

the wider view to direct the high-resolution view. Both modes can acquire images in reflectance, fluorescence and fluorescence polarization.

"The non-invasive system and methods we have developed in the course of this project will enable us to identify tumor margins and small tumor nests *in situ*, which can lead to improved outcome of cancer treatments," she says. "The diagnostic application of the technology can potentially replace biopsy, thus reducing morbidity and time associated with this invasive procedure."

Yaroslavsky uses her wide-field, high-resolution optical imaging system, which has proven to be successful in dermatological oncology, in conjunction with a variety of dyes with specific tumor affinity. In addition to skin cancer, she utilizes wide-field, high-resolution optical polarization imaging to identify boundaries of infiltrative brain tumors.

"Our goal is to improve the quality of life and survival in patients with infiltrative brain tumors," she says. "We seek to improve the surgeon's ability to distinguish brain from tumor on a microscopic scale at the margins. Given the demonstrated benefit of resection for patients with a variety of intrinsic brain tumors, we hope that microscopic total resection will result in improved outcomes."

Diagnosing Cancer at Terahertz Wavelengths

Yaroslavsky is also currently collaborating with Prof. Robert Giles of the Submillimeter-Wave Technology Laboratory on imaging malignant and benign skin structures in the terahertz spectral range (see page 13).

"Continuous-wave terahertz imaging has the potential to offer a safe, non-invasive imaging modality that can be used for detecting and treating common skin cancers," says Yaroslavsky.

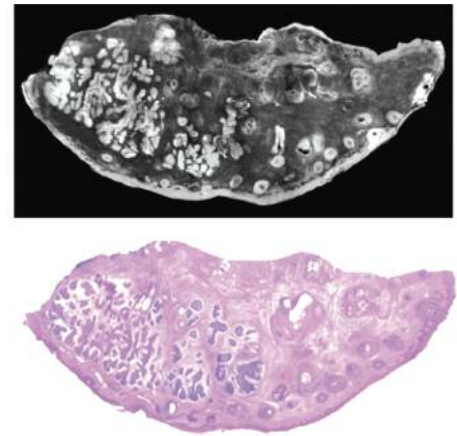
She says terahertz pulse imaging has already shown that there is contrast between basal cell carcinoma and normal skin.

"Continuous-wave imaging offers a simpler, lower-cost alternative to terahertz pulse imaging," she says. "Our goal is to determine the feasibility of using continuous-wave terahertz radiation for detecting skin cancer *in vivo*."

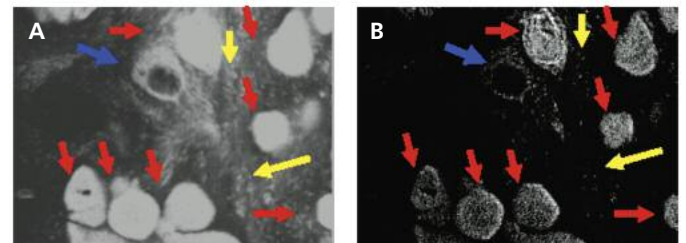
Due to the high absorption of terahertz rays by water, *in vivo* imaging systems have to be reflection based. The project aims to isolate the optimal contrast frequency for a continuous-wave terahertz imaging system and demonstrate reflection-based *in-vitro* imaging of non-melanoma skin cancers.

"After these measurements are validated by histology, the next step is to identify and design a system capable of performing *in vivo* tests at the desired measurement frequency," she says.

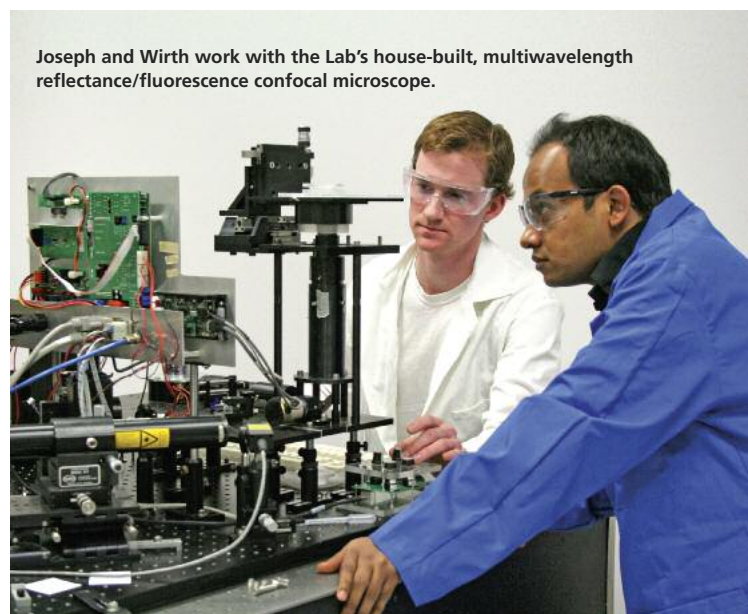
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A fluorescence confocal image (excitation wavelength = 630 nm) of a thick, fresh skin sample (size: 85 × 55 × 5 mm) with basal cell carcinoma and stained with a dye (top panel) is compared to a frozen, stained section (~5 μm thick) of the same sample. The confocal image demonstrates that straightforward comparison with the histological section is possible.



These panels show confocal fluorescence (A) and fluorescence polarization (B) images of a skin sample with micronodular basal cell carcinoma (size: 0.8 × 0.6 mm). The red arrows point to cancer cells, blue to hair follicle and yellow to inflammatory infiltrates. Comparison of fluorescence emission and fluorescence polarization images shows that cancer exhibits higher fluorescence polarization than hair follicles and inflammatory infiltrates.



Joseph and Wirth work with the Lab's house-built, multiwavelength reflectance/fluorescence confocal microscope.