

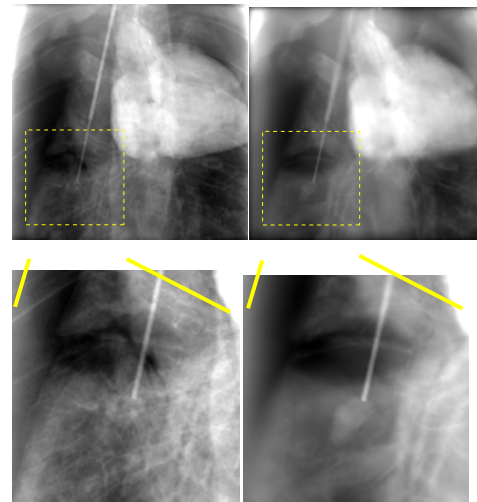
**Organization:** Stanford University School of Medicine  
**Lead Researcher:** Rebecca Fahrig, PhD  
**Project Title:** Improving lung nodule diagnosis by combining electromagnetic navigation and a new, fast low-dose x-ray tomosynthesis imaging system.

**Project Abstract:**

Lung cancer is the most common cause of cancer death in the United States and tobacco smoking accounts for the vast majority of lung cancer cases. The prognosis is poor, where the overall 5-year survival for lung cancer is less than 15%. Such poor prognosis is largely attributable to lack of efficient diagnostic methods for early detection. A major National Institute of Health (NIH) program for screening of lung cancer for early detection recently completed recruitment of 50,000 subjects, and follow-up for 5 years is now underway. This screening program and others like it have led to a significant increase in the number of biopsies, a test that determines if a suspicious lump of tissue (a nodule) is cancer.

One of the safer and more comfortable ways to biopsy is transbronchial needle biopsy (TBNbx), a needle on a flexible tube is directed through the airways to the nodule. The TBNbx procedure uses a small camera to guide the needle to the nodule, but often additional guidance is needed to reach the smallest branches of the lung. One safe and time-saving technique is electromagnetic navigation bronchoscopy (ENB). ENB is designed to guide biopsy tools to predetermined locations within the lung airway tree using a previously acquired computed tomography image (CT) and an electromagnetic navigation system. Although ENB is a highly specialized real-time navigation system, it doesn't directly show the nodule, which becomes especially important when localizing a small target nodule located in very small airways. Therefore, current literature suggests a need for a guidance strategy that combines imaging techniques with ENB to provide real-time direct visualization of nodules.

We propose a ***new clinically viable 3D real-time imaging system*** to be used in conjunction with ENB to provide improved visualization for image guidance of TBNbx procedures. There are 3 requirements for the proposed imaging system:



*The images on the left (overview on top, zoom view of a subregion on the bottom) show what a normal x-ray imaging system would provide. The images on the right (overview on top, zoom view of a subregion on the bottom) show what happens when the imaging system uses tomosynthesis. The lung nodule is much easier to see on the right because the over- and underlying structure has been removed from the image.*

- 1) it should permit real-time (video frame rate 30 images/second) simultaneous visualization of the target nodule, bronchial tree, and the needle/biopsy instrument;
- 2) it should provide accurate, high resolution 3D volume information to provide localization of the target and needle; and
- 3) patient and operator dose should be as low as possible.

An imaging technique that has the potential to satisfy the 3 requirements is tomosynthesis using new x-ray tube and x-ray detector hardware – the SBDX system. Using this system, tomosynthesis images of an object can be acquired in as little as 1/30 of a second with very low radiation dose levels. The specific goal of this proposal is to research, develop, and optimize the software and hardware for this new SBDX system.

Our proposed system has the potential to directly contribute to a more **effective and potentially earlier diagnosis of lung cancer**. Direct visual verification of the biopsy needle entering the nodule may also permit confident biopsy of smaller nodules. Increasing the population for which TBNbx can be used may also significantly **reduce the morbidity associated with lung cancer and with lung cancer screening**. Use of a minimally invasive approach leads to much lower incidence of lung collapse, and therefore to faster post-procedure recovery and shorter hospital stays, **reducing the economic costs of lung cancer and lung cancer screening**.

#### **About the Lead Researcher:**

Dr. Rebecca Fahrig is an associate professor (research) of radiology. Prior to joining the Department of Radiology at Stanford University, Dr. Fahrig completed her PhD in medical biophysics at the University of Western Ontario and a postdoctoral fellowship at Stanford University. She has won numerous awards including selection as a School of Medicine Faculty Fellow for 2008; the Greenfield Award for the Best Paper (nonradiation dosimetry) published in *Medical Physics* in 2005; the Fellowship Research Trainee Prize (along with Zhu, PhD, candidate) from the Radiological Society of North America (RSNA) Physics Subcommittee; and the Faculty Scholar in Translational Research Award from the Baxter Foundation. Dr. Fahrig's research focuses on imaging for guidance of minimally invasive procedures. She works on software and hardware that permit the use of a C-arm system for both fluoroscopy and CT imaging, and she has extended the applications of C-arm CT to retrospectively gated 3D/4D cardiac imaging in the interventional suite. Dr. Fahrig is also developing an MR-compatible X-ray fluoroscopy system, including a new rotating-anode X-ray tube for use in the fringe fields of 1.5T and 3.0T magnets.