

# User Manual: Phantom for Measuring Lateral Resolution and Contrast of Ophthalmic Adaptive Optics (AO) Imaging Systems

## Tool Reference

RST Reference Number: RST26OM04.01

Date of Publication: 05/05/2026

Recommended Citation: U.S. Food and Drug Administration. (2026). *Phantom for Measuring Lateral Resolution and Contrast of Ophthalmic Adaptive Optics (AO) Imaging Systems* (RST26OM04.01). <https://cdrh-rst.fda.gov/phantom-measuring-lateral-resolution-and-contrast-ophthalmic-adaptive-optics-ao-imaging-systems>

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## Phantom for Measuring Lateral Resolution and Contrast of Ophthalmic Adaptive Optics (AO) Imaging Systems

### Introduction

This document describes the materials and methods to image an AO lateral resolution and contrast phantom fabricated and characterized per the reference below.

### Materials

Item	Quantity	Supplier (Product ID[s]) *recommended supplier and products; alternatives are possible	Image(s)
Model eye with pre-installed phantom	1	FDA	 <div style="display: flex; justify-content: space-around; margin-top: 5px;"> <span>Front view</span> <span>Back view</span> </div>
Adjustable iris	1	Thorlabs (SM1D12C)	
Neutral density filter with anti-reflective coating	1	Thorlabs* (NE05A-B)	

### IMAGING INSTRUCTIONS

1. Mount model eye to chin rest or other sturdy element near AO system exit pupil. Cage rod holes in bottom of model eye may facilitate mounting.
2. Thread adjustable iris onto front of model eye. Do not overtighten, in case removal is necessary while model eye is mounted. Open iris fully.
3. Align front surface of model eye lens with exit pupil in the axial dimension by one of two methods:
  - a. Use the known distance from a reference surface in the AO system.
  - b. Visualize spots on AO wavefront sensor live image and adjust model eye axially until image wobble is minimized.

4. Align model eye in lateral dimensions with exit pupil.
  - a. Visualize spots on AO wavefront sensor live image and close iris partially until vignetting is observed.
  - b. Center vignetted image in both lateral dimensions within the wavefront sensor pupil.
5. If wavefront sensor image exhibits intensity saturation, insert neutral density filter near final optic of AO system and tilt slightly to deflect its specular reflection just outside the system pupil.
6. Close the AO system control loop to minimize wavefront error.
7. Visualize the primary live AO image and add sphere (defocus) to the AO deformable mirror for visually optimum image sharpness across the field of view.
8. Using the two actuator screws on the model eye, adjust the lateral position of the phantom within the model eye to center the arrays and/or bars of interest in the AO field of view.
9. If desired, hold the deformable mirror at the optimized prescription to prevent AO correction drift during the imaging session.
10. Acquire and save AO images.

#### **USAGE NOTES**

1. Do not touch the model eye lens surface. Put a lens cap on the model eye when not in use.
2. Note that the model eye actuator translation limits are +/- 1 mm. Pay attention when approaching the limits and do not use excessive force on the actuators.

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#### **Reference**

A. Agrawal, I. Rosenthal, D. M. Fitzgerald, Z. Liu, D. X. Hammer, R. D. Sochol, and A. Agrawal, "3D-printed phantoms for measuring lateral resolution and contrast performance of ophthalmic adaptive optics imaging systems," *Biomedical Optics Express*, accepted for publication (2025). DOI: 10.1364/BOE.551755