Study of 3D position determination of the interaction point in monolithic scintillator blocks for Positron Emission Tomography

Zhi LI

Positron emission tomography (PET) is a nuclear medicine imaging technique based on the detection of gamma rays emitted by positron-emitting isotopes. It is one of the noninvasive technologies, which can be used as a diagnostic tools to detect tumors, neurological disorders and heart problems, etc, as well as a research tool in e.g. pre-clinical testing on laboratory animals, mapping brain functions, ...

A very important parameter in the design of PET scanners is the accuracy and efficiency with which the gamma photons can be localized by the detectors in the scanner. The goal of this thesis is to improve the performance of an upcoming detector concept for PET based on monolithic scintillation crystals.

This thesis presents a study of possible models to describe the relation between the scintillation light point-of-origin and the measured photo detector pixel signals in monolithic scintillation crystals. From the model, the X, Y and depth of interaction (DOI) coordinates can be estimated simultaneously by nonlinear least-square fitting.

This model was evaluated using simulation and experimental data by positioning a beam of 511 keV photons at known positions on the 20*20*10 mm LSO block. The results compare favorably to two other algorithms, maximum likelihood and neural networks. In addition the new method depends only on the information embedded in the signals of individual events, and therefore does not need any prior position training or calibration.