sampling within each frame. A downside of the resonant scanners is that they scan in a sinusoidal fashion and therefore do not sample the scanned field with the same frequency throughout. With a fixed frequency pixel clock, the center of the field for which the scanner is moving fastest, is sampled less frequently then the edges. The design of the AOSLO needs to be set so that the sampling frequency at the center of the field is sufficient for foveal cones.

Focus Adjustment: While the depth of focus is typically around 60 microns for AOSLO imaging, precise focus adjustments can be made in steps of 0.05D, which correspond to approximately 20 microns in depth at the retina. When imaging the foveola, the defocus is adjusted to optimize the visibility of the smallest cones. This focus will be slightly different than what is required to provide the best focus of neighboring cones since the ELM tends to be slightly elevated at the foveola. The elevation is approximately 25 microns, which corresponds to a defocus shift of ~0.06D [34]. As a result it is important to consider the defocus position carefully and make adjustments to optimize the visibility of the smallest cones, especially when imaging the foveal region.

Anisoplanatism: It is possible that topography of the inner retina at the foveal pit could introduce anisoplanatism across the AOSLO field. If this was the case, then the average wavefront across the field, which is what the AO system in a typical AOSLO uses to correct the wavefront, would be compromised everywhere and may limit the quality of the optical correction. The refraction of light along the slope of the pit is about 1 degree [40]. Owing to the narrowness of the scanning beam at the retinal surface, we expect that any aberrations introduced due to anisoplanatism will have a negligible effect on the overall aberrations observed. Other studies have shown that the isoplanatic patch size at the fovea is 0.81 degrees on average [41], which is the field size we use for foveal imaging.

5. Conclusions

Developing a better understanding of the limits of AOSLO systems that use low-coherence light sources is an essential step on the path toward recording the highest fidelity images of the retina. This paper carefully models the process of AOSLO imaging of foveal cones, taking into account the nature of the light source as well as the unique structure of the cones and the way they pack into a mosaic, particularly cones in the foveal center. Our simulations compare well with actual images recorded in our system, lending support to the notion that interference artifacts impose limits on our ability to resolve cones in the foveal center. The model has also led to new ideas on potential ways to overcome these limits.

Acknowledgments

The authors would like to thank Joe Carroll for the cone coordinates used in the model. This work has been supported by the National Institute of Health grants NIH EY014375 and NIH EY018986, the National Science Foundation grant NSF AST9876783, AF contract FA8650-05-C-6552, and the AOF Ezell Fellowship.

#133434 - $15.00 USD Received 17 Aug 2010; revised 13 Oct 2010; accepted 22 Oct 2010; published 15 Nov 2010