ULMF05 proceedings

- PDF files of presentations in web site ASAP !
- Special issue of AN (~220 pages)
- Abstracts and papers in ADS
- Edited by Martin&Magazzu
- Refereed by ULMSFE05 SOC
- Page limits: 6 pages (30 min. talks)
- 4 pages (20 min. talks)
- 2 pages (posters)
- Soft deadline (July 31st)
- Hard deadline (late summer, I guess)

A High Resolution Near Infrared Spectrograph for GTC

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***N** ear*
*Infr **A** red*
***H** igh*
*resol **U** tion*
*spectrogr **A** ph for*
*p **L** anet search*

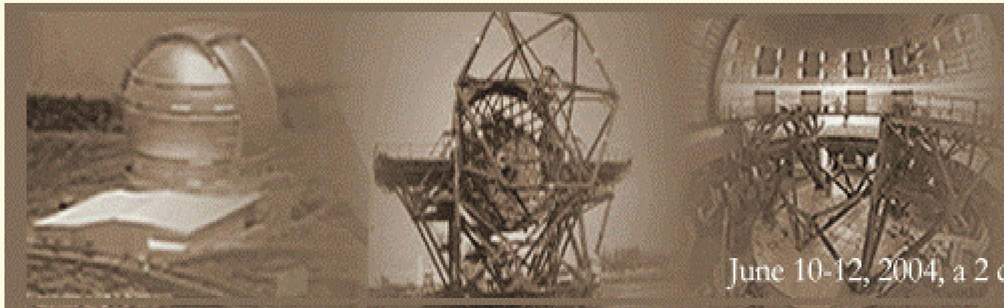
The instrumentation at the GTC

	Optical	Near IR	Mid-IR
Photometry	OSIRIS/ELMER	EMIR*/CIRCE**	CanaCam
L-R Spec.	OSIRIS/ELMER	EMIR* /CIRCE**	CanaCam
H-R Spec.	UES**	**NAHUAL****	N/A
H-R Spa.	N/A	FRIDA*	N/A

- *Second generation instrument.
- ** Visiting instrument.

Possible NAHUAL logos

- Art dept. IAC



First NAHUAL meeting:

A high-resolution near-infrared spectrograph for the GTC

June 10-12, 2004, a 2 day meeting at the Parador Nacional de La Gomera

▷ Home ▷ Logistics ▷ Program ▷ Registration ▷ Participants

MOTIVATION

The GTC is scheduled to start scientific operations in 2006. It will boast the largest aperture of any single optical-infrared telescope in the world. A niche to be covered by the GTC will be sensitive high-resolution near-infrared spectroscopy. The science that will be enabled by such an instrumental capability include: Radial velocity searches for planets around ultracool dwarfs; Radial velocity searches for planets around young red stars; Dynamical studies of protoplanetary disks; Dynamical studies of pre-planetary nebulae stars; Chemical composition of solar-system bodies; Magnetic fields in red objects; Astrosismology of red stars.

NAHUAL (Near-infrAred High-resolUtion spectrogrAph for pLanet hunting) will be a high-resolution (R~100,000) near-infrared spectrograph for the GTC. A 2.5 day meeting is planned to bring together international scientists interested in high-resolution near-infrared spectroscopy in order to lay down the basic concept of NAHUAL and prepare a scientific case for it.

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High Spectral Resolution in the Near Infrared
Why is it important?

- The low mass stars and brown dwarfs of spectral type M, L (2200-1400 K) and T (1400-700 K) emit most of their energy at NIR wavelengths.
- The RV accuracy is expected to improve when searching for planets around young stars and ultracool dwarfs in the NIR.
- The line broadening due to magnetic fields scale with lambda^2.
- IR lines probe different parts of the stellar/substellar atmosphere.
- High z gamma ray burst are bright in the NIR.

The NAHUAL Scientific Case

The driving idea:

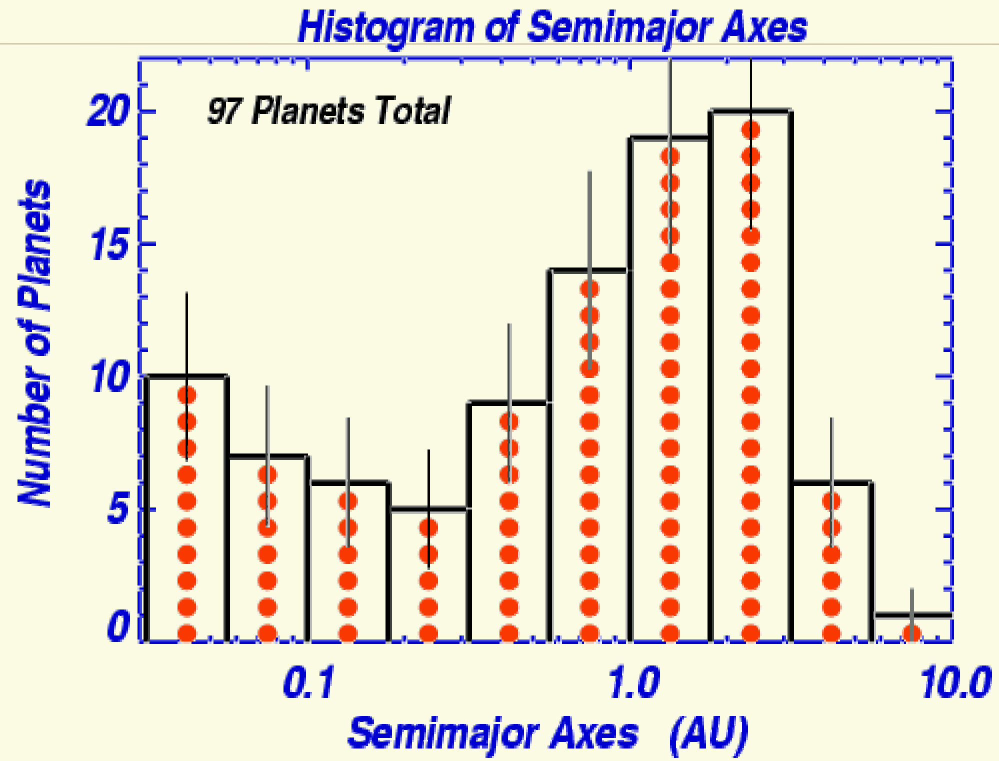
- Detection of exoplanets using the radial velocity method in the NIR

Other important goals:

** ASTROBIOLOGY

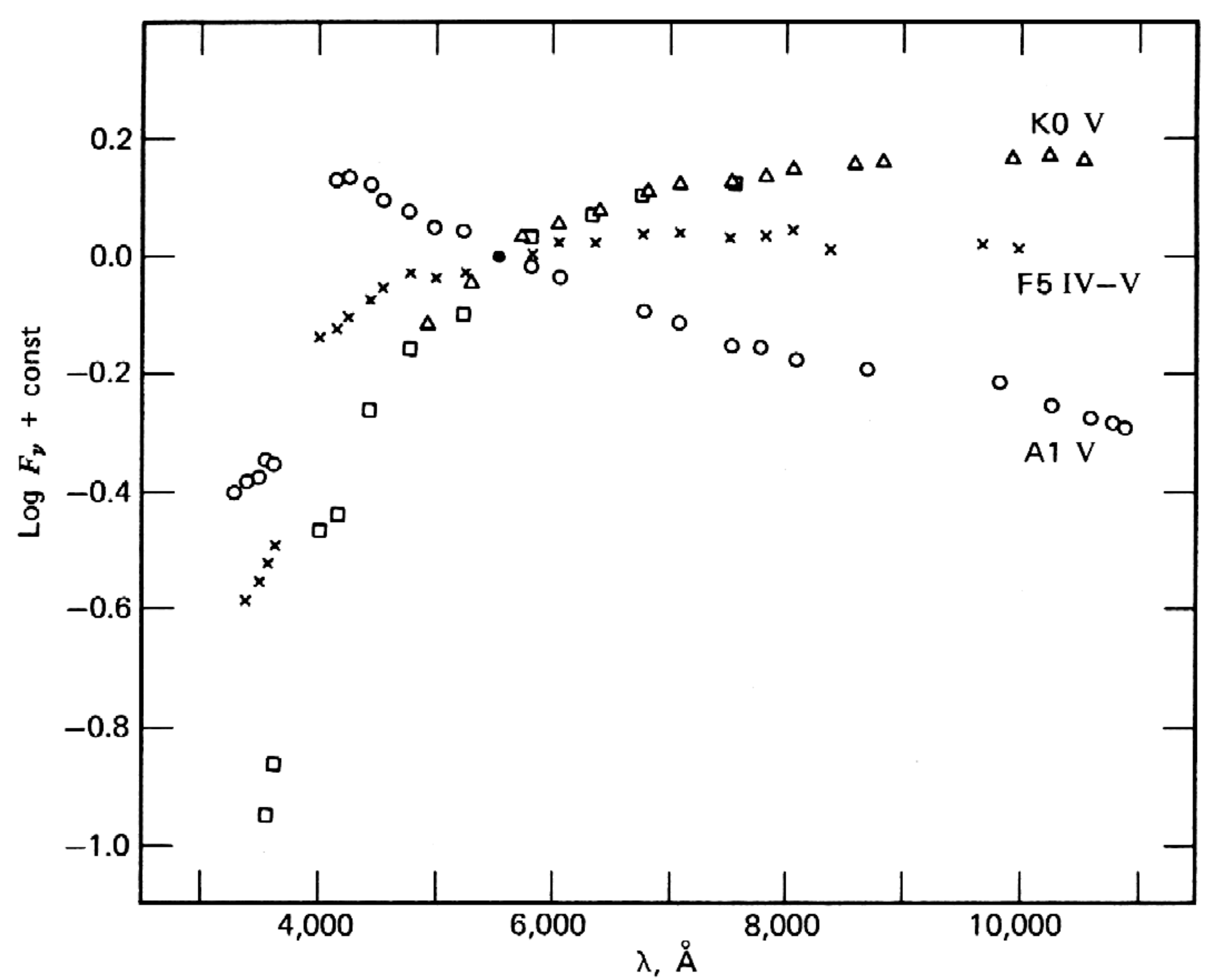
- Chemical abundances in cool stars
- Activity and magnetic fields
- Circun(sub)stellar disks
- Ultracool dwarfs
- Astroseismology
- High-z gamma ray bursts

RV-surveys:semimajor axis distribution



How does this distribution depend on primary mass ?

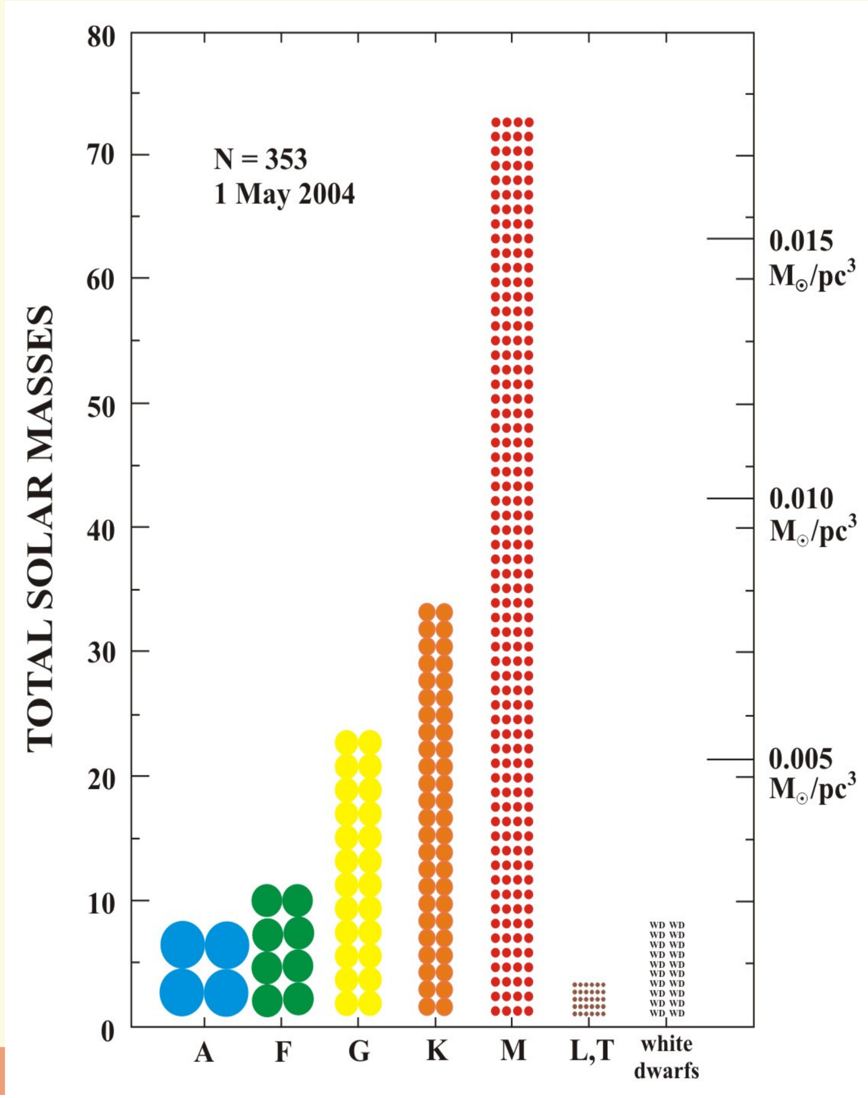
Benefits from the IR: cool stars



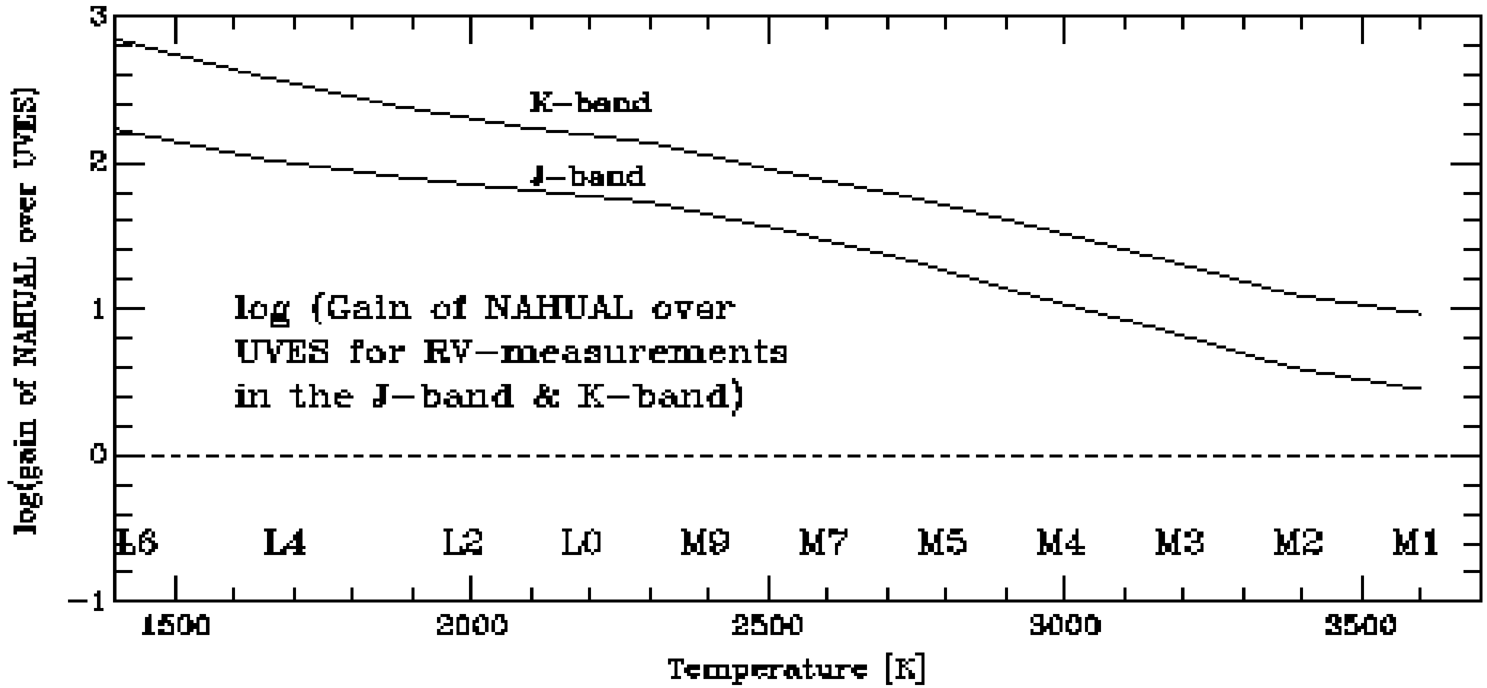
Flux gain

Martin et al. 2005, RevMex AA

The 2004 census of the solar neighborhood

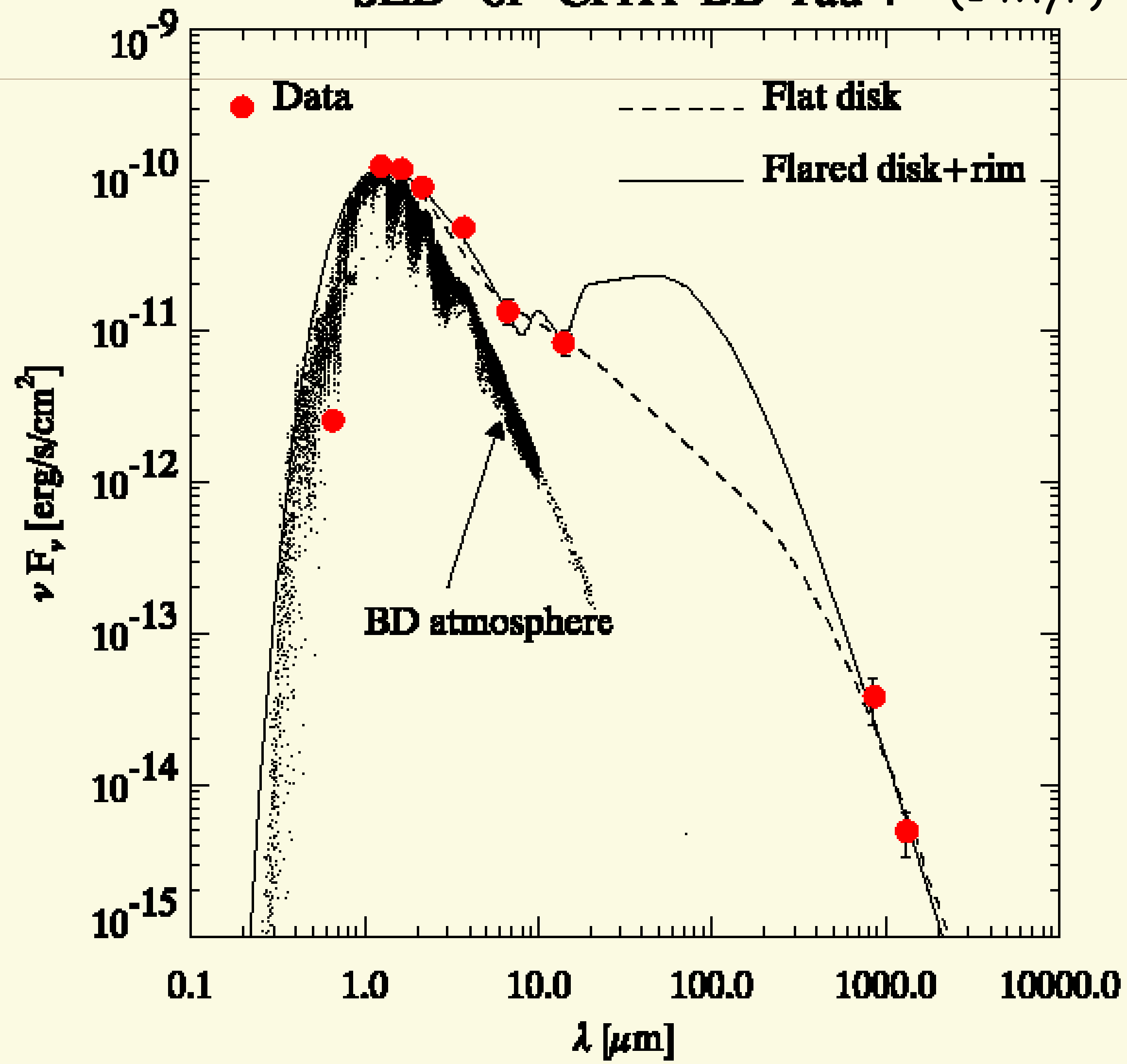


The IR advantage: Exoplanets

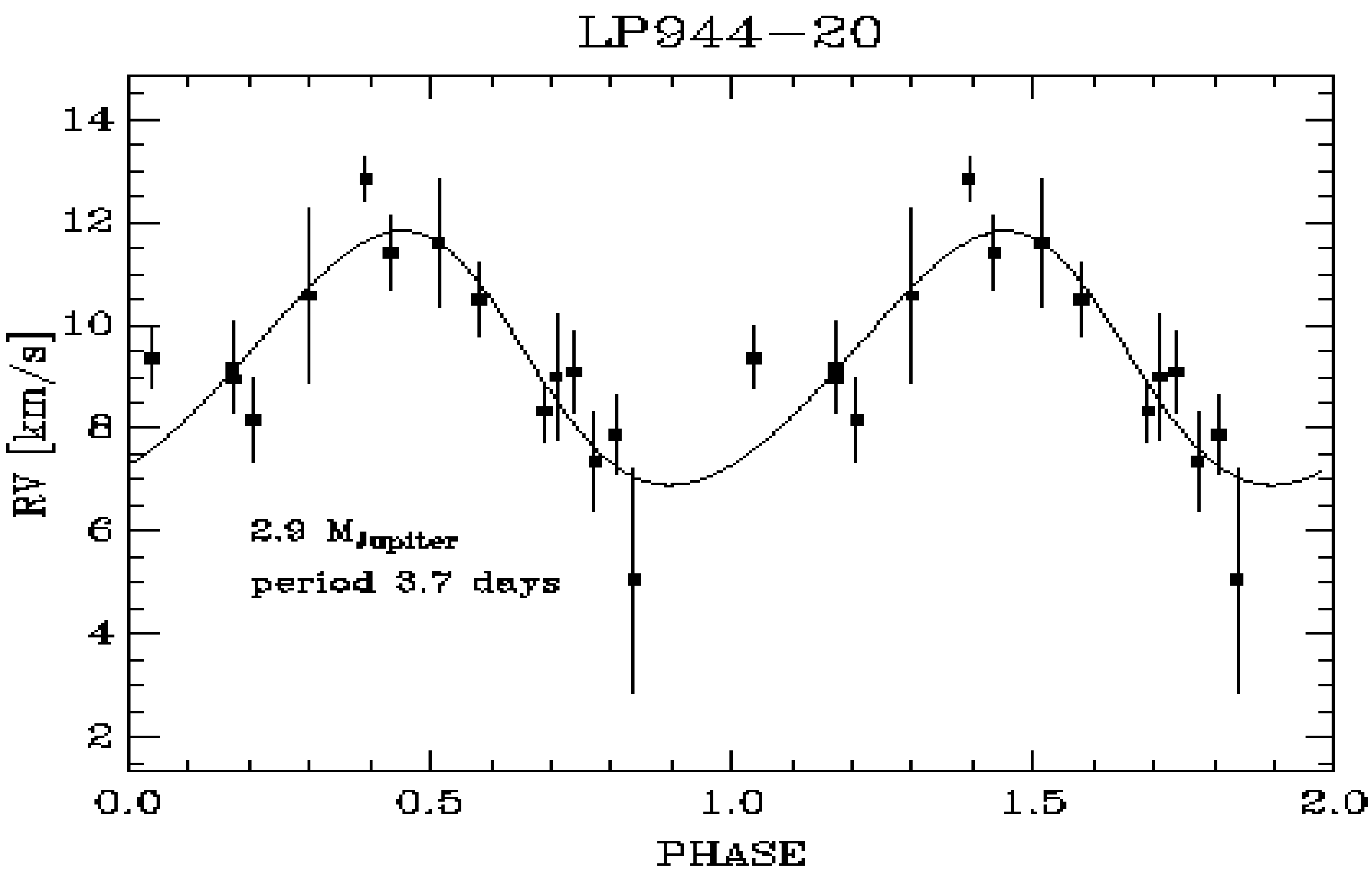


Discs around young brown dwarfs

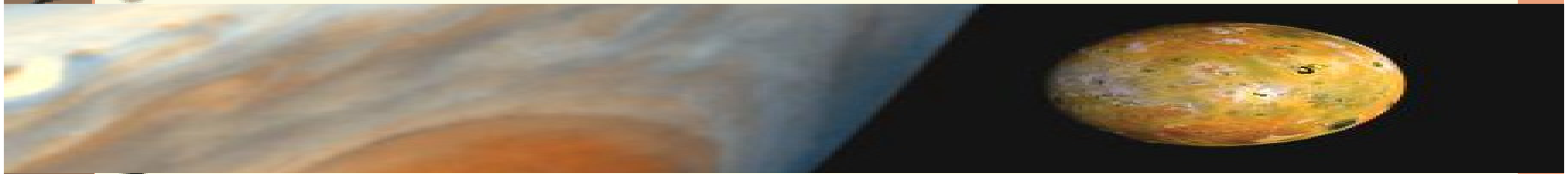
SED of CFHT-BD-Tau 4 (1 Myr)



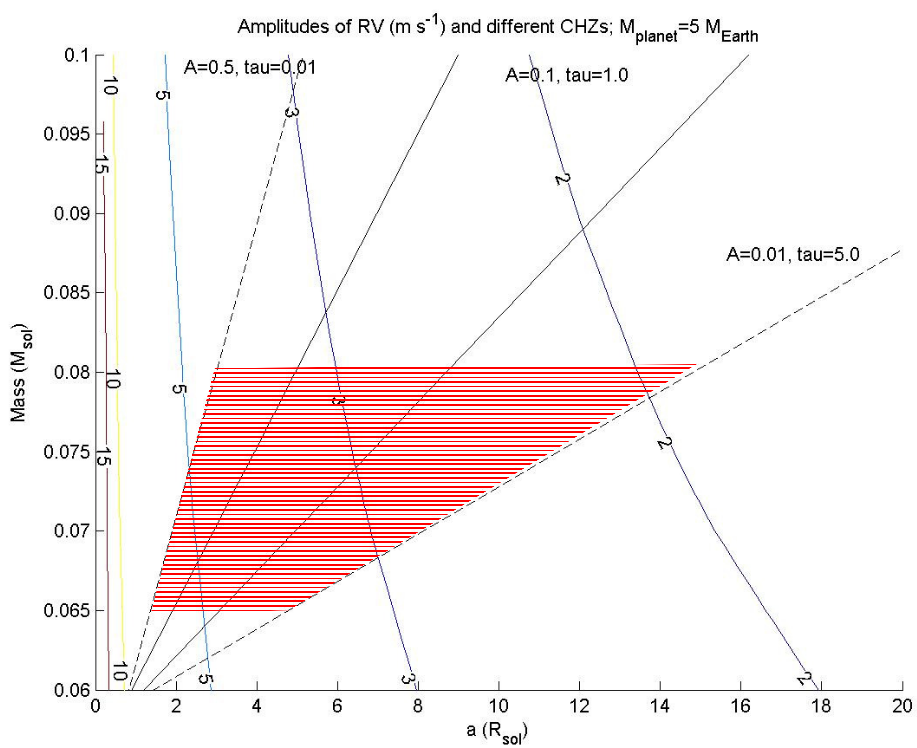
Planets around brown dwarfs:



Habitable zones around very low-mass dwarfs



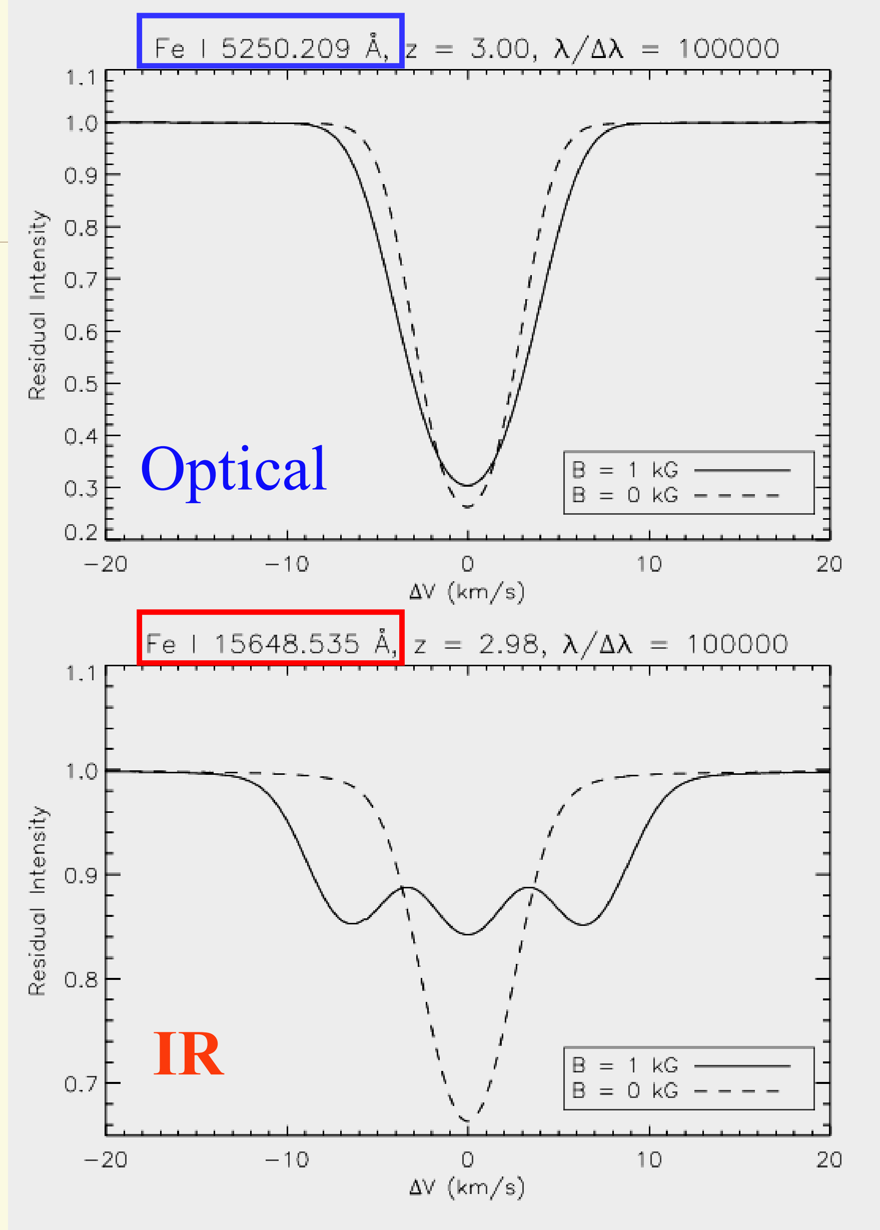
- Primaries with masses 0.1- 0.065 M_{so}
- Periods from ¼ to 8 days.
- Massive teluric planets (2-10 $M_{\oplus}$) give radial velocity amplitudes K_1 from 2 to 18 m s^{-1}



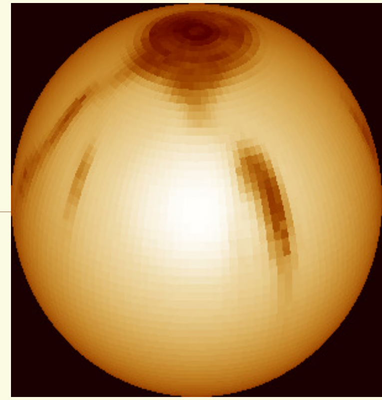
Benefits from the IR

- Spectral lines are less blended in the infrared. Hence, line profile variations are more clearly detected
- The Zeeman effect is enhanced for lines in the IR $\left(\propto \lambda^2\right)$
- Radiation flux and pulsation amplitudes increase with increasing wavelength for cooler stars.
- IR lines can probe different parts of the atmosphere.
- High-z events are better observed in the near-infrared.

The IR advantage: Magnetic Fields



Active stars:Science goals



- Dynamo geometry
  - Solar-like or something different?
  - Polar spots and active belts
- Spot structure
  - Resolved or not?
- Differential rotation and meridional flows
- Lifetimes of individual spots and active regions
- Stellar “butterfly diagrams”
- Different stellar types
  - Pre-main sequence stars
  - Young main-sequence stars
  - Subgiants and giants

Gamma ray bursts

- Titanic explosions related to SN.
- All-sky GRB event rate determined by BATSE = 1300 per year.
- 1 burst per month with $K<15$
- 2-3 hour response time.
- Optical spectroscopy impossible for $z>5$ because of Lyman drop-out.
- Some afterglows are affected by dust.

Scientific and Technical Requirements

- ***Cross-dispersed echelle*** design => wide spectral coverage
- Located at the ***AO Nasmyth focus***.
- Short and long term radial velocity ***accuracy of 1 m/s***.
- Spectral range: ***0.8-5 microns***.(0.9-2.4 microns for exoplanet work)
- Spectral resolution: ***40,000*** and ***100,000*** in natural seeing or AO modes.
- Monitoring of stability of position of star on slit using a wavefront sensor infarred adquisition camera. ***Stability requirement of 10%*** of the slit width.
- ***Image rotator*** to align slit with paralactic angle.
- Customized ***software packages*** for data reduction and radial velocity analysis
- ***Slit wheel*** to change from AO to non-AO modes.
- Slith length 10 times larger than slit width. ***Nodding*** along the slit.
- ***K(limit) = 17*** in natural seeing (16 in AO) for 10 S/N in 1 hour.

Other considerations

- ***Polarimetry*** mode.
- Imaging mode
- Long slit mode.
- Multiple-object mode

The financing and the Schedule

-2004 – First NAHUAL meeting in La Gomera

-2005.- Feasibility study and second meeting (Segovia)

-2006 – Funding proposals

- Goal: First light at the GTC in 2009

Conceptual optical design

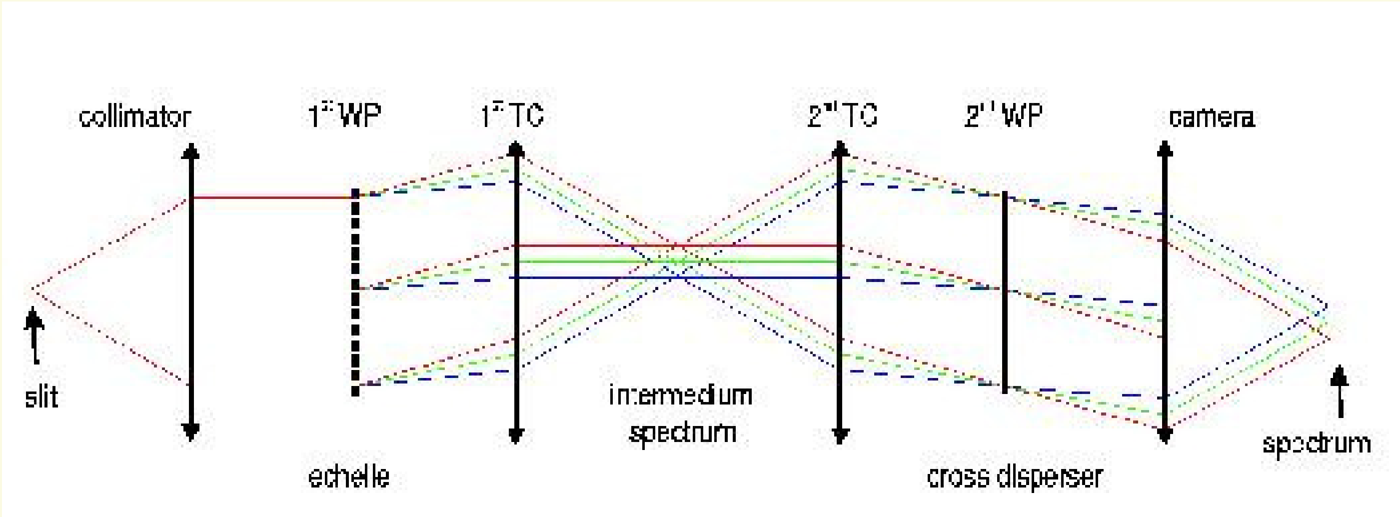
- Two arms: one covering from 0.8 to 1.3 microns (2 Rockwell 2k detector), the other covering from 1.3 to 5 microns (Rockwell 4k detector).

Strawman two arm design

Blue arm design

- 2 x 2048x2048 Rockwell detector
- 18 microns pixels
- 40 mm x 40 mm device
- R2 grating, constant = 31.6 gr/mm, blazed at $\alpha_B=63^o$
- A resolving power of R=100,000 is obtained for a slit width of 0.16 arcsec.

White pupil optical design



Three mirror camera

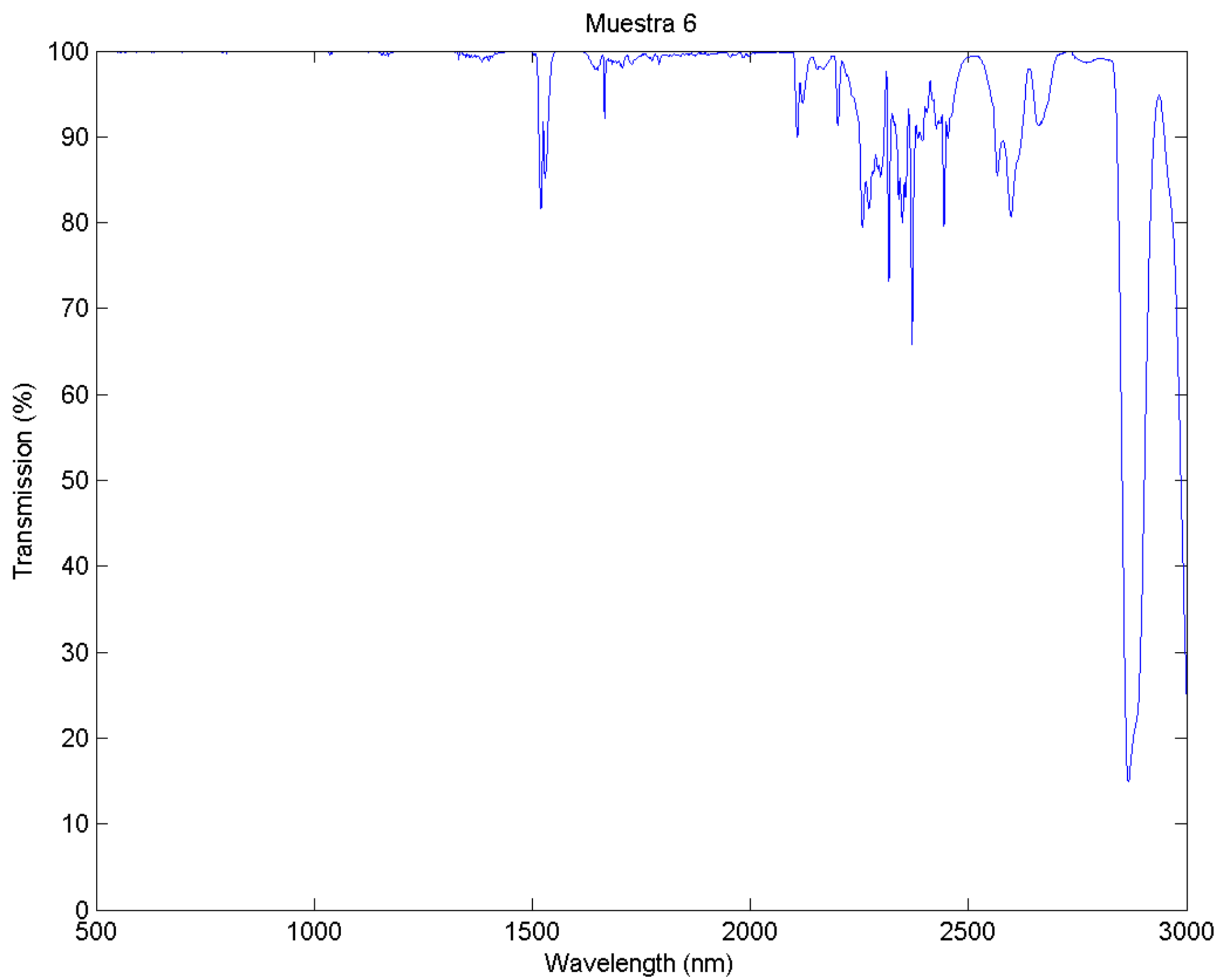
- Beam size 200 mm.
- F-ratio of echelle camera = 4.6.
- Focal length of camera = 918 mm.
- FOV=80x40 mm
- Wav. Range=0.8 – 1.35 microns
- Excellent spot concentration

Rough budget

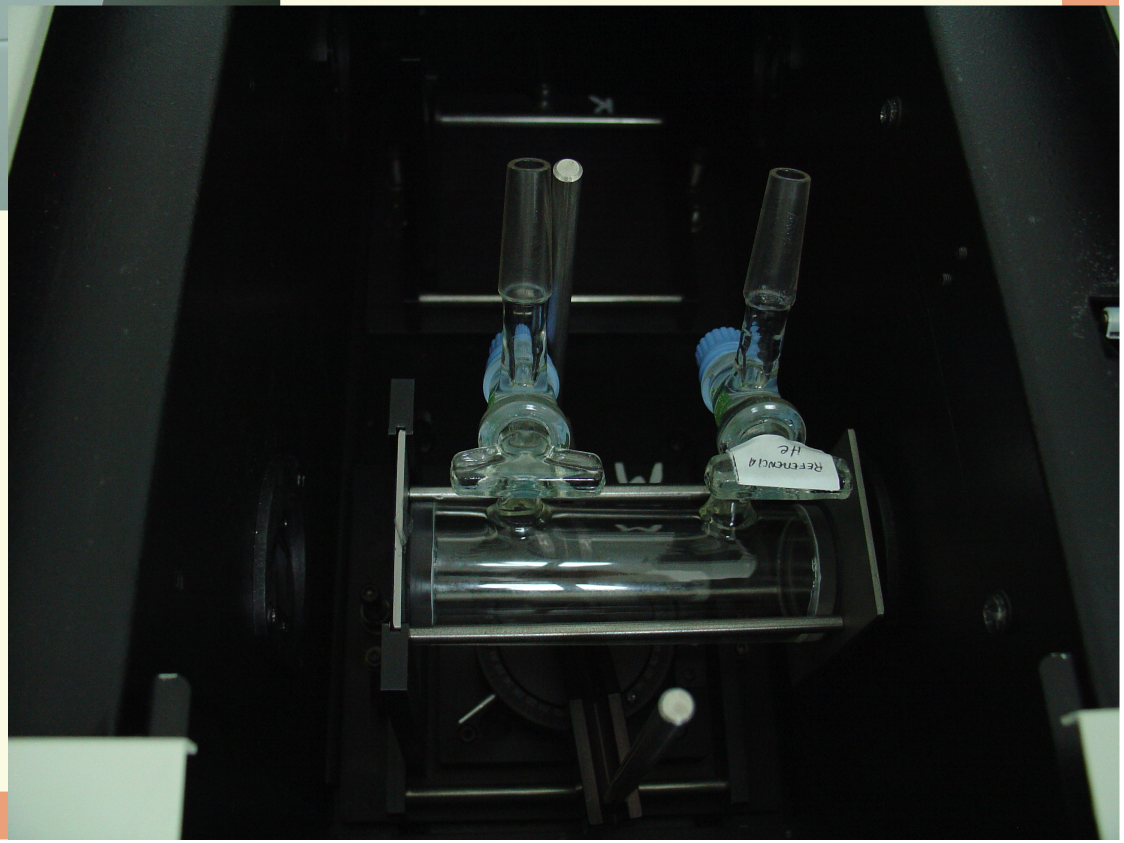
- Detailed design studies 100,000 euros
- 2 echelle gratings 160,000 euros
- 2 cross dispersers 60,000 euros
- 10 slits 20,000 euros
- 2x 2k Rockwell detector and electronics 700,000 euros
- Total hardware=1,040,000 euros


CH4
H2C2
N2O
He

$H_2C_2 + N_2O + CH_4$ (27% +30%+18%)



IAC optical lab



Future plans