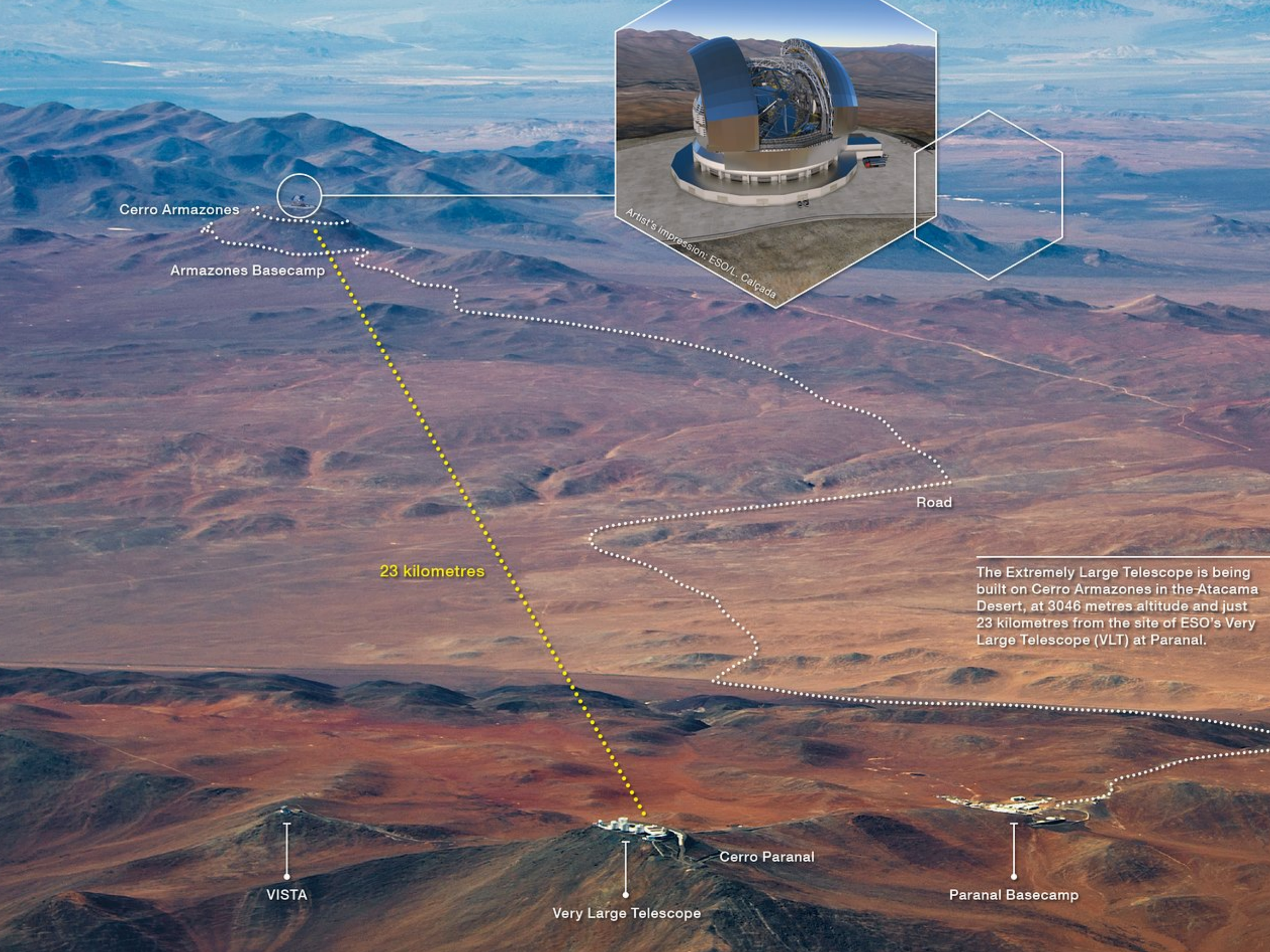
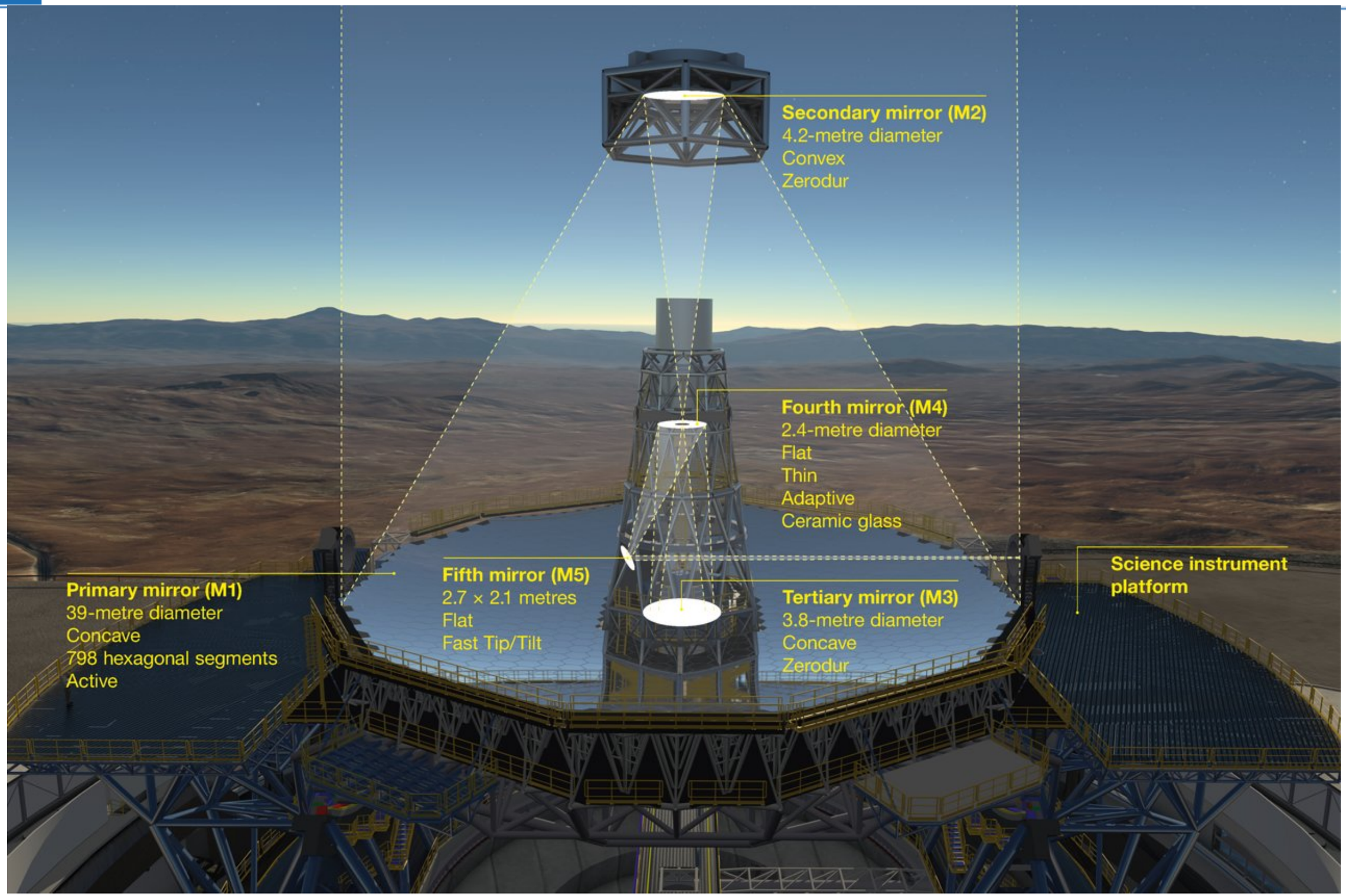
HIRES at ESO

Celine Peroux (ESO Project Scientist)

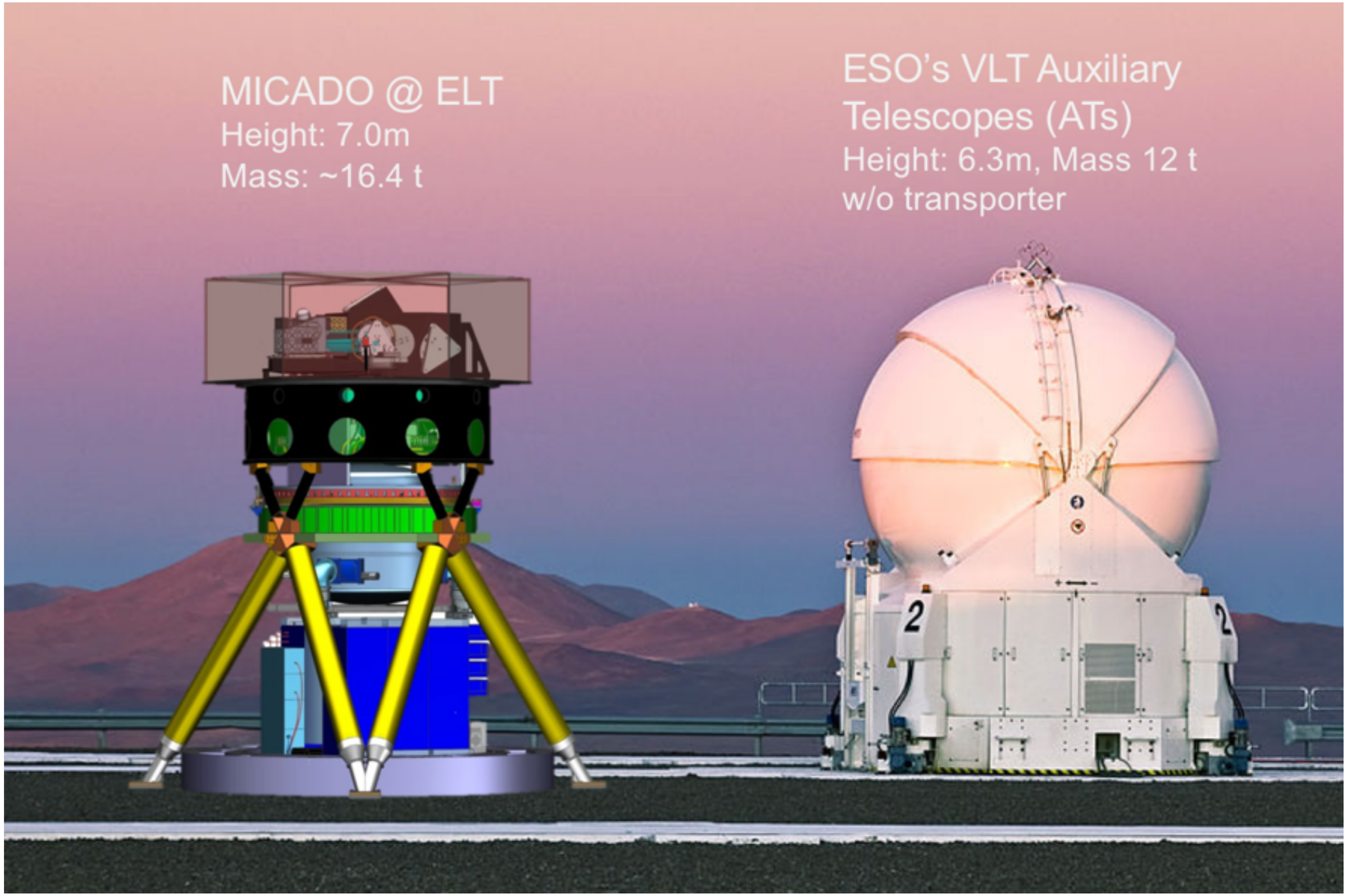


The Extremely Large Telescope is being built on Cerro Armazones in the Atacama Desert, at 3046 metres altitude and just 23 kilometres from the site of ESO's Very Large Telescope (VLT) at Paranal.

ELT Optics


Secondary mirror (M2)
4.2-metre diameter
Convex
Zerodur
Fourth mirror (M4)
2.4-metre diameter
Flat
Thin
Adaptive
Ceramic glass
Fifth mirror (M5)
2.7 × 2.1 metres
Flat
Fast Tip/Tilt
Tertiary mirror (M3)
3.8-metre diameter
Concave
Zerodur
Science instrument platform
Primary mirror (M1)
39-metre diameter
Concave
798 hexagonal segments
Active

An Idea of Scale

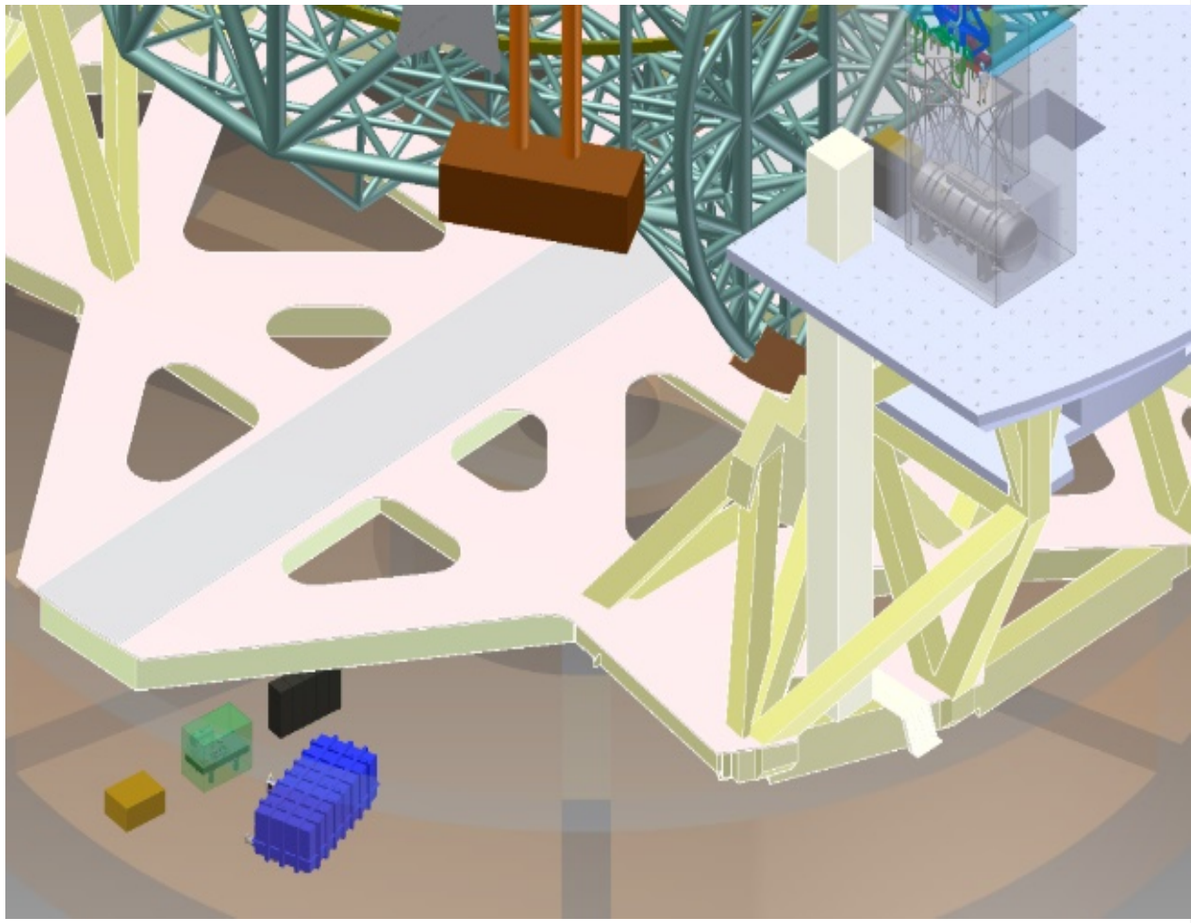


ESO Garching Integration Hall

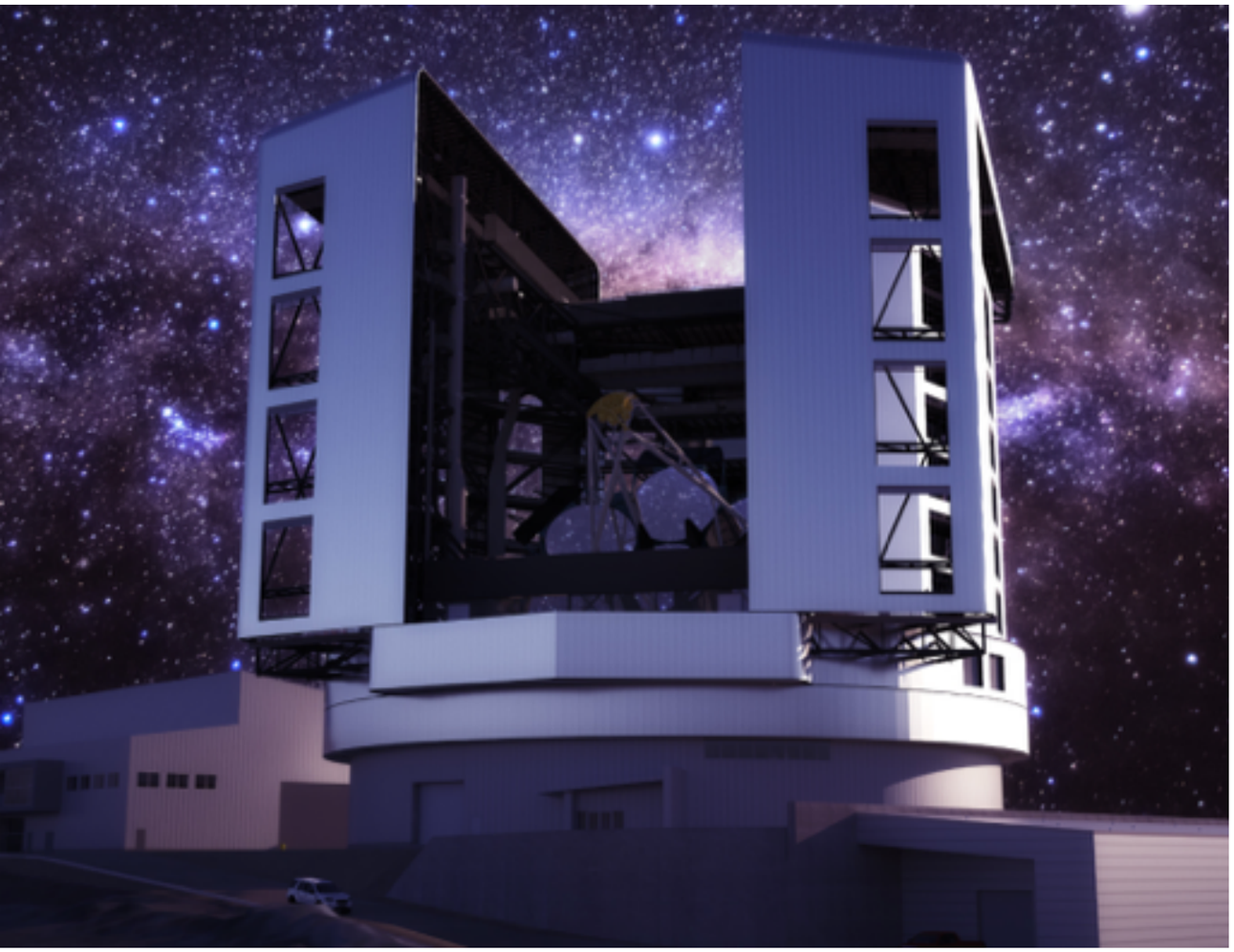
HIRES in a Nutshell

- *HIRES is a modular, stable high-resolution spectrograph for the ELT*

- *It combines common-user capabilities and cutting-edge, Nobel-prize science cases*



GMT: G-CLEF



- Δ(λ)=0.35-0.85 μm
- R=35,000 & 108,000
- start in 2023
- first light on GMT -> **main competitor**
- reduced collecting area
- no near-infrared arm (for exoplanet atm)

TMT: HROS & NIRES

- **HROS**
  Δ(λ)=0.31-1.1 μm
  R=50,000 & >95,000
  operations 2029

- **NIRES**
  Δ(λ)=1-5 μm
  20,000<R<100,000
  operations 2029

HIRES Team @ ESO

Celine Peroux
Project Scientist

Frederic Derie
Project Manager

Oliver Pfühl
System Engineer

Status

- *HIRES has successfully completed its **Phase A in 2018***
- *consortium and ESO have actively worked together*
- *the project is ready to move to **Phase B***

High-Resolution Spectroscopy @ ESO

Publication Statistics (refereed papers)

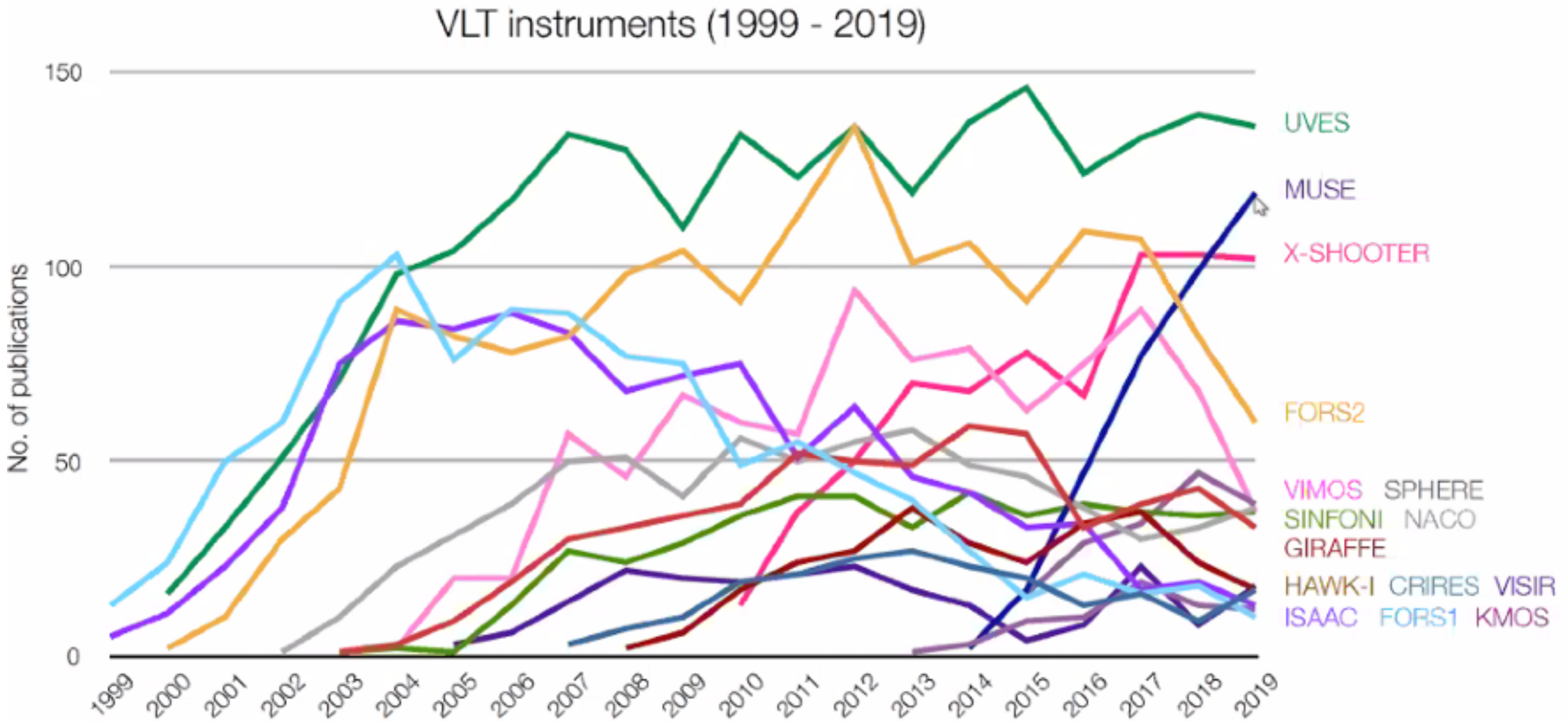
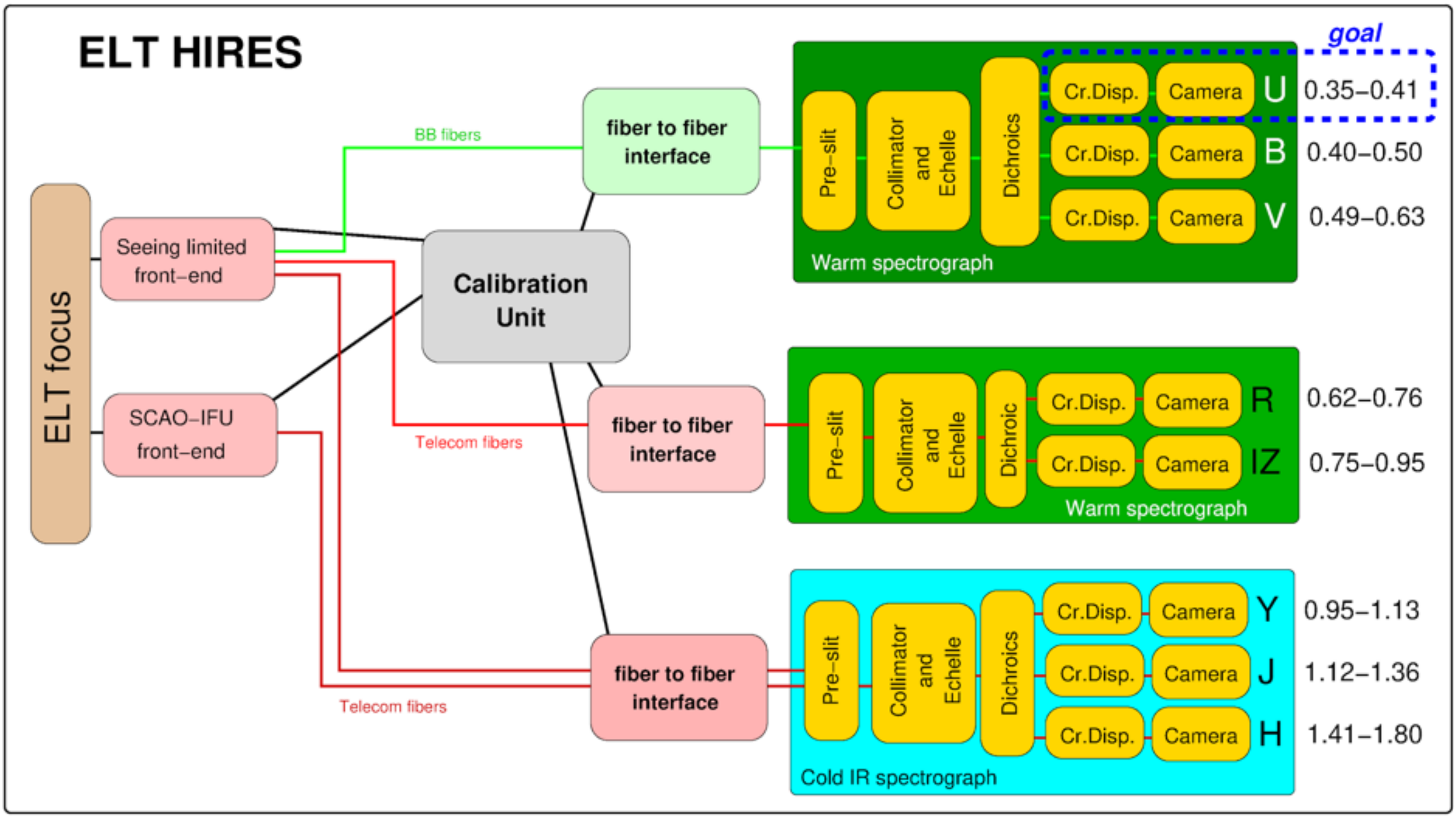


Fig. 4: Refereed publications using data from VLT instruments

HIRES' design



HIRES: the ELT workhorse inst

- **Exoplanets** (characterisation of Exoplanets Atmospheres: detection of signatures of life)
- **Protoplanetary Disks** (dynamics, chemistry and physical conditions of the inner regions)
- **Stellar Astrophysics** (abundances of solar type and cooler dwarfs in galactic disk bulge, halo and nearby dwarfs: tracing chemical enrichment of Pop III stars in nearby universe)
- **Stellar Populations** (metal enrichment and dynamics of extragalactic star clusters and resolved stellar populations)
- **Intergalactic Medium** (Signatures of reionization and early enrichment of ISM & IGM observed in high-z quasar spectra)
- **Galaxy Evolution** (massive early type galaxies during epochs of formation and assembly)
- **Supermassive Black Holes** (the low mass end)
- **Fundamental Physics** (variation of fundamental constants - α, m_p/m_e Sandage Test)

Community White Paper: Maiolino et al. 2013, ArXiV:1310.3163

+ Add you science here

Defining Technical Specifications

- Top Level Requirements (**TLR**) issued by ESO
- **Prioritisation** exercise from HIRES Science team: 4 science priorities translate in tech requirements
- Consortium and ESO agree on **Technical Specifications**, which are contractual
- Define **requirements**, but also goals (nice to have)

HIRES Science

The Nobel Prize in Physics 2019

© Nobel Media. Photo: A. Mahmoud

James Peebles

Prize share: 1/2

© Nobel Media. Photo: A. Mahmoud

Michel Mayor

Prize share: 1/4

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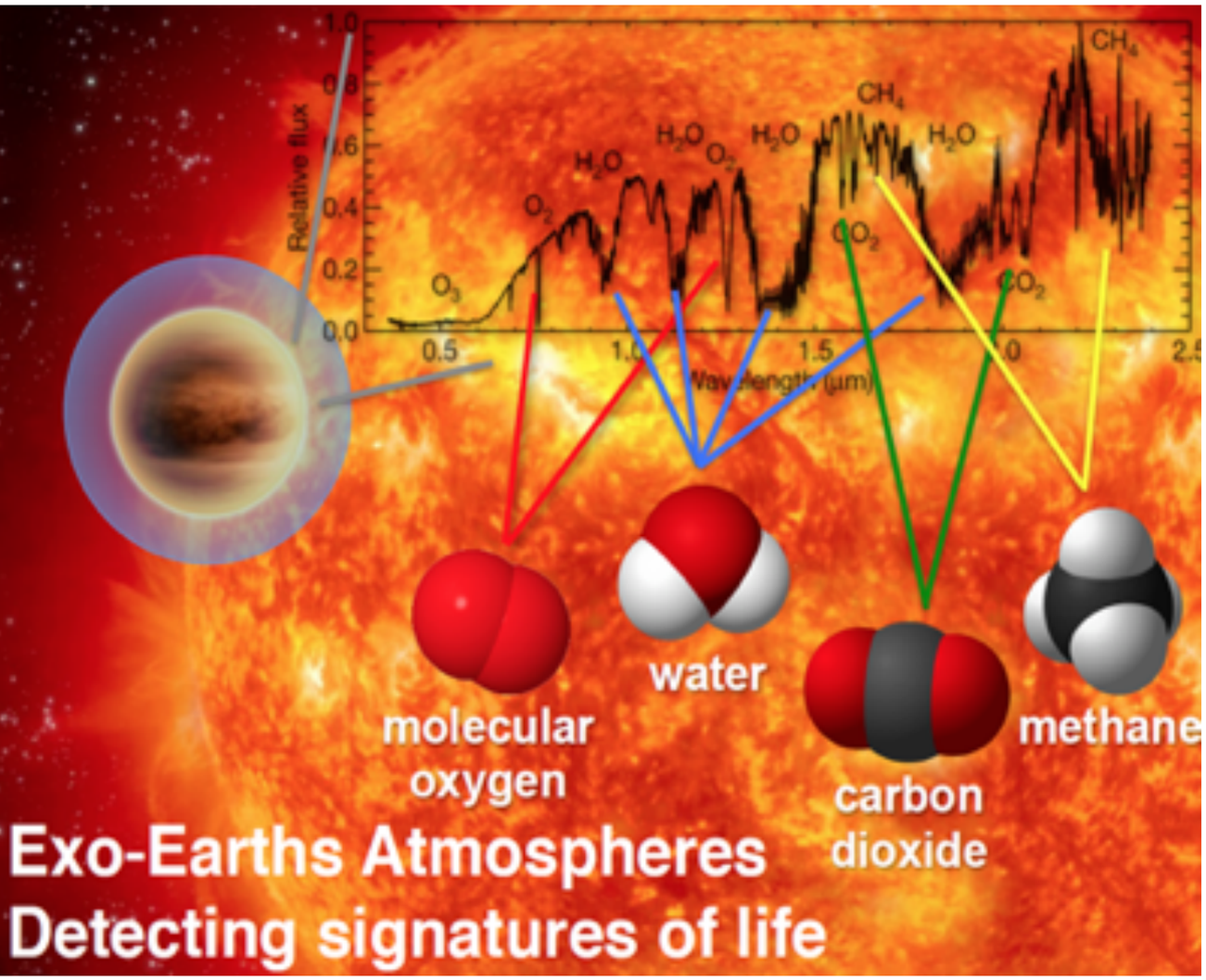
Didier Queloz

Prize share: 1/4

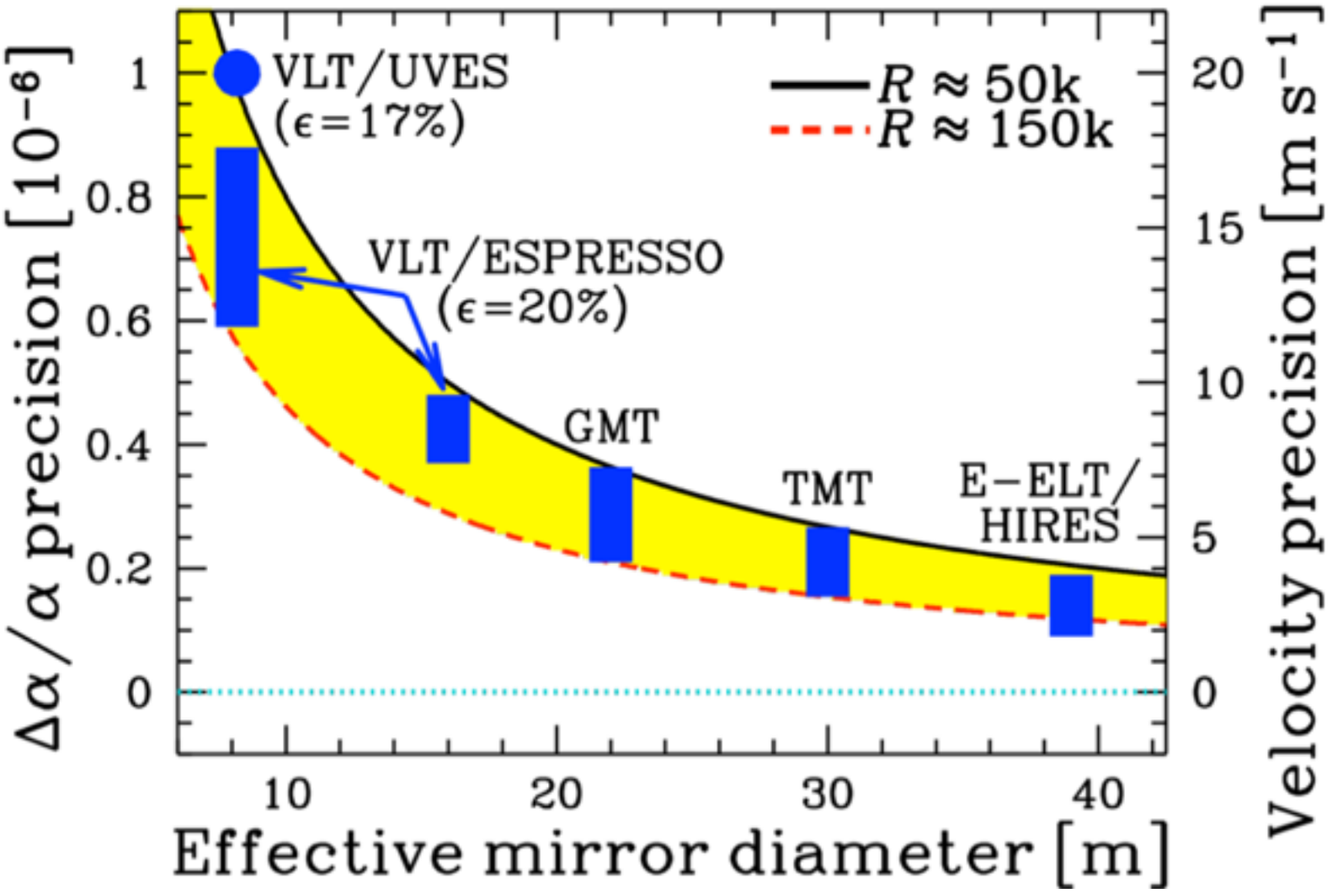
Exoplanet atmosph. (transmission)



- *R>100,000*
- *spec. sampling>2.5px*
- *$\Delta(\lambda)$=0.5-1.8 μ*
- *High flat-field accuracy and/or PSF/detector stability*
- *stability of wavelength calibration accuracy=1m/s*

Enable other science cases: reionisation, cool stars, near pristine gas, CGM 3D reconstruction, transients

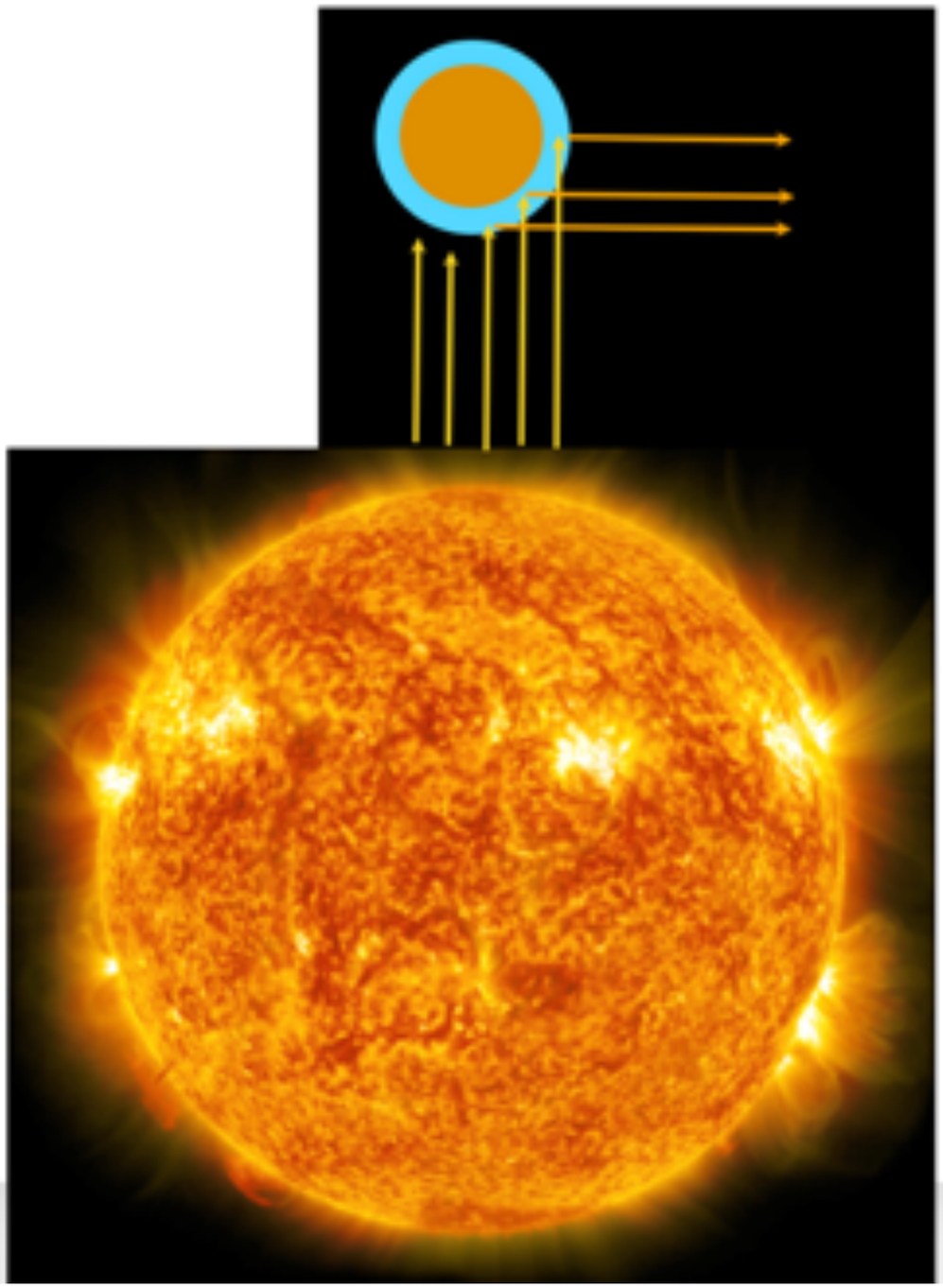
Variation of Fundamental Constants



- *Δ(λ)=0.37-0.67 μm*

Enable other science cases: CMB temperature, Deuterium abundance, primitive stars

Exoplanet atmospheres (reflection)

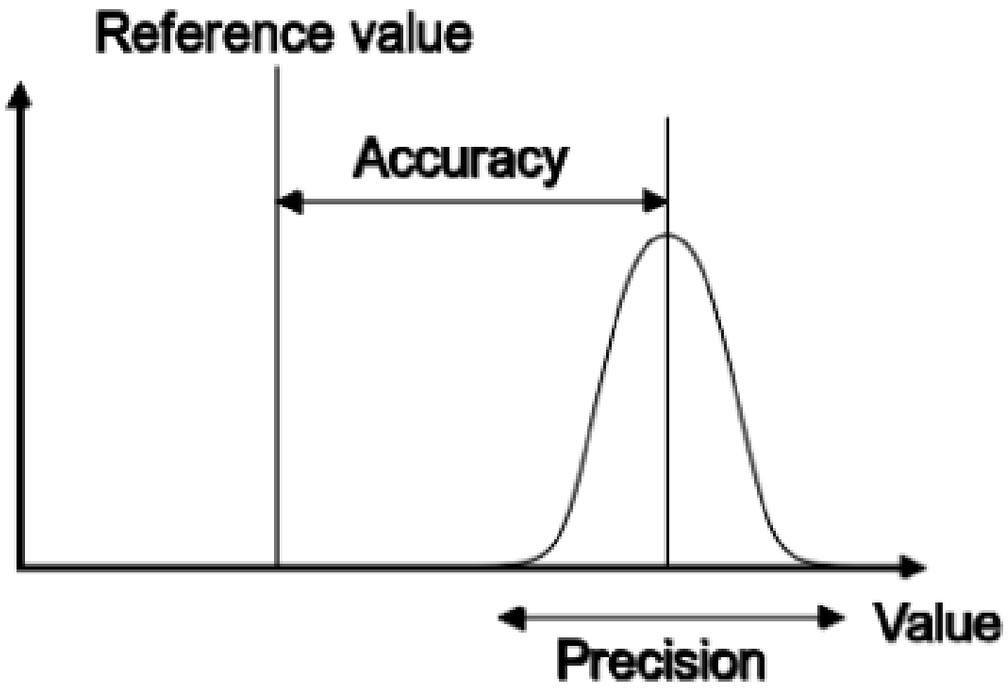


- *Single Conjugate Adaptive Optics*
- *Integral Field Unit*

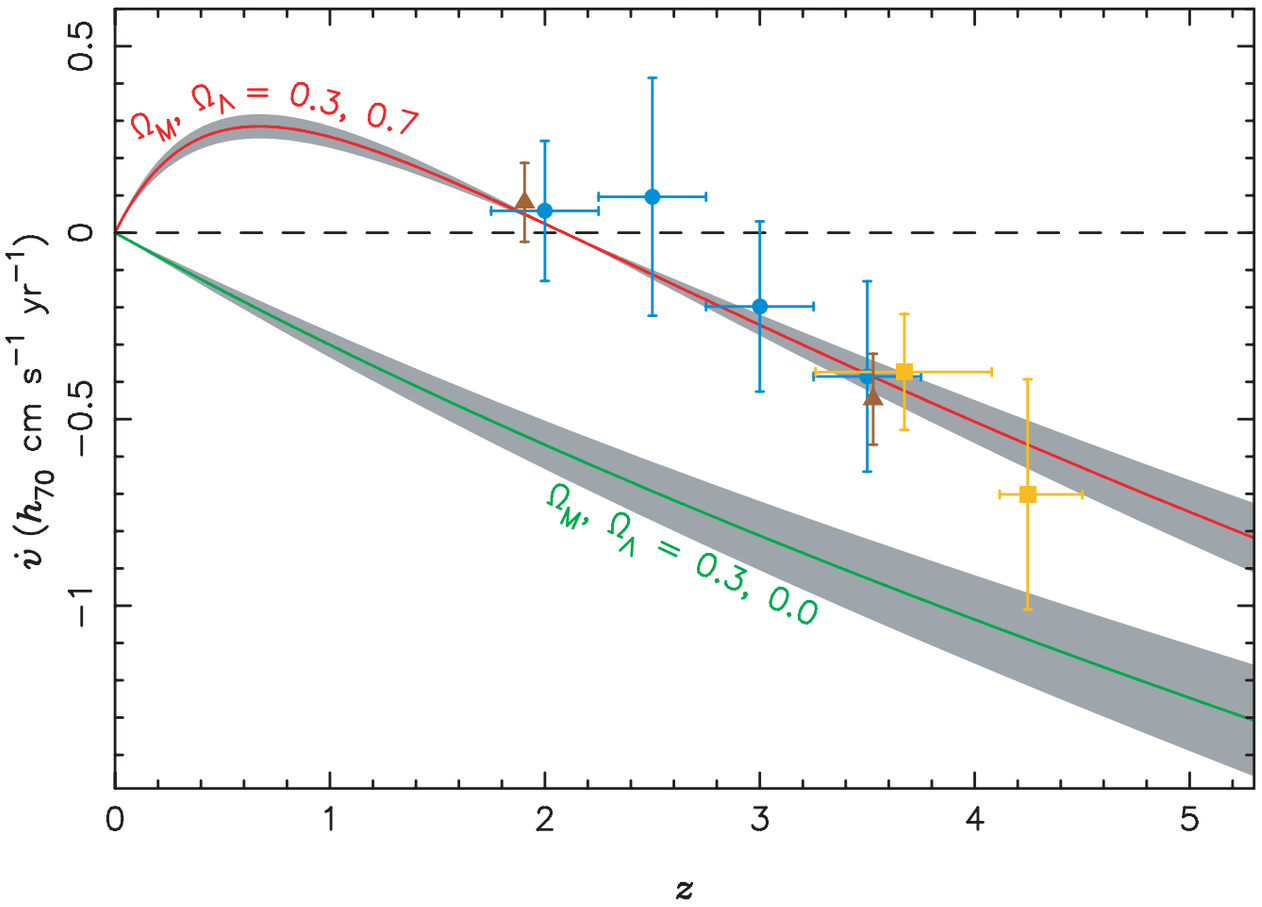
Enable other science cases: protoplanetary disks, stellar atmosphere, low mass black holes

Definition Recap

- ***Precision*** *is the dispersion of a set of measurements after repeating the same experiment. It does not require an absolute calibration.*
- ***Accuracy*** *is the offset of a measurement from the true value. It requires an absolute calibration.*
- ***Stability*** *describes the time variation of accuracy and/or precision.*



Sandage Test



- *$\Delta(\lambda)$=0.40-0.67 μ*
- *stability of wavelength calibration accuracy=2cm/s*

Enable other science cases: mass determination of Earth-like exoplanets, RV search for exoplanet around M-dwarf stars

HIRES unique on ELT

- cover unrivalled parameter space: **optical/blue** wavelength coverage
- the technology is **ready**, clear path ahead
- will operate in **seeing-limiting** conditions
- will be widely **used**

HIRES is for you

- ELT = fewer foci = fewer photons per astronomers
- Think now which science you want to do
- Get engaged!

Take Home Messages

- HIRES will open a new discovery space from astrophysics to fundamental physics
- HIRES unique in the ELT inst program: versatile, operates in seeing-limited
- Unique opportunity: get involved with HIRES now!