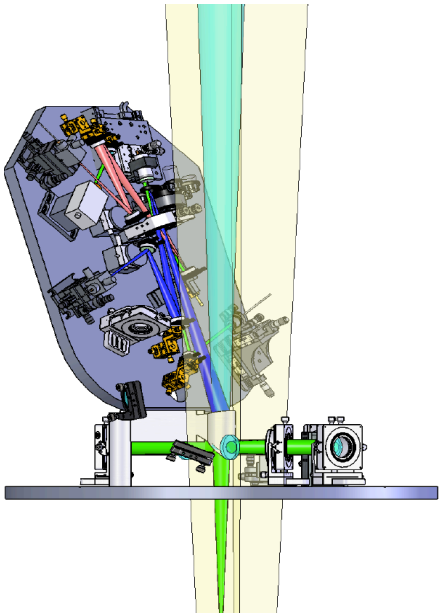
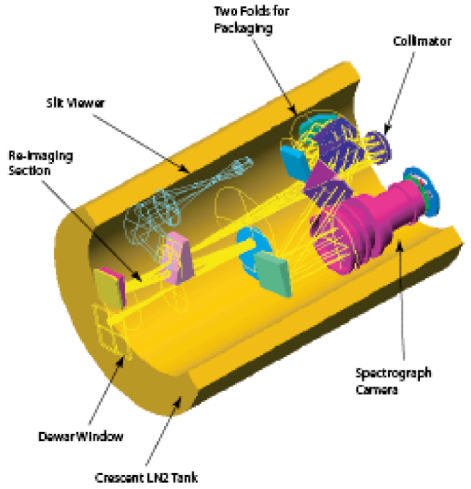
Precise Radial Velocimetry in the Near-Infrared with T-EDI:

The TripleSpec Externally Dispersed Interferometer

Palomar Observatory
200" Hale Telescope



Fixed-Delay Interferometer
(Michelson-Morley)



TripleSpec Near-IR
Spectrograph
(JHK, R=2700)

Philip S. Muirhead[1], Jerry Edelstein[2], Matthew Muterspaugh[2],
David J. Erskine[3], Terry Herter[1], James P. Lloyd[1]
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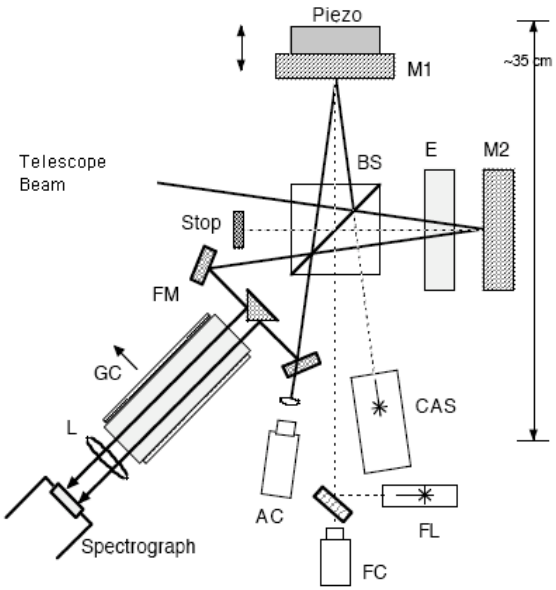

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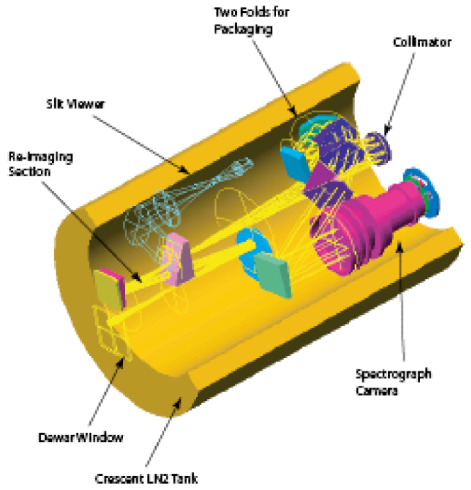

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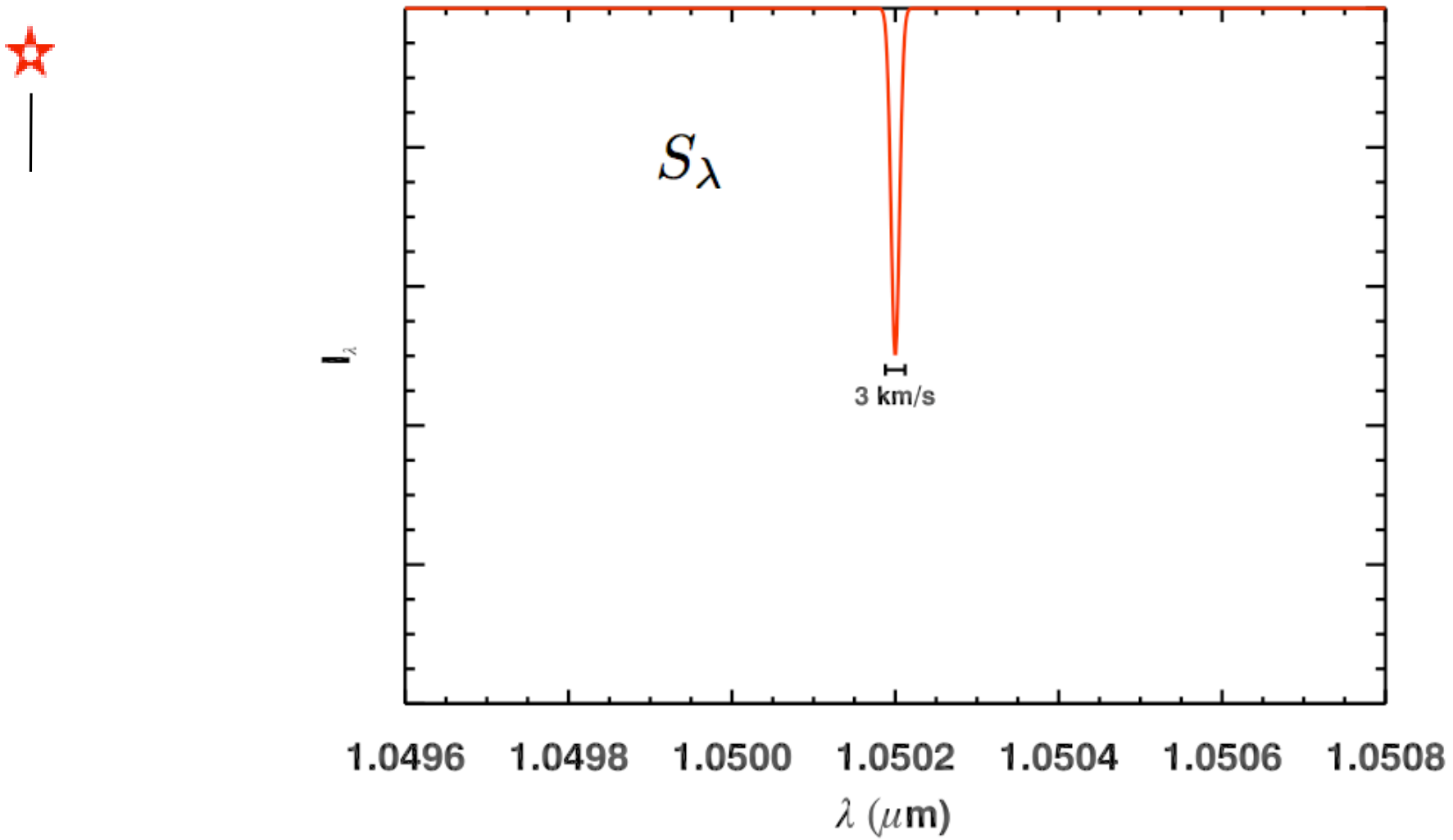
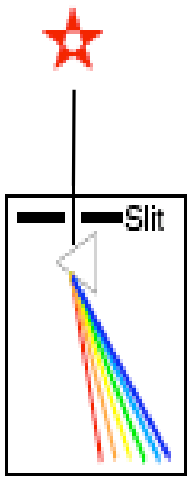
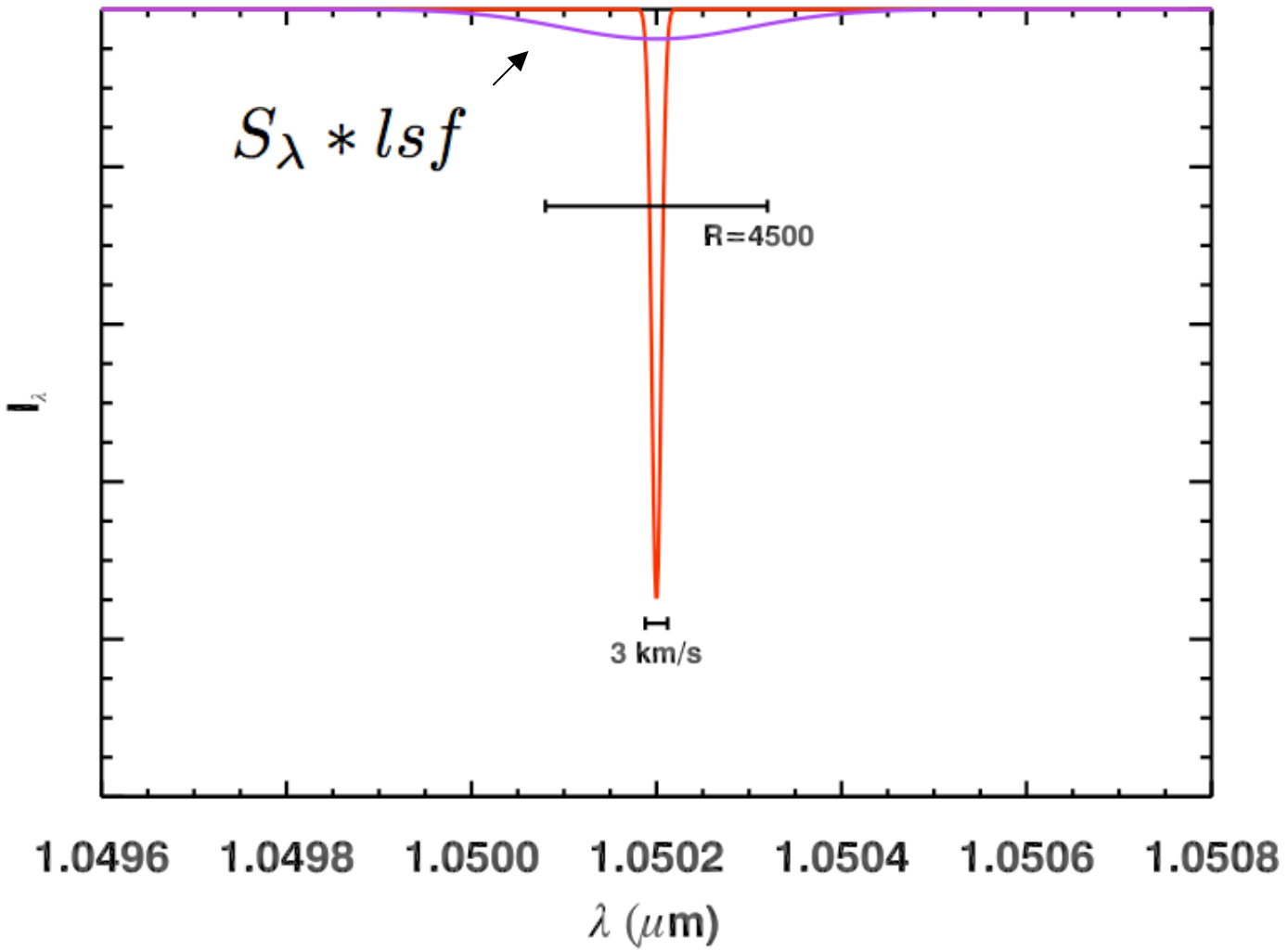
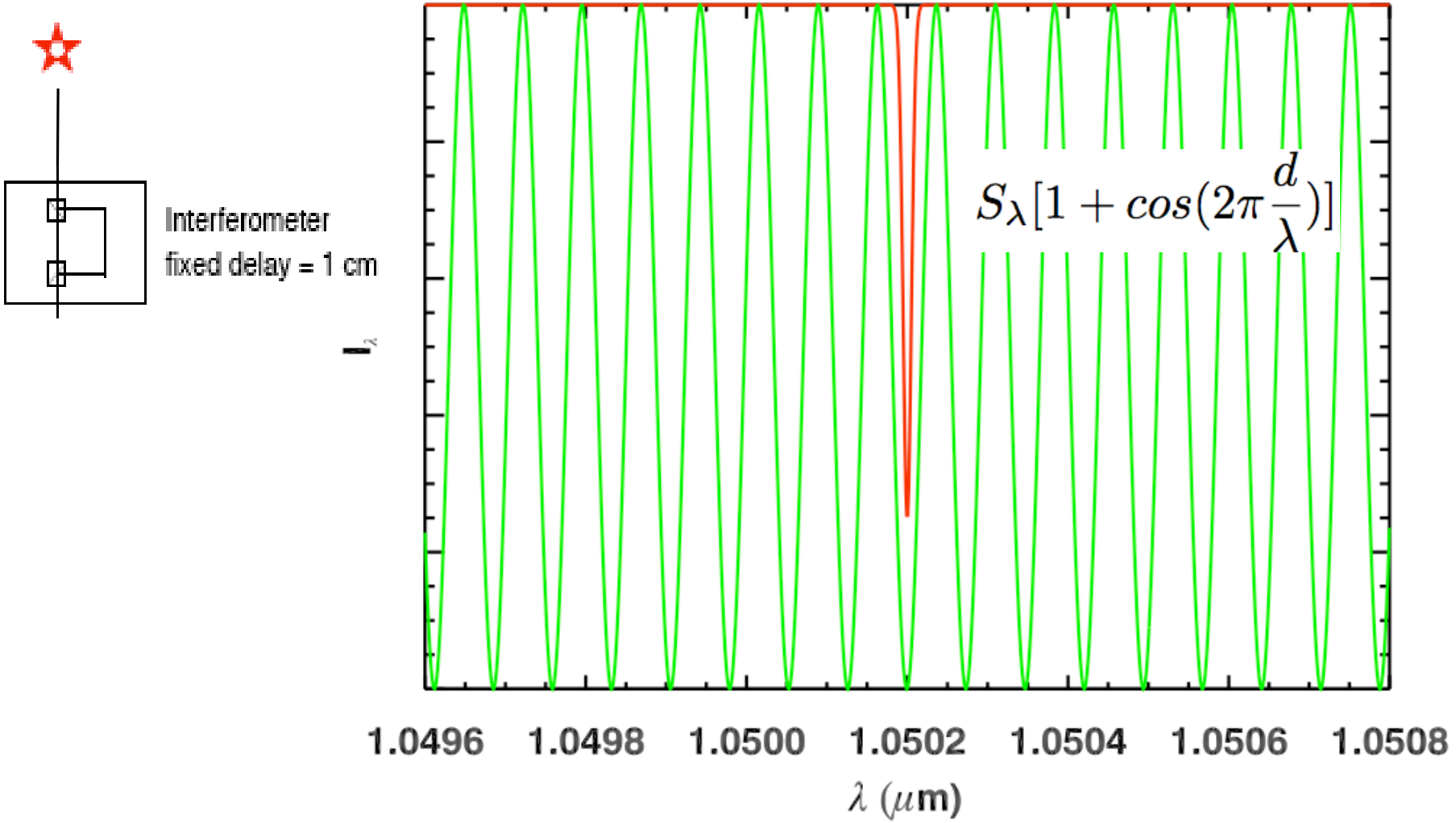
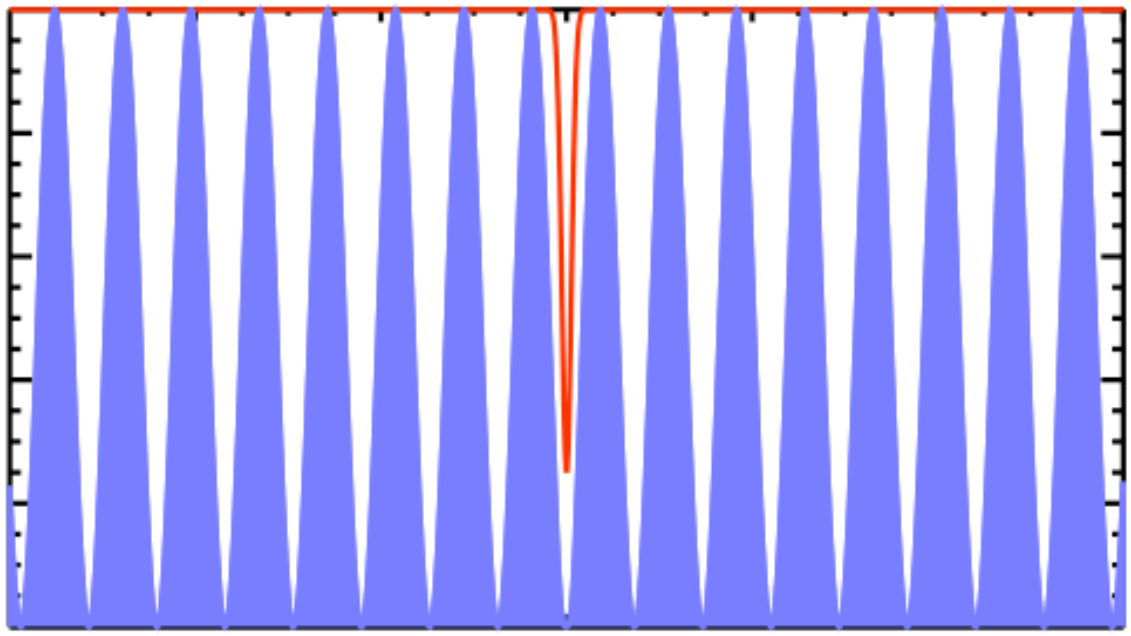

S_λ
3 km/s
1.0496
1.0498
1.0500
1.0502
1.0504
1.0506
1.0508
λ (μm)

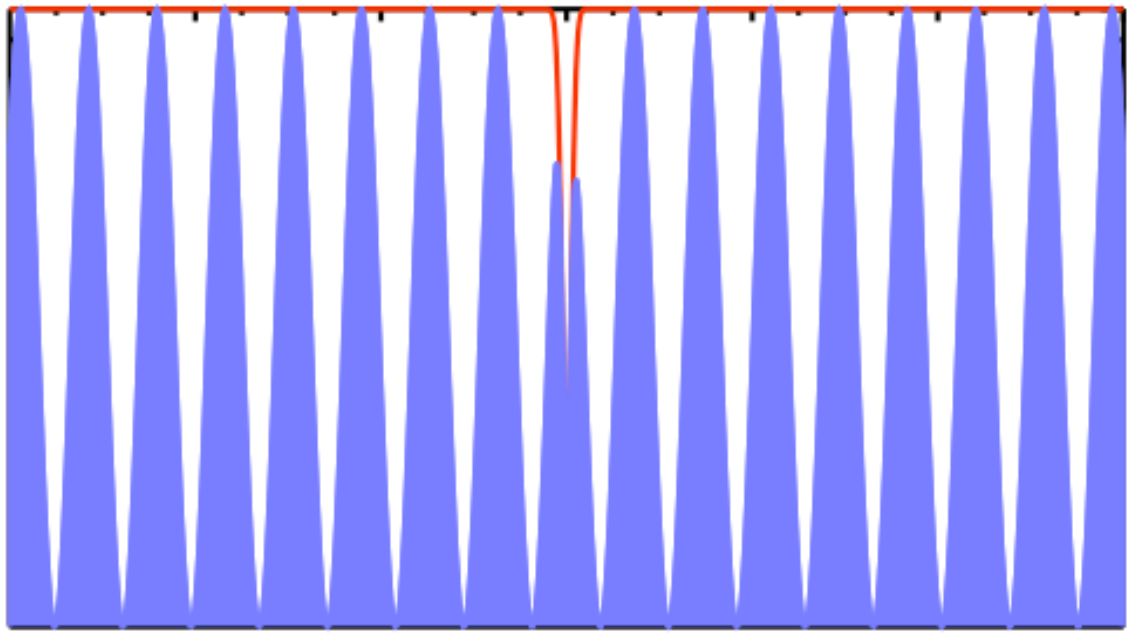

Slit

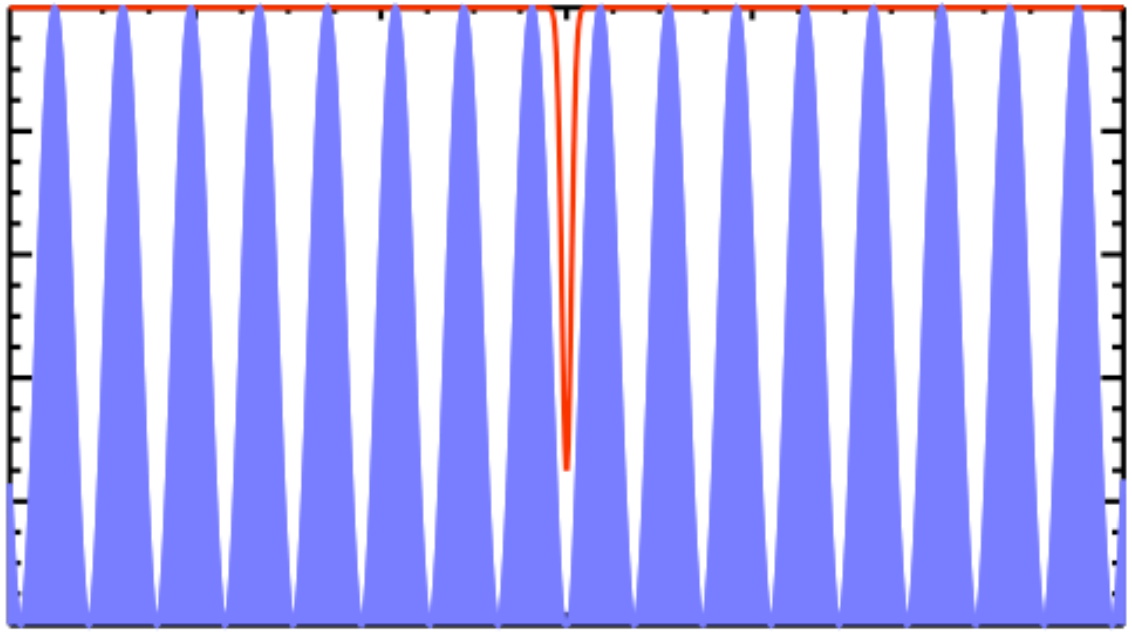

$S_\lambda * lsf$
R=4500
3 km/s
I_λ
1.0496
1.0498
1.0500
1.0502
1.0504
1.0506
1.0508
λ (μm)

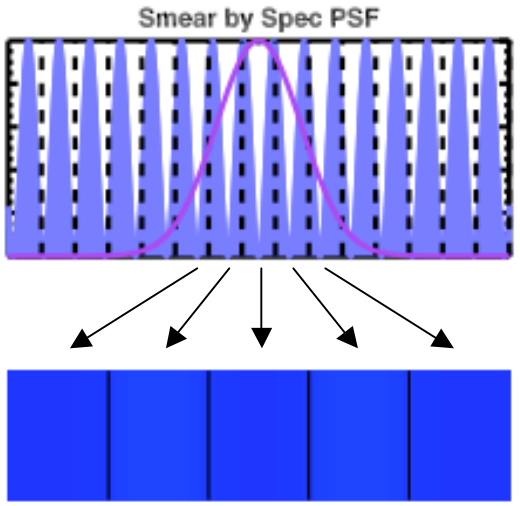

Interferometer
fixed delay = 1 cm
I_λ
$S_\lambda[1 + cos(2\pi \frac{d}{\lambda})]$
1.0496
1.0498
1.0500
1.0502
1.0504
1.0506
1.0508
λ (μm)



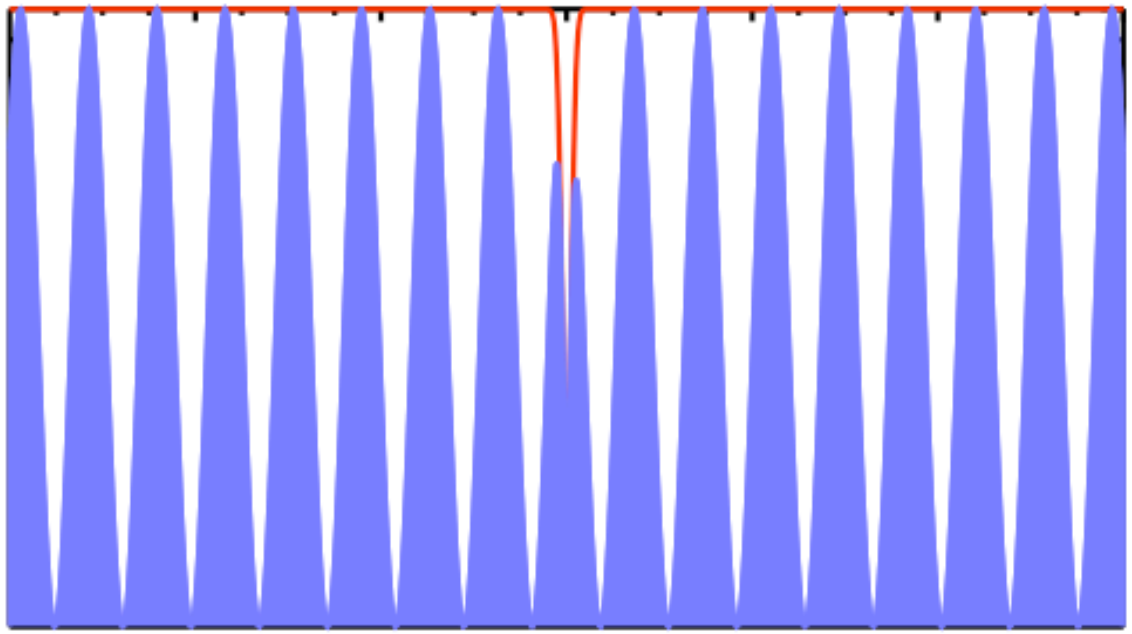
Shift Interferometer Phase π

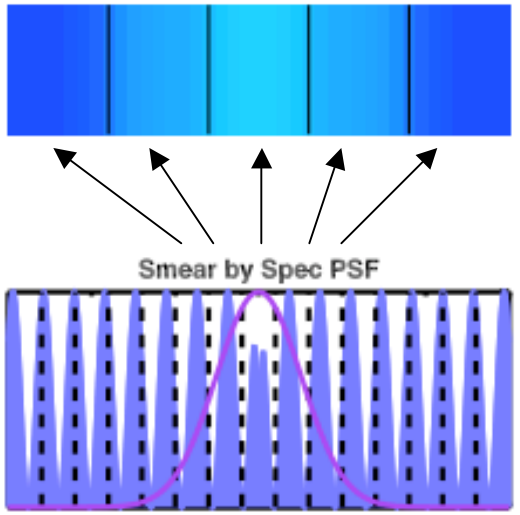


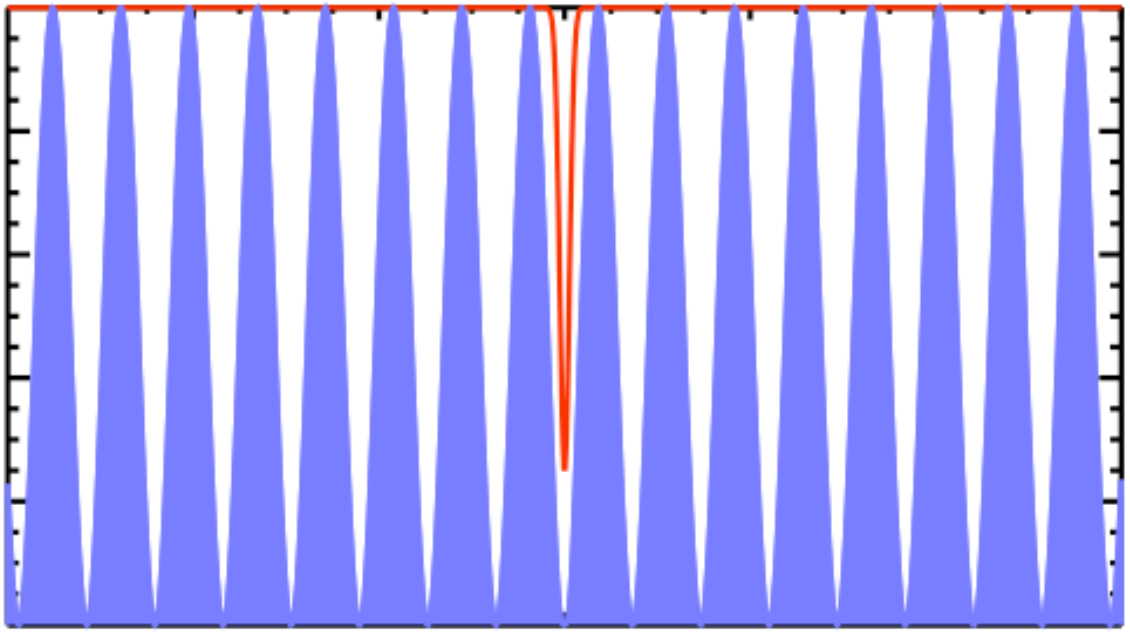




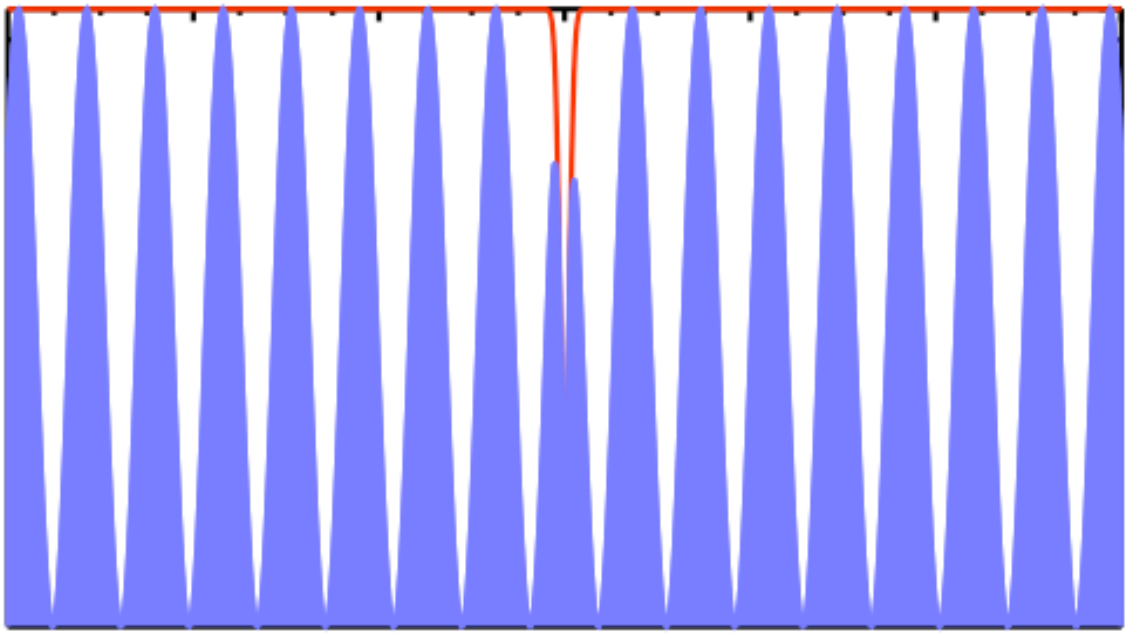
Shift Interferometer Phase π

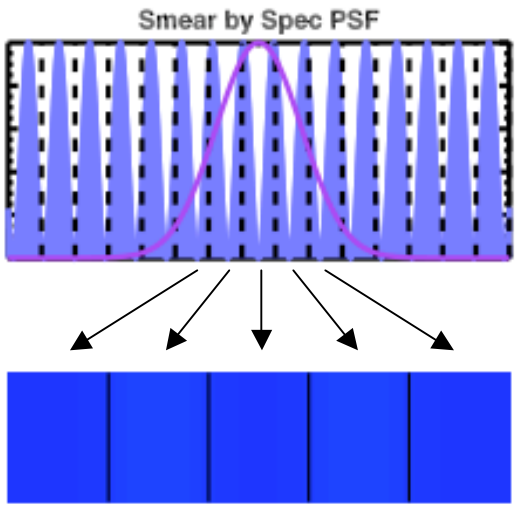






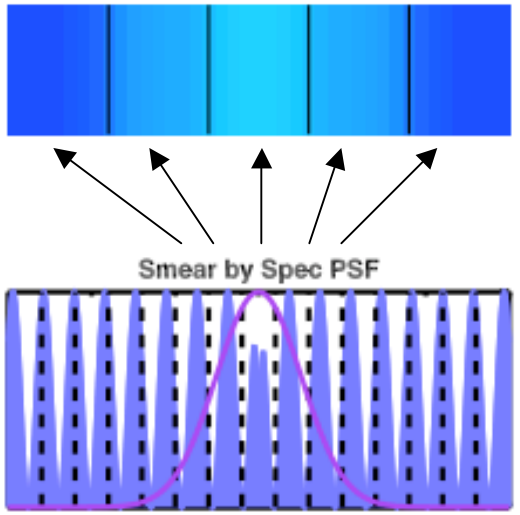
Shift Interferometer Phase π



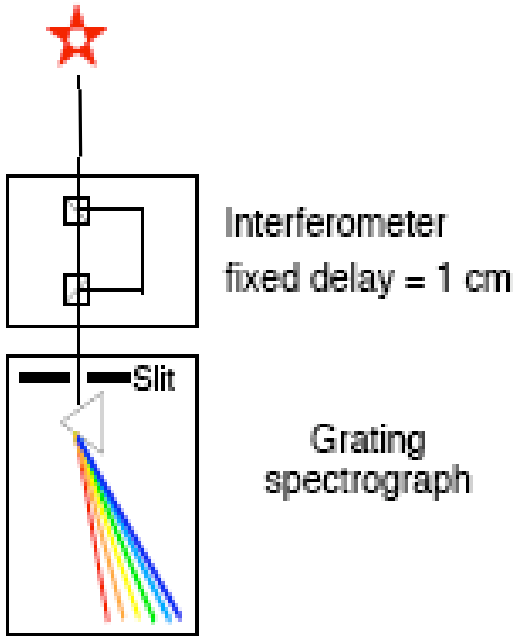


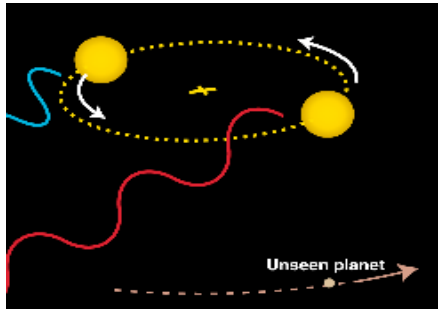
Shift in the spectrum (δRV)

= dramatic change in fringe contrast



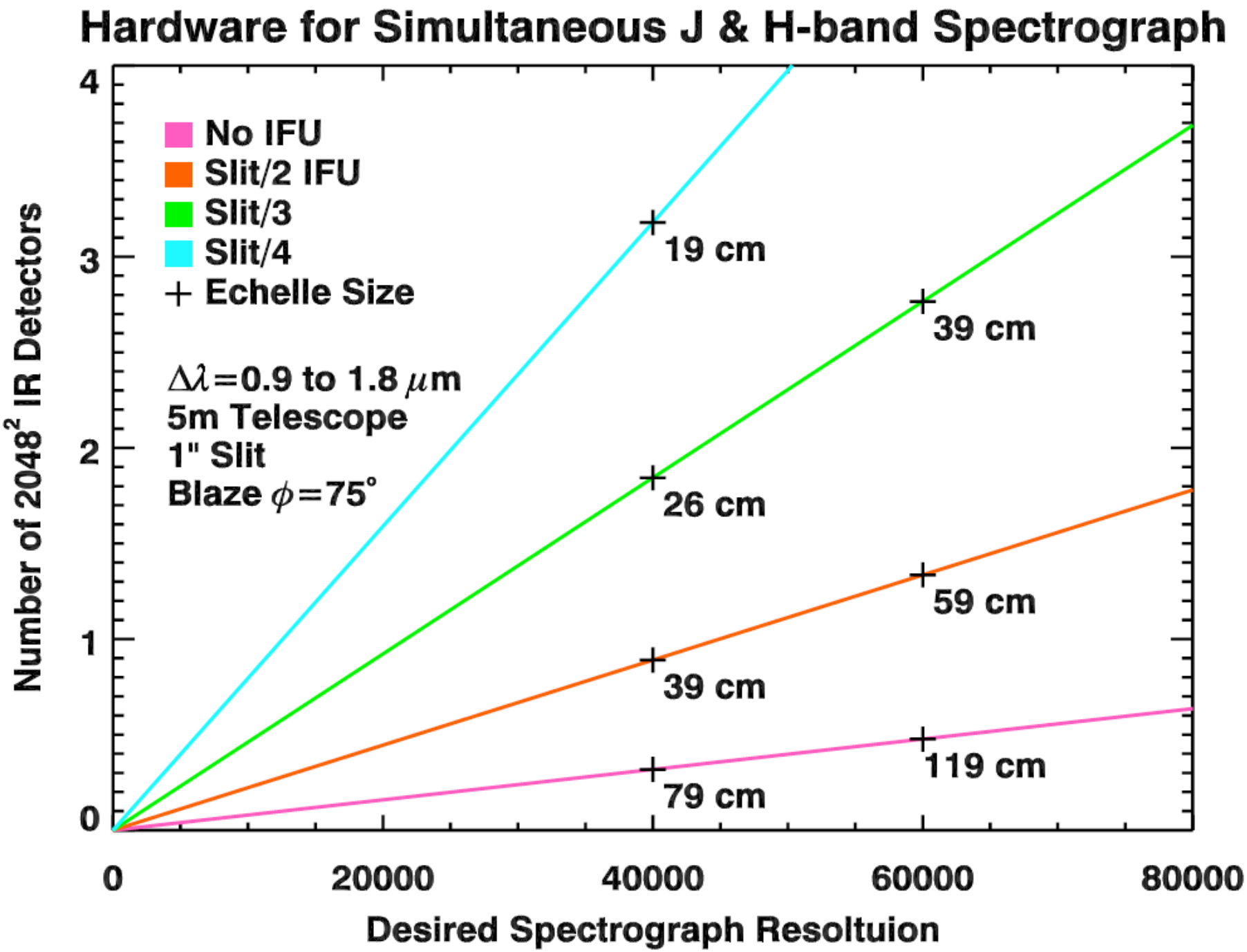
Advantages

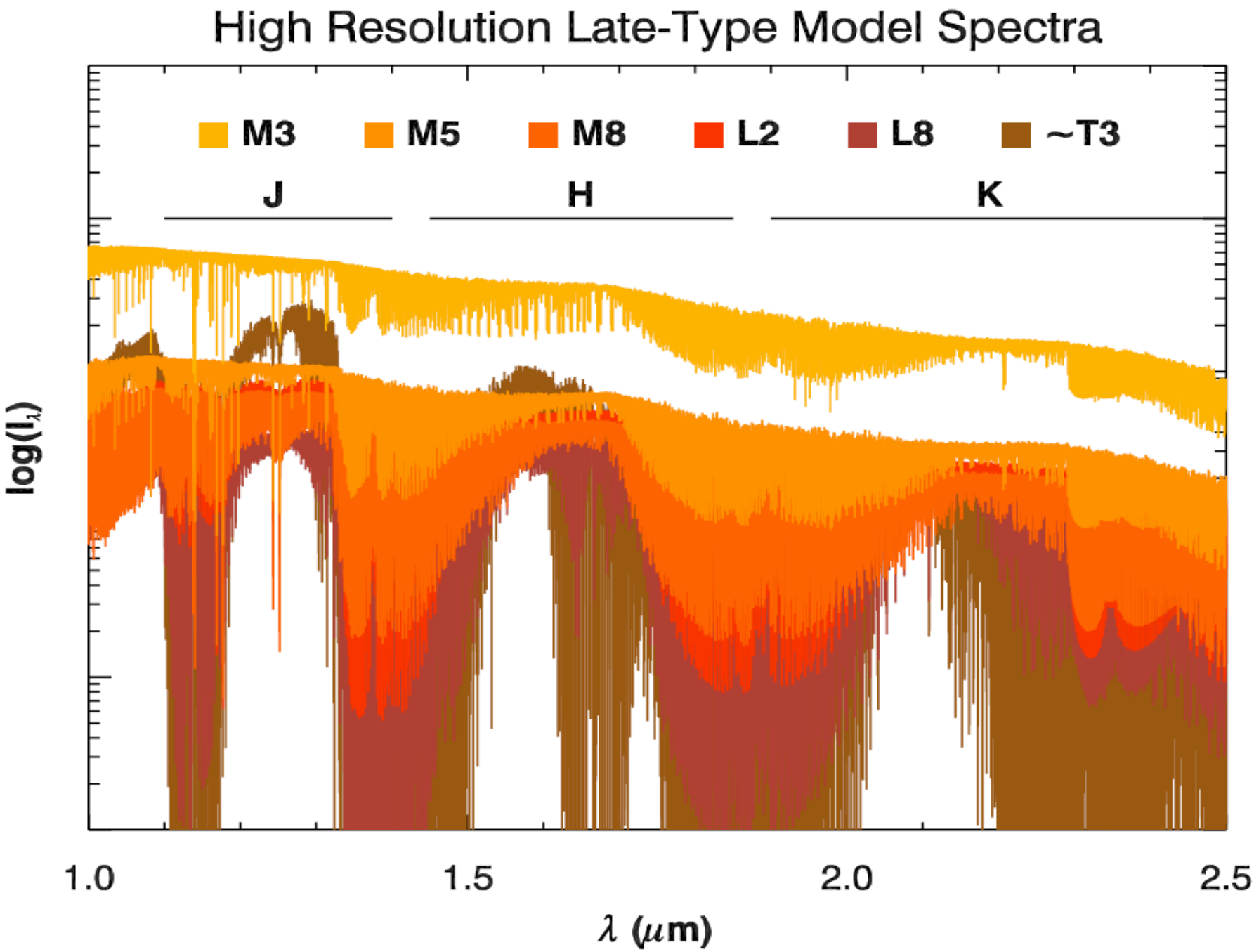




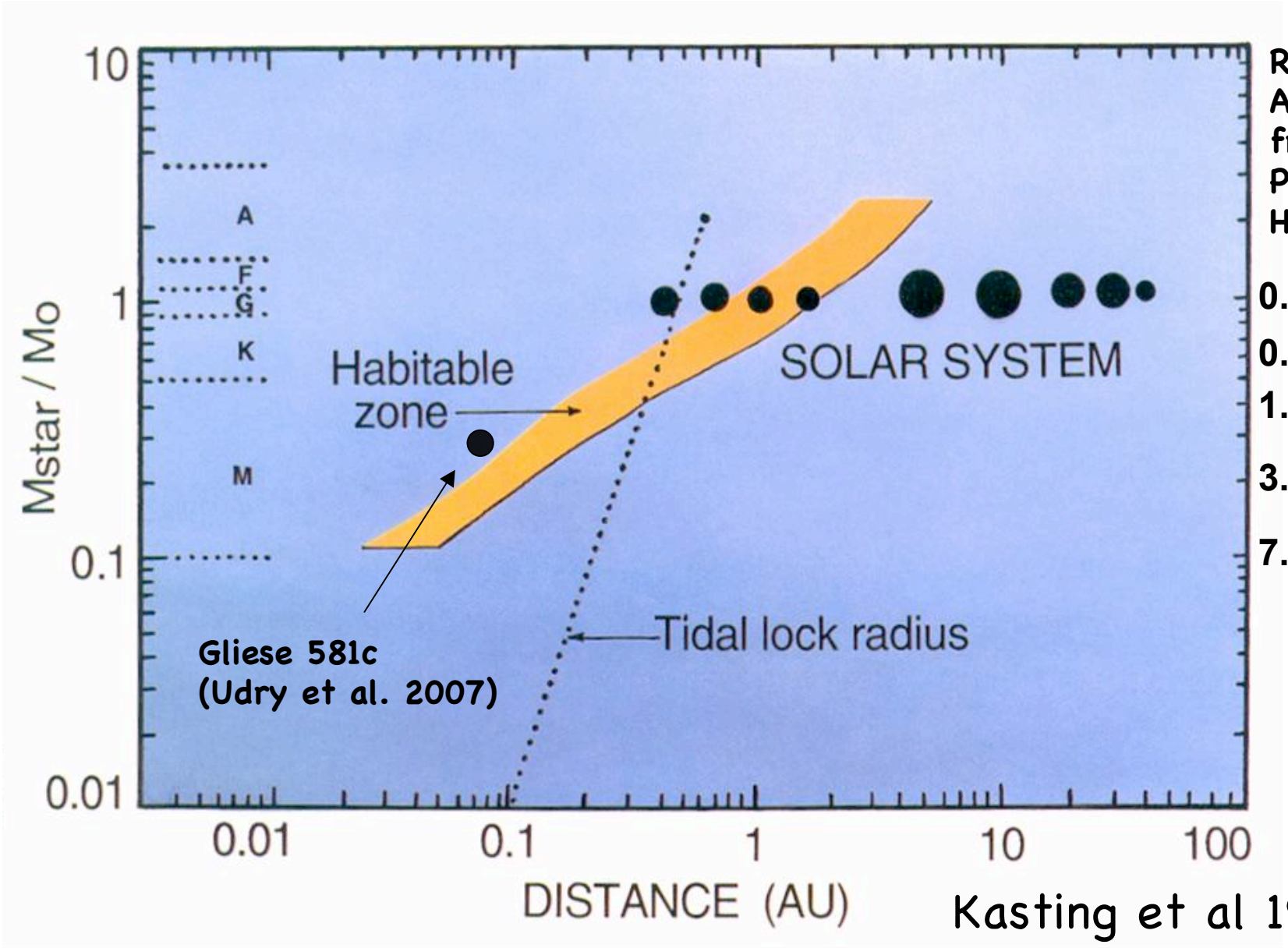
from exoplanets.org

- Shifts systematic calibration from the spectrograph onto the optical path difference of an interferometer
- Moderate resolution spectrograph is stable with large simultaneous bandwidth.
- Well suited for near-IR precise radial velocimetry (detecting exoplanets)!


Hardware for Simultaneous J & H-band Spectrograph
No IFU
Slit/2 IFU
Slit/3
Slit/4
Echelle Size
Δλ=0.9 to 1.8 μm
5m Telescope
1" Slit
Blaze φ=75°
19 cm
39 cm
26 cm
59 cm
39 cm
119 cm
79 cm
Number of 2048² IR Detectors
Desired Spectrograph Resoltuion
0
1
2
3
4
0
20000
40000
60000
80000


High Resolution Late-Type Model Spectra
M3
M5
M8
L2
L8
~T3
J
H
K
log(I$_\lambda$)
1.0
1.5
2.0
2.5
λ (μm)

M Dwarfs: a cool place to live!



Kasting et al 1993

What to take away

- M, L and T dwarfs are ~10 times brighter in near-IR than the visible with high RV signal
- Precise Near-IR RV surveys enable late-type planet detection in 1/10th the time!
  - PhD in the US vs an entire career
- T-EDI is has a design goal of 10m/s, but 5m/s calculated photon-limited performance
  - HZ planets around late M dwarfs
- Check out my poster! (with discussion of telluric calibration)