Starshade Earth Characterizer with SALSO

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Introduction

- SEC is an exoplanet experiment to find and characterize earth analogs, as well as larger outer planets and debris disks.
- SEC is compatible with other experiments making SALSO a robust mission satisfying multiple objectives.
Mission Concept

Earth-Sun-L2 Halo Orbit

Occulter launches with SALSO on EELV and separates on-orbit

Occulter holds formation with SALSO during observations to create a dark shadow

45,000 ± 1,000 km

S-Band 2-way Com < 0.005 HZ control loop

32m starshade

Instrument senses occulter position with IR cameras and radios error signal

Occulter maneuvers to next target with Solar Electric Propulsion

Formation Flying at Earth-Sun L2 is an innovative use of NASA capabilities

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* Starshade Earth Characterizer with SALSO
Measurement Performance – Search Mode

SEC can photometrically detect Ozone with short exposures
Measurement Performance – Characterization Mode

120 mas IWA

500-1100 nm Bandpass

22,500 km

1 x 10^{-10}
Starlight suppression

4 x 10^{-11}
planet contrast detection threshold

Unlimited OWA

R70 Spectral Resolution using 20% Observatory time

SEC can ????

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Science Performance - Detections

- Detect Earth analogs in habitable zones of 100 F,G,K stars
- Follow up known giant exoplanets, beyond IWA
- Obtain “family portraits” of complete planetary systems
- Reveal structure of inner debris disks
- Explain planet simulations
\( R_A \approx 70, \lambda=250-550 \text{ nm:} \)
- oxygen
- ozone
- water
- Rayleigh scattering
- plants, continents?

\( \lambda=500-1100 \text{ nm:} \)
- strong water bands
- carbon dioxide
- methane (young Earth)
Instrumentation with Telescope

• Limited Instrumentation, leaving ample resources for other experiments
  - Total mass < 120 kg
  - Total power < 120 W
  - Dimensions shown to right

• No telescope modification required

• NUV camera is photometric and not diffraction limited

• Radio system may be integrated with spacecraft
Occulter System Design

- Compact stowed volume enables a joint launch with SALSO in std. 5 m fairings
- 2,000 kg total mass leaves ample mass to rest of system (e.g., Atlas 551 delivers 6,400 kg)
- Spins (~ 5 min. period) to relax tolerancing
- SEP for efficient retargeting performance
- Power from thin-film PV cells, integrated with starshade blankets

Add cutaway view of occulter?
Technology Readiness

Formation Flying simulations indicate low BW controller

Small-scale optical testing demo's 3E-10 contrast

Larger-scale optical testing to demo 1E-10 contrast *

Full-scale (6m) TDEM-1 petal

3/5th scale TDEM-2 partial system

Full-scale full-system prototype*

Demonstrated Mfr. tolerances in 2012

Demo deploy tolerances in 2013

Establish TRL-6 by 2017

Addresses engineering challenges typical of deployable antenna systems * Not yet funded

Modeling demo's large stability margins

Optical Edge Development

SEC is highly “doable” experiment with a clear and limited risk path to TRL-6 and launch readiness by 2022

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Conclusions

- SEC is an attractive option for SALSO, as it: *(more pithy statement !)*
  - Addresses a major NASA strategic goal, much earlier than otherwise possible
  - Makes innovative use of NASA capabilities
  - Is highly compatible with other experiments to address multiple objectives
  - Is very doable and offers controllable cost and early retirement of risk
  - Innovative use of processes or partnership arrangements ???