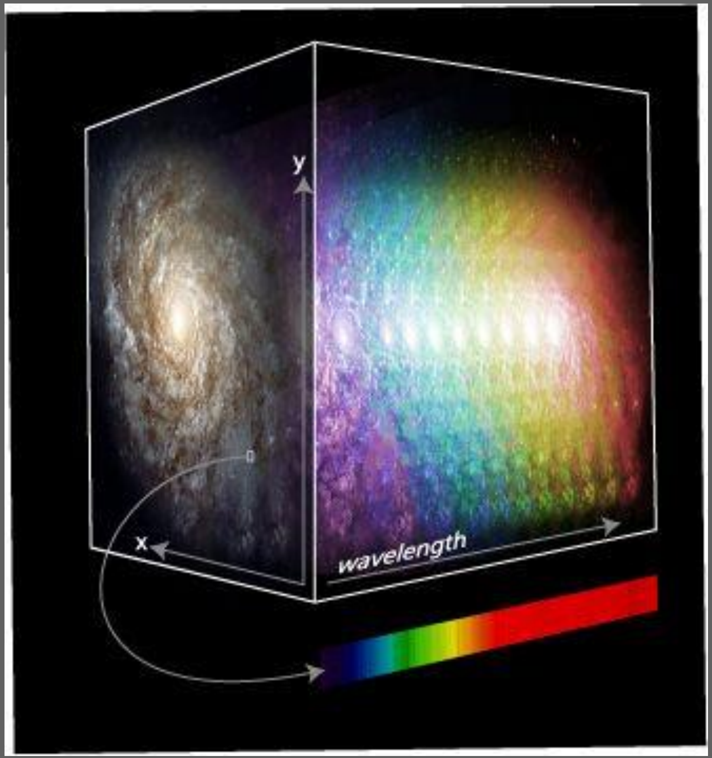
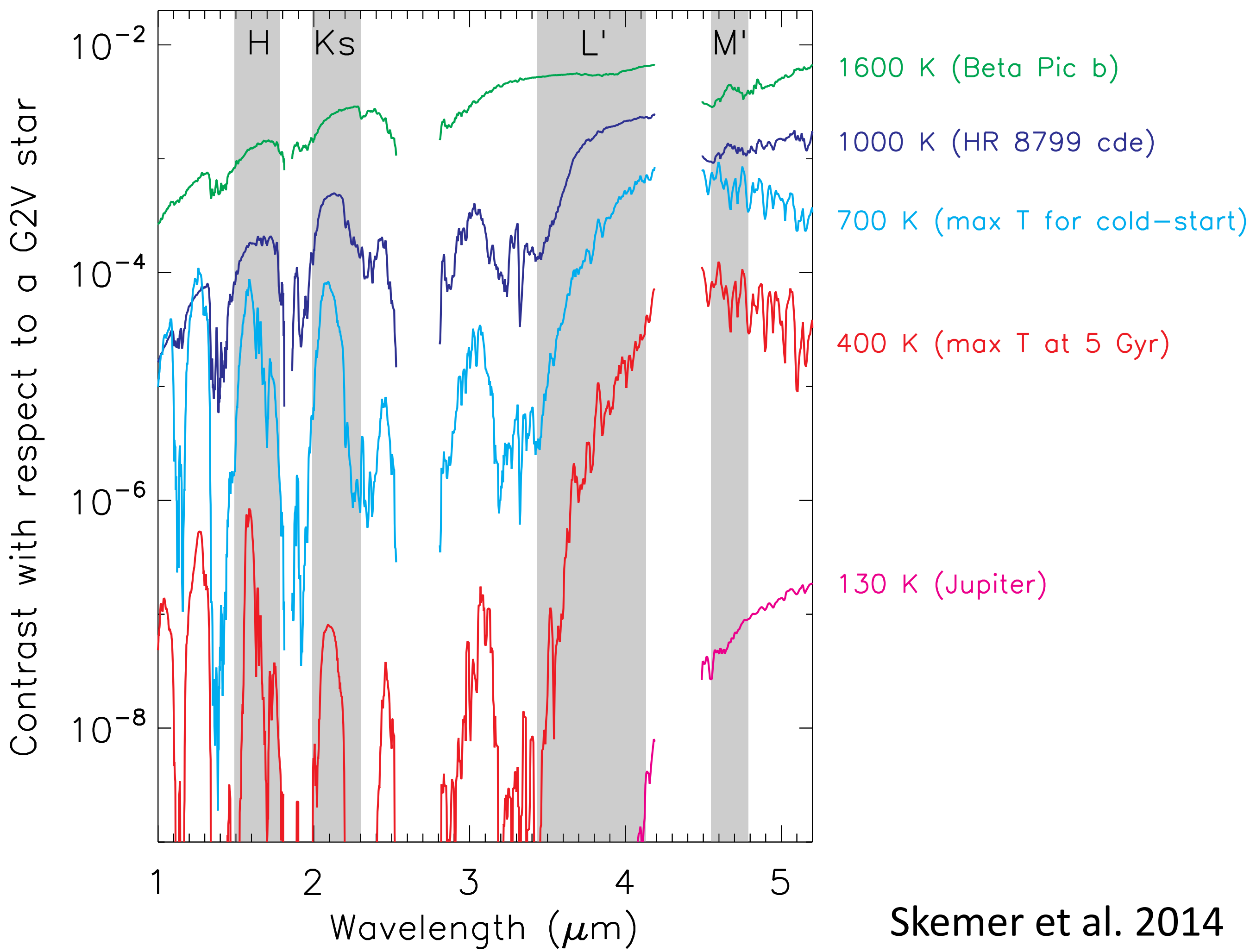
An IFU for LMIRCam (and other upgrades)



Andy Skemer, Mike Skrutskie, Phil Hinz, Jarron Leisenring, John Wilson, Matt Nelson

Pushing to Longer Wavelengths



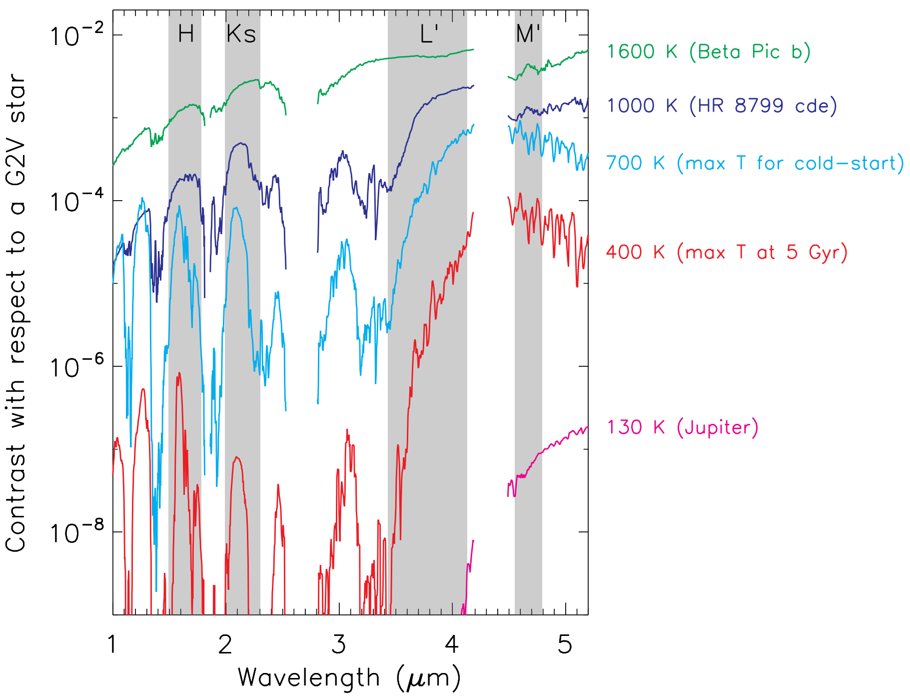
Skemer et al. 2014

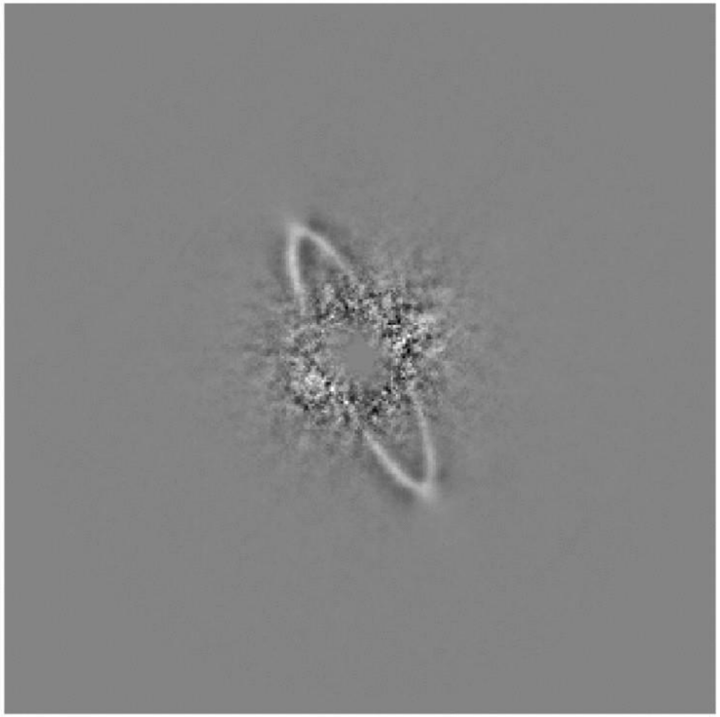
Current State-of-the-Art Planet Imaging Methods

Work at 3-5µm, where planets are bright

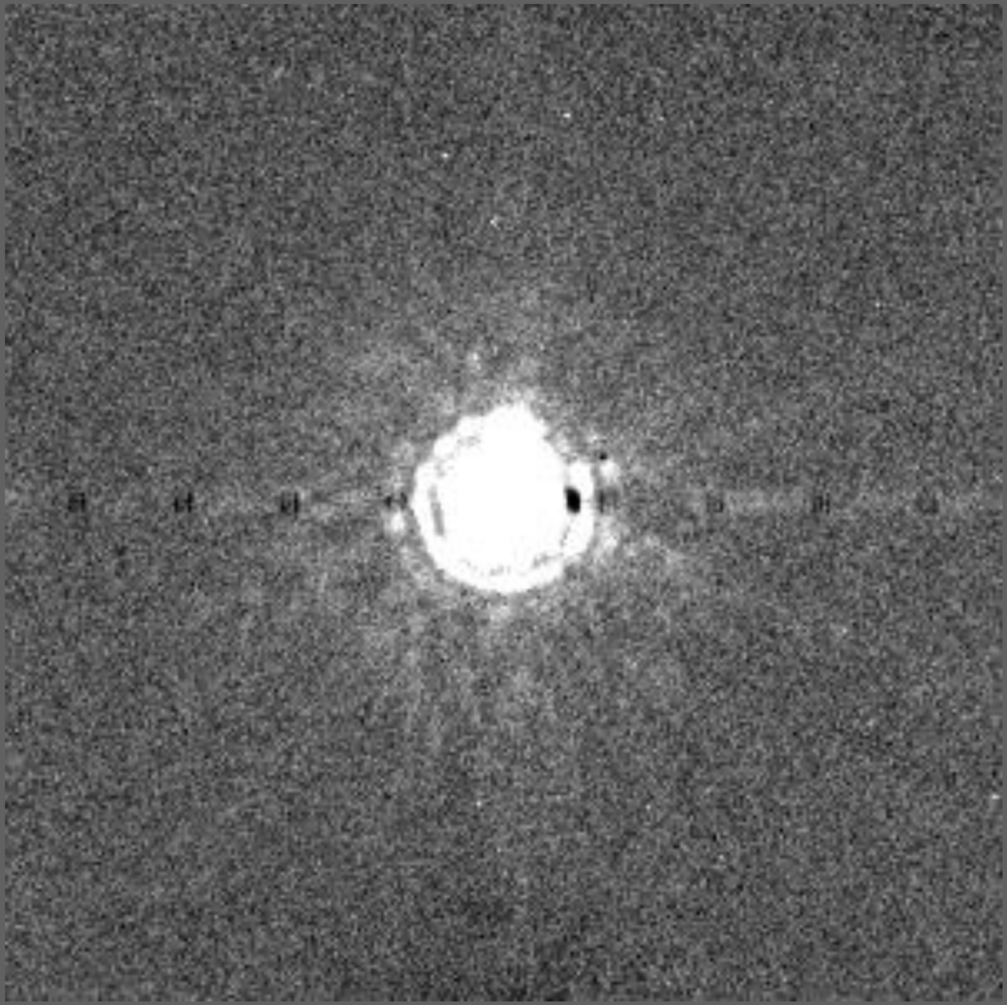
vs

Use an IFS to discriminate between planets and speckles



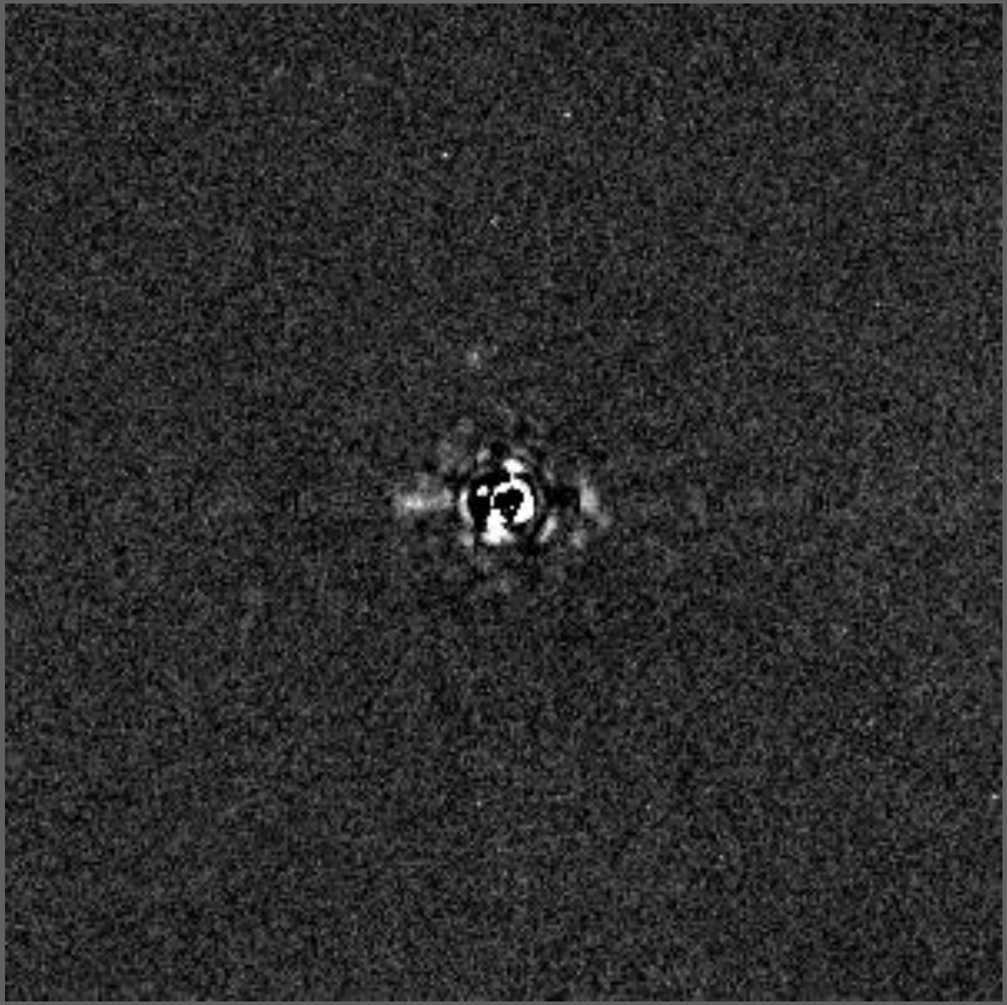


IFUs are the only way to take Spectra of Directly-Imaged Planets



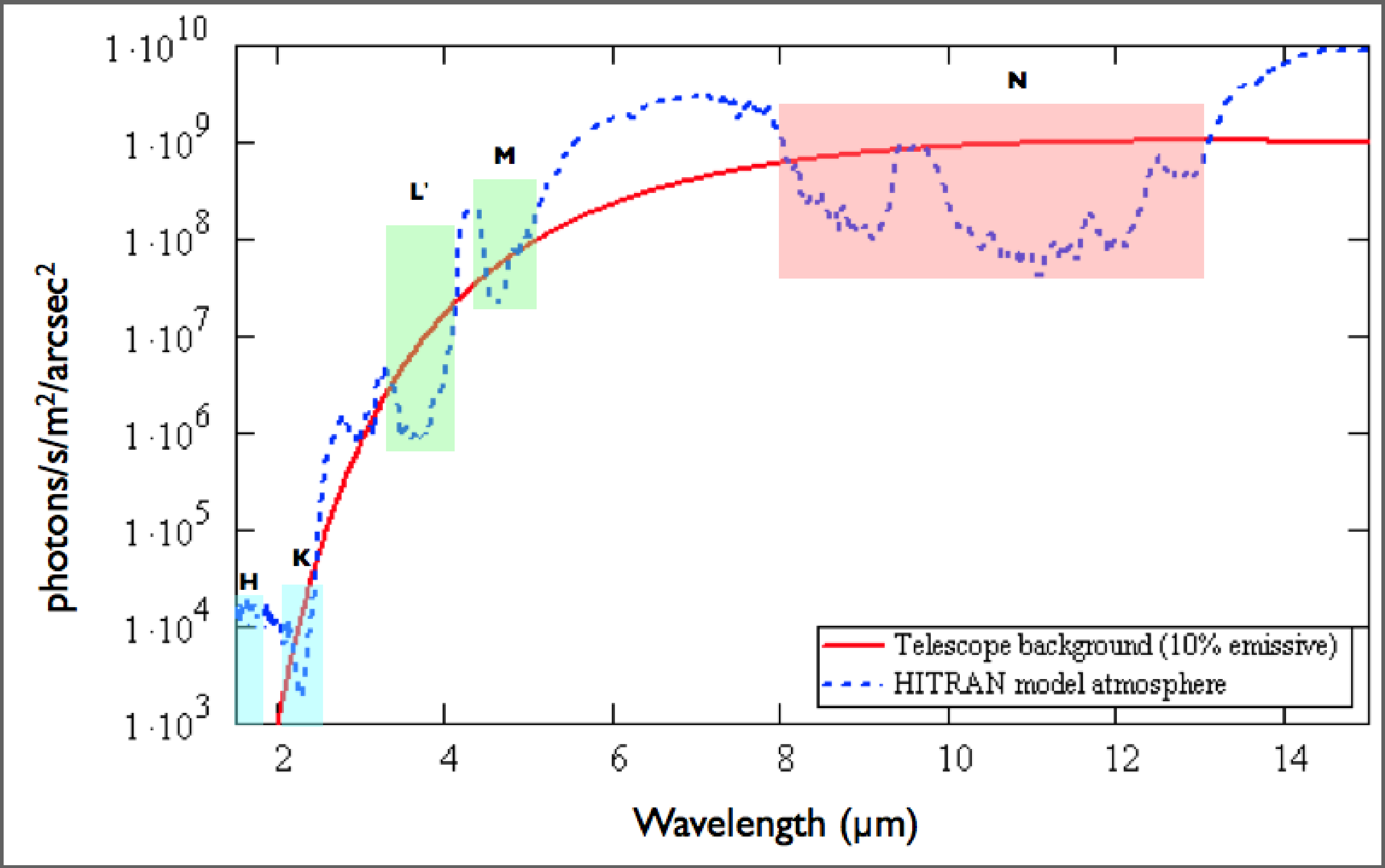
High contrast imaging requires... imaging

IFUs are the only way to take Spectra of Directly-Imaged Planets



High contrast imaging requires... imaging

So Why Don't All (Any) Planet-Imaging IFUs work from 3-5 µm?



Typical AO Systems are Not Optimized for the Mid-Infrared

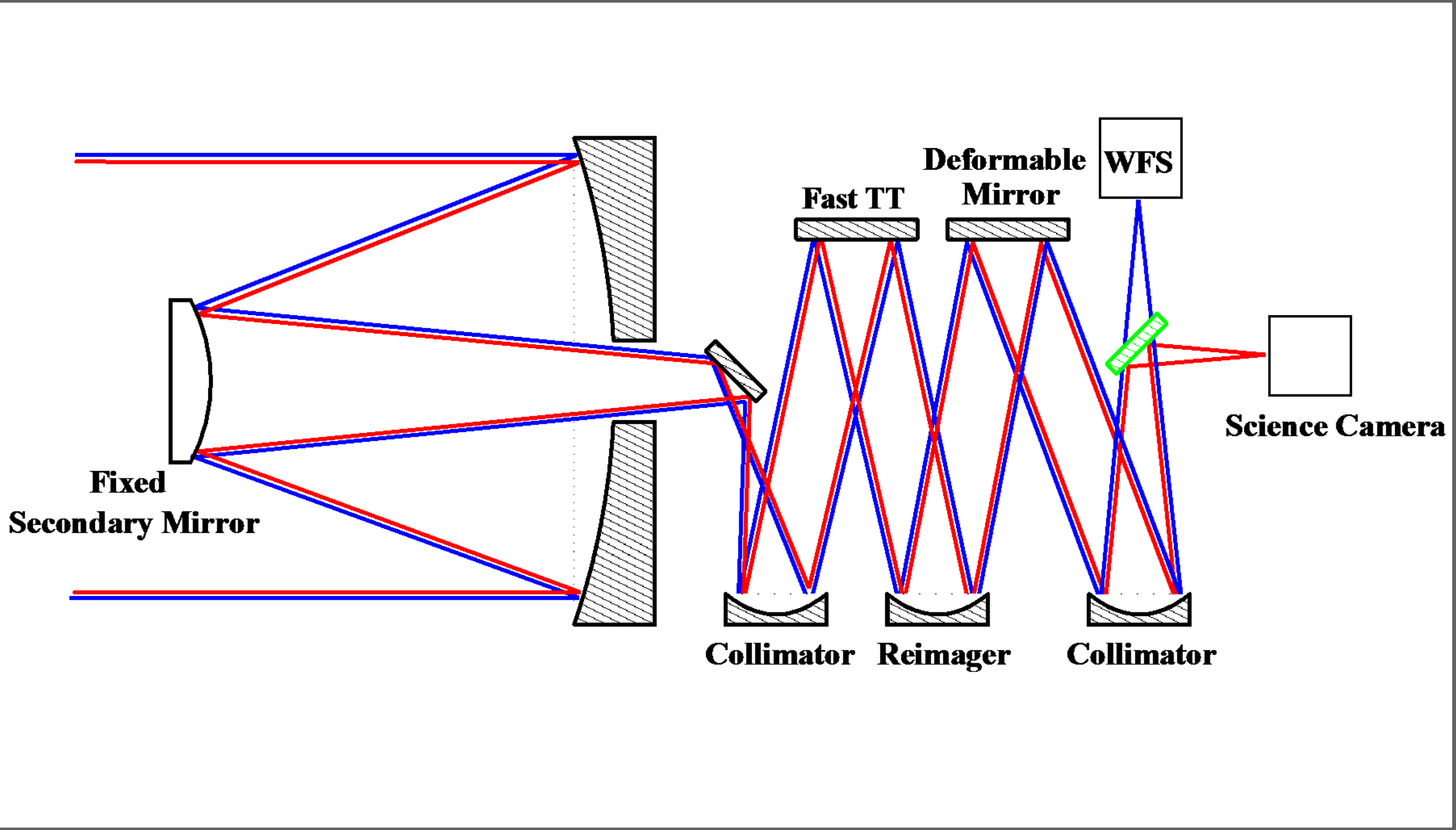


Figure by Matt Kenworthy

Typical AO Systems are Not Optimized for the Mid-Infrared

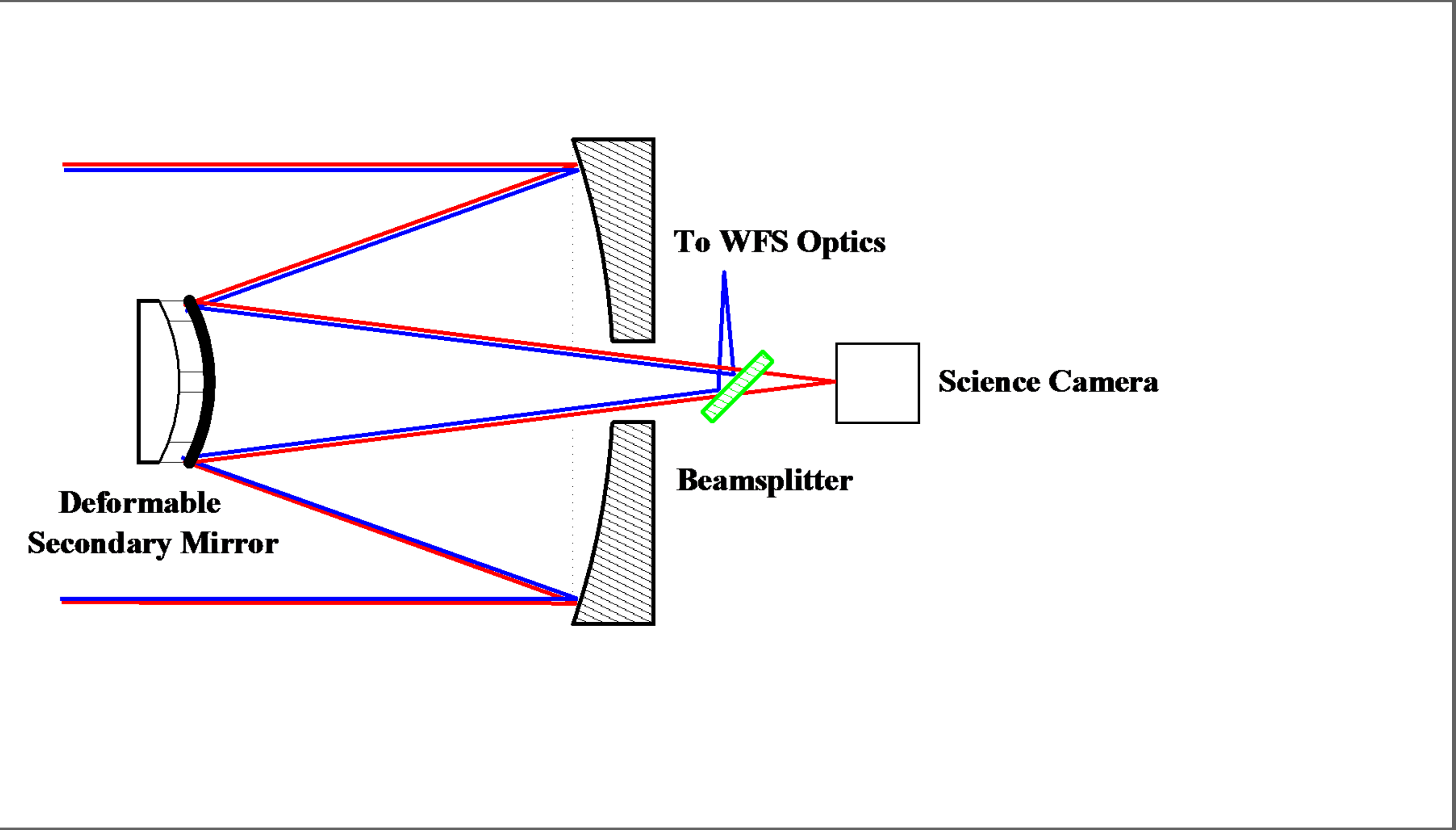


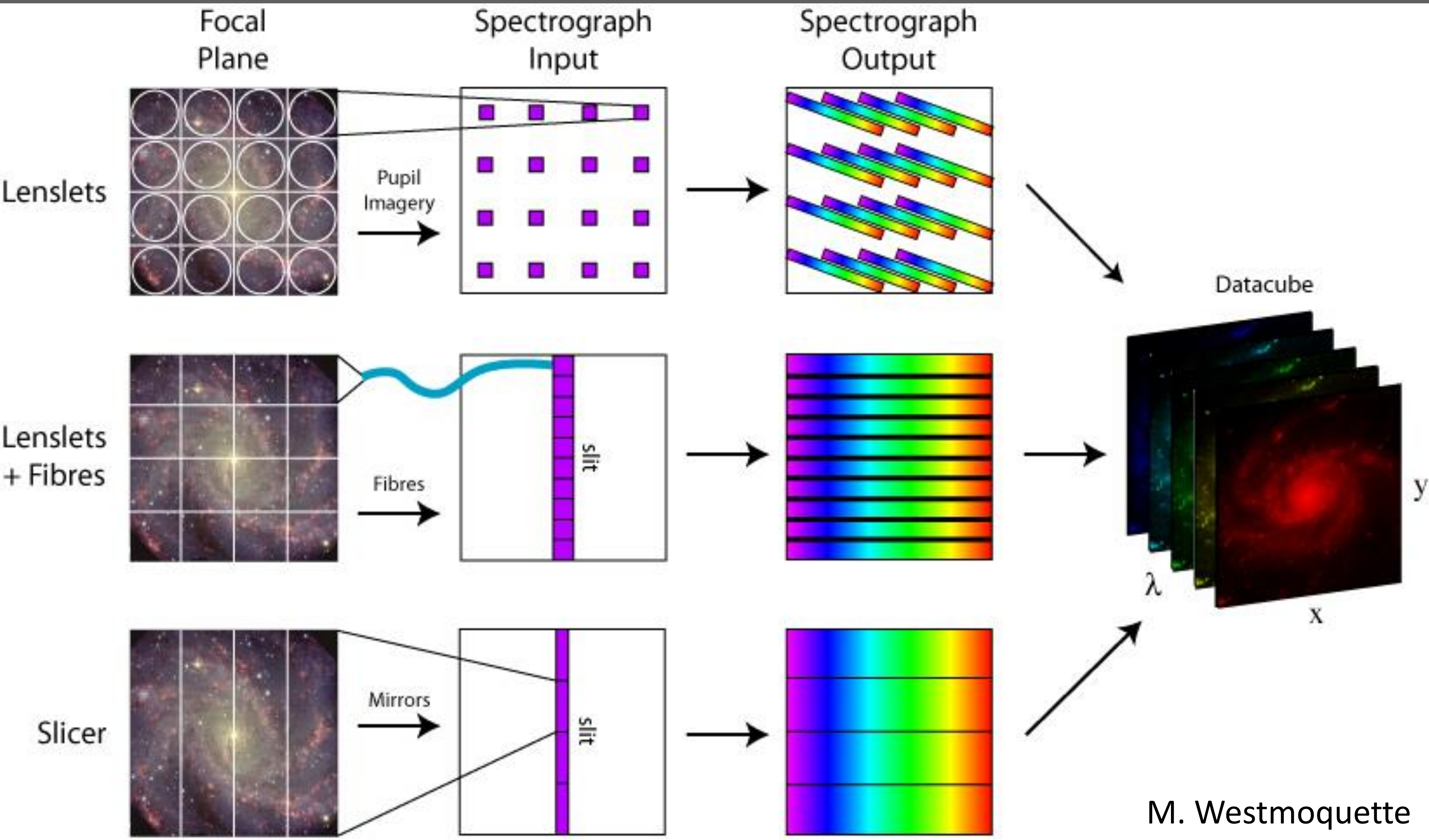
Figure by Matt Kenworthy

A 3-5μm IFU for LBTI/LMIRCam

Takes Advantage of:

- 2 working adaptive secondaries
- An interferometer (if you want it)
- A 1-5μm science camera (with a spectrograph)
- LBTI's 3 intermediate focal planes, 4 pupil-plane filter wheels (modular optics)
- Malleable PIs

Flavors of IFU



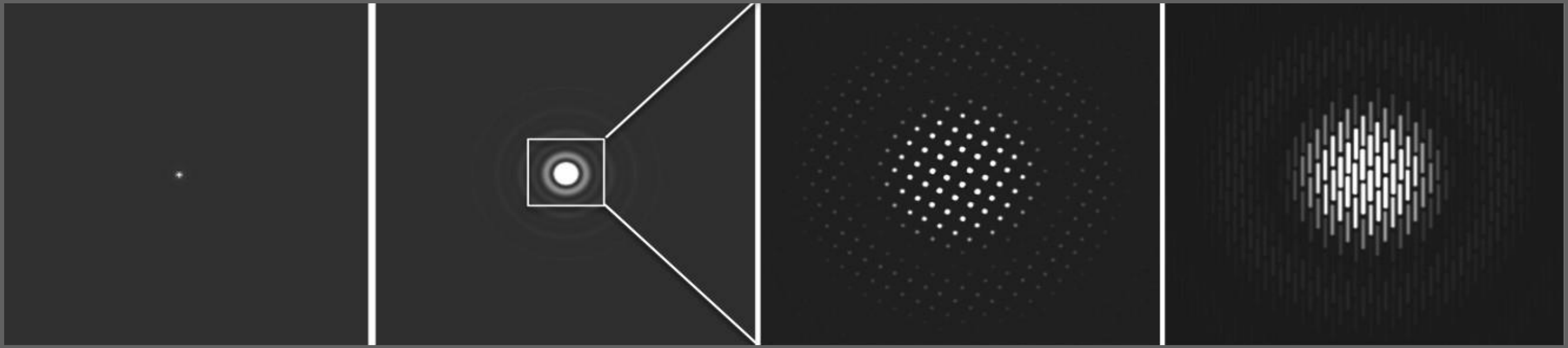
M. Westmoquette

Fitting an IFU into LMIRCam

Insert Magnifying Optics

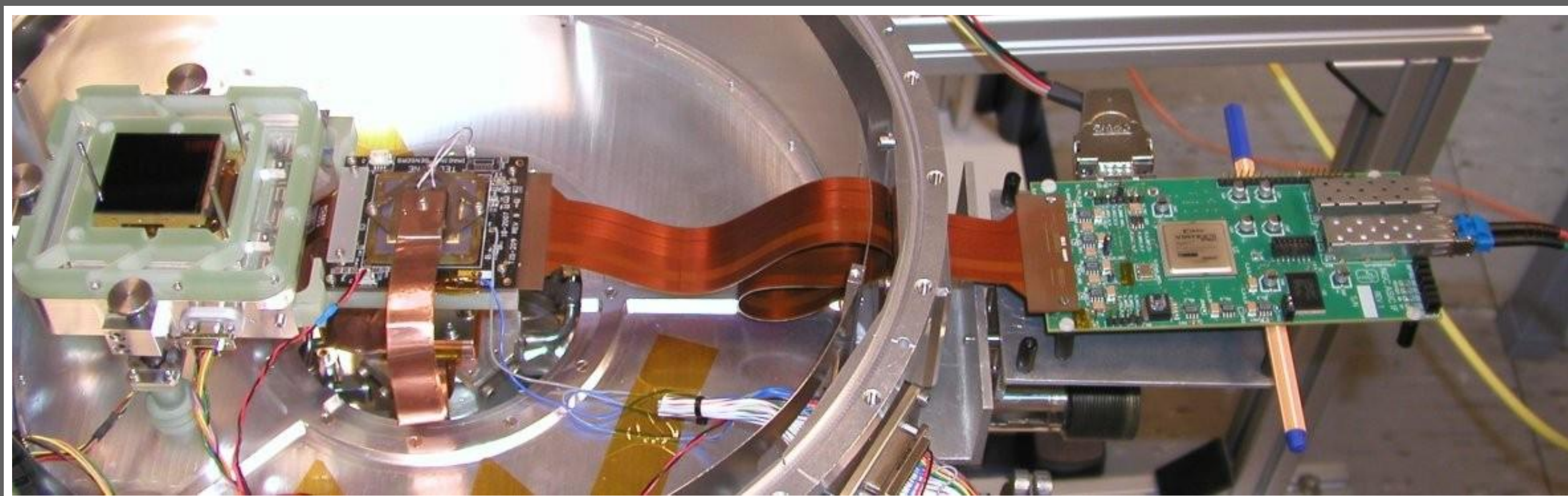
Insert Lenslet Array

Insert Disperser



- Just need to install magnifying optics, a lenslet array and a filter/disperser combination
- Design fits into existing filter wheels (2 intermediate focal planes and 4 pupils)
- Completely modular—will expand to include different modes based on community input

FOV Enhancement



- Currently have a 2k chip with 1k electronics
- Teledyne ASIC-Sidecar electronics will increase FOV from 1024x1024 pixels to 2048x2048 pixels.
- Very important to our lenslet-based IFU, which like most IFUs, is pixel starved

Rough Specs

- Two lenslet arrays with 10 mas spaxels and 25 mas spaxels (one for interferometry, one for imaging)

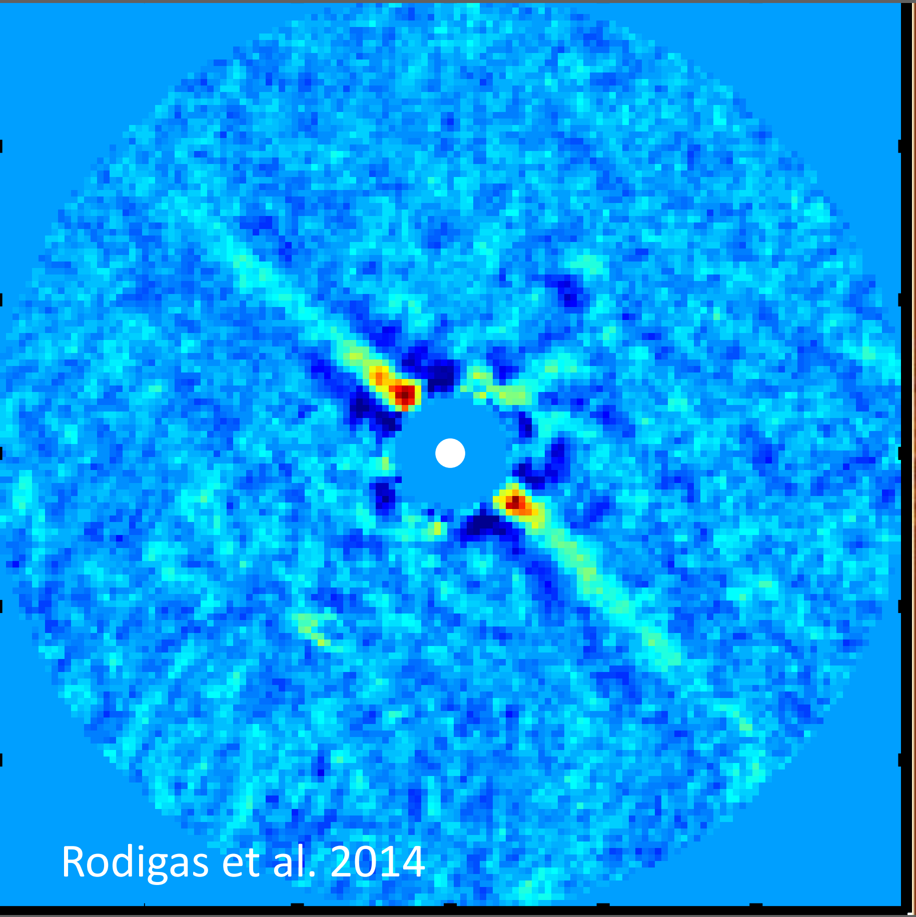
- 1.3”x1.3” and 3.4”x3.4” FOVs respectively

- ~33 pixels per spectrum (wavelength from H-M, resolution from ~20-4000).

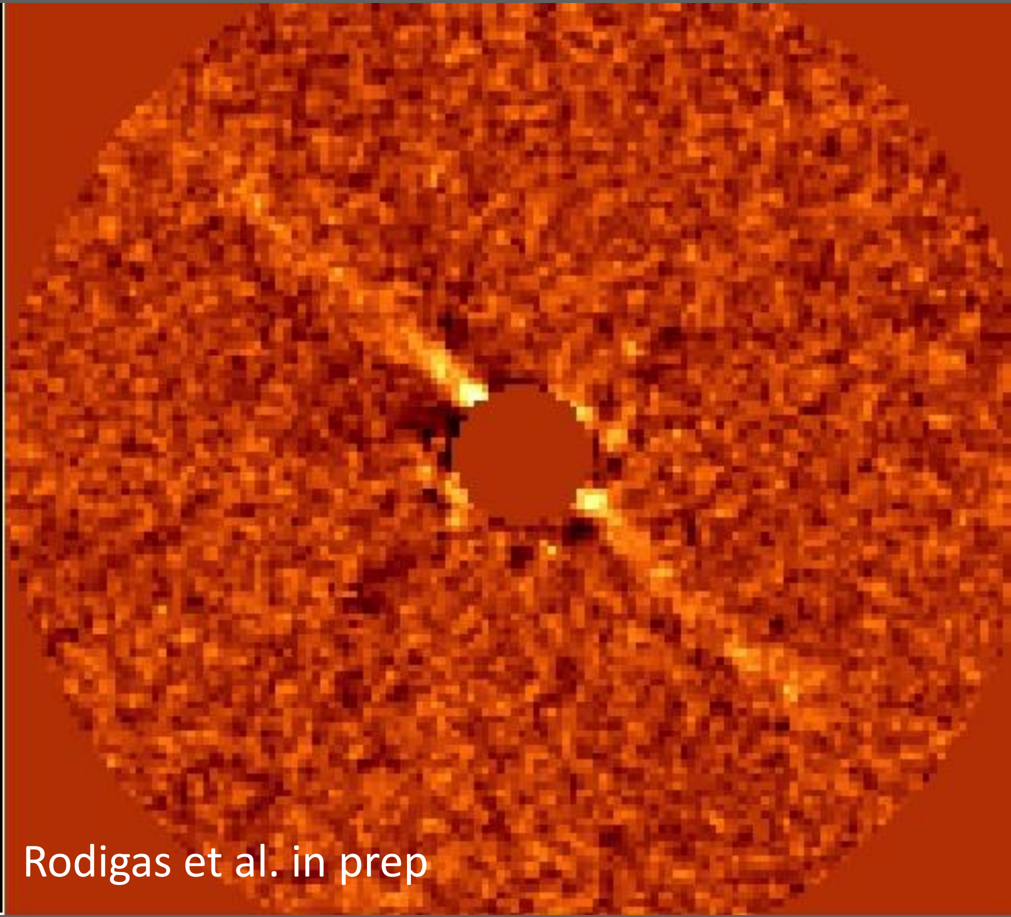
- **First Mode: 25 mas spaxels, 3.4”x3.4” FOV, R~40 from 3-4 µm.**

Ice-Line Imaging of Circumstellar Disks and Solar System Objects

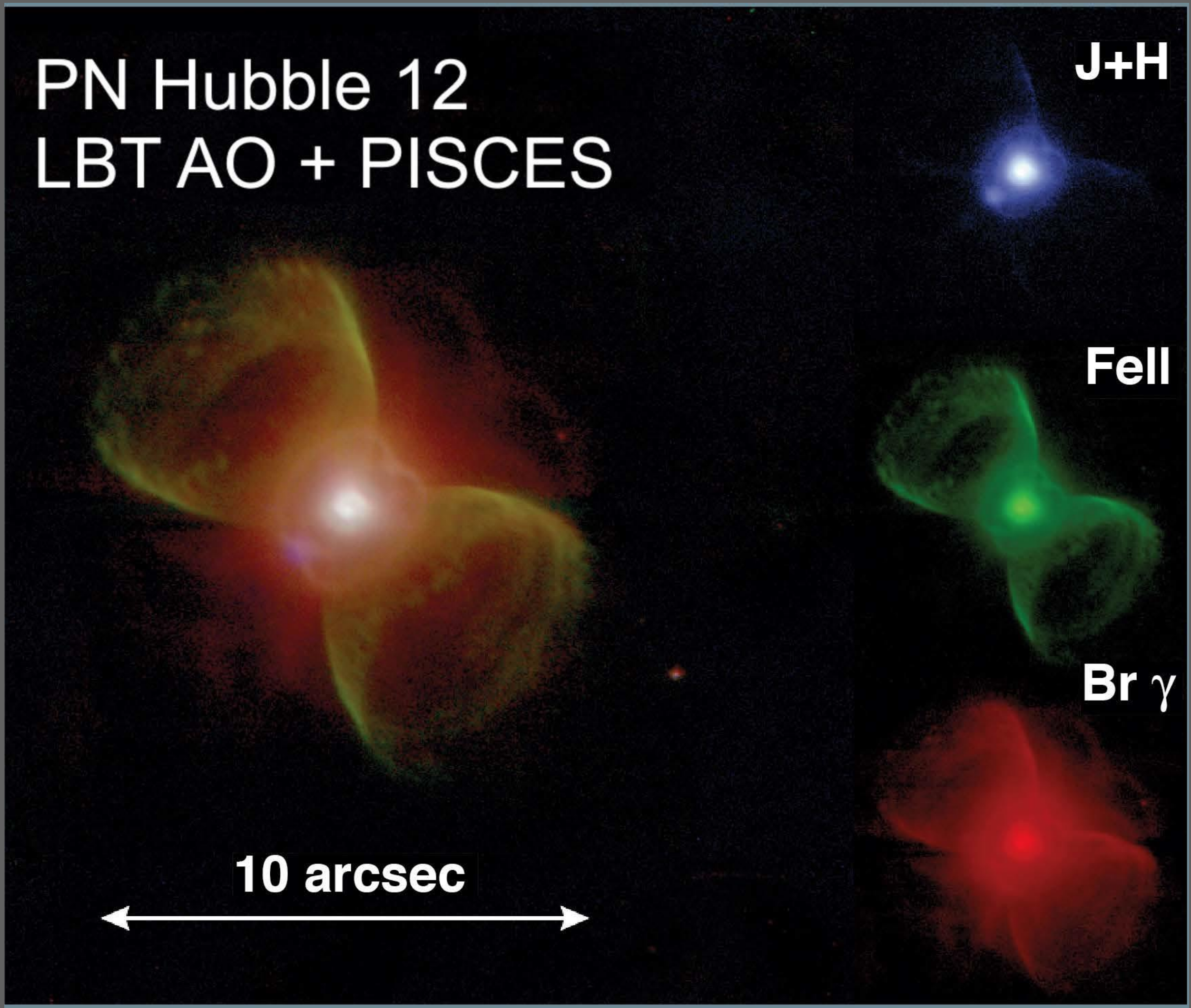
3.8 microns



3.1 microns (Ice)



Nebular Emission from Massive Stars, Planetary Nebulae, etc.



ELT Science



All 3 telescopes are building a near-IR IFU for first light!

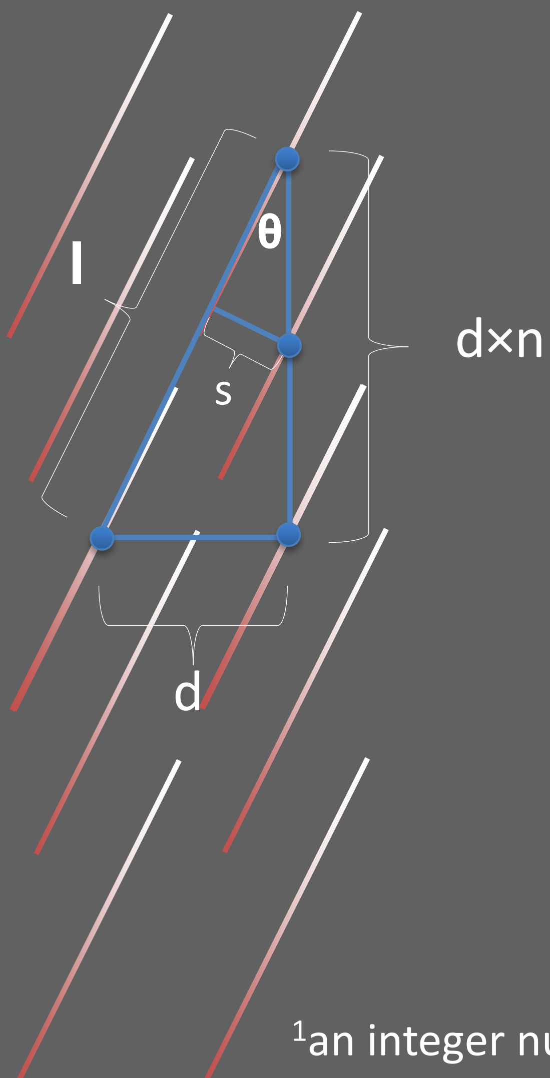
Summary

- World's first IFU to operate at lambda > 3 µm
- Combines the two best methods for exoplanet imaging
- Modular and versatile
- Interferometric mode can do low-hanging fruit for ELTs

- Open and looking for partners!

Extras

Lenslet Rotation



d=spaxel separation in pixels
n=integer number of spaxels[1]
θ=angle between lenslet array and grism
l=length of spectrum in pixels
s=separation between spectra

$\theta = \tan^{-1}(1/n)$
$s = d \times \sin(\theta)$
$\mathbf{l} = d/\sin(\theta)$

[1]an integer number is necessary to keep the spectra from overlapping

Lenslet Rotation for 0.025" Spaxels

$$\theta = \tan^{-1}(1/n)$$
$$s = d \times \sin(\theta)$$
$$\mathbf{l} = d / \sin(\theta)$$

d=spaxel separation in pixels
n=integer number of spaxels[1]
θ=angle between lenslet array and grism
l=length of spectrum in pixels
s=separation between spectra

n	θ (degrees)	l (pixels)	s (pixels)
1	45.00	21.2	10.6
2	26.57	33.4	6.7
3	18.43	47.4	4.7
4	14.04	61.8	3.6