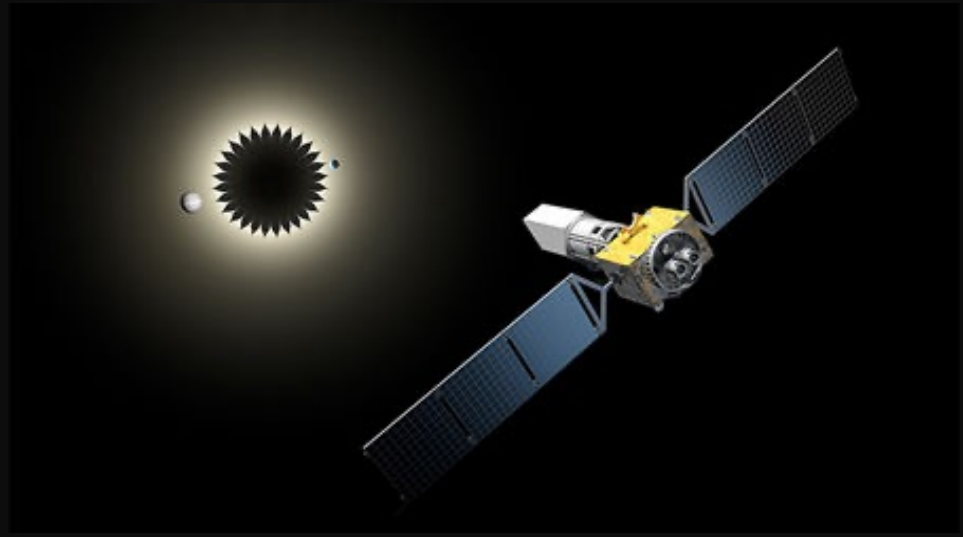
Jet Propulsion Laboratory
California Institute of Technology

Broadband Imaging Simulations for Starshade Rendezvous



Sergi R. Hildebrandt, JPL/Caltech, on behalf of the SEDC team

04/07/21

Instrumental Components

- Imperfect starshade petals with a estimated performance within mission requirements and a 10x further degraded scenario. Updated
- Residual motion from realistic formation flying simulations including thruster blackout times. Updated
- Solar glint with anti-reflection coated edges
- Roman optical throughput
- Detector QE from lab measurements
- EMCCD parameters as defined in Roman's IPAC website
- Telescope's pointing jitter RMS 14 mas
- Now we include dimmer effects such as straylight from micrometeorite, Earth, Jupiter, and Milky Way shine. Updated

Astrophysical Components

- 4 K & G host stars: τ Ceti, ε Indi A, σ Draconis, β CVn between 3.5 and 9 pc
- A total of 10 astrophysical scenarios with these 4 host stars that have some undisclosed exoplanets and some visual inclination. Updated
- Realistic atmospheric models in the 425-552 nm and 615-800 bands (undisclosed)
- Exozodiacal cloud model with some undisclosed dust density and forward scattering
- Extragalactic background (undisclosed)
- Local zodiacal light (undisclosed)
- Public data. Anyone can download and publish their own results

Release 1: Reminder

There were a total of **30** files with:

1 starshade contrast of $\sim 10^{-10}$ at the IWA

1 passband: 425-552 nm

1 physical models of exozodi: ‘smooth cloud’

1 level of dust density

1 visit

The 30 files were the result of:

10 independent exoplanetary scenarios with **3** SNR levels

Release 2
Broad Band Imaging Simulations for Starshade Rendezvous

This is the complete set of broad band imaging simulations. The scenarios in release 1 are included as a subset, although with slightly updated instrumental parameters

We provide two contrast scenarios that bracket other temporal degradation factors or some potential second-order effects not considered explicitly yet.

Spectroscopic simulations will be released later in the spring

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Release 2
Broad Band Imaging Simulations for Starshade Rendezvous

There are a total of **1,440** files that are subdivided into the following subsets:
2 starshade contrast scenarios of 1e-10 and of 1e-9 at the IWA with **720** files each
Divided into **2** passbands: 425-552 nm and 615-800 nm with **360** files each
Divided into **10** independent exoplanetary scenarios with **36** files each
Divided into **2** physical models of exozodi ('smooth' and 'resonant cloud') with **18** files each
Divided into **3** levels of dust density with **6** files each
Divided into **3** SNR levels with **2** files each, and
Divided into **2** visits with **1** file each

The simulations were generated with SISTER: sister.caltech.edu
The resonant cloud models were generated with gravitational N-body simulations by Chris Stark, GFSC

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Objectives

SEDC's objective is to quantify the required accuracy of noisy background calibration to detect planets and exozodiacal disks

We are not seeking to learn about orbital fitting, phase curve or albedo precision from these imaging simulations. There are already studies about these topics and Starshade Rendezvous*

Analysis results will include exozodiacal dust density compared to the solar system, visual inclination, planet detection, astrometry, photometry and SNR, which will eventually be compared to input values to assess fidelity and precision as a function of the instrumental and astrophysical components

(*) A. Romero-Wolf et al. (2021) ***Starshade rendezvous: exoplanet sensitivity and observing strategy*, JATIS, 7(2) 021210**
M. Turnbull et al. (2021) *A Community Exoplanet Imaging Data Challenge for Roman CGI and Starshade Rendezvous.* **JATIS. To be published.**

Calibration data

- PSF response at different angular distances from the starshade center for the two contrast scenarios
- Starshade transmission at different angular distances from the starshade center for the two contrast scenarios

Data format

FITS files with detailed information in header

Documentation

https://exoplanets.nasa.gov/exep/technology/starshade-data-challenge/

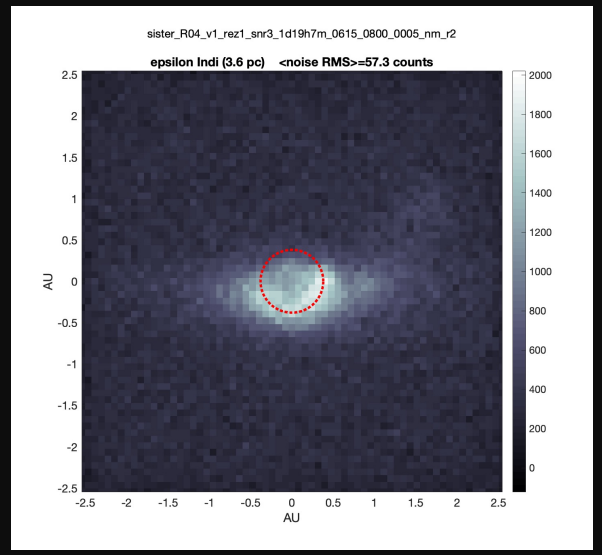
Live doc

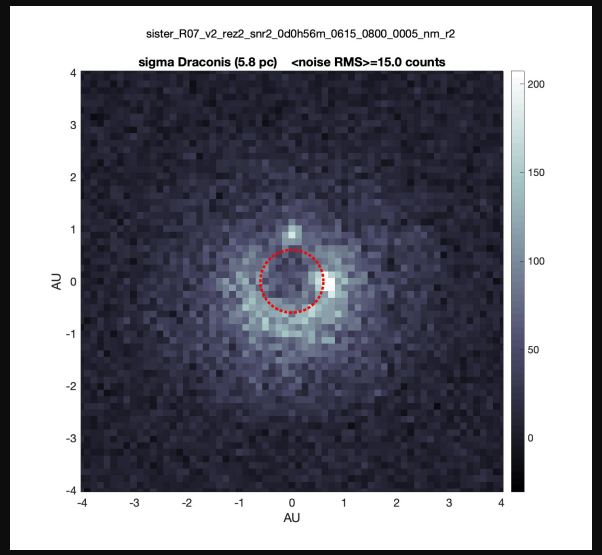
https://docs.google.com/document/d/1bsDX5wIIDidiLt_7wmAkJ-g5SBQ74WNjdgQW3twrtI0/edit?usp=sharing

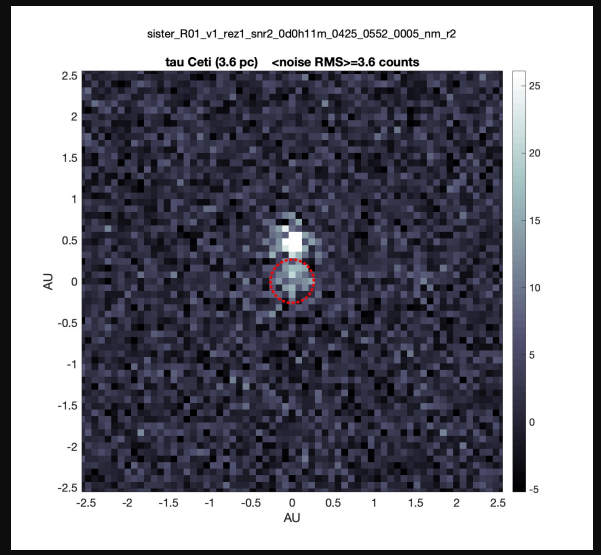
Slack channel

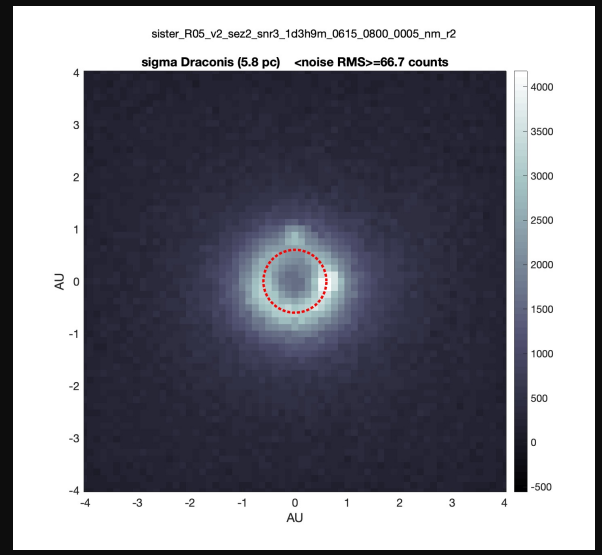
starshadedata-ett3036.slack.com

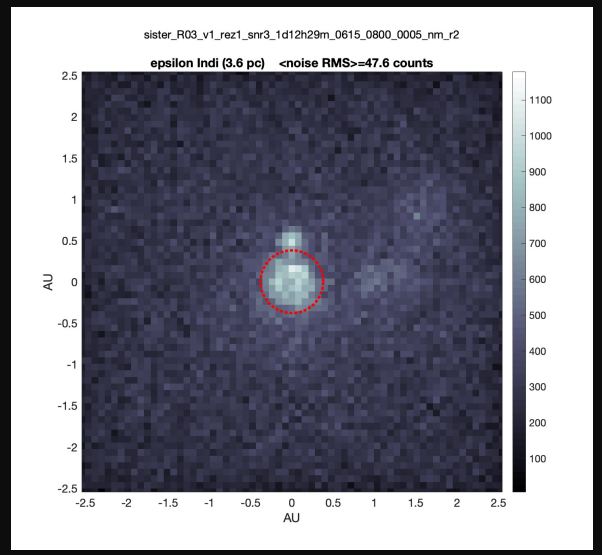
Some examples

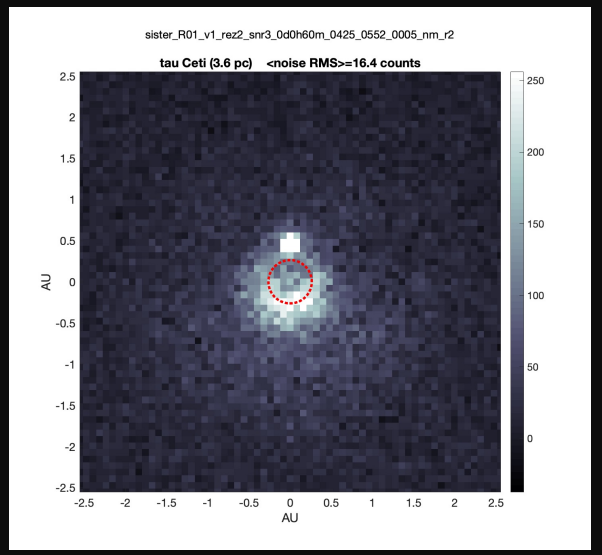


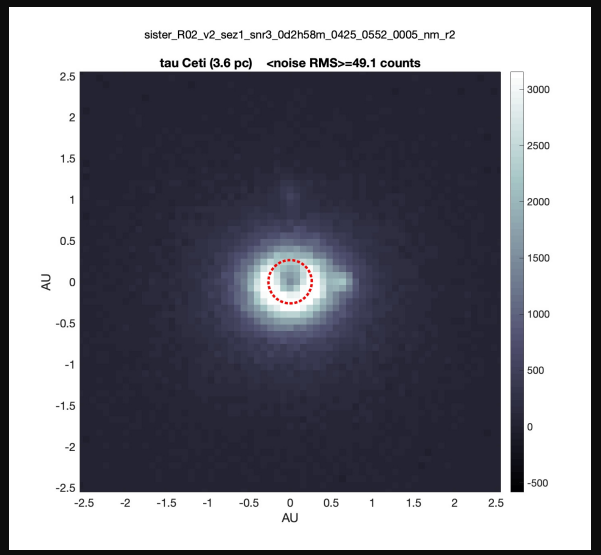


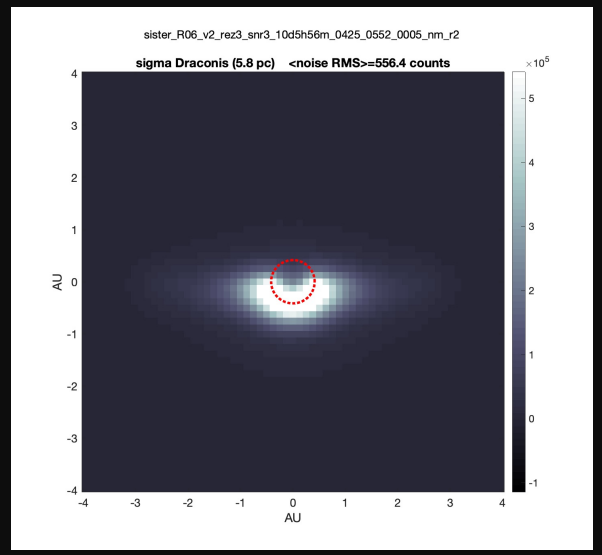












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Thank you for your interest
&
analysis!