STUDIES OF 100 μm-THICK SILICON STRIP DETECTOR WITH ANALOG VLSI READOUT

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A silicon strip detector (SSD) has the highest position resolution among the electric tracking devices in particle physics experiments. However, an error in measuring the track angle is dominated by the multiple scattering effect for particles with a low velocity. If the effect is reduced with a very thin SSD, new experiments which are impossible by the present technology will be realized [1].

In this paper, we evaluate the performances of a 100 μm-thick silicon strip detector. The performances are compared with those of the 300 μm and 500 μm-thick silicon strip detectors.

Single-sided silicon detectors with the dimensions of 1 cm $\times$ 1.3 cm have been fabricated by Hamamatsu Photonics. The strip pitch is 100 μm. The widths of implantation strips and aluminum electrodes are 42 μm and 34 μm, respectively. Three detectors with different thicknesses (100 μm, 300 μm, and 500 μm) were tested. The 100 μm-thick SSD was made by etching a 300 μm-thick wafer. The analog VLSI chips (VA2[2]) [2] are used as a readout circuit of the detectors. An SSD and a VLSI chip were mounted on a printed circuit board called "hybrid board".

Two different particles were used for evaluation of the detector performances. A proton beam was used to measure the response of detectors for heavy particles, while a ^{90}Sr β-ray source was used to see the response for light and high velocity particles.

The momentum of detected protons was 800 MeV/c with the momentum spread of $< 0.05\%$. The energy loss for a proton with 800 MeV/c is 68 keV for the 100 μm-thick SSD, which is about 1.7 times larger than that for the minimum ionizing protons.

The readout system is schematically shown in Fig. 1. The hybrid board consisting of a silicon strip and a VA2 chip was connected to a "repeater card", which contained level converters for logic signals, buffer amplifier for analog output signal, and adjustable bias supply for the VA2 chip. Analog multiplexed output from VA2 was sent to a flash ADC through the repeater card. Two layers of trigger counters were placed in front of the SSD. Signal shaping time was about 700 ns. Signals were read out in 4 μsec clock repetition. Typical trigger rate was about 30 Hz.

In addition to a proton beam test, measurements with a ^{90}Sr β-ray source were also performed. The ^{90}Sr β-ray source was placed at 15 mm from the SSD. A collimator with a

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Figure 1:

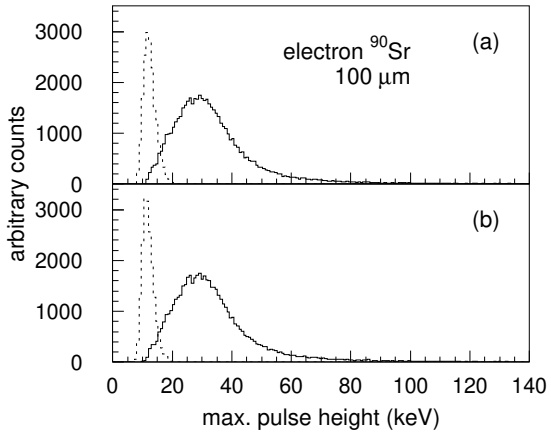

Figure 3: Maximum pulse height of electrons from ^{90}Sr source for the 100 μm SSD after the CMN subtraction by constant (a) and linear-fitting (b).

Table 1: S/N ratios for β-ray electron signal.

SSD thickness	100 μm	300 μm
without CMN subtraction	4.91	17.1
constant CMN	7.45	28.7
linear-fitted CMN	7.88	29.7

detecting light and high velocity particles.

References

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