Introduction

The state of the art in molecular imaging methods includes fluorescence tomography, positron emission tomography (PET), and single photon emission computed tomography (SPECT). PET and SPECT are well-established methods that utilize the concept of complete angle tomography to provide specific molecular information, but require the use of radioisotopes for imaging contrast. The high initial cost of facility setup (i.e. radiation shielding) for radioisotope-based imaging methods, high instrumentation cost, additional radiation permits and costs to properly train staff, all create a high and expensive initial barrier to PET or SPECT integration into the lab. In addition, the repeated cost and practical concerns (i.e. half-life) of using radioisotopes are further challenges for researchers. An alternative to the radioisotope-based methods is fluorescence tomography, which is an optical method that utilizes chemically inert fluorescent dyes or transgenic fluorescent proteins for imaging contrast. Using light for fluorescence excitation, fluorescence tomography eliminates the need for using radioisotopes and the associated costs, while still enabling interrogation of specific molecular information.

The InSyTe FLECT/CT (Figure 1) by TriFoil Imaging (Chatsworth, CA) is a small animal imaging platform that combines fluorescence emission computed tomography (FLECT) and an inline X-ray CT into a single instrument that gives molecular imaging capability with anatomical reference. FLECT is the radioisotope-free, optical analog to PET and SPECT. The InSyTe FLECT/CT offers industry-first, complete angle tomography data acquisition, which is superior in accuracy and sensitivity compared to the raster scanning approaches used by other optical imaging instruments claiming fluorescence tomography capabilities. This is achieved by using a rotating gantry, analogous to existing tomographic imaging modalities, for full 360° acquisition of fluorescence emission in vivo. The InSyTe FLECT/CT is configured for detection of near-infrared (NIR) fluorescence for deep tissue in vivo imaging and intended for imaging of mice only.

InSyTe FLECT/CT Details and Applications

To perform complete angle tomography for FLECT data acquisition, the InSyTe FLECT/CT optical geometry is set up on a rotating gantry. This enables FLECT data acquisition in full 360° around the subject. The InSyTe FLECT/CT is equipped with 4 lasers (642 nm, 705 nm, 730 nm, 780 nm) in the near-infrared (NIR) and corresponding NIR fluorescence emission filters. The lasers are directed into the FLECT collimator assembly and excite the fluorescence in the...
subject. A ring of 48 photodiode detectors surrounding the subject collect the emitted fluorescence (Figure 2).

By rotating the gantry around the subject, the region of interest is illuminated at different angles and the emitted fluorescence captured by the surrounding detectors. FLECT data is acquired in 1 mm slices, with the animal bed moving axially through the FLECT portion of the gantry over the entire region of interest, resulting in acquisition of 3D data. Once acquired, the acquired FLECT data is computationally reconstructed into a volumetric image that can be visualized in 3D.

The CT sub-gantry of the InSyTe FLECT/CT is comprised of a 30–50 kVp X-ray tube with maximum power of 50 W that produces a 50 µm focal spot. The CT subsystem is equipped with several CT filters (Al 1 mm, Al 2 mm, Mo, Sn, and Pd) for beam hardening and noise reduction. Designed to provide anatomic reference for FLECT, the CT subsystem is capable of high quality soft tissue imaging, enabling visualization of organs in mice (Figure 3). Additionally, both the CT and FLECT reconstructed data is output in a standard DICOM format, enabling straightforward co-registration with imaging data from other modalities (Figure 3).

The InSyTe FLECT/CT has been used in a wide variety of preclinical research applications, including cancer [1], theranostics [2,3], probe development [4], drug delivery [5], cardiovascular research [6], and neuroscience. With an industry-first, rotating gantry design for complete angle fluorescence tomography data acquisition, the InSyTe FLECT/CT enables radioisotope-free, molecular imaging in deep tissue. To learn more about the InSyTe FLECT/CT technology and research applications, please contact TriFoil Imaging at insyte@trifoilimaging.com.

References