On the forefront of astronomical research

-

ESO

(05 November 2014 part of Lecture 5 & 6 & 7)

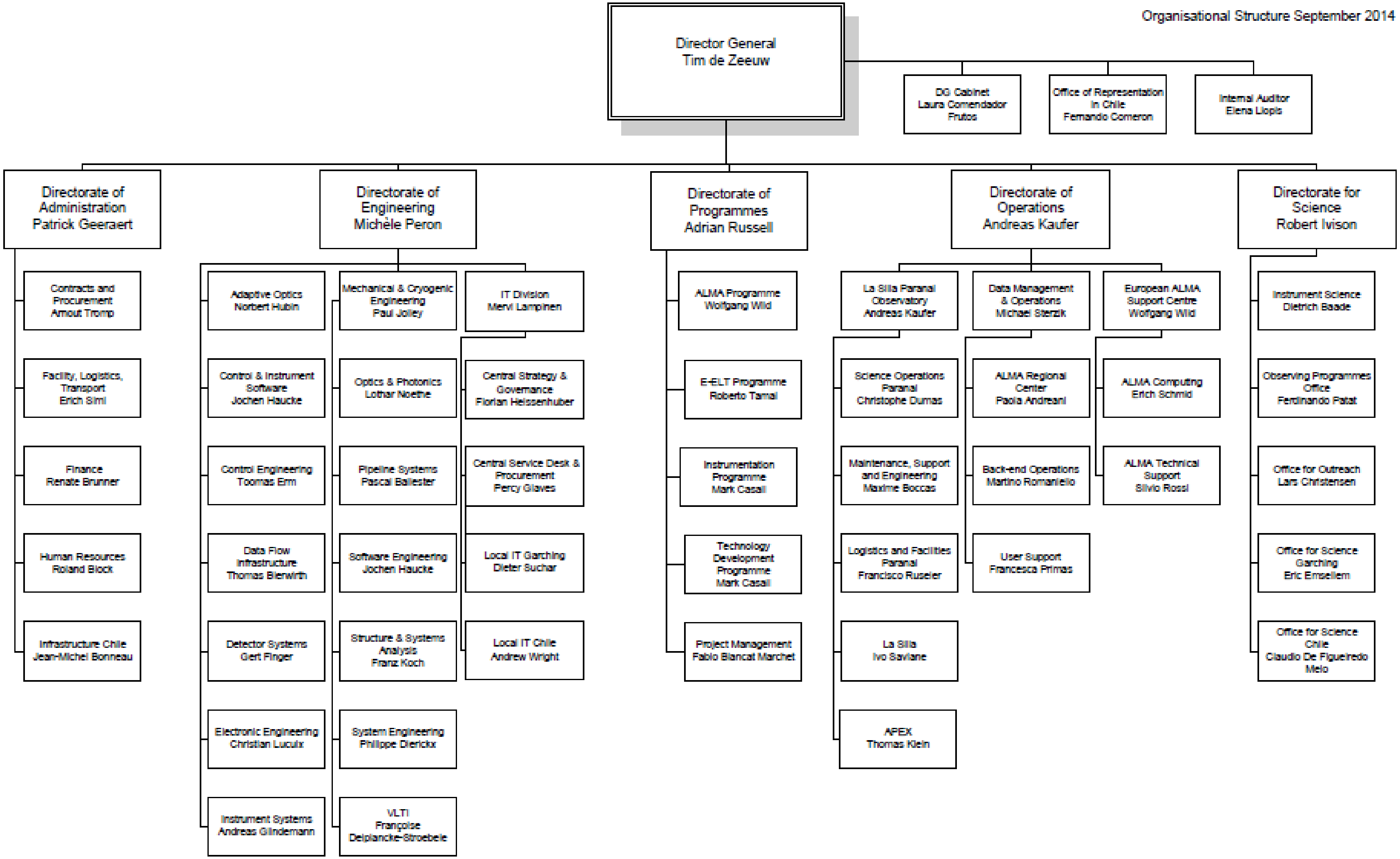
Outline

- Brief history of ESO
- ESO observatories overview
- Detectors and instruments
- Behind the scenes (how to get time?)

ESO today in 5 lines

- 15 member states+1 associated country
- approx. 700 employees (various national.)
- 4 observatories (1, ALMA, jointly operated)
- HQ in Garching, Offices Santiago
- Director General + 5 directorates

In more detail….



Brief history of ESO
How did it all start?

21 June 1953 Leiden

Why conferences are important!

http://www.eso.org/public/images/wbaade-cschalen/

http://www.eso.org/public/images/vkourganoff-jhoort-hspencer/

ESO is born

- In October 5, 1962, after years of meetings and struggles, the ESO Convention, between five of the first six countries was finally signed (Great Britain went its own way). The required ratification, however, was only completed in January 17, 1964

- **Belgium**, **France**, **Germany**, **Great Britain**, the **Netherlands** and **Sweden**

  (later GB left the negotiations)

- **Southern hemisphere selected (SA preferred that time)**

Africa?

- http://www.eso.org/public/images/south-africa-1961-05/
- http://www.eso.org/public/images/south-africa-1961-03/

Direction Chile!

Why Chile?

- Site testing near today’s La Silla proven better than South Africa in 1960’s
- Relatively good accessible, dry environment, easier for logistics, owned by the government
- La Silla selected 26 May, 1964 (Cinchado-Norte mountain)
- October 30, 1964 contract between ESO and Chile signed

La Silla inauguration

- March 25, 1969
- mid sized telescopes
  1-m, 1.5-m, 1.2
  Schmidt
  50-cm ESO telescope
- later national
  telescopes

Dream comes true!

- http://www.eso.org/public/images/lso_inauguration_03-69_2/

La Silla

Paranal approved December 1987

- http://www.eso.org/public/images/council87/

VLT inauguration
4 December 1996

- http://www.eso.org/public/images/1996-12-vlt-inaugur/

ALMA inauguration
13 March 2013

http://www.eso.org/public/images/ann13027a/

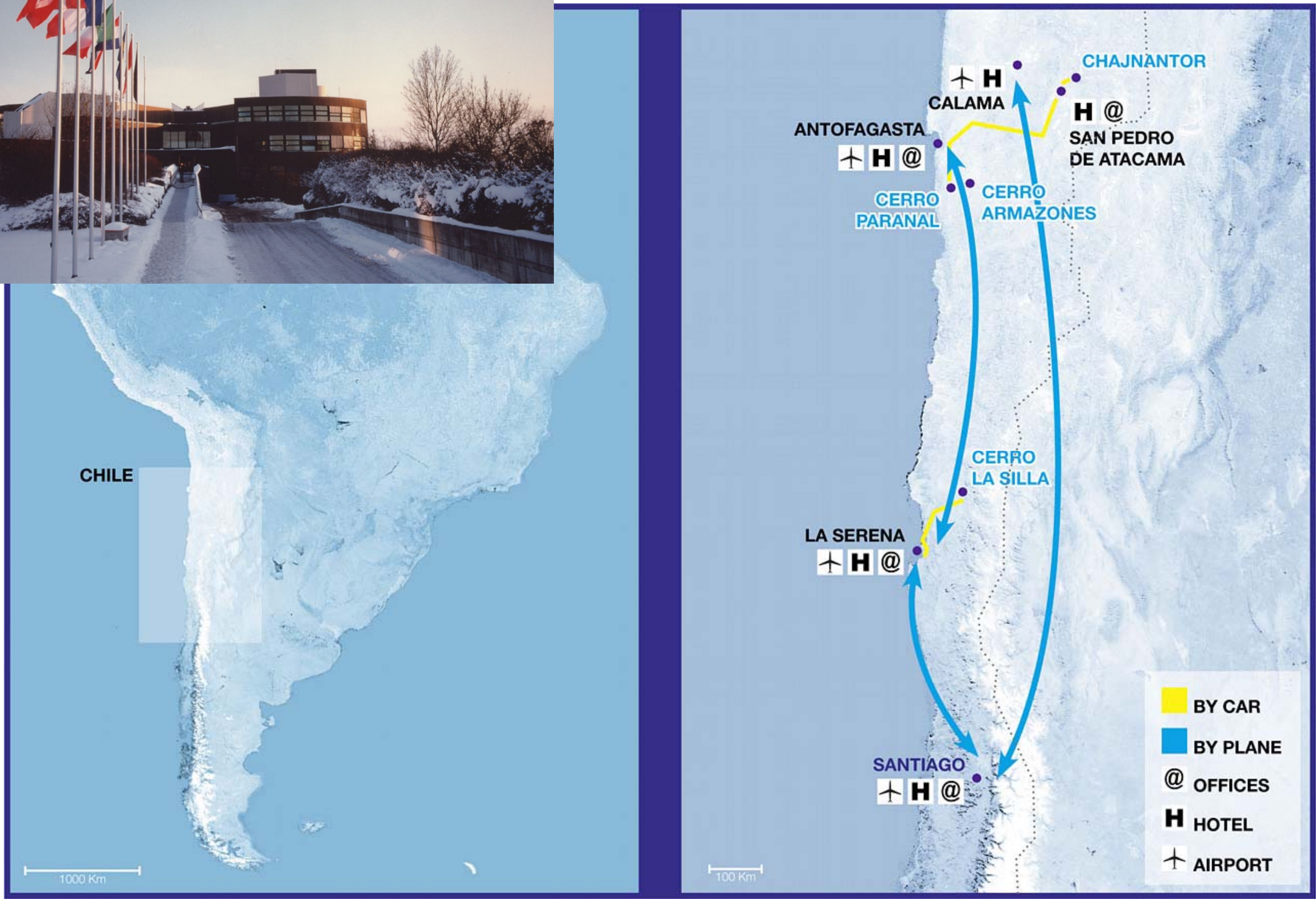
E-ELT start
19 June 2014

http://www.eso.org/public/images/eso1419a

http://www.eso.org/public/images/potw1424a/

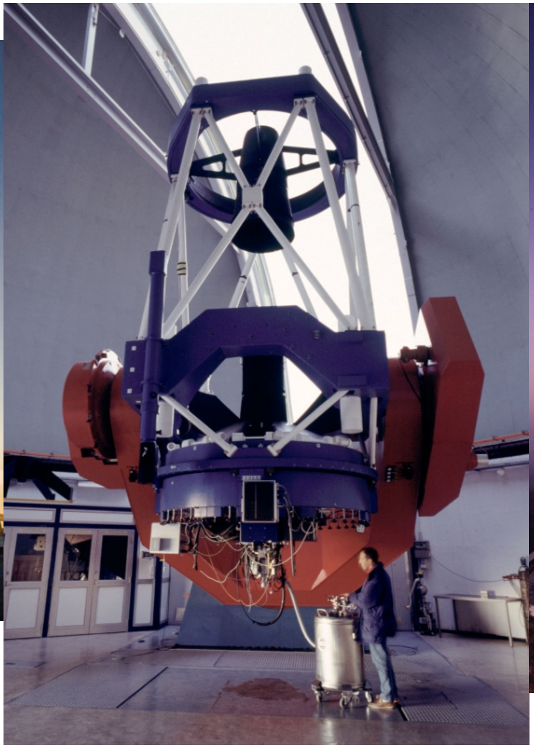
Overview of ESO facilities (as of today)

ESO sites today

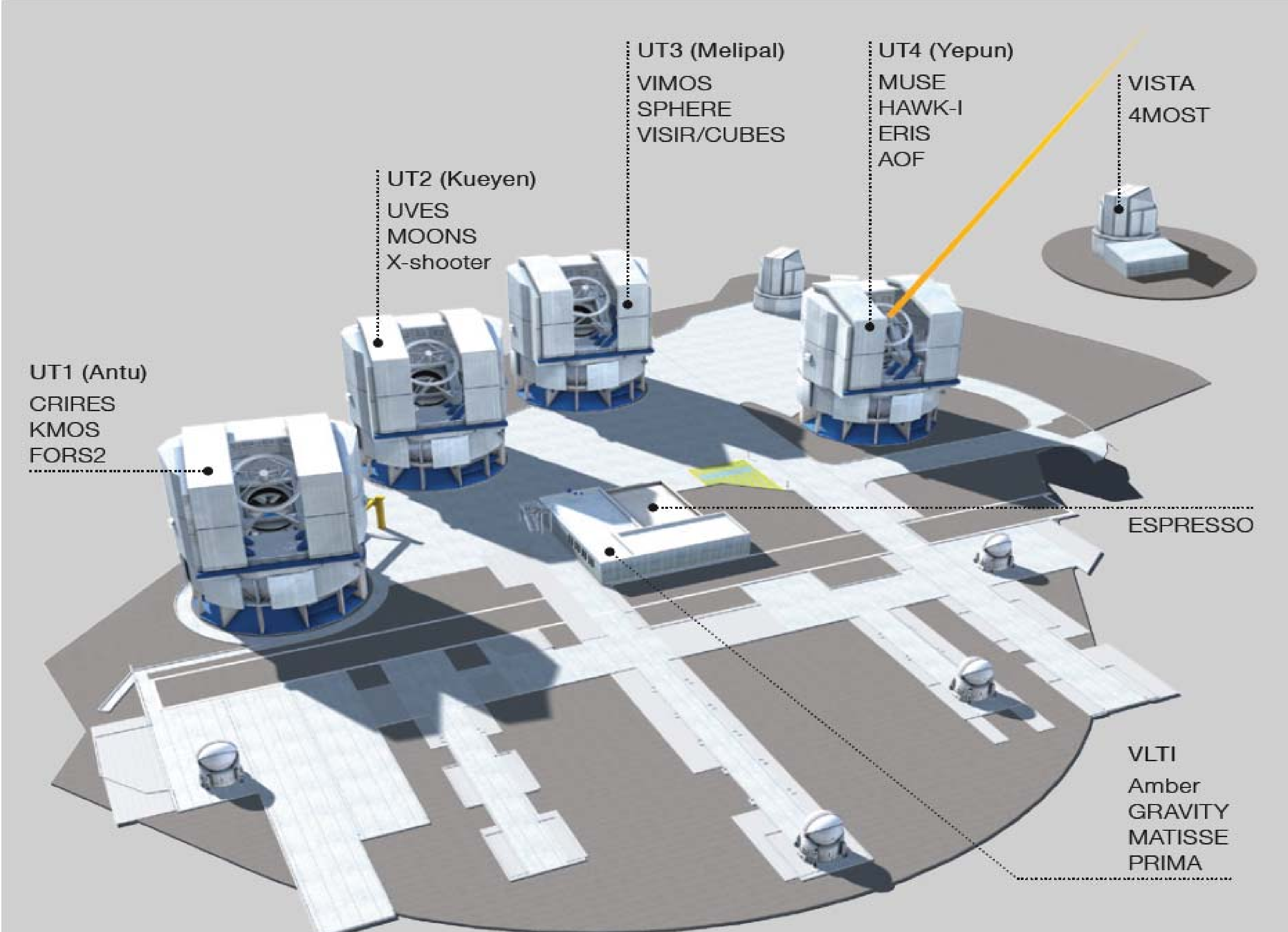


La Silla 2010+

- Concept of national telescopes
- NTT – ESO
- 3.6-m ESO with planet hunter HARPS
- 2.2-m Max Planck Institute – FEROS, WFI, GROND


Paranal



Pasquini et al., Messenger 154

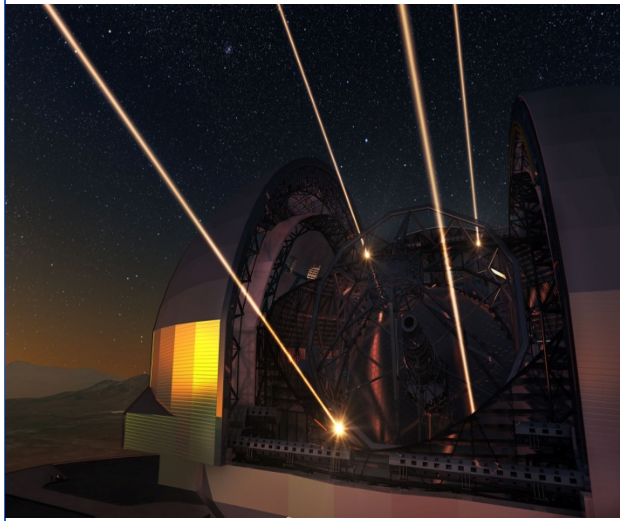
APEX
The Atacama Pathfinder Experiment

- 1st light 14 July 2005
- single 12-m dish
- Pathfinder for ALMA
- Science goals are: astrochemistry, cold Universe

Atacama Large Mm/submm Array (JAO)
Operated by: ESO, NAOJ, NRAO

- Chajnantor plateau 4500-5000 m
- 66 antennas
- 0.32 to 3.6 mm
- 12-m array 50 antennas
- 12-m array of 4 antennas
- 7-m array of 12 antennas
- baselines 150m-16km
- Star formation, molecular clouds, early Universe

E-ELT era



Key science topics

- **Extra-solar planets**
- **Resolved stellar populations in a representative sample of the Universe**
- **The physics of high redshift galaxies**
- **Cosmology and fundamental physics**

Operations start - 2024

Benefits of ESO membership (CZ perspective)

ESO and the Czech Republic

- CZ joined ESO in 2007 as member state nr. 13

- Direct access to all ESO facilities for CZ affiliated astronomers
  - in case of visitor mode run all expense for trip paid for by ESO

- Influence in decision making for ESO's heading (ESO council, ESO finance committee, ESO scientific technical committee, ESO users committee)

ESO and the Czech Republic

- Preference for employment of CZ nationals
- Preferred access to ESO studentship/internship
- Support for CZ companies in tenders
- Potential for boosting of international collaboration
- Participation of CZ in forefront astronomical research facility

That was 13th anniversary April 1, 2012 (Google)

Let's hope for another 13+ anniversaries

How does ESO work?

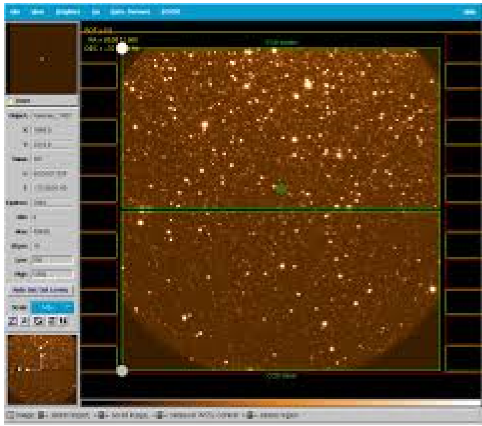
Outline

- Detectors at ESO
- Telescopes
- Adaptive optics
- LIVE from Paranal (tech. permitting 12 Nov)
- Paranal instrumentation programme (12 Nov)
- Behind the scenes (12 Nov)

Detectors at ESO

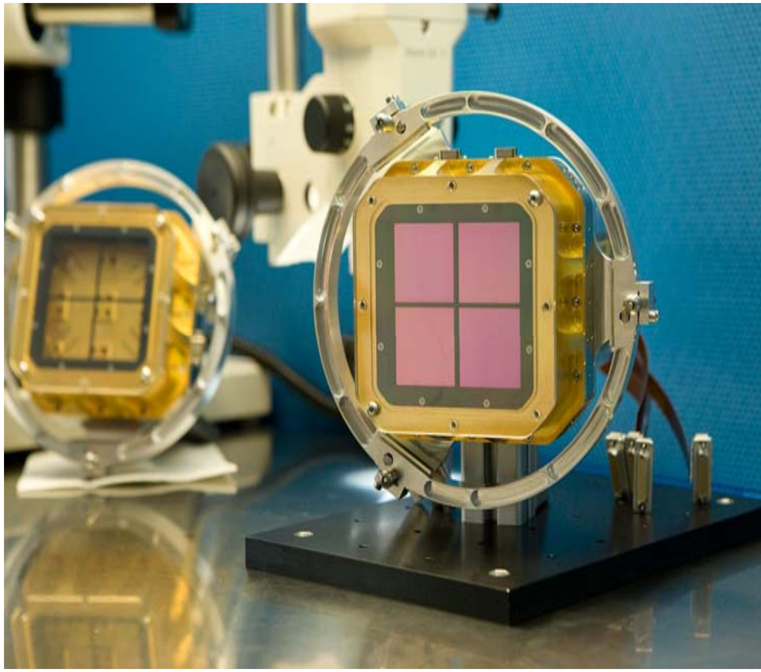
CCDs (you know them already)

- E.g. FORS2 EEV and MIT detectors (blue, red)
- Highly linear till 65000 ADUs
- Large field of view
- Photoelectric effect
- Optical detectors at ESO controlled by FIERA controllers (optical, NIR is IRACE) – box attached to the detector/instrument which commands the detector directly – interface with user



IR detectors (NO CHARGE TRASNFER)

- no charge trasnfer
- but photoelectric effect in charge!
- electronical readout
- typically Id and Hg due to suitable band gaps
- cooling required

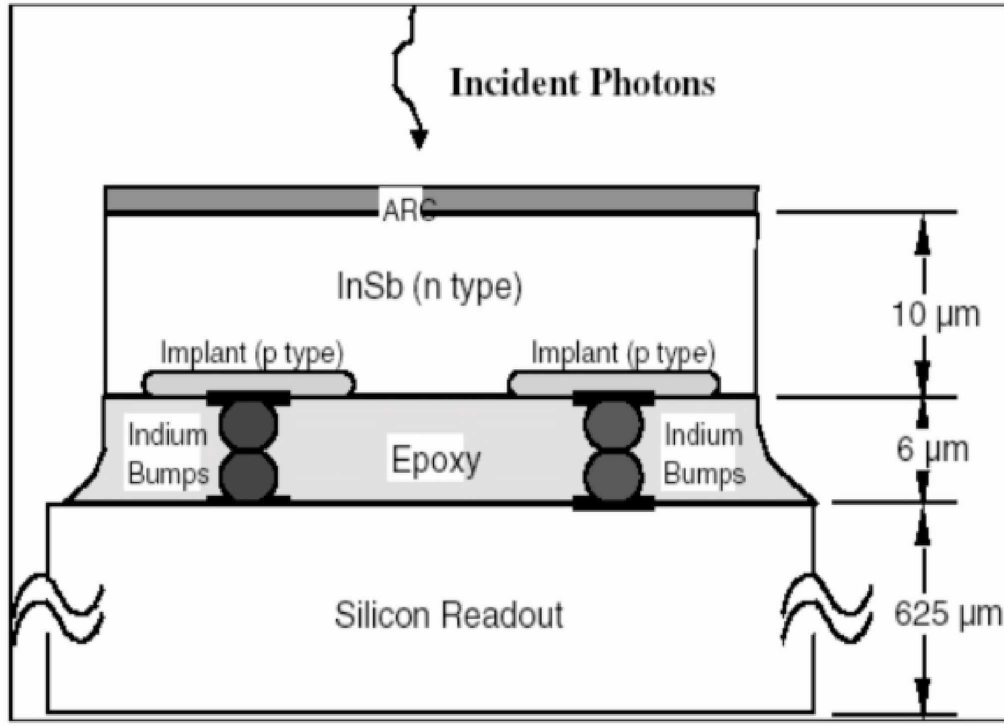


HgCdTe 0.48 eV = 2.55 μm

InSb 0.23 eV = 5.4 μm

IR detectors

Readouts
 NON-Destructive
 - DCS
 - Fowler
DIT vs. NDIT
Temperature sensitive
 - high sky counts
 - instrument/telesc. heat
3+ micron nodding/chopping
= M2/telescope offsets
Cooling + vacuum for NIR
detectors is a must!



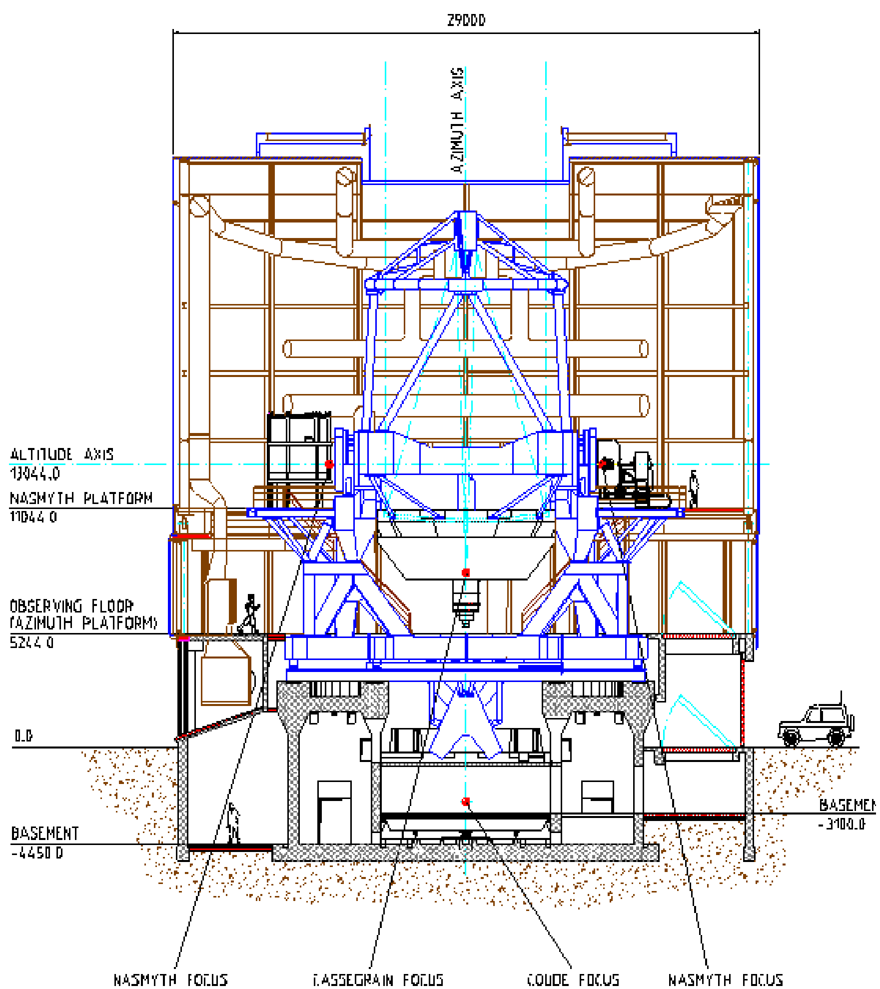
Joyce, D., NOAO Gemini data workshop 2010

Where to find them?

- Si CCD 0.3 – 1 μm 170 K FORS2, GMOS
- HgCdTe 0.8 – 2.5 μm 75 – 80 K HAWKI NIFS, NICI, FLAMINGOS2
- InSb 0.8 – 5.4μm 30 K CRIRES, NACO NIRI, GNIRS, PHOENIX
- Si:As 5 – 28 μm 12 K VISIR, MICHELLE, TReCS

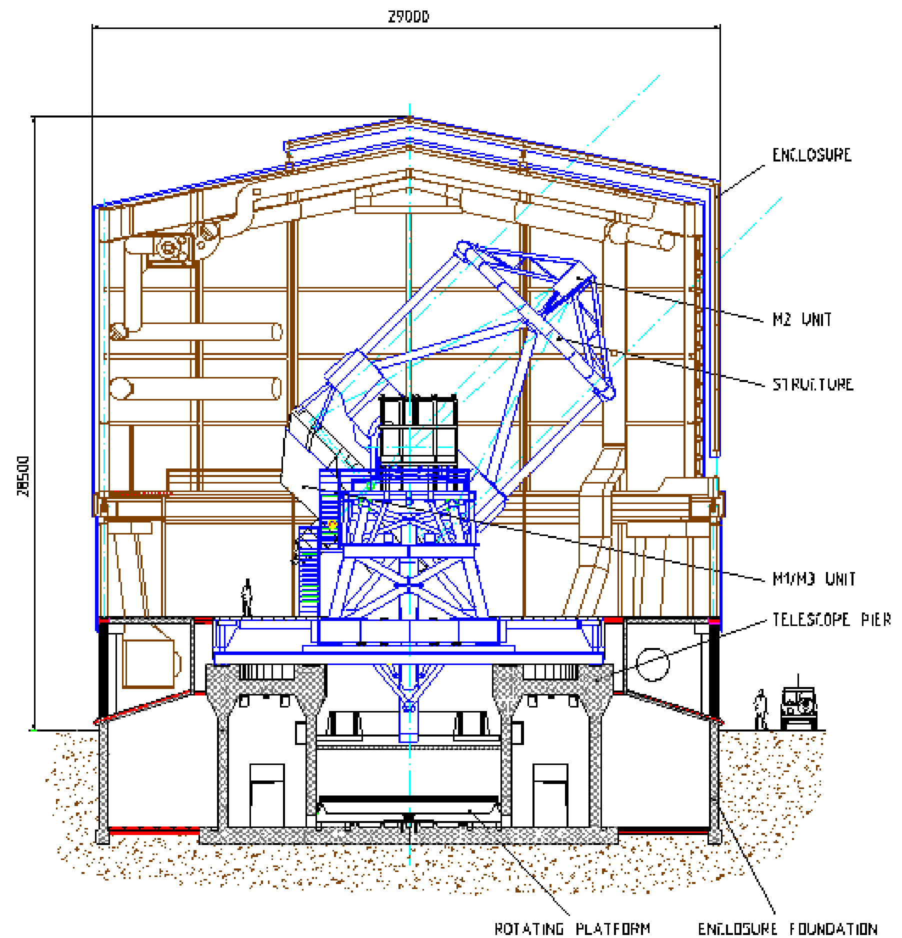
UTs
Antu, Kueyen, Melipal, Yepun

EUROPEAN SOUTHERN OBSERVATORY
VERY LARGE TELESCOPE



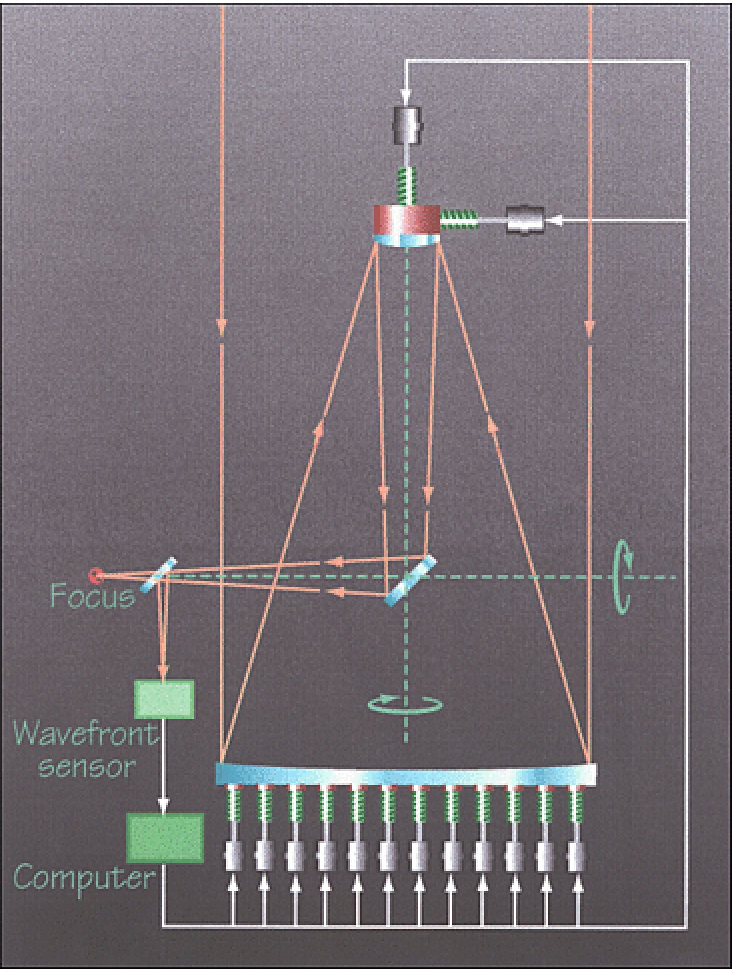
FRONT VIEW (Section)

EUROPEAN SOUTHERN OBSERVATORY
VERY LARGE TELESCOPE



SIDE VIEW (Section)

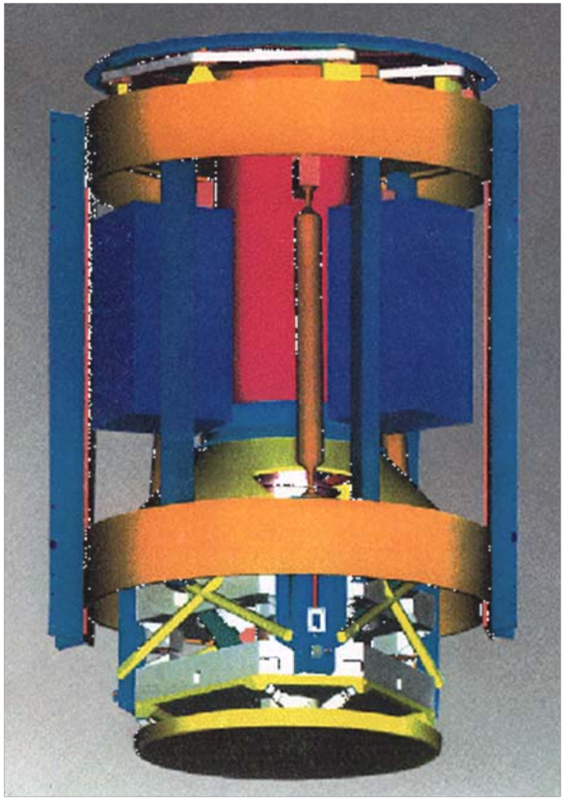
Unit Telescopes



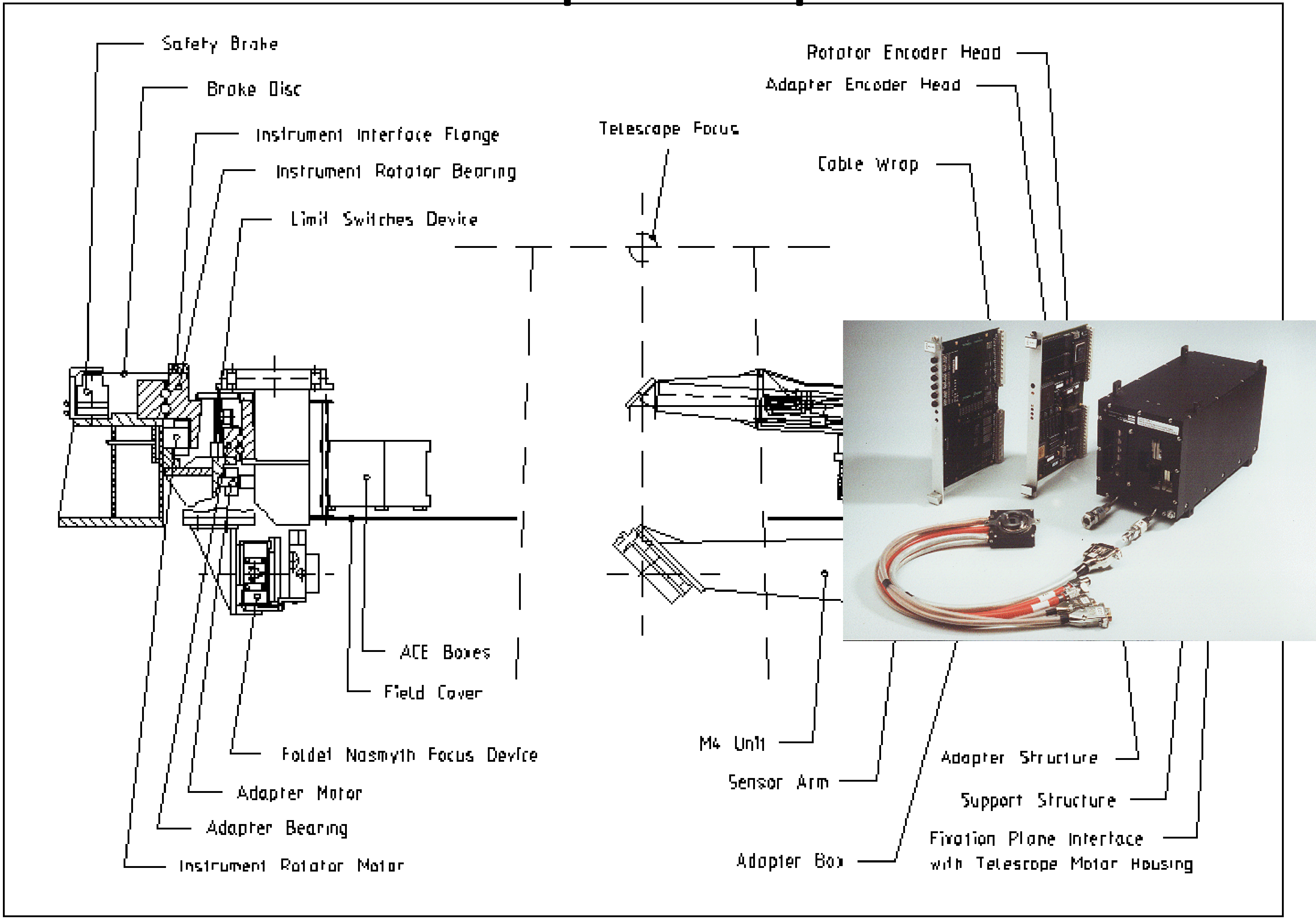
Active optics principle

- Active optics (deforming M1)
- Guiding
- 3 instruments

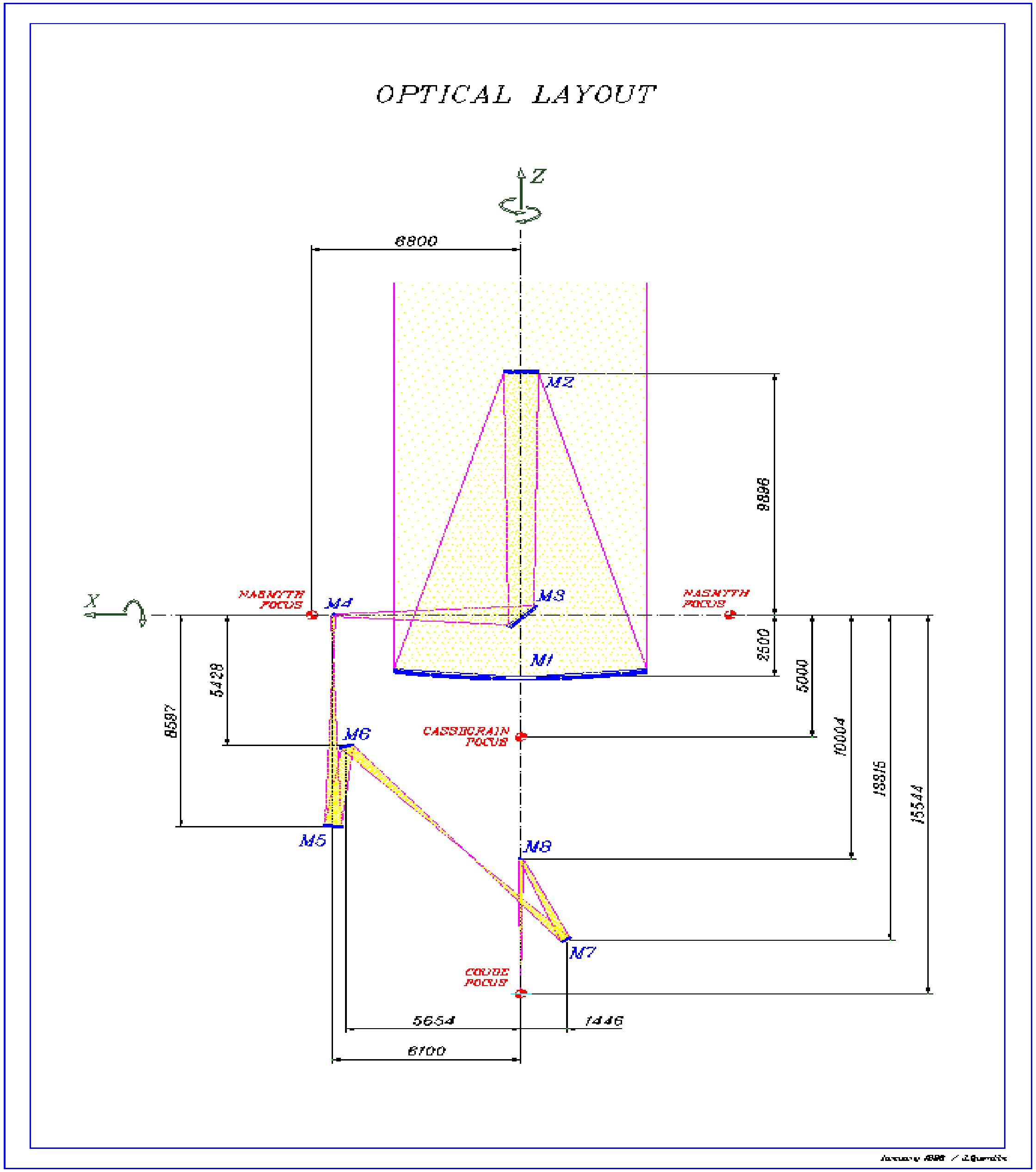
M2 tower



Telescope adapter



Coude focus UTs



Auxiliary Telescopes

- 1.8-m telescopes (Coude)
- 4 telescopes, support VLTI (interfermoetry)
- Baselines up to 200 m
- movable

Adaptive optics
Fighting the atmospheric turbulence

Diffraction limited imaging

angular res limit ~ λ/D

1 - m 550nm 5.50e-7 rad ~ 0.1 arcsec

10 - m 550nm 5.50e-8 rad ~ 0.01arcsec

Atmospheric turbulence can cut down about factor 100!

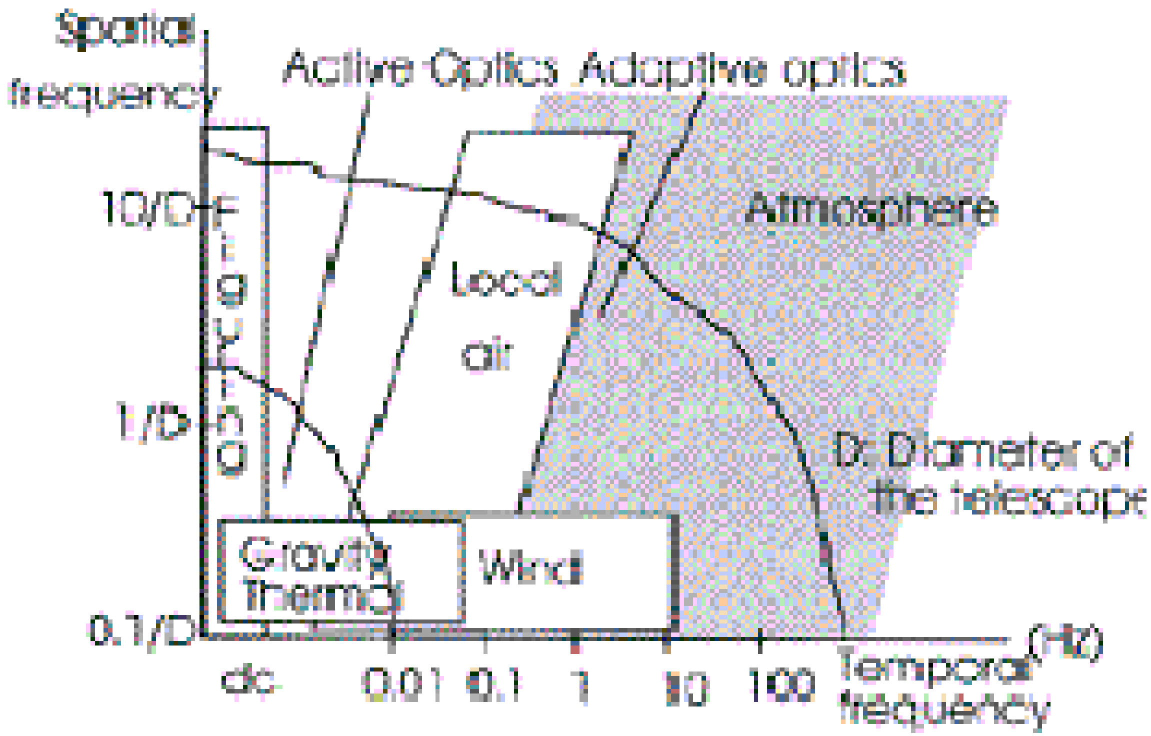


Figure 1: Frequency domain of wavefront aberrations generated by various sources. The spatial frequency is measured in terms of D, the diameter of the telescope

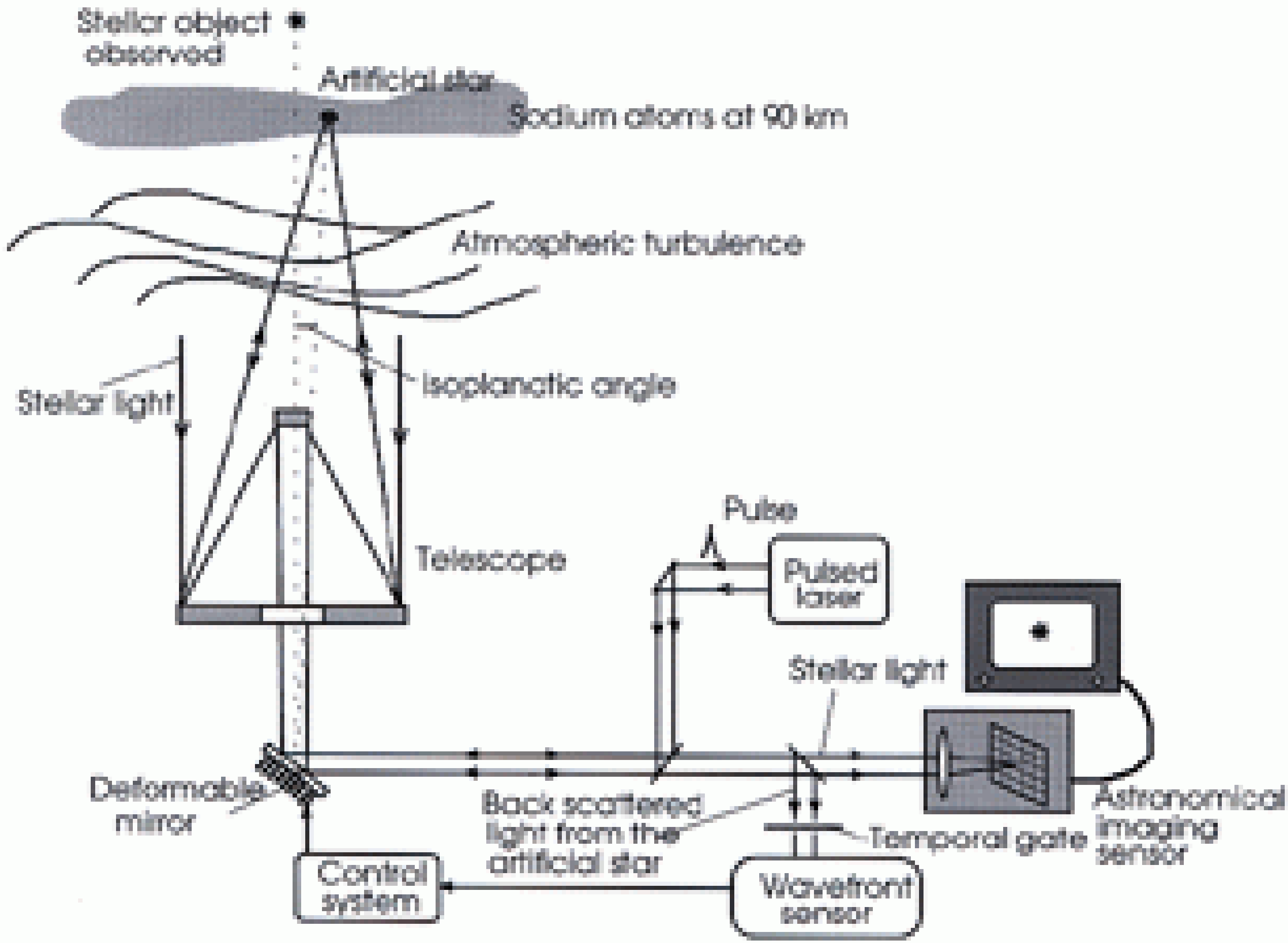


Figure 4: Adaptive Optics with laser guide star

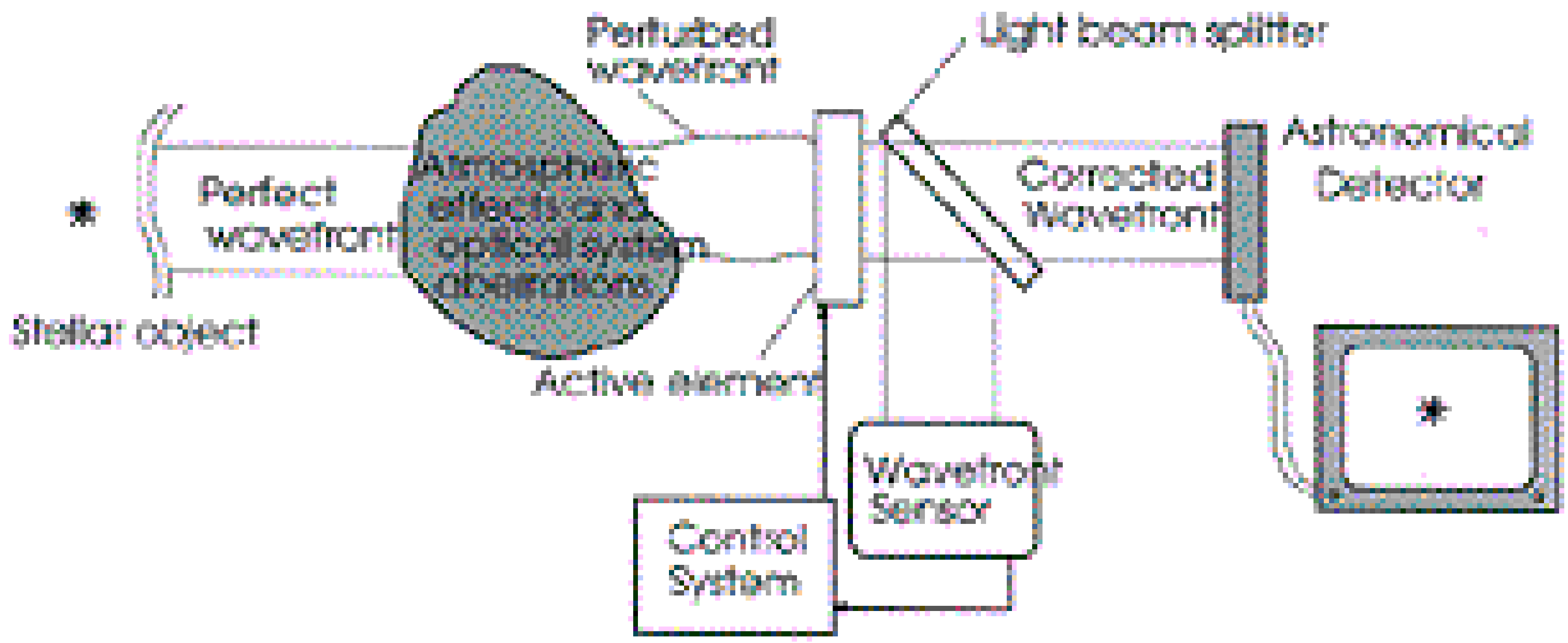
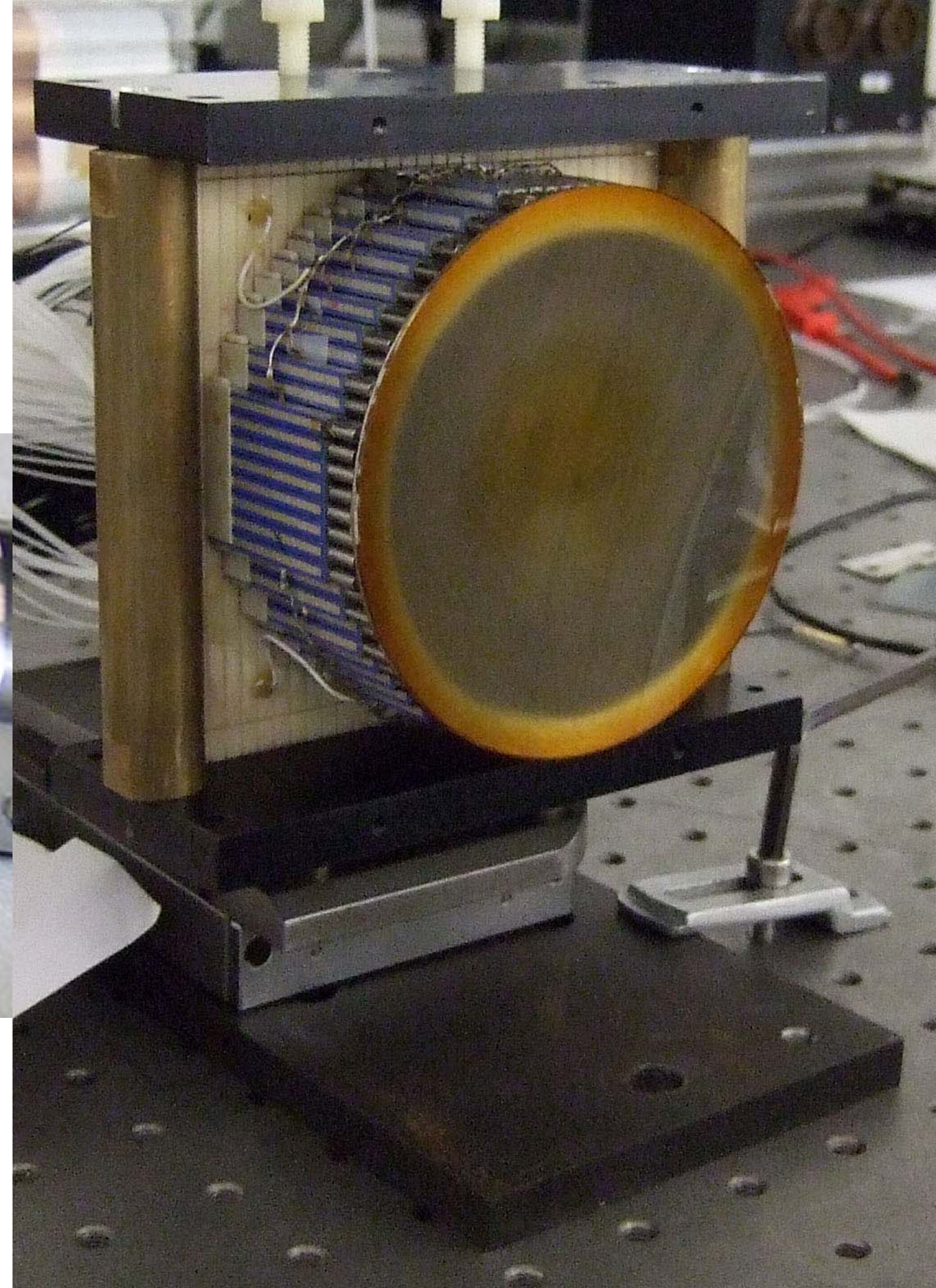


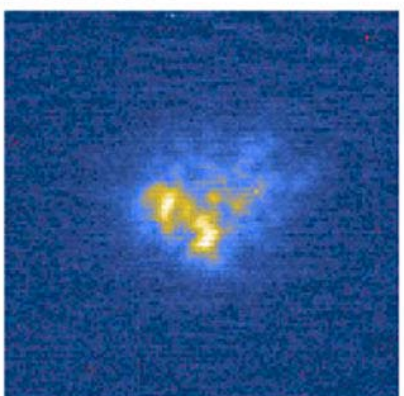
Figure 2: The principle of Active and Adaptive Optics

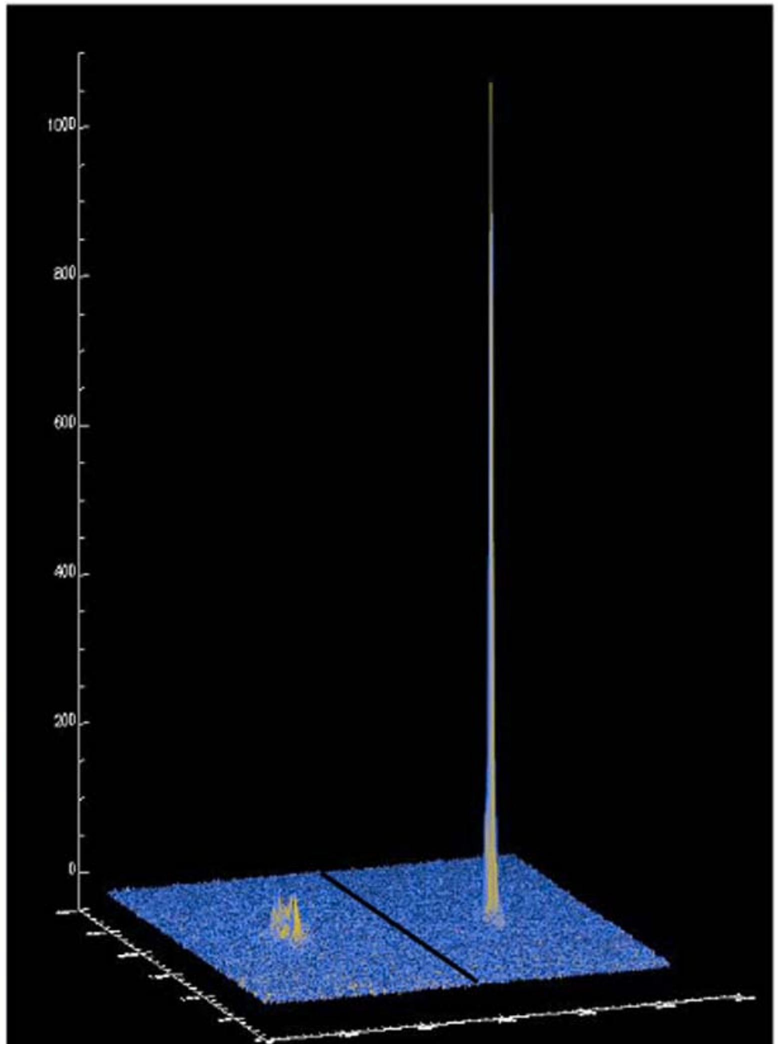
Source ESO web

Diffraction limited

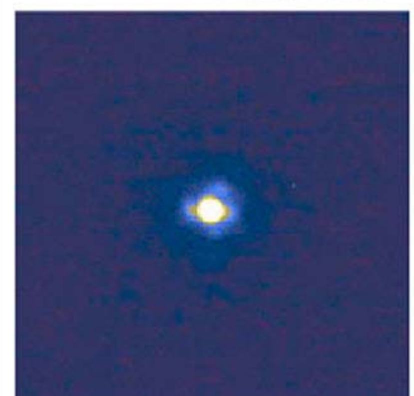
Uncorrected image
FWHM: 0.50"





Left: uncorrected Right: corrected

AO corrected image
FWHM: 0.07"



ESO archive

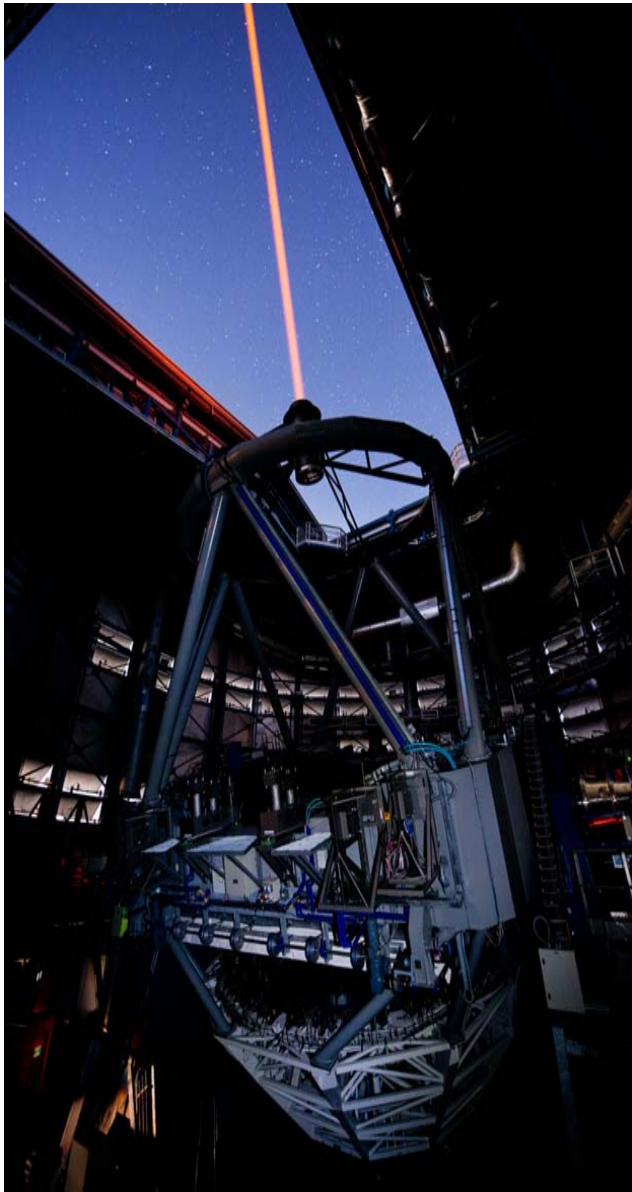
PARLA (LGS)

- Up to 7 Watts of output and is very stable. In the future 4 lasers together.

- This upgrade of the laser source takes advantage of a new solid-state Raman fibre laser technology currently under development at ESO, together with industrial partners, for the AOF.

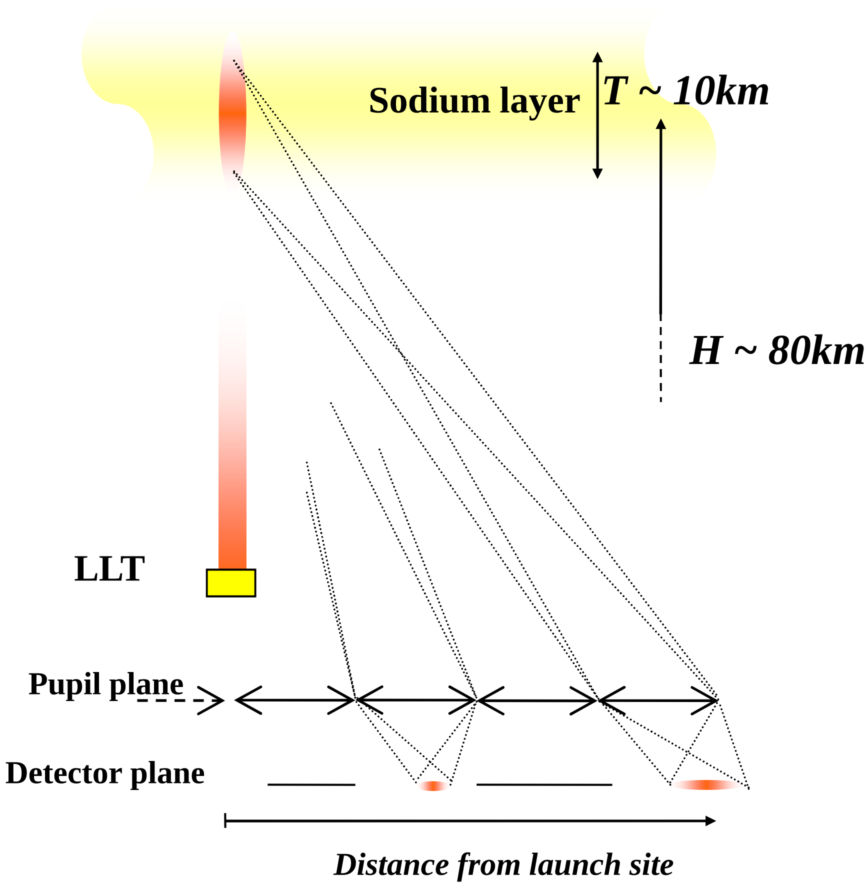
- During the commissioning, and for demonstration purposes, several targets were successfully observed using the new laser in conjunction with different VLT instruments. These included the dwarf planet Haumea and its moons, observed with SINFONI, and the nucleus of Centaurus A with NACO. These observations are available from the ESO Science Archive Facility.

- The original PARSEC dye laser saw six years of service, during which it enabled important discoveries, particularly on the Galactic Centre. The upgrade simplifies the laser operation greatly and allows more flexibility in planning observations.

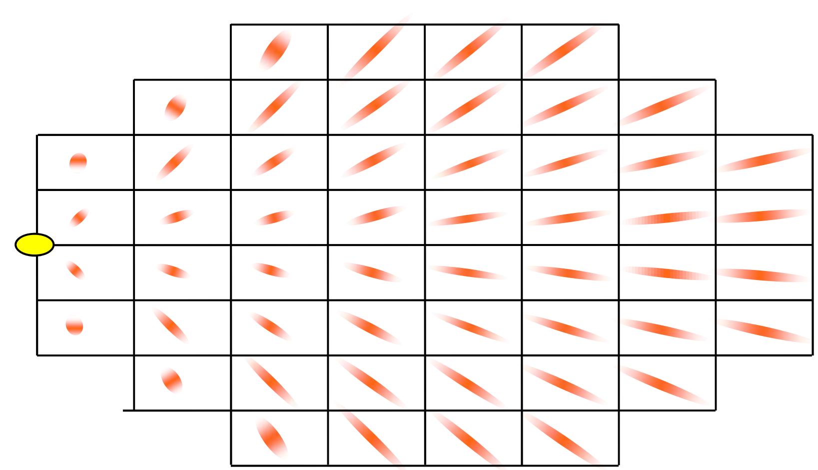


Picture from ESO image archive

Adaptive optics + LGS



Predicted spot elongation pattern



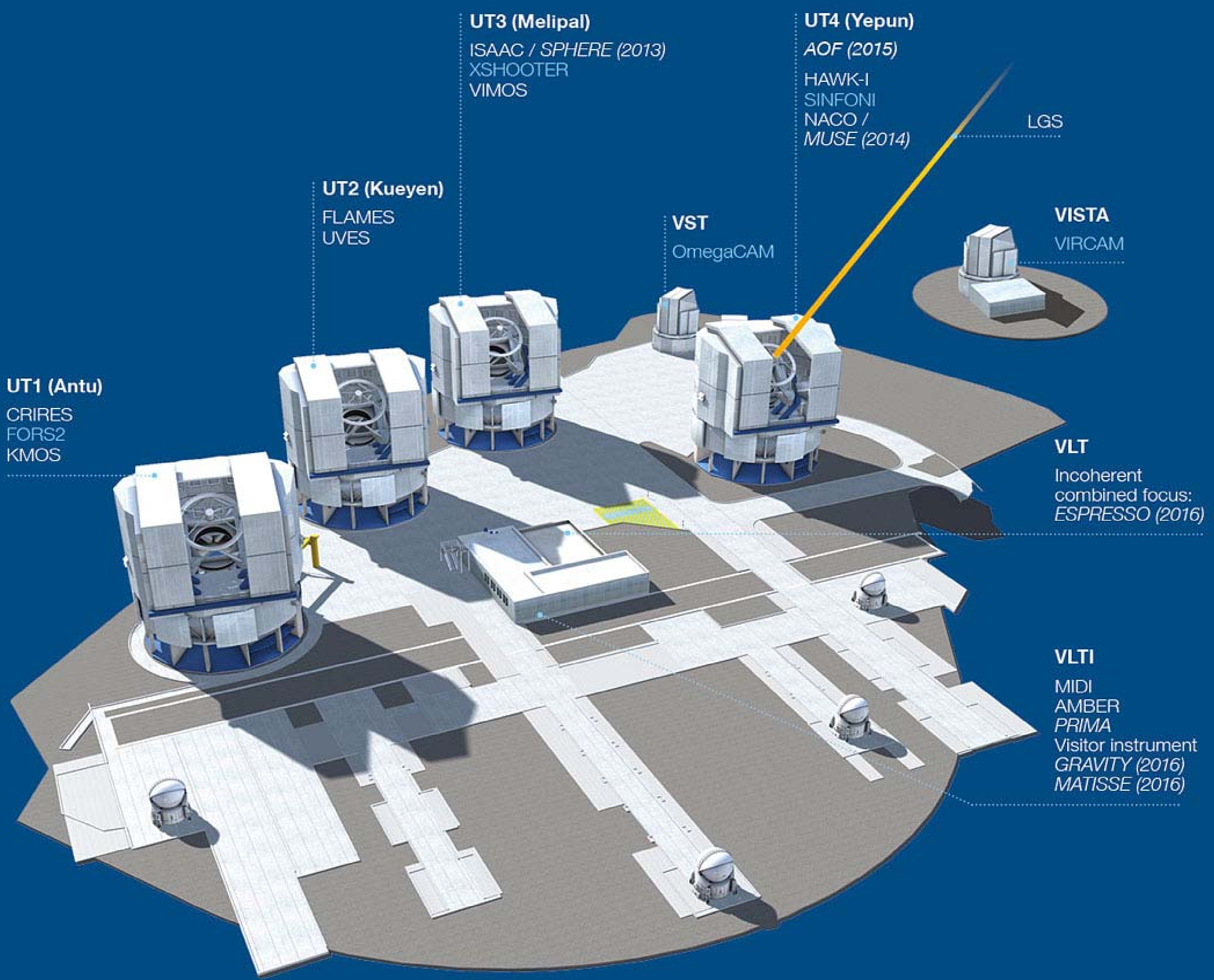
Downing DfA 2009: AO WFS Detectors

Next:

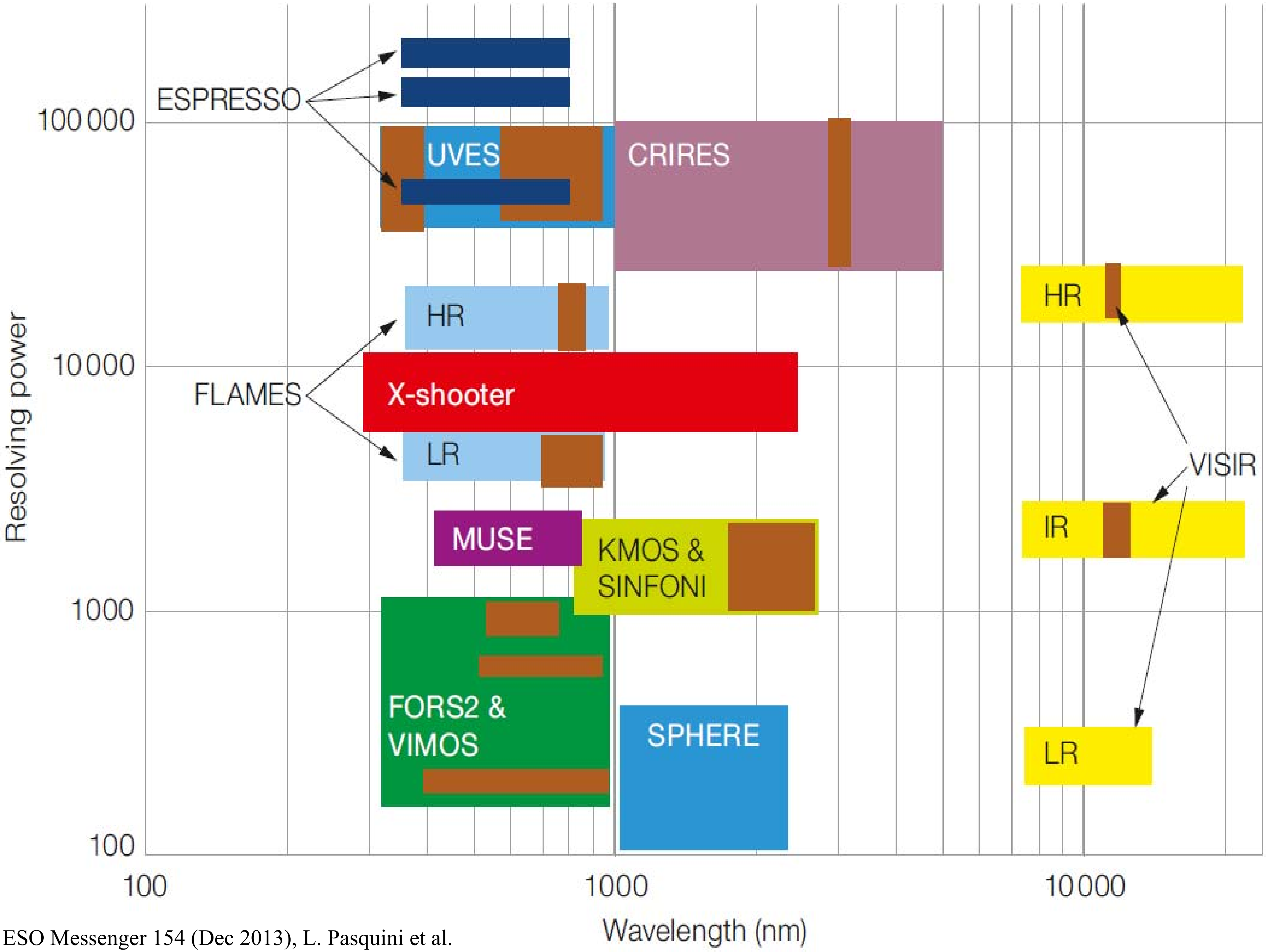
- 12 November: Live from Paranal (if no tech. problems)
- We start at 16:00 but finish 17:15 instead of 17:00!

Have a great week!

Paranal instrumentation programme
Lecture 6 (12 November)



ESO image archive



ESO Messenger 154 (Dec 2013), L. Pasquini et al.

UT1 – Antu (The Sun)

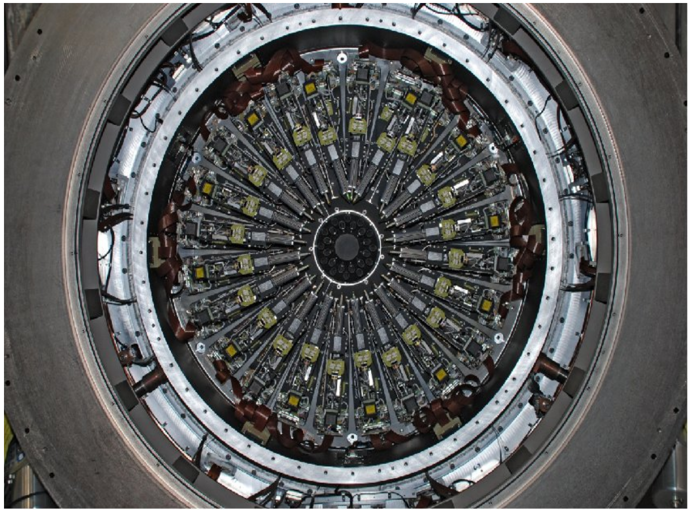
- KMOS - **K-band Multi-Object Spectrograph**
- CRIRES - **CRyogenic high-resolution InfraRed Echelle Spectrograph (Upgrade till 2017)**
- FORS2 - **FOcal Reducer/low dispersion Spectrograph 2**

ESO picture archive

KMOS

- The spectrometers each utilise a single 2kx2k HgCdTe detector and use a reflective collimator with a 6-element achromatic camera.

Requirement	Baseline Specification
Optical Throughput (predicted)	J>20%, H>30%, K>30%
Wavelength coverage	0.8 to 2.5 microns
Spectral Resolution	IZ grating R~3200 YJ grating R~3400 H grating R~4000 K grating R~4200 HK grating R~1800
Number of IFUs	24
Extent of each IFU	2.8 x 2.8 sq. arc seconds
Spatial Sampling	0.2 arc seconds
Patrol field	7.2 arcmin diameter circle
Close packing of IFUs	>=3 within 1 sq arcmin
Closest approach of IFUs	>=2 pairs of IFUs separated by 6 arcsec



FORS2

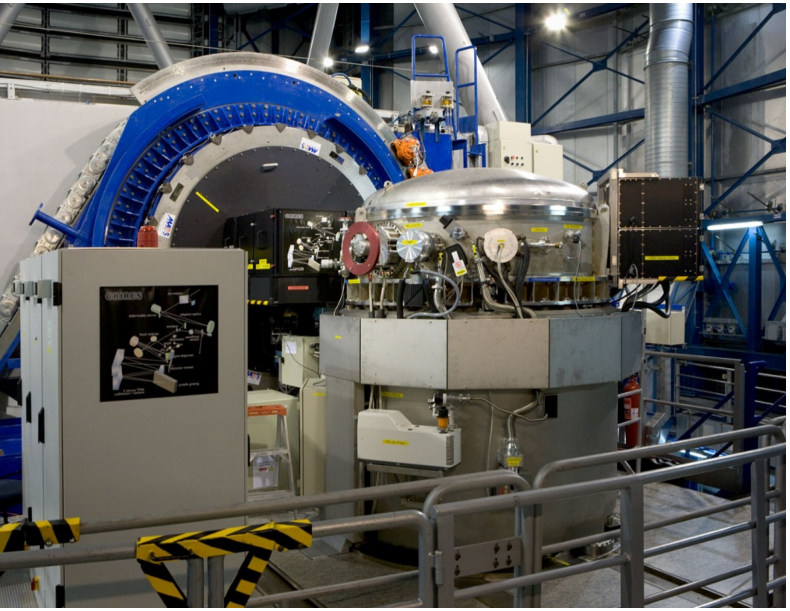
- FORS2 - imaging, polarimetry, long slit and multi-object spectroscopy (spec. res. up to 2600)
- MXU – spectroscopy with masks
- **Long-Slit (LSS) mode**
- FORS2 has 9 long-slits with fixed widths of between 0.3'' and 2.5''.
- **Moveable Slitlets (MOS) mode**
- FORS2 has a set of 19 pairs of arms that can be moved into the focal plane to form slitlets with user-defined widths.
- 0.25''/pixel (with the Standard Resolution collimator) and 0.125''/pixel (with theHigh Resolution collimator)
- FoV 6.8' x 6.8' and 4.25' x 4.25'

Science highlights – FORS2

- Bean, Jacob L. at al., 2010, "A ground-based transmission spectrum of the super-Earth exoplanet GJ 1214b". *Nature* **468** (7324): 669–672

- Sterzik, M. et al. 2012, Biosignatures as revealed by spectropolarimetry of Earthshine, 2012Natur.483...64S

CRIRES



• Resolving power of up to 10^5 (0."2 arcsec slit)

• Spectral range from 1 to 5.3μm.

• Simultaneous spectral coverage is maximized through a mosaic of four Aladdin IIIInSb arrays providing an effective 4096 x 512 focal plane detector array in the focal plane.

• Adaptive Optics (MACAO - Multi-Applications Curvature Adaptive optics) is used to optimize the signal-to-noise ratio and the spatial resolution.

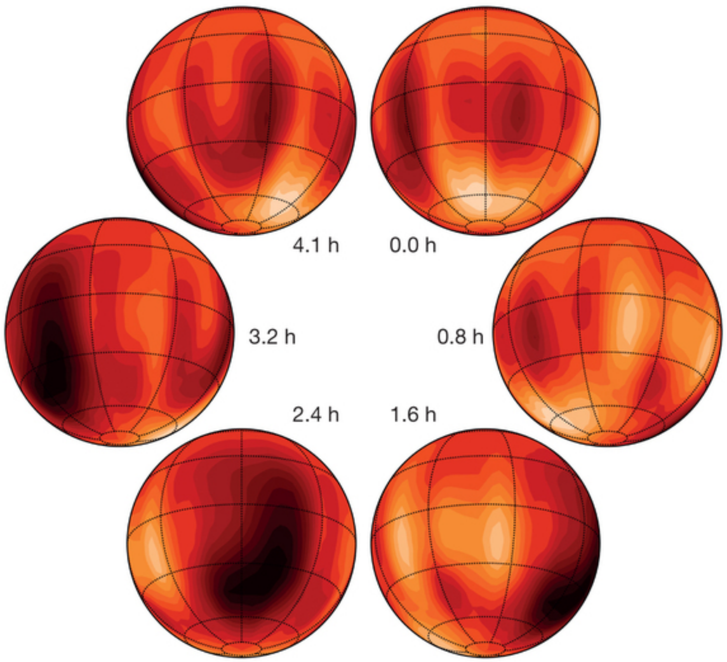
• CRIRES can boost all scientific applications aiming at fainter objects, higher spatial(extended sources), spectral and temporal resolution.

UPGRADE ONGOING!

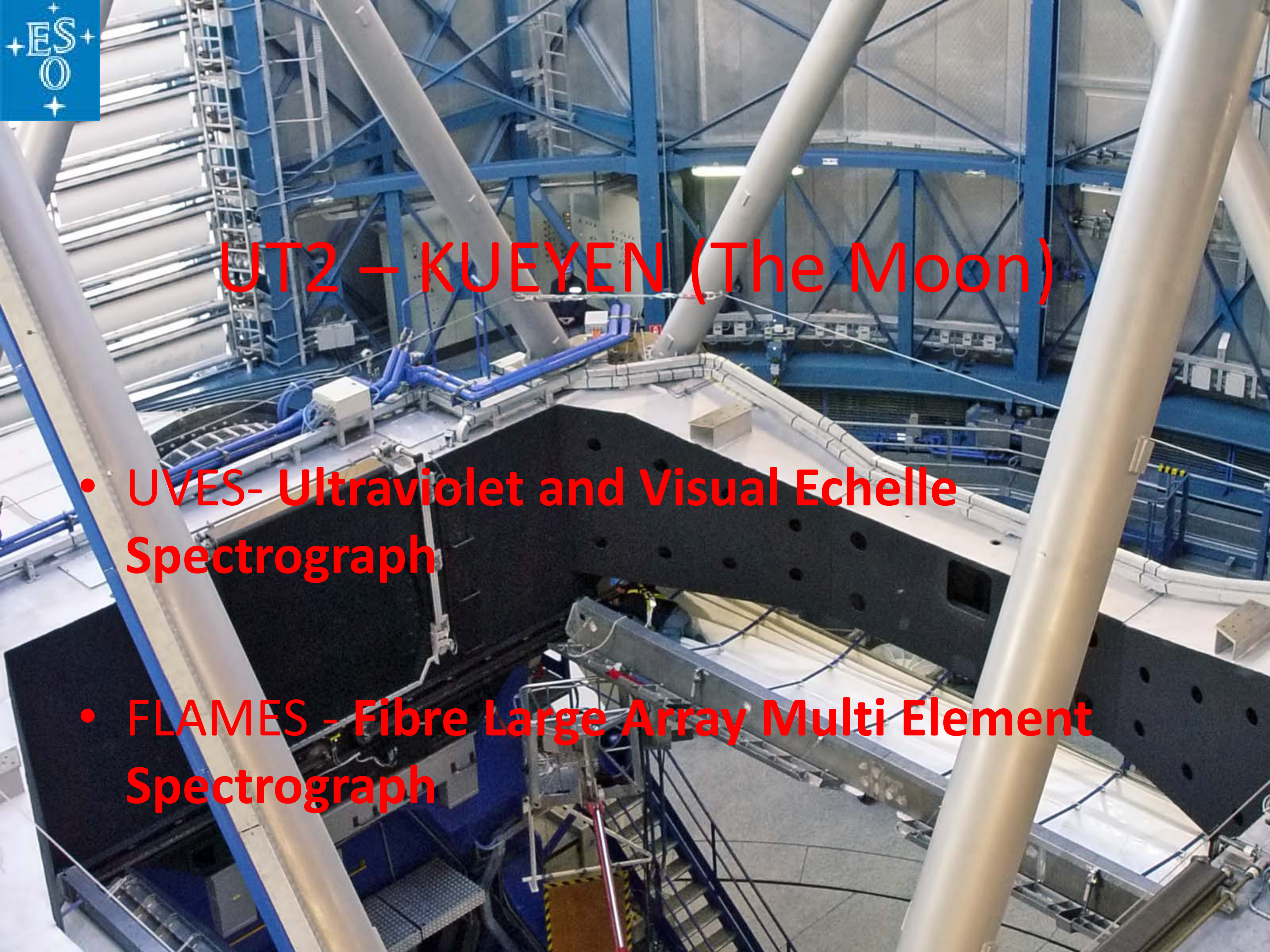
Käufl, H.U. et al. 2004, SPIE, 5492, 1218

Science highlights - CRIRES

- Crossfield, I. J. M. et al. [A global cloud map of the nearest known brown dwarf](), [2014Natur.505..654C]()
  Data obtained within: 291.C-5006



- Paganini, L. et al. The unexpectedly Bright Comet C/2012 F6 (Lemmon) Unveiled at Near-infrared wavelengths 2014, AJ, 147, 15P
  Data obtained within: 290.C-5016



UT2 – KUEYEN (The Moon)

- UVES- **Ultraviolet and Visual Echelle Spectrograph**
- FLAMES - **Fibre Large Array Multi Element Spectrograph**

UVES

- A cross-dispersed echelle spectrograph designed to operate with high efficiency from the atmospheric cut-off at 300 nmto the long wavelength limit of the CCD detectors (about 1100 nm).

- Two arms UV to B, and V to R
  The two arms can be operated separately, or in parallel via a dichroic beam splitter.

- Resolving power is about 40,000 when a 1-arcsec slit is used. The maximum (two-pixel) resolution is 80,000 or 110,000 in the Blue- and the Red Arm, respectively.

- Three image slicers available

- Iodine cell available

Dekker, H. et al. 2000, SPIE, 4008, 534.

Science highlights - UVES

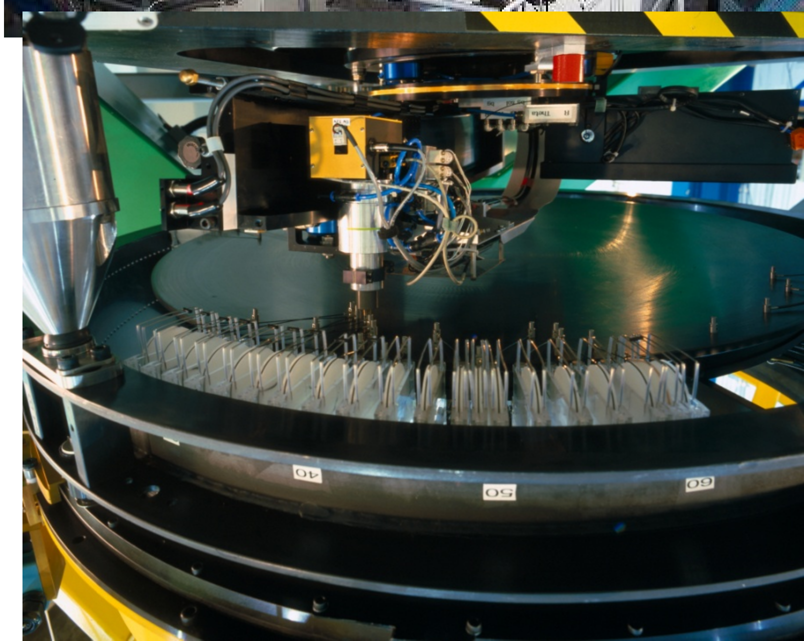
- Maxted, Pierre F. L. et al. Multi-periodic pulsations of a stripped red-giant star in an eclipsing binary system, 2013Natur.498..463M
  UVES 086.D-0194

- Bernet, Martin L. et al. Strong magnetic fields in normal galaxies at high redshift, 2008Natur.454..302B

UVES 075.A-0841, 076.A-0860

FLAMES

- multi-object, intermediate and high resolution spectrograph of the VLT.
- field of view 25 arcmin in diameter.
- feeds two different spectrograph covering the whole visual spectral range:GIRAFFE and UVES.
- GIRAFFE allows the observation of up to 130 targets at the time or to do integral field spectroscopy, with intermediate resolution (either R ~ 25000 or R~ 10000).
- UVES provides the maximum possible resolution (R=47000) but can access only up to 8 objects at the time.



Science highlights - FLAMES

- Campbell, Simon W. et al. Sodium content as a predictor of the advanced evolution of globular cluster stars, 2013Natur.498..198C
FLAMES, ***GIRAFFE*** 089.D-0038

- Chiappini, Cristina et al. Imprints of fast-rotating massive stars in the Galactic Bulge, 2011Natur.472..454C
FLAMES, ***GIRAFFE*** 073.B-0074, 71.B-0617

UT3 – Melipal (The Southern Cross)

- VIMOS - **VIsible MultiObject Spectrograph**
- XSHOOTER
- (SPHERE) - Spectro-Polarimetric High-contrast Exoplanet Research
- VISIR - **VLT Imager and Spectrometer for mid Infrared**

VIMOS

- VIMOS is a visible (360 to 1000 nm) wide field imager and multi-object spectrograph
- The instrument is made of four identical arms with each a field of view of7' x 8' with a 0.205" pixel size and a gap between each quadrant of~2'. Each arm is equipped with 6 grisms providing a spectral resolution range from ~200-2500 and with one EEV CCD 4k x 2k.
- VIMOS operates in three different modes:Imaging (**IMG**), Multi-Object Spectroscopy (**MOS**),and with Integral Field Unit (**IFU**).
- **IMG:** Imaging is possible in *UBVRIz* filters in a 4 x 7' x 8' field of view.
- **MOS:** Multi-object spectroscopy is carried out using masks (one per quadrant) prepared in Paranal using a laser cutting Mask Manufacturing Unit. Depending on the grism used, the spectral resolution varies from 200 to 2500, and the observable range is from 360 to 1000 nm. The maximum number of slits per mask (quadrant) varies from ~40 at *R*=2500 to ~150-200 at *R*=200, for a field of view of 4 x 7' x 8'.
- **IFU:** VIMOS is also equipped with an integral field unit made of 6400 fibers. The scale on the sky can be changed from 0.67" per fiber to 0.33" per fiber and the integral field unit can cover up 13"x 13" up to 54"x54" on sky depending on spectral resolution and spatial magnification. Spectral resolution and coverage are similar to MOS

Le Fevre, O. et al. 2003, SPIE 4841, 1670.

Science highlights - VIMOS

- Massey, Richard et al. Dark matter maps reveal cosmic scaffolding, 2007Natur.445..286M
  VIMOS 175.A-0839

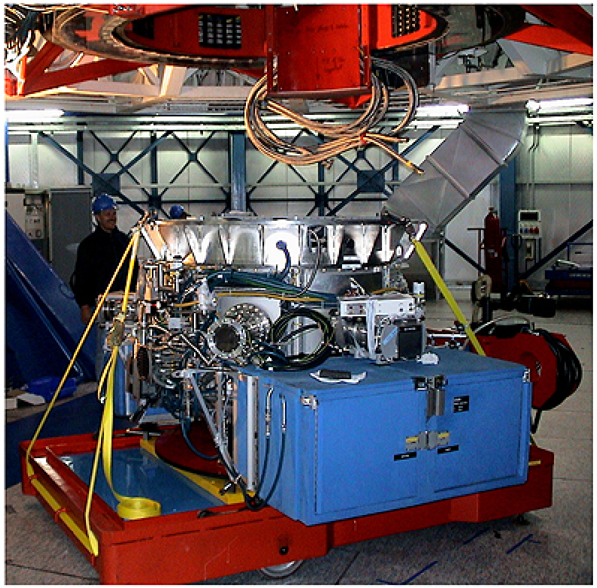
- Farrell, Sean A. et al. An intermediate-mass black hole of over 500 solar masses in the galaxy ESO243-49, 2009Natur.460...73F
  VIMOS 075.A-0716

VISIR (currently upgrade ongoing)

- Built by CEA/DAPNIA/SAP and NFRA/ASTRON

- Provides diffraction-limited imaging at high sensitivity in the two mid infrared (MIR) atmospheric windows: the N band between 8 to 13µm and the Q band between 16.5 and24.5µm, respectively.

- It features a long-slitspectrometer with a range of spectral resolutions between 150 and30000.



VISIR under the Cassegrain Focus of the 8.2-m VLT Melipal Telescope

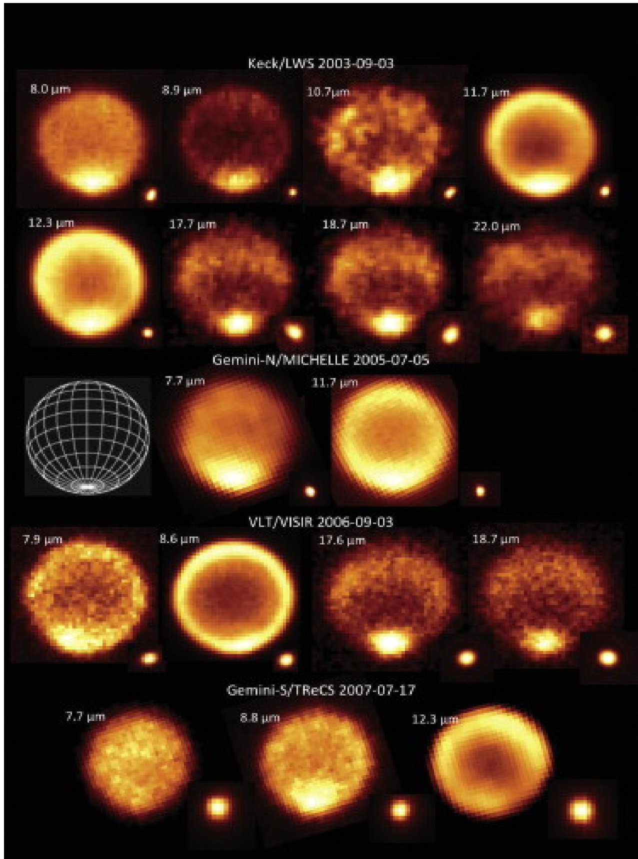
ESO PR Photo 16a/04 (12 May 2004)

Lagage, P.O. et al. 2004, The Messenger 117, 12.

Science highlights - VISIR

- 2014 Fletcher, Leigh N. et al. Neptune at summer solstice: Zonal mean temperatures from ground-based observations, 2003-2007, 2014Icar..231..146F
  VISIR 077.C-0571

- 2010 Umana, G. et al. Spitzer, Very Large Telescope, and Very Large Array Observations of the Galactic Luminous Blue Variable Candidate HD 168625, 2010ApJ...718.1036U
  VISIR 079.D-0748



XSHOOTER

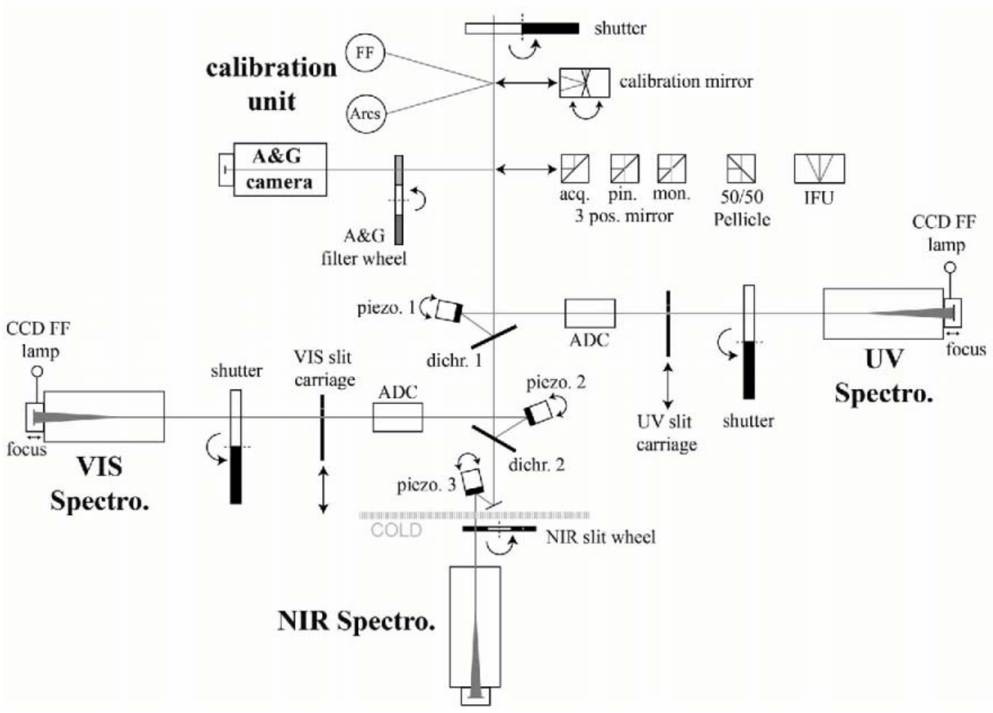
- multi wavelength (300-2500nm) medium resolution spectrograph
- 4 arms with the Acquisition and Guiding camera. It has 3 spectroscopic arms, each with optimized optics, dispersive elements and detectors:

  UVB, range 300-559.5 nm

  VIS, range 559.5-1024 nm

  NIR, range 1024-2480 nm

- Autoguider of a1.5'x1.5' FoV
- IFU spectroscopy, 1.8''x4'' FoV
- Slit spectroscopy

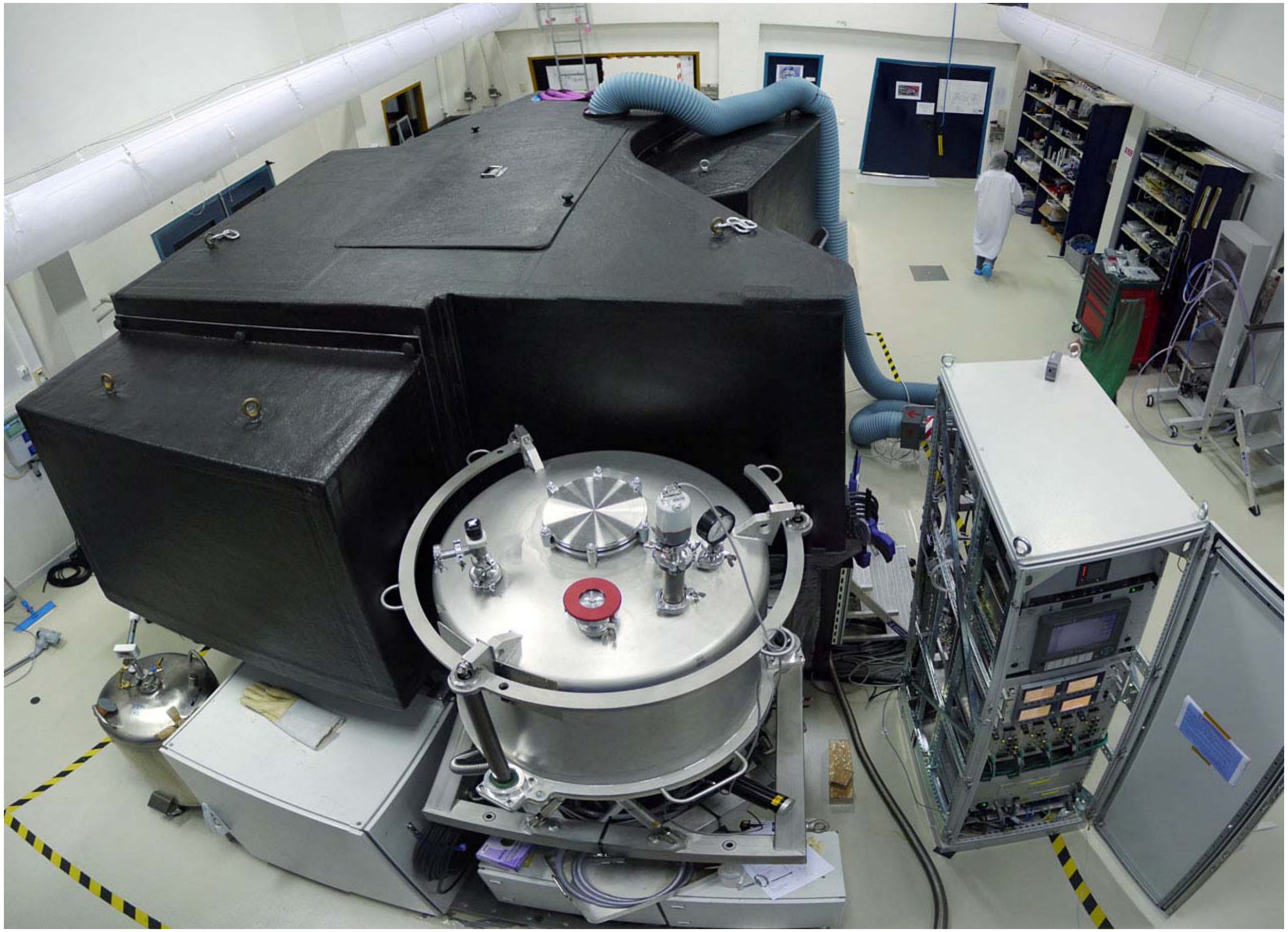


Science highlights - XSHOOTER

- Marocco, F et al., 2014, The extremely red L dwarf ULAS J222711-004547 - dominated by dust, 2014MNRAS.439..372M

- Kawka, A.; Vennes, S., 2012, VLT/X-shooter observations and the chemical composition of cool white dwarfs, 2012A&A...538A..13K

SPHERE (commissioned successfully)



SPHERE continued

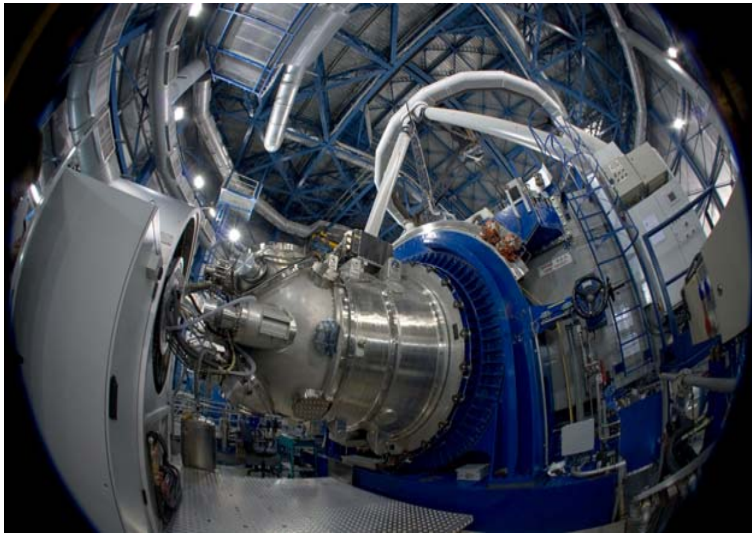
- The prime objective of the Spectro-Polarimetric High-contrast Exoplanet Research (SPHERE) instrument for the VLT is the discovery and study of new extra-solar giant planets orbiting nearby stars by direct imaging of their circumstellar environment.
- Wavelength: 0.6 - 2.3 micron, imaging (11 arces FoV), spectroscopy, coronograph – all using eXtreme adaptive optics – faster than current: 1.2 kHz correction rate, 40 sub-apertures of the WFS

UT4 - Yepun (Venus – the evening star)

- SINFONI - **Spectrograph for INtegral Field Observations in the Near Infrared**
- HAWKI - High Acuity, Wide field K-band Imaging
- MUSE - **Multi-Unit Spectroscopic Explorer**

HAWK-I

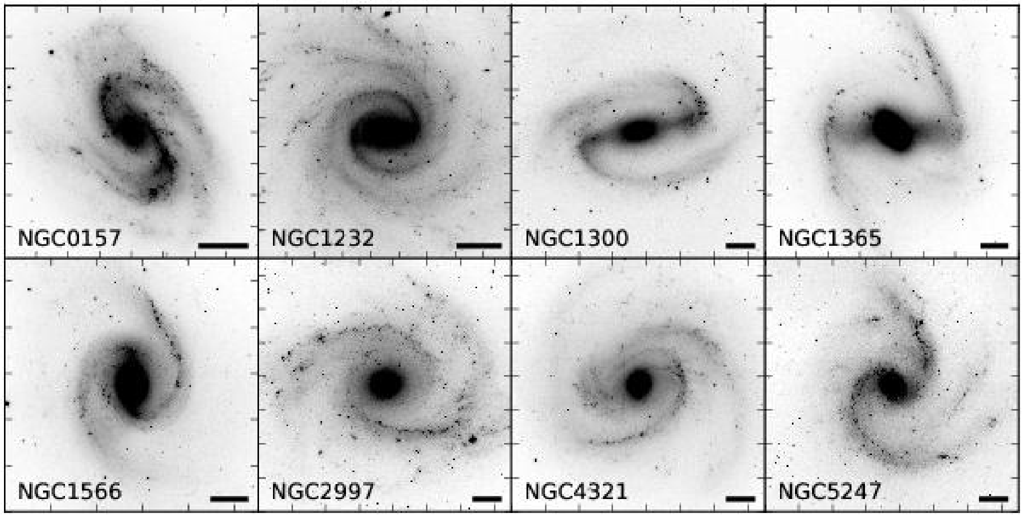
- Cryogenic wide-field imager
- Field of view is 7.5'x7.5
- The pixel scale is of 0.106".
- 4 broad band (Y, J, H & K) and 6 narrow band (Bracket gamma, CH_4, H_2, 1.061 µm, 1.187 µm & 2.090 µm) filters.



Pirard et al., 2004, SPIE 5492, 510
Casali et al., 2006, SPIE 6269, 29
Kissler-Patig et al., 2008, A&A 491, 941
Siebenmorgen et al., 2011, The Messenger 144, 9

Science Highlights – HAWK-I

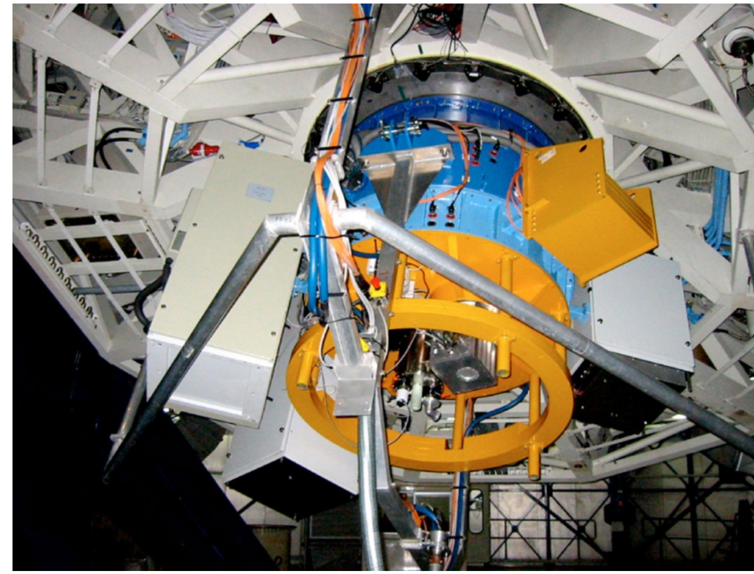
- Searching for spiral feaures in external disk galaxies. Data from Grosbol and Dottori 2012.



- Anderson et al. 2010, H-band thermal emission from the 19-h period planet WASP-19b, 2010A&A...513L...3A

SINFONI

- Near-infrared (1.1 -- 2.45 μm)
- IFUpectrograph fed by an adaptive optics module.
- Gratings J, H, K, H+K
- Spectral res. 1500-4000
- 2048 pixels of the Hawaii 2RG (2kx2k) detector
- 3 choices of the slice height.: 250mas, 100mas and 25mas
- Field of views: 8"x8", 3"x3", and 0.8"x0.8“



- 32 slitlets are imaged onto 64 pixels of the detector. Thus one obtains 64x32 spectra of the imaged region on the sky.

(Not only SINFONI) AO & LGS

- MACAO, which stands for Multi-Application Curvature Adaptive Optics, is an ESO in-house developed 60 elements curvature adaptive optics system. MACAO-VLTI is the application of this AO principle to be used by the VLT interferometer (VLTI). Four MACAO-VLTI systems have been installed at the each UT Coude' focii feeding the VLTI delay lines with a corrected IR beam from 1000-13000nm with up to 50% Strehl @ 2.2microns.
- eXtrem AO – for SPHERE, faster, more strehl, Shack-Hartmann wave front sensor with 40 sub-apertures

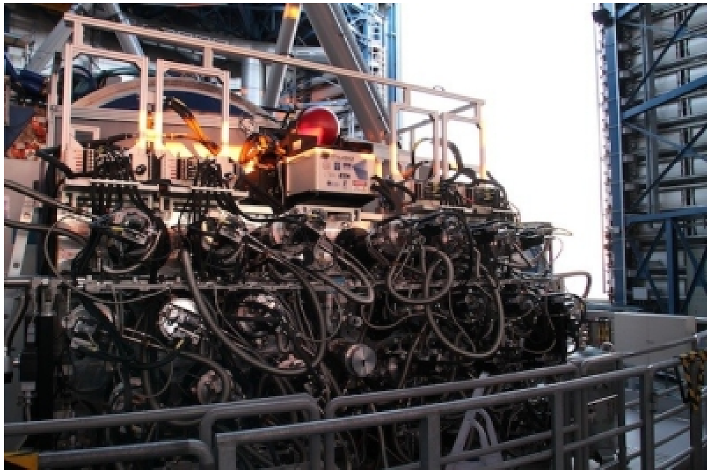
Science highlights - SINFONI

- 2012 Gillessen, S. et al. A gas cloud on its way towards the supermassive black hole at the Galactic Centre, 2012Natur.481...51G
NACO, ***SINFONI***, SPIFFI 073.B-0085, 073.B-0775, 074.B-9014, 077.B-0552, 081.B-0568, 081.B-0648, 082.B-0952, 087.B-0117, 087.B-0280, 179.B-0261, 183.B-0100, 60.A-9026, 60.A-9235, 70.A-0229, 71.B-0077

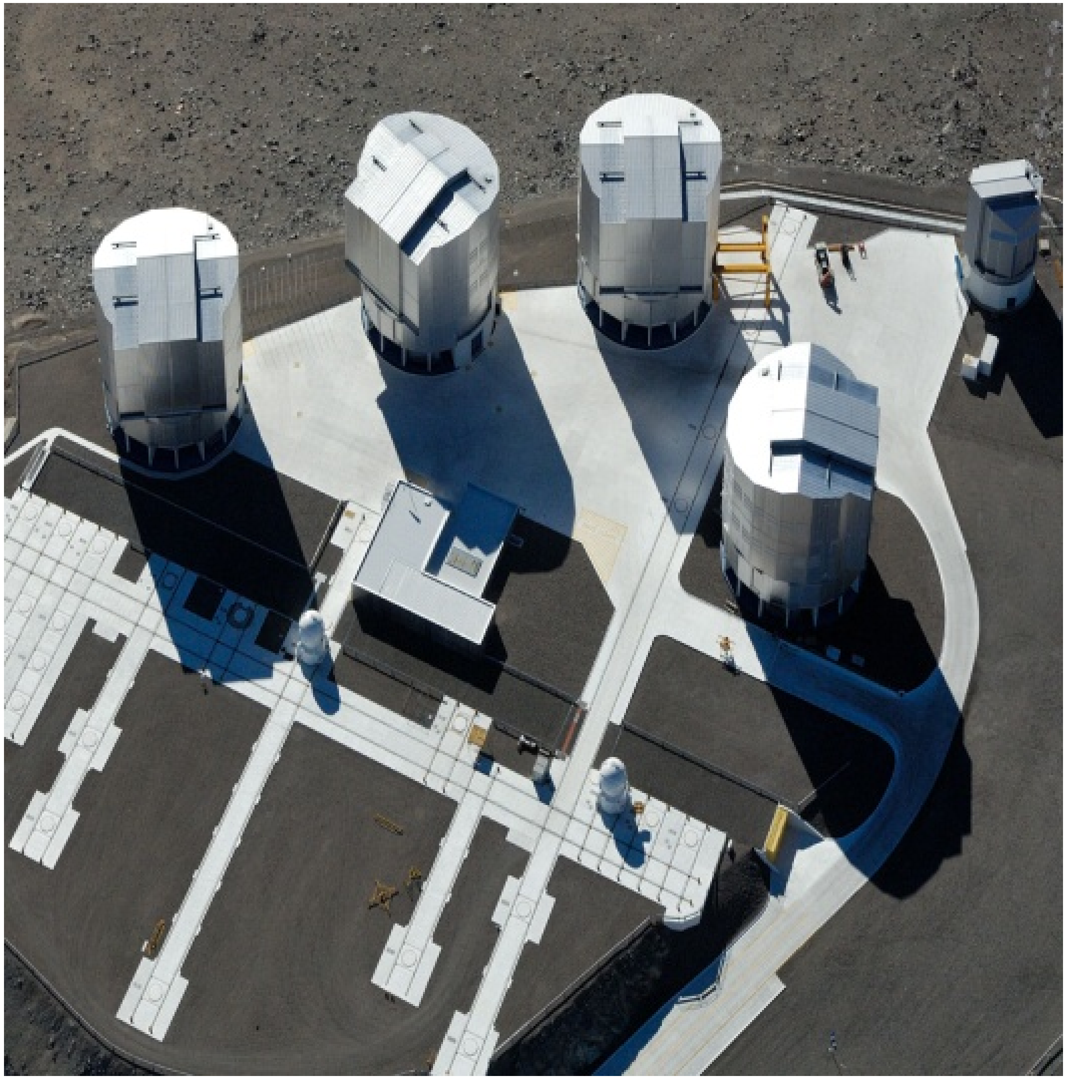
- 2010 Lehnert, M. D. et al. Spectroscopic confirmation of a galaxy at redshift z = 8.6, 2010Natur.467..940L
SINFONI 283.A-5058

MUSE

- Integral Field Spectrograph
- It has a modular structure composed of 24 identical IFU modules that together sample, in Wide Field Mode (WFM), a near-contiguous 1 squared arcmin field of view.
- almost the full optical domain with a mean resolution of 3000. Spatially, the instrument is designed to exploit the VLT AO Facility via the GALACSI AO system, sampling the sky with 0.2 arcseconds spatial pixels.
- MUSE is currently offered in Wide Field Mode with natural seeing mode. In the future, once the AOF is commissioned, a Narrow Field Mode (NFM) will be made available, and will cover 7.5x7.5 arcsec^2 field of view sampled at 0.025"/pixel, always with AO-correction.
- **Science Objectives**
- Formation of galaxies
- Nearby galaxies
- Stars and resolved stellar populations
- Solar system
- Serendipity



VLTI



Interferometry

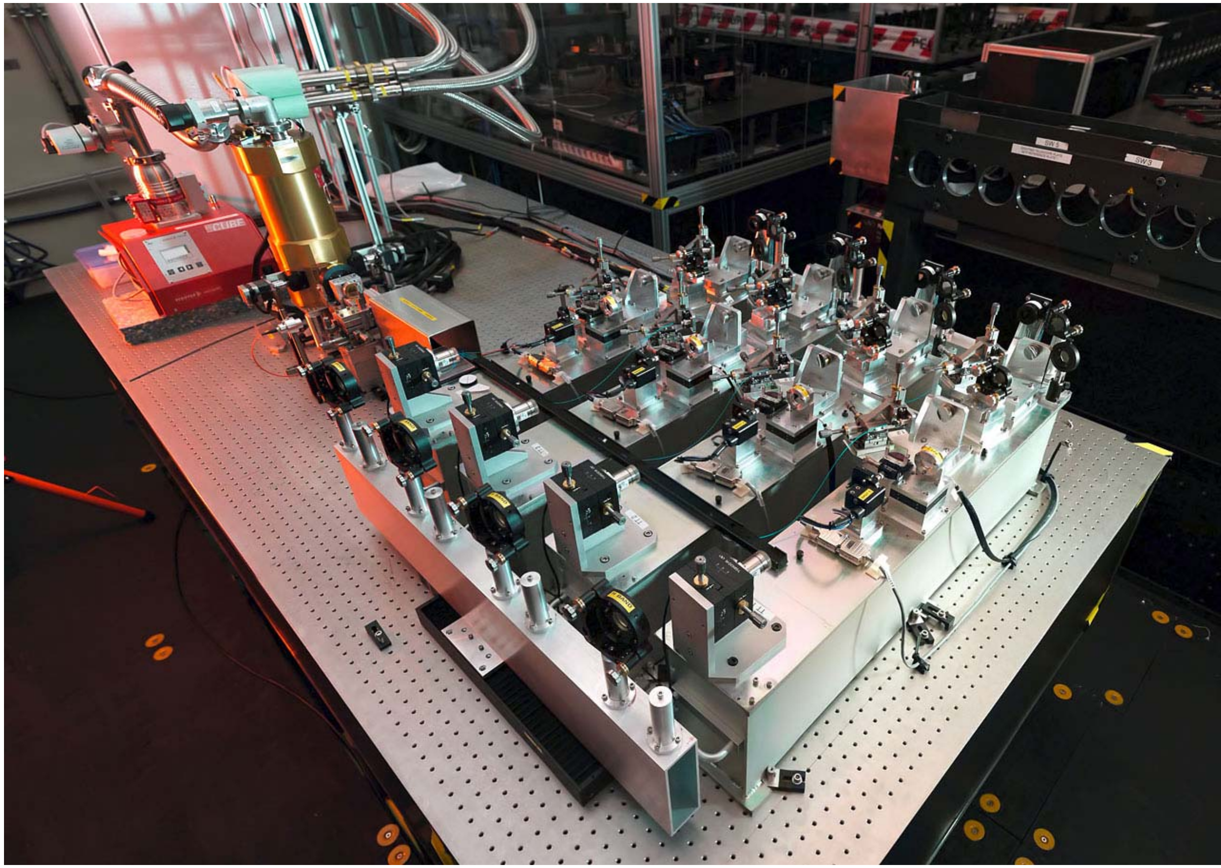
- Combining the light from 2-4 telescopes (VLTI)

- AMBER, MIDI, PIONIER (all NIR wavelengths)
- More details in lecture by Dr. Liz Guzman 03 December – especially ALMA
- Reading:

  https://www.eso.org/sci/meetings/2010/stars2010/Presentations/Primer-haniff_garching10-as-used.pdf

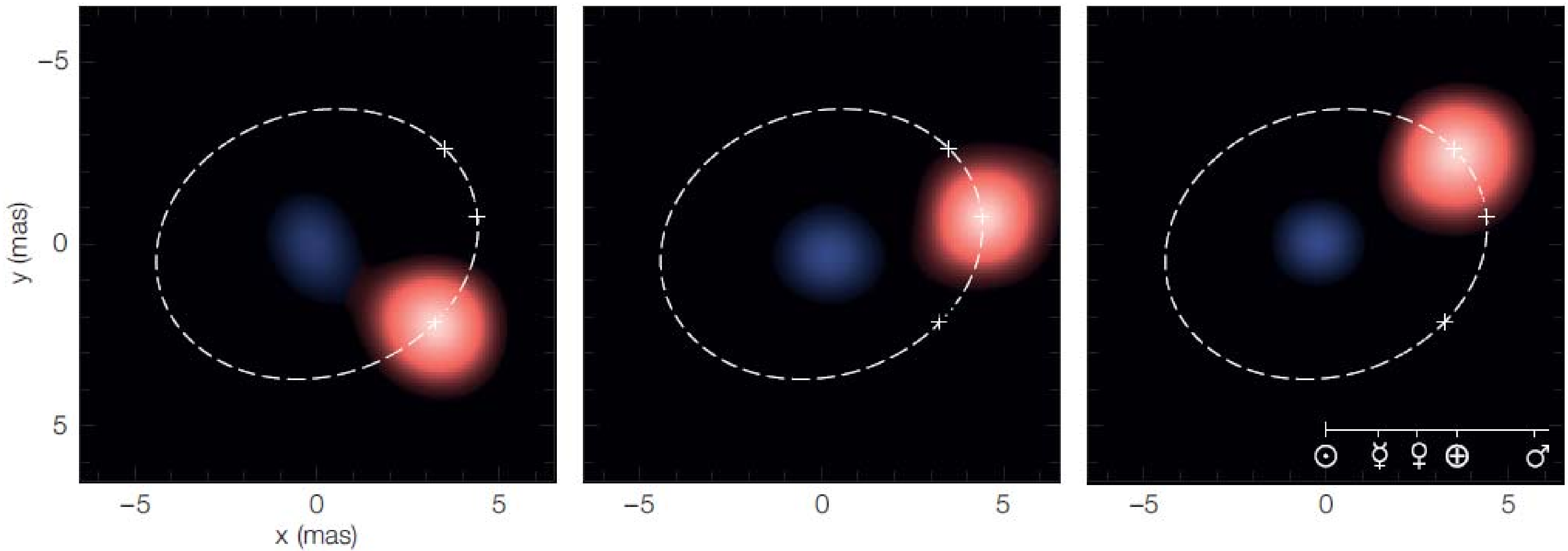
PIONIER

- 4 telescopes



http://www.eso.org/sci/publications/messenger/archive/no.146-dec11/messenger-no146-12-17.pdf

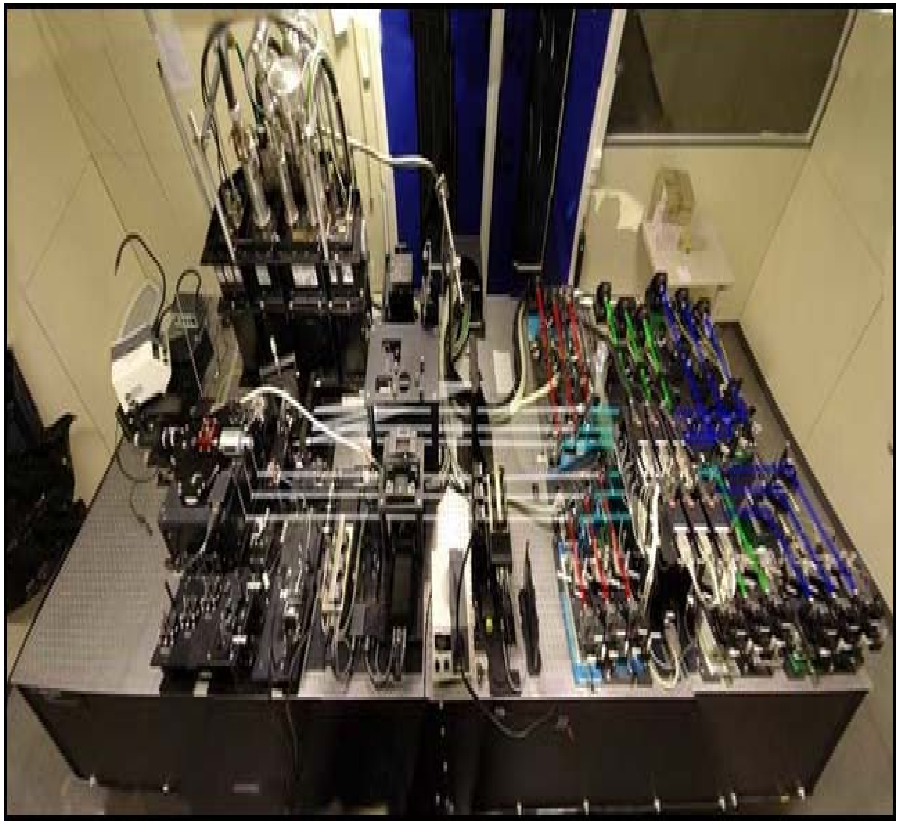
PIONIER results

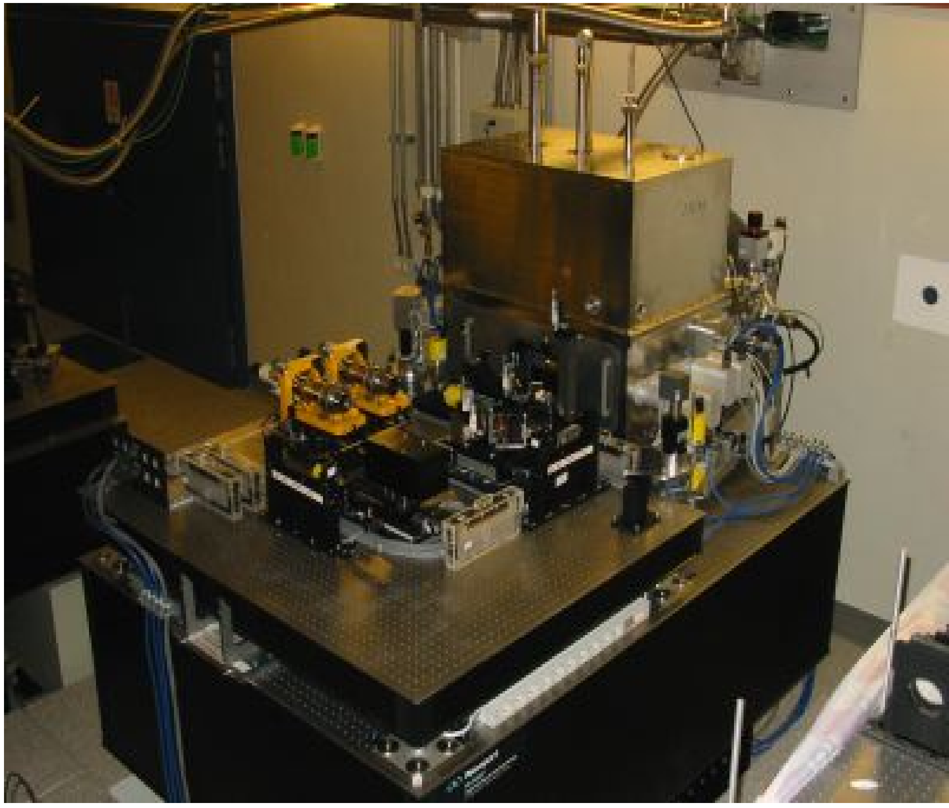


http://www.eso.org/sci/publications/messenger/archive/no.146-dec11/messenger-no146-12-17.pdf

AMBER & MIDI

- AMBER – 3 telescopes
- MIDI – 2 telescopes (will be decommissioned)

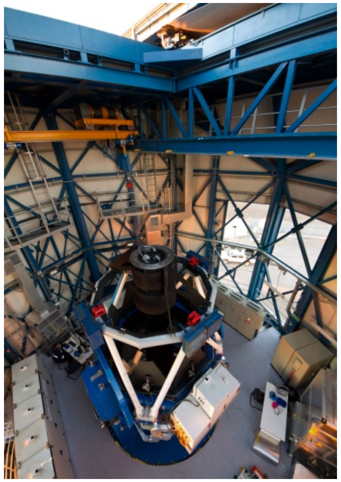




Other Paranal telescopes

VISTA

VST



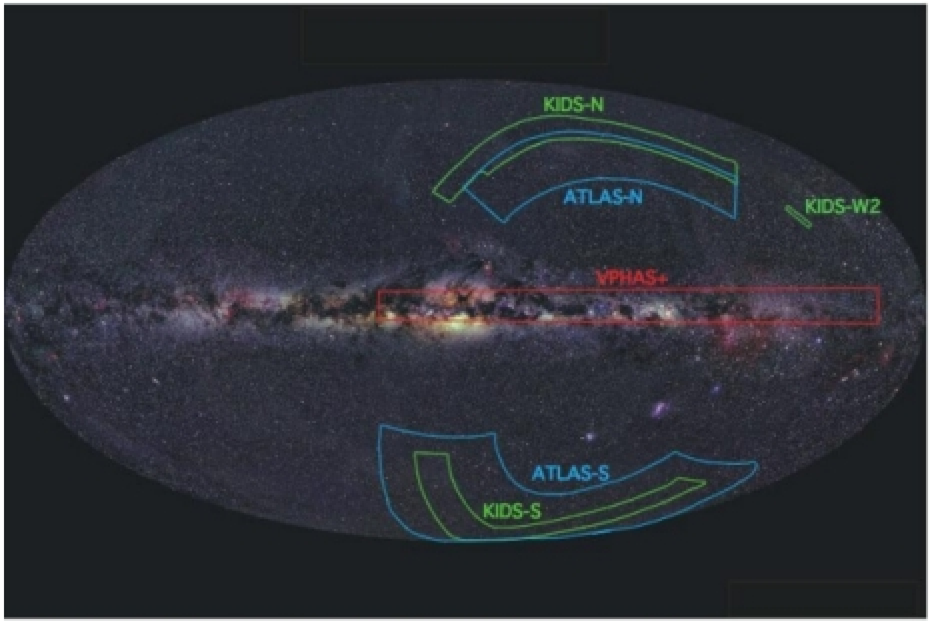
DIMM+site testing

- the Next-GenerationTransitSurvey (not ESO operated start 2014)
- Please come to listen to talks presented by Stan and Ernst!

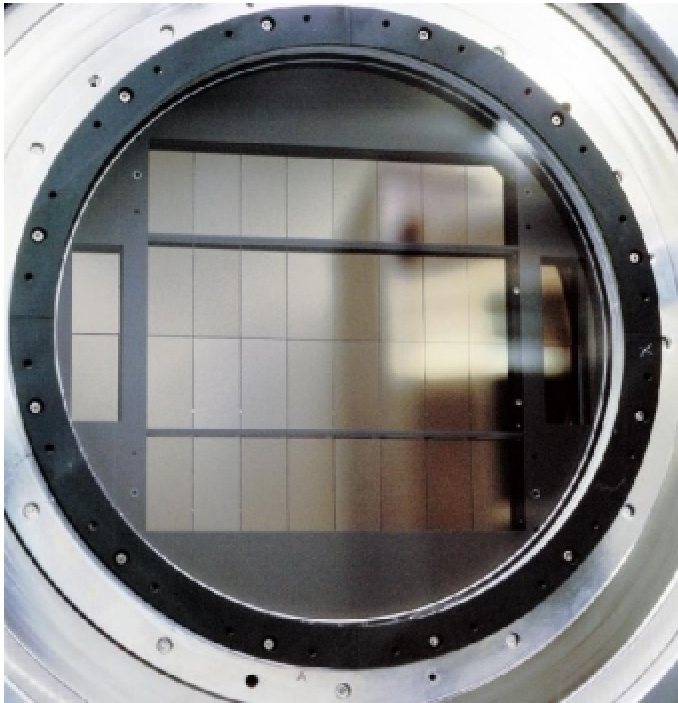
All images ESO images archive

SURVEYS

- OMEGACAM – on 2.6-m VST (SURVEYS)
  - imager with 1x1 deg FoV
  - CCD 16x16k pixels
  - optical till 1 micron



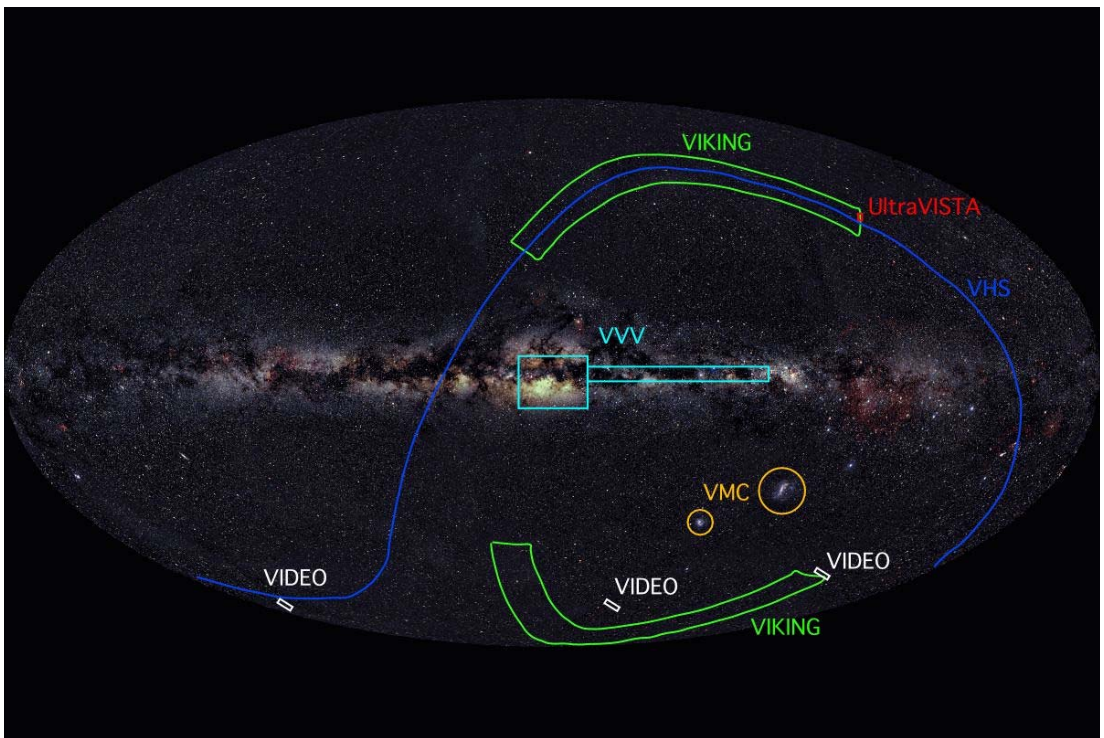
ESO



VIRCAM

- VIRCAM at VISTA – at 4-m class telescope

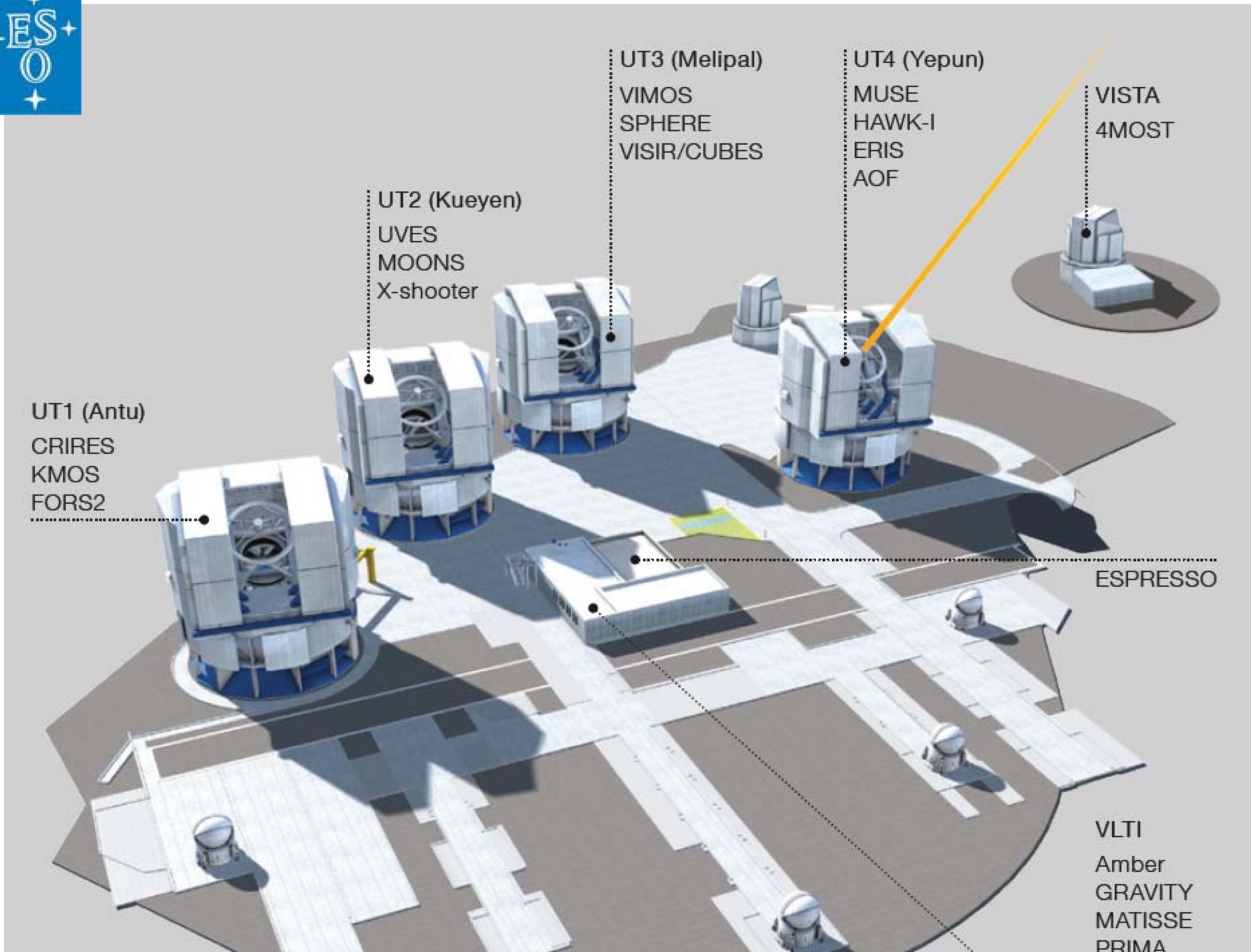
  - 1.6 deg FoV, 65 millions pix.
  - 0.8 – 2.3 micron
  - public surveys



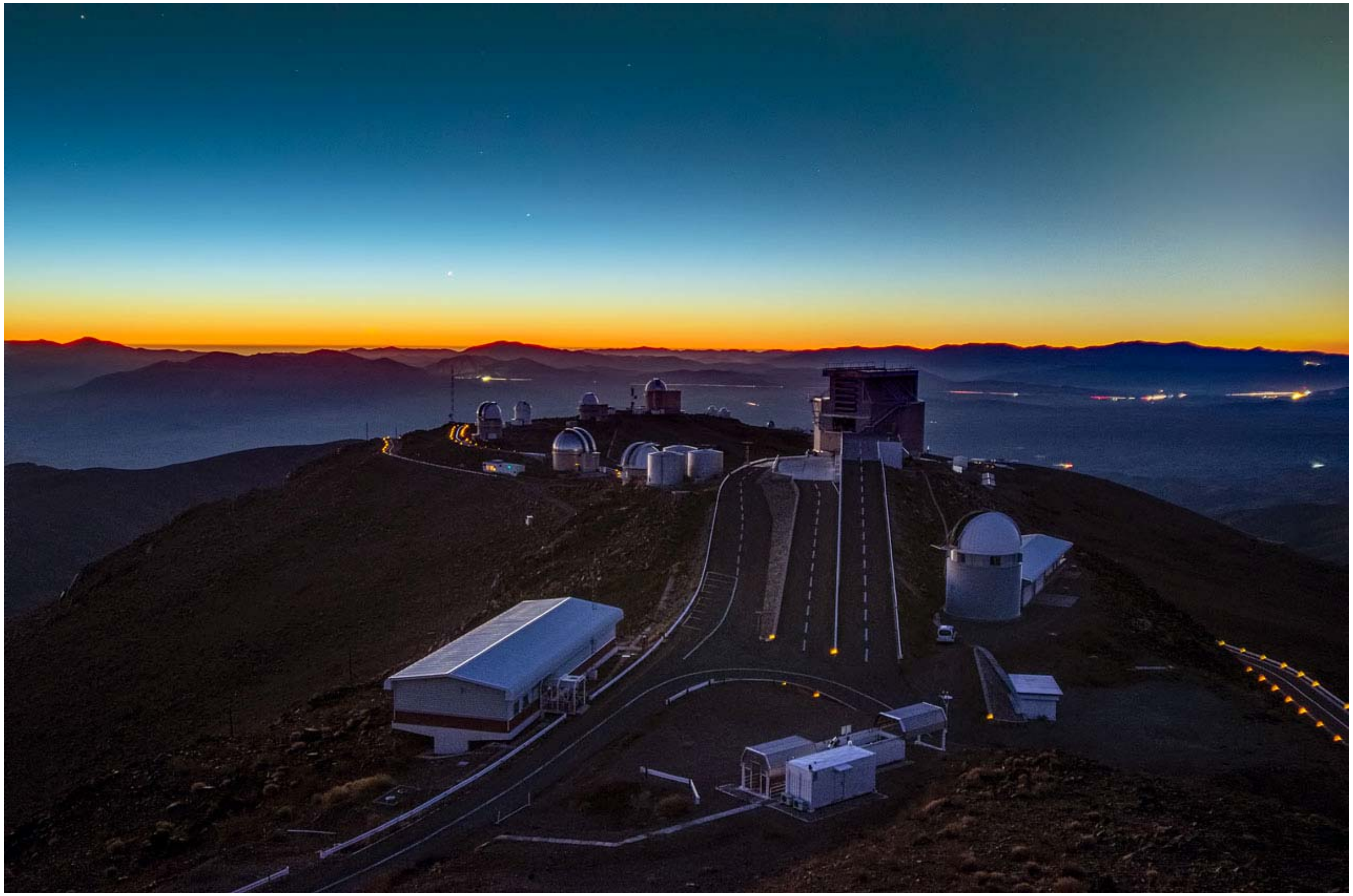
What's next?

Year	Phase A	Design & Construction	Delivery
2012	CUBES CRIRES upgrade	ERIS	KMOS VIMOS upgrade
2013		MOONS CRIRES upgrade	MUSE SPHERE
2014	Letter of interest NTT	4MOST	VISIR upgrade PRIMA astrometry GRAVITY LFC for HARPS
2015	New I (NTT?)	CUBES (?)	AOF MATISSE
2016	New II	New I (NTT?)	ESPRESSO VLTI
2017	New III	New II	CRIRES upgrade
2018	New IV	New III	CUBES(?) MOONS
2019	New V	New IV	ERIS 4MOST
2020	New VI	New V	New I (NTT?)

Pasquini et al., Messenger 154

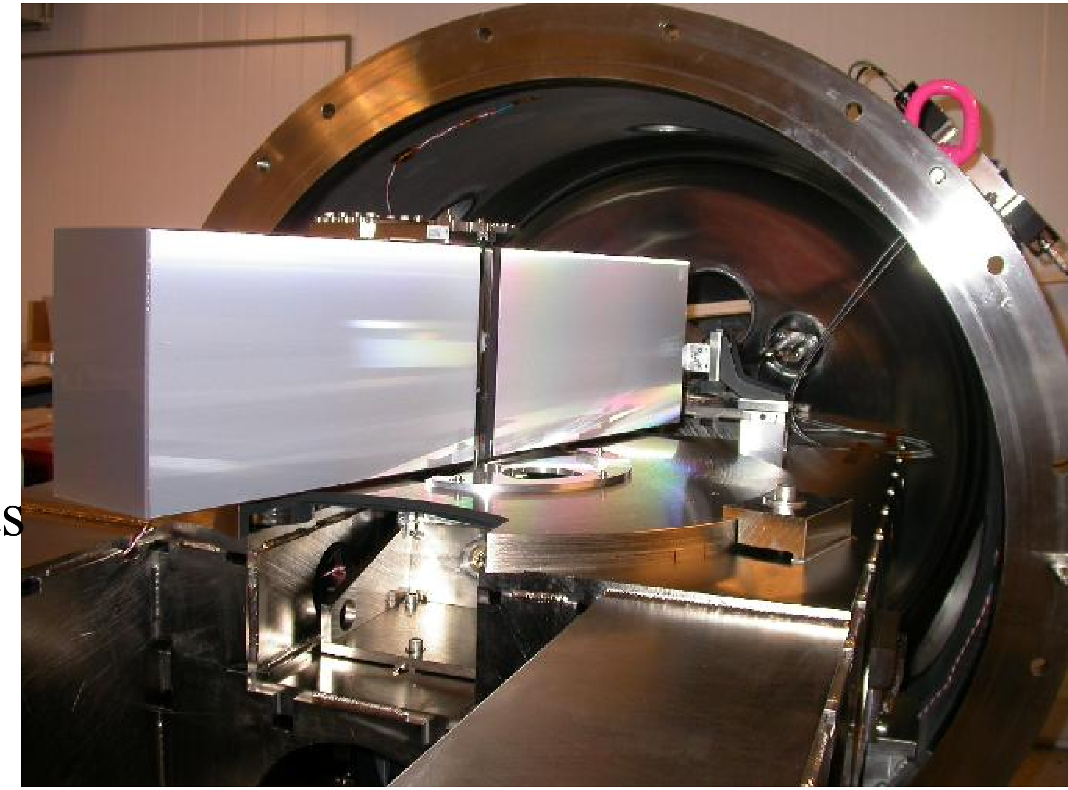

UT3 (Melipal)
VIMOS
SPHERE
VISIR/CUBES
UT4 (Yepun)
MUSE
HAWK-I
ERIS
AOF
VISTA
4MOST
UT2 (Kueyen)
UVES
MOONS
X-shooter
UT1 (Antu)
CRIRES
KMOS
FORS2
ESPRESSO
VLTI
Amber
GRAVITY
MATISSE

La Silla



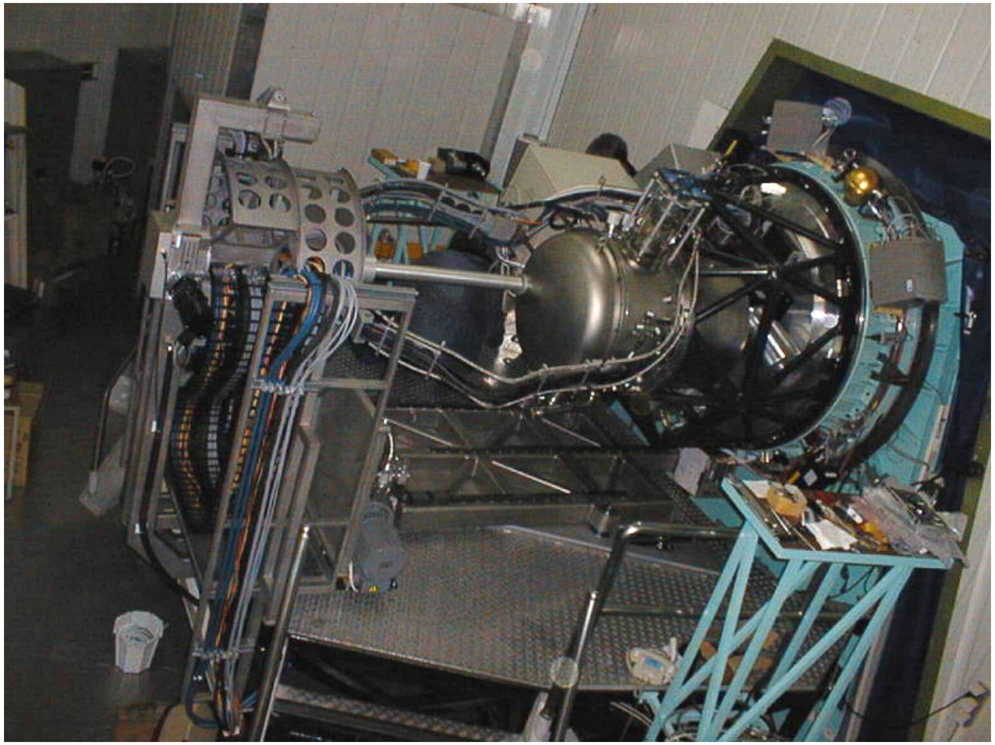
HARPS

- Planet hunter operated by ESO/Geneva University
- @ 3.6-m telescope
- high res. Echelle spectrograph
- Radial Velocities – few m/s
  - attempts a few cm/s
- detection of hundreds of planets
- even small sized planets
  - Neptune and smaller
- brother HARPS-N @ Canary islands



SOFI

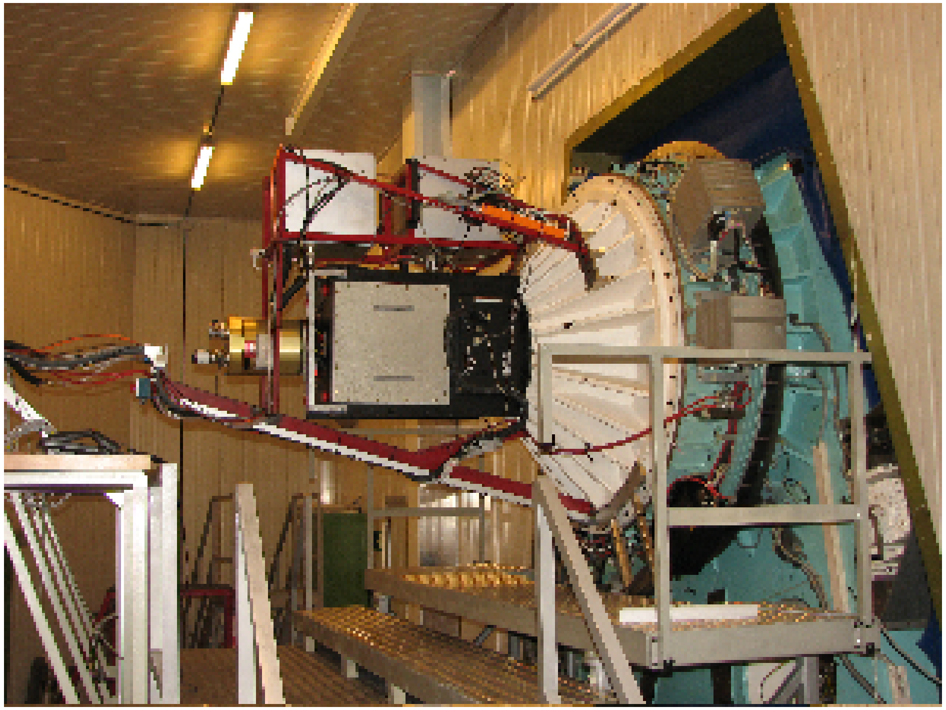
- @ NTT – 3.2-m telescope
- NIR imager & spectrograph
  0.9-2.3 micron
- large FoV 4.92 arcmin
- large slit 4.5 arcmin
- only Visitor Mode



EFOSC

- @NTT – plenty of modes
- 305-1110 nm
- 4.1x4.1' FoV

IMA	imaging
MOS	multi-object spectroscopy (masks)
LSS	longslit spectroscopy
IPOL	imaging polarimetry
SPOL	spectropolarimetry
COR	coronography



Danish 1.54-m & MPG 2.2-m

- CZ involvement in both
- MPG-2.2-m
- FEROS – high res. spectrograph
- WFI – wide field optical imager
- on both AV CR has observing time in frame of TYCHO grant

- DANISH 1.5-m
  - optical imaging
  - asteroids
  - robotic thanks to Projectosft

http://www.eso.org/sci/facilities/lasilla/instruments/feros.html

TRAPPIST

- http://www.ati.ulg.ac.be/TRAPPIST/Trappist_main/Gallery/Pages/Mission-Mars2014.html#1
- 60-cm
- EXOPLANETS/COMETS

LA SILLA IS ALIVE!!!!

Next:

- 26 November (SPECIAL): Dr. Liz Guzman (ESO ALMA Fellow) – ALMA observatory and science
- 03 December: ESO behind the scenes
- 03 December: Observing process, data reduction pipelines, ESO data archives

How does observing work?
(Beyond the scenes - Paranal)

The way from a proposal to the observed OB

+ insight beyond the scene

(03 December – Lecture 8)

1.

EUROPEAN SOUTHERN OBSERVATORY

Organisation Européenne pour des Recherches Astronomiques dans l'Hémisphère Austral
Europäische Organisation für astronomische Forschung in der südlichen Hemisphäre

OBSERVING PROGRAMMES OFFICE • Karl-Schwarzschild-Straße 2 • D-85748 Garching bei München • e-mail: opo@eso.org • Tel.: +49-89-32 00 64 73

APPLICATION FOR OBSERVING TIME SHORT PROGRAMME PERIOD: 86A

Important Notice:

By submitting this proposal, the PI takes full responsibility for the content of the proposal, in particular with regard to the names of CoIs and the agreement to act according to the ESO policy and regulations, should observing time be granted

1. Title Category: C–7
First ground based spectrum of the extrasolar planet CoRoT-1b in near infrared

2. Abstract / Total Time Requested
Total Amount of Time: 1.2 nights VM, 0 hours SM
One of the most challenging tasks of the last decade is the characterization of the

2.

Status	Programme ID	Title
✗	286.C-5039	Patfinder program for ground-based detection of thermal emission from extrasolar planets at 3.6\,μm: the compact planet HAT-P-20b.
✗	386.C-0516	First ground based spectrum of the extrasolar planet CoRoT-1b in near infrared

3.

EURO

Organisation
Europäische

OBSERVING PROGRAMMES OFFICE • K

APPLICATION FOR OBSER

Important Notice:

By submitting th
names of CoIs and the agreement

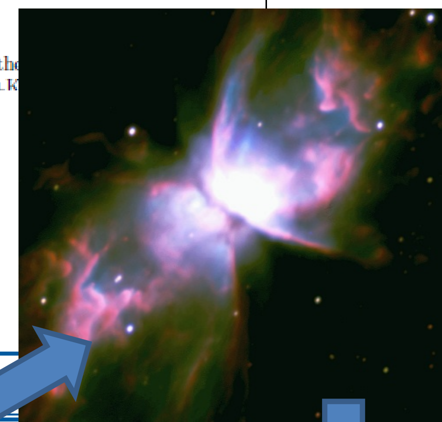
1. Title
First ground based spectrum of the extrasolar planet CoRoT-1b in ne

2. Abstract / Total Time Requested
Total Amount of Time: 1.2 nights VM, 0 hours SM
One of the most challenging tasks of the last decade is the character

4.

Status	Programme ID	Title
✗	290.C-5075	Water or clouds in the atmosphere of the sub-Neptune GJ1214b?
●	490.L-0594	
✔	290.C-5196	

5.



6.

Letter

Nature 464, 384-387 (18 March 2010) | doi:10.1038/nature08856; Received 30 November 2009; Accepted 19 January 2010

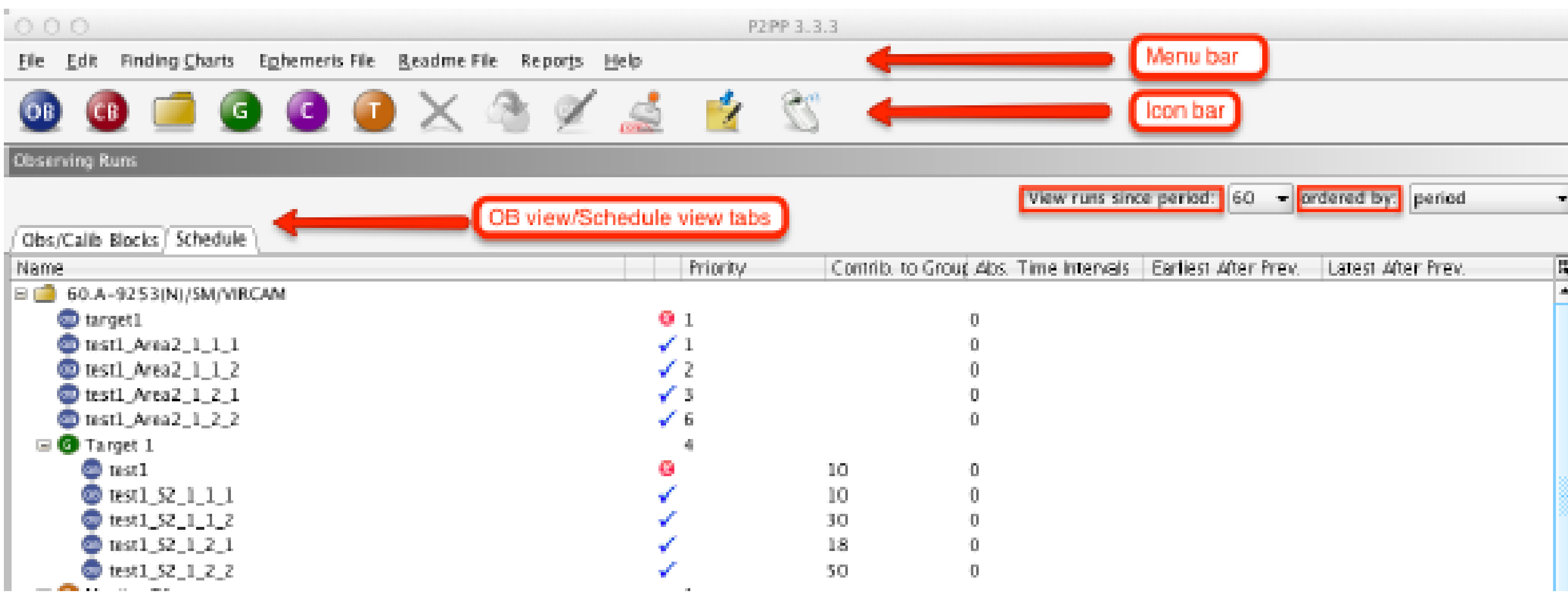
A transiting giant planet with a temperature between 250 K and 43 K

H. J. Deeg[1,2], C. Moutou[3], A. Erikson[4], Sz. Csizmadia[4], B. Tingley[1,2], P. Barge[3], H. Bruntt[5], M. Havel[6], S. Aigrain[7,8], J. M. Almenara[1,2], R. Alonso[9], M. Auvergne[5], A. Baglin[5], M. Barbieri[3,10], W. Benz[11], A. S. Bonomo[3], P. Bordé[12], F. Bouchy[13,14], J. Cabrera[4,15], L. Carone[16], S. Carpano[17], D. Ciardi[18], M. Deleuil[3], R. Dvorak[19], S. Ferraz-Mello[20], M. Fridlund[17], D. Gandolfi[21], J.-C. Gazzan

Service & Visitor modes

Details of proposal life cycle were given by Nando earlier!

18 *P2PP version 3 User Manual* *Doc. No. VLT-MAN-ESO-19200-5167*



SM observing

Maximize **science efficiency** by executing the programmes with highest scientific priority first and under the required observing conditions;

Maximize **operational efficiency** by sharing calibration data between programmes, and by helping infrequent users of complex facilities in optimizing the use of the allocated observing time;

Maximize the **scientific use** of telescope time by having appropriate programmes ready for execution under a broad range of observing conditions;

Maximize the **scientific productivity** of the facility by means of the reuse of the data, made possible by building uniform data sets accessible through an archive.

Who is involved at ESO side?

- The Observing Programmes Office(OPO),
- The User Support Department (USD),
- The Paranal Science Operations Team or
- the La Silla Science Operations Team,
- The Data Flow Operations (DFO) Department and its Quality Control (QC) Group, and
- The Science Archive Facility (SAF).

Further I will talk mostly about Paranal operations!

Hints for a successful SM OB

- Check carefully your observing constraints!
  - do you really need 0.6” seeing?
  - do you really need dark time?
  - do you really need photometric conditions?
  - can your program be done as a filler?

- BUT if you need one or more of above conditions
  do NOT relax the OB constraints

- The time scheduling constraints double checked?

- The coordinates, proper motion value and offsets etc. double checked?

Visitor Mode (VM)

- Used for difficult and challenging runs where real time decision are required
- The visiting astronomer is responsible for preparation and checking of his/her OBs directly at Paranal
- The visitor is supported directly by the Night Astronomer and/or the Telescope Instrument Operator at the telescope control in the Control room
- The losses due to weather are not compensated

How to decide VM or SM?

- Difficult run? Adjustments needed during the run? Special modes are requested?

THEN
Visitor Mode

- Flexible scheduling constraints? Easy run, where target can be identified well or the position is known? And many hours of observing needed?

THEN
Service Mode

The observing process
(what happens after phase 2?)

Paranal Operations

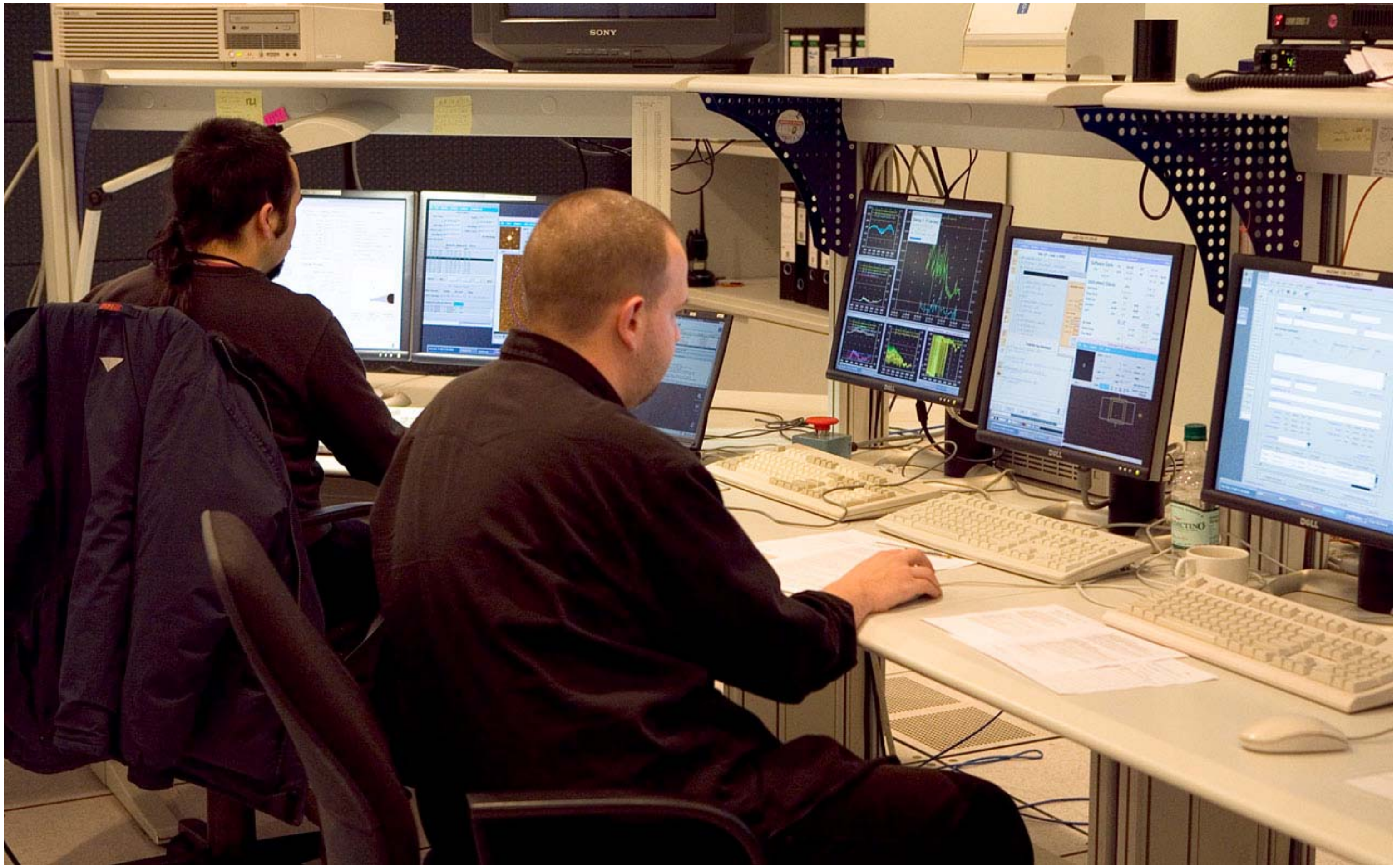
- Engineering – maintenance of the instruments

- Paranal Science Operations department:

  - ***Astronomers*** *– operation of the instruments, SM queues, astronomical decisions during observing, interaction with the USD department, VM handling*

  - ***Telescope Instrument Operators*** *– operating the instruments and telescopes*

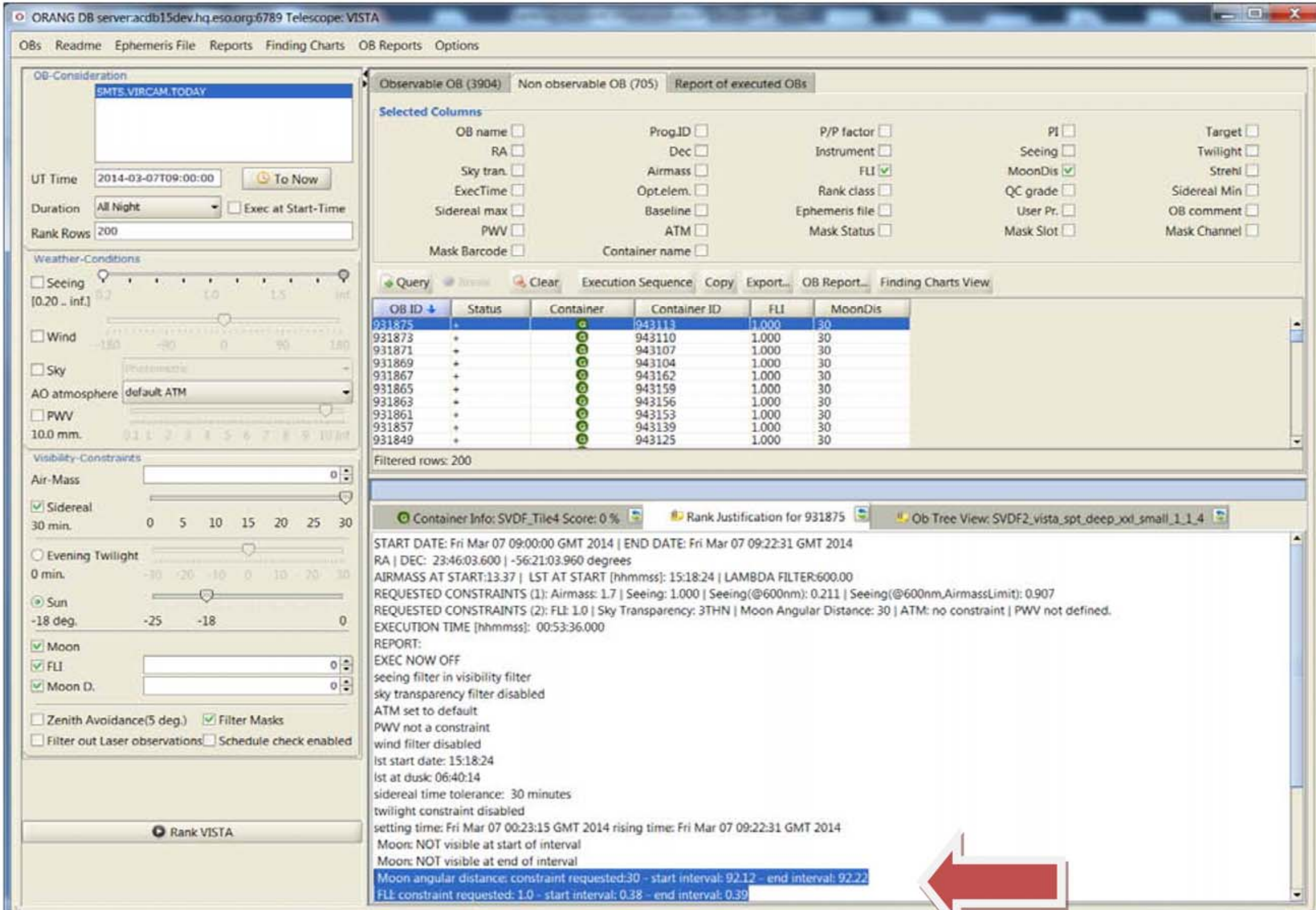
The Control Room



How are the Obs observed in the SM?

- Three queues system – A,B,C (highest -> lowest rank)
- An automated tool OT3 (Observing Tool 3) ranks observations based on the weather/other conditions (time critical) provided by the Night Astronomer or the Telescope Instrument Operator
- The highest ranked OB by OT3 is observed
- Night astronomer classifies according to conditions

OT3 (Observing tool)



First quality check

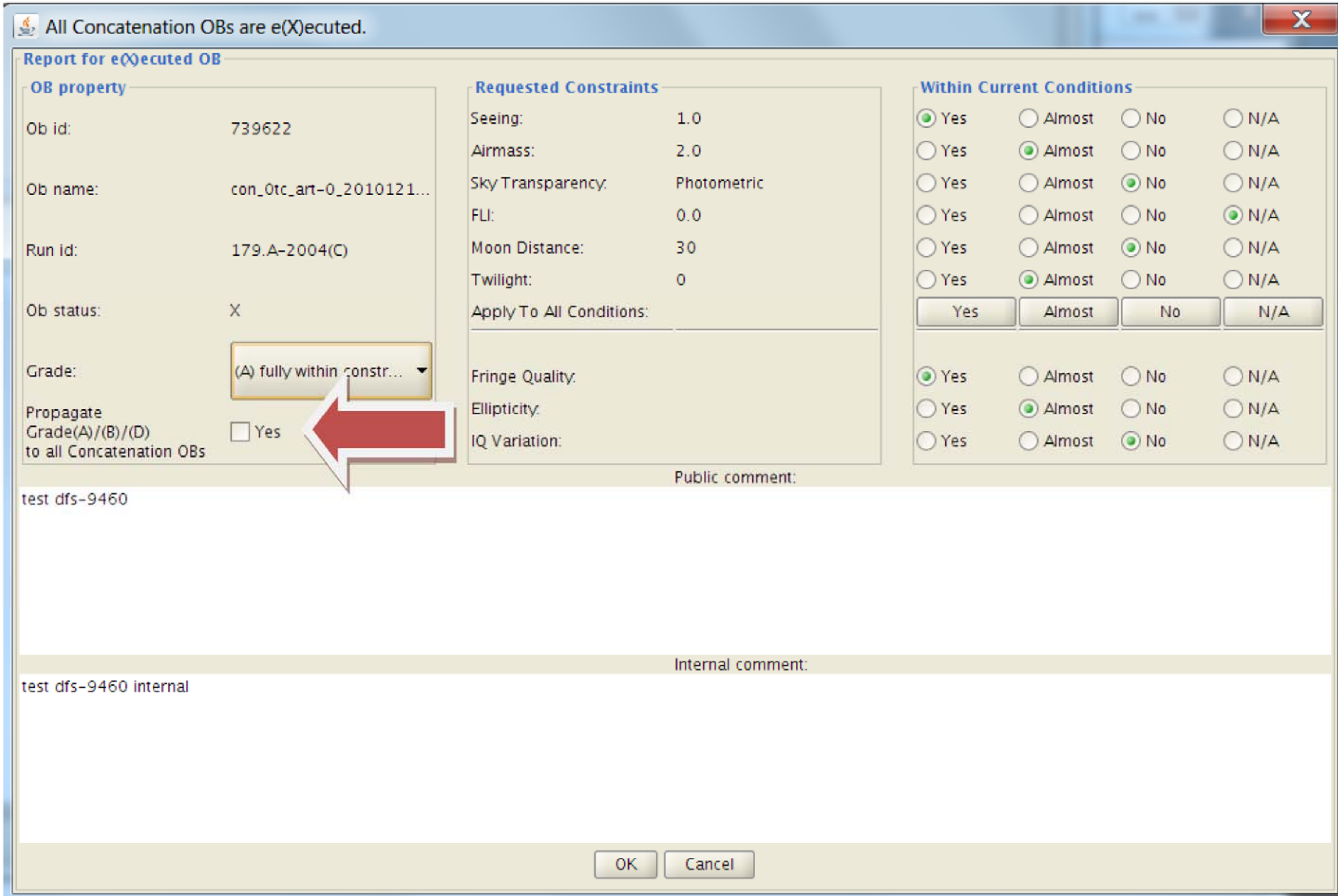
- The Night Astronomer at the mountain checks the quality of the data taken

  - checking if the correct object is observed with the Finding chart

  - checking if the conditions like seeing, sky transparency, sometimes SNR in frame are fulfilled

  - classifies the obtained data based on the above constraints as A,B, C or D (fulfilled completely, some constraints violated but still acceptable, must repeat, not fulfilled but not repeat)

Classification



Calibrations and data cycle

- Next day, calibration data is taken
- The instrument performance is checked regularly by the Paranal and Garching staff
- The data are archived in the ESO Archive where it can be downloaded by the PIs

Daily calibrations check

FORS2 calChecker: calibration completeness monitor for science data http://www.eso.org/observing/dfo/quality/FORS2/reports/CAL/calChec...

Calibration completeness monitor

mirror sites: PL (internal link) HQ [?]

[all links are internal] [page auto-refreshes after 300 sec] [stop | on] [press Ctrl+Shift+R to enforce refresh of 'ago' time information]

CAL | HC | refs | QC

CALCHECKER

HOME | HELP

ALL INSTRUMENTS

UT1: CRIRES, FORS2, KMOS
UT2: FLAMES/GIRAFFE, UVES&FLAMES/UVES
UT3: VIMOS, X-SHOOTER, VISIR (out of ops)
UT4: HAWK-I, NACO (out of ops), SINFONI
VLTI: AMBER, MIDI
Survey Cameras: OMEGACAM, VIRCAM

QC links: QC home, Cal Checker, Health Checks, Reference Frames, QC1 database, Paranal autrep database (ESO internal)

CAL FORS2 calChecker: calibration completeness monitor

Last update: 2014-04-07T19:26:27 (UT) **(0d 00h:08m ago)** [?] Paranal date*: **2014-04-06** muc01 [?] server: **www.eso.org HQ** HELP ASSOC-RULES DETAILS

Last header: FORS2.2014-04-07T11:13:19.140.hdr transfer ngas [?] *Date on this monitor changes at 21:00 UT. Refresh frequency: 1/2hr day and night

General news:

FORS2 news:

Long-term calibrations and maintenance complete overview | how to execute [?]

type of calibration	validity (days)	age (days)	evaluation
DARK_low_gain_MIT	30	30.1	REMINDER: take as soon as possible
DARK_high_gain_MIT	30	30.2	REMINDER: take as soon as possible
DETECTOR_MON_high_gain_2x2_MIT	30	26.2	soft REMINDER: next 12 day(s)
DETECTOR_MON_low_gain_2x2_MIT	30	26.2	soft REMINDER: next 12 day(s)
DETECTOR_MON_low_gain_1x1_MIT	30	26.1	soft REMINDER: next 12 day(s)

HC analyse ISSUES | HELP | Q&A | ASSOC-RULES | history... | contact | DataTransferMonitor | BandWidth

science . cal4cal . [?]

Product availability depends on the data transfer to Garching and the archive access there (check the 'transfer' and 'ngas' flags above).

daytime calibs: finished 11:18UT

Data types:	Setup: DATE*: [?] [color if science data acquired]	2014-03-31	2014-04-01 SM 4	2014-04-02 SM 36	2014-04-03 SM 62	2014-04-04 SM 128	2014-04-05	2014-04-06	LOST? [may require OB (take these data types ... grade review)]	Calibration action?	[?] Setup: ... for these setups
		report | NLT	report | NLT	report | NLT	report | NLT	report | NLT	report | NLT	report | NLT			
P...	Product quality: [?]	products	products	products	products	products	products	products			
SCI_IMG	200Kps/low_SR_2x2				ok analyzed: [1]					all ok	
	200Kps/low_SR_R_SPECIAL_2x2		ok	ok	ok					all ok	
	200Kps/low_SR_b_HIGH_2x2		ok	ok	ok					all ok	
	200Kps/low_SR_u_HIGH_2x2		ok	ok	ok					all ok	
	200Kps/low_SR_v_HIGH_2x2		ok	ok	ok					all ok	
SCI_MXU	100Kps/high_SR_GG435_G600RI_+923017_2x2			nok analyzed: [2]						STD_MOS	100Kps/high_SR_GG435_G600RI_+923017_2x2
SCI_MOS	100Kps/high_SR_OG590_G300I_43963_2x2		ok							all ok	
SCI_LSS	100Kps/high_SR_G1200B_0_7_2x2	ok	ok							all ok	
	100Kps/high_SR_GG435_G1200R_0_7_2x2	ok	ok							all ok	
	100Kps/high_SR_OG590_G1028z_1_0_2x2				nok analyzed: [3]					STD_MOS	100Kps/high_SR_OG590_G1028z_1_0_2x2

ANALYSIS NOTES:

index	data type	setup	date	flag	analysis
[1]	SCI_IMG	200Kps/low_SR_2x2	2014-04-03	OK	[science OB does not require a standard (analyzed by sertel@eso.org)]
[2]	SCI_MXU	100Kps/high_SR_GG435_G600RI_+923017_2x2	2014-04-02	NOK	[the last relevant STD_MOS calibration is too old, please take a new one soon (analyzed by qc_fors2@eso.org)]
[3]	SCI_LSS	100Kps/high_SR_OG590_G1028z_1_0_2x2	2014-04-03	NOK	[the last relevant STD_MOS calibration is too old, please take a new one soon (analyzed by qc_fors2@eso.org)]

INFORMATION SPECIFIC TO FORS2 [?]

The following keys are used to define a SCIENCE FORS2 setup:

det.win1.binx, det.win1.biny (= 1, 2)

det.read.clock (= 100Kps/2ports/high_gain, 200Kps/2ports/low_gain, 625Kps/2ports/low_gain)

ins.coll.name (= SR, HR)

CONFIGURATION [?]

Number of days scanned: 7

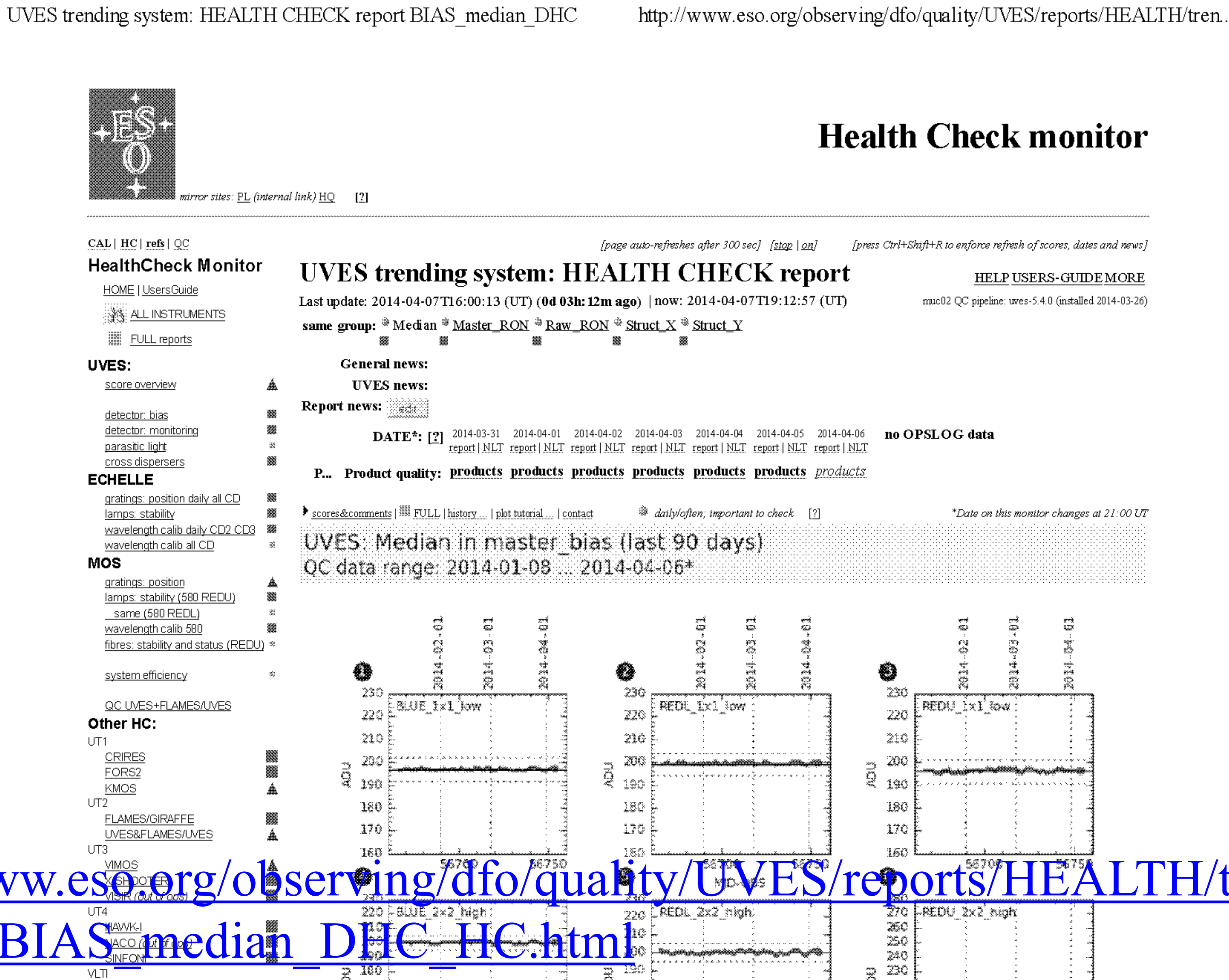
Range of days for the issue memory (configured): 15

Range of days for the calibration memory (issue memory plus longest validity): 22

Days in the calibration&issue memory: 2014-03-15

http://www.eso.org/observing/dfo/quality/FORS2/reports/CAL/calChecker_FORS2.html

Instrument health monitoring



http://www.eso.org/observing/dfo/quality/UVES/reports/HEALTH/trend_report_BIAS_median_DHC_HC.html

ESO archive – data retrieval

Data made available very fast after the observing night!

http://archive.eso.org/eso/eso_archive_main.html

ESO Archive Query Form   http://archive.eso.org/eso/eso_archive_main.html

ESO Archive Query Form

ESO Archive Overview   Help Page   FAQ   Archive Facility HOME   ESO HOME

If you would like to query the Archive for instrument specific parameters, please use the dedicated query forms.
To search for **reduced Data Products**, please have a look at the ESO Data Products page and the Advanced Data Products query form.
To search through the science data products generated by the observers, please refer to the Phase 3 query form.

The checkboxes on the right of the parameters define whether or not they will be displayed on the query result page.

Search   Reset   Output preferences: html table   Return max 200 rows.   All Fields   Syn

Target, Program and Scheduling Information

Target Name   Resolved by SIMBAD   **Night**   (YYYY MM(M) DD)
RA   **DEC**   *J2000*   *Otherwise give a query range using the following start/end dat*
Search Box 00 10 00   **Input** RA(h) DEC(deg)   **Start**   12 hrs [UT]   **End**   12 hrs [UT]
Output Sexagesimal (h, deg)   **Program ID**   **Program Type** Any
PI CoI   **SV** Any
List of Targets Browse... No file selected.   **Title**

Observing Information

Imaging	Spectroscopy	Interferometry	Other
ALL NONE	ALL NONE	ALL NONE	ALL NONE
EFOSC2/LaSilla	CES/LaSilla	AMBER/VLTI	BOL/APEX
EMMI/LaSilla	CRIRES/VLT	MIDI/VLTI	HET/APEX
FORS1/VLT			LGSF

Data Product Info

ESO data reduction pipelines

Does it make sense to apply for the VLT time?

- Well, if the program requires 8-m telescope then YES!
- VLT is a leading facility and Czech Republic is an ESO member state, therefore we should be using the advantages of being ESO members
- Competition is tough. If the time is not awarded immediately, one has to resubmit or modify and resubmit again the proposal
- Before applying, the ESO Archive should be checked -> there is plenty of data already available!

What’s next?

NEXT LECTURE: 03 December

Dr. Liz Guzman ALMA ESO Fellow

Introduction to ALMA observing & science