Laboratory Demonstration of High Contrast Using PIAACMC on a Segmented Aperture

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To directly image and characterize exoplanets, starlight suppression systems rely on coronagraphs to optically remove starlight while preserving planet light for spectroscopy. The Phase-Induced Amplitude Apodization Complex Mask Coronagraph (PIAACMC) is an attractive coronagraph option for the next generation of large space telescopes optimized for habitable exoplanet imaging: PIAACMC offers high throughput, small inner working angle (IWA) with little loss in image quality. PIAACMC is also compatible with segmented apertures, with little loss in performance compared to a full pupil. Coronagraph compatibility with segmented aperture is essential for the success of habitable planet characterization with future large apertures, such as the Large UV / Optical/ Infrared (LUVOIR) and HabEx telescope mission concepts currently under way to inform the 2020 decadal survey.

We propose a three-year effort aimed at laboratory validation of the PIAACMC concept for segmented apertures. The effort builds upon the successful demonstration of PIAACMC for the centrally obscured WFIRST pupil, and re-uses numerical tools, test facility and team experience that have been acquired during this process. Our high contrast demonstrations will be conducted at the High Contrast Imaging Testbed (HCIT) at JPL, with supporting testing and component validation performed at the Ames Coronagraph Experiment (ACE) testbed. At the end of year 2, we will demonstrate monochromatic performance with a 2 λ/D IWA and a 1e-9 raw contrast (Milestone #1). Similar performance will then be demonstrated in a 10% wide spectral band in year 3 (Milestone #2).

The team, consisting of coronagraph experts at NASA Ames, JPL, and University of Arizona, will design the PIAACMC for a segmented aperture, and procure its key components: aspheric mirrors and masks. The focal plane mask, which in the PIAACMC architecture diffracts starlight away from the geometric pupil, is a critical component of the coronagraph, and multiple design / fabrication / testing cycles will be exercised in the course of the effort. The mask will be fabricated at JPL's MicroDevices Laboratory (MDL), with alternative design and manufacturing processes evaluated in parallel at the University of Arizona.

Our broadband 1e-9 contrast demonstration of the PIAACMC architecture on a segmented aperture will mature it from technology readiness level 3 to 4 in the context of the LUVOIR and HabEx mission concepts to be evaluated in the 2020 decadal survey.