

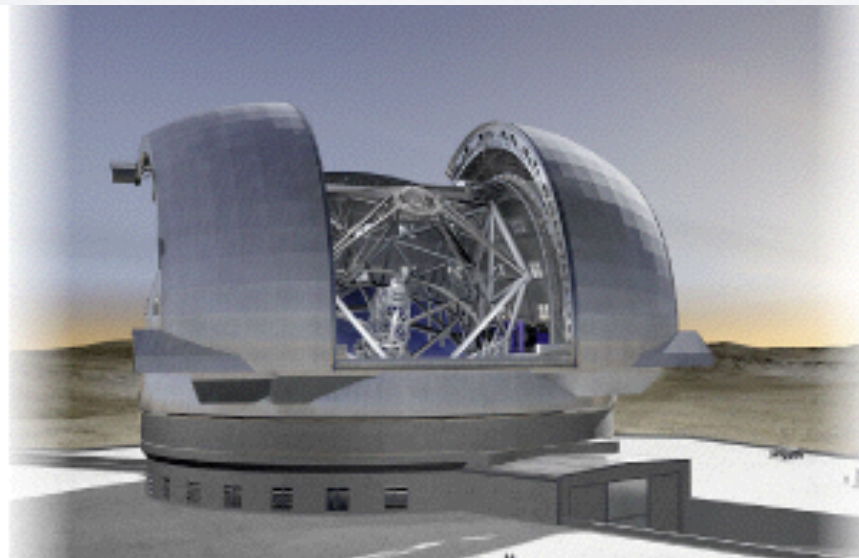
# Exoplanet Science with E-ELT/METIS

Sascha P. Quanz (ETH Zurich)

METIS Project Scientist



EPSC 2015 - Nantes  
1 Oct 2015



# METIS is a 3–19 micron imager and spectrograph...

## METIS instrument baseline design

- **Imaging at 3 – 19 micron** with low/medium resolution slit spectroscopy as well as coronagraphy for high contrast imaging
- **High resolution ( $R \sim 100,000$ ) IFU spectroscopy at 3 – 5 micron** including extended instantaneous wavelength coverage
- **Work at the diffraction limit** with single conjugate (SC) and eventually assisted by a laser tomography adaptive optics (LTAO) system

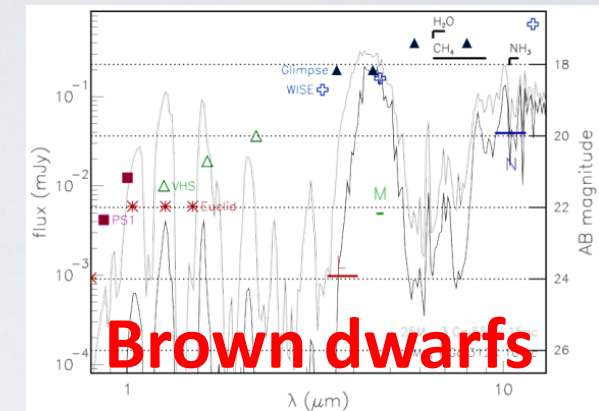
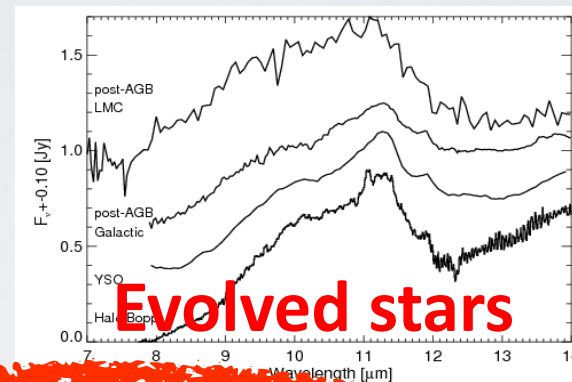
**Complementary to JWST  
and other E-ELT instruments**



# The METIS science case is broad with exoplanets being a main driver

**Martian  
atmosphere**

**History of  
our Solar  
System**

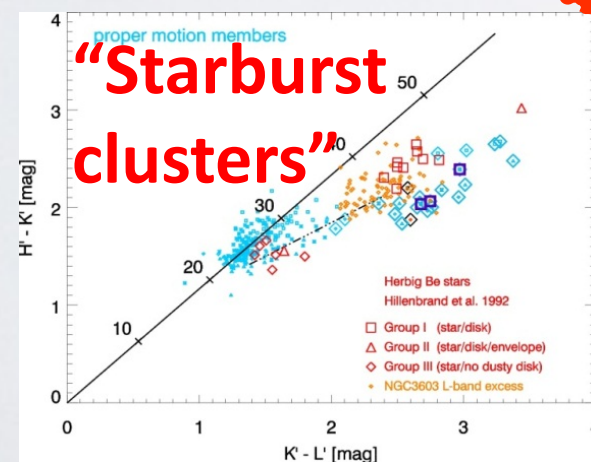


**Galactic  
Center**

**Proto-planetary  
Disks**

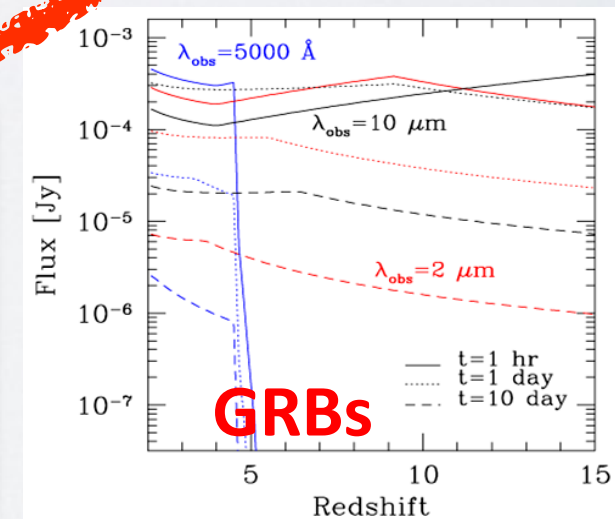
**Exoplanets**

**MYSOs &  
UCHIRs**



**Growth of  
SMBHs**

**Evolution of  
high-z Galaxies**



# METIS exoplanet science themes

The  
formation  
of planets

Exoplanet  
demo-  
graphics

Exoplanet  
atmospheres  
and climates

Towards  
other Earths



# METIS exoplanet science themes

The  
formation  
of planets

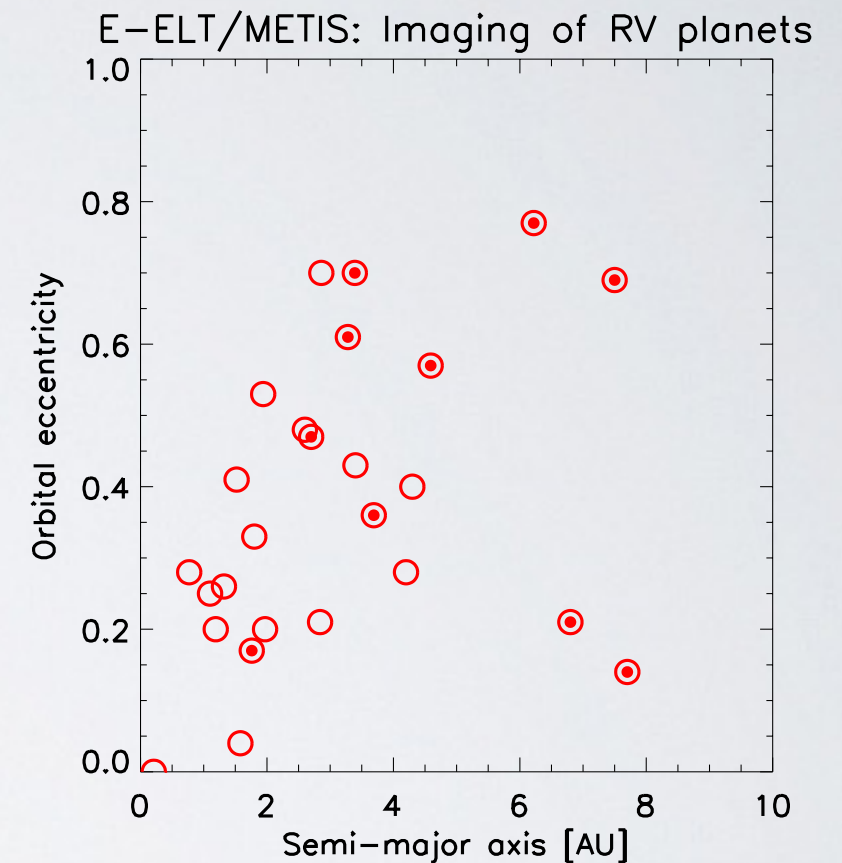
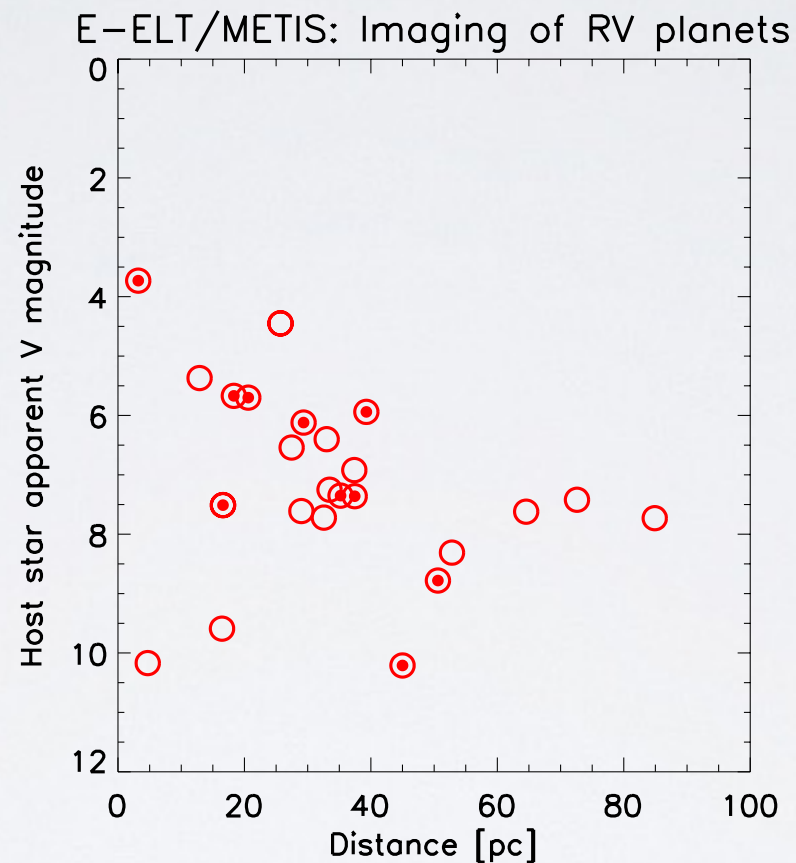
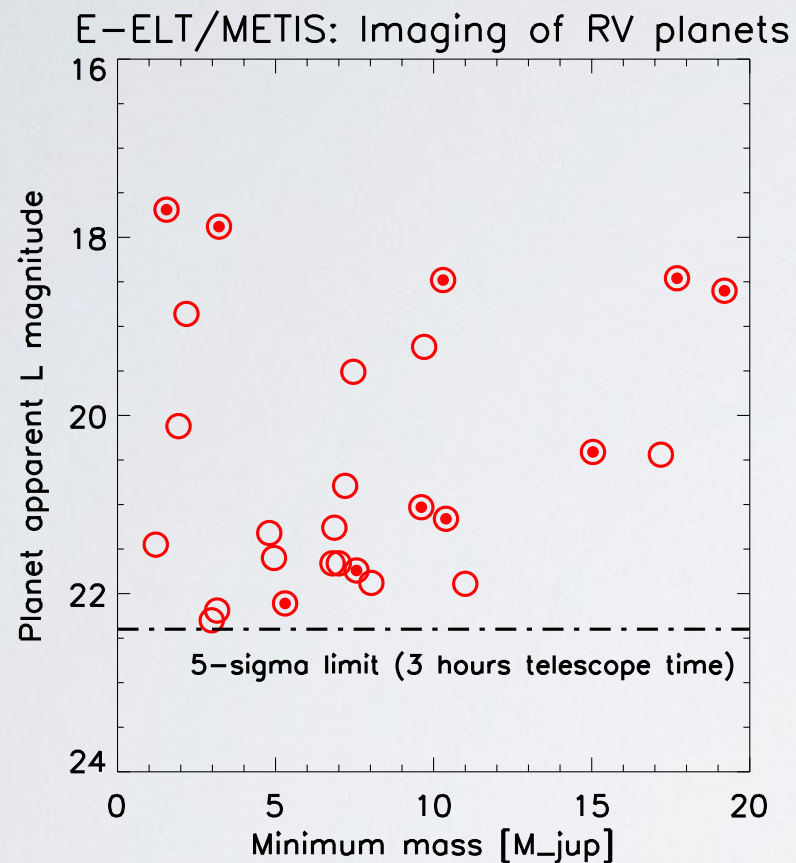
**Exoplanet  
demo-  
graphics**

**Exoplanet  
atmospheres  
and climates**

**Towards  
other Earths**

# Determining luminosities of RV detected planets

Exoplanet  
demo-  
graphics

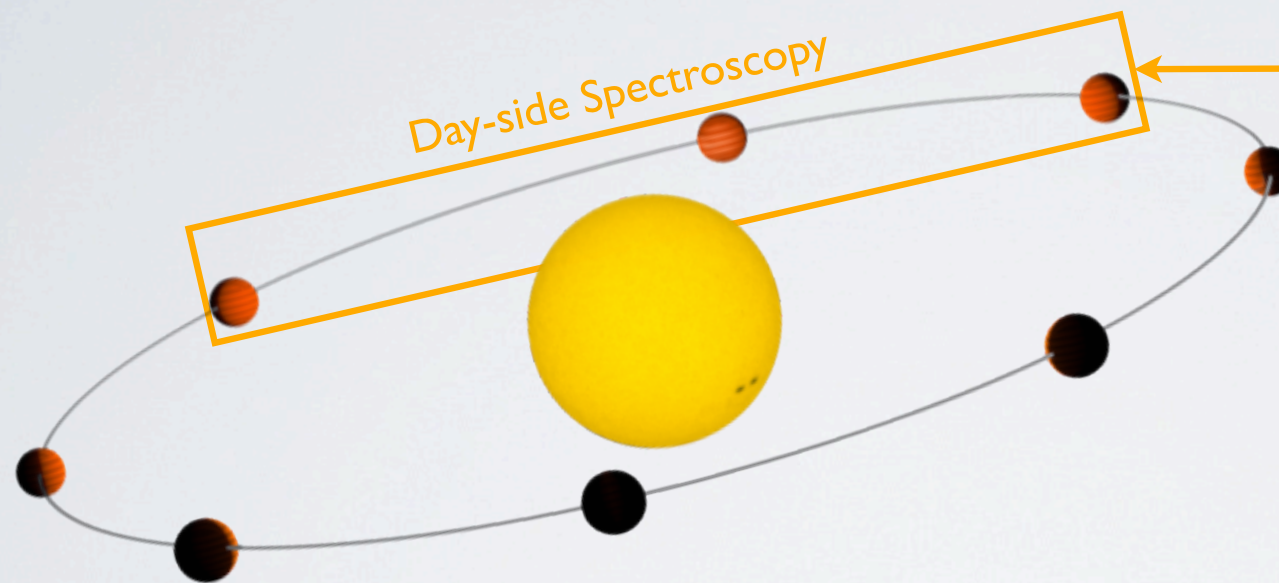




# Characterizing non-transiting hot planets

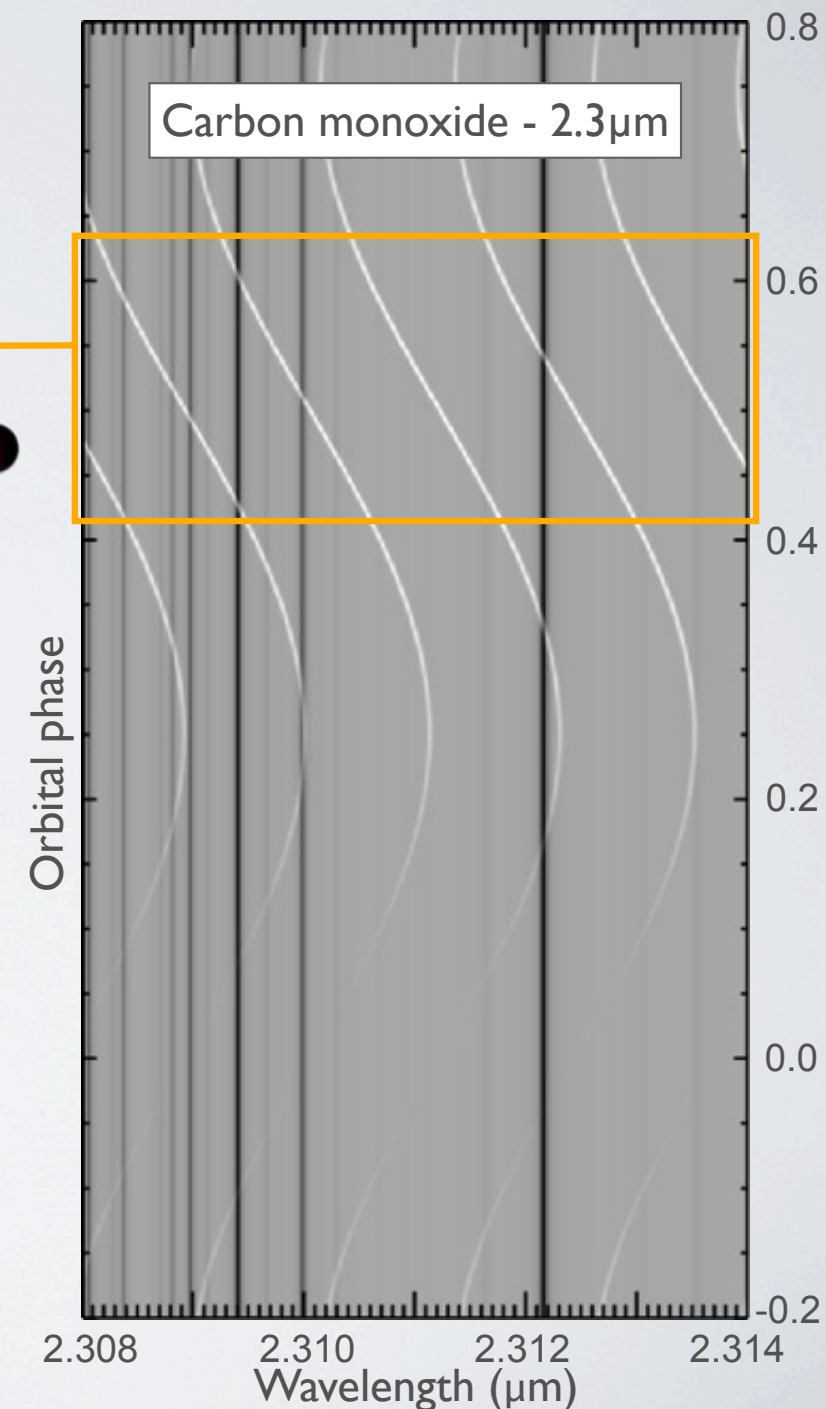
Exoplanet  
atmospheres  
and climates

The **thermal spectrum**  
of the planet is targeted.



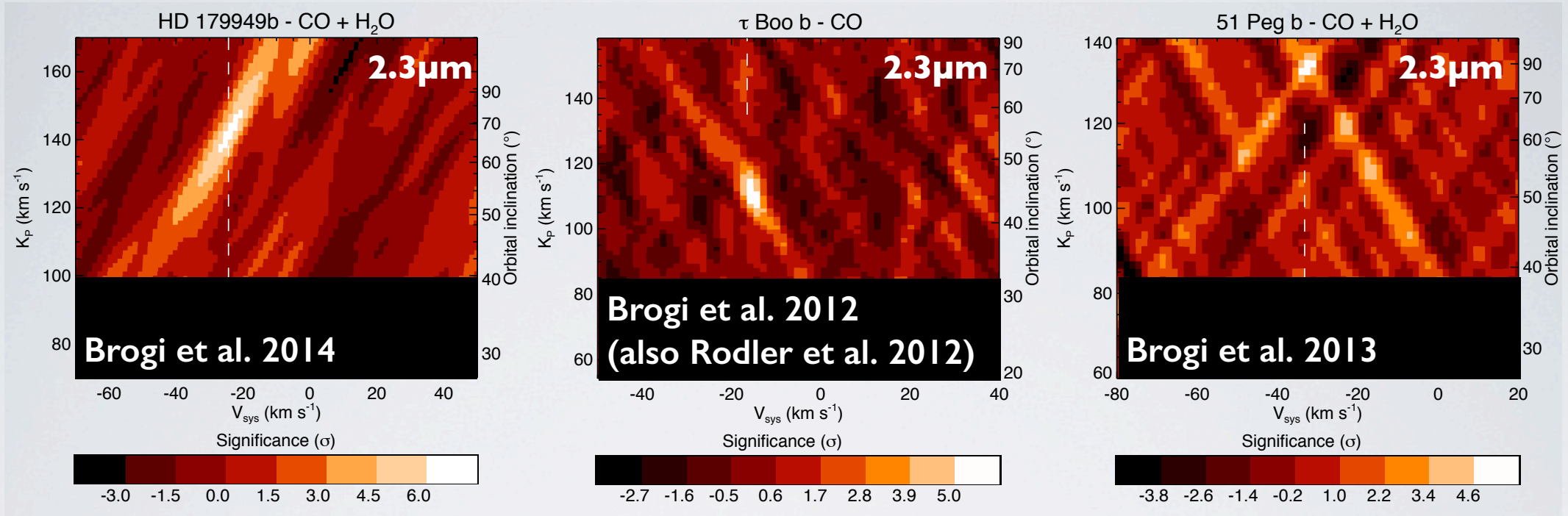
Molecules resolved into individual **lines**  
⇒ Robust identification via line matching

Planet **motion** resolved  
⇒ Telluric and planet signal disentangled



# Characterizing non-transiting hot planets

Exoplanet  
atmospheres  
and climates



	τ Boo b	51 Peg b	HDI79949
Integr. time	18 hrs	10 hrs	14 hrs
Molecules	CO	CO, H <sub>2</sub> O	CO, H <sub>2</sub> O
S/N	6.2	5.9	6.3
Mass	5.95	0.46	0.98
Inclination	44.5°	≥ 79.6°	68.0°

+ relative abundances

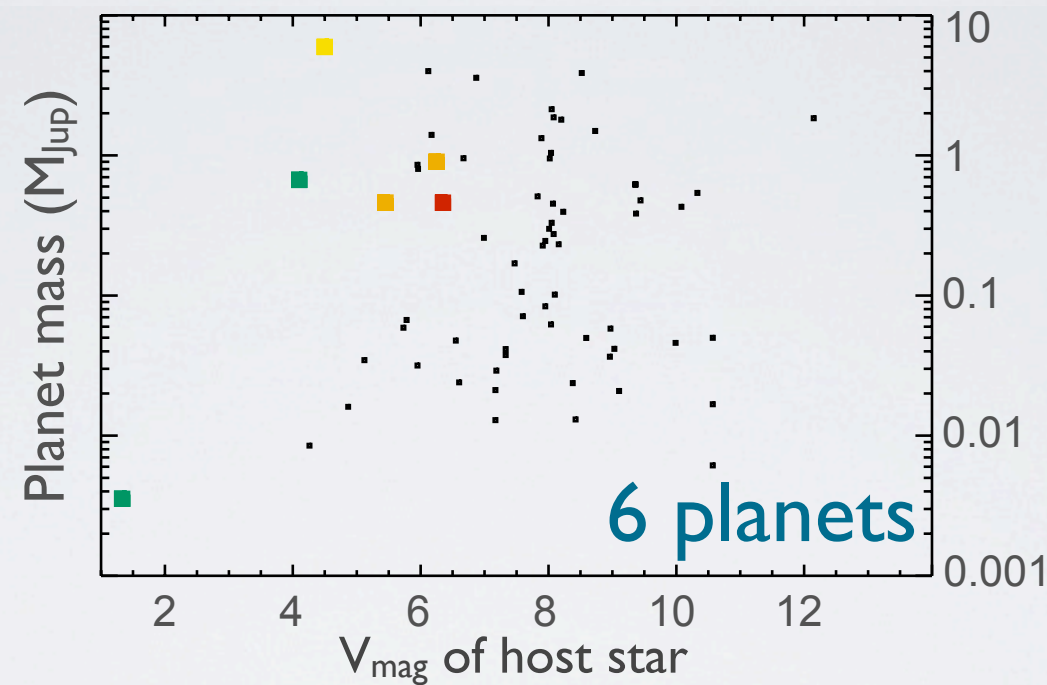


# Characterizing non-transiting hot planets

Exoplanet  
atmospheres  
and climates

VLT

Easy  
Robust  
Tentative

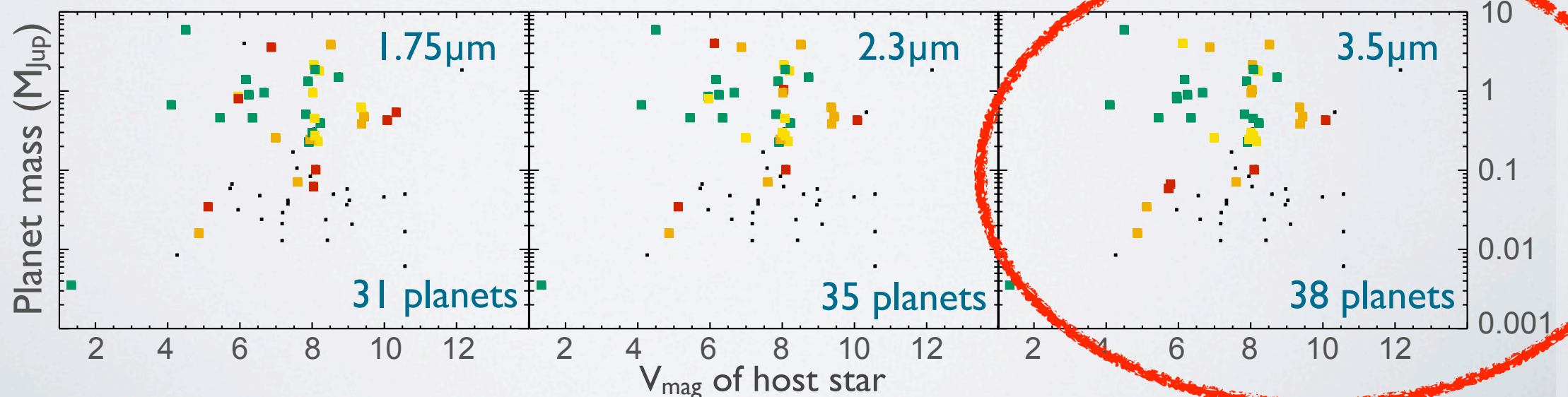


20h telescope time

**VLT**  
Current CRRES, 8m

**E-ELT**  
39m mirror  
6x spectral range  
2x throughput

E-ELT



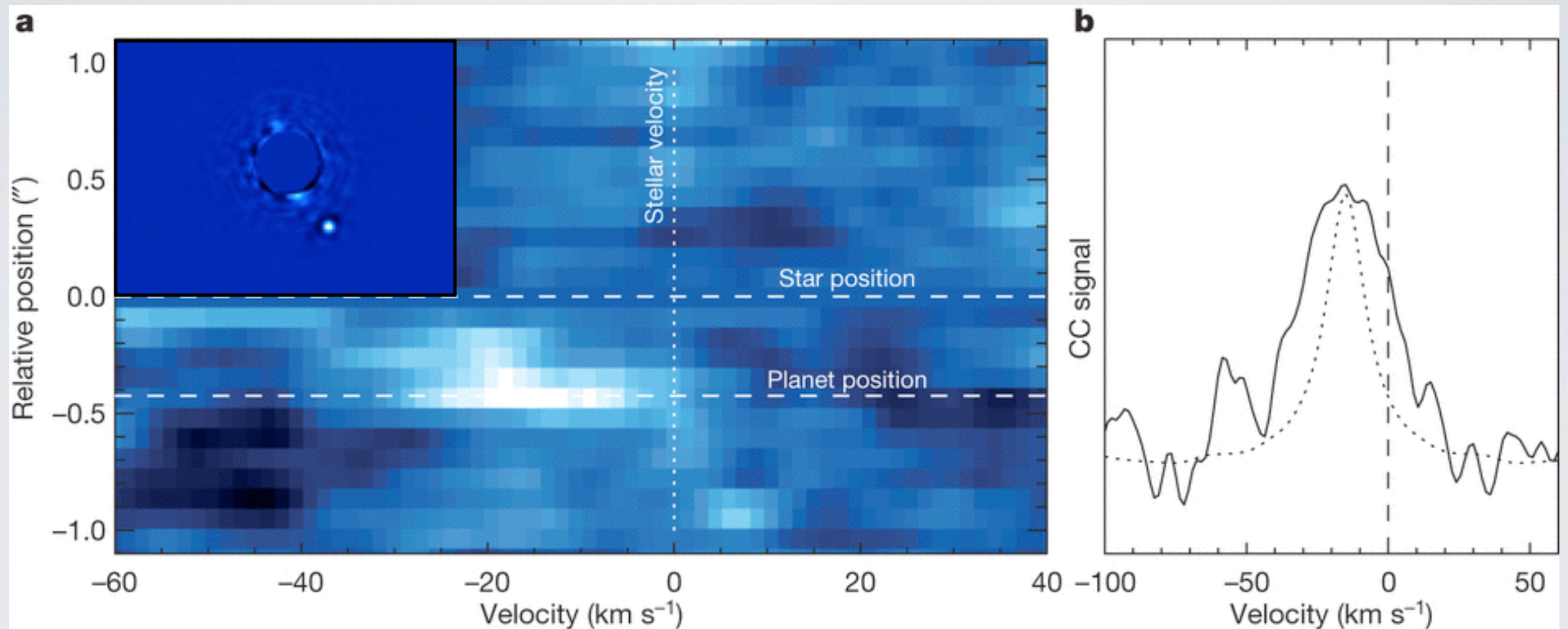
Slide courtesy of Matteo Brodi

# Measuring rotation periods of cool gas giant planets

**State-of-the-art (VLT/CRIRES):**

**The directly imaged planet beta Pic b**

Exoplanet  
atmospheres  
and climates



Snellen et al. 2014, Nature

Credit: Planet image (GPI) processing by Christian Marois, NRC

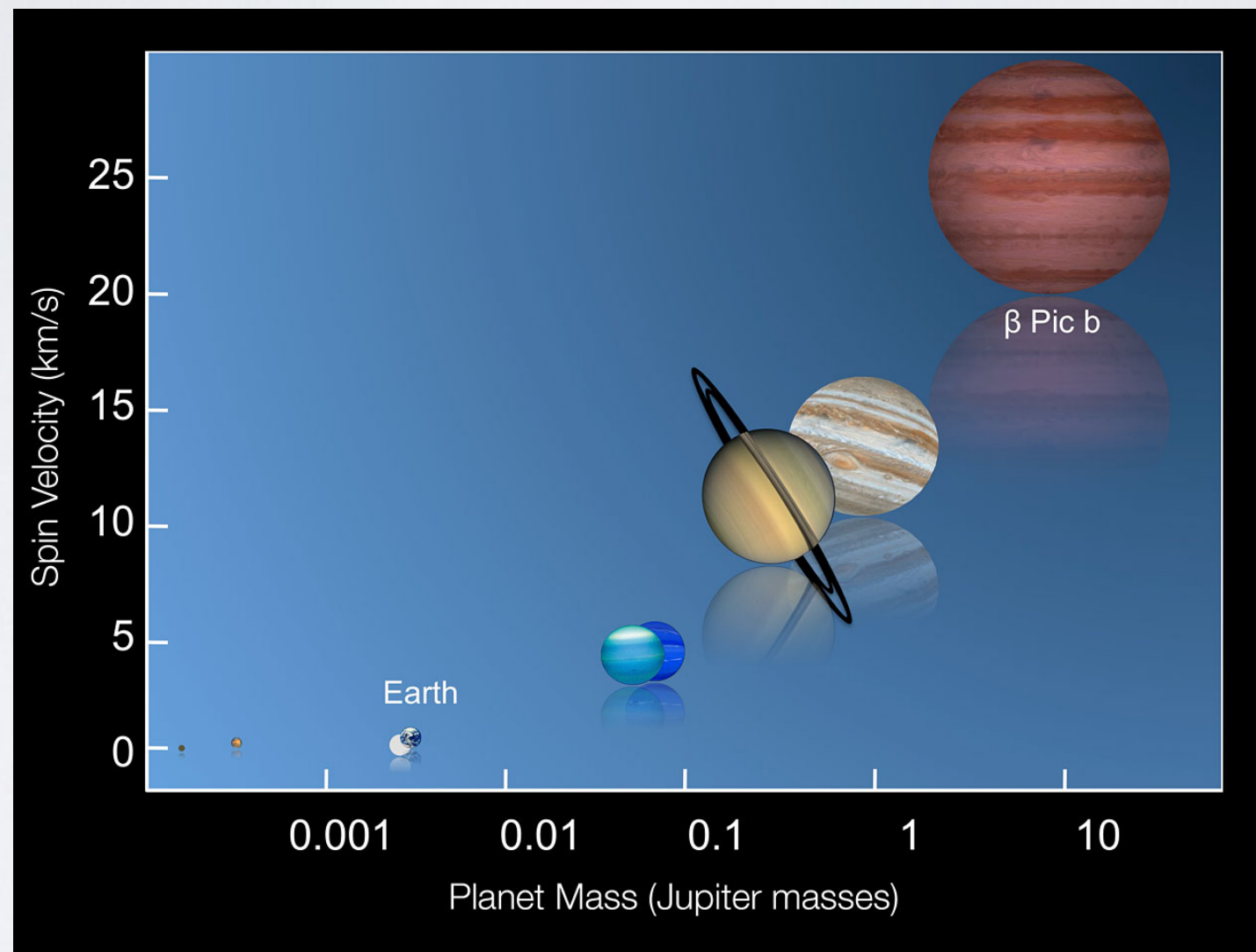


# Measuring rotation periods of cool gas giant planets

**State-of-the-art (VLT/CRIRES):**

**The directly imaged planet beta Pic b**

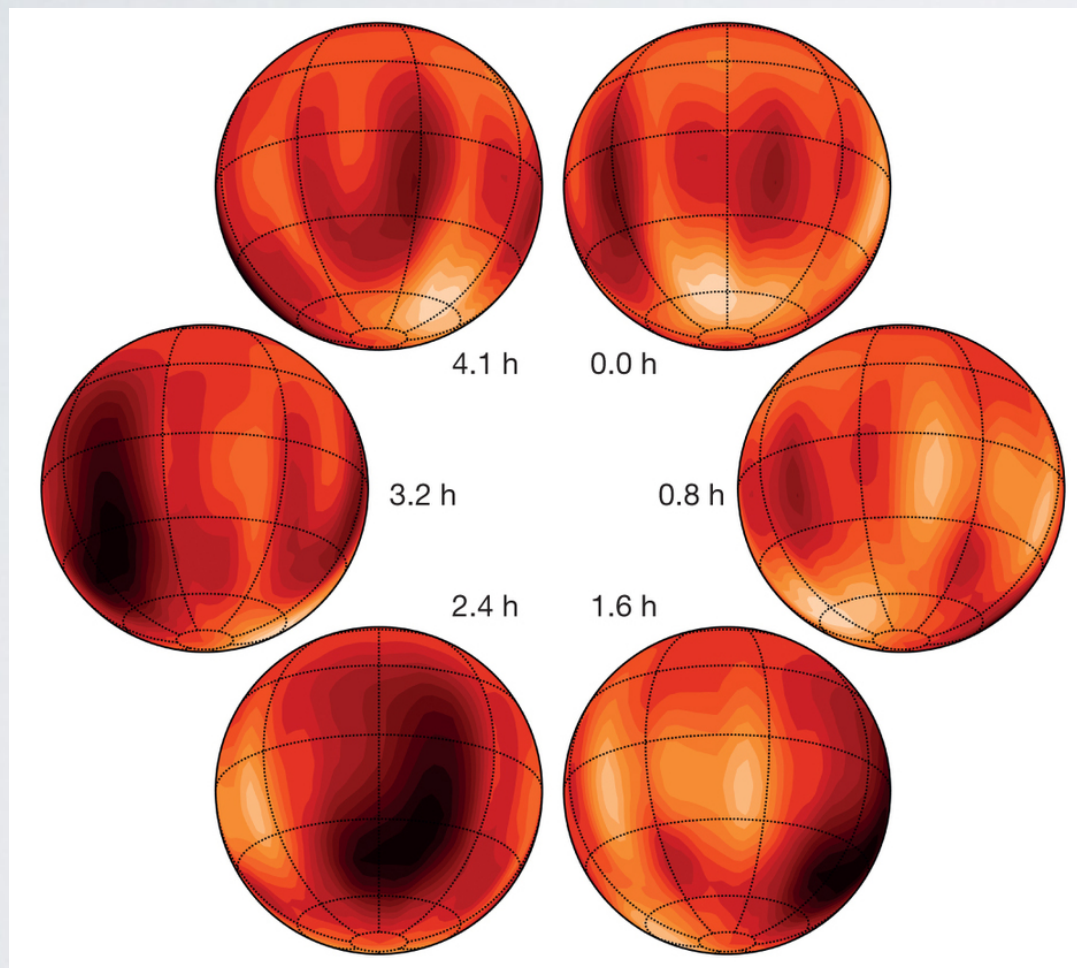
Exoplanet  
atmospheres  
and climates



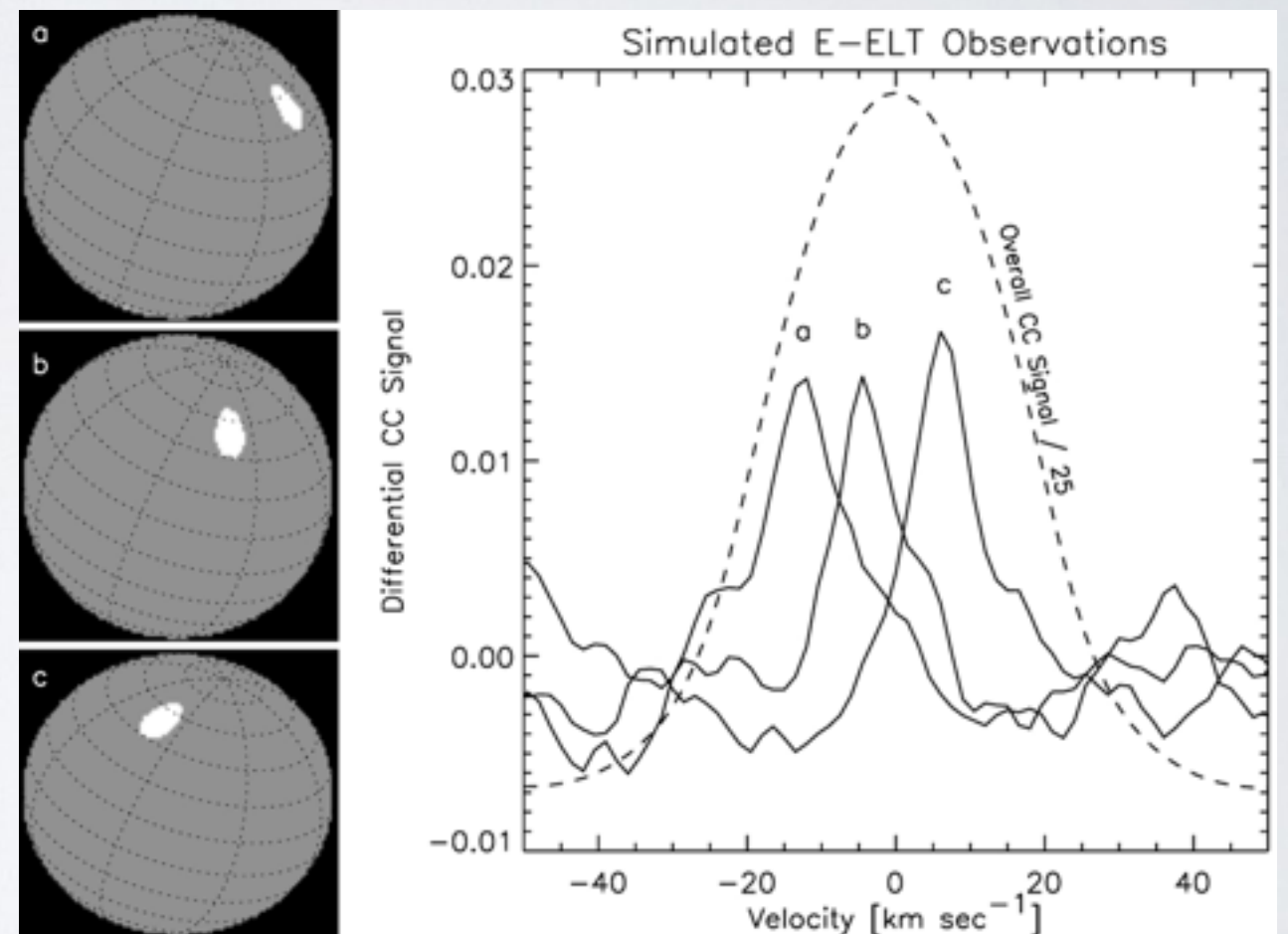
# 2D maps of exoplanets using Doppler Tomography

Exoplanet  
atmospheres  
and climates

## VLT/CRIRES data of the Brown Dwarf Luhman 16 B



## Simulating E-ELT observations of beta Pic b

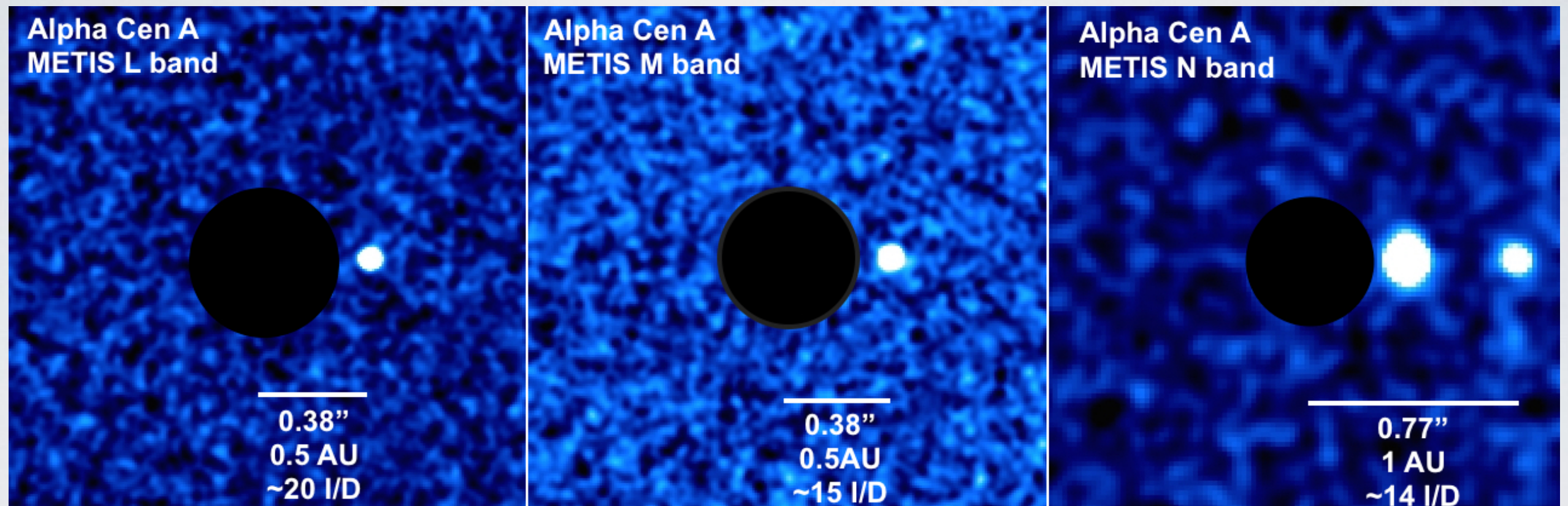




# Direct detection of small planets around nearby stars

Towards  
other Earths

## Simulated METIS observations of 2 Earth twins around Alpha Cen A



# Take home message

**METIS** is an **exoplanet instrument** covering a **unique** part in exoplanet parameter space in the 2025-2030 timeframe

**METIS** is **complementary** to **JWST** and other **ELT exoplanet instruments**



Thanks for your attention

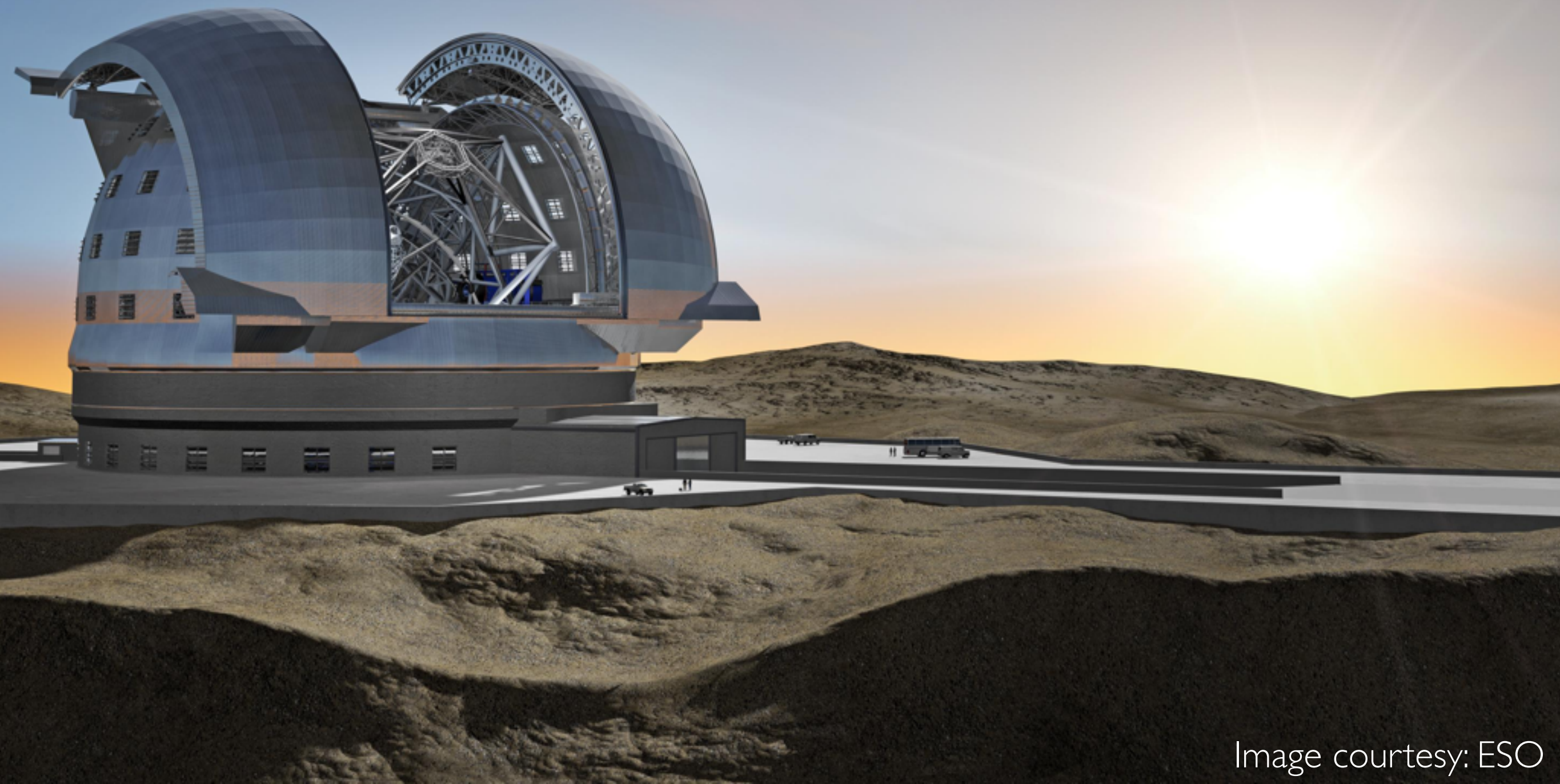


Image courtesy: ESO