NEREA (Near Earths and high-Res Exoplanet Atmospheres): a red/near-IR spectrograph concept for the GTC

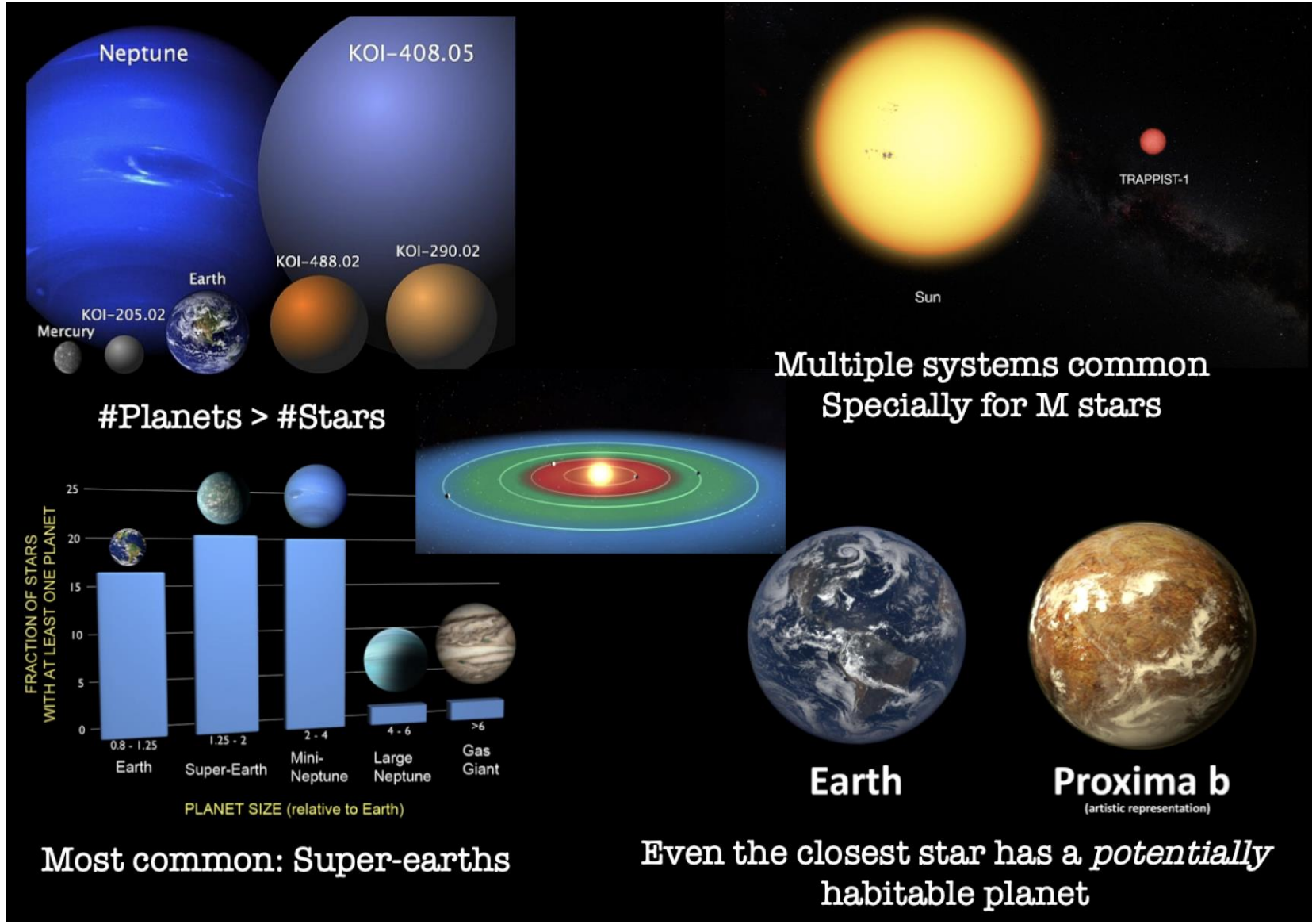
Enric Palle & NEREA team

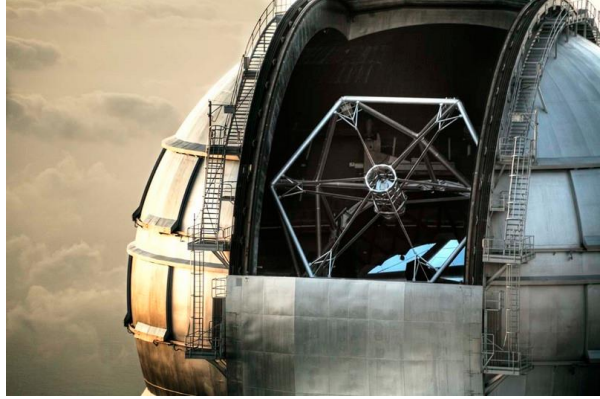
Instituto de Astrofísica de Canarias

NEREA is a stable, compact, high-resolution spectrometer concept for the GTC. NEREA is proposed as a general purpose instrument with a variety of science cases, however, its top level requirements are driven by two science goals in mind: i) The discovery and characterization of planets around nearby late-M type stars. Using GTC's large 10m collecting area, NEREA would be capable of reaching out for planets around cooler, smaller and dimmer stars than current facilities; contributing to completing the census of small planets in our stellar neighborhood (<30pc). ii) The characterization of planetary atmospheres from Hot-Jupiters to Super-earths. NEREA would be capable of detecting species including H2O, CH4, CO2 and ionized metals in planetary atmospheres; as well as detecting and resolving individual Na I, Hαand He I line profiles, improving our understanding of the physical and chemical evolution of planetary atmospheres. Due to the GTC's collecting area, the current planetary sample size can be expected to increase by ∼40 times

Call for new instrumentation for GTC:

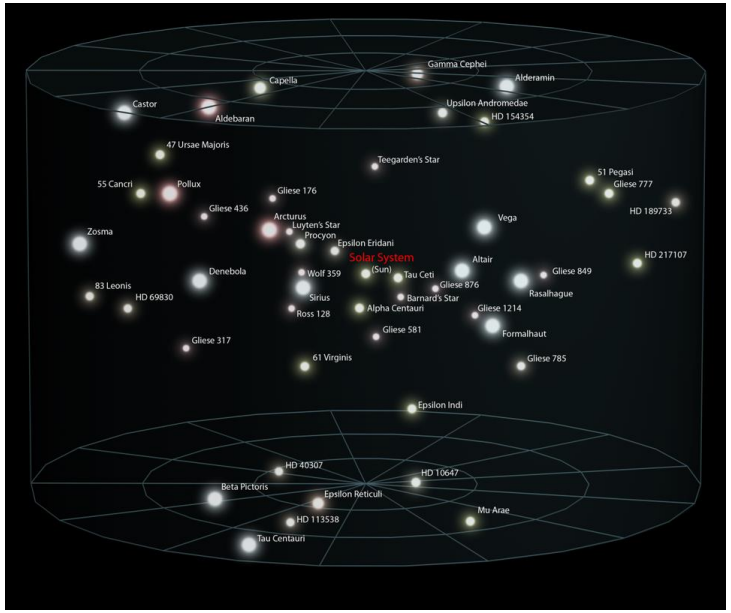
We propose an instrument concept based on a double science case for *exoplanets*





NEREA (*Near Earths and high-Res Exoplanet Atmospheres*): An instrument designed for a double science case for the study of exoplanets (R>100000 , 0.7-1.7 micron, RV estability1 m/s)

- Exploration (RV) of the closest stars to Earth
- Atmopheric characterization from “Hot Jupiters” to “super-Earths”



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Proposed Instrument

Broad Spectral range 800 -1700 nm

Spectral Resolution R > 70,000 up to 110,000

Stability 1 m/s

Compact design (behind AO system)

“Fast” construction and development

Common user instrument for a variety of science cases.

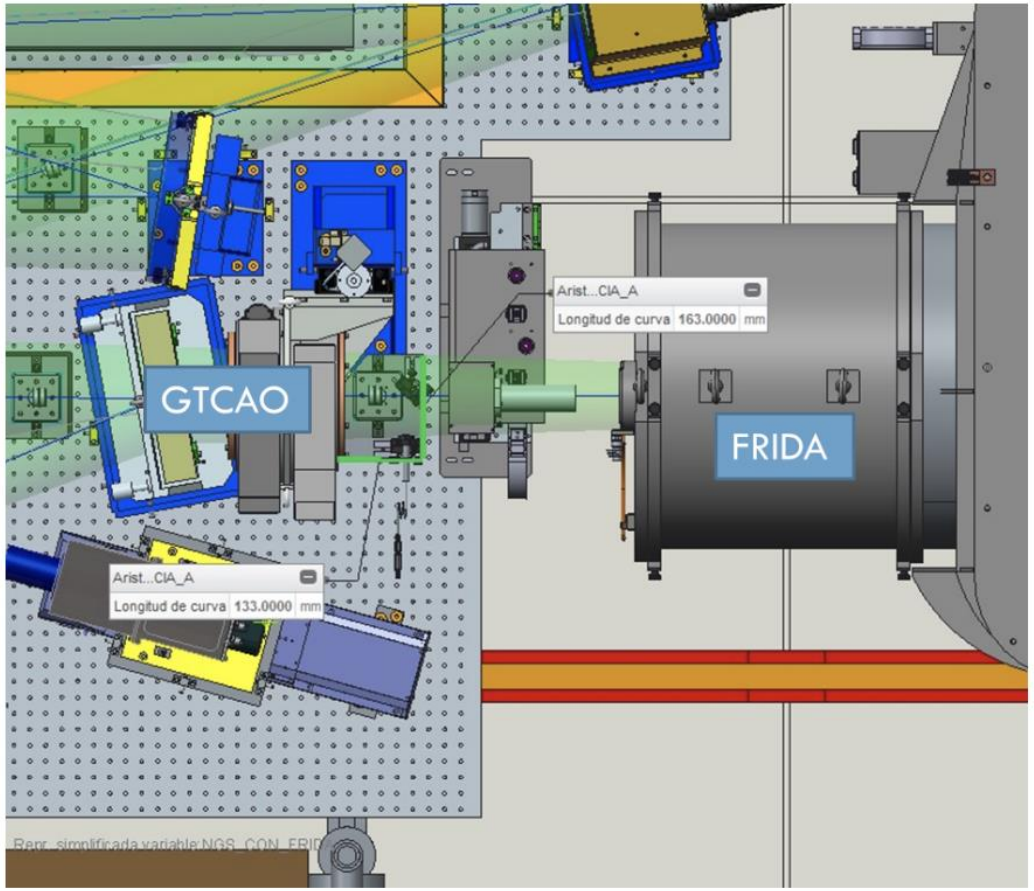
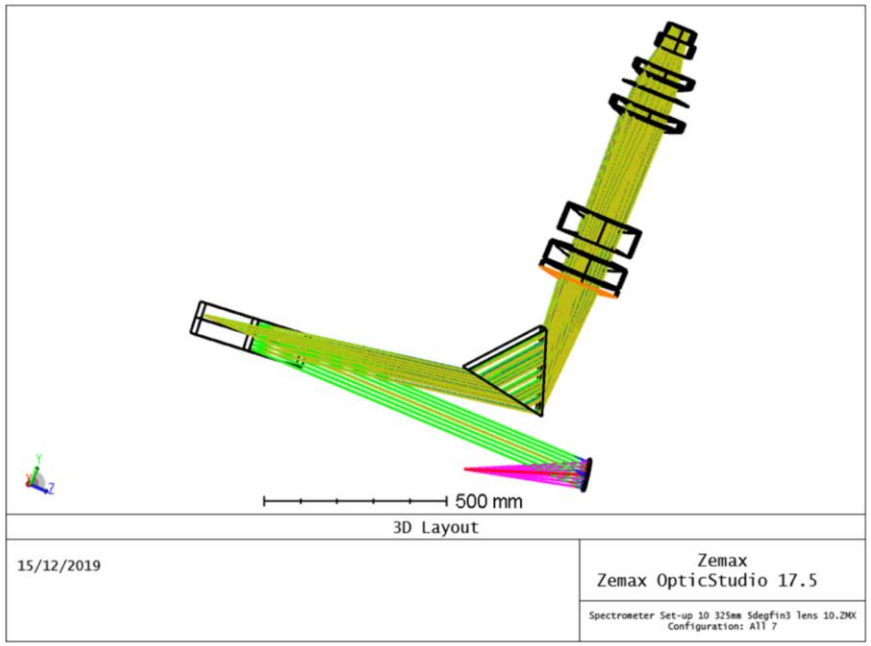


Figure 1. Diagram showing the NEREA fibre coupling system on the current optical bench.

3. Results

Table 1. Outline of NEREA's top-level requirements.

Property	Technical Requirement	Goal
Input	Fibre-fed spectrograph with a front-end throughput efficiency of >70%.	Fibre-fed spectrograph with a front-end throughput efficiency of >80%.
Spectral Resolving Power	>70,000, sufficient to resolve atomic and molecular spectral lines on main sequence stars and planets. This resolution is also sufficient to resolve the signature of Earth atmospheric molecular gases.	110,000.
Wavelength Coverage	800-1700nm.	700-1700nm.
Efficiency (From Input To Detector)	>10% for 800-1700nm, comparable with existing echelle spectrometers.	>15% for 700-1700nm.
Abs. Wave-length Calib.	<2m/s hard-ware stability.	<50cm/s sky stability.
Adaptive Optics Requirement	Moderate AO requirement with an input image size: 0.3 arcsec.	
Size	1.5mX1.5mX1m.	1mX1mX0.5m.
Hard-ware Budget	€3million.	€2million.
Other Requirements	Compact design, behind an AO system, also able to operate under seeing limited conditions (R4∼30 000, or 70,000 with high losses).	



Schematic layout of the optical design of the NEREA spectrograph

NEREA is a unique opportunity for GTC to make a substantial impact on the exoplanet research field, and in astrophysics research in general, before the ELTs era