A laser for nanomedicine

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A modified femtosecond laser can correct poor eyesight and identify malignant melanomas. In addition, it represents an effective tool for laser nanomedicine: It can be used for example to drill nanoholes in cellular membranes and to transfer genes into cells by means of light.

Sixty-four percent of Germans cannot see properly without glasses or contact lenses. One in two short- or long-sighted adults could be treated by a laser operation, and femtosecond lasers are being increasingly used. This type of laser can be focussed through the tissue directly onto the working area, saving time and improving the healing process.

There is a disadvantage, however: residual radiation permeates the eye right through to the retina, and may cause impaired vision. Karsten König and his team at the Fraunhofer Institute for Biomedical Engineering IBMT are working on eliminating these side effects. “We are attempting to remove tissue constituents gently and very precisely using extremely low pulse energies of just a few nanojoules,” explains König. This is made possible by a heavily modified femtosecond laser system with a very high pulse sequence, which can focus its beam with great accuracy using precision optics from Zeiss.

The laser paves the way for entry into nanolaser medicine, a new branch dealing with the diagnosis and therapy of individual cells. Depending on the laser power and optics used, the system can be a “femtoscope” providing insights into living tissue which are a thousand times more precise than the best computer tomographs. It is also a precision tool.

The team of research scientists succeeded in performing the world's smallest incision into living tissue – with a width of just 70 nanometers. This opens up new possibilities: gene transfer by light, in which foreign genetic material is inserted into living cells using ultra-short laser pulses, without destroying the cells. "In this way we can introduce pharmaceutical agents or genes into individual cells," emphasises König. He has been awarded the new Technology Prize for his human-centered technology.

The first application – diagnosis and therapy of melanomas – was realized in cooperation with dermatologists at Jena University Hospital. The "femtoscope" renders the cell layers of the skin visible. Diseased cells are diagnosed by comparing samples. In future, doctors could use the same device for treatment: The diseased cell would be radiated with increased laser power and destroyed. After approval of the process, it would no longer be necessary to perform biopsies and time-consuming histological tests. The laser system could also be used outside the medical field, in microchip manufacture. The high-precision lasers are able to produce structures in silicon which are smaller than 100 nanometers.

Source: Fraunhofer-Gesellschaft