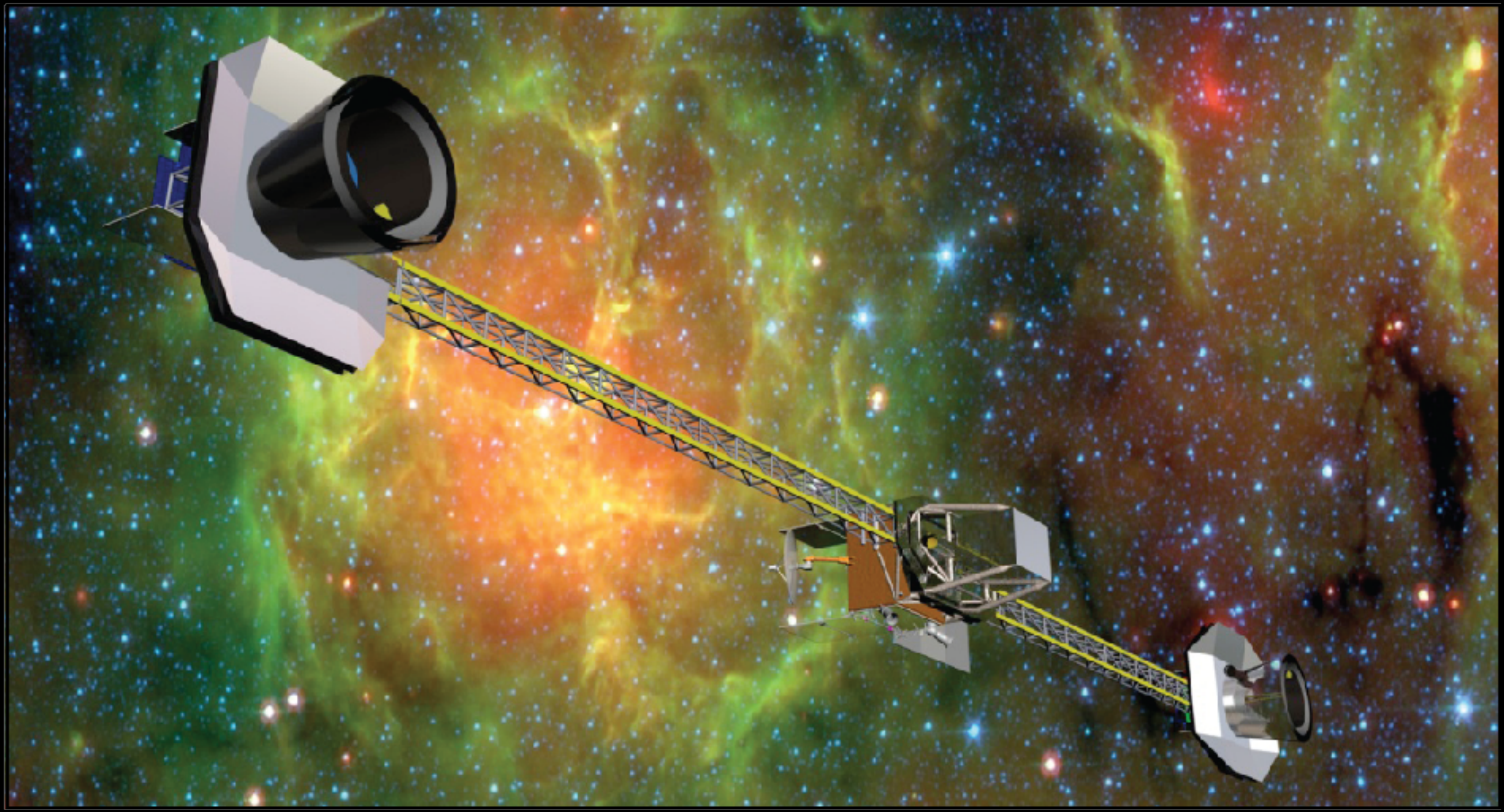
SPIRIT: A Far-IR Probe

Dave Leisawitz, NASA GSFC



SPT019

Interferometry is the natural choice when the need for better angular resolution surpasses the need for improved sensitivity as the driver for aperture size.

The 85 cm diameter Spitzer telescope demonstrates the extraordinary power of a space-based cryogenic telescope equipped with low-noise detectors. The sky is teeming with far-IR photons!

In the far-IR, interferometry (wavefront control) is not difficult; the technical challenges are those to which we are accustomed: detectors and cold temperatures.

SPIRIT Origins Probe Mission Concept Study Team

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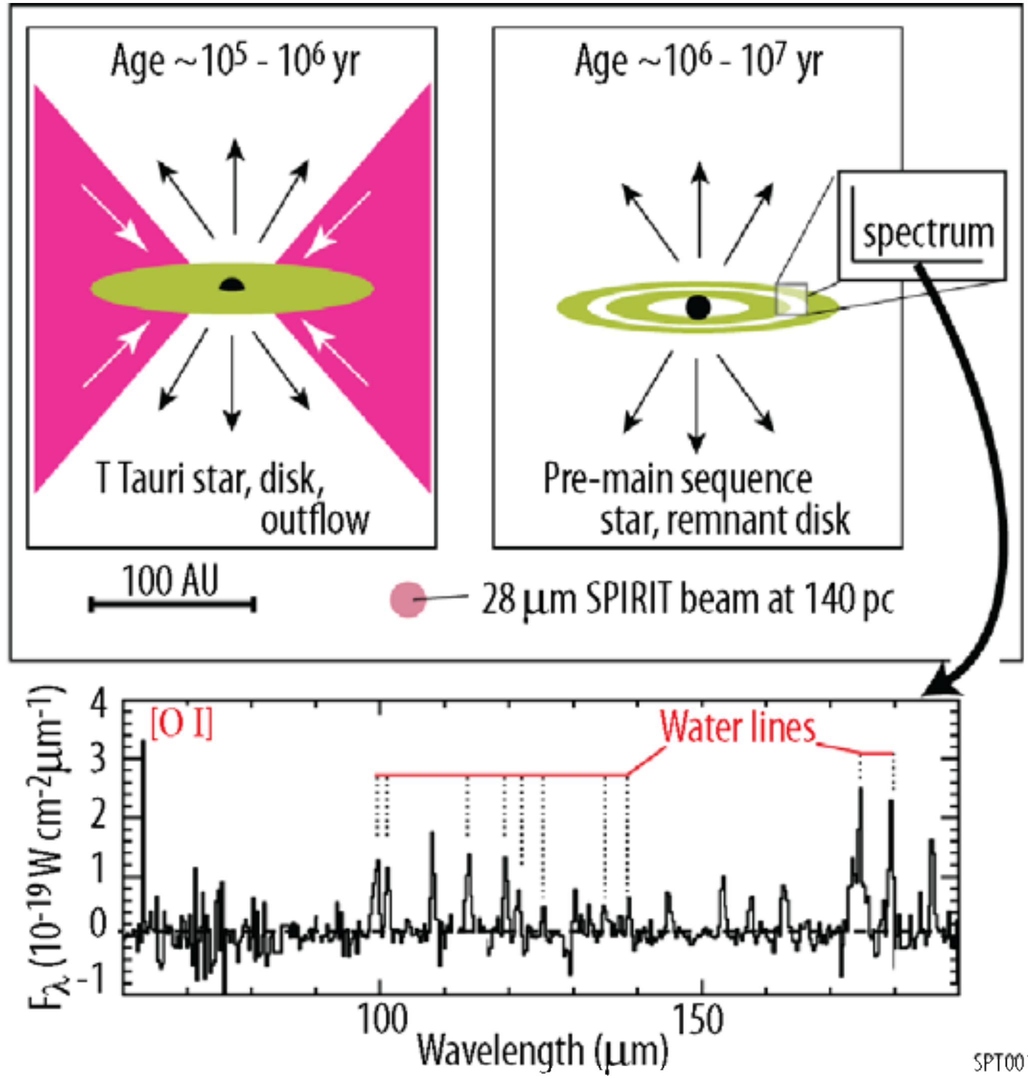
Compelling Science Goals

- How do the conditions for planetary habitability arise during planet formation? ("follow the water")
- Find and characterize exoplanets by imaging and measuring the structures in protoplanetary and debris disks.
- How did high-redshift galaxies form and merge to form the present-day population of galaxies? (How did a hot, smooth universe give rise to the Milky Way?)

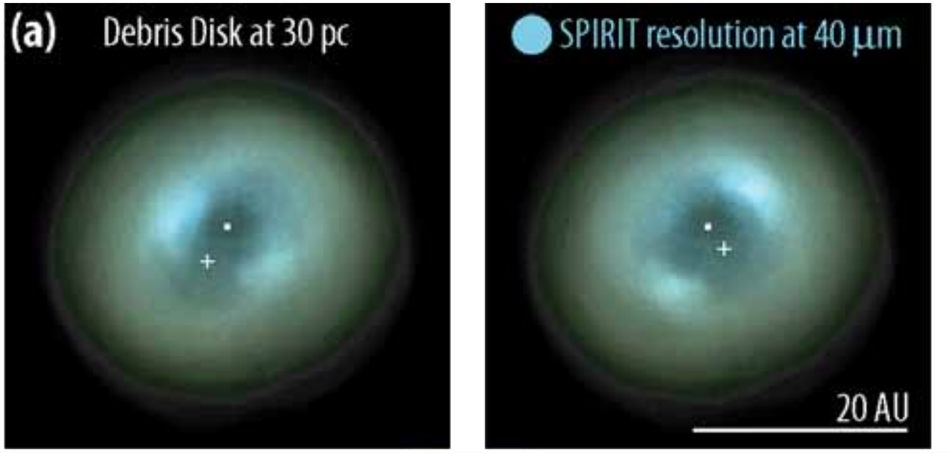
Water, water everywhere! (Some gaseous, some solid.)

How do the conditions for planet habitability arise during planet formation?

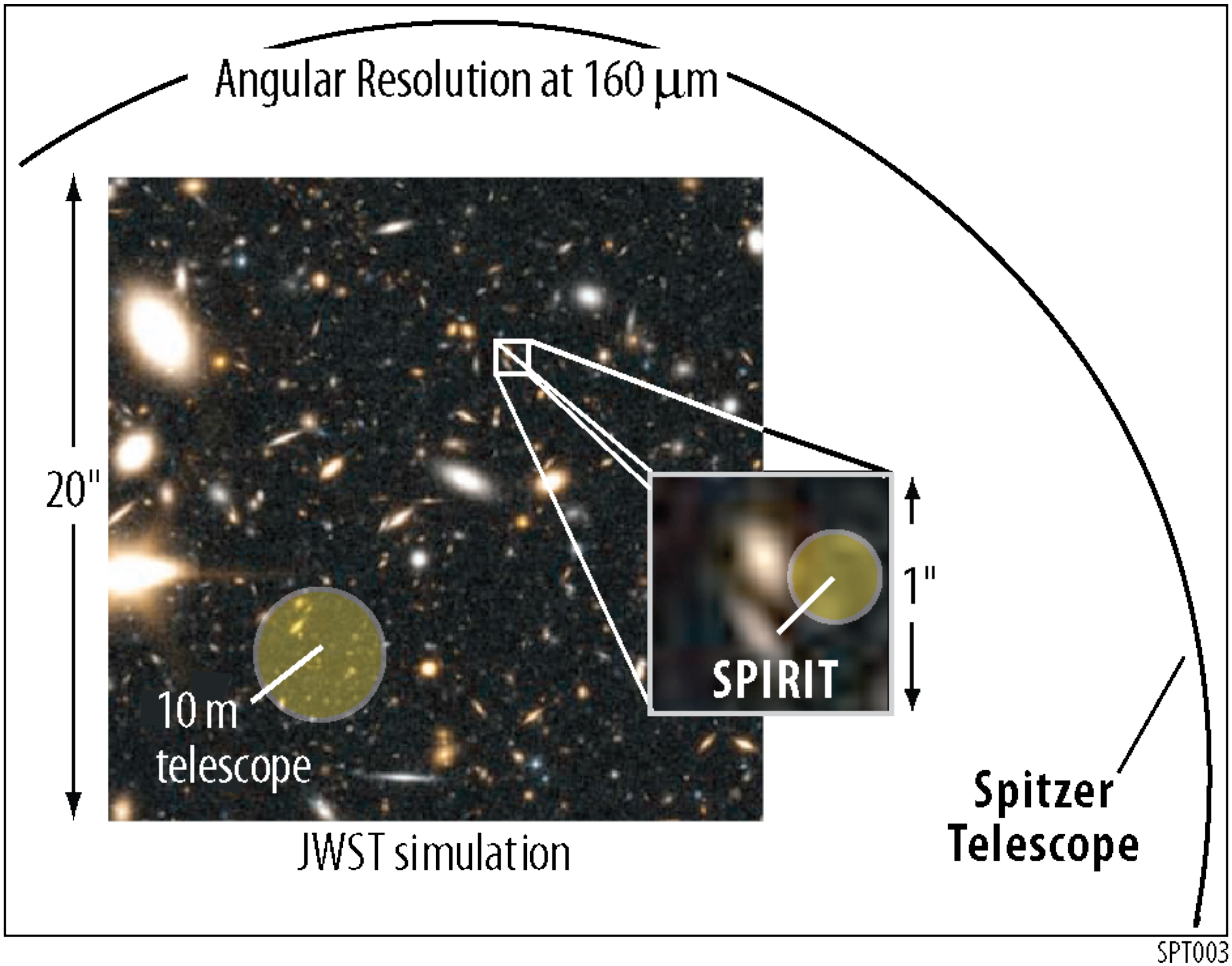


Find and characterize planets by detecting lumps of gravitationally trapped dust in debris disks.

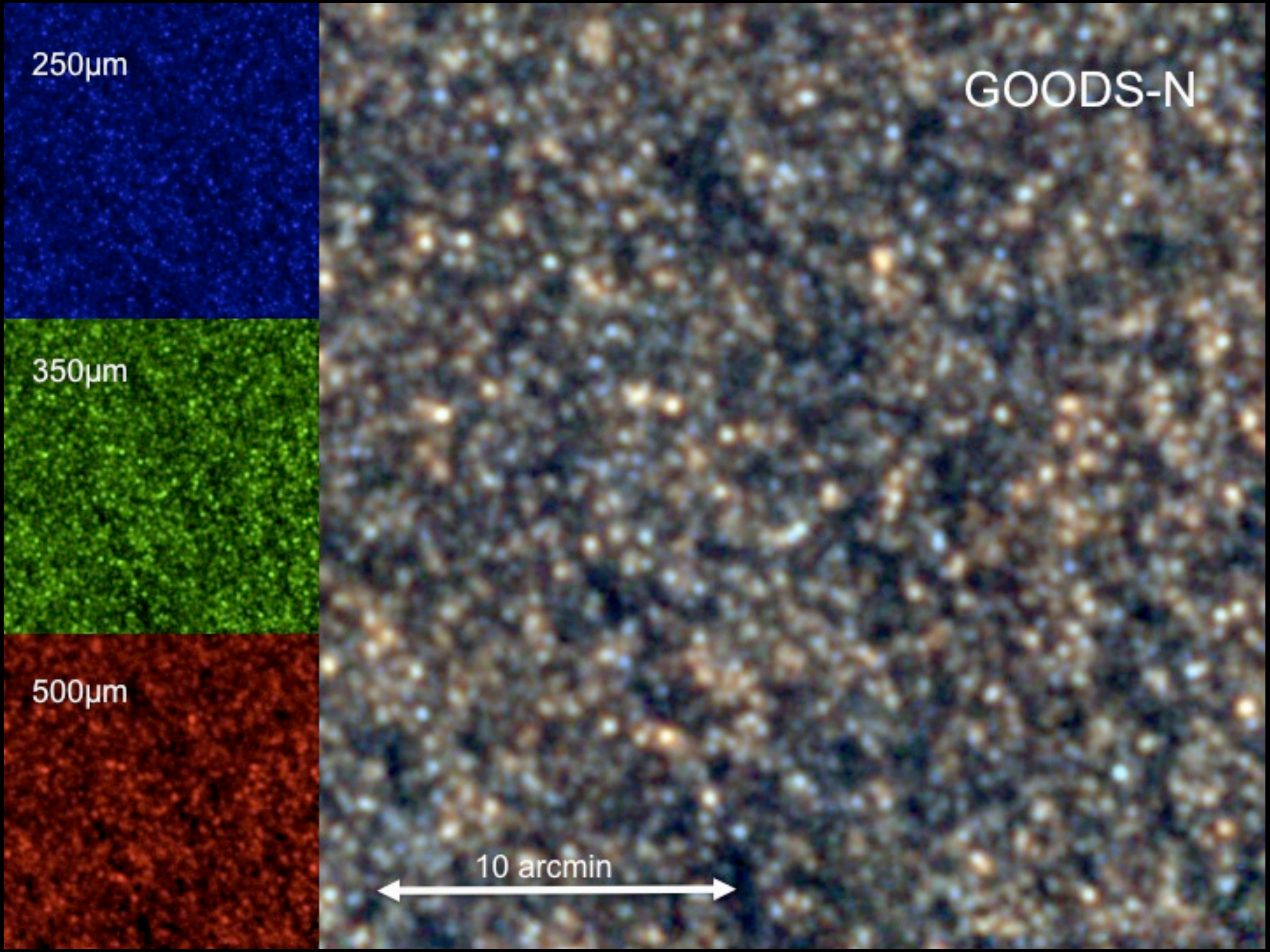
Kuchner et al. Eps Eri model scaled to 30 pc



How did high-z galaxies form and merge to form the present-day population of galaxies?

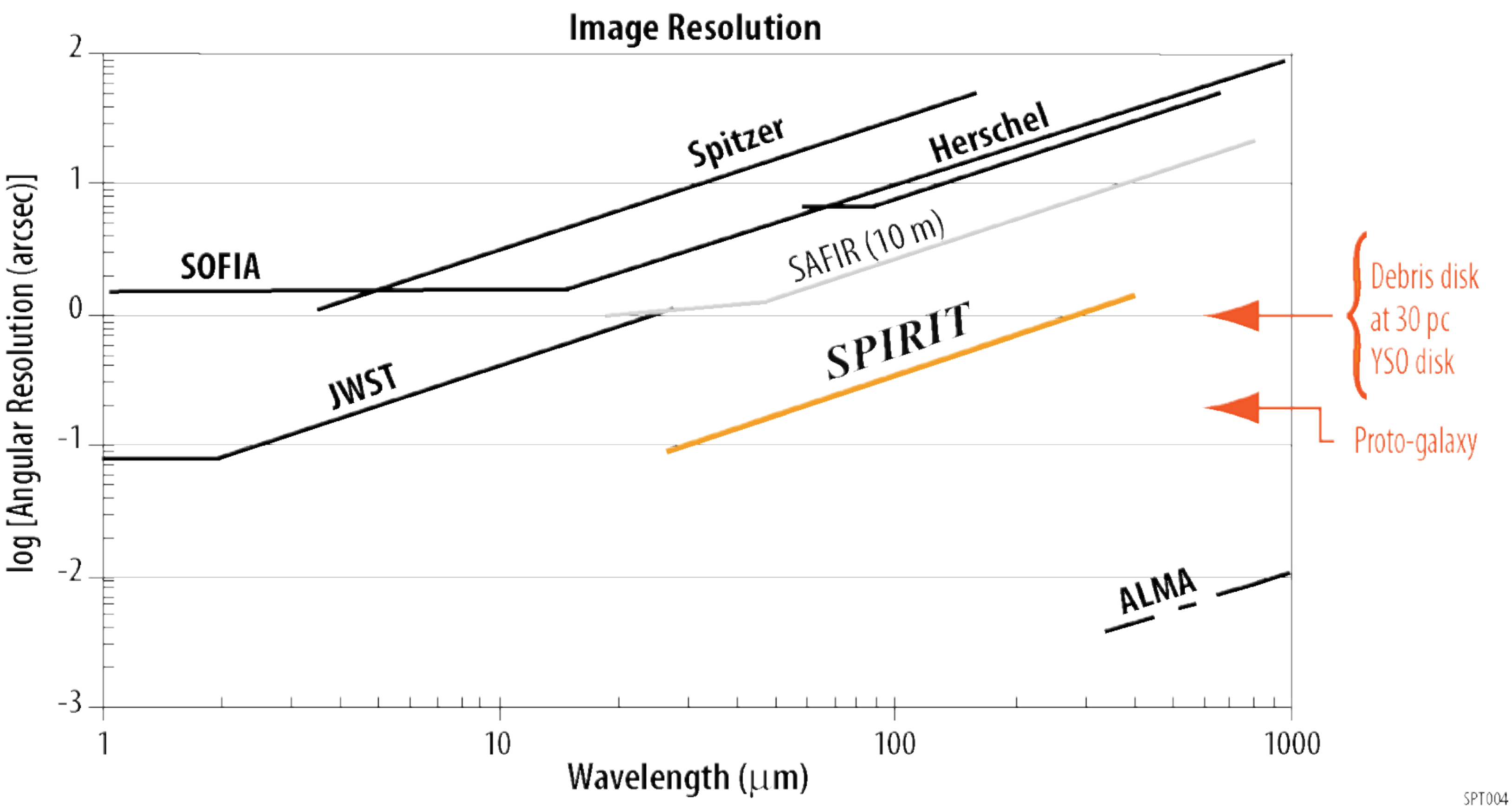


Herschel GOODS-N Deep Field



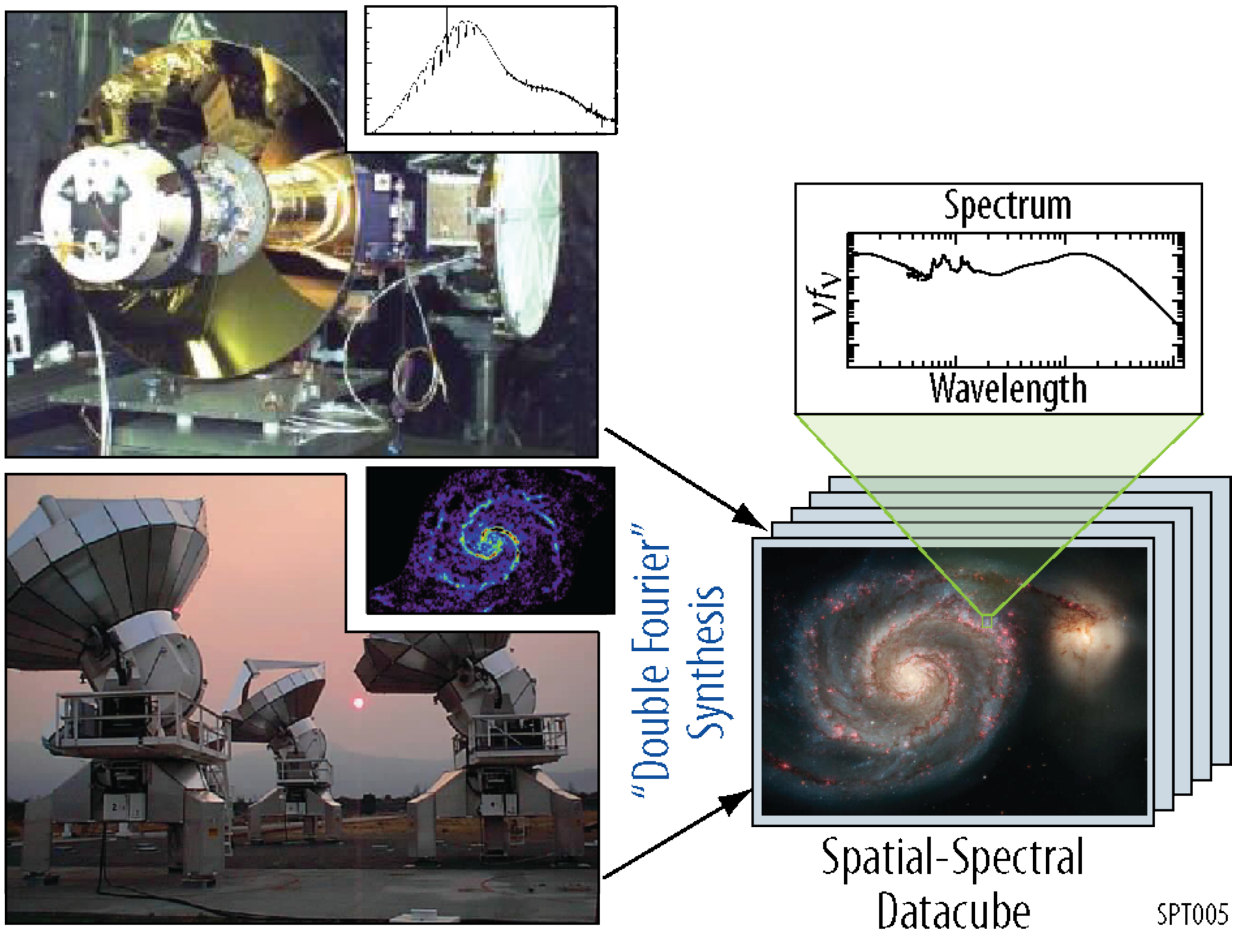
Derived Requirements

- Sub-arcsecond angular resolution over the wavelength range 25 – 400 μm (between JWST and ALMA)
  - Image protostellar and debris disks
  - Resolve the far-IR extragalactic background
- ~10 μJy continuum, 10^{-19} W/m^2 line sensitivity
  - Detect low surface brightness debris disks
  - Measure SEDs and spectral lines of high-z galaxies
- >1 arcmin instantaneous FOV
- Spectral resolution, R ~ 3000 (integral field spectroscopy)

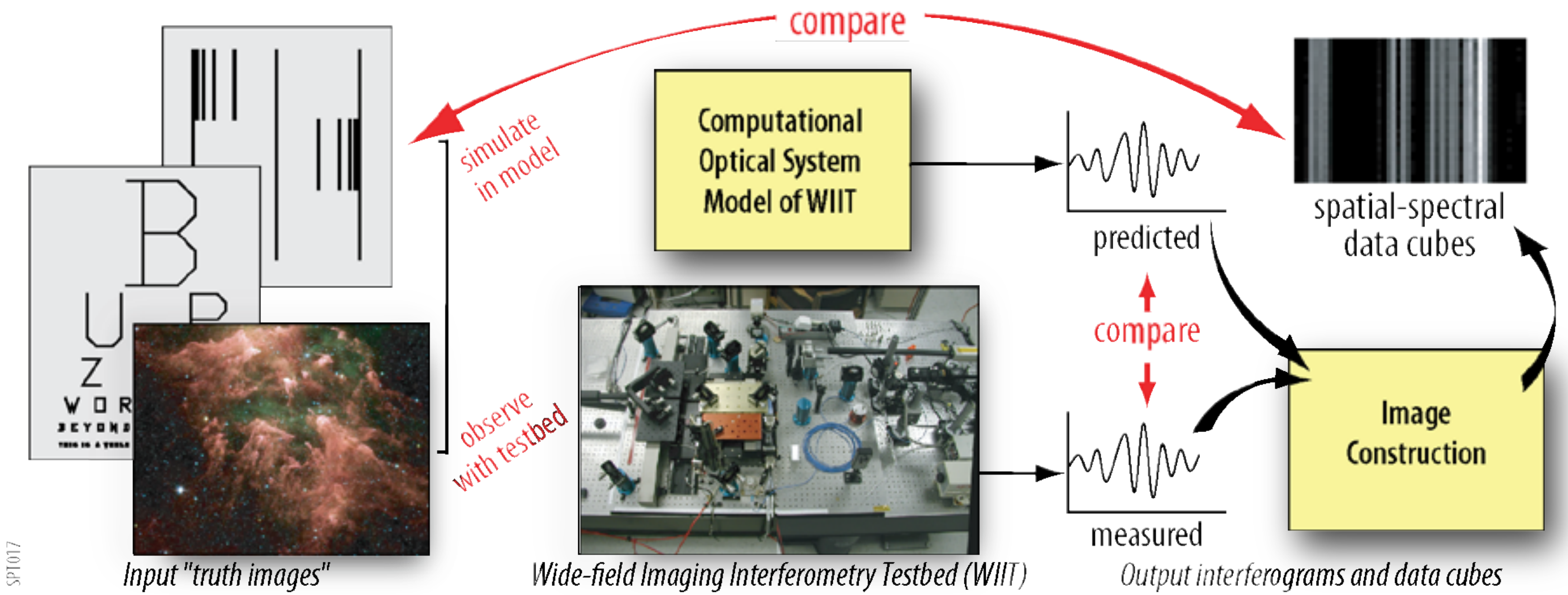


To image protoplanetary and debris disks and definitively distinguish the emissions of individual high-z galaxies requires sub-arcsecond angular resolution. This capability is sorely lacking in the far-IR, where these objects are bright and their information content is great.

The technique: something old and something new…



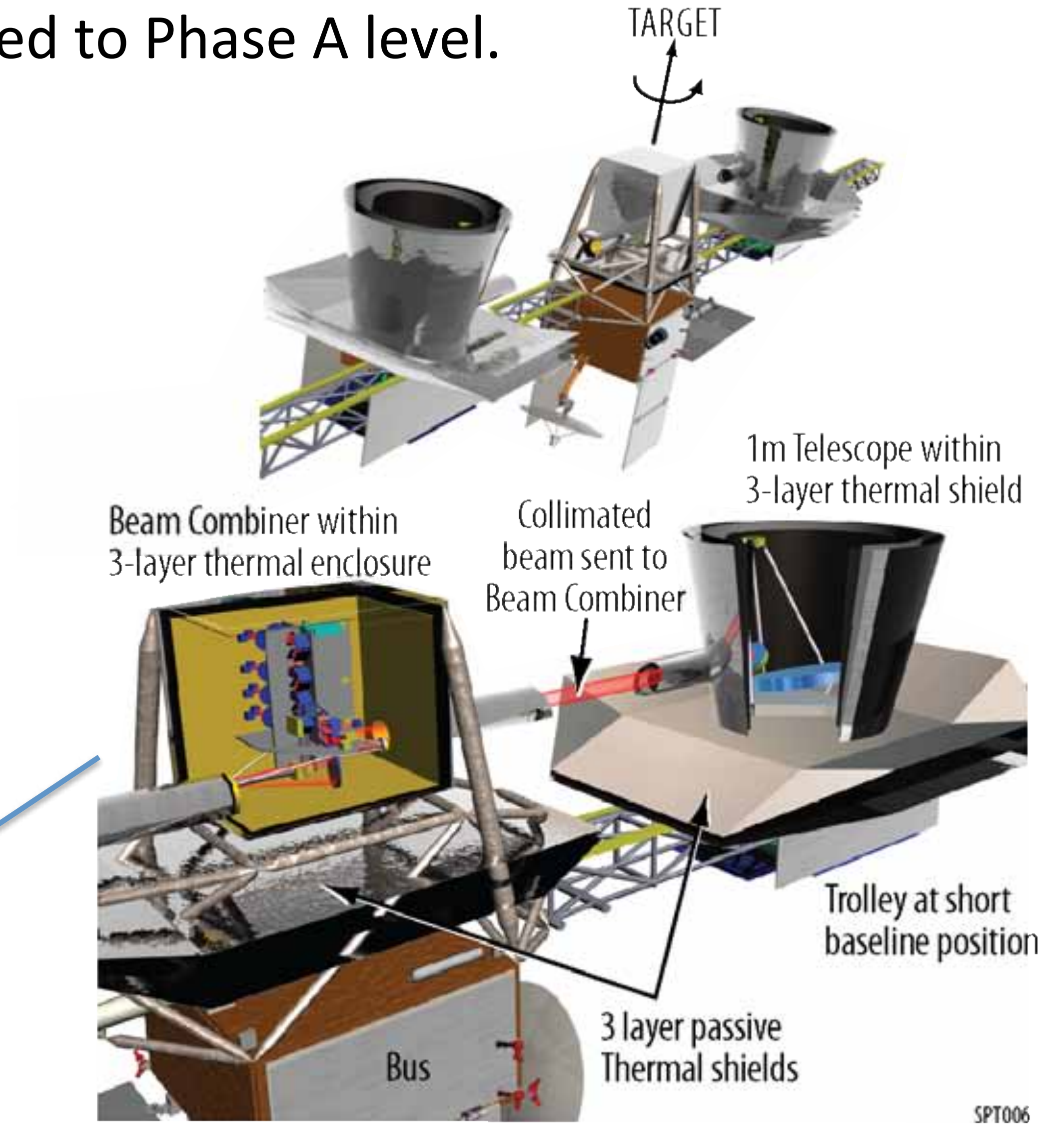
Wide-field double-Fourier (spatio-spectral) interferometry



We've been developing and gaining practical experience with this technique in the lab for the past decade

SPIRIT was studied as a candidate Origins Probe mission and recommended to the Decadal Survey Committee.

The concept has matured to Phase A level.



A single instrument

An optimist's perspective

All feasible good ideas are ultimately realized

Let's ask ourselves

- When?
- How should the US be involved?
- What investments will be necessary to ensure the desired involvement?

Key Decision Point

Probe sooner … OR … flagship later?

First Cosmic Origins Probe could fly by ~2025

Earliest opportunity for a Cosmic Origins flagship is in ~2040 if a PCOS mission follows JWST

A Probe mission line would restore vitality to the Astrophysics portfolio