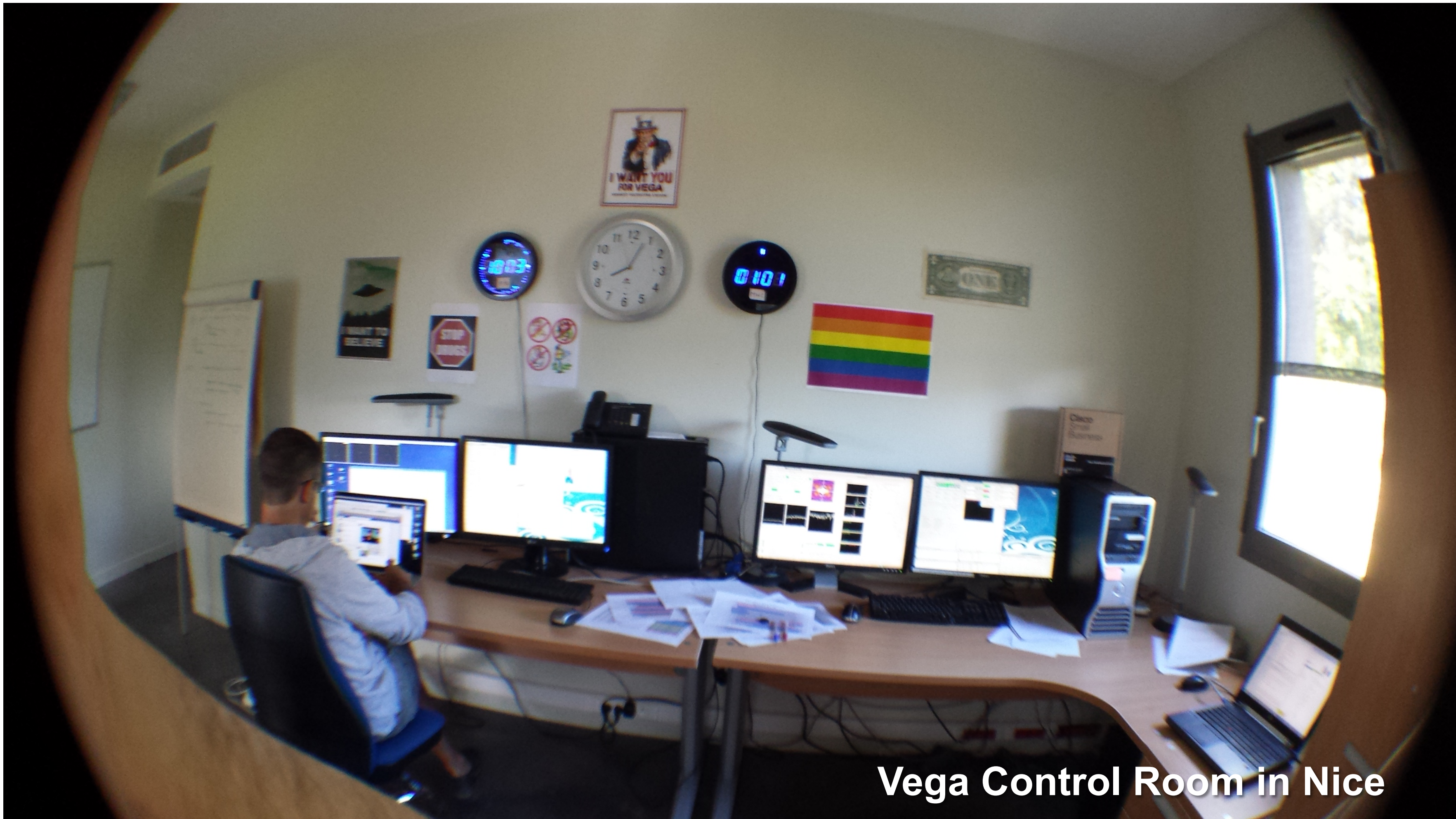
Overview and current state of the VEGA scientific programmes



Vega Control Room in Nice

What do we do with VEGA?

« Large Band » interferometry

Measure angular diameters down to 0.2 mas (highest spatial resolution)

But also study geometry like binary, flatening…

But limited imaging due to lack of closure phase and 2nd lobe V^2 measurements

Spectrally-resolved interferometry

Study variation of visibility and phase through emission or absorption lines

Localize chemical elements
Study kinematics

Spectro-imaging (thanks to differential phase)

I. Measuring angular diameters

Why?

- Fundamental parameters of stars
- Exoplanets host-stars (calibration)
- Calibration of various distance relations

I. Measuring angular diameters

1. Fundamental parameters of stars

Physical processes like convection, rotation, magnetic fields, non-radial pulsations, etc. are based on **fundamental parameters**

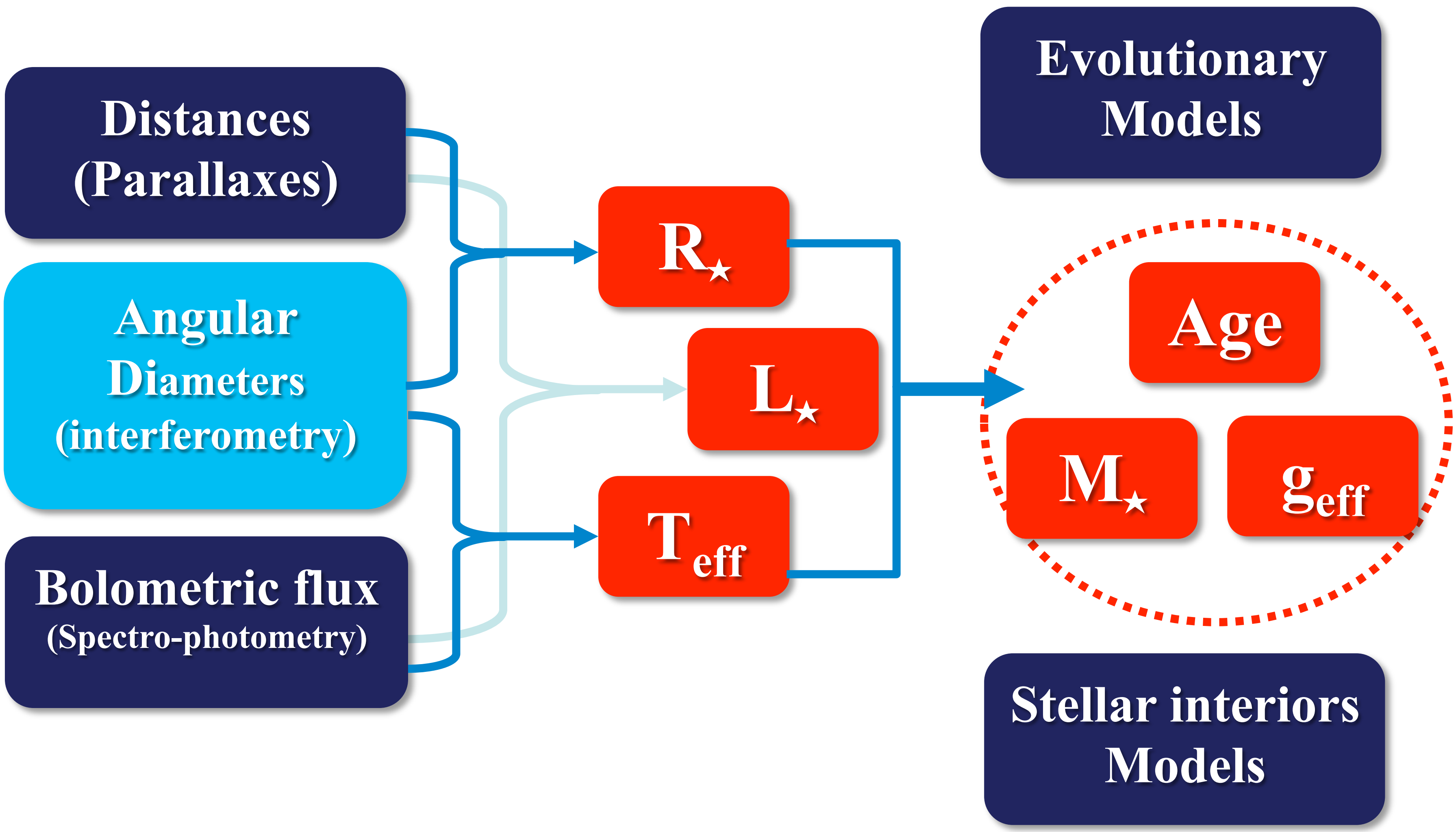
- $M_\star$, $R_\star$, $L_\star$, T_{eff}, g_{eff}, ρ , *abundances*

From the measurement of these fundamental parameters and theoretical evolutionary tracks, one can put into test **models**

- *Stellar interiors, evolutionary stages*
- *Magnetic field topology, pulsation excitation*
- *Planetary systems*

I. Measuring angular diameters

1. Fundamental parameters of stars

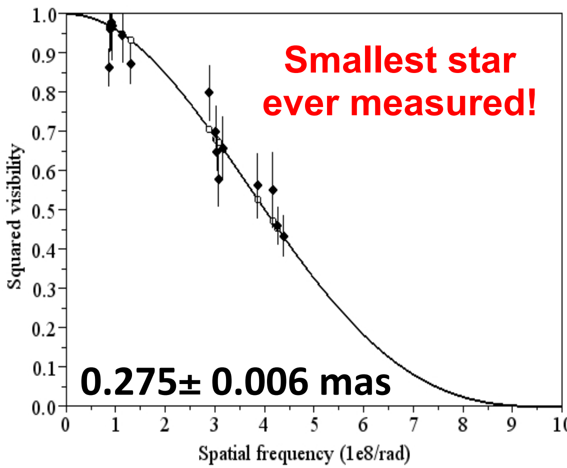


I. Measuring angular diameters

1. Fundamental parameters of stars

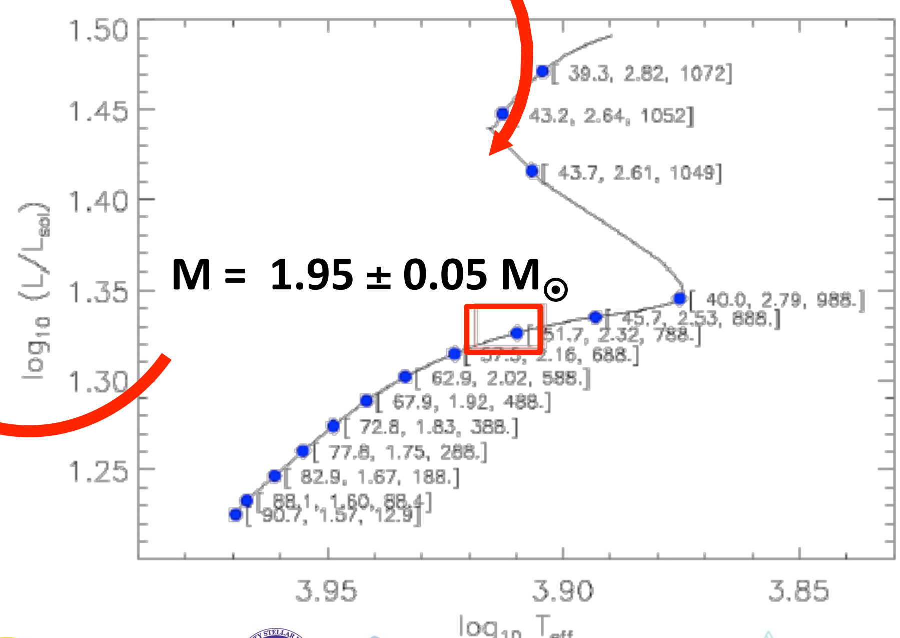
10Aql

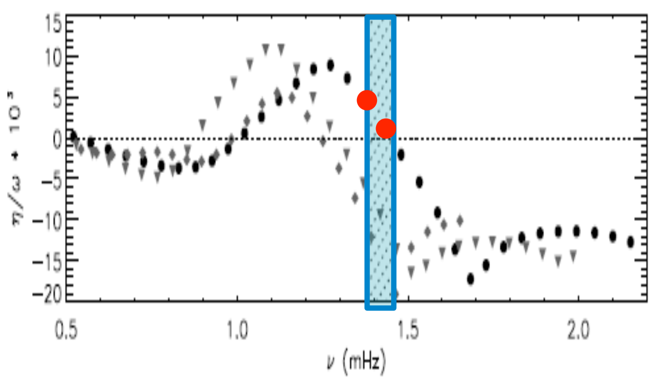
Perraut+ (2013)



R = 2.317 ± 0.070 $R_\odot$

+ Bolometric flux and parallax
+ Large frequency separation Δν
+ Evolutionary track (CESAM2K)





Oscillation modes models

[Perraut et al. A&A, 559, A21 (2013)]

I. Measuring angular diameters

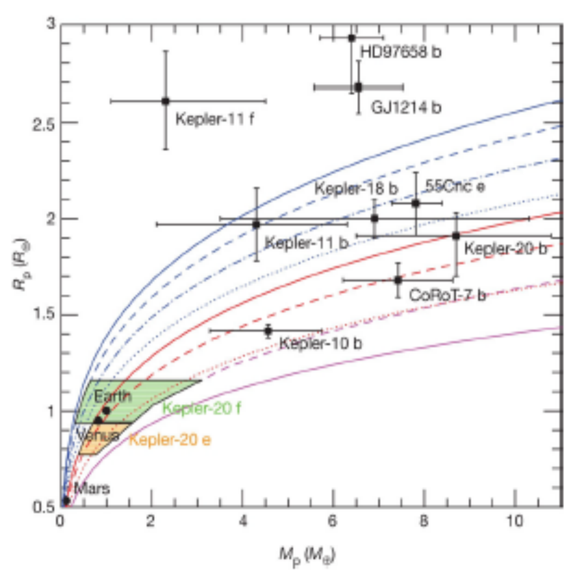
1. Fundamental parameters of stars

- **ro Ap stars** (Perraut)
  - 2 Papers published (Perraut+ 2011, Perraut+ 2013)
  - New observations for 2014
- **COROT Targets** (Creevey & Bigot)
  - 1 paper published (Bigot+ 2011)
  - New observations for 2014
- **Subgiant stars** (Mourard & Farrington)
  - 1 Paper to be submitted in 2014
- **Red giant stars** (Creevey & Bigot)
  - 1 paper in preparation
- **Metal-Poor** (Bigot & Creevey)
  - 1 Paper to be submitted in 2014

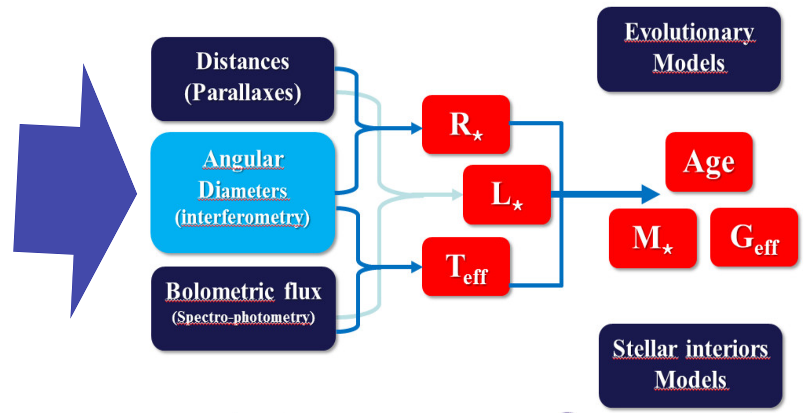
I. Measuring angular diameters

2. Exoplanets host-stars

Planet Radius and Mass given as a ratio of Host-star $R_\star$ and $M_\star$



Fressin et al. 2012



Back to fundamental params. of star

First paper on 4 host-stars

Ligi, Mourard et al. (2012)

Ligi PhD thesis defended in 2013

Observation are going-on

2nd paper in preparation

I. Measuring angular diameters

3. Calibration of distance relations

The Araucaria Project and the VEGA/CHARA Instrument

Nardetto et al.

1

Cepheids

Comparing angular diameter from VEGA and FLUOR

Nardetto et al. in prep.

2

Late-Type stars

large program including VEGA & FLUOR + PIONEER

paper(s) in preparation

3

Early-type stars

VEGA/CHARA observations of 8 stars

Challouf et al. submitted
Challouf et al. in prep

SB relation and p-factor controversy

improvment of the SB relation (1%)

improvment of the SB relation (5%)

transverse theme: the surface brightness

CEPHEIDS

Better use of BW distances (MW and LMC)

ECLIPSING BINARIES

45 systems in LMC: distance at 1%

ECLIPSING BINARIES

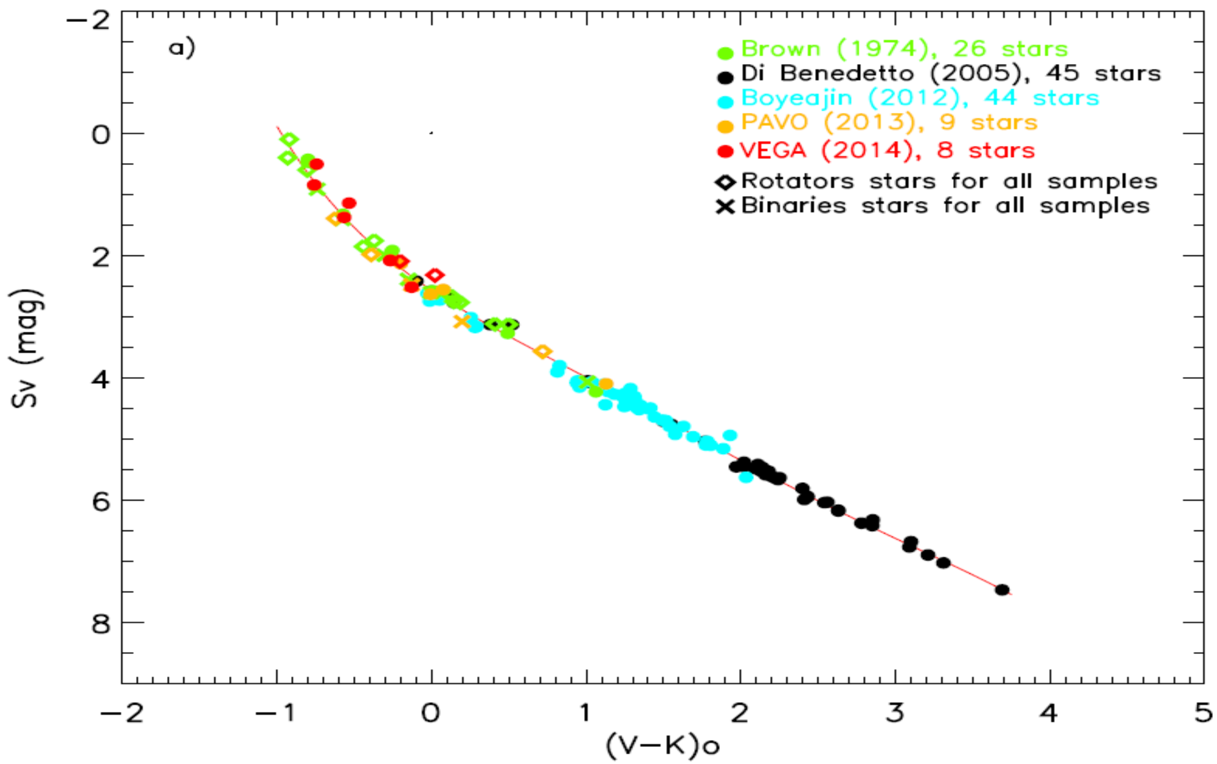
many more systems discovered in nearby galaxies: e.g. M33 at 5%

Internal test on the λ tau Galactic eclipsing binary VEGA + MIRC *Nardetto et al. in prep*

Observational cosmology Hubble constant to **2%**

I. Measuring angular diameters

3. Calibration of distance relations

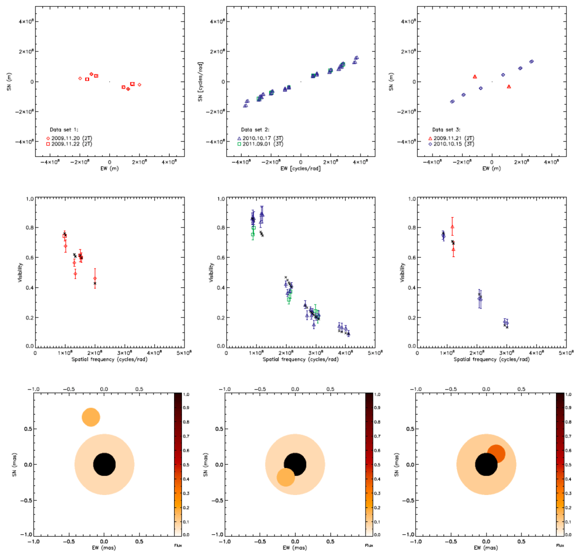


M. Challouf[1,2] , N. Nardetto[1] et al. 2014, submitted

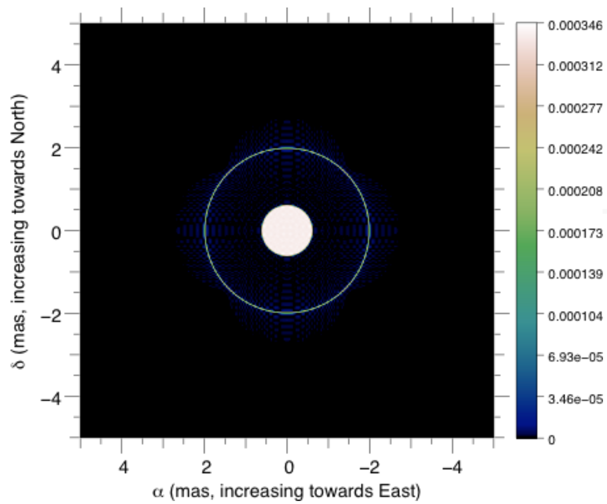
- ✓ angular diameters of 8 early-type stars in the visible with a **≈1,5% accuracy**
- ✓ S_v relation with **0,11 mag of accuracy** (**5% on predicted angular diameter**)

I Measuring angular diameters

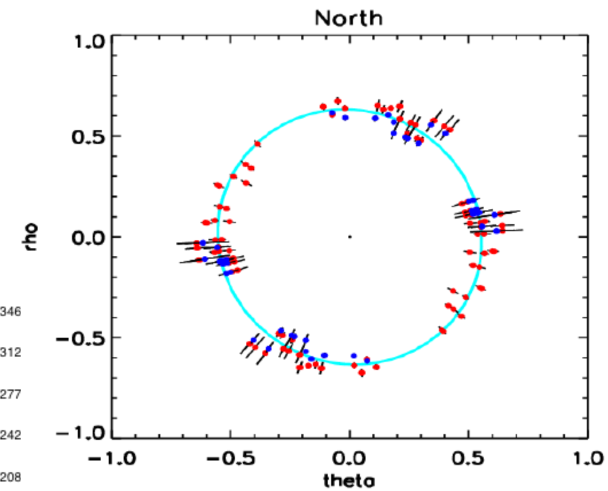
4. Beyond diameters : binaries, environment, flattening…



λ Tau eclipsing binary
Nardetto+ in preparation



extended environment around δ Cep
Nardetto+ to be submitted in 2014



Flatening of δ Per
Challouf+ in preparation

II spectro-interferometry

1. Overview of published papers

11 papers (total VEGA papers = 20 – 3 technical ones)

9 papers on circumstellar environment

Disk of Be stars (Delaa+ 2011, Meilland+ 2011, Smith+ 2012, Stee+2012)
Disk and/or Wind of YSO (Peraut+ 2010, Benisty+ 2013)
Interacting binary (Bonneau+ 2011)
Wind of supergiants (Chesneau+ 2010)
Peculiar stars (Mourard+ 2012)

2 papers on stellar surface or atmosphere

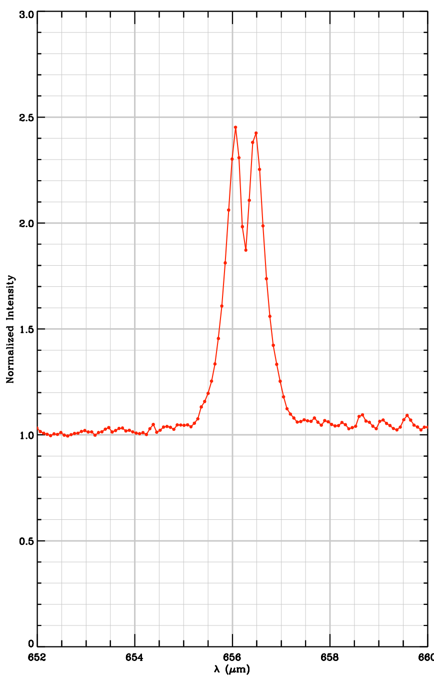
Chromosphere of K giants (Bério+ 2011)
Rotation of α Cep (Delaa 2013+)

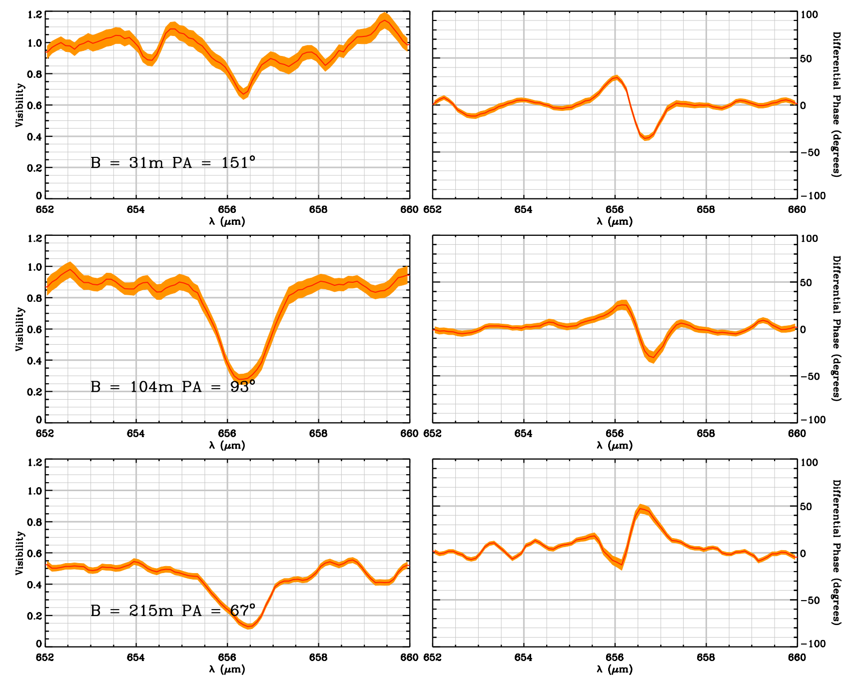
5 papers with only geometry and/or extension (Hα, Hβ, CaII triplet, SiII, HeI)

6 papers with kinematics constraints (mainly in Hα)

II spectro-interferometry

2. Access to kinematics thanks to differential vis. and phase





The Be star Omi Aqr

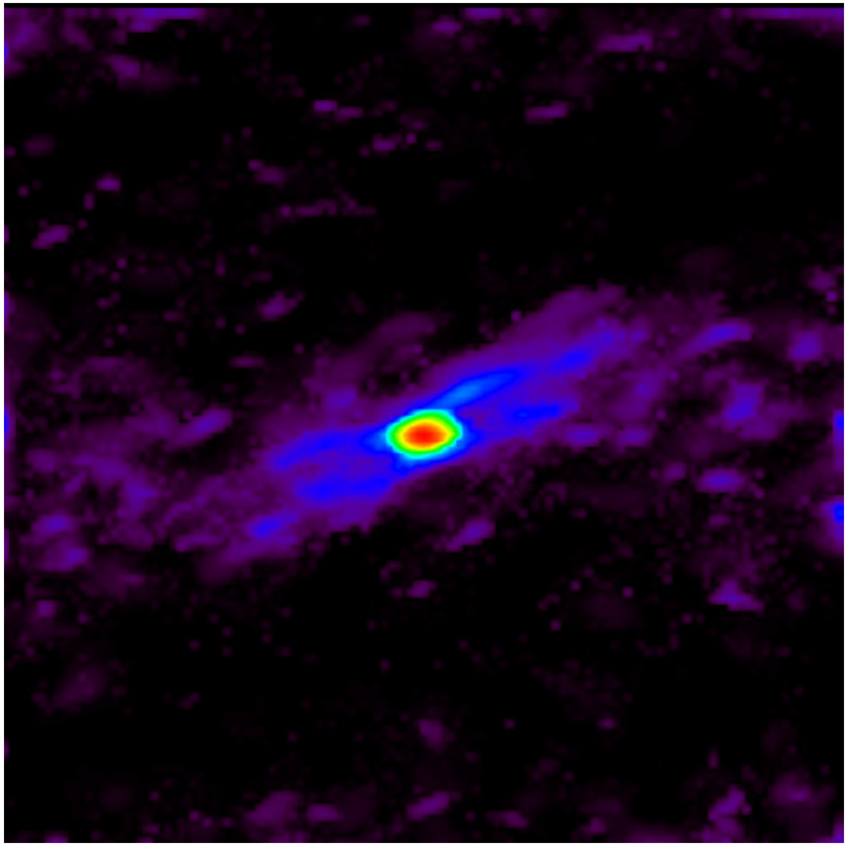
II spectro-interferometry

2. Ongoing programmes

	2013		2014
YSO	▪ 51 Oph (YSO?) ▪ θ1 Ori C (YSO binary) ▪ SS Lep (symbiotic YSO)		▪ YSO CE (disk/Wind) ▪ Late YSO (51 Oph and HD141569) ▪ SS Lep (symbiotic YSO)
Be Stars	▪ β Lyr imaging (binary Be star) ▪ Be/Bn stars		▪ Fast Rotation of Bn stars ▪ Edge on Be stars ▪ Magnetic Be stars
Other	▪ Stellar Spots ▪ Yellow Hyper Giants ▪ ε Aur ▪ P Cyg ▪ Nova Del		▪ YHG (evolution and eruption) ▪ Chromosphere of Red Giants ▪ ε Aur ▪ P Cyg

II spectro-interferometry

4. VEGA imaging capabilities



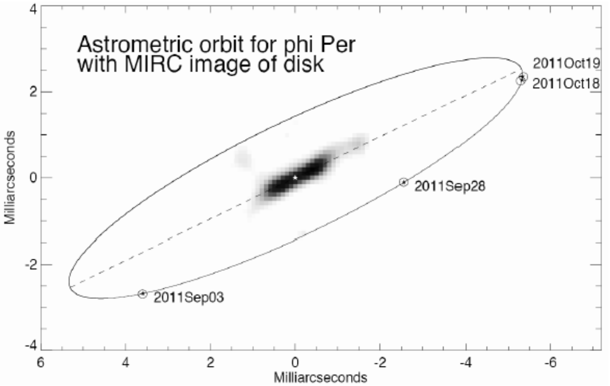
Integrated image in the whole Hα line

MIRA software (Thiébaut) + self-calib algorithm (Millour)

The circumstellar disk of
The edge Be star φ Per

Mourard, Monnier et al. 2014, in preparation

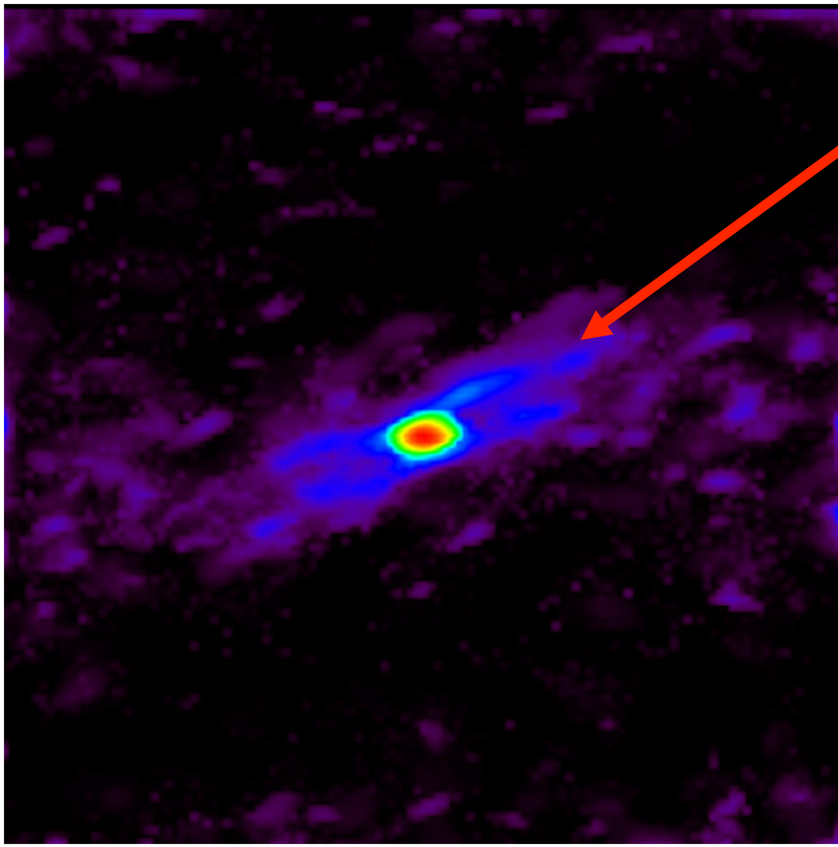
VEGA 4T
8 Observations (= 48 uv pts)
in the Hα line
R≈1600 (180 km/s)
+
MIRC 6T



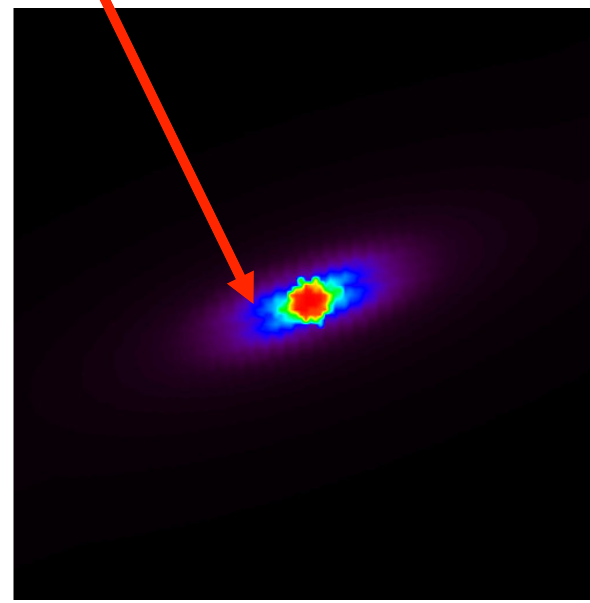
II spectro-interferometry

4. VEGA imaging capabilities

Artifacts or not?



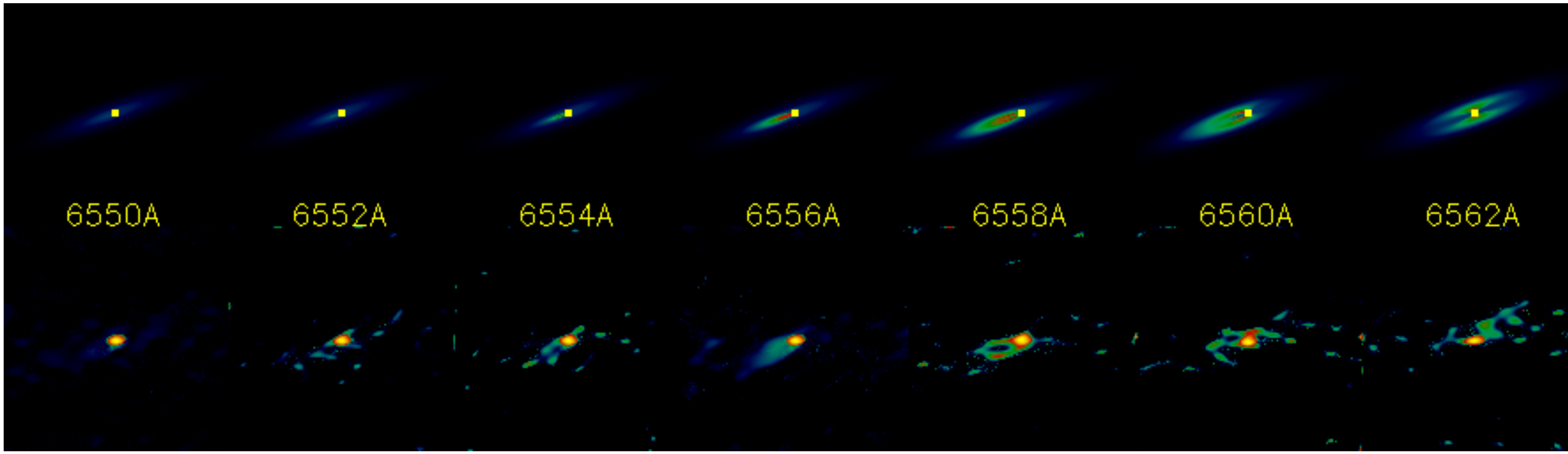
Integrated image in the whole Hα line
MIRA software (Thiébaut) + self-calib algorithm (Millour)

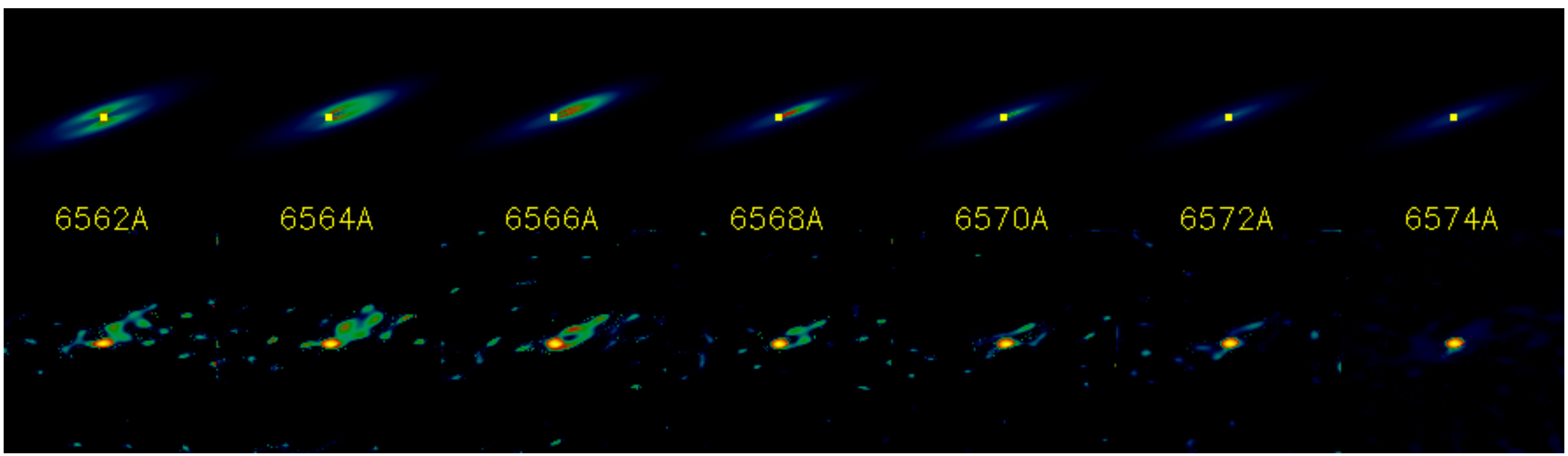


Some random model
at high inclination
using the BEDISK code
(A. Sigut & C. Jones)

II spectro-interferometry

4. VEGA spectro-imaging capabilities



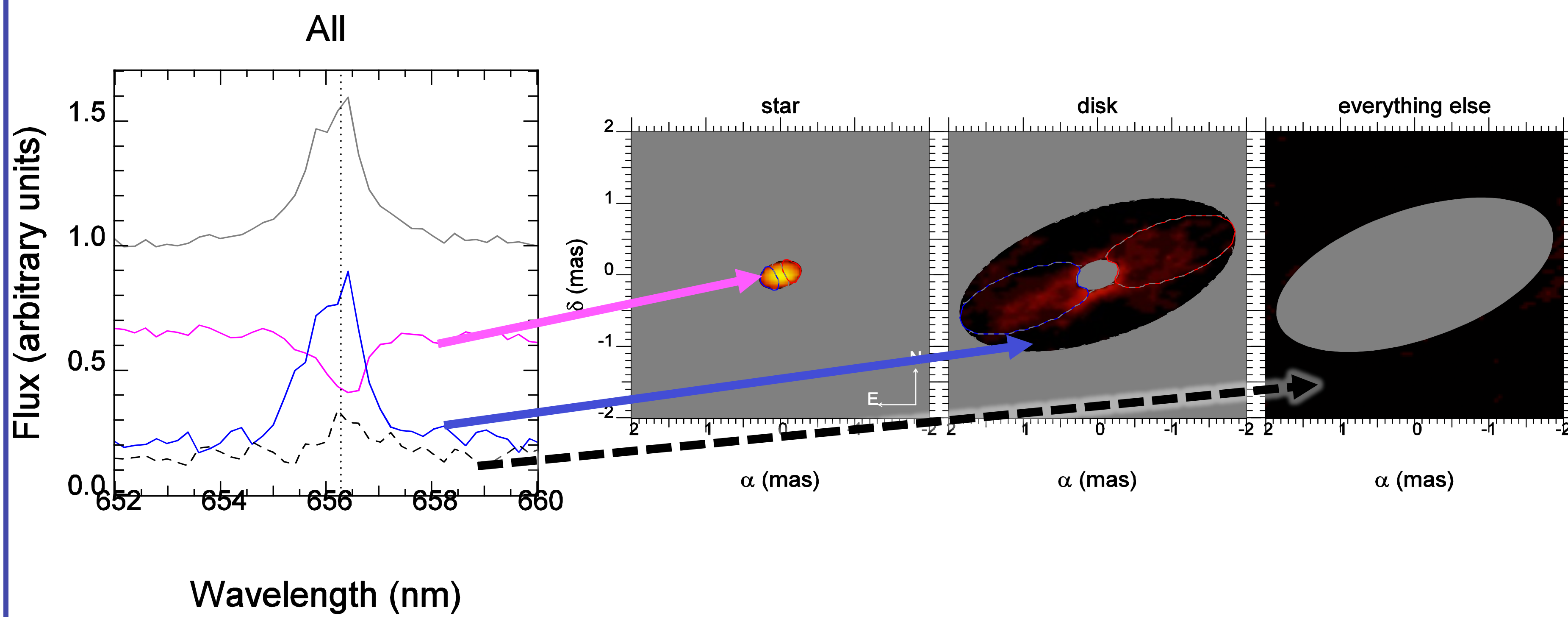


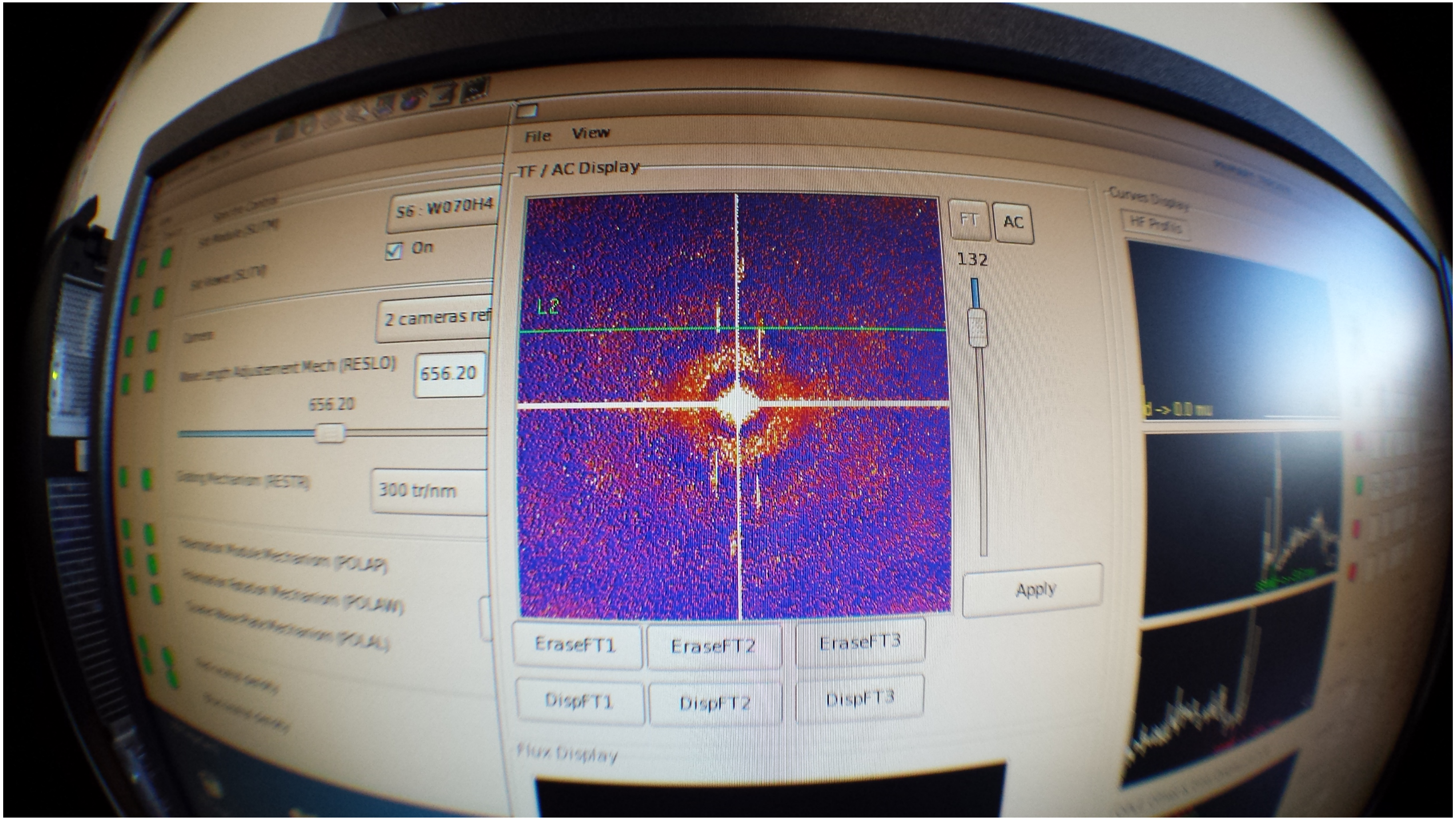
II spectro-interferometry

4. VEGA spectro-imaging capabilities

=

Integral-field spectroscopy
with a high spatial resolution





Merci CHARA et à bientôt!