C

Telescopios e instrumentos

En vano os veo permanecer
Mudos como telescopios
Mil metros sobre el nivel
De paranoia en vuestros ojos

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192 noches de telescopio[1] es una cifra que denota de manera evidente la *observacionalidad* de esta Tesis. Es obligatorio, por tanto, dedicar unas líneas a algunos detalles de los telescopios e instrumentos utilizados. En este Apéndice se ha extraído la información necesaria de las respectivas páginas web de cada telescopio e instrumento. Se ha conservado en la medida de lo posible el texto original (incluyendo el idioma), y se enfatizará en la descripción de los instrumentos más complejos o más importantes para esta Tesis. Al final del Apéndice se ofrecen dos tablas con los datos técnicos más importantes y las páginas web de donde se ha extraído la información.

C.1 8.2 m Very Large Telescope UT1 Antu

The ESO [European Southern Observatory] Very Large Telescope consists of an array of four 8-meter telescopes which can work independently or in combined mode. In this latter mode the VLT provides the total light collecting power of a 16 meter single telescope. The telescopes may also be used in interferometric mode providing high resolution imaging. The useful wavelength range extends from the near UV up to 25 μm in the infrared. In addition to the 8.2 m telescopes the VLTI will soon be complemented with four Auxiliary Telescopes (AT) of 1.8m diameter to improve its imaging capabilities and enable full nighttime use on a year-round basis. Two telescopes for imaging surveys are also under construction for Paranal, the VLT Survey Telescope (VST, 2.6 m) for the visible, and the Visible and Infrared Survey Telescope for Astronomy (VISTA, 4 m).

[1] 192 noches de observación, de las que 37 han sido en telescopios de clase 4 m. Durante estos cinco años, alrededor de una noche de cada diez la he pasado en una sala de control...

C.1.1 ISAAC

ISAAC is an IR (1–5 μm) imager and spectrograph that lies at the Nasmyth B focus of UT1. It has two arms, one equipped with a 1024 $\times$ 1024 Hawaii Rockwell array, and the other with a 1024 $\times$ 1024 InSb Aladdin array from Santa Barbara Research Center. The Hawaii arm is used at short wavelengths (1–2.5 μm). Prior to [proposal semester] P70, the Aladdin arm was used exclusively at long wavelengths (3–5 μm). From P70 onwards this arm is also offered for JHK imaging.

C.2 4.2 m William Herschel Telescope

The William Herschel Telescope is the largest of the telescopes at the Canarian Observatories, indeed it is the largest in Western Europe. It has an altazimuth mount with a 4.2-metre diameter f/2.5 parabolic primary mirror. Instruments can be mounted at the corrected f/2.81 prime focus, f/11 cassegrain focus, or either of two f/11 Nasmyth foci. Total weight of the telescope is about 210 tonnes. The telescope is a general purpose facility, instrumented to allow a wide range of astronomical observations.

C.2.1 NAOMI+INGRID

NAOMI (Nasmyth Adaptive Optics for Multi-purpose Instrumentation), mounted at the WHT Nasmyth focus, delivers near-diffraction-limited images in J, H and K bands (FWHM $\sim$ 0.15 arcsec), and significant correction at shorter wavelengths. There are currently two science instruments: the optical integral-field spectrograph OASIS, and the IR imager INGRID. OASIS offers a choice of 4 different spatial samplings, field of view up to 17 arcsec, and a choice of 15 spectroscopic modes. INGRID has a 40-arcsec field of view (0.04 arcsec pixel^{-1}), and is equipped with a variety of broad-band and narrow-band filters. A coronagraph, OSCA, can be placed in the light path to INGRID.

NAOMI can be used to observe any astronomical target having a suitable guide star ($V < 14$, within a few 10s arcsec). The guide star can be the science target itself, if it is sufficiently bright and compact. NAOMI has been used to study a wide variety of objects, including comets, binary asteroids, cicumstellar disks, nuclei of normal galaxies, AGN, QSO hosts and gravitational lenses. A Rayleigh laser guide star, GLAS, is under development, with on-sky commissioning expected summer 2006.

The AO correction achieved depends on the magnitude of the guide star, separation of the science target from the guide star, the natural seeing, and the wavelength of observation. In median seeing (0.7 arcsec in the optical), a guide star with $V = 11.5$ typically yields FWHM $\sim$ 0.2 arcsec, Strehl = 0.2, out to a radius $\sim$ 20 arcsec in H band (1.6 μm). The correction is usually marginal for V $>$ 14, or for radius of more than a few tens of arcsec from the guide star, or in natural seeing worse than 1.5 arcsec. In the optical, NAOMI typically improves the FWHM by a factor of two (e.g. from 0.6 to 0.3 arcsec).

C.2.2 WYFFOS+AF2

AF2/WYFFOS is the multi-object, wide-field, fibre spectrograph working at the Prime focus of the 4.2 m WHT. It contains 150 science fibres each of 1.6 arcsec diameter, and 10 fiducial bundles for acquisition and guiding. At the prime focus, the fibres are placed onto a field plate by the robot positioner Autofib at user-defined sky coordinates. Object light is transmitted along fibres 26 metres in length to the Wide Field Fibre Optical Spectrograph (WYFFOS), whose Long Camera was recently commissioned. The path from prime focus to the spectrograph consists of a prism, fibre button, 26 metres of fibre, finger, microlens and the facet block.

Fibres can be positioned over a field of 1 degree diameter; though it should be noted that there is some vignetting starting at a radius of 20 arcminutes, and that the image quality outside the 25 arcmin radius is quite poor, the PSF showing a large elongation that causes a lot of light to be lost for targets in this outer area.

Due to the size of the fibre buttons in AF2, fibres can not be placed closer than approximately 25 arcsec from each other. More important, the fibre rods running radially out from a positioned fibre block a much larger area. It should also be noted that, unlike 2dF, fibres cannot cross with AF2/WYFFOS.

With the new WYFFOS Long Camera, the detector used by AF2+WYFFOS is the 2-chip EEV mosaic, also used for the WHT Prime Focus Imaging Camera (PFIP). The mosaic is usually windowed and mosaiced so as to have 4300×4200 13.5 μm pixels. Binning is allowed , and two readout speeds are offered [slow and fast]. WYFFOS uses a series of gratings whose tilt angle is computer controlled and can be varied in order to select a specific wavelength region. In the normal (reflection) mode, WYFFOS uses the ISIS gratings. The echelle mode of WYFFOS is set by using a low-order echelle grating and a set of narrowband order sorting filters.

Sky subtraction with fibres is never as good as with a slit spectrograph, since one is limited by the fibre diameter. Achieving the best possible sky subtraction with fibres requires careful planning and observing strategies, and inevitably involves tradeoffs. Absolute flux calibration can never be done with fibres, since again one is limited by the fixed fibre diameter. The accuracy of the relative flux calibration using spectrophotometric standard stars observed in different fibres than the science objects [is being investigated].

For a correct preparation of [the] configuration fields, [it is needed to run] the program AF2_CONFIGURE.

C.2.3 LIRIS

LIRIS (Long-slit Intermediate Resolution Infrared Spectrograph) is a near-IR imager / spectrograph for use at the Cassegrain focus of the 4.2m WHT. It was built and developed at IAC and became a common user instrument at ING. LIRIS uses a 1k x 1k HAWAII detector for the 0.8 to 2.5 μm range. The pixel scale is 0.25 arcsec pixel^{-1}, yielding a field of view of 4.27×4.27 arcsec^2.

C.2.4 INGRID

Based around a 1024×1024 pixel^2 Hawaii-1 array, the Isaac Newton Group Red Imaging Device (INGRID) imager provides a field of view > 16 arcmin^2 (at the Cassegrain focus) whilst Nyquist sampling the median summer seeing disc. When used in conjunction with the Nasmyth Adaptive Optics for Multi-Purpose Instrumentation (NAOMI) system and a second set of collimation optics, a high spatial resolution mode (0.04 arcsec pixel^{-1}) is offered, providing near-diffraction-limited imaging. INGRID uses an all-refractive design and employs a cold stop to reduce thermal background emission, critical to the performance as it is used on the non-infrared optimized 4.2-m William Herschel Telescope (Packham et al. 2003).

C.3 3.58 m Canada France Hawai'i Telescope

The Canada-France-Hawaii Telescope (CFHT) is operated by the Canada-France-Hawaii Telescope Corporation, located in Waimea (also known as Kamuela), on the island of Hawaii (The Big Island). It is located on Mauna Kea at an altitude (declination axis) of 4204 m, at latitude +19 49 41.86 and longitude 155 28 18.00.

The CFH telescope is of the yoke type similar to the Palomar 5 meter telescope. It is a classical Prime Focus/Cassegrain combination. The primary mirror has a usable diameter of 3.58 m and has a parabolic figure. The primary and secondary mirrors are made of the low expansion coefficient glass-ceramic "Cer-Vit" and are thus practically immune to thermal distortion.

C.3.1 CFHT-IR

CFHT-IR is a general purpose 1024 x 1024 near-infrared camera for direct imaging at the f/8 Cassegrain focus (0.2 arcsec pixels, 3.5 arcmin FOV). It has also been in the past the infrared detector for multi-object spectroscopy with OSIS. CFHT-IR has been developed as a collaborative effort between Université de Montréal and CFHT. Commissioning took place in November 2000 and CFHT-IR has been regularly used for science since then.

C.4 3.58 m Telescopio Nazionale Galileo

The Telescopio Nazionale Galileo (TNG), with a primary mirror of 3.58m, is the national facility of the Italian astronomical community, and is located at Roque de Los Muchachos Observatory (ORM).

It was operated by the Centro Galileo Galilei (CGG) which was created in 1997 by the Consorzio Nazionale per l'Astronomia e l'Astrofisica (CNAA). In 2002 it became a part of the Italian National Institute of Astrophysics (INAF) which is ensuring its financial support.

TNG is equipped with 5 instruments which are permanently operating on its foci and offer a large variety of observing modes covering the optical and near infrared wavelength ranges and spanning from broad band imaging to high resolution spectroscopy.

C.4.1 NICS y AMICI+NICS

NICS (Near Infrared Camera Spectrometer) is the TNG infrared (0.9–2.5 μm) multimode instrument which is based on a HgCdTe Hawaii 1024 $\times$ 1024 array. Its observing capabilities include imaging (4.2 $\times$ 4.2 arcmin^2 f.o.v.), high-throughput low resolution spectroscopy

(R = 50–500), medium resolution spectoscopy (max-R = 2500), imaging polarimetry, spectropolarimetry and, when coupled to the adaptive optics module, nearly diffraction limited imaging.

C.4.2 AdOpt@TNG+NICS

The Adaptive Optics for the TNG provides high resolution images for the near IR camera thanks to tip-tilt (TT) and to high-orders (HO) correction. At the moment only the TT correction is offered for observations while the HO correction will be available in the next future. The AdOpt@TNG system is permanently mounted at the Nasmyth focus, it removes most of the aberrations due to atmospheric turbulence with a tiltable off-axis parabola and a 97 piezo-stack actuators deformable mirror. The wavefront sensing is performed with a Pyramid sensor, for TT and HO correction, or separetly with a 4-APDs sensor (TT) and one of two Shack-Hartmann with different pupil sampling (HO). AdOpt@TNG also feeds a real-time speckle camera as a further facility.

C.4.3 ARNICA

Instrumento no ofertado en la actualidad. Era una cámara DRO para imagen infrarroja, operaba en las longitudes de onda desde 0.9 a 2.6 μm y estaba equipada con un detector Nicmos3 256×256 píxel^2. Tenía una escala en píxel de 0.41 arcsec/píxel y un campo de unos 90×90 arcsec^2.

C.5 3.50 m Calar Alto Teleskop

The German-Spanish Astronomical Center at Calar Alto is located in the Sierra de Los Filabres (Andalucía, Southern Spain) north of Almería. It is operated jointly by the Max-Planck-Institut für Astronomie in Heidelberg/Germany and the Instituto de Astrofísica de Andalucía (IAA-CSIC) in Granada/Spain. It provides three telescopes with apertures of 1.23m, 2.2m and 3.5m.

C.5.1 Ω-Cass

OMEGA-CASS provides imaging and spectroscopic modes over 1.0–2.5 μm. Imaging polarimetry and spectropolarimetry modes are also available. Detector: Rockwell 1024 × 1024 HgCdTe HAWAII array. Focal Station: Mounted at Cassegrain focus with either f/10 or f/25 with ALFA.

C.5.2 ALFA+Ω-Cass

ALFA is the Adaptive optics with a Laser For Astronomy system for the Calar Alto 3.5-m telescope. ALFA is a system which dramatically improves the image resolution in the near-infrared regime. Diffraction limited images at 2.2 μm obtained with ALFA have a higher spatial resolution than those obtained with the Hubble Space Telescope. ALFA is based on a Shack-Hartmann sensor with a high-speed low-noise CCD camera, a 97-actuator deformable mirror, a tip-tilt sensor (CCD camera), a tip-tilt mirror and a continuous Ar-Ion laser pumped dye laser which generates the laser beacon in the sodium layer of the mesosphere.

ALFA has been successfully used with the near-infrared NICMOS 3 camera MAGIC, the imaging near-infrared Spectrometer 3D, and the optical CCD camera of CHARM. Since September 1997 the new near-infrared camera OMEGA-CASS with a 1024 × 1024 pixel (HAWAII) detector is the standard science instrument for ALFA.

C.5.3 Ω-2000

Omega2000 is a prime focus near infrared wide field camera for the 3.5m telescope at Calar Alto, Spain. Having a large field of view and an excellent optical quality, the instrument is particularly designed for survey observations. A cryogenic focal reducer delivers a 15.4 × 15.4 arcmin^2 field of view with a pixel scale of 0.45 arcsec pixel^{-1}. The 2k × 2k HAWAII-2 detector is sensitve from z to K band. A set of broad and narrow band filters covers a wide range of observing applications.

C.6 2.56 m Nordic Optical Telescope

The Nordic Optical Telescope (NOT) is a modern 2.6-m telescope operated at the Observatorio del Roque de los Muchachos on the island of La Palma in the Canaries, Spain. NOT is the main northern-hemisphere telescope facility for Nordic astronomy and offers excellent image quality, state-of-the-art detectors and instruments, and an informal, friendly working environment.

The high priority properties of the Nordic Optical Telescope are intended to define a low cost compact telescope in a small enclosure. With a moderately large aperture, highest weight has been given to design features providing optimum image quality. Further, the telescope has only a Cassegrain focus station, which should minimize instrumental polarization and favour image quality and speed. High interest in observations in the infrared wavelength range, also in day time, emphasizes the need for high pointing and tracking accuracy. The telescope has an altazimuth mounting, a fast, f/2.0, primary mirror of Ritchey-Chrétien type, made of Zerodur, with a diameter of 2.56 metres and an aspect ratio of 13.5. The effective f ratio of the telescope is 11.0 and the unvignetted field of view 25 arc minutes. The image quality specification is for the combined optical system 80 per cent geometrical energy within 0.3 arc seconds in passive mode. For the integrated optomechanical system, the corresponding specification is 80 per cent geometrical energy within 0.4 arc seconds for zenith distances smaller than 60 degrees.

C.6.1 ALFOSC

Andalucia Faint Object Spectrograph and Camera, ALFOSC, at the 2.56 m Nordic Optical Telescope and the rest of the xFOSC family of instruments produced by the Astronomical Observatory of Copenhagen (BFOSC instrument on the 1.52m Cassini Telescope at Loiano, DFOSC on the ESO/Danish 1.54m, and so on up to ten) share identical design and operation. ALFOSC is an Optical faint-object imager, spectrograph and polarimeter with an

E2V 2k × 2k detector, a plate sacale of 0.19 arcsec pixel^{-1} and a field of view of 6.4 × 6.4 arcmin^2.

C.7 2.54 m Isaac Newton Telescope

The Isaac Newton Telescope has a 2.54-metre primary mirror with a focal ratio of f/2.94. It uses a polar-disc/fork type of equatorial mount. Instruments can be mounted at the corrected f/3.29 prime or f/15 Cassegrain foci. Total weight of the telescope is about 90 tonnes. The role of the telescope is as a facility for wide-field imaging and intermediate to low dispersion spectroscopy.

C.7.1 WFC

The WFC (Wide Field Camera) is an optical mosaic camera for use at the prime focus of the 2.5m INT. The WFC consists of 4 thinned EEV 2kx4k CCDs. The CCDs have a pixel size of 13.5 μm corresponding to 0.333 arcsec pixel^{-1}. The edge to edge limit of the mosaic neglecting the ∼1 arcmin inter-chip spacing is 34.2 arcmins. The cycle time for the whole mosaic is around 42 seconds. Binning and windowing are not supported. Both broadband and Strömgren filtersets are available, as well as a range of narrowband filters.

C.8 2.4 m Hubble Space Telescope

The Hubble Space Telescope is a collaboration between ESA and NASA. It is a long-term, space-based observatory. The observations are carried out in visible, infrared and ultraviolet light. In many ways Hubble has revolutionised modern astronomy, by not only being an efficient tool for making new discoveries, but also by driving astronomical research in general.

At the heart of Hubble are a 2.4 m primary mirror and a collection of five science instruments that work across the entire optical spectrum – from infrared, through the visible, to ultraviolet light. There is one camera, three combined camera/spectrographs and a set of fine guidance sensors onboard Hubble. Hubble was designed to be serviced in space, allowing outdated instruments to be replaced. The telescope was placed into a low-Earth orbit by the Space Shuttle and uses modular components so that it can be recovered on subsequent Shuttle Servicing missions and faulty or outdated parts more easily replaced before being re-released into orbit.

Power for the computers and scientific instruments onboard is provided by two 2.6 × 7.1 m^2 solar panels. The power generated by the panels is also used to charge six nickel-hydrogen batteries that provide power to the spacecraft for about 25 minutes per orbit while Hubble flies through the Earth's shadow.

The telescope uses an elaborate system of attitude controls to improve its stability during observations. A system of reaction wheels manoeuvres the telescope into place and its position in space is monitored by gyroscopes. Fine Guidance Sensors (FGS) are used to lock onto guide stars to ensure the extremely high pointing accuracy needed to make very accurate observations.

C.8.1 NICMOS+Coronograph

The Near Infrared Camera and Multi-Object Spectrometer (NICMOS) provides imaging capabilities in broad, medium, and narrow band filters, broad-band imaging polarimetry, coronographic imaging, and slitless grism spectroscopy, in the wavelength range 0.8–2.5 μm. NICMOS has three adjacent but not contiguous cameras, designed to operate independently, each with a dedicated array at a different magnification scale.

NICMOS coronagraphic imaging capability is provided by a hole in the Camera 2 Field Divider Assembly which provides a 0.3 arcsec radius coronagraphic spot, with an effective useful radius of 0.4 arcsec at the detector image plane. A hole was bored through the Camera 2 FDA mirror. This hole, combined with a cold mask at the pupil (Lyot stop), provides coronagraphic imaging capability.

Internal cold baffling was designed to screen out residual thermal radiation from the edges of the HST primary and secondary mirrors and the secondary mirror support structures (pads, spider, and mounts). An image of a star is formed on the FDA mirror and is re-imaged on the detector. The image of a star in the hole will have diffraction spikes. The hole traps the light from the core of the PSF, reducing the diffracted energy outside of the hole by reducing the high frequency components in the PSF.

The light scattering downstream of the FDA is greatly reduced. The hole edge acts as a new diffraction aperture, and the residual roughness about the hole from the drilling process creates a complex image of the star in the hole. At a radius of 0.3 arcsec, in an idealized PSF, a natural break occurs in the encircled energy profile at 1.6 μm with 93% of the energy in the PSF enclosed. Beyond this radius, the encircled energy profile flattens out toward larger radii.

The light pattern about the coronagraphic hole is not symmetric due in part to the coronagraphic optics and to the Optical Telescope Assembly (OTA) input PSF. The spectral reflections from the roughness about the hole, and imaged in Camera 2, will vary depending upon the location of the target in the hole. There is one azimuth region where the residual light pattern, historically called glint, is brightest. The presence of glint brings the useful coronagraphic radius at the detector to $\sim$0.4 arcsec.

Detectors: NICMOS employs three low-noise, high QE, 256x256 pixel HgCdTe arrays. Active cooling by NCS will keep the detectors at a temperature between 75 K and 86 K.

C.9 1.52 m Telescopio Carlos Sánchez

El TCS [Telescopio Carlos Sánchez] fue diseñado y construido bajo la dirección del Prof. J. Ring (ICSTM), en colaboración con otros grupos del Reino Unido y el Instituto de Astrofísica de Canarias (IAC). Operativo desde 1972, pertenece al IAC desde 1982, año en que fue cedido por el SERC (Science and Engineering Research Council), propietario original del telescopio. Originariamente, fue diseãdo como un colector de flujo infrarrojo de bajo coste para Astronomía Infrarroja, siendo uno de los primeros telescopios de espejo delgado. Tenerife fue elegido para la instalación del telescopio después de un período de dos aos probando el mejor lugar entre Tenerife, La Palma y Sierra Nevada. El presupuesto total del telescopio fue de tan sólo 58 000 libras esterlinas (unos 66 000 Euros).

C.9.1 CAIN-II

Cámara de infrarrojo cercano, con un detector NICMOS-3 256 × 256 y 1.00 arcsec píxel^{-1} y capacidad de observación con filtros anchos (J, H, K –short, continuum–) y estrechos (Paβ, Brγ, Fe II λ16440, H_2(1–0) y H_2(2–1)).

C.10 1.0 m Jacobus Kaptein Telescope

The 1-m JKT telescope was previously offered to visiting astronomers with the 2k × 2k SITe2 CCD camera and the JAG autoguiding box. The camera provided an unvignetted field of view of 10 × 10 arcmin^2, with a pixel sampling of 0.33 arcsec. The 1-m Jacobus Kapteyn Telescope has been taken out of service as a common-user facility as of August 2003.

C.11 1.0 m European Space Agency Orbital Ground Station

La Estación Óptica Terrestre (OGS), instalada en el Observatorio del Teide, del Instituto de Astrofísica de Canarias (IAC), es parte de un proyecto más amplio de la Agencia Europea del Espacio (ESA) que consiste en desarrollar sistemas de comunicación óptica entre satélites. Su principal función es la realización de pruebas en órbita de la carga de pago óptica de ARTEMIS, un satélite avanzado para la comprobación y operación de nuevas técnicas y servicios en telecomunicaciones. Esta carga de pago es el denominado experimento“SILE”, que es una terminal óptica provista de un conjunto de emisores (láseres de semiconductor) y un receptor, que le permite intercambiar datos con otros satélites o con estaciones en tierra.

La OGS puede también utilizarse como instrumento para observaciones astronómicas de objetos extensos y para realizar cualquier tipo de búsquedas o mapas que necesiten cubrir grandes áreas del cielo, [como la observación de basura espacial].

C.11.1 ESACCD

La configuración de Ritchey-Cherétien de este telescopio está equipado con un espejo secundario esférico y un reductor de focal que ofrecen una focal de 4.5. El mosaico de detectores ESACCD está equipado con cuatro chips CCD42–40 de E2V Technologies (2048 × 2048 píxeles^2, 0.62 arcsec píxel^{-1}), lo que proporciona un campo de visión total de unos 0.5 deg^2 en una única exposición.

C.12 0.82 m Telescopio IAC-80

El IAC-80 es un telescopio diseñado y construido enteramente en el Instituto de Astrofísica de Canarias y el primero que se llevó a término en España de esta clase. Se empezó a construir en los años ochenta y fue instalado en 1991. Su montura es ecuatorial alemana, con una relación focal efectiva de f/11,3, una longitud focal efectiva de 9.02 m y un espejo primario de 82 cm de diámetro. La instrumentación se instala en el foco primario Cassegrain. El IAC-80 es un telescopio ideal para programas de larga duración o para colaboraciones con otros telescopios.

C.12.1 CCD

Instrumento de uso común, que consiste en una cámara óptica y un detector CCD, que hasta 2005 se trataba de una CCD Thomson 1024×1024 (0.4325 arcsec pixel^{-1}).

C.13 Miscelánea

Tabla C.1: Datos básicos de los instrumentos utilizados.

Telescopio	Instrumento	$\Delta\lambda$ (Å) o banda	Tamano de píxel (arcsec^{-1})	Tamano del detector ($\mathrm{píxel}^2$)	Campo de visión (arcmin^2)
Antu	ISAAC	J	0.148	1024×1024	2.53×2.53
WHT	INGRID[a]	H	0.250	1024×1024	4.27×4.27
	NAOMI + INGRID	JHK_s...	0.040	1024×1024	0.68×0.68
	LIRIS	HK_s	0.250	1024×1024	4.27×4.27
	AutoFib2 + WYFFOS	6400–6800	—	(2×) 4096×2048	$\sim \pi\ 30^2$
CFHT	CFHT-IR	HK	0.211	1024×1024	3.60×3.60
TNG	NICS, LF	JHK_c	0.249	1024×1024	4.25×4.25
	NICS, SF	JHK_c	0.129	1024×1024	2.20×2.20
	AdOpt@TNG + NICS	JHK_c	0.043	1024×1024	0.73×0.73
	ARNICA	JHK_c	0.359	256×256	1.53×1.53
3.5 m	Ω-Cass (vHR)	JHK	0.119	1024×1024	2.02×2.02
	Ω2K	JHK_s	0.452	2048×2048	15.4×15.4
	ALFA + Ω-Cass(HR)	JHK_s	0.077	1024×1024	1.31×1.31
	ALFA + Ω-Cass(vHR)	JHK_s	0.038	1024×1024	0.66×0.66
NOT	ALFOSC	RI	0.190	2048×2048	6.48×6.48
INT	WFC	VRI	0.333	(4×) 4096×2048	4×22.7×11.4
Hubble	NICMOS	$F110W\,F160W$ $F180M\,F207M$	0.076	256×256	0.32×0.32
TCS	CAIN-2	JHK_s	1.02	256×256	4.26×4.26
JKT	CCD-JAG	VRI...	0.332	2048×2048	11.3×11.3
OGS	ESACCD	open	0.62	(4×) 2048×2048	4×21×21
IAC-80	CCD	VRI...	0.4325	1024×1024	7.38×7.38

[a]: Ya no está diponible en el foco Cassegrain.

Tabla C.2: Páginas web de los instrumentos.

Telescopio(s)	Web
Antu	`http://www.eso.org/instruments/`
WHT, INT y JKT	`http://www.ing.iac.es/Astronomy/instruments`
CFHT	`http://www.cfht.hawaii.edu/Instruments/Detectors/IR/CFHT-IR/`
TNG	`http://www.tng.iac.es/instruments/`
3.5 m y 2.2 m	`http://w3.caha.es/CAHA/Instruments/index.html`
NOT	`http://www.not.iac.es/instruments/alfosc/`
Hubble	`http://www.stsci.edu/hst/nicmos`
TCS	`http://www.iac.es/telescopes/cain/cain.html`
OGS	`http://www.iac.es/telescopes/ogs/instr.html`
IAC-80	`http://www.iac.es/telescopes/iac80/iac80.htm`