

Development and characterization of glass multi-gap RPC for INO experiment

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The multi-gap resistive plate chamber (MRPC) detectors are gas ionisation detectors with multiple gas sub-gaps, made of highly resistive electrodes. The high voltages (HV) are applied to the outermost resistive plates only, and the interior plates are electrically floating. Avalanche by a charged particle in any of the sub-gaps induce fast signals on these electrodes and the resultant signal is a summation from all the gas gaps. Copper pickup strips placed outside the cathode and anode collect the signal, with a reduced time jitter, through induction.

The resistive plate chamber (RPC) detectors (with a single gas gap) have been chosen as the active detector elements for the magnetized iron calorimeter (ICAL) detector at INO, due to their excellent efficiency, position (mm) & timing (ns) characteristics and suitability for large detector coverage. The MRPC detectors, due to their superior timing resolutions in addition to the above properties, are being tested to find potential application in INO experiment as well as medical and societal spin-offs.

The fabrication and preliminary characterization including efficiency, counting rate, leakage current and time resolution of MRPC detectors (dimension 27 cm \times 27 cm \times 0.75 cm) have been done. Glasses of 2 mm thickness coated with a conductive layer, with the surface resistances being in the range (0.5-1) M Ω /□, are used as the external electrodes. The interior electrodes are of thickness 0.410 mm. Two sided non conducting adhesive tapes are used to make small circular spacers of diameter 4 mm and width 0.250 mm. The pickup panel consists of honeycomb panels with copper strips of width 3 cm. The gas gaps are sealed by glueing side spacers between the outermost electrodes. The MRPCs are being tested in avalanche mode with a gas mixture of R134a (95.2%), C₄H₁₀ (4.5%), SF₆ (0.3%) with a flow rate of 5 SCCM. Three scintillator paddles of width 2 cm in coincidence mode has been used for the trigger. The signals from the pick up strips are amplified with the NINO ASIC and then taken with coincidence with the trigger. NINO is an ultra fast preamplifier-discriminator chip suitable for the fast signals from an MRPC, initially designed for MRPCs used in the ALICE TOF experiment. Each channel in an NINO chip takes the differential signal from the pick up strips as input, and amplifies them in a four stage cascade amplifier. The maximum leakage current is found to be \sim 250 nA. The efficiency increases with HV and at 16 KV the MRPCs obtained 90% efficiency. The counting rate at the same HV is \sim 36.13 Hz/cm². The relative time resolutions of the MRPCs are found to be in the range 270 - 500 ps. The study on the detector performance with varying HV and at different concentrations of the gas mixture components will be presented in detail.