High Counting Rate Position Sensitive Resistive Plate Counters

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It is by now unanimously accepted that a high counting rate RPC could be obtained by decreasing the gap thickness and the resistivity of the glass electrodes. Decreasing the gap thickness requires an increased number of gaps, consequently a larger amount of material while a decrease of the resitivity by increasing the glass temperature implies a series of technical incovenince for a large area subdetectors based on these type of counters. Obviously for a given number of gaps, their size and glass electrode thickness, the best alternative is to use lower resistivity glass electrodes. An other aspect which is worth to be considered for future applications of position sensitive RPCs is to replace the single ended readout structure with a differential readout. Results of preliminary tests using ^{60}Co source of a position sensitive RPC based on Pestov glass and the first differential readout prototype, ready to be tested in the near future, are presented in this report.

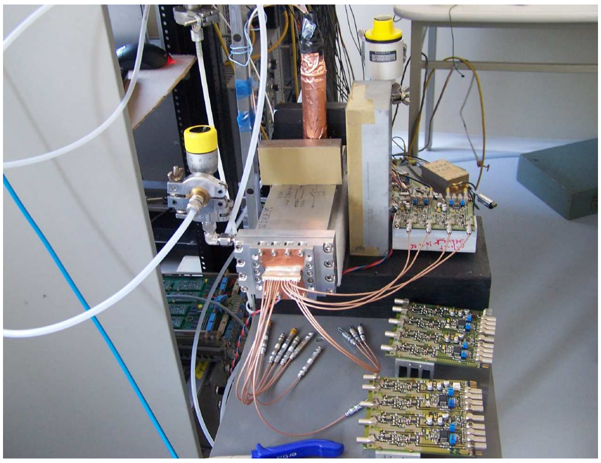

Figure 1: Experimental configuration used for radioactive source tests

A prototype of two times double-gap RPC in which the resistive electrodes are produced from Pestov glass of $\sim 10^{10}$ $\Omega\cdot$cm resitivity and the read-out of the induced fast signals done via stripe line intermediate electrode, the coresponding strips on the two sides being connected together [1], was designed and built. The gaps between these electrodes of 300 μm are realized by spacers made from fishing rod of such thickness. The read-out electrode, sandwiched by the two symmetric halfs has 16 readout strip lines on each side with a pitch of 2.54 mm and a width of 1.1 mm, the corresponding strips on the two sides being connected together.

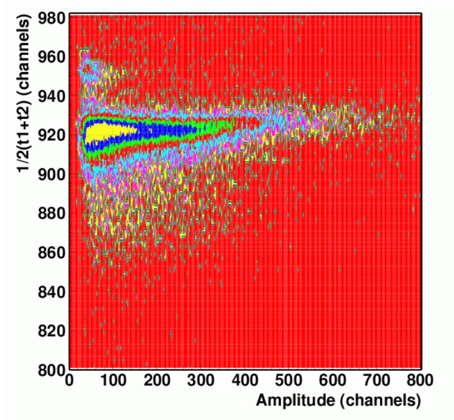

Figure 2: t_{sum}-amplitude correlation

The signals, are feed through lateral flanges of a rectangular, thin Al container. The inner structure is fixed on a special plexiglass plate which alignes the structure relative to the container. The results reported here have been obtained using a high voltage of 3.1 kV for each gap and a flow of standard gas mixture (85% $C_2F_4H_2$, 10% SF_6 and 5% C_4H_{10} (isobutane)) at normal pressure. Fig.1 shows the experimental configuration.

The signals delivered by the detector have been amplified by broad band fast amplifiers developed for similar RPCs based on comercial float glass used for FOPI TOF barrel [2]. CF4000 constant fractions have been used for timing. Time spectra have been obtained from γ - γ coincidence using ^{60}Co source, between the two ends of a middle stripe and a plastic scintillator (NE102) of cylindrical geometry (Φ = 25 mm and h=20 mm) coupled to a photomultiplier. The RPC amplitude - t_{sum} (t_{sum}=1/2(t_{left} + t_{right})) correlation is presented in Fig. 2.

A profile histogram of t_{sum} as a function of left-right time difference can be followed in Fig.3.

With a 3cm cut in the position in the region where the radioactive source was positioned, the time spectrum presented in Fig.4 is obtained.

A Gaussian fit gives σ=3 channels (one TDC8222A channel corresponds to 42 psec). Substracting quadratically the contribution of the plastic scintillator measured in separate runs using 2 identical scintillators and phototubes, a $\sigma \leq 50$ ps is obtained.

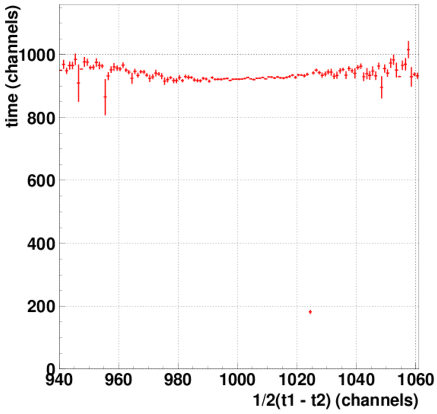

Figure 3: t_{sum} versus position along the counter

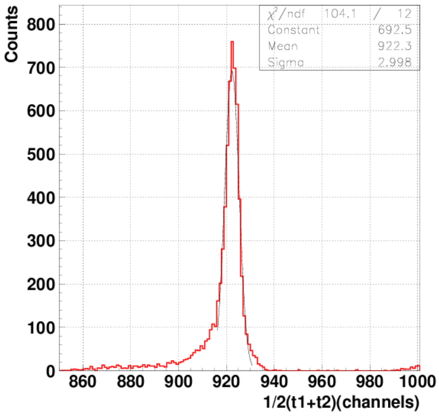

Figure 4: t_{sum} spectrum for a 3cm cut on the position in the region where the radioactive source was positioned

The results of these tests show that the counter has the requested performance in terms of time resolution. Studies of the counting rate performance will be done in the near future using MIPs at GSI Darmstadt.

A second prototype in which the cathode electrodes have identical strip line structure as the central electrode was realized and can be operated in a differential mode. A photo of the inner structure, housing box and flanges is presented in Fig.5.

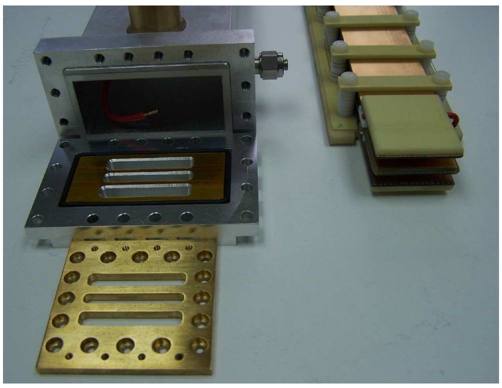

Figure 5: Inner structure, housing box and flanges of the diffrential, strip readout RPC prototype

The prototype was assembled, tasted for tightness, introduced in the gas flow and is presently ready for tests using the ^{60}Co source.

References

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