Installation and cosmic ray test of the high voltage system of the BESIII drift chamber

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Abstract After examination of the designed high voltage power supply system of the BESIII drift chamber in the beam test of the full length prototype of drift chamber, a full system covering all the channels of high voltage was installed. The system's training and the high voltage value adjustment were carried out in the cosmic ray test of the BESIII drift chamber. The cosmic ray test for the full system and its final installation on the BESIII drift chamber were reported. The full system of high voltage power supply works stably and reliably.

Key words BESIII drift chamber, high voltage system cosmic ray test, installation

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1 Introduction

The new generation Beijing spectrometer (BESIII) drift chamber is the central tracking system of the detectors[1]. It consists of an inner chamber and an outer chamber, which include the stepped section and the outer section. Small cell structure is chosen for the BESIII drift chamber to obtain good space resolution and dE/dx resolution. The individual drift cell is nearly square, with one sense wire in the center surrounded by eight field wires that are shared by the adjacent cells. 6796 drift cells are arranged in 43 circular layers, respectively. 8 sense wire layers are located in the inner section, the following 12 sense wire layers are located in the stepped section, and the other 23 layers are arranged in the outer section. A dedicated comic ray test for the drift chamber was performed in order to investigate and then resolve the potential problems. After that, the chamber was moved to the experimental hall, where the high voltage system of the drift chamber was then installed.

The cosmic ray test for the full system and its final installation on the BESIII drift chamber are reported in this paper. The BESIII drift chamber high voltage system consists mainly of high voltage power supply device, H.V. distribution crate, high voltage board and cables for connection, as shown in Fig. 1. Of these, CAEN SY1527 is used for providing the requested high voltages, and it can be remotely controlled by an online computer, where the monitoring software can also be run to guarantee that the system runs with correct parameters. The distribution crates are used to distribute the incoming high voltages to the high voltage boards downstream. The high voltage boards supply high voltages to the drift chamber,

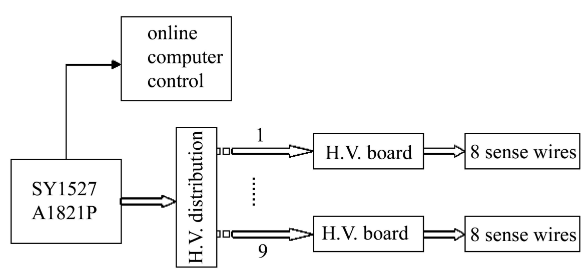

Fig. 1. The overall schematic view of the high voltage system of the BESIII drift chamber.

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finally. In such way only one SY1527, along with 9 H.V. distribution crates is needed for the whole system. A detailed description of the high voltage system can be found in Ref. [2].

2 Installation of high voltage system

Before the cosmic ray test, the full system of high voltage, including all the 6796 channels, was installed to the drift chamber. The installation in cosmic ray test is a complete rehearsal for the final installation when the drift chamber is moved to the experiment hall. It includes three major steps: grounding wire installation, high voltage board installation and high voltage cables installation.

2.1 Installation of grounding wire

According to the design[2], the sense wires in the drift chamber are on positive potential while the field wires around them are on the ground potential to form drift electric field. In order to assure that all the 21884 field wires are connected reliably to the grounding screws which are directly fixed on endplates of the drift chamber, the daisy chain mode is adopted. Using a certain pin, each feedthrough of field wire is connected with a conducting wire, which is joined one by one to form a daisy chain. Then the head of the chain is connected to the grounding screw/pin. In the inner section, each chain is not uniform because each grounding socket (29 pin per socket) is distributed asymmetrically due to the space limitation. In the stepped section, 12 field wires of every two adjacent sense layers and field layers are connected together.

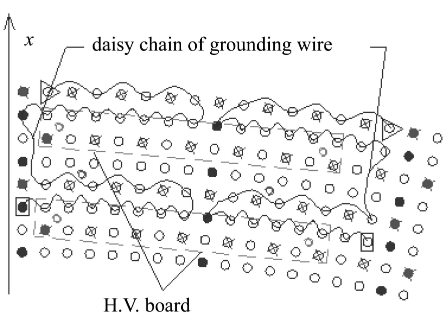

Fig. 2. The grounding chain of the outer section.

Then the 12-head chains are connected to the 10-pin grounding boards which are mounted in the endplate. In the outer section, the chain should be connected to the endplate directly. The grounding chain of the outer section is shown in Fig. 2.

2.2 Installation of the high voltage board

In the outer section of the drift chamber, all the high voltage boards were mounted in the two endplates directly, with the odd layers on one side (west) and the even layers on another side (east). As to the inner section and the stepped section of the drift chamber, the high voltage boards were arranged in the support rings which are next to the sixth steps because of the limited space. The installation of high voltage boards in the east support ring is shown in Fig. 3.

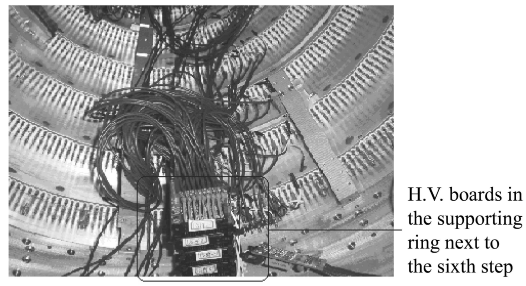

Fig. 3. Installation of the high voltage board.

2.3 Installation of high voltage cable

The high voltage cables of the adjacent sense wire layers are led to the high voltage boards mounted in two endplates from east and west endplates, respectively. The distribution of high voltage cables is shown in Table 1.

Table 1. The high voltage cable lead scheme.

endplate	location (face to the endplate)	cable length/m	H.V. distribution crate number	layer number
east	northeast	17	1	2,4,6,8,10,12,14,16,18
	northwest	22	2	20,22,24,26,28
	southwest	17	3	30,32,34,36
	southeast	13	4	38,40,42
west	northwest	21	5	1,3,5,7,9,11,13,15,17
	northeast	26	6	19,21,23,25,27
	southeast	21	7	29,31,33,35
	southwest	17	8,9	37,39,41,43

3 Cosmic ray test of the BESⅢ drift chamber high voltage system

As it is mentioned above, a cosmic ray test was performed for the BESⅢ drift chamber, in which the test of the final high voltage system is an important content. In the test, high voltage system training and high voltage value adjustment were carried out.

3.1 High voltage system training

Some problems happened in high voltage system training when the cosmic ray test of BESⅢ drift chamber was carried out. Some capacitances whose withstanding voltages are 3 kV, in the filter circuit and 1/4 watt resistances in the high voltage board were broken down. And even some open circuits were found because of the bad assembled RC filter circuits. To solve these problems, the capacitances of high quality, whose withstanding voltages are up to 6 kV, and 1/2 watt resistances were used. Even the RC filter circuits were redesigned to assure the reliability. After being improved, the high voltage power supply system worked well during the cosmic ray test.

3.2 High voltage value adjustment[3]

The high voltage values for the sense wire layers of the BESIII drift chamber were calculated by GARFIELD[4]. But some adjustments by manual should be done because the gas gain is not uniform in different layers (especially the boundary layers) in the real chamber, which is more complicated than the ideal one. In the cosmic ray test, a normal charge spectroscopy, corresponding to a group of given high voltages, was obtained. According to the charge spectroscopy, the high voltage of layer with higher gas gain was turned down in some sort and turned up vise versa. The process was repeated until the gas gain was almost uniform for different layers.

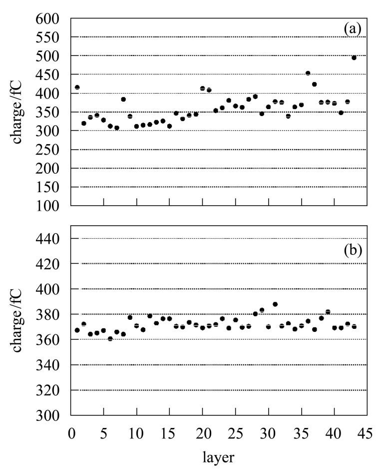

Fig. 4. (a) 2150 V before adjustment; (b) 2150 V after adjustment.

Three groups of high voltage of 2150 V, 2175 V, 2200 V were adjusted in the cosmic ray test. The gas gain of each layer when the high voltage was set according to GARFIELD is showed in Fig. 4(a), Fig. 5(a) and Fig. 6(a), respectively. The gas gain of the boundary layers fluctuates even more than 30%. It is greatly improved after high voltage adjustment. As shown in Fig. 4(b), Fig. 5(b) and Fig. 6(b), the gas gain of each layer is controlled within ±5%.

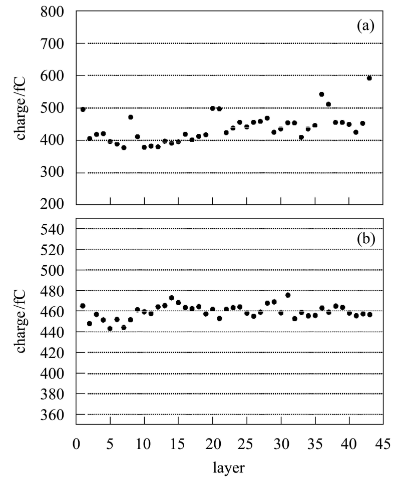

Fig. 5. (a) 2175 V before adjustment; (b) 2175 V after adjustment.

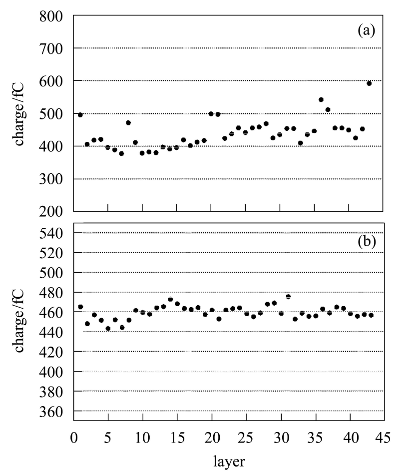

Fig. 6. (a) 2200 V before adjustment; (b) 2200 V after adjustment.

4 Conclusions

The performance of the high voltage power supply system of BESIII drift chamber was improved a lot from the preliminary design to the last version, including the replacement of some electronics components, high voltage value adjustment, etc. And now it was installed in the BESIII experimental hall safely. The high voltage power supply system of BESIII drift chamber can work stably and reliably.

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