Development and characterization of SOI based event driven neutron imaging sensor

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Abstract: We have developed a neutron imaging pixelated sensor based on ^{10}B coated SOI(Silicon-on-Insulator)-CMOS pixel silicon device and characterized it by irradiating the neutron beam at J-PARC facility. From the result, the time-of-flight capability and event identification capability has been evaluated, which will be useful for the imaging application requiring neutron/γ discrimination.

Keywords: imaging sensor, semiconductor, neutron

1. Introduction

For quantum beam imaging area, imaging sensors based on semiconductor technologies are widely used because of its high spatial and temporal resolutions with its integrated readout scheme. Neutron imaging sensors are useful for the application of ultra-cold neutron (UCN) imaging, neutron transmission imaging and the application to the decommissioning in nuclear reactors. In this study, we have developed a neutron imaging sensor based on ^{10}B coated XRPIX7 event driven SOI-CMOS pixel silicon device (^{10}B-XRPIX7). It can readout the energy deposition pattern with the programmed area size through the in-pixel trigger function. We have evaluated the time-of-flight capability of this sensor by irradiating the neutron beam at J-PARC facility. The capability of event identification can be confirmed.

2. Experiment procedure

In the experiment, ^{10}B-XRPIX7 devices are tested with neutron beam supplied from J-PARC, MLF-BL10. Neutrons are emitted with the time pulse 25Hz, beam power 600kW. Pb neutron filter with 75mm thickness was inserted in the beam line to reduce fast and thermal neutron components. The time of flight (TOF) information from the trigger signal was measured by ^{10}B-XRPIX7 devices. During each testing, 500000 events were taken.

3. Result and Discussion

Fig.1 shows the results of TOF measurement. The vertical axis shows the measured counts and the horizontal axis shows the time difference between the beam trigger to the ^{10}B-XRPIX7 trigger signal.

Fig.2 shows the results of the energy deposition pattern of 16 × 16 pixels surrounding the first-triggered pixel. The neutron event patterns are considered to be generated by the alpha or Lithium particles and γ-ray event patterns by the recoiled electrons. We can classify the neutron events and γ events by comparing the two images.

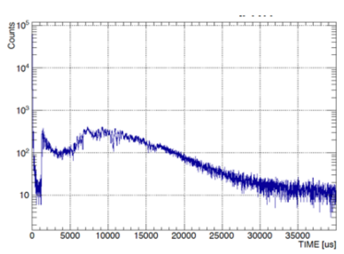

Fig.1 TOF measurement by ^{10}B-XRPIX7 imaging device

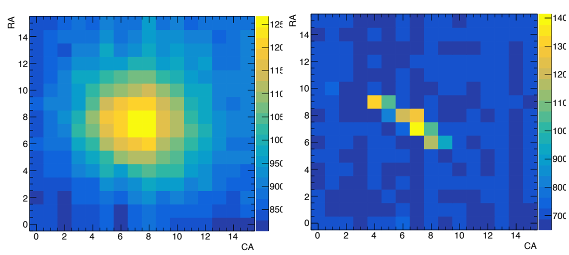

Fig.2 Image of neutron and γ event.

References

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