Starshade Earth Characterizer with SALSO

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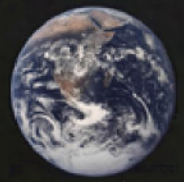
Introduction

- 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



Occulter launches
with SALSO on EELV
and separates on-orbit

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

Earth-Sun-L2
Halo Orbit

± 1m
control

45,000 ± 1,000 km

32m
starshade

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

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

Measurement Performance – Search Mode

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

60 mas IWA

250-550 nm Bandpass

45,000 km

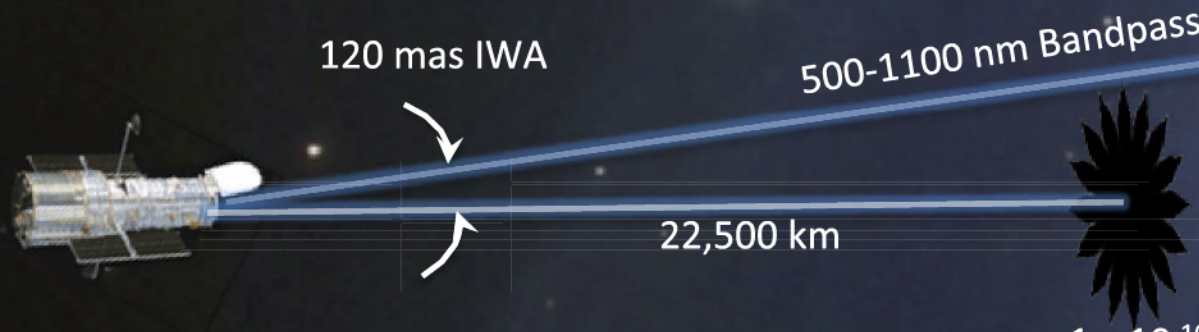
4-channel photometry
using 20% Observatory time

1×10^{-10}
Starlight suppression

Unlimited OWA

SEC can photometrically detect Ozone with short exposures

Measurement Performance – Characterization Mode



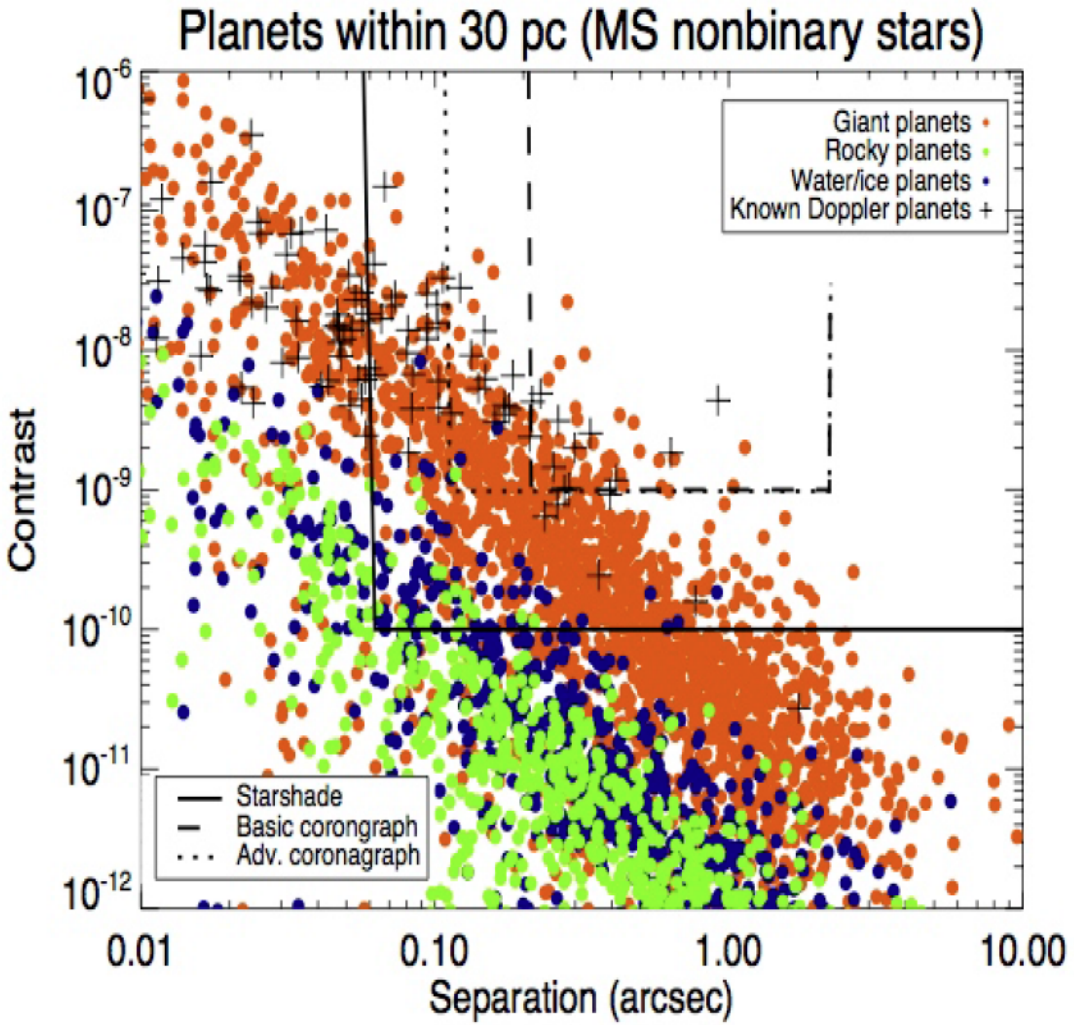
R70 Spectral Resolution
using 20% Observatory time

SEC can ????

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



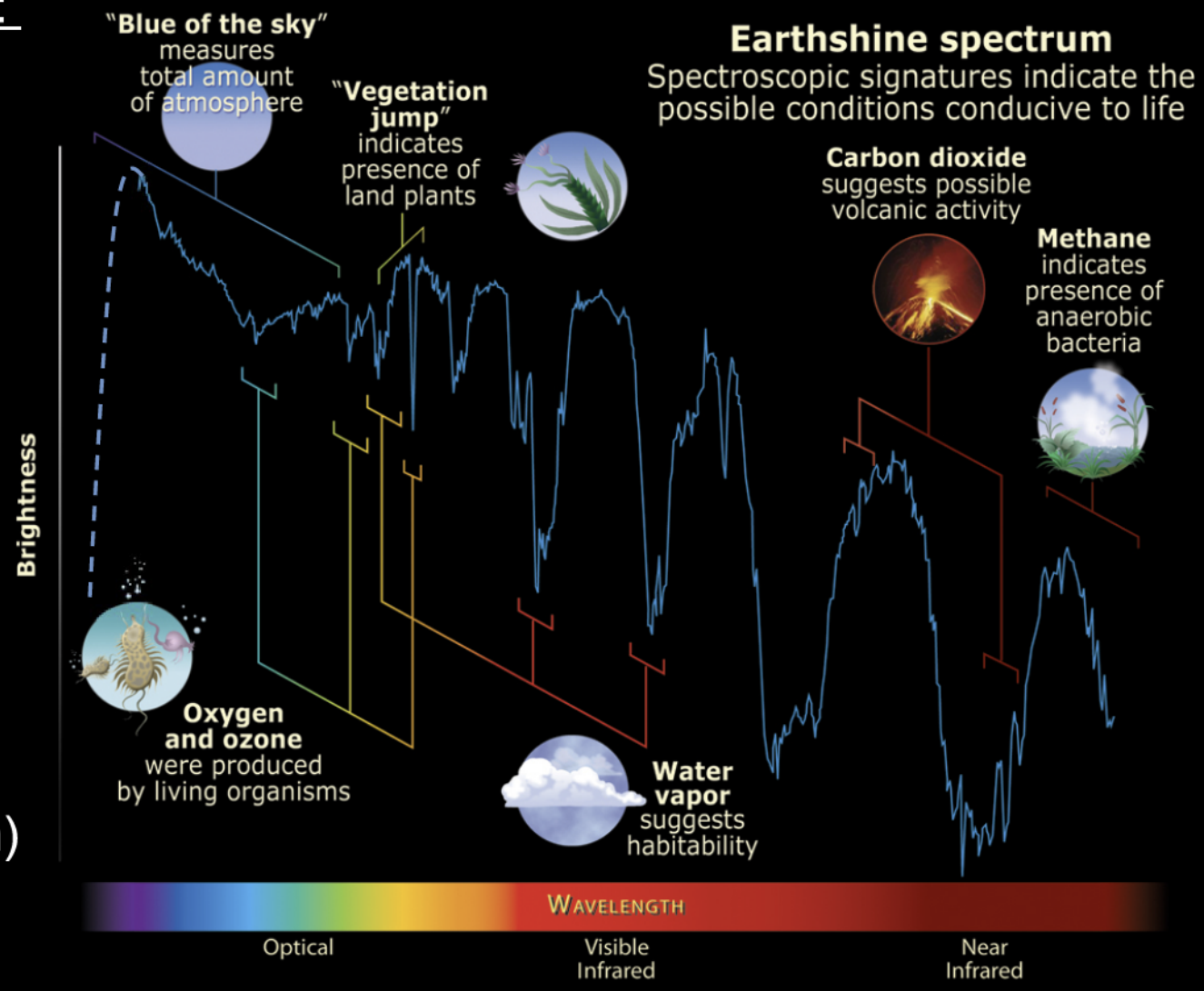
Science Performance - Characterization

$R_A \approx 70$, λ=250-550 nm:

- oxygen
- ozone
- water
- Rayleigh scattering
- plants, continents?

λ=500-1100 nm:

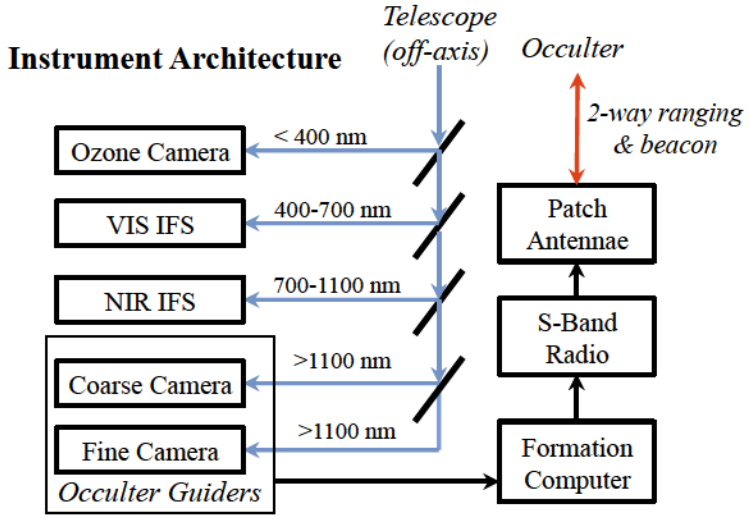
- strong water bands
- carbon dioxide
- methane (young Earth)



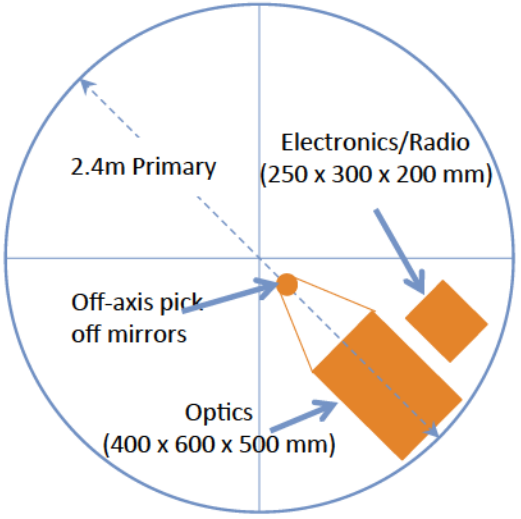
Alignment with Agency Goals

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



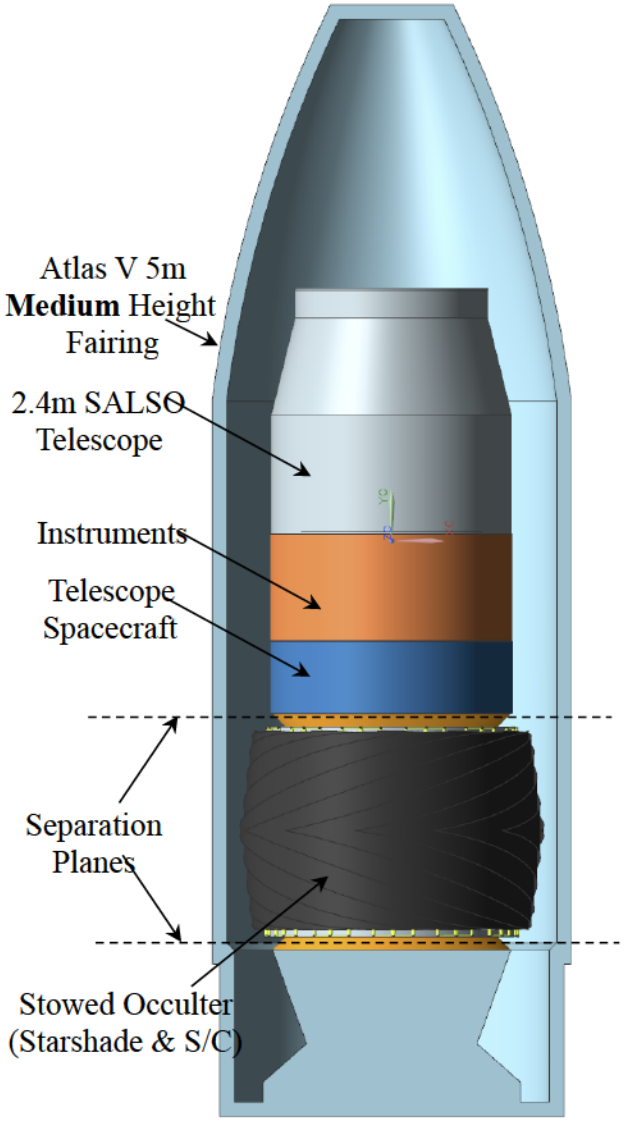
Instrument Layout Concept



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 ?



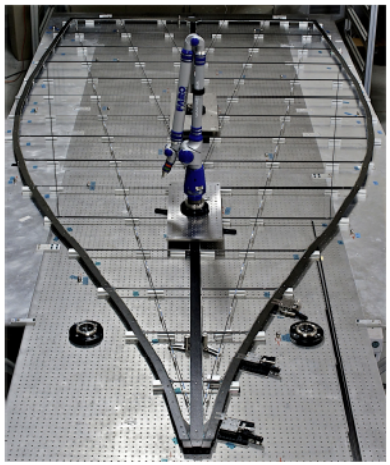
Technology Readiness

Formation Flying simulations indicate low BW controller

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

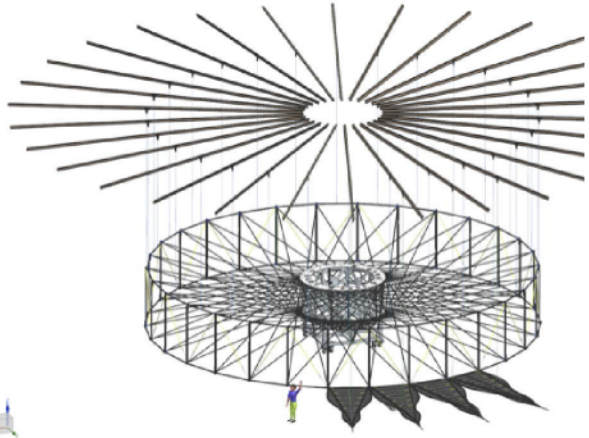
Larger-scale optical testing to demo 1E-10 contrast *

Full-scale (6m) TDEM-1 petal



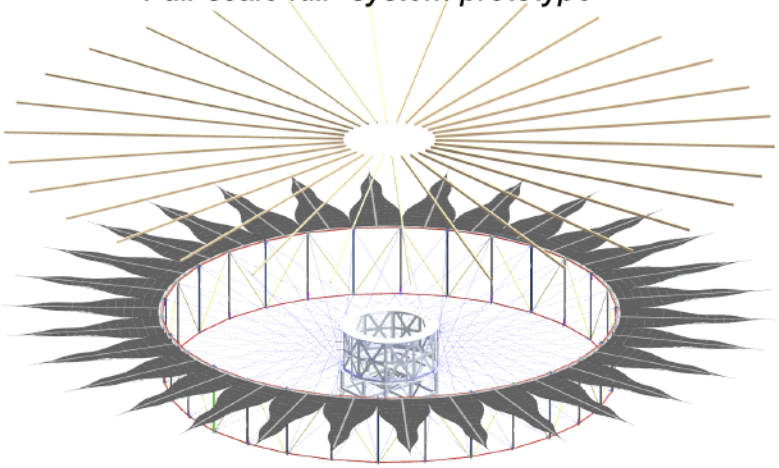
Demonstrated Mfr. tolerances in 2012

3/5 th scale TDEM-2 partial system



Demo deploy tolerances in 2013

*Full-scale full- system prototype**



Establish TRL-6 by 2017

Modeling demo's large stability margins

Optical Edge Development

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

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

Partnerships

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 ???