5 - 5 Development of 3×3 Grid Silicon Detector

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Silicon detectors have been widely used in high energy, astrophysics and nuclear medicine due to their perfect position resolution and energy resolution, wide linear range and quicke response time[1,2]. They are also used as vertex detectors and track detectors in the world nuclear physics laboratories[3]. Ion-implanted silicon decetors such as strip decetors and have been used in experiment. A pisition-sensitive decetor, that is 3×3 grid silicon deterctor, is further developed for experiment purpose. It is shown in Fig. 1, which is made of nine 10 mm×10 mm square silicons pads.

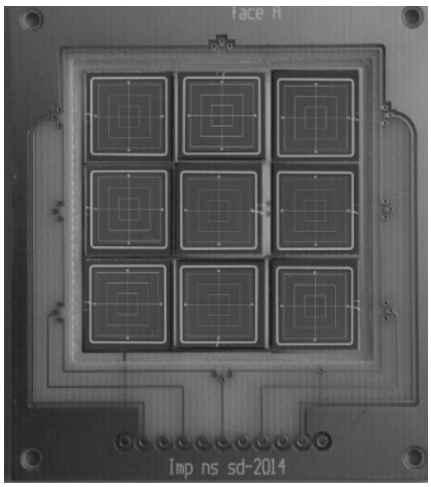

Fig. 1 The picture of 3×3 deterctor grid silicon detector.

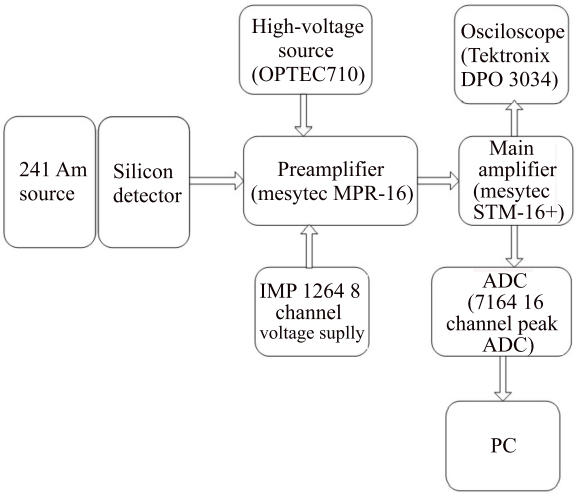

Fig. 2 Schematic diagram of the measurement system.

The forward resistance and reverse resistance of the grids are shown in Table 1. It can be clearly see that the forward resistance of the nine square silicons is 20 kΩ, and the reverse resistance are approximately infinity which is greater then 500 MΩ. Thus the 3×3 grid silicon deterctor manufactured have perfect pn junction characteristic.

Table 1 The results of electrical characterization and detection performance for 3×3 detector.

Detetor number	Forward resistance / Ω	Reverse resistance / Ω	Voltage / V	Leakage current / nA	Energy resolution / %
1	20k	8	-30	20	1.24
2	20k	8	-30	20	1.28
3	20k	8	-30	20	1.24
4	20k	8	-30	20	1.11
5	20k	8	-30	20	1.17
6	20k	8	-30	20	1.18
7	20k	8	-30	20	1.15
8	20k	8	-30	20	1.27
9	20k	8	-30	20	1.25

A standard ^{241}Am source was used to mesure the detection performance of the 3×3 grid silicon deterctor. The α source was placed 3 cm away from the detector's surface in a vacuum chamber. The aquisition system is shown in Fig. 2. The Mesytec MPR-16 preamplifier is a 16-channel input preamplifier which works in a linear mode. The STM-16+ is a main amplifier which has 16 parallel input channels allowing. Its shaping time was selected as 1 μs. The signals were changed to digital data via a 7164 16 channel peak ADC, and the events were finally recorded by a control PC. The trigger signal of STM-16+ is provided by GG8020 and was used to set a gate on the 7164 ADC.

Fig. 3 shows energy spectra of a ^{241}Am source measured at the negative voltage 30 V of the 3×3 grid silicon detector. One peak is clearly seen in the energy spectrum. The energy resolutions of the nine square silicon detectors are about 1.2%. It should be mentioned the detector was not totally depletion and the incident particles were not

collimated. The energy resolution will be improved when the detector works at the full depletion voltage after collimation.

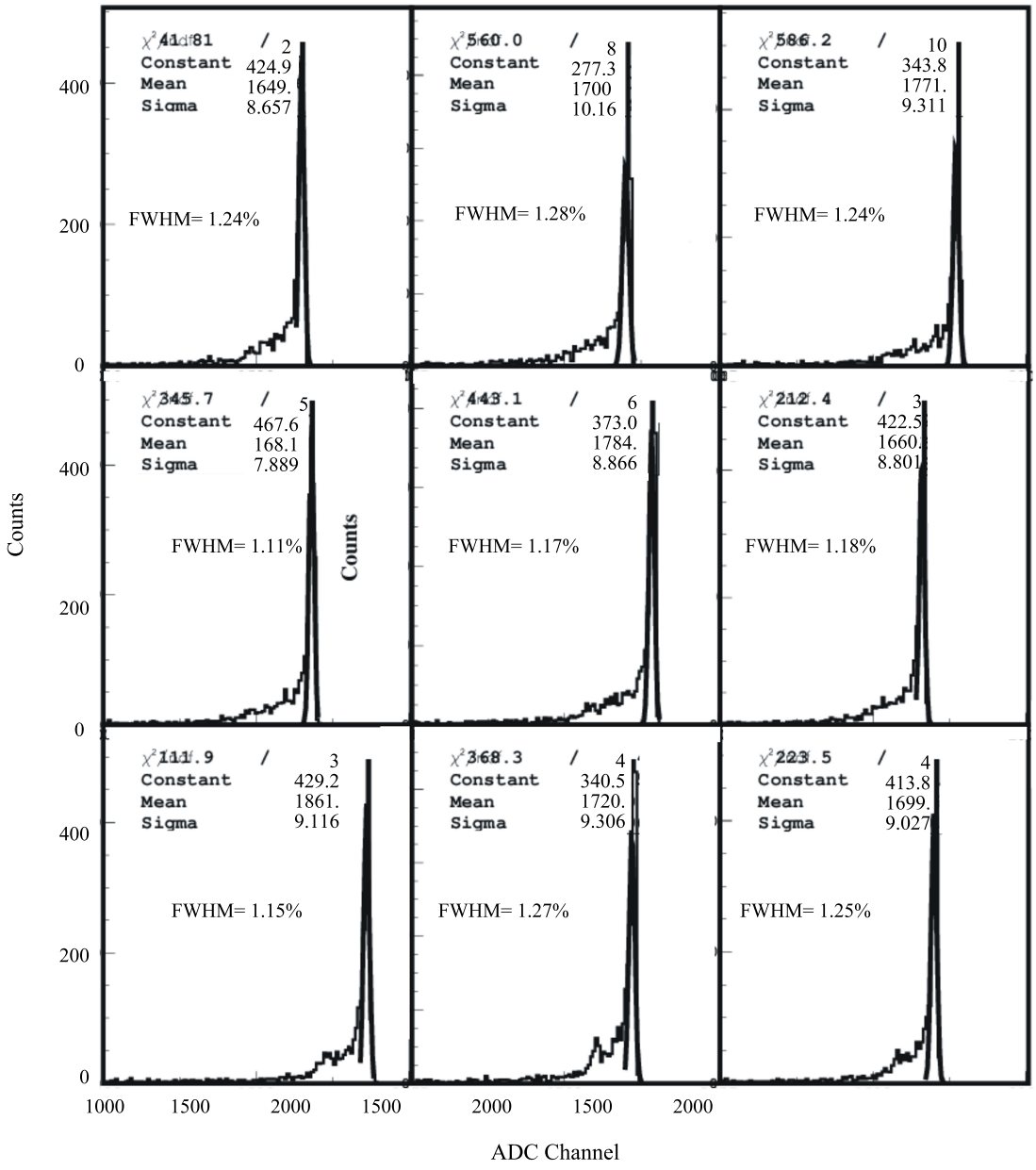

Fig. 3 Energy spectra of a ^{241}Am source measured at the negative voltage 30 V of the 3×3 grid silicon detector.

References

[1] Y. Onuki, I. S. Belle. Nucl. Instr. and Meth, 765(2014)99.

[2] X. J. Liu, H. Bornefalk, H. Chen, et al., IEEE. Trans. Nucl. Sci, 61(2014)1099.

[3] F. Hartmann. Nucl. Instr. and Meth, 628(2011)40.