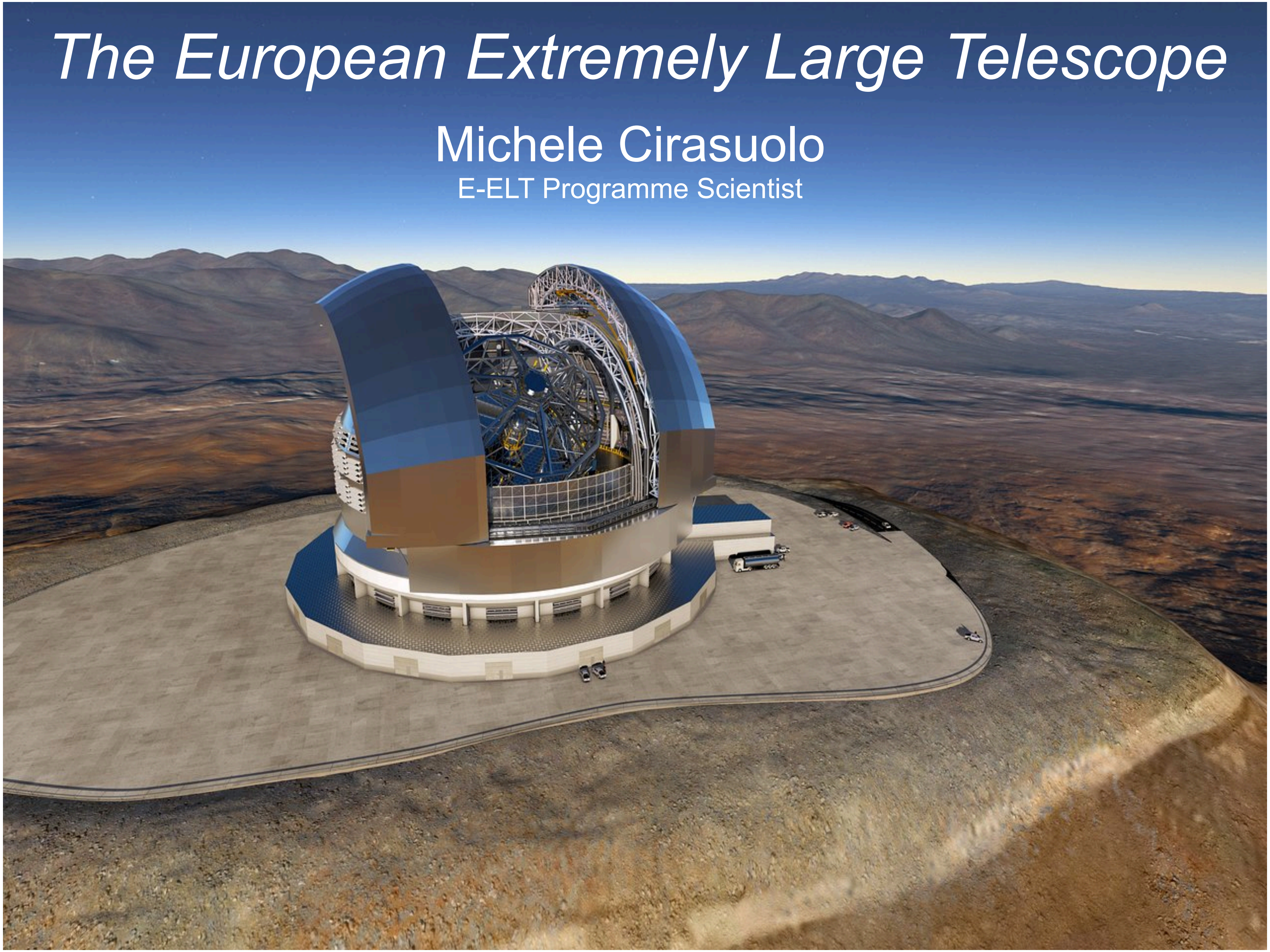
The European Extremely Large Telescope

Michele Cirasuolo
E-ELT Programme Scientist



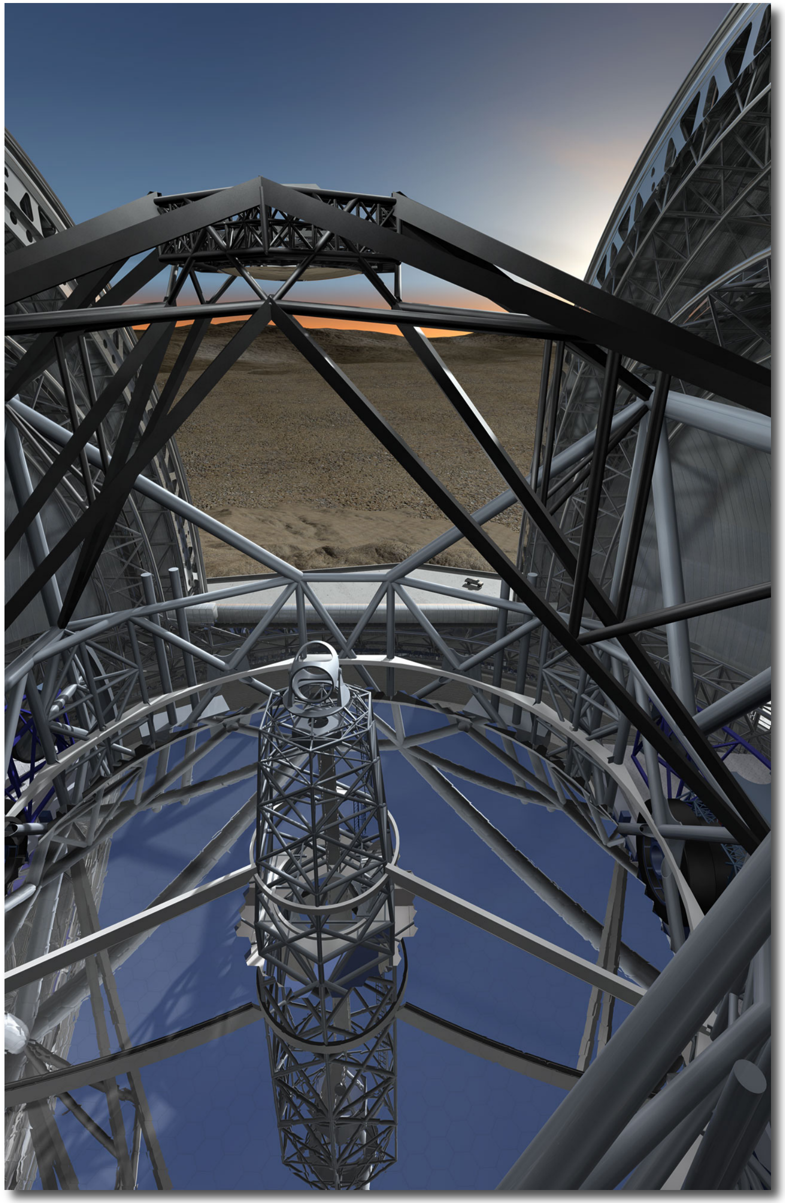
Outline

- Overview of E-ELT Programme
- Updates on the instruments
- Science and Synergies with JWST

The E-ELT

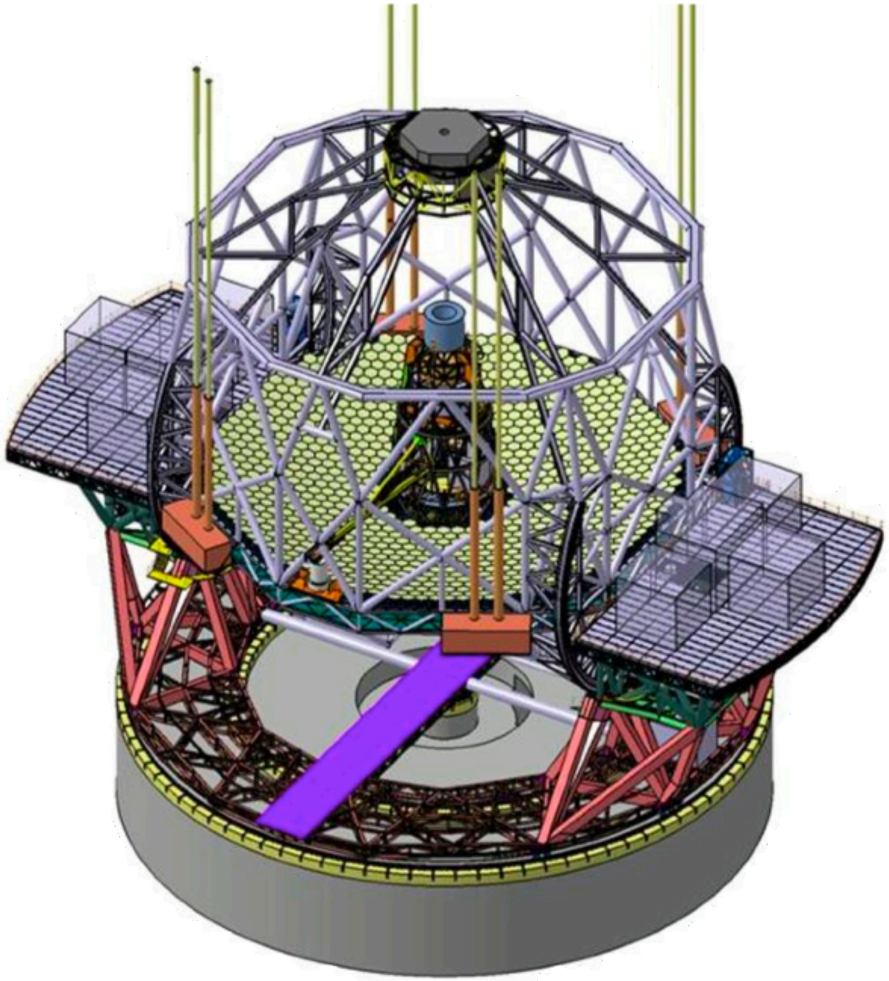
39-m class telescope
the largest optical/near-IR

- Adaptive optics built in to deliver diffraction limited performance.
- Dec 2014: ESO Council gave green light for E-ELT construction in two phases
  - Funding approved for Phase I
  - Still expected that both phases will be completed.
  - Comprehensive suit of state-of-the art instrumentation
- Work well underway
- June 2016: Council approved first light 2024



The E-ELT: overview

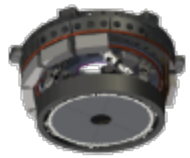
- Novel 5 mirror design to include adaptive optics in the telescope
- Segmented primary mirror (**798 segments**)
- Diffraction limited over full **10’ FoV**



M1 Unit
39-m
Concave – Aspheric f/0.9
Segmented (798 Segments)
Active + Segment shape Control

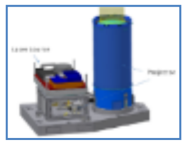
M2 Unit
4-m
Convex Aspheric f/1.1
Passive + Position Control

M3 Unit
4-m – Concave – Aspheric f/2.6
Active + Position Control



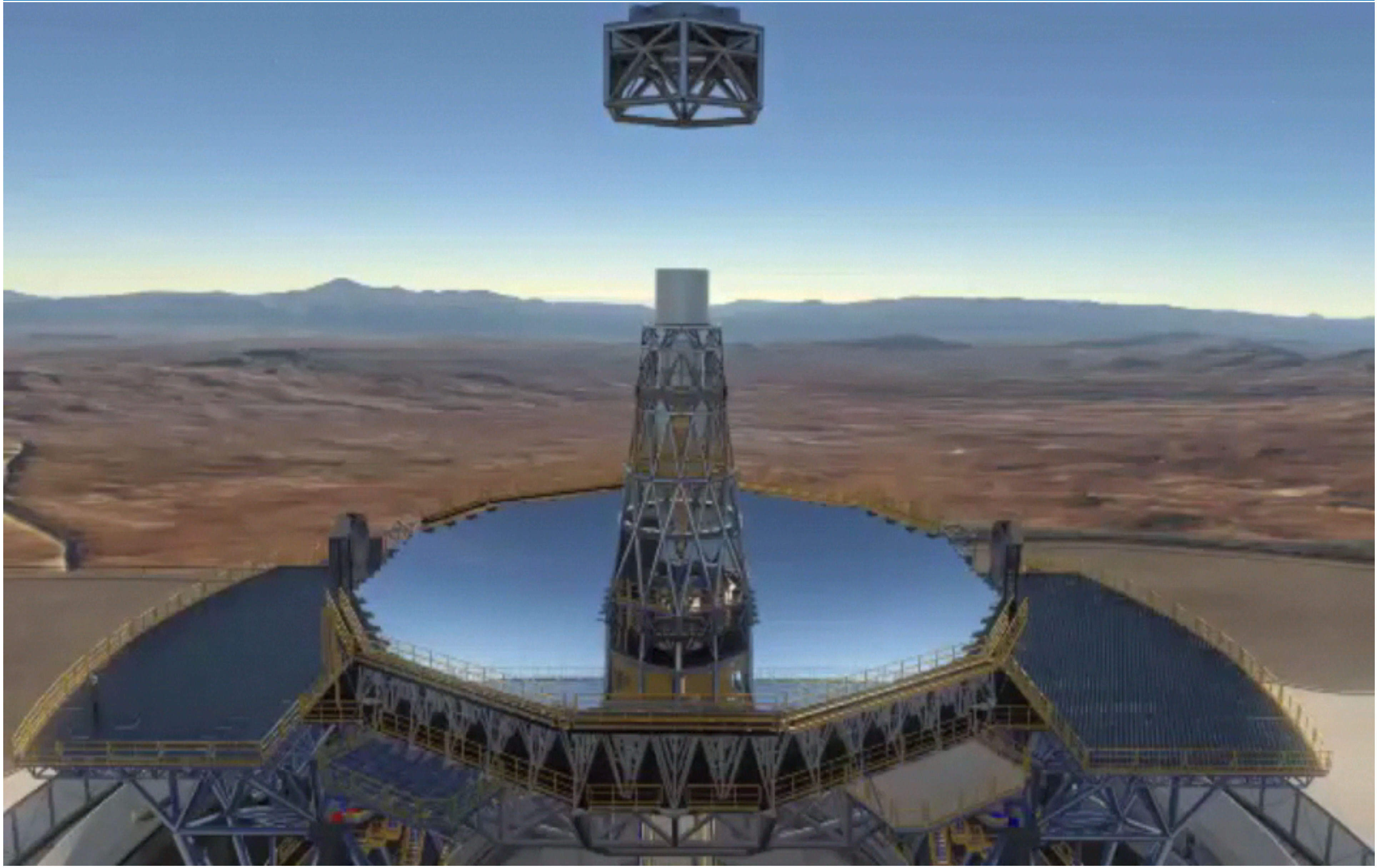
M4 Unit
2.4-m
Flat
Segmented (6 petals)
Adaptive + Position Control

M5 Unit
2.7x2.1-m
Flat
Passive + Fast Tip/Tilt



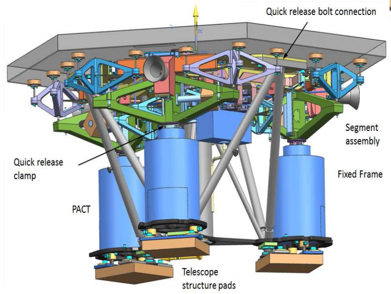
LGSU
(Laser Guide Star Units)
Laser Sources + Laser Beacons
shaping and emitting

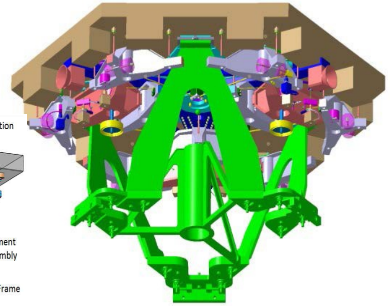
E-ELT Optomechanics



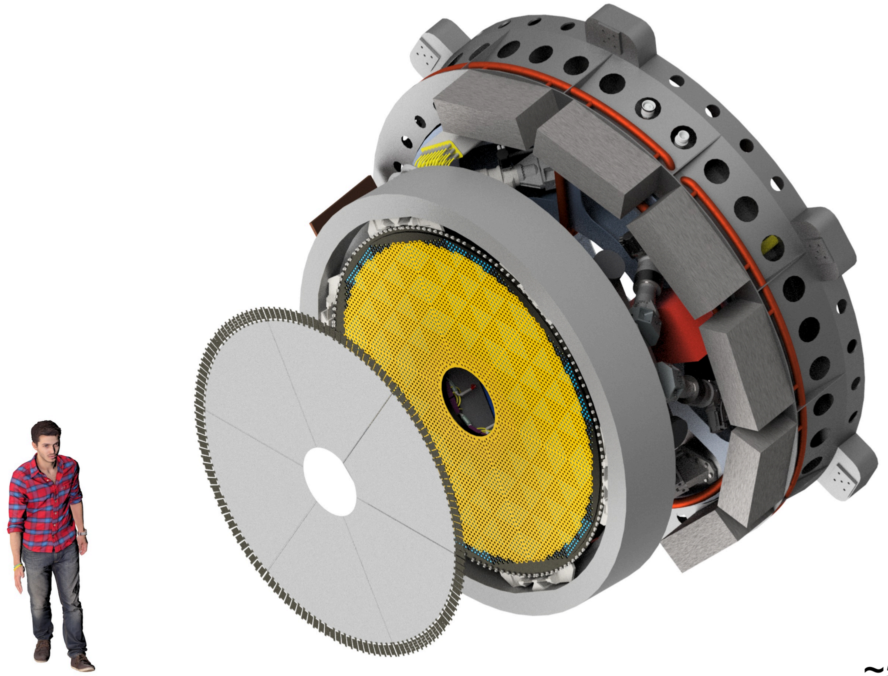
Running contracts Status

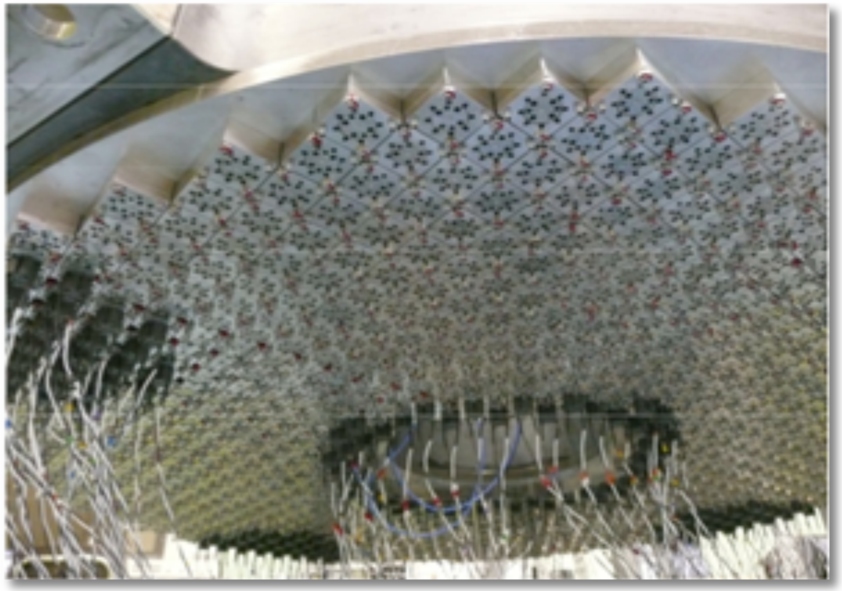
- M1 Segment Support (x2, VDL and CESA):
  - Design to FDR and delivery of 4 qualification models





- M4 Cell (AdOptica)
- M4 Shell and blanks





~5300 contactless actuators driving the mirror shape at 1 kHz

M4 Shells

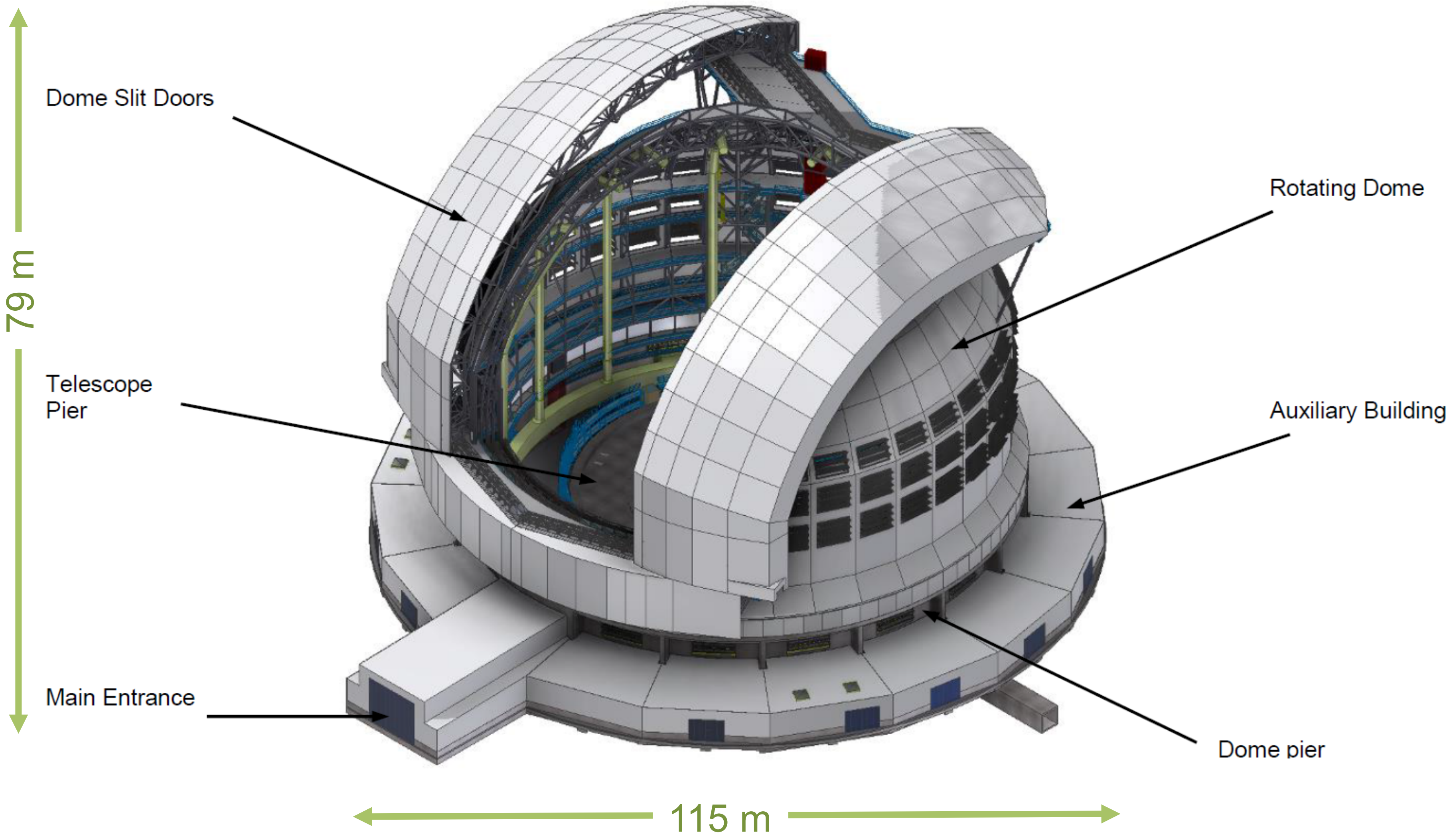
M4 Blanks

Running contracts Status

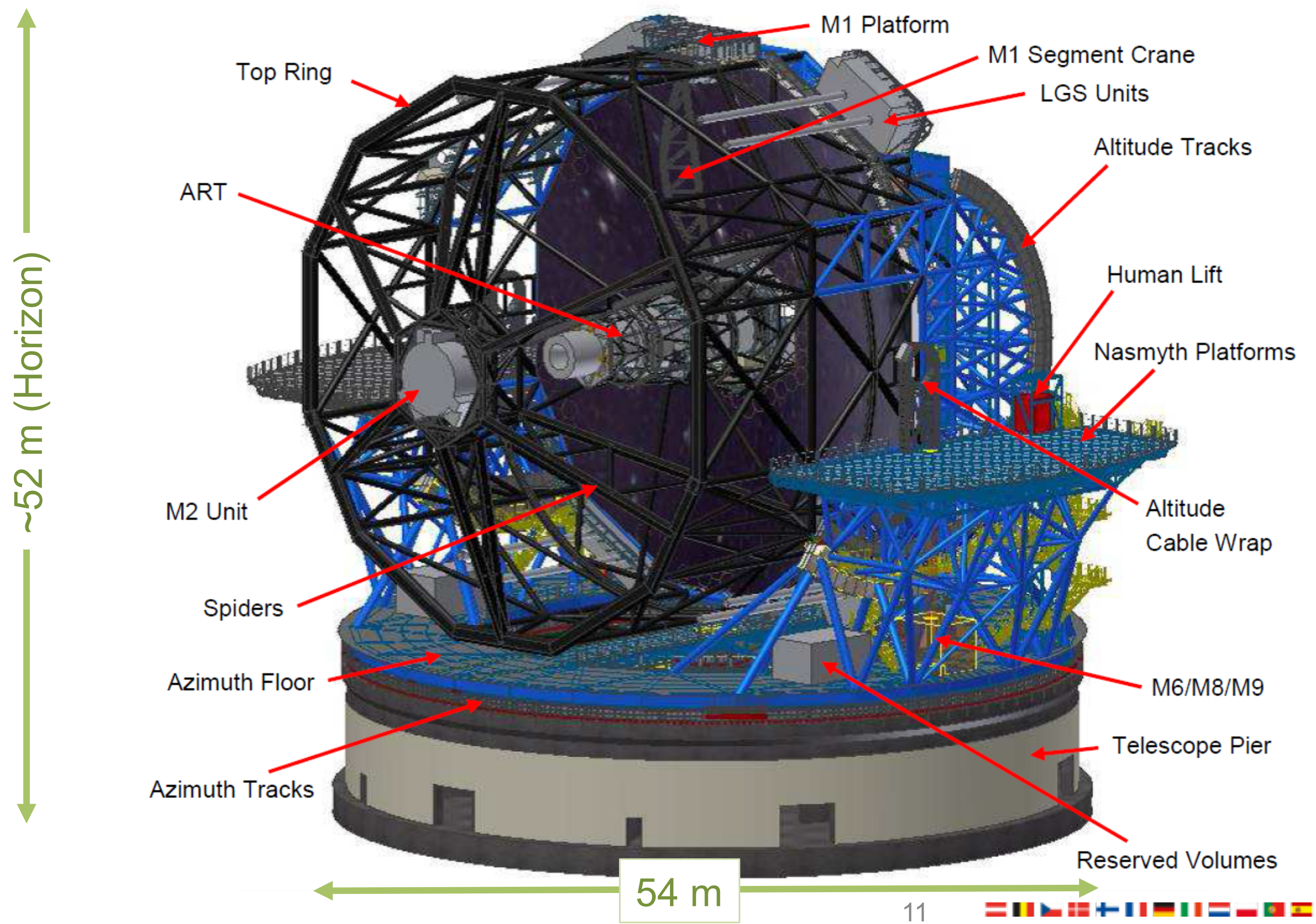
- M1 Segment Support (x2, VDL and CESA):
  - Design to FDR and delivery of 4 qualification models

- M4 Cell (AdOptica)
- M4 Shell and blanks
- Dome and Main structure
  - Contract with ACe consortium signed 25th May 2016

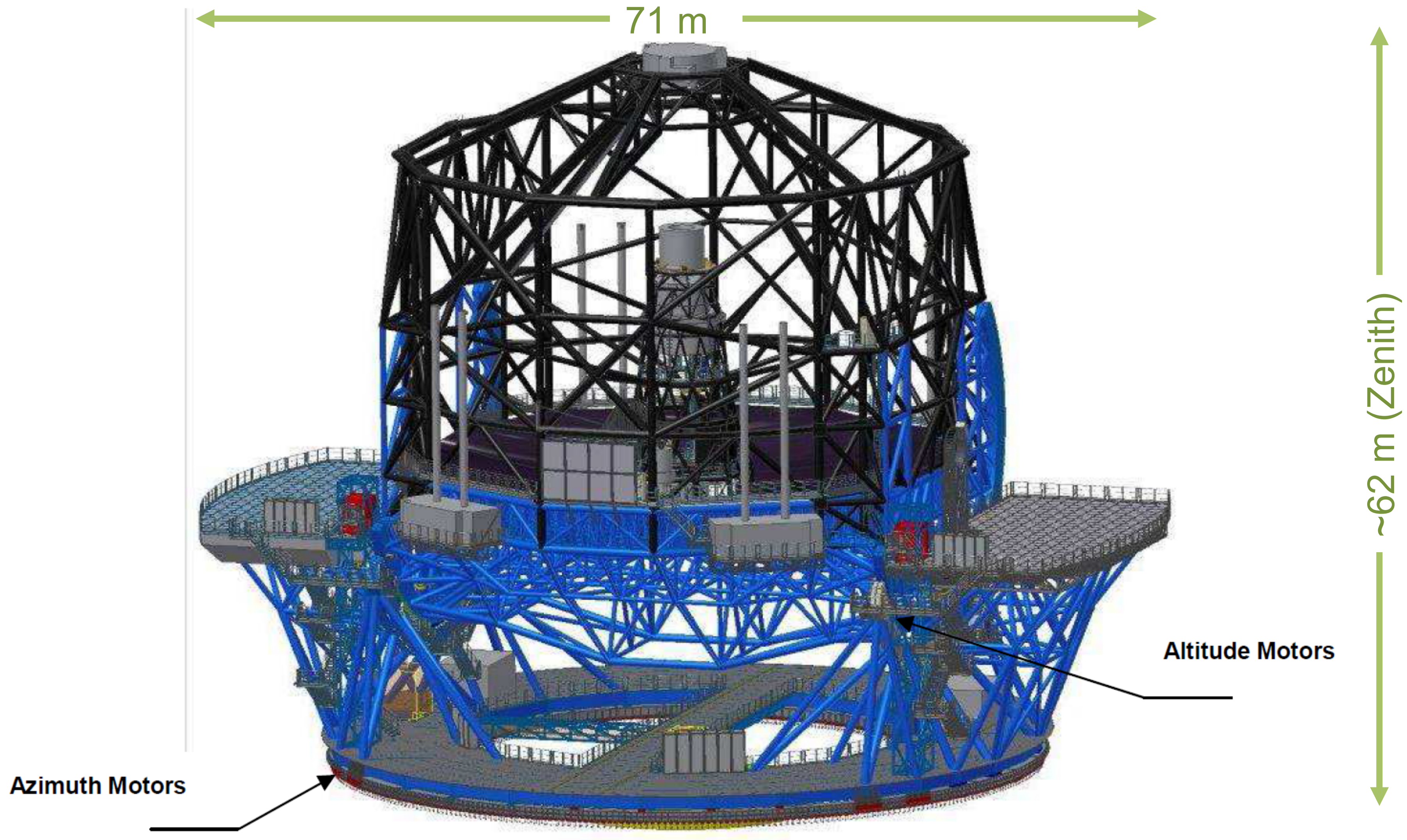
ACe proposed Dome



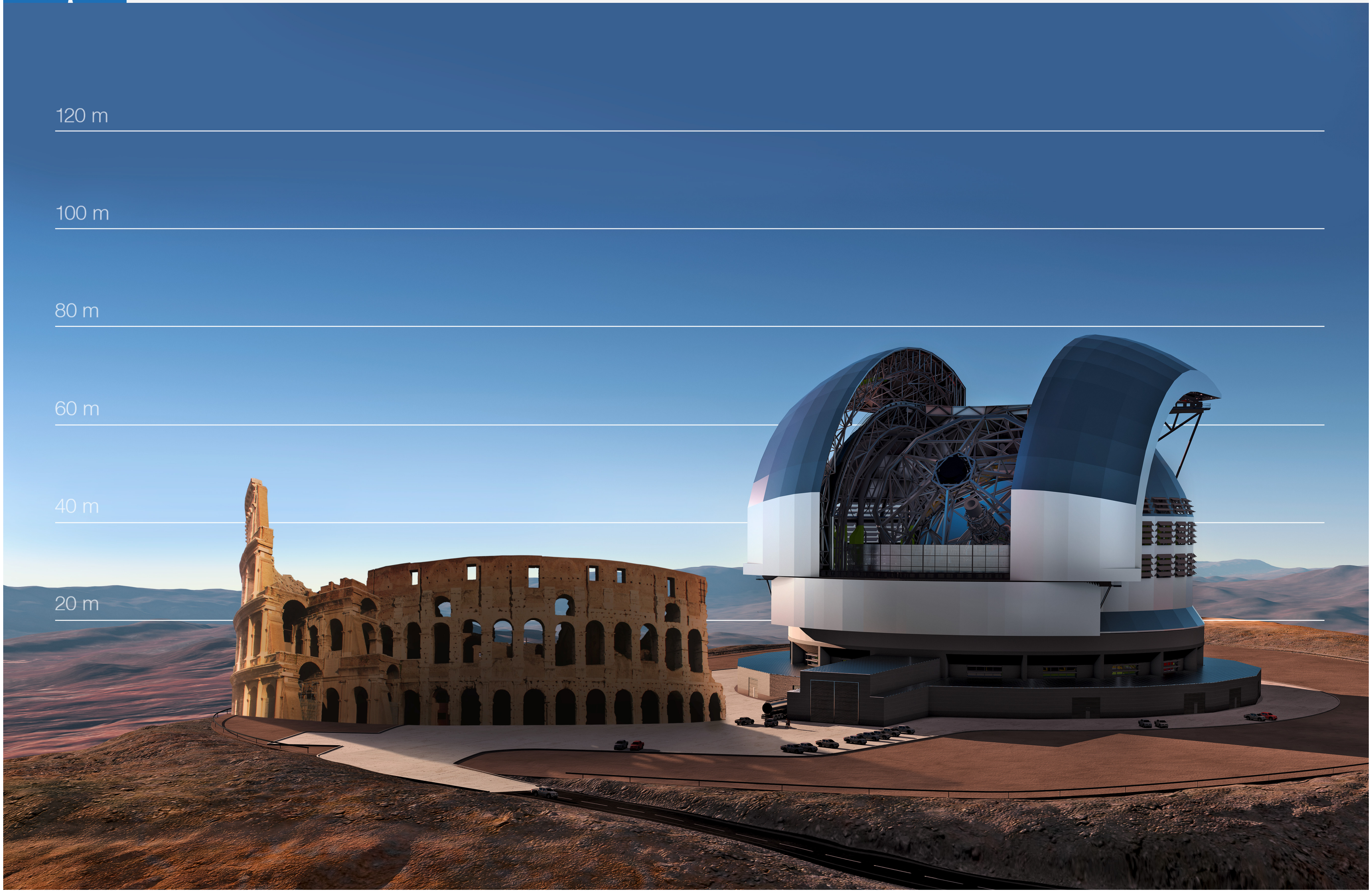
ACe proposed Main Structure



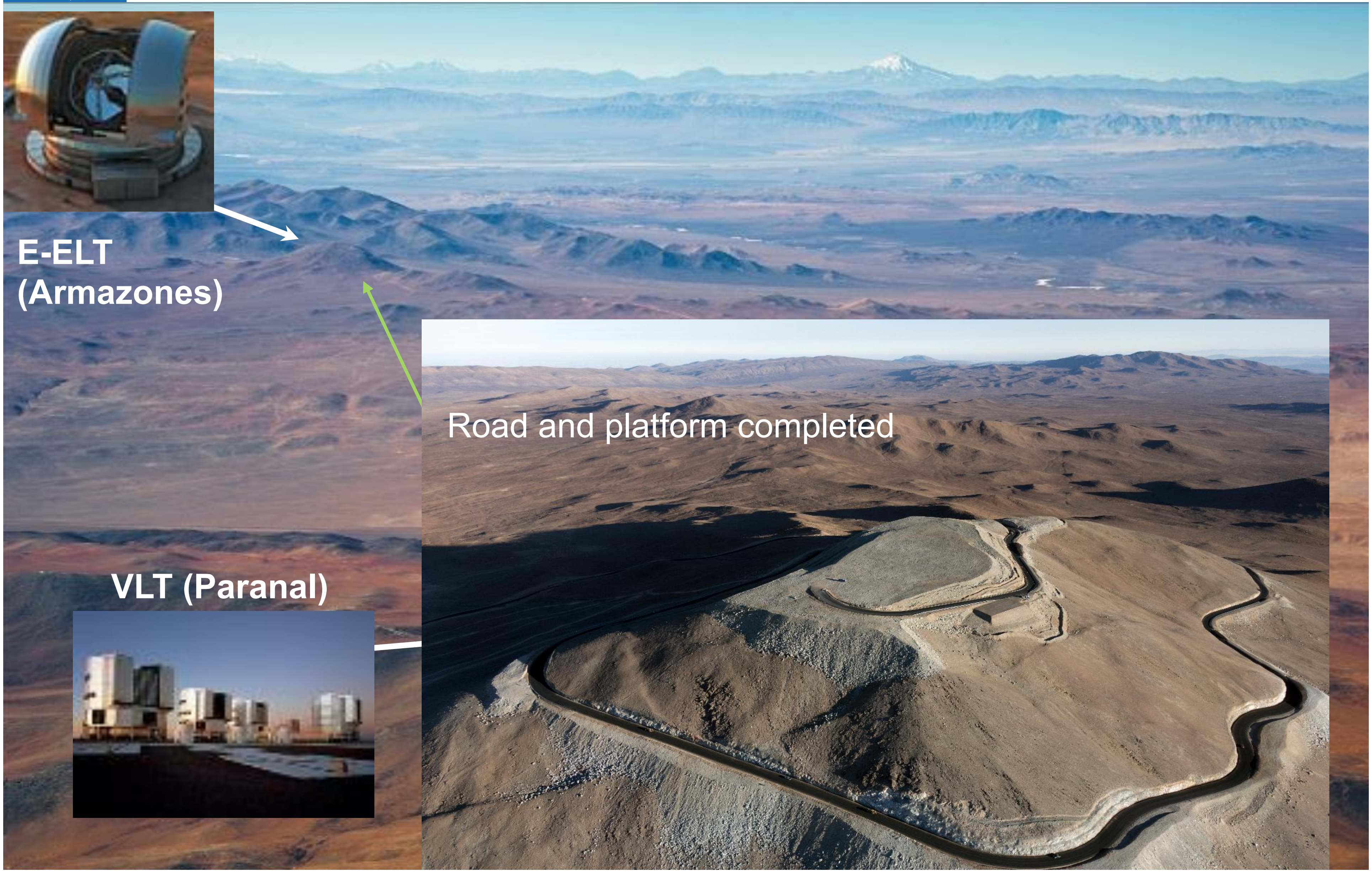
ACe proposed Main Structure



E-ELT



Armazones and Paranal



E-ELT Instrumentation Programme

Instrumentation Roadmap

- ELT-CAM (MICADO+MAORY)
- ELT-IFU (HARMONI+LTAO)
- ELT-MIDIR (METIS)

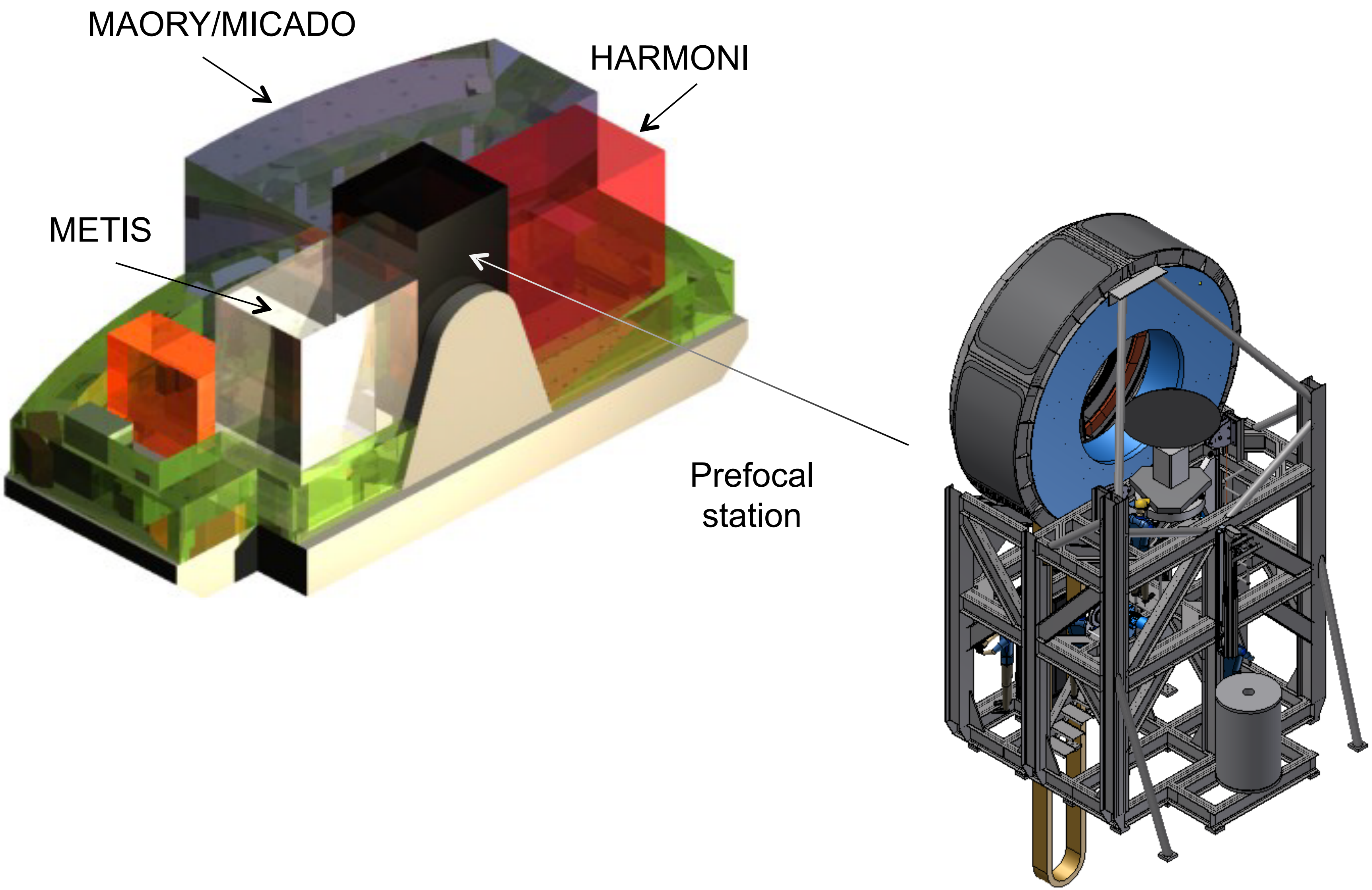
Preliminary design started in September 2015

- High resolution spectrograph (HIRES)
- Multi-object spectrograph (MOS)

Phase A started in April 2016

- Open slot 6
- XAO PCS instrument

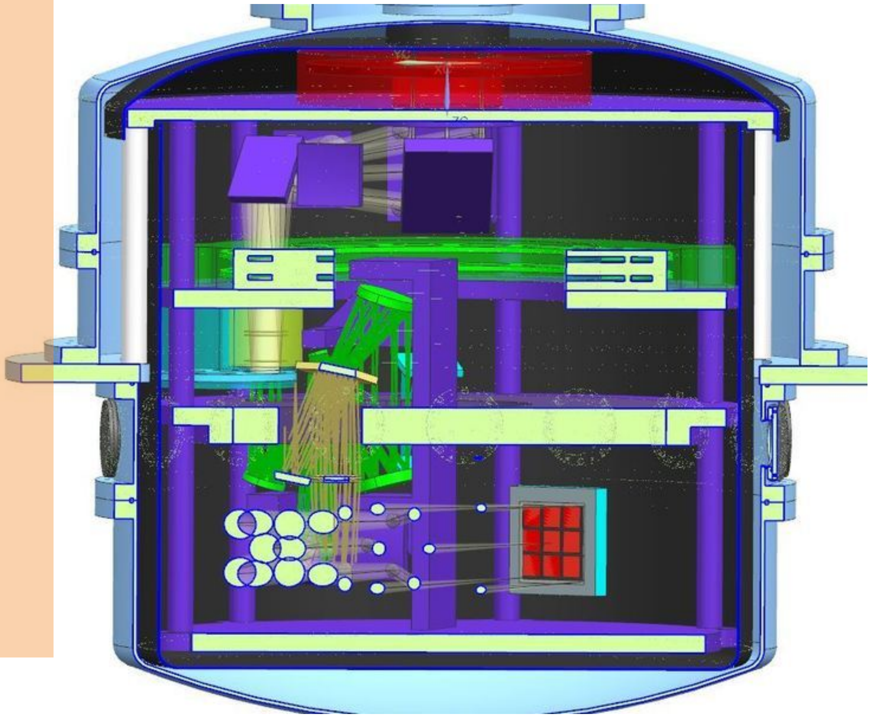
Instruments update



MICADO+MAORY

MICADO
PI: R. Davies MPE, Germany

- **Imaging** 0.8-2.4µm, pixel scales of
  - 4mas (FoV ~53")
  - 1.5mas (FoV ~20")
- **Astrometric imaging** with 50µas precision
- **Spectroscopy for single slit** R~8000.
- **Coronagraphic** imaging
- Time Resolved Astronomy (goal)

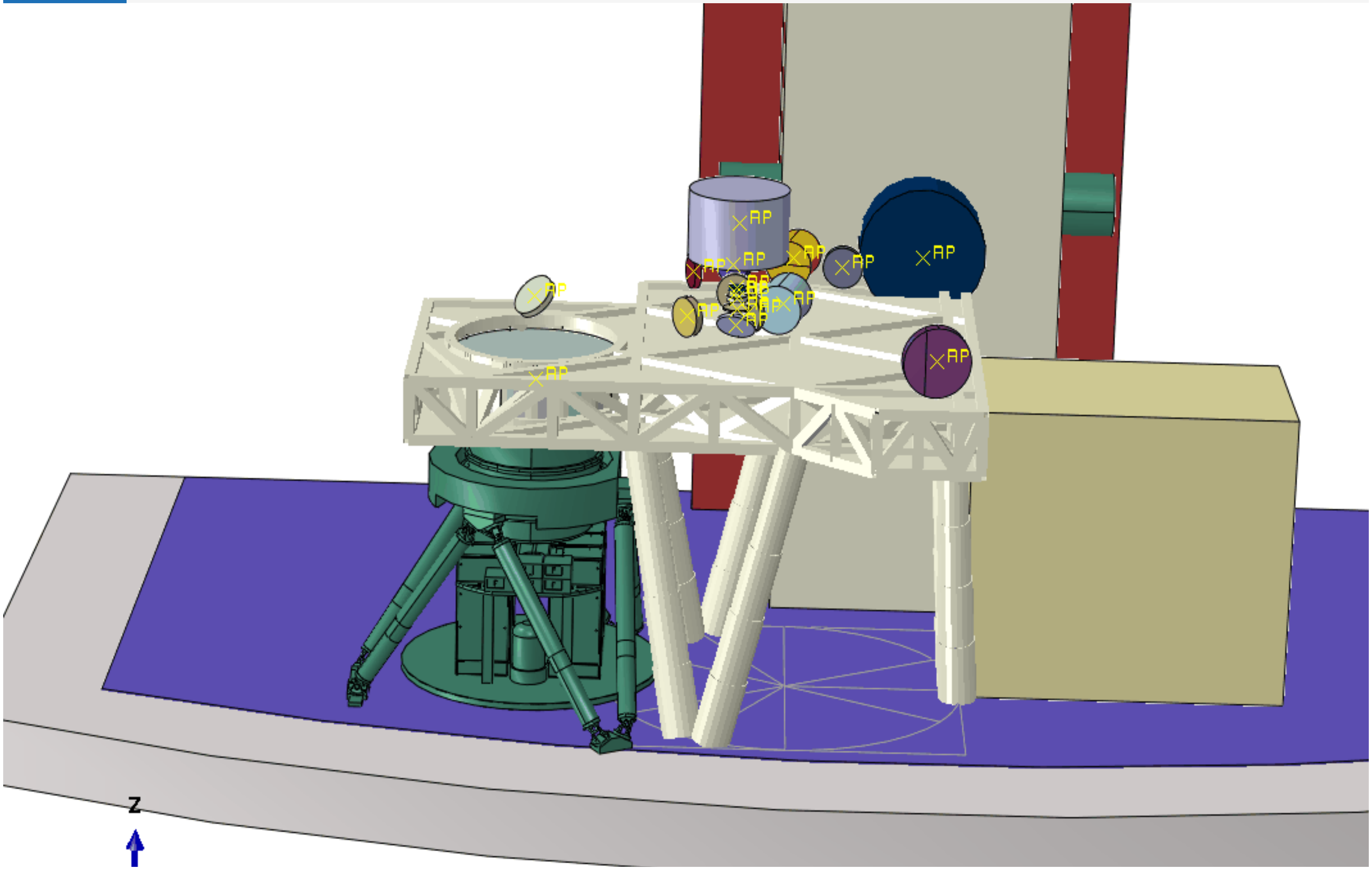


MICADO+MAORY

MAORY
PI: E. Diolaiti INAF, Italy

- **SCAO and Multi-conjugate AO**
- 6 laser, 3 natural guide stars
- **2 deformable mirrors** conjugated to 4km, 12.7km + M4
  - (Single DM initial, upgrade path to 2 DMs)
- **2 output ports** (MICADO + future instrument)
- $0.6\ \mu m < \lambda < 2.4\ \mu m$
- **Field of view** 2 arcmin, 1 arcmin clear

MICADO+MAORY

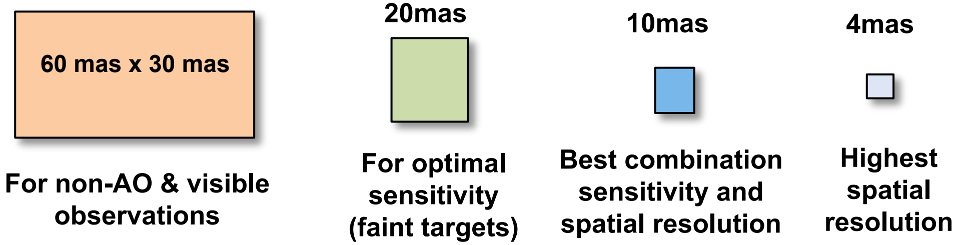


HARMONI

HARMONI
PI: N. Thatte University of Oxford, UK

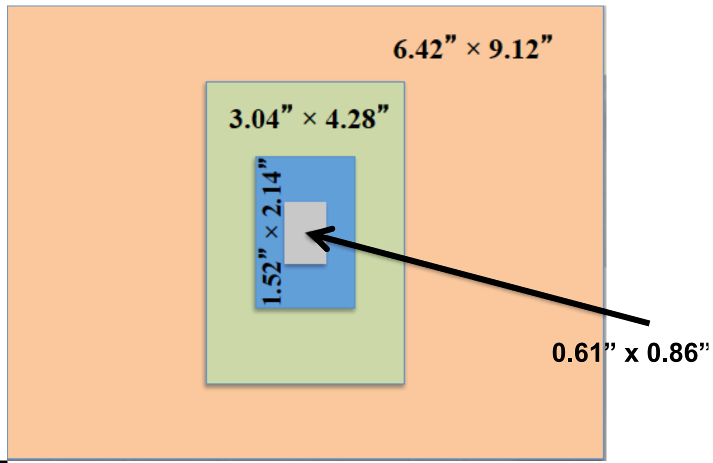
- **3D spectrograph** (IFU)
- Covering **optical** (0.47 μm) to **near-IR** (2.45 μm)
- From **seeing limited** down to the **diffraction limit** with SCAO and LTAO
- Range of **resolving powers** from R=3500 to 20000
- Range of **spatial scales** with field of views from 9”x6” to 0.8”x0.6”

HARMONI + LTAO



Diffraction-limited, single field NIR IFU

- Four spaxel scales / fields of view;
  - 60x30mas/6.5 x 9.1” FoV (Seeing)
  - 20x20mas/4.3 x 3.0” (LTAO faint sources)
  - 10x10mas/2.1 x 1.5” (LTAO bright sources)
  - 4x4mas/0.8 x 0.6” (SCAO / diffraction limit)



Large wavelength range & resolution combinations:

Bands	Wavelengths (µm)	R
“V+R” or “I+z+J” or “H+K”	0.45-0.8, 0.8-1.35, 1.45-2.45	~3000
“I+z” or “J” or “H” or “K”	0.8-1.0, 1.1-1.35, 1.45-1.85, 1.95-2.45	~7500
“Z” or “J_high” or “H_high” or “K_high”	0.9, 1.2, 1.65, 2.2 (TBD)	~20000

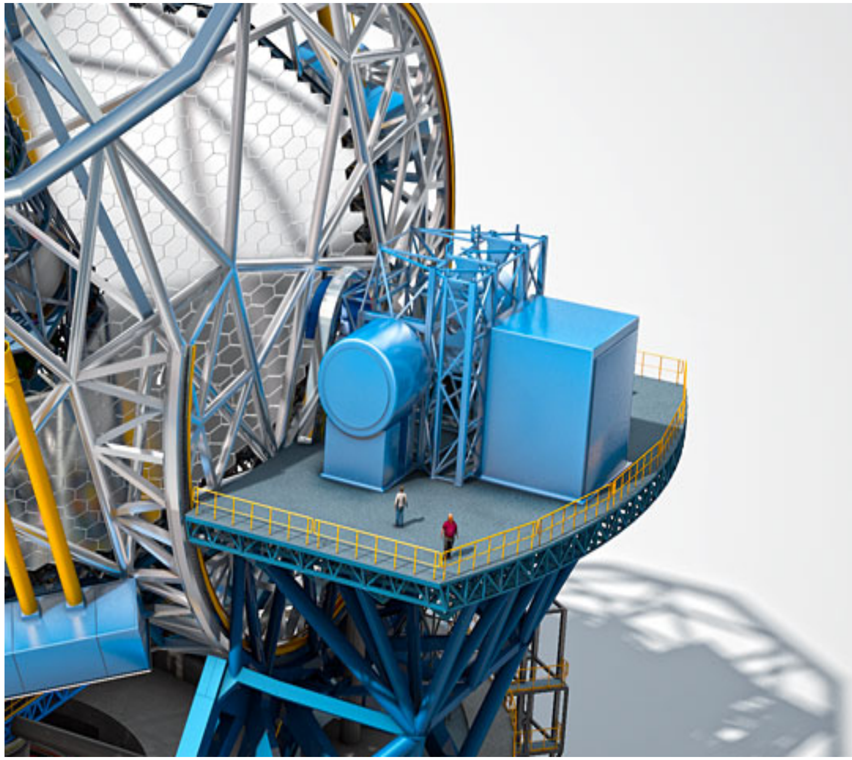
METIS

METIS
PI: B. Brandl NOVA, Leiden , The Netherlands

- **Imaging at L, M, N, Q**-bands;
- **Coronagraphy for high contrast imaging** at L, M and N-band (goal: coronagraphy for IFU spectroscopy);
- Low/medium resolution **slit spectroscopy** at L, M, and N-band;
- **High resolution R~100,000 IFU spectroscopy** at L and M band (goal: high resolution IFU spectroscopy at N band);

Second generation instruments

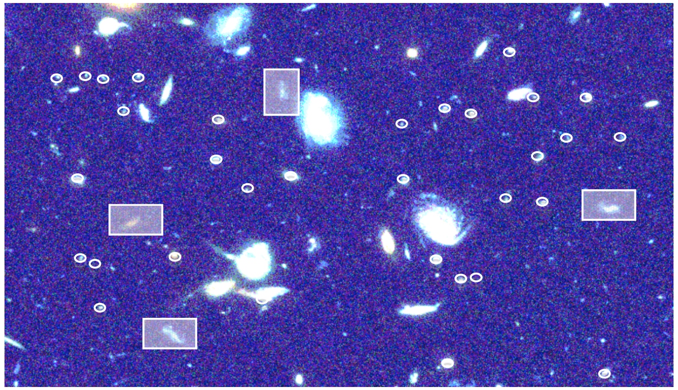
Selected in 2015
and
Phase A started in March 2016



ELT-MOS

Multi-object spectrograph (MOSAIC)

PI: Francois Hammer (GEPI, France)



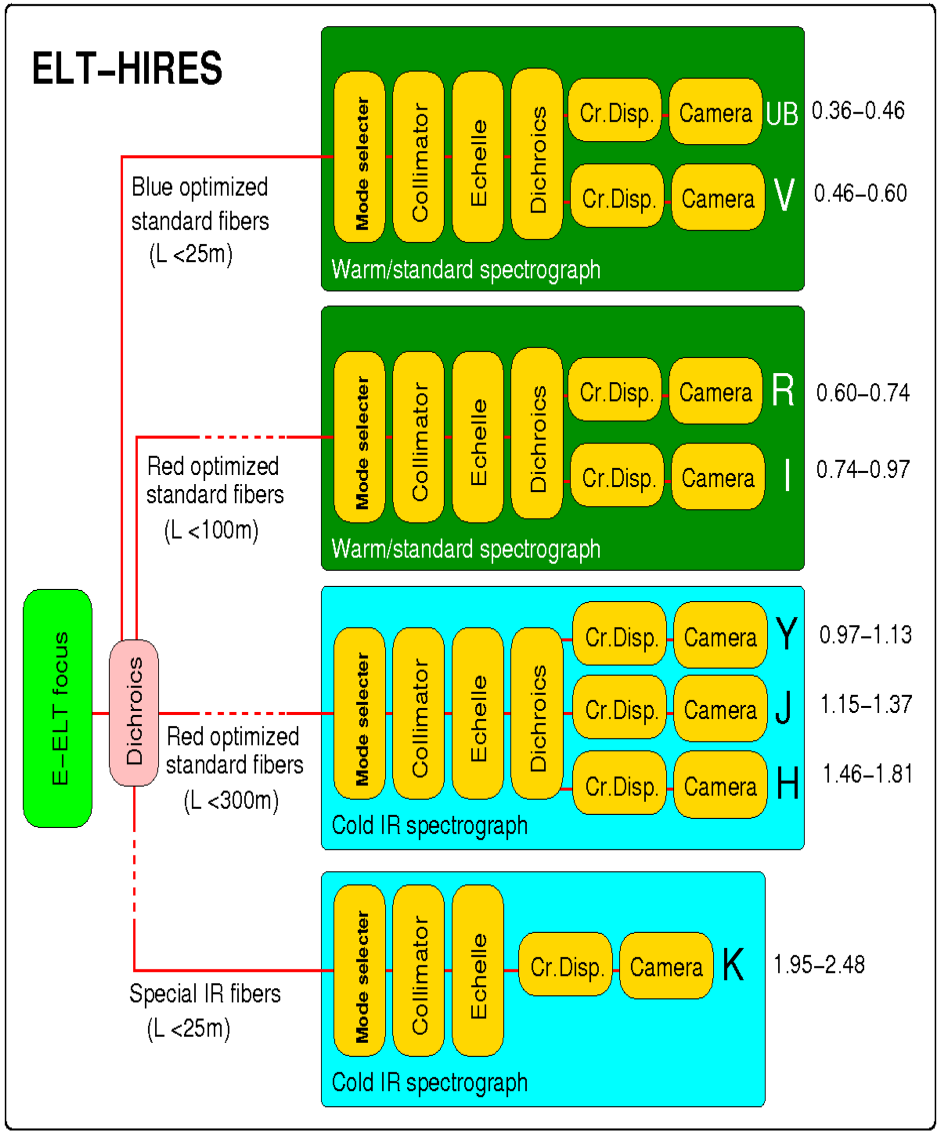
- Wavelength range: **0.4 – 2.45 µm**
- **High definition** (HDM, 80 mas/pix) with **≥10 MOAO IFUs**
- **High multiplex (HMM, 100-250**), GLAO/seeing resolution
- R=5000-20,000

ELT-HIRES

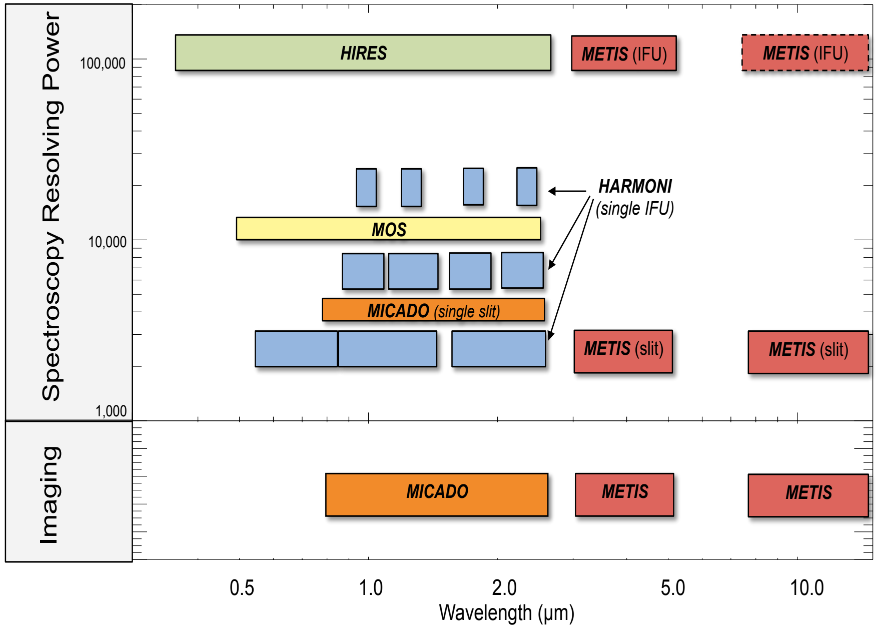
High-resolution spectrograph

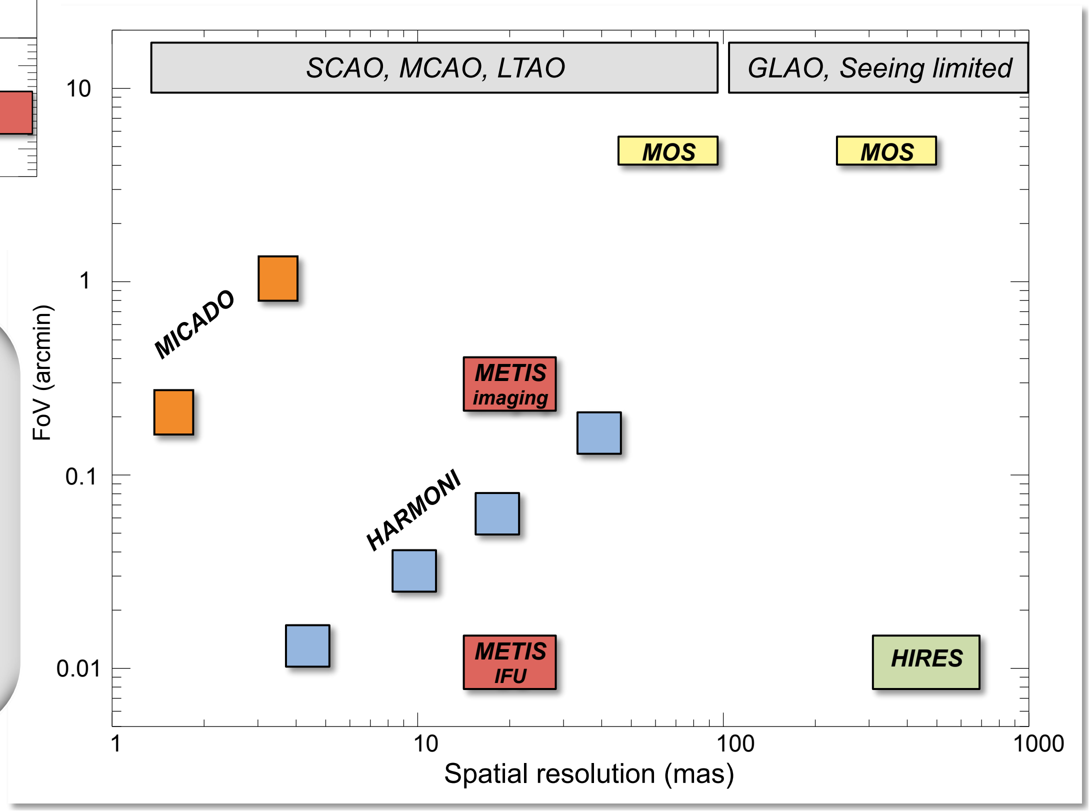
PI: Alessandro Marconi (INAF, Italy)

- Spectral resolution: **R > 100,000**
- Wavelength range: **0.37 – 2.4 µm**
- Accuracy: <10cm/s



E-ELT capabilities

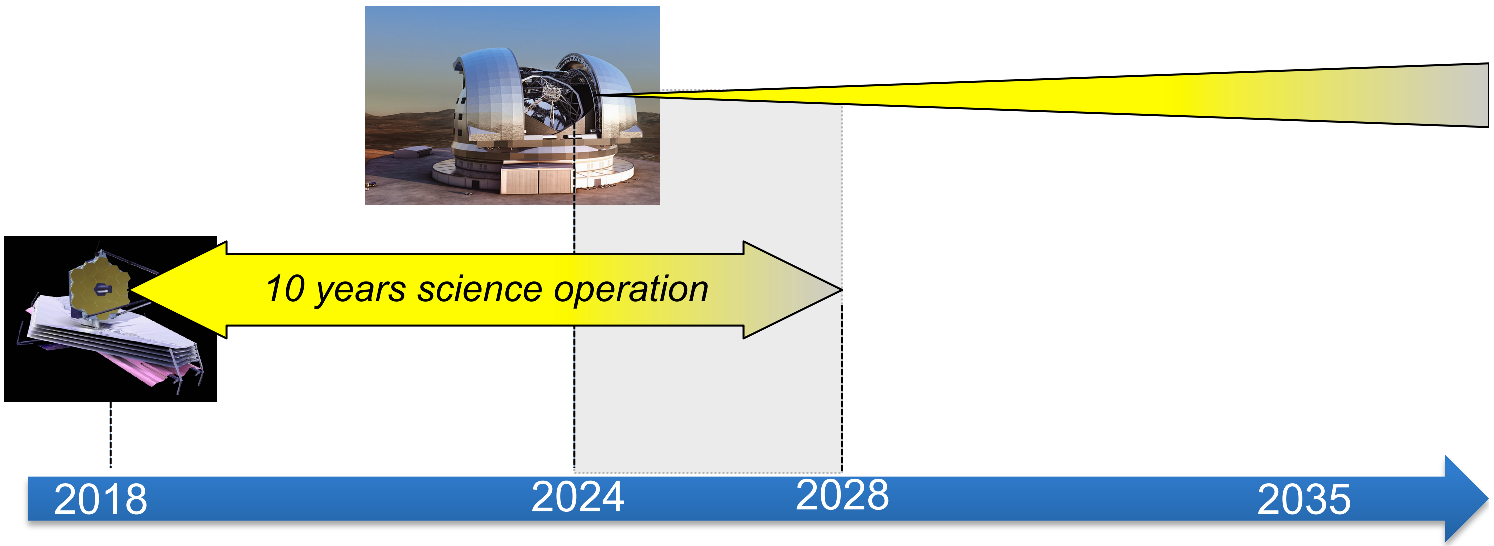




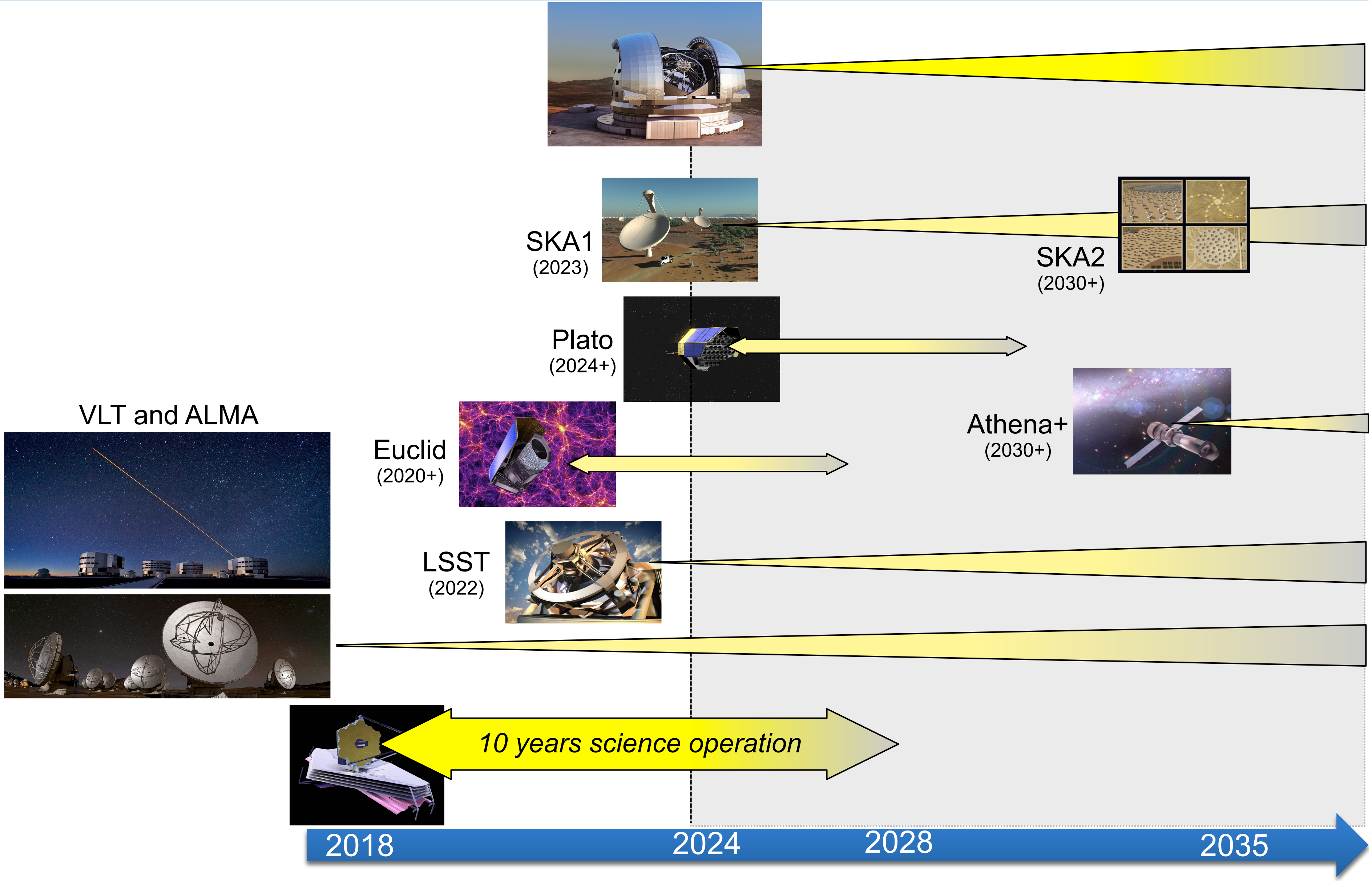
- Near-diffraction limit performance
- Multiple plate scales
- 50μas precision astrometry (MICADO)
- High-contrast / Coronograph
- Non-siderial tracking

E-ELT and JWST

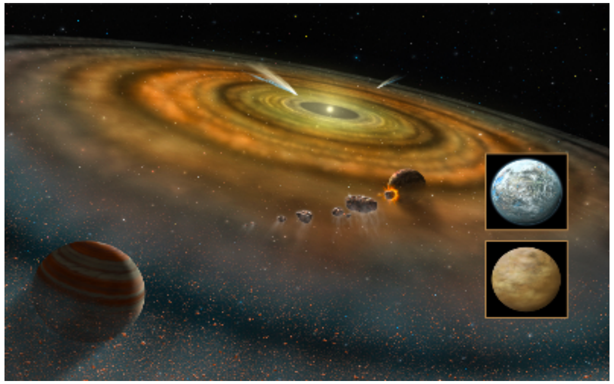
E-ELT first light in 2024 is crucial to guarantee a strong synergy with JWST



E-ELT synergies



Pioneering science

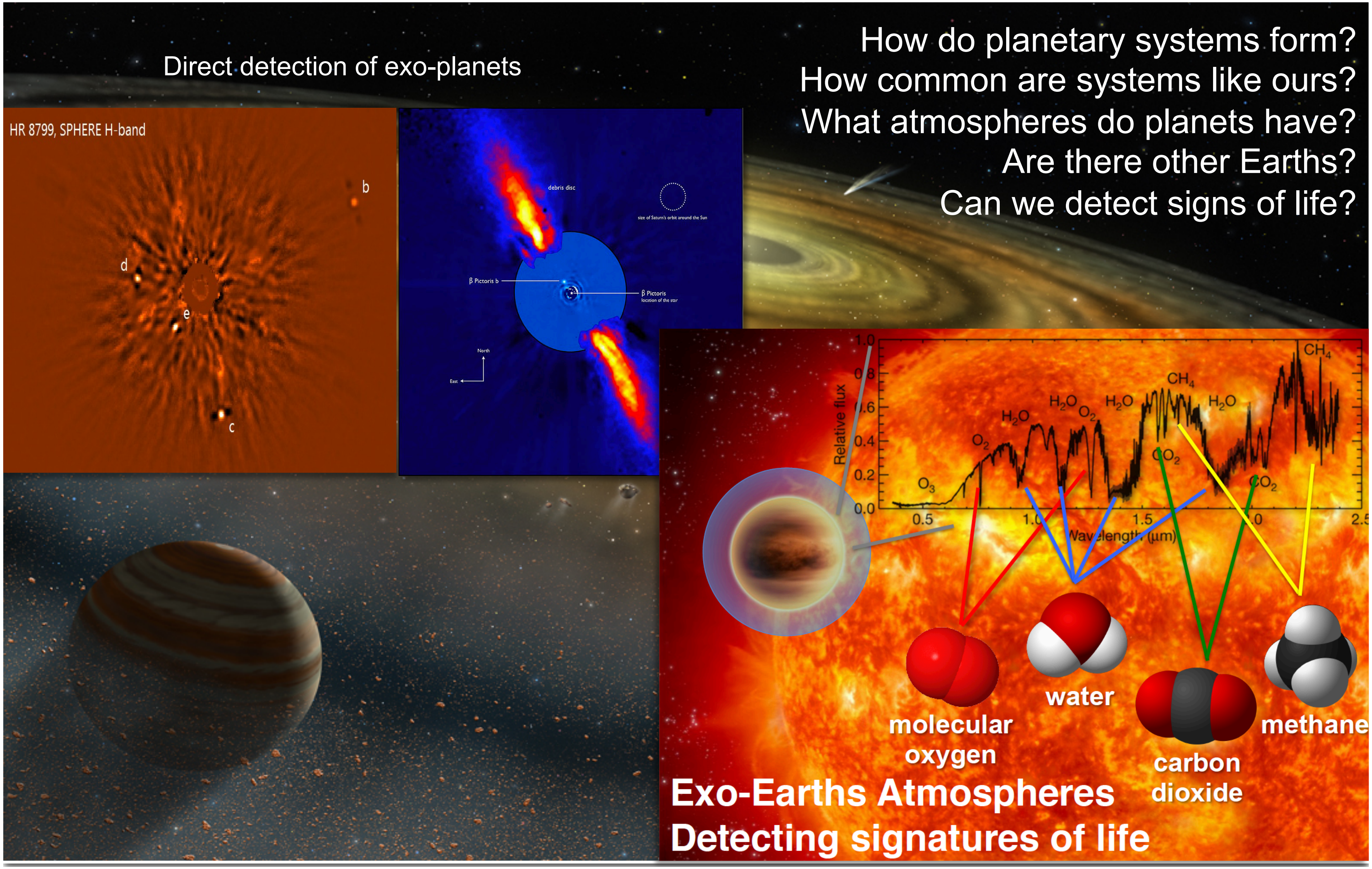


Planets & Stars

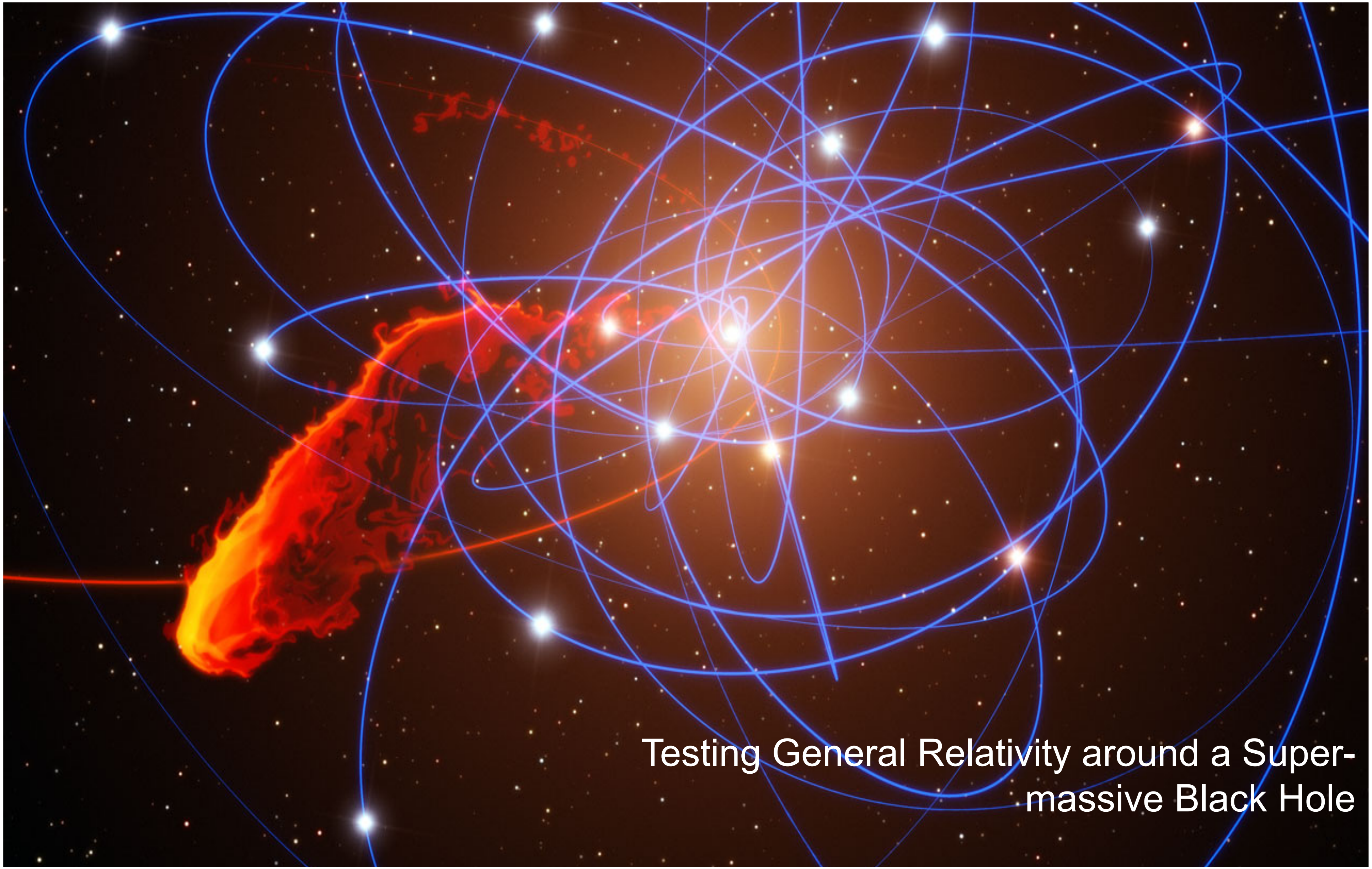
Stars & Galaxies

Galaxies & Cosmology

Exo-planets and proto-planetary disks

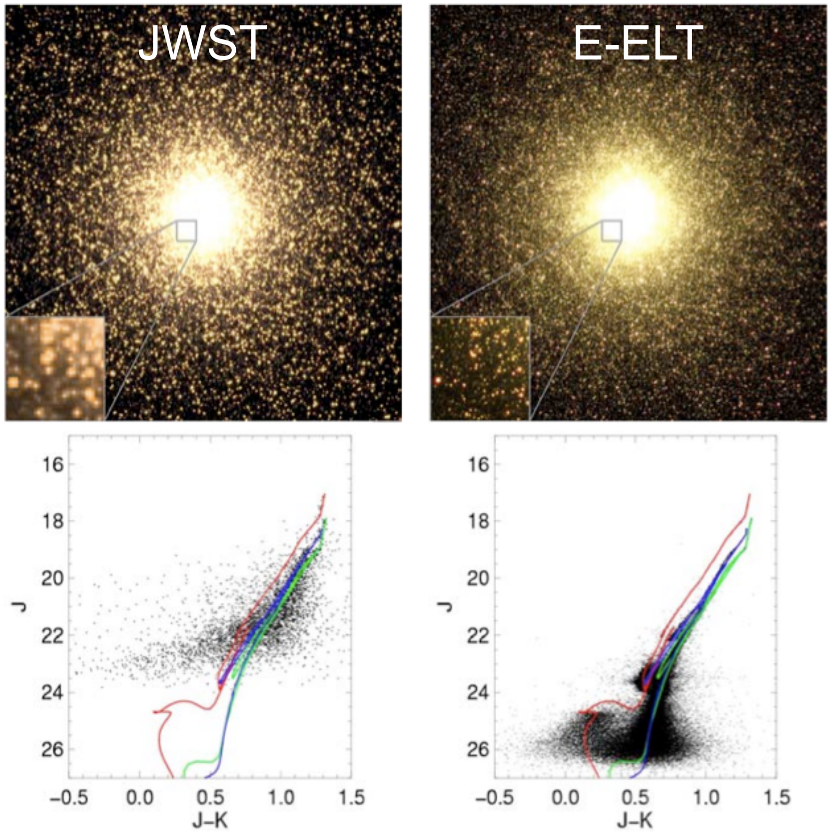


The Galactic centre



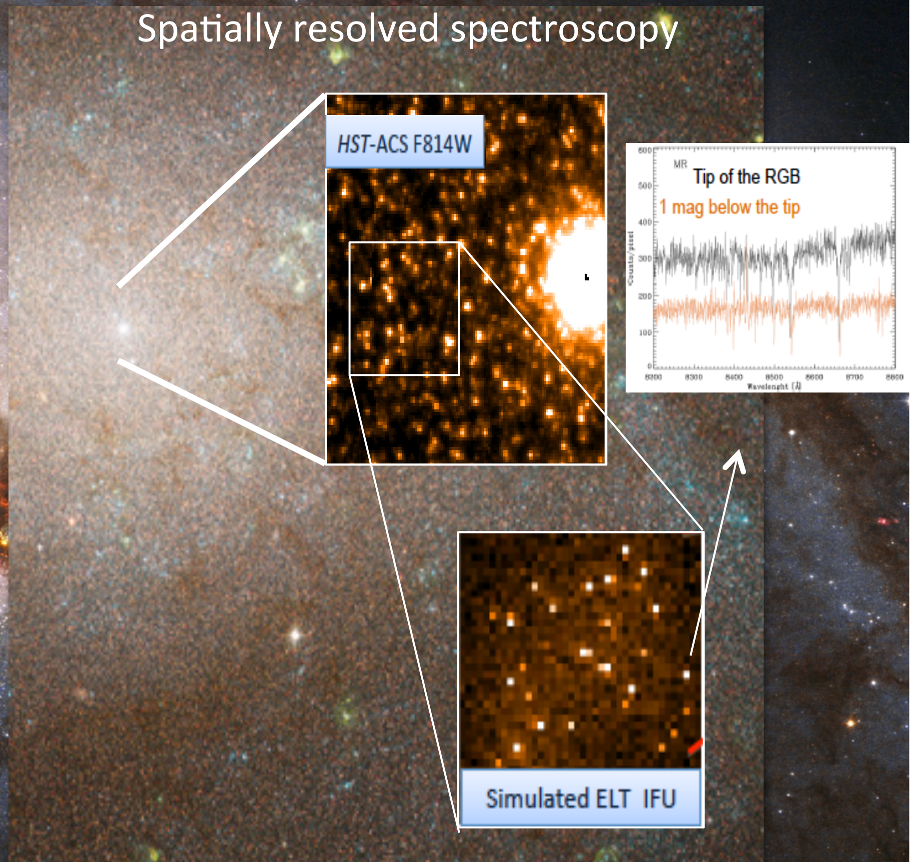
Resolved stellar population

Colour-magnitude diagrams



Simulated observations of M32

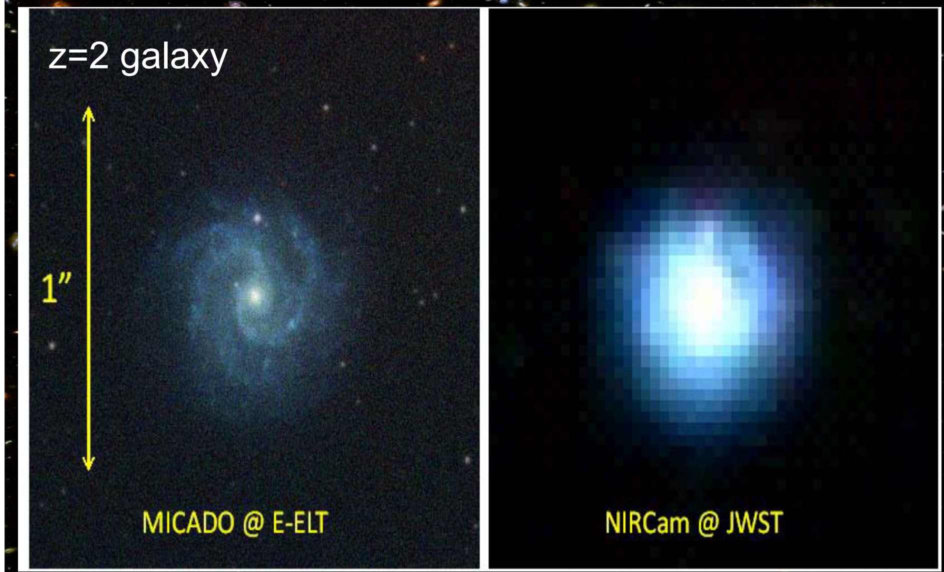
Spatially resolved spectroscopy



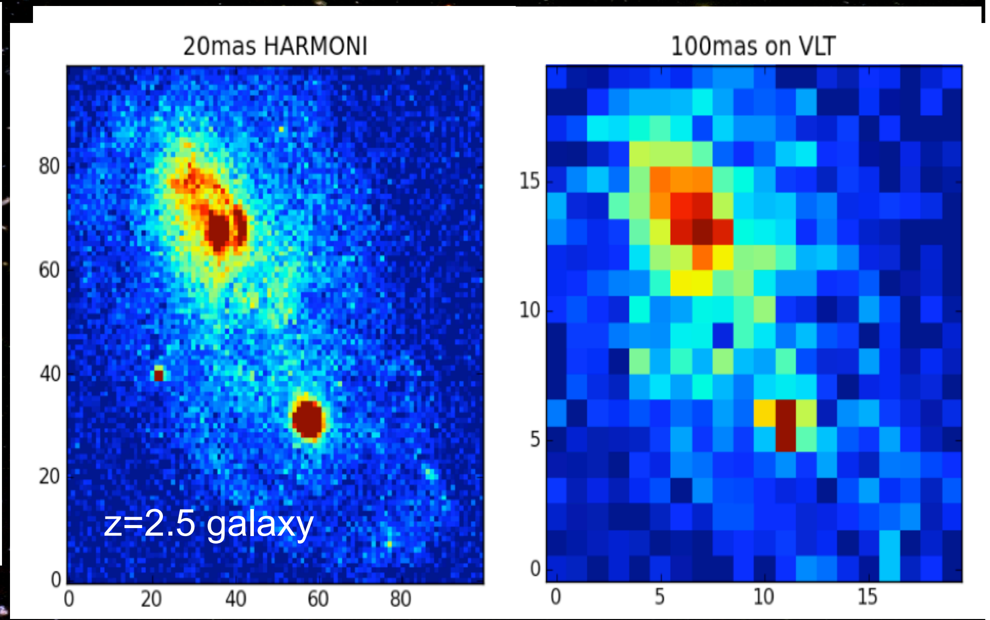
What is the evolution and merger history the Milky Way?

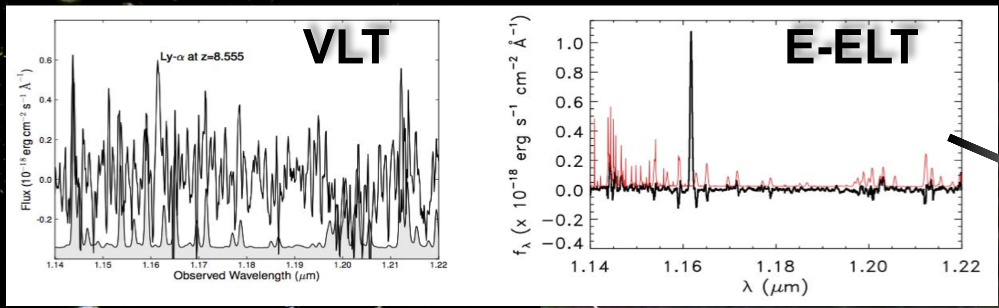
High redshift Universe

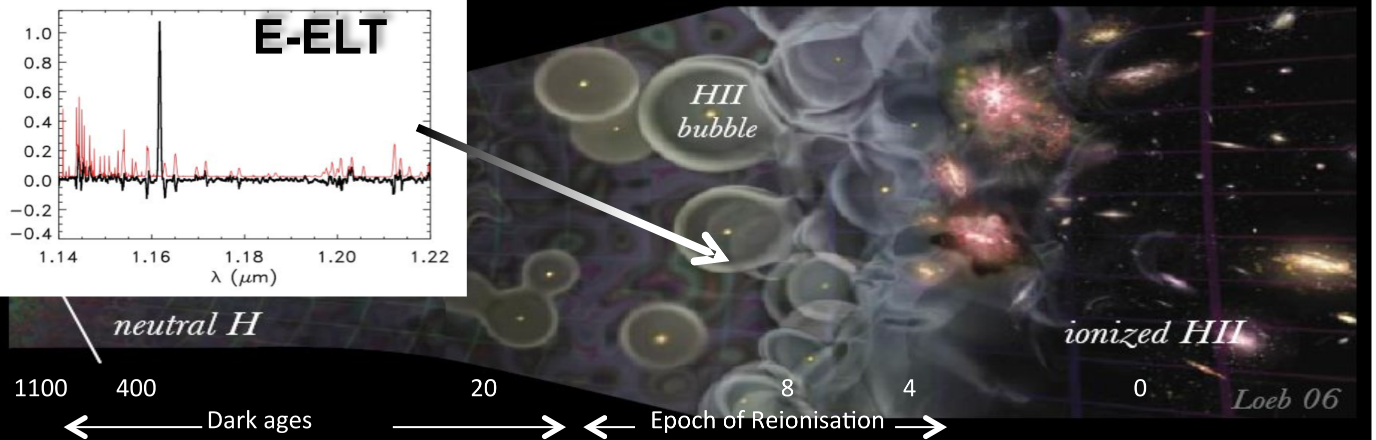
Structure and morphology of galaxies



Dynamics and physics from spatially resolved spectroscopy

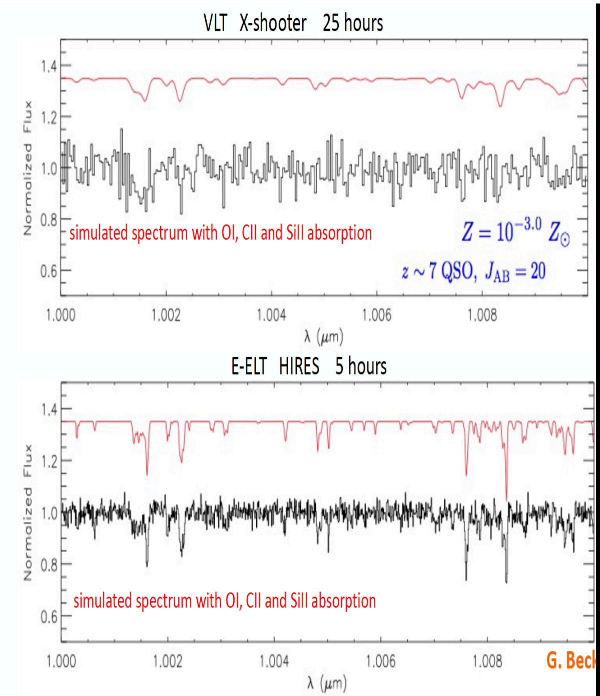


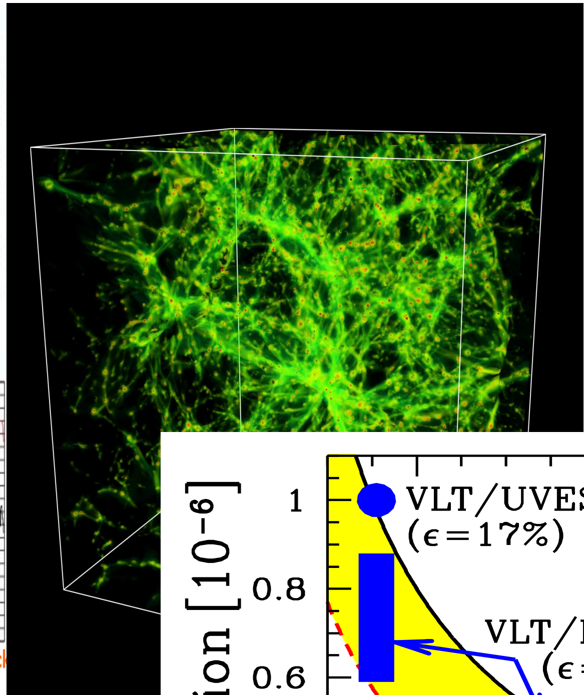


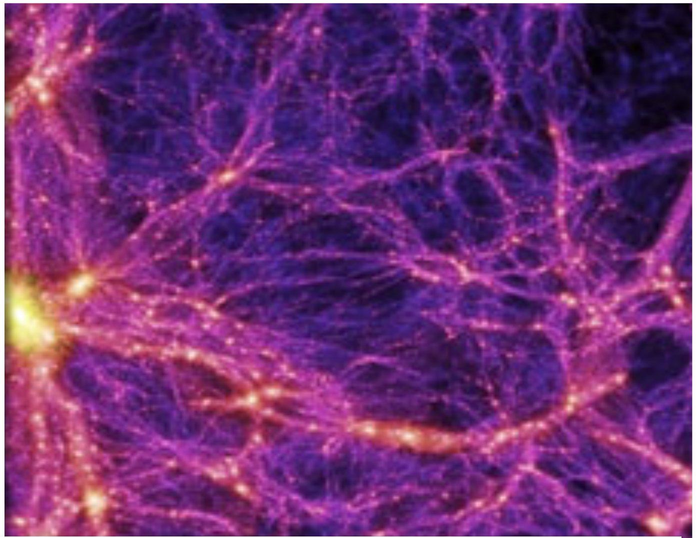


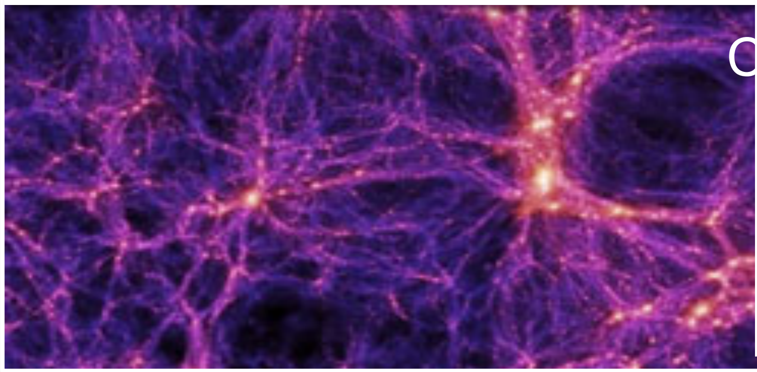
Cosmology and Fundamental Physics

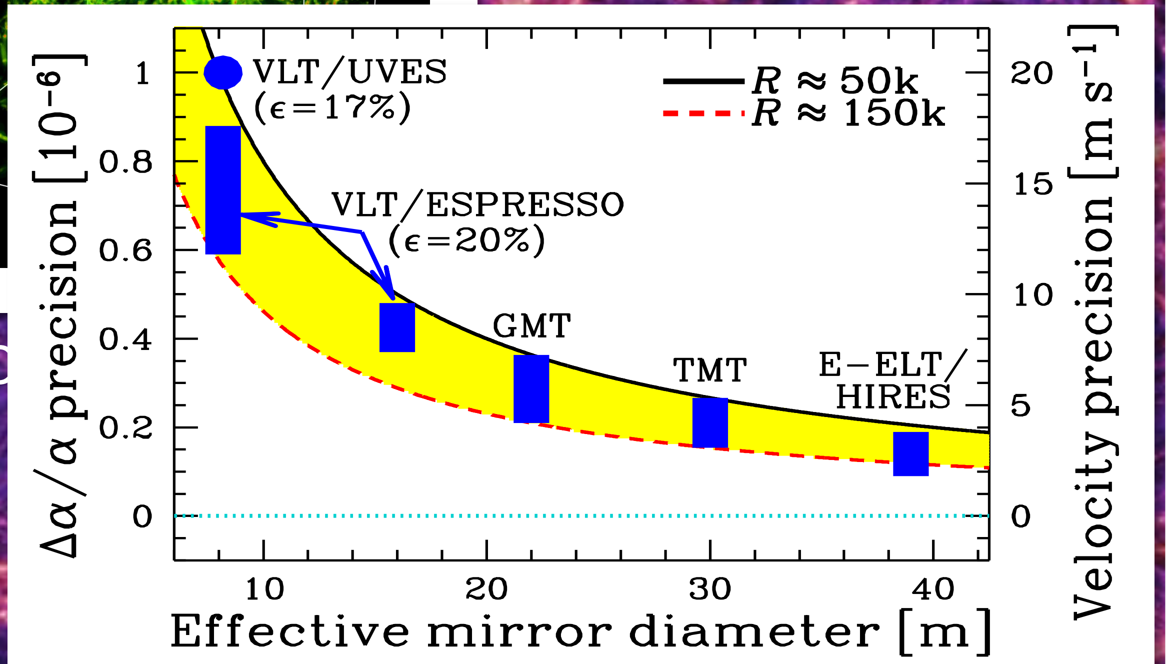
Chemical enrichment of the IGM











Summary

The E-ELT will be the largest optical/near-IR telescope excelling in **collecting power** and **angular resolution**

- Good momentum across the E-ELT Programme
- Most of the contracts ongoing
- Preliminary Designs of instruments progressing well
- Exciting scientific capabilities and strong synergies with JWST
- Planned first light in 2024