GAMMA-RAY IMAGING DETECTOR FOR SMALL ANIMAL RESEARCH

Andrew G. Weisenberger

College of William & Mary, Department of Applied Science, 1998
Field: Accelerator Science, Degree: Ph.D.

Advisor: Dennis Manos, CSX Professor of Physics and Applied Science

Abstract

A novel radiation imaging technology for in vivo molecular imaging in small mammals is described. The goal of this project is to develop a new type of imaging detector system suitable for real-time in vivo probe imaging studies in small animals. This technology takes advantage of the gamma-ray and x-ray emission properties of the radioisotope iodine 125 which is employed as the label for molecular probes. The radioisotope 125I is a gamma-ray emitting radioisotope that can be commercially obtained already attached to biomedically interesting molecules to be used as tracers for biomedical and molecular biology research. The isotope iodine 125 decays via electron capture consequently emitting a 35 keV gamma-ray followed by the near coincident emission of several 27-32 keV K alpha and K beta shell x-rays. Because of these phenomena, a coincidence condition can be set to detect iodine 125 thus enabling the reduction of any background radiation that could contaminate the image. The detector system is based on an array of CsI(Na) crystal scintillators coupled to a 125 mm diameter position sensitive photomultiplier tube. An additional standard 125 mm diameter photomultiplier tube coupled to a NaI(Tl) scintillator acts as the coincident detector. To achieve high resolution images the detector system utilizes a custom-built copper laminate high resolution collimator. The 125I detector system can achieve a spatial resolution of less than 2 mm FWHM for an object at a distance of 1.5 cm from the collimator. The measured total detector sensitivity while using the copper collimator was 68 cpm/mCi. Results of in vivo mouse imaging studies of the biodistribution of iodine, melatonin, and a neurotransmitter analog (RTI-55) are presented. Many studies in molecular biology deal with following the expression and regulation of a gene at different stages of an organism's development or under different physiological conditions. This detector system makes it possible for laboratories without access to standard nuclear medicine radiopharmaceuticals to perform in vivo imaging research on small a mammals using a whole range of iodine 125 labeled markers that are obtainable from commercial sources.