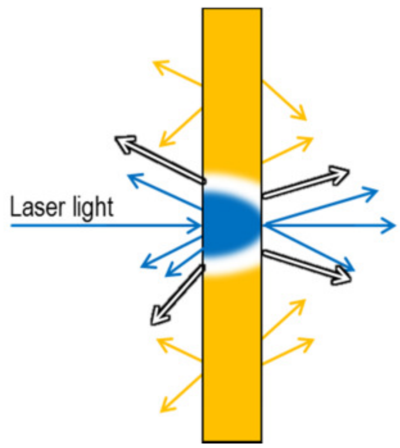
Simulation of laser-based lighting systems

Supervisor: Prof. Dr.-Ing. Roland Lachmayer, Institute of Product Development
Dr. rer. nat. Nadine Tinne, Laser Zentrum Hannover e.V.

Project ID: A11

Laser-based white light sources, so-called remote phosphor systems, offer a significantly higher luminance than LEDs. Optical systems that generate a specific light distribution may become much smaller using laser than systems with LEDs. One application of these light sources are automotive headlamps since designers claim for slim contours while the ECE regulations demand specific light distributions. The solution: A light source with high luminous flux and small étendue. While the semiconductor laser can be focused very precisely on the phosphor layer, the conversion element is often considered the weak spot of remote phosphor systems. The high-intensity exciting laser beam in combination with the limited thermal conductivity of ceramic phosphor materials leads to thermal quenching. The conversion layer exhibits strong temperature gradients, hence position-depending properties.

In this project laser-based lighting systems are being investigated and simulated. Today's optical simulation tools typically describe phosphor materials as additional light sources, based on a data base. Using ray tracing and wave optic tools the exciting light as well as the converted light can be described. But the correlation between the temperature profile within the phosphor material and its emission characteristics are not fully implemented. Thus this simulation strategy is insufficient and a coupling of different simulation tools is necessary. One goal of this project is the development of optical systems working on the thermal limit of the conversion layer. This would offer a light source with a very small étendue without sacrificing a significant amount of the systems efficiency.



Emission characteristics of a phosphor sample

This is a third-party funded PhD-project of Tailored Light. Tailored Light is a coordinated PhD-program of the Hanover Centre for Optical Technologies from the Leibniz Universität Hannover together with the Hochschule Hannover, the Laser Zentrum Hannover, the HAWK Hildesheim/ Holzminden/ Göttingen, the TU Braunschweig and the TU Clausthal.

Students interested in this or another project of Tailored Light can apply for fellowships. Have a look at www.tailored-light.uni-hannover.de for details.