

Testing and integration of front end electronics for INO-ICAL RPCs

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The India based Neutrino Observatory (INO) is an multi institutional facility that involves the construction of a underground laboratory for the basic research in neutrino physics. The magnetized Iron calorimeter detector is the primary experiment in this facility and is going to shed light on many important issues related to the atmospheric neutrinos. The ICAL geometry is going to utilize about 29000 single gap Resistive Plate Chambers (RPCs) as triggering and tracking elements. The ICAL RPC will have two dimensional readout and comprising of 64 readout channels in each plane. The complete readout of the ICAL detector requires the implementation of millions of electronic readout channels. In order to cope up with enormous number of electronics channels, a multichannel based front end ASIC namely HARDROC has been tested and commissioned. The study incorporates the various calibration tests concerning the different parameters of HARDROC. Finally the first ever performance results of single gap glass based RPC using HARDROC as front end electronics are presented.

INO experiment

- □ The India-based Neutrino Observatory (INO) is a particle physics project aimed at building a world-class underground laboratory.
- □ The INO experiment will host multiple experiments and one such experiment will be Iron CALorimeter (ICAL)

ICAL detector

The main detector proposed to be built at the INO is the magnetised Iron CALorimeter (ICAL) with a mass of 50 kt.

□ Iron plates act as target and Resistive ^{Width of RPC readout}

Constitution of ICA1 module	
Specification	n of ICAL module
Number of Modules	3
Dimension of single module	16m X 16m X 14.5m
Dimension of complete detector	48m X 16m X 14.5m
Number of layers	151
Thickness of iron plate	5.6cm
Gap for RPC layers	4.0cm
Magnetic field	1.5 Tesla
Specification of RPC	
Dimension of RPC unit	2m X 2m
Width of RPC readout strip	3cm

Motivation for the study

The INO ICAL experiment requires huge number of RPCs for its operation.

□In order to read signals, millions of

dedicated to study atmospheric neutrinos.





Figure: The INO laboratory and its geometry.

HARDROC

- □ The HARDROC is a semi-digital front end ASIC developed primarily for the readout of the RPC detectors.
- The ASIC has 64 channels and each channel consists of a pre-amplifier, four shapers - one slow and three fast, three discriminators, a latch and a readout circuit.
- □ The preamplifier gain is adjustable in the range between 0 to 2 to an accuracy of 1 %.
- □ The discriminators are provided with a variable charge sensitive threshold (100 fC- 10 pC).

□ The features like compactness, low-noise high-dynamicrange amplification and pulse shaping, high-rate radiation tolerant data transmission and low power consumption, etc. makes it favourable in many HEP experiments. plate chambers act as active detector Total number of RPC unit ~ 29000 Number of readout electronic channels 10⁶ elements.



Figure: The ICAL detector and its geometry.

electronic channels needed to be instrumented.

 To cope up with enormous number of electronic channels, a semi-digital front end readout namely HARDROC has been tested and commissioned.

HARDROC testing and performance

Various tests on bench like charge testing, DAC characterization and gain calibartion have been performed to understand the various setting and readout mode of the ASIC.





Figure:Experiemental set up and test results.

Efficiency of RPC using HARDROC

The glass RPCs operated in avalanche mode are tested for their performance under R134a (95.0%), C4H10 (5.0%), SF6 (0.0%).
The analog RPC pulse and trigger pulse were fed into the input channels of the HARDROC.



The study shows that the response of each FSB corresponding to the injected charge is linear for the specified charge range.
The dispersion of the channels response after gain correction is lowered significantly.
A cross-talk of 3% is observed amongst the HARDROC channels.
Efficiency more than 90% is

Results

Efficiency more than 90% is obtained using HARDROC.



Frontier Detectors for Frontier Physics 14th Pisa Meeting on Advanced Detectors. La Biodola, Isola d'Elba (Italy). May 27 – June 2 2018.

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