

Testing Timing of Resistive Plate Chambers with Relativistic Neutrons at Experiment S406*

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Last Autumn 2012, quasi-monoenergetic neutrons were produced from a deuterium beam in experiment S406 to calibrate the neutron detector LAND and to study the performance of the NeuLAND prototype, the new neutron detector of the R³B experiment [1]. During this experiment, prototypes based on the alternative detector concept considered during the R&D phase of the NeuLAND detector, which were based on timing Resistive Plate Chambers (tRPCs) [2], were also exposed to neutron beams of various energies (from 200 MeV to 1.5 GeV). More details on experiment S406 can be found in [3]. In this report we depict the characteristics of one of the two different approaches considered for the RPC concept, which was based on distinct converter materials for the detection and characterization of relativistic neutrons. Both prototypes were placed behind the NeuLAND prototype. The configuration during the experiment can be seen in Fig. 1.

The prototype described in this work, developed and constructed by a Portuguese collaboration involving the LIP laboratory in Coimbra and the Nuclear Physics Centre of the University of Lisbon, consisted in 4 tRPC layers. The particular aspect of this concept is that the glass electrodes that make up the gas gaps within the RPC act also simultaneously as converter material to detect the relativistic neutrons. The thickness of the adopted glass plates was approximately 3 mm [4]. This detector configuration was previously simulated, obtaining very satisfactory efficiency and momentum resolution results that motivated its construction and test at GSI [4].

Each RPC layer, with an active area of about 2000 x 500 mm², is made of 2 modules containing the active gaps. Half of the layers are built from modules with 2 gaps, while the rest are built with 5 gaps, all in multigap construction [5]. Each module consists in a plastic tight case enclosing the active gaps built entirely from 2.85 mm thick float glass¹ electrodes and defined by 300 μ m nylon mono-filaments. The HV is applied to the outer glasses through a resistive surface layer applied on the glass surface with airbrush techniques. The readout of the signals is made by a pick-up electrode located in between two iden-

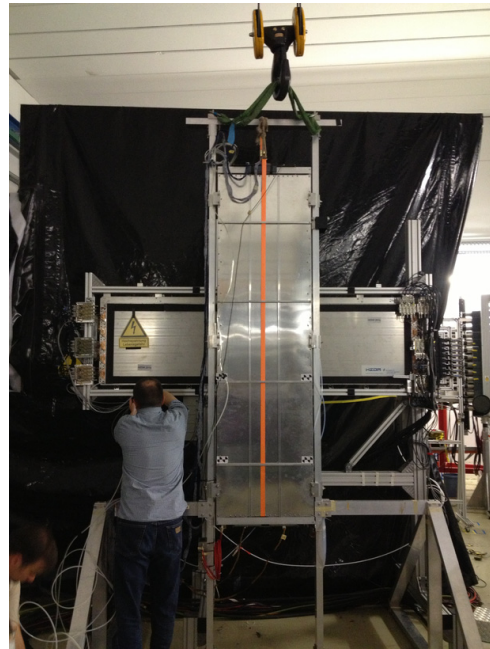


Figure 1: tRPCs mounted during experiment S406. The prototype described in this work was mounted on a vertical configuration.

tical modules equipped with 15 copper strips 30 mm wide. The prototype is operated with a non-flammable gas mixture composed of 90 % C₂H₂F₄ and 10 % SF₆ under a continuous gas flow of 120 cm³/min at a pressure slightly under atmospheric pressure to define correctly the gap width. The prototype was mounted in a vertical configuration, as it can be seen in Fig. 1.

The readout of the entire prototype comprises 120 Front End Electronics (FEE) channels [6]. These, together with the corresponding Low Voltage Power Supply (LVPS) and service boards [7, 8], were borrowed from the RPC-TOF Wall [9] of the HADES collaboration [10]. The Data Acquisition System (DAQ) consists basically in a TRB (Trigger Readout Board, [11]) while data gathering is performed by standard HADES eventbuilder software on a compact ARM based "dreamPlug" computer [12] able to write 12 kEvents/s to the disk. This all together forms a

*Work supported by the European Community FP7 Capacities, contract ENSAR no. 262010, and Portuguese FCT project PTDC/FIS/114876/2009

¹Bulk resistivity of approximately 6.10¹² Ω cm at 25°C.

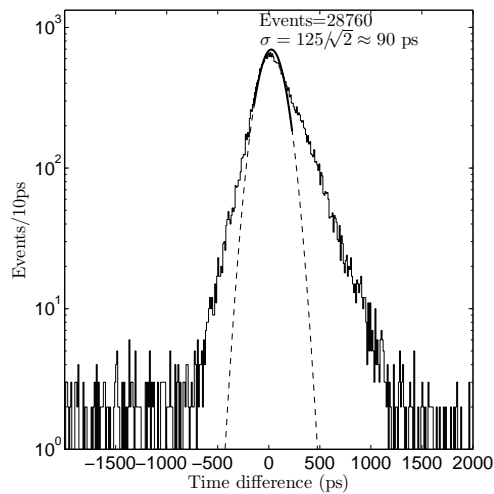


Figure 2: Time difference for two layers of the Portuguese prototype showing a time resolution for the entire chain (RPC + FEE +DAQ) of $\sigma \approx 90$ ps per layer.

very compact and portable DAQ, which is ideal for testing proposes. Additionally, the RPC DAQ has been synchronized with the MBS-based (Multi Branch System, [13]) LAND DAQ by means of a synchronization message from a VOLUM4 [14] module to the TRB. This allows an off-line synchronization of both data streams for later data analysis.

This prototype has been tested and calibrated previously with cosmic rays showing a time resolution better than 90 ps (See Fig. 2)

The second RPC prototype present at the measurements had been developed by HZDR [15].

The prototype has been exposed to relativistic neutrons during S406 experiment in order to characterize the response of tRPCs to this type of particles. The data analysis is ongoing.

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