



ESO Call for Proposals – P85

Proposal Deadline: 1 October 2009, 12:00 noon CEST

Call for Proposals

ESO Period 85

**Proposal Deadline: 1 October 2009,
12:00 noon Central European Summer Time**

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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.

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Part I

Phase 1 Instructions

1 ESO Proposals Invited

The **European Southern Observatory (ESO)** invites proposals for observations at ESO telescopes during Period 85 (**1 April 2010 – 30 September 2010**). In Period 85 the following instruments are offered:

La Silla

[EFOSC-2](#) (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)
[ISAAC](#) (Infrared Spectrometer And Array Camera)
[MIDI](#) (MID-infrared Interferometric instrument)
[NAOS-CONICA](#) (High Resolution NIR Camera and Spectrograph)
[SINFONI](#) (Spectrograph for INtegral Field Obs. in the NIR)
[UVES](#) (UV–Visual Échelle Spectrograph)
[VIMOS](#) (Visual Multi Object Spectrograph)
[VISIR](#) (VLT Imager and Spectrometer for mid Infra Red)
[X-SHOOTER](#) (UV–Visual–NIR medium resolution echelle spectrograph)

Chajnantor

[SHFI](#) (Facility heterodyne receiver unit covering 211–370 GHz and 1.25–1.39 THz)
[LABOCA](#) (295 channel 870 μm bolometer array)
[SABOCA](#) (37 channel 350 μm bolometer array)
[APEX-SZ](#) (330 channel 2 mm bolometer array)
[CHAMP+](#) (dual channel carbon heterodyne array covering 620–720 and 780–900 GHz)
[FLASH](#) (First Light APEX Submillimeter Heterodyne receiver covering 430–500 GHz)

The ESO proposal submission deadline is:

**1 October 2009,
12:00 noon Central European Summer Time.**

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.

A number of policies and procedures have been changed since Periods 83 and 84, the most important of which are highlighted below. All proposers should read the Call for Proposals carefully before

submitting their Phase 1 proposal.

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.

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

1.1 Important recent changes (since Periods 83 and 84)

- **General changes**

- **ESO User Portal:** Retrieval of the proposal package and proposal submission require users to identify themselves via the ESO User Portal. In the latter, all actions (e.g., Download ESOFORM packages, Submit a proposal, etc.) are accessed via a pulldown menu that is displayed when pointing with the cursor to the “Actions” button of the main menu shown in the left frame of the web pages.
- **OPTICON:** A new OPTICON contract has started in 2009 as part of the European Union’s Seventh Framework Programme (FP7). The OPTICON Programme offers travel funds to research teams from eligible non-ESO member states to observe at the 3.6-m telescope and at the NTT (see Sect. 11.8.1 for details).
- **Guaranteed Time Observations (GTO)** will be carried out in Period 85 with **MIDI, AMBER, X-SHOOTER and HARPS**. For details about the planned observations, please see <http://www.eso.org/sci/observing/visas/gto/85>.

- **La Silla**

- As in previous periods, proposals for Large Programmes on **the NTT and the 3.6-m telescope** are encouraged. Large Programmes on these two telescopes may have a duration of up to **four years**. However, users should note that, for Periods 85 to 87, a large fraction of the available science time on the 3.6-m telescope is already committed to Large Programmes started in Periods 83 and 84. Accordingly, the number of new Large Programmes using this telescope that may be accepted until Period 88, and the amount of time that may be allocated to them are limited.
- With respect to Period 83, the **minimum run length of 3 nights for runs** to be executed with La Silla telescopes has been amended as follows. 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 two exceptions:
 1. There is no minimum duration for runs to be carried out with Visitor Instruments (see Sect. 8). Note however that, in order to minimise the overheads associated with their installation on and removal from the telescope, such instruments are normally scheduled in blocks including several contiguous runs using them; the length of these combined blocks is typically greater than 3 nights.
 2. On the NTT, users can apply for combined runs using both EFOSC-2 and SOFI. The total duration of each of these runs must be greater than or equal to three nights. The combined runs must be requested using the instrument name “SOFOSC”. Details are also available in Sect. 3.2.1 and the ESOFORM Users’ 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, not to the total duration of the programme, summed up over all runs (see Sect. 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 not be schedulable.

- In P85, time is available on **the 2.2-m telescope** for new proposals by general users, for observations to be executed during the slots assigned to ESO (see Sect. 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.
- Starting with P84 a streamlined operation model has been introduced in La Silla. While Visiting Astronomers do not have a specific support astronomer assigned on the mountain, technical and logistical support will be delivered as usual by ESO staff. See Sect. 4.1 for additional details.

- **Paranal**

- **VLT-XMM proposals** are invited, for scientific programmes requiring both VLT(I) and XMM-Newton observations. Such proposals may be submitted for the next XMM-Newton cycle, which extends over ESO Periods 85 and 86. For more details, see Sect. 11.10.
- **Rapid Response Mode (RRM):** FORS2 on UT1, UVES and X-SHOOTER on UT2, ISAAC on UT3, SINFONI and HAWK-I on UT4 are offered in this mode in Period 85. 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 these runs involve strictly time-critical observations). For details on the RRM policies, see Sect. 11.5.1.
- **CRIFRES:** The available slit length is now 40 arcsec. The mechanism of the intermediate slit has been replaced leading to a much improved illumination reproducibility. Metrology fibers have been installed in May 2009: once the corresponding software integration is completed, wavelength setting reproducibility will be improved.
- **UVES and FLAMES-UVES:** The MIT CCD in the CCD mosaic of the red arm of UVES (see [UVES User Manual](#)) was replaced in July 2009 with a detector of the same type but of better cosmetic quality. On-sky tests reveal that the fringing is much reduced and the throughput in the red has increased by a factor of ~ 2 at ~ 900 nm. At wavelengths bluer than ~ 800 nm the red response is similar to that of the old MIT CCD. Results of the recommissioning are available on the [UVES web page](#).
- **VIMOS:** As a part of a VIMOS upgrade project, ESO plans to replace the currently installed four CCDs with E2V deep depletion CCDs (similar to the ones installed in GIRAFFE). The new detectors will have a better throughput in the red and a much reduced fringing. The expected gain in QE at 900 nm is a factor 1.5. The intervention is expected to take place in the middle of Period 85, *i.e.*, in the months of June and July 2010. Please consult the [VIMOS web page](#) for the latest news on the upgrade.
- **ISAAC:** ISAAC has been moved from the Nasmyth B focus of UT1 to the Nasmyth A focus of UT3 during August 2009. At the time of writing the instrument is in its recommissioning phase at the new focus station. The results of the recommissioning will be made available on the [ISAAC web page](#). However, no major changes of the instrument performance are expected.
- **NACO:** In Period 85, the following changes are foreseen:
 - * The LGS mode without tip-tilt star, the so-called seeing-enhancer mode is **offered** in P85. Users requesting this mode must specify “CLR” or better for the transparency, and a seeing better than 0.8” in their Phase 1 application.
 - * Cube mode without pupil tracking will be offered in SM and VM.
 - * Lyot coronagraphy, SDI+4 and 4QPM modes will be offered in VM only.
 - * Fabry-Perot Imaging will still be unavailable.
 - * Grism spectroscopy will be offered in Visitor mode only.
 - * All programmes requesting special calibrations in P85 will be moved to VM.

- **SINFONI:** The LGS mode without a tip-tilt star (the seeing-enhancer mode) has been offered since Period 84. Users requesting this mode must specify a transparency condition of “CLR” or better and seeing of 0.8” or better in their proposal.
The observation of PSF calibrators in the seeing-enhancer mode requires the definition of a separate OB; the corresponding observing time must be requested in the proposal.
- **Laser Guide Star:** The experience that has now been acquired by ESO with the Laser Guide Star (LGS) shows that, when it works nominally, it can be effectively used at most for 20% of the UT4 science time, due to the frequency of realisation of the required sky conditions and to intrinsic LGS operational constraints. As of P84, the LGSF is offered with NACO and SINFONI in SM and VM. Taking into account the already existing commitments for this facility (in particular, for on-going Large Programmes and for Guaranteed Time Observations), it is expected that it will be possible to allocate only a limited amount of time (less than 19 nights) in P85 to new NACO or SINFONI programmes requiring usage 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 study carefully the possibility of performing them with a NGS.
- **ATs:** New baselines are offered as of P85 (see [the VLTI baseline page](#)). Note also the new information on limitations of STRAP guiding related to the moon (see Sect. 4.2.5).
- **VLTI open for visitor instruments:** The possibility to install a Visitor Instrument at the VLTI is offered to the community.
- **X-SHOOTER:** The first “second generation instrument” has been offered since P84. The details can be found in Section 6.5 of this document and also from the [X-SHOOTER](#) web pages. Users should consult the instrument web pages for the latest updates.
- **Latest News** on Paranal telescopes and instruments can be found at <http://www.eso.org/sci/facilities/lpo/news/>.

- **Chajnantor**

- **SABOCA:** This 350 μ m bolometer array has been offered since Period 84. The sensitivity of the instrument has increased thanks to a technical upgrade which allows all 37 bolometers to be used.
- **FLASH:** The 460 GHz channel of this MPIfR PI instrument is again offered in Period 85, in collaboration with the PI team. Users should contact the instrument PI before submitting a FLASH proposal.
- **SHFI:** The facility heterodyne receiver SHFI is offered with three receivers covering 211 to 370 GHz and 1.25 to 1.39 THz. The APEX-3 receiver is not offered in Period 85.
- **SHFI:** The Fast Fourier Transform Spectrometer no longer offers the option of 16384 channels. The highest spectral resolution is now offered by the 8192 channel configuration (122 kHz channel separation).
- **APEX-SZ:** This MPIfR/Berkeley PI instrument is offered during ESO time in collaboration with the instrument team. Users should contact the instrument PI before submitting an APEX-SZ proposal.
- **CHAMP+:** This MPIfR PI instrument is offered during ESO time in collaboration with the instrument team. Users should contact the instrument PI before submitting a CHAMP+ proposal.

- **ESO/GTC proposals**

- ESO/GTC proposals are not invited at this time. The next call for ESO/GTC proposals will likely be issued in February 2010 together with the call for ESO proposals for Period 86.

1.2 Important reminders

- **Observing mode on the VLT:** As per the VLT/VLTI Science Operations Policy, at least 40% of the available time on the VLT is reserved for Visitor Mode observations; and Service Mode observations are scheduled for at least 50% of the available time. Departures from the observing mode requested by the proposers may be implemented by ESO so as to ensure that the intended distribution between Service Mode and Visitor Mode is achieved. As a rule, proposers should request Service Mode only for observations that demonstrably benefit from the short-term scheduling flexibility allowed by this mode, or for those instrument modes that are offered by ESO exclusively in Service Mode. Otherwise, Visitor Mode should be requested. Proposers who wish to do so 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.
- **APEX:** In their Phase 1 proposal, APEX users
 - must specify the requested precipitable water vapour (PWV) for their project to allow a better distinction between observations requesting a range of atmospheric transparencies;
 - if they wish to observe extended line-emitting regions, they should either indicate an appropriate off-source position or request time to find such a position;
 - need to merge all observations on a given APEX instrument into a single run. This also accounts for the different receivers of SHFI, which should be grouped into a single run. Different runs should only be used for different APEX instruments. For Large Programmes, this restriction should be understood as a single run per instrument and per period. Different runs should be specified for observations planned to take place in different periods.
- **Duplications:** Proposers are reminded that large amounts of data are available via the ESO data archive (Sect. 2.3, see also: <http://archive.eso.org>) and they are therefore strongly advised to check if observations equivalent to the proposed ones have been performed already. Before submitting, proposers must check that their proposed observations are not duplicating [Guaranteed Time Observations approved for Period 85](#).
- **Overheads:** All proposers (Service Mode and Visitor Mode) are reminded that they must include all overheads in the computation of the total observing time to be requested in their proposals (see Sect. 9).
- **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 will be evaluated by the Observatory.
- **Access to SM data:** As of 1 April 2008, Principal Investigators of Service Mode programmes have access to their proprietary SM raw data as soon as the data have been ingested in the ESO Archive. Reduced data will also be made available soon after the ingestion of the raw data. The data access is provided through the User Portal interface.
- **Pre-imaging, Paranal:** for VLT instruments and modes for which pre-imaging is required, **a separate pre-imaging run must be specified** in the proposal (to be executed in Service Mode). Failure to do so will, in case the programme is approved for execution, result in the deduction of the time necessary for the pre-imaging from the allocation destined to the main part of the project (see Sect. 13.6).
- **Pre-imaging, La Silla:** Pre-imaging frames for EFOSC-2 will have to be obtained at the beginning of the spectroscopic run itself. The resulting lower efficiency should be taken into account in the computation of the execution time required for this run.
- **Monitoring programmes:** Monitoring programmes in Service Mode are executed on a best effort basis only, *i.e.*, a monitoring sequence might be interrupted by long periods of unsuitable weather conditions or Visitor Mode scheduling.

- Although proposals requesting Visitor Mode do not need to include a backup programme, the observer must normally prepare one for the case of unfavourable weather (note in particular Sect. 4.2.6). Approval of this backup programme must be sought at least one month in advance through the change request form located at:
<http://www.eso.org/sci/observing/phase2/ProgChange/> (see Sect. 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 Sect. 13.5).

1.3 Foreseen changes in the upcoming Periods

- **HARPS:** A new spectropolarimetric mode for HARPS is currently under commissioning and is expected to be offered to the community in Period 86.
- **NACO** is expected to be decommissioned by the end of 2011 to allow the installation of the second generation instrument MUSE on UT4. Proposals for Large Programmes with NACO should take this limited availability of NACO into account.
- **SHFI**, the Facility APEX-3 receiver, covering 385 to 500 GHz is expected to be commissioned during 2010, and may be offered during Period 86.

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). 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. Thus it is important that proposers consult technical documentation about the capabilities and sensitivities of the instrument(s) that will be used to obtain the observations. Proposers are reminded about the existence of P2PP (Phase 2 Preparation tool) tutorials (<http://www.eso.org/sci/observing/phase2/P2PP/P2PPDocumentation.html>) and a P2PP tutorial account for all VLT instruments that can be useful in preparing Phase 1. When necessary, proposers should discuss their technical requirements with the appropriate experts (contacts provided via the ESO User Support Department, usd-help@eso.org for Paranal and Chajnantor, and via lasilla@eso.org for La Silla) before submitting their proposals. Advice about policies and about the practical aspects of proposal preparation (e.g. specification of time constraints, fulfilment of minimum run length for La Silla, etc.) should be sought from the Observing Programmes Office opo@eso.org.

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

2.1 Distribution of requested Right Ascension

The distribution of the demand in Right Ascension (RA) is far from uniform throughout the year 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 telescope 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. If possible, proposers should avoid the RA demand peaks discussed below.

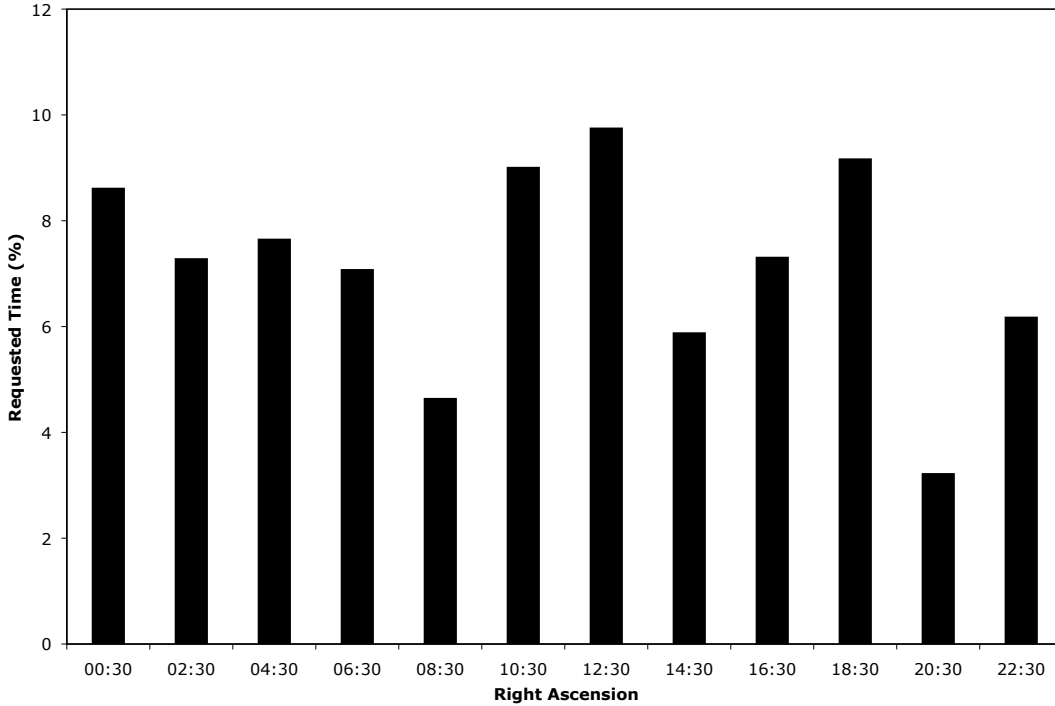


Figure 1: Distribution of requested time (percentage of total) on Paranal and La Silla as a function of Right Ascension (RA). The histogram bins have a width of 2 h and are labelled with the RA of their centre. The data for all requested targets over the last 10 periods are shown here.

Figures 1 and 2 highlight the fact that there is a non-uniform distribution of RA demand across the sky. 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’s dark time. On the other hand, the opposite is true for January and August (see Fig. 1). The time request for targets in these months (RA \sim 8h and 20h, respectively) is very low, allowing a significantly higher fraction of runs applying for time at these RAs to be scheduled (if considered useful by the OPC).

While an accurate knowledge of the distribution of favourite sky regions helps the Observatory in optimizing short- and long-term scheduling of observations and engineering activities, this optimization can only do so much when the demand for time is non-uniform. ESO observers are encouraged to take advantage of this situation and investigate if targets around RA \sim 9h and \sim 21h will suit their science goals.

2.1.1 Prediction of RA demand during Period 85

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 85. Note that during Period 85 the distribution of instruments on the UTs will be: UT1 (CRIRES + FORS2), UT2 (FLAMES + UVES + X-SHOOTER), UT3 (ISAAC + VIMOS + VISIR), UT4 (HAWK-I + NACO + SINFONI). Proposers should take advantage of this information in choosing targets to maximize the probability of scheduling and completion of their runs (see Fig. 2). Proposers should also consider the time expected to be allocated in Period 85 to on-going Large Programmes started in earlier periods shown in Fig. 3 (telescopes on which no time has been requested by on-going Large Programmes do not appear in this figure).

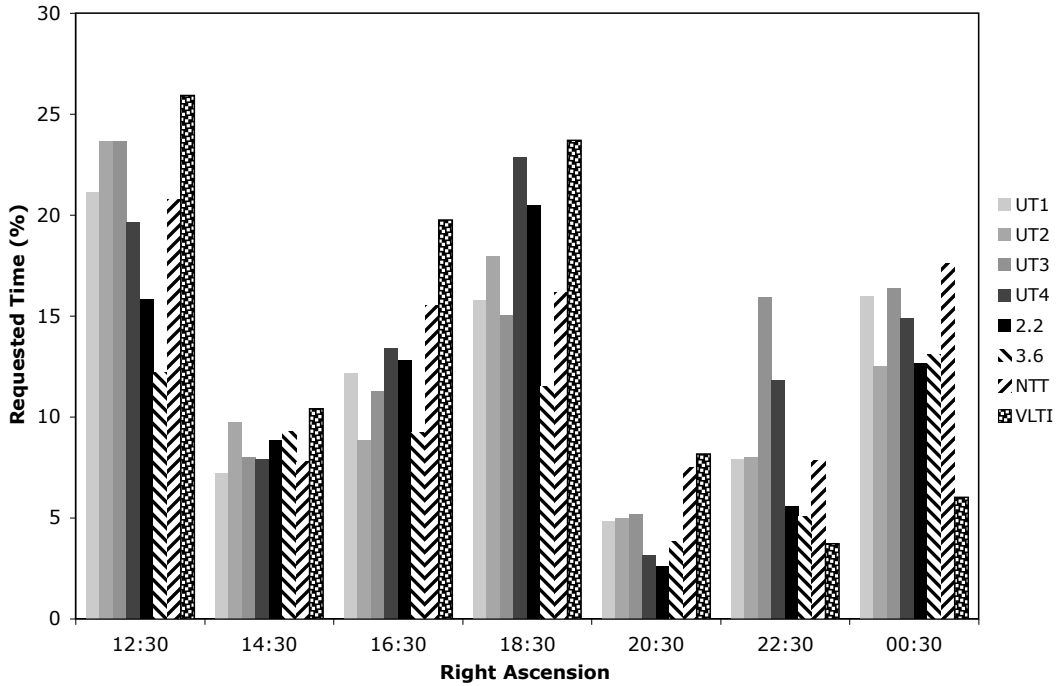


Figure 2: Prediction of RA distribution of demand during Period 85 (percentage of the total amount of time requested on the considered telescope). The RA bins are defined as for Fig. 1. The first and last bins also include the requested targets with RAs respectively earlier than the lower limit and later than the upper limit of the nominal range corresponding to the period.

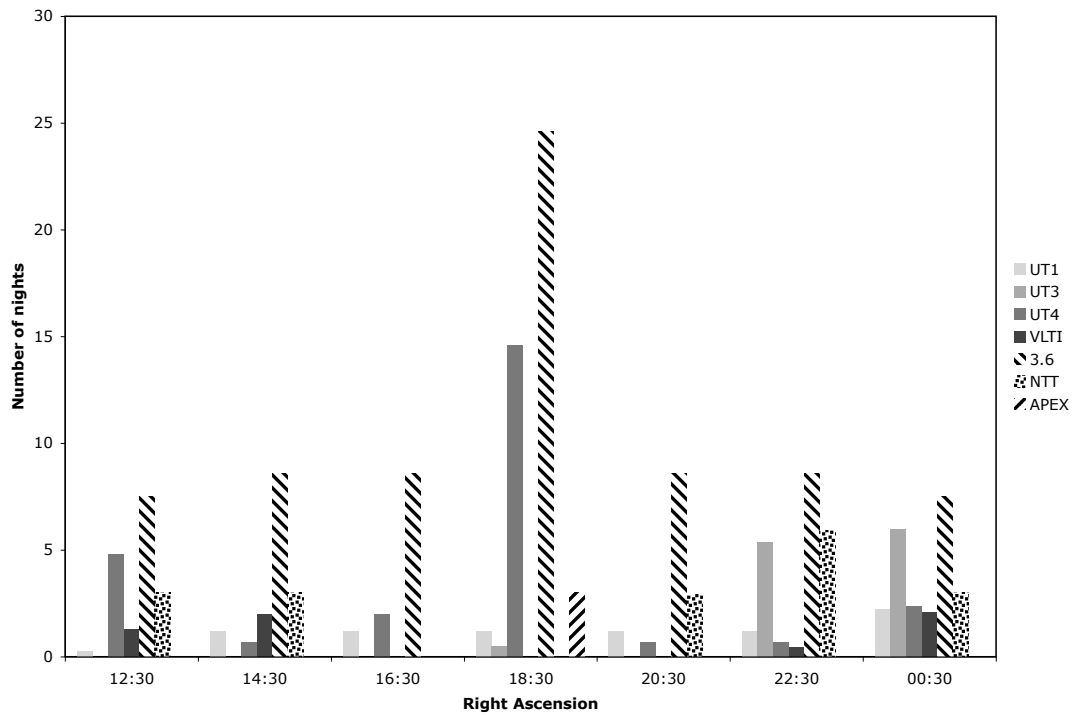


Figure 3: Expected time allocation (in nights) for ongoing Large Programmes in Period 85. The RA bins are defined as for Figs. 1 and 2.

2.2 Exposure Time Calculators available Online

To aid proposers in calculating exposure times needed to achieve their scientific objectives, Exposure Time Calculators (ETCs) for ESO instruments are accessible directly on the ESO Web. They can be reached via:

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

for La Silla and Paranal instrumentation. For APEX instrumentation please go to:

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

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

<http://www.eso.org/sci/observing/tools/index.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 lunar phase” of their proposals.

Please check the ESO web pages for the ETC version to be used in Period 85. Please note that while the sky background values used in the ETCs generally reflect actual conditions on Paranal accurately, they do not account for local effects such as observation in 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 Sect. 13.5) that the requested observing conditions are binding in Phase 2, hence consistency is required between the seeing constraint indicated in the first page of the proposal and the seeing value used in the ETC to estimate the observing time necessary to complete the programme. 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 Imaging Surveys, Science Verification, Advanced Data Products, etc.

Public data from observations made with Paranal and La Silla telescopes can be searched for at: <http://archive.eso.org>.

Most of the data taken in Period 83 will become available during Period 85. Users are reminded of these opportunities in order to stimulate the scientific use of the Archive and to allow a better preparation of projects for Period 85.

Several sets of reduced data products are available online at

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

These include Advanced Data Products (ADP) from the GOODS imaging and spectroscopic campaign or delivered to ESO by the community, data from the ESO Imaging Survey (EIS), Science Verification/Demonstration and Commissioning data of VLT and VLTI instruments.

UVES reduced data have been ingested into the ESO Science Archive and can be retrieved using a dedicated Request Form: http://archive.eso.org/eso/eso_archive_adp.html.

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 Sect. 11.3). 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 to ESO the resulting data products within 1 year of the completion of the corresponding observations.

Voluntary submission of Advanced Data Products by PIs of Normal or Short 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 may be obtained by logging into the ESO User Portal. Please follow the instructions at:

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

3.2 How to fill the ESOFORM Proposal Form

The “ESOFORM Users’ Manual” describes in detail how to fill the L^AT_EX template, and which information is needed to make a proposal valid. Please be aware that the ESOFORM package is regularly updated, and that only the Period 85 package may be used for proposal preparation.

The telescope schedules are prepared using scheduling software, which 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 often impossible.**

3.2.1 Important recent changes to ESOFORM

- Like in Period 84, users have the possibility to submit proposals involving observations with both EFOSC-2 and SOFI for which the amount of time requested with either of the instruments is below the 3-night minimum duration limit applicable to La Silla runs, provided that the considered EFOSC-2 and SOFI observations are to be executed on contiguous nights, and that the sum of the durations of the EFOSC-2 run and of the associated SOFI run is greater than or equal to 3 nights. In Period 85, a new convention should be used to identify such runs in Box 3 of the ESOFORM proposal form: the instrument designation SOFOSC refers to the combined usage of EFOSC-2 and SOFI in a single contiguous run. The combined run must have a duration of at least 3 nights. The respective amounts of time required for observations with each of the two individual instruments must be specified in the time justification section (Box 9). Examples illustrating this new convention can be found in the ESOFORM Users’ Manual.
- As of P85, additional flexibility is allowed for specification of the observing run duration and of the breakdown of observing runs in Box 3 of the proposal form. Details may be found in the ESOFORM Users’ Manual.
- With the introduction in P85 of new AT baselines for the VLTI (see [the VLTI baseline page](#)), detailed specification of the 2-AT (for MIDI) or 3-AT (for AMBER) baselines has been moved from Phase 1 to Phase 2. Accordingly, users should only specify the required AT quadruplets in the VLTI page of the Phase 1 proposal form.
- For encapsulated figures, version 1.4 of the pdf format is supported as of P85. More details are given in the ESOFORM Users’ Manual.

- For Period 85 proposers have to indicate in the ESOFORM if they are applying for VLT-XMM time under the ESA-ESO agreement (see Sect. 11.10).

If you are re-submitting a proposal **you need to address the OPC comments received on the previous submission of this proposal.**

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 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 image has been taken through the entire telescope and instrument. *It is not the instantaneous seeing outside the dome.* For AO instruments, as well as for FLAMES and the IFU mode of VIMOS, the reference seeing is the one measured at the wavefront sensor of the active optics of the telescope. Please note that the seeing does not have a strong influence on the feasibility of MIDI observations that use MACAO, and therefore the seeing is not part of the constraint set at Phase 2. Hence, MIDI runs must indicate ‘no restriction’ in the Phase 1 proposal. VLTI runs with MIDI that do not make use of MACAO require excellent seeing conditions; MIDI runs that do not use MACAO for more than 20% of the requested time, should indicate 0.6'' as the seeing constraint. Please note that observations without MACAO should be carried out in Visitor Mode only. AMBER observations without MACAO are not possible. Authors of NACO proposals should note that the seeing specified in the NAOS Preparation Software is the DIMM (Differential Image Motion Monitor) seeing corrected to zenith.
- Moon
 - Moon illumination is defined as the percentage of the lunar disk which 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 = 0 when the moon is below the local horizon. Please note that the lunar illumination does not have a noticeable influence on the feasibility of MIDI and AMBER observations; MIDI and AMBER runs should thus indicate ‘no restriction’ on this constraint. However, for the Auxiliary Telescopes, users should pay attention to the possible impact of guiding restrictions on the planning of their observations (see Sect. 4.2.5).

Naturally, seeing and moon illumination conditions are not relevant for APEX observations, which require an acceptable precipitable water vapour (PWV) range to be specified in mm.

Please note that observing conditions requested at Phase 1 **cannot be changed at Phase 2** (see Sect. 13.5 for more detail).

3.3 Proposal Submission

Proposals can be submitted via a web upload that can be accessed by logging into the User Portal at:

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

prior to the submission deadline:

**1 October 2009,
12:00 noon Central European Summer Time.**

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 and JPEG file formats.
- 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 receiver software in order to verify that your proposal complies with ESO's requirements when you submit the proposal via the web interface. 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 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 OPO at opo@eso.org.

Proposals, or additions or corrections to proposals, submitted after the deadline will not 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°43′ longitude West, 29°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. Since Period 82, 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. At the NTT, for programmes involving observations with both EFOSC-2 and SOFI to be performed on contiguous nights, the minimum duration requirement applies to the combined length of the corresponding EFOSC-2 and SOFI runs (the naming convention SOFOSC is used to refer to this combination – see Sect. 3.2.1 and the ESOFORM manual to learn how to specify such combined runs in the ESOFORM proposal form).

Requests for usage of the NTT and the 3.6-m telescope for the execution of Large Programmes are particularly encouraged. As of Period 83, the maximum duration for Large Programmes with these telescopes has been increased to four years. However users should be aware of the limited possibilities of approval of new Large Programmes on the 3.6-m telescope in Periods 85 to 87, as described in Sect. 1.1. Large Programme proposals are not accepted for the 2.2-m telescope.

Starting with P84 a streamlined operation model is being introduced in La Silla. While technical and logistical support will be delivered as usual by ESO staff on the mountain, no support astronomer will in general be available on site.

General information can be found on the La Silla web page on

<http://www.eso.org/sci/facilities/lasilla/>.

Proposers are also strongly advised to read the La Silla Science Operation page that provides updated information on support and procedures at

<http://www.eso.org/sci/facilities/lasilla/sciops/>.

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-Chretien 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 EFOSC-2 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. Since Period 78, 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-Chretien 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. In 2008, an extension of the agreement until March 31, 2013, was signed between ESO and MPG, according to which MPG is allocated 9 months of observations per year as of Period 83.

Accordingly, the preliminary breakdown of the time on the 2.2-m telescope in Period 85 is as follows (from noon of the start date to noon of the end date):

from April 1, 2010 to April 29, 2010: MPG time
 from April 29, 2010 to May 21, 2010: ESO time
 from May 21, 2010 to June 18, 2010: MPG time
 from June 18, 2010 to July 2, 2010: ESO time
 from July 2, 2010 to July 30, 2010: MPG time
 from July 30, 2010 to August 21, 2010: ESO time
 from August 21, 2010 to September 17, 2010: MPG time
 from September 17, 2010 to October 1, 2010: ESO time

(These dates may be subject to minor changes.)

In addition, about 9 nights during the Period 85 ESO time slots will be allocated to the National Observatory of Brazil for final compensation of the GROND overrides (see below) that took place during Brazilian slots in previous periods.

One night per month during the ESO time slots will be reserved for scheduled technical activities and execution of the calibration plan. In Period 85, ESO will be allocating approximately 57 nights for execution of scientific programmes on the 2.2-m telescope; the corresponding runs will be scheduled exclusively during the ESO time slots. Of these 57 nights, up to 18 will be allocated to Chilean proposals (see Sect. 11.9), within the framework of the guaranteed time to which Chile is entitled as host country, as per the agreement between ESO and Chile (see Sect. 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 have to be given away to such observations. A compensation buffer of 9 nights is included in the ESO 57 nights of science time. The ESO telescope time allocation includes this compensation; users whose programmes are affected by GROND interruptions are not entitled to any additional compensation.

FEROS and WFI are permanently mounted on the telescope.

4.2 Paranal

4.2.1 The VLT 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.

A UT main mirror is a single Zerodur blank of diameter 8.20 m, the secondary has a diameter of 1.12 m. 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 $3''$. 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

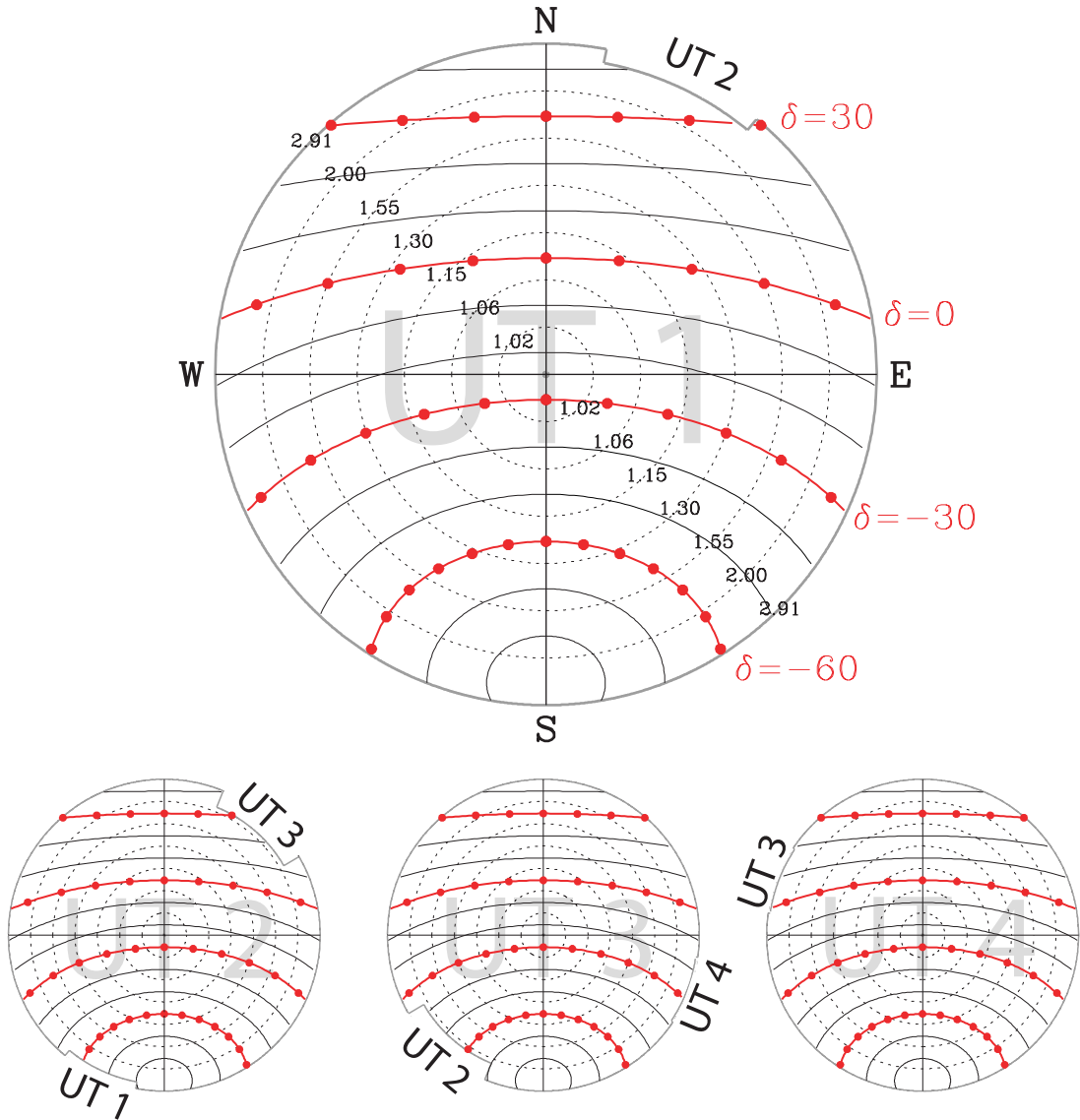


Figure 4: Sky accessibility and vignetting by neighbour for the 4 UTs. See Section 4.2.4 for more details.

should specify the additional velocities in RA and Dec for their targets, for the purpose of feasibility assessment.

- **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 Coude 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 $< 1.5''$, $\tau_0 > 1.5$ ms and airmass < 2 . The distance of the natural guide star from the science target is restricted to be within $57.5''$.

4.2.3 Laser Guide Star facility on UT4

UT4 is equipped with a sodium laser that can be used to create an artificial point source which can then be used with NACO and SINFONI. In most cases a tip-tilt star (TTS) is still necessary to

correct for tip and tilt. SINFONI (since P84) and NACO (as of P85) can be used with the Laser Guide Star but without a TTS (the so-called 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. For example, the transparency needs to be clear (CLR) or better, the airmass constraints need to be tighter and the atmosphere needs to 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. As of P84, the LGSF is offered with NACO and SINFONI in Service and Visitor Mode.

The peak K-band Strehl ratio that one gets 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.

Observations with a NGS, on the one hand, and with the LGS, on the other hand, as part of the same programme should be specified as different runs in the proposal form.

4.2.4 Paranal Sky accessibility, zones of avoidance

Figure 4 represents the sky accessibility for the 4 UTs. The outermost circle marks the telescope safety limit (zenith distance 70°). All other concentric circles come in zenith distance intervals of 10° and are marked with the corresponding airmass value. An object will move along one of the curves of constant declination. The solid dots on those curves mark the movement in 1 hour intervals, the maximum visibility period of a given object can be read directly off the figure (counting intervals between dots). The smaller plots (for UT2, UT3 and UT4) are similar, only the vignetting by neighbour domes vary.

4.2.5 The ATs (VLTI only)

The VLT Interferometer is complemented by an array of relocatable 1.8-m Auxiliary Telescopes (ATs). For Period 85 the ATs are offered with MIDI and AMBER. New baselines are offered for the first time: see [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 is restricted to be within $57.5''$.

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.

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

4.2.6 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 here. 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.

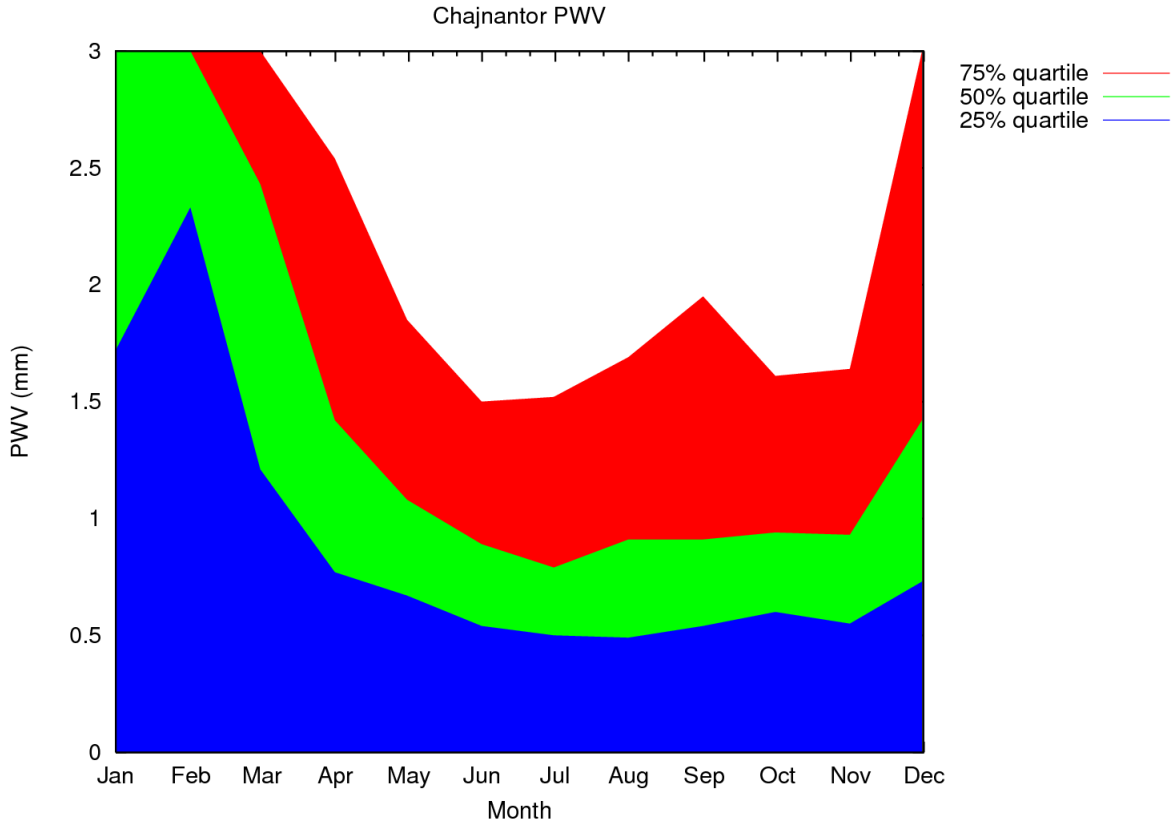


Figure 5: Annual variation of the Precipitable Water Vapour (PWV) content at Chajnantor, based on 10 years of site testing. During Period 85, observations will only be scheduled from April to August, when median conditions are expected to be slightly better than $\text{PWV} \sim 1$ mm.

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 Figure 5). Water vapour absorbs and attenuates sub-mm radiation and thus a dry site is required for high-frequency radio astronomy.

Llano de Chajnantor is one of the best sites available on Earth for sub-mm astronomy; it is also the site where ALMA is under construction — a collaboration between Europe, North America and East Asia to construct and operate a large interferometer for high sensitivity, high frequency imaging of the southern sky.

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. During period 85, the ESO time is tentatively scheduled in April, June and August. Time-critical programmes should be scheduled during these months.

For Period 85, applications are invited for the Swedish Heterodyne Facility Instrument (SHFI), the $870 \mu\text{m}$ LABOCA bolometer array, the $350 \mu\text{m}$ SABOCA bolometer array, and in collaboration with MPIfR, the PI instruments APEX-SZ (152 GHz bolometer array), FLASH (430 to 500 GHz single pixel heterodyne spectrometer) and CHAMP+ (7+7 pixel dual channel heterodyne array covering 620 to 720 GHz and 780 to 900 GHz). Observations will be done for up to 24 hours per day, but users should be aware that afternoon conditions are often significantly worse than night or morning. Observations using high frequency instruments (APEX with the APEX-T2 receiver, SABOCA, CHAMP+ and FLASH) 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.** Note that due to the ongoing commissioning of the APEX instruments, the APEX schedule and instrument availability can be subject to change at short notice.

From Period 81, the [wobbling secondary](#) is offered on all SHFI proposals. 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 0.3 K 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, when weather conditions are expected to be the worst, with a shorter re-cycling procedure 11 to 12 hours later. The exact schedule will be optimised according to the LST 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.

All APEX proposals should clearly indicate the requested PWV for their observations in Box 12 of the proposal form. Figure 5 gives the statistical distribution of PWV throughout the year.

For each proposal, all observations with the same APEX instrument should be merged in 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.

More on APEX, including SHFI, LABOCA, SABOCA and FLASH 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 and has the following observing modes:

- Imaging with plate-scales of 0.273 and 0.288''/pixel using broad and narrow-band filters in the wavelength range 0.9 to 2.5 microns. SofI provides a field of view of 4.92'. As of Period 80, the imaging modes with 0.144''/pixel plate-scales, *i.e.*, the small field objective and the large field plus focal elongator, are no longer offered. 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), 0.93–2.54 micron spectroscopy with fixed width slits of 0.6, 1 and 2''.
- Medium resolution (R=1500) spectroscopy with the same fixed width slits.
- 0.9–2.5 micron imaging polarimetry

SofI is equipped with a Hawaii HgCdTe 1024×1024 detector. Up-to-date information and documentation on the instrument are available at:

<http://www.eso.org/sci/facilities/lasilla/instruments/sofi/>.

SofI is only operated in Visitor Mode.

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

EFOSC-2, 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.

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

Starting from P81, two new volume-phase holographic gratings (VPHG) are 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 EFOSC-2 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 EFOSC-2 is now mounted at the NTT Nasmyth-B focus there is strong instrumental polarisation which 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 EFOSC-2 filter page](#) for details. Up-to-date information and documentation on the instrument are available on the [EFOSC-2 web page](#).

Since Period 83, EFOSC-2 is mounted on the NTT and only operated in Visitor Mode. Information about the characterisation of the instrument at the new focal station and telescope is available on the web pages.

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.

The instrument is built to obtain very precise radial velocities (on the order of 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 star light, while the second is used to either record simultaneously a Th-Ar

reference spectrum or the background sky. 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 signal-to-noise ratio 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 ($v \sin i < 2 \text{ km/s}$).

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.

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. However the intrinsic instrument stability (better than 1 m/s) is much superior to the EGGS radial velocity accuracy. The achievable radial velocity accuracy of the EGGS mode is limited by systematics and is of the order of 10 m/s RMS. The amount of diffuse light in the spectrograph is of the order of 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 be both used on the same night. The time needed to switch from one mode to the other is of the order of 1 minute. For radial velocity measurements a calibration sequence similar to that of the base mode should be used.

HARPS will be offered only in Visitor Mode during Period 85.

The user manual and exposure time calculator are available through the HARPS web page at <http://www.eso.org/sci/facilities/lasilla/instruments/harps/index.html>.

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 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 $2''.9$.

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.

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-DRS package (provided at the [FEROS web site](#)), can be used to re-reduce the data to obtain publication quality results.

A new atmospheric dispersion corrector (ADC) was installed in March 2006, correcting the loss of transmission in the previous ADC. It dramatically decreases the loss of light injected into the fibre when observing at airmasses greater than 1.3.

During Period 85, FEROS will be offered only in Visitor Mode. The available ESO time-slots at the 2.2-m telescope, as defined in Sect. 4.1, need to be taken into account for proposal preparation.

Further details can be found in the FEROS web pages.

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.

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], $H\alpha$ 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 below. The table should only be used as a quick guide of feasibility. Proposers should refer to the detailed information that is available via <http://www.eso.org/sci/facilities/lasilla/instruments/wfi/index.html>.

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.

As of Period 82, WFI is offered only in Visitor Mode. All applicants are invited to take into account the availability restrictions of the 2.2-m during ESO time and the corresponding lunar phases (see Sect. 4.1).

6 Scientific Instruments: Paranal

6.1 CRIRES, Cryogenic high-resolution IR Échelle Spectrograph

CRIRES is the infrared ($0.95 \mu\text{m} - 5.4 \mu\text{m}$) high-resolution spectrograph located at the Nasmyth A focus of UT1. It provides long-slit ($40''$) 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.

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

The recommended minimum slit width is $0.2''$, providing a resolving power up to $R \simeq 100,000$. A resolution of $R \sim 50,000$ can be reached with a $0.4''$ slit width. Standard and free wavelength settings are offered for both Visitor Mode (Sect. 12.1) and Service Mode (Sect. 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 4 and 5 of the User Manual report the spectral range free of these effects for all standard settings.

Despite the availability of a Krypton and ThAr lamps and of the N_2O and CO gas-cells, the lack of wavelength calibration lines still affect some settings.

Provided an adequate observational strategy is followed, radial velocity measurements to better than $\approx 30\text{m s}^{-1}$ can be reached for stars showing a sufficient number of spectral features.

For the latest information on the instrument, please consult [the CRIRES web pages](#).

Table 2: Point source sensitivities determined using a $0.4''$ slit, adaptive optics, optical seeing of $0.8''$ and nodding along the slit. The values listed correspond to a S/N of 10 for a 1 h on-source integration in one spectral dispersion element. They are obtained by integrating the spectrum profile along the spatial direction.

Band	Sensitivity (mJy)	Magnitude
J	1.1	15.4
H	1.1	15.1
K	1.1	14.6
L	9.5	11.2
M	26	9.4

6.1.1 Calibration

The observer has to supply his/her own standard star calibration OBs to correct for telluric features. 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. High-precision wavelength calibration or flat-fielding requires an attached template. The observing time needed to execute these 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 in any case better for redder wavelengths.

6.1.2 Sensitivity

Table 2 lists the offered sensitivities. This table is only intended to be a quick feasibility guide.

Proposers should refer to the Exposure Time Calculator at <http://www.eso.org/observing/etc/> to assess the feasibility of their programmes. Detailed information regarding CRIRES is provided in the Users' Manual, available via [the CRIRES web pages](#).

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. Following the merging of the two FORS instruments at the beginning of P83, it has two detector systems and a wide range of exchangeable optical elements.

The default MIT detector consists of a mosaic of two $2k \times 4k$ MIT CCDs ($15 \mu\text{m}$ 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 ($> 750 \text{ nm}$) 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.

The image scale in the default readout mode (2 by 2 binning) is $0''.125/\text{pixel}$ in the high resolution (HR) mode and $0''.25/\text{pixel}$ in the standard resolution (SR) mode. The field of view in these two modes is, respectively, $4''.25 \times 4''.25$ and $6''.8 \times 6''.8$ (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:

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 (Sect. 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 4). 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 High Time Resolution mode

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 grisms 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 (in the range 0.1–20 secs), the rows of the CCD are rapidly (in 50 microsec) shifted, 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 pages](#).

Table 3: Offered FORS2 imaging modes for Period 85

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

The magnitude limits in Table 3 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 new 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.

The magnitude limits given in Table 4 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/FORS/FIMS.html>

for instructions on how to install FIMS and to the [FIMS Users' Manual](#) on how to use FIMS.

Table 4: Offered FORS2 spectroscopic modes for Period 85

Instrument Mode	$R_s = \lambda/\Delta\lambda$	Magnitude limit
E2V		
MOS – movable slits ^[1]	260–1700	R = 24.0–22.8
Long slit Spectroscopy ^[2]	260–1700	R = 24.0–22.8
Spectropolarimetry ^[3]	260–1700	R = 19.2–17.2
MIT		
MOS – movable slits ^[1]	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.

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, therefore limiting 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 5. 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.

6.3.1 Instrument Capabilities

GIRAFFE is a medium-high ($R = 5600\text{--}48000$) 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 magnification scales are available: “1:1” with a sampling of 0''.52/microlens and a total aperture of 11''.5 \times 7''.3, and “1:1.67” with 0''.3/microlens and a total aperture of 6''.6 \times 4''.2. In addition, 15 ARGUS sky fibres can be positioned in the 25' field.

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

UVES is the high resolution spectrograph at UT2 of the VLT (see Sect. 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 wavelength 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. Since Period 76, a high-speed readout mode (625 kHz, unbinned, low gain) with increased readout noise but less overheads has been offered 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 ~ 47000 . 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 (see Sect. 1.1).

Table 5: 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.

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 $11''$. 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.

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

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 to the user.

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). To this purpose, the light beam from the telescope is split in 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 Arm, while using a $0.4''$ and $0.3''$ slit respectively. Three image slicers are also 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 85 are listed in Table 6. 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 6 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 6: UVES Period 85 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 6 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 peculiar spectral formats and the reduced sample of the sky spectrum with the image slicer also have to be taken into account.

Since Period 77, eight interference filters have been 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%.

Finally, in July 2009 the MIT CCD was replaced by an improved version that offers less fringing and higher throughput redwards of ~ 800 -nm. See the [UVES news page](#) for details.

6.5 X-SHOOTER: multi band, medium resolution échelle spectrograph

X-SHOOTER, the first VLT-2nd 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 is maintained aligned against instrument flexure and corrected for differential atmospheric refraction between the telescope guiding wavelength and each arm central wavelength. Two pairs of ADC prisms in the optical path of the UVB and VIS arms compensate for the atmospheric dispersion at different airmasses.

Two instrument modes are offered: (short) slit spectroscopy (SLT) with a selection of different slit

widths for each arm and a fixed length of 11 arcsec, and IFU spectroscopy, which allows observing a field of 1.8×4 arcsec² reformatted to a 0.6×12 arcsec longslit. 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 instrument was successfully commissioned during P82 and P83 and science verification is now scheduled for the end of P83. As the instrument characteristics and the instrument operations are still being finalized and subject to changes, please refer to [the XSHOOTER pages](#) for any update and news.

6.6 ISAAC, Infrared Spectrometer And Array Camera

ISAAC is an infrared (1–5 μm) imager and spectrograph, which will be mounted on the Nasmyth A focus of UT3 as of the end of P84. It has two independent arms, one equipped with a 1024×1024 Hawaii array and the other with a 1024×1024 InSb Aladdin array. The Hawaii arm is used at short wavelengths (1 – 2.5 μm). The Aladdin arm is used predominantly at long wavelengths (3–5 μm) but is also available for short wavelength imaging with broad band filters. Below we summarise in two tables the operational modes and the performance of ISAAC. These tables are only intended to be quick reference guides. Proposers should refer to the detailed information available via [the ISAAC web pages](#).

During Period 85 we will continue to offer, in both Visitor Mode (Sect. 12.1) and Service Mode (Sect. 12.2), all ISAAC instrument modes already offered in Period 84 (*i.e.*, short-wavelength imaging, spectroscopy and polarimetry, and LW imaging and spectroscopy).

Starting in Period 80 we offered two new imaging modes with the Aladdin detector: Burst mode and FastJitter mode. They are offered both in Visitor Mode and Service Mode. However, please note that for lunar occultation observations only disappearances can be supported in Service Mode; appearances must be in Visitor Mode. The Burst and the FastJitter modes are intended for fast relative photometry (of the order of few milliseconds) with the hardware windowed Aladdin array. Technical details, restrictions and overheads of the new modes are available at [the ISAAC web page](#).

Table 7: ISAAC Period 85 offered imaging modes

Instrument Mode	Scale (" / pixel)	FOV (arcsec ²)	Magnitude limits
SW Imaging ^[1]	0.148	152×152	J=24,H=23,Ks=22
SW Polarimetry	0.148	$3 \times 20 \times 150$ ^[2]	J=23,H=22,Ks=21
LW Imaging	0.071	73×73	L \approx 16, M,NB \approx 13
LW Imaging 3.21, 3.28 μm	0.148	152×152	L \approx 16
LW FastPhot (JHK)	0.148	4.7×4.7 to 152×152	–

[1] For both the Hawaii and Aladdin arrays

[2] In polarimetry the FOV consists of three non-overlapping strips each of $20'' \times 150''$

The magnitude limits (c.f. Table 7) are the J (1.25 μm), H (1.65 μm), Ks (2.2 μm), and L (3.8 μm) background limited magnitudes for a flat spectrum point source that would result in a S/N of 5 in one hour of integration under typical background conditions and a seeing FWHM of 0''.65.

In addition to the standard J, H, Ks, and L broadband filters, ISAAC is equipped with a wide selection of narrow-band (typically $\Delta\lambda/\lambda \approx 0.015$) filters. It is not possible to observe with ISAAC with user-supplied filters.

The magnitude limits given in Table 8 are the short wavelength (SW) and long wavelength (LW) magnitudes of a flat spectrum point source that would result in a S/N of 5 per resolution element in the continuum in one hour of integration under typical background conditions, a seeing FWHM of 0''.65, and using a 1'' slit. Limits on IR spectroscopic capabilities vary strongly with wavelength due to the absorption/emission spectrum of the atmosphere, the range of values given in Table 8 reflects this variation.

Table 8: ISAAC Period 85 offered spectroscopic modes

Instrument Mode	$\lambda/\Delta\lambda$	Scale ("'/pixel)	Mag-limit Range
SW LRes Spectroscopy	≈ 500	0.147	18–20.5
SW MRes Spectroscopy	≈ 3000	0.147	17.5–19.5
LW LRes Spectroscopy	≈ 500	0.147	11–14
LW MRes Spectroscopy	≈ 2000	0.147	10–13

6.7 VIMOS, Visible Multi-Object Spectrograph

VIMOS will be refurbished during Period 85. For details on expected performance and availability please visit the news section of [the VIMOS web pages](#).

VIMOS is a multi-mode, wide-field optical instrument attached at the Nasmyth focus B 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.

VIMOS is also equipped with an integral field unit (IFU) with 6400 microlenses coupled to fibres, with 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.

The VIMOS instrument works in the wavelength range 360–1000 nm. VIMOS modes (IMG, MOS, and IFU) are summarised in Table 9. 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 (Sect. 12.1) and Service Mode (Sect. 12.2), except for pre-imaging runs, which are carried out in Service Mode only.

The magnitude limits in Table 10 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 $S/N \sim 5$. The magnitude limits in **MOS mode** are ~ 23.8 for the lower resolution settings and ~ 22.2 for the higher resolution settings (S/N is computed per pixel integrated along the slit direction; it refers to central wavelength and corresponds to a $1.0''$ slit); in **IFU mode**, ~ 23.3 for the lower resolution settings and ~ 20.8 – 21.5 for the higher resolution settings (depending also on the spatial magnification). These values should only be used as a *rough guide*. Users should refer to the Exposure Time Calculator, available at (<http://www.eso.org/observing/etc>), to test the feasibility of their programme and to estimate the corresponding execution time. The observing overheads are given in Table 17 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.

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

6.7.1 VIMOS Observation Requirements: IMG

Offsets $> 30''$ during OB execution often cause the loss of the guide star, resulting in large operational overheads. For this reason, offsets $> 30''$ are not allowed with VIMOS. If an offset pattern with a greater amplitude is needed, users should use separate OBs at each offset position. Please make sure you take into account the increased overhead time due to this feature when estimating the total

Table 9: VIMOS Period 85 offered settings and modes

Mode	Scale	FOV	Wavelength range (nm) ^[1]	$\lambda/\Delta\lambda$ ^[2]	Dispersion Å /pix	Spectral multiplex ^[3]
IMG <i>UBVRIZ</i>	0.205"/pix	4 × 7' × 8'	–	–	–	–
MOS LR Blue	0.205"/pix	4 × 7' × 8'	370–670	180	5.3	4
MOS LR Red	0.205"/pix	4 × 7' × 8'	550–950	210	7.3	4
MOS MR	0.205"/pix	4 × 7' × 8'	480–1000	580	2.5	1
MOS HR Blue	0.205"/pix	4 × 7' × 8'	415–620	2050	0.5	1
MOS HR Orange	0.205"/pix	4 × 7' × 8'	520–760	2150	0.6	1
MOS HR Red	0.205"/pix	4 × 7' × 8'	630–870	2500	0.6	1
IFU LR Blue	0.67"/fibre	54" × 54"	390–670	220	5.3	4
IFU LR Red	0.67"/fibre	54" × 54"	580–915	260	7.3	4
IFU MR	0.67"/fibre	27" × 27"	490–1015	720	2.5	1
IFU HR Blue	0.67"/fibre	27" × 27"	415–620	2550	0.5	1
IFU HR Orange	0.67"/fibre	27" × 27"	525–740	2650	0.6	1
IFU HR Red	0.67"/fibre	27" × 27"	640–860	3100	0.6	1
IFU LR Blue	0.33"/fibre	27" × 27"	390–670	220	5.3	4
IFU LR Red	0.33"/fibre	27" × 27"	580–915	260	7.3	4
IFU MR	0.33"/fibre	13" × 13"	490–1015	720	2.5	1
IFU HR Blue	0.33"/fibre	13" × 13"	415–620	2550	0.5	1
IFU HR Orange	0.33"/fibre	13" × 13"	525–740	2650	0.6	1
IFU HR Red	0.33"/fibre	13" × 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.

Table 10: VIMOS IMG limiting magnitudes

Magnitude limit (S/N=5)					
U=25.9	B=27.2	V=26.8	R=26.4	I=25.5	z=24.6

time needed for VIMOS imaging runs.

In IMG mode, filter exchanges are allowed within an OB. Overheads for filter exchanges should be taken into account using the estimate given in Table 17.

6.7.2 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 ([vmmmps](#)) for slit definition and positioning for Phase 2 preparation (equivalent to FIMS for the FORS instruments). The user can define rectangular slits of width wider than 0.6" and length up to 30". Inclined slits can be defined.

Pre-imaging is mandatory 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. Therefore, even in the case when imaging data have been obtained with VIMOS, the short pre-imaging run is mandatory.

If there is pre-imaging data available for the selected fields, and it was taken in R-band, and after January 2007, it **might** be used for the mask preparations with VMMPS. Users are invited to write an email to usd-help@eso.org, to ask if such pre-imaging from previous periods can be used.

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 angle on sky, with slits oriented N-S, and the target within 2 h of the meridian. Special requirements for different field orientations should be clearly stated in the proposals.

In MOS mode, instrumental flexures will introduce wavelength offsets if calibration data are taken at a very different rotator angle to the science exposure. In order to minimise these effects *attached night-time arcs are mandatory for the blue settings and strongly recommended for the red settings*. The corresponding overheads need to be taken into account at Phase 1 and can be estimated using Table 17.

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.

6.7.3 MOS Observations in Visitor Mode

Due to the rule that MOS observations should be carried out within 2 h of the meridian, in Visitor Mode it is desirable that the targets are uniformly distributed in RA for the night(s) of the observations. If this is not the case, users should apply for Service Mode observations. For operational reasons a maximum number of **7** visitor masks (per quadrant) will be made available in the instrument each night. If a visitor is granted half nights, the above number is reduced to **3** masks (per quadrant).

Normally, 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.

6.7.4 VIMOS Observation Requirements in IFU Mode

In IFU mode instrumental flexures will 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 17.

In IFU mode, only one filter+grism combination per OB is permitted. 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.

6.8 VISIR, VLT Imager and Spectrometer for mid Infra Red

VISIR is the mid-infrared imager and spectrometer of the VLT. It works in the wavelength ranges $8 - 13 \mu\text{m}$ and $17 - 24 \mu\text{m}$ and has been offered to the community since Period 75.

6.8.1 Imaging Modes offered in Period 85

In Period 85 the **imager** with a 256×256 detector array is offered with image scales of $0''.075/\text{pixel}$ (SF) and $0''.127/\text{pixel}$ (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 sensitivities, with only few exceptions, range between about 4 and 20 mJy $10\sigma/1\text{ h}$ in N band and between about 50 and 150 mJy $10\sigma/1\text{ h}$ in 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.

6.8.2 Spectroscopy Modes offered in Period 85

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

- Low resolution (LR) mode with a resolution of $R \approx 350$ in four settings which cover the full N band. Sensitivities are 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 only for targets brighter than 200 mJy using the N_SW or N_LW filters, and for targets brighter than 50 mJy using the [NeII] filter. Fainter targets can be acquired with restrictions on allowed airmass and slitwidth using the imager with sensitivities as given in the web page.
- Absorption line spectroscopy is untested and flatfielding problems may be anticipated.

The slits cover a range of $0''.4 - 1''.0$ in width and the image scale of the 256×256 detector array is $0''.127/\text{pixel}$. 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.

6.8.3 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.

6.8.4 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 17. For more details please consult the VISIR User Manual available at

<http://www.eso.org/instruments/visir/doc/>.

6.9 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.

The instrument is cryogenic (120 K, detectors at 80 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 $169 \mu\text{m}$ on the detector).

As of Period 83, proposers can use the Rapid Response Mode (RRM) to trigger HAWK-I observations. For details on RRM policies, please see Sect. 11.5.1.

On-line information on HAWK-I can be found in the [instrument web pages](#).

6.9.1 Imaging mode

HAWK-I is offered with 10 observing filters placed in two filter wheels: Y(Z), J, H, K (with transmission curves identical to the [VISTA](#) filters), as well as 6 narrow-band filters (Br γ , CH4, H2 and three cosmological filters at 1.061 , 1.187 , and $2.090 \mu\text{m}$).

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).

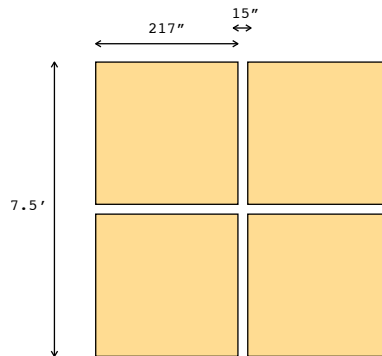


Figure 6: HAWK-I field of view sketch

6.9.2 Bright limiting magnitude and persistence

The HAWK-I detectors show a persistence effect if the observed sources are heavily saturated, which affects subsequent observations of faint sources. Therefore, observations of fields containing objects brighter than $K=8.6$ mag, $H=9.6$ mag or $J=9.3$ mag should be carried out in Visitor Mode.

6.9.3 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 11.

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

Table 11: HAWK-I limiting magnitude examples

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

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

6.10 NACO (NAOS+CONICA)

NACO provides adaptive optics assisted imaging, polarimetry, spectroscopy, and coronagraphy in the 1–5 μm range.

NAOS, the adaptive optics front end, has been designed to work with Natural Guide Stars (NGS) and *moderately* extended objects, and 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.

The LGS mode (see Section 4.2.3 for additional details) can be used with or without a tip-tilt star. If a tip-tilt star (TTS) is used, it should be in the V magnitude range 12–18 and can be as far away as $60''$ from the science target, however, with decreasing performance with increasing distance and 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. For observations in LGS mode without TTS, the corresponding entry field should be left blank.

Additional **compulsory** information both for NGS and LGS must be the magnitude of the star and the corresponding bandpass in which the magnitude is given.

If applying for LGS mode, the Transparency must be set to either Clear (CLR) or Photometric (PHO). Proposals requesting LGS in THN conditions will be rejected at the technical feasibility stage.

In Period 85 the LGS mode of NACO is offered in Service and Visitor Mode.

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.

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](#).

In Period 85, two new modes will be offered:

- **Cube mode (a.k.a. Lucky imaging):** Simple imaging in cube mode with several readout windows from 128 x 128 pixels to full window. No pipeline support is available for this mode.
- **Seeing enhancer mode:** Observations with laser guide star without tip-tilt star.

We remind the reader that in Period 85, the following applies:

- Grism spectroscopy is offered in VM.
- Lyot coronagraphy, SDI+4 and 4QPM coronagraphy are only offered in VM as flexures inside NACO require the observer to monitor constantly the centering of the star in the coronagraphic spot.

- Special calibrations: Proposals for observations requiring calibrations not defined in the NACO Calibration Plan should use VM in general. 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 Sect. 6.10.4 for details.
- Polarimetry: wire grid polarimetry is discontinued. Users can opt for the Wollaston_00 in combination with the retarder plate.
- For technical reasons, the Fabry-Perot Imaging is not offered in Period 85. Users are encouraged to consider SINFONI as an alternative to FPI.

A summary of the offered modes is given in Table 12.

Table 12: NaCo modes in Period 85

Instrument mode	Offered observing mode	Notes
Imaging	SM and VM	All filters
Imaging + chopping	SM and VM	L' and M', up to 20'' throw on-axis
Imaging + cube	SM and VM	Limited setups
SDI+	SM and VM	Replaces SDI
Lyot Coronagraphy	VM	C_0.7, C_1.4 (all cam), C_0.7_sep_10 (not S13 camera)
4QPM Coronagraphy	VM	Optimized for H and K,
SDI+4	VM	
Polarimetry	SM and VM	Woll_00, retarder plate only
Grism Spectroscopy	VM	all modes
SAM	VM	Includes pupil tracking and cube mode
SAM+Pol	VM	SAM with Woll_00
NACO + LGS	SM and VM	See section 4.2.3
NACO + SE	SM and VM	See section 4.2.3
NACO + Pupil Tracking	VM	with Imaging and coronagraphy.

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 and ISAAC, which generally have larger fields of view, lower backgrounds and higher throughputs.

Important note: Due to the upcoming MUSE commissioning and operations, scientists interested in submitting Large Programme proposals for NACO should carefully plan their time request, because ESO cannot guarantee NACO observations beyond the end of P87 (September 2011).

6.10.1 Additional notes: Imaging, Polarimetric and Coronagraphic Modes

Imaging, polarimetry and coronagraphy can be done with a variety of filters, pixel scales and fields of view (Table 13).

Table 13: 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_4.07,NB_3.74	54.7	56×56
NB_4.07,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 can now only be done in combination with the retarder plate and the Wollaston_00. Wire grid polarimetry is discontinued. Note that 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 done with occulting masks of $0.7''$ and $1.4''$ in diameter, as well as with a semi-transparent mask of $0.7''$ diameter, with a transmission of 0.4% (0.3%) for H-band (Ks-band). Since Period 80, the two new “four quadrant phase” (4QPM) masks are offered in Visitor Mode. One mask is optimised to work at K band (4QPM_K) and offers a $13'' \times 13''$ FOV, while the other one (4QPM_H) is optimised for H band observation and has an $8'' \times 8''$ FOV. Accurate centering is critical for the performance of the 4QPM and it is the main reason why these modes are offered only in VM. Recent investigation has also found out that flexures affect the centering of the Lyot masks, by up to 1.5 pixels; for this reason, Lyot coronagraphy has been moved to VM as well.

The approximate limiting magnitudes for imaging are listed in Table 14. 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 14: 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.

6.10.2 Additional notes: Simultaneous Differential Imager (SDI+)

This is a high contrast imaging mode using the simultaneous differential imager (SDI+), which has been offered since Period 81. 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 $\approx 8'' \times 8''$. SDI+ replaces the old SDI, which is not offered anymore. The performance of SDI+ is equivalent to that of SDI, but the mode offers a larger square FOV of $8'' \times 8''$, with the same pixel scale. For more information, consult the NACO web pages.

6.10.3 Additional Notes: Spectroscopic Modes offered in Period 85

Prism and slitless spectroscopy are **not** offered, while the remaining spectroscopic modes are offered in Visitor Mode only. Two slit widths (86 mas and 172 mas) are available. The slits are $40''$ long (restricted to $28''$ for the S/L27 cameras).

6.10.4 Additional Notes: NACO Calibrations, Special calibrations

Not all combinations of detector readout mode and instrument setup are supported with calibrations. Information about what is supported is given in [the NACO Users' Manual](#) and is detailed in [the calibration plan](#).

Special calibration requests will be handled differently than before. Special calibrations cannot be handled easily at the observatory on a routine basis. Therefore, such requests will automatically set the proposal mode to VM. Exceptions to this rule may be considered on a case-by-case basis, as part of the evaluation of the technical feasibility of the proposal by the Observatory. It is important that users interested in special calibrations provide the following information in the proposal form:

- A comprehensive justification of the need for SM observations as opposed to VM (Box 8D of the proposal form)
- A detailed description of the calibration strategy and needs in Box 9.
- Specification of the need of special calibrations in Section 14, by uncommenting the provided lines.

Users are encouraged to send requests and questions to usd-help@eso.org.

The observing time used for night time calibrations will be charged to the observing run.

6.11 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. The spectrograph operates with 4 gratings (J, H, K, H+K) with spectral resolutions of 2000, 3000 and 4000 with the J, H and K gratings, respectively, and 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.

In the NGS mode, the star should, for peak performance, be brighter than $R \sim 11$ mag. 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. Ideally, 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. If a tip-tilt star (TTS) is used, it should be in the V 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. For observations in LGS mode without TTS, the corresponding entry field should be left blank.

In Period 85 the LGS mode of SINFONI is offered in Service and Visitor Mode.

The LGS mode without a tip-tilt star (the so-called seeing-enhancer mode) is offered as of Period 84.

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, please leave the TTS name blank. If the user of the LGS mode without a tip-tilt star requires observation of a PSF calibrator associated with a science target, this PSF calibrator has to be observed via a separate OB (i.e., the template 'SINFONI.ifs.cal.PSF' cannot be used within the science OB itself); 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 84, proposers can use 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 Sect. 11.5.1.

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).

6.11.1 Instrument Performance

Table 15 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 15: 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>).

6.11.2 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.

6.11.3 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 $\text{NDIT}_{\text{sky}} = 1/2 \text{NDIT}_{\text{target}}$).

6.11.4 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.

6.11.5 Modes that are not offered

Observations with the sky spider and spectral dithering are not offered in Period 85.

6.12 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 has been offered in both Service and Visitor Modes

Table 16: MIDI uncorrelated magnitudes

Telescopes	Beam combiner	Spectrograph	Limit (N mag)	Limit (Jy@12 μ m)
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

since Period 73 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](#).

The main features of MIDI for Period 85 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 ($R = 230$).
- Beam combiner optics: either “HIGH_SENS” (no simultaneous photometric measurement of beams before combination), or “SCLPHOT” (simultaneous photometric measurement).
- Limiting uncorrelated magnitudes are given in Table 16.
- For MIDI, the correlated flux is defined by the uncorrelated flux (in Jy@12 μ m) multiplied by the estimated visibility. The limiting correlated flux (CF) can be obtained, for each mode, from the uncorrelated flux (UF) of this mode (see Table 16), using the formulae :
 - Without FINITO: $CF = 0.5 \times UF$
 - With FINITO $CF = 0.1 \times UF$
- 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. We offer two calibration modes, either Science-Calibration for normal accuracy requirements, or Calibration-Science-Calibration, for high accuracy requirements.

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 17. Time constrained observations (*e.g.* variable objects) can further be requested in the appropriate section of the proposal.

FINITO (the VLTi fringe-tracker) is available with MIDI on the ATs and in Visitor Mode only (since there is no pipeline to process MIDI data by blind coherent integration). It provides cophasing in N-band with an accuracy close to 0.12 rad RMS at 10 μ m. Users must be aware that the limiting uncorrelated flux of the target for MIDI remains unchanged and, to be observable by FINITO, the target should have:

- H_mag < 5 (ATs) < 7 (UTs)
- Visibility in H > 15 % (ATs) > 10% (UTs)

6.13 AMBER, Astronomical Multi-BEam combineR

AMBER is a near-infrared, multi-beam interferometric instrument, combining up to 3 telescopes simultaneously. AMBER can be used in Period 85 with UTs or ATs. For specifications of the UT and AT performances see Sect. 4.2.2 and Sect. 4.2.5. 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, it is recommended that any scientific programme on the UTs is designed so that scientifically meaningful results can be achieved in a single night.

6.13.1 Spectral Modes and Coverage

The following spectral modes are offered: the Low Resolution K band (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](#).

When using short DIT (smaller than 200 ms, see Sect. 6.13.2), only a limited spectral range can be recorded. Users interested in obtaining visibility measurements at several spectral positions inside the range allowed by each configuration can add up to two additional spectral bands.

6.13.2 Integration times, DIT

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 atmospheric turbulence. For LR-HK and MR-K and MR-H, DITs are fixed to 25 ms on the UTs and 25 ms or 50 ms on the ATs if *absolute visibility* measurements are the goal. In HR-K it is assumed a DIT of 50 ms for absolute visibilities. For *closure-phase* and *differential-mode* the maximum allowed DIT is twice the DIT allowed in absolute mode. DITs longer than this can only be done in Visitor Mode (under exceptional weather conditions or if only closure-phase or differential-mode is the goal).

External fringe tracking with FINITO is available on both the UTs and the ATs. In this case, longer DITs are possible allowing (*i*) AMBER to use HR-K on the ATs and (*ii*) the full chosen spectral band in MR-K and HR-K to be read out.

6.13.3 Limiting magnitudes

Limiting magnitudes for AMBER are estimated assuming an unresolved source, *i.e.*, with a calibrated visibility of unity. Resolved sources will have lower limiting magnitudes corresponding to their visibility. Limiting magnitudes have been estimated under the assumption of 0.8'' (1.0'' on the ATs) seeing, and they can be significantly degraded as a result of atmospheric conditions. In particular for poor seeing and τ_0 (above 1.2'' and below 2.5 ms respectively), a loss of sensitivity of one magnitude or more can be expected.

Conversely, please note that the 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 might want to account for one or more repeated observations of the same spectral band in her/his proposal (see Sect. 6.13.5 below) to obtain more frames with sufficient SNR.

AMBER+FINITO limiting magnitudes are given considering that FINITO operations are only feasible for seeing below 1.2'', τ_0 above 2.5 ms, and Airmass below 1.5. The minimum target visibility **in the H-band** is 10% in all modes. The limiting correlated magnitude depends on the AMBER spectral resolution and the tracking mode. The main interest of FINITO Group-Tracking on faint magnitude is to enhance the SNR on the AMBER closure-phase.

The limiting correlated magnitudes are strongly dependent on the seeing and coherence times. The details of the limiting magnitude dependency on seeing can be found on [the AMBER web page](#):. The most updated values on limiting magnitudes and details on the Visibility accuracy and Closure phase accuracy can be found in the instrument web pages.

We warn the user that *absolute visibility* calibration of the AMBER+FINITO data may be difficult if one of these parameters is close to the limit: seeing (1.2"), airmass (1.5), correlated H magnitude, or visibility in the H-band (10%). If more than two parameters are at the limit, the proposal will be declared unfeasible at technical evaluation.

6.13.4 Calibration strategies

AMBER requires frequent calibration on-sky, using calibrator stars. We offer two calibration modes: "CAL-SCI" and "CAL-SCI-CAL". The first one is the standard mode, which should be used if one is interested in *wavelength differential quantities*. "CAL-SCI-CAL", on the other hand, should be used if *absolute calibration* is required for best accuracy. This should be specified in the "calibration request" section of the proposal.

6.13.5 Execution times

The user should assume that 30 minutes are required for one measurement (i.e. a measurement of the science object **OR** a measurement of an interferometric calibrator star). This applies to all spectral modes with only one band. Each additional band in the observation adds 15 minutes to the total time. Hence a normal (one band) "CAL-SCI" cycle will take 60 minutes, whereas a "CAL-SCI-CAL" will take 90 minutes. Note that if FINITO is used, then the full wavelength range can be read out with the longer DITs and thus there is no need to add spectral bands. A maximum of 3 bands per observation is allowed. Please consult [the AMBER web pages](#) for more information.

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) 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 lower frequencies than previously offered at APEX, allowing observations during conditions with $\text{PWV} > 2$ mm.
- APEX-2: a Single Side Band receiver covering 275–370 GHz with SSB receiver temperature T_{rec} around 135 K. APEX-2 has replaced the APEX-2A Double Side Band receiver, whose frequency coverage is assured by APEX-2 at similar sensitivity.
- APEX-3: this receiver is not offered in Period 85.
- APEX-T2: a Double Side Band (DSB) HEB receiver operating at 1.25-1.39 THz with DSB T_{rec} around 1200 K. THz observations require excellent weather conditions ($\text{PWV} < 0.2$ 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](#). As backend, the Fast Fourier Transform Spectrometer (FFTS) has two units with a fixed bandwidth of 1 GHz, of which the central 900 MHz are usable. This allows users to cover up to 1.8 GHz instantaneous bandwidth. Spectral resolutions ranging from 976.56 ($\sim 0.92 \text{ km s}^{-1}$) to 122.07 kHz ($\sim 0.12 \text{ km s}^{-1}$) can be selected. 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 $870\ \mu\text{m}$ atmospheric window, with a beam size of $18.6\pm 1''$ and a total field of view of $11.4'$. The instrument was commissioned in May 2007.

An overview of the instrument is given on the APEX home page:

www.apex-telescope.org/bolometer/laboca/.

As the beam switching mode using the wobbling secondary has not been commissioned yet, we will only offer the continuous integration modes during Period 85. Proposals which would benefit from using the wobbler (e.g. flux determinations of single sources) may mention this in the technical description (Box 9 of the proposal form). If the beam switching mode is available at the time of the observations, this mode may be used. However, integration time calculations should be based only on the compact mapping mode given by the observing time calculator.

The following observing patterns will be offered:

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

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) = $120\ \text{mJy}\sqrt{s}$ and 248 working bolometers. For point source detection experiments, one can apply a low frequency sky noise filtering, improving the sensitivity to $\text{NEFD}\sim 75\ \text{mJy}\sqrt{s}$. All proposers should use the LABOCA observing time calculator, available from

www.apex-telescope.org/bolometer/laboca/obscal/.

All integration times calculated using the LABOCA observing time calculator should be multiplied by a **factor of 1.9** to account for overheads such as acquisition, software setup, telescope slewing and calibrations (skydip, pointing, focus and flux calibration). The LABOCA integration time calculator also provides the total time including this 90% overhead.

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 center channel and 3 concentric hexagons (one channel is known to be broken). 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.

As the beam switching mode using the wobbling secondary has not been commissioned yet, we will only offer the continuous integration modes during Period 85. Proposals which would benefit from using the wobbler (e.g. flux determinations of single sources) may mention this in the technical description (box 9 of the proposal form). If the beam switching mode is available at the time of the observations, this mode may be used. However, integration times should be based only on the compact mapping mode given by the observing time calculator.

Exposure time estimates should assume a noise equivalent flux density $\text{NEFD} = 200 \text{ Jy s}^{1/2}$, 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/obscalc/>.

7.4 APEX-SZ, the APEX Sunyaev-Zel'dovich camera

The MPIfR/Berkeley PI instrument APEX-SZ is a bolometer array operating at $152 \pm 23 \text{ GHz}$ (2 mm). It is optimised for surveys of the Sunyaev-Zel'dovich effect in distant clusters, but can also be used for other studies. APEX-SZ consists of an array of 330 superconducting TES (Transition Edge Sensor) thermistors with SQUID (Superconducting Quantum Interference Device) multiplexers. There are 330 channels in the focal plane, of which 232 can be read out reliably, with a typical Noise Equivalent Power (NEP) of $10^{-16} \text{ W Hz}^{-1}$. Typically, 160 low-noise channels are used for mapping.

The APEX beam at this wavelength is $59''$, and the total field of view for APEX-SZ is $23'$.

The standard observing mode for clusters are raster scans, which reach a central map rms of $75 \mu\text{K}$ (CMB) in 1 hour of observing time. The alternative observing mode are circle drifts, which are smaller and thus have higher central coverage, but do not allow as much skynoise filtering to be applied. This mode obtains an rms of $60 \mu\text{K}$. All observing time estimates should assume the above sensitivities and a 90% overhead for slewing, pointing, focus and calibrations.

As the operation of the APEX-SZ instrument requires the presence of the instrument team, all APEX-SZ observations from the different APEX partners will be scheduled in a joint observing block. The exact dates of operation for 2010 have not been determined yet, but it is likely to be during the first months of the period. Time critical observations using APEX-SZ are therefore very difficult to schedule.

Proposers interested in using APEX-SZ should include a coI from the instrument team and should, at least 1 week prior to submission of a proposal, contact [Dr. Adrian Lee](#). Further information on APEX-SZ can be found on the [APEX-SZ homepage](#). Technical questions should be directed to the ESO APEX Project Scientist, [Dr. Carlos de Breuck](#).

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 $350 \mu\text{m}$ and $450 \mu\text{m}$ 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 $450 \mu\text{m}$ and 780-900 GHz for the $350 \mu\text{m}$ 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 was 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 in 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 2010 have not been determined yet, but they are likely to be in the later part of the period, when the atmospheric transparency is expected to be better. Time critical observations using CHAMP+ are therefore very difficult to schedule.

Users who would like to use CHAMP+ shall contact the PI, [Dr. Rolf Guesten](#) 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 FLASH heterodyne receiver (MPIfR PI instrument)

The 460 GHz channel of the MPIfR PI instrument FLASH is again offered to the ESO community on a collaborative basis with MPIfR.

FLASH is a single pixel DSB receiver covering the 430–495 GHz range with typical $T_{rx}(DSB)=200$ K. Note that the 810 GHz channel is **not** offered in Period 85. As a backend, the facility FFTS is used using the same setup constraints as with SHFI. For time estimates, proposers should use the [heterodyne observing time calculator](#).

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

If the APEX-3 facility heterodyne receiver (covering 385 to 500 GHz) is successfully commissioned before or during Period 85, FLASH may be de-commissioned, and all FLASH proposals would then be executed with APEX-3.

Users who would like to use FLASH shall contact the PI, [Dr. Rolf Guesten](#) 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.

8 Visitor Instruments

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

<http://www.eso.org/sci/facilities/paranal/instruments/visfocus/>.

As of period P84, the VLT Visitor Focus is located at the Nasmyth B focus of UT1 (Antu). For technical information concerning the interface between an instrument and the VLT Visitor Focus please consult

<http://www.eso.org/sci/facilities/paranal/instruments/visfocus/requirements.html>.

A comparable 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 URL

<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. In Service Mode observations, the total execution time must include all overheads, from telescope pre-setting, to target acquisition and to all other relevant instrument overheads, for every planned Observation Block. In order to fulfil the 1 h OB rule, proposers should note that all overheads must be accounted for within this one hour. Also in Service Mode, time for night-time calibrations and associated overheads should be included only in cases where the accuracy of the 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 VIMOS IFU and some MOS modes; see the VIMOS User Manual for details). The time needed to execute such attached calibrations needs to be included in the proposal; see also Section 10.2. As a guideline to help proposers estimate the overheads associated with their observations, we provide “typical” numbers in Table 17. 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:

<http://www.eso.org/sci/observing/phase2/P2PP/P2PPDocumentation.html>.

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

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 on-line from

<http://www.eso.org/qc/pipeline-status.html>.

10.2 Calibration Plans and Calibration of Science Observations

The typical target accuracy of the calibrations plans to calibrate science data is 5–10%. This may not be sufficient for all science programmes. **Important:** not all instrument modes and/or configurations are covered by the current calibration plans. Read the appropriate Users 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 data are obtained in the morning immediately after night-time operations conclude. Service and Visitor Mode users receive these data automatically.

For **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 Users manuals. For many programmes, these calibrations may be sufficient. In this case, Service Mode proposers should only request enough time to complete their

Table 17: 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
SOFI	Imaging	~30% of total int. time
SOFI	Spectroscopy	~35% of total int. time
EFOSC-2	Read-out	2
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	6
FORS2	Acquisition (1 cycle w/o exp. time) ^[1]	1.5 or 2
FORS2	Through Slit Image (2 cycles w/o exp. times) ^[2]	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
CRIRES	Acquisition without AO	3
CRIRES	Acquisition with AO	5
CRIRES	Read-out	10%–60% exposure time ^[3]
CRIRES	Nodding cycle	0.4
CRIRES	Change of wavelength setting	1.4 – 2.4 ^[3]
CRIRES	Change of derotator position angle	1
CRIRES	Attached wavelength calibration	2.5
CRIRES	Attached lamp flat	2

[1] 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.

[2] 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.

[3] See CRIRES User's Manual for more detail.

Table 17: Telescope and Instruments Overheads (continued)

Hardware item	Action	Time (minutes)
ISAAC ^[4]	Instrument Setup, Imaging	0.5
ISAAC	Instrument Setup, Spectroscopy (incl. slit check)	7
ISAAC	Telescope Offsetting	0.25
ISAAC	Target Acquisition	1–4
ISAACHw	Read-out (per DIT, imaging)	0.07
ISAACAL	Read-out (per DIT, imaging without chopping) ^[5]	negligible
ISAACHw	Read-out (per DIT, spectroscopy)	0.13
ISAACAL	Read-out (per DIT, spectroscopy without chopping) ^[6]	negligible
ISAACAL	Imaging with chopping	40% ^[7]
ISAACAL	Spectroscopy with chopping	30% ^[7]
ISAAC	Night-time flat ^[8] (one on-off pair)	4
ISAAC	Night-time arc ^[8] (one on-off pair)	3
ISAAC	Burst and FastJitter Modes	See the Burst web page
UVES	Instrument Setup	1
UVES	Acquisition. Bright Point Source	2
UVES	Acquisition. Faint, Extended or Crowded Field	5
UVES	Read-out ^[9] , 1 × 1, Fast	0.75
UVES	Read-out ^[9] , 2 × 2, Slow	0.75
UVES	Attached ThAr, Night-time	1.5
UVES	Attached Flat, Night-time	2
X-SHOOTER	Target acquisition	3-5
X-SHOOTER	Telescope offsetting	0.25
X-SHOOTER	Instrument setup Slit	0.5
X-SHOOTER	Instrument setup IFU	1
X-SHOOTER	UVB Read-out ^[12] , 1 × 1, Slow/Fast	70 / 19 sec
X-SHOOTER	UVB Read-out ^[12] , 1 × 2, Slow/Fast	38 / 12 sec
X-SHOOTER	UVB Read-out ^[12] , 2 × 2, Slow/Fast	22 / 8 sec
X-SHOOTER	VIS Read-out ^[12] , 1 × 1, Slow/Fast	92 / 24 sec
X-SHOOTER	VIS Read-out ^[12] , 1 × 2, Slow/Fast	48 / 14 sec
X-SHOOTER	VIS Read-out ^[12] , 2 × 2, Slow/Fast	27 / 9 sec
X-SHOOTER	NIR Read-out (per DIT)	0.88 sec
NACO	see Users' Manual	—
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) ^[10]	5-8
VIMOS	Attached arc (MOS) ^[11]	4

[4] ISAAC refers to both Aladdin and Hawaii, ISAACHw only to Hawaii detector, ISAACAL only to Aladdin detector.

[5] For the Aladdin SW J+Block,H,K and LW low background NB.3.21 and NB.3.28 filters only.

[6] In Medium Resolution (MR) only.

[7] Global overheads in % are used for the LW imaging and spectroscopic chopping templates.

[8] When required, see <http://www.eso.org/sci/observing/phase2/CalibrationPlan.html> and the ISAAC user manual.

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

[10] Flat and arcs are mandatory for IFU.

[11] Arcs are mandatory for MOS blue settings and strongly recommended for the MOS red settings.

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

Table 17: Telescope and Instruments Overheads (continued)

Hardware item	Action	Time (minutes)
FLAMES	Acquisition ^[13]	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 ^[14]	0–20
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
SINFONI	Acquisition no AO	3
SINFONI	Acquisition AO (NGS)	$2 + 4 * (\text{DIT} * \text{NDIT})^{[15]}$
SINFONI	Acquisition AO (LGS)	$9 + 4 * (\text{DIT} * \text{NDIT})^{[15]}$
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
HAWK-I	Target Acquisition and Instrument Setup	1
HAWK-I	Target Acquisition (MoveToPixel) and Instrument Setup	3
HAWK-I	Telescope Offset (large)	0.50
HAWK-I	Telescope Offset (small)	0.15
HAWK-I	Read-out (per DIT)	0.03
HAWK-I	Filter change	0.35
MIDI	One calibrated Visibility SCI-CAL ^[16]	60
MIDI	One calibrated Visibility CAL-SCI-CAL ^[16]	90
AMBER	One calibrated Visibility SCI-CAL ^[16]	$30 + 30 * (\text{number of bands})^{[17]}$
AMBER	One calibrated Visibility CAL-SCI-CAL ^[16]	$45 + 45 * (\text{number of bands})^{[17]}$

[13] Includes configuration of UVES fibres, homing the rotator to zero degrees, swapping of the plates, and the acquisition of field; telescope preset, acquisition of the guide star, and start of the active optics are not included and account for additional 6 minutes. For ARGUS fast acquisition (Visitor Mode only), the acquisition overhead is 2 minutes and is calculated assuming that plate 2 is already attached to the telescope.

[14] 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.

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

[16] This time includes all telescope and instrument overheads **as well as** the integration times on the science target **and** the calibrator.

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

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.*

Please note that ESO further accepts Calibration Programmes to achieve improved calibration of its instruments (see Sect. 11.7 for details).

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

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 calibration data. These ESO obtained data will be used to monitor instrument performance and to assure a baseline calibration accuracy within the ESO Science Archive for data obtained during this night. 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.

ESO-obtained calibration data are made available automatically to both Visitor and Service Mode users as part of their end-of-run data package. All users receive the relevant raw data. In addition, Service Mode users may also receive master calibration data (e.g. combined stacks of bias frames, reduced flat-fields, wavelength dispersion solutions), depending on the instrument configuration and pipeline availability.

Important note for La Silla users: It is the responsibility of the Visiting Astronomer to obtain all nighttime 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.

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/sci/data-processing/software/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 graciously handle ESO HIERARCH keywords, e.g. convert them for use with other packages like IRAF.

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 below).
- **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** — using pipeline-generated master calibration products, science products are produced by the Data Processing and Quality Control group in Garching for supported instrument modes (e.g. combined ISAAC jitter stacks; bias-corrected, flat-fielded FORS images; wavelength-calibrated UVES spectra). The accuracy of the science products

can be limited both by the quality of the available master calibration products and by the algorithmic implementation of the pipelines themselves. In particular, adopted reduction strategies may not be suitable for all scientific goals. Therefore, ESO assumes no responsibility for the usefulness of reduced data for any specific scientific project.

Pipelines can also be run on the end 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 for home use and can be downloaded with two front-end applications (esoRex and Gasgano) from <http://www.eso.org/pipelines>.

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

10.3.2 Pipelines in the ESO Environment

Available pipelines are installed on Paranal and La Silla and normally run automatically at all times (only HARPS, FEROS, and SofI have pipelines at La Silla). These **on-line pipelines** use recent (but typically not the most recent) archival master calibration data to produce quick-look QC 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 as they wish. 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. If they wish, 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 **off-line pipelines** for VLT/VLTI instruments do use the best available and certified (quality-checked) master calibration products during Service Mode science product creation. The Garching master calibration products are created from the daily calibration data-stream and then used to process science data acquired during the same time interval. Service Mode users can access their pipeline science data products for supported instrument modes during the period via the User Portal. Master calibration products produced in Garching are ingested into the ESO Science Archive and can be requested for some instruments together with raw science by all users.

10.4 Quality Control

As mentioned above, 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, including instrument specific quality control parameters (e.g. zero-points, colour terms, wavelength solutions) are maintained on [the ESO Quality Control Web pages](#). These pages provide information and data about actual instrument performance since the start of VLT operations. Corresponding La Silla calibration data are reviewed by La Silla Science Operations and used for instrument health checks. The trends are available from the web pages of the respective instruments.

Part III

Proposal Types, Policies, and Procedures

11 Proposal Types

For Period 85 the list of proposal types is:

- Proposals for Normal Programmes,
- Proposals for Short Programmes,
- Proposals for Large Programmes,
- Director’s Discretionary Time Proposals,
- Target of Opportunity Proposals,
- Proposals for Calibration Programmes.

Proposals for all of those categories must be submitted by the current deadline, except proposals for Director’s Discretionary Time (DDT) which may be submitted at any time.

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 (Sect. 12.1) must request time in nights, proposals for *Service Mode* observations (Sect. 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 Sect. 9).

11.1 Proposals for Normal Programmes

The largest fraction of ESO observing time in Period 85 is foreseen to be allocated to Normal Programmes. Proposers must use the standard L^AT_EX template (Sect. 3.1). In this template the proposer may use a total of two pages (not including figures) for the five sections:

- A) Scientific Rationale
- B) Immediate Objective
- C) Telescope Justification
- D) Observing Mode Justification (Visitor or Service)
- E) Strategy for Data Reduction and Analysis

An additional 2 pages of attachments (for inclusion of figures or tables) is permitted. Proposals for Normal Programmes must be used only when the total amount of requested telescope time, summed over all the individual runs, is greater than 10 hours. If the total amount of requested time, summed over all runs, is less than or equal to 10 hours, the proposal form for Short Programmes **must** be used (see Sect. 11.2).

If the programme contains Visitor Mode runs, the total amount of requested time must be computed after the conversion of these runs from nights to hours. For Period 85, 1 night is taken to be equivalent to 10 hours.

If the proposal contains runs requesting La Silla telescopes and instruments, the duration of each such run must be greater than or equal to 3 nights, except for runs using Visitor Instruments or for combinations of contiguous EFOSC-2 and SOFI runs totalling at least 3 nights (see Sect. 4.1).

11.2 Proposals for Short Programmes

Short Programmes are similar to Normal Programmes, except that the total amount of time required to complete them (summed over all their runs) is less than or equal to 10 hours. For the conversion between hours in Service Mode and nights in Visitor Mode see Sect. 11.1. When applying for a Short Programme, proposers **must** use the L^AT_EX template for Short Programmes. In this template, the proposers may use a total of one page (not including figures) for the five sections:

- A) Scientific Rationale
- B) Immediate Objective
- C) Telescope Justification
- D) Observing Mode Justification (Visitor or Service)
- E) Strategy for Data Reduction and Analysis

One additional page of attachments (for inclusion of figures or tables) is permitted. Proposals for Short Programmes are evaluated by the OPC on the same basis as Proposals for Normal Programmes, and a single merged ranking is established for both types of proposals.

11.3 Proposals for Large Programmes

Up to a maximum of 30% of the observing time distributed by the OPC on the VLT/VLTI can be allocated to Large Programmes. Proposals for Large Programmes may also be submitted for APEX; they are encouraged for the 3.6-m telescope and the NTT. The definition of an ESO Large Programme is as follows:

- a programme requiring a minimum of 100 hours of ESO telescope time, spread over a maximum of two years (four years for La Silla);
- 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;
- not a ToO programme (see Sect. 11.5).

A good organizational 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 (Sect. 3.1). Because of the extra requirements on the Large Programme proposals, the proposers may here use a total of three pages (not including figures) for the four sections:

- 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) will be evaluating their proposal, and that **they should clearly explain the relevance of the proposed programme to general astrophysics**.

Fall back option: Under certain circumstances a panel may wish to review a proposed Large Programme as a Normal Programme. This cannot be done without the pre-approval of the PI. Hence, for Large Programmes it is important that the PI indicates, in the assigned box of the proposal template, whether or not the programme can be considered as a Normal Programme (with reduced time allocation — proposers should specify how this reduction could be achieved).

If a Large Programme proposal contains runs requesting La Silla telescopes and instruments, the duration of each such run must be greater than or equal to 3 nights.

Proposers should be aware that, since Period 75, 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/>. For further information, proposers are invited to write an email to usd-help@eso.org.

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](#).

11.4 Director's Discretionary Time Proposals

Up to 5% of the available ESO general observing time may be used for *Director's Discretionary Time Proposals* (DDTs) in Period 85. 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.

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 8D of the application form) why the programme should be considered for DDT allocation and why it was not submitted through the normal OPC procedure. 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 written using the special ESOFORM DDT template. Proposers must upload the DDT ESOFORM template and submit their DDT proposals by registering and logging into the User Portal. You can find more details at:

<http://www.eso.org/sci/observing/proposals/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.

11.5 Target of Opportunity Proposals

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 recognizes two categories of Targets of Opportunity:

1. **Unpredictable ToOs** are those concerning unpredictable astronomical events which 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, biannual deadline. They **qualify for allocation of Director Discretionary Time**. Corresponding

applications for observing time should be submitted as DDT proposals (Sect. 11.4), not as ToO proposals.

2. **Predictable ToOs** are those concerning predictable events in a generic sense only. This is 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 programmes may *only* be submitted using the Normal Programme ESOFORM template, by the same biannual deadline as Normal Programmes. In particular, the Short Programme proposal template should *not* be used, even if the total amount of requested time does not exceed 10 hours (the Normal Programme template should be used instead). Proposals should be for generic targets and/or times, but if accepted by the OPC the programme will not be executed until the PI contacts ESO to request its activation after the predicted event has occurred. The observing strategy must be the one approved by the OPC and the amount of requested time may not exceed that granted by the OPC. The observations will be conducted in Service Mode and, in exceptional cases, ongoing programmes will be interrupted. Read more on [ToO policy](#).

Note that users submitting a ToO programme will need to indicate in the L^AT_EX template the number of targets per run and the requested number of triggers per target using the appropriate macros. 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, with exactly the same scientific goal and aiming at observing the same object, will be rejected by ESO except if it is a coordinated project in collaboration with the PI of the accepted ToO programme. 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), so that they should clearly explain the relevance of the proposed programme to general astrophysics.

11.5.1 Rapid Response Mode (RRM)

As in previous periods, ESO continues to offer VLT Rapid Response Mode (RRM). During Period 85, FORS2 on UT1, UVES and X-SHOOTER on UT2, ISAAC on UT3, 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 (e.g., a GRB). After this deadline observations should be requested through normal ToO triggers.**
- As with ToO programmes, proposers will need to indicate in the L^AT_EX 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 ESOFORM 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 85 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, except if the latter are strictly time-critical.

Additionally, the following instrument specific restrictions apply:

- UVES can only be used with standard wavelength settings
- ISAAC can only be used in the SW imaging and SW spectroscopic modes
- 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 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

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

11.6 Guaranteed Time Observations

Guaranteed Time Observations (GTO) arise from contractual obligations of ESO vis-à-vis the external consortia who build ESO instruments (see <http://www.eso.org/observing/proposals>). Guaranteed Time Observers must submit proposals for their GTO time using the standard templates, and by the standard proposal deadline. The Short Programme template should *not* be used, even if the total amount of requested time does not exceed 10 hours (the Normal Programme template should be used instead). 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 general, GTO runs must be conducted in Visitor Mode (Sect. 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).

11.7 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. In recognition of this, ESO has introduced a new type of programmes, the Calibration Programmes, for which users are invited to submit proposals that aim at filling in some of the gaps in the existing coverage of the calibration of ESO instruments.

Up to 3% of all 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. The OPC is supported by a dedicated ESO internal calibration programme committee to review the 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 will be non-proprietary and made available to the entire community through the ESO archive, and the respective instrument Web pages. Scientific publications that take advantage, or make use of the data or results of Calibration Programmes, will have to reference the corresponding proposals.

Calibration Programmes must only be submitted using the L^AT_EX template for Normal Programmes. In particular, the Short Programme proposal template should not be used, even if the amount of requested time does not exceed 10 hours (the Normal Programme template should be used instead). 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 subcategory code L0 should be used to distinguish them. The PI 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/>.

11.8 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 (Sect. 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. 11.9 and 13.1).

11.8.1 OPTICON proposals

OPTICON, the Optical Infrared Coordination Network for Astronomy, is an EU funded “Infrastructure Cooperation Network”. Through this network the European Commission offers travel funds to research teams from eligible non-ESO member countries to observe at the La Silla telescopes.

In Period 85, 6 nights on the NTT and 6 nights on the 3.6-m telescope will be available to OPTICON Access proposals. To be eligible for OPTICON funding, the PI and at least 50% of the CoIs must belong to institutes from the European Union countries or associated countries that are not members of ESO.

To flag your proposal as a candidate for OPTICON travel funds use the OPTICON flag in the ESOFORM L^AT_EX template. OPTICON Access proposals will be treated identically to regular ESO proposals throughout the submission and evaluation process.

11.9 Host State Proposals

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

11.10 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.

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. A proposal submitted to ESO 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 ESO 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 85, 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 Sect. [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; see <http://www.eso.org/sci/observing/phase2/P2PP/P2PPTool.html>.

12.1 Visitor Mode

In *Visitor Mode* (VM) the astronomer is physically present at the observatory during the data acquisition. Each approved VM run will be allocated specific calendar nights. One of the programme investigators will travel to the Observatory and execute the observations.

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. However, P2PP allows OBs to be constructed and/or modified in real-time at the telescope (with only the partial exception of VIMOS, see Sect. [6.7](#)). Unless informed otherwise, 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 at Phase 1 and approved by the OPC. In case the observing conditions are not ideal (see Sect. [4.2.2](#)) the proposer should prepare a backup/alternative

programme to be executed in place of the primary programme. 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/>. In the absence of a backup programme, if the conditions prevent the execution of the observations intended for the Visiting Astronomer's primary programme, the telescope will be used by the Observatory for execution of Service Mode observations.

For Paranal instruments, proposers should request VM if their observing programme requires real-time decisions. Usage of VM should also be considered for those observations whose execution does not strongly benefit from the short-term scheduling flexibility allowed by Service Mode (see Sect. 12.2). For the La Silla instruments, as of Period 82, only VM is offered. VM is not supported on APEX.

Please note that **VM proposers must include overheads** for all science exposures. Guidelines are provided in Sect. 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, which typically account for approximately 60% of the allocated time. Under exceptional circumstances, the Director of the Observatory may decide to interrupt VM runs to allow Service Mode observations.

12.2 Service Mode

Up to approximately 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. Service Mode is no longer offered on La Silla.

Investigators awarded SM time will be required to specify their programme by submitting to ESO in advance a Phase 2 package, consisting 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 astronomers 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 September 2001 edition of The ESO Messenger ([issue 105, p. 18](#)). The purpose of the article is to help proposers understand how they may optimize their use of this mode of observing, and it should be considered compulsory reading for SM proposers. The interval between the completion of the run or of the period and the release of the SM data package to the PI is typically a few weeks, depending on the instrument mode and the data volume. SM PIs have direct access (via their personal User Portal account) to their own raw proprietary data as soon as the data is ingested in the ESO Archive. Pipeline reduced data products will also become available to PIs of the corresponding SM programmes shortly afterwards.

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

ESO will absorb all time required to complete all calibration sequences to the level of accuracy foreseen in the calibration plan (see Sect. 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.

For Paranal, in general, proposers should request SM if their planned observations demonstrably benefit from the short-term scheduling flexibility allowed by this mode, provided that their programmes can be fully pre-specified without requiring any real-time decisions. Proposers are especially encouraged to request Service Mode 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 [USD Web pages](#).

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. Some of them need to be carefully taken into account at the time of preparing an application for SM observations and are summarized here. Please note that most of 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) are executed non-contiguously.** 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 pre-setting and acquisition overheads (as specified in Table 17) have been properly accounted for.
- **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. For this reason, OBs taking more than one hour to execute are not normally accepted (with the exception of AMBER). 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.** ESO will not allow any change of constraints at Phase 2, since constraints play an essential role in determining the long-term scheduling of SM time. Substantial 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 with a Strehl ratio within 50% of the specified constraint will not be repeated. 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. Examples are observations coordinated with other observing facilities, optimal sampling of light-curves, and searches for SN and moving targets. 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 to execute successfully. 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, ESO will try to execute it as soon as possible thereafter on a best-effort basis, taking into account the user-specified constraints and the constraints imposed by other scheduled runs. ESO will not restart a sequence of linked observations if the pre-specified timing constraints cannot be fulfilled.

- **Split runs with targets at widely different positions:** It must be recalled that, according to the current procedure for the final release of SM data packages, the complete data distribution takes place only after the run is completed. It is thus advisable to split runs with targets in two widely separated regions of the sky, so that the distribution of data for the targets observable at the beginning of the period can already take place before the observations for targets observable at the end of the period are completed. This does not apply to the direct access that PIs now have via their User Portal account to their SM raw data.
- **VLTI:** For VLTI observations, one separate run must be indicated for each requested baseline.

13 Policy Summary

Several policies regarding all aspects of use of ESO telescopes have been refined over the years by the ESO Observing Programmes Committee (OPC), and by the Scientific Technical Committee (STC). Here we summarize those policies relevant for ESO proposers for Period 85. 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 principally responsible for the programme. The PI will also act as the official contact between ESO and the proposers for all later correspondence (*e.g.* Phase 2 information, data distribution). 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 act according to 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 should not be created or used by the same user. Failure to comply with this restriction may lead to the rejection by ESO of the proposals of the offending PI.

Any proposal received by ESO prior to the submission deadline will be reviewed by the sub-disciplinary panels, and by the OPC, who will rank them according to the following criteria:

- Scientific merit of the proposal and the importance of its contribution to the advancement of scientific knowledge.
- Evidence that detailed plans exist for complete and timely data analysis, and that the proposing individual or team will have sufficient time and resources to carry out the analysis.

Proposals should be self-contained. Their evaluation will be based solely on their explicit contents, to the exclusion of external references such as personal webpages, etc.

For non-member state proposals (Sect. 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 (“Acuerdo”), governs the allocation of time to *Host State Proposals* (Sect. 11.9): “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 exceptionally take priority, leading 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 prior to submitting the Phase 1 proposal. Corresponding requests, including a brief justification, must be submitted by email to esoform@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

For Paranal, it is ESO’s intention to offer all the most frequently utilized instrument configurations and modes in both Service and Visitor Mode. 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 not be accepted in Service 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, such justification must be provided by 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/WaiverChanges.html>) at least one week before the Phase 2 deadline. ESO reserves the right to reject the changes if insufficiently justified, if conflicting with any other approved programmes, or if they 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

On the basis of OPC ranking, the runs to be conducted in Service Mode will be subdivided, for operational reasons, into the following Classes:

- **Class A:** All possible effort 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:** Best effort will be made to have these runs conducted in the requested observing period. 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 which are not completed by the end of Period 85, 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.

13.4.2 ToO programme execution

As for any other Service Mode run, successful proposers of ToO runs will have to prepare OBs for their observations well ahead of the beginning of an observing period (see Sect. 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 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.

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 constraints, 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 Sect. 13.4).

13.6 Pre-imaging runs

A separate pre-imaging run must be specified for VLT programmes for which pre-imaging is required. 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, in case that the pre-imaging run is not specified separately, this will not happen automatically. The risk thus exists in that case that pre-imaging might not be identified as such until a later time. For this reason, please be sure to indicate the pre-imaging character of the run by using the corresponding `\INSconfig` macro in the \LaTeX ESOFORM template.

13.7 Data rights, archiving, data distribution

All data are ESO property. ESO grants a twelve month default 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 exposure individually. The period starts as files are being made available to (or retrieved by) PIs: in particular, for Visitor Mode runs, it starts at the time of the observation; while for Service Mode runs, as soon as any data is made available to the PI. The latter refers to the standard SM data package (usually shipped to the PI once the run is completed) and/or to any PI direct request for proprietary raw data via his/her User Portal account during the period. Should you wish to specify a shorter period than the nominal 12 months in Period 85, please do so using

the `\ProprietaryTime` macro in the L^AT_EX ESOFORM template. 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. In the case of Service Mode observations, data products, raw data, calibration data and any associated pipeline calibrated data will be distributed to the programme PI at the conclusion of their Service Mode run.

SPECIAL NOTE: Since ESO has recently revised some of its data distribution procedures, we shall here spell out the up-to-date rules more clearly.

- As a general rule, Service Mode data packages are distributed upon completion of a given run or at the end of the period, whatever comes first. An additional overhead for data processing has to be taken into account. At the end of a semester data from all Service Mode runs will be distributed, also for those high-priority runs to be continued in the next semester (carry-overs).
- The exceptions to the general rule are ToO data and pre-imaging data, which are made available to the PI via FTP directly from the archive. This automatic service will normally take place within a maximum of 48 hours from the observations time.
- As of April 2008, Service Mode PIs have direct access to their proprietary data via their User Portal account. Data can be made available to the PI as soon as they have been safely archived in the ESO Science Archive in Garching.
- The proprietary period for Service Mode data starts when the data is made available for the first time to the user (this also includes archive requests submitted during the period in order to access proprietary data).

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 085.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

ADP	Advanced Data Products
AMBER	Astronomical Multi-BEam combineR
APEX	Atacama Pathfinder EXperiment
APEX-SZ	APEX Sunyaev Zel'Dovich camera
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
DPS	Deep Public Survey
EIS	ESO Imaging Survey
EFOSC2	ESO Faint Object Spectrograph and Camera
ESO	European Southern Observatory
ETC	Exposure Time Calculator
FEROS	Fibre-fed Extended Range Optical Spectrograph
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-millimetre Heterodyne
FLI	Fraction of Lunar Illumination
FORS1	Focal Reducer/low dispersion Spectrograph 1
FORS2	Focal Reducer/low dispersion Spectrograph 2
FOV	Field Of View
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
LABOCA	LArge BOlometer CAmera
LADC	Linear Atmospheric Dispersion Compensator
LGS	Laser Guide Star
LST	Local Sidereal Time
LW	Long Wavelength (in the IR)
MIDI	MID-infrared Interferometric instrument
MOS	Multi Object Spectroscopy
MPG	Max Planck Gesellschaft
MPIfR	Max Planck Institut für Radioastronomie
NACO	NAOS-CONICA
NAOS	Nasmyth Adaptive Optics System
NGS	Natural Guide Star
OB	Observation Block
OPC	Observing Programmes Committee
OPO	Observing Programmes Office (formerly VISAS)
P2PP	Phase 2 Proposal Preparation (software tool)
PI	Principal Investigator

PWV	Precipitable Water Vapour
RRM	Rapid Response Mode
SABOCA	Submillimetre APEX BOlometer CAmera
SHFI	Swedish Heterodyne Facility Instrument
SINFONI	Spectrograph for INtegral Field Observations in the Near Infrared
SM	Service Mode (programme)
STC	Scientific Technical Committee
SV	Science Verification
SW	Short Wavelength (in the IR)
ToO	Target of Opportunity (proposal)
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	Visible MultiObject Spectrograph
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
X-SHOOTER	UV-Visual-NIR medium resolution echelle spectrograph

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