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Zemax OpticStudio toolbox as a method for visual quality analysis in multifocal contact lenses

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Aim: The purpose of this study is to explore Zemax OpticStudio as a toolbox to analyze the visual quality of optical systems such as multifocal contact lenses for presbyopic patients. The Visual Strehl ratio (VSOTF) for on-axis and off-axis objects and for different aperture diameters were studied. Moreover, Zemax opens the possibility of assessing more visual merit figures (aberrations, spot diagrams, image simulation, distortion etc.) not usually given for multifocal contact lens evaluation, specially for changes in the visual field.

Experimental method: A multifocal contact lens with centre-near design was simulated in Zemax OpticStudio. As developed in previous scientific articles which only take the wavefront coming out from the lens into account [1], a study of VSOTF was performed, with the difference that we also analyzed an off-axis object at 20° and higher fields and far distance. The sagittal data (vertical field

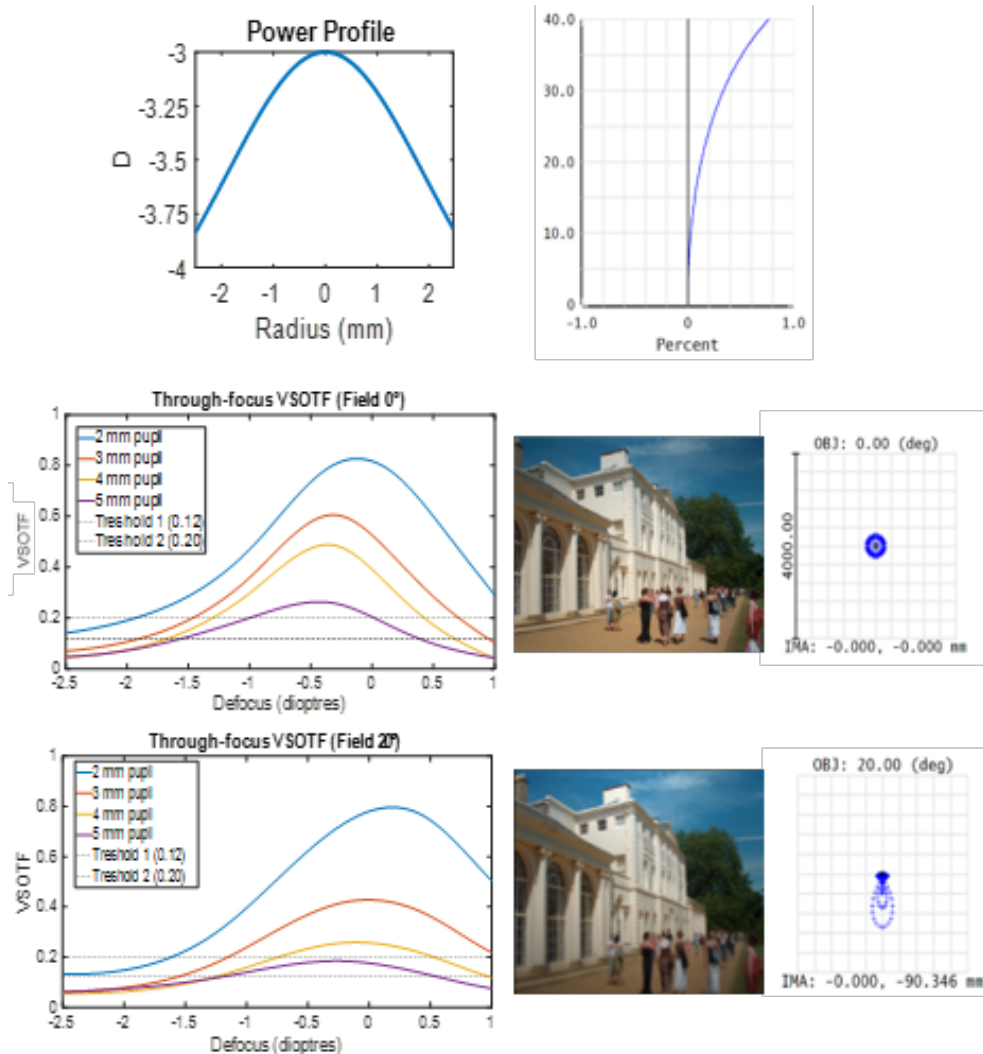


FIGURE 1. Image quality results. Power profile and distortion with field (top), VSOTF for several pupils and object field (left, 0° and 20°), image simulation (image size 20°, center for image centered at 0°, bottom centered at 20°), and spot diagrams (right column).

deviation) of the modulation transfer function via fourier transform (FFT-MTF) was obtained from Zemax for several distances and aperture diameters. Afterwards, the data were transferred to Matlab, where the VSOTF formula was calculated, taking into account a nominal contrast sensitivity function [2]. Several quality curves were displayed. At the same time, the optical aberrations of the system, such as the Optical Path Difference (OPD), Ray Fan, spot diagram and

image simulation were studied and compared for on-axis and off-axis objects with Zemax OpticStudio [3].

Results: The results from the quality analysis are depicted in Figure 1. The method evaluates different pupil diameters easily. On axis, the VSOTF curves for all the pupil diameters are above the ocular FFT-MTF threshold, considered 0.2. In the off-axis analysis (field of 20°), the real prescription of the lens changes by around 0.25 diopters. For fields from 20° to 40°, it changes by 0.11D per field degree. The maximums of the VSOTF decrease and the curves are displaced to the left as the pupil gets bigger for both on-axis and off-axis representations. From 0° to 40°, the maximum of VSOTF decreases by 17.65%, 34.8% and 44.4% for 2,3,4 mm diameter, respectively. Image quality and spot diagrams show an increase of aberrations with the field not normally reported. Distortion curves were also studied (0.2% at 5° and 0.76% at 40°).

Discussion: The results show image quality and prescription changes with the object field that could vary among different lens design analyses. The increase of aberrations with field extends the depth of focus and change the image quality (see Figure 1). Zemax OpticStudio provides more merit figures than usually reported, especially variations with field of view that could be very interesting in multifocal contact lens design for presbyopic applications.

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