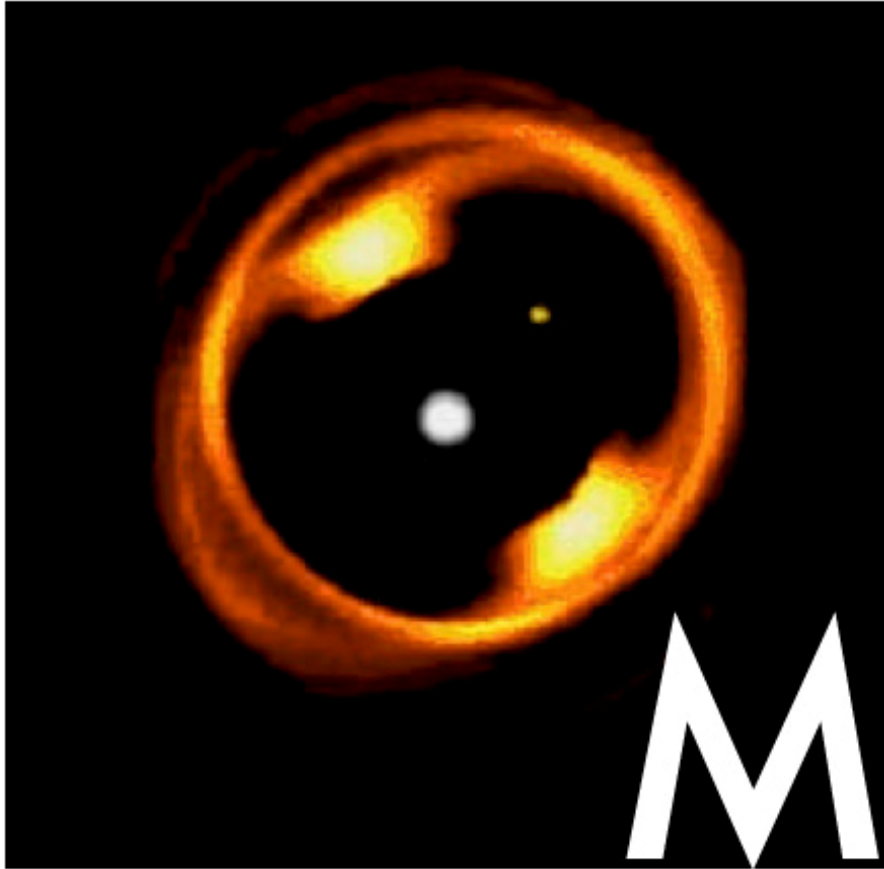


Exo-planets in the mid-IR with METIS



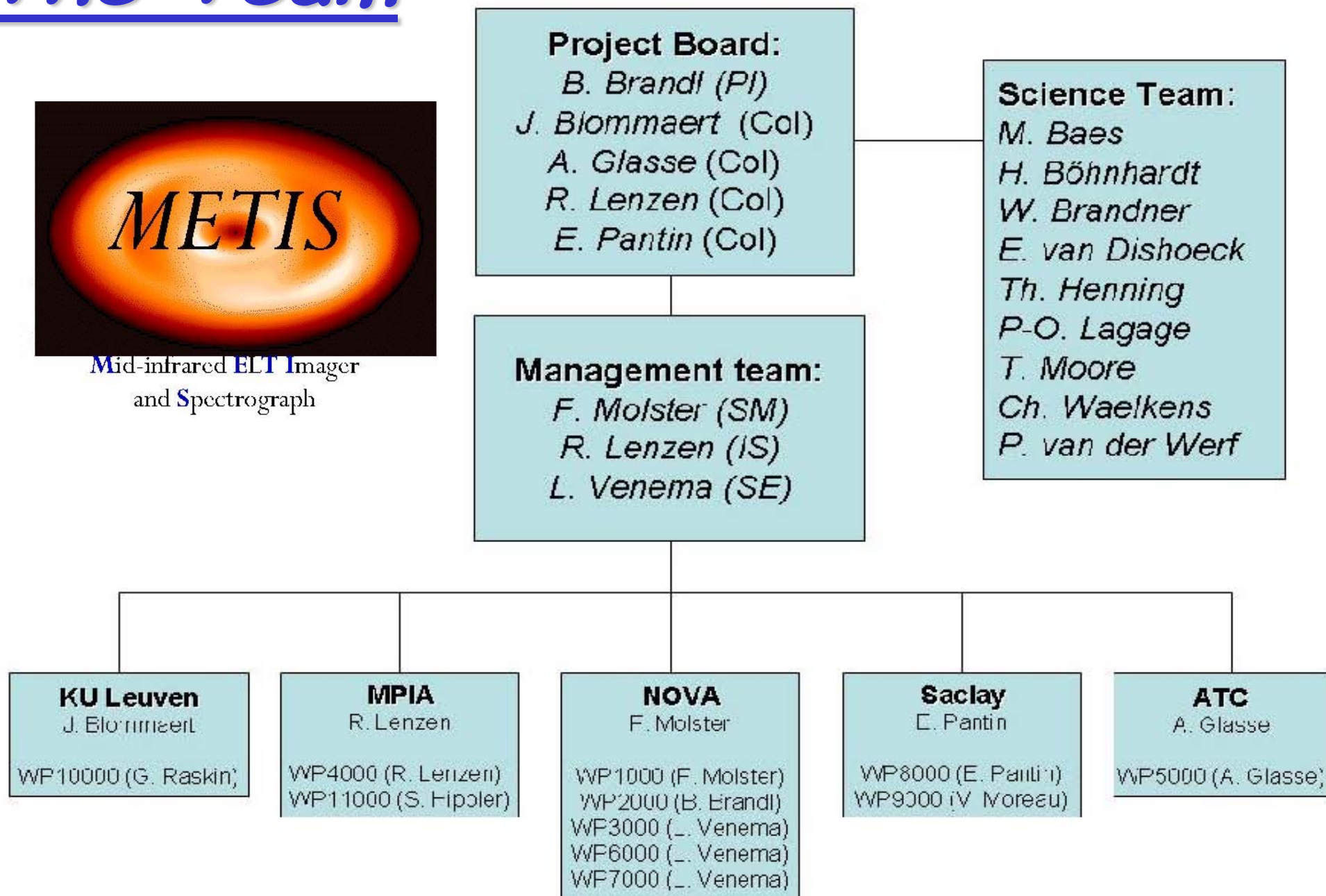
Mid-infrared
Extremely Large
Telescope
Imager and
Spectrometer

METIS

The Team



Mid-infrared **ELT** Imager
and Spectrograph



Instrument baseline concept:

performance:	BLIP, diffraction limited
wavelength:	3 - 13 μm (<25 μm)
detector:	1kx1k (N), 2kx2k (L,M)
fov:	18"x18"
pfov:	0.017"
spectro:	IFU with R ~100,000 (+MR)
imager:	filter + long slit R~250
options:	coronagraphy differential imaging polarimetry parallel L-N Q band



Mid-infrared **ELT** Imager
and Spectrograph



Mid-infrared ELT Imager
and Spectrograph

METIS science goal:

Exo-planets in the mid-IR

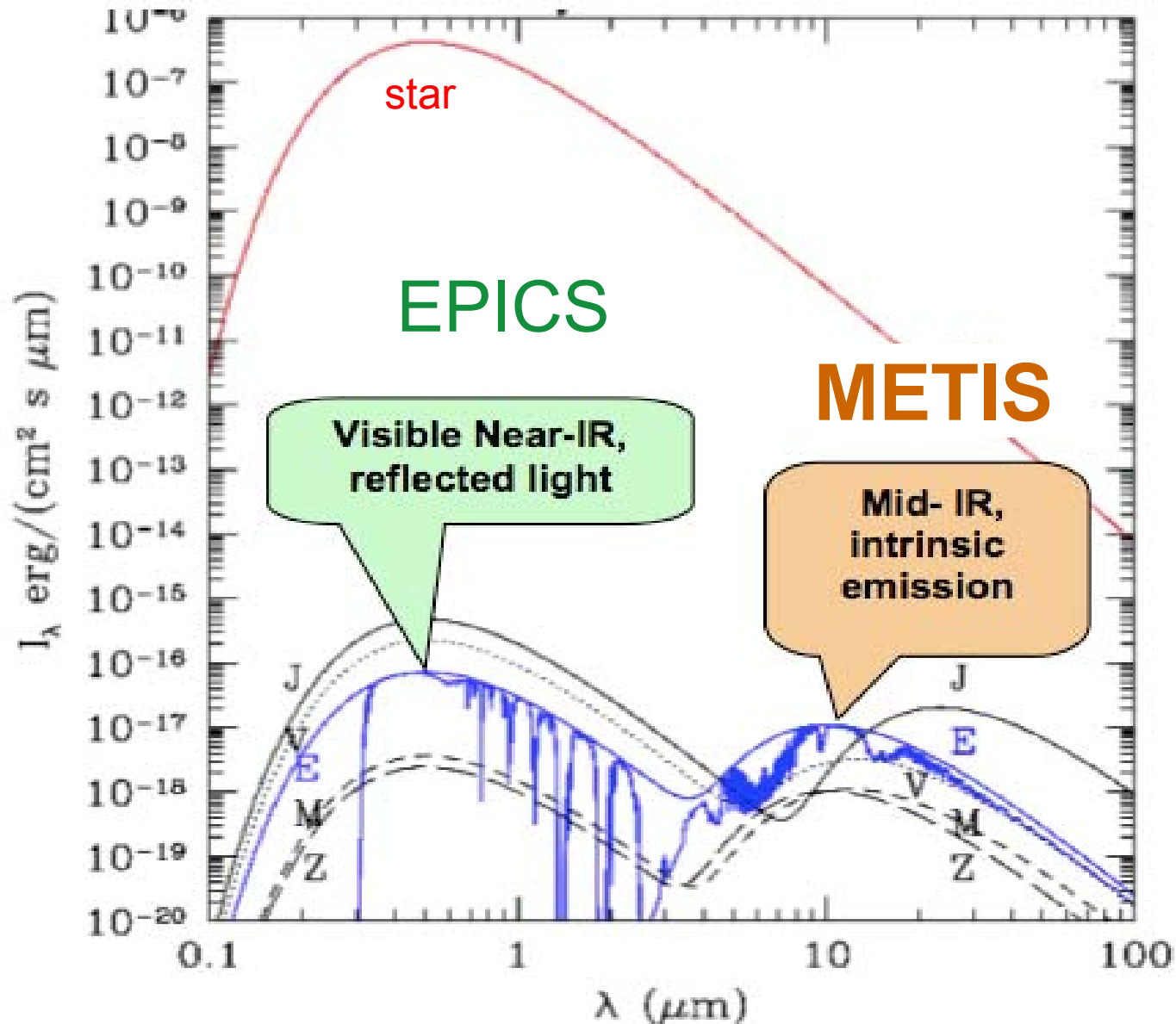


- Survey nearby stars for exo-planets
- Study physical and chemical properties of exo-planets in the mid-IR

Focus on nearby stars ->

Detection limits versus brightness and angular separation
between star and exo-planet

Pick your... – observing wavelength -



Exo-planets in the mid-IR with METIS



Contenders

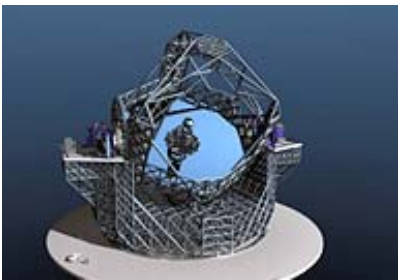
V-NIR:

MIR:



*NACO-SDI-4QPM,
SPHERE*

VISIR



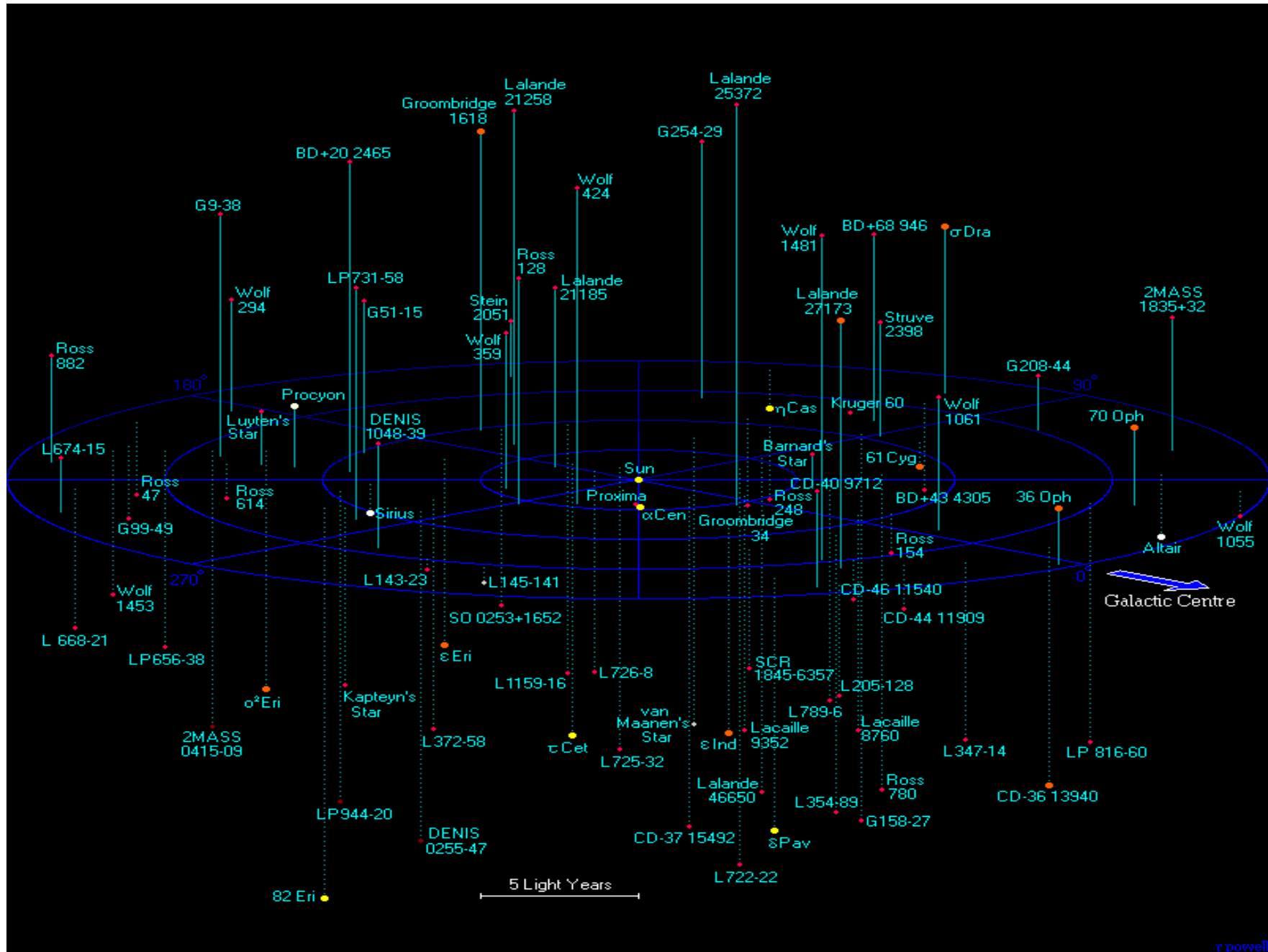
EPICS

METIS 😊

Science Goal

Survey nearby stars for exoplanets and study the physical and chemical properties of the exoplanets.

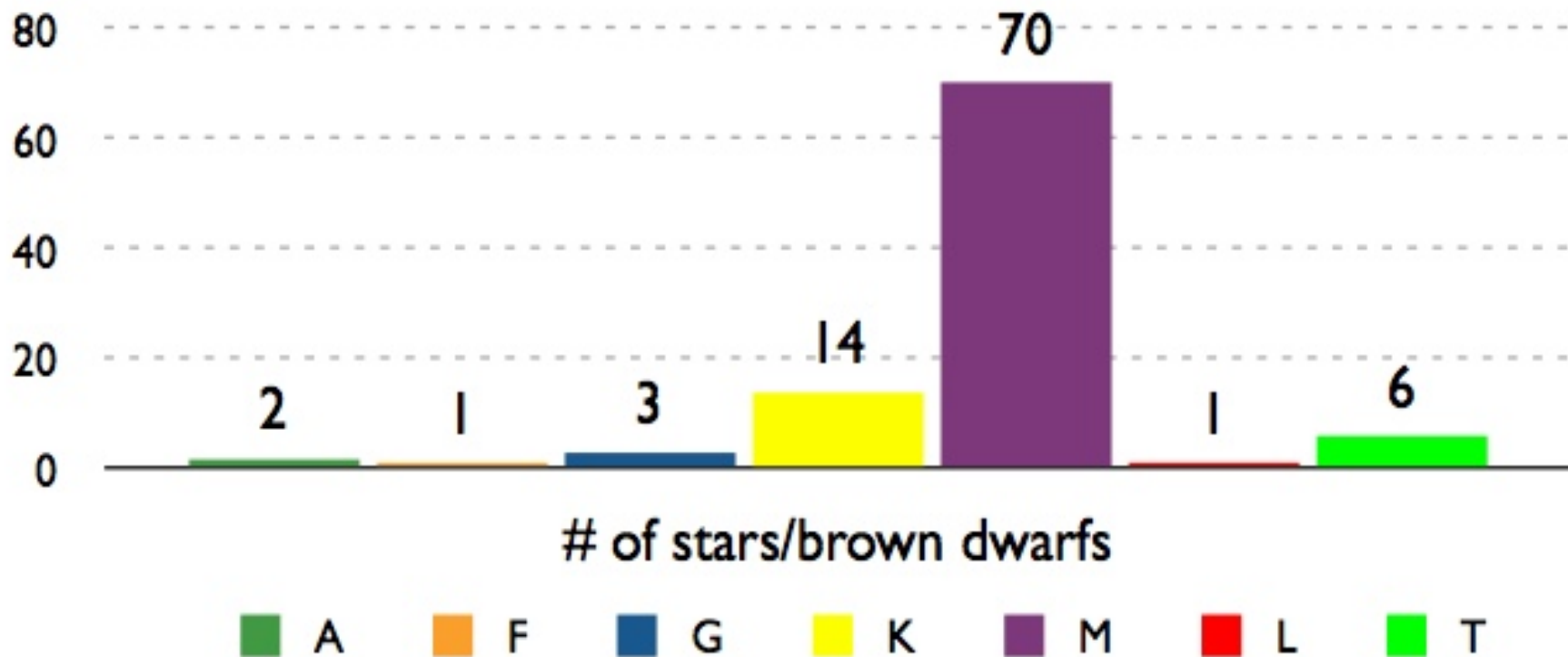
Pick your star... - The 6 pc sample -



The 6 pc sample

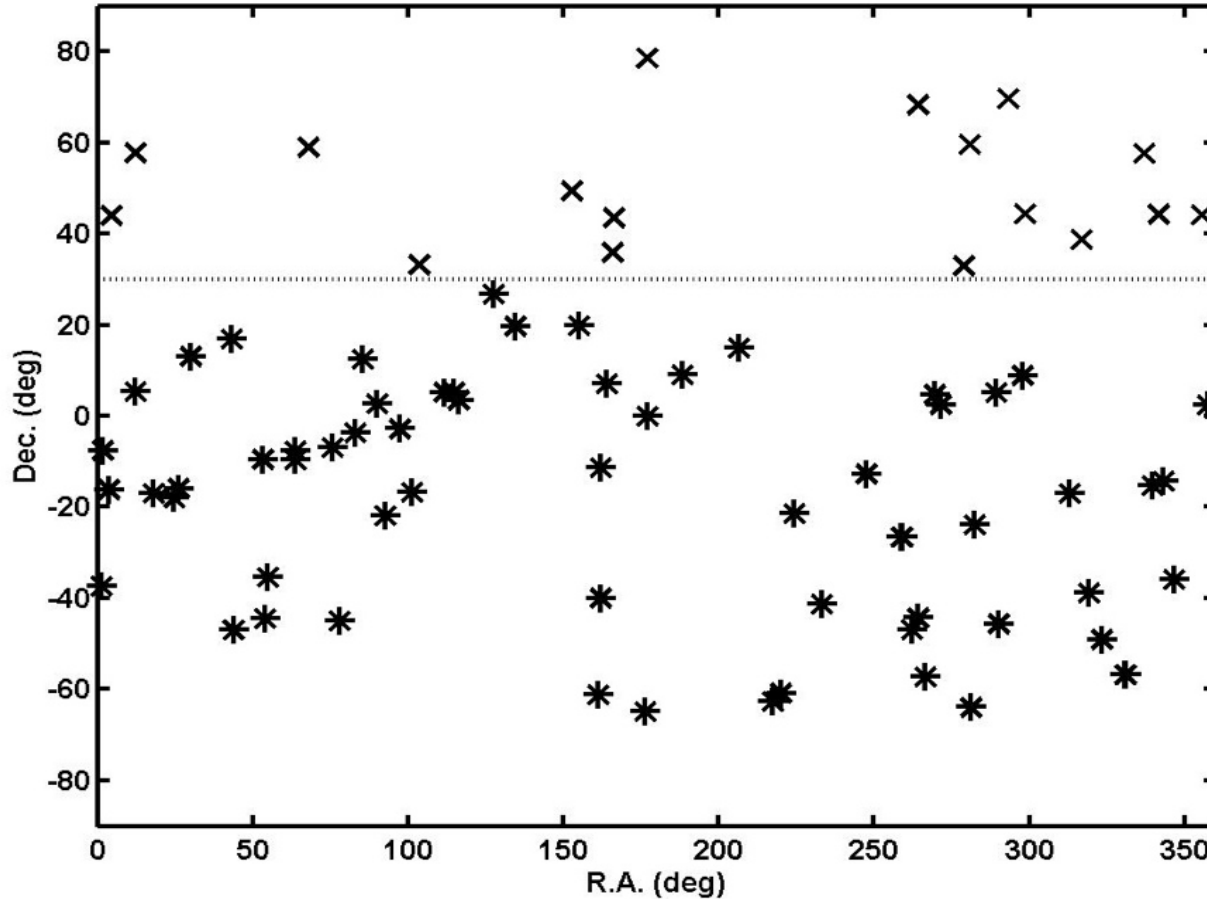


SPECTRAL TYPE DISTRIBUTION OF THE 6 PC SAMPLE



~ 90 stars, dominated by K- and M-dwarf

The 6pc sample



80% of sample at
declination $< +30^\circ$

~70 stars to be surveyed in
southern hemisphere

Exo-planets are brighter with:

- increasing mass and stellar luminosity: $\sim (M, L)$
- decreasing age and semi-major axis: $\sim 1/(t, d)$
- lower mass stars tend to have lower mass planets

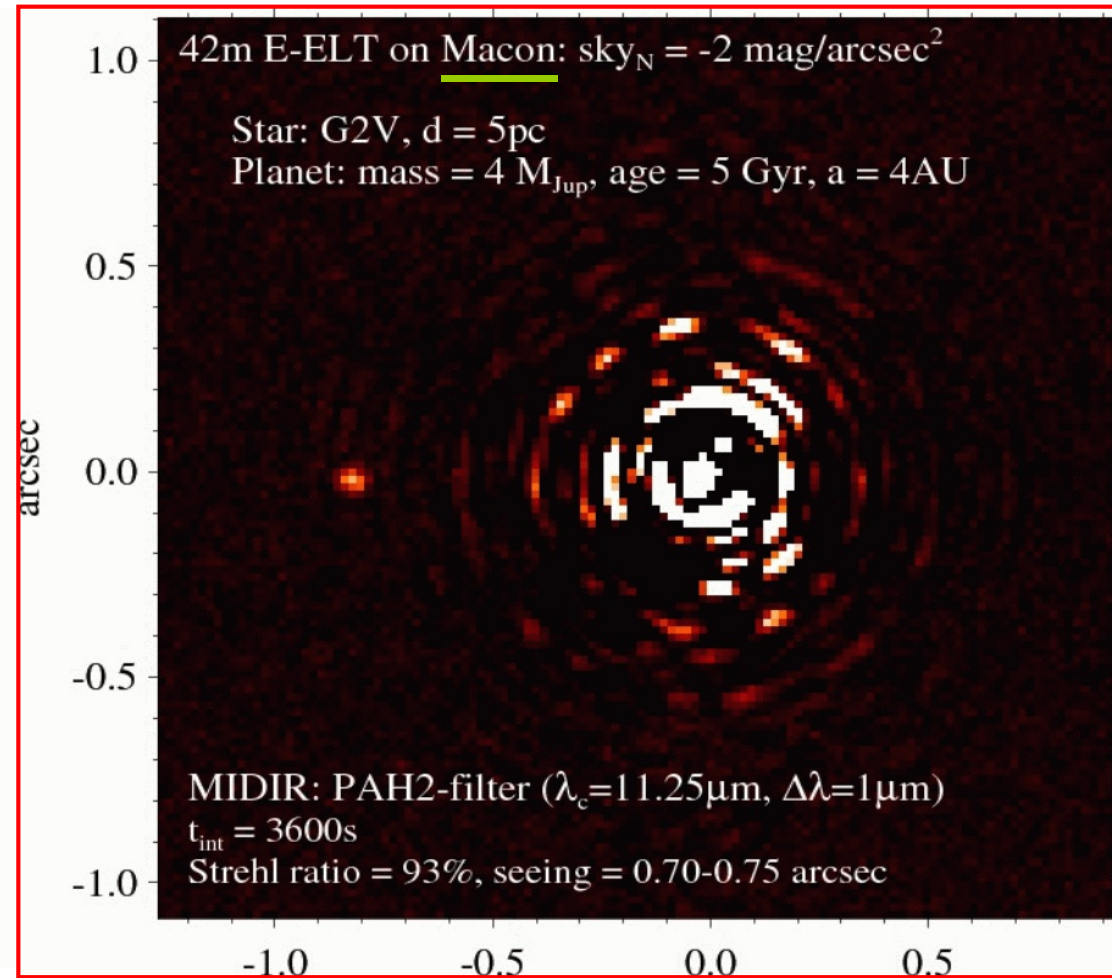
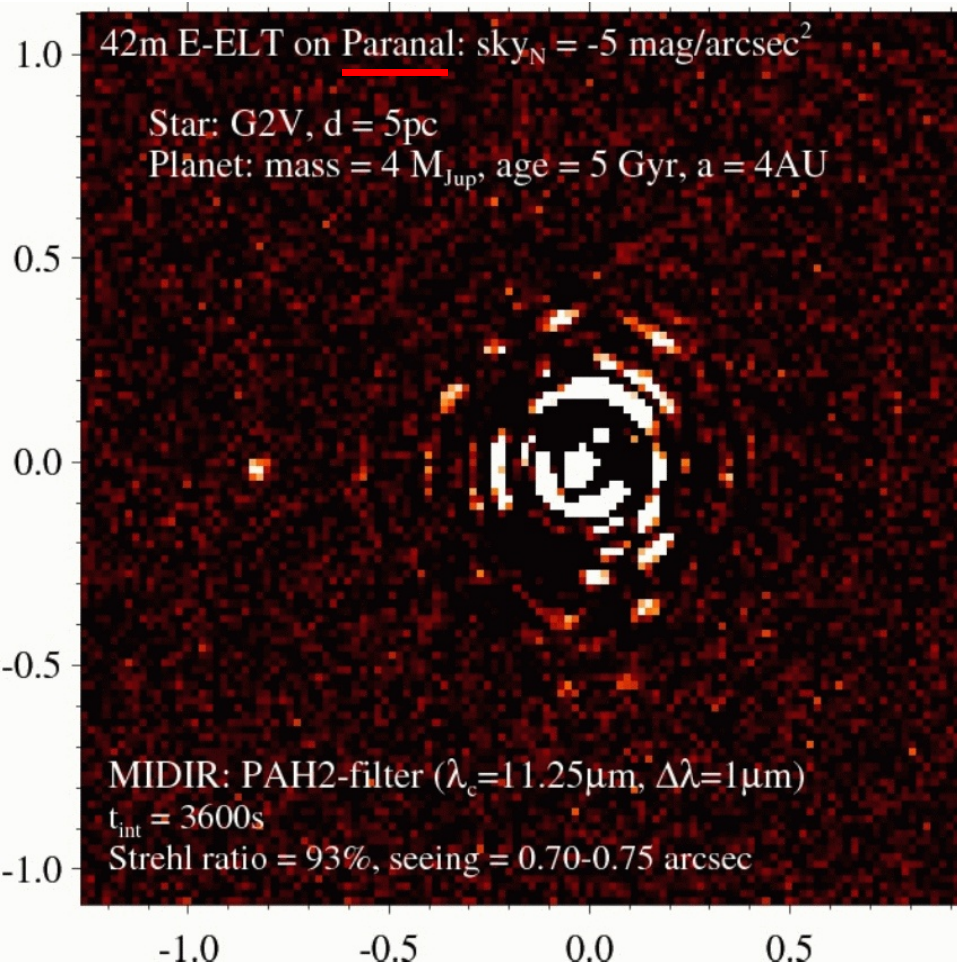
70 M stars within 6 pc: high probability to have young stars (<1Gyr) in the sample

METIS simulations

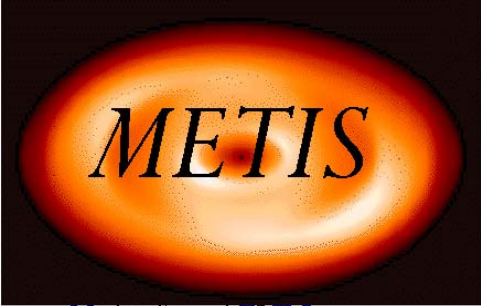


- Photon statistics: background noise limit
- Based on AO-corrected E-ELT PSF provided by ESO Adaptive Optics group
- PSF variations: seeing 0.7" - 0.75"
- does not yet include: broad-band PSF, water induced PSF variations, atmopsh. model of the ELT site, instrumental aberrations, detectors...

Exoplanets in the mid-IR with METIS - Imaging



Residuals of PSF subtraction limits contrast \rightarrow coronagraph



Mid-infrared ELT Imager
and Spectrograph

Exo-planets in the mid-IR: METIS imaging



M-dwarf:
D=4pc, age = 1 Gyr

Exo-planet:
1AU, $1M_J$

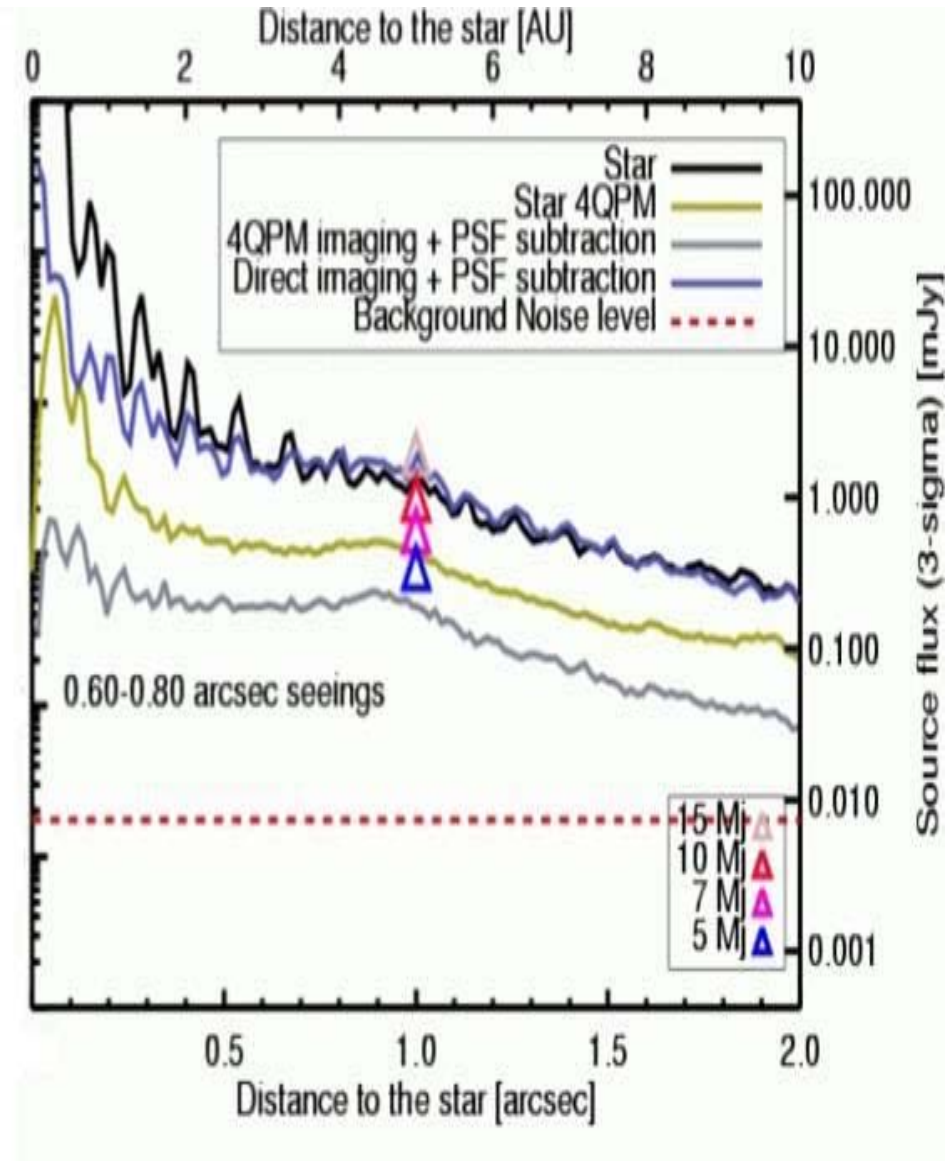
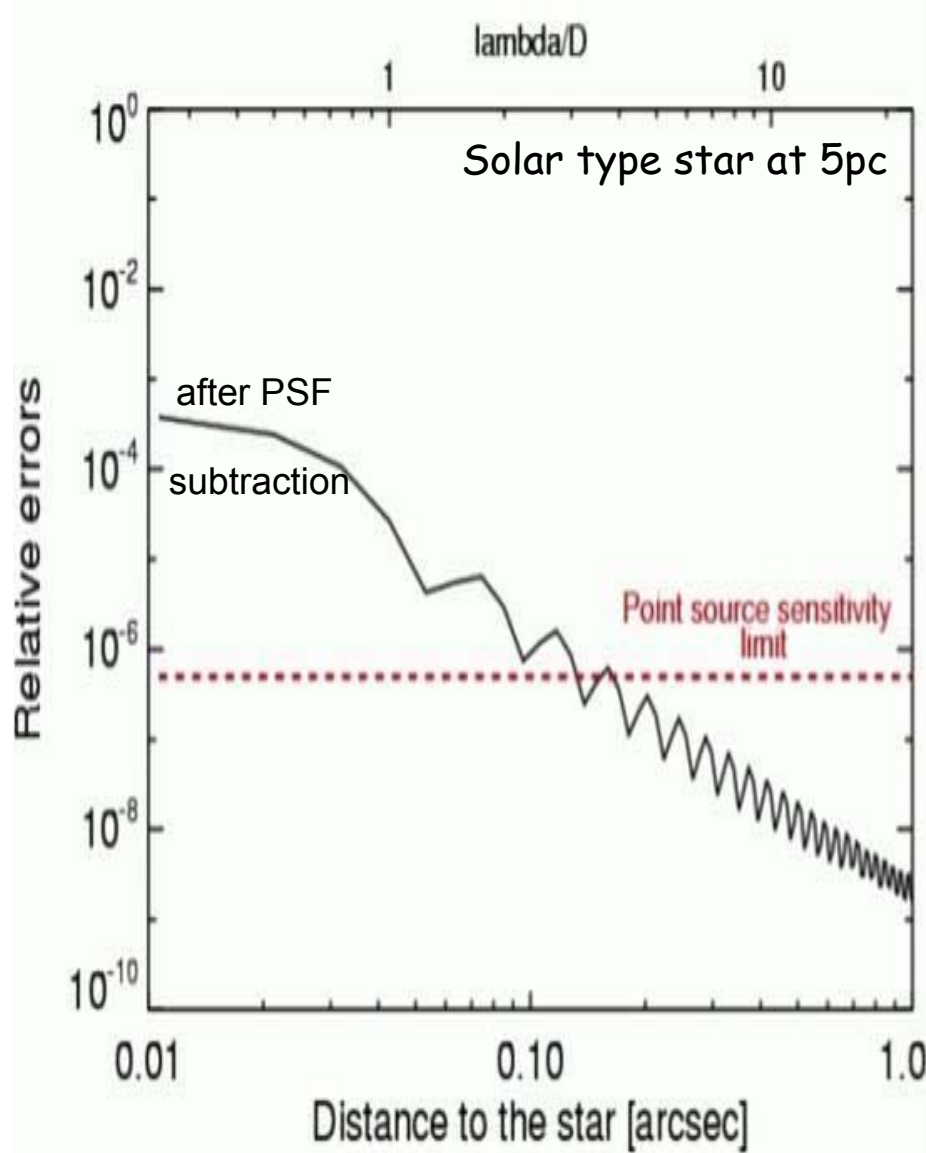
Planet detection (4σ):

Paranal: 20h

Macon: 1h

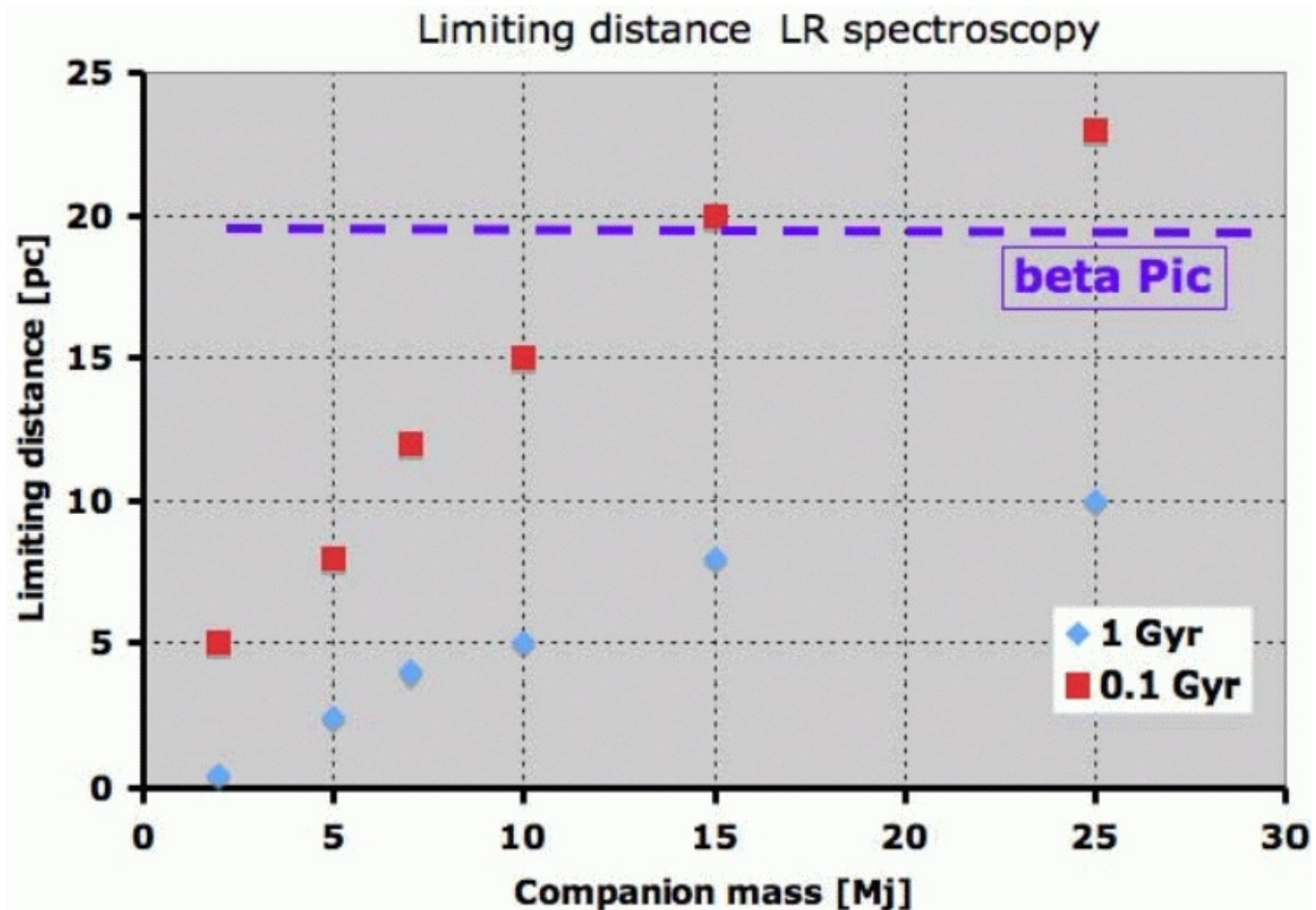
E-ELT site selection crucial for mid-IR sensitivity

Exoplanets in the mid-IR: METIS imaging

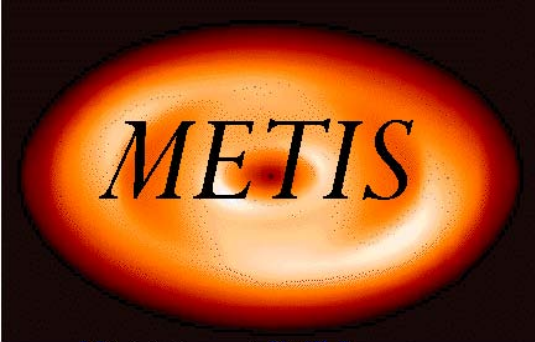


Phase mask = > detection of lower mass planets

Exo-planets: detection limits in N band low-resolution spectroscopy



METIS complementary wavelengths to EPICS



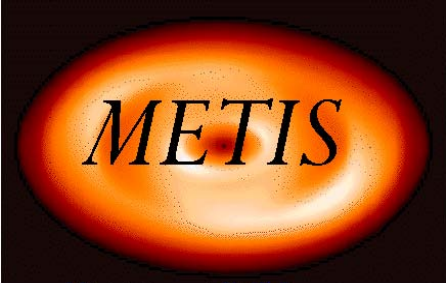
Mid-infrared **ELT** Imager
and Spectrograph

Exoplanets in the mid-IR - METIS Spectroscopy



Follow-up on Exoplanets

- L-M-N band low-res spectro.:
 NH_3 , PH_3 , C_2H_4 , CH_4 , ...
- High-resolution ($R=50,000$): H_3^+



Mid-infrared ELT Imager
and Spectrograph



Typical observing sequence:

- All observations use E-ELT facility AO system.
- Imaging survey: typically 1h N-band integration per star, burst mode, no optical de-rotation.
- Imaging with 4-quadrant phase mask: additional tip-tilt correction might be required to stabilize star behind the mask to ~ 0.1 pixel (3 mas).
- Spectroscopy (long-slit): typically a few hours of integration on brighter exo-planets.



METIS

Mid-infrared **ELT** Imager
and Spectrograph

Exoplanets in the mid-IR

-Science goal:

survey nearby stars for exo-planets and study the physical and chemical properties of the exo-planets in the mid-IR

- *E-ELT* site selection crucial for mid-IR sensitivity
- *METIS* complementary wavelength coverage to *EPICS*