High-contrast imaging of circumstellar environments

A new discovery space with VLT/SPHERE

J. Milli, SPHERE instrument fellow

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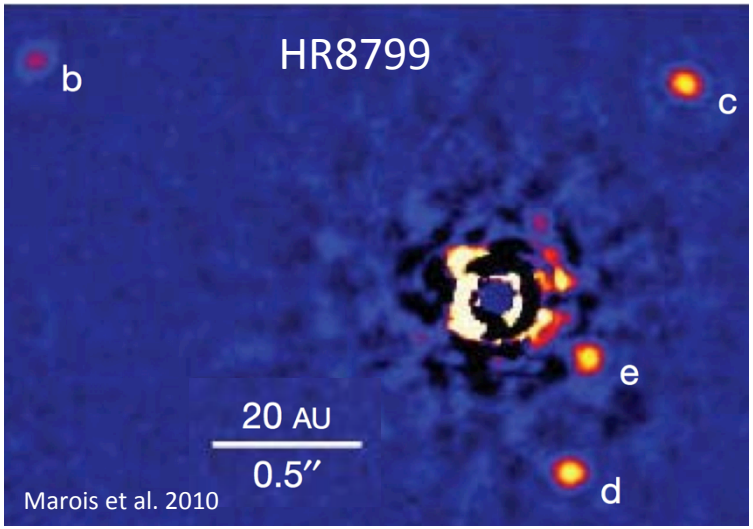
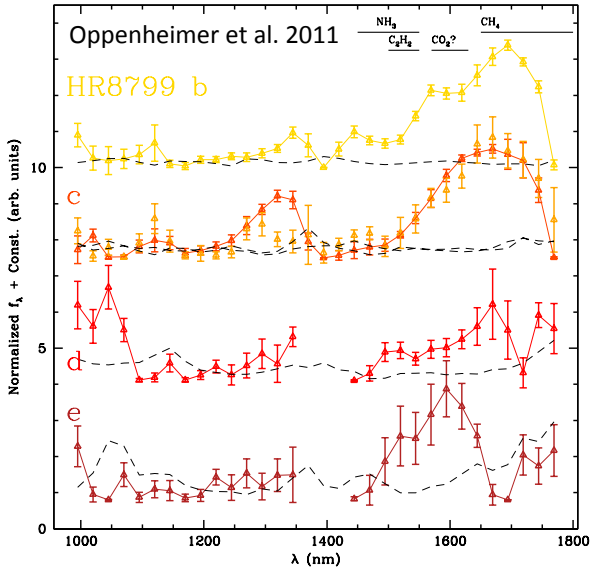
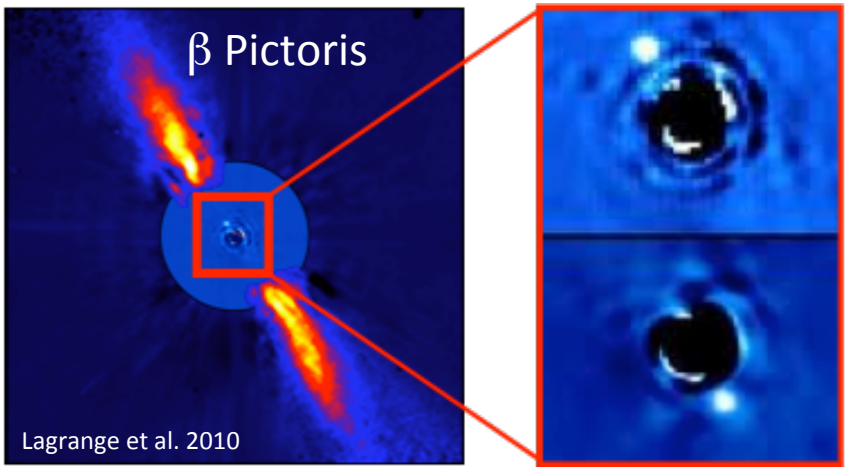
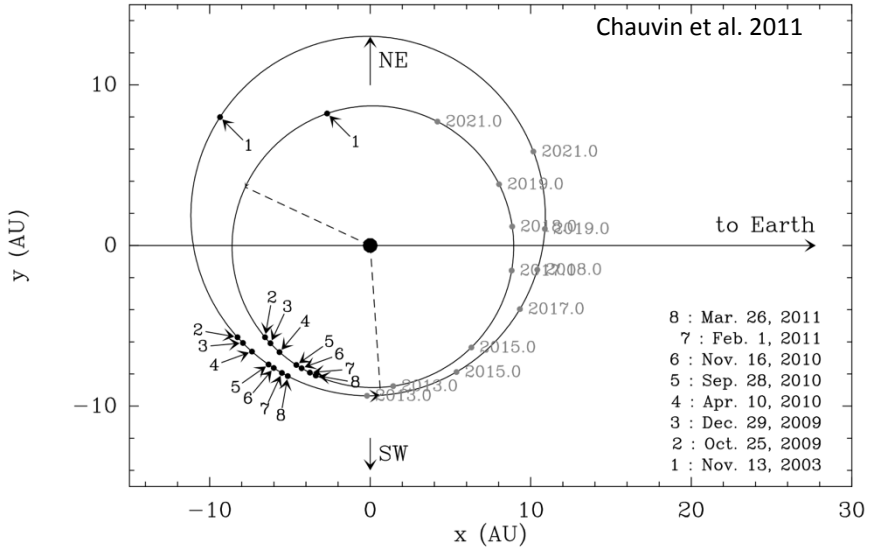
Perspectives

A very rich technique to study planets

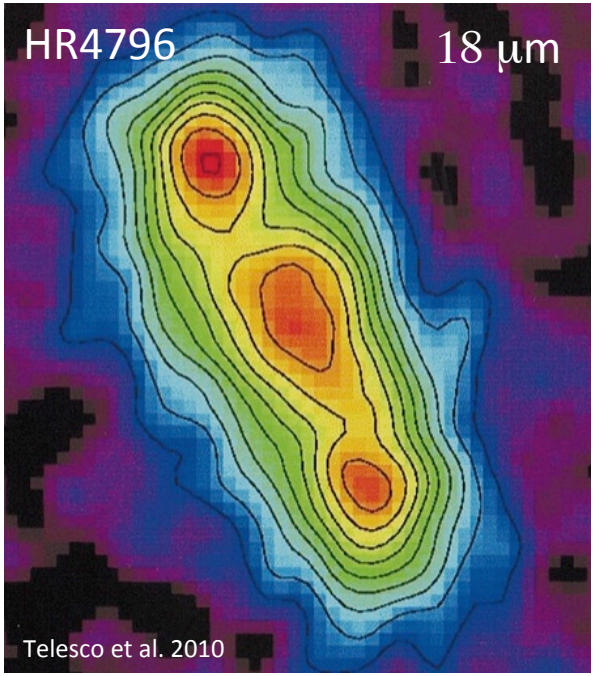


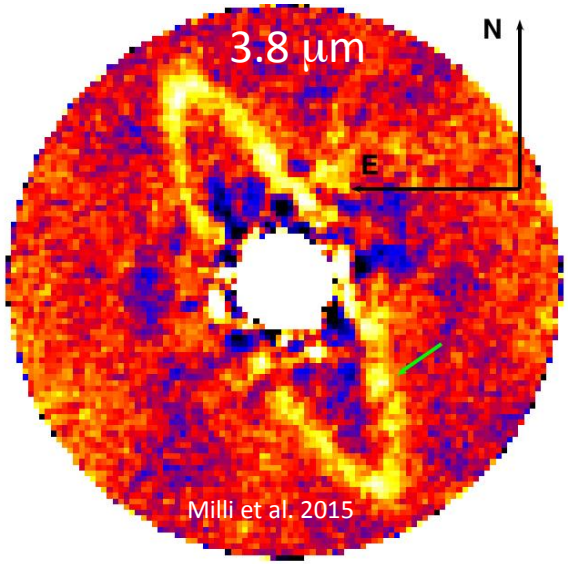






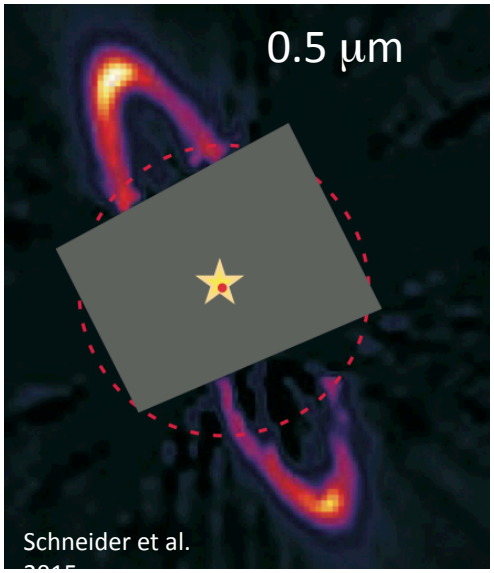
… and their environments





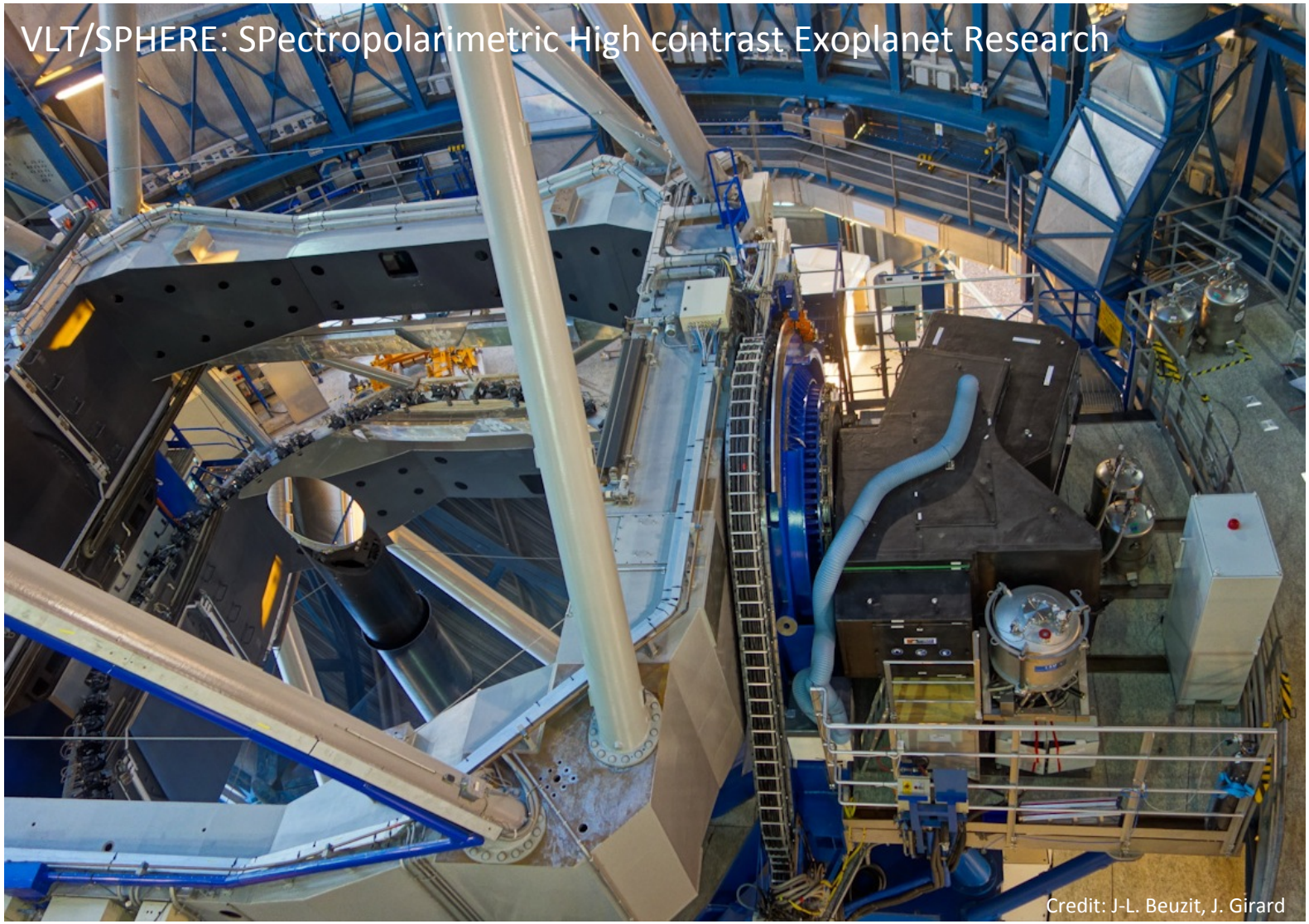
1 arcsec

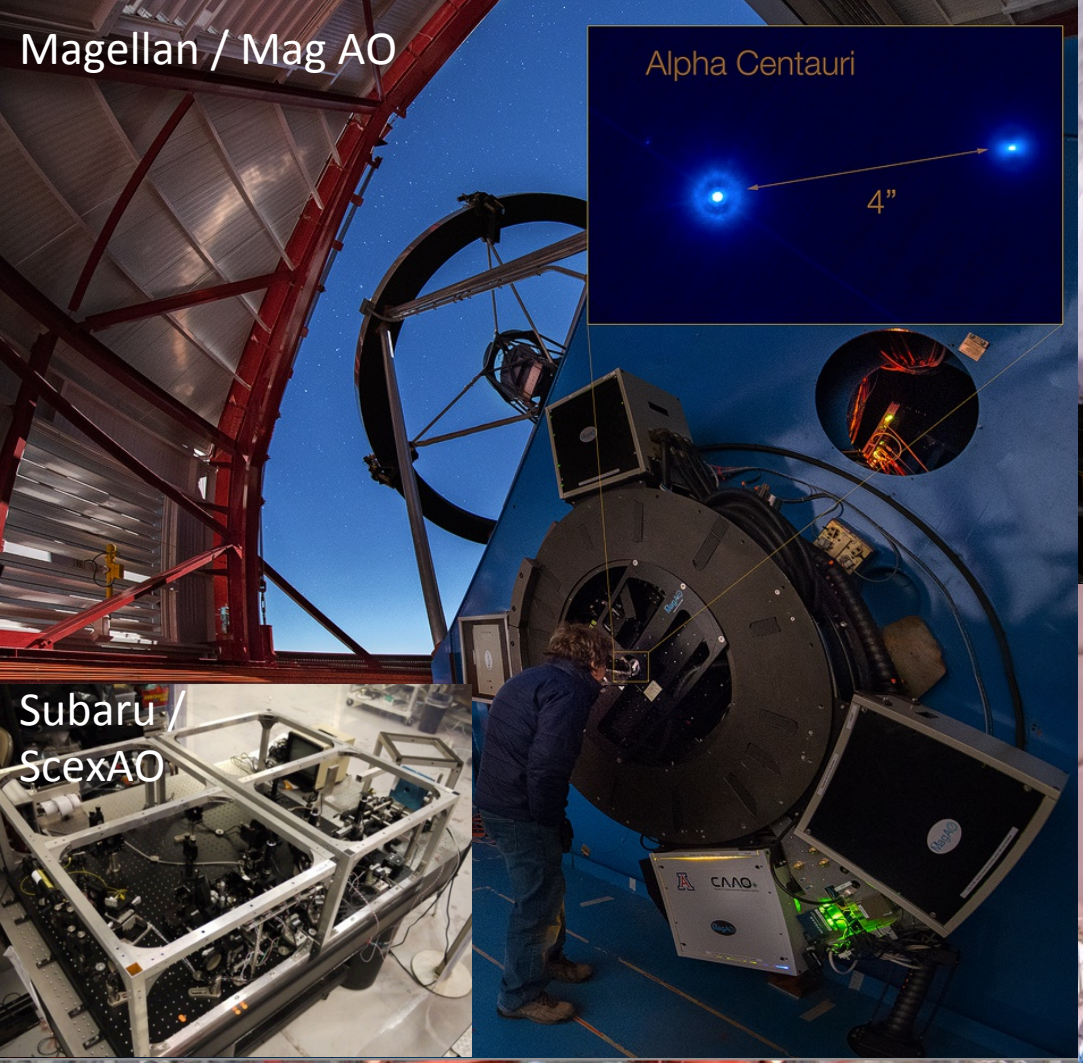
73 AU



Angular resolution and high-contrast are critical for direct imaging.

Revolution in direct imaging: second-generation instruments

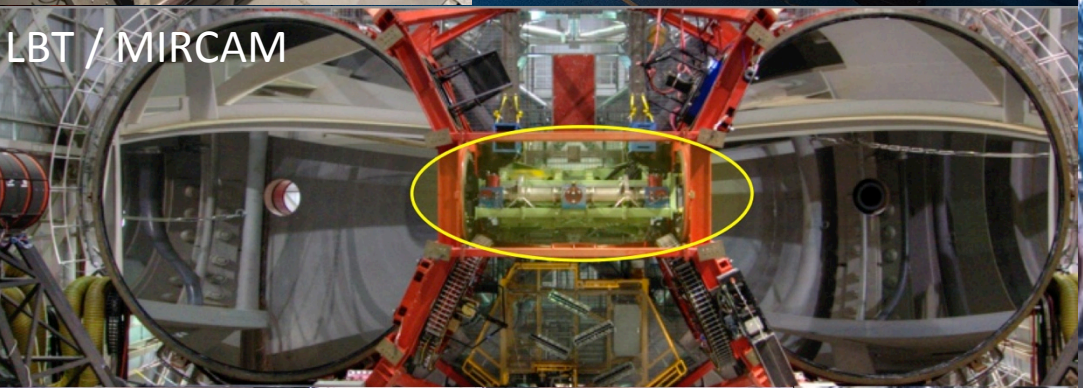



Magellan / Mag AO
Alpha Centauri
4”

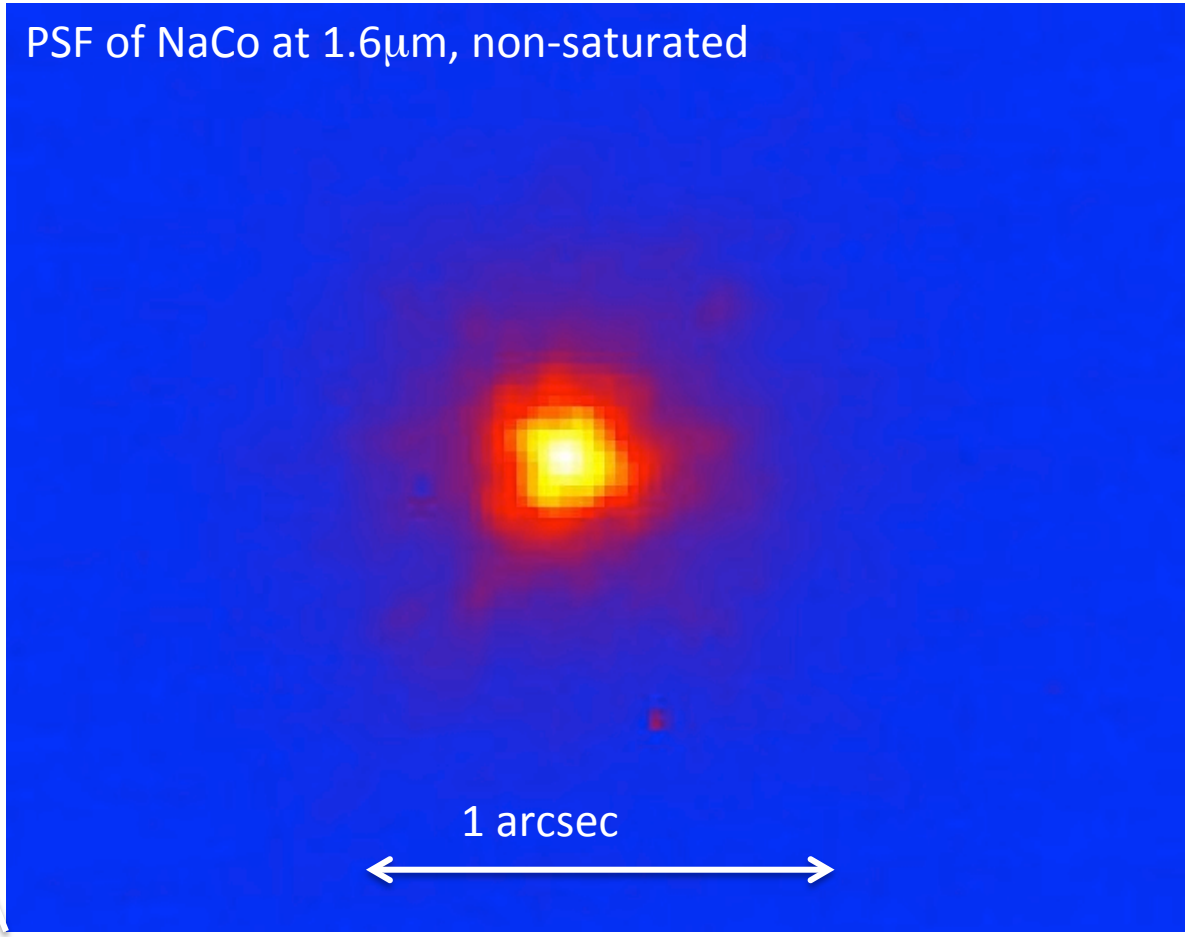

Hale / P1640

Subaru /
ScexAO


Gemini / GPI


LBT / MIRCAM

What do they bring ?



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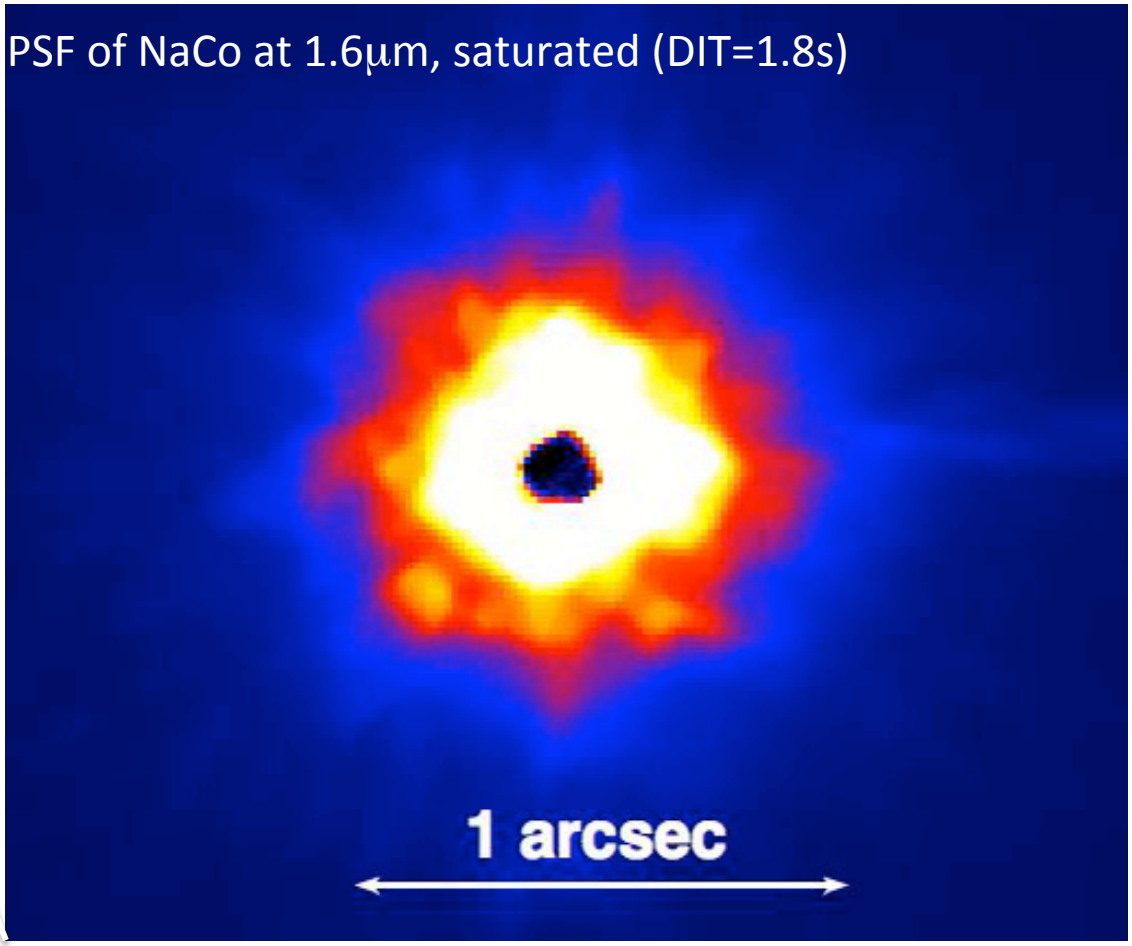
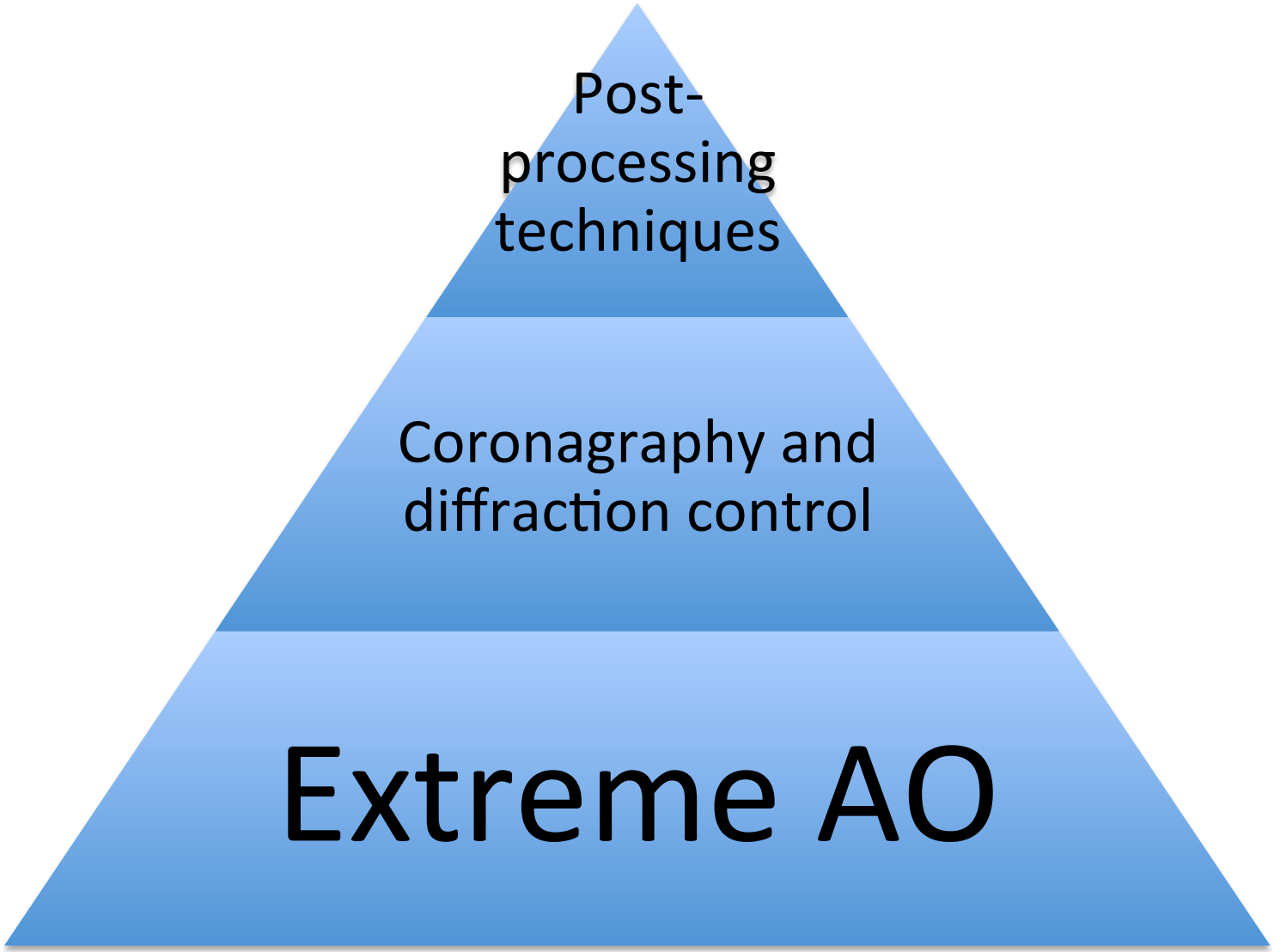
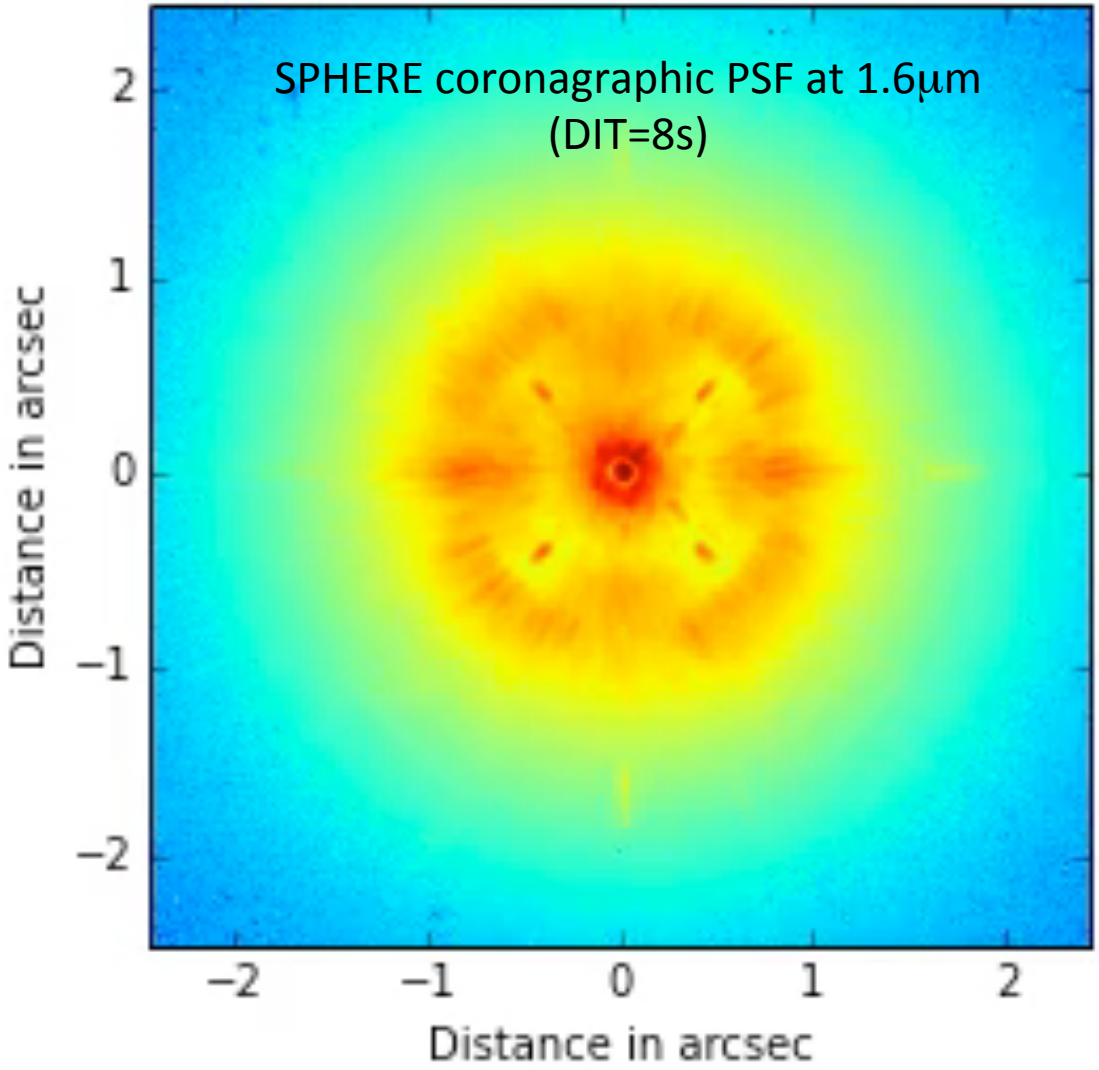


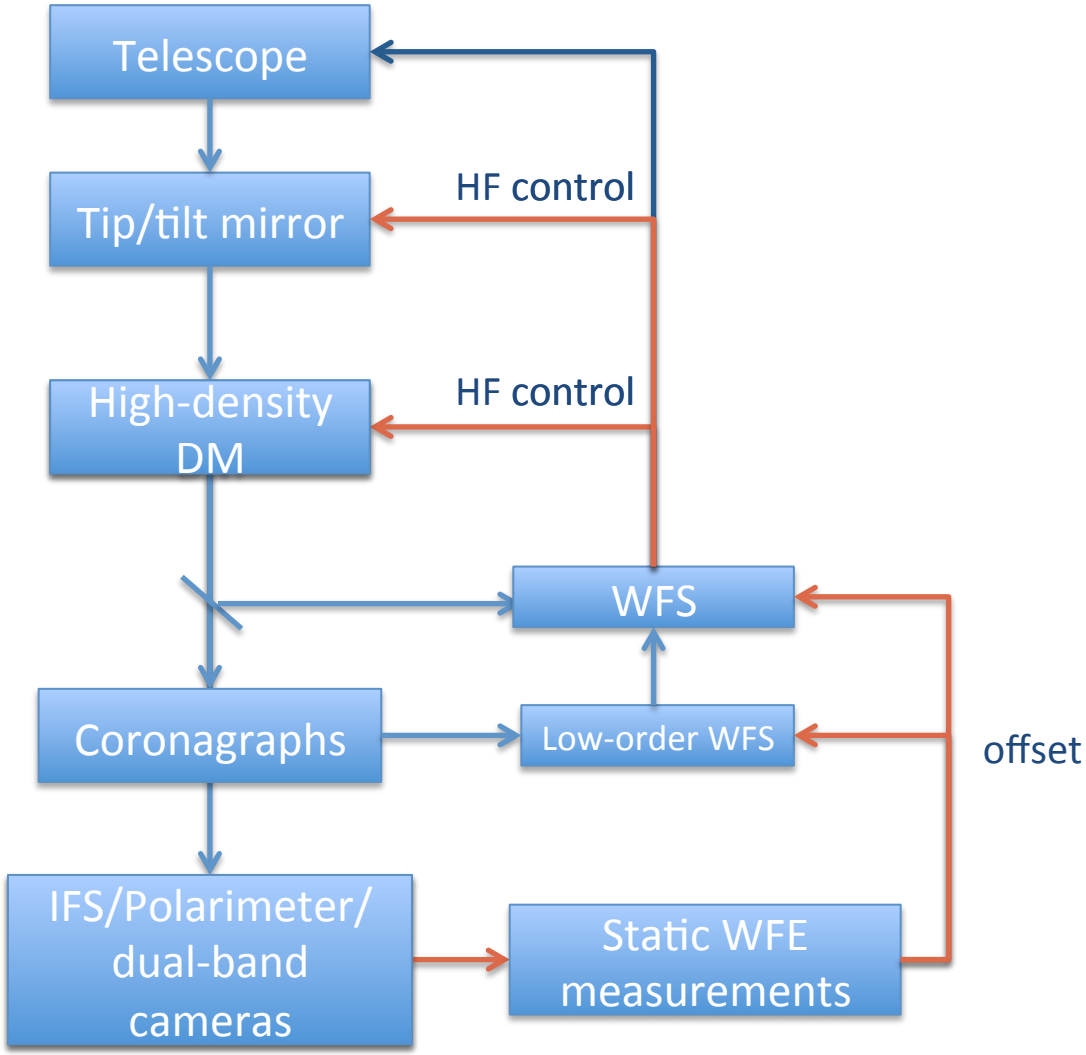
I. SPHERE secrets



I. SPHERE secrets: stability, high Strehl, and diffraction control

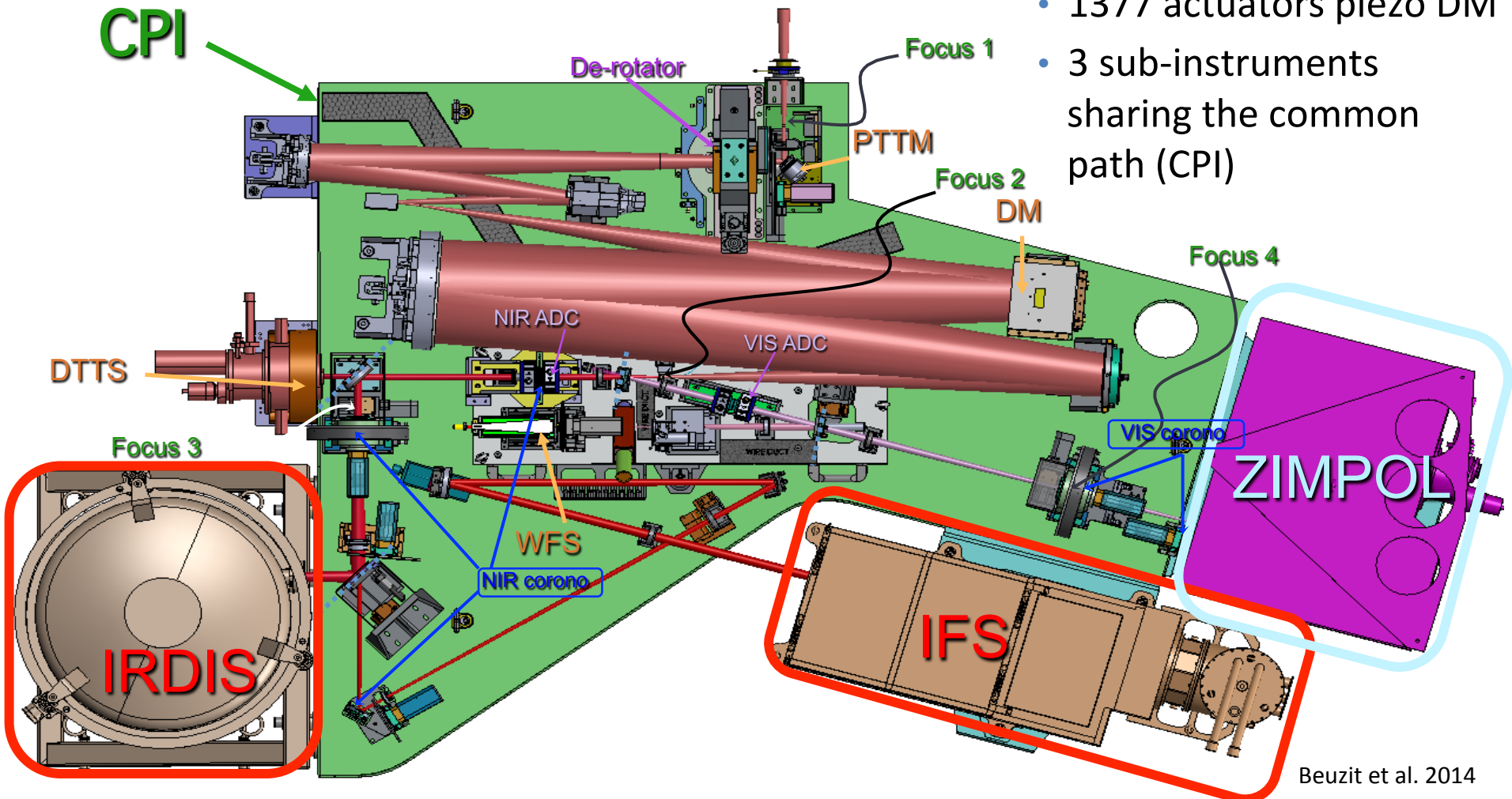


From 1st to 2nd generation: a few additional tricks



Final result: a heavy, stable instrument

- Nasmyth focus
- 1377 actuators piezo DM
- 3 sub-instruments sharing the common path (CPI)



Beuzit et al. 2014

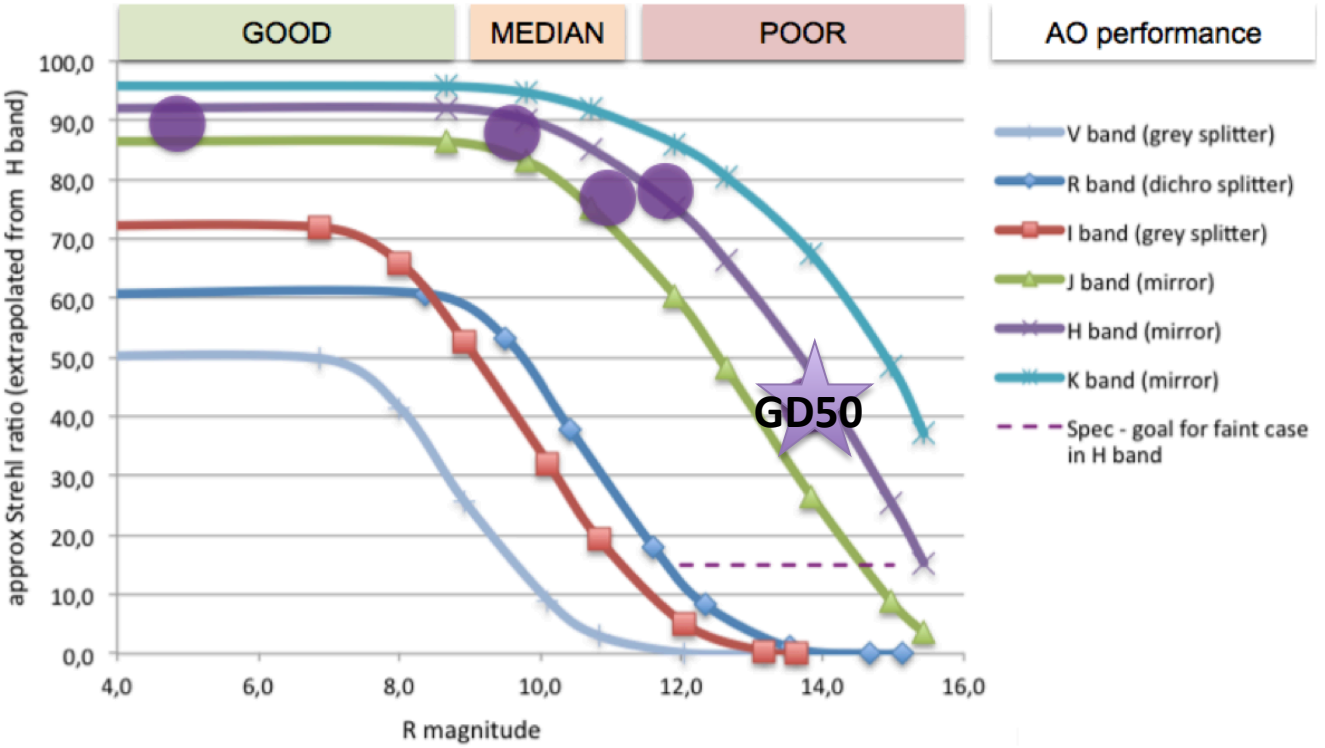
II. Early science results

Selected examples of new discovery spaces in exoplanetary science

A. Planet search around white dwarfs

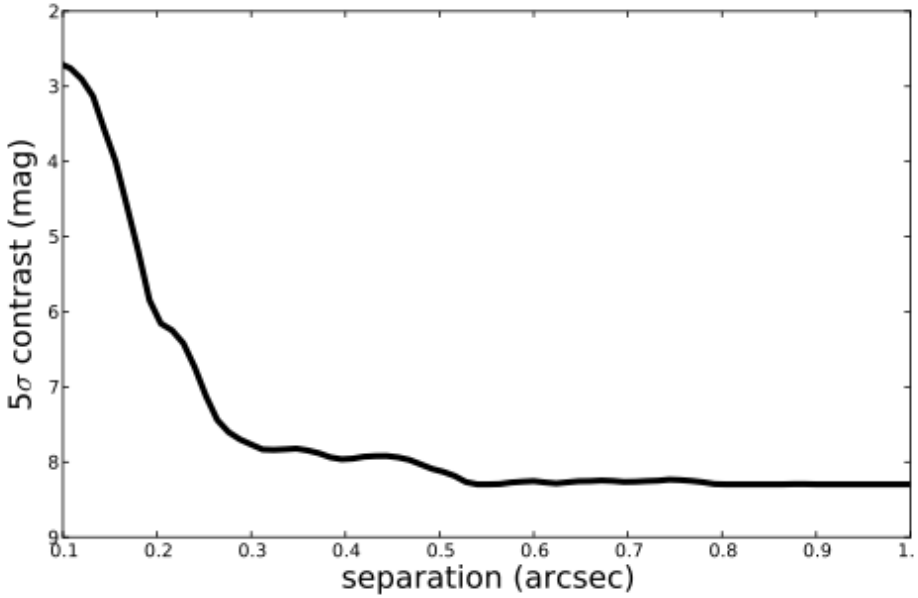
- Technical challenge: white dwarfs are very faint targets
- Example of the young (125Myr), nearby (31pc) white dwarf GD50: R=14.2 (Xu et al. submitted)

40% Strehl reached at H

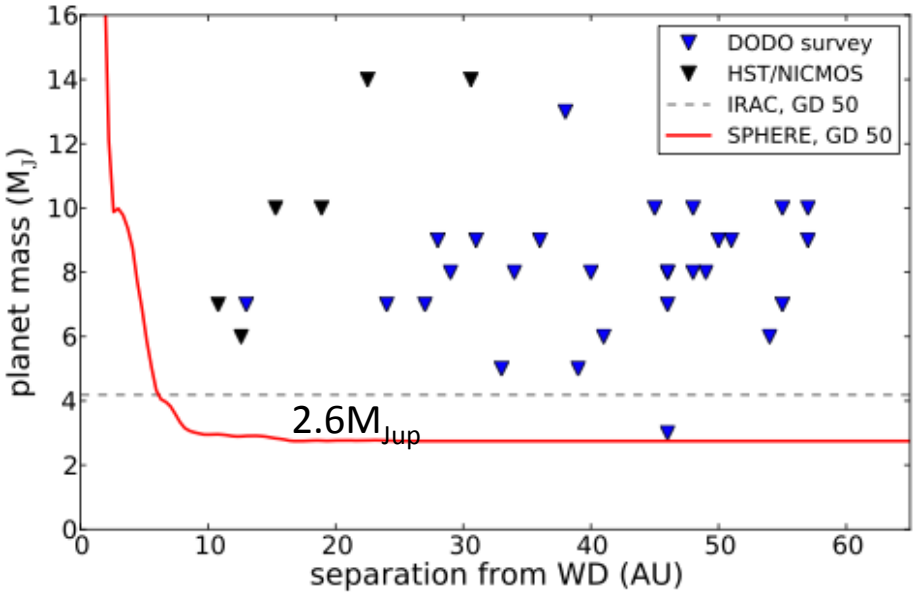


No detection but strong constraints on planets

Broad-band imaging in H band, ~1 hour observation



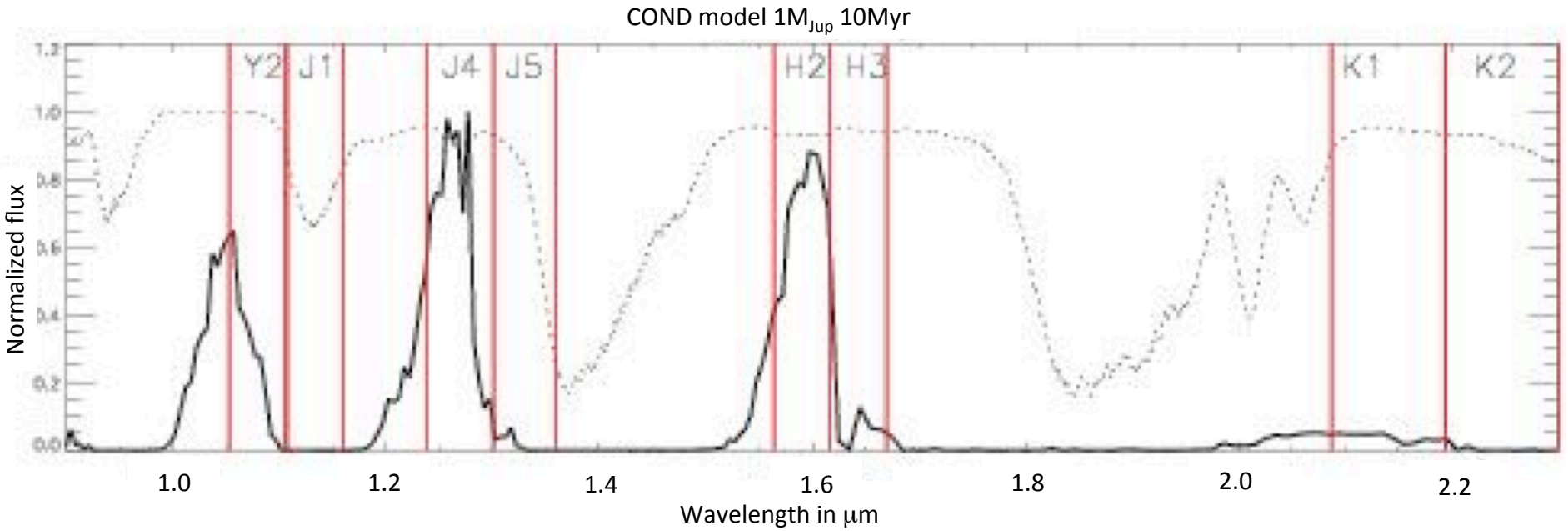
Xu et al. submitted to A&A



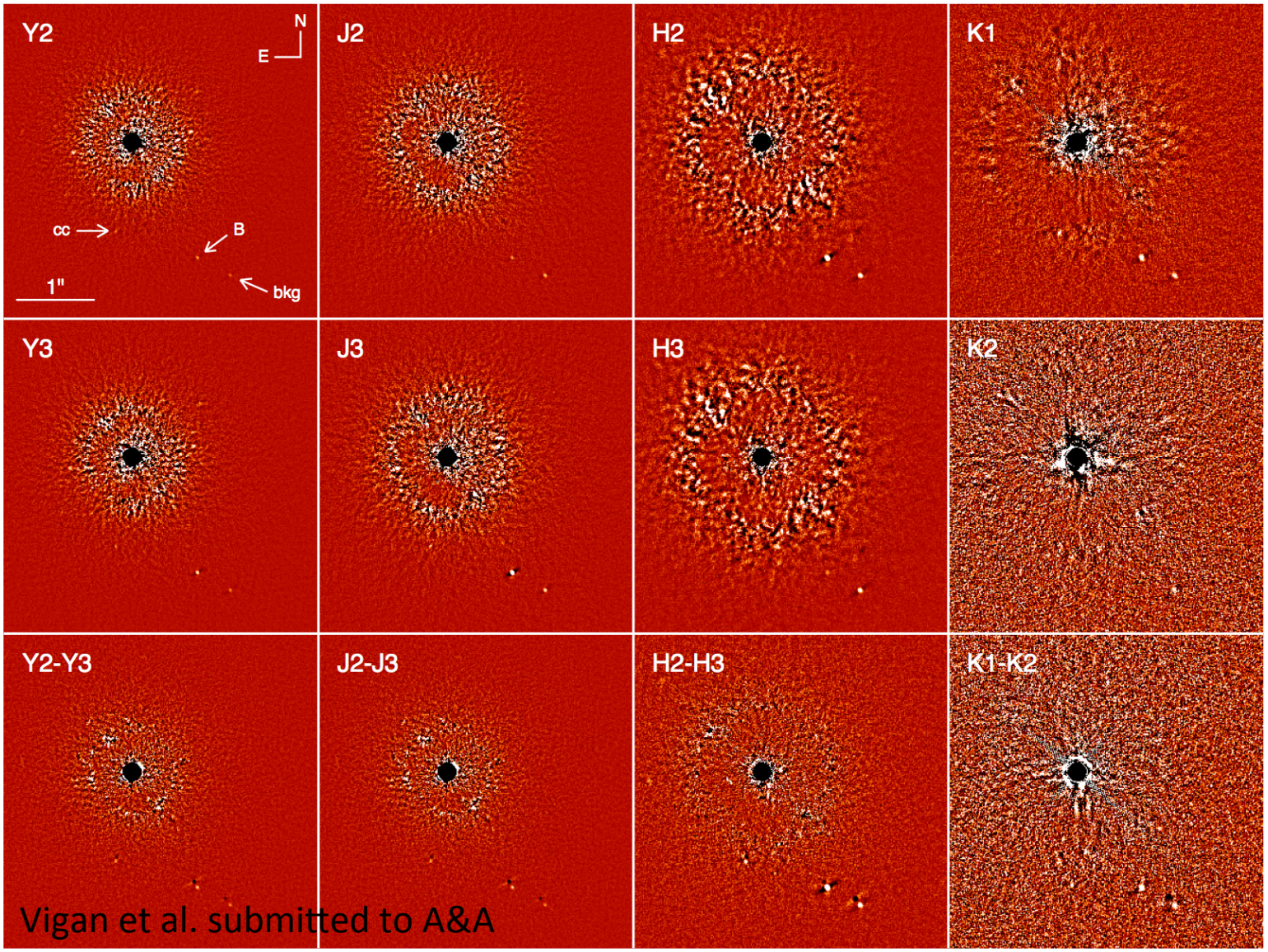
Expansion by a factor 5 expected during the AGB phase → Probe close-in planets

B. Planet searches in dual-band imaging with Irdis

Set of DB filters compared to a young massive giant planet



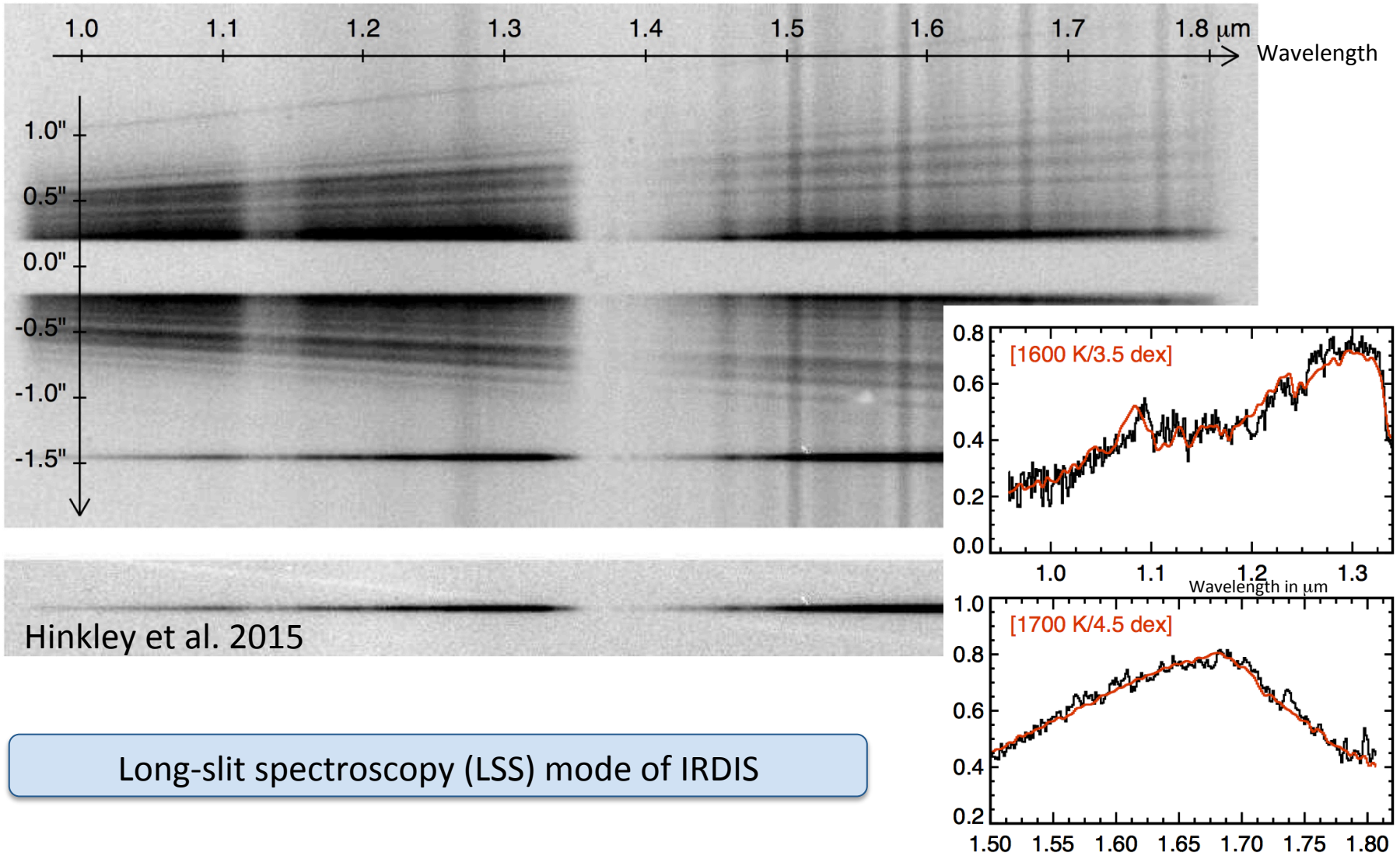
Application on GJ 758



G9V star
5-9Gyr
16pc

Vigan et al. submitted to A&A

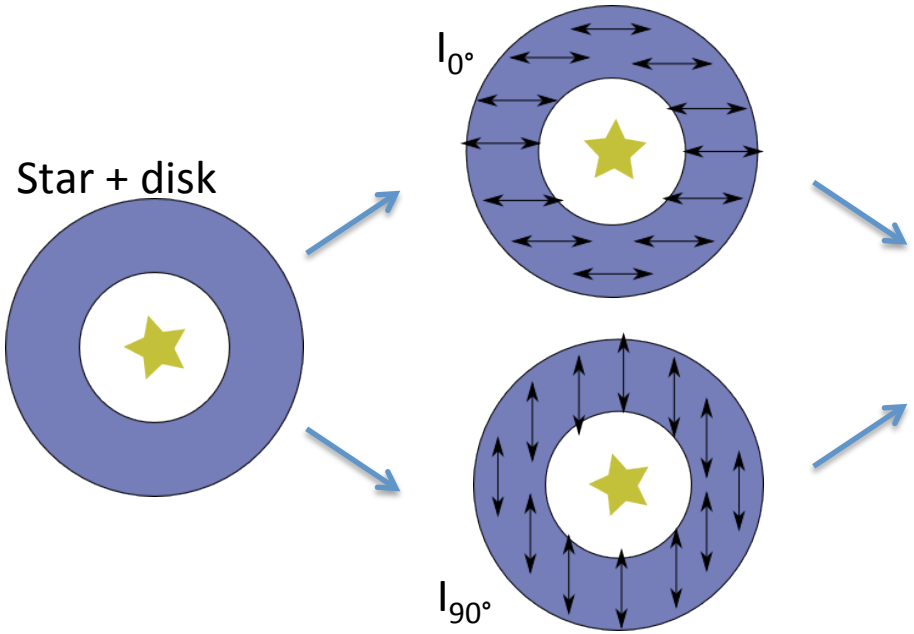
C. One step further: the spectrum of the young companion 2M0122–2439B

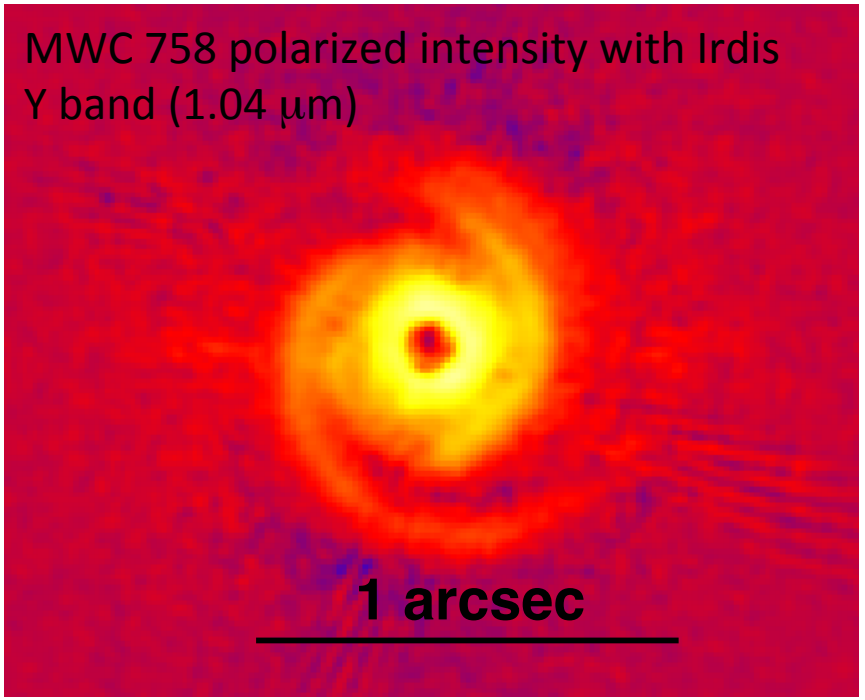


Long-slit spectroscopy (LSS) mode of IRDIS

III. Disk science

A. Polarization: a great tool to detect dust

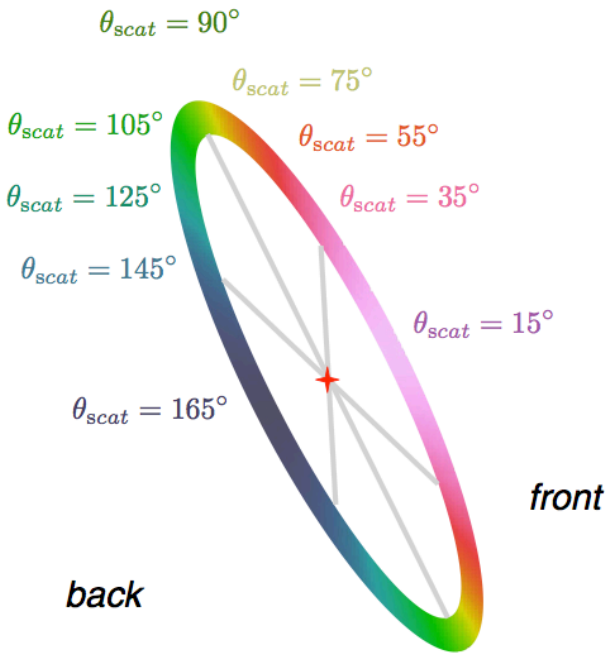


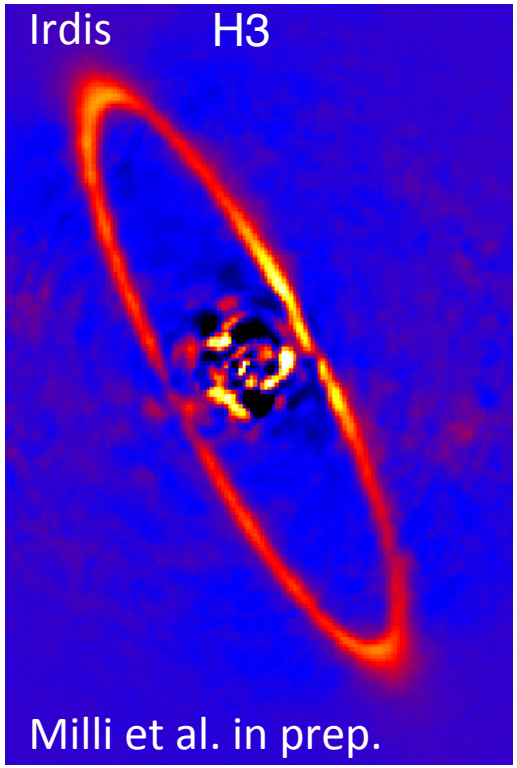


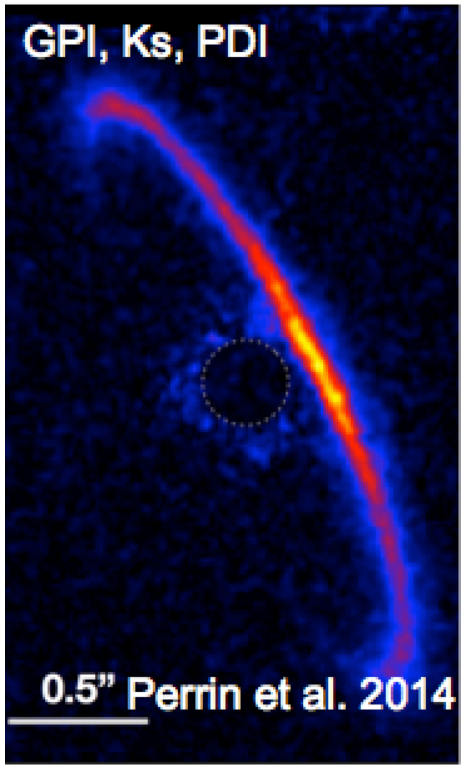
Benisty et al. 2015

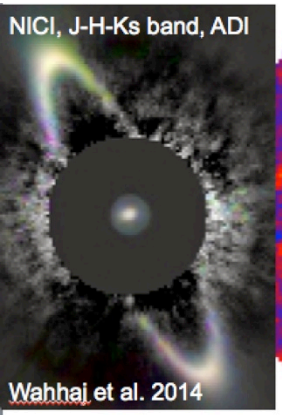
Protoplanetary disk with spiral waves probably potentially launched by embedded planets.

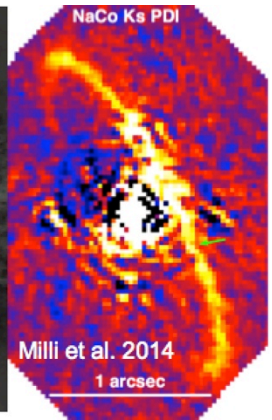
B. Polarization to characterize dust around HR4796











Disk detected entirely, even along the semi-minor axis (0.3'')

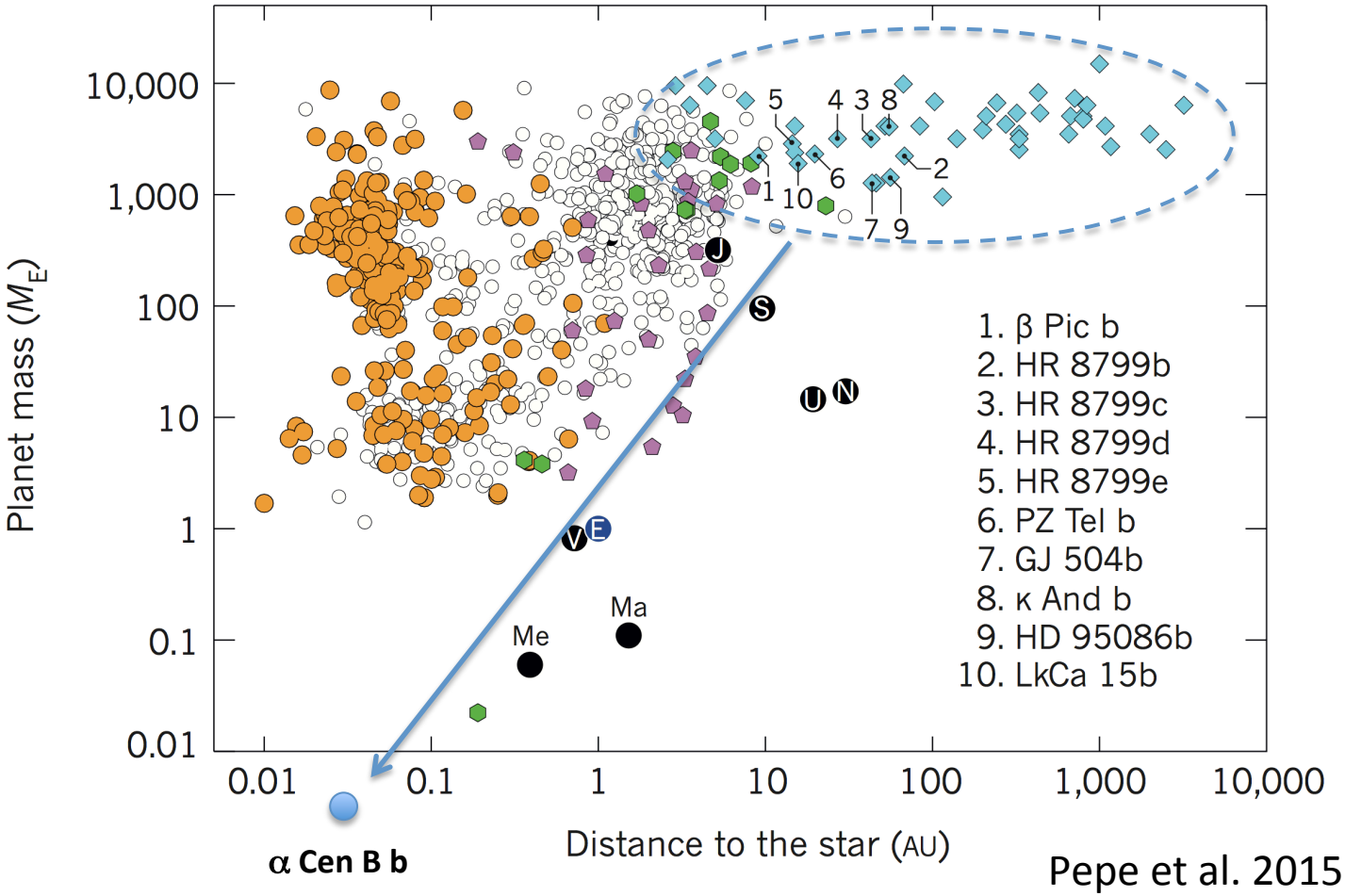
C. Integral field spectroscopy to study dust properties

SPHERE / IFS from Y to J

Milli et al. in prep.

Wavelength dependance of the albedo and phase function

Conclusion: a challenging technique

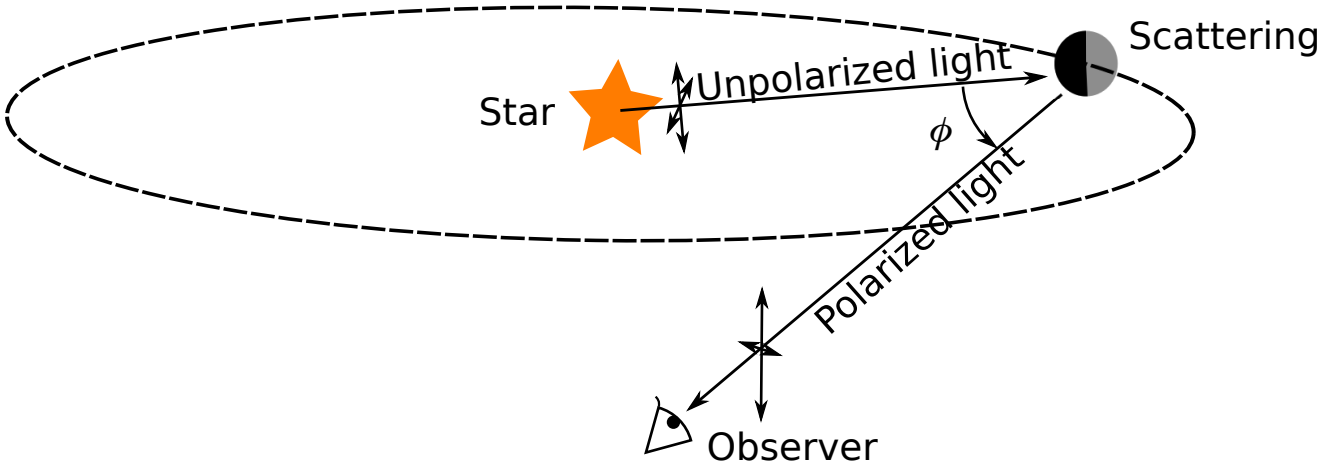


Pepe et al. 2015

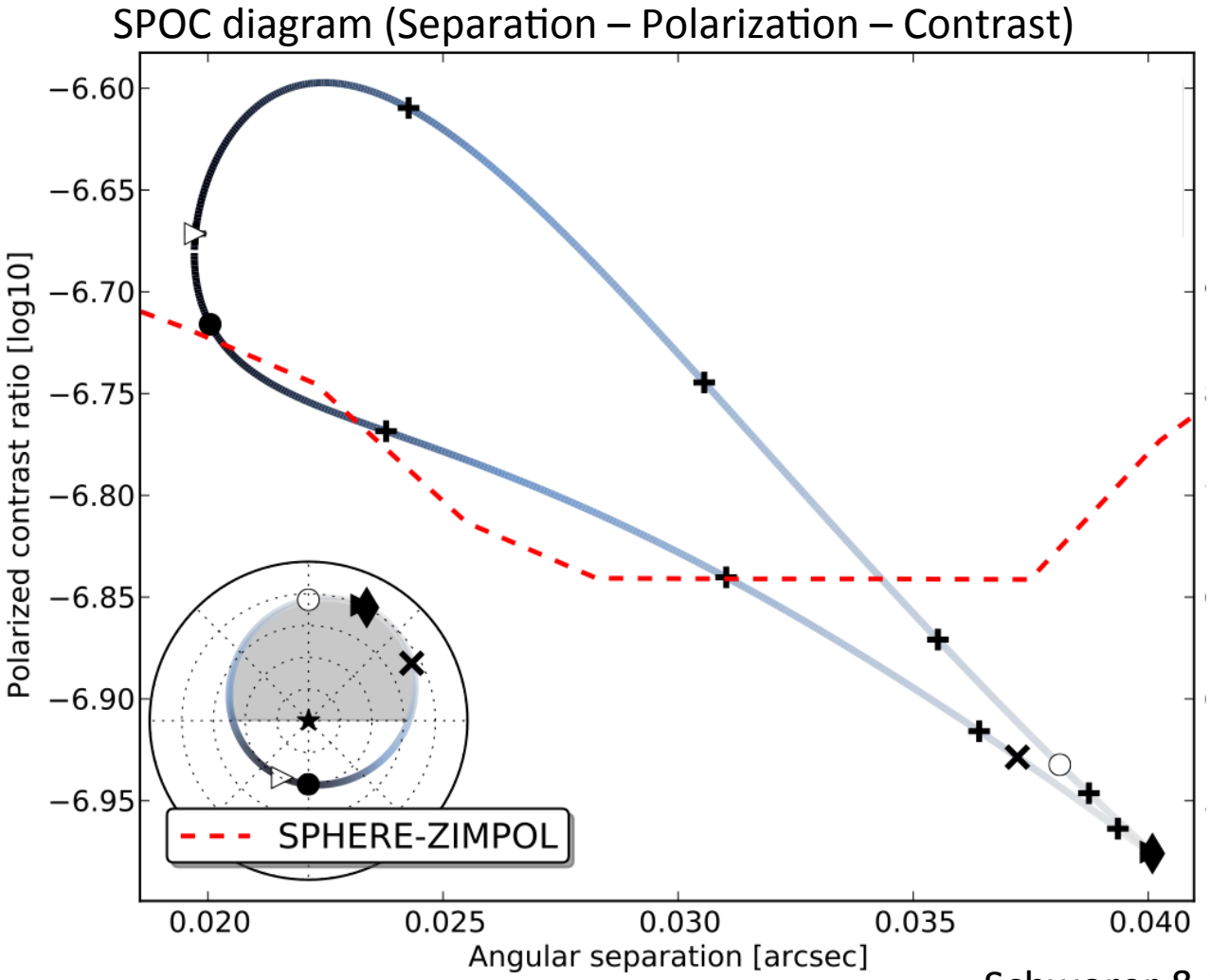
Exciting perspective: planets in reflected light in the optical

Wavelength	550nm	1.6μm
Angular resolution	14mas	42mas
Strehl (Extreme AO)	~40%	~90%

Exquisite angular resolution in the optical but still poor AO correction
→ additional trick to enhance contrast: polarization



The promising case of α Cen B b



Schworer & Tuthill 2015

Exciting discoveries to come !!