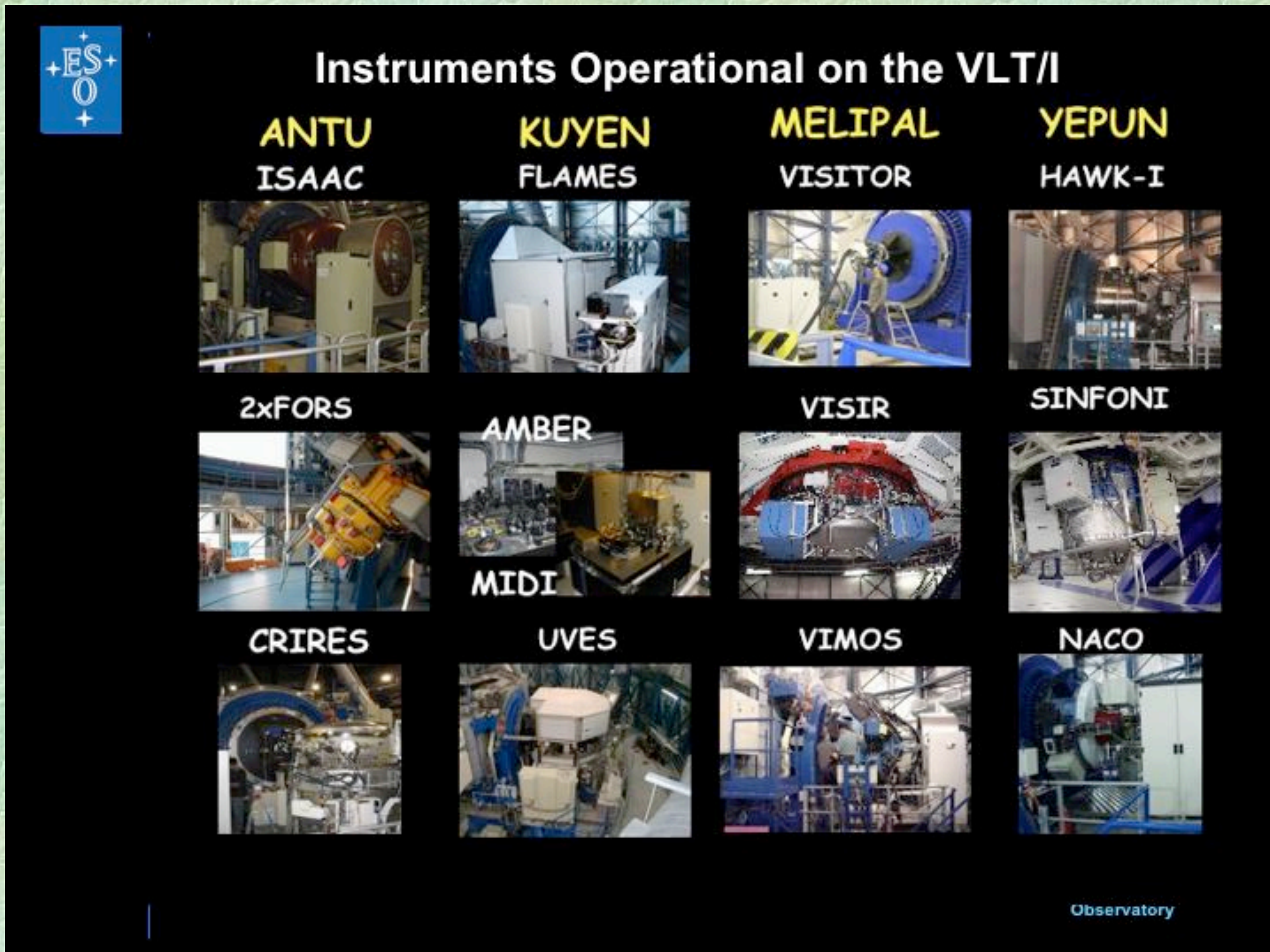
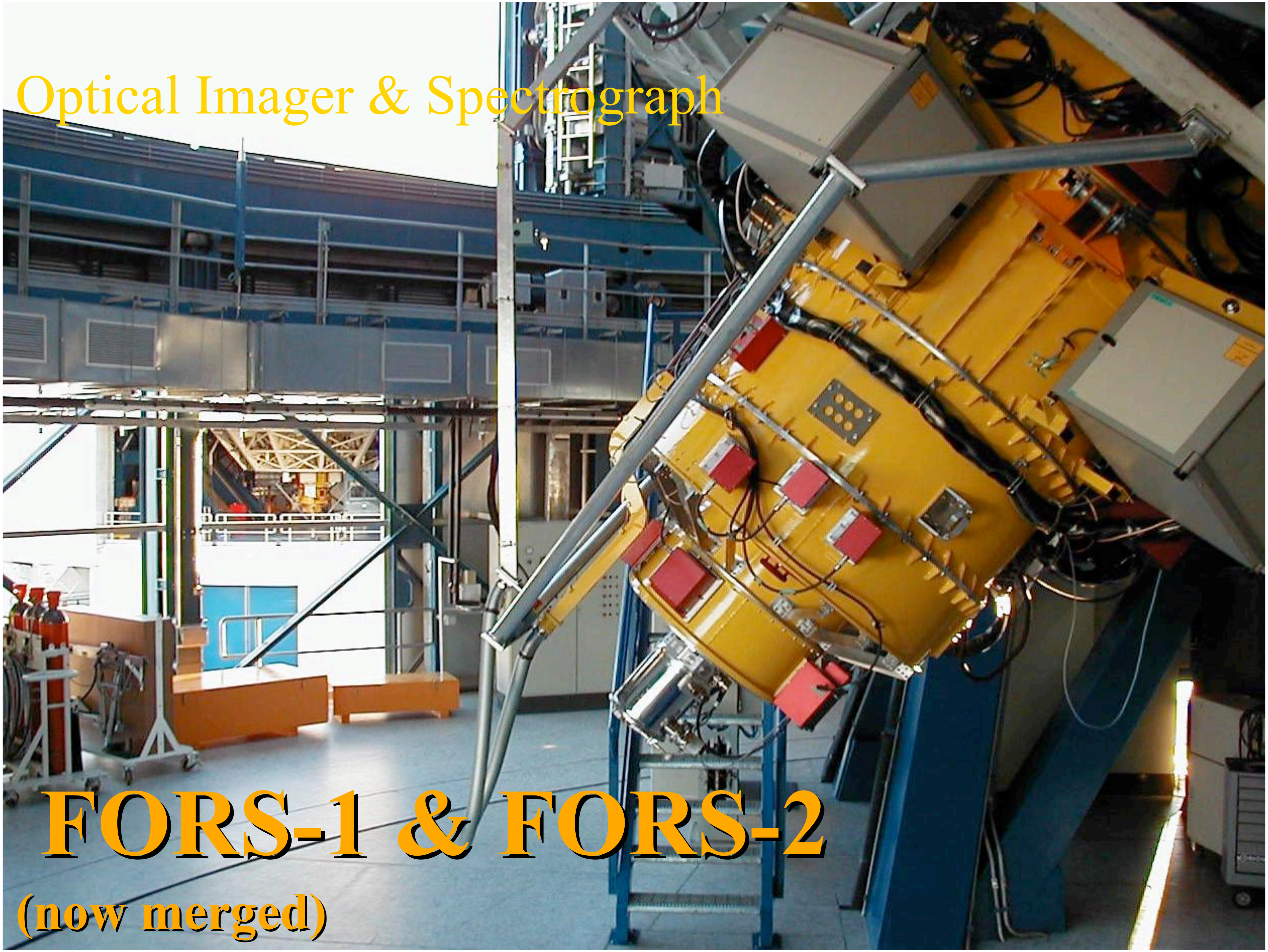
VLT/I Instrumentation

Luca Pasquini, ESO

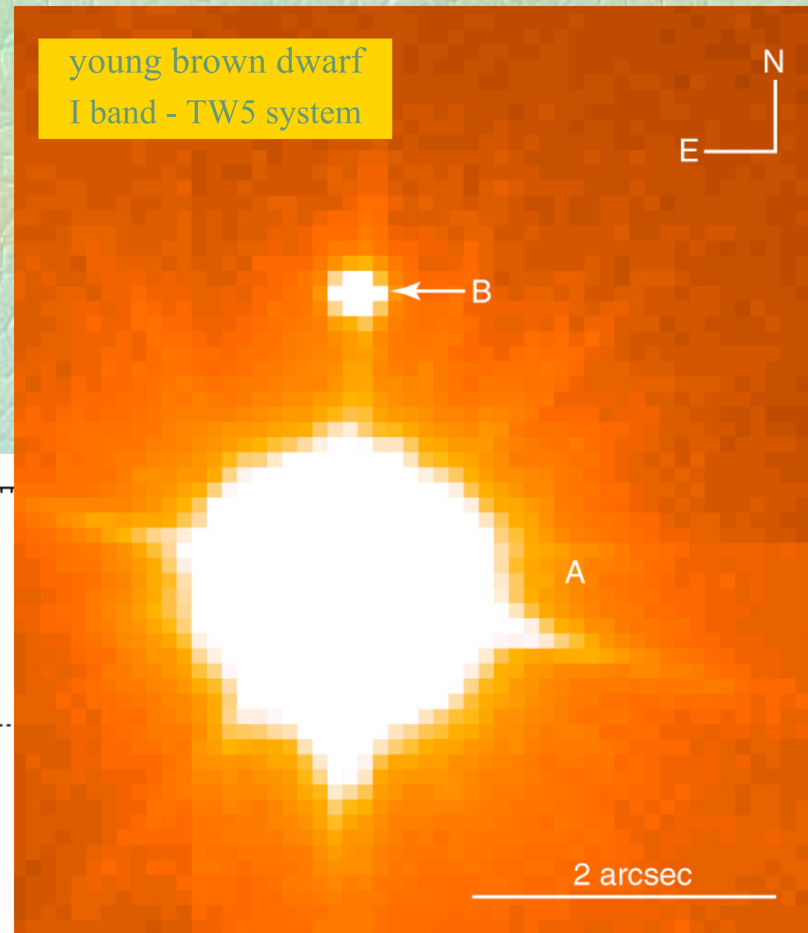
VLT Instruments



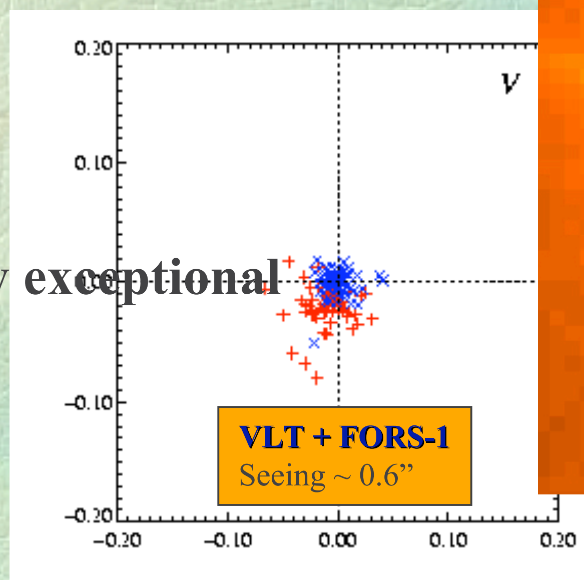

Optical Imager & Spectrograph
FORS-1 & FORS-2
(now merged)

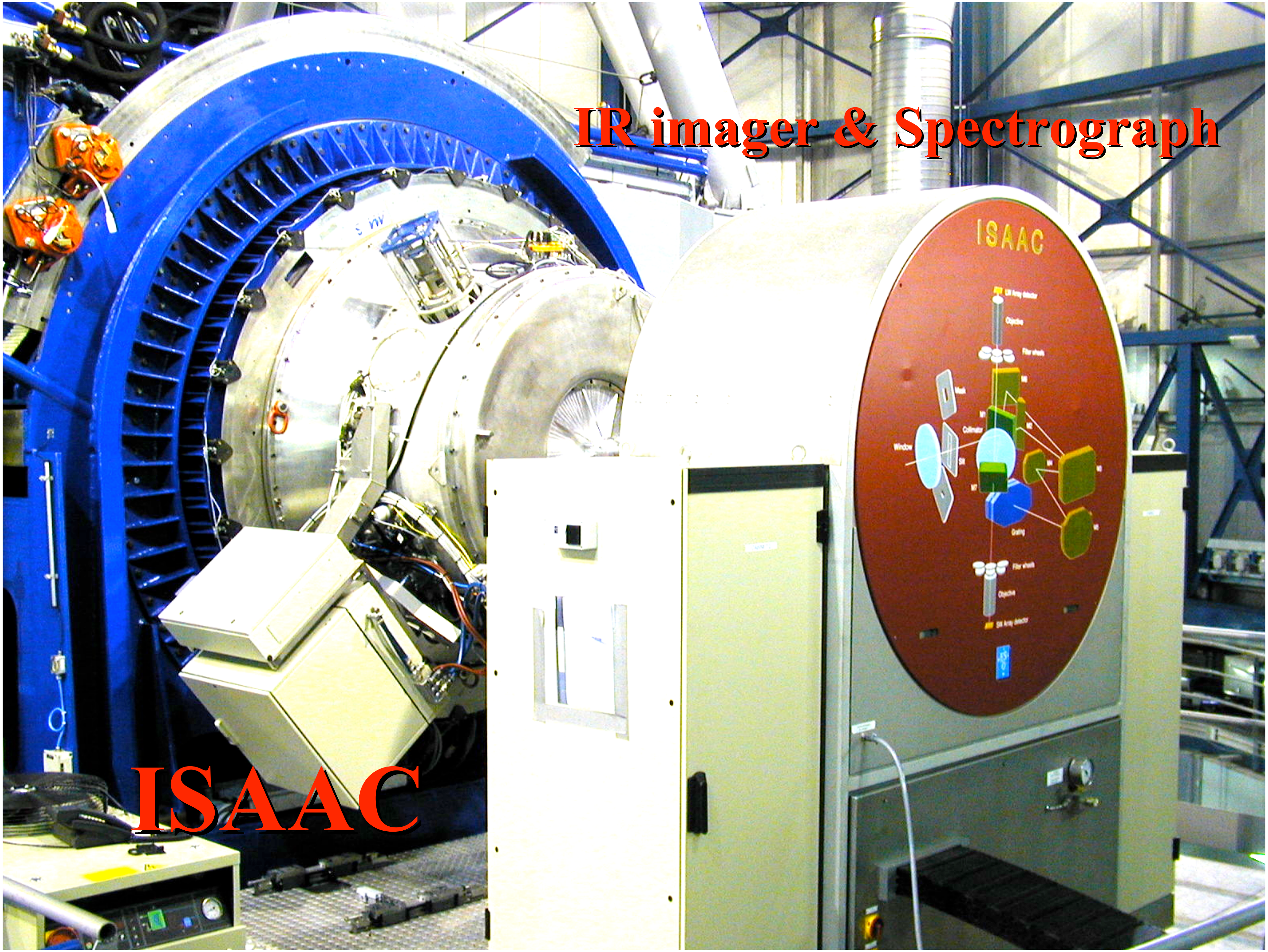
FORS Image Quality & Stability

- Image Quality Telescope driven
  - Best image obtained (HR mode)
    - 0.18” (integration time: a few seconds)
    - 0.25” (integration time: several minutes)

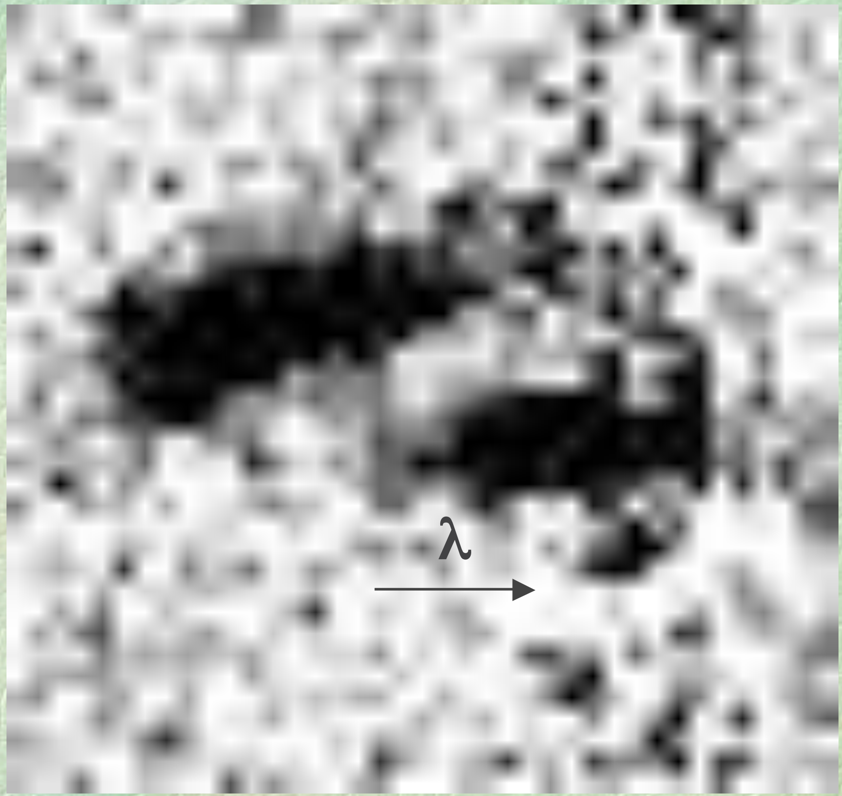


- **Image Stability exceptional**



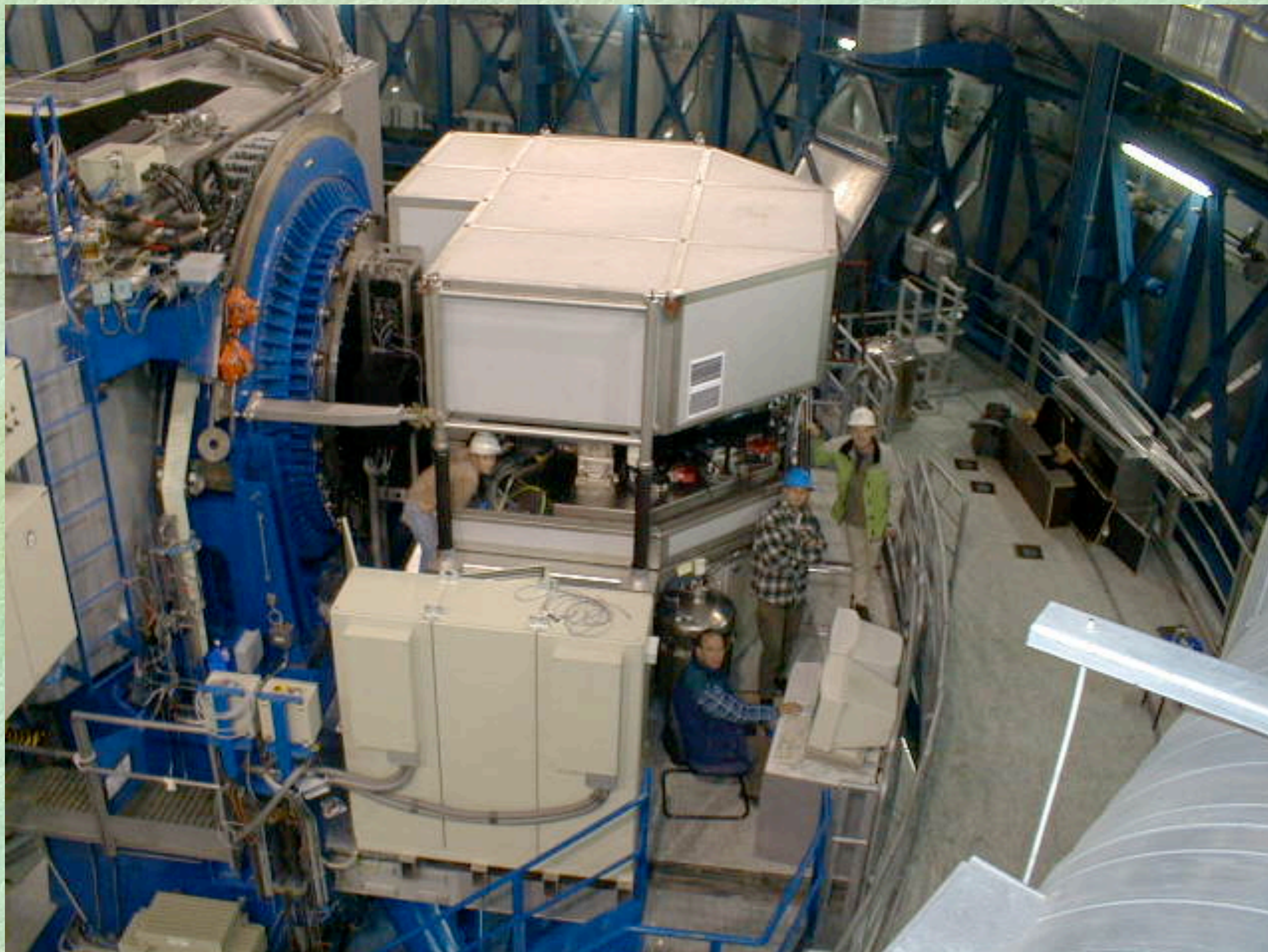

IR imager & Spectrograph
ISAAC
ISAAC

ISAAC Spectroscopic Sensitivity



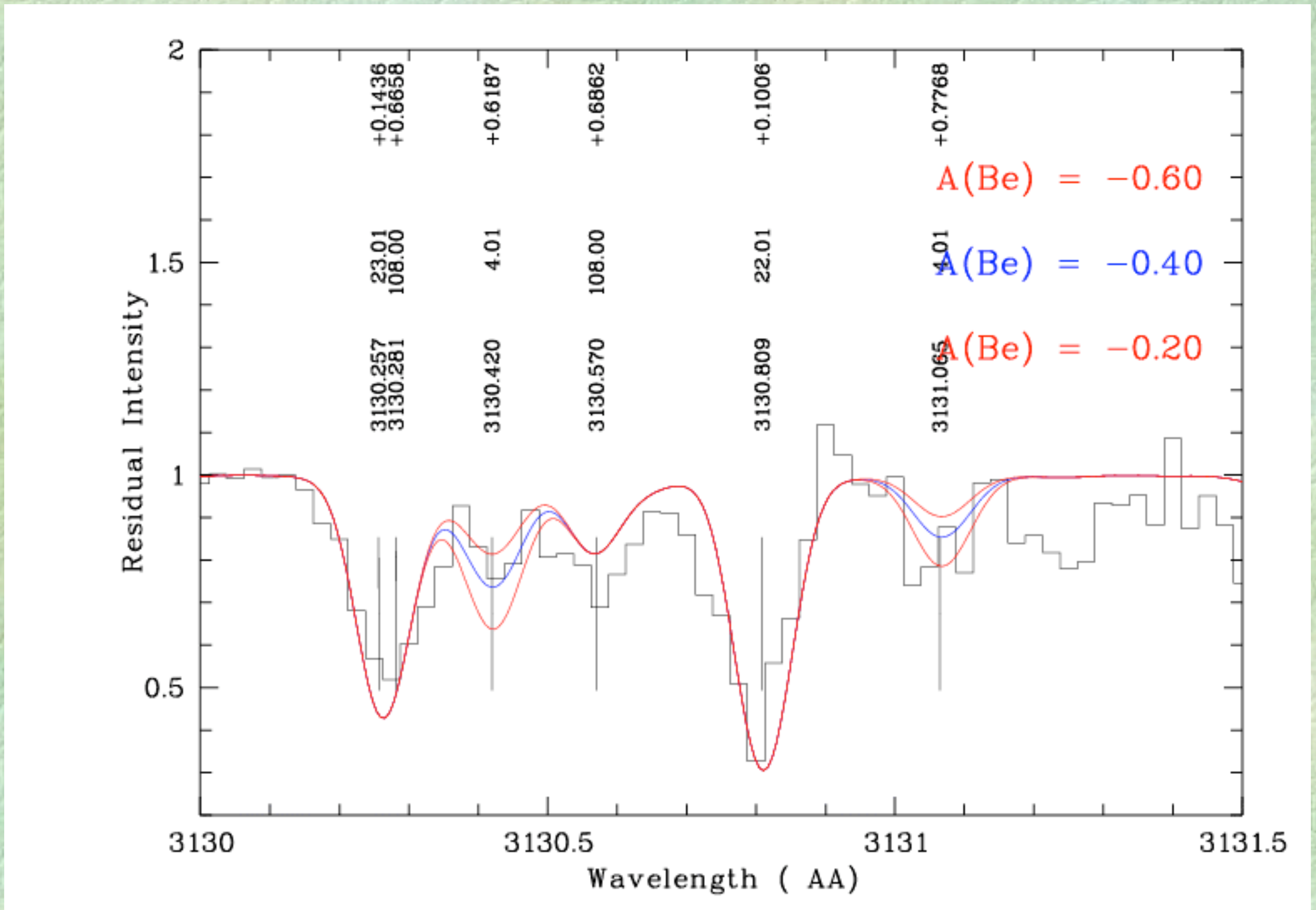
z =3.2 galaxy “rotation” (ΔV ~ 700 km/s)

OIII lines; 6 hr exposure; 0”.4 seeing



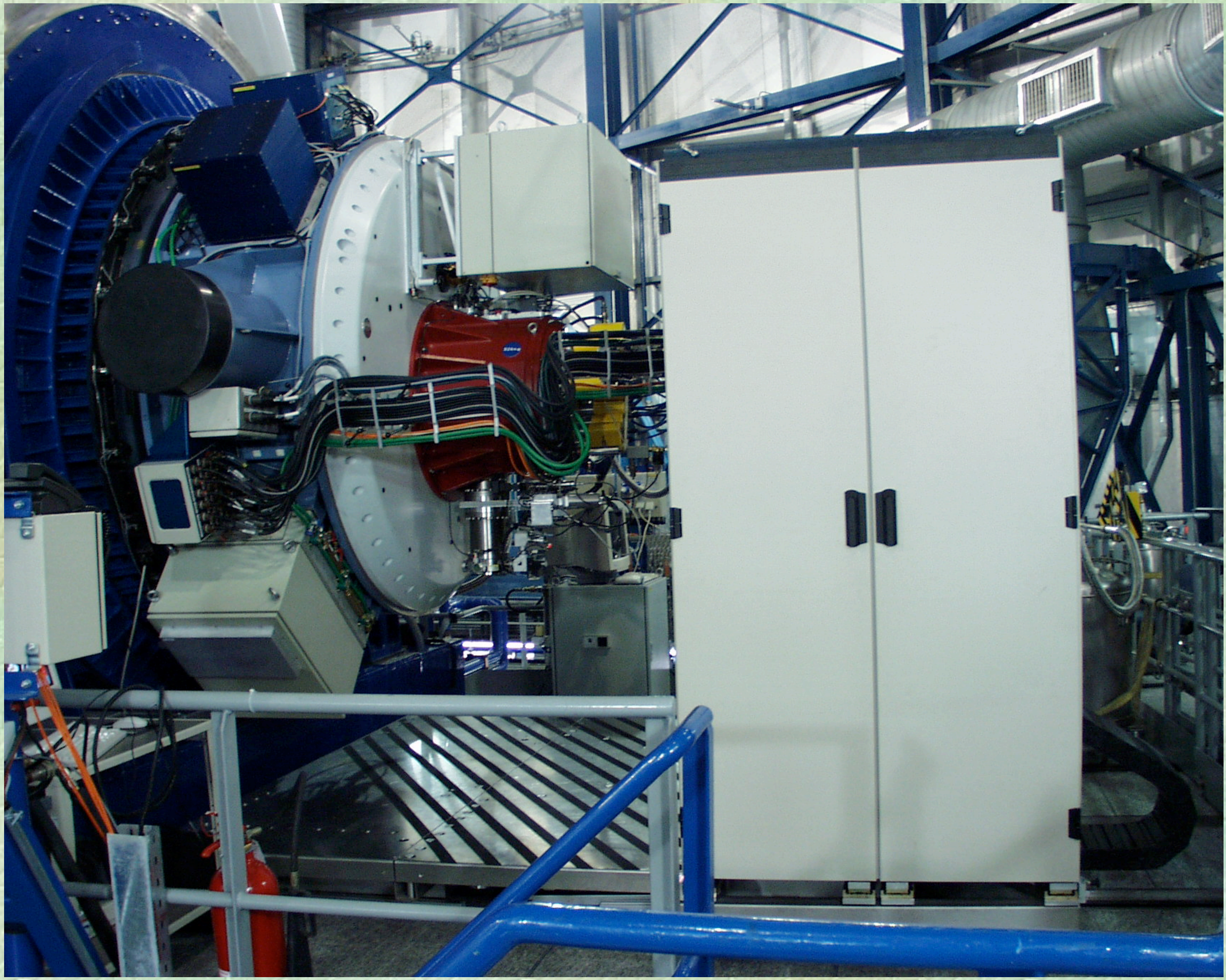
UVES @ UT2 Nasmyth

UVES: highly sensitive R~10^5 Spectrometer

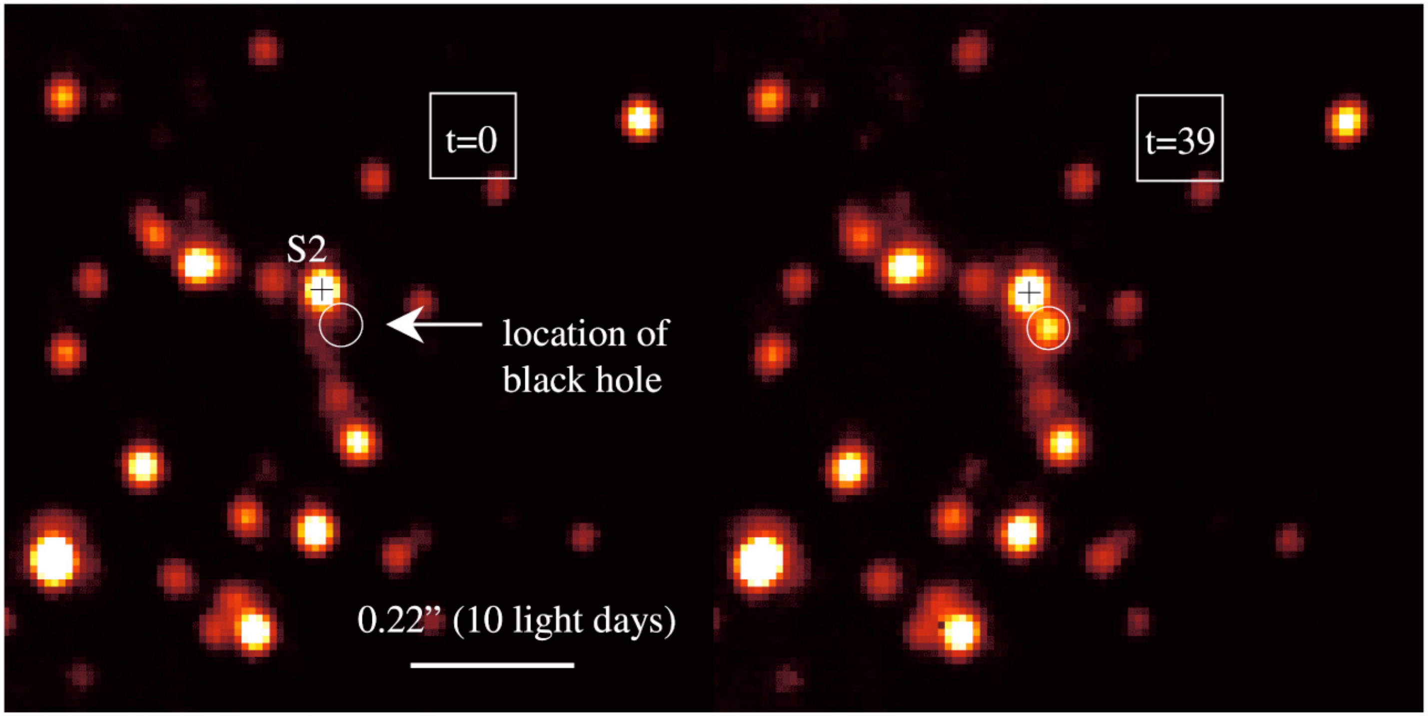


Be (0.313 μm) abundance in stars of a Globular Cluster (V=16(!))

NA-CO: At Diffraction Limit



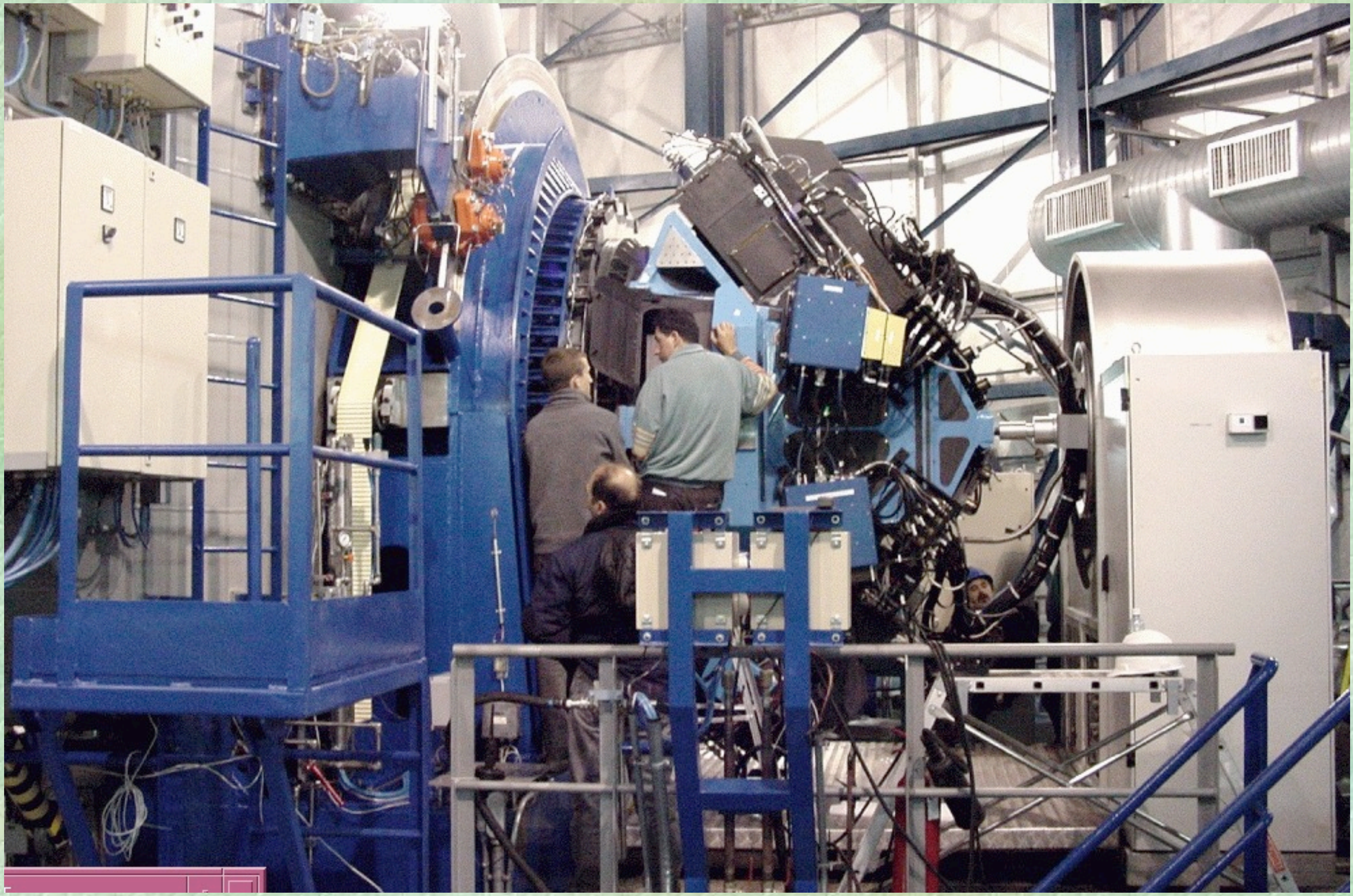
NA-CO Galactic Center



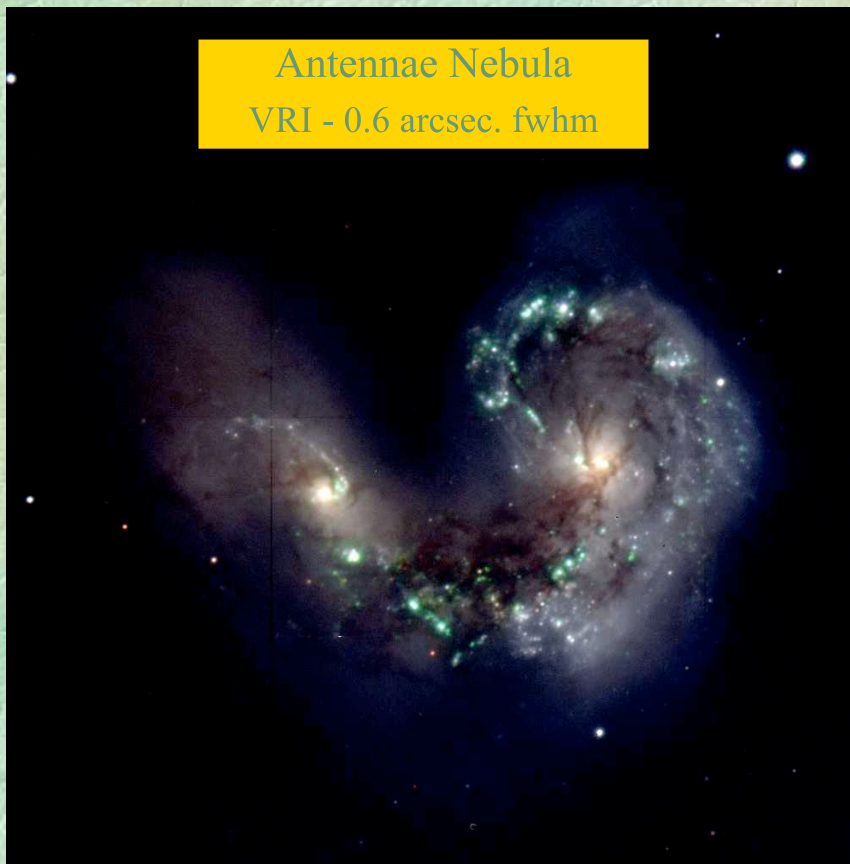
Near-IR Flare from Galactic Centre (VLT YEPUN + NACO)

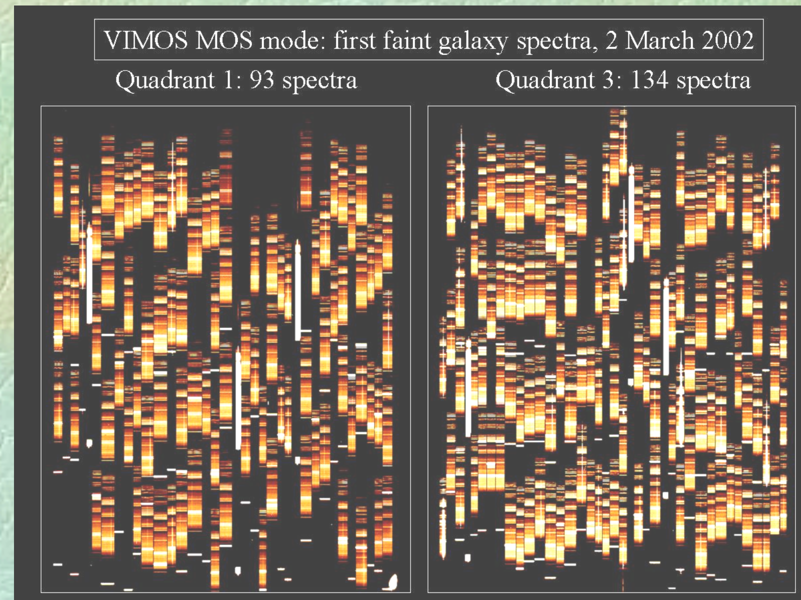
ESO PR Photo 29a/03 (29 October 2003)

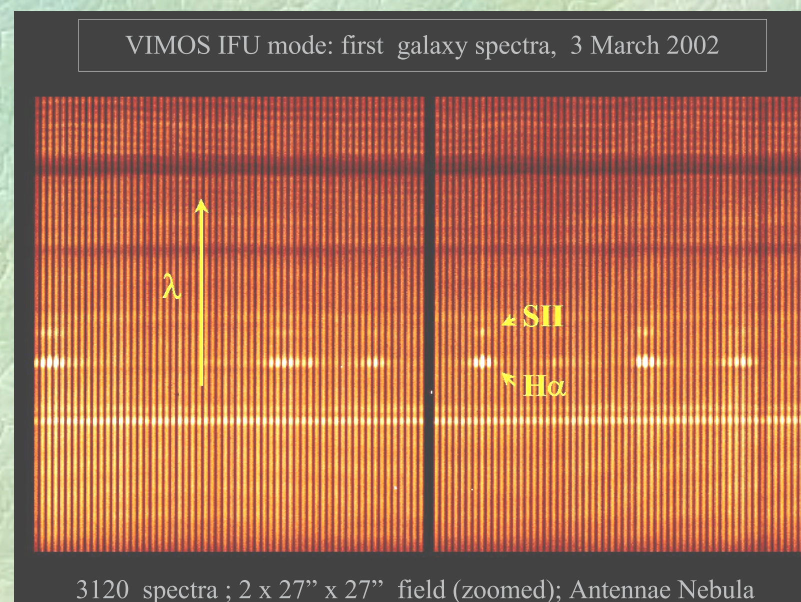
Visible Imaging Multi-Object Spectrograph (VIMOS)



MULTIPLEX !







4 Imagers & Spectrographs

4x 7’x8’ FOV, up to 700 spectra

FLAMES Facility

Multi Object - Multi mode High Resolution

Largest FoV (25 arcmin Diameter)

GIRAFFE (R~6000 to ~30000):
132 MEDUSA 1.2” fibres
15 Deployable 2x3” IFUs
1 central IFU

+
8 1” Fibres to UVES Red
(R=45000)

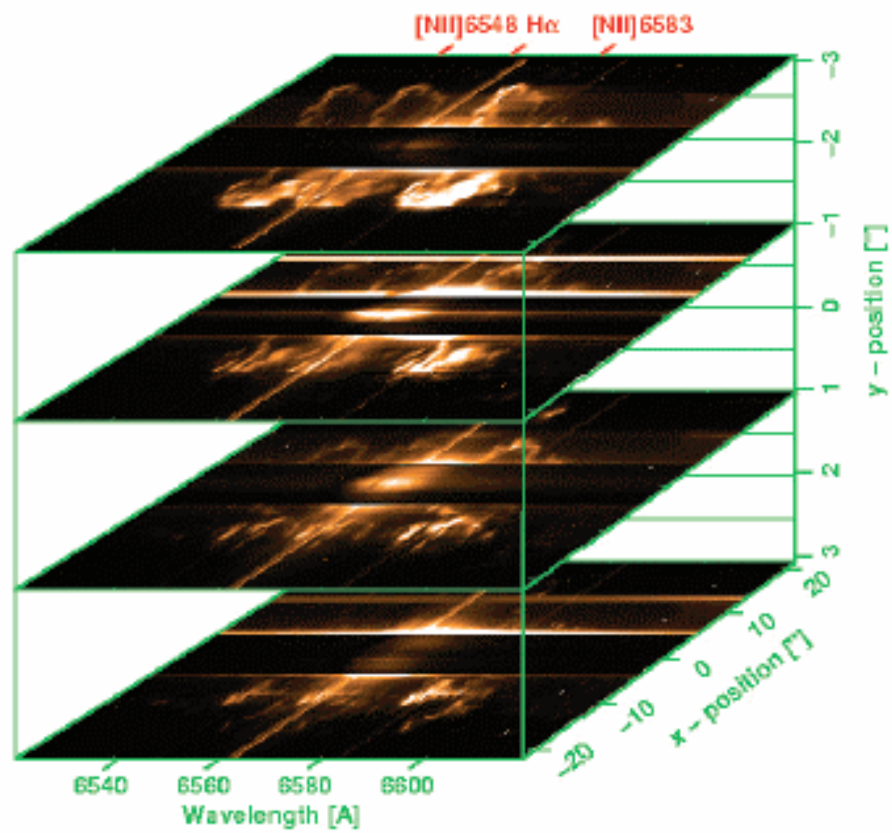
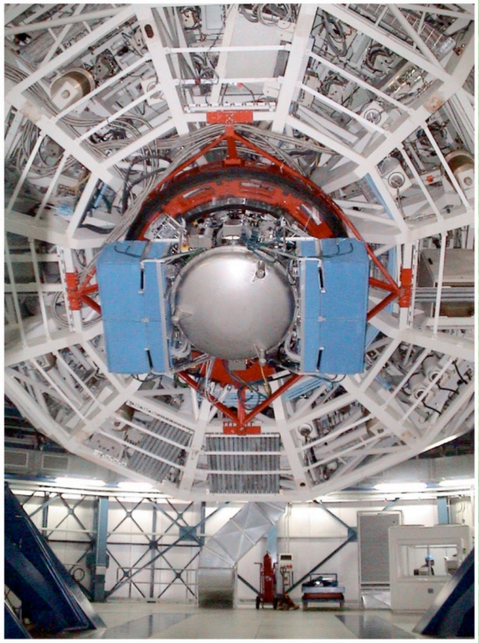


Figure 3: Four out of 14 slices from the η Carinae ARGUS data cube around the Hα and the [NII] lines. The horizontal lines at the back indicate the positions of the 10 slices which could not be shown.

VLT Imager and Spectrometer for the InfraRed



VISIR Mounted behind the 8.2-m Mirror of Melipal

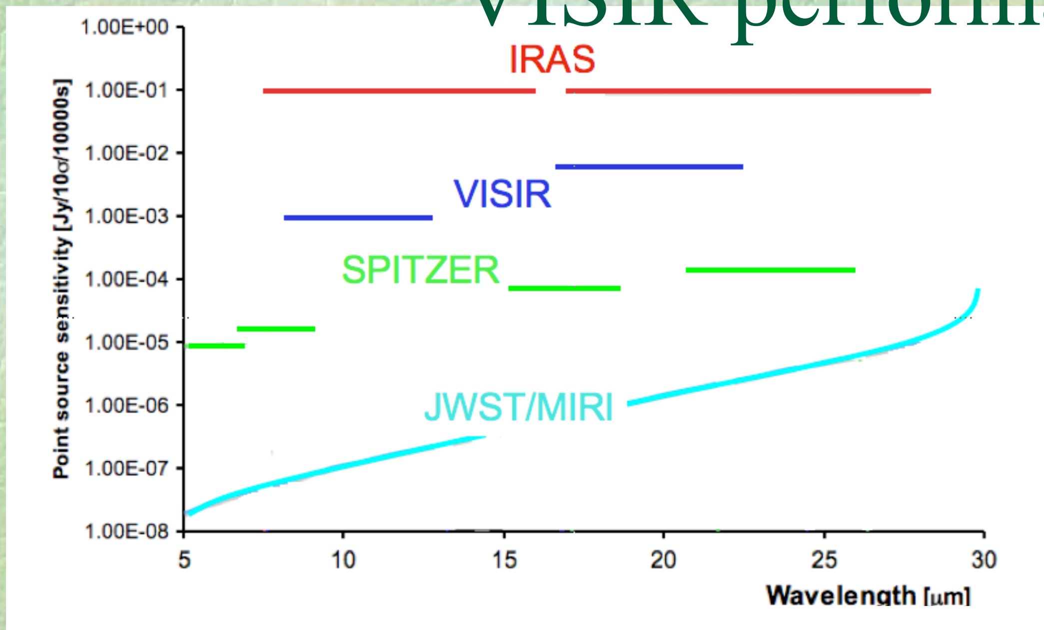
ESO PR Photo 16b/04 (12 May 2004) © European Southern Observatory

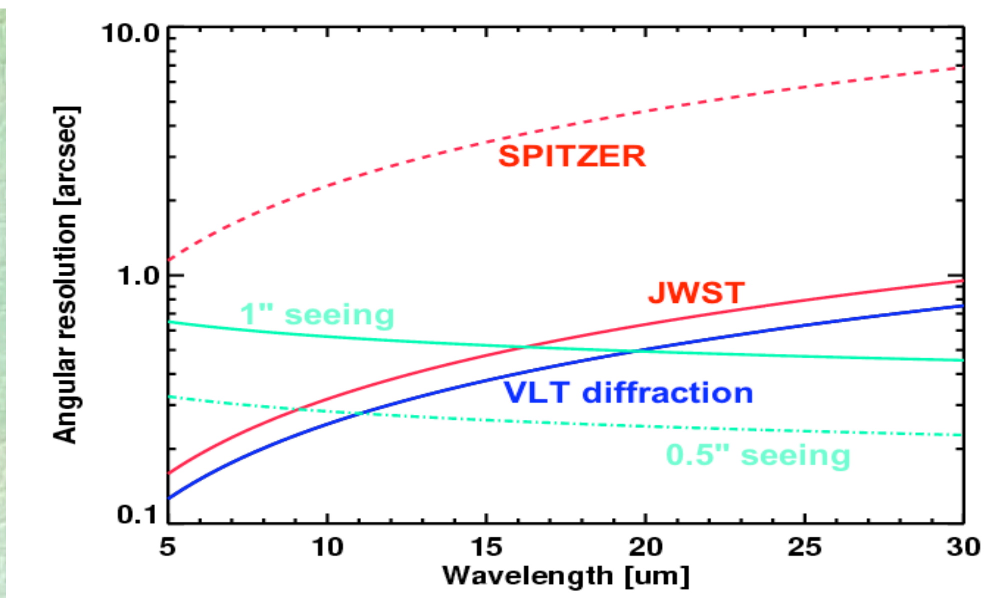
Diffraction-limited (seeing < 0.8")

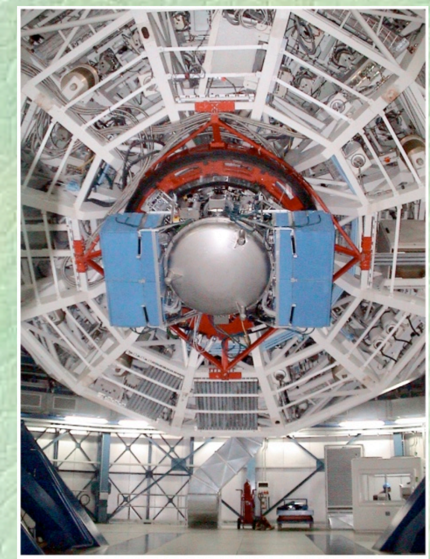
Multi-mode instrument :

- Imaging: N(8-13 μm) and Q(16-20 μm)
  18 filters (R=20 to 100)
  pfov: 0.075" and 0.127"
- Long slit Spectroscopy: LR (R=300),
  MR (3000) and
  HR (15000-30000 in Q and N)

VISIR performance





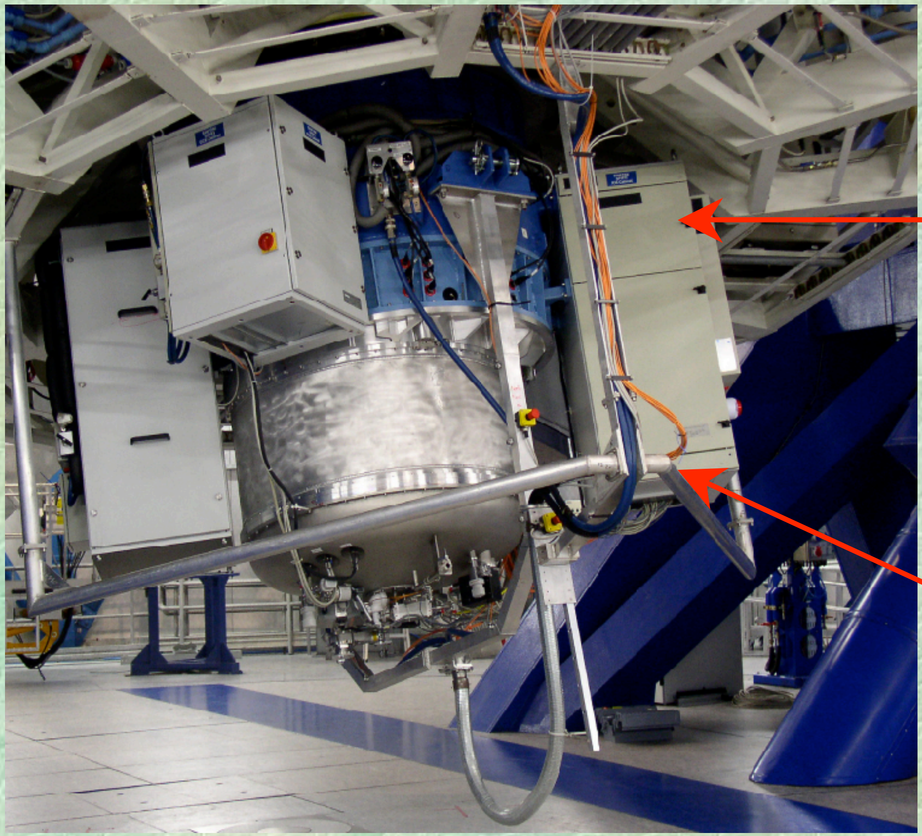


VISIR Mounted behind the 8.2-m Mirror of Melipal

Detector Upgrade
In preparation

VLT UT4 (YEPUN)

First Light Jan ‘04



SINFONI

AO Module

60 elements curvature
Natural & Laser Guide Star

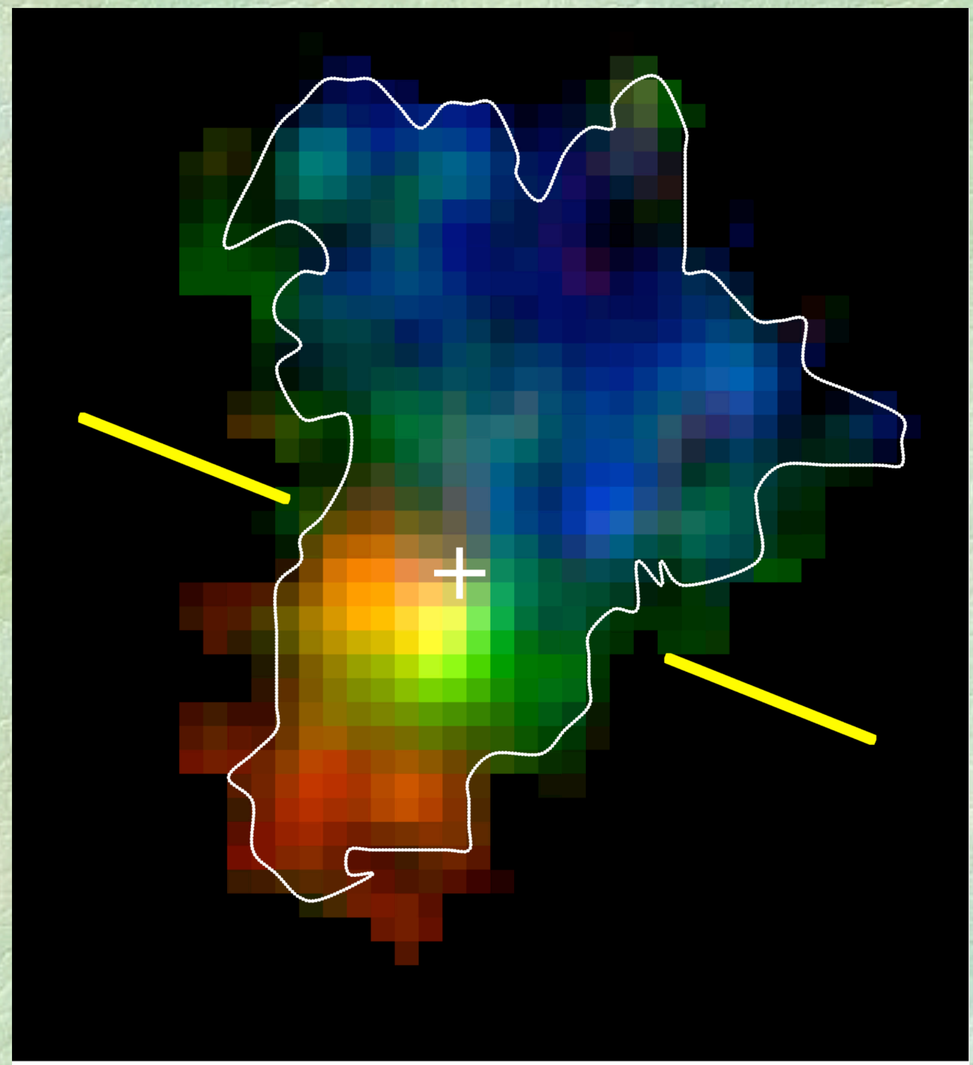
SPIFFI

3D spectrometer (0.95-2.5μm)
FOV = 0”.8 to 8”, λ/Δλ ~ 4000
(32 x 32) pixels, 1024 channels

AO-corrected 3D IR spectro-imager ⇨ any small structured target

AO Assisted IFU

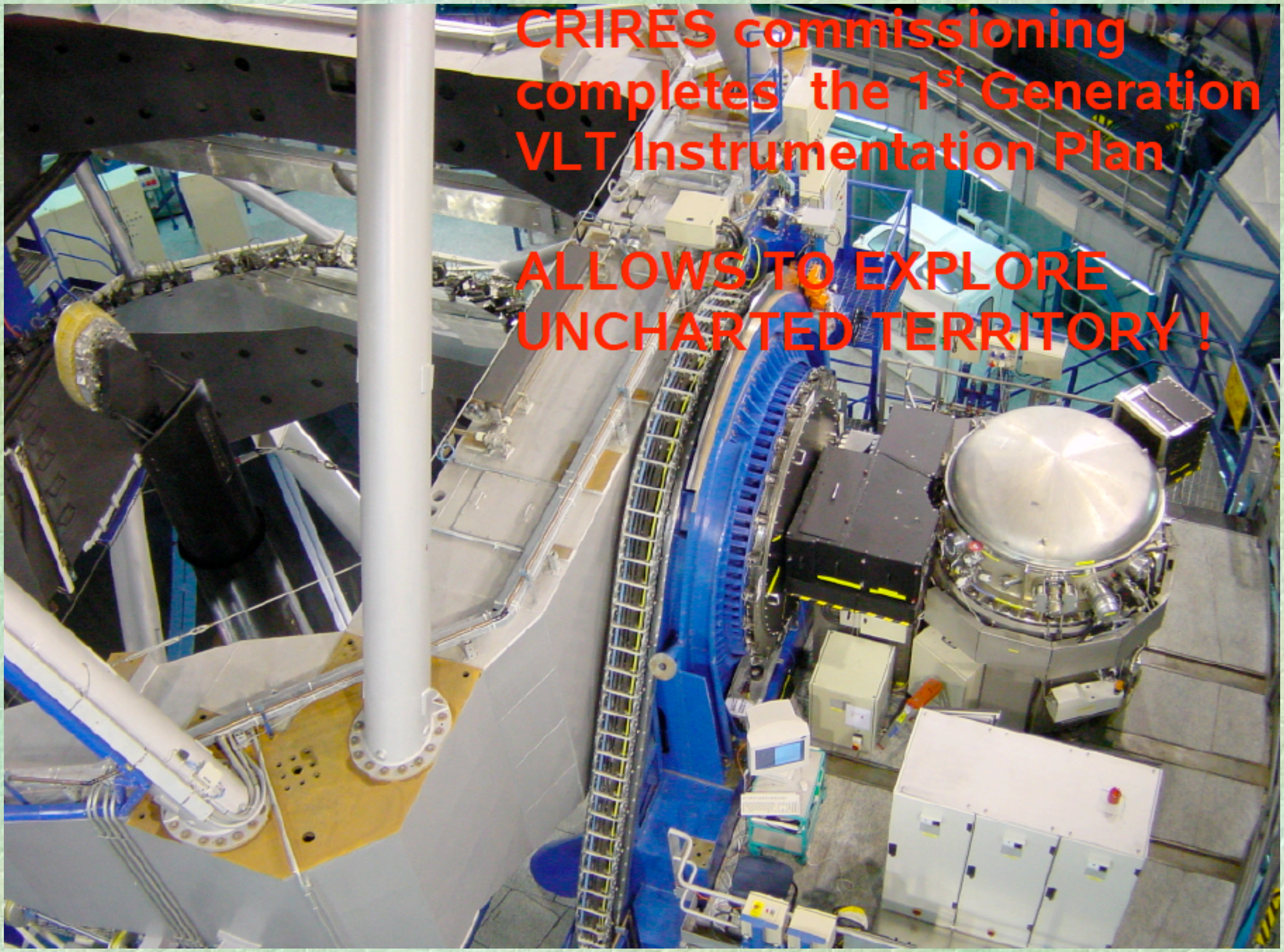
Z=2.4 Hα Velocity Map
Resolution ~ 0.15”
V dispersion ~ 240 km/sec

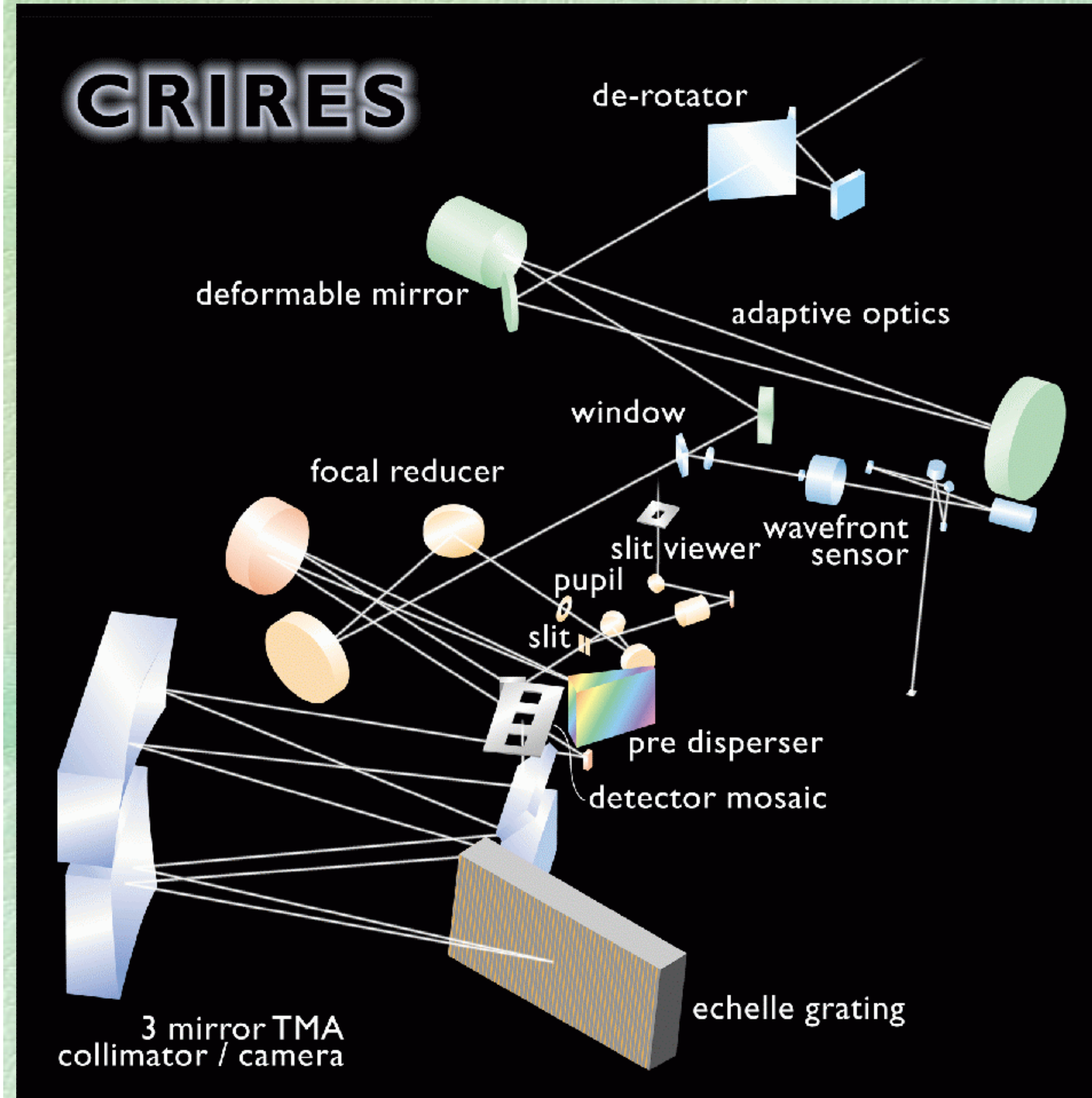


Emission of the Galaxy BzK-15504 (SINFONI/VLT)

ESO Press Photo 31a/06 (17 August 2006)

9 yrs after … CRIRES





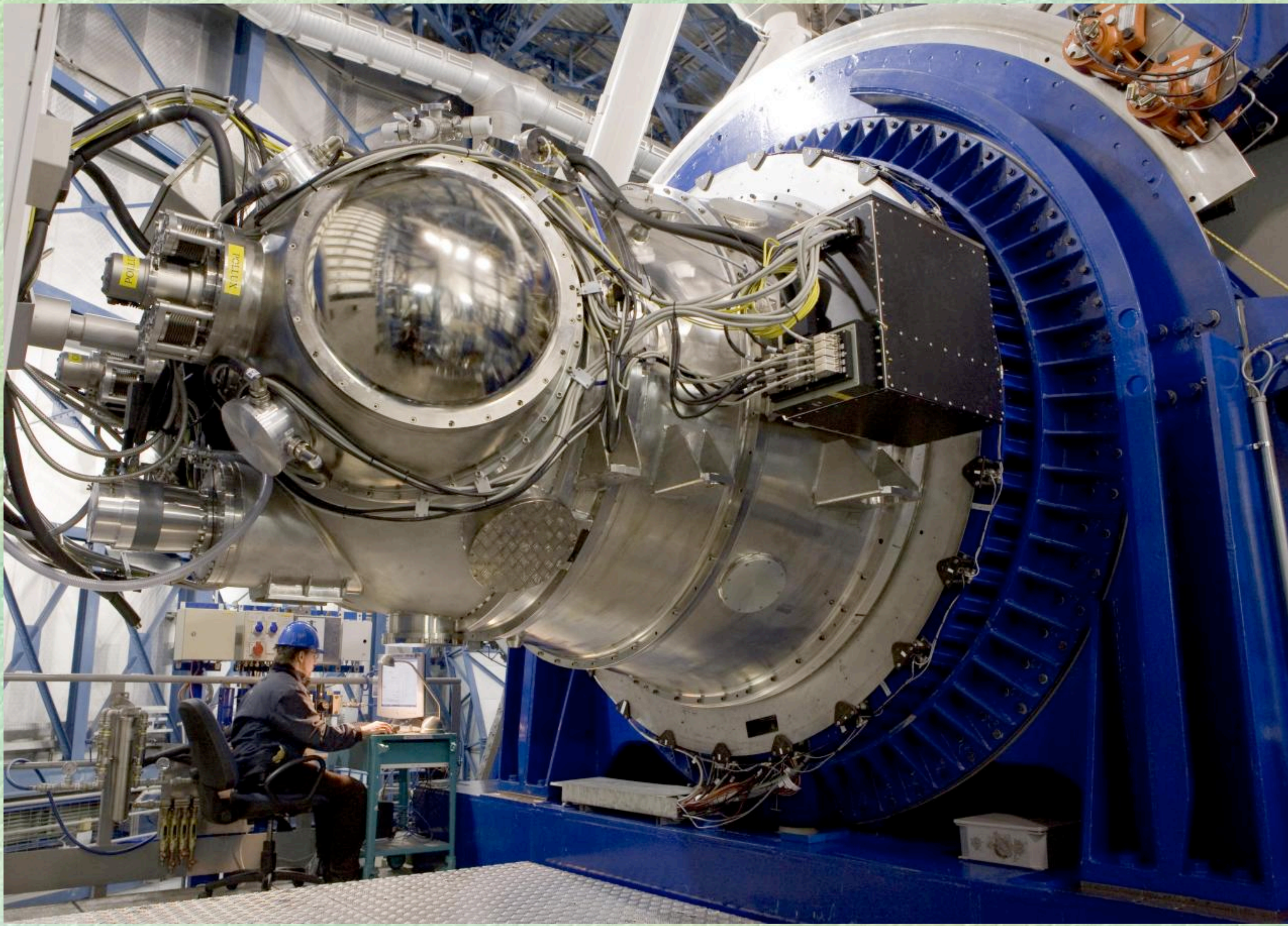
- 1-5 μm range
- $\Re \sim 10^5$ with 0.2” slit:

<u>AO ASSISTED!</u>

- single order
  (echelle + pre-disperser)

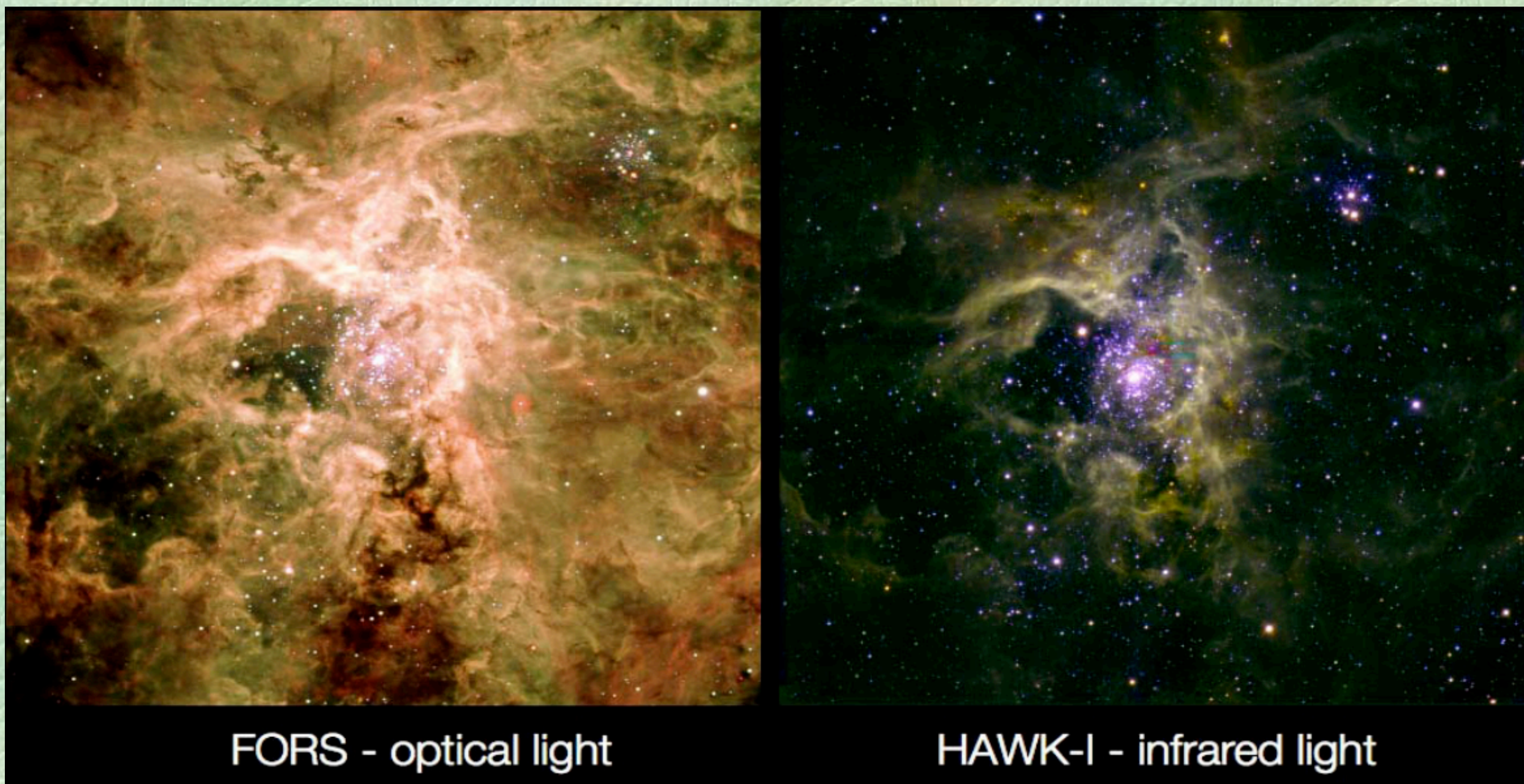
•75 m/sec calibration and stability precision

VLT 1.5 Generation:HAWK -I



HAWK - I : FoV + Resolution

7.5 x 7.5 arcmin with 0.1” sampling (4 x 2Kx2K IR array)
From Y(Z) to K band



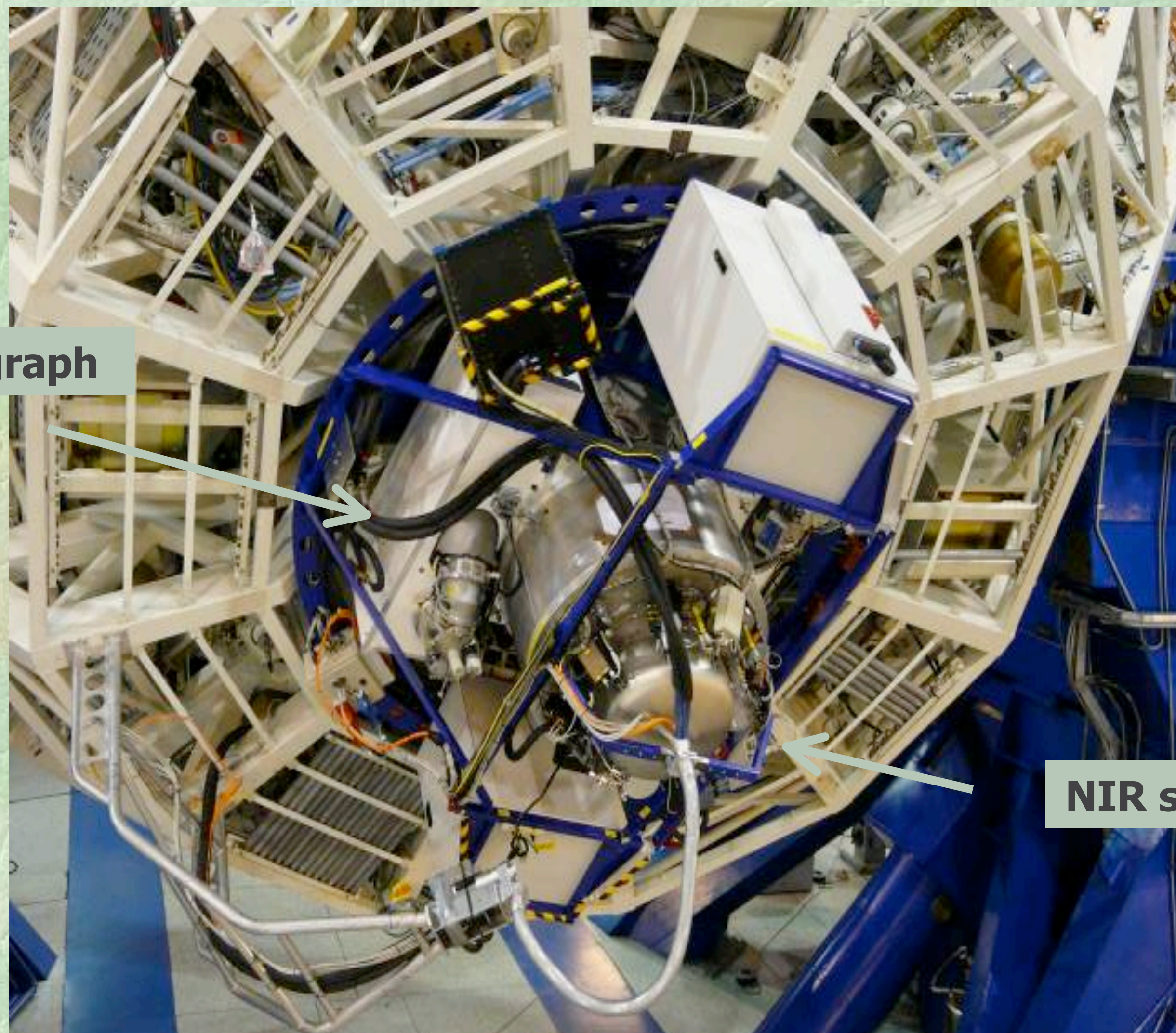
X-shooter,2nd generation VLT instrument #1, will start operations on October 1, 2009

Detecting First Fireworks: Gamma-ray bursts and SNae

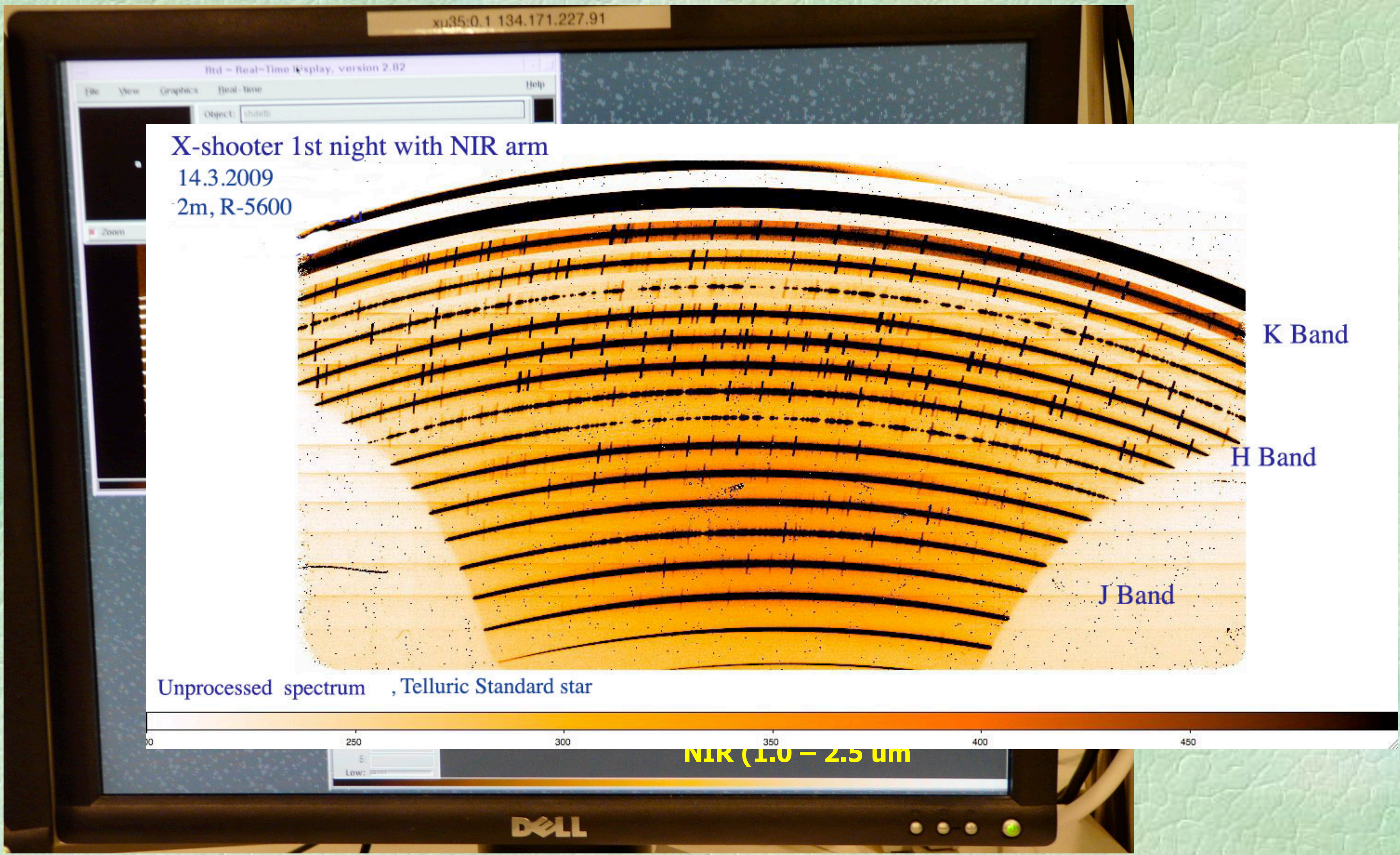
Denmark	P. Rasmussen (coPI and PM), J. Hjorth (Science Team cochair))
ESO	S. D’Odorico (coPI), H.Dekker (PM), J.Vernet (IS). J.L. Lizon (Integration), M.Downing (CCDs), G. Finger (NIR array), C.Lucuix (Electronics), A. Modigliani (pipeline)
France	F. Hammer (coPI), I. Guinouard (IFU PM), P.Goldoni (DRS PM)
Italy	R. Pallavicini (coPI,†2009), S. Randich (coPI 2009->), F. Zerbi (PM)
Netherlands	L. Kaper (coPI), R. Navarro (PM), P. Groot (Science Team chair)

UV to K’ bands in one shot,
Single target (slit or mini IFU),
Fix format,
Intermediate Resolution
High-Efficiency Spectrograph

X-shooter at Cassegrain of UT3, March 09



Very first light spectra with all 3 arms on the real time display, 14/03/09 23:22
Standard Star, 10s



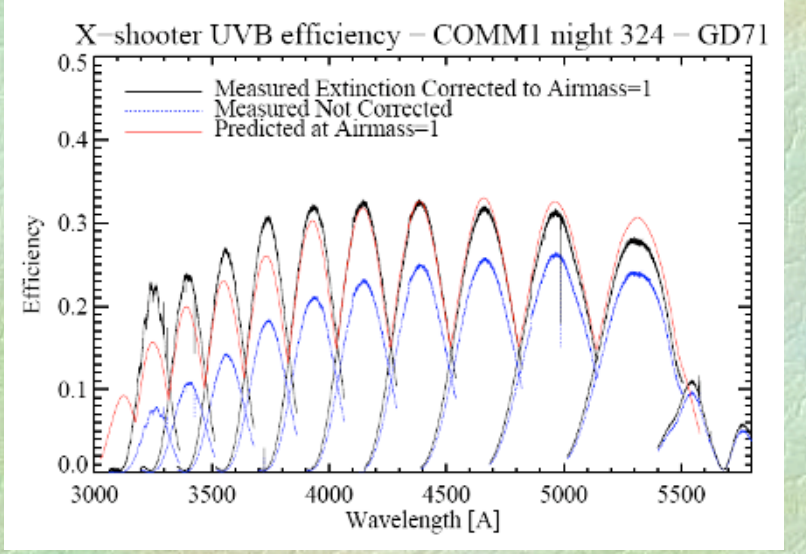
X-shooter
Characteristics

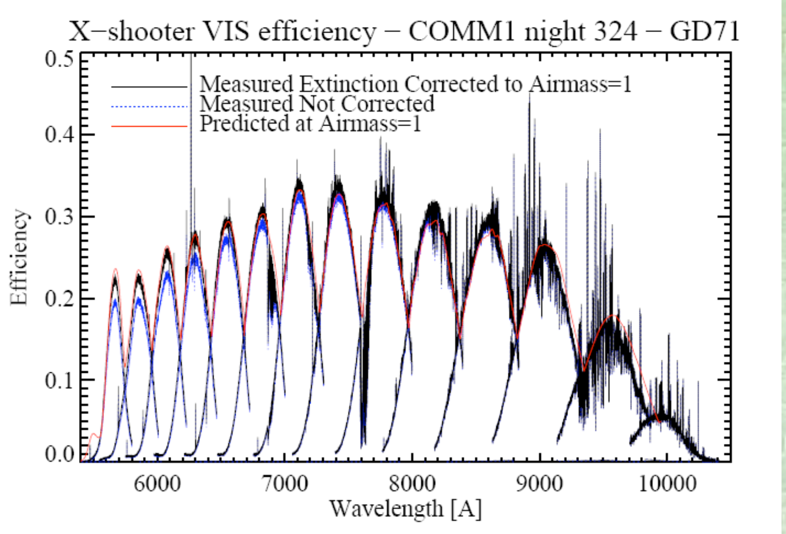
- **Wavelength range: three arms covering 300 nm to 2500 nm (NIR arm fully cryogenic)**
- **Active control centering of targets on the three slits**
- **Fixed prism cross-dispersed echelle format (slit length 11″or 1.8″x4″ IFU - reformattable)**
- **Spectral resolution: ~7,000 to 12,000 for 0.6″ slit or IFU**
- **Detectors: 2Kx4K 15 um CCDs (UVB and VIS arms); 2Kx1K 18 um Hawaii 2RG MBE (NIR arm)**
- **ADC for UVB and VIS arms, calibration unit and A&G unit**
- **High Detective Quantum Efficiency**
- **Quality pipeline delivering sky-subtracted, wav cal 2D spectra and 3D data cube for the IFU**

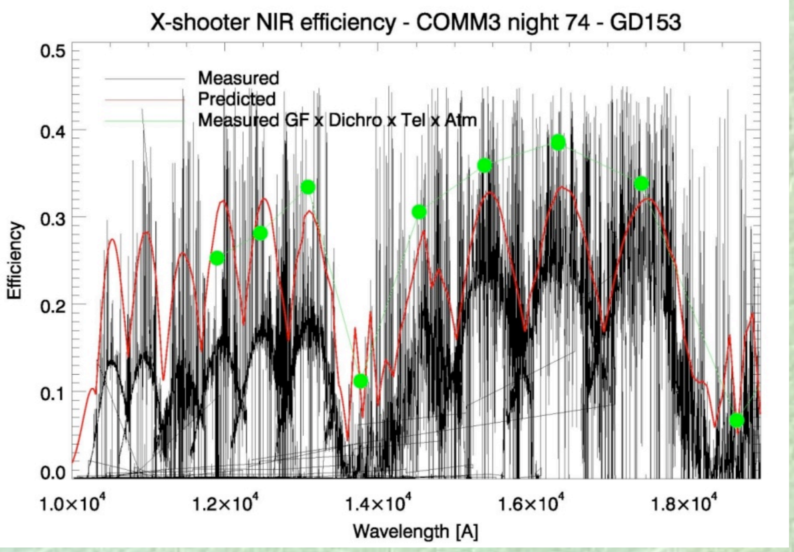
Summary overview of instrument performance (measured at UT3 versus predicted)

- Three arms parallel operation successful demonstrated (acquisition and centering on the three slits)
- UV and V ADC performance to specifications
- Instrument flexures in backbone , UV-B and V-R arms within specifications. NIR arm flexures a factor 1.5 out of specs
- Efficiency of UV-B and V-R arm in specs; NIR lower, under investigation
- Smooth operation of the control and observing software

Efficiency (predicted vs. measured) atmosphere + telescope + instrument

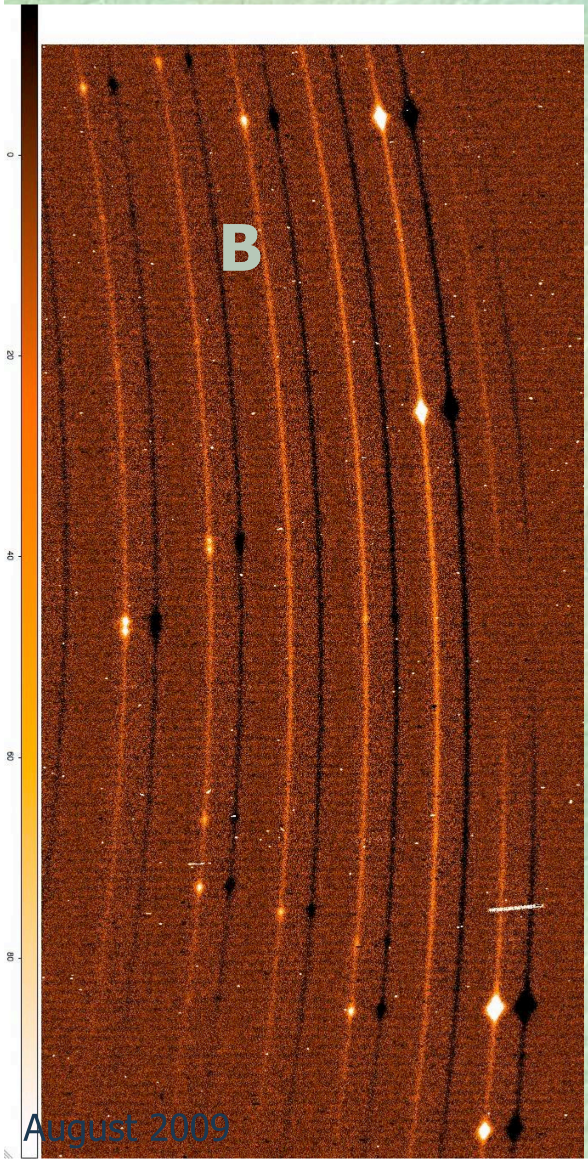


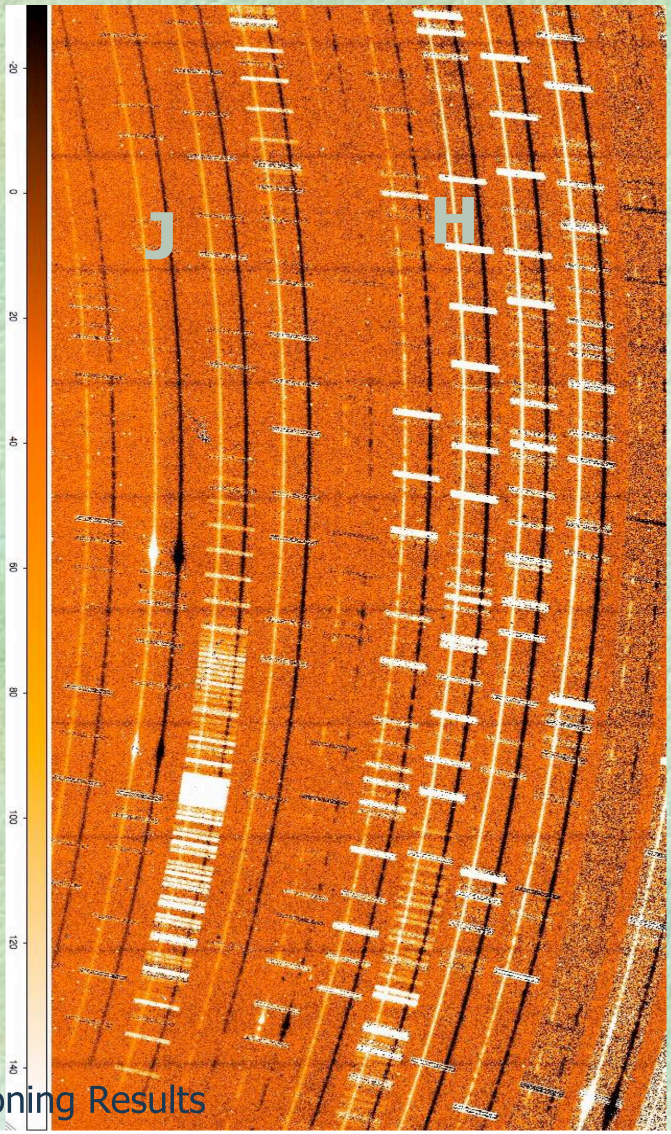




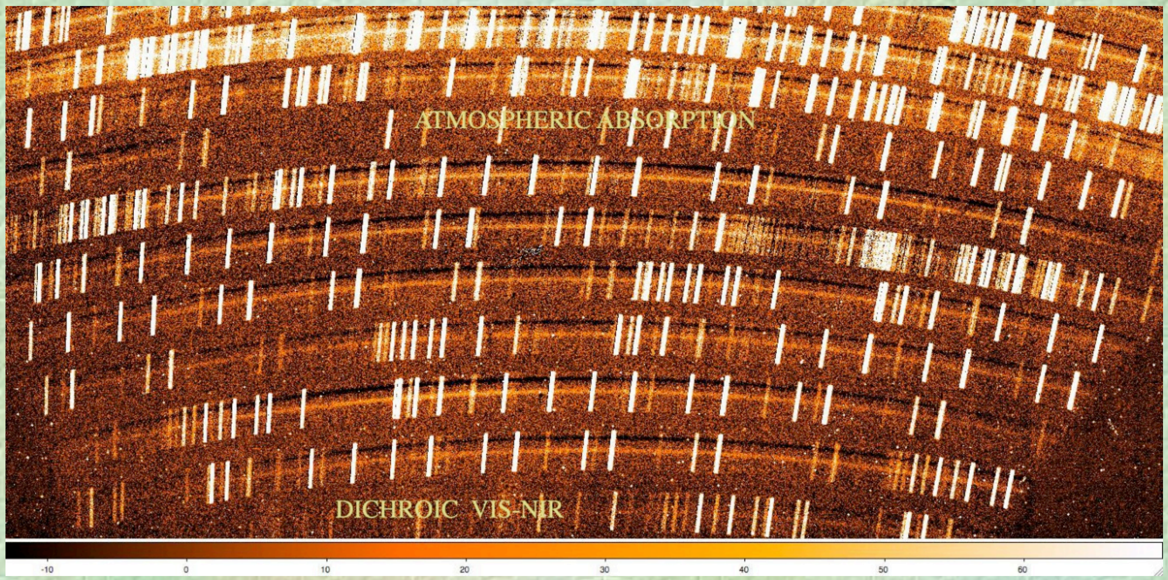
- *Efficiency of UV-B and V-R arms as predicted*
- *NIR arm efficiency lower then predicted (50% in J, 20% in H .) Pupil alignment , to be verified , could account for 20% losses. Poor transmission of the prism s likely culprit of the poor J performance.*

Examples of scientific performance: GRB host, starburst , emission line galaxy at z=0.105, r=20.5, K=16.6 (4x1200s exposures, combined for sky subtraction). **UVB: 320-559nm, R= 5100, VIS:560-1040nm, R=8800, NIR: 1040-2400, R=5600**



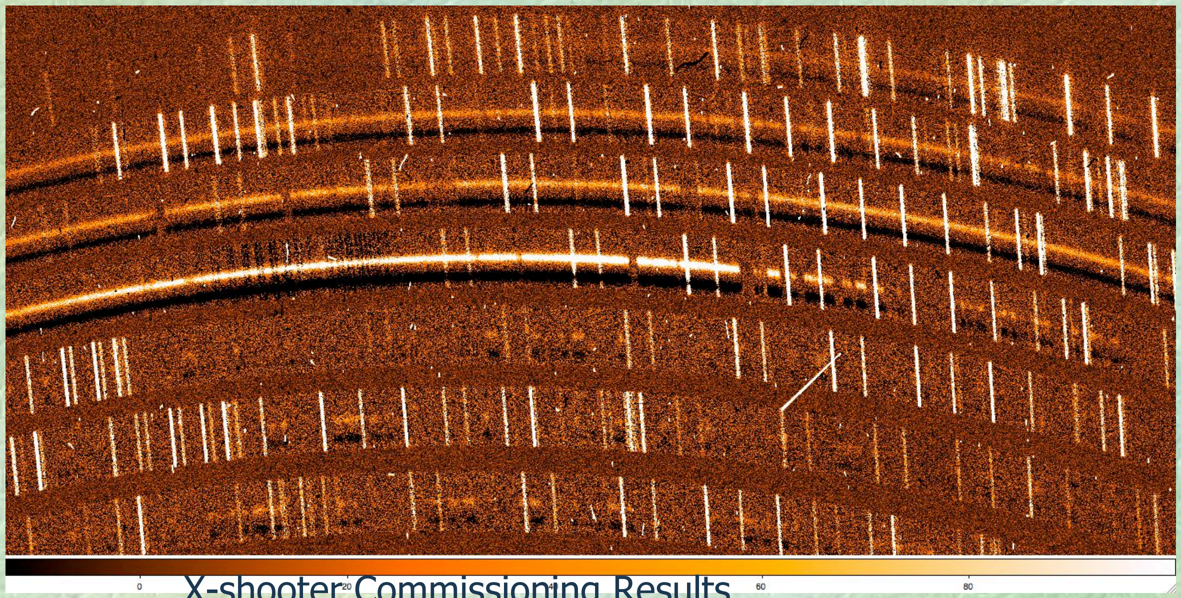


Examples of scientific performance: QSO at z=6.016 . J (Vega)=18.8 (2x30m, A-B)



H and J Bands,

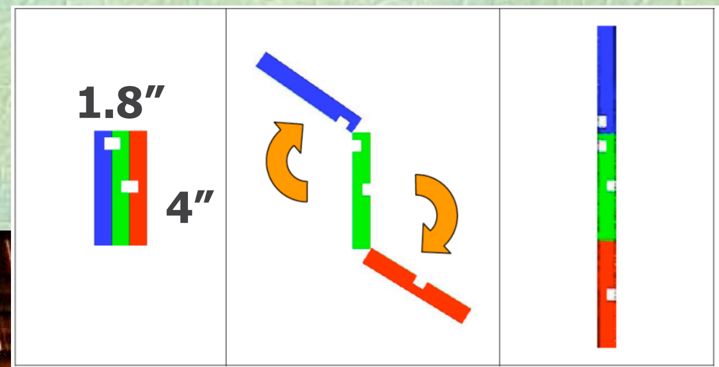
R= 5900

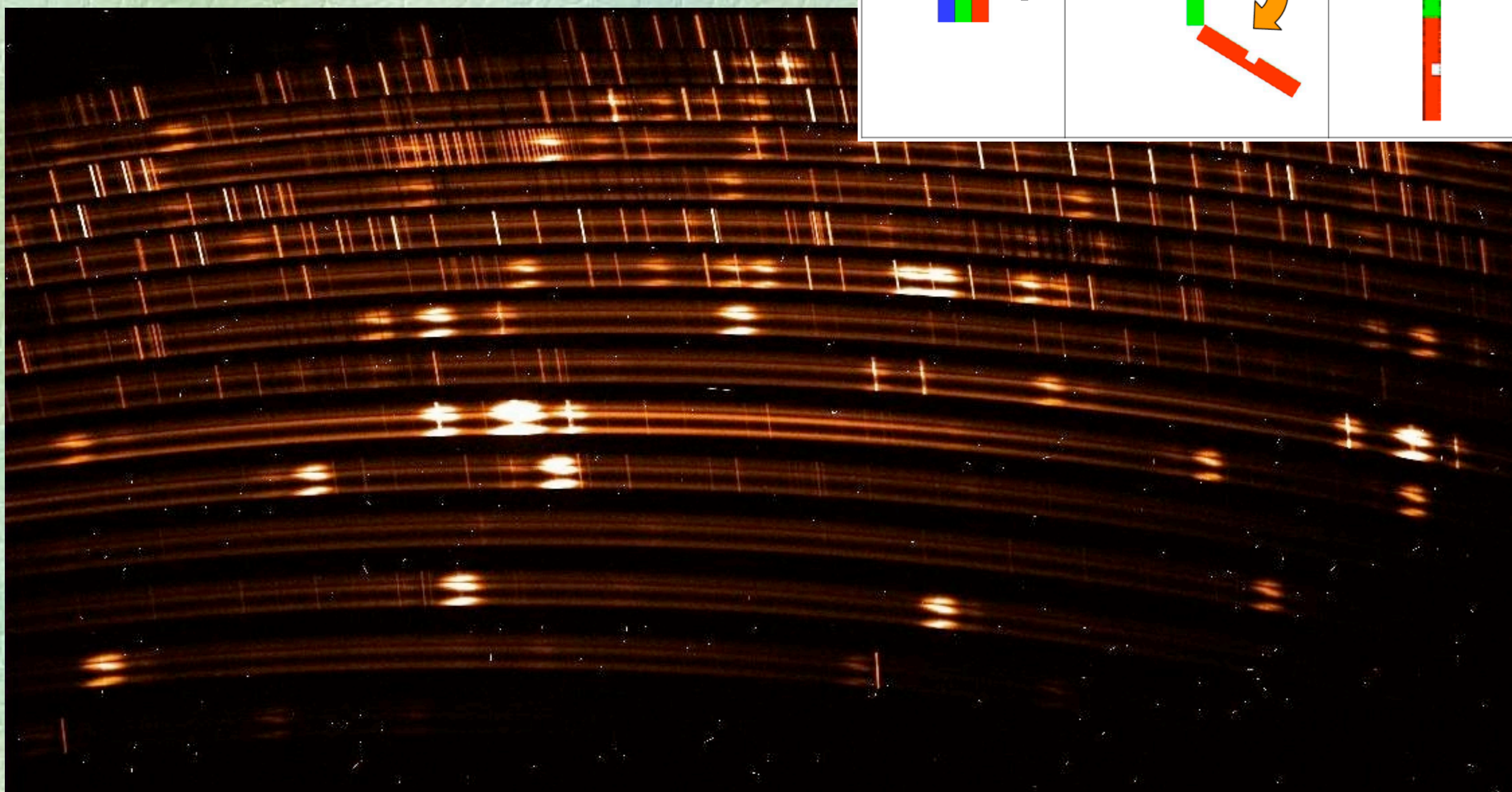


VIS-R above 700nm,

R= 8800

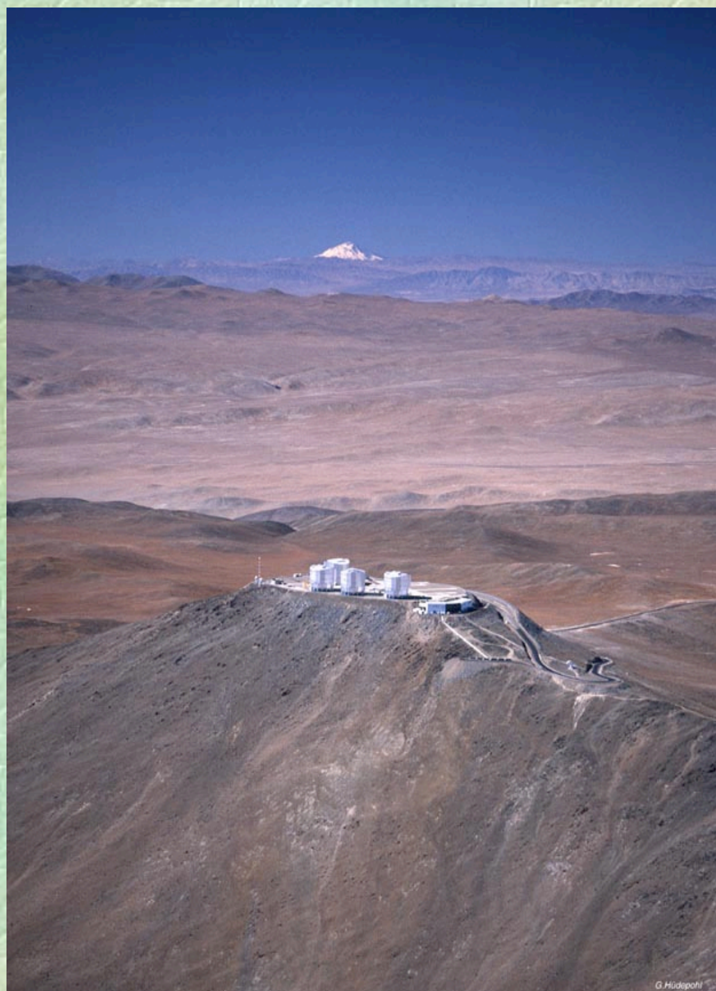
Examples of scientific performance: IFU Vis-R spectrum of SN 1987A in the LMC





20m integration, Spectral Range 550-1025 nm, R=12600

VLTI

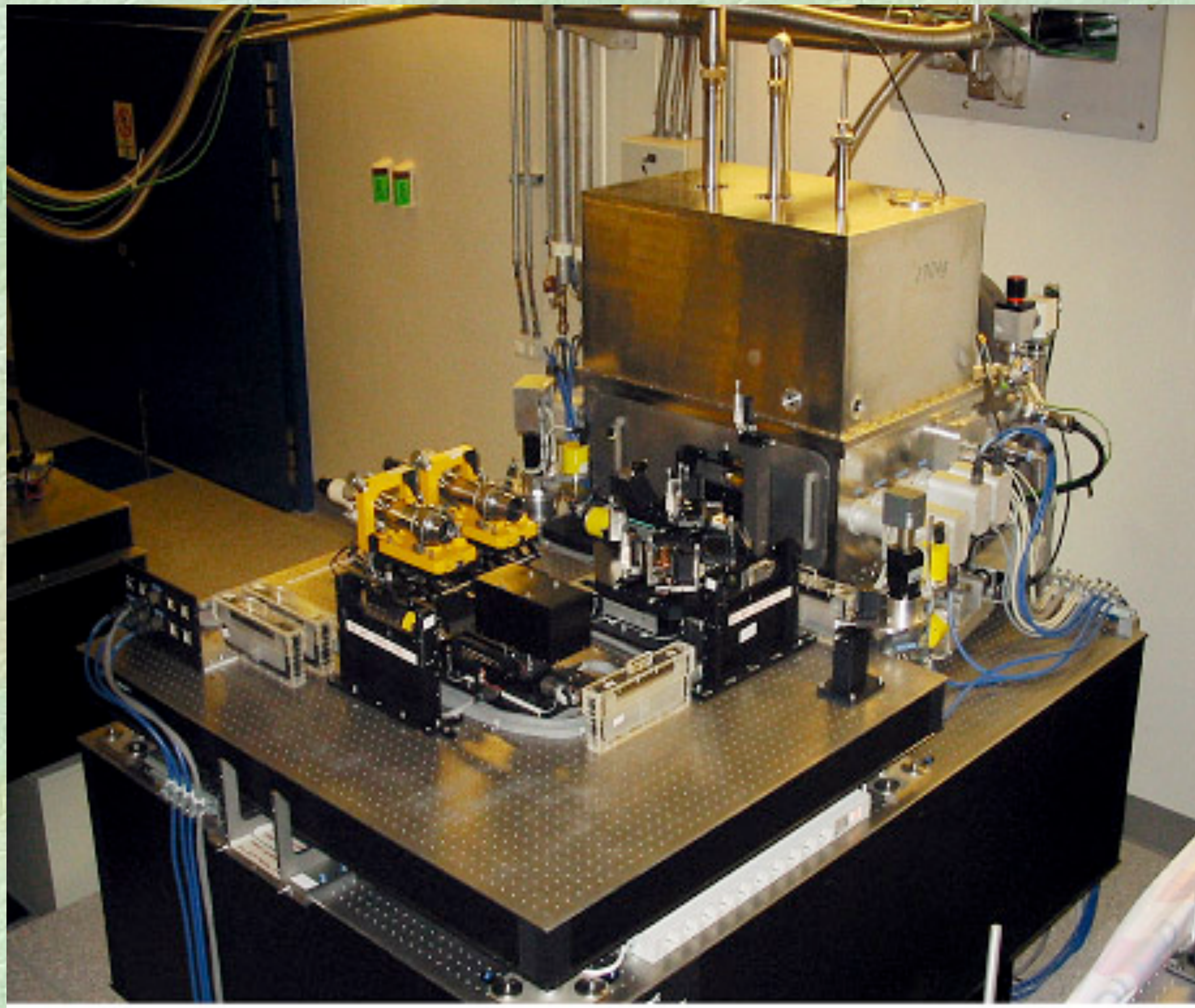


- Four 8.2m telescopes (UTs)
- All equipped with AO (MACAO)
- Six Baselines 47m-130m

- Four 1.8m telescopes (ATs)
- Movable to 30 stations
- Baselines 8m-202m

- Six delay lines
- PRIMA dual feed facility
- IRIS lab tip/tilt tracker
- FINITO fringe tracker
- MIDI/AMBER/VINCI

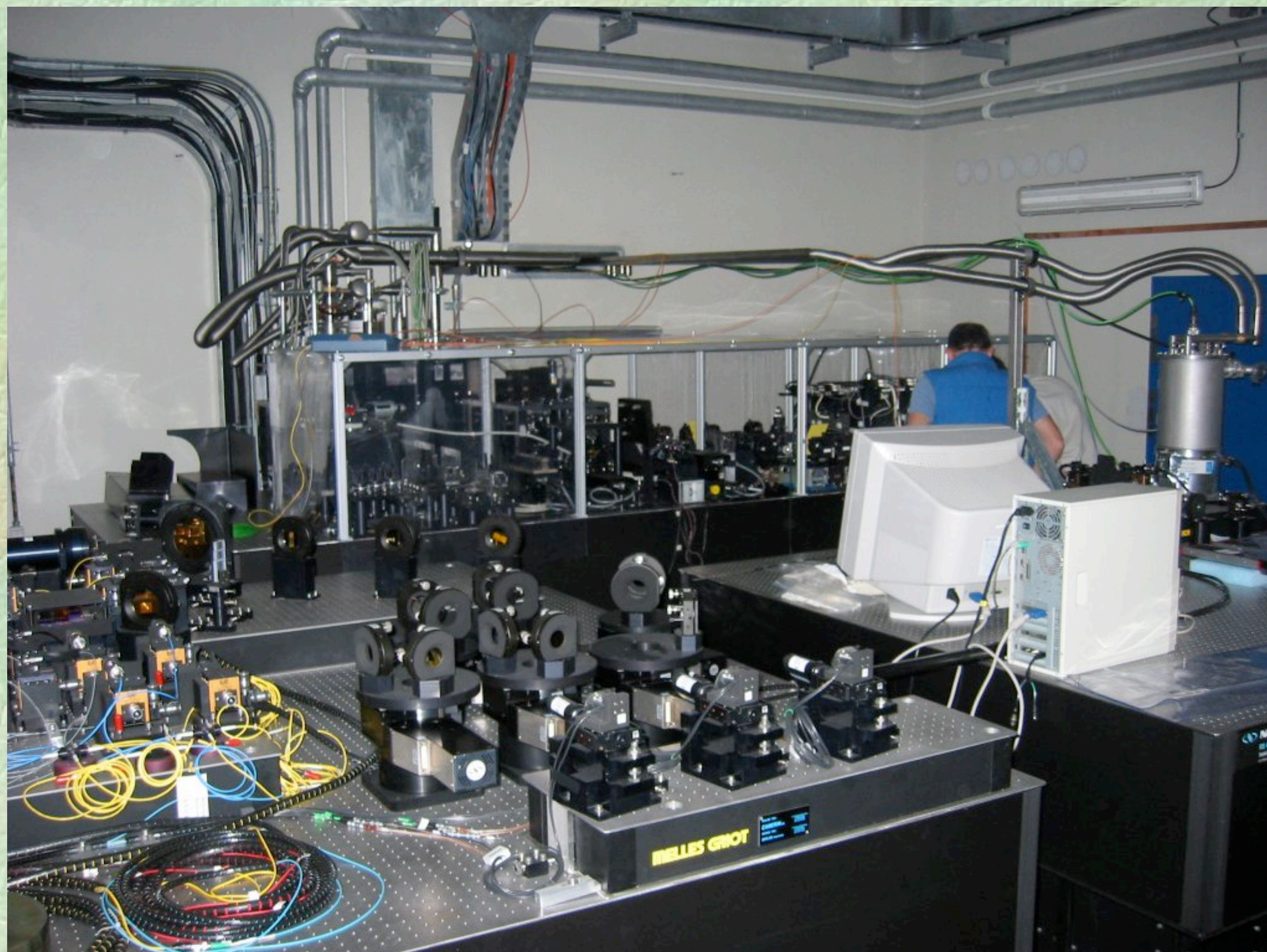
MIDI in the VLTI lab



The MIDI Instrument at the VLT Interferometric Laboratory on Paranal

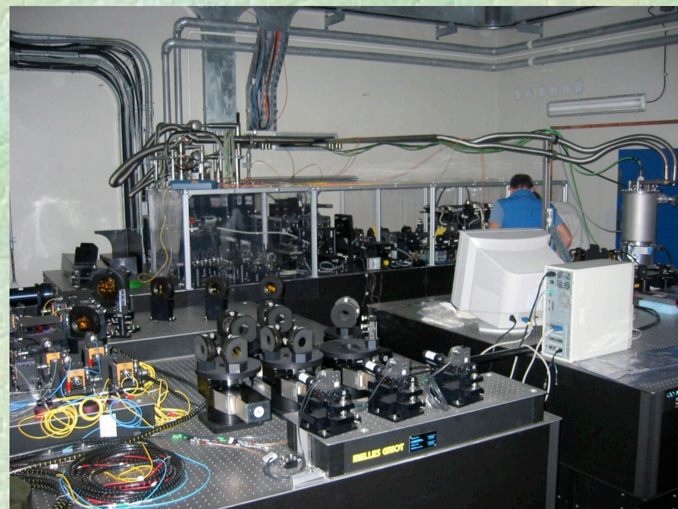
ESO PR Photo 30c/02 (18 December 2002)

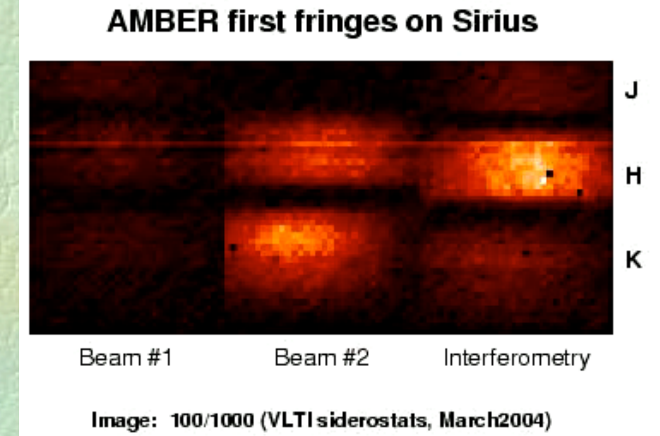
AMBER in the VLTI Lab



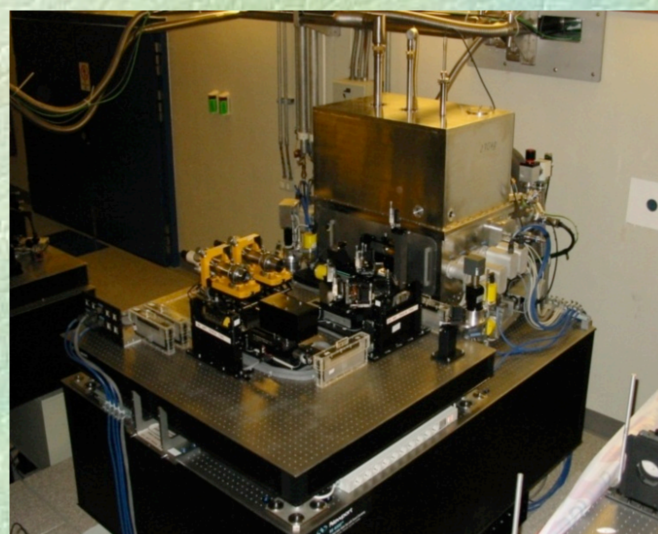
The VLTI Today

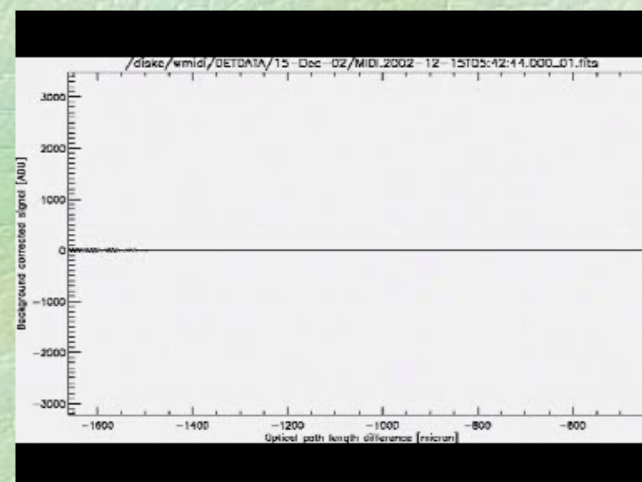
AMBER
2-3 beam, JHK R=35, 10^3, 10^4
Paranal 2004/2





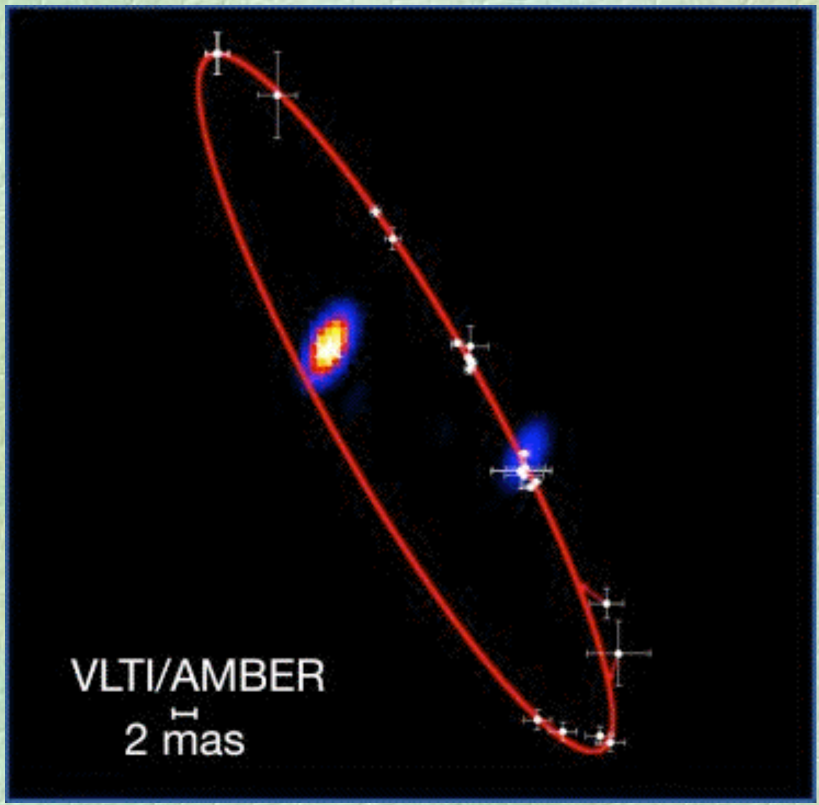
MIDI
2 beam, N-band R=30, 230
Paranal 2002/11



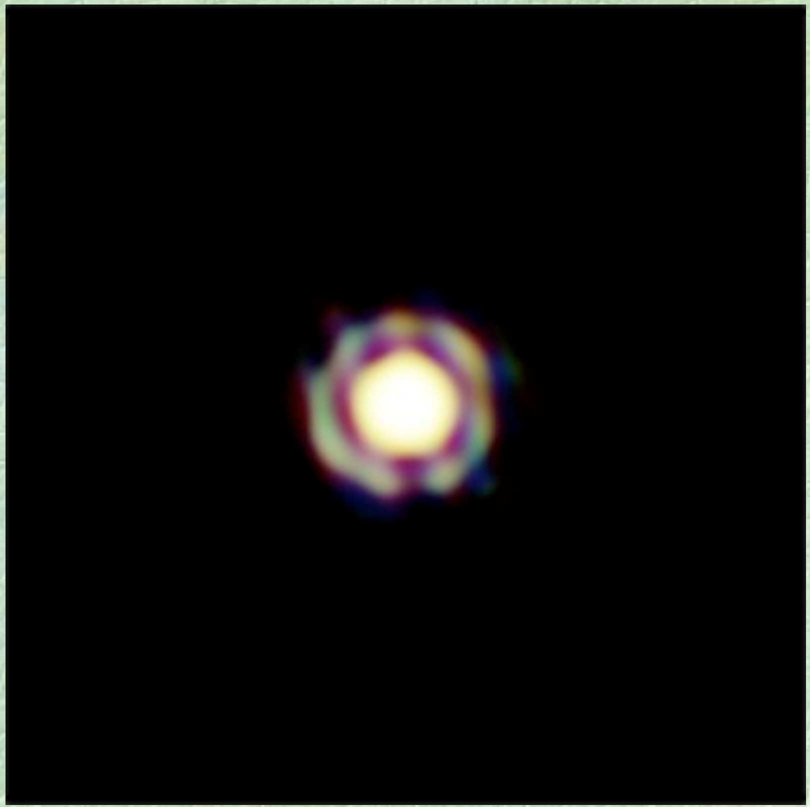


+ FINITO, IRIS, Differential Delay Lines, ARAL, vibration correction, ...

Imaging with the VLTI



Kraus et al. 2009 (in press)

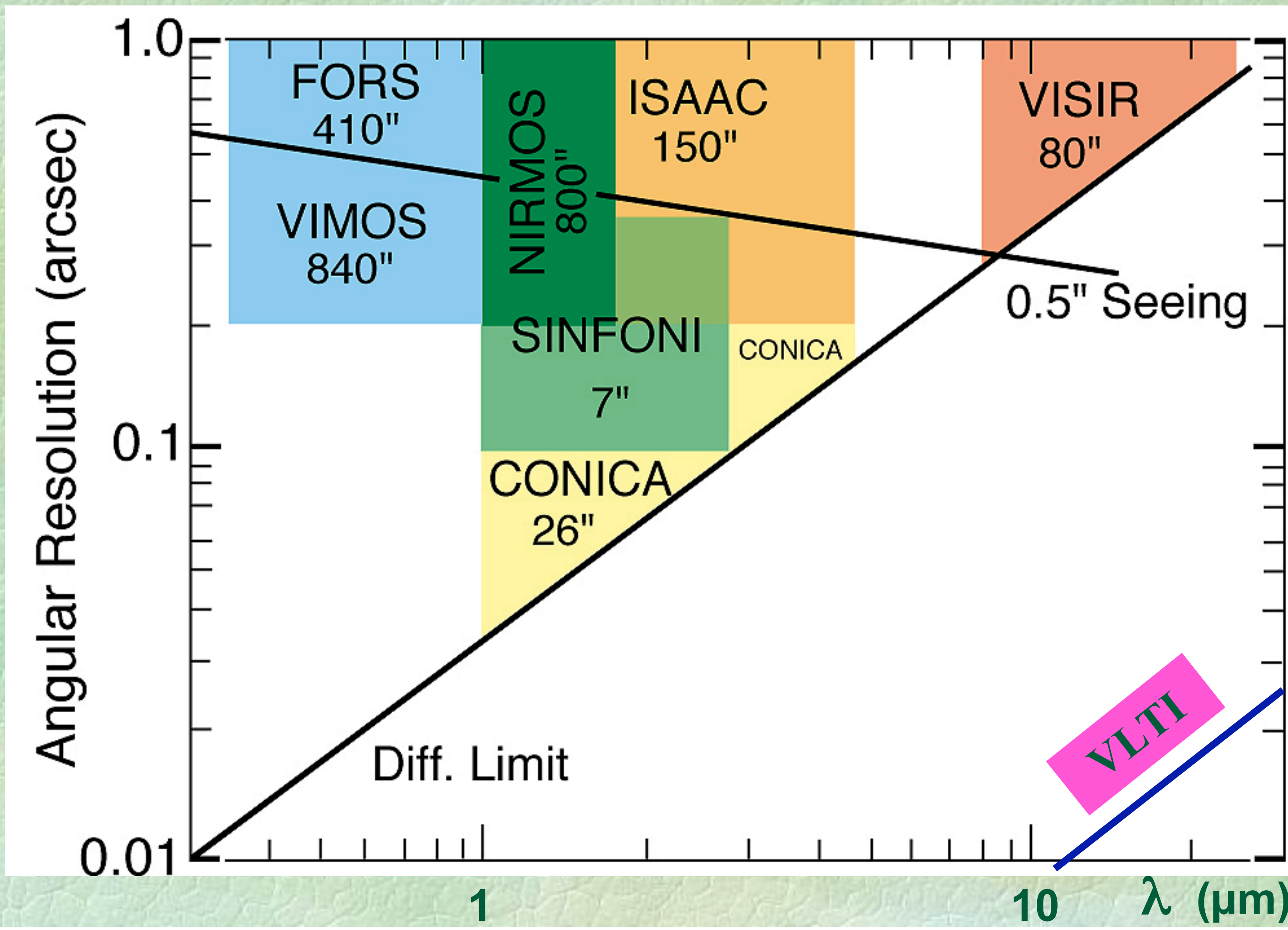


LeBouquin et al. 2009 (in press)

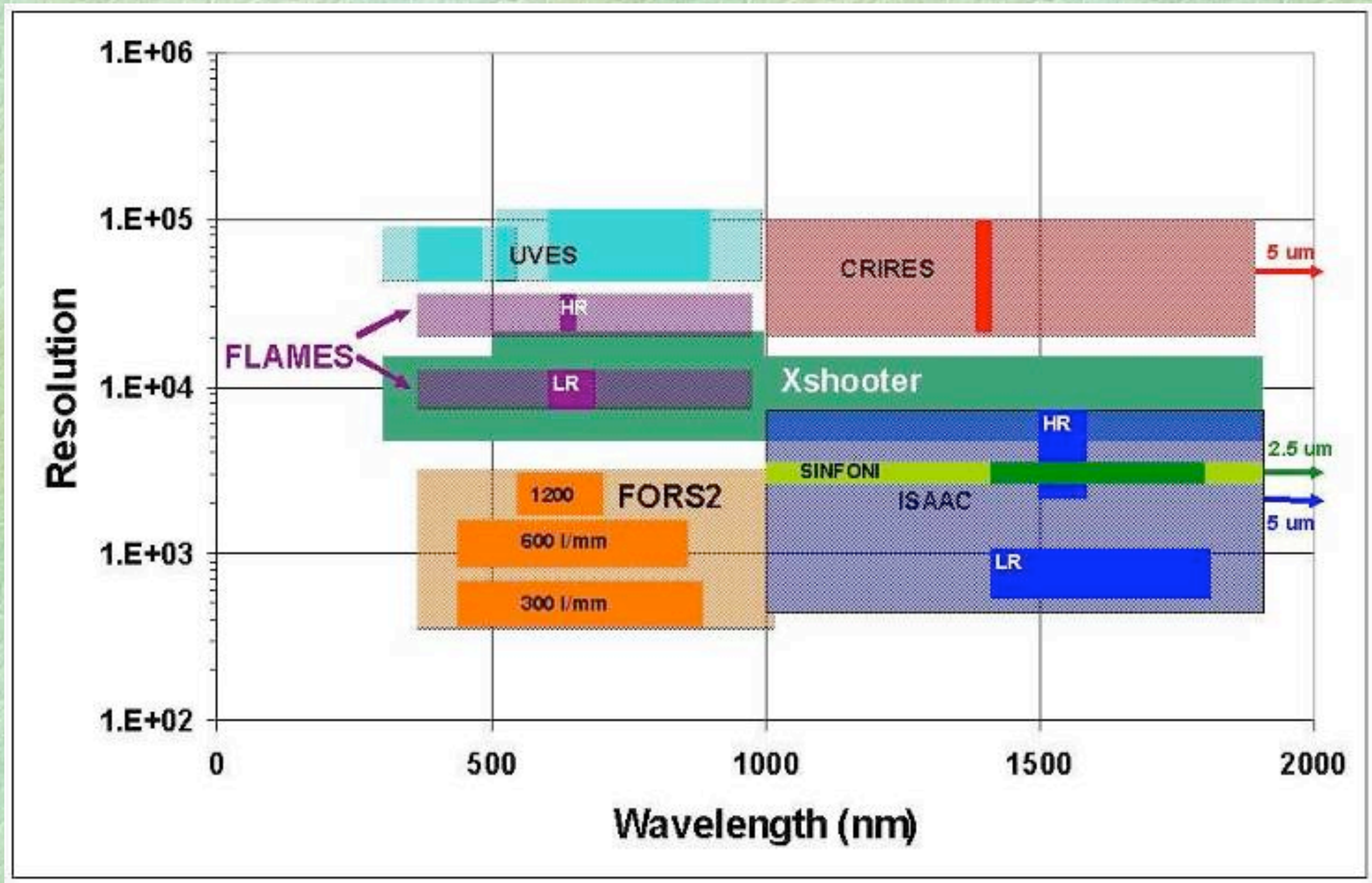
Imaging with the VLTI is logistically difficult
AT quadruples to be offered soon

VLT/I Angular Resolution

An extensive θ -δθ Coverage



VLT/I Spectral Resolution



VLT/I Instruments: an European Effort

The study, development and construction of VLT instruments has been done by, and in collaboration with, more than 40 institutes within ESO countries.

Thank You