Supplemental Document

applied optics

All-fiber probes for endoscopic optical coherence tomography of the large airways: supplement

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In order to determine if Zemax simulations (as opposed to the ABCD method) would yield better agreement with the measured beam profiles, simulations with OpticStudio (Zemax LLC.) were performed for several ball lens probes. The measured l_s and r_b dimensions of fifteen ball lens probes, before applying the 10 µm and 5 µm modifications as described in the Methods section, were used to create lens models in OpticStudio. The working distance (WD) and spot size (SS) of these probes were estimated using the paraxial Gaussian beam propagation, physical optics propagation (POP) and geometrical ray tracing options available in the program. The values of WD and SS obtained from these simulations were compared against the values obtained by fitting a Gaussian to the measured beam profile and also to the results from the ABCD model that used the same l_s and r_b dimensions. The results of these comparisons are summarized in Figure S1. The geometrical ray tracing method yielded incorrect values for the beam SS and the WD, and results obtained from this method did not compare well with the ABCD predictions. The results obtained from the paraxial Gaussian beam propagation method were identical to the ABCD predictions, which is to be expected as they use identical models. The POP method, expected to be the most physically accurate, yielded values that were very close to the ABCD results.

Except for geometrical ray tracing, all methods appeared to significantly overestimate SS from that measured in the experiments. The agreement between the measured and the ABCD predicted results improved when the measured value of r_b was reduced by 5 µm and the measured value of l_s was increased by 10 µm, as described in the Methods section. Therefore, the differences between the measured and predicted beam parameters are believed to be a result of uncertainties in the measurement of the lens segment dimensions.

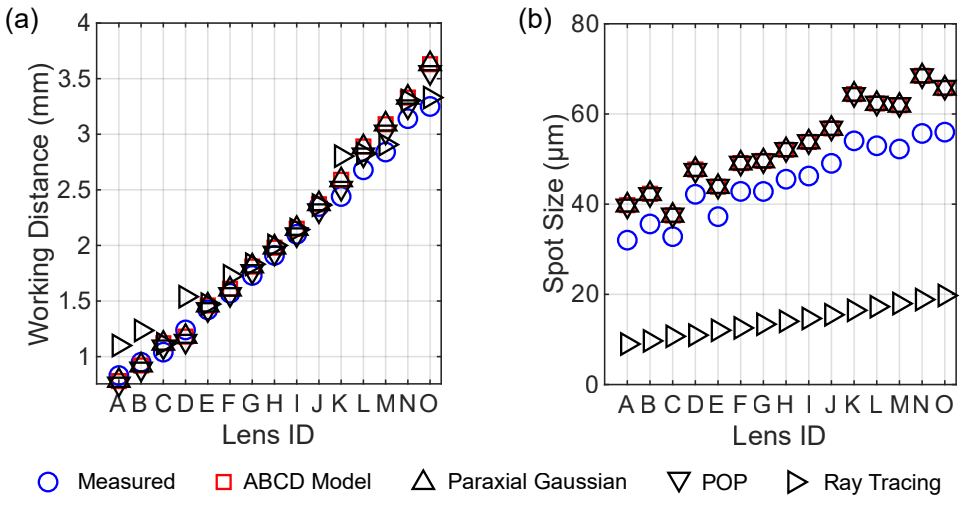

Fig. S1. Zemax and ABCD comparison. (a) Measured working distance for several ball lens probes compared against ABCD predictions and OpticStudio simulations using the paraxial Gaussian beam propagation, physical optics propagation (POP) and geometrical ray tracing options. (b) Measured spot size compared against ABCD predictions and OpticStudio simulations.