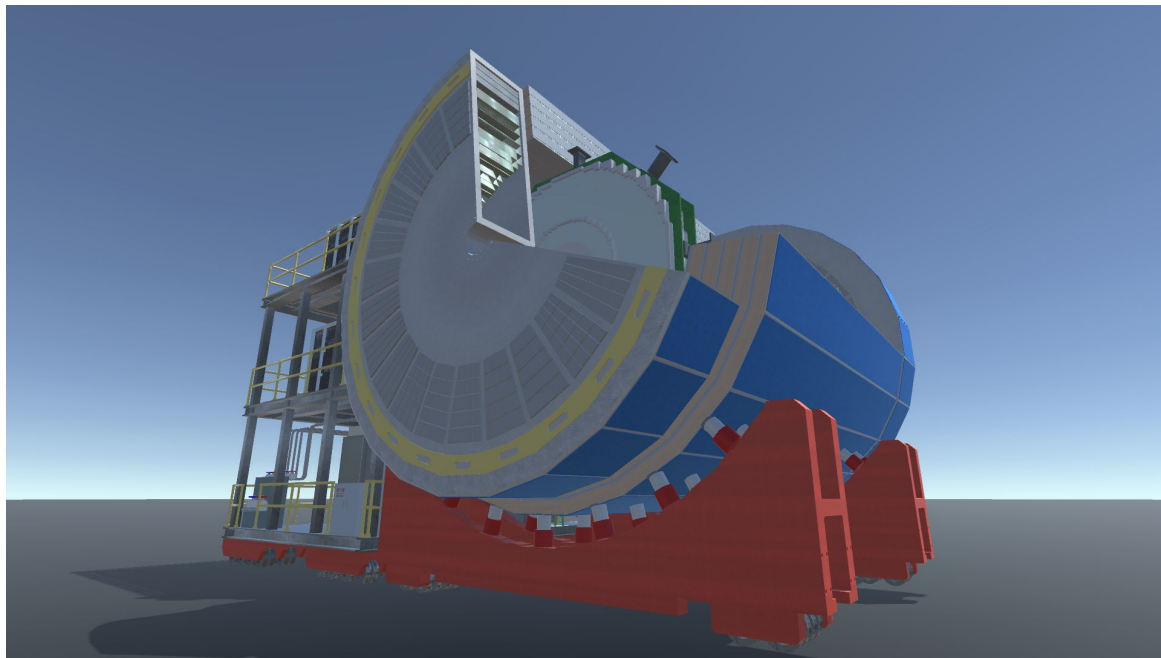


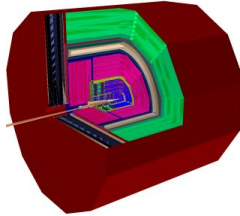
DD4HEP simulations of the ATHENA detector



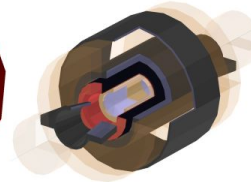
The DD4HEP community



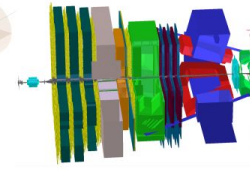
Super Charm
Tau Factories



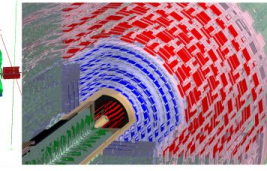
Production



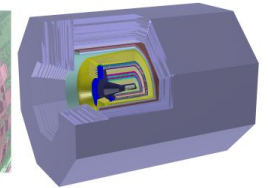
Production



Production
Run 3



Under
investigation
Run 3

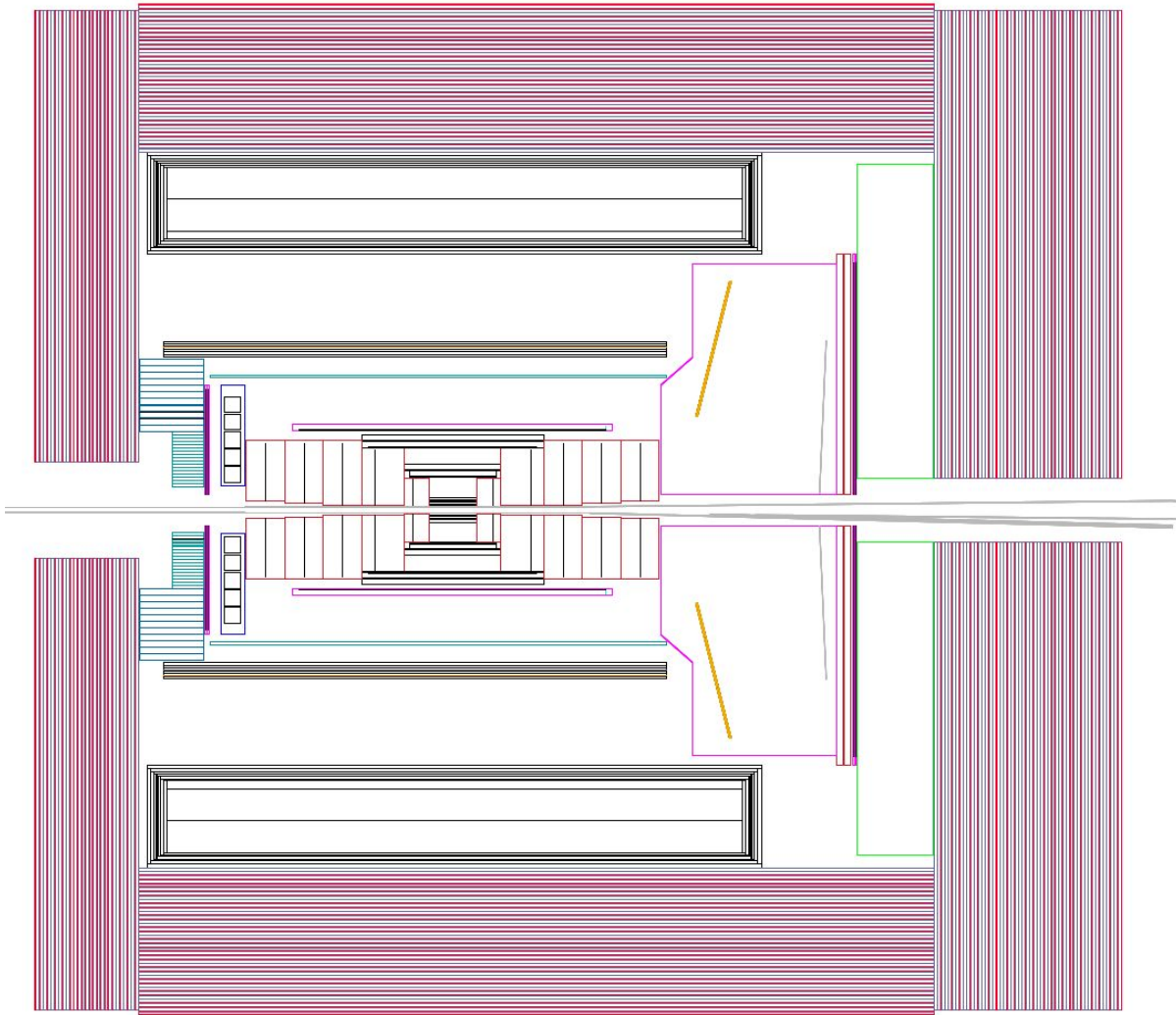


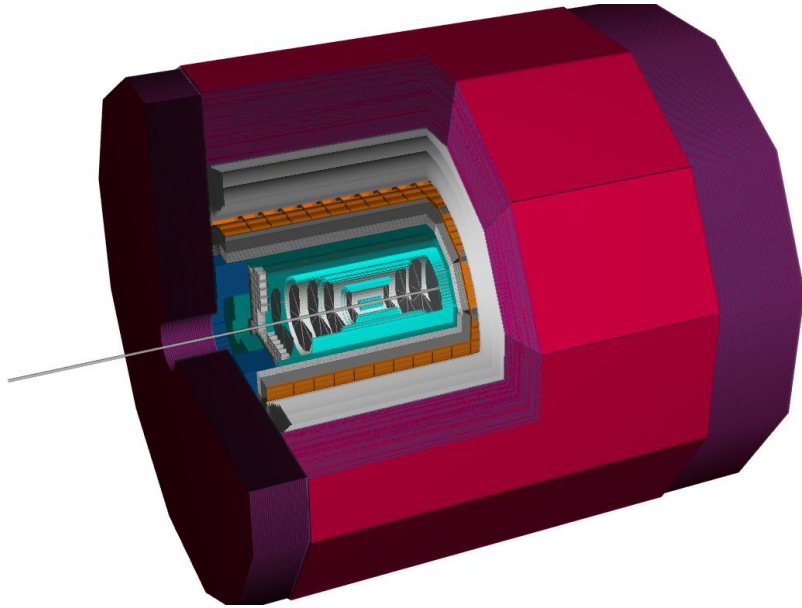
Production

“framework for providing a complete solution for full detector description (geometry, materials, visualization, readout, alignment, calibration, etc.)”

<https://eicweb.phy.anl.gov/EIC/detectors/athena>

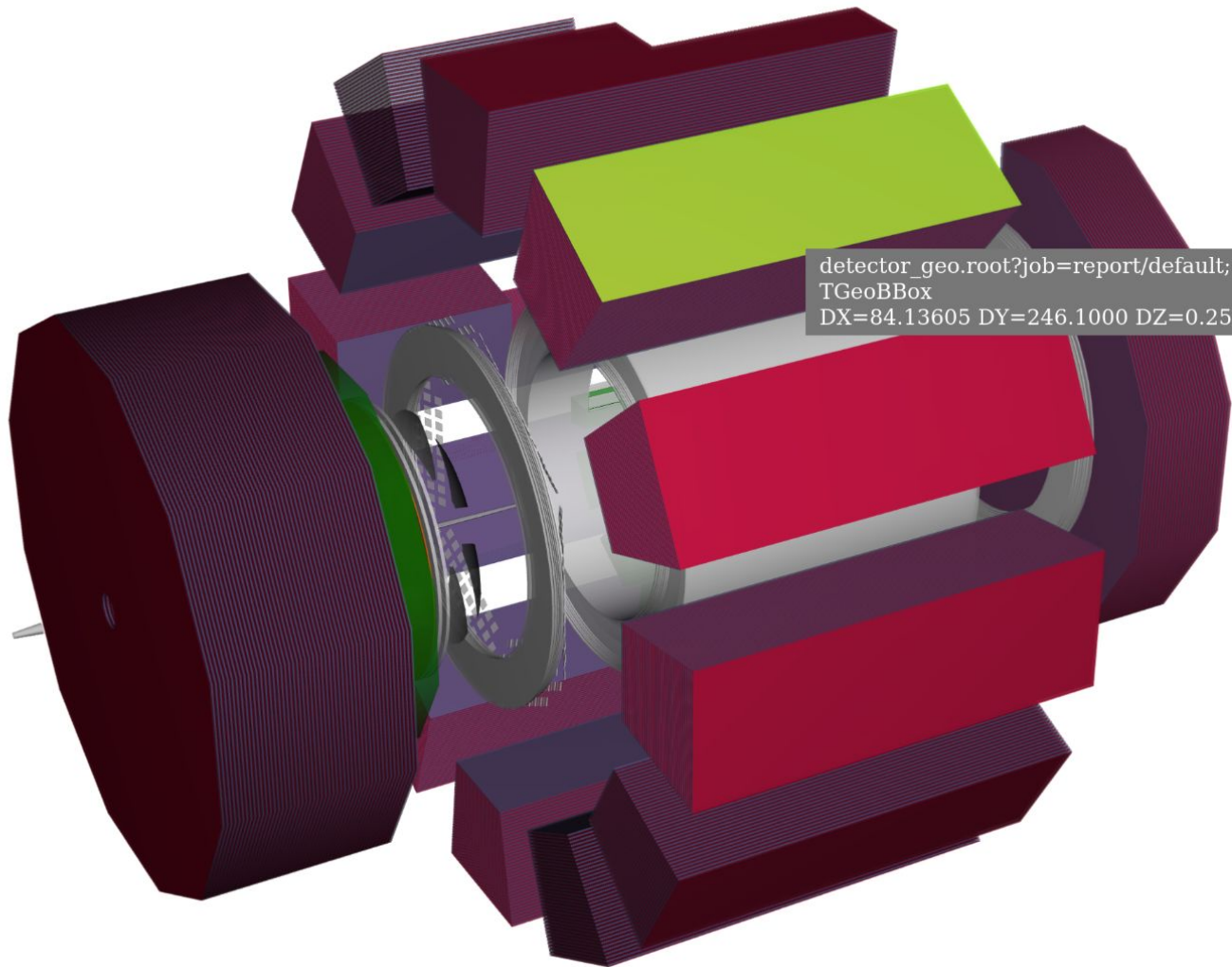
Geometry, materials
and reconstruction code
is already in place to do
calorimeter-based
hadronic reco





Check model out if
you have not done
so yet

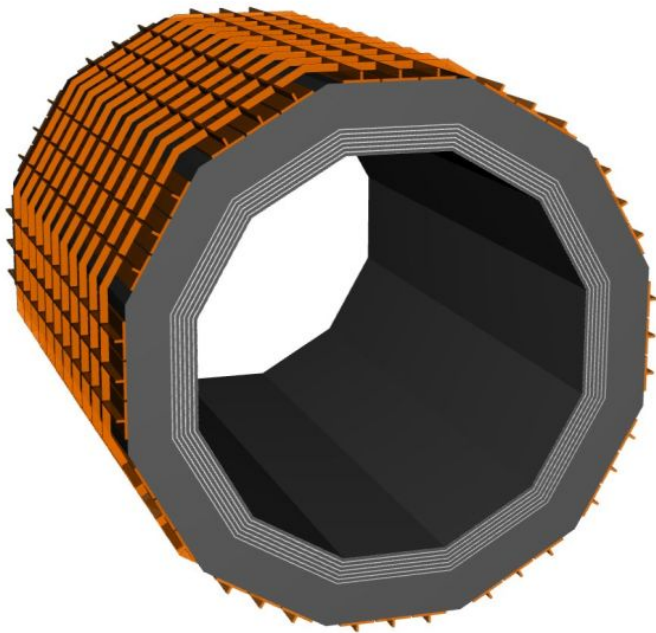
https://eic.phy.anl.gov/geoviewer/index.htm?nobrowser&file=https://eicweb.phy.anl.gov/api/v4/projects/473/jobs/artifacts/master/raw/geo/detector_geo.root?job=report&item=default;1&opt=clipxyz;transp30;zoom100;ROTY0;ROTZ0;trz100;trr0;ctrl:all&



detector_geo.root?job=report/default;1
TGeoBBox
DX=84.13605 DY=246.1000 DZ=0.250

SiFi Calorimeter

Implementation in dd4hep



6 imaging layers with SiFi/Pb with 1.5 cm SiFi/Pb:
 $6 \times 2.25 \text{ cm} = 13.53 \text{ cm}$

Layer of SiFi/Pb:
20.0 cm

Total:
33.53 cm

Step #1: Get simulation samples

Accessing Large Data Productions: From the Web

(username: eicS3read , eicS3read pass)

<https://dtn01.sdcc.bnl.gov:9000/minio/login>

The screenshot displays the Minio web interface for the 'eicS3read' user. The interface shows a directory structure with a sidebar on the left and a main content area. The sidebar lists the following directories: AT, CC, EC, Te, and cp. The main content area shows the 'ATHENA' directory, which contains the following subdirectories: EVGEN/, FULL/, RECO/, JETS/, SINGLE/, neutron/, and pi+/. The 'neutron/' directory is highlighted, showing its contents: '2021-06-17/' and 'neutron_10GeV_45to135deg.0001.full_cal_clustering.root'. The interface also includes a search bar and a 'Used: 31.66 GB' indicator.

Directory	Subdirectory	File
ATHENA /	EVGEN/	
	FULL/	
	RECO/	
	JETS/	
	SINGLE/	
	neutron/	
	pi+/	
neutron_10GeV_45to135deg.0001.full_cal_clustering.root		

Accessing Large Data Productions: Command Line

Download the Minio client:

```
wget https://dl.min.io/client/mc/release/linux-amd64/mc
```

Register your S3 instance:

```
./mc config host add S3 https://dtn01.sdcc.bnl.gov:9000 $u $p
```

Copy files (recursively):

```
./mc cp -r S3/eicctest/ATHENA/RECO/SINGLE/neutron/2021-06-17 .
```

Full docs: http://doc.athena-eic.org/en/latest/howto/s3_file_storage.html

Also works in one line in python

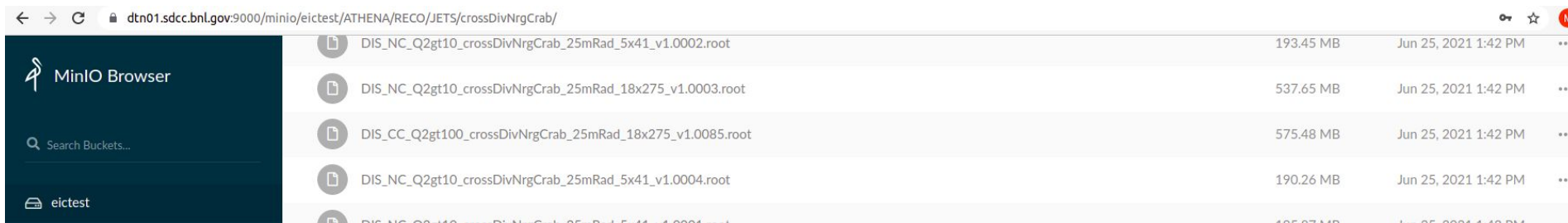
```
In [10]: #!/matplotlib notebook  
import uproot as ur  
import matplotlib.pyplot as plt  
import numpy as np  
import awkward as ak  
  
import pandas as pd
```

Get data, transform ROOT tree into array

```
In [11]: events = ur.open('root://sci-xrootd.jlab.org//osgpool/eic/ATHENA/RECO/JETS/crossDivNrgCrab/DIS_NC_Q2gt10_crossDivNrg')
```

Both NC and CC samples available

Min Q2 of 10 GeV2 or 100 GeV2 for now (Pythia8 samples)



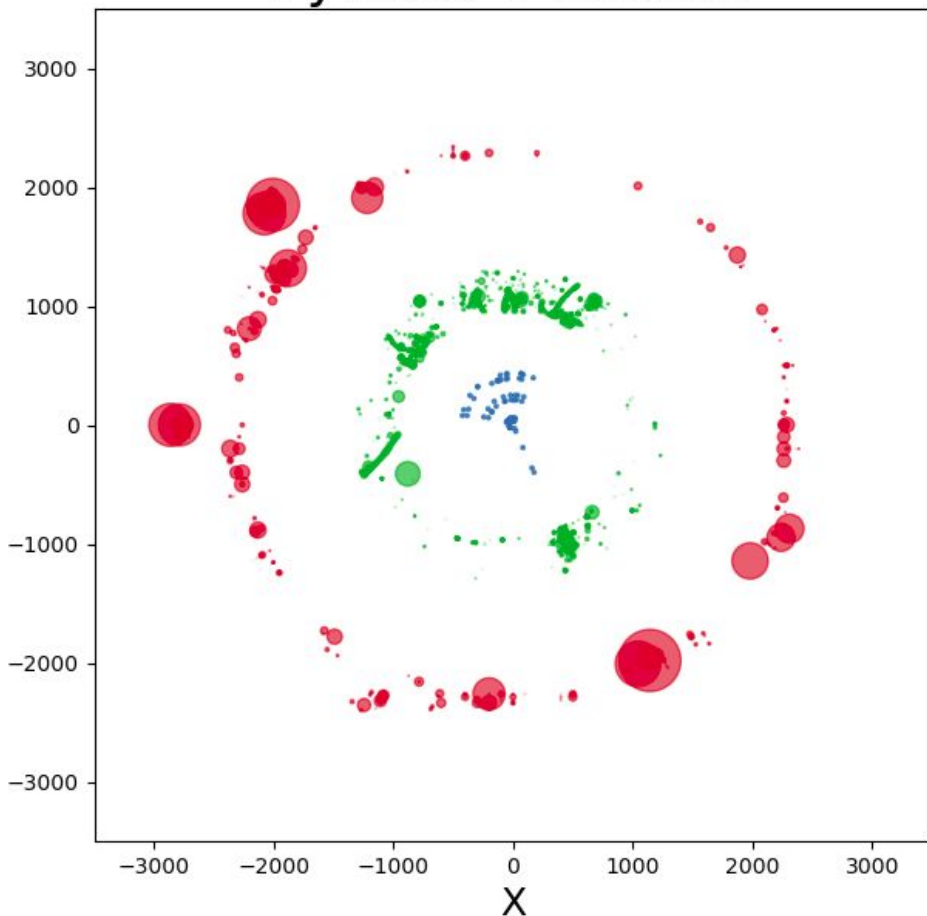
The screenshot shows a web browser window with the address bar displaying `dtm01.sdcc.bnl.gov:9000/minio/eicctest/ATHENA/RECO/JETS/crossDivNrgCrab/`. On the left, a dark sidebar for the MinIO Browser contains a search bar labeled "Search Buckets..." and a breadcrumb "eicctest". The main area displays a table of files with columns for file names, sizes, and timestamps.

File Name	Size	Timestamp
DIS_NC_Q2gt10_crossDivNrgCrab_25mRad_5x41_v1.0002.root	193.45 MB	Jun 25, 2021 1:42 PM
DIS_NC_Q2gt10_crossDivNrgCrab_25mRad_18x275_v1.0003.root	537.65 MB	Jun 25, 2021 1:42 PM
DIS_CC_Q2gt100_crossDivNrgCrab_25mRad_18x275_v1.0085.root	575.48 MB	Jun 25, 2021 1:42 PM
DIS_NC_Q2gt10_crossDivNrgCrab_25mRad_5x41_v1.0004.root	190.26 MB	Jun 25, 2021 1:42 PM
DIS_NC_Q2gt10_crossDivNrgCrab_25mRad_5x41_v1.0001.root	195.87 MB	Jun 25, 2021 1:42 PM

ATHENA simulation

Pythia8 + Geant4

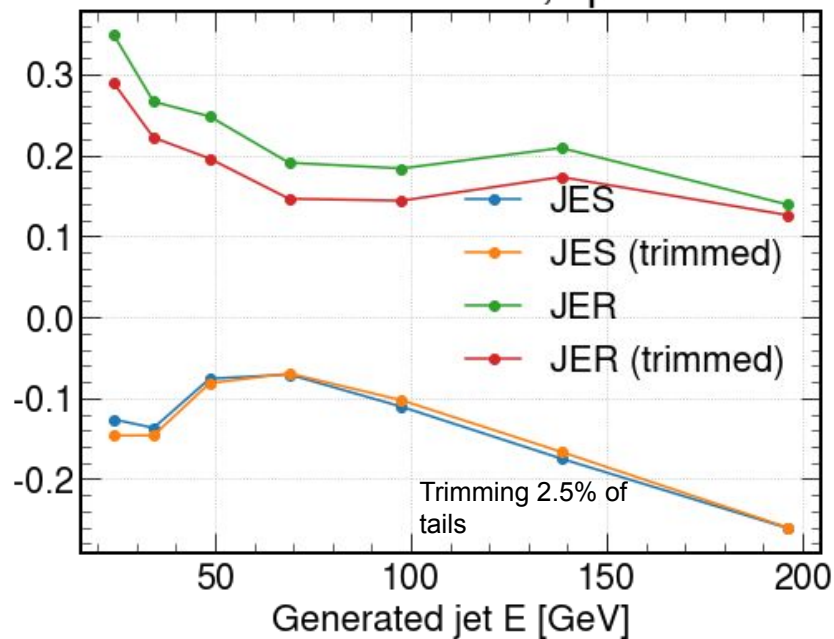
SLIDE FROM June 14th



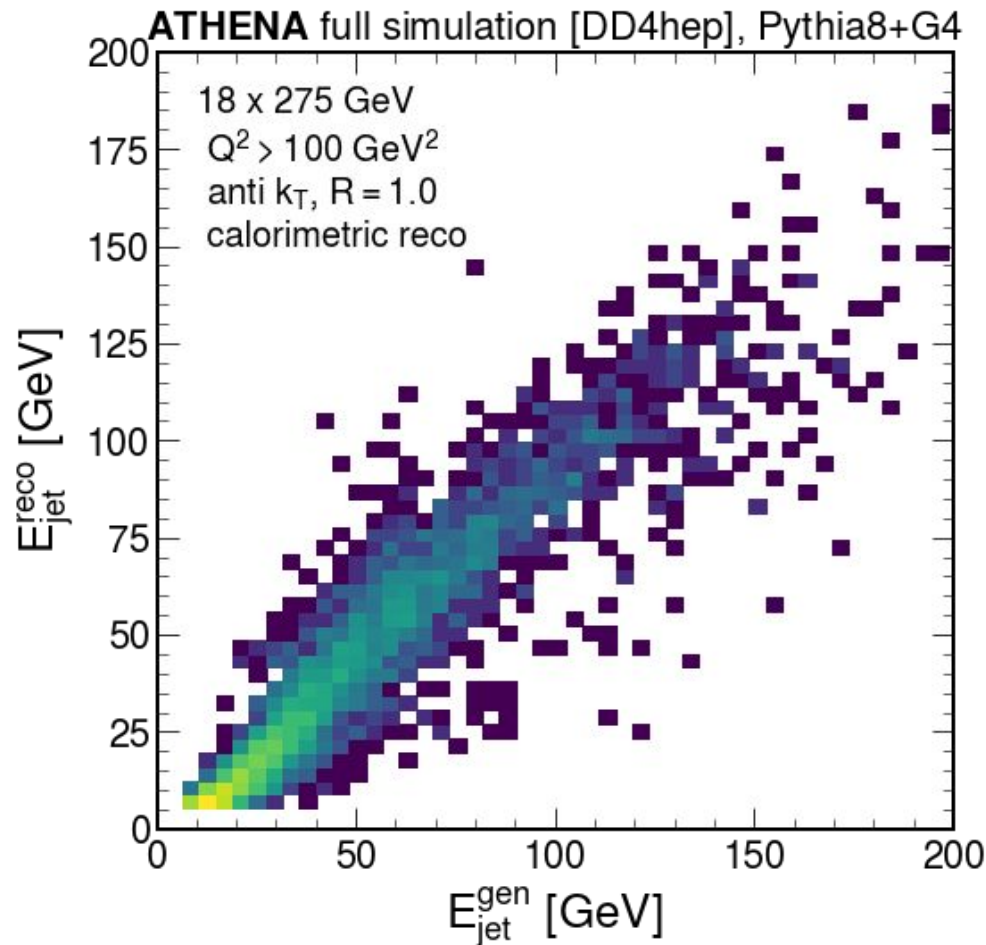
- First full-simulation campaign successfully ran last week (Wouter) using Pythia8 DIS events (Brian)
- Useful test to stress computer resources, estimate data sample sizes, and start physics analysis!

A milestone!

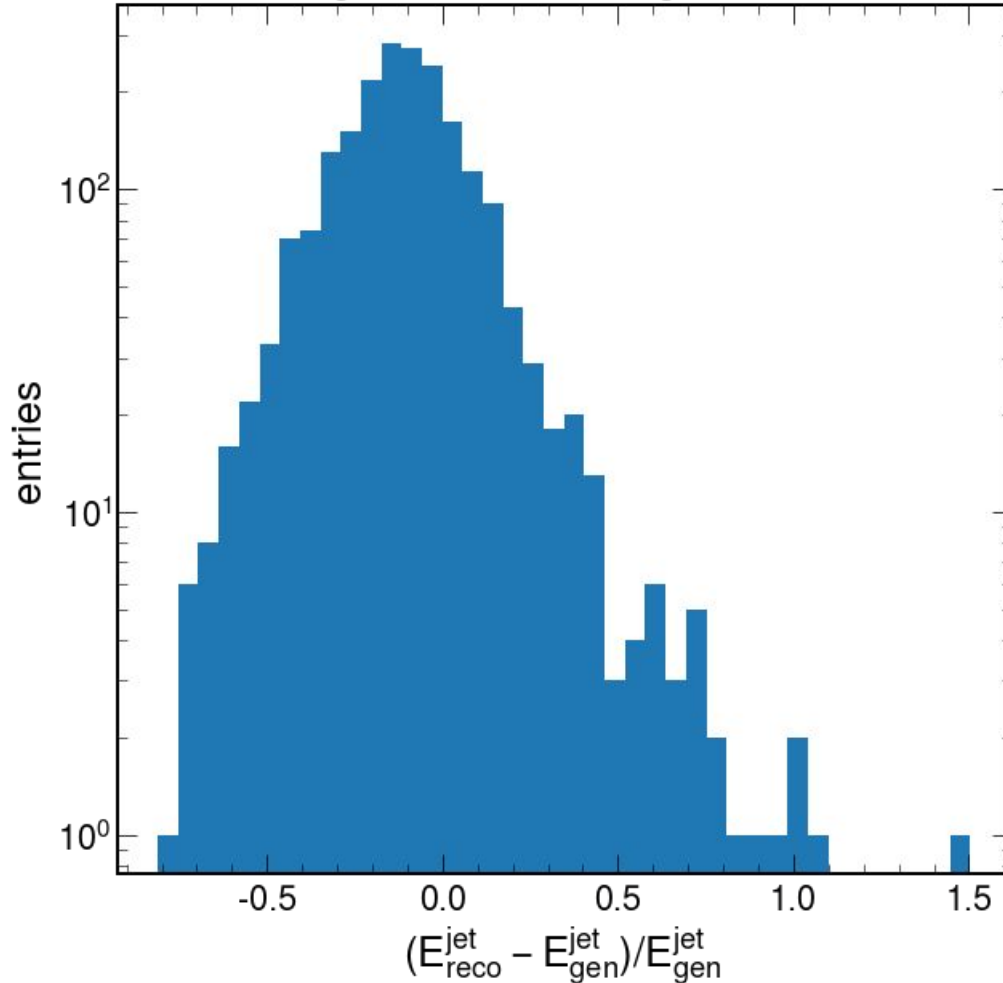
Relative jet-energy scale and resolution, $\eta > 1.5$



This is going to improve after we improve calibration on the simulation



$E_{\text{gen}}^{\text{jet}} > 20 \text{ GeV}, \eta_{\text{gen}}^{\text{jet}} > 1.5$

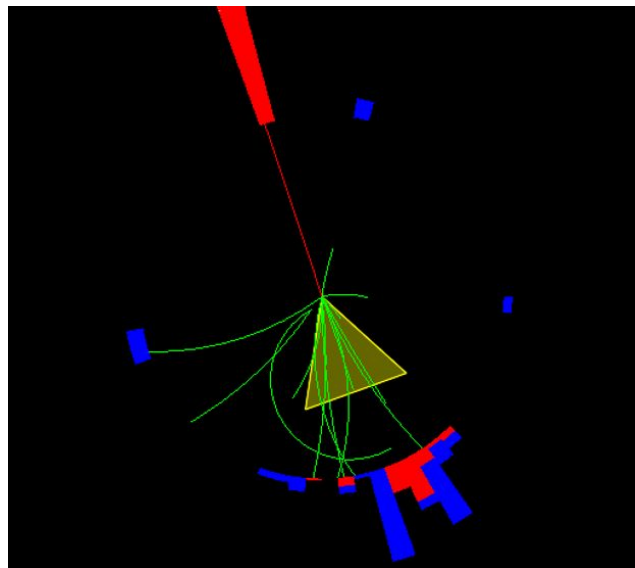


We define the jet-energy scale (JES) as the mean of distribution
And jet-energy resolution as the standard deviation.

There is some degree of arbitrariness.
Options:

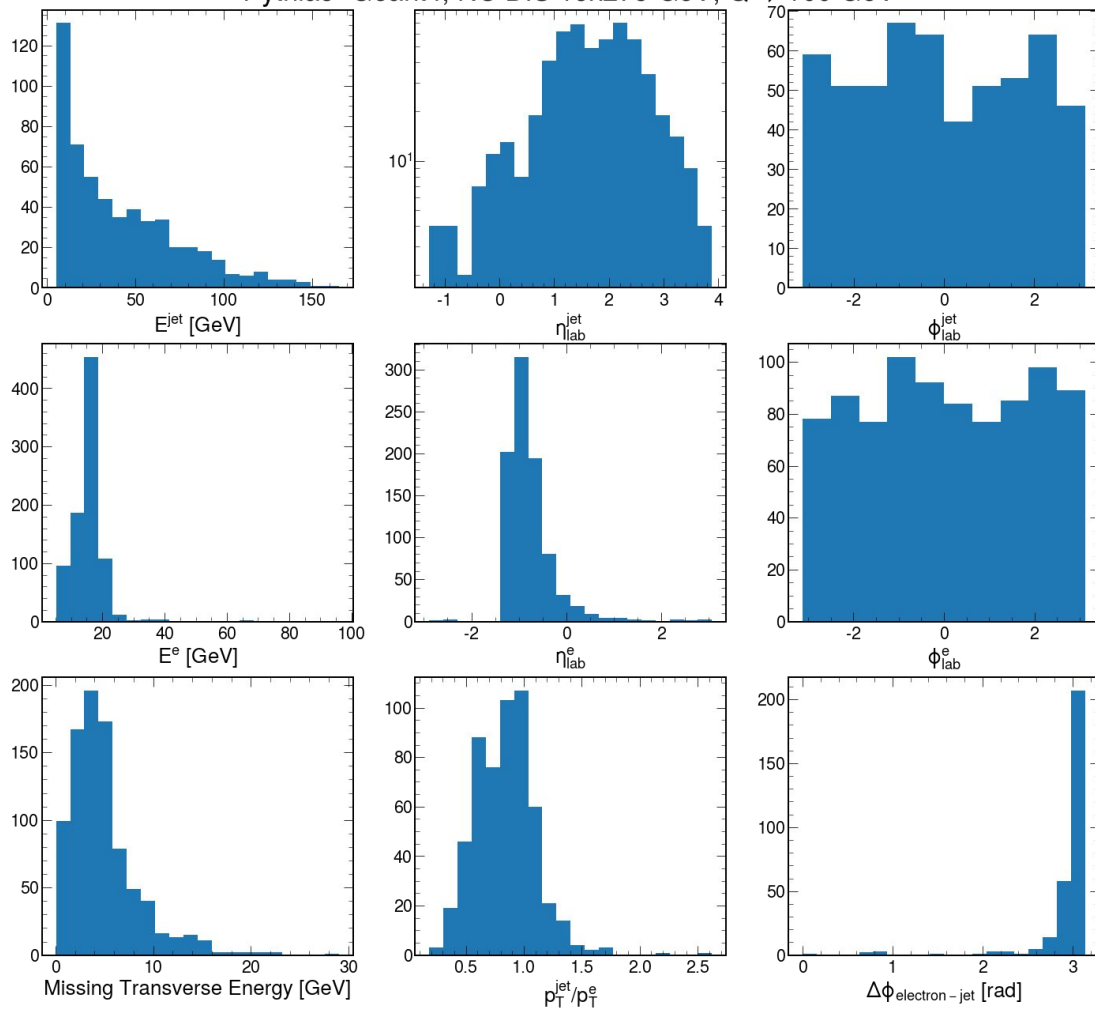
- Gaussian fit,
- Define with entire distribution, no fit
- Define with ~95% or 90% of distribution (cut 2.5% tail at either end)

FYI, we are very close to get first performance metrics for this channel!

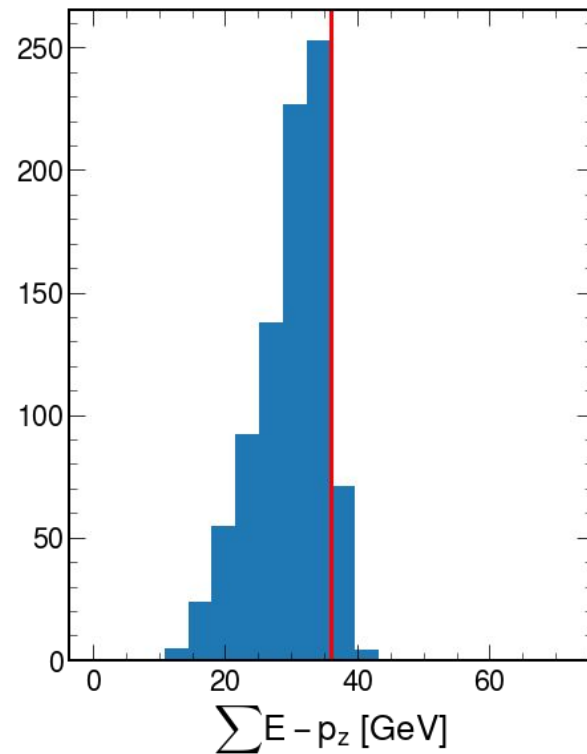
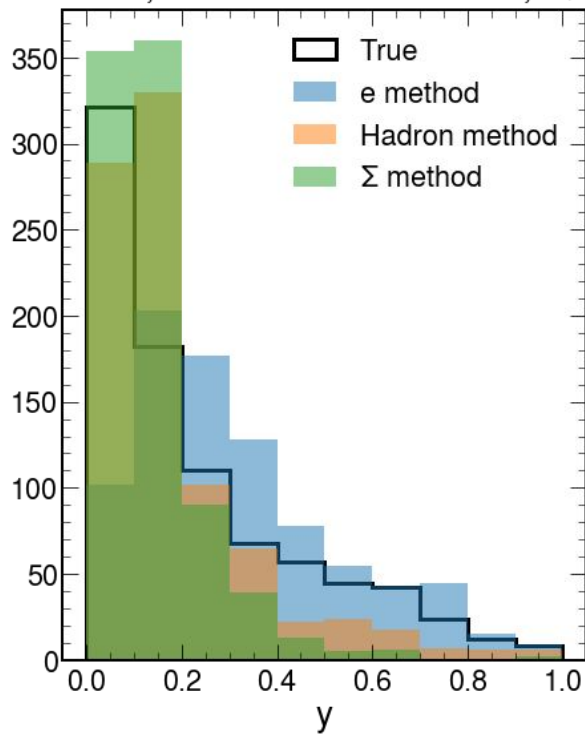
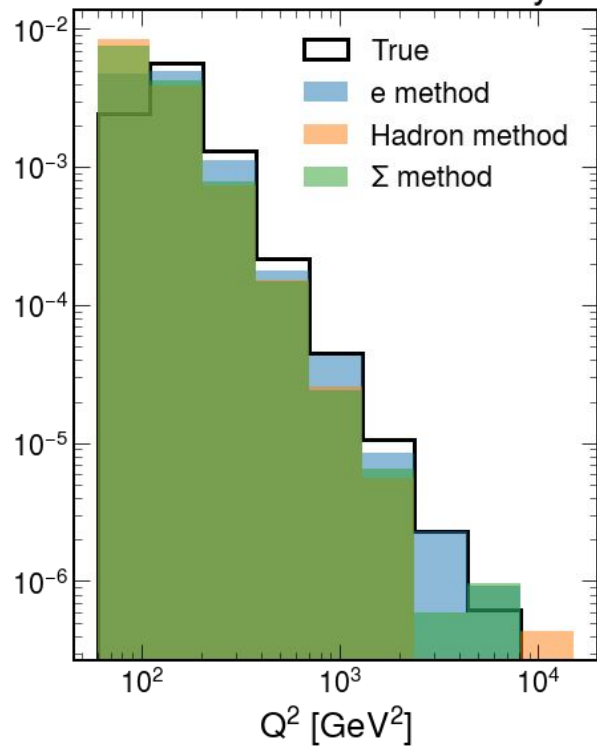


ATHENA full simulation [DD4hep]

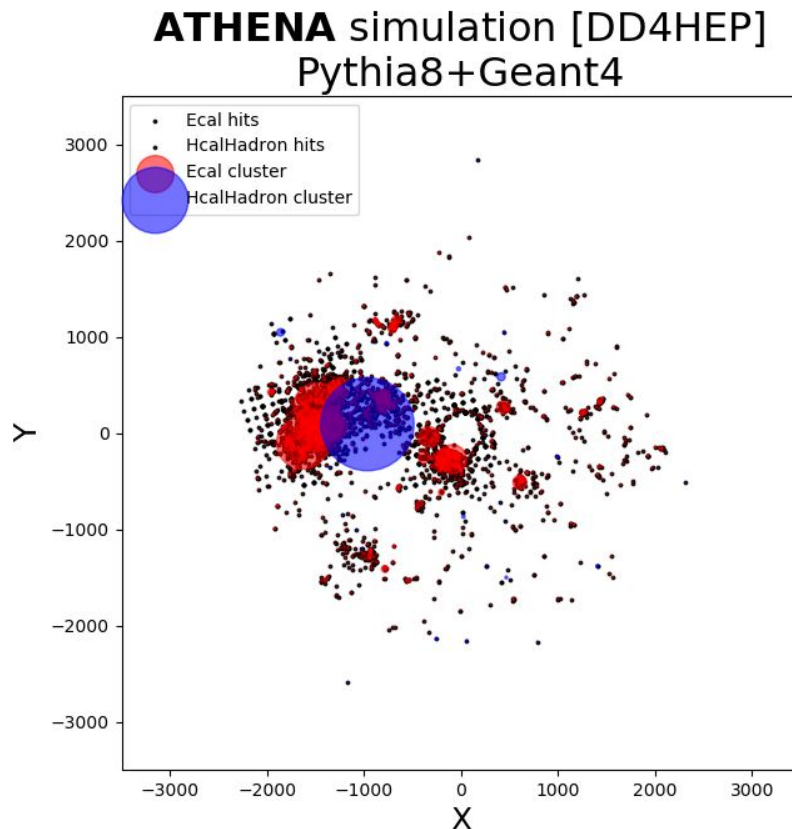
Pythia8+Geant4, NC DIS 18x275 GeV, $Q^2 > 100 \text{ GeV}^2$



ATHENA full simulation [DD4hep]
Pythia8+Geant4, NC DIS 18x275 GeV, $Q^2 > 100 \text{ GeV}^2$



Forward rapidities: tracking-calorimetry merging seems rather challenging



Code shared and tested by others, e.g. Prof. Owen Long:

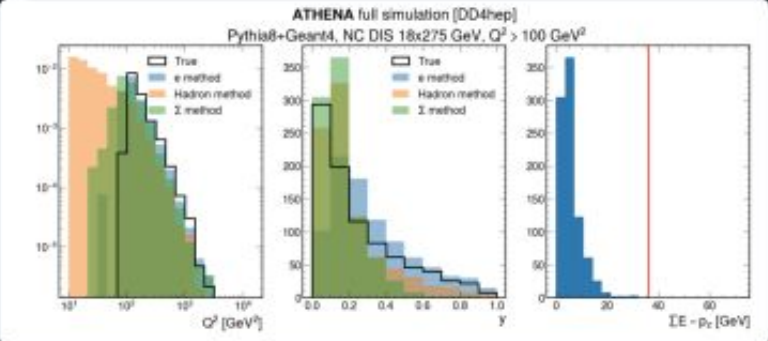
Friday, July

 **Owen Long** 11:00 AM

I found one minor thing in your code that I think only affects one histogram. I think you don't skip the electron in the ECAL sum. You do skip it in calculating the E_{mpz} the plot on the right here. Probably not a big deal, but I thought I would mention it.

0-empz-mine.png ▼

ATHENA full simulation [DD4hep]
Pythia8+Geant4, NC DIS 18x275 GeV, $Q^2 > 100 \text{ GeV}^2$



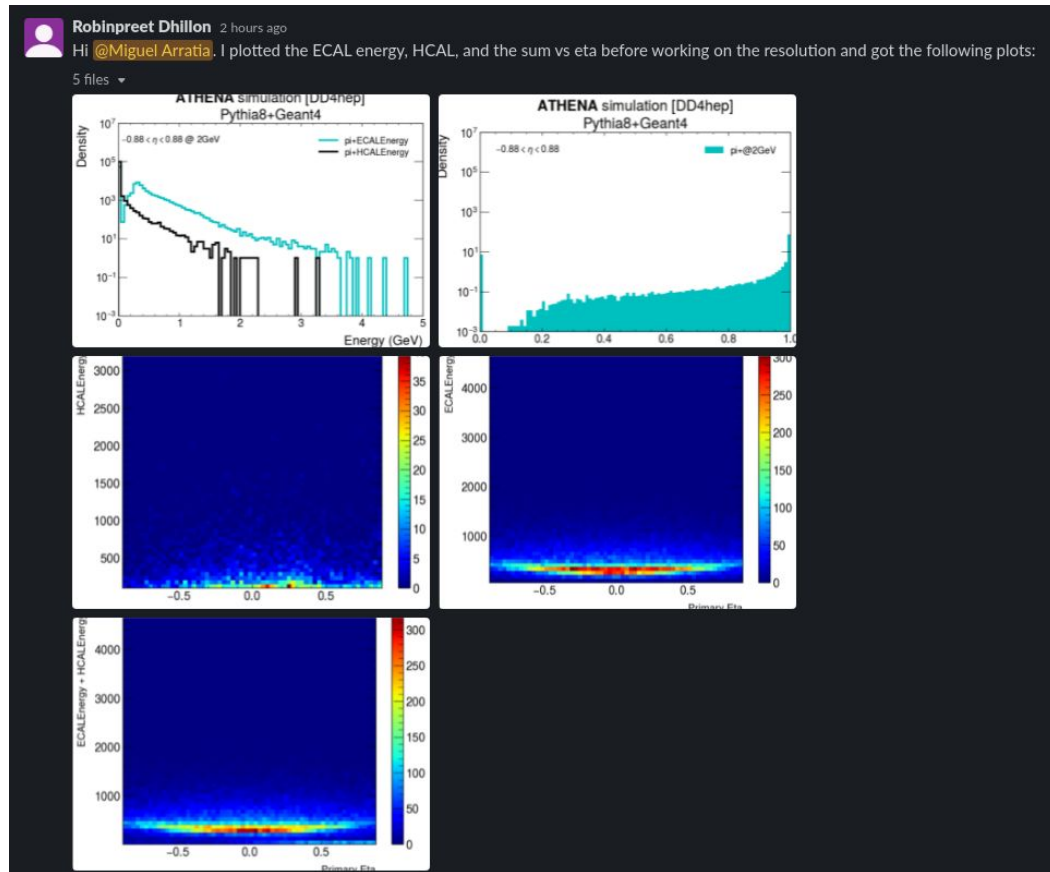
The figure displays three histograms comparing simulation methods: True (black line), e method (blue), Hadron method (orange), and Z method (green). The left plot shows the distribution of Q^2 [GeV²] on a logarithmic scale. The middle plot shows the distribution of y . The right plot shows the distribution of $|E - p_z|$ [GeV] with a vertical red line at approximately 35 GeV.

Miguel Arratia 11:02 AM

Already student friendly:

Robinpreet is
An undergraduate student

Zhiwan, Ryan, UCLA
Graduate students are
Starting to look



Summary.

ATHENA full simulation chain is working, samples for NC and CC analysis are ready (*calorimeter-based reco only for the moment)

Let's work together on implementing energy-flow for hadronic reconstruction (needs tracking + calo)