Decoupling the image-plane and low-order wavefront sensors for the PICTURE-C coronagraph

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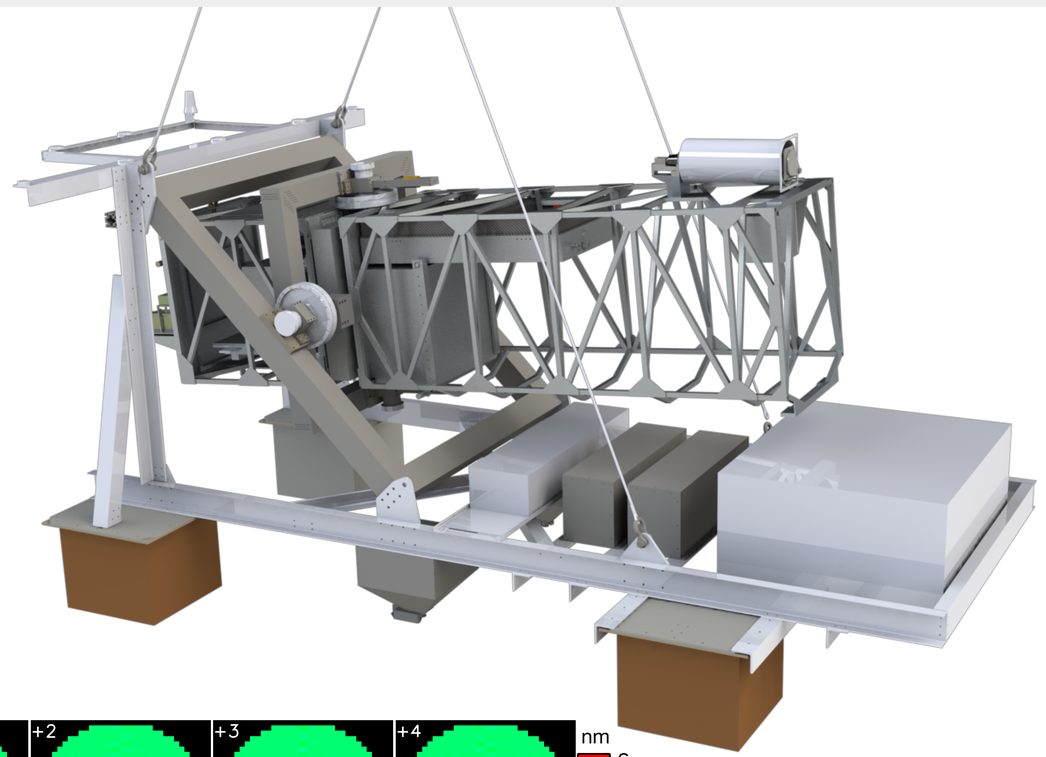
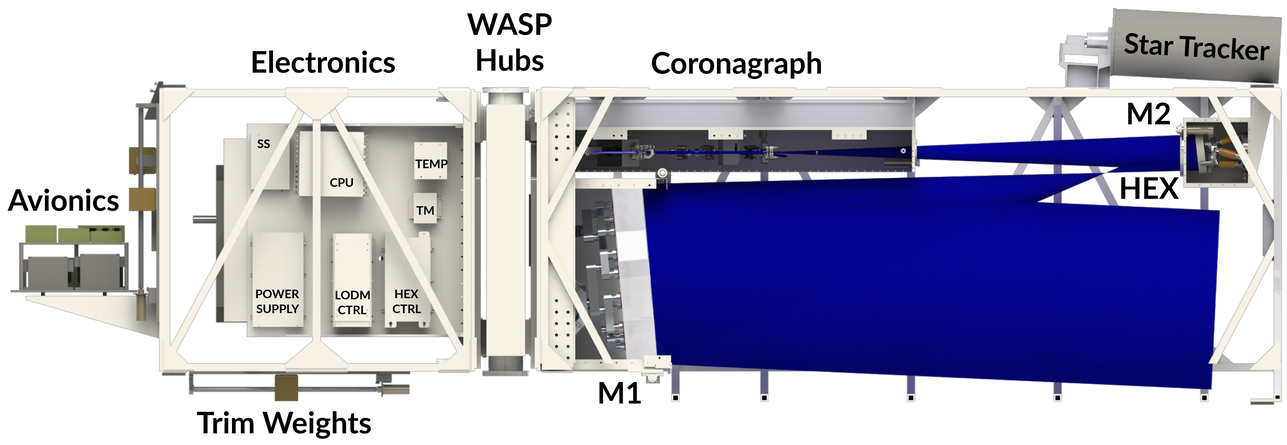
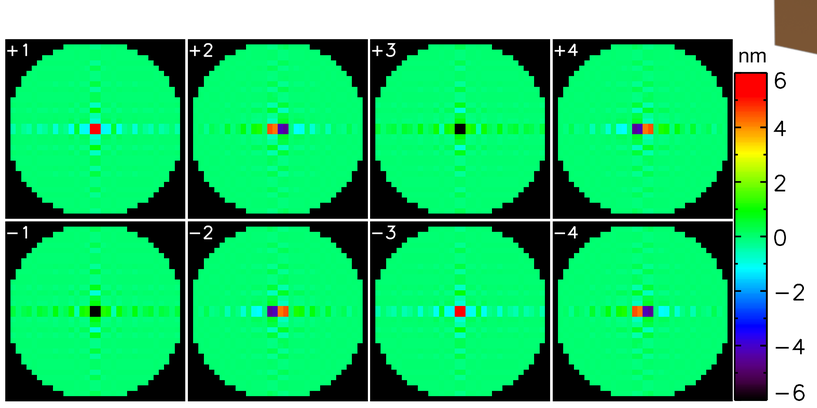
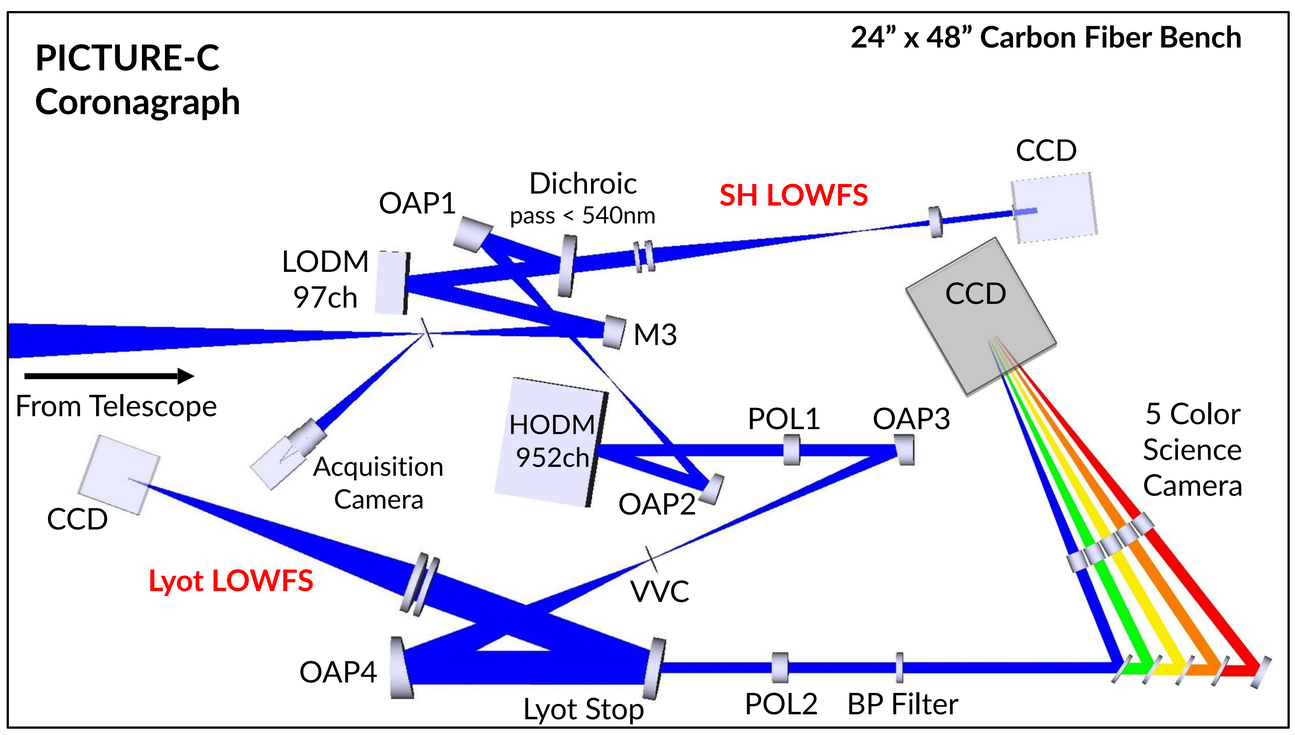
Abstract: The Planetary Imaging Concept Testbed Using a Recoverable Experiment - Coronagraph (PICTURE-C) mission will directly image debris disks and exozodiacal dust around nearby stars from a high-altitude balloon using a vector vortex coronagraph. PICTURE-C employs both image-plane wavefront sensing for high-order wavefront control and a reflective Lyot-stop sensor for low-order wavefront control. Since both of these systems lie downstream from the coronagraph's deformable mirror, and since both must run simultaneously, they must be calibrated as to not interfere with each other. The deformable mirror probe patterns required for image-plane sensing appear as wavefront errors to the low-order sensor. This paper presents simulations of low and high-order wavefront sensing for PICTURE-C and calibration techniques for decoupling the two sensors.

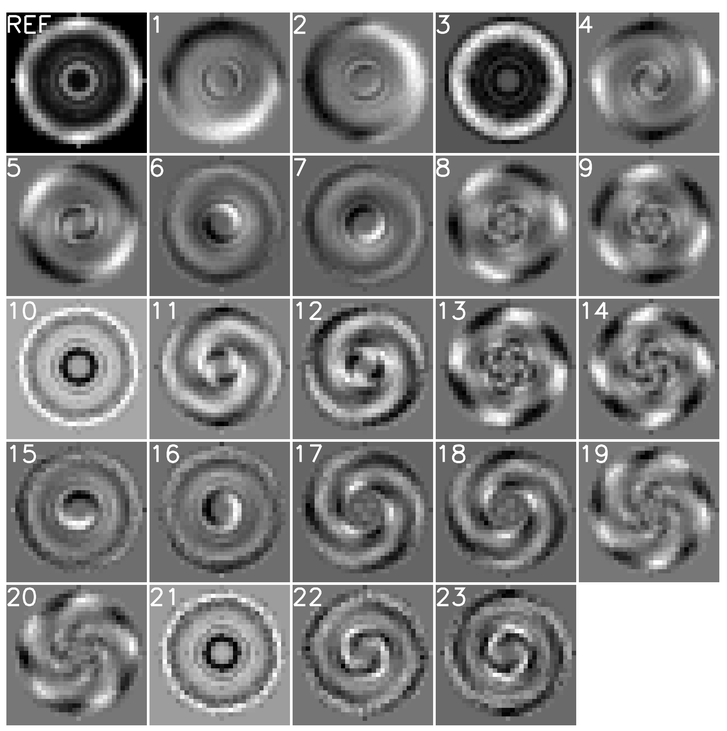


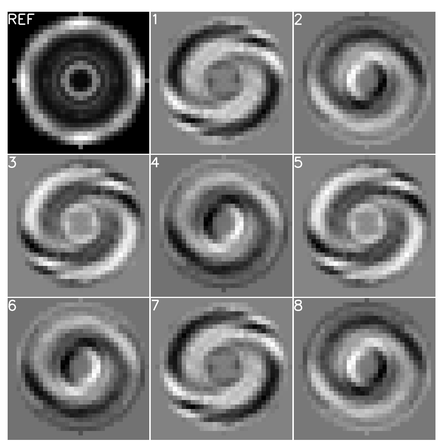




HODM probe patterns for HOWFS





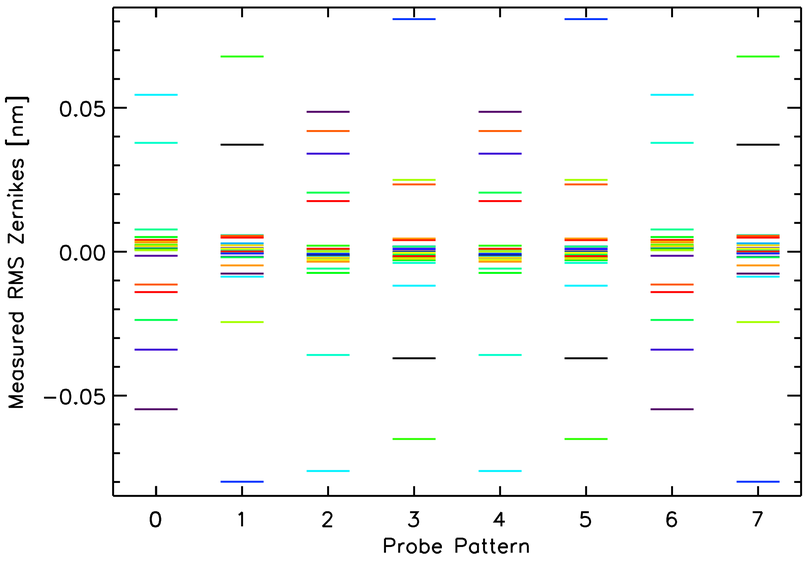


LLOWFS influence images for HODM probes

LLOWFS influence images for LODM Zernikes

HOWFS & LOWFS cross-coupling:

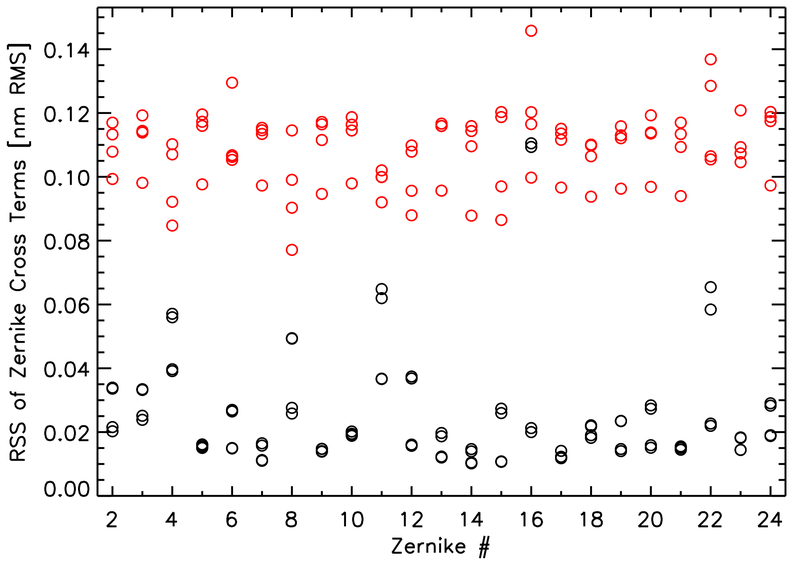
HODM probe patterns register as Zernikes on LLOWFS



LLOWFS Zernike measurement of each HOWFS DM probe pattern

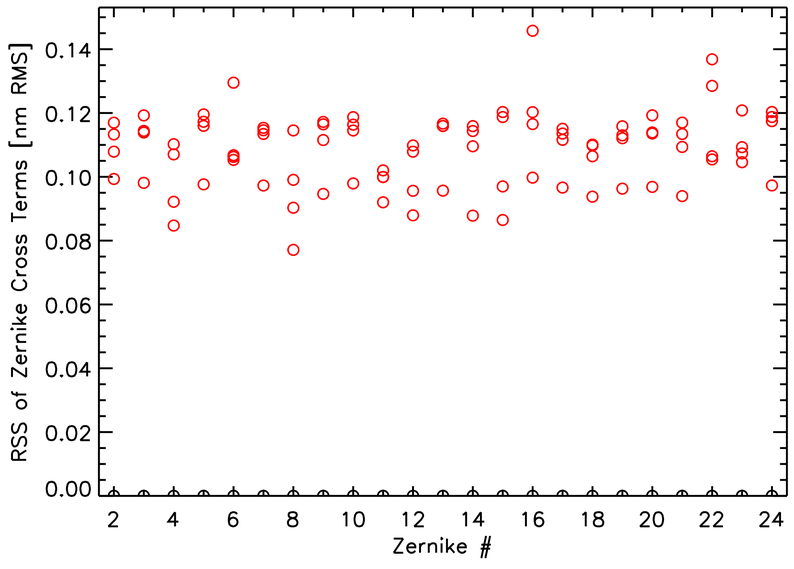
Single-point calibration:

Use unique reference image for each HODM probe



Multi-point calibration:

Use unique Zernike matrix for each HODM probe



The Zernike on the X-axis is commanded on the LODM with a 10nm RMS amplitude. The dots show the RSS of all LLOWFS-measured Zernikes other than the commanded one. Each dot represents one of the 8 HOWFS probe patterns.
Red is uncalibrated. **Black** is calibrated.