



Jet Propulsion Laboratory  
California Institute of Technology

# What to do with the NEW Telescopes?

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California Institute of Technology



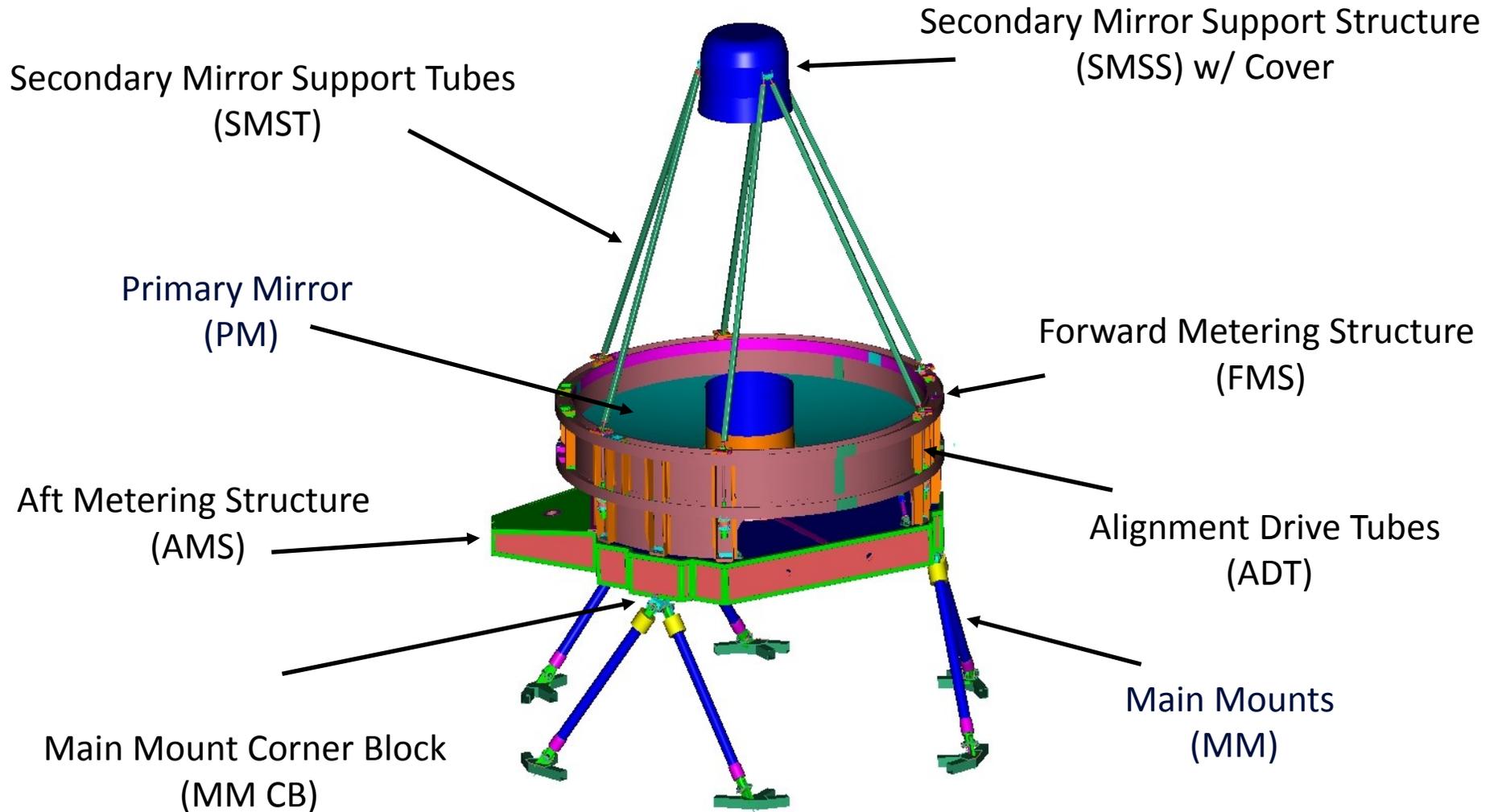
## Perspective and Summary

- NASA has obtained two 2.4-m telescopes and is in the process of estimating the costs associated with their possible use to advance Astrophysics Decadal Survey Science.
- Applications relevant to other science programs, human spaceflight, and NASA technology development are also being considered.
  - Two, 2.4m, two-mirror telescopes
    - One completed with full thermal hardware
    - Electronics & Actuators have been harvested but can be rebuilt to existing drawings
  - Two outer barrel assemblies
    - One fully completed with thermal blankets and butterfly doors
  - One hardware radiator/electronics bays
    - Aluminum structures for radiator and electronic attachment
    - Acted as a “spacer” between the spacecraft and the outer barrel assembly

The above list and Charts 3, 4, 5, and 6 of this presentation are courtesy of Gary Matthews, ITT Exelis.

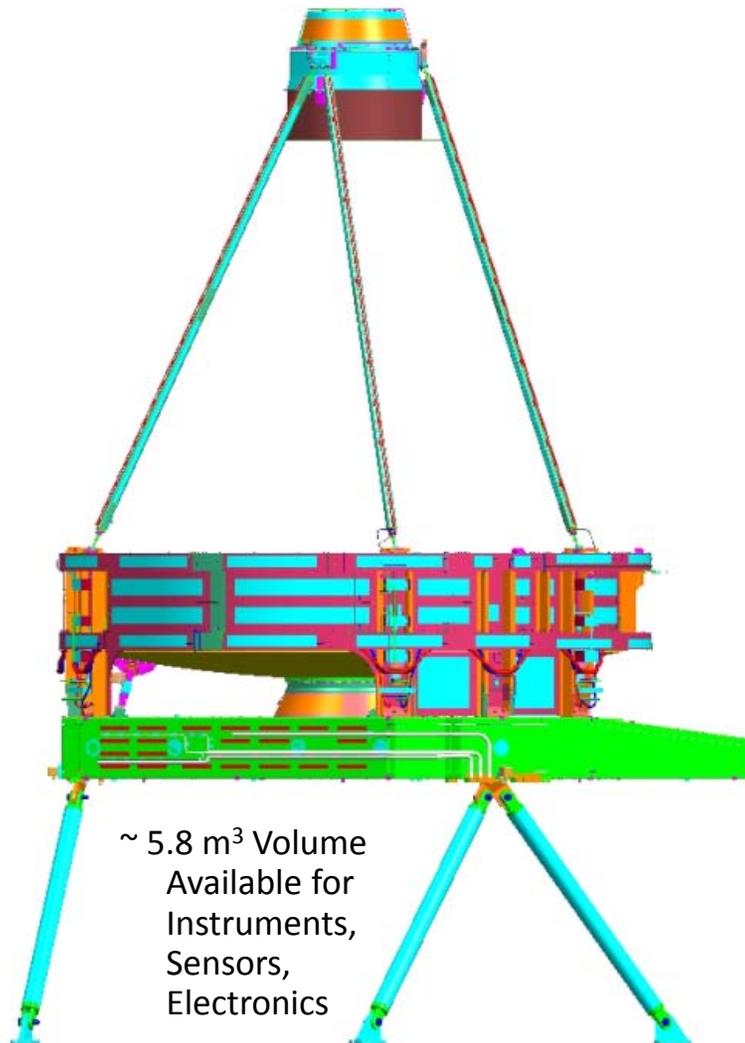


# Forward Optics Assembly (FOA) Configuration





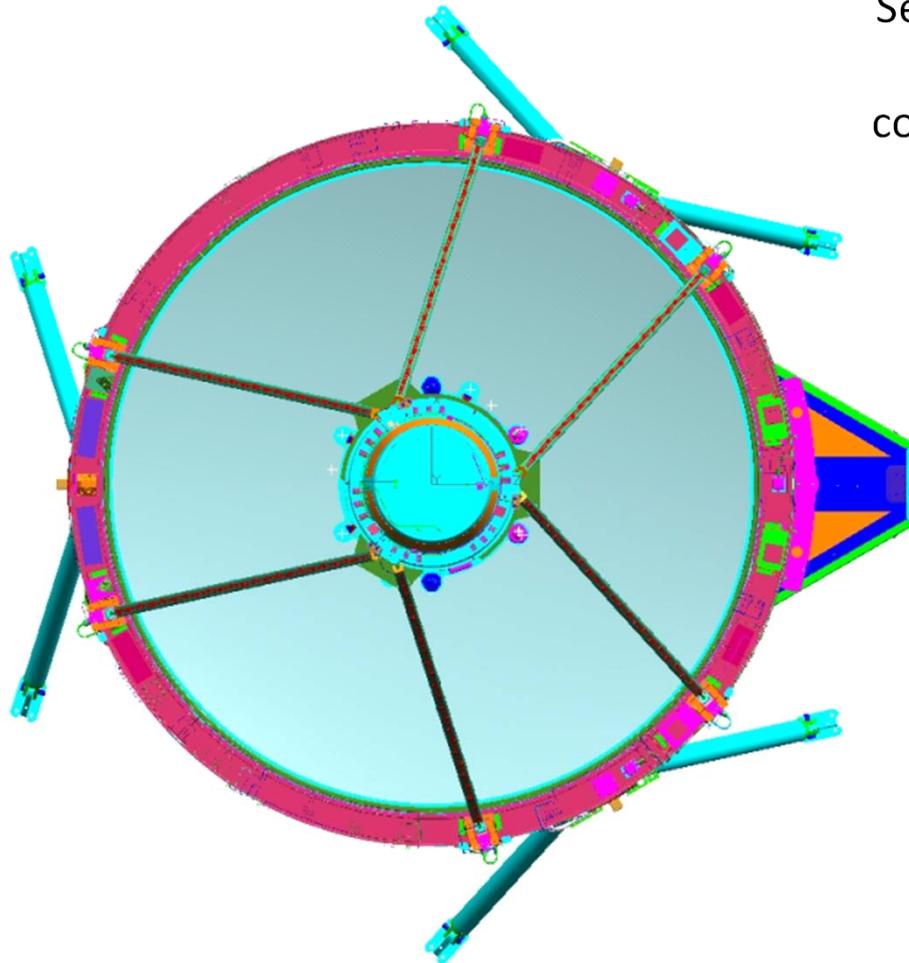
## 2.4m Space Telescope Form



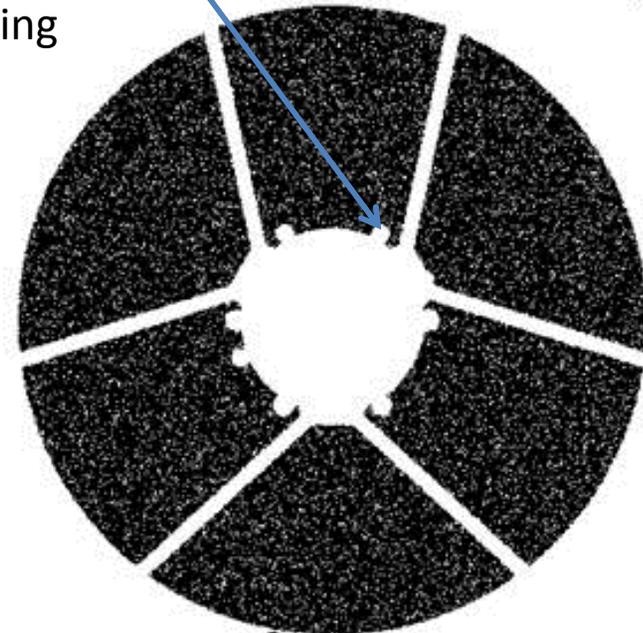
- **Optical Form: 2 Mirror, f/8**
- **Aperture: 2.37m**
- **Unvignetted Field of View: ~ 1.8<sup>o</sup> Dia.**
- **Wavefront Quality: <60 nm rms**
- **Secondary Mirror Assembly Control –**
  - **6 DOF plus fine focus**
  - **6 DOF Actuators are at the base of the secondary struts**
  - **Focus actuator is behind the SMA**
- **Mass: 840kg**
- **Back Focus: 1.2m behind PM Vertex**



# System Obstruction



Seven coating artifacts correctable by recoating



## On Axis Pupil

17% Obstructed

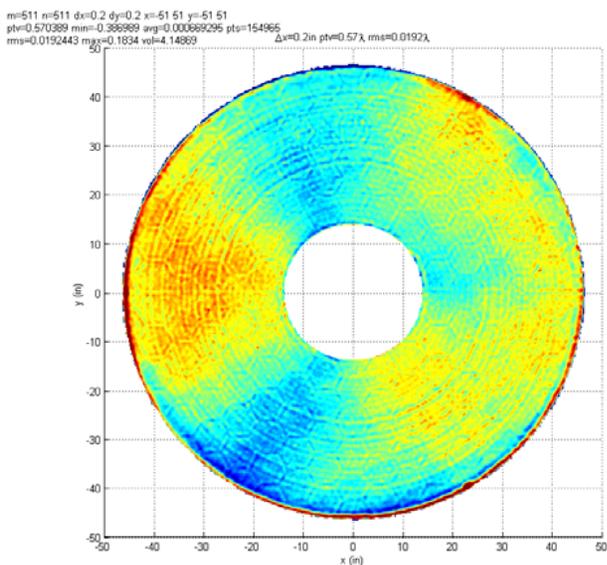
Strut Mean Width: 41mm

Strut Obstruction Length: 881mm

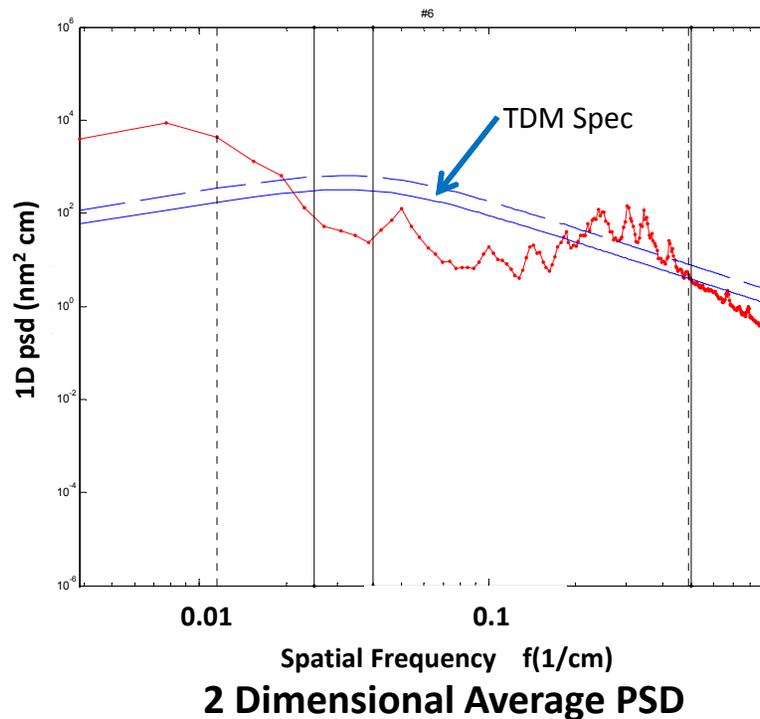


# Mirror Quality and Coating

- **Primary Mirror (~40kg/m<sup>2</sup>)**
  - Clear Aperture: 2.37m OD, 0.7m ID
  - Surface Quality: 12nm RMS
  - Form: Concave, F/1.2
  - Mirror Coating: Protected Silver



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## **Secondary Mirror**

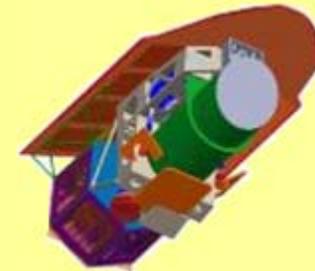
- Clear Aperture: 0.53m OD, 0.02m ID
- Surface Quality: 16nm rms
- Form: Convex
- Mirror Coating: Protected Silver



# Wide Field InfraRed Survey Telescope: Studies to Date

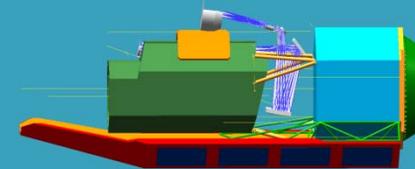
## ☐ Interim Design Reference Mission (IDRM)

- 1.3 meter off-axis telescope
- 3-channel payload
- 5 year mission
- Atlas V Launch Vehicle



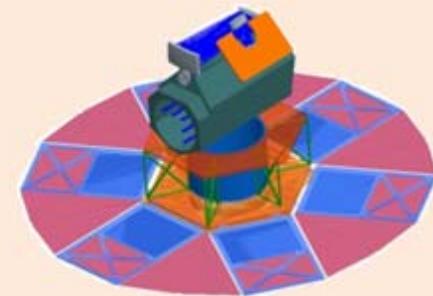
## ☐ Design Reference Mission 1 (DRM1)

- 1.3 meter off-axis telescope
- Single channel payload
- 5 year mission
- Atlas V Launch Vehicle



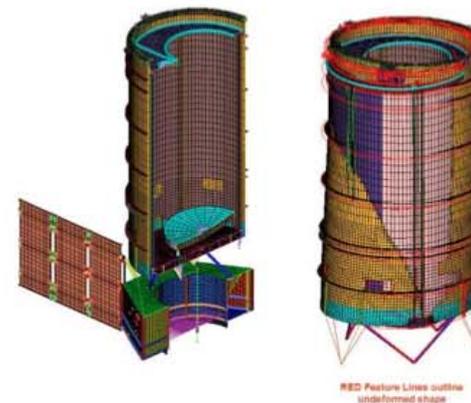
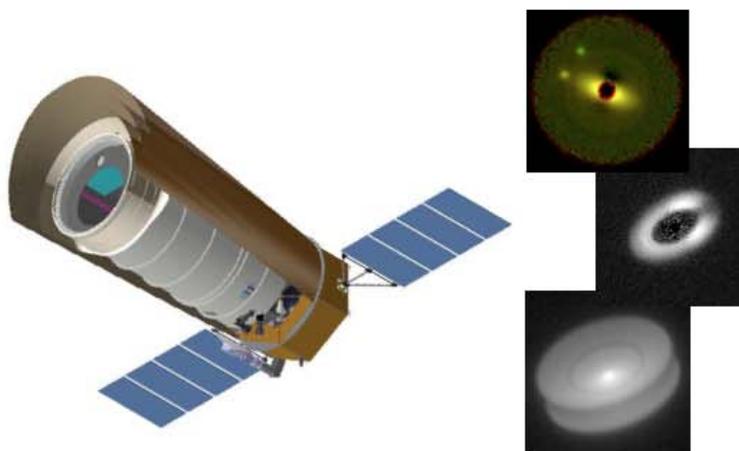
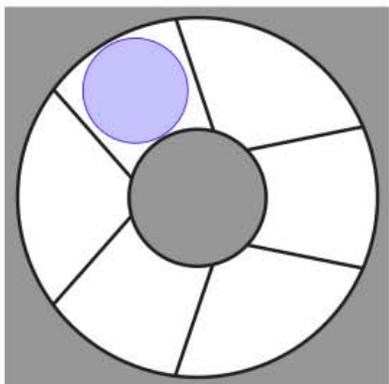
## ☐ Design Reference Mission 2 (DRM2)

- 1.1 meter off-axis telescope
- Single channel payload
- 3 year mission
- Falcon 9 Launch Vehicle





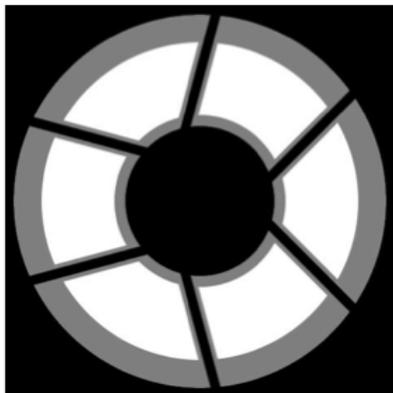
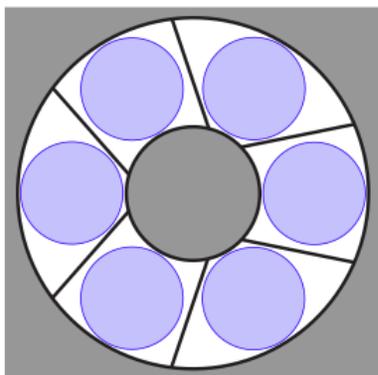
# Example: Clear Sub-aperture



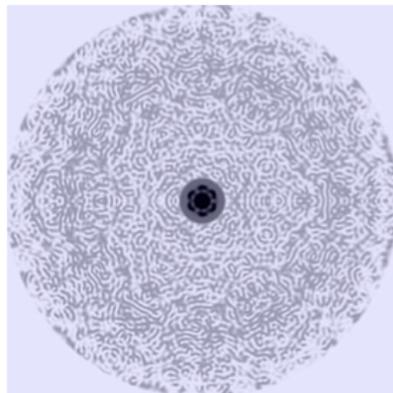
Courtesy of John Trauger (JPL/Caltech)



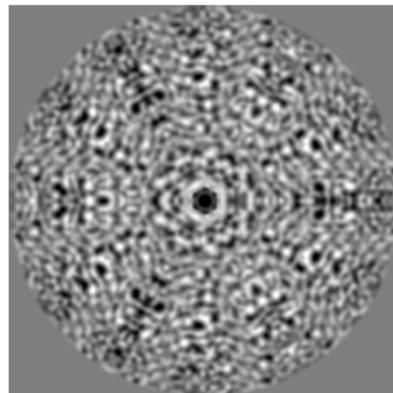
# Obstructed Full Aperture



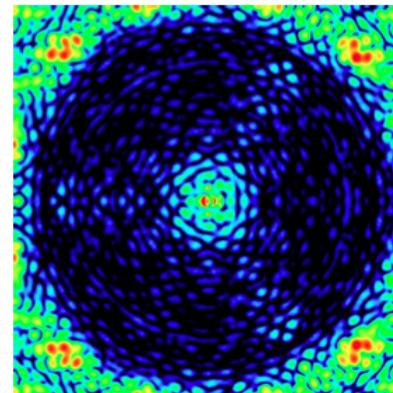
TELESCOPE APERTURE & LYOT MASK



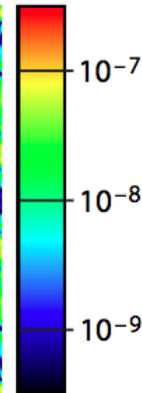
LYOT FOCAL PLANE MASK (TRANSMITTANCE)



LYOT FOCAL PLANE MASK (PHASE SHIFT)



HIGH CONTRAST DARK FIELD



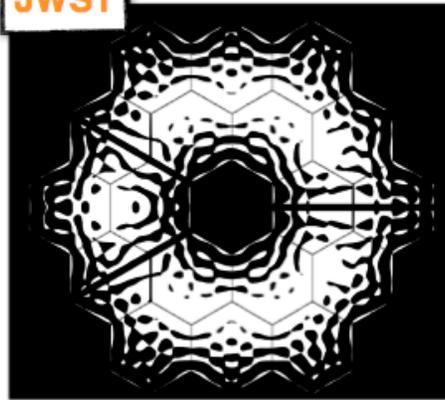
Courtesy of John Trauger (JPL/Caltech)



# Pupil Masking Approaches

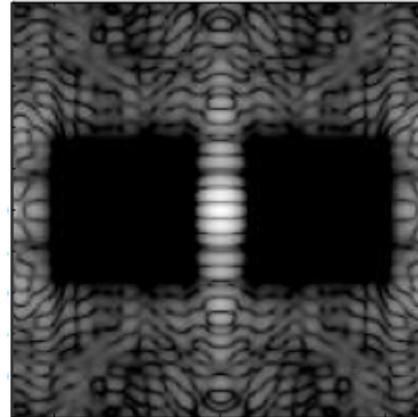
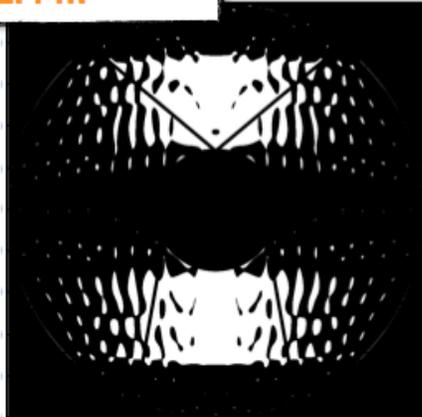
## 2-D Shaped Pupil Mask Tailored for Telescope Aperture

JWST



Working Angles 5 to 15  $\lambda/D$   
Contrast:  $10^{-5}$

2.4 m



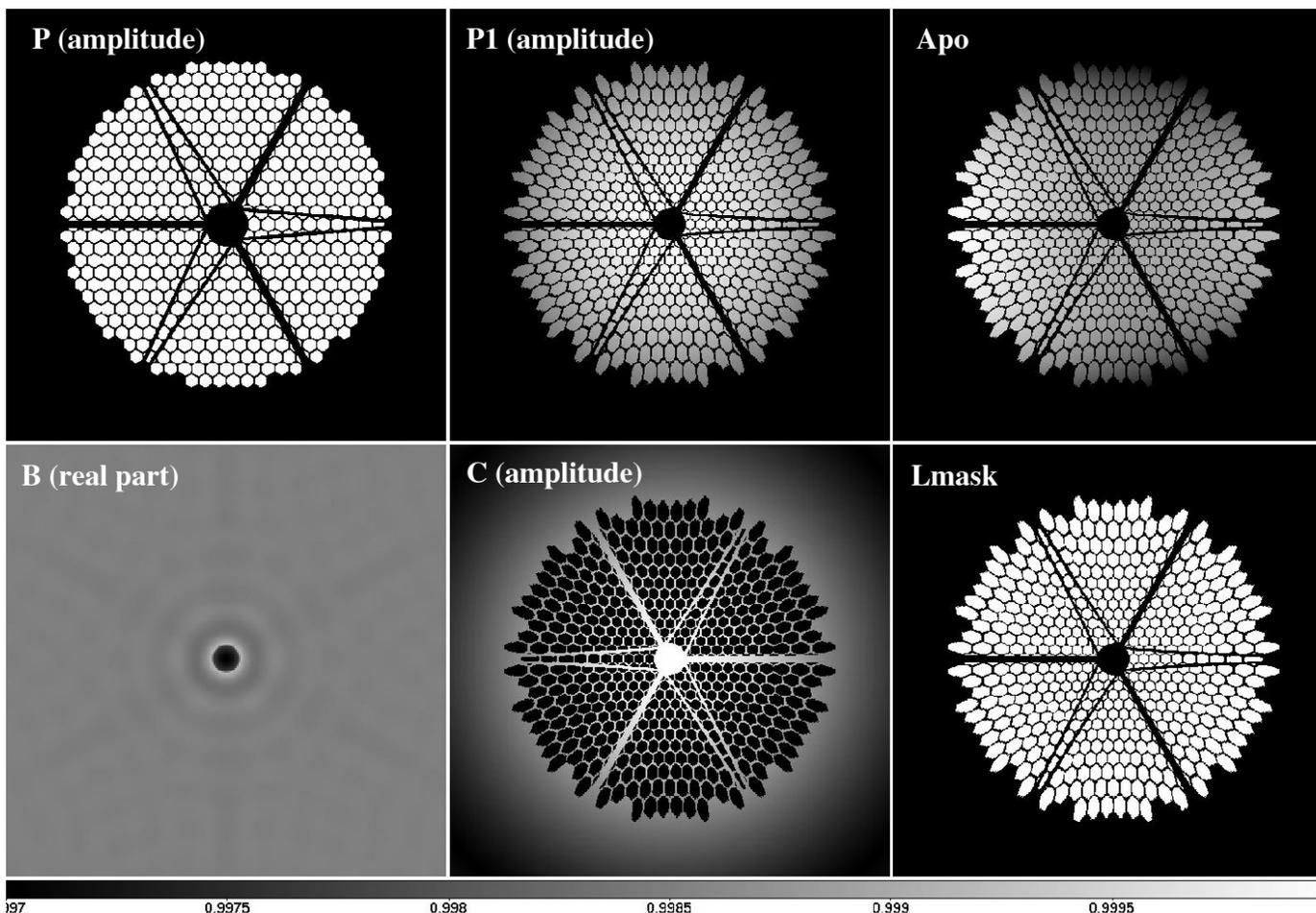
Working Angles 3 to 21  $\lambda/D$   
Contrast:  $10^{-8}$   
Throughput: 23%

3  $\lambda/D$  is  $\sim 0.2''$  at  
800 nm for a 2.4 m  
telescope

R. Vanderbei, et al., 2011  
A. Carlotti, et al., 2012

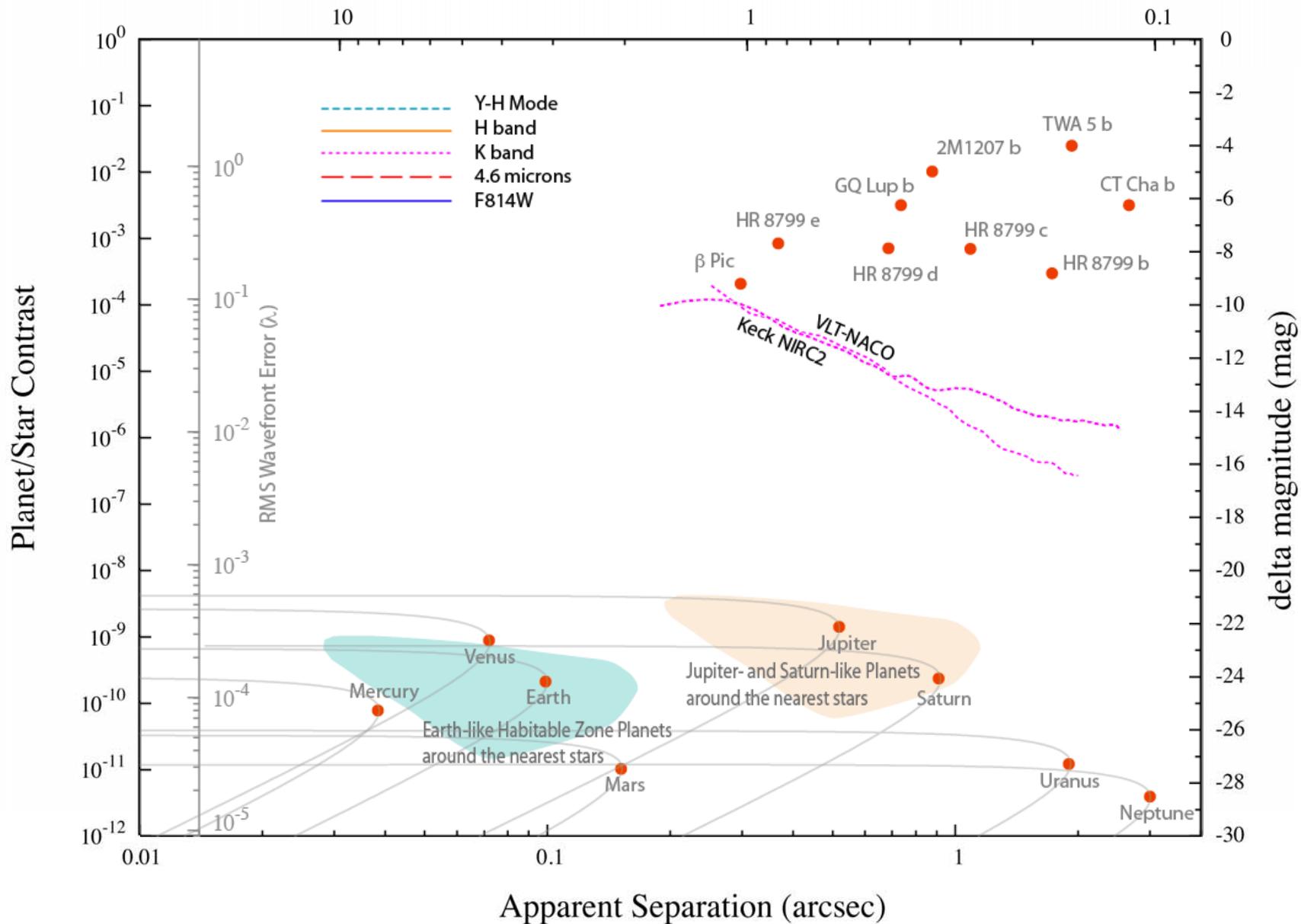


# Phase-Induced Amplitude Apodization Complex-Masks



Courtesy of Olivier Guyon (NAOJ, University of Arizona)

### Mirror Diameter (m) for Inner Working Angle of $2\lambda/D$ at 750 nm





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