

Quality assurance test of hybrid sensors for new silicon pixel detector

T. Sumita,^{*1} Y. Akiba,^{*1} H. Asano,^{*1,*2} T. Hachiya,^{*1} M. Kurosawa,^{*1} T. Moon,^{*1,*3} H. Nakagomi,^{*1,*4}
C. Pancake,^{*5} H. Sako,^{*1} S. Sato,^{*1} A. Taketani,^{*1} H. Torii,^{*1} and the PHENIX VTX group

A silicon vertex tracker (VTX) was installed in the PHENIX detector at the Relativistic Heavy Ion Collider. The VTX detector consists of two inner layers of silicon pixel detectors and two outer layers of silicon strip detectors. We are currently fabricating new spare pixel detector ladders. A pixel ladder is composed of a mechanical stave, four hybrid sensors, and two readout buses. A hybrid sensor is an assembly consisting of a silicon pixel sensor and four readout chips (ALICE1LHCb¹) bump-bonded to the sensor. One readout chip has 8,192 pixels, with a pixel size of $425 \mu\text{m} \times 50 \mu\text{m}$, organized in 32 columns and 256 rows. For production of new pixel ladders, a quality assurance (QA) test is required for the hybrid sensors. The test was conducted by HAYASHI WATCHWORKS CO., LTD.

Figure 1 shows a schematic of the QA system. The test system consists of a probe station (SUSS MicroTec), a probe card, a DAQ adapter board, VME equipment for a DAQ system, and a Windows PC². The following tests are performed for each sensor.

- (1) Current consumption:
The current consumptions of analog and digital circuits of the chip are measured.
- (2) JTAG functionality:
It is confirmed whether the configuration settings in the chip can be controlled by using Joint Test Action Group (JTAG³) protocol.
- (3) Minimum threshold:
The minimum threshold in all pixels is determined.
- (4) Test with β -ray source (^{90}Sr):
Faulty bump bonds are evaluated by the source test.

The sensor is biased at 50 V during the measurements in items (3) and (4).

The criteria for the hybrid sensor to be used for a ladder are as follows.

- Current consumptions of analog and digital circuits must be lower than 350 mA and 270 mA, respectively.
- The configuration settings in the chip must be controllable using JTAG protocol.
- The number of defect pixels must be less

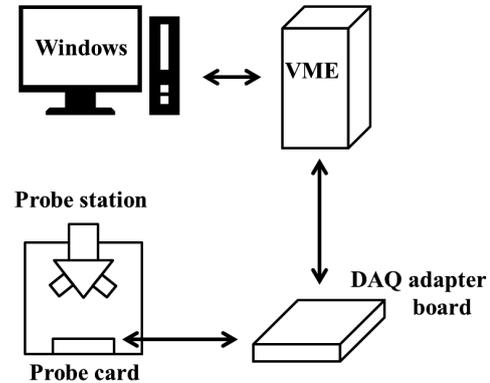


Fig. 1. Schematic of the QA test system.

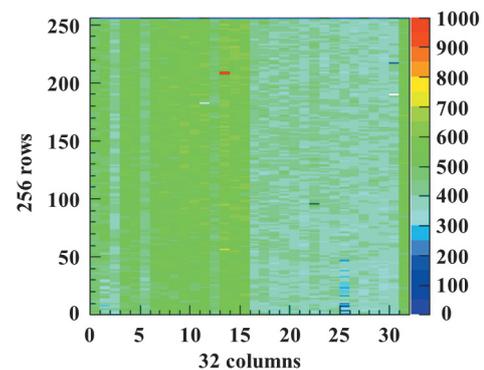


Fig. 2. Typical result of a readout chip in the source test. The color of the pixel indicates the number of hits.

than 163 ($\approx 2\%$) in the source test.

A total of 50 hybrid sensors have been tested, and 33 hybrid sensors met the criteria. The average number of defect pixels is about 21 ($\approx 0.3\%$). A typical result of a readout chip in the source test is shown in Fig. 2. The main reason for failure to meet the criteria was faulty bump bonds. About one or two readout chips out of four readout chips on the sensor may have caused higher current consumption than the upper limit of the criteria.

In summary, we obtained 33 hybrid sensors to be used for new pixel ladders. Currently, the production of new pixel ladders using these sensors is underway.

References

- 1) W. Snoeys et al.: Nucl. Instr. Meth. A **466**, 366 (2001).
- 2) M. Kurosawa et al.: RIKEN Accel. Prog. Rep. **41**, 173 (2008).
- 3) IEEE Std 1149.1.

*1 RIKEN Nishina Center

*2 Department of Physics, Kyoto University

*3 Department of Physics, Yonsei University

*4 Department of Physics, University of Tsukuba

*5 Department of physics, Stony Brook University