THz Impulse Radar for Medical Imaging

E.R. Brown,[a] Shijun Sung[b], W.S. Grundfest[b,c,d], Z.D. Taylor,[b]

[a]Depts. of Physics and Electrical Engineering, Wright State University, Dayton, OH 45435
[b]Dept. of Bioengineering, UCLA, 420 Westwood Plaza, Los Angeles, CA, USA 90095
[c]Dept. of Surgery, UCLA, 200 UCLA Medical Plaza, Los Angeles, CA, USA 90095
[d]Dept. of Electrical Engineering, UCLA, 420 Westwood Plaza, Los Angeles, CA, USA 90095

The THz impulse radar is an "RF-inspired" sensor system that has performed remarkably well since its development nearly six years ago. It was developed for *ex vivo* skin-burn imaging, and has since shown great promise in the sensitive detection of hydration levels in soft tissues of several types, including *in vivo* rabbit cornea and partial and full thickness burns in rat models. An intriguing aspect of the impulse radar is its hybrid architecture which combines the high-peak-power of photoconductive switches with the high-responsivity and -bandwidth (RF and video) of Schottky-diode rectifiers. The result is a very sensitive sensor system which is quasi-coherent in the sense that its signal-to-noise ratio varies approximately linear with the integration time, but the phase information is discarded, which is beneficial in mitigating the effects of clutter and speckle. This talk will summarize studies done on the optimization of THz impulse radar using optical (Gaussian-beam) and large-signal-processing (MATLAB) analysis. A system-performance example will be presented for corneal hydration sensing, and the inherent affordability of this system compared to existing THz spectrometric (time- and frequency-domain) instruments will be emphasized. This architecture may be optimal in medical imaging applications where the presence of water is a defining disease/injury feature.