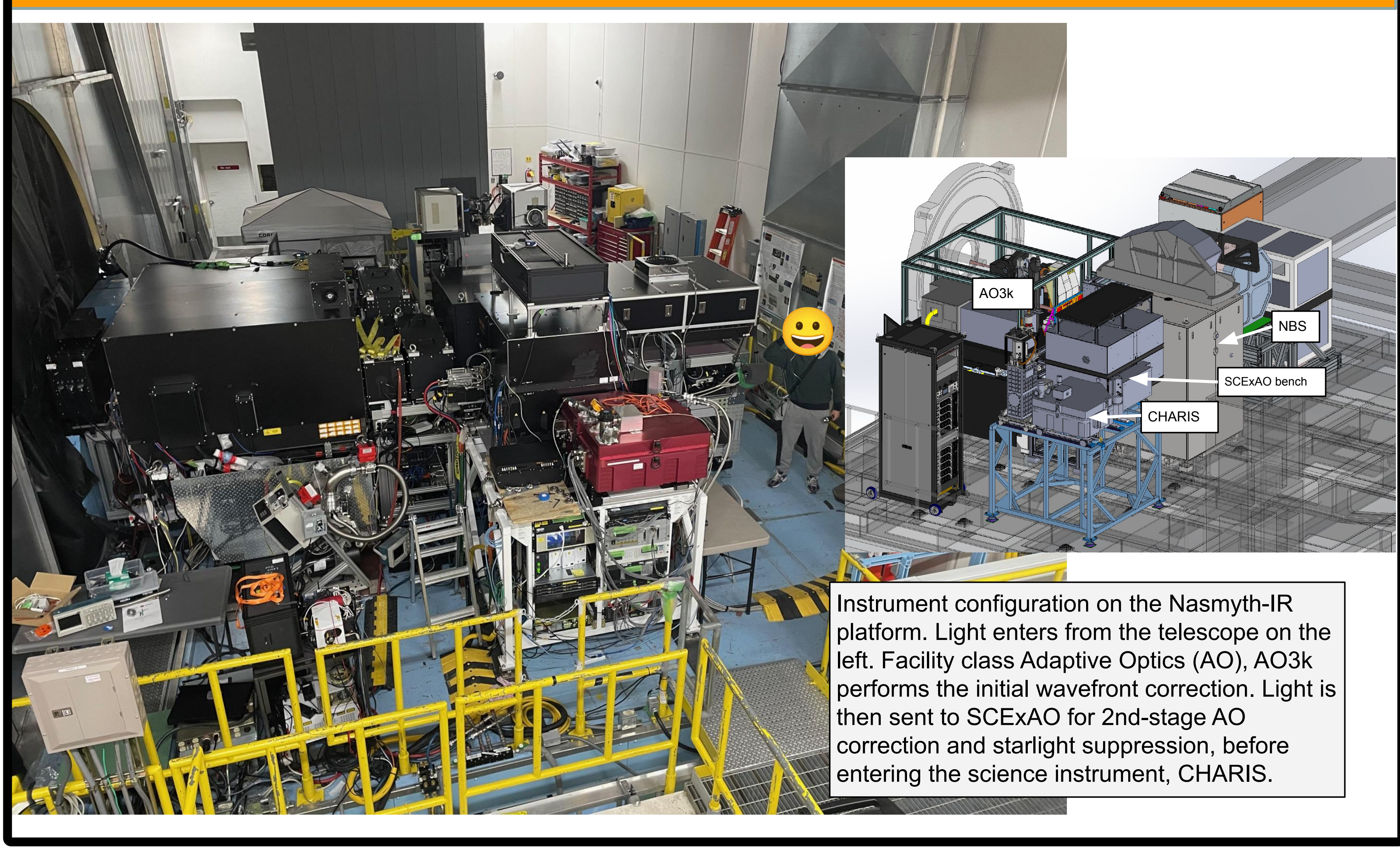


Olivier Guyon<sup>a,b,c</sup>, Julien Lozi<sup>a</sup>, Sebastien Vievard<sup>a,d</sup>, Garima Singh<sup>a,b</sup>, Sandrine Juillard<sup>a,c</sup>, Vincent Deo<sup>e</sup>, Kyohoon Ahn<sup>f</sup>, Tyler Groff<sup>g</sup>, Jeffrey Chilcote<sup>h</sup>, Barnaby Norris<sup>i</sup>, Miles Lucas<sup>c</sup>, Peter Tuthill<sup>i</sup>, Tomoyuki Kudo<sup>a</sup>, Elsa Huby<sup>j</sup>, Sylvestre Lacour<sup>j</sup>, Manon Lallement<sup>k</sup>, Yoo Jung Kim<sup>l</sup>, Takayuki Kotani<sup>b</sup>  
<sup>a</sup>NAOJ, <sup>b</sup>Astrobiology Center, <sup>c</sup>University of Arizona, <sup>d</sup>University of Hawaii, <sup>e</sup>Optical Sharpeners, <sup>f</sup>KASI, <sup>g</sup>NASA GSFC, <sup>h</sup>Notre Dame, <sup>i</sup>University of Sydney, <sup>j</sup>Paris Observatory, <sup>k</sup>University Grenoble Alpes, <sup>l</sup>University of California

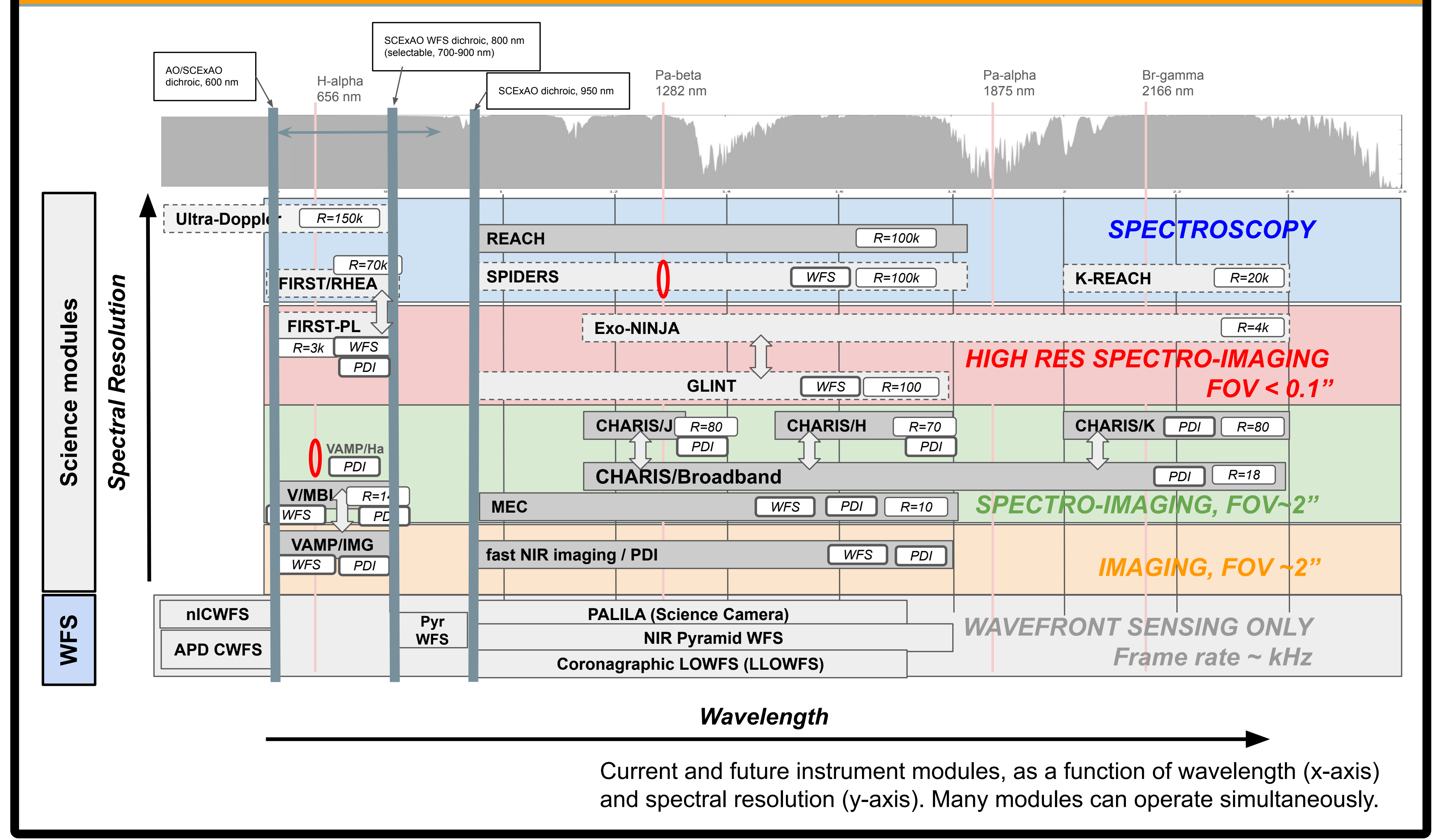
Contact: [gsingh@naoj.org](mailto:gsingh@naoj.org)

## SCEXAO ARCHITECTURE



Instrument configuration on the Nasmyth-IR platform. Light enters from the telescope on the left. Facility class Adaptive Optics (AO), AO3k performs the initial wavefront correction. Light is then sent to SCEXAO for 2nd-stage AO correction and starlight suppression, before entering the science instrument, CHARIS.

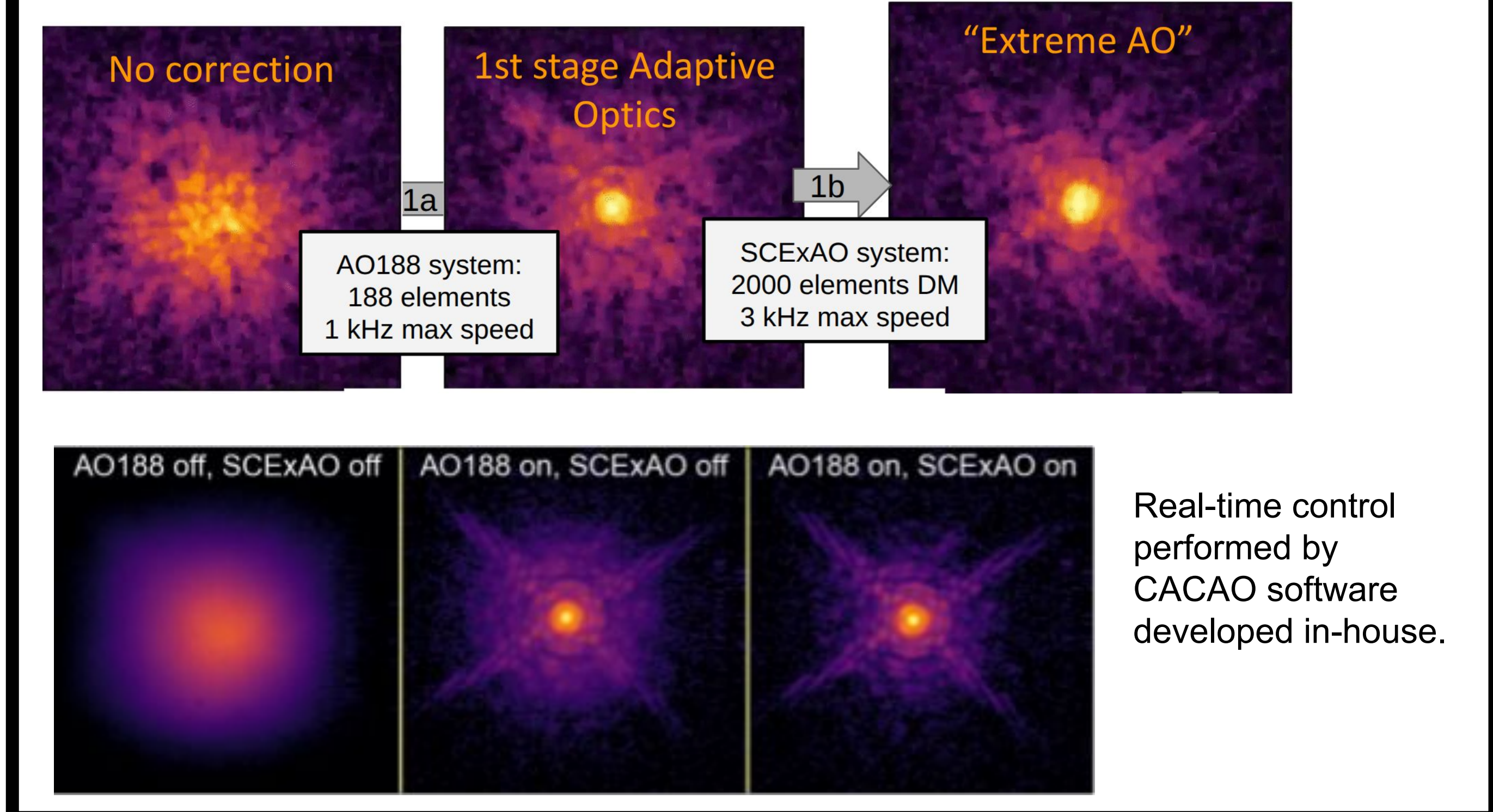
## INSTRUMENT MODULES & MEASUREMENTS



Current and future instrument modules, as a function of wavelength (x-axis) and spectral resolution (y-axis). Many modules can operate simultaneously.

## WAVEFRONT CONTROL

The SCEXAO system combines high-performance “extreme” AO correction with instrument/modules optimize for high contrast imaging, spectroscopy and polarimetry.

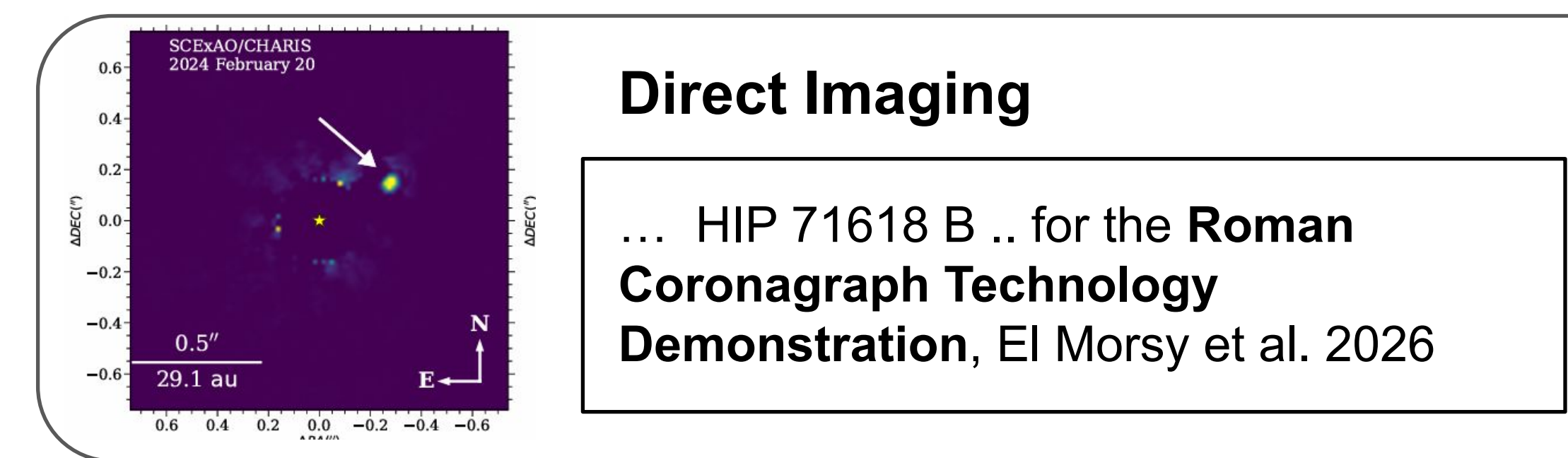


Real-time control performed by CAAO software developed in-house.

## CORE SCIENCE

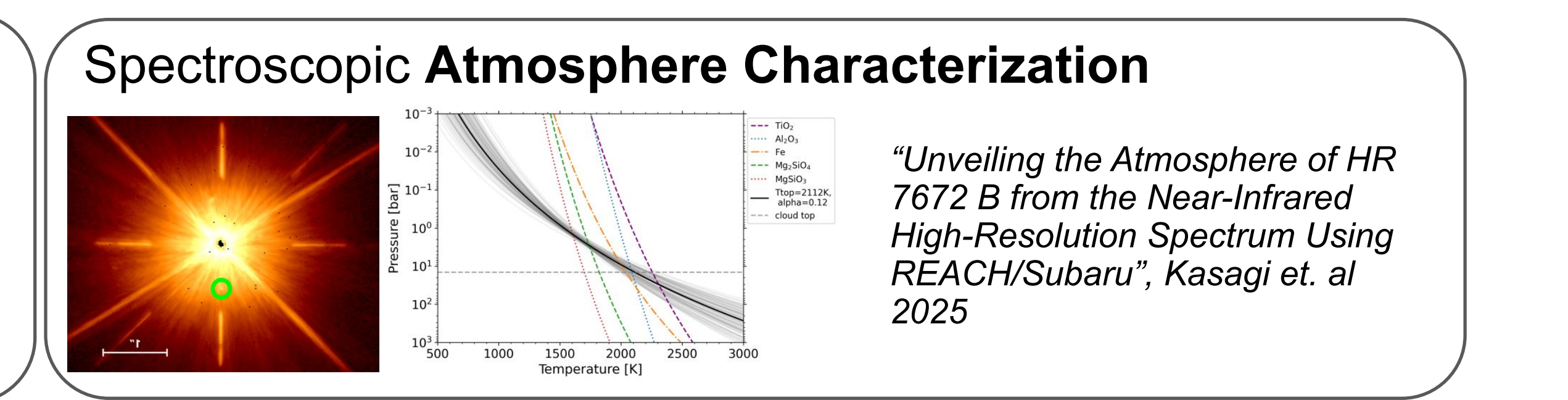
### Direct Imaging

... HIP 71618 B .. for the Roman Coronagraph Technology Demonstration, El Morsy et al. 2026



### Spectroscopic Atmosphere Characterization

“Unveiling the Atmosphere of HR 7672 B from the Near-Infrared High-Resolution Spectrum Using REACH/Subaru”, Kasagi et al. 2025

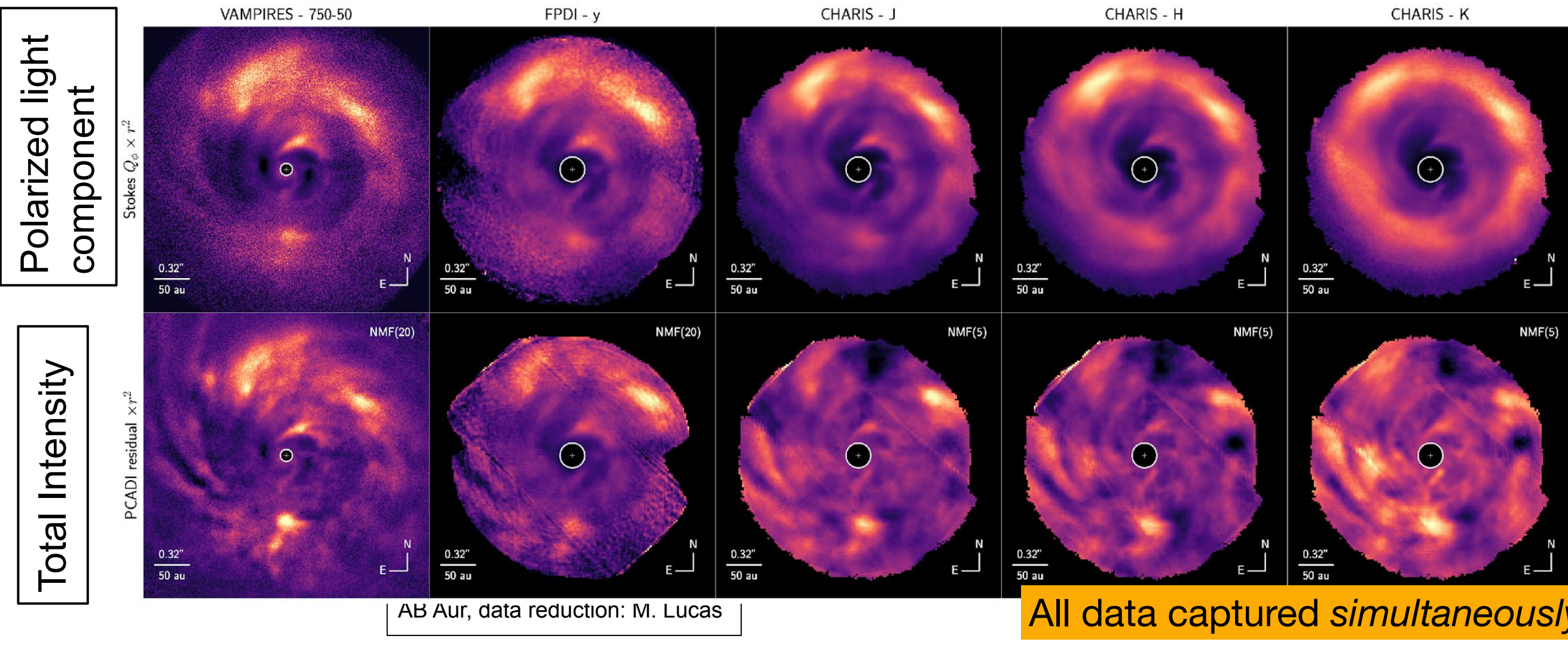


### Circumstellar disks

SCEXAO provides a broad range of measurement capabilities to study exoplanet and disks. In this example, the AB Aur disk was observed from visible to NIR. From left to right:

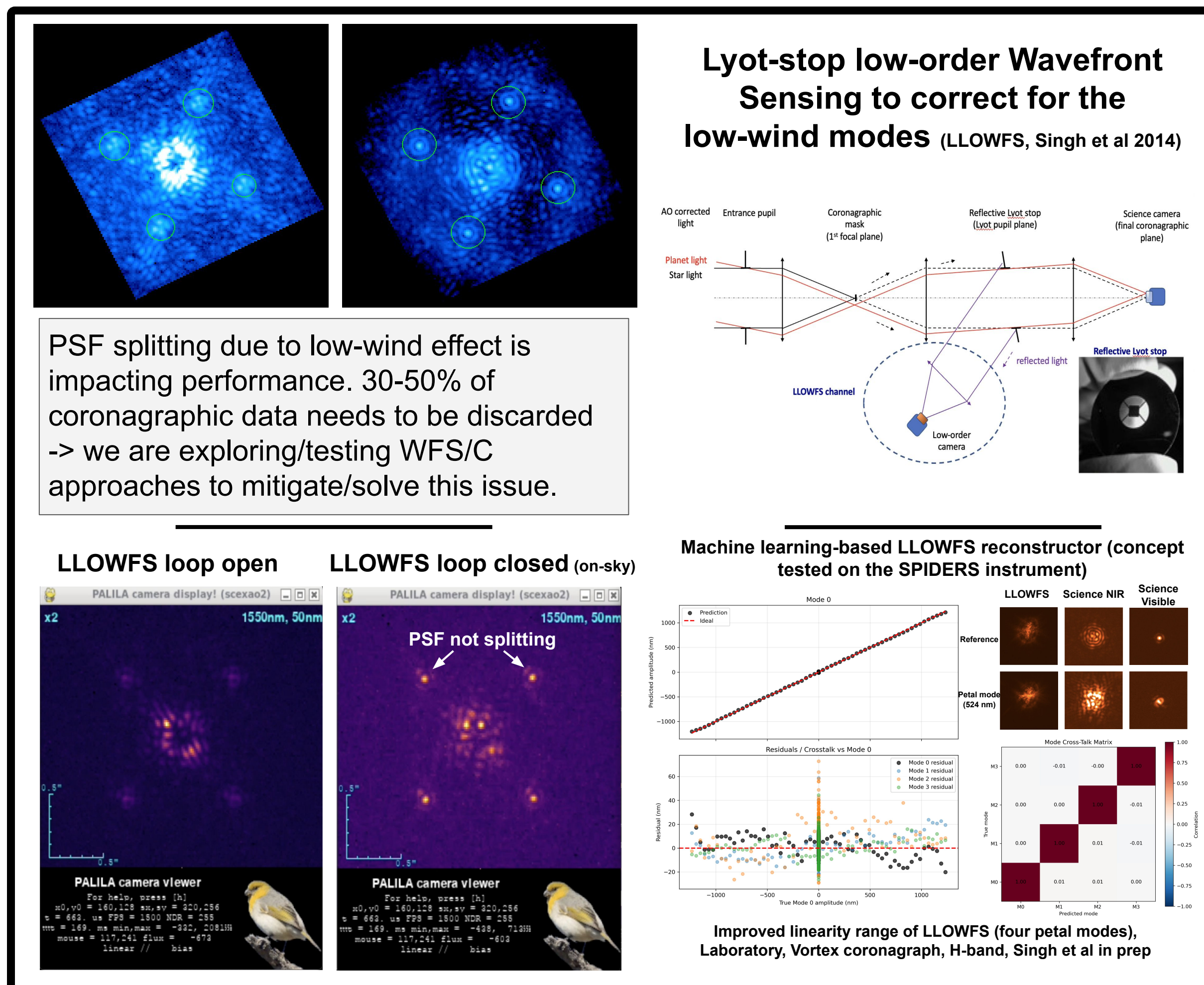
- VAMPIRES @ 750nm (one of 4 bands available)
- fast-PDI in y band
- CHARIS in J, H and K bands (raw data has 20 bands)

Each of the 3 instruments was used in PDI mode: PDI shown at the top, total intensity in the bottom. All measurements obtained with coronagraph.



## FUTURE PLANS & ACTIVITIES

### Lyot-stop low-order Wavefront Sensing to correct for the low-wind modes (LLOWFS, Singh et al 2014)

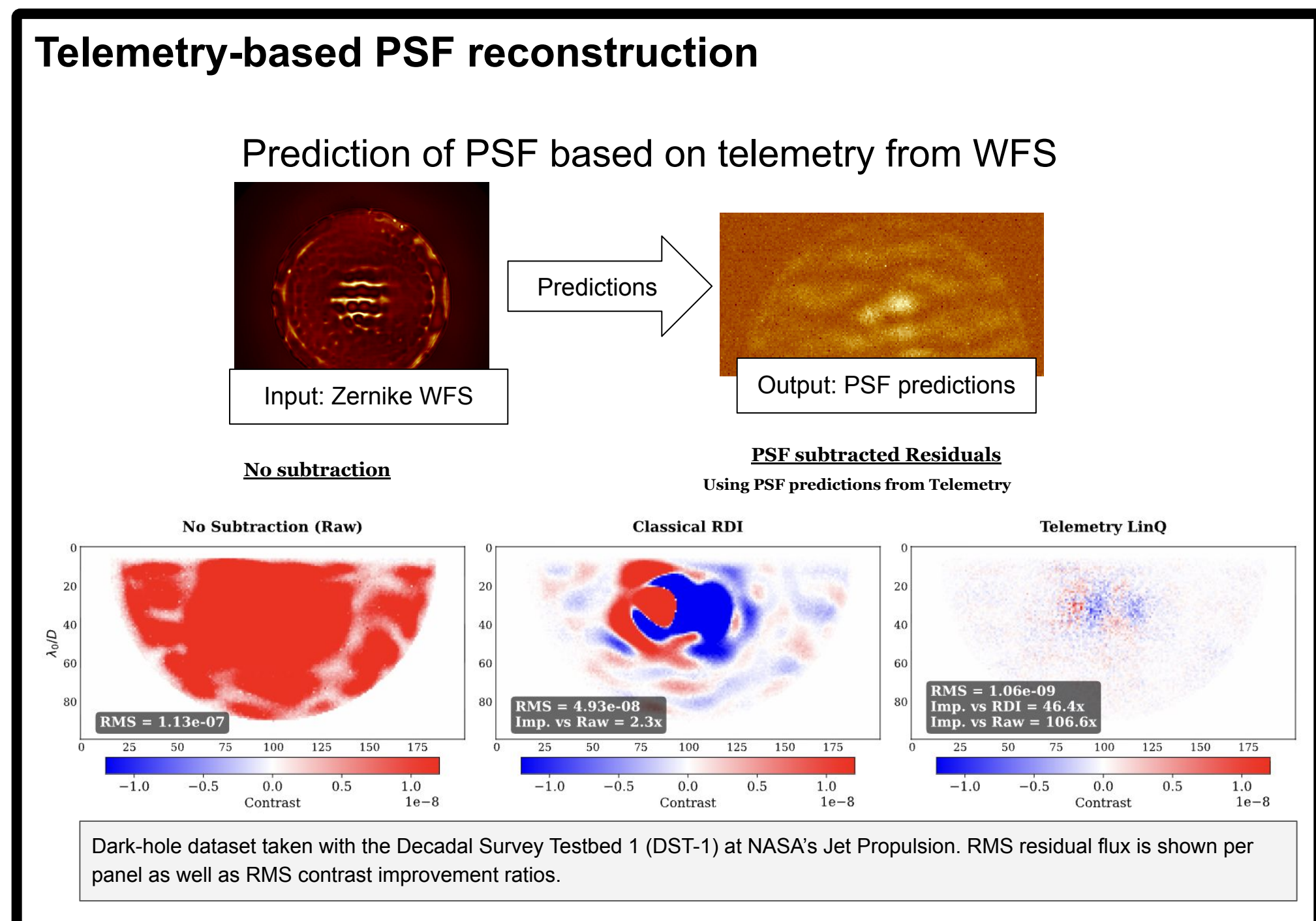


Machine learning-based LLOWFS reconstructor (concept tested on the SPIDERS instrument)

Improved linearity range of LLOWFS (four petal modes), Laboratory, Vortex coronagraph, H-band, Singh et al in prep

### Telemetry-based PSF reconstruction

Prediction of PSF based on telemetry from WFS



Dark-hole dataset taken with the Decadal Survey Testbed 1 (DST-1) at NASA's Jet Propulsion. RMS residual flux is shown per panel as well as RMS contrast improvement ratios.

### Detector Upgrade

Exploring upgrade from H2RG to ImAPD for lower RON and higher frame rate  
-> enabled better PSF subtraction  
-> Key to focal-plane WFS/C upgrades

### Vibration Correction

Accelerometers near primary mirror  
Fast tip-tilt mirror to correct for vibrations

### Improvements to AO correction

Predictive control  
Automatic tuning  
WFS reference updating

### User support for data analysis

Deployment of data analysis server at Hilo base

### Coronagraph system upgrades

Low-order WFS is being commissioned for auto-centering of PSF on mask  
Better focal plane masks to leverage improved AO correction

### NEW INSTRUMENT MODULES

Deeper contrast imaging with MEC-prime. Exoplanet spectroscopy with dedicated fiber-fed spectroscopy modes: ExoNINJA will provide R~4,000 NIR spectroscopy with mini-IFU and photonic lantern modes. K-REACH will extend high-res spectroscopy to K-band. We are also deploying photonic solutions to enhance exoplanet detection and spectroscopy at small angular separations (GLINT). See posters P28, P29, P30.

## Acknowledgements

The authors wish to recognize and acknowledge the very significant cultural role and reverence that the summit of Maunakea has always had within the Hawaiian community. We are most fortunate to have the opportunity to conduct observations from this mountain. The development of SCEXAO was supported by the National Astronomical Observatory of Japan (NAOJ), the Astrobiology Center of the National Institutes of Natural Sciences, Japan, the Subaru Telescope, the Japan Society for the Promotion of Science and the Mt Cuba Foundation.