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Development Electron Tracking Compton Camera (ETCC) for multipurpose medical imaging

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PET and SPECT achieved great successes in medical imaging. These detectors, however, have energy limitations, which is a problem in designing new-molecular imaging reagents. We have developed an Electron-Tracking Compton Camera (ETCC) to give the wide energy range (200-1500keV), wide field of view (4str) and abilities of background rejection and clear imaging using the tracking of recoil electrons. Thus ETCC has a potential of the development of new reagents. Until now we carried out several imaging reagent studies of double clinical tracer imaging with FDG and I-131-MIBG, and imaging of Zn-65, Mn-54 and Fe-59 in mice. Also, ETCC images continuum gamma-rays by removing backgrounds using dE/dx of the track, which enables to monitor the Bragg peak location by detecting prompt gammas. We successfully obtained the on-time images of 511keV and continuum gammas rays from the water irradiated by 140MeV proton (S.Kurosawa, Cur.Apl.Phys, 2012).
In 2013 we have improved all readout system of ETCC, by which its tracking efficiency and data transfer rate ere improved with 10 times, and 50 times. Now ETCC obtain clear images with the use of 50MBq FGD, and starts the test of tomographic image using two ETCCs. We will present its imaging performance including the proton beam test with similar intensity in proton therapy.

Summary

We have developed an ETCC to give the wide energy range, wide field of view and abilities of background rejection and clear imaging for medical imaging.
Our ETCC consists of a Time projection Chamber with a micro pixel gas detector and pixel scintillator arrays. By measuring the track of an electron, ETCC measures the direction of gamma-rays as a small arc, which provides a good background rejection using the kinematical test and energy loss rate of the track (particle identification), and clear imaging. TPC obtains a fine electron 3-D track with 0.8mm pitch spacing, which gives us very precise dE/dx and the direction of it with similar resolution to that determined by multiple scattering. Such a fine dE/dx easily removes most of background particles. Also such a good angular direction of electron tracks improves the significance of signal detection by a factor of 10 compared to that of Conventional Compton Camera. Using such good performances, our ETCC can operate with keeping same performances as that in normal condition under the intense radiation condition similar to that in proton therapy.

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