VEGA: Status and future plans

Denis Mourard

2011 observations

- 60 nights scheduled, 48 with data
  - 2 runs (june=10n, october=11n)
  - 39 nights in remote (july, august, september, november, december)
- ~300 calibrated measurements, ~6-7 per night. 2To.
- ~10-15 programs in //.

- Almost no technical activities on VEGA in 2011:
  - Improvements of network reliability in Nice
  - Ghost removal in the red camera
  - Data processing improvement
  - Installation of vegadrs-mwi (thanks Nils & Theo)

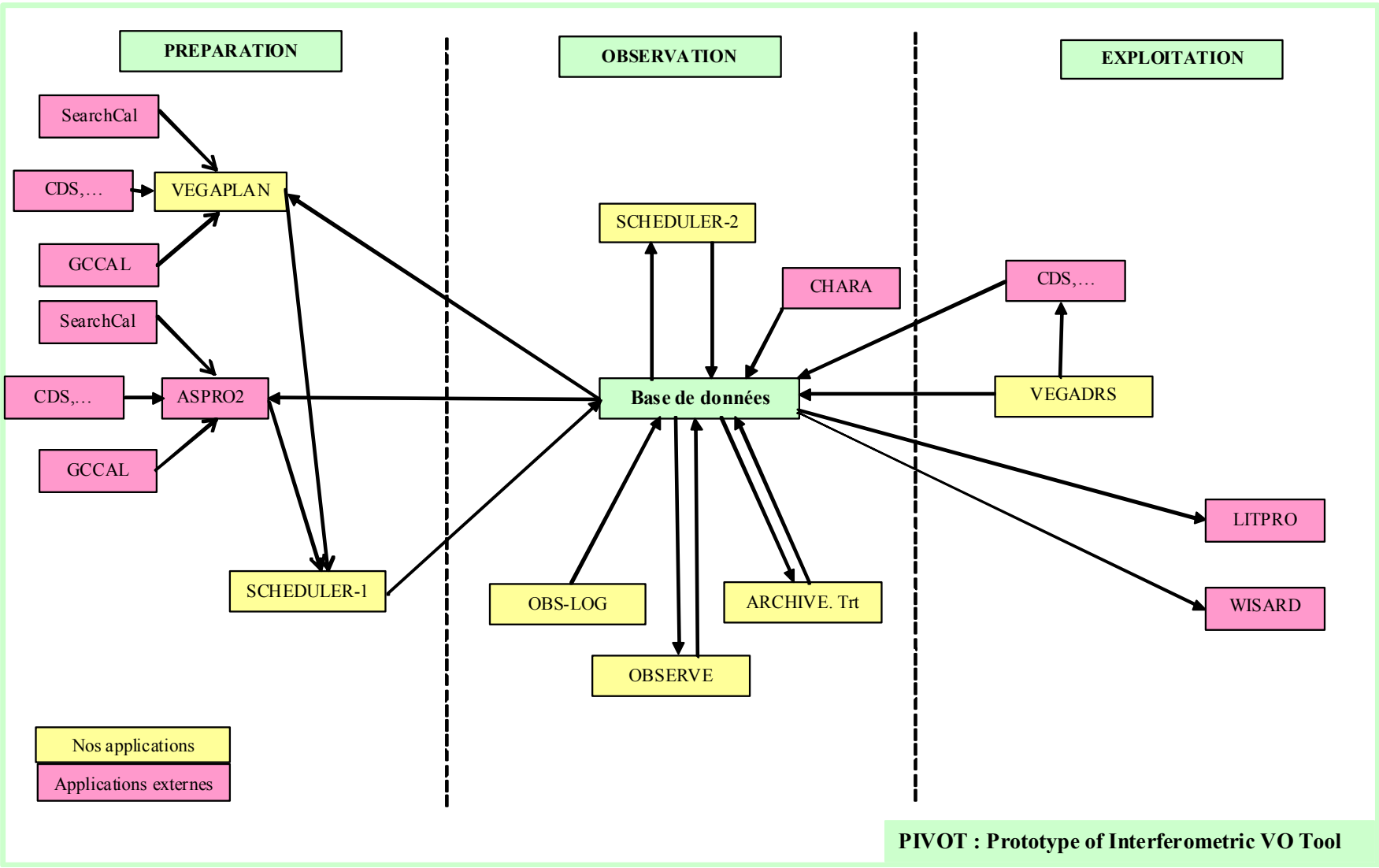
2011 science activities

- Science (vegaobs@oca.eu): 30 persons
  - 15 OCA/Lagrange with 3 engineers (20-30%)
  - 5 in other labs in France (Grenoble, Lyon mainly)
  - 10 international collaborators: CHARA, Univ. Michigan, Denver, Univ. Praha, MPIA Heidelberg, Univ. Tunis, Téhéran, Leuven

- Data reduction (vega-drs@oca.eu): 6-8 persons
  - Improvements of post-processing tools
  - Systematic error related to calibrator's diameter uncertainty
  - Better estimate of statistical errors

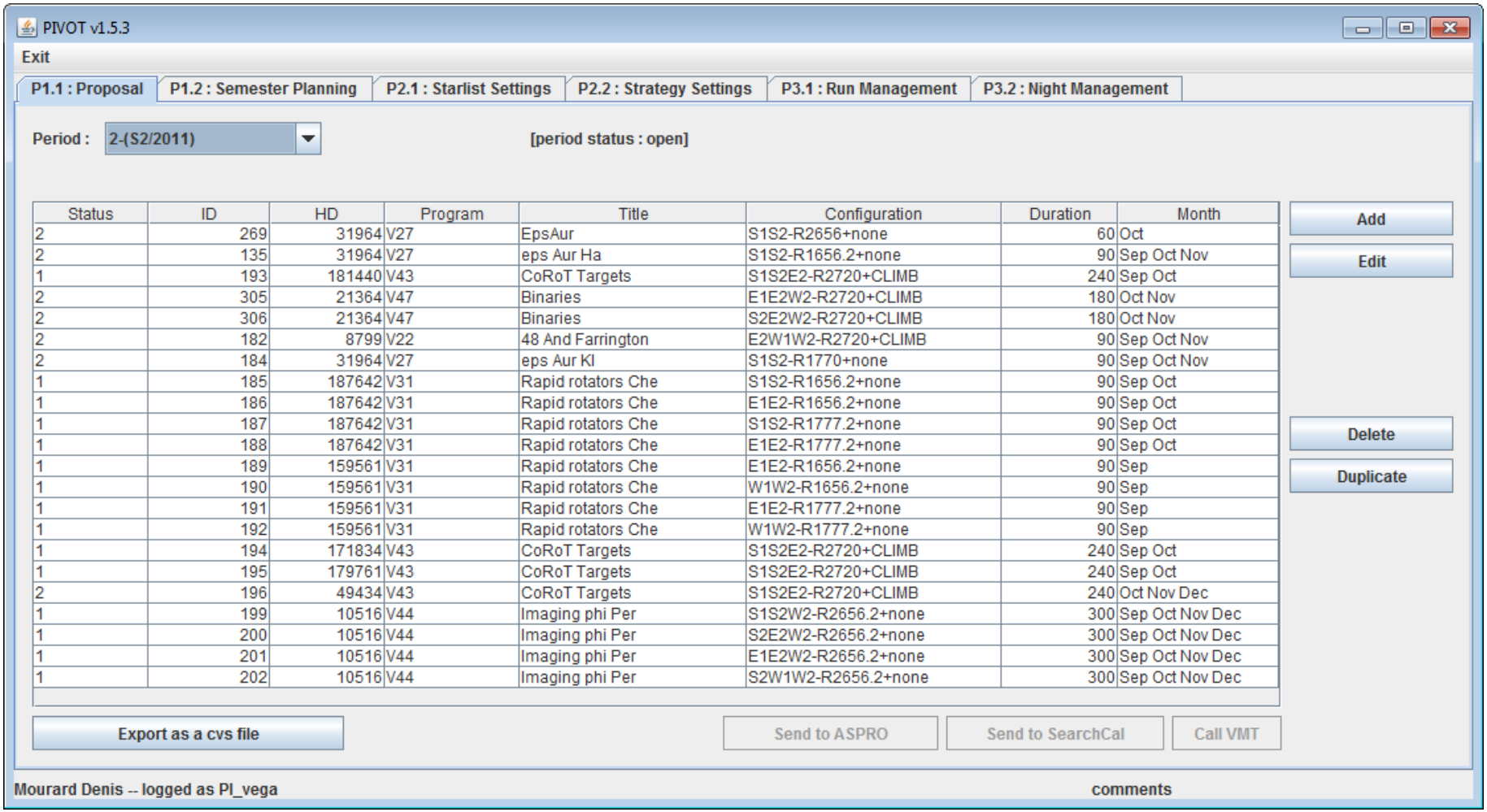
- Funding of VEGA in 2012
  - CNRS=7.9k€, OCA=11k€
  - Special funding of Lagrange laboratory ~ 25k€ (detector)
  - Grenoble and Lyon Observatory funding (CNRS and University) ~5k€
  - *Request for ANR funding (400k€/4 years): 2 post-docs position, 1 software engineer.*
    "100 étoiles": exoplanet host stars, asteroseismology, close stars… 3D hydro + transfer modeling

VEGA management



PIVOT : Prototype of Interferometric VO Tool

PIVOT interface



Status	ID	HD	Program	Title	Configuration	Duration	Month
2	269	31964	V27	EpsAur	S1S2-R2656+none	60	Oct
2	135	31964	V27	eps Aur Ha	S1S2-R1656.2+none	90	Sep Oct Nov
1	193	181440	V43	CoRoT Targets	S1S2E2-R2720+CLIMB	240	Sep Oct
2	305	21364	V47	Binaries	E1E2W2-R2720+CLIMB	180	Oct Nov
2	306	21364	V47	Binaries	S2E2W2-R2720+CLIMB	180	Oct Nov
2	182	8799	V22	48 And Farrington	E2W1W2-R2720+CLIMB	90	Sep Oct Nov
2	184	31964	V27	eps Aur KI	S1S2-R1770+none	90	Sep Oct Nov
1	185	187642	V31	Rapid rotators Che	S1S2-R1656.2+none	90	Sep Oct
1	186	187642	V31	Rapid rotators Che	E1E2-R1656.2+none	90	Sep Oct
1	187	187642	V31	Rapid rotators Che	S1S2-R1777.2+none	90	Sep Oct
1	188	187642	V31	Rapid rotators Che	E1E2-R1777.2+none	90	Sep Oct
1	189	159561	V31	Rapid rotators Che	E1E2-R1656.2+none	90	Sep
1	190	159561	V31	Rapid rotators Che	W1W2-R1656.2+none	90	Sep
1	191	159561	V31	Rapid rotators Che	E1E2-R1777.2+none	90	Sep
1	192	159561	V31	Rapid rotators Che	W1W2-R1777.2+none	90	Sep
1	194	171834	V43	CoRoT Targets	S1S2E2-R2720+CLIMB	240	Sep Oct
1	195	179761	V43	CoRoT Targets	S1S2E2-R2720+CLIMB	240	Sep Oct
2	196	49434	V43	CoRoT Targets	S1S2E2-R2720+CLIMB	240	Oct Nov Dec
1	199	10516	V44	Imaging phi Per	S1S2W2-R2656.2+none	300	Sep Oct Nov Dec
1	200	10516	V44	Imaging phi Per	S2E2W2-R2656.2+none	300	Sep Oct Nov Dec
1	201	10516	V44	Imaging phi Per	E1E2W2-R2656.2+none	300	Sep Oct Nov Dec
1	202	10516	V44	Imaging phi Per	S2W1W2-R2656.2+none	300	Sep Oct Nov Dec

JAVA Webservice+Data base linked with ASPRO2 (JMMC)

2011 publications

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

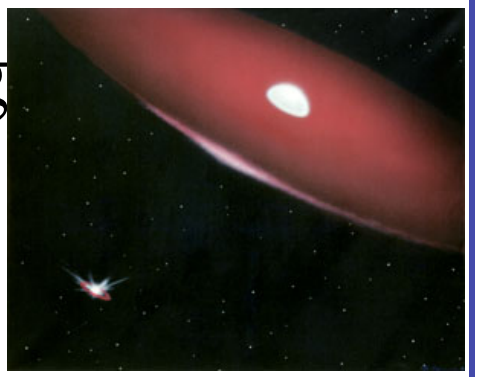
1. "An investigation of the close environment of β Cep with the VEGA/CHARA interometer", Nardetto, Mourard, Tallon-Bosc et al., A&A 525 (A67) (2011)
2. "The fundamental parameters of the roAp star γ Equ", Perraut, Brandao, Mourard et al. , A&A 526 (A87) (2011)
3. "Kinematics and geometrical study of the Be stars 48 Per and ψ Per with the VEGA/CHARA interferometer", Delaa, Stee, Meilland et al., A&A 529 (A87) (2011)
4. "Spatio-spectral encoding of fringes in optical long-baseline interferometry. Example of the 3T and 4T recombining mode of VEGA/CHARA", Mourard, Bério, Perraut et al., A&A 531, A110 (2011)
5. "A large Hα line forming region for the massive interactive binaries β Lyrae and υ Sagitarii", Bonneau, Chesneau, Mourard et al., A&A 532, A148 (2011)
6. "The binary Be star δ Sco at high spectral and spatial resolution. I Orbital elements, disk geometry and kinematics before the 2011 periastron", Meilland, Delaa, Stee et al., A&A 532, A80 (2011)
7. "The diameter of the CoRoT target HD49933. Matching the hydrodynamical limb darkening, asteroseismology and the VEGA/CHARA interferometric data", Bigot, Mourard, Thévenin et al., A&A 534, L3 (2011)
8. "Chromosphere of K giant stars: geometrical extent and spatial structure detection", Bério, Merle, Thévenin et al., A&A 535, A59 (2011)

Works in progress

- γ Cas I & II (Smith et al., Stee et al.)
- MWC361: almost ready: discussion on accretion at periastron. Benisty et al.
- ε Aur: almost ready for submission, Mourard et al.
- α Cephei: rotation. paper almost ready, Delaa et al.
- θ Cyg + others host stars (see Ligi)

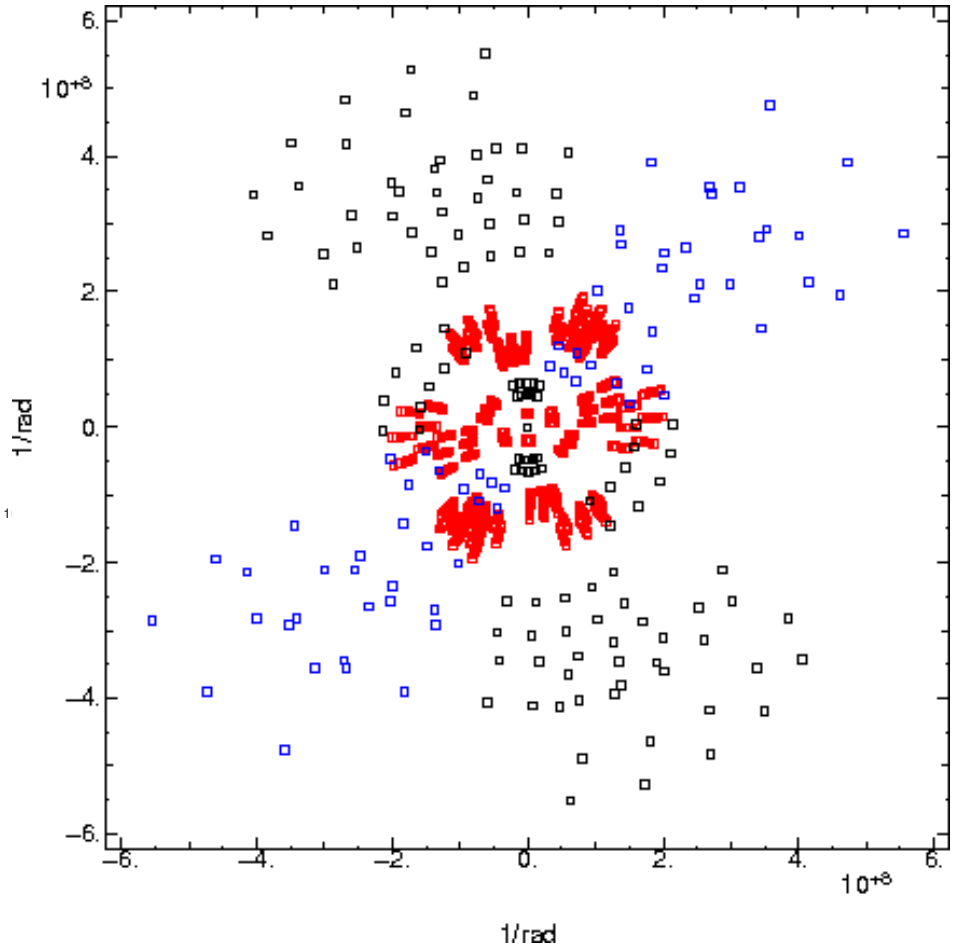
- HR7349: CoRoT giant target, VEGA+CLIMB but more data is expected. Bigot et al.
- AB Aur: paper on the model including VEGA data. Variability for long term purpose. Perraut et al.
- λ Tau: eclipsing binary. Paper in preparation, Nardetto et al.
- CoRoT targets: good data, interpretation in progress
- P Cygni: draft existing including modeling (OC). CLIMB Brγ to come.
- Phi Persei: MIRC6T+VEGA4T: april-may (John's visit in Nice)

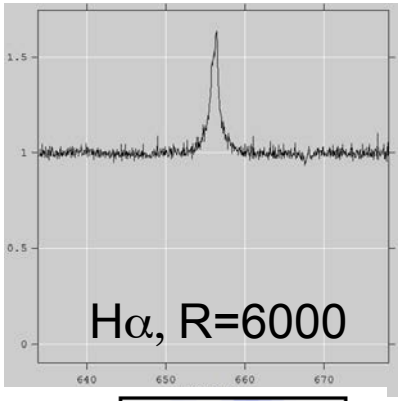
Perspectives of spectral imaging

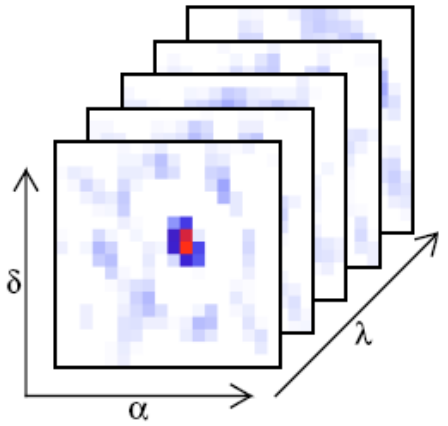


October 18th and 19th on CHARA ϕ Persei

MIRC 6T @ 1.6μm, VEGA 4T @ 656-487nm







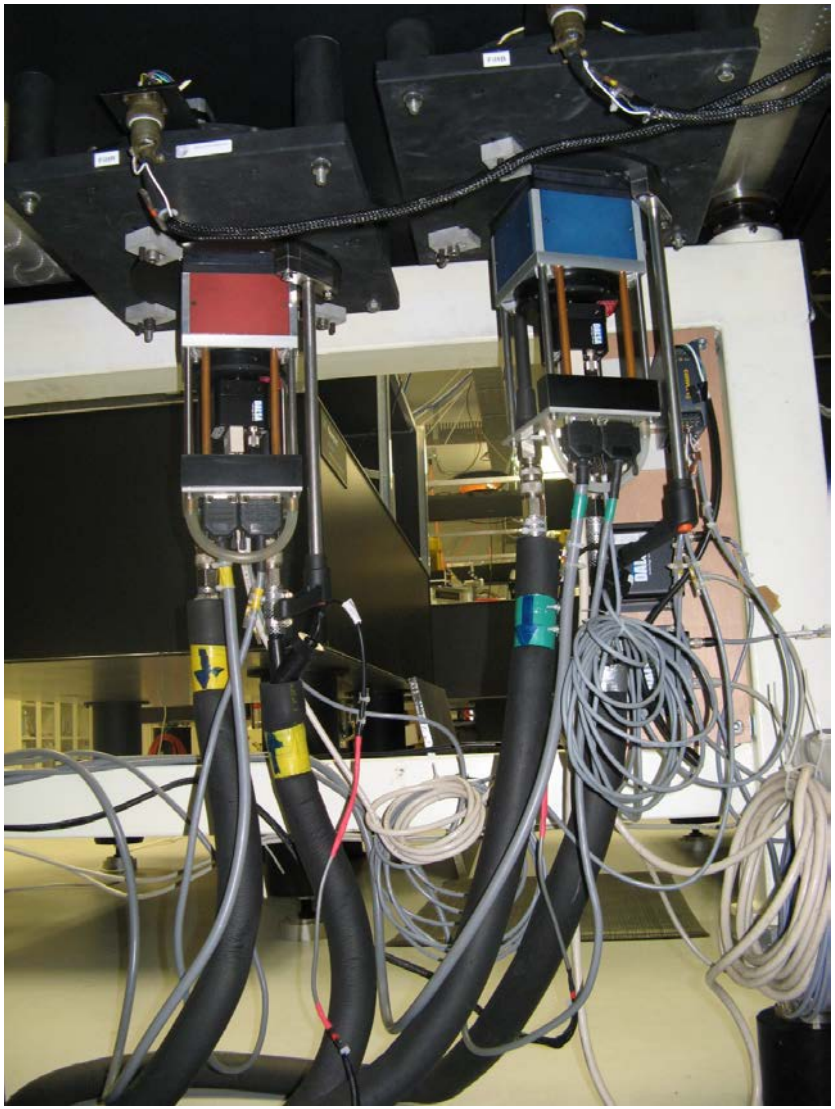
Principle in Millour et al., A&A526, 2011

Current known limitations

- Photon counting detectors: saturation effects
  - Locally on intense emission lines
  - Globally on bright stars or 3T/4T modes
  - Quantum efficiency
  - Overheads (15ms of exposure every 25ms)
  - Hard to work around 500nm (seeing effects)
- Hard to get accurate measurements on low V^2
- SNR of closure phase measurements in photon counting regime.

- Instrumental V^2
  - Difference between baselines
  - Difference with time on a same baseline

EVOLUTION OF VEGA DETECTORS

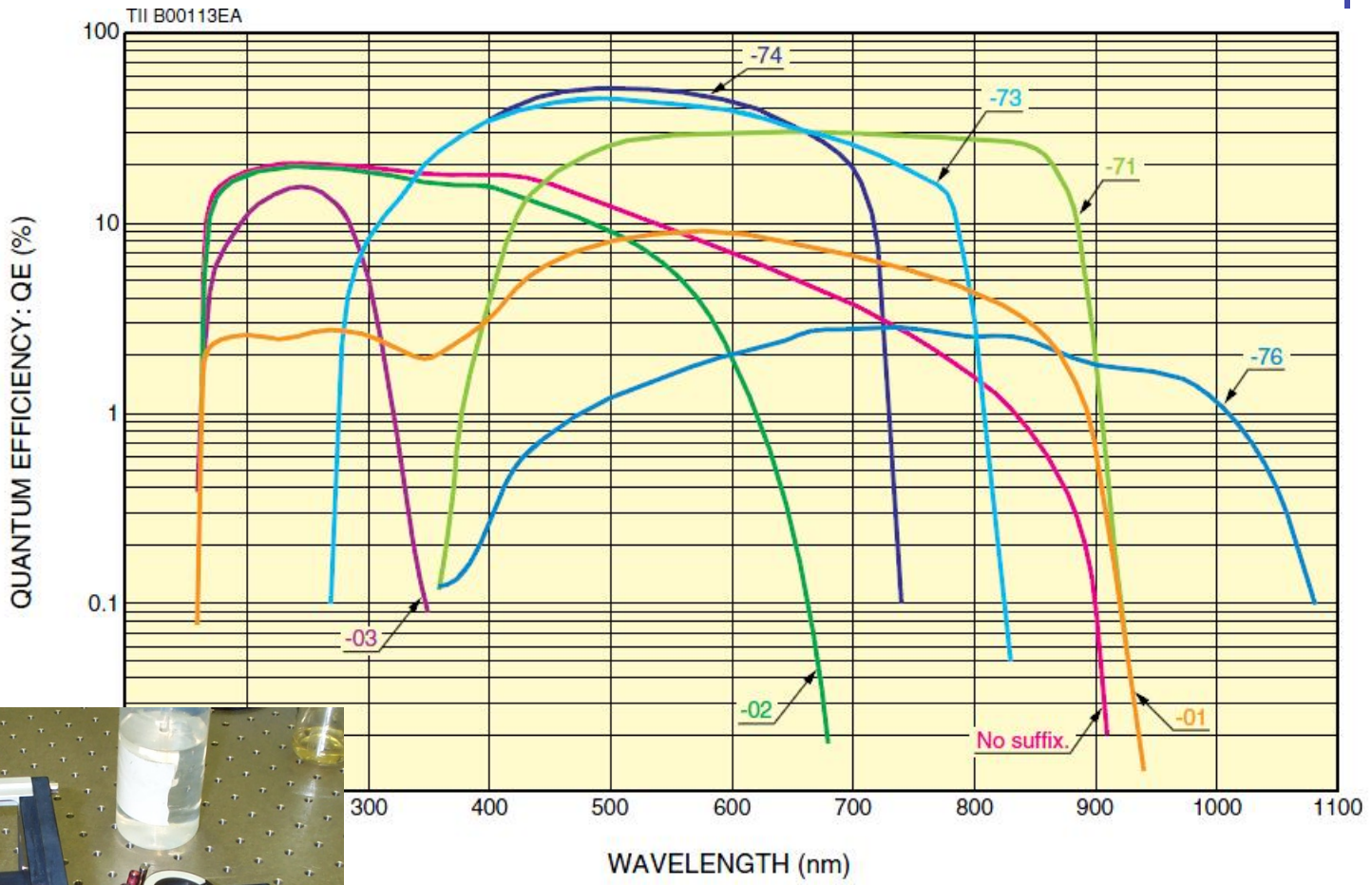


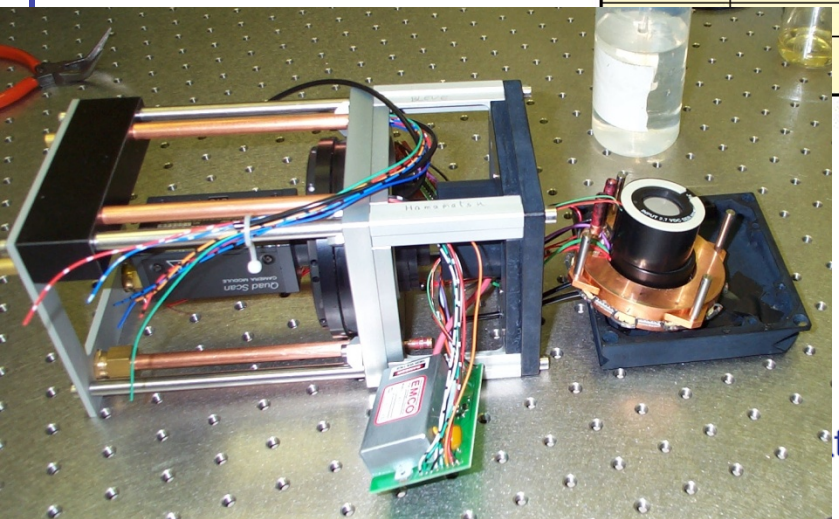
ALGOLR & ALGOLB
Photon counting detector

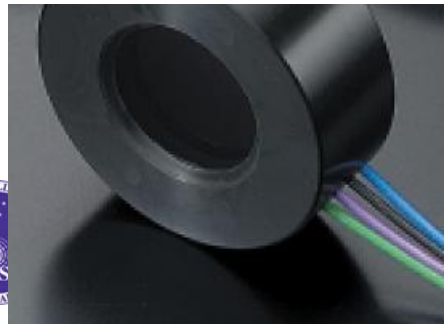
Upgrade of ALGOLB
towards a modern
ALGOLR-2

Intensifier modification

71 instead of 74







New camera

Point Grey Gazelle
Pixel 5.5 µm 2048x2048
Binning 2x2
150 Frames/sec
MROI (multiple Region Interest)
2 cameralink 10m cables

New computer

Windows Seven, 1 processor 6 cores
High speed disk 15K rpm
Frame Grabber Dalsa Xcelera PX4 Full
On board functions
Dark substract
Flat field correction

Integration will start in april. Tests in lab during summer, on the sky in october
Overhead: 40% → 0%, 5ms of exposure time (x3 in flux)

Evolution of VEGA in 2-3 years from now

Why thinking to a second generation of instrument?

- Installation of AO on CHARA telescopes
- Saturation in photon counting (high flux ou low D/r0)

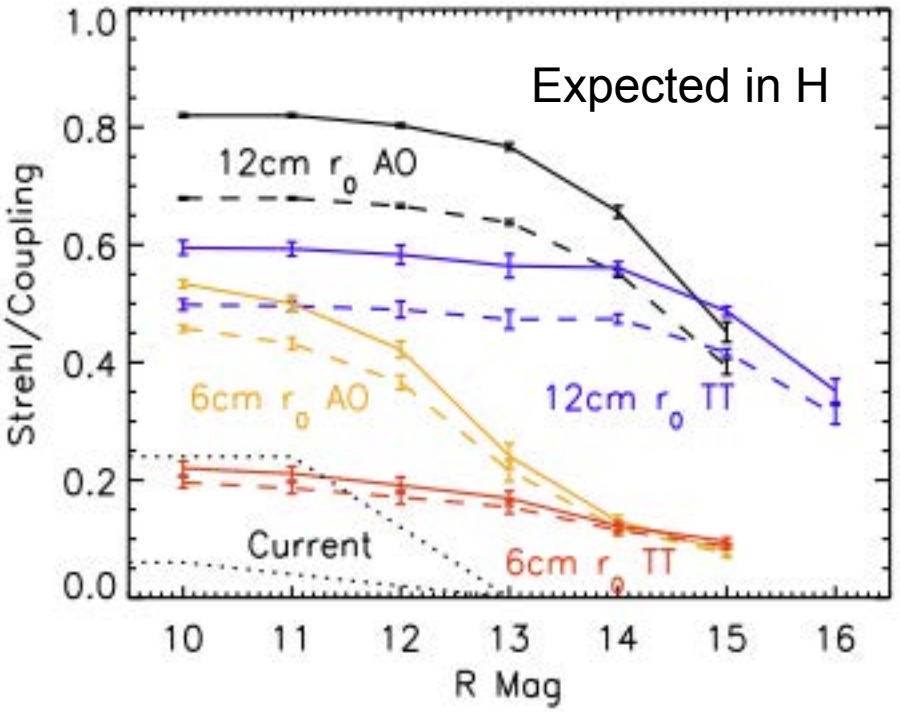
Analog detectors, low noise, high QE

- Measuring low V^2 is difficult
- Improving the limiting magnitude
- Improving accuracy of measurements

Spatial filtering

- 6 beams combination

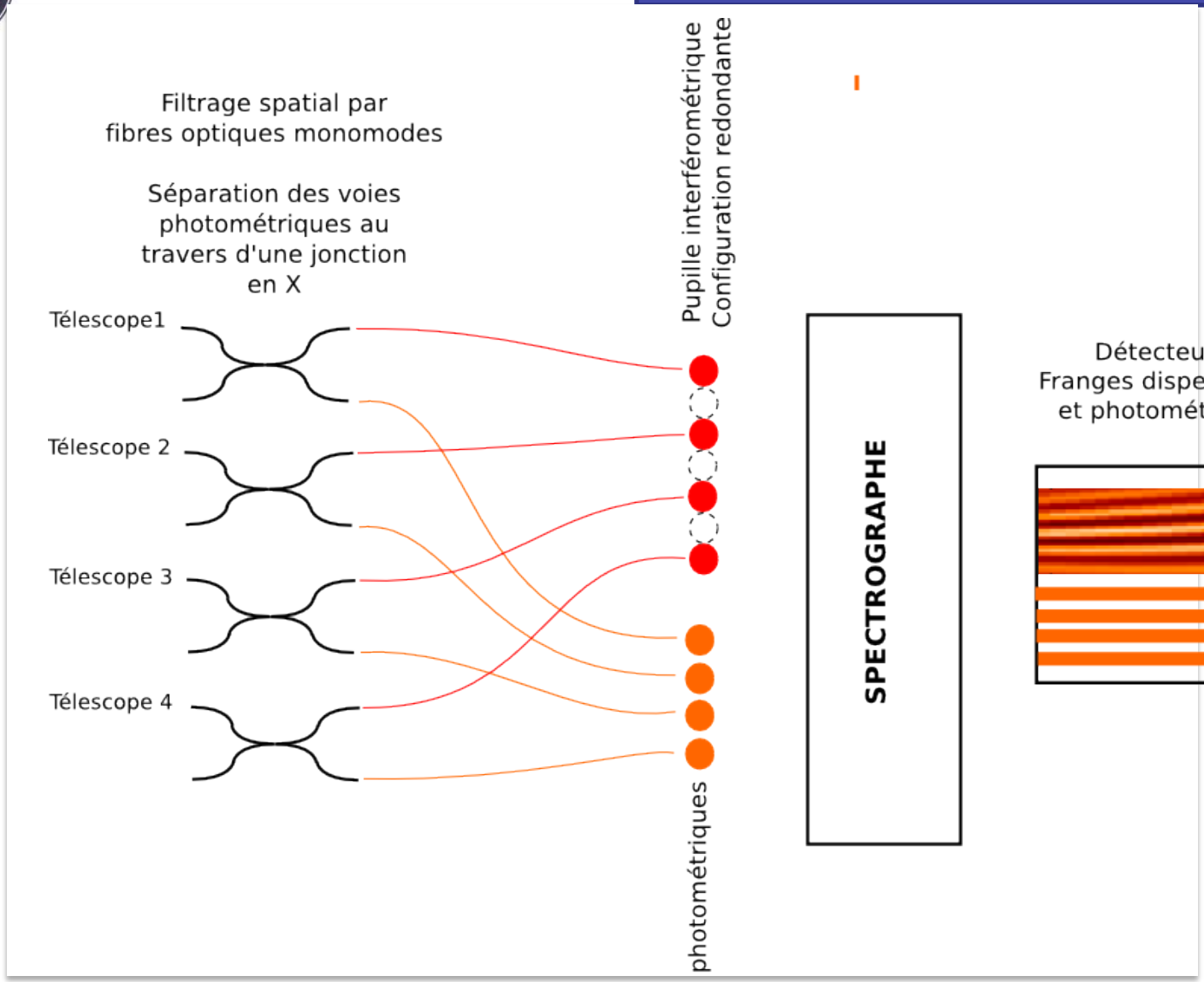
Estimation of CHARA-AO performances



Estimation in visible (700nm)

- Strehl ≈30% for r0=12cm
  => coupling efficiency ≈25%
- Strehl ≈6% for r0=6cm
  => Coupling efficiency ≈5%

Principle of beam combination



Low noise detector

Commercial solution:

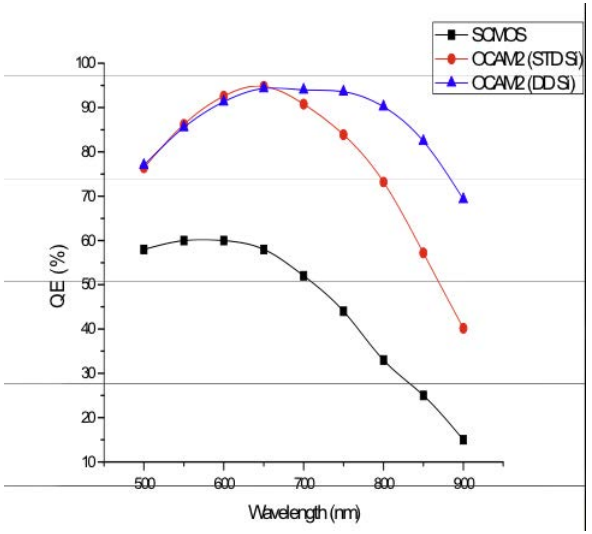
ORCA-flash4 de Hamamatsu, NEO sCMOS de Andor

- 100 fps
- QE < 70%
- readout noise > 1.3 e^-
- > 4Mpixels

OCAM2:

Fast and low noise detector (Grenoble&Marseille)

- 1500 fps
- QE > 90% from 600nm to 800nm
- readout noise 0.13 e^-
- 240x240 pixels

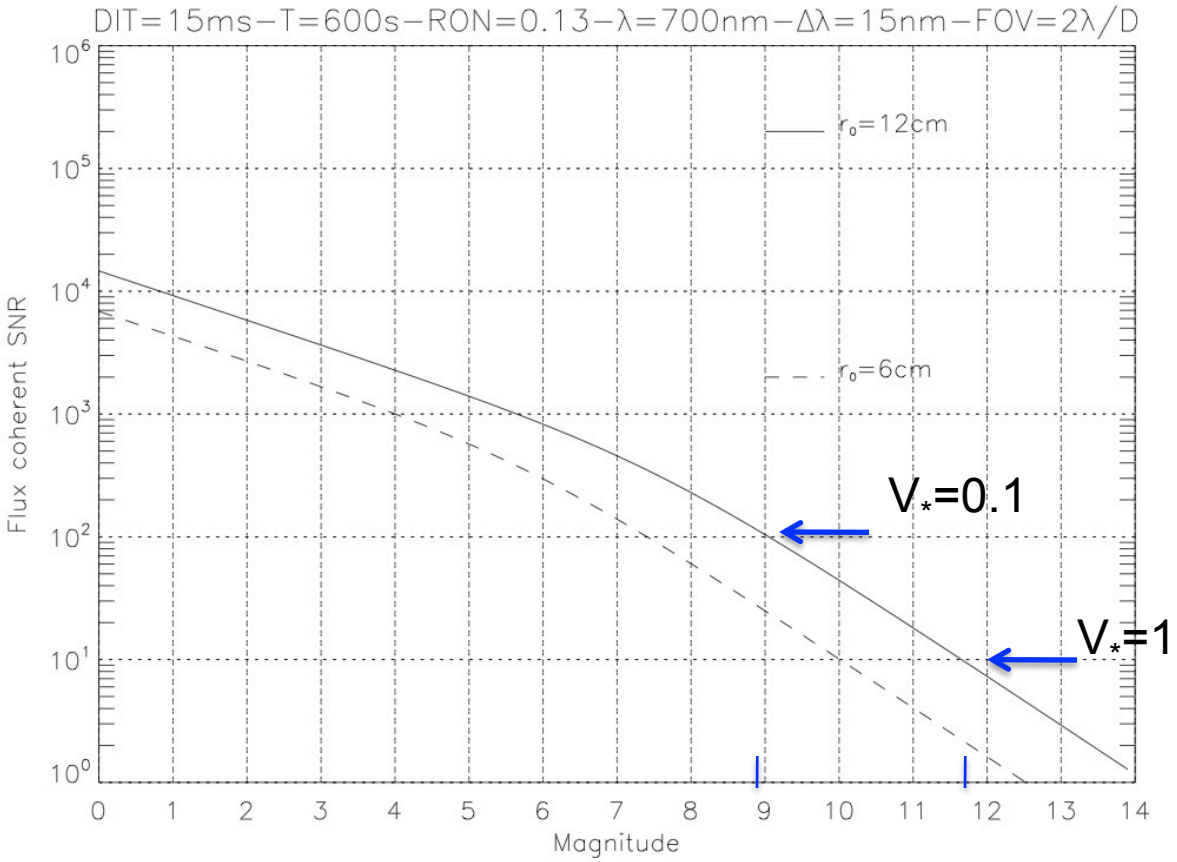


Expected Performances with OCAM2

$$SNR_V = \frac{\sqrt{M} N V_{inst} V_*}{\sqrt{n_{tel} N + n_{pix} RON^2}}$$

Paramètres avec OCAM2:

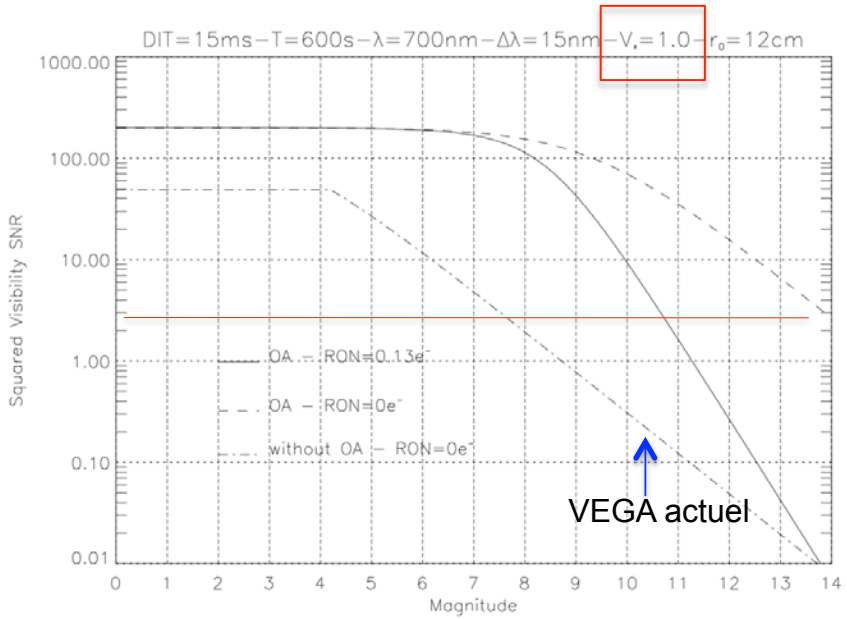
- Efficacité quantique: 90%
- Transmission CHARA: 3%
- Transmission Spectro: 46%
- Transmission OA: 80%
- Transmission Polar: 50%
- Bruit de lecture: 0.13
- 4 pixels par frange
- FOV: 2λ/D
- Δλ: 15nm @ 700nm
- n_{pix}: 48x214
- DIT: 15ms
- M: 40000 (10 minutes)
- V_{inst}: 0.7
- RatioPhot: 20%

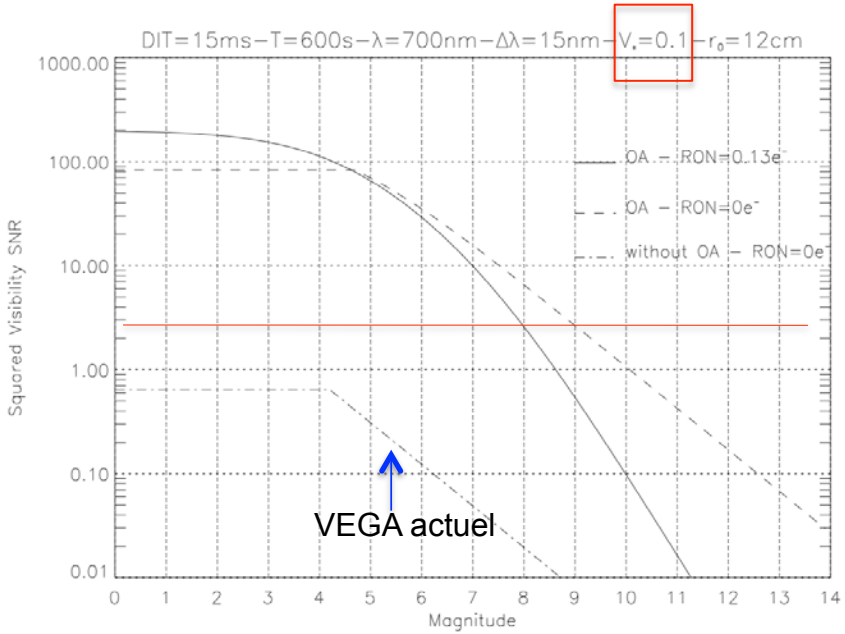


=> Almost 4 magnitudes better than VEGA

SNR of power spectrum Gordon&Buscher (2011)

- Cross terms between readout and photon noise
- SNR of fringe detection, not really for estimation of measurement errors





=> Photon counting detectors are still interesting at very low flux

Solution AO/OpticalFiber/OCAM2 seems very promising
=> theoretical limiting magnitude around 11

But:

- 240 pixels maximum in the spectral direction
  - reduction of spectral band or image of three different bands
- To cover 600-900, possibly 3 different optical fibers set…

Next steps:

- Improved simulations (AO simulator of Mike Ireland)
- Better performances estimation
- Tests of an OCAM2 detector on VEGA this year (october is foreseen)
- Definition of exact fiber sets

To be decided:

Low noise for bright objects & Photon counting for faint objects
Budget?

VEGAS (VEGA Second generation)
Berio, Clausse, Mourard et al.

Thank you for your attention

Calern meeting, february 6th, 2012