

DVCS Geant4 Simulation Update

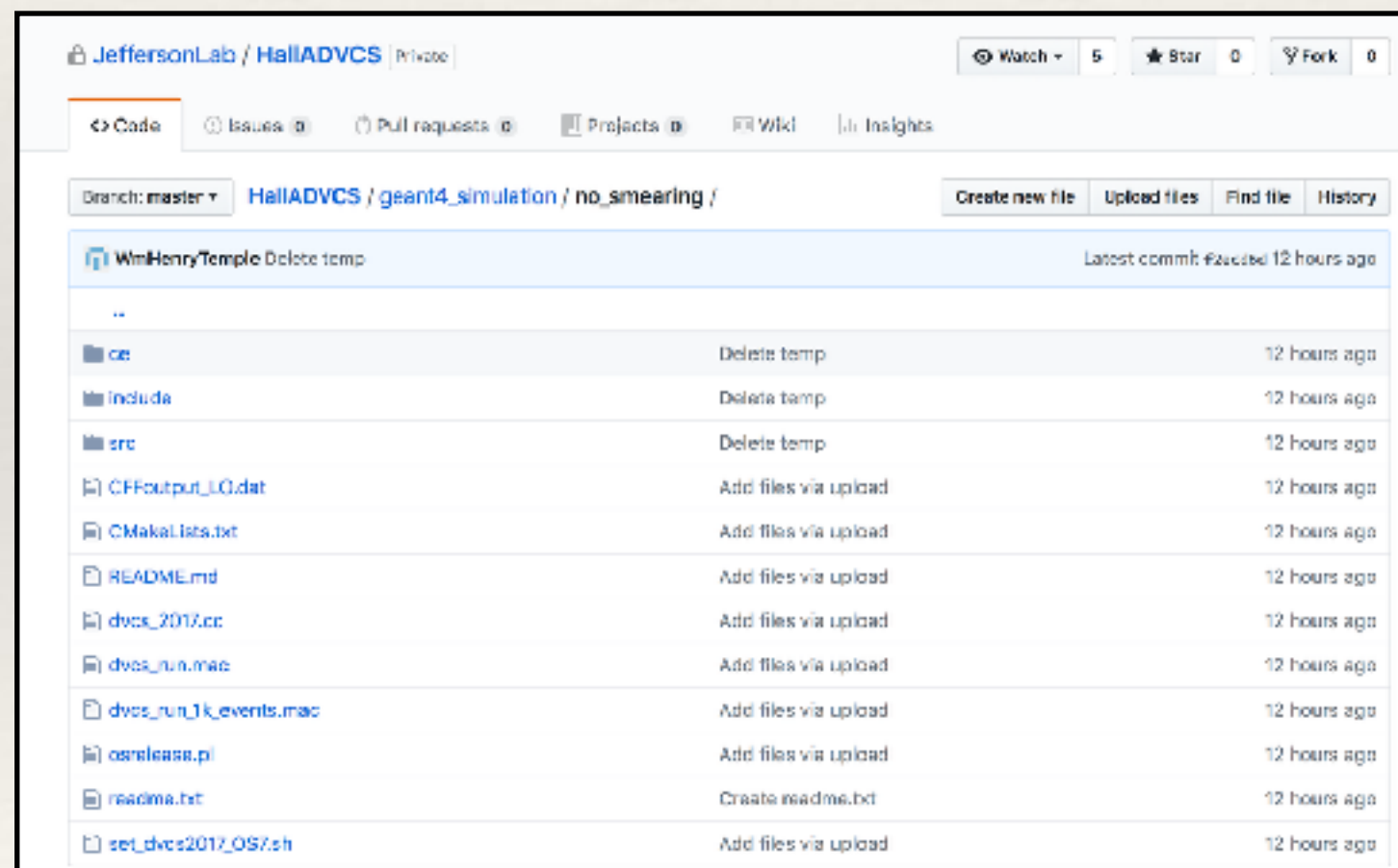
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Temple University

Advisors- Jim Napolitano and Don Jones

Getting and Running the Code

```
ifarm1401.jlab.org> git clone https://github.com/JeffersonLab/HallADVCS
ifarm1401.jlab.org> cd HallADVCS/geant4_simulation/no_smearing/
ifarm1401.jlab.org> chmod 774 osrelease.pl
ifarm1401.jlab.org> source set_dvcs2017_OS7.sh
ifarm1401.jlab.org> cmake .
ifarm1401.jlab.org> make
ifarm1401.jlab.org> ./dvcs_2017 dvcs_run_1k_events.mac 482
```



Recent Changes to Code

```
//HRS_angle  
Double_t ry = -0.01*smear_vertz*TMath::Sin(TMath::ATan2(Px[4],Pz[4])); // 0.  
Double_t rdp= (sqrt(Px[4]*Px[4]+Py[4]*Py[4]+Pz[4]*Pz[4])-pcentral)/pcentral;  
Double_t rtheta = TMath::ATan2(-Py[4],TMath::Sqrt(Px[4]*Px[4]+Pz[4]*Pz[4]));  
Double_t rphi = TMath::ATan2(Px[4],Pz[4]) - HRS_angle;  
//R_function *rfunc_gula= new R_function(Form("/lustre/exp/phy/volatile/halla/  
//double r_val = rfunc_gula->Global_R_function(rphi,rdp,rtheta,ry); //dvcs_event  
double r_val = RFunction(run,rtheta,rdp,rphi,ry); //Alexa's Rfunction/  
hist_man->SetRvalRec(r_val);
```

- Implemented Alexa's R-Function
- corrected error in DVCSEventAction.cc (Elog 473)

```
calo_event->GetCluster(k)->Analyze();  
*L_calophot = dvcs_event->GetPhoton(k, 7, 0);  
//*L_calophot = 1.04*(*L_calophot);
```

- Removed 4% “correction” to photon energy

```
//dvcs_event->SetVertex(0, 0, smear_vertz);  
dvcs_event->SetVertex(0, 0, vert_z);
```

- Removed z vertex smearing

```
// block->SetBlockEnergy(rand2.Gaus(calo_edep[j], sqrt(calo_edep[j]/175.)));  
block->SetBlockEnergy(calo_edep[j]);
```

- Removed smearing of energy deposited in calorimeter blocks

Using Auger

```
ifarm1402.jlab.org>
ifarm1402.jlab.org> pwd
/w/halla-scifs17exp/dvcs/disk1/bill/geant4/workingOS7/ROOTFiles
ifarm1402.jlab.org> ls
353 361 362 363 481 482 483 484 601 603
ifarm1402.jlab.org> cd 361
ifarm1402.jlab.org> ls
run10jobs.sh temp1 temp2 temp4 temp6 temp8
run10jobs.sh~ temp10 temp3 temp5 temp7 temp9
ifarm1402.jlab.org> ls temp1
cv dvcs_2017.root dvcs_sim_kinel.root out.txt.tmp test.jsub
CP3output_10.dat dvcs_run.log myJob.sh quickCheck.sh
dvcs_2017 dvcs_run.mac parseIssues.pl quick.mac
ifarm1402.jlab.org> source run10jobs.sh
Parsing script ... (it may take while)
<jsub><request><index>23852033</index><jobIndex>48465147</jobIndex></request></jsub>
Parsing script ... (it may take while)
<jsub><request><index>23852034</index><jobIndex>48465148</jobIndex></request></jsub>
Parsing script ... (it may take while)
<jsub><request><index>23852035</index><jobIndex>48465149</jobIndex></request></jsub>
Parsing script ... (it may take while)
<jsub><request><index>23852036</index><jobIndex>48465150</jobIndex></request></jsub>
Parsing script ... (it may take while)
<jsub><request><index>23852037</index><jobIndex>48465151</jobIndex></request></jsub>
Parsing script ... (it may take while)
<jsub><request><index>23852038</index><jobIndex>48465152</jobIndex></request></jsub>
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<jsub><request><index>23852039</index><jobIndex>48465153</jobIndex></request></jsub>
Parsing script ... (it may take while)
<jsub><request><index>23852040</index><jobIndex>48465154</jobIndex></request></jsub>
Parsing script ... (it may take while)
<jsub><request><index>23852041</index><jobIndex>48465155</jobIndex></request></jsub>
Parsing script ... (it may take while)
<jsub><request><index>23852042</index><jobIndex>48465156</jobIndex></request></jsub>
ifarm1402.jlab.org> hadd sim361 nosmear.root temp/*.root
hadd Target file: sim361 nosmear.root
hadd Source file 1: temp10/dvcs_sim_kinel.root
hadd Source file 2: temp1/dvcs_sim_kinel.root
hadd Source file 3: temp2/dvcs_sim_kinel.root
hadd Source file 4: temp3/dvcs_sim_kinel.root
hadd Source file 5: temp4/dvcs_sim_kinel.root
hadd Source file 6: temp5/dvcs_sim_kinel.root
hadd Source file 7: temp6/dvcs_sim_kinel.root
hadd Source file 8: temp7/dvcs_sim_kinel.root
hadd Source file 9: temp8/dvcs_sim_kinel.root
hadd Source file 10: temp9/dvcs_sim_kinel.root
hadd Target path: sim361_nosmear.root:/
ifarm1402.jlab.org>
```

- By running 10 smaller jobs one can simulate a production data run in a couple of hours
- After the jobs finish I combine the ROOT files with hadd
- Combined files are about 100 MB

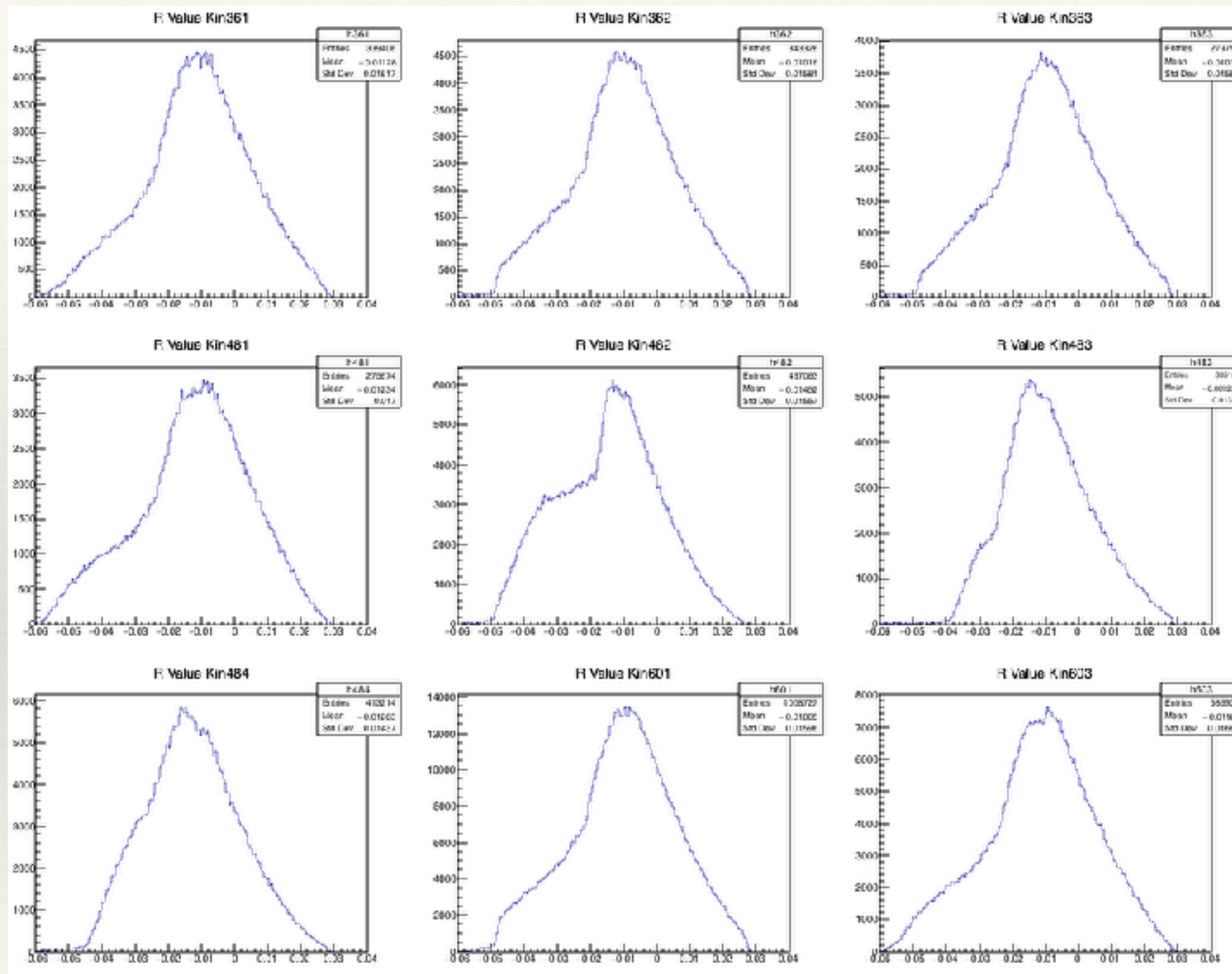
Events Simulated

Simulated 100M events for each setting

Kinematic Setting	Beam Energy	Calo dist (cm)	Calo Angle (deg)	HRS Angle	HRS Momentum	DVCS Events Simulated
361	7.36105	150	10.592	22.8302	2.71007	339,496
362	8.517	200	11.635	20.985	3.187	343,326
363	10.617	250	10.618	18.675	3.998	279,752
481	4.48	150	15.198	37.14	1.485	275,675
482	8.843	200	15.184	20.244	3.996	437,065
483	8.843	250	11.728	26.271	2.92	335,188
484	11	250	10.069	24.925	3.36	413,215
601	8.517	150	15.892	24.564	3.594	1,008,727
603	10.617	250	11.014	29.004	3.154	586,937

ROOT Files stored in /work/halla/dvcs/disk1/bill/geant4/workingOS7/ROOTFiles

R-Values(Alexa) Implemented

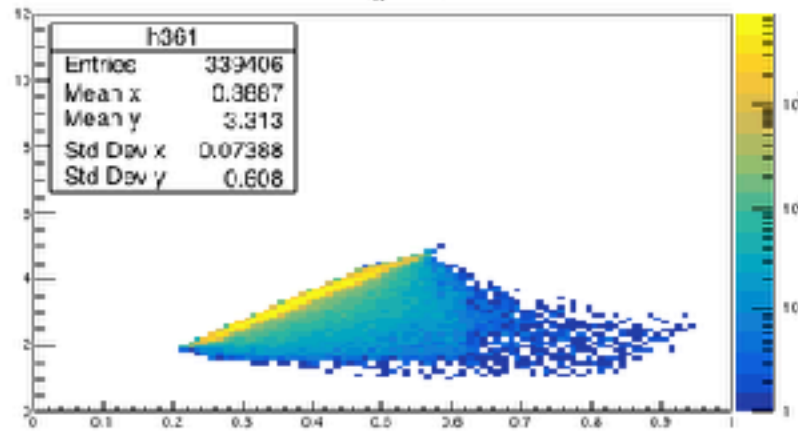


Root File Branches

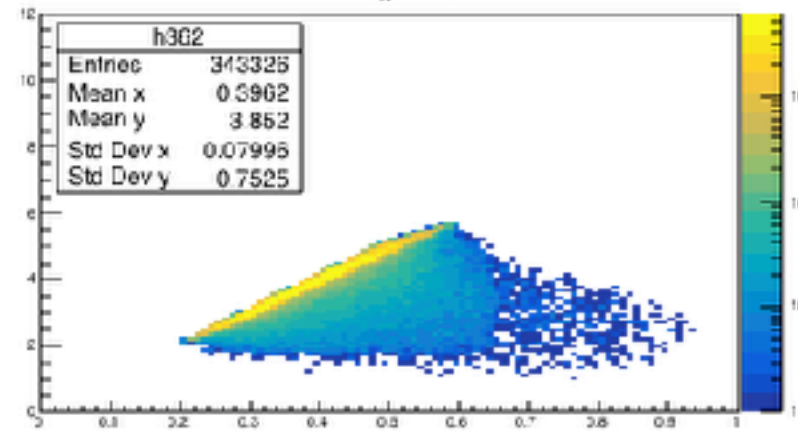
ene	Energy of the cluster in the calo	TCaloEvent Class
xc	X coordinate of the cluster	TCaloEvent Class
yc	Y coordinate of the cluster	TCaloEvent Class
mm2	missing mass square $ep \rightarrow e\gamma X$	Calculated in dvcsEventAction::EndOfRunAction
size	number of blocks in the cluster	TCaloEvent Class
psf	phase space factor $\Delta Q^2 \times \Delta x_B \Delta t \Delta \phi_e \Delta \phi_\gamma$	dvcsEventAction::DefineWeights
kx	X component of reconstructed beam momentum	0
ky	Y component of reconstructed beam momentum	0
kz	Z component of reconstructed beam momentum	EBeam
kx_v	X component of beam momentum at production vertex	Px[0]
ky_v	Y component of beam momentum at production vertex	Py[0]
kz_v	Z component of beam momentum at production vertex	Pz[0]
kpx	X component of electron's momentum when it reaches HRS window	Px[4] Invoked in Stepping Action
kpy	Y component of electron's momentum when it reaches HRS window	Py[4]
kpz	Z component of electron's momentum when it reaches HRS window	Pz[4]
kpx_v	X component of electron's momentum at production vertex	Px[1]
kpy_v	Y component of electron's momentum at production vertex	Py[1]
kpz_v	Z component of electron's momentum at production vertex	Pz[1]
qx	X component of reconstructed photon's momentum	TDVCSEvent::GetPhoton
qy	Y component of reconstructed photon's momentum	TDVCSEvent::GetPhoton
qz	Z component of reconstructed photon's momentum	TDVCSEvent::GetPhoton
qx_v	X component of photon's momentum at production vertex	Px[2]
qy_v	Y component of photon's momentum at production vertex	Py[2]
qz_v	Z component of photon's momentum at production vertex	Pz[2]
vz	reconstructed vertex z coordinate	1 smeared vertex
vz_v	vertex z coordinate at production vertex	dvcsPrimaryGeneratorAction
t	reconstructed t	Calculated in dvcsEventAction::EndOfRunAction
t_v	t at production vertex	Calculated in dvcsEventAction::EndOfRunAction
xB	reconstructed xB	Calculated in dvcsEventAction::EndOfRunAction
xB_v	xB at production vertex	Calculated in dvcsEventAction::EndOfRunAction
q2	reconstructed q2	Calculated in dvcsEventAction::EndOfRunAction
q2_v	q2 at production vertex	Calculated in dvcsEventAction::EndOfRunAction
phi	reconstructed phi (angle between leptonic and hadronic planes)	Calculated in dvcsEventAction::EndOfRunAction
phi_v	phi at production vertex	Calculated in dvcsEventAction::EndOfRunAction
crs_sum	total unpolarised cross section	Calculated in dvcsEventAction::EndOfRunAction
crs_dif	cross section difference between two beam helicities	dvcsEventAction::DefineWeights
rval	reconstructed r_values (used for HRS fiducial cuts)	dvcsEventAction::DefineWeights
rval_v	r_value at production vertex	dvcsEventAction::DefineHRS_em
		dvcsEventAction::DefineHRS_em

Kinematic Coverage

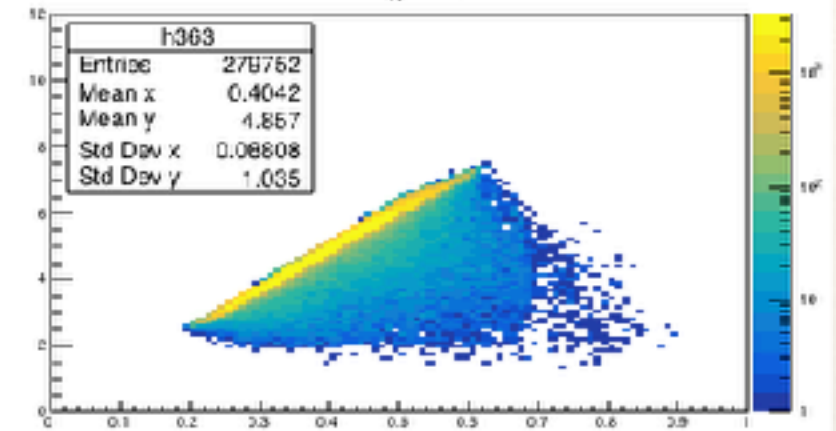
Q^2 vs X_N Kin361



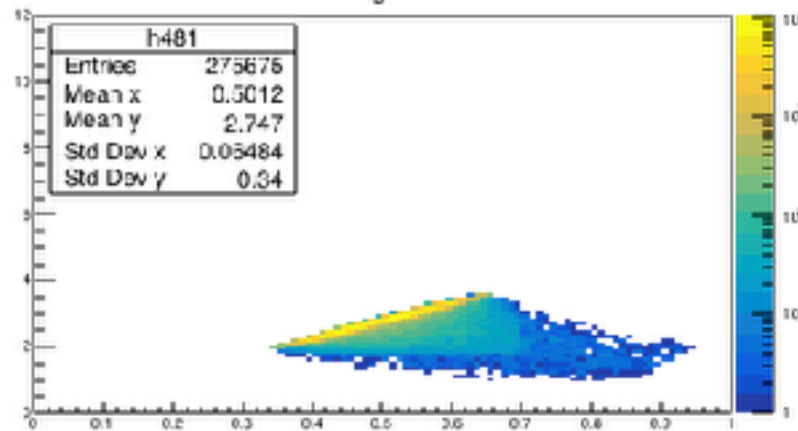
Q^2 vs X_N Kin362



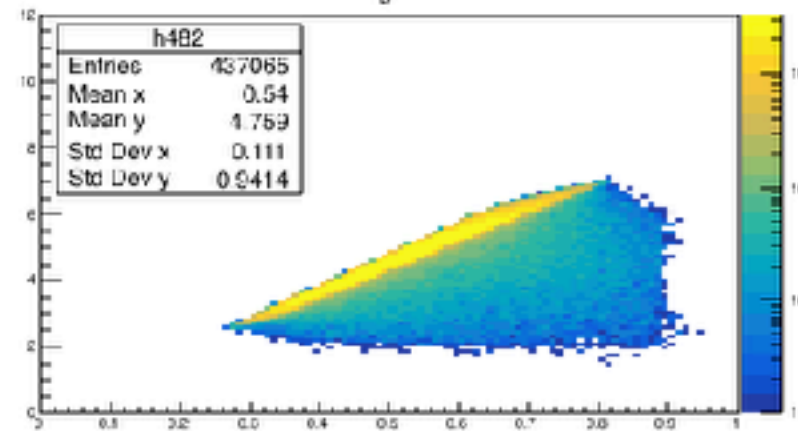
Q^2 vs X_N Kin363



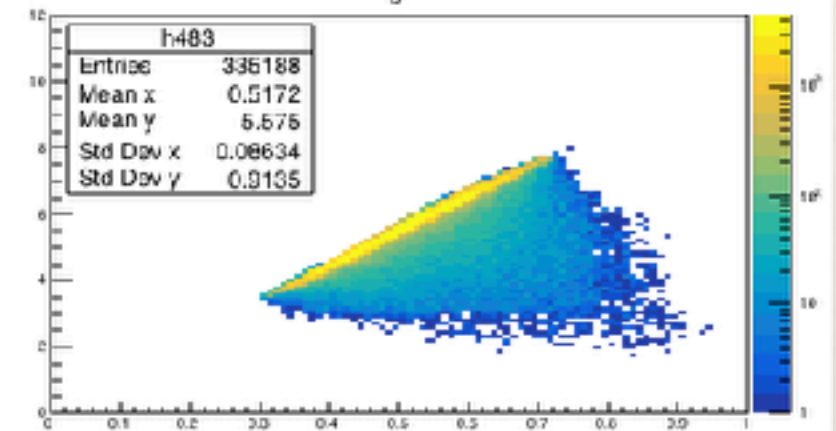
Q^2 vs X_N Kin481



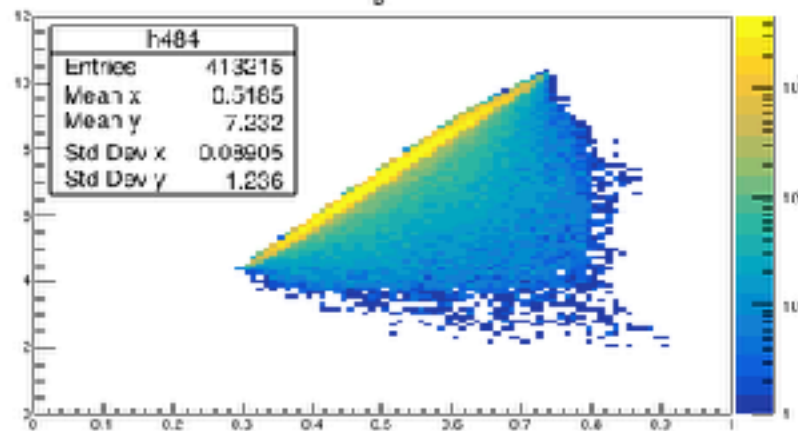
Q^2 vs X_N Kin482



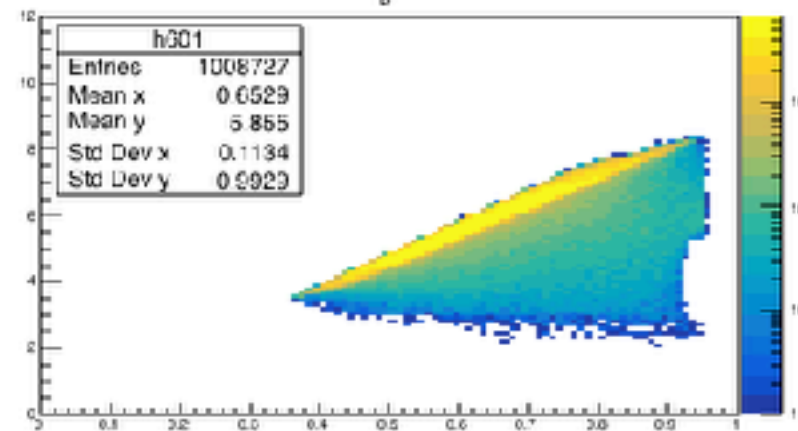
Q^2 vs X_N Kin483



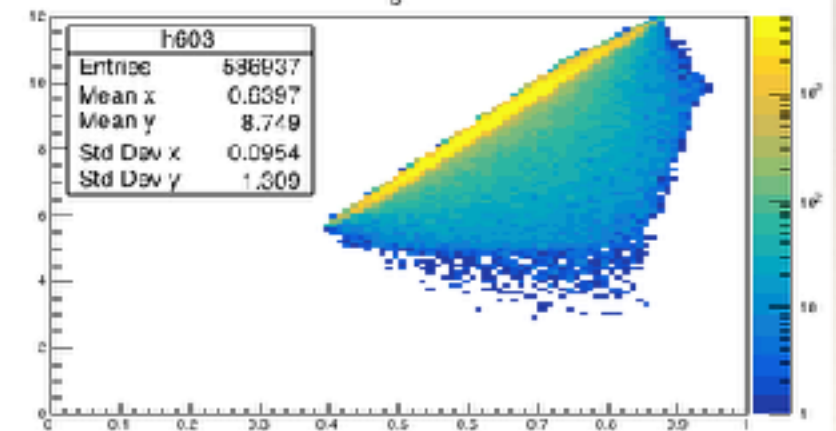
Q^2 vs X_N Kin484



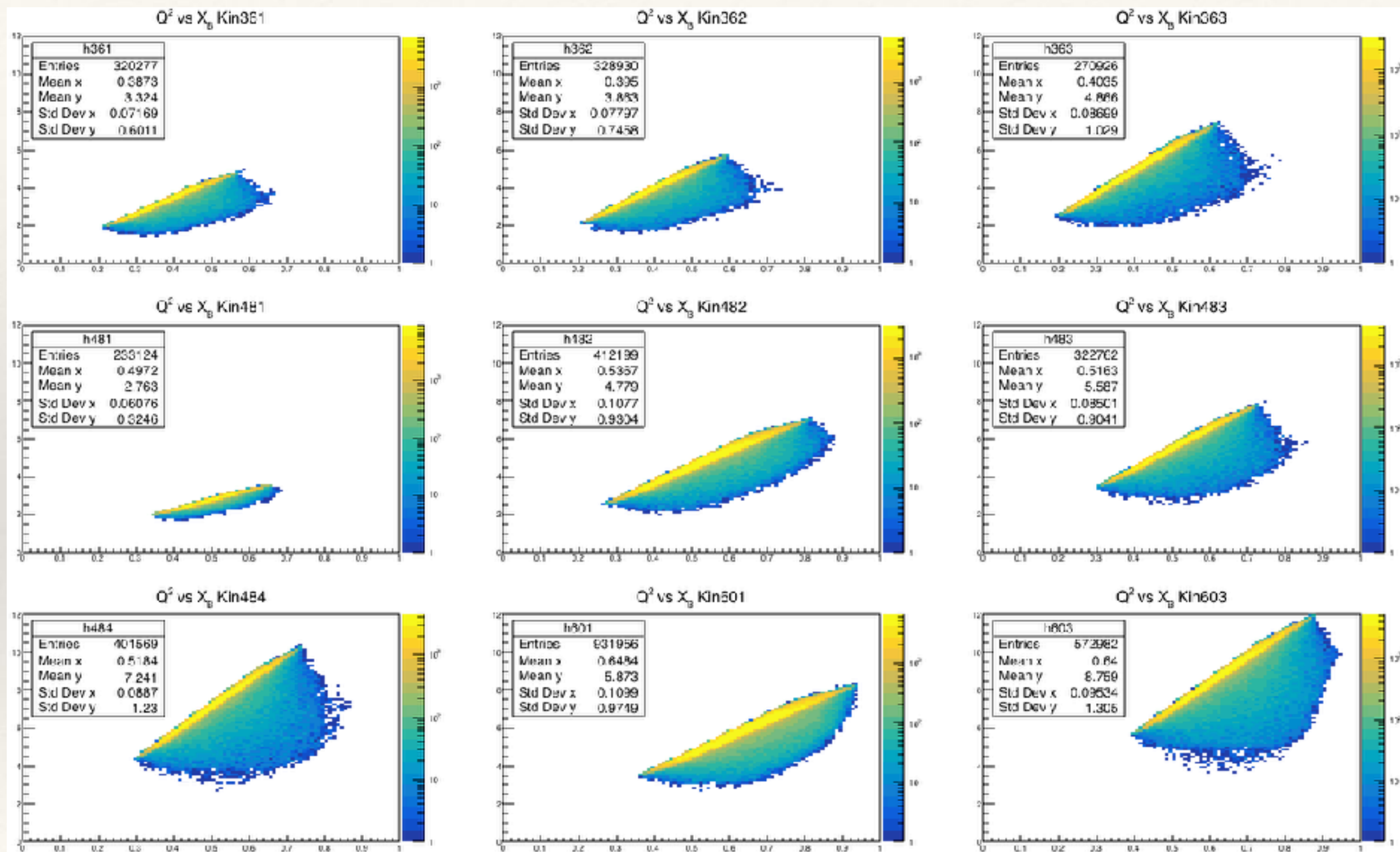
Q^2 vs X_N Kin601



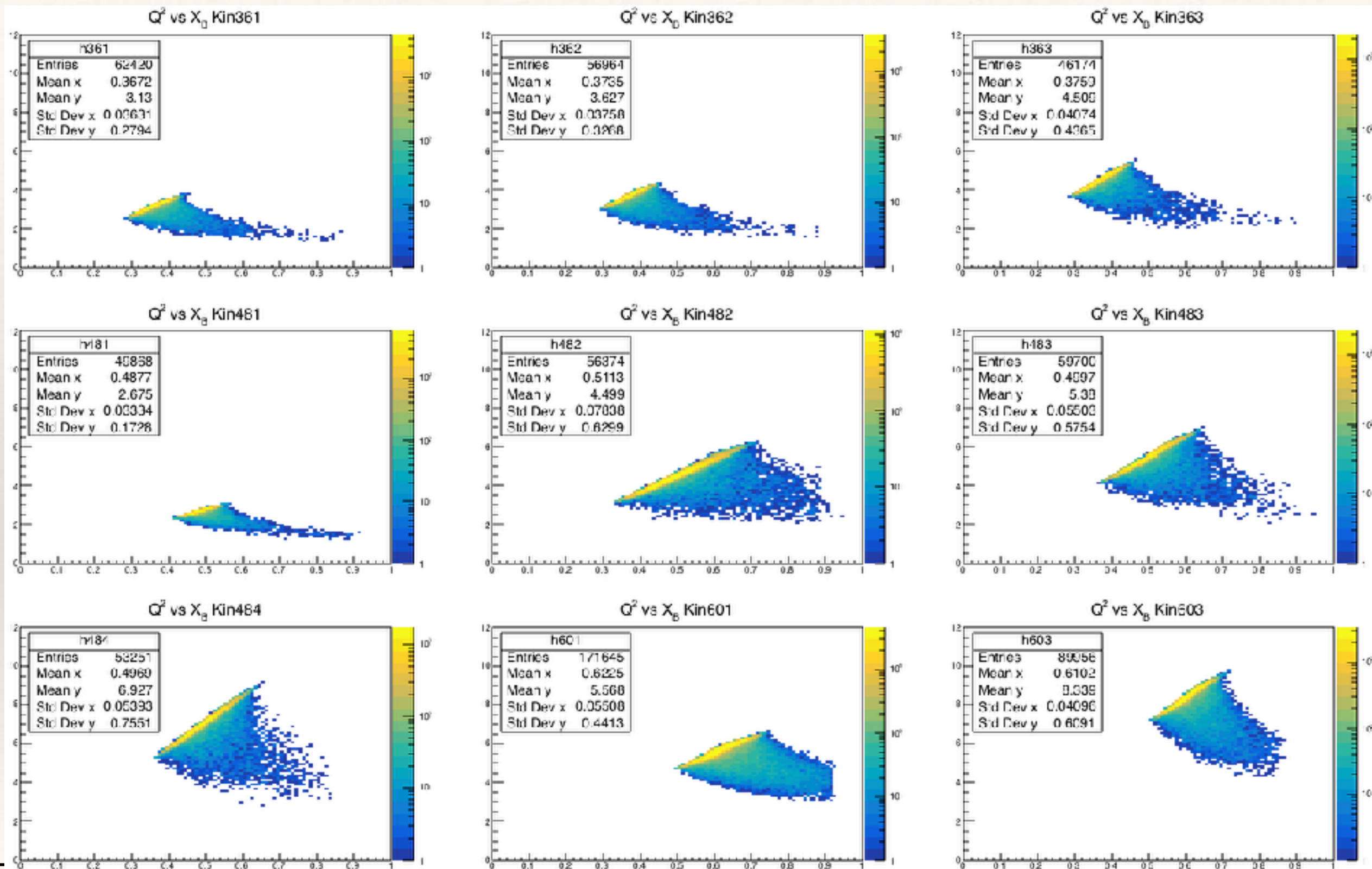
Q^2 vs X_N Kin603



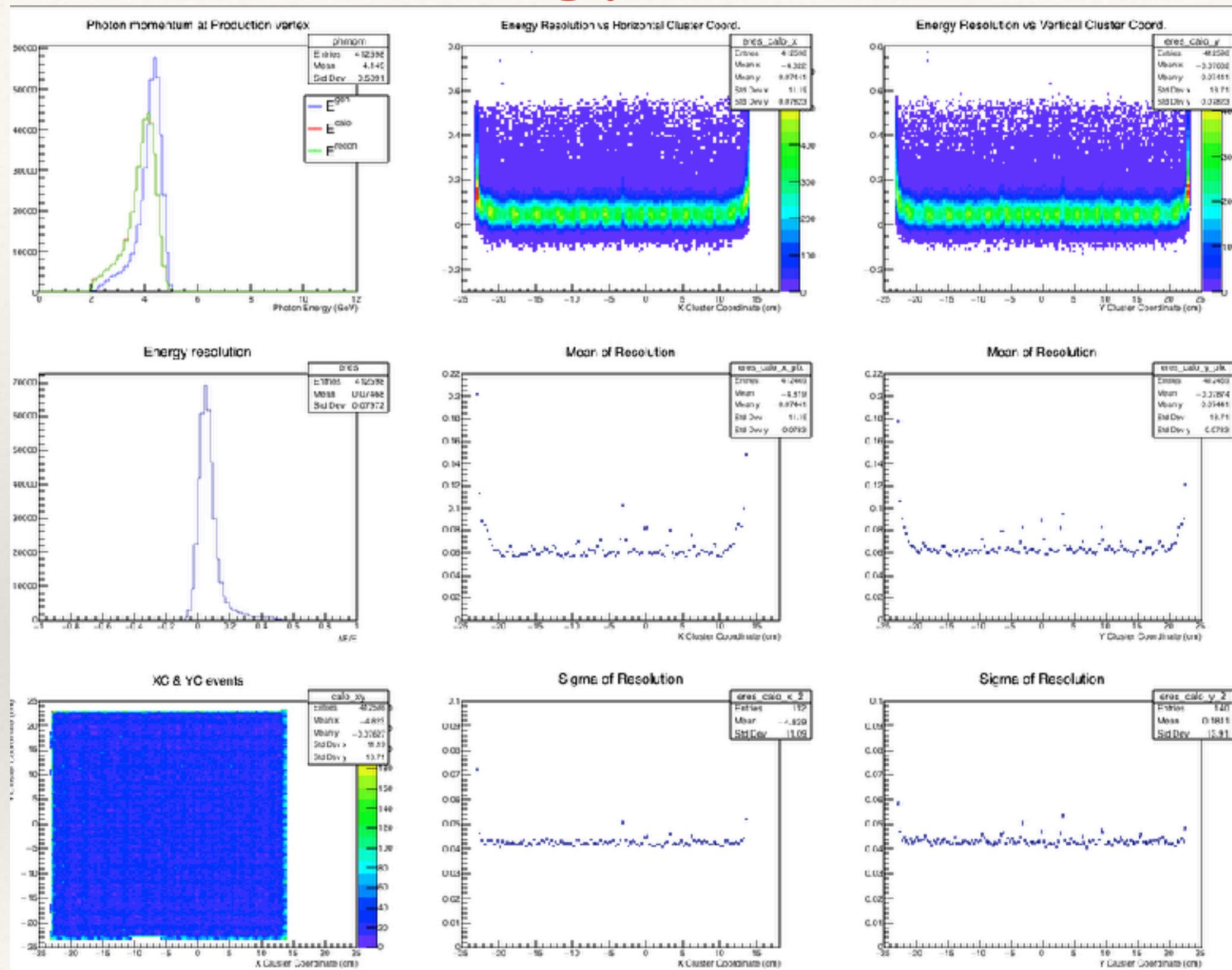
Kinematic Coverage (2 GeV Calo Energy Cut)



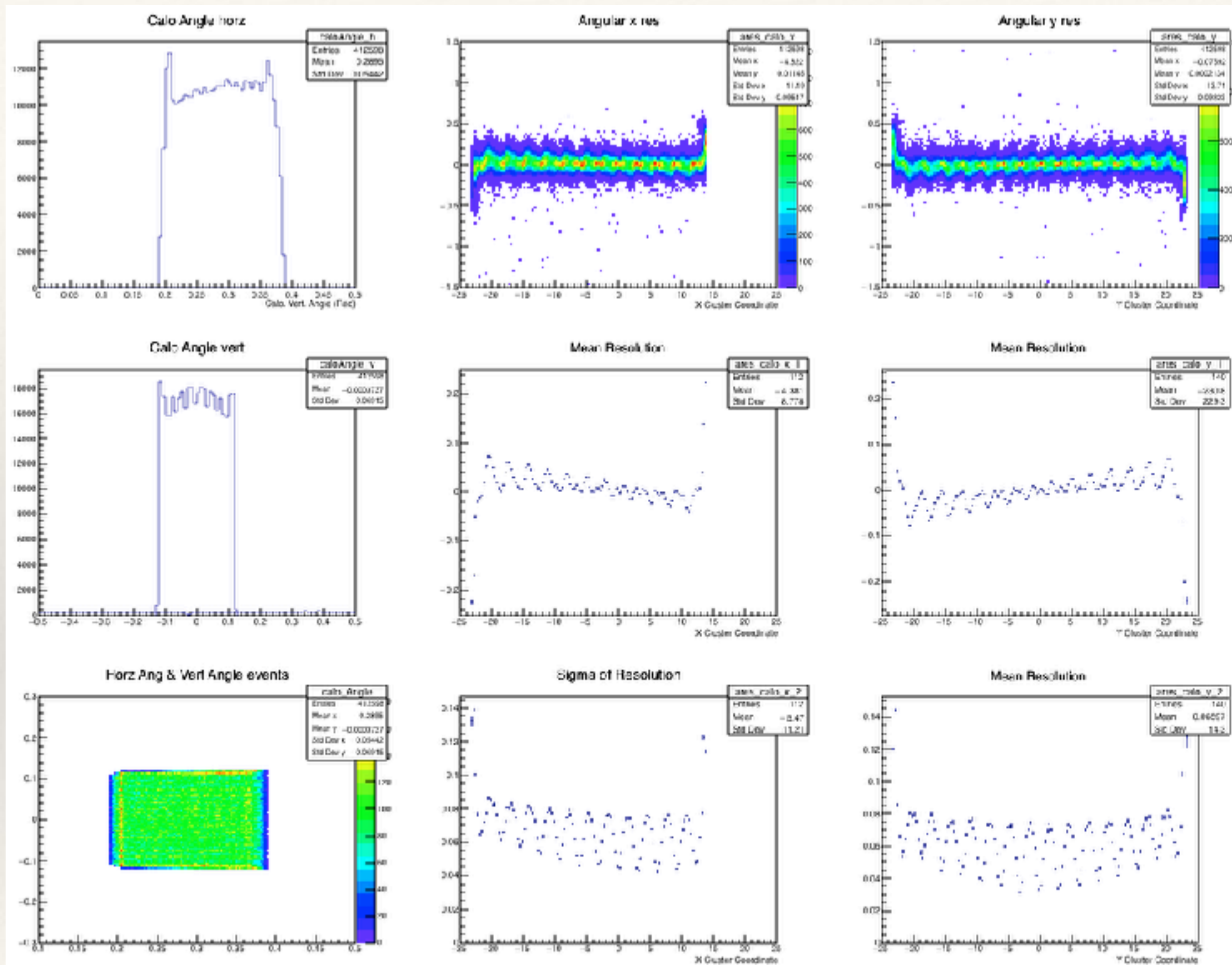
Kinematic Coverage (R-Function DIS cut)



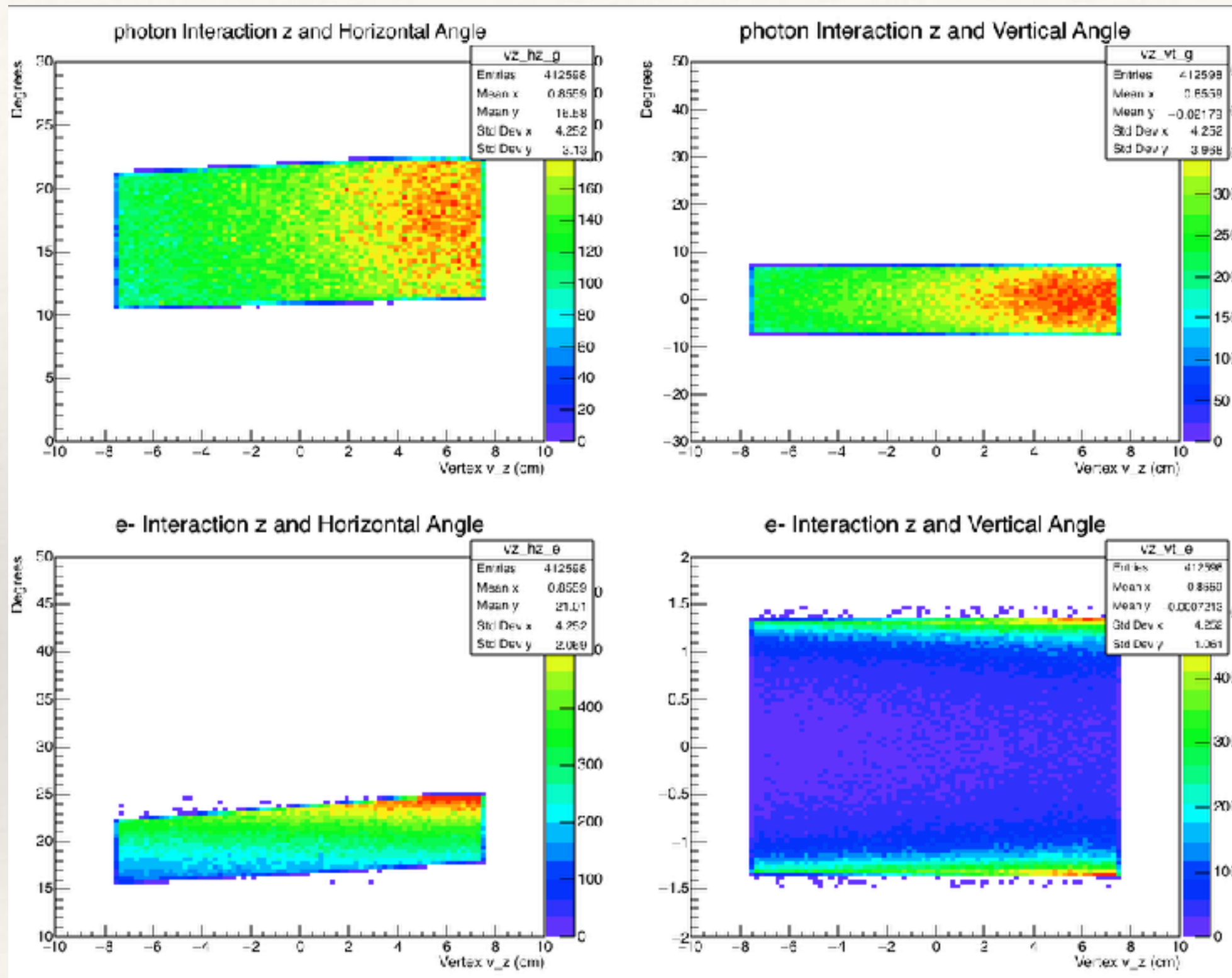
Calo Energy Resolution



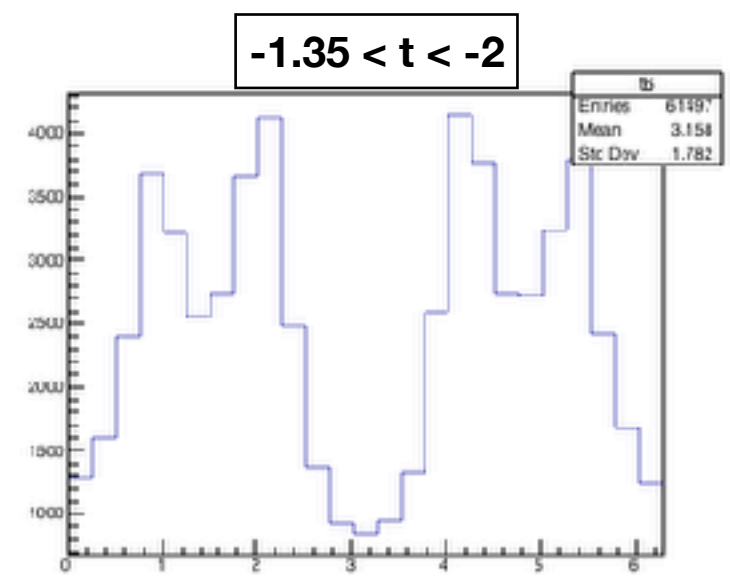
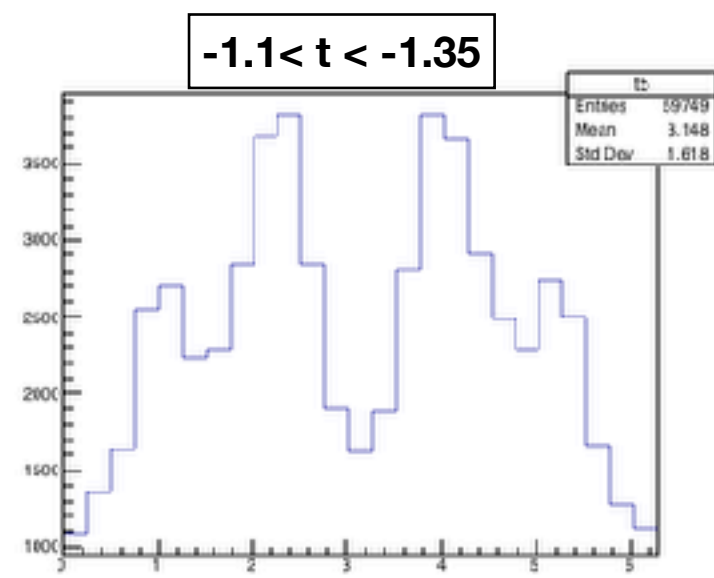
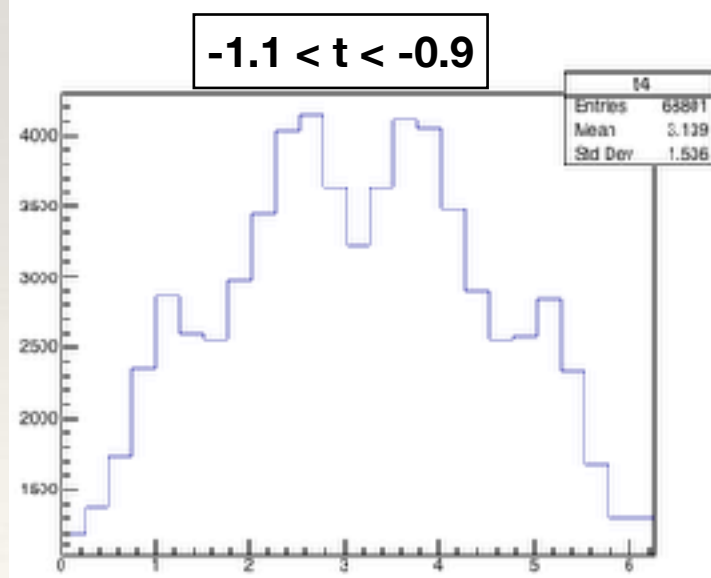
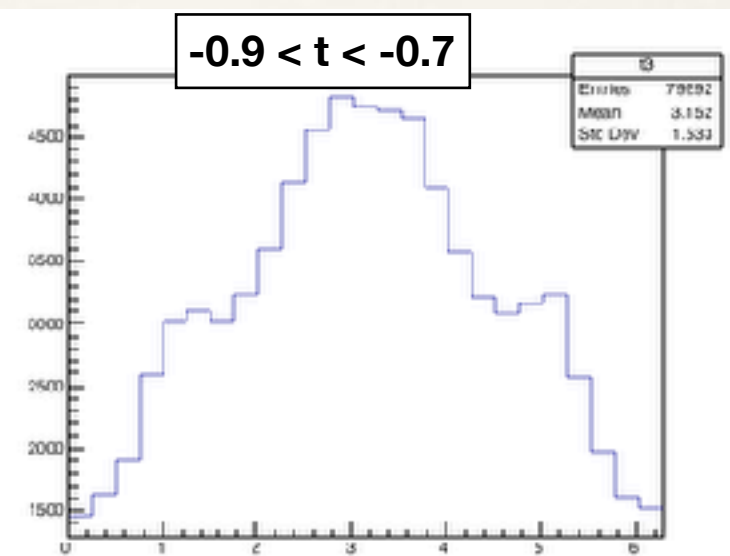
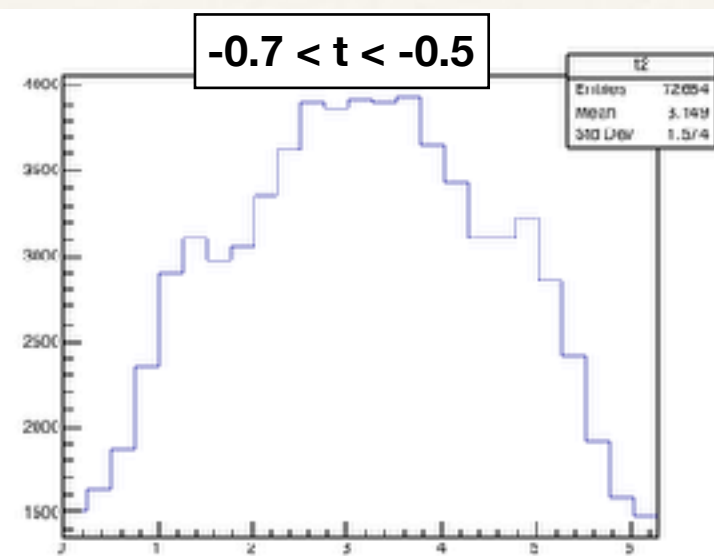
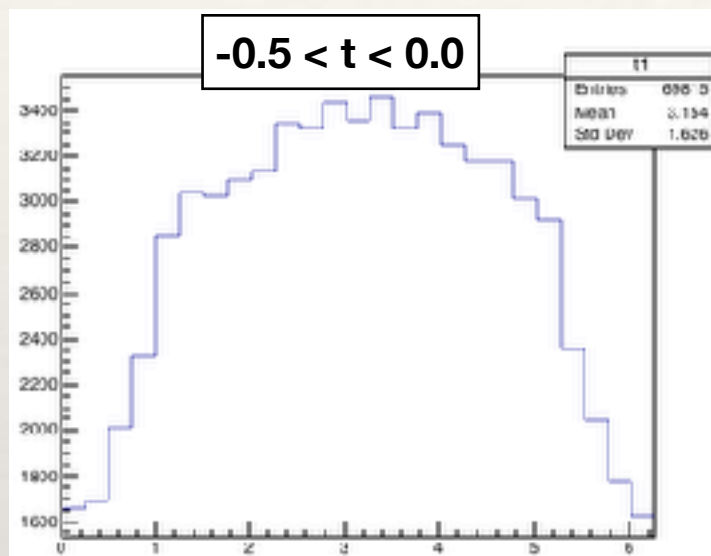
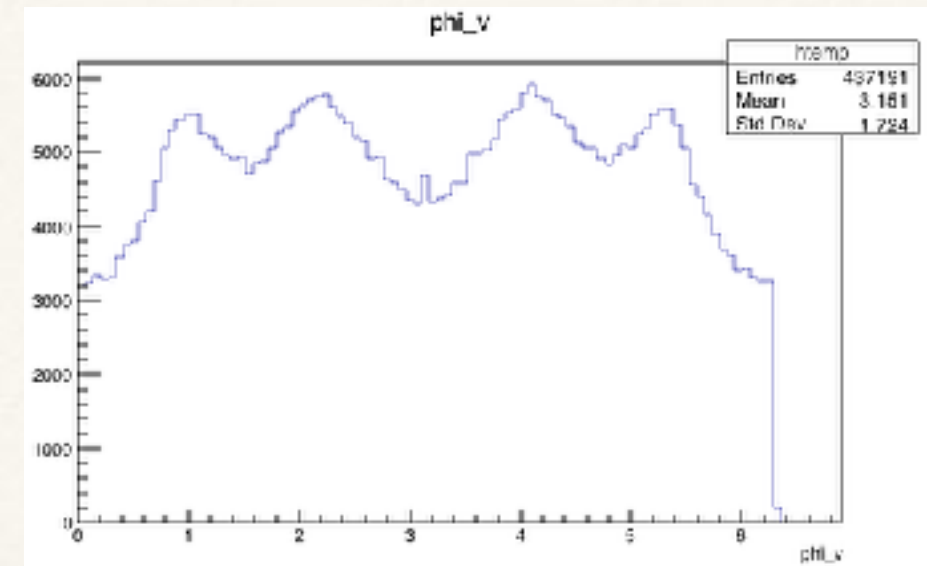
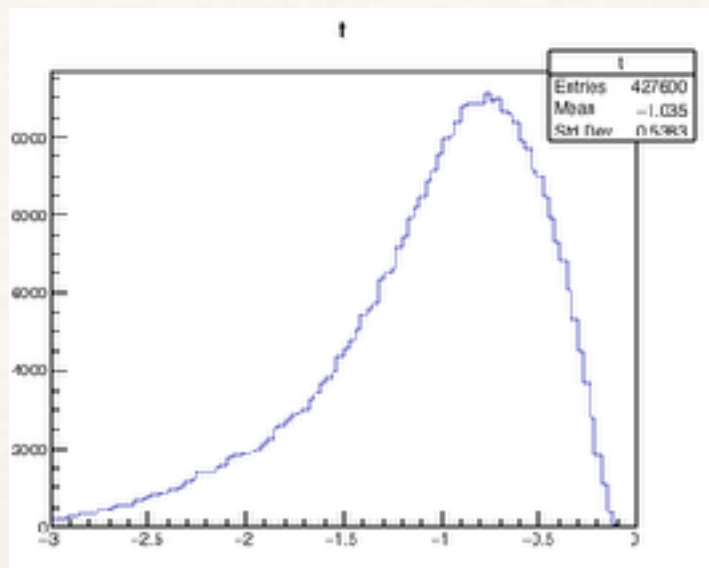
Calo Angular Resolution



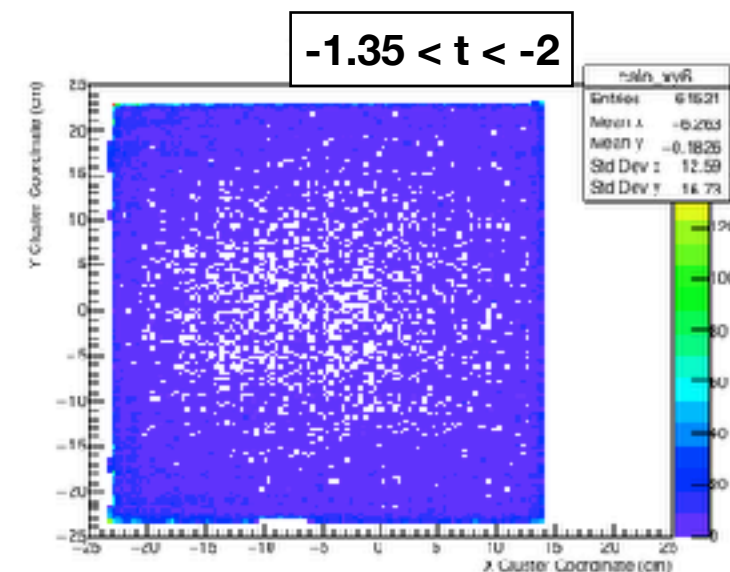
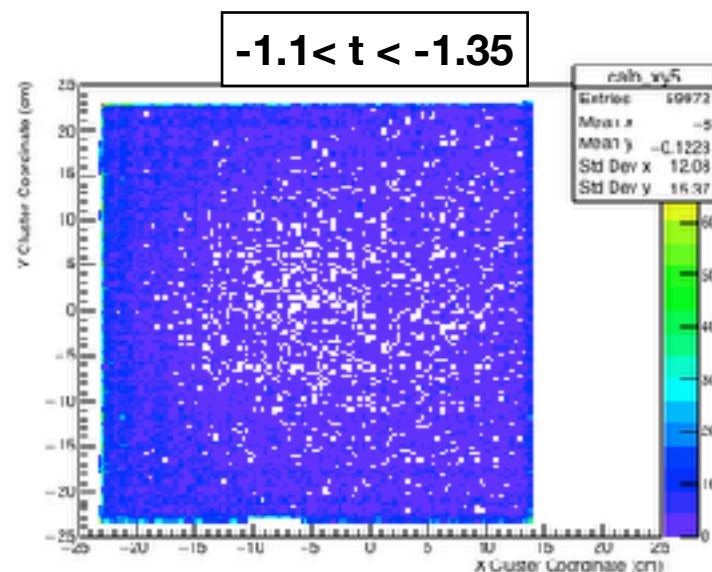
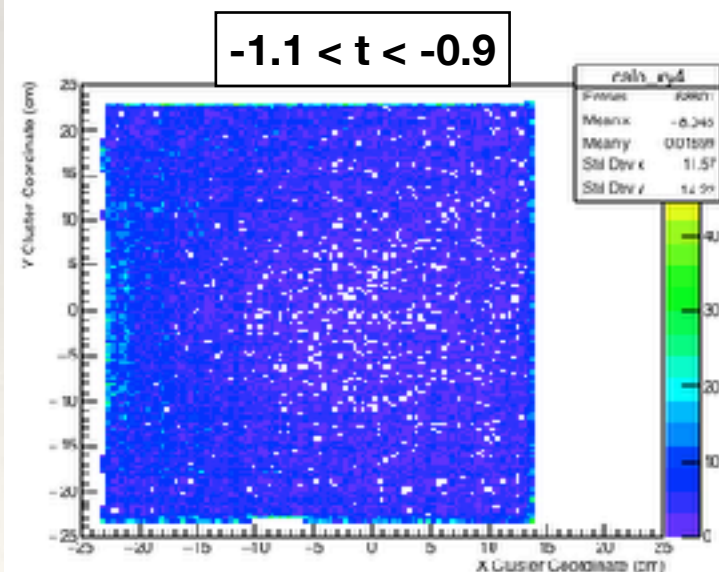
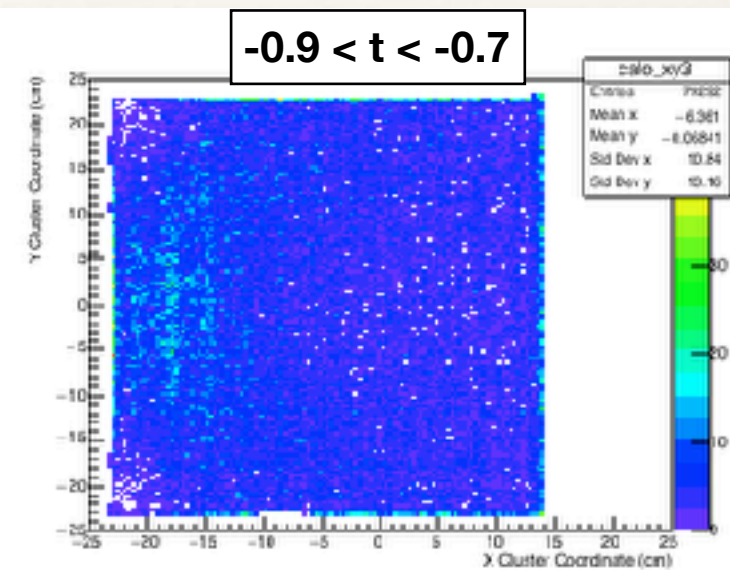
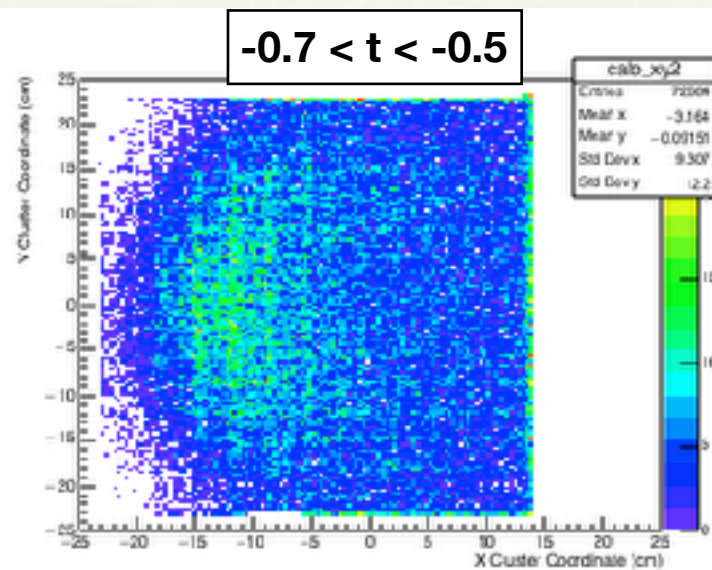
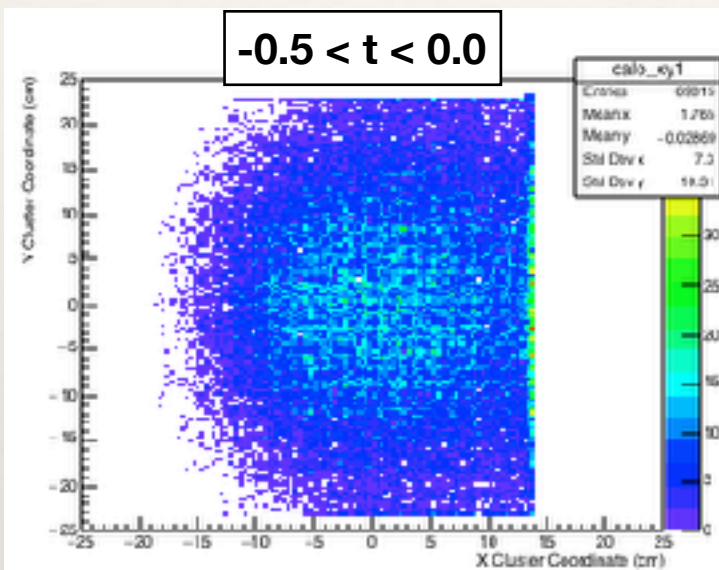
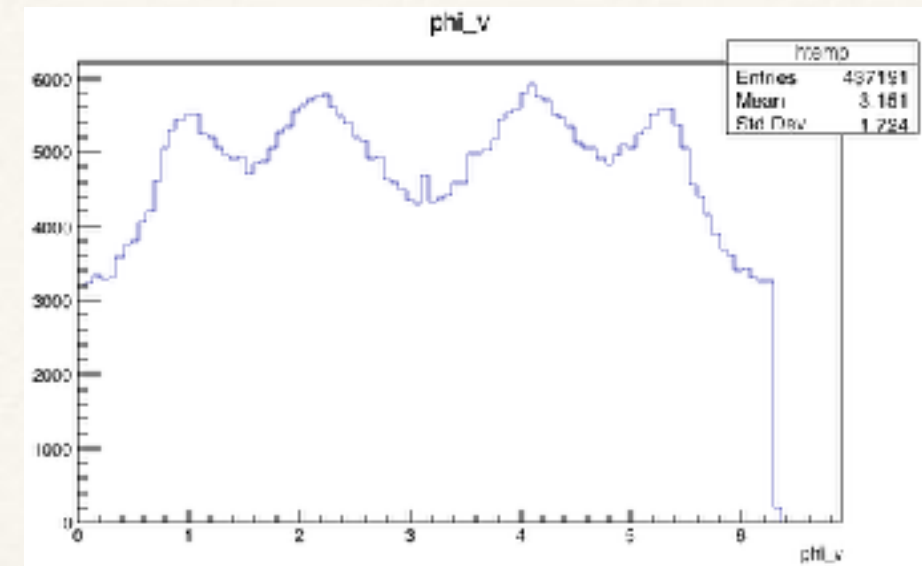
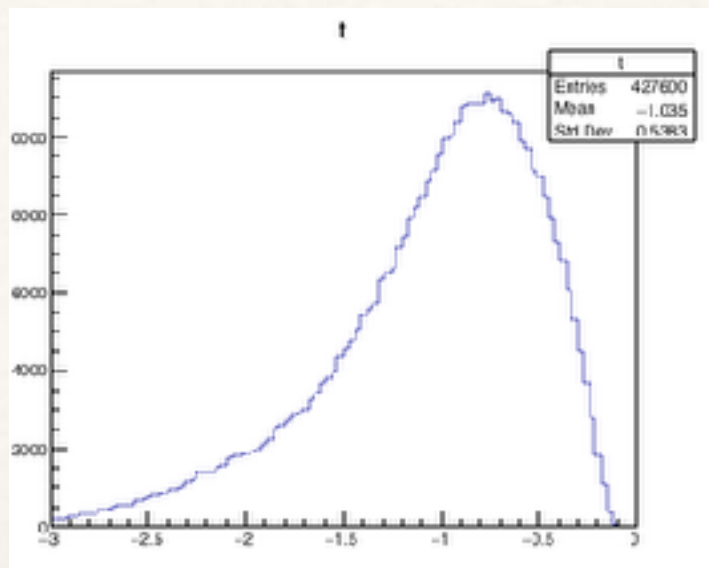
Acceptance



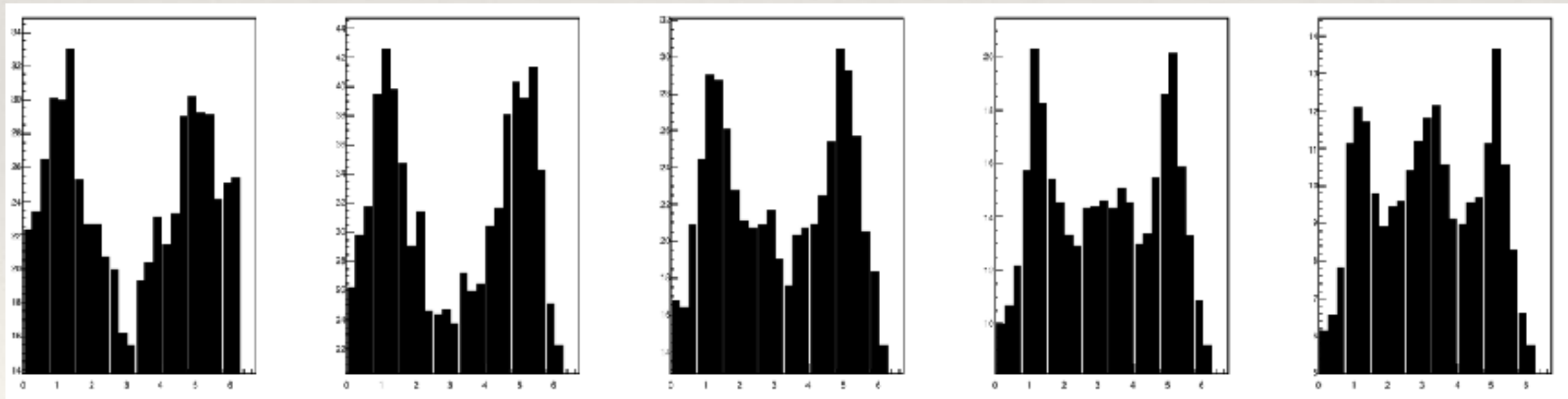
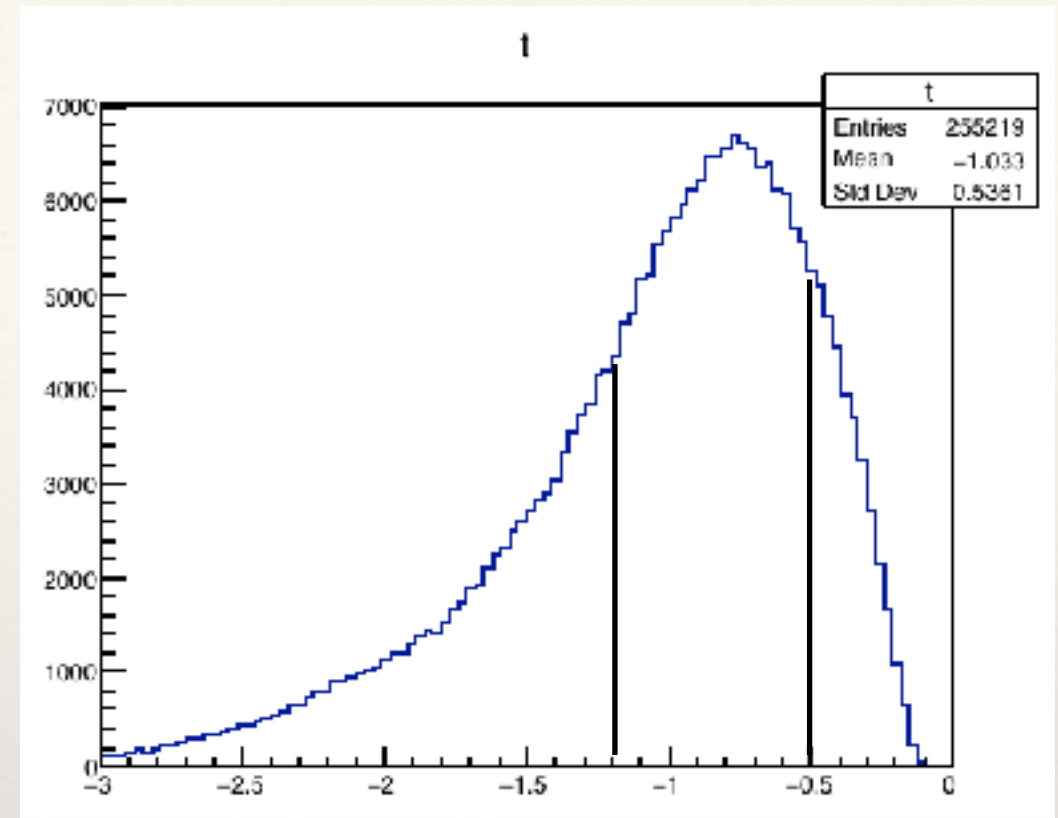
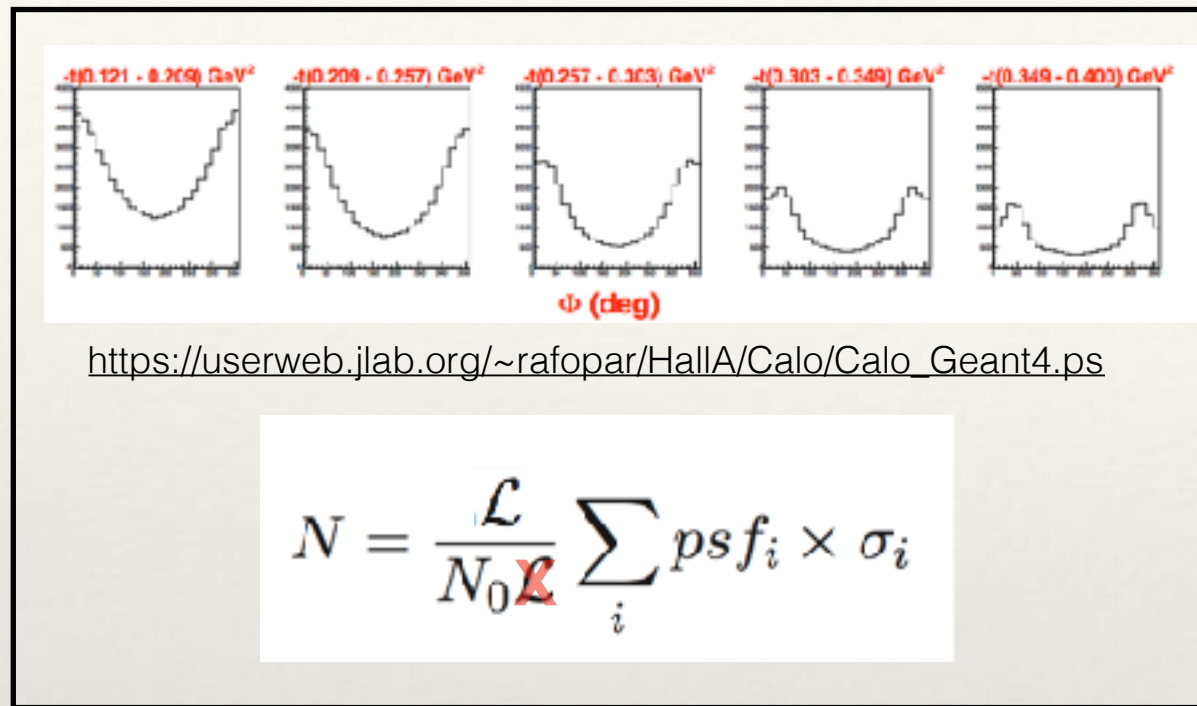
Phi and t dependence



Phi and t dependence



Work in Progress: Calculating Phi Rates

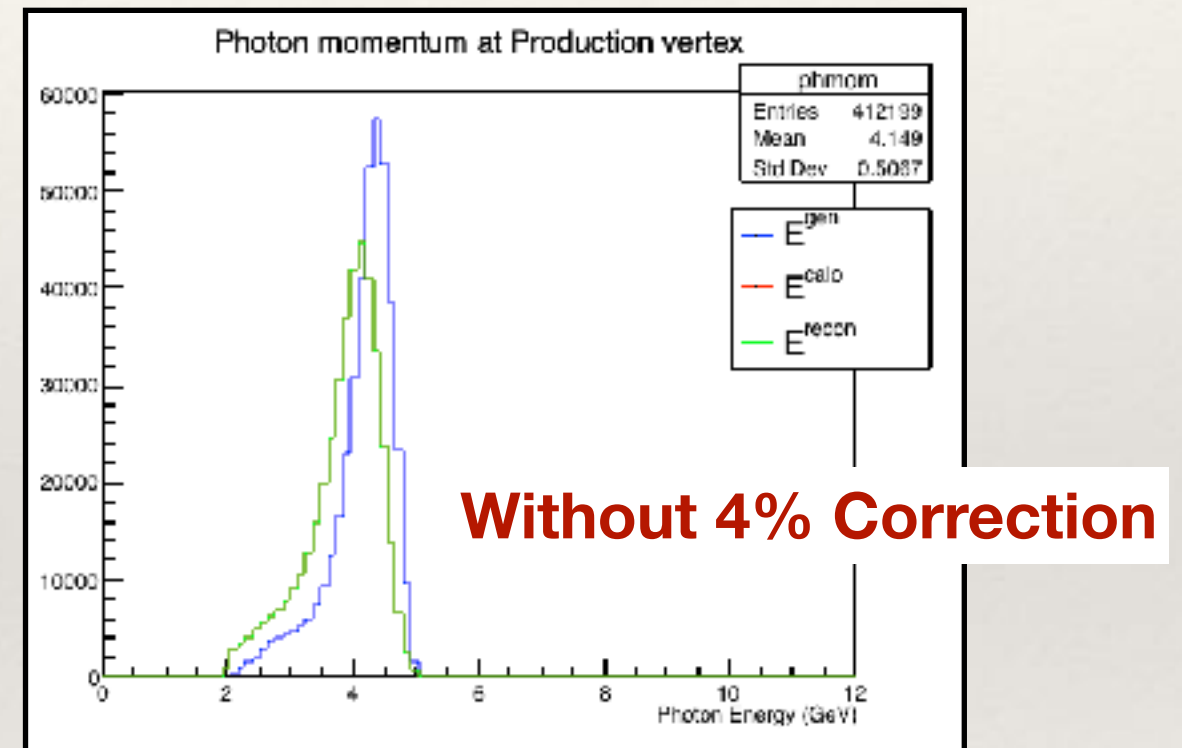
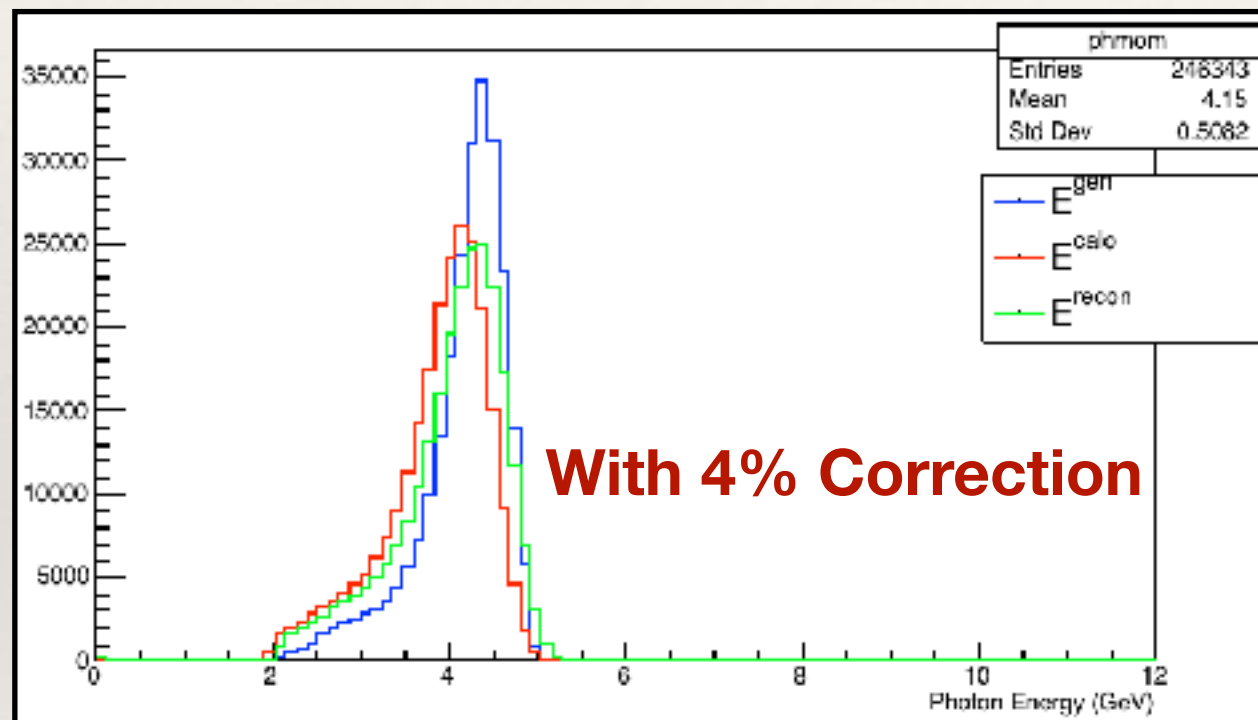


Outstanding Issues

E_{gen} -> Energy at Production Vertex (Given by generator)
 E_{calo} -> Energy deposited in calorimeter
 E_{recon} -> Reconstructed Energy

Energy Resolution

$$\frac{\Delta E}{E_{\text{gen}}} = \frac{E_{\text{gen}} - E_{\text{calo}}}{E_{\text{gen}}}$$



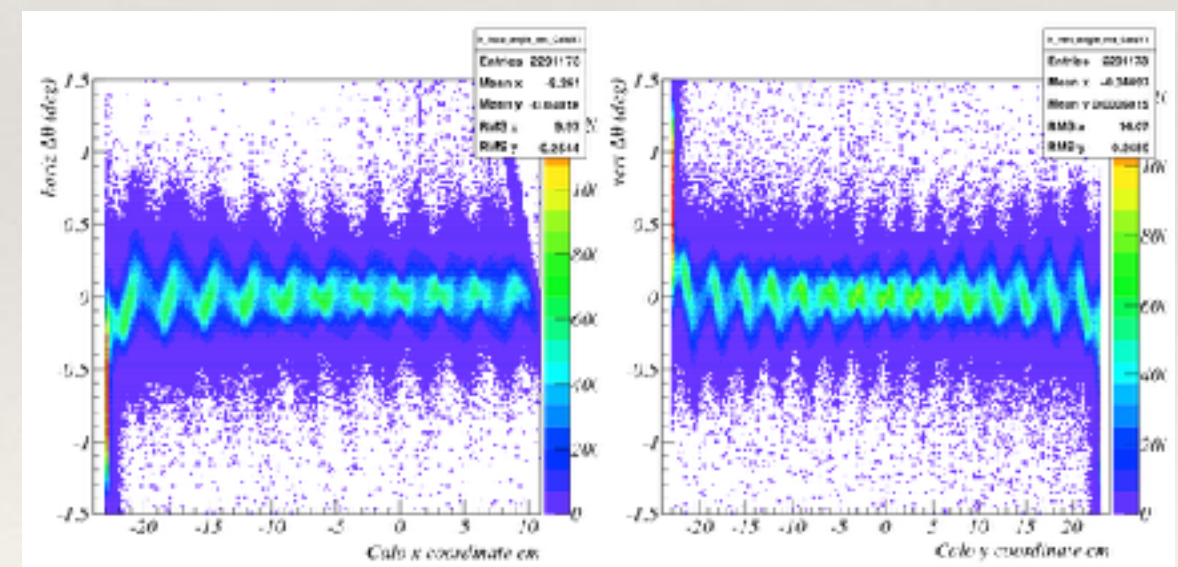
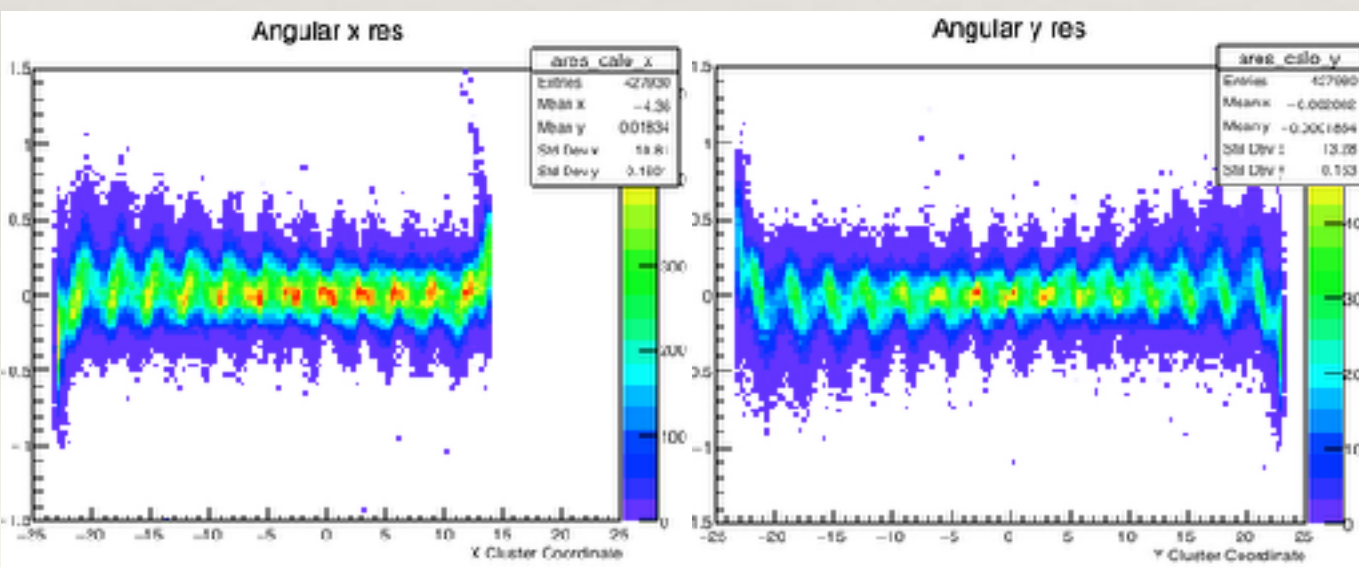
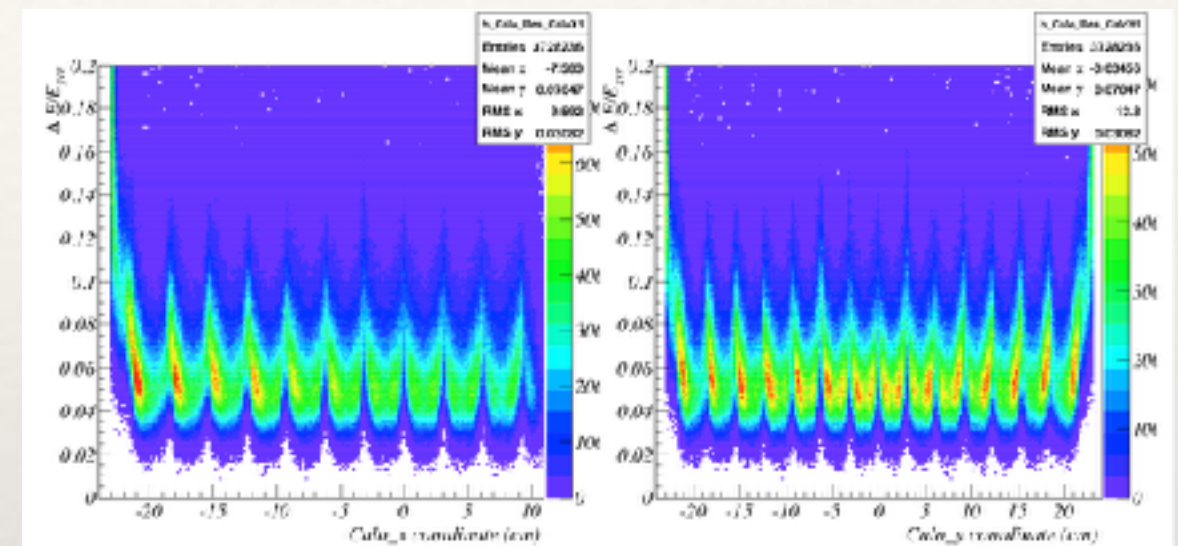
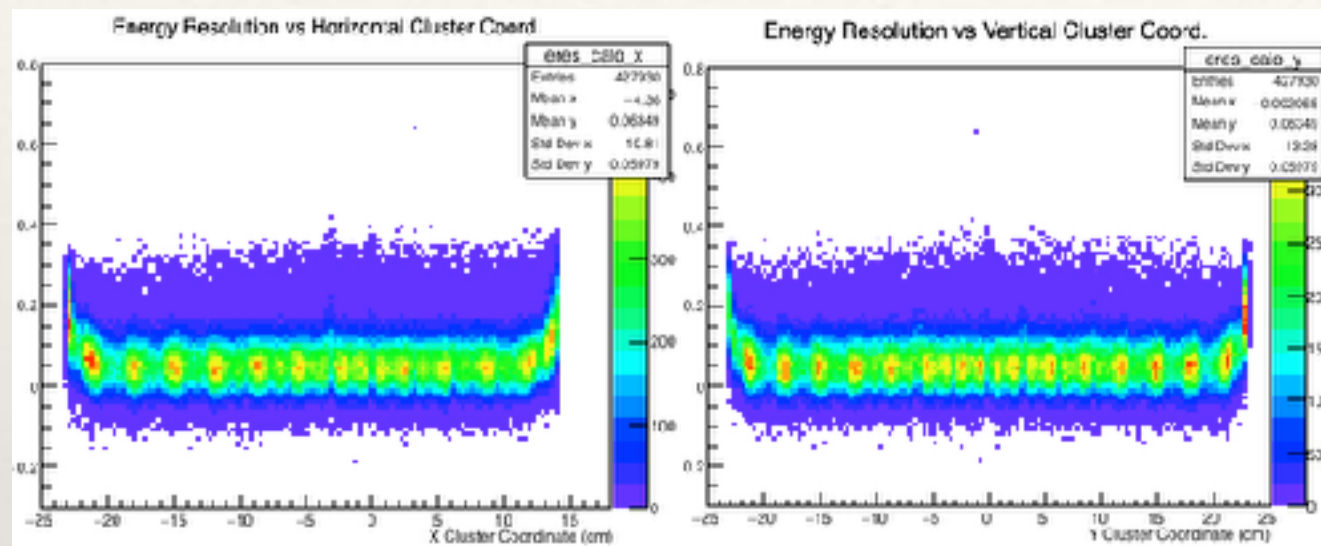
Energy deposited in calorimeter is the same as reconstructed energy!?

Outstanding Issues

Still can't reproduce Maxime and Rafayel's results

My Results

Rafayel and Maxime



Summary and Outlook

- Geant4 MC is working on OS7 and available on GitHub
- All nine kinematics have been simulated (without smearing) and ROOT files are available at /work/halla/dvcs/disk1/bill/ROOTFiles
- When changes are made to Geant4 code the ROOT files can be reproduced in about day for ALL settings
- Simulation analysis scripts will be available shortly