Exoplanets

Lecture 14
MFF UK
07 January 2022

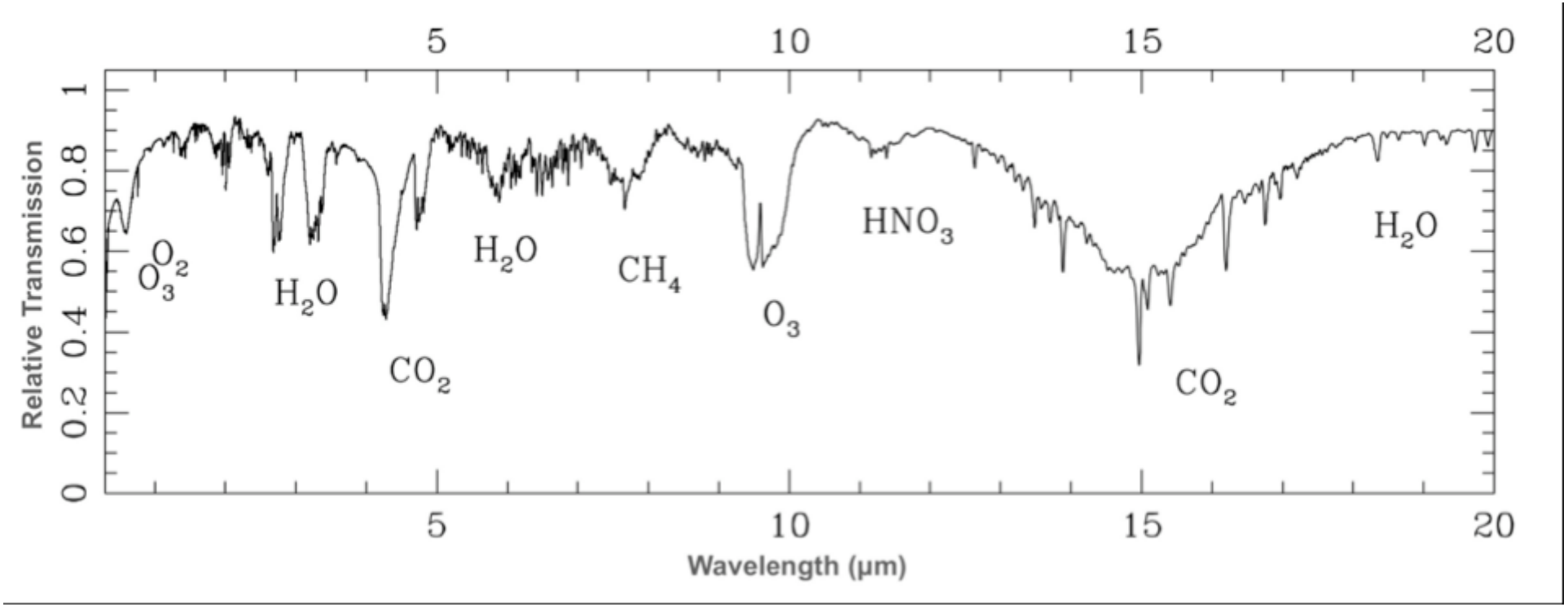
Outline

- Life on Jupiter (Sagan paper)
- Future missions and instruments
- Discussion wrap-up

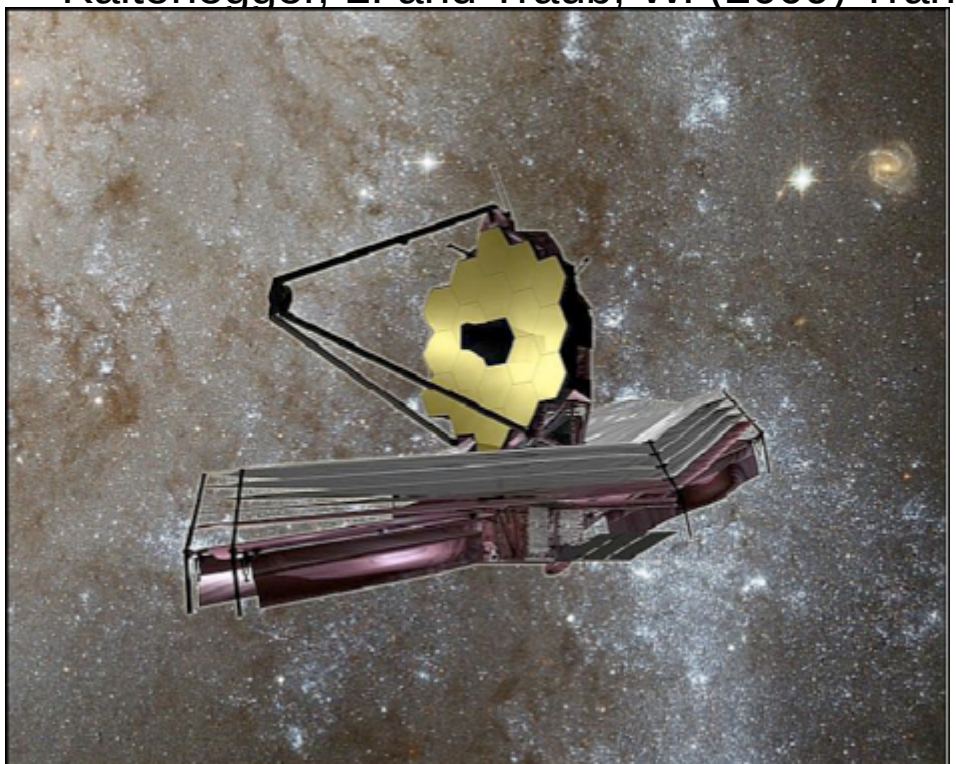
Credit: Carl Sagan Cosmos

JWST

- MIRI - mid-IR camera
- NIRI – near-IR camera
- NIRSpec – near-IR spectrograph
- NIRISS – near-IR imager and slitless spectrogr.
- Exoplanets and Solar systém one of the key themes
- Launch date 2021



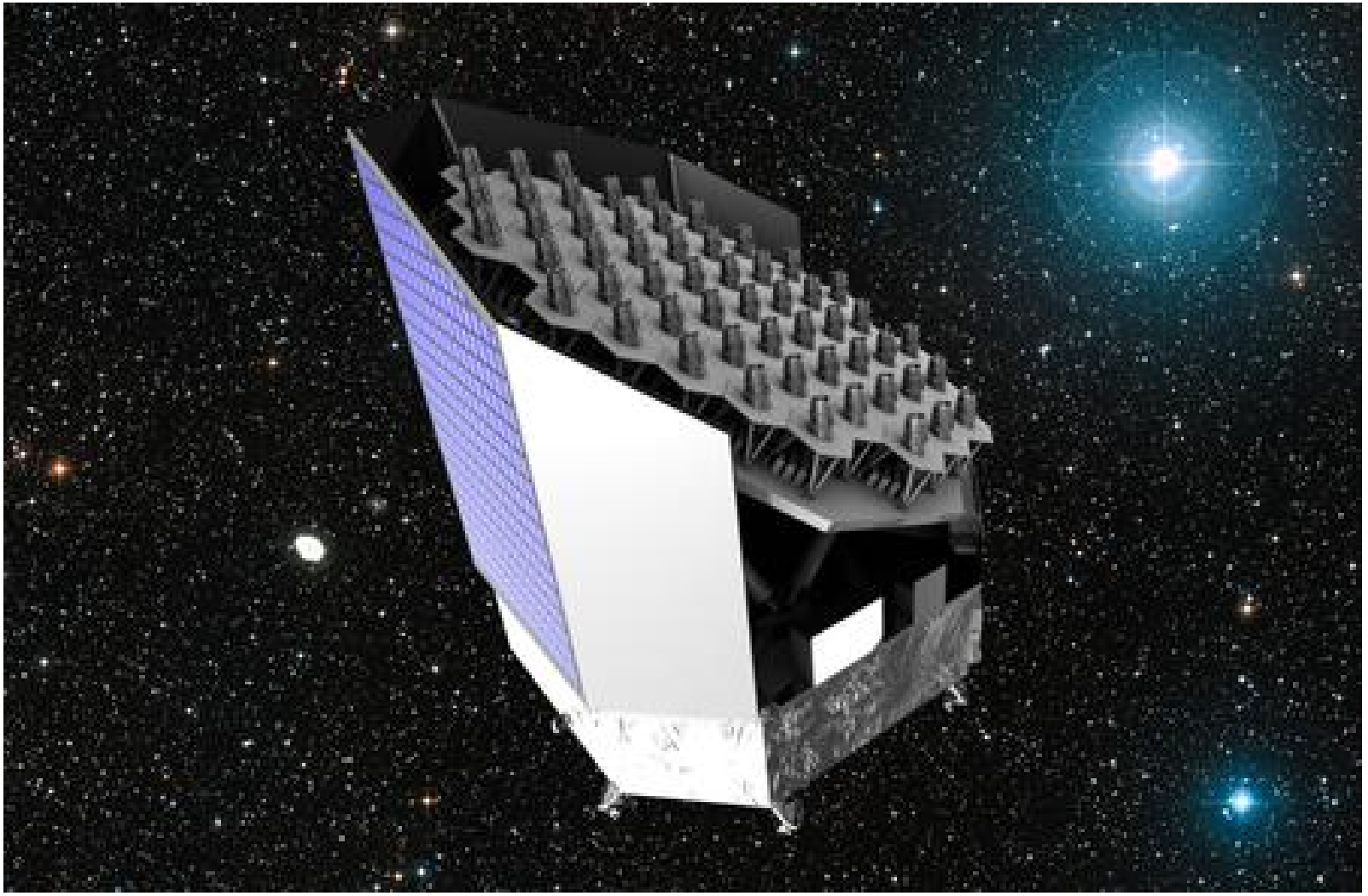
Kaltenegger, L. and Traub, W. (2009) Transits of Earth-Like Planets. Astrophysical Journal



JWST
Launch 2021
Ideal for characterization of small planets in infrared

Image NASA

Plato Space mission



Credit: Thales Alenia Space

PLATO Space mission

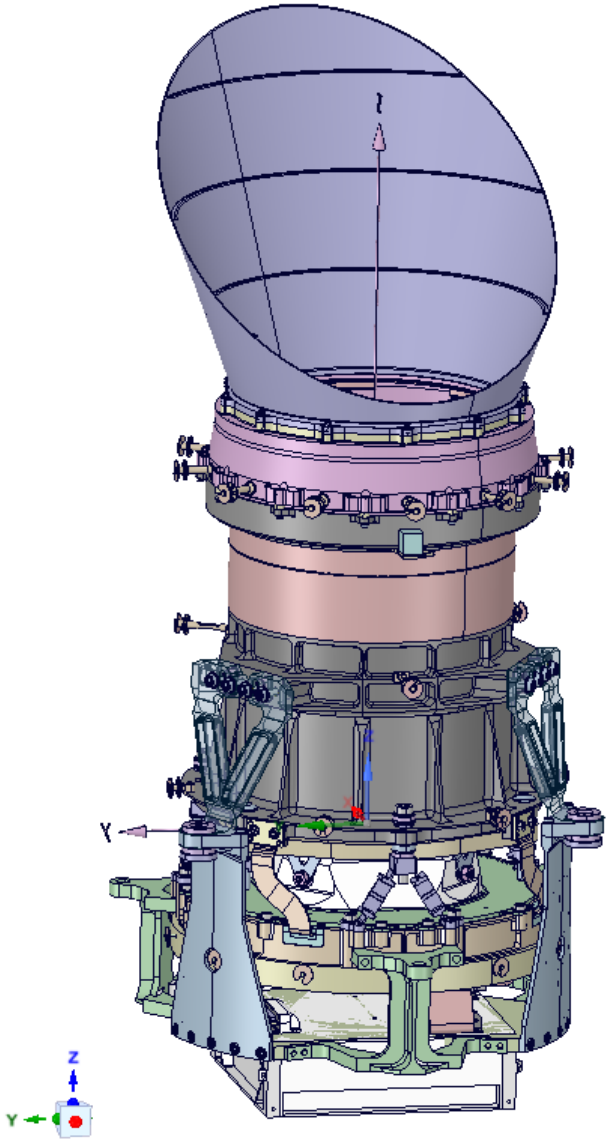
- PLAnetary Transits and Oscillations of stars
- Theme: What are the conditions for planet formation and the emergence of life?
- Primary Goal Detection and characterisation of terrestrial exoplanets around bright solar-type stars, with emphasis on planets orbiting in the habitable zone.
- Photometric monitoring of a large number of bright stars for the detection of planetary transits and the determination of the planetary radii (around 2% accuracy)
- Ground-based radial velocity follow-up observations for the determination of the planetary masses (around 10% accuracy)
- Asteroseismology for the determination of stellar masses, radii, and ages (up to 10% of the main sequence lifetime)
- Identification of bright targets fr spectroscopic follow-up observations of planetary atmospheres with other ground and space facilities

- LAUNCH 2026

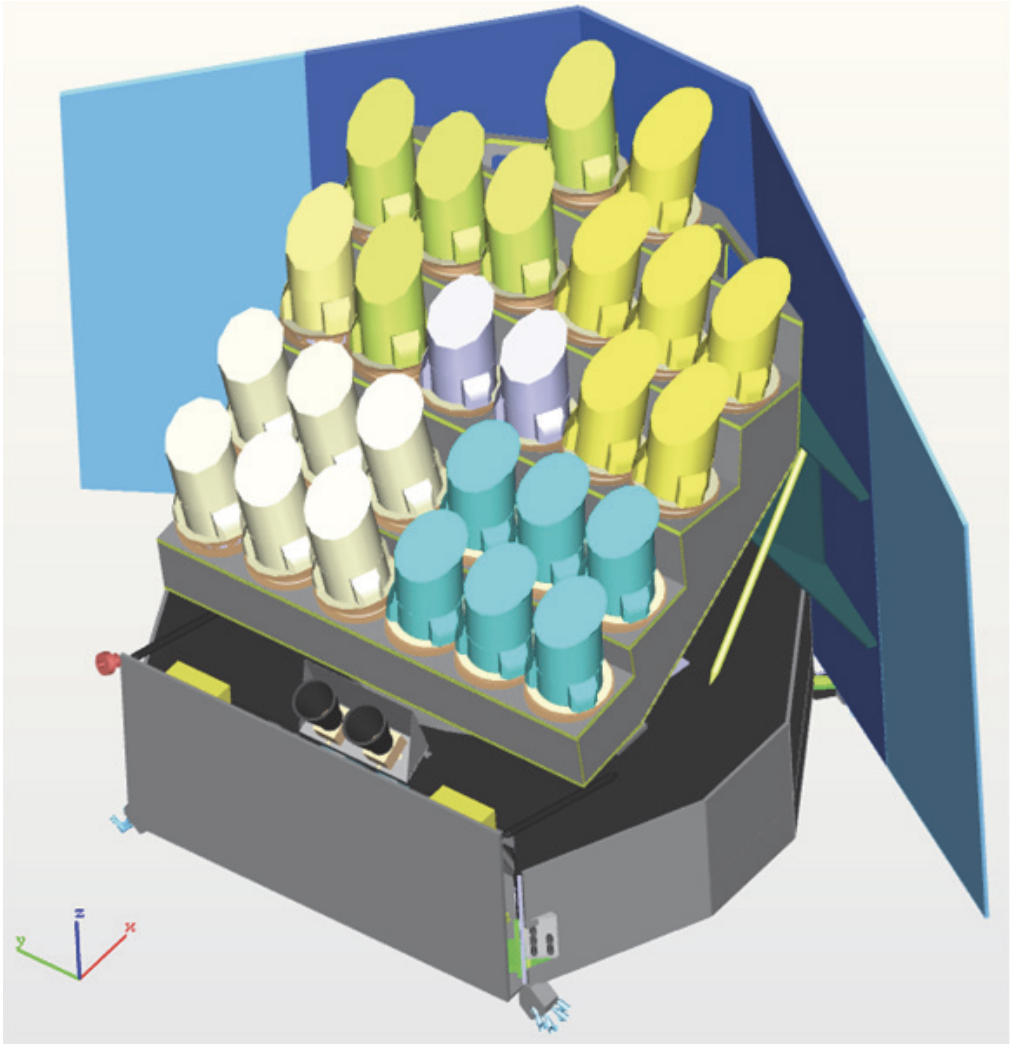
PLATO Space mission

- The instrument consists of 26 "normal" telescopes
- Stars with mV > 8. Two additional “fast” cameras with high read-out cadence (2.5 s) will be used for stars with mV ~4–8
- Each camera has an 1100 deg2 FoV and a pupil diameter of 120 mm and is equipped with a focal plane array of 4 CCDs each with 45102 pixels of 18 μm size

PLATO camera

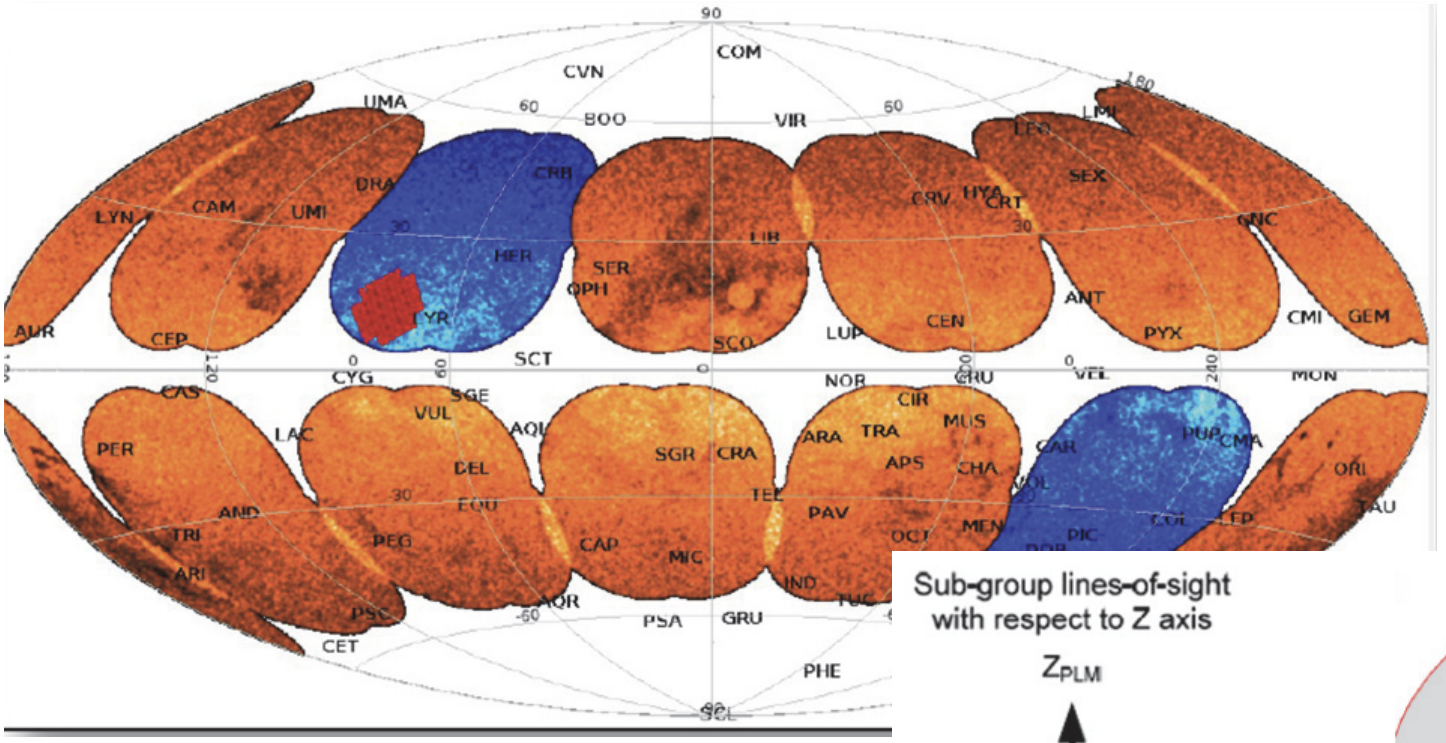


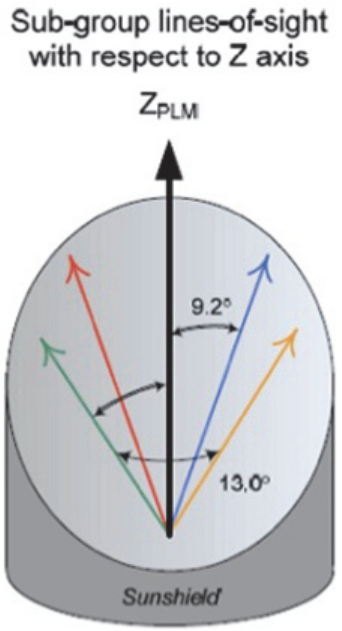
Credit: PLATO consortium

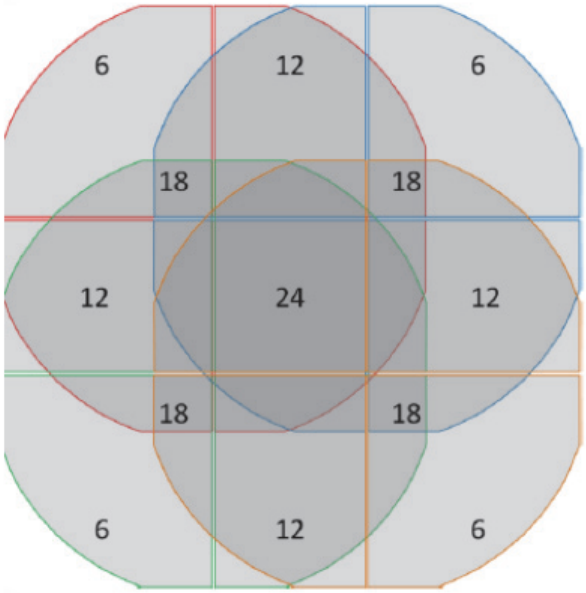


Credit: PLATO consortium

PLATO observing strategy







Approx 40% sky coverage

Credit: PLATO consortium

ELT - 2024

- EPICS – Exoplanet imagng camera and spectrograph

  https://www.eso.org/sci/libraries/SPIE2010/7735-84.pdf
- METIS - The Mid-infrared E-ELT Im. and Spectr. - 3–20 μm

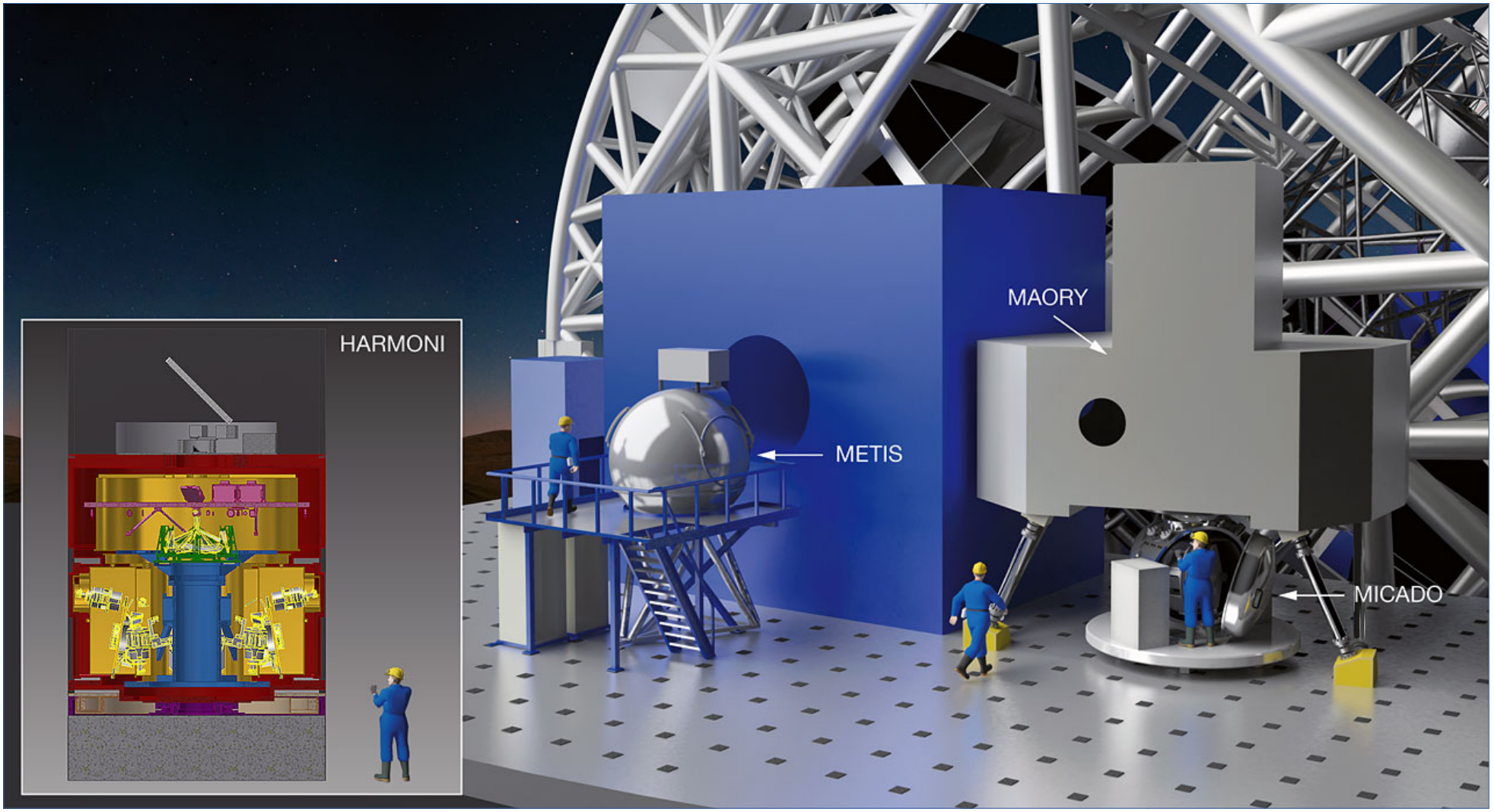
  Low-resolution (R < 1,000) at L,M,N

  Medium-resolution (R <10,000) at N

  High-resolution (R~100,000) IFU at L,M
- HARMONI - is a visible and near-infrared (0.47 to 2.45 μm) integral field spectrograph, providing the E-ELT's core spectroscopic capability, over a range of resolving powers from R (≡λ/Δλ) ~500 to R~20000.

https://www.eso.org/public/images/ann15056a/

ELT



Credit: ESO

https://stelweb.asu.cas.cz/plato/index.html

PLATO Space mission

- Monitoring of 1 million bright stars
- Need for extensive RV follow-up
- ***Minimum*** 50 nights/year on 1-2 m facilities
- **Ground based follow-up for PLATO is recognized by ESA as a part of the mission!**
- **Literally every spectrograph on a 1-2 m class telescope will be needed! There are no projects like PLATOSPec!**
- **Contribution to TESS space mission is foreseen too!**

PlatoSpec

PLATOSPec specs

- Stellar parameters
- Initial screening of candidates
- Rejection of false positives
- Characterization of hot Jupiters
- Exoatmospheres
- Asteroseismology
- Additional science

- RV measurements
  - accuracy 5-10 m/s
  - for stars 4-11 mag
  - SNR 30-40 in max. 1 hrs (est.)

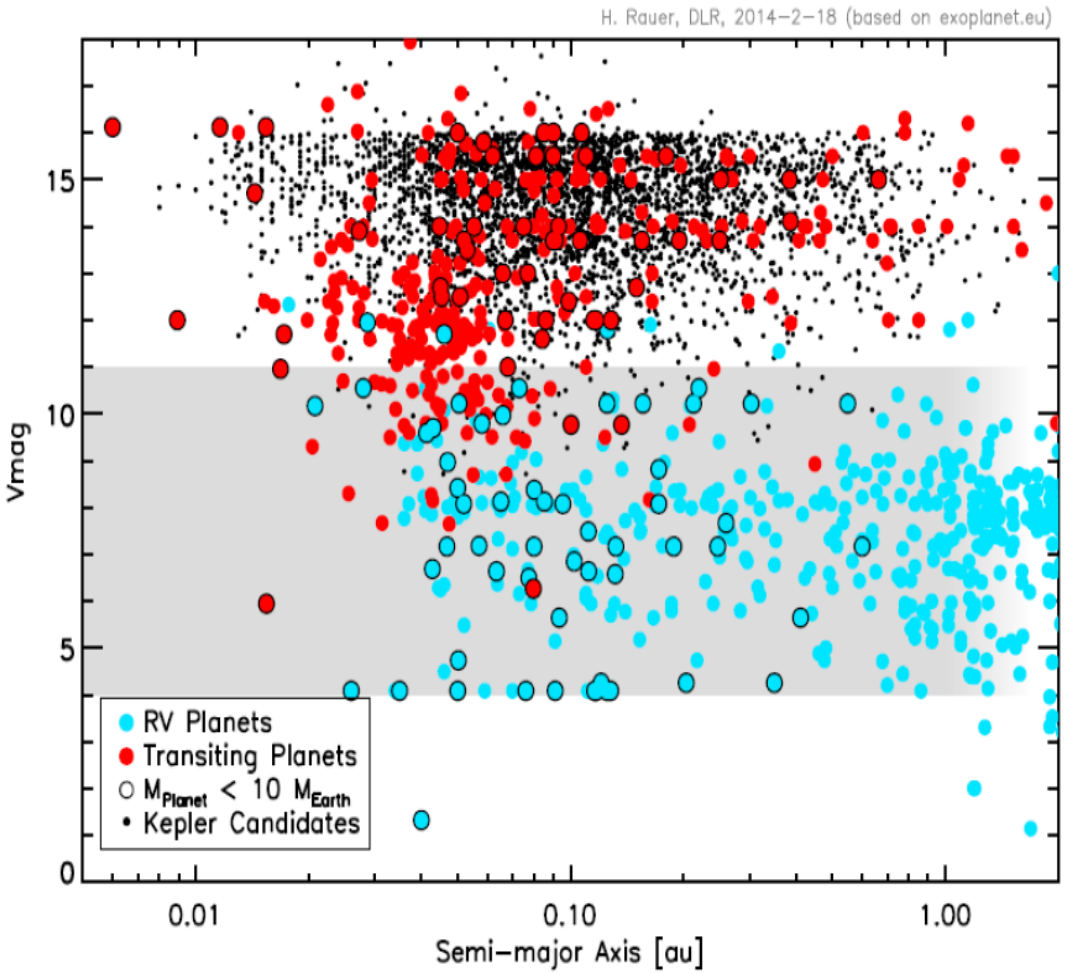
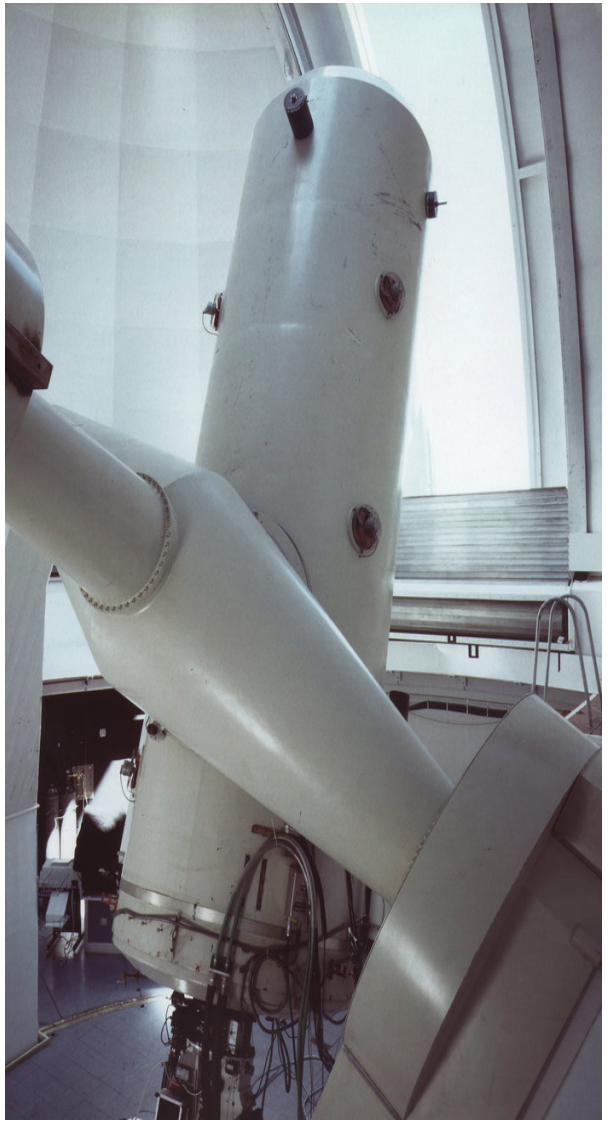


Fig. 2: *PLATO space mission will provide photometric measurements for about 1 million Stars in the grey area of the Figure. From Rauer et al. 2012*

PlatoSpec

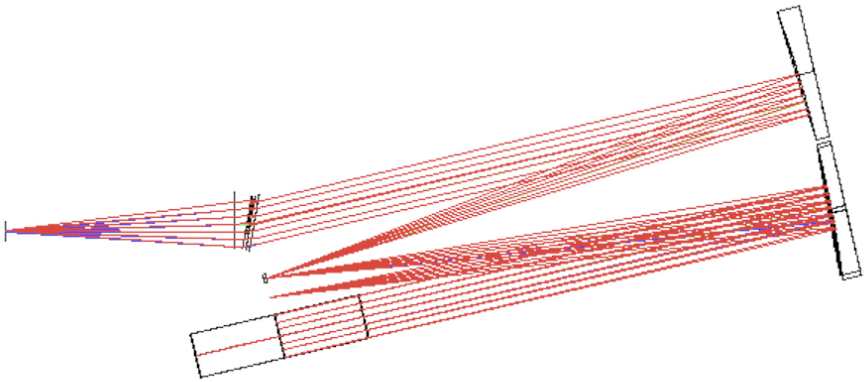
The Telescope

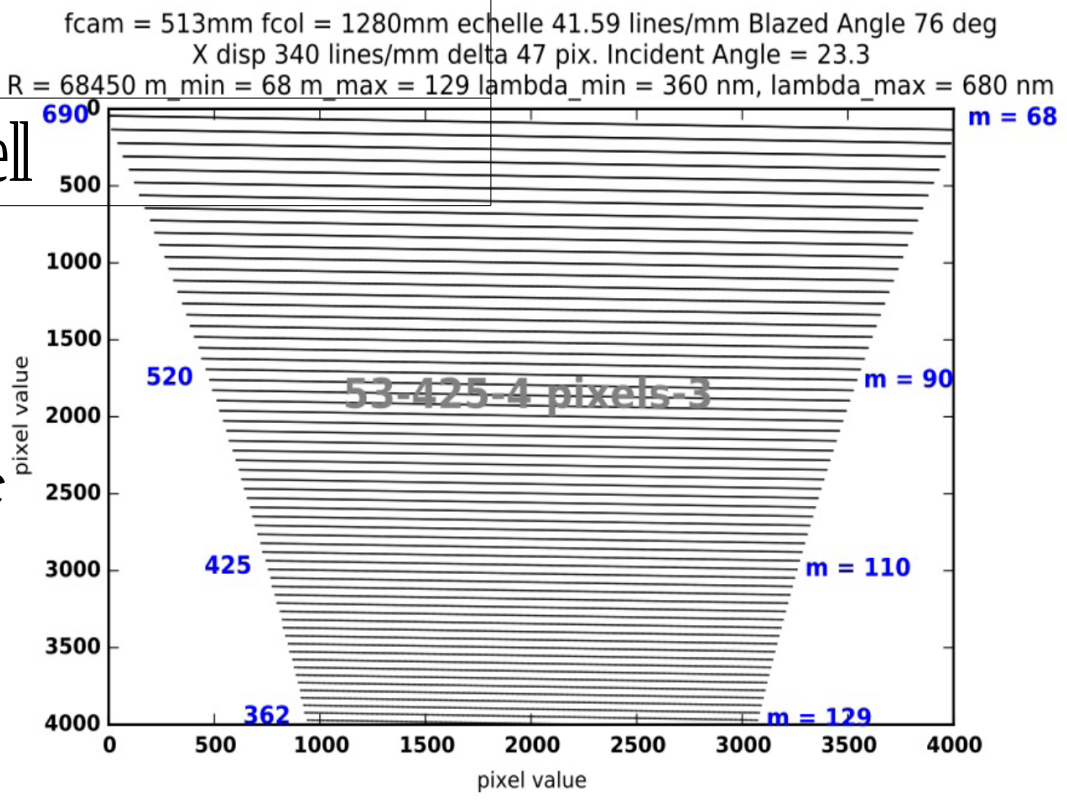


1.52-m former ESO telescope at La Silla

The instrument

Table 1: Main paramateres of the spectrograph	
Echelle spectrograph	Parameter value
Wavelength coverage	360-680 nm
Spectral resolution	70k
Thermal stability	0.1deg
RV accuracy	3m/s
Calibration	ThAr+Iodine cell





Figures and Table from:

PLATO science justification report - ESO STC

What comes next?

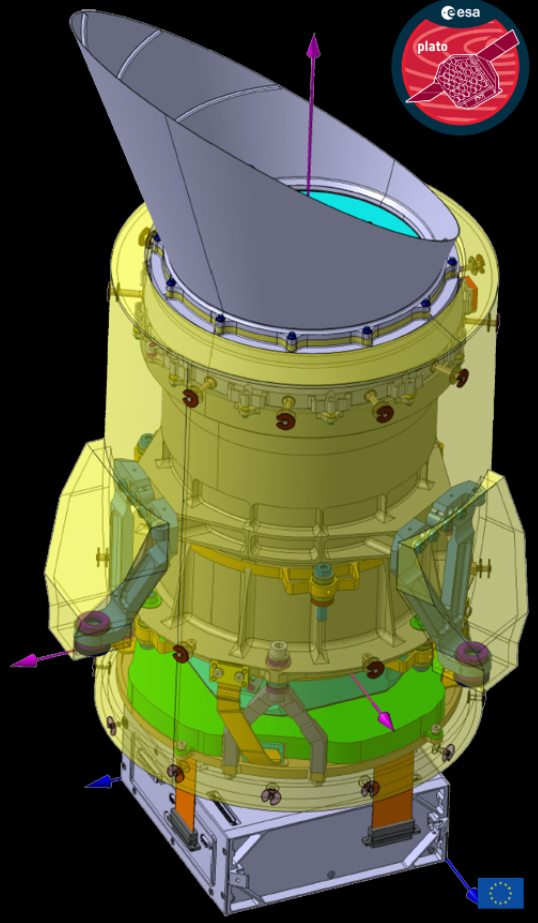
- NIR spectrograph for characterization of exo-atmospheres
- Launch date 2028
- CZ contribution

Credit: ARIEL consortium

Elliptical primary mirror:Â 1.1 x 0.7 metres

Planet Hunters

PlatoSpec



Space observatory
PLATO telescope
(2026)

E152 telescope
ESO, La Silla observatory
Chile (2021)

Astronomický ústav AV ČR

2-meter Perek Telescope
Astronomical Institute ASCR
Czech Republic

2-meter Alfred Jensch Telescope
The Karl Schwarzschild Observatory
Germany

Images credit: Zdenek Bardon/ESO

Astronomický ústav AV ČR

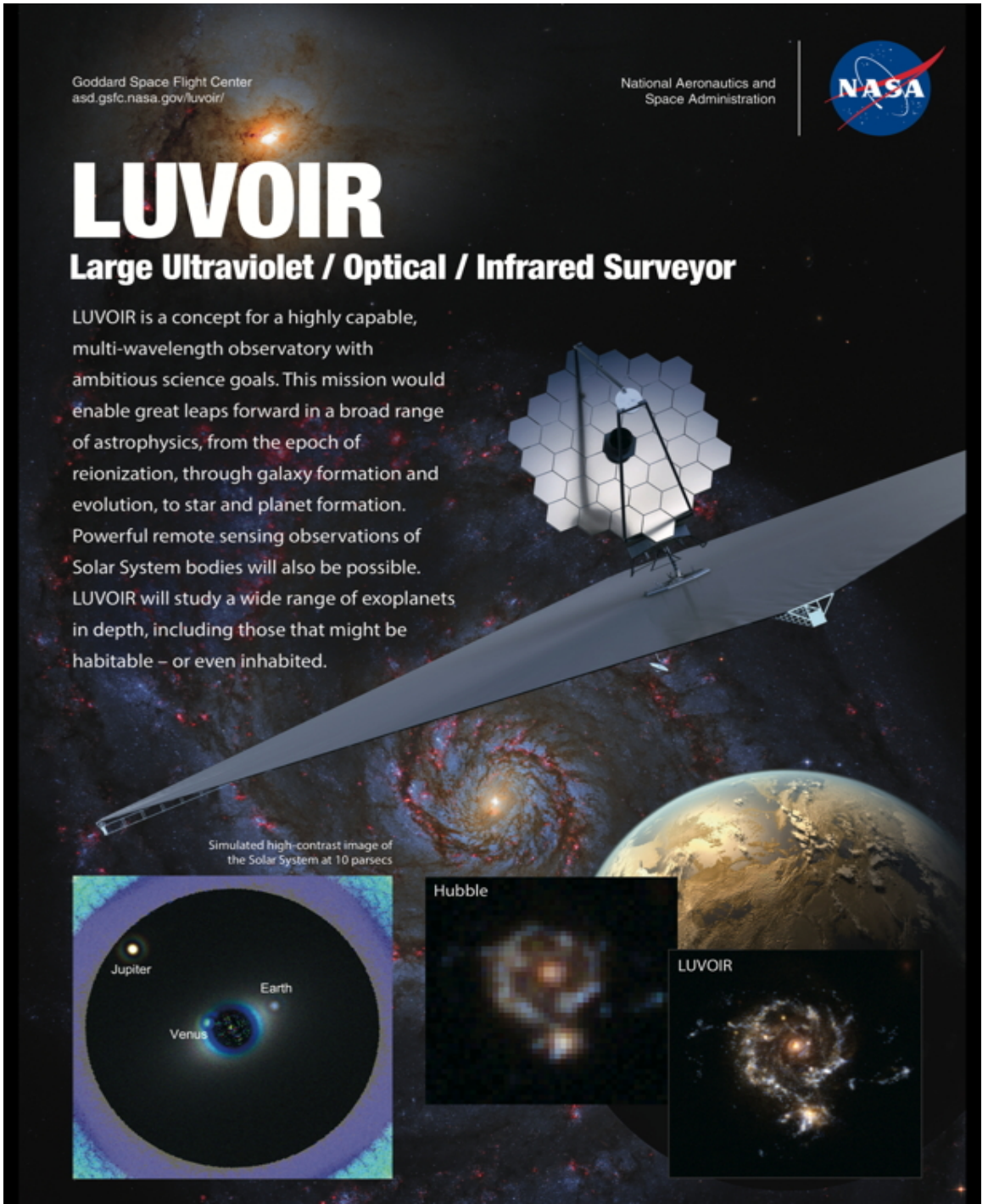
Nice pictures

Foto Z. Bardon

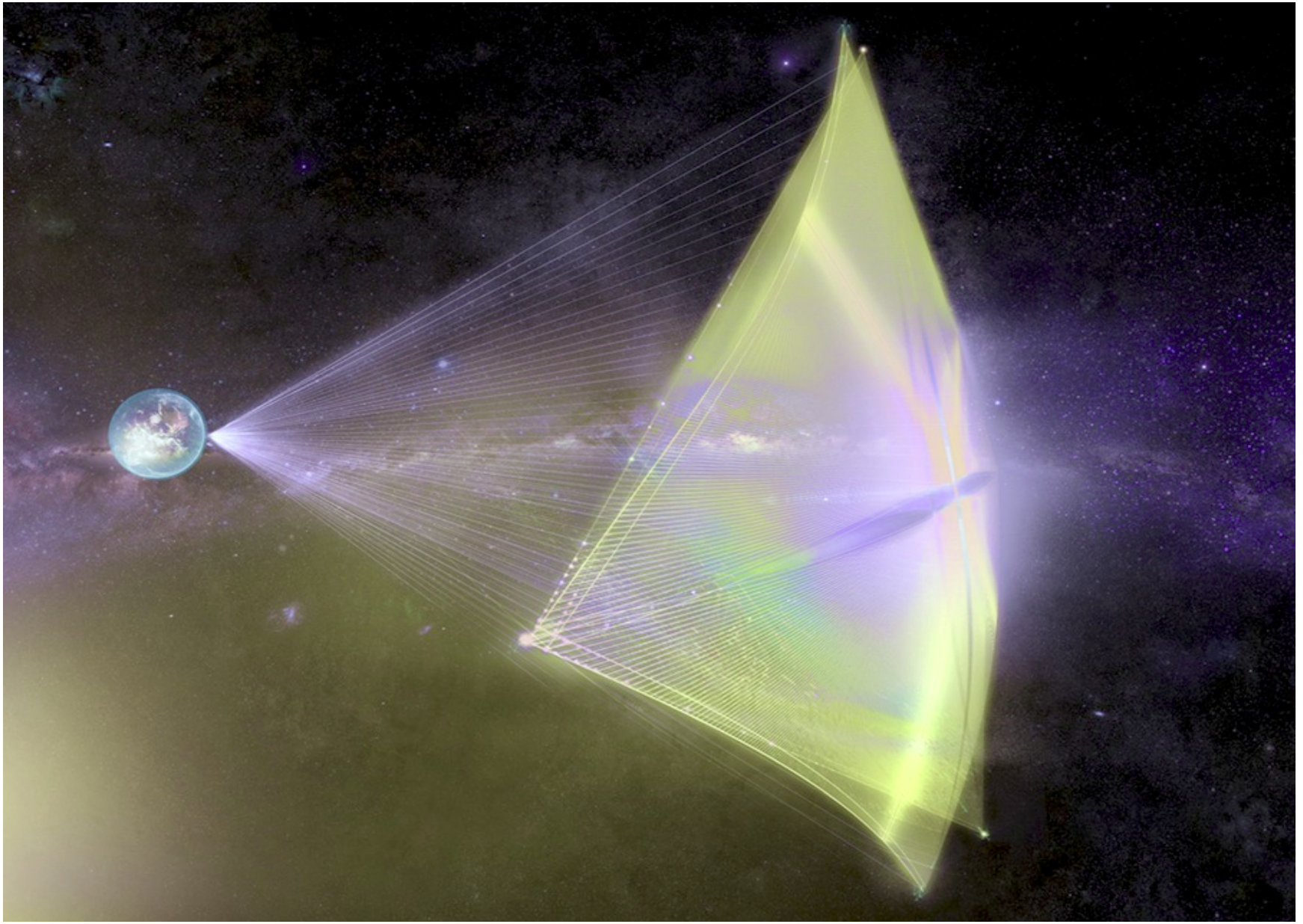
Astronomický ústav AV ČR

Foto Z. Bardon

2030+


Goddard Space Flight Center
asd.gsfc.nasa.gov/luvoir/
National Aeronautics and Space Administration
NASA
LUVOIR
Large Ultraviolet / Optical / Infrared Surveyor
LUVOIR is a concept for a highly capable, multi-wavelength observatory with ambitious science goals. This mission would enable great leaps forward in a broad range of astrophysics, from the epoch of reionization, through galaxy formation and evolution, to star and planet formation. Powerful remote sensing observations of Solar System bodies will also be possible. LUVOIR will study a wide range of exoplanets in depth, including those that might be habitable – or even inhabited.
Simulated high-contrast image of the Solar System at 10 parsecs
Jupiter
Earth
Venus
Hubble
LUVOIR

The Breakthrough initiative Starshot



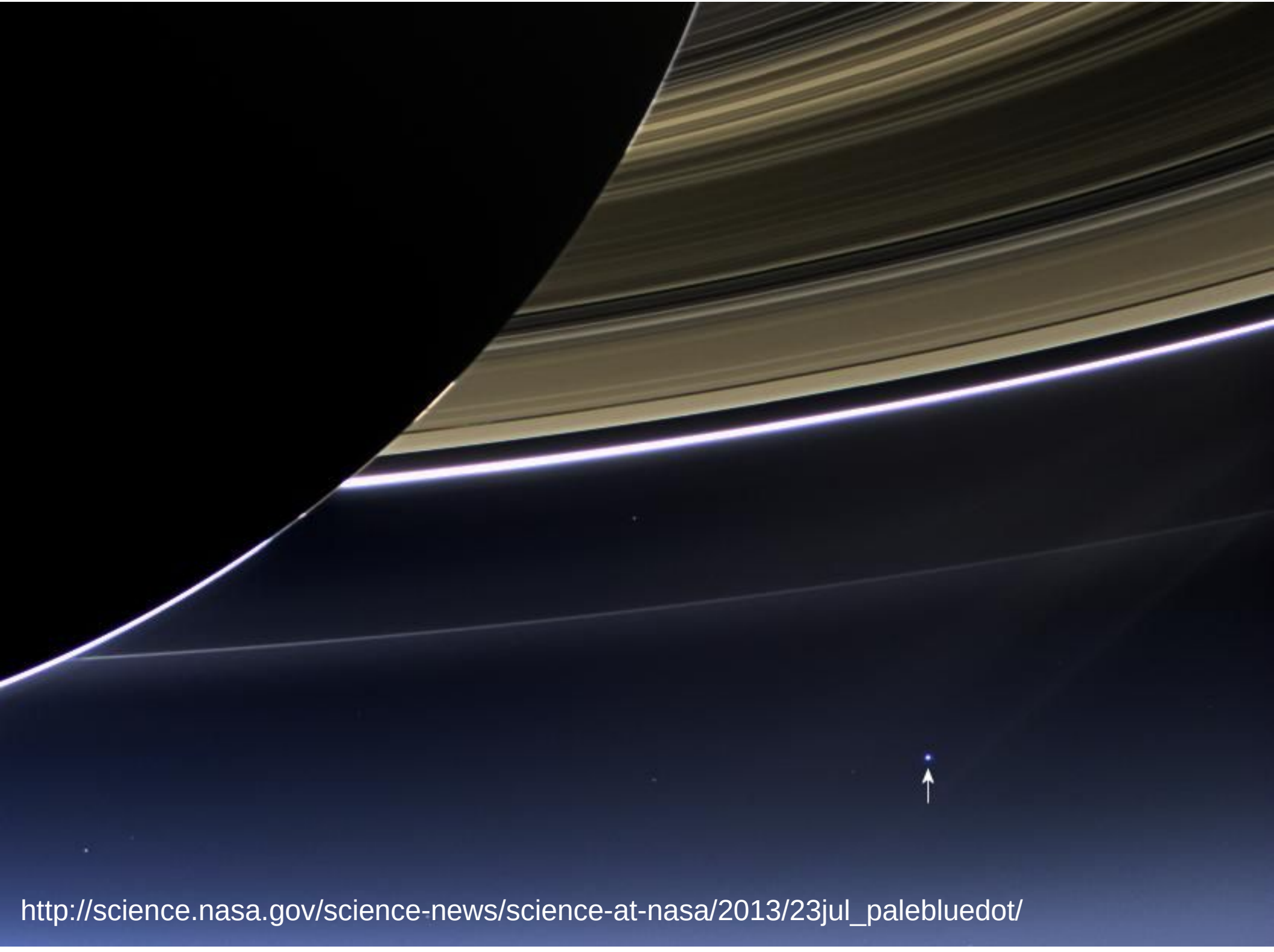
https://breakthroughinitiatives.org/Initiative/3

Erasmus+

- If you are interested in collaboration within astronomical research and in staying abroad at leading astronomical institute please check:

- www.erasmus.asu.cas.cz

- This lecture materials will be available through ERASMUS+ web



http://science.nasa.gov/science-news/science-at-nasa/2013/23jul_palebluedot/

Astronomický ústav AV ČR

Thank you!

Foto Z. Bardon

https://stelweb.asu.cas.cz/plato/ WEB PLATOSpec

http://stelweb.asu.cas.cz/exogroup/ WEB exoplanet group