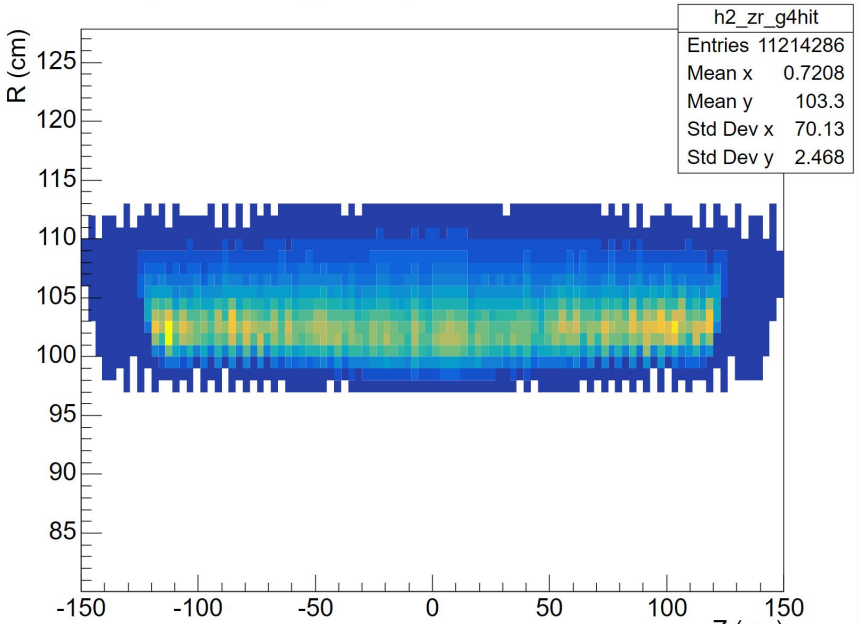
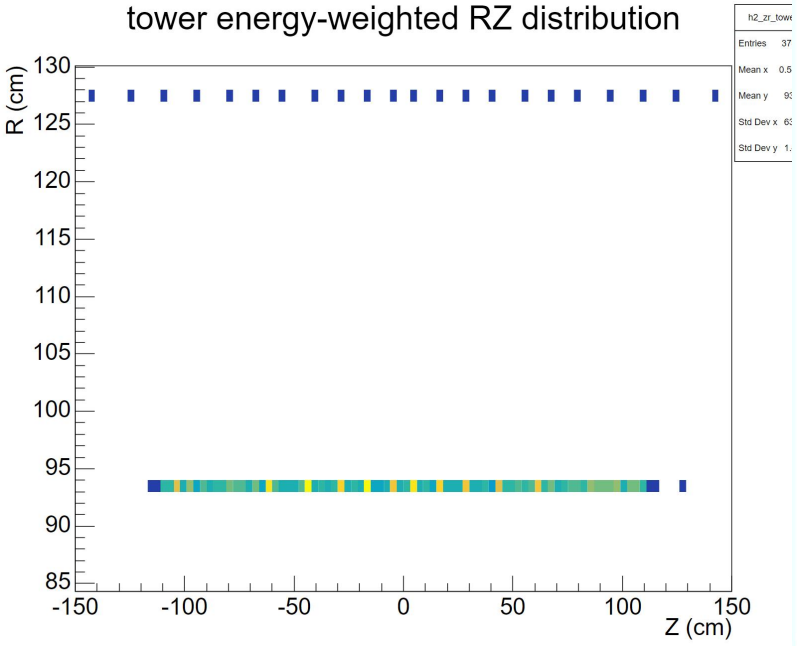
EMC position modify

Jingyu

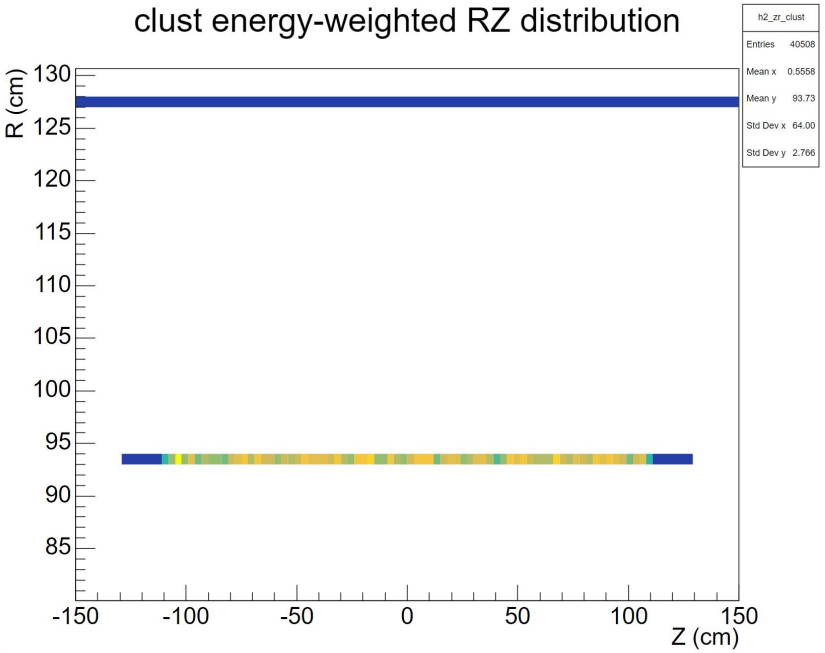
g4hit energy-weighted RZ distribution

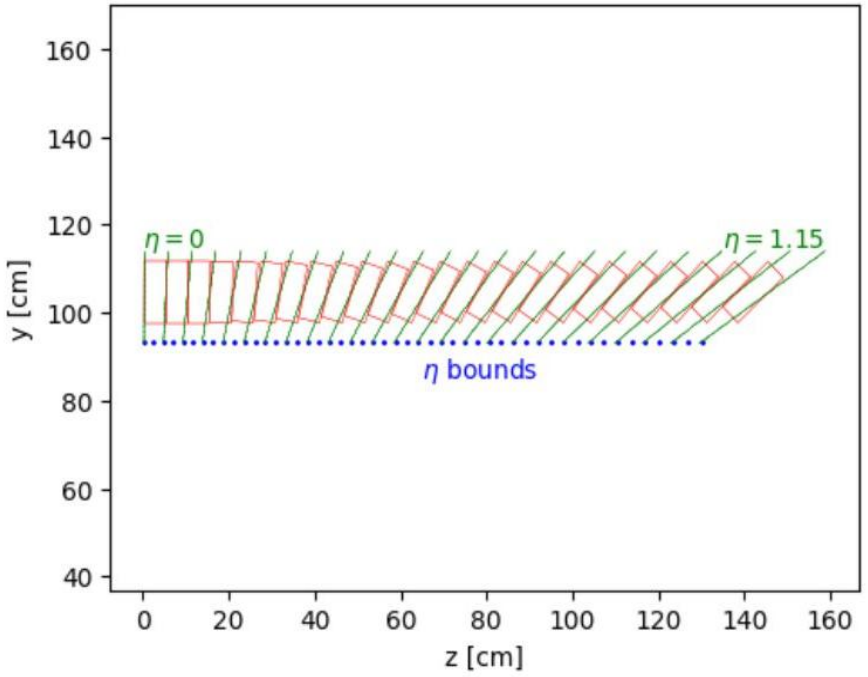


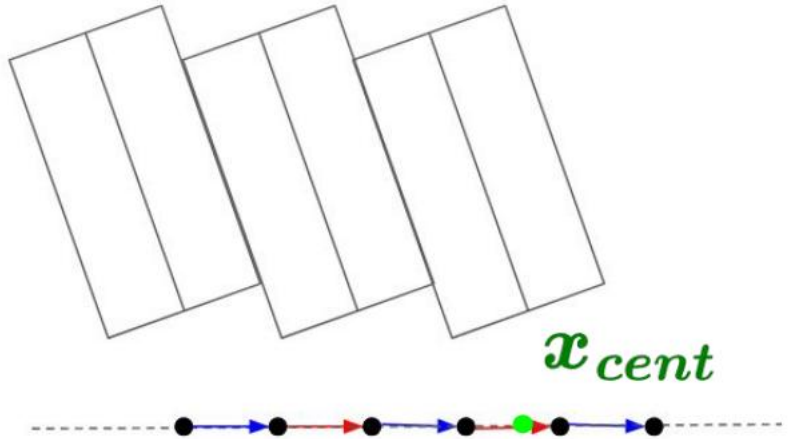
tower energy-weighted RZ distribution



clust energy-weighted RZ distribution



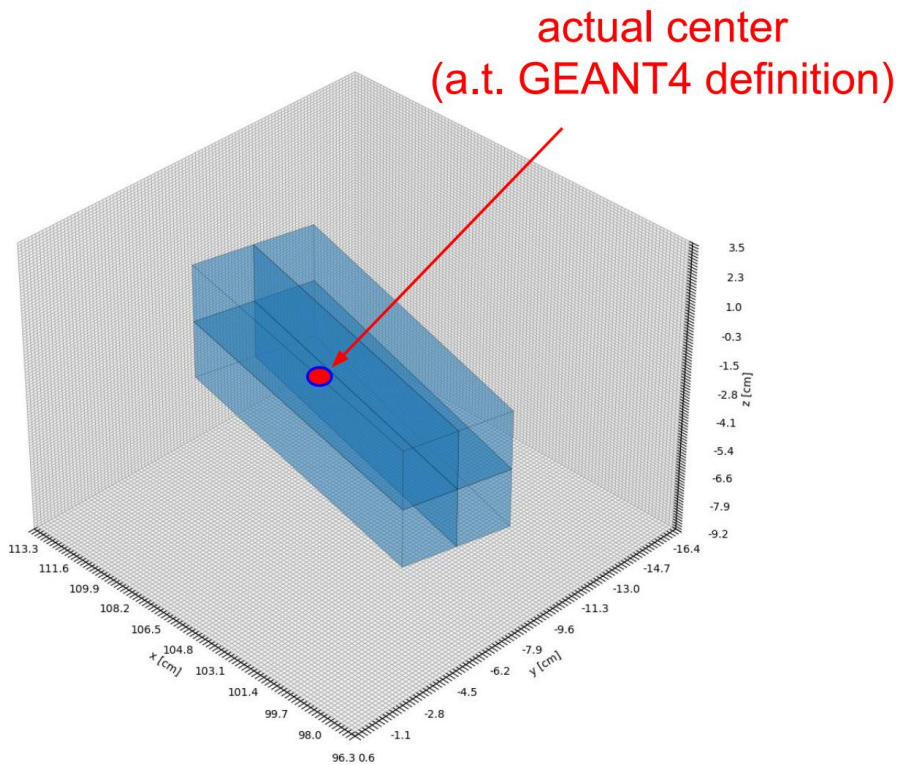


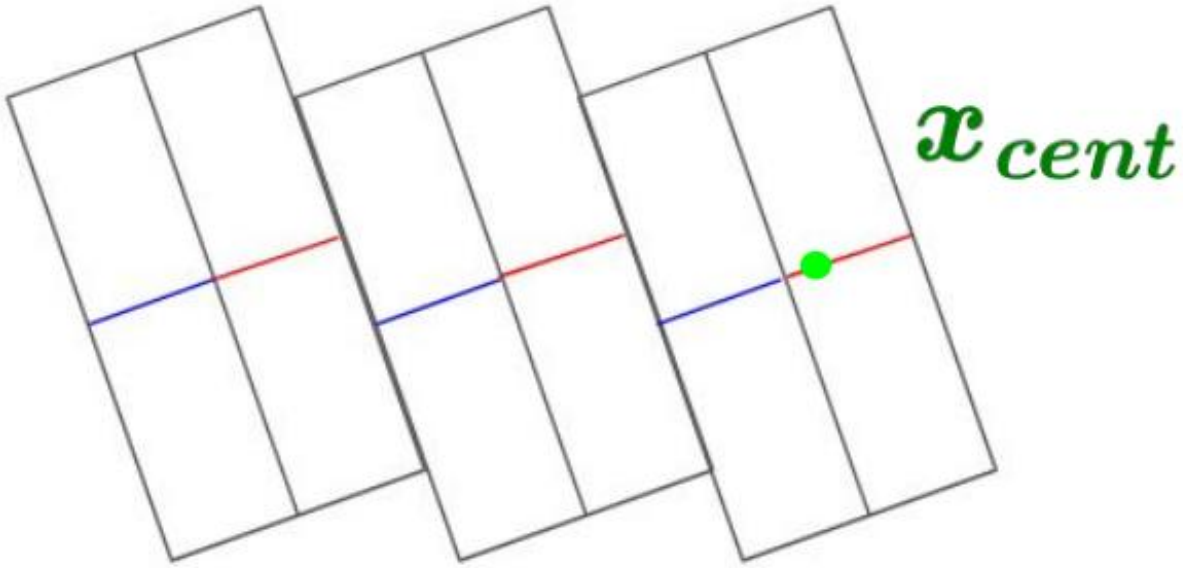


Modify geo from Virgile

Refined geometry -> read tower center directly from GEANT4 objects

Former geometry: Approximate center: projection at R = 93.5 cm
New geometry: actual tower center and individual rotation





CaloGeomMappingv2: create RawTowerGeomv5

```
void RawTowerGeomv5::set_vertices(const std::vector<double>& vertices)
{
  /*       y
           |                    7_____6
           |                   /|    /|
           |_____ z          8/_|___/5|
          /                   | |   | |
         /                    |3|___|_|2
        /                     | /   | /
     -x                      4|/____|/1
  */

  if ((int) vertices.size() != _nVtx * 3)
  {
    std::cerr
       << "RawTowerGeomv5::set_vertices - input " << vertices.size() << " vertices given. Expected 8 x 3." << std::endl;
    exit(1);
  }

  const bool face_outside[_nVtx] = {false, false, false, false, true, true, true, true};
  const bool face_inside[_nVtx] = {true, true, true, true, false, false, false, false};
  const bool face_low_eta[_nVtx] = {false, false, true, true, false, false, true, true};
  const bool face_high_eta[_nVtx] = {true, true, false, false, true, true, false, false};
  const bool face_low_phi[_nVtx] = {false, true, true, false, false, true, true, false};
  const bool face_high_phi[_nVtx] = {true, false, false, true, true, false, false, true};
```

```
std::cout << "Geometry tower (" << ix << ", " << iy << "):\n";
std::cout << "center of tower: " << "("
          << towerg->get_center_x() << ","
          << towerg->get_center_y() << ","
          << towerg->get_center_z() << ")\n";
std::cout << "center of tower inner face: " << "("
          << towerg->get_center_int_x() << ","
          << towerg->get_center_int_y() << ","
          << towerg->get_center_int_z() << ")\n";
std::cout << "center of tower outer face: " << "("
          << towerg->get_center_ext_x() << ","
          << towerg->get_center_ext_y() << ","
          << towerg->get_center_ext_z() << ")\n";
std::cout << "center of tower lateral face (low phi): " << "("
          << towerg->get_center_low_phi_x() << ","
          << towerg->get_center_low_phi_y() << ","
          << towerg->get_center_low_phi_z() << ")\n";
std::cout << "center of tower lateral face (high phi): " << "("
          << towerg->get_center_high_phi_x() << ","
          << towerg->get_center_high_phi_y() << ","
          << towerg->get_center_high_phi_z() << ")\n";
std::cout << "center of tower lateral face (low eta): " << "("
          << towerg->get_center_low_eta_x() << ","
          << towerg->get_center_low_eta_y() << ","
          << towerg->get_center_low_eta_z() << ")\n";
std::cout << "center of tower lateral face (high eta): " << "("
          << towerg->get_center_high_eta_x() << ","
          << towerg->get_center_high_eta_y() << ","
          << towerg->get_center_high_eta_z() << ")\n";
```

code and compile

- /sphenix/user/jzhang1/Virgikguide/CaloBase/RawTowerGeomv5.h
- /sphenix/user/jzhang1/Virgikguide/CaloBase/RawTowerGeomv5.cc

- /sphenix/user/jzhang1/Virgikguide/CaloReco/CaloGeomMappingv2.h
- /sphenix/user/jzhang1/Virgikguide/CaloReco/CaloGeomMappingv2.cc
- /sphenix/user/jzhang1/Virgikguide/calo_geom_mapping_exact.root

- /sphenix/user/jzhang1/Virgikguide/CaloReco/RawClusterBuilderTemplate.cc

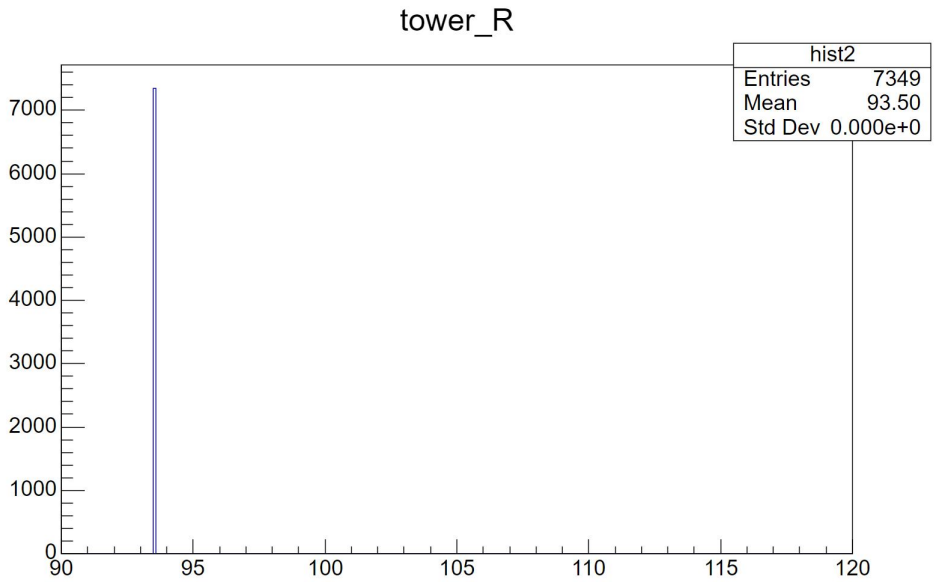
Compilation order:
CaloBase -> CaloReco -> Your analysis module (eg. physiTuto/tutorial)

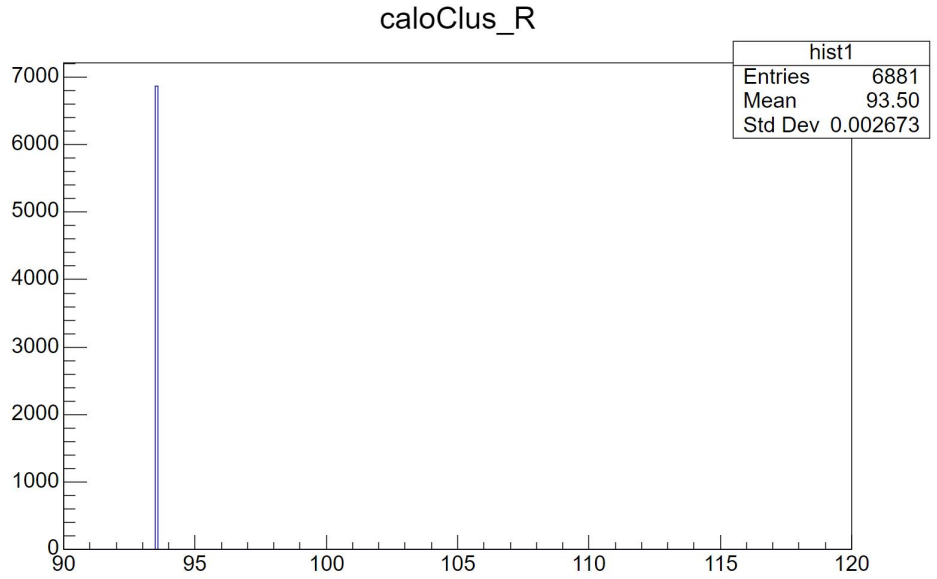
How to use the modify geo

- Fun4All_physiTuto.C :
- // Load the modified geometry
- CaloGeomMappingv2 *cgm = new CaloGeomMappingv2();
- cgm->set_detector_name("CEMC");
- cgm->setTowerGeomNodeName("TOWERGEOM_CEMCv3");
- se->registerSubsystem(cgm);

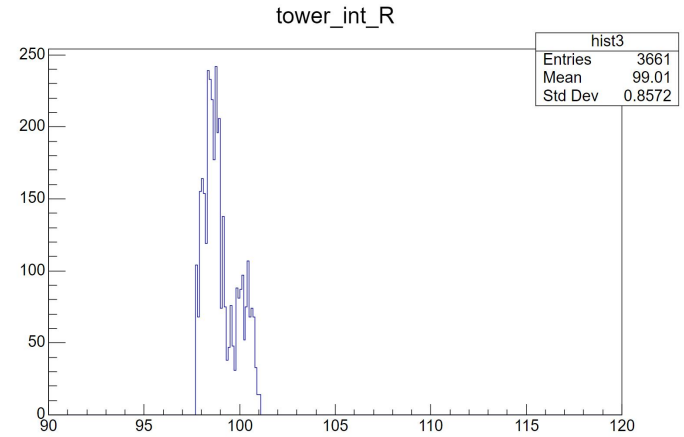
- tutorial:
- geomEM = findNode::getClass <RawTowerGeomContainer> (topNode, "TOWERGEOM_CEMCv3");

before modify:

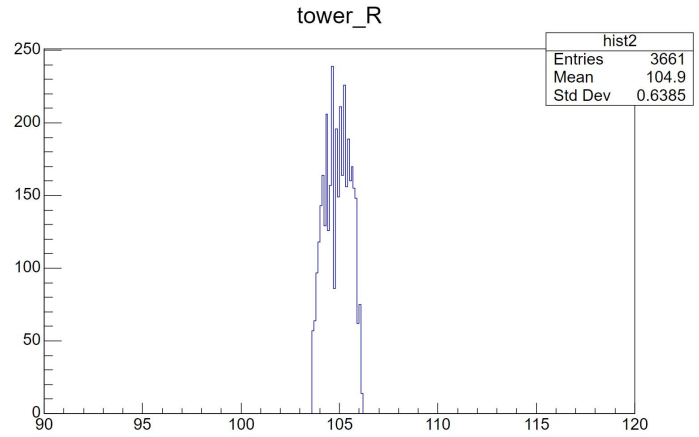




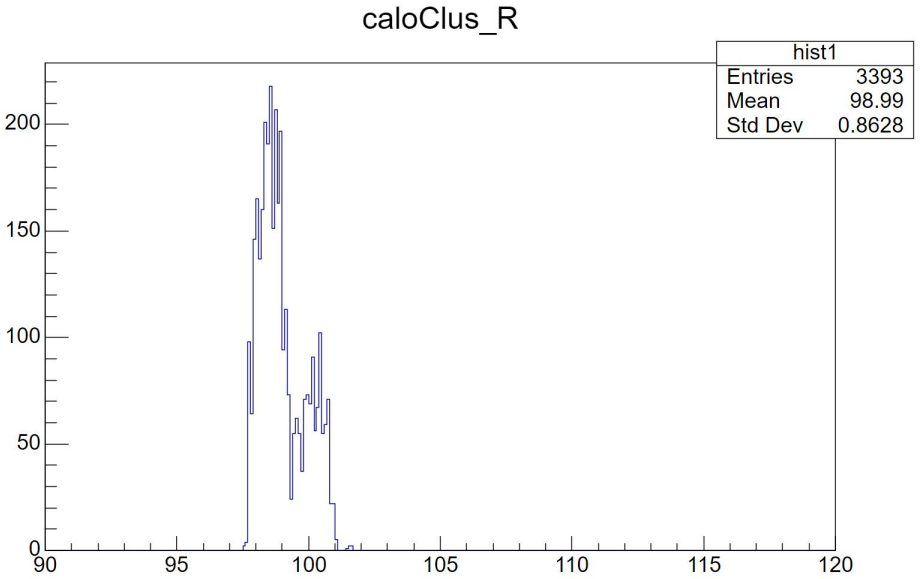
after modify:



inner face



center

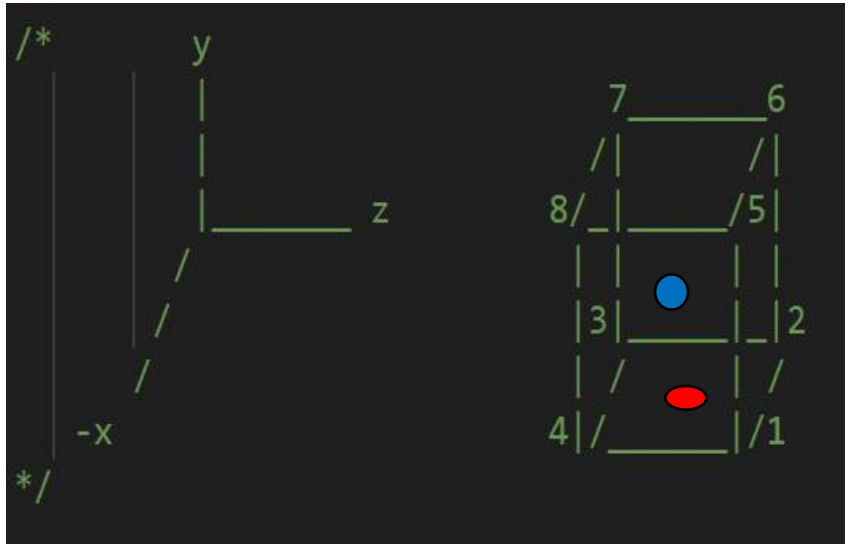


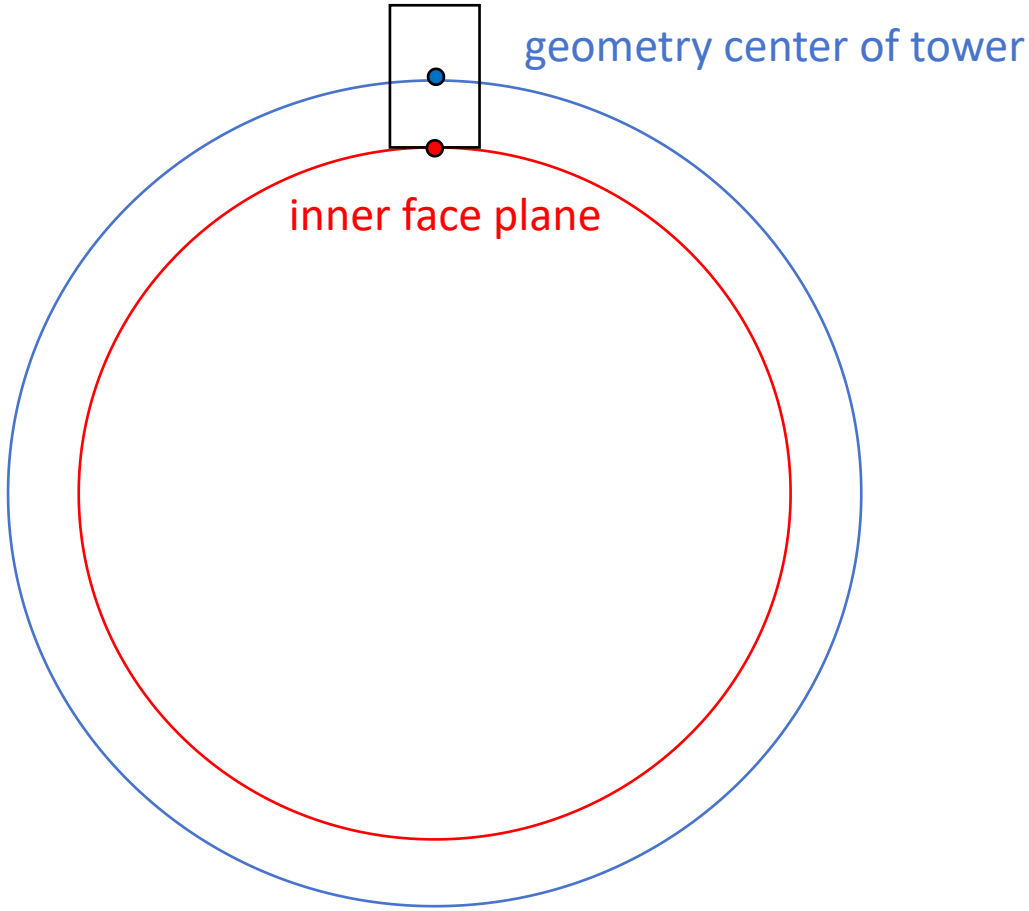
EMC pos reco 0226

Jingyu

Tower geom

Reference code: RawTowerGeomv5 , CaloGeomMappingv2





New geom:
8 vertex to describe tower geometry
we get innerface center （center of 1234） &
geomery center (center of 12345678)

EMC cluster geom

Reference code: RawClusterBuilderTemplate , G4_CEmc_Spacal

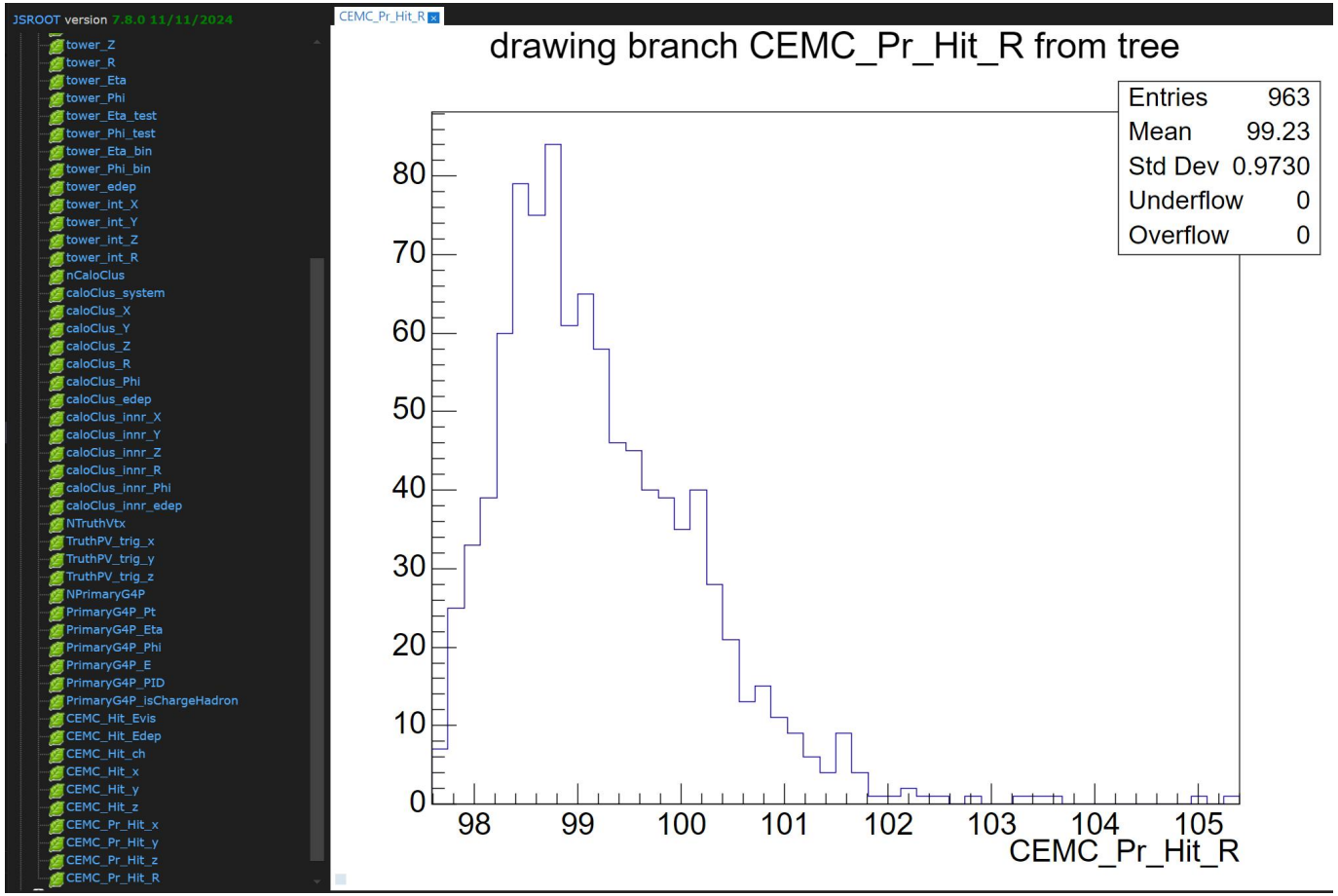
```
void setUseRawTowerGeomv5( bool flag = true) { m_use_RawTowerGeomv5 = flag; }
void setProjectToInnerSurface( bool flag = true ) { m_project_tower_innersurface = flag; }
```

I modified the tower geometry used in cluster reconstruction, and you can set the cluster geometry through these two interfaces.

```
363  // JingyuM
364  void CEMC_Clusters()
365  {
366    int verbosity = std::max(Enable::VERBOSITY, Enable::CEMC_VERBOSITY);
367
368    Fun4AllServer *se = Fun4AllServer::instance();
369
370    if (G4CEMC::Cemc_clusterizer == G4CEMC::kCemcTemplateClusterizer)
371    {
372      RawClusterBuilderTemplate *ClusterBuilder1 = new RawClusterBuilderTemplate("EmcRawClusterBuilderTemplate1");
373      ClusterBuilder1->Detector("CEMC");
374      ClusterBuilder1->setUseRawTowerGeomv5(true);
375      ClusterBuilder1->setProjectToInnerSurface(false);
376      ClusterBuilder1->Verbosity(verbosity);
377      ClusterBuilder1->set_threshold_energy(0.030);  // This threshold should be the same as in CEMCprof_Thresh**.root file below
378      std::string emc_prof = getenv("CALIBRATIONROOT");
379      emc_prof += "/EmcProfile/CEMCprof_Thresh30MeV.root";
380      ClusterBuilder1->LoadProfile(emc_prof);
381      if (!Enable::CEMC_G4Hit) ClusterBuilder1->set_UseTowerInfo(1);  // just use towerinfo
382      //    ClusterBuilder1->set_UseTowerInfo(1); // to use towerinfo objects rather than old RawTower
383      se->registerSubsystem(ClusterBuilder1);
384
385      RawClusterBuilderTemplate *ClusterBuilder2 = new RawClusterBuilderTemplate("EmcRawClusterBuilderTemplate2");
386      ClusterBuilder2->Detector("CEMC");
387      ClusterBuilder2->setUseRawTowerGeomv5(true);
388      ClusterBuilder2->setProjectToInnerSurface(true);
389      ClusterBuilder2->Verbosity(verbosity);
390      ClusterBuilder2->set_threshold_energy(0.030);  // This threshold should be the same as in CEMCprof_Thresh**.root file below
391      // std::string emc_prof2 = getenv("CALIBRATIONROOT");
392      // emc_prof2 += "/EmcProfile/CEMCprof_Thresh30MeV.root";
393      ClusterBuilder2->LoadProfile(emc_prof);
394      if (!Enable::CEMC_G4Hit) ClusterBuilder2->set_UseTowerInfo(1);  // just use towerinfo
395      //    ClusterBuilder2->set_UseTowerInfo(1); // to use towerinfo objects rather than old RawTower
396      se->registerSubsystem(ClusterBuilder2);
397    }
398    else if (G4CEMC::Cemc_clusterizer == G4CEMC::kCemcGraphClusterizer)
399    {
400      RawClusterBuilderGraph *ClusterBuilder = new RawClusterBuilderGraph("EmcRawClusterBuilderGraph");
401      ClusterBuilder->Detector("CEMC");
402      ClusterBuilder->Verbosity(verbosity);
403      se->registerSubsystem(ClusterBuilder);
404    }
```

Modify the CEMC_Clusters() function defined in G4_CEmc_Spacal.C;
currently, both the geometry center and the innerface center are being obtained.

position information



what we can get position information are
Truth level:
Primary electron hit on CEMC innerface
Shower g4hit on CEMC

Reco level:
Tower(be hitted) innerface center
Tower(be hitted) geometry center

EMC cluster reco by tower innerface center with energy weight
EMC cluster reco by tower geometry center with energy weight

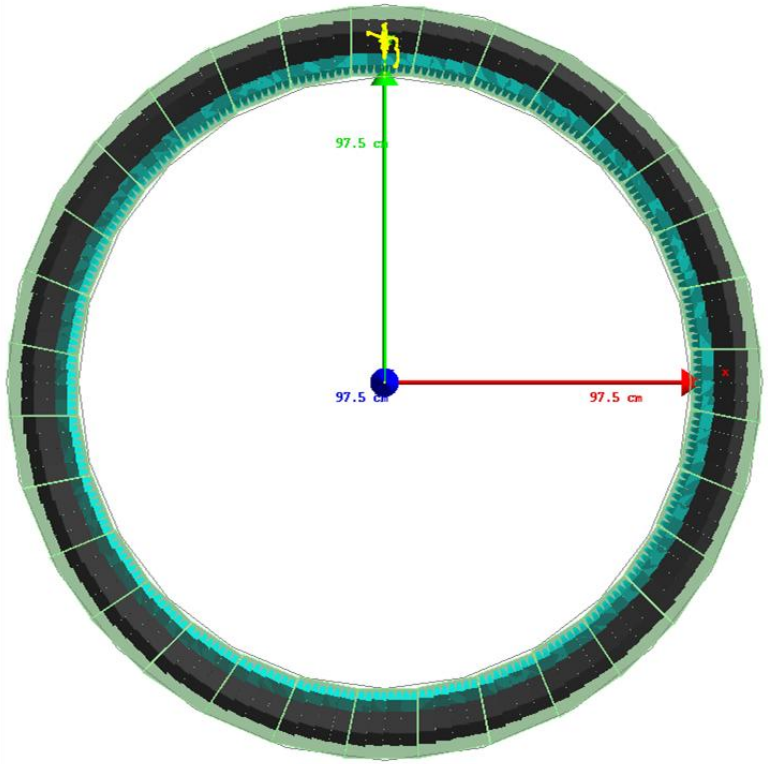
Plan

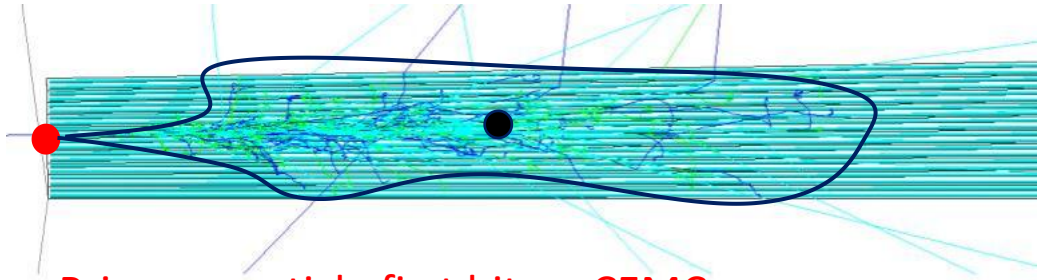
- Compare truth and reco information
- Get position resolution verse energy

Compare the positon 0312

Jingyu

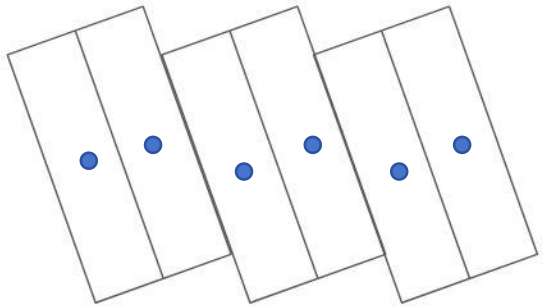
4 position

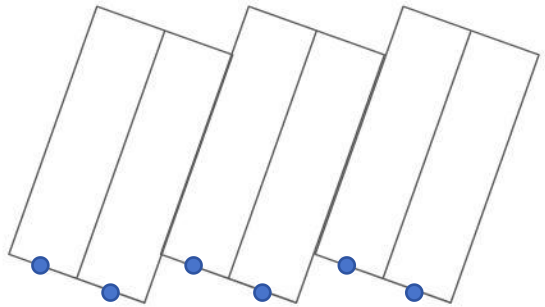




Primary particle first hit on CEMC

Shower center with energy weight



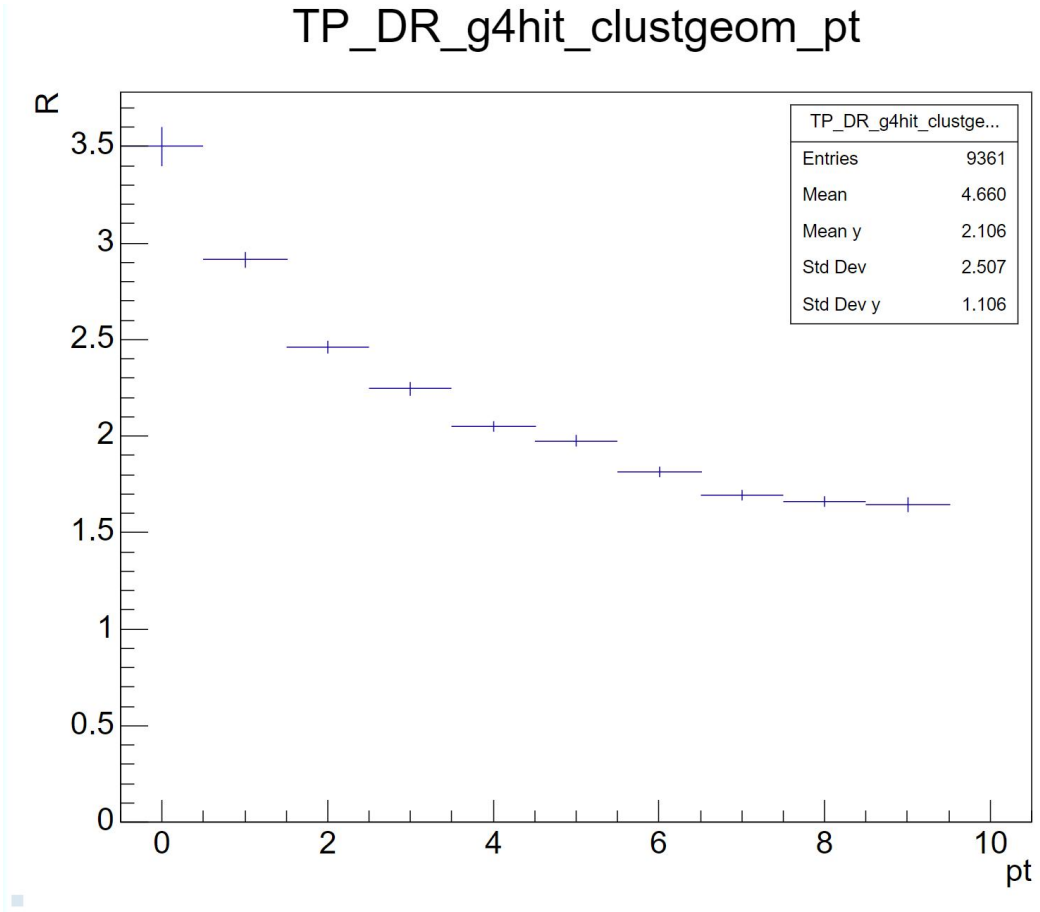


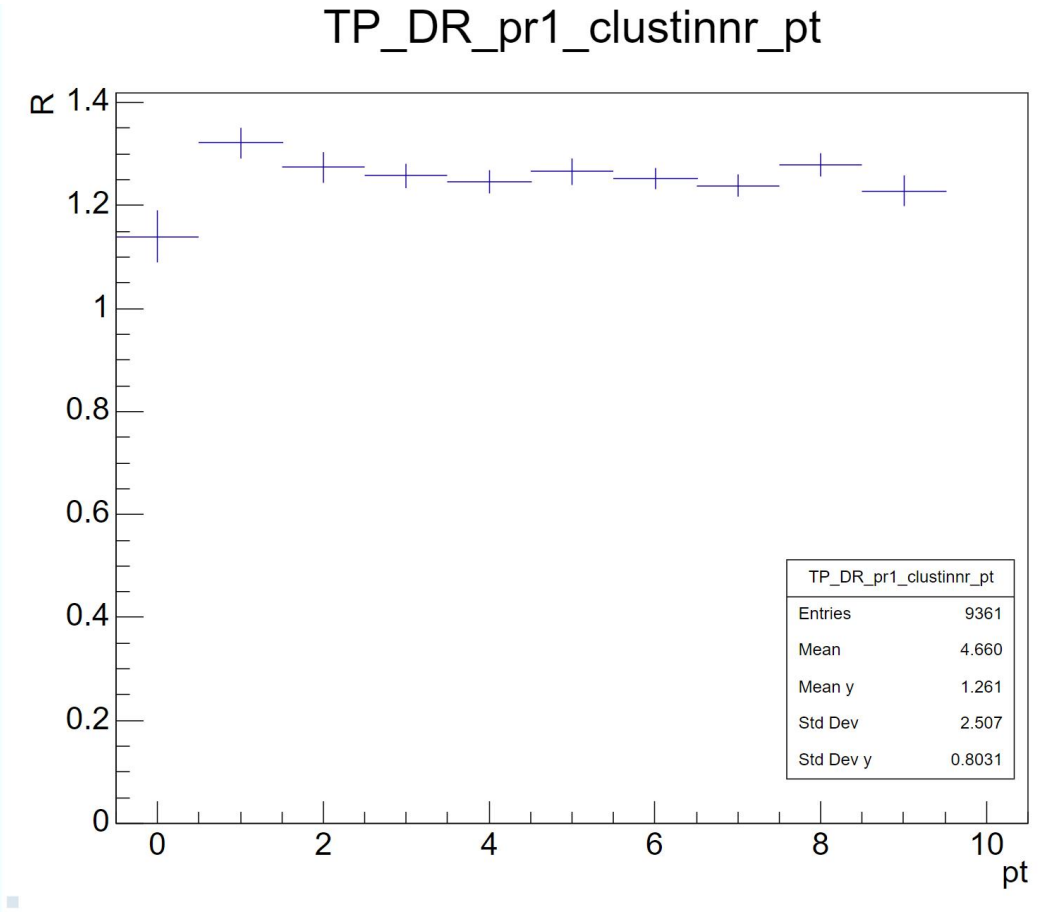
cluster positon reco with geom center

cluster positon reco with innerface center

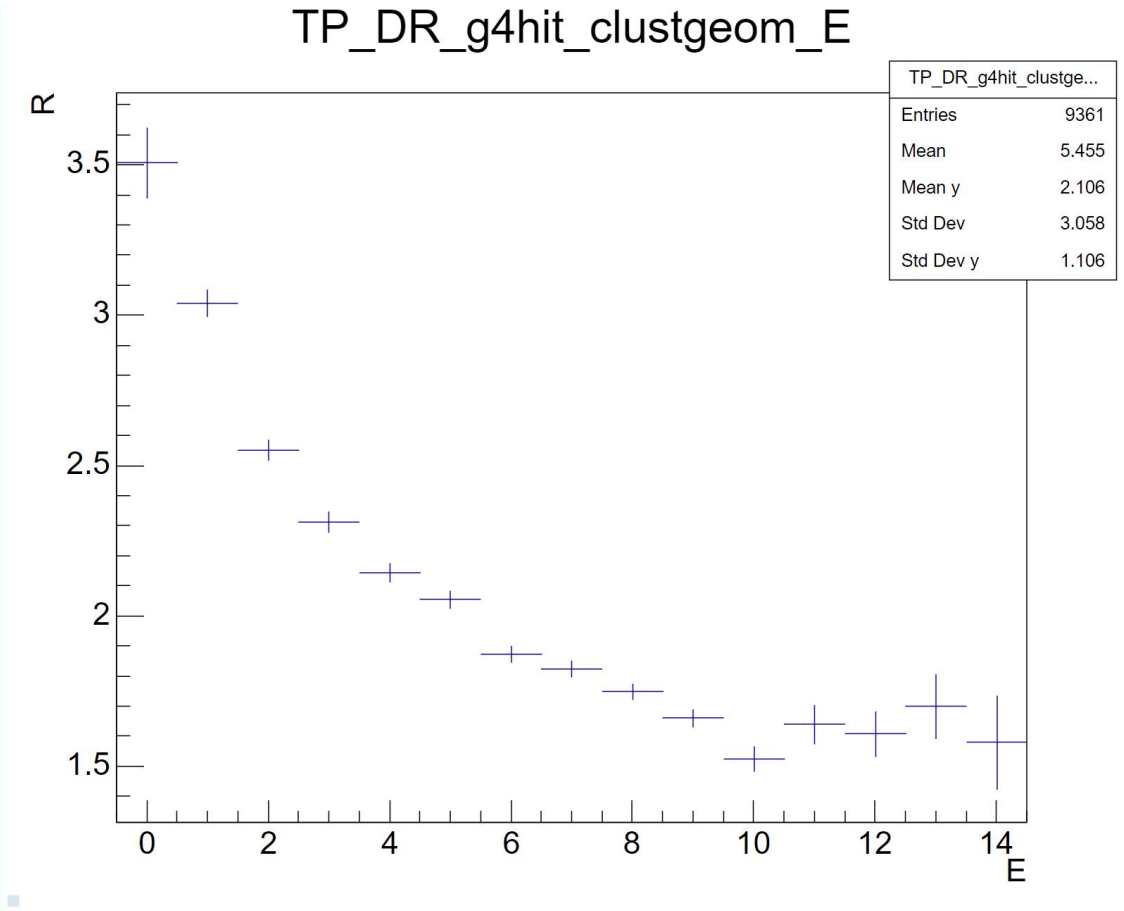
Compare the pos

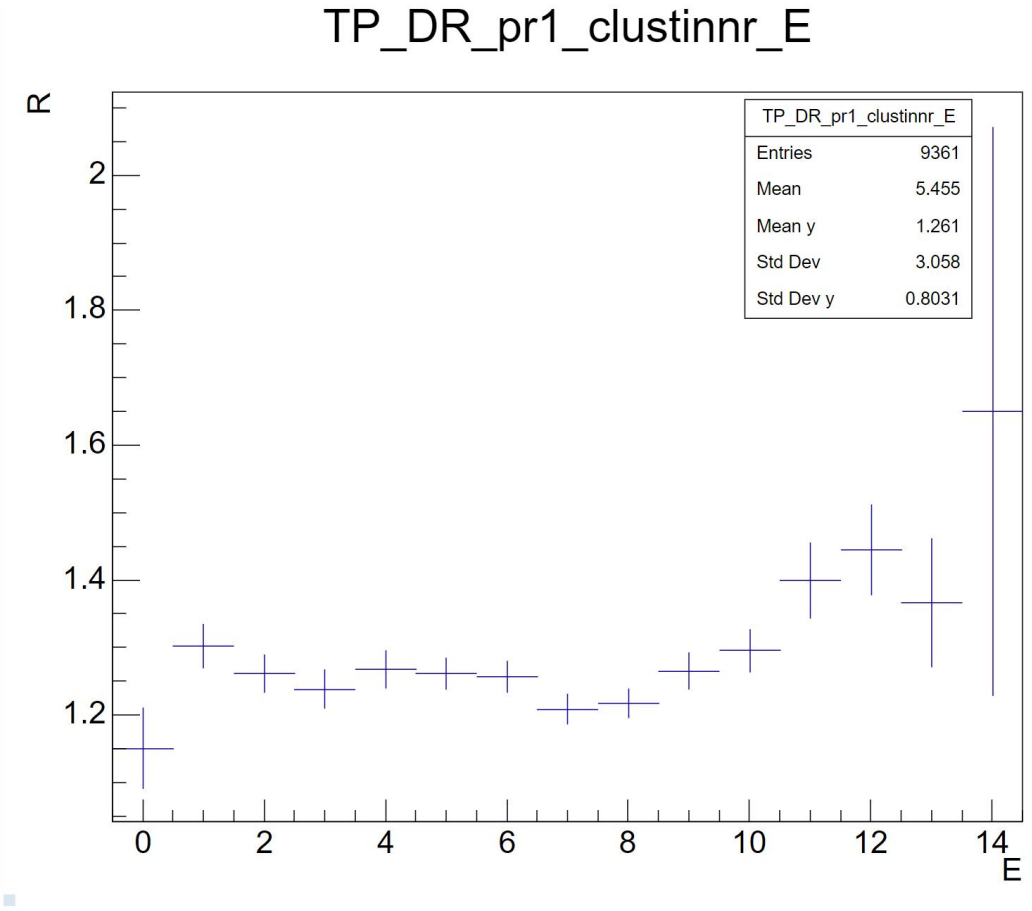
```
double distance_R = sqrt(delta_x*delta_x+delta_y*delta_y);
```





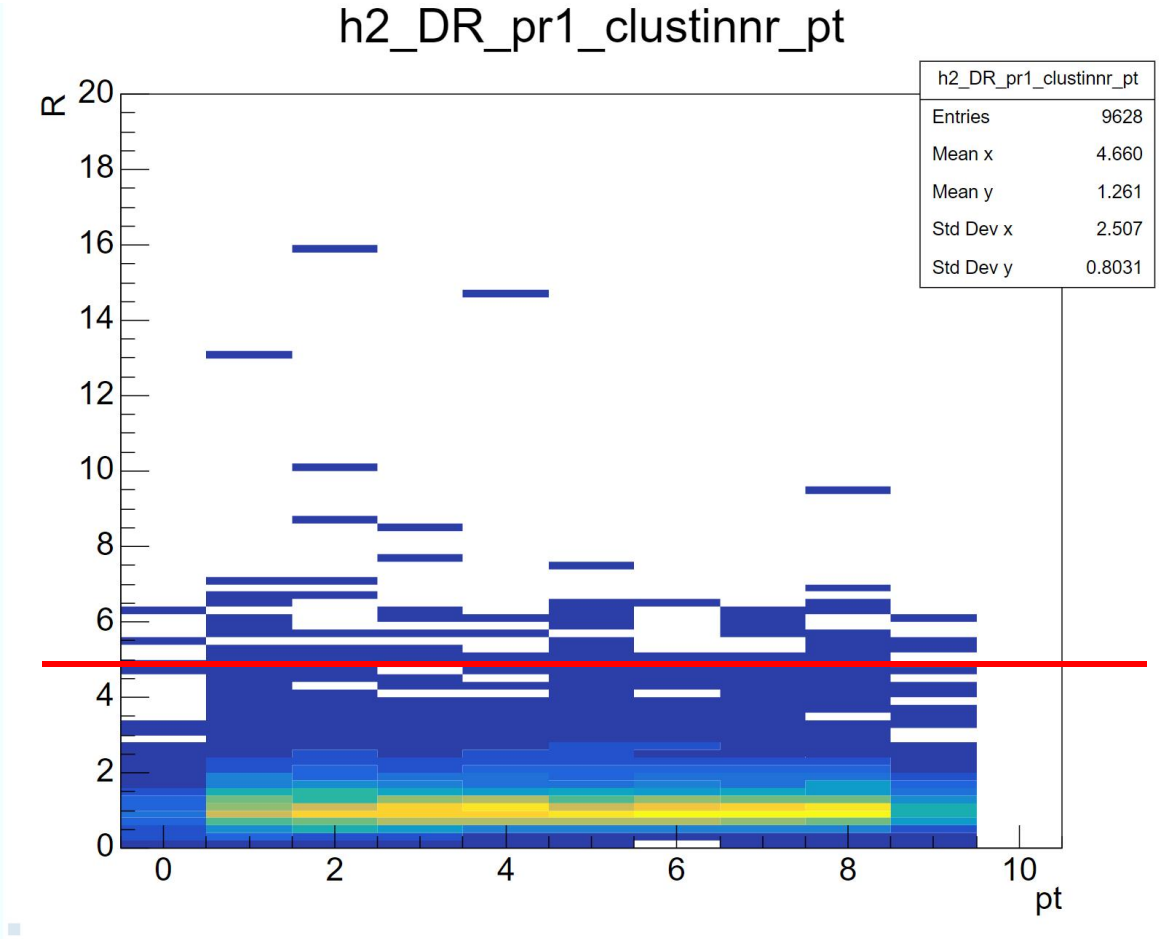
The final strange rise comes from the insufficient amount of data.



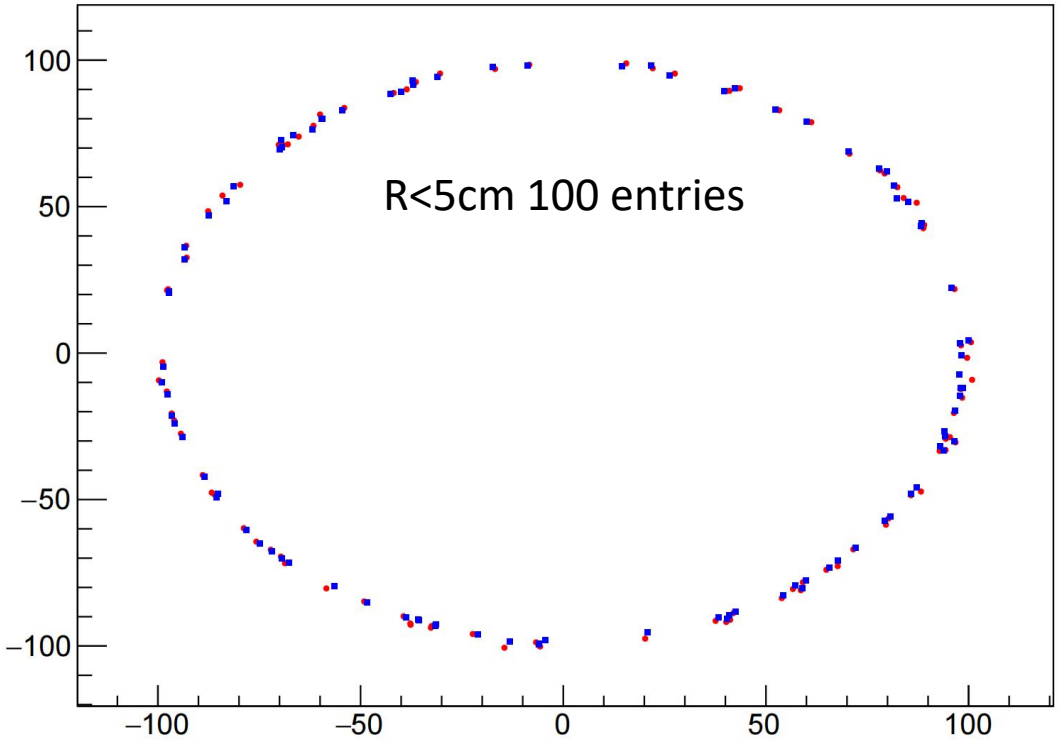


- Using the inner face center to reconstruct the cluster position gives the best results now
- Using the inner face center to reconstruct the cluster position gives the best results now

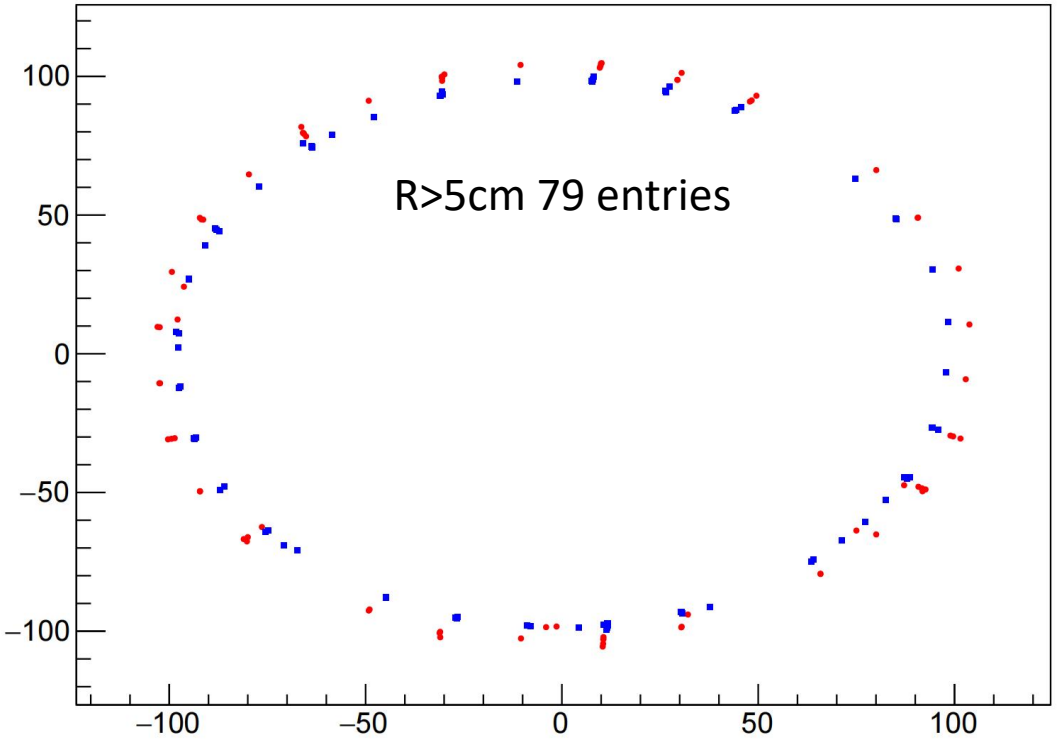
where the large R from?



X-Y plane display



1% ~3% electron



Donnot it interact immediately arrive the CEMC?

Plan

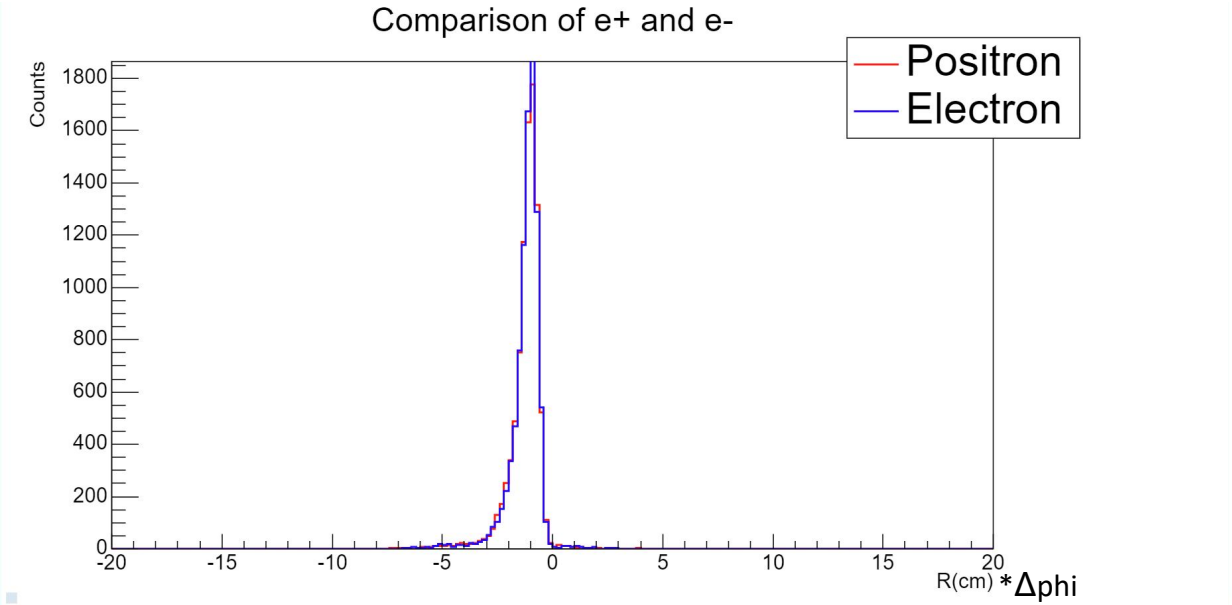
- better calo pos?
- Pico dst?
- other anything?

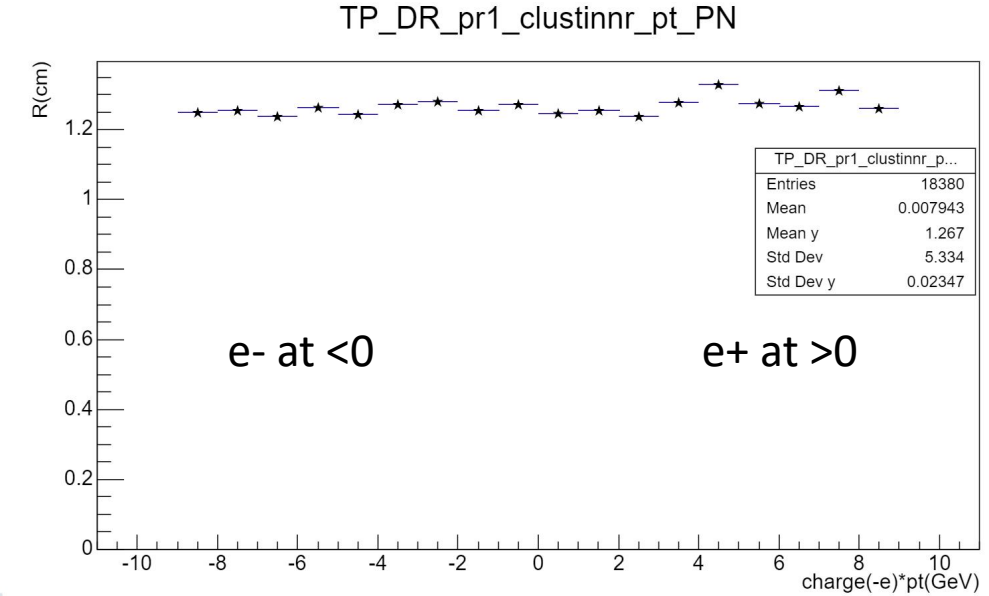
- which one is more important now?

make reco close to truth

Jingyu

electron and positron



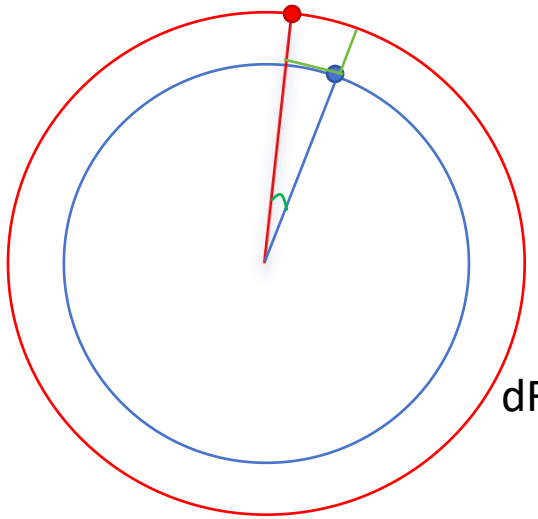


sign from phi_truth - phi_reco to mark reco on the left/right of truth

positron and electron have similar behavior

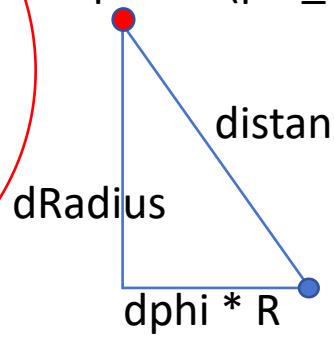
dphiR and dR

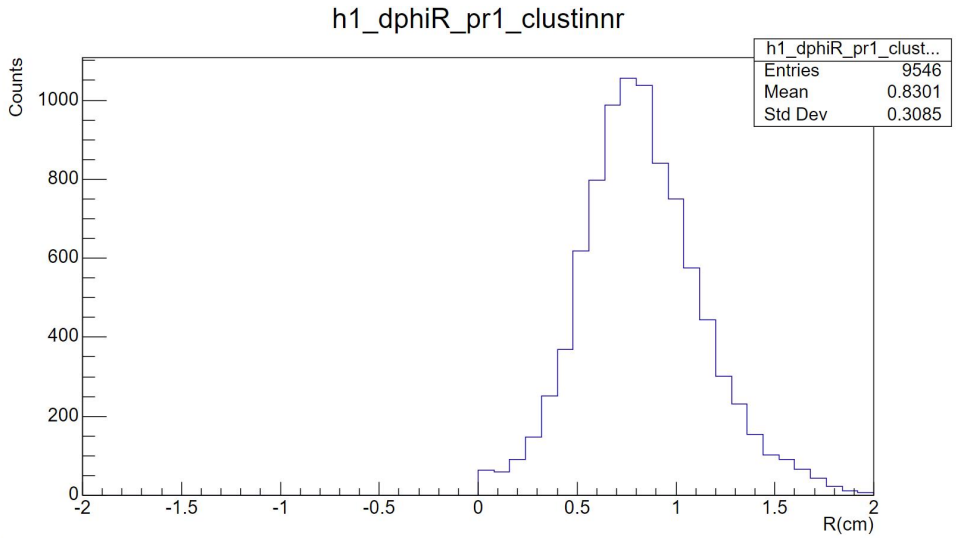
In the tangential direction, the truth-reco distribution shows a deflection of -0.0083 rad, then dphi*R have a ~0.8cm shift

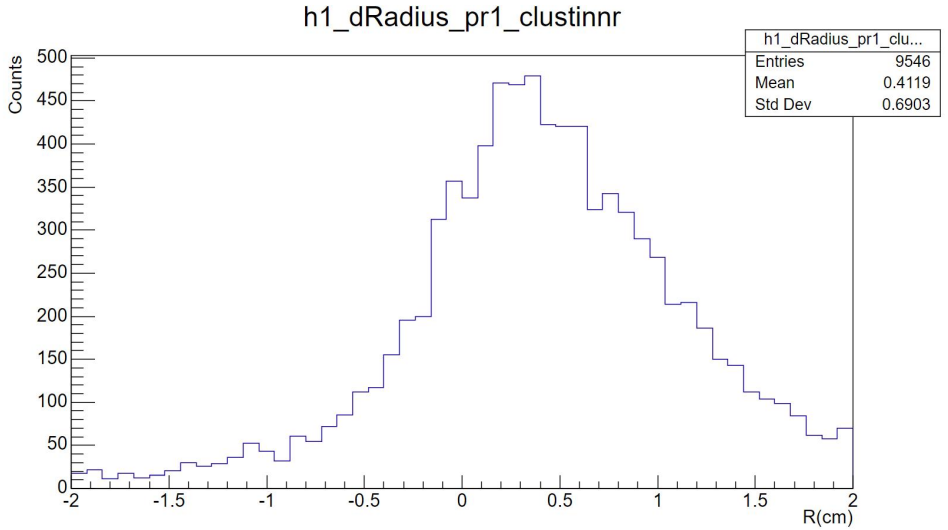


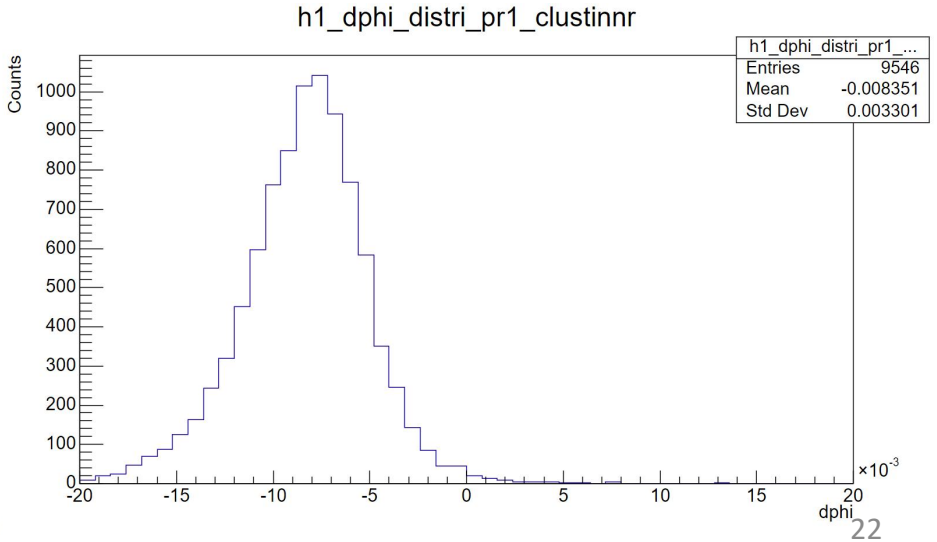
dRadius = Rradius_reco - Rradius_truth

dphiR = (phi_truth - phi_reco) * Rradius



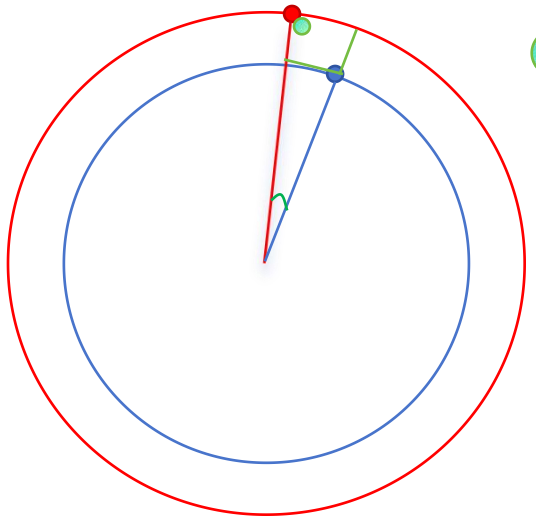


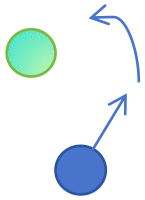




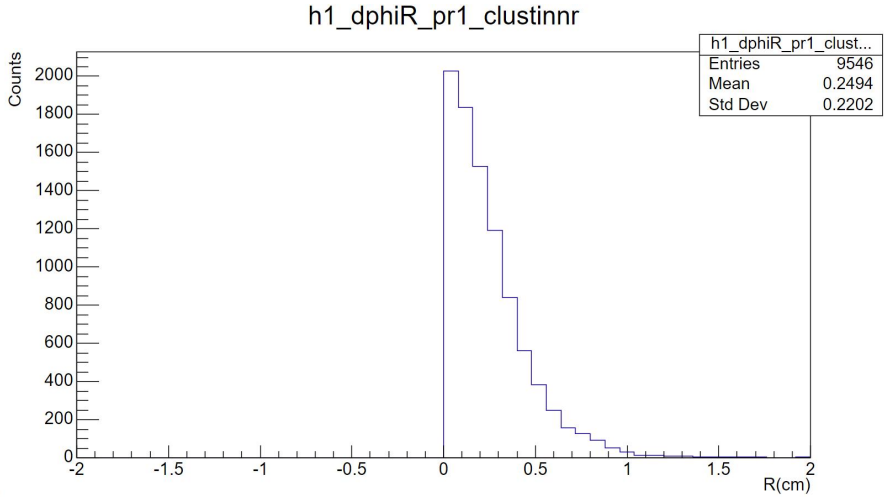
In the radial direction, the truth-reco peak is around 3 mm,

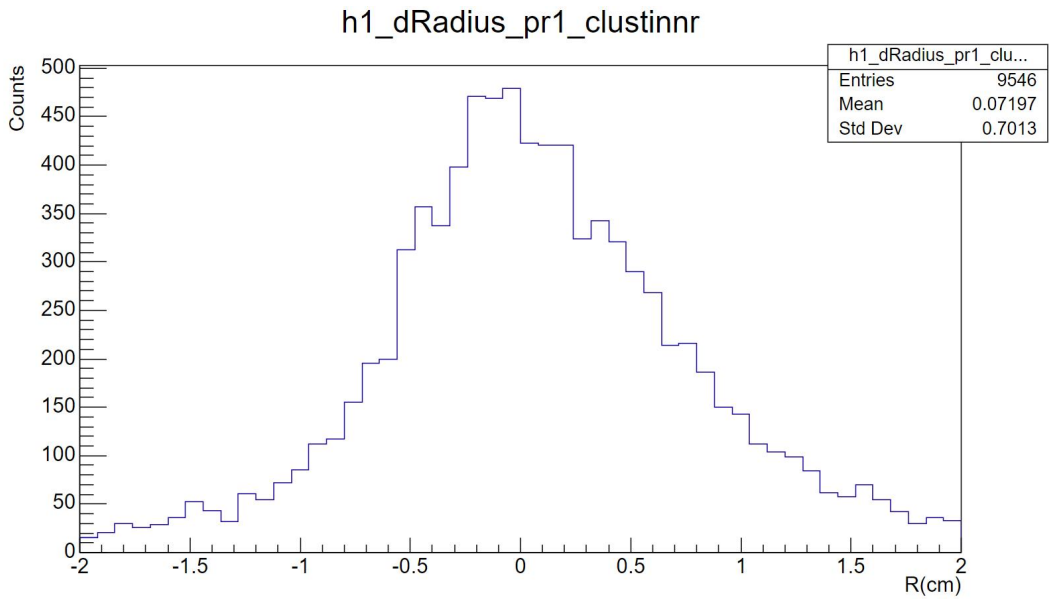
modify dphiR(rotation) and dRadius(shift)

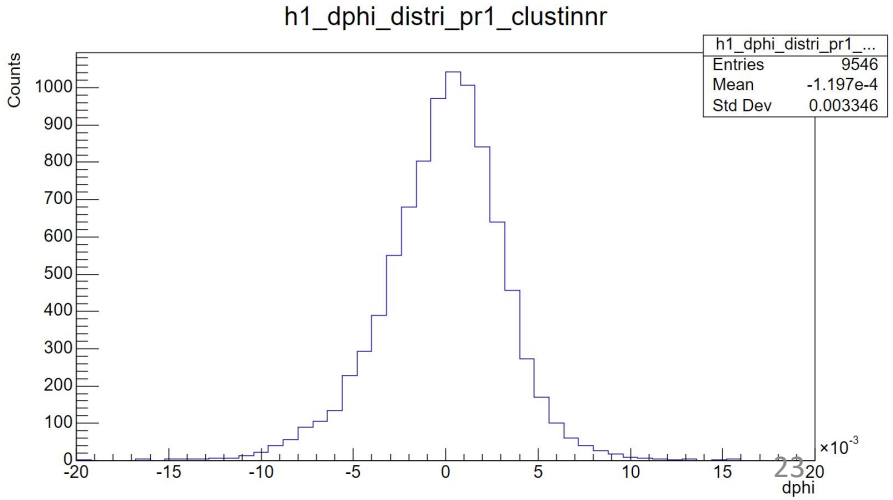




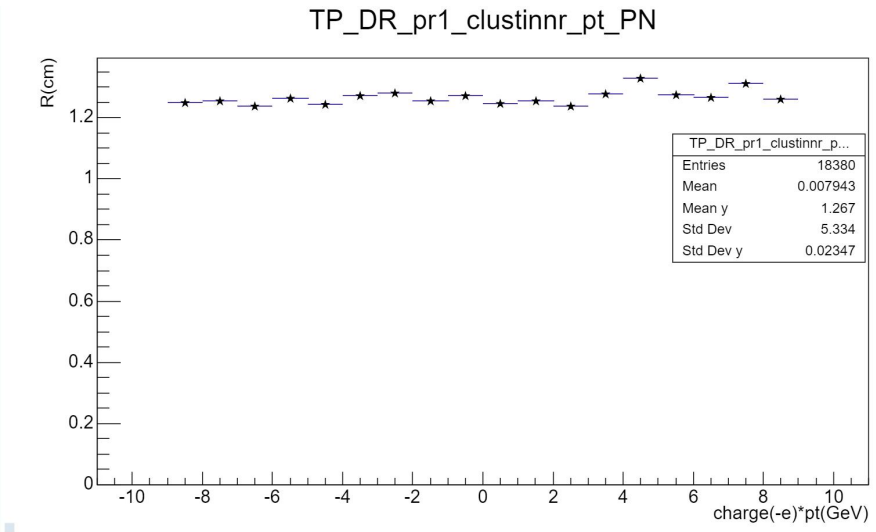
reco position: rotation -0.0083 rad
radius + 0.3cm

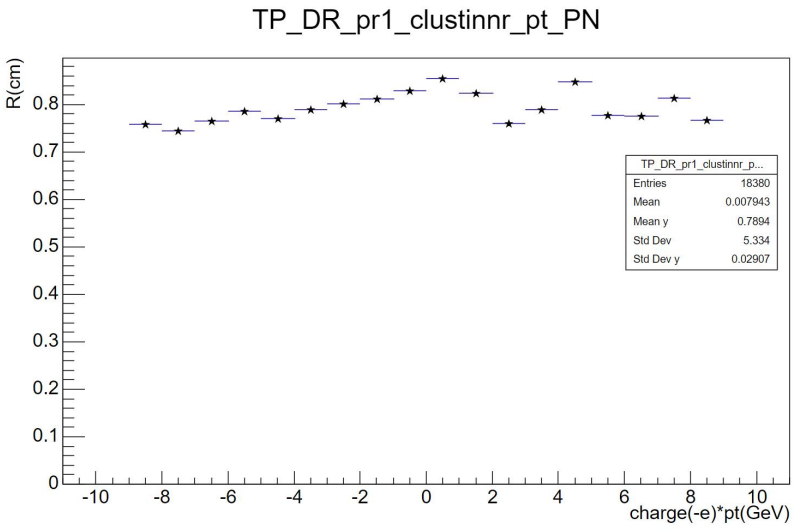


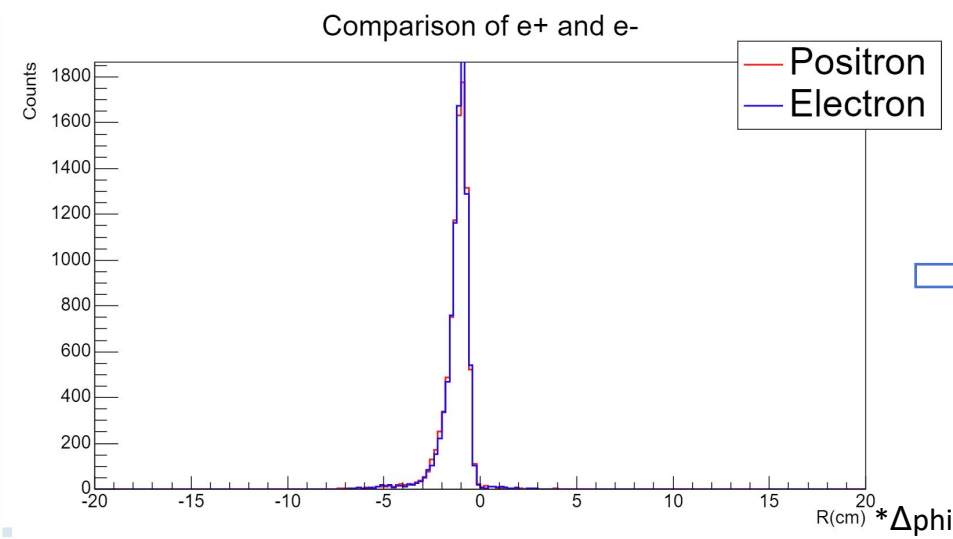


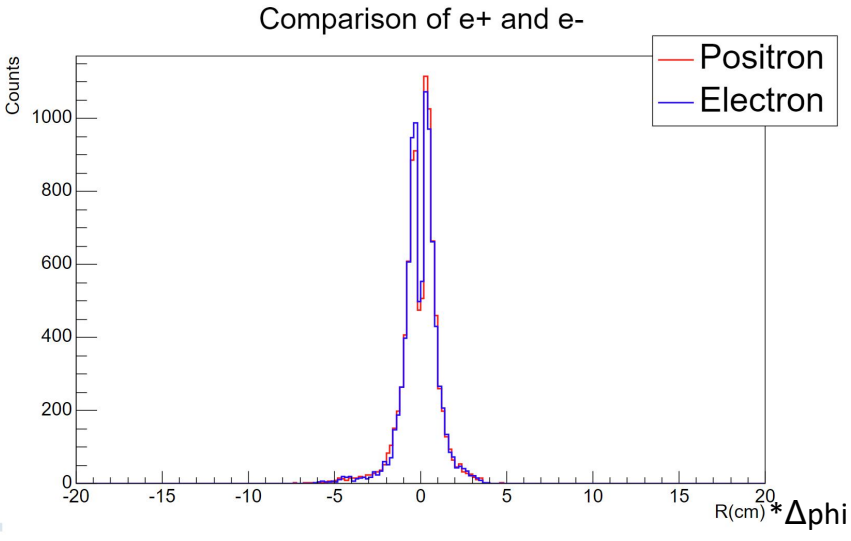


more close to the truth position

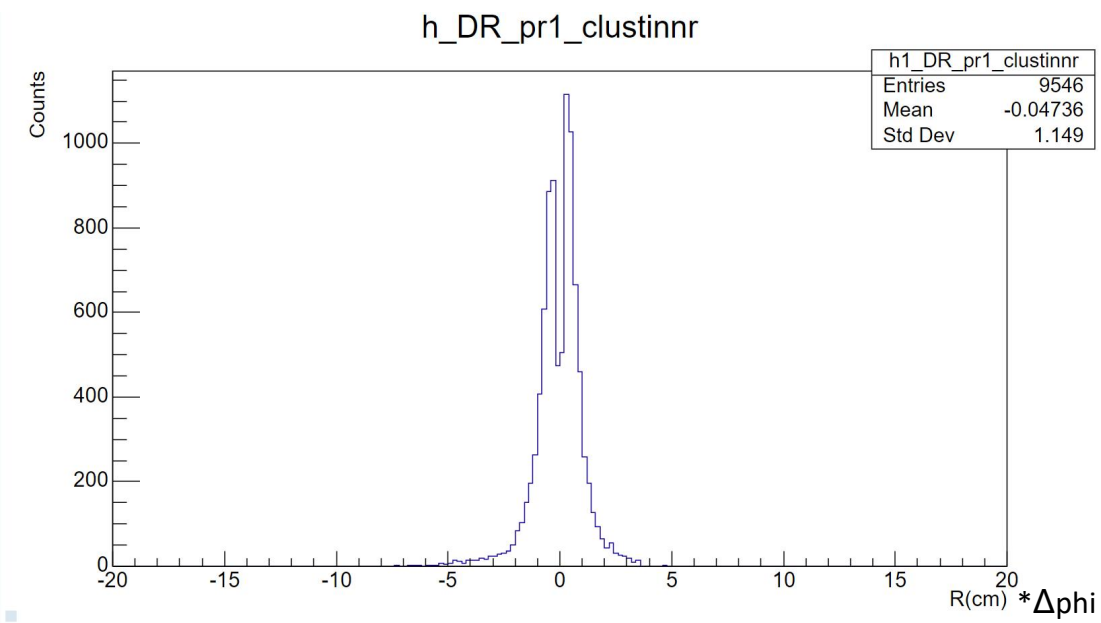


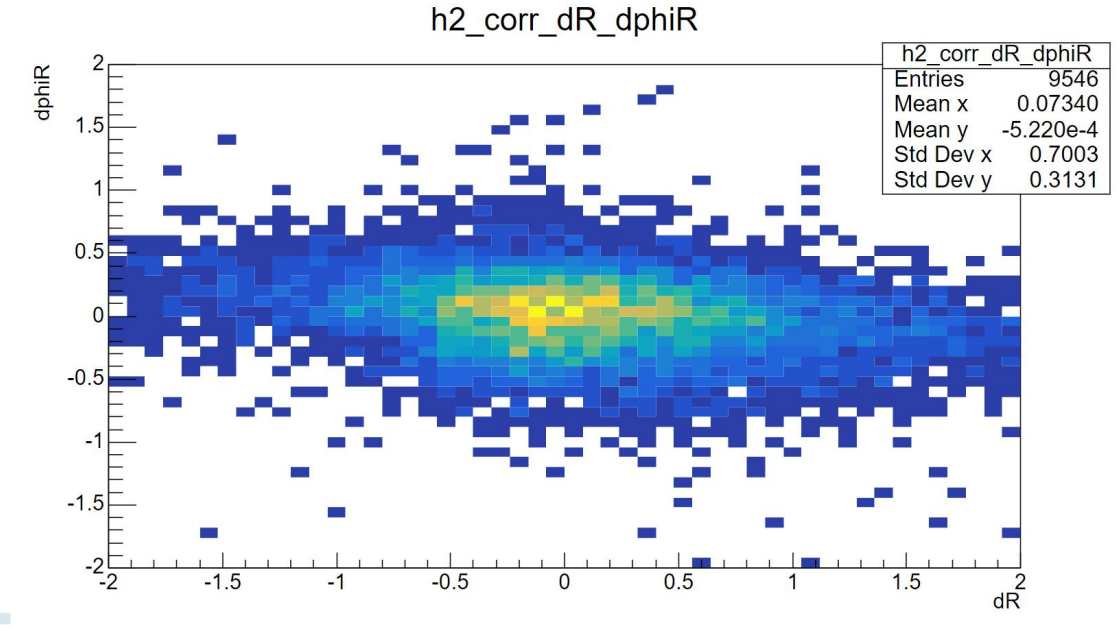






Problem and plan





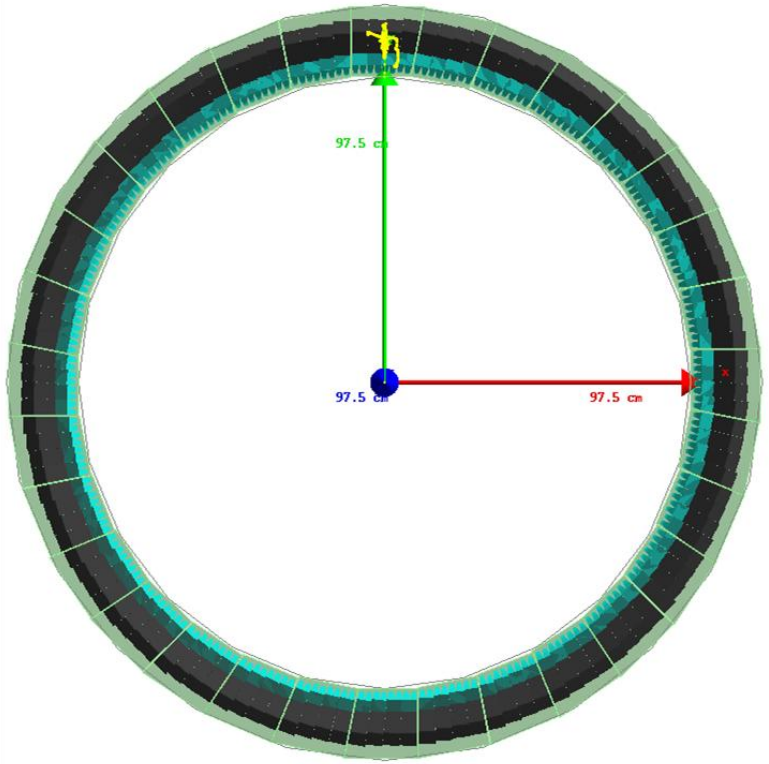
where is the little shift from? are the deviations in these two directions not independent?
But from the 2D plot, I still can't see why the peak isn't at 0 cm.

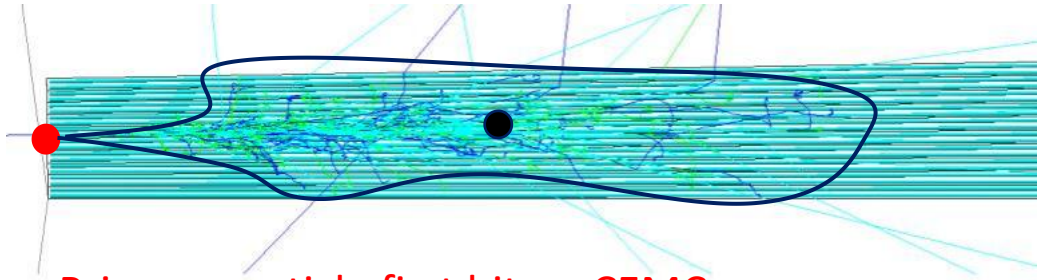
how to get smaller width ? for single particle reco-truth: pt/energy dependent? have correlation with others varible? particle-by-particle modify the reco position

z-dependence 0417

Jingyu

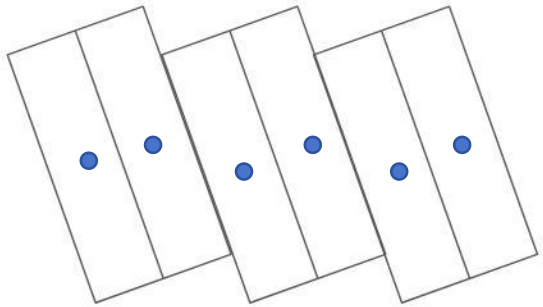
4 position

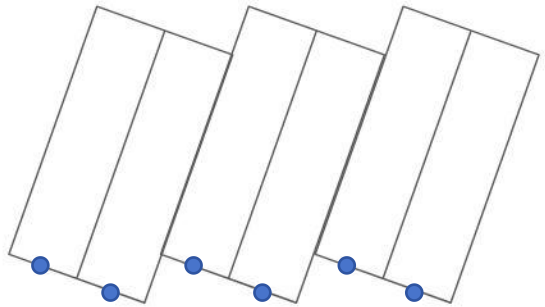




Primary particle first hit on CEMC

Shower center with energy weight



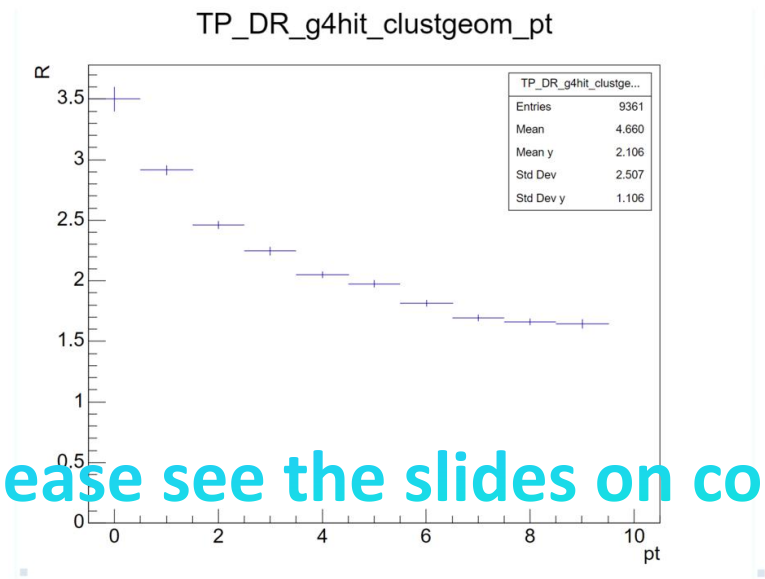


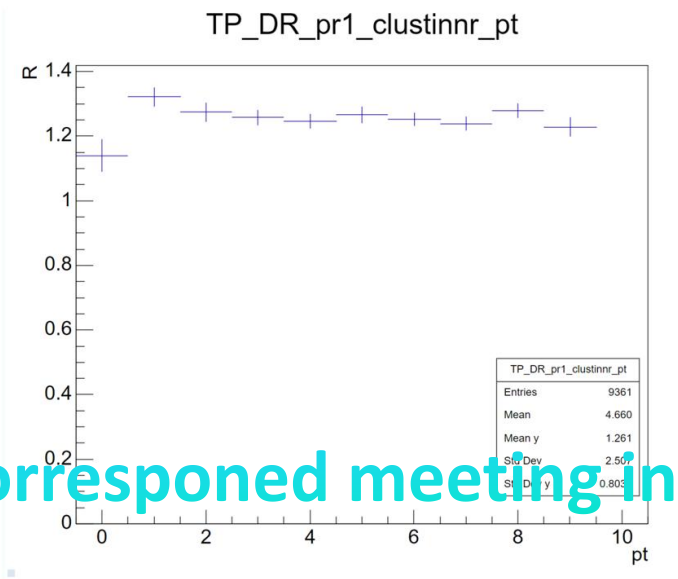
cluster positon reco with geom center

cluster positon reco with innerface center

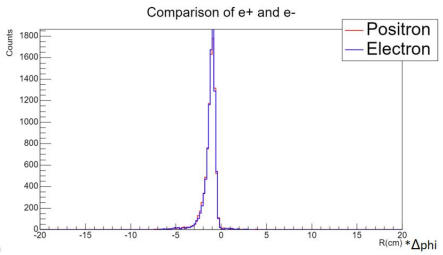
Compare the pos

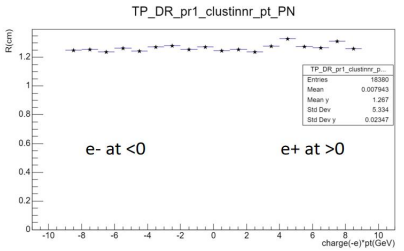
```
double distance_R = sqrt(delta_x*delta_x+delta_y*delta_y);
```





electron and positron





sign from phi_truth - phi_reco to mark reco on the left/right of truth

positron and electron have similar behavior

21

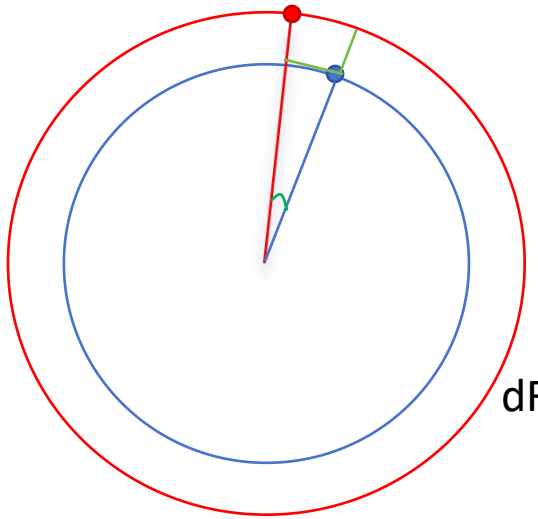
Please see the slides on corresponed meeting indico at 02.26

- Previously, I observed that the cluster position reconstructed using the tower inner face center was close to the position of the particle's G4Hit in the CEMC (which I treated as the hit point).
- I think the first hit point on CEMC can be better used for reconstruction than the shower center, because it represents the actual particle passage location.

- I do some modify to let reco with inner face center to close to the truth(hit) position

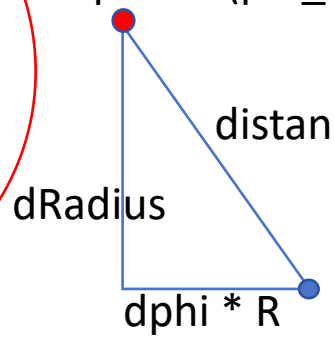
dphiR and dR

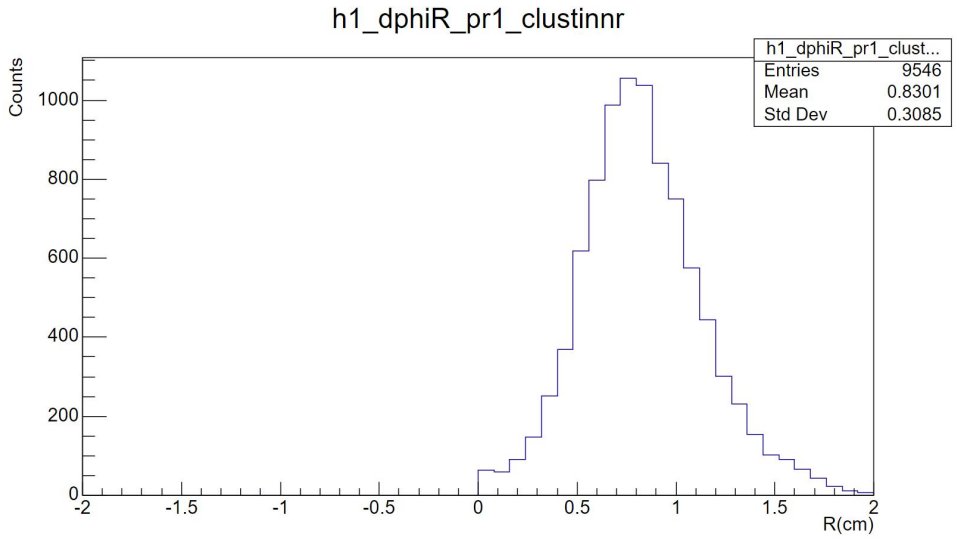
In the tangential direction, the truth-reco distribution shows a deflection of -0.0083 rad, then dphi*R have a ~0.8cm shift

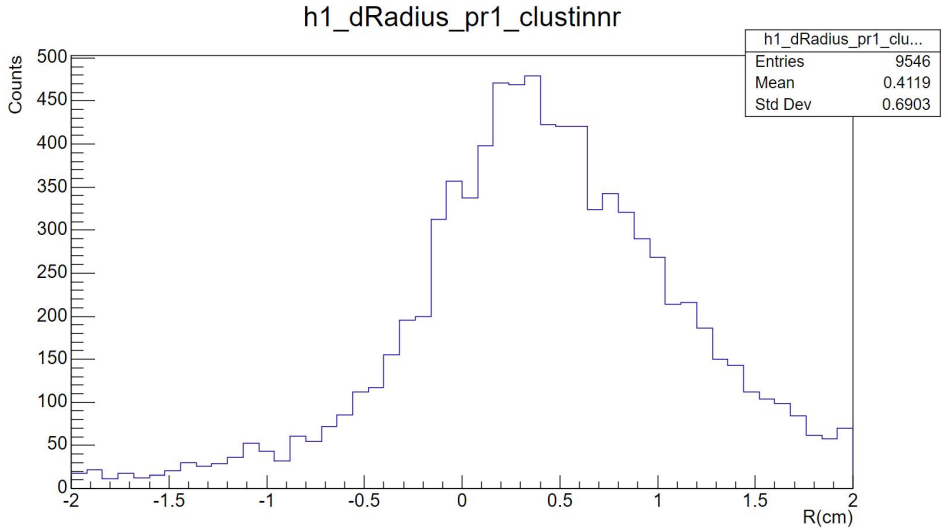


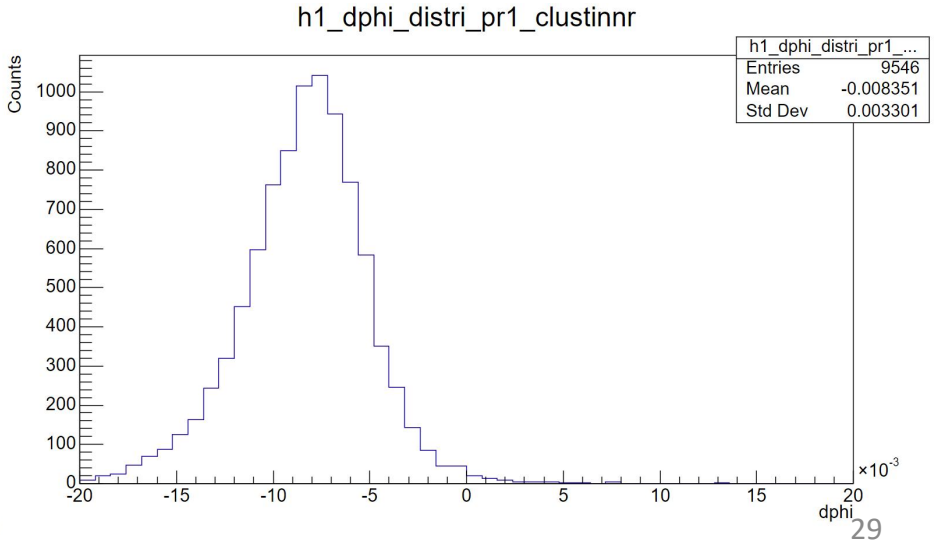
dRadius = Rradius_reco - Rradius_truth

dphiR = (phi_truth - phi_reco) * Rradius



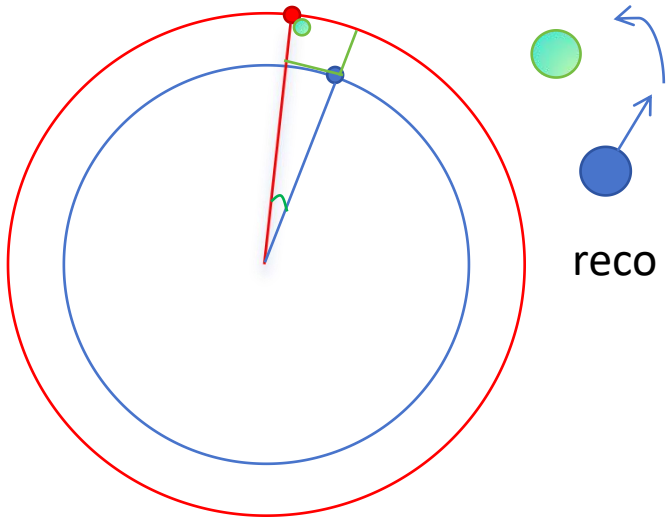




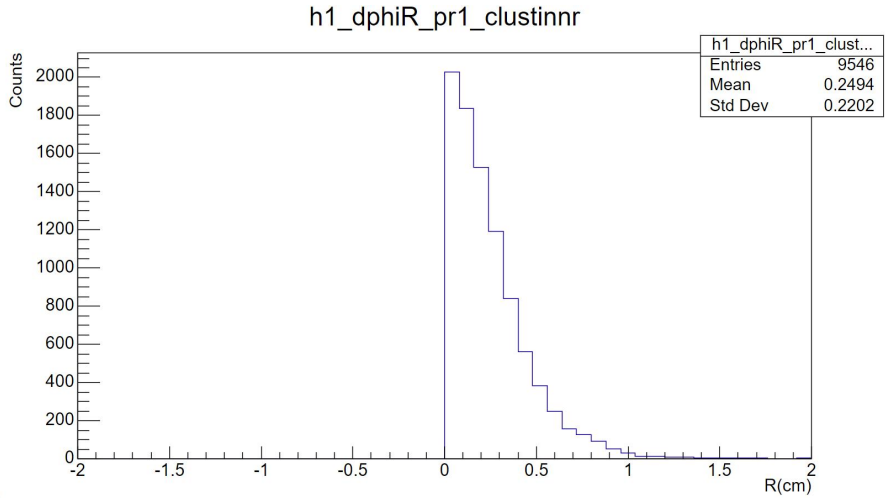


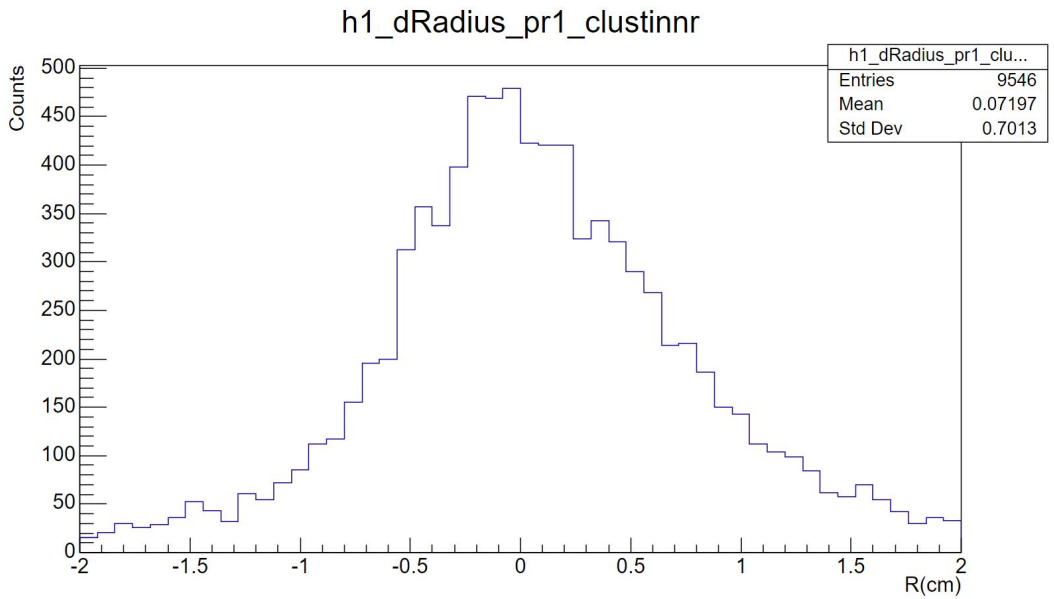
In the radial direction, the truth-reco peak is around 3 mm,

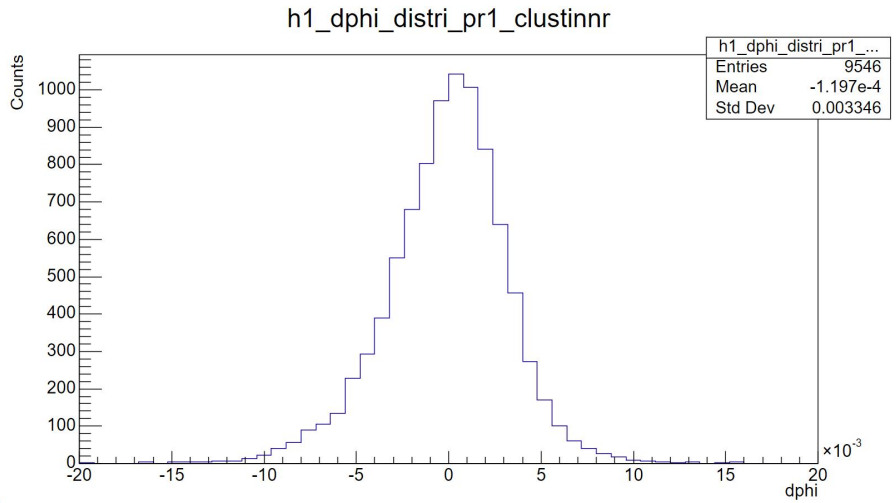
modify dphiR(rotation) and dRadius(shift)



reco position: rotation -0.0083 rad
radius + 0.3cm

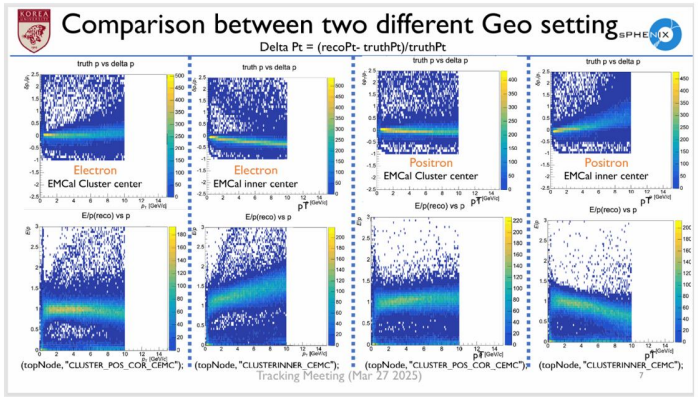


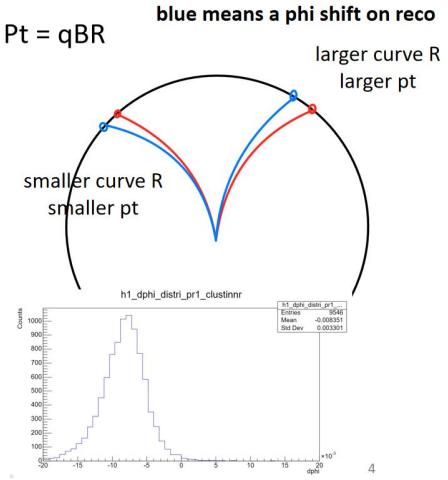


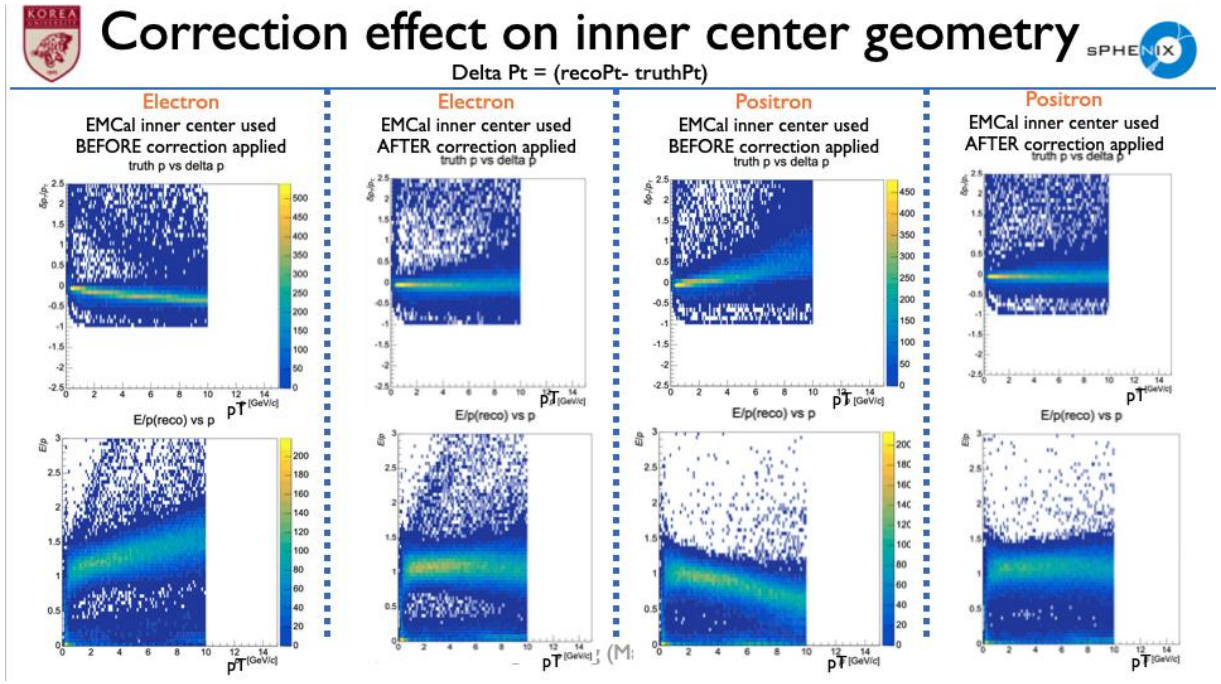


positon modify effect on pt resolution and E/p

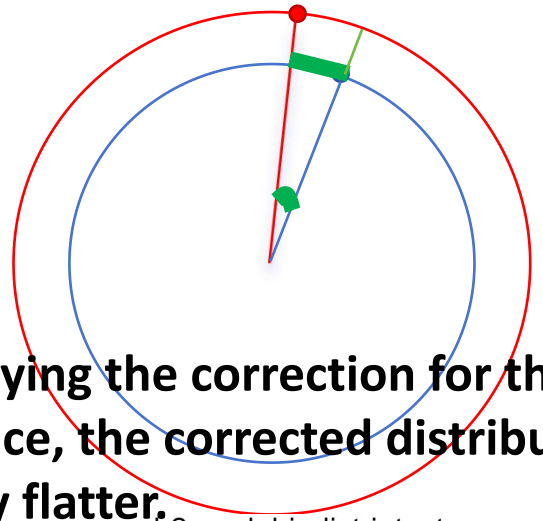
the shift effect on pt resolution and E/p



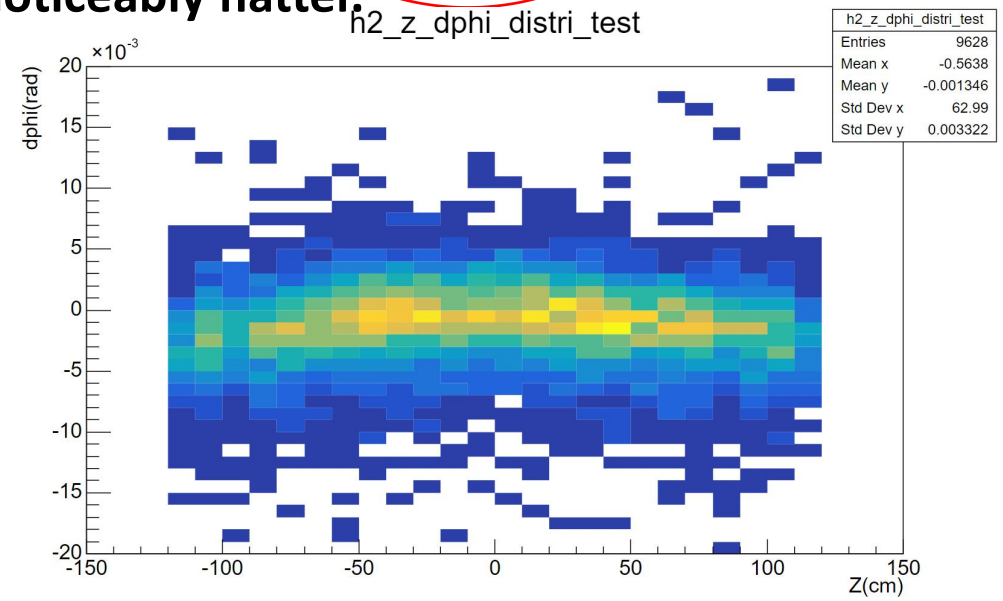


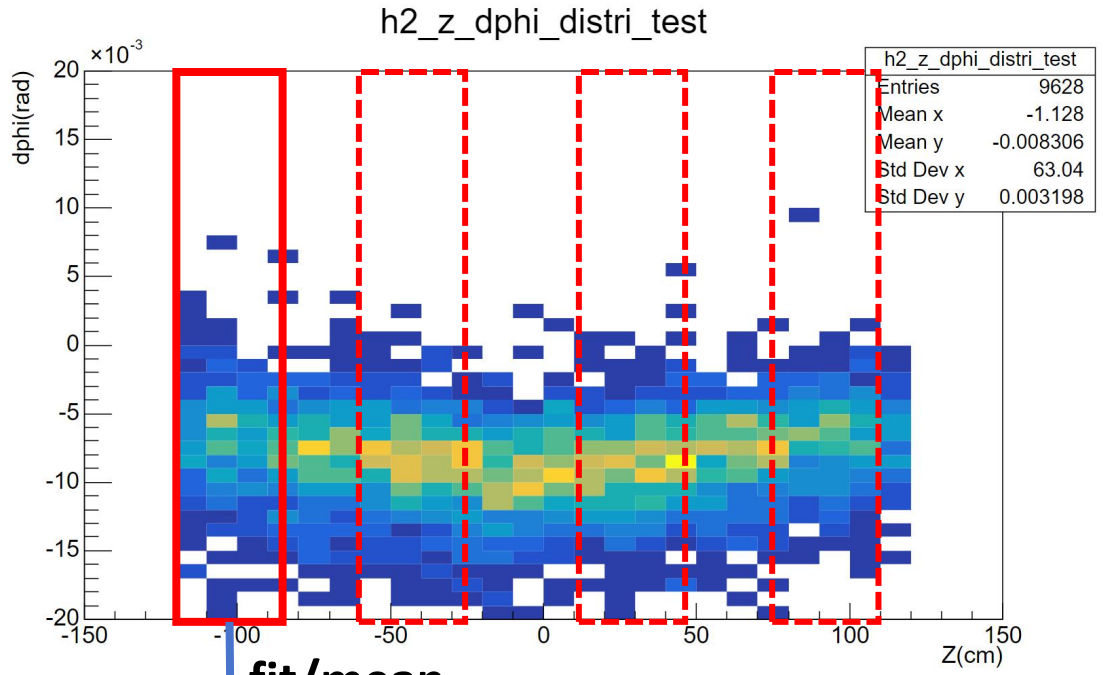


dphi z-dependence

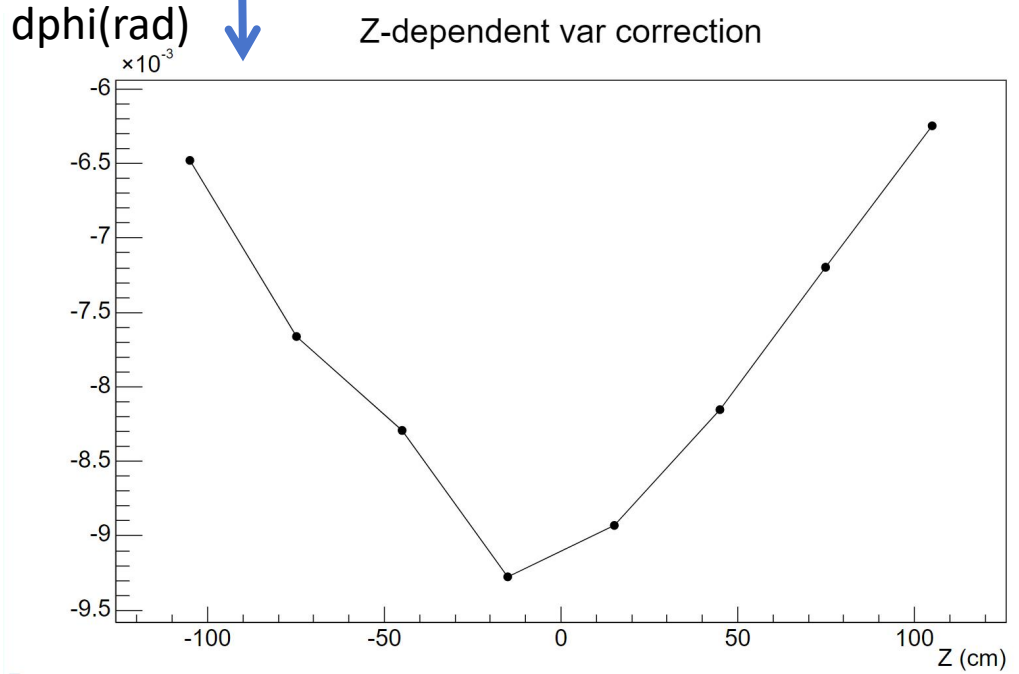


After applying the correction for the z-direction dependence, the corrected distribution becomes noticeably flatter.

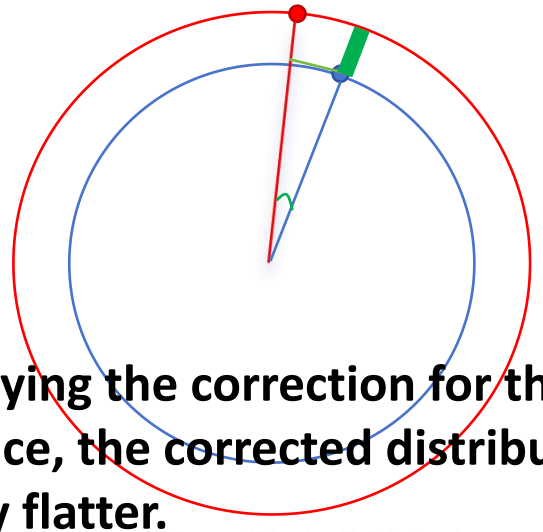




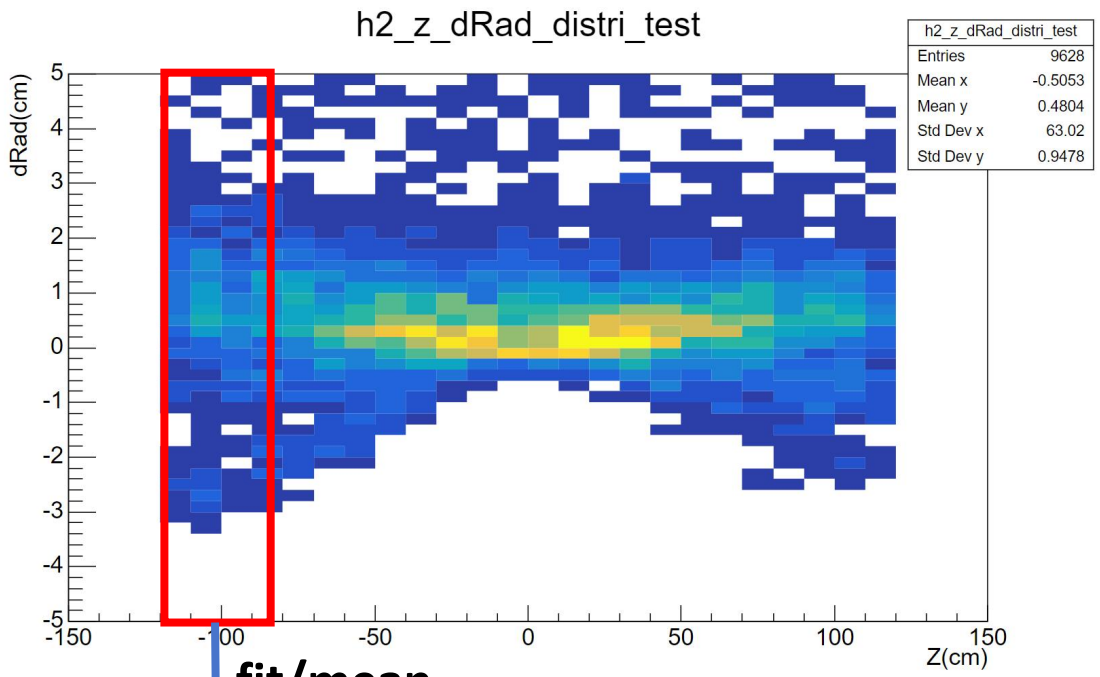
fit/mean



dRadius z-dependence



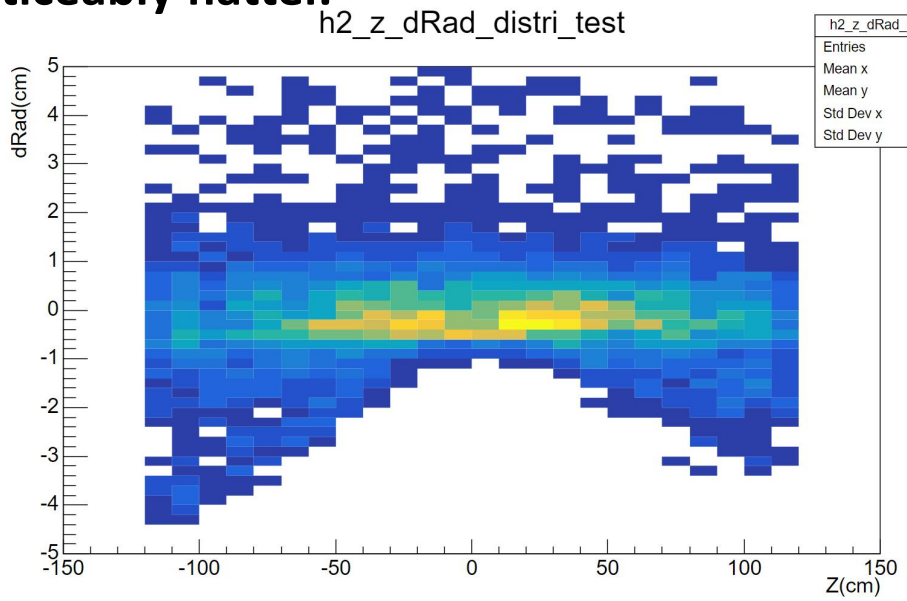
After applying the correction for the z-direction dependence, the corrected distribution becomes noticeably flatter.

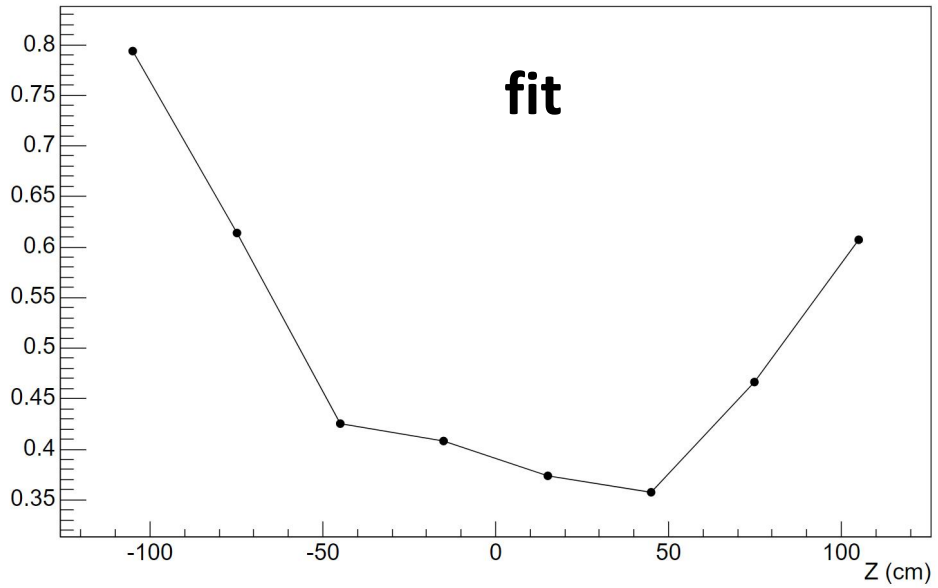


fit/mean

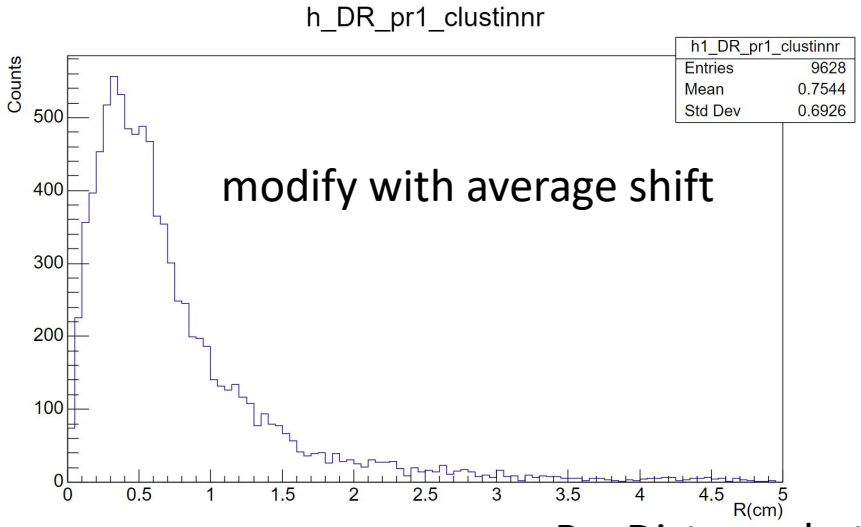
dRadius(cm)

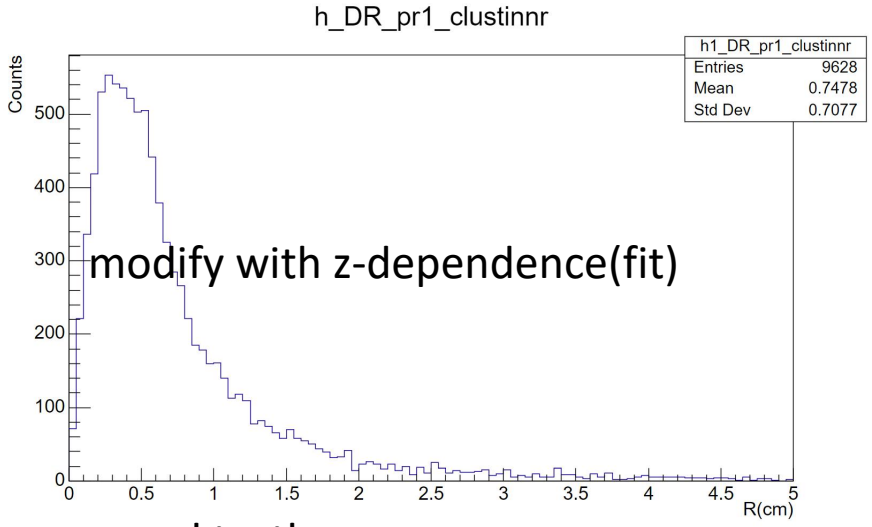
Z-dependent var correction



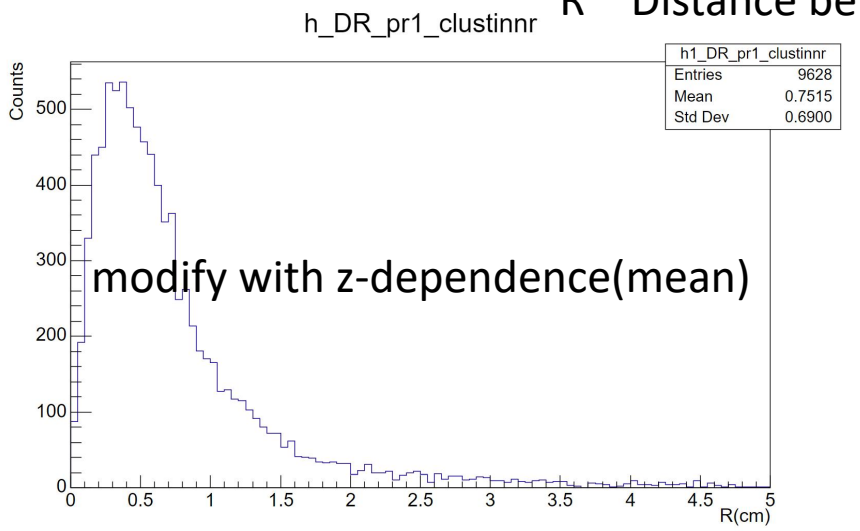


Distance between reco and truth with diff-modify





R ~ Distance between reco and truth



Taking the z-dependence into account and applying corrections in the radial and tangential directions still did not make the reconstruction closer to the truth.

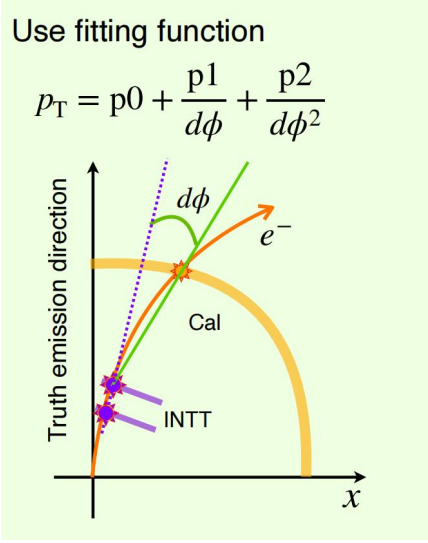
Plan

- Continue study how to make the reconstruction closer to the truth position, especially in the tangential direction (smaller dphi angle).
- Study the distance between the shower center and the cluster reconstructed with the geometry center.

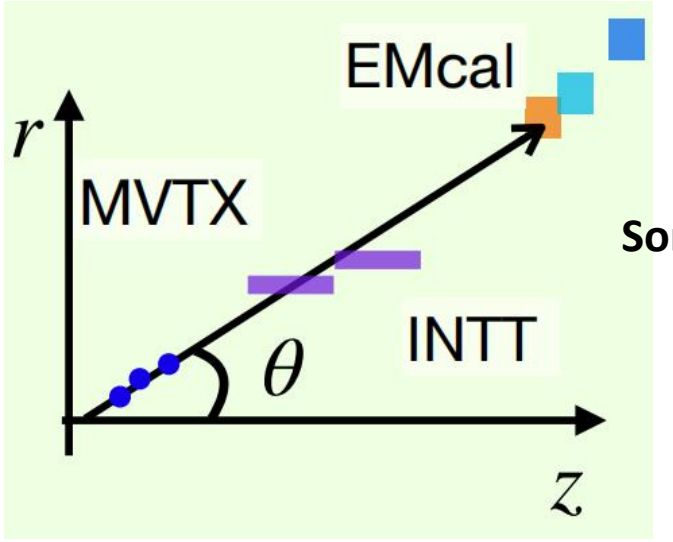
- Use calo energy to improve the Performance

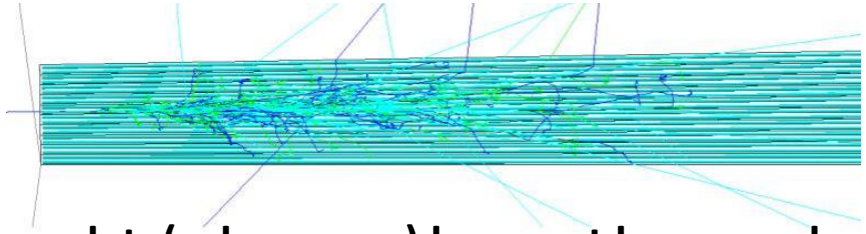
Now. Use hit positon (x, y, z)

Get pt from curve in the xy-plane



Calculate energy from pt and eta(theta) angle

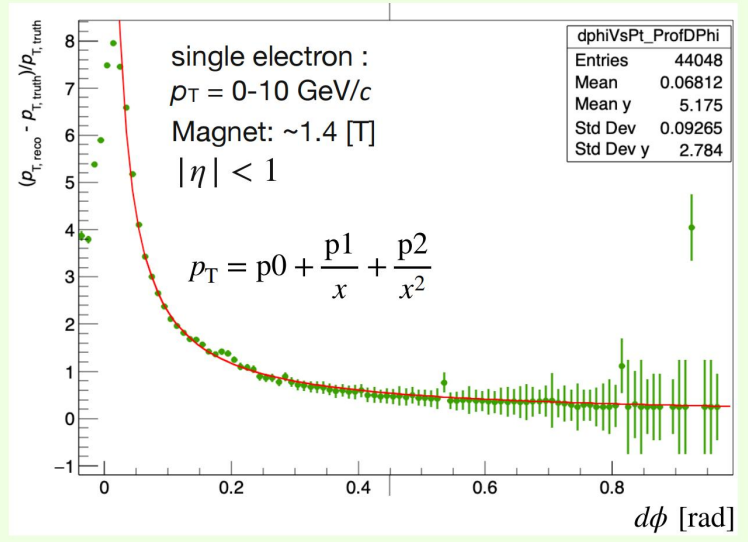




Some data(calo energy) have not been used yet.

Plan. Energy from calo

If including the EMCal(+HCal) Energy in the calculation maybe improve the resolution.



For example: In the current fitting, we have **pt = f(dphi)**,
instead use **pt = f(dphi) * g(E_emc)**,
where g could be something like gaus(E * cos(eta)), it might enhance the resolution.