What is the present focus of your work?

My research involves the investigation of new and more effective ways to detect cancer. Currently, my primary focus is on breast cancer and developing a system that is less painful and more accurate, especially for women with dense breasts.

Can you describe how your background has shaped your research?

My career in medical imaging technologies began 15 years ago when I obtained a position at GE Medical Systems. As a senior physicist, I was involved in the development, assembly and imaging performance evaluation of a device for functional breast imaging. This project was accomplished with clinical evaluation in the Mayo Clinic, USA, through comparative studies with conventional techniques for breast cancer treatment follow-up.

Shortly after this clinical study began, we were informed about a patient who previously underwent lumpectomy (breast conserving surgery) and had a follow-up scan with our technology; the device was able to detect recurrent cancer which would otherwise have remained undetected as it was located close to the surgical scar and thus masked on a mammographic image. This completely changed my perception of my work and it was then that I realised that what I am doing can save lives.

Why is there a particular need for improved mammography techniques?

Considering the benefits of detection and treatment, the drawbacks may appear insignificant and a small price to pay to save a patient’s life. But my goal is to provide an improved method that eliminates these drawbacks and provides a tool that is more accessible and painless, with the hope that more women will be screened, more cancers will be caught earlier and more lives will be saved.

An improved breast cancer screening technique is also needed for women with a higher than average risk of developing breast cancer. This includes those with a mutation in the breast and ovarian cancer susceptibility genes, BRCA1 and BRCA2, and women with family history of breast and other cancers. Intensified surveillance is recommended to reduce breast cancer incidence in these women. However, due to the early onset age of familial or hereditary breast cancer, high-risk women have to be screened at a substantially younger age than those with an average risk.

In what ways does your positron emission mammography (PEM) tool fulfil this need?

In the US, the Cancer Genetics Studies Consortium task force has recommended annual mammography for female carriers of a BRCA1 or BRCA2 high-risk mutation, beginning at the age of 25-35. Due to the low sensitivity of mammography for lesions in dense breast, X-ray mammography screening is ineffective in this high-risk population.

In this high-risk population.

Therefore, while remaining an essential tool for screening the average risk population, for high-risk women X-ray mammography should be replaced by an alternative imaging technique with detection performance independent of breast density and PEM is the best tool for this case.

Will your imaging technique reduce the amount of radiation patients are exposed to?

For medical radiation detectors, we are limited by how much radiation we can use before damaging human tissue. In my approach to medical imaging detectors, I am aiming to optimise the use of the radiation. In some applications this means using photon counting strategies for detector design, in others this can be best accomplished by increasing the gain of the system to overcome the amplifier noise. These approaches allow us to minimise the amount of radiation used.

How important is the training of undergraduates to your research aims?

Ultimately, I believe exposure to a research environment at an undergraduate level is essential to building the next generation of medical imaging professionals. Through providing them with opportunities like the Summer School of Medical Imaging that I designed, they have the opportunity to learn about many different careers in the medical imaging field and how even basic research can have an impact on healthcare standards.

Where do you see your research leading in the near future?

My big picture objective includes a desire to enhance and ensure the excellence and marketability of new medical imaging detectors to bring valuable contributions to the lives of patients and to translate those innovations into real benefits.
BREAST CANCER IS the most common cancer among Canadian women and accounts for approximately 14 per cent of all cancer deaths in this demographic. According to World Health Organization (WHO) estimations, 508,000 women died from the disease worldwide in 2011 alone. Although there is no single cause of breast cancer, factors known to increase disease risk include family history or a mutation in the breast and ovarian cancer susceptibility genes, and high breast tissue density.

Mammography, a special type of X-ray imaging used to create detailed images of the breast, plays a major role in early detection of breast cancers, which is crucial as successful treatment depends on early diagnosis. Along with breast ultrasound and magnetic resonance imaging (MRI), mammography is one of the most common and efficient imaging methods used to accurately diagnose breast cancer.

ROOM FOR IMPROVEMENT

While mammography detects approximately 80 per cent of tumours in women over 50, it only detects 60 per cent of tumours in younger women. There are a number of factors that affect the technique’s success rate, among which is younger women’s denser breast tissue that can render the image difficult to interpret. Furthermore, mammography produces a number of false positives, which can cause unnecessary worry as benign micro-califications are often misinterpreted as cancer. Improved imaging techniques are particularly important for women at higher risk of developing breast cancer, as they have to be tested more often and from an earlier age when they have more dense breast tissue.

Associate Professor of physics Dr Alla Reznik is Canada Research Chair in the Physics of Medical Imaging at Lakehead University and Senior Scientist in the Thunder Bay Regional Research Institute (TBRII) team. Assisting physicians in the development of improved imaging devices is the focus of her research. “An opportunity to contribute to the overall health and wellbeing of cancer patients, as well as to provide a safer and more confident technique for cancer diagnosis and treatment remains the biggest motivation of my work,” she enthuses.

In collaboration with colleagues at TBRII and Lakehead graduate students, Reznik is developing a new method for breast imaging – the portable positron emission mammography (PEM) device. The researchers have been awarded a three-year grant of $450,000 from the Canadian Breast Cancer Foundation to develop the technique, which will improve sensitivity for cancer detection, enabling early-stage diagnosis of the disease.

AN ADVANTAGEOUS METHOD

Mammography uses low dose X-rays to examine the breast, with areas of low density appearing translucent and areas of dense cancerous tissue appearing whiter on a black background. In dense breasts, the image can be more difficult to interpret. The PEM technique, however, is a molecular breast imaging modality and distinguishes cancerous cells from normal cells by comparing biological processes and functional properties using a radiotracer. This allows for small masses to be detected, irrespective of their density, and thus the device will be more effective for detecting tumours in women with denser breast tissue.

Another advantage of PEM is the device’s portability, allowing for patients who live in remote locations or with limited mobility to access the same level of healthcare as that available in centralised healthcare facilities. “The device will give all patients equal access
Positron emission mammography is a molecular breast imaging modality that distinguishes cancerous cells from normal cells by comparing biological processes and functional properties using a radiotracer.

to advanced diagnostics as the technology will be equipped on its own wheeled table and can be set up anywhere with an electricity source,” Reznik explains. She and her team are currently building a prototype of the device and, once this stage is complete, the researchers will embark on clinical trials with patients at the Thunder Bay Regional Health Sciences Centre in order to demonstrate the feasibility of the PEM technology as a suitable screening technique for use with patients in the surrounding area.

VALUABLE COLLABORATIONS
Reznik has played a key role in forging close ties and establishing a collaborative network between TBRRRI and Lakehead University. Furthermore, she is partnering with Canadian industry through the Collaborative Research and Training Experience (CREATE) Program, which seeks to develop trainees into successful employees in Canada’s workforce. “Through this partnership we have been able to provide our students with valuable industrial internships at Philips Healthcare and others, allowing them to gain hands-on experience in the process of transferring research from bench to bedside,” she enthuses.

Another one of Reznik’s collaborations, which also offers profitable opportunities to students, is with local spin-off company XLV Diagnostics, a relatively young company developing economical X-ray detectors for digital radiology machines to be used for early cancer detection and treatment. “The ingenuity and enthusiasm my students develop through these industrial experiences, and their desire to benefit the future of healthcare, builds a momentum and synergy that drives new ideas and research platforms that will have major impact in the future,” she aptly states.

Experiences such as these, as well as the 16-week Summer School of Medical Imaging at Lakehead University and TBRRRI created by Reznik – which brings together scientists, researchers, physicians and other professionals in the field of medical imaging and allows them to present their work and research to students – equips undergraduates, graduate students and postdoctoral fellows with the skills necessary for their future careers as medical imaging professionals, something Reznik is passionate about.

ROADMAP FOR SUCCESS
Looking ahead, in addition to expanding and enhancing their collaborations and nurturing the development of the next generation of researchers in the field, Reznik and her team will be starting a company with the ability to manage the production and corporate needs of the PEM device. The researchers are currently working with the Centre for Imaging Technology Commercialization to develop a roadmap for bringing the technique to market. Reznik’s intentions are clear: “For me, it’s not about a single discovery or a quantifiable impact. It’s about thinking ‘outside the box’: developing advanced detector technologies based on exciting, innovative scientific and engineering techniques and not letting myself be biased by the current technologies and the status quo,” she concludes.

PERKS OF PEM
- Less painful than traditional X-ray mammography
- More accurate diagnoses in younger women with dense breast tissue
- Enables detection of smaller masses through analysis of functional properties of tissue
- Portability facilitates access to more women