

WIRC+Spec, WIRC+Pol (Wide-field InfraRed Camera)

Presented at Palomar Jamboree

April 1-2 2019

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What is WIRC?

- WIRC is an infrared wide field imaging camera operated at the prime focus of the 200-inch
- It has a $\sim 2\text{K} \times 2\text{K}$ CCD with an $\sim 8.7 \times 8.7$ arc min field of view
- Two filter wheels, each with 7 slots.
 - FW1: Open, polarization grating, Br-gamma, Diffuser, Fe II, H-cont, Grism
 - FW2: K-cont, CO (0-2), H₂, Open, Ks, H, J
- Current science being performed: brown dwarf spectropolarimetry, transiting exoplanet spectroscopy, transit-timing variation measurements

WIRC – Key Characteristics

- Detector – 2Kx2K Hawaii-II (HgCdTe)
- Pixel Scale - 0.25"/px
- Field of View - 8.7x8.7 arcmin
- Read noise – 12e⁻,
- Gain – 1.2 e⁻/ADU
- Detector linear to 0.5% at 22K ADU, to 1% at 30K ADU, full well at 50K ADU
- Minimum exposure time – 0.92s
- Filter Wheel includes Diffuser for photometry:
 - 500 ppm/30 min bin for J = 14 mag star (with diffuser)

What are WIRC+Spec and WIRC+Pol?

- WIRC+Spec

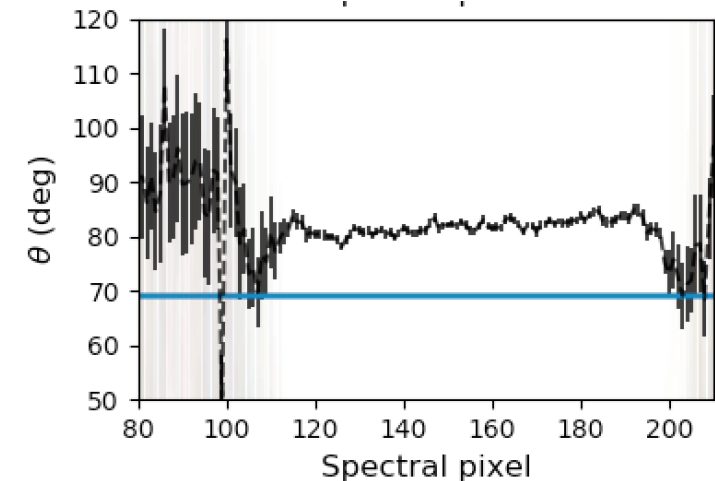
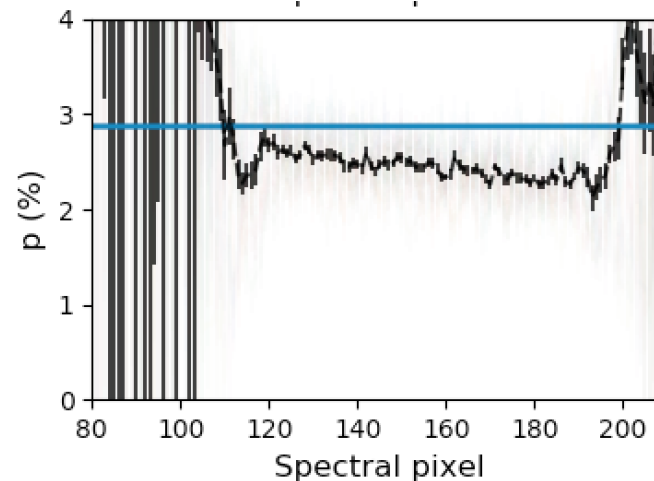
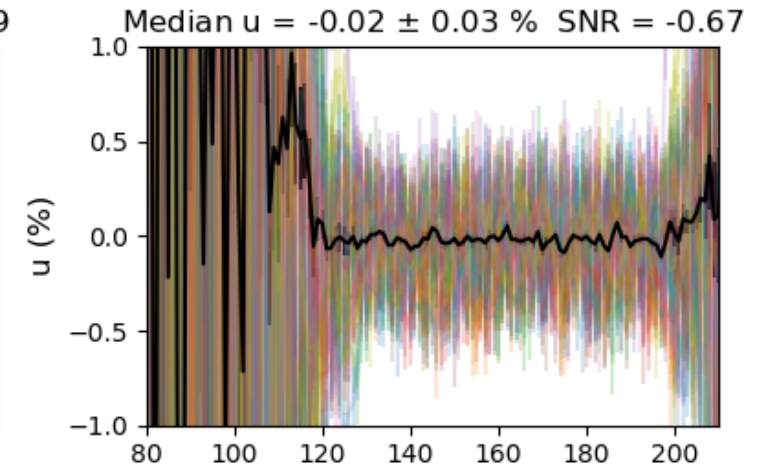
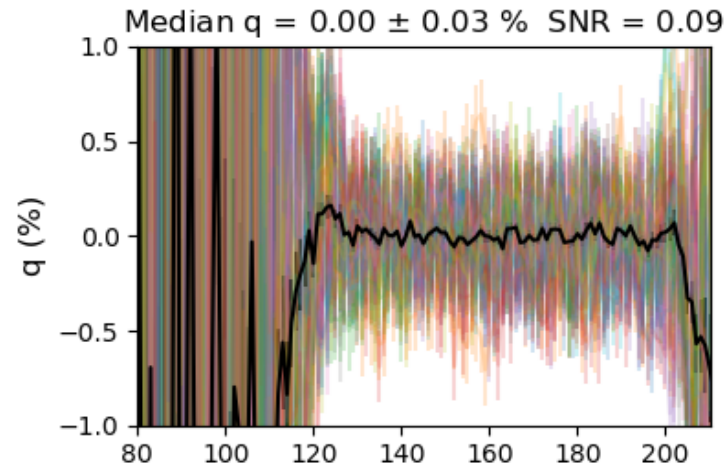
- Grism-based slitless spectroscopy
- J, H and K Bands
- Resolving Power $R \sim 100$ (seeing limited)
- Current Science Programs: Transit and Secondary Eclipse Spectroscopy
- Sensitivity (work in progress)

- WIRC+Pol

- Polarization grating-based spectropolarimetry
- 4.3×4.3 arc min FOV
- J and H-bands
- Resolving Power $R \sim 100$ (seeing limited)
- Current Science Programs: Brown Dwarf Atmospheric Characterization, Kepler Dippers, YSOs, Asteroid Polarized Phase Functions

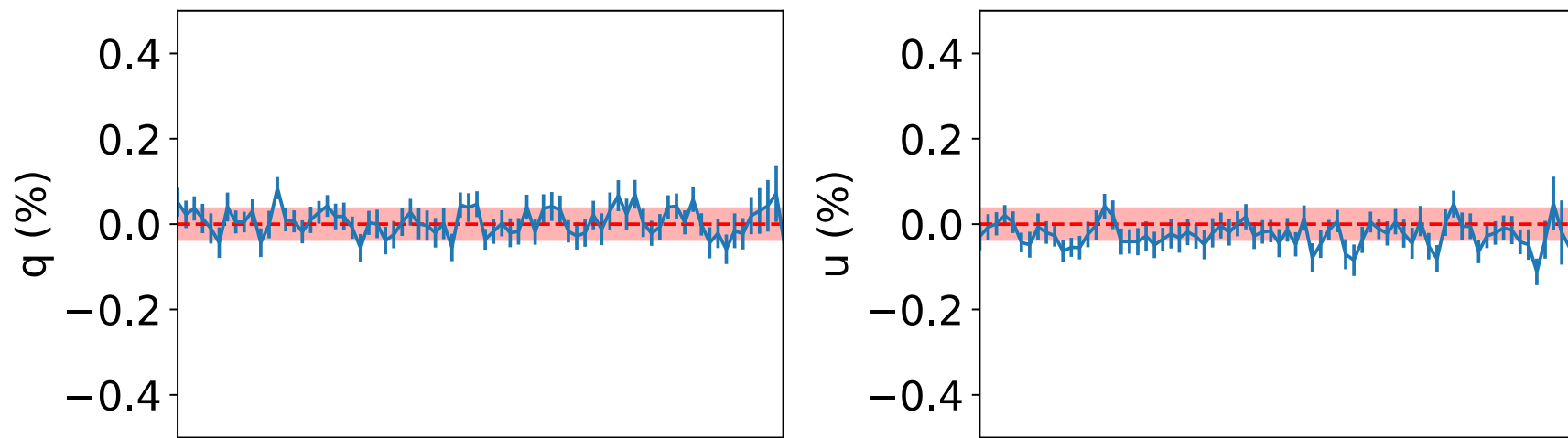
WIRC+Pol: New Half-wave plate Upgrade (Better systematics)

- Unpolarized Standard:
 - $<0.03\%$ instrumental polarization
- Polarized Standard:
 - Not 100% efficiency
 - Instrument Model in progress.

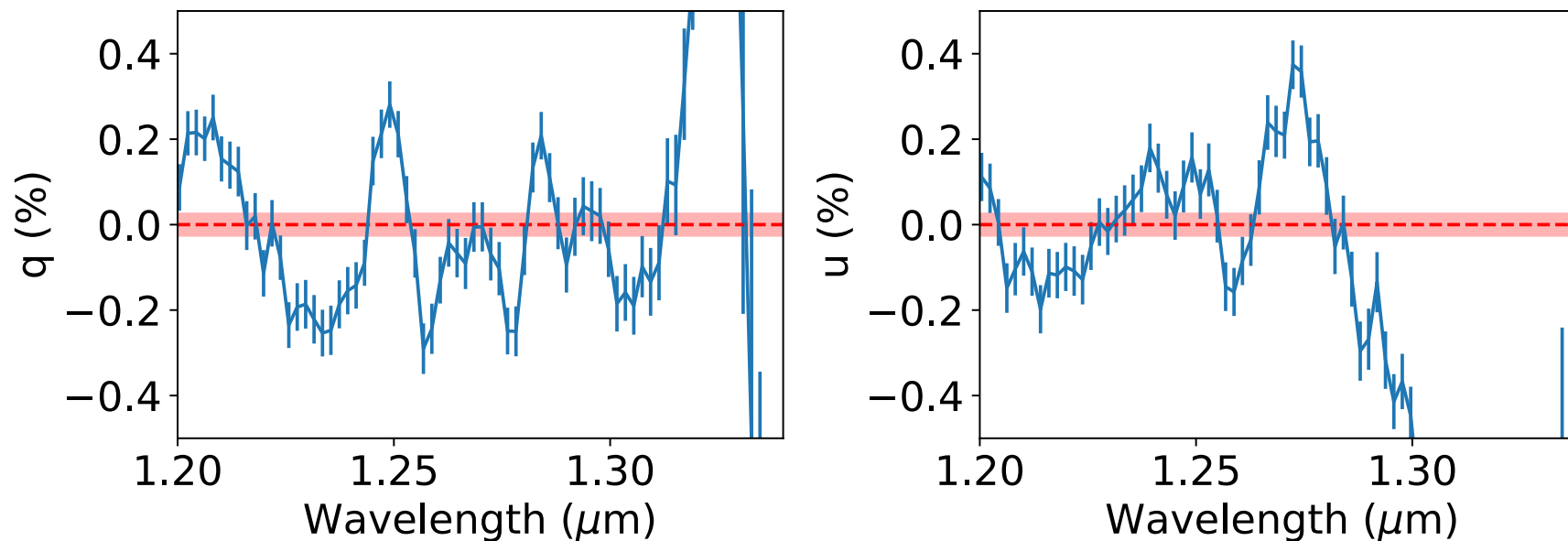


Pre Vs. Post Upgrade

WIRC+Pol post-upgrade, Unpolarized standard star



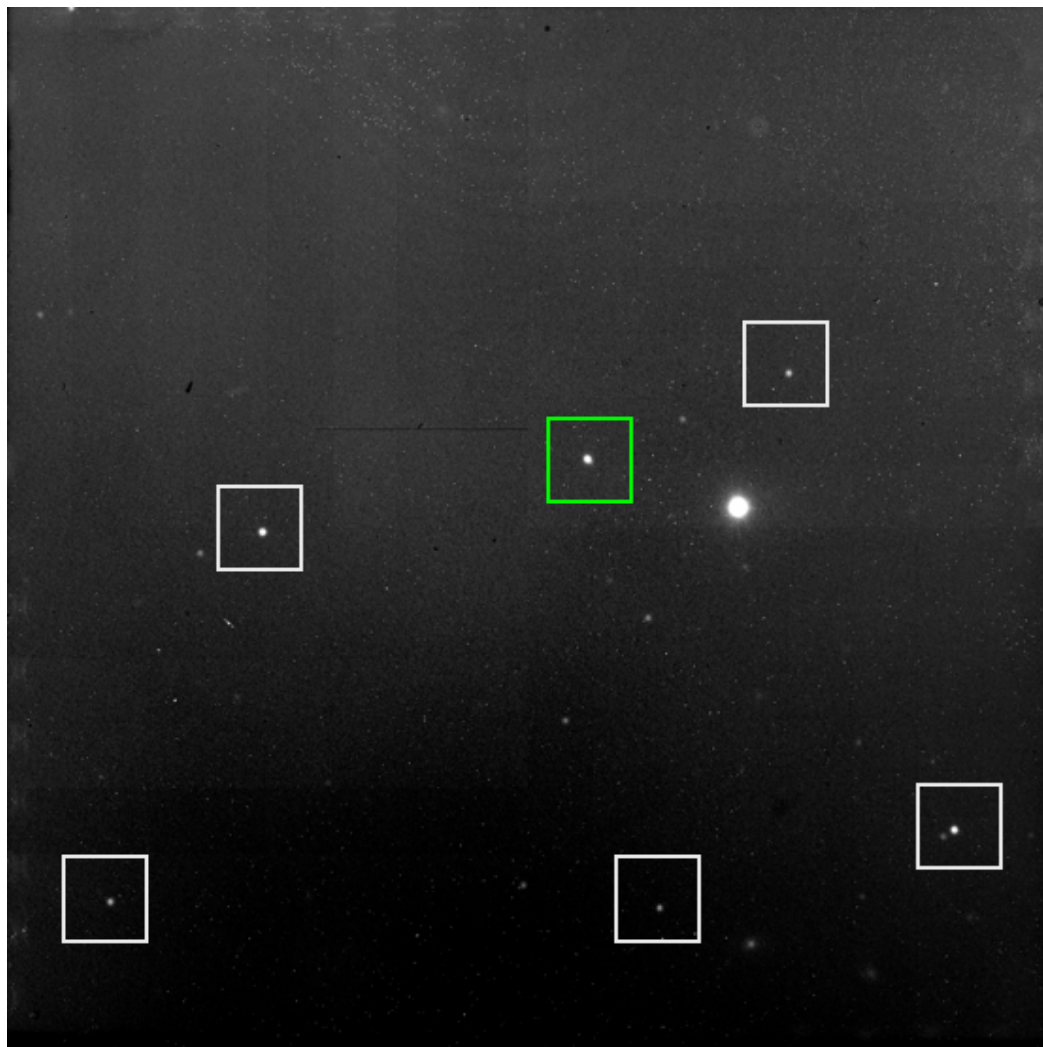
WIRC+Pol pre-upgrade, Unpolarized standard star



WIRC+Spec and WIRC+Pol – Things you might need to know about observing and data reduction

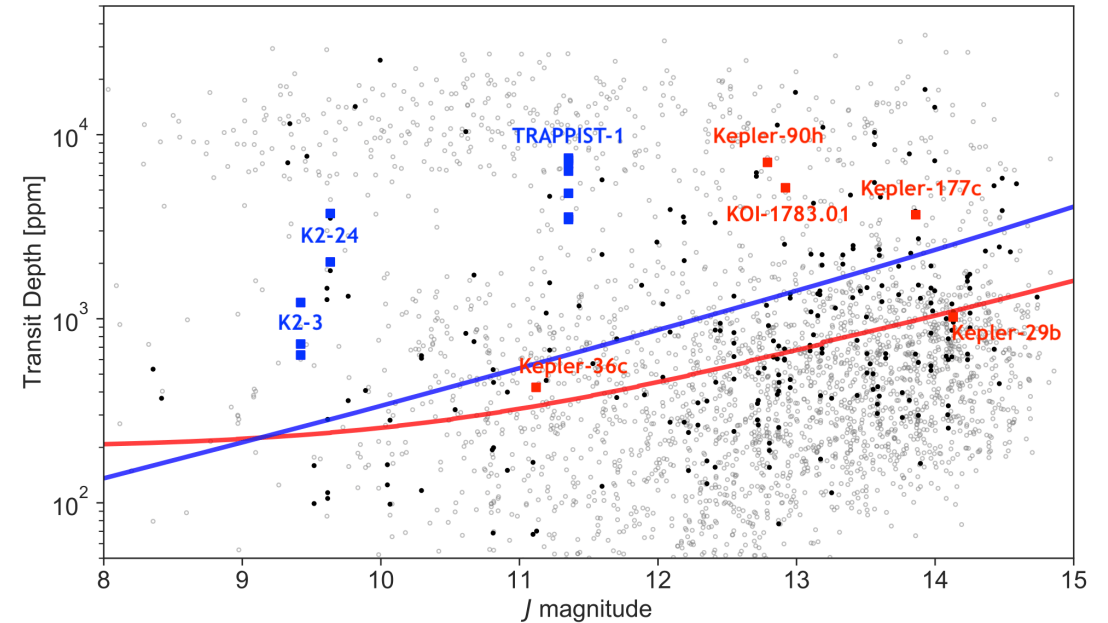
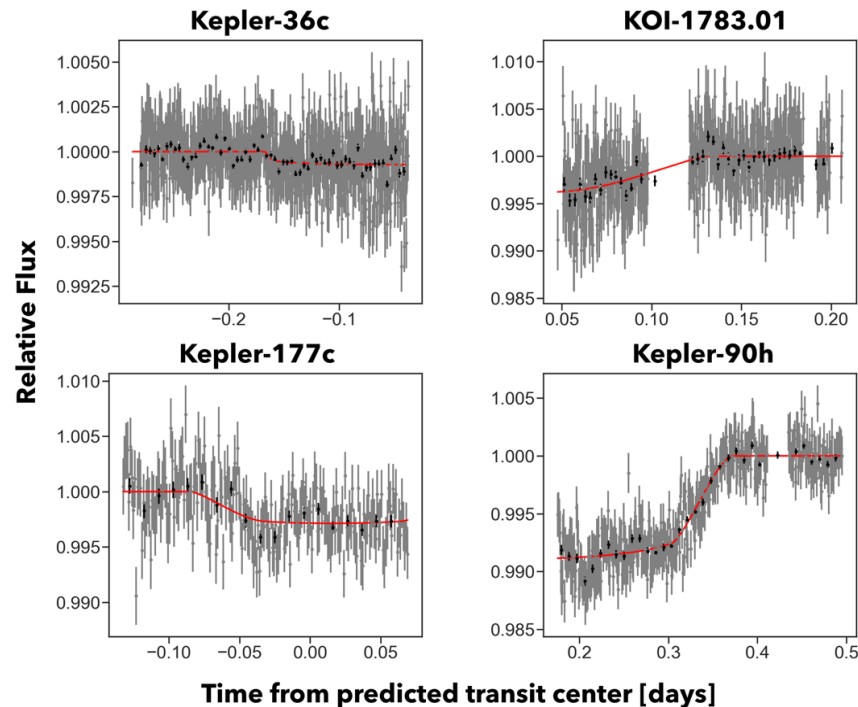
- Good documentation available at WIRC's website:
<http://www.astro.caltech.edu/palomar/observer/200inchResources/wircspecs.html>
- Observing procedures available on internal wiki (contact us):
<http://www.astro.caltech.edu/wiki-wircpol/doku.php?id=start>
- WIRC+Pol Instrument paper (Tinnyanont et al. 2019):
<http://adsabs.harvard.edu/abs/2019PASP..131b5001T>
- Exposure times are typically set dynamically for observations to bring you to ~20K ADU on your target's PSF maximum
- Python data reduction pipeline in active development for all exoplanet/BD observing modes
- Photometry mode data reduction is most mature
- If you have questions, please talk to us!

WIRC Diffuser – Sample Data



- J band photometry data (with diffuser) on the left; target star in green, comparison stars in white
- Basically take this picture 100s of times throughout the night, perform photometry, and detrend to build up light curve

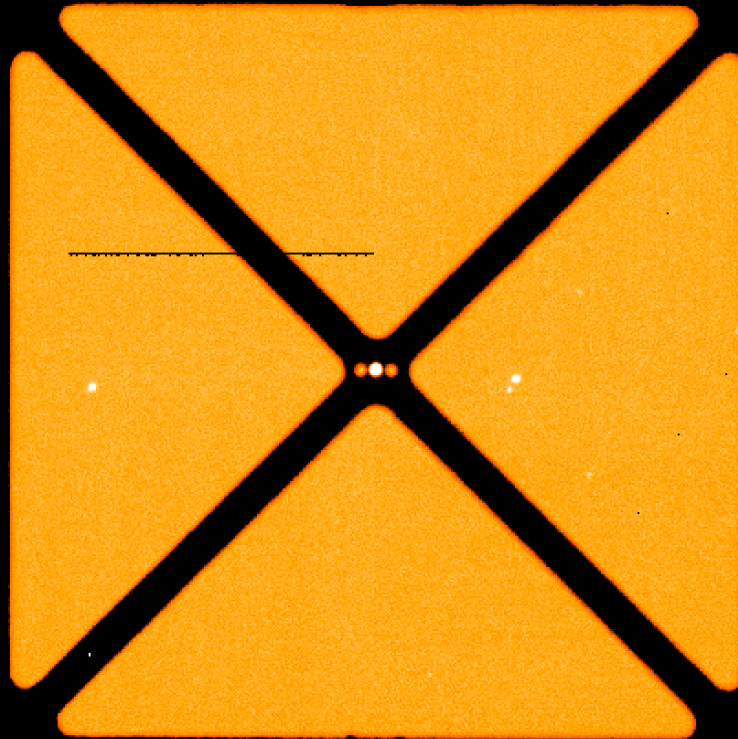
WIRC – Shreyas science project



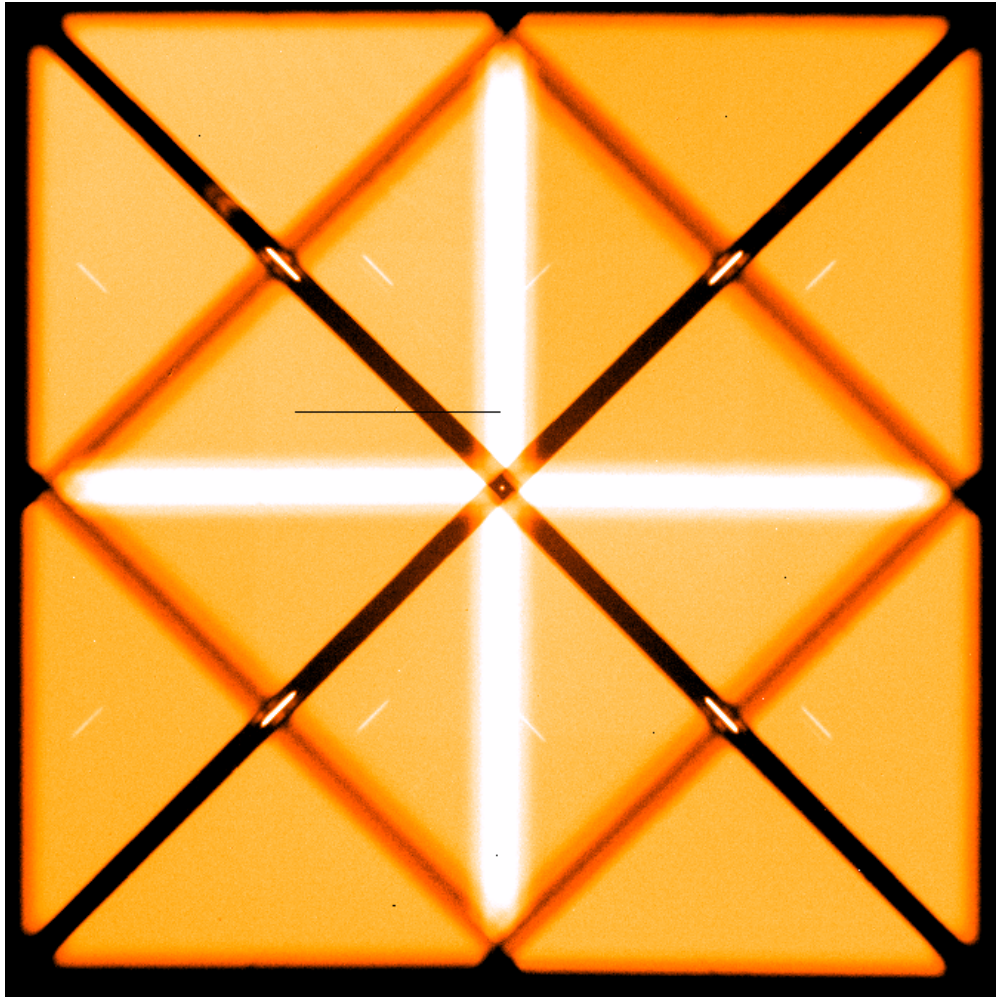
Better photometric precision than
Spitzer for stars fainter than $J \sim 9.5$

- We have used WIRC to measure transit timing variations in five systems, achieving a better photometric precision than Spitzer for stars fainter than $J \sim 9.5$ (Vissapragada et al. in prep.)

WIRC-POL Data – Slit Mask (old)

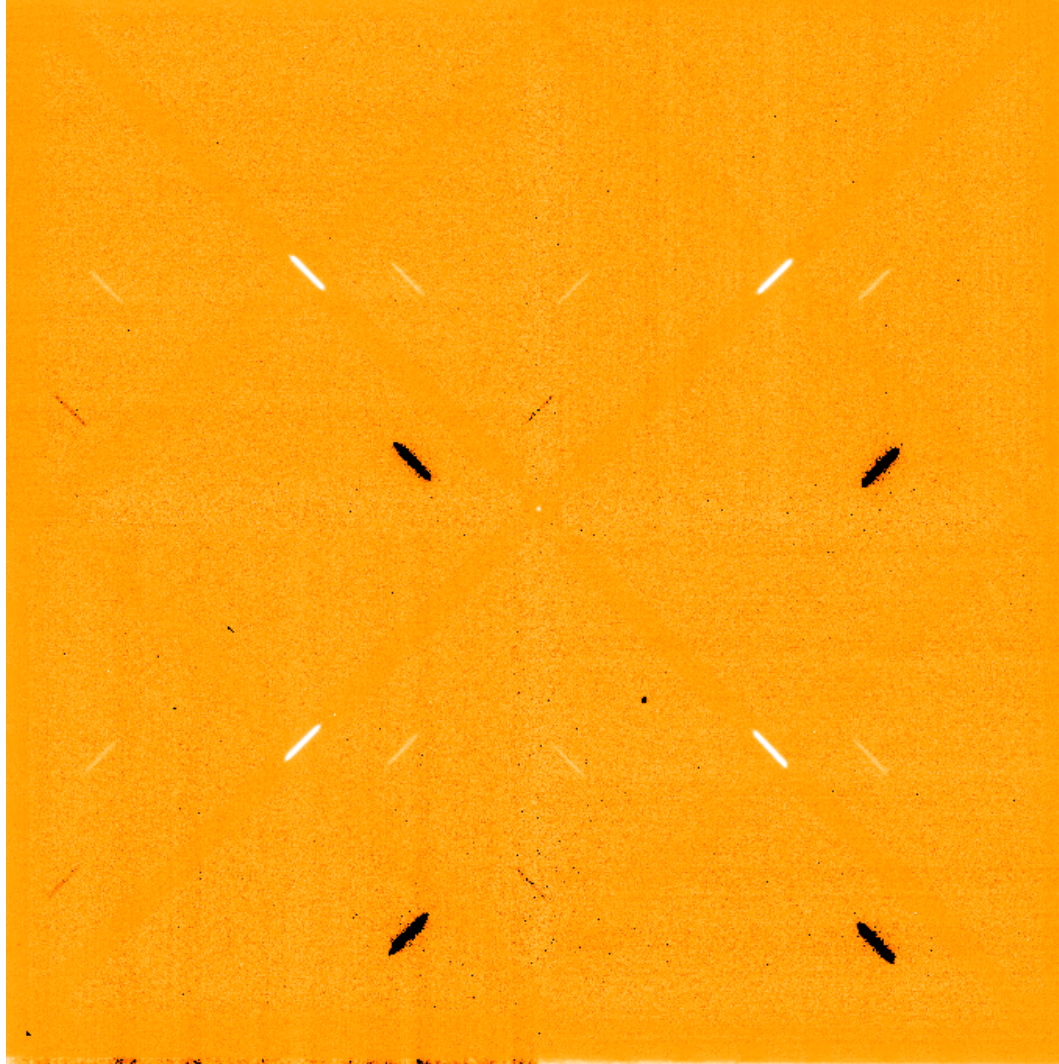


WIRC+Pol – Sample Data – Raw Data



- Raw data looks intense. Most of it is background.
- J-band data

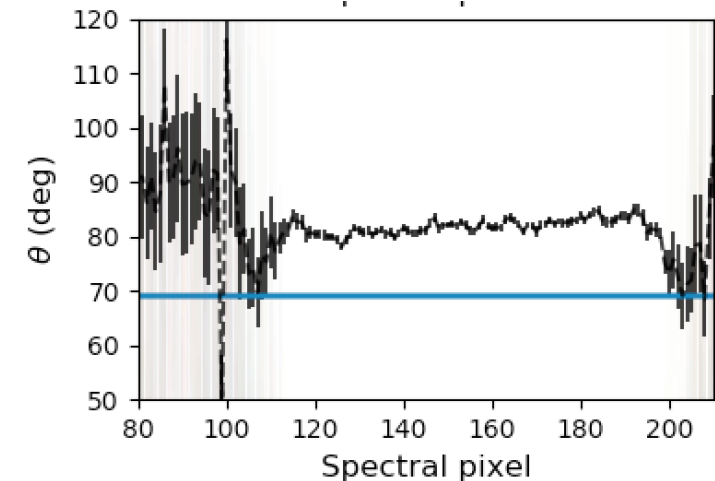
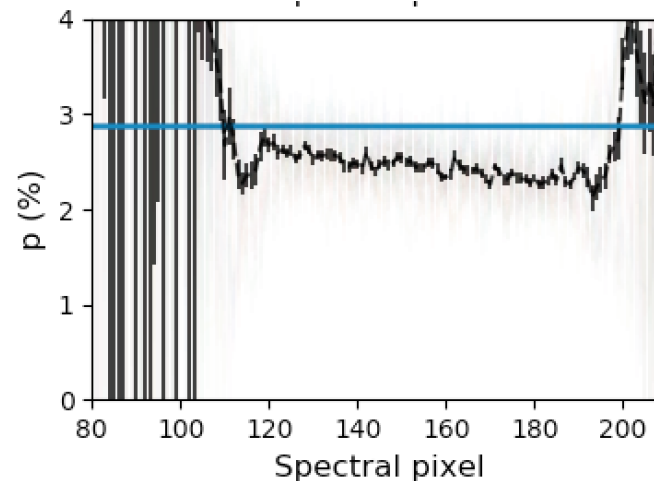
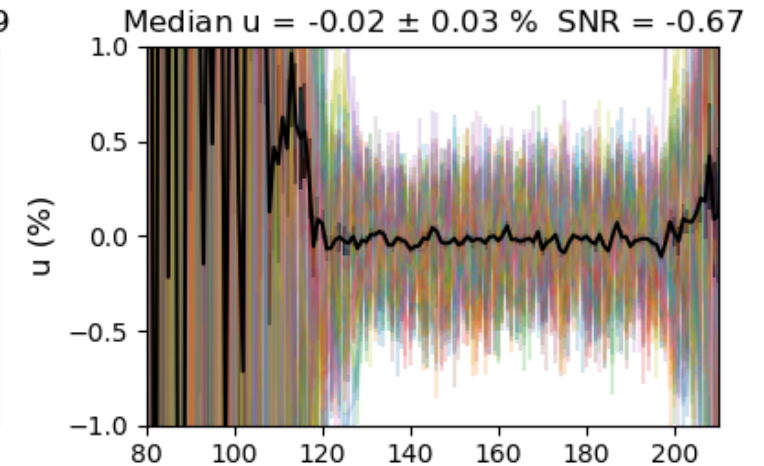
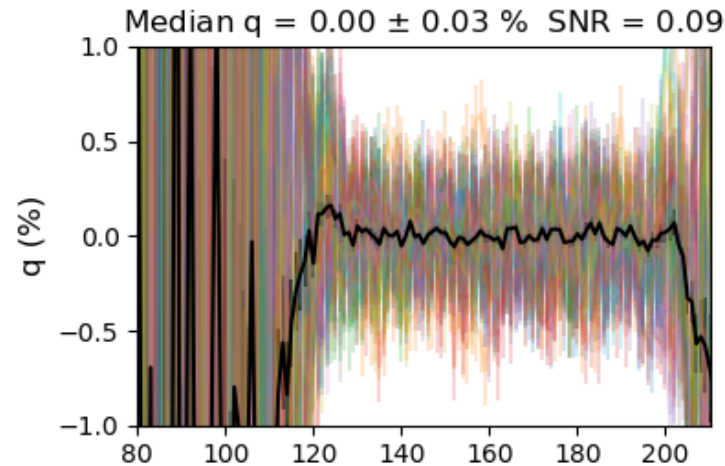
WIRC+Pol – Sample Data - Background Subtracted



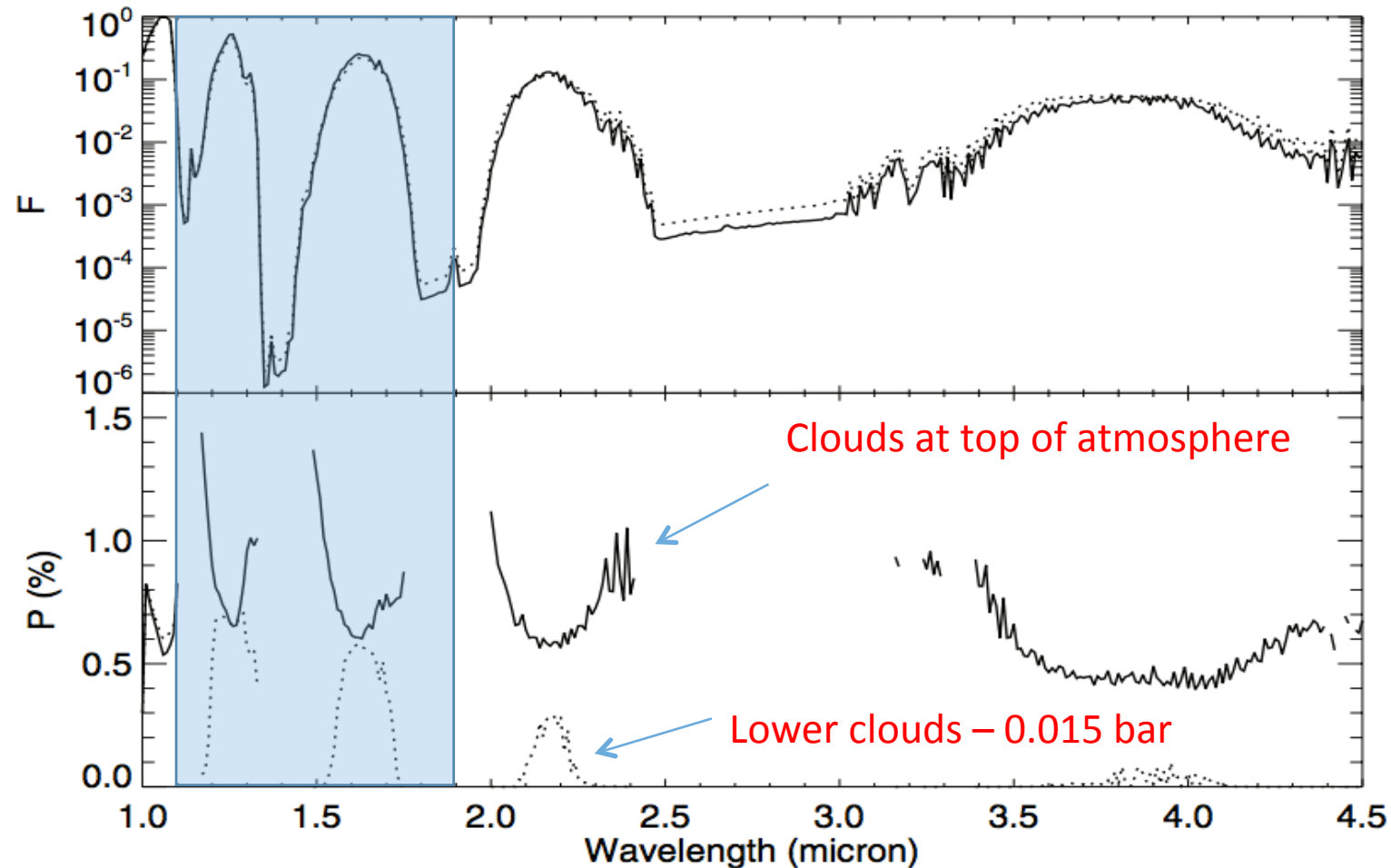
- One target in central slit, two reference targets in the field
- (Dark regions are background-nods)

WIRC+Pol: New Half-wave plate Upgrade (Better systematics)

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My Science - Polarimetry as a diagnostic of Brown Dwarf Cloud Properties



Main Contacts

- JPL:
 - Max Millar-Blanchaer (me!)
 - Gautam Vasisht
- Caltech
 - Kaew Tinyanont
 - Shreyas Vissapragada
 - Ricky Nilsson
 - Dimitri Mawet
 - Heather Knutson