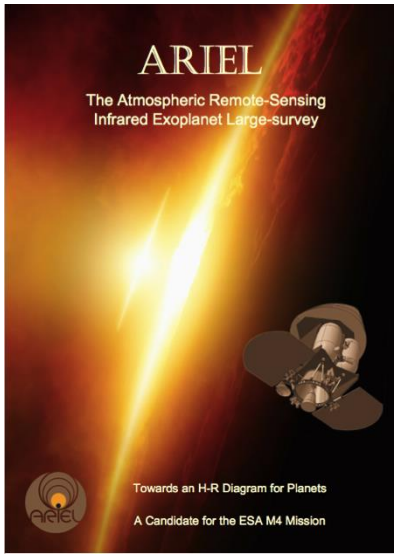
FINESSE and ***ARIEL + CASE***: Dedicated Transit Spectroscopy Missions for the Post-*TESS* Era



Jacob Bean (University of Chicago)

Presented on behalf of the *FINESSE*/*CASE* science team:

Mark Swain (PI), Nicholas Cowan, Jonathan Fortney, Caitlin Griffith, Tiffany Kataria, Eliza Kempton, Laura Kreidberg, David Latham, Michael Line, Suvrath Mahadevan, Jorge Melendez, Julianne Moses, Vivien Parmentier, Gael Roudier, Evgenya Shkolnik, Adam Showman, Kevin Stevenson, Yuk Yung, & Robert Zellem

FINESSE

Fast Infrared Exoplanet Spectroscopy Survey Explorer

Exploring the Diversity of New Worlds Around Other Stars

Candidate NASA MIDEX mission for launch in 2023

Objectives

FINESSE will test theories of planetary origins and climate, transform comparative planetology, and open up exoplanet discovery space by performing a comprehensive, statistical, and uniform survey of transiting exoplanet atmospheres.

Strategy

- Transmission spectroscopy of 500 planets: M_p = few – 1,000 M_{Earth}
- Phase-resolved emission spectroscopy of a subset of 100 planets: T_{eq} > 700 K
- Focus on synergistic science with *JWST*: homogeneous survey, broader context, population properties, and bright stars

Hardware

- 75 cm aluminum Cassegrain telescope at L2
- 0.5 – 5.0 µm high-throughput prism spectrometer with R > 80
- Single HgCdTe detector with *JWST* heritage for science and guiding

Advantages of Transiting Planets

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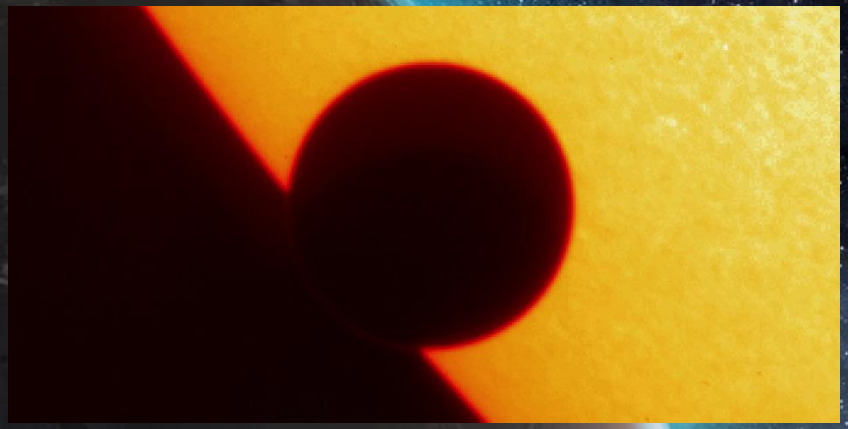

The "Small Black Shadow" vs. "The Pale Blue Dot"

Strengths:

- Know the planet masses and radii
- Multiple probes of the atmosphere
- Can study planets close-in to their host stars
- Rapidly advancing field with substantial heritage to build on

Targets

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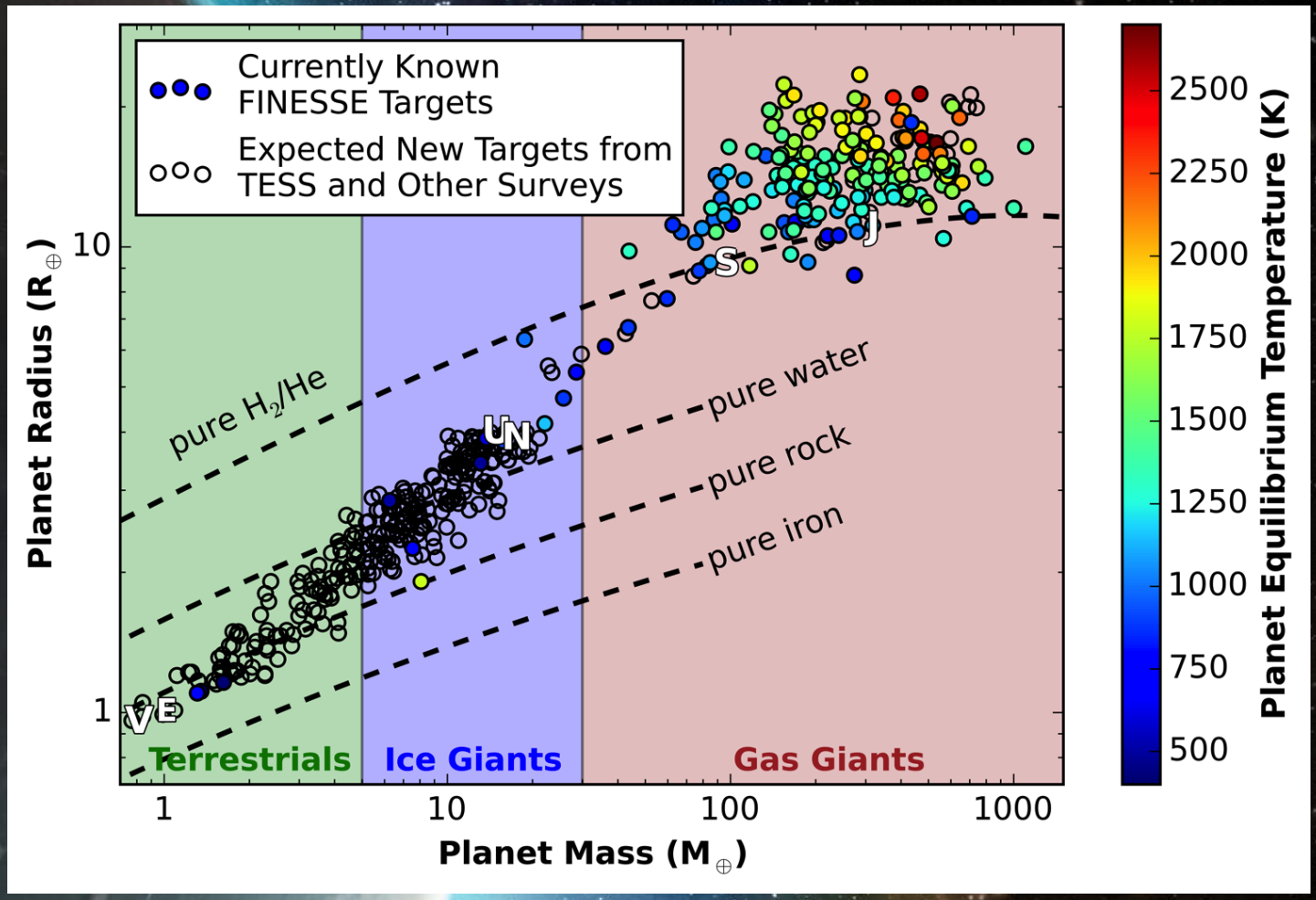

Measurement Technique

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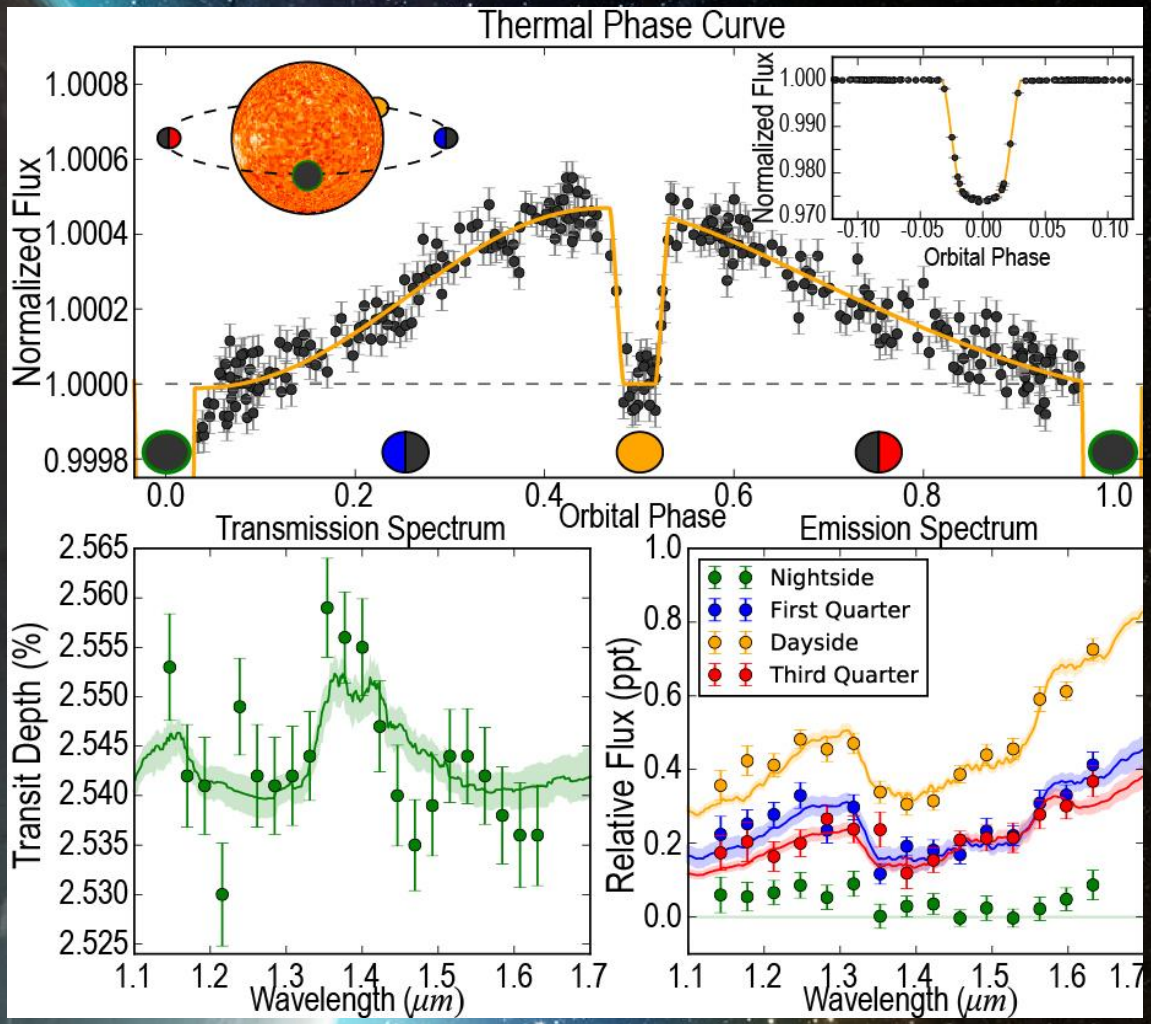

Diagnostic Chemical Species

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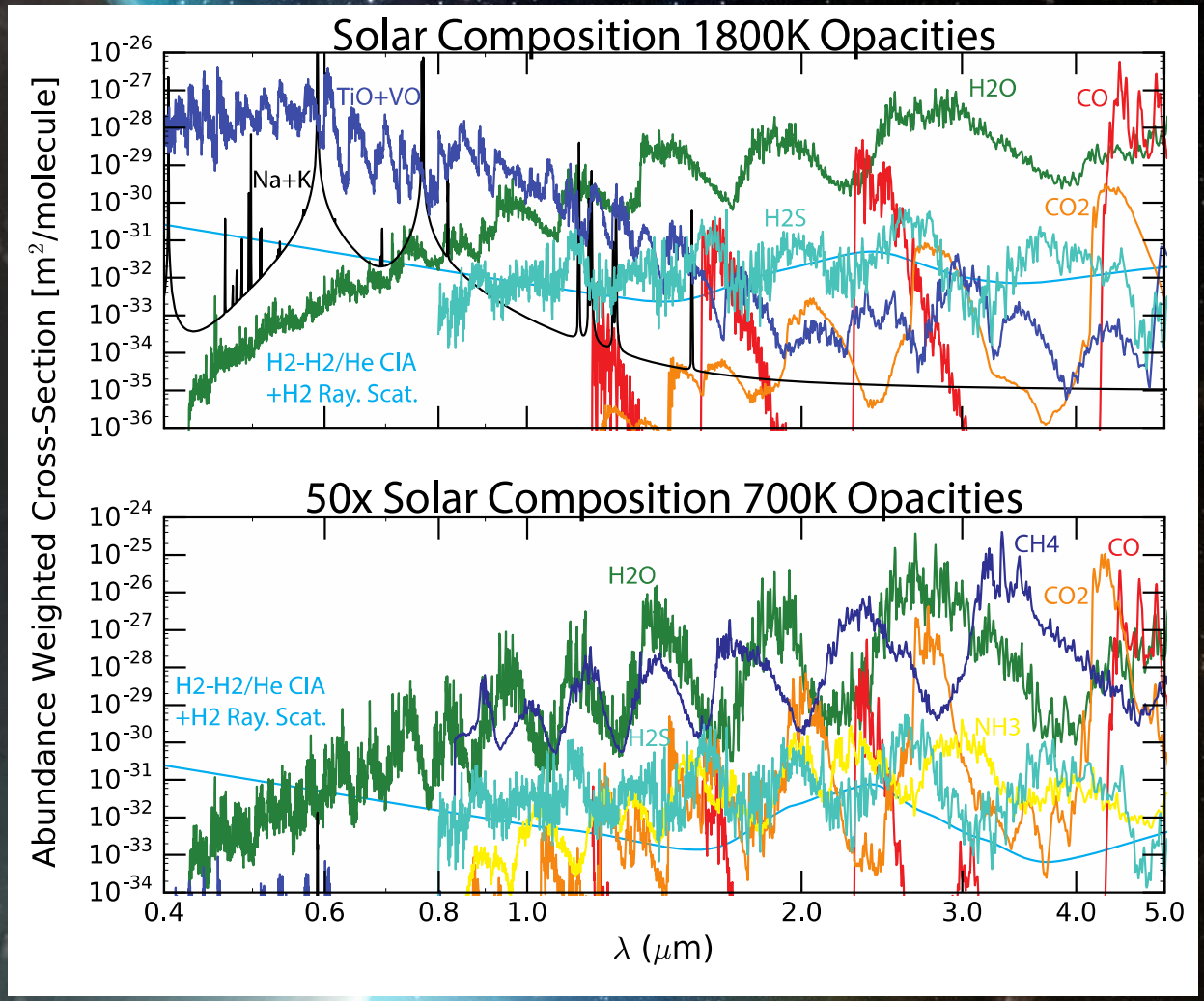

Simulated Data

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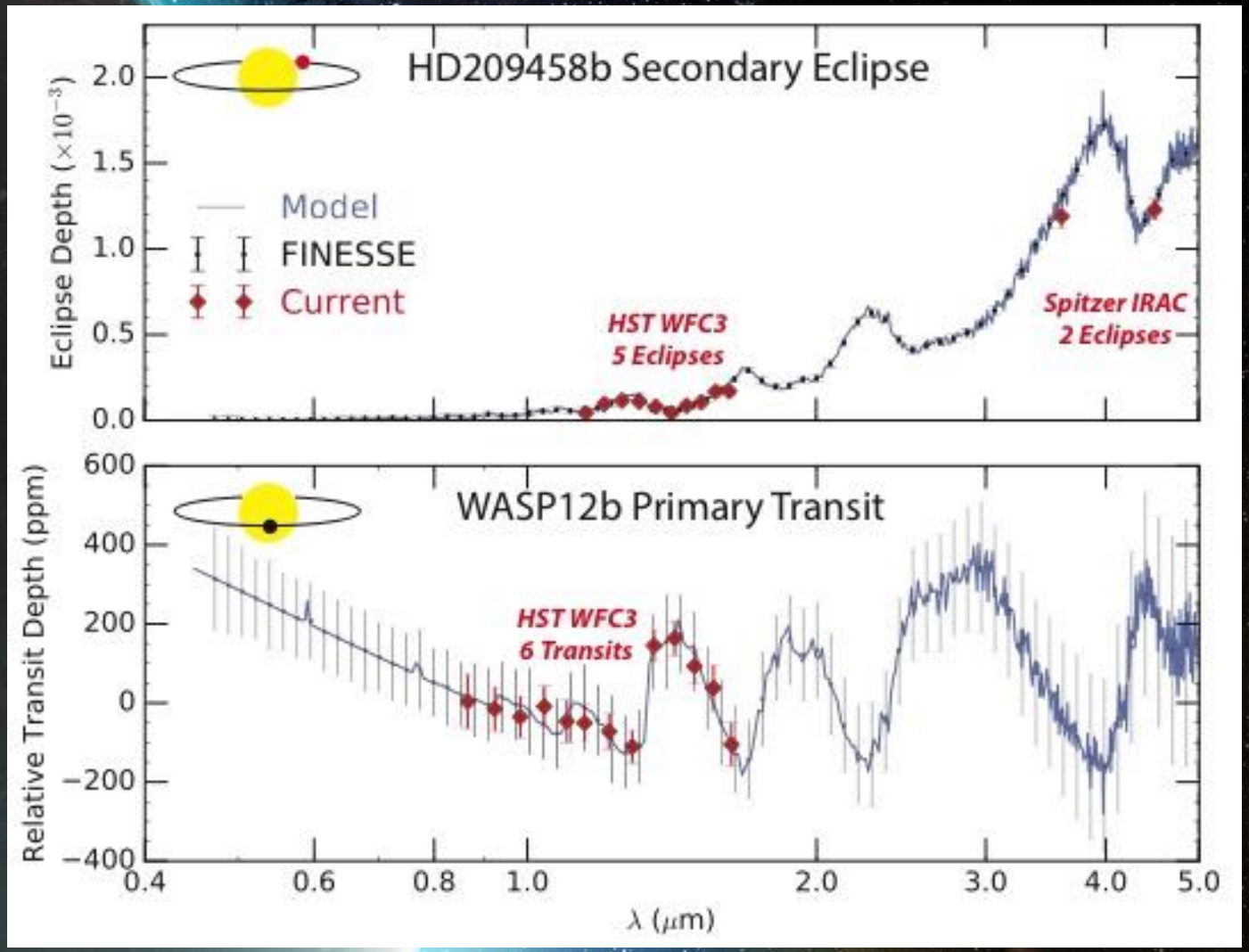

Survey Strategy

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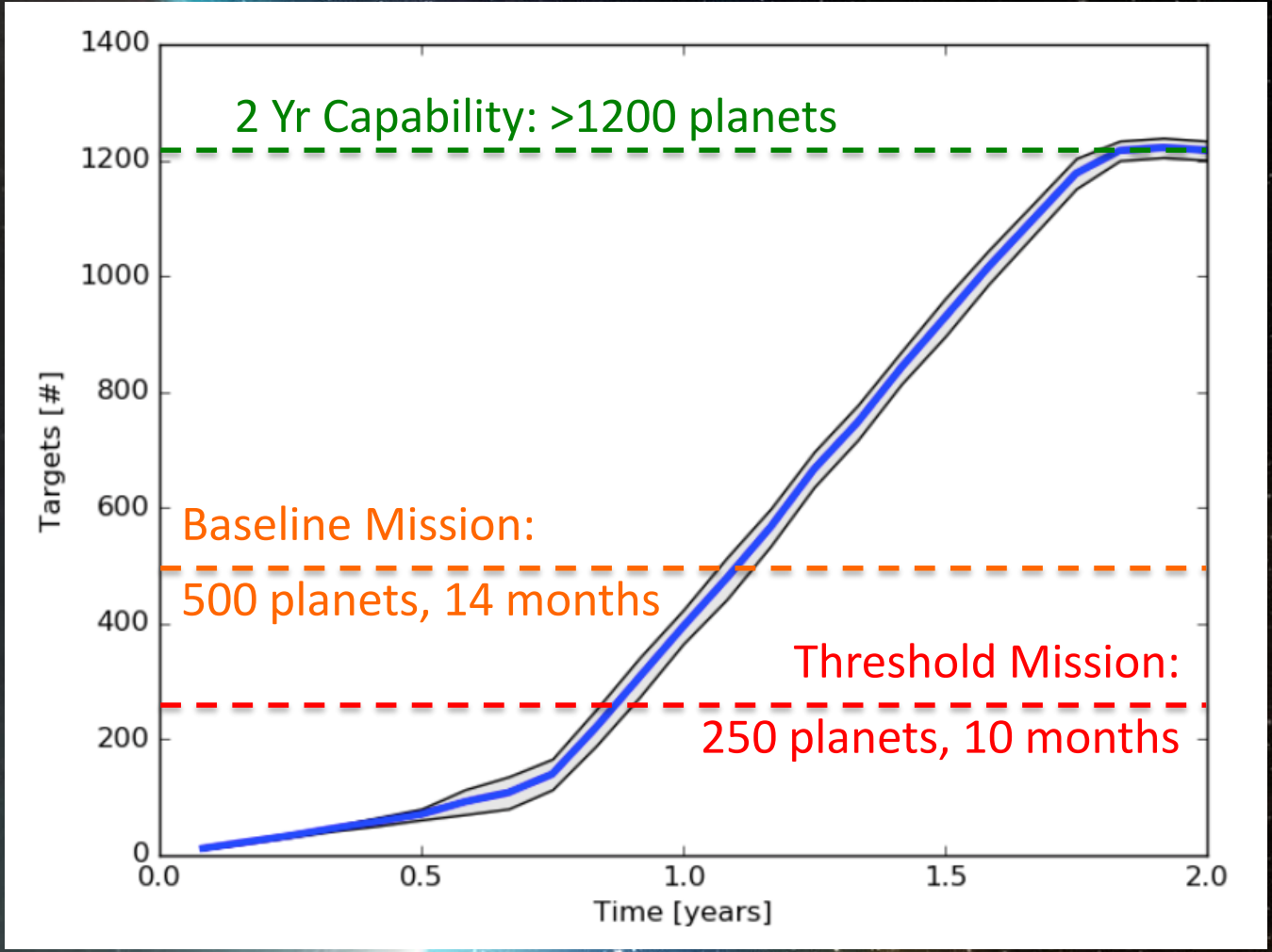

Science

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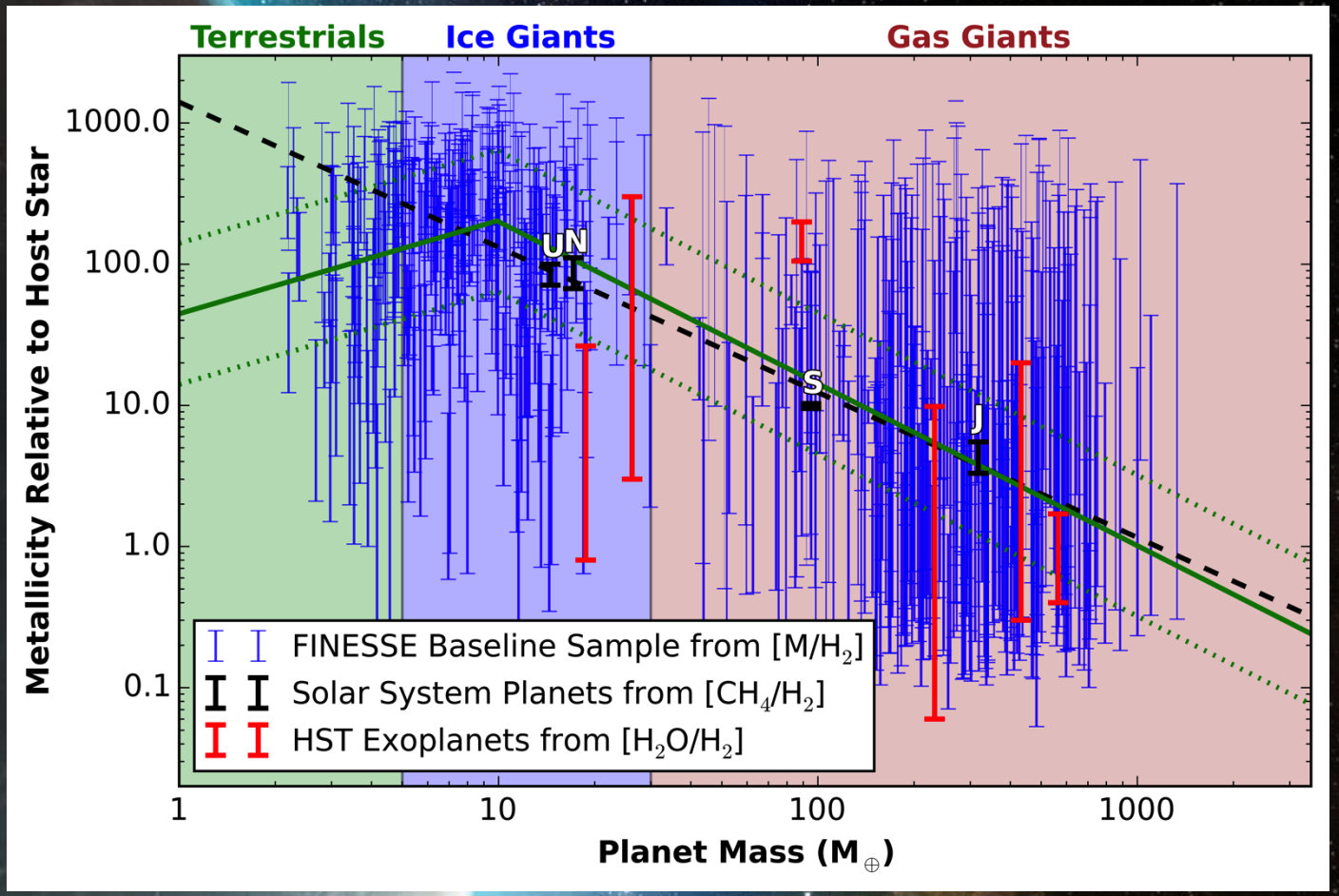

Science

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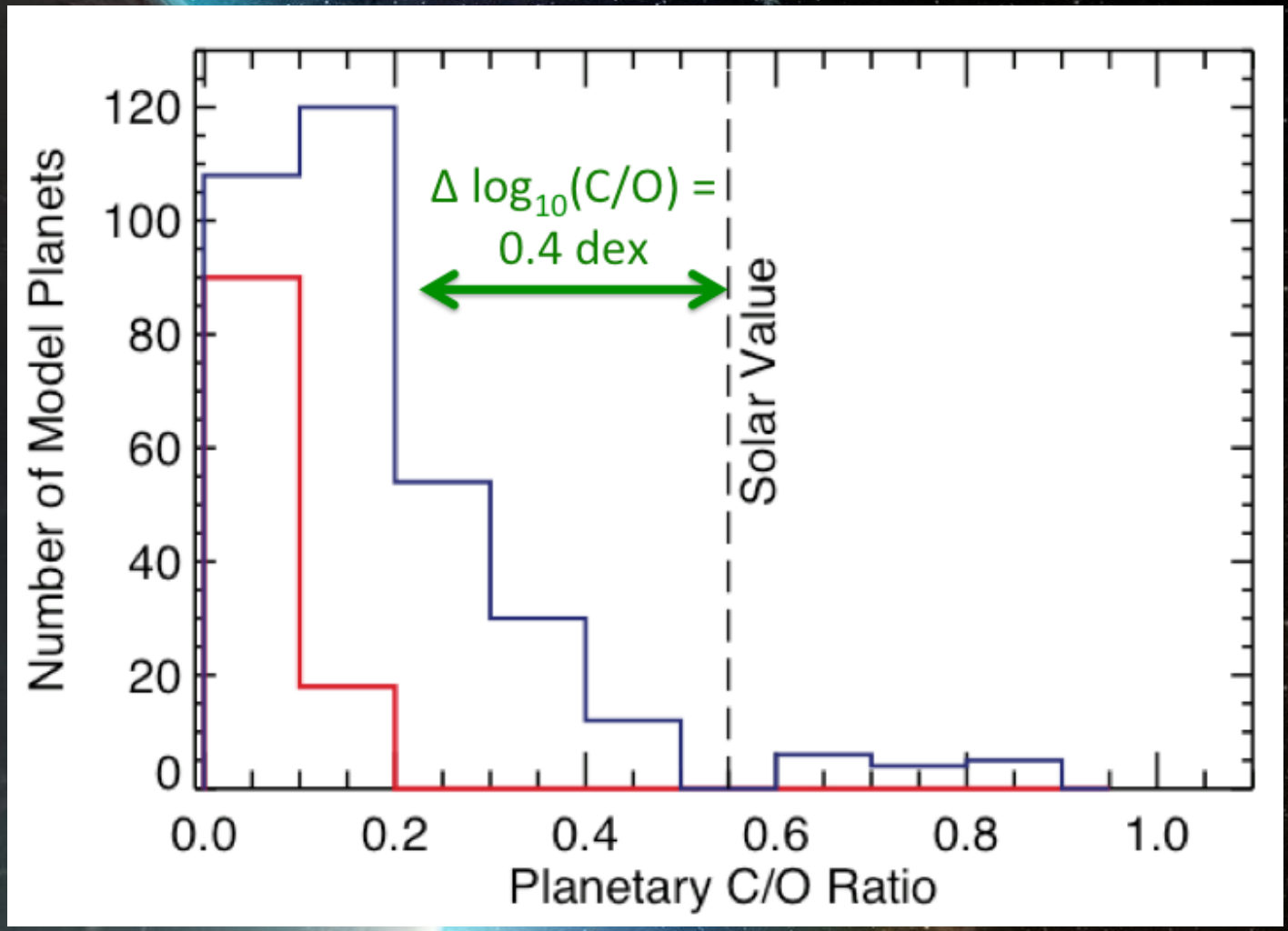

Science

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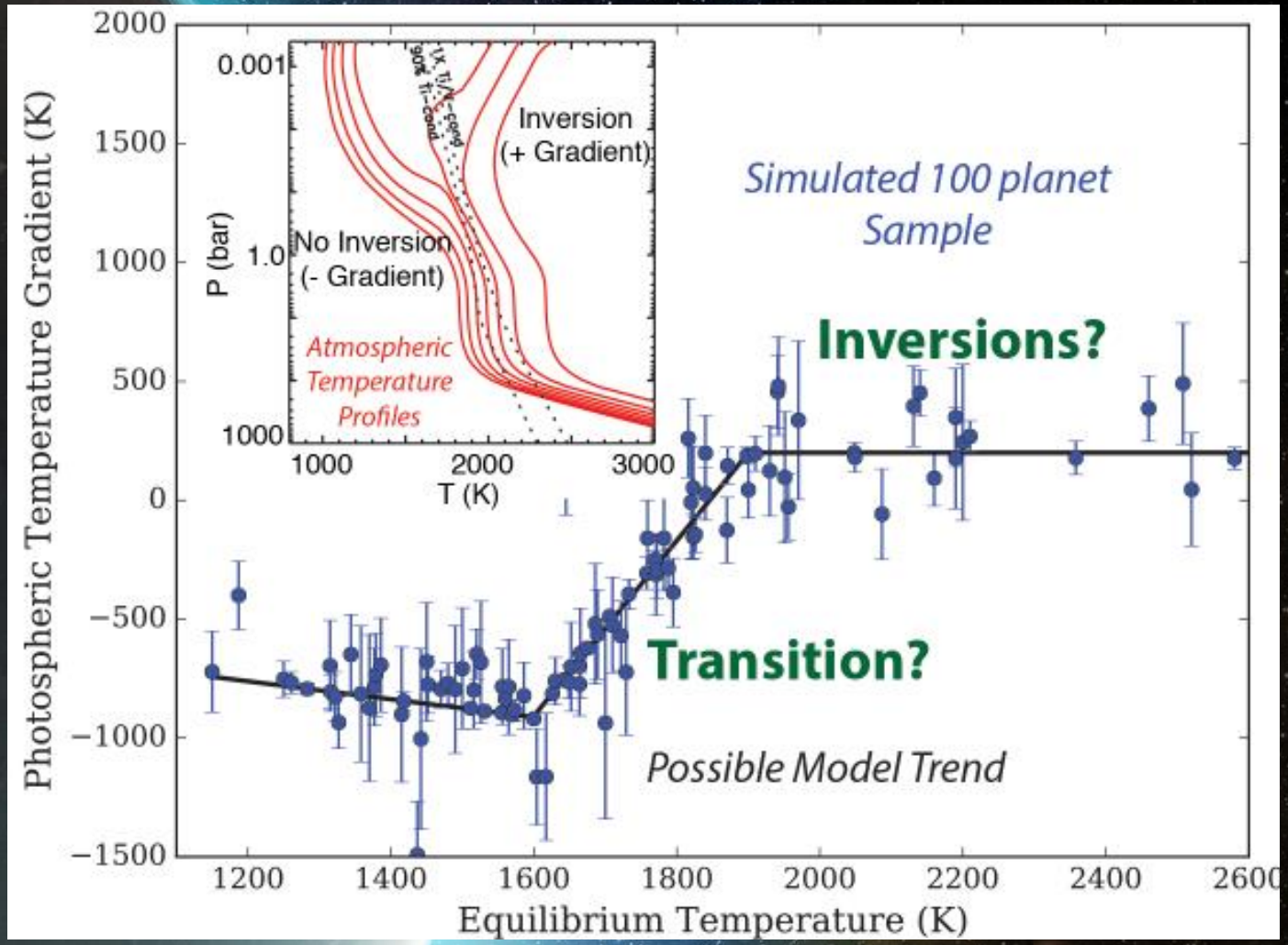

Science

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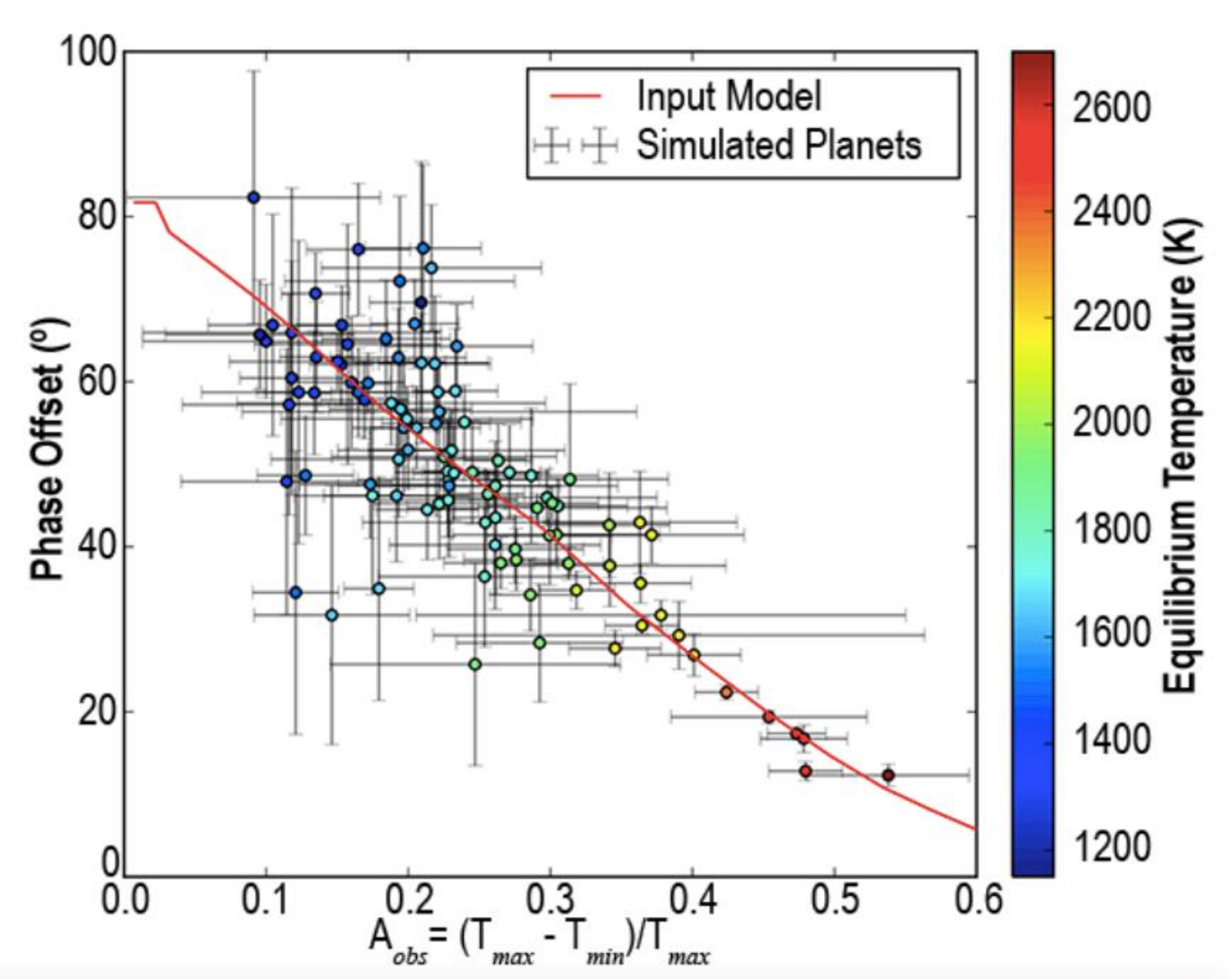
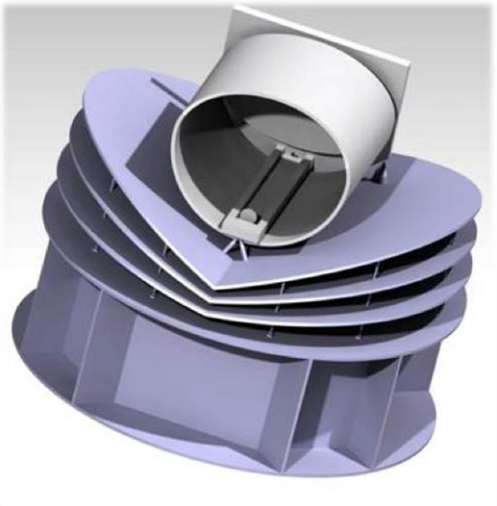


ARIEL – key facts

- European Space Agency M4 mission candidate
- Competing for launch 2026
- 1-m telescope, spectroscopy from VIS to IR
- Satellite in L2 (1.5M km away from Earth)
- ~1000 exoplanets observed (rocky + gaseous)
- Simultaneous spectra (0.5) 2.0 - 7.8 micron
- Lifetime 4 years (extendable to 6)
- Payload consortium: 12 EU countries:

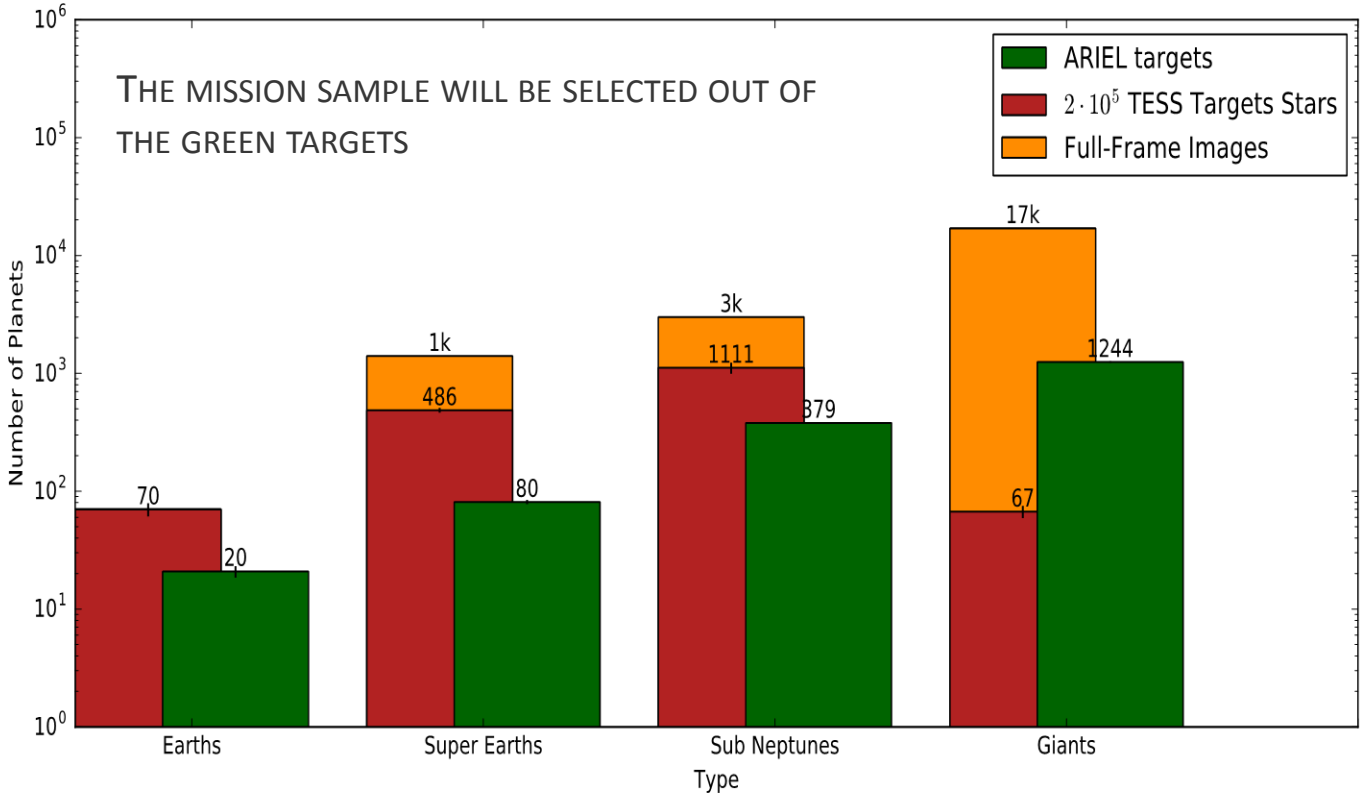
UK, FR, IT, DE, BE, PL, NL, AT, DK, IE, SP, PT



More information online at:
http://ariel-spacemission.eu

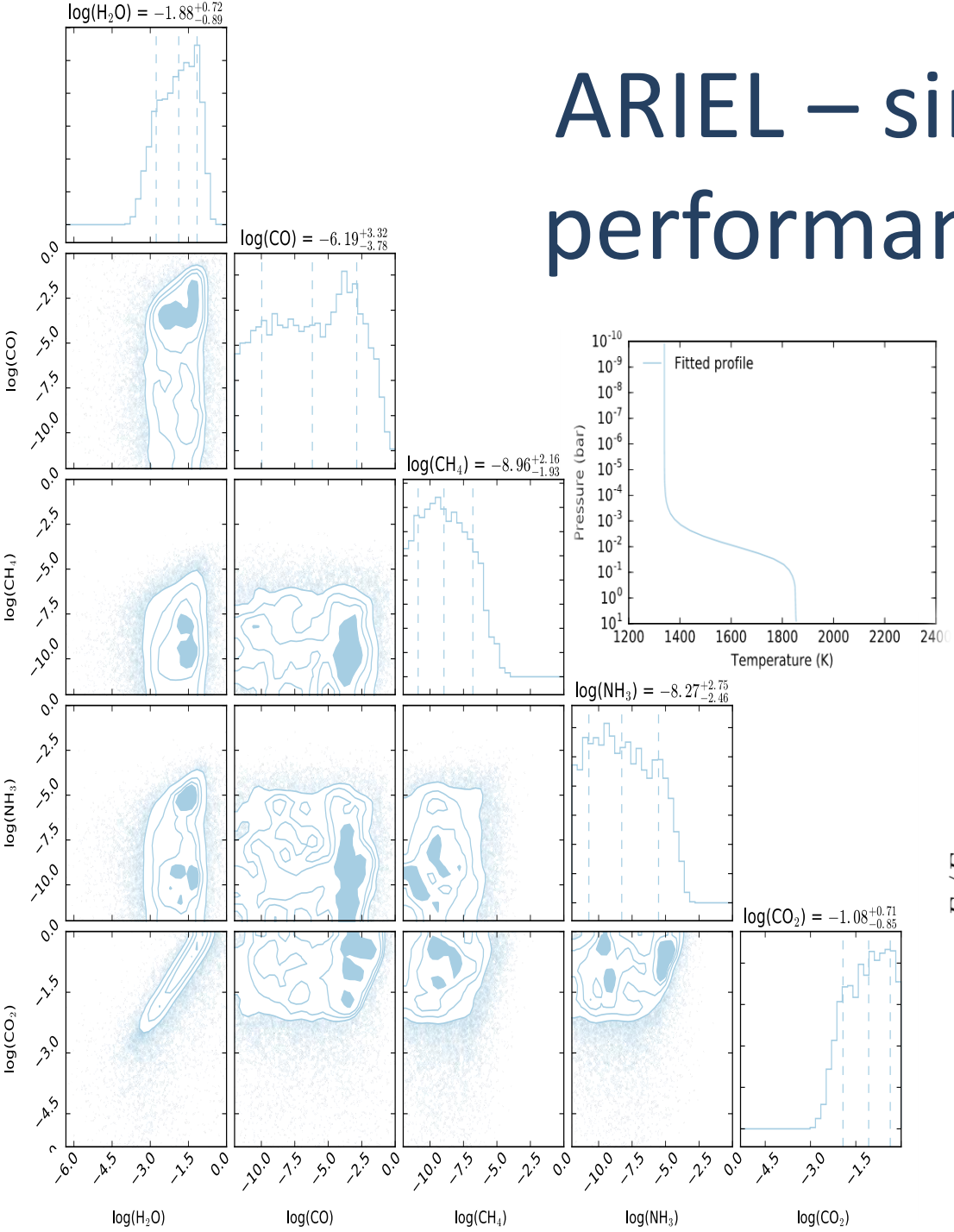
Slide provided by PI Giovanna Tinetti

ARIEL – targets

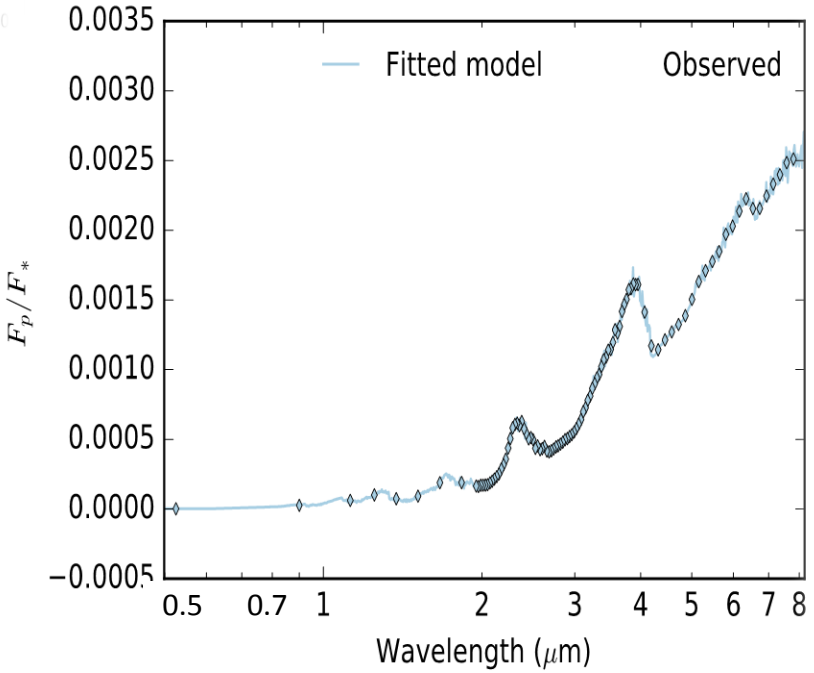


Zingales et al, in prep.

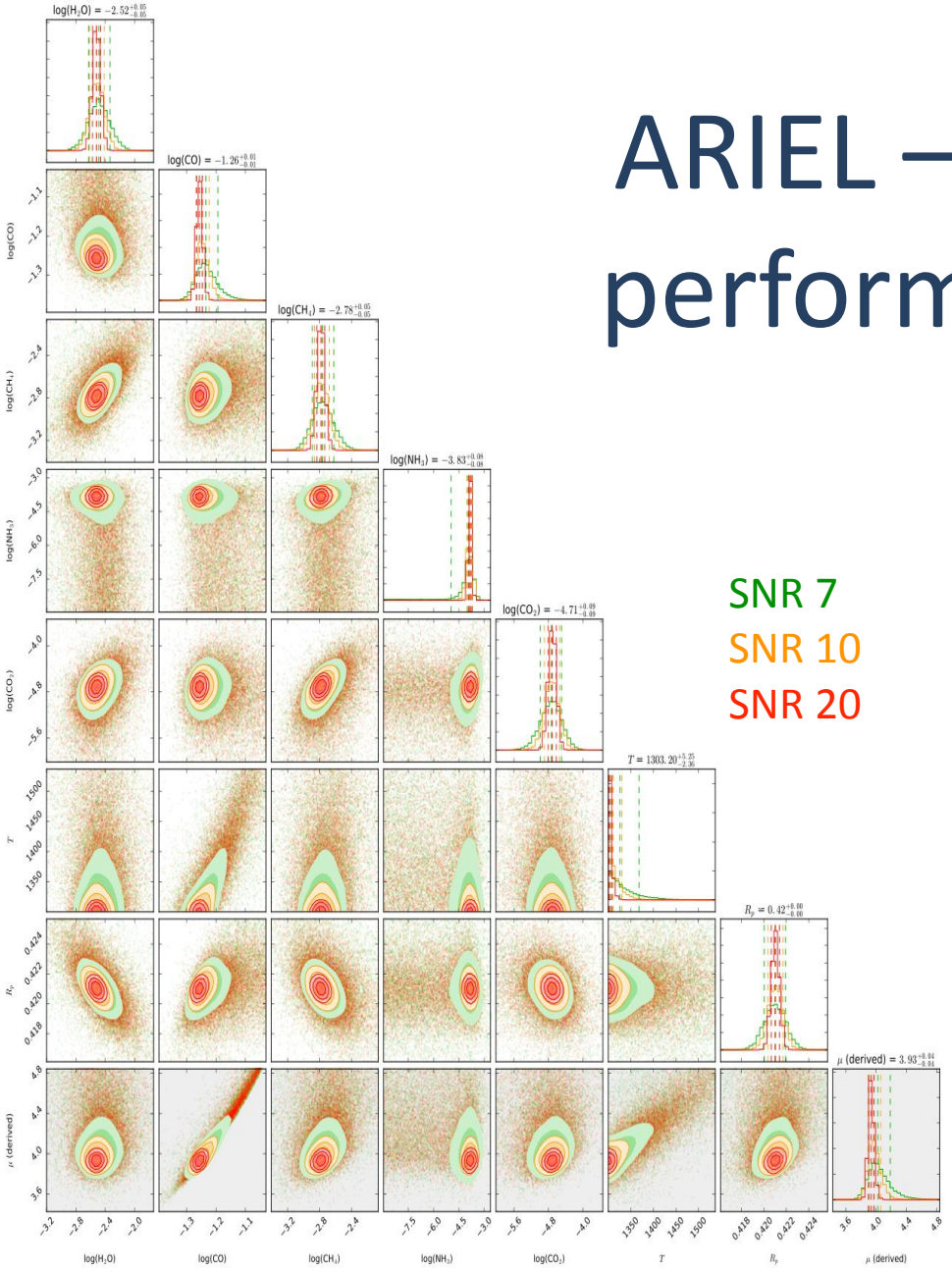
ARIEL – simulated performances



- HD189733b type planet
- performances reached with one Ariel visit

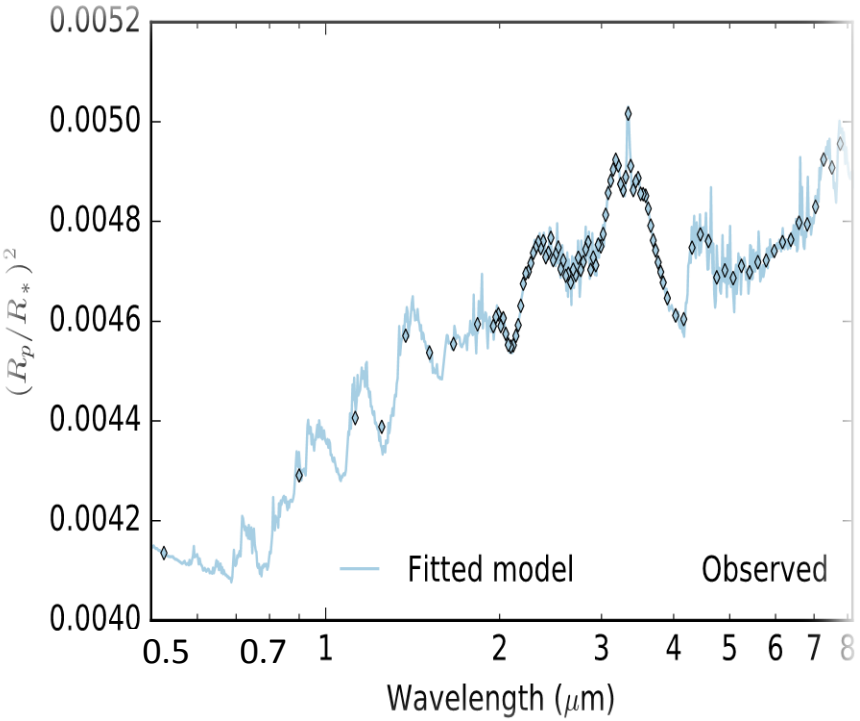


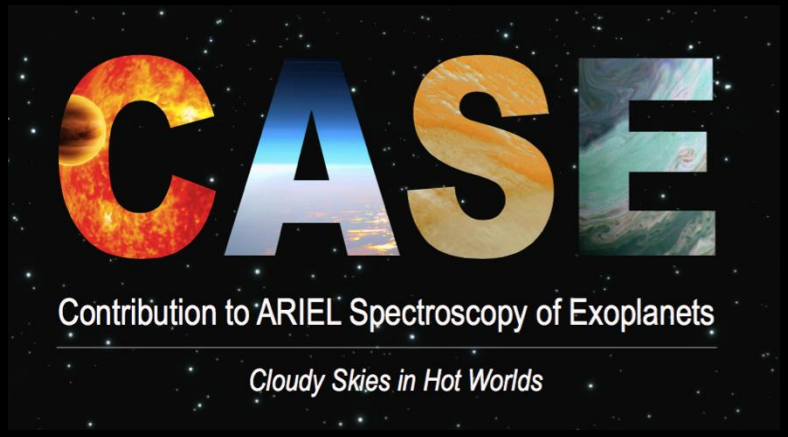
ARIEL – simulated performances



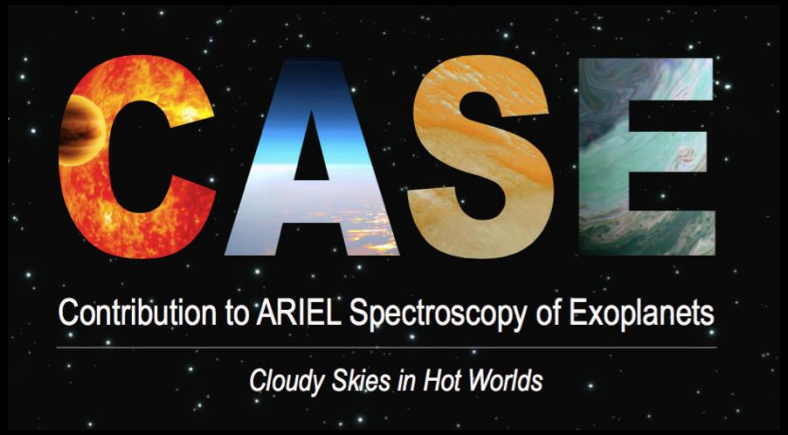
SNR 7
SNR 10
SNR 20

- HAT-P-11b type planet
- performances reached with one Ariel visit



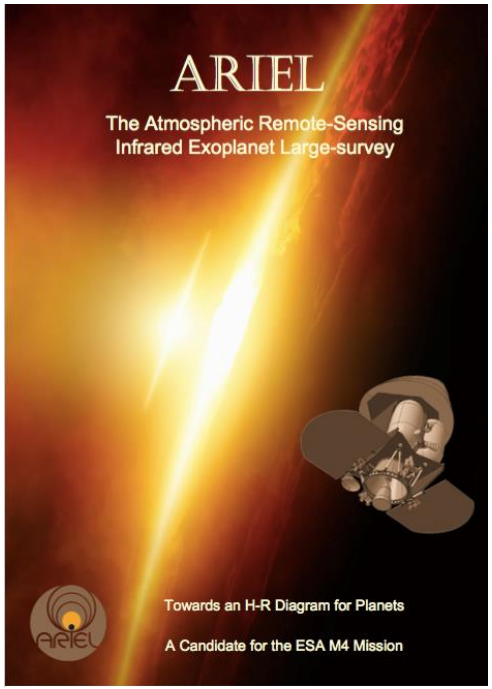


- Candidate NASA Mission of Opportunity to contribute to *ARIEL* - *conditionally selected* August 2017
- Identical PI and science team as *FINESSE*
- NASA would provide two Fine Guidance Sensors:
  - FGS1 – photometric bands at 0.55 and 0.90 µm
  - FGS2 – photometric band at 1.12 µm and R>10 spectroscopy at 1.25 – 1.90 µm
- Technical justification is to provide critical pointing control
- Science case is to enable the detection and discrimination of aerosols and the measurement of geometric albedos
- Enables US participation in *ARIEL*



- *CASE* is conditionally selected for flight pending:
  - Further development of the mission through a non-competitive phase A concept study
  - Selection of *ARIEL* (possibly in ~~November 2017~~ February 2018)
  - NASA negotiating a data sharing policy with ESA
- If *ARIEL* + *CASE* is selected NASA has stated that *FINESSE* will be terminated
- The *CASE* concept study will be terminated if *ARIEL* is not selected

FINESSE and *ARIEL + CASE*



Enabling the community to fully capitalize on the legacy of planet-finding surveys in the era of *JWST*

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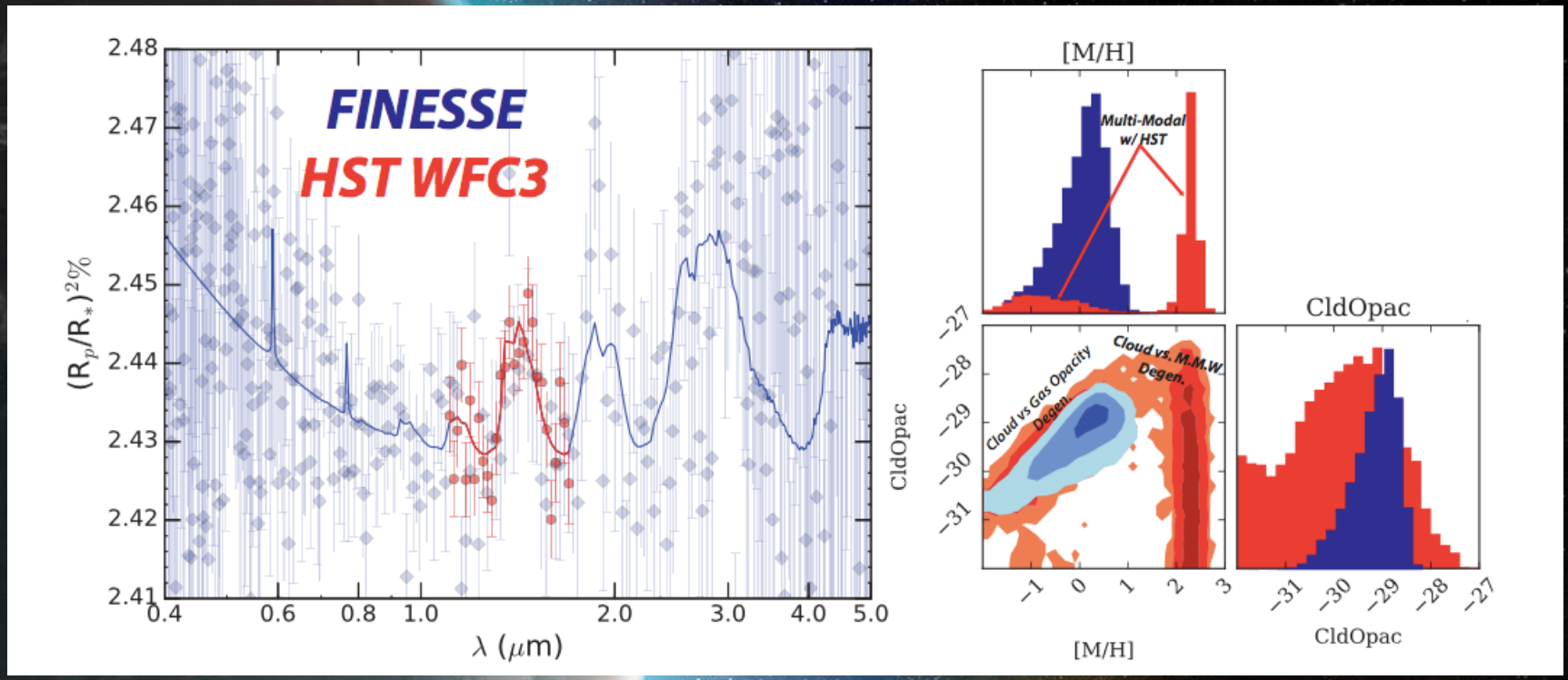

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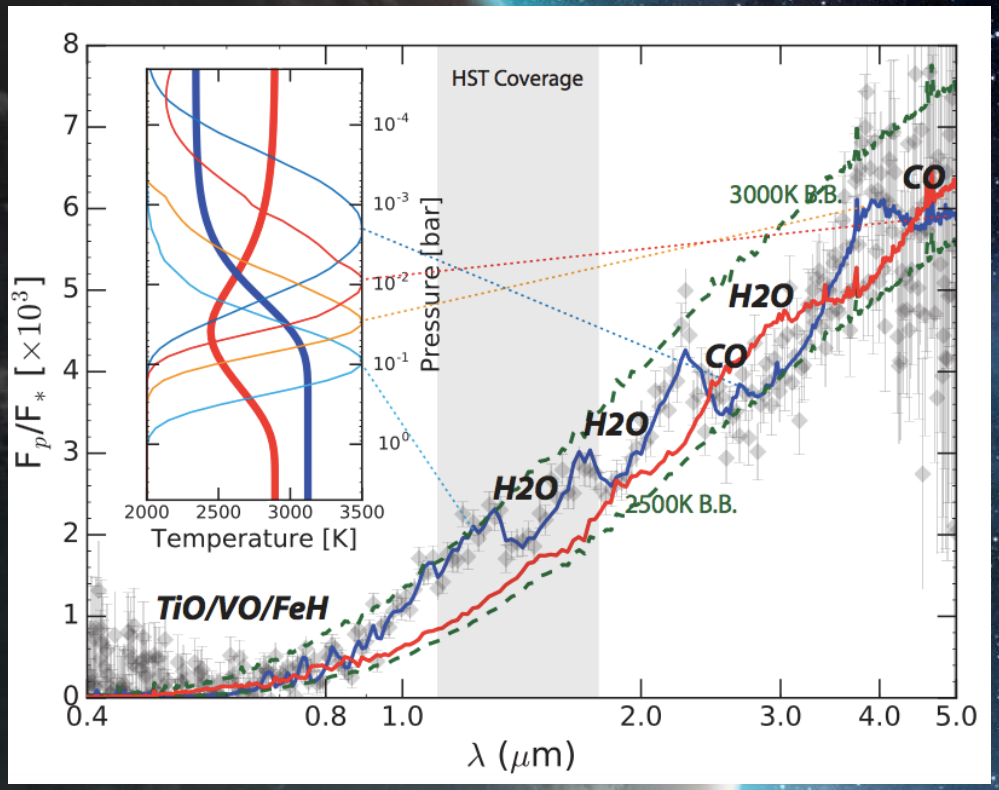

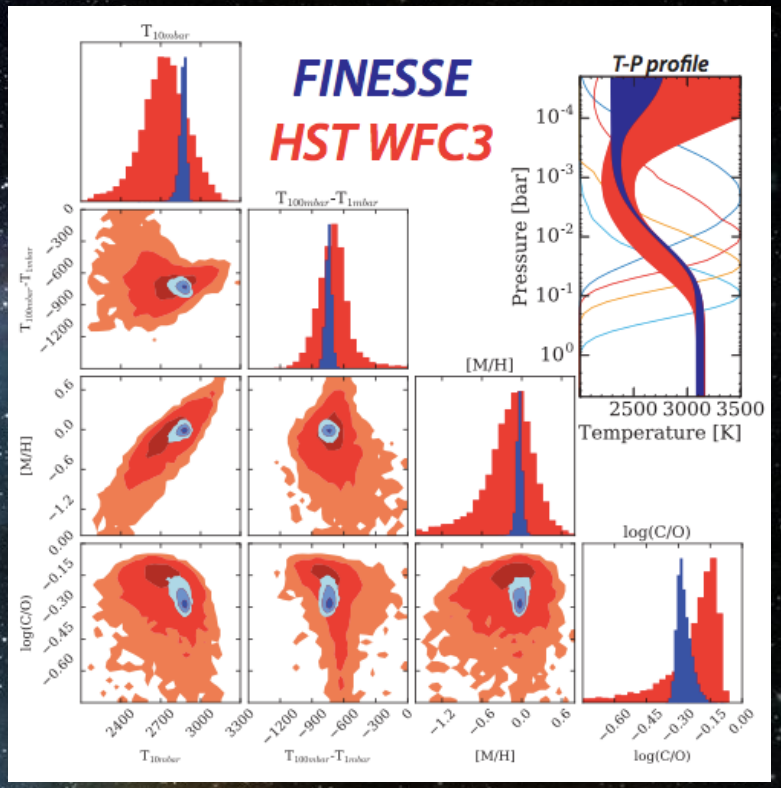

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Status

- *FINESSE* and two other missions were selected in August to proceed to Phase A
- Phase A will culminate with the delivery of a Concept Study Report (CSR) in May 2018 with a site visit in the following months
- Selection of one MIDEX mission for implementation is foreseen in early 2019
- Competition:
  - Arcus: Exploring the Formation and Evolution of Clusters, Galaxies and Stars

    (a high-resolution X-ray spectroscopy mission led out of the CfA)
  - Spectro-Photometer for the History of the Universe, Epoch of Reionization, and Ices Explorer (SPHEREx): An All-Sky Spectral Survey

    (all-sky near-IR spectroscopy survey lead out of Caltech/JPL)
- Evaluation of the CSRs will be in terms of science implementation and technical, management, and cost feasibility; science merit is not re-reviewed
- Science team will fill in the details of how the proposed experiments will lead to science, the need for a large sample, and the posture vis-à-vis *JWST*