# Habitable Worlds Observatory, Exploratory Analytic Cases Formulation and Analysis

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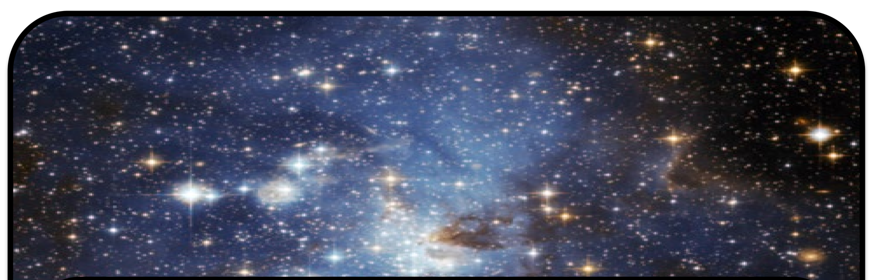
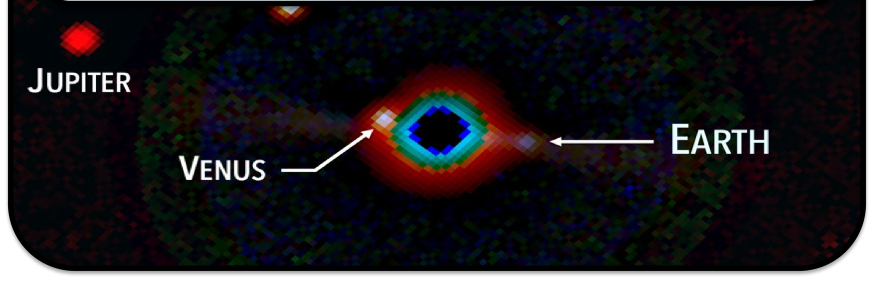
HABITABLE WORLDS OBSERVATORY

## NASA's next flagship mission, recommended by the Astro2020 Decadal Survey



Large Aperture UV/Optical/NIR observatory performing transformative astrophysics across cosmic time

First telescope designed to directly image and characterize Earth-like exoplanets, including search for signs of life



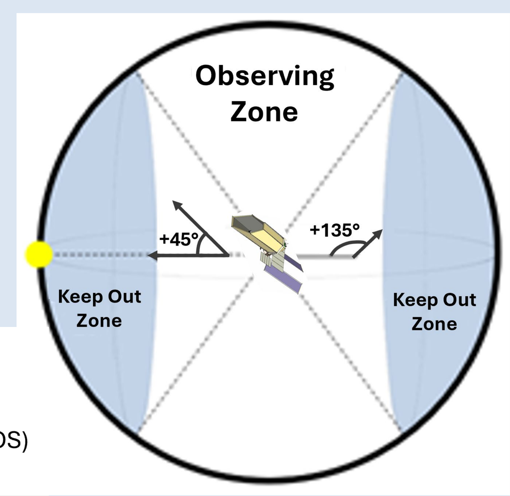

## Exploratory Analytic Cases (EAC)

**Mission architectures developed to explore the HWO trade space:**

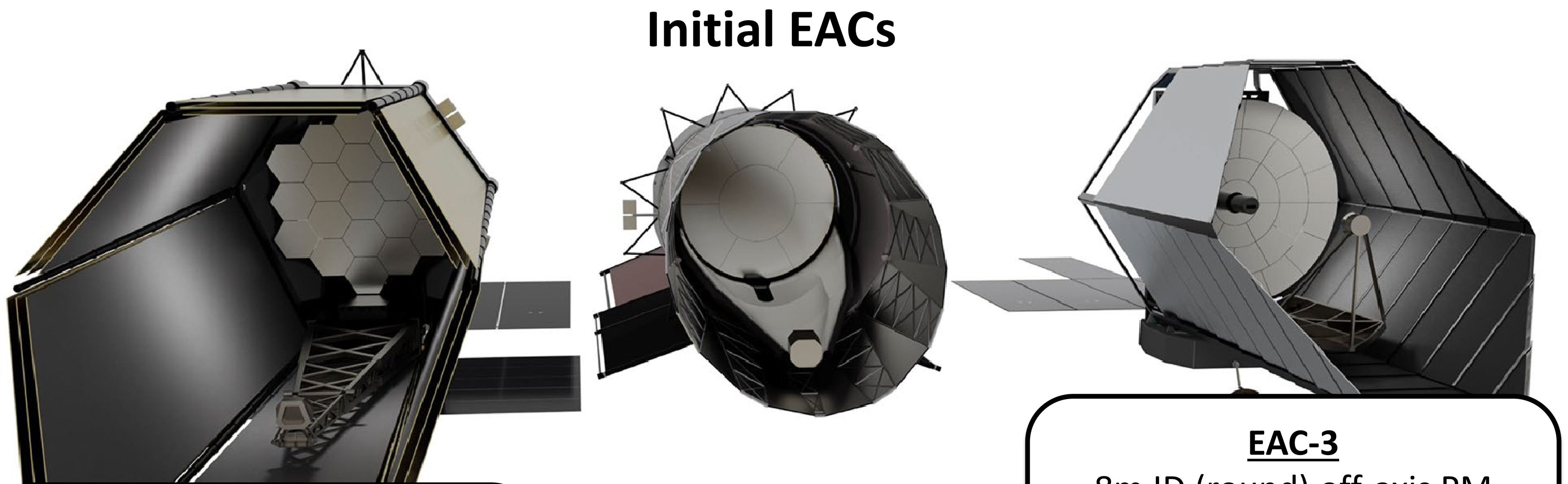
- Explore key architectural options and breakpoints to guide future point design decisions
- Develop end-to-end models and tools to understand modeling capabilities and needs
- Identify technology gaps and guide maturation of potential solutions
- Provide early feedback to launch vehicle vendors to help influence their direction

## EAC Design Guidelines

- Segmented primary mirror and coronagraph instrument
- Orbit at Sun-Earth L2 with a serviceable architecture
- Baffle/barrel protection against micrometeoroid impacts
- Compatible with at least two future launchers
- Field-of-Regard: ±45° pitch, ±22.5° roll, 360° yaw
- Slew/Settle: 90° in 60 min
- Observatory LOS stability: 4 mas
- Passive cooling for NIR detectors
- ULE glass mirrors (primary/secondary) at room temperature for simplified I&T




## Initial EACs



**EAC-1**
6m ID / 7.2 m OD off-axis PM
19 hex segments
PM faces horizontal in rocket
JWST-like wing deployment

**EAC-2**
6m ID (round) off-axis PM
Central 3 m round mirror +6 keystone
PM faces up in rocket
Non-deployed PM

**EAC-3**
8m ID (round) off-axis PM
34 keystone segments
PM faces horizontal in rocket
JWST-like wing deployment

### Telescope

| | |
|---|---|
| Diameter | ≳6.0 m |
| Bandpass | ~100–2500 nm |
| Diff. Limit | ~500 nm |

### Coronagraph

| High-contrast imaging and imaging spectroscopy | |
|---|---|
| Bandpass | ~450–1700 nm |
| Contrast | $\lesssim 1 \times 10^{-10}$ |
| R (λ/Δλ) | Vis: ~140, NIR: ~70 |

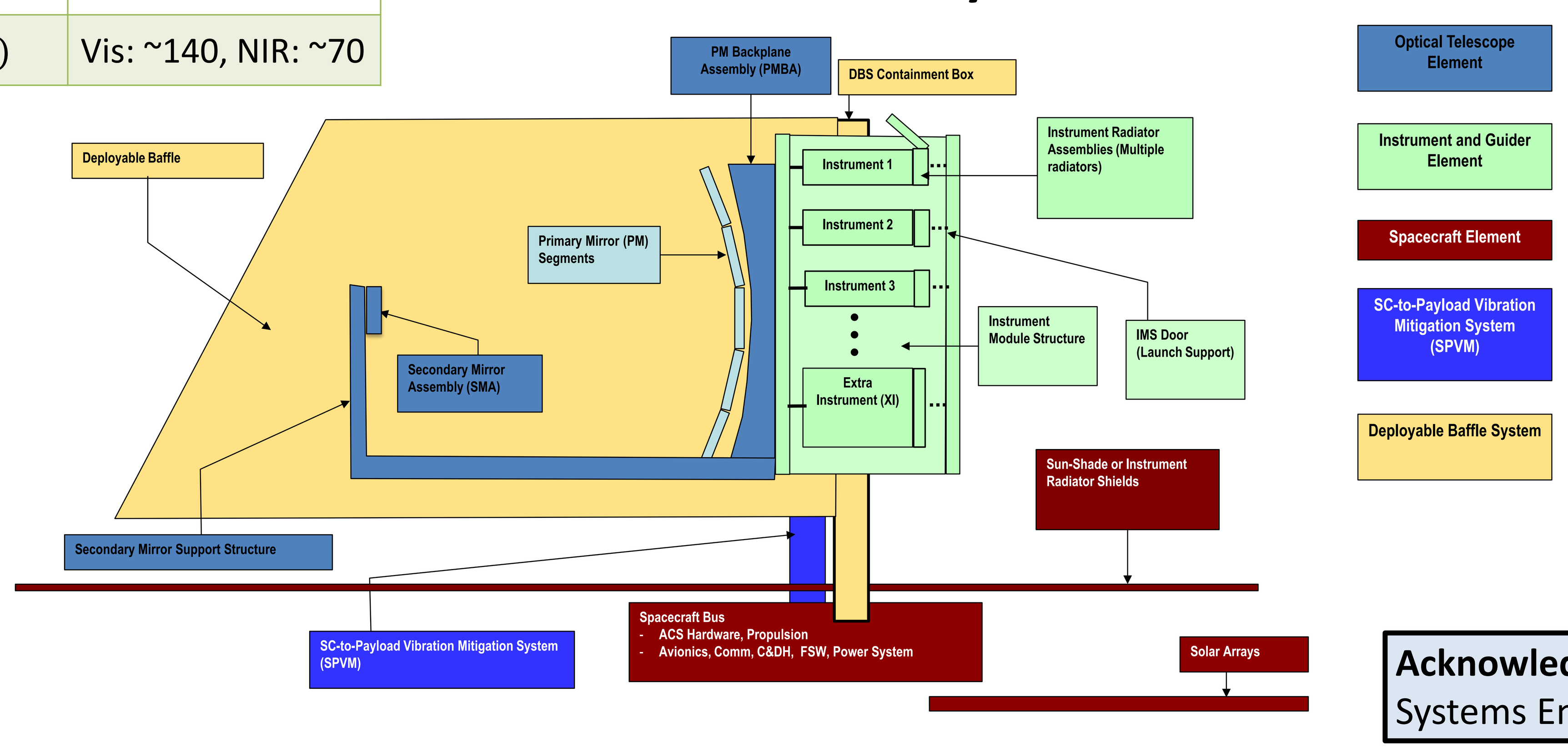
### High-Resolution Imager

| UV/Vis and NIR imaging | |
|---|---|
| Bandpass | ~200–2500 nm |
| Science FoV | ~2.5′ × 2.5′ |
| Astrometry FoV | ~12 sq. arcmin |
| ~40 science filters & grism | |

### UV Multi-Object Spectrograph

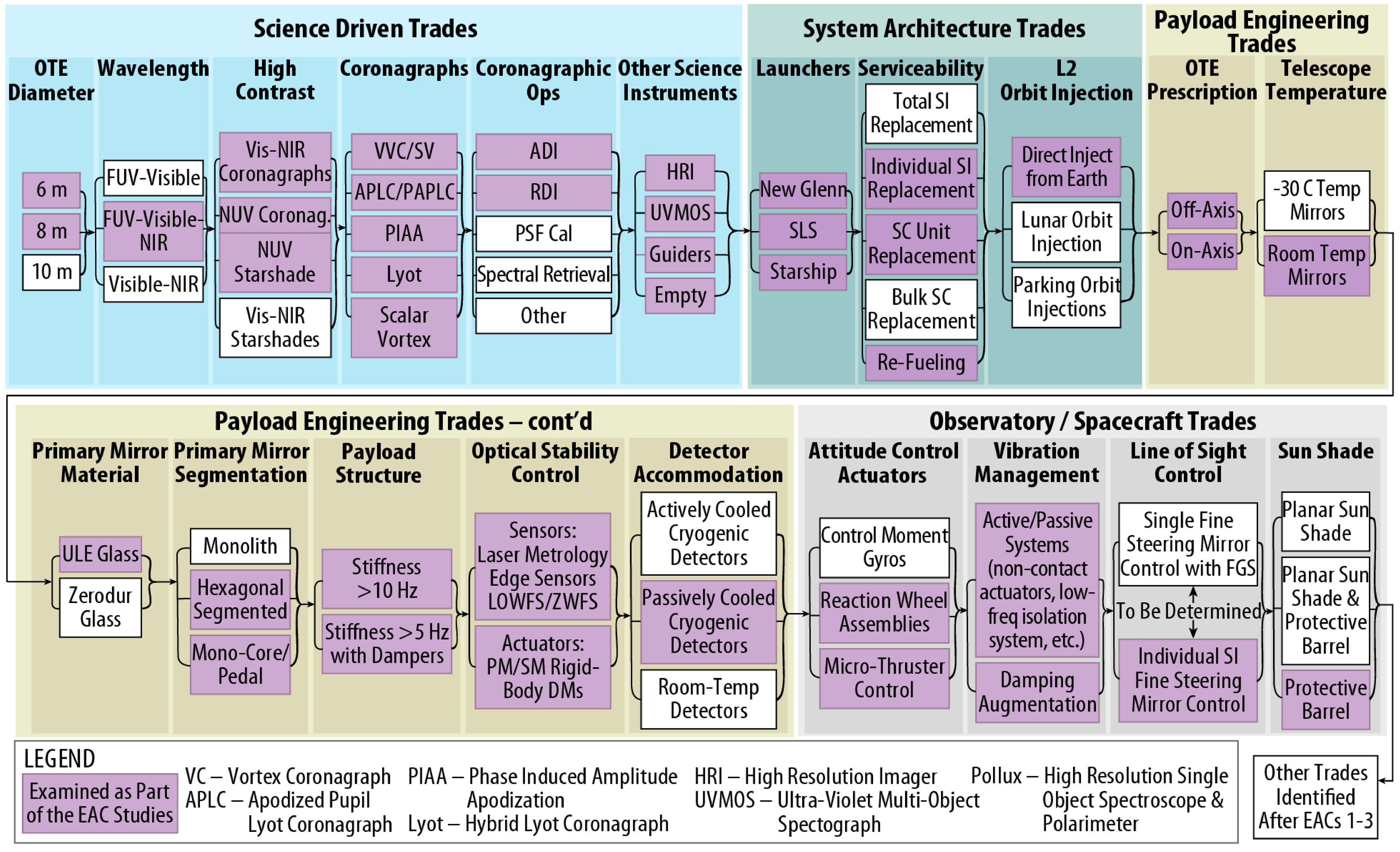
| UV/Vis multi-object spectroscopy and FUV imaging | |
|---|---|
| Bandpass | ~100–700 nm |
| Field-of-View | ~2′ × 2′ |
| Apertures | ~840 × 420 |
| R (λ/Δλ) | ~500 & 50,000 |

## Observatory Element Schematic

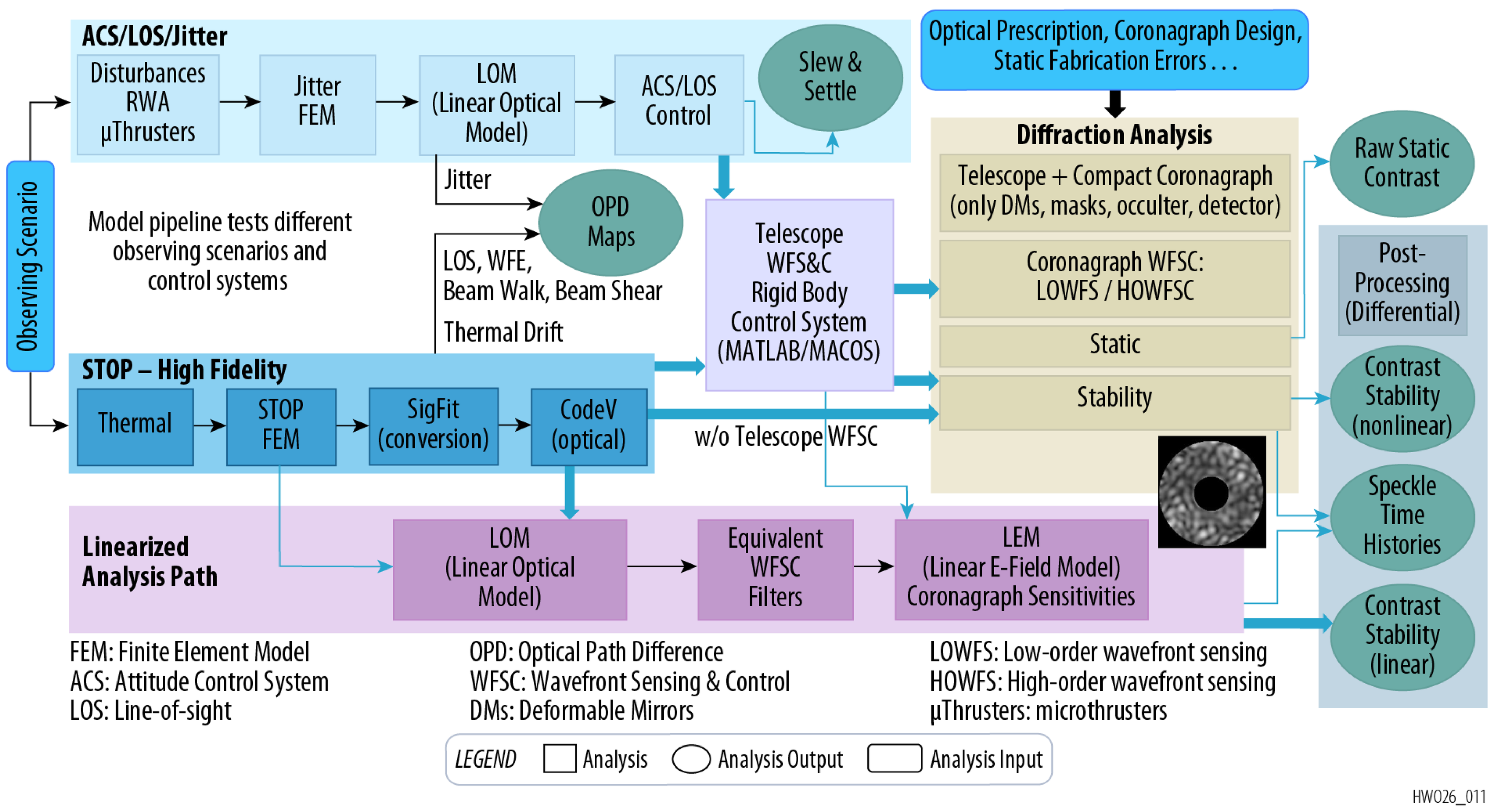



## Architecture Trade Options

The first 3 EACs examined a wide range of trade options spanning science, mission system, observatory, payload, and spacecraft, with some trades continuing to future EAC iterations




Building on JWST and Roman heritage, HWO is leveraging **Integrated Modeling**, a multidisciplinary analysis used to predict system performance, to quickly bridge design exploration and end-to-end engineering and science performance metrics




## EACs 1-3 Key Findings

- Deployable baffle poses significant engineering challenges, requiring thermal stability, MMOD protection, and solar heat rejection while stowable in fairing volume and deployable on-orbit
- Solar arrays limit radiator heat rejection options; The coronagraph requires optimal cold space view factors to achieve passive detector cooling
- Primary mirror thermal environment directly drives optical performance and active control system complexity
- The large CP-CM offset (>1 m) creates significant attitude control challenges, driving high propellant consumption and complex thruster placement requirements
- Key serviceability challenges include maintaining picometer-level latch stability during instrument exchanges, robotic cryogenic heat strap connections, and structural access constraints from the primary launch structure

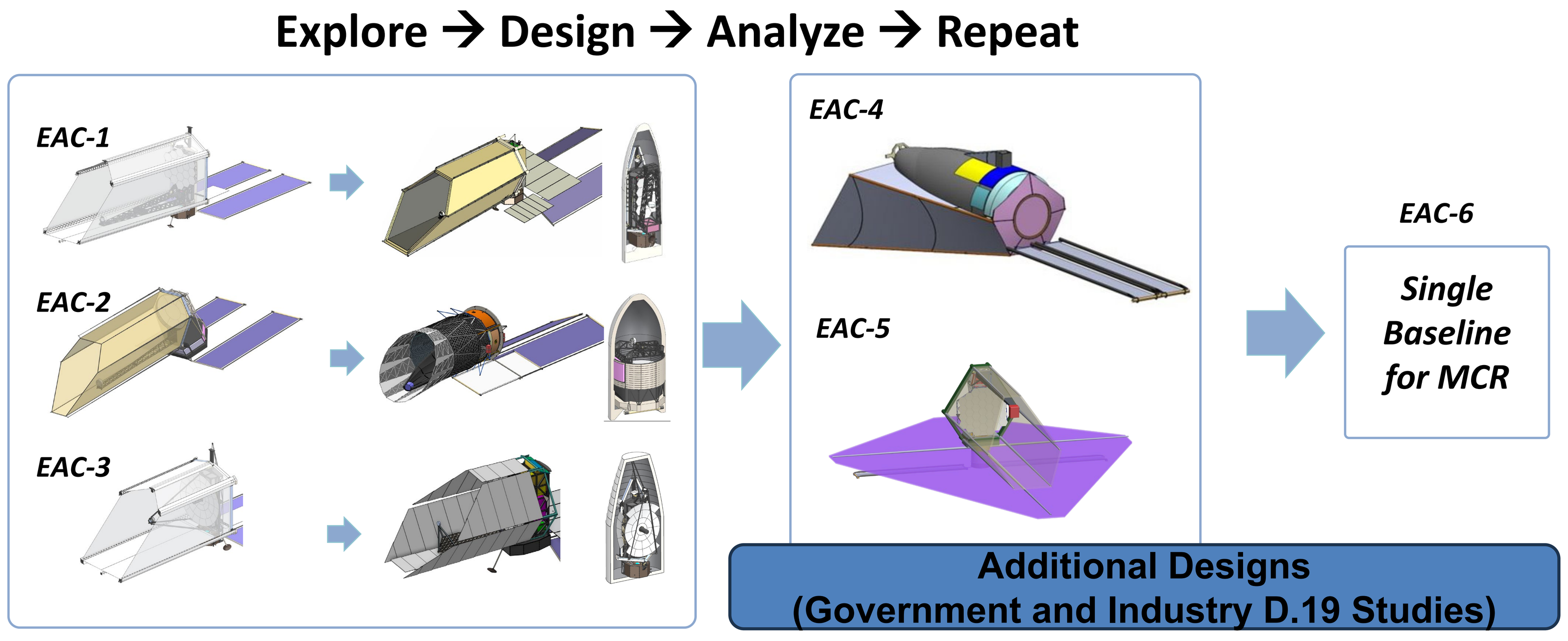
## EAC-4 Objectives

- Balance cost, schedule, risk and science
- Maximize aperture diameter while reducing baffle and PM deployment complexity
- Mitigate baffle-related engineering risks

## EAC-5 Objectives

- Driven by science goals with realistic launch vehicle constraints and technological advances
- Minimum 8-m inscribed diameter aperture
  - Consider large flat sunshade
  - Includes mass and design margin

### Explore → Design → Analyze → Repeat

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