VEGA: Status and Future Plans

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VEGA 2009: main points

- Huge effort on data processing
- Publication on principle and performance
- First science results
  - High spectral resolution: Deneb, Rigel.
  - Faint objects: AB Aur
  - New programs on fundamental parameters: 13 Cyg, ro Ap
  - “Classical” programs: Be stars, binaries

Nights 2009: not a great success

- 25 nights over 56: Gloom, fire, weather.
- Some troubles with the internal fringe tracker.
- Lot of programs but troubles with processing.

But:

- Good operations also in remote. Control system is now stable.
- Alignment is very stable.
- Good progress on the pupil shapes. Images…

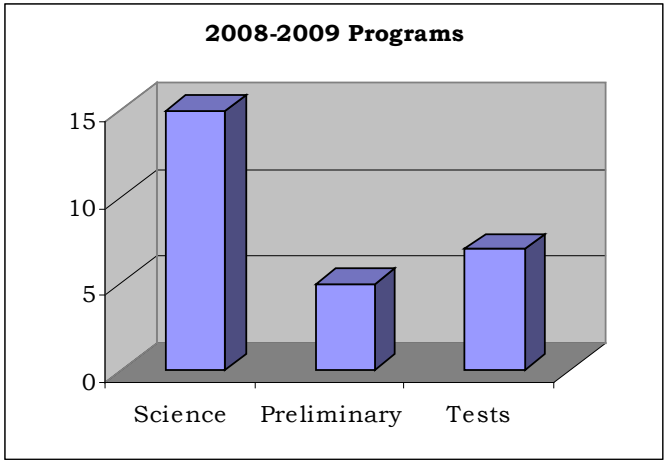
Status of programs

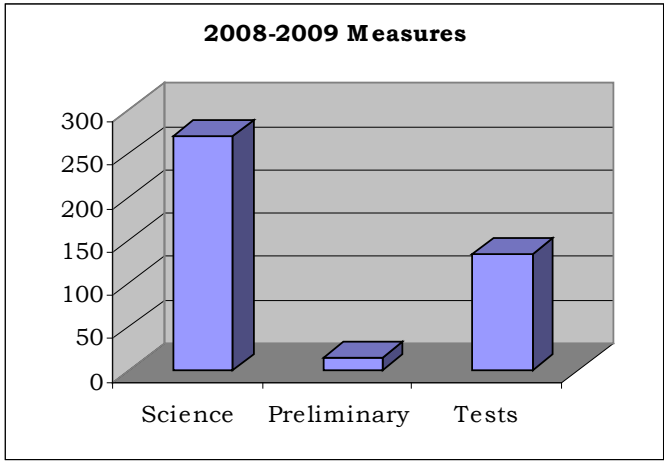
2008: 29 nights with data 2009: 25 nights with data

Total=54 nights*~8h=432h

27 programs, 44 objects, 421 measures

1 measure = 1 hour for Cal-Tar-Cal + Spectral Calibration





Summary of the VEGA Science Programs

- First priorities
  - A/B Supergiants (Chesneau): see later
  - AB Aur (Perraut): see later
- Circumstellar environments (see Omar's presentation)
  - Four Be stars
  - ups Sgr and bet Lyr
- Fundamental parameters (see Nicolas's presentation)
  - 13 Cyg
  - bet Cep
  - ro Ap stars
  - sub giants
- Then: eps Aur, alp Cep, P Cyg, theta OriC…

Status of the Science Programs

Number	Title	Nights	Data	Processing	Quality	Analysis	Publication
V08	DenebRigel	12	20	100%	Good to excellent	Done	almost submitted
V12	HaeBe	13	15	50%	Medium	In progress	In preparation
Vxxx	del Sco, Chi Oph, Be	24	58	100%	Medium	Done	almost ready
V11	bet Lyr/Ups Sgr	14	30	75%	Good	In progress	In preparation
V27	eps Aur	2	9	100%	Good to excellent	Standby	In preparation
V01	13 Cyg	8	12	100%	Good	Done	
V03	bet Cep	11	21	100%	Medium to excellent	More data	
V06	HD49933	5	8	100%	Bad	New data	
V23	del Cep	3	7	100%	Bad		
V02	Sirius	3	3	50%	Good	Standby	
V16	ro Ap	7	9	50%	Good	In progress	
V28	theta OriC	4	10	50%	good	Standby	
V30	P Cyg	3	5	50%	Medium	Standby	
V31	Fast rotators	5	36	50%	Good	Standby	
V22	sub Giant	16	33	30%	Good	Partly done	

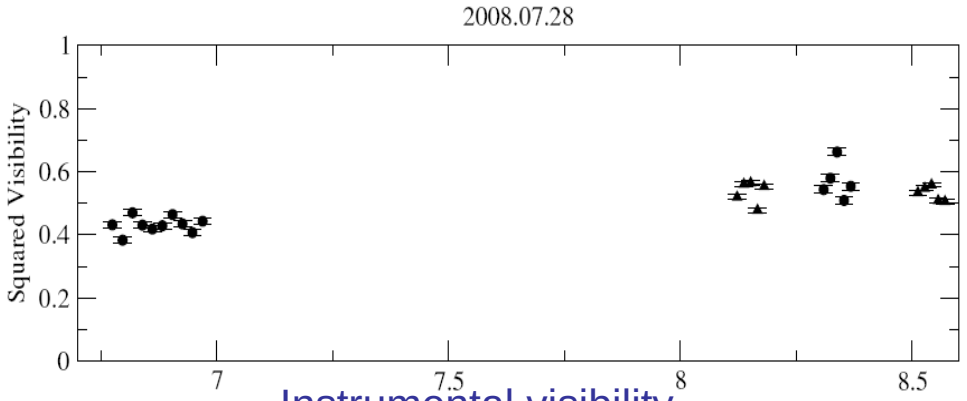
Status of VEGADRS

- Pipeline is now defined with a small number of modes
  - $V^2(t)$, V^2, $Ve^{i\varphi}$
- Still some parameters to adjust depending on SNR
  - Number of frames
  - Spectral width of science channel
- Main limitations in the processing
  - Photon centroiding hole in V^2 mode. Low V^2.
  - Accurate spectral calibration in High Spectral Resolution.
  - OIFITS output in $Ve^{i\varphi}$ mode.
  - Post-processing tools for handling large amount of individual data.
- Main limitations in the data
  - Phase noise residual
  - Group delay tracking
  - Saturation of detector in photon counting regime

Summary of performances *(A&A 508 2009)*

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

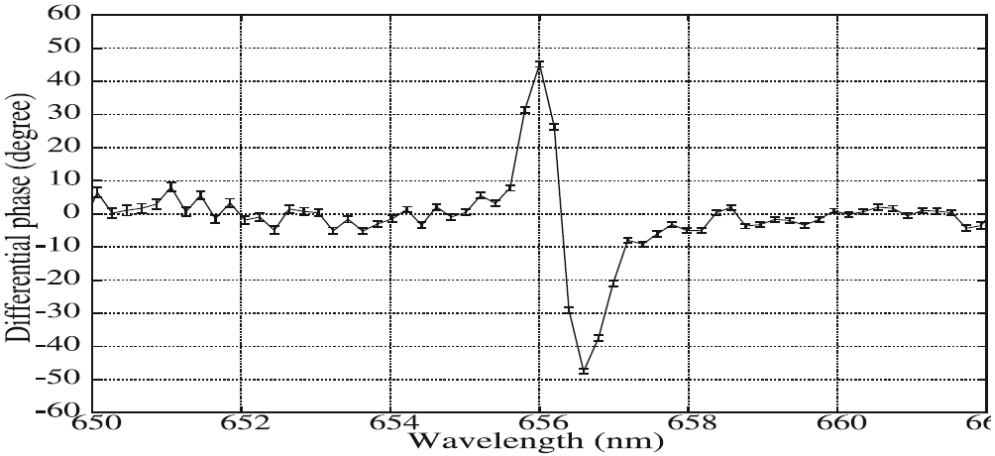
Spectrograph Characteristics



Instrumental visibility

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

Limiting magnitude



Differential phase

δ	HA(h)	λ(nm)	$V^2_{\rm Nat}$	$V^2_{\rm High}$	$V^2_{\rm Low}$
29°	[0;+5]	640	0.36 ± 0.02	0.34 ± 0.02	0.36 ± 0.03
29°	[0;+5]	650	0.34 ± 0.03	0.36 ± 0.02	0.38 ± 0.04
52°	[−1;+4]	640	0.40 ± 0.04	0.34 ± 0.03	0.38 ± 0.02
52°	[−1;+4]	650	0.38 ± 0.03	0.38 ± 0.03	0.44 ± 0.01
63°	[−1;+4]	640	0.26 ± 0.01	0.24 ± 0.01	0.24 ± 0.02
63°	[−1;+4]	650	0.28 ± 0.01	0.28 ± 0.02	0.28 ± 0.02

Polarisation behaviour

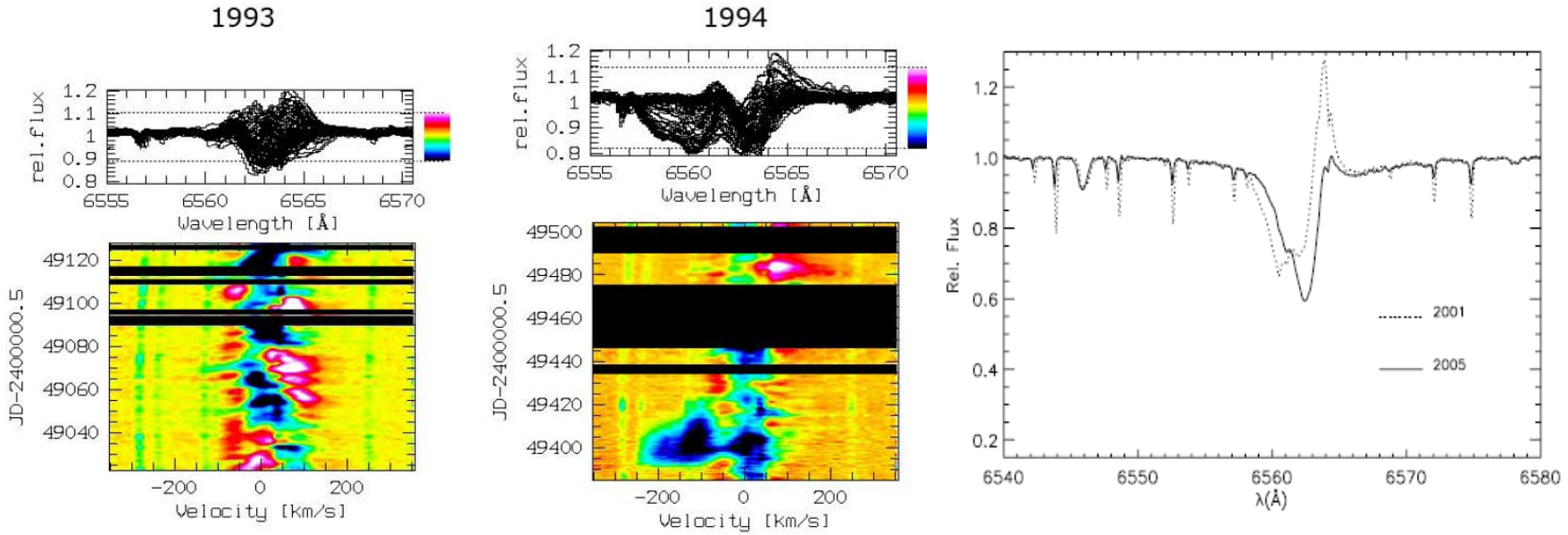
A spatially and spectrally resolved temporal monitoring of the Hα line-forming regions of Deneb and Rigel with VEGA/CHARA ⋆

Submitted soon

O. Chesneau[1], L. Dessart[2] D. Mourard[1], Ph. Bério[1], Ch. Buil[3], D. Bonneau[1], M. Borges Fernandes[1], J.M. Clausse[1], O. Delaa[1], A. Marcotto[1], A. Meilland[4], F. Millour[4], N. Nardetto[1], A. Roussel[1], K. Perraut[5], A. Spang[1], P. Stee[1], I. Tallon-Bosc[6], H. McAlister[7,8], T. ten Brummelaar[8], J. Sturmann[8], L. Sturmann[8], N. Turner[8], C. Farrington[8] and P.J. Goldfinger[8]

Interests in the visible of A/B supergiants (e.g. Deneb A2Ia, and Rigel B8Ia):

- Very bright and used as stellar candles,
- large diameters (60-100 solar radii), Deneb and Rigel are 2-3mas sources
- Variability in Hα line (R>10000), sensitive to mass-loss and its perturbations, time scale weeks to months.

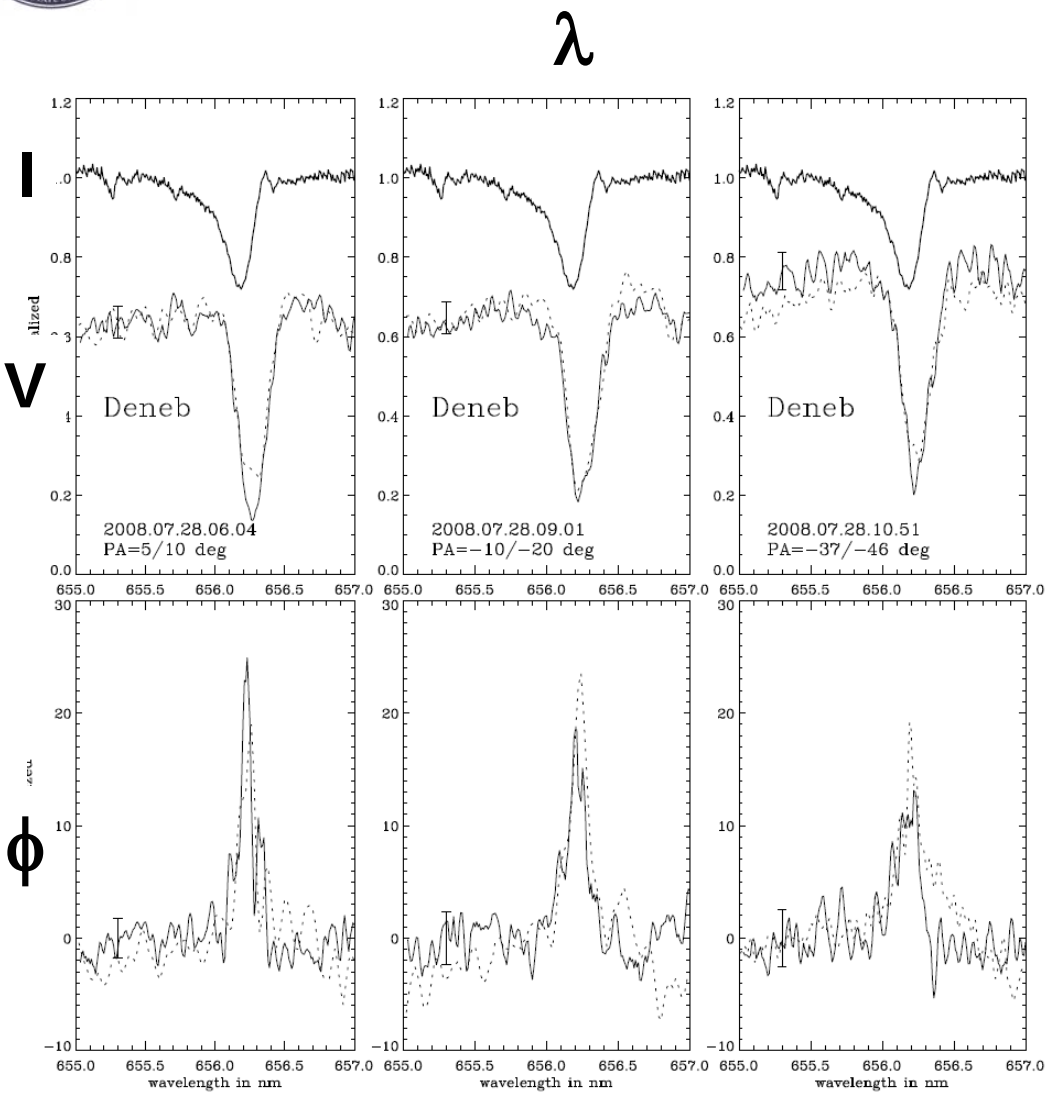


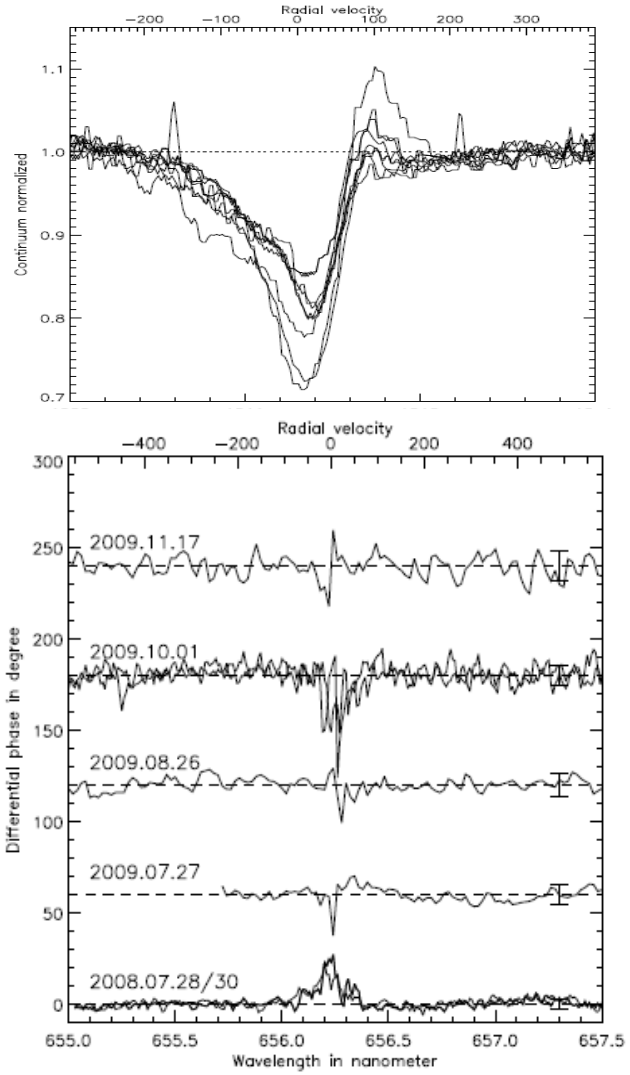
Rigel, Kaufer et al. 1997, PhD thesis

Deneb, Przybilla et al. 2008

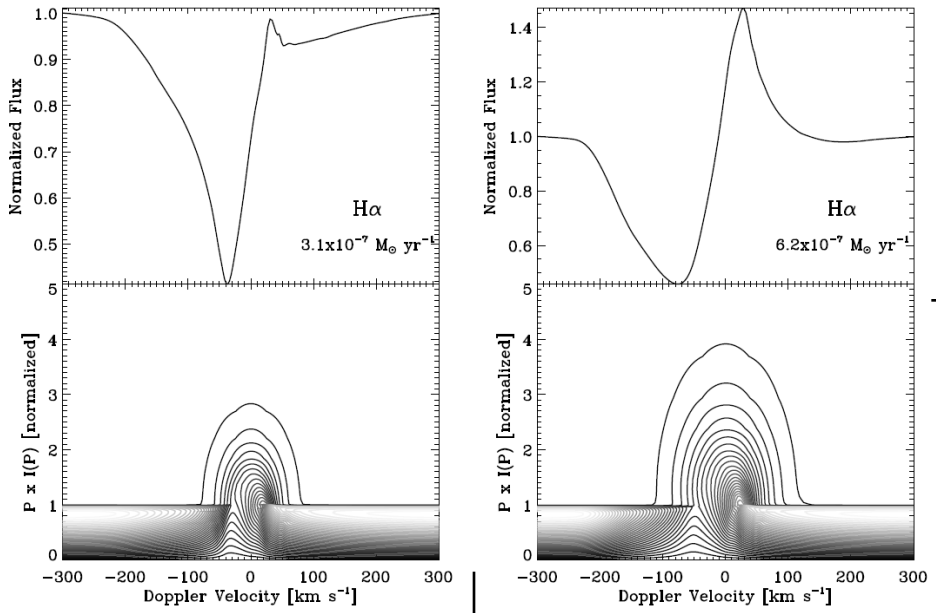
VEGA/CHARA observations of Deneb: the Hα line

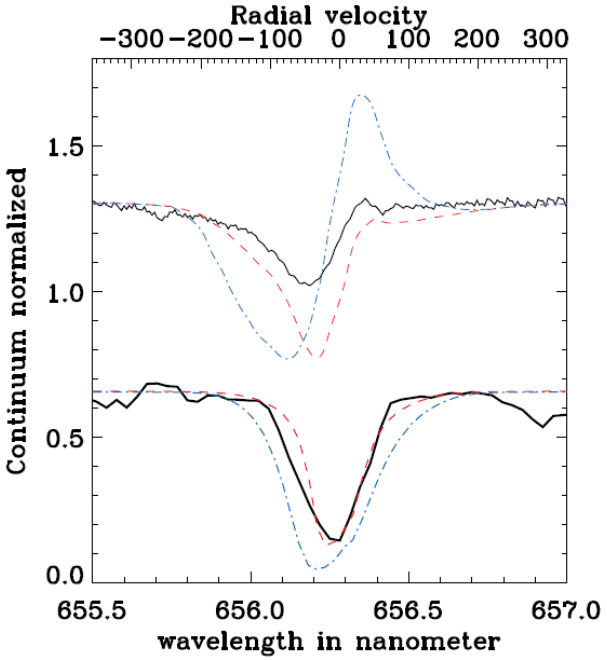
Time variability

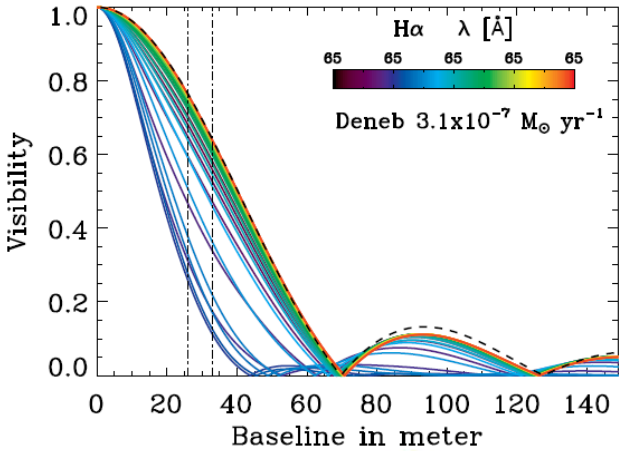




Full 1D modeling of the wind of Deneb







Parameters from the model of Schiller et al. 2008

Conclusions:

-The Hα line is complex, subtle opacity effects,

-The visibility curve is a better indicator of mass-loss rate. The observed visibilities are *very close* to the model

- The continuum diameter in the near-IR is predicted to be 2-3% larger than in the visible,

- The near-IR visibility curve is *much less dependant on any mass-loss rate variations than in the visible*. The CHARA/FLUOR observations were probably not very sensitive to circumstellar material.

LETTER TO THE EDITOR

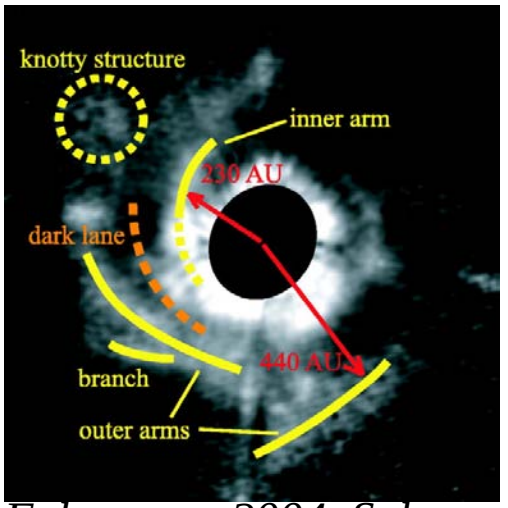
Submitted soon

The Hα line forming region of AB Aur spatially resolved with VEGA/CHARA ⋆

K. Perraut[1], S. Rajabi[2,3], M. Benisty[3], D. Mourard[4], F. Bacciotti[3], Ph. Bério[4], D. Bonneau[4], O. Chesneau[4], J.M. Clausse[4], O. Delaa[4], A. Marcotto[4], A. Roussel[4], A. Spang[4], Ph. Stee[4], I. Tallon-Bosc[5], H. McAlister[7,8], T. ten Brummelaar[7], J. Sturmann[7], L. Sturmann[7], N. Turner[7], C. Farrington[7] and P.J. Goldfinger[7]

AB Aur is a **prototype of Herbig Ae/Be stars** and, as such, it has been fully observed in spectroscopy, in infrared interferometry (PTI, IOTA, …)

- Spectral type : A0
- Magnitudes : V = 7.1 / K = 4.4
- Distance : 144 pc
- Luminosity : 47 $L_{\odot}$
- Large infrared excess
- No jets, no CO flow
- Variability of the Hα emission at a scale of a few hours

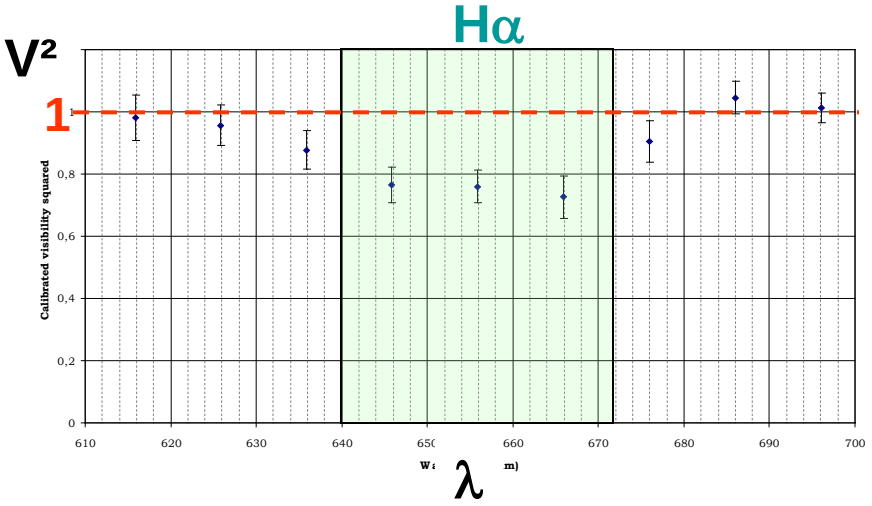


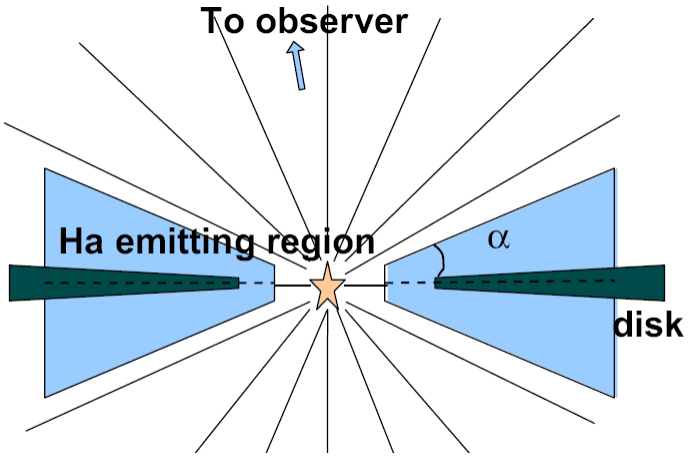
Fukagawa, 2004. Subaru

⇨ **Stellar activity, link wind and disc, …**

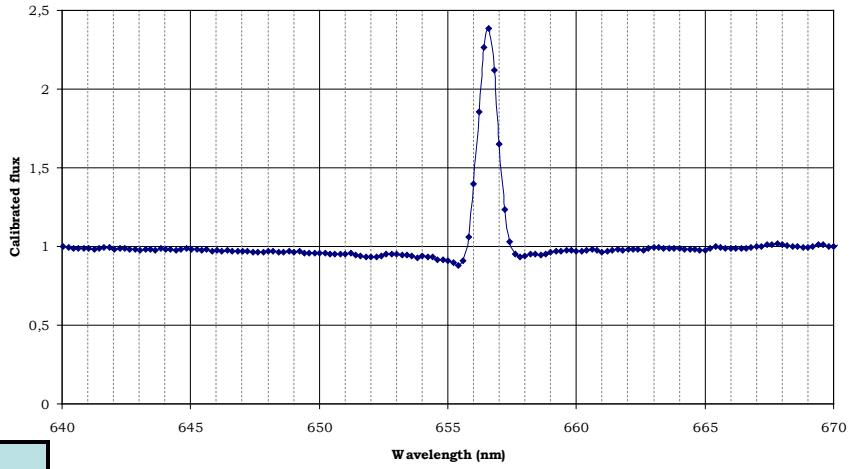
VEGA observations

- **2008. S1S2: Clear spatial resolution of AB Aur in Hα**
- **2008. W1W2:** Fringes but SNR too poor
- **2009. S1S2:** Tracking problem





Wind modelling



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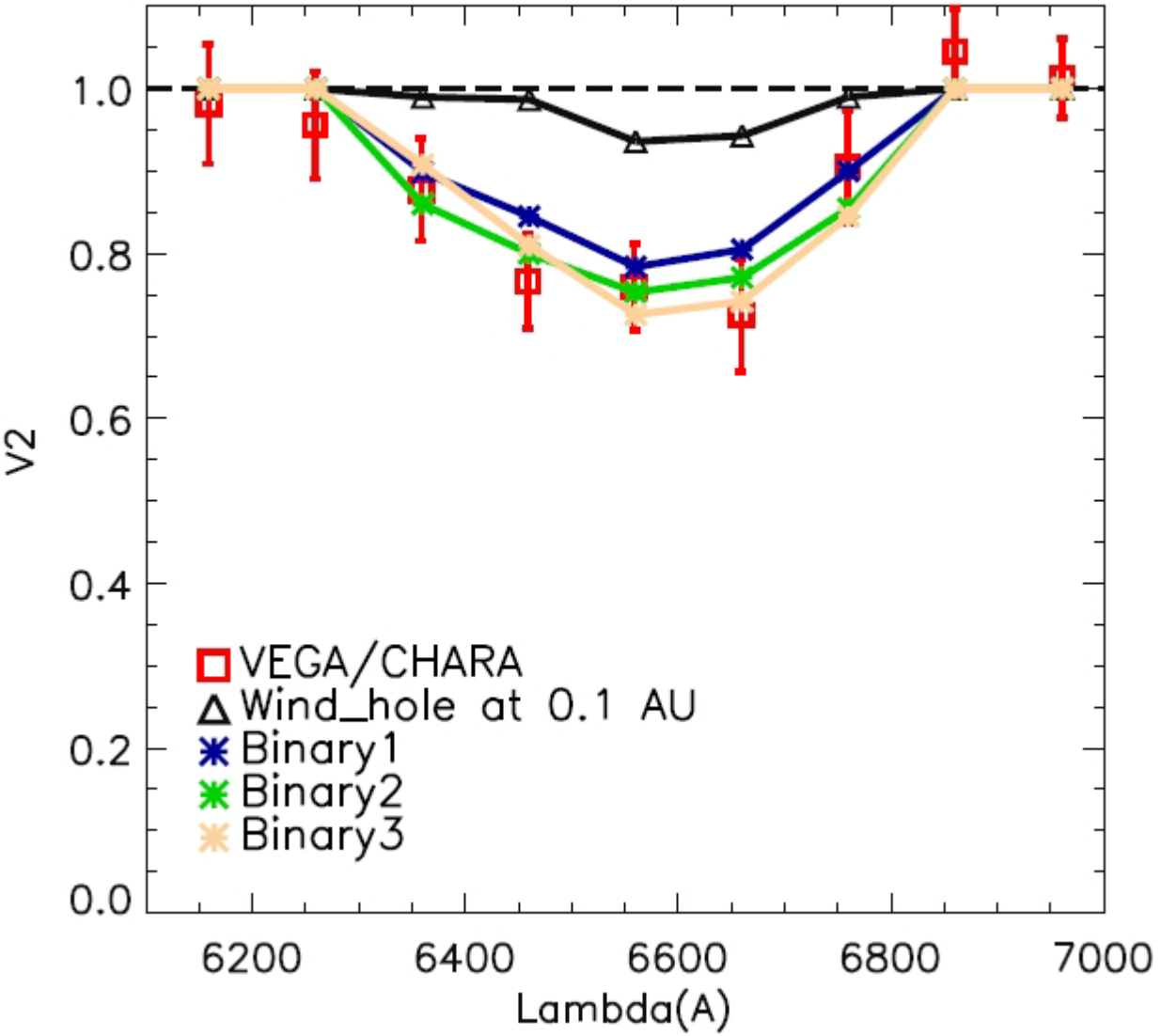

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Future plans

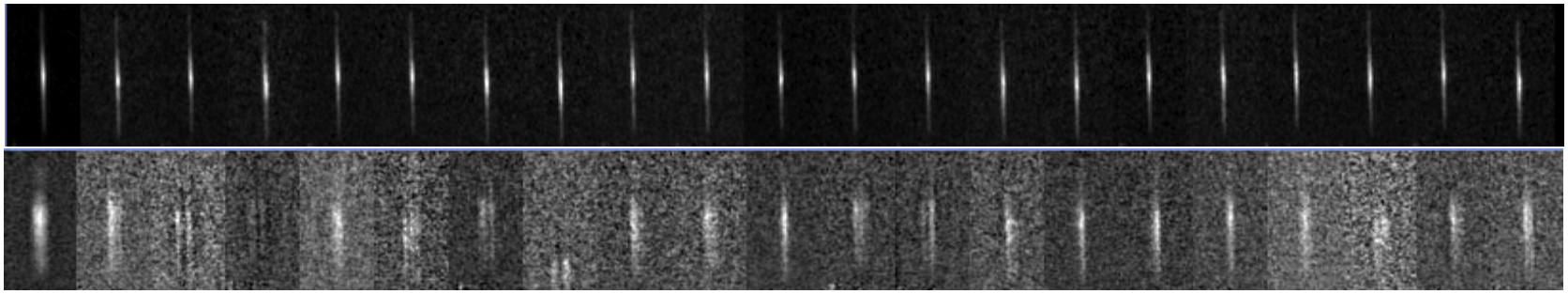
- Publications

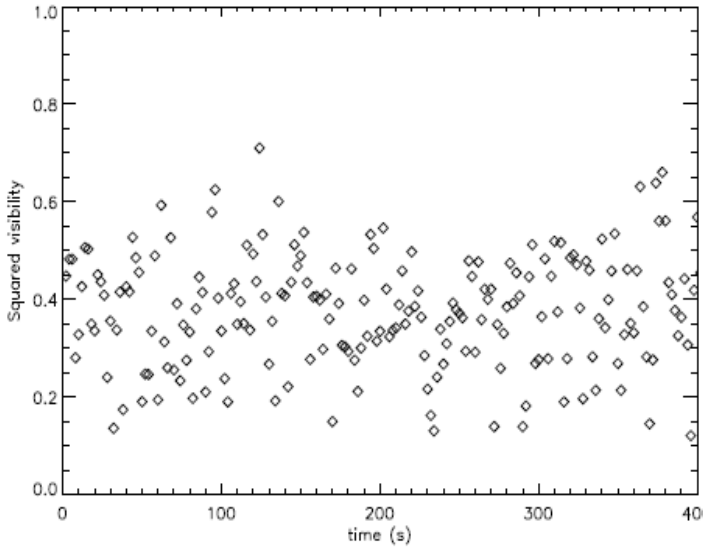
- Improved processing
- Tracking
- Stability and optimization of the instrumental visibility
- Better ergonomics of VEGA in general

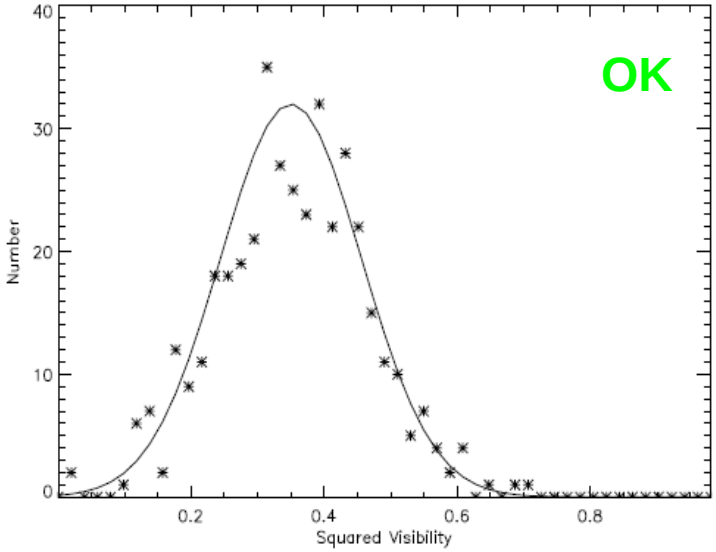
Recent works: temporal processing

OK

KO?

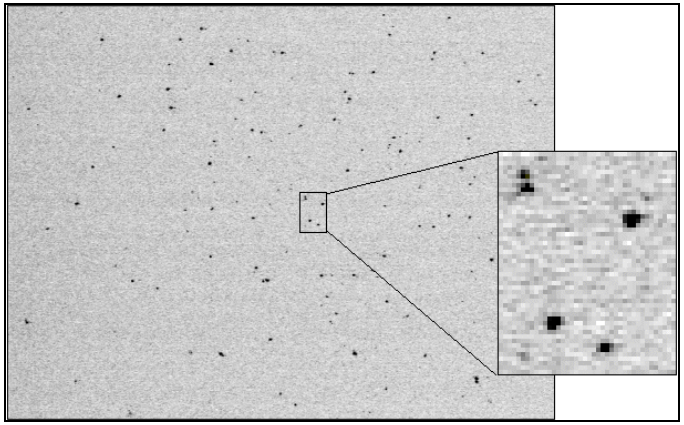


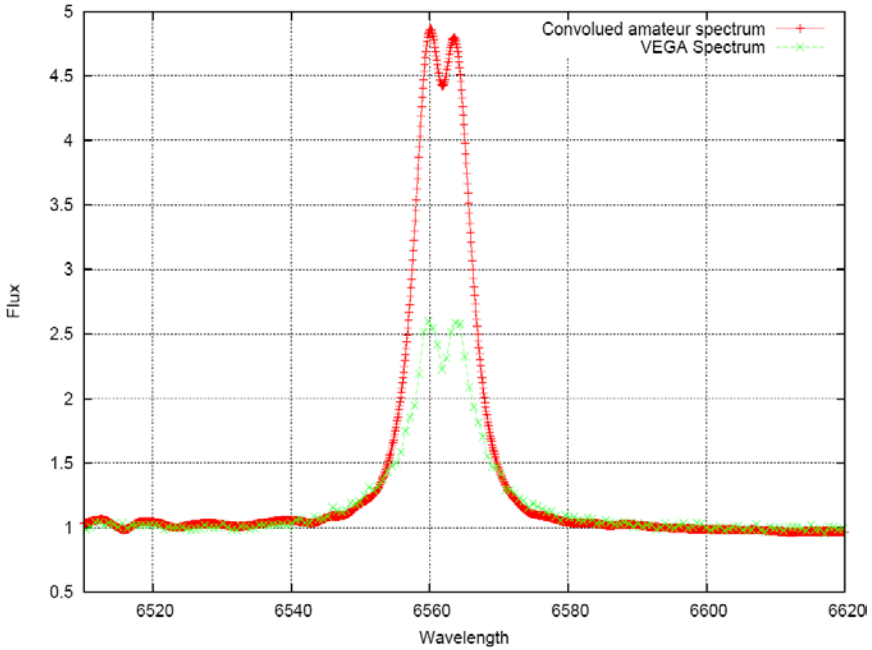




This statistical analysis improves the data analysis: bias removal, better estimation even in case of poor tracking.

Recent work: photon centroiding hole





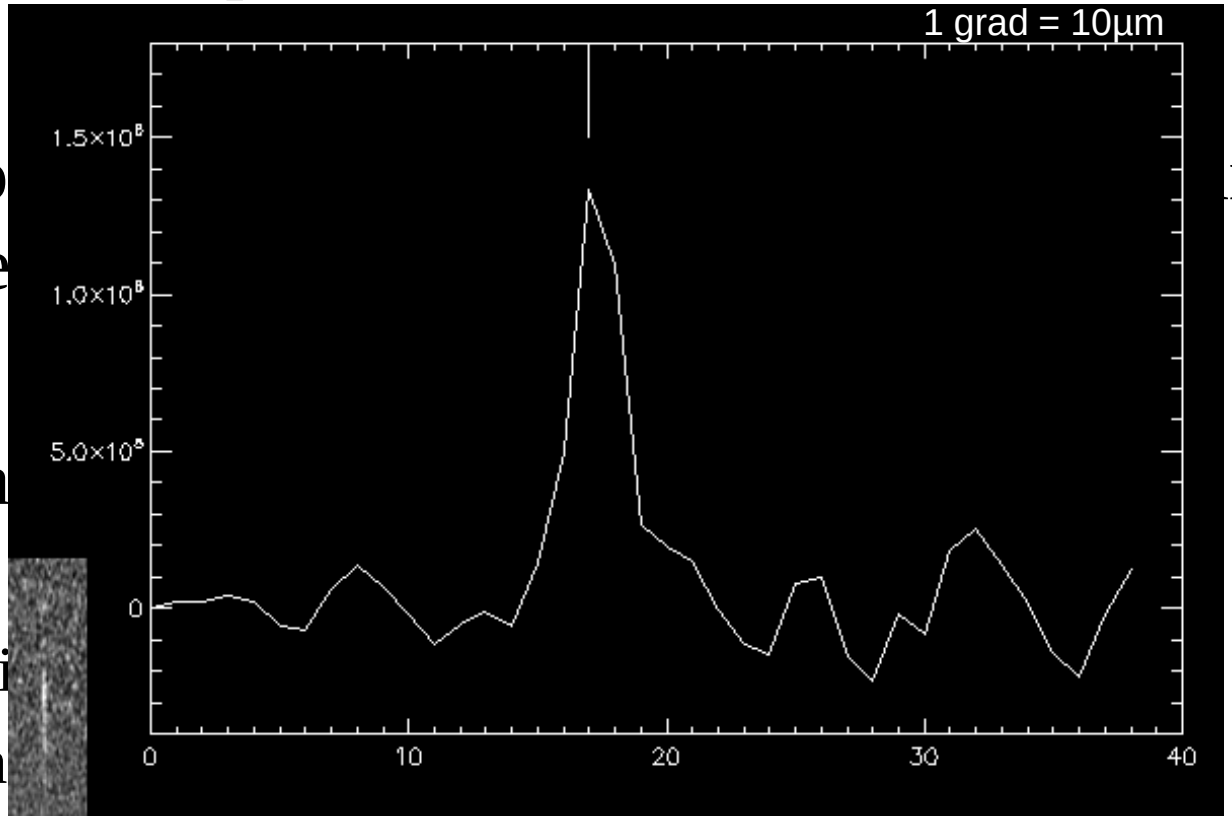
Saturation effect in the emission lines

Improved algorithm will be necessary: need to record more and larger sub-images and develop an optimized post-processing.

We plan some tests of EMCCD detectors that could be used in the future in the bright flux regime.

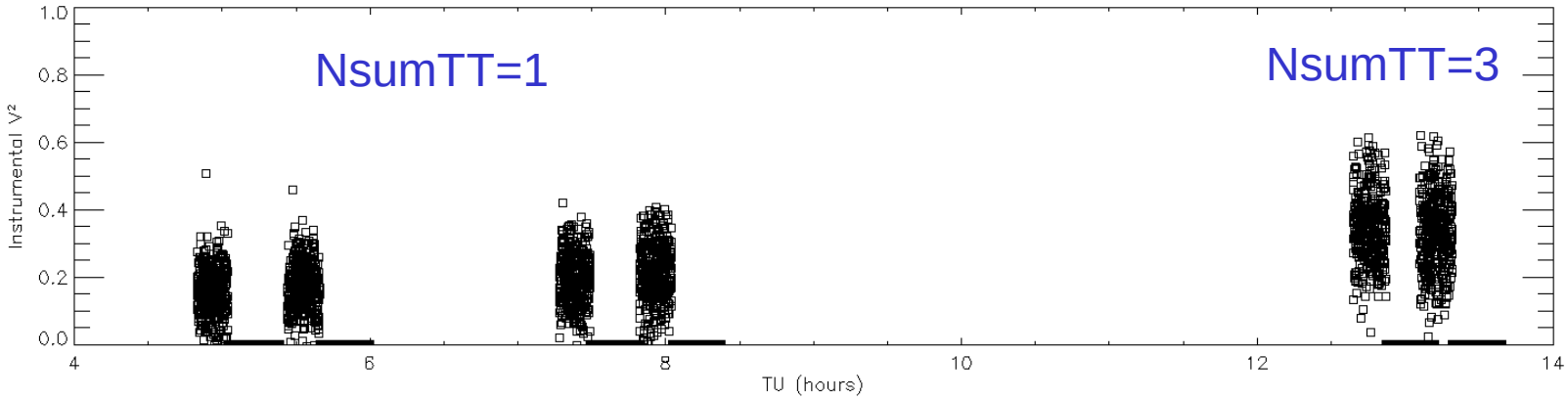
Work on tracking

- Bad behaviour of the internal group delay tracking. Need some improvements.
- Tests o re foresee
- Accura
  - Low
  - Medi
  - High



Instrumental visibility

Calibrator of eps Aur, on 2009 november 17th



The idea is to take time to test that in different conditions:

- integration time of the tip/tilt (fast piston noise?)
- effects of OPLE position?
- effects of external perturbations?

Ergonomics of VEGA

- Preparation is fine, for 2T.
  - New plans for 3T with improved performances (via JMMC and new ASPRO software).
- Night scheduling is horrible:
  - different strategies, important number of observing blocks, experience of observers.
  - Needs are identified but nobody for doing that!
  - Two levels: during the preparation and at the time of observations.
  - Similar needs on other instruments?
- Automatic fast processing at the end of the night.
  - Should be operational by the summer.
  - The idea is an automatic quality check with results stored in the database.
- We are starting a kind of VO tool aiming at managing all information and software related to VEGA observations.
  - Prototype by the end of 2010 if funded.

Conclusions

Continuous efforts on data processing.

Better focus on specific and unique science programs.

Better ergonomics of VEGA for a wider use inside the CHARA group.

Develop the VEGA and CHARA communications for a better operation.

Thanks to CHARA team

Hal, Theo, Judit, Laszlo, Nils, Chris, PJ, Gail, Steve and Larry