Development of a Cosmic Rack for characterization of RPCs

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A newly designed cosmic rack has been commissioned this year in the RPC Lab., in NPD-BARC (Fig. 1). The rack consists of nine shelves each providing a clear area of 160 cm x 225 cm. Each of the shelf is separated by a distance of 30 cm, providing sufficient distance for fast electronics to respond and also providing an easy access for loading and removing the RPCs. The total height of the cosmic rack is 2.8 metres. A typical fully integrated RPCs covers an approximate area of 2 m^2 and weighs about 60-70 kg. The rack has been basically designed, keeping in mind the varied requirements as regards to the RPCs based current and futuristic programmes which are listed below :

1. Testing of large area trapezoidal bakelite gas-gaps and RPCs for the CMS experiment, keeping in mind the production rate of five RPCs per month.
2. The proposed muon tomography programme with 1 m x 1m glass RPCs and
3. Characterization of glass RPCs (1m x 2m) for the INO experiment in near future.

The rack has nine shelves, out of which shelf # 2 and shelf # 9 are loaded with large area plastic scintillators (180 cm x 18 cm x 1cm – eight scintillators in each shelf) for providing the muon trigger from cosmics. The distance between the bottommost shelf # 1 and shelf # 2 is 60 cm and occupies the HV power supplies, NIM bins for pulse processing and the VME-DAQ. In designing the rack, care has been taken to ensure that the rack is accessible from all the four sides and that the cabling and plumbing of gas pipe remains confined within the rack footprint. The remaining 6 shelves can be used for characterizing the gas-gaps and RPCs. Each of these shelves, is provided with two ports each for "gas flow in" and "gas flow out", using 6 mm seamless SS pipes. There are 15 HV cables to operate RPCs in either avalanche or streamer mode and 32 HV cables for powering the PMTs for the hodoscope, which have been elegantly taken around the cosmic rack. Each of the wooden shelves are cladded with 1 mm aluminum sheets for providing efficient grounding. The process of characterizing the RPCs first requires the bare gas-gaps to be tested for their mechanical and electrical properties before being configured into an RPC. In order to load and unload these gas-gaps/RPCs, a special scissor lift had been designed and commissioned in RPC lab., which provides a working platform of 1.50 m x 2.25 m, with a SWL of 500 kg and can be raised or lowered, electrically, from a collapsible height of 60 cm to 300 cms above the ground with precise control. The scissor lift has a rotating platform on top, on which first the RPCs shall be assembled and then guided inside the shelves by rotating its platform, without much effort.

Fig. 1 Cosmic Rack at NPD for characterization of RPCs with the scintillator hodoscope loaded in shelf # 2 and # 9

The RPCs after full integration shall be clamped with six, 12 mm diameter, steel bearings, on the honey comb panels, on either sides, so that they glide very gently inside the shelves, as a result the honey comb panels surface of the RPCs does not get damaged/scratched while inserting and taking out the RPCs. All these handling equipments have been designed, keeping in mind the limited space available inside the lab. For the upcoming RPC upgrade project for the CMS experiment [1], the shelves shall be used to evaluate the following simultaneously :

a) Resistivity measurements of three bakelite gas-gaps with Argon gas at a flow rate of 5 lph.

b) HV scan of three bakelite gas-gaps with RPC gas mixture consisting of R134a : Iso-butane : SF_6 :: 96.2 : 3.5 : 0.3 at a flow rate of 5 lph.

c) Complete characterization of three fully integrated RPCs in terms of their efficiency, cluster size, strip profile and noise.

For the proposed muon tomography programme in the 12th plan, the schematic is shown in Fig. 2, where we intend to have three glass RPCs (1m x 1m) on top, the scatterer in the middle and remaining three glass RPCs at the bottom. The first three RPCs will track the incoming muon and the bottom three RPCs will track the scattered muon. The scattered muon will provide us the relevant θ, required for identifying the "Z" of the material. The top three RPCs will be placed in shelf # 6,7,8 and the bottom RPCs shall be placed in shelf # 3, 4 and 5. The scattering material will be placed in the shelf marked 6', equidistant from the top and bottom layers.

The present experience gained in commissioning the cosmic rack and various handling equipments developed for maneuvering the RPCs, would be useful in the context of the INO programme, where a large number of similar RPCs would need to be tested and characterized before installing them inside the INO cavern.

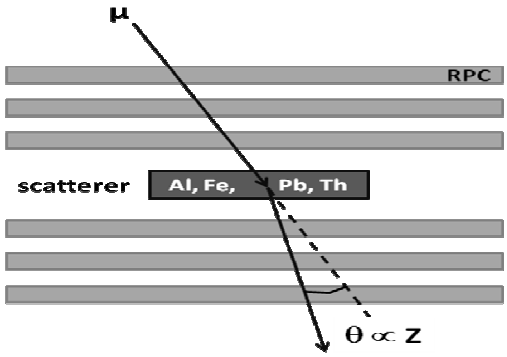

Fig. 2 Schematic of a muon scattering being detected by RPCs in the cosmic rack

References

[1] CMS Muon Technical Design Report [CERN/LHCC 97-32]