

Arbor

Manqi RUAN

Laboratoire Leprince-Ringuet (LLR)
Ecole Polytechnique
91128, Palaiseau

Concept

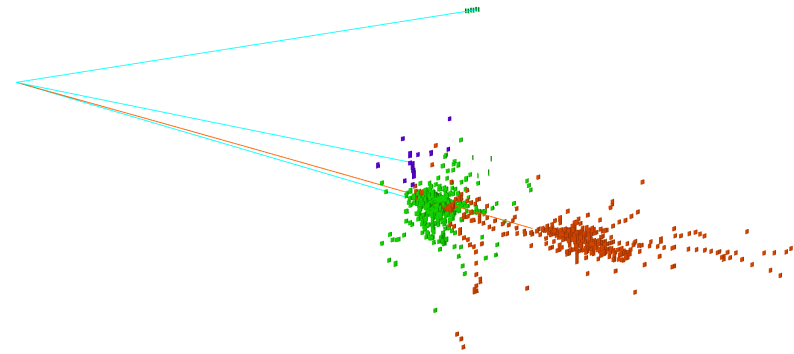
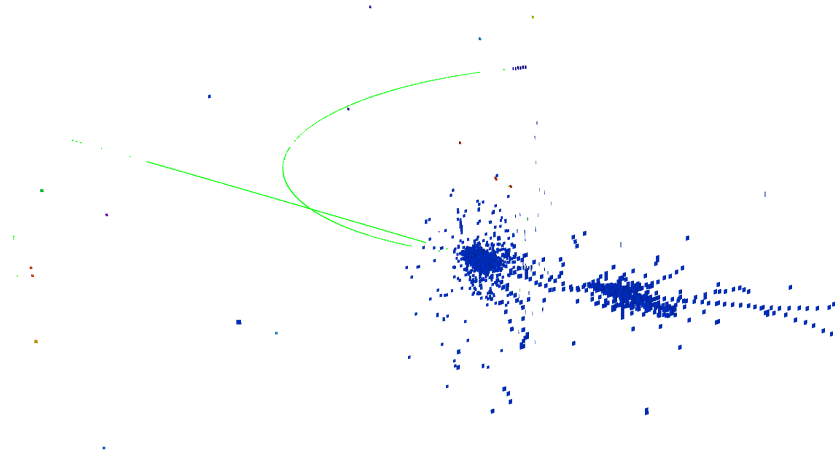
PandoraPFA: Promising performance.

But:

Optimized for AHCAL with 3 * 3 cm cells, while DHCAL has 1 * 1 cm cell

Confusion not negligible (worse at higher energy):

eg, ~10% of pions affected by PFA double counting



To improve:

Higher granularity ~ Better separation

Alternative Algorithm

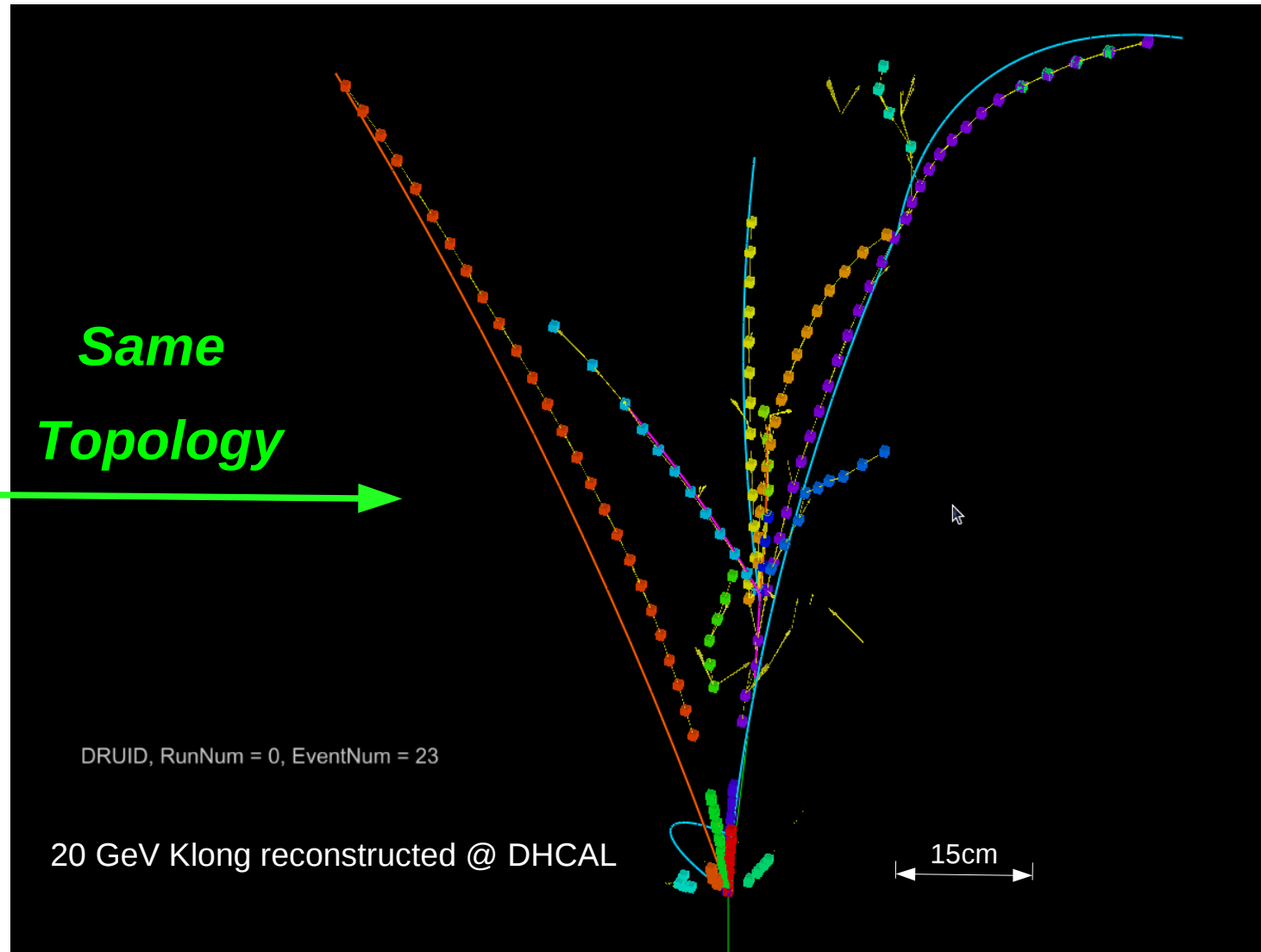
Better pattern recognition based on shower geometry

Better Measurement: more dedicate estimators

Arbor: shower ~ tree



**Same
Topology**

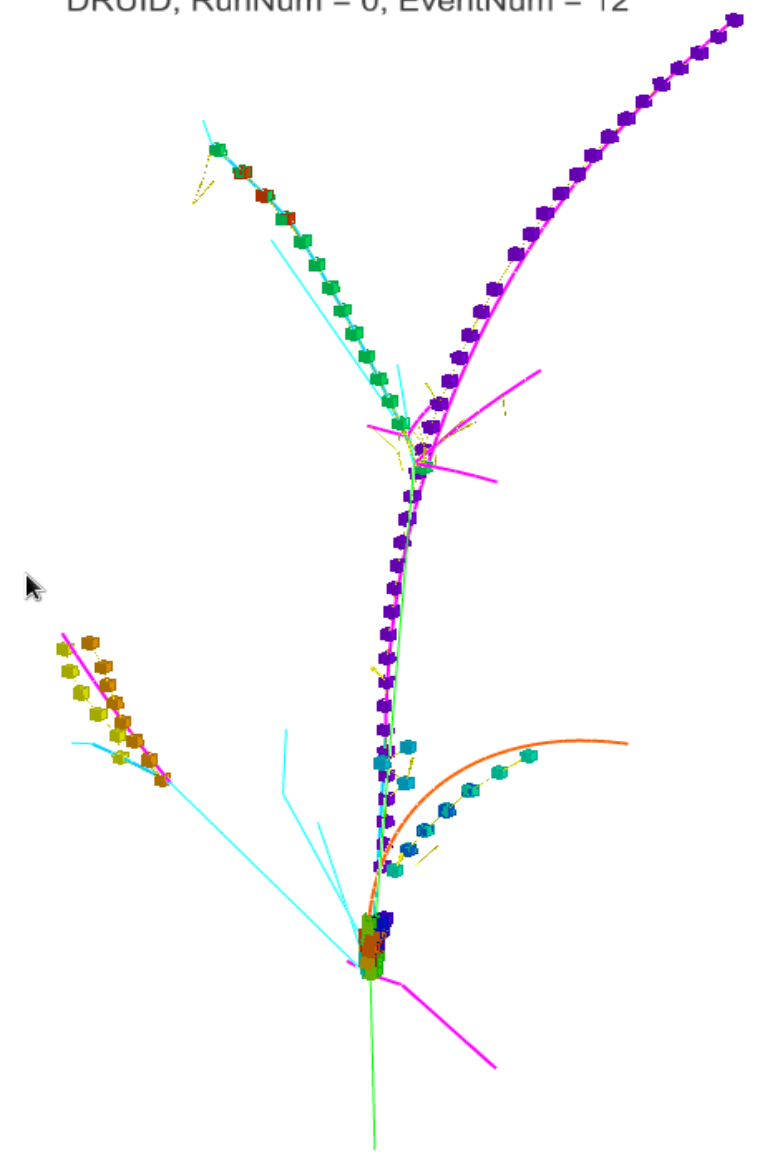


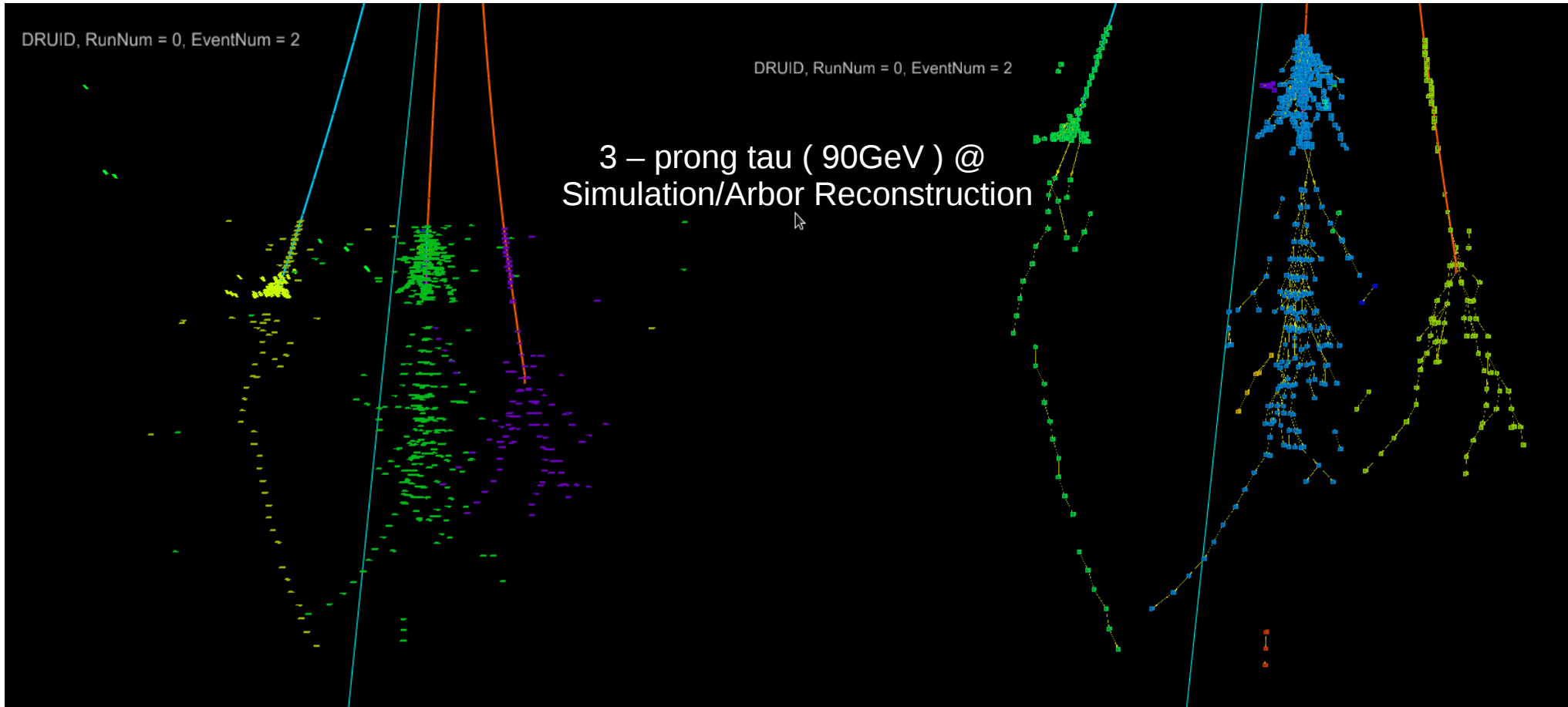
- *Start from Micro structures: Full usage on high granular information*
- *Original idea from Henri Videau, in hadronic shower reconstruction @ ALEPH*

DRUID, RunNum = 0, EventNum = 12

- Arbor: Promising branch tagging, with lots of potential applications
 - In situ Calibration/Stability monitoring
 - Kink & Pre interaction tagging
 - Track – Cluster linking
 - Calo Tracks Measurement:
 - Energy Estimation ~ Leakage correction
 - EM/Had hits tagging
 - ...

- Momentum reconstruction with Fit (J. Sniff, Princeton/LLR)
 - ~10% resolution on MIP track in the barrel & leakage correction using 1 cm² DHCAL cells

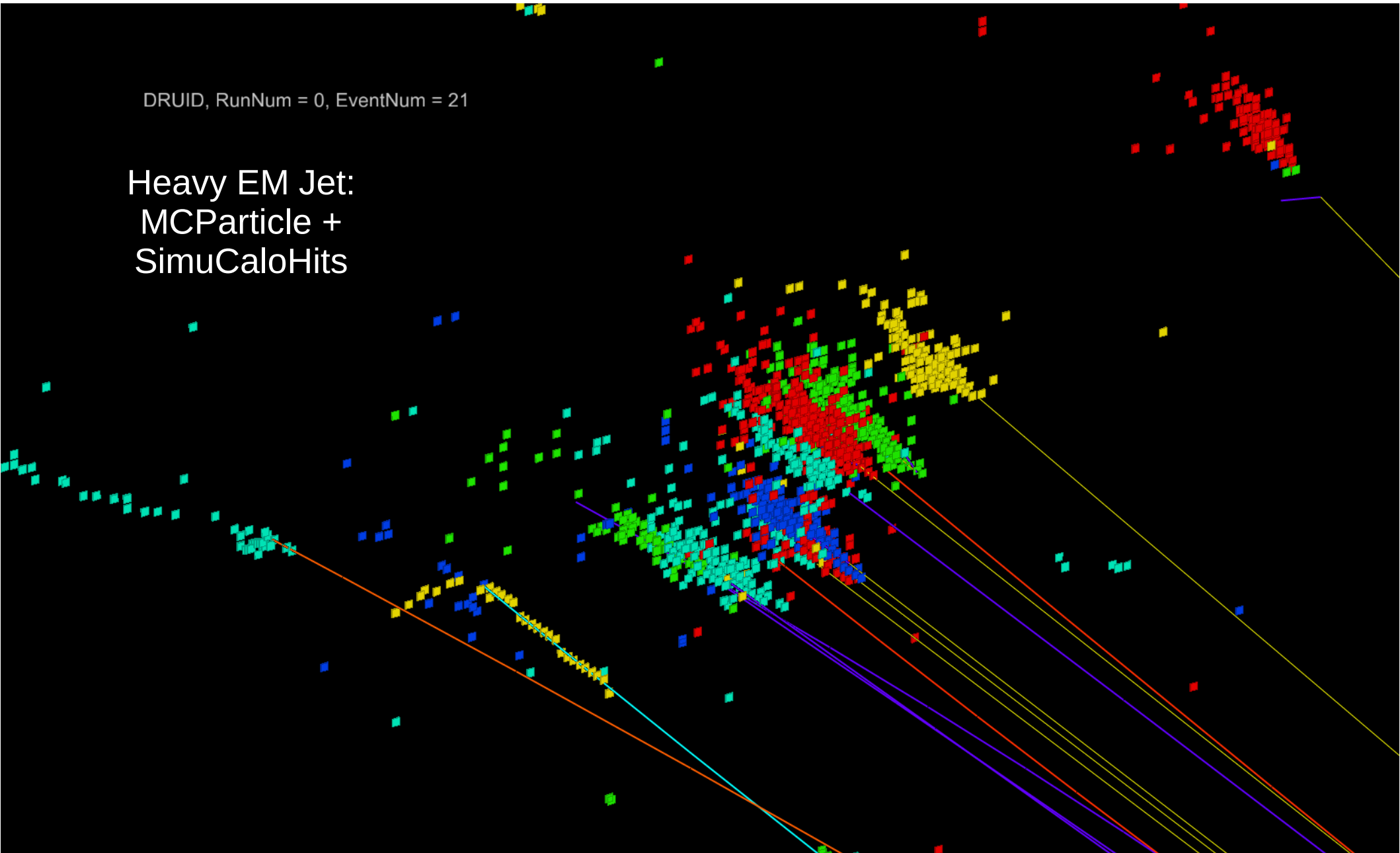




Merging Branches together : Reconstruction of Shower @ Calo

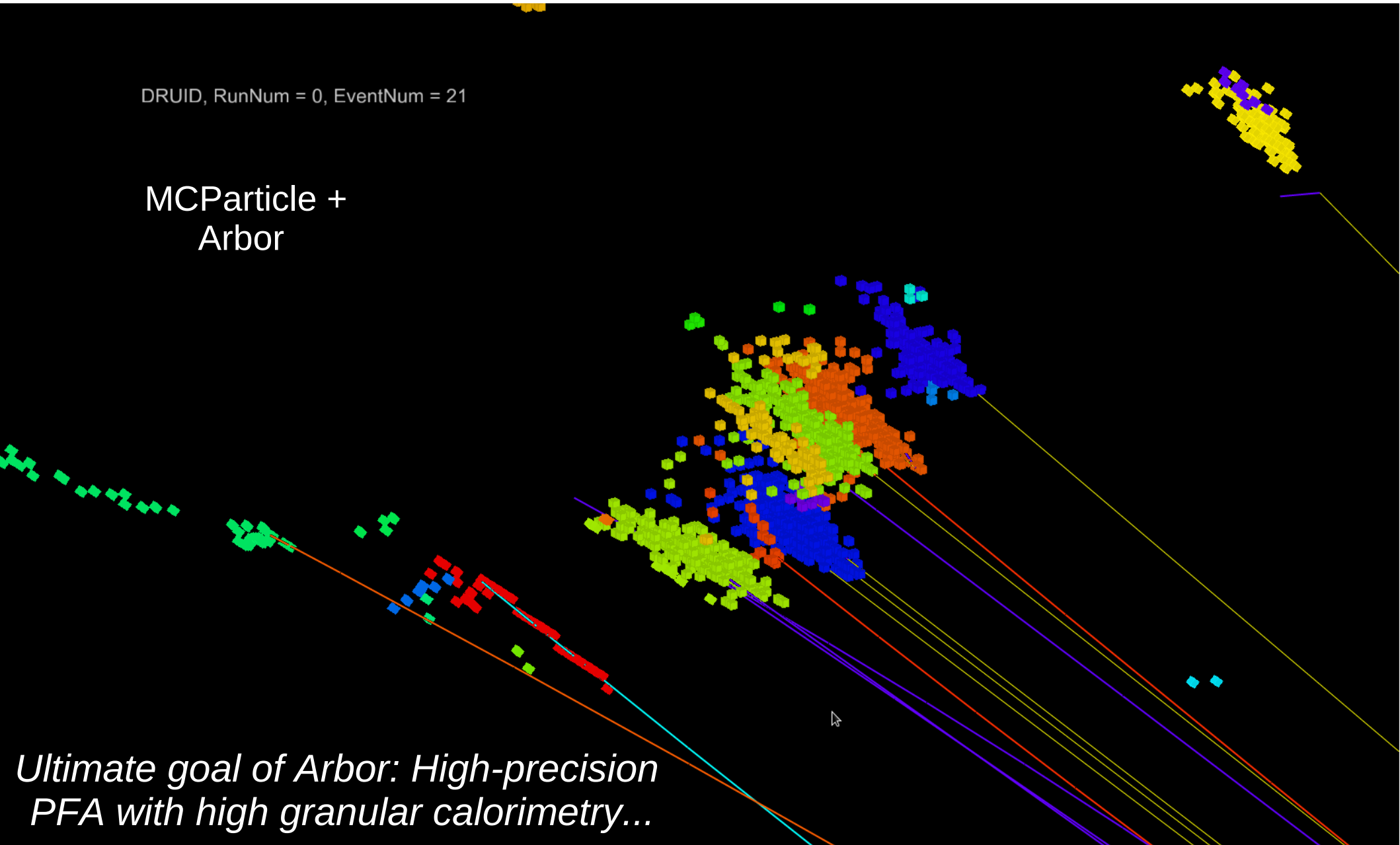
DRUID, RunNum = 0, EventNum = 21

Heavy EM Jet:
MCParticle +
SimuCaloHits



DRUID, RunNum = 0, EventNum = 21

MCParticle +
Arbor



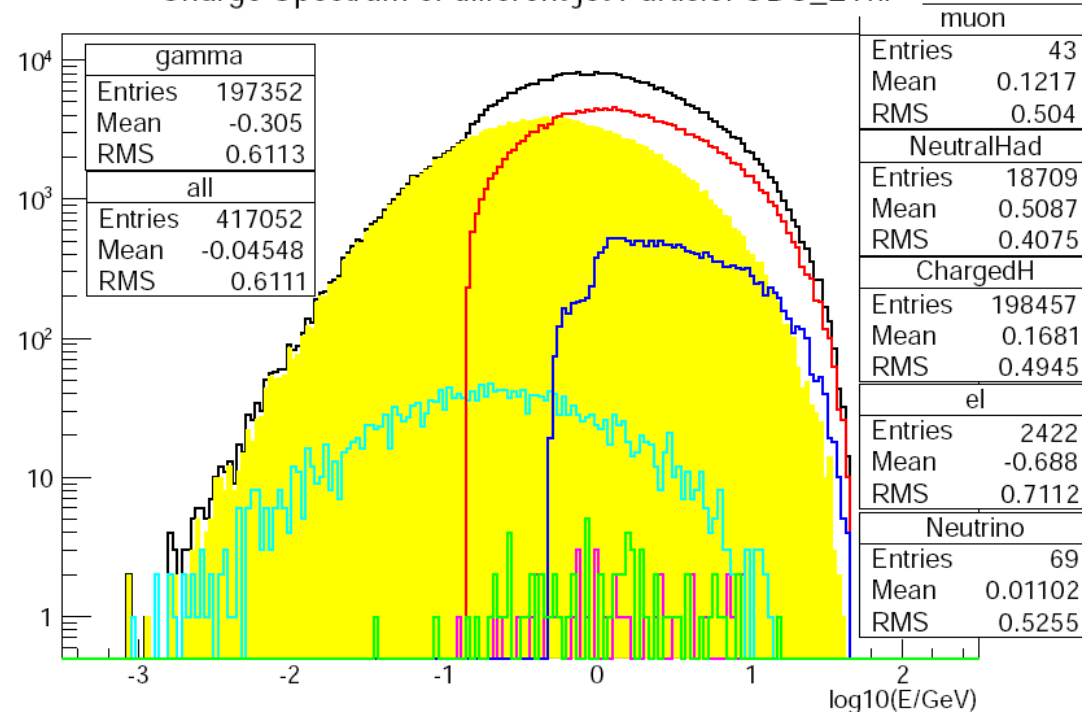
*Ultimate goal of Arbor: High-precision
PFA with high granular calorimetry...*

Performance & Optimization

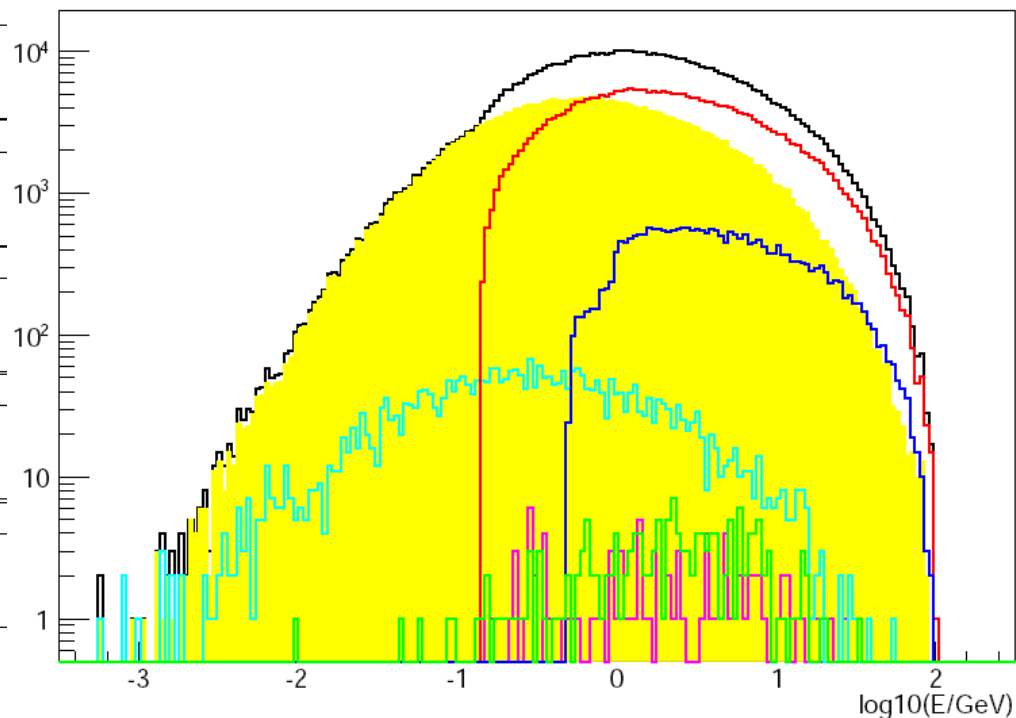
	MIP	EM	Charged Hadron	Neutral Hadron	Neutrinos
MIP					
EM					
Charged Hadron (CH)					
Neutral Hadron (NH)					
Neutrinos					

- MIP: muon (initial or pion decay) + sailing through charged hadron
- EM: e^+e^- (very rare), photon...
- Charged Hadron: pion, charged kaon(321), proton(2212), ions
- Neutral Hadron: Klong(130), Kshort(310), Neutron, anti-Neutron(2112)

Charge Spectrum of different jet Particle: UDS_ZThr



Charge Spectrum of different jet Particle: UDS_200GeV

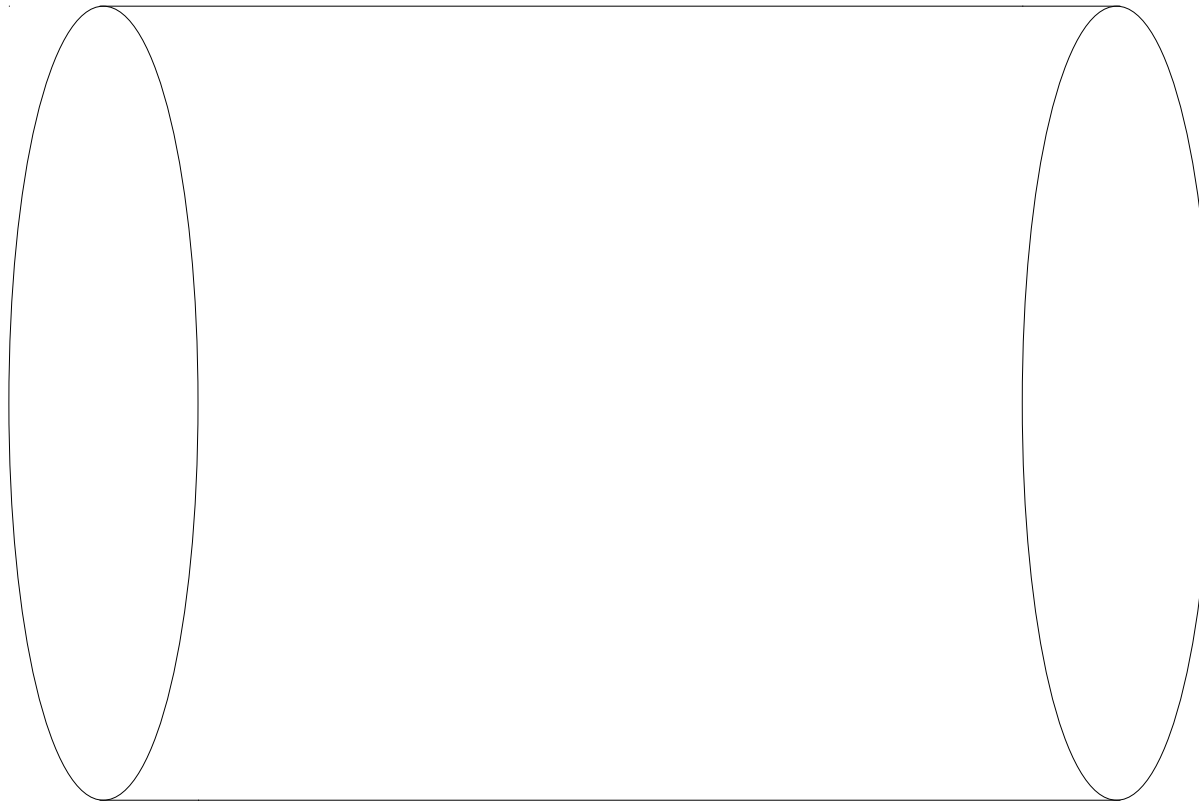


- QQ @ Zthr: 19.7 photon (Mean Energy = 1.26 GeV, total E = 24.5GeV) + 19,8 Charged Hardon (ME/TE = 2.86/56.6 GeV) + 1.8 Neutral Hadron (5.08/9.1 GeV)+ ...
- QQ @ 200 GeV: 26.9 photon (2.07/55.7 GeV) + 26.8 Charged Hadron (4.64/124.2 GeV) + 2.45 Neutral Hadron (8.01/19.2 GeV) + ...
- QQ @ 360 GeV: 33.5 photon (3.08/101 GeV) + 33.3 Charged Hadron (6.72/223.8 GeV) + 2.99 Neutral Hadron (11.45/34.3 GeV) + ...

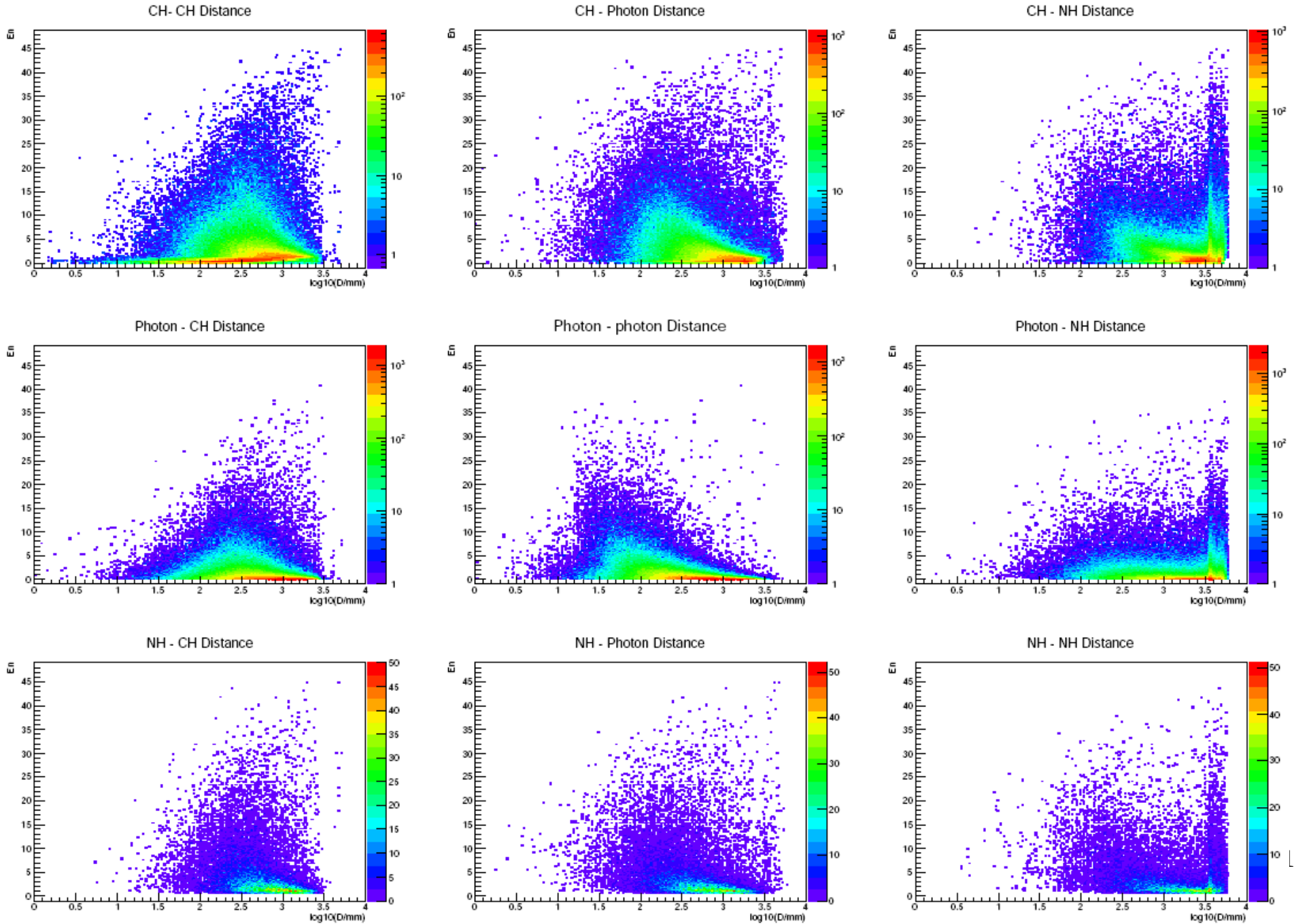
Hit Distance



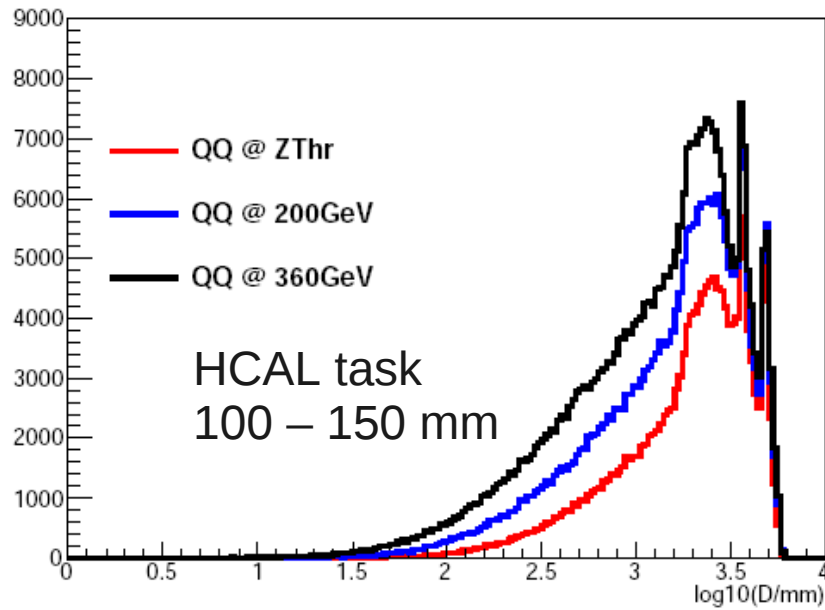
- Distance: spatial distance between expected hit positions at TPC boundary (slightly smaller than the distance at Calorimeter Clusters)



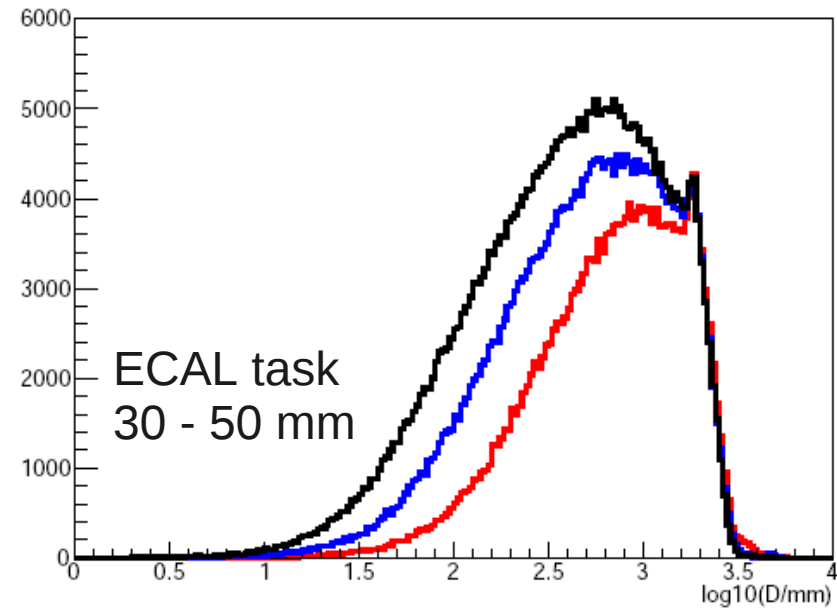
Distance at ZThr



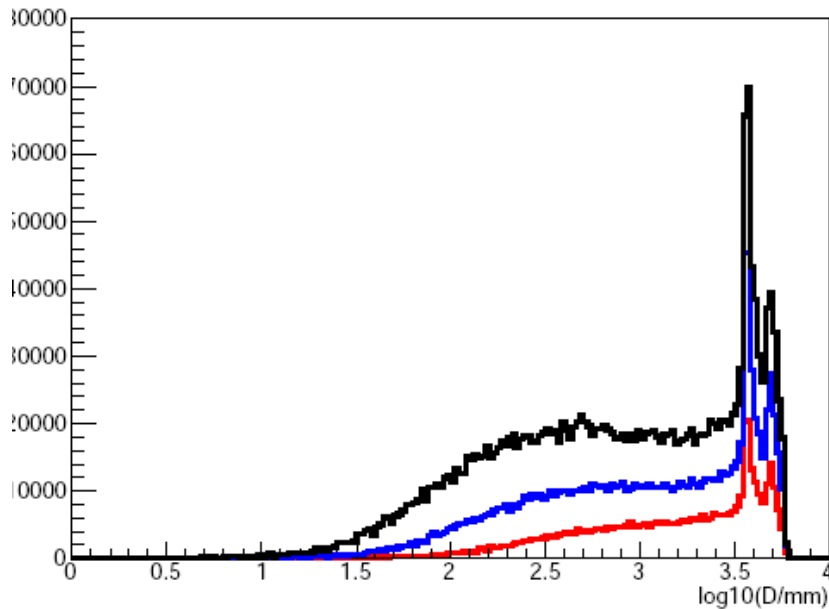
Distance between CH to closet NH



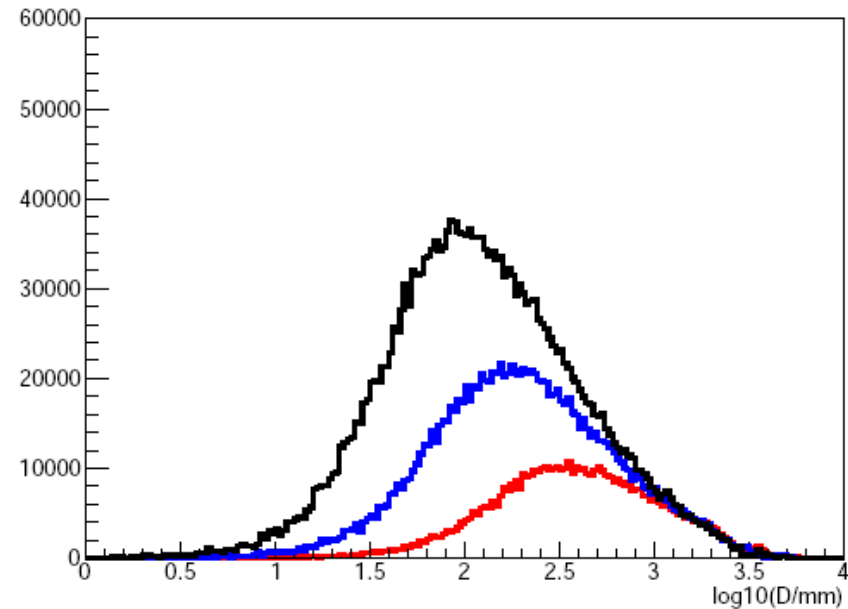
Distance between CH to closet NH, energy weighted



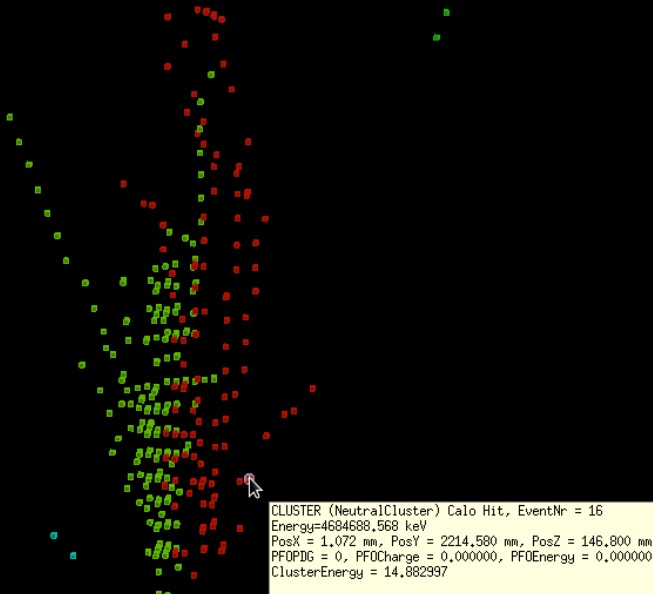
Distance between CH to closet Photon



Distance between CH to closet Photon, energy weighted

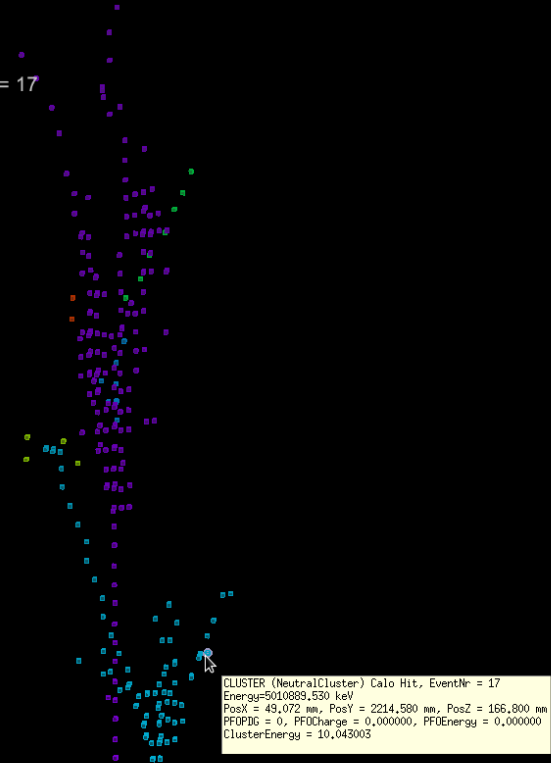


DRUID, RunNum = 0, EventNum = 16



CLUSTER (NeutralCluster) Calo Hit, EventNr = 16
 Energy=4684688.568 keV
 PosX = 1.072 mm, PosY = 2214.580 mm, PosZ = 146.800 mm
 PFOPIDG = 0, PFOCharge = 0.000000, PFOEnergy = 0.000000
 ClusterEnergy = 14.882937

DRUID, RunNum = 0, EventNum = 17



CLUSTER (NeutralCluster) Calo Hit, EventNr = 17
 Energy=5010889.530 keV
 PosX = 49.072 mm, PosY = 2214.580 mm, PosZ = 166.800 mm
 PFOPIDG = 0, PFOCharge = 0.000000, PFOEnergy = 0.000000
 ClusterEnergy = 10.043003

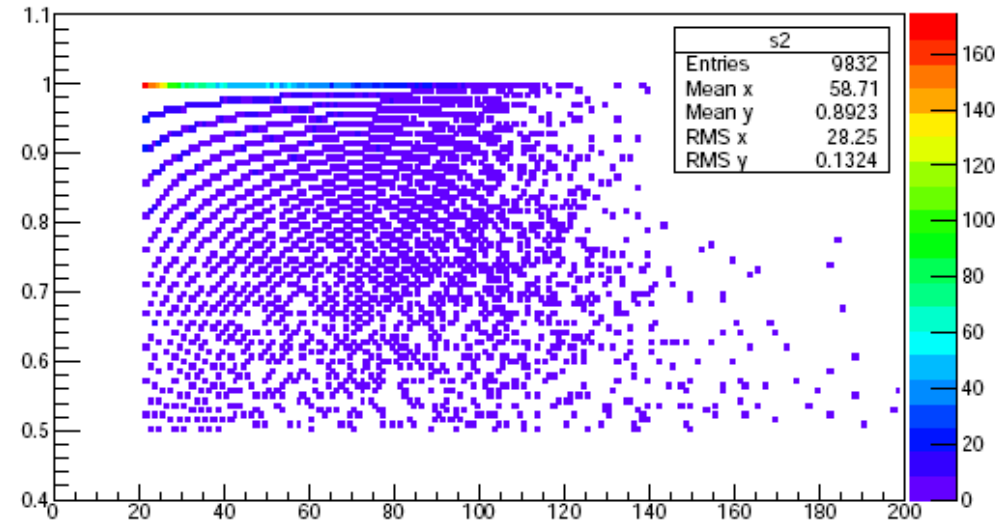
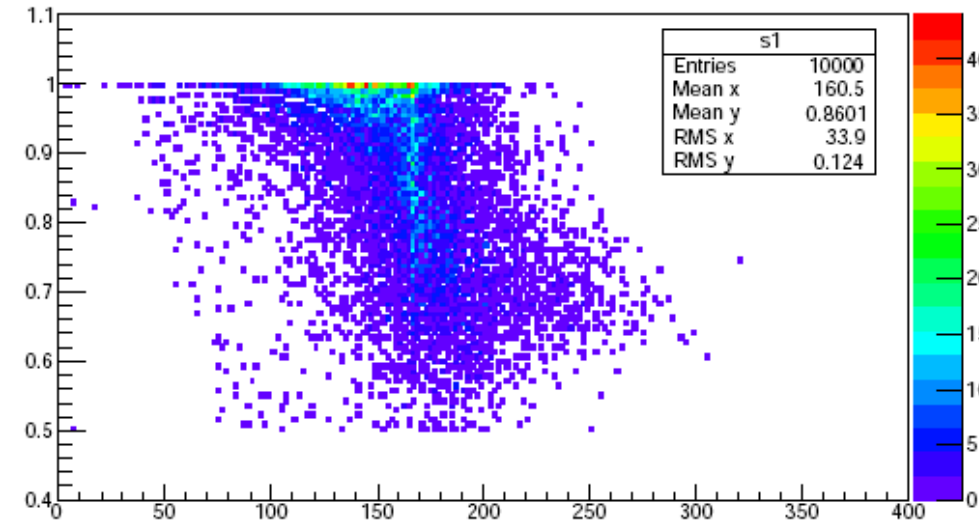
- 20 GeV Pi + 10 GeV Klong with adjustable separation distance (Shift distance set as parameter in Digitizer)
- *Displayed event: 50mm separation, multiplicity effect muted*
- *Performance depends on Energy as well ...*

Global Performance: Sep = 50



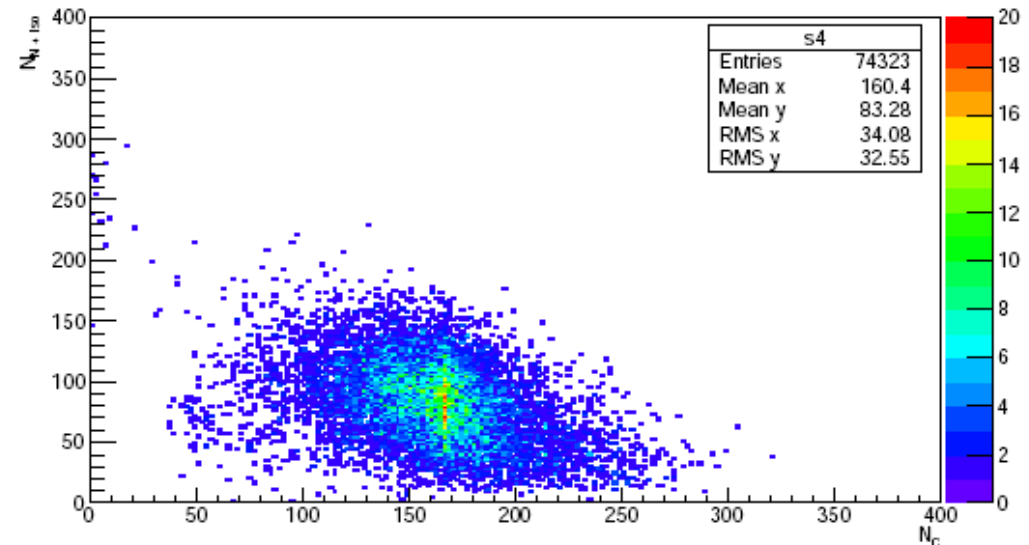
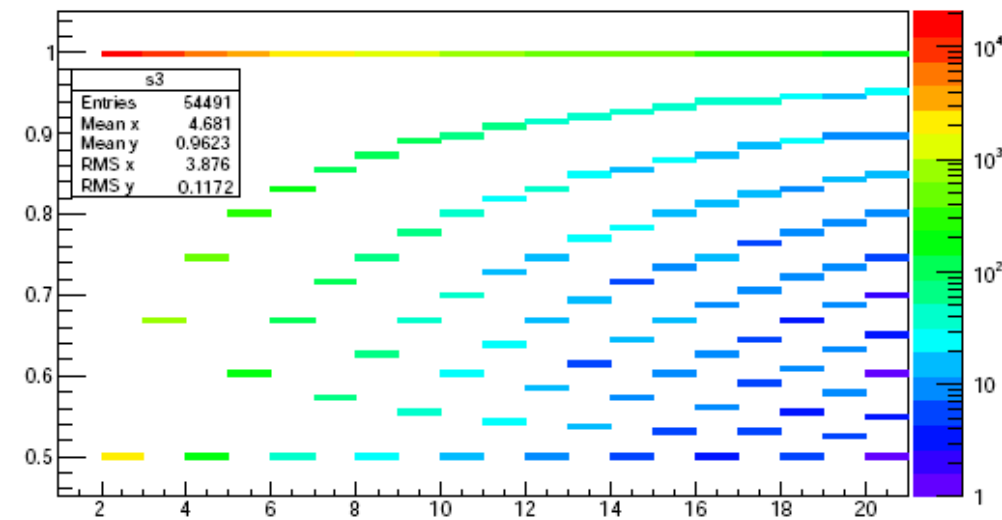
Core Charged Cluster

Core Neutral Cluster



Isolated Cluster

NHit Charge Vs NHit Neutral + Isolated

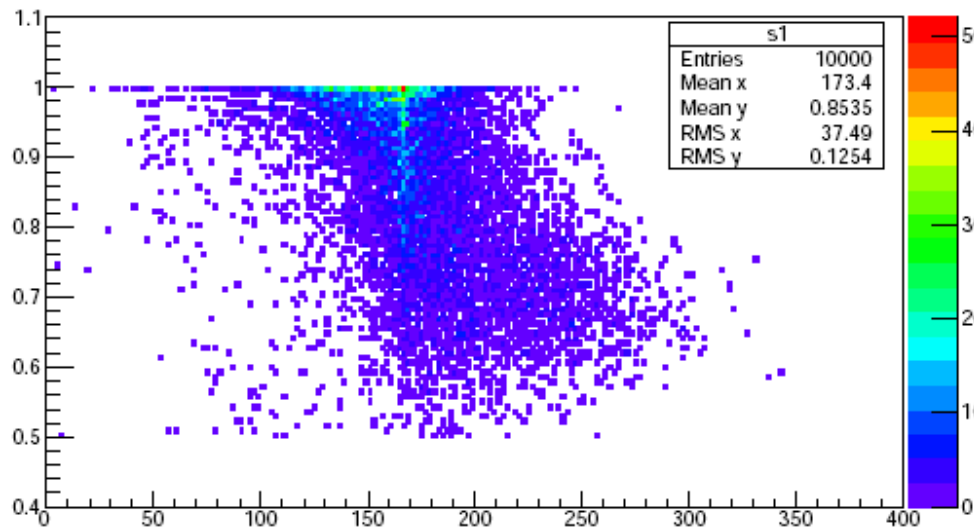


Global Performance

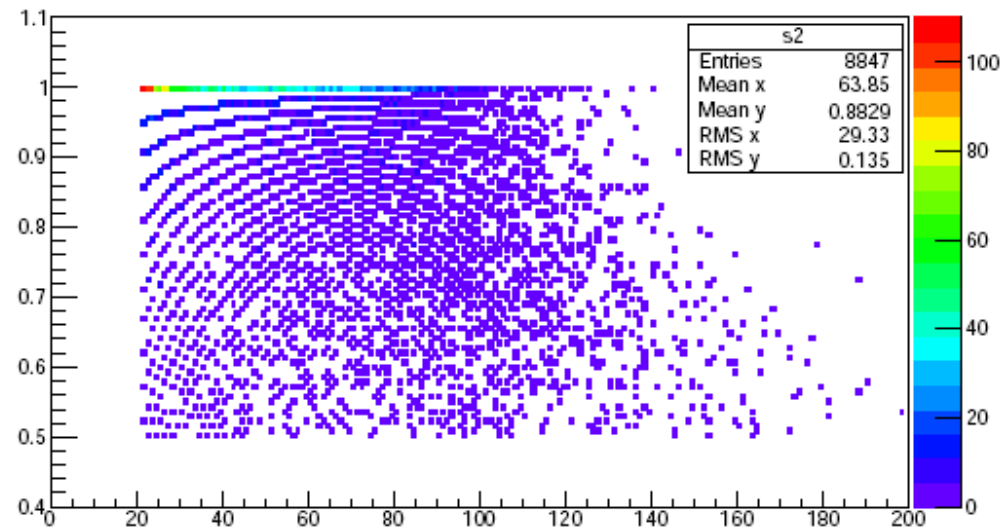
Sep = 50



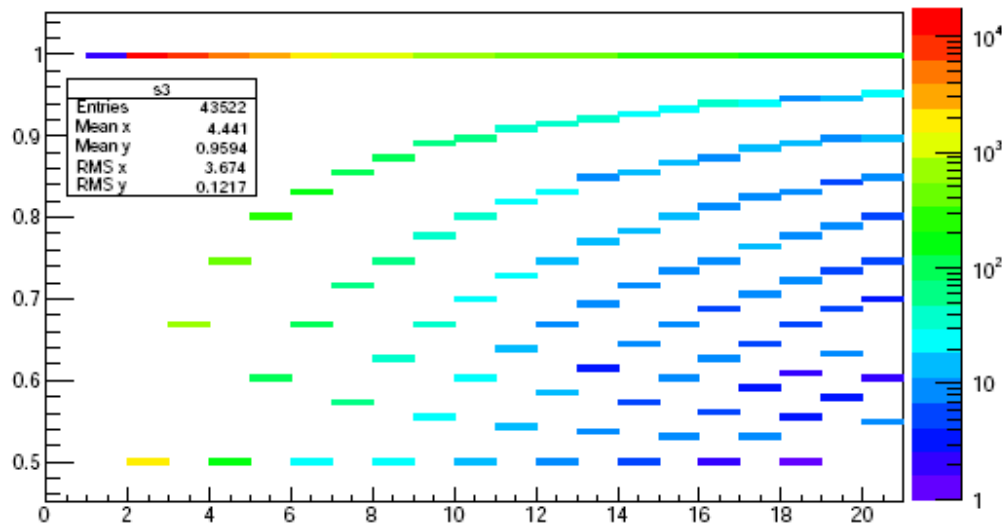
Core Charged Cluster



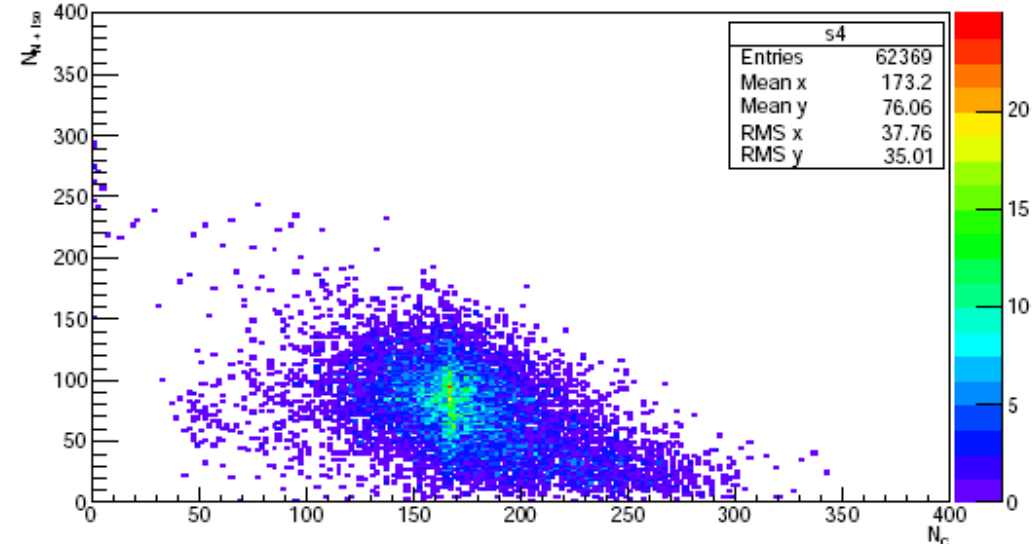
Core Neutral Cluster



Isolated Cluster



NHit Charge Vs NHit Neutral + Isolated

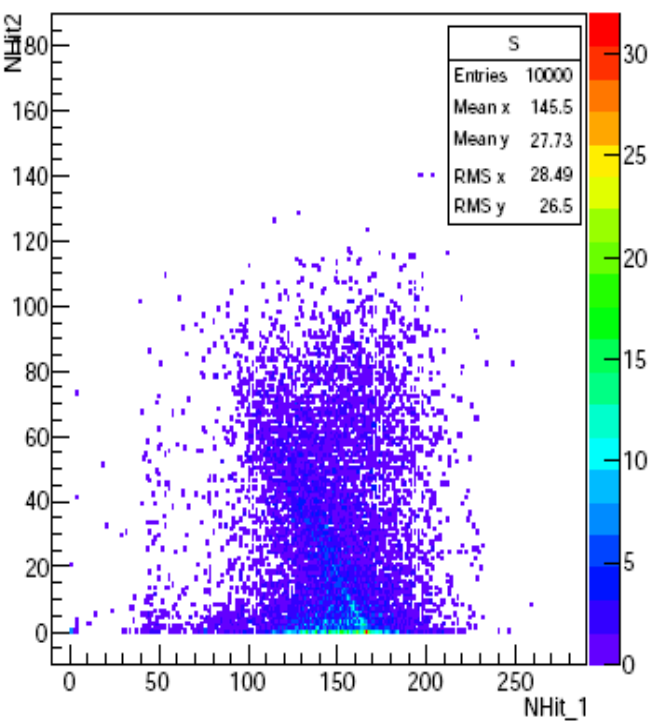


Global Performance

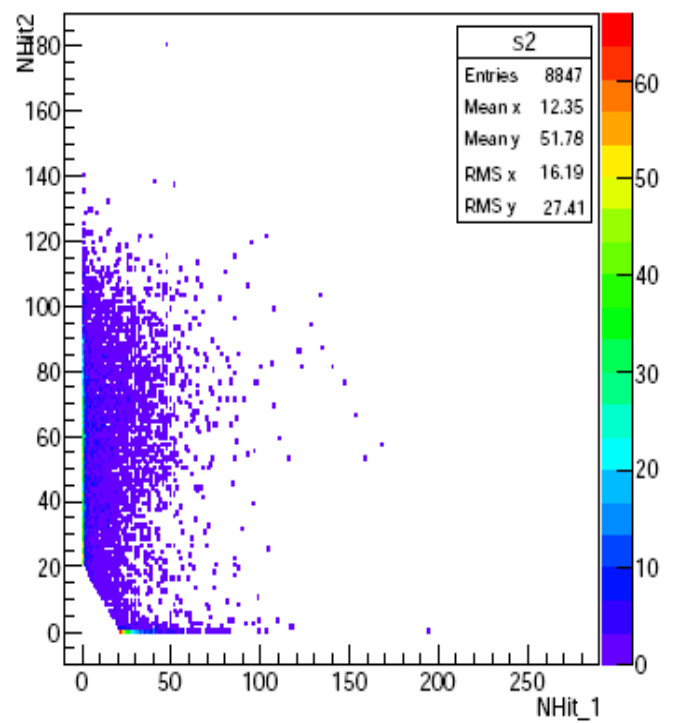
Sep = 50



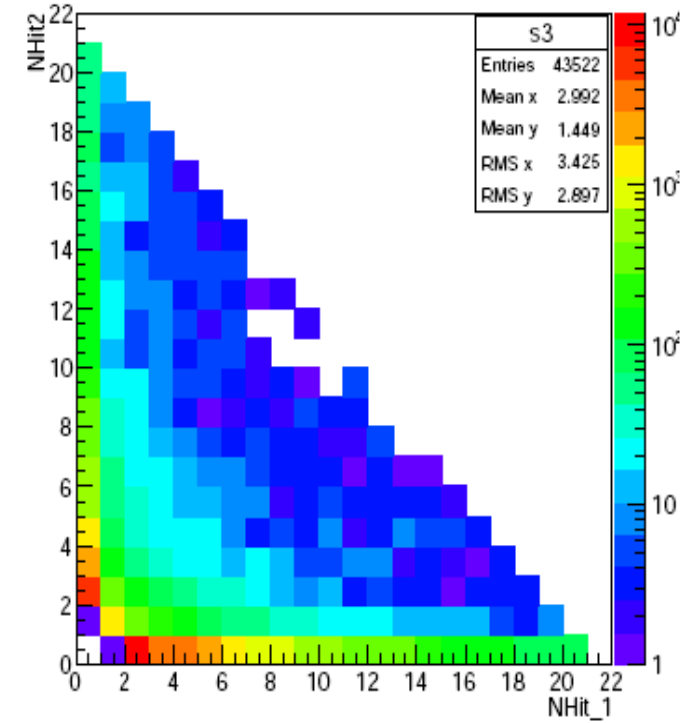
Charged Cluster at $D_{\text{separation}} = 50\text{mm}$



Neutral Cluster at $D = 50\text{mm}$



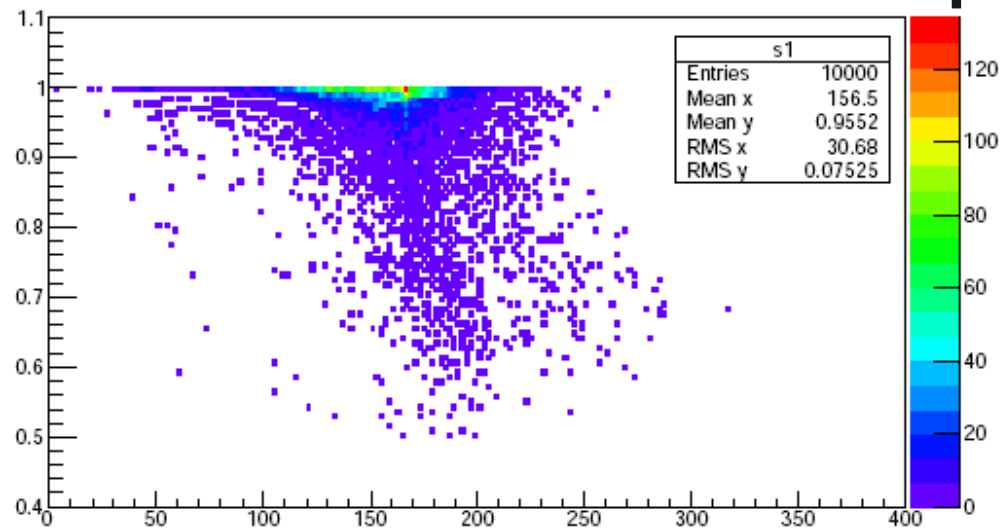
Isolated Cluster at $D = 50\text{mm}$



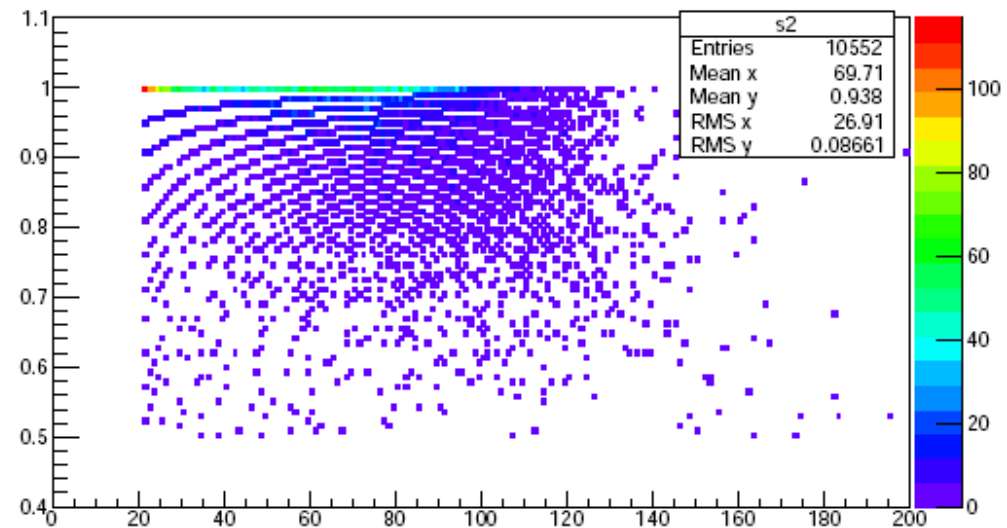
Sep = 50, Iteration Once with Dis = 40, Dis_Iter = 90

Sep = 100

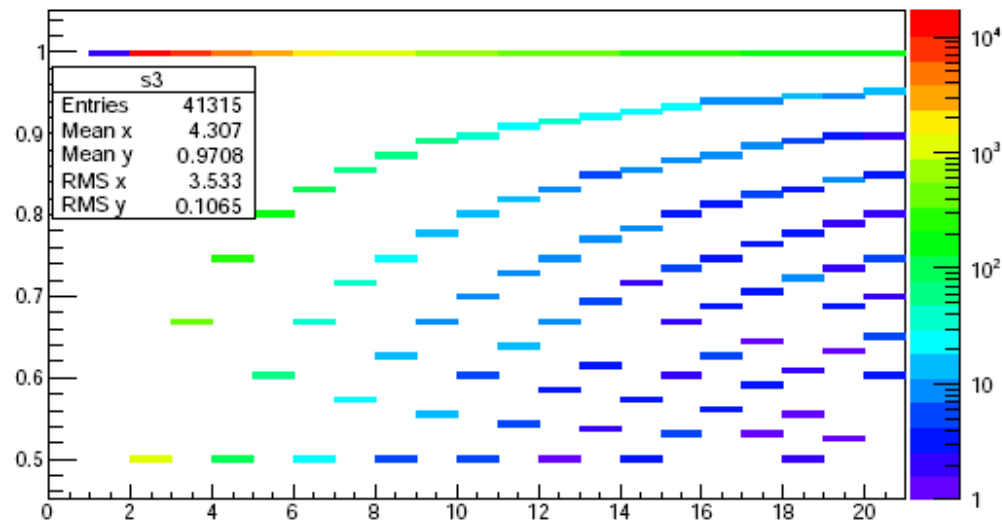
Core Charged Cluster



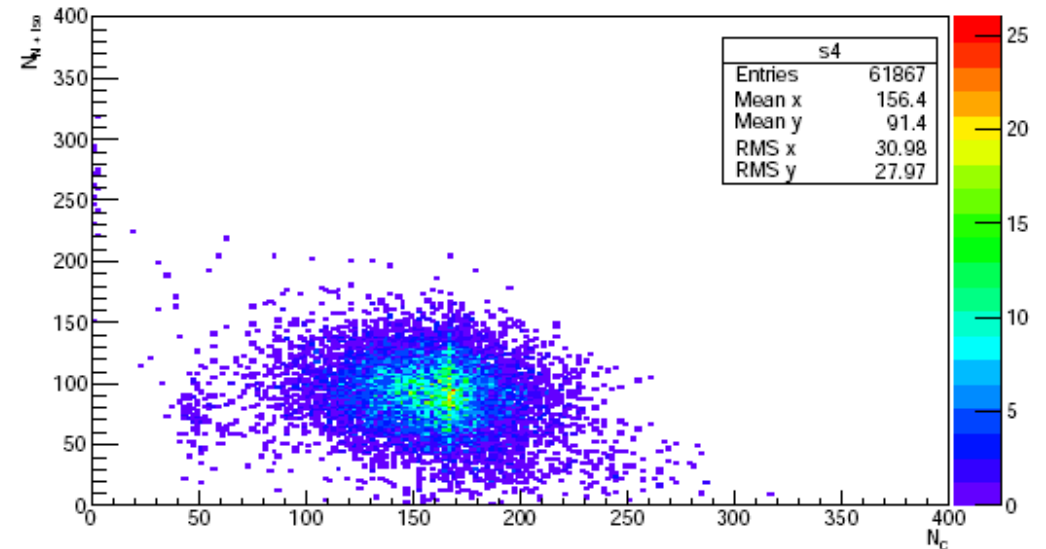
Core Neutral Cluster



Isolated Cluster



NHit Charge Vs NHit Neutral + Isolated

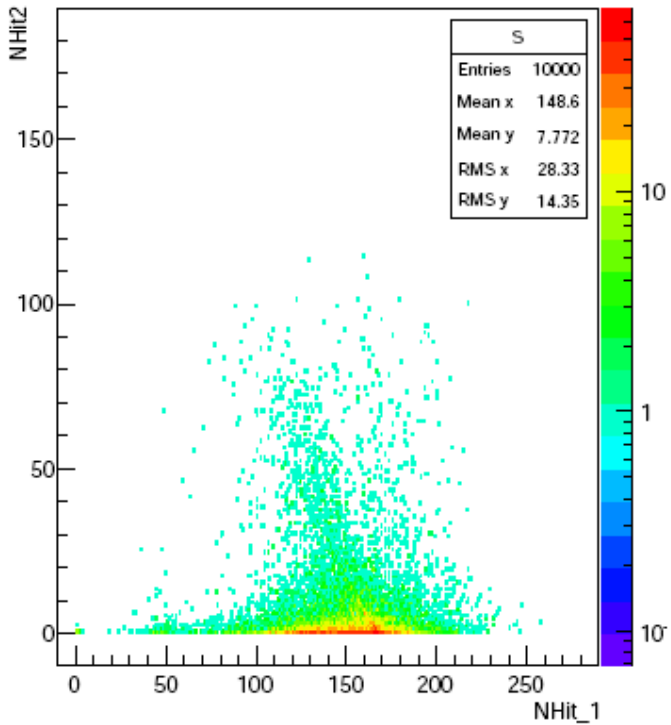


Global Performance

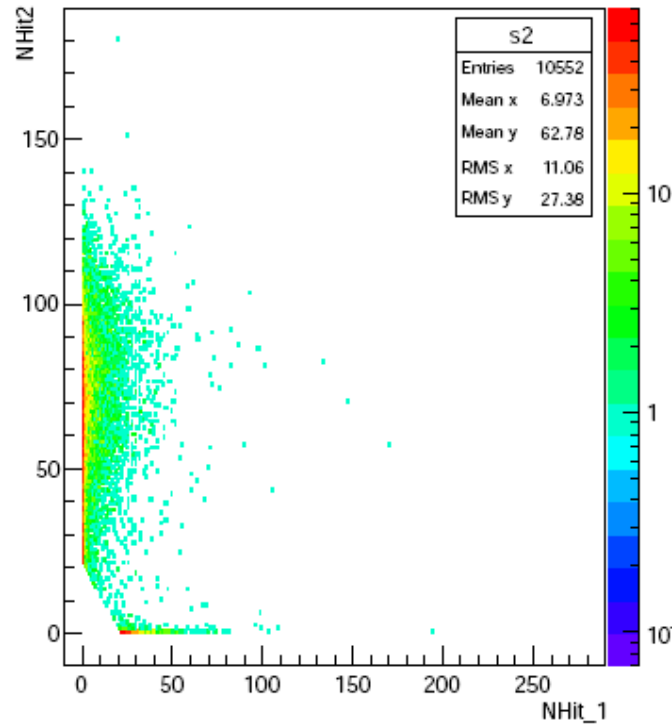
Sep = 100



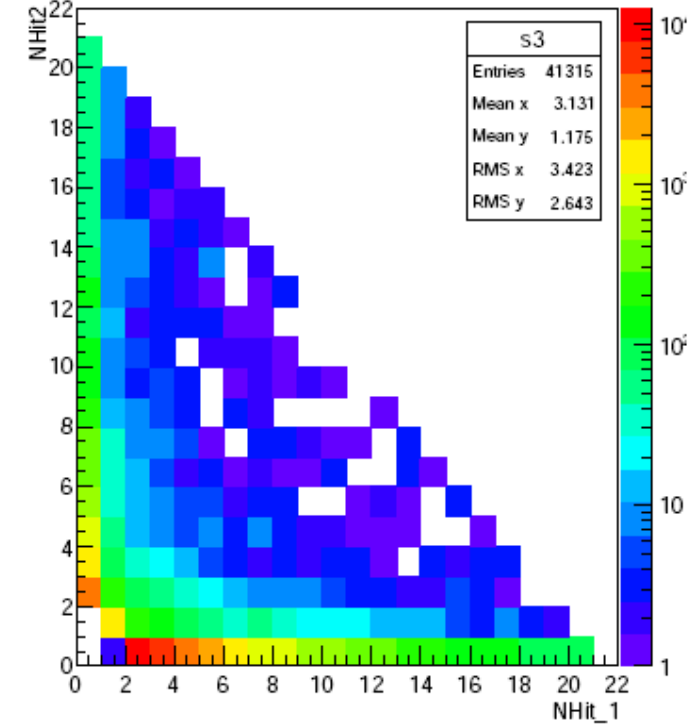
Charged Cluster at $D_{\text{separation}} = 100\text{mm}$



Neutral Cluster at $D = 100\text{mm}$



Isolated Cluster at $D = 100\text{mm}$



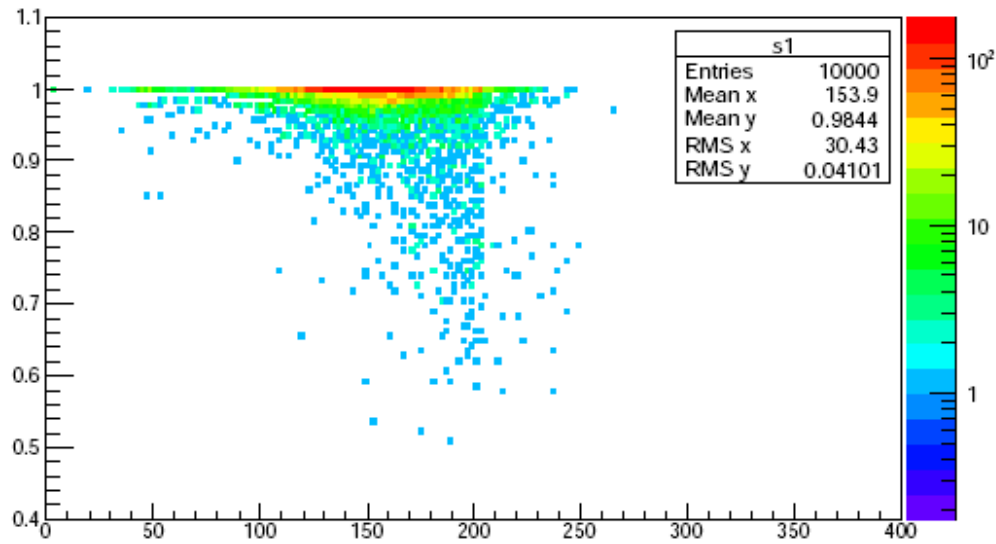
Sep = 100, Iteration Once with Dis = 40, Dis_Iter = 90

Global Performance

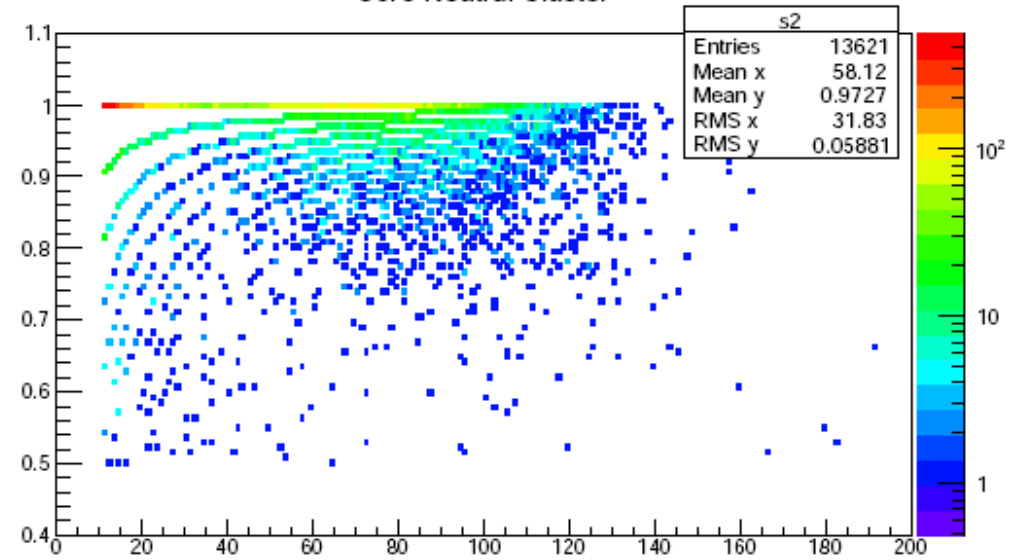
Sep = 150



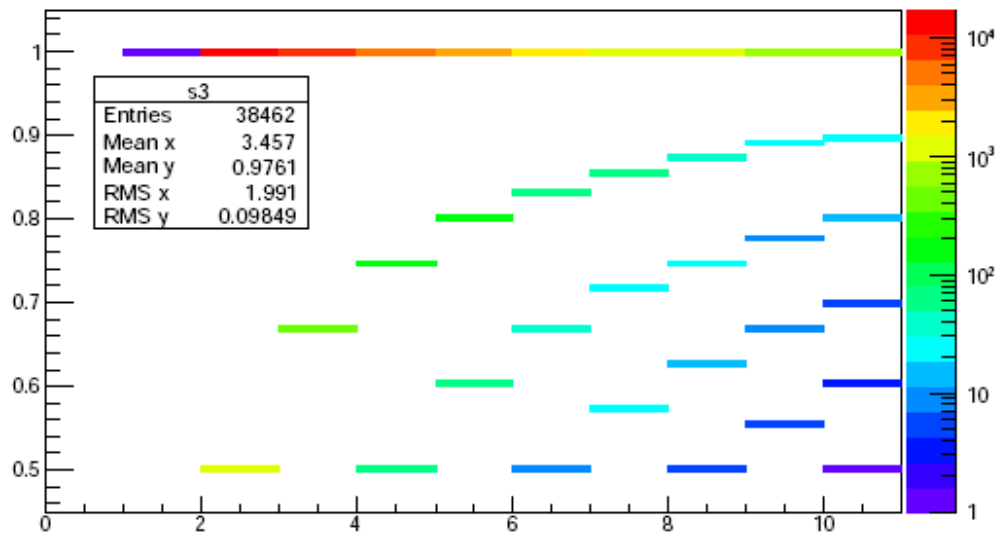
Core Charged Cluster



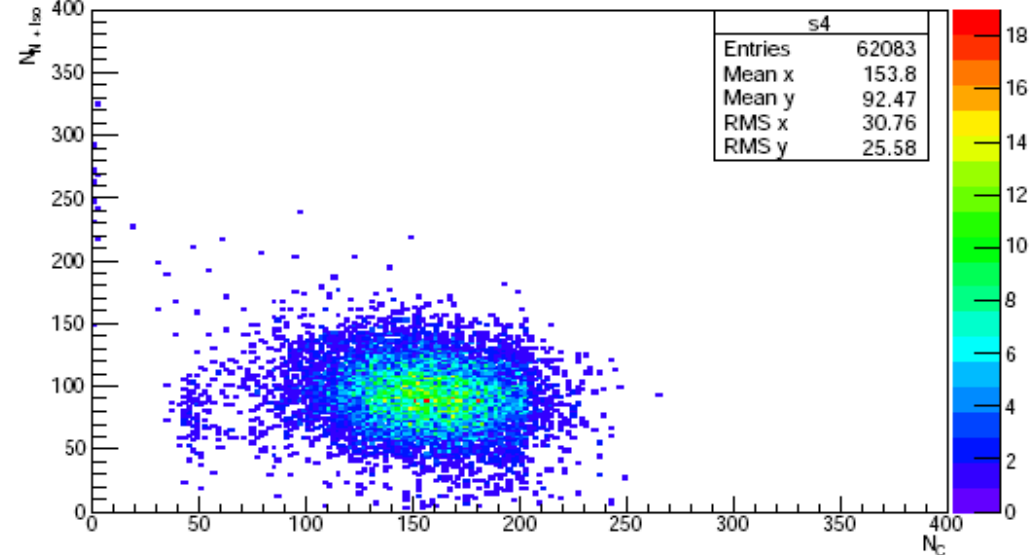
Core Neutral Cluster



Isolated Cluster



NHit Charge Vs NHit Neutral + Isolated



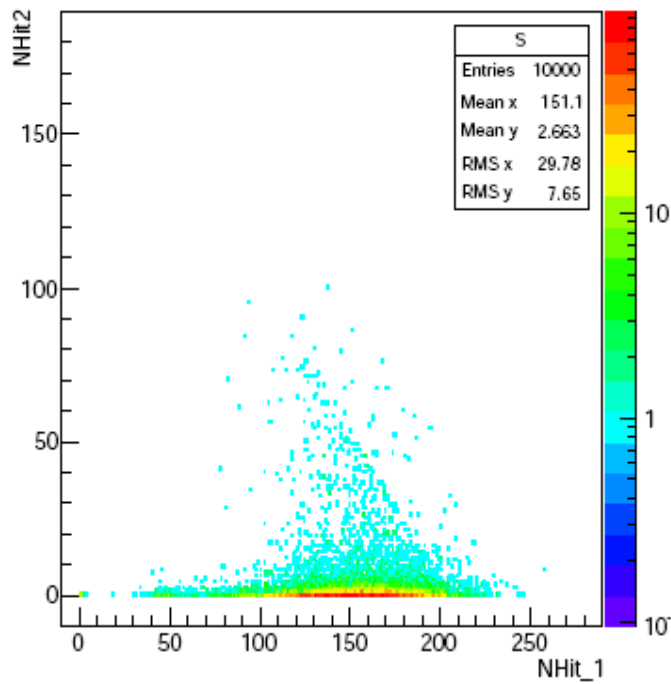
Sep = 150, Iteration Once with Dis = 40, Dis_Iter = 90

Global Performance

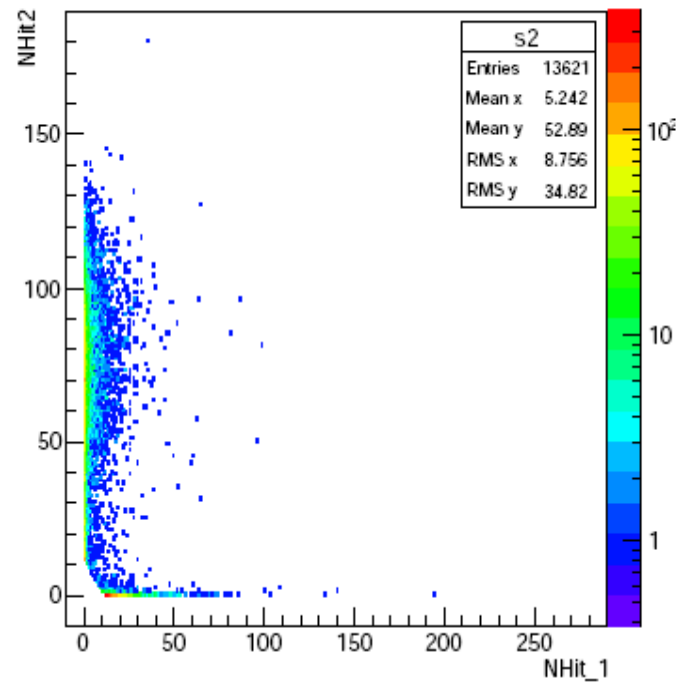
Sep = 150



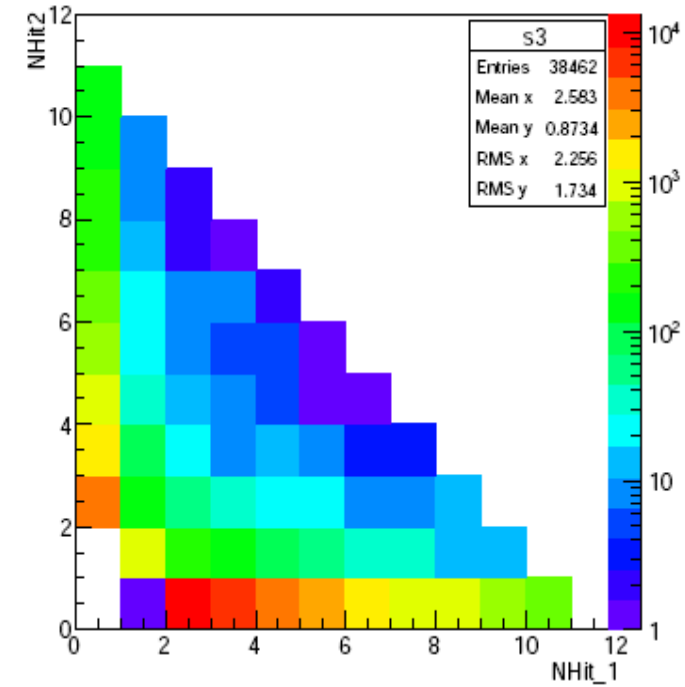
Charged Cluster at D = 150mm



Neutral Cluster at D = 150mm



Isolated Cluster at D = 150mm



Sep = 150, Iteration Once with Dis = 40, Dis_Iter = 90

Pattern tagging

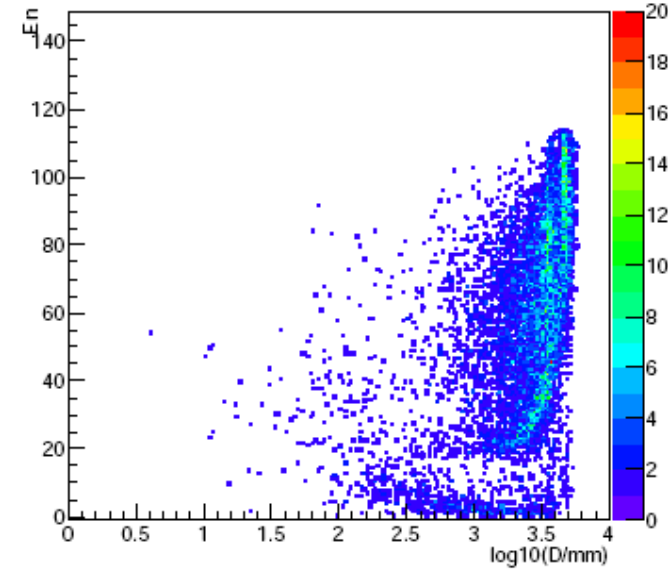
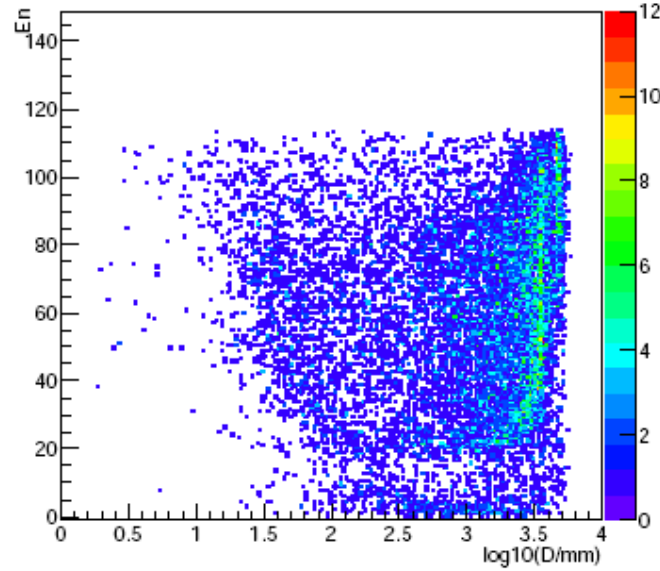
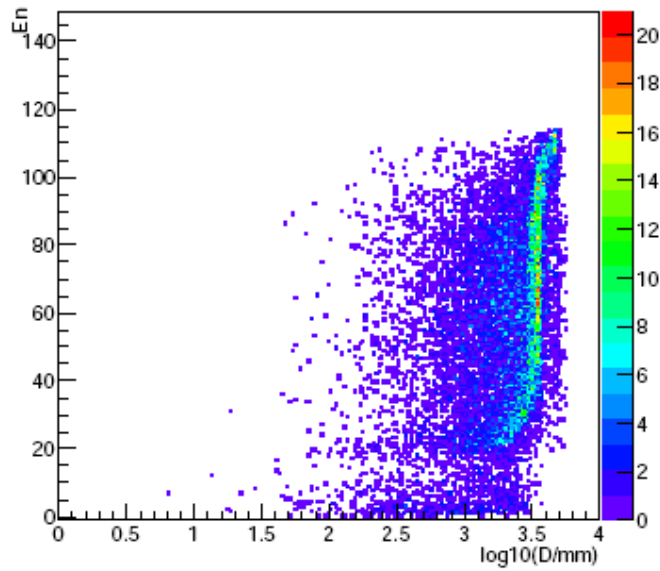
ZZ evt at $s = 230\text{GeV}$



Mu - CH Distance

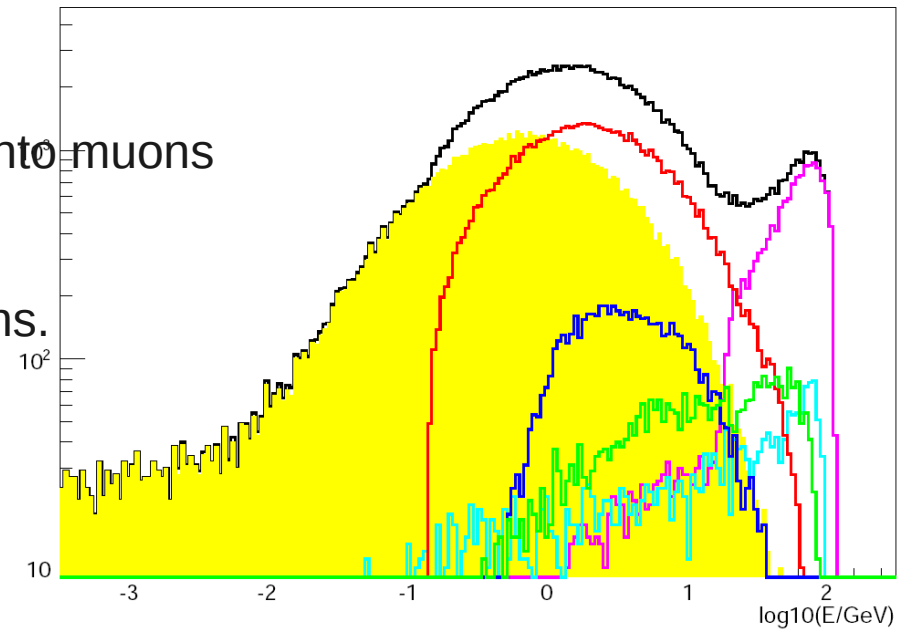
Mu - Photon Distance

Mu - NH Distance



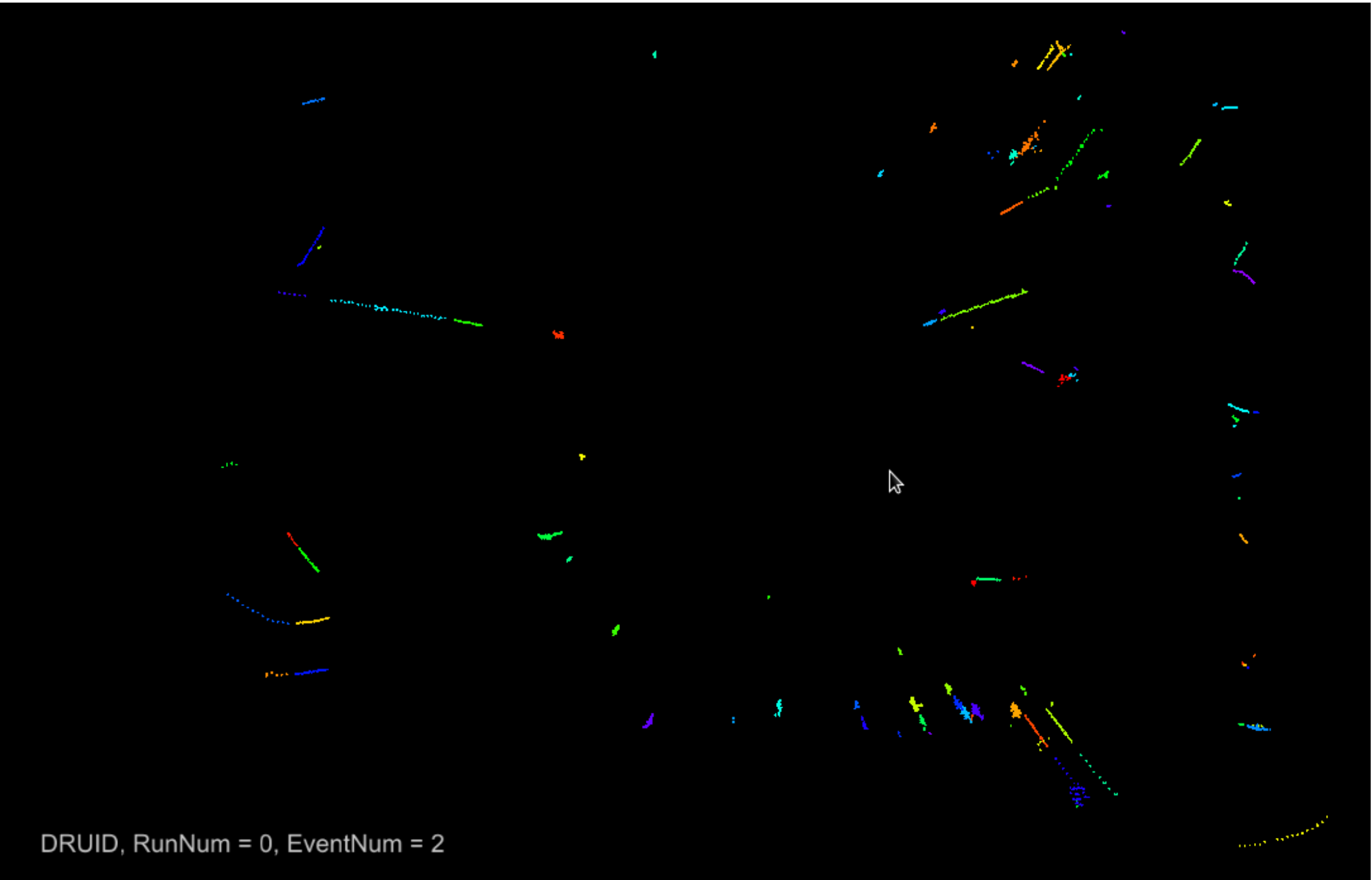
Energy Spectrums of ZZ @ 230GeV cms

- Background ZZ evts of ZH evts with Z into muons
- Arbor: working as Muon Id – lepton id
- Muon: well separated from other hadrons.
Sometime close to photon: radiation?



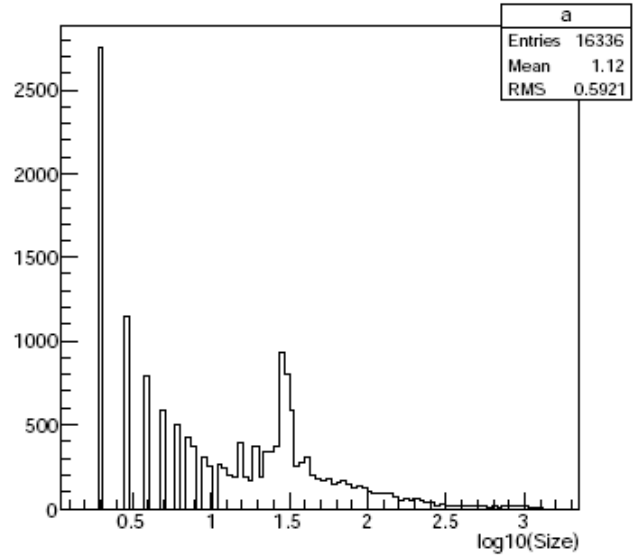
- Objects: Calorimeter Bushes (ECAL & HCAL) as Arbor output
- Objective: measure the nature of bushes (core cluster), and interconnect
 - Technically:
 - ECAL
 - Fully penetrating MIPs: Muon/sailing through candidates
 - Partly penetrating MIPs: CH interacts at ECAL
 - EM Cluster
 - HCAL
 - Penetrating MIPs, link with ECAL penetrating mips
 - Hadron Cluster developed at HCAL entrance: to be linked with ECAL case 1 & 2
 - Hadron Cluster developed deep inside HCAL: Neutral Hadron
 - Physically: lepton id
 - Core part identification, and radiation effect tag & correction

Arbor Bushes of a ZZ evt

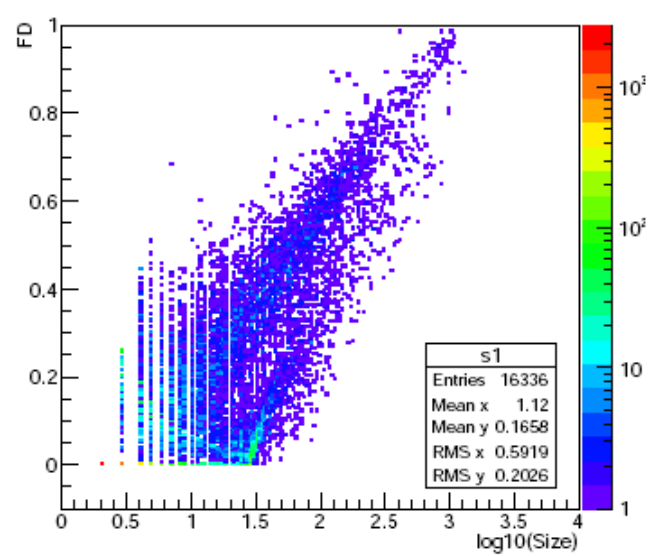


FD Vs NHits

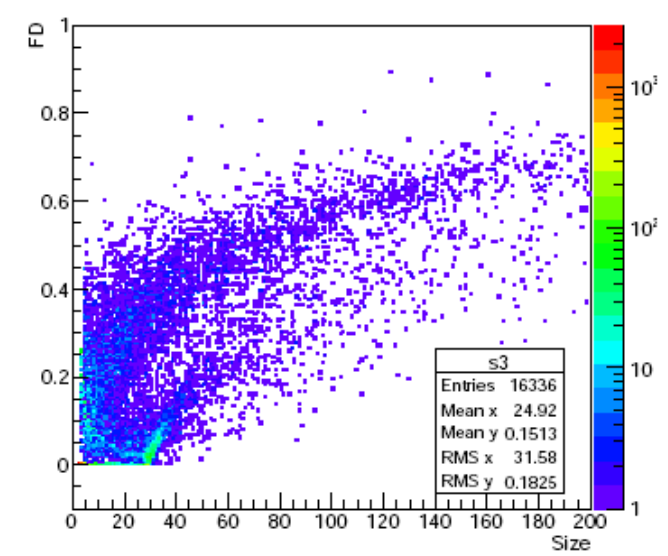
ECAL Bush Size



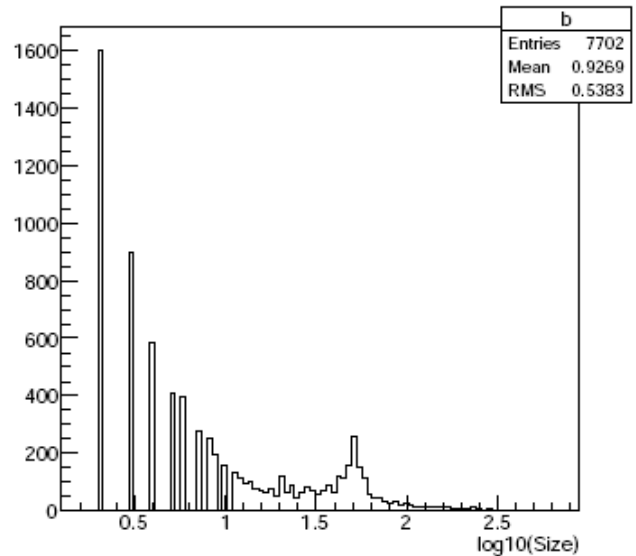
ECAL Bushes: FD Vs Size at ZZ s230 evts



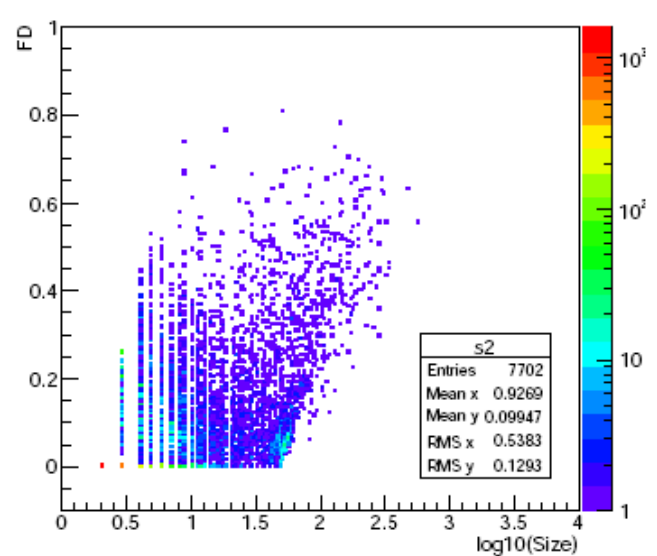
ECAL Bushes



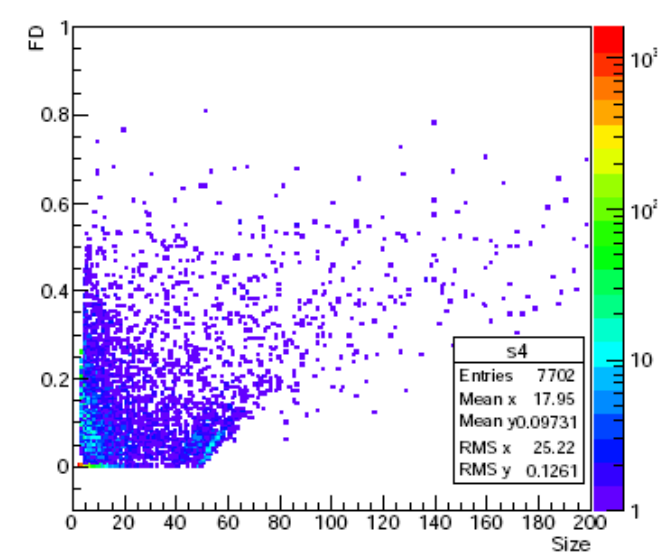
HCAL Bush Size



HCAL Bushes: FD Vs Size



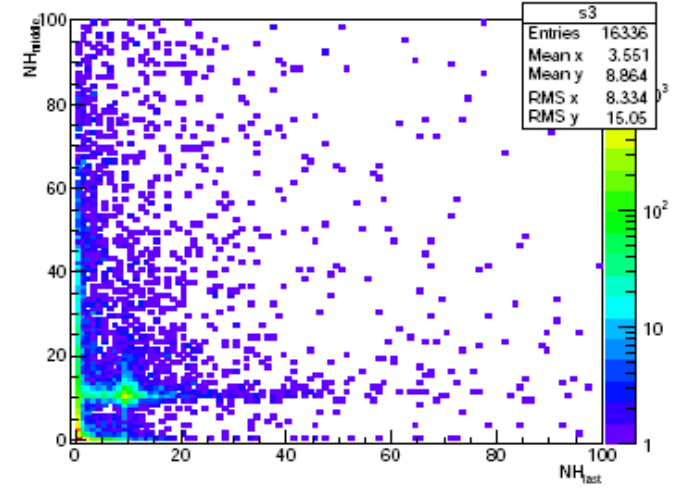
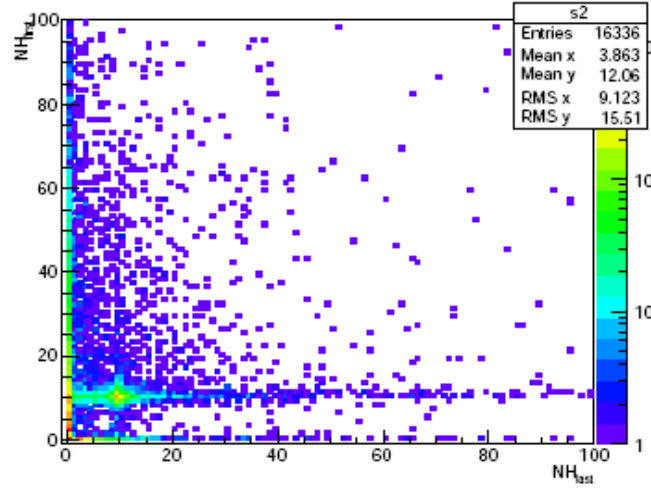
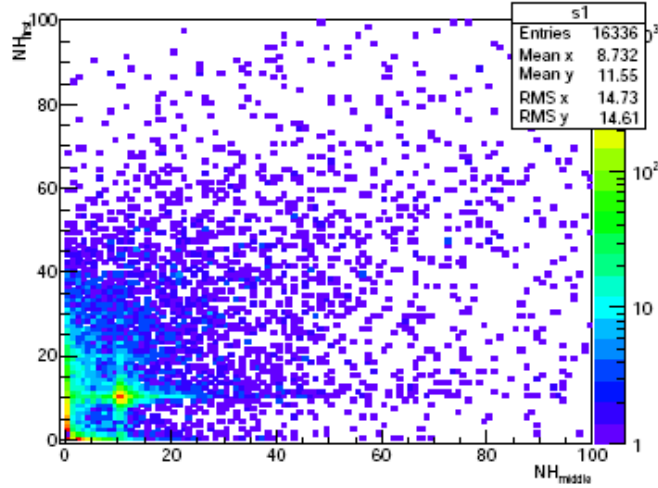
HCAL Bushes



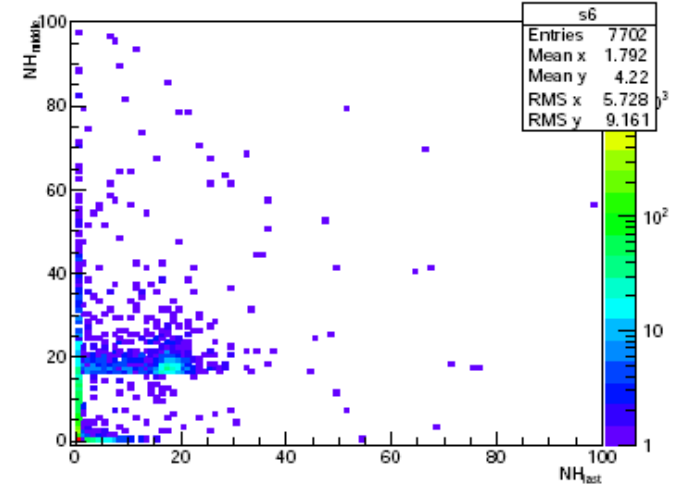
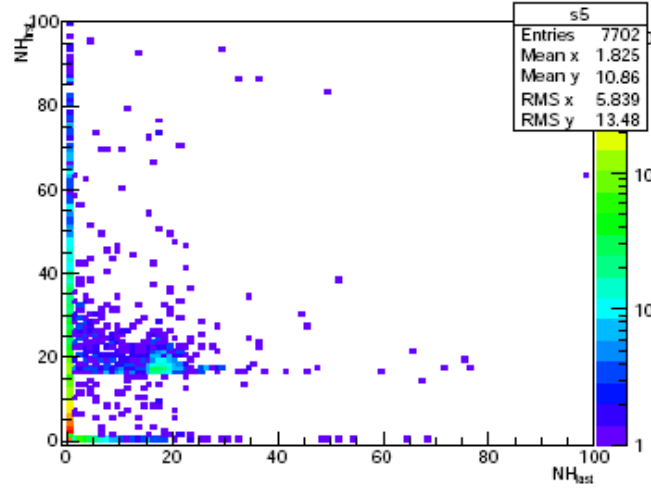
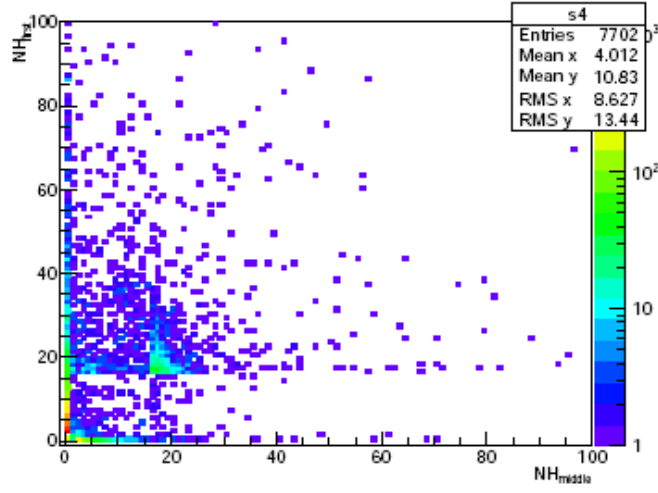
NH at different depth



ECAL



HCAL



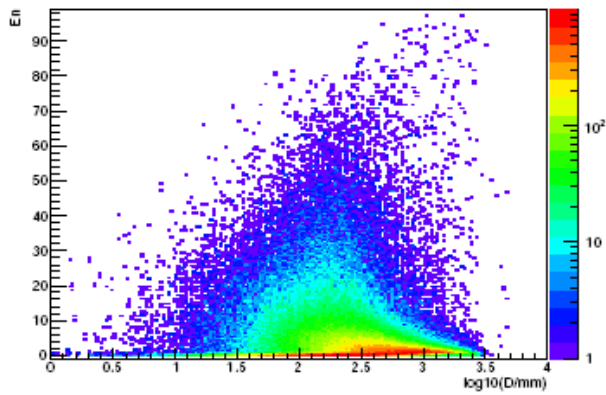
To do...

Backup slides

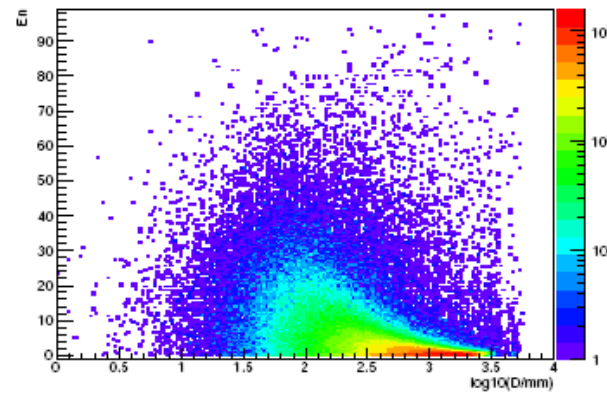
Distance at 200GeV



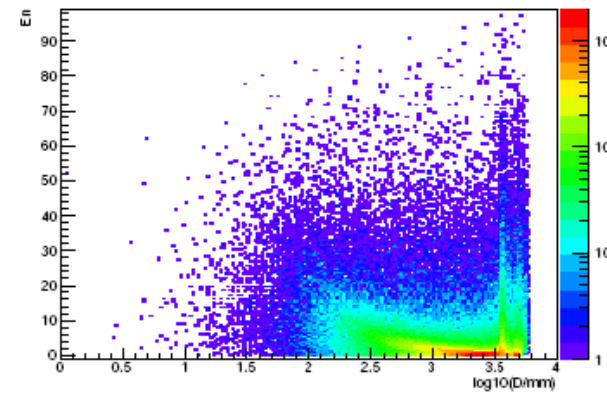
CH - CH Distance



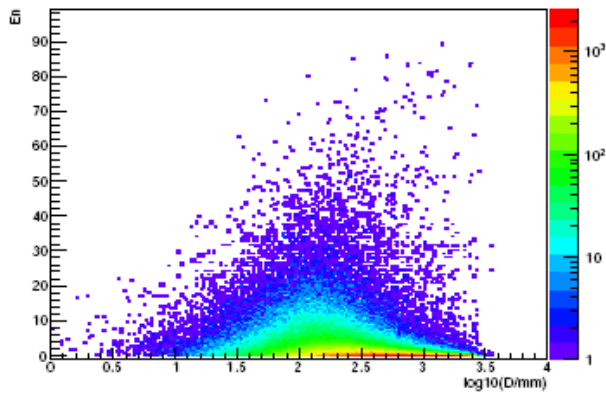
CH - Photon Distance



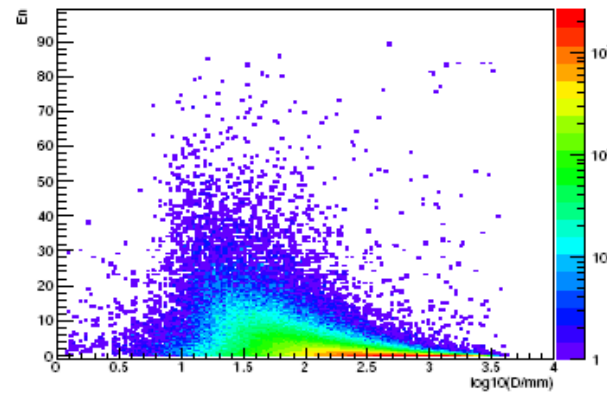
CH - NH Distance



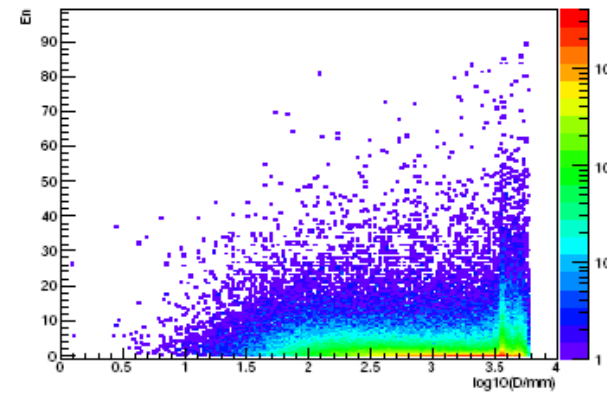
Photon - CH Distance



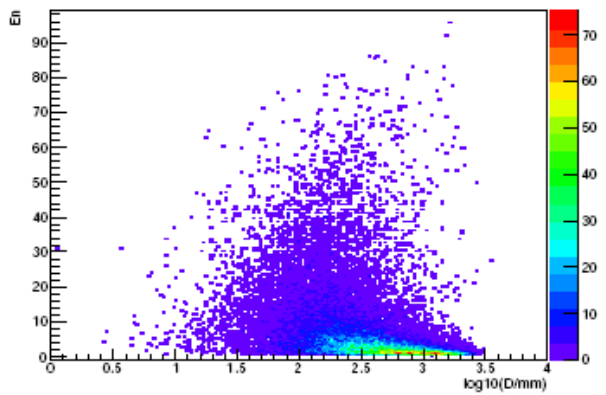
Photon - photon Distance



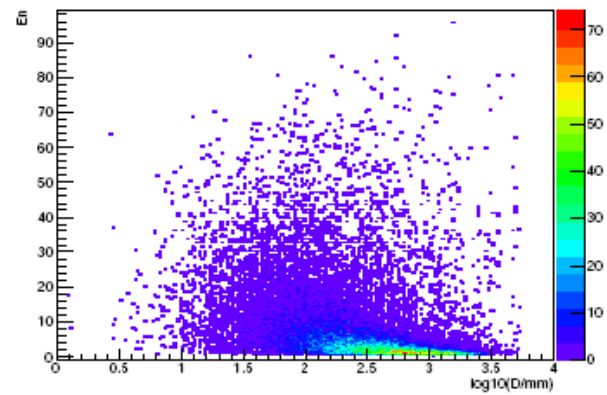
Photon - NH Distance



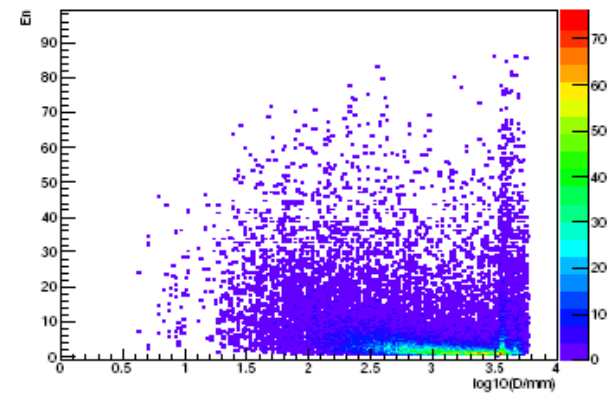
NH - CH Distance



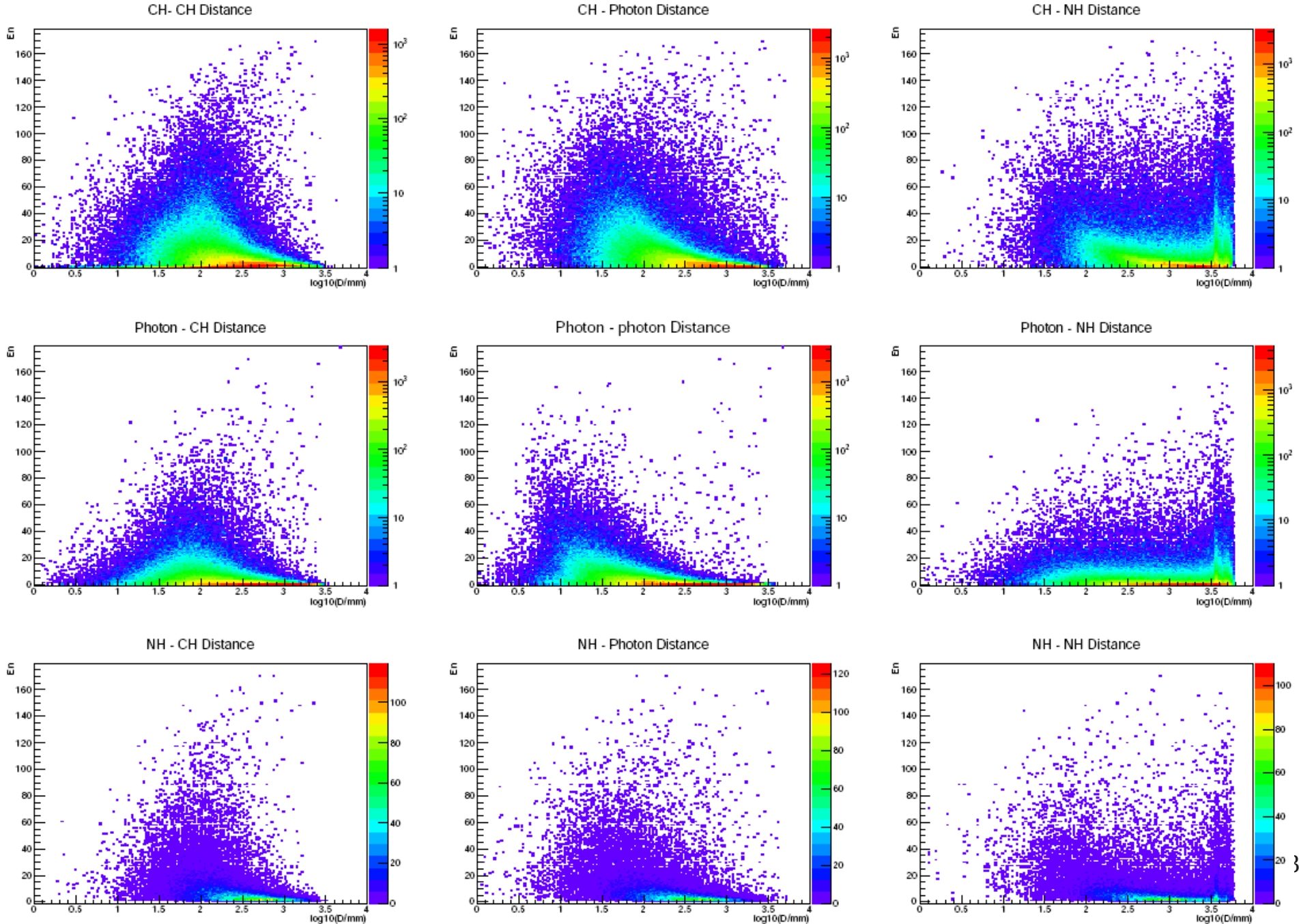
NH - Photon Distance



NH - NH Distance



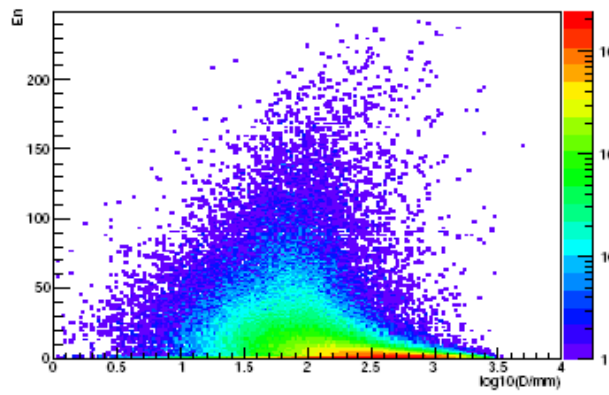
Distance at 360GeV



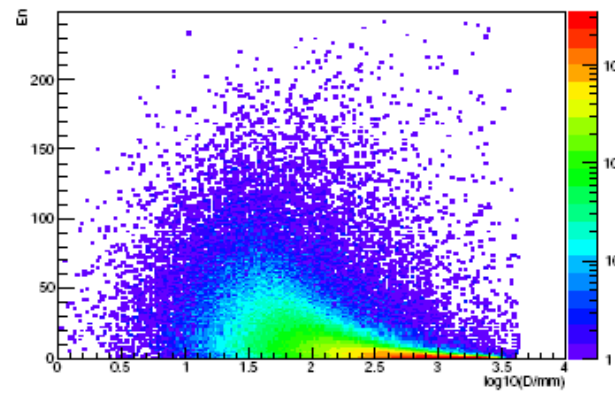
Distance at 500GeV



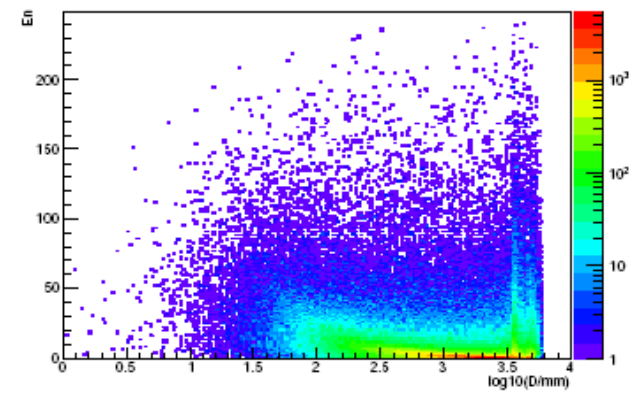
CH - CH Distance



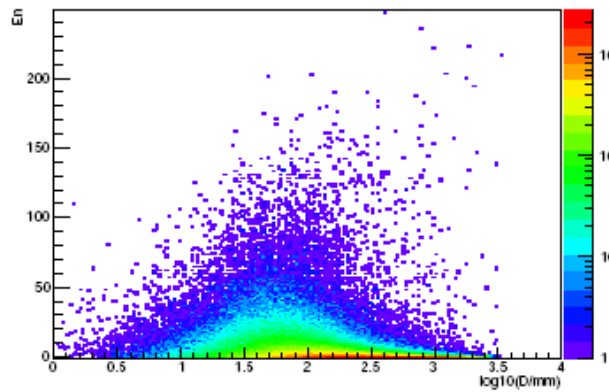
CH - Photon Distance



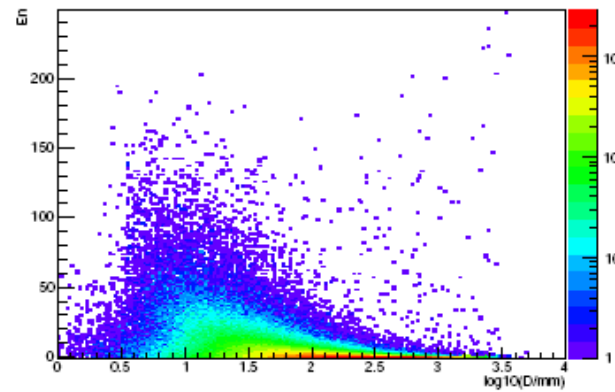
CH - NH Distance



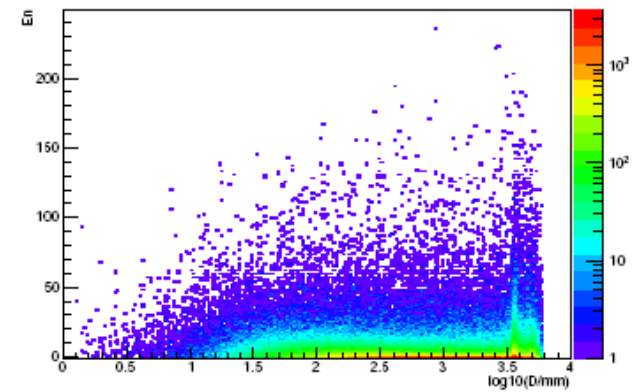
Photon - CH Distance



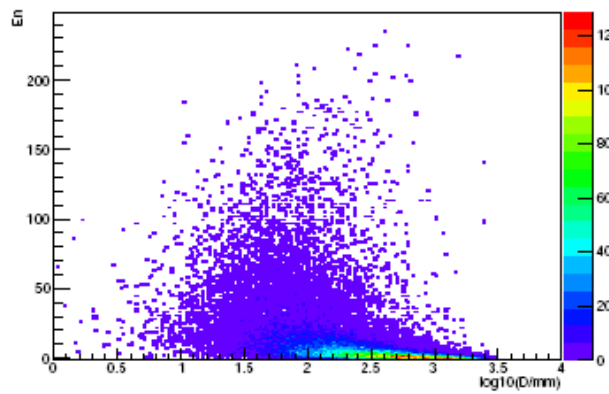
Photon - photon Distance



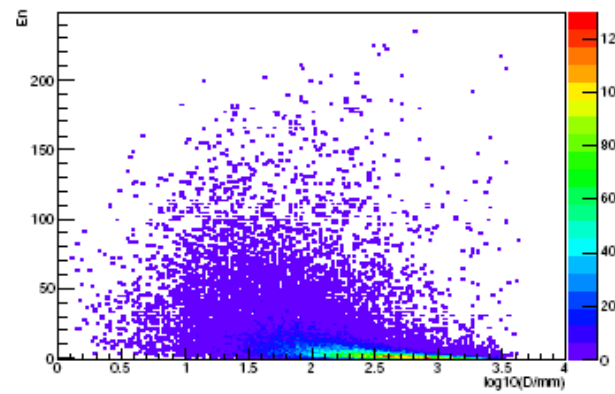
Photon - NH Distance



NH - CH Distance



NH - Photon Distance



NH - NH Distance

