Characterization of the RPC (~2m×2m) Detector for INO-ICAL

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(FOR INO COLLABORATION)

1. Introduction

India based Neutrino Observatory (INO) has plans to build an exceptionally large magnetized iron calorimeter (ICAL) of around 50K tonnes under the mountain. The main physics motive of ICAL is to study the atmospheric neutrinos and its oscillation parameters. The Resistive Plate Chamber (RPC) detector of glass electrodes is an active element of the ICAL. The complete dimension of the ICAL is 48m (L)×16m (W)× 14.5m (H), consists of three modules, each having area of 16m×16m and will consist of 151 horizontal layers of 5.6cm thick magnetized iron plates and 4cm gap for housing of active detector [1].

The RPC detector (~30,000) is a parallel plate gaseous detector having good spatial and time resolution commensurable with the other homogeneous detectors. The active RPC detector is composed of a pair of 3mm thick glass plates of 2m ×2m area, separated by 2mm spacers [2]. The RPC detector assembly will be in between the 4mm gap of the soft iron plates. The present article is based on the work done at the IICHEP Madurai, which involves the characterization of 2m×2m size RPC detectors made up of the Saint Gobain glass and gas gaps by the Saint Gobain Company, Chennai (India).

2. Surface resistivity measurement of RPC Detector

The surface resistivity measurement of graphite coated glass electrodes carried out with the help of multimeter and jig, which is made of copper bars, as shown in the Figure 1 inset. The glass plates were imaginarily divided into 8 measuring points equally spread across the surface. The surface resistivity measurements were carried out in the both the directions - horizontally and vertically. The measured surface resistivity values are plotted in Figure 2.

Figure 1: Surface resistivity measurement of graphite coated RPC detector's electrodes and inset picture is of the Copper Jig.

From the Figure 2, it can be observed that the variation in the surface resistivity values represent the variations in the thickness of the graphite coating. As we know that, the value of the surface resistivity has inverse relation with the thickness of the coated layer.

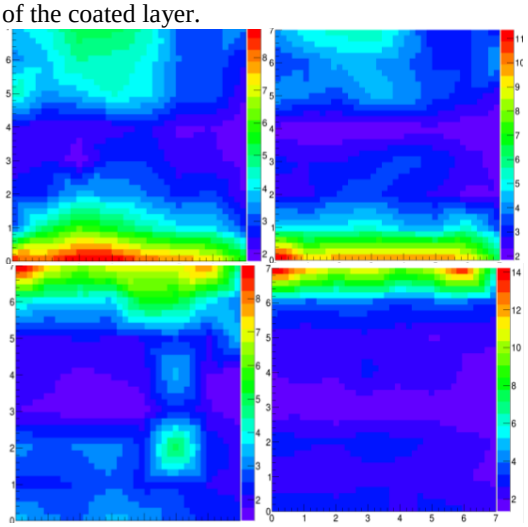

Figure 2: Horizontally and vertically measured surface resistivity for both the electrodes (top and bottom glass) of the RPC detector.

3. High Voltage (HV) Test

The high voltage test is performed for the RPC detectors. At a time, two detectors were placed side-by-side on the trolley as shown in Figure 3. The two RPC detectors gas inlet and outlet were connected in series i.e. the inlet of the first RPC detector is connected with the Freon gas, the outlet of the second RPC detector is connected with the bubbler that indicates the flow of gas. The high voltage cables soldered with copper tape, and connected to the corners of RPC electrodes, after that copper tape is properly insulated to avoid the short circuit.

Figure 3: High Voltage Test stand for the RPC detector at IICHEP, Madurai.

The RPC glass electrodes are coated with graphite paint so the high voltage is distributed across the plates. Before applying the high voltage to the RPC electrodes, the RPC gas gap is flushed with Freon gas continually for a minimum of 10 to 12 hours to remove moisture. Two types of HV test are performed for the RPC detector. First, one is RPC detector electrode current–voltage characteristics, as shown in Figure 4. As expected, the current value should be of the order of few tens of nA up to few KV applied voltage. From Figure 4, one can see that the I-V characteristic curves are similar for four electrodes and current change rate with respect to the applied voltage is very slow up to the breakdown voltage i.e. 4KV. The second test is for the long-term stability. For the test we kept, the applied high voltage value fixed i.e. 5KV for long duration and measured the current value after every 12 hrs. Through this test, we can study the stability of the current value during fixed time interval.

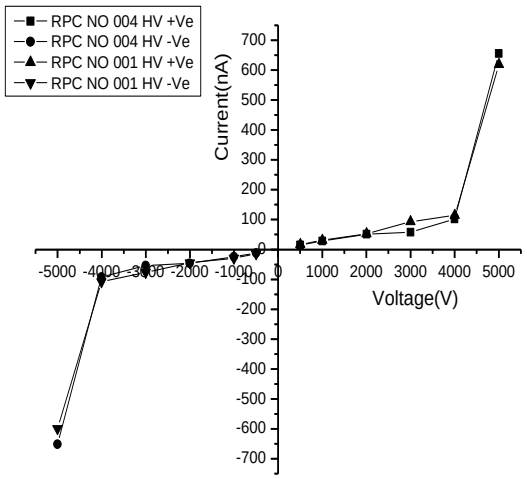

Figure 4: High Voltage Test result in terms of I - V characteristic curves for four of the tested electrodes.

Conclusion

RPC detector is an active element in the INO-ICAL experiment. In this article, successful characteristic studies of large area (~2m x 2m) RPC detectors have been demonstrated. Performance study of the RPC detector's surface resistivity measurement and HV test shows satisfactory results. Tested RPC detectors have been placed into the prototype stack at IICHEP, Madurai for efficiency and long-term stability tests.

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