AbstractID: 11936 Title: Where sound meets electricity: the acoustoelectric effect in biomedicine

The acoustoelectric (AE) effect is a well-documented interaction between local pressure and electric resistivity. In recent years, the phenomenon has been revived for applications in biomedical imaging and therapy. My laboratory is developing two new approaches based on this concept: 1) ultrasonic imaging of current flow and 2) novel detection and imaging of an acoustic beam.

Ultrasound Current Source Density Imaging (UCSDI) is a new modality for mapping electrical current deep into tissue. This approach combines moderate acoustic pressure with recording electrode technology to directly image current densities. We have demonstrated feasibility of UCSDI in saline, tissue-equivalent phantoms, neural tissue and direct mapping of the cardiac activation wave in the live rabbit heart. Although potential applications of UCSDI are diverse, we are focusing on enhancing electrical cardiac mapping during ablation treatment of arrhythmias. There are several potential advantages of UCSDI over conventional electrophysiology and electrical imaging, highlighted by 1) enhanced spatial resolution determined by the size of the ultrasound focus (<1 mm); and 2) automatic co-registration of UCSDI with pulse echo ultrasound, depicting current density maps superimposed on heart structure and motion.

In addition to UCSDI, we are also developing the AE hydrophone as a new device for detecting pressure and imaging an ultrasound beam. As clinical applications for ultrasound therapy continue to proliferate—from lithotripsy to ablation treatment of uterine fibroids and cancer—the need for simple, rapid, and accurate estimates of the acoustic field become increasingly important. The AE hydrophone does not depend on a piezoelectric material; instead, a small region with high current density is used as a gain mechanism for detecting ultrasonic waves. I will present early results from initial prototypes and compare with conventional hydrophones, as well as simulations. The AE hydrophone has attractive attributes not typically seen with other devices, including simple construction, low cost, decent sensitivity, and resistant to damage at high intensity ultrasonic fields.