Intrinsic resolution of SVD using simulated event

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Intrinsic resolution of strip detector

It depends on

- Strip pitch
- Charge sharing
  - Diffusion during charge collection
  - Capacitative charge coupling between strips
  - Inclination of track

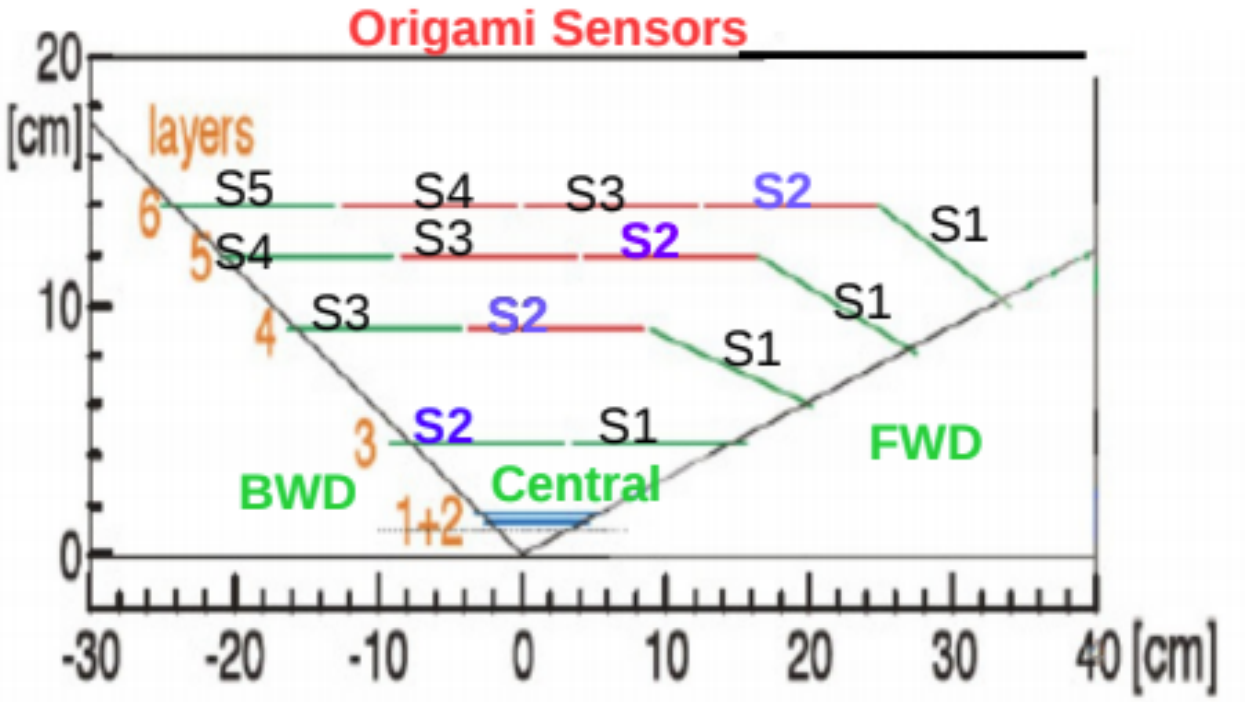
Event generation

Parameter choosen for event generation using particle gun module

- vertex parameter unformlay distributed (x=[-3.00,3.00],y=[-3.00,3.00],**z[-15cm,20cm])**
- theta uniform distribution in range [17,150] deg
- phi normal distribution with $\mu = 0$ deg $\sigma = 10$ deg
- pdg code 211,-211
- momentum normal distribution with $\mu = 0.5$ Gev and $\sigma = 0.1$ Gev
- number of track per event is one
- Phase2 geometry used

I have used all clusters to get and corresponding truehit to get residual

Sensors

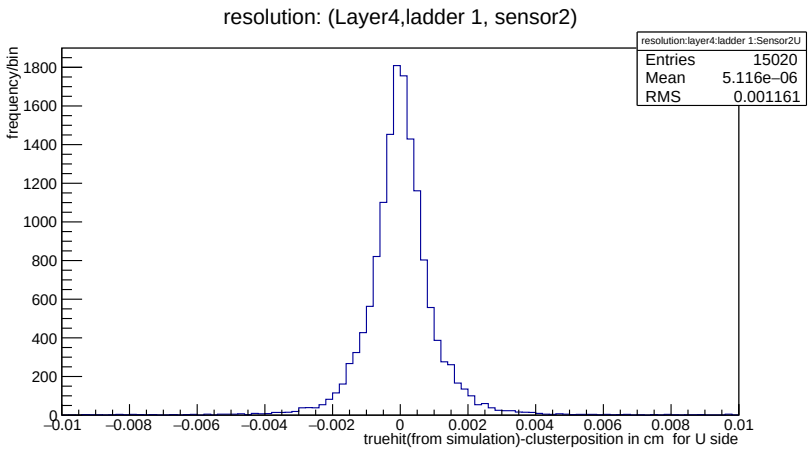

Origami Sensors
20
[cm]
layers
6
S5
S4
S3
S2
S1
5
S4
S3
S2
S1
10
4
S3
S2
S1
3
S2
S1
FWD
BWD
Central
1+2
0
-30
-20
-10
0
10
20
30
40 [cm]

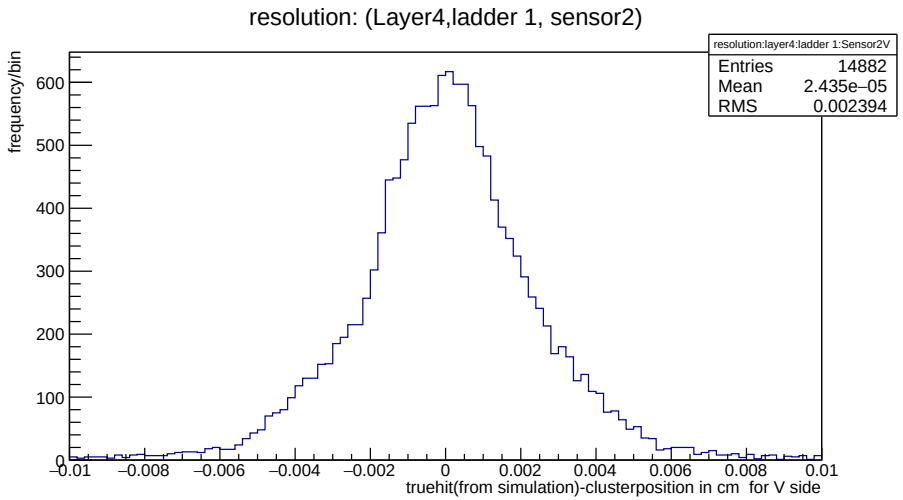
Checked the histogram of residual using three different way

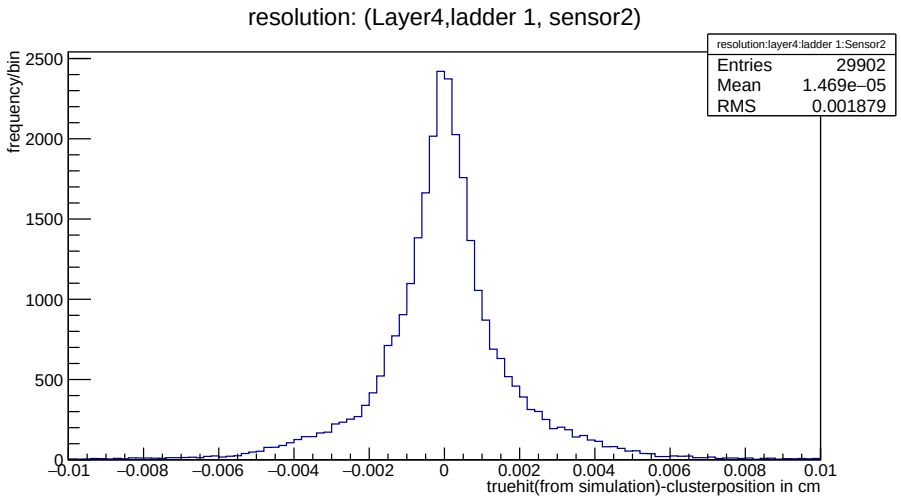
- Taking all clusters and defining residual as cluster position–true hit position
- Taking track related clusters and defining residual as cluster position–true hit position
- Taking clusters and linking these clusters with SVDIntercepts through RecoTrack(effectively track related clusters) and defining residual as cluster position–svd intercept position

overall intrinsic resolution using all clusters(Methos 1)

- layer4,ladder1,sensor2



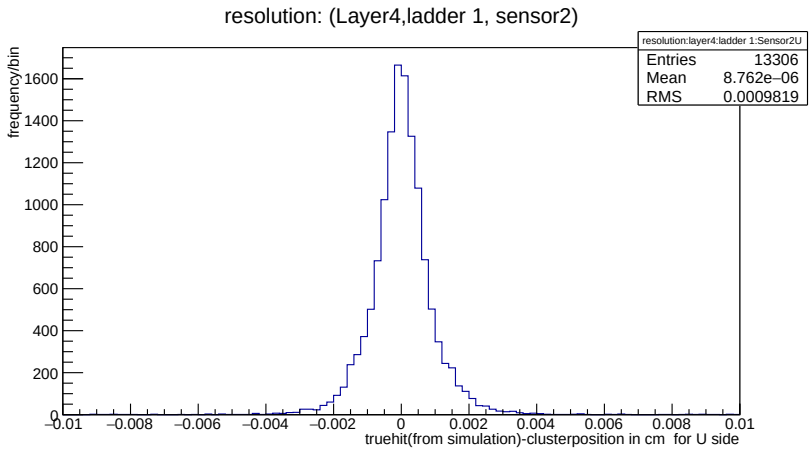


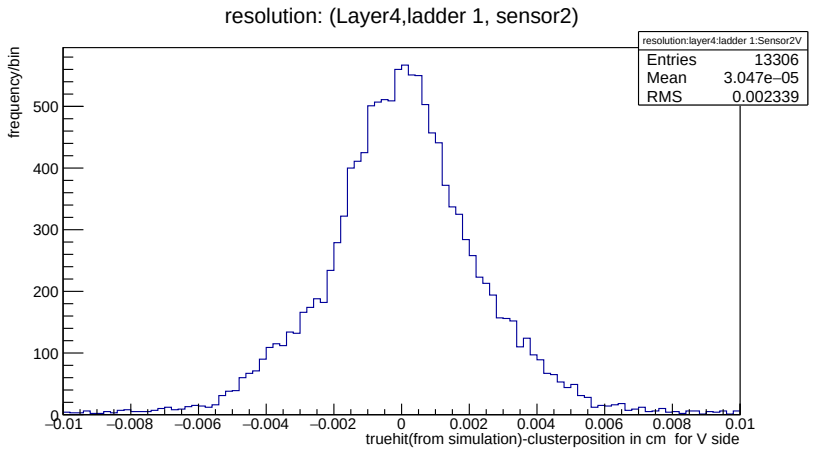


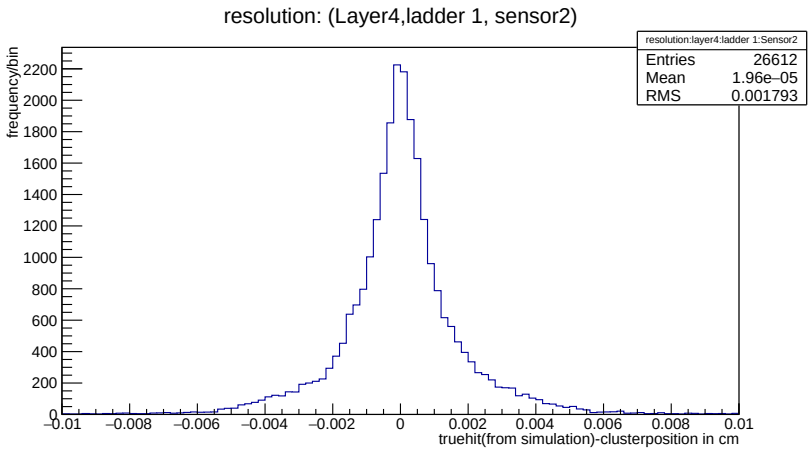
RMS of residuals:11μm(only U),23μm(only V),18μm(U+V)

overall intrinsic resolution Method 2

- layer4,ladder1,sensor2



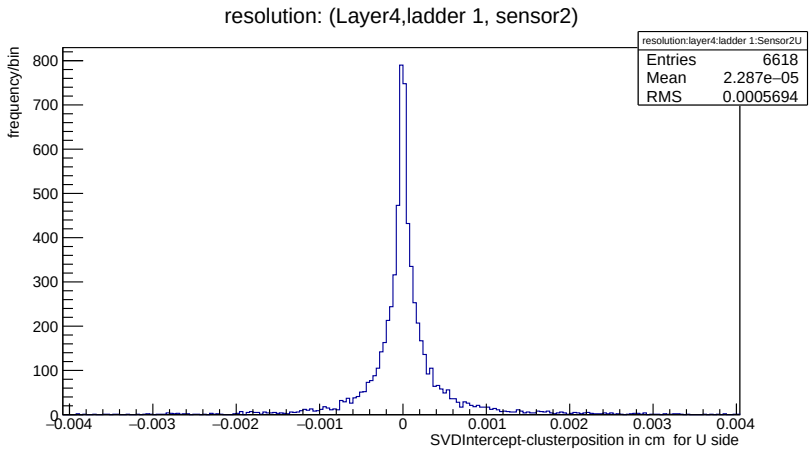


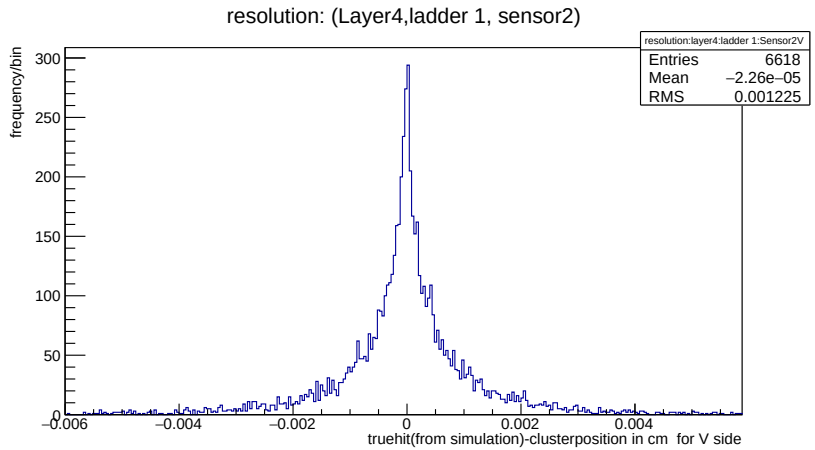


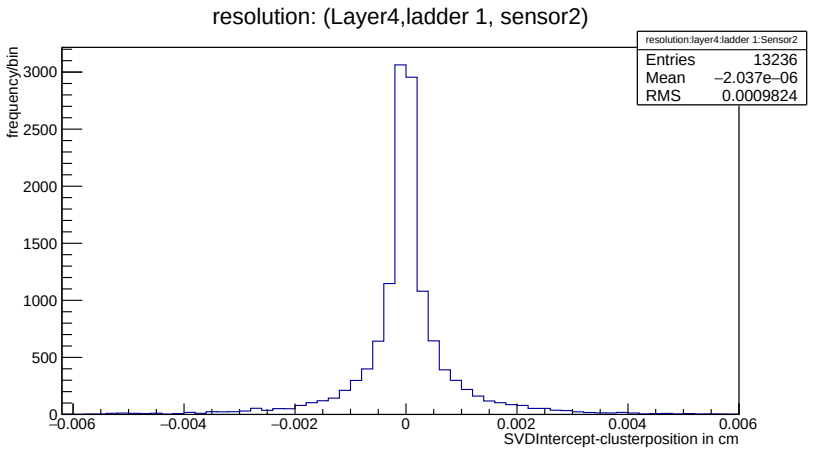
RMS of residuals:9.8μm(only U),23μm(only V),17μm(U+V)

overall intrinsic resolution Method 3

- layer4,ladder1,sensor2







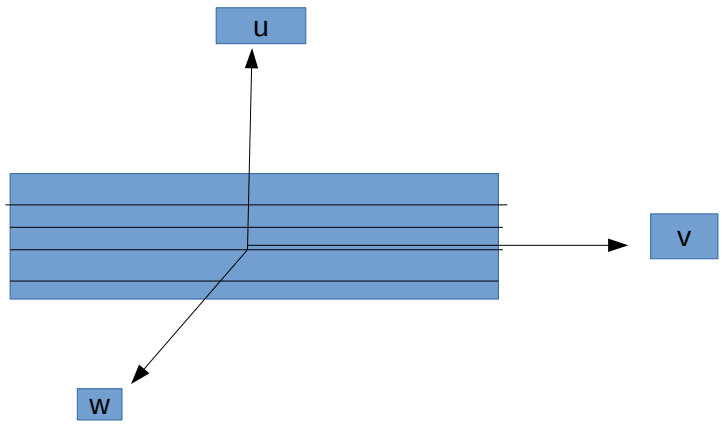
RMS of residuals:5μm(only U),14μm(only V),8μm(U+V)

Table containg resolution using these three method

Layer Ladder Sensor Side	Resolution using Method 1	Resolution using Method 2	Resolution using Method 3
3 1 1 U	18.34	12.47	3.20
3 1 1 V	20.92	20.00	9.33
3 1 1 U+V	19.67	16.67	6.9
3 1 2 U	17.94	12.78	2.75
3 1 2 V	20.23	19.28	7.56
3 1 2 U+V	19.13	16.37	5.69
4 1 2 U	11.61	9.81	7.27
4 1 2 V	23.93	23.59	14.12
4 1 2 U+V	18.79	17.92	11.23
4 1 3 U	11.08	9.27	6.08
4 1 3 V	24.04	23.0	13.4
4 1 3 U+V	18.70	17.54	10.4

definig θ and ϕ

- Define a co-ordinate system uvw where U_co-ordinate is a measure of U_side cluster position (U axis perpendicular to U side strips/long strips) and V_co-ordinate is a measure of V_side cluster position (V axis perpendicular to V side strip strip/short strips) and W co-ordinate is perpendicular to the sensor plane

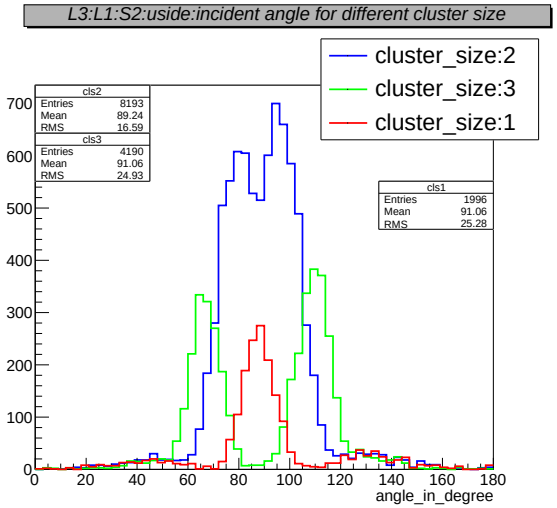


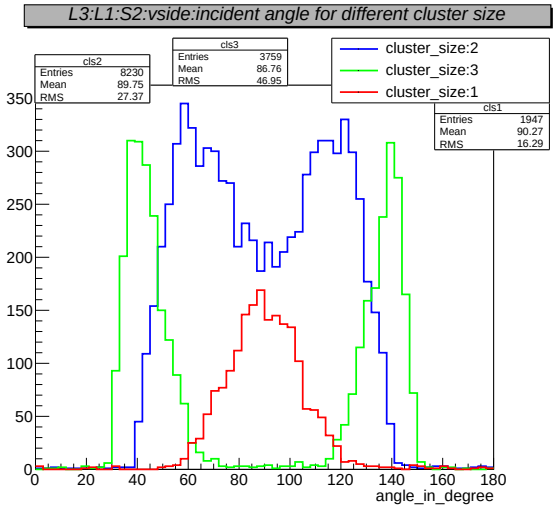
define θ and ϕ

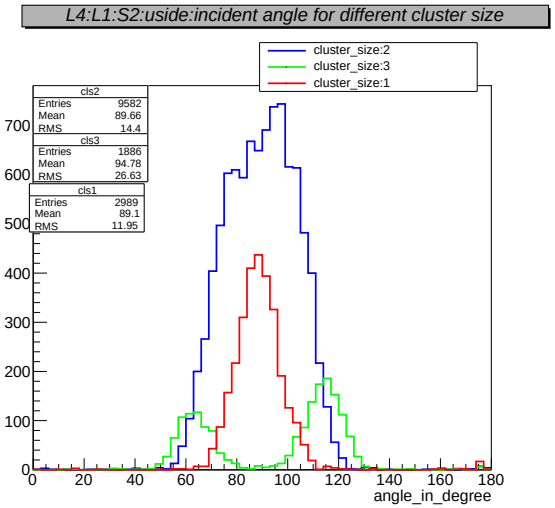
- θ' is angle between w axis and and track projected in vw plane.
- direction of track inside sensor is measured by $p = \frac{(p_{entry}+p_{exit})}{2}$
- to project it on vw plane $p_\theta = (0, p_v, p_w)$
- $\cos\theta' = \frac{\vec{p_\theta}\cdot\hat{w}}{|\vec{p_\theta}|}$
- if $p_v > 0$ then $\theta = 90 + \theta'$ and if $p_v < 0$, $\theta = 90 - \theta'$

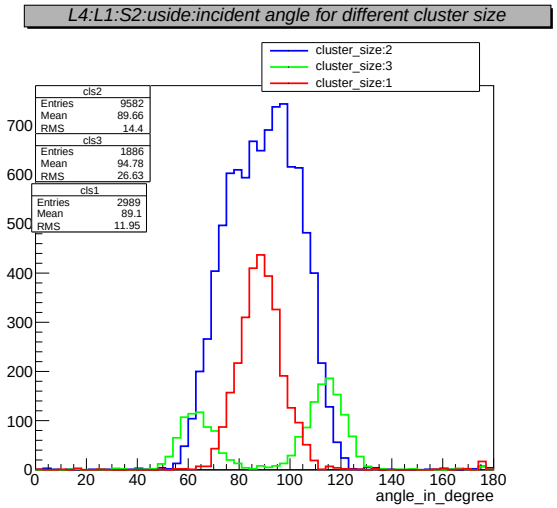
clustersize at different incident angle

- layer3/4,ladder1,sensor2 uside/vside cluster
- for v side plotted against θ and for u side plotted against ϕ
- Method:1



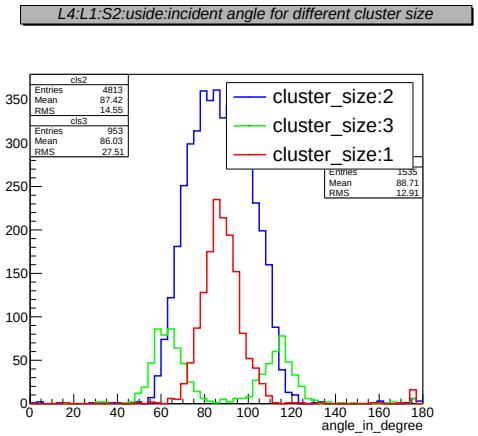




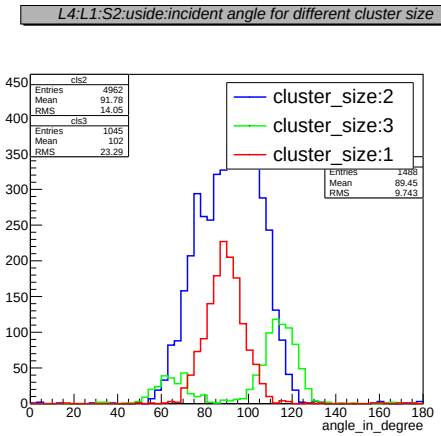


clustersize at different incident angle(ϕ) for MC

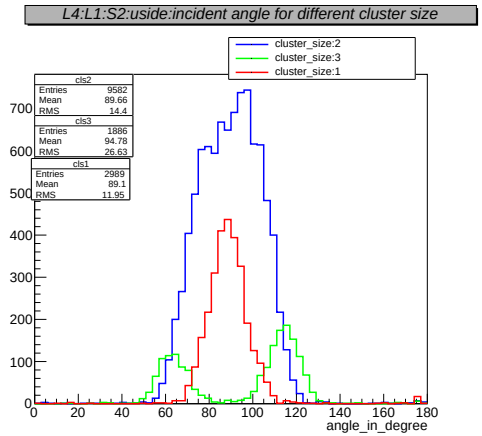
- layer4,ladder1,sensor2 uside/vside cluster



(a) π^+



(b) π^-

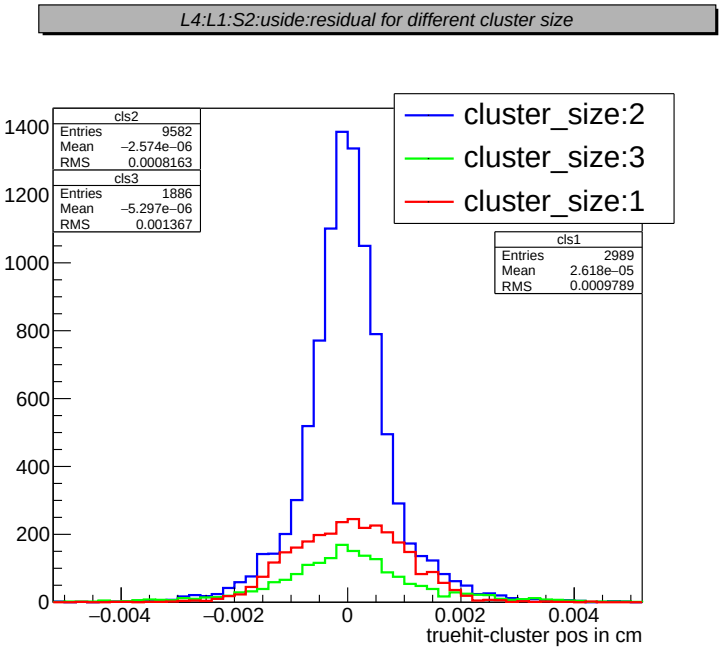


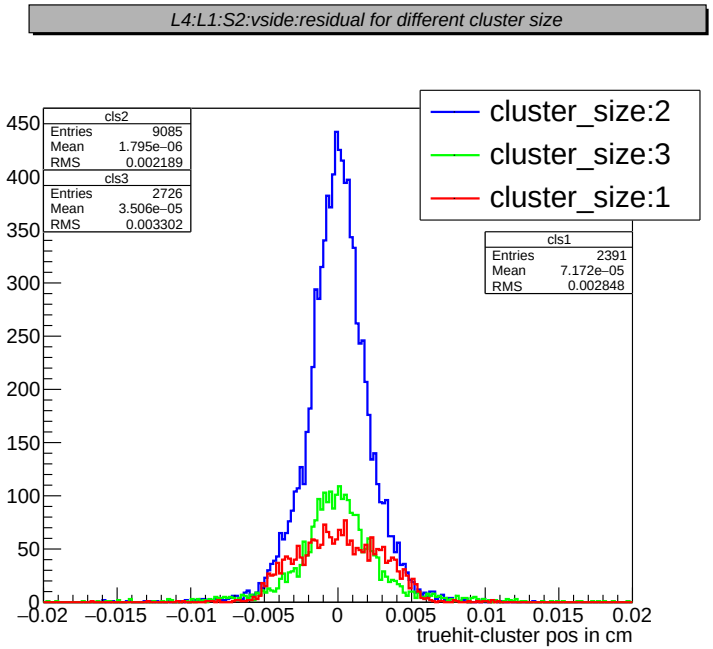
(c) π^+ and π^-

Cause of Assymetry?

Resolution(SVDTrueHit–Cluster) for different cluster size

- layer4,ladder1,sensor2 uside/vside cluster





So clustersize2 has best resolutoin relative to clustersize1/clustersize3

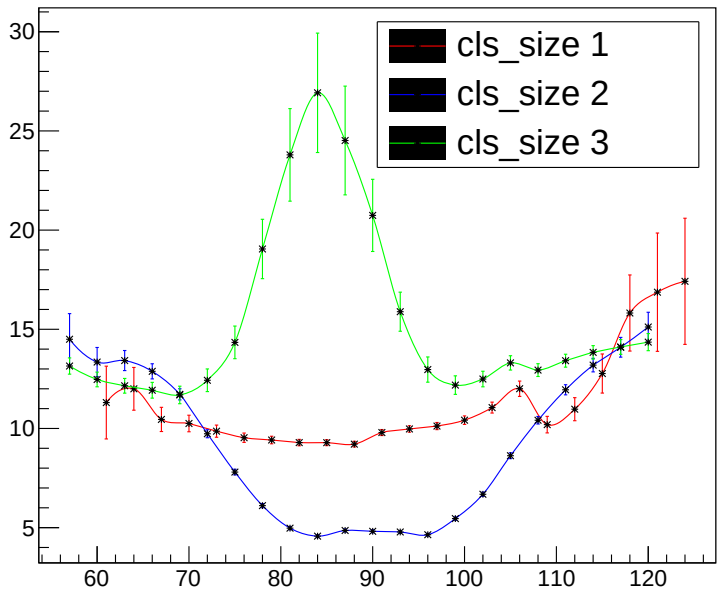
Resolution(SVDTrueHit–Cluster) for different cluster size

- layer4,ladder1,sensor2

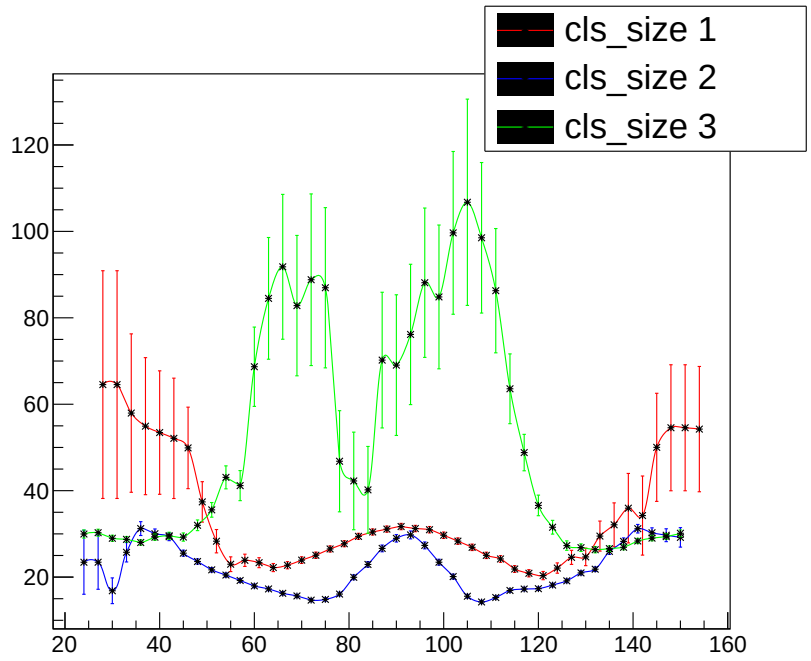
u/v	cluster size	residual rms(in μm)
v	1	28
	2	21
	3	33
u	1	9
	2	8
	3	13

Resolution(SVDTrueHit–Cluster) as a function of incident angle

- layer4,ladder1,sensor2 uside/vside cluster
- for v side plotted against θ and for u side plotted against ϕ



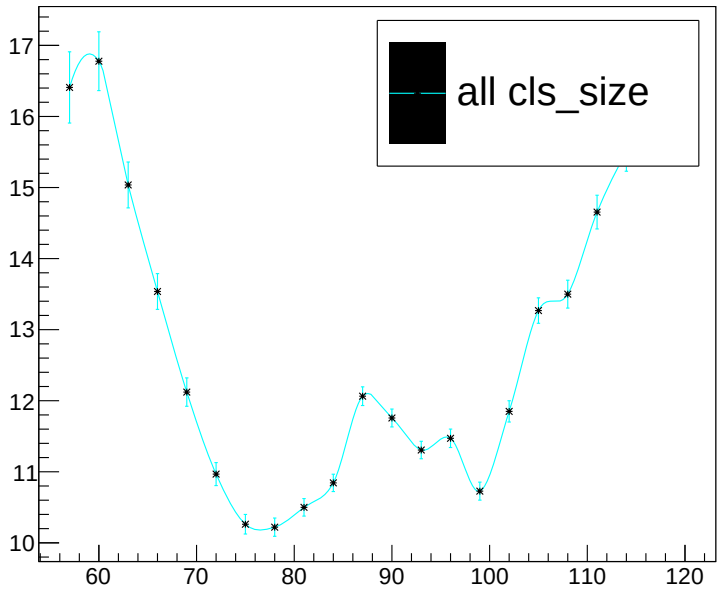
(a) U side



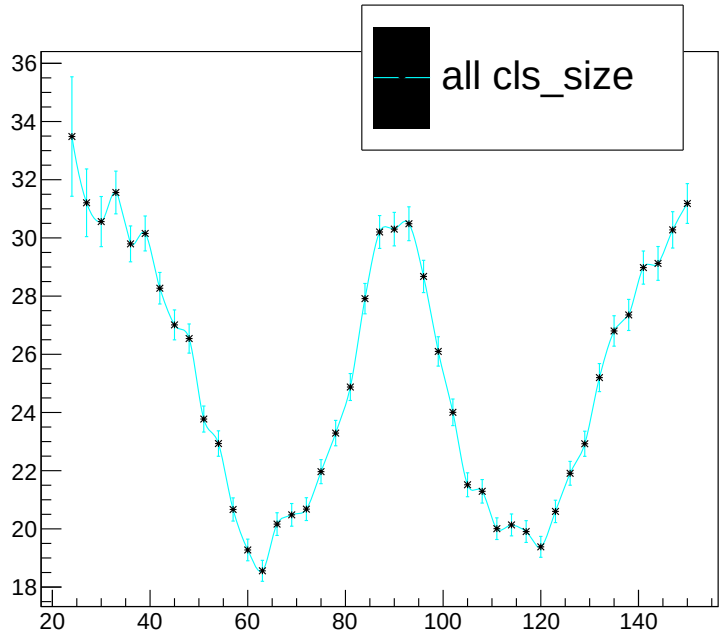
(b) V side

Resolution(SVDTrueHit–Cluster) as a function of incident angle

- layer4,ladder1,sensor2 uside/vside cluster



(a) U side



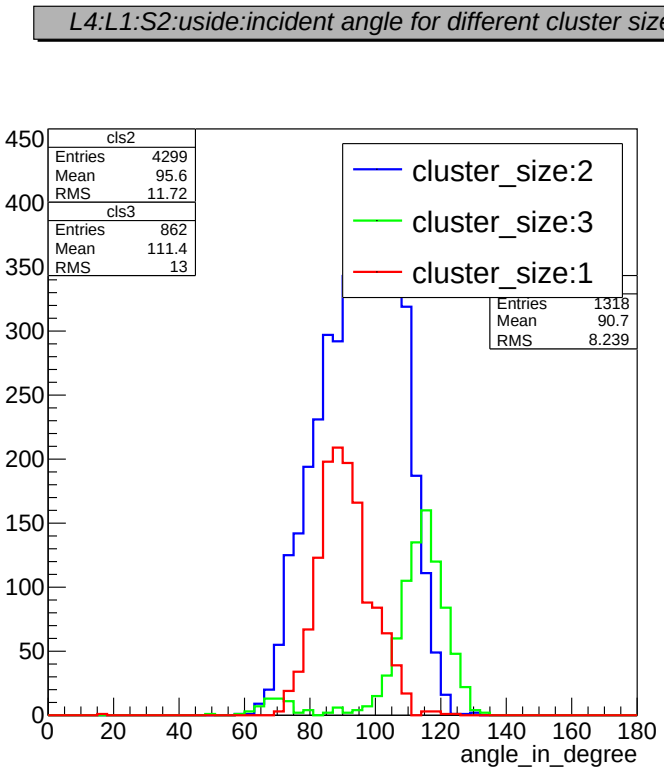
(b) V side

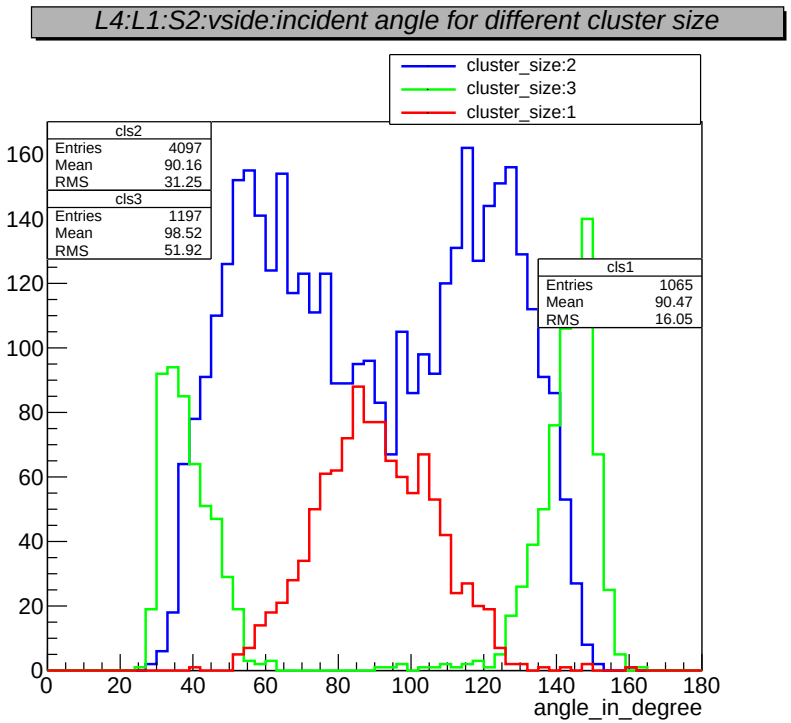
Large pitch vs small pitch

Method 3

clustersize at different incident angle(θ/ϕ)

- layer4,ladder1,sensor2 uside/vside cluster
- θ/ϕ calculated from SVDTrueHit

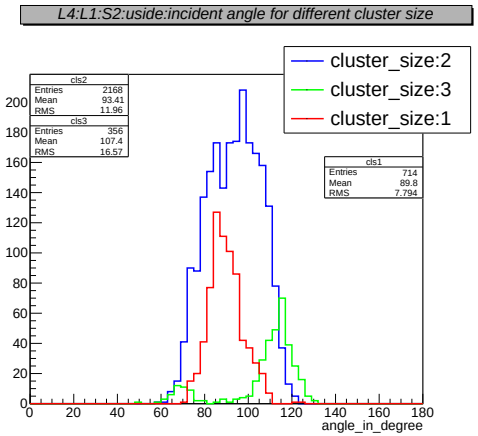




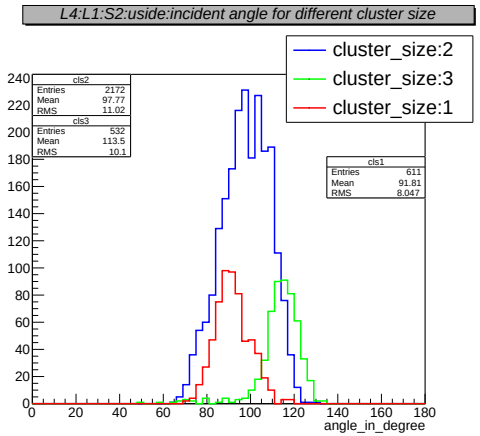
Assymetry for U side !! Repeat for π^+ and π^- individually

clustersize at different incident angle(ϕ)

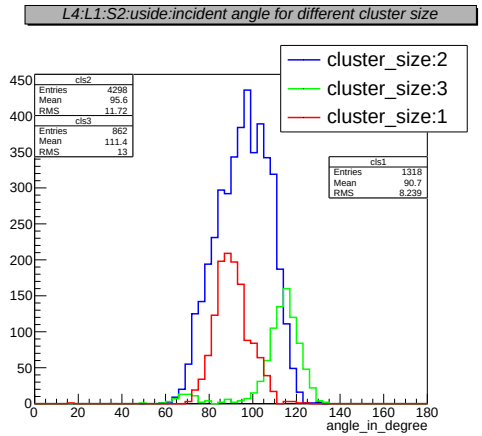
- layer4,ladder1,sensor2 uside/vside cluster



(a) π^+



(b) π^-

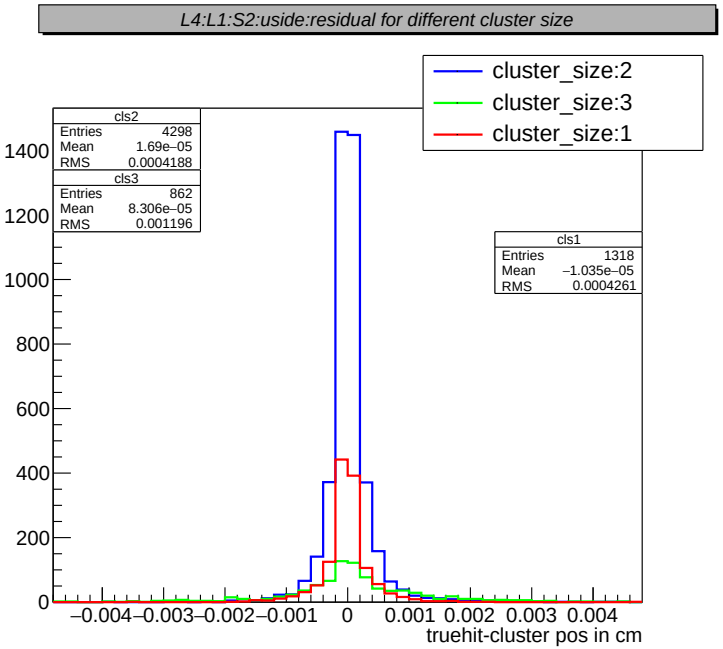


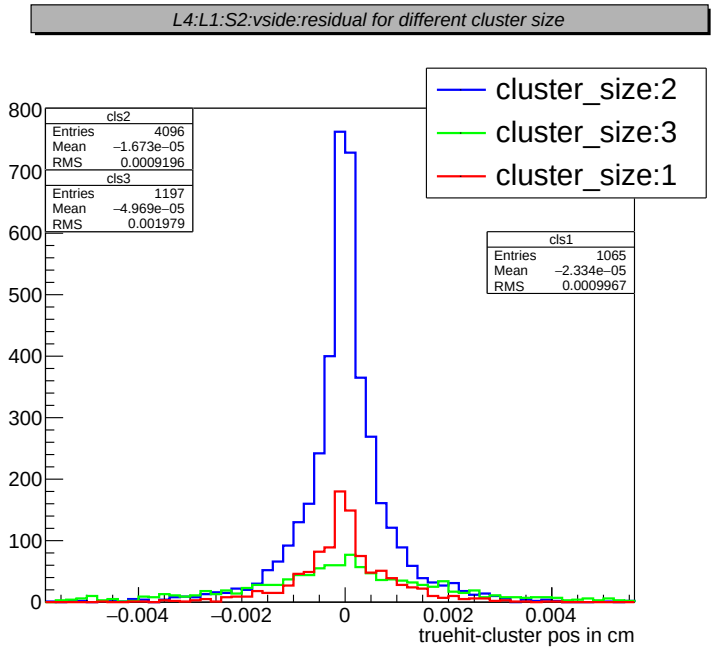
(c) π^+ and π^-

Cause of Assymetry?

Resolution(SVDIntercept–Cluster) for different cluster size

- layer4,ladder1,sensor2 uside/vside cluster





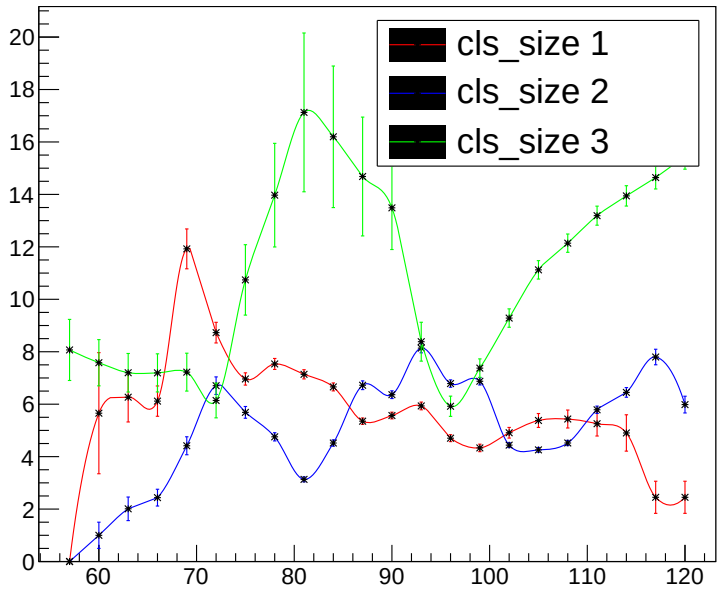
Resolution(SVDIntercept–Cluster) for different cluster size

- layer4,ladder1,sensor2

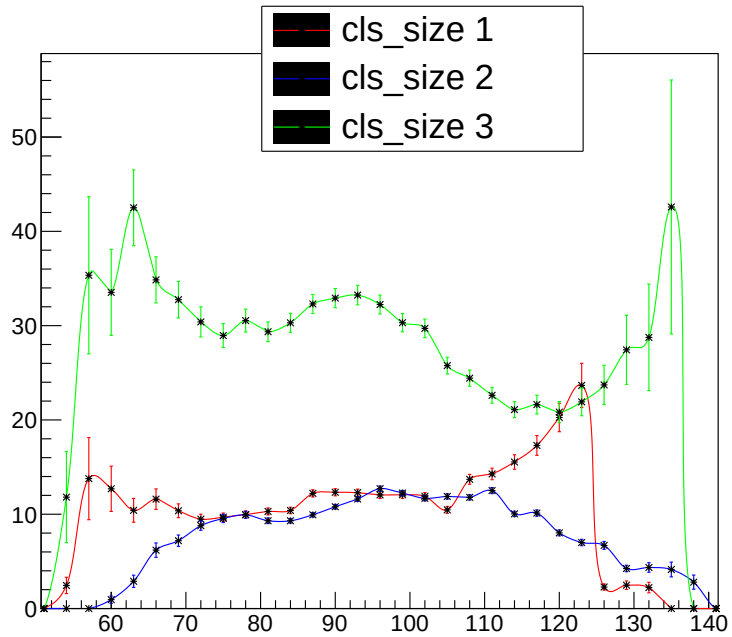
u/v	cluster size	residual rms(in μm)
v	1	10
	2	9
	3	19
u	1	4.2
	2	4.1
	3	11.9

Resolution(SVDIntercept–Cluster) as a function of incident angle

- layer4,ladder1,sensor2 uside/vside cluster



(a) U side



(b) V side

Large pitch vs small pitch

Thank You

We need

- θ and ϕ from track

Screenshot of module

- layer4,ladder1,sensor2 uside/vside cluster

```
void intrinsic_Res_MCModule::event(){
 const StoreArray<SVDCluster> cluster("SVDClusters");
  for(int i=0;i<cluster.getEntries();i++){
      RelationVector<SVDTrueHit> truehit = cluster[i]->getRelationsTo<SVDTrueHit>("SVDTrueHits");  //loin
      if(truehit.size()==0) continue;
      float res;
      VxdID theVxdID = cluster[i]->getSensorID();
      if (cluster[i]->isUCluster())
          res = (truehit[0]->getU()-cluster[i]->getPosition(cluster[i]->isUCluster()));
      else
          res =(truehit[0]->getV()-cluster[i]->getPosition(cluster[i]->isUCluster()));   //residual=trueh
      int sensor_num=theVxdID.getSensorNumber()-1;
      int layer_num = theVxdID.getLayerNumber()-3;
      int ladder_num =  theVxdID.getLadderNumber()-1;
      int size=cluster[i]->getSize();
      TVector3 p_true=(truehit[0]->getExitMomentum()+truehit[0]->getEntryMomentum());
      TVector3 phi_p(0,p_true(1),p_true(2));
      TVector3 theta_p(p_true(0),0,p_true(2));
      TVector3 z_unit(0,0,1);
      //float angle_truhit=57.29578*(z_unit.Angle(p_true));
      float theta=57.29578*(z_unit.Angle(theta_p));
      if(theta_p(0)>0) theta=theta+90;
      else theta=90-theta;//check it
      float phi=57.29578*(z_unit.Angle(phi_p));
      if(phi_p(1)>0) phi=phi+90;
      else phi=90-phi;//check it
      //B2INFO("theta:"<<theta<<"  phi:"<<phi);
      // if(theta>180 || theta<0 || phi >180 || phi<0) B2INFO(p_true(0)<<" "<<p_true(1)<<" "<<p_true(2));
       if(cluster[i]->isUCluster()){
            resangleu[layer_num][ladder_num][sensor_num]->Fill(theta,res);
            size_res_u[layer_num][ladder_num][sensor_num]->Fill(res,size);
            angle_size_u[layer_num][ladder_num][sensor_num]->Fill(theta,size);
            angle_res_sizeu[layer_num][ladder_num][sensor_num]->Fill(theta,res,size);
           }
        else{
            resanglev[layer_num][ladder_num][sensor_num]->Fill(phi,res);
            size_res_v[layer_num][ladder_num][sensor_num]->Fill(res,size);
            angle_size_v[layer_num][ladder_num][sensor_num]->Fill(phi,size);
            angle_res_sizev[layer_num][ladder_num][sensor_num]->Fill(phi,res,size);
          }
      histosoumen[layer_num][ladder_num][sensor_num]->Fill(res);
      if(cluster[i]->isUCluster()==1 ) histosoumenu[layer_num][ladder_num][sensor_num]->Fill(res);
      if(cluster[i]->isUCluster()==0 ) histosoumenv[layer_num][ladder_num][sensor_num]->Fill(res);
       }
```