Studies on the readout strip plane

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1, Test set-up

We want to study how the output signal shape will be affected by the width of the strip and its termination condition at two ends. The test set-up is shown in Fig. 1 and 2.

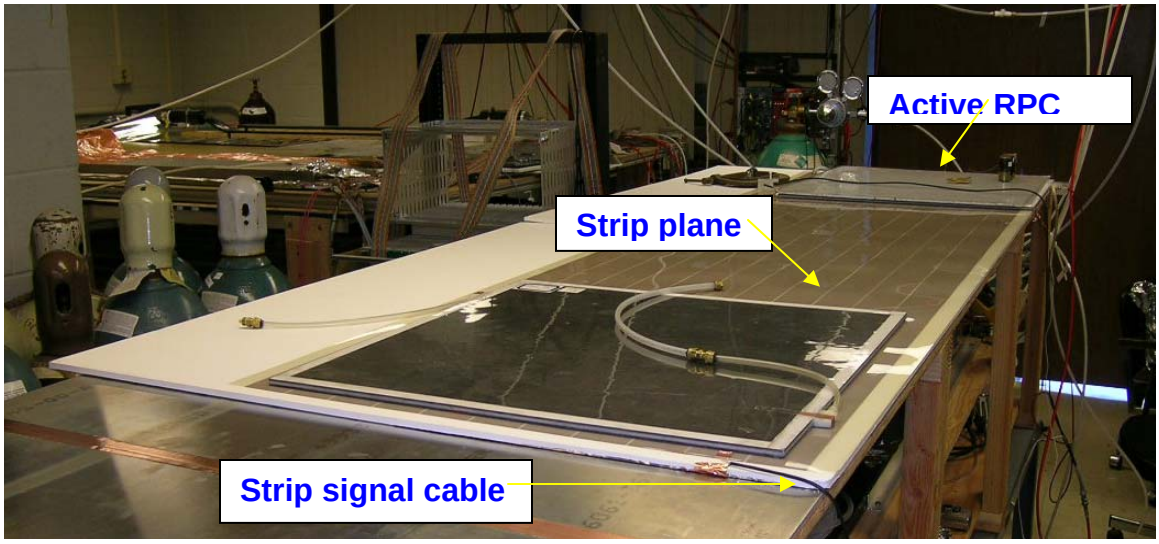

Figure 1. Photo of the test set-up.

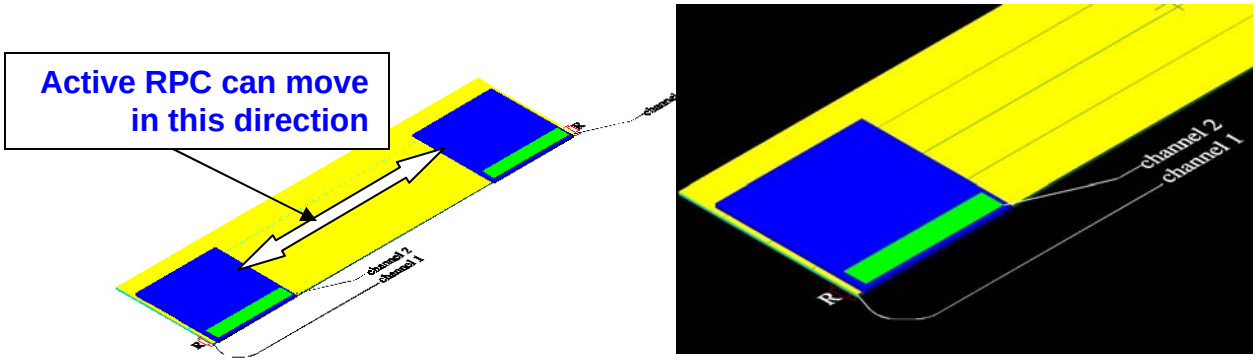

Figure 2. Illustration of the test set-up.

The width of a single strip is 5cm, we can use copper tape to bridge the neighboring strips to double or triple the width of the strip. We have tested two widths: 5cm and 15cm. The pulse shapes are shown in the next page.

We place a smaller RPC(50x50cm^2) on the top of the strip plane, use the streamer signal generated by this RPC as the signal source for the strip line. The RPC chamber can be moved along the strip line direction to see the streamer position effect on the output signal.

2, Test results

Figure 3. Pulse shape in different termination conditions, the RPC chamber is placed near the signal cable end.

In figure 3 we show the pulse shape for various termination conditions: the left column shows the terminator resistor is only provided at one end (right side in figure 2), the other end (signal cable side) has no termination resistor; the right column shows both ends of the strip line have termination resistors. The value of the terminator is displayed on each picture. The positive pulse is from cathode side of the RPC (on top), we use it as the trigger signal; the negative pulse is from 2m long strip line that is placed under the RPC chamber. We can clearly see that the pulse shape depends on the terminator's value. The characteristic impedance of the strip line is ~11Ω (15cm wide, 0.5cm foam thickness between the strip and ground plane).

To compare the strip line signal in different termination cases we have to find a way to normalize the strip signal since the amplitude from pulse to pulse varies. We use the positive signal from the cathode of the test RPC chamber to normalize. Use the maximum amplitude of the cathode signal to divide the strip line signal as the normalization. For four different termination cases we plot their normalized signals in figure 4(c) and (d) for 15cm and 5cm width strips respectively. We can see that 5cm width strip has narrower pulse and higher amplitude, also the leading edge is slightly faster, but the signal from 15cm strip is still quite decent, won't cause our readout electronics any trouble.

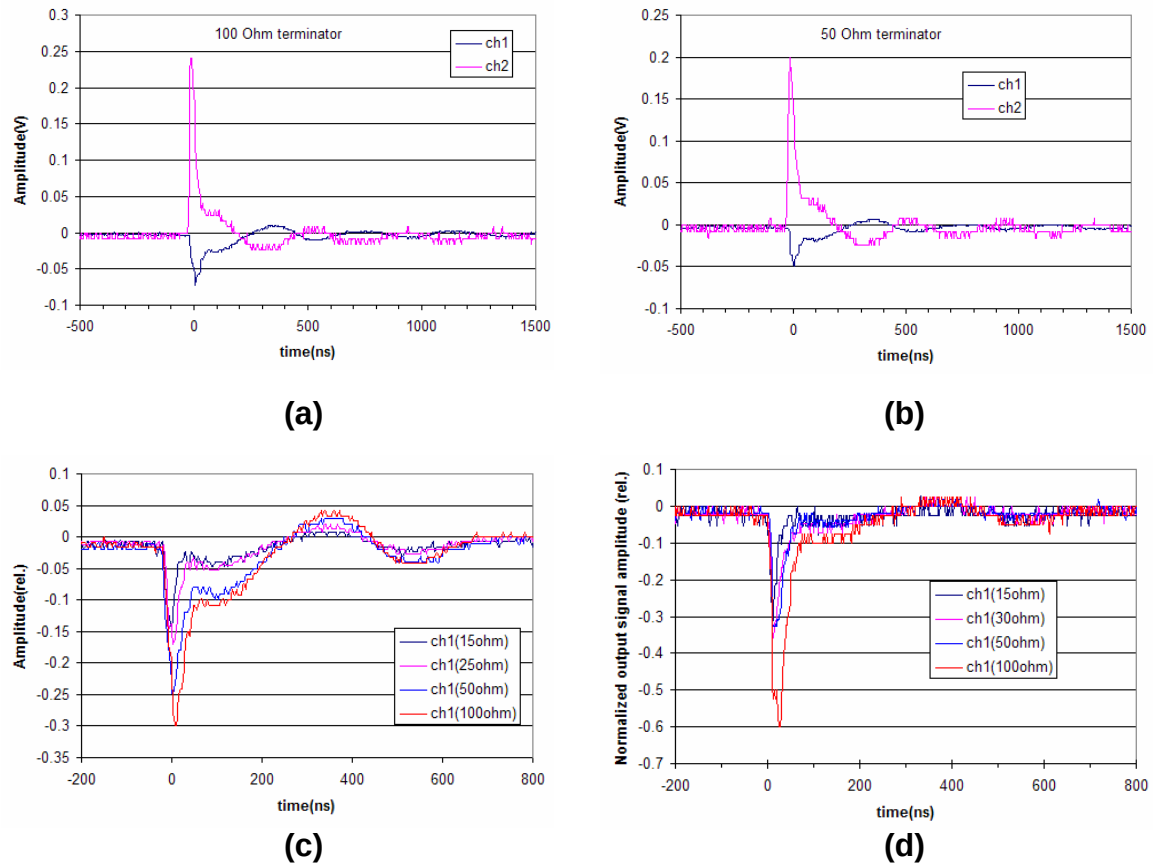

Figure 4. (a) (b) show simultaneously recorded cathode and anode (strip line) signals, (c) normalized strip line signal for 15cm wide strip, (d) normalized strip line signal for 5cm wide strip line for four different termination cases.

3, Calculated and tested characteristic impedance and propagation time of the strip line

The transmission line formed by strip and ground plane can be readily calculated with the existing formula. We also can use Tektronix CSA 803 Communication Signal Analyzer to measure these parameters; the results are shown in the following table, and they are consistent with each other:

# of strips	Impedance(Ω)		Propagation time(ns/m)	
	Calculated	Measured	Calculated	Measured
3	11	12	3.3	3
1	28	31	3.3	3

4, Summary

We have tested 5cm and 15cm wide strip lines for their signal shape under four different termination conditions. 5cm width strip has narrower signal and larger amplitude, but 15cm width strip line still can provide quite decent signal, it won't cause any trouble for our readout electronics. The time jitter due to the propagation delay along the strip line is very small, ~6ns maximum for 2m long strip line, that is negligible.