HIRES

- Science cases
- Prioritisation
- Plans for Phase B

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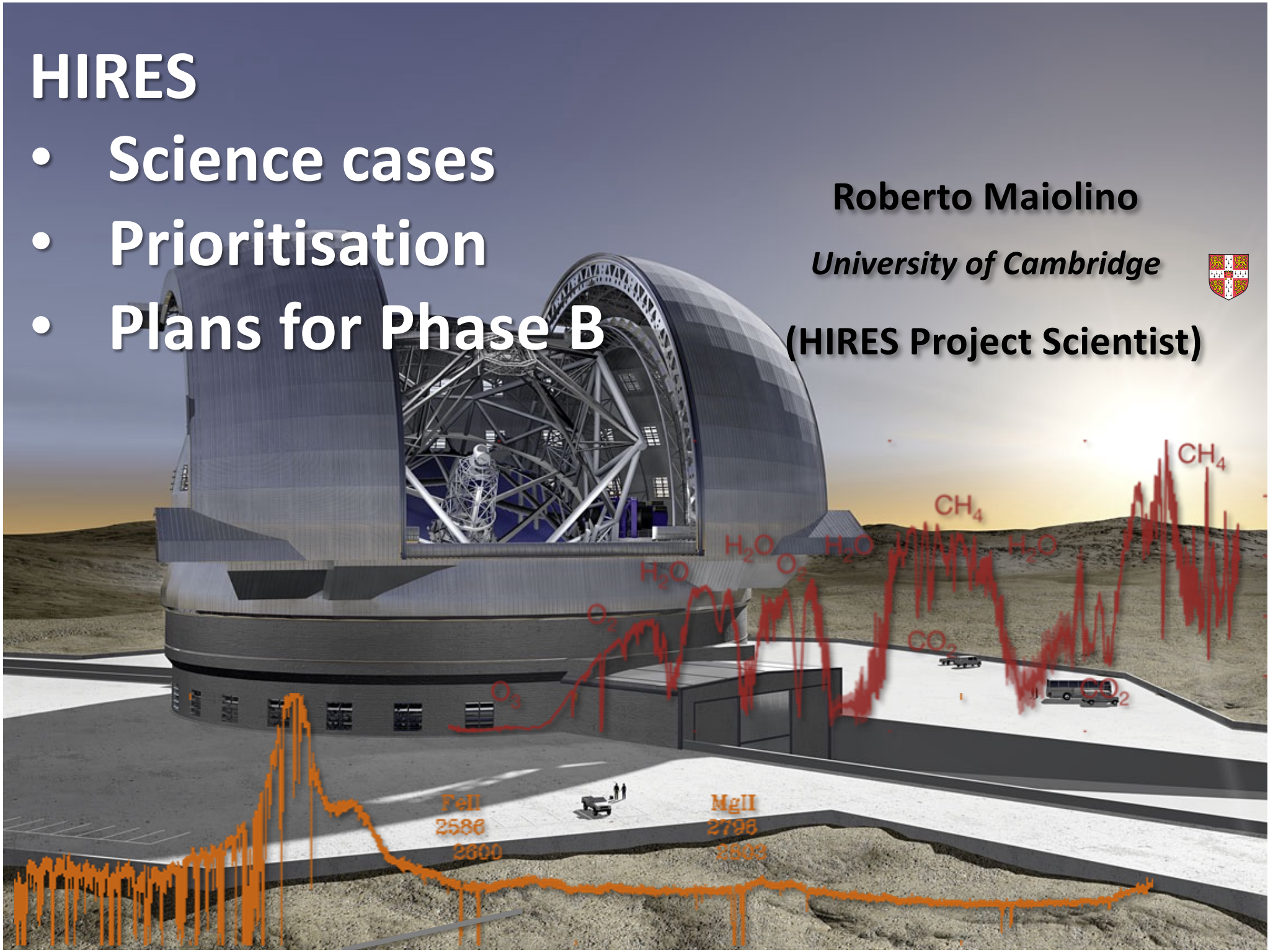
(HIRES Project Scientist)



HIRES' uncommon breadth

High resolution spectroscopy at the ELT can tackle a huge range of diverse interdisciplinary science cases, spanning most fields of Astrophysics, going even beyond the traditional boundaries of Astronomy

(HIRES White Paper, Maiolino+2014)

Wide transversal support from scientists across the most diverse fields in Astronomy and Physics

Phase A (& pre-B) Science Organogram

Science Advisory Committee (SAT): 63 experts in High-Res spectrosc.

Project Scientist & SAT Chair (R. Maiolino)

WG1 Exoplanets and Circumst. Discs	WG2 Stars and Stellar Pop.	WG3 Galaxies and IGM	WG4 Cosmology and Fundam. Physics
Chair: E. Palle Co-Chair: C. Lovis	Chair: C. Allende Co-Chair: A. Korn	Chair: V. D'Odorico Co-Chair: E. Zackrisson	Chair: J. Liske Co-Chair: C. Martins
20 scientists	17 scientists	17 scientists	9 scientists

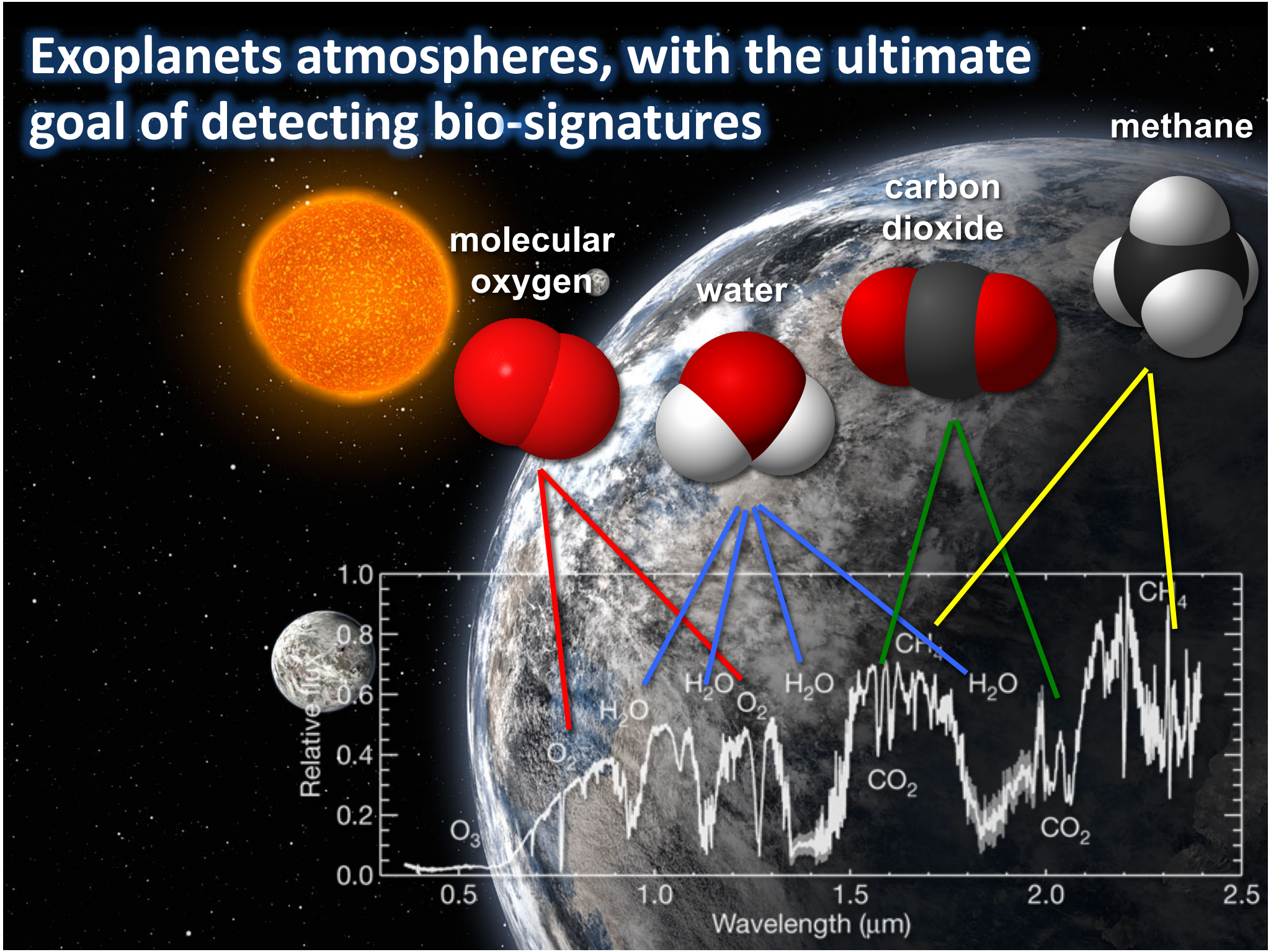
➔ **Definition of science cases, priorities and requirements**

A subset of the HIRES Science Cases

- **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)

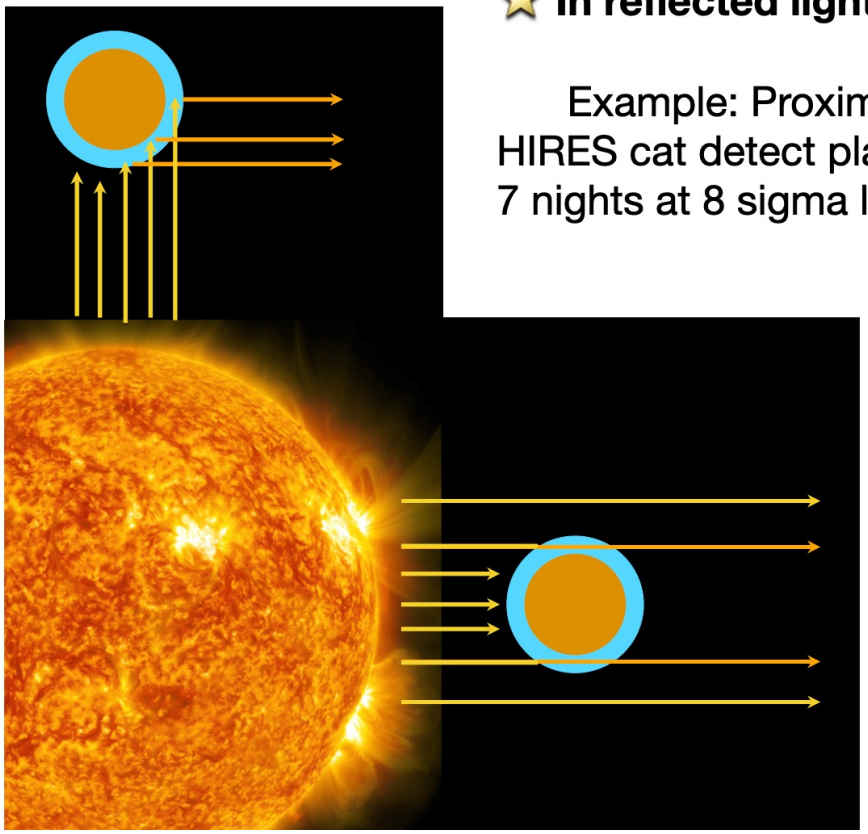
Community White Paper: Maiolino et al. 2013
ArXiV:1310.3163

Exoplanets atmospheres, with the ultimate goal of detecting bio-signatures



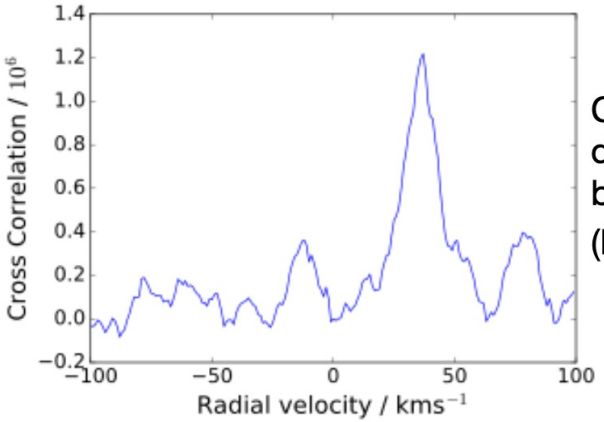
Exoplanet atmospheres

Use high-resolution spectroscopy to disentangle the planetary and stellar spectra by comparing the combined spectrum to a star-only reference spectrum aided by the radial velocity offset (e.g. Snellen+15)



In reflected light

Example: Proxima b HIRES cat detect planet in 7 nights at 8 sigma level



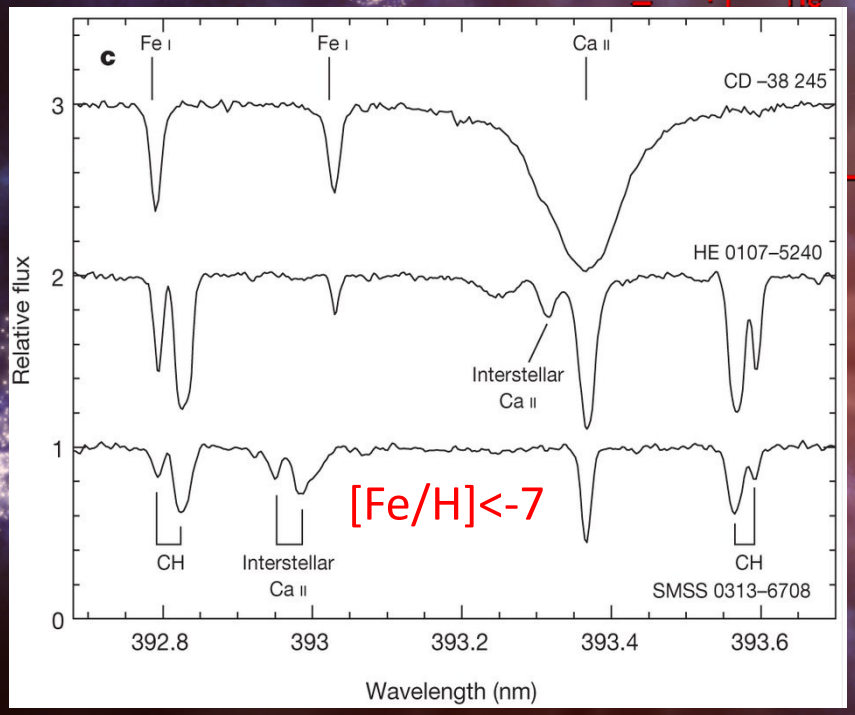
CCF with the detection of Proxima b in O_2 in 70h (Hawker & Parry 19)

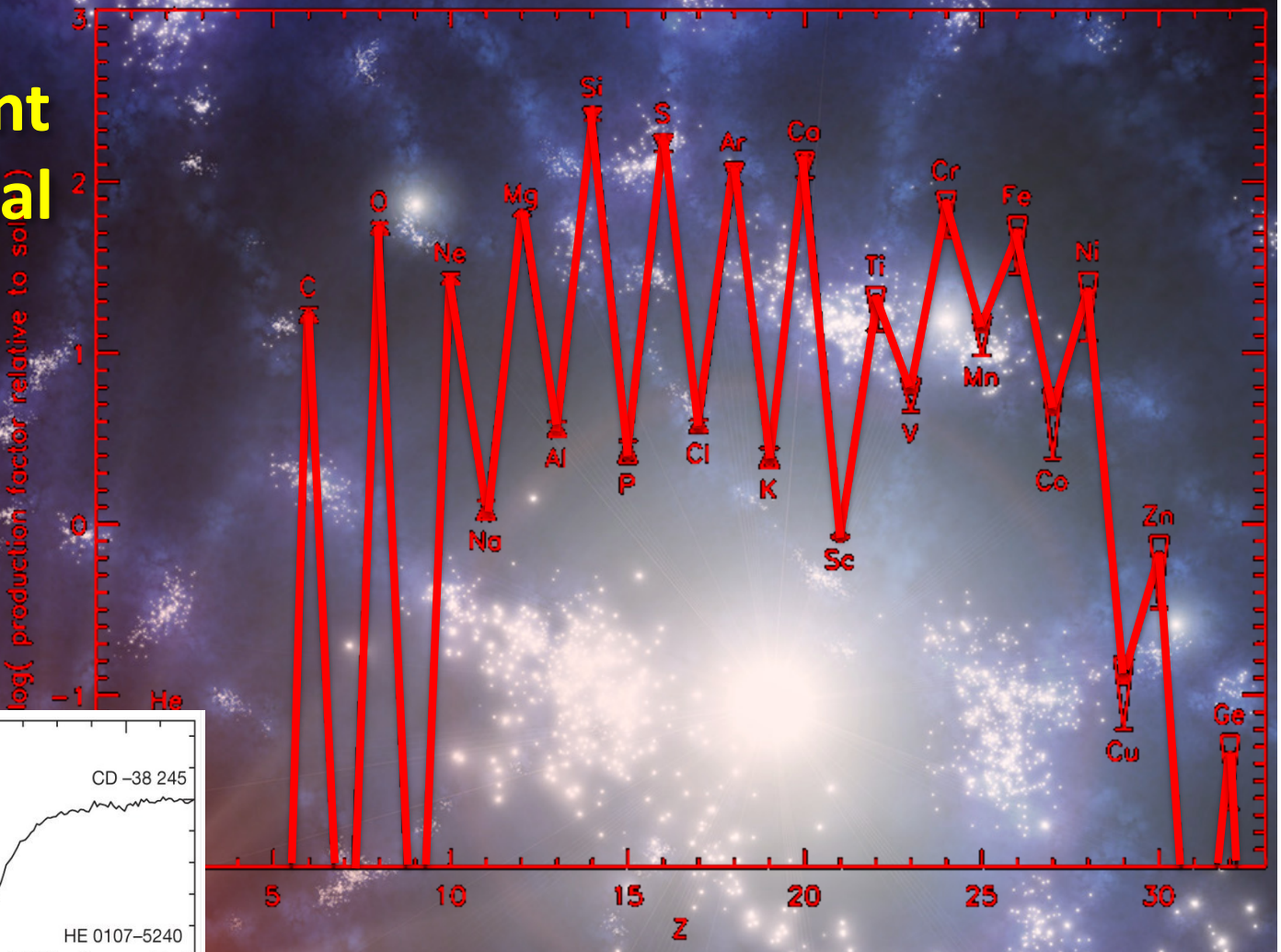
In transmitted light

Example: Trappist 1 & 2 HIRES cat detect:

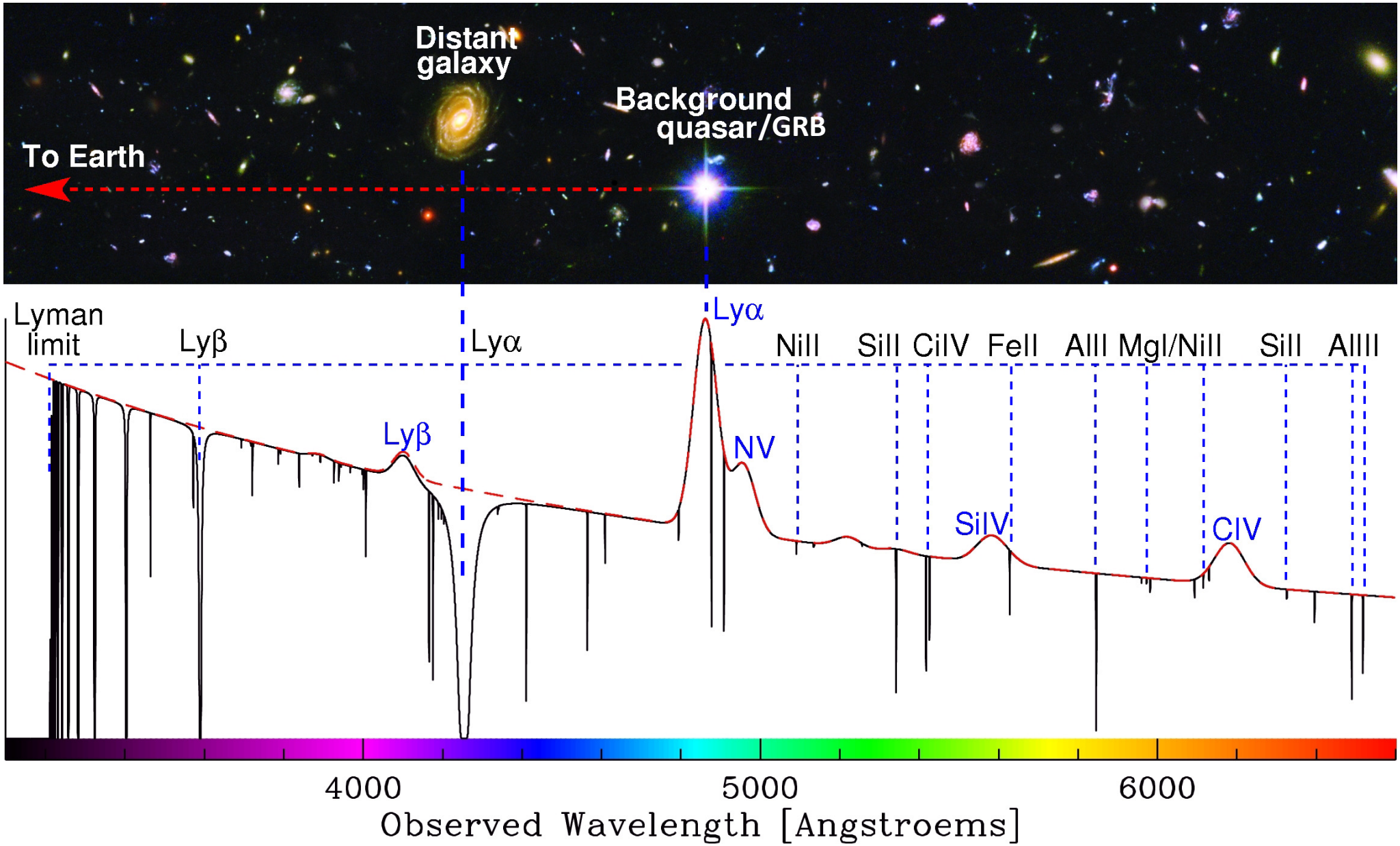
- H_20 (1.3-1.7 μm) in 2 transits
- H_20 (0.9-1.1 μm) in 4 transits
- CO_2 in 4 transits
- O_2 in 25 transits

Searching the chemical enrichment imprint of primordial supernovae: PopIII signatures in extremely metal poor stars

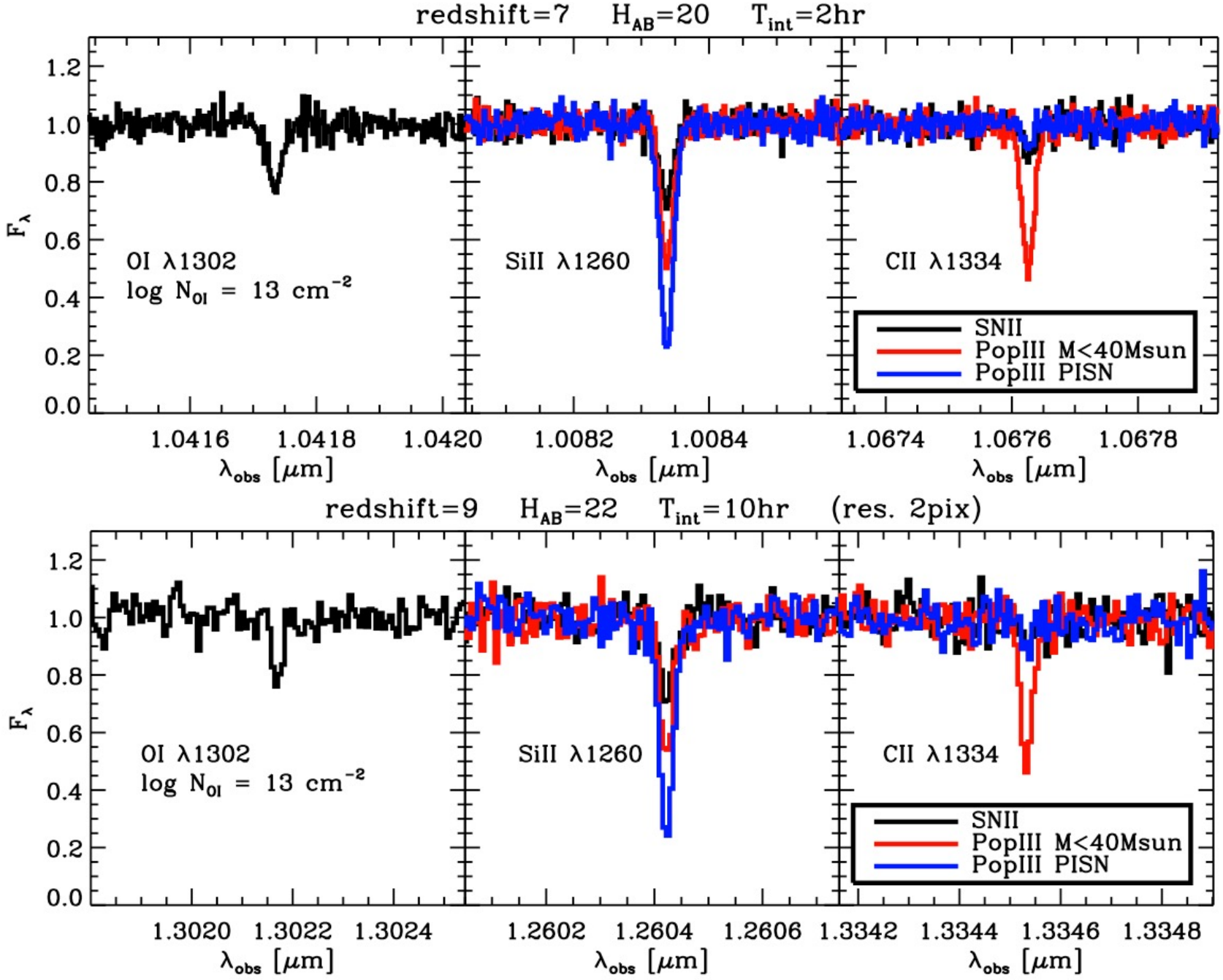




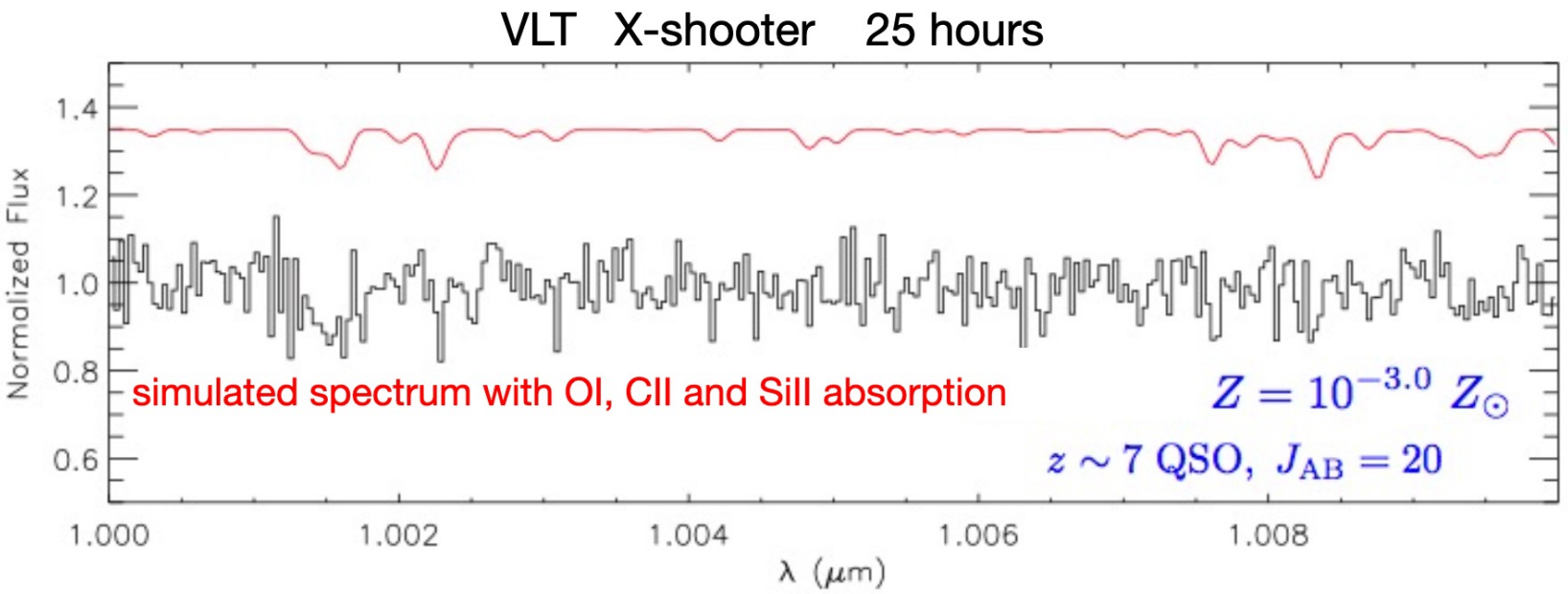
The Inter-Galactic Medium: tracing the reionization process and chemical enrichment of the primeval Universe

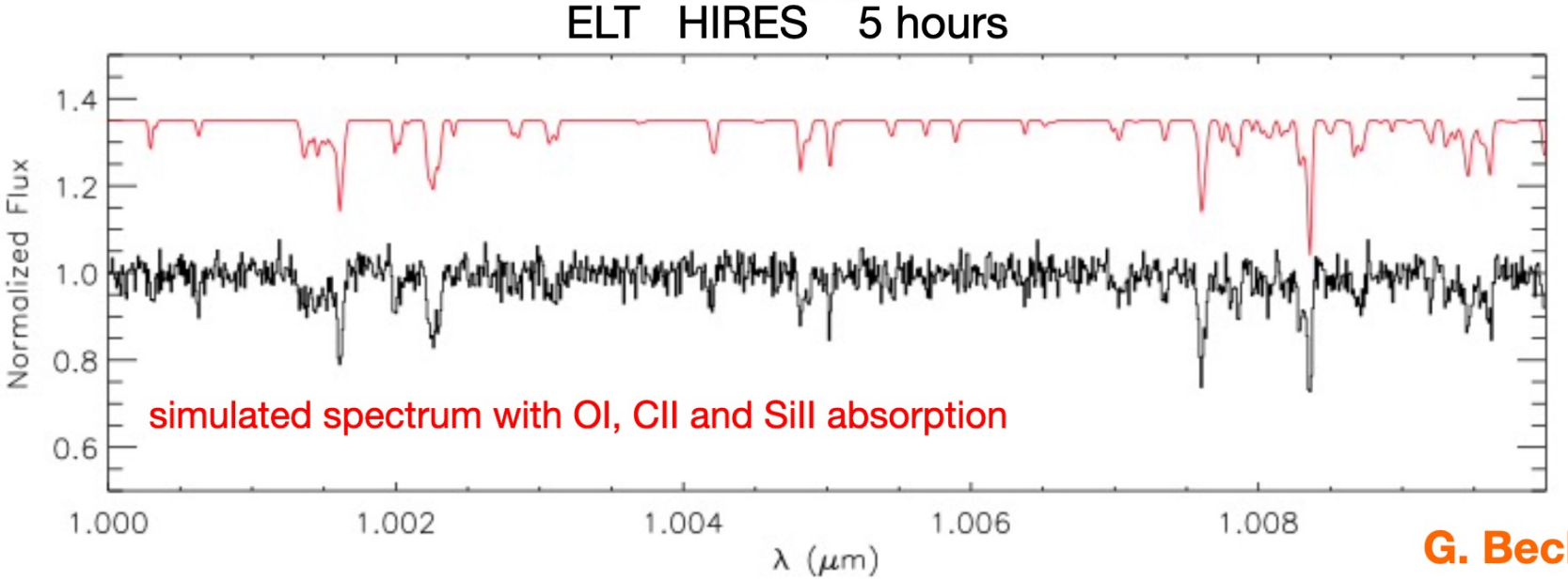


Chemical fingerprint of primordial supernovae: PopIII signatures in the intergalactic medium in the early Universe



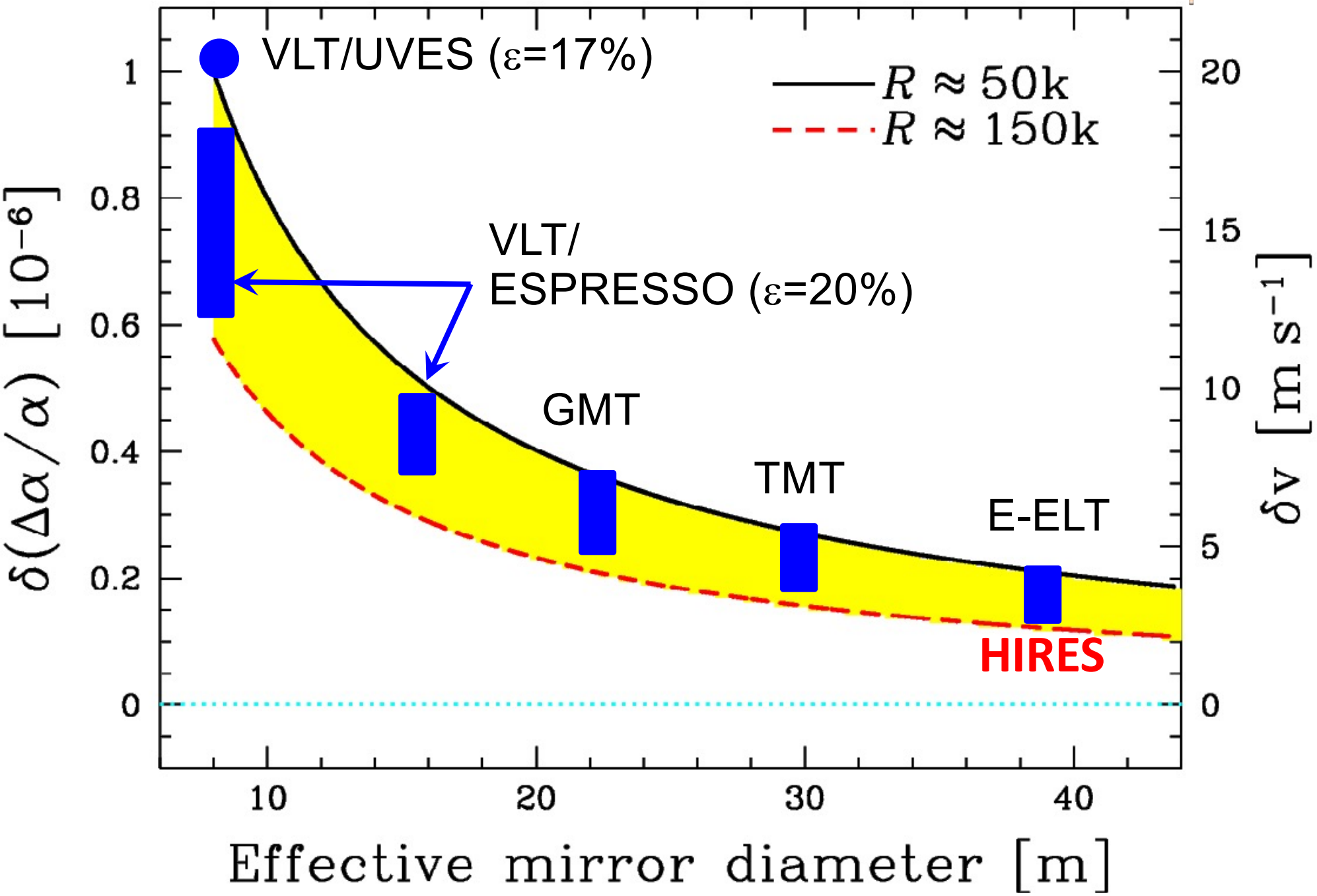
Probing the early chemical enrichment





G. Becker

Fundamental Physics:
variation of the fundamental constants ($\alpha=e^2/\hbar c$, $\mu=m_p/m_e$)

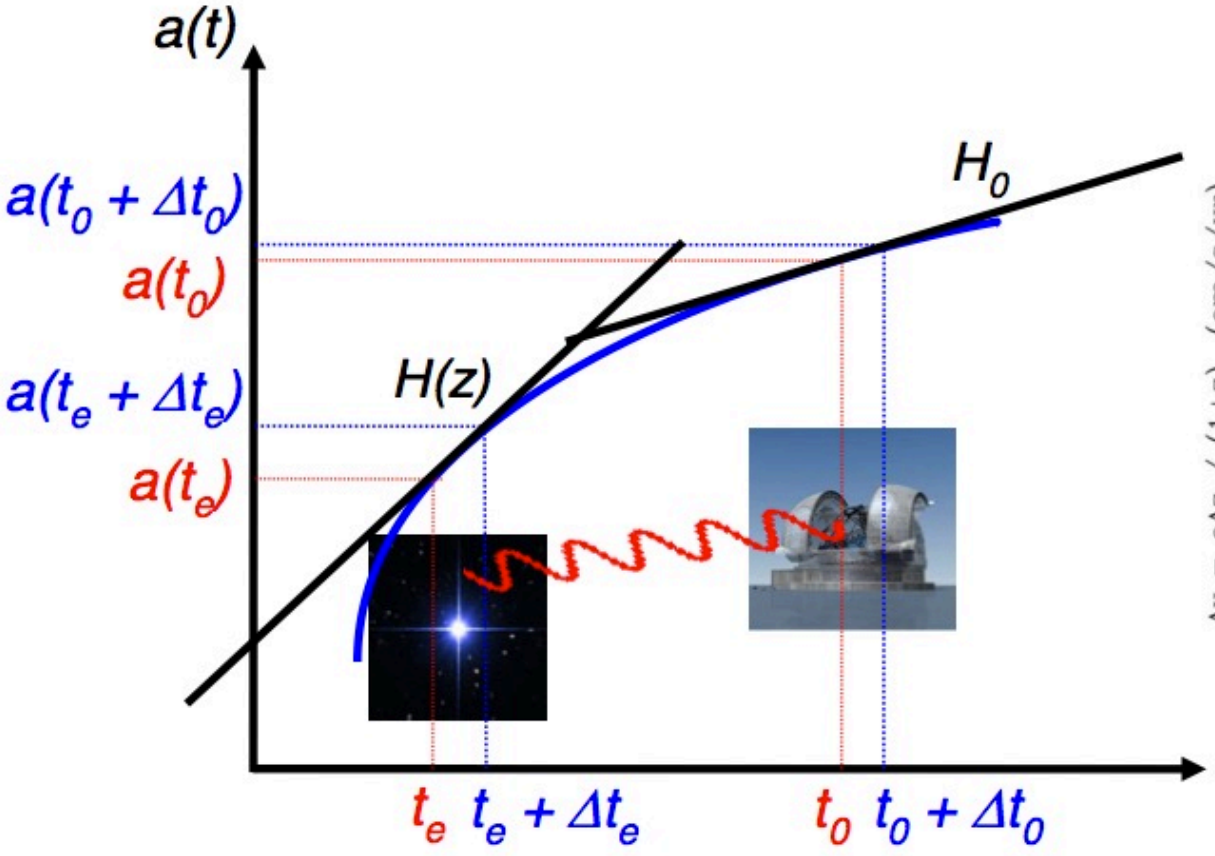


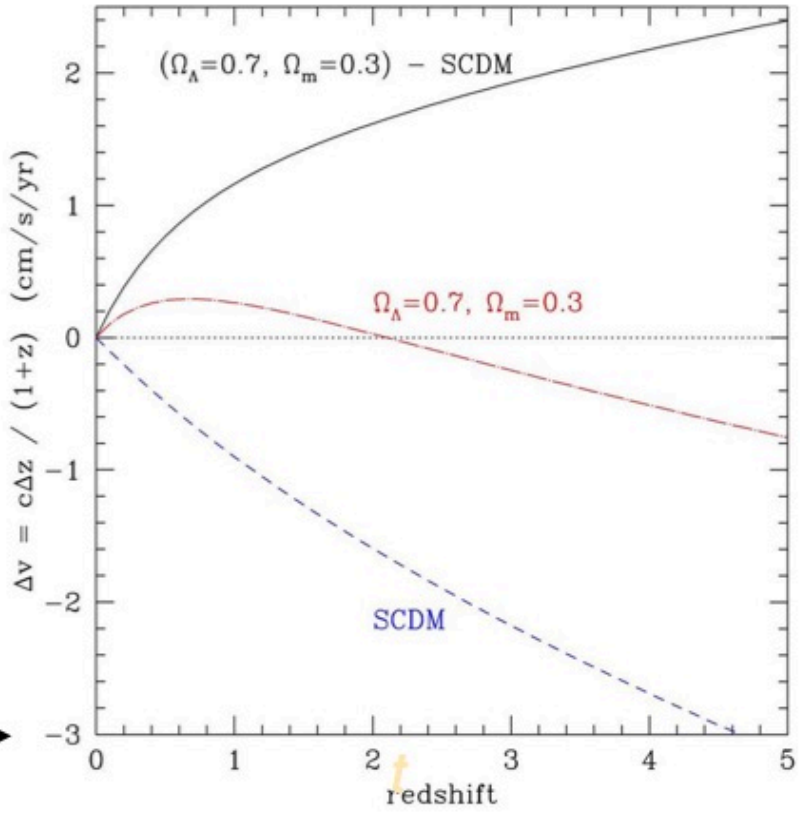
Redshift drifts ("Sandage test"):

Direct non-geometric (model-independent) measurement of the expansion history of the Universe

➔ alternative to all other geometrical methods

➔ exploring potential new physics



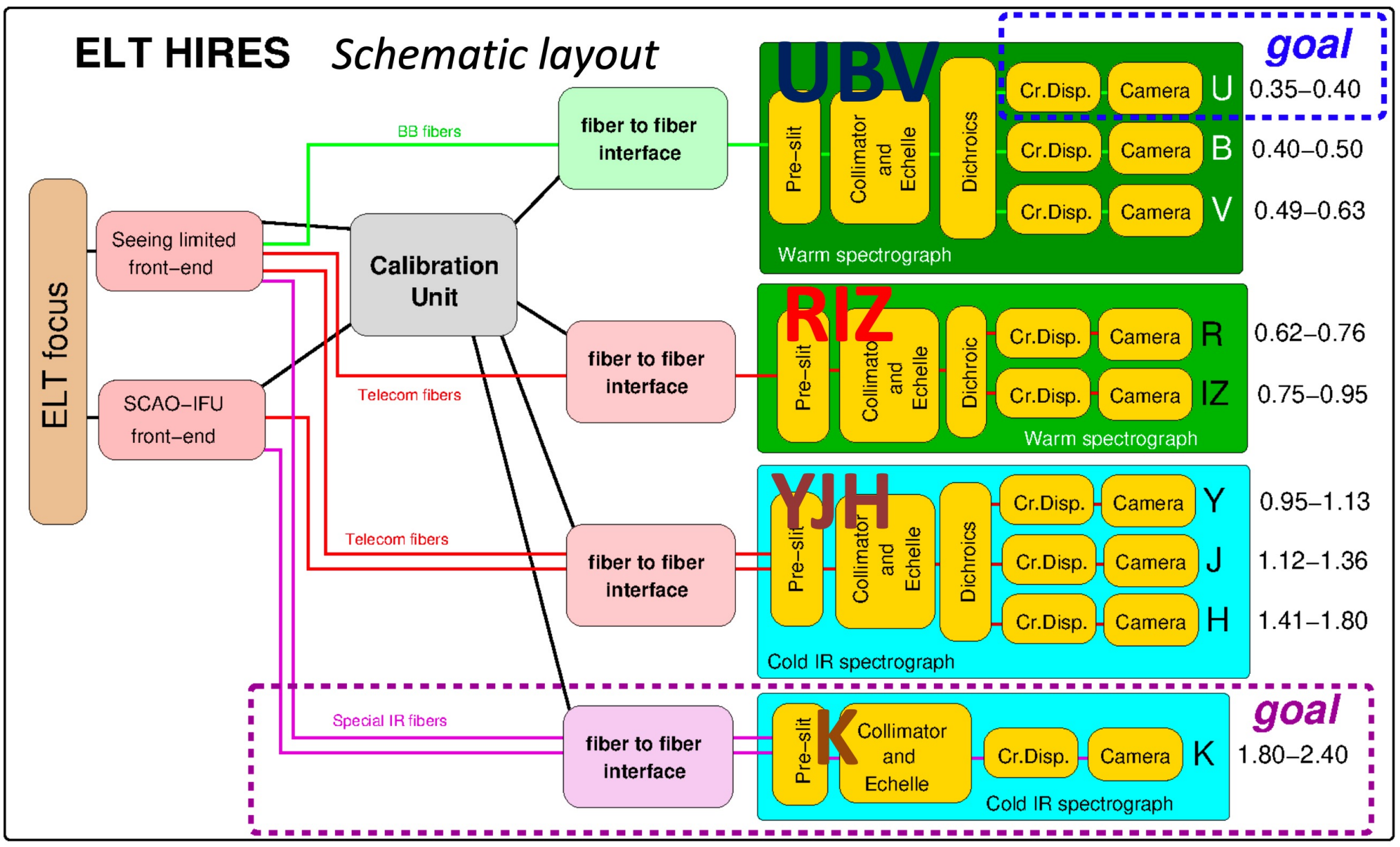


... and ~30 additional science cases illustrated in the HIRES White Paper and Phase A documents

Science Priorities

- **Priority 1: Exoplanet atmospheres via transmission spectroscopy (potential detection of bio-signatures)**
  - **TLR 1: R > 100,000, 0.5-1.8 µm, *et alia***
  - Enables: reionization of Universe; characterization of Cool stars
  - Doable: detection and investigation of near pristine gas; 3D reconstruction of the CGM; Extragalactic transients
- **Priority 2: Variation of the fundamental constants of Physics**
  - **TLR 2: blue extension to 0.37 µm**
  - Enables: Cosmic variation of the CMB temperature, Determination of the deuterium abundance; investigation and characterization of primitive stars
- **Priority 3: Exoplanet atmospheres via reflection spectroscopy (potential detection of bio-signatures)**
  - **TLR 3: SCAO+IFU**
  - Enables: Planet formation in protoplanetary disks; characterization of stellar atmospheres; Search of low mass Black Holes
  - Doable: characterization of the physics of protoplanetary disks
- **Priority 4: Redshift drift (Sandage test)**
  - **TLR 4: λ accuracy 2 cm/s, stability 2 cm/s**
  - Enables: Mass determination of exoplanets (Earth-like objects)
  - Doable: Radial velocity search for exoplanets around M-dwarf stars

Resulting Baseline concept and extension goals



Phase B

Definition of the Science Team

- Formally, the Science Team does not yet exist: it should be established based on the "Partners Shares" (which are still tentative, until Funding Review)
- Starting from the Phase-A/pre-Phase-B composition, the board is updating proposals for membership (taking into consideration new circumstances, additional active people in the various fields, new partners,...)

  -> **nominations by end of January 2022**
- PS, PI, WG coordinators will assess nominations taking into account: affiliations/shares, expertise in various areas, balance, etc...

  -> converge on a Science Team of ~80-100 members by ~mid February (to be approved by the Board)
- **Kickoff meeting end of February/early March**
- Science Team composition will be revised after Funding Review

Preliminary List of Action for the ST in Phase-B

(additional input/feedback welcome)

- **Re-write the Science Document**, which is now 4 years old, which may result also into a **new White Paper** (which is 7 years old). The new document will also confirm the priorities, or revise them if needed, at the light of the more recent developments in the various fields.

- **K-band spectrograph**: Revise the science case and its importance + iteration with possible technical solutions

- **UV extension**: Revise the science case and its importance

- **IFU and AO modes**: Expectations and potential revision of requirements, in particular:

  - **IFU+SCAO** mode: contrast requirements + science implications of solutions adopted (AO solutions, choice of fibres, scrambling, etc…)

  - **IFU-seeing limited** mode: FoV, sensitivity and science implications of solutions adopted

- Together with IS:
  - **Calibration requirements and strategies**
  - **End-to-end simulator**


Thank you!
CH_4
CH_4
H_2O
H_2O
H_2O
H_2O
O_2
O_2
CO_2
CO_2
O_3
FeII
2586
2600
MgII
2796
2803