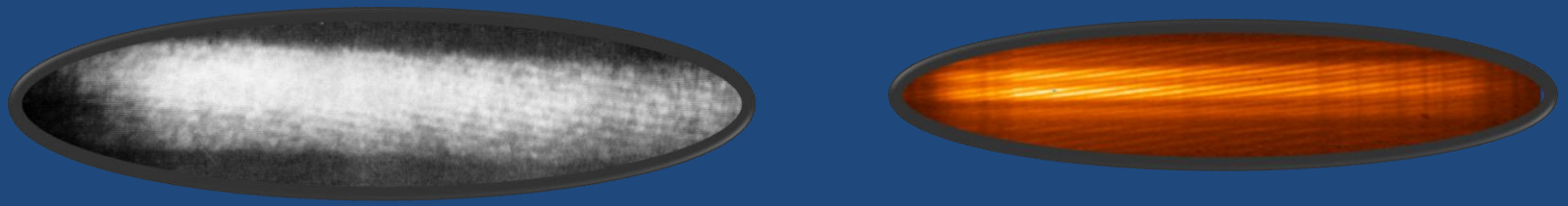
Unveiling the visible face of VLTI



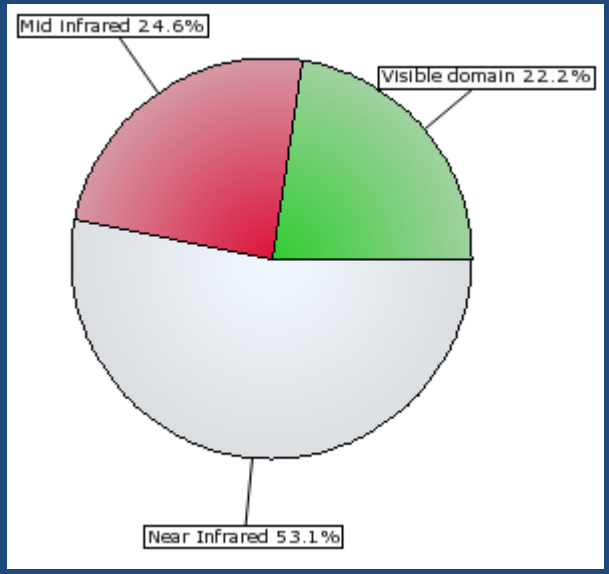
D. Mourard[1]

O. Chesneau[1], , N. Nardetto[1], K. Perraut[2], Ph. Stee[1], I. Tallon-Bosc[3]

[1] *Nice/Fizeau,* [2] *Grenoble/IPAG,* [3] *Lyon/CRAL*

Interferometry at visible wavelengths

- The early-bird pionniers:
  - I2T, MarkIII, GI2T, COAST
- The still on-going instruments:
  - SUSI
  - NOI
- The most recent developments:
  - CHARA: PAVO/VEGA
  - VEGA/VLTI proposed in 2005…
- VLTI should be visible now!



Source: OLBIN Oct.2011

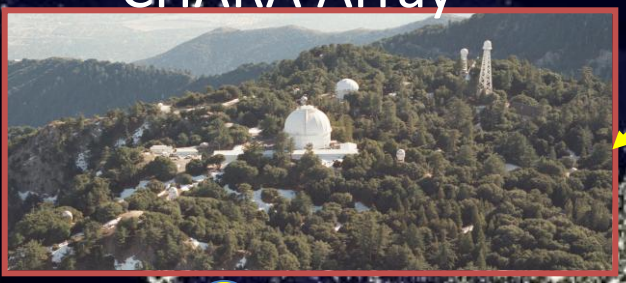
Why doing visible interferometry?

- New spectral window:
  - New objects
  - New physical processes
  - Complementary view
- Possibility to reach very high spectral resolution
  - VEGA@CHARA R=30000
- VLTI@0.6μm&200m ≈ VLTI@2.2μm&750m
- Last but not least: because it is working well!

VEGA/CHARA High angular and spectral resolution (0.3mas et R=6000/30000)

Remote control

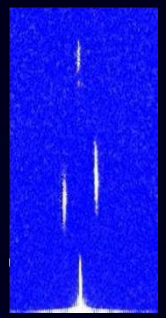
CHARA Array



09-2007: Integration
07-2008: First science light
10-2008: Mode 3T
07-2009: Remote operation
06-2010: First science papers
10-2010: Mode 4T
08-2011: 11 papers in total (2 technical)

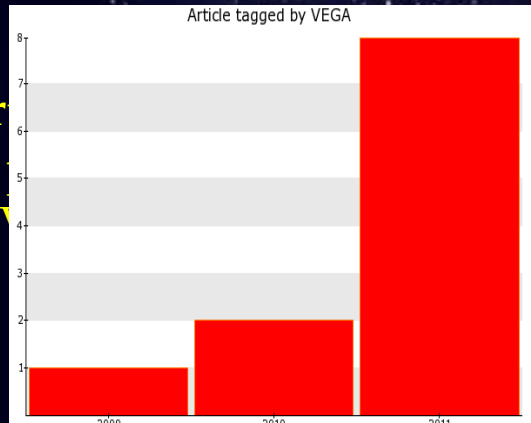
2011 :

3T/4T VEGA + IR instr
30 programs, 50 nights
Collaboration through V



Mode 3T

Mode 4T



Summary of performances

Mourard et al. A&A 2009, 508 (for 2T) & Mourard et al. 2011, 531 (for 3T/4T)

Spectrograph Characteristics

Grating	R	$\Delta\lambda$ (Blue)	$\Delta\lambda$ (Red)	$\lambda_R - \lambda_B$
R1: 1800 gr/mm	30 000	5 nm	8 nm	25 nm
R2: 300 gr/mm	5000	30 nm	45 nm	170 nm
R3: 100 gr/mm	1700	100 nm	150 nm	not possible

Limiting magnitude **R0=8cm** **R0=15cm**

Resolution	R	Typical lim. magnitude	Best perf.
Low	1700	6.8	7.5
Medium	6000	6.5	7.5
High	30 000	4.2	5.5

Summary of the VEGA Science Programs

http://www-n.oca.eu/vega/en/publications/index.htm

- **Fundamental parameters** ***(very high angular resolution + IR Group delay)***
  - roAp stars: Perraut et al., A&A 526 (2011)
  - **CoRoT Targets: HD49933: Bigot et al., A&A (2011), in press**
  - Exoplanet host stars
  - Sub giants radii and orbits (class IV stars)
  - Eclipsing Binaries

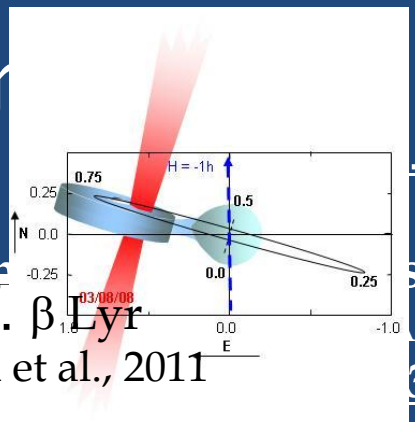
- **Circumstellar environments** ***(high spectral resolution)***
  - AB Aur (disk): Perraut et al, A&A 516 (2010)
  - **A/B Supergiants (wind): Chesneau et al, A&A 521 (2010)**
  - β Cep (disk): Nardetto et al. , A&A 525 (2011)
  - Be stars (wind): Delaa et al. A&A 529 (2011)
  - Ups Sgr & Bet Lyr (Interactive massive stars): Bonneau et al., A&A 432 (2011)
  - **δ Sco (Interactive massive stars): Meilland et al. A&A 532 (2011)**
  - The chromosphere of K giants: Berio et al. A&A (2011) in press
  - Eps Aur (co-rotating disk eclipsing the central star)
  - Young Stellar objects (MWC361, AB Aur, ...)
  - Rotation of stars and interaction with environment

Sum … he V

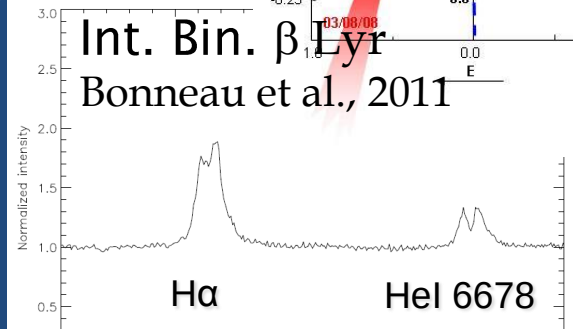
…oca.eu

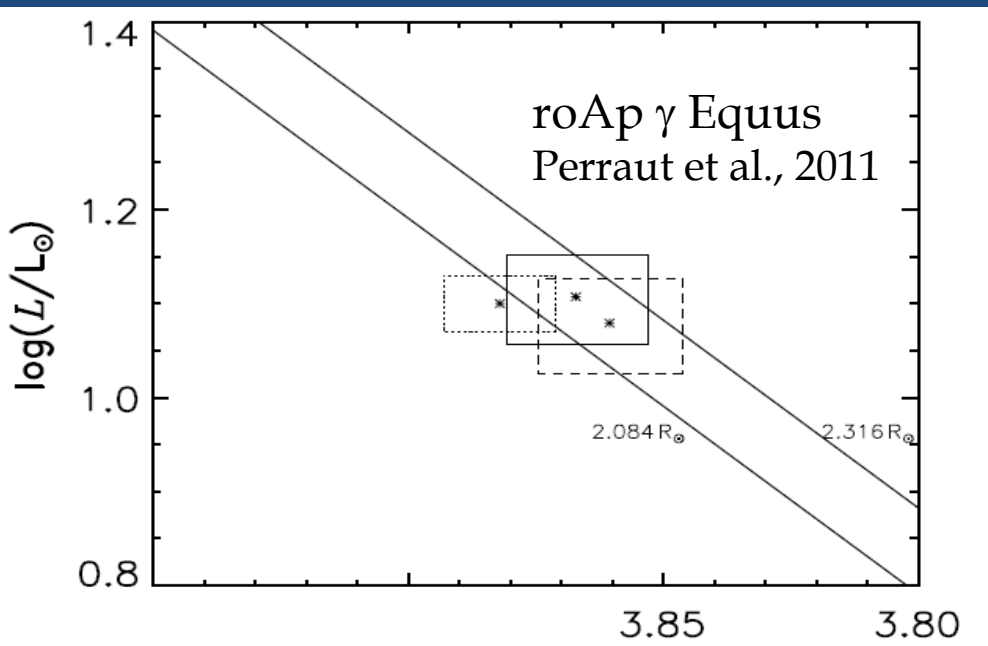
- **Fundam… s (*very*** …&A 526 **…33: Bigo**

…bits (class IV

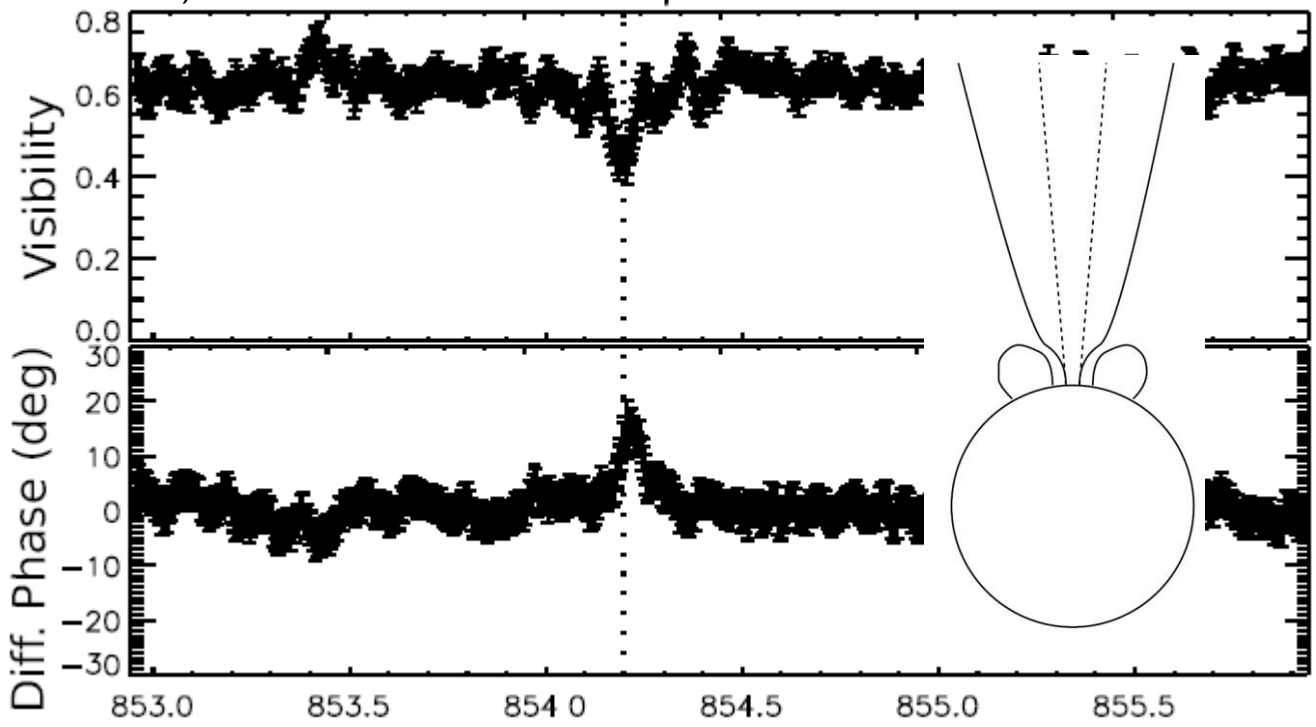


Int. Bin. β Lyr
Bonneau et al., 2011



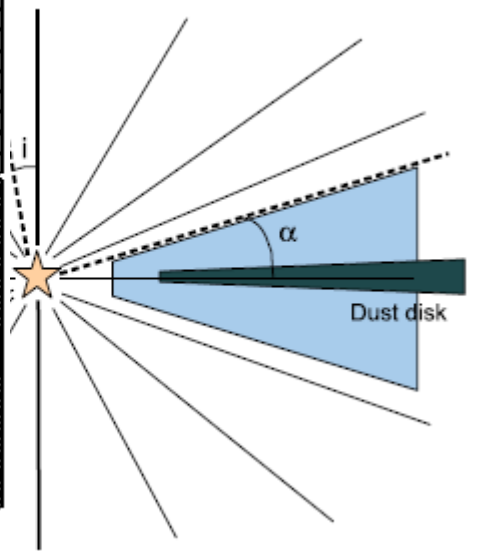


Berio et al., 2011



$g(T_{eff})$

0)

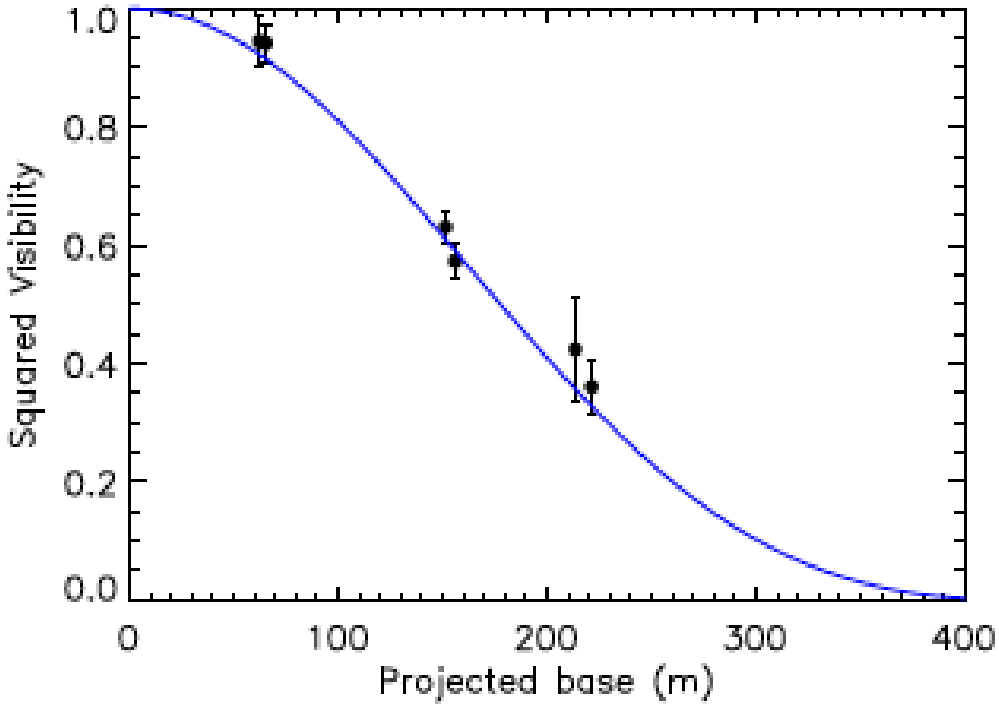


HD49933

Bigot et al., A&A (2011), in press

- Observations Oct. 2010

Direct measurement of C2: θ_{UD} = 0.474 ± 0.014mas

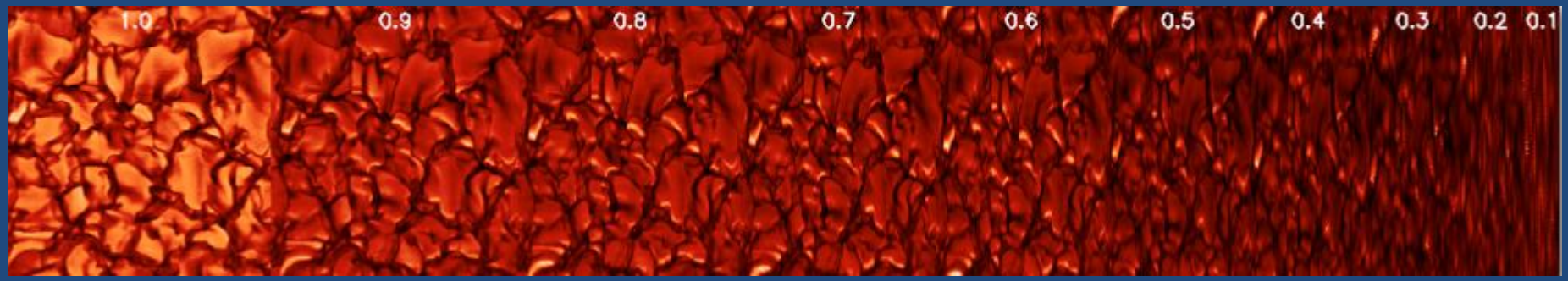


$\theta_{LD,HD49933}$ = 0.445±0.012mas

→

R = 1.42 ± 0.03 $R_\odot$

3D radiative and hydrodynamical modeling



Intensity profile @730nm : μ = 1.0 (disk center) à 0.1 (limb).
Cells of 21000 × 21000 km.

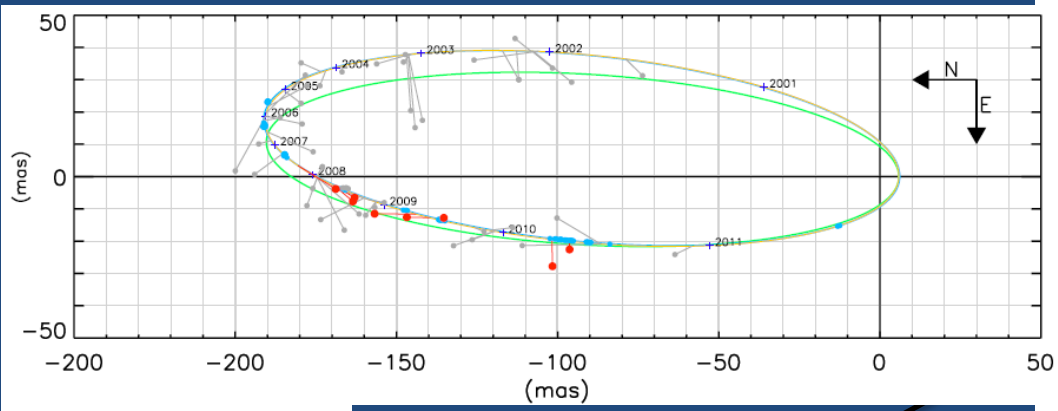
Radiative and hydrodynamical code (STAGGER CODE, Nordlund & Galsgaard, 1995)
Simulation of the surface convection and of the atmosphere stratification.

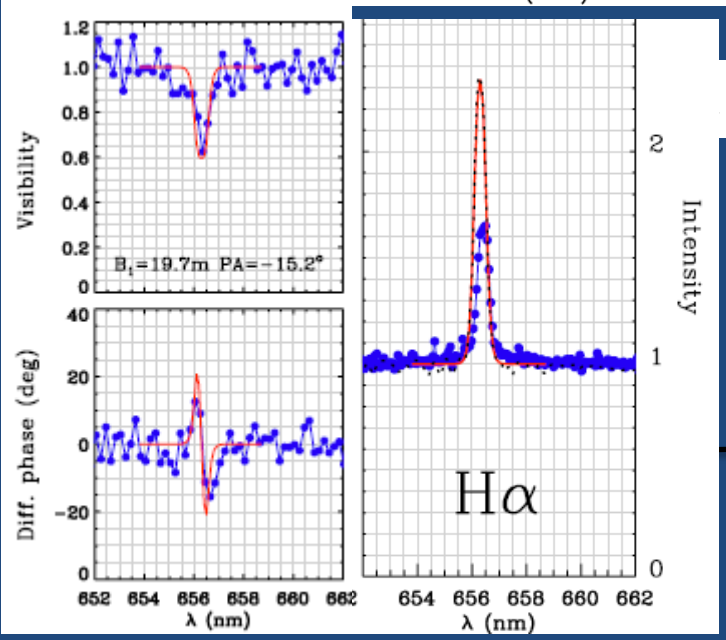
Global fitting of the evolution model taking into account the CoRoT frequencies (small and large separations) AND the angular diameter

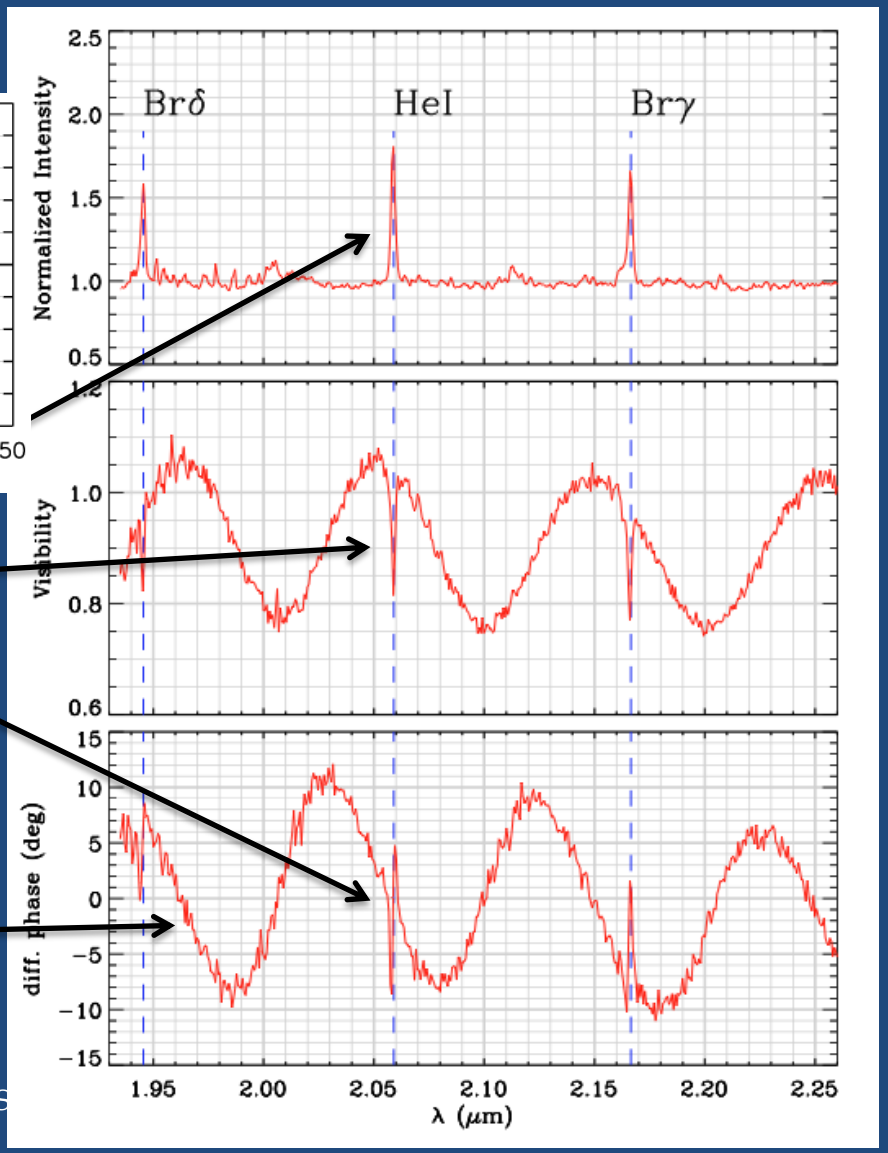
M/M⊙	R/R⊙	log g	Y_0	$(Z/X)_0$	αov	Age (My)	T_{eff} (K)	log L/L⊙	Xc	Ys	(Z/X)s	[Fe/H]	Δ_0(μHz)
1.20	1.42	4.21	0.29	0.016	0.35	2690	6640	0.55	0.47	0.20	0.011	-0.38	87.33
6%		**2%**		**3%**		*relative uncertainty*		**1.5%**					

Complementarity CHARA and VLTI

- δ Sco observed by AMBER and VEGA
- Medium spectral resolution (R=1500/5000)



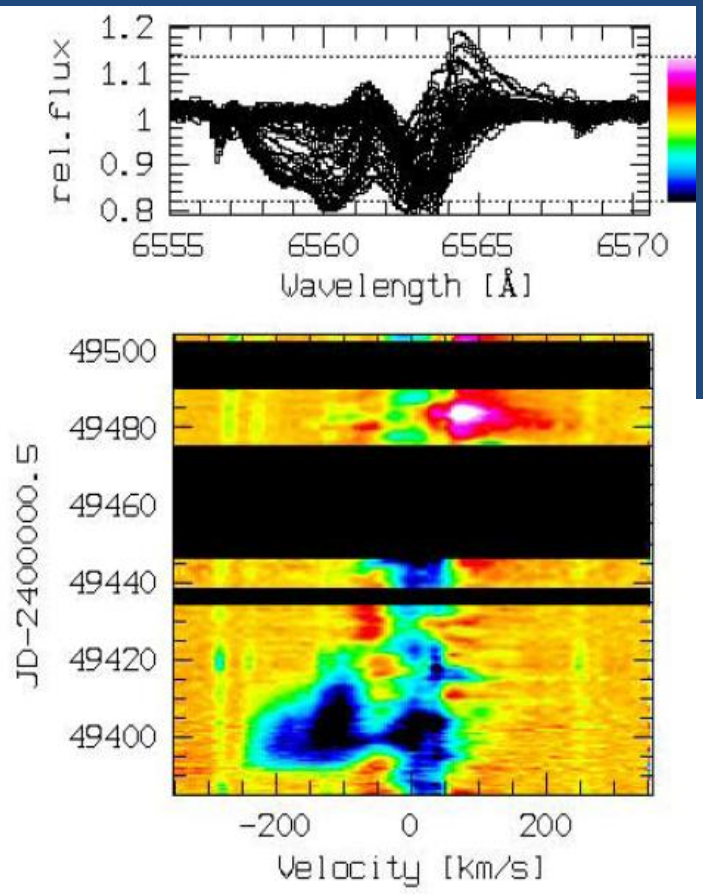


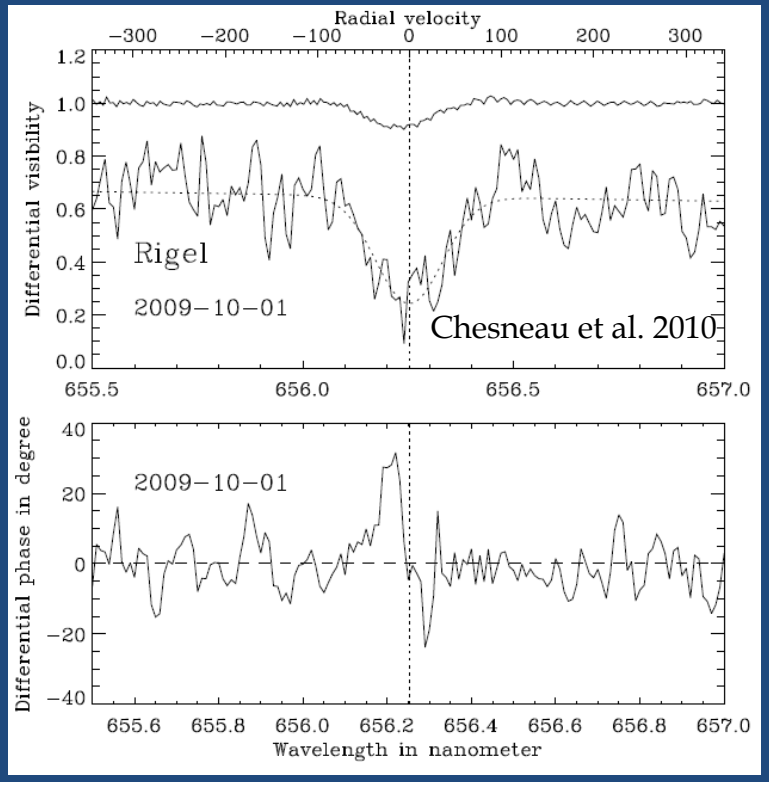


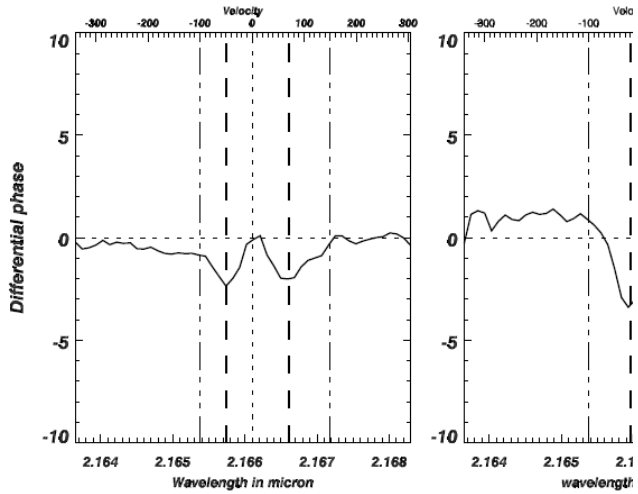
VEGA/CHARA & VIS

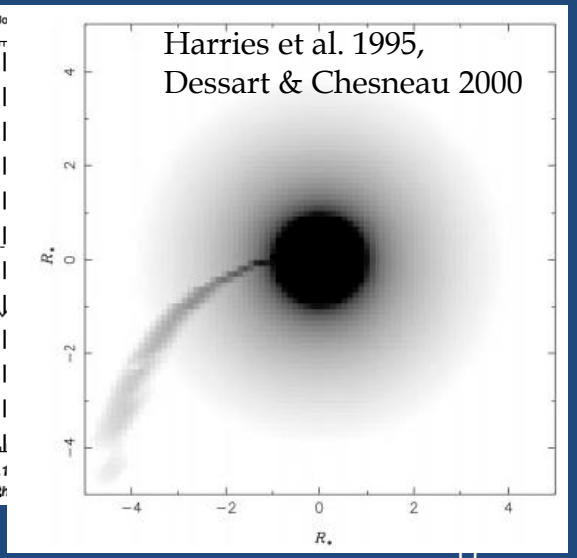
CHARA&VLTI: 2nd example

Rigel observed by AMBER and VEGA
High spectral resolution (R=30000/12000)





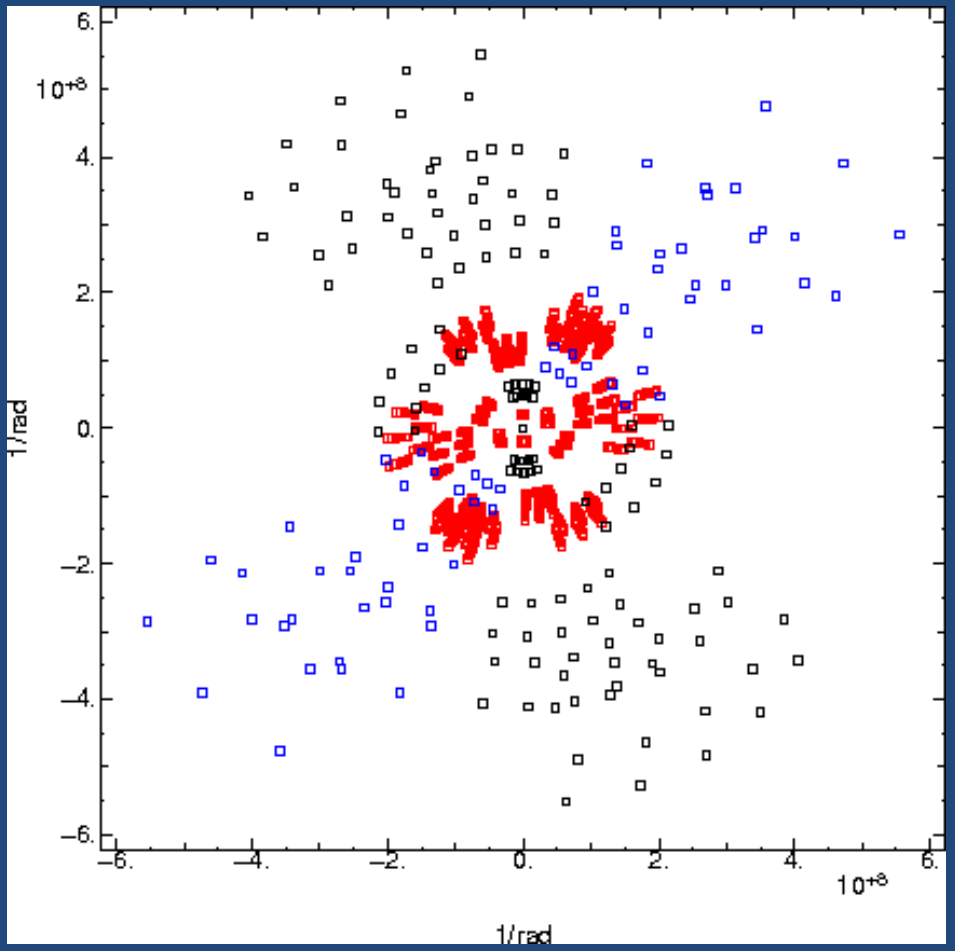


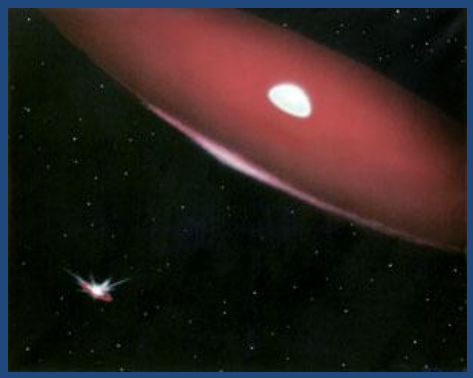


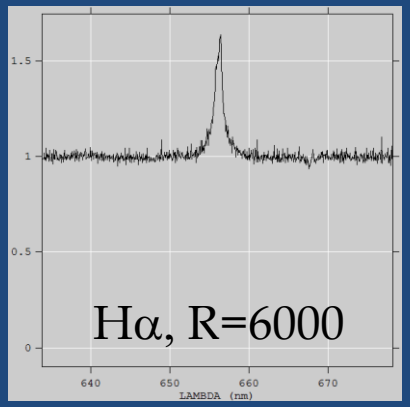
Perspectives of spectral imaging

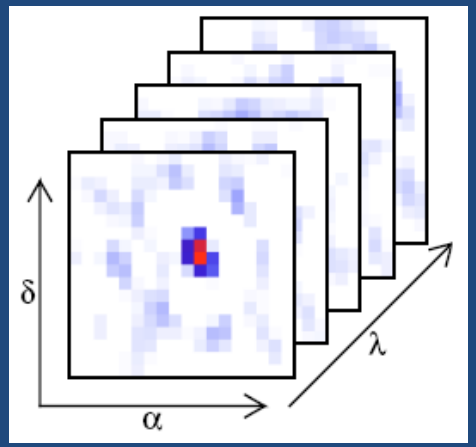
October 18th and 19th on CHARA ϕ Persei

MIRC 6T @ 1.6µm, VEGA 4T @ 656-487nm









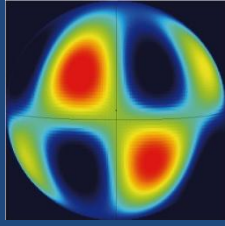
Towards a VLTI visible instrument

- Progresses of **VLTI + VEGA/CHARA** bring unique opportunities for key astrophysical questions.

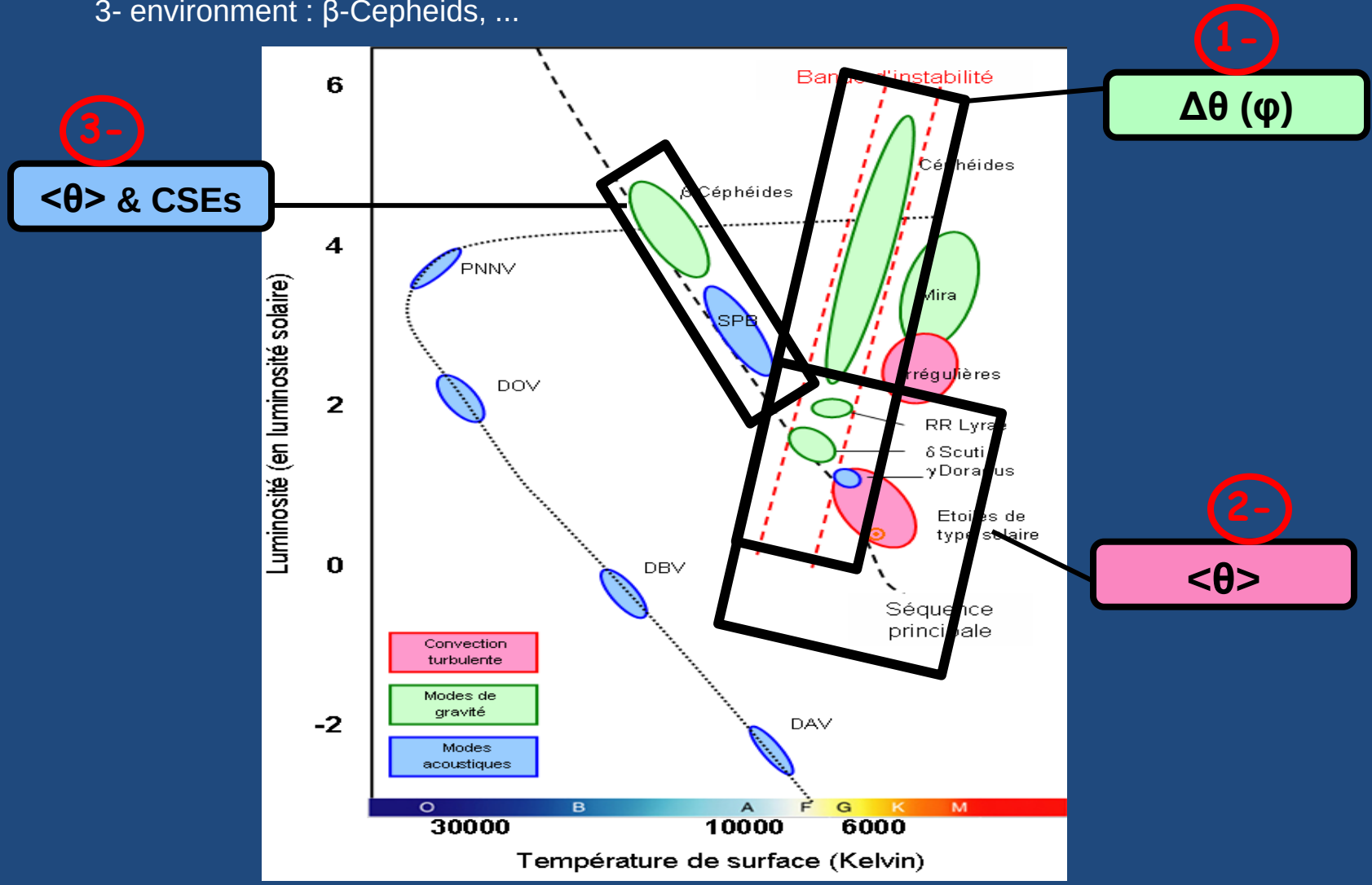
- Imaging at very **high angular and spectral resolution** for asteroseismic sources, exoplanet's host stars and general stellar physics.

- Main features:
  - 4T/6T beam combiner + spectrograph
  - IR group delay tracking
  - VISA infrastructure: *well-optimized for imaging in the visible.*
    - # of ATs, AO on Ats: *denser than CHARA (more short baselines)*
    - longest baselines, fast reconfiguration.

Perspective : pulsating star / asteroseismology

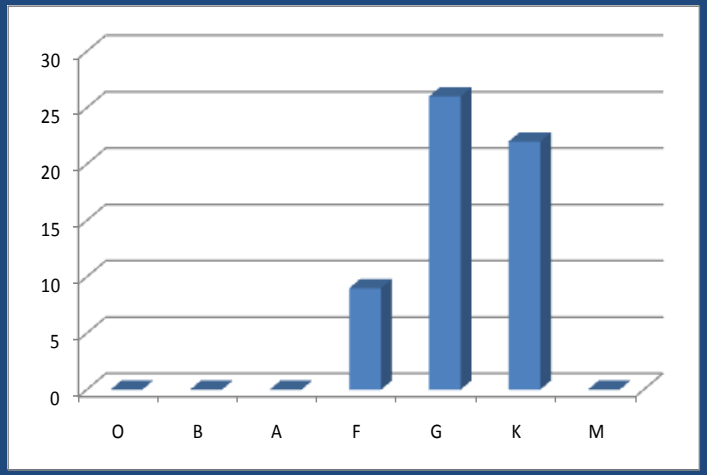


1- distances IBW : Cepheids + HADS
2- asteroseismology : Solar types/γ Dor/δ-Scuti/RR Lyrae/roAp/β-Cepheids
3- environment : β-Cepheids, ...



Exoplanet's host stars

- Angular diameter @ 1% of relative uncertainty
- Direct limb darkening characterization



- Example of VEGA/CHARA possibilities

- Science Goals
  - Better determination of planet's parameters
  - Removal of stellar noise due to activity (spots, pulsation) for RV systems
  - Direct removal of limb darkening bias for transit systems

- Importance of the definition of a large program: study in progress at VEGA consortium level.

….and Happy Birthday VLTI….

Thank you to VEGA and CHARA groups