PFA Status and Plans for the SiD Concept

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Standard Detector Model Tools
- *Calibration*
- *Perfect PFA*

PFA Template
- *New Photon Finding*

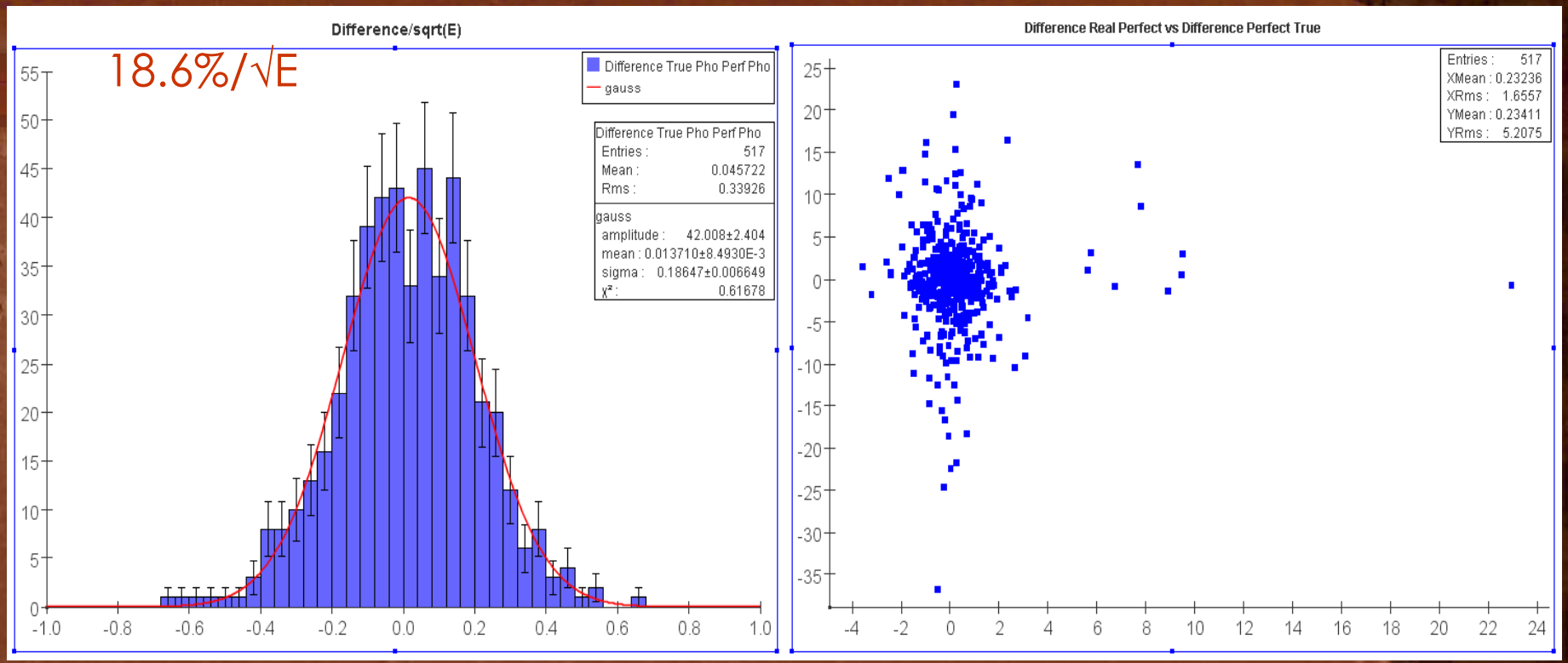
Energy Sum and Dijets

Standard Detector Model Tools

Calorimeter Calibration

- Essential for PFA development, detector model comparison
- Method developed by R. Cassell
- Standard calibrations for at least 4 detector models

EM Calibration



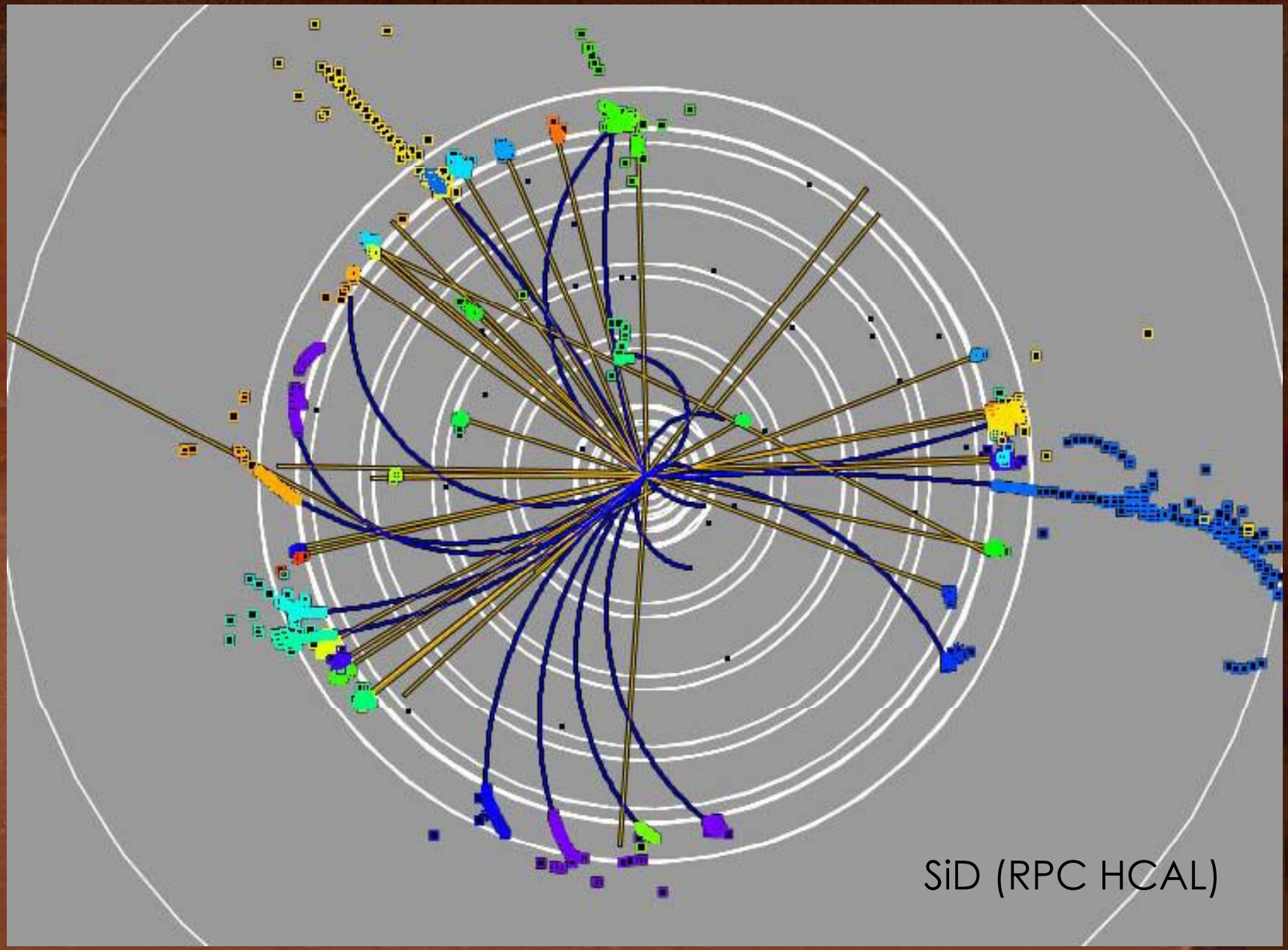
Perfect PFA

Perfect PFA Definition

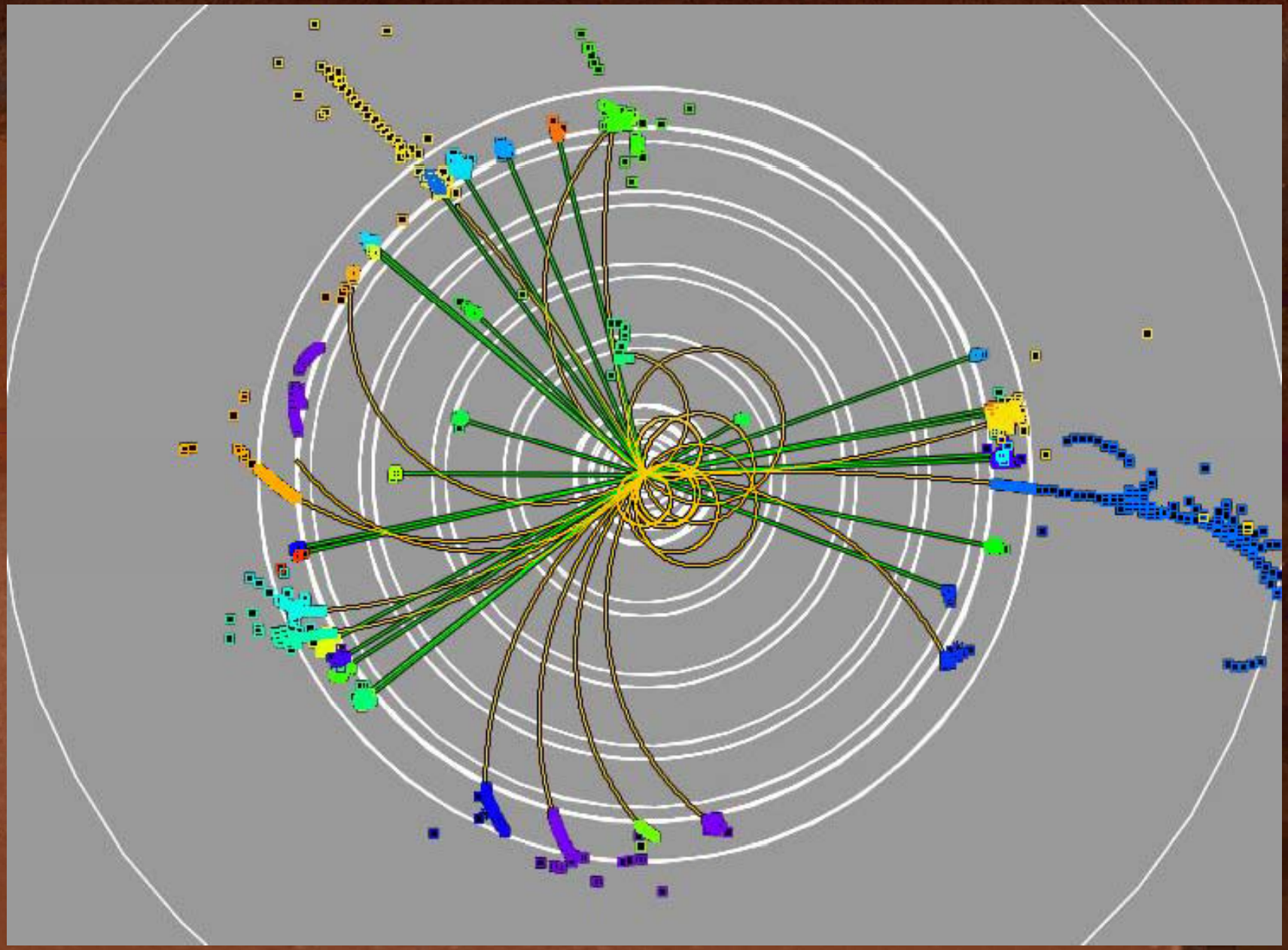
- Essential for PFA development, useful for detector model comparisons
- Based on Generator or Simulated Particles?
- Standard cheated tracks, cheated clusters

```
    // Set up the MC list for perfect PFA
    double rcut = 400.;  //  Bruce said 400 mm at meeting March 13
    double zcut = 400.;
//    CreateFinalStateMCParticleList mcListMakerGen = new CreateFinalStateMCParticleList("Gen");
    CreateFinalStateMCParticleList mcListMakerSim = new CreateFinalStateMCParticleList("Sim");
    mcListMakerSim.setRadiusCut(rcut);
    mcListMakerSim.setZCut(zcut);
//    add(mcListMakerGen);
    add(mcListMakerSim);
//    String mcListGen = "GenFinalStateParticles";
    String mcListSim = "SimFinalStateParticles";
    String mcList = mcListSim; // Can choose the Gen or Sim list here

    String Tname = "RefinedCheatTracks";
    add(new CheatTrackDriver());

    String Cname = "PerfectCheatClusters";
    String[] collections = {"EcalBarrDigiHits","EcalEndcapDigiHits","HcalBarrDigiHits","HcalEndcapDigiHits"};
    add (new CheatClusterDriver(collections,Cname));

    String CRPname = "CheatReconstructedParticles";
    CheatParticleDriver cpd = new CheatParticleDriver(Cname,Tname,mcList);
    //  Inputs Cheated Tracks, Cheated Clusters, and MC particle list to create Cheated Particles
    cpd.setOutputName(CRPname);
    add(cpd);

    // now make (more realistic) cheat tracks, etc with PPR driver
    String outName = "PerfectRecoParticles";
    int minT = 0;
    int minC = 0;
    PPRParticleDriver d = new PPRParticleDriver(CRPname, outName);
    d.setMinTrackerHits(minT);
    d.setMinCalorimeterHits(minC);
    add(d);

    //  this makes perfect tracks from the perfect particles
    PerfectTrackDriver perftrk = new PerfectTrackDriver();
    perftrk.setParticleNames(outName);
    perftrk.setTrackNames("PerfectTracks");
    add(perftrk);
```

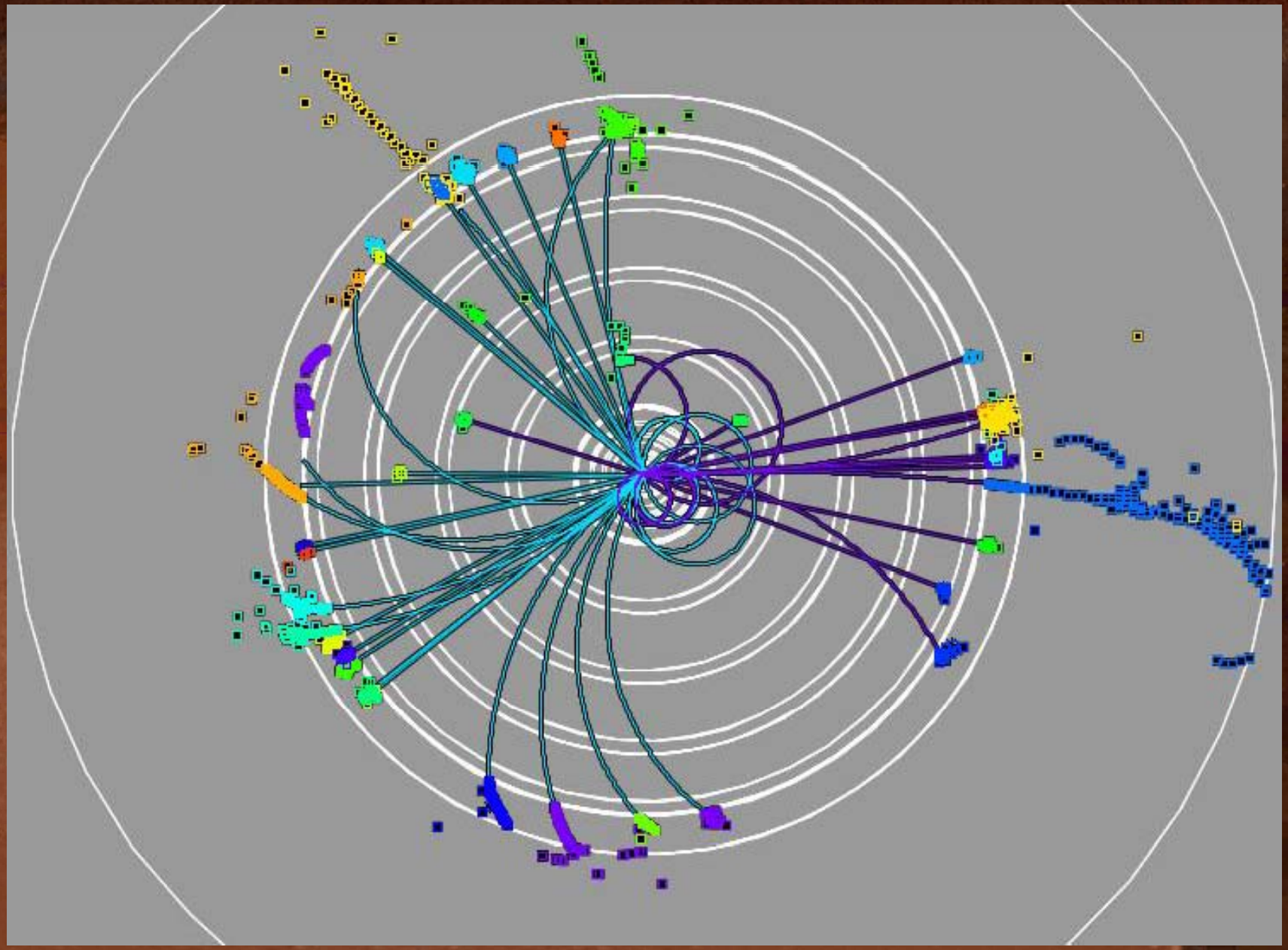
Perfect PFA Definition, ZPole event, all MC Particles, Perfect Clusters



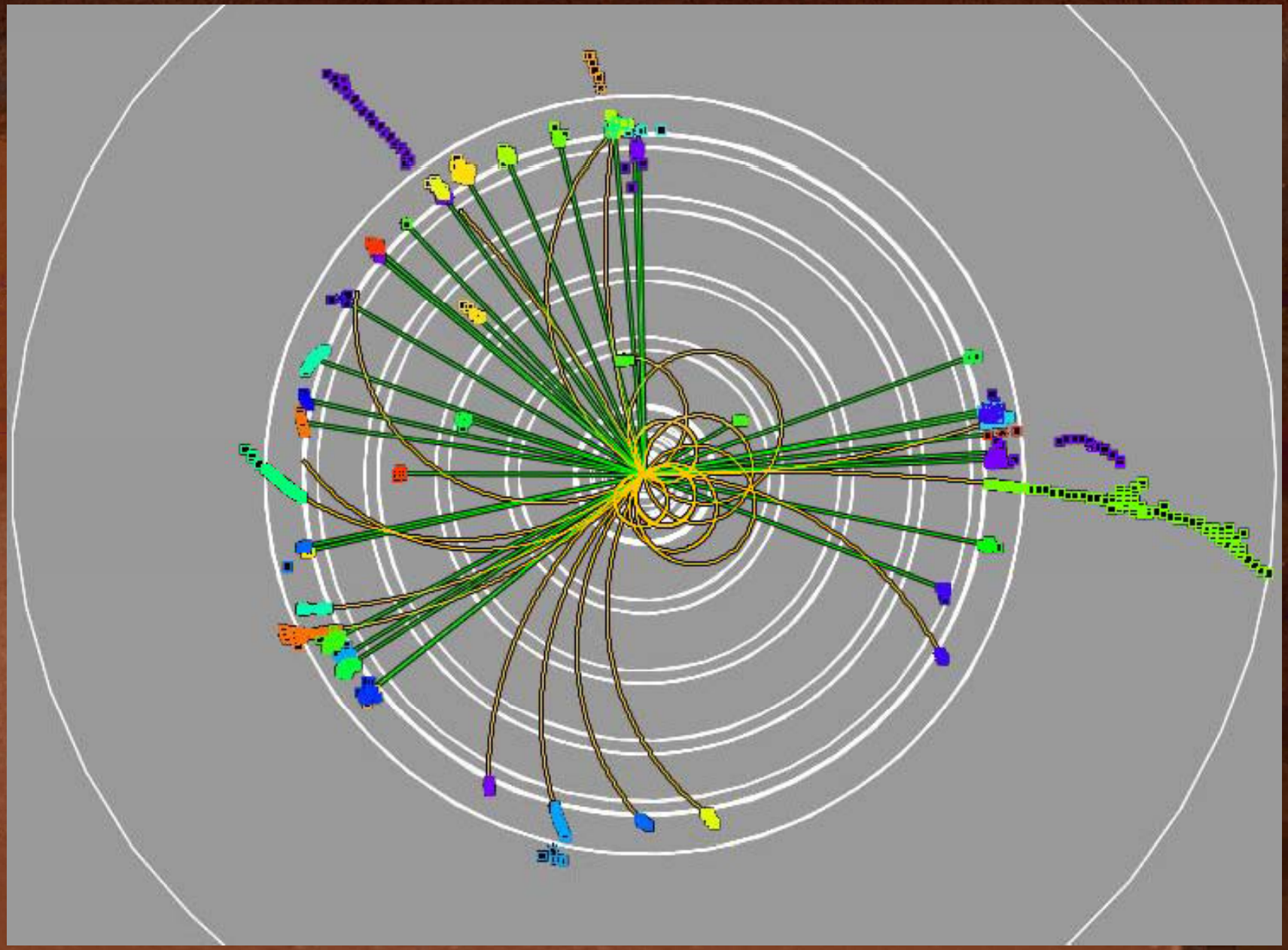
ZPole event, Perfect PFA Particles, Perfect Clusters



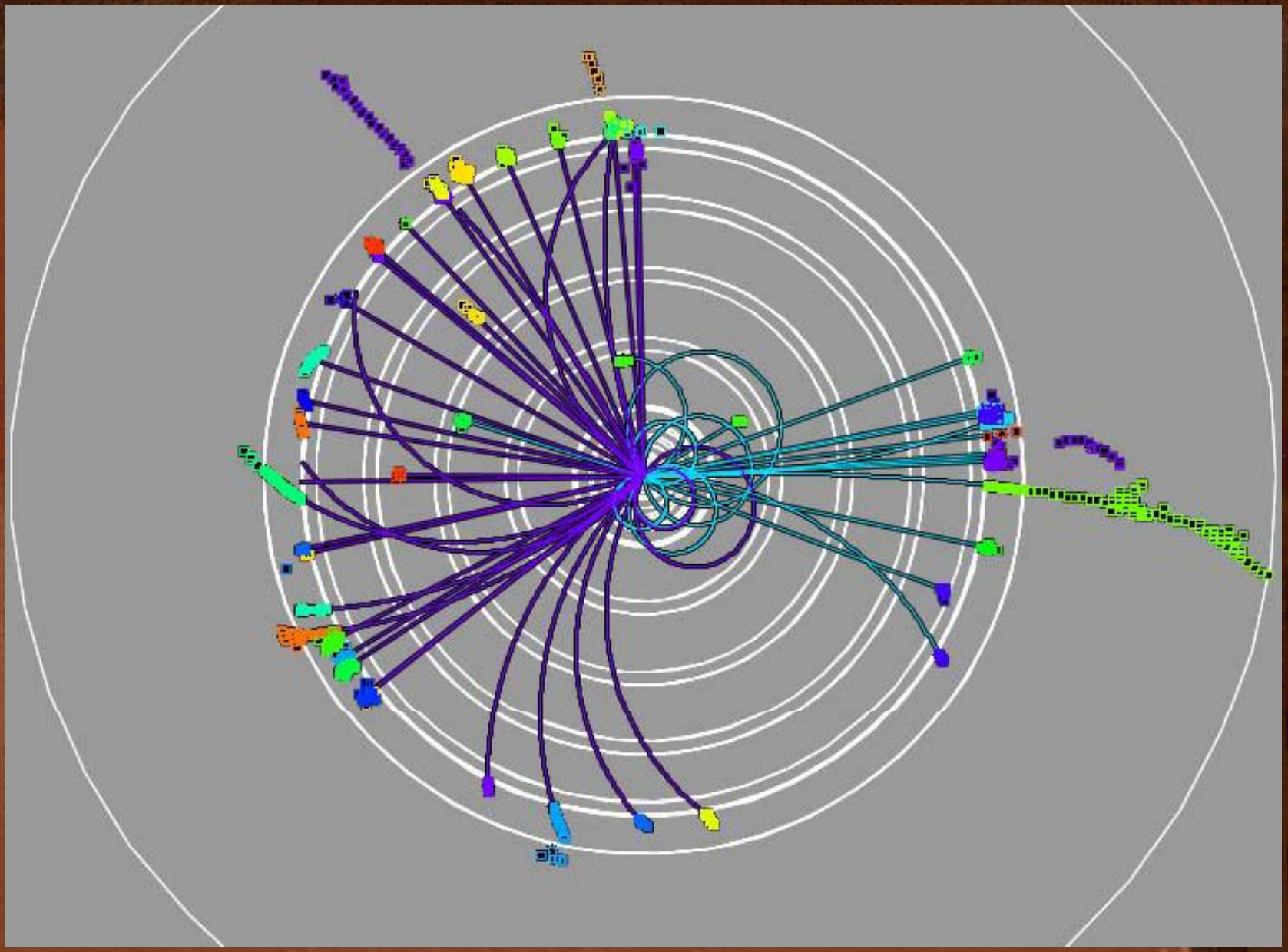
ZPole event, Perfect PFA Jets, Perfect Clusters



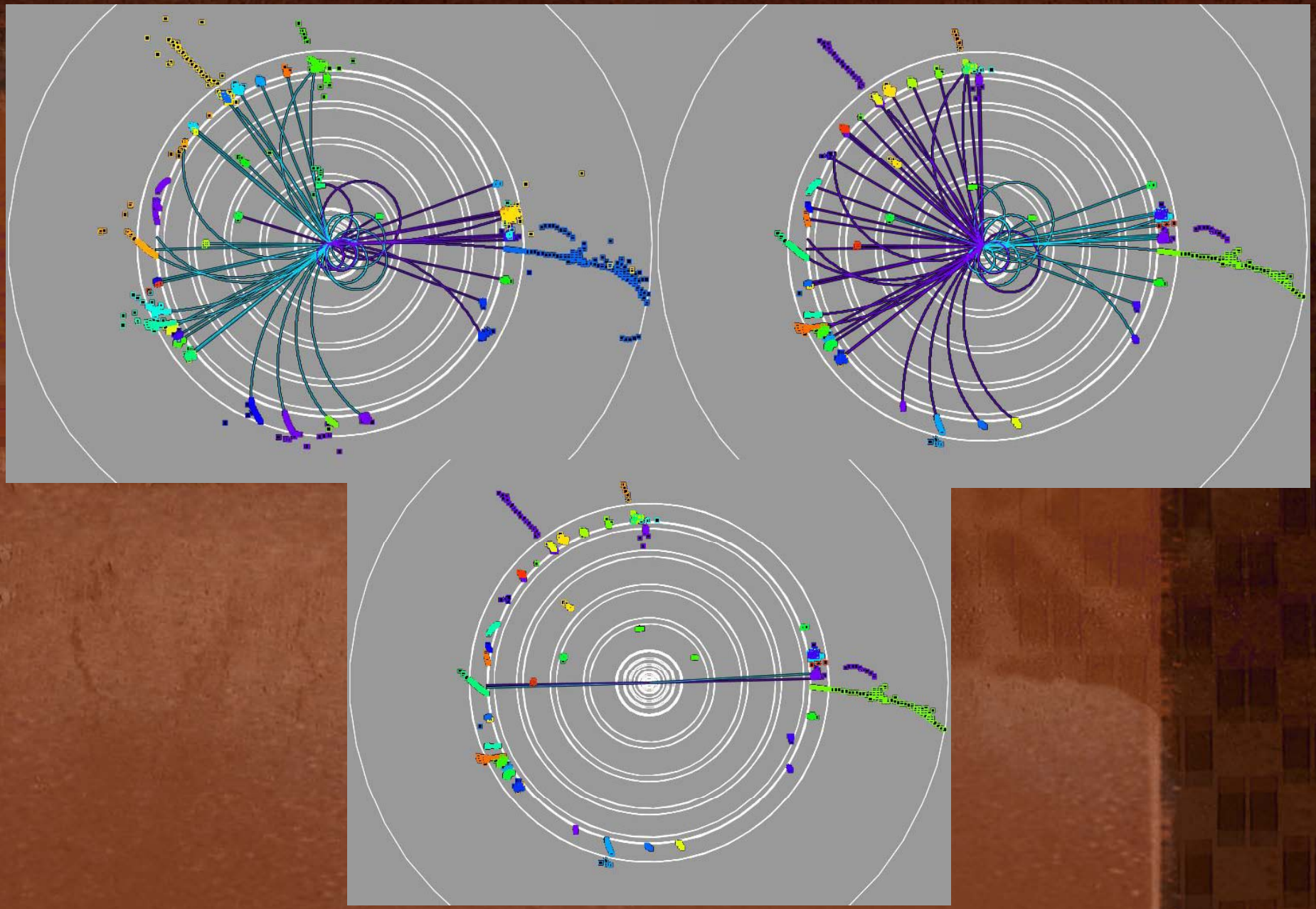
ZPole event, Reconstructed Particles, PFA Clusters



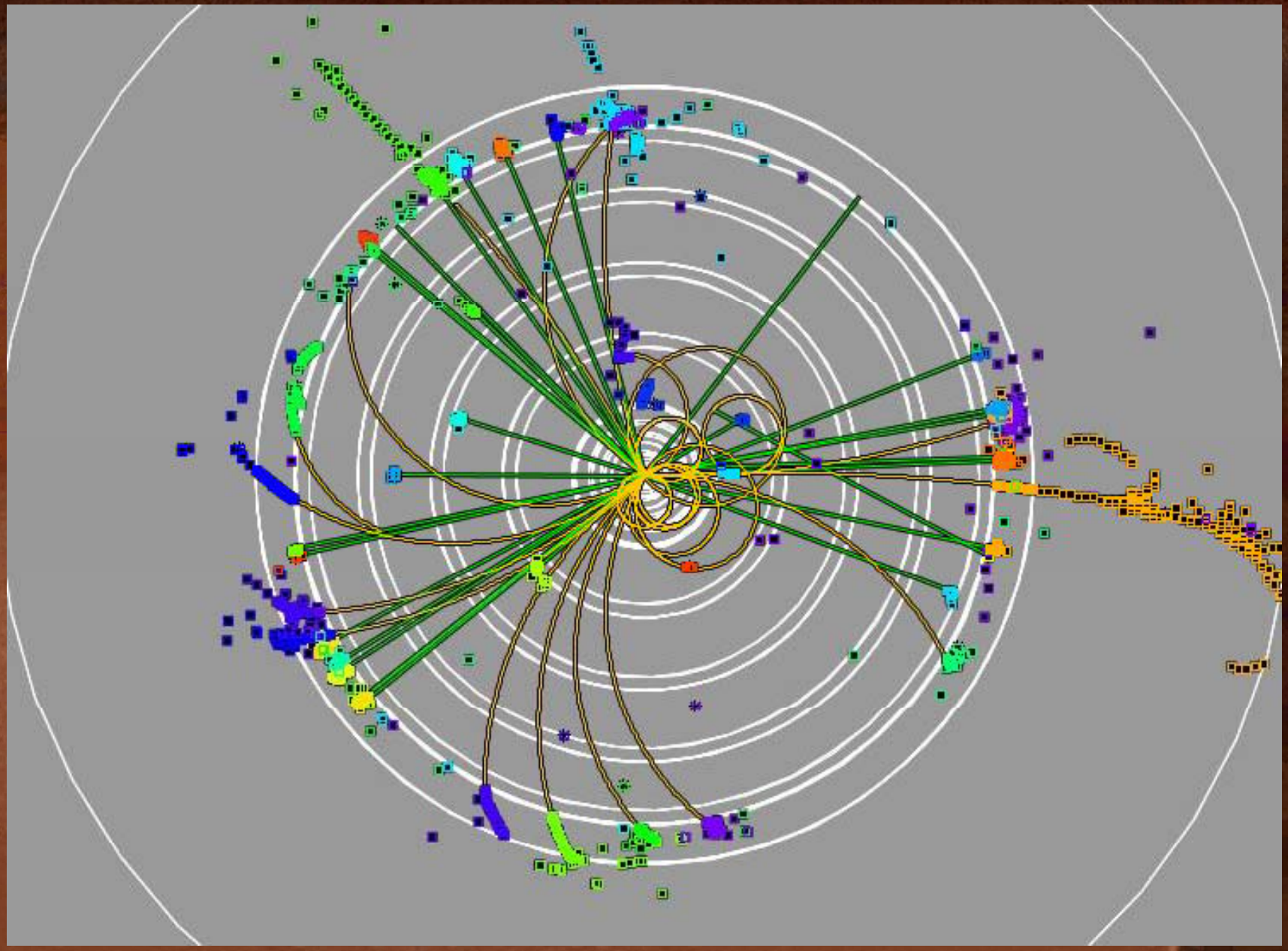
ZPole event, PFA Jets, PFA Clusters



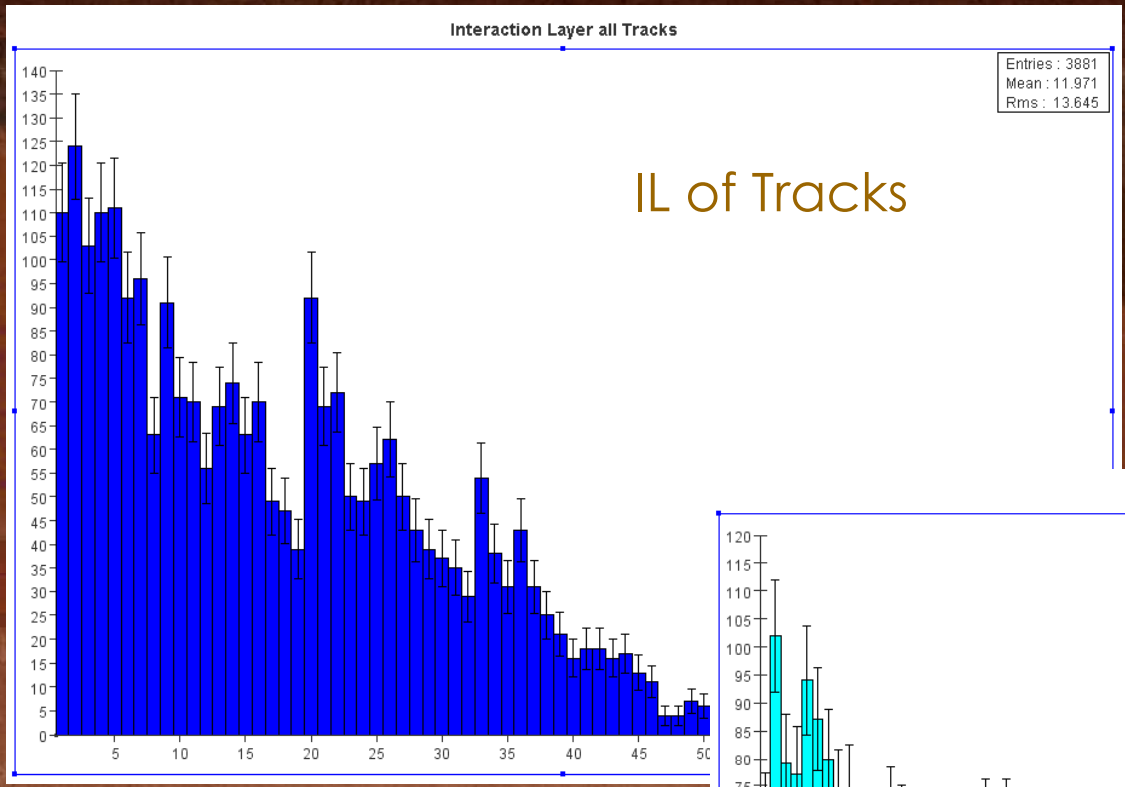
ZPole event, Jet Comparison, Perfect Jets, PFA Jets



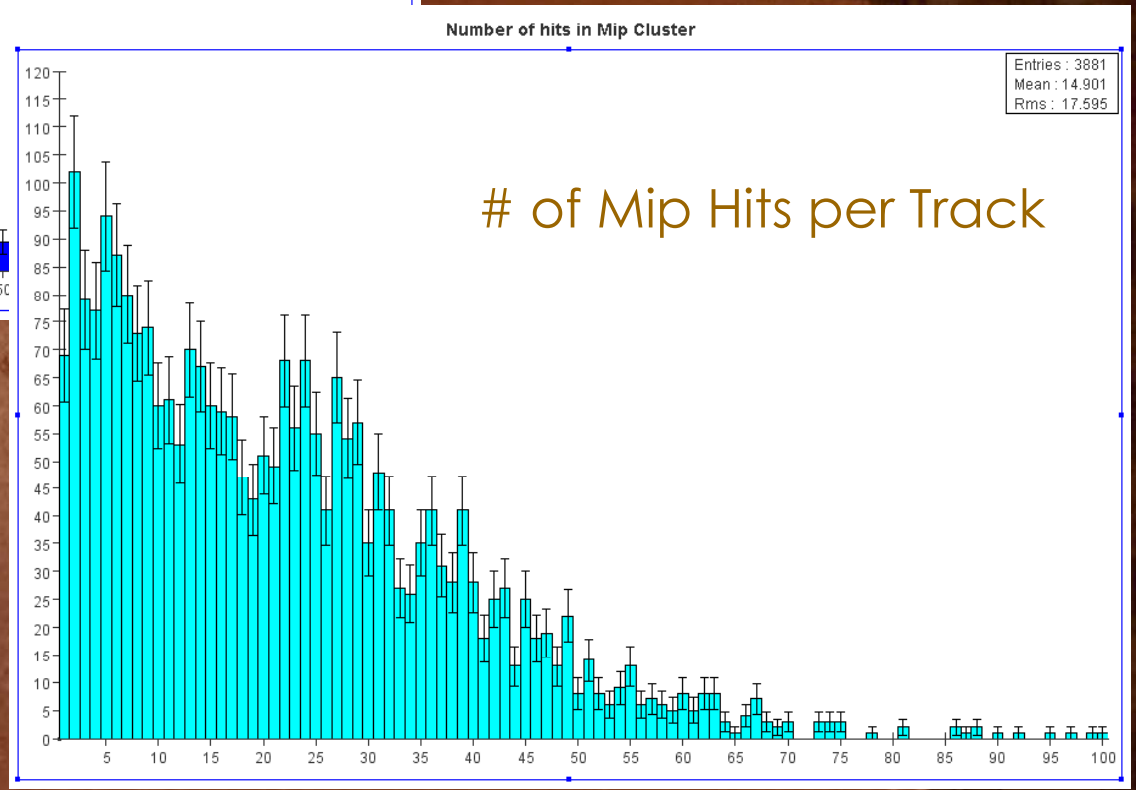
ZPole event, Improved Perfect PFA, Perfect Clusters



Mip Finding at ZPole



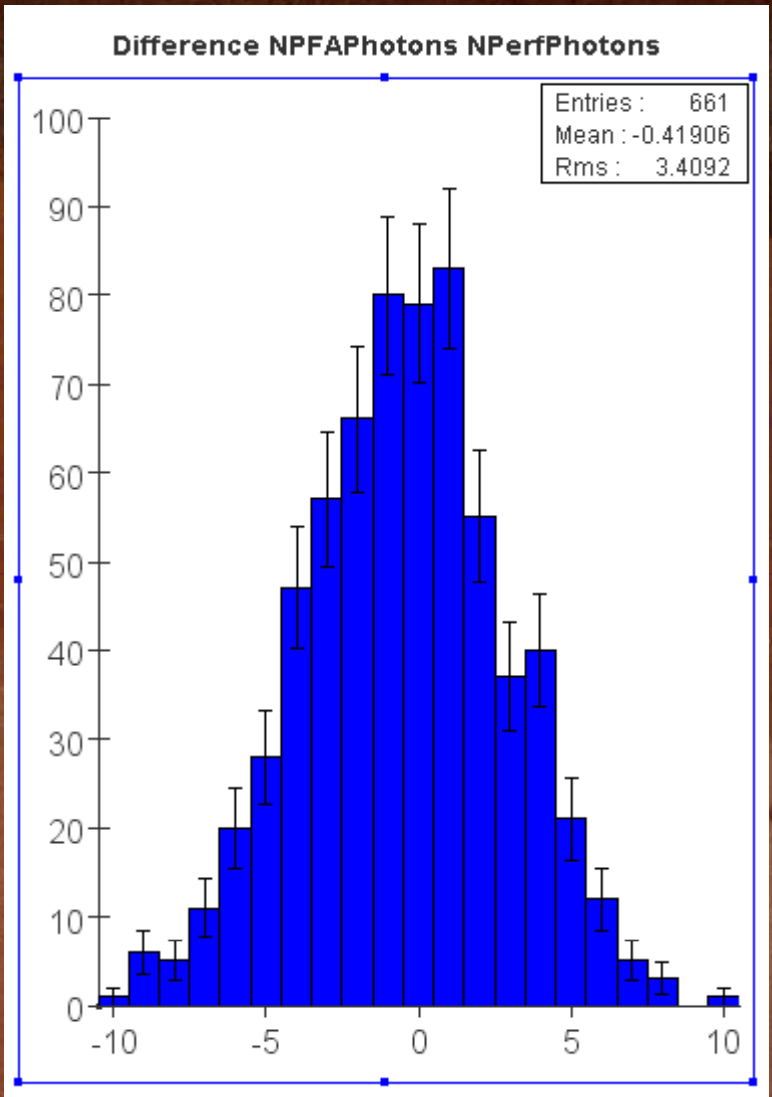
IL of Tracks

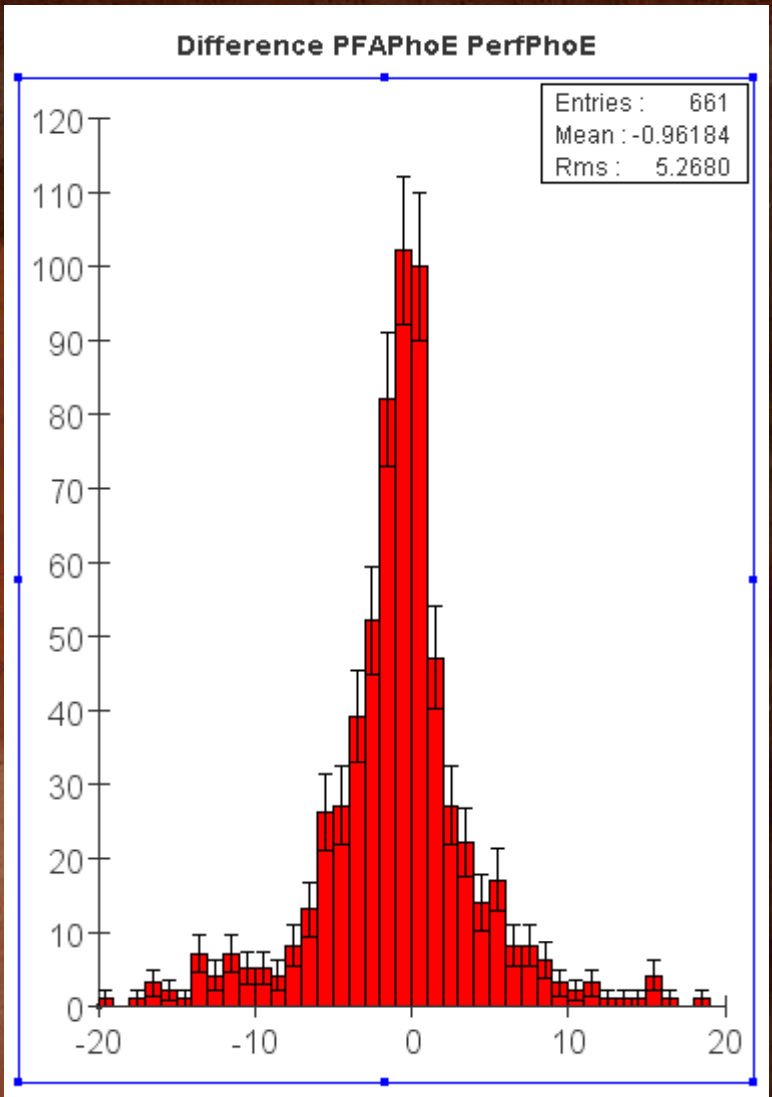


# of Mip Hits per Track

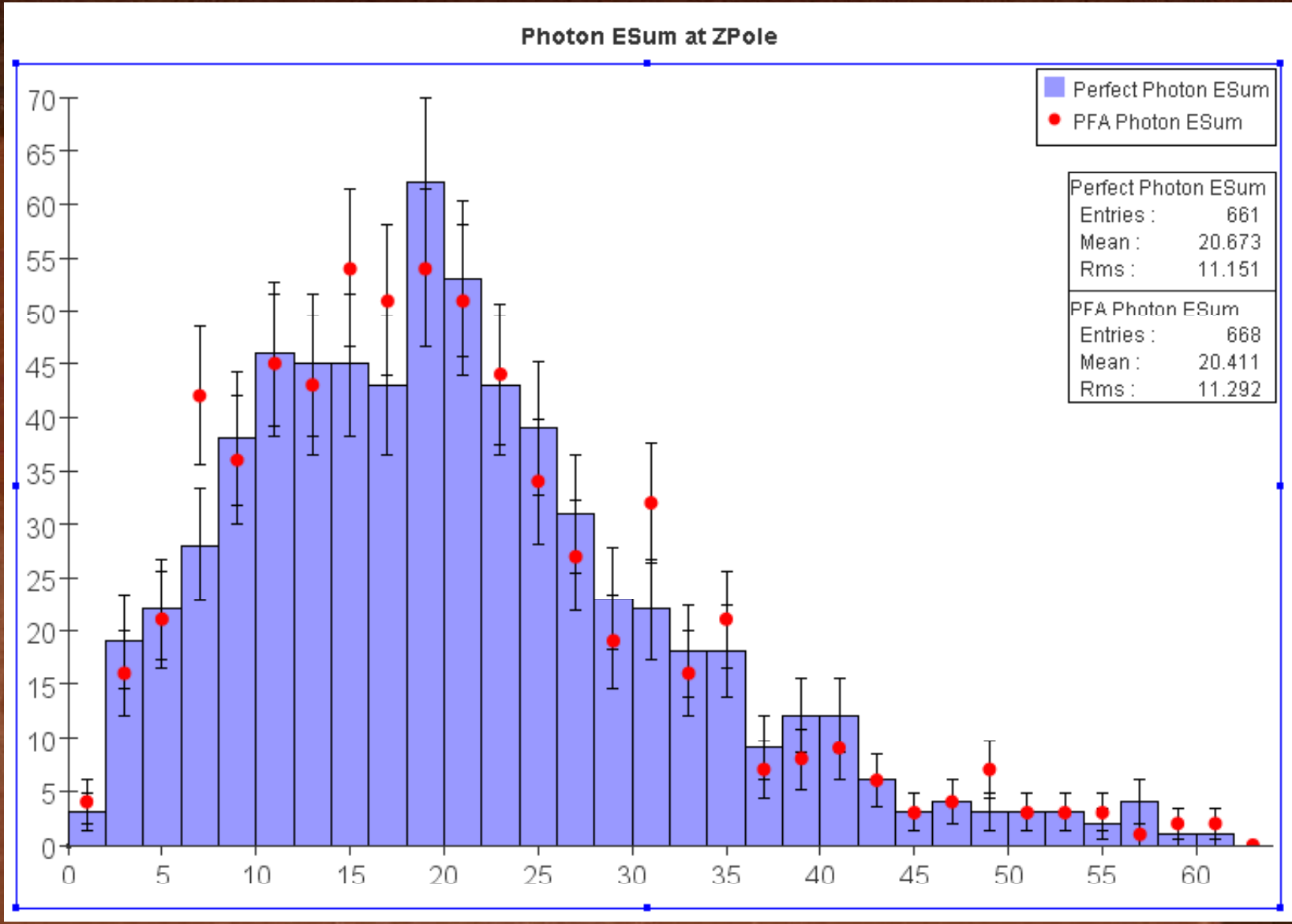
Tuned with 1-10 GeV muons
4-176 degrees in theta

Photon-Finding at ZPole





Photon-Finding at ZPole



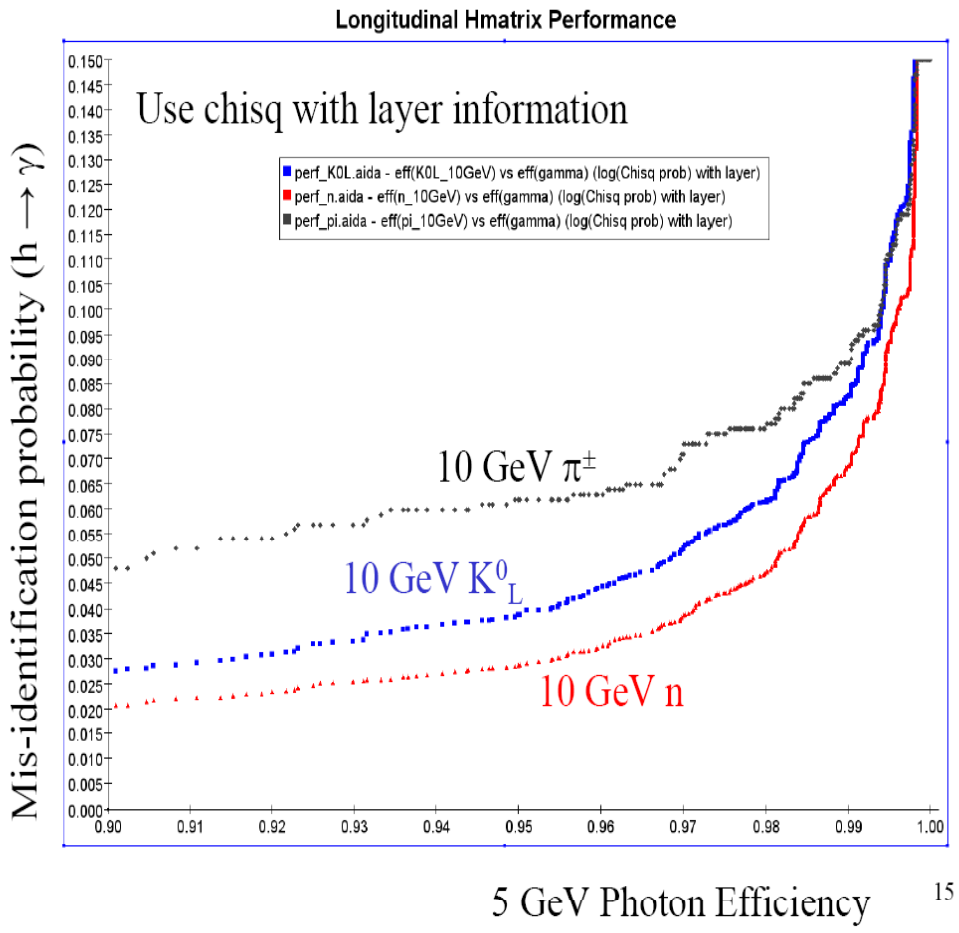
Photon-Finding Optimization

Update on Photon ID using a Longitudinal H-Matrix

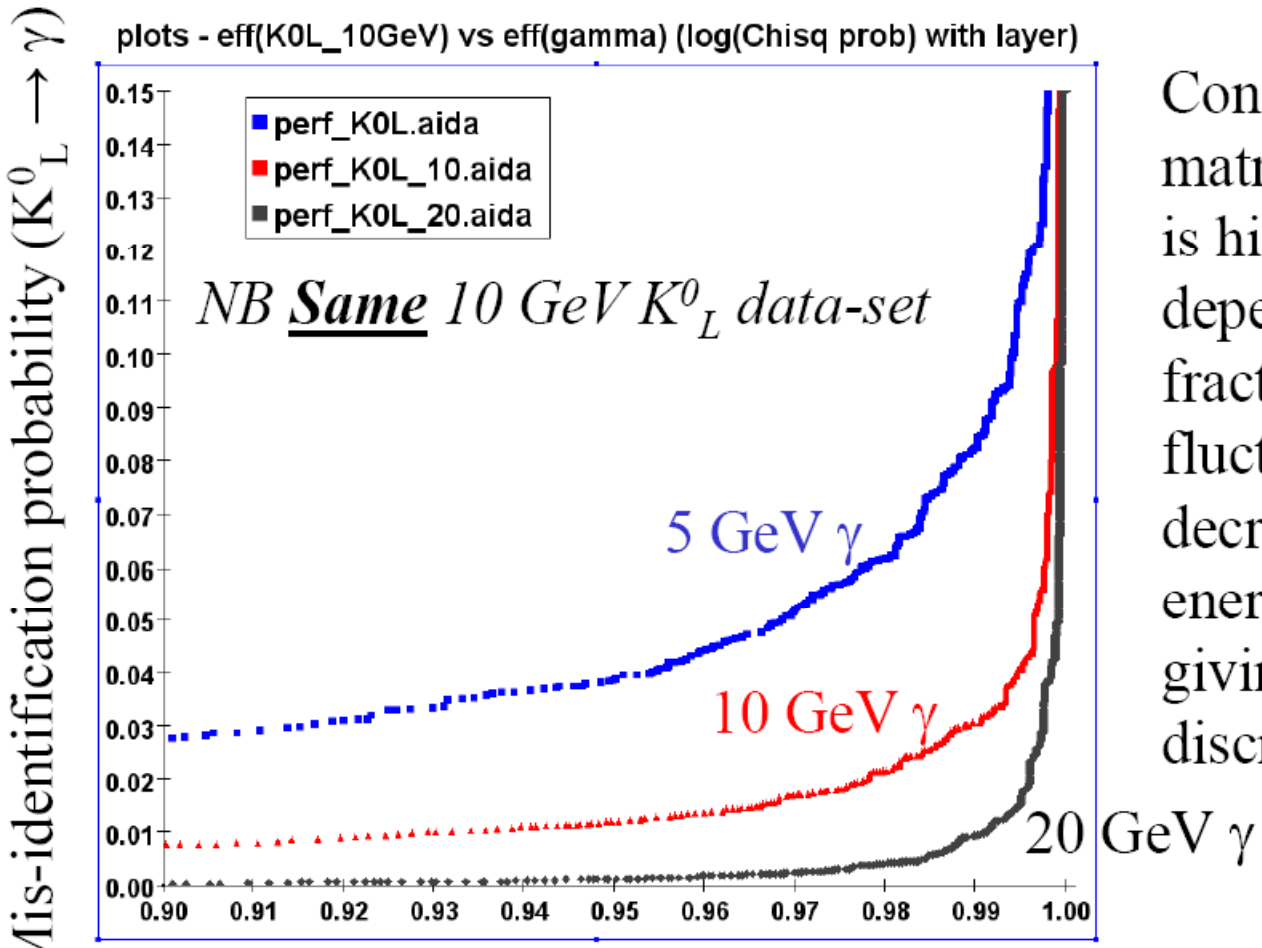
Graham W. Wilson
Univ. of Kansas
April 3rd 2007

Further H-matrix studies (with Eric Benavidez).

See Sept 19th 2006 for previous report

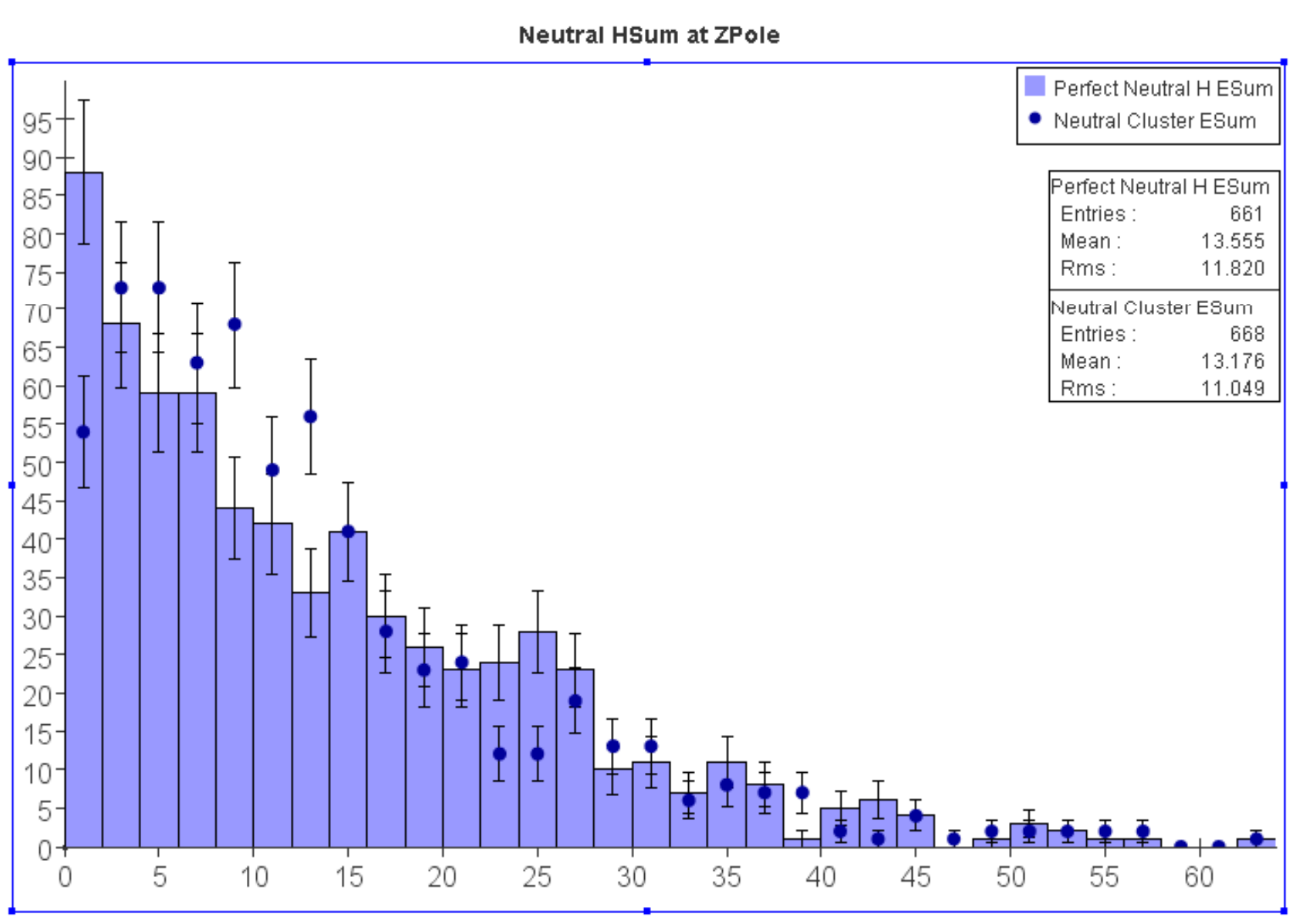


10 GeV K^0_L analyzed with 5 GeV, 10 GeV, 20 GeV photon H-matrices



Conclusion: H-matrix performance is highly energy dependent. The fractional fluctuations decrease at high energy for photons, giving more discrimination

Neutral Hadrons at ZPole



Progress on PFA at Z-pole

L. Xia

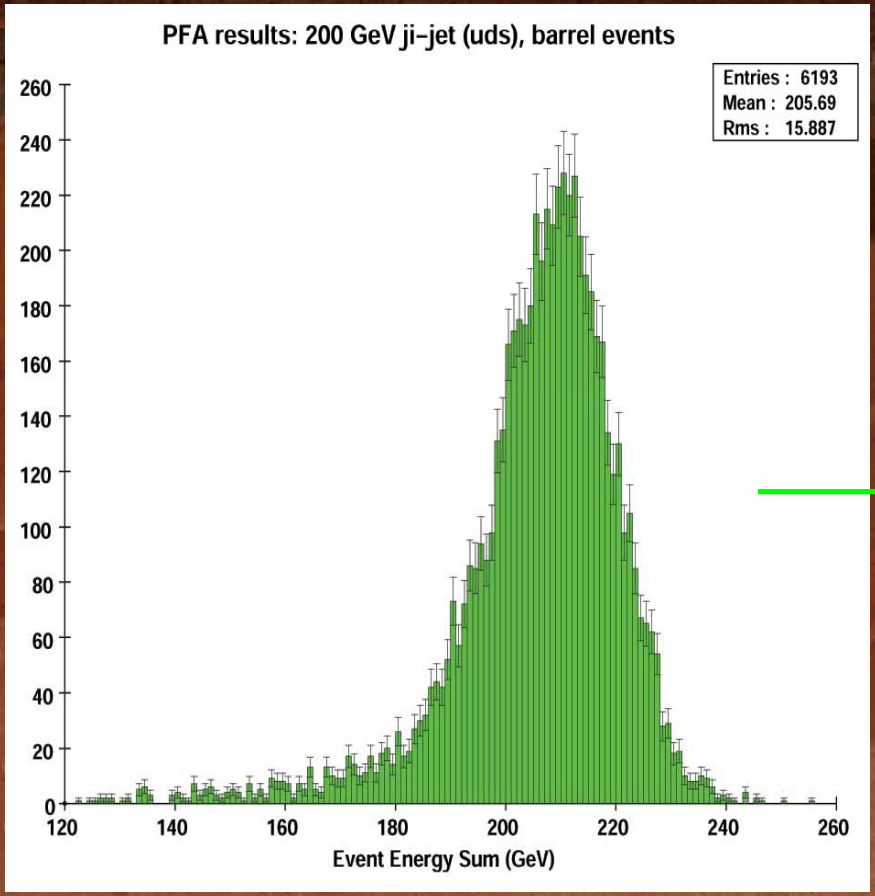
	Barrel events	All events
• ALCPG Vancouver workshop (7/2006)	46. %/sqrt(E)	49. %/sqrt(E)
• Last SiD workshop (10/2006, SLAC)	38.2 %/sqrt(E)	41.6 %/sqrt(E)
• SiD calorimeter meeting (11/2006)	35.9 %/sqrt(E)	39.1 %/sqrt(E)
• This workshop (4/2007, Fermilab)	%/sqrt(E)	%/sqrt(E)

- Compare to
  - LDC (PendoraPFA) 30. %/sqrt(E)
  - GLD 29.8 %/sqrt(E)

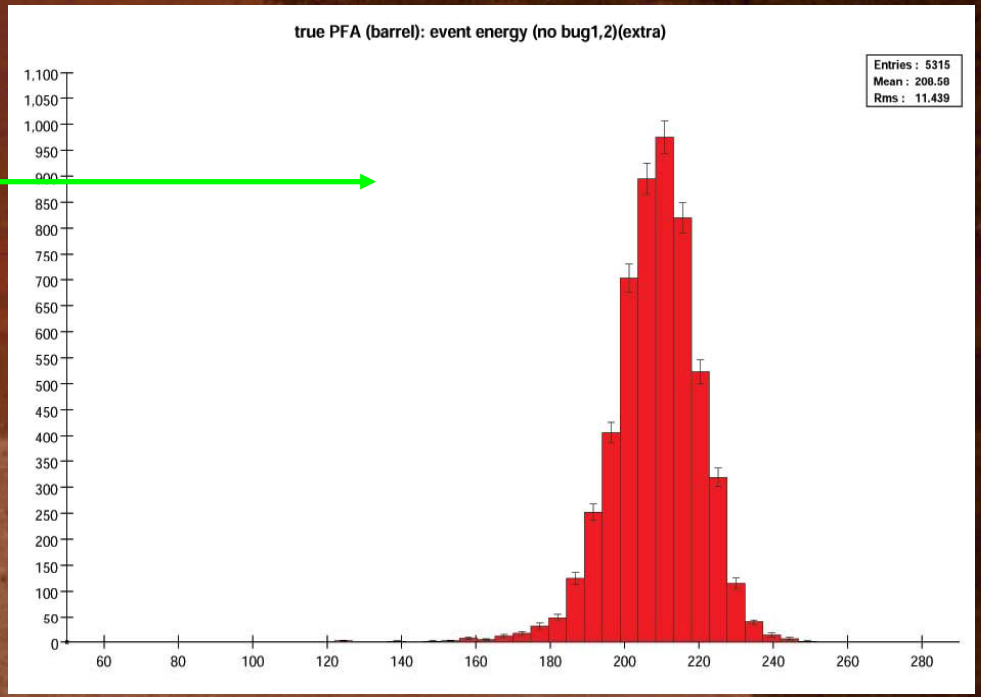
Using Z-pole tuned PFA at higher energies

Barrel events	200 GeV	350-360 GeV	500 GeV
• SiD calorimeter meeting (10/2006)	132. %/sqrt(E)		201. %/sqrt(E)
• Last SiD workshop (10/2006, SLAC)	77. %/sqrt(E)		140. %/sqrt(E)
• SiD calorimeter meeting (11/2006)	66.7 %/sqrt(E)		127. %/sqrt(E)
• This workshop (4/2007, Fermilab)	? %/sqrt(E)		? %/sqrt(E)
• Compare to			
– LDC (PendoraPFA)	37. %/sqrt(E)	57. %/sqrt(E)	75. %/sqrt(E)
– GLD	~45 %/sqrt(E)	~68 %/sqrt(E)	~85 %/sqrt(E)

Shower leakage: di-jet at 200 GeV



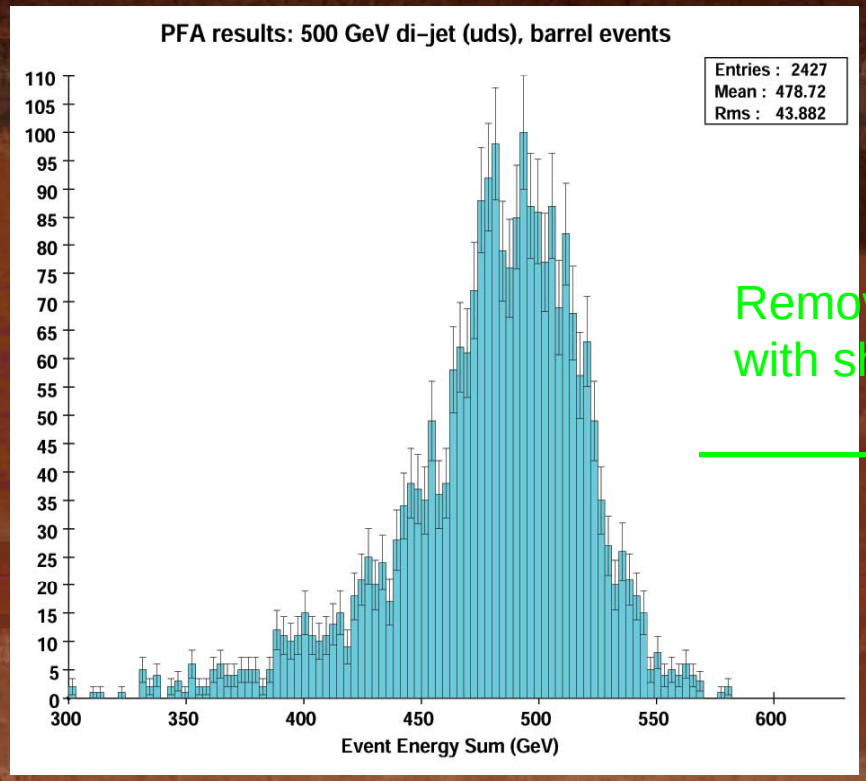
Removing events
with shower leakage



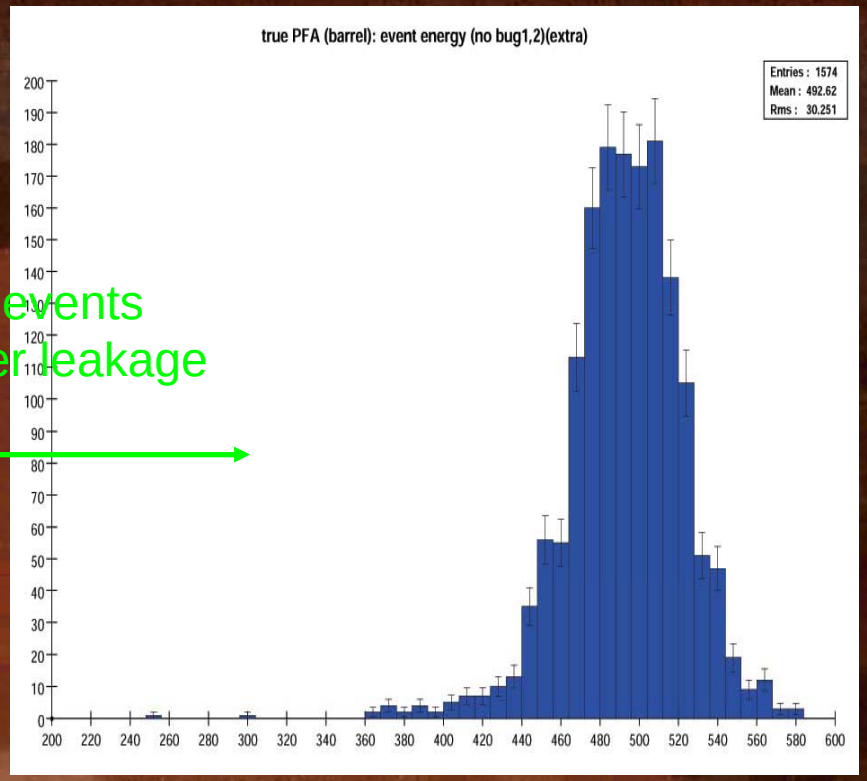
RMS = 15.89 GeV
RMS90 = 9.632 GeV
[66.7%/sqrt(E)]

RMS = 11.44 GeV
RMS90 = 8.45 GeV
[~59%/sqrt(E)]

Shower leakage: di-jet at 500 GeV



Removing events
with shower leakage



RMS = 43.88 GeV
RMS90 = 28.11 GeV
[127.%/sqrt(E)]

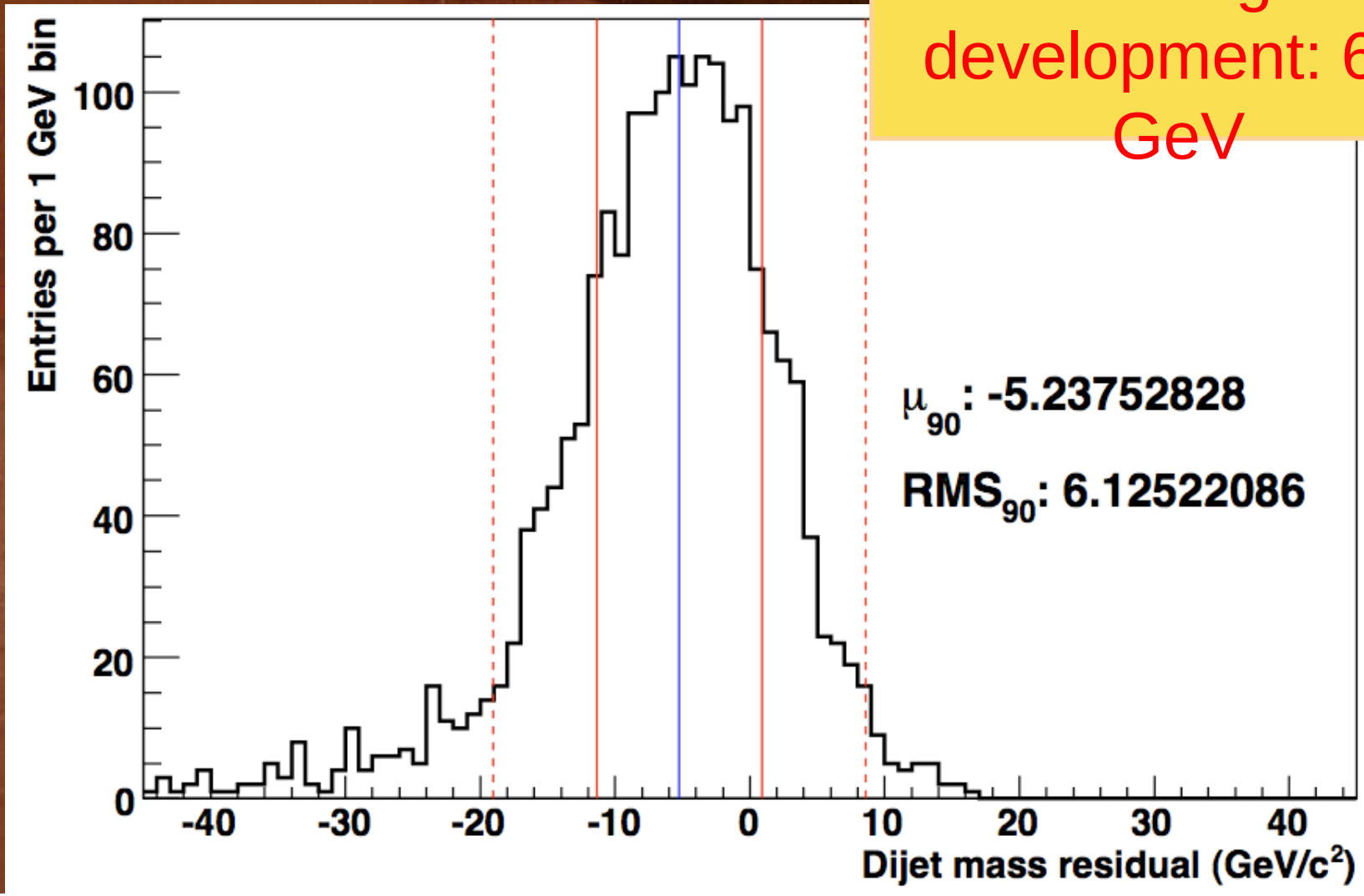
RMS = 30.25 GeV
RMS90 = 21.4 GeV
[~97%/sqrt(E)]

- Shower leakage affect PFA performance at high energy
- Events with heavy shower leakage could be identified by hits in the muon detectors
- Use hits in the muon detectors to estimate shower leakage?

ZZ -> qqνν acme0605_W_Scintillator M. Charles

Mass residuals in barrel

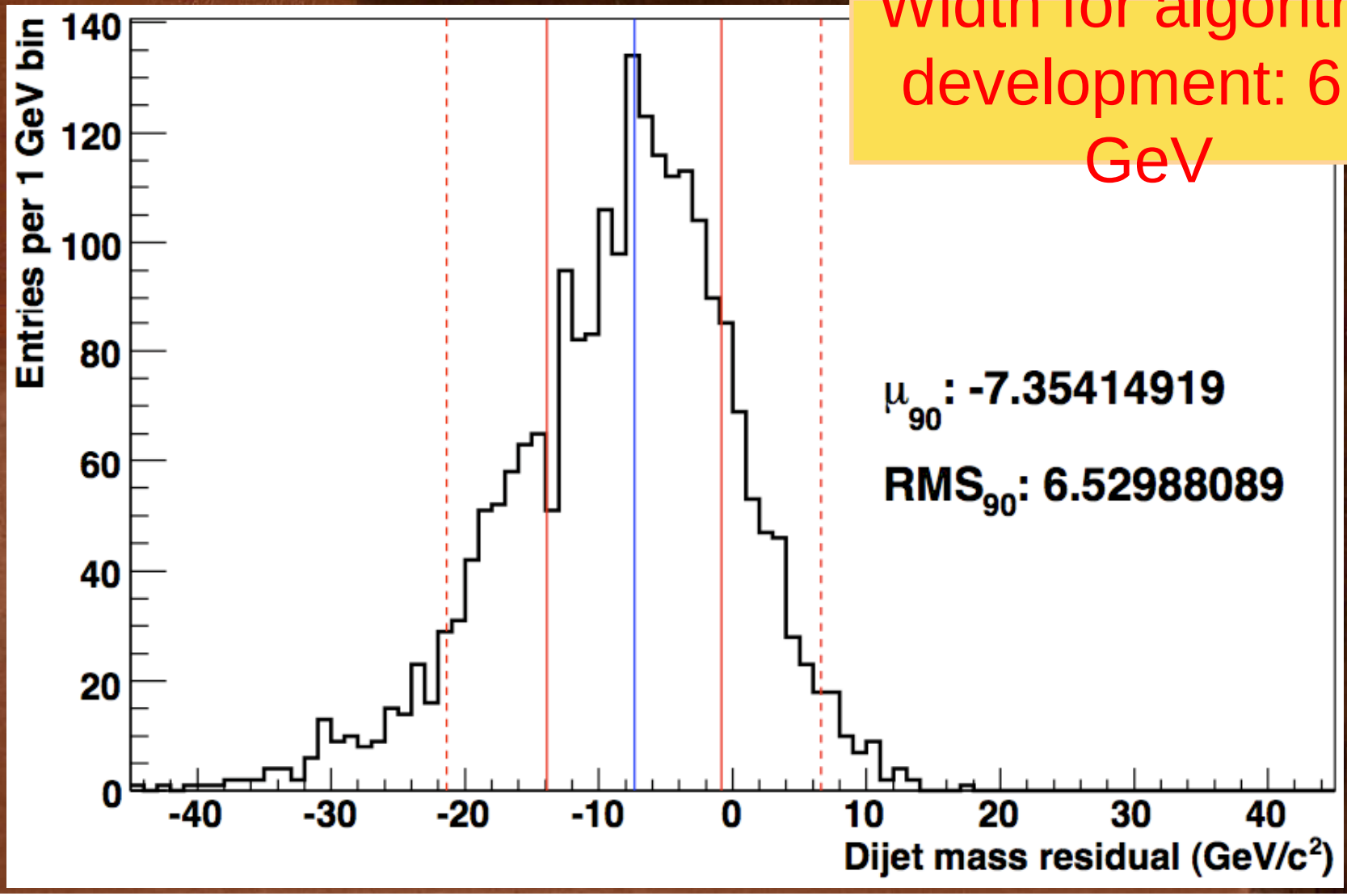
Width for algorithm development: 6.1 GeV



acme0605_steel_scint

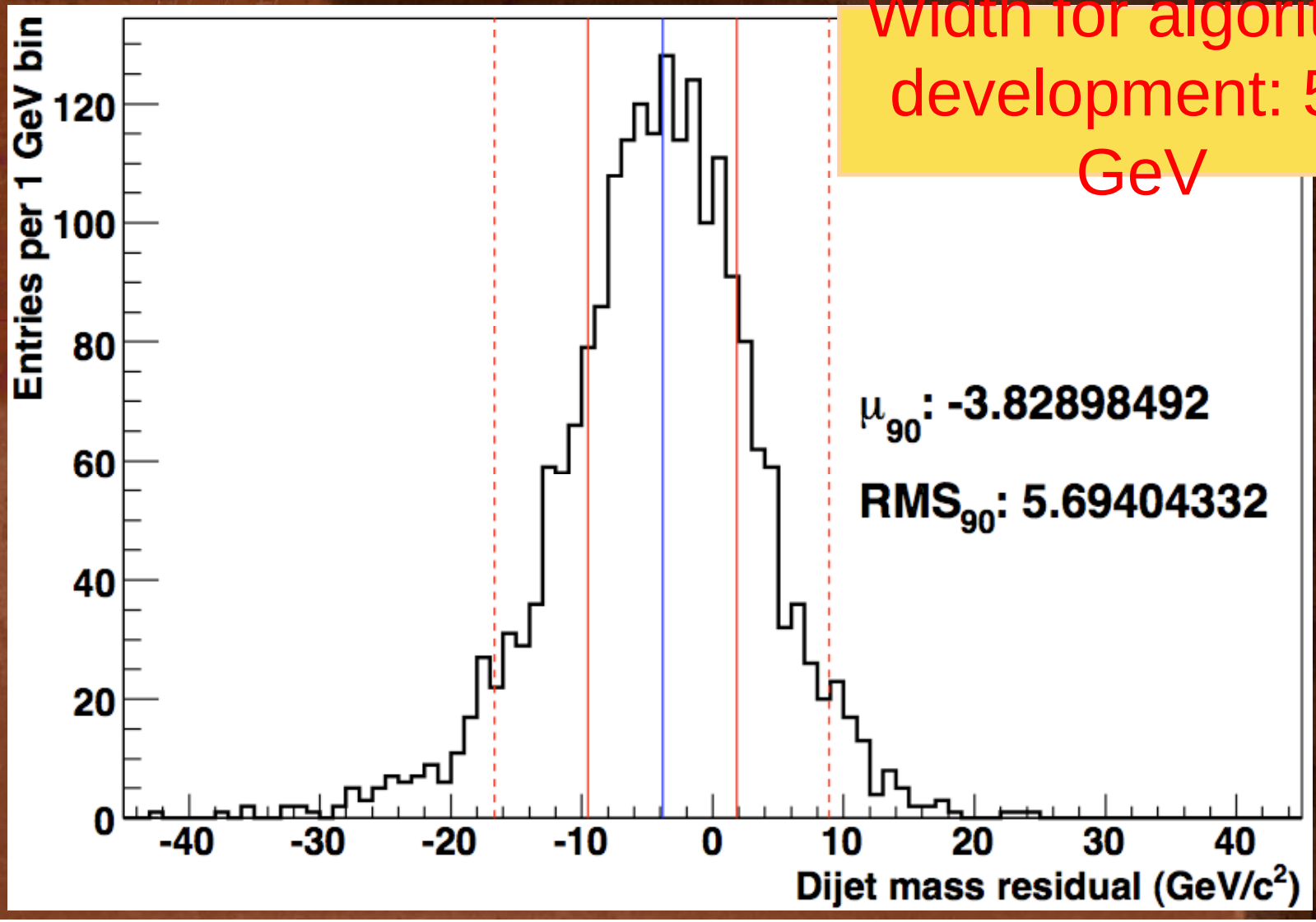
Mass residuals in barrel

Width for algorithm development: 6.5 GeV



acme0605_w_rpc

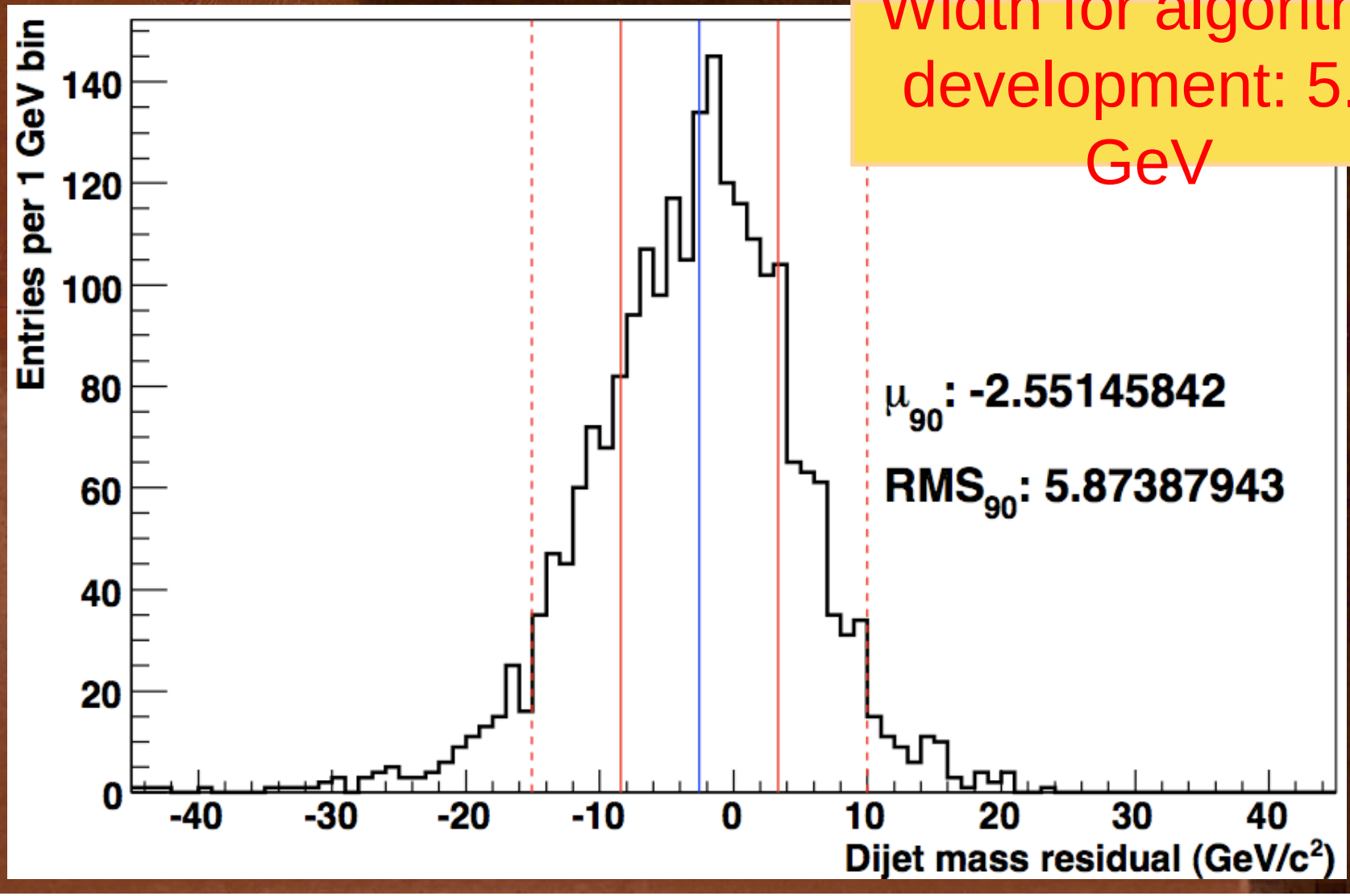
Mass residuals in barrel



Width for algorithm development: 5.7 GeV

acme0605_steel_rpc

Mass residuals in barrel



Width for algorithm development: 5.9 GeV

Design	RMS_{90} of mass (including Γ)	RMS_{90} of residuals (no Γ)	Bias
acme0605 [w/scint]	6.9 GeV	6.1 GeV	−5.2 GeV
acme0605_steel_scint	7.3 GeV	6.5 GeV	−7.4 GeV
acme0605_w_rpc	6.6 GeV	5.7 GeV	−3.8 GeV
acme0605_steel_rpc	6.8 GeV	5.9 GeV	−2.6 GeV

For this real (i.e. confused) PFA:

- RPCs give noticeably better resolution and smaller bias than scintillators
- Tungsten gives somewhat better resolution than steel

Plans for PFA Development

e+e- -> ZZ -> qq + $\nu\nu$ @ 500 GeV

- Development of PFAs on ~120 GeV jets – most common ILC jets
- Unambiguous dijet mass allows PFA performance to be evaluated w/o jet combination confusion
- PFA performance at constant mass, different jet E (compare to ZPole)
- dE/E, dθ/θ -> dM/M characterization with jet E

e+e- -> ZH

e+e- -> ZZ -> qqqq @ 500 GeV

- 4 jets - same jet E, but filling more of detector
- Same PFA performance as above?
- Use for detector parameter evaluations (B-field, IR, granularity, etc.)

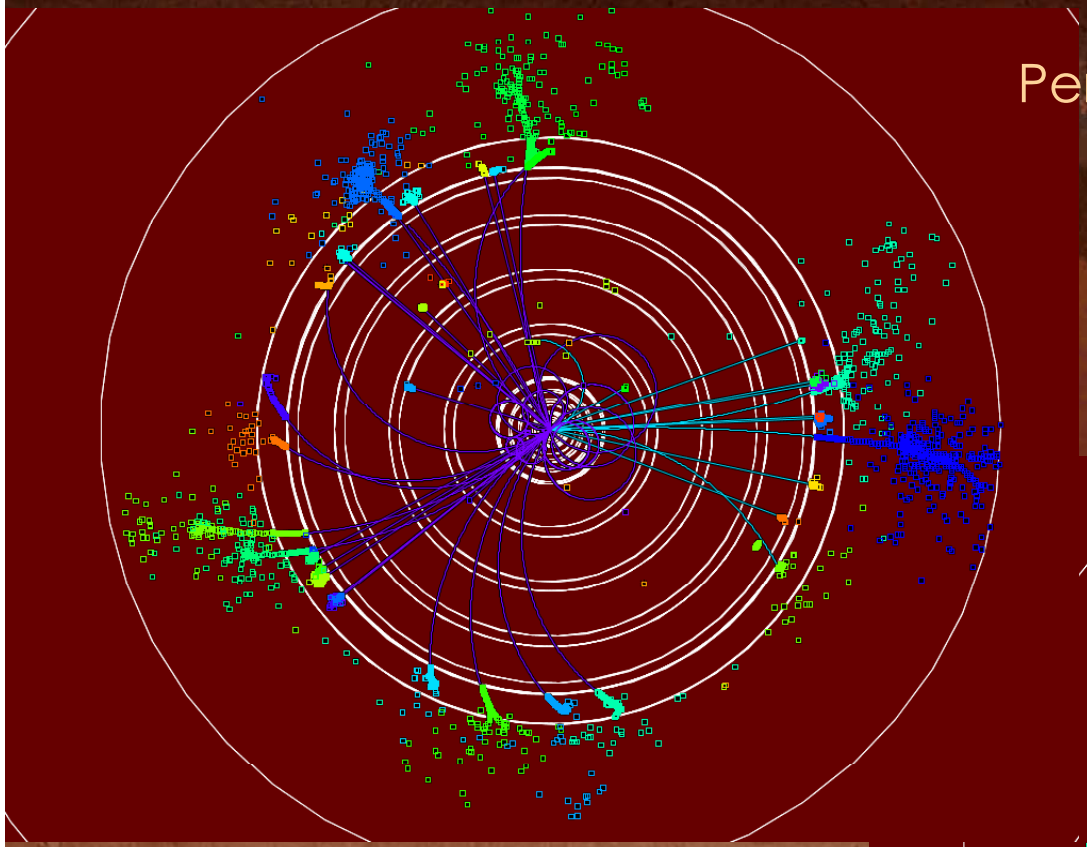
e+e- -> tt @ 500 GeV

- Lower E jets, but 6 – fuller detector

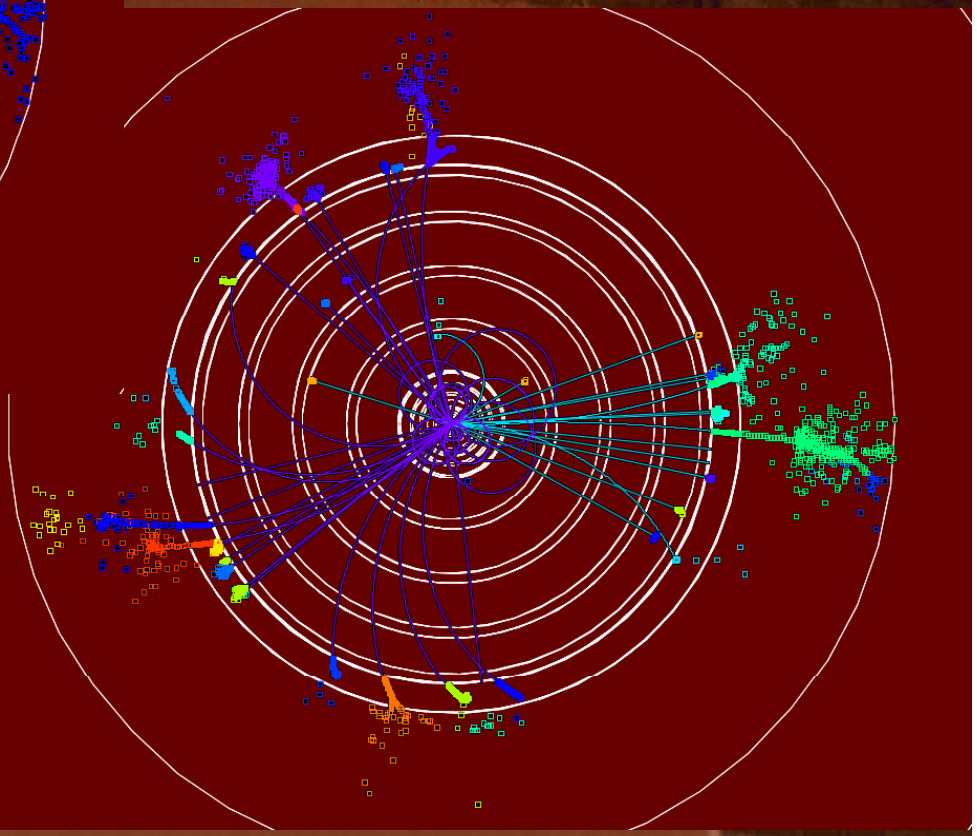
e+e- -> qq @ 500 GeV

- 250 GeV jets – challenge for PFA, not physics

PFA Development – ZPole Jets



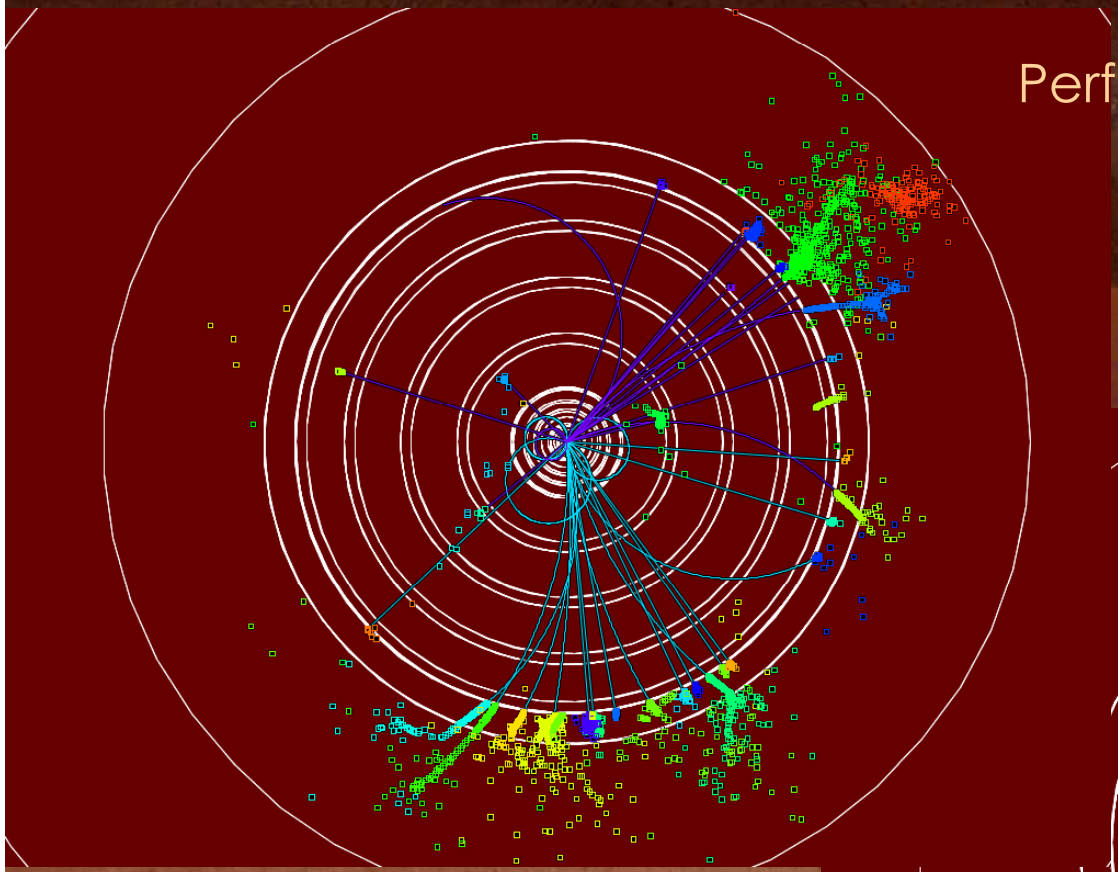
Perfect PFA Jets



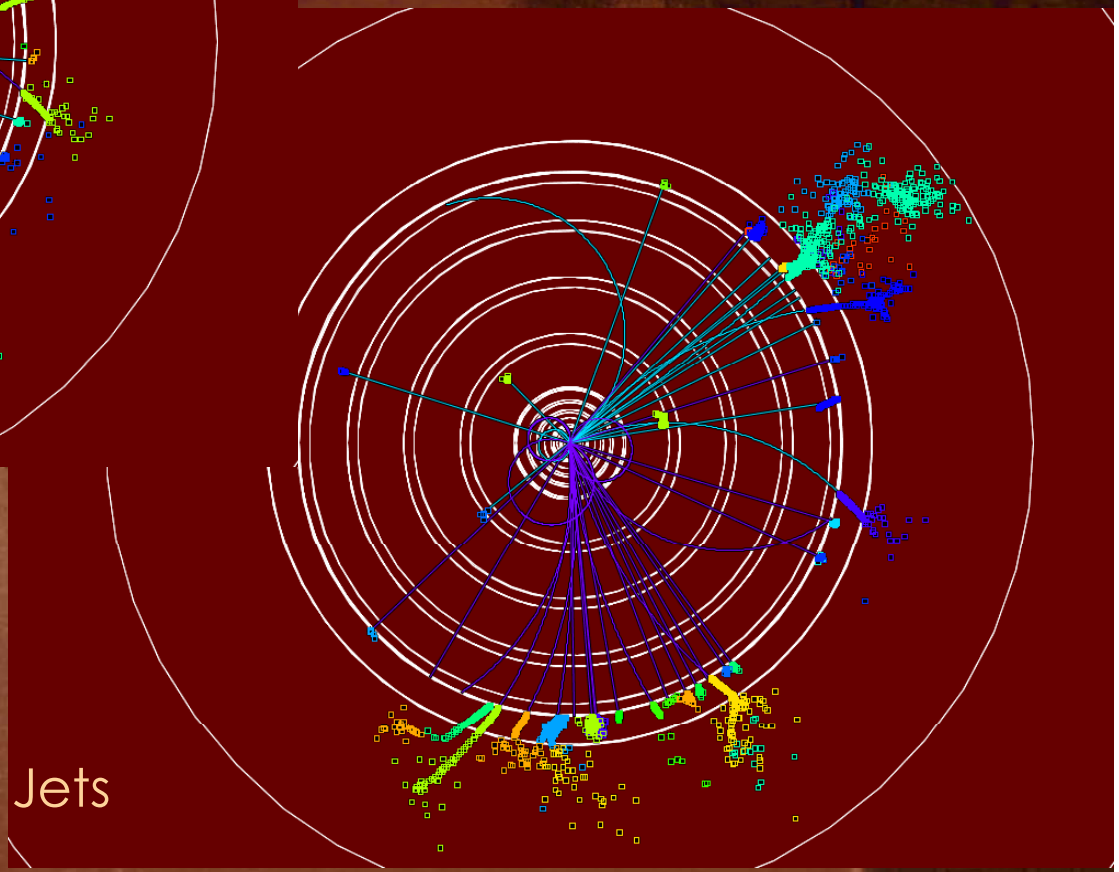
kT jet algorithm in 2 jet mode

PFA Jets

Plans for PFA Development – ZZ -> qqνν Jets



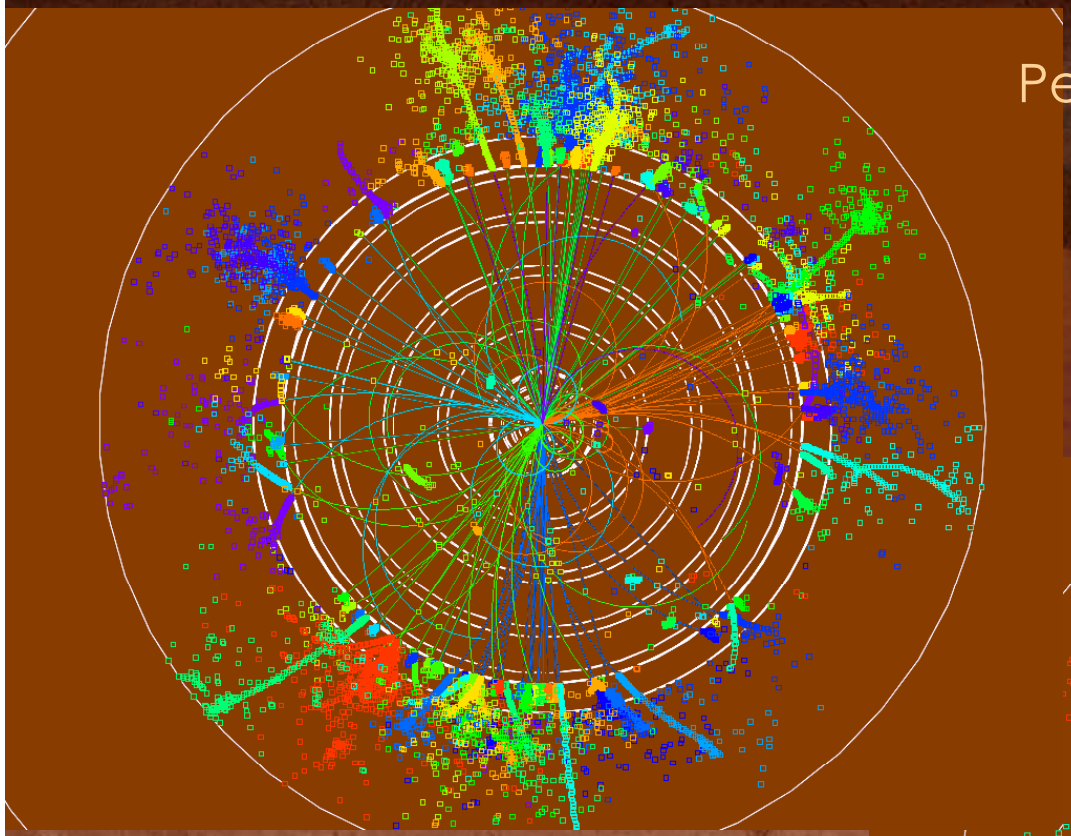
Perfect PFA Jets



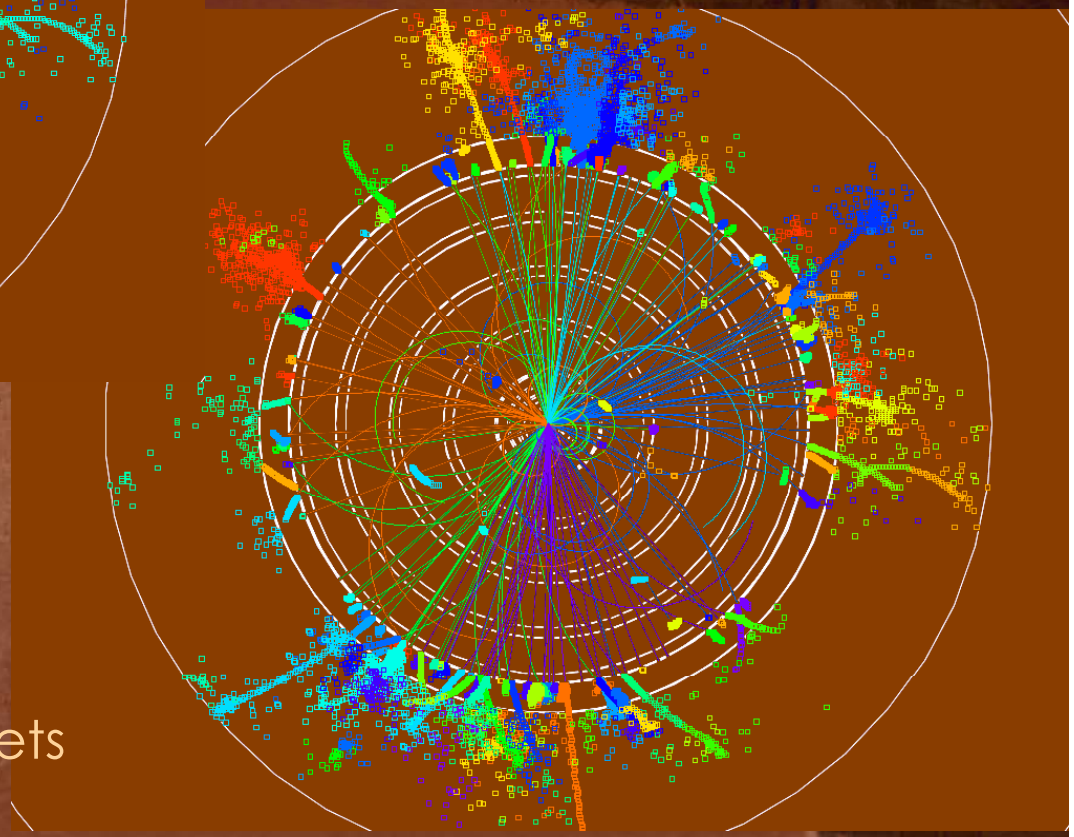
kT jet algorithm in 2 jet mode

PFA Jets

Plans for PFA Development – tt Jets



Perfect PFA Jets



6 jets in both events using
ycut = 0.00025 in kT jet algorithm

PFA Jets

Plans for PFA Development with SiD Model

By Paris Sim Workshop (May 2-4) :

- Finish standard Perfect PFA definition
- Use Perfect PFA to study contributions to dM/M w/o confusion (dE_j/E_j, $d\theta_{12}/\theta_{12}$)
- Results for PFA on ZZ -> qqνν @ 500 GeV (Barrel, then whole detector)
- Results for PFA on ZZ -> qqqq @ 500 GeV

By LCWS-DESY :

- PFA performance on ZZ -> qqνν @ 500 GeV, ZZ -> qqqq @ 500 GeV, tt @ 500 GeV
- E_j dependence of dijet mass (3 points including ZPole, single Z,W?)
- PFA performance on ZH benchmark process?
- With template, study confusion contribution to PFA (E_j dependence? by comparing with ZPole results)
- Add real track reconstruction to PFA?

Plans for PFA Development with SiD Model

After LCWS-DESY :

- Start detector model comparisons using PFA on ZH @ 500 GeV
  - B-field variations
  - ECAL IR variations
  - HCAL technology/parameter variations
  - LDC, GLD comparisons with SiD variants
- Ongoing optimization of PFA algorithms - π^0 reconstruction, cluster fragment pointing analyses, etc.
- Explore limits of PFA performance – very high E (250 GeV jets, physics at 1 TeV CM?, 2 TeV at NLC?

By end 2007 :

- Optimized SiD Detector for ILC @ 500 GeV
- Characterization of PFA performance for SiD model variants
- Physics Benchmark studies with SiD and real PFA analysis
- Towards merger with another concept?

Summary

Finishing development of tools necessary for PFA development

- Calibration method for detector models
- Perfect PFA prescription

Finished and released PFA Template

- Cluster algorithm substitution
- CAL hit/cluster accounting

PFA development emphasis on DiJets at 500 GeV CM

Optimization of photon finder

Closing in on path to PFA/Detector optimization