



ESO Call for Proposals – P91

Proposal Deadline: 27 September 2012, 12:00 noon CEST

Call for Proposals

ESO Period 91

Proposal Deadline: 27 September 2012,
12:00 noon Central European Summer Time

Issued 30 August 2012

Preparation of the *ESO Call for Proposals* is the responsibility of the ESO Observing Programmes Office (OPO). For questions regarding preparation and submission of proposals to ESO telescopes, please contact the ESO Observing Programmes Office, opo@eso.org.

The ESO Call for Proposals document is a fully linked pdf file with bookmarks that can be viewed with [Adobe Acrobat Reader](#) 4.0 or higher. Internal document links appear in red and external links appear in blue. Links are clickable and will navigate the reader through the document (internal links) or will open a web browser (external links).

ESO Call for Proposals Editor: Gaitee A.J. Hussain

Approved: -----

Tim de Zeeuw
Director General

Contents

I	Phase 1 Instructions	1
1	ESO Proposals Invited	1
1.1	Important recent changes (since Periods 89 and 90)	2
1.2	Important reminders	5
1.3	Foreseen changes in the upcoming Periods	8
2	Getting Started	8
2.1	Distribution of telescope demand	9
2.1.1	Distribution of requested Right Ascension	9
2.1.2	Prediction of RA demand during Period 91	11
2.2	Exposure Time Calculators	11
2.3	Online Data Products: Public Surveys, Science Verification, Advanced Data Products	12
3	How to submit an ESO Phase 1 proposal	13
3.1	How to obtain the ESOFORM Proposal Package	13
3.2	The ESOFORM Proposal Form	13
3.2.1	Important recent changes to ESOFORM	13
3.2.2	Observing conditions: definitions	13
3.3	Proposal Submission	14
II	ESO Telescopes and their Instrumentation	16
4	The Observatory	16
4.1	La Silla	16
4.2	Paranal	17
4.2.1	The VLT Unit Telescopes (UTs)	18
4.2.2	UTs Performance	18
4.2.3	Laser Guide Star facility on UT4	18
4.2.4	The ATs (VLTI only)	19
4.2.5	VISTA	19
4.2.6	VST	19
4.2.7	Paranal meteorological conditions	20
4.3	Chajnantor	20
5	Scientific Instruments: La Silla	21
5.1	Sofi — Son of ISAAC, on the NTT	21
5.1.1	ESO Public Spectroscopic Surveys	22
5.2	EFOSC2 — ESO Faint Object Spectrograph and Camera 2, on the NTT	22
5.2.1	ESO Public Spectroscopic Surveys	23
5.3	HARPS — High Accuracy Radial velocity Planetary Search, on the 3.6-m	23
5.4	FEROS — Fibre-fed Extended Range Optical Spectrograph, on the 2.2-m	24
5.5	WFI — Wide Field Imager, on the 2.2-m	24
6	Scientific Instruments: Paranal	25
6.1	CRIFRES, Cryogenic high-resolution IR Échelle Spectrograph	25
6.1.1	Calibration	26
6.1.2	Sensitivity	26
6.2	FORS2, Focal Reducer/low dispersion Spectrograph 2	26
6.2.1	Multi-object Spectroscopy	27
6.2.2	High throughput filters	27
6.2.3	Volume-phased holographic gratings	27
6.2.4	Polarimetry	27
6.2.5	Imaging modes and performance summary	27
6.2.6	FORS Instrumental Mask Simulator (FIMS)	28

6.2.7	Accurate Astrometry or Pre-imaging Required	28
6.3	FLAMES, Fibre Large Array Multi-Element Spectrograph	29
6.3.1	Instrument Capabilities	29
6.3.2	Observational Requirements	30
6.3.3	Calibration	31
6.3.4	ESO Public Spectroscopic Surveys	31
6.4	UVES, Ultraviolet and Visual Échelle Spectrograph	31
6.5	XSHOOTER: multi band, medium resolution échelle spectrograph	32
6.6	VIMOS, VISible Multi-Object Spectrograph	33
6.6.1	VIMOS Observation Requirements: IMG	35
6.6.2	VIMOS observation requirements: MOS and pre-imaging	35
6.6.3	MOS Observations in Visitor Mode	35
6.6.4	VIMOS Observation Requirements in IFU Mode	36
6.7	VISIR, VLT Imager and Spectrometer for mid Infra Red	36
6.7.1	Imaging Modes	36
6.7.2	Spectroscopy Modes	36
6.7.3	Calibrations	37
6.7.4	Exposure Time Calculator	37
6.8	HAWK-I, High Acuity Wide-field K-band Imager	37
6.8.1	Filters and field of view	38
6.8.2	Observing modes	38
6.8.3	Brightness limit and persistence	38
6.8.4	Limiting magnitudes	38
6.9	NACO (NAOS+CONICA)	39
6.9.1	Adaptive optics correction with Natural and Laser Guide Stars	39
6.9.2	Offered modes	39
6.9.3	NACO Calibration plan and special calibrations	42
6.10	SINFONI, Spectrograph for INtegral Field Observations in the Near-Infrared	42
6.10.1	Instrument Performance	43
6.10.2	Brightness Limits	43
6.10.3	Sky Subtraction	44
6.10.4	Calibrations	44
6.10.5	Modes that are not offered	44
6.11	MIDI, MID-infrared Interferometric instrument	44
6.12	AMBER, Astronomical Multi-BEam combineR	46
6.12.1	Spectral Modes and Coverage	46
6.12.2	Integration times, DIT	46
6.12.3	Limiting magnitudes	46
6.12.4	Calibration strategies	47
6.12.5	Execution times	47
6.13	VIRCAM, VISTA InfraRed CAMera	47
6.13.1	Filters	48
6.13.2	Focal plane geometry	48
6.13.3	Instrument performance	49
6.13.4	VISTA Public Surveys and Open Time Proposals	49
6.13.5	VIRCAM calibration plan	49
6.14	OmegaCAM	49
7	Scientific Instruments: Chajnantor	50
7.1	SHFI	50
7.2	LABOCA, the Large APEX Bolometer Camera	51
7.3	SABOCA, the Submillimetre APEX Bolometer Camera	52
7.4	FLASH heterodyne receiver (MPIfR PI instrument)	52
7.5	CHAMP+: The Carbon Heterodyne Array of the MPIfR	53
7.6	Z-Spec: The broadband millimeter-wave spectrometer	53
8	Visitor Instruments	54
9	How to estimate overheads	54

10 Calibration Plans and Pipelines	58
10.1 Data Quality Control	58
10.2 Calibration Plans and Calibration of Science Observations	58
10.3 Data Reduction Pipelines	59
10.3.1 Data Organization: Gasgano and SAFT	59
10.3.2 Pipelines in the ESO Environment	59
10.4 Quality Control	60
10.5 The ESO Science Data Products Forum	60
III Proposal Types, Policies, and Procedures	61
11 Proposal Types	61
11.1 Normal Programmes	61
11.2 Large Programmes	62
11.3 Target of Opportunity	62
11.3.1 Rapid Response Mode (RRM)	63
11.4 Guaranteed Time Observations	64
11.5 Proposals for Calibration Programmes	65
11.6 Director’s Discretionary Time	65
11.7 Host State Proposals	66
11.8 Non-Member State Proposals	66
11.9 VLT-XMM proposals	66
12 Observing Modes	67
12.1 Visitor Mode	67
12.1.1 ToO programme execution during VM observations	68
12.2 Service Mode	68
12.2.1 Service Mode policies	68
13 Policy Summary	70
13.1 Who may submit, time allocation policies	70
13.2 Requesting use of non-standard observing configurations	70
13.3 Policy regarding offered/available observing configurations	71
13.4 Observing programme execution	71
13.4.1 Service Mode run execution	71
13.5 Phase 2 Service Mode policy: constraints and targets are binding	71
13.6 Pre-imaging runs	72
13.7 Data rights, archiving, data distribution	72
13.8 Publication of ESO telescope results	72
13.9 Press Releases	72
IV Appendix	73
A Acronyms	73

Part I

Phase 1 Instructions

1 ESO Proposals Invited

The **European Southern Observatory (ESO)** invites proposals for observations at ESO telescopes during Period 91 (**1 April 2013 – 30 September 2013**). The following instruments are offered in this period:

La Silla

[EFOSC2](#) (ESO Faint Object Spectrograph 2)
[FEROS](#) (Fibre-fed Extended Range Optical Spectrograph)
[HARPS](#) (High Accuracy Radial velocity Planetary Searcher)
[Sofi](#) (Son of ISAAC)
[WFI](#) (Wide Field Imager)

Paranal

[AMBER](#) (Near-infrared interferometric instrument)
[CRIRES](#) (Cryogenic high-resolution IR Échelle Spectrograph)
[FLAMES](#) (Fibre Large Array Multi Element Spectrograph)
[FORS2](#) (FOcal Reducer/low dispersion Spectrograph 2)
[HAWK-I](#) (High Acuity Wide field K-band Imager)
[MIDI](#) (MID-infrared Interferometric instrument)
[NAOS-CONICA](#) (High Resolution NIR Camera and Spectrograph)
[OmegaCAM](#) (Wide Field Imager for the VST at Paranal)
[SINFONI](#) (Spectrograph for INtegral Field Obs. in the NIR)
[UVES](#) (UV-Visual Échelle Spectrograph)
[VIMOS](#) (Visual Multi-Object Spectrograph)
[VIRCAM](#) (VISTA InfraRed CAMera)
[VISIR](#) (VLT Imager and Spectrometer for mid Infra Red)
[XSHOOTER](#) (UV-Visual-NIR medium resolution échelle spectrograph)

Chajnantor

[LABOCA](#) (Large Apex Bolometer CAMera)
[SABOCA](#) (Submillimetre APEX Bolometer CAMera)
[SHFI](#) (Swedish Heterodyne Facility Instrument)
[CHAMP+](#) (Carbon Heterodyne Array of the MPIfR)
[FLASH](#) (First Light APEX Submillimeter Heterodyne receiver)
[Z-Spec](#) (Broadband millimeter wave spectrometer)

The main characteristics of all instruments offered at La Silla, Paranal and Chajnantor in this call are available in the [ESO Instruments Summary Table](#).

The ESO proposal submission deadline is:

<p>27 September 2012, 12:00 noon Central European Summer Time.</p>

In each submitted proposal, one single person, the Principal Investigator (PI), must be identified as being principally responsible for this proposal. By submitting a proposal the PI agrees that

he/she and his/her collaborators will act according to ESO's policies and regulations (including the conditions specified in the present Call for Proposals) if observing time is granted.

Any question about policies or the practical aspects of proposal preparation should be addressed to the ESO Observing Programmes Office, opo@eso.org. Enquiries about technical requirements of the planned observations should be sent to the User Support Department (usd-help@eso.org) for Paranal and Chajnantor and to lasilla@eso.org for La Silla. Enquiries can also be made through the "Ask for help" link in the User Portal, which is listed under "Other Services".

Part I of this Call for Proposals provides information on how to complete and submit a Phase 1 proposal to ESO, Part II summarises the capabilities of ESO telescopes and available instrumentation, while Part III describes the policies and procedures regarding proposing for, carrying out, and publishing ESO observations.

1.1 Important recent changes (since Periods 89 and 90)

- **General changes**

- **ESO proposal submission deadline:** Please note that the ESO deadline will be strictly enforced. It is the PI's responsibility to resolve any verification or upload problems related to the instrument configuration, LaTeX file or associated figures well before the deadline. ESO cannot provide support beyond 11:00 CEST on the day of the deadline. The online receiver will switch off at 12:00 CEST. No submissions or amendments to submitted proposals can be accepted after this time.
- **PI Pack Service and Science Processing:** As of October 2011, the PI Pack service and science processing in Garching have been discontinued. PIs and their delegates can access their raw science data through the [ESO Science Archive Facility](#); this requires authentication through the ESO User Portal. A new archive service, the [CalSelector](#), has been deployed to automatically associate science files with the complete set of calibrations and ancillary files needed for processing and data exploitation.
- **Precipitable Water Vapour (PWV):** A radiometer was successfully commissioned at Paranal in October 2010, which continuously provides a measurement of the amount of the precipitable water vapour (PWV) above the observatory. Users of CRIRES and the APEX instruments in service mode should specify PWV as an observing constraint during their Phase 1 and Phase 2 preparation. Examples are shown in the ESIFORM package template files. It is expected that VISIR users will also be able to provide PWV constraints during their Phase 2 preparation.
- **Large Programmes:** As in previous periods no Large Programmes will be accepted for the 2.2-m, VISTA or VST telescopes. On APEX, Large Programmes will not be accepted for the PI instruments, CHAMP+, FLASH and Z-Spec. In Period 91 Large Programmes are also not offered for the following VLT instruments: CRIRES, HAWK-I, NACO, VIMOS. These restrictions are due to the following reasons:
 - * CRIRES may be affected by possible future changes;
 - * HAWK-I will be affected by the installation of the AOF in 2014;
 - * NACO will likely be removed in 2013 to allow the installation of the second generation VLT instrument, MUSE;
 - * VIMOS has a significant number of existing commitments.

Large Programmes for MIDI and/or the VLTI visitor instrument must not request periods beyond Period 91 due to the arrival of the second generation VLTI instruments.

- **ESO/GTC Large Programmes:** There will be no further calls for ESO/GTC Large Programmes. The titles and target lists of these approved programmes are listed on the following page:
[Targets for approved ESO/GTC Programmes.](#)
- **Guaranteed Time Observations (GTO)** will be carried out in Period 91 with **AMBER, MIDI, NACO, OmegaCAM, SINFONI, XSHOOTER and the VLTI Visitor Instrument**. For details about the planned observations, please see <http://www.eso.org/sci/observing/teles-alloc/gto/91.html>.

- **Paranal**

- News on Paranal telescopes and instruments can be found at <http://www.eso.org/sci/facilities/lpo/news/>.
- **VLT-XMM proposals:** Proposals are invited for scientific programmes requiring both VLT(I) and XMM-*Newton* observations (Section 11.9). These proposals may be submitted for the next XMM-*Newton* cycle, which extends over ESO Periods 91 and 92. However, proposers should take the limited availability of some of the VLT(I) instruments in Periods 91 and 92 into account; see below for details on instrument availability.
- **VLT Visitor instruments:** No Visitor Instrument focus is available on the VLT due to the installation of KMOS during Period 90.
- **UT1 – Antu:**
 - * **CRIRES:**
 - Starting from Period 90 a metrology system should ensure sub-pixel reproducibility of the wavelength scale. It is possible that the calibration frequency will be decreased due to the improved stability of the instrument.
 - Users of CRIRES should specify PWV as a constraint during their Phase 1 and Phase 2 preparation.
 - Large Programme proposals using CRIRES will not be accepted.
 - * **FORS2** A new functionality has been added to the fast acquisition templates (including the RRM ones) for long-slit spectroscopy, spectropolarimetry, and spectrophotometry. It is now possible to align the slit along any direction defined by two objects and offer several centering options.
 - * **KMOS** will be installed on the UT1 Nasmyth B platform in November 2012. Its commissioning runs will take place during Period 90 and 91.
- **UT2 – Kueyen:**
 - * **XSHOOTER:**
 - Telluric standard stars will be observed in nodding instead of staring mode in Period 91. The 400 kHz readout mode for the UVB/VIS arms will be used independently of the readout speed used for the science observations. Detector binning will be the same as for the science observations. This change gives a better correction of the telluric emission and absorption lines as well as bad pixels, especially in the NIR arm. The provided S/N will be between 50-150 by default. Users requiring higher S/N are encouraged to submit their own telluric star OBs, in which case the corresponding execution time must be included in the time requested at Phase 1.
There is no change for the IFU telluric standard stars observations.
 - The Atmospheric Dispersion Correction (ADC) systems on the UVB/VIS arms are not reliable. Since August 1st, 2012, the ADCs have been fixed in their non-deviation position. Data obtained in this configuration can be reduced by the pipeline without significant degradation. Updates on the status of the ADCs can be found on the [XSHOOTER news](#) webpage. The latest version of the user manual provides plots for helping users prepare observations without ADCs.
Users are recommended to carry out observations at the parallactic angle whenever possible or to take special care on the airmass constraint to avoid flux loss.
- **UT3 – Melipal:**
 - * **ISAAC and SPHERE:** SPHERE installation is expected to take place during Period 90. Commissioning runs will therefore occur during Period 90 and 91. As a consequence ISAAC is no longer offered.
 - * **VIMOS:**
 - A final adjustment to the focussing hardware will be done at the end of 2012. This should improve the focussing range for the IFU mode.
 - The new VPH HR_blue grisms have been characterized and have been in normal operations since Period 89. See details in the [VIMOS web pages](#).

- A new Pre-Image-Less MOS (PILMOS) mode will be offered starting from Period 91 in which a user provided catalogue with accurate target coordinates ($\leq \pm 0.2''$) can be used to design masks. In the PILMOS mode the slit orientation must be N-S (rotator angle 90 deg).
 - Starting from Period 91 the requirement for a fixed orientation of the MOS slit along the N-S direction is relaxed. Provided the requested target field declination is within $-45^\circ < \delta < -5^\circ$, slits can also be oriented E-W (rotator angle 0 deg) and the observations executed within ± 3 h from meridian. In this case a pre-imaging run must be requested.
 - VIMOS is not available for Large Programmes in Period 91 due to existing commitments.
 - * **VISIR** has undergone a major upgrade during Period 89, which includes a recommissioning and a performance validation phase. The aim of this upgrade is to optimize its performance and enhance its scientific output. Details are available in the [VISIR web pages](#). VISIR users will be able to set constraints on the PWV during their Phase 2 preparation.
- **UT4 – Yepun:**
- * **VLT Laser Guide Star**
 - PARSEC, the current laser used by the Laser Guide Star Facility (LGSF), will be decommissioned during Period 90. It will be replaced by a prototype of the laser used by the coming Adaptive Optics Facility. Its commissioning is expected to be completed by the end of February 2013.
 - The current Laser Guide Star (LGS) can be used for up to 15% of the UT4 science time due to the required sky conditions and intrinsic operational constraints. Provided that the new laser is successfully commissioned, both the delivered power and the number of nights during which the LGSF can be used every month will be significantly increased. However, taking into account the existing commitments for this facility (in particular, for ongoing Large Programmes and for Guaranteed Time Observations), it is expected that only a limited amount of time can be allocated in Period 91 to new programmes requiring the use of the LGS. Accordingly, proposers are encouraged to carry out a critical assessment of the need for LGS for execution of their observations, and to carefully study the possibility of using a Natural Guide Star (NGS).
 - * **HAWK-I:**
 - Large Programmes using HAWK-I will not be accepted in Period 91.
 - A user provided narrow-band filter centered at $0.984\mu\text{m}$ was installed in August 2012 in the slot used by the NB1190 narrow-band filter, which is therefore not offered in P91.
 - * **NACO:**
 - NACO will likely be removed from the UT4 Nasmyth B platform in the second half of 2013 to allow for the installation of MUSE.
 - Large Programmes using NACO will not be accepted.
 - Since Period 90, pupil tracking mode with focal-plane coronagraphic masks has been offered also in SM.

All programmes requiring special calibrations must request VM. Chopping is unavailable: users should use the L' or NB_4.05 filters without chopping instead.
- **VLTI:**
- * **VLTI-ATs:** New baselines have been offered since Period 90 (see the [VLTI baseline page](#)).
 - * **AMBER:** AMBER can be operated in self-coherencing mode which significantly improves the quality of data when FINITO cannot be used for fringe tracking. This possibility is only offered in visitor mode. Check the [AMBER Users' Manual](#) for details.

- * **MIDI:**

- Starting from Period 91 MIDI will be offered with the FSU-A as an external fringe-tracker. FSU-A works in K-band and will be used for on-axis tracking. MIDI with the ATs will be able to attain a sensitivity similar to what is now possible with UTs, after data reduction using the fringe tracker data. This configuration is only offered in visitor mode.
- Given the arrival of the second generation VLTI instruments, ESO cannot guarantee the availability of MIDI after Period 91.
- Large Programmes requiring the use of MIDI beyond Period 91 will not be accepted.

- * **VLTI Visitor instruments:**

- Given the arrival of the second generation VLTI instruments, ESO cannot guarantee the availability of a VLTI visitor focus beyond Period 91.
- Large Programmes requiring the use of a VLTI visitor instrument beyond Period 91 will not be accepted.

- **La Silla**

- **3.6m:** A significant fraction (35%) of the available science time is committed to ongoing Large Programmes in Period 90 (see Fig. 4). Large programmes on the 3.6m telescope can span up to seven periods, until Period 97.
- **NTT:** A large fraction (50%) of the available science time on the NTT telescope is committed to ongoing programmes (see Fig. 4). A significant fraction of the available dark and grey conditions are committed to these programmes. Large programmes on the NTT can span up to seven periods, until Period 97.
- **2.2-m:** Time is available on this telescope for proposals requesting observations to be executed during the slots assigned to ESO (see Section 4.1 for details). Proposers should take these time slots into account for the selection of the targets of their proposals. Proposals for Large Programmes will not be accepted for this telescope.

- **Chajnantor**

- **SHFI:** The APEX-T2 receiver is offered conditional to a successful repair mission planned in January 2013.
- **CHAMP+:** This MPIfR PI instrument is offered again to the ESO community in collaboration with MPIfR.
- **FLASH:** This MPIfR PI instrument has been upgraded to allow simultaneous observations in the 272-377 GHz and 385-495 GHz bands. Limited observing time is offered to the ESO community in collaboration with MPIfR.
- **Z-Spec:** This PI instrument is offered again at APEX, in collaboration with the instrument team.

1.2 Important reminders

- **General information**

- **ESO User Portal:** Proposals are submitted via a web upload procedure using the online tool, Web Application for Submitting Proposals (WASP). This requires users to first log in to the ESO User Portal at: <http://www.eso.org/UserPortal>. See Section 3 for more details.
- **Duration of one night:** Proposers are reminded that for all ESO telescopes, the duration of one night is 8 hours in even periods and 10 hours in odd periods.
- **Duplications:** Large amounts of data are available via the ESO data archive (Section 2.3; see <http://archive.eso.org>). Proposers are strongly advised to check if observations equivalent to the proposed ones have been performed already. Proposers must check that their planned observations are not duplicating Guaranteed Time proposals for Period 91: [GTO for Period 91](#) or ongoing [Public Survey observations](#).

- **Public Spectroscopic Surveys (PSS):** Two Public Spectroscopic Surveys are being carried out on the NTT telescope (EFOSC2 & SOFI), and on the UT2 telescope using FLAMES (GIRAFFE & UVES). Further details are available on the ESO [Public Surveys Projects](#) webpage.
- **Overheads:** All proposals (Service Mode or Visitor Mode) must include all overheads when computing the total observing time request (see Section 9).
- **Access to Service and Visitor Mode data:** Principal Investigators of Service and Visitor Mode programmes and their data delegates have access to their proprietary raw data as soon as the data have been ingested in the ESO Archive. The data access is provided through the ESO User Portal. The [CalSelector](#) archive service packs together the science files with any ancillary files that are needed to process the data, (*e.g.* acquisition images, calibrations, etc.).
Please note that the 1-year proprietary period starts as soon as the data are made electronically available to the PI.
- **Non-standard observing configurations:** The use of non-standard instrumental modes, configurations or filters requires the prior approval by the ESO User Support Department. A detailed justification should be sent to usd-help@eso.org at least two weeks before the proposal submission deadline (also see 13.2).
- **Backup programme:** Although Phase 1 proposals requesting Visitor Mode do not need to include backup targets and/or a backup programme, the observer should prepare one in case of unfavourable weather conditions (see Section 4.2.7). The original science goals must be adhered to in this backup scenario. Approval of a backup programme must be sought at least one month in advance through the change request form as described in Section 12.1.
- The information provided in the proposal is binding: all observing runs must be executed as described in the proposal. Deviations from the proposal (either by observing different targets or by using different instrument modes or different constraints) may be allowed only under exceptional circumstances and after approval by ESO (see Section 13.5).

- **Paranal**

- **Observing mode on the VLT:** Departures from the observing mode requested by the proposers may be implemented by ESO so as to achieve a balanced distribution between Service Mode and Visitor Mode.
As a rule, proposers should request Service Mode only for observations that demonstrably benefit from the short-term scheduling flexibility allowed by this mode. Proposers may identify runs that lend themselves for observations in either Service or Visitor Mode by specifying one of the modes using the alternative run feature in Box 3 of the ESOFORM Phase 1 proposal form. Please note that if a certain instrument mode is offered exclusively in either Service Mode or Visitor Mode then this overrides these scheduling considerations.
- **Service Mode OBs:** Service Mode Observation Blocks (OBs) including all overheads can last up to a maximum of 1 hour. Longer OBs have to be specifically requested and justified at Phase 2 via a waiver request, which is evaluated by the Observatory.
- **Pre-imaging for VLT instruments and modes:** A **separate pre-imaging run** must be specified in the proposal (to be executed in Service Mode). Failure to do so will result in the deduction of the time necessary for the pre-imaging from the allocation to the main part of the project (see Section 13.6).
- **Monitoring in Service Mode:** Monitoring a target in Service Mode is carried out on a best effort basis only, *i.e.* a monitoring sequence may be interrupted by long periods of unsuitable weather conditions or Visitor Mode scheduling. All the time needed to observe one target should be included in one single run; these can be split into the single epoch observations using a time-linked series in version 3 of the [Phase 2 Preparation Tool](#) (P2PP) (see Section 12.2.1 for more information).
- **Rapid Response Mode (RRM):** FORS2, UVES, XSHOOTER, SINFONI and HAWK-I continue to be offered in this mode in Period 91. RRM observations that correspond to events with exceptional characteristics may be activated during either Service Mode

or Visitor Mode runs, over which they have observational priority (except if the service or visitor mode runs involve strictly time-critical observations). For details on the RRM policies, see Section 11.3.1.

- **VISTA:** Due to ongoing Public Surveys only a limited amount of open time is available on VISTA; these observations are carried out in Service Mode only and for restricted Right Ascension ranges. Open time proposals should clearly justify the scientific goals and why they are not achievable through the scheduled public survey observations. Only those proposals that have complementary constraints and coordinate ranges with respect to public survey observations may be scheduled, as the highest priority is given to advance public surveys on VISTA.

• La Silla

- **Support during observing runs and transportation schedule:** A streamlined operation is in effect in La Silla. Technical and logistical support will be delivered as usual by ESO staff, but no specific support astronomer is assigned. Please note that the transportation schedule to and from La Silla may have an impact on the arrival and departure days of the observers at the site. See Section 4.1 for additional details and check the [online instructions for visiting astronomers](#).
- Large Programmes on NTT and the 3.6-m telescopes may have a duration of up to **four years**.
- There is a **minimum length of 3 nights for runs** to be executed with La Silla telescopes. Proposals including La Silla runs with a duration of less than 3 nights will be rejected at submission time by the automatic proposal reception system, with three exceptions:
 1. There is no minimum duration for runs to be carried out with Visitor Instruments (see Section 8). However, in order to minimise the overheads associated with their installation and removal, such instruments are normally scheduled in blocks including several contiguous runs; the length of these combined blocks is typically greater than 3 nights.
 2. On the NTT, users can apply for combined runs using both EFOSC2 and SOFI. The total duration of each of these runs must be at least three nights. The combined runs must be requested using the instrument name “SOFOSC”. Details are also available in Section 3.2.1 and the ESOFORM User Manual.
 3. There is no minimum duration for runs of Calibration Programmes.

Note that the minimum duration requirement for La Silla is applicable to each individual run of a proposal involving a La Silla instrument (see Section 11 for more information about the definition of “programme” and “run”). More generally, proposals for **long** runs are strongly encouraged on the La Silla telescopes. Splitting of runs in half nights (*e.g.* a 3-night run spread over 6 half nights) should be avoided as much as possible; such runs may be impossible to schedule.

- **Pre-imaging:** Pre-imaging frames for EFOSC2 will have to be obtained at the beginning of the spectroscopic run. The resulting lower efficiency should be taken into account in the computation of the execution time required for such runs.

• Chajnantor

- **APEX:** This telescope is offered in Service Mode only. APEX users should ensure that their proposal meets the following requirements:
 - * specify if time is requested from other APEX partners in the macro, `\SpecialRemarks` (Box 5);
 - * specify the requested PWV using the macro, `\Target` (Box 11), for their project to allow a better distinction between observations requesting a range of atmospheric transparencies;
 - * either indicate an appropriate off-source position or request time to find such a position if they wish to observe extended line-emitting regions;

- * merge all observations for any APEX instrument into a single run (note that this also applies for the different receivers of SHFI). For Large Programmes this restriction should be understood as a single run per instrument and per period. Separate runs should be specified for observations in different periods.

1.3 Foreseen changes in the upcoming Periods

- **Monitoring Programmes:** The OPC Working Group and the ESO Users Committee have recommended the introduction of Monitoring Programme proposals. These proposals will enable users to request a limited amount of time to monitor targets over more than one period. The Observing Programmes Office is actively working towards implementing this new programme type by Period 93.
- **2nd Generation VLT Instruments:**
 - The commissioning of KMOS and SPHERE will continue in Period 92.
 - The installation of MUSE on UT4 is planned for Period 92.
- **UT4 – Yepun:**
 - UT4 will not be available during part of Period 92 to allow for the installation of the Deformable Secondary Mirror and re-commissioning of the telescope.
 - The **Laser Guide Star Facility** (LGSF) is expected to be decommissioned at the end of Period 92 to allow for the installation of the Deformable Secondary Mirror (part of the AOF).
 - **NACO** is expected to be removed from the UT4 Nasmyth B platform during 2013 to allow the installation of the second generation instrument, MUSE.
- **VIMOS:** A call for public spectroscopic surveys may be issued for VIMOS in the near future, if the instrument upgrade is successful and the observation backlog has been resolved.
- **MIDI:** Given the arrival of the second generation VLTI instruments, ESO cannot guarantee the availability of MIDI beyond Period 91. Proposals for Large Programme using this instrument beyond Period 91 will therefore not be accepted.
- **ZEUS-2:** Pending successful commissioning, the redshift (z) and Early Universe Spectrometer (ZEUS-2) may be offered as a PI instrument during Period 92. ZEUS-2 is a broadband spectrograph covering 7 telluric windows covering 200 to 850 μm . For details, see [Ferkinhoff et al. 2010](#).

2 Getting Started

Observing proposals must contain a scientific case, a summary of the proposed observing programme, a list of desired instrument modes and configurations, a target list, and a precise definition of required observing conditions (seeing, atmospheric transparency, lunar illumination, etc.). In addition, a calculation of the number of hours/nights of observing time needed to accomplish the scientific goals must be carried out and summarized in the proposal. It is therefore important that proposers consult technical documentation or instrument experts regarding the instrument capabilities and sensitivities. Section 9 provides more details on how calculate overheads with different instrument setups using the [Phase 2 Preparation Tool](#) (P2PP).

The following sections give some additional information and references that should be useful to proposers.

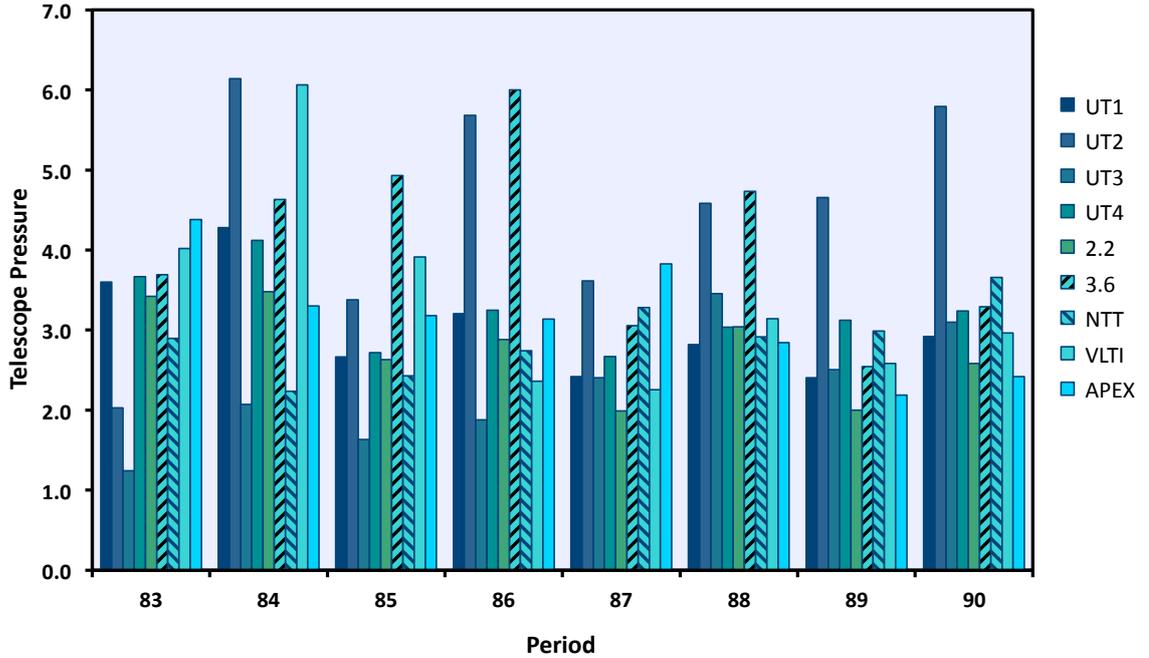


Figure 1: Ratio of the amount of requested time to the amount of allocated time (pressure) on each telescope over the past 4 years. Large, ToO, Calibration and GTO programmes are not included.

2.1 Distribution of telescope demand

On all telescopes, the amount of requested time exceeds the amount of time that can be allocated by a significant factor. Figure 1 shows the pressure on each telescope over the past 4 years. The pressure is defined as the ratio of the amount of time requested on the considered telescope for execution of Normal Programmes to the amount of time allocated to these programmes on this telescope. Large, ToO, Calibration and GTO Programmes, whose selection and scheduling are handled differently (in particular, with pre-defined upper limits of time allocation), are not included in the figure.

2.1.1 Distribution of requested Right Ascension

The distribution of the demand in Right Ascension (RA) is far from uniform throughout the year (see Figs. 2 and 3), and the probability that an OPC recommended run is successfully scheduled and completed depends on this pressure. Proposers are encouraged to read the article by Alves & Lombardi (2004, [The ESO Messenger, 118, 15](#)) on the sky distribution of VLT observations. In order to optimize the chances of time allocation, and to maximize the scientific return of the Observatory, proposers should be aware that choosing targets at certain RA's can have an enormous impact on the probability of successful scheduling and completion of their runs.

In this section we present statistics for previous periods. For the telescope scheduler, favourite sky regions mean higher demand for observation time at certain times of the year, *i.e.* increased competition for specific Right Ascensions. For example, there are only a limited number of photometric dark nights in April (a particularly popular demand), on average 10 times less than the total requested by observers. A direct consequence of this is that only the top OPC ranked runs make it to the telescopes during April dark time. On the other hand, the opposite is true for August (see Fig. 2). The time request for targets in this month (RA \sim 20h 30) is relatively low, allowing a significantly higher fraction of runs applying for time at this RA to be scheduled (if considered useful by the OPC).

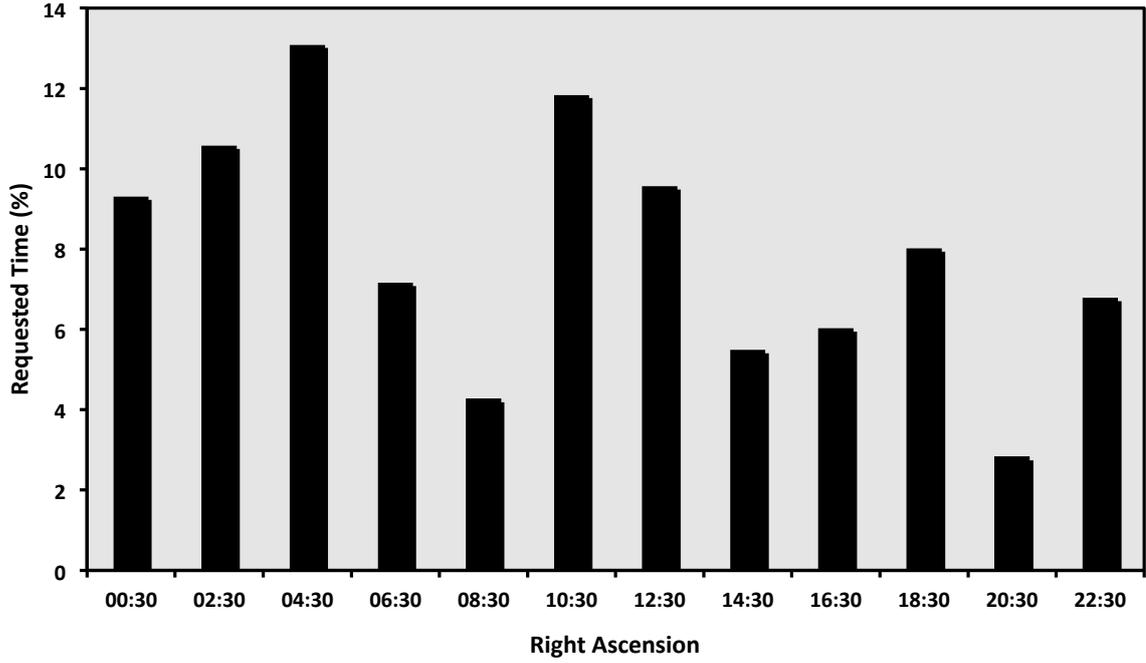


Figure 2: Distribution of requested time (percentage of total) on Paranal and La Silla as a function of Right Ascension (RA). The histogram bins have a width of 2h and are labelled with the RA of their centre. The data for all requested targets over the last 10 periods are shown here.

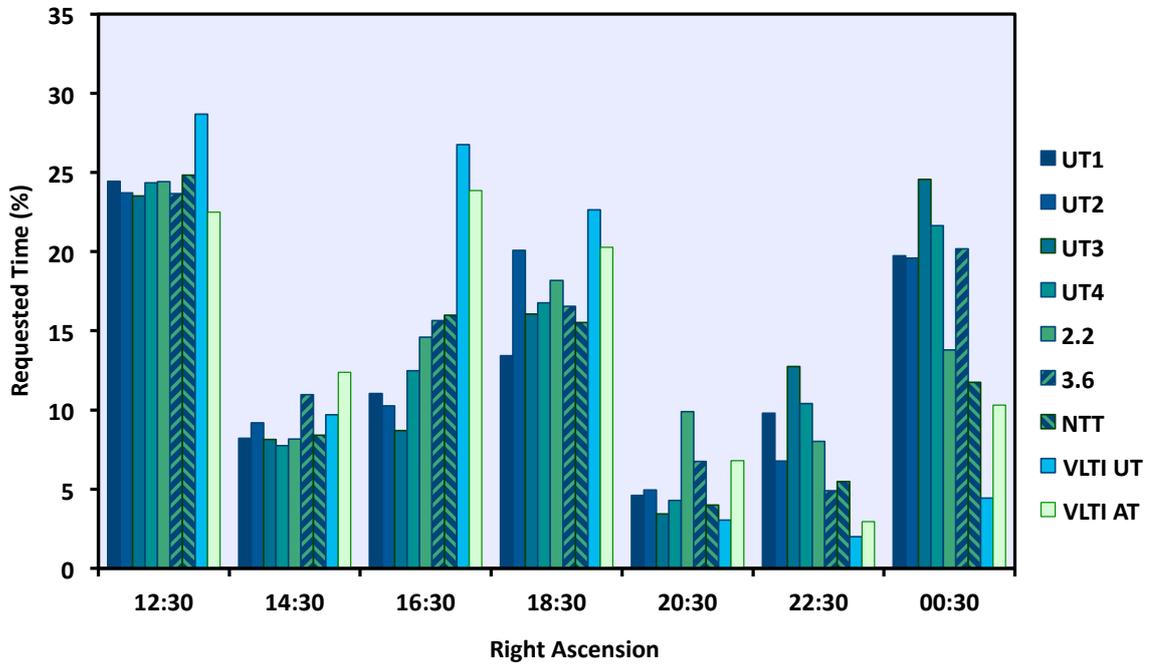


Figure 3: Prediction of RA distribution of demand during Period 91 based on requests for the last five odd periods. For each telescope this is calculated as $(100 \times \text{Time}_{\text{RA}}) / (\text{Total Time})$. The RA bins are defined as for Fig. 2. The first and last bins also include the requested targets with RAs earlier and later than the nominal RA range corresponding to the period.

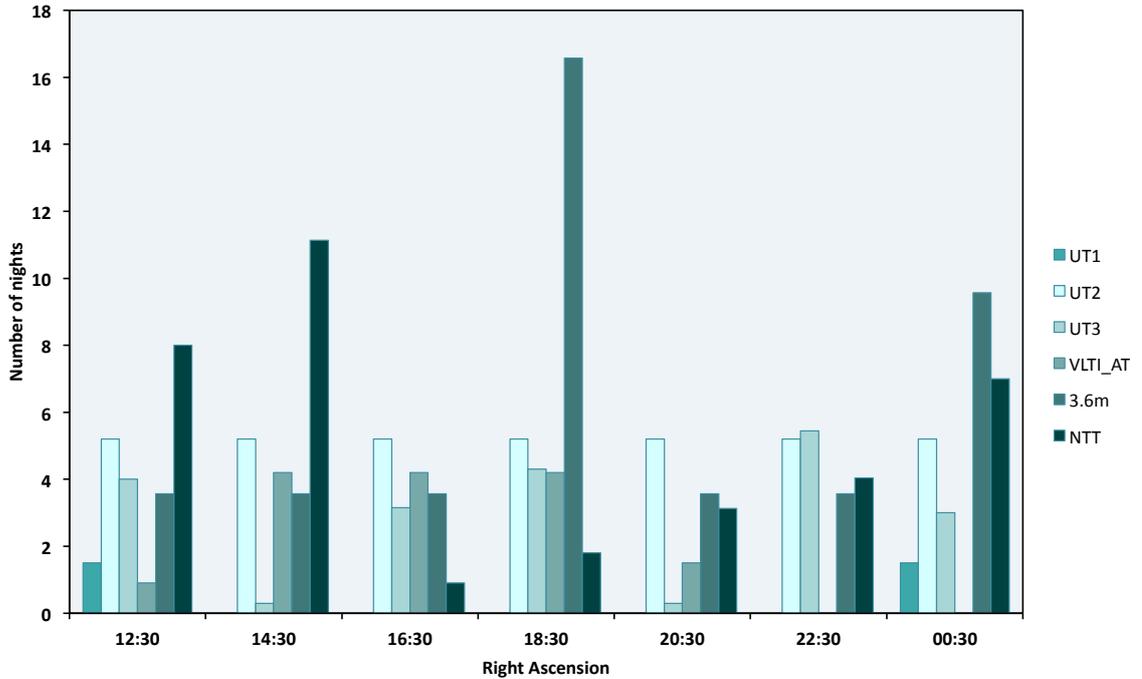


Figure 4: The expected time allocation (in nights) for ongoing Large Programmes in Period 91. This includes time allocated to Public Spectroscopic Surveys on UT2 and NTT and runs carried over from previous periods on UT3. Telescopes with no ongoing Large Programmes do not appear in this figure. The RA bins are defined as for Figs. 2 and 3.

2.1.2 Prediction of RA demand during Period 91

Based on the time request for all the ESO telescopes in the last 10 periods, one can make an educated guess of the RA demand expected during Period 91. Note that during Period 91 the distribution of instruments on the UTs will be: UT1 (CRIRES + FORS2), UT2 (FLAMES + UVES + XSHOOTER), UT3 (VIMOS + VISIR), UT4 (HAWK-I + NACO + SINFONI). Proposers should take advantage of this information in choosing targets to maximize the probability of the allocation of time and successful execution of their runs (see Fig. 3). Proposers should also consider the time expected to be allocated in Period 91 to ongoing Large Programmes started in earlier periods (Fig. 4).

2.2 Exposure Time Calculators

Exposure Time Calculators (ETCs) for ESO instruments are accessible directly on the ESO Web. For La Silla and Paranal instrumentation:

<http://www.eso.org/observing/etc>

For APEX instrumentation please go to:

<http://www.apex-telescope.org/instruments>.

Links to useful proposal preparation software tools (*e.g.* the Object Observability Calculator, Airmass Calculator, Digitized Sky Survey) can be found at:

<http://www.eso.org/sci/observing/tools.html>.

Information on standard stars and sky characteristics, as well as additional tools, are available at

<http://www.eso.org/sci/facilities/paranal/sciops/tools.html>.

The parameters used by the ETCs are based on data collected during instrument commissioning and operations. The ETC parameters are frequently updated and changes will be reflected by the running “version number”. To help the observatory staff assess the technical feasibility of observations,

proposers are requested to specify the version number of the ETC they used in the section “9. Justification of requested observing time and observing conditions” of their proposals.

Please check the ESO web pages for the ETC version to be used in Period 91. Please note that while the sky background values used in the ETCs generally reflect actual conditions on Paranal, they do not account for local effects such as the zodiacal light.

Proposers of VLTI observations should check the feasibility of their proposed observations with the visibility calculator “viscalc”, available from the ETC page. At Phase 2, users are also encouraged to select a suitable calibrator star for their planned observations using the CalVin tool, available also from <http://www.eso.org/observing/etc>.

Service Mode proposers are reminded (see Section 13.5) that the requested observing conditions are binding in Phase 2, hence proposers should check the exact definition of seeing in the ETC used to estimate the observing time necessary to complete the programme. They should also ensure that the observing conditions specified in the proposal are consistent with these requirements. The same is true for the requested sky transparency and lunar phase. Non-photometric sky transparency can be simulated by adding 0.1/0.2 mag to the object magnitude for CLEAR/THIN-CIRRUS conditions respectively.

2.3 Online Data Products: Public Surveys, Science Verification, Advanced Data Products

Public data from observations made with Paranal and La Silla telescopes are available from the [ESO Science Archive Facility](#).

Most of the data obtained in Period 88 and before are available in the archive. Users are reminded of these opportunities in order to stimulate the scientific use of the Archive and to better prepare for Period 91 projects.

Several sets of reduced data products are available online at

<http://archive.eso.org/cms/eso-data/data-packages>.

These include [ESO Advanced Data Products \(ADP\)](#) delivered to ESO by the community, from the GOODS campaign, the ESO Imaging Survey (EIS), as well as Science Verification/Demonstration and Commissioning data of VLT and VLTI instruments.

Raw data from the Public Surveys are immediately available and advanced data products (*e.g.* stacked images, catalogues) will become available in incremental releases. Details of the first release of advanced data products from the VISTA Public Surveys are available from:

[the Phase 3 Data Releases page](#). These data products can be downloaded directly using the [VISTA Query Form](#).

The PIs of Large Programmes that have been accepted since Period 75 are required to deliver final data products to ESO by the time their results are published (see Section 11.2). The procedure to be followed is described at <http://archive.eso.org/cms/eso-data/data-submission>. An overview of ADP releases from Large Programmes is given at :

<http://archive.eso.org/cms/eso-data/advanced-data-products-releases>.

The PIs of Calibration Programmes are required to deliver the resulting data products to ESO within 1 year of the completion of the corresponding observations.

Voluntary submission of Advanced Data Products by PIs of Normal Programmes is also encouraged. The procedure for submission to ESO of ADP from all types of programmes is the same as for Large Programmes.

3 How to submit an ESO Phase 1 proposal

3.1 How to obtain the ESOFORM Proposal Package

The ESOFORM Proposal Package for this period may be obtained by logging into the ESO User Portal. Please follow the instructions at:

<http://www.eso.org/sci/observing/phase1/esoform.html>

3.2 The ESOFORM Proposal Form

The “ESOFORM User Manual” describes in detail how to fill the L^AT_EX template, and the information required to prepare a valid proposal. Please be aware that the ESOFORM package is regularly updated. Proposers should only use the Period 91 package to prepare their proposals.

The telescope schedules are prepared using scheduling software that relies on accurate constraints (see Alves 2005, [The ESO Messenger, 119, 20](#)). Hence, scheduling constraints that are not indicated or are inaccurately specified in BOX 13 of ESOFORM are unlikely to be taken into account by the scheduler. **Retrofitting scheduling constraints after the release of the schedule is not possible.**

3.2.1 Important recent changes to ESOFORM

- **ESO proposal submission deadline:** Please note that the ESO deadline will be strictly enforced: users should plan accordingly. It is the PI’s responsibility to resolve any verification or upload problems related to the instrument configuration, LaTeX file or associated figures. The online receiver will switch off at 12:00 CEST on the day of the deadline; ESO cannot provide support with problem proposal submissions after 11:00 CEST. Requests for submissions or amendments after the deadline will not be considered.
- **Precipitable water vapour (PWV) constraints:** PWV constraints must be specified for CRIRES and all APEX instruments in the “Additional Notes” column of the Target macro. Please see the ESOFORM User Manual for more details.
- **PhD thesis information:** The `\Thesis` macro (Box 7) has been removed from the Normal proposal template form in order to allow more space for “Special remarks”.
- **VLT-XMM Proposals:** Proposers must indicate in the ESOFORM if they are applying for VLT-XMM time under the ESA-ESO agreement (see Section 11.9). VLT-XMM proposals may include observing runs to be executed in Period 91 and/or in P92.

If the proposal is a re-submission of an old proposal then **OPC comments must be addressed** in this new submission.

3.2.2 Observing conditions: definitions

Observing conditions are defined as follows:

- Sky Transparency
 - Photometric: No visible clouds, transparency variations under 2%, only assessable by the analysis of photometric standard stars.
 - Clear: Less than 10% of the sky (above 30 degrees elevation) covered in clouds, transparency variations under 10%.
 - Thin cirrus: transparency variations above 10%.

- Seeing
 - Seeing is defined as the image FWHM in arcsec, *at the wavelength of observation*, on the focal plane of the instrument’s detector, *i.e.* after the image has been taken through the entire telescope and instrument. *It is not the instantaneous seeing outside the dome.*
 - For MACAO instruments (CRIRES, SINFONI, MIDI, AMBER), FLAMES and the IFU mode of VIMOS, where the seeing cannot be measured on the detector, the reference seeing is the one measured at the wavefront sensor of the active optics of the telescope.

Users should note that:

- Phase 1 seeing constraint for observations using AO instruments should not exceed 1.4".
 - VLTI runs with MIDI that do not make use of MACAO should be carried out in Visitor Mode only. Note that such observations require excellent seeing conditions (0.6"). AMBER observations without MACAO are not possible.
 - The seeing specified in the NAOS Preparation Software and therefore in the proposal is the DIMM (Differential Image Motion Monitor) seeing corrected to zenith.
 - Use of the LGS in seeing-enhancer mode requires a seeing better than 0.8".
- Moon
 - Moon illumination (fraction of lunar illumination, FLI) is defined as the fraction of the lunar disk that is illuminated at local (Chile) civil midnight, where 1.0 is fully illuminated. Dark time (specified by ‘d’ in Box 3 of the ESOFORM package) corresponds to moon illumination < 0.4, grey time (‘g’) to moon illumination between 0.4 and 0.7, and bright time (specified by ‘n’) to moon illumination ≥ 0.7. However, in Service Mode, ‘bright time’ (specified by ‘n’ at Phase 1) is understood as meaning that no restriction is set regarding the lunar illumination (FLI=1.0 at Phase 2). By definition, moon illumination equals 0 when the moon is below the local horizon.
 - Lunar illumination does not have a noticeable influence on the feasibility of infrared observations.
 - However, the UT active optics can be adversely affected by the proximity of the bright moon to the science target, requiring a moon minimum angular distance of 30°. For MACAO UT instruments (CRIRES and SINFONI) as the wavefront sensor is sensitive in the R-band, restricted moon constraints should be considered for AO observations with a natural guide star (NGS) fainter than R = 15 mag. In these cases, reducing the FLI constraint to approximately 0.7 and increasing the distance to the Moon to approximately 50 degrees is generally adequate. Similar restrictions affect observations using the Auxiliary Telescopes (see Section 4.2.4). Observers must therefore pay attention to the moon distance to the target while planning their observations.
 - Precipitable Water Vapour (PWV):
 - Acceptable upper limits for the PWV must be specified for all proposals requiring CRIRES and any APEX instrument. The seeing and moon illumination conditions are not relevant for any APEX observations.
 - The PWV constraints must be specified using the `\Target` macro in the proposal form as shown in the ESOFORM User Manual.

Please note that observing conditions requested at Phase 1 **cannot be altered at Phase 2** (see Section 13.5 for more details).

3.3 Proposal Submission

Proposals must be submitted in their final version by the submission deadline:

**27 September 2012,
12:00 noon Central European Summer Time.**

This is done via a web upload procedure that can only be accessed by logging into the ESO User Portal at:

<http://www.eso.org/UserPortal>.

In order to efficiently verify and submit your proposal, please note that:

- **Postscript figures are not accepted.** The proposals are compiled using the pdfL^AT_EX package which accepts only PDF (up to version 1.4) and JPEG file formats. Please note that there is a size limit of 1MB for each figure to be uploaded.
- Always compile your proposal locally with pdfL^AT_EX. Some of the checks are made at the L^AT_EX level and checking your proposal in this way will save you time. If there are errors please read the output carefully in order to identify the problem.
- Further checks are made by the web software (“the receiver”), which uploads your proposal and checks that it complies with ESO’s requirements. The receiver allows you to verify your proposal without actually submitting it. **You should take advantage of this feature to check that your proposal is technically correct well before the Phase 1 deadline.** This can be done by verifying a “skeleton” version of the proposal early; this version should contain all the technical details but not necessarily the full scientific description. This will ease the final submission process considerably.
- Plan ahead! Over past periods, congestion of the proposal submission system has repeatedly occurred in the last few hours before the proposal deadline, leading to delays in response time that occasionally exceeded 1 hour. Try to submit proposals at least one day before the deadline and avoid “last-minute stress”.

At the end of the submission procedure an acknowledgment page is displayed. Please print it as a receipt. The PI of the proposal and the submitter will also receive later a confirmation ticket via email, but **the acknowledgment page is the official receipt**. If you are not sure if your proposal has successfully entered the system, **do not** re-submit it but rather contact ESO at esoform@eso.org.

Neither proposals nor corrections to proposals that are submitted after the deadline will be considered.

Part II

ESO Telescopes and their Instrumentation

4 The Observatory

4.1 La Silla

The La Silla Observatory site is located at $70^{\circ}43'$ longitude West, $29^{\circ}15'$ latitude South, at an altitude of 2375 m. The telescopes operated by ESO are the New Technology Telescope (NTT), the ESO 3.6-m telescope, and the ESO/MPG 2.2-m telescope. Proposals for observations with these three telescopes are restricted to Visitor Mode runs. Each run must have a minimum duration of 3 nights. This restriction does not apply to runs using Visitor Instruments.

For NTT programmes involving observations with both EFOSC2 and SOFI to be performed on contiguous nights, the minimum duration requirement applies to the combined length of the corresponding EFOSC2 and SOFI run. The naming convention SOFOSC is used to refer to this combination – see Section 3.2.1 and the ESOFORM manual for more details on how to specify such combined runs in the ESOFORM proposal form.

Requests for the usage of the 3.6-m and NTT telescope for the execution of Large Programmes are encouraged. The maximum duration for Large Programmes with these telescopes is four years. However users should be aware of the limited possibilities of approval of new Large Programmes on the 3.6-m and NTT telescopes in Periods 90, as described in Section 1.1. Large Programme proposals are not accepted for the 2.2-m telescope.

Technical and logistical support is delivered as usual by ESO staff on the mountain. However, no support astronomer is available on-site in general.

General information can be found on the [La Silla web page](#).

Proposers are also strongly advised to read the [La Silla Science Operations page](#), which provides updated information on support and procedures. The median seeing in La Silla is $0.8''$ and the sky is photometric 70% of the time. For more information take a look at [La Silla weather statistics](#).

- **NTT telescope:** The New Technology Telescope is an Alt-Az, 3.5-m Ritchey-Chrétien telescope housed in a rotating building designed for optimized air flow. Its thin meniscus Zerodur mirror is controlled in order to maintain the optical figure so that the total aberrations are smaller than $0.15''$ (80% encircled energy) — the NTT was the first telescope to be equipped with “Active Optics”. The instruments SofI and EFOSC2 are permanently mounted at the two Nasmyth foci.

The telescope has a pointing accuracy of $2''$ RMS; objects can be observed at zenithal distances from 2° to 75° . Currently, moving targets can be observed only with differential tracking (not guiding). Moving objects can be followed for up to 15 min with a tracking error smaller than $0.5''$.

- **3.6-m telescope:** The 3.6-m telescope was commissioned in 1977, and completely upgraded in 1999. Only the f/8 Cassegrain focus is available. In August 2004, the f/8 top end was completely replaced by a new unit permitting the secondary mirror to be actively controlled. This system provides an improved image quality. The pointing error is better than $5''$ RMS. The only available facility instrument, HARPS, is permanently mounted at the Cassegrain focus. The pointing limitations are described in the [3.6-m pages](#). Full differential guiding is possible to observe moving targets.
- **2.2-m Telescope:** The 2.2-m telescope is a Ritchey-Chrétien design mounted in an equatorial fork mount. It is on loan to ESO from the Max Planck Gesellschaft (MPG) and has been in operation since 1984.

A new loan agreement between ESO and the MPG is being finalized at the time of writing. The new agreement will likely extend until September 30, 2015. According to this, the MPG

is allocated 9 months of observations per year, while ESO is allocated 3 months per year. The detailed distribution will be announced on the [Late Breaking News](#) page once available.

One night per month during the ESO time slots will be reserved for scheduled technical activities and execution of the calibration plan. In Period 91, ESO will be allocating approximately 69 nights for the execution of scientific programmes on the 2.2-m telescope; the corresponding runs will be scheduled exclusively during the ESO time slots. Of these 69 nights, up to 18 will be allocated to Chilean proposals (Sects. 11.7 & 13.1).

During ESO time, Visitor Mode runs may be interrupted for target-of-opportunity observations of Gamma-Ray Bursts and X-ray transient afterglows with the GROND instrument of the Max Planck Institute for Extraterrestrial Physics; up to 15% of the time allocation of each run may be given away to such observations. A compensation buffer of 9 nights is included in the 69 nights of science time. ESO users whose programmes are affected by GROND interruptions are therefore not entitled to any additional compensation.

FEROS and WFI are permanently mounted on the telescope.

4.2 Paranal

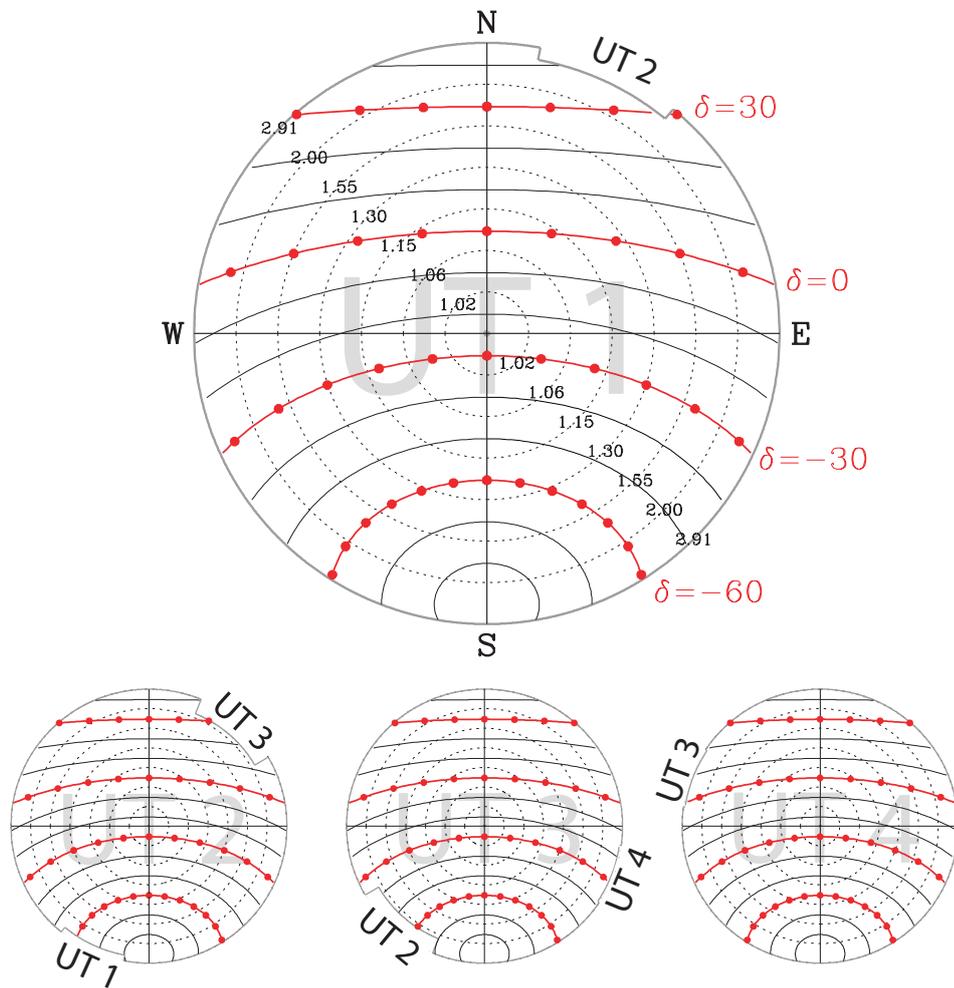


Figure 5: Sky accessibility and vignetting by neighbouring domes for the four UTs. This shows the sky accessibility for the 4 UTs. The outermost circle marks the telescope safety limit (zenith distance 70°). Concentric circles denote zenith distance intervals of 10° and are marked with the corresponding air mass value. An object will move along a curve of constant declination; with solid dots marking the movement in 1-hr intervals. The maximum visibility period of an object can be read directly (counting intervals between dots). The smaller plots (for UT2, UT3 and UT4) are identical, only the vignetting due to neighbouring domes vary.

4.2.1 The VLT Unit Telescopes (UTs)

The VLT consists of four Unit Telescopes (UTs). From a user's perspective the four UTs can be regarded as identical. The Paranal Observatory site is located at $70^{\circ}25'$ longitude West, $24^{\circ}40'$ latitude South, at an altitude of 2635m.

Each UT primary mirror is a single Zerodur blank of diameter 8.20 m, the secondary has a diameter of 1.12m. The UTs have four foci: two Nasmyth, one Cassegrain, and one Coudé. They are Alt–Az mounted and cannot observe at zenith distances less than 4° or larger than 70° . The VLT Interferometer only operates at zenith distances less than 60° .

4.2.2 UTs Performance

- **Pointing and tracking:** The UTs have a pointing accuracy of $3''$ RMS. The expected tracking accuracy under nominal wind load is $0''.1$ rms over 30 minutes when field stabilization is active. The UTs also have the capability of tracking targets with additional velocities (*e.g.* Solar System targets) under full active optics control. Proposers who need this capability should specify the additional velocities in RA and Dec for their targets.
- **Active optics guiding:** For all observations a guide star is used for acquisition, active optics, and field stabilization. The typical guide star magnitude ranges from $R=11$ to $R=14$ (in optimal conditions). Observations for which no suitable guide star exists cannot be carried out.
- **Adaptive optics guiding (VLTI only):** The Coudé foci of the UTs are equipped with MACAO (Multi Application Curvature Adaptive Optics) units, which can be used with natural guide stars with $1 < V < 17$, seeing $< 1.5''$, $\tau_0 > 2.0$ ms and airmass < 1.7 . The distance of the natural guide star from the science target must be less than $57.5''$. For observations using the fringe tracker FINITO, $V < 15$, distance $< 13''$.

4.2.3 Laser Guide Star facility on UT4

Important note: The **Laser Guide Star Facility** is expected to be decommissioned at the end of Period 92 to allow for the installation of the Deformable Secondary Mirror on UT4, part of the Adaptive Optics Facility. All programmes requiring its use should therefore be completed by then.

UT4 is equipped with a sodium laser that can create an artificial point source to be used with NACO and SINFONI. A tip-tilt star (TTS) is always necessary to correct for tip and tilt. However, SINFONI and NACO can be used with the Laser Guide Star but without a TTS, using the seeing-enhancer mode. Please note that the TTS can be both fainter and further away from the science target than natural guide stars (NGS), thus giving users access to a larger fraction of the sky.

Observations using the Laser Guide Star (LGS) require more stringent observing conditions than observations using natural guide stars. The transparency needs to be clear (CLR) or photometric, the airmass constraints are tighter and the atmosphere must be quiet (*i.e.* good seeing and a weak or absent jet stream). Further note that for operational reasons, the LGSF is currently scheduled in blocks of typically one week per month. The LGSF is offered with NACO and SINFONI in both Service Mode and Visitor Mode.

The peak K-band Strehl ratio achieved with the LGS in ideal conditions is around 20%. This depends on many factors, so users are encouraged to use the SINFONI and NACO ETCs.

The point at which one should consider using the laser instead of a natural guide star can be estimated with the ETCs. Although the details depend on the distance of the NGS/TTS from the science target, the airmass and the vertical profile of the turbulence, the magnitude at which one should consider using the laser is around $R=13.5$ to 14.

A programme that requires observations using both an NGS and the LGS should separate these into two distinct runs in the proposal form.

During Period 90, PARSEC, the current laser used by the Laser Guide Star Facility will likely be

decommissioned. It will be replaced by a prototype of the laser used by the coming Adaptive Optics Facility. Its commissioning is expected to be completed by end of February 2013. Provided that the new laser is successfully commissioned, both the delivered power and the number of nights during which the LGSF can be used every month will be significantly increased.

4.2.4 The ATs (VLTI only)

The VLT Interferometer is complemented by an array of relocatable 1.8-m Auxiliary Telescopes (ATs). For Period 91 the ATs are offered with MIDI and AMBER. The baselines offered for this period are specified at [the VLTI baseline page](#).

The ATs are equipped with STRAP units, which provide tip-tilt correction for targets with $-1.7 < V < 13.5$. The distance of the guide star from the science target must be less than $57.5''$. For observations using the fringe tracker FINITO, $V < 13.5$, distance $< 15''$.

While observations on AMBER and MIDI are not affected by the moon there are some restrictions due to the guiding of the telescopes.

- If the FLI is $> 90\%$, guiding is not possible for stars fainter than 9th magnitude if the distance to the moon is lower than 20 degrees.
- If the FLI is $> 90\%$, guiding is impossible for any star if the distance to the moon is lower than 10 degrees.

Visiting astronomers are requested to check for potential limitations during the preparation of their observations.

4.2.5 VISTA

The Visible and Infrared Survey Telescope for Astronomy (VISTA) is a 4-m class wide field survey telescope for the southern hemisphere. VISTA is located at ESO's Cerro Paranal Observatory in Chile on its own peak about 1.5 km from the four UTs. The telescope has an altitude-azimuth mount, and quasi-Ritchey-Chrétien optics with a fast $f/1$ primary mirror giving an $f/3.25$ focus to the instrument at Cassegrain. Shape and position of the mirrors are actively controlled by high- and low-order curvature wave front sensors (WFS) located inside the instrument focal plane. The low order WFSs are used simultaneously with the scientific observations.

VISTA is equipped with VIRCAM, which is described in Section 6.13.

4.2.6 VST

The VLT Survey Telescope (VST) is a 2.6-m wide field survey telescope for the southern hemisphere. It is located on the VLT platform on ESO's Cerro Paranal Observatory and is equipped with just one focal plane instrument, OmegaCAM, which is described in Section 6.14.

The telescope has an altitude-azimuth mount with a $f/5.5$ modified Ritchey-Chrétien optical layout. It contains an actively controlled meniscus primary mirror, a hexapod driven secondary mirror and an image analysis system. It also contains two interchangeable correctors: one is a high-throughput two-lens corrector which provides high throughput from the u to the z band, the other contains an Atmospheric Dispersion Corrector (ADC) for observations at lower elevations. The throughput of the ADC is very low in the u band. However, since it has not been demonstrated to improve significantly the image quality in regular operations, the ADC is not offered. The entrance window of the OmegaCAM cryostat is the final optical element.

The VST operates from the u to the z band, preserving, within a corrected field of view of 1 by 1 degree, the excellent seeing conditions achievable at the Cerro Paranal site.

4.2.7 Paranal meteorological conditions

Extensive statistical information on meteorological conditions on Paranal (seeing, wind, water vapour etc.) can be found on the [Paranal Web page](#). Information about general climate and seismic statistics can also be found there. Wind statistics at Paranal show that the wind speed is between 12 and 15 m/s $\sim 10\%$ of the time. These conditions allow observations to be made only with the telescope pointing down wind. Predominant winds blow from the North.

4.3 Chajnantor

The Llano de Chajnantor site is located on $67^{\circ} 45'$ longitude West, $23^{\circ} 00'$ latitude South, at 5104 m altitude in the Chilean Atacama desert. It is a very dry site — inhospitable to humans — but an excellent site for sub-mm astronomy (see Fig. 6). Water vapour absorbs and attenuates sub-mm radiation and thus a dry site is required for high-frequency radio astronomy. The Atacama Large Millimeter/submillimeter Array (ALMA) — a collaboration between Europe, North America and East Asia — has started early science observations at the Llano de Chajnantor.

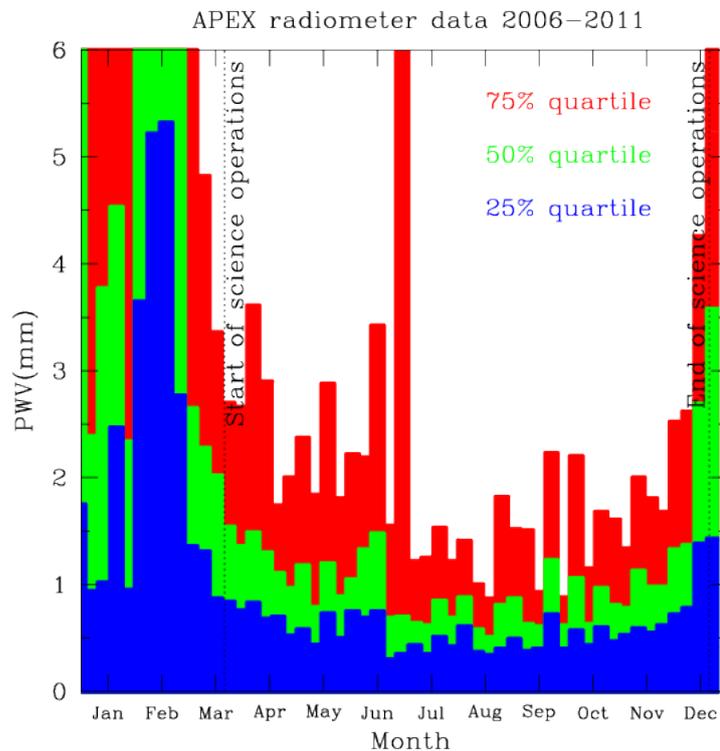


Figure 6: Annual variation of the precipitable water vapour (PWV) content at Chajnantor, based on 6 years of observations with the APEX radiometer. Blue, green and red histograms indicate the 25, 50 and 75 percentile levels, respectively. The yearly APEX science operations period from 20 March till 20 December is scheduled to avoid the worst conditions during Altiplanic winter. During Period 91, ESO observations are expected to be scheduled in May and July.

ESO has been offering time on the Atacama Pathfinder Experiment (APEX, a 12 meter radio telescope) at the Chajnantor site since Period 77. APEX is an international collaboration involving the Max-Planck-Institut für Radioastronomie (MPIfR), Onsala Space Observatory (OSO), and ESO. ESO receives 24.7% of the observing time on APEX. The distribution of the observing time between the APEX partners can be found on the [APEX web pages](#). During Period 91, the ESO time is expected to be scheduled in May and July. Time-critical observations should only be requested during these ESO periods.

Applications are invited for the $870 \mu\text{m}$ LABOCA bolometer array, the $350 \mu\text{m}$ SABOCA bolometer array and the Swedish Heterodyne Facility Instrument (SHFI). In collaboration with MPIfR, applications are also invited for the PI instrument, CHAMP+ (7+7 pixel dual channel heterodyne array

covering 620 to 720 GHz and 780 to 900 GHz), and FLASH (280-370 GHz + 385-495 GHz sideband separating receiver). Finally, in collaboration with its instrument team, applications are invited for the PI instrument, Z-Spec (190-308 GHz single-beam diffraction-grating spectrograph).

Observations will be done for up to 24 hours per day, but users should be aware that afternoon conditions are often significantly worse than those during the night or morning. Observations using high frequency instruments (SHFI/APEX-T2, SHFI/APEX-3, SABOCA) should avoid the afternoon time. All observations will be done in Service Mode by the local APEX staff. In exceptional cases (*e.g.* moving targets), remote observing from Bonn (in collaboration with MPIfR) can be considered. **No Visitor Mode proposals will be accepted for APEX.**

The [wobbling secondary](#) is offered for all SHFI proposals. The wobbler can also be used with LABOCA and SABOCA to obtain sensitive observations of isolated point sources with accurately known positions. The APEX wobbler can chop in azimuth up to $300''$ with rates up to 2 Hz.

Because the LABOCA detectors need to be cooled to 0.3K using liquid Helium, the LABOCA observations will be scheduled in continuous blocks of observing time. This will make time-critical observations during ESO time difficult to schedule. The re-filling of the Helium will generally be done during the afternoon, with a shorter re-cycling procedure 11 to 12 hours later. The exact schedule will be optimised according to the RA pressure on the targets.

SABOCA also has a liquid Helium cooled cryostat, but as the hold time is 48 hours, the observations can be scheduled with more flexibility. During Period 91, SABOCA is expected to be available only in July 2013.

All APEX proposals must clearly indicate the requested PWV for their observations in Box 12 of the proposal form. Figure 6 gives the statistical distribution of PWV throughout the year. The need for good PWV conditions needs to be justified in the proposal.

For each proposal, all observations with the same APEX instrument should be merged into a single run. This also accounts for the different receivers of SHFI, which should be grouped into a single run. Different run ID's should only be used for different instruments (or in Large Programme proposals, for observations to take place in different periods). This restriction is needed to increase the observing efficiency at APEX.

Proposals requesting time from different APEX partners are required to mention the amount of time requested from MPIfR, Sweden or Chile in Box 5.

More on APEX, including SHFI, LABOCA and SABOCA observing time calculators, can be found at www.apex-telescope.org.

5 Scientific Instruments: La Silla

5.1 SofI — Son of ISAAC, on the NTT

SofI is the infrared spectro-imager mounted on the NTT. It is equipped with a Hawaii HgCdTe 1024×1024 detector.

SofI is only offered for Visitor Mode observations and has the following observing modes:

- Imaging with plate-scales of 0.273 and $0.288''/\text{pixel}$ using broad and narrow-band filters in the wavelength range $0.9\text{--}2.5\ \mu\text{m}$. SofI provides a field of view of $4.92'$. A Js filter similar to that on ISAAC is available in addition to the standard J filter.
- High time-resolution imaging in Burst and FastPhot mode with integration times of the order of a few tens of milliseconds via hardware windowing of the detector array. Information about technical details, restrictions, and overheads is available in the [SofI user manual](#).
- Low resolution ($R = 600$), $0.93\text{--}2.54\ \mu\text{m}$ spectroscopy with fixed width slits of 0.6 , 1 and $2''$.
- Medium resolution ($R = 1500$) spectroscopy with the same fixed width slits.
- $0.9\text{--}2.5$ micron imaging polarimetry.

Up-to-date information and documentation on the instrument are available at:
<http://www.eso.org/sci/facilities/lasilla/instruments/sofi/>.

5.1.1 ESO Public Spectroscopic Surveys

In Period 91, there will be up to 30 NTT nights assigned to the ESO Public Spectroscopic Survey entitled “PESSTO: Public ESO Spectroscopic Survey for Transient Objects”. Further details are available on the ESO [Public Surveys Projects](#) webpage. Proposers should check that their science goals do not duplicate those of this public survey.

5.2 EFOSC2 — ESO Faint Object Spectrograph and Camera 2, on the NTT

EFOSC2 is a very versatile instrument for low resolution spectroscopy and imaging in the visible and near UV. It also has polarimetric capabilities (both for imaging and spectroscopy) and a coronagraphic mode, and it can efficiently perform multi-object spectroscopy.

EFOSC2 is only offered in Visitor Mode.

The instrument is equipped with a Loral/Lesser UV-flooded 2k×2k CCD. The pixel size is 0.12", with a corresponding field of view of 4.1'.

The gratings cover the 318–1100 nm wavelength range, with resolutions ranging from 100 to 1000. Slits from 0.5" to 15" are available.

Two volume-phase holographic gratings (VPHG) have been offered for medium resolution spectroscopy. The blue grism (#19) covers the wavelength range from 440 nm to 510 nm, at a resolution of up to ~4000 with a 0.5" slit, while the red grism (#20) covers the range 605 nm to 715 nm at a resolution of up to 4000 with the 0.5" slit. The gratings introduce a lateral shift of the beam, so the effective field of view is 3.1' and 2.7' for the blue and red VPHGs respectively.

The wavelength range of the blue VPHG grism (#19) can be extended to cover a more useful range (*e.g.* reaching the Mg triplet at 520 nm or the G-band at 430 nm) by using slits offset to the red or blue. With 15 mm offsets (corresponding to wavelength offsets of 21.8 nm) the wavelength range coverage for the grism #19 is 418 nm to 532 nm (the full range is achievable by combining red offset and blue offset spectra). There are offset slits available with 15mm offsets to the blue and red with the full range of slit widths available for the normal slits. These slits can of course be used with any other grism, with the wavelength offset depending on the grism dispersion. See the [web pages](#) for more details.

Up to 5 MOS plates can be loaded simultaneously. They are punched off-line, so additional plates can be punched at any time. To create multi-slit masks, pre-imaging must be acquired using EFOSC2 with the same position angle as for the actual observations, typically one day before the spectroscopic observations. Therefore, NTT observers in La Silla may be asked to give up to 20 minutes of their allocated time for pre-imaging observations for subsequent EFOSC2 MOS runs.

The coronagraphic mode features focal stops of 8.0" and 4.0" and a Lyot pupil mask.

The polarimetric measurements are performed using either a half-wave plate or a quarter-wave plate. These super-achromatic plates can be moved into the optical path and rotated to measure the polarisation at different angles without rotating the whole instrument. The plates are housed in separate units, and only one unit (plate) per night can be used. Note that since EFOSC2 is mounted at the NTT Nasmyth B focus there is strong instrumental polarisation that varies with telescope pointing. Users should allow time for additional observations of unpolarised standard stars to correct for this.

For imaging, a set of standard Bessell and Gunn filters as well as several narrow-band filters are available. See [the EFOSC2 filter page](#) for details.

Up-to-date information and documentation on the instrument are available on the [EFOSC2 web page](#).

5.2.1 ESO Public Spectroscopic Surveys

In Period 91, there will be up to 45 NTT nights assigned to the ESO Public Spectroscopic Survey entitled “PESSTO: Public ESO Spectroscopic Survey for Transient Objects”. Further details are available on the ESO [Public Surveys Projects](#) webpage. Proposers should check that their science goals do not duplicate those of this public survey.

5.3 HARPS — High Accuracy Radial velocity Planetary Search, on the 3.6-m

HARPS is the ESO facility for the measurement of very precise radial velocities. It is fed by two fibres from the Cassegrain focus of the 3.6-m telescope.

HARPS is offered in Visitor Mode only during Period 91.

The instrument is built to obtain very precise radial velocities (~ 1 m/s). To achieve this goal, HARPS is designed as an échelle spectrograph fed by a pair of fibres and is contained in a vacuum vessel to avoid spectral drift due to temperature and air pressure variations. One of the two fibres collects the starlight, while the second is used to either record a Th-Ar reference spectrum or the background sky simultaneously. The two HARPS fibres (object + sky or Th-Ar) have a sky aperture of $1''$, resulting in a resolving power of 115,000. Both fibres are equipped with an image scrambler to provide a uniform spectrograph pupil illumination, independent of pointing decentring. The spectral coverage distributed over the échelle orders 89-161 is 378 nm–691 nm. As the detector consists of a mosaic of 2 CCDs (altogether $4k \times 4k$, $15 \mu\text{m}$ pixels), one spectral order ($N=115$, from 530 to 533nm) is lost in the gap between the two chips.

HARPS reaches a S/N of 110 per pixel at 550 nm for a $M_V = 6$ G2V star in 1 minute ($1''$ seeing, airmass = 1.2). When using the Simultaneous Thorium Reference Method, which is the mode for achieving the highest radial velocity accuracy, this signal-to-noise ratio should be sufficient to achieve a photon-noise-dominated radial velocity accuracy of about 0.90 m/s. Taking into account errors introduced by the guiding, focus, and instrumental uncertainties, a global radial velocity accuracy of about 1 m/s RMS is achieved. This is obtained for spectral types later than G and for non-rotating stars ($v \sin i < 2$ km/s).

In simultaneous Th-Ar mode, HARPS users should strictly follow the calibrations foreseen by the Calibration Plan, which includes a number of biases, flatfields and Th-Ar exposures taken before the night.

Since Period 89, a Fabry-Perot Calibration System (FPCS) is available as an alternative calibration source for simultaneous drift measurements. The Fabry-Perot etalon is illuminated by a super-continuum laser source providing a uniform density of lines and a relatively flat spectrum over the HARPS wavelength range.

In the FPCS case, no contamination is seen due to the strong Ar lines; the photon noise is half of that measured in the ThAr lamp (i.e. $\sim 4 \text{ cm s}^{-1}$), while the stability within one night is better than $\sim 10 \text{ cm s}^{-1}$.

Programmes that require very high precision and for which contamination of the stellar spectra by ThAr should be avoided might benefit from the use of the FPCS. However, we caution users that the long term behavior is still under study.

HARPS is equipped with its own pipeline (installed on La Silla). This pipeline provides the visiting astronomer with extracted and wavelength calibrated spectra in near real-time (in all observing modes). When the Simultaneous Thorium Reference Method is applied, the pipeline delivers precise radial velocities (RV, relative to the solar system barycentre) for late-type stars whose RV is known within 1–2 km/s, provided that a set of standard calibrations has been executed in the afternoon.

An additional fibre, with a larger aperture ($1.4''$ on the sky) is available for HARPS. This high efficiency mode is dubbed “EGGS”. The higher efficiency compared to the base mode (referred to as “HAM”) is achieved by reducing flux losses through the larger fibre aperture and by dispensing the image scrambler. The resolving power of the mode, due to the larger fibre, decreases to about 80 000. This mode is particularly useful for faint objects. Its peak efficiency is 11% and the gain in

flux with respect to the HARPS base mode is 75% at 530 nm with a seeing of $0.8''$. This mode is now equipped with only one fibre, therefore neither the sky subtraction nor the simultaneous Thorium reference method can be applied. The intrinsic instrument stability (better than 1 m/s) is superior to the EGGs radial velocity accuracy; the achievable radial velocity accuracy of the EGGs mode is limited by systematics and is ~ 10 m/s RMS. The amount of diffuse light in the spectrograph is $\sim 4\%$.

The EGGs mode is also supported by a full reduction pipeline running at the telescope. Both raw and reduced data will be delivered to the user. The HARPS baseline mode and the high efficiency mode can both be used during the same night. The time needed to switch from one mode to the other is about 1 minute. For radial velocity measurements a calibration sequence similar to that of the base mode should be used.

A polarimeter is also available on HARPS. The unit is able to perform both circular and linear polarimetry. Measurements of the throughput indicate a light loss with respect to the base mode of HARPS in the range of 20% to 30%, increasing to $\approx 40\%$ in the bluest orders. Instrumental polarization is not detected down to a level of 10^{-4} for zenith angles smaller than 60 degrees. Closer to the horizon instrumental polarization grows rapidly if the Atmospheric Dispersion Corrector is in the light beam. HARPS polarimetric data are reduced by the online pipeline.

Up-to-date information and documentation on the instrument, including the user manual and exposure time calculator, are available on the [HARPS web page](#).

5.4 FEROS — Fibre-fed Extended Range Optical Spectrograph, on the 2.2-m

FEROS is ESO's high-resolution, high-efficiency spectrograph on the 2.2-m telescope. It is a bench-mounted, thermally controlled, prism-cross-dispersed échelle spectrograph, providing, in a single spectrogram spread over 39 orders, almost complete¹ spectral coverage from ~ 350 to ~ 920 nm at a resolution of 48 000.

The available ESO time-slots at the 2.2-m telescope, as defined in Section 4.1, need to be taken into account for proposal preparation.

FEROS is offered in Visitor Mode only.

The spectrograph is fed by two fibres, allowing simultaneous spectra of an object and either the sky or a calibration source (normally a wavelength calibration lamp). The fibres are illuminated via apertures of $2''.0$ and are separated by $2''.9$.

The mechanical and thermal stability of FEROS is such that the wavelength calibration obtained during the day is sufficiently accurate for most purposes. Additional night-time calibrations are not necessary. Although not intended as a 'radial velocity machine', precise radial velocity work (accuracies of ~ 25 m/s or better) is possible, especially via the Object-Calibration mode.

A dedicated pipeline provides, in almost real time, extracted 1-dimensional, wavelength calibrated spectra, which can be used as a preview and to check S/N. The core of the FEROS pipeline is included in the standard MIDAS distribution and, together with the FEROS Data Reduction System (FEROS-DRS) package (provided at the [FEROS web site](#)), can be used to re-reduce the data to obtain publication quality results.

Up-to-date information and documentation on the instrument can be found via the [FEROS web page](#).

5.5 WFI — Wide Field Imager, on the 2.2-m

The Wide Field Imager (WFI) has a field of view of $34' \times 33'$ and is composed of a mosaic of 4×2 CCD detectors with a pixel size of $0.24''$ and narrow inter-chip gaps, yielding a filling factor of 95.9%. It offers excellent sensitivity from the atmospheric UV cut-off to the near IR. All applicants should take the availability restrictions of the 2.2-m during ESO time and the corresponding lunar phases into account (Section 4.1).

¹The two spectral ranges 853.4–854.1 nm and 886.2–887.5 nm are lost due to non-overlap of the spectral orders.

WFI is offered in Visitor Mode only.

The filter storage and exchange mechanism, with 50 positions, accommodates 11 broad-band filters (including a fully transparent one), 27 medium-band filters covering the whole wavelength range, and 8 narrow-band filters centred at [OIII], [SII], H α and a few other wavelengths. The large number of medium- and narrow-band filters are specifically selected to support the determination of photometric redshifts of distant objects.

We summarise the performance of WFI in Table 1. The table should only be used as a quick guide of feasibility.

Table 1: WFI limiting magnitudes

Filter	Limiting magnitude (S/N=5)
U	23.8
B	26.0
V	25.5
R	25.3
I	24.3

The limiting magnitudes correspond to a one-hour integration with dark sky, clear conditions, a seeing FWHM of 0".8 and an airmass of 1.2, and have been calculated for a point source of zero colour (A0V star). To estimate the operational overheads of your proposed observations, please consult Chapter 5.1. of the [WFI handbook](#). Note that for dithering offsets larger than 150", the overhead increases by 1 minute per offset. These extra overheads must be properly accounted for.

Up-to-date information and documentation on the instrument can be found via the [WFI web page](#).

6 Scientific Instruments: Paranal

6.1 CRIRES, Cryogenic high-resolution IR Échelle Spectrograph

CRIRES is the infrared (0.95 μm – 5.2 μm) high-resolution spectrograph located at the Nasmyth A focus of UT1. It provides long-slit (39") spectroscopy with a spatial sampling of $\approx 0.1''$. Spatial resolution and signal-to-noise ratio can be maximized by the optional use of a MACAO adaptive optics system equipped with an optical (R band) wavefront sensor. Good correction is obtained with stars as faint as R ~ 14 mag under average seeing conditions, while moderate image quality improvement is seen with stars as faint as R ~ 16 mag under good seeing (FWHM < 0.6") conditions.

Important note: Large Programmes using **CRIRES** will not be accepted in Period 91.

The main optical elements consist of a prism acting as a pre-disperser and a 31.6 lines/mm échelle grating. Total spectral coverage per individual wavelength setting is $\sim \lambda/70$ thanks to an array of four 1024 x 512 Aladdin III detectors. Acquisition and guiding are performed by the means of a slit viewer equipped with an additional Aladdin III detector and a series of five filters (J,H,K and two neutral density H filters).

Possible slit widths are 0.2 and 0.4", providing a resolving power of $R \simeq 100,000$ and $R \simeq 50,000$, respectively. Standard and free wavelength settings are offered for both Visitor Mode (Section 12.1) and Service Mode (Section 12.2). For settings shortward of $\sim 3\mu\text{m}$, the blue and red ends of the wavelength coverage can be affected by contamination from adjacent orders and lack of illumination reproducibility. Tables 3 and 4 of the [User Manual](#) report the spectral range free of these effects for all standard settings. Starting from Period 90, the implementation of the metrology system should ensure the reproducibility of the wavelength scale to sub-pixel accuracy. Despite the availability of a Krypton and ThAr lamps and of the N₂O and CO gas-cells, the lack of wavelength calibration lines affect some settings. During P89 a UNe lamp for wavelength calibration was tested that in the future may act as a complimentary calibration source.

Provided an adequate observational strategy is followed, radial velocity measurements to better than $\approx 20\text{m s}^{-1}$ can be reached for stars showing a sufficient number of spectral features. See the

[CRIRES User Manual](#) for details.

6.1.1 Calibration

The observer has to supply his/her own standard star calibration OBs to correct for telluric features if necessary. An alternative possibility is the use of an atmospheric model, for example available at <http://www.eso.org/observing/etc/skycalc/skycalc.htm>. The efficacy of such a model in the wavelength region of interest should be checked *a-priori*.

In particular for Service Mode observations, OBs are typically executed in one-hour blocks; therefore, a telluric OB should be supplied for each science OB in order to achieve a proper correction. Science-telluric pairs of OBs can be used as a concatenation with total execution time of 1.5 hours. High-precision wavelength calibration or flat-fielding requires an attached template. The observing time needed to execute these night-time calibrations is charged to the observer.

The Observatory provides day-time calibrations such as lamp flats and wavelength calibrations with the same wavelength settings as those used for the science, as well as darks obtained with the same detector settings as the science and telluric observations, lamp flats and wavelength calibration frames. Note however, that day-time wavelength calibrations are only provided for $\lambda < 2.4\mu\text{m}$, as calibrations based on sky lines are better for redder wavelengths in any case.

From Period 90 there has been the possibility to take night-time calibrations with a 0.2'' or 0.4'' slit.

Finally, it is possible that, due to the improved stability of the system caused by the installation of fixed slits, the calibration frequency will be decreased at some point.

6.1.2 Sensitivity

Proposers should refer to the Exposure Time Calculator at <http://www.eso.org/observing/etc/> to assess the feasibility of their programmes. In particular, starting from Period 90, the amount of reciptable water vapour is a user-definable constraint which can be set during Phase 2 preparation for SM users.

Detailed information regarding CRIRES is provided in the Users' Manual, available via [the CRIRES web page](#).

6.2 FORS2, Focal Reducer/low dispersion Spectrograph 2

FORS2 is a multi-mode optical instrument placed at the UT1 Cassegrain focus. It is capable of imaging, polarimetry, long slit and multi-object spectroscopy. It has two detector systems and a wide range of exchangeable optical elements.

The default MIT detector consists of a mosaic of two 2k×4k MIT CCDs (15 μm pixels) and is available for Service and Visitor Mode observations. A blue-optimized e2v mosaic is available **only for Visitor Mode observations**. Compared to the e2v detector, the MIT mosaic provides greatly improved red sensitivity (> 750 nm) with very low fringing. However, the response of the MIT detector below 600 nm is reduced. The detector systems are not mounted at the same time, hence the use of the e2v detector is limited to Visitor Mode and must be justified in the Phase 1 proposal.

Whether the MIT or e2v detector are required must be explicitly requested in Box 14 by uncommenting the corresponding instrument configuration line. This will ensure smooth operations by flagging the detector change in the schedule.

The image scale in the default readout mode (2 by 2 binning) is 0''.125/pixel in the high resolution (HR) mode and 0''.25/pixel in the standard resolution (SR) mode. The field of view in these two modes is, respectively, 4'.25 × 4'.25 and 6'.8 × 6'.8 (note that the detector area is larger than the field of view). The different magnifications are chosen by setting one of the two collimators. Hence, each magnification has to be calibrated independently. Unbinned CCD readout modes are only offered for

applications that specifically require them; the use of unbinned modes must be explicitly requested in the proposal.

In addition to the standard imaging and longslit spectroscopy modes, some of the key capabilities of FORS2 are listed below.

6.2.1 Multi-object Spectroscopy

FORS2 provides two multi-object spectroscopy modes. The MOS mode comprises 19 movable slitlets of fixed slit lengths between 19" and 21" and user-selectable slit widths. The MXU mode provides the possibility to insert a mask in the focal plane, in which slits of different lengths, widths and shapes can be cut with a dedicated laser cutting machine. The FIMS tool (Section 6.2.6) must be used for Phase 2 preparation of MOS and MXU observations. The performance of the MOS and MXU modes are equivalent (cf. Table 3). Both modes are only offered with the standard resolution collimator.

6.2.2 High throughput filters

A set of high throughput filters are used on FORS2 to maximize the sensitivity below 600 nm.

6.2.3 Volume-phased holographic gratings

In addition to the standard low-resolution gratings, a number of high throughput VPH gratings are available which are optimised for both the MIT and E2V detectors.

6.2.4 Polarimetry

FORS2 is capable of measuring both linear and circular polarisation for direct imaging and spectroscopy. It uses a Wollaston prism as the beam splitting analyser and two superachromatic phase retarder plate mosaics located in the parallel beam.

6.2.5 Imaging modes and performance summary

The High Time resolution (HIT) mode is available with FORS2 (currently only with the MIT detector) in imaging (Visitor and Service Modes) and spectroscopy (Visitor Mode only) with a range of filters for imaging and the 600B and 300I gratings for spectroscopy.

In the one-shift mode, the times for a full shift across the mosaic are 1, 4, 16, 64, 256 sec, providing time resolutions for 1" on sky from 2.3 msec to 0.6 sec. The multiple-shift (MS) mode is predominantly implemented for fast spectroscopy and allows a block of rows to be shifted together. In MS mode, two user-defined slits can be used; these place the spectra of the target and a comparison star onto a small region of the CCD. After a pre-defined 'wait' time (0.1–20 secs), the rows of the CCD are rapidly shifted (50 microsec), causing the exposed region to be moved into the 'storage area' (the unexposed region) of the CCD and a new region to be illuminated. This 'shift and wait' scheme continues until the first pair of spectra taken reach the limit of the storage region and the CCD is subsequently read-out in the normal way allowing 41 pairs of spectra per CCD readout.

We summarise the operational modes and performance of FORS2 in the two tables below. These tables are only intended to be quick feasibility guides. Proposers should refer to the detailed information (*e.g.* Users' Manual, Exposure Time Calculator) available via [the FORS web page](#).

The magnitude limits in Table 2 correspond to a one hour integration with dark sky, clear conditions, a seeing FWHM of 0".8 and an airmass of 1.2, and have been calculated for a point source of zero colour (A0V star). The U, B and V magnitude limits are calculated using the high throughput filters. The values are shown for both the standard MIT detector mosaic, as well as the E2V mosaic which is available for Visitor Mode observations.

Table 2: Offered FORS2 imaging modes for Period 91

Instrument Mode	Magnitude limit (S/N=5)
Direct Imaging (MIT)	U=24.8 B=27.3 V=27.1 R=26.7 I=25.7 z=24.7
Direct Imaging (E2V)	U=25.9 B=27.6 V=27.3 R=26.7 I=25.7
HIT Imaging (MIT)	U=16.0 B=19.5 V=20.0 R=20.3 I=19.5

Table 3: Offered FORS2 spectroscopic modes for Period 91

Instrument Mode	$R_s = \lambda/\Delta\lambda$	Magnitude limit
E2V		
MOS – movable slits ^[1,2]	260–1700	R = 24.0–22.8
Long slit Spectroscopy ^[3]	260–1700	R = 24.0–22.8
Spectropolarimetry ^[3]	260–1700	R = 19.2–17.2
MIT		
MOS – movable slits ^[1,2]	260–2600	R = 24.2–23.3
MXU – exchangeable masks ^[2]	260–2600	R = 24.2–23.3
Long slit Spectroscopy ^[3]	260–2600	R = 24.2–23.3
HIT-MS spectroscopy	660–780	R = 19.5–12.3
HIT-OS spectroscopy ^[4]	660–780	R = 14.3

[1] In multi-object spectroscopy one may have 19 slitlets of length alternating between 20'' and 22''.

[2] Only offered with the SR collimator.

[3] In long slit spectroscopy the slit is chosen out of a set of 9 slits with fixed width between 0'3 and 2'5.

[4] In HIT-OS mode slit masks with widths between 0.5'' and 5.0'' are available.

The magnitude limits given in Table 3 are the R-band magnitudes of a point source of zero colour that would result in a S/N of 5 per pixel at 650 nm (grisms 150I and 600RI) in the continuum in a one-hour integration with dark sky, clear conditions, a seeing FWHM of 0'8, an airmass of 1.2, and using the 1'0 slit and the SR-collimator. The two limits given are for the two representative resolutions. In the case of the HIT-MS mode, the two limits represent the slowest and fastest readout modes available. In the case of the HIT-OS mode it is simply the limiting magnitude for the slowest mode available (HIT-OS5-256sec).

6.2.6 FORS Instrumental Mask Simulator (FIMS)

To prepare precise target acquisitions during Phase 2, ESO provides the FIMS software tool. Usage of FIMS is required when using several spectroscopic modes, as well as to prepare occulting bar imaging and spectropolarimetric observations. Phase 1 proposers who wish to justify their time request by optimising movable or MXU slitlet positions during Phase 1 may find it useful to download and install FIMS. Please refer to:

<http://www.eso.org/sci/observing/phase2/SMGuidelines/FIMS.html>

for instructions on how to install FIMS and to the [FIMS Users' Manual](#) on how to use FIMS. Users are reminded that only the FIMS version specifically assigned to a given period may be used. Older versions should never be used as they may not contain the correct FORS set-up.

6.2.7 Accurate Astrometry or Pre-imaging Required

Highly accurate relative astrometry is required for any observing mode that makes use of FIMS or does blind offsets during the acquisition. The mask preparation with FIMS requires input images that are astrometrically corrected within the definitions and precision given below. DSS images will, in almost all cases, **not** be suitable for the task.

In general the relative astrometry must be known to better than $1/6$ of the slit width over the entire field of view. Relative astrometry here means that the slit positions must be known relative to

those of the reference stars in the field of view with the given precision. These relative astrometric calibrations are fulfilled if your FIMS preparation is based on images taken with FORS1 after March 22, 2003 or on any FORS2 images.

An important exception is multi-object spectroscopy with unbinned CCD readout modes: users wishing to apply for this mode must request additional pre-imaging, even if previous FORS1 or FORS2 images are available.

If images of adequate quality are not available, Phase 1 proposers **must** apply for pre-imaging defined as a separate run in the Phase 1 proposal and clearly marked as pre-imaging (PRE-IMG) in the “Instrument configuration” section of the proposal. Failure to do so will result in the deduction of the pre-imaging time from the time allocation assigned to the main project, if the programme is approved for execution. As a rule, pre-imaging runs are carried out in Service Mode, even for programmes whose main (spectroscopic) runs are conducted in Visitor Mode.

For further information, FORS2 proposers should visit the [FORS web page](#).

6.3 FLAMES, Fibre Large Array Multi-Element Spectrograph

FLAMES is the multi-object, intermediate and high resolution spectrograph of the VLT. Mounted at the Nasmyth A platform of UT2, FLAMES can access targets over a large corrected field of view (25' diameter). It consists of three main components:

- A **Fibre Positioner** (OzPoz) hosting two plates: while one plate is observing, the other positions the fibres for the subsequent observations. This limits the dead time between one observation and the next to less than 15 minutes, including the telescope preset and the acquisition of the next field.
- A medium-high resolution optical spectrograph, **GIRAFFE**, with three types of feeding fibre systems : **MEDUSA**, **IFU**, **ARGUS**.
- A link to the **UVES spectrograph** (Red Arm) via 8 single fibres of 1'' entrance aperture.

Special observing software (**FLAMES OS**) coordinates the operation of the different subsystems, also allowing simultaneous acquisition of UVES and GIRAFFE observations with the observing modes listed in Table 4. For combined observations, the exposure times for UVES and GIRAFFE do not need to be the same. Note that it is not possible to observe simultaneously in two GIRAFFE modes, or to observe the same target simultaneously with the two spectrographs.

For more detailed information on instrument setups and performance estimates the user is referred to [the FLAMES web page](#).

6.3.1 Instrument Capabilities

GIRAFFE is a medium-high ($R = 5,600\text{--}48,000$) resolution spectrograph for the entire visible range, 370–950 nm. It is equipped with two gratings and several filters are available to select the required spectral range. Five additional fibres allow simultaneous wavelength calibration of every exposure. Each object can be observed in only one, or a fraction of, a single échelle order at once. The fibre system feeding GIRAFFE consists of the following components:

- Two **MEDUSA** slits, one per positioner plate: up to 132 separate objects (including sky fibres) are accessible in MEDUSA single fibre mode, each with an aperture of 1''.2 on the sky.
- Two **IFU** slits: each IFU (deployable Integral Field Unit) consists of a rectangular array of 20 microlenses of 0''.52 each, giving an aperture of 2'' \times 3''. For each plate there are 15 IFU units dedicated to objects and another 15 dedicated to sky measurements. In the latter, only the central fibre is present.
- One **ARGUS** slit: the large integral field unit ARGUS is mounted at the centre of one plate of the fibre positioner and consists of a rectangular array of 22 \times 14 microlenses. Two

Table 4: FLAMES Observational Capabilities

Spectro.	Mode	N. Objects	Aperture ["]	R*	Cover.	Comments
UVES6/8	RED	6 or 8 (with sky)	1.0	47000	200	6 fib@520nm +Sim.Calib.
UVES7+1	RED	7 (with sky)	1.0	47000	200	
GIRAF HR	MEDUSA	131 ^a (with sky)	1.2	21000 ^[1]	$\lambda / 22 - \lambda / 12$	
GIRAF LR	MEDUSA	131 ^[2] (with sky)	1.2	7000 ^[1]	$\lambda / 7.5$	
GIRAF HR	IFU	15 (+15 sky)	2×3	32000 ^[1]	$\lambda / 22 - \lambda / 12$	
GIRAF LR	IFU	15 (+15 sky)	2×3	11000 ^[1]	$\lambda / 7.5$	
GIRAF HR	ARGUS	1	11.5×7.3 or 6.6×4.2	32000 ^[1]	$\lambda / 22 - \lambda / 12$	
GIRAF LR	ARGUS	1	11.5×7.3 or 6.6×4.2	11000 ^[1]	$\lambda / 7.5$	

[1] The resolving powers (R) given here are only average values, for more details see <http://www.eso.org/sci/facilities/paranal/instruments/flames/doc/> which contains a description of all the GIRAFFE setups.

[2] The number of allocable buttons is 132, but only 131 spectra are fully covered on the detector.

magnification scales are available: “1:1” with a sampling of 0'52/microlens and a total aperture of 11'5×7'3, and “1:1.67” with 0'3/microlens and a total aperture of 6'6×4'2. In addition, 15 ARGUS sky fibres can be positioned in the 25' field.

GIRAFFE is equipped with one 2k×4k EEV CCD (15 μm pixels), with a scale of 0'3/pixel in MEDUSA, IFUs and ARGUS direct mode, and a scale of 0'15/pixel in the 1.67 scale ARGUS mode. GIRAFFE is operated with 39 fixed setups (31 at high resolution + 8 at low resolution modes).

The standard readout mode of FLAMES-GIRAFFE is 225 kHz (unbinned) which ensures low readout noise. A high-speed readout mode (625 kHz, unbinned, low gain) with increased readout noise but less overheads is offered in Visitor Mode only. No pipeline support is available for this mode.

UVES is the high resolution spectrograph at UT2 of the VLT (see Section 6.4). It was designed to work in long slit mode but it has been possible to add a fibre mode (6 to 8 fibres, depending on setup and/or mode) fed by the FLAMES positioner to its Red Arm only. Only three of the standard UVES Red setups are offered, with central wavelengths of 520, 580 and 860 nm respectively (see [the UVES Users' Manual](#) for details).

The standard readout mode of FLAMES-UVES is 225 kHz (unbinned) which ensures low readout noise. A high-speed readout mode (625 kHz, unbinned, low gain) with increased readout noise but less overheads is offered as well in Visitor Mode only. No pipeline support is available for this mode.

With an aperture on the sky of 1", the fibres project onto 5 UVES pixels giving a resolving power of $\sim 47,000$. For faint objects and depending on the spectral region, one or more fibres can be devoted to recording the sky contribution. In addition, for the 580 nm setup only, a separate calibration fibre is available to acquire simultaneous ThAr calibration spectra. This allows very accurate radial velocity determinations. In this configuration, 7 fibres remain available for targets on sky.

The upgrade of the MIT CCD in the UVES red arm in July 2009 has provided a marked increase in sensitivity in the 860-nm setting and decrease in fringing.

6.3.2 Observational Requirements

The operation of FLAMES requires the observer to have his/her own list of target coordinates, with a relative astrometric accuracy better than 0'3, when preparing Phase 2. **Bad astrometry results in large losses at the fibre entrance and therefore in much poorer performance.** The minimum object separation is 11" for MEDUSA fibres. The Fibre Positioner is able to place the fibres with an accuracy better than 0'1. During Phase 2 it is necessary to run dedicated software (FPOSS) that assigns the fibres to the selected objects. Considerations regarding the relevant

astrometric effects induced by the atmosphere can be found in the [FLAMES Users' Manual](#), Sec 4.4. For any given target field the astrometric effects can also be found using the [FLAMES Airmass Plotter](#).

6.3.3 Calibration

All required standard FLAMES calibrations are acquired by the observatory staff during daytime. No night-time calibrations are foreseen except for screen flatfields (so-called attached flatfields) if additional flatfielding accuracy is required. For ARGUS mode, screen flatfields are taken for Service Mode programmes in twilight together with a spectrophotometric standard star at no extra cost.

6.3.4 ESO Public Spectroscopic Surveys

In Period 91 there will be approximately 30 nights assigned to the ESO Public Spectroscopic Survey entitled “The Gaia-ESO Survey” on FLAMES.

Further details are available on the ESO [Public Survey Projects](#) webpage. Proposers should check that their science goals and targets do not duplicate those of this public survey.

6.4 UVES, Ultraviolet and Visual Échelle Spectrograph

UVES is the high resolution optical spectrograph of the VLT and is located at the Nasmyth B focus of UT2. UVES is a cross-dispersed échelle spectrograph designed to operate with high efficiency from the atmospheric cut-off at 300 nm to the long wavelength limit of the CCD detectors (1100 nm). The light beam from the telescope is split into two arms (UV to Blue and Visual to Red) within the instrument. The two arms can be operated separately or in parallel via a dichroic beam splitter. With two dichroic observations, the complete wavelength range (300–1100 nm) can be covered. The resolving power is $\sim 40,000$ when a $1''$ slit is used. The maximum (two-pixel) resolution is 80,000 or 110,000 in the Blue- and the Red-Arms, while using a $0.4''$ and $0.3''$ slit respectively. Three image slicers are available to obtain high resolving power without excessive slit losses. The instrument is built for maximum mechanical stability and therefore allows accurate calibration of the wavelength scale.

The UVES instrument modes offered in Period 91 are listed in Table 5. This table is intended as a quick guide only; for detailed information, proposers should refer to the UVES Users' Manual and Exposure Time Calculator (ETC) available through [the UVES web page](#).

Table 5 indicates, for a given mode, the accessible wavelength range, the maximum resolving power that can be obtained, the approximate wavelength range covered in one exposure, and an estimate of the limiting magnitude. **Please note that for each instrument mode standard settings have been defined; in Service Mode, only UVES standard settings are allowed.** Visitor Mode observers are encouraged to use the specially defined UVES standard settings.

Table 5: UVES Period 91 instrument modes

Instrument mode	Accessible λ range (nm)	Maximum resolution ^[1] ($\lambda/\Delta\lambda$)	Covered λ range (nm)	Magnitude limits
Blue arm	300–500	$\sim 80,000$	80	17–18
Red arm	420–1100	$\sim 110,000$	200–400	18–19
Dichroic#1	300–400	$\sim 80,000$	80	17–18
	500–1100	$\sim 110,000$	200	18–19
Dichroic#2	300–500	$\sim 80,000$	80	17–18
	600–1100	$\sim 110,000$	400	18–19
I ₂ cell	500–600	$\sim 110,000$	200	17

[1] With a $0.4''$ (blue) and $0.3''$ (red) slit.

The magnitude limits listed in Table 5 are estimated on the basis of the following conditions: continuum source, 0.7'' seeing, 1'' slit, no binning, 3-hour integration, S/N of 10 (per resolution element) at the peak of the central order, no moon. They are indicative of the limiting performance of the instrument only as they depend on the wavelength. UVES proposers should use the ETC for their S/N estimates.

Whether or not an image slicer should be used depends on the trade-off between slit losses due to seeing and the reduced transmission (reduction between 20 and 40%) when using an image slicer. The special spectral formats and the reduced sample of the sky spectrum with the image slicer also have to be taken into account.

Eight interference filters are offered with the UVES RED arm in Visitor Mode. The purpose of these filters is to isolate certain échelle orders to allow the use of the maximum slit length of 30''. The central wavelengths of the filters are chosen to permit observations of the most important emission lines in extended objects. The filters and their central wavelengths are: H α (656.6 nm), H β (486.1 nm), OIII (500.7 nm), OIII (436.3 nm), NII (575.5 nm), OI (630.0 nm), SII (672.4 nm), and HeII (468.6 nm). The peak transmissions of the filters range from 70 to 90%.

In July 2009 the MIT CCD was replaced by an improved version that offers less fringing and higher throughput redwards of \sim 800-nm. See the [UVES news page](#) for details. Proposals for the very red end of the UVES range (around 1 micron) should consider whether CRIRES would be better suited. A detailed comparison of UVES and CRIRES performance around 1 micron is given on the [CRIRES news page](#).

For more detailed information on instrument setups and performance estimates the user is referred to [the UVES web page](#).

6.5 XSHOOTER: multi band, medium resolution échelle spectrograph

XSHOOTER – the first VLT second generation instrument – is the UV-Visual-NIR medium resolution spectrograph mounted at the UT2 Cassegrain focus. Three arms, each with optimized optics, dispersive elements and detectors, allow high efficiency observation simultaneously in the wavelength range 300-2480 nm.

Each arm is an independent cross-dispersed échelle spectrograph complete with its own shutter and/or slit mask. The incoming light is split into the three different spectrographs/arms through 2 dichroics that have cut-off wavelengths at 5595Å (for the separation of UVB-VIS light) and 10240Å (for the separation of the VIS-NIR light). Three piezo-controlled mirrors, located in front of each arm, guarantee that the optical path remains aligned against instrument flexure and corrected for differential atmospheric refraction between the telescope guiding wavelength and each arm central wavelength.

The two pairs of ADC prisms in the optical path of the UVB and VIS arms, which normally compensate for the atmospheric dispersion are currently disabled. Because their mechanical system is damaged and are therefore not reliable anymore, they have been fixed in their non deviation position since August 1st, 2012. Data obtained in this configuration can be reduced by the pipeline without significant degradation. Use of ADCs in the future depends on the result of further investigations and possible intervention.

Users should check the [XSHOOTER News](#) webpage to follow the status of the ADCs. The last version of the user manual provides plots for helping the observation preparation with XSHOOTER without ADCs.

Users are recommended to carry out observations at the parallactic angle whenever possible or to take special care on the airmass constraint to avoid flux loss.

Two instrument modes are offered:

- slit spectroscopy (SLT) with a selection of different slit widths for each arm and a fixed length of 11 arcsec. In Period 91, the offered slits have widths of
 - for the UVB arm: 0.5, 0.8, 1.0, 1.3, 1.6, 5.0 arcsec,

- for the VIS arm: 0.4, 0.7, 0.9, 1.2, 1.5, 5.0 arcsec,
 - for the NIR arm: 0.4, 0.6, 0.6 + K-band blocking filter, 0.9, 0.9 + K-band blocking filter, 1.2, 5.0 arcsec, a blind position.
- IFU spectroscopy, which allows observations of a 1.8×4 arcsec² field reformatted to a 0.6×12 arcsec long-slit.

The spectral format is fixed. The orders in each detector are highly curved and the sky/arc lines within each order are highly tilted.

The background between the OH lines in the J and H bands is strongly affected by photons scattered from the very bright K-band orders. In order to allow sky limited performance in the J and H bands, two new slits of width 0.6" and 0.9" combined with a K-band blocking filter were installed on the slit wheel of the NIR arm in July 2011. One of these new slits replaced the 1.5" slit, which is therefore not offered anymore. These new slits allow for a reduction of the overall background by a factor of 3 to 4 in the H and J bands.

The minimum DIT in the NIR arm is 0.66s. The 1800s DIT in the NIR arm is only offered in full-night VM as it introduces severe remnants. However, the use of 1800 s DIT in the NIR arm with the 0.6 or 0.9" slit combined with a K-band blocking filter could be possibly granted also in SM observations provided the strategy is very well-justified through a waiver request at Phase 2.

We encourage the users to read the [XSHOOTER NIR readout mode description](#), about the NIR non destructive readout mode and its different regimes.

More detailed information regarding the instrument are provided in the [XSHOOTER page](#).

6.6 VIMOS, VISIBLE Multi-Object Spectrograph

VIMOS is a multi-mode, wide-field optical instrument attached at the Nasmyth B focus of Melipal (UT3). VIMOS allows imaging (IMG) and multi-object spectroscopy (MOS) at low- ($R \sim 200$) to medium-resolution ($R \sim 2500$) over a field of view (FOV) composed of four quadrants, each $7' \times 8'$, separated by $2'$ gaps. MOS masks, which are prepared with the Mask Manufacturing Unit (MMU) on Paranal, allow considerable freedom in the positioning, shape, and orientation of the slits. The maximum number of slits that can be typically accommodated in the VIMOS FOV is up to 750 at low resolution, and up to 150 at higher resolution. The actual number of slits will depend on the multiplex used, target density and their distribution in the field of view.

Important notes:

- The VIMOS upgrade project continues with the refurbishment of the focus unit to permit proper focussing at all temperatures in IFU mode. Details on the scope of the upgrade project, expected performance, validity of pre-imaging observations, and availability of the instrument are given in the News section of [the VIMOS web pages](#).
- Starting from P91, a new Pre-Image-Less MOS (PILMOS) mode is offered, in which a user provided catalogue with accurate target coordinates ($\leq \pm 0.2''$) can be used to design masks. Slit orientation must be N-S.
- This period we have relaxed the requirement on MOS slit orientation: if target declination is within $-45^\circ < \delta < -5^\circ$, slits can also be oriented E-W and the observations executed within ± 3 h from meridian. In this case a pre-imaging run must be requested.
- Due to existing commitments no Large Programmes using VIMOS can be submitted in Period 91.

VIMOS is equipped with an integral field unit (IFU) with 6400 microlenses coupled to fibres and a choice of two spatial samplings (magnifications): 0.67" per fibre or 0.33" per fibre. With the lower spectral resolution settings, the FOV of the IFU is $54'' \times 54''$ (using the 0.67" magnification), or $27'' \times 27''$ (using the 0.33" magnification). A quarter of these fields are covered at intermediate to higher spectral resolutions.

Table 6: VIMOS Period 91 offered settings and modes

Mode	Scale	FOV	Wavelength range (nm) ^[1]	$\lambda/\Delta\lambda$ ^[2]	Dispersion $\text{\AA} / \text{pix}$	Spectral multiplex ^[3]
IMG <i>UBVRIz</i>	0.205"/pix	$4 \times 7' \times 8'$	–	–	–	–
MOS LR Blue	0.205"/pix	$4 \times 7' \times 8'$	370–670	180	5.3	4
MOS LR Red	0.205"/pix	$4 \times 7' \times 8'$	550–950	210	7.3	4
MOS MR	0.205"/pix	$4 \times 7' \times 8'$	480–1000	580	2.5	1
MOS HR Blue	0.205"/pix	$4 \times 7' \times 8'$	370–552	1430	0.71	1
MOS HR Orange	0.205"/pix	$4 \times 7' \times 8'$	520–760	2150	0.6	1
MOS HR Red	0.205"/pix	$4 \times 7' \times 8'$	630–870	2500	0.6	1
IFU LR Blue	0.67"/fibre	$54'' \times 54''$	390–670	220	5.3	4
IFU LR Red	0.67"/fibre	$54'' \times 54''$	580–915	260	7.3	4
IFU MR	0.67"/fibre	$27'' \times 27''$	490–1015	720	2.5	1
IFU HR Blue	0.33"/fibre	$13'' \times 13''$	370–552	1790	0.71	1
IFU HR Orange	0.67"/fibre	$27'' \times 27''$	525–740	2650	0.6	1
IFU HR Red	0.67"/fibre	$27'' \times 27''$	640–860	3100	0.6	1
IFU LR Blue	0.33"/fibre	$27'' \times 27''$	390–670	220	5.3	4
IFU LR Red	0.33"/fibre	$27'' \times 27''$	580–915	260	7.3	4
IFU MR	0.33"/fibre	$13'' \times 13''$	490–1015	720	2.5	1
IFU HR Blue	0.33"/fibre	$13'' \times 13''$	370–552	1790	0.71	1
IFU HR Orange	0.33"/fibre	$13'' \times 13''$	525–740	2650	0.6	1
IFU HR Red	0.33"/fibre	$13'' \times 13''$	640–860	3100	0.6	1

[1] In MOS mode, with the LR and MR settings, the actual spectral range depends also on the order separation filter used; with the HR settings, the actual spectral coverage depends also on the position of the slit in the field of view.

[2] This is the resolution given by a slit with width 1'' in MOS mode, and by 1 fibre in IFU mode.

[3] This is the number of slitlets that can be accommodated along the dispersion direction.

The VIMOS instrument works in the wavelength range 360–1000 nm. VIMOS modes (IMG, MOS, and IFU) are summarised in Table 6. Users should refer to the detailed information available on the [VIMOS web page](#) to assess the feasibility of their programme with VIMOS.

All instrument modes and settings are offered both in Visitor Mode and Service Mode, except for pre-imaging runs, which are carried out in Service Mode only.

Table 7: VIMOS IMG limiting magnitudes

Magnitude limit (S/N=5, A0 star)					
U=26.2	B=27.4	V=27.0	R=26.6	I=25.5	z=25.1

The magnitude limits in Table 7 correspond to a one-hour integration with dark sky, clear conditions, a seeing of 0.8'' and an airmass of 1.2, for a point source of zero colour (A0V star) giving S/N~5. Fringing in the red is negligible with the new CCDs.

The magnitude limits in **MOS mode** and **IFU mode** should be obtained using the Exposure Time Calculator (<http://www.eso.org/observing/etc>) to test the proposed programme's feasibility and the corresponding execution time. The observing overheads are given in Table 16 and more details are given in the VIMOS web pages.

Note: For MOS runs ESO will consider OBs as successfully executed when at least 3 of the 4 quadrants are operational and work within specifications.

We summarise some important requirements for OB preparation below that must be taken into account during Phase 1.

6.6.1 VIMOS Observation Requirements: IMG

Offsets greater than $30''$ are not allowed during OB execution as they often cause the loss of the guide star, resulting in large operational overheads. If an offset pattern with a greater amplitude is needed, users should use separate OBs at each offset position. The increased overhead time due to this feature must be accounted for when estimating the total time needed for VIMOS imaging runs.

In IMG mode, filter exchanges are allowed within an OB. Overheads for filter exchanges need to be included using the estimate given in Table 16.

6.6.2 VIMOS observation requirements: MOS and pre-imaging

MOS observations are performed with machine-cut masks that have to be prepared well in advance. ESO provides a software package ([vmmps](#)) for slit definition and positioning for Phase 2 preparation (equivalent to FIMS for the FORS2 instrument). The user can define rectangular slits of width wider than $0.6''$ and length up to $30''$. Inclined slits can be defined.

The change of CCDs that took place during P85 (June-July 2010) invalidated all pre-imaging data taken before August 1, 2010.

Pre-imaging is *recommended* for subsequent spectroscopic (MOS) follow-ups, even when targets come from a pre-defined catalogue, and must be carried out with the *R* filter. Pre-imaging is done in Service Mode (this also applies for MOS Visitor runs); **separate runs must be requested for pre-imaging in the Phase 1 proposal** and associated overheads have to be taken into account by the users. Pre-imaging runs are carried out typically two months in advance of the spectroscopic follow-up. Masks need to be prepared as soon as possible after the pre-imaging has been completed and submitted according to Phase 2 procedures.

The observations taken as part of a pure imaging run (without the pre-imaging flag set) cannot be used for the subsequent mask preparation due to the lack of the controlled mask-to-ccd transformation keywords in the headers. Even in the case when imaging data have been obtained with VIMOS, if the user wishes to use a VIMOS image to design the mask then a short pre-imaging run is mandatory.

Starting from Period 90 we are offering a Pre-Image-Less MOS mode, PILMOS, that can be used for mask preparation when the user has a pre-defined catalogue of targets with good quality astrometry (relative positioning accuracy better than $\pm 0''.2$). See manual for details.

VIMOS is not equipped with an Atmospheric Dispersion Corrector. In order to minimise slit losses, MOS observations and their pre-imaging are taken at a pre-defined position angles on sky, with slits oriented either N-S or E-W. For N-S orientation the observations are executed within 2 h of the meridian. If target declination is $-45^\circ < \delta < -5^\circ$, slits can be oriented E-W and the observations will be executed within 3 h of the meridian. Special requirements for different field orientations should be clearly stated in the proposals.

Due to the recently commissioned automatic flexure compensation system (AFC) attached arcs and flats are no longer mandatory in MOS mode. Nevertheless, we recommend that users still attach 3 flats and 1 arc if they want the maximum wavelength precision and flat fielding accuracy in any of the high resolution grism. This is specially true for the new VPH HR_blue grism, because the number of sky and arc lines is rather limited in the blue. The corresponding overheads need to be taken into account at Phase 1 and can be estimated using Table 16.

In MOS mode only one filter+grism combination per OB is permitted (the only filter exchange allowed is the one between acquisition and science template). Users who want to observe the same targets with different filter+grism combinations are requested to submit separate OBs for different filter+grism combinations and to consider the respective overheads.

6.6.3 MOS Observations in Visitor Mode

Because MOS observations should be carried out within 2 h of the meridian, targets must be uniformly distributed in RA for the night(s) of the Visitor Mode observations. If this is not possible

users should apply for Service Mode observations. A maximum number of **7** visitor masks (per quadrant) will be made available each night, with only (**3** masks) per quadrant for half-night runs.

Users should submit OBs for mask preparation well before their observing run, so that masks can be manufactured before they arrive. Visitor Mode (VM) observers who wish to use VIMOS in MOS mode are required to submit part of their OBs at least 3 weeks before the first night of the VM run. Exceptionally, limited additional support is guaranteed for mask preparation on the mountain, up to 3 sets of masks per night, to be prepared at least 48 h in advance.

6.6.4 VIMOS Observation Requirements in IFU Mode

In IFU mode instrumental flexures introduce flatfield residuals and wavelength calibration offsets if the calibration data and the science data are taken at very different rotator angles. In order to minimise these effects *attached night-time arcs and screen flats are mandatory in IFU mode for all settings*. The corresponding overheads need to be taken into account at Phase 1 and can be estimated using Table 16.

Only one filter+grism combination per OB is permitted in IFU mode. Users who want to observe the same targets with different filter+grism combinations are requested to submit separate OBs for different filter+grism combinations and to consider the respective overheads.

6.7 VISIR, VLT Imager and Spectrometer for mid Infra Red

VISIR is the mid-infrared imager and spectrometer at the Cassegrain focus of UT3. It operates in the wavelength ranges $8 - 13 \mu\text{m}$ and $17 - 24 \mu\text{m}$.

Important note: VISIR has undergone a major intervention during Period 89. The upgrade project included the replacement of the old DRS detector with the new Aquarius arrays. Moreover, it included an intervention on the low-resolution spectroscopy mode in order to provide complete N-band coverage in a single shot.

Details are available on the [ESO VISIR instrument page](#). The intervention, recommissioning and a performance validation phase are planned to be completed at the start of Period 90, after which VISIR will resume regular operations.

6.7.1 Imaging Modes

In Period 91 the **imager** with a 1024×1024 detector array is offered with image scales of $0''.045/\text{pixel}$ (SF) and $0''.0762/\text{pixel}$ (IF). The filters available are: PAH1, ArIII, SIV_1, SIV, SIV_2, PAH2, SiC, PAH2.2, NeII.1, NeII, NeII.2, Q1, Q2, Q3, B8.7, B9.7, B10.7, B11.7, B12.4, J7.9, J8.9, J9.8 and J12.2.

The offered sensitivities correspond to the old detector. They range between about 4 and 20 mJy $10\sigma/1\text{ h}$ in the N band and between about 50 and 150 mJy $10\sigma/1\text{ h}$ in the Q band, depending on the selected filter and image scale.

The **Burst** read out mode is offered in **Visitor mode only** for the imager. It allows one to save every single DIT of the observation providing a time resolution of few tens milliseconds, depending on the instrument setup.

Please refer to [the VISIR Web pages](#) for further details.

6.7.2 Spectroscopy Modes

The **spectrometer** is offered for N and Q band spectroscopy in the following modes:

- Low resolution (LR) mode with a resolution of $R \approx 225$ for a $0''.4$ slit width in one setting that covers the full N band, with sensitivity about 50 mJy $10\sigma/1\text{ h}$.

- Medium Resolution (MR) mode with a resolution of up to $R \approx 3600$ in the N band for the wavelength ranges of $7.4 - 9.4 \mu\text{m}$ and $10.2 - 13.0 \mu\text{m}$, and with a resolution of $R \approx 1800$ in the Q band for the wavelength ranges of $17.1 - 19.0 \mu\text{m}$ and $19.9 - 20.3 \mu\text{m}$. Sensitivities are between about 200 and 2000 mJy $10\sigma/1 \text{ h}$, depending on the spectral range.
- High resolution (HR) mode with a resolution of $R \approx 15000 - 30000$ at wavelengths near the [H2 S4], [NeII], [H2 S1] lines in longslit mode, and a wider range of wavelengths including the [H2 S3], [H2 S2], [ArIII], [SIV], [CoII], [ClIV], [NeII], [CoIII], [CoI], [PIII], [FeII], [NiII], [SIII], [NaIV], HD(0,0) R(9),R(10) lines in cross-dispersed mode. Sensitivities are between about 2000 and 10000 mJy $10\sigma/1 \text{ h}$, depending on the spectral range and mode.

The VISIR spectrometer observing modes have the following restrictions:

- Acquisition is possible with the spectro-imager for targets brighter than 50 mJy using the [ArIII] or [NeII] filter. Please contact usd-help@eso.org for fainter targets.
- Absorption line spectroscopy is untested and flatfielding problems may be anticipated.

The slits cover a range of $0''.4 - 1''.0$ in width and $40''$ in length. The image scale in the spatial direction is $0''.0762/\text{pixel}$. Please refer to [the VISIR Web pages](#) for further details. Note that sensitivity limits in the MIR vary strongly with wavelength due to the atmosphere.

6.7.3 Calibrations

In imaging, one photometric standard star observation will be provided per science target with no cost for the user. In low-resolution spectroscopy, the Observatory will provide spectrophotometric observations of a telluric standard star. Such a calibration measurement will be performed at least once per night, per instrument configuration. The Observatory does **not** provide standard star calibrations for VISIR medium- and high-resolution spectroscopy. If MR, HR or any additional standard star observations are required, the user has to supply his/her own calibration OBs using the corresponding calibration templates. The observing time needed to execute this calibration is charged to the programme.

6.7.4 Exposure Time Calculator

The users are requested to use the ETC (<http://www.eso.org/observing/etc>) in order to test the feasibility of their programme and estimate the corresponding execution time. The corresponding observing overheads are given in Table 16. For more details please consult the VISIR User Manual available at <http://www.eso.org/instruments/visir/doc/>.

6.8 HAWK-I, High Acuity Wide-field K-band Imager

HAWK-I is a near-infrared ($0.85-2.5 \mu\text{m}$) wide-field imager installed at the Nasmyth A focus of UT4. The instrument is cryogenic (120 K, detectors at 75 K) and has a fully reflective design. The light passes four mirrors and two filter wheels before hitting a mosaic of four Hawaii 2RG 2048×2048 pixels detectors. The final f-ratio is $f/4.36$ ($1''$ on the sky corresponds to $169.4 \mu\text{m}$ on the detector).

As of Period 83, proposers can request the Rapid Response Mode (RRM) to trigger HAWK-I observations. For details on RRM policies, please see Section 11.3.1.

Important note: Due to possible future changes, Large Programmes using HAWK-I will not be accepted in Period 91.

Online information on HAWK-I can be found via the [instrument web page](#).

6.8.1 Filters and field of view

HAWK-I is offered with 10 observing filters placed in two filter wheels: 4 broad-band filters Y, J, H, Ks (with transmission curves identical to the [VIRCAM](#) filters), as well as 6 narrow-band filters (Br γ , CH4, H2 and three cosmological filters at 0.984, 1.061, and 2.090 μm).

In particular, please note that the filter at 1.187 μm has been removed to make space to a new filter, at 0.984 μm since August 2012.

The field of view of HAWK-I on the sky is $7.5' \times 7.5'$, covered by the mosaic of the four Hawaii-2RG chips. The four detectors are separated by a cross-shaped gap of $\sim 15''$. The pixel scale is $0.1064''/\text{pix}$ with negligible distortions ($< 0.3\%$) across the field of view. The image quality is seeing limited down to at least $0.4''$ seeing (*i.e.* $0.3''$ measured in K).

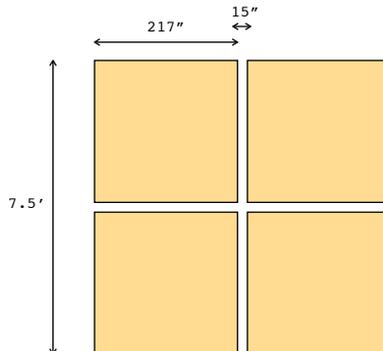


Figure 7: Sketch of the HAWK-I field of view.

6.8.2 Observing modes

HAWK-I is a wide-field imager and the standard observing mode is imaging.

In Period 91, the Fast Photometry (FastPhot) mode is only offered in Visitor Mode. However, in the case of lunar occultations only disappearances can be supported in Service Mode. In the case of observing appearances, Visitor Mode must be requested. For more details about the FastPhot Mode, please refer to the [HAWK-I User Manual](#).

6.8.3 Brightness limit and persistence

The HAWK-I detectors show a persistence effect if the observed sources are heavily saturated, which affects subsequent observations of faint sources. In general, the maximum intensity per DIT allowed for Service Mode observations correspond to 5 times the saturation level. Observations of fields containing objects brighter than Ks=8.1 mag, H=9.1 mag or J=8.8 mag should be carried out in Visitor Mode. When using Fast Photometry these limits can be broken under bad (recommended) seeing conditions and if noAO (BadAO) is used. The magnitude of the brightest source in the field must be explicitly written in the proposal.

6.8.4 Limiting magnitudes

Typical limiting magnitudes of HAWK-I (S/N of 5 on a point source, 3600 s integration on source) under average conditions ($0.8''$ seeing, 1.2 airmass) are given in Table 8.

The read-out noise is around $5 e^-$ for DIT > 15 s, while the dark current of the instrument is around $2 e^-/\text{pix}/\text{s}$.

The [exposure time calculator](#) should be used for detailed exposure time calculations, in particular for narrow-band filters,

Fast photometry will be offered in **Period 91** only in *Visitor mode*.

Table 8: HAWK-I limiting magnitude examples

Filter	Limiting mag	Limiting mag
	[Vega]	[AB]
J	23.9	24.8
H	22.5	23.9
Ks	22.3	24.2

6.9 NACO (NAOS+CONICA)

NACO provides adaptive optics-assisted imaging, polarimetry, spectroscopy, and coronagraphy in the 1–5 μm range and is installed at the Nasmyth B focus of UT4.

Important note: Large Programme proposals using NACO will not be accepted in Period 91 due to the planned installation of MUSE in the course of 2013.

Details of the instrument, tools and observing modes can be found through the [NACO Web page](#).

6.9.1 Adaptive optics correction with Natural and Laser Guide Stars

NAOS, the adaptive optics front-end, has been designed to work with Natural Guide Stars (NGS) and *moderately* extended objects. It is equipped with one infrared and one visual wavefront sensor. For a point-like reference source with a visual brightness of $V=12$, NAOS can provide Strehl ratios as high as 50% (on axis) in the K band in optimal weather conditions. A more realistic value is 40% in good conditions. It can provide partial correction for targets as faint as $V=17$. Users should use [the preparation software](#) and the [NACO ETC](#) for the preparation of their proposals.

NAOS can also be used with the LGS (LGS mode, see Section 4.2.3 for additional details). Two modes are possible:

- with a tip-tilt star (TTS), of V magnitude in the range 12–18 and with a maximum angular separation of $55''$ from the science target. However, the performance of the adaptive optics correction decreases with increasing angular separation from the science targets. Finally, the choice of the TTS imposes some constraints on the field orientation. The name of the TTS must be specified in the target list of the Phase 1 proposal using the ESOFORM proposal template;
- without a tip-tilt star, also called *seeing enhancer mode*. The name of the TTS must be left blank in the target list of the Phase 1 proposal.

It is compulsory to provide the magnitude of the star and the bandpass in which the magnitude is given for both NGS and LGS with TTS. Observations in LGS mode require either clear (CLR) or photometric (PHO) conditions: the transparency constraint must be set accordingly in the proposal.

In addition, LGS without TTS (seeing enhancer mode) must require seeing conditions better than $0.8''$. Separate runs should be specified in the proposal form for observations using a NGS, on the one hand, and for LGS observations, on the other hand.

The LGS mode of NACO is offered in Service and Visitor Mode.

Note that PARSEC, the laser currently used by the **Laser Guide Star Facility** will be decommissioned during Period 90. It will be replaced by a prototype of the laser used by the coming AOF. Its commissioning is expected to be completed before the start of Period 91.

6.9.2 Offered modes

CONICA is the imager and spectrograph which is fed by NAOS. CONICA offers a large range of modes, filters, grisms and masks. Only the main characteristics of each mode are described here. Details can be found in the [NACO Users' Manual](#).

For low Strehl ratios (a few percent or less), users should carefully weigh the advantages of using NACO over other IR instruments such as HAWK-I, which generally have larger fields of view, lower backgrounds and higher throughputs.

A summary of the offered modes is given in Table 9.

Table 9: NaCo modes in Period 91

Imaging Imaging + cube noAO (Open loop Imaging + cube)	SM and VM SM and VM SM and VM	All filters except Mp Limited setups Limited setups
SDI+ Lyot Coronagraphy	SM and VM SM and VM	Replaces SDI C_0.7, C_1.4 (all cameras), C_0.7_sep_10 (not S13 camera), field and pupil tracking
Phase-Mask Coronagraphy (4QPM)	SM and VM	Optimized for H and K field and pupil tracking
APP Coronagraphy SAM SAM+Pol	SM and VM VM VM	Simple Imaging, L' and NB_4.05 only Includes pupil tracking and cube mode SAM with Woll_00
Polarimetry Polarimetry+cube	SM and VM SM and VM	Woll_00, retarder plate only Woll_00, retarder plate only
Grism Spectroscopy Grism Spectroscopy + APP	SM and VM VM	All modes except pupil tracking All modes except pupil tracking, no pipeline support
Prism Spectroscopy	VM	Limited setups
LGS LGS/SE	SM and VM SM and VM	See Section 4.2.3 See Section 4.2.3
Pupil Tracking	SM and VM	Simple Imaging, SDI+, APP, Lyot and Phase Masks (4QPM)

Visitor Mode must be requested for programmes requiring special calibrations, *i.e.* calibrations not defined in the NACO Calibration Plan (see Section 6.9.3).

SM proposals require a detailed justification for the need for SM and will be considered on a case-by-case basis as part of the technical feasibility evaluation of the Observatory. See Section 6.9.3 for details.

Imaging, Polarimetric and Coronagraphic Modes Imaging, polarimetry and coronagraphy can be done with a variety of filters, pixel scales and fields of view (Table 10).

Table 10: NACO pixel scales and fields of view

Wavelength range	Scale (mas/pix) ¹	FOV (arcsec)
SW filters ²	54.3	56×56
SW filters	27.0	28×28
SW filters	13.3	14×14
NB_4.05,NB_3.74	54.7	56×56
NB_4.05,NB_3.74, L'	27.1	28×28

[1] For reference: the diffraction limited FWHM of a point source imaged with an 8m telescope are J(32 mas), H(42 mas), Ks(56 mas), L'(98 mas), and M'(123 mas).

[2] Short Wavelength (SW) filters refer to filters with wavelengths shorter than 2.5 μm .

Polarimetry observations are carried-out using the retarder plate and the Wollaston_00. J-band polarimetry observations are not possible because of the location of the J filter in the same wheel as the Wollaston.

Coronagraphy can be performed with a portfolio of focal-plane masks. NACO indeed offers a choice

of occulting Lyot-type masks of $0.7''$ and $1.4''$ in diameter, as well as a semi-transparent mask of $0.7''$ diameter, with a transmission of 0.4% (0.3%) for H-band (Ks-band). NACO also offers a series of phase-mask coronagraphs in both Service and Visitor modes: one “four quadrant phase masks” (4QPM) is optimised to work at K band (4QPM_K) and offers a $13'' \times 13''$ FOV, while another one (4QPM_H) is optimised for H band observation and has an $8'' \times 8''$ FOV. Owing to the fix of the drift of the PSF in pupil tracking mode, all focal-plane coronagraphs (Lyot and 4QPM) has been offered in SM both in field and pupil tracking modes since Period 90.

Since P86, the pupil-plane apodizing phase plate (APP) is available on NACO in the 3-5 μm domain. As it is operationally equivalent to direct imaging without mask, APP imaging is offered in SM and VM. As explained by Figure 5-18 of the [NACO Users' Manual](#) (Section 4.6.11), the useful field of view (FoV) with the L27 camera is about $28''$ in X but only $8''$ in Y. This limited FoV must be taken into account in choosing the offset pattern. Observations in cube mode with a window of 512×514 pixels further reduce the useful FoV to to $\sim 14'' \times 2.5''$.

Since P87 APP enhanced (grism) spectroscopy is offered but only in VM and for the setups detailed in Section 5.5.2 of the [NACO Users' Manual](#).

The approximate limiting magnitudes for imaging are listed in Table 11. These limits depend on many factors such as the readout mode, the NAOS dichroic, etc. Users should use [the preparation software](#) and [the ETC](#) for detailed calculations.

Table 11: NACO magnitude limits with the NAOS visual dichroic

Band	J	H	Ks	L'
FWHM [mas]	32	42	56	98
Sky Background [mag]	16.0	14.0	13.0 ^[1]	3.0
Limiting Magnitude ^[2]	24.05	24.05	23.35	18.55

[1] With the NAOS N90C10 dichroic, the background for Ks is 11.0 mag per square arc second.

[2] 5 sigma in 1 hour using a V=11.5 mag reference $10''$ away from the source with a visible seeing of $0.8''$. Please note that these limits are valid for point sources and have been computed over apertures with a radius of 1.25 times the values listed in the first row. For NB filters, subtract 2 to 3 magnitudes; for spectroscopy, subtract 4 to 5 magnitudes.

For L'-band imaging without chopping, observations are done only with the AutoJitter template to ensure proper sky subtraction.

Observations leading to saturation of an object in the field-of-view produce remanence and electronic ghosts. As a consequence, observational constraints listed in Section 6.14 of the [NACO Users' Manual](#) must be respected. In particular, the diameters of the saturated area for each bright target must be provided in the Phase 1 proposal. **Observations leading to a saturated area whose diameter exceeds 4 pixels must be clearly identified in the technical justification in the Phase 1 proposal. They must usually be carried out in visitor mode; in special cases, they can be executed in service mode pending the approval of a waiver during the Phase 2 preparation.**

Simultaneous Differential Imager (SDI+) High contrast imaging can be carried out using the simultaneous differential imager (SDI+). Contrasts of 30,000 can be obtained at $0''.5$ in 40 min at S/N of 6 between a bright ($H < 7$ mag) primary star and a methane rich ($T_{\text{eff}} < 1000$ K) companion. The pixel scale of this mode is 17.25 mas/pixel and the FOV is $\approx 8'' \times 8''$. For more information, consult the [NACO](#) web pages.

Spectroscopic Modes Grism spectroscopy can be carried out using two slit widths (86 mas and 172 mas). The slits are $40''$ long (restricted to $28''$ for the S/L27 cameras).

Prism spectroscopy is only offered in VM for a limited number of setups and without any pipeline support.

Slitless spectroscopy has been decommissioned.

APP enhanced grism spectroscopy is available in visitor mode only and for limited setups since P87 (see above).

6.9.3 NACO Calibration plan and special calibrations

The NACO [calibration plan](#) does not support all combinations of detector readout mode and instrument setup. Observations requiring special calibrations must be carried out in VM.

In exceptional cases, SM observations that require special calibrations will be considered and only if the following informations are provided in the proposal:

- A comprehensive justification of the need for SM observations as opposed to VM;
- A detailed description of the calibration strategy and needs (box 9.C of the proposal templates);
- Instrument setup(s) compatible with the special calibrations needs, by uncommenting the provided lines (box 14 of the proposal templates).

6.10 SINFONI, Spectrograph for INtegral Field Observations in the Near-Infrared

SINFONI is a near-infrared (1–2.5 μm) integral field spectrograph fed by an adaptive optics (AO) module. It is currently installed at the Cassegrain focus of UT4.

The spectrograph operates with 4 gratings (J, H, K, H+K) with spectral resolutions of 2000, 3000 and 4000, corresponding to the J, H and K gratings respectively, and $R \sim 1500$ with the H+K grating. Each wavelength band fits fully onto the Hawaii 2RG (2k \times 2k) detector. The SINFONI field of view on the sky is sliced into 32 slices. The pre-slit optics allows one to choose the width of the slices. The choices are 250 mas, 100 mas and 25 mas, leading to fields-of-view of $8'' \times 8''$, $3'' \times 3''$, and $0.8'' \times 0.8''$, respectively. Each one of the 32 slitlets is imaged onto 64 pixels of the detector. Thus, one obtains $32 \times 64 = 2048$ spectra of the imaged region of the sky.

The adaptive optics module of SINFONI can be used with natural guide stars (NGS), the laser guide star (LGS), or without guide stars (the noAO mode), in which case the AO module just acts as relay optics and the spatial resolution is dictated by the natural seeing. If more than one of these modes are used in a given programme, they should be requested as part of different runs.

PARSEC, the laser currently used by the **Laser Guide Star Facility** will be decommissioned during Period 90. It will be replaced by a prototype of the laser used by the coming AOF. Its commissioning is expected to be completed before the start of Period 91.

Important notes:

- In order to allow for the installation of the Deformable Secondary Mirror, UT4 will not be available during part of Period 92. Large Programmes using SINFONI should take this limited availability of SINFONI into account.
- The **Laser Guide Star Facility** is expected to be decommissioned during Period 92 to allow for the installation of the Deformable Secondary Mirror on UT4, part of the Adaptive Optics Facility. All programmes requiring its use should therefore be completed by then.

In the NGS mode, the star should be brighter than $R \sim 11$ mag for peak performance. However, the AO can work (and will provide moderate image quality improvement) with stars as faint as $R \sim 17$ mag in excellent seeing conditions. The NGS should be as close as possible to the scientific target (if not the science target itself), and usually closer than $10''$. The NGS can be chosen to be as far as $30''$ away from the science target (or as far as $60''$ but with some constraints on the field orientation), and, depending on atmospheric conditions, the AO system can still provide a mild

improvement in the encircled energy. The name of the NGS must be specified in the target list of the Phase 1 proposal using the ESOFORM proposal template.

The LGS mode (see Section 4.2.3 for additional details) can be used with or without a tip-tilt star. In Period 91 the LGS mode of SINFONI is offered in Service and Visitor Mode.

If a tip-tilt star (TTS) is used, it should be in the R magnitude range 12–18 and can be as far away as $60''$ from the science target. However, performance decreases with increasing distance, and there are some constraints on the field orientation. The name of the TTS must be specified in the target list of the Phase 1 proposal using the ESOFORM proposal template.

The LGS mode without a tip-tilt star (the so-called seeing-enhancer mode) is also offered. Users requesting this mode must specify CLR or better for the transparency, and a seeing better than $0.8''$ in their Phase 1 application. In the target list of the Phase 1 proposal using the ESOFORM proposal template, the TTS name should be left blank. Since Period 87, users of this mode requiring observation of a PSF calibrator associated with a science target must make use of the template 'SINFONI_lfs_cal_GenericOffset', that allows one to take the PSF calibrations data within the same OB as the science data (please see the [SINFONI User Manual](#) for details). For the observation of the PSF calibrator sufficient time must be requested in the proposal.

The `fast_acquisition` template must be used only in case of acquisition of bright targets, which would saturate the detector in closed loop with the large scale. Excellent astrometry is required for this acquisition mode.

As of Period 87, proposers can request the Rapid Response Mode (RRM) to trigger SINFONI observations. This mode is offered with the NGS and noAO modes of SINFONI. For details on RRM policies, please see Section 11.3.1.

Pre-Imaging runs can also be proposed with SINFONI. Such observations are typically dedicated to test the feasibility of a specific science programme (*e.g.* faint target, difficult acquisition).

Further details can be found on the [SINFONI instrument web pages](#).

6.10.1 Instrument Performance

Table 12 gives the limiting magnitudes (S/N of 5) for continuum sources integrated over the typical size of the point-spread function in one hour of integration time.

Table 12: SINFONI fields of view and limiting magnitudes

Field of View	Spatial Scale	Mode	Limiting Magnitudes (continuum)
$8'' \times 8''$	125×250 mas	noAO	J=20.2, H=19.9, K=17.9, H+K=19.6
$3'' \times 3''$	50×100 mas	NGS	J=19.4, H=19.6, K=18.8, H+K=19.8
$0.8'' \times 0.8''$	12.5×25 mas	NGS	J=17.8, H=18.7, K=18.3, H+K=19.2

These values were calculated for a visual seeing of $0.8''$ which would provide infrared seeing values of $0.67''$, $0.63''$, $0.59''$ and $0.61''$ at the central wavelength of the J, H, K and H+K gratings, respectively. For the closed loop adaptive optics observations with natural guide stars (NGS) we have assumed a guide star at a distance of $10''$ with a photometric brightness of $R = 12$ and $B-R = 1.5$ magnitudes. We encourage the use of the exposure time calculator for more detailed estimates (<http://www.eso.org/observing/etc>).

6.10.2 Brightness Limits

To avoid saturation of the detector and detector persistence, which affects subsequent observations of faint sources, no objects with J, H, K magnitudes < 6 mag must be visible in a field of view of $15''$ around the AO guide star and/or the science target. However, if `fast_acquisition` is used, the limits are brighter by 1 and 2 magnitudes for $0''.1/\text{pix}$ and $0''.025/\text{pix}$ respectively.

To exclude any risk of artefacts produced by detector persistence, in all templates DITs must always be selected such that intensities are at most 8 000 for K, 7 000 for H and H+K and 6 000 for

J ADUs/DIT over the entire spectrum.

6.10.3 Sky Subtraction

The user should note that sky offset fields are mandatory for observations in the 25 and 100 mas scales. The corresponding overheads have to be taken into account when estimating the required time for an observing run. Typically, 50% (or 33%) of the observing time is spent on sky if $\text{NDIT}_{\text{Sky}} = \text{NDIT}_{\text{Target}}$ (or $\text{NDIT}_{\text{Sky}} = 1/2 \text{NDIT}_{\text{Target}}$).

6.10.4 Calibrations

Observations of telluric standard stars at an airmass within ± 0.1 of the science observation will be offered as part of the SINFONI calibration plan for all modes available (*i.e.* for all combinations of image scales and gratings). Darks, internal flat-fields, and wavelength calibrations are also part of the SINFONI calibration plan and are taken during daytime. Time to obtain special calibrations, such as observations of PSF reference stars, must be requested in the proposal.

6.10.5 Modes that are not offered

Observations with the sky spider and spectral dithering are not offered in Period 91.

6.11 MIDI, MID-infrared Interferometric instrument

MIDI is the VLTI instrument for N-band ($8 - 13 \mu\text{m}$) interferometry. It is a two-beam recombiner giving values of moduli of fringe visibility (samples in the (u,v) plane) depending on the wavelength (spectral resolution: $R = 30$ or $R = 230$). MIDI is offered in both Service and Visitor Modes and can be used with either the UTs or the ATs. For a list of the offered telescope configurations, please refer to [the VLTI baseline page](#).

Important note: Given the arrival of the second generation VLTI instruments, ESO cannot guarantee the availability of MIDI beyond Period 91. Proposals for Large Programme using MIDI beyond Period 91 will not be accepted.

Since Period 88 a correlated flux mode has been offered. In the MIDI fringe exposures the background can be subtracted without residuals because it is fully uncorrelated. This is not possible for the photometry, and for this reason good fringe data can be obtained for fainter magnitudes than good photometry data. The correlated flux mode is suited for observations for which visibilities are not needed, *i.e.* when it is intended to compare them to correlated flux observations of the same object at other projected baselines.

Starting from Period 91 the Fringe Sensor Unit FSU-A can be used as an external K-band fringe-tracker for MIDI. The fringe-tracker is only offered on-axis, *i.e.* fringe tracking on the science target itself. There are two immediate advantages in using the FSU-A with MIDI. A sensitivity gain during the observations themselves because of the OPD correction applied, which is more precise than the standard MIDI self-coherencing. As a consequence the fringes are stable on the detector. An advantage in the reduction and calibration process of the MIDI data where the measurements of K-band group and phase delay constitute valuable information. Users can only benefit optimally from this new mode if they are expert in MIDI data processing. For $K = 7.5$ and for seeing $0''.6$, MIDI with FSU-A reaches a sensitivity with the ATs comparable to that reached by stand-alone MIDI observations with the UTs. Thus, fainter objects can now profit from the extended uv -coverage provided by the AT array. **Note:**, because of the faintness of the sources targeted in this mode, the MIDI photometry exposures will be worthless and are therefore not taken. The mode thus allows only to get information on the morphology of a target via an extended uv -coverage, but not on its absolute angular size, like in correlated flux mode.

The MIDI + FSU-A mode is offered in VM only and the data produced is not supported by the ESO pipeline. The execution time is expected to be conservatively 50% longer than normal OBs.

Table 13: MIDI limiting uncorrelated flux (LUF).

Telescopes	Beam combiner	Spectrograph	Limit (N mag)	Limit (Jy@12 μ m)
UTs	CORR_FLUX	PRISM	5.7	0.2
UTs	HIGH_SENS	PRISM	4	1
UTs	HIGH_SENS	GRISM	2.8	3
UTs	SCLPHOT	PRISM	3.2	2
UTs	SCLPHOT	GRISM	2	6
ATs	HIGH_SENS	PRISM	0.74	20
ATs	HIGH_SENS	GRISM	0.31	30
ATs	SCLPHOT	PRISM	0.0	40
ATs	SCLPHOT	GRISM	-0.44	60

The main features of MIDI for Period 91 are:

- Interference fringes recorded in “dispersed-Fourier” mode (long slow scan with coherencing at 1-Hz rate).
- Spectrograph optics: either NaCl PRISM mode ($R = 30$), or KRS5 GRISM mode ($R = 230$). In correlated flux mode the PRISM is used.
- Beam combiner optics: either “HIGH_SENS” (no simultaneous photometric measurement of beams before combination), or “SCLPHOT” (simultaneous photometric measurement). In correlated flux mode the HIGH_SENS optics is used.
- Limiting uncorrelated magnitudes are given in Table 13.
- For MIDI, the correlated flux is defined by the uncorrelated flux (in Jy@12 μ m) multiplied by the estimated visibility. Except for the correlated flux mode, where the MIDI limiting correlated flux (LCF) limit is equal to the MIDI limiting uncorrelated flux (LUF) limit, the LCF can be obtained for each mode from the LUF of this mode using: $LCF = 0.5 \times LUF$ (see Table 13).
- Various spectral filters for acquisition images.

Details on MIDI and its instrumental modes can be found on the [MIDI web page](#).

The raw accuracy of the visibility measurements is typically better than 20%. The highest accuracy for calibrated visibilities can be obtained in SCLPHOT mode, provided target and calibrator are both brighter than 15Jy for UTs and 200Jy for ATs. The visibility of the Science source is absolutely calibrated by observing a Calibration Source. Two calibration modes are offered: Science-Calibration (SCI-CAL) for normal accuracy requirements, or Calibration-Science-Calibration (CAL-SCI-CAL) for high accuracy requirements.

For the correlated flux mode, a CAL-SCI-CAL sequence is mandatory with the additional restriction that the same calibrator star should be used before and after the science target observations. Since correlated fluxes are not normalized like visibilities, they must be compared to other correlated fluxes of the same object taken at different baseline vectors in order to infer the source geometry. A single correlated flux measurement is not useful. As correlated flux measurements are obtained in Visitor Mode, source photometry is taken at the user’s discretion. ESO does not guarantee this photometry to be useful, in particular for visibility calibration.

A proposal can consist of different observations of the same target with different baselines and/or hour angles in which case the observing time to be requested is simply computed as the number of required time-slots multiplied by the duration of one slot as given in Table 16. Time-constrained observations (*e.g.* variable objects) can be requested.

6.12 AMBER, Astronomical Multi-BEam combineR

AMBER is a near-infrared, multi-beam interferometric instrument, combining up to 3 telescopes simultaneously. In Period 91, AMBER can be used with UTs or ATs. For specifications of the UT and AT performances see Section 4.2.2 and Section 4.2.4. All possible triplets of UTs are available, and a number of selected AT combinations. For the telescope positions and baseline lengths of the different AT and UT baselines, please refer to [the VLTI baseline page](#).

Because of the limited availability of UTs for AMBER, any scientific programme on the UTs should be designed so that scientifically meaningful results can be achieved in a single night.

Important note: In addition, in order to allow for the installation of the Deformable Secondary Mirror, UT4 will not be available during part of Period 92. Large Programmes using UT4 with AMBER should take this limited availability of UT4 into account.

6.12.1 Spectral Modes and Coverage

The following spectral modes are offered: the Low Resolution H+K bands (LR-HK), Medium Resolution K band (MR-K), High Resolution K band (HR-K) and Medium Resolution H Band (MR-H). For central wavelengths and wavelength coverages for LR-HK, MR-K, MR-H and HR-K see [the AMBER web page](#).

6.12.2 Integration times, DIT

External fringe tracking with FINITO is available on both the UTs and the ATs. The use of FINITO allows the entire AMBER detector to be read, maximizing simultaneous spectral coverage. It also allows the AMBER DITs to be adjusted to yield sufficient signal-to-noise ratio per frame in the fringes. However, the DIT has to remain small since, even with the help of the fringe tracker, interferometric fringes get significantly blurred after integrations lasting seconds. Note that medium and high resolution are only offered with external fringe-tracking as standard setup.

If no fringe tracker is used (*i.e.* faint and/or extended objects, or airmass too high) the integration times with AMBER will have to be short to minimise the blurring caused by the atmospheric turbulence. In Low Resolution, without external fringe tracking, the maximum authorized DITs are set to 100ms on the ATs and 50ms on the UTs. If *absolute visibility* measurements is the goal, the shortest authorized DITs are recommended (see Table 2 in the Template manual); if *closure-phase* and *wavelength differential-mode* are the quantities of interest, the maximum recommended DIT should be used.

As of Period 91 it will be possible (only in visitor mode) to operate AMBER in self-coherencing mode which significantly improves the quality of data when FINITO cannot be used for fringe tracking. Check the [AMBER Users' Manual](#) for details.

Special Modes: Special Programmes may require a different combination of modes and DITs. This is the case when using MR or HR without external fringe-tracking. A shorter DIT strongly reduces the limiting magnitude. It also reduces the spectral coverage that can be read. Any proposal requiring a non-standard DIT should carefully detail the justification and the technical feasibility. It will be scheduled in Visitor Mode.

In Service Mode the AMBER DITs ought to be chosen while preparing the Phase II. The AMBER template manual, available on the [AMBER documentation page](#), provides the recommended DITs for all offered configurations.

6.12.3 Limiting magnitudes

AMBER and the VLTI have limitations in magnitude (V-band, H-band and K-band), fringe contrast (H-band and K-band), airmass and seeing. The details of these limitations can be found on the

[AMBER web page](#);, as well as the most updated values on visibility accuracy and closure phase accuracy.

The limiting magnitudes are estimates on the basis of at least 50% of the frames being successfully processed by the AMBER pipeline. If a lower yield rate is accepted, an increase of up to 0.5 in the limiting magnitude can be achieved. In this case, the user should account for additional integration in the same spectral band (Section 6.12.5) to obtain more frames.

The limiting correlated magnitude depends on the AMBER spectral resolution, the FINITO tracking mode (No-Tracking, Group-Tracking or Fringe-Tracking), and the seeing conditions. The main interest of FINITO Group-Tracking at faint magnitudes is to enhance the SNR on the AMBER closure-phase, but reducing the flux in the H-band.

In order to be observable with FINITO, the target should have:

H magnitude:	-2 to 5 (ATs)	1 to 7 (UTs)
Visibility in H:	> 15% (ATs)	>10% (UTs)

6.12.4 Calibration strategies

AMBER requires frequent calibration on-sky, using calibrator stars. We offer two calibration modes: “CAL-SCI-CAL” and “CAL-SCI”. The first one is the standard mode which should be used in most cases, in particular when *absolute calibration* is required for best accuracy. Absolute calibration is required in most programmes, but for some programmes *wavelength differential quantities* provide the astrophysical information. In that case, “CAL-SCI” (or indifferently “SCI-CAL”) is sufficient.

The choice of on-sky calibration strategy should be specified in the “calibration request” section of the proposal. **The strategy will be reviewed particularly carefully during the technical feasibility. Proper justification must be provided if “CAL-SCI” is requested instead of the standard “CAL-SCI-CAL”.**

6.12.5 Execution times

For each Observing Block (OB), either SCI or CAL the proposer(s) should consider the following:

- Acquisition requires 10min in HR or MR, 5 minutes in LR, including the spectrograph setup and the recording of the calibration fringes (so called P2VM). See Table 16 for more details.
- Integration requires 15min. A maximum of 3 integrations is allowed per OB, which could consist in repeating 3 times the same integration or 3 integrations around 3 different central wavelengths *within the same spectral setup*.

Hence a normal “CAL-SCI-CAL” sequence requires 75min in MR or HR and 60min in LR.

When observing targets close to the limiting magnitude in MR or HR, it is recommended to double or triple the integration, and to focus on *wavelength differential quantities*. Hence a “SCI-CAL” sequence with triple integration requires $2 \times 1\text{h} = 2\text{h}$.

Using a non-standard DIT (below 200ms in MR and HR, or below 25ms in LR, see Section 6.12.2) can strongly reduce the spectral coverage available within one integration. To obtain measurements at different position within the range of the spectrograph setup, the user can use 2 or 3 integrations with different central wavelengths.

6.13 VIRCAM, VISTA InfraRed CAMera

VISTA (Section 4.2.5) is equipped with the near infrared camera VISTA InfraRed CAMera (VIRCAM), which covers a 1.65 degree diameter field of view with a loosely packed detector mosaic totalling ≈ 67 million pixels of mean size $0.339''$. The point spread function (PSF) of the telescope+camera system including pixels is measured to have a FWHM of $0.51''$.

Further information on this instrument can be found on the [VISTA web page](#).

6.13.1 Filters

The filter wheel of VIRCAM has eight slots. One is reserved for a blank, and the rest holds the filters listed in Table 14. "Visitor" filters can be accommodated by replacing one of the currently available filters, but the specifics of the cryogenic instrument and the usage of the current filters in already scheduled surveys makes this difficult. Filter exchanges must be linked to instrument and telescope maintenances which are expected to occur about once every two years. Please contact usd-help@eso.org for further details. As described in Section 13.2, proposers wishing to use their own filters need prior approval by the observatory.

Table 14: VISTA filters

Filter	Wavelength [μm]	FWHM [μm]	Comment
Z	0.88	0.12	required by public surveys
Y	1.02	0.10	required by public surveys
J	1.25	0.18	required by public surveys
H	1.65	0.30	required by public surveys
Ks	2.15	0.30	required by public surveys
NB1.18	1.18	0.01	required by public surveys
NB980/NB990	0.98/0.99	0.01	2 sets of filters in one slot; require instrument rotation for complete observations

6.13.2 Focal plane geometry

The sixteen 2048×2048 pixel IR detectors (Raytheon VIRGO HgCdTe $0.84 - 2.5\mu\text{m}$) in the camera are not buttable and are arranged as shown in Fig. 8. The diagram shows the focal plane as it would be seen looking directly down the camera body (down the Z-axis which on the telescope points towards the sky). On the sky (in the default instrument rotator position) +Y corresponds to N, and +X to West.

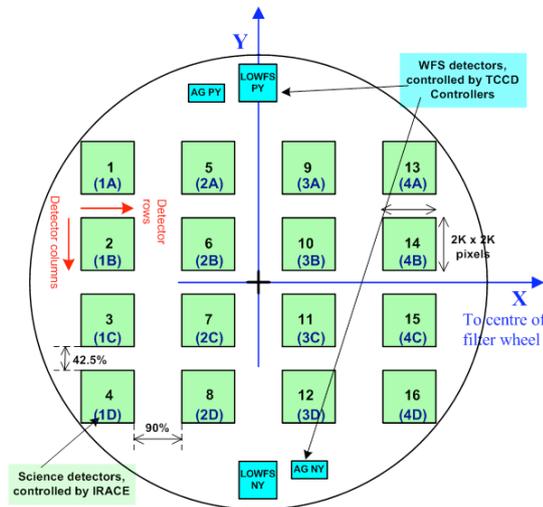


Figure 8: VIRCAM focal plane geometry

A single integration of length DIT secs (or a co-added series of these known as an Exposure) produces a sparsely sampled image of the sky known as a **pawprint**. The area of sky covered by the pixels of a pawprint is 0.6 deg^2 . Full, almost uniform, sky coverage of a **tile** of 1.501 deg^2 can be achieved with six pawprints, offset by $\pm 47.5\%$ in y at two respective x-positions offset by 95% of the detector size. Any sky position of a tile will fall at least on two of these six pawprints.

6.13.3 Instrument performance

Table 15 summarizes the instrument performance as established during commissioning. The instrument performance can be further evaluated from the publicly available Science Verification data sets which are available through the [VISTA Science Verification web page](#).

Table 15: VISTA performance

pixel scale	0.34"/pixel
best image quality achieved	0.6" including seeing, optics and sampling
estimated image quality	Paranal seeing convolved with the instrument PSF of 0.51"
image distortion	< 15% in the corners
photometric calibration	$\pm 2\%$ RMS in respect to 2MASS in J, H, Ks
photometric calibration	$\pm 2\%$ RMS internally
astrometric accuracy	< 0.2" with respect to 2MASS
sky concentration/illumination	< 5% absolute, can be corrected down to < 2%
detector	16 Raytheon VIRGO HgCdTe arrays, sensitive over 0.84 to 2.5 μm , high quantum efficiency, large number of hot pixels, some dead areas on detector 1

6.13.4 VISTA Public Surveys and Open Time Proposals

VISTA will be dedicated for its first five years of operation primarily to the execution of six public surveys. At least 75% of the observing time will be devoted to them. For details please refer to the [VISTA Public Survey web page](#).

As of Period 87, a limited amount of observing time is made available to the community. Open time proposals should clearly justify the scientific goals and why they are not achievable through the scheduled public survey observations. Only those proposals that have complementary constraints and coordinate ranges with respect to public survey observations may be scheduled, as the highest priority is given to advance public surveys on VISTA. Any unallocated time will be returned to the public surveys. All VISTA observations are carried out in Service Mode.

Users who plan to propose their own "visitor" filter set to be used in their science programme have to consider that only one free slot is available in the VIRCAM filter wheel for visitor filter and that the selected filter will be mounted for a minimum of two years corresponding to the planned maintenance intervals of the instrument. At proposal submission, the proposal PI will have to demonstrate the availability of the visitor filter set, its compatibility with the instrument requirements, and the basic performance of the individual filters.

6.13.5 VIRCAM calibration plan

The VIRCAM calibration plan is described in the VIRCAM/VISTA User Manual. It is continuously refined and improved based on ongoing observations. Future applicants should presume that the photometric calibration is based on 2MASS stars in the field of view, with an extinction correction according to Hodgkins et al. (2009, MNRAS 394, 675) in the extrapolated Y and Z bands. Proposers will have to include the time for additional standards in their proposals.

6.14 OmegaCAM

OmegaCAM is the wide-field imager for the Cassegrain focus of the VLT Survey Telescope (VST). It is the only instrument on this telescope. All observations are carried out in service mode. OmegaCAM has started regular scientific observations in Q4/2011.

In the first two years of operation ESO expects to dedicate all of the available observing time on VST to Public Surveys, Chilean and GTO programmes. Further details of the public surveys are available at the [Public Survey web page](#).

Important note: Only Chilean and GTO programme proposals will be accepted in Period 91 (Sects. 11.4 & 13.1). ESO reserves the right to reject any submitted proposals that do not conform to these requirements.

In the first semesters of operation there has been a lack of OmegaCAM programs that accept relaxed observing conditions. ESO therefore especially encourages proposals (GTO/Chilean for THN clouds or seeing $\gtrsim 1.5$): Also the full moon period has typically been undersubscribed for moderate to large seeing. Possible science cases include proper motion studies, photometric monitoring in single fields, and generally accumulating photons in pre-calibrated fields.

The VST/OmegaCAM system is designed to critically sample the best seeing at Paranal over a wide field: the VST provides a 1 degree unvignetted field of view, which OmegaCAM samples with a 32-CCD, 16k x 16k detector mosaic at 0.21 arcsec per pixel. The CCDs are thinned, blue-sensitive, 3-edge butttable CCD44-82 e2v devices of high cosmetic quality. Image quality is specified such that in the absence of seeing 80% of the energy from a point source should fall within a 2x2 pixel area over the full field. The field distortion is very low, so that the image scale is virtually constant over the whole field. There are narrow gaps between the CCDs: the overall geometric filling factor of the array is 91%.

In addition to the 32 CCDs making up the science array, OmegaCAM also contains four auxiliary CCDs around the edges of the field. Two of these are used for autoguiding, so that both field position and rotation can be tracked accurately. The other two auxiliary CCDs are mounted 2mm outside the focal plane (one in front, one behind), and are used for recording defocused star images for curvature wavefront sensing and controlling the active optics system of the VST.

OmegaCAM contains a 12-filter exchange mechanism. Currently the available filters include the Sloan *ugriz* set, Johnson B and V filters, several narrow-band filter mosaics, a Stromgren v filter, and a special calibration filter. OmegaCAM data are taken in the context of a calibration plan that ensures that all data can be photometrically and astrometrically calibrated to 0.05 magnitude and 0.1 arcsec rms precision, respectively.

The image quality distribution measured on OmegaCAM images in *g*, *r*, *i* between August 2011 and January 2012 is available in the [OmegaCAM Web page](#). These measurements show median IQ of 0.80-0.85'' in *r* and *i* bands, and 0.95'' in *g* band. The numbers are consistent with an outside median seeing of 0.8'' at 500-600nm, convolved with an internal IQ of $\sim 0.4''$. Users are encouraged to take these on-detector statistics into account when defining seeing constraints for Phase 1 and 2. In operations these constraints are always interpreted as IQ on detector, not the outside seeing.

Please see the [OmegaCAM page](#) for more details, including Phase I and II manuals.

7 Scientific Instruments: Chajnantor

7.1 SHFI

The APEX Swedish Heterodyne Facility Instrument SHFI contains 4 single pixel receivers:

- APEX-1: a Single Side Band (SSB) Superconductor-Insulator-Superconductor (SIS) receiver covering 211–275 GHz with SSB receiver temperature T_{rec} around 130 K between 210 and 260 GHz and 180 K between 260 and 270 GHz. APEX-1 covers low frequencies, allowing observations during conditions with $\text{PWV} > 2$ mm. Larger proposals for $\text{PWV} > 2$ mm conditions are encouraged.
- APEX-2: a Single Side Band receiver covering 275–370 GHz with SSB receiver temperature T_{rec} around 135 K. Observations at these frequencies generally require $\text{PWV} < 2$ mm conditions.
- APEX-3: a Double Side Band (DSB) SIS receiver covering 385–500 GHz with DSB T_{rec} around 110 K. Observations in this frequency range require the best quartile of precipitable water vapour conditions ($\text{PWV} < 0.5$ mm). Only a limited amount of observing time will be available on APEX-3, so proposals should be self-contained and the requested amount of time should be modest.

- APEX-T2: a Double Side Band (DSB) Hot Electron Bolometer (HEB) receiver operating at 1.25-1.39 THz with DSB T_{rec} around 1200 K. APEX-T2 is offered conditional to a successful repair mission planned in January 2013. THz observations require excellent weather conditions (PWV < 0.2 mm). APEX-T2 proposals should therefore be very short and concentrate on bright sources.

Further information on the SHFI receivers can be found on the [APEX instrumentation pages](#). Since June 2011, SHFI uses two XFFTS units as back-end. These units cover the full 4 GHz intermediate frequency bandwidth with a fixed overlap region of 1 GHz in the centre. Each XFFTS unit provides 32768 spectral channels with a fixed separation of 76 kHz (0.1 km/s).

For exposure time calculations, users should use the [SHFI observing time calculator](#). Note that the time needed to search for an appropriate off-source position in extended line-emitting regions is *not* included. SHFI users wishing to map extended line-emitting regions should either provide an appropriate off-source position, or request additional observing time in the technical justification section to search for such a position. The overhead for this amounts to ~ 30 min per field.

7.2 LABOCA, the Large APEX Bolometer Camera

LABOCA is a 295 channel bolometer array, operating in the 870 μm atmospheric window, with a beam size of $19''.2 \pm 0''.7$ and a total field of view of $11.4'$.

An overview of the instrument is given on the APEX home page: www.apex-telescope.org/bolometer/laboca/.

The following observing patterns will be offered:

- Spiral mode;
- Raster map in spiral mode;
- On-The-Fly mapping (OTF).
- Point source photometry mode.

The point source photometry mode consists of single pixel chopping, using a sensitive and stable pixel near the optical axis (currently pixel 71). As the LABOCA pixels are separated by twice the beam size, single pixel chopping improves the on-source efficiency from 6.25% in a Nyquist sampled map to $\sim 30\%$ in photometry mode. The same RMS can thus be reached 4.8 times faster than in mapping mode. The recommended wobbler throw and frequency are $50''$ and 1 Hz. The recommended nodding time is 30s, but can be adapted to the weather conditions. The data can be reduced using the [Data Reduction Software for Bolometer Arrays](#). Note that due to remaining instabilities in the atmosphere and the instrument itself, the photometric accuracy obtained from these wobbler on-off observations is not as accurate as in mapping observations. The required atmospheric stability usually requires PWV < 1 mm conditions. There are two important requirements to use the photometry mode: (1) the positions should be known with an accuracy of $\lesssim 1''$, and (2) the sources should not have other emission within the wobbler throw radius.

For mapping, the main advantages of the spiral modes are that (1) the scanned area is only slightly larger than the LABOCA field of view, leading to a maximum of integrations on the central $11'$ field of view, and (2) the overheads by the telescope control system are much smaller, as the spirals use a continuous data taking mode while there is a “dead” time when the telescope turns at the edges of the OTF maps. The optimal observing pattern depends on the spatial extent of the source to be imaged. Recommendations are provided on the APEX home page: www.apex-telescope.org/bolometer/laboca/observing/.

For integration time calculations, users should assume the following values: Noise Equivalent Flux Density (NEFD) = $120 \text{ mJy s}^{1/2}$ and 230 working bolometers. For point source detection experiments, one can apply a low frequency sky noise filtering, improving the sensitivity to $\text{NEFD} \sim 75 \text{ mJy s}^{1/2}$. All proposers should use the LABOCA observing time calculator, available from www.apex-telescope.org/bolometer/laboca/obscal/.

This tool allows one to calculate the total integration time required to reach a given RMS or the RMS for a given total integration time. Users should always include the generic 65% overhead factor provided by the calculator. This 65% overhead includes acquisition, software setup, readout, telescope slewing and calibrations (skydip, pointing, focus and flux calibration).

7.3 SABOCA, the Submillimetre APEX Bolometer Camera

SABOCA is a bolometer array operating in the atmospheric window at $350\ \mu\text{m}$ (855 GHz). SABOCA consists of an array of 39 superconducting TES (Transition Edge Sensor) thermistors with SQUID (Superconducting Quantum Interference Device) amplification and multiplexing. Of these, 37 are arranged in a hexagonal layout consisting of a centre channel and 3 concentric hexagons. Two additional bolometers, identical to the inner 37 but optically not coupled (called blind bolometers) were added to the layout at two diametral opposite positions, for monitoring purposes. The bolometers are designed to be operated at a temperature of about 300 mK, provided by a cryostat using liquid nitrogen and helium, in combination with a close-cycle helium-3 sorption cooler.

The APEX beam size at this wavelength is $7.7''$, and the total field of view for SABOCA is $90''$. The array is undersampled on the sky; the separation between channels is twice the beam size ($15''$). To obtain fully sampled maps it is necessary to move the array on the sky during observations by scanning in one direction and then stepping in the other, or by moving in a circular or spiral pattern in the telescope or astronomical coordinate system.

The photometry mode can also be used for SABOCA. The implementation is similar to LABOCA, though a smaller wobbler throw of $25''$ is recommended. The required observing time to reach the same RMS for a point source is a factor of 6.2 shorter compared to the mapping mode. Potential users of the SABOCA photometry mode should be aware that a very accurate pointing is essential to use this mode. This generally requires the availability of a bright ($S_{350\ \mu\text{m}} > 1\ \text{Jy}$) pointing source within 10° of the targets. In addition, very stable conditions with $\text{PWV} < 0.5\ \text{mm}$ are required.

During period 91, SABOCA is expected to be available only in July 2013. Exposure time estimates should assume a noise equivalent flux density, $\text{NEFD} = 200\ \text{Jy s}^{1/2}$, weather conditions of $\text{PWV} = 0.5\ \text{mm}$, 37 working bolometers and a 90% overhead for slewing, pointing, focus and calibrations. A dedicated SABOCA integration time calculator is available at <http://www.apex-telescope.org/bolometer/saboca/obscal/>.

Note that a first commissioning of the Artemis instrument will occur in March 2013. If the $350\ \mu\text{m}$ array of Artemis is more performant, accepted SABOCA programmes may be executed with Artemis instead.

7.4 FLASH heterodyne receiver (MPIfR PI instrument)

The 345 GHz channel of the MPIfR PI instrument FLASH is again offered to the ESO community on a collaborative basis with MPIfR. **Users who would like to use FLASH shall contact the PI, Dr. Rolf Guesten (rguesten[AT]mpifr-bonn.mpg.de) at least two weeks prior to submitting the proposal for which they are requesting approval.** Members of the PI team should be included as CoIs on the proposal. The observations will be done by the PI team during a maximum of 3 days. Large programmes or time critical observations with FLASH will not be accepted.

FLASH consists of two single pixel sideband-separating receiver covering the 280–370 GHz and 385–495 GHz range with typical $T_{\text{rx}}(\text{SSB}) = 100\text{--}150\ \text{K}$. The receivers are a copy of the ALMA band 7 and 8. The PI XFFTS backends has the same characteristics as the facility XFFTS. Both IF sidebands are recorded simultaneously, allowing to cover $2 \times 4\ \text{GHz}$, separated by 12 GHz in each band, i.e. 16 GHz in total. Only a limited amount of observing time is available to the ESO community, and preference will be given to proposals using the dual-beam, wide-bandwidth capabilities of FLASH.

Technical questions on FLASH should be directed to the ESO APEX Project Scientist, Dr. Carlos De Breuck (cdebreuc[AT]eso.org).

7.5 CHAMP+: The Carbon Heterodyne Array of the MPIfR

CHAMP+ is a MPIfR PI instrument which is offered to the ESO community on a collaborative basis with MPIfR. CHAMP+ is a heterodyne array operating simultaneously in the 350 μm and 450 μm atmospheric windows. It is composed of 14 pixels, divided into two sub-arrays of 7-pixels each, arranged in a hexagonal configuration. The two sub-arrays operate at orthogonal signal polarizations. The RF tuning range is 620-720 GHz for the 450 μm and 780-900 GHz for the 350 μm sub-array.

The beam-spacing is 2.15 times the half-power beam widths of 8.8'' (at 692 GHz) and 7.7'' (806 GHz), so only the central pixels of the two sub-arrays are spatially co-aligned on sky. The front-end is connected to a FFT spectrometer array back-end, providing up to 2.8 GHz of bandwidth for each detector pixel, with spectral resolution of 212 kHz. The system is operated in single-sideband mode. For exposure time calculations, users should assume SSB system temperatures of typically 1000–1400 K (at the frequency of the CO(6-5) line at 691 GHz) and 2500–4000 K (CO(7-6) at 806 GHz, closer to the edge of the atmospheric window). The image gain suppression is better than 10-15 dB for all pixels (in the centre of the IF band). All CHAMP+ proposals should add a 20% additional overhead for instrument characterisation and calibration purposes such as the establishment of a pointing model and the determination of the gain curves.

Further information on CHAMP+ can be found on the [CHAMP+ homepage](#).

As the operation of CHAMP+ requires the presence of the instrument team, all ESO CHAMP+ observations will be scheduled on fixed dates. The exact dates of operation for Period 91 have not been determined yet, but they are likely to be in June 2013, when the atmospheric transparency is expected to be better. Large programmes or time critical observations with CHAMP+ will not be accepted.

Users who would like to use CHAMP+ should contact the PI, Dr. Rolf Guesten (rguesten[AT]mpifr-bonn.mpg.de), at least two weeks prior to submitting the proposal for which they are requesting approval. Members of the PI team that will operate the instrument for the guest proposal shall be included as CoIs on the proposal.

7.6 Z-Spec: The broadband millimeter-wave spectrometer

Z-Spec is a single-beam diffraction-grating spectrograph which disperses the 190–308 GHz band across a linear array of 160 bolometers. The detector spacing increases from ~ 1 part in 400 at the low-frequency end ($\Delta\nu = 500$ MHz), to ~ 1 part in 250 at the high-frequency end of the band ($\Delta\nu = 1200$ MHz), while the spectrometer resolving power runs from $R \sim 300$ at low frequencies to $R \sim 250$ at the high frequency end of the band. Z-Spec observes in a traditional chop-and-nod mode, with the secondary chopping between 1 and 2 Hz, and a nod period of 20 seconds. The channel-to-channel calibration uncertainties are estimated to be less than 10% except at the lowest frequencies, which are degraded by the wing of the 186 GHz atmospheric water line.

The measured sensitivity of Z-Spec at APEX varies from ~ 800 mJy $\text{s}^{1/2}$, or 7.3×10^{-18} W m^{-2} $\text{sec}^{1/2}$ per channel at the central frequencies to > 1 Jy $\text{s}^{1/2}$ below 210 GHz. In 2 hours, the 3σ sensitivity per channel is thus 28 mJy. Since Z-Spec does not resolve most emission lines, on average 1.6 channels are required to measure a line flux. This translates to a minimum detectable line flux (3σ) in 2 hours of 4.4×10^{-19} W m^{-2} in the typical 1 GHz Z-Spec channel. Users should add a 20% overhead factor for bandpass calibrations.

Z-Spec is offered as a PI instrument to the ESO community in Period 91. The operations will be grouped in order to save Helium consumption. The observations are expected to occur in April or May 2013. Time critical observations are therefore very difficult to schedule. There are no guarantees that Z-Spec will be offered beyond Period 91, and no large programmes will be accepted.

Users who would like to use Z-Spec should contact [the instrument team](#) at least two weeks prior to submitting the proposal for which they are requesting approval. The following members of the instrument team that will operate Z-Spec for the guest proposal shall be included as CoIs on the proposal: Dr. James Aguirre (University of Pennsylvania), Dr. Matt Bradford (Jet Propulsion Laboratory) and Dr. Jason Glenn (University of Colorado). Additional

CoIs may be requested by the instrument team. For technical questions, users should contact the ESO APEX Project Scientist, [Dr. Carlos De Breuck](#).

8 Visitor Instruments

Visitor instruments can be mounted at the VLTI, the NTT, the 3.6-m telescope and at APEX in order to permit innovative observations by teams with their stand-alone instruments or to test new instrumental concepts for the development of new facility instruments.

No Visitor Instrument focus is available on the VLT due to the installation of KMOS. Given the arrival of the second generation VLTI instruments, ESO cannot guarantee the availability of a VLTI Visitor focus beyond Period 91.

The requirements for visitor instruments are substantially reduced compared to the requirements for fully integrated facility instruments. A set of guidelines on how to propose a visitor instrument on the VLTI is available at

<http://www.eso.org/sci/facilities/paranal/instruments/vlti-visitor/>.

Technical information on the interface for VLTI Visitor Instruments can be found at

<http://www.eso.org/sci/facilities/paranal/instruments/vlti-visitor/requirements.html>.

Technical information on the interface to the NTT and 3.6-m telescope is found at

<http://www.eso.org/sci/facilities/lasilla/instruments/visitor/VisitorInstruments.pdf>.

9 How to estimate overheads

Service and Visitor Mode observers **must** include the overhead times associated with their science target observations in their proposals. For Service Mode observations, the total execution time requested for every planned Observation Block (OB) must include all overheads, from telescope presetting and target acquisition to all other relevant instrument overheads. Proposers should note that all overheads must be accounted for within one hour for each OB (Section 12.2.1). Time for night-time calibrations and associated overheads must be included only in cases where the accuracy of the observatory calibration plan is not deemed sufficient for the science goals. Please note that calibrations need to be executed as part of the science OBs in some instrument modes (*e.g.* attached calibrations for all VIMOS IFU and MOS modes; see the [VIMOS User Manual](#) for details). The time needed to execute such attached calibrations must be included in the proposal (Section 10.2). Table 16 provides typical overheads associated with individual instruments. More details can be found in the instrument manuals.

Proposers are strongly encouraged to make use of the [Phase 2 Preparation Tool \(P2PP\)](#) during the preparation of their proposals in order to accurately determine the overheads required by their programmes. It is possible to simulate the detailed breakdown of the programme in terms of its constituent Observation Blocks (OBs) using the P2PP tutorial accounts: see Section 1.4 of the P2PP User Manuals available at:

<http://www.eso.org/sci/observing/phase2/P2PPTool/P2PPDocumentation.html>

for La Silla observations;

for observations with Paranal instruments see

<http://www.eso.org/sci/observing/phase2/P2PPSurveys/P2PP3Documentation.html>.

The Execution Time Report option offered by P2PP provides an accurate estimate of the time needed for the execution of each OB including all the necessary overheads. The total execution time estimated by P2PP reflects the official ESO time accounting in Service Mode.

Table 16: Telescope and Instrument Overheads

Hardware item	Action	Time (minutes)
La Silla telescopes	Preset (point and acquire target)	4
La Silla telescopes	Preset (NTT with image analysis)	6
HARPS	Read-out	1
EFOSC2	Read-out	2
SOFI	Imaging	~30% of total int. time
SOFI	Spectroscopy	~25% of total int. time
FEROS	Read-out	2
WFI	Move to gap/pixel	7
WFI	Template change (with initial offset $\leq 120''$)	0.5
WFI	Template change (with initial offset $> 120''$)	1
WFI	Filter change	1
WFI	Offset + readout	1.17
Paranal telescopes	Preset (UTs)	6
CRIRES	Acquisition without AO	3
CRIRES	Acquisition with AO	5
CRIRES	Read-out	10%–60% exposure time ^[1]
CRIRES	Nodding cycle	0.4
CRIRES	Change of wavelength setting	1.5 – 2.5 ^[1]
CRIRES	Change of derotator position angle	1
CRIRES	Attached wavelength calibration	2.5
CRIRES	Attached lamp flat	2
FORS2	Acquisition (1 cycle w/o exp. time) ^[2]	1.5 or 2
FORS2	Through Slit Image (2 cycles w/o exp. times) ^[3]	4
FORS2	Instrument Setup	1
FORS2	Retarder Plate Setup per PMOS/IPOL OB	1
FORS2	Read-out 100kHz binned (spectroscopy)	0.7
FORS2	Read-out 200kHz binned (imaging)	0.5
FLAMES	Acquisition ^[4]	9
FLAMES	Instr. Setup GIRAFFE	1
FLAMES	Instr. Setup UVES	1
FLAMES	CCD read-out GIRAFFE	1
FLAMES	CCD read-out UVES	1
FLAMES	Screen Flatfields	7
FLAMES	Plate Configuration ^[5]	0–20
UVES	Instrument Setup	1
UVES	Acquisition. Bright Point Source	2
UVES	Acquisition. Faint, Extended or Crowded Field	5
UVES	Read-out ^[6] , 1×1 , Fast	0.75
UVES	Read-out ^[6] , 2×2 , Slow	0.75
UVES	Attached ThAr, Night-time	1.5
UVES	Attached Flat, Night-time	2

[1] See [CRIRES User Manual](#) for more details.

[2] Typically one cycle for the target acquisition (exposure time of the acquisition image not included). MXU, MOS and PMOS: 2 min. LSS, IPOL, ECH: 1.5 min (per cycle). IMG none.

[3] Through-slit exposures are mandatory for all spectroscopic OBs. Two cycles are typically enough to centre the target on the slit (exposure time of the through slit image not included). MXU, MOS, PMOS, LSS, ECH 2.0 min (per cycle), IMG and IPOL none.

[4] Includes configuration of UVES fibres, homing the rotator to 0° , swapping of the plates, and field acquisition. For ARGUS fast acquisition (Visitor Mode only), the overhead is 2 minutes if plate 2 is attached to the telescope.

[5] Plate configuration takes 20 minutes at most (Medusa fibres). This does not translate into additional overheads if the running exposure on the other plate is at least 20 minutes long. Plate configuration overheads have to be added if the exposure time is shorter than 20 minutes.

[6] In a dichroic exposure the CCDs are read out in parallel.

Table 16: Telescope and Instruments Overheads (continued)

Hardware item	Action	Time (minutes)
XSHOOTER	Target acquisition	3-5
XSHOOTER	Telescope offsetting	0.25
XSHOOTER	Instrument setup Slit	0.5
XSHOOTER	Instrument setup IFU	1
XSHOOTER	UVB Read-out ^[7] , 1 × 1, Slow/Fast	70 / 19 sec
XSHOOTER	UVB Read-out ^[7] , 1 × 2, Slow/Fast	38 / 12 sec
XSHOOTER	UVB Read-out ^[7] , 2 × 2, Slow/Fast	22 / 8 sec
XSHOOTER	VIS Read-out ^[7] , 1 × 1, Slow/Fast	92 / 24 sec
XSHOOTER	VIS Read-out ^[7] , 1 × 2, Slow/Fast	48 / 14 sec
XSHOOTER	VIS Read-out ^[7] , 2 × 2, Slow/Fast	27 / 9 sec
XSHOOTER	NIR Read-out (per DIT)	0.88 sec
VIMOS	IMG acquisition + Instrument setup	3
VIMOS	MOS acquisition + Instrument setup	15
VIMOS	IFU acquisition + Instrument setup	10
VIMOS	Read-out IMG,MOS,IFU (4 quadrants)	1
VIMOS	Change of Filter (IMG)	3
VIMOS	Attached screen flat+arc (IFU, MOS) ^[8]	5-8
VISIR	Imaging target acquisition (incl. setup):	
VISIR	fine acquisition (> 1 Jy source)	5
VISIR	blind preset (<1 Jy source)	2
VISIR	Imaging read-out/chopping	50% of int.time
VISIR	Burst read-out/nod-chopping	80% of int.time
VISIR	Spectroscopy target acquisition (incl. setup):	
VISIR	> 1 Jy source	15
VISIR	0.2–1 Jy source	30
VISIR	Spectroscopy read-out/nod-chopping	50% of int.time
HAWK-I	Acquisition and Instrument Setup	1
HAWK-I	Acquisition (MoveToPixel) and Instrument Setup	3
HAWK-I	Telescope Offset (large)	0.75
HAWK-I	Telescope Offset (small)	0.15
HAWK-I	Read-out (per DIT)	0.03
HAWK-I	After-exposure (per exposure)	0.13
HAWK-I	Filter change	0.35
NACO	see User Manual	see User Manual
SINFONI	Acquisition no AO	3
SINFONI	Acquisition AO (NGS)	$2 + 4 * (\text{DIT} * \text{NDIT})$ ^[9]
SINFONI	Acquisition AO (LGS)	$9 + 4 * (\text{DIT} * \text{NDIT})$ ^[9]
SINFONI	Acquisition target (AO and no AO)	$4 + 4 * (\text{DIT} * \text{NDIT})$
SINFONI	Instrument setup (per grating change)	2.5
SINFONI	Science exposure read-out (per DIT)	0.07
SINFONI	Detector setup (per DIT×NDIT)	0.3

[7] The detectors are read sequentially; see User Manual for details.

[8] Flat and arcs are mandatory for IFU and MOS.

[9] DIT and NDIT as required for the AO natural guide star (NGS).

Table 16: Telescope and Instruments Overheads (continued)

Hardware item	Action	Time (minutes)
AMBER	One calibrated Visibility CAL-SCI-CAL:	
AMBER	LR ^[10]	$15 + 45 * (\text{number of bands})^{[11]}$
AMBER	MR, HR ^[10]	$30 + 45 * (\text{number of bands})^{[11]}$
AMBER	One calibrated Visibility SCI-CAL:	
AMBER	LR ^[10]	$10 + 30 * (\text{number of bands})^{[11]}$
AMBER	MR, HR ^[10]	$20 + 30 * (\text{number of bands})^{[11]}$
MIDI	One calibrated Visibility SCI-CAL ^[10]	50
MIDI	One calibrated Visibility CAL-SCI-CAL ^[10]	75
MIDI	with FSU-A	
MIDI	One calibrated Visibility SCI-CAL ^[10]	75
MIDI	One calibrated Visibility CAL-SCI-CAL ^[10]	115
VISTA	Preset	2
VISTA	Preset: 2nd OB	
	and following in concatenation	$0.33 + (\phi/60)^{[12]}$
VIRCAM	Guide Star handling	0.05
VIRCAM	Autoguiding start	0.083
VIRCAM	Active Optics start	0.75
VIRCAM	Filter change	0.35-0.67
VIRCAM	Detector readout	0.03 per DIT
VIRCAM	Image writing to disk (per exposure)	0.067
VIRCAM	Pawprint change	0.17
VIRCAM	Jitter offset	0.067
VIRCAM	Micro step	0.067
VST	Preset	2
VST	Offset at template start	0.25
VST	Set rotator position angle (PA) ($\text{PA} < 180$)	$ \text{PA} /120$
VST	2nd OB and following in concatenation:	
VST	Preset:	$0.5 + (\phi/90)^{[12]}$
VST	Set rotator PA:	$(\text{PA}_n + \text{PA}_{n+1})/120$
OmegaCAM	Guide Star acquisition	1.00
OmegaCAM	Acquisition of new Guide star after offset	1.00
OmegaCAM	Re-acquisition of same Guide Star after offset	0.08
OmegaCAM	Time for pick object	0.75
OmegaCAM	Filter change (different/same magazine)	1.08 / 1.92
OmegaCAM	Detector readout and data writing to disk	0.67
OmegaCAM	Start Active Optics/Image analysis	3.00

[10] This time includes all telescope and instrument overheads **as well as** the integration times on the science target **and** the calibrator. The values for MIDI+ FSU-A are rough estimates only.

[11] With a maximum number of 3 bands per wavelength setting. For each new wavelength setting, a new calibrated visibility has to be obtained.

[12] ϕ is the separation, expressed in degrees, between two successive targets.

10 Calibration Plans and Pipelines

10.1 Data Quality Control

ESO has implemented **calibration plans** for all instruments. The primary purposes of these plans are to assure data quality, monitor instrument performance and calibrate science observations. Based on these plans, calibration data are obtained for certain standard instrument modes on a regular basis. Paranal calibration data are reviewed on a daily basis by Paranal Science Operations and the Garching Data Processing and Quality Control group. A brief summary of the calibration plan for each instrument is available online from <http://www.eso.org/qc/pipeline-status.html>.

10.2 Calibration Plans and Calibration of Science Observations

The calibration plans typically aim to calibrate science data to a target accuracy of 5–10%. This may not be sufficient for all science programmes.

Important note: Not all instrument modes and/or configurations are covered by the current calibration plans. Read the appropriate user manual and online documentation carefully (<http://www.eso.org/qc/pipeline-status.html>).

Daytime calibrations included in the calibration plans (*e.g.* bias, flat-fields, and arc-lamp exposures) are performed by the Observatory for both Service and Visitor Mode runs. Whenever possible, these calibration data are obtained in the morning, immediately after the conclusion of night-time operations. Service and Visitor Mode users receive these data via the [CalSelector](#) (see below).

Service Mode runs: Certain ESO specified night-time calibrations (*e.g.* photometric standard stars, telluric absorption correction stars) are obtained systematically as described by the calibration plan in the instrument-specific user manuals. For many programmes these calibrations may be sufficient. Service Mode proposers should only request enough time to complete their science observations. *If the published calibration plan is not sufficient, Service Mode proposers must request more time (including all operational overheads) for additional user-defined calibrations.*

Important note: For some instrument modes, calibrations need to be obtained immediately after the science observation by means of attached calibration templates. Such attached calibrations are an integral part of the science OB and are not considered as a part of the calibration plan. Their execution time must therefore be included in the time applied for.

Visitor Mode runs: Night-time calibrations are the responsibility of the visiting observer with the following exception: up to approximately 30 minutes per night will be used by the observatory staff to obtain standard ESO calibrations. The ESO-obtained data will be used to monitor instrument performance and to assure a baseline calibration accuracy within the ESO Science Archive. ESO does not guarantee that these standard calibration data will be sufficient to calibrate the Visitor Mode science observations to the accuracy desired by the observer. Visitor Mode proposers should plan accordingly.

Raw science data and associated calibrations are made available to the respective PIs and delegates through the [ESO Science Archive Facility](#). The [CalSelector](#) archive service packs together all the files needed to process the science data including ancillary files, *e.g.* acquisition images, etc.). More information on the CalSelector can be found at: <http://www.eso.org/sci/archive/calselectorInfo.html>.

La Silla: It is the responsibility of the Visiting Astronomer to obtain all night-time and daytime calibration frames required. Although ESO staff will execute standard day calibration sequences and make them available to the visitor, all afternoon calibrations and sky flat-fields must be obtained by the visitor.

Calibration Programmes: Please note that ESO further accepts Calibration Programmes to achieve improved calibration of its instruments (see Section 11.5 for details).

10.3 Data Reduction Pipelines

10.3.1 Data Organization: Gasgano and SAFT

Gasgano, a Java-based data file organizer developed and maintained by ESO, is made available to the community and can be used to manage and organize the astronomical data observed and produced by all VLT compliant telescopes in a systematic way. Gasgano can be retrieved from <http://www.eso.org/gasgano/>.

It is also possible to build Unix shell scripts for data organisation using the Stand-Alone FITS Tools (SAFT) available from <http://archive.eso.org/saft>. In particular, the `dfits` and `fitsort` tools can be used in combination to select groups of related files (*i.e.* all frames with the same instrument configuration) for processing.

SAFT, and in particular the `hierarch28` tool, can be effectively used to handle ESO HIERARCH keywords, *e.g.* convert them for use with other packages like IRAF.

10.3.2 Pipelines in the ESO Environment

In collaboration with the various instrument consortia, ESO has undertaken to implement data reduction pipelines for the most commonly used VLT/VLTI instrument modes. These data reduction pipelines serve three main purposes:

- **Data quality control:** Pipelines are used to produce the quantitative information necessary to monitor instrument performance (see Section 10.4).
- **Master calibration product creation:** Pipelines are used to produce master calibration products (*e.g.* combined bias frames, super-flats, wavelength dispersion solutions).
- **Science product creation:** Pipelines can be run on the user's desktop in order to fine-tune the reduction to specific science needs. For this purpose, the algorithmic part of the VLT/VLTI pipelines (pipeline recipes) are available and can be downloaded with the front-end applications, `esoRex`, `Gasgano` and `Reflex`, from <http://www.eso.org/pipelines>.

A brief summary of current and anticipated VLT/VLTI pipeline availability and functionality for each instrument is available online from <http://www.eso.org/qc/pipeline-status.html>.

Available pipelines are installed on Paranal and La Silla, and normally run automatically at all times. These **online pipelines** use standard (but typically not the most recent) archival master calibration data to produce quick-look quality control information for the observatory staff, as well as quick-look science products for supported instrument configurations. These science products are available to Visitor Mode observers for review and use. With the exception of HARPS and FEROS, they are **not** included in the data package delivered to the Visitor Mode observer at the end of their observing run. Users may copy these science products onto removable media (CD-ROM and DVD). Blank media are available from the Observatory for this purpose. However, these science products may not be the best possible because they do not use the most recent master calibration data.

The Garching-based offline pipelines for VLT/VLTI instruments are run by the Quality Control and Data Processing Group (QCDP) to produce certified (quality-checked) master calibration products. These are used to monitor instrument performance and assure that it is maintained within the published ranges (see below). PIs and their data delegates can access their raw science and calibration data via the [ESO Science Archive Facility](#) after authenticating with their User Portal credentials. Raw data are available via the User Portal shortly after acquisition.

Raw calibration data can be downloaded from the archive by all users immediately. Raw science data are accessible by everyone after the proprietary protection has expired. During the proprietary period the data are only accessible to the corresponding PIs and their delegates. See the [Data Access Page](#) and the [Archive User Manual](#) for full details.

10.4 Quality Control

The ESO pipelines are used to monitor the performance of the various instruments and their temporal trends.

Extensive information about Paranal data handling and processing (*e.g.* zero points, colour terms, wavelength solutions) is maintained on the [ESO Quality Control web pages](#).

The Quality Control Group also maintains the [Health Check Monitor](#) with information and data about actual and historical instrument performance and trending.

10.5 The ESO Science Data Products Forum

The [ESO Science Data Products Forum](#) is a platform for sharing ideas, methods, software and data to assist with the production of science data products from ESO telescopes. The forum is a service for the ESO community. Contributions are by users of the ESO instruments.

Users are encouraged to contribute on any topic related to the reduction, calibration and analysis of science data from ESO instruments. Posts might simply describe problems encountered with the data reduction, or offer solutions to such problems. Software, calibration data or documents up to 100MB in size can be attached to any post.

Part III

Proposal Types, Policies, and Procedures

11 Proposal Types

For Period 91 the list of proposal types is:

- Normal Programmes
- Large Programmes
- Target of Opportunity
- Guaranteed Time Observations
- Calibration Programmes
- Director’s Discretionary Time

All proposals except Director’s Discretionary Time (DDT) proposals must be submitted by the current deadline. DDT proposals may be submitted at any time.

Only the Normal and Large Programme template forms should be used for the preparation of proposals. An observing programme, as described in a single proposal, may consist of several runs, *e.g.* for observations with different instruments, or to be executed in different observing modes or at different epochs. Proposals for **Visitor Mode** observations (Section 12.1) must request time in nights, proposals for **Service Mode** observations (Section 12.2) must request time in hours. Note that any given proposal may request a mix of Visitor/Service Mode observations provided that they are split into separate runs.

- **Please note:** All proposers (Service and Visitor Mode) must include time for all overheads (telescope + instrument) in their proposals (see Section 9 and Table 16).

11.1 Normal Programmes

Most of the observing time on ESO telescopes will be allocated to **Normal Programmes** in Period 91. Proposers must use the standard L^AT_EX template (Section 3.1). The scientific case of the programme may take up to two pages including attachments (figures or tables). The scientific description contains two sections:

- A) **Scientific Rationale**
- B) **Immediate Objective**

Attachments are optional. The respective fraction of the above-mentioned two pages occupied by the scientific description and by the attachments is left to the discretion of the proposers, but attachments are restricted to the second of these pages.

If the proposal contains runs requesting La Silla telescopes and instruments, the duration of each such run must be at least 3 nights, except for runs using Visitor Instruments or for combinations of contiguous EFOSC2 and SOFI runs totalling at least 3 nights (Section 4.1).

Proposers should keep in mind the need for each OPC panel to cover a broad range of scientific areas; proposals may not fall within the main area of specialisation of any of the panel members. Proposers should make sure that the context of their project and its relevance for general astrophysics, as well as the recent related results, are emphasised in a way that can be understood by their peers regardless of their expertise.

11.2 Large Programmes

Large Programmes are not accepted on the 2.2-m, VST or VISTA telescopes. Due to existing commitments and upcoming changes Large Programmes will also not be accepted for CRIFES, HAWK-I, NACO and VIMOS, (see Section 1.3 for more details). Also, given the arrival of the second generation VLTI instruments, ESO cannot guarantee the availability of MIDI and of a VLTI visitor instrument focus beyond Period 91.

Up to a maximum of 30% of the observing time distributed by the OPC on the VLT/VLTI can be allocated to Large Programmes. An ESO Large Programme is defined by the criteria listed below. For ESO telescopes, one night is 8 hours in even periods and 10 hours in odd periods.

- A programme requiring a minimum of 100 hours of ESO telescope time.
- A programme that has the potential to lead to a major advance or breakthrough in the field of study, has a strong scientific justification, and a plan for a quick and comprehensive effort of data reduction and analysis by a dedicated team.
- Large Programmes can span from 1 to 4 periods (*i.e.* up to a maximum of two consecutive years) for Paranal instruments, and from 1 to 7 periods (*i.e.* up to Period 97 for La Silla);
- ToO programmes cannot be submitted as Large Programmes (Section 11.3).

A good organisational structure of the proposing team, availability of resources and relevant expertise must be demonstrated. A special L^AT_EX template must be used for Large Programmes (Section 3.1). The proposers may use a total of three pages (not including figures) for the four sections of the scientific description:

- A) Scientific Rationale
- B) Immediate Objective
- C) Telescope Justification
- D) Observing Mode Justification (Visitor or Service)

An additional 2 pages of attachments are permitted. Proposers of Large Programmes should keep in mind that **the entire OPC** (hence also non-experts in a specific field) as well as the specialised OPC panels will be evaluating their proposal, and that **they should clearly explain the relevance of the proposed programme to general astrophysics**.

If a Large Programme proposal contains runs requesting La Silla telescopes and instruments, the duration of each such run must be at least 3 nights.

Proposers should be aware that the PIs of successful proposals for Large Programmes are required to provide all data products (processed images and spectra, catalogues) to the ESO archive by the time their scientific results are published in a refereed journal. Guidelines for submission of these data products, including a description of the required metadata and formats, can be found at <http://archive.eso.org/cms/eso-data/data-submission/>. Proposers are invited to write an email to usd-help@eso.org for further information.

During the period of execution of a Large Programme, and upon its completion, the PI will be invited by ESO to report to the OPC on the programme's preliminary results. He/she may also be asked to give a more comprehensive presentation of the outcome of the programme at an ESO Large Programme workshop, similar to those of [May 19-21, 2003](#) and of [October 13-15, 2008](#).

11.3 Target of Opportunity

Normally, up to 5% of the available ESO general observing time may be used for **Target of Opportunity** (ToO) proposals. For events with exceptional characteristics ESO will also consider overriding Visitor Mode observations.

ESO recognises two categories of Targets of Opportunity:

1. **Unpredictable ToOs** are those concerning unpredictable astronomical events that require immediate observations. The occurrence of such events cannot be foreseen with sufficient anticipation to allow them to be the subject of proposal submission by the regular deadline. They **qualify for allocation of Director Discretionary Time**. Corresponding applications for observing time should be submitted as DDT proposals (Section 11.6) and not as ToO proposals.
2. **Predictable ToOs** are those concerning predictable events in a generic sense only. These are typically (but not limited to) known transient phenomena and follow-up or coordinated observations of targets of special interest. Proposals aimed at studying such events are, in the ESO proposal terminology, ToO proposals.

ToO proposals must be submitted using the Normal Programme ESOFORM template. Proposals should be for generic targets and/or times. However, if accepted by the OPC the programme will not be executed until the PI (or one of his/her delegates) contact ESO to request its activation after the predicted event has occurred. The observing strategy must be the one approved by the OPC, and the triggers may not exceed the allocated time and number of triggers granted by the OPC. The observations will be conducted in Service Mode and, in exceptional cases, ongoing programmes may be interrupted. Read more on [ToO policy](#).

As ToO programmes may require a mixture of ToO runs and normal (see 3.2.1) runs proposers are requested to specify the type of runs (TOO or normal) in the tenth (final) field of the `\ObservingRun` macro of the ESOFORM L^AT_EX template. A more detailed description and examples can be found in the ESOFORM User Manual.

ToO runs are defined as runs for which the target cannot be known more than one week before the observation needs to be executed. Such runs will be scheduled for execution upon receipt of an activation trigger by ESO; the target (and observing time) information will be inserted by the observatory support staff into generic Observation Blocks (OBs) submitted by the PI at Phase 2. Targets that are unknown at Phase 1 proposal submission time but can be observed more than one week after they have been identified should be observed as part of normal (non-ToO) runs. The related OBs should be defined or updated by the PI once the target is known. The OBs should be stored in the ESO database with the complete information needed to allow them to be executed as part of the regular Service Mode queues.

Note that users submitting a ToO programme will need to indicate the number of targets per run and the requested number of triggers per target using the appropriate macros in the L^AT_EX template. A trigger is defined as the request for execution of one Observation Block with a given instrument at a given epoch. Similar observations to be executed with the same instrument at different epochs count as different triggers, as do observations with different instruments at the same epoch.

Any observing request by other groups at the time an event occurs (*e.g.* a DDT proposal), with exactly the same scientific goal and aiming at observing the same object, will be rejected by ESO. ToO programmes are **not** carried over to the following periods.

ToO proposers should bear in mind that ToO proposals are ranked across OPC categories by the whole OPC (hence including non-experts in their specific field). They should therefore clearly explain the relevance of the proposed programme to general astrophysics.

11.3.1 Rapid Response Mode (RRM)

ESO continues to offer VLT Rapid Response Mode (RRM). During Period 91, FORS2 on UT1, UVES and XSHOOTER on UT2, and SINFONI and HAWK-I on UT4 are available in RRM.

RRM proposers should note that:

- A RRM trigger is a special ToO trigger that **can only be activated up to 4 hours after an event**. If a longer time span has passed since the event, observations should be requested through normal ToO triggers.

- As with ToO programmes, proposers will need to indicate in the \LaTeX template the number of targets per run and the requested number of triggers per target.
- **RRM runs have to be specified as separate runs** in the ESIFORM template.

Upon receiving an encoded alert indicating the coordinates of the target and the associated Observing Block (OB) to be executed, any ongoing integration will automatically be terminated and the RRM OB will be executed. Depending on the instrument and the target position, the telescope/instrument will be at the location of the target within about 6 minutes following the arrival of the alert at Paranal. Depending on the target brightness and instrument mode target acquisition may take some more time.

RRM observations in Period 91 are subject to the following restrictions:

- The requested instrument must already be in operation. No change of instrument (and telescope focus) is accepted by the automatic RRM system.
- RRM activations will be accepted during Service Mode and Visitor Mode runs. They have overriding priority over other observations, unless the latter are strictly time-critical.

Additionally, the following instrument specific restrictions apply:

- UVES can only be used with standard wavelength settings;
- FORS2 can only be used in the broad-band imaging, long slit spectroscopic, imaging polarimetric and spectro-polarimetric modes;
- SINFONI is available in NGS and noAO mode but not in LGS mode;
- HAWK-I: all the filters can be used, but the trigger requesters must follow the users' manual indications closely as far as brightness restrictions of objects in the field are concerned.

The delivery of the encoded alerts to the Paranal Observatory is entirely the responsibility of the PI. Successful PIs will be asked to provide a set of OBs by the Phase 2 deadline, to be certified for execution as is done for other Service Mode runs. Details on the activation mechanisms and the preparation of RRM observations can be found at the Phase 2 [RRM Observation page](#).

11.4 Guaranteed Time Observations

Guaranteed Time Observations (GTO) arise from contractual obligations of ESO vis-à-vis the external consortia who build ESO instruments (see the [GTO Policy page](#)). Guaranteed Time Observers must submit proposals for their GTO time using the Normal Programme templates, and by the standard proposal deadline. All GTO proposals will be evaluated and ranked together with Normal Programme proposals to provide feedback to the GTO teams on the scientific standing of their GTO programmes. In exceptional cases, badly ranked GTO proposals may not be scheduled. The policies describing the obligations of Guaranteed Time Observers are defined in Appendix 2 of the [ESO Council document ESO/Cou-996](#).

In general, GTO runs must be conducted in Visitor Mode (Section 12.1). The only exceptions are those explicitly stated in the contractual agreement between ESO and the corresponding external consortium. However ESO may exceptionally transfer some GTO runs from Visitor Mode to Service Mode for operational reasons (such as the availability of VLTI baselines or the availability of the LGSF).

Some GTO programmes require ToO runs² (see Section 11.3). If this is the case then this should be specified in the ESIFORM package using the `\ObservingRun` macro of the \LaTeX template.

²The possibility for GTO teams to request ToO observations as part of their guaranteed time is restricted to those cases in which this option is explicitly mentioned in the GTO contract.

11.5 Proposals for Calibration Programmes

ESO operates a large number of complex instruments with many possible configurations and observing modes. Although the Observatory executes a rigorous calibration plan for each instrument, ESO does not have the resources to fully calibrate all potential capabilities of all instruments. On the other hand, the astronomical community has expressed interest to perform calibrations for certain uncalibrated or poorly calibrated modes, or to develop specialized software for certain calibration and data reduction tasks. ESO introduced the **Calibration Programmes** in order to allow users to complement the existing calibration of ESO instruments and to fill gaps in the calibration coverage that might exist.

Up to 3% of all the available observing time may be made available for calibration proposals. Calibration Programmes will be evaluated by the OPC, with a view to balancing the added calibration value for future science with the more immediate return of the regular science proposals of the current period. Calibration Programmes are reviewed by ESO with regards to their technical and operational feasibility.

Successful proposers will be required to deliver documentation, and data products and software to ESO to support future observing programmes. The raw calibration data, as well as the advanced calibration products that are obtained as part of Calibration Programmes are non-proprietary and made available to the entire community through the ESO archive, and the respective instrument Web pages. Scientific publications that make use of the data or results of Calibration Programmes will have to reference the corresponding proposals.

Calibration Programme proposals must be submitted using the ESIFORM template for Normal Programmes. In Box 8A (entitled “Scientific rationale”) the proposers should clearly state the limits of the existing calibration plan and the expected improvement that can result from the proposed observations. Moreover the proposal should emphasise the relevance and the overall scientific gain of the calibration techniques and products resulting from these observations. Calibration Programmes do not pertain to any of the standard OPC categories (A, B, C or D), since in general they are not directly related to a unique scientific area: the special sub-category code L0 should be used to distinguish them. The PIs of Calibration Programmes are required to deliver to ESO the resulting Advanced Data Products within one year of the completion of the corresponding observations. The procedure to be followed is described at <http://archive.eso.org/cms/eso-data/data-submission/>.

11.6 Director’s Discretionary Time

Up to 5% of the available ESO general observing time may be used for **Director’s Discretionary Time** (DDT) proposals in the current period. Only DDT proposals belonging to one of the following categories will be considered:

- proposals of ToO nature requiring the immediate observation of a sudden and *unexpected* astronomical event,
- proposals requesting observations on a highly competitive scientific topic,
- proposals asking for follow-up observations of a programme recently conducted from ground-based and/or space facilities, where a quick implementation should provide break-through results,
- proposals of a somewhat risky nature requesting a small amount of observing time to test the feasibility of a programme.

DDT programmes that have target of opportunity runs should mark their corresponding Run Types as “TOO” in the `\ObservingRun` macro. See the ESIFORM User Manual for more details. DDT programmes involving TOO runs should also fill in the `\TOORun` macros in the ESIFORM proposal template as instructed.

Approved DDT proposals are carried out in Service Mode on Paranal and Chajnantor, or in Visitor Mode override on La Silla. Very few non-time-critical DDT proposals are foreseen to be approved

so proposers should provide a clear justification (in Box 9b of the application form) why the programme should be considered for DDT allocation and why it was not submitted through the regular OPC channel. In the absence of such a justification, the proposal will not be considered for DDT allocation, and the proposers will be encouraged to resubmit their proposals for the next appropriate OPC submission deadline. *As a general rule, proposals originally submitted to the OPC that were not allocated time must not be submitted as DDT proposals.*

DDT proposals may be submitted at any time. They must be prepared using the special ESOFORM DDT template. Proposers must upload the DDT ESOFORM template and submit their DDT proposals by registering and logging into the ESO User Portal. You can find more details at:

<http://www.eso.org/sci/observing/phase1/esoform.html>

DDT proposals are reviewed at ESO and approved by the Director General. Urgent requests must be clearly identified in Box 5 (Special Remarks) of the application form.

Please note: Within one month following the delivery of the data, the PI of an accepted DDT proposal must submit a report on the achieved science to opo@eso.org.

11.7 Host State Proposals

Qualifying proposals whose PI is affiliated with an institute of the Host State (Chile) are counted as *Host State Proposals*. The designation as *Host State Proposal* is independent of the fraction of non-member state CoI's.

11.8 Non-Member State Proposals

A **Non-Member State Proposal** is a proposal where 2/3 or more of the proposers are not affiliated to ESO member state institutes independently of the nationality of the proposers and of the affiliation of the PI. Non-member state proposals are submitted in the usual way, but a separate set of criteria are used for the review of such proposals (Section 13.1). This non-member state policy does not apply to the host state, Chile, whose participation is regulated by the “Interpretative, Supplementary and Amending Agreement” to the 1963 Convention (Sects. 11.7 and 13.1).

11.9 VLT-XMM proposals

With the aim of taking full advantage of the complementarity of ground-based and space-borne observing facilities, ESA and ESO have agreed to establish an environment for those scientific programmes that require observations with both the XMM-Newton X-ray Observatory and the ESO VLT(I) telescopes to achieve outstanding and competitive results.

By agreement with the XMM-Newton Observatory, ESO may award up to 290 ksec (~80 hours) of XMM-Newton observing time. Similarly, the XMM-Newton project may award up to 80 hours of ESO VLT observing time. This applies to the duration of an XMM-Newton cycle, which normally extends over two ESO observing periods. However, proposers should take the limited availability of some of the VLT(I) instruments in Periods 91 and 92 into account; see below for details on instrument availability. See Section 1.1 for more details regarding instrument availability during these periods.

Proposers wishing to make use of this opportunity will have to submit a single proposal in response to either the [XMM-Newton](#) or the ESO call for proposals: proposals for the same programme submitted to both observatories will be rejected. To submit a proposal to ESO, the Normal Programme template must be used. Such a proposal will be reviewed exclusively by the OPC. A proposal submitted to the XMM-Newton Observatory will be reviewed exclusively by the XMM-Newton OTAC. Proposals that request different amounts of observing time on each facility should be submitted to the Observatory for which the greatest amount of time is required. The primary criterion for the award of observing time is that both VLT and XMM-Newton data are required to meet the scientific objectives of the proposal. The project does not need to require simultaneous XMM-Newton and

ESO telescope observations. Targets of Opportunity and “Triggered Observations” are excluded from this cooperative programme.

It is the proposers’ responsibility to provide a full and comprehensive scientific and technical justification for the requested observing time on both facilities. Both the ESO and XMM-Newton observatories will perform feasibility checks of the approved proposals. They each reserve the right to reject any observation determined to be unfeasible for any reason. The rejection by one Observatory could jeopardize the entire proposed science programme.

Apart from the above, for both ESO and the XMM-Newton Observatory, the general policies and procedures currently in force for the final selection of the proposals, the allocation of observing time, the execution of the observations, and the data rights remain unchanged.

12 Observing Modes

In Period 91, most VLT and VLTI instruments will be offered in two modes: *Visitor Mode* (VM) and *Service Mode* (SM). These modes have been extensively described in the Data Flow Operations section of the [December 1997](#) and [June 1998](#) issues of The ESO Messenger (see also an article on Service Mode scheduling in the [September 2001](#) issue). As part of the Phase 1 proposal, investigators will have to specify which mode they desire and why they request that mode. While it will be attempted as much as possible to follow the desire of the proposers with respect to observing mode, ESO does reserve the right to allocate time in a mode different from the one requested. Note especially the restrictions of available modes detailed in Sects. [12.1](#) and [12.2](#), and the policy in Section [13.3](#).

The telescope, as well as the instruments, will be operated by observatory staff only. The astronomer interfaces with the telescope/instruments via Observation Blocks (OBs), produced using the Phase 2 Proposal Preparation (P2PP) tool. For La Silla observations observers use [P2PP 2.13.1](#); while for Paranal observations observers use [P2PP 3](#).

12.1 Visitor Mode

In **Visitor Mode** (VM) the astronomer is physically present at the observatory during the observations. Each approved VM run will be allocated specific calendar nights. One of the programme investigators will travel to the Observatory and execute the observations. Visitor Mode is not offered on VST, VISTA or APEX.

For all ESO instruments data acquisition will be done by executing Observation Blocks (OBs), *i.e.* observing sequences specified by the astronomer which are based on templates provided by ESO. VM investigators will be encouraged to construct their OBs before arriving on the site using P2PP. At the telescope OBs can be created or further modified in real-time at the telescope (with the exception of VIMOS, see Section [6.6](#)). VM investigators will be required to arrive on Paranal before the start of their observing run as follows: 24 hours for UVES, and 48 hours for all other instruments. On La Silla, Visiting Astronomers shall arrive 1 to 2 days before the start of the observations, and may leave the site up to 1 to 2 days after the end of their observing run according to the transportation schedule (see the [La Silla Science Operations page](#)). Note that programmes must be executed as specified and approved at Phase 1. The proposer should prepare a backup/alternative programme to be executed in place of the primary programme if the observing conditions are not ideal Section [4.2.2](#). The original science case and goals should be followed. Such backup programmes must be approved by ESO prior to the observing run. The corresponding requests must be submitted via the web-based form available at <http://www.eso.org/sci/observing/phase2/ProgChange/>. If the conditions prevent the Visiting Astronomer’s primary programme to be executed the telescope will be used for the execution of Service Mode observations; assuming no backup programme is in place and that Service Mode observations are allowed on that telescope. Raw data are available for download shortly after acquisition.

Please note that **VM proposers must include overheads** for all science exposures. Guidelines are provided in Section [9](#).

12.1.1 ToO programme execution during VM observations

VM observations may be interrupted by time-critical DDT or ToO programmes. As far as possible, the execution of observations for such programmes will be confined to scheduled Service Mode periods. Under exceptional circumstances, the Director of the Observatory may decide to interrupt VM runs to allow Service Mode observations. ToO runs in the Rapid Response Mode (RRM) may also interrupt VM observations (see Section 11.3.1).

12.2 Service Mode

About 60% of the total time available for observations on Paranal will be carried out in Service Mode (SM). SM is also the only mode supported for APEX, VST and VISTA. It is not offered on any La Silla telescope.

Investigators with runs allocated in SM time will be required to specify their programme by submitting a Phase 2 package in advance to ESO. This package consists of OBs, finding charts, and a Readme form. Observers intending to submit proposals to be executed in SM may find it useful to familiarize themselves with the Phase 2 Service Mode [procedures](#). Once the OBs are completed, they will be submitted to ESO for verification and acceptance.

Accepted OBs will be executed by ESO staff based on their OPC recommended priority and a proper match between the requested and the actual observing conditions. An article about SM scheduling appeared in [The ESO Messenger \(2001, v. 105, p. 18\)](#). The article helps proposers understand how they may optimize their use of this observing mode, and it should be considered compulsory reading for SM proposers. SM PIs and their delegates have direct access (via their personal ESO User Portal account) to their own raw proprietary data as soon as the data is ingested in the ESO Archive. Note that in Service Mode the proprietary period for a given science file starts as soon as the data are made electronically available to PIs or to those to whom they have delegated their data access rights.

Please note that **SM proposers must include overheads** for all science exposures. Guidelines are provided in Section 9.

ESO will absorb all the time required to complete the calibration sequences to the level of accuracy foreseen in the calibration plan (see Section 10.2), as well as overheads associated with such calibrations. If those calibrations are not adequate, the SM proposer must include time for any additional calibrations including overheads.

Proposers are especially encouraged to request Service Mode (on Paranal) if their programme involves Target of Opportunity events or synoptic observing, or if they require the best observing conditions (which occur at unpredictable intervals). Further information on SM observing may be found in the [Service Mode Guidelines](#).

12.2.1 Service Mode policies

To ensure the efficiency of SM observing, ESO has implemented a number of rules, procedures and limitations on Service Mode runs. They need to be carefully taken into account at the time of preparing an application for SM observations and are summarized here. Please note that these items have important consequences on the way that execution overheads must be taken into account.

- **Some observing strategies cannot be supported in Service Mode;** in particular, real-time decisions about the sequencing of OBs, complex OB sequencing, or decisions based on the outcome of previously executed OBs (like adjustment of integration times or execution of some OBs instead of others).
- **Observation Blocks (OBs) execution.** OBs are executed non-contiguously (with the exception of OBs within the concatenation scheduling containers; see [Programmes with linked time-requirements](#) below). Since efficient SM operations require continuous flexibility to best match the OB constraints with actual observing conditions, OBs

for a given run are normally scheduled non-contiguously. It is thus not possible to reduce acquisition overheads by requiring the sequential execution of OBs with the same target field.

- **Multi-mode, multi-configuration OBs are normally not permitted in SM.** Although multiple configurations within one OB may sometimes reduce overheads, scheduling and calibrating such OBs is extremely inefficient. Different configurations should thus be in different OBs.
- **OB Total Execution Time.** Proposers should make sure that all overheads, including telescope presetting and acquisition overheads (as specified in Table 16) have been properly included.
- **OB execution times must be below 1 hour.** Long OBs are more difficult to schedule and execute within the specified constraints because of the unpredictable evolution of the observing conditions. OBs taking more than one hour to execute are not normally accepted. Proposers are especially encouraged to plan for OBs substantially shorter than one hour if the execution conditions are particularly demanding, as the fulfilment of all the constraints during the entire execution time becomes more unlikely as the OB becomes longer.
- **Phase 1 constraints are binding** (also see Section 13.5). As constraints play an essential role in determining the long-term scheduling of SM time, a relaxation of observing constraints is permissible at Phase 2 but ESO will not allow any tightening of constraints. Changes with respect to the times on target specified at Phase 1 will not be allowed at Phase 2.
- **Fulfilment of Phase 2 constraints:** ESO will consider an OB as successfully executed if all the conditions in the constraint set are fulfilled. OBs executed under conditions marginally outside constraints by no more than 10% of the specified value will not be scheduled for re-execution. Adaptive Optics-assisted observations within 50% of the requested Strehl ratio will not be repeated (assuming that other constraints are suitably met). VLTI OBs executed marginally outside the specified LST intervals by no more than 30 min will not be scheduled for re-execution.
- **Programmes with linked time requirements:** SM is also intended to support programmes with special timing requirements. However, proposers planning such programmes should keep in mind that at most 60% of both bright and dark time is allocated to SM (on Paranal), and that observing conditions cannot be predicted when a time-series is started. This means that timing sequences that are extremely long and/or complex, timing links that are very restrictive, and time-series for observations requiring excellent observing conditions, are unlikely to be successfully completed. Therefore, all such proposals are reviewed for technical feasibility and may be rejected if judged to be too complex. Proposers for programmes requiring timing links are strongly encouraged to consider how they may simplify their timing sequences as much as possible, as this will minimize the risk that the observations are deemed unfeasible.

If a given OB cannot be executed within its intended observability window, it will be removed from the observing queue and will not be attempted again. If it was part of a time-linked series, then the time-series observation will continue with the next OB if appropriate. ESO will not restart a sequence of linked observations if the pre-specified timing constraints cannot be fulfilled. More details on how version 3 of the Phase 2 Proposal Preparation (P2PP) tool can be used to time-link, group or concatenate various OBs, are described in <http://www.eso.org/sci/observing/phase2/P2PPSurveys.html>.

- **VLTI:** A separate run must be specified for each requested baseline configuration.
- **ToO programme execution** Successful proposers of ToO runs will have to prepare OBs for their observations well ahead of the beginning of an observing period (see Section 12.2). Mostly ToO OBs will have to be “dummy” OBs with default values for target coordinates, integration times etc. At the time of occurrence of the predicted event, the PI of the programme (or one of his/her delegates) must activate it and at the same time provide the missing information for completion of the OBs. The service observer will update and execute the specified OBs. Further details are available on the Phase 2 [ToO Procedures page](#).

13 Policy Summary

Several policies regarding all aspects of the use of ESO telescopes have been refined over the years by the ESO Observing Programmes Committee (OPC), and by the Science and Technology Committee (STC). Here we summarize those policies relevant for ESO proposers for Period 91. For details on individual policies we refer to the [VLT/VLTI Science Operations Policy](#) document.

13.1 Who may submit, time allocation policies

ESO proposals may be submitted by any group or individual. One single person, the **Principal Investigator** or PI, must be assigned to be responsible for the programme. The PI will also act as the official contact between ESO and the proposers for all later correspondence (Phase 2 information, data distribution, etc.). By submitting a proposal, the PI takes full responsibility for its contents, in particular with regard to the names of CoIs and the agreement to follow the ESO policies and regulations, including the conditions specified in the present Call for Proposals. Following the introduction of the ESO User Portal, PIs identify themselves uniquely in Phase 1 proposals by their User Portal username. Note that each individual is allowed to have only one account in the User Portal database; multiple accounts must not be created. Failure to comply with this restriction may lead to the rejection by ESO of the proposals by the offending PI.

All valid proposals received by ESO prior to the submission deadline will be reviewed by the OPC, who will rank them according to the scientific merit of the proposal and the importance of its contribution to the advancement of scientific knowledge. Furthermore, proposals should provide evidence that the proposing individual or team have the expertise and sufficient resources to carry out the analysis.

Proposals should be self-contained. The evaluation will be based solely on their contents, to the exclusion of external references.

For non-member state proposals (Section 11.8) the following additional criteria will be taken into account:

- The required telescope/instrumentation is not available at any other observatory accessible to the applicants.
- If an ESO member state proposal and a non-member state proposal are rated equally, preference will be given to the ESO member state proposal.

The following policy, extracted from the agreement between ESO and its host state Chile, governs the allocation of time to **Host State Proposals** (Section 11.7): “Chilean scientists who present meritorious projects shall have the right to obtain up to 10% of the observing time of ESO telescopes”. For VLT projects at least one half of this 10% shall be dedicated to projects of Chilean astronomers in cooperation with astronomers of ESO member countries.

Following the recommendations of the OPC and a technical feasibility check, the ESO Director General grants observing time based on OPC ranking and availability. However, in the case of sudden astronomical events a ToO or DDT programme may be activated, and may lead to an interruption of the currently active run.

13.2 Requesting use of non-standard observing configurations

Proposers should pay particular attention to the fact that, as indicated in the instrument manuals, use of certain non-standard instrumental modes or configurations requires prior approval by ESO. This approval must be obtained before submitting the Phase 1 proposal. Corresponding requests, including a brief justification, must be submitted by email to usd-help@eso.org at least two weeks before the proposal submission deadline. Failure to follow this rule may lead to the rejection of the proposal by ESO for technical reasons.

13.3 Policy regarding offered/available observing configurations

Users will be promptly informed if it becomes impossible to support some currently offered instrument mode, and may be asked to switch from Service Mode to Visitor Mode or vice versa. In general, runs requiring non-standard configurations will only be accepted in Visitor Mode.

13.4 Observing programme execution

Observations in both Visitor and Service Mode must be executed as described in the Phase 1 proposal, including the instrument modes and specified targets. Departures from Phase 1 specifications and targets will not generally be allowed, unless a sound scientific justification exists, and provided that the change does not involve a significant increase in the pressure factor on oversubscribed regions of the sky. The request for changes of targets and instrument set-up(s), along with the corresponding scientific justification, must be submitted via the web-based form available at <http://www.eso.org/sci/observing/phase2/ProgChange/>.

For any other departure from Phase 1 specifications a justification must be provided in writing to paranal@eso.org at least one month before the beginning of the observations for runs scheduled in Visitor Mode. For Service Mode runs, these requests and associated justifications must be submitted to usd-help@eso.org or to p2pp-waiver@eso.org (clear instructions are available at <http://www.eso.org/sci/observing/phase2/SMGuidelines/WaiverChanges.html>) at least one week before the Phase 2 deadline.

ESO reserves the right to reject the changes if they are insufficiently justified, conflicting with any other approved programmes, or imply significant changes in the overall distribution of scheduled targets in the sky. Observations of targets for which no authorization has been obtained are not allowed at the telescope.

13.4.1 Service Mode run execution

The runs to be conducted in Service Mode will be subdivided into the following classes for operational reasons:

- **Class A:** All possible efforts will be made to execute all OBs corresponding to the runs in the requested observing period. Approximately the first half (according to the OPC ranking) of the total amount of Service Mode time scheduled on each telescope falls in this class.
- **Class B:** These runs will be executed in the requested observing period on a best-effort basis. Approximately the second half (according to the OPC ranking) of the total amount of Service Mode time scheduled on each telescope falls in this class.
- **Class C:** Filler runs. OBs will only be executed if the observing conditions do not permit observations for runs within classes A and B.

For Class A runs that are not completed by the end of Period 91, ESO will decide whether they can be declared “substantially complete”, or have to be carried over to the next period provided that this is technically feasible. In general, a class A run will not be carried over for more than one additional natural visibility period. Class B and C runs will not be carried over. ToO runs are by definition Class A regarding priority in execution but they will not be carried over to the following periods regardless of their completion status.

13.5 Phase 2 Service Mode policy: constraints and targets are binding

To optimize the use of ESO telescopes in Service Mode a proper mix of runs requiring various observing conditions, and with targets spread over the entire range of RAs for a given period, is necessary. For this reason proposers are requested in their Phase 1 proposal to specify not only the targets with accurate coordinates, but also the needed observing conditions (lunar phase, seeing,

sky transparency). **Due to their essential role in determining the long-term scheduling of Service Mode time, the constraints specified at Phase 1 are binding.** Successful proposers will not be allowed to change the instrument set-ups, target lists and/or times per target that were requested at Phase 1 in their Phase 2 submissions, unless explicitly authorized by ESO (see Section 13.4). At Phase 2, only the relaxation of observing constraints is allowed. See Section 13.4 for more details on how to request waivers for Service Mode runs.

13.6 Pre-imaging runs

A separate run must be specified for a VLT programme requiring pre-imaging. If this is not specified in the proposal, the time needed for the execution of the pre-imaging will be deducted from the total allocation of the project. Pre-imaging runs are always scheduled in priority class A, but must be specified as pre-imaging runs as this will not occur automatically. Please be sure to indicate the pre-imaging character of the run by using the corresponding `\INSconfig` macro in the L^AT_EX ESOFORM template.

13.7 Data rights, archiving, data distribution

All data obtained with ESO facilities are ESO property. ESO grants a twelve month proprietary period for science and acquisition data to the PI of the programme as part of which these data were obtained. This period applies to each data file individually. For Visitor Mode runs, it starts at the time of the observation; while for Service Mode runs, as soon as the data are made available to the PI or his/her delegates. Should you wish to specify a shorter period than the nominal 12 months in Period 91, please do so using the `\ProprietaryTime` macro in the L^AT_EX ESOFORM template. Raw data of Public Surveys, calibration and technical data are not subjected to proprietary period and become publicly available as soon as they are ingested in the ESO Archive.

For Visiting Astronomers, raw data will in general be made available before astronomers leave the observatory site. For both Visitor Mode and Service Mode observations, raw science data and associated calibration data are distributed to the PIs and their delegates from their ESO User Portal accounts.

13.8 Publication of ESO telescope results

Publications based on observations collected at ESO telescopes should state this in a footnote to the article's title. The corresponding observing proposal should be clearly identified by its ESO reference number. For example: *“Based on observations collected at the European Southern Observatory, Chile (ESO Programme 091.C-1234)”*.

13.9 Press Releases

Should you consider that your results are worthy of a press release to the general public, please contact the ESO Outreach Department (information@eso.org) as soon as possible, preferably no later than when the paper is submitted for publication. ESO reserves the right to use any data obtained with ESO telescopes as part of programmes allocated ESO time for press releases.

Part IV

Appendix

A Acronyms

4QPM	Four Quadrant Phase Mask
ADP	Advanced Data Products
AMBER	Astronomical Multi-BEam combineR
APEX	Atacama Pathfinder EXperiment
APP	Apodizing Phase Plate
AT	Auxiliary Telescope for the VLT Interferometer
CHAMP+	Carbon Heterodyne Array of the MPIfR
CoI	Co-Investigator
CONICA	High-Resolution Near Infrared CAmera
CRIRES	Cryogenic high-resolution IR Echelle Spectrometer
DDT	Director's Discretionary Time (proposal)
DIT	Discrete Integration Time
EIS	ESO Imaging Survey
EFOSC2	ESO Faint Object Spectrograph and Camera 2
ESO	European Southern Observatory
ETC	Exposure Time Calculator
FEROS	Fibre-fed Extended Range Optical Spectrograph
FLASH	First-Light Apex Sub-millimeter Heterodyne
FFTS	Fast Fourier Transform Spectrometer
FIMS	FORS Instrumental Mask Simulator
FINITO	Fringe Tracking Instrument of Nizza and Torino
FLAMES	Fibre Large Array Multi Element Spectrograph
FLASH	First-Light Apex Sub-millimeter Heterodyne
FLI	Fraction of Lunar Illumination
FORS1	Focal Reducer/low dispersion Spectrograph 1
FORS2	Focal Reducer/low dispersion Spectrograph 2
FOV	Field Of View
FSU	Fringe Sensor Unit
GTC	Gran Telescopio Canarias
GTO	Guaranteed Time Observations
HARPS	High Accuracy Radial velocity Planet Searcher
HAWK-I	High Acuity Wide field K-band Imager
IFU	Integral Field Unit
IR	InfraRed
ISAAC	Infrared Spectrometer And Array Camera
KMOS	K-band Multi-Object Spectrograph
LABOCA	LARge BOlometer CAmera
LGS	Laser Guide Star
LST	Local Sidereal Time
MIDI	MID-infrared Interferometric instrument
MOS	Multi-Object Spectroscopy
MPG	Max Planck Gesellschaft
MPIfR	Max Planck Institut für Radioastronomie
MUSE	Multi Unit Spectroscopic Explorer
NACO	NAOS-CONICA
NAOS	Nasmyth Adaptive Optics System
NB	Narrow Band
NGS	Natural Guide Star
OB	Observation Block
OmegaCAM	Wide Field Imager for the VST at Paranal

OPC	Observing Programmes Committee
OPO	Observing Programmes Office
P2PP	Phase 2 Proposal Preparation (software tool)
PI	Principal Investigator
PWV	Precipitable Water Vapour
QCDP	Quality Control and Data Processing Group
RRM	Rapid Response Mode
SABOCA	Submillimetre APEX BOlometer CAmera
SAM	Sample Aperture Mask
SDI	Simultaneous Differential Imager
SE	Seeing Enhancer
SHFI	Swedish Heterodyne Facility Instrument
SINFONI	Spectrograph for INtegral Field Observations in the Near Infrared
SIS	Superconductor-Insulator-Superconductor
SM	Service Mode (programme)
SPHERE	Spectro-Polarimetric High-contrast Exoplanet REsearch
STRAP	System for Tip-tilt Removal with Avalanche Photodiodes
SV	Science Verification
SW	Short Wavelength (in the IR)
ToO	Target of Opportunity
USD	User Support Department
UT1	Unit Telescope 1 (Antu)
UT2	Unit Telescope 2 (Kueyen)
UT3	Unit Telescope 3 (Melipal)
UT4	Unit Telescope 4 (Yepun)
UV	Ultra Violet
UVES	UV-Visual Echelle Spectrograph
VIMOS	VIisible MultiObject Spectrograph
VIRCAM	VISTA InfraRed CAmera
VISIR	VLT Imager and Spectrometer for mid Infra Red
VISTA	Visible and Infrared Survey Telescope for Astronomy
VLT	Very Large Telescope
VLTI	Very Large Telescope Interferometer
VM	Visitor Mode (programme)
VST	VLT Survey Telescope
WFI	Wide Field Imager
WFS	Wave front sensor
XFFTS	eXpanded Fast Fourier Transform Spectrometer
XSHOOTER	UV-Visual-NIR medium resolution echelle spectrograph
ZEUS-2	Redshift (z) and Early Universe Spectrometer
Z-Spec	Broadband millimeter-wave Spectrometer

(end of document)