



# HADRON ENERGY RESOLUTION OF THE INO-ICAL DETECTOR

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# THE INO PROJECT

- The India Based Neutrino Observatory (INO) is a proposed underground Neutrino laboratory.
- Goal: Conducting decisive experiments in neutrino physics & hosting other experiments which need an underground facility.

- Site : Bodi West Hills, South India ( $\sim 10^{\circ}$  N,  $77^{\circ}$  E). The overburden is 1289m from the crown of the cavern.



The INO collaboration currently plans to host these experiments,

1. ICAL : A magnetized Iron CALorimeter to study neutrino oscillation and some of the open questions in the field of neutrino physics today.

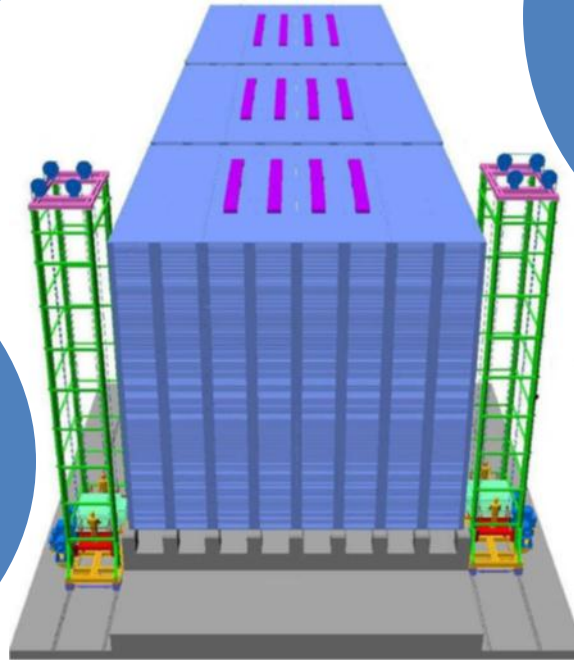
2. NDBD: A neutrino-less double beta decay experiment using Sn Bolometer.

# THE INO-ICAL DETECTOR

It is a magnetized **Iron CAL**orimeter, capable of charge identification.

Active Detector Element:  
**Resistive Plate Chamber** (2m X 2m X 35mm), active volume element (2m X 2m X 2mm).

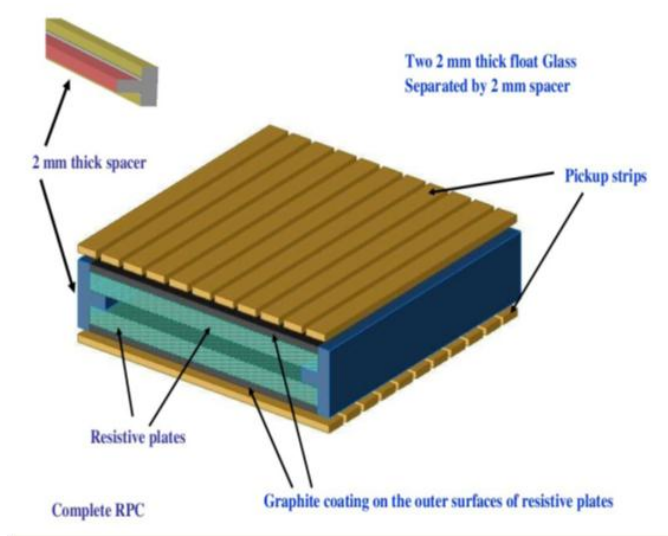
Dimension:  
**48mX16mX14.4m**  
(3 modules of dimension 16mX16m X14.4m each).



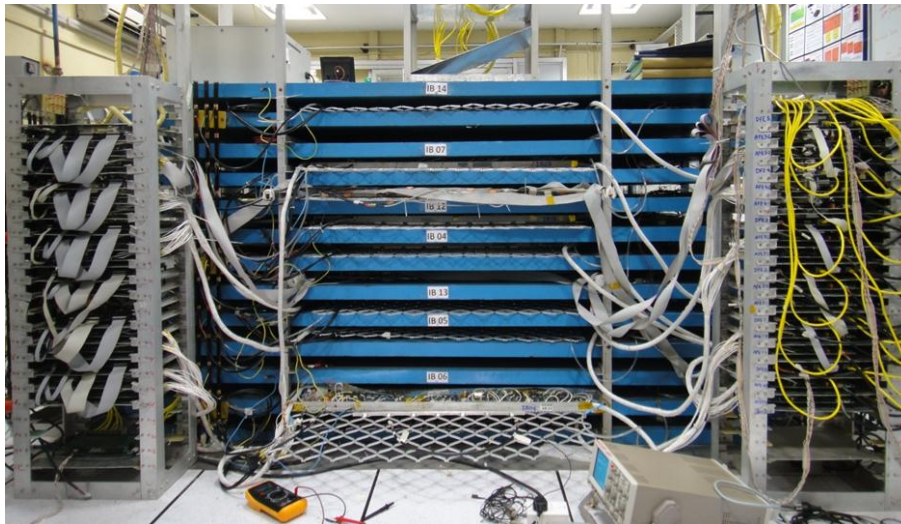
Absorber : **Iron plates** (thickness 5.6cm).

Mass : **50 kTon** (Approximately).

# RESISTIVE PLATE CHAMBER (RPC)



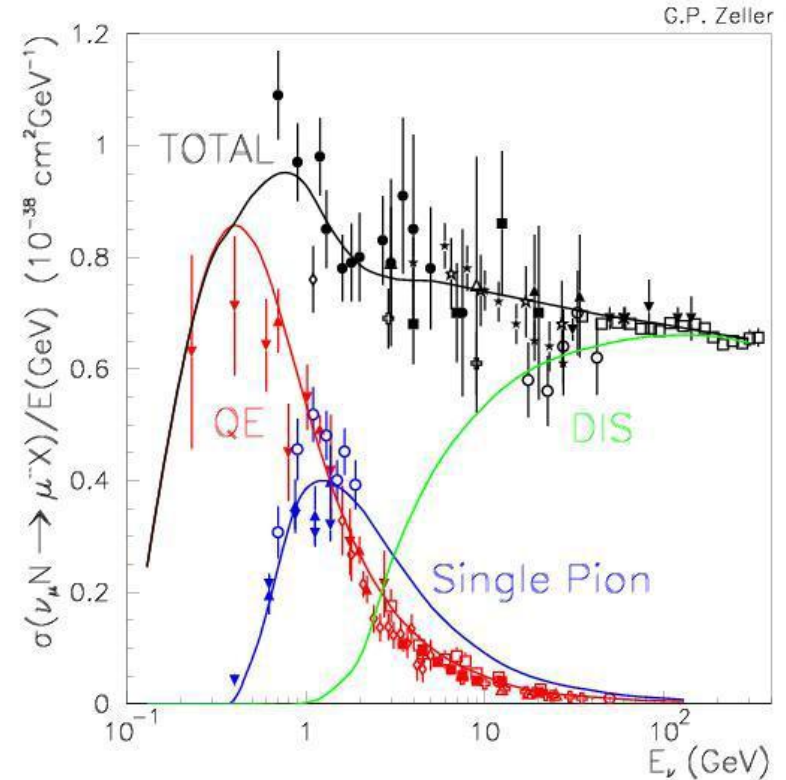
- When a charged particle passes through it, the hit information is obtained for X & Y planes.
- ICAL is most sensitive to muons.



- The ICAL prototype at The Variable Energy Cyclotron Center, Kolkata, India.

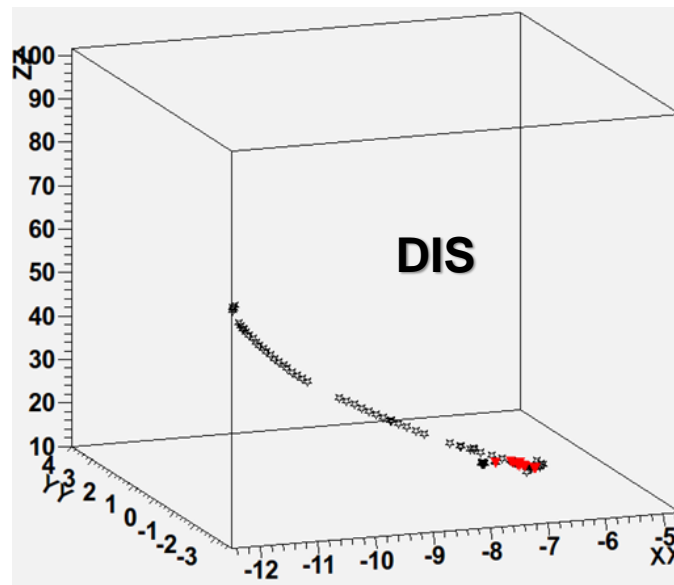
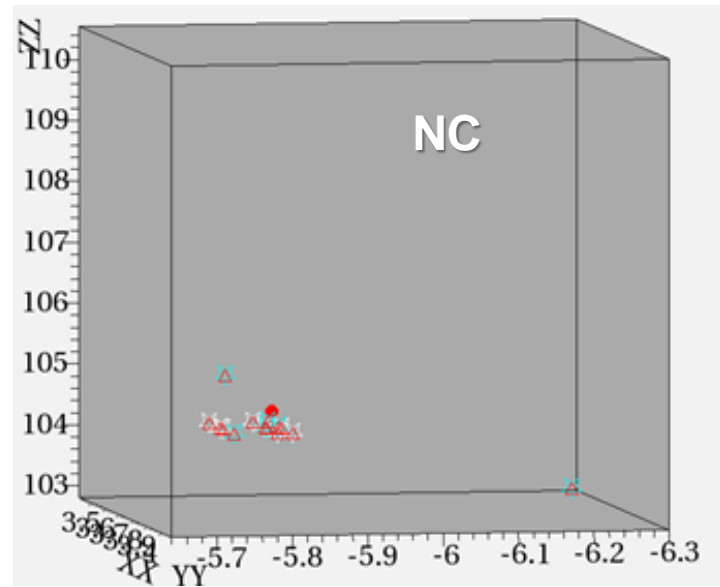
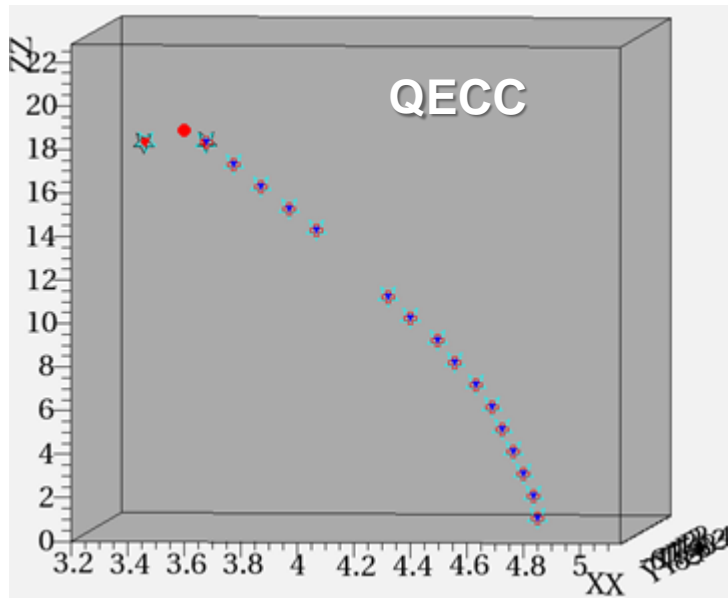
# INTERACTION OF NEUTRINO WITH THE DETECTOR

- Quasi-Elastic (QE) interaction events. They produce associated leptons.
- Deep Inelastic Scattering (DIS) interaction events . They produce a number of **hadrons**.
- Resonance Interaction events. They produce **Single pion events**.

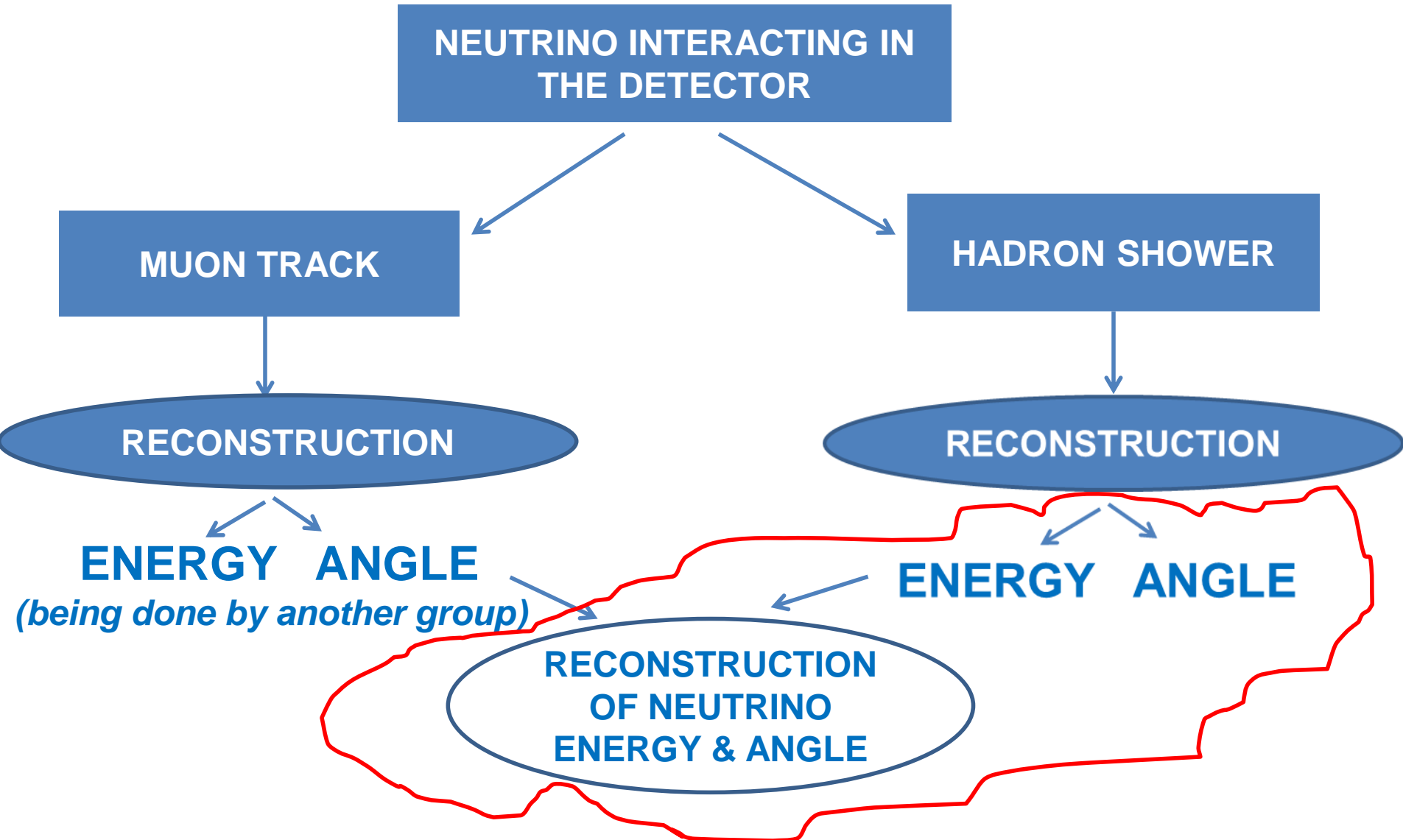


**Produced muon gives distinct track inside the detector, whereas hadron produces shower.**

# Some Simulated Events in the Detector



# MY AREA OF INTEREST: RECONSTRUCTION OF NEUTRINO ENERGY AND ANGLE.



# IMPORTANCE OF HADRON ENERGY CALIBRATION

- $E_\mu$  is reconstructed from the track radius in the detector.
- From the hit information of the Hadron Shower, the Hadron energy needs to be calibrated.
- For Hadron shower fluctuation in energy loss is much larger than the electromagnetic process.
- The hadron energy resolution is affected by ,
  - Leakage of energy.
  - Invisible energy loss mechanism.



# The Simulation Study:

## EVENT GENERATION

1. GEANT4 MC HADRON EVENTS
2. NEUTRINO EVENTS BY NUANCE.

EVENT

SIMULATION  
(GEANT4)

HIT  
INFORMATION

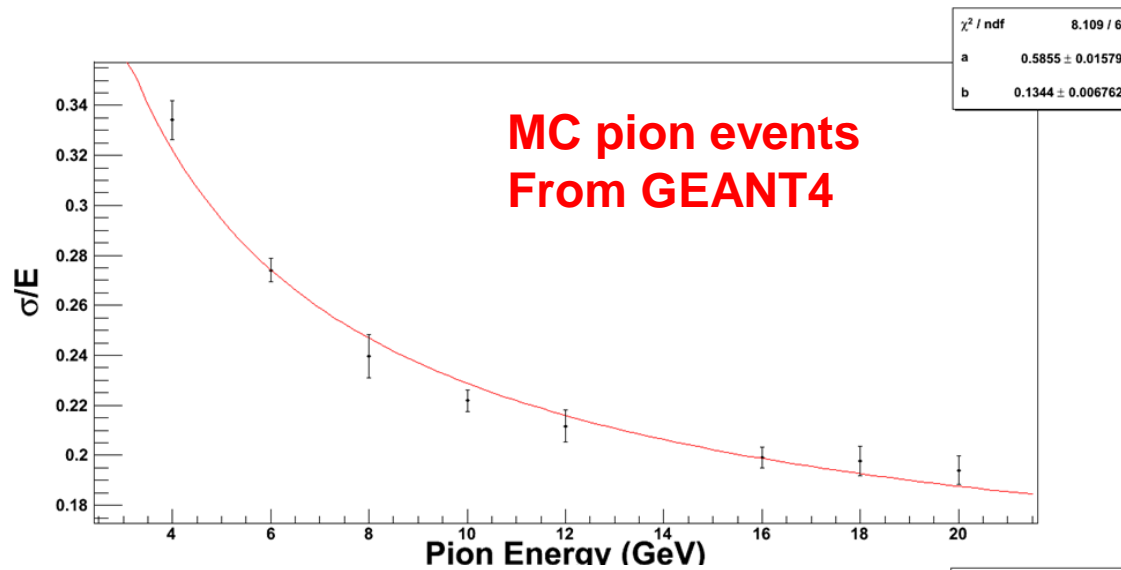
ANALYSIS

OUTPUT  
(ROOT  
TREE)

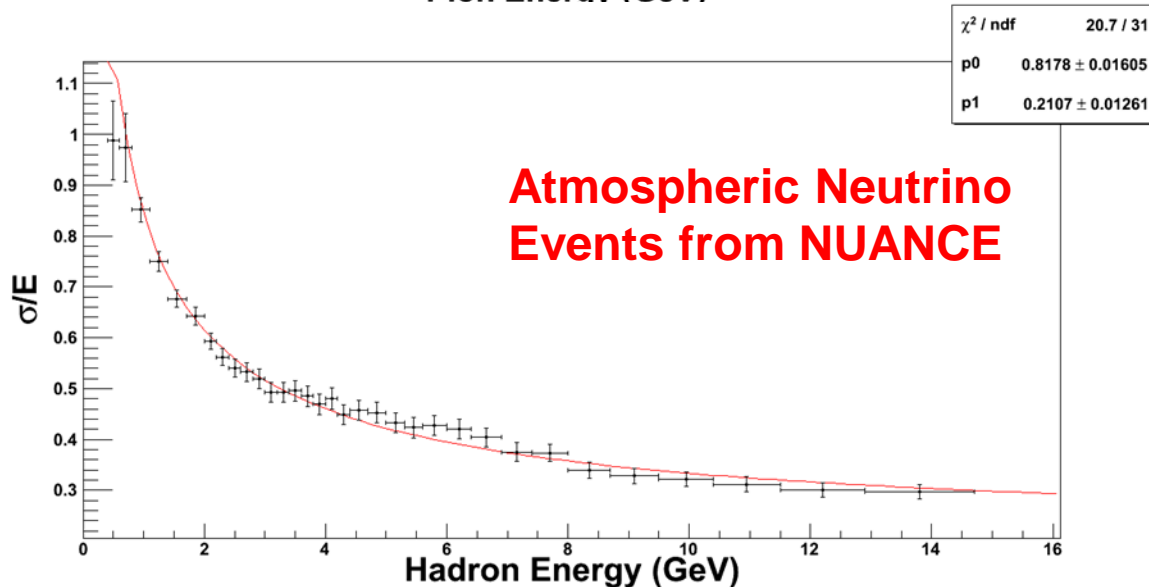
RESULT



# Preliminary Results:



**Resolution~60.4%  
(at E=1GeV)**



**Resolution~84.45%  
(at E=1GeV)**

**Thank you**