HADRONIC ENERGY RESOLUTION OF THE ICAL DETECTOR

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OUTLINE

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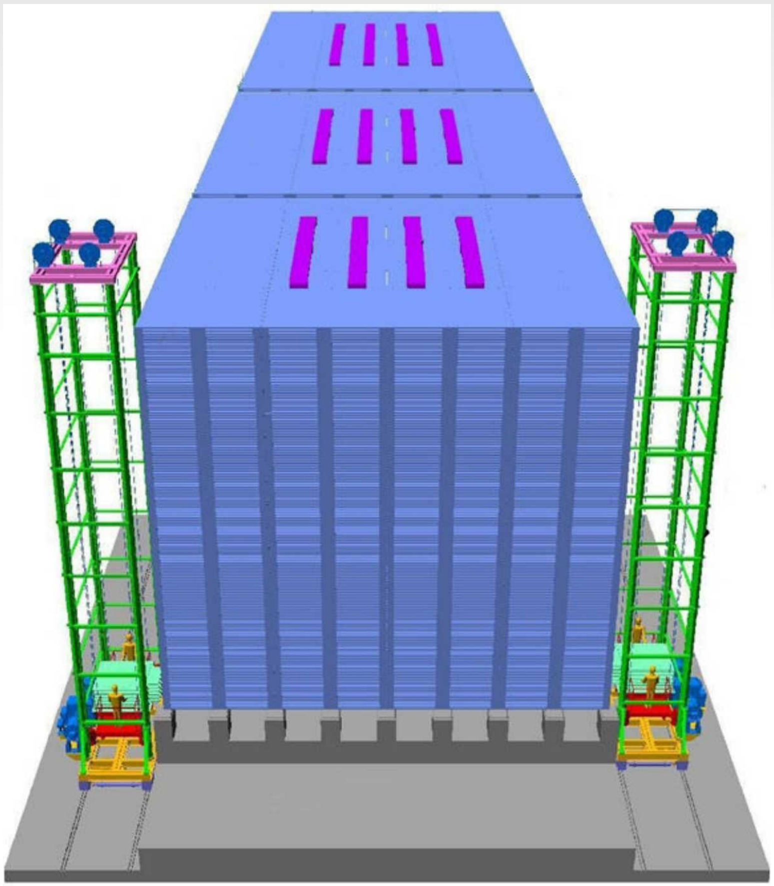
- **WHY HADRON ENERGY CALIBRATION IS IMPORTANT**
- **GEANT SIMULATION**
- **CONCLUSION**

INTRODUCTION

ICAL--> Large mass magnetised Iron CALorimeter with charge identification capibility.



Dimension of ICAL= 48m X 16m X 12m

Absorber = Iron plate with thickness 5.6cm.

Active detector element= Resistive Plate Chamber with dimension 2m X 2m.

The readout of RPC is performed by external orthogonal pick up strips(X and Y strips).

INTRODUCTION

Interaction of neutrino with detector:

The atmospheric neutrinos inside the detector go through the quasi-elastic charge current (qecc) interactions, resonance interactions at low energy (up to a few GeV) and deep inelastic scattering (DIS) at higher energies.

→ CC interaction events produce associated leptons.
→ DIS produce large number of hadrons
→Resonance interactions produce at most one pion along with the lepton.

Produced muon gives clear track inside detector where as hadron produces shower.

Why is hadron energy calibration important

In the first phase INO will look for the confirmation of the first oscillation dip as a function of L/E_ν, precise measurement of the oscillation parameters and deterination of the mass heirarchy. So measurement of E_ν plays a crucial role here.

To recostruct the E_ν both precisely both muon energy and hadron energy have to be measured very precisely

$$E_\nu = E_\mu + E_h$$

reconstructed

The energy of the muons are reconstructed from the track length in the detector.

What about hadrons?

For Hadron shower fluctuation in energy loss is much larger then the electromagnetic process.

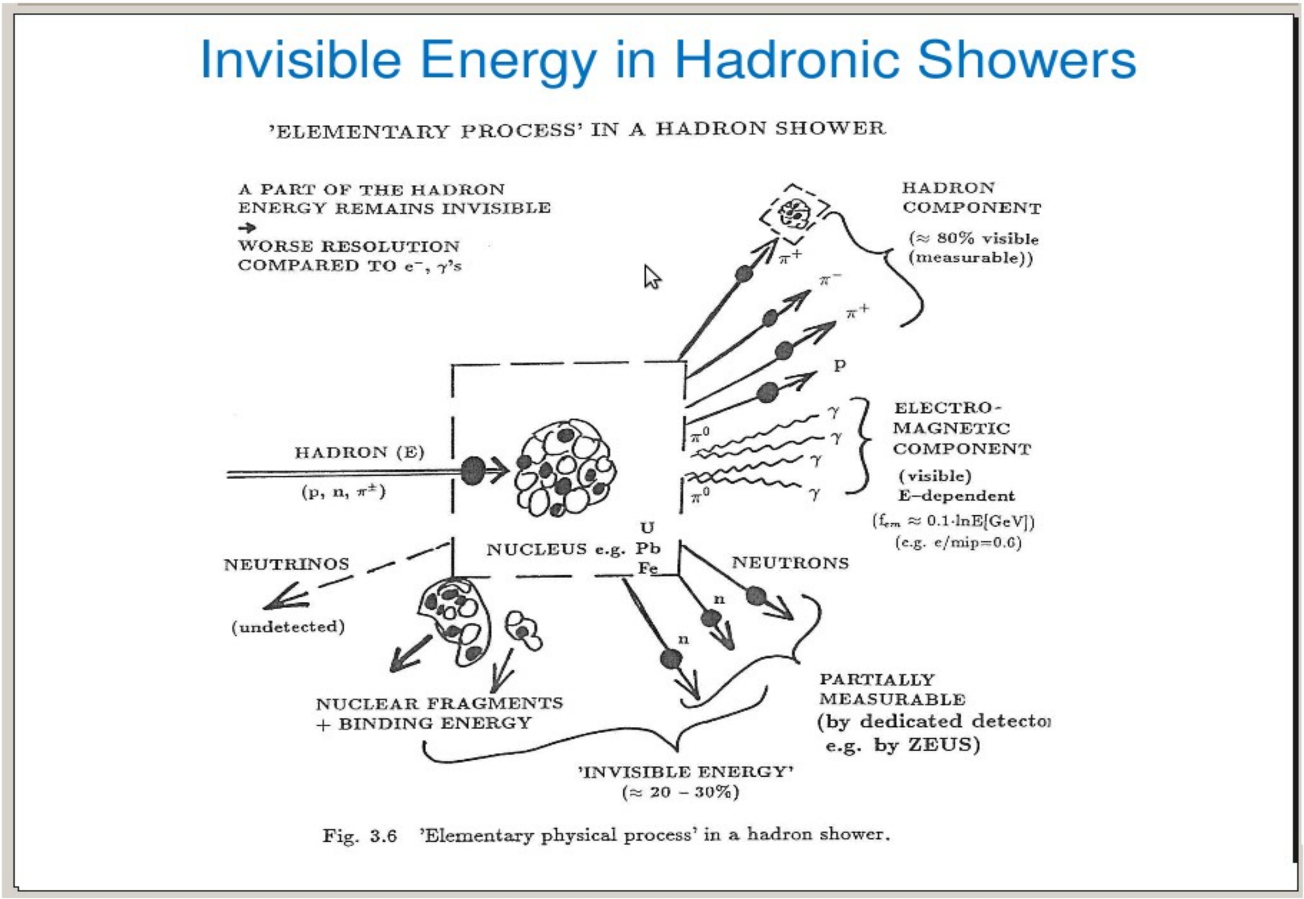


Fig. 3.6 'Elementary physical process' in a hadron shower.

Reference of this figure--> *Robert S.orr* **(University of Toronto), 2009 TRIUMF summer institute**

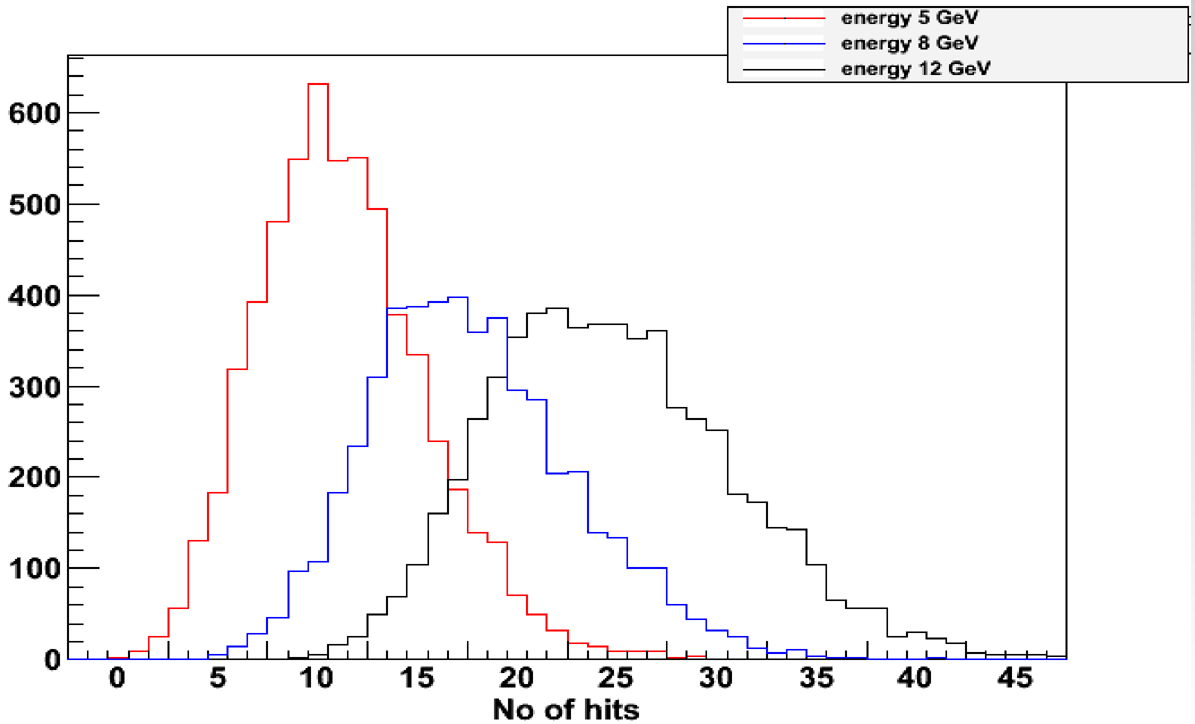
GEANT4 SIMULATION

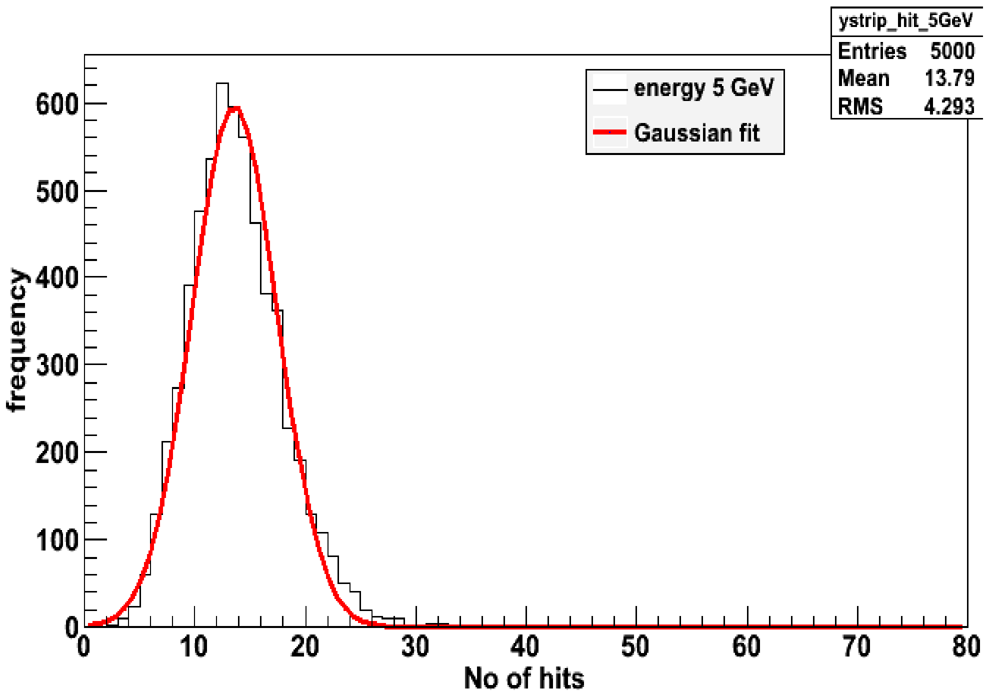
Geant4 is used for the simulation. It is a toolkit for simulating the passage of particle through matter. It includes a complete range of functionality including tracking, geometry, physics models and hits.

Having the information for total number hits, try to calbrate the energy of the hadron by digitizing the hits.

For hadron energy calibration:

- single particle pion has been used
- 5000 events have been run for each calculations
- Ged rid off from the ghost hit-- one type of data is used X Strip or Y Strip data.
- Energy range used : 1 GeV – 12 GeV.





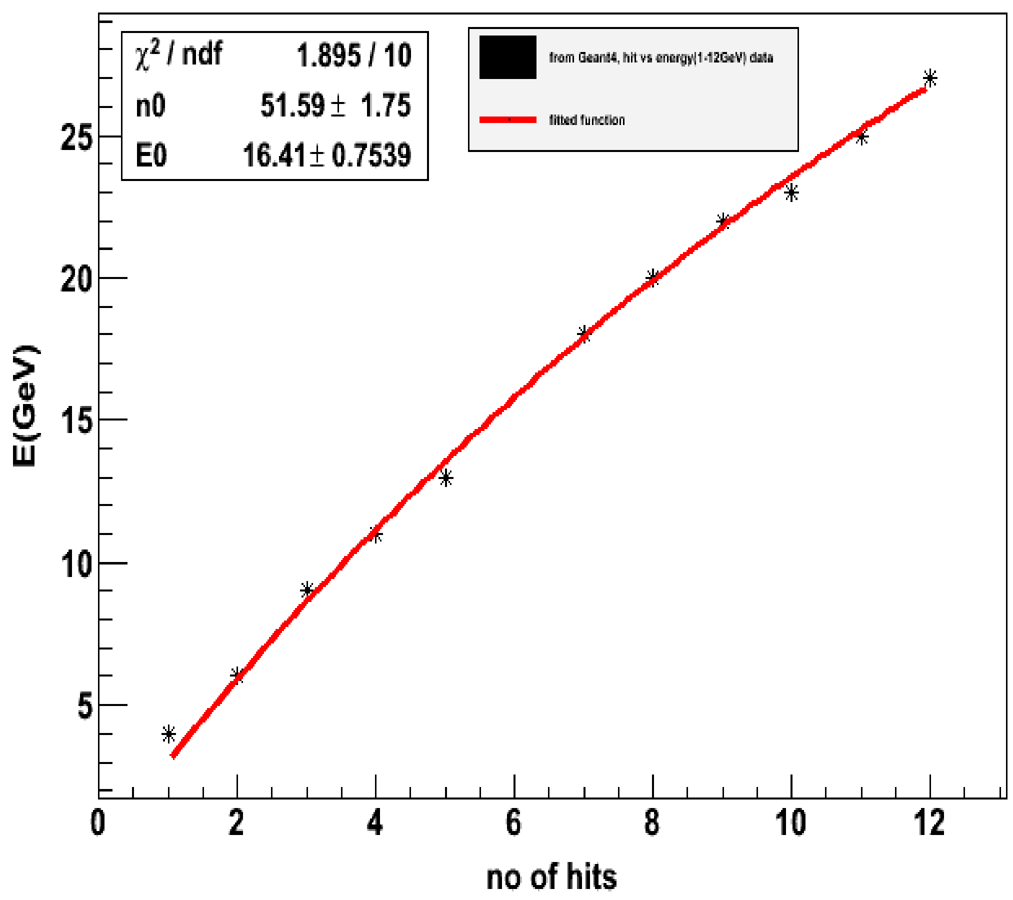
For each energy , got a hit distribution , which is gaussian in nature:

$$n_h = A_o(\exp(-(x-x_o)^2/2\sigma^2))$$

Where

n_h = number of hits

x_o, σ = parameters.

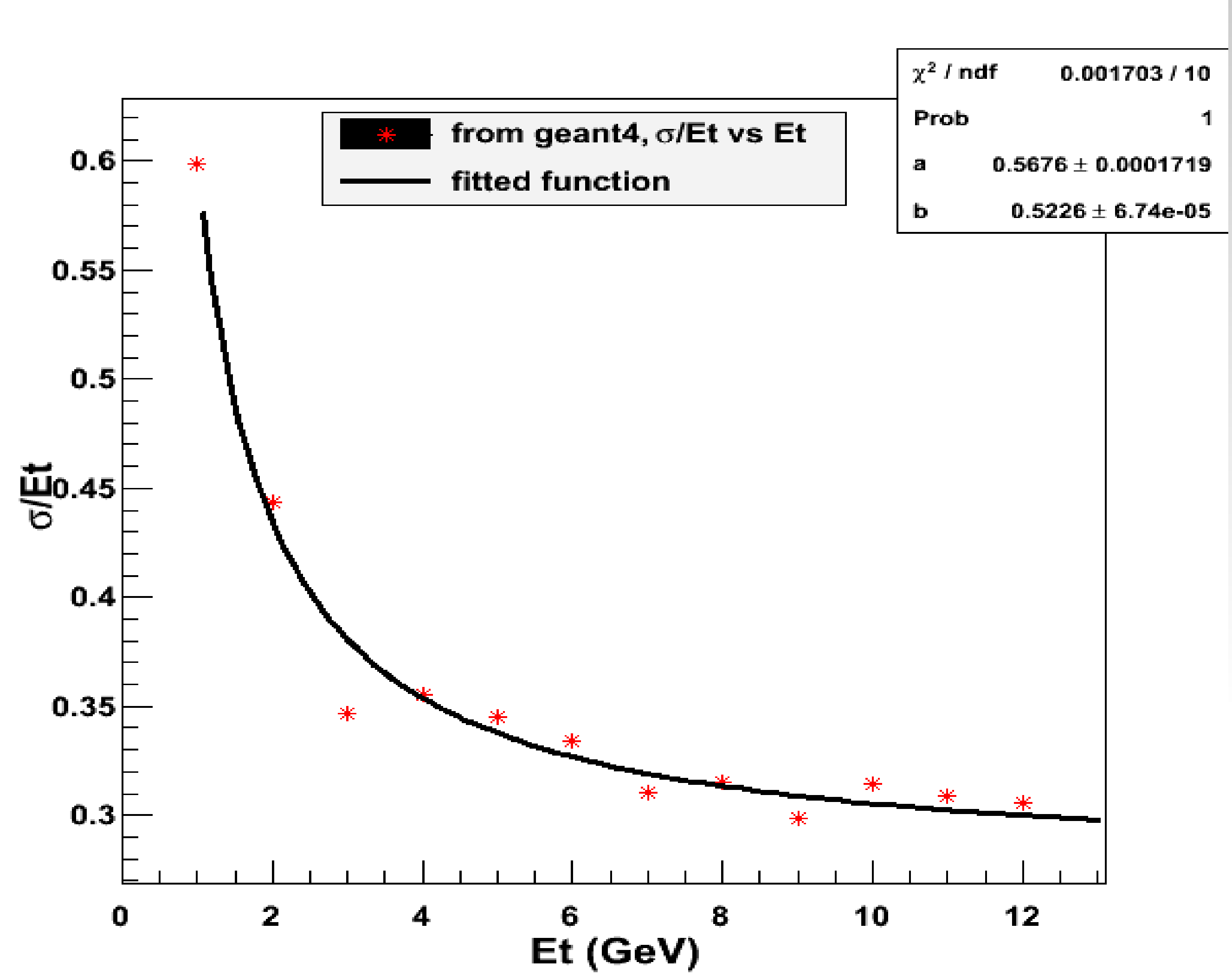


n_h (in eq^n 1) has been plotted as a function of energy and the fitted function used -

$$\mathbf{N_h = n_o(1\text{-}exp(E/E_0))}$$

N_o, E_o = Parameters of calibration.

These parameters are used to obtain resolution function of the hadron energy.



This plot shows the variation of σ as a function of energy Et. The data are fitted with the function described by :

$$\sigma/E = a/\sqrt{E} + b$$

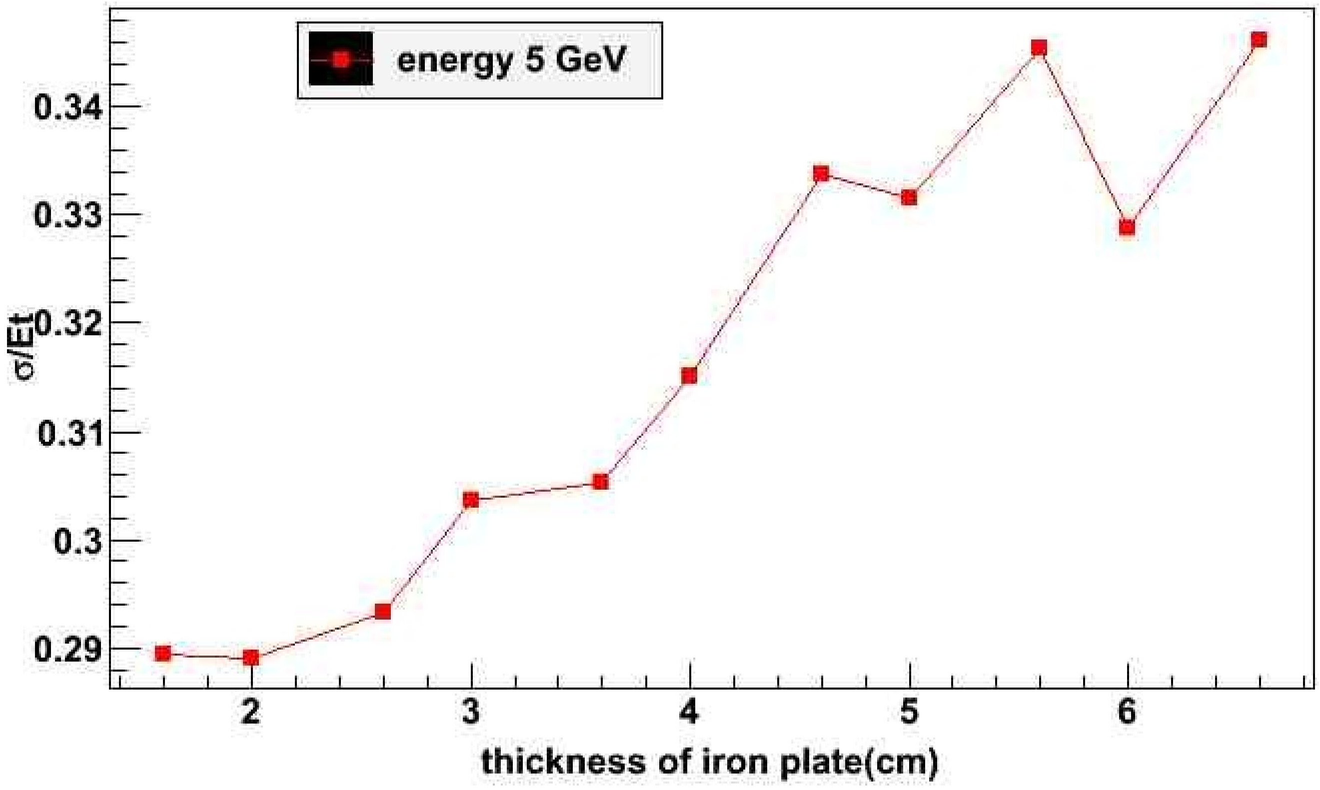
The fitted paramters are:

a=.56√GeV

B=.52

Which give the energy dependence of the energy resolution σ.

Vary the thickness of the iron plate and see how the resolution function of hadron energy varies:



In this plot the thickness varies From
1.6cm – 6.6cm by 1cm interval.
Energy=5GeV

CONCLUSION

- Single pion events have been used to get the resolution function of hadronic energy.
- Thickness of iron plate has been varied to see variation in resolution function. We see that varying the thickness 4->6cm, resolution function varies 31% to 33%.
- To optimize the hadronic response of the detector neutrino generator wil be is used. Genie is ready to use for that.

Thank you!