

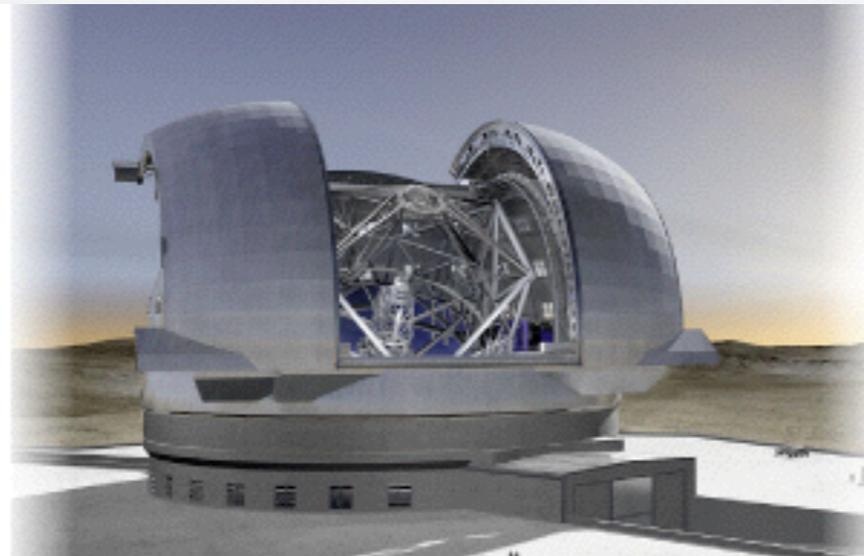
Exoplanet Science with E-ELT/METIS

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METIS Project Scientist



EPSC 2015 - Nantes
1 Oct 2015



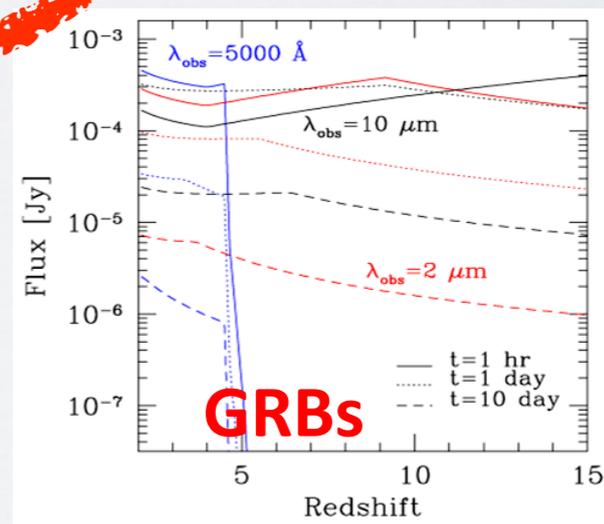
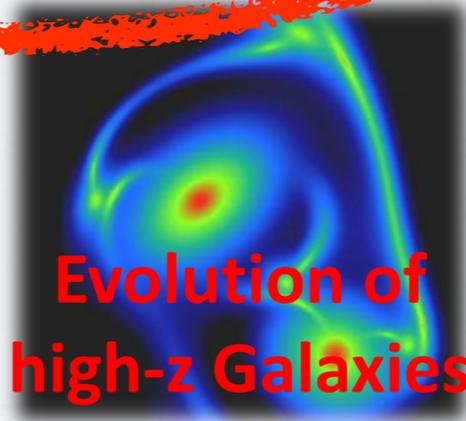
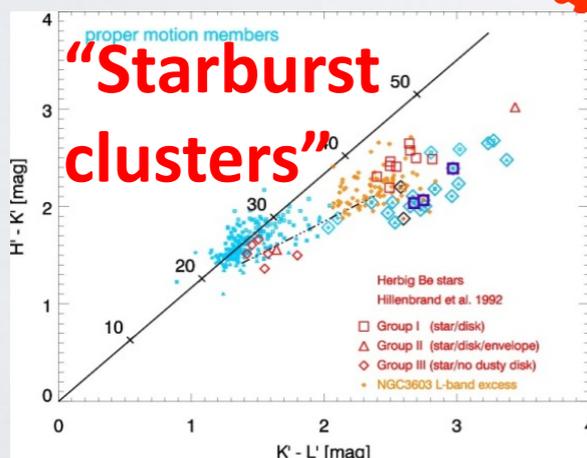
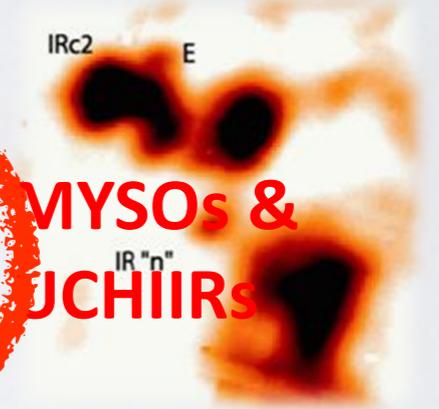
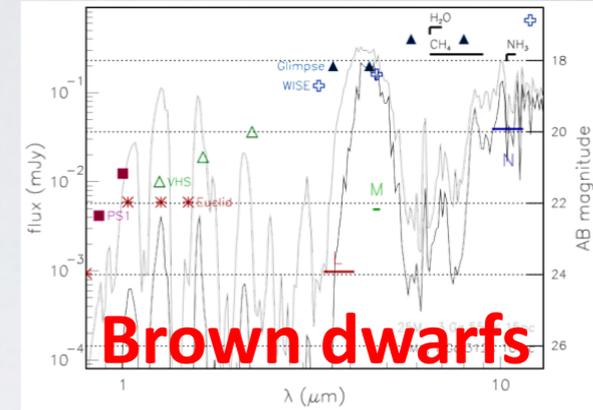
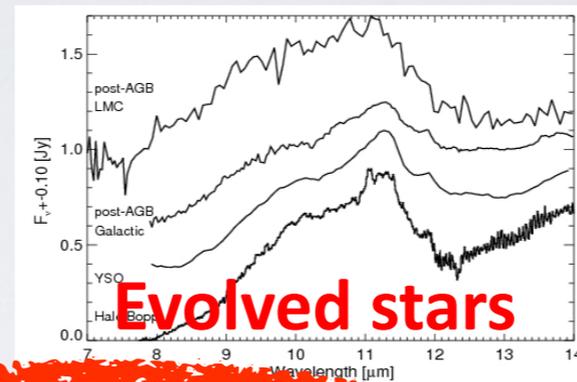
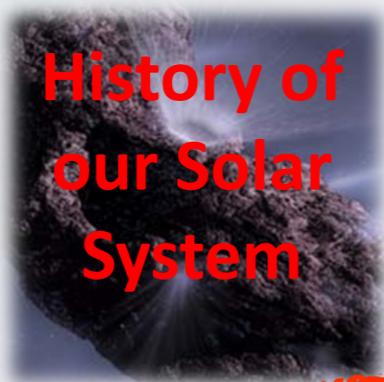
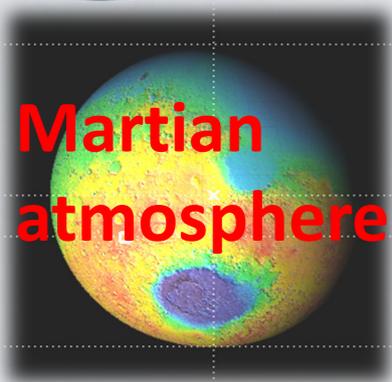
METIS is a 3-19 micron imager and spectrograph...

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



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

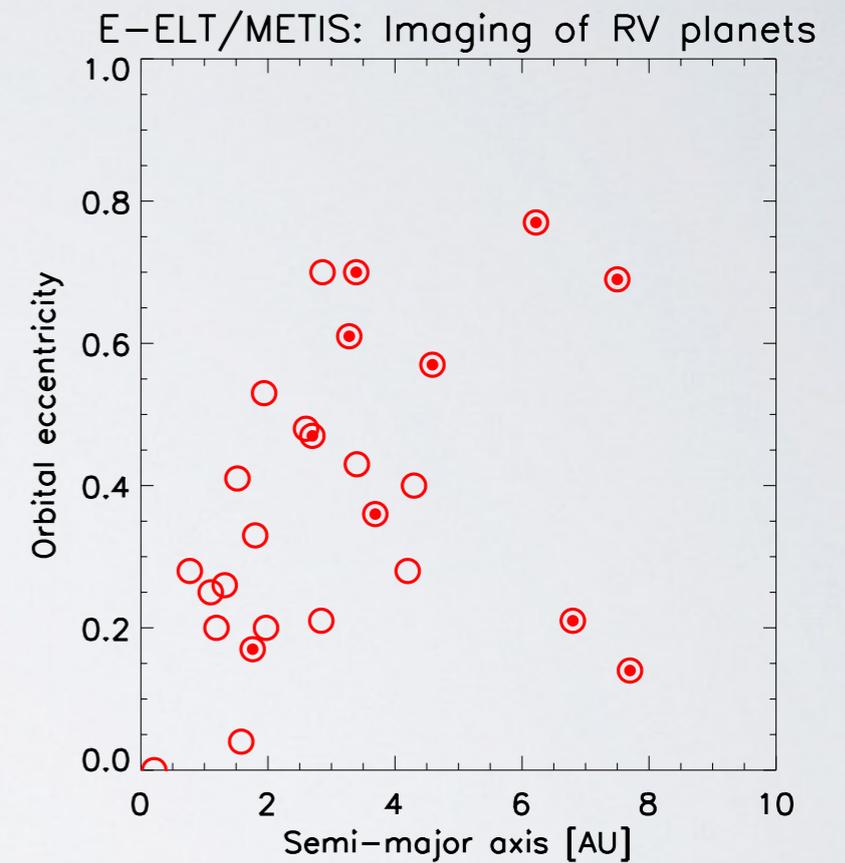
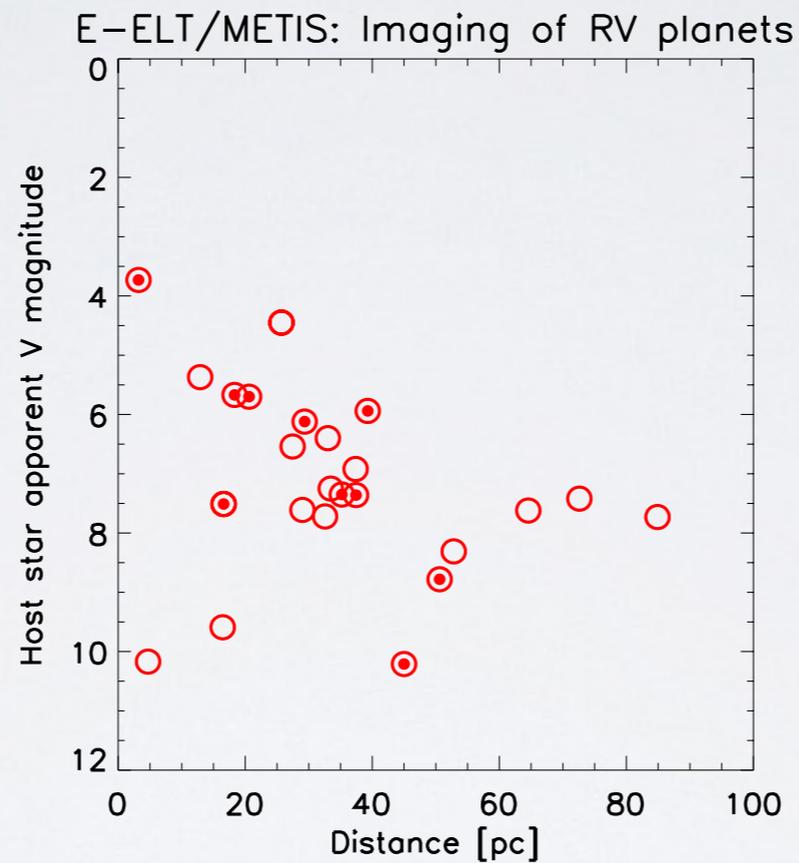
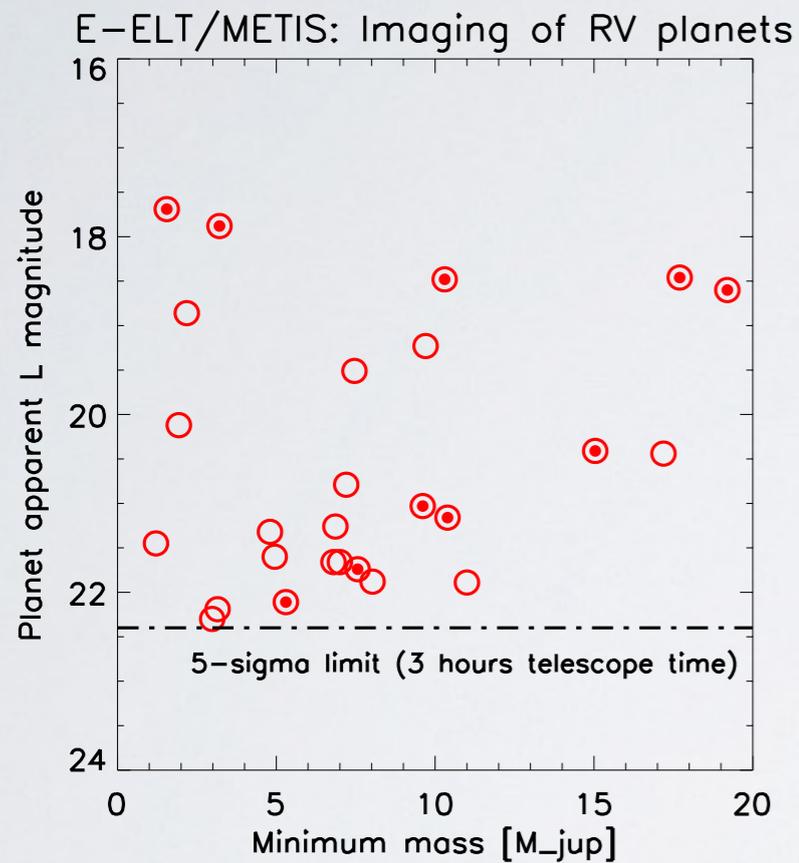
**Exoplanet
demo-
graphics**

**Exoplanet
atmospheres
and climates**

**Towards
other Earths**

Determining luminosities of RV detected planets

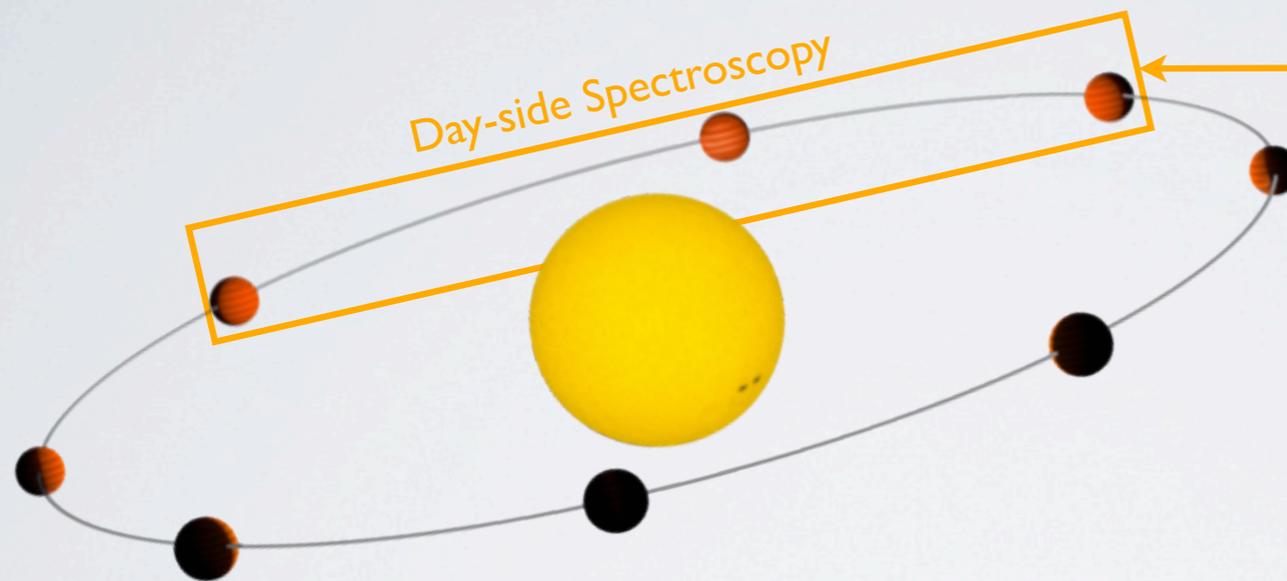
Exoplanet
demo-
graphics



Characterizing non-transiting hot planets

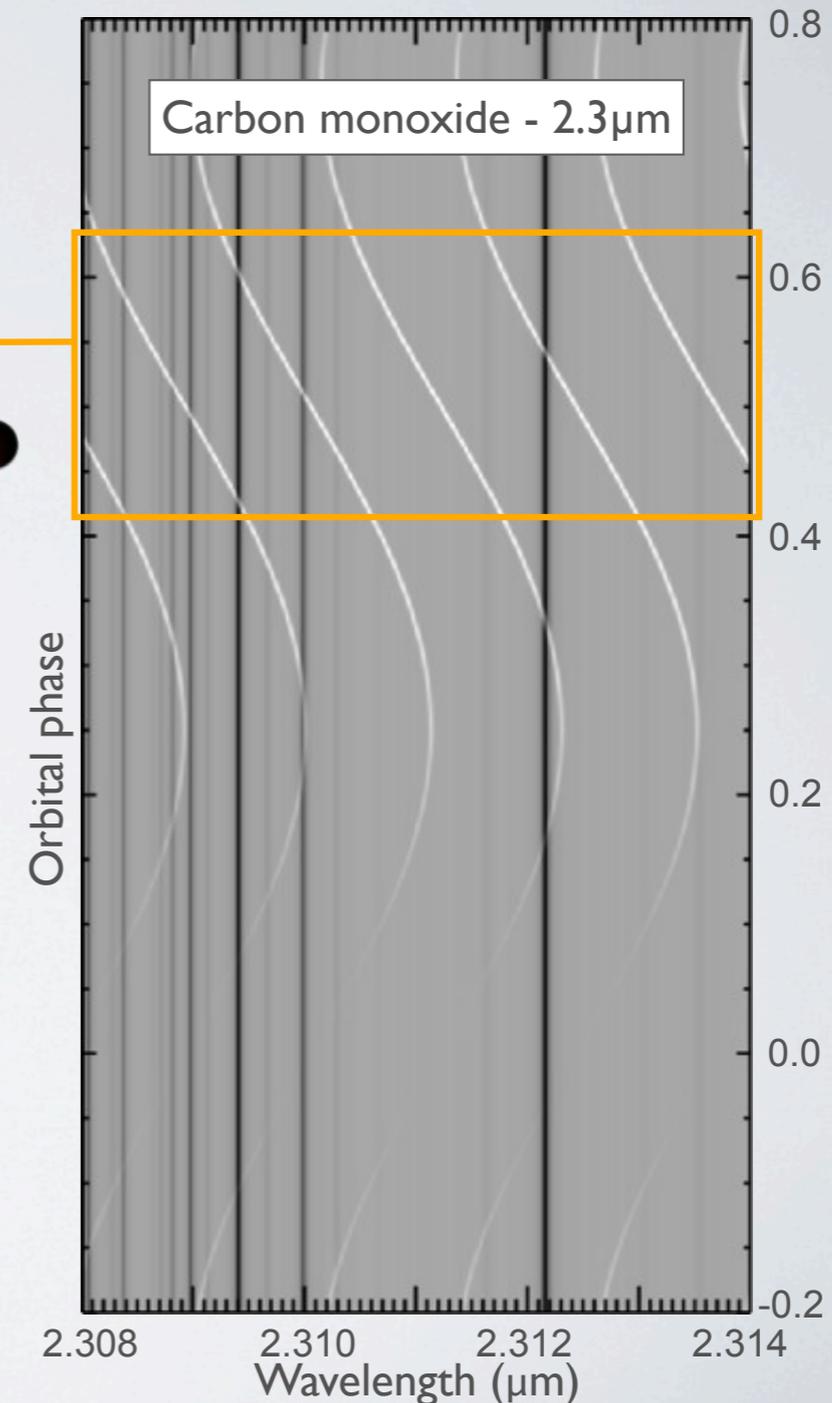
Exoplanet
atmospheres
and climates

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



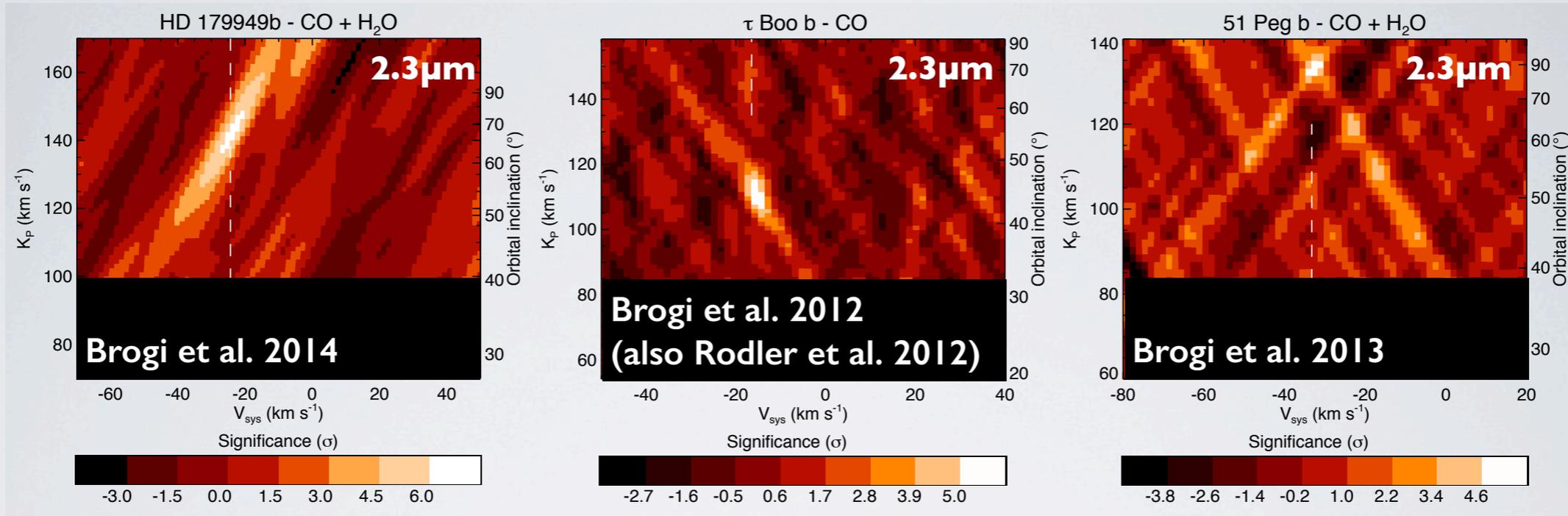
Molecules resolved into individual **lines**
⇒ Robust identification via line matching

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 ₂ O	CO, H ₂ O
S/N	6.2	5.9	6.3
Mass	5.95	0.46	0.98
Inclination	44.5°	$\geq 79.6^\circ$	68.0°

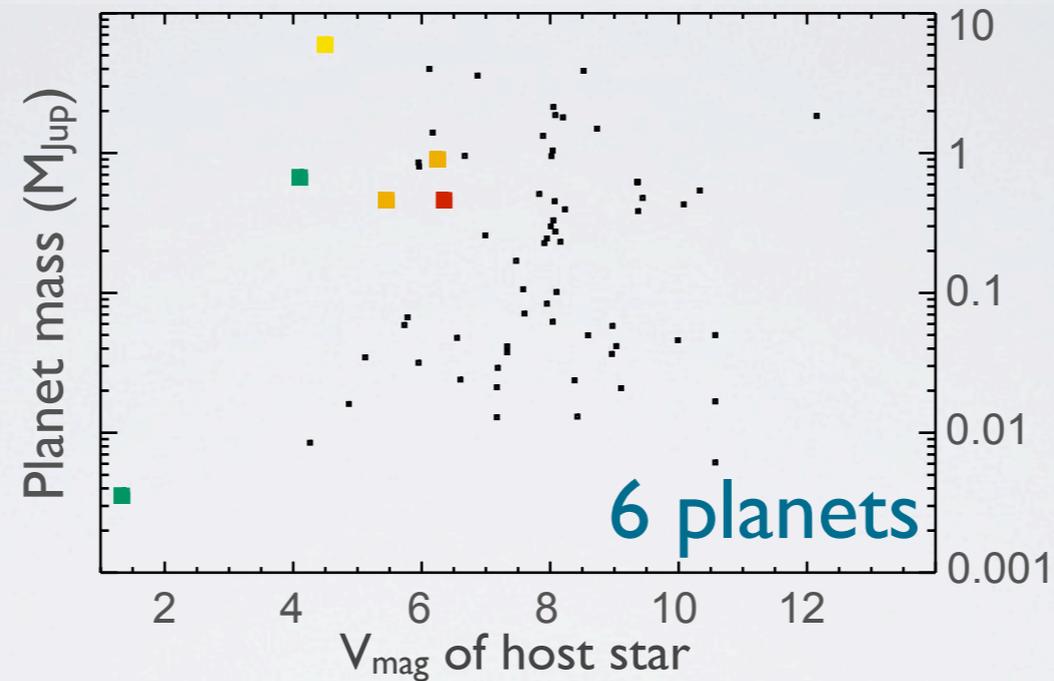
+ relative abundances

Characterizing non-transiting hot planets

Exoplanet
atmospheres
and climates

VLT

Easy
Robust
Tentative

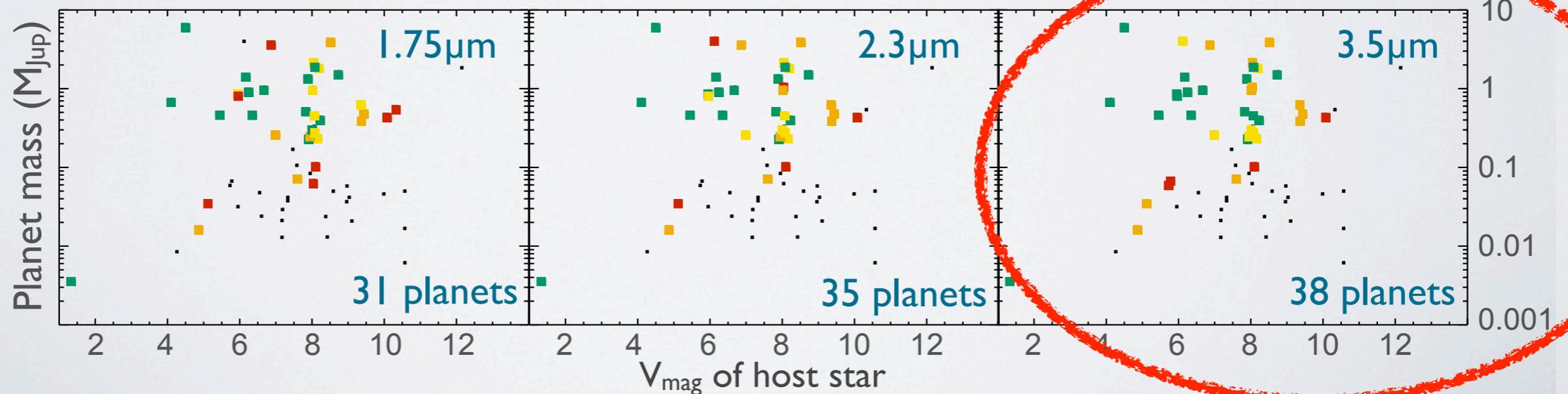


20h telescope time

VLT
Current CRIRES, 8m

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

E-ELT

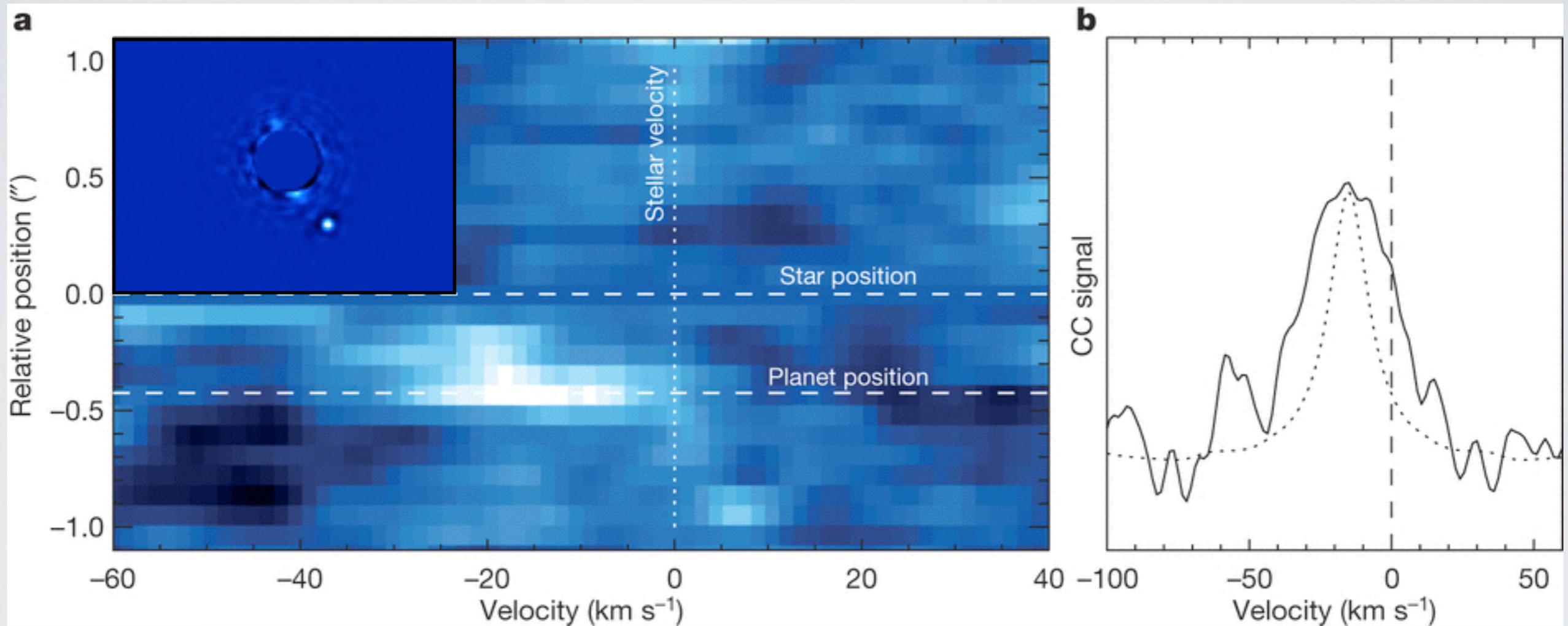


Slide courtesy of Matteo Brodi

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

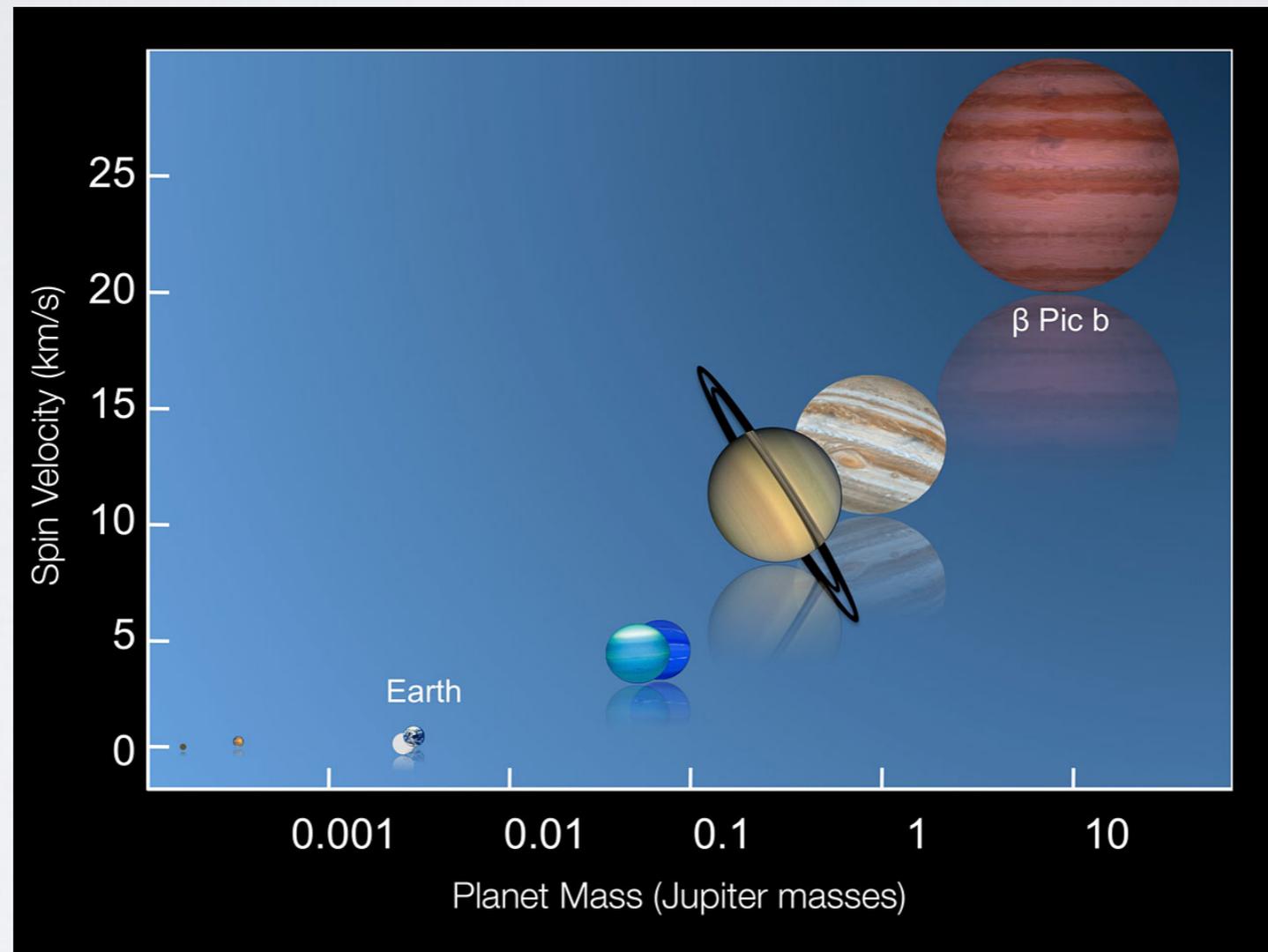
Credit: Planet image (GPI) processing by Christian Marois, NRC

Measuring rotation periods of cool gas giant planets

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

The directly imaged planet beta Pic b

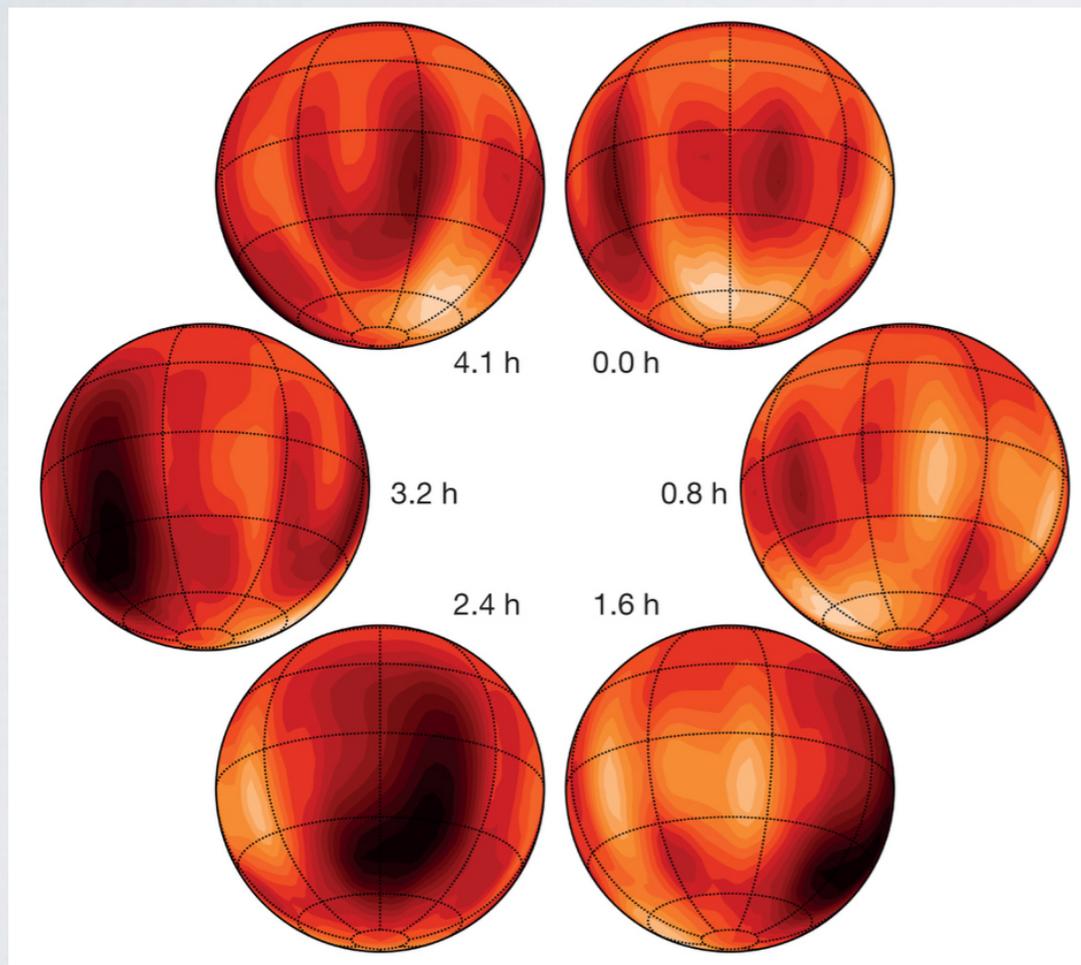
Exoplanet
atmospheres
and climates



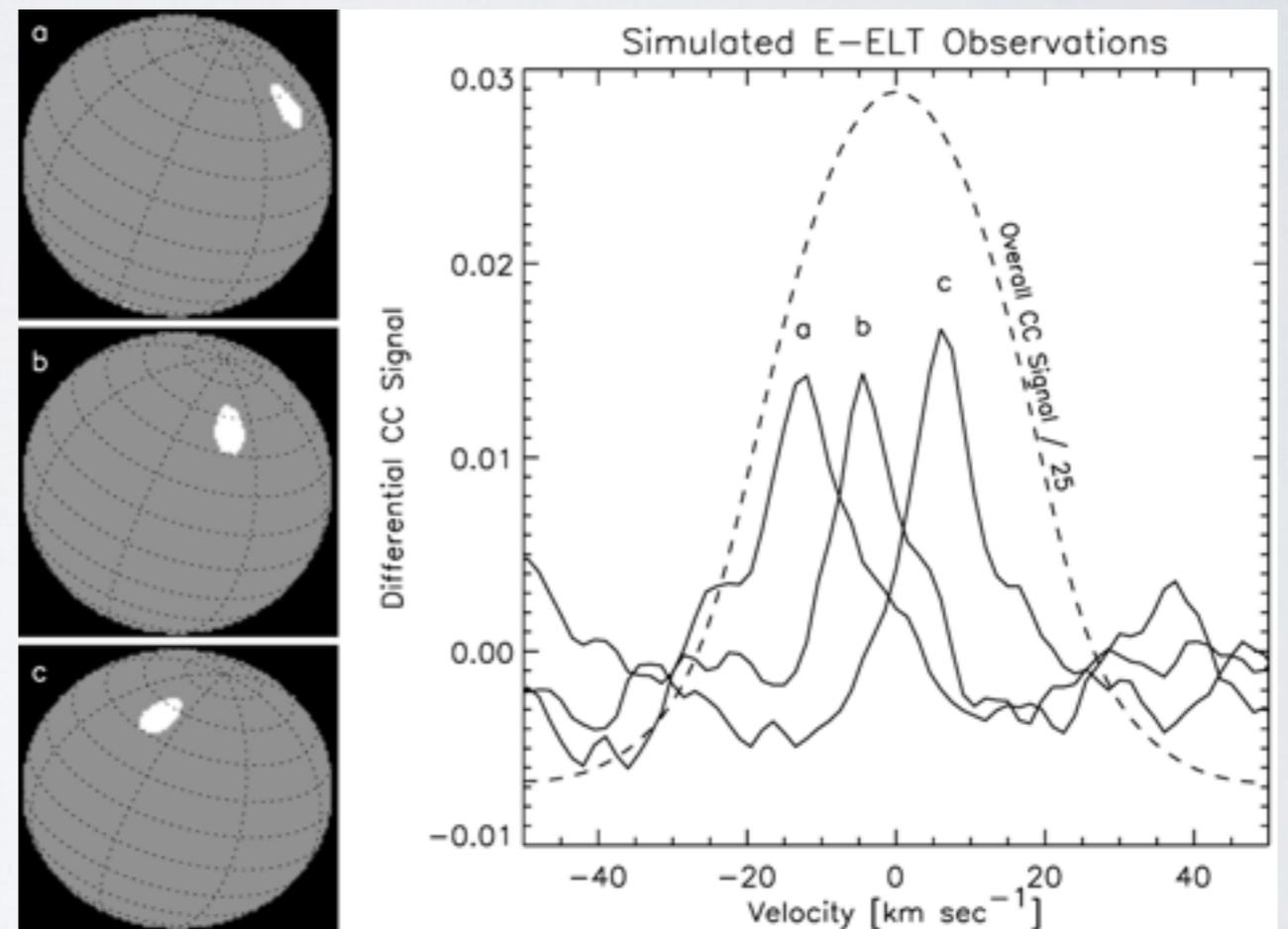
2D maps of exoplanets using Doppler Tomography

Exoplanet
atmospheres
and climates

VLT/CRIRES data of the Brown Dwarf Luhman 16 B



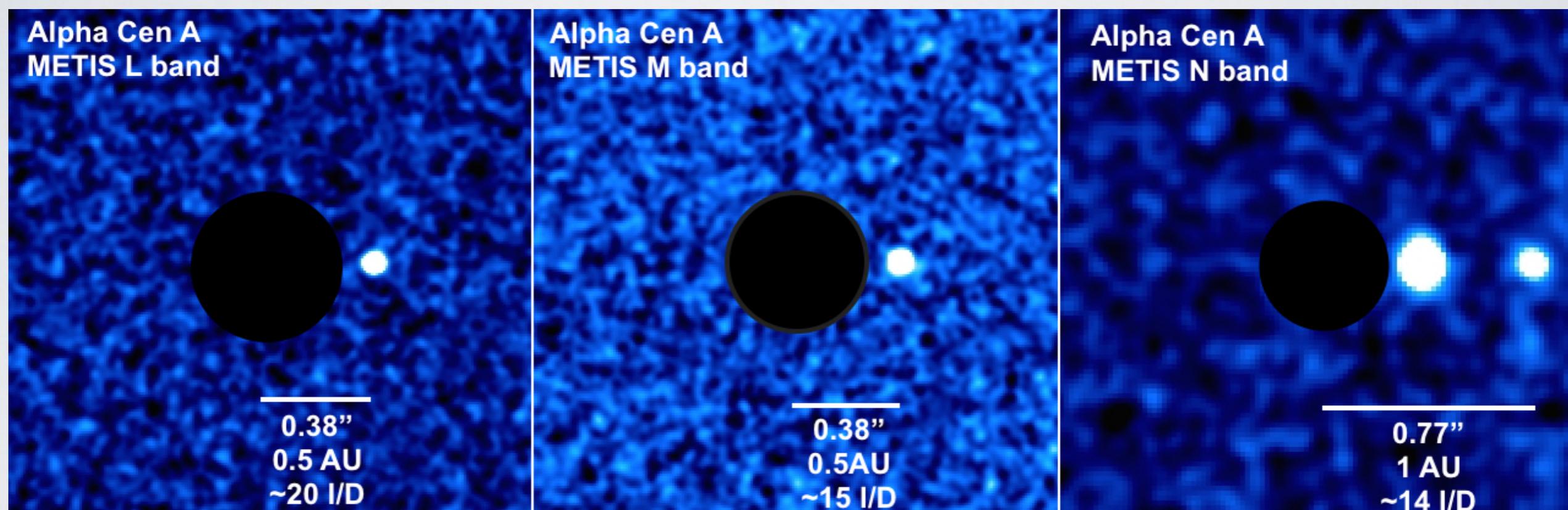
Simulating E-ELT observations of beta Pic b



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

