The first common user AO facility

ADONIS

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LAOG

From COME-ON+ to ADONIS

- COME-ON+ is working well but quite complicated to use !
  - Numerous calibrations required at beginning of each run and during the nights
  - Several instrumental parameters have to be optimised according to object characteristics and atmospheric conditions
  - All calibrations and optimisations are performed manually and lead to non optimal use of telescope time
- Requires a "fairly large team of qualified personnel", i.e. at least 3 trained operators…
- State of the art AO system but poor suite of focal modes/detectors
- COME-ON+ still suffers from flexures, dust and light contamination

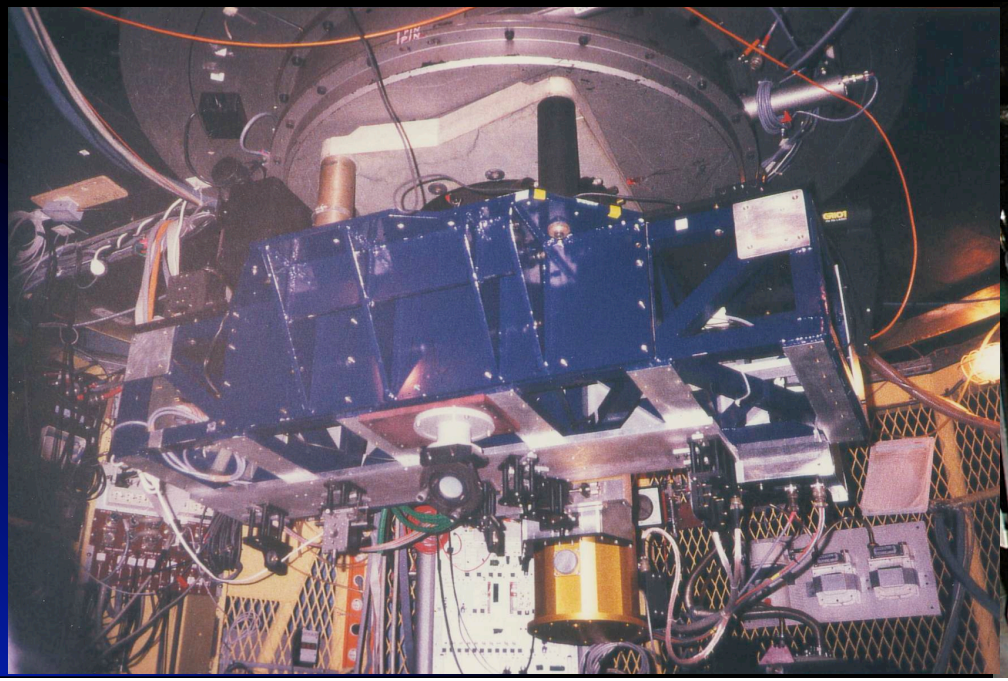
  => **Improve performance, versatility and efficiency**

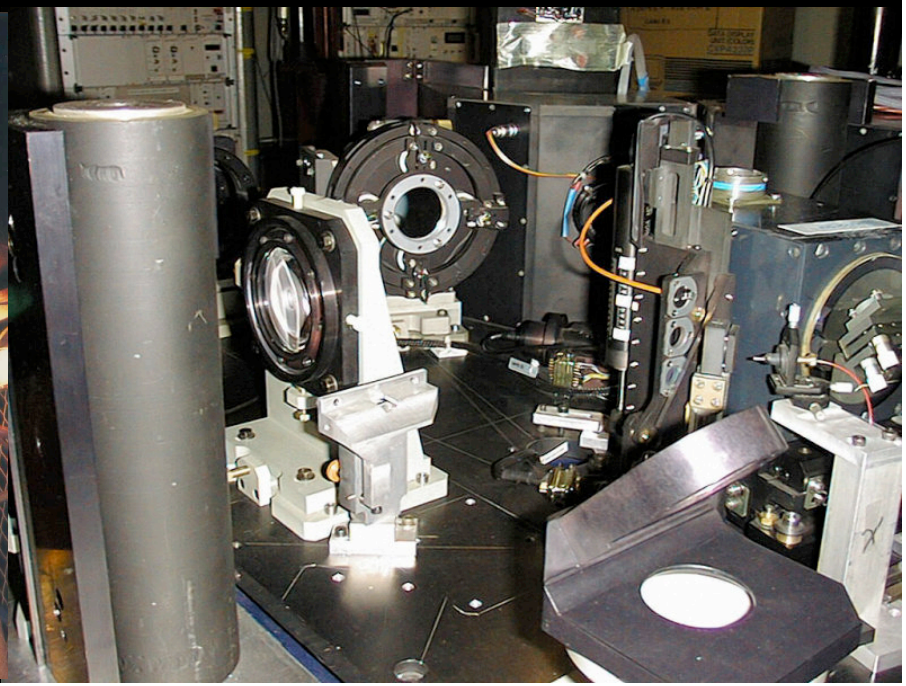
ADONIS main characteristics

Optomechanics	Total no. of Mirrors in the science path	9 mirrors + 1 beam splitter in reflection
	Total no. of elements in the WFS path	6 (7 for Reticon) mirrors 1 beam splitter + 5 lenses
	Relay optics transmission - WFS Vis	30% measured
	Relay optics transmission, IR cameras	52% measured
	Field of view	60" diameter, circular
Wavefront Sensor	Type	Shack-Hartmann
	no. subapertures	7 x 7, squared - 51.4 cm pupil subaperture
	Detectors	Reticon and LEP-EBCCD
	Field of view	6", electronic masking available
Deformable Mirror	Type	continuous thin faceplate Piezo stack
	no. of actuators	52, no guard ring
	Stroke	±10 µm
	Useful/Available aperture diameter	65/100 mm
	Conjugation	Primary mirror - entrance pupil
Control	Sampling - command rate	selectable from 400 to 25 Hz, discrete
	Max bandwidth 0dB	60 Hz
	Optimization	Modal with digital filter gain adjustment
	Digital filtering	choice of PID or pure integrator
Prefocal Optics		CVF (R=60), 2x Fabry Perot (R=900, R=2500), linear polarization, choronograph
Focal Plane IR Cameras	Sharp II 1 - 2.5 µm	Nicmos 256x256, 0.035"/pxl - 0.05"/pxl - 0.1"/pxl
	Comic 1- 5 µm	LIR Grenoble, 128x128, 0.035"/pxl - 0.1"/pxl

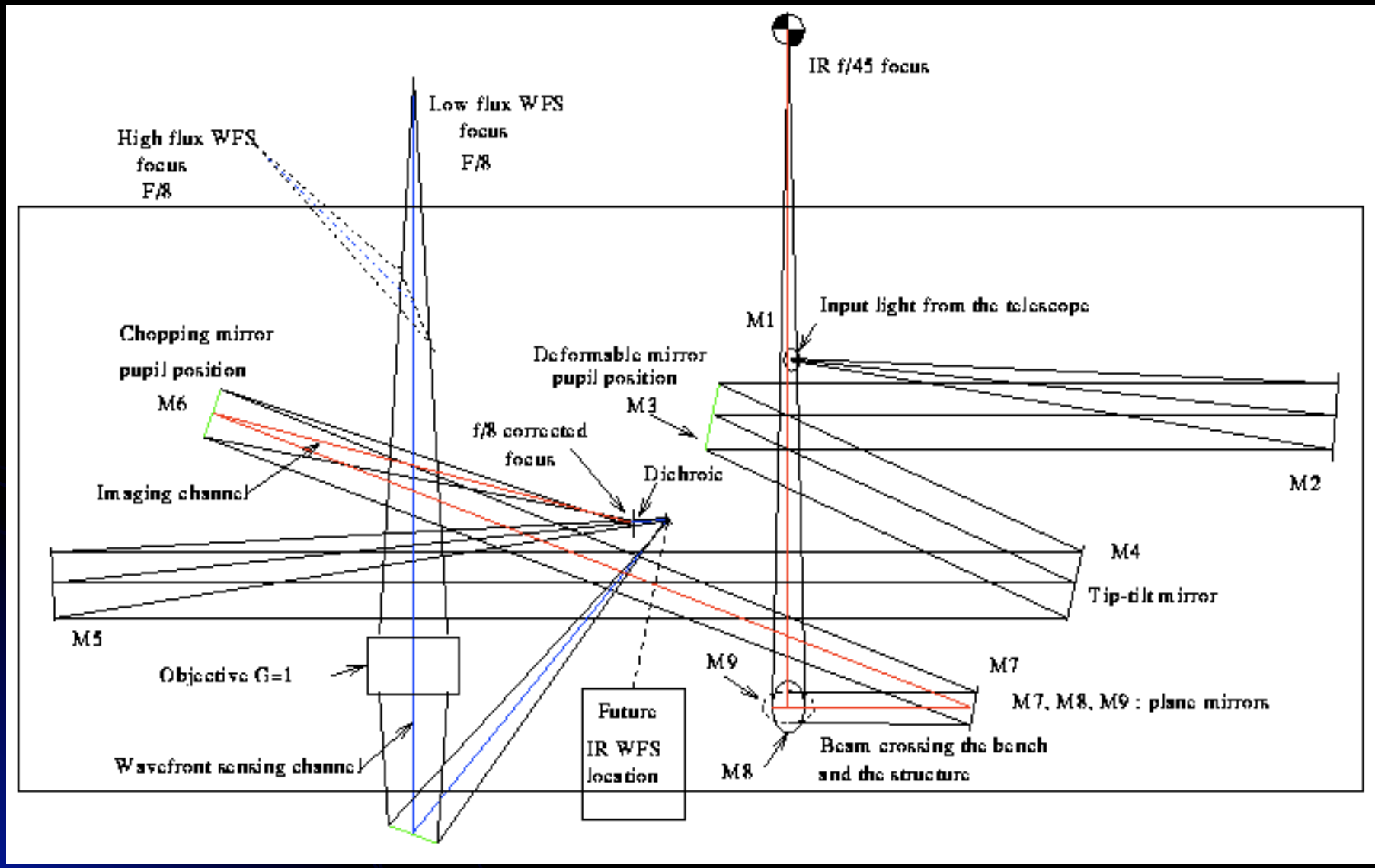
Bench optomechanical modifications

- Improved stiffness to reduce flexures
- Modified optical and mechanical interface to allow visitor modules (under the main bench)
- Instrument cover to protect from dust and external light
- Motorized functions to select WFS, insert calibration devices, etc.





Optical layout



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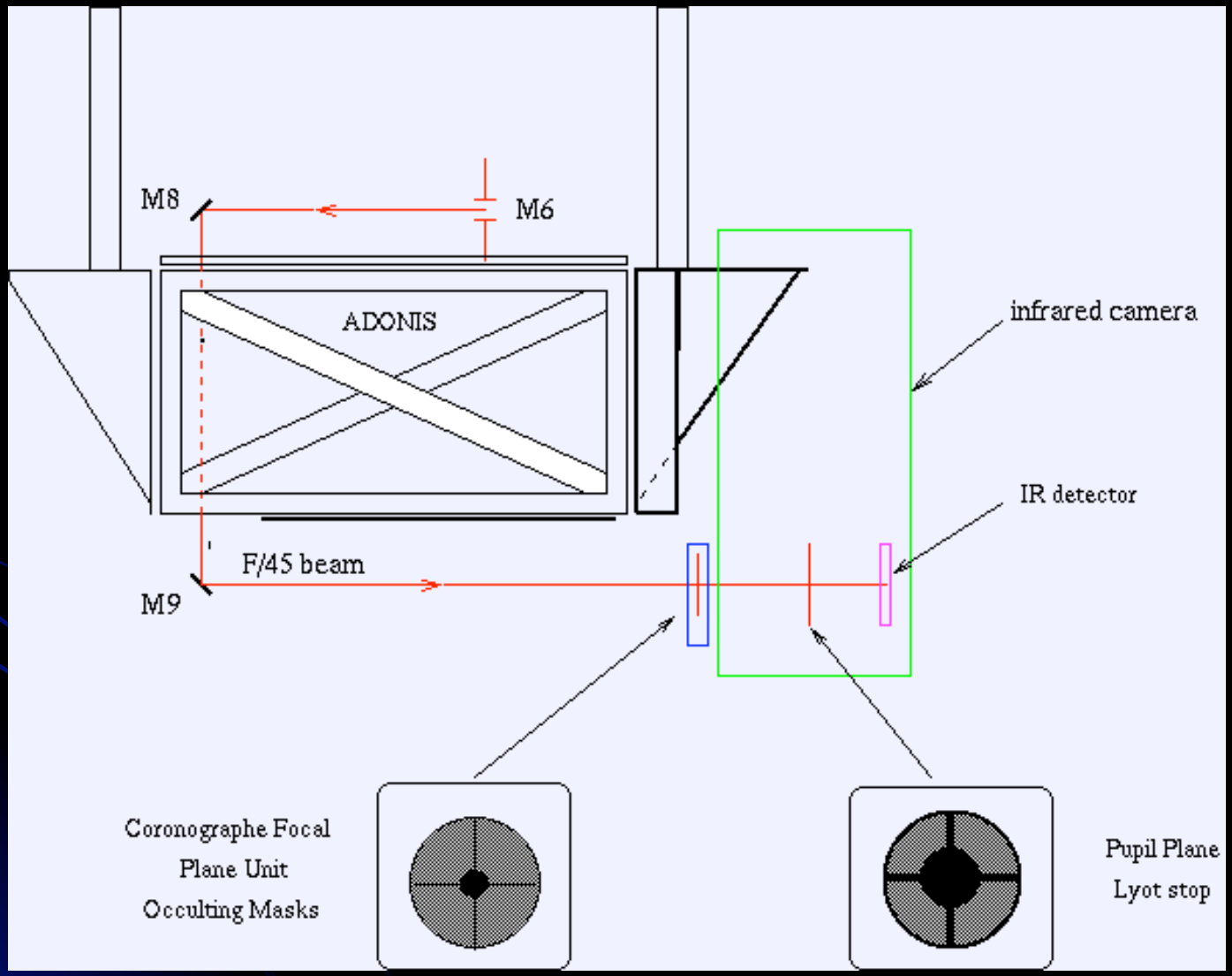


Real-time computer

- Improved computing power and reduced size and dissipation in Cassegrain cage
- Specifically developed by Shakti for AO, based on DSP C40 boards
- Real-time SH images, X-Y slopes and DM commands allowing to optimise correction during the observations and to retrieve PSF for off-line processing
- Process 7X7 SH subapertures (8x8 pixels per subaperture) less than 0.1 ms after end of WFS integration

Master computer

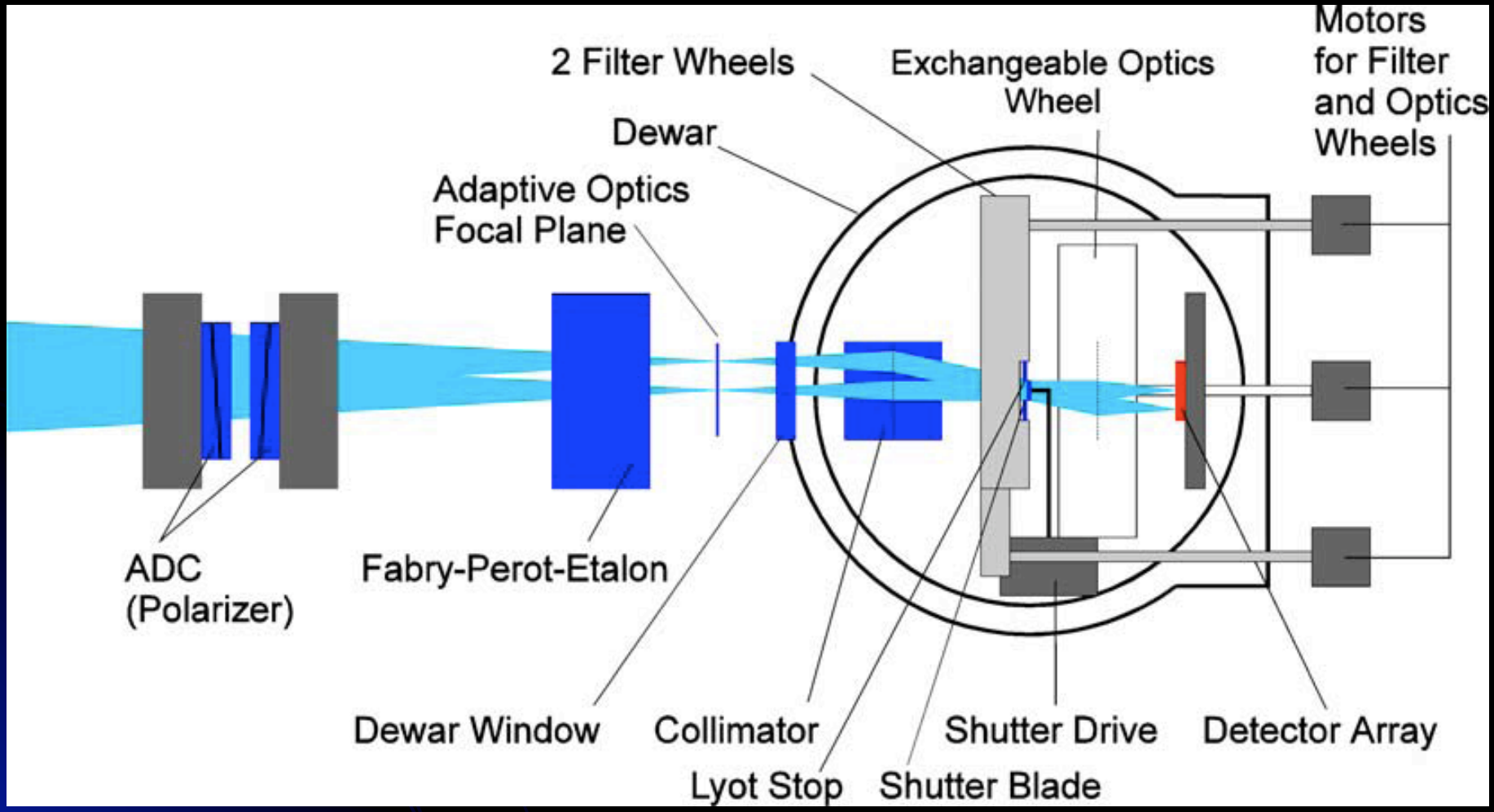
- Direct control over the main functions of the system such as the WFS (WFS selection, frequency, gain, density, etc.), the IR chopping mirror, the calibration sources…
- Extended user's control panel with all information on current instrumental status and performance estimation
- Smart software tools to help operator optimise the system during observations: modal control optimisation for instance

- It worked…
  - Since 1996, the telescope operator has also been running ADONIS

Two new IR cameras

- SHARP II (MPIE Garching)
  - 256 x 256 pixels NICMOS3 HgCdTe array
  - 1 – 2.5 microns
  - 35-50-100 mas/pixel (8.5"x8.5", 12.5"x12.5", 25.6"x25.6")
  - Cold shutter (integration times down to 20 ms)
- COMIC (LAOG + DESPA)
  - 128 x 128 pixels HgCdTe device from CEA/LETI/LIR
  - 1 – 5 microns
  - 35 mas/pixel for J, H, K (4.5" x 4.5")
  - 100 mas/pixel for L, M (12.8" x 12.8")
- Common acquisition system (VME-based)
  - On-line data processing
  - Quick-look display
  - Batch programming

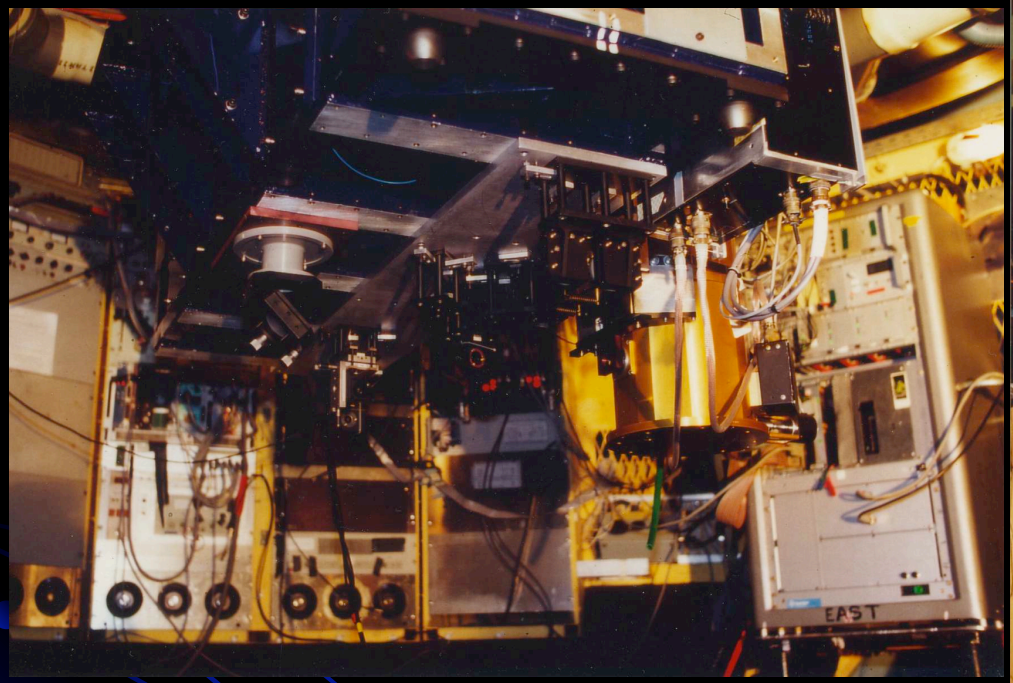
SHARP II concept

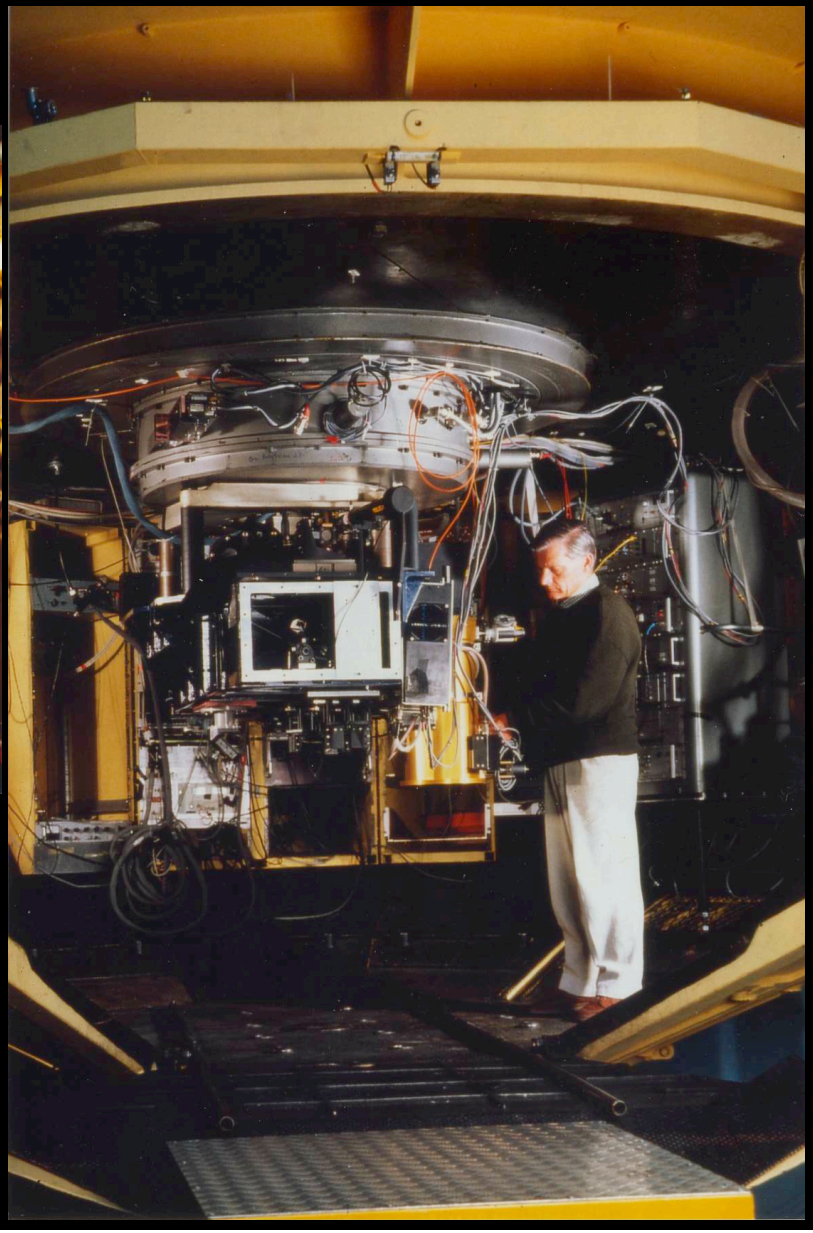


Focal modules

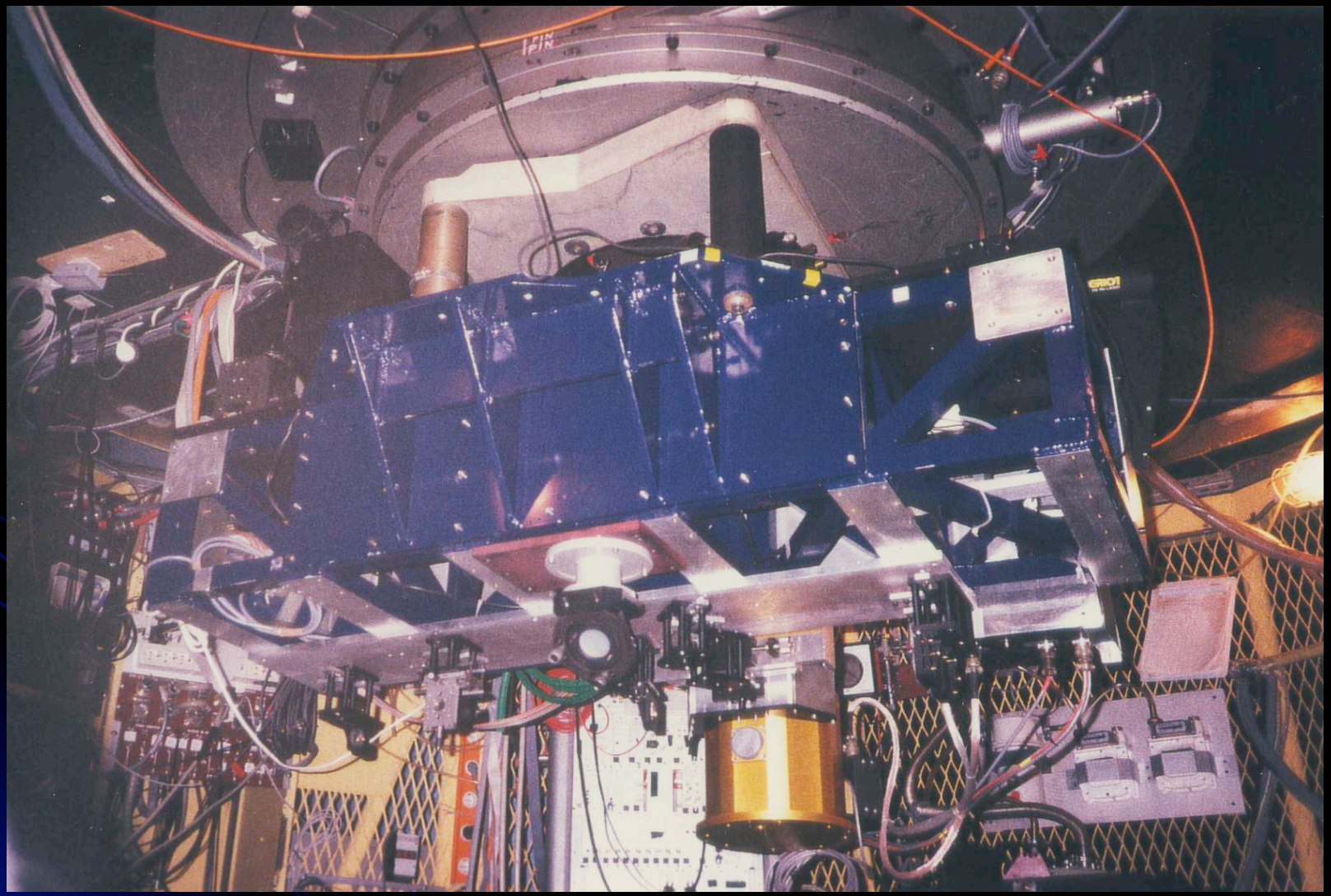
- Atmospheric dispersion compensator (ADC) to limit elongation to 5 mas when observing in broad-band J, H, K bands
- Wire grid linear polarizer
  - 1 – 5 microns (SHARP II or COMIC)
  - Any polarizer position angle allowed (sequence can be programmed)
- Fabry-Pérot etalons
  - 2 devices with spectral resolutions of 950 and 2500 (corresponding to finesses of 40 and 50)
  - Both working in K-band
- Coronagraph
  - Occulting masks at F/45 focal plane (no substrates)
  - Lyot stop inside SHARP II camera
  - Mask sizes ranging from 0.4" to 5"
  - Contrast ~12.5 magnitudes at 2" in K-band
- Open to visitor modules (GraF 3-D spectrograph)

ADONIS at the telescope





ADONIS at the telescope



ADONIS (performances)

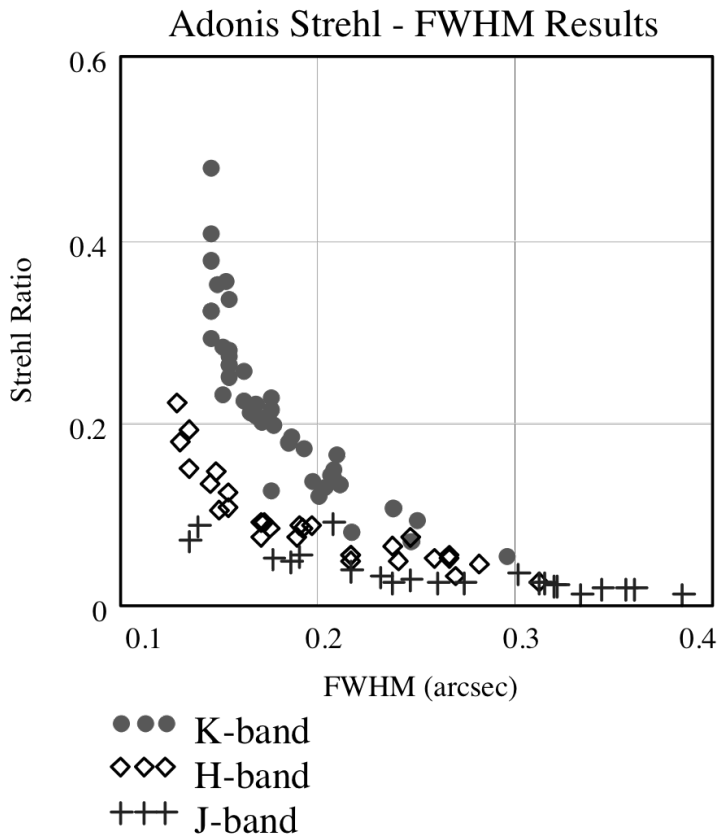


Figure 10: Strehl Ratio obtained with Adonis, vs FWHM in arcsec. Both EBCCD and Reticon WFS results are plotted

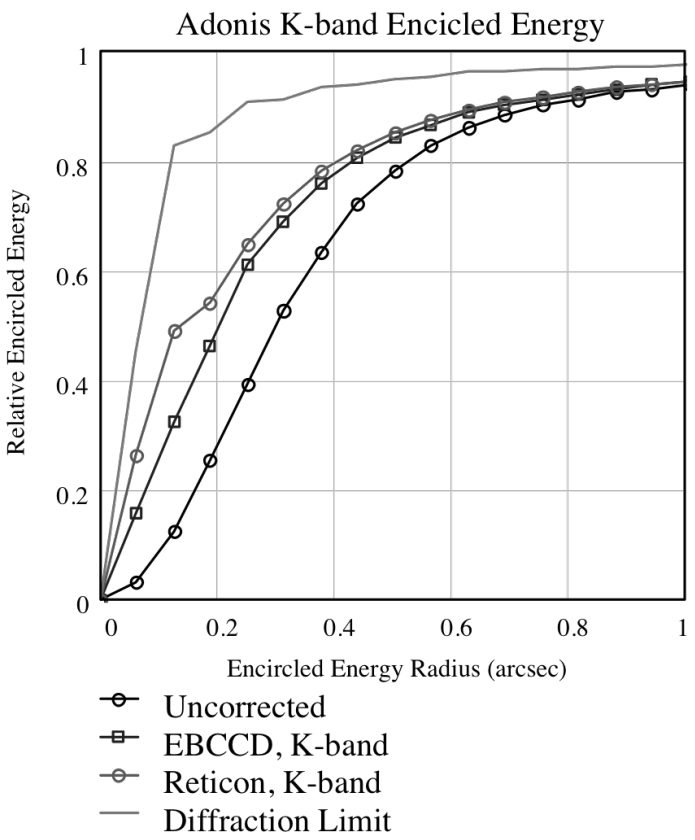
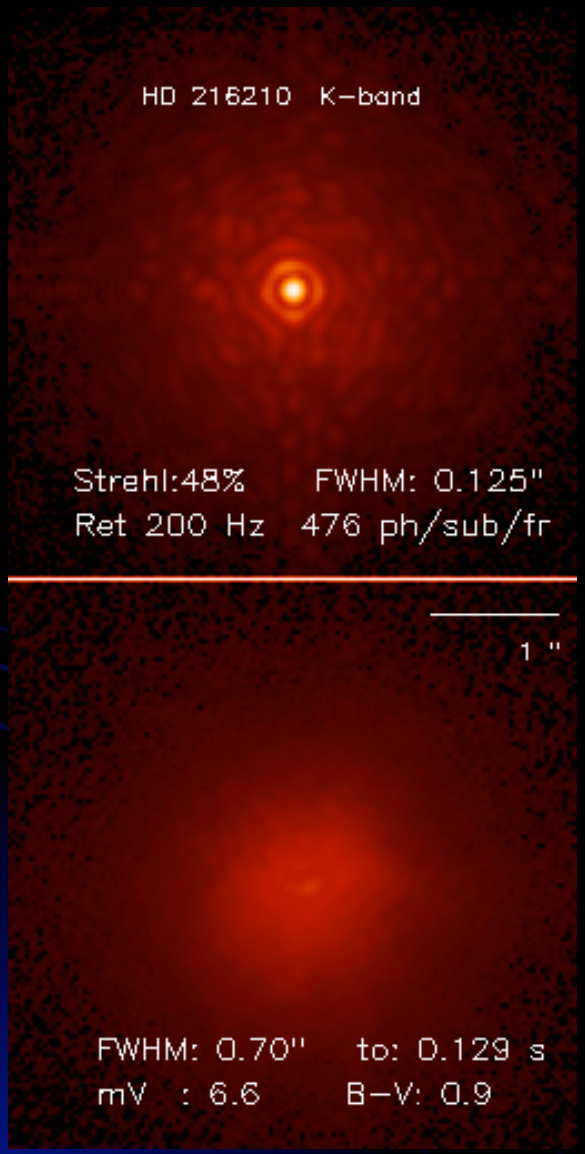
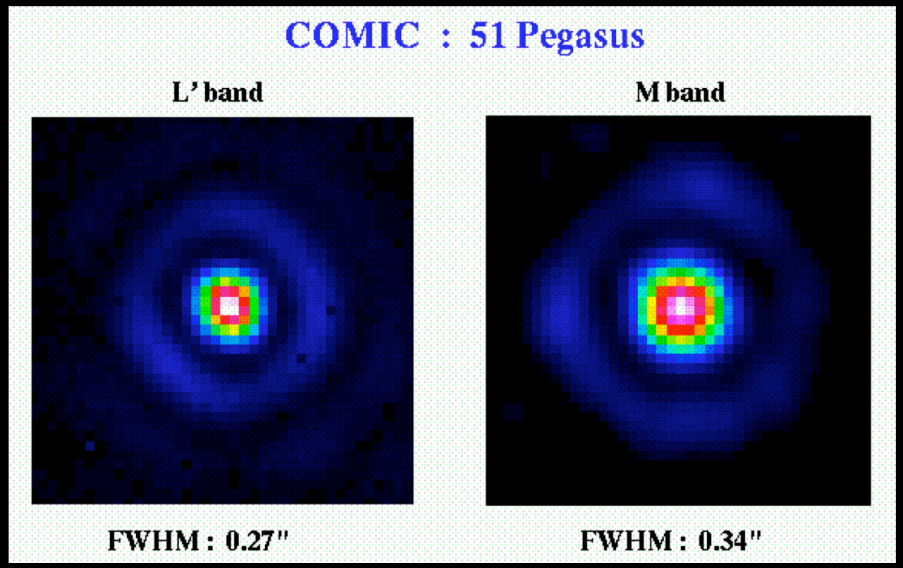


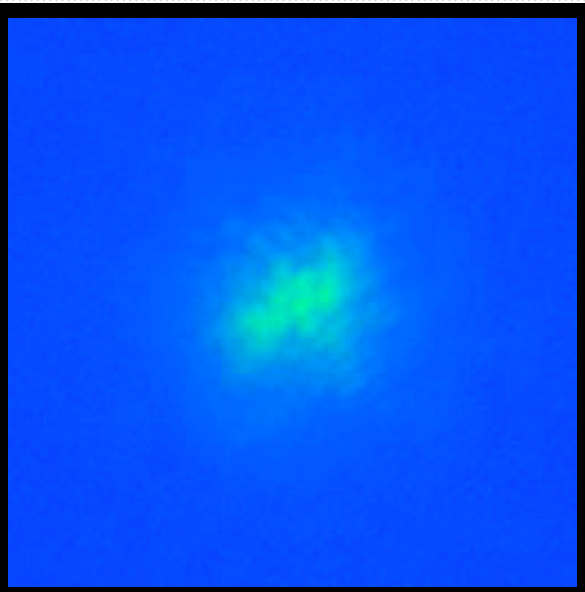
Figure 11: Adonis performance in terms of Encircled Energy, in K-band. The simulation is based on measured performances in average La Silla seeing (0.7" in V-band).It assumes NGS m=5 for the Reticon and m=10 for the EBCCD.

From Bonaccini et al., SPIE 2007

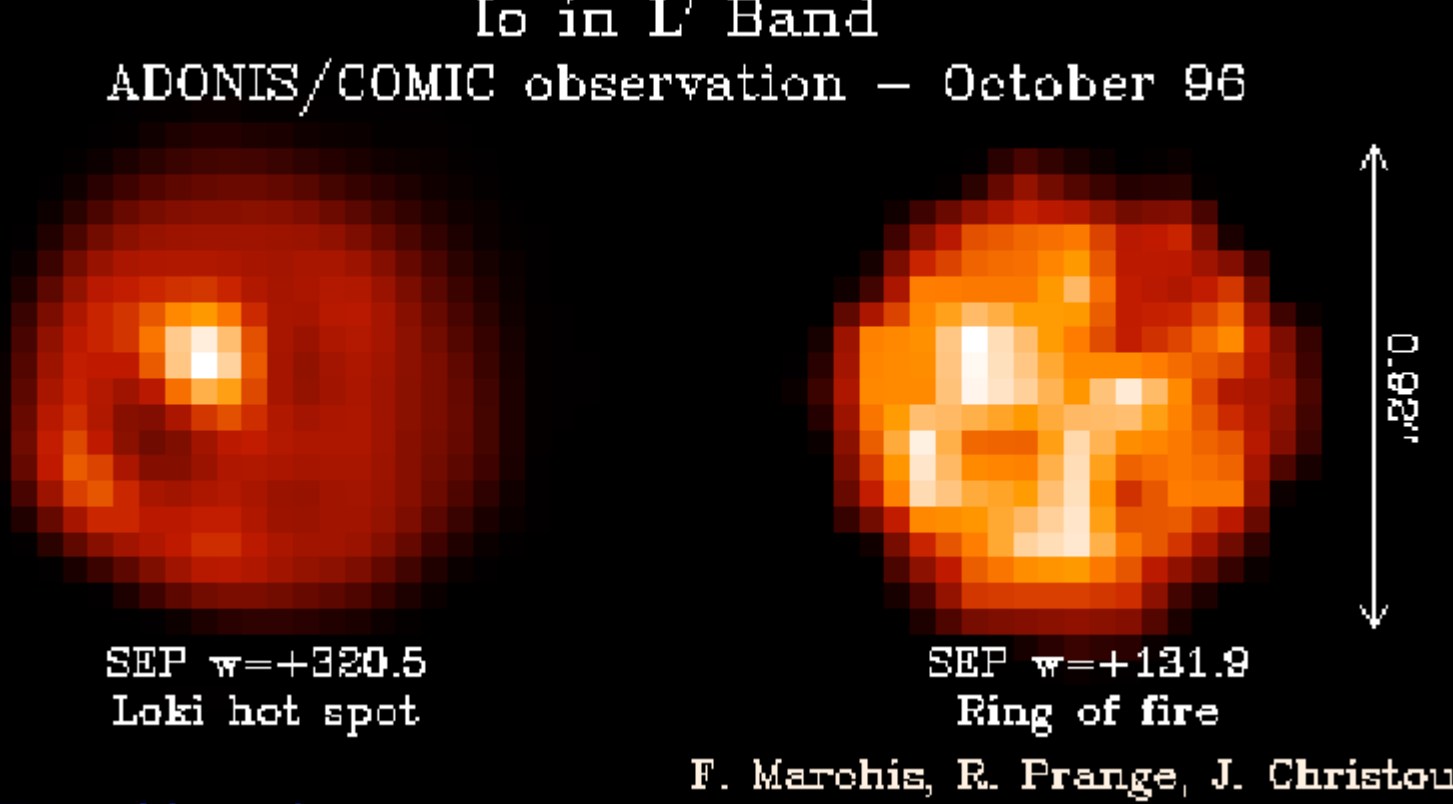
ADONIS (performances)







ADONIS: a few results



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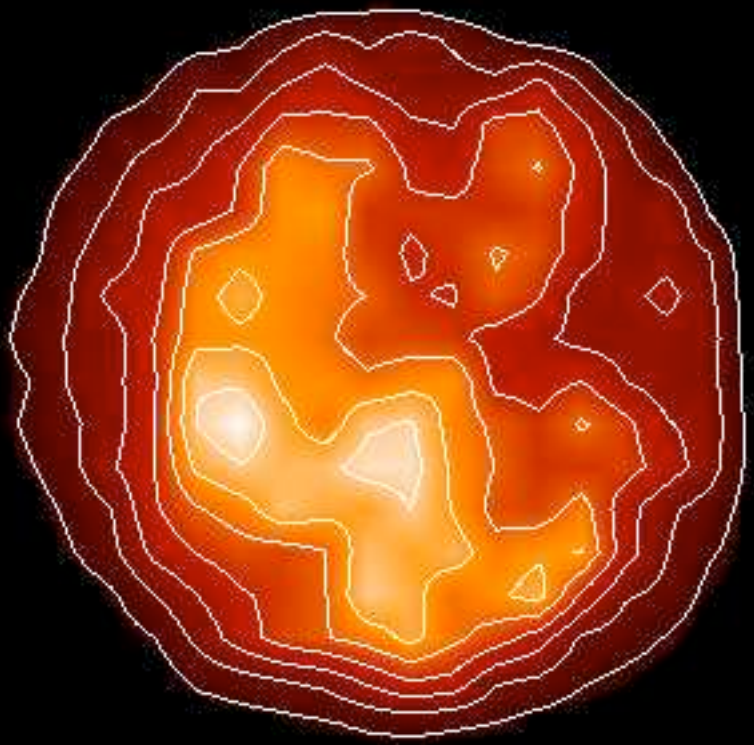
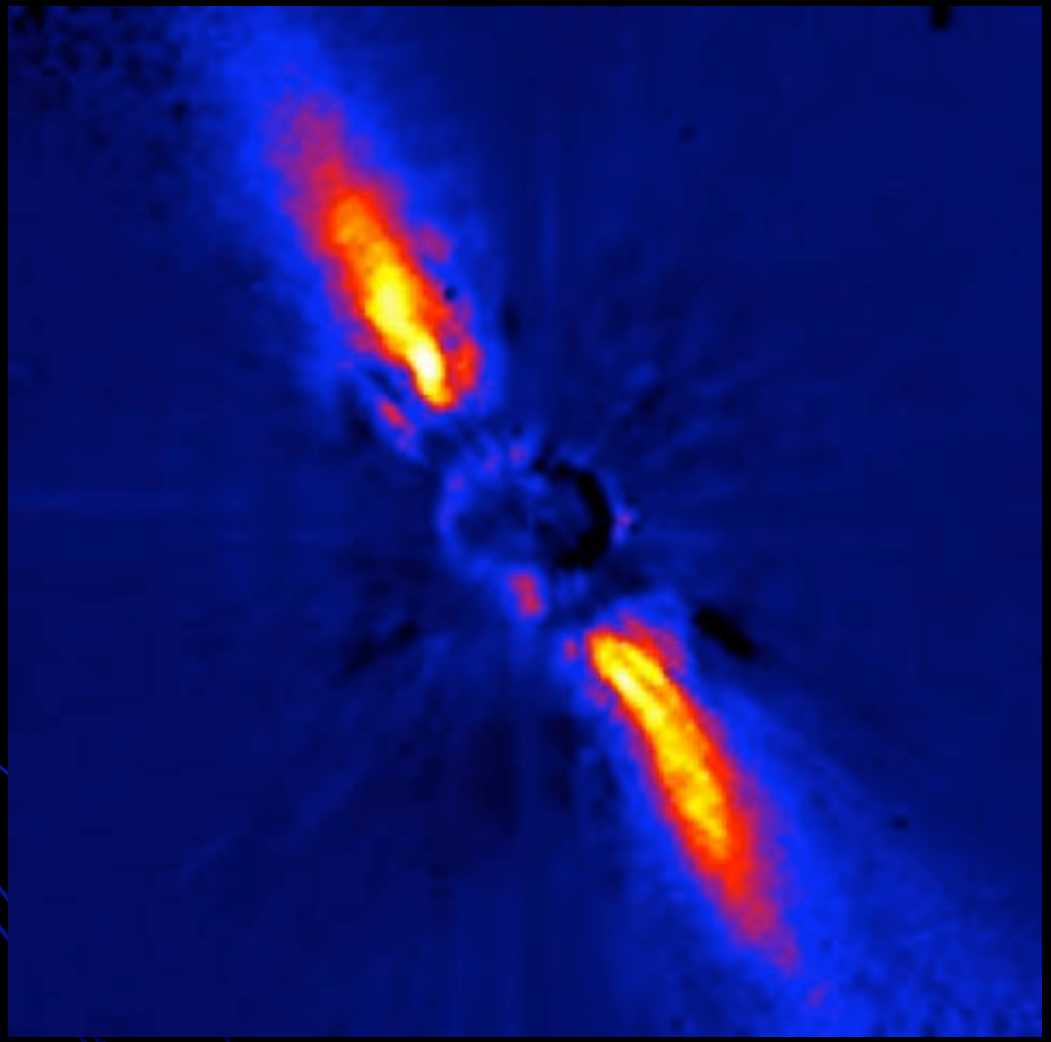


ADONIS, 2 microns

HST, 1 micron

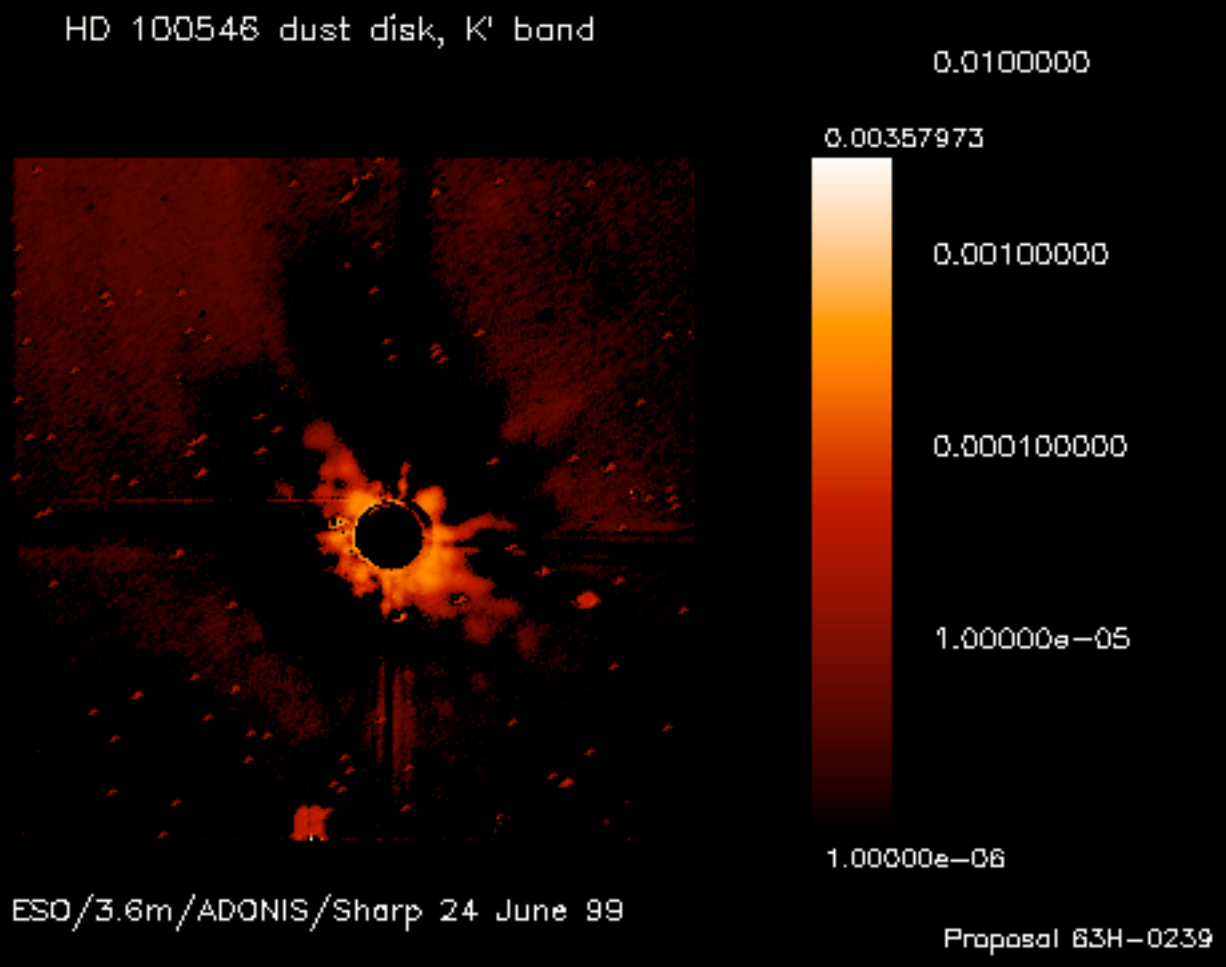
Coustenis et al., 1995

ADONIS: a few results



Mouillet et al., 1996

ADONIS: a few results



Pantin et al., 1999

Conclusions

- First common user AO facility offered to a wide astronomical community
- Used as a versatile test bench for future systems (and NACO in particular)
- Also very productive in terms of published results
- An exciting adventure for some of us…

The Team !

- ESO: N. Hubin, D. Bonaccini, M. Faucherre, E. Prieto, P. Prado, J. Roucher, P. Bouchet, M. Maugis, R. Tighe, H. Geoffray, D. Le Mignant, F. Marchis, K. Brooks, O. Marco and the whole La Silla support groups !
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- ONERA: G. Rousset, P.-Y. Madec, D. Rabaud
- LAOG: P. Feautrier, P. Petmezakis, J.-L. Monin
- MPIE: B. Brandl, A. Eckart, L. Tacconi, R. Hofmann, F. Eisenhauer, B. Sams III

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