IV. 5. Preliminary Report of Position Sensitive CdTe Detector for a Semiconductor PET Camera

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Application of small semiconductor detectors to PET camera is an effective way to achieve high spatial resolution because it can make possible that data are obtained in fine spatial sampling width. But, the use of small detector may cause decreasing of system sensitivity. When detectors are aligned, vacancy between them is needed in order to divide detectors electrically, and this causes that packing ratio becomes lower.

In order to avoid decreasing of packing ratio, we propose to embed a position sensitive detector to a semiconductor PET camera. We report about development of a position sensitive CdTe detector for a semiconductor PET camera. From our previous research, it was determined that CdTe (cadmium telluride) semiconductor detector, whose atomic number was high (Cd: 42, Te 52), was suitable for application of PET. In particular, schottky CdTe detector which is made by evaporating In an Pt as electrode can be available in high bias voltage, so that fast timing performance is expected.

A position sensitive semiconductor detector is made by formation of resistive area electrode. Several output lines are connected to the surface and detection position is determined by calculating fraction between output amplitude of signals. In order to form the resistive electrode, thickness of evaporation metal on the crystal is controlled. This may make it possible that resistive electrode is formed, preserving good timing performance. With ion beam induced charge (IBIC) method, we confirmed formation of resistive electrode by controlling electrode thickness. IBIC is a technology which is for research about charge collection ability of radiation detector by irradiating ion beam to the detector. A CdTe detector whose electrode thickness was controlled was irradiated 3 MeV proton with micro beam line in Fast Neutron Laboratory, Tohoku University and a correlation between irradiation position on the electrode and signal outputs.

Thickness of In evaporated electrode was controlled and, two Au wire which transfers signal were attached on the electrode. 3 MeV proton beam which was focused with the micro beam line was irradiated on each position on the electrode. Signals from In electrode were measured simultaneously together with a signal of Pt electrode, using multi-parameter ADC. Schematic of the experiment is indicated in Fig. 1.

Figure 2 shows the results of irradiation at 0.5 mm pitch. This plot indicates correlation between one of signals from In electrode and the signal from Pt electrode. It was confirmed that irradiation in each position could be identified clearly. Fig.3 shows histogram of ratio of In signal amplitude to Pt signal amplitude in 1 mm pitch irradiation. Position resolution can be calculated from distance between irradiation positions and width of distribution and the resolution on a center of the detector is less than 0.3 mm. This resolution is for 3 MeV proton and it is assumed that resolution is decreased by reducing energy deposition. But, it is supposed that the detector has enough resolution to 511 keV and can be applied to PET camera.

We will optimize control parameters of the detector and discuss way to apply to PET camera.

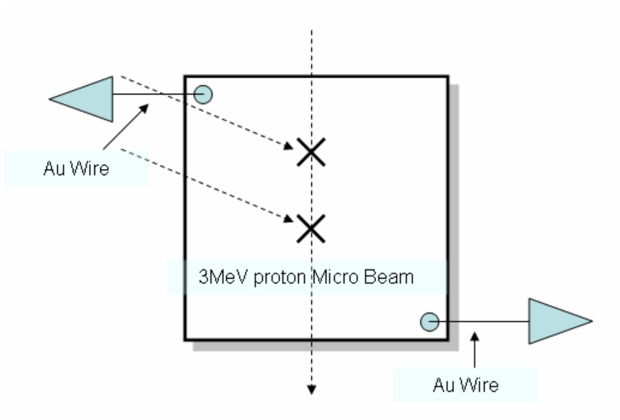

Figure 1. Schematic image of irradiation in IBIC experiment.

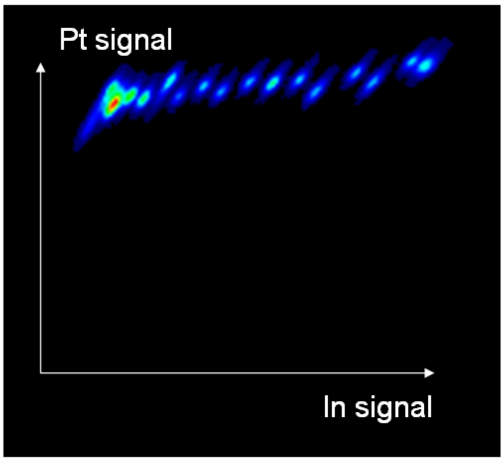

Figure 2. Correlation between Pt signal output and In signal output in each irradiation position

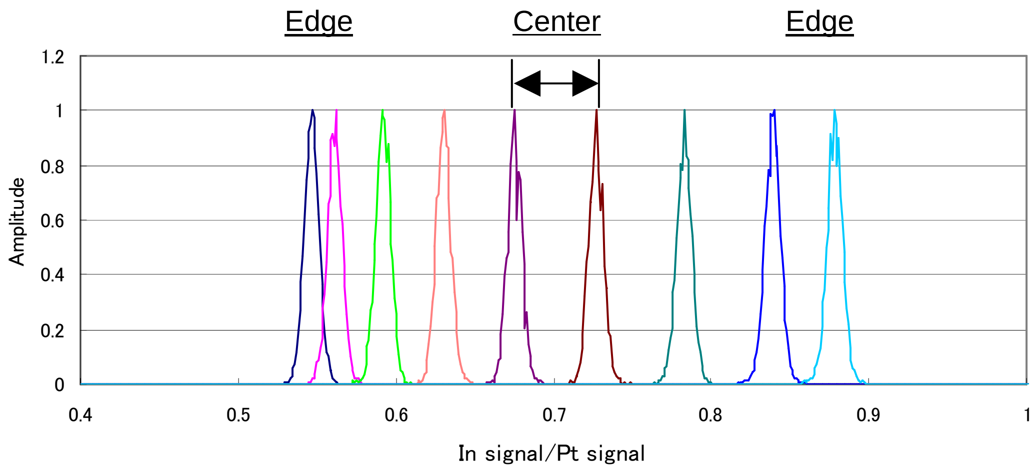

Figure 3. Ratio (In signal)/(Pt signal) in each position of 1mm pitch irradiation.