The Progress of SDHCAL In ILD Software

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Outline

- **GRPC Digitization**

  Cosmic data->Standalone G4 Simulation->Comparison with TB →Implant in Marlin

- **Mechanism Development**

  GRPC @ Videau Modle && Tesla Modle

- **PFO Energy Reconstruction**

--single K_L^0 events @ Videau/Tesla, Digital/Semi-Digital 1cm/3cm pads, GRPC/Sci,

--uds events for AHCAL/SDHCAL based on Tesla Model

- **Ongoing Study**

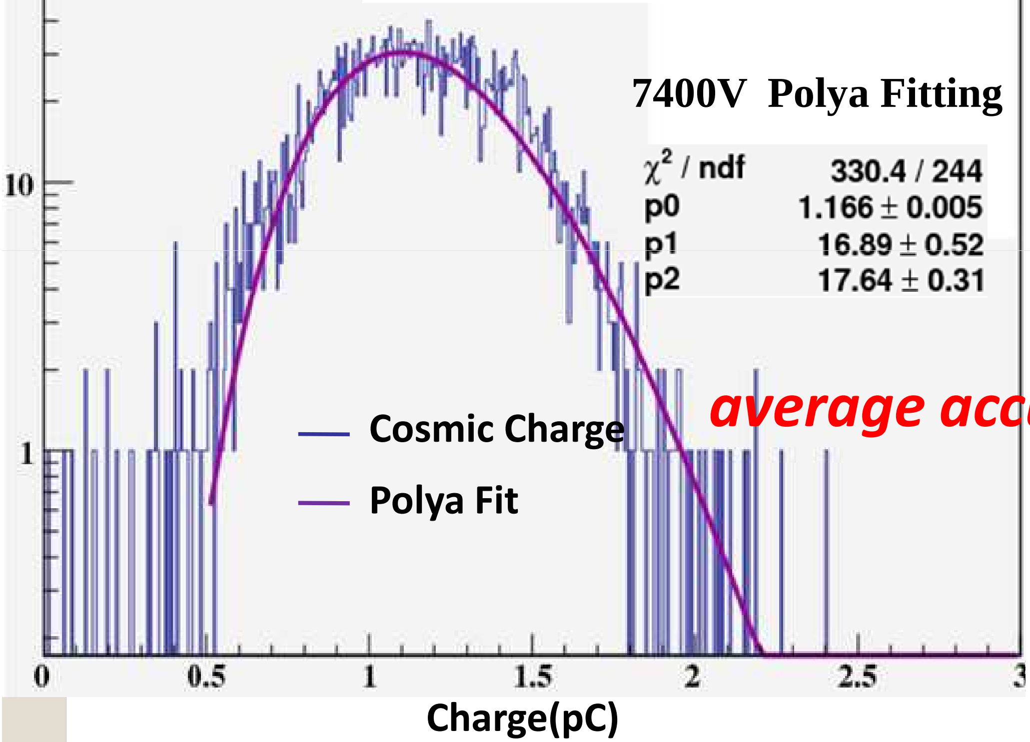
Neutral Network, Tracking and Clustering ,PFO Algorithm

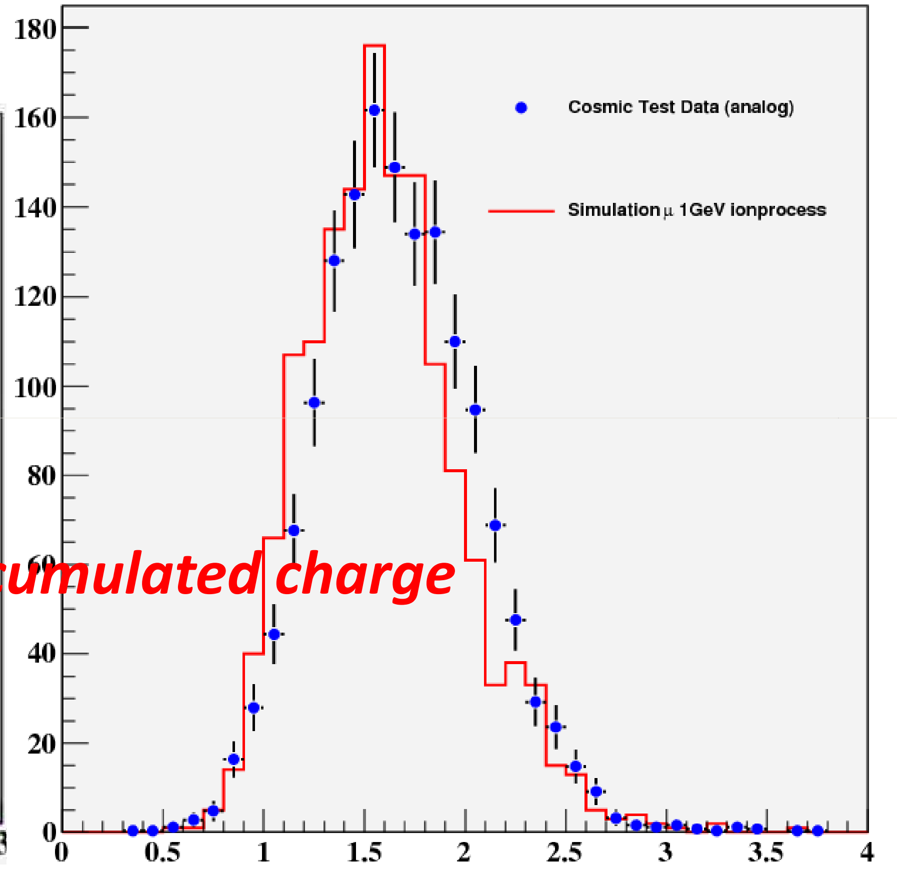
Part I -- GRPC Digitization

- Getting the Charge Distribution from Cosmic Rays
- Fitting the Distribution and Feed Parameters to Standalone Geant4 Simulation
- Comparing Simulation with Testbeam Data in Multiplicity and Efficiency
- Implanting Digitization Process to Marlin Processes, Using accumulated charge in one cell

Charge Distribution of Cosmic Data

Polya-distribution $Q = c\,\frac{(b+1)^{(b+1)}}{b!}\left(\frac{x}{a}\right)^{b} e^{\left(-(b+1)\frac{x}{a}\right)}$

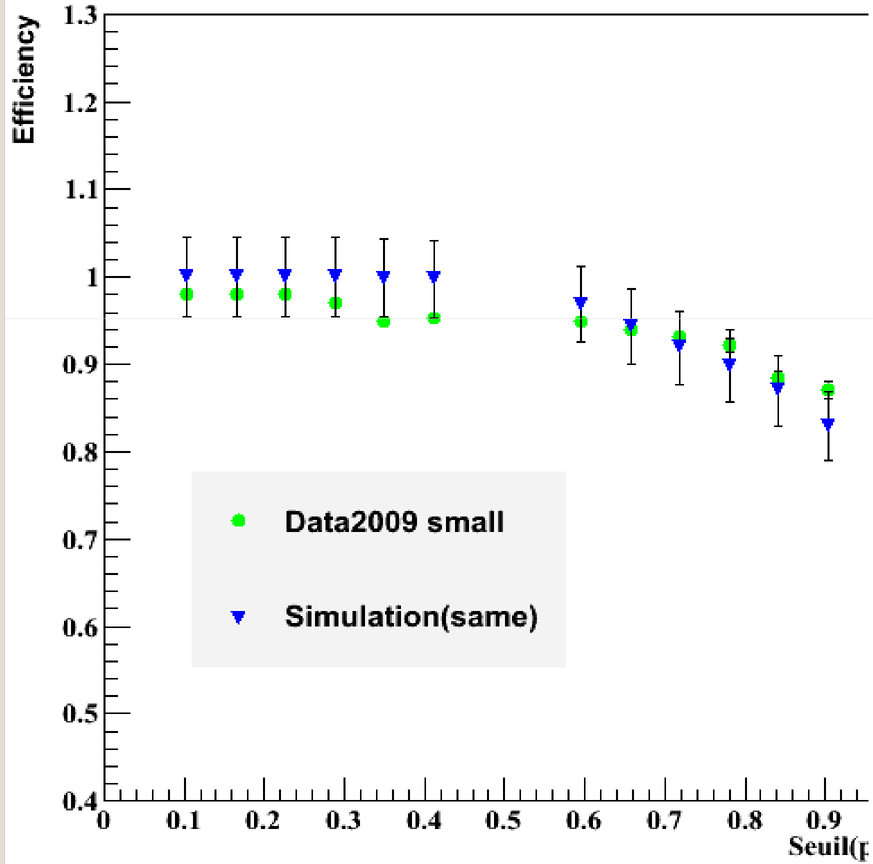


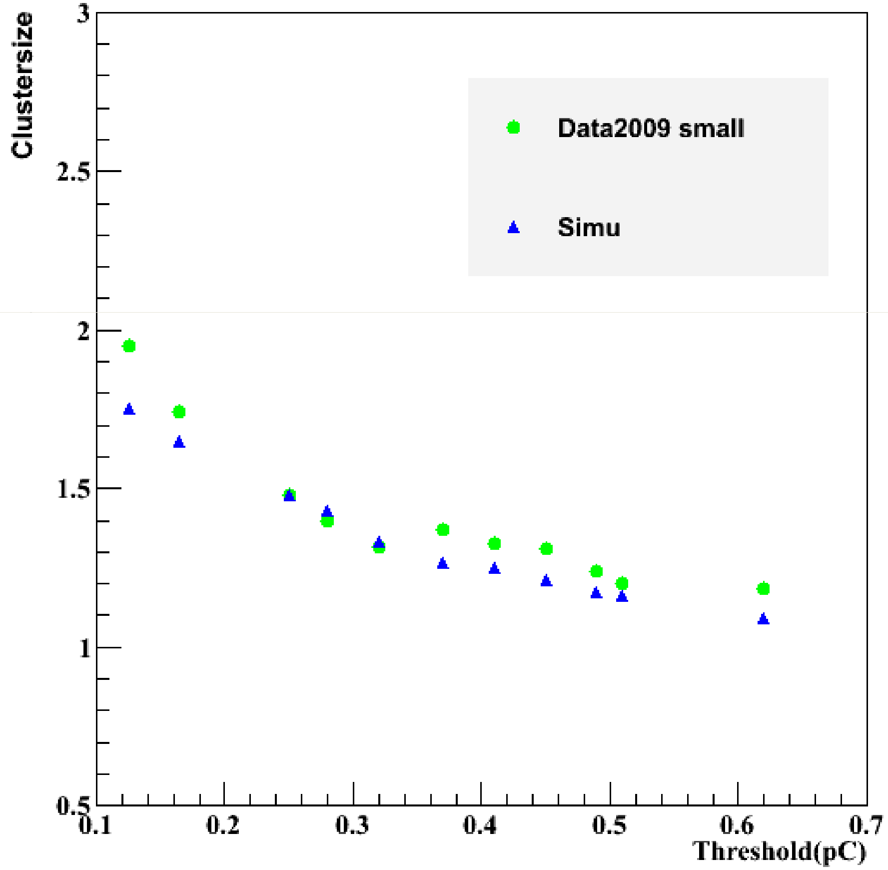


average accumulated charge

Get from data , **extract parameters in Polya function from Data**

Standalone Simulation and Test Beam Comparison



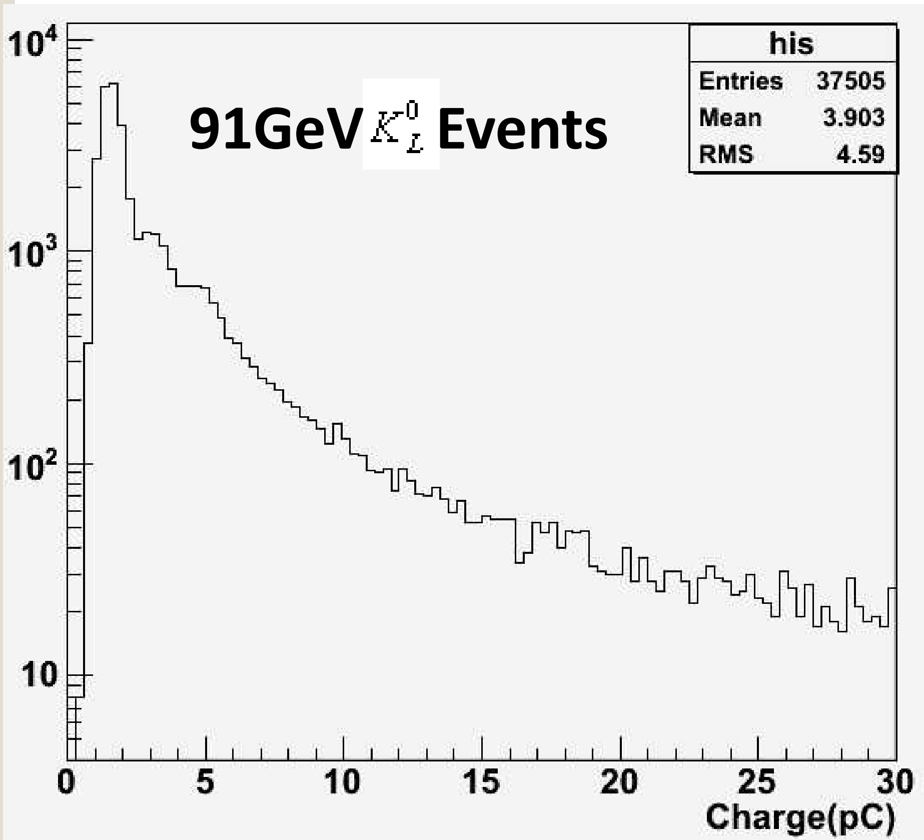


Implant Digitization in Marlin

1- Setup new Digitization for GRPC: SimpleGRPCDigitization

2- Sum charges of multiply particles in one cell

3- Energy saved in SimcalrometerHits → Charge saved in HCALCarlormeterHits



- ✓ Realistic simulation of GRPC Properties and Standalone G4 Simulation
- ✓ Add GRPC Digitization in Marlin

- ➢ Add Multiplicity in Marlin
- ➢ Test Charge Distribution with heavy ionizing particles

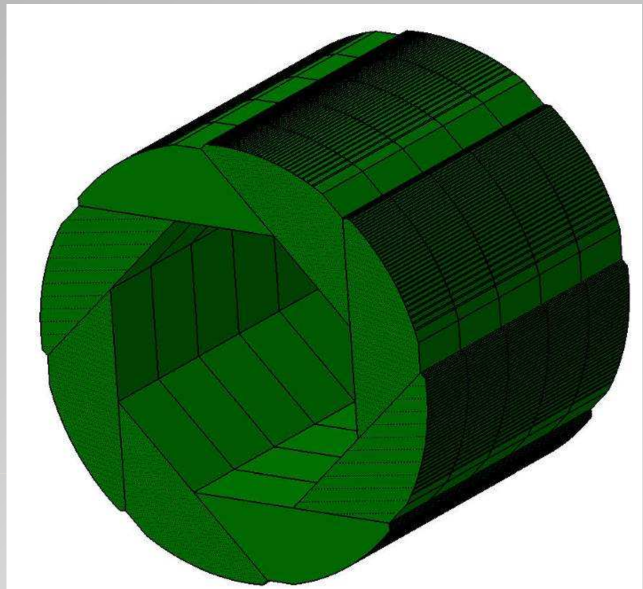
Part II – ILD Simulation MOKKA

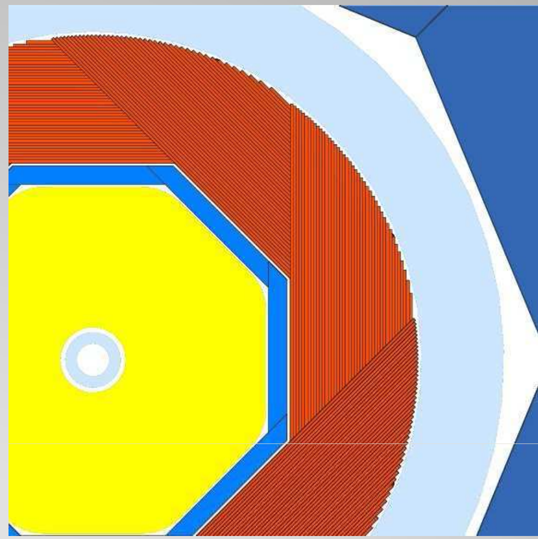
- The Geometry of HCAL in Mokka
- The Process of RPC Implantation in Tesla Model (used to only Vieadu model)
- Validation with Muon Events

Two ILD-HCAL Models in Mokka

Videau

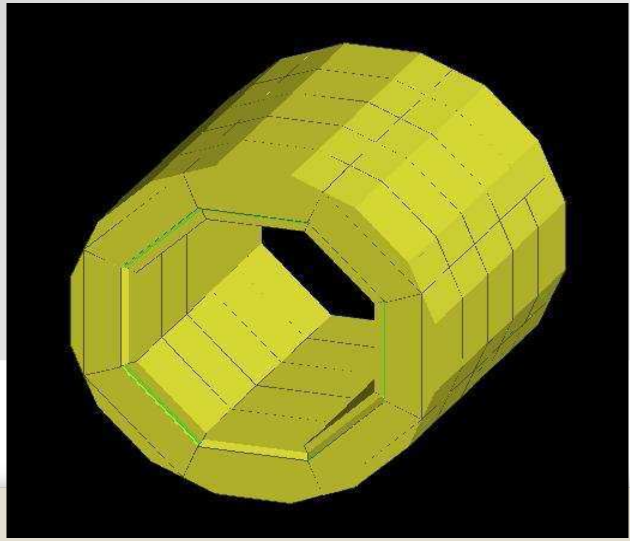
Driver:
~/Mokka/source
/Geometry/LDC/
SHcalRPC01—
ONLY GRPC

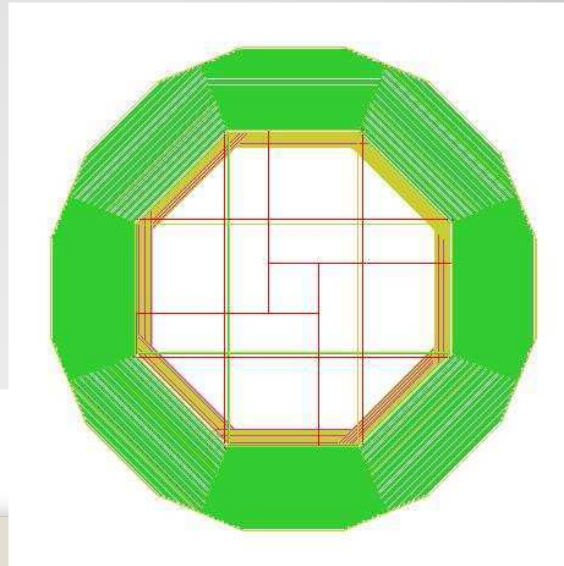




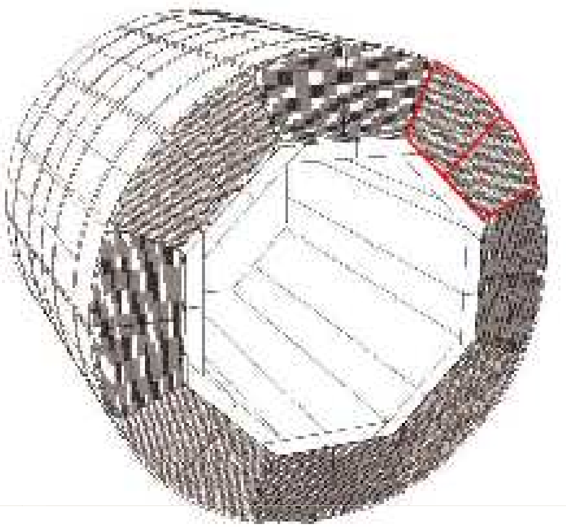
Tesla

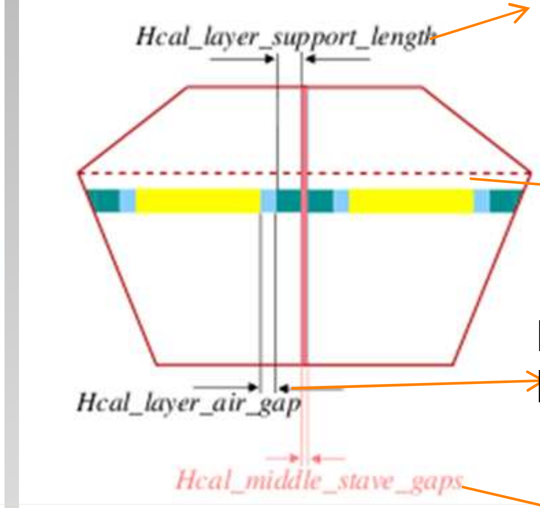
SHcalRPC02
BOTH GRPC and SCI





How to Implant RPC in Tesla



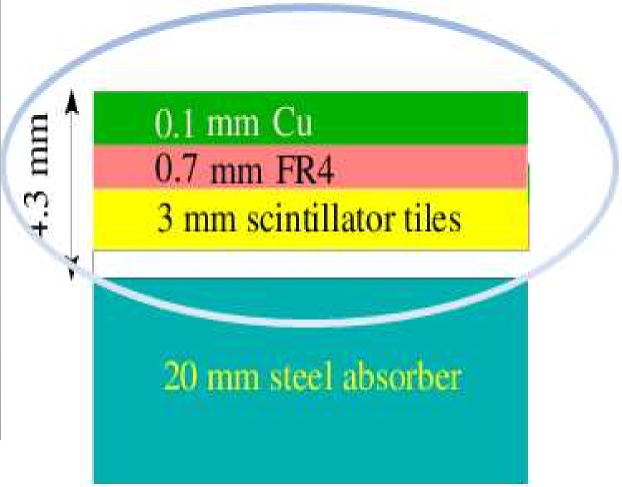


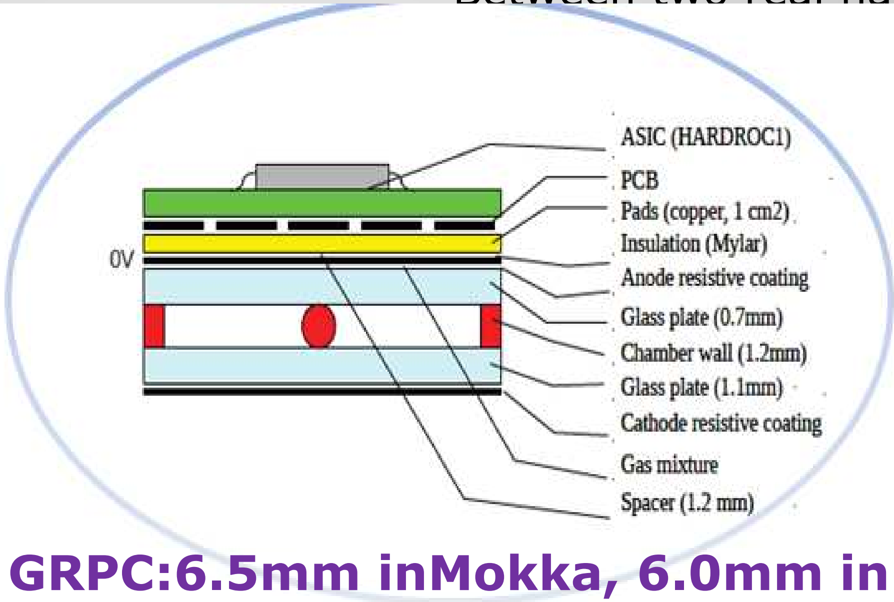
Build layer
Support structure 5mm

BarrelHalfRegularChambe
Build the chamber

Build the gap
between chambers and layer suppor

simulated the gaps
Between two real halves



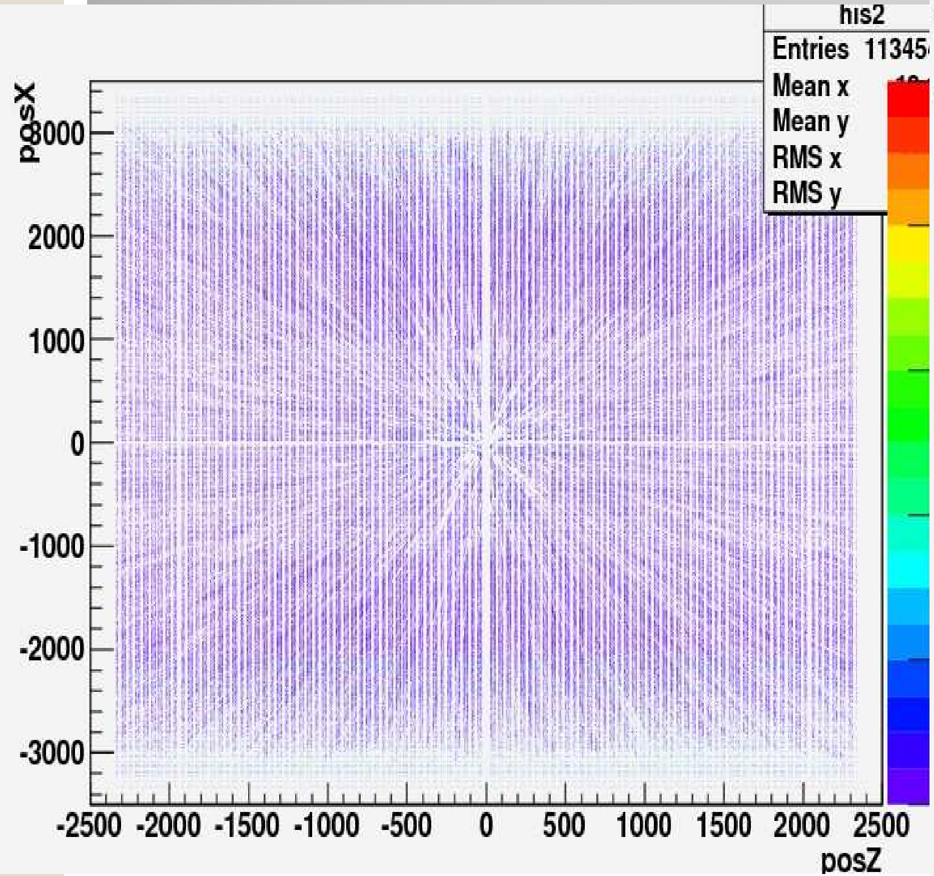


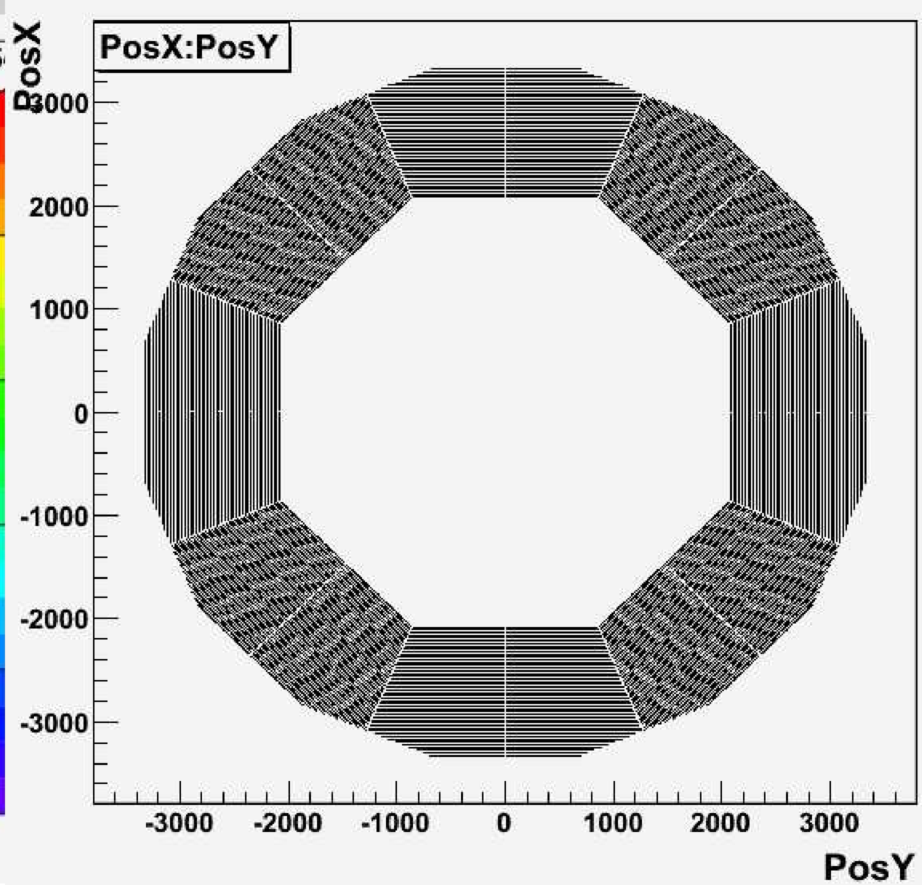
SCI:4.3mm inMokka; GRPC:6.5mm inMokka, 6.0mm in reality

100GeV Muon Events

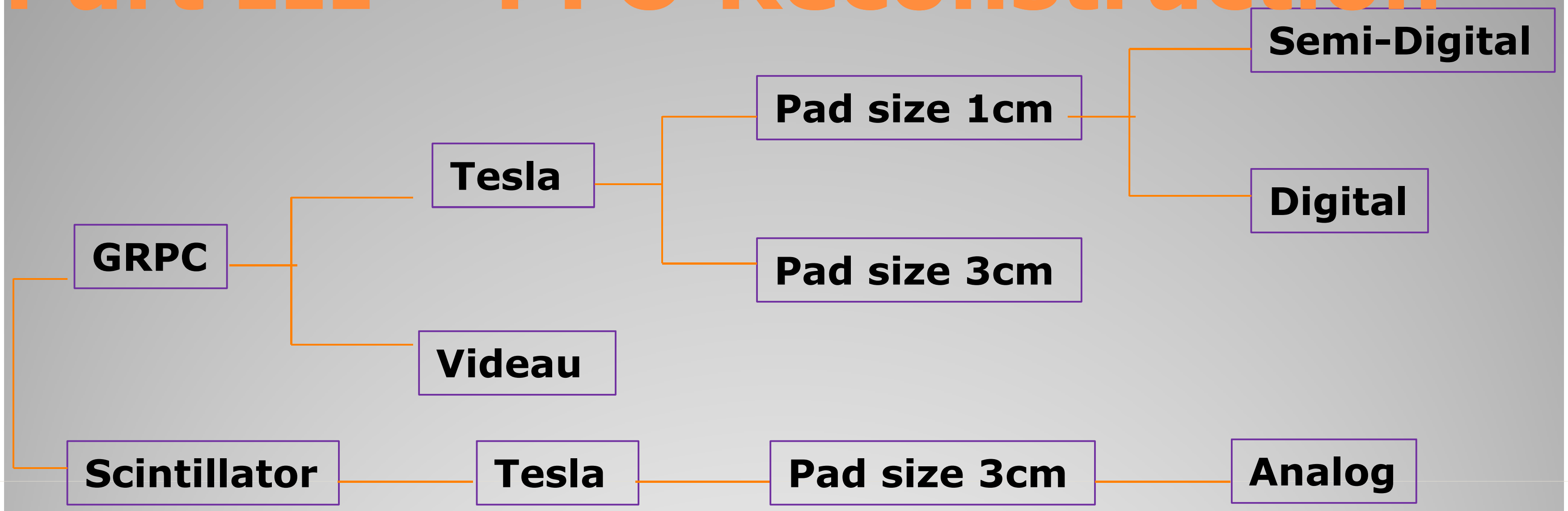
Geometry: Stave && Module

24000





Part III – PFO Reconstruction

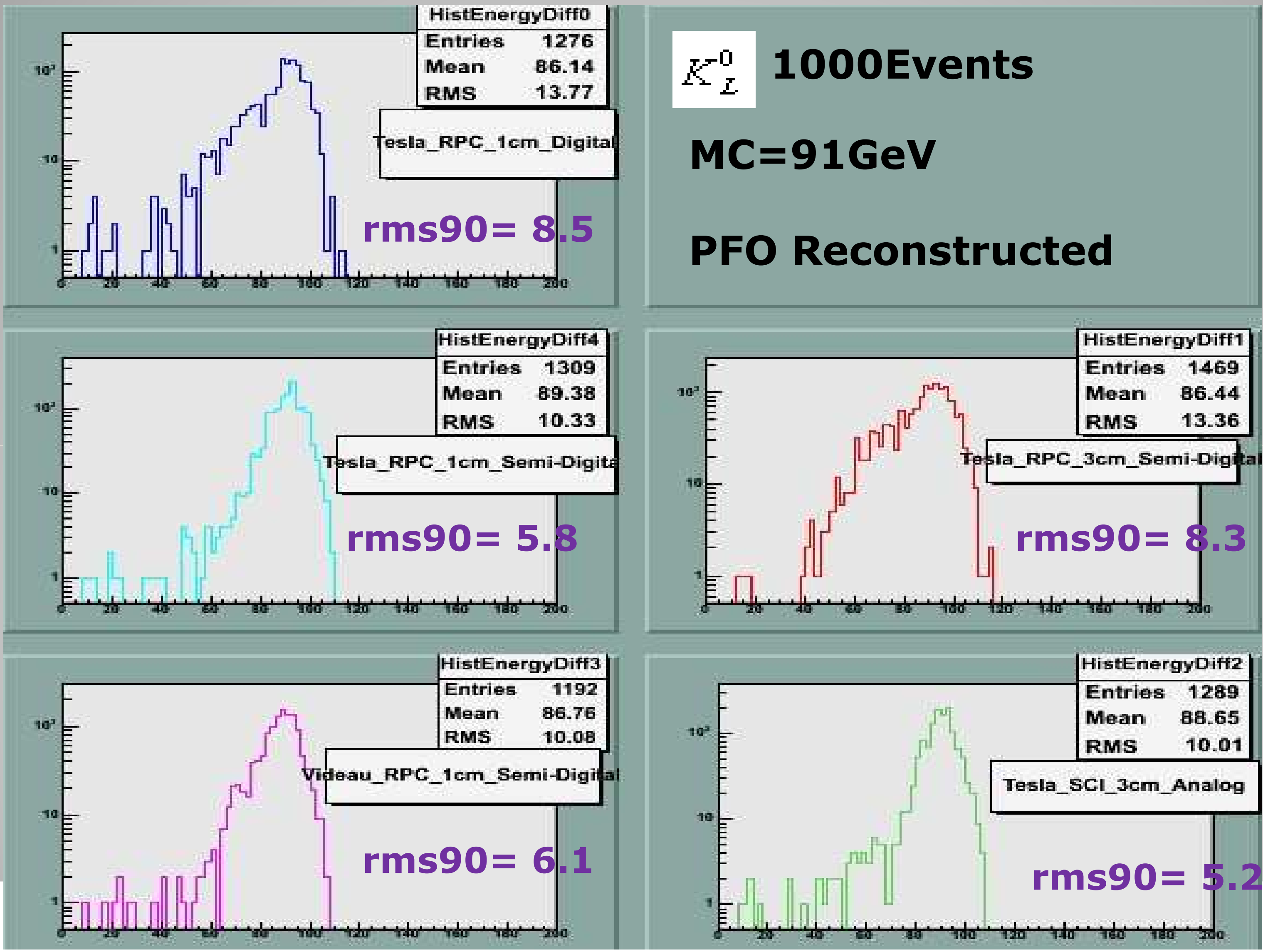


Mokka Kaon0-long GRPC_Tesla_1cm / GRPC_Videau_1cm
GRPC_Tesla_3cm/ SCI_Tesal_3cm

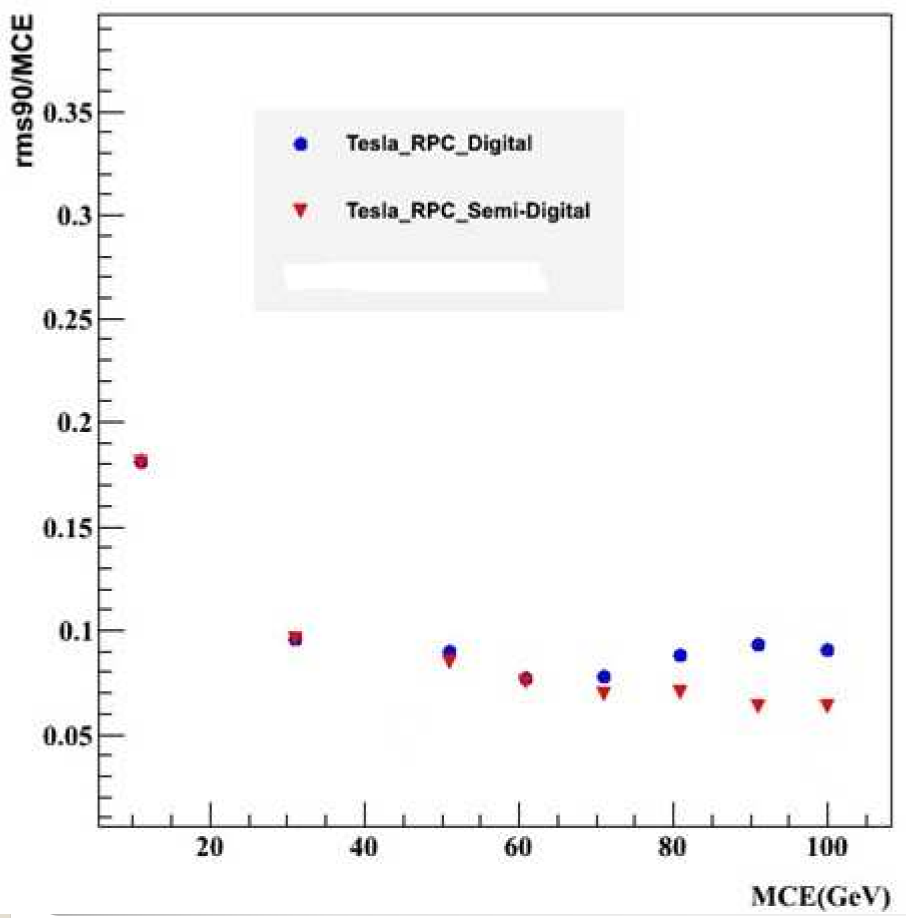
Marlin SCI:NewLDCDigitization ;DigitalHcal==0
GRPC:SimpleRPCDigitization, DigitalHcal==1
Digital: 0.4pC; CalibrHCAL=0.10503
Semi-Digital : 0.4pC, 4.8pC, 15pC ;CalibrHCAL= 0.07, 0.05, 0.55

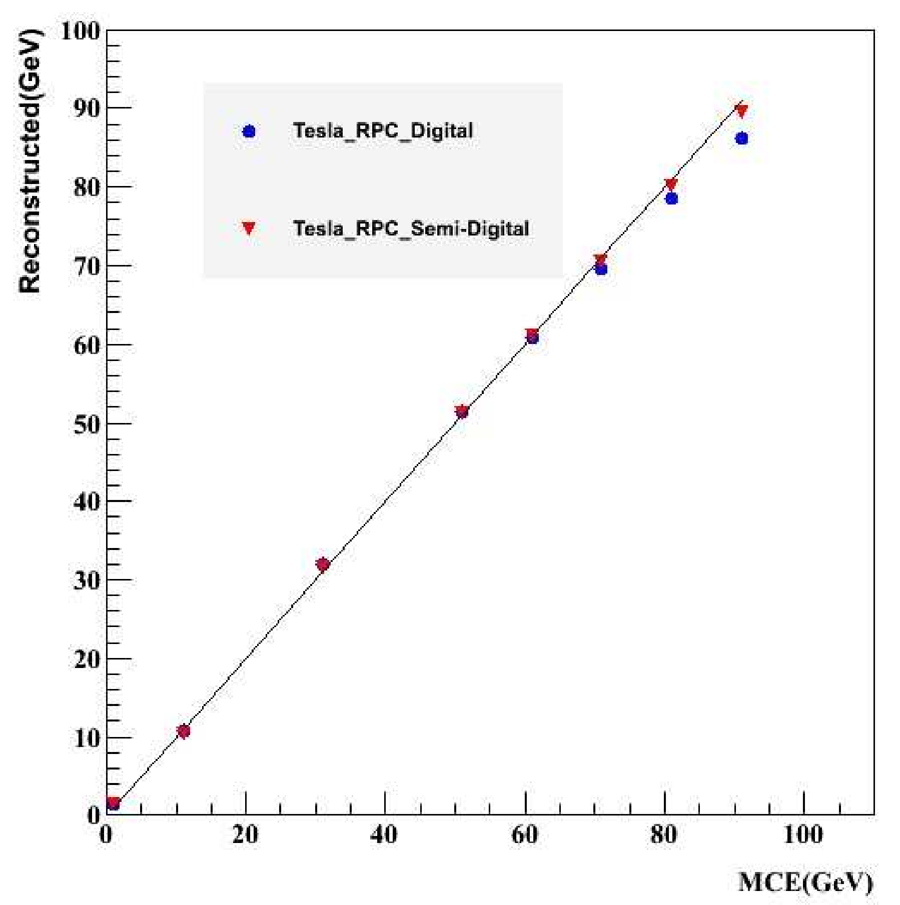
Pandora GRPC: HCalToMipCalibration= 1.0; HCalMipThreshol=0.0
SCI: default in bbudsc_3evt_stdrecon.xml

PFO Reconstructed Energy Distribution



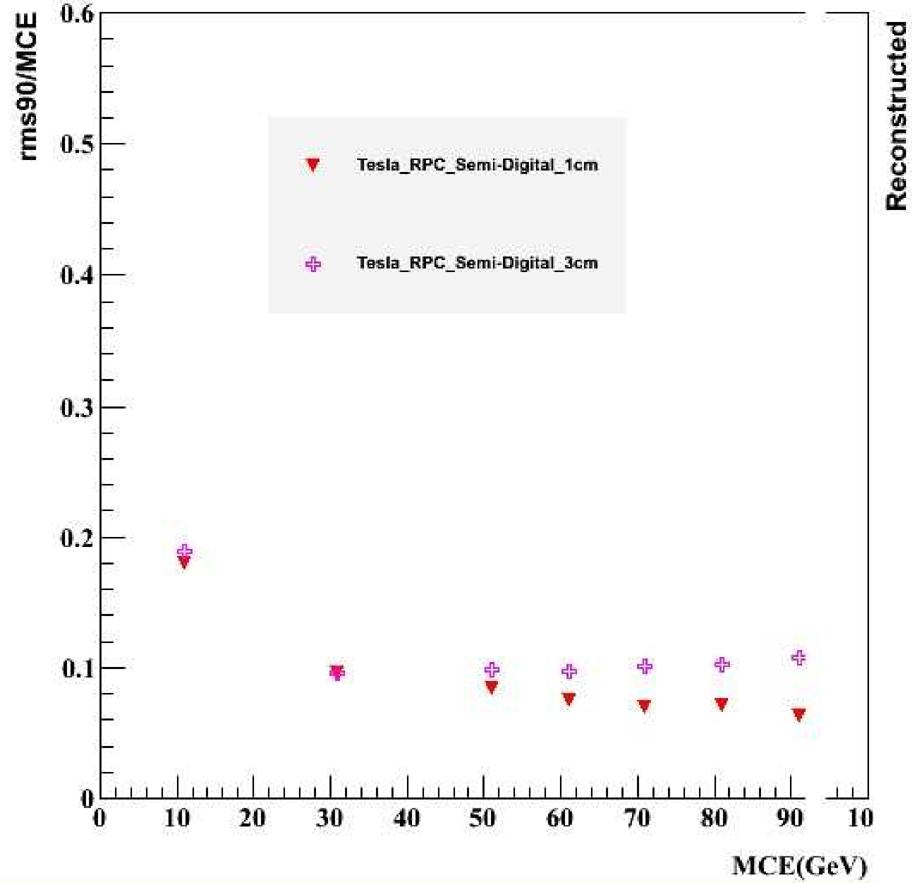
Energy Scan
Digital vs Semi-Digital

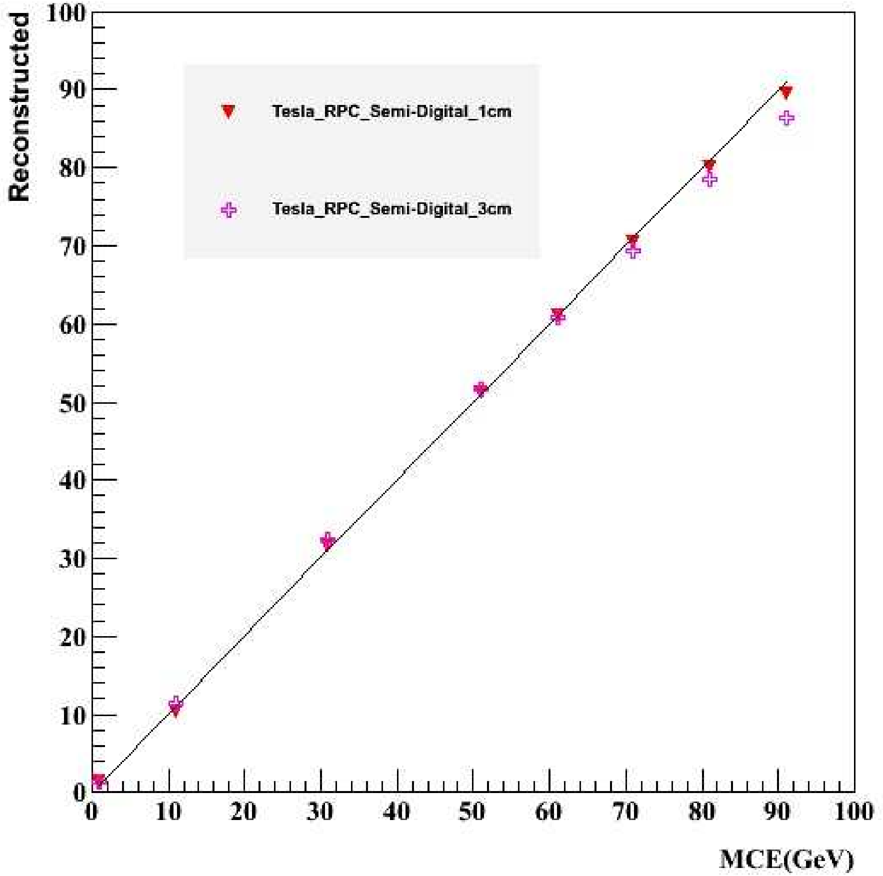




Semi-Digital is better than Digital at high energy

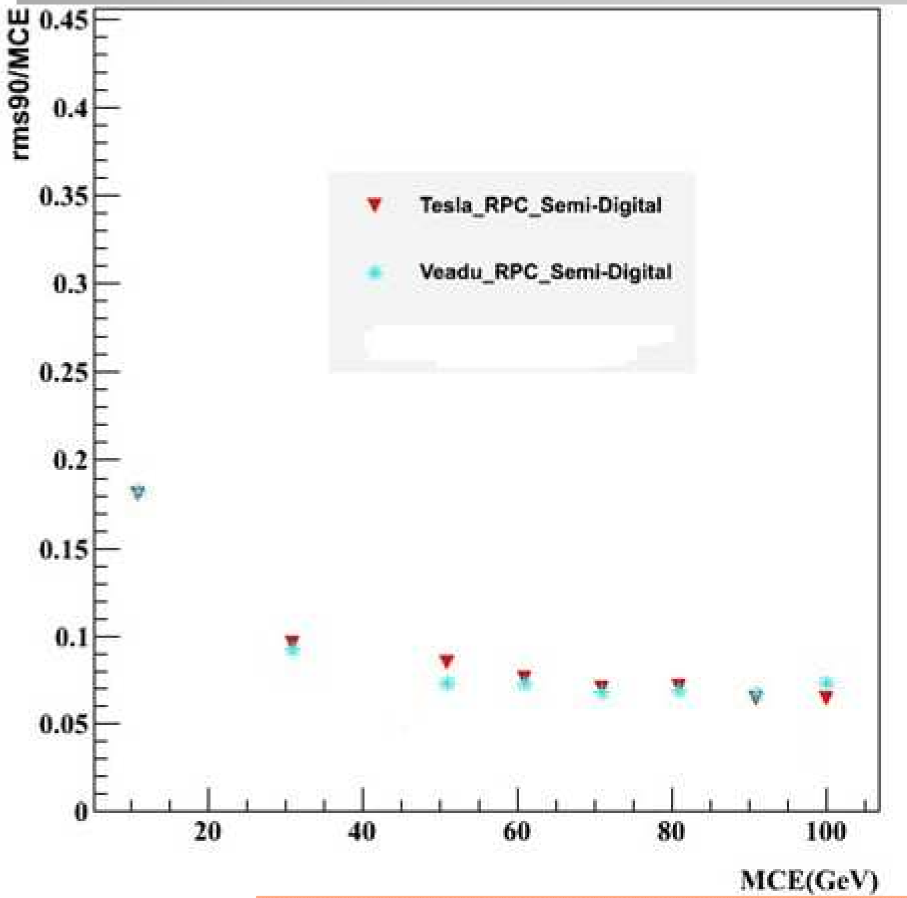
Energy Scan
1cm vs 3cm for SDHCAL

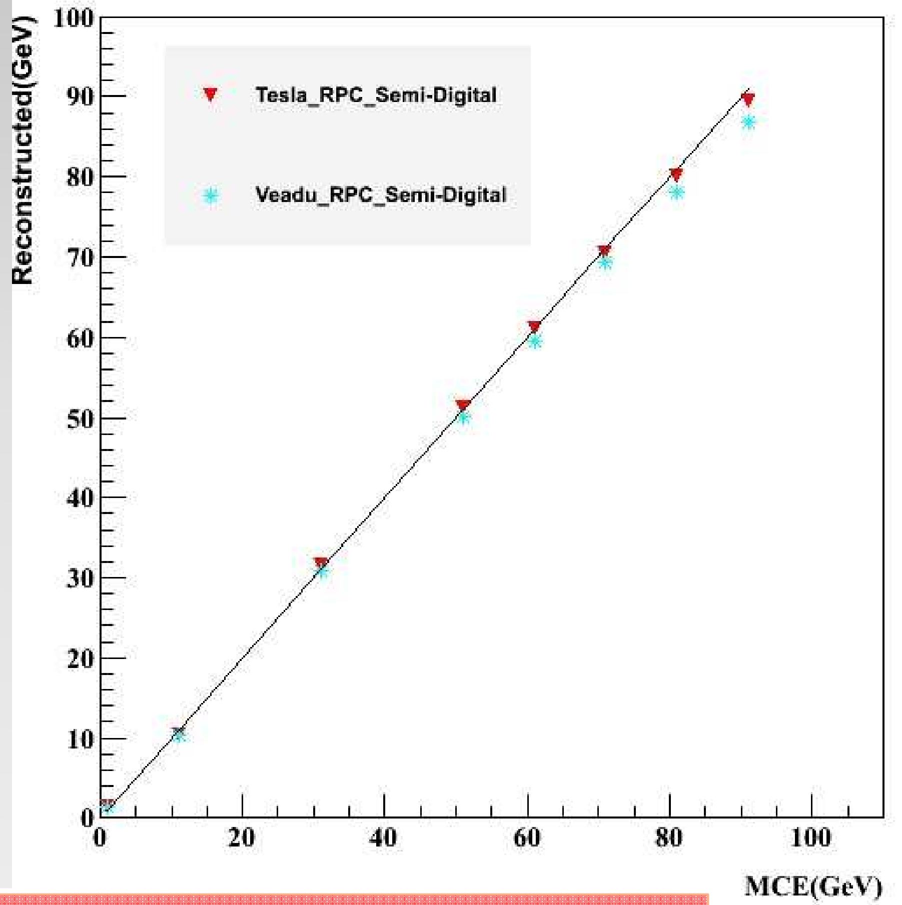




At Semi-Digital case, 1cm is much more better than 3cm

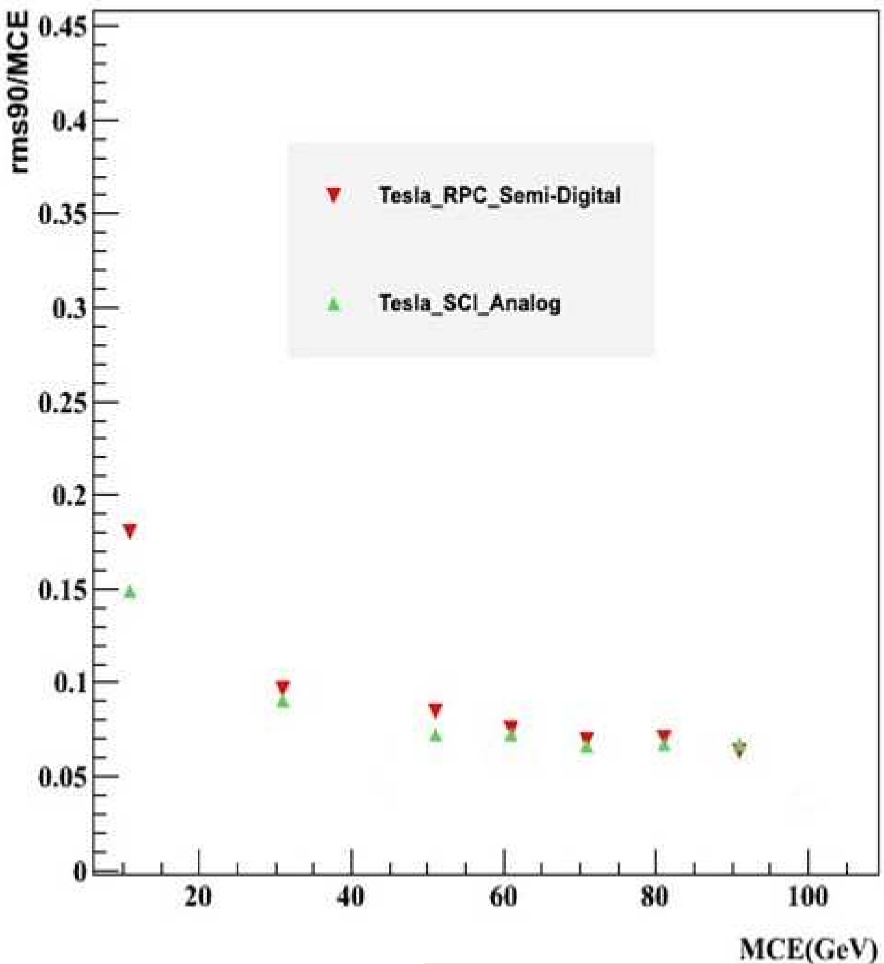
Energy Scan
Videau vs Tesla

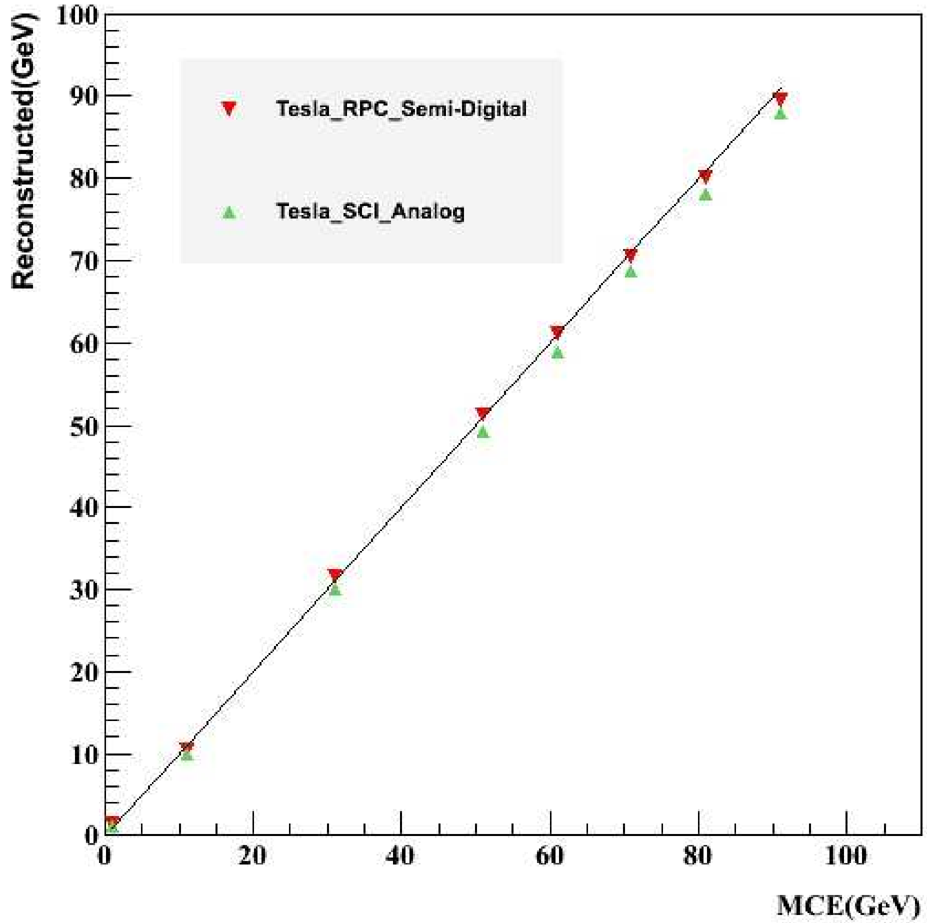




No big difference with two Geometry,
Module gap not implanted in Pandora for Videau

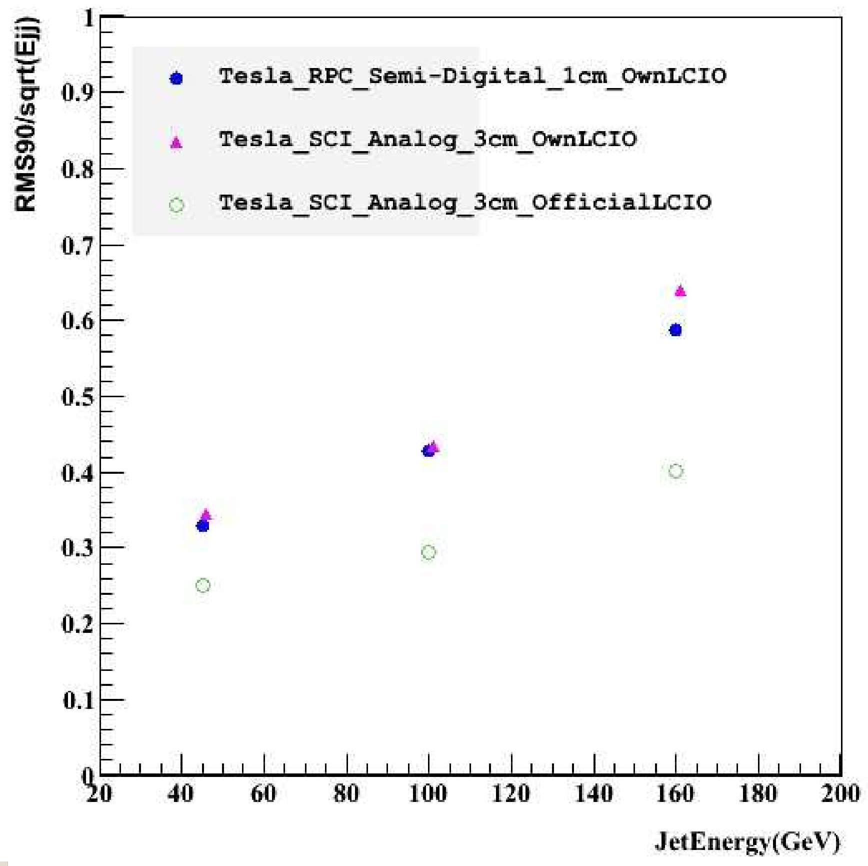
Energy Scan
SDHCAL vs AHCAL





SDHCAL comparable AHCAL
Still has space to improve

AHCAL vs SDHCAL qqbar



AHCAL

Jet Energy	raw rms	rms_{90}	$rms_{90}/\sqrt{E_{jj}/GeV}$
45 GeV	3.3 GeV	2.4 GeV	25.0 %
100 GeV	5.8 GeV	4.1 GeV	29.5 %
180 GeV	11.2 GeV	7.5 GeV	40.1 %

45GeV	4.07	3.13	33.0%
100GeV	7.80	5.90	42.7%
180GeV	16.8	11.0	58.8%

SDHCAL

45GeV	4.10	3.20	34.5%
100GeV	7.81	6.04	43.4%
180GeV	17.8	12.0	64.0%

1- ILD MC Simulation
Global Detector Model(ILD00,IDL01),
AHCal Driver(SHcalSc02,SHcal03)
Physics List
2- MARLIN-Pandora Process
Optimization Constants

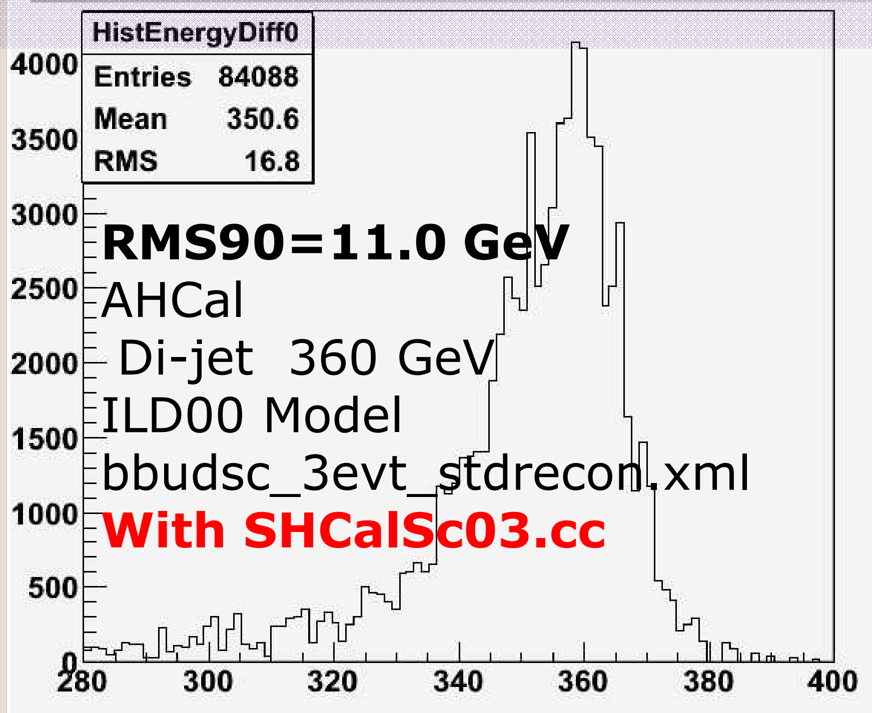
Why AHCal Can't Reach (ILD simulation)

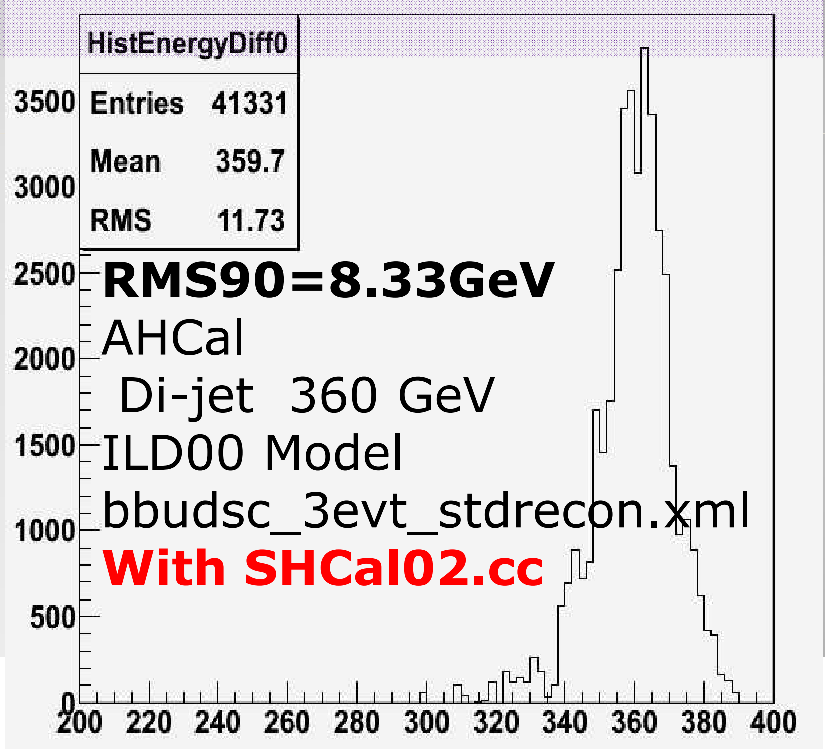
History: Tesla---- SHCalSc01, SHCalSc02, SHCalSc03
Videau--- SHCalRpc01

Mark's

Mine

2011/01: Tesla--- SHCalSc01,SHCalSc02,SHCalSc03 &&
SHCalRpc02 (basic frame inherit from SHCalSc03
Videau--- SHCalRpc02





Why SDHCal Can't Reach (ILD simulation)

Ongoing Study

Fast Guess

1- Optimization factor in Pandora not suit for HCAL driver I am using

2- Optimization factor in Pandora not suit for our digitization process

3- Pandora is not the case for 3-Thresholds

SDHCAL Comparable with AHCAL, and should be get better after Gerald developing Pandora for SDHCAL

Part IV – PFA Development

- Use Neutral Network to find the best constants for energy reconstruction

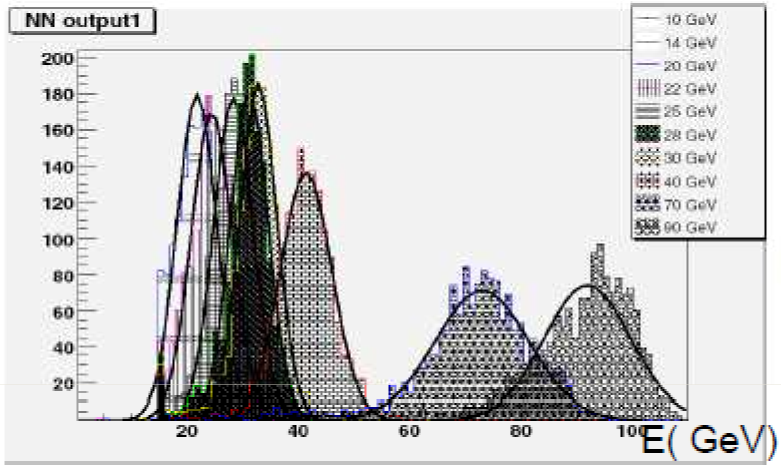
- Tracking /Clustering

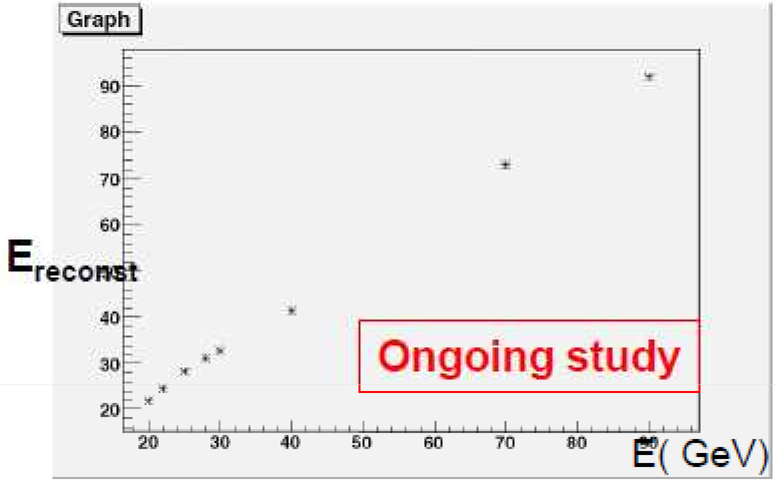
  Hough Transform/Minimum Spanning Tree

- Open Pandora –implant algorithm in for SDHCAL

Energy Resolution

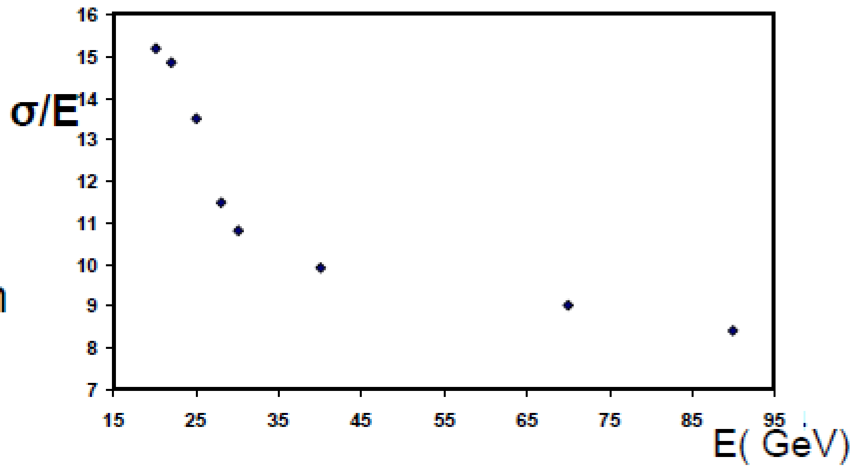
To determine the energy a Neural Network can be very helpful





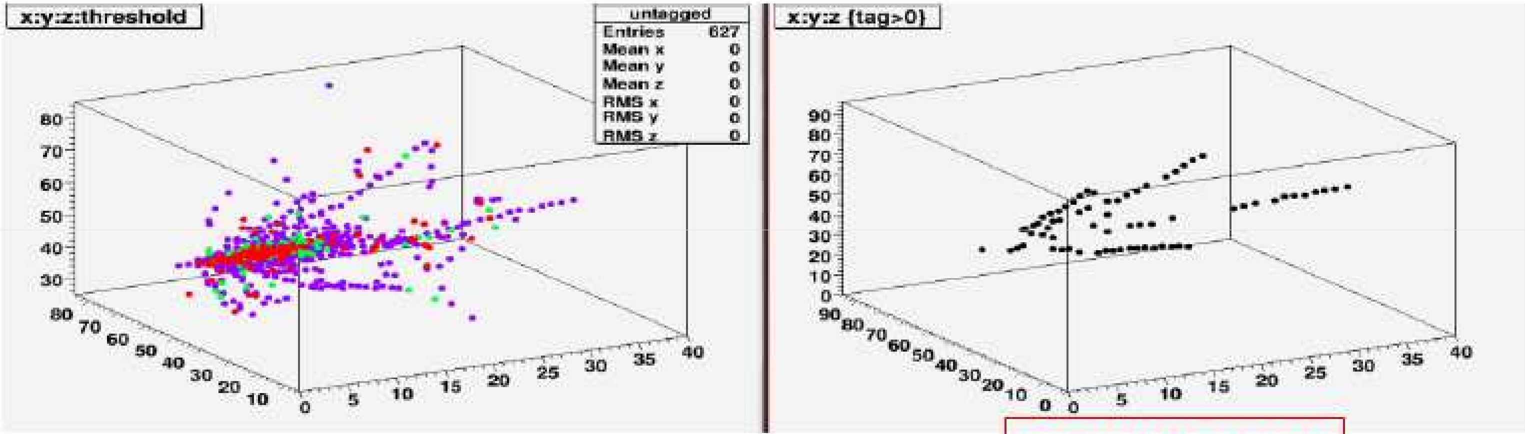
INPUTS : Number of pads with 1st,2d and 3d threshold (N_1,N_2,N_3)

Additional inputs taking into account the shower shape and its extension as well as shower density distribution are being studied



Tracking, clustering algorithms

Hough Transform : find MIP inside the hadronic shower and use them to calibrate/control the detector

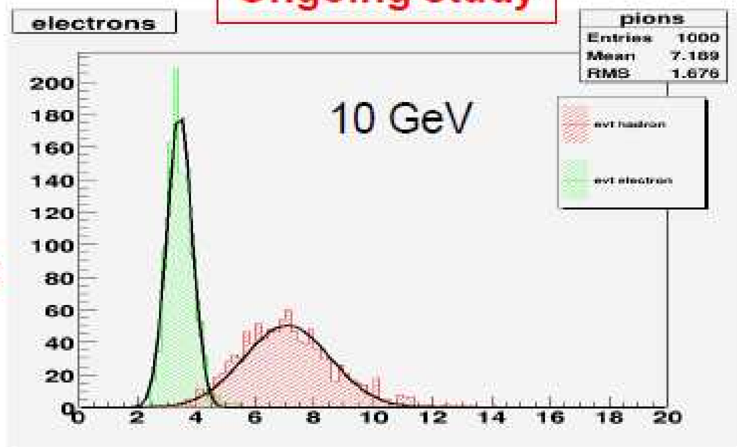


Ongoing study

Minimum Spanning Tree :

→Powerful tool to connect clusters into appropriate branches.

→Useful to separate electromagnetic from hadronic contribution



Summary

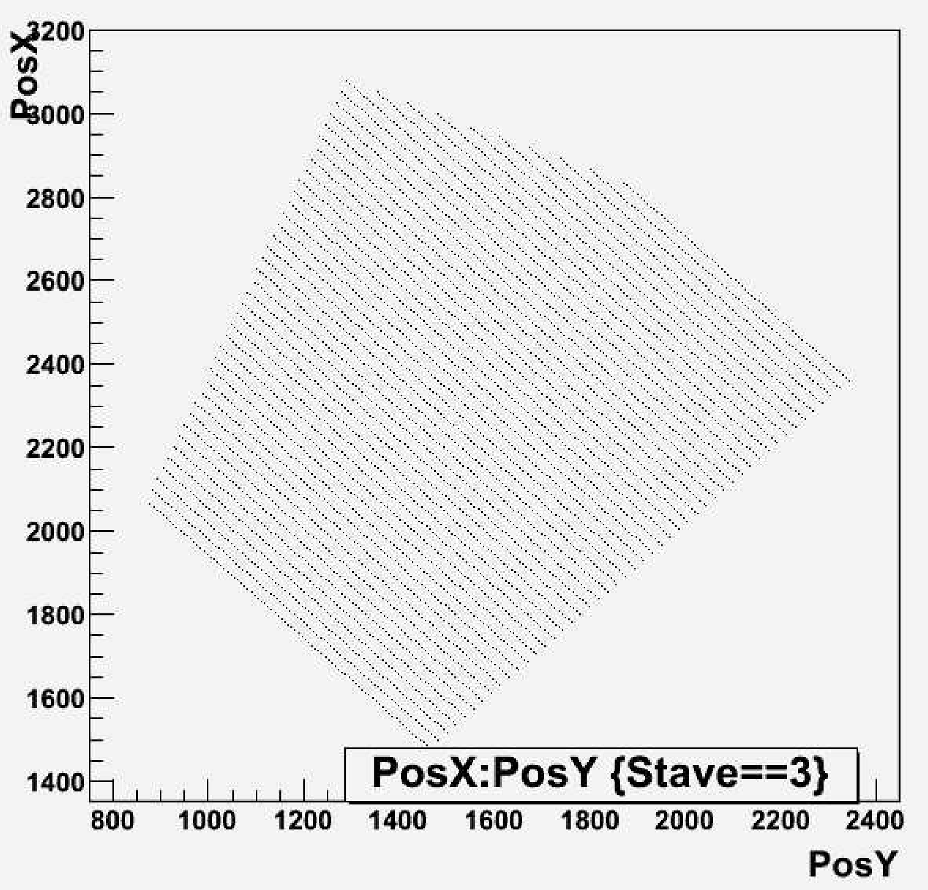
- Realistic simulation of GRPC Properties
  Digitization Process

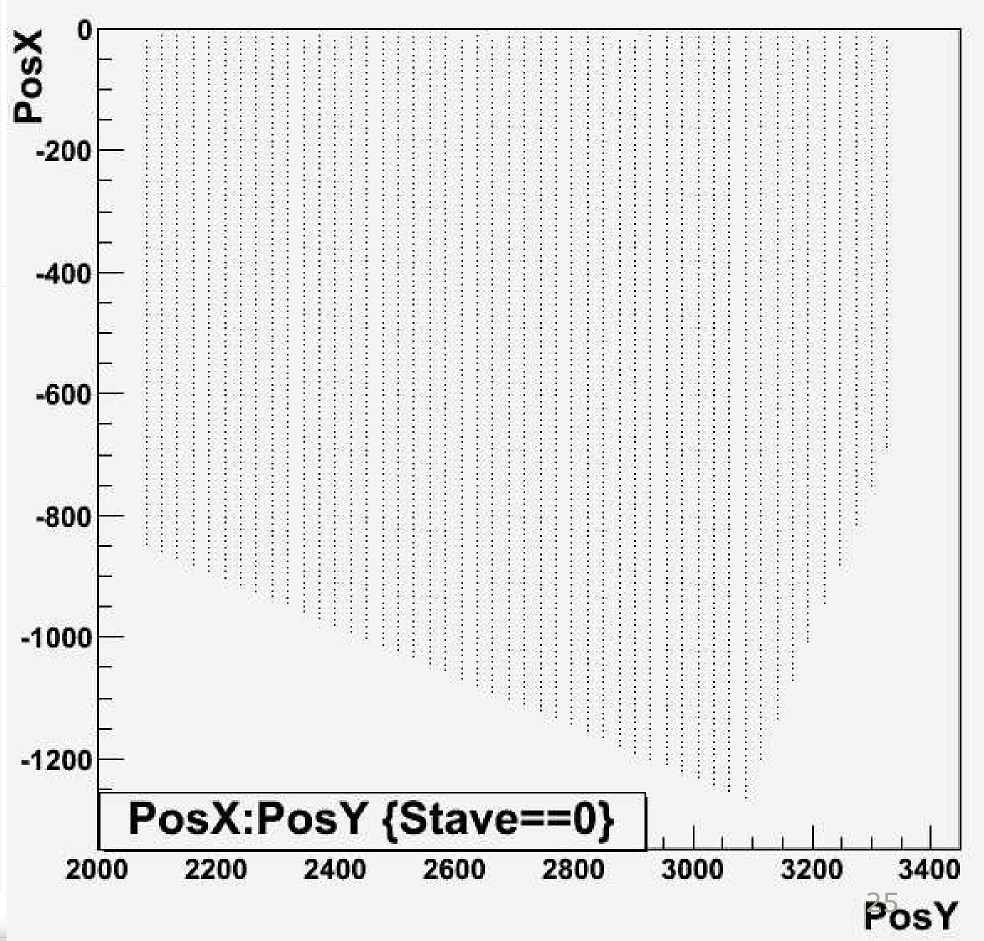
- GRPC has both Videau and Tesla Model

- Pandora Reconstruction
  1- SDHCAL > DHCAL @ High Energy
  2- 1cm pad size> 3 cm pad size for SDHCAL
  3- Tesla .vs. Videau NO BIG DIFFERENCE
  4- AHCAL .vs. SDHCAL ongoing study

BACK UP

Zoom in Stave/Tesla



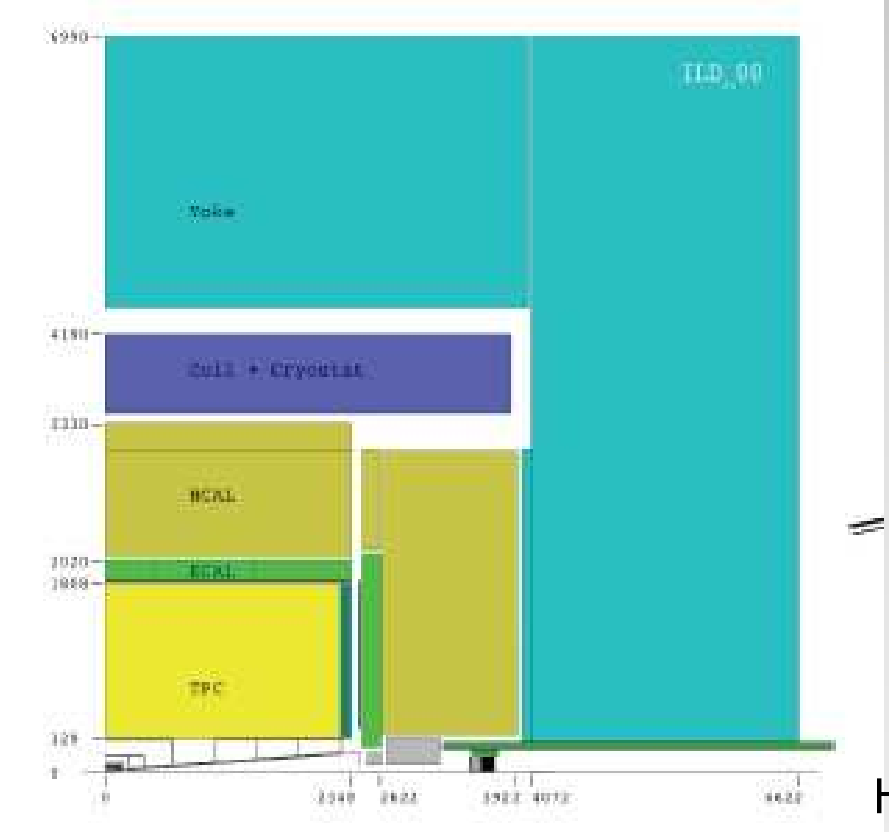


What is in Layers (geantino)

1	-844	-1.9e+03	365	4e+04	0	2.11e+03	2.11e+03	BarrelHcalModule	Transportation
2	-853	-1.92e+03	369	4e+04	0	21.8	2.13e+03	physiRPCFree	Transportation
3	-853	-1.92e+03	369	4e+04	0	0.402	2.13e+03	physiRPCmylarCathode	Transportatio
4	-853	-1.92e+03	369	4e+04	0	0.196	2.13e+03	physiRPCGraphiteCathode	Transportation
5	-853	-1.92e+03	369	4e+04	0	0.0544	2.13e+03	physiRPCThickGlass	Transportation
6	-854	-1.92e+03	369	4e+04	0	1.2	2.13e+03	physiRPCGap	Transportation
7	-854	-1.92e+03	370	4e+04	0	1.31	2.14e+03	physiRPCThinGlass	Transportation
8	-855	-1.92e+03	370	4e+04	0	0.761	2.14e+03	physiRPCGraphiteAnode	Transportat
9	-855	-1.92e+03	370	4e+04	0	0.0544	2.14e+03	physiRPCmylar	Transportation
10	-855	-1.92e+03	370	4e+04	0	0.0544	2.14e+03	physiRPCPCB	Transportation
11	-855	-1.92e+03	370	4e+04	0	1.31	2.14e+03	physiRPCElectronics	Transportation
12	-856	-1.93e+03	370	4e+04	0	1.74	2.14e+03	BarrelHcalModule	Transportation

Digital: 0.2pC; CalibrHCAL=
CalibrHCAL=0.10503
Semi-Digital 0.4pC, 4.8pC, 15pC
;CalibrHCAL= 0.1507272 0.0550067
0.5565631

Size changes



SDHCAL
Hcal_total_dim_y=1287
Hcal_outer_radius = 3227
AHCAL
Hcal_total_dim_y=1181.4
Hcal_outer_radius = 3121.4
1287 -1181.4=3227-3121.4= (6.5-4.3)*4

<   - Yoke_barrel_inner_radius =
4440.0297851562
>   - Yoke_barrel_inner_radius =
4332.3601074219
Hcal_Coil_aditional_gap=29.5

HCAL endcap rings will have 5 layer
HCAL endcap rings will have 6 layers.