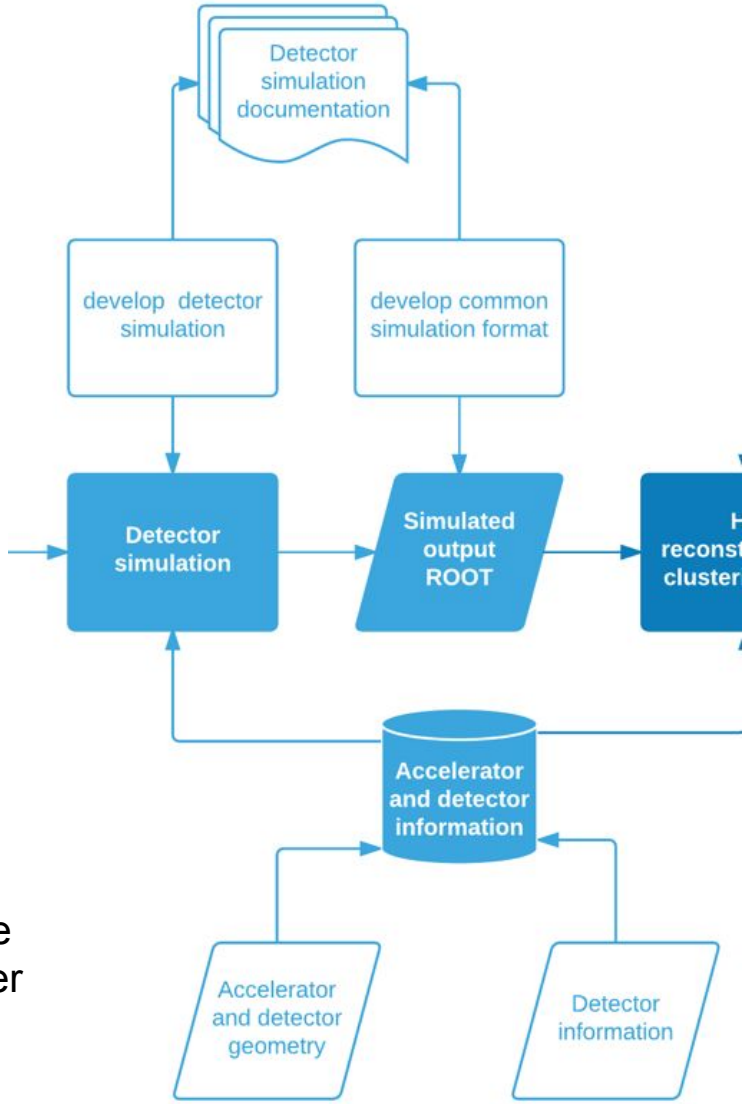
GEMC for JLEIC

Ideal for detector concepts

- application for detector simulations based on Geant4
- reducing the learning curve for Geant4 simulations
- macro language for detector design
- various geometry definitions (GEMC, CAD, gdml, ROOT)
- data card (XML) to steer application, all Geant4 macro commands supported by design
- GUI for interactive sessions
- excellent documentation
- full Geant4 support: adding Geant4 features relatively simple
- transparent in-house development

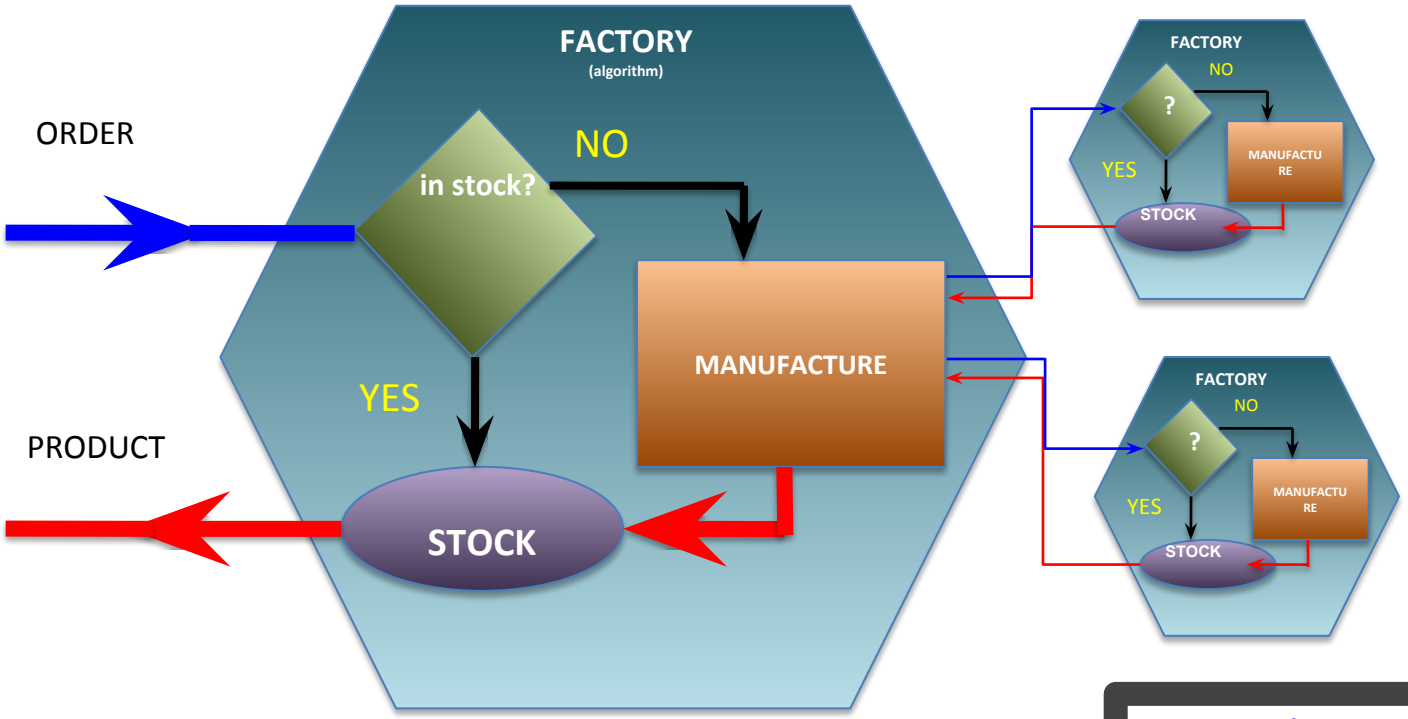
Simulations level

- same application for fast and full detector simulations
- fully adjustable simulation levels, e.g.,
  - only material transport
  - using Geant4 for geometry and physics only in some critical areas and ad-hoc non-Geant4 models in other regions



Jefferson Lab

JANA Factory Model



Data on demand = Don't do it unless you need it

const Stock = Don't do it twice

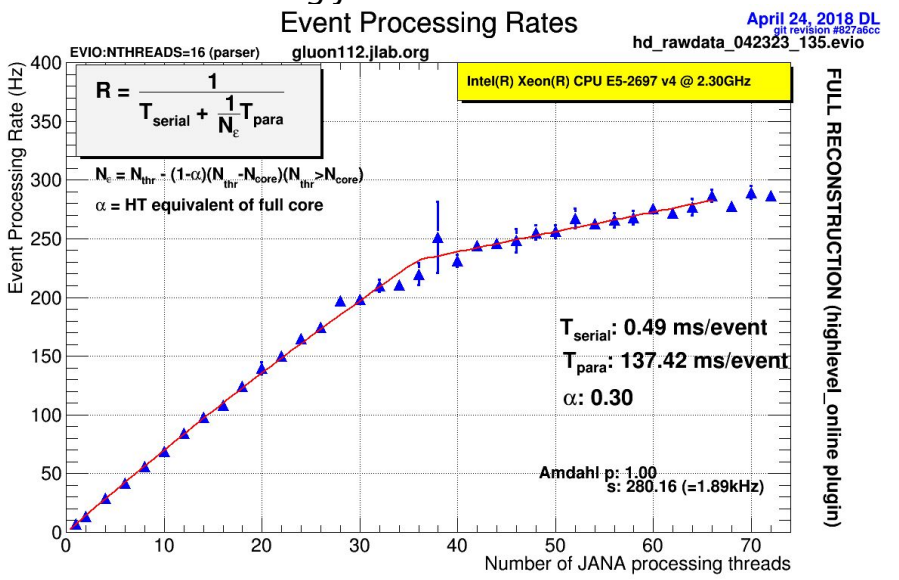
Conservation of CPU cycles!

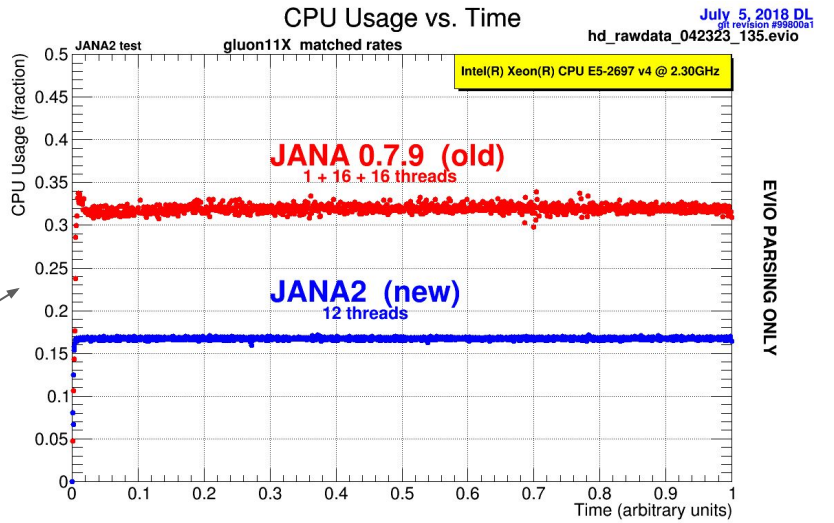
```
auto tracks = jevent->Get<DTrack>();

for(auto t : tracks){
  // ... do something with a track
}
```

JANA: C++ Software framework for Reconstruction Workflow

- Multi-threaded
- Modular, user-focused design
- Developed over the past 13 years specifically for 12GeV era of high rate experiments at JLab
- Used for GlueX online DQM, offline reconstruction and L3 trigger system*
- LDRD project for development of JANA2 started in FY18

JANA rate scaling for GlueX Data Reconstruction

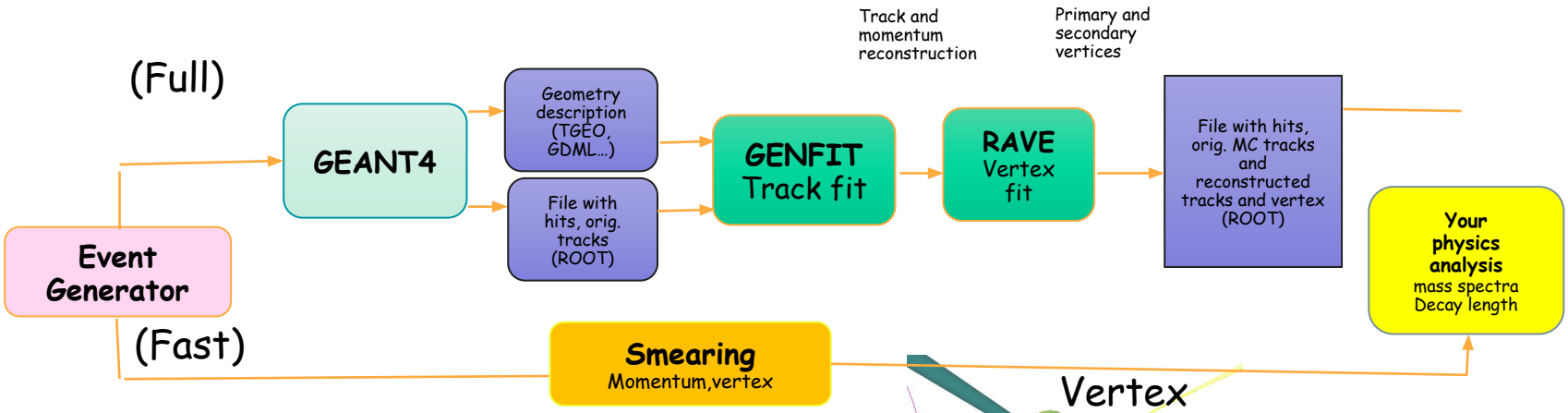




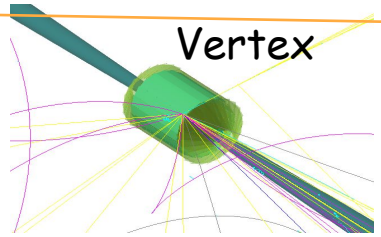
Jefferson Lab

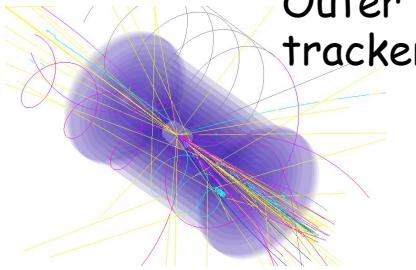
Reconstruction Chain (for LDRD)

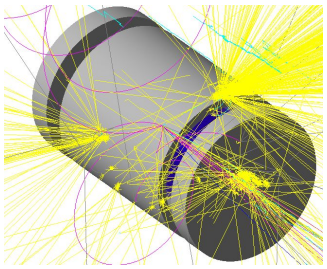
This chain has been developed to validate tracking and vertex parameters and was used for JLAB LDRD- 1601/1701 project ("Nuclear gluons with charm at EIC") to estimate a detector effect on a charm reconstruction. (Many thanks to Whitney Armstrong, Alexander Kiselev and "software consortium" for ideas and discussions)



- Geometry created/described **inside GEANT4**, and then distributed via **Root TGEO**
- All parts are connected via intermediate **Root files** (ntuples)
- Event generators (Pythia6, Herwig 6 and 7) HEPMC, Lund format.
- Original (MC) tracks are traced down to analysis
- No pattern recognition ! Only track fit and vtx!





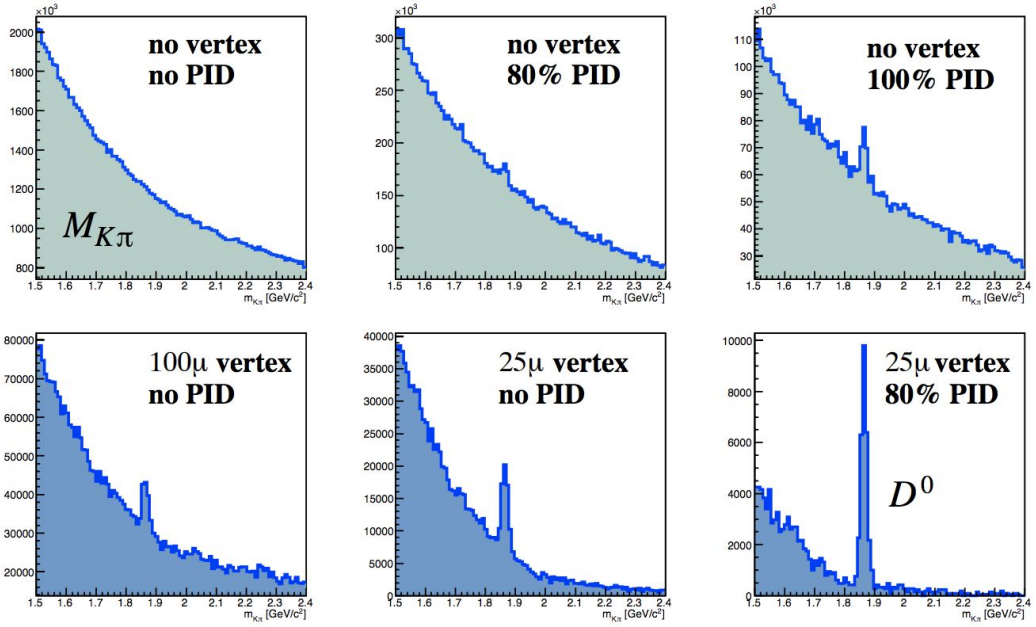


https://wiki.jlab.org/nuclear_gluons/

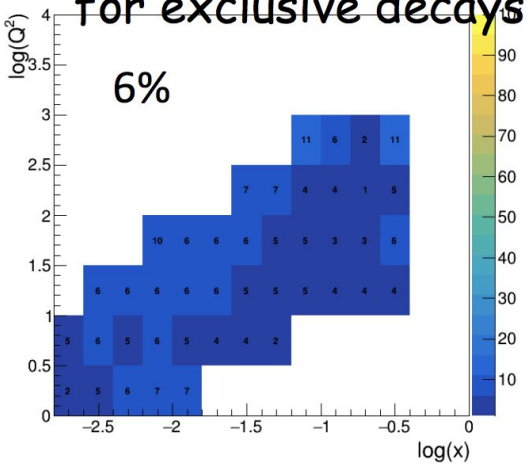
Analysis

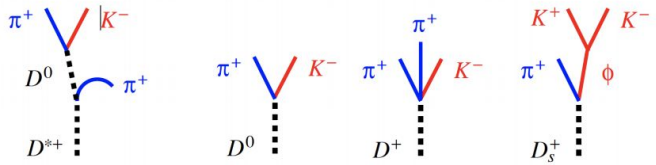
- ✓ Process charm (BGF)-only events
- ✓ Process and add all "background" events (all other non -BGF DIS events)
- ✓ Estimate efficiency and set a requirements for detector (PID, vertex, etc)

D^0 on top of DIS background



Charm efficiency for exclusive decays

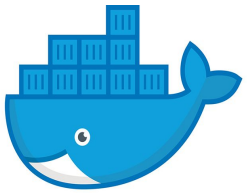





SECURITY

Containers

1. Install Docker or Singularity



2. Run container

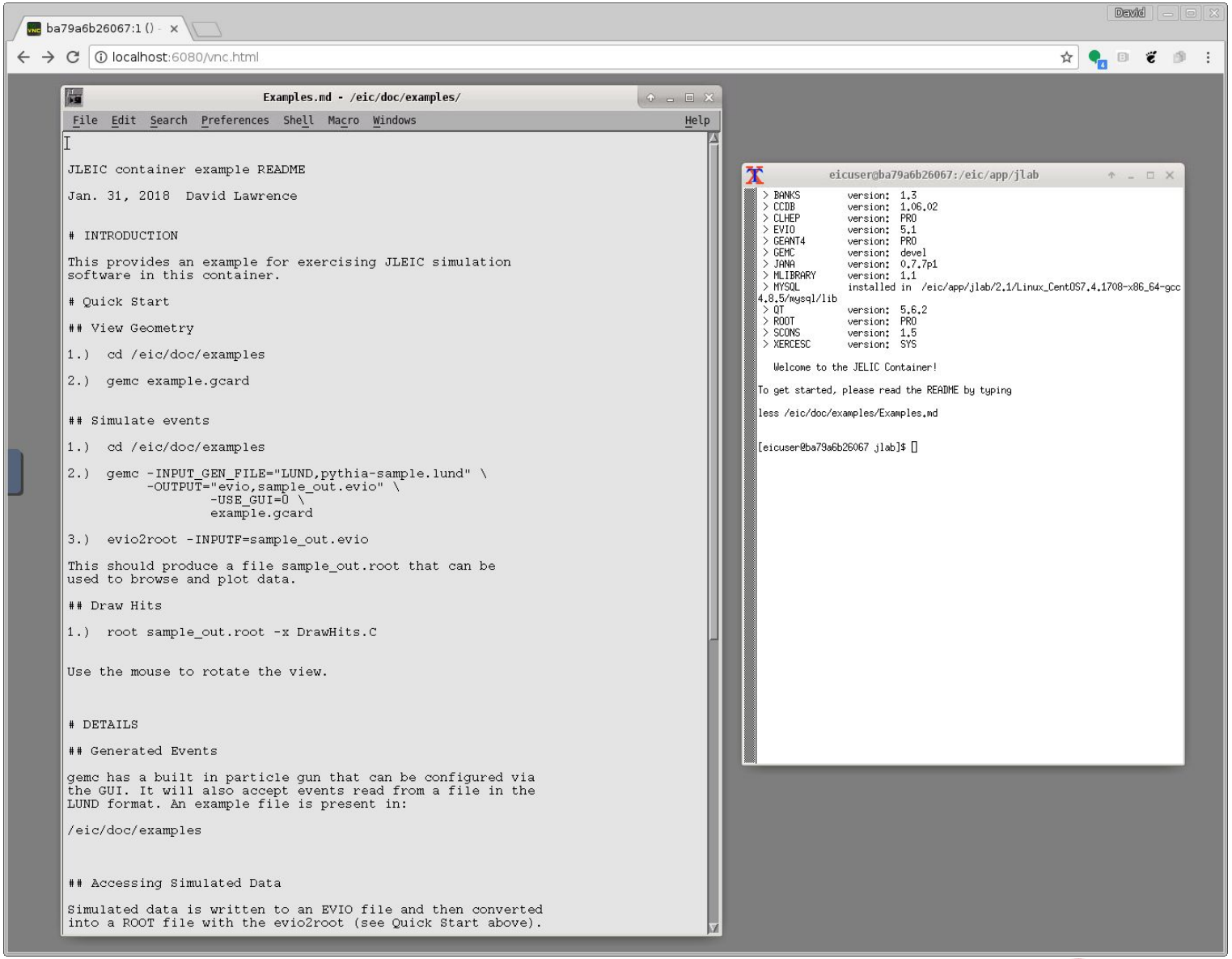
   docker run -p 6080:6080 -v /my/data/dir:/data -it --rm electronioncollider/jleic:1.0.4
   or
   singularity shell shub://electronioncollider/jleic:1.0.4 /container/utilities/xstart.csh

3. Point browser to:

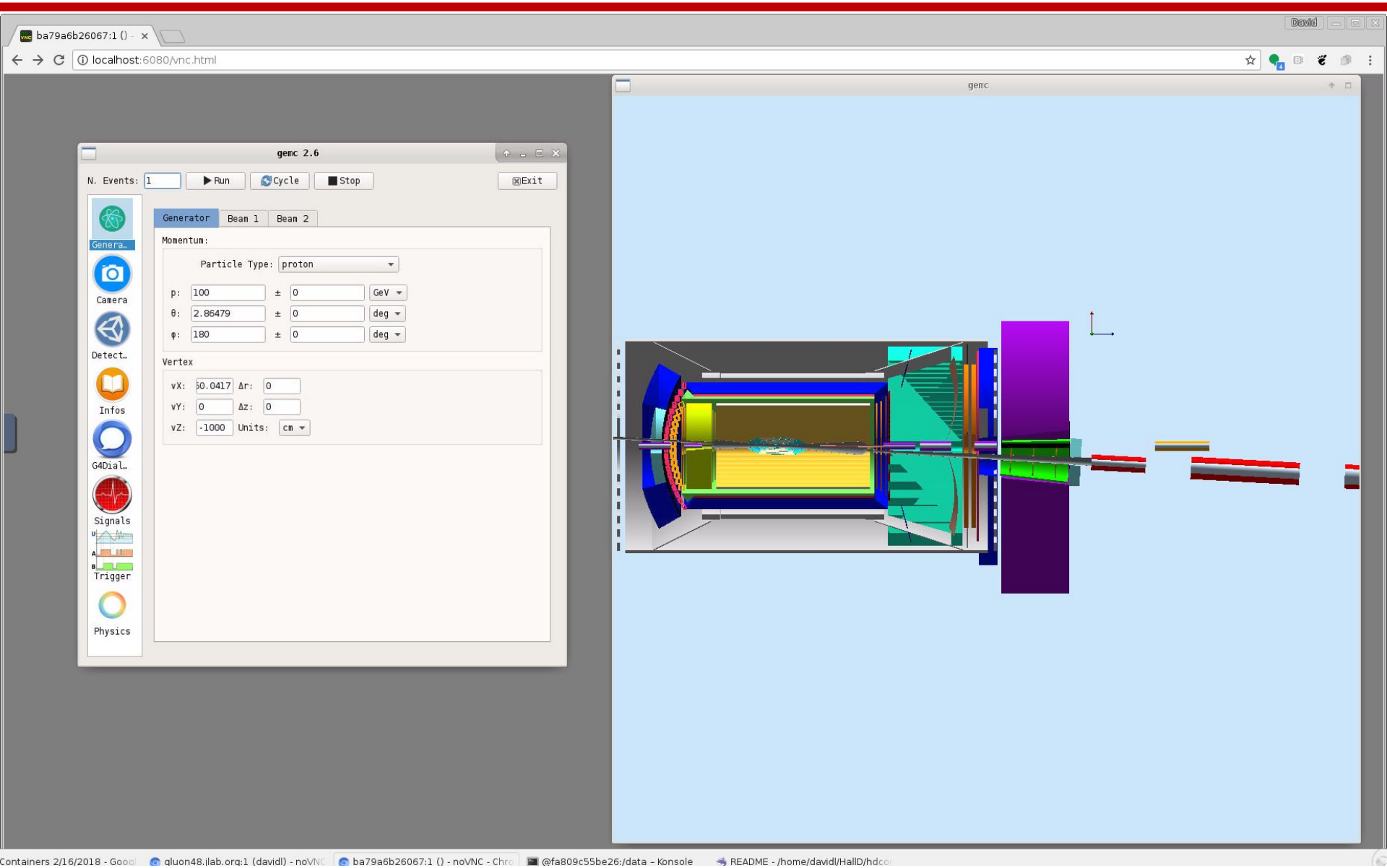
   http://localhost:6080

Containers

JLEIC Desktop Environment via web browser on host



Containers


ba79a6b26067:1 ()
David
localhost:6080/vnc.html
gemc 2.6
N. Events: 1
Run
Cycle
Stop
Exit
Genera…
Camera
Detect…
Infos
G4Dial…
Signals
Trigger
Physics
Generator
Beam 1
Beam 2
Momentum:
Particle Type: proton
p: 100 ± 0 GeV
θ: 2.86479 ± 0 deg
φ: 180 ± 0 deg
Vertex
vX: 50.0417 Δr: 0
vY: 0 Δz: 0
vZ: -1000 Units: cm
gemc
Containers 2/16/2018 - Goog
gluon48.jlab.org:1 (davidl) - noVNC
ba79a6b26067:1 () - noVNC - Chro
@fa809c55be26:/data - Konsole
README - /home/davidl/HallD/hdco

Containers

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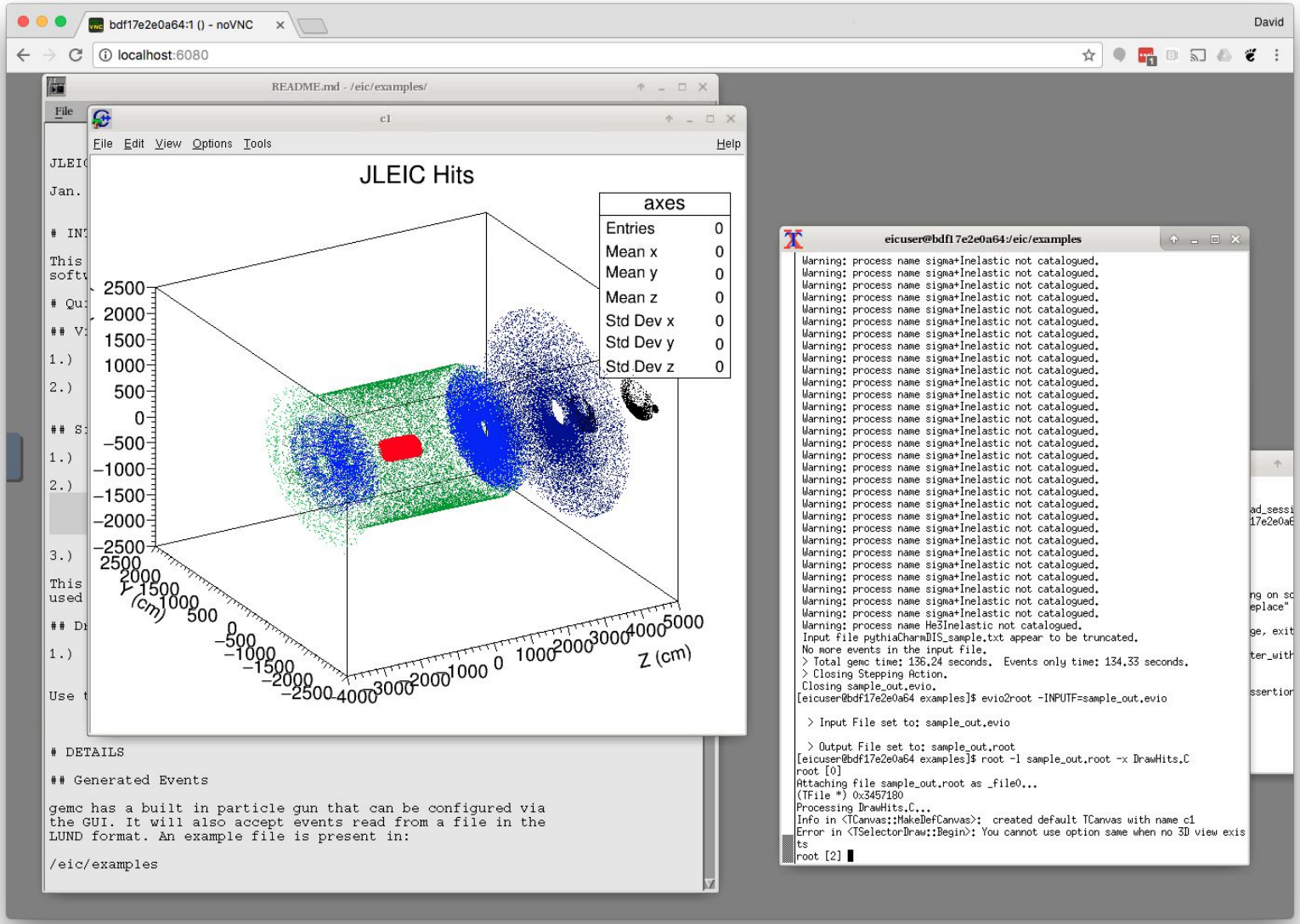


Summary and Future

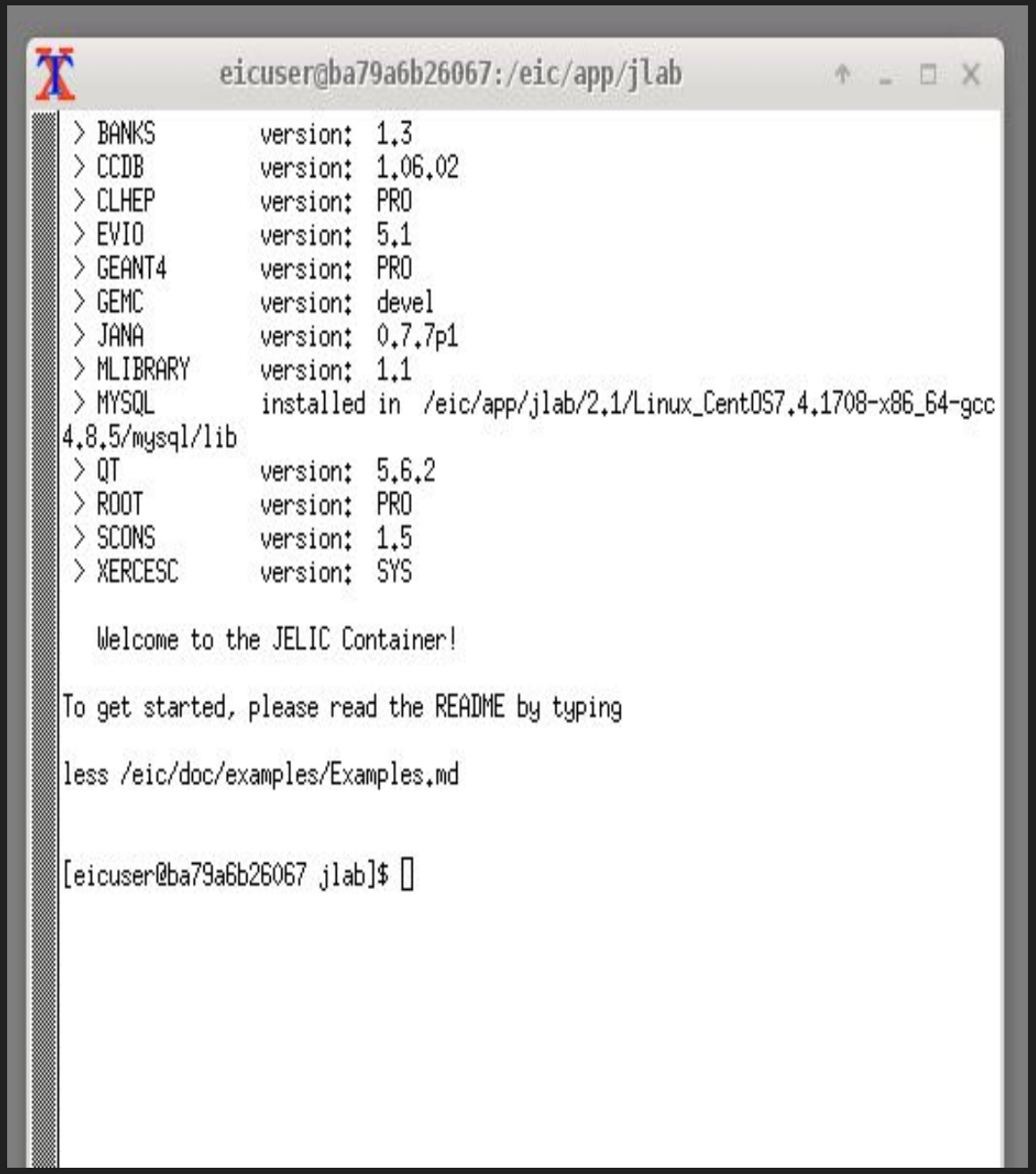
- Simulation
  - GEMC (Geant4) used for simulation
  - Refining and merging geometries

- Reconstruction
  - Some work completed on tracking/vertexing using GenFit and RAVE
  - Actively integrating reconstruction components into single project using JANA framework
  - Plans to incorporate other ESC software (e.g. ProIO)

- Containers
  - jleic containers published on Docker hub and Singularity hub
  - targeting interactive desktop/laptop use vs. batch

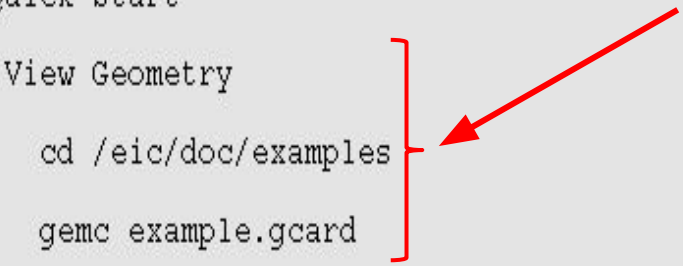
Backups

JLEIC Desktop Environment via web browser on host



JLEIC Desktop Environment via web browser on host

```
JLEIC container example README

Jan. 31, 2018  David Lawrence


# INTRODUCTION

This provides an example for exercising JLEIC simulation
software in this container.

# Quick Start

## View Geometry

1.)  cd /eic/doc/examples

2.)  gemc example.gcard


## Simulate events

1.)  cd /eic/doc/examples

2.)  gemc -INPUT_GEN_FILE="LUND,pythia-sample.lund" \
          -OUTPUT="evio,sample_out.evio" \
                  -USE_GUI=0 \
                  example.gcard

3.)  evio2root -INPUTF=sample_out.evio

This should produce a file sample_out.root that can be
used to browse and plot data.
```



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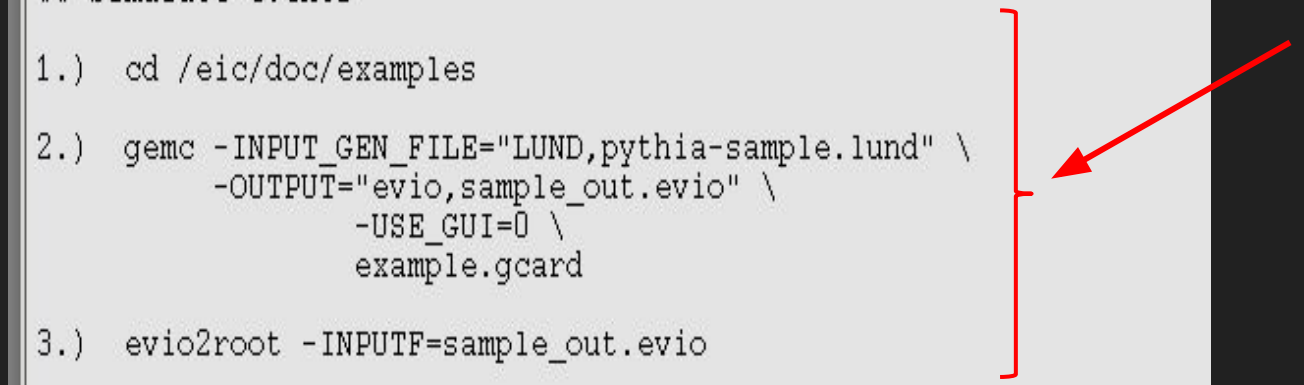

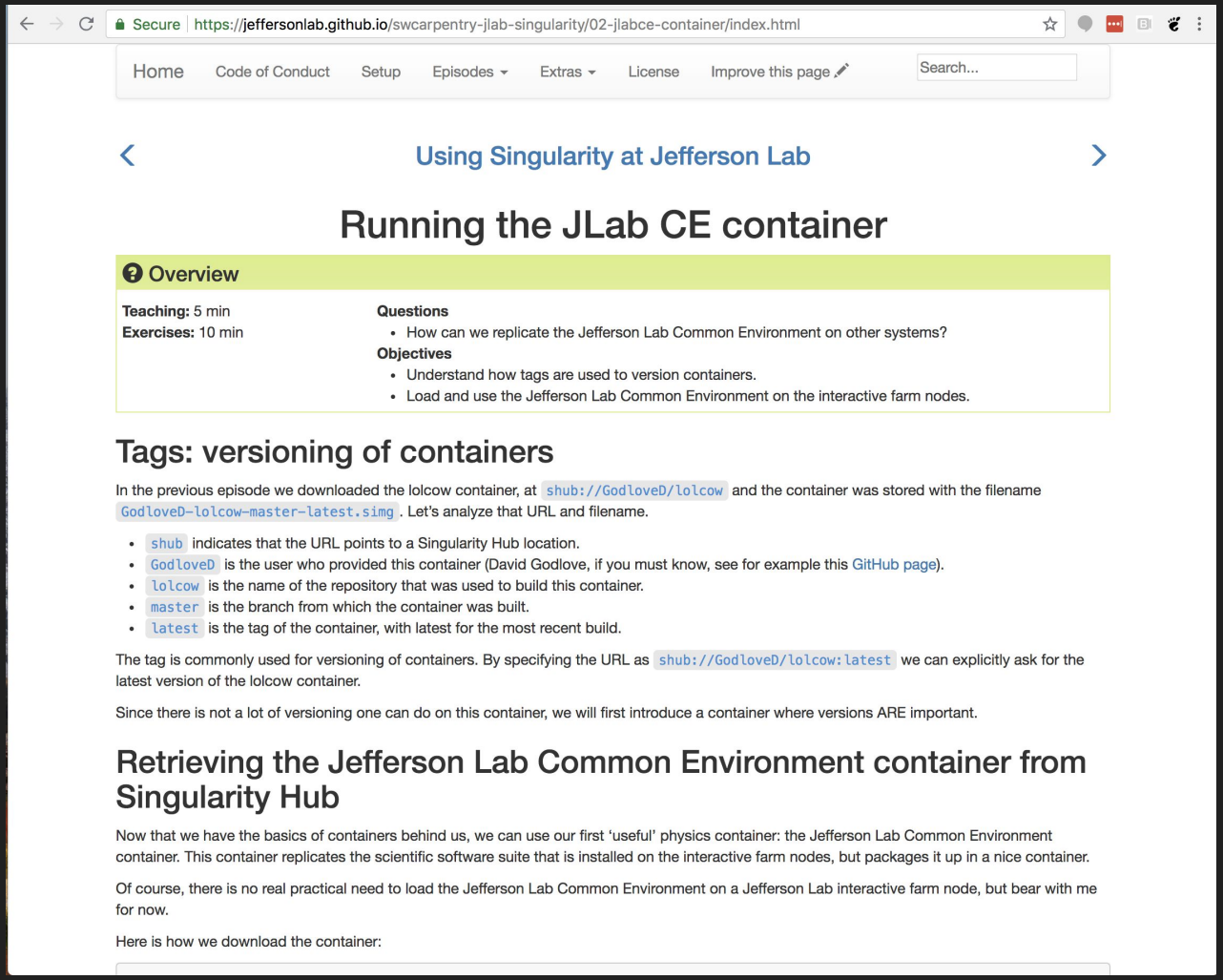

JLab Software Carpentry Workshop:

EIC container effort feeding back into production operations at JLab