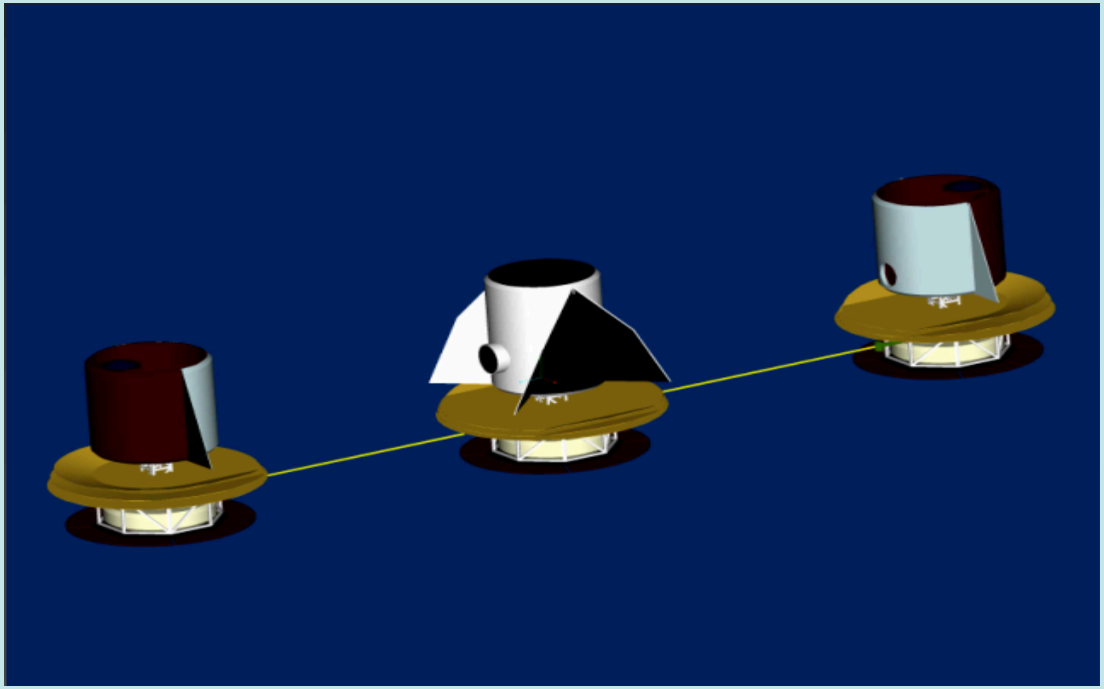
SPECS

The Submillimeter Probe of the Evolution of Cosmic Structure:

Far-IR Interferometry and the
Benefits of an Ares V Launch

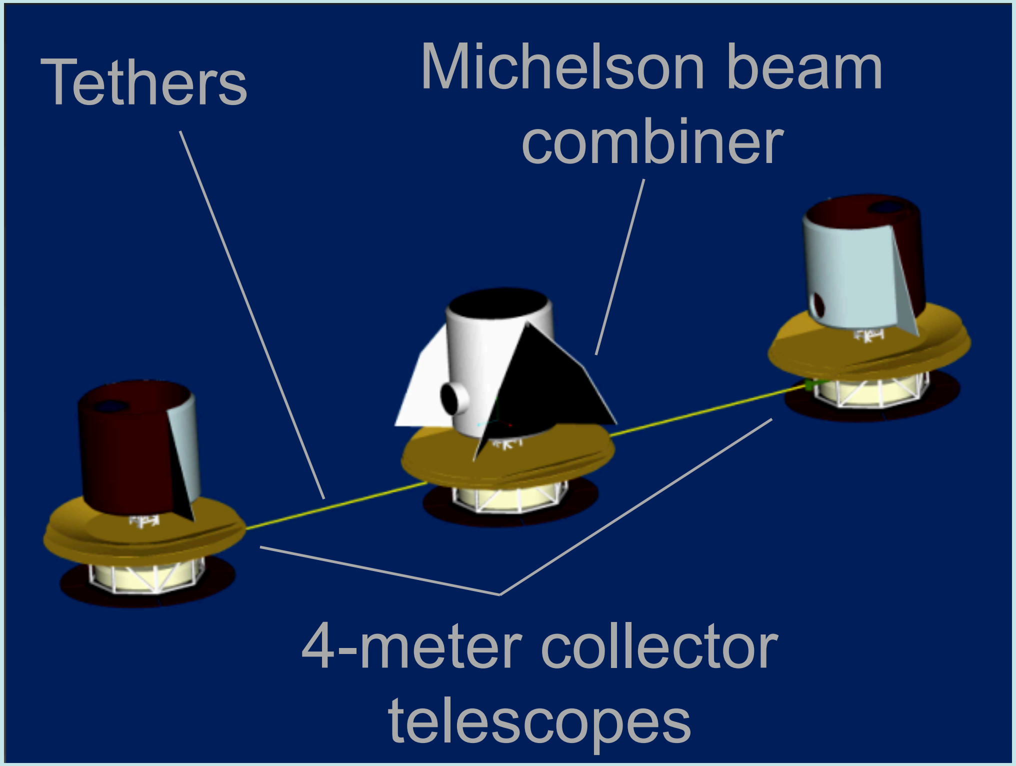


S. Rinehart

NASA's GSFC

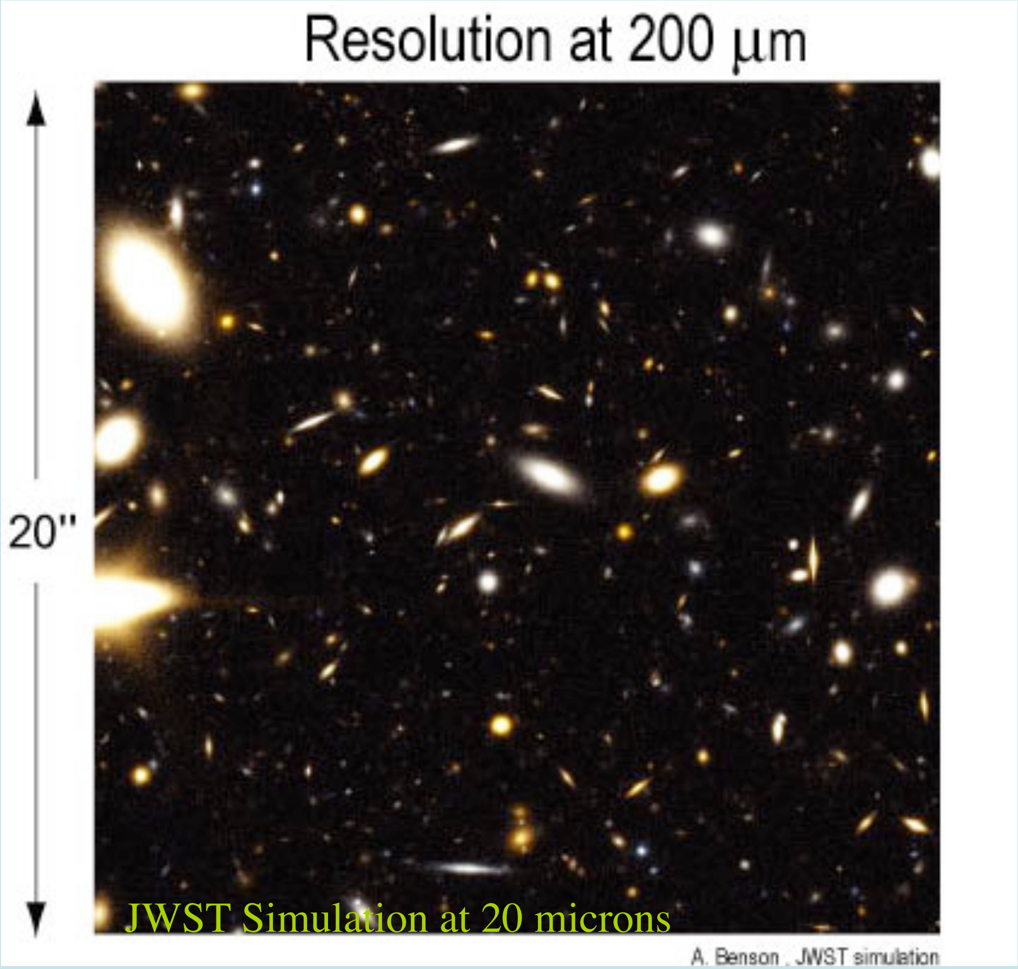
What is SPECS?

SPECS is a kilometer-baseline far-IR interferometer in space, studied as a NASA Vision Mission

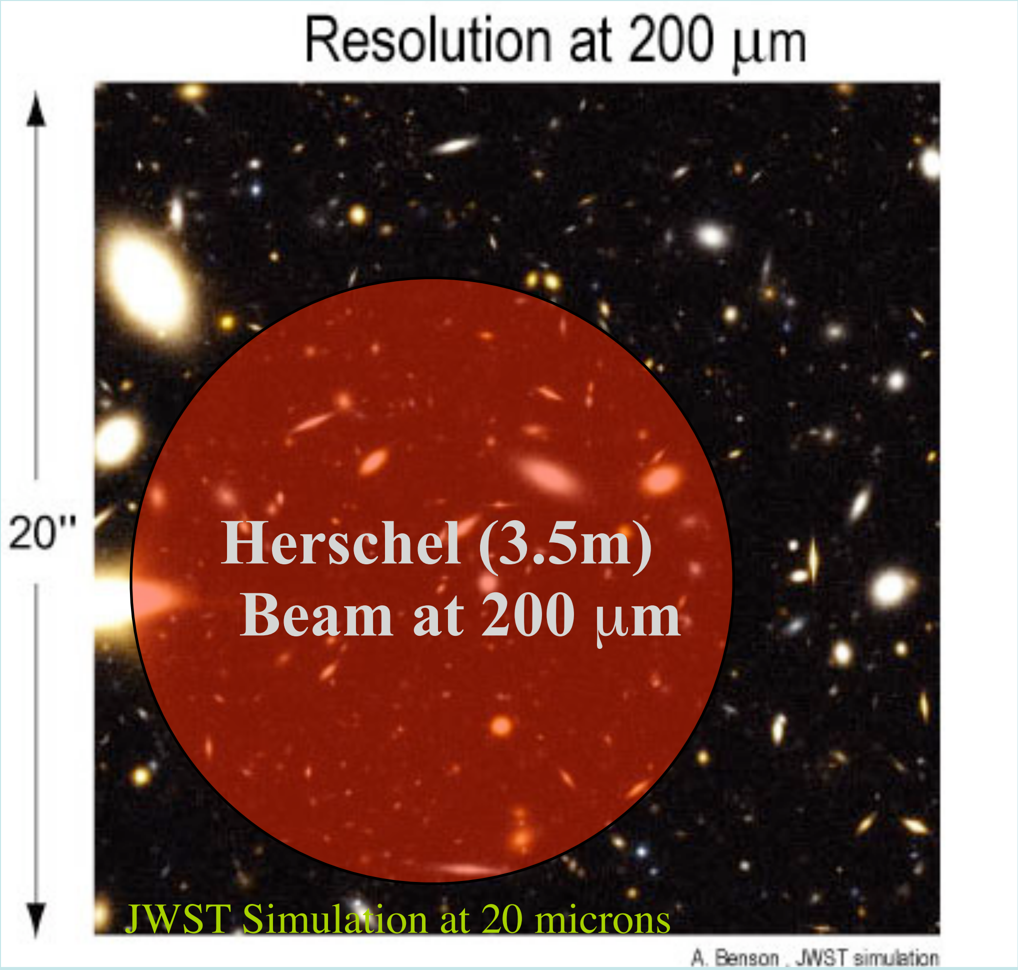


SPECS will provide angular resolution of 50 milliarcseconds over the wavelength range of 40-640 μm, simultaneously obtaining spectral and spatial information.

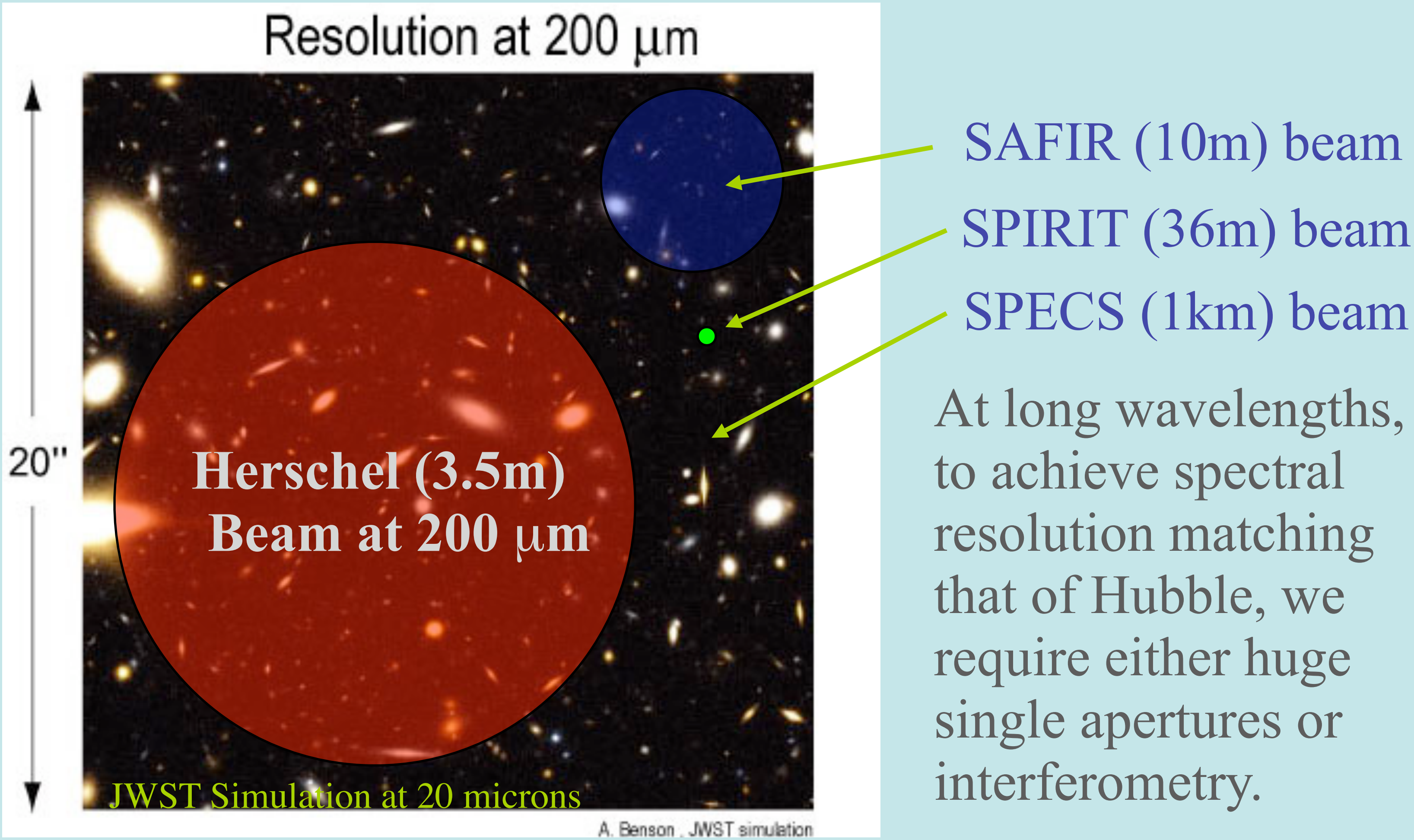
Angular Resolution



Angular Resolution



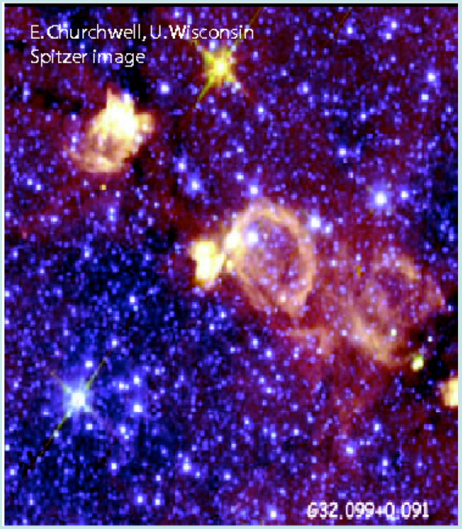
Angular Resolution



At long wavelengths, to achieve spectral resolution matching that of Hubble, we require either huge single apertures or interferometry.

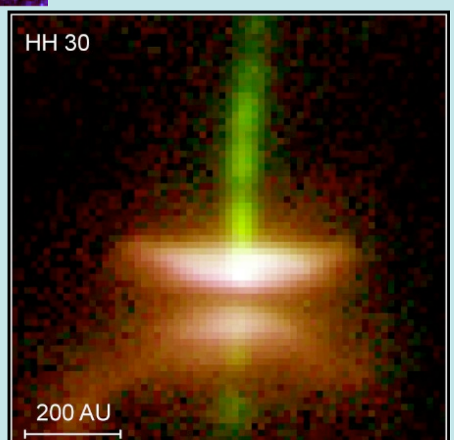
Why do we need SPECS?

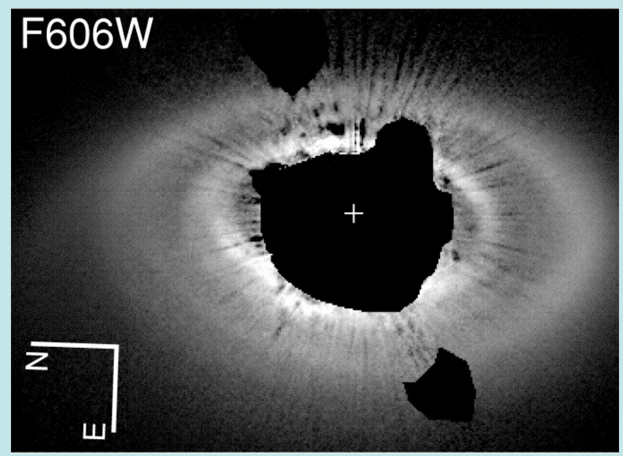
1. The First Stars



2. Galaxy Evolution

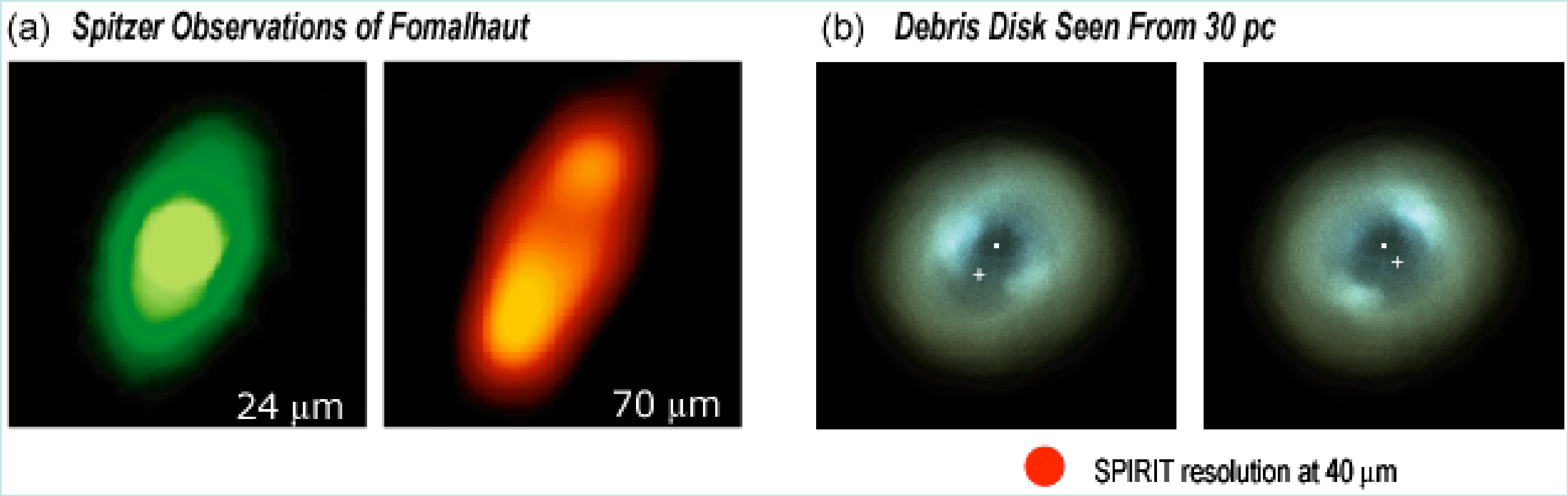
3. Star formation





4. Planetary and Debris Disks

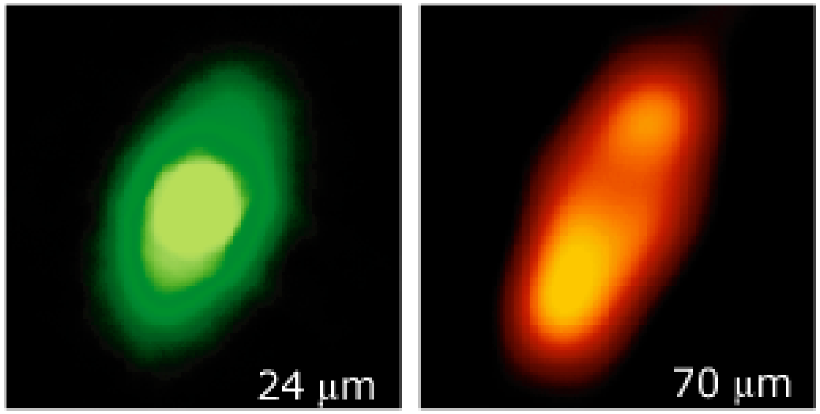
Planetary Systems



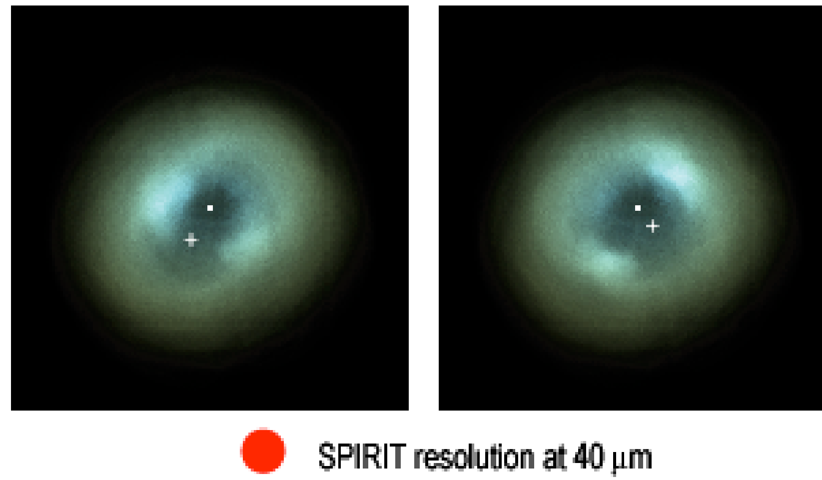
Simulated images of Epsilon Eridani in the FIR

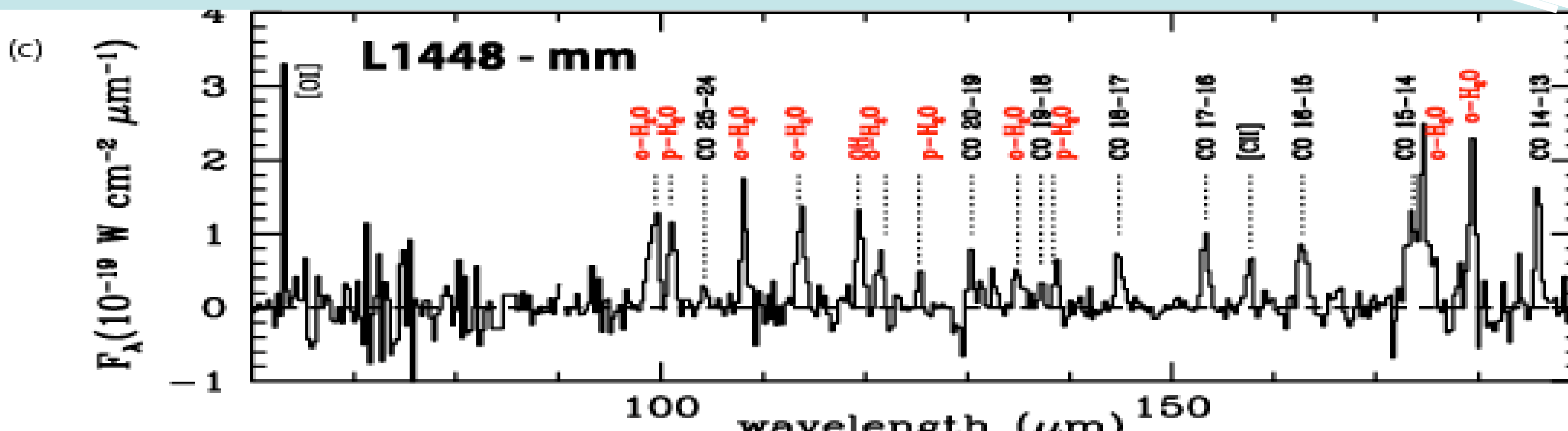
Planetary Systems

(a) *Spitzer Observations of Fomalhaut*



(b) *Debris Disk Seen From 30 pc*





Science Requirements

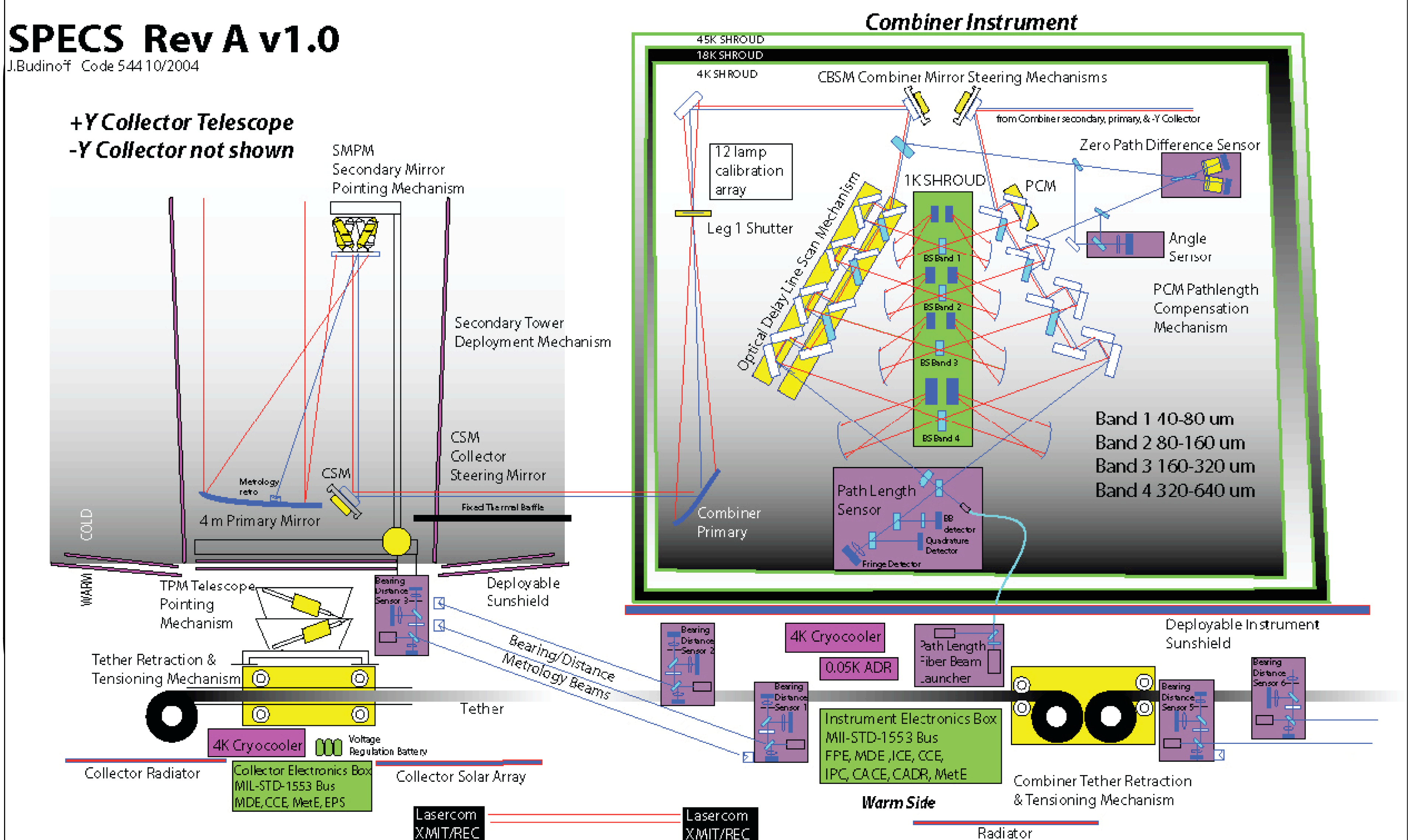
Based on the science case, SPECS must have:

1. A FOV of 1.0 arcmin or greater.
2. Wavelength coverage from 40-640 micron
3. Spatial resolution of 50 mas or better
4. Multiple observing modes:
   a. Photometry mode with wide FOV
   b. R = 3000 mode with wide FOV
   c. $R=10^5$ over small fields
5. Ability to obtain 300 images / year for at least 5 years
6. Ability to survey at least 2 star formation regions
7. Sufficient sensitivity to map high redshift extragalactic sources

Science → Technical

1. An interferometer with many baselines up to a maximum of 1 km
2. Total light collection area of > $25 m^2$
3. Optical system cooled to 4 K
4. Direct detectors cooled to <0.1 K
5. Direct detectors with Noise Equivalent Power (NEP) of 10^{-19} to 10^{-20} $W/Hz^{1/2}$
6. Heterodyne detectors with sensitivities close to the quantum limit
7. Environment free of significant differential forces on the collectors
8. Ability to communicate large data streams back to earth
9. Clean environment to prevent deposition of contaminants on cold surfaces
10. Metrology at submicron levels along all optical paths
11. Ability to control optical alignment and path length
12. Ability to point the light collectors with accuracy and jitter of < 10 mas

SPECS Design Schematic

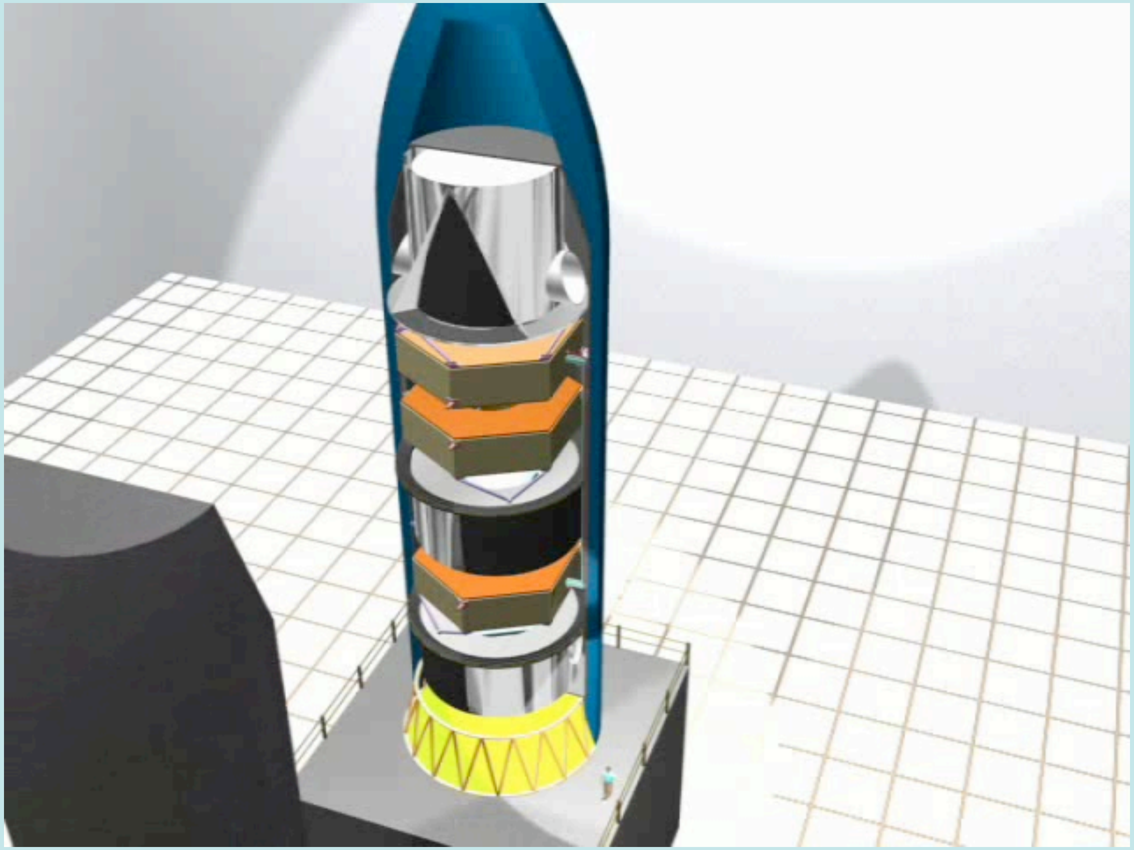


Benefits from Ares V

The larger fairing of the Ares V allows:

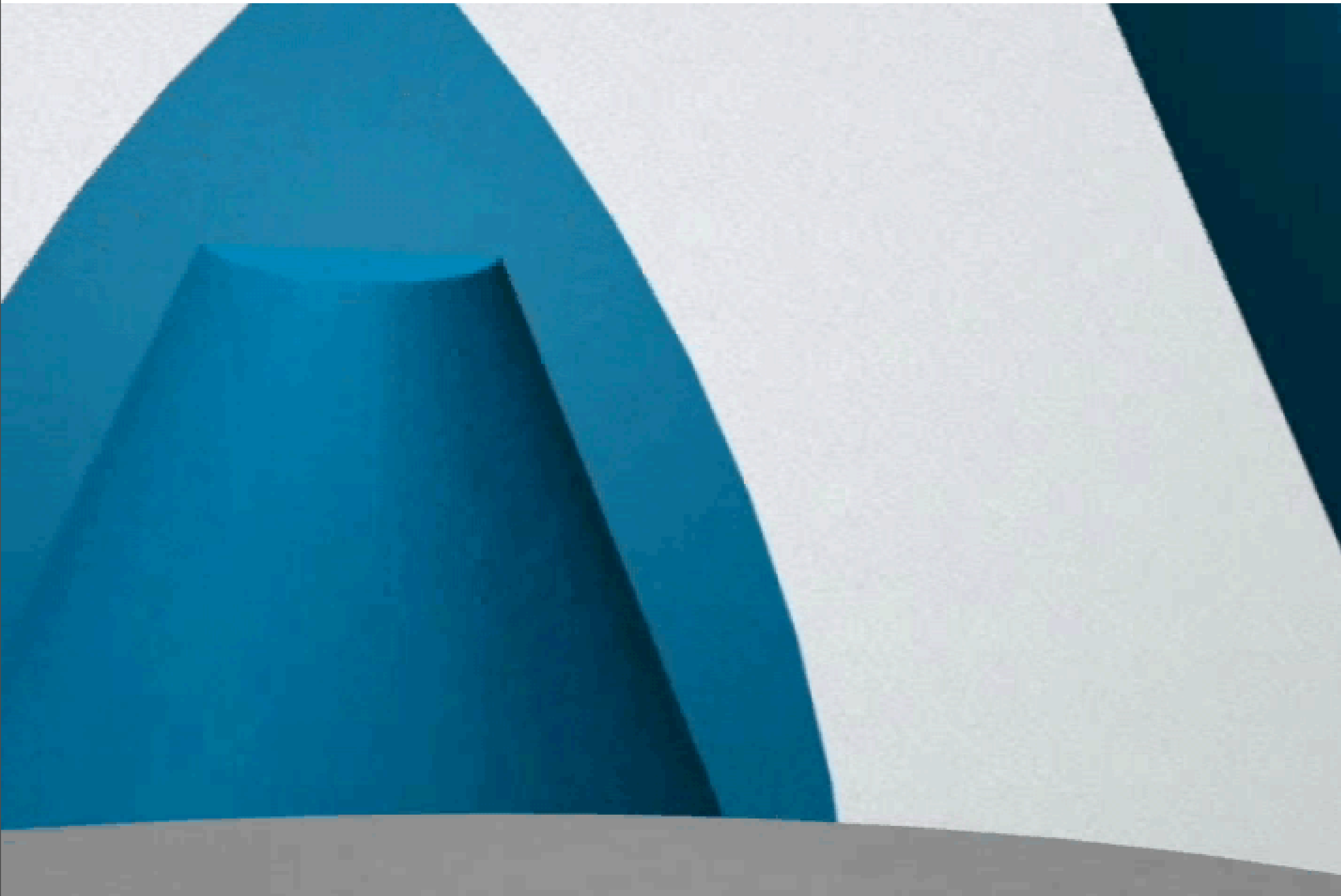
- New packaging options
  - Simplifying and reducing risks from deployment
- Would allow larger collector telescopes
  - A single Delta-IV Heavy launch limits SPECS to a pair of 4-meter monolithic mirrors
- Could allow more collector telescopes
  - The SPECS study assumed 2 telescopes to minimize complexity and to require only a single launch
  - Using 3 (or more) telescopes may provide significant advantages at the cost of increased complexity

Deployment

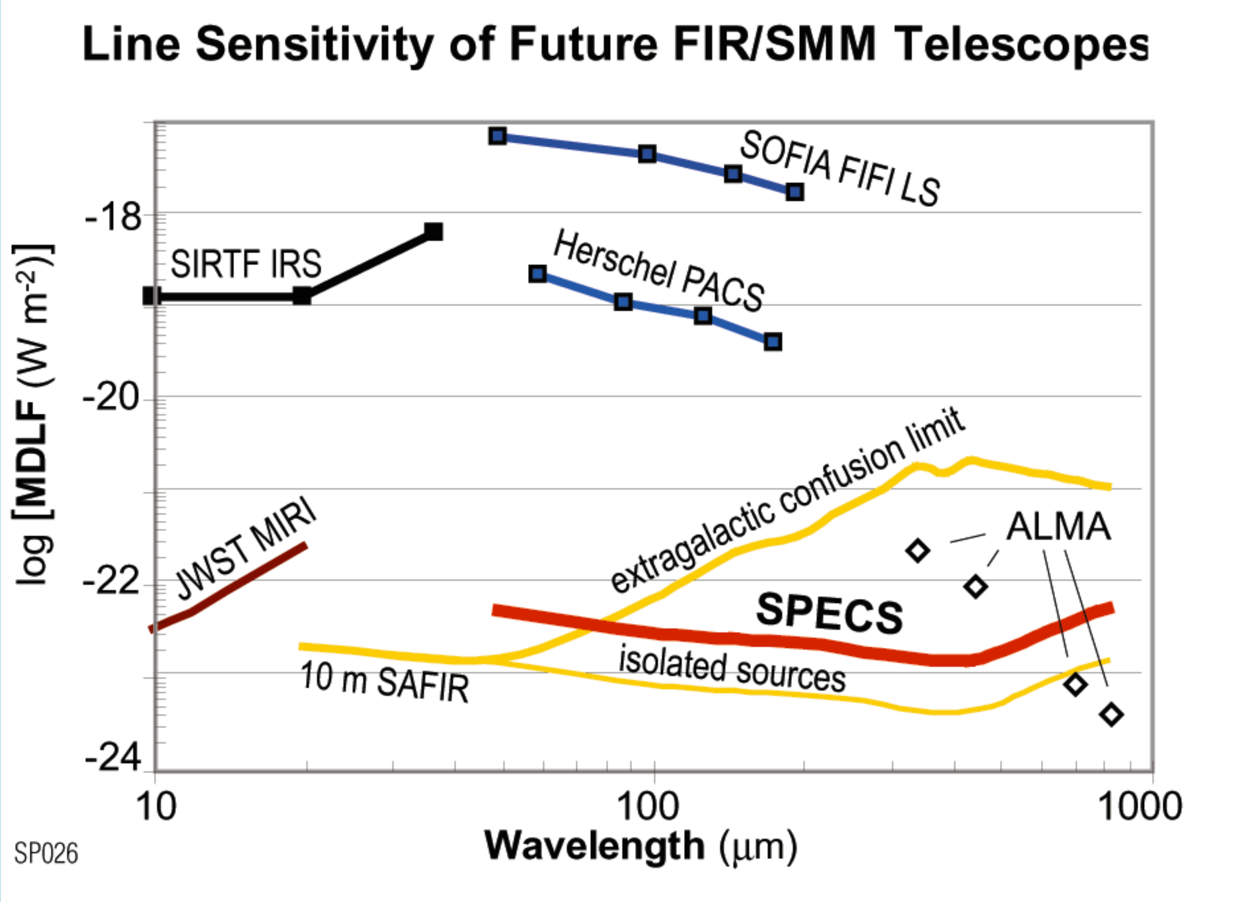


For the SPECS study, the interferometer was packaged in a Delta-IV Heavy; the two collector telescopes and the combined are stacked.

Deployment isn't exactly simple…



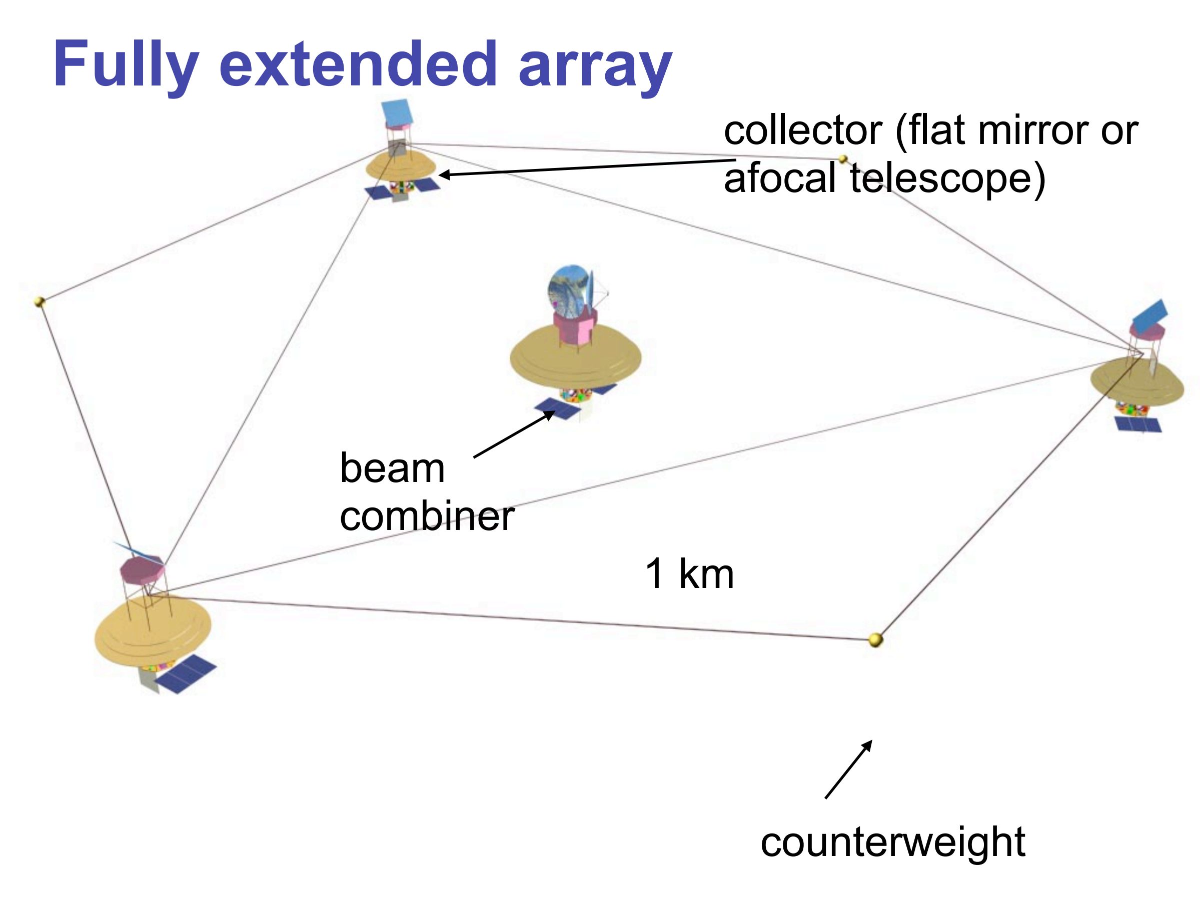
Larger Telescopes



The SPECS we studied is incredibly sensitive:

Larger telescopes lead to greater sensitivity; more observations and/or deeper observations.

More Telescopes



Tether configuration developed by Farley and Quinn (2001)

Having multiple telescopes can complicate the beam combiner.

However, it can lead to improved sensitivity and provide system redundance.

(3 identical spacecraft?)

Other potential benefits (?)

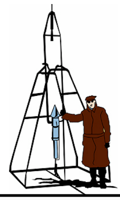
- Greater launch mass
  - more propellant, longer operational lifetime
- Servicing?
  - Refueling
  - Repair/replacement of mechanisms
  - Replacing tethers

Conclusions

SPECS, as studied for a NASA Vision Mission, does not **require** an Ares V

However, the capabilities provided by an Ares V have the potential to both increase capabilities and reduce complexities associated with this mission.

and Thanks



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