



The Far-Infrared Enhanced Survey Spectrometer (FIRESS) for PRIMA



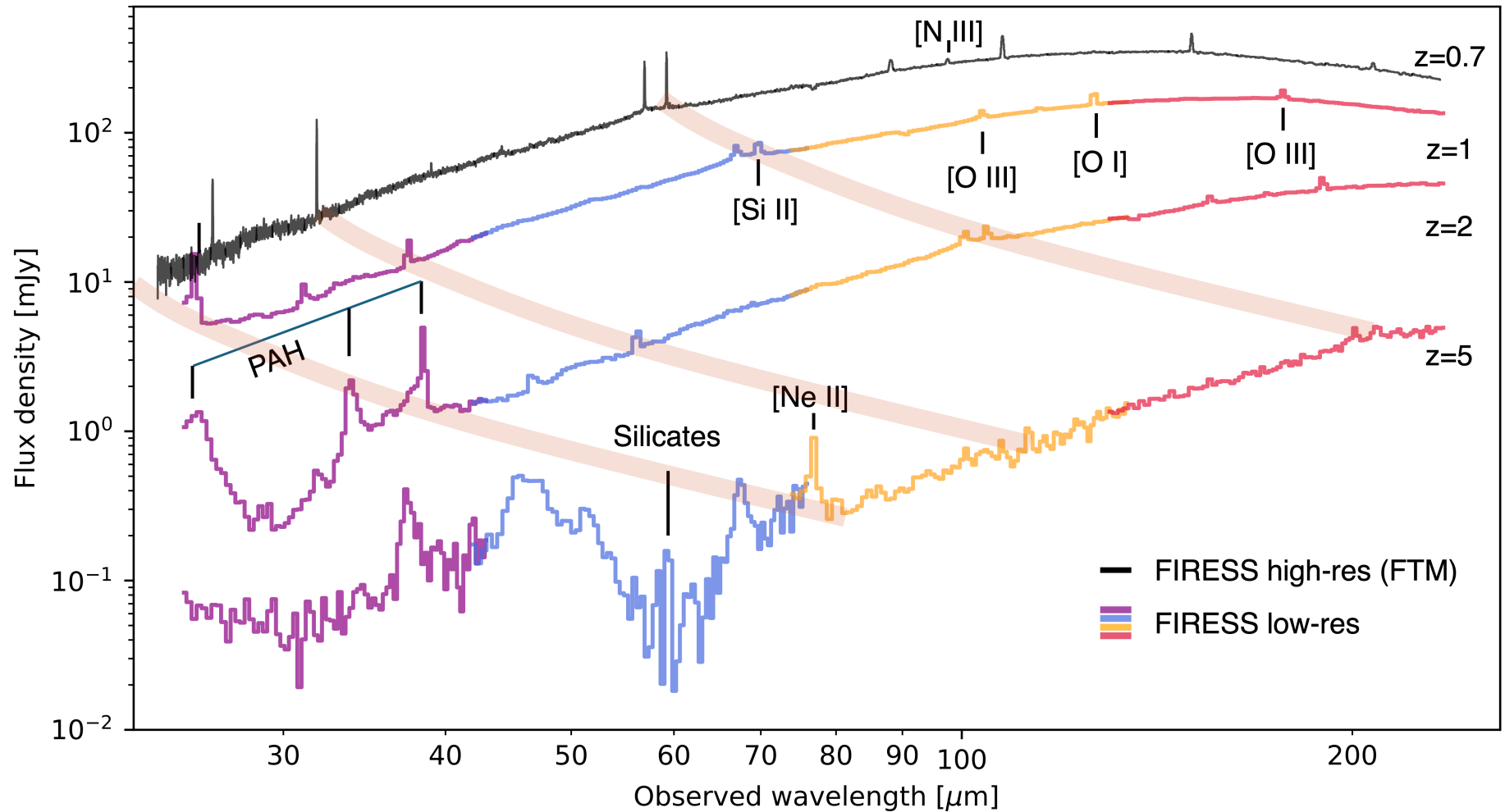
Jason Glenn for Matt Bradford* & the FIRESS team
Especially: Phil Korngut, Joe Green, JD Smith, Al Kogut

SPIE Copenhagen
July 10, 2026

* Jet Propulsion Laboratory, California Institute of Technology

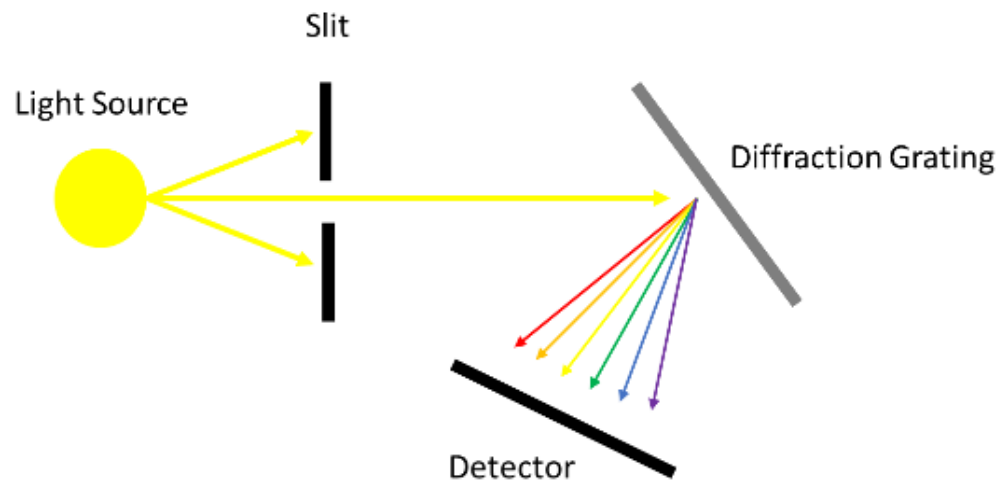
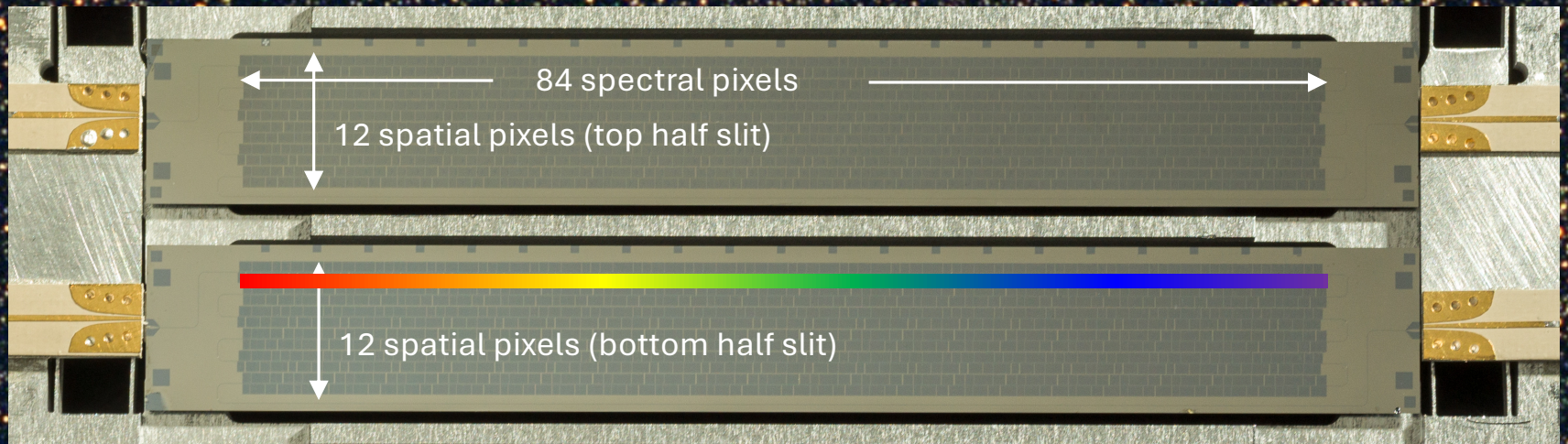


FIRESS: Designed for obtaining full-band spectra



FIRESS Spectrometer Approach: 4 bands, each like this

Slit on sky

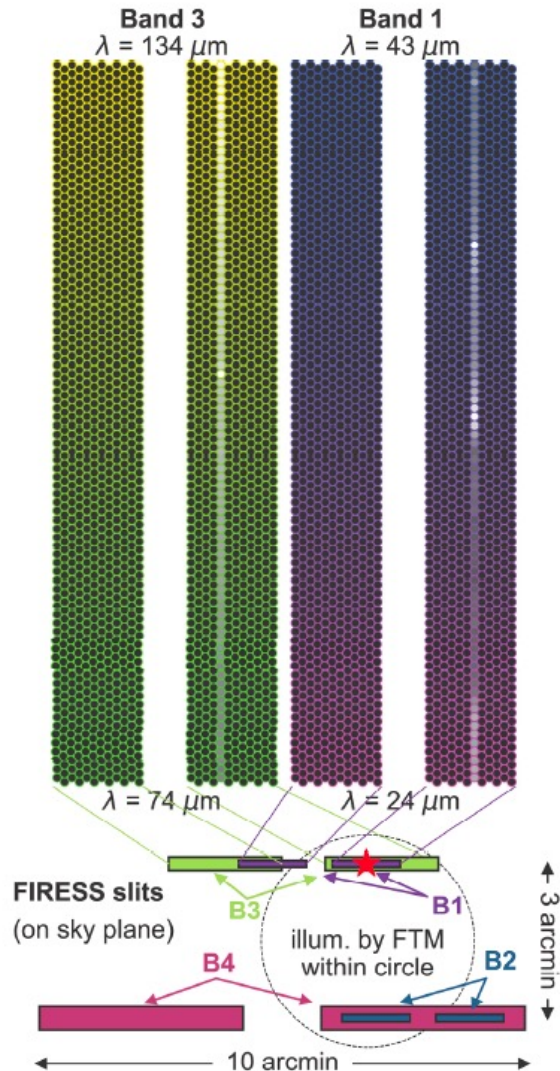


Band	min wave	max wave
1	24 μm	43 μm
2	42 μm	76 μm
3	74 μm	134 μm
4	130 μm	235 μm



PRIMA

The PRObe far-Infrared
Mission for Astrophysics

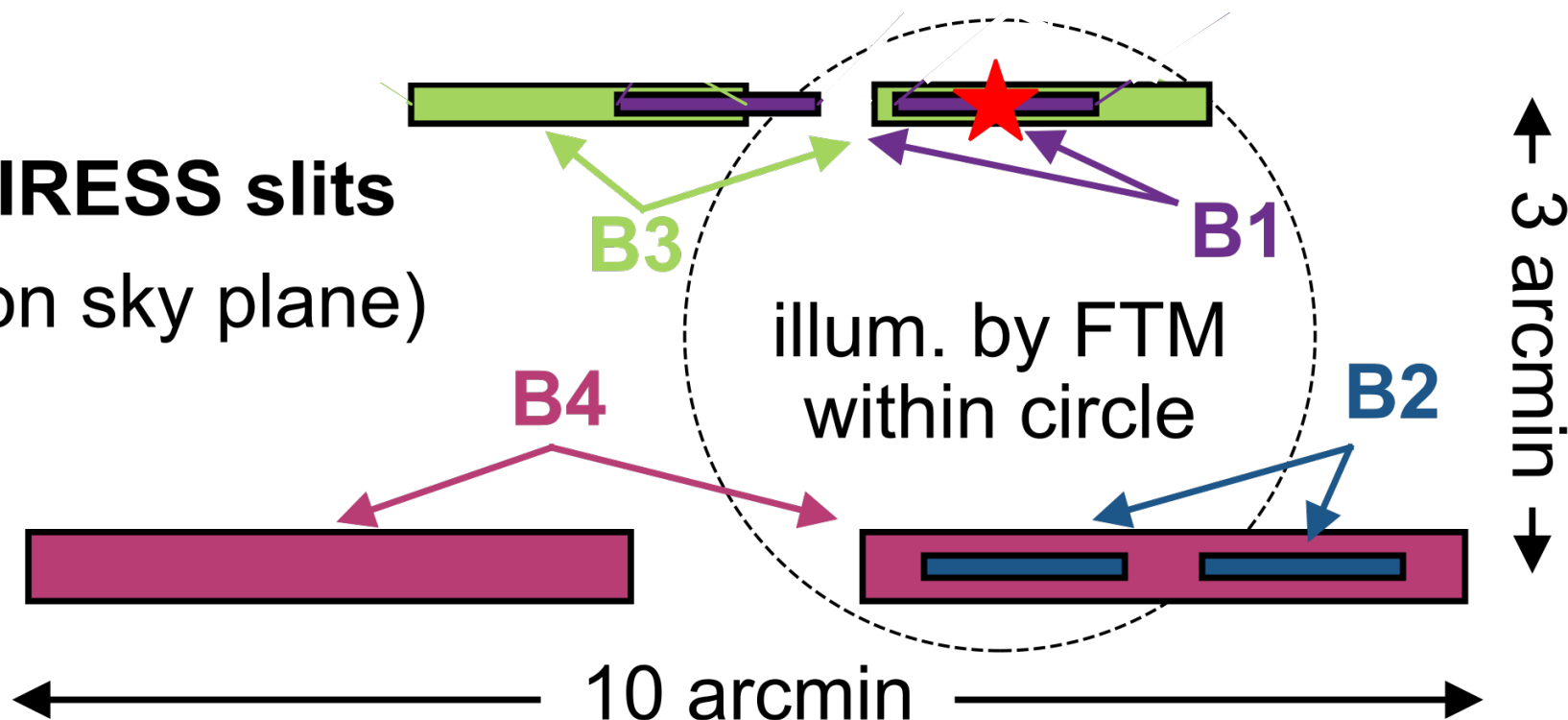


FIRESS Approach

- 4 slit-fed grating modules spaced logarithmically with some wavelength overlap. $R > 100$
- Common detector array approach: 24 spatial x 84 spectral pixels. Spatial is 12 + 12 w/ gap.
- Target of interested observed in Bands 1 and 3 simultaneously, or Bands 2 & 4 simultaneously.
- All detectors in all bands read out simultaneously.
- Band 1 and 2 common design and plate scale.

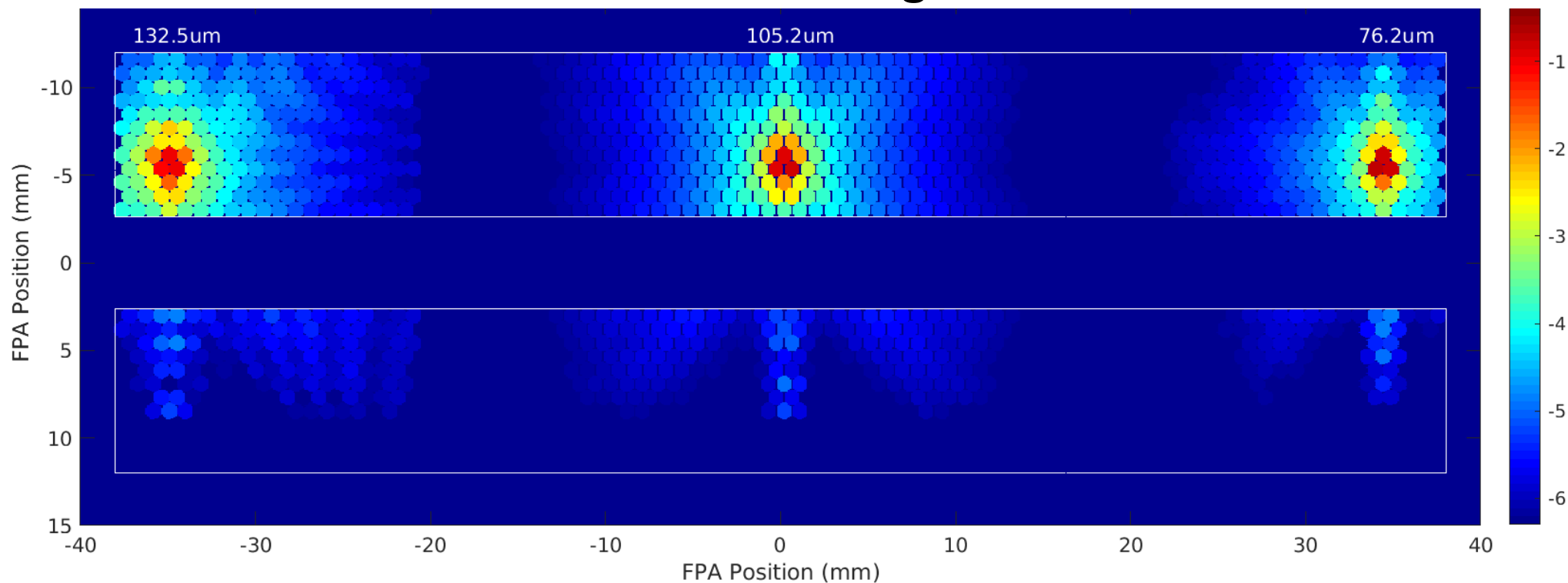
Parameter	Band 1	Band 2	Band 3	Band 4
Spectral range (μm)	24–43	42–76	74–134	130–235
Array format per band	24 spatial x 84 spectral pix, 900- μm pitch			
Pix size on sky (arcsec)	7.6		12.7	22.9

FIRESS slits (on sky plane)



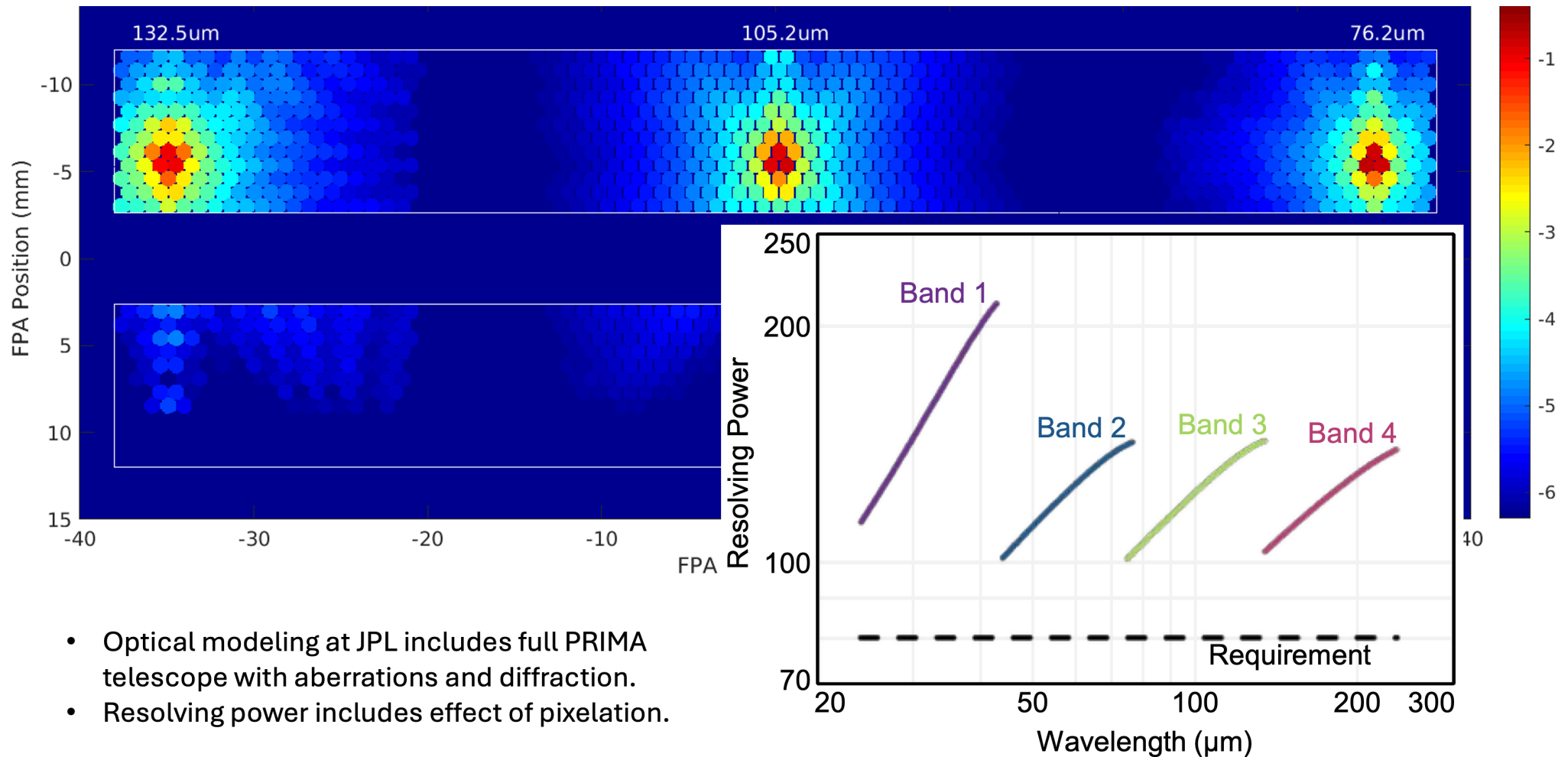
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FIRESS Resolving Power



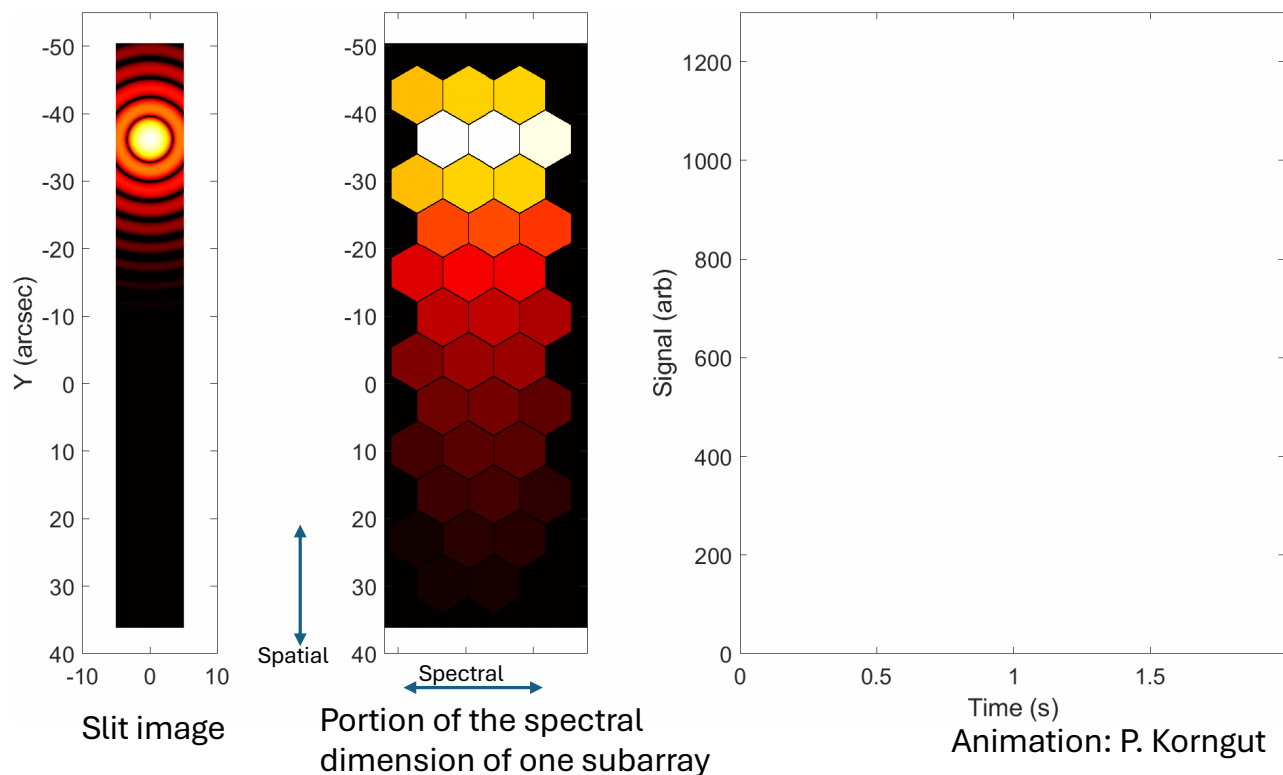
- Optical modeling at JPL includes full PRIMA telescope with aberrations and diffraction.
- Resolving power includes effect of pixelation.

FIRESS Resolving Power

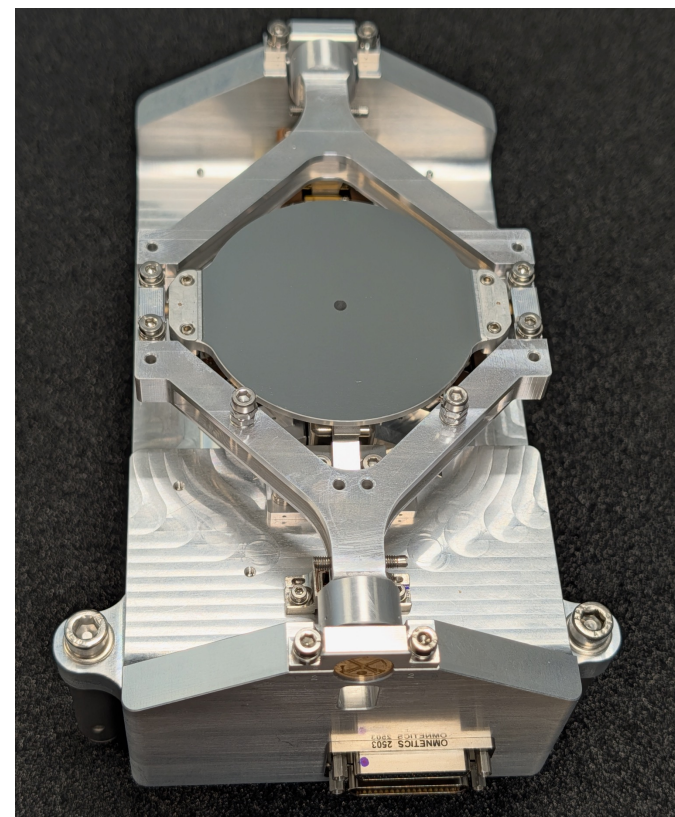


FIRESS Low-Resolution Observing Modes: Chopping

Individual sources of interest: Chop along slit with beam steering mirror (BSM)



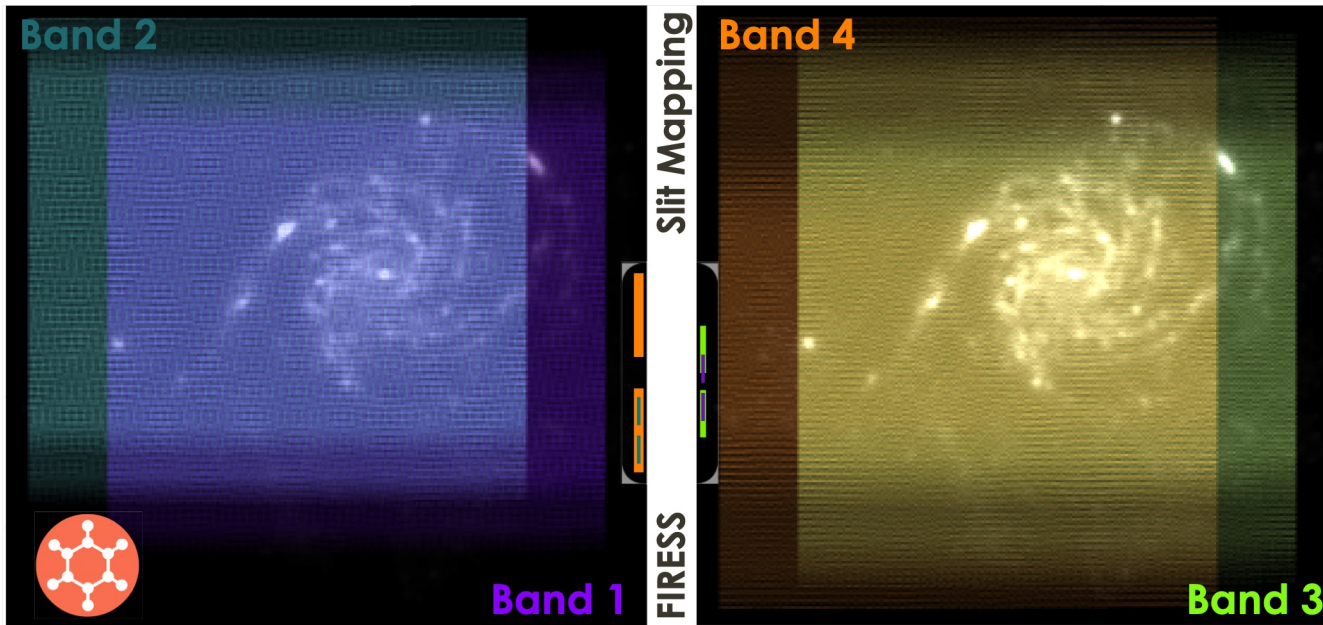
- Source is alternatively positioned in two spatial positions with complementary spectral coverage.
- Chop frequency adjustable. Fiducial is 5 Hz, for which we will have at least 85% duty cycle



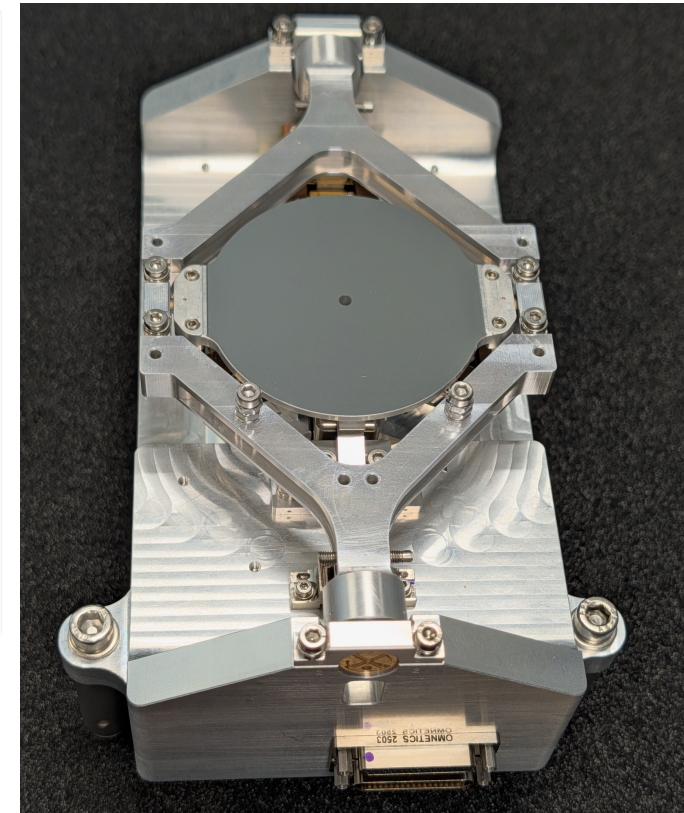
2 axis cryogenic steering mirror (MPIA / DLR), O. Krause

FIRESS Low-Resolution Observing Modes: Mapping

Mapping spectroscopy: Scan slits on the sky with BSM and/or observatory, reconstruct map from timestream data..

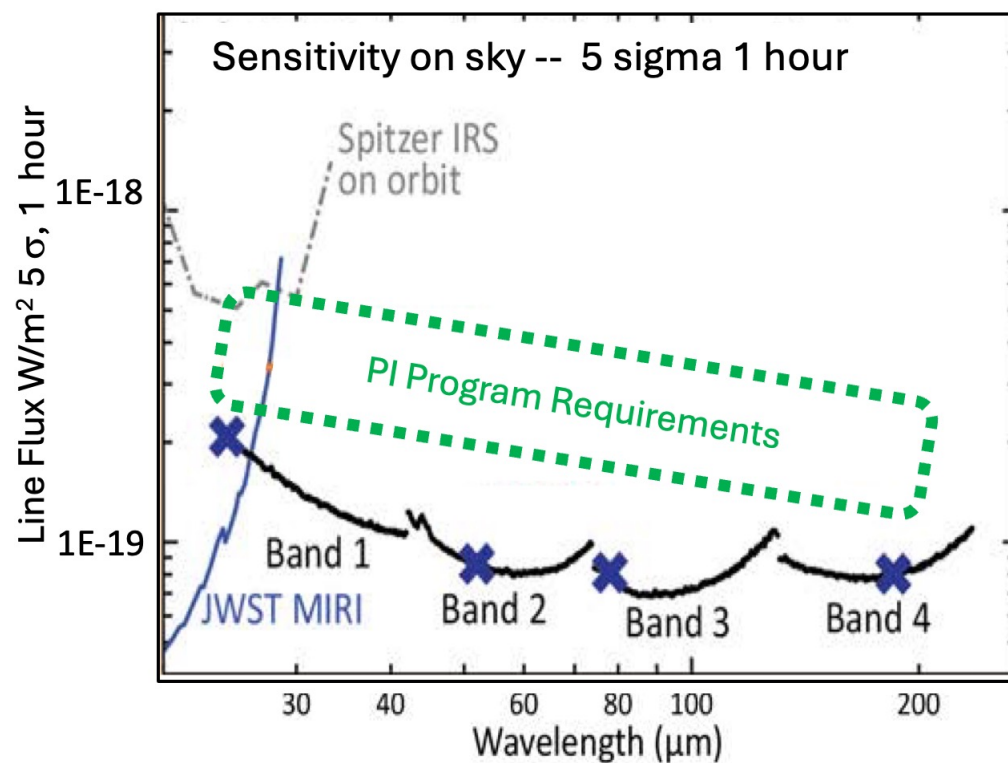
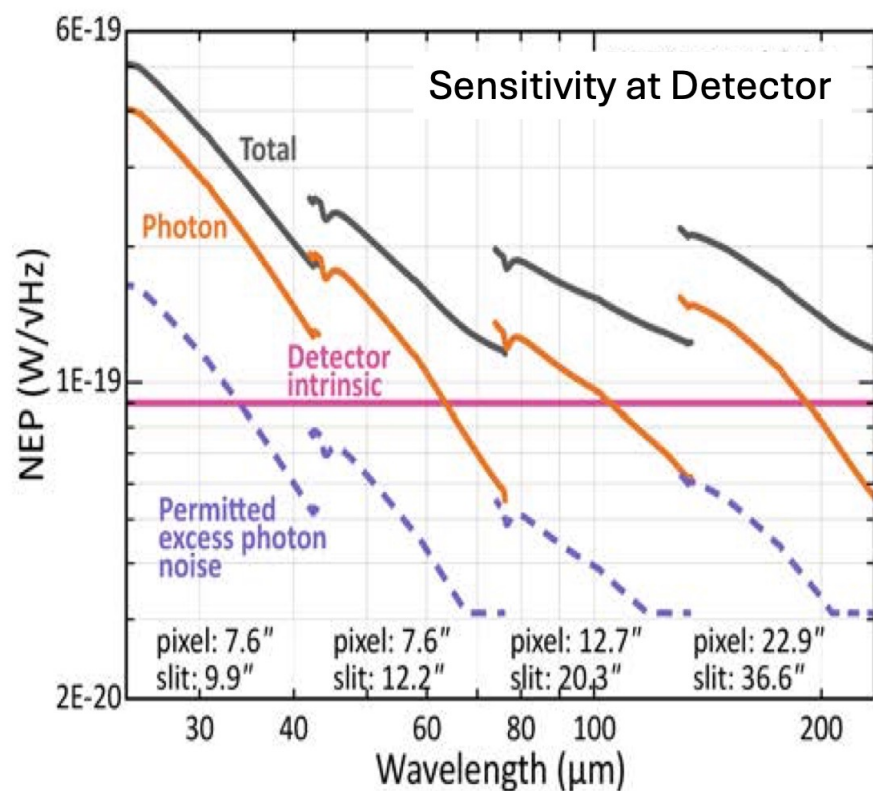


- Simulated FIRESS coverage map of M101 using a $2' \times 10.4'$ scan of the BSM (horizontally), combined with telescope drift (vertically).
- A single map of this size completes in 1.3 minutes.
- Depth is accumulated via repeated scanning of the field with dithered pixel positions.



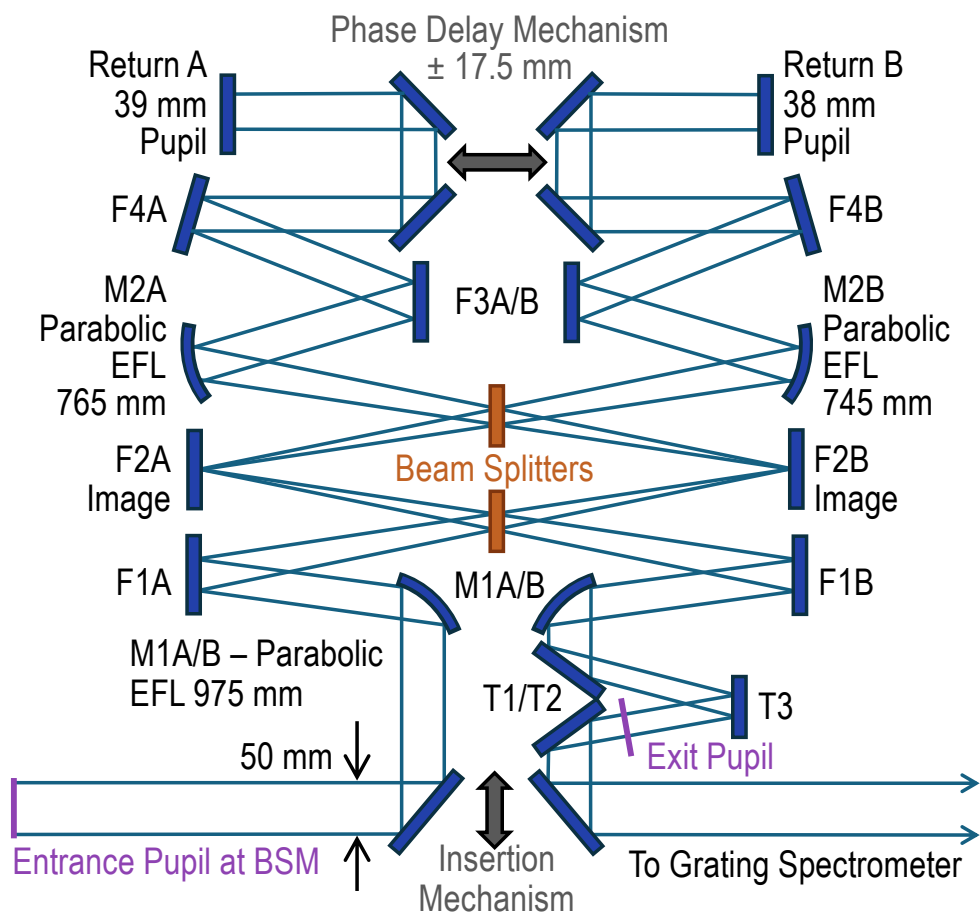
2 axis cryogenic steering mirror (MPIA / DLR), O. Krause

FIRESS Estimated Sensitivity



More information on the approach to the sensitivity can be found in Bradford et al. 2025 (JATIS FIRESS paper)

High-Res Mode: FIRESS Fourier Transform Module (FTM)



Modulates light on its way to the grating, when engaged.

Couples to all slits
- 4.5 arcminute field of view.

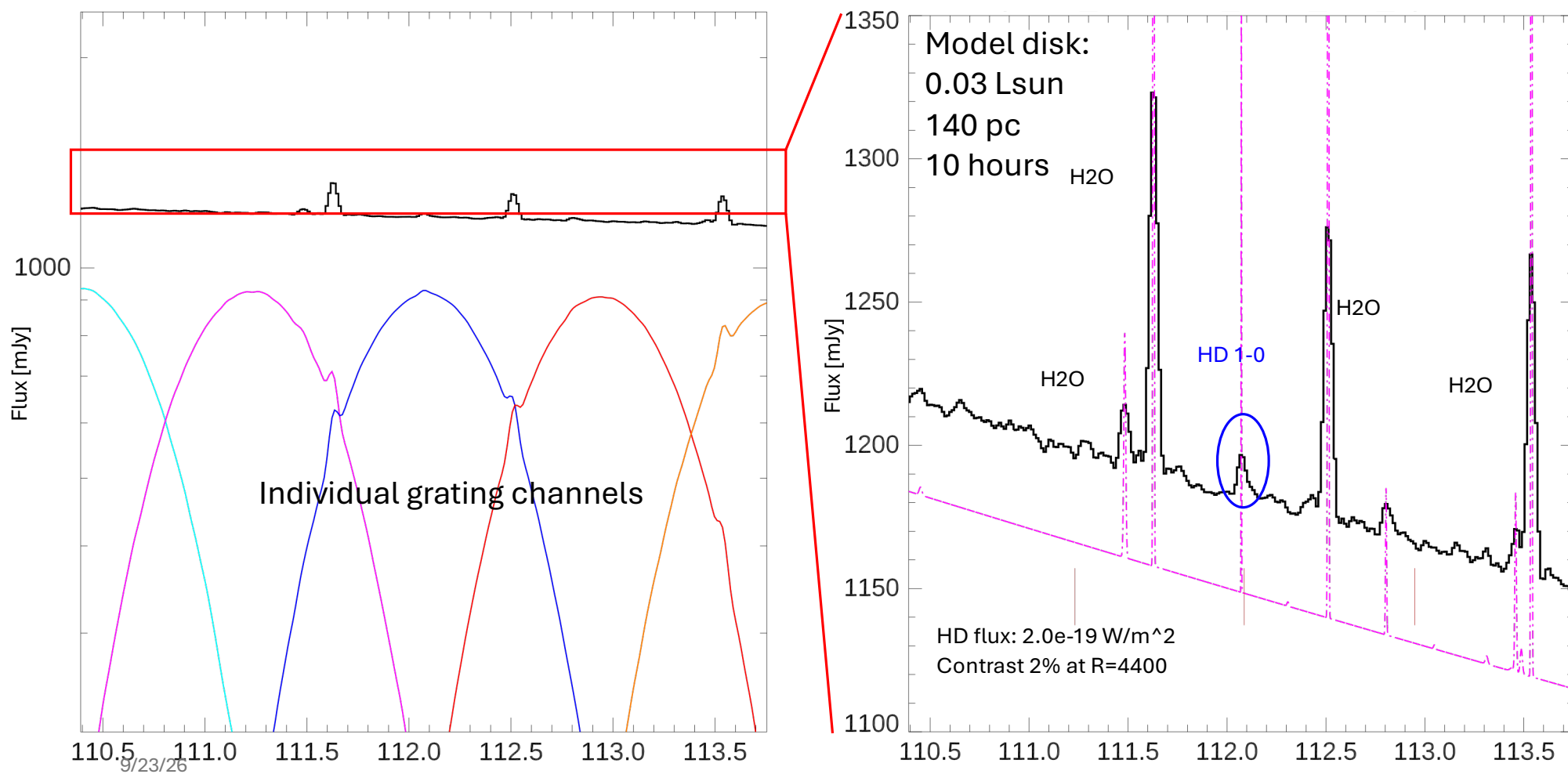
Polarizing FTS but couples both polarizations.
- Polarizing splitters at 45 deg to one another.

Efficient: input and output ports are sky and grating modules slits -> White light position transmits all sky signal to gratings.

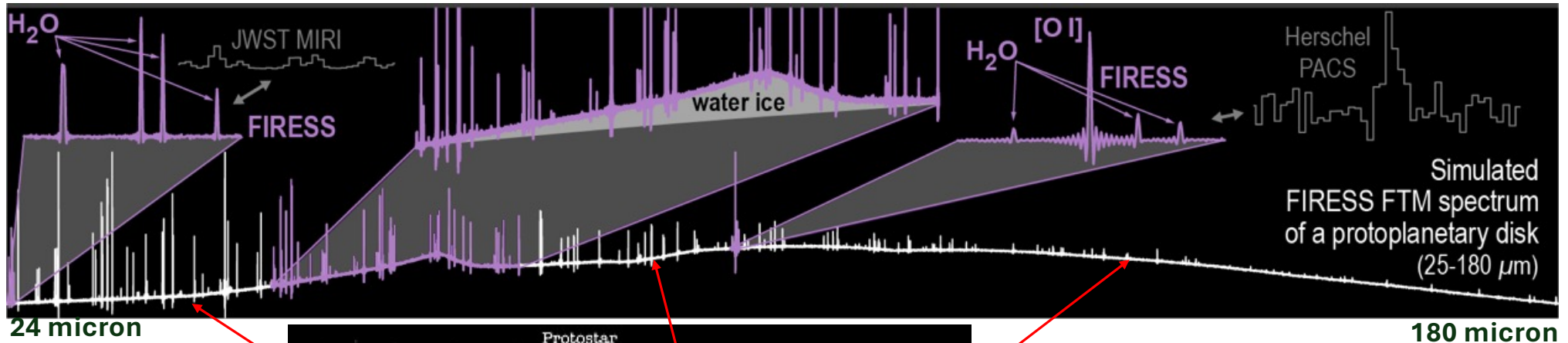
8x path folding: OPD / physical motion.
- zero path at one side of scan.

More on FIRESS Fourier Transform Module in Kogut presentation Thursday: 14156-40

Simulated high-res mode observation

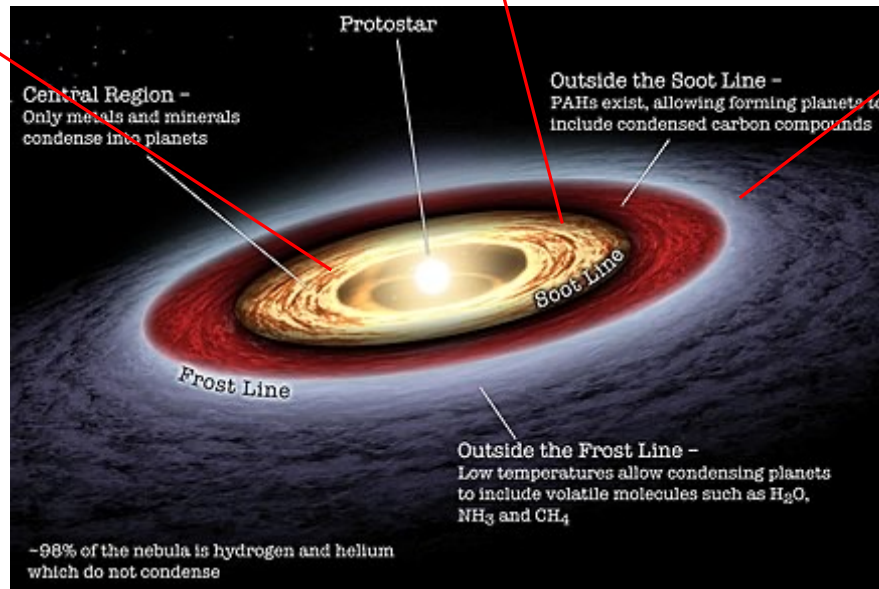


High-res mode operates over the full range (in two pointings for the two slit pairs)



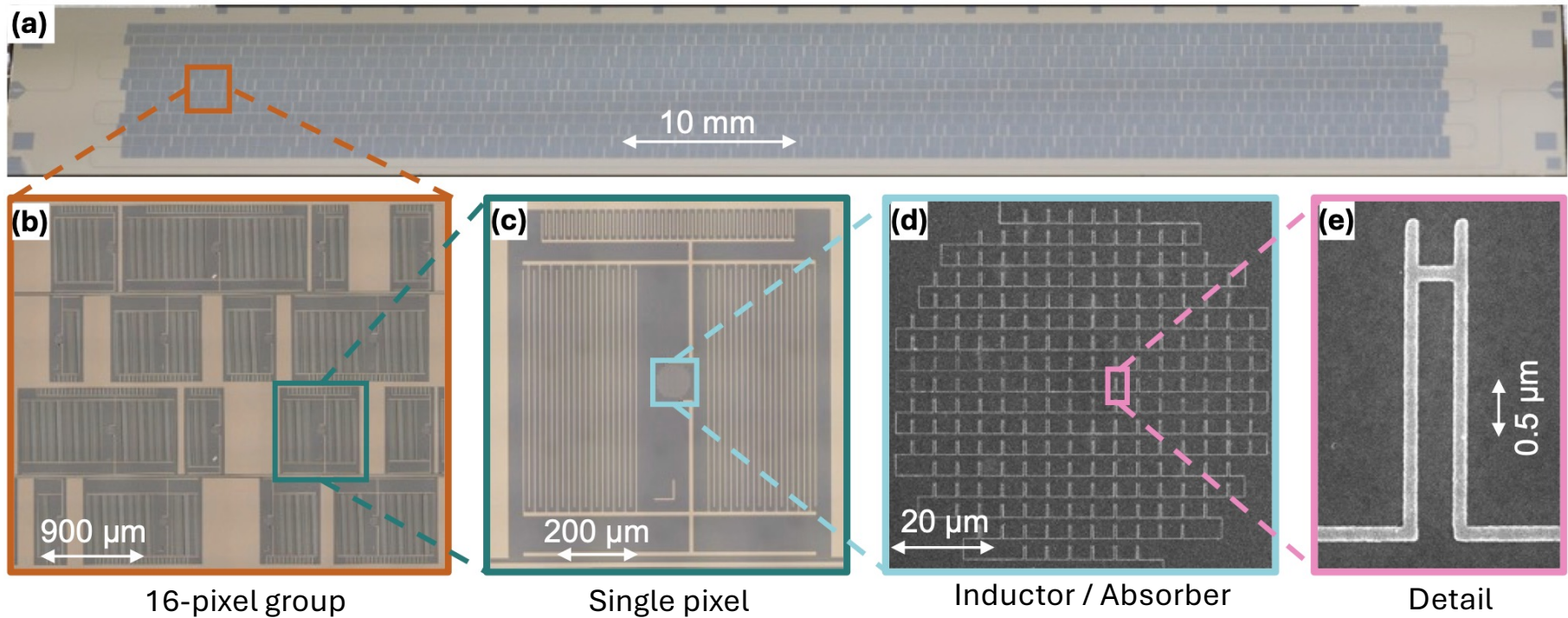
PRIMA Disk Observations

- 200 PP Disks
- 0.5-2.0 M_{sun}
- 24-235 micron
- $R=2,000-20,000$



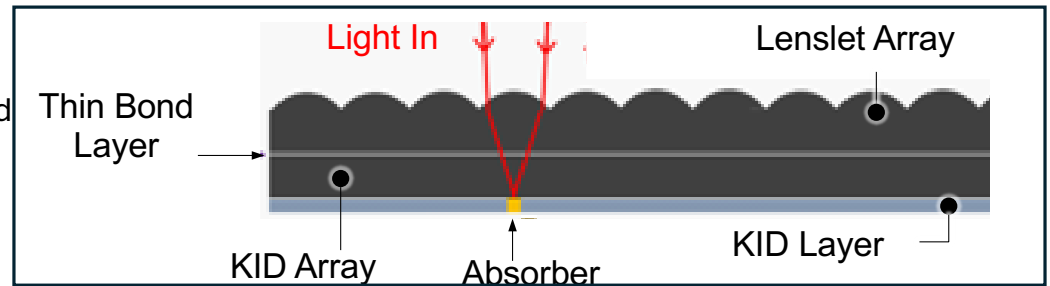
*More on FIRESS Fourier
Transform Module in Kogut
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FIRESS KIDs: each band has two 1008-pixel sub-arrays

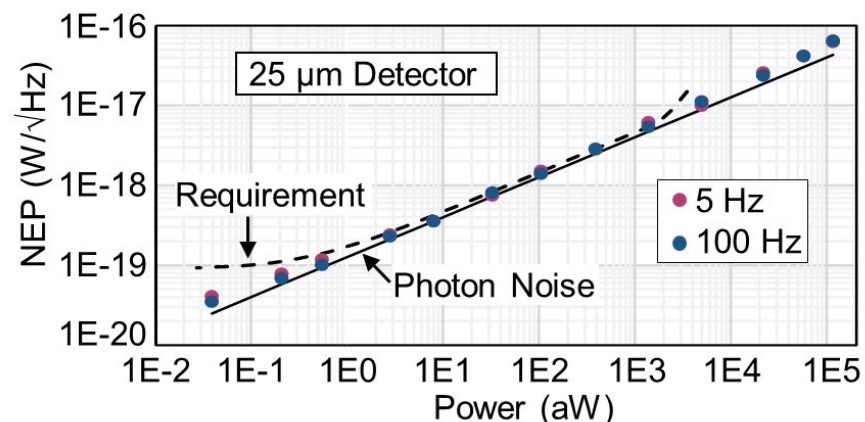
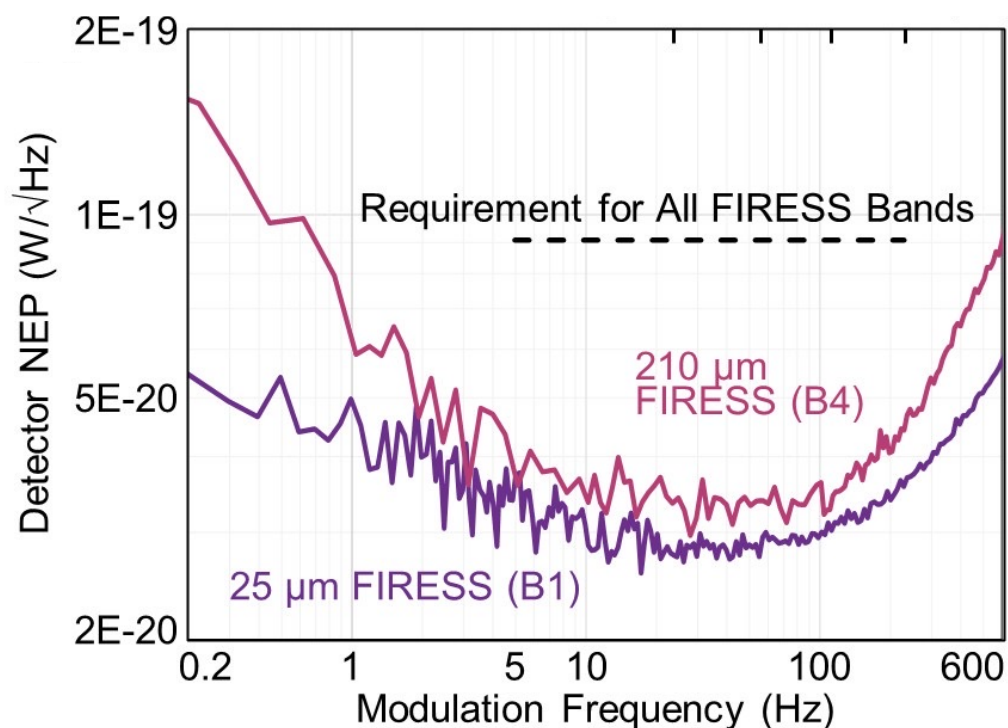


More on FIRESS KID arrays:
Wednesday talks: **L. Foote, E. Kane**
Thursday talk: **C. Albert**

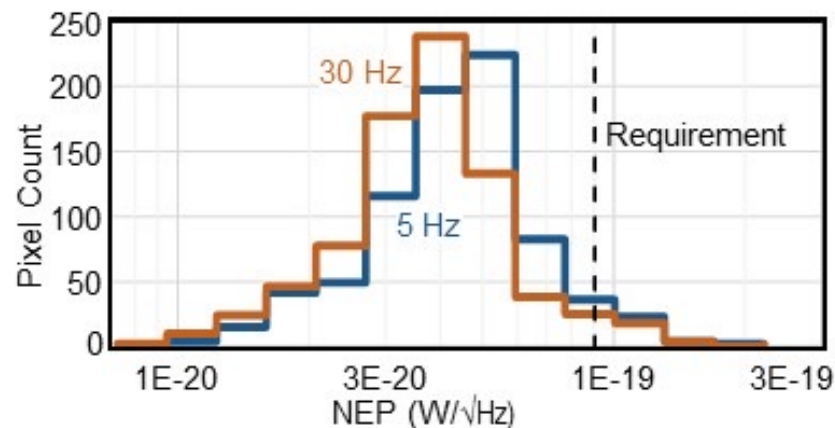
Hybridization:
KID arrays bonded
to matching
microlens arrays
built at GSFC



FIRESS arrays meeting sensitivity requirements



FIRESS KIDs are nearly photon noise (background) limited over a wide range of power, and meet the PRIMA requirements.

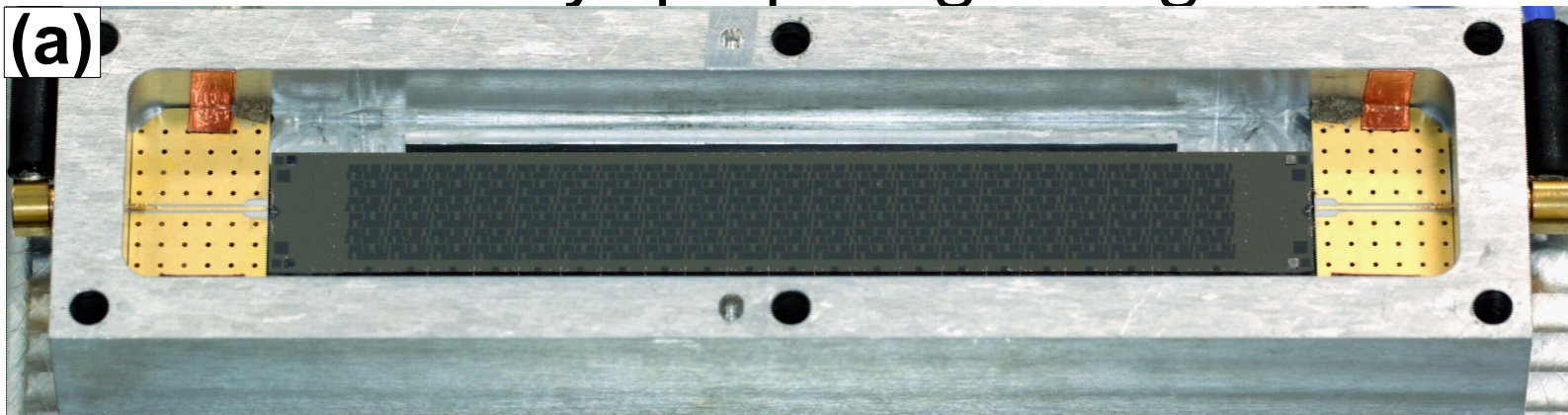


More on FIRESS KID arrays:

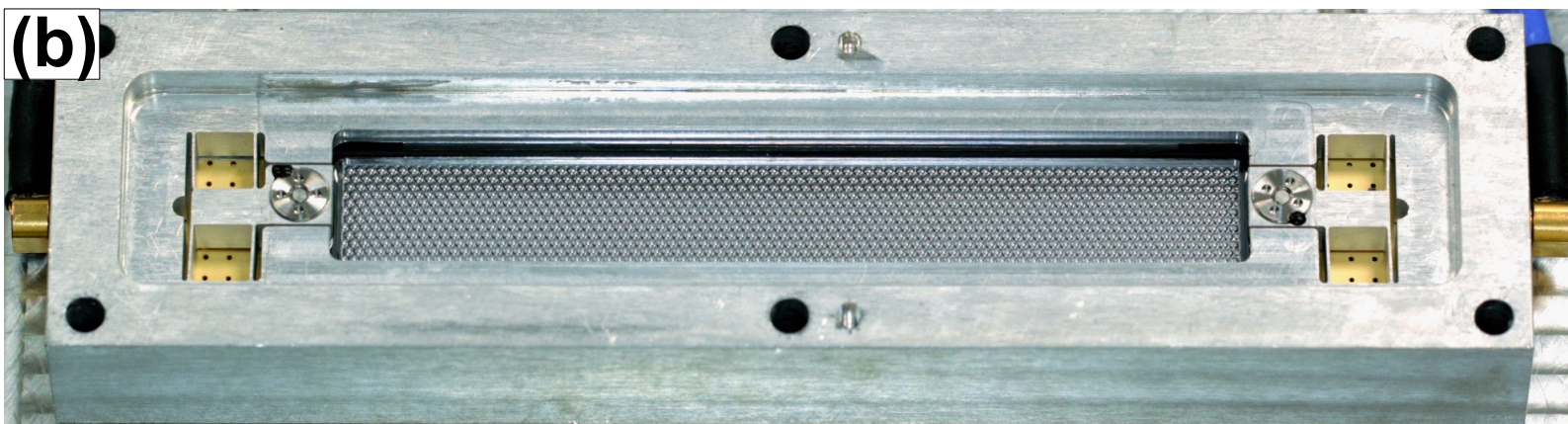
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FIRESS KID arrays preparing for flight



KID side



Lenslet side

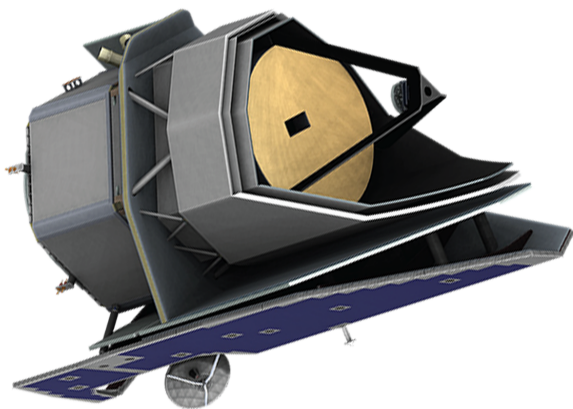
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Flight dynamics and particle total dose tests done – no issues

PRIMA *The PRobe far-Infrared Mission for Astrophysics*



Thank you