Optical beam coupling unit for OCT dosimetry control during retinal laser treatment

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Although the eye is a small part of the body, diseases or disabilities of the eye have severe consequences on activities of daily living. Diseases of the center of the retina can result in a significant and irreversible disruption of central vision. In an aging society, age-related macular degeneration (AMD) is especially problematic and frequent, while the diabetic retinopathy and its consequences are the main cause of blindness in people of working age. 1

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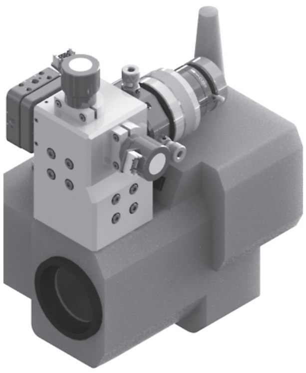
Introduction

For treatment of these diseases using selective retina therapy (SRT), short laser pulses are applied in the microsecond range to selectively damage the retinal pigment epithelium (RPE). This should ideally lead to a reduction of macular edema and neovascularization and thus to a stabilization or even improvement of visual acuity. The triggered effect and the energy dose of the laser must, however, be precisely controlled because of the extremely sensitive tissue in the retina. Therefore, the availability of a secondary system, monitoring the introduced tissue damage is crucial. In this project, this is achieved by an infrared laser, which is coupled into the therapy setup to enable measurement of visual changes in the retina in real time by using optical coherence tomography (OCT). To enable simultaneous OCT measurement during SRT, the treatment and therapy laser need to be combined in order to share the identical delivery optics.



Isometric view of the optical beam coupling unit for OCT dosimetry control during retinal laser treatment

Approach

The merging of the two laser systems is optically complex. To guarantee a high quality OCT measurement, the placement of the deflection mirrors should be optimized. Further, optical losses in the system should be reduced and the alignment of the two lasers should be optimized as well. The newly designed system must not limit the physician in any way and must operate reliably and stably. It must also adhere to certain requirements defined by the clinical protocol. To redesign and optimize the system in the construction, the focus is on saving space and compactness to zoom out optical losses. Subsequently optical simulations and tests show whether it is possible to further improve the focusing by replacing the existing achromatic lens with an aspheric lens. Based on the results, the optical module is constructed and appropriately integrated on the scanning digital ophthalmoscope (SDO).

Result

The newly developed system contains several improvements. The spot size of the SRT therapy laser can be precisely adjusted via a zoom housing. Further, a XY translational mount allows an accurate alignment of the SRT therapy laser compared with the OCT laser which features a kinematic mount with tip and tilt. The SRT therapy laser can also be completely shut off with a zero aperture iris. By replacing the achromatic lens with an aspheric lens, aberrations are reduced and the quality of the top hat energy distribution profile of the SRT-Laser has been improved. All of these improvements are packaged in a system, which is 15 mm shorter in its length and 45 mm in height. This guarantees more freedom of movement to the attending physician and high graded therapy because of the reduced optical losses.