

Quality assurance test of pixel detector ladders for VTX

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} 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. A pixel ladder is composed of a mechanical stave, four hybrid sensors¹⁾, and two readout buses. A hybrid sensor is an assembly consisting of a silicon pixel sensor and four readout chips (ALICE1LHCb²⁾) bump-bonded to the sensor. One ladder has 16 readout chips and 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.

We fabricated new spare silicon pixel ladders. In order to ensure correct operation before the assembly of the VTX detector, quality assurance (QA) test of the ladders need to be performed. This report presents the results of the QA test for the ladders.

The QA test system consists of Silicon Pixel Read-Out (SPIRO) modules, Front-End Module (FEM), and NOVEC HFE-7200.³⁾ The SPIRO modules provide all electricity, control the readout chip of the sensor module and read out pixel data. The FEM is an interface between the SPIRO modules and the data acquisition system. NOVEC HFE-7200 was used to cool the readout chips. The following tests are performed for each ladder.

- (1) Current consumption:
The current consumption of the analog and digital circuits of the readout chips are measured.
- (2) JTAG functionality:
It is confirmed whether the configuration settings in the chip can be controlled by using Joint Test Action Group (JTAG⁴⁾) protocol.
- (3) Minimum threshold:
For all chips, the minimum threshold in all pixels are determined.
- (4) Pulse test:
Pulse test is to check for dead chips and connections. The test pulse from the pulsar inside the chip is transmitted to each pixel cell.
- (5) Test using a β -ray source (^{90}Sr):
Faulty bump bonds and the maximum efficiency are evaluated by β -source measurements

The ladder is biased at 10 V during the measurement.

A total of 7 ladders were tested, and correct operation of all the ladders was confirmed except for one lad-

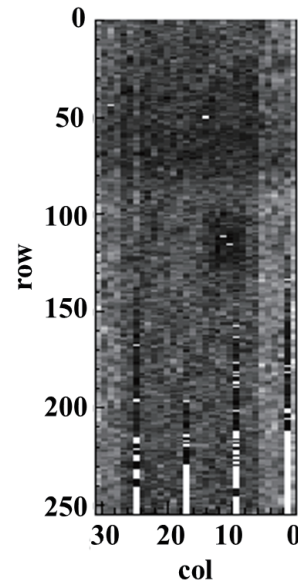


Fig. 1. Typical result of a readout chip in the source test. The horizontal and vertical axes represent pixel position along the column and row directions, respectively. Low gray-levels represents a low number of hits.

der. Four chips (one hybrid sensor) of the incorrectly working ladder did not respond to the tests because of a short circuit in the readout bus. A typical result of a readout chip in the source test is shown in Fig. 1. The inefficient area at the bottom of columns 1, 9, 17, and 25 is attributed to the presence of the test pulse signal generator on the readout chips, which affected the readout circuit.

In summary, QA tests for the seven new assembled pixel ladders were performed. The results confirmed that six ladders are working properly and that a part of one ladder is not functional. One of functional ladders will be used in the 2015 run.

References

- 1) T. Sumita et al.: RIKEN Accel. Prog. Rep. **47** 230 (2013).
- 2) W. Snoeys et al.: Nucl. Instr. Meth. A **466**, 366 (2001).
- 3) M. Kurosawa et al.: RIKEN Accel. Prog. Rep. **43** 208 (2010).
- 4) 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