Qualification of New Companies for the Production of Resistive Plate Chambers

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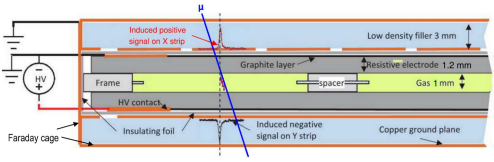
Abstract

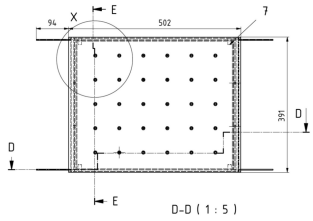
Resistive plate chambers (RPCs) with electrodes of high-pressure phenolic laminate and small gas gap widths down to 1 mm provide large area tracking at relatively low cost in combination with high rate capability and fast response with excellent time resolution of better than 500 ps. They are perfectly suited for experiments requiring sub-nanosecond time resolution and spatial resolution on the order of a few millimetres over large areas. Thin-gap RPCs will therefore be used for the upgrade of the barrel muon system of the ATLAS experiment at HL-LHC and are candidates for the instrumentation of future collider detectors and experiments searching for long-lived particles in experiments like ANUBIS. RPCs are also frequently used in large area cosmic ray detectors. The large demand for RPCs exceeds the presently available production capacities. At the same time, the requirements on mechanical precision, reliability and reproducibility for collider detectors have increased, especially with the reduced gas gap widths. Additional suppliers with industry-style quality assurance are therefore urgently needed.

Thin-gap RPCs



Electrodes: phenolic high-pressure laminate with graphite coating on the outside and linseed oil coating on the inside to prevent point discharges.
Gap: 1 mm.
Gas mixture: $C_2H_2F_4$/iso-C_4H_{10}/SF_6(94.7/5/0.3).
Operating voltage: 5.8 kV.

Preparations for the industrialized production of RPCs

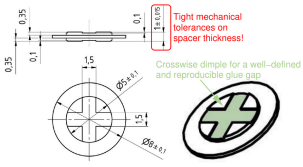


Starting point: production procedures used by ATLAS and CMS.

These procedures were refined for a production in industry and applied to a 30x50 cm² test-sample RPC guaranteeing the scalability of all methods to the final RPC dimensions of 1x2 m².

Test sample were successfully produced both at the MPI for Physics and at 4 companies in Germany.

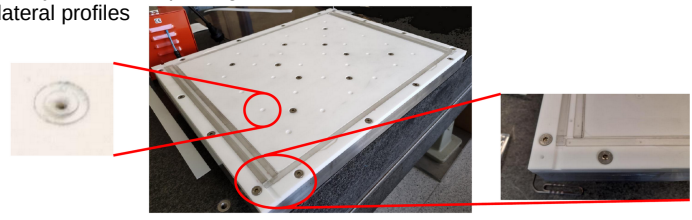
Optimization of the design and the production procedure



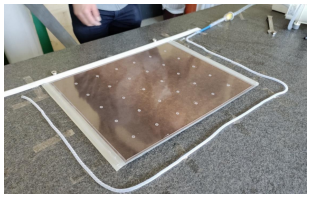
Mechanically precise polycarbonate spacers are essential to guarantee a constant size of the gas gap. To achieve the require maximum thickness deviation of ±15 µm injection moulding is used. In order to prevent additional deviations from thickness variations of the glue keeping the spacers in positions and to define a reproducible glue gap crosswise dimples were introduced to the spacer surfaces.

Production steps

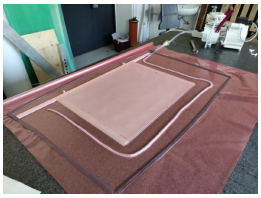
1. Graphite coating of the electrodes by silk-screen printing
2. Positioning of the spacers and lateral profiles



3. Gluing of the first electrodes onto the spacers and lateral profiles



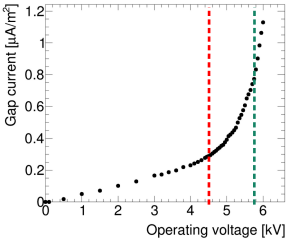
Electrode with spacers and lateral profiles after the first gluing step.



RPC gas gap under a vacuum bag after closing it with the second electrode plate

4. Adding electrical contacts and gas pipes
5. Insulation of the electrode surfaces with a PET foil and sealing with hotmelt glue.
6. Leak detection and repair of leaks with glue.
7. Linseed oil coating

Functional test



- Voltage-current curve in agreement with expectations.
- Start of the avalanche region at ~4.5 kV.
- Large gain at the nominal operating point of 5.8 kV.