Prototype of new delay line with chip inductors for the PPAC

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In Parallel Plate Avalanche Counter (PPAC), which is used at the BigRIPS, the XY position is deduced by using the delay line readout method.[1] The X and Y electrode strips are connected to multi-tapped delay lines (DLs). The inductance of the DL is formed by a coil made by winding a ϕ0.3 wire wound around a ϕ2.0 Bakelite rod. Additionally ϕ0.12 lead wires are soldered onto the coil wire every eight turns. Thus, the fabrication and maintenance of this DL is a difficult work that requires an expert for soldering. To simplify the DL fabrication, prototyping of new DL consisting of chip inductors and capacitors has been started.

The new DL is fabricated by the reflow soldering method. A soldering paste is put on the pads of the G10 board via a 200 μm-thick mask. The chips are placed on the pads and then the board is heated up to around 160°C on a hot plate to melt the solder. Images of the ordinary DL and the new DL are shown in Fig. 1.

Several new DLs were fabricated and tested. In this report, the properties of the X DL named CLDLX#02 are described. The chip inductors are Murata LQW2BAN91NG00L, whose inductance L is 91 nH ± 2%. The chip capacitors are Murata GRM2162C1H390JZ01D, whose capacitance C is 39 pF ± 5%, and chips having the same C within one decimal place were used to realize the same delay time of one pitch ($T_{dt} = 1.07\sqrt{LC}$). The measured average T_{dt} was 2.02 ns with 1.0% of the standard deviation.

The performance of the 240 mm × 150 mm PPAC with new DLs was evaluated with an α source. Figure 2 (a) shows the X-axis position spectrum of the α-rays that are uniformly irradiated on the PPAC. The uniformity of the detection sensitivity from −108 mm to +108 mm (90% of the full range of X) excluding the statistical fluctuation was 1.8%. Figure 2 (b) is the spectrum measured with a position calibration mask, which has a slit interval and width of 5 and 0.5 mm, respectively. The position resolution was measured to be 0.32 mm in σ. The characteristics of CLDLX#02 are summarized in Table 1 with those of an ordinary multi-tapped DL (25X#34) for comparison. As presented, the position resolution of CLDLX#02 is slightly wider than that of the 25X#34. Thus, with further modification to obtain better performance, the new DL can be used for the PPAC instead of the ordinary DL. In addition, we are also considering another type of DL whose coil is directly patterned on the G10 board.

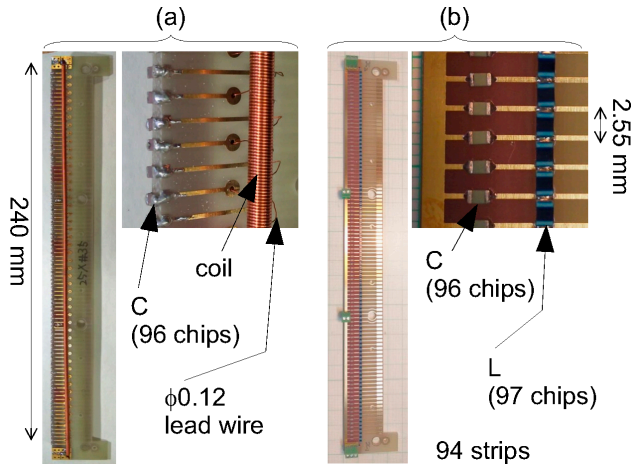

Fig. 1. Images of the DL boards for X. (a) ordinary multi-tapped DL. (b) new DL.

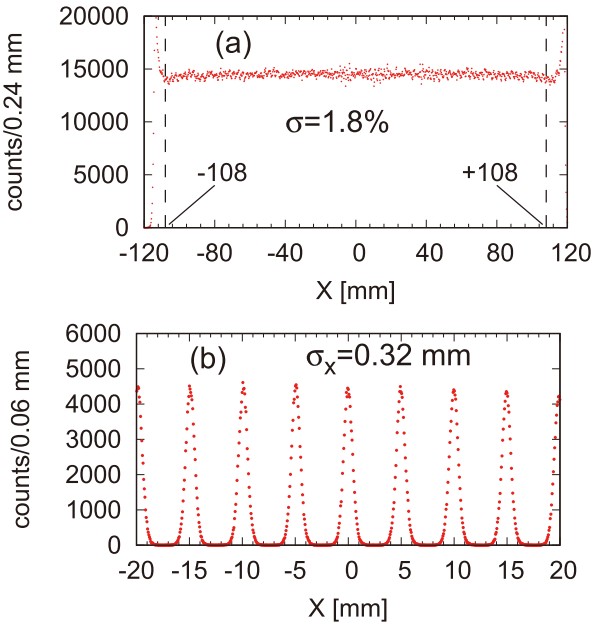

Fig. 2. X-axis position spectrum: (a) uniformly irradiated, (b) with a position calibration mask.

Table 1. Characteristics of CLDLX#02 and 25X#34.

	CLDLX#02	25X#34
inductance [nH]	91	90
capacitance [pF]	39.1	38.4
total delay time [ns]	193	192
delay time of one pitch [ns]	2.02	2.02
signal speed [mm/ns]	1.265	1.261
attenuation rate [%]	65	68
uniformity of sensitivity [%]	1.8	1.4
position resolution [mm]	0.32	0.25

Reference

1) H. Kumagai *et al.*, Nucl. Instrum. Methods Phys. Res. B **317**, 717 (2013).

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