E-ELT HIRES
Spettroscopia ad alta risoluzione

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The HIRES project

- HIRES is a high resolution spectrograph capable of providing a spectrum at R~100,000 over 0.4-2.5 μm
- Merging of instruments which completed phase A studies in early E-ELT phases: CODEX (optical) and SIMPLE (near IR)
- International Consortium
  - **Italy** INAF lead technical institution, A. Marconi PI
  - **Brazil** (Theoretical and Experimental Physics of the Natal University), **Chile** (Pontificia Universidad Catolica+), **Denmark** (Niels Bohr Institute Copenhagen +), **France** (Laboratoire d'Astrophysique de Marseille+), **Germany** (Leibniz-Institute for Astrophysics Potsdam+), **Poland** (Nicolaus Copernicus University Toruń +) **Portugal** (Institute of Astrophysics and Space Sciences), **Spain** (Instituto de Astrofisica de Canarias+), **Sweden** (Uppsala University+), **Switzerland** (Observatoire de Genève+), **United Kingdom** (University of Cambridge+)
- HIRES Consortium has been awarded the Phase A study for a high resolution spectrograph at E-ELT
- Kick Off date: March 22, 2016, Max Duration: 2 years

Science Cases to be addressed

- **Exoplanets** (characterisation of Exoplanets Atmospheres: detection of signatures of life)
- **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)
- **Intergalactic Medium** (Signatures of reionization and early enrichment of ISM & IGM observed in high-z quasar spectra)
- **Fundamental Physics** (variation of fundamental constants - α, m_p/m_e Sandage Test)
- **Protoplanetary Disks** (dynamics, chemistry and physical conditions of the inner regions)
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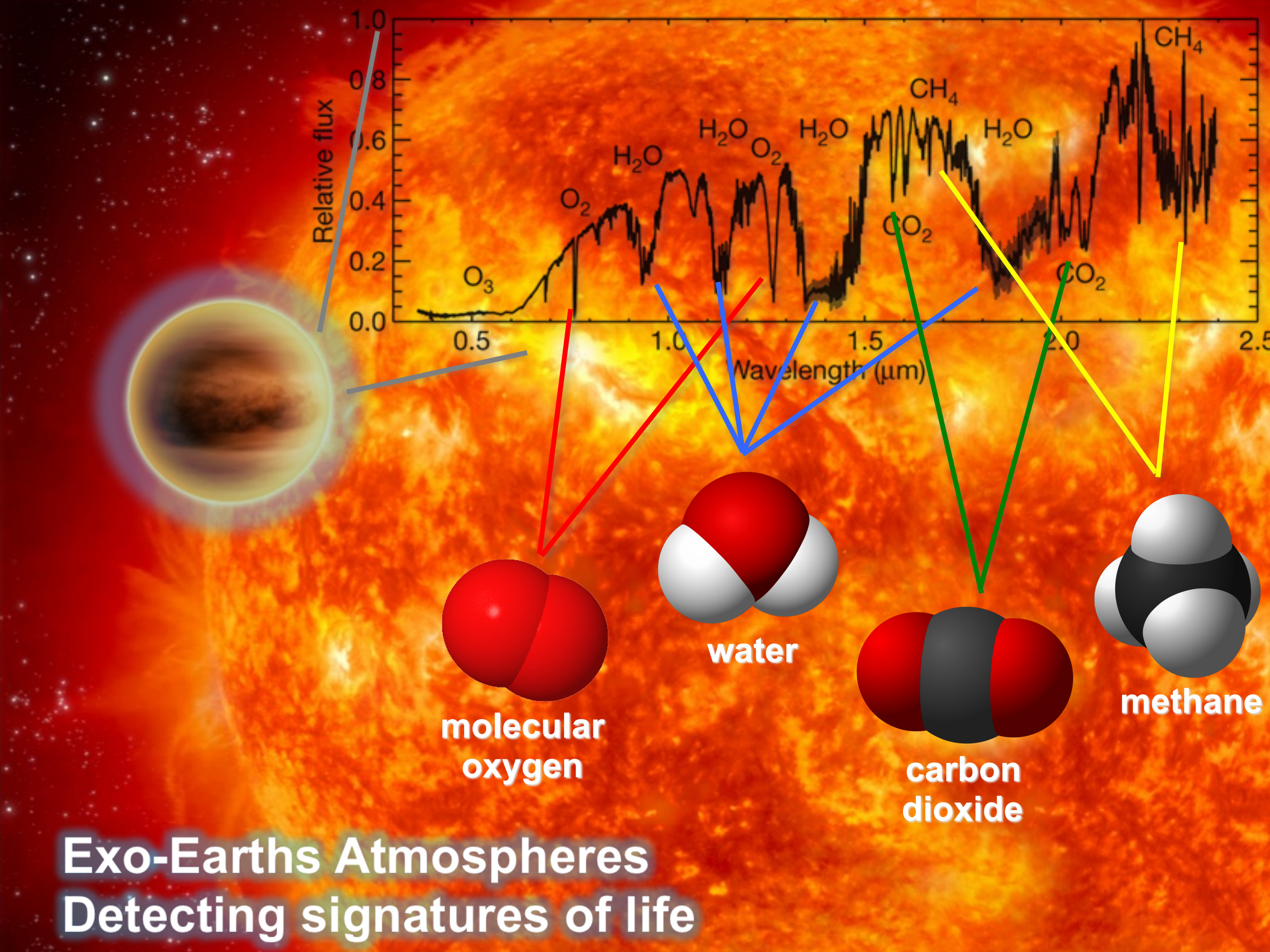
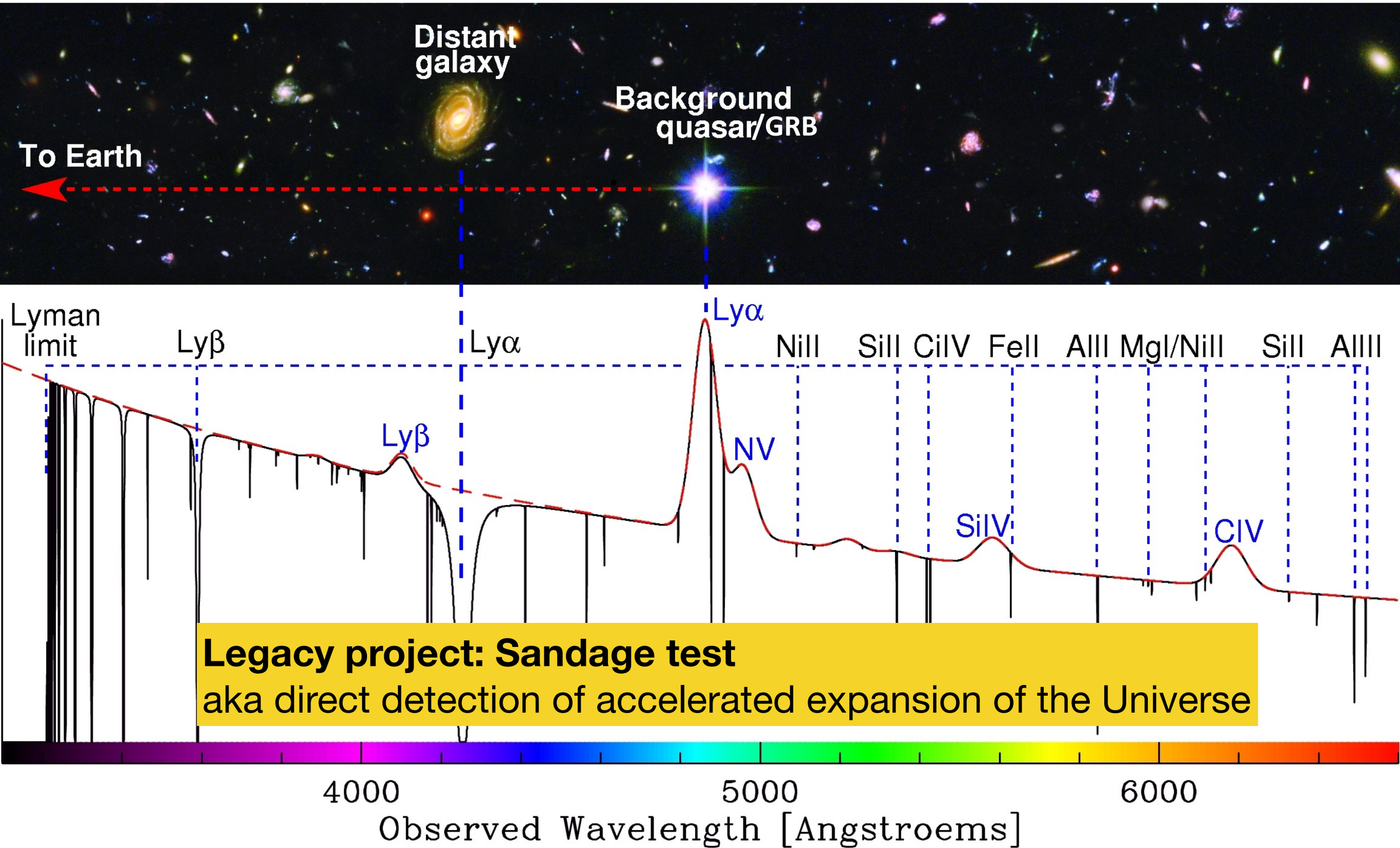
- **Galaxy Evolution** (massive early type galaxies during epochs of formation and assembly)
- **Supermassive Black Holes** (the low mass end)

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


Relative flux
1.0
0.8
0.6
0.4
0.2
0.0
0.5
1.0
1.5
2.0
2.5
Wavelength (μm)
O_3
O_2
H_2O
H_2O
O_2
H_2O
CH_4
CO_2
H_2O
CO_2
CH_4
molecular oxygen
water
carbon dioxide
methane
Exo-Earths Atmospheres
Detecting signatures of life

The Inter-Galactic Medium:
tracing the chemical enrichment of the universe (e.g. Pop III SNe)

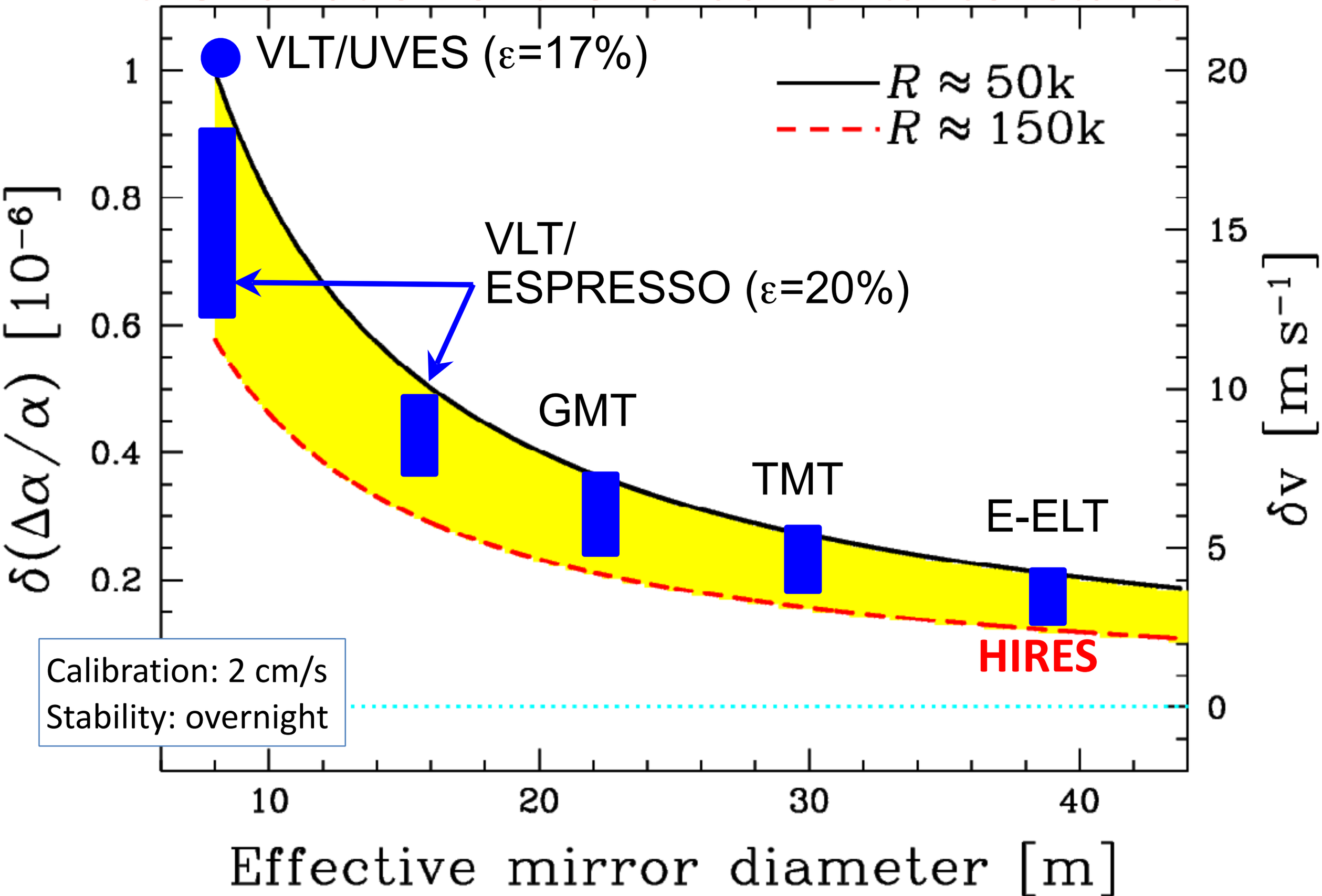
High spectral resolution (R>50-100x10^3) and broad spec. cov. (opt+NIR)



Legacy project: Sandage test

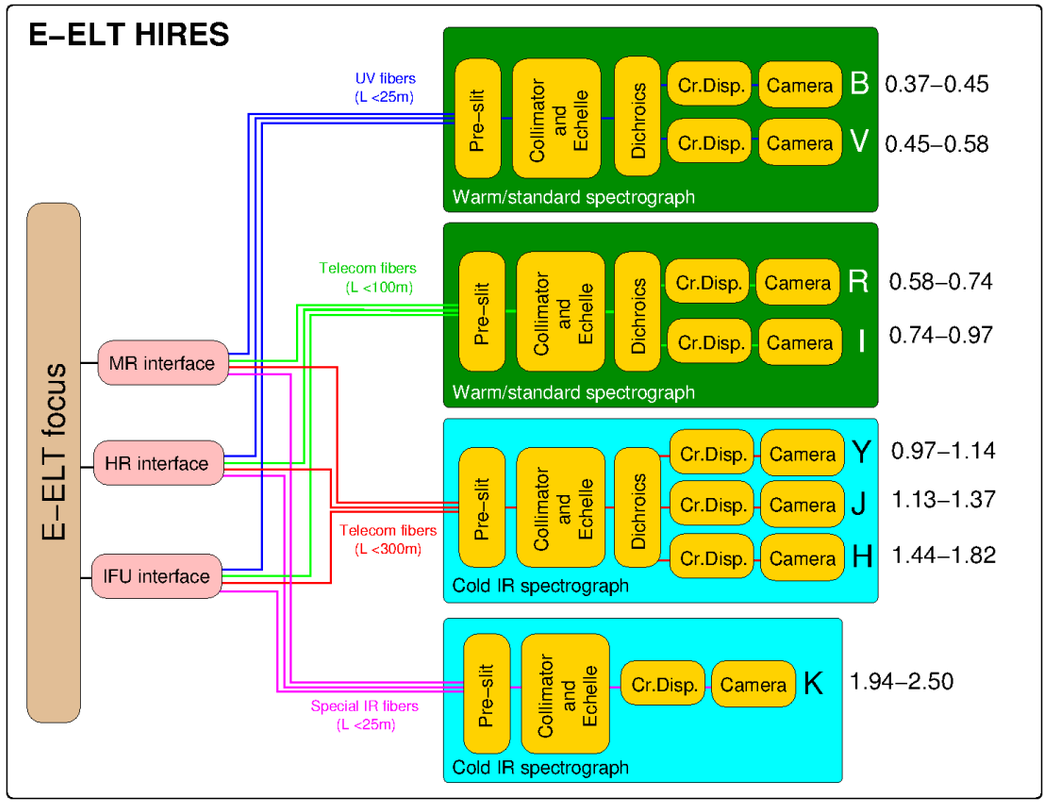
aka direct detection of accelerated expansion of the Universe

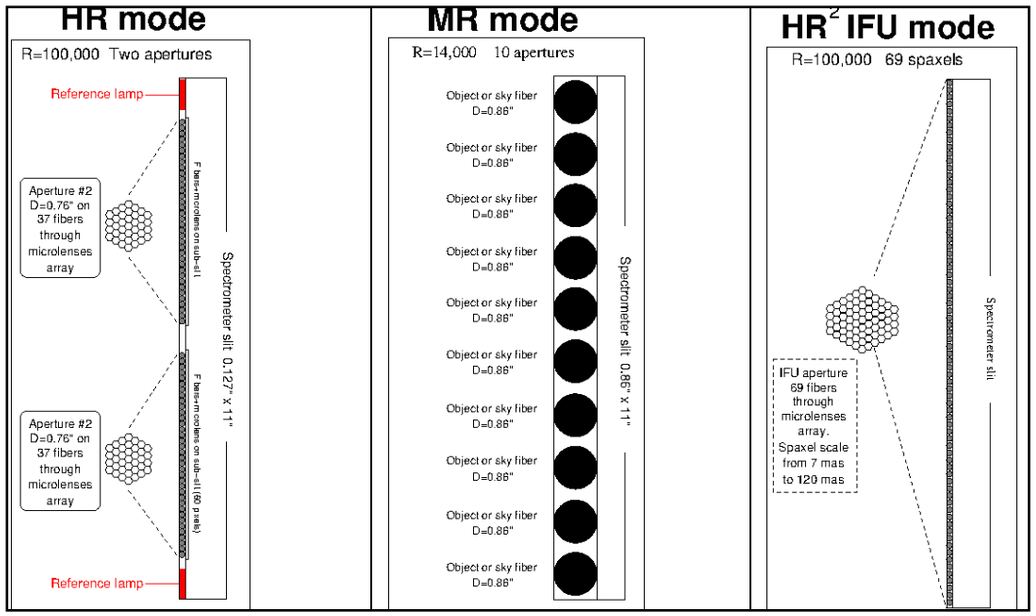
Fundamental Physics:
the variation of the fundamental constants



Instrument Concept

- 4 independent fiber-fed spectrometers optimized over 4 spectral ranges (UBV, RI, YJH, K): simultaneous coverage 0.37-2.5 μm
- Different observing modes are obtained using different and independent groups of fibers feeding each spectrometer: from bundle of fibers to pseudo-slits
- Observing mode is selected in the pre-slit section (fore-optics) of each module. No change inside the spectrometers.
- "Seeing" or diffraction limited
- Possible main observing modes
  - **UHR** R=150,000
  - **HR** R=100,000
  - **MR** R=14,000 x10 MOS capability
  - **HR²** R=100,000 IFU with 69 spaxels





Prioritisation *not* given in White Paper ➪ will be given by HIRES Science Team during Phase A study by June 2016

Clear "key" science cases:

- Exoplanet Atmospheres → near-IR, R>~100,000, detector stability/linearity/etc..
- Early metal enrichment (PopIII) → near-IR, R>~50,000, sensitivity (detector RO noise)
- Fundamental Physics → Optical, R>~100,000, accuracy 2cm/s intra-night stability

None of them requires E-ELT diffraction limited capabilities (from the science point of view)

Other requirements:

- Simultaneous spectral coverage 3700Å - 2.5μm
- Some multiplexing at medium resolution (R~15,000)
- AO+IFU
- Extension to < 3700Å (mirror coating)
- Absolute wavelength calibration to 1 cm/s

HIRES organigram

Principal Investigator (PI): Alessandro Marconi

Project Scientist: Roberto Maiolino (UK)

Project/ Study Manager (PM): Luca Valenziano

System Engineer (SE): Marco Riva

Software System Engineer (SSE): Paolo Di Marcantonio

Instrument Scientist (IS): Livia Origlia

Executive Board:

Brazil: J. Renan de Medeiros

Denmark: J. Fynbo

Germany: K. Strassmeier

Portugal: N. Santos

Sweden: N. Piskunov

United Kingdom: M. Haehnelt

Chile: L. Vanzi

France: I. Boisse

Poland: A. Niedzielski

Spain: R. Rebolo

Switzerland: F. Pepe

Science Team

Exoplanets & Circumstellar Disks

⭐ Coordinator Palle, E. (ES)

⭐ Deputy Lovis, C. (CH)

…, Raffaele Gratton, Giusi Micela, Brunella Nisini, …

Stars & Stellar Populations

⭐ Coordinator Allende C. (ES)

⭐ Deputy S. Korn (S)

…, Alessio Mucciarelli, Donatella Romano, …

Formation and evolution of Galaxies and Intergalactic Medium

⭐ Coordinator D'Odorico, V. (I)

⭐ Deputy Zackrisson E., (S)

…, Giovanni Cresci, Stefano Covino, …

Cosmology and Fundamental Physics

⭐ Coordinator Liske, J. (D)

⭐ Deputy Martins, C. (PT)

…, Stefano Cristiani, Paolo Molaro, …

Science Team Italiano

Large number of people in Italy interested in science provided by HIRES
Idea to create Italian Science Team that follows HIRES development and provides support to HIRES Science Team.

But this should have a wider scope with other potential applications like

- ⭐ astrophysical forum on high res spectroscopy in general
- ⭐ projects/proposals for UVES, Espresso CRIRES+, HARPS-N, GIANO etc.
- ⭐ comparison and development of methodologies for high spectral resolution data analysis
- ⭐ support for simulations
- ⭐ training of young astronomers

Coordinator: Stefano Cristiani

If interested send email to:
Stefano Cristiani (cristiani@oats.inaf.it)
Alessandro Marconi (marconi@arcetri.inaf.it)

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