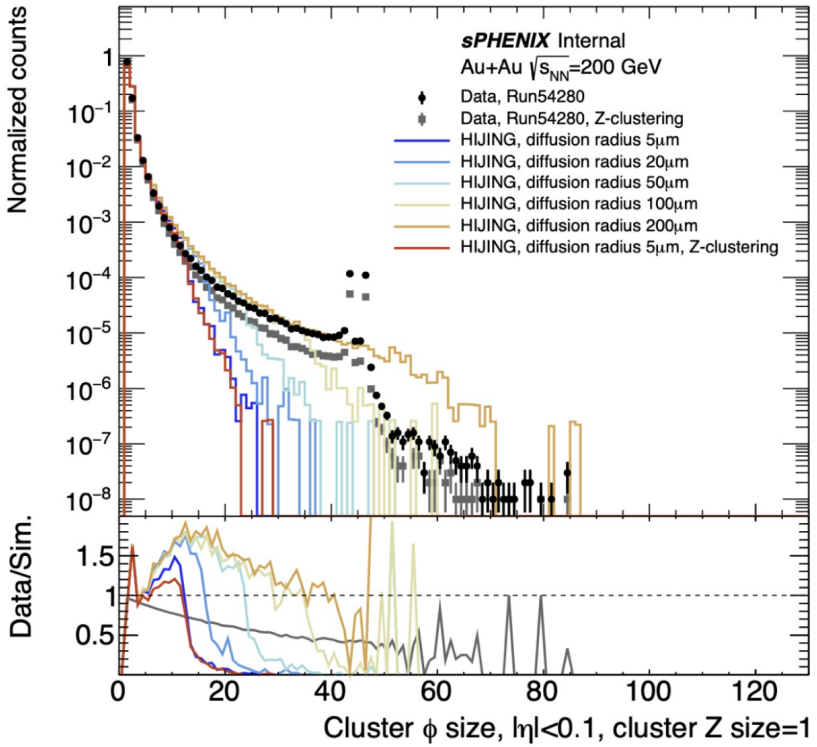
INTT Simulation Optimization

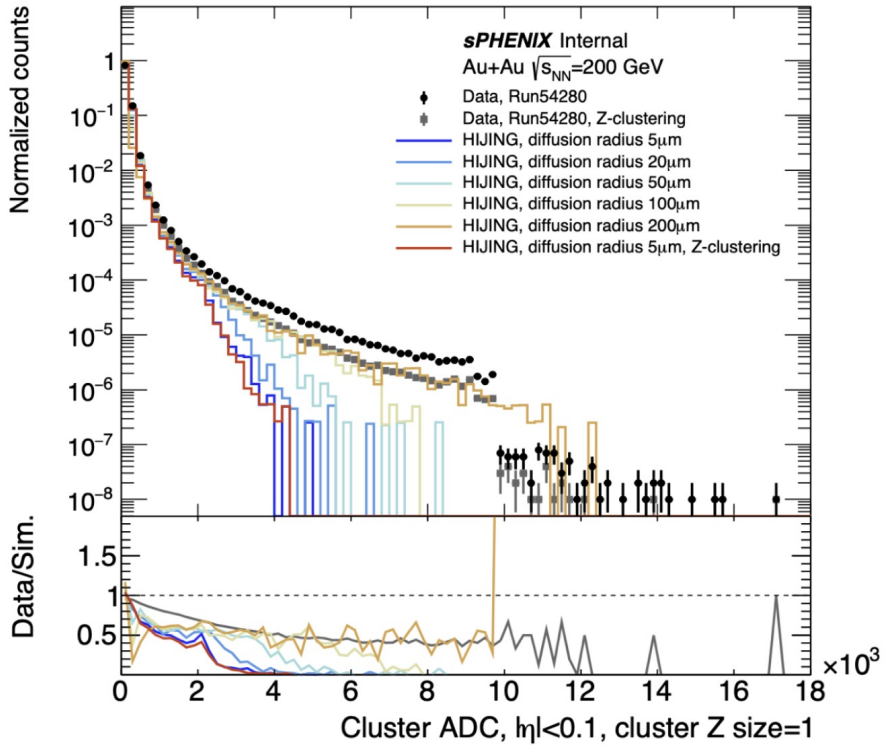
Milan Stojanovic[1], Cheng-Wei Shih[2]

[1]Wayne State University

[2]National Central University & RIKEN

Description





Discrepancy of cluster phi size & ADC in data and simulation

- simple change of diffusion radius does not fix it

Diffusion algorithm

- Diffusion fixed within cylinder with constant radius
- Only do the charge diffusion if the number of strips involved for this G4step is smaller than 13

```
double diffusion_radius = diffusion_width;

if (Verbosity() > 5)
{
  std::cout << " segment " << i
            << " interval " << interval
            << " frac " << frac
            << " local_in.X " << hiter->second->get_local_x(0)
            << " local_in.Z " << hiter->second->get_local_z(0)
            << " local_in.Y " << hiter->second->get_local_y(0)
            << " pathvec.X " << gsl_vector_get(m_PathVec, 0)
            << " pathvec.Z " << gsl_vector_get(m_PathVec, 2)
            << " pathvec.Y " << gsl_vector_get(m_PathVec, 1)
            << " segvec.X " << gsl_vector_get(m_SegmentVec, 0)
            << " segvec.Z " << gsl_vector_get(m_SegmentVec, 2)
            << " segvec.Y " << gsl_vector_get(m_SegmentVec, 1) << std::endl
            << " diffusion_radius " << diffusion_radius
            << std::endl;
}

// Now find the area of overlap of the diffusion circle with each pixel and apportion the energy
for (int iz = minstrip_z; iz <= maxstrip_z; iz++)
{
  for (int iy = minstrip_y; iy <= maxstrip_y; iy++)
  {
    // Find the pixel corners for this pixel number
    double location[3] = {-1, -1, -1};
    layergeom->find_strip_center_localcoords(ladder_z_index, iy, iz, location);
    // note that (y1,z1) is the top left corner, (y2,z2) is the bottom right corner of the pixel - circle_rectangle_intersection expects this ordering
    int type = (ladder_z_index == 0 || ladder_z_index == 2) ? 0 : 1; // ladder ID 0 and 2 are type-A (1.6 cm), ladder ID 1 and 3 are type-B (2.0 cm)
    double y1 = location[1] - layergeom->get_strip_y_spacing() / 2.0;
    double y2 = location[1] + layergeom->get_strip_y_spacing() / 2.0;
    double z1 = location[2] + layergeom->get_strip_z_spacing(type) / 2.0;
    double z2 = location[2] - layergeom->get_strip_z_spacing(type) / 2.0;

    if (Verbosity() > 5)
    {
      std::cout << PHWHERE << " ladder_z_index " << ladder_z_index  << " strip size in z (from CylinderGeomIntt) " << fabs(z1 - z2) << " strip size in y (from CylinderGeomIntt) " << fabs(y1 - y2) << std::endl;
    }

    // here m_SegmentVec.1 (Y) and m_SegmentVec.2 (Z) are the center of the circle, and diffusion_radius is the circle radius
    // circle_rectangle_intersection returns the overlap area of the circle and the pixel. It is very fast if there is no overlap.
    double striparea_frac = PHG4Utils::circle_rectangle_intersection(y1, z1, y2, z2, gsl_vector_get(m_SegmentVec, 1), gsl_vector_get(m_SegmentVec, 2), diffusion_radius) / (M_PI * (diffusion_radius * diffusion_radius));
```

All the G4Steps have the same charge diffusion radii, not nature

Plan overview

1. **Understand diffusion logic**

   - ❑ Using particle gun MC
   - ❑ Simplest environment where we can isolate effect

MC only

2. **Use beam test data to tune MC**

MC generation

Using module prepared by Cameron: dNdeta_sPHENIX_simulations

```
const string generator = "SIMPLE",
const bool fullSim = true,
const bool turnOnMagnet = false,
const bool idealAlignment = true,
const string particleType = "pi+"

set_eta_range(-0.005, 0.005)
set_pt_range(10, 20.)
```

MC generation

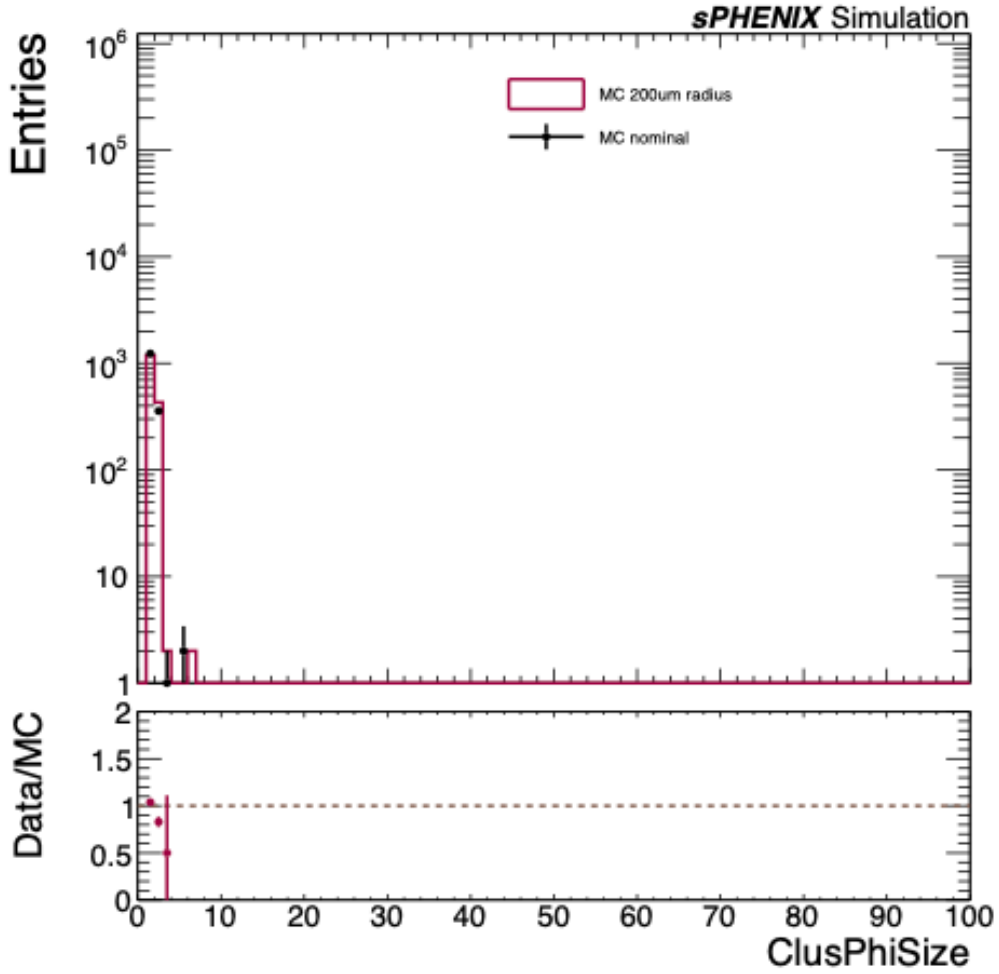
Changes to the core software: PHG4InttHitReco.cc

```
diffusion_width = 5.0e-04
→
diffusion_width = 200.0e-04
```

Commented out:

```
if (maxstrip_y - minstrip_y > 12 || maxstrip_z - minstrip_z > 12)
```

Result



Framework check

- Diffusion radius modification
  → different Cluster Phi Size distribution
- Larger radius → larger ClusPhiSize

Summary & Next steps

- Framework for studying diffusion implementation ready
  - Particle gun generator
- In process of understanding and optimization
  - Modify the function
  - Add some fluctuations in diffusion radius
- Use beam test data for comparison