INDIA-BASED NEUTRINO OBSERVATORY

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).

Modules	3
Module Dimension	16m x 16m x 14.5m
Layers	150
Iron Plate Thickness	56mm
Magnetic Field	1.3 Tesla

RPC Dimensions	1.84m x 1.84m x 24 mm
Read-out strips/RPC/plane	64 (30 mm pitch)
RPCs/Layer/Module	64 (8 x 8)
Total number of RPCs	28,800
Total Electronic Channels	3.6 Million

Considering the physics possibilities and given the past experience of Indian scientists at the Kolar Gold Mines, it was decided to start with a modern Iron Calorimeter (ICAL) detector with Resistive Plate Chambers (RPC) as active detector elements. The detector will be placed inside a mountain near Madurai in South India. The geographical location is particularly interesting, as all the existing neutrino detectors are at latitudes larger than 35° N or S. There is none close to the equator as yet. There is world-wide interest in this type of detector and a quick implementation of such a project can achieve many physics goals such as:

i) Unambiguous and more precise determination of oscillation parameters using atmospheric neutrinos.

ii) Study of matter effects through electric charge identification, that may lead to determination of sign of Δm^2_{23}.

iii) Study of CP violation in the leptonic sector and possible CPT violation studies.

iv) Study of very-high energy neutrinos and multi-muon events.

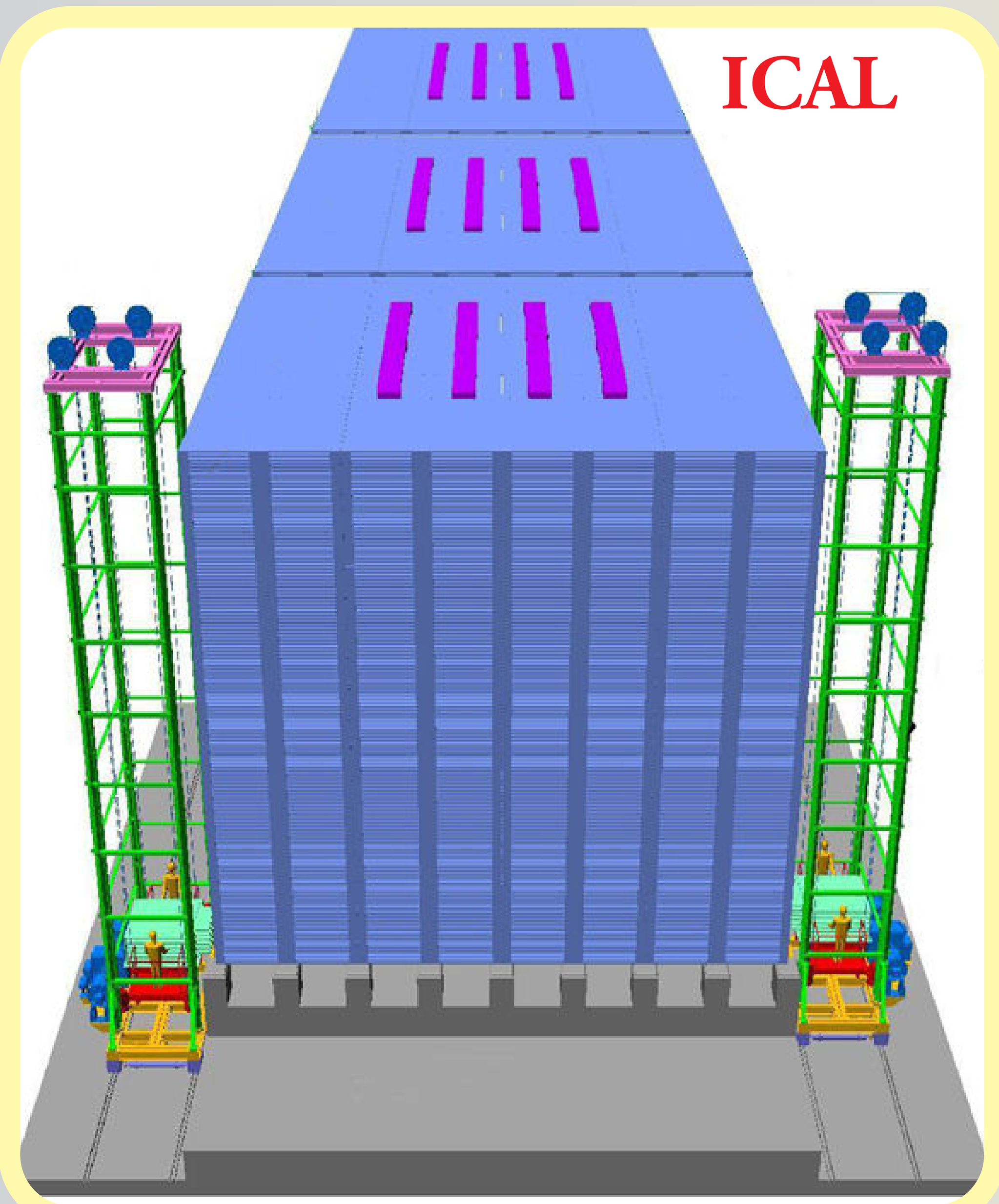
Future Goals

i) Precision determination of the oscillation parameter when ICAL will be used as a far-end detector for a long b ase-line neutrino experiment.

ii) Neutrino-less double beta decay study to determine if neutrinos are Dirac or or Majarona particles.

iii) Solar, supernova and geo-neutrino studies.

iv) Tomography of the Earth using natural and laboratory neutrino sources.



Choice of the Detector

The following factors have been considered while finalizing the choice of the detector type and technology:

i) A large target mass to achieve a statistically significant number of neutrino interactions in a reasonable time-frame.

ii) Good energy and angular resolution so that L/E can be measured with an accuracy better than half of the modulation period.

iii) Identification of the electric charge of muons so as to distinguish between neutrino and anti-neutrino interactions.

iv) modularity and possibility of phasing and

v) compactness and ease of construction.

Current Status and Developments

Site construction and related jobs are expected to start soon this year. Meanwhile, various R&D activities have already begun.

The collaboration at the Tata Institute of Fundamental Research in Mumbai, India has built a prototype detector consisting of 12 layers of 1m x 1m RPCs. This stack is currently used as a cosmic muon telescope. The health of the RPCs and their efficiencies are being continuously monitored.

Recently the collaboration has started developing 2m x 2m glass RPCs, the size that will be used in the final detector.

The group at Variable Energy Cyclotron Centre in Kolkata , India is involved in the development of Bakelite RPCs.

Apart from this, other centers in India work on various aspects of the detector like the Magnet, Electronics and Gas Systems etc.