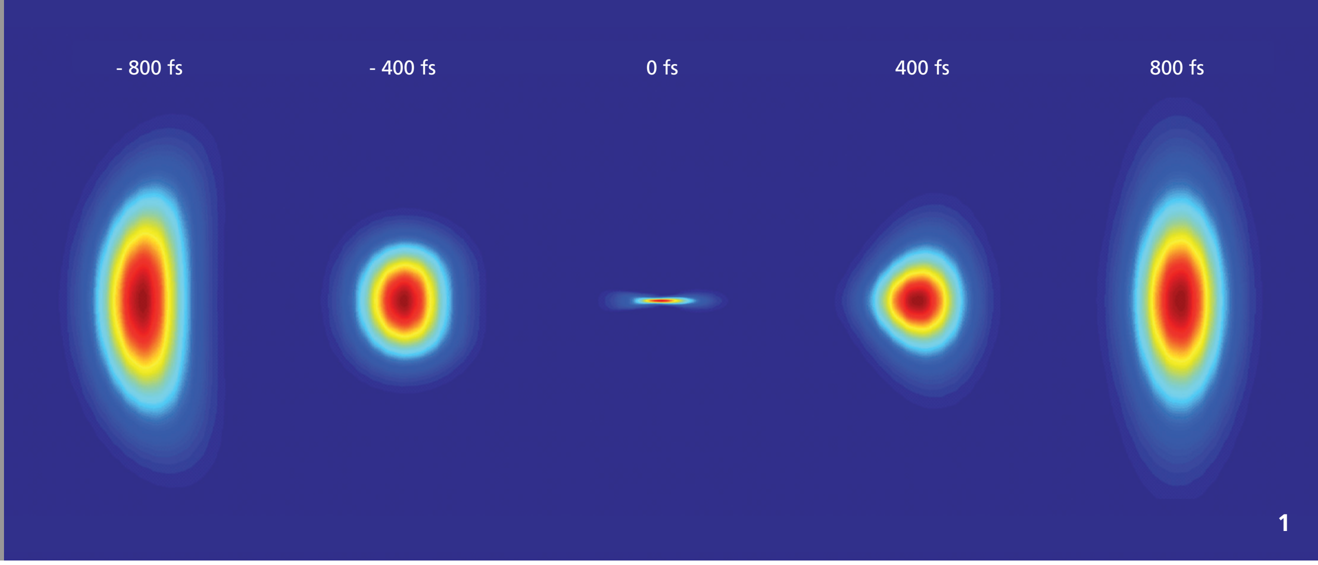

DEFORMATION OF ULTRA-SHORT LASER PULSES BY OPTICAL SYSTEMS

Task

The use of scanning systems has been proven valuable in laser material processing, but, for processing operations with ultra-short laser pulses (< 1 ps), it places new requirements upon the optical systems that focus the radiation behind the scanner. Dispersion in the beam guiding and forming optics causes delays between pulse and phase front, leading to a scanning angle-dependent deformation of the pulse front. Consequently, locally varying pulse characteristics upon the workpiece result during material processing, which cause undesirable processing results dependent upon the processing location. This projects aims to simulate scanning angle-dependent pulse front deformations for optical systems and to develop methods to compensate for them.

Method

The complete field information consisting of amplitude and phase is simulated at the observation plane behind an optical system on the basis of wave-optical methods. From this, the pulse front as well as the phase front is extracted, whose temporal difference is calculated and, subsequently, the deformation is determined, or rather the tilt of the pulse front in relation to the phase front.

1 Spatial intensity distribution of a focused laser pulse at different times.

Result

First simulations show that the pulse front of a laser pulse, which passes through an f-theta optic at an angle, is tilted compared to the propagation direction. This so-called pulse front tilt is dependent upon the scanning angle. Deformation and tilting of the pulse front lead to a significant extension of the pulse duration in the focus as well as an enlargement of the focusing volume.

Applications

The simulations enable a user to estimate how much optical systems influence the focusing behavior and, thus, material processing itself. Further steps in developing the process consist in integrating the described analysis process in the design process of optical systems in order to reduce scanning-angle dependent effects upon pulse shaping.

Contact

M.Sc. Lasse Büsing
Telephone +49 241 8906-359
lasse.buesing@ilt.fraunhofer.de

Dr. Jochen Stollenwerk
Telephone +49 241 8906-411
jochen.stollenwerk@ilt.fraunhofer.de