# E1039 OFFLINE SOFTWARE:
## STATUS AND PLAN

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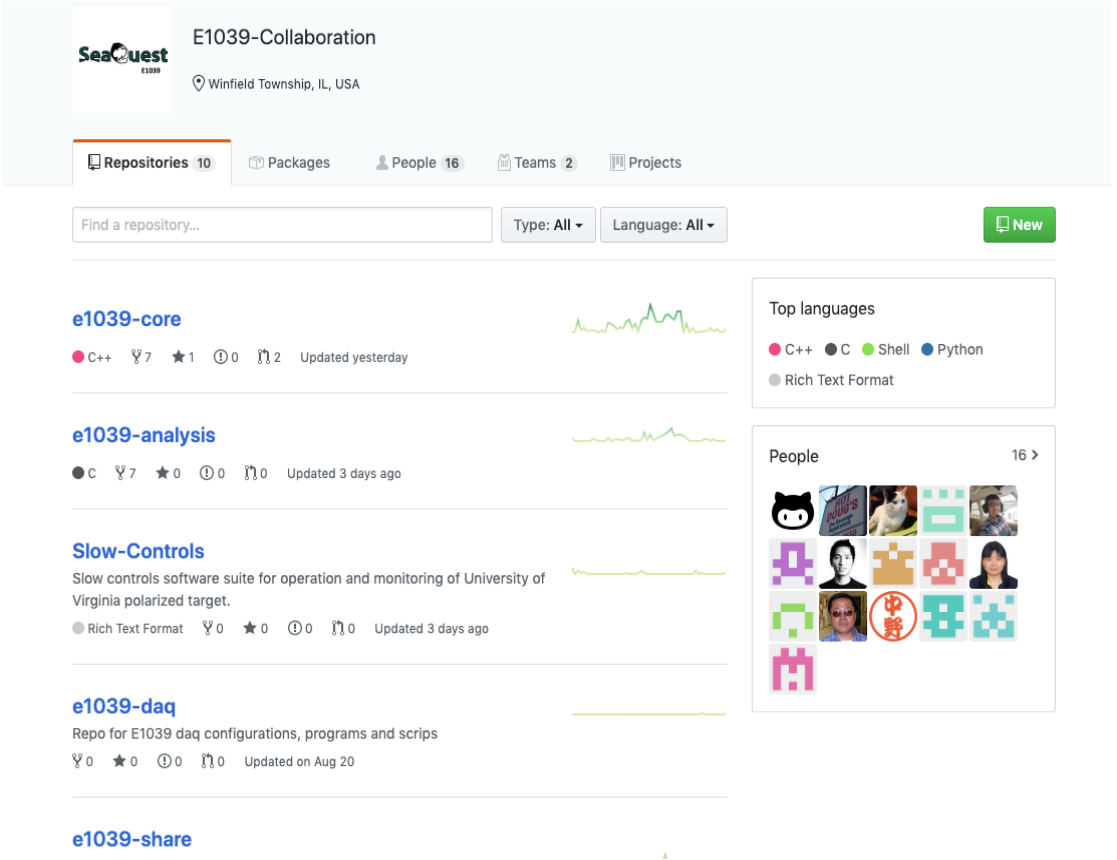
SpinQuest Collaboration Meeting 2019 Fall, Fermilab
(Oct 24-25, 2019)

# Fun4all Software framework

- Developed by ***C. Pinkenburg*** for PHENIX experiment
- Extended for sPHENIX experiment with GEANT4 integration
- Implemented to SpinQuest by ***Haiwang Yu***
- ROOT based I/O
- Modularized for easier collaborative development
- Comes with a GEANT4 based simulation sub-framework
- Details: DocDB **5509** (slides, video of talk by Haiwang)

# E1039 Offline Software Status:

- **Stable state**
- All the codes available via GitHub; can clone them from E1039 GitHub page :https://github.com/E1039-Collaboration
  - git clone https://github.com/E1039-Collaboration/e1039-core.git
- Work on your analysis by creating your own module  and can contribute to main frame-work by giving pull request
- Register a GitHub account send me (abipun@nmsu.edu) your github account



# Resources:

- https://github.com/E1039-Collaboration/e1039-tutorial/tree/master/cm1811 (by Haiwang)
  - How to login and clone the codes from github
  - How to run the simulation
  - How to compile and run your own analysis module

- More Resources:
  - GitHub Tutorial: https://github.com/E1039-Collaboration/e1039-wiki/blob/master/github-tutorial.pdf
  - Software wiki: https://github.com/E1039-Collaboration/e1039-wiki/wiki
  - Doxygen: https://e1039-collaboration.github.io/e1039-doc/index.html

# What changed since last Collaboration Meeting?

- Modification to store unmerged H4 hits (H4Tu, H4Td, etc.) in DST
- Updates for better stability of MainDAQ decoder
- The 3D event display now keeps its view point when moving to next event
- Issues with insensitive volume (F/KMAG, instrumentation, target, shielding, collimator) geometry fixed

# E1039 Offline Software: Plans

- ✓**E1039 Vertex Generator**
- **Import E906 Physics Generator**
- **Insensitive Subsystem**: SpinQuest version
- **Tracking (kTracker)**
  - Short term goal:
    - optimize cuts for the new target position,
    - Flexible conditions for the tracker and analyzer
  - Long term goal: improving the running speed

**Goal: Full reconstruction of a spill in the counting house, between spills**

- **Target Geometry set up**:
- **Digitizer**: efficiencies and resolution
- **Minimum Bias generator**: more faster version with filters (eg. Event filtering)

# Current options in PYTHIA Vertex:

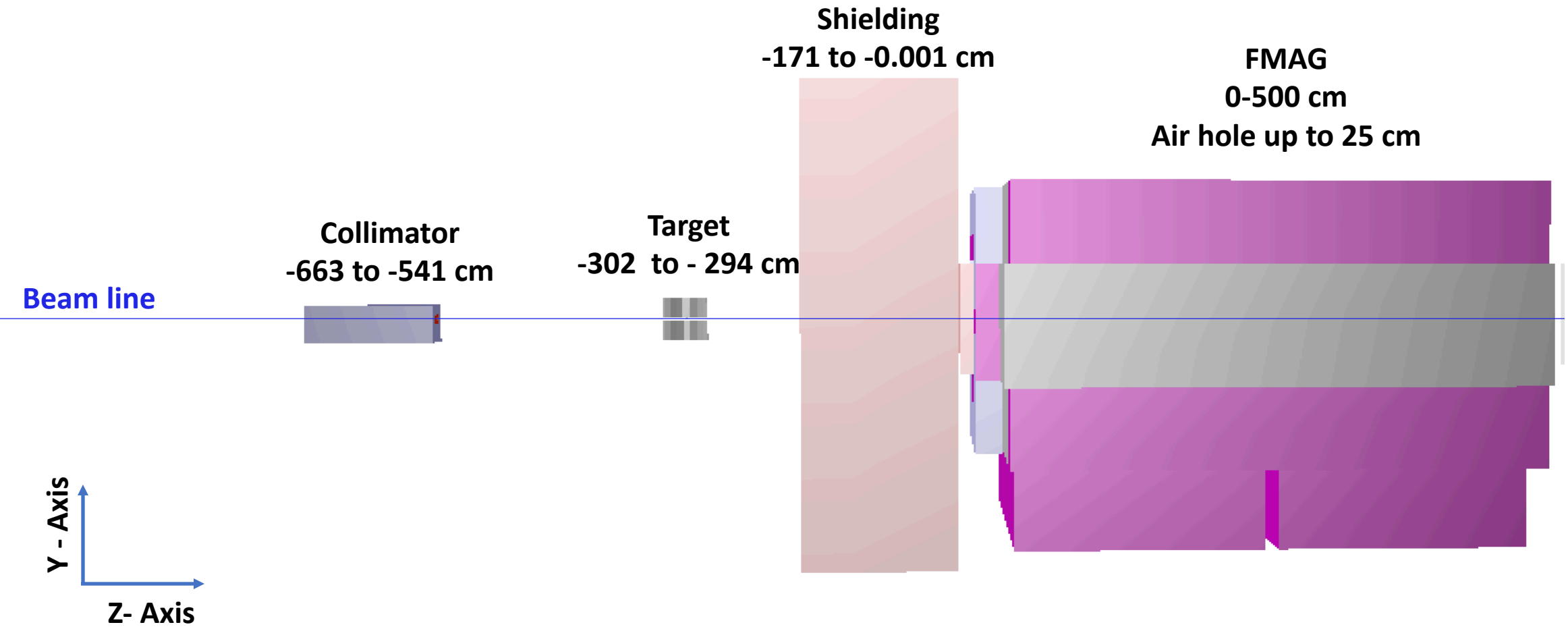
- **set_vertex_distribution_function**(VTXFUNC x, VTXFUNC y, VTXFUNC z, VTXFUNC t)
  - VTXFUNC : enumerator in the PHHepMCGenHelper class and only includes the Gaussian (Gaus) and Uniform distribution
- **set_vertex_distribution_mean**(const double x, const double y, const double z, const double t);
- **set_vertex_distribution_width**(const double x, const double y, const double z, const double t);
- **set_reuse_vertex**(int src_embedding_id)

# E1039 Vertex Generator

- Goal:
  - Generate realistic vertex distribution for E1039 experiment and make it available for the physics generators

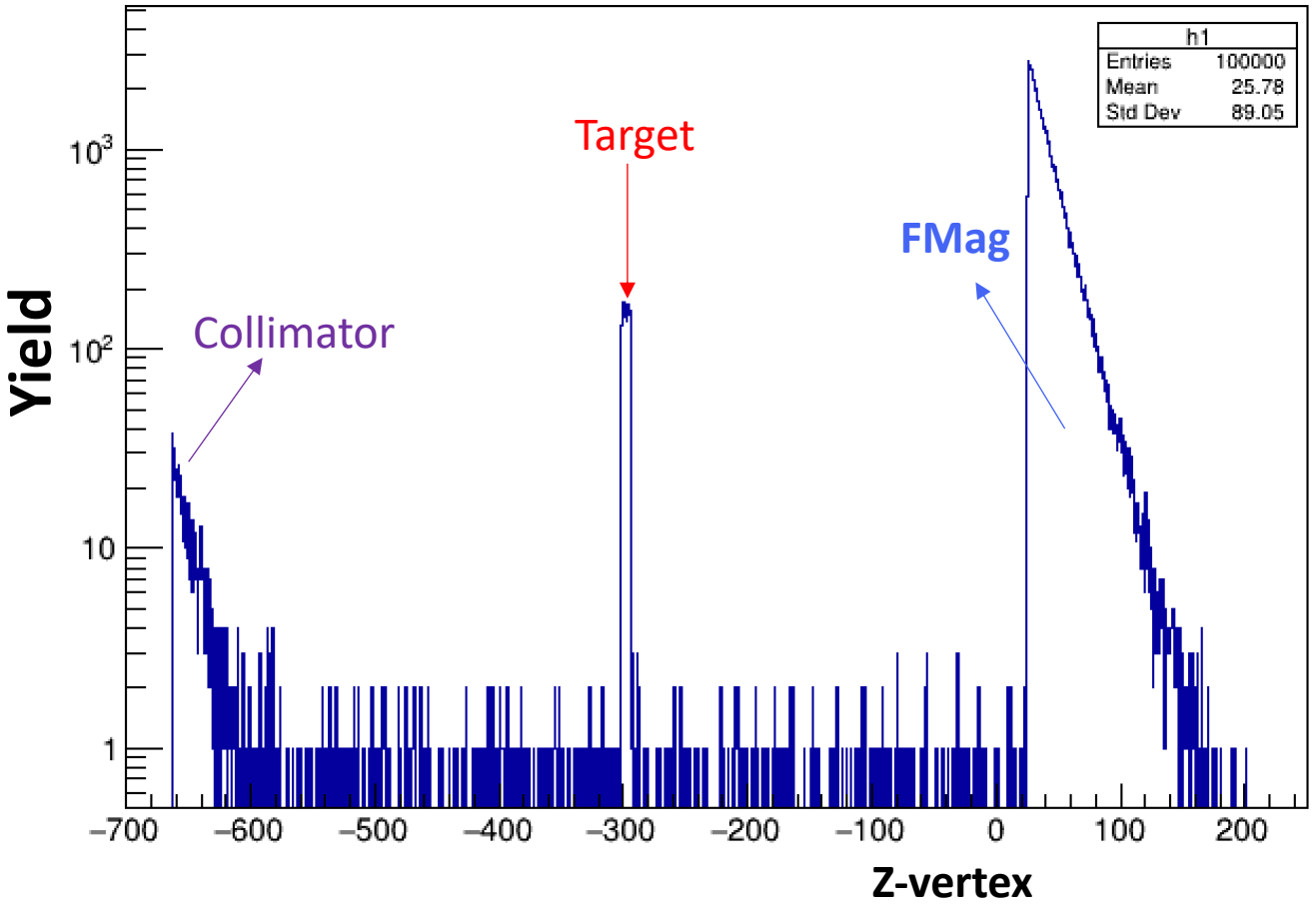
- Method: (based on the previous E906 generator developed by Kun)
  - Collect the volumes in the beamline
  - Fill the space between the volumes with air
  - Get their properties ( size, density,  Nuclear interaction length) and set the attenuation, probabilities
  - Generate vertex (Z) randomly (based on their properties)

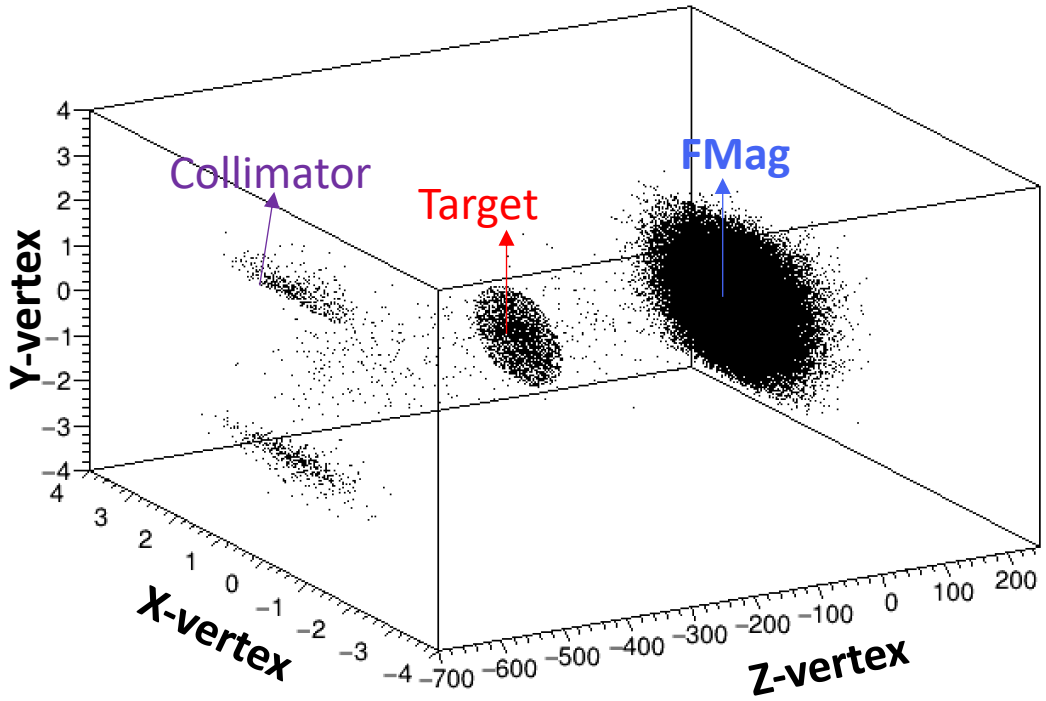
# Beam Volumes: (x <1.0, y < 1.0 and -700 < z < 500 cm)



# Z-vertex Distribution ( Beam with 6.5 mm width (sigma) in both X and Y:

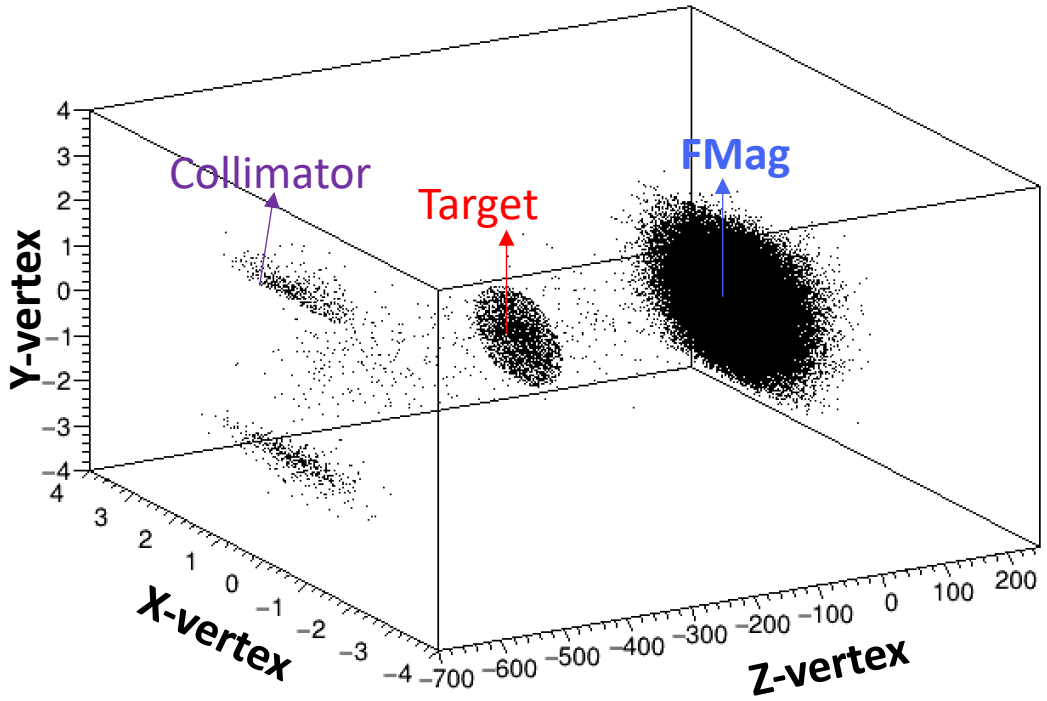
Beam tail (1/r) not included)



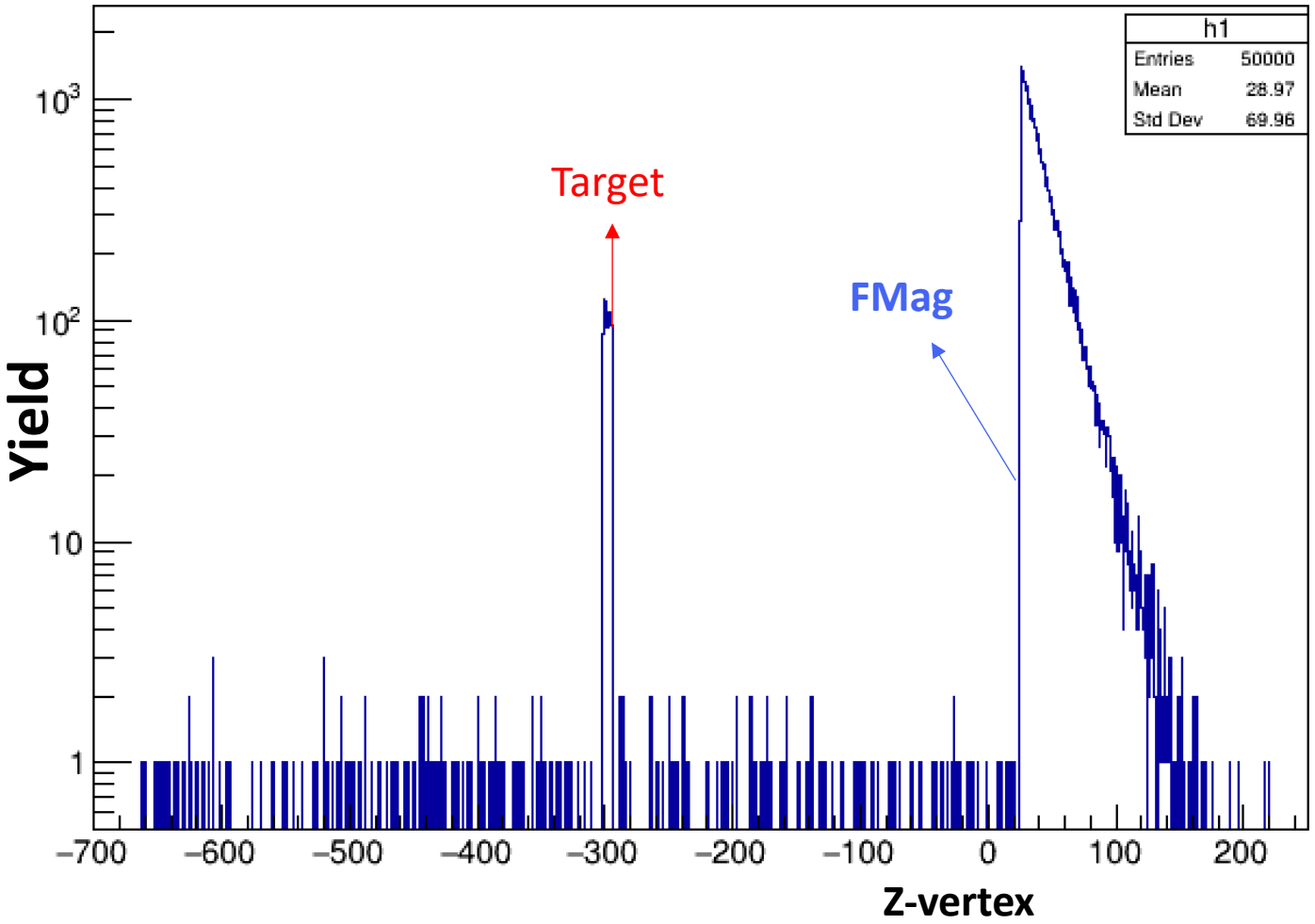
# Z-vertex Distribution (with 6.5 mm beam width (sigma) in both X and Y Beam tail (1/r) not included)

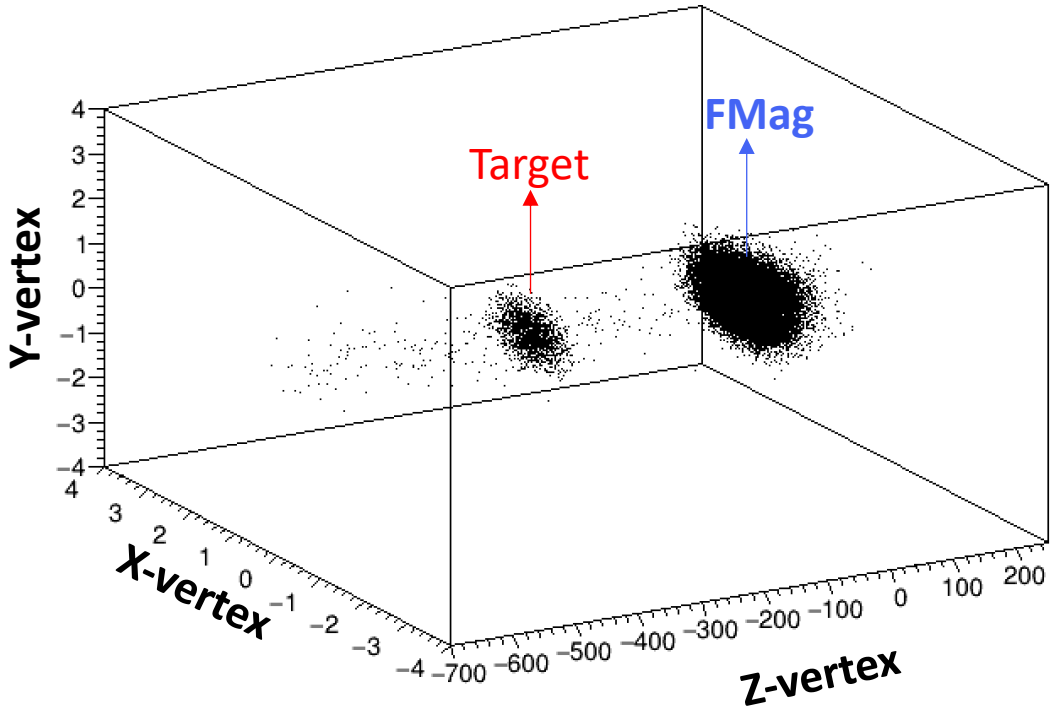
- Collimator: ~ 1%
- Target: ~1.8 %
- Shielding: Negligible
- FMag: ~96%
- Airgaps: Negligible



# Z-vertex Distribution ( Beam with x-width = 4.14 mm and y-width = 3.43 mm:

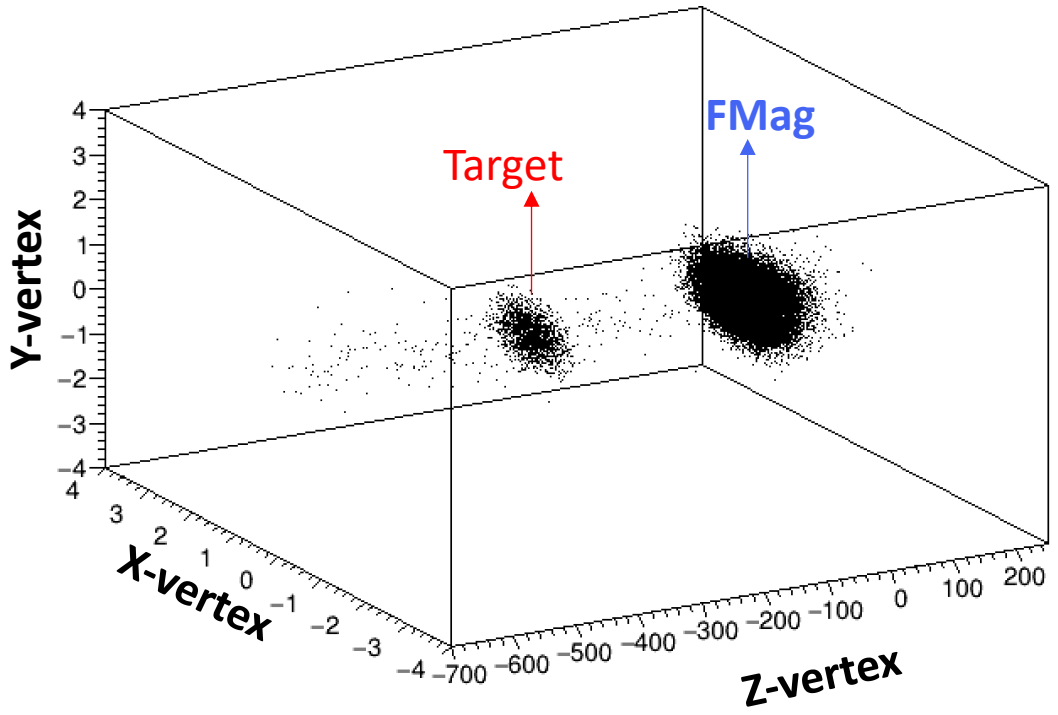
Beam tail (1/r) not included)



# Z-vertex Distribution ( Beam with x-width = 4.14 mm and y-width = 3.43 mm: Beam tail (1/r) not included)

- Collimator: Negligible
- Target: ~2.5 %
- Shielding: Negligible
- FMag: ~96 %
- Airgaps: Negligible



# Summary for Vertex Generator

- More reasonable vertex generator is ready (Many thanks to Kun )
- FMag has majority of contribution for the primary vertex
- Collimator contribution depends upon the beam profile
- Shielding has negligible contribution because of big hole in its center
- Code will be available soon in GitHub and can be used with it for particle gun and simple particle generator
- Working on Physics generator

# PHYSICS Generator:

- Current available Option: PYTHIA (PHPhythia)
  - Can configure it while running simulation
  - Fun4Sim currently configure Drell-Yan (phpythia8_DY.cfg)

- Goal for E1039 PHYSICS Generator:
  - More efficient with multiple options, e.g.;
    - Drell-Yan
    - J-Psi
    - Pythia Dimuon
    - Custom Dimuon
    - Pythia Single

# Event Display:

- Developed by **Haiwang** by using ROOT TEve and currently being maintained by **Kenichi**
- Geometry, Magnetic field: from Fun4All node tree
- Fired wire and Track: with TEve functions
- For more details: DocDB 5887, 5795 (presentations from Haiwang)

**Plan:**

- Change to automatic mode from interactive mode

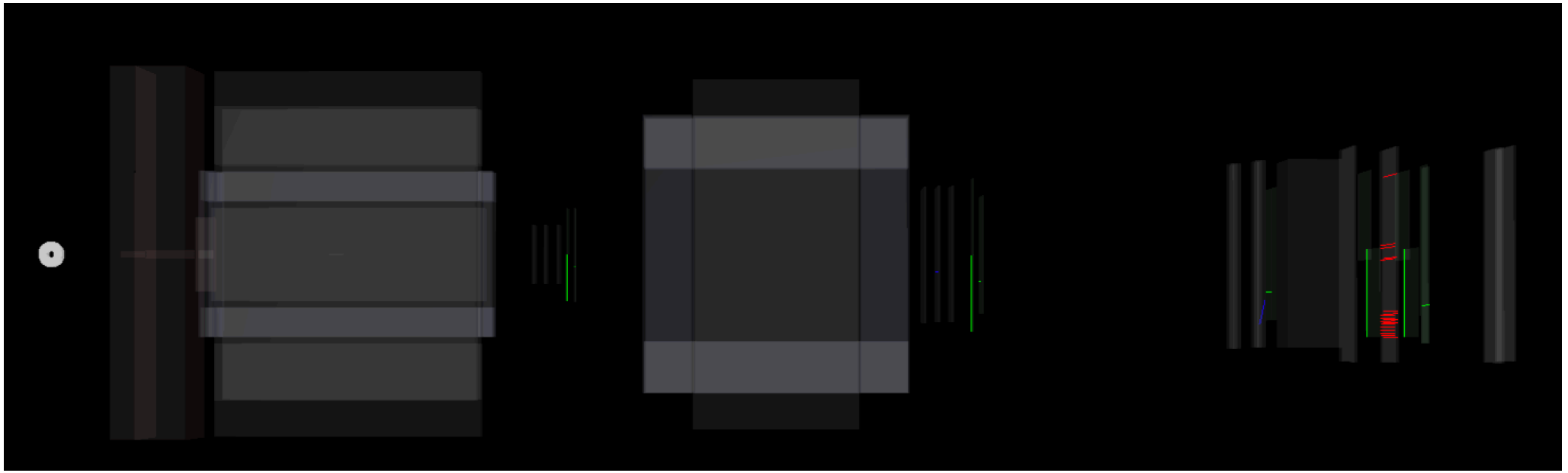
Trigger:
NIM {1,1,0,1,0}
MATRIX {1,1,1,1,1}

Hodoscope Hits

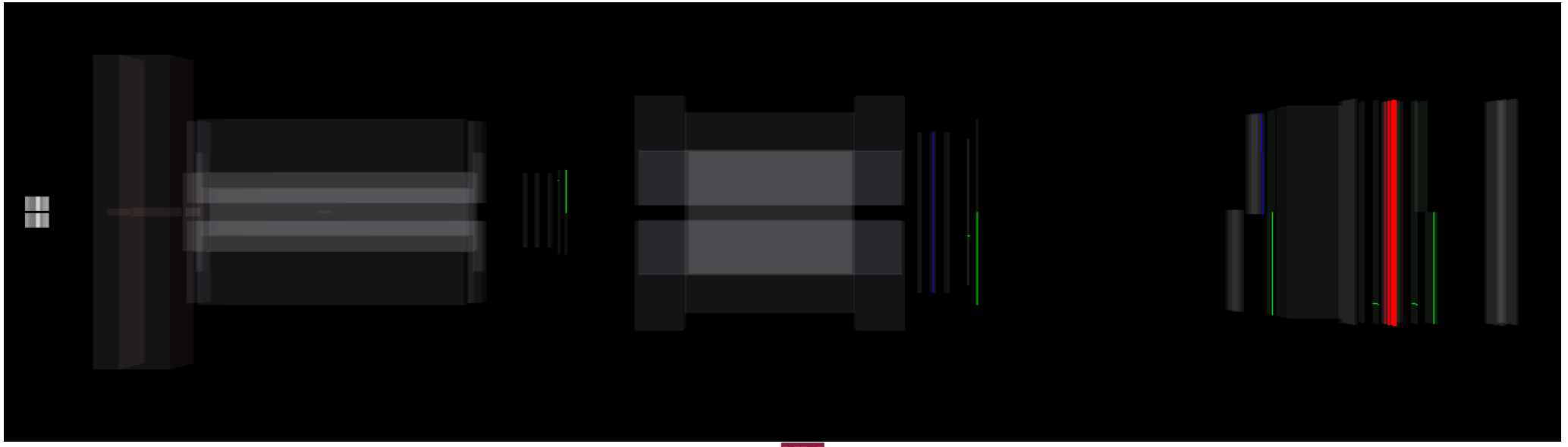
Wire Chamber Hits

Proportional Tube Hits

## Top View



## Side View



# Thank You

# Back Ups

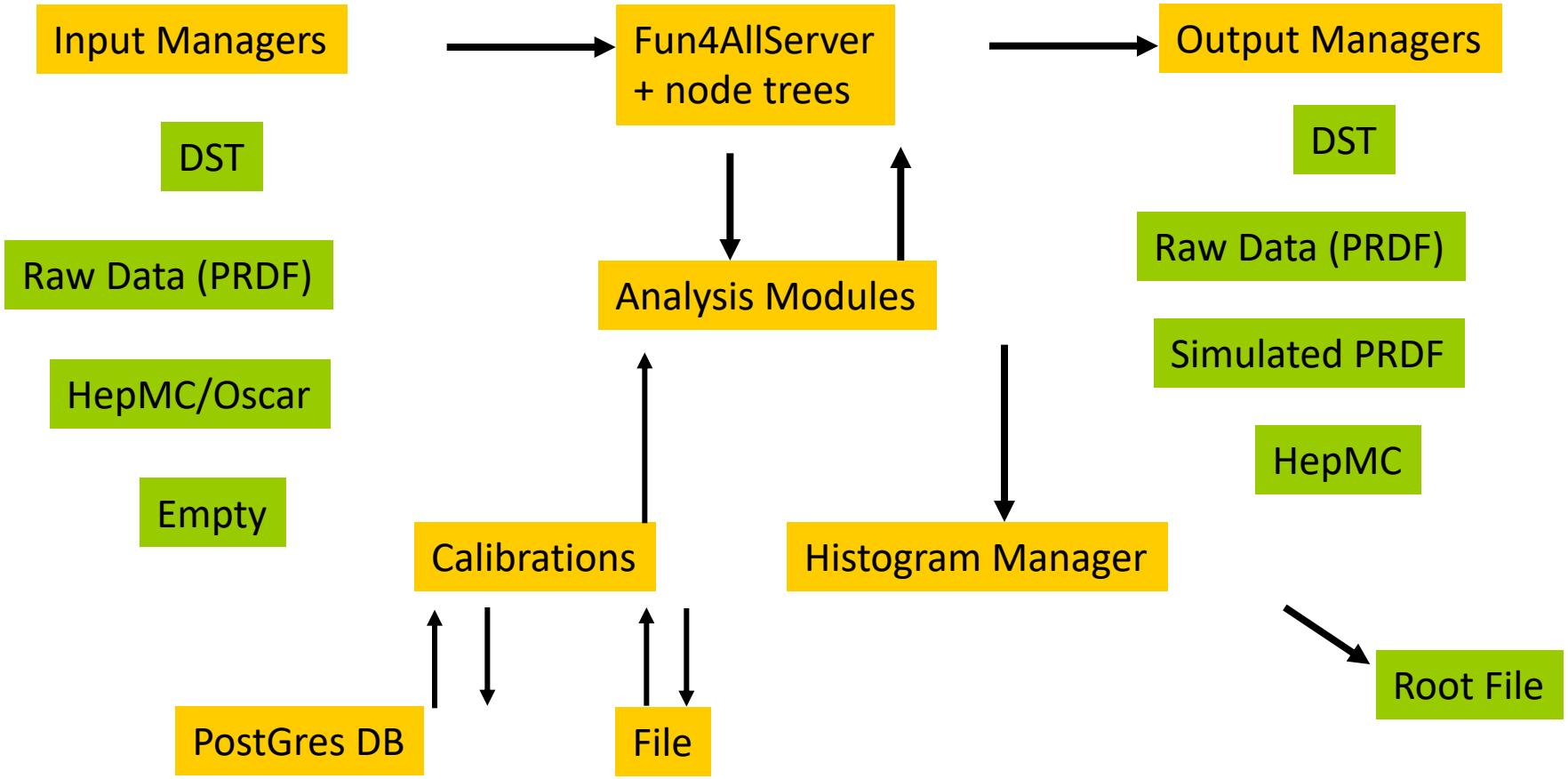
# Beamline Volumes Information

- Collimator: (G4_Cu, 12.7 cm x 9.67 cm)
  - Rectangular hole **( 7.8 cm x  3.5 cm** ) : G4_Galactic
- Target: (He, H, Nitrogen) 20 mm in diameter, 79 mm length
- Shielding: (Concrete)
  - Holes: Two circular (10.16 cm, 15.24 cm), Square hole (15.24 x 15.24)
  - 10 cm hole is implemented for all shieldings as conservative estimate
- Inner FMag: Fe
  - Hole up to 25 cm

```
0 Beamline object name AirGap_0 at -541.400 <-- -602.410 --> -663.420
   Z = 7.179, A = 14.364, N = 7.185
   Nuclear inc. len. = 65932.038, density = 0.001
   -0.185% interaction length,  upstream attenuation = 0.000
   Attenuation by itself = -0.002,  real attenuation = -0.002
   Collision prob = -0.122, accumulated prob = 0.000
1 Beamline object name InnerEnv_outer at -663.320 <-- -602.360 --> -541.400
   Z = 29.000, A = 63.546, N = 34.546
   Nuclear inc. len. = 15.514, density = 8.960
   785.864% interaction length,  upstream attenuation = -0.002
   Attenuation by itself = 1.000,  real attenuation = 1.001
   Collision prob = 139.210, accumulated prob = -0.122
2 Beamline object name InnerEnv_inner at -663.420 <-- -602.360 --> -541.300
   Z = 1.000, A = 1.008, N = 0.008
   Nuclear inc. len. = 352778443350252836609851392.000, density = 0.000
   0.000% interaction length,  upstream attenuation = -nan
   Attenuation by itself = 0.000,  real attenuation = 0.000
   Collision prob = 0.000, accumulated prob = 139.088
3 Beamline object name AirGap_1 at -541.300 <-- -421.625 --> -301.950
   Z = 7.179, A = 14.364, N = 7.185
   Nuclear inc. len. = 65932.038, density = 0.001
   0.363% interaction length,  upstream attenuation = 1.000
   Attenuation by itself = 0.004,  real attenuation = 0.000
   Collision prob = 0.000, accumulated prob = 139.088
4 Beamline object name Target_0 at -301.950 <-- -298.000 --> -294.050
   Z = 5.539, A = 10.925, N = 5.386
   Nuclear inc. len. = 114.542, density = 0.578
   6.897% interaction length,  upstream attenuation = 1.000
   Attenuation by itself = 0.067,  real attenuation = 0.000
   Collision prob = 0.002, accumulated prob = 139.088
5 Beamline object name AirGap_2 at -294.050 <-- -232.787 --> -171.525
   Z = 7.179, A = 14.364, N = 7.185
   Nuclear inc. len. = 65932.038, density = 0.001
   0.186% interaction length,  upstream attenuation = 1.000
   Attenuation by itself = 0.002,  real attenuation = 0.000
   Collision prob = 0.000, accumulated prob = 139.090
```

```
6 Beamline object name Shielding1_0_outer at -171.525 <-- -148.666 --> -125.807
   Z = 11.098, A = 22.337, N = 11.238
   Nuclear inc. len. = 41.247, density = 2.300
   110.839% interaction length,  upstream attenuation = 1.000
   Attenuation by itself = 0.670,  real attenuation = 0.000
   Collision prob = 0.023, accumulated prob = 139.090
7 Beamline object name Shielding2_0_outer at -125.806 <-- -80.086 --> -34.366
   Z = 11.098, A = 22.337, N = 11.238
   Nuclear inc. len. = 41.247, density = 2.300
   221.691% interaction length,  upstream attenuation = 1.000
   Attenuation by itself = 0.891,  real attenuation = 0.000
   Collision prob = 0.010, accumulated prob = 139.113
8 Beamline object name AirGap_3 at -34.366 <-- -31.635 --> -28.904
   Z = 7.179, A = 14.364, N = 7.185
   Nuclear inc. len. = 65932.038, density = 0.001
   0.008% interaction length,  upstream attenuation = 1.000
   Attenuation by itself = 0.000,  real attenuation = 0.000
   Collision prob = 0.000, accumulated prob = 139.123
9 Beamline object name Shielding3_0_outer at -28.904 <-- -14.453 --> -0.001
   Z = 11.098, A = 22.337, N = 11.238
   Nuclear inc. len. = 41.247, density = 2.300
   70.073% interaction length,  upstream attenuation = 1.000
   Attenuation by itself = 0.504,  real attenuation = 0.000
   Collision prob = 0.001, accumulated prob = 139.123
10 Beamline object name AirGap_4 at -0.001 <-- 12.699 --> 25.400
   Z = 7.179, A = 14.364, N = 7.185
   Nuclear inc. len. = 65932.038, density = 0.001
   0.039% interaction length,  upstream attenuation = 1.000
   Attenuation by itself = 0.000,  real attenuation = 0.000
   Collision prob = 0.000, accumulated prob = 139.124
11 Beamline object name fmag_bodyinner_vol_I at 25.400 <-- 251.460 --> 502.920
   Z = 26.000, A = 55.845, N = 29.845
   Nuclear inc. len. = 16.770, density = 7.870
   2847.466% interaction length,  upstream attenuation = 1.000
   Attenuation by itself = 1.000,  real attenuation = 0.000
   Collision prob = 0.001, accumulated prob = 139.124
```

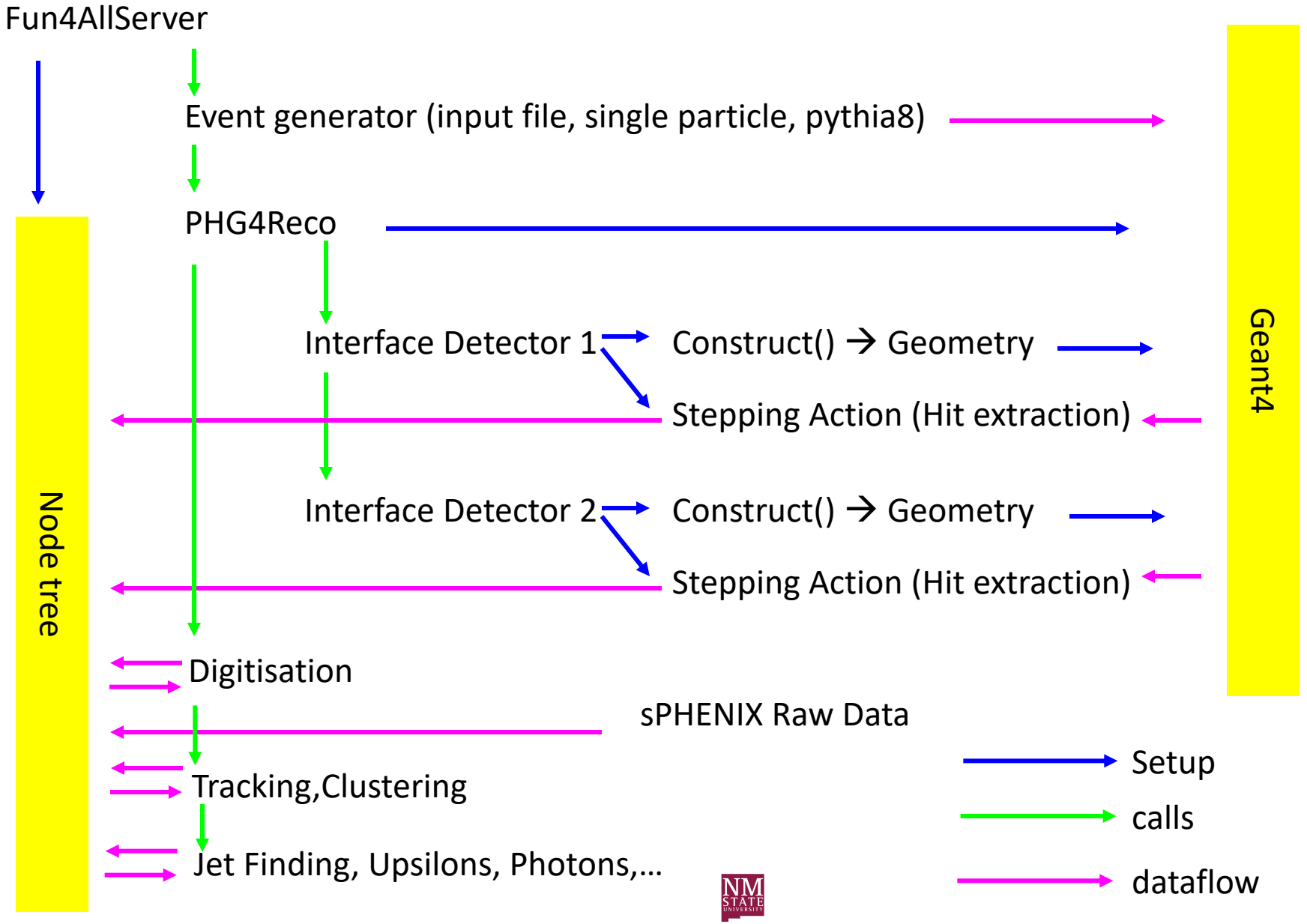
# Structure of Fun4All




That's all there is to it (8000 lines of code)

C. Pinkenburg's Talk https://www.jlab.org/indico/event/187/contribution/4/material/slides/0.ppt

# G4 program flow with Fun4All




C. Pinkenburg's Talk https://www.jlab.org/indico/event/187/contribution/4/material/slides/0.ppt

# SubsystemReco: common base modules

Need to inherit from the SubsysReco Baseclass which gives the methods which are called by Fun4All.

- **Init(PHCompositeNode *topNode):** called once when you register the module with the Fun4AllServer
- **InitRun(PHCompositeNode *topNode):** called whenever data from a new run is encountered
- **ResetEvent(PHCompositeNode *topNode)**: called after each event is processed so you can clean up leftovers of this event in your code
- **EndRun(const int runnumber):** called before the InitRun is called (caveat the Node tree already contains the data from the first event of the new run)
- **EndRun(const int runnumber):** called before the InitRun is called (caveat the Node tree already contains the data from the first event of the new run)

# PHG4Reco

- Fun4All Interface to GEANT4 (is itself a Subsys Reco module)
- Sets features of the world (size, shape, material, magnetic field, physics list)
- Provides interface to GEANT command line (especially useful for event display)
- Manages our detectors
- totally configurable on macro level

# Example with the simulation chain

wiki page location:
https://github.com/E1039-Collaboration/e1039-wiki/wiki/E1039-simulation-tutorial---Apr.-19