THE UNIVERSITY OF ARIZONA
COLLEGE OF SCIENCE
Astronomy & Steward Observatory

Presented at:



Latest Results and Planned Upgrades from the Space Coronagraph Optical Bench

(This poster)

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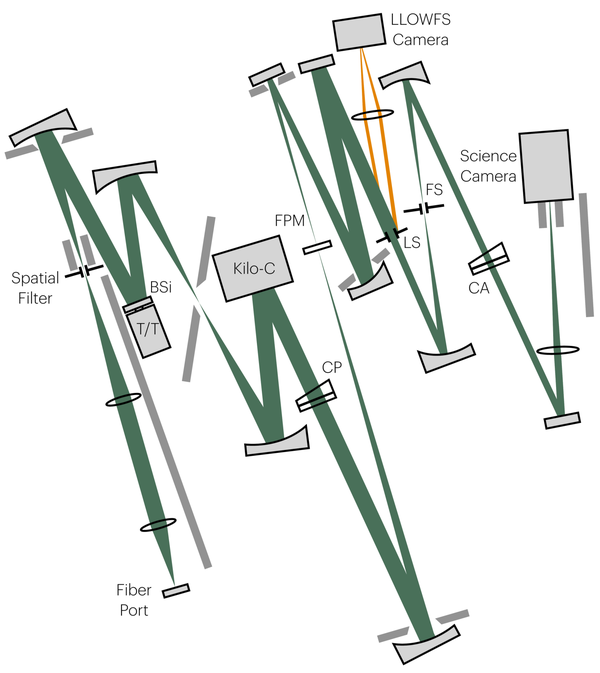
University of Arizona, Steward Observatory UA Space Astrophysical lab and collaborators

Science and Design Motivation

Space-based high-contrast imaging is expected to be necessary to image terrestrial planets around sunlike stars.

SCoOB is designed to uncover the physics that limit coronagraphy at the extreme contrasts necessary to image sub-Neptune and terrestrial planets around sunlike stars. Key Features include:

- super-continuum laser with spectral tuner
- custom pinhole (Jenkins et al 2025)
- simple circular pupil
- ~5nm RMS optics
- thermal-vacuum chamber
- Boston Micromachines 952 actuator microelectromechanical (MEMS) deformable mirror w/ 16 bit upgrade (recently upgraded to 100% yield)
- varied coronagraphs: liquid crystal polymer charge-6 vector vortex mask, (Van Gorkom et al 2024), Triple-grating (Doelman 2022), knife-edge (Van Gorkom 2022.



Current layout of SCoOB. Notable recent changes include an upgraded black silicon (BSi) pupil stop, a 100% yield Al-coated Kilo-C DM, reflective Lyot stop (LS), and circular polarizers (CA, CP) between wedged substrates. A handful of baffles (shown as gray blocks) have been added in an attempt to mitigate stray light. The focal plane mask (FPM) is a charge-6 VVC in an ~f/51 beam with a 45μm-diameter opaque dot (Van Gorkom et al. 2026).



Image of an early layout of the 1m square coronagraph unit being aligned in front of the vacuum chamber before installation of baffles.

https://uasal.github.io/Facilities/

Education and Open Source

Education is a key part of SCoOB's mission, training students, postdocs, staff, and faculty from Astronomy, the Center for Astronomical Adaptive Optics, and the UA Wyant College of Optical Sciences and external partners.

SCoOB is a fundamental research facility that provides hands on experience in:

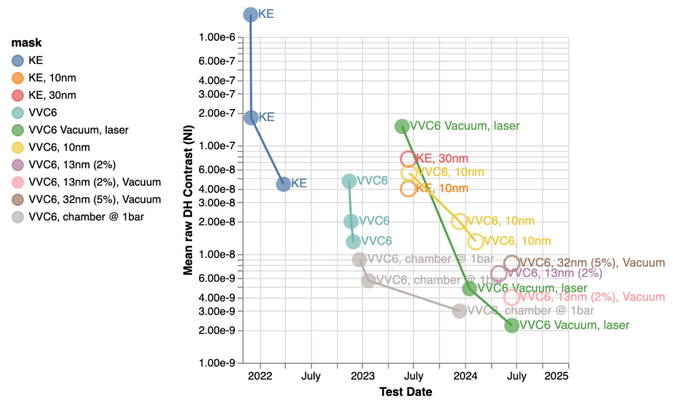
- designing, developing, and testing an active optics systems for space
- development and testing of optical propagation routines (e.g. contributions to POPPY, EXOSIMS, CACAO)
- Vacuum and clean room operations

Key repositories:

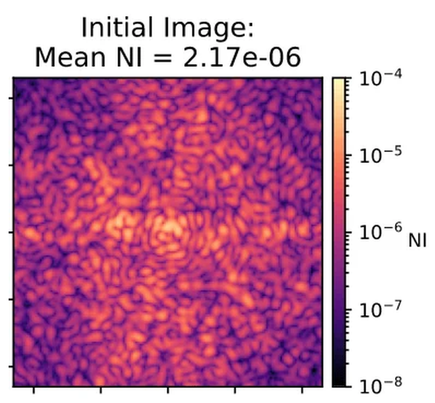
- github.com/uasal/XWCToolkit
- github.com/uasal/lina
- github.com/uasal/scoob-psf

Highlights

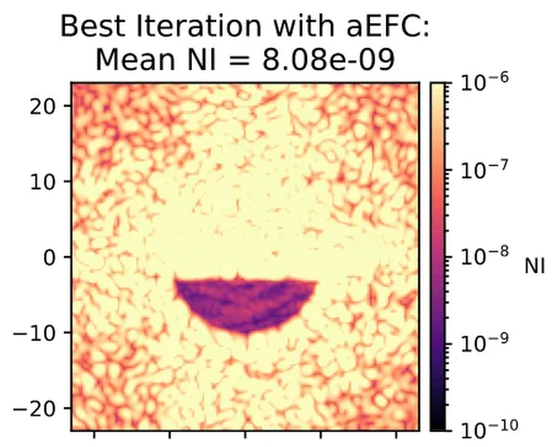
Thanks to algorithmic advances like iEFC (below), the flexible software platform and an experienced team and SCoOB has rapidly advanced to ultra high-contrasts (<1e-8), see plot of mean the testbed'd best dark hole contrast versus time over the past several years and two recent published examples:



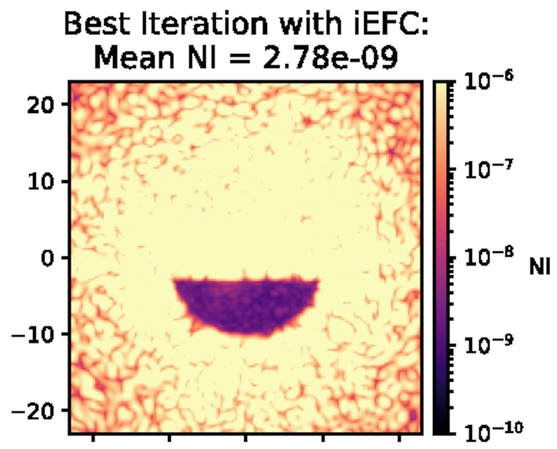
Dark hole contrast (normalized intensity) starting with a knife-edge coronagraph at 1e-6 in late 2021 to 2e-9 with a vector vortex in vacuum in summer 2024



Initial image (reproduced from Milani et al 2025a).



Adjoint EFC demonstration eliminates the Jacobian and uses algorithmic differentiation and nonlinear optimization to solve for the actuator commands (reproduced from Milani et al 2025a).

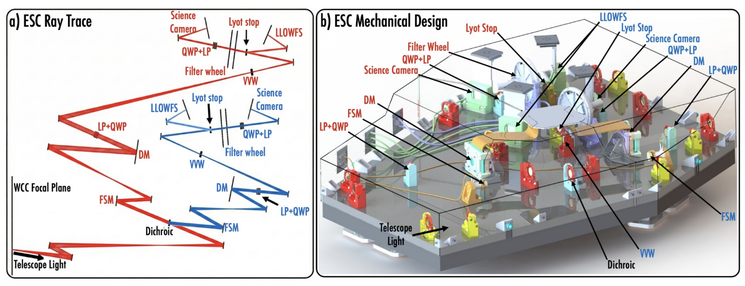


Best iteration with implicit EFC (iEFC) (reproduced from Milani et al 2025a).

Ongoing and Future Work

SCoOB is a platform for studying key HWO coronagraph technologies

- HOWFS and LLOWFS Operation at lowered flux levels (Douglas et al in prep)
- Development and testing of a contrast budget for ultraviolet coronagraphy (Van Gorkom et al 2025 in JATIS and NASA TDEM whitepaper)
- Testing of black silicon masks from JPL (Riggs, TDEM whitepaper)
- Increased automation for remote, asyncronous operation
- Testing use of dichroics for multichannel coronagraphy (Rosenbluth et al in prep)
- Testing of Zernike-LLOWFS (Rahim et al in prep, Hathaway in Prep) — UA CNRS collaboration
- Testing alternative HOWFS algorithms and dark-hole maintenance (Subramanian et al in prep)



Preliminary optical ray trace (a) and mechanical design (b) of the ExtraSolar Coronagraph (ESC) for the Lazuli Space Observatory. Reproduced from Roy et al. (2026), Fig. 6; CAD by H. Olivas and G. West.

The Lazuli ESC coronagraph (Roy et al 2026) is a direct descendent of SCoOB

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