

FY24 Strategic Initiatives Research and Technology Development (SRTD)

Optimization and System Integration of Photonics for Advanced Astrophysics Mission Concepts

Principal Investigator: Jeffrey Jewell (398); **Co-Investigators:** Luis Pereira da Costa (389), Tobias Wenger (389), Dylan McKeithen (383), Ryan Briggs (382), James Wallace (326)

Strategic Focus Area: Photonics | Strategic Initiative Leader: Charles Lawrence

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Objectives:

Develop a photonic component design, fabrication, and test capability leading to instruments on the critical path to infusion in future astrophysics missions.

Iterative development cycle: photonic circuit design, fabrication, and test
Photonics testbed facilities for end-to-end instrument development

Background:

- Key 7x challenges enabled:
 Focal plane wavefront sensing and control for segmented apertures
- Near-ideal small inner working angle coronagraphs
- High resolution, high throughput photonic spectrographs





Prototype Dynamic Photonic Integrated Circuit (PIC), with 21 input and output waveguides, capable or sorting an arbitrary mode with all the light in that mode output on one channel. The PIC can be integrated into the back end of the lantern array shown above, providing an end-to-end photonic coronagraph.

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Publications:

Dylan McKeithen et al, "Hardware Development Towards the Demonstration of an Ideal Photonic Coronagraph", Proc. SPIE Vol. 13092, 130925-V, 2024, doi: 10.1117/12.3020775

PI/Task Mgr. Contact Information:

Jeffrey B. Jewell, 626-487-2364, Jeffrey.B.Jewell@jpl.nasa..gov

(B) (Left): Photonics instrument testbed, featuring a segmented deformable mirror matching the Keck segmented aperture telescope, a pupil plane Zernike Wavefront Sensing (WFS) arm, and focal plane arm housing a spatial array of photonic lanterns for free-space coupling of light into Photonic Integrated Circuits (PICs).

(**Right**): A. Pupil image in the WFS arm showing aberrated wavefront. B. Focal plane image. C. Microlens-fed spatial array of photonic lanterns, each coupling to the LP01, LP11a, LP11b modes (for a total of 21 single-mode output waveguides in a 1D array, for future edge-coupling into a PIC for general linear operations, and near ideal mode-sorting of starlight from an exoplanet orthogonal mode!

Significance/Benefits to JPL and NASA:

- Photonic coronagraph concept has the potential to achieve near ideal performance for exoplanets very close to the host star
- Directly addresses the key science goal of the Astrophysics Decadal Habitable Worlds Observatory mission concept

