Ultrafast Laser Surgery: (Marjoribanks (Physics) / Lilge (Dept. Medical Biophysics) / Akens (TECHNA Institute, UHN))

In this project, we are developing ultrafast lasers (100-300 fs, 1-30 µJ/pulse) as platforms for laser surgery, particularly arthroscopic surgery in the knee. The remarkable feature of femtosecond laser pulses, not true of nanosecond or longer duration, is that they are capable of removing material while hardly heating or damaging the material immediately adjacent. This has special advantages for biotissues, since many of the problems of tissue surgery arise from the cellular response to heat or shockwaves.

We have a particular piece of laser-biotissue interaction science that we would like to examine, which we hope to publish and add to a recent patent application.

We are looking for a student with interest in physics and biology as he or she will test the effect of the laser on tissue (cartilage and/or bone). The student will be involved in modifying the optical laser setup, designing, and conducting the experiment and then analyzing the results. The effect of the laser treatment on the tissue will be evaluated using confocal and non-linear microscopic techniques to assess thermal damage to the tissue and the extent thereof, molecular-biological assays of DNA damage, and micro-Raman spectroscopy to identify particular molecular structural changes in the surrounding tissue.

The student on this project will have an interest in biophysics and knowledge of cellular and molecular biology. He or she will have a direct daily impact, preparing the tissue samples, making modifications to the optical setup, learning to align and operate ultrafast lasers, helping to design and conduct interaction experiments, and then taking responsibility in the analysis of the results.

State-of-the-art diagnostics that we will train you for include: confocal microscopy, molecular-biological assays of DNA damage, and micro-Raman spectroscopy. The student will get direct hands-on experience of these important modern tools. Laser safety training will be provided, as well as training in ultrashort pulse lasers and laser-plasma physics.

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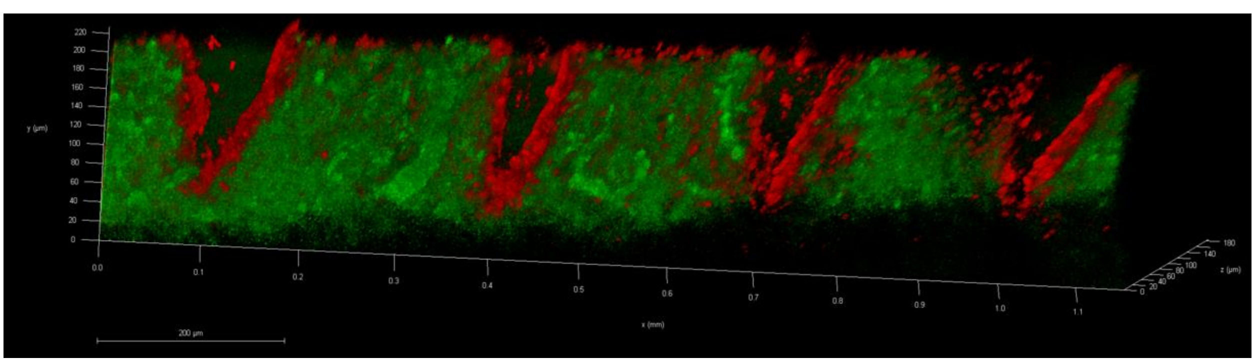

Graph 1: Confocal laser-scanning image of laser cuts made in ex vivo cartilage. Green assay-stain marks viable cells; red assay-stain marks necrotic cells. Altogether, these show the impact of laser heating, and shockwaves, on cartilage tissue. Drills and saws routinely generate significant frictional heat, and the dead-tissue layer created makes grafts and healing more difficult.