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An energy-partition diagnostic and a hydrogel tissue proxy for characterizing dynamics and effects of 133 Mhz burst-mode ultrafast laser ablation

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Plasma-mediated ablation by ultrafast lasers has been widely investigated for its application in material processing, bio-medical surgery and scientific research. High repetition rate burst-mode ultrafast lasers that output pulsetrains of >1MHz repetition rate have shown advantages including higher material removal rate, and extra degrees of control. Ablation by such lasers is a highly dynamic process due to pulses interacting with the plasma created by previous pulses, and development of the ablation crater.

For capturing the dynamics of burst-mode ultrafast laser ablation, we have built an energy-partition diagnostics based on integrating spheres. The device time-resolves specular reflection, diffuse reflection, and transmission of each pulse. Distinct dynamic absorption of glass, metal, and biotissues during ablations by a 133 MHz burst-mode ultrafast lasers are shown using this device.

For studying ablation effects of burst-mode ultrafast-laser on bio-tissues in particular, we have also developed a 3d-living cell tissue proxy that mimics low-tensile strength tissue. The tissue-proxy is optically transparent, and allows diffusion of various fluorescent markers. Such feature allows examining of cell mortality (necrosis & apoptosis) and sub-cellular damage (DNA double strand breaks) post laser irradiation using confocal laser-scanning microscopy.

Primary authors: COVARRUBIAS JARAMILLO, Andres (U); MARJORIBANKS, Robin (U); QIAN, Zuoming (University of Toronto)

Co-author: Prof. LILGE, Lothar (Princess Margaret Cancer Centre and Department of Medical Biophysics, University of Toronto)

Presenter: MARJORIBANKS, Robin (U)

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