INO-ICAL prototype detector status at VECC

INO Collaboration

About the Project

The existence of non-zero neutrino masses has profound implications on fields as varied as nuclear physics, geophysics, astrophysics and cosmology apart from being of fundamental interest to particle physics. The discovery of neutrino mass and oscillation is but a first step and there are several questions that may require different experiments spanning many decades to be resolved. We still do not know the scale of neutrino mass, we only partly know the extent of mixing and not even sure if the neutrino is its own antiparticle or not. The experimental field of neutrino physics is now moving into a phase where decisive and high precision experiments are needed. It was in this context that an initiative began to take shape a few years ago leading to the idea of the India-based Neutrino Observatory (INO).

The ICAL

The detector will be placed inside a mountain at Pottipuram, Theni near Madurai in South India. A schematic of the main ICAL is shown below. This Iron Calorimeter (ICAL) detector consists of a massive electromagnet (50 kton) with Resistive Plate Chambers (RPC) as active detector elements.

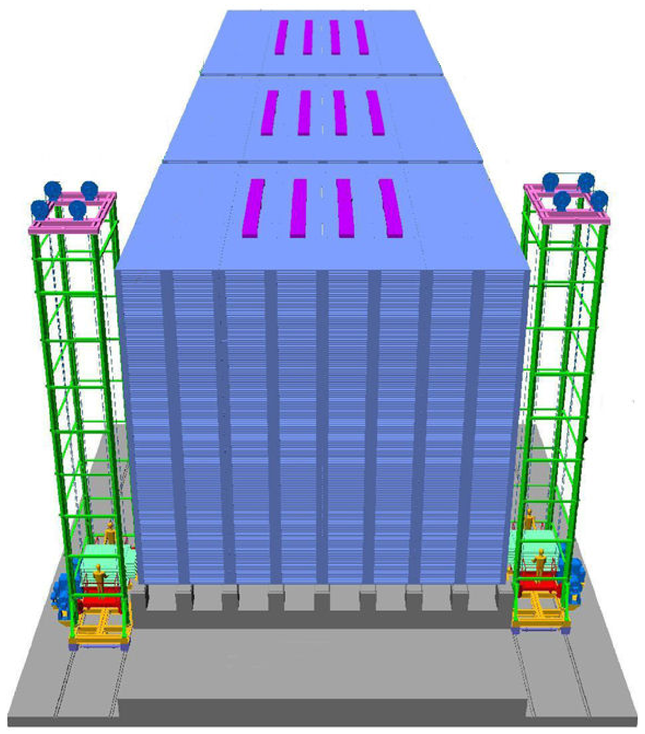

Figure: The Iron Calorimeter.

Detector Parameters

- 3 modules each of size 16m x 16m x 14.5m.
- 150 layers of RPCs interleaved by Iron plates of thickness 56mm.
- 64 (8 x8) RPCs per layer per module.
- Total of 28,800 RPCs of size 1.84m x 1.84m x 24mm, with 64 strips (30mm pitch) on either read-out planes.
- Magnetic field of 1.3 Tesla.
- Total of 3.6 million electronic channels.

Contact

Visit us at www.ino.tifr.res.in to know more about this project.

The ICAL prototype Detector in VECC

The prototype detector cosnsists of 13 layers of Iron of 5cm width with RPC as active detector elements. In the very begining of the detector R&D while TIFR started developing glass RPCs, VECC-SINP took charge for developing bakellite RPCs. In this stack 8 glass RPCs and 4 bakellite RPCs are running continuously. Glass RPCs are running in Avalanche mode and here pulse height is ∼mV and requires amplification using pre-amplifiers. Bakellite RPCs are running in streamer mode and here pulse height is ∼few hundreds mV, so no need for amplification.

Figure: Visit of Dr. Banerjee in INO lab, VECC.

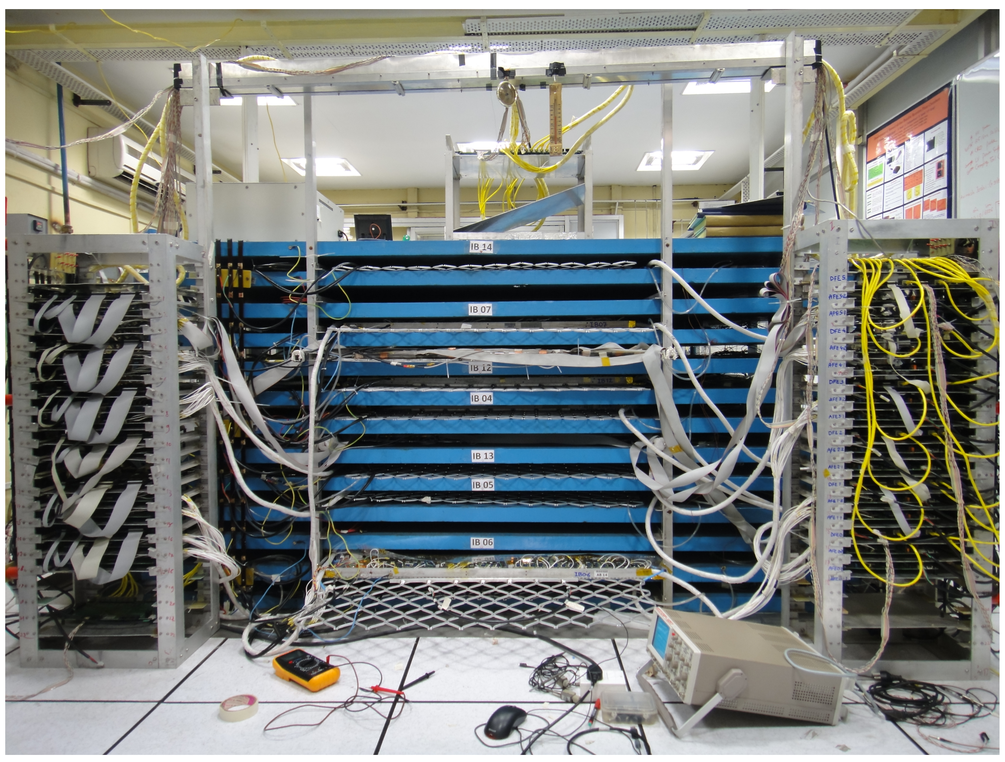

Figure: The ICAL prototype at VECC.

Prototype Detector Parameters

- module size 2.48m x 2.17m x 1.302m.
- 12 layers of RPCs interleaved by Iron plates of thickness 50mm.
- Total weight ∼50 ton (∼0.1% of main ICAL).
- Glass RPCs dimension 1m x 1m x 24mm, with 32 strips (30mm pitch) on either read-out planes. Glass thickness is 3mm and gas gap is 2mm.
- Operating HV for glass RPC:9.5kV. Current drawn in either side ∼100nA at ∼ $25^{\circ}C$ with RH ∼40%.
- Operating HV for bakellite RPC:8.0kV. Current drawn in either side ∼ 2μA at ∼ $25^{\circ}C$ with RH ∼40%.
- Magnetic field of ∼1.5 Tesla with 500AT (Ampere Turn) current.
- Total 768 electronic channels (∼0.02% of main ICAL).

B-field measurement in prototype ICAL magnet

Each Iron layer is made of 'C'and 'T'section. The magnet is excited by four coils, each having 5 number of turns. The power supply has two current sources and it is operated in master-slave mode. Using a digital flux meter, magnetic flux density is measured in each layer. The 20MM and 200MM (Mega-Maxwell) Maxwell turn ranges in the flux meter are used for measuring flux density. The average flux (flux measured with +ve and -ve polarity of current) is divided by the cross sectional area of the plate to get the magnetic flux density for that layer. A measurement is shown in the following Fig.

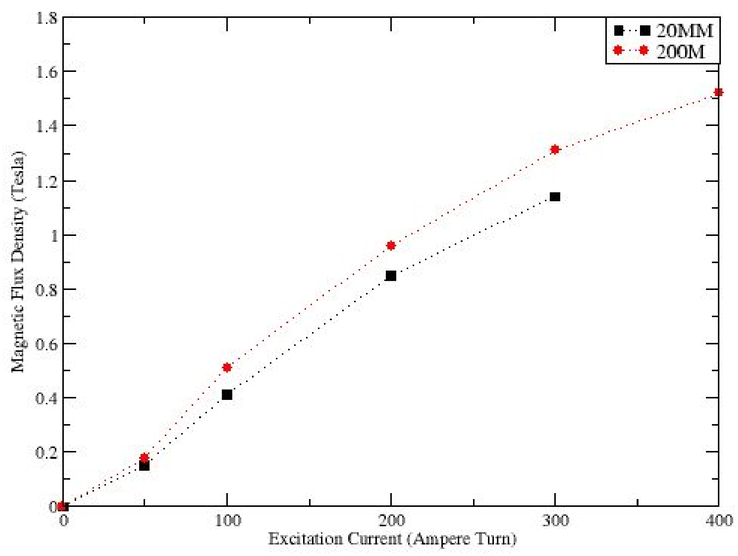

Figure: Magnetic flux density profile.

Glimpses of bending Muon tracks

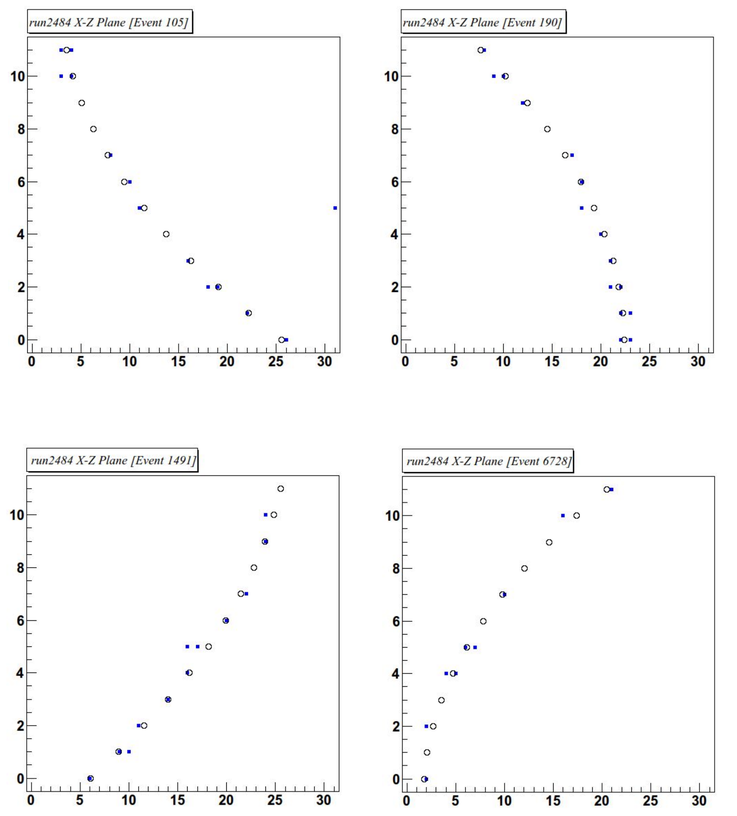

Figure: Offline snapshots of bending tracks; blue squares are real hits and hollow circles are fit points.

Offline Analysis

The detector is running satisfactorily with full magnetic field. Data is being recorded with different trigger conditions. Offline analysis is going on to understand this bending which will take us to the real physics.