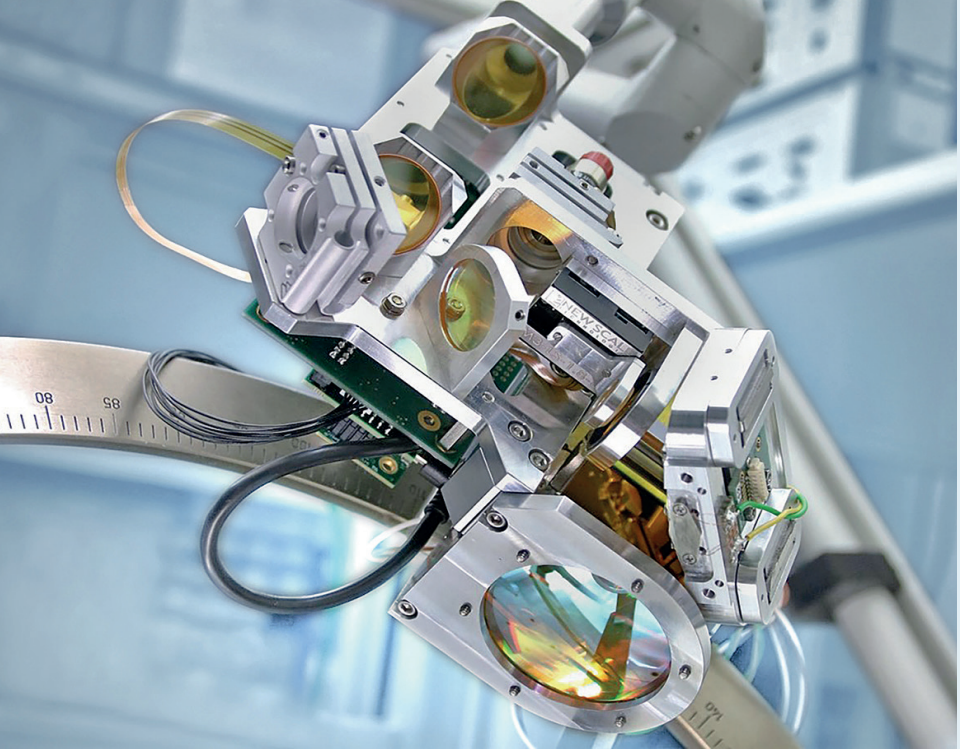

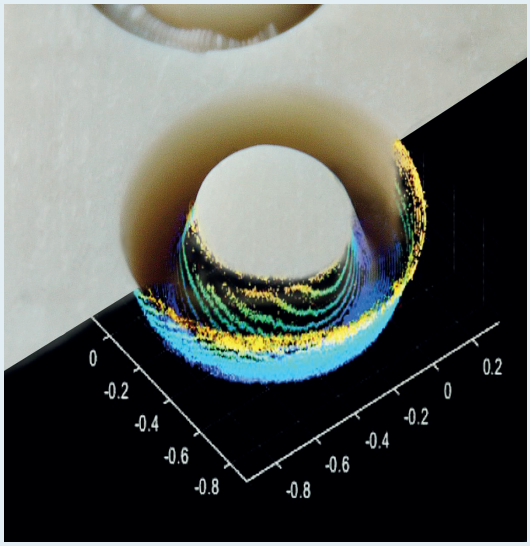

1 Laser applicator with integrated mini-scanner, telescope, OCT sensor and beam position monitoring.
2 Circular laser cut on a bovine bone with superimposed point cloud from the measurement data of the OCT scan.

Laser craniotome for awake surgery for deep brain stimulation

Towards gentle craniotomy in awake patients

The shaking paralysis (tremor) that occurs in patients with Parkinson's disease can be suppressed by deep brain stimulation (THS) with a brain pacemaker. To accomplish this, a surgeon must position an electrode with submillimeter precision in the target volume of the brain while functionally testing it on the awake patient. The combination of THS and awake surgery significantly increases the success rate in the treatment of patients with severe movement disorders. However, opening the skull (craniotomy) causes massive stress in awake patients who are only locally anesthetized. Scientists at Fraunhofer ILT are, therefore, developing a laser surgical system for craniotomy to minimize patient trauma and increase acceptance of the effective procedure.

Innovative laser surgery system combines cutting laser beam, mini-scanner and OCT measurement

The laser cutting process uses an applicator to distribute pulses of a CO_2 laser beam along the cutting line by means of a mini-scanner, such that the 2-mm-wide laser cut can be made efficiently in bone to a depth of 6 mm without causing thermal tissue damage. In addition to the cutting laser, an OCT measurement beam is guided along to measure the cutting depth and residual bone thickness during ablation. This real-time monitoring is intended to prevent injury to the underlying hard meninges (dura) and brain.

The laser ablation process investigated here was implemented in a demonstrator for the use case of deep brain stimulation. All subsystems such as mini-scanner, OCT sensor, beam monitoring and the cutting laser system can be monitored and controlled via control software. In an automated process sequence, the proof of concept has been provided on a sheep skull with the deep brain stimulation demonstrator. A round bone flap of 10 mm diameter and 3 mm thickness was cut out and the cutting depth was determined with an integrated OCT measurement. The laser craniotome is designed for cutting hard tissue on the skull and its functional scope can be extended to other applications such as brain tumor surgery. The project is funded by the Fraunhofer-Gesellschaft within the research program ATTRACT under the project name STELLA.

Authors: Lazar Bochvarov M. Sc., Christina Giesen M. Sc., lazar.bochvarov@ilt.fraunhofer.de, christina.giesen@ilt.fraunhofer.de

Contact

Dr. Georg Meineke
Group Manager Laser Medical Technology and Bioanalytics
Phone +49 241 8906-8084
georg.meineke@ilt.fraunhofer.de