

## Efficiency study of RPC detector in drastic environment

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### Introduction

India-based Neutrino Observatory (INO) is an approved mega science project, which will provide suitable underground facility to various experiments such as INO-ICAL, DINO, Tin-Tin etc. INO-ICAL (Iron Calorimeter) is a 50-ton iron based tracking detector that will initiate study the oscillation of the atmospheric neutrinos and set sensitive limit on neutrino mass hierarchy, WIMP search etc. ICAL will consist of RPC as an active detector along with 5.6 cm thick soft iron layer. ICAL will use more than 30,000 Resistive Plate Chamber (RPC) detectors at a time of full operation. The final dimension of the RPC detector is  $2\text{m} \times 2\text{m} \times 0.02\text{m}$ . The above dimension and the number of RPC detectors involved will be the biggest and largest in the world.

In this article, we performed the experiment to study the efficiency of the glass electrodes base RPC detector under any drastic circumstances such as failure of electric power, huge jump in the relative humidity etc. Such kind of scenario may be possible during the operation of INO-ICAL. We performed this study along with the use of Silicon Fiber Sheet based pickup panel. We are aware that relative humidity changes when temperatures change. Because warm air can hold more water vapor than cool air, therefore, relative humidity falls when the temperature rises, if no moisture is added to the air. The dew point is the temperature at which a given sample of air will have a relative humidity of 100%; hence, the saturation temperature. Some study, in a limited range of temperature and humidity has been done for the performance of the RPC detector [1].

### Creation of a controlled environment for the measurement of efficiency

To create suitable controlled environment according to the objective of the study, we made

a box of dimension  $1\text{m} \times 1\text{m} \times 1\text{m}$  using acrylic sheet of thickness 4mm having reflective coating on the inner surface of the box as shown in Fig. 1. This box is equipped with temperature and humidity sensors and microcontrollers. A temperature and humidity sensor DHT11 coupled with Arduino (microcontroller) is placed inside the box, which is interfacing using computer. Arduino sensor records the temperature inside the box after every 1 second. The ambient parameters were controlled within a unit. For the efficiency measurement complete set up are placed inside the covered box. A halogen bulb of 500 W powers is connected with AC rehosted in series to control the temperature. With this setup a temperature range from 25 (room) to  $42^{\circ}\text{C}$  is achieved. Temperature and humidity values are taken in the integral form. Another component “two input channel relay module” is used to control the temperature of the box. Halogen bulb switches OFF/ON was controlled with the help of coding a fix desire temperature that can be maintained.



Fig. 1: Box Photograph of controlled environment box of acrylic sheet.

### Efficiency of RPC detector with different surrounding temperature and relative humidity

For the measurement of efficiency, one RPC detector and two pad type plastic scintillation detectors are arranged in two and three fold configuration mode [2]. Three plots are taken at different temperature and corresponding relative humidity (RH) with variation of applied voltage. The constant temperatures are maintained in the controlled environment box (CEB) using window air conditioner at 20°C and RH 40%. Relative humidity (RH) depends on temperature inside the CEB. The temperature is increased in a closed box using halogen bulb. Second plot are taken at 28°C and RH 35%, third plot is at 40°C and RH 32%, and efficiency is taken with respect to applied voltage from 4KV to 9KV. Temperature of the CEB is increased up to 42°C as beyond this limit black plastic protection of scintillation detector starts shrinking. From Figure 2 shows, that the efficiency reaches a plateau that is higher at higher temperature. It also shows that there is a drop in efficiency of RPC detector at high temperature.

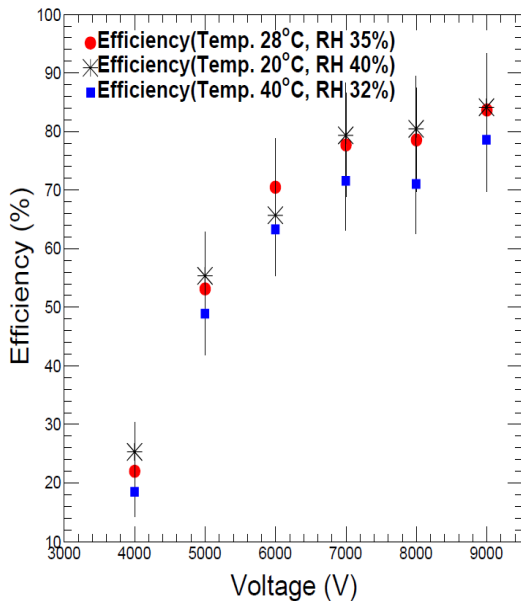


Fig. 2: Plot shows the variation of efficiency with respect to the applied voltage.

### RPC detector’s efficiency with respect to temperature

We observed that the efficiency of RPC detector using 100% Freon gas along with Silicon Fiber Sheet and Plastic based pickup panels are ~80% and ~75%, respectively at 20°C and at 9kV. Fig. 3 shows that the efficiency for both type of pickup panel is almost same within statistical error and both show temperature independent behavior. It also shows that the performance of both type of panels are almost similar within statistical error.

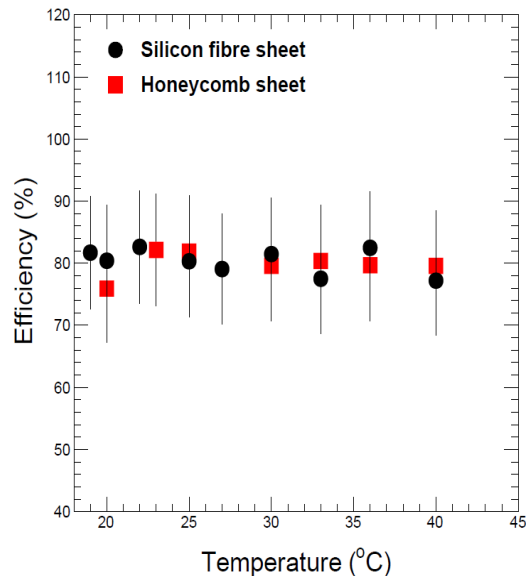


Fig. 3: Plot shows the variation of efficiency at different temperature and at 9kV applied voltage.

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### References

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- [2] M. K. Singh et al., DAE Nucl. Phys. Proc. **59**, 976 (2014).