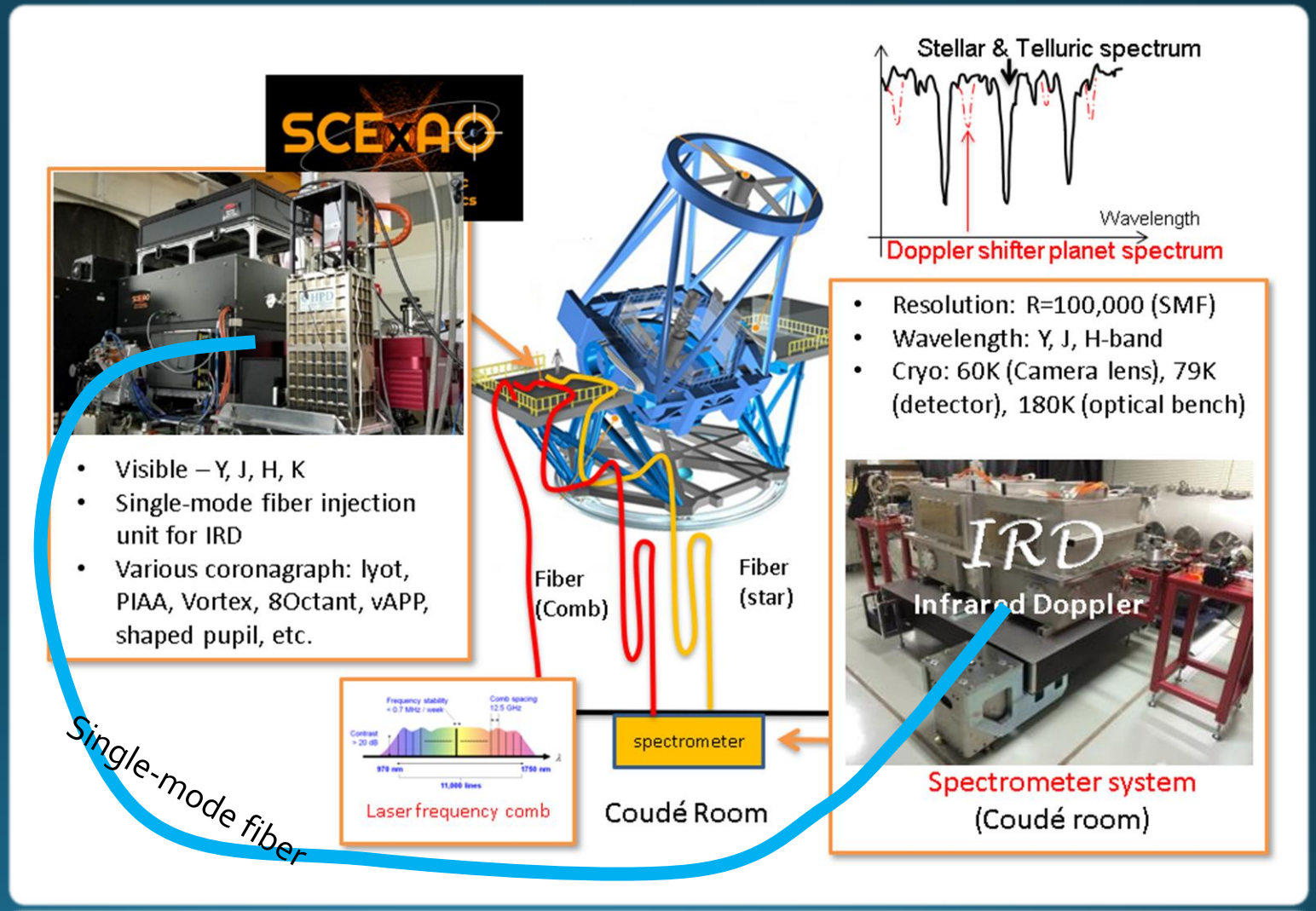
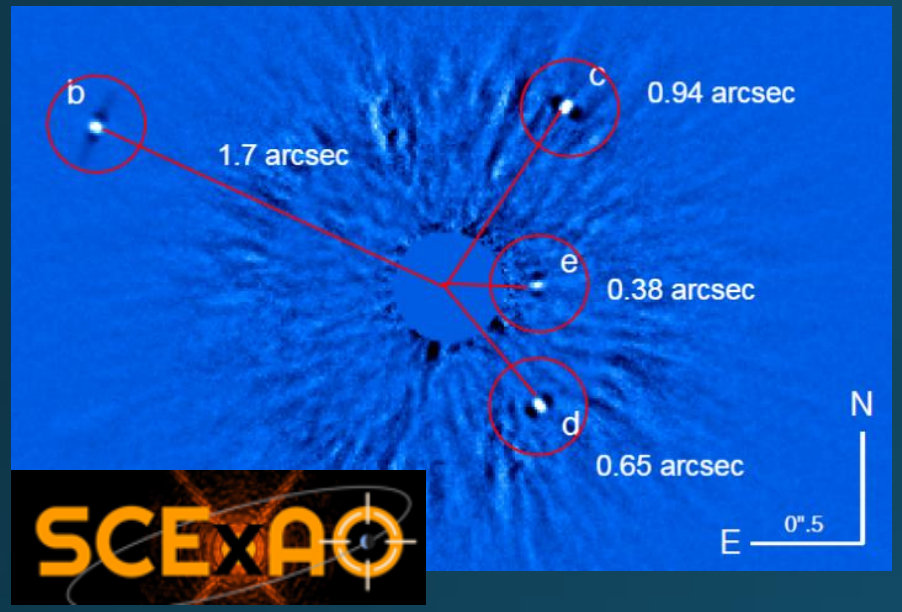
REACH: a new capability to realize very high-contrast and high spectral resolution observation for the Subaru Telescope by combining SCExAO and IRD

Takayuki Kotani and REACH team

- REACH is a system to combine SCExAO and IRD with a single-mode fiber
- Extreme-AO assisted, high-contrast ($>10^4$) and high-res spectroscopy ($R=10^5$) covering $0.97-1.75$ μm simultaneously
- REACH is available to the community from S20B
- For more information, please see Kotani et al. 2020, Proc. SPIE, Vol. 11448, 1144878

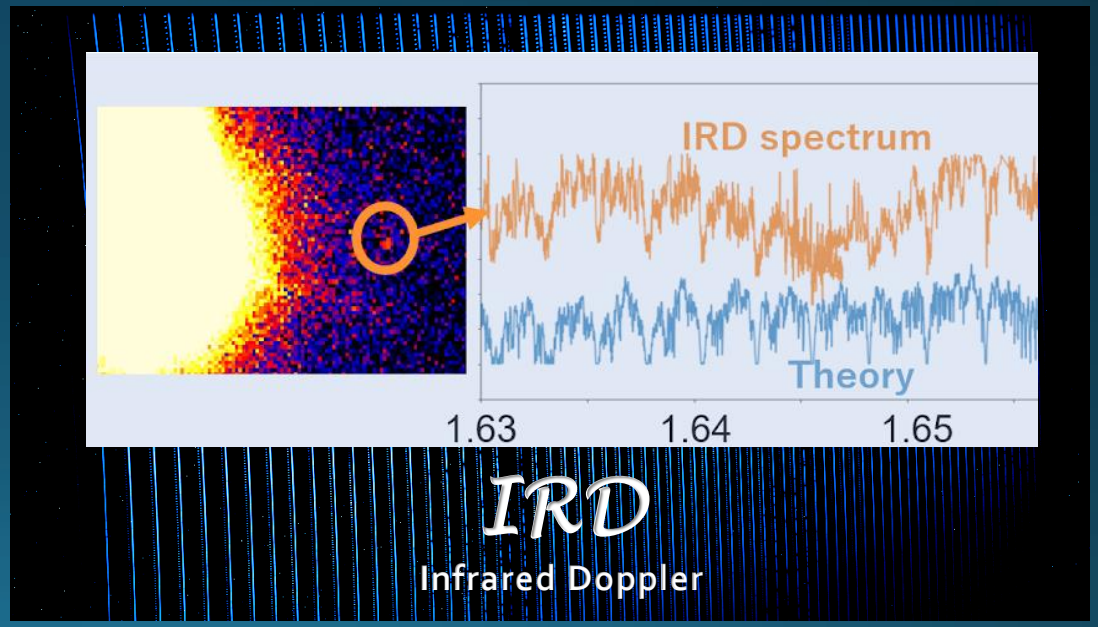


REACH: combining high-contrast imaging capability and high-spectral resolution for exoplanet characterization



Very high contrast (>10^4)

- Spectroscopic detection of molecules in the atmosphere of self-luminous giant planets via high-contrast and high spectral resolution measurements
- Extreme Adaptive optics (SCExAO) and a single-mode fiber will reduce the scattered light from a star and feed the planet light to IRD

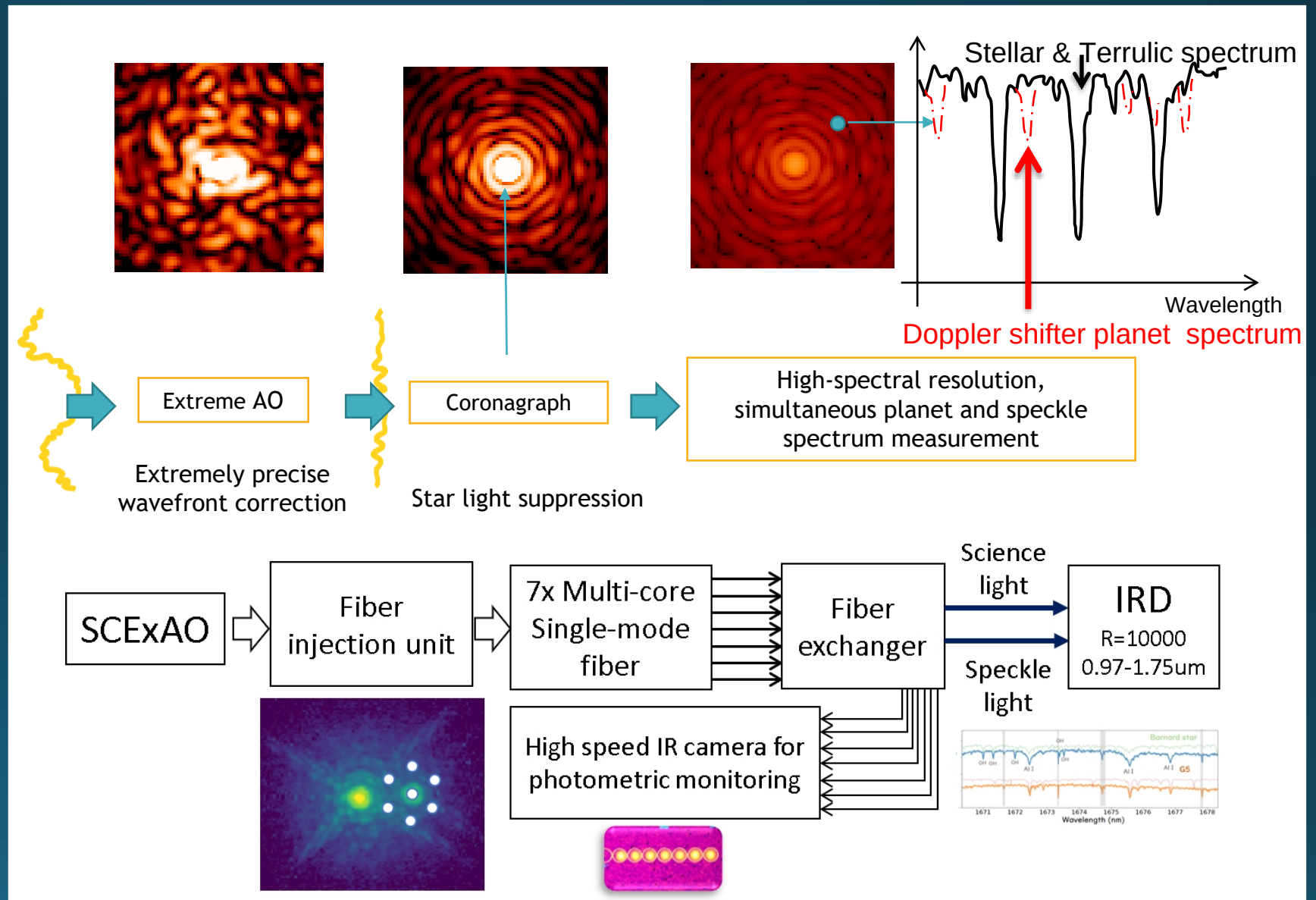


Very high spectral resolution (100,000)

- REACH also can be considered as a precursor and testbed of MODHIS and the Planetary Systems Imager for TMT for future biosignature detection

REACH instrument concept

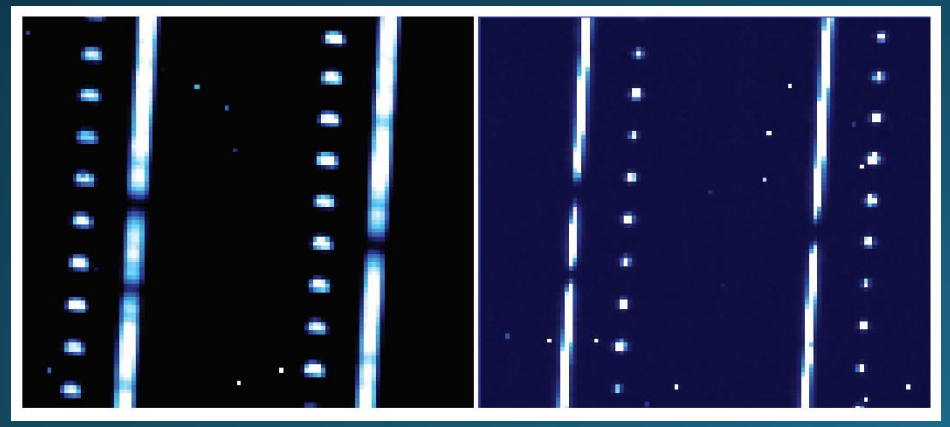
- REACH consists of mini-IFU like 7 single-mode fiber bundle, a high-speed photometric monitoring camera, and a beam switching and feed system from the fiber bundle to IRD's 2 single-mode fibers
- Science object light is coupled to a central fiber, while outside fibers (speckle fibers) sample residual scattered stellar light for photometric monitoring
- Science object fiber and one of the speckle fibers are connected to IRD to measure spectra of the science and scattered light simultaneously



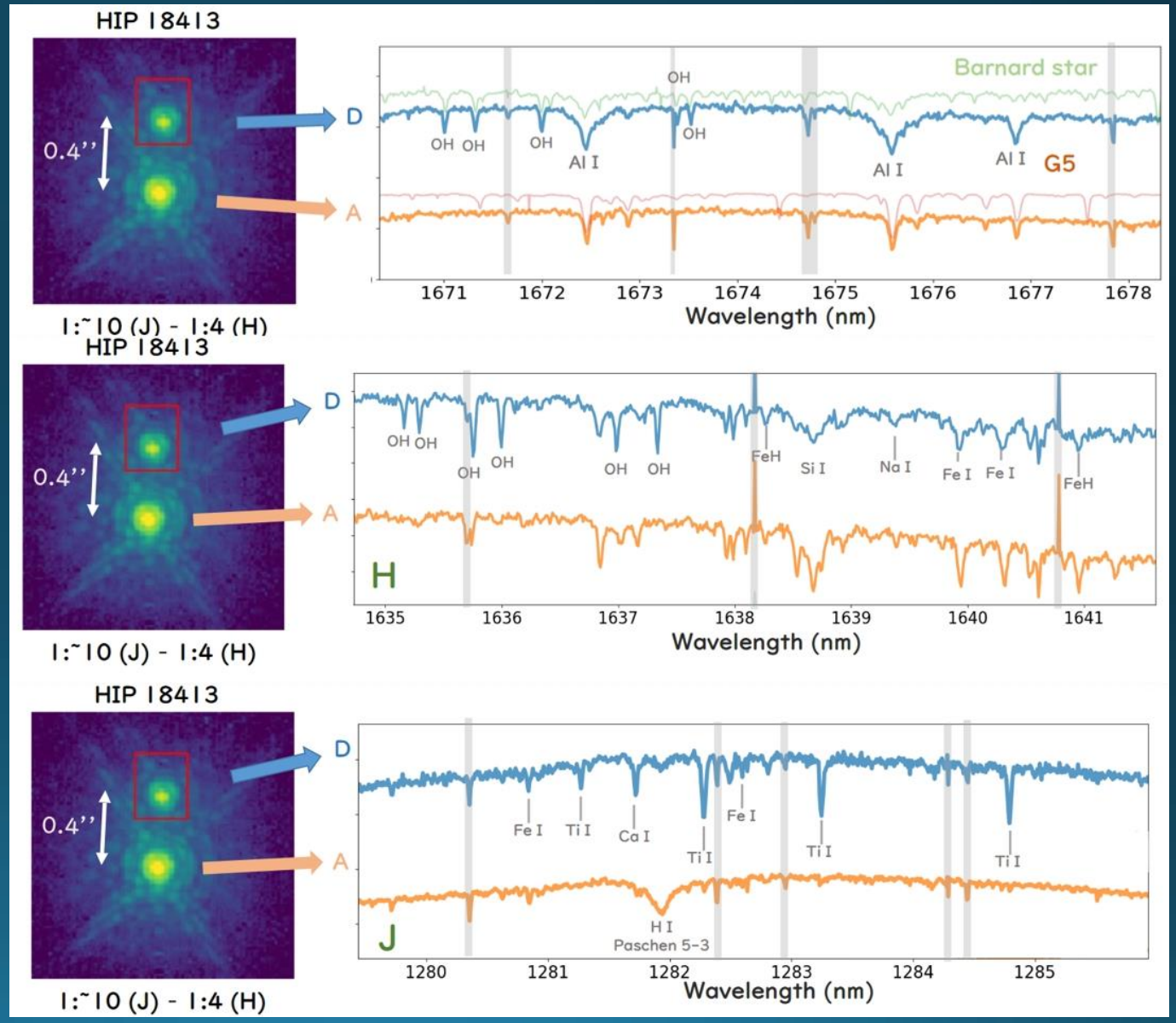
On-sky demonstration of REACH

- Spectrum of the multiple system HIP18413 A and D. For comparison, Barnard's star spectrum and G5 star template spectrum is also plotted for comparison. The gray bands indicate the position of telluric absorption lines. The component B and C are out of the FoV of the camera

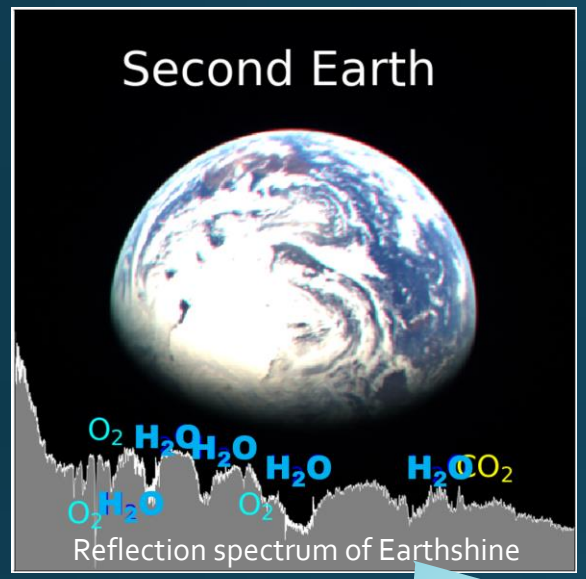
Comparison of the spectrum obtained with a multi-mode fiber (MMF) and a single-mode fiber (SMF)



IRD/MMF REACH/SMF



Pathway towards biosignature detection



0.5 μm 2.5 μm

Biosignature detection in 2030's

Planetary Systems Imager (PSI)
Ultimate high-contrast imaging and spectroscopy

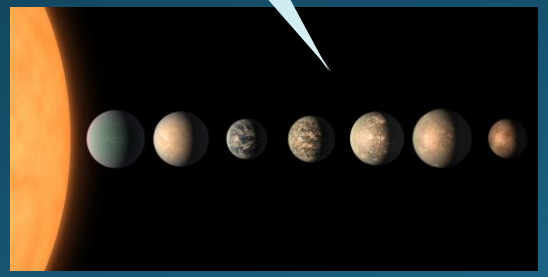
HiSPEC/MODHIS
NIR high-res spectrometer

TMT Era

Characterization of young giant planets

REACH
High-contrast and NIR high-res spectroscopy

8-meter telescopes



RV Detection of Earth-like planets

SCExAO
Extreme Adaptive Optics

IRD
NIR high-res spectrometer

REACH and SCExAO can be a precursor and a test-bed for the TMT/Planetary Systems Imager (PSI) and its precursor instrument MODHIS for directly imaging of Earth-like planets around nearby M stars and characterize their atmospheres