

Dark Hole Algorithms Working Group

1/28/2021: Dark hole maintenance and multi-star wavefront control

Links to presentation files:

[2021-01-28_Redmond_DH_maintenance.pdf](#)

[2021-01-28_Sirbu_MSWC.pdf](#)

Neil and Julien went over access to the STScI Roman Outerspace page where the WG will store notes and presentation materials. Members outside the Roman science teams are welcome to use this, although it requires first setting up a MyST/Outerspace account and then contacting the STScI support desk.

Susan Redmond presented the status of an experiment to demonstrate the dark hole maintenance algorithm on the HiCAT testbed.

- The dark hole maintenance demonstration uses a classical Lyot coronagraph on HiCAT, without a segmented pupil.
- stabilized in-air environment- contrast degrades by factor of 2 over 14 hours.
- The DM actuator dithers act as the probes, high spatial frequency only.
- The drift applied in the experiment was a random walk on the DM actuators, at 0.01 nm / iteration.
- For larger dithers, the lab and simulation match up well. But if the initial contrast is too high you can't measure small dithers.
- Future work needed to map the radiometry onto flight-like star brightness and drift time scales.
- Note that direct image statistics are not the most important performance metric, since the estimator is able to separate the planet from the speckles.

Dan Sirbu presented the concept of multi-star wavefront control (MSWC) with the Roman Coronagraph, and the status of MSWC testbed demonstrations at HCIT.

- A large fraction of nearby FGK stars are binary. Alpha Cen A + B are especially attractive - in terms of inner working angle, 3x better than any other target. Earth-like planets could be accessible at CGI CBE $1E-9$ contrast.
- When binary companion is beyond control radius, need super-Nyquist control. Alpha Cen A + B separation is $150 \lambda/D$
- Diffraction grating creates grid of spots. The wide field SPC mask is the mode most applicable to applying this technique on CGI. There is a special MSWC SPC mask with a custom field stop.
- Plan to simulate with Phase C optical model after it becomes public.
- The off-axis star is slightly vignetted, which causes some loss of actuator control
- Hagopian has manufactured a prototype MSWC SPC mask. $1E-3$ reflectivity in black part - no performance degradation.
- Decadal Survey Testbed vacuum testbed results: achieved a super Nyquist dark hole at $50 \lambda/D$
- Current experiments move the fiber to simulate two stars; do not yet have two stars implemented simultaneously.

General discussion notes

- John Krist is working on finalizing the Phase C CGI model. Still pending some lens design decisions, and configuration of optical error maps. The public models of the telescope mirrors must omit spatially correlated structure since they are ITAR. TCA optics and CGI optic maps are not. Error maps are filtered to 80 cycles / D.
- Question about GITL commanding, as applicable to MSWC. Eric: Command dictionaries not yet available, though expect some more info after CDR.