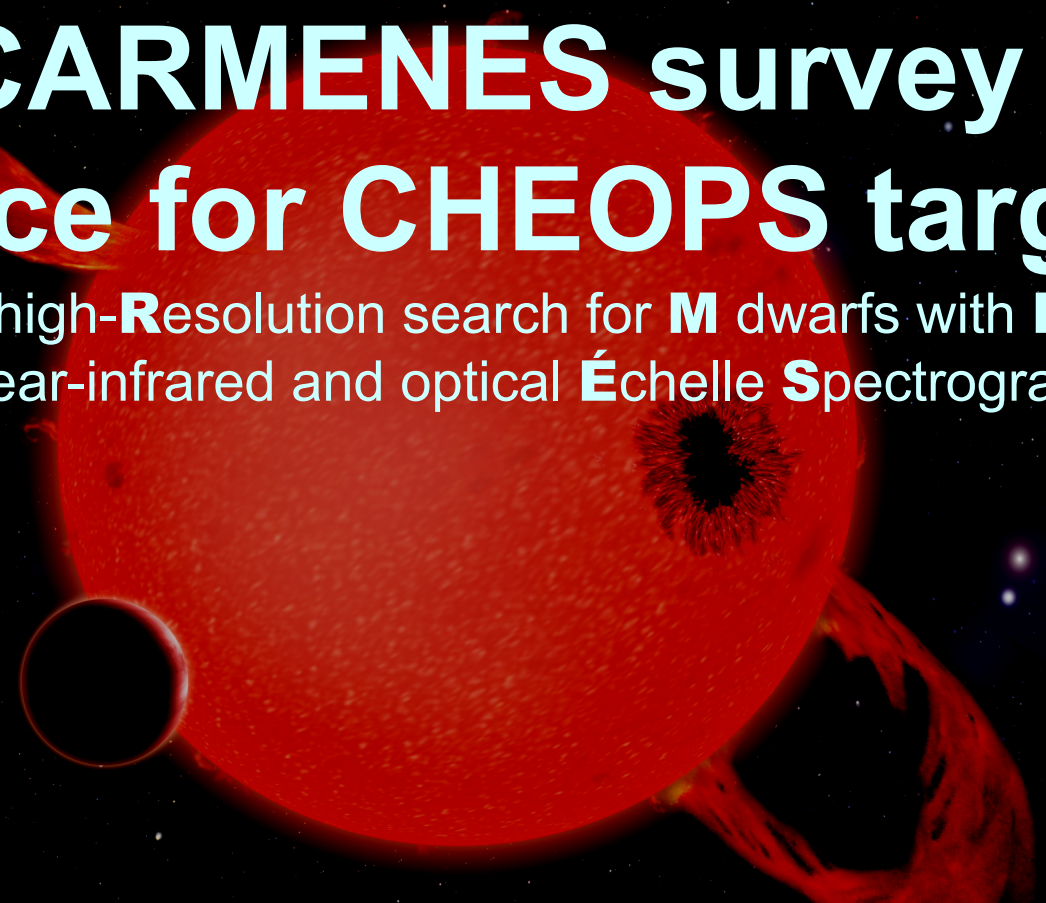
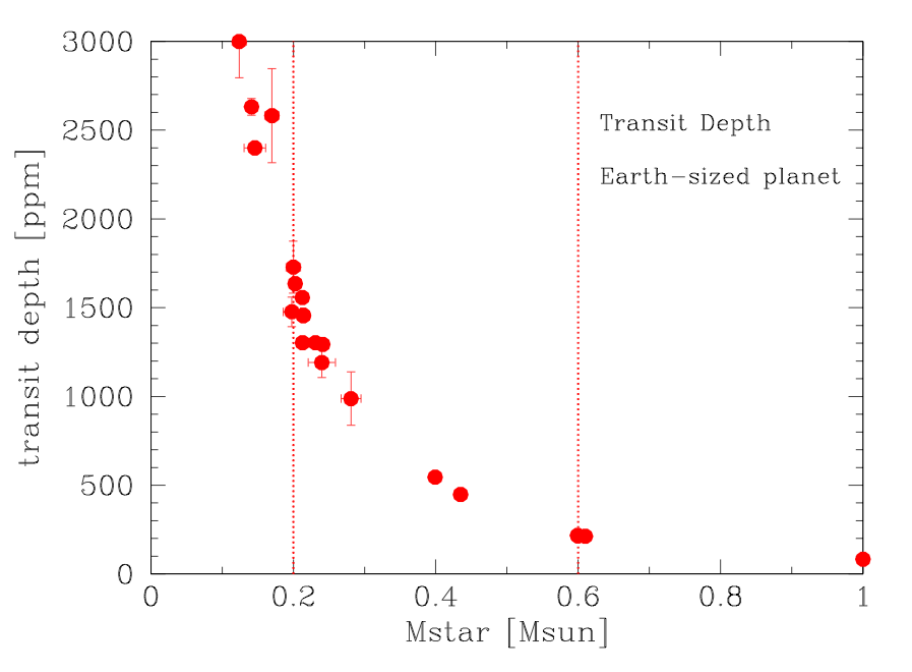
The CARMENES survey as a source for CHEOPS targets

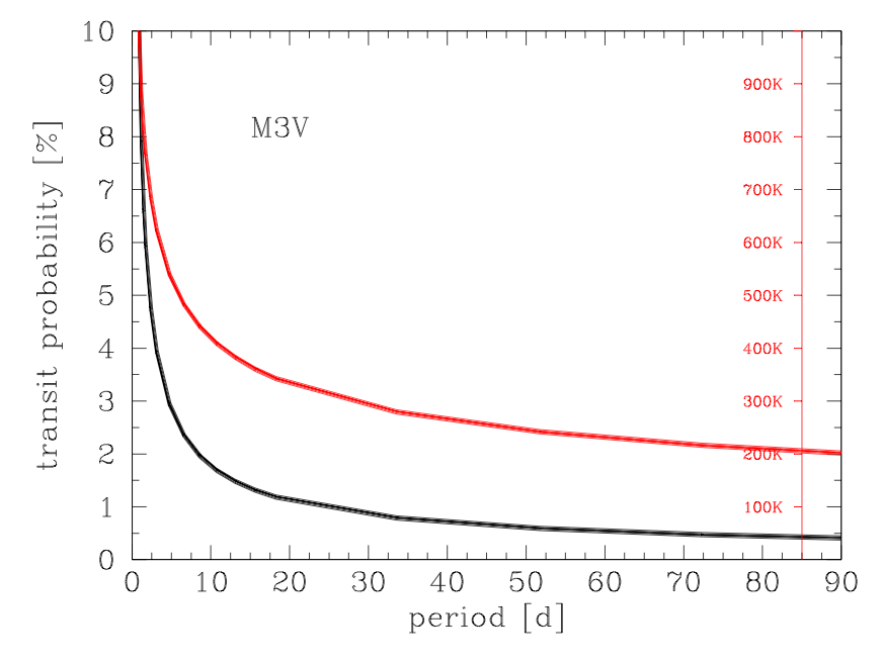
(**C**alar **A**lto high-**R**esolution search for **M** dwarfs with **E**xoearths with **N**ear-infrared and optical **É**chelle **S**pectrographs)



Fike W. Guenther
and thee CARMENES team

Why are transiting planets of M-stars interesting?





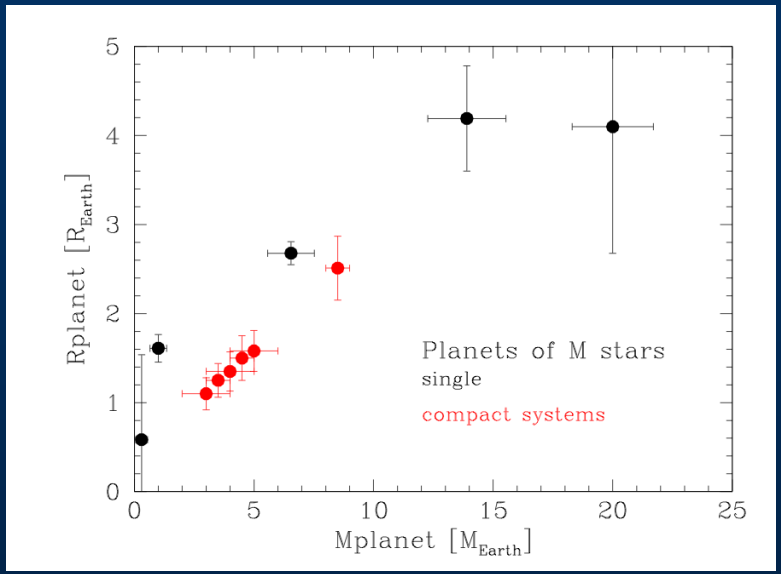
Kepler-445-system: periods: 2.98, 4.87, 8.15 days; radii: 1.6, 2.5, 1.3 R_{earth} --> 2.9% transit probability

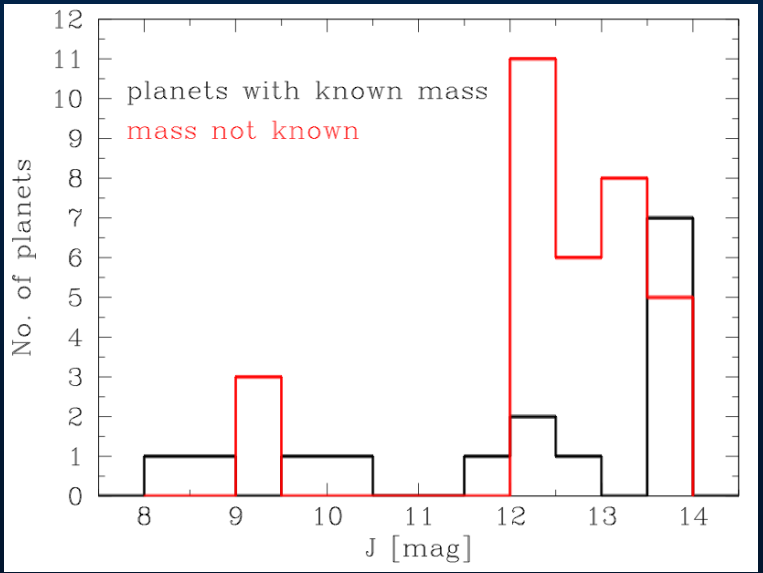
Kepler-446-system: periods: 1.57, 3.04, 5.14 days; radii: 1.5, 1.1, 1.4 R_{earth} --> 4.2% transit probability.

What is known about M-stars planets?

- 21^{+7}_{-5}% of the M-stars have compact systems containing low-mass planets with orbital periods of 10 days or less (Kepler). One out of 100...150 M-stars has a system with at least one transiting planet.

- The masses of 13 transiting planets of M-stars have been determined, and we know of 33 additional ones were the masses still have to be determined. All of them are within the range of CARMENES.

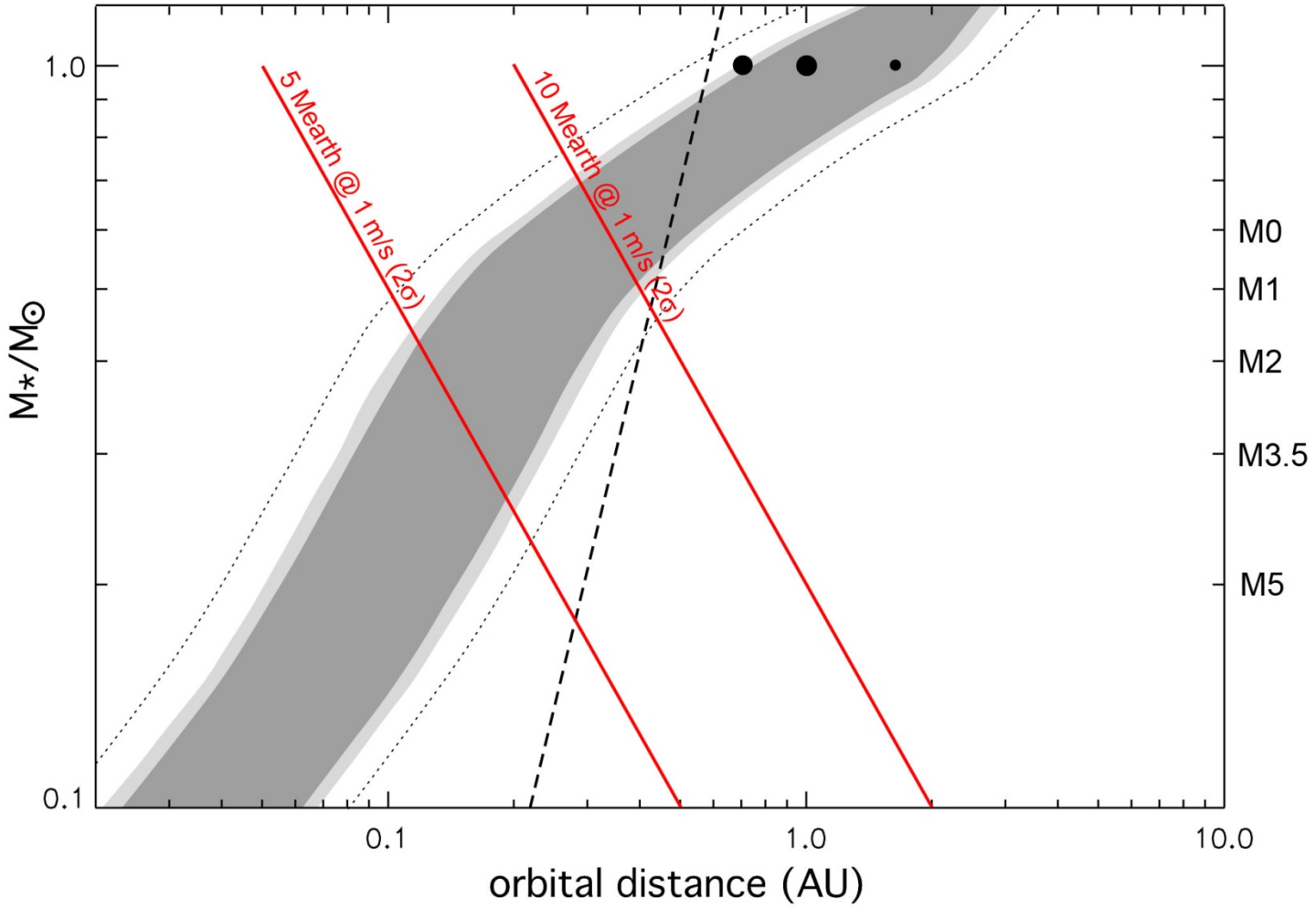




CARMENES sample M-stars:
M0V J<7 (20 pc) ... M5V J<9.5 (10 pc)

Expected performance J=9; S/N=150, 900s

---> 2-3 transiting planets expected.



Brightness of super-Earth with 10 M_{Earth} and 2 R_{Earth} of an M3V star

Star:

J=8-10 (1.25 mm) --> d=10...30 pc

V (550 nm)=11.8-13.8 K (2200 nm)=7.1-9.1 mag

L (3450 nm)=6.9-8.9 N (10300 nm) = 6.9-8.9 mag

Planet:

Molten planet with 1 (2) R_{Earth}: age 30-100 Myrs, Teff=1500 K, ML=15.5 (14) mag; (3000 (750) times fainter than the host star), Tunaca-Horologium association is at a distance of 10-60 pc, age=10-35 Myrs.

Planet with 2 R_{Earth} at 280 K --> MN =14 mag (700 times fainter).

CARMENES, the consortium

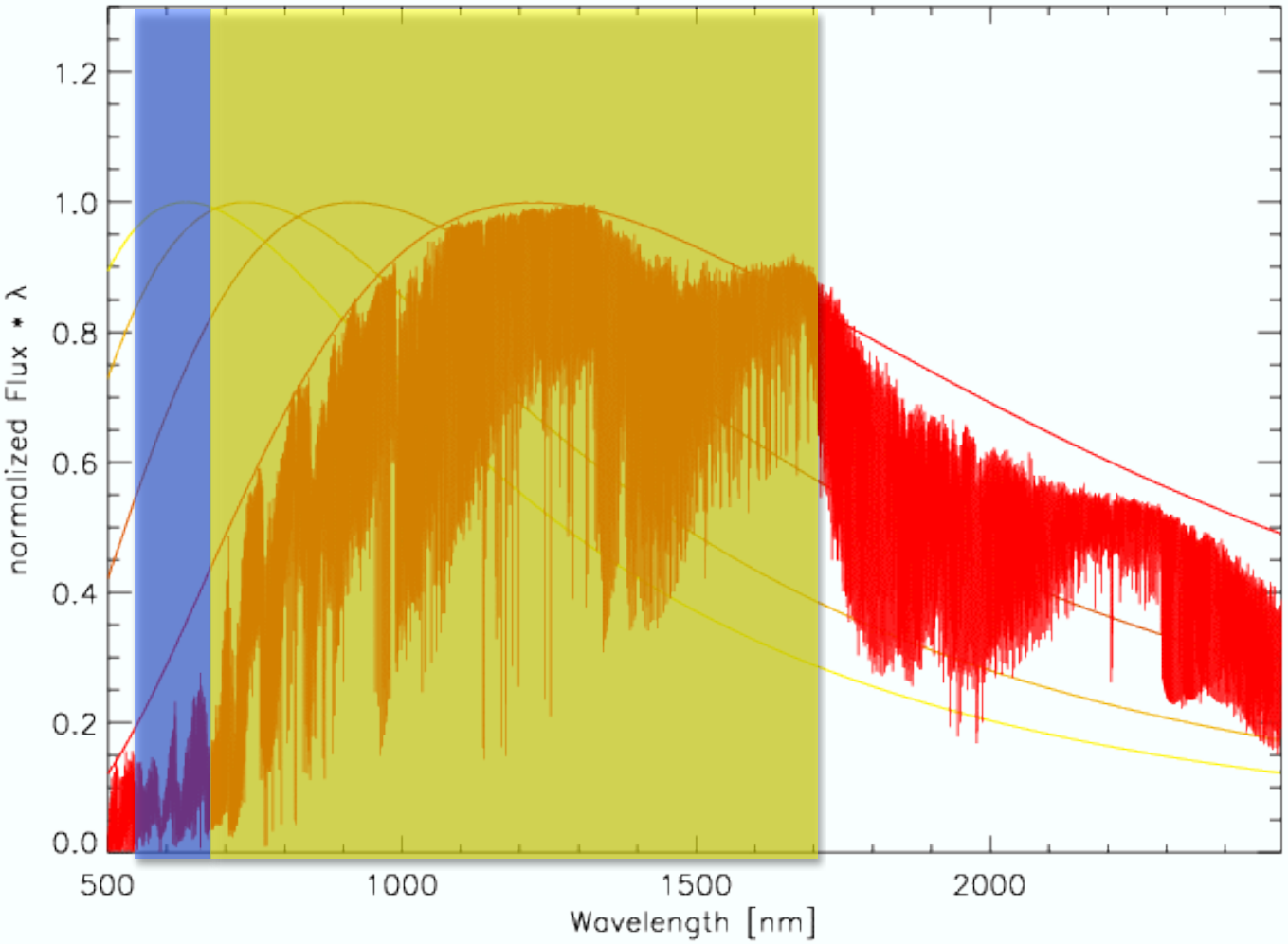
MPIA (Heidelberg) • **IAA** (Granada) • **LSW** (Heidelberg) • **ICE** (Barcelona) • **IAG** (Göttingen) • **IAC** (Tenerife) • **TLS** (Tautenburg) • **UCM** (Madrid) • **HS** (Hamburg) • **CAB** (Madrid) • **CAHA** (50% MPG + 50% CSIC)

Germany + Spain 6 MEUR (hardware)

(the redder, the better)

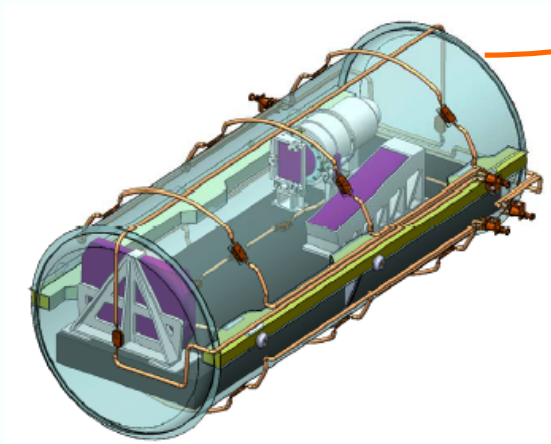
HARPS $\Delta\lambda$ = 533-691 nm

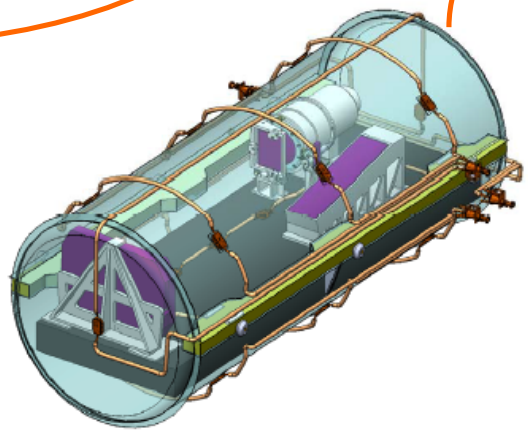
But M dwarfs are faint (and active) in the optical!



CARMENES, the instrument

An optical and a NIR fibre-fed stabilised échelle spectrograph (R=82,000) will be placed into the refurbished and temperature stabilized coudé rooms of the Calar Alto 3.5-m-telescope.





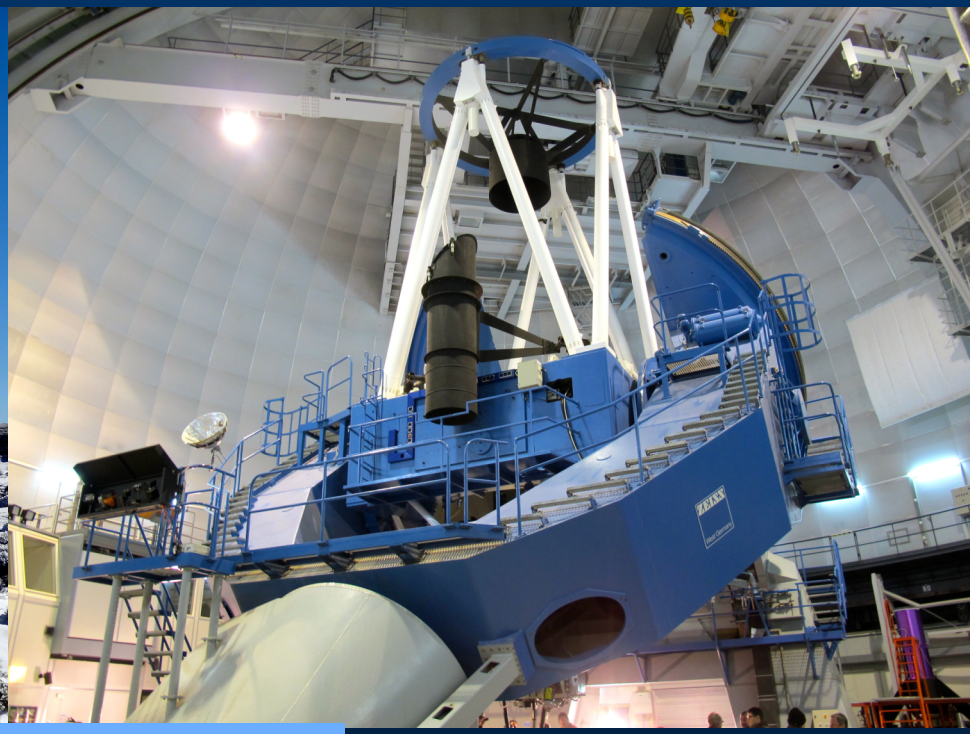
CARMENES, the instrument

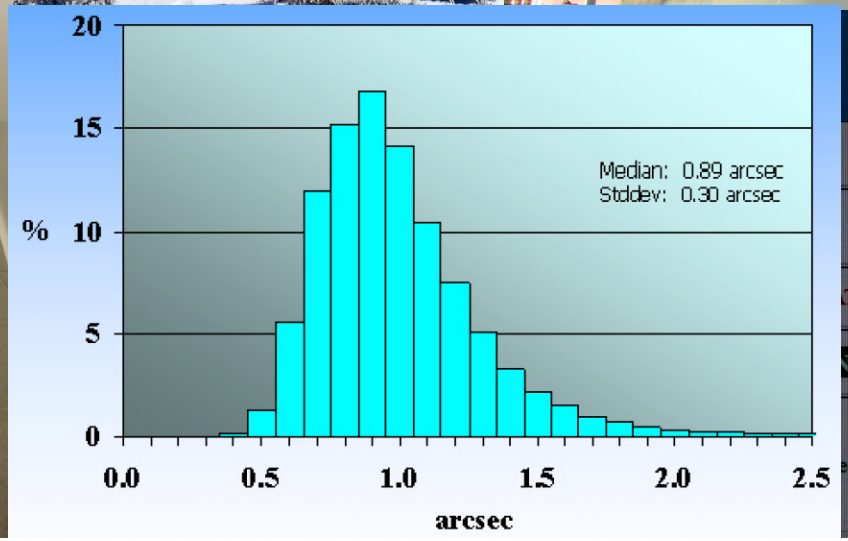
Basic engineering parameters	**NIR channel**	**VIS channel**
Δλ [μm]	0.90-1.70 (29 orders)	0.55-1.05 (53 orders)
Cross disperser	Grism, infrasil	Grism, LF5 glass
Working T [K]	140	295
Detector(s)	2 x 2kx2k Hawaii 2-RG (2.5 μm)	1 x 4kx4k e2v CCD231-84
Calibration λ	U-Ne [F-P etalon]	Th-Ne [F-P etalon]
Optical parameters	Fixed R=82,000*, 2.8-pix sampling (>2.3 pix), 7-pix inter-fibre spacing	

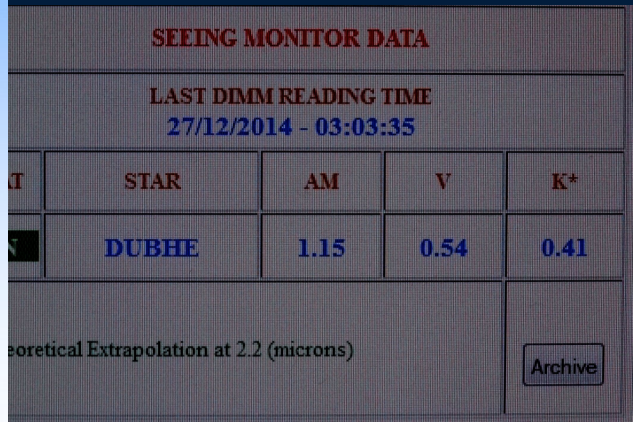
Summary of advantages

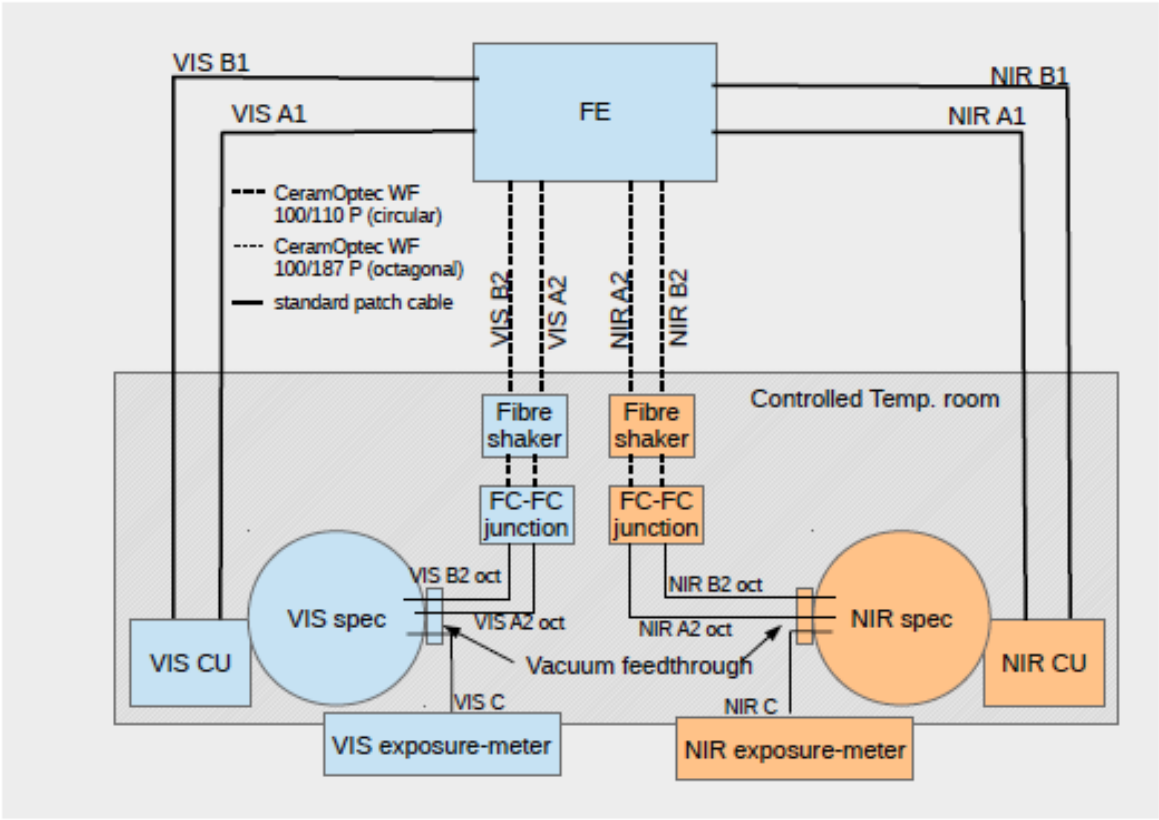
- Simultaneous near-infrared and visible observations.
- Both high resolution and wide spectral coverage.
- Dedication to stable high-precision radial-velocity spectrograph that is optimized for M dwarfs (3 m/s required; 1 m/s goal).
- 600-750 clear nights of guaranteed time if the instrument **finished by Dec 31, 2015.**

3.5-m- telescop@Calar Alto, Andalucía









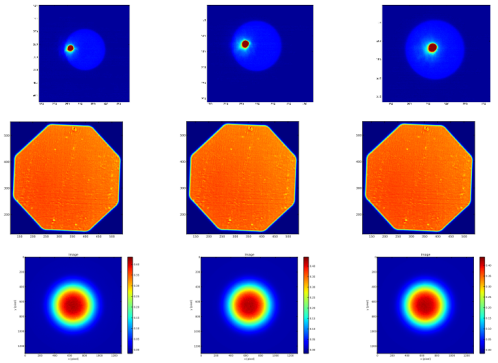


Table 3: Fibre entrance (top row), nearfield (middle) and farfield (bottom) of the 20 m circular - 5,m octagonal fibre splice)

The guiding of the telescopes introduces RV-shifts. The recently developed octagonal fibres reduce this effect by more than a factor 2000.

2 CALIBRATION UNITS:

(“blaues Wunder”, “roter Drache”)

Fabry-Pérot used during the night

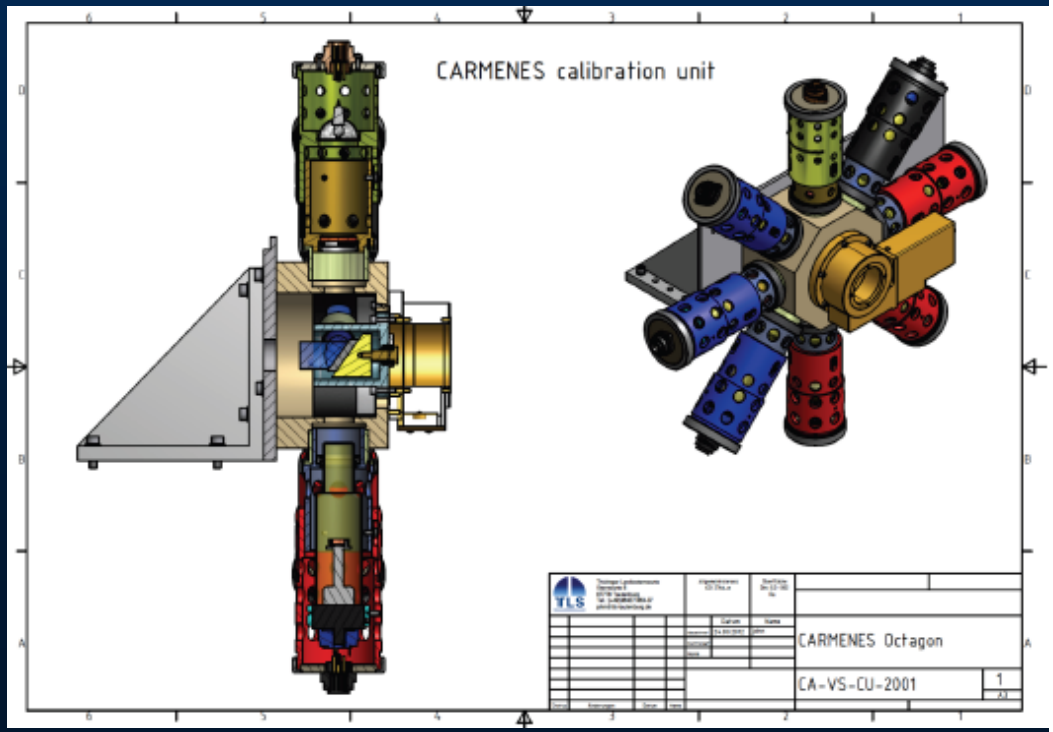
VIS: Thorium-Neon HCL-lamps (scanned with FTS)

NIR: Uranium-Neon HCL-lamps (scanned with FTS)

1 lamp to calibrate Fabry-Pérot every morning/evening

3 master lamps, used about once a week

3 Super-Master lamps, used 2x per year. When not in use stored in tank filled with Neon.



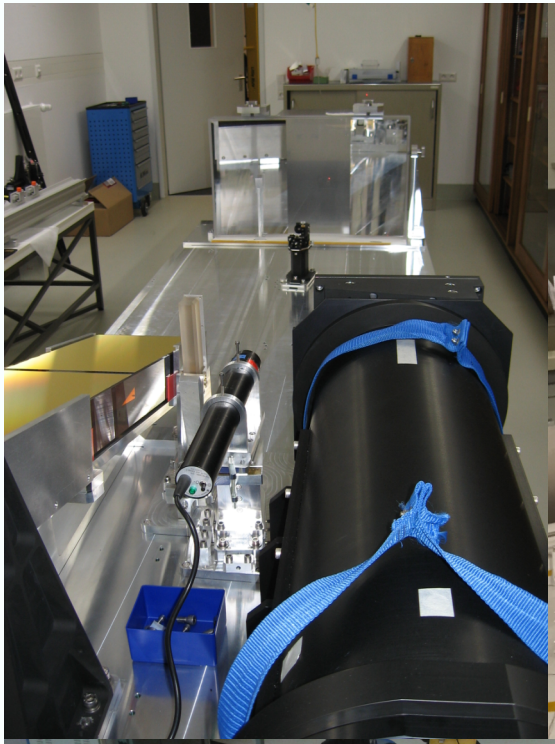
The two vacuum tanks

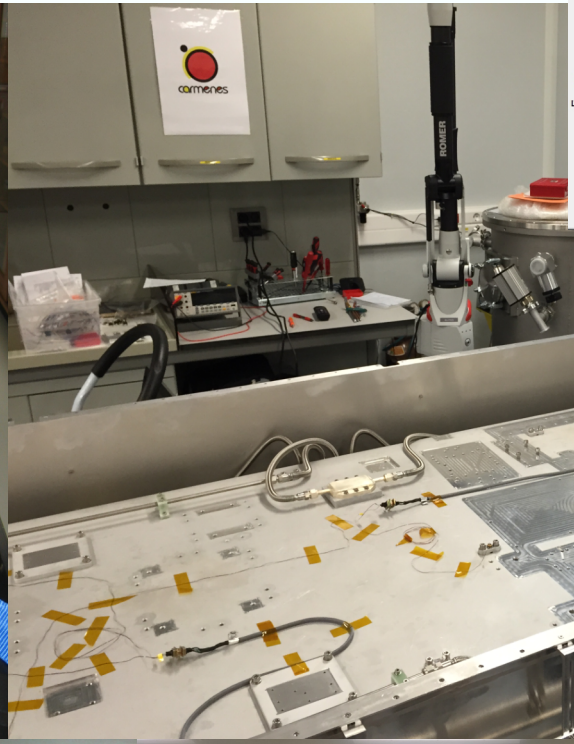
The operating temperatures will be 140 K and 295 K.

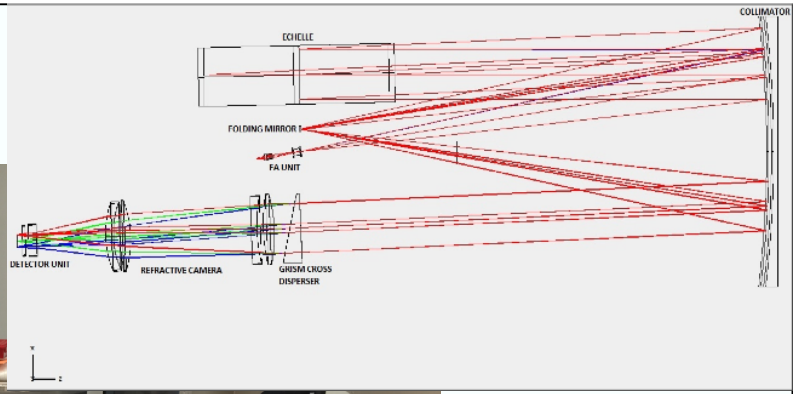
Thermal stability of room: 0.1 K.

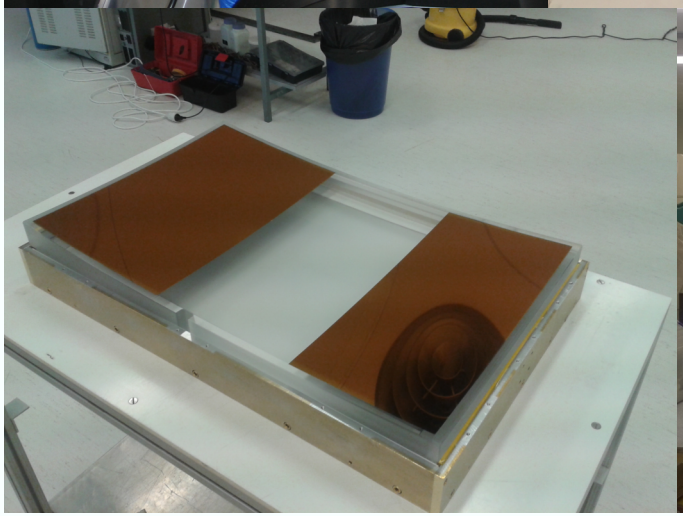
Optics within the tank: <0.01 K

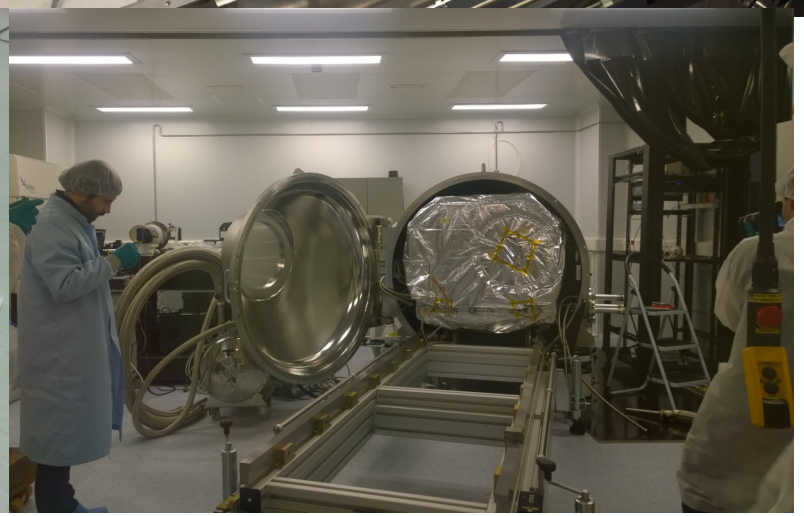
Spectrograph optics







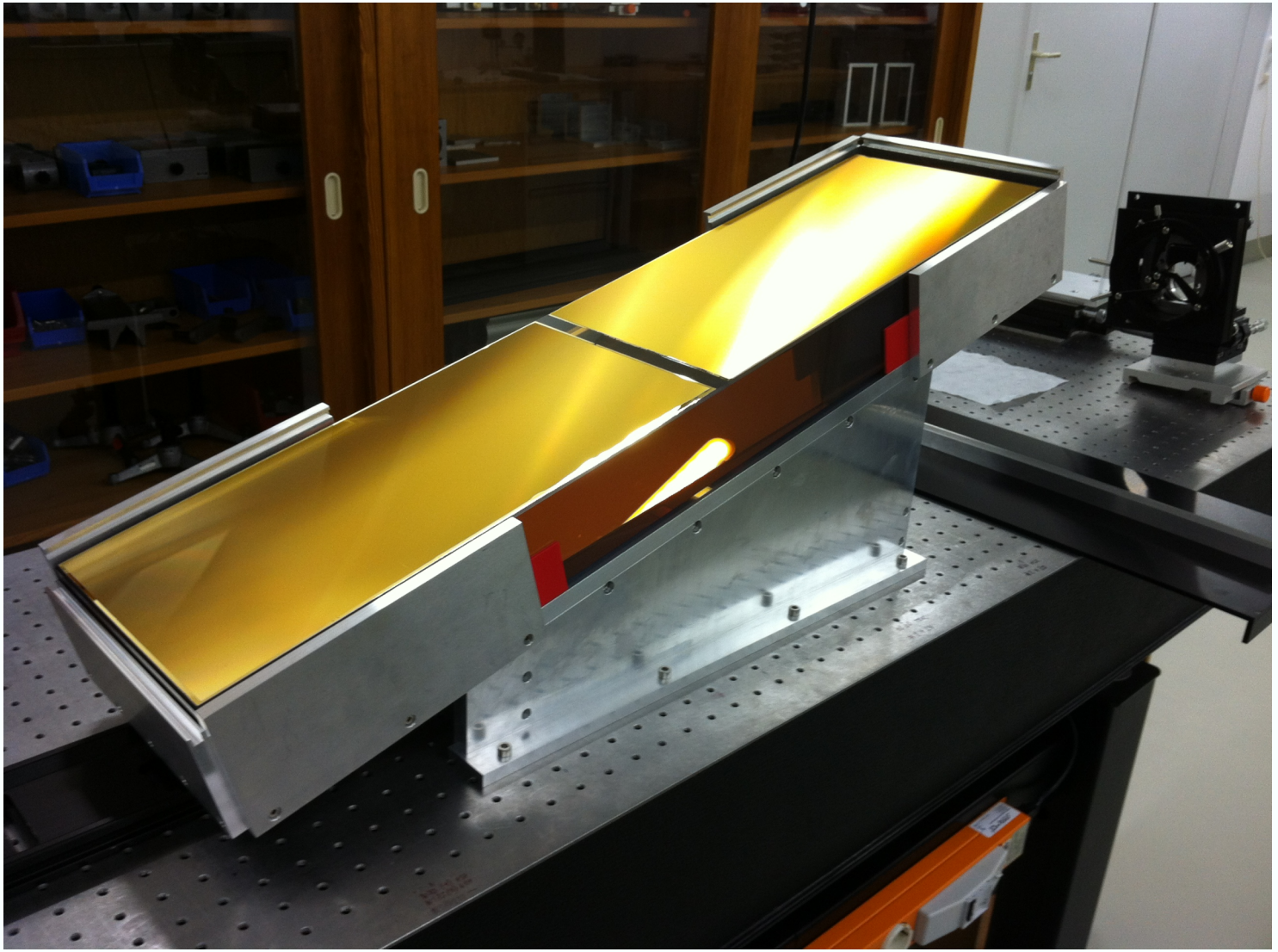




Grating with its mounting

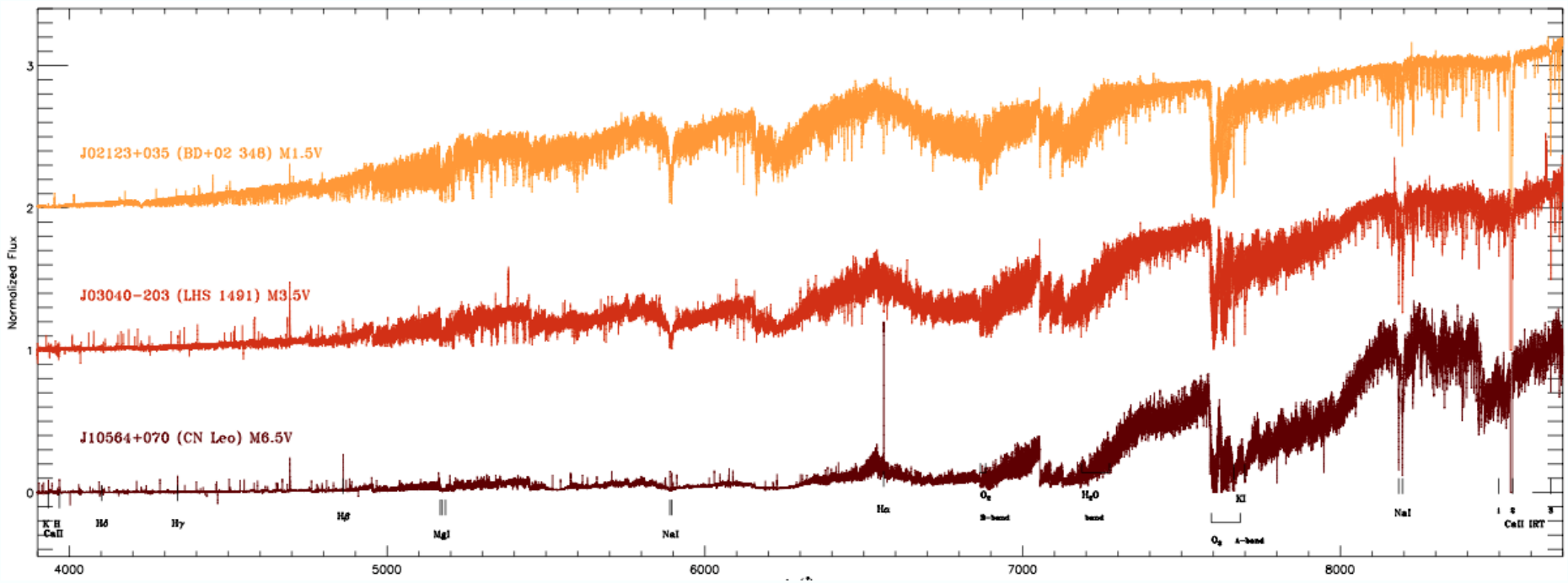
Echelle granting mosaic blazed at 76°, size 214x840 mm,

NIR grating gold coated.



CARMENCITA: preparation

• **High-resolution spectroscopy** (CAFÉ, FEROS, HRS): V_r, *vsini*, other activity indicators, spec. multiplicity (N >1). TLS-Echelle: precise RV-measurements of a few circumpolar M-stars.



http://carmenes.caha.es

(unitedsoundsofcosmos)