India-based Neutrino Observatory: A Mega Science Project

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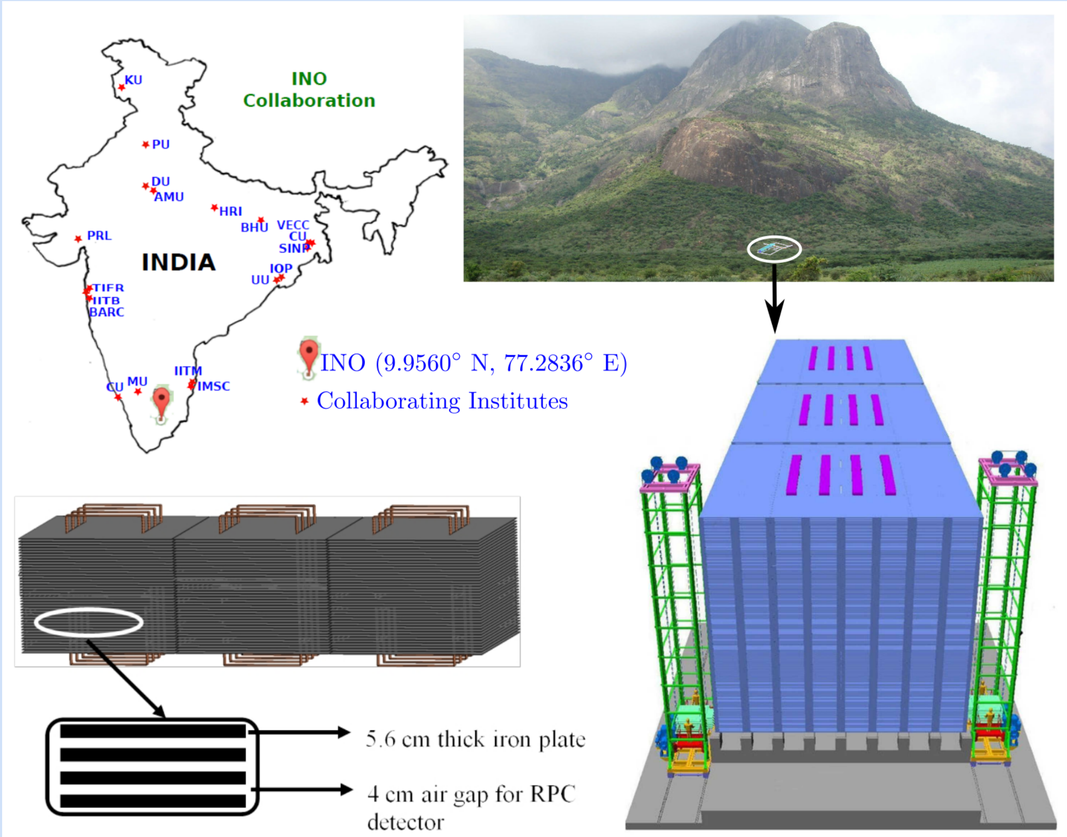
http://www.ino.tifr.res.in

Introduction

- The India-based Neutrino Observatory (INO) Project [1] is a multi-institutional effort.
- INO aims to construct an underground laboratory and associated surface facilities at Pottipuram in Bodi West hills of Theni District of Tamilnadu with a rock cover of approx. 1200 m.
- This rock coverage will absorb cosmic charged particles, therefore more than one low background experiment are proposed to be housed in this laboratory.
- One of the main experiments under INO project is Iron Calorimeter (ICAL) detector.
- IOP, Bhubaneswar is actively involved in this project.



Components of the ICAL Detector

- The ICAL detector of size 48 m × 16 m × 14.5 m, consists of 50000 tons of magnetized iron plates arranged in stacks with a strength of 1.5 Tesla.
- This magnet will be the world's largest magnet.
- Around 30000 Resistive Plate Chambers (RPCs) of size 2 m × 2 m will be inserted as an active detector in the gap between the iron layers.
- The Data Acquisition System (DAQ) includes advanced electronics.

What is RPC?

- Resistive plate chamber is a gaseous detector. The gas is confined between the two parallel resistive glass plates.
- Whenever a charged particle passes through the gaseous medium, the signal is generated which is induced on the pickup strip.
- The signal is given as input to the electronic circuit where it is processed further.
- The signals from electronic circuits are used to reconstruct the track of charged particles.

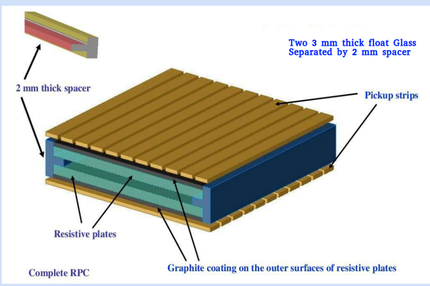


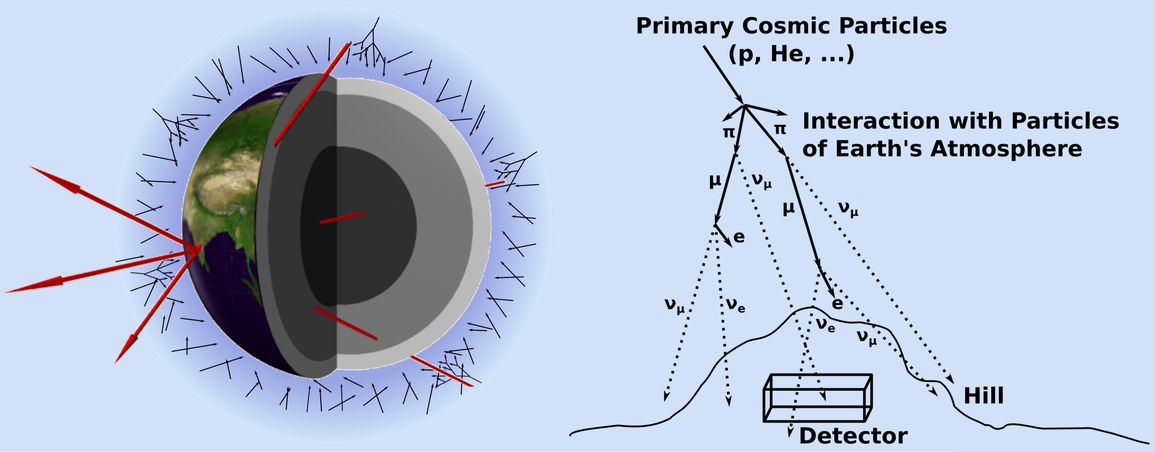
Figure 2: *Schematic layout of RPC*

Aim of the ICAL Detector

- The ICAL detector will observe atmospheric neutrinos coming from all the directions.
- The magnetic field of the ICAL detector enables it to identify neutrino and anti-neutrino separately which have different behavior during the propagation in the matter of the Earth.
- The main goal of the ICAL detector is to find which neutrino is heaviest, resolve the mass ordering of neutrino.
- One can search for dark matter, non-standard interactions and monopoles in the ICAL detector.

Atmospheric Neutrinos

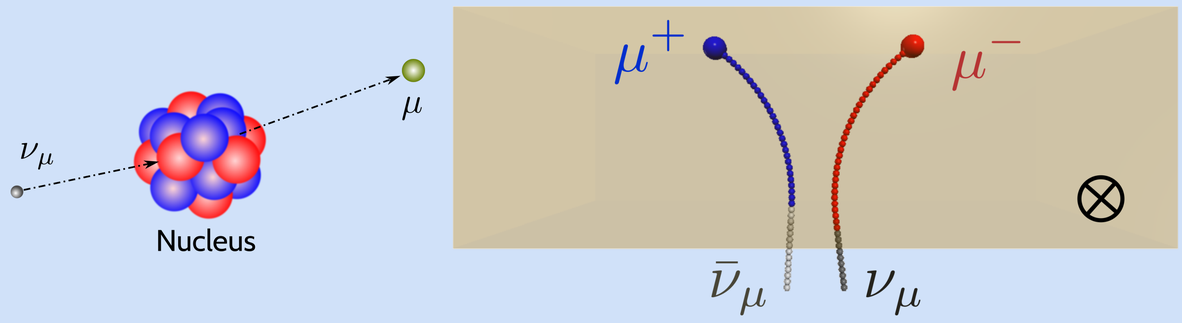
The atmospheric neutrinos are produced when the cosmic ray particles interact with the nuclei of the atmosphere.



[1] INO-ICAL Physics White Paper: https://arxiv.org/pdf/1505.07380.pdf
[2] https://www.tifr.res.in/ tin.tin/
[3] http://www.saha.ac.in/web/about-dino

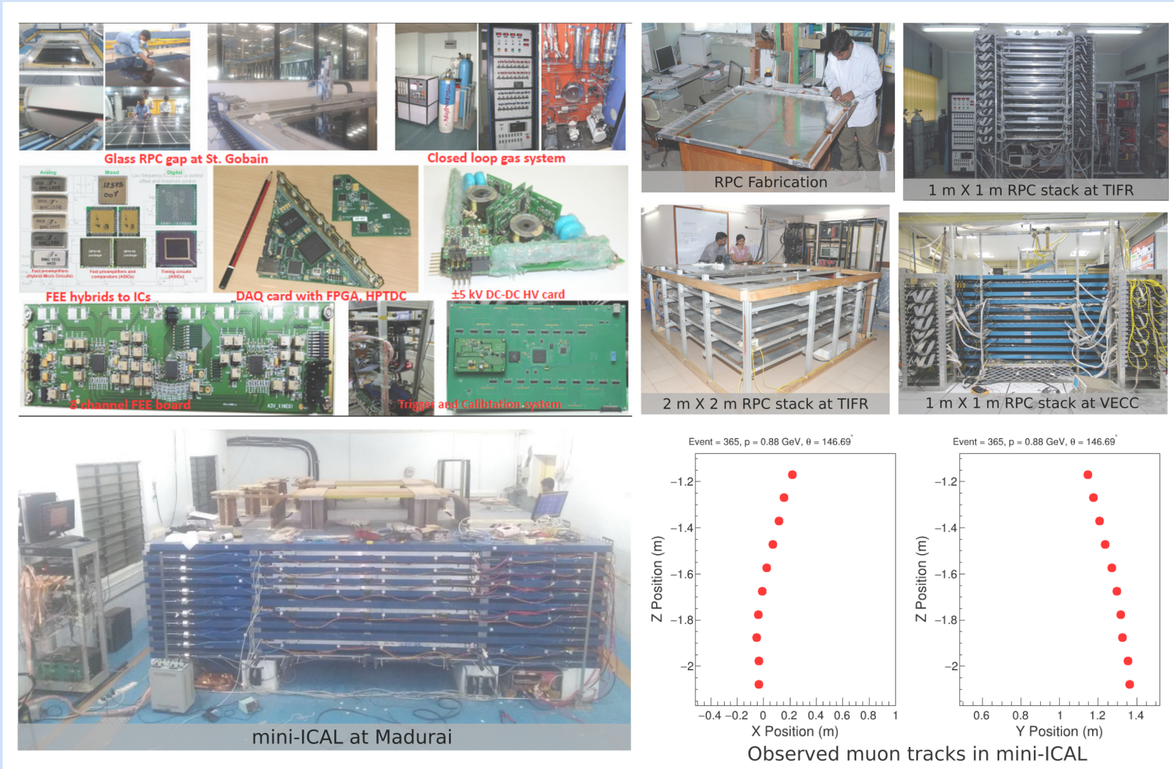
How ICAL will Detect Neutrinos?

- Neutrinos cannot be seen directly because they are neutral particles.
- Neutrinos interact with iron nuclei and produce charged particles like muons and hadrons.
- RPC will detect these charged particles and tracks will be reconstructed.
- The neutrino produces negatively charged particle (μ^-) and antineutrino produces positively charged particle (μ^+). The positively and negatively charged particles bend in the opposite direction under the influence of the magnetic field.



The Research and Development

- Indigenous development of RPC and technology transfer to industry.
- A fast and efficient electronics has been developed.
- A closed-loop gas system for RPC is developed.
- The prototype of a magnetized iron calorimeter called mini-ICAL is currently working at IICHEP, Madurai.



Other Proposed Experiments under INO

- **The INdia-based TIN Detector (TIN.TIN [2])**: Search for Neutrinoless Double Beta Decay.
- **Dark-matter at INO (DINO [3])**: Search for weakly interacting massive particles (WIMP) as candidates for Dark Matter.

Research Activities

- At present, nearly 26 institutions and about 100 scientists from all over INDIA are actively involved in the INO collaboration
- More than 30 students have already completed their Ph.D. and around 15 students are pursuing their Ph.D. under Graduate Training Program.

How can you Participate?

- You can visit INO labs at collaborating institutes such as TIFR Mumbai, IICHEP Madurai, SINP Kolkata, and VECC Kolkata, etc.
- You can do a short term project at INO labs.
- If you want to know more about INO, please visit us at http://www.ino.tifr.res.in
- You can follow IOPB Neutrino Group at https://www.facebook.com/iopbneutrino/ and https://twitter.com/iopbneutrino
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