

HPF

The Habitable Zone Planet Finder

Joe Ninan (The Pennsylvania State University)

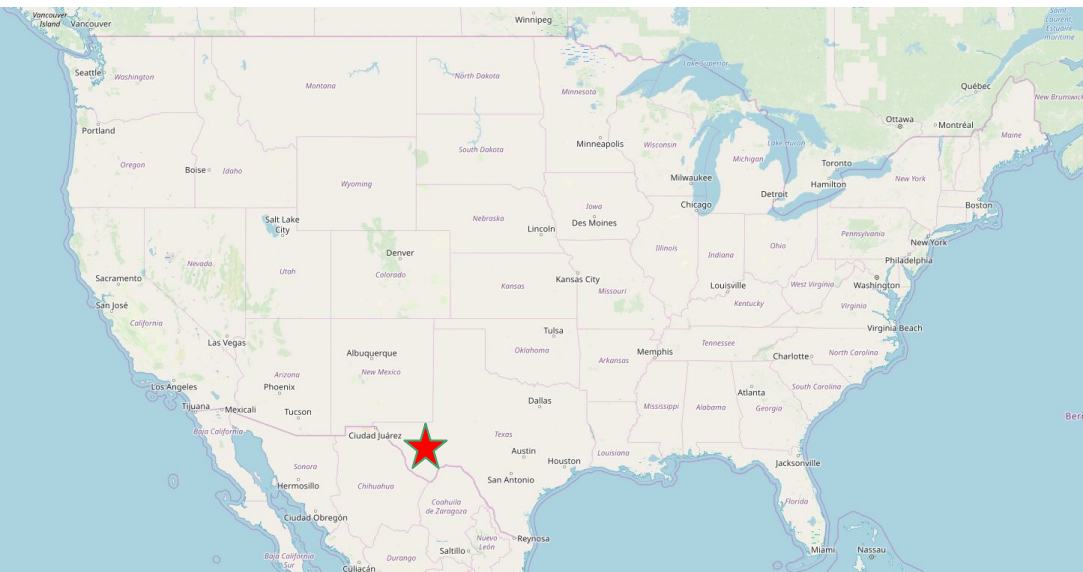
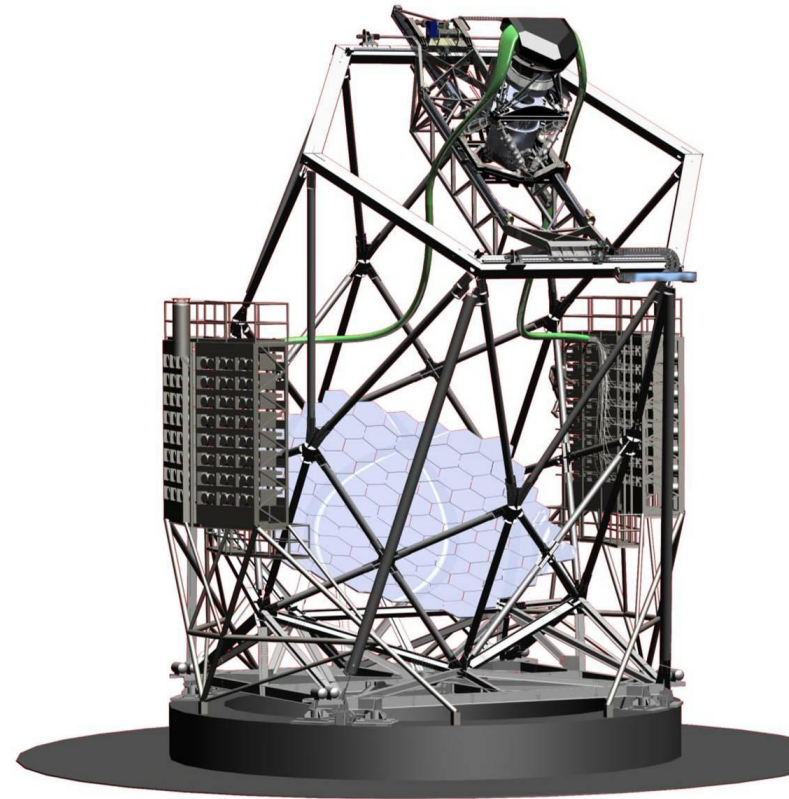
On behalf of the HPF team

PennState



The Habitable Zone Planet Finder @ HET

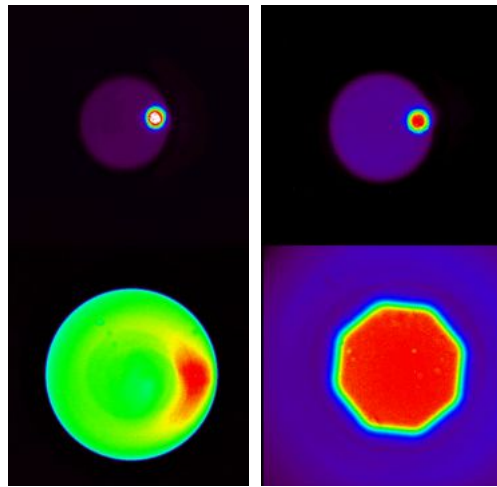
- HPF wavelength coverage: **0.8 to 1.27 microns**
- **R=55,000**
- Located at 10m Hobby Eberly Telescope, McDonald Observatory, Texas, USA
- Fully Queue based observing
- **Fixed altitude telescope (55 +/- 4 degrees)**
- Typical track length approx 1 hour.



Stabilised Input

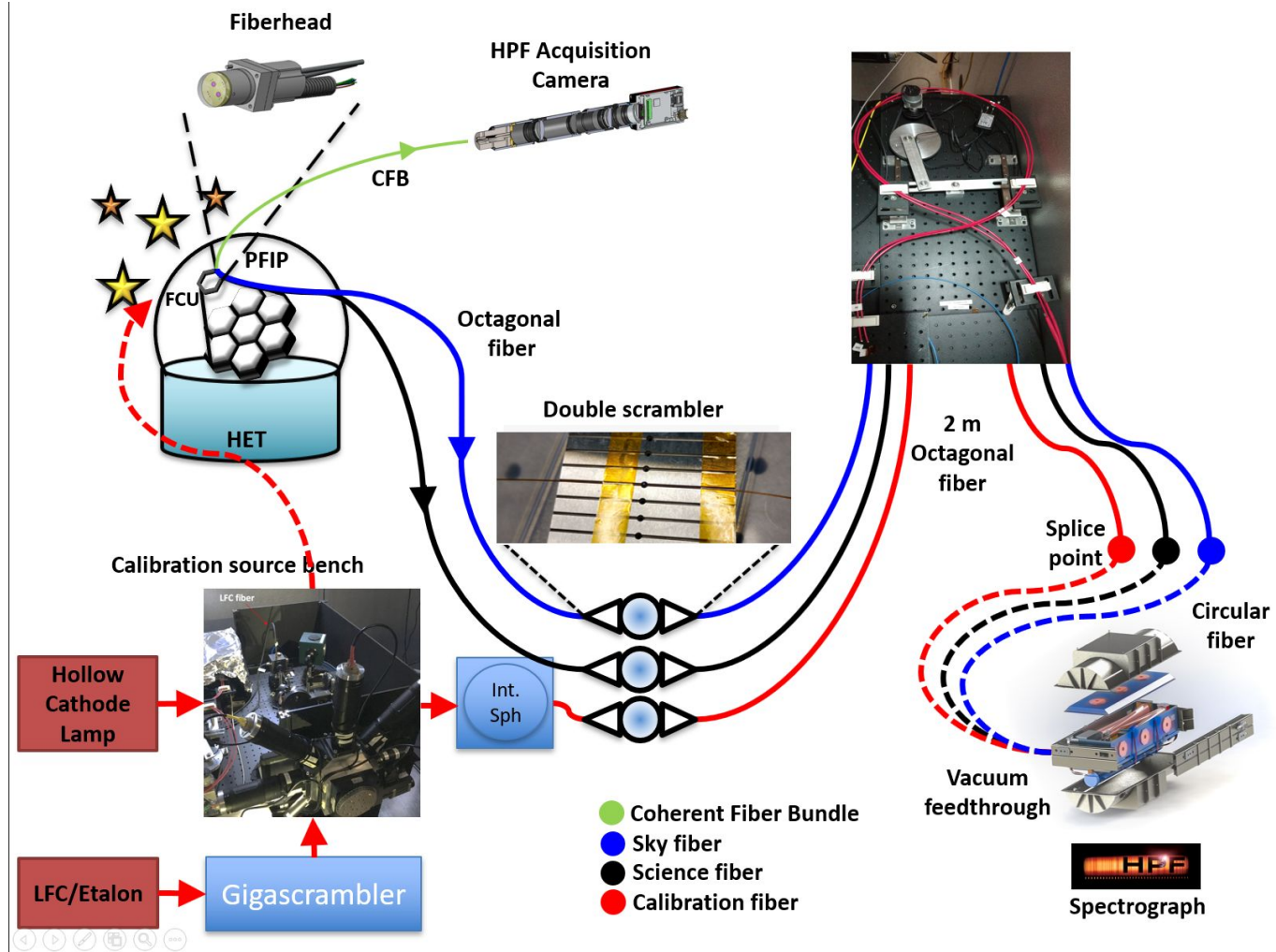
Near & Far field scrambling

& Model noise scrambling



Roy+, (2017)

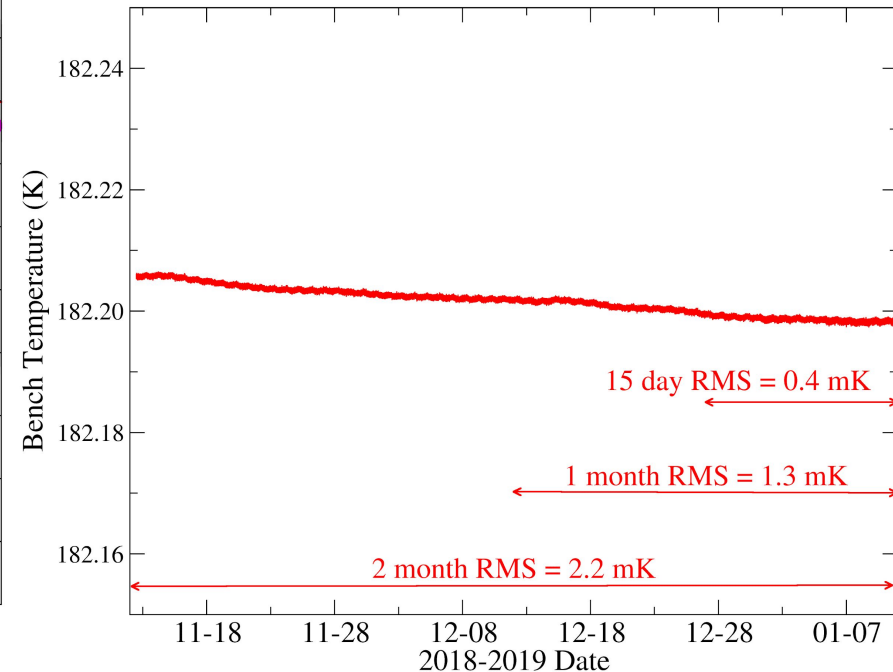
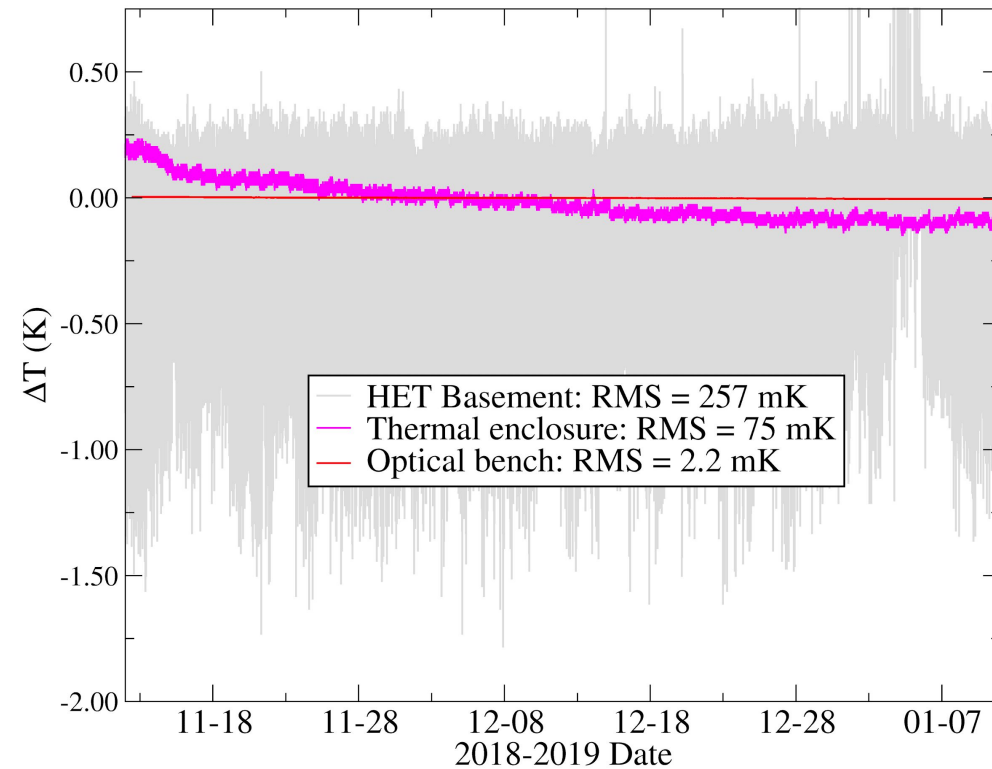
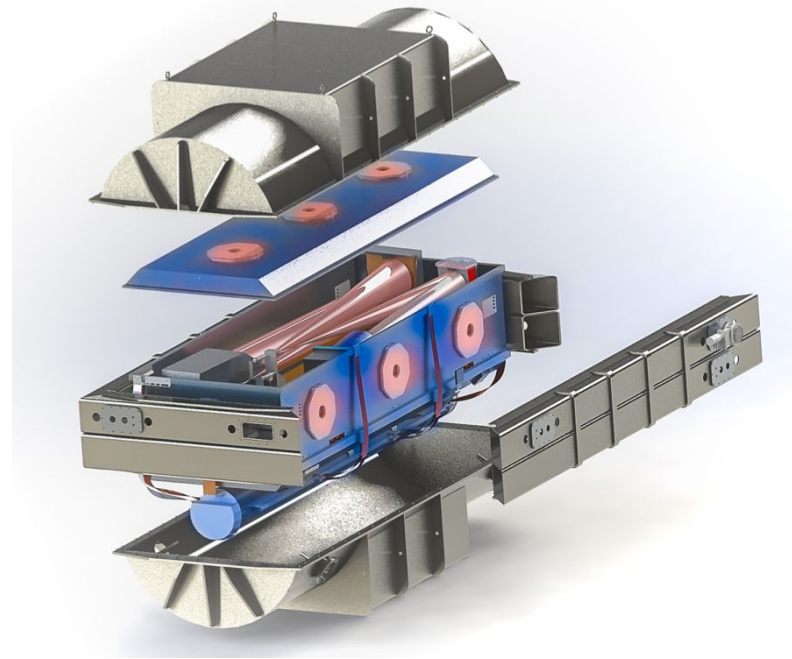
Kanodia + (2018)



Thermally stabilised

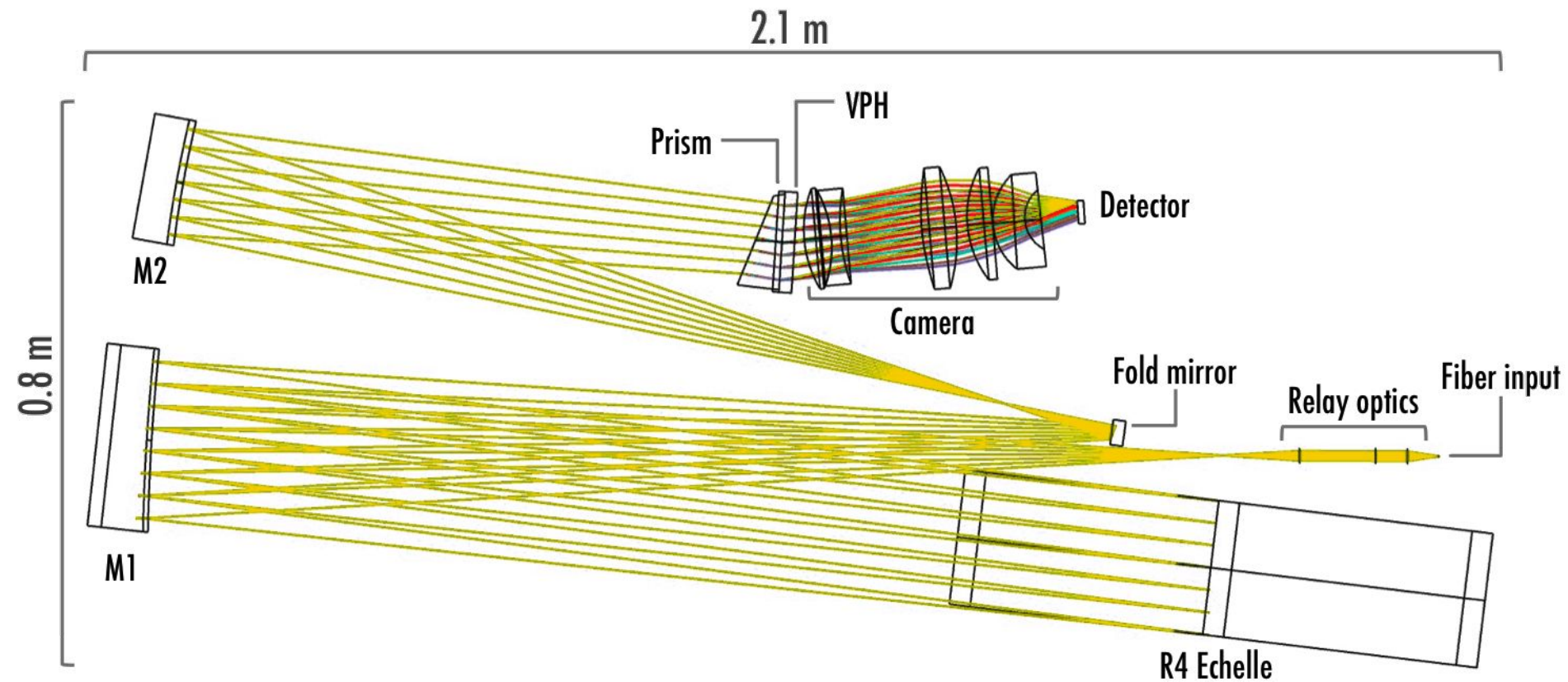
Actively controlled

Stefansson+ (2016), Robertson+ (2016)

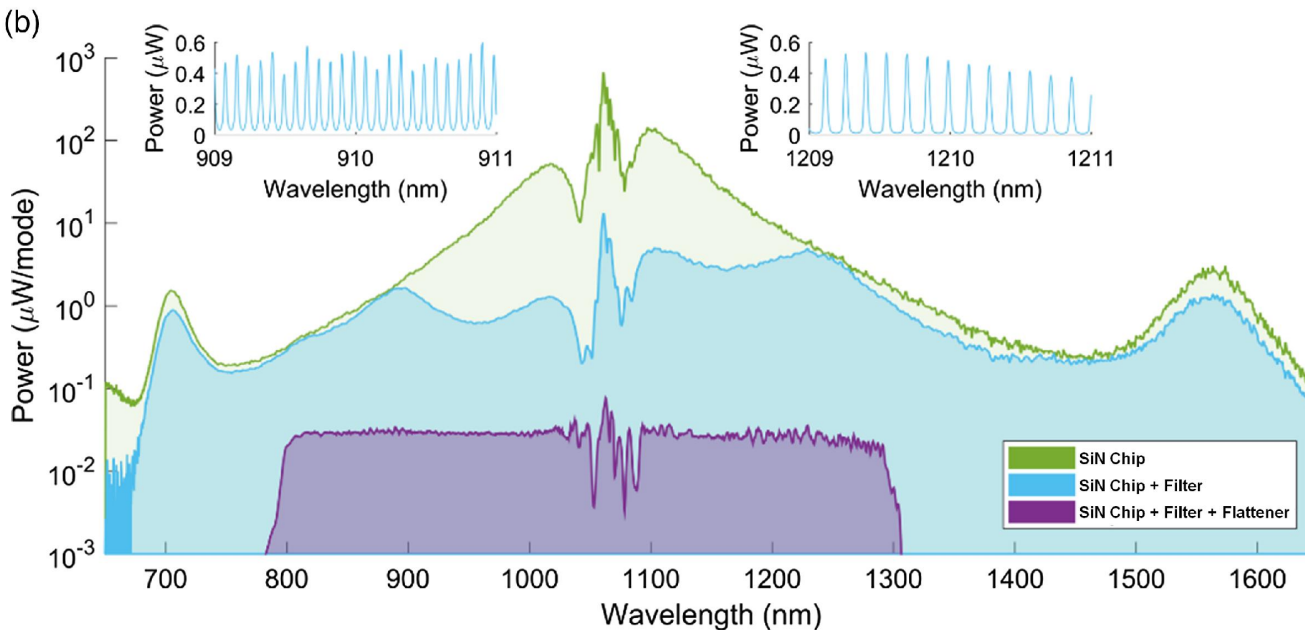
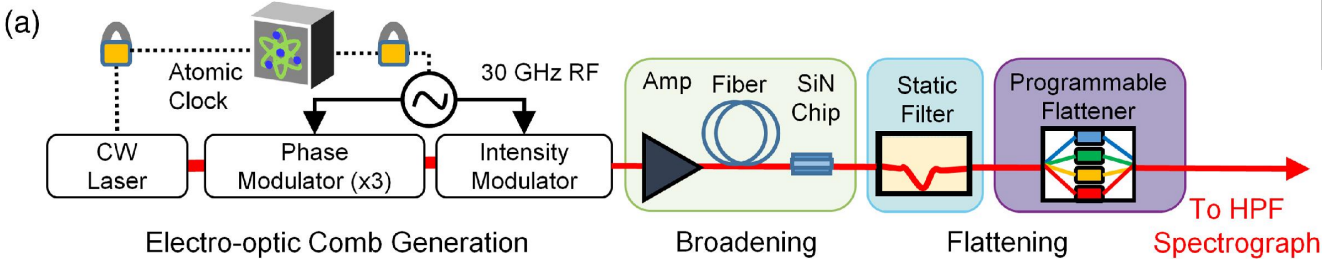


Optical Design - Asymmetric white pupil

R4 Echelle Grating for dispersion and VPH for Cross-dispersion



30 GHz EO Laser Frequency Comb

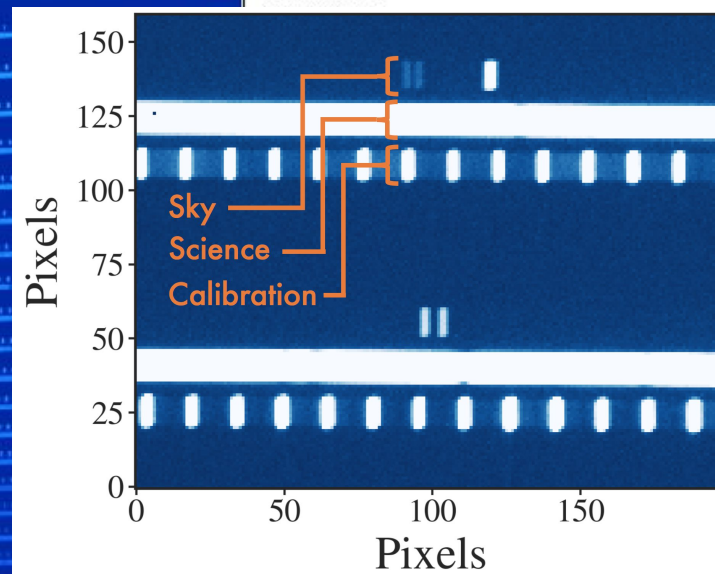
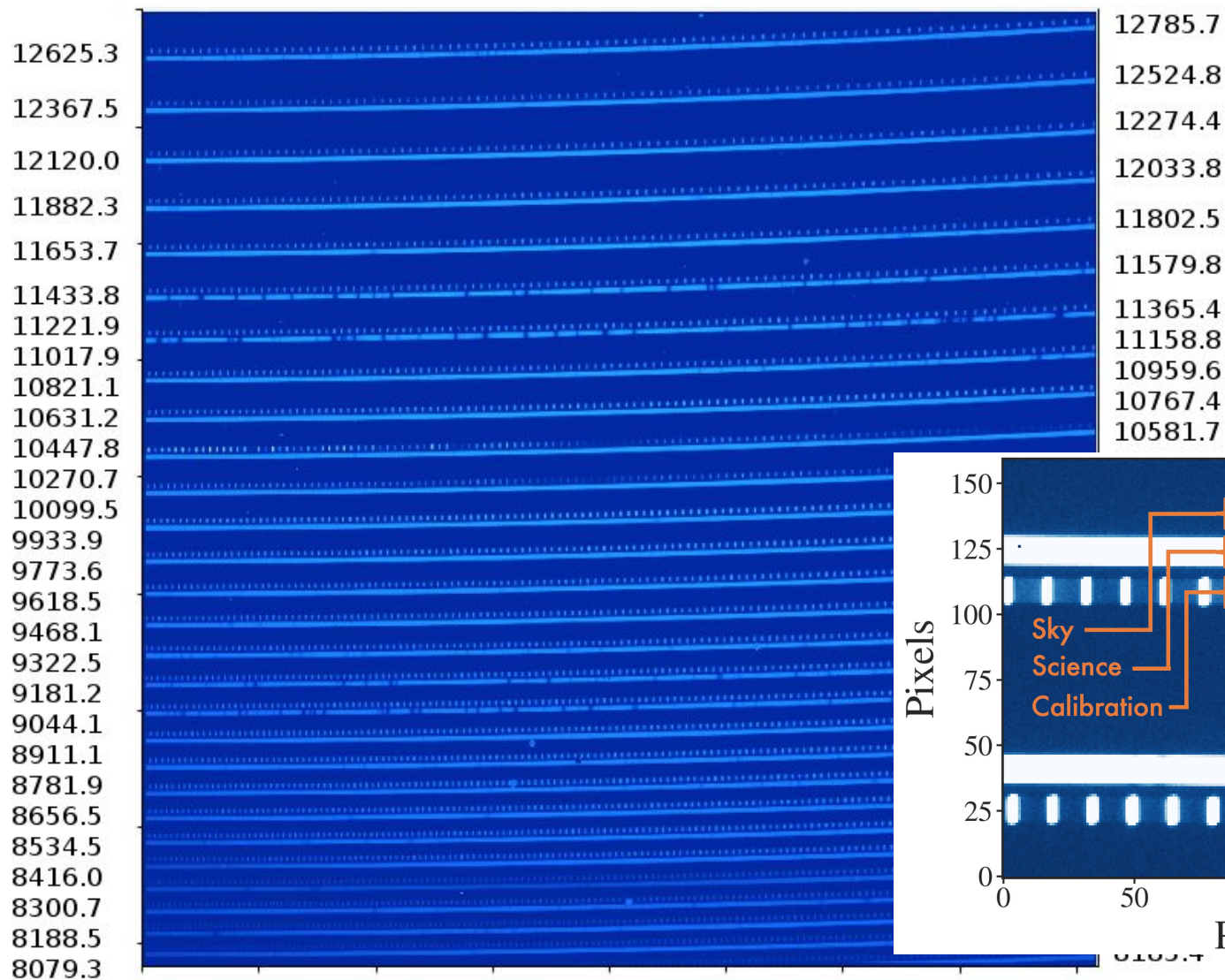


Operating continuously for ~1 year since February 2018

~98% uptime

Metcalf+ 2019, Also see Conner et. al.'s poster in the next room

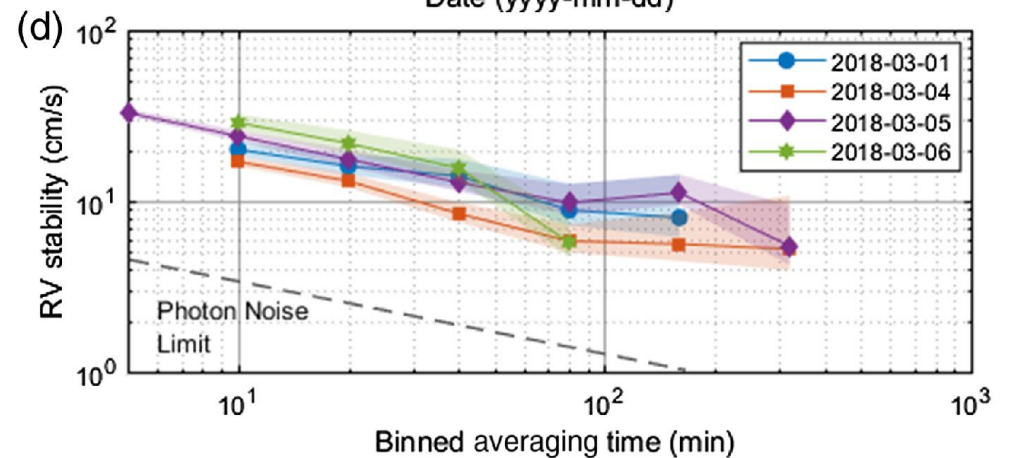
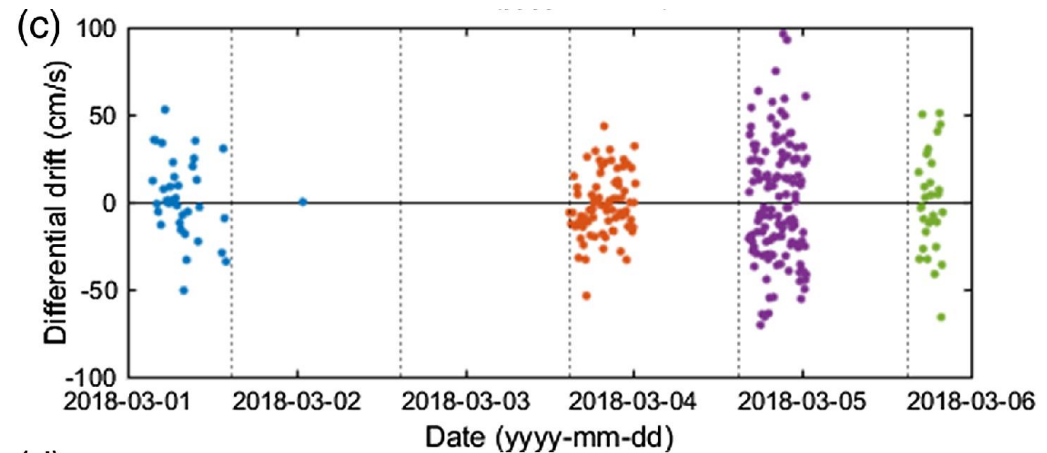
On Sky Data with LFC



Fiber to Fiber Drift calibration

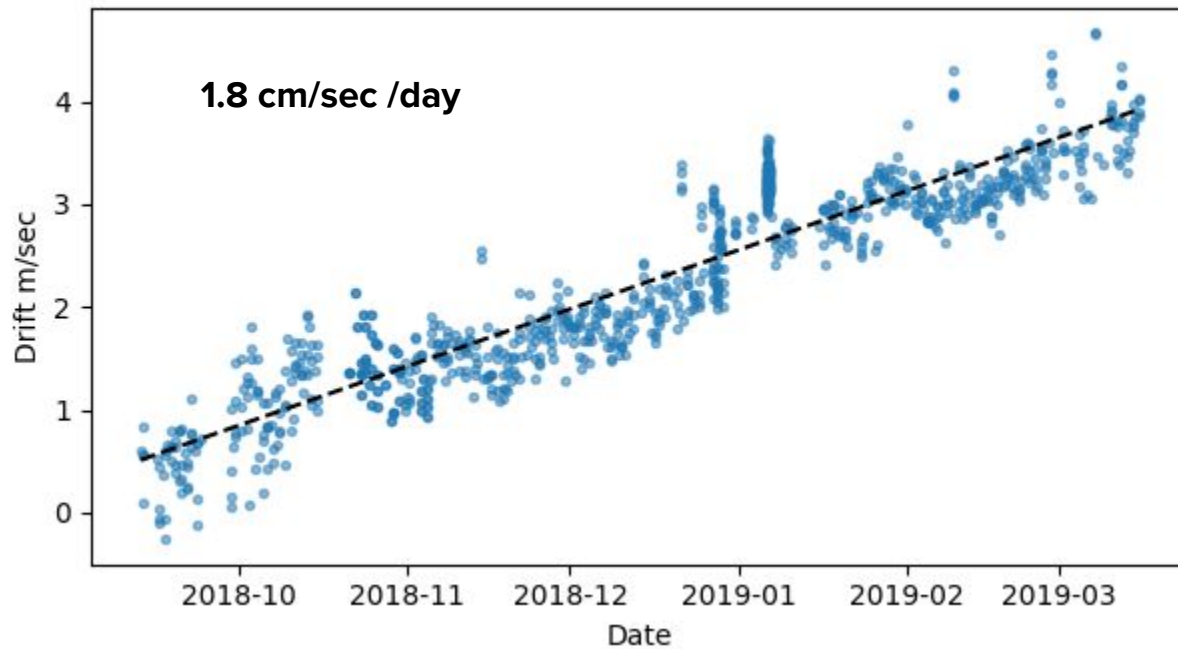
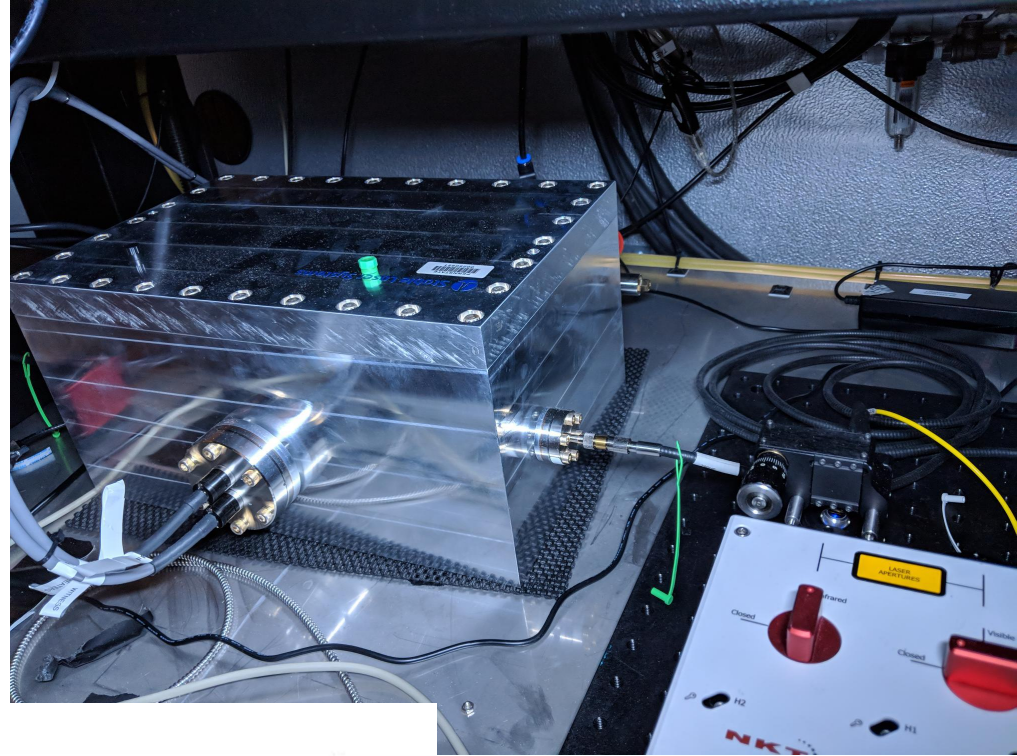
Differential drifts constrained by illuminating both fibers of HPF simultaneously.

We reach **10 cm/sec in 300 minutes** average bins.



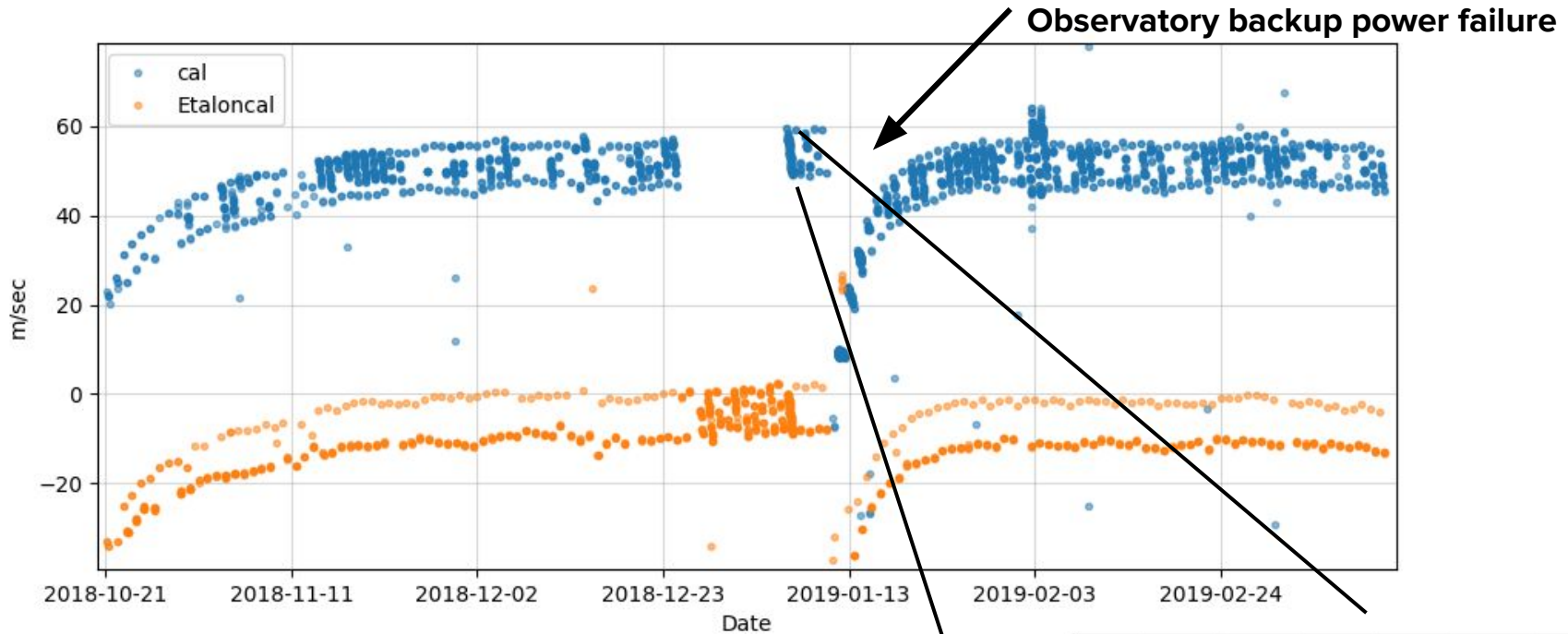
HPF Etalon

all-ULE (ultra-low expansion glass)



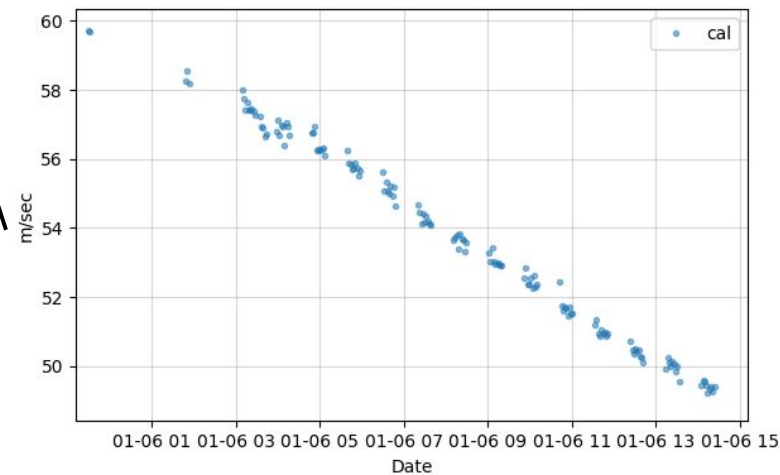
See also Conner et. al.
poster..

Absolute drift over many months



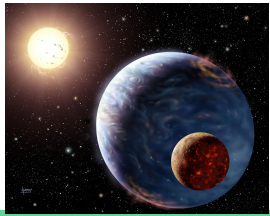
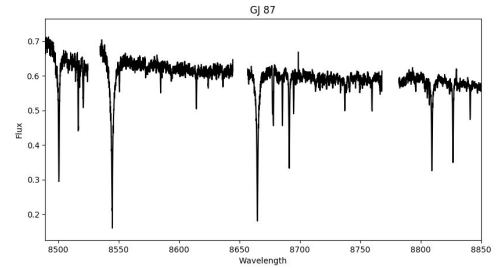
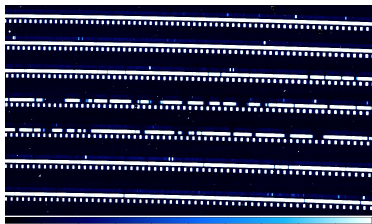
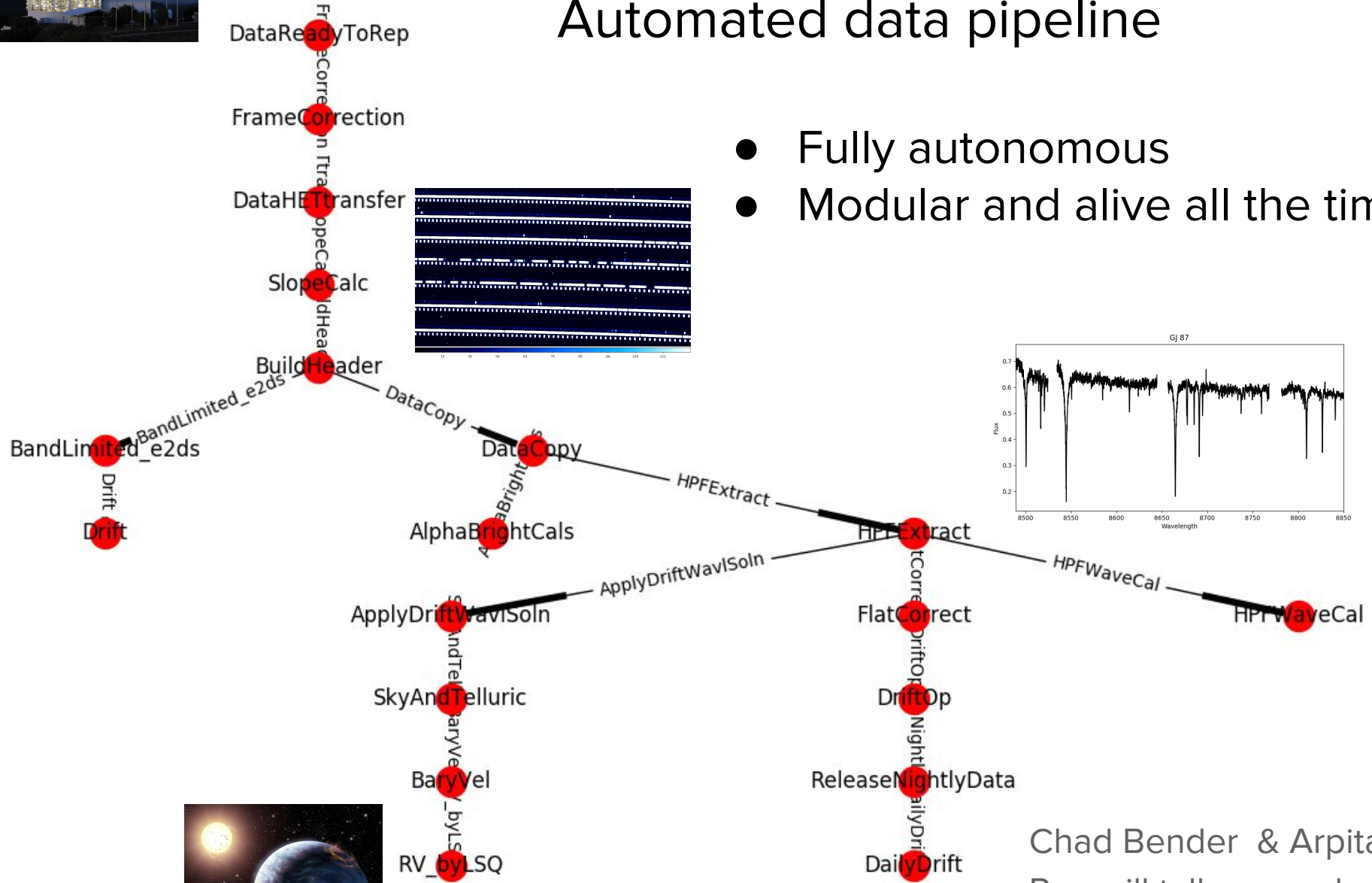
Intra-Day linear absolute drift

Easily correctable by linear interpolation



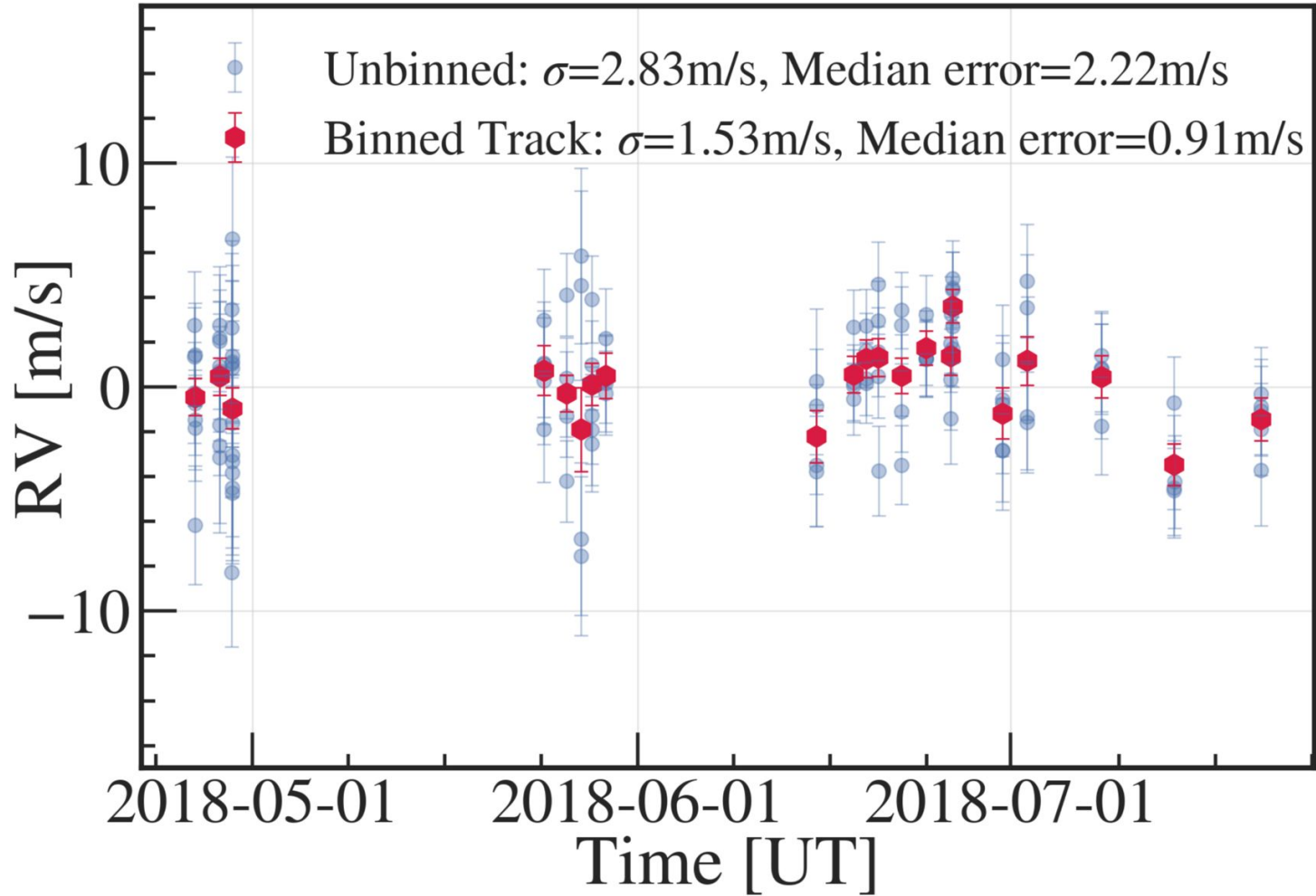
Automated data pipeline

- Fully autonomous
- Modular and alive all the time

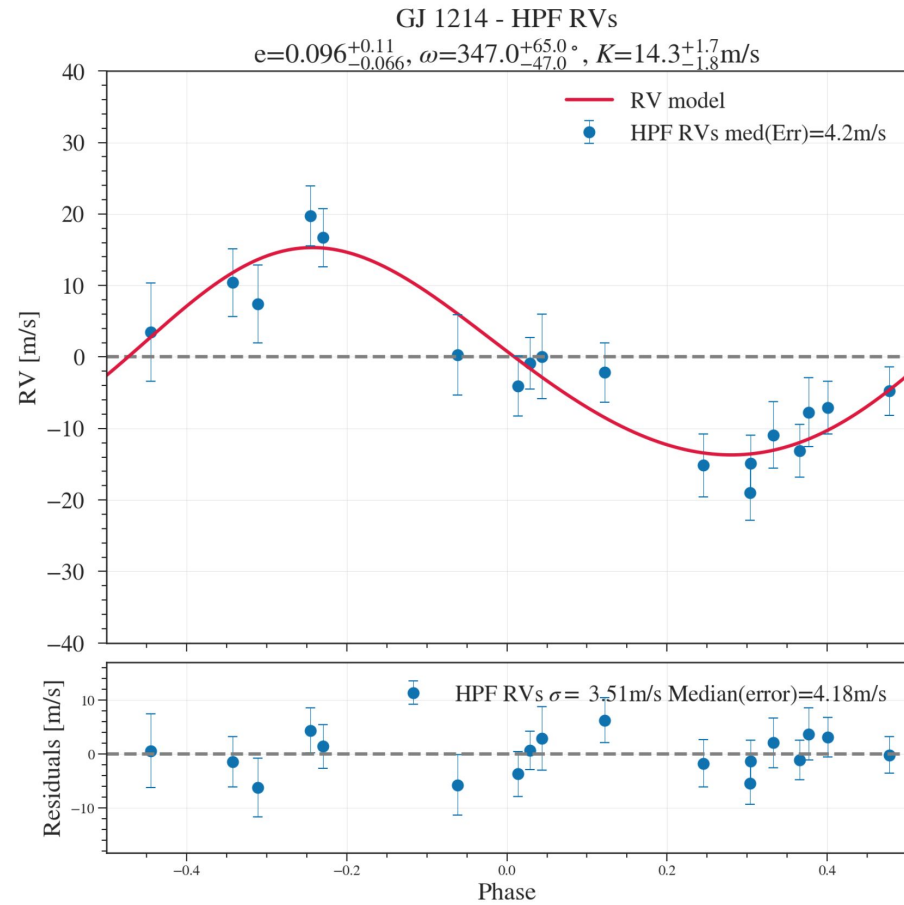
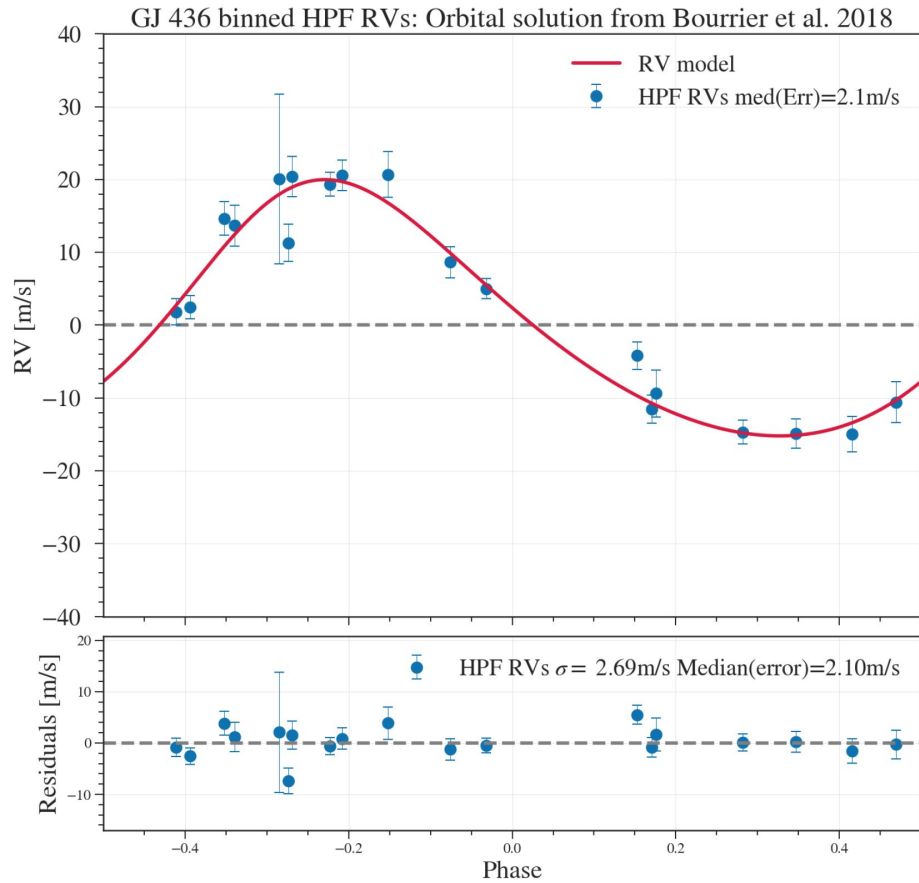


Chad Bender & Arpita Roy will talk more about it tomorrow.

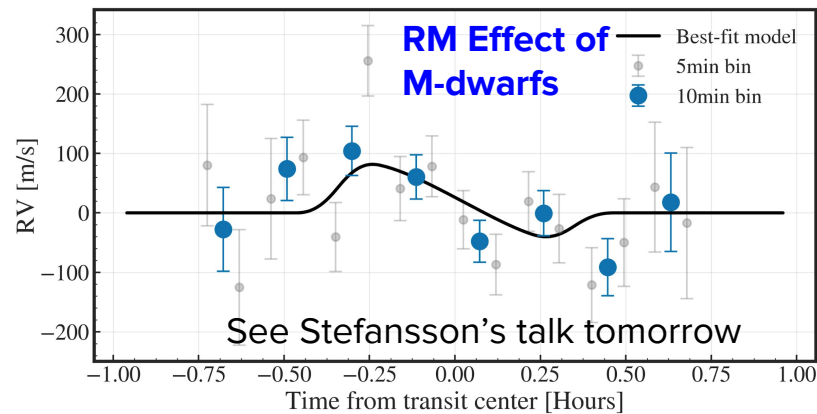
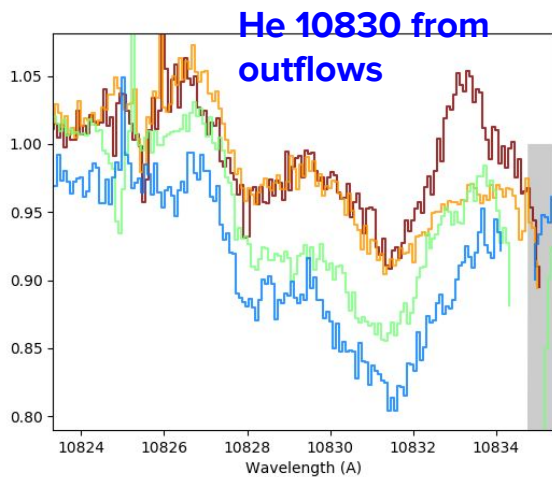
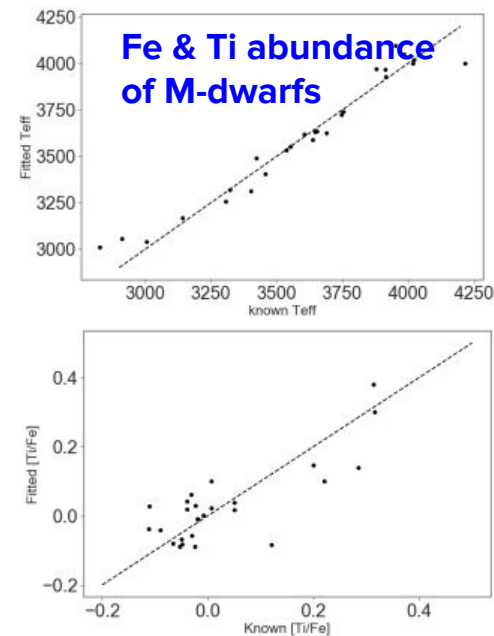
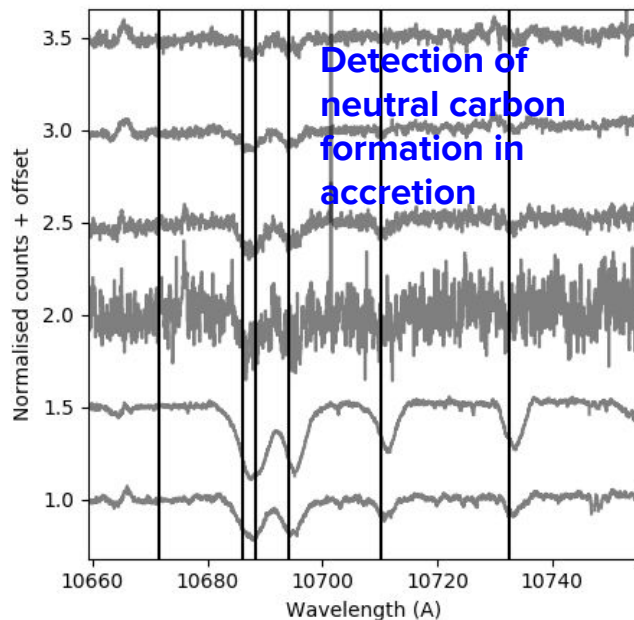
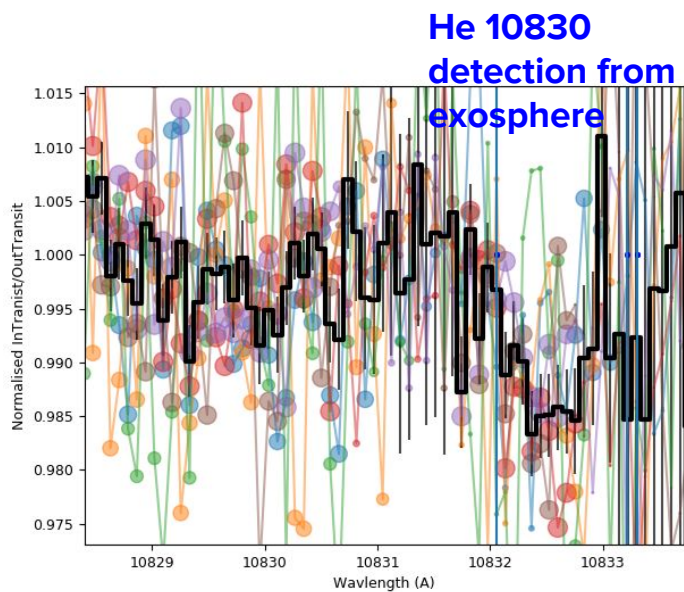
On Sky RV Performance with Barnard's star



On Sky RV Performance:

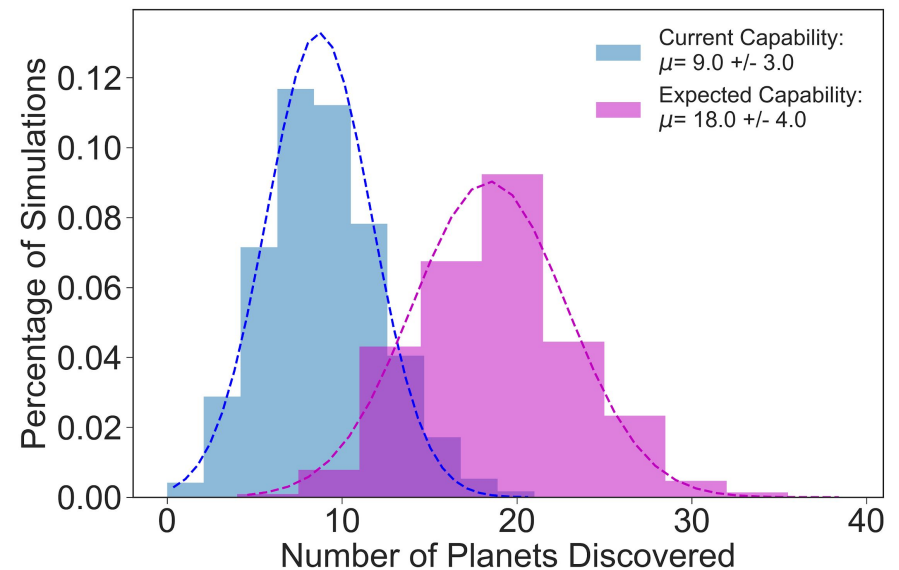
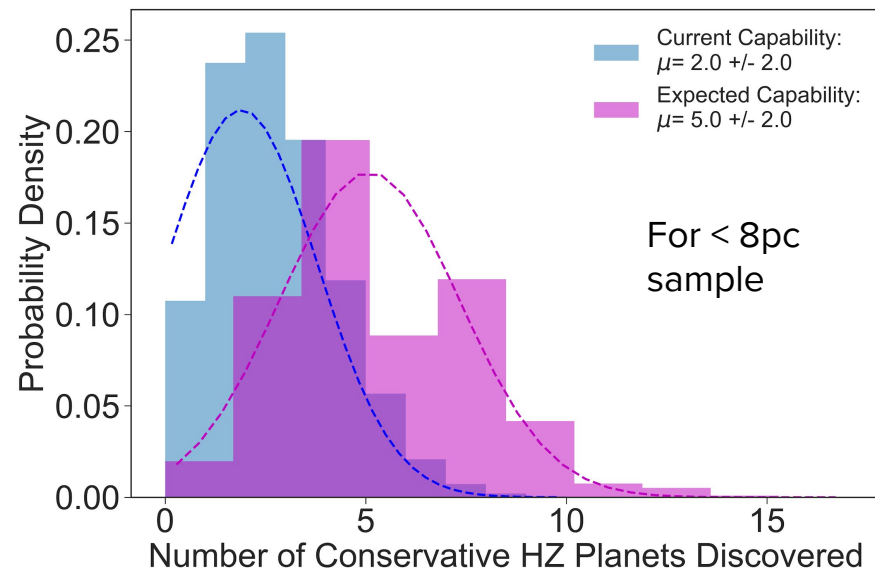


Snapshot of various other early non-RV science results from HPF



GTO program

- 900 hours of telescope time spread over 5 years.
- Focused on nearby mid-late M dwarfs (both 8 pc sample, and additional M dwarfs < 30 pc)



The Team



PennState



Suvrath Mahadevan (PSU - PI)

Ryan Terrien (Carleton College)

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Arpita Roy (Caltech)



Fred Hearty (PSU)

Gudmundur Stefansson (PSU)

Sam Halverson (MIT)

Shubham Kanodia (PSU)

Chad Bender (UA)

Emily Lubar (PSU)

Chris Schwab (Macquarie)

Scott Diddams (NIST)

Paul Robertson (UCI)

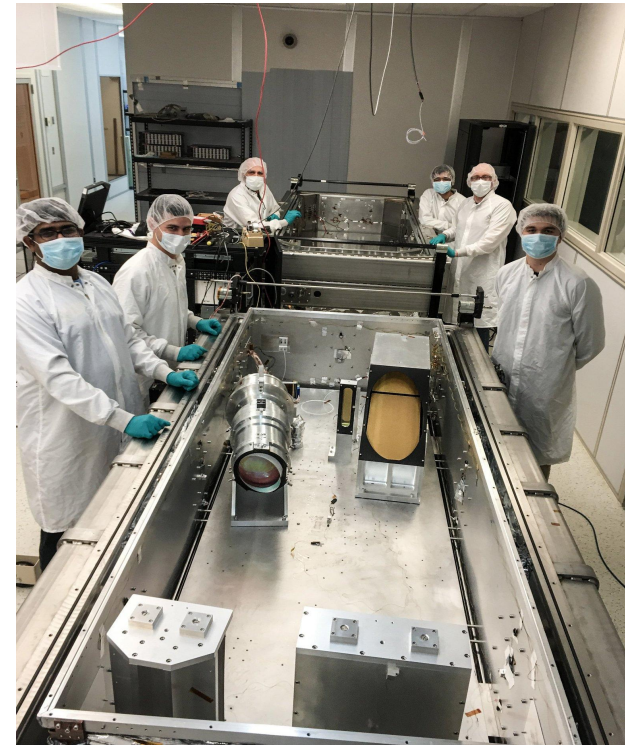
AJ Metcalf (NIST)

Andy Monson (PSU)

Conner Fedrick (NIST)

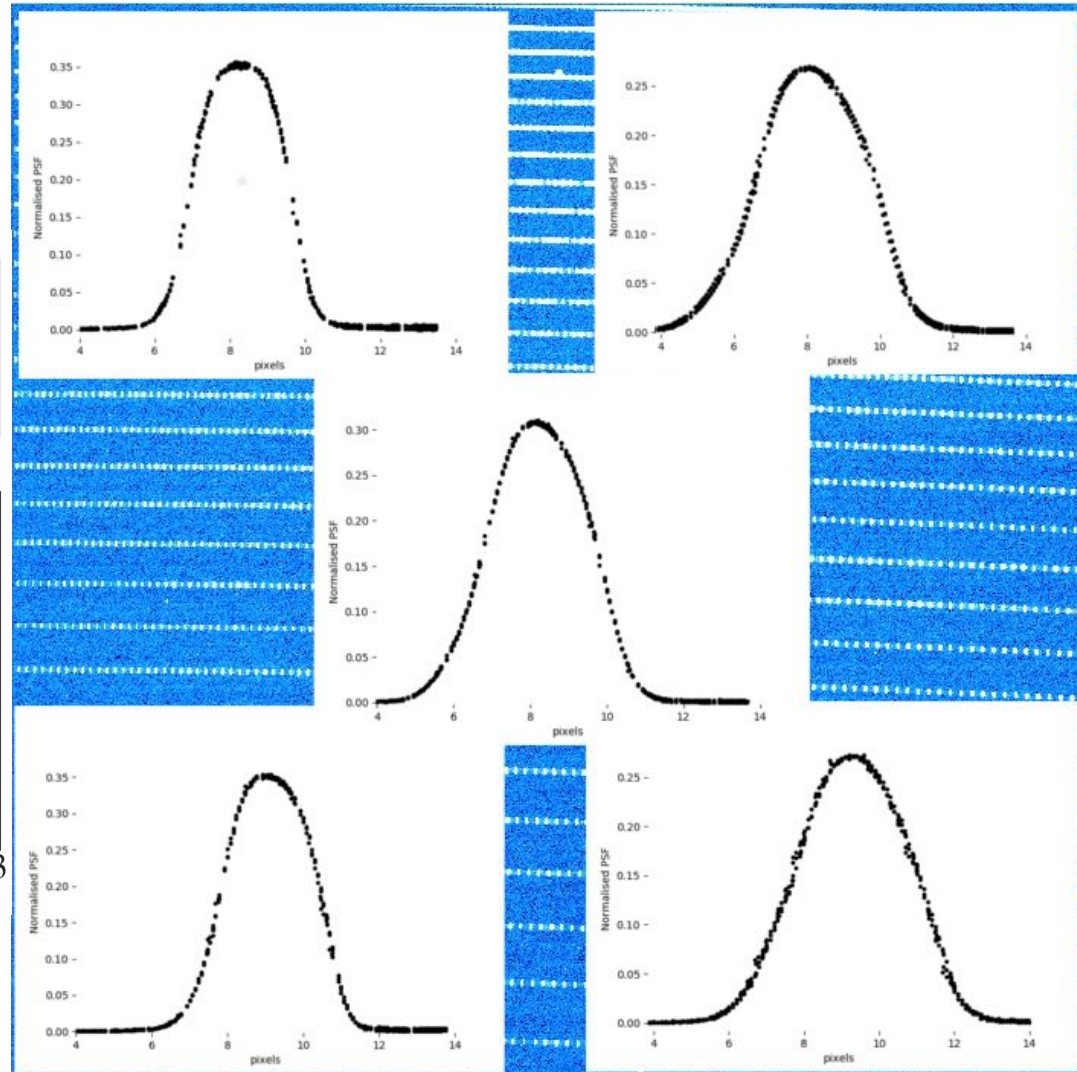
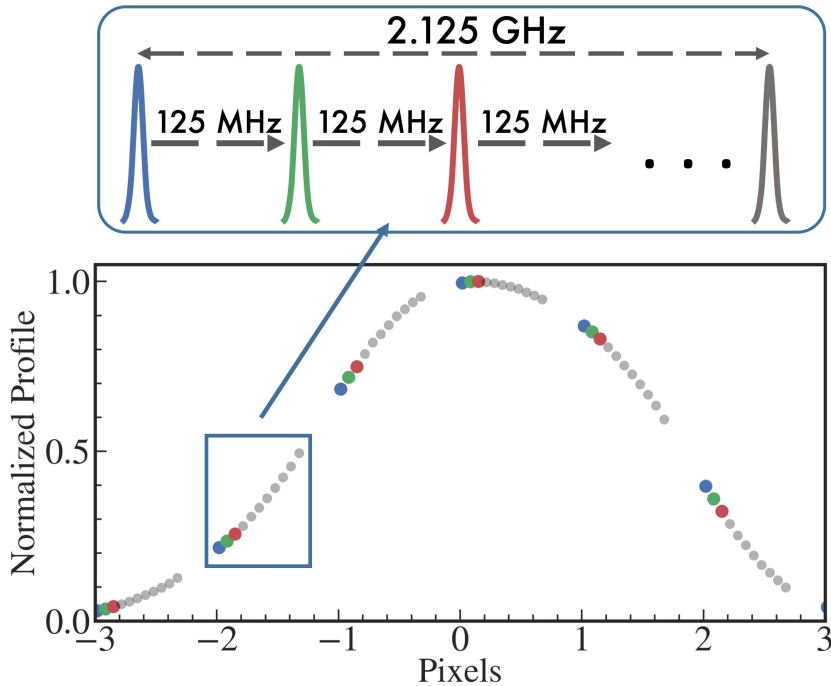
Jason Wright (PSU)

Joe Ninan (PSU)



Backup slides

LFC scanning to obtain super-resolution PSF



Bernard Star phased up to orbit

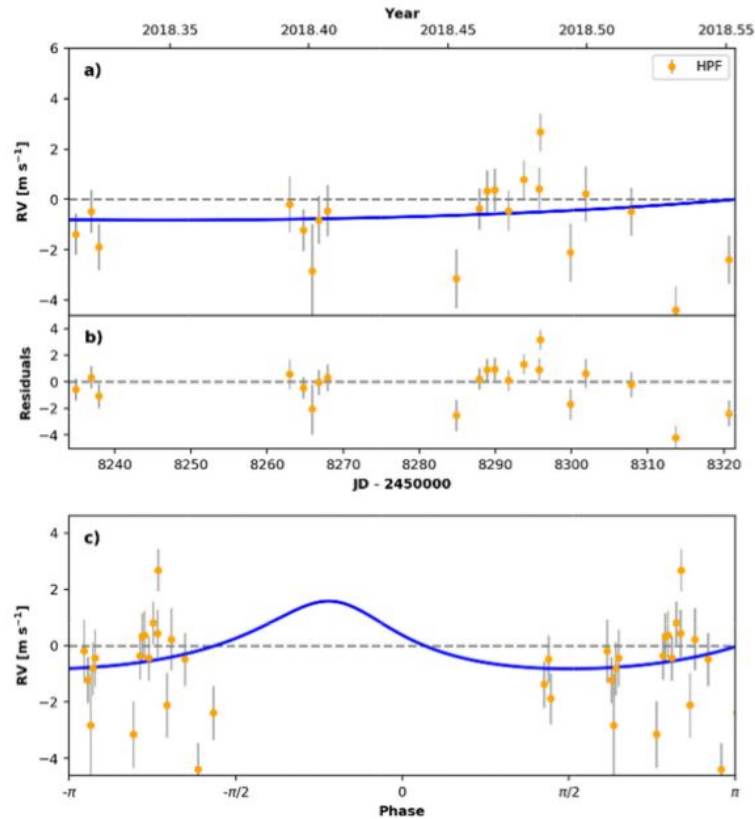


Figure S2: a) HPF observations (gold) with the proposed 233-day exoplanet orbit from Ribas et al [21] shown as a solid blue line. We have fit and subtracted a zero-point offset to the HPF velocities. b) Residuals of the HPF RVs after subtracting the exoplanet model. The residuals have an RMS scatter of 1.59 m/s, statistically indistinguishable from our baseline 1.53 m/s stability. c) HPF RVs phased to the proposed 233-day exoplanet period. Figures generated using *RadVel* [22].