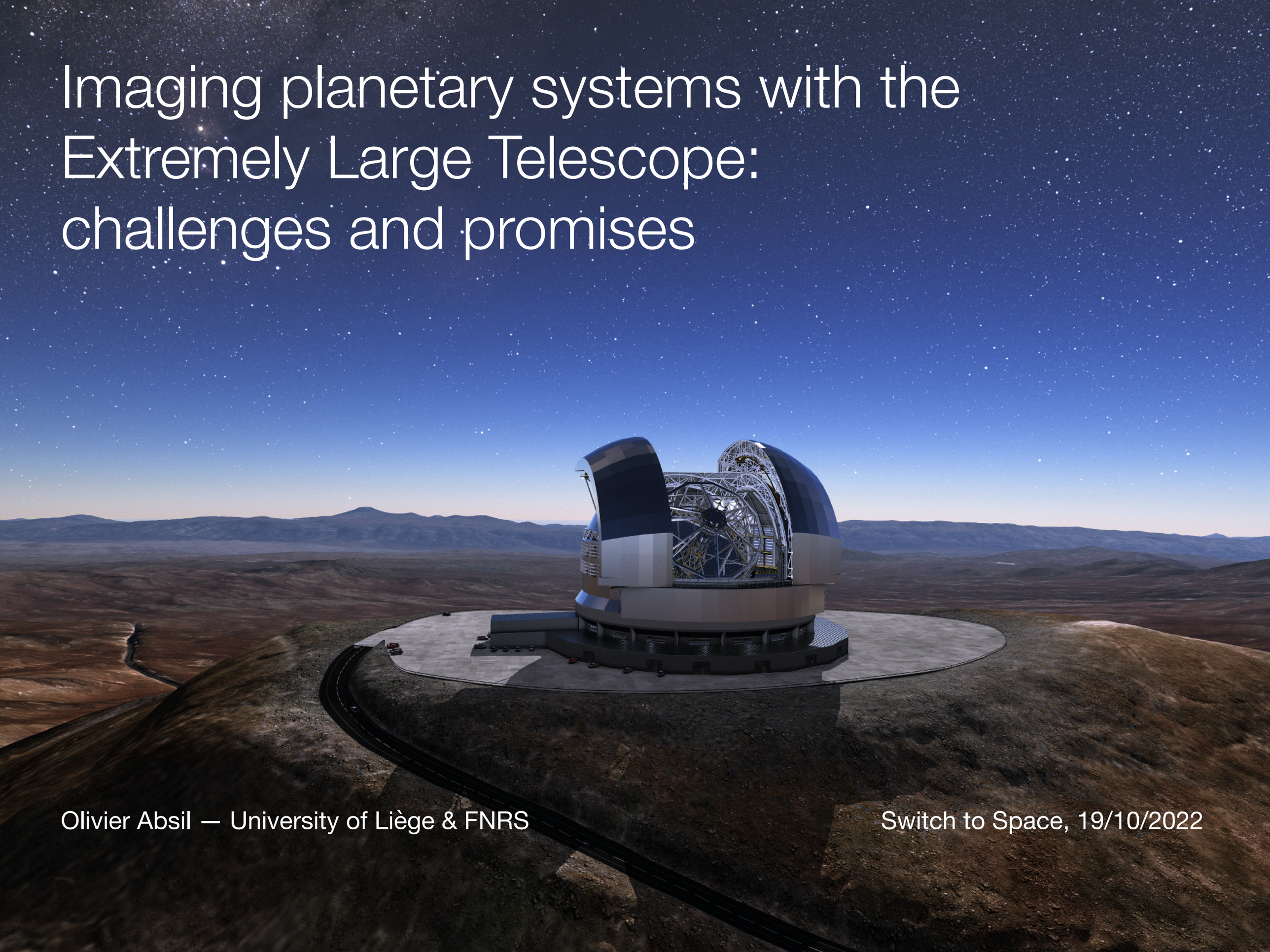
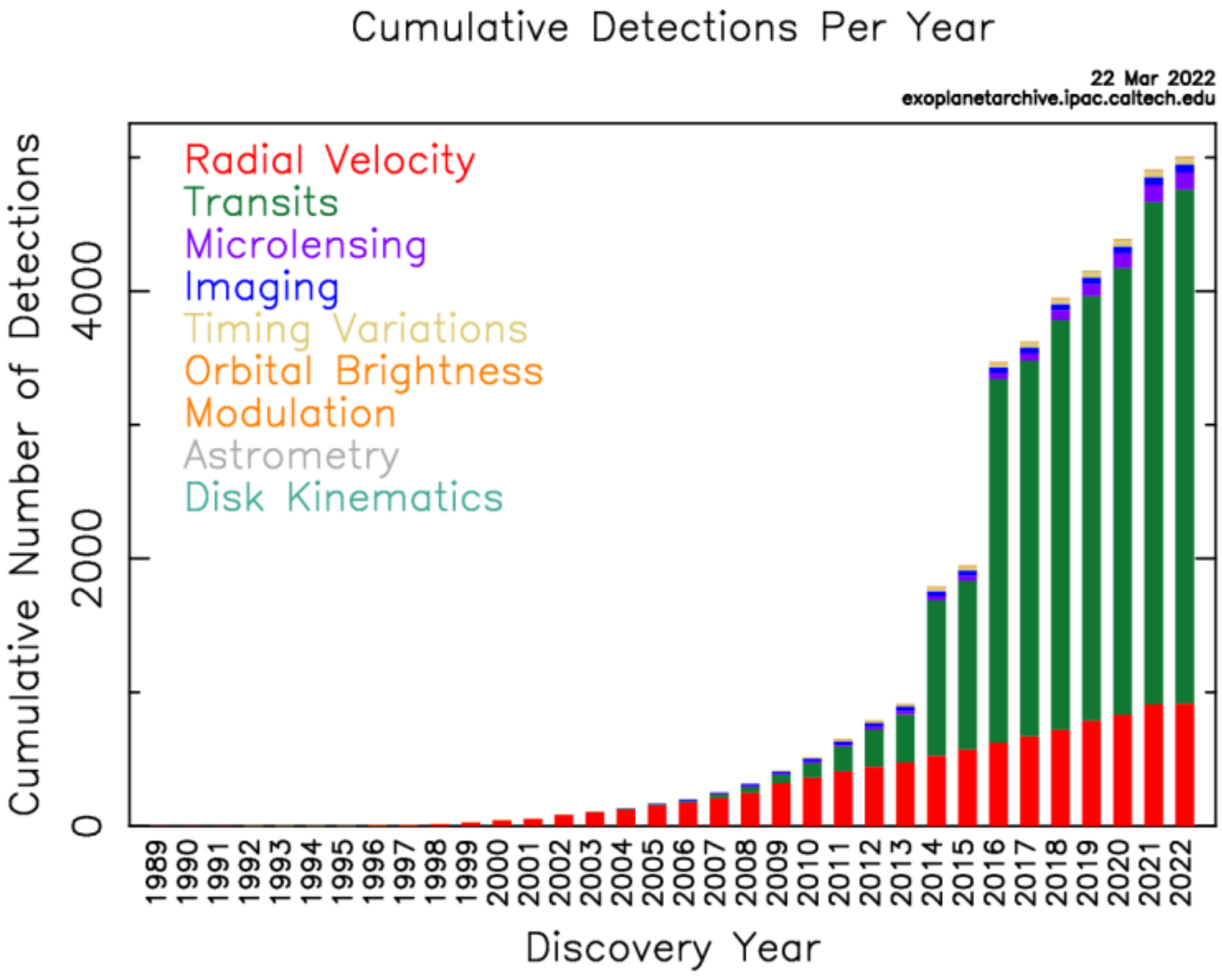
Imaging planetary systems with the Extremely Large Telescope: challenges and promises



Olivier Absil — University of Liège & FNRS

Switch to Space, 19/10/2022

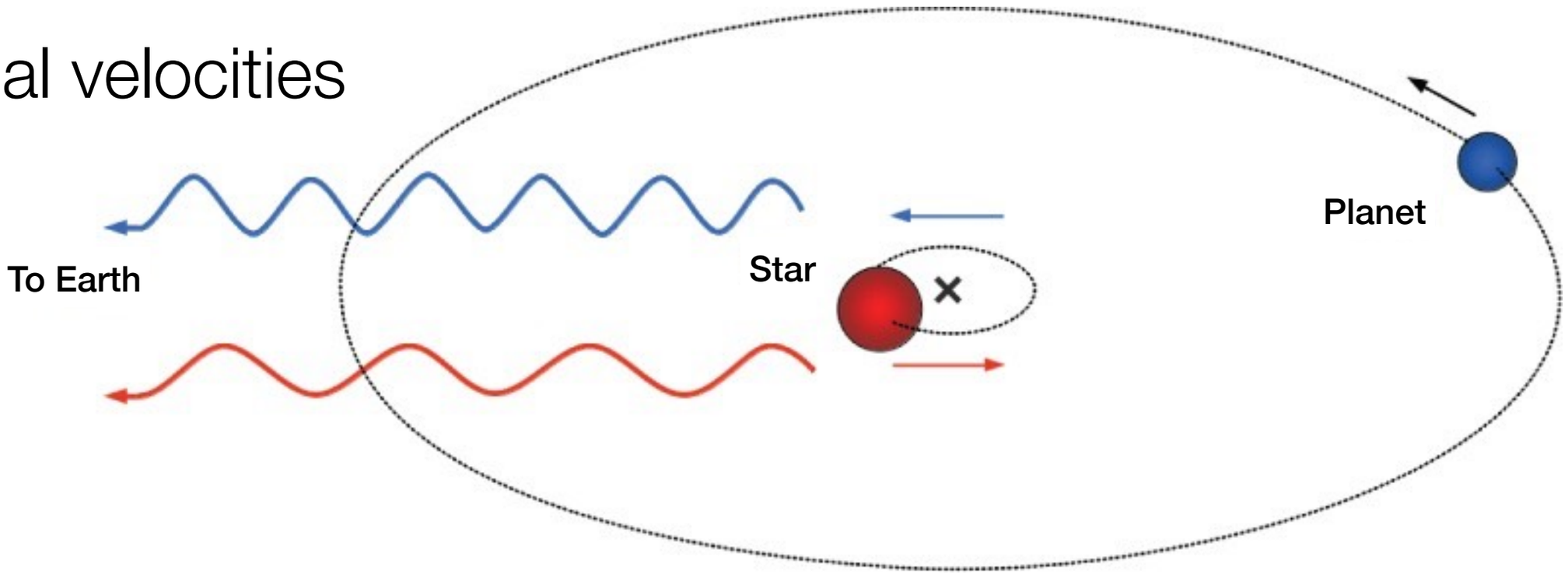
Exoplanets galore!



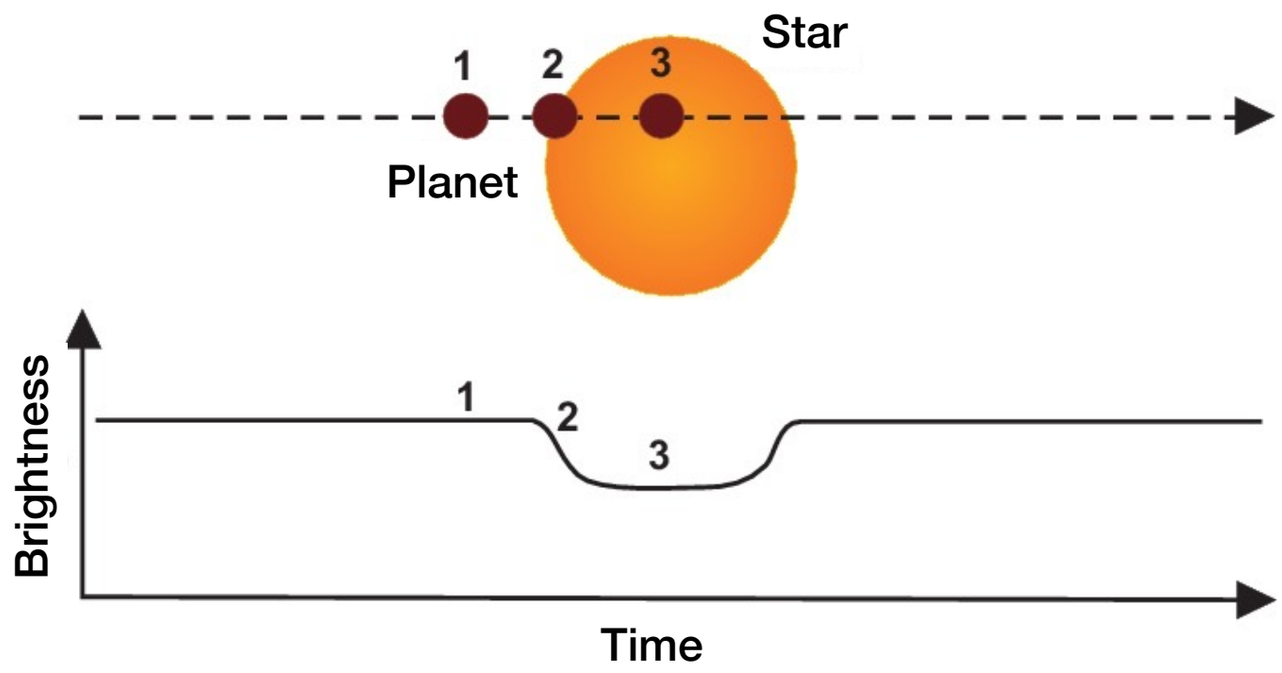

but… still far from this level of details!

Detections mostly **indirect**

Radial velocities

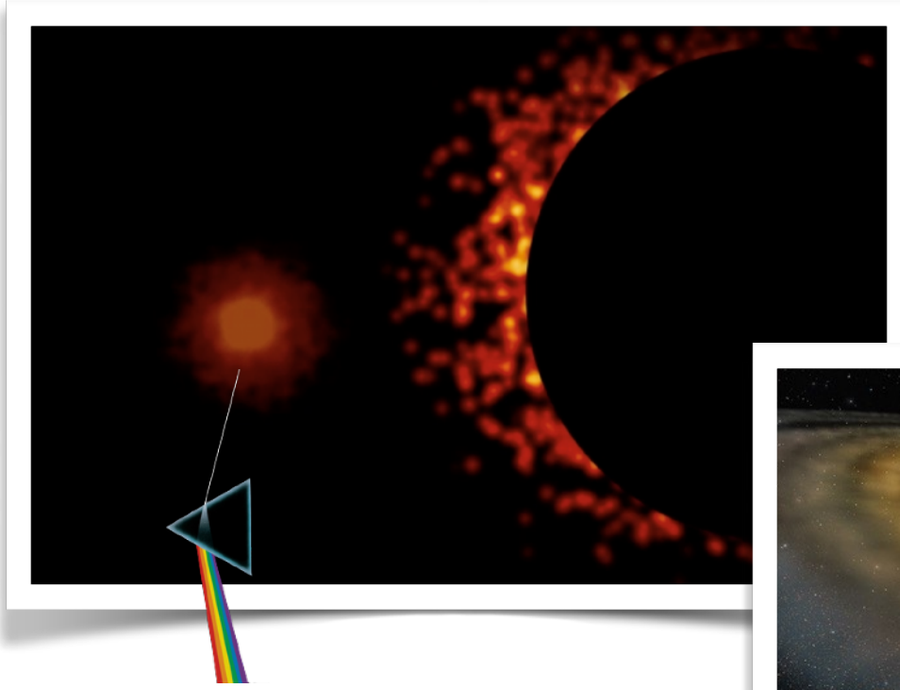


Transits

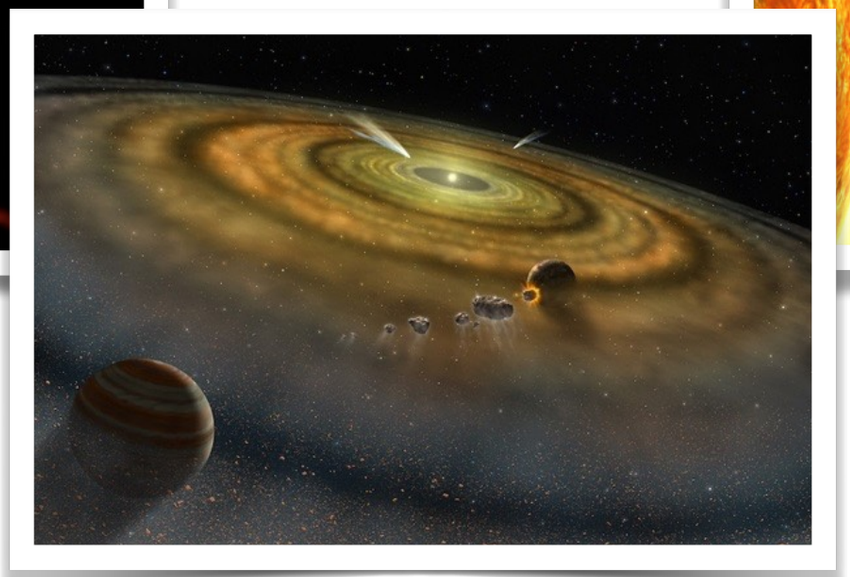


Why **direct** imaging is key

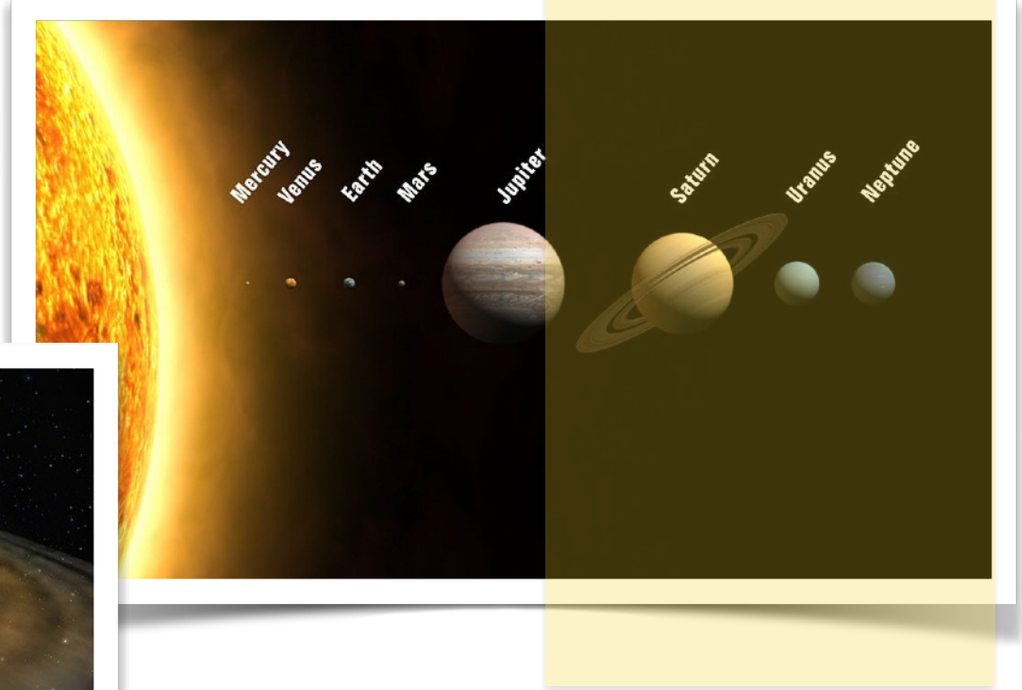
- Indirect techniques have limited characterization power
- Direct imaging gives access to more information



measure spectrum
= chemical composition



probe planet formation and evolution



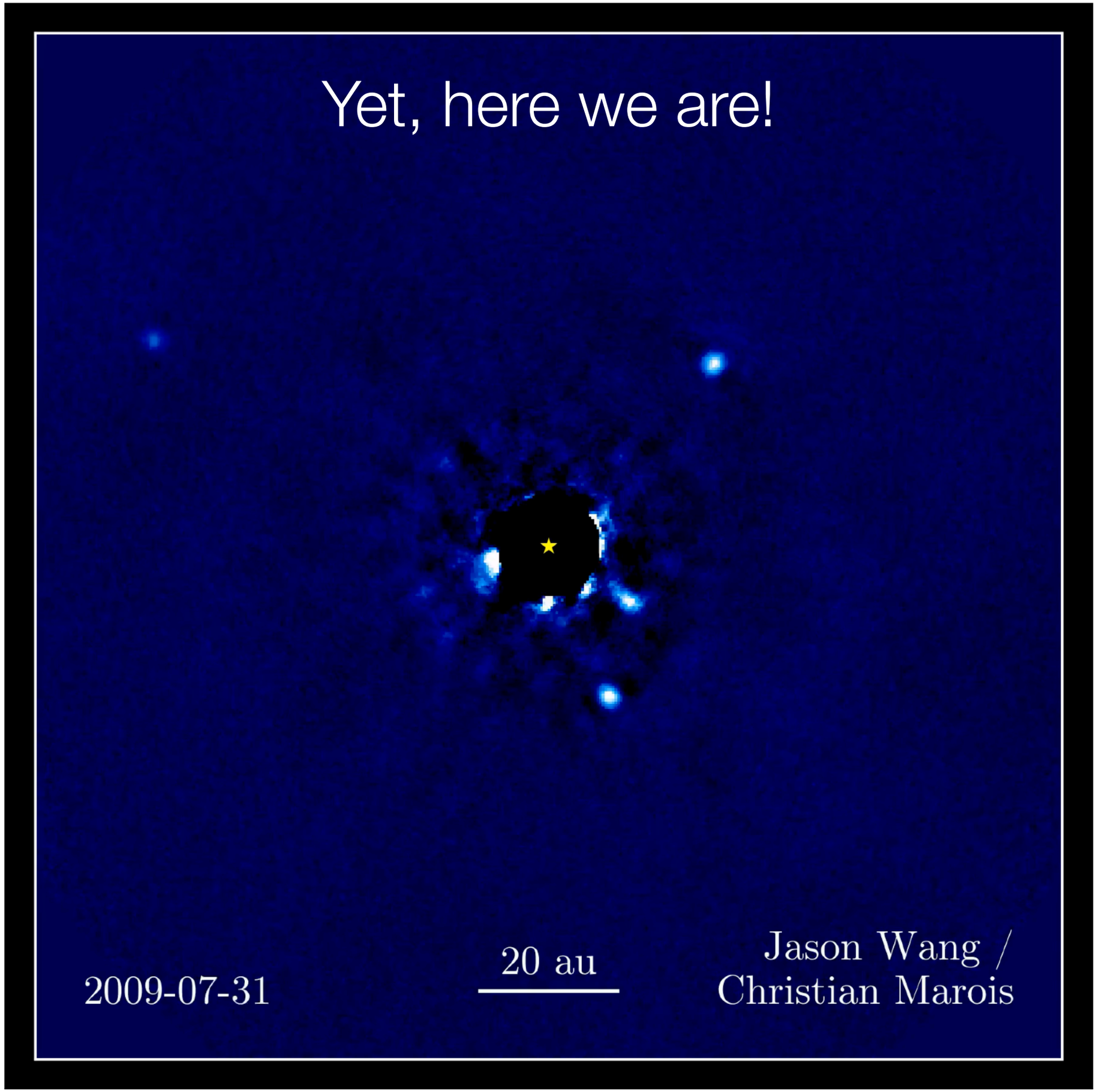
observe outer
planetary systems,
mostly inaccessible
by indirect methods

Direct imaging: a major challenge

Huge brightness ratio and very small separation

… like detecting a firefly next to a lighthouse, 1000 km away

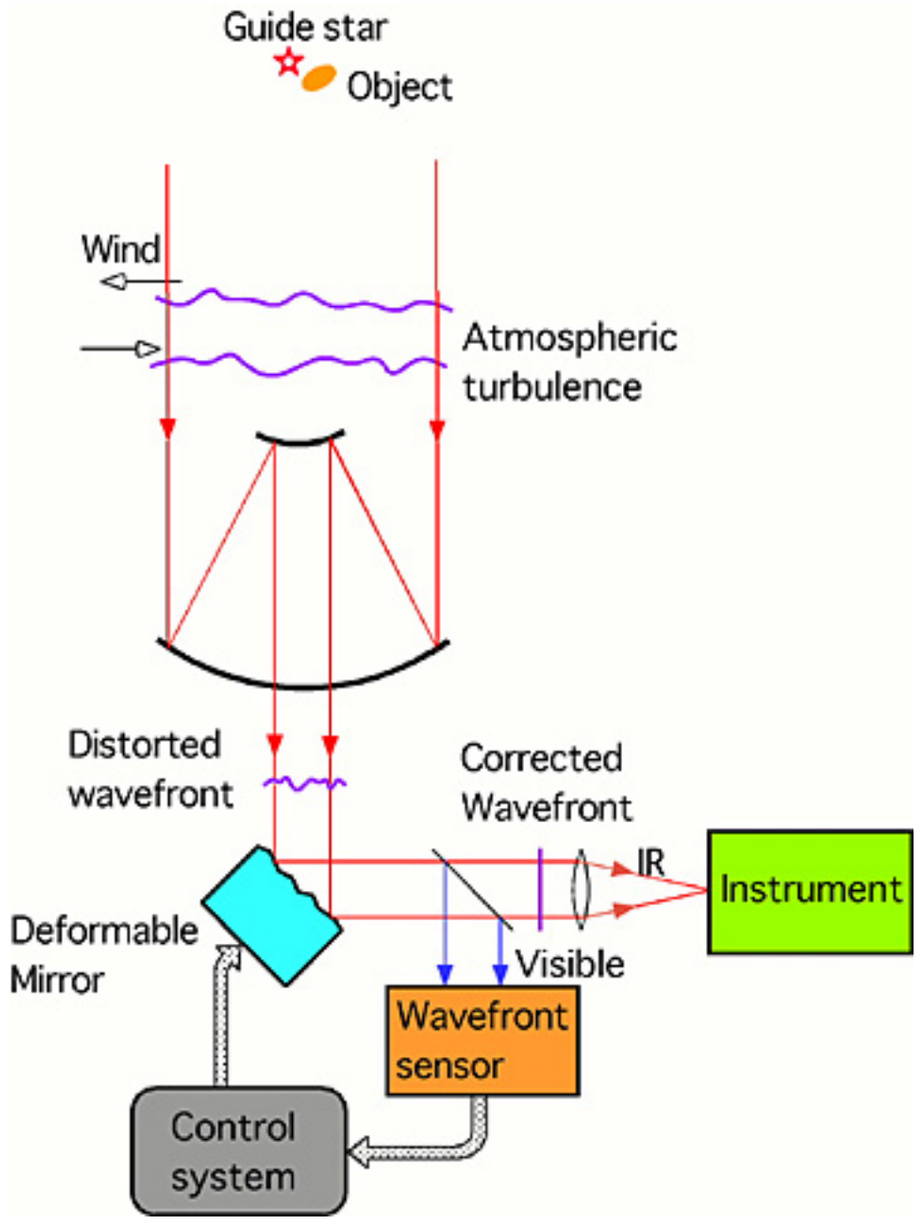
(note: the star never turns off)


Yet, here we are!
2009-07-31
20 au
Jason Wang /
Christian Marois

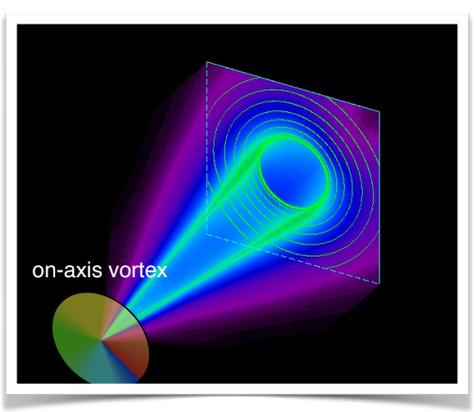
Enabling technologies:
where engineering meets astronomy

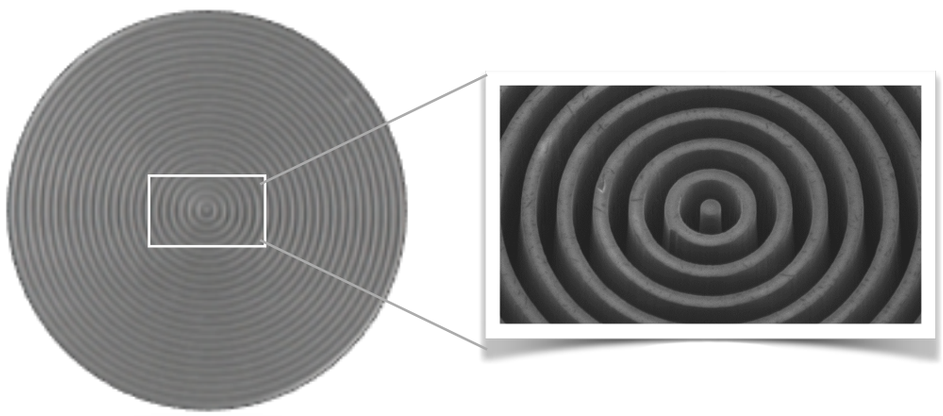
10-m class telescopes: resolving power

Adaptive optics: turbulence correction

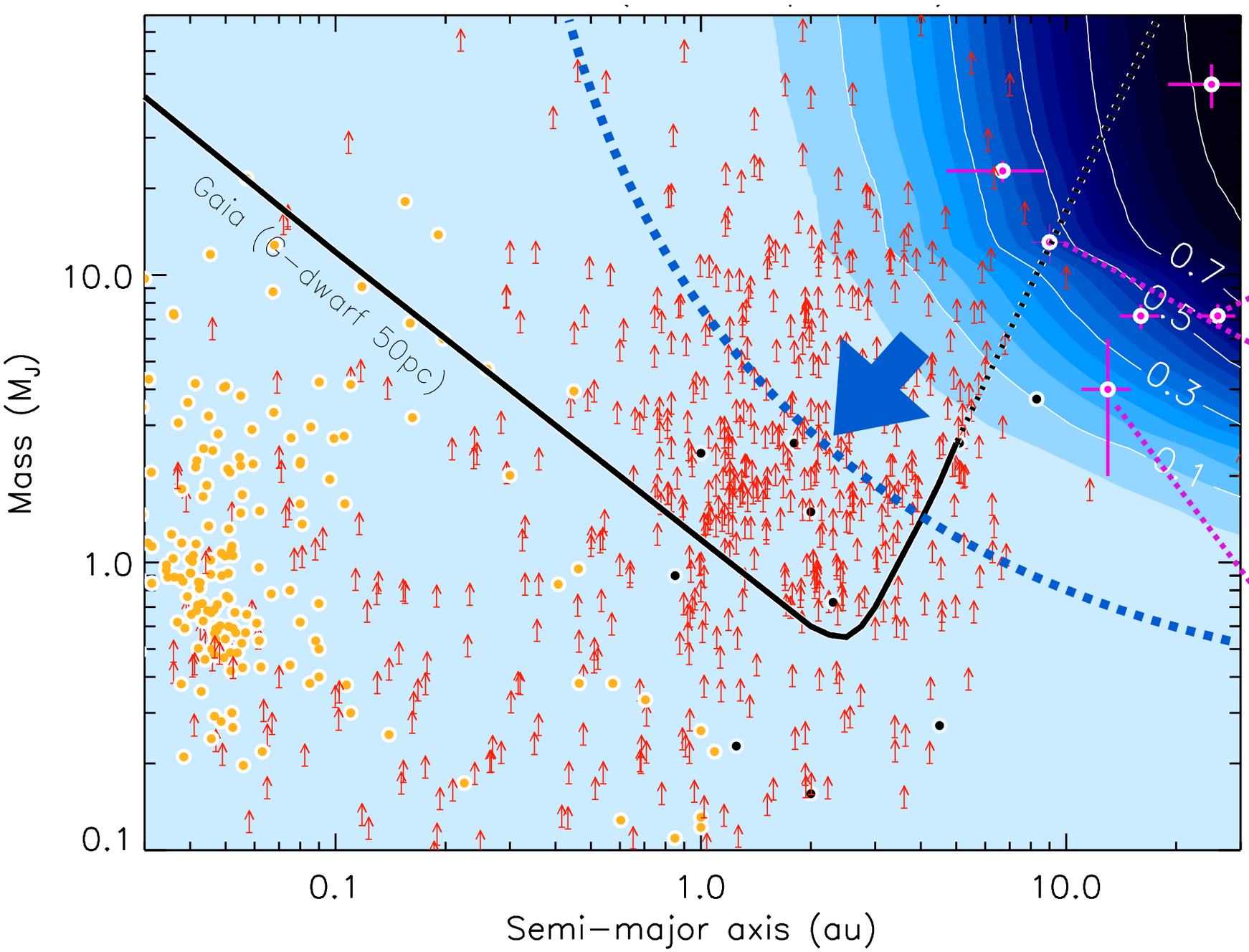


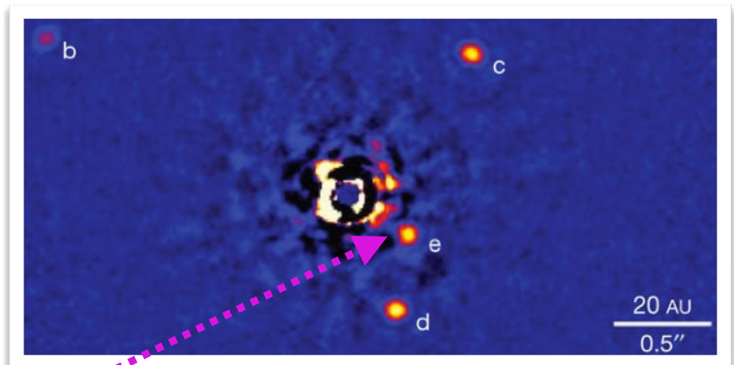
Coronagraphy: cancelling the blinding stellar light

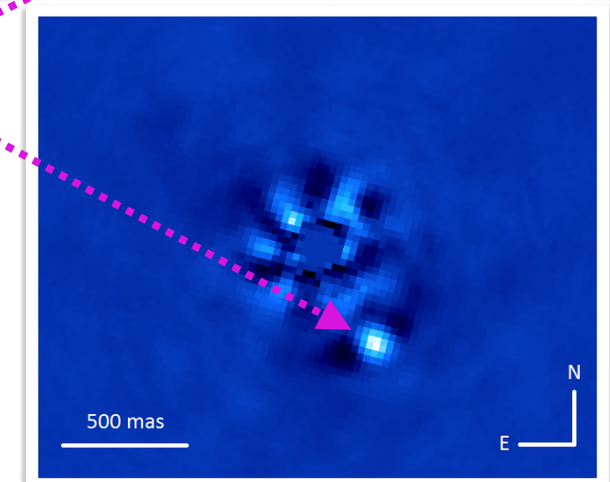


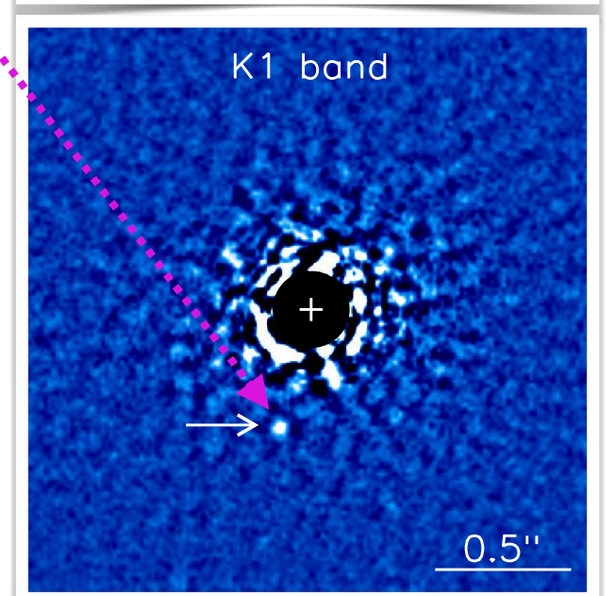


Only a dozen exoplanets imaged:
10m is not enough!

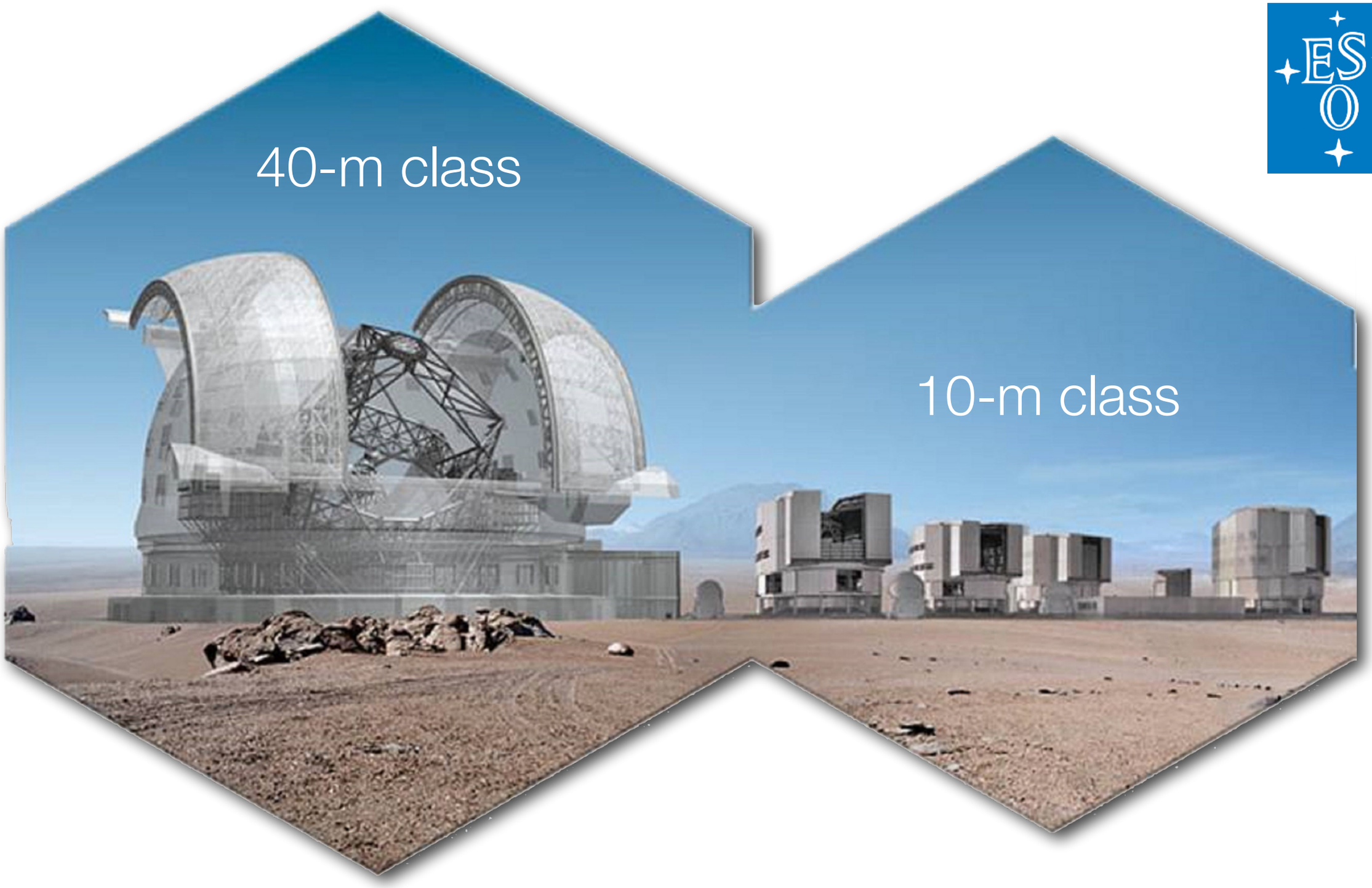




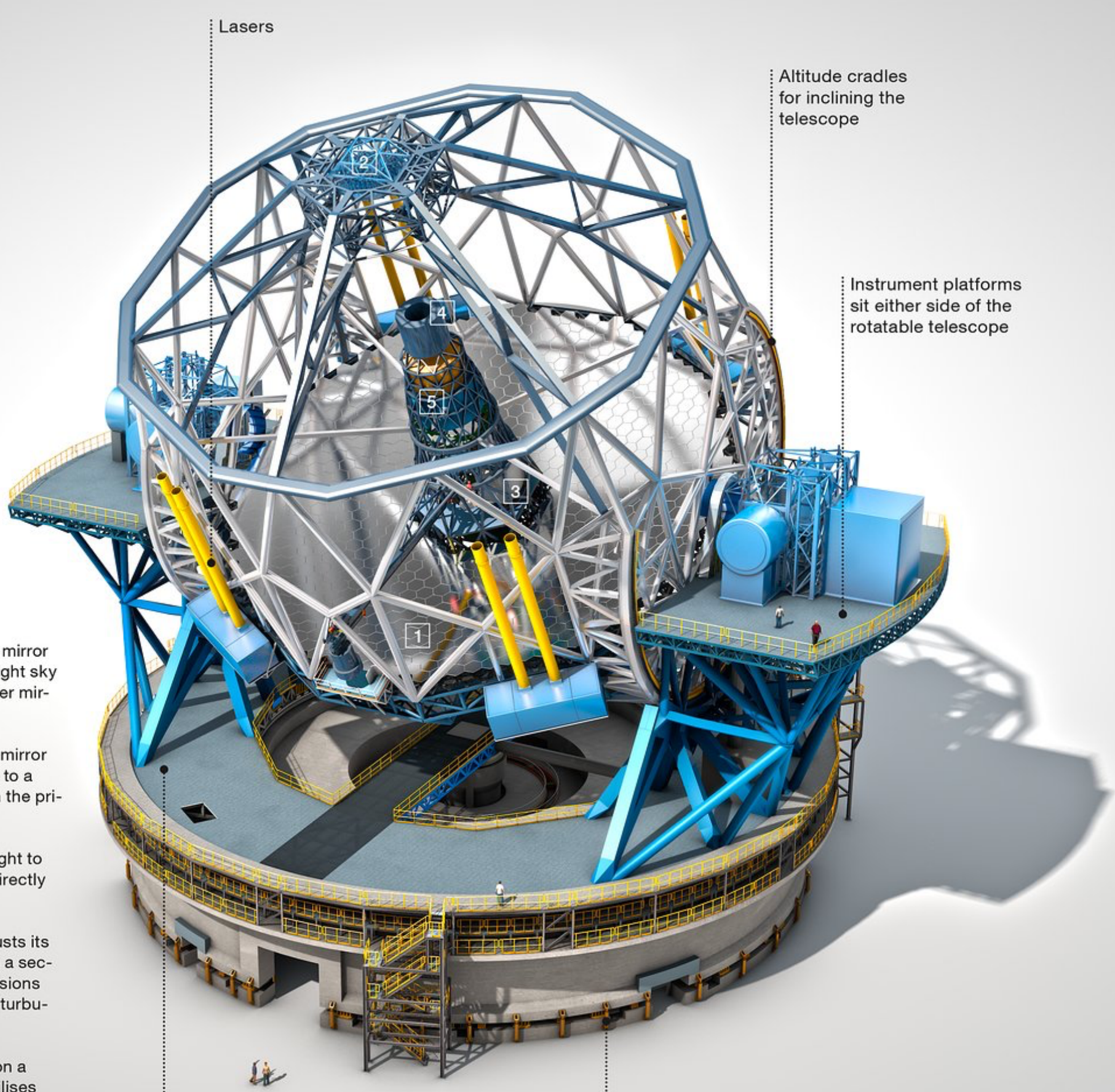




Extremely Large Telescope: the next (**BIG**) step



The ELT being built at Cerro Armazones (Chile)



Five-mirror design

1. The 39.3-metre primary mirror collects light from the night sky and reflects it to a smaller mirror located above it.

2. The 4-metre secondary mirror reflects light back down to a smaller mirror nestled in the primary mirror.

3. The third mirror relays light to an adaptive flat mirror directly above.

4. The adaptive mirror adjusts its shape a thousand times a second to correct for distorsions caused by atmospheric turbulence.

5. A fifth mirror, mounted on a fast-moving stage, stabilises the image and sends the light to cameras and other instruments on the stationary platform.

METIS: an ELT first-generation instrument with a strong Belgian contribution

Mid-infrared
E-ELT Imager and
Spectrograph

1:1 scale model

METIS PI

NOVA

Max-Planck-Institut für Astronomie Heidelberg
Max Planck Institute for Astronomy Heidelberg

KU LEUVEN

LIÈGE université

DE LA RECHERCHE À L'INDUSTRIE
cea

UKRI Science and Technology Facilities Council

centra
multidisciplinary centre for astrophysics

UNIVERSITY OF MICHIGAN

A*

ESO

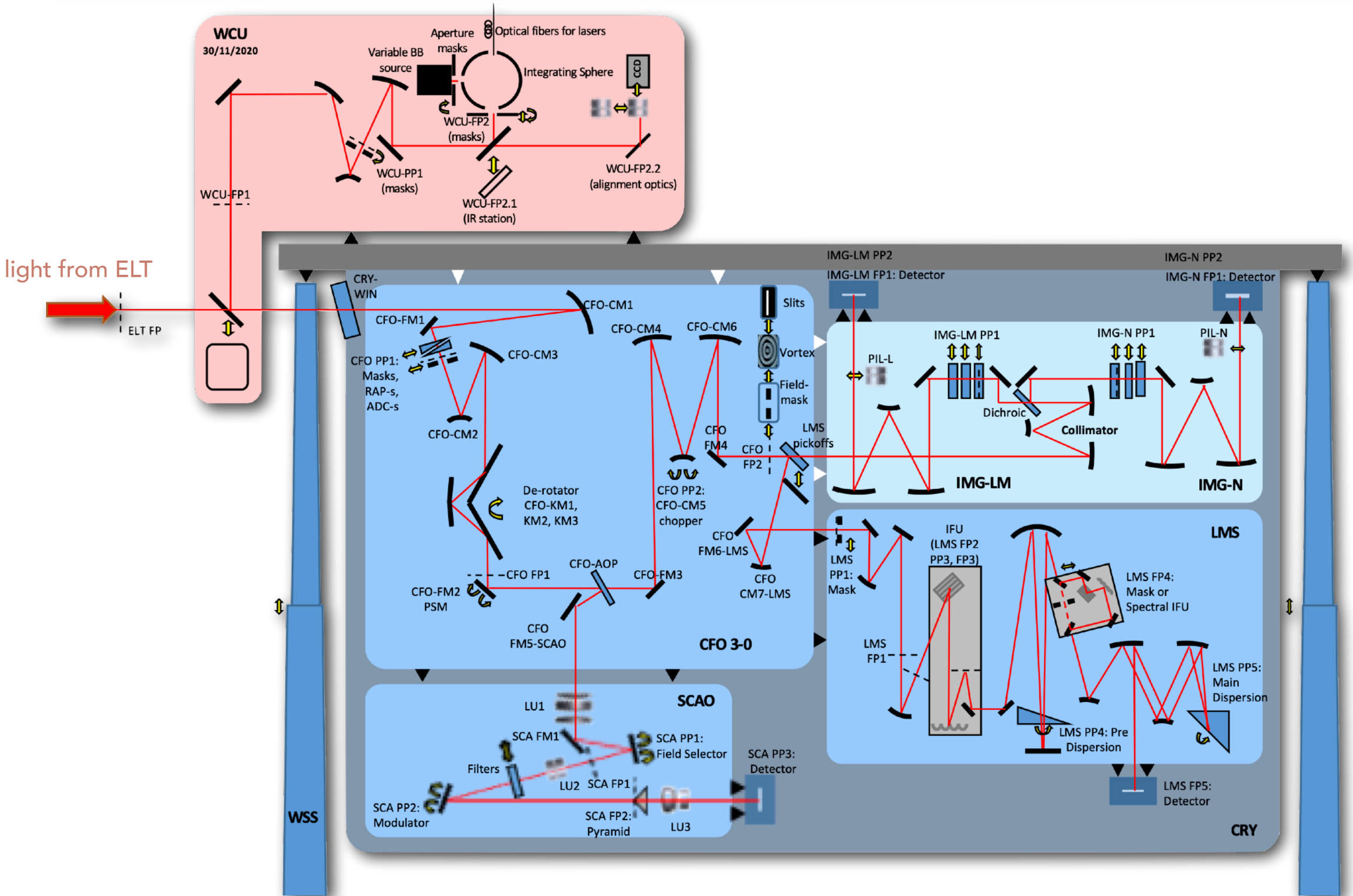
Universität zu Köln

ETH zürich

ASIAA

A complex mid-IR instrument, combining (high-contrast) imaging and spectroscopy

METIS
Mid-infrared
E-ELT Imager and
Spectrograph

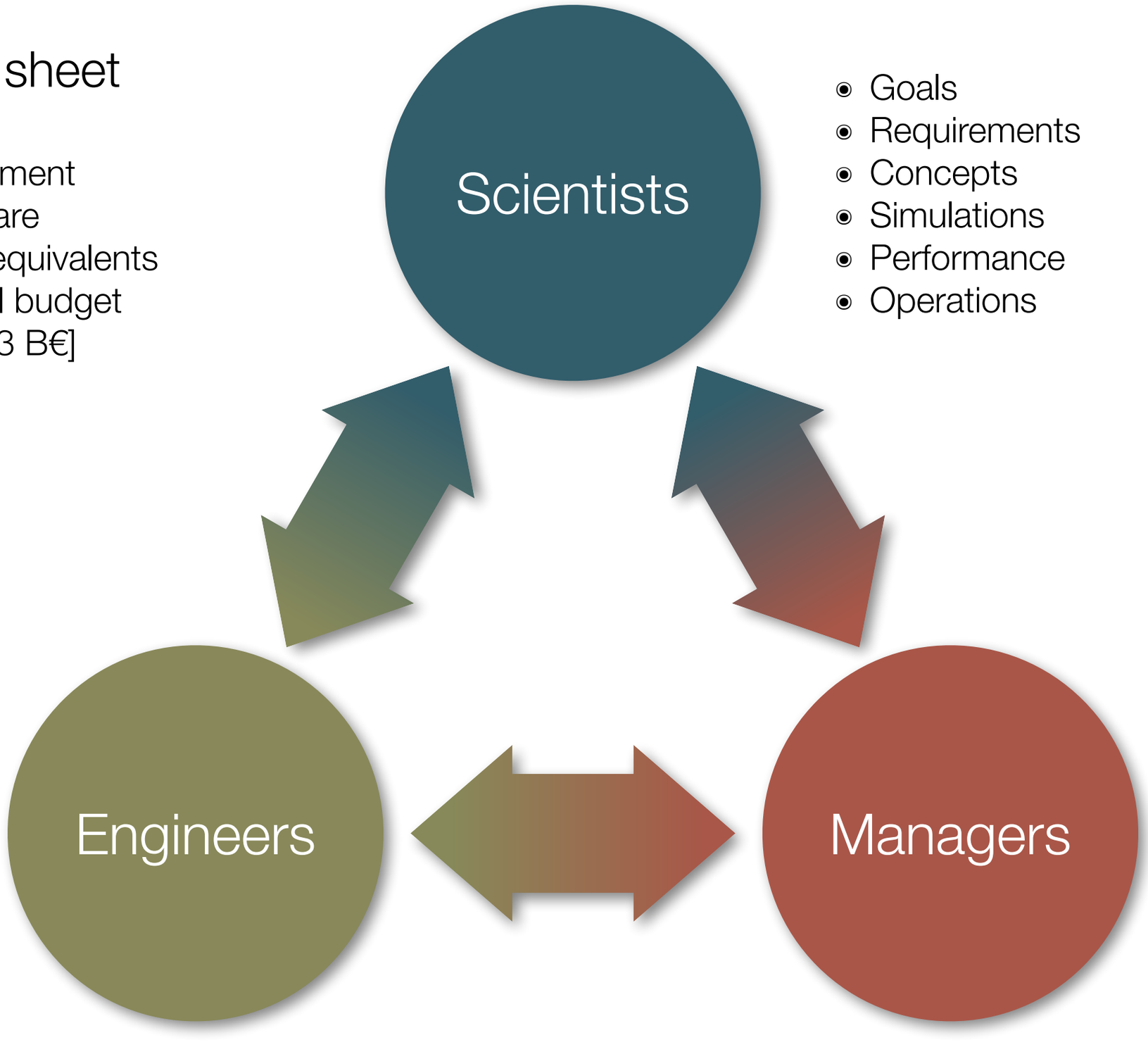


A synergy between many disciplines

METIS
Mid-infrared
E-ELT Imager and
Spectrograph

METIS fact sheet

- 13-yr project
- 21 tons instrument
- 20 M€ hardware
- 670 full-time equivalents
- ~100 M€ total budget
- [telescope: 1.3 B€]



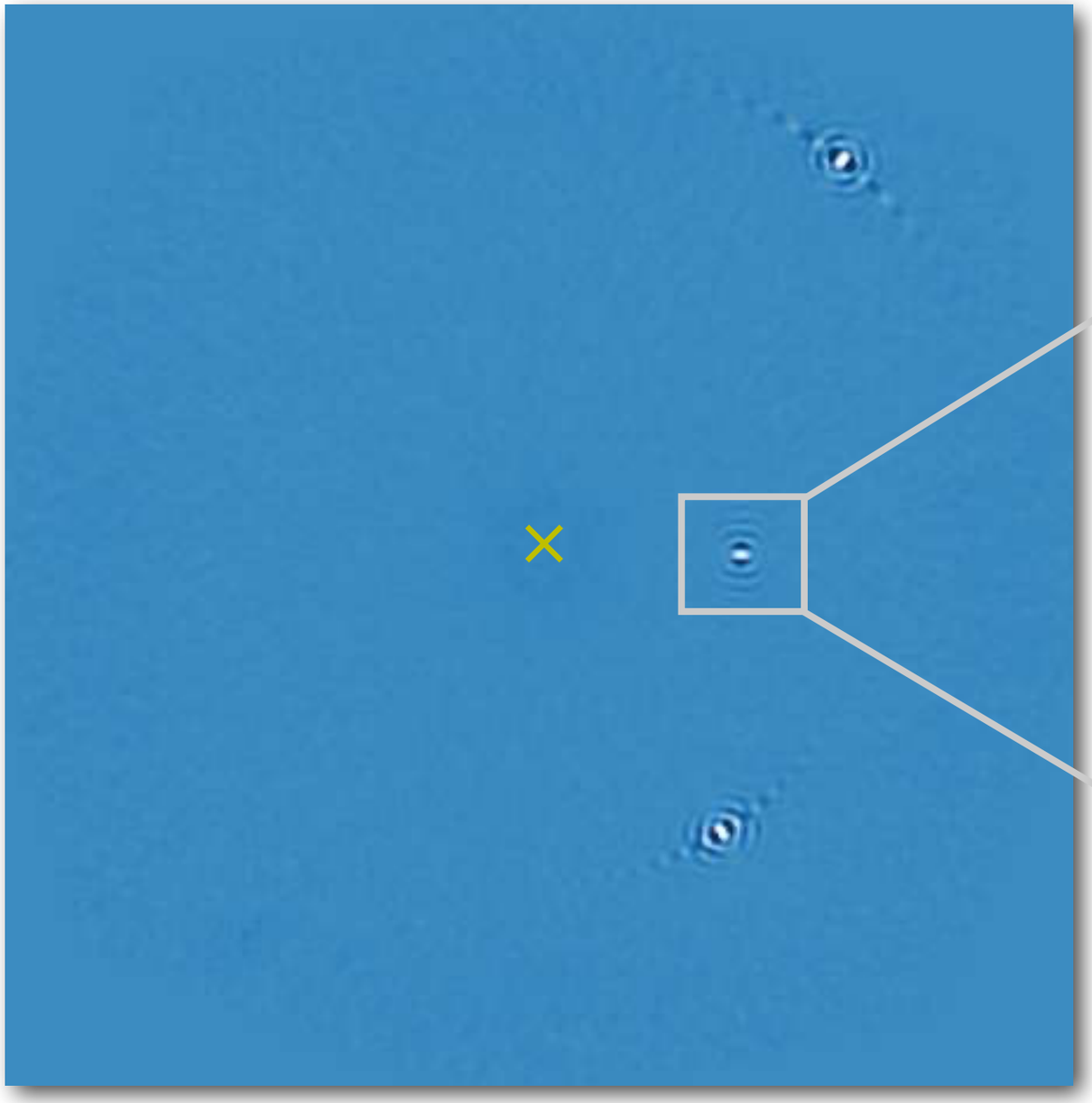
- Goals
- Requirements
- Concepts
- Simulations
- Performance
- Operations

- System
- Optics
- Mechanics
- Cryogeny
- Interfaces
- Control
- Software

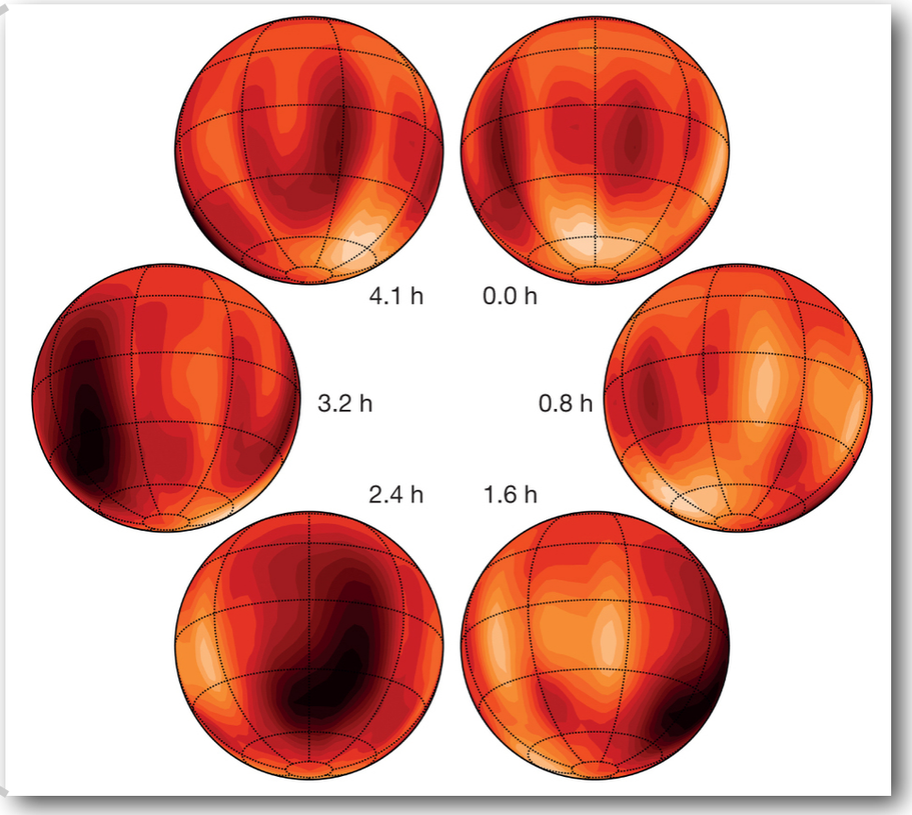
- Coordination
- Planning
- Risks
- Quality
- Procurement
- Budget

New insights into giant exoplanets using tomographic imaging techniques

METIS
Mid-infrared
E-ELT Imager and
Spectrograph



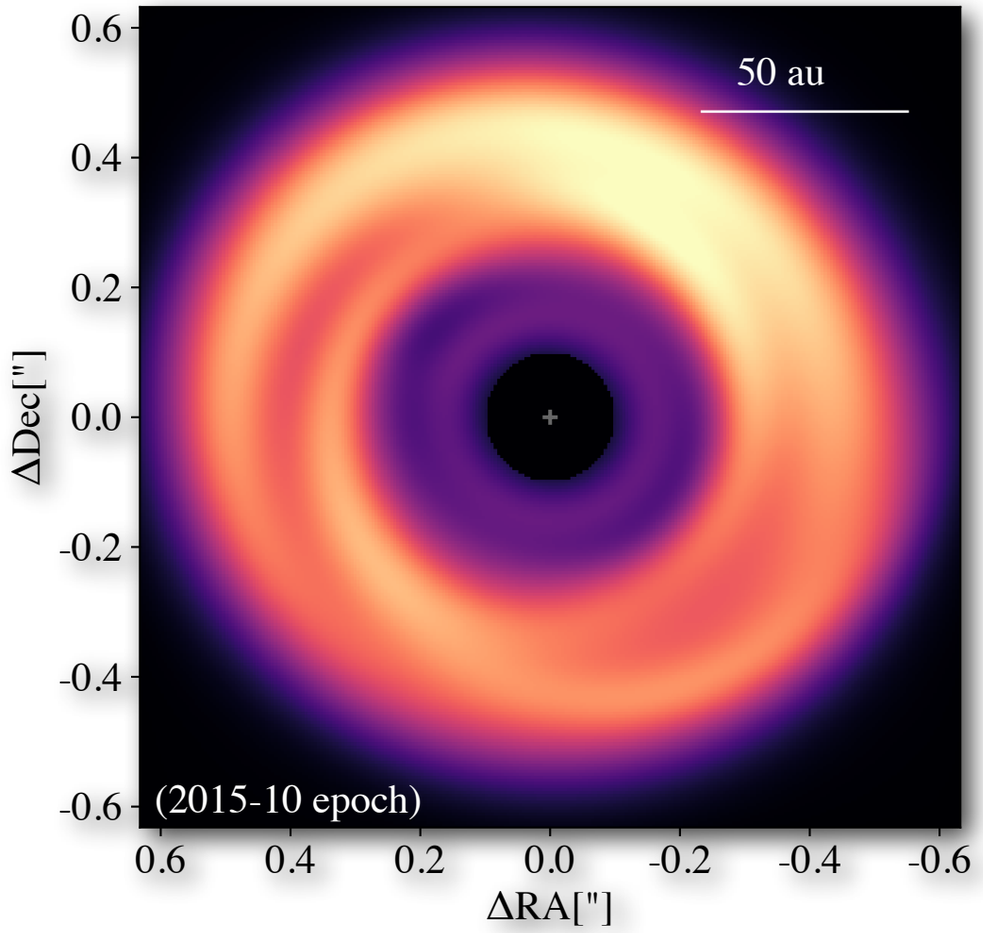
weather patterns on giant exoplanets



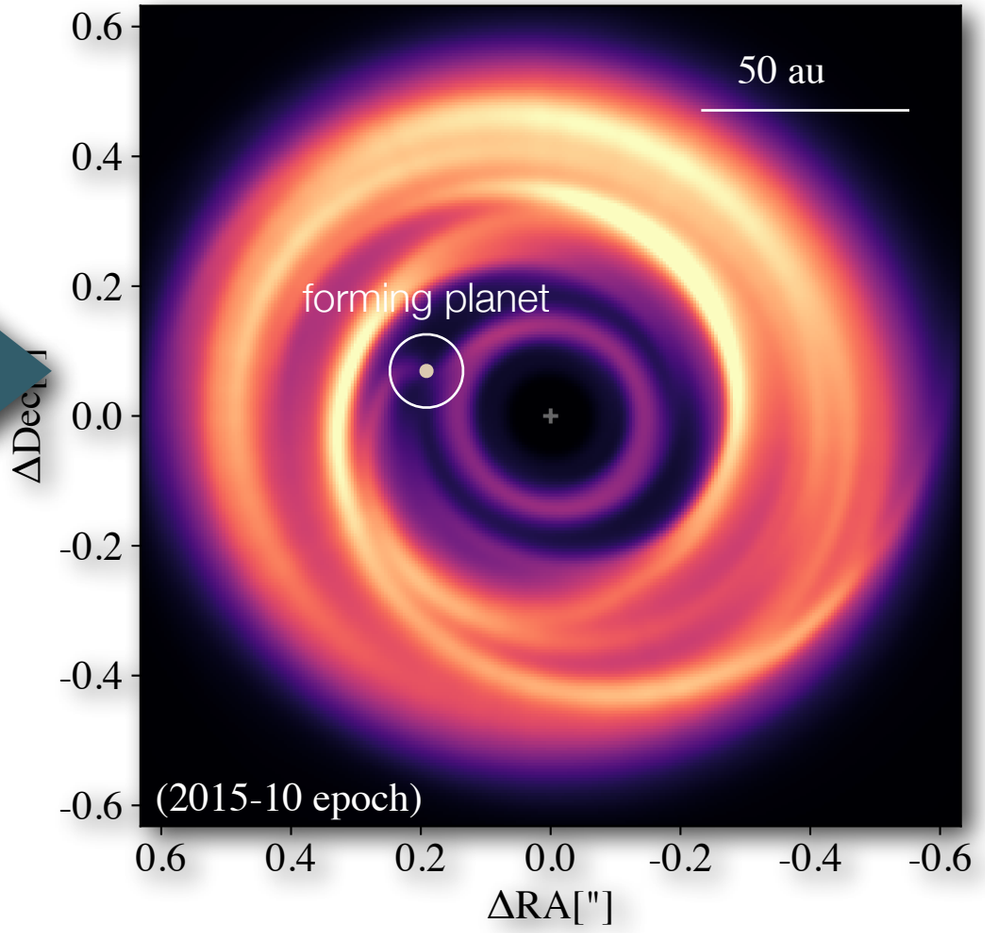
Witness the birth of planets around young stars

METIS
Mid-infrared
E-ELT Imager and
Spectrograph

10m class telescope

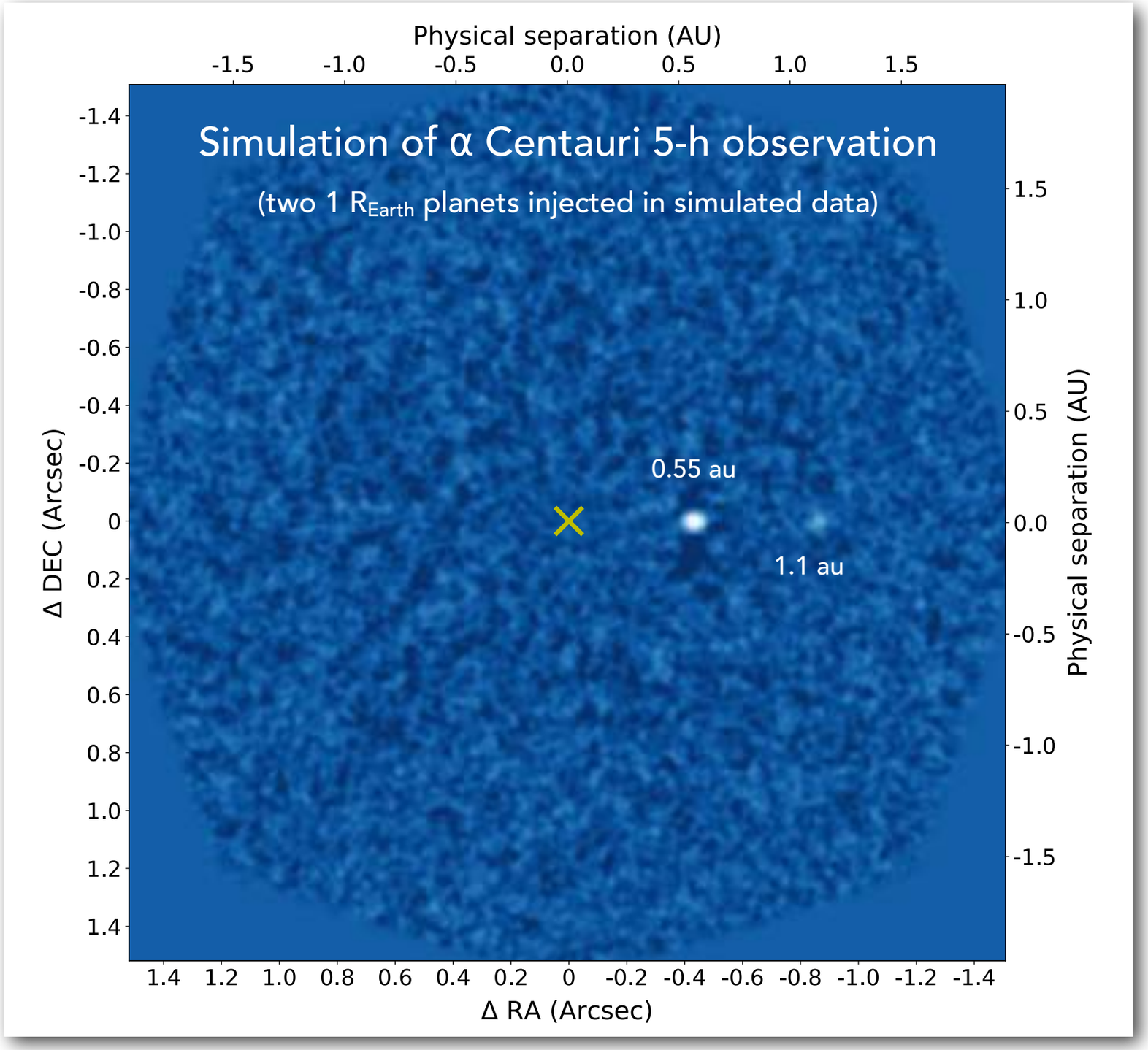


40m class telescope

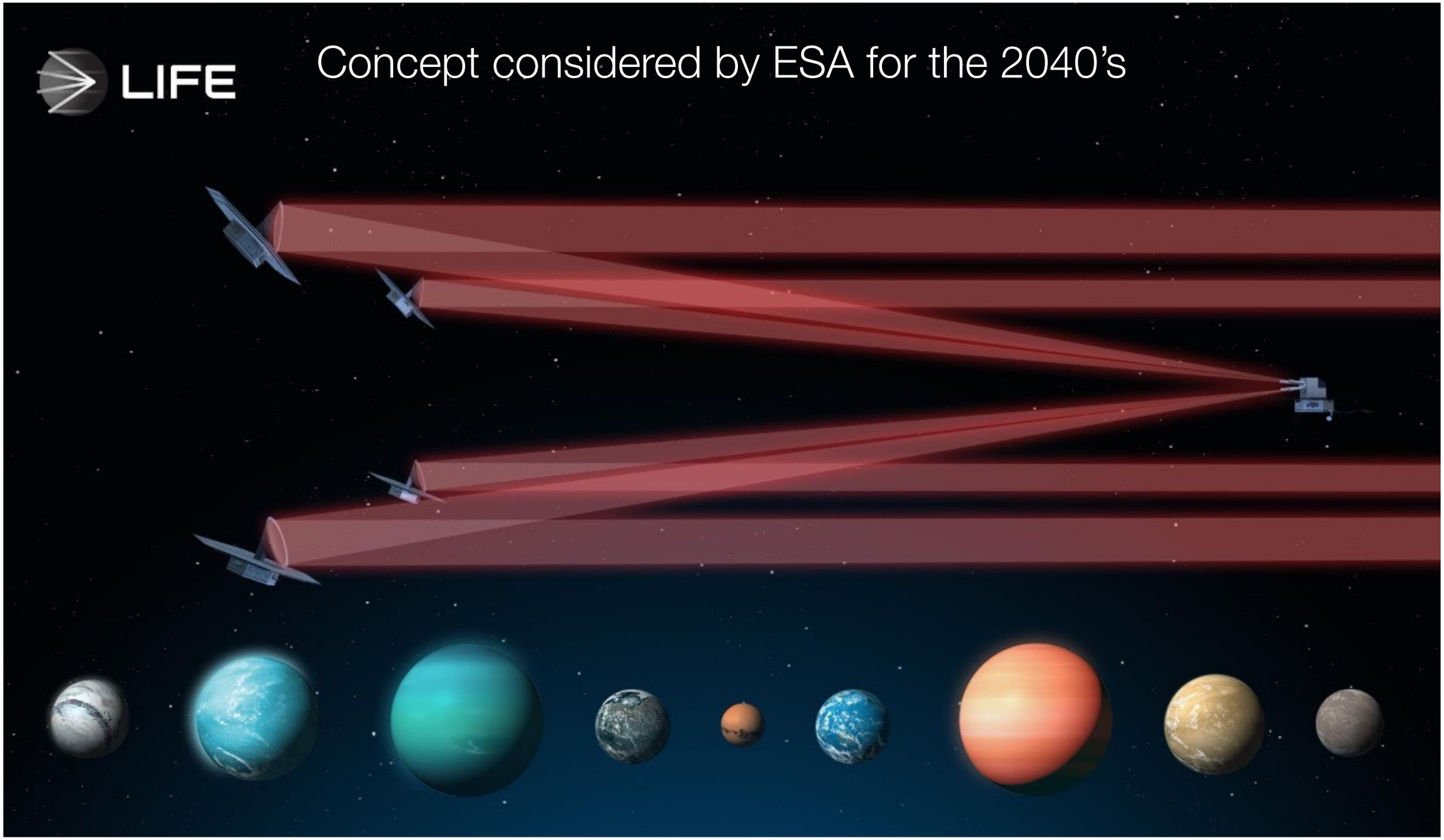


A first short at imaging Earth-like planets

Mid-infrared
E-ELT Imager and
Spectrograph



Towards a large sample of rocky planets & thorough atmospheric characterization



The future is bright for exoplanet science