Gran Telescopio Canarias

Phase-2 Preparation Tool

Valid from period 2026A and later

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1. The GTC Phase-2 System

1.1. Introduction

This document describes how to use the Phase-2 tool for preparing observations at the Gran Telescopio CANARIAS (GTC).

Each Principal Investigator (PI) who has successfully got observing time at GTC through the Phase-1 call for proposals is required to complete a detailed definition of her/his observations, referred to as the "Phase-2". The purpose is to describe the observations sufficiently well to allow GTC staff astronomers to carry them out in service mode, as part of the observing queue. Each program has associated a support astronomer at GTC to assist in dealing with any question or problem that might occur, and to advise on the best possible use of the telescope.

To complete the Phase-2 there is no need to download or install code on your computer because the tool itself runs on a GTC server and is accessed through a web browser. You don't have to worry about having the latest version, because the version on-line is always the latest one. The products of the Phase-2 are also stored on the GTC server so never lose your work.

The web page (Figure 1) hosting the Phase-2 tool is:

URL: http://gtc-phase2.gtc.iac.es/science/F2

which is also reachable from the GTC home page. At any given time a user should open only one window to avoid conflicts when saving data and hence to avoid data loss.

Figure *1*: *Phase-2 login page under Linux-firefox appearance.*

1.2. Logging in

Each PI that has been allocated observing time on GTC will be provided with a *username* and *password* combination to enter the Phase-2 tool, and then create, inspect, modify or delete its own observing blocks. The PI will also be given a contact Support Astronomer at GTC to deal with specific queries related to the observing proposal and the preparation of the Phase-2. In case of delay in answering your queries you may always contact the GTC user helpdesk at: astro-helpdesk@gtc.iac.es.

Once you have logged in, the system will show you all your proposals, including those of previous periods. At the very bottom of the list a button for sending us your opinion/suggestion to improve the tool is shown.

To proceed with the preparation of the Phase-2 select the proposal you want to prepare the phase-2 for. You will be presented with the Phase-2 summary page for the corresponding proposal (Figure 2).

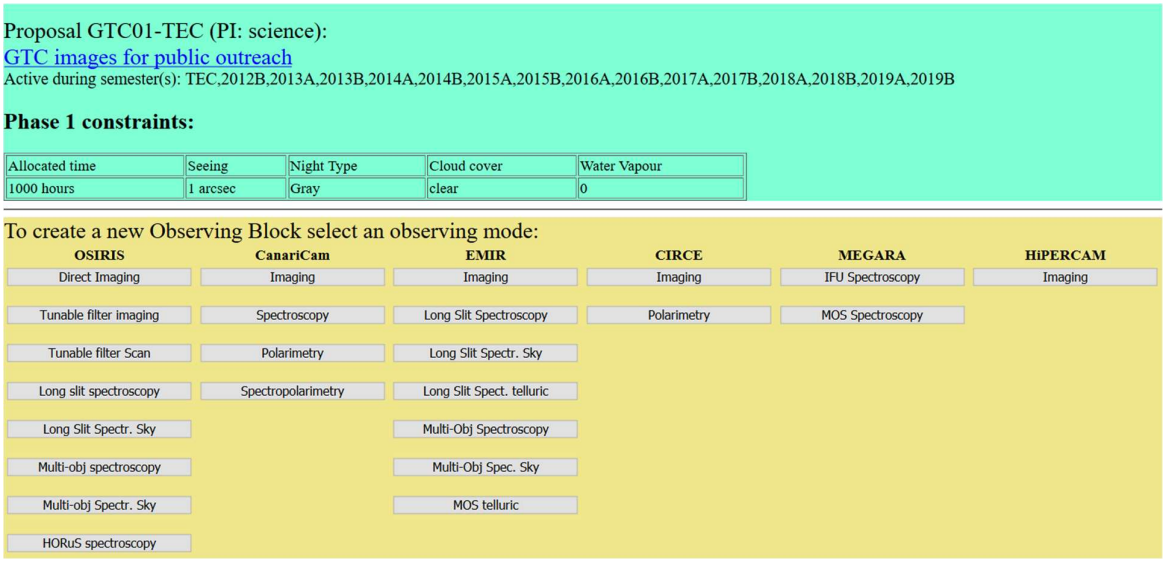


Figure 2: *The Phase-2 summary page as it appears when no OBs have been created. The constraints from Phase-1 are shown, as well as the list of all possible observing modes shown below the corresponding instrument.*

WARNING: only one session at the time should be started for a given proposal. Using multiple sessions might produce inconsistent result and/or loss of data.

1.3. Phase 2 simulator

Users can access to GTC Phase-2 tool even if they don't have an account in order to get familiar with the tool before doing things for real and/or precisely to estimate the overheads associated with planned observations during Phase 1. In the Phase-2 login page, you must select *Phase-2 simulator* option (bottom right panel in Figure 1) and login with username *simulator_#* and password s*imulator*, where # is a number of user's choice from 1 to 999 (for instance "simulator_47" will do). In case of conflict with other user, PI will be advised to select a different login number.

Once you are logged in, you will access to the full capabilities of the Phase 2 tool, including all observing modes of all instruments. There is no limit to the number of OBs you can create. Note the Phase 1 constraints, as well as the number of hours allocated are set to arbitrary values you can safely disregard. Please note **this is not the place to store OBs for later use.** Once you log out all your work will be cleaned out.

We kindly recommend to users to use this simulation mode to test in advance the associated overheads of a requested observation. This is also extremely useful for accounting the total telescope time needed by the time of preparing the corresponding call for proposals.

2. Defining an observing block

After selecting a proposal for which the Phase-2 is to be completed you will be presented with the Phase-2 summary page (Figure 2). You always can move back and forth to this page by pressing the dedicated button located just below the title of the summary page. Here you will see the title of the proposal, the proposal code, the time allocated, and the observing constraints coming from Phase-1 as approved by the time allocation committee. Basically, this is the home page for preparing Observing Blocks, or OBs, and for managing the Phase-2. In particular, you will be able to:

- Create an observing block for the requested instrument and observing mode.
- Modify and/or inspect existing observing block.
- Duplicate an existing observing block.
- Delete observing blocks.
- Duplicate OBs from one proposal to another.
- Fill in the README file.

An observing block (OB) is the smallest part in which your program can be subdivided. Normally an OB includes the information to acquire a target, and one or more templates. As a rule, at the telescope OBs are executed as indivisible units; they are treated like atoms of an observing program and are normally not split in time. Long observing blocks are more difficult to schedule and more sensitive to unstable observing conditions (both atmospheric and technical). **The observatory only guarantees the required observing conditions for observing blocks up to one hour and therefore recommends using this duration as the maximum total length of any observing blocks.** That is to say, if you need to integrate for 5 hours on a very faint target, you should not prepare a single OB containing 5 exposures of 1 hour each. Rather, you should prepare 5 OBs, each one with 1 exposure. Then, during the semester each OB will be most probably executed on different nights according to time availability and weather conditions. Keep in mind that short OBs have much more chances to be scheduled than long ones.

Each OB is in turn subdivided in templates, each one fully describing a specific action to be performed by the telescope. This can be the acquisition image, or for instance a number of exposures on the science target with a given filter.

Please ensure that your observing blocks adheres to the Phase-1 request. GTC staff will check the correctness of each set of observing blocks at the end of the process in order to ensure that the Phase-2 result matches the original instrument setup and time allocation. In particular, you should ensure that the total allocated time is not exceeded. Also note that in queue mode two observing blocks of the same target or otherwise linked, can be executed in separate nights. If for whatever reason they must be executed one after the other, this must be notified to the support astronomer through the README file.

Below follows a detailed description of how to fill an OB for each observing mode.

2.1. Creating an observing block for OSIRIS+

To start filling an OB just click on the corresponding observing mode. For OSIRIS+, the list of choices are the same as the ones previously available for OSIRIS:

- OSIRIS Direct Imaging, i.e., both standard broad band imaging with Sloan filters, and medium band imaging with SHARDs or OS filters.
- OSIRIS Imaging with Tunable Filter at fixed wavelengths (NOT AVAILABLE YET).
- OSIRIS Tunable Filter Scan, i.e. imaging with tunable filter scanning a range of wavelengths (NOT AVAILABLE YET).
- OSIRIS Long Slit Spectroscopy
- OSIRIS Long Slit Spectroscopy Sky, i.e., with offsets perpendicular to the slit to get the sky.
- OSIRIS Multi-object Spectroscopy
- OSIRIS Multi-object Spectroscopy with offsets perpendicular to the slit to get the sky.

Once you have decided which observing mode is the most appropriate for your OB, you must provide some information that is common to all observing modes, with some other specific items depending on the mode.

2.1.1. Target definition

Target Name: This is the name that will appear in image header. It does not have to be unique, but for later handling it is better if it is. Special characters and spaces are not allowed.

Observing Priority: a number between 1 to 9, being 1 the maximum priority. The night astronomer will attempt to execute first the OBs with higher priority.

Coordinates (J2000): Target coordinates in the format HH:MM:SS.SS (-)DD:MM:SS.S. Note that positive declinations must be written without the + sign. It is required that you enter the coordinates with the exact number of decimals (i.e. 2 for the right ascension and 1 for the declination).

For the main observing modes of OSIRIS+ a reference position on the CCD has been adopted as the location where targets will be placed, this means that **the coordinates introduced by the PI in the Phase-2 will be positioned at those pixels:**

- **Direct Imaging:** The standard pointing is at the CCD pixel (1050, 925) to maximize the available FOV.
- **LongSlit Spectroscopy:** Objects are centered on the slit at the coordinate Y=750 of the CCD, that is, pixel coordinates (1051,750). On this area, the distortion of the spectra is very low and it follows the same approach as in old detector, by placing the targets at approximately 1 arcmin away from the image center.

- **Tunable Filter Imaging (NOT AVAILABLE YET):** The position of the objects in the TF observing mode depends on the requirements of the PI since the value of the wavelength changes with the object's position in the FOV. The PI must indicate, in the Phase-2 form, the coordinates to which the telescope will be pointing and the CCD pixel position for these observations (defining an acquisition image to do this). If there is no specific location at the Phase-2, the pointing will be done at 15 arcsecs of the optical center, at pixel TBD in the CCD.

- **Multi-Object Spectroscopy:** Pointing coordinates will refer to pixel (1050,1005) in CCD coordinates, but in this case the file coming from the Mask Designer Tool will include that information and no further action within Phase-2 tool is needed.

If user demands a different location than this, an acquisition image would be needed.

The exact location of your target on the field of view depends on the observing mode. The night astronomer is taking care of placing the science target on a defect-free region of the CCD. For later scheduling coordinates are required even for non-sidereal targets. In this case enter a value close to the mean position the target will have during the period of visibility.

Proper Motion: If appropriate enter proper motion values in milli-arcseconds per year. This field can be left empty. (see Appendix A.8 for details in the proper motion definition).

Non-Sidereal Target: Activate this flag for solar system targets. If selected, later you will be asked to enter a file of coordinates.

Example screen shots are presented in Figure 3 and Figure 4.

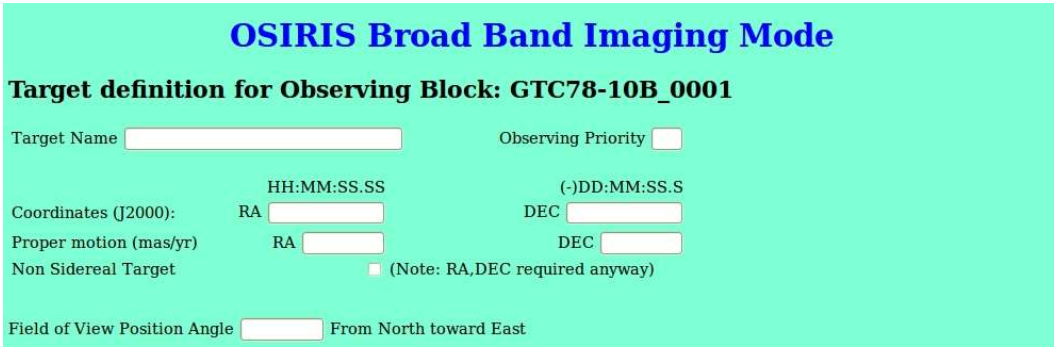


Figure 3: *Target definition for the case of OSIRIS+ Broad band imaging. The same parameters are used for Osiris Tunable-filter imaging.*

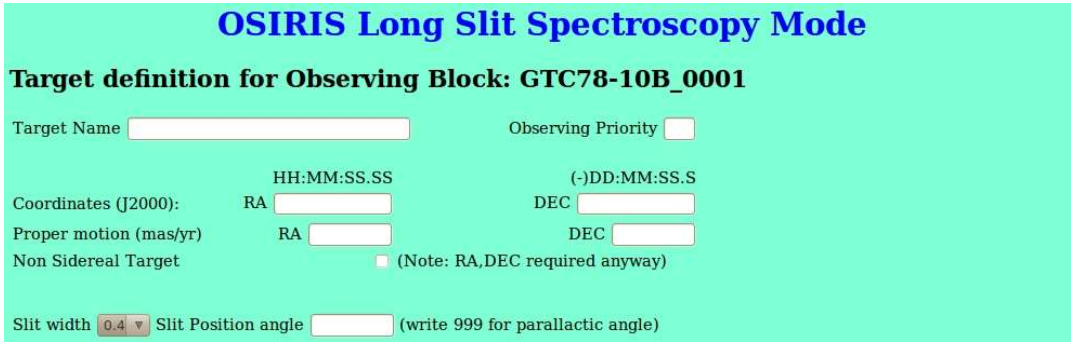


Figure 4: *Target definition for the case of OSIRIS+ Long Slit Spectroscopy.*

2.1.2. OSIRIS+ Broad-Band Imaging

In addition to the fields described in section 2.1.1, the following parameters are needed:

Field of view position angle: By default the instrument field of view is oriented so to have the North up and East to the right. However, the instrument can be oriented differently. If so, write in this field the desired position angle in degrees, starting from North toward East. Angles are assumed to be positive from North to East. For instance, a value of 90 means that you will have East up and North left.

Then, at least one template must be filled in, to define the details of the science exposures associated to the OB (Figure 5).

Acquisition Image: To center the target at a different pixel than the one corresponding to the OSIRIS standard pointing, that is, at the CCD pixel (1050, 925) (see 2.1.1) an acquisition image is required. User can also skip this image if standard pointing is enough for his/her purpose.

The parameters to define the acquisition image are:

- Filter: A pull down menu allow the selection of the filter to be used.
- Exptime: Integration exposure time in seconds.
- Readout mode: Readout speed (200 kHz is the only available in OSIRIS+).

Science templates: Each template allows the user to define a series of one or more exposures to be taken with a given filter, exposure time, and readout mode, in different positions on the sky. The parameters to be configured are:

- The filter to be used. The pull-down menu lists all filters available for the active semester.
- The exposure time in seconds.
- The number of exposures, ”N exp”, in the series.
- The CCD readout mode: Please note that 200 kHz is the only available in OSIRIS+. This readout mode is preselected.
- The CCD binning. The standard mode for imaging, 2 x 2 binning, is preselected. If you wish to use a different binning, the time for taking the non-standard calibrations will be charged to the project.
- The offsets between images, in arcseconds. Note that within a template each offset will be added to the previous one, and if the requested number of exposures is greater than the number of offsets (or if no offsets at all are given) the telescope will reuse the last position as many times as needed. At the end of each template the telescope is sent back to the starting position. Values are given as a space separated array.

At the bottom of the form there is one final (optional) parameter to be defined:

Number of times the templates should be repeated: This refers to the number of repetitions of all the templates within the OB. It is important to understand that this parameter is not meant to repeat the full OB, but rather to allow the repetition of sequences of templates, for instance taking series of images alternating two filters.

Pressing the "Reset form" button at any time will clear all values from the form, including the fields for the target definition and the acquisition image for blind offset.

Submit: Once you are happy with the values that you have filled, the submit button takes you to the next page in the Phase-2 completion process. The next steps consist of uploading a finding chart (Section 2.4), uploading an ephemeris file in the case of non-sidereal targets (Section 2.5) and filling in a README file with further information (Section 3.3).

Here follow some examples:

Example 1: To take four exposures of 600 seconds each in the u band, readout mode 200kHz, in a squared dithering pattern 10" on a side, starting from the target position, the template should be filled as follow:

u, 600 , 4, 200kHz, 2x2, 0 10 0 -10, 0 0 10 0

Example 2: To take a similar sequence in g and r bands over the same positions on the sky:

g, 500 , 4, 200kHz, 2x2, 0 10 0 -10, 0 0 10 0

r, 400 , 4, 200kHz, 2x2, 0 10 0 -10, 0 0 10 0

Note that the very same offsets are given in both templates because at the end of the first one the telescope goes back to the pre-set position.

Example 3: Take 3, 10 sec exposure in z band, in a fixed position on the sky, and readout mode 200 kHz

z, 10, 3, 200kHz, 2x2 (note that no offsets are given).

Example 4: To take 3 exposures in the z band each one with a different exposure time, three templates must be configured:

z, 60, 1, 200kHz, 2x2

z, 120, 1, 200kHz, 2x2

z, 240, 1, 200kHz, 2x2

To loop through any of the above sequences 10 times, set the number of repetition to 10. Note that this last parameter is not meant to repeat the whole OB, but only the templates are repeated. That is to say, one cannot set the number of repetitions to 3 instead of preparing 3 separated OBs.

In the case of needing more templates than the maximum number offered, please contact your support astronomer.

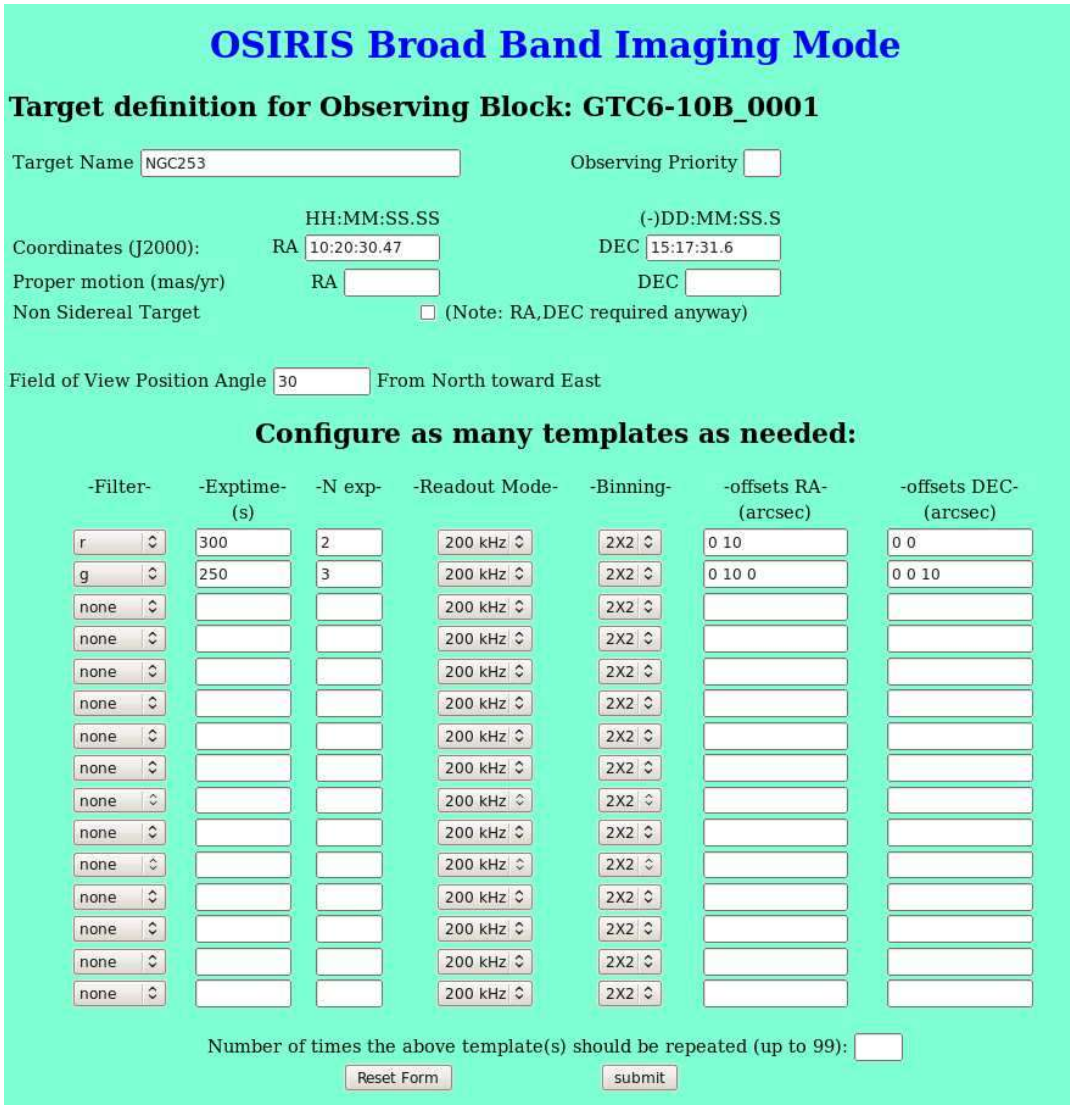


Figure 5: *The form to prepare an OB for OSIRIS+ imaging mode.*

2.1.3. OSIRIS+ Tunable Filter Imaging (NOT AVAILABLE IN OSIRIS+)

The form specific to Tunable filter observations is shown in Figure 6.

Acquisition Image: To center the target at a different pixel than the one corresponding to the OSIRIS standard pointing, that is, pixel TBD in CCD2 (see 2.1.1.) an acquisition image is required. As an accurate positioning in Tunable Filter images is mandatory due to the wavelength displacement along the FOV this acquisition image is needed in all the Tunable Filter observations. User can also skip this image if standard pointing is enough for his/her purpose.

The parameters to define the acquisition image are:

- Filter: A pull down menu allow the selection of the filter to be used.
- Exptime: Integration exposure time in seconds.
- Readout mode: Readout speed (200 kHz is the only available in OSIRIS+).

Science Templates: Each template allows the user to define a series of one or more exposures to be taken with a given Tunable filter, exposure time, and readout mode, in different position on the sky. This observing mode is quite similar to that of regular broad band imaging. Be aware that **if you want to observe in more than one wavelength separated by a fix, small steps, it is more efficient to use the "TF scan mode".**

After filling the upper part of the form, the remaining parameters to be configured are:

- The Tunable Filter to be used (RED or BLUE)
- The order sorter filter (OS) needed to isolate the wavelength of interest (Tables 1 and 2). The user is asked to explicitly select the OS filter, but be aware that moving from one wavelength to another a new OS filter might be required, which implies a full setup of OSIRIS, with the corresponding overheads.
- The central wavelength in nanometers to be tuned. The FWHM of the passband in nanometers.
- The exposure time in seconds.
- The number of times, "N exp" the exposures must be repeated.
- The CCD readout mode: Please note that 200 kHz is the only available in OSIRIS+. This readout mode is preselected.
- The CCD binning. The standard mode for imaging, 2 x 2 binning, is preselected. If you wish to use a different binning, the time for taking the non-standard calibrations will be charged to the project.
- The offsets between images in arcsec, given as a space-separated array. The meaning of the offsets is the same as in Section 2.1.2.
- The number of times the defined templates should be repeated.

At the bottom of the form there is one final (optional) parameter to be defined:

Number of times the templates should be repeated: This refers to the number of repetitions of all the templates within the OB. It is important to understand that this parameter is not meant to repeat the full OB, but rather to allow the repetition of sequences of templates, for instance taking series of images alternating two setups.

Pressing the "Reset form" button at any time will clear all values from the form, including the fields for the target definition and the acquisition image for blind offset.

Submit: Once you are happy with the values that you have filled, the submit button takes you to the next page in the Phase-2 completion process. The next steps consist of uploading a finding chart

(Section 2.4), uploading an ephemeris file in the case of non-sidereal targets (Section 2.5) and filling in a README file with further information (Section 3.3).

Here follow some examples:

Example 1: Take three exposures of 250s at 682.5 nm, with FWHM=1.9 nm, in dithered 20" positions on the sky, and 200 kHz readout mode:

TF RED, f680/43, 682.5, 1.9, 250, 3, 200 kHz, 2x2, 0 20 0, 0 0 20

Example 2: Take four 60s exposures at 700 nm, FWHM=0.9 nm, readout mode 200 kHz, in a squared 10" dithering pattern starting from the target position:

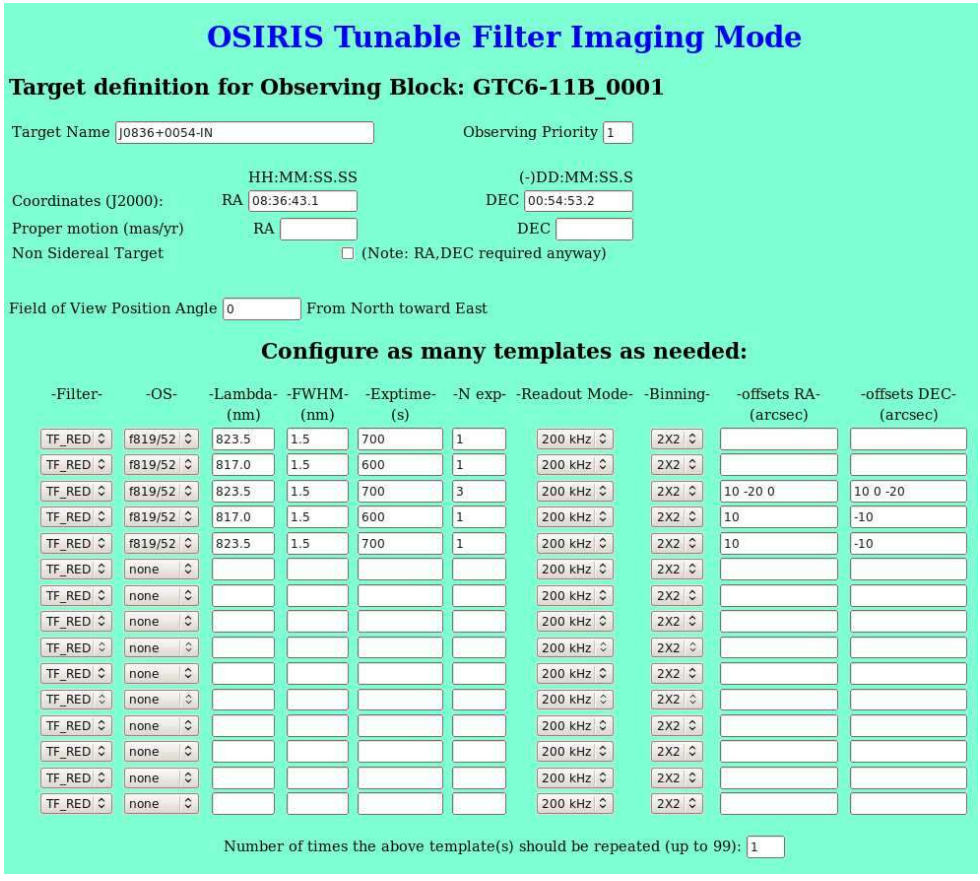
TF RED, f709/45, 700, 0.9, 60 , 4, 200 kHz, 2x2, 0 10 0 -10, 0 0 10 0

Example 3: Take two sequences like above as part of a single observing block:

TF RED, f680/43, 682.5, 1.9, 250, 3, 200 kHz, 2x2, 0 20 0, 0 0 20

TF RED, f 709/45, 700, 0.9, 60, 4, 200 kHz, 2x2, 0 10 0 -10, 0 0 10 0

Note that at the end of the first template the telescope goes back to the pre-set position, thus the first exposure of the second template is centered on the target.



OSIRIS Tunable Filter Imaging Mode

Target definition for Observing Block: GTC6-11B_0001

Target Name: J0836+0054-IN Observing Priority: 1

	HH:MM:SS.SS	(-)DD:MM:SS.S
Coordinates (J2000):	RA 08:36:43.1	DEC 00:54:53.2
Proper motion (mas/yr)	RA	DEC

Non Sidereal Target ☐ (Note: RA,DEC required anyway)

Field of View Position Angle: 0 From North toward East

Configure as many templates as needed:

-Filter-	-OS-	-Lambda- (nm)	-FWHM- (nm)	-Exptime- (s)	-N exp-	-Readout Mode-	-Binning-	-offsets RA- (arcsec)	-offsets DEC- (arcsec)
TF_RED	f819/52	823.5	1.5	700	1	200 kHz	2X2		
TF_RED	f819/52	817.0	1.5	600	1	200 kHz	2X2		
TF_RED	f819/52	823.5	1.5	700	3	200 kHz	2X2	10 -20 0	10 0 -20
TF_RED	f819/52	817.0	1.5	600	1	200 kHz	2X2	10	-10
TF_RED	f819/52	823.5	1.5	700	1	200 kHz	2X2	10	-10
TF_RED	none					200 kHz	2X2		
TF_RED	none					200 kHz	2X2		
TF_RED	none					200 kHz	2X2		
TF_RED	none					200 kHz	2X2		
TF_RED	none					200 kHz	2X2		
TF_RED	none					200 kHz	2X2		
TF_RED	none					200 kHz	2X2		
TF_RED	none					200 kHz	2X2		
TF_RED	none					200 kHz	2X2		
TF_RED	none					200 kHz	2X2		

Number of times the above template(s) should be repeated (up to 99): 1

Figure 6: *The form to prepare an observing block for OSIRIS+ Tunable Filter imaging mode.*

2.1.4. OSIRIS+ Tunable Filter Scan (NOT AVAILABLE IN OSIRIS+)

This mode of observation is meant for taking images with the TF while scanning over a range of wavelengths. The form specific to this mode of observations is shown in Figure 7. The upper section of the form is identical to the one for imaging mode.

Each template allows the user to define a series of one or more exposures to be taken with a given exposure time and readout mode, in different position on the sky, scanning over a series of wavelength. The parameters to be configured are:

- The Tunable Filter to be used. (RED or BLUE).
- The order sorter filter (OS) needed to isolate the wavelength of interest (Tables 1 and 2). The user is asked to explicitly select the OS filter, but be aware that moving from one wavelength to another a new OS filter might be required, which implies a full setup of OSIRIS, with as a consequence the overheads.
- The initial central wavelength in nanometers to be tuned. The FWHM of the passband in nanometers
- The step in wavelength to be applied between exposures in the scan.
- The number of steps to the carried out. For instance to scan with a step of 25 nm from 600 to 800 nm, the number of steps is 9 (including the first exposure at 600 nm).
- The exposure time in seconds.
- The number of exposures, ”N exp”, in the series. Please note that this parameter has the following meaning: it is the number of exposures taken at a given wavelength. That is to say, at every “step” in wavelength “N exp” exposures will be taken (each one at the position specified by the given offsets).
- The CCD readout mode: Please note that 200 kHz is the only available in OSIRIS+. This readout mode is preselected.
- The CCD binning. The standard mode for imaging, 2 x 2 binning, is preselected. If you wish to use a different binning, the time for taking the non-standard calibrations will be charged to the project.
- The offsets between images in arcsec, given as a space-separated array. The meaning of the offsets is the same as in section 2.1.2.

At the bottom of the form there is one final (optional) parameter to be defined:

Number of times the templates should be repeated: This refers to the number of repetitions of all the templates within the OB. It is important to understand that this parameter is not meant to repeat the full OB, but rather to allow the repetition of sequences of templates, for instance taking series of images alternating two scans.

Pressing the "Reset form" button at any time will clear all values from the form, including the fields for the target definition and the acquisition image for blind offset.

Submit: Once you are happy with the values that you have filled, the submit button takes you to the next page in the Phase-2 completion process. The next steps consist of uploading a finding chart (Section 2.4), uploading an ephemeris file in the case of non-sidereal targets (Section 2.5) and filling in a README file with further information (Section 3.3).

Here follow some examples:

Example 1: Take a series of 5 exposures of 250s, at 200 kHz read out speed and binning 2 x 2, starting at 685 nm, with FWHM 1.2 nm, and step of 2 nm:

TF RED, f694/44, 685, 1.2, 2, 5, 250, 1, 200 kHz, 2x2

In this example one image at each wavelength will be taken, scanning the values 685-687-689-691-693 nm.

Example 2: As in example 1, but we now want to scan up to 703 nm. In this case one single template is not enough, because at 695 nm we have to change OS. Thus we have to write:

TF RED, f694/44, 685, 1.2, 2, 6, 250, 1, 200 kHz, 2x2

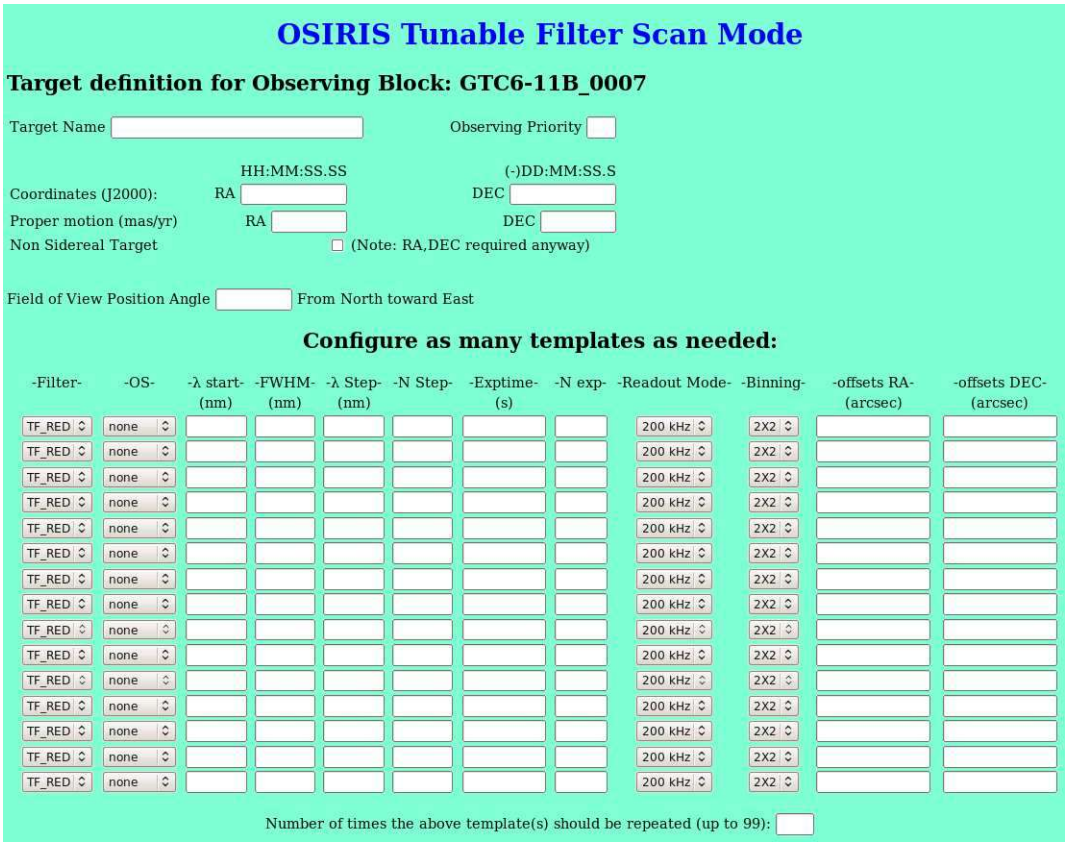
TF RED, f709/45, 697, 1.2, 2, 4, 250, 1, 200 kHz, 2x2

The first template ask for 7 steps scanning the wavelengths 685-687-689-691-693-695 nm, and the second will take 4 more exposures at 697-699-701-703 nm.

Example 3: As in example 1 but now we want to take 4 exposures in four positions on the sky, at each wavelength:

TF RED, f694/44, 685, 1.2, 2, 5, 250, 4, 200 kHz, 2x2, 0 10 0 -10, 0 0 10 0

Example 3: To repeat 6 times the sequence of example 2, just set the number of repetitions to 6.



OSIRIS Tunable Filter Scan Mode

Target definition for Observing Block: GTC6-11B_0007

Target Name Observing Priority

		HH:MM:SS.SS		(-)DD:MM:SS.S
Coordinates (J2000):	RA		DEC	
Proper motion (mas/yr)	RA		DEC	

Non Sidereal Target ☐ (Note: RA,DEC required anyway)

Field of View Position Angle From North toward East

Configure as many templates as needed:

-Filter-	-OS-	-λ start- (nm)	-FWHM- (nm)	-λ Step- (nm)	-N Step-	-Exptime- (s)	-N exp-	-Readout Mode-	-Binning-	-offsets RA- (arcsec)	-offsets DEC- (arcsec)
TF_RED	none							200 kHz	2X2		
TF_RED	none							200 kHz	2X2		
TF_RED	none							200 kHz	2X2		
TF_RED	none							200 kHz	2X2		
TF_RED	none							200 kHz	2X2		
TF_RED	none							200 kHz	2X2		
TF_RED	none							200 kHz	2X2		
TF_RED	none							200 kHz	2X2		
TF_RED	none							200 kHz	2X2		
TF_RED	none							200 kHz	2X2		
TF_RED	none							200 kHz	2X2		
TF_RED	none							200 kHz	2X2		
TF_RED	none							200 kHz	2X2		
TF_RED	none							200 kHz	2X2		
TF_RED	none							200 kHz	2X2		

Number of times the above template(s) should be repeated (up to 99):

Figure 7: *Form to prepare an OB for OSIRIS+ Tunable Filter Scan mode.*

Table 1: Order separating filters for use with the Blue Tunable Filter and for medium narrow-band imaging.

Filter	Central Lambda (nm)	FWHM (nm)	Useful range for TF (nm)
f451/13	450.7	13.1	448 - 458
f454/13	454.3	13.2	458 - 461
f458/13	457.9	13.3	461 - 464
f461/13	461.5	13.4	464 - 468
f465/13	465.1	13.5	468 - 473
f469/14	469.0	14.0	473 - 476
f473/14	473.1	14.1	476 - 481
f477/14	477.2	14.2	481 - 484
f481/14	481.4	14.4	484 - 489
f486/14	485.6	14.5	489 - 494
f490/15	490.0	15.1	494 - 498
f495/15	494.7	15.2	498 - 503
f499/15	499.5	15.4	503 - 506
f504/16	504.2	15.5	506 - 511
f509/16	509.1	15.7	511 - 516
f514/16	514.0	15.8	516 - 522
f519/16	519.1	16.5	522 - 528
f525/17	524.6	16.7	528 - 533
f530/17	530.1	16.8	533 - 538
f536/17	535.7	17.0	538 - 543
f542/18	541.6	17.8	543 - 550
f548/18	547.8	18.0	550 - 556
f554/18	554.1	18.2	556 - 562
f561/19	560.8	19.0	562 - 569
f568/19	567.9	19.2	569 - 576
f575/19	575.0	19.5	576 - 584
f583/20	582.6	20.4	584 - 593
f591/21	590.5	20.7	593 - 600
f599/22	599.0	21.8	600 - 610
f608/22	607.9	22.1	610 - 618
f617/23	617.4	23.3	618 - 628
f627/24	627.4	23.7	628 - 638
f638/25	638.0	25.0	638 - 649
f649/25	649.2	25.5	649 - 658
f661/27	661.2	27.0	658 - 671

Table 2: Order separating filters for use with the Red Tunable Filter and for medium narrow-band imaging.

Filter	Central Lambda (nm)	FWHM (nm)	Useful range for TF (nm)
657/35	657.2	35.0	649 - 660
666/36	666.8	35.5	660 - 670
680/43	680.2	43.2	670 - 685
694/44	694.4	44.0	685 - 695
709/45	708.8	44.9	695 - 710
723/45	723.3	45.2	710 - 725
738/49	738.0	46.1	725 - 735
754/50	754.2	49.6	735 - 755
770/50	770.6	49.7	755 - 770
785/48	785.6	47.6	770 - 788
802/51	802.0	51.3	788 - 803
819/52	819.0	52.4	803 - 818
838/58	838.6	57.8	818 - 845
858/58	858.2	57.9	845 - 860
878/59	878.2	59.3	860 - 885
893/50	893.2	49.6	885 - 900
902/44	902.4	40.1	900 - 910
910/40	910.6	40.5	910 - 912
919/41	918.9	40.8	912 - 920
923/34	923.8	34.2	920 - 925
927/34	927.9	34.4	925 - 930
932/34	932.0	34.5	930 - 935

2.1.5. OSIRIS+ Long-Slit Spectroscopy (including sky mode)

This section applies to both long slit modes, the only difference being on the definition of the offsets, see below.

In addition to the fields commented in Section 2.1.1, to define a long-slit spectroscopy observation the following information is needed (Figure 8):

Slit Width: Select the slit width. Only one slit per observing block can be selected. See Figure 4.

Slit Position Angle: Select the slit position angle on the sky, starting from North toward East, ranging from -90 to 90 degrees. For instance, PA=90 sets the slit along the East-West direction. To position the slit along the parallactic angle at the moment of observations, enter ”999”.

Acquisition Image: To center the target on the slit a direct image of the field is taken and the target identified. The parameters to define the acquisition image are:

- Filter: A pull down menu allow the selection of the filter to be used.
- Exptime: Integration exposure time in seconds.
- Readout mode: Readout speed (200 kHz is the only available in OSIRIS+).

Through slit image: After placing the target on the slit, an image of the target is taken with the slit in position (but without inserting the grism) to further improve centering. Here the user selects the filter and exposure time of the exposure, as readout mode is fixed for OSIRIS+ (See Figure 8). Values can be different from the ones used for acquisition. The meaning of the parameters is the same as for the acquisition image.

Blind offset: For faint targets the user can provide a blind offset from a known well defined celestial position, to be applied after the through-slit image. That is, it is possible to acquire on a bright target and then blindly offset the telescope to place the science target on the slit. The offset must be given in arcsec. To give the offsets with the correct sign keep in mind that the telescope will move from the bright to the faint target. It is important to bear in mind, that **when the acquisition image for blind offset is selected, the coordinates in the target definition section shall be the ones of the bright reference source**, not the ones of the science target. Be aware that the offsetting accuracy of the telescope is 0.2” for offsets as large as 30”, hence try to avoid larger offsets when a narrow slit is selected.

Filling the templates: In order for an OB to be valid at least one science template must be filled in. Each template allows the user to define a series of one or more exposures to be taken with the selected slit, exposure time, and readout mode, in different positions on the sky. The parameters to be configured are:

- The grism to be used.
- The exposure time in seconds.
- The number of exposures, ”N exp”, in the series.

- The CCD readout mode: Please note that 200 kHz is the only available in OSIRIS+. This readout mode is preselected.

- The CCD binning. The standard mode for spectroscopy, 2 x 2 binning, is preselected. If you wish to use a different binning, the time for taking the non-standard calibrations will be charged to the project.

- The offsets. Offsets have different meaning according to the mode selected. **In the standard long slit mode offsets are allowed only along the slit** (defined as positive when displacing the target to the right in the slit, and negative in the opposite direction), while in the long-slit sky mode, offsets are allowed in any direction. The standard mode is simpler because you only define the size of the offset and at the time of observation the observing engine will take care of computing the right movement of the telescope to ensure your target will remain on the slit. The size of the offset is given in arcseconds. Offsets are cumulative, thus within a series each offset will be added to the previous one, and if the requested number of exposures is greater than the number of offsets (or if no offsets at all are given) the last position is re-used as many times as needed. At the end of each template the telescope is always sent back to the starting position. **In the "sky" mode, offsets in arcsec must be specified for both RA and DEC.** This allows the offsetting position to be anywhere in the sky. Also in this case offsets are cumulative.

At the bottom of the form there is one final (optional) parameter to be defined:

Number of times the templates should be repeated: This refers to the number of repetitions of all the templates within the OB. It is important to understand that this parameter is not meant to repeat the full OB, but rather to allow the repetition of sequences of templates, for instance taking series of images alternating two spectral setups.

Pressing the "Reset form" button at any time will clear all values from the form, including the fields for the target definition and the acquisition image for blind offset.

Submit: Once you are happy with the values that you have filled, the submit button takes you to the next page in the Phase-2 completion process. The next steps consist of uploading a finding chart (Section 2.4), uploading an ephemeris file in the case of non-sidereal targets (Section 2.5) and filling in a README file with further information (Section 3.3).

Here follow some examples:

Example 1: Take 3 exposures of 600 s with R500B grism, without order separator, in 3 dithered positions of 5" below the slit center along the slit, on the slit center, and 5" above the slit center, everything in the standard 200 kHz readout mode and binning 2 x 2:

R500B, 600, 3, 200 kHz, 2x2, -5 5 5

Example 2: Take the same sequence as above but in a fixed position on the sky

R500B, 600, 3, 200 kHz, 2x2 (note that no offsets are given)

Example 3: Use sky mode to perform a typical ABBA sequence of four spectra, exposing initially on target, then two exposures off-slit to get the sky, and a final spectrum back on target. Let assume the point where you want to measure the sky is located 10 arcsec in RA and 5 arcsec in DEC away from

your target. Finally assume the use of grism R1000R, exptime 300 s, 200 kHz, binning 1x1. Fill the template like this:

R1000R, 300, 4, 200 kHz, 1x1, 0 10 0 -10, 0 5 0 -5

Note the first pair of offsets is 0,0 meaning the telescope remain on the initial presetting position. Then the second pair is 10,5 meaning the telescope will move of that many arcseconds to reach the requested sky position. The third pair is again 0,0 to repeat a second spectra on the sky. Finally the forth pair is -10,-5 to send the telescope back to the target.

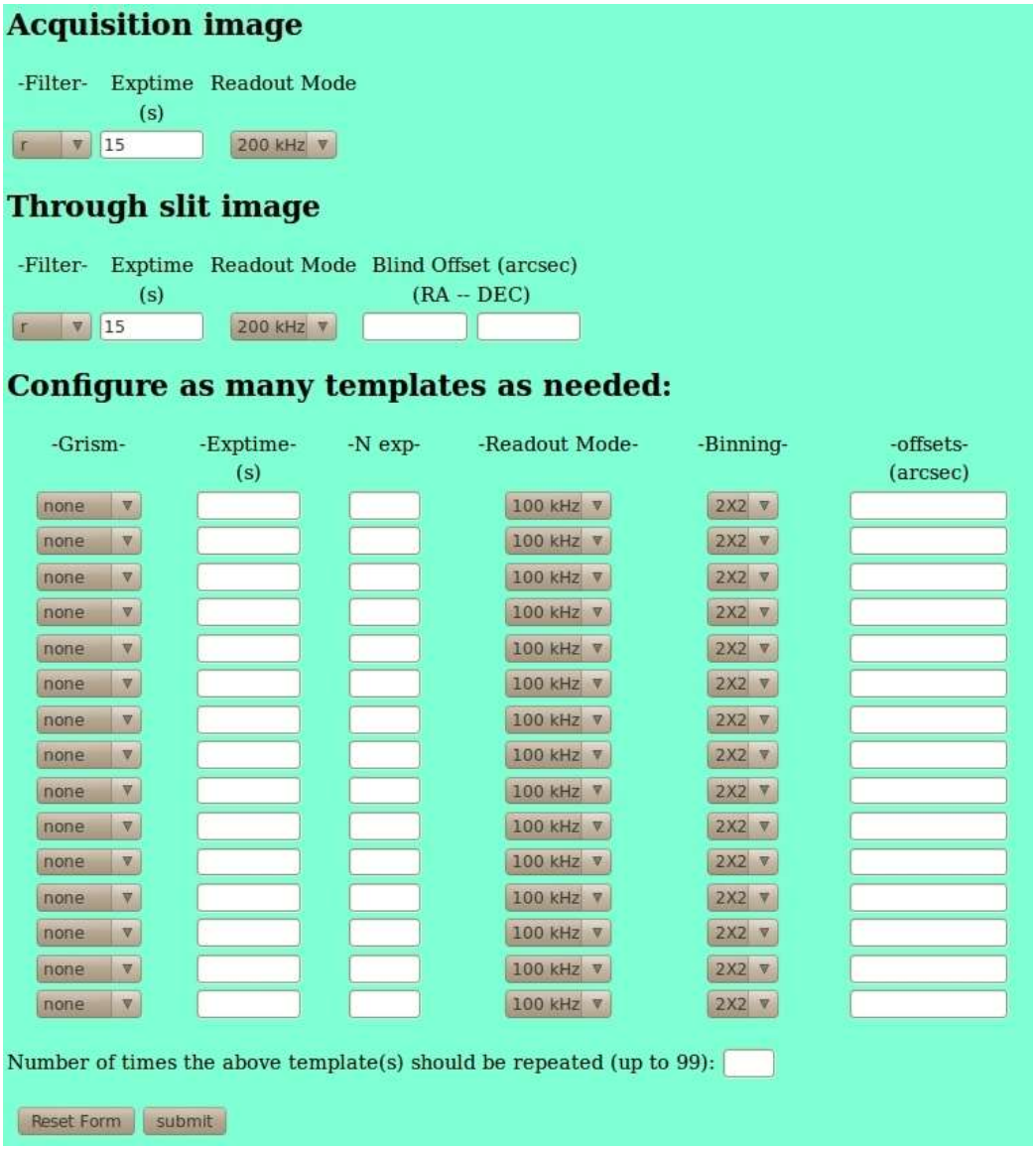


Figure 8: *Form to define an OB for OSIRIS+ standard Long Slit spectroscopy. The section relative to the target definition is not shown. In the case of long-slit spectroscopy sky, the offsets will include two fields to give offsets in both RA and DEC.*

2.1.6. OSIRIS Multi-Object Spectroscopy (including sky mode)

This observing mode requires the initial preparation of an instrument focal plane slit mask, which is done with a separate Mask Designer tool:

http://www.gtc.iac.es/instruments/osiris+/osiris+MOS.php#MDtool

Once you have designed the mask and saved it on a file called, let say, *mask.mdf*, you are ready to prepare your observing block.

The first thing you are asked to do is to upload the mask file. After uploading, the center of the mask and the selected grism will be shown in order to double check whether it is the mask you wanted to upload. If not, then just go back with the navigator back button and upload the correct file.

When you are satisfied press "continue" and you will be presented with the form where to define the following parameters:

Acquisition Image: To center the targets on the slits, a direct image of the field is taken and the reference targets identified. Please select the exposure time and broad band filter to be used for this exposure (readout mode is fixed for OSIRIS+, and for technical reasons the binning is also fixed to the default for imaging: 2 x 2). This step is always required in MOS mode.

For the acquisition image you are asked to specify the filter to be used, the integration time in seconds, and the readout mode.

Through slit image: After placing the target on the slit, an image of the target is taken with the slit mask in position (but without inserting the grism) to further improve centering. Please select the filter and exposure time of the exposure, as readout mode is fixed for OSIRIS+ Values can be set differently from the ones used for acquisition. The meaning of the columns is the same as in acquisition.

Filling in the templates: Because the focal plane setup is already defined, you are left to configure only few other parameters:

- The exposure time in seconds.
- The number of exposures, "N exp", in the series.
- The CCD readout mode: Please note that 200 kHz is the only available in OSIRIS+. This readout mode is preselected.
- The CCD binning. The standard mode for OSIRIS+, 2 x 2 binning, is preselected. **Note that in OSIRIS+ MOS mode, only 2 x 2 binning is supported.**
- The offsets along the slits between images, in arcseconds. Note that within a series each offset will be added to the previous one, and if the requested number of exposures is greater than the number of offsets (or if no offsets at all are given) the last position is re-used as many times as needed. At the end of each template the telescope is always sent back to the starting position.
- The offsets. Offsets have different meaning according to the mode selected. **In the standard MOS mode offsets are allowed only along the slit,** (defined as positive when displacing the target to the right in the slit, and negative in the opposite direction), while in the MOS sky mode,

offsets are allowed in any direction. The standard mode is simpler because only the size of the offset has to be defined. At the time of observation the observing engine will take care of computing the right movement of the telescope to ensure your target will remain on the slit. The size of the offset is given in arcseconds. Offsets are cumulative thus within a series each offset will be added to the previous one, and if the requested number of exposures is greater than the number of offsets (or if no offsets at all are given) the last position is re-used as many times as needed. At the end of each template the telescope is always sent back to the starting position. **In the "sky" mode, offsets in arcsec must be specified for both RA and DEC.** This allows the offsetting position to be anywhere in the sky. Also in this case offsets are cumulative.

At the bottom of the form there is one final (optional) parameter to be defined:

Number of times the templates should be repeated: This refers to the number of repetitions of all the templates within the OB. It is important to understand that this parameter is not meant to repeat the full OB, but rather to allow the repetition of sequences of templates, for instance taking series of images alternating two spectral setups.

Pressing the "Reset form" button at any time will clear all values from the form, including the fields for the target definition and the acquisition image for blind offset.

Submit: Once you are happy with the values that you have filled, the submit button takes you to the next page in the Phase-2 completion process. The next steps consist of uploading a finding chart (Section 2.7), uploading an ephemeris file in the case of non-sidereal targets (Section 2.8) and filling in a README file with further information (Section 3.3).

Here follow some examples:

Example 1: Take 3 exposures of 600 s with R300R grism and a given mask, in 3 dithered positions of 5" below the slit center (obviously along the slit), on the center, and 5" above the slit center, and everything in the standard readout mode binning 2 x 2:

R300R, 600, 3, 200 kHz, 2x2, -5 5 5

Example 2: Take the same sequence as above but in a fixed position on the sky

R300R, 10, 3, 200 kHz, 2x2 (note that no offsets are given)

2.2. Creating an observing block for CanariCam

Observations in the mid-infrared are particularly challenging. Because of that, to properly fill the GTC phase-2 for CanariCam it is important to have a good understanding of how CanariCam works and to be familiar with the chopping and nodding techniques. Figure 9 shows a general representation of the definition of the chopping and nodding and field of view position angles. This figure shows a case of an extended source surrounded by more extended emission, so that the chop and nod throws must be defined larger than the detector field-of-view (FOV). In the case of point sources (e.g. a standard star) chop and nod throws can have values smaller than the detector FOV. As a rule, for best performance in thermal infrared observations, chop and nod throw should have the same value, and the chop and nod angles should differ by 180 degrees. Users are allowed to ignore this rule, as long as they are aware of

the risks involved. Section 2.2.2 contains a step-by-step guide to define the chopping and nodding configuration.

For CanariCam, the observing modes available are:

- CanariCam Imaging.
- CanariCam Spectroscopy.
- CanariCam Polarimetry (only in the 10-micron window)
- CanariCam Spectropolarimetry (only in the 10-micron window)

Below follow detailed descriptions of how to prepare OBs for each mode.

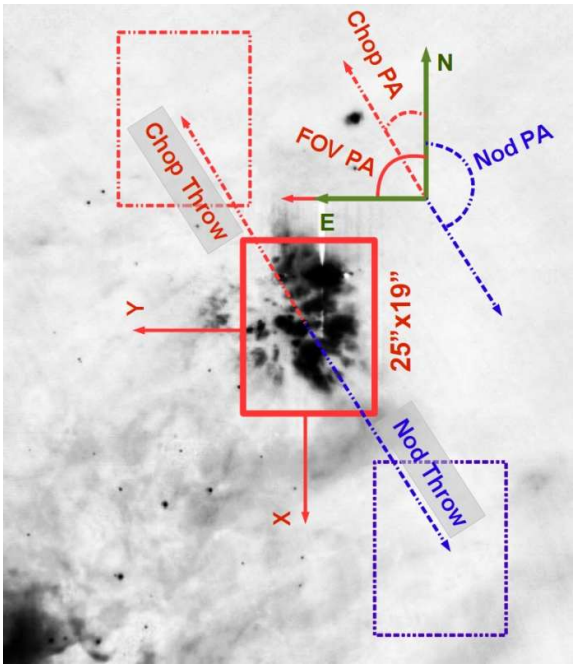


Figure 9: *Graphical representation of the three angles that must be defined as part of the target definition. The field of view (FOV) position angle defines the orientation of the Y axis of the detector with respect to the celestial North, being the angles positive from North to East. The Chop and Nod angle differ by 180 degrees between each other and are also defined with respect to the North.*

2.2.1. Target definition

Once the observing mode has been selected in the Phase-2 summary page (see **¡Error! No se encuentra el origen de la referencia.**), the following acquisition information (Figure 10), common to all CanariCam observing modes must be provided.

Target Name: This is a string defining the target name. It does not have to be unique but for archiving purposes it is better if it is. Special characters and spaces are not allowed.

Observing Priority: This is a number between 1 and 9 defining the Observing Block priority, being 1 the maximum priority. The night astronomer will attempt to execute first the OBs with higher priority.

Coordinates (J2000): Target coordinates in the format HH:MM:SS.SS (-)DD:MM:SS.S. Note that positive declination must be written without the + sign. It is required that you enter the coordinates with the exact number of decimals (i.e. 2 for the right ascension and 1 for the declination).

Proper Motion: Target proper motion values in milli-arcseconds per year. This field can be left empty. (see Appendix A.8 for details in the proper motion definition).

Non Sidereal Target: This flag shall be used for Solar System targets. If selected, later you will be asked to enter an Ephemeris file.

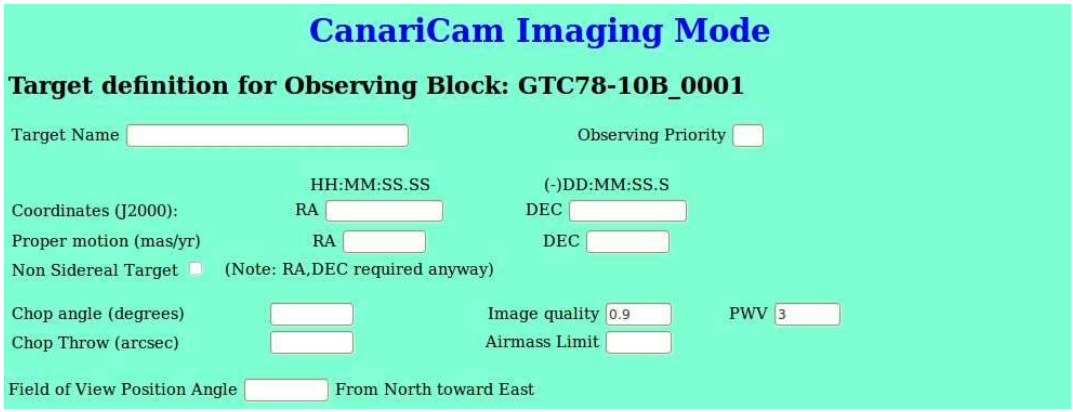


Figure 10: *Parameters for target definition in the case of CanariCam imaging mode.*

Chop Angle (degrees): Chop position angle in degrees with respect to the North. The telescope secondary mirror (M2) will chop along this direction on the sky. Angles are assumed positive from North to East. This value is defined between -180 and 180 degrees.

Chop Throw (arcsec): Distance between the two chop beams in arcseconds. The chop throw cannot be larger than 60 arcsec. This field cannot be left empty.

Nod Angle (degrees): Angle of nodding from North to nod position. The telescope axes will nod along this direction on the sky. To optimize the radiative offset correction, the nod and chop angles must have opposite orientations. Only nodding parallel to chopping is supported. Angles are assumed positive from North to East. This value is defined between -180 and 180 degrees. This field cannot be left empty.

Nod Throw (arcsec): Distance between the two nod beams in arcseconds. The nod and chop throws must have the same value. The nod throw cannot be larger than 60 arcsec. This field cannot be left empty.

Field of View Position Angle: This option is available only in imaging mode. The position angle is specified in degrees and indicates the angle of the detector vertical axis with respect to the North. Angles are assumed to be positive from North to East. By default the instrument field of view is assumed to have North up and East to the left. For instance, a value of 90 degrees means that the images will have

West up and North to the left. **In spectroscopy and spectropolarimetry this field is named Slit Position Angle** (see below).

Image Quality (arcsec): Only in the case of CanariCam observations one can relax the image quality restrictions from the Phase-1, for each OB. It is not possible to select image quality requirements more stringent than those from the Phase-1. If no value is input in this field, the Phase-1 requirement will be adopted.

PWV (mm): Only in the case of CanariCam observations one can relax the Precipitable Water Vapor (PWV) restrictions from the Phase-1, for each OB. It is not possible to select PWV requirements more stringent than those from the Phase-1. If no value is input in this field, the Phase-1 requirement will be adopted. Note that due to GTC policy, in the case of observations in the 10-micron window, observations will be performed up to 15mm of PWV no mater what the value is included in this field of the Phase-2 form. Please consult the GTC web site for more information.

Airmass Limit: This field is required only for CanariCam observing modes. If there is any airmass above which the observations would not be useful for science it must be stated here. If no value is input in this field, no airmass limitation will be assumed. Since this value is not defined in the Phase-1 it is taken as a guideline only, but not as a solid limitation to an observation. Observers will do their best to perform the observations within the requested airmass limit.

Slit Width: This option is only available in spectroscopy mode. A drop-down menu allows the selection of the slit width (in arcseconds) to be used for the observation. Only one slit per OB can be selected.

Slit Position Angle: This option is only available in spectroscopy and spectropolarimetry mode. Slit position angle in degrees with respect to the North. Angles are considered positive from North to East. Due to the symmetry of the slit orientation on the sky the Slit Position Angle must be defined in the interval between -90 and 90 degrees. If the observation must be performed with the slit along the parallactic angle, "999" should be introduced in this field.

Mask Position Angle: This option is available only in polarimetry mode. Mask position angle in degrees with respect to the North. Angles are considered positive from North to East. The mask is formed by horizontal stripes along the detector. The reference direction on the mask to measure the mask position angle is the perpendicular to the slots, i.e. the detector vertical axis.

2.2.2. Step-by-step definition of chop-nod configuration

The steps to the chop-nod and instrumental configuration are:

In imaging mode (see Figure 11**):**

1. Define Field of View position angle based on your object morphology.
2. Define Chop Angle. The chop angle can be defined in any direction that may be needed depending on the morphology of the source that is going to be observed.
3. Calculate Nod Angle = Chop Angle +/– 180, where the (+) sign must be used if Chop Angle is negative and the (-) sign must be used if Chop Angle is positive.
4. Choose Chop Throw based on the object morphology and observing requirements.

5. Nod Throw = Chop Throw.

In spectroscopy mode (see Figure 12**):**

Define Slit Position angle based on your object morphology.
Define Chop Angle. The chop angle can be along the slit if you want to use the negative images of the spectrum. However one can define the Chop Angle in any other direction non-related with the slit angle that may be needed depending on the morphology of the target.
Calculate Nod Angle = Chop Angle +/– 180, where the (+) sign must be used if Chop Angle is negative and the (-) sign must be used if Chop Angle is positive.
Choose Chop Throw based on the object morphology and observing requirements.
Nod Throw = Chop Throw.

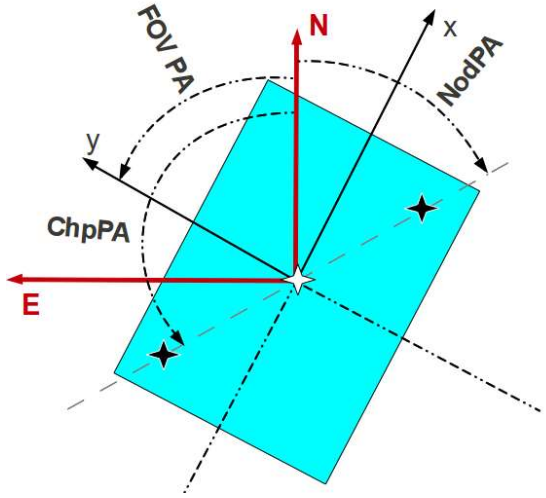


Figure 11: *Relative orientation between FOV, chop and nod PA's in imaging mode. The sketch corresponds to chopping and nodding on chip. The white star represents the positive image of the source and black stars the negative images.*

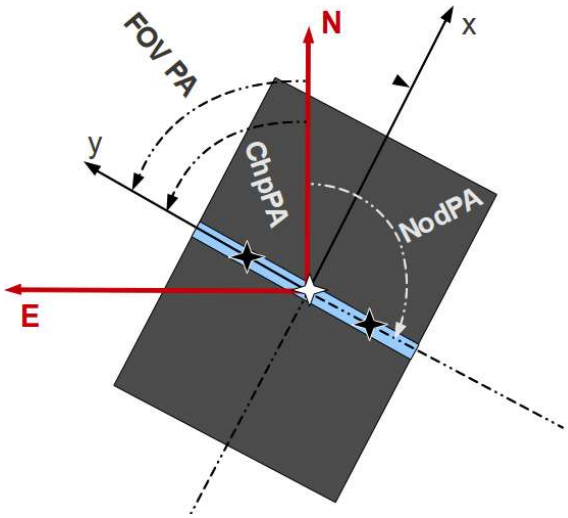


Figure 12: *Relative orientation between FOV, slit (in blue), chop, and nod PA's in spectroscopy mode. The sketch corresponds to chopping and nodding along the slit and on chip. The white star represents the positive image of the source and the black stars the negative images.*

In polarimetry mode (See Figure *13***)**

1. Define mask position angle based on your object morphology.

2. Define Chop Angle. The chop angle can be along the mask slot if you want to use the negative images of the spectrum. However one can define the Chop Angle in any other direction non-related with the mask angle that may be needed depending on the morphology of the source that is going to be observed.

3. Calculate Nod Angle = Chop Angle +/– 180, where the (+) sign must be used if Chop Angle is negative and the (-) sign must be used if Chop Angle is positive.

4. Choose Chop Throw based on the object morphology and observing requirements.

5. Nod Throw = Chop Throw.

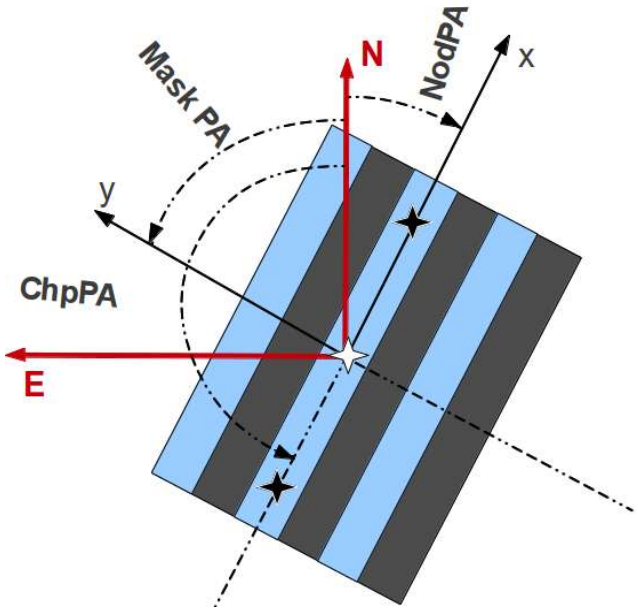


Figure 13: *Relative orientation between FOV (Mask), chop and nod PA's in polarimetry mode. The sketch corresponds to chopping and nodding on chip. The white star represents the positive image of the source and black stars the negative images.*

In spectropolarimetry mode (See Figure *14***)**

1. Define slit position angle based on your object morphology. Not that in this case the polarimetric mask slots are perpendicular to the slit orientation, i.e. the spectra will appear along the polarimetric mask slots.

2. Define Chop Angle. The chop angle can be along the slit if you want to use the negative images of the spectrum. However one can define the Chop Angle in any other direction non-related with the slit angle that may be needed depending on the morphology of the target.

3. Calculate Nod Angle = Chop Angle +/– 180, where the (+) sign must be used if Chop Angle is negative and the (-) sign must be used if Chop Angle is positive.

4. Choose Chop Throw based on the object morphology and observing requirements.

5. Nod Throw = Chop Throw.

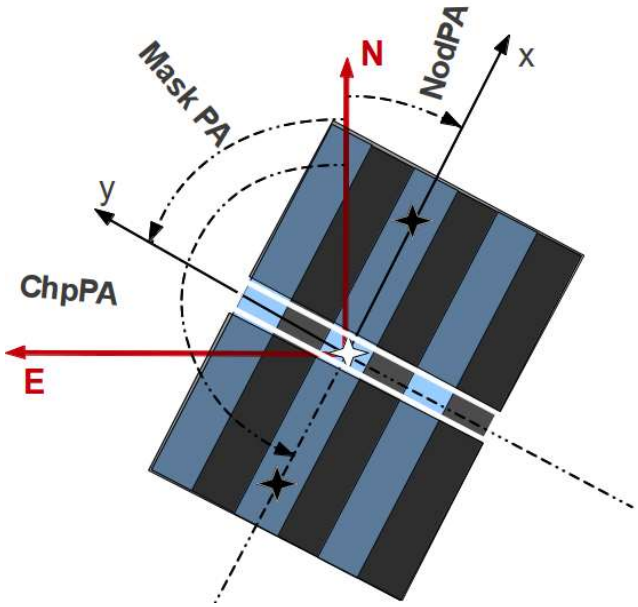


Figure 14: *Relative orientation between FOV (Mask), the slit and chop and nod PA's in spectropolarimetry mode. The sketch corresponds to chopping and nodding on chip. The white star represents the positive image of the source and black stars the negative images. In the case represented in the figure the negative spectra will be lost. To make sure that the negative spectra can also be used, the chopping/nodding should be along the slit, i.e. perpendicular to the polarimetric mask slots.*

In general, for all observing modes, in the case of extended sources, it is recommendable that the chop and nod throw are at least 1.5 times the diameter of the source in the mid-IR, to avoid overlapping of the negative and positive images.

As an example of imaging mode, let's assume that we want to observe an extended source that has a size of 10" by 5" with its largest dimension along a position angle of -30 degrees (see Figure 15). We define the FOV PA=-30 deg. to do the chopping and nodding along the shortest dimension of the extended source, so that the optical aberrations due to M2 tilt while chopping are minimized. Since we are interested in doing on-chip imaging to use the negative images of the source, the chop and nod throws must be defined along the largest dimension of the detector. Therefore, we set the Chop PA=60 deg and the Nod PA= 60 – 180 = -120 degree, as illustrated in Figure 15). Finally, we select a Chop and Nod throw of 9" so that the negative image of the source is sufficiently far away from the positive image, but both are still within the detector FOV.

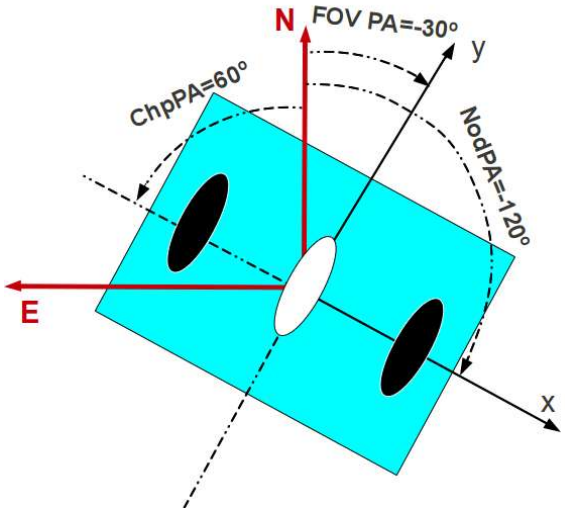


Figure 15: *Example of angles definition in imaging mode of an extended (elliptical) source of 5"x10".*

2.2.3. CanariCam Imaging

Besides the information described in Section 2.2.1, in the case of CanariCam imaging, an optional acquisition image for blind offset can be defined (Figure 16). This can be useful when the science target is very weak so that the telescope is initially pointed and centered on a nearby bright reference source.

The fields to fill in for the acquisition image are the following:

Filter: Filter to be used for the acquisition image. This filter does not necessarily have to be the same as the filter(s) for the science observations.

On-Source time: Time on-source in seconds for the acquisition image. Note that there is an overhead factor of 3.1 between the on-source time and the total time, due to chopping and nodding duty cycles. Also note that the on-source time should be at least 60 seconds, which is the effective minimum time to configure chopping and nodding sequences.

Blind offset: The offset in RA and DEC, in arcseconds, to be applied in order to center the faint science target. To enter the offset with the correct sign, please remember that the telescope will move from the bright reference target to the faint scientific target. It is important to bear in mind, that **when the acquisition image for blind offset is selected, the coordinates in the target definition section shall be the ones of the bright reference source**, not the ones of the science target.

Skip: Activate this box if no acquisition image for blind offset is required. If so, any value defined for the previous parameters will be neglected.

Figure 16: *Form to define an acquisition image for blind offset in imaging mode. To enter the offset with the correct sign, please remember the telescope will move from the bright reference target to the faint scientific target. The flag "Skip" allows to activate or deactivate this option.*

Once telescope and instrument have been configured for acquisition, it is necessary to define the details of the actual observation. This is done by filling in one or more observing templates (Figure 17). At least one observing template must be filled in for the OB to be valid. CanariCam imaging observing templates have the following fields:

Filter: The filter required for the observation is selectable using a drop-down menu. The menu shows all filters available in the current semester.

On-source time: Single image on-source time in seconds for the image. This time does not include the chop and nod duty cycle overhead, which is a factor of 3.1 (for a detailed description of the overheads see the Appendix).

N repeats: Number of images to be taken in the template.

Offsets RA and DEC: The offsets between images in Right Ascension and Declination, expressed in arcseconds. Offset are given as a space-separated array. Within a template, each offset will be added to the previous one. Thus for instance the following sequence of three offsets 0 10 -10 will result in the first and third image to be taken at same position on the sky. If the requested number of images (N repeats) is greater than the number of offsets (or if no offsets at all are given) the telescope will reuse the last position as many times as needed. At the end of each template the telescope is sent back to the starting position.

Some examples of template definition are given in Figure 18, Figure 19 and Figure 20.

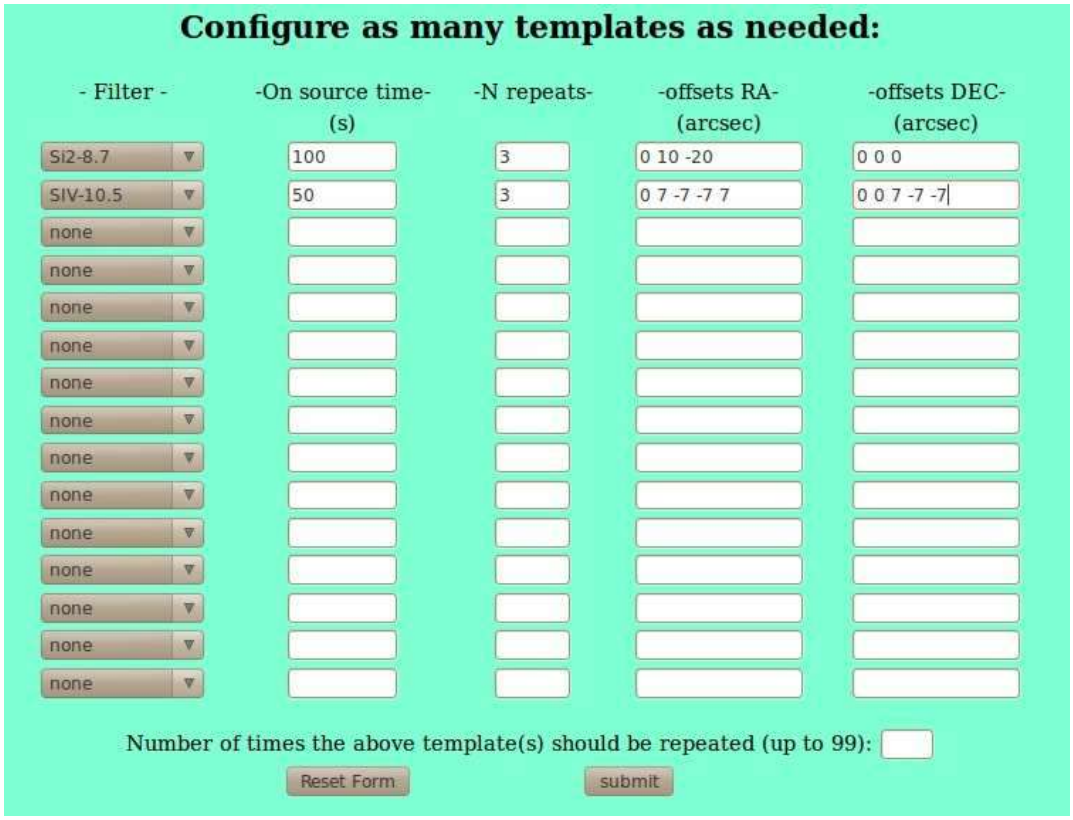


Figure 17: *Observation templates definition page for CanariCam imaging.*

At the bottom of the form there is one final parameter to be defined:

Number of times the templates should be repeated: This refers to the number of repetitions of all the templates within the OB. It is important to understand that this parameter is not meant to repeat the full OB, rather it is meant to allow the repetition of sequences of templates, for instance taking series of images alternating two filters.

Pressing the "Reset form" button at any time will clear all values from the form, including the fields for the target definition and the acquisition image for blind offset.

Submit: Once you are happy with the values that you have filled, the submit button takes you to the next page in the Phase-2 completion process. The next steps consist of uploading an optional finding chart (Section 2.7), uploading an ephemeris file in the case of non-sidereal targets (Section 2.8) and filling in a readme file with further information (Section 3.3).

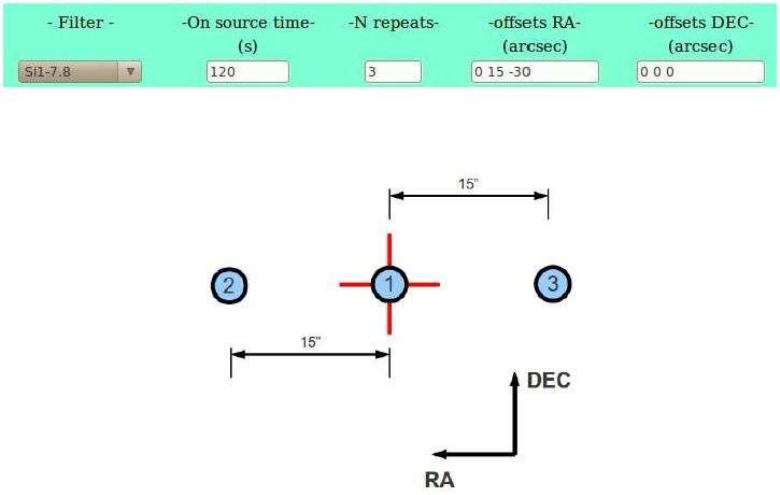


Figure 18: *Correct configuration of a science template to take a series of three images in the Si-7.8 filter, with 2 minutes on-source time each, using a 3-step dither pattern along the RA axis, with an amplitude of 15 arcsec between positions. The sketch below shows the corresponding positions (blue points) where the images will be taken. The red cross represents the telescope pointing that in this case being 0,0 the first offset coincide with the position of the first exposure.*

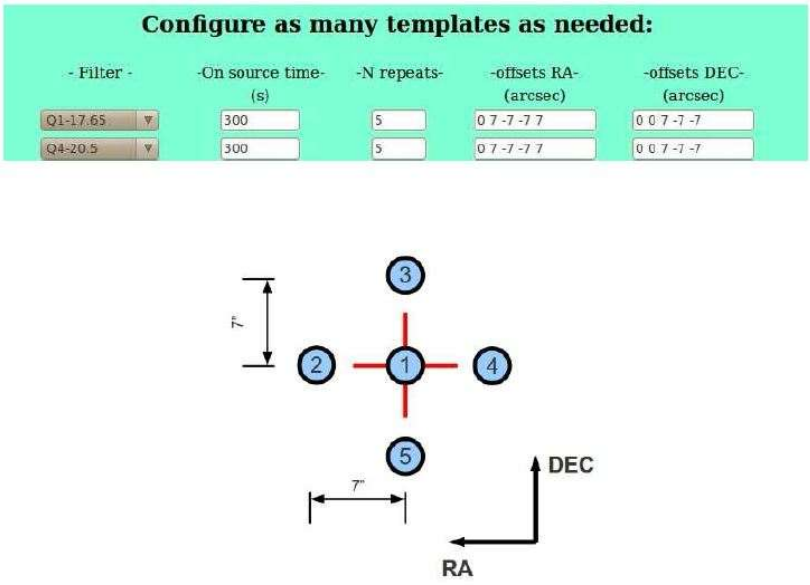


Figure 19: *Example of configuration of two templates. The first is meant to take five images in the Q1-17.65 filter, each one with 5 minutes on-source time, using 5-step dither pattern in RA and DEC, with an amplitude of 7 arcsec between positions. The second template is meant to take another five images, with the same on-source time and dither pattern as in the previous template, using the filter Q4-20.5. Note that after the first template is completed the telescope is sent back to the preset position, thus the very same offset sequence is given in the two templates. Symbols are as in* Figure *18.*

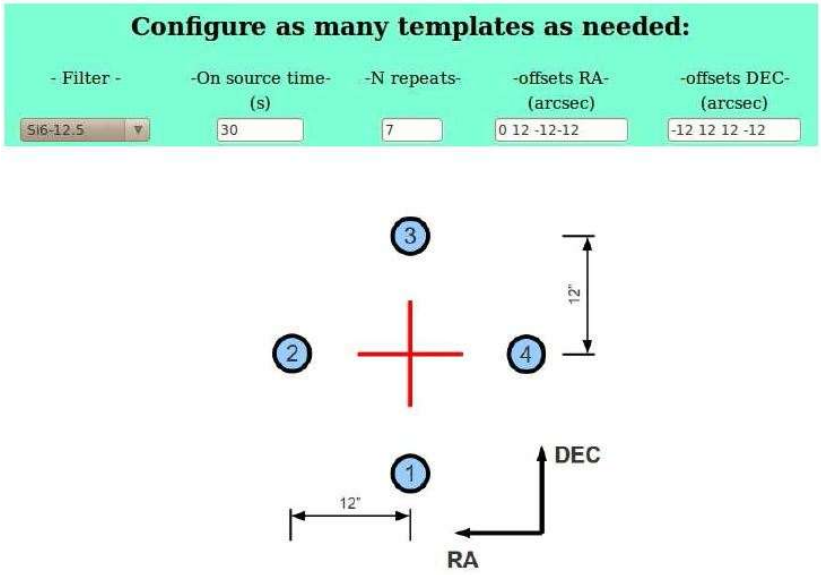


Figure 20: *Example of correct configuration of a science template to take seven images in the Si6-12.5 filter, with 30 seconds on source time each, using a 4-step dither pattern, with an amplitude of 12 arcsec between positions. As only four offsets are given, images 4, 5, 6, and 7 are taken at the same position.*

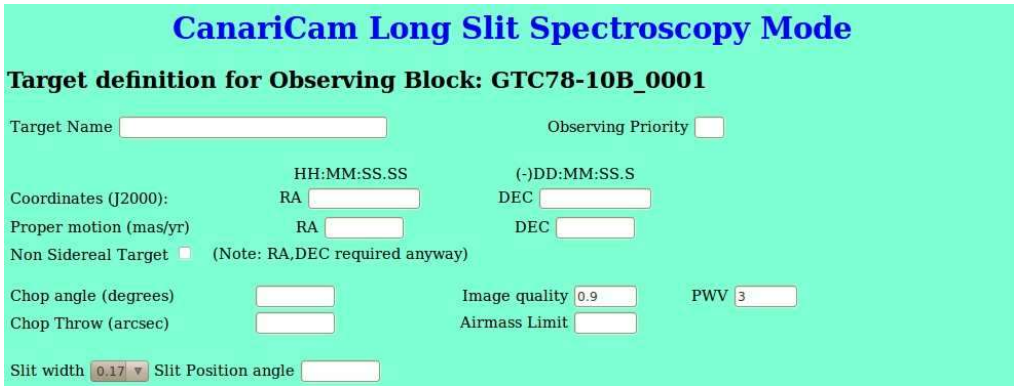


Figure 21: *Parameters for target definition in the case of CanariCam spectroscopy mode. Note the presence of the fields to select the slit width and angle.*

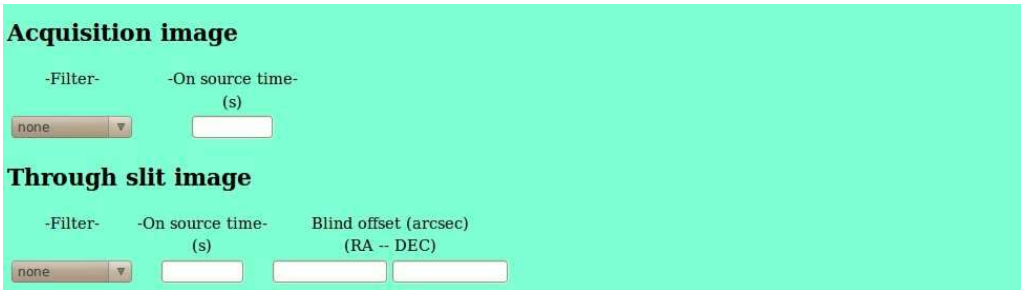


Figure 22: *Acquisition and through-slit image for CanariCam spectroscopy.*

2.2.4. CanariCam Spectroscopy

The form for preparing CanariCam spectroscopic mode OBs is very similar to the one for imaging mode. In the upper part you enter the general information described in Section 2.2.1, additionally you select the slit width and the position angle, in degrees from North toward East, (Figure 21). These values will apply to the whole OB.

In the mid-section you define the acquisition image and the through slit image (Figure 22). Both are mandatory and cannot be skipped. The following fields shall be filled in.

The fields to fill in for the acquisition image are the following:

Filter: Filter used for the acquisition image.

On-source time: On-source time in seconds for the acquisition image. Note that the on-source time should be at least 60 seconds, which is the effective minimum time to configure chopping and nodding sequences.

And similarly for the through-slit image:

Filter: Filter used for the through-slit image, which can be different from the one used for acquisition.

On-source time: On-source time in seconds for the through-slit image.

Blind offset: Optionally after the through slit image you can specify a blind offset in arcsec. To enter the blind offset with the correct sign keep in mind that the telescope will move from the bright reference target, to the faint scientific target. It is important to bear in mind, that **when the acquisition image for blind offset is selected, the coordinates in the target definition section shall be the ones of the bright reference source**, not the ones of the science target.

Once telescope and instrument have been configured for acquisition, it is necessary to fill in the details of the actual observation. This is done by defining observing templates (**¡Error! No se encuentra el origen de la referencia.**). It is necessary to define at least one observing template for the OB to be valid. CanariCam spectroscopy observing templates have the following fields:

Grating: Grating to be used for the observation. At present there is only one choice, LowRes-10.

On-source time: Single spectrum on-source time in seconds. This time does not include the chop and nod duty cycle overhead, which for spectroscopy is a factor of 3.7 (for a detailed description of the

overheads see the Appendix.) We stress that the exposure time to be given here is the on-source time. All the additional overheads will be automatically computed by the phase-2 tool (and shown in the summary page). See the Appendix for a complete list of the overheads associated to CanariCam observations.

N repeats: number of times the exposure should be repeated.

Offsets: The offsets between spectra along the slit, expressed in arcseconds. Note that these offsets refer to the creation of a dithering pattern, not to the nodding. Offset values are given as a space-separated array. Within a template, each offset will be added to the previous one. If the requested number of spectra (N repeats) is greater than the number of offsets (or if no offsets at all are given) the telescope will remain in the last position as many times as needed. At the end of each template, the telescope is sent back to the starting position.

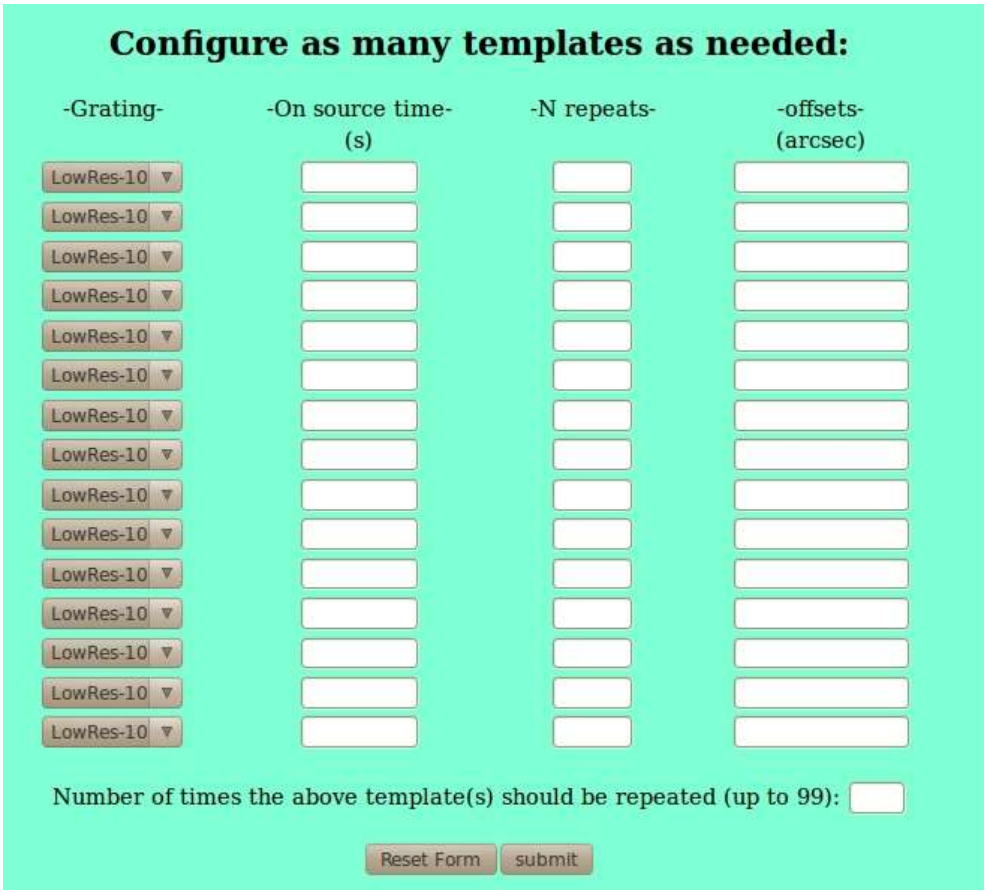


Figure 23: *Observation templates definition page for CanariCam spectroscopy.*

At the bottom of the form there is one final parameter to be defined:

Number of times the templates should be repeated: This refers to the number of repetitions of all the templates within the OB. It is important to understand that this parameter is not meant to repeat the full OB, rather it is meant to allow the repetition of sequences of templates, for instance taking series of images alternating two filters.

Submit: Once you are happy with the values that you have filled, the submit button takes you to the next page in the Phase-2 completion process. The next steps consist of uploading an optional finding chart (Section 2.7), uploading an ephemeris file in the case of non-sidereal targets (Section 2.8) and filling in a readme file with further information (Section 3.3).

2.2.5. CanariCam Polarimetry

In the upper part of the form to prepare a polarimetry OB, you enter the general information described in Section 2.2.1, additionally you select the mask position angle, in degrees from North toward East, (Figure 24). These values will apply to the whole OB.

In the mid-section you define the acquisition image and the mask image (Figure 25). **Both are mandatory and cannot be skipped**. The following fields shall be filled in.

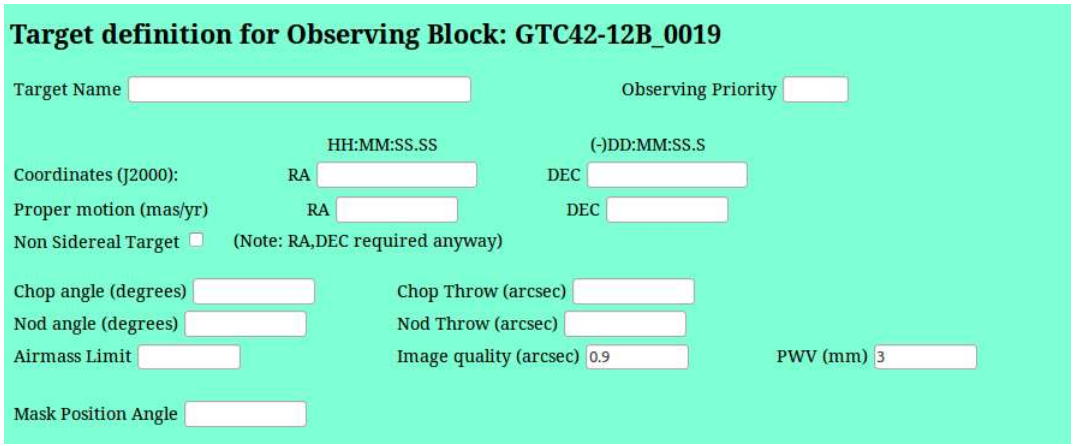


Figure 24: *Parameters for target definition in the case of CanariCam polarimetry mode. Note the presence of the field to select the mask position angle on the sky.*

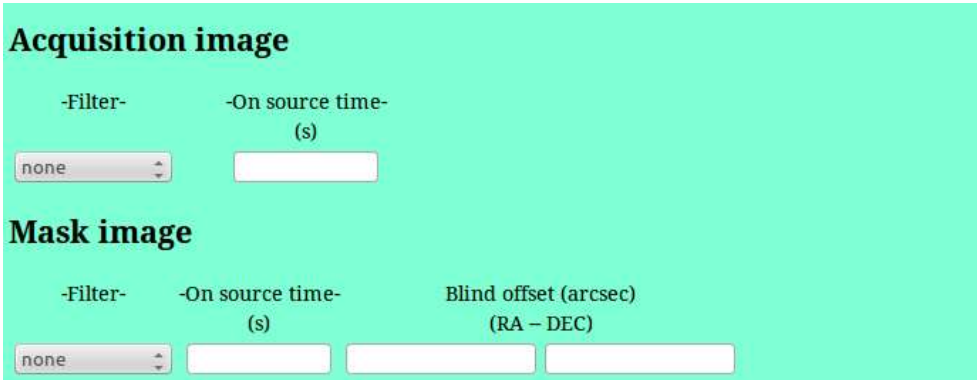


Figure 25: *Parameters to define the acquisition and the mask images for CanariCam polarimetry mode.*

The fields to fill in for the acquisition image are the following:

Filter: Filter used for the acquisition image.

On-source time: On-source time in seconds for the acquisition image. Note that there is an overhead factor of 3.1 between the on-source time and the total time, due to chopping and nodding duty cycles. Also note that the on-source time should be at least 60 seconds, which is the effective minimum time to configure chopping and nodding sequences.

And similarly for the mask image:

Filter: Filter used for the mask image, which can be different from the one used for acquisition.

On-source time: On-source time in seconds for the mask image.

Unless otherwise stated in the README file, the object will be centered at the center of the middle open slot in the polarimetric mask.

Blind offset: Optionally after the mask image you can specify a blind offset in arcsec. To enter the blind offset with the correct sign keep in mind that the telescope will move from the bright reference target, to the faint scientific target. It is important to bear in mind, that **when the acquisition image for blind offset is selected, the coordinates in the target definition section shall be the ones of the bright reference source**, not the ones of the science target.

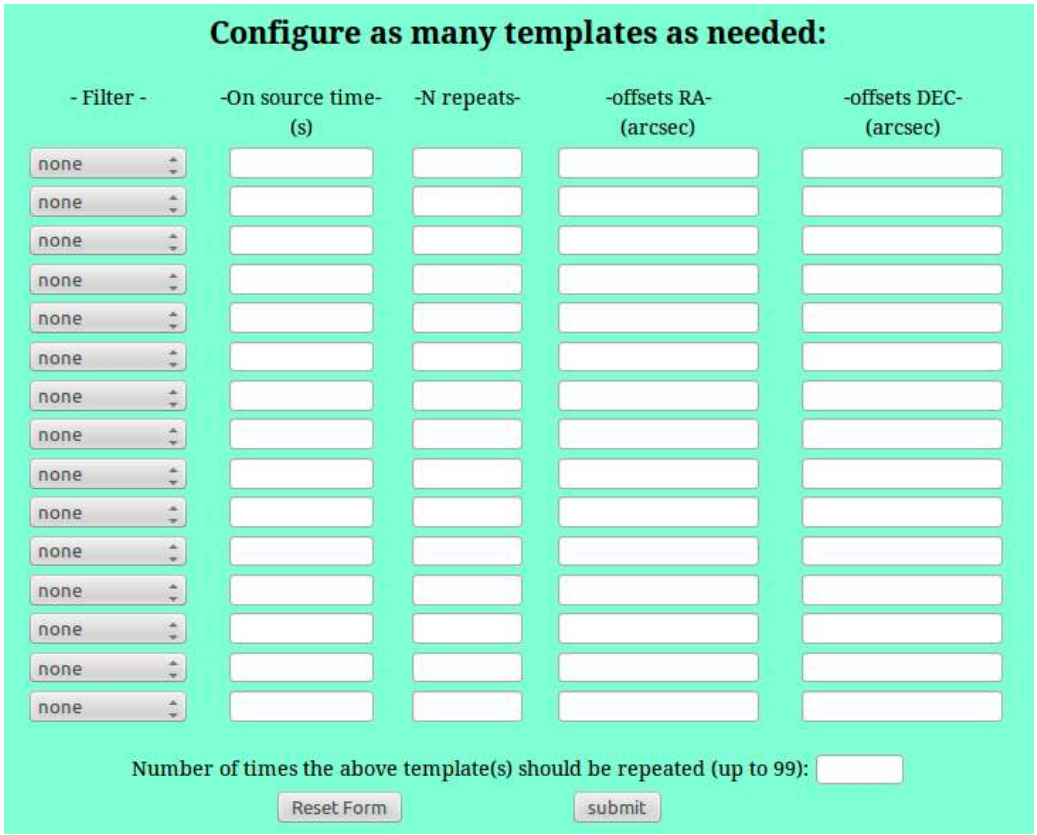


Figure 26: *Observation templates definition page for CanariCam polarimetry.*

Once telescope and instrument have been configured for acquisition, it is necessary to fill in the details of the actual observation. This is done by defining observing templates (Figure 26). It is necessary to define at least one observing template for the OB to be valid. CanariCam polarimetry observing templates have the following fields:

Filter: The filter required for the observation is selectable using a drop-down menu. The menu shows all filters available in the current semester.

On-source time: Single image on-source time in seconds. This time does not include the chop and nod duty cycle overhead, which for polarimetry is a factor of 3.1. We stress that the exposure time to be given here is the on-source time. All the additional overheads will be automatically computed by the phase-2 tool (and shown in the summary page). See the Appendix for a complete list of the overheads associated to CanariCam observations. It should also be noted that such on-source time includes all half-wave-plate angles; 0º, 45º, 22.5º and 67.5º, which is the same on-source time used in the CC ITC and in the polarization accuracy estimates.

N repeats: number of times the exposure should be repeated.

Offsets: The offsets between images in Right Ascension and Declination, expressed in arcseconds. Note that these offsets refer to the creation of a dithering pattern, not to the nodding. Offset values are given as a space-separated array. Within a template, each offset will be added to the previous one. If the requested number of spectra (N repeats) is greater than the number of offsets (or if no offsets at all are given) the telescope will remain in the last position as many times as needed. At the end of each template, the telescope is sent back to the starting position.

At the bottom of the form there is one final parameter to be defined:

Number of times the templates should be repeated: This refers to the number of repetitions of all the templates within the OB. It is important to understand that this parameter is not meant to repeat the full OB, rather it is meant to allow the repetition of sequences of templates, for instance taking series of images alternating two filters.

Submit: Once you are happy with the values that you have filled, the submit button takes you to the next page in the Phase-2 completion process. The next steps consist of uploading an optional finding chart (Section 2.7), uploading an ephemeris file in the case of non-sidereal targets (Section 2.8) and filling in a readme file with further information (Section 3.3).

2.2.6. CanariCam Spectropolarimetry

In the upper part of the form to prepare a spectropolarimetry OB, you enter the general information described in Section 2.2.1, additionally you select the mask position angle, in degrees from North to East (Figure 27). These values will apply to the whole OB.

In the mid-section you define the acquisition image and the mask image (Figure 28). **Both are mandatory and cannot be skipped**. The following fields shall be filled in.

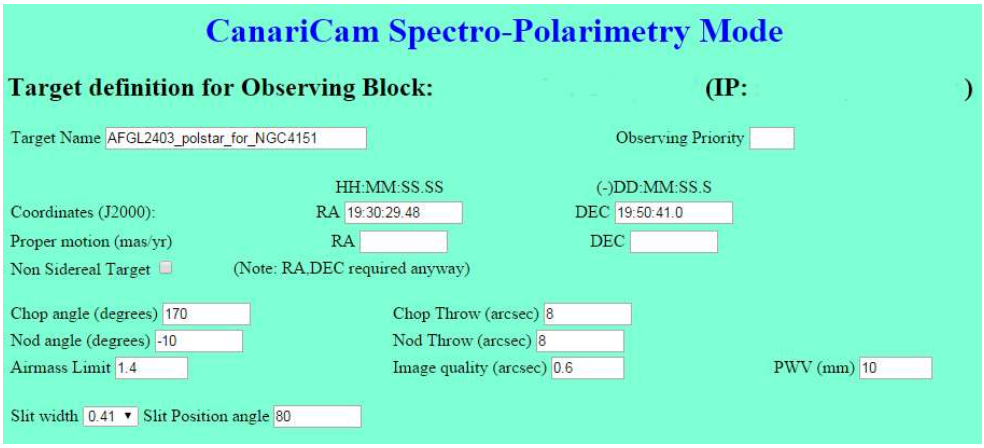


Figure 27: *Parameters for target definition in the case of CanariCam spectropolarimetry mode. Note the presence of the field to select the slit position angle on the sky. The polarimetric mask is perpendicular to the slit.*

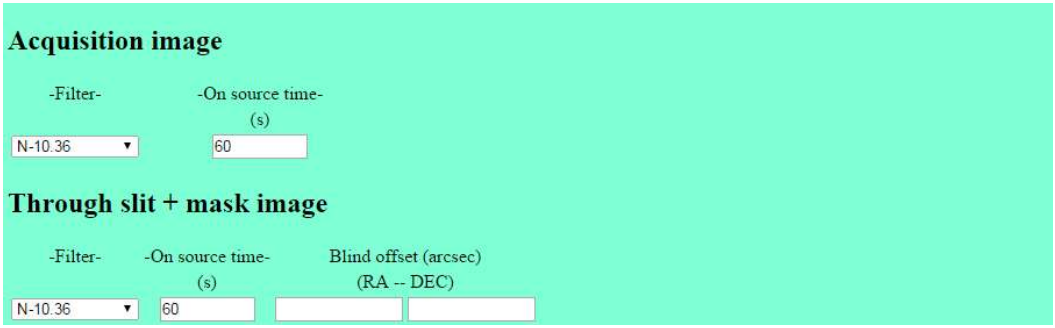


Figure 28: *Parameters to define the acquisition and the mask images for CanariCam spectropolarimetry mode.*

The fields to fill in for the acquisition image are the following:

Filter: Filter used for the acquisition image.

On-source time: On-source time in seconds for the acquisition image. Note that there is an overhead factor of 3.1 between the on-source time and the total time, due to chopping and nodding duty cycles. Also note that the on-source time should be at least 60 seconds, which is the effective minimum time to configure chopping and nodding sequences.

And similarly for the slit+mask image:

Filter: Filter used for the slit+mask image, which can be different from the one used for acquisition.

On-source time: On-source time in seconds for the slit+mask image.

Unless otherwise stated in the README file, the object will be centered at the intersection between the slit and the middle open slot in the polarimetric mask.

Blind offset: Optionally, after the slit+mask image you can specify a blind offset in arcsec. To enter the blind offset with the correct sign keep in mind that the telescope will move from the bright reference target, to the faint scientific target. It is important to bear in mind, that **when the acquisition image for**

blind offset is selected, the coordinates in the target definition section shall be the ones of the bright reference source, not the ones of the science target.

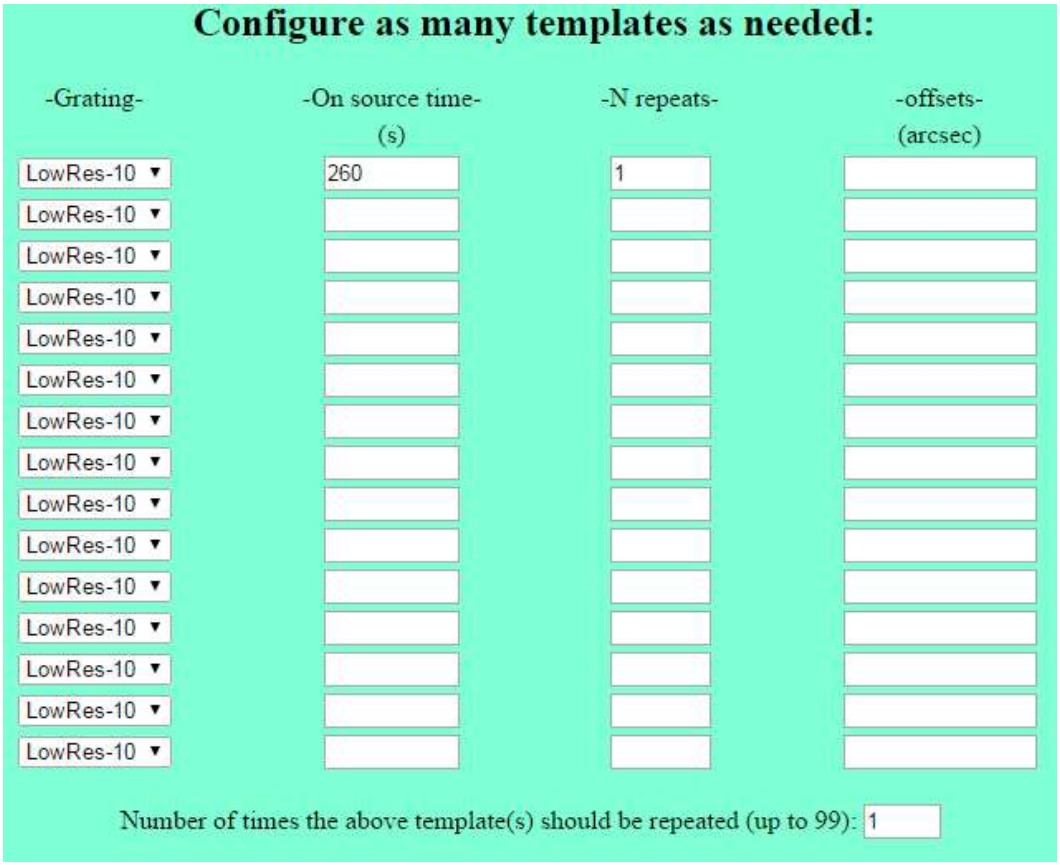


Figure 29: *Observation templates definition page for CanariCam spectropolarimetry.*

Once telescope and instrument have been configured for acquisition, it is necessary to fill in the details of the actual observation. This is done by defining observing templates (Figure 29). It is necessary to define at least one observing template for the OB to be valid. CanariCam spectropolarimetry observing templates have the following fields:

Grating: Grating to be used for the observation. At present there is only one choice, LowRes-10.

On-source time: Single spectrum on-source time in seconds. This time does not include the chop and nod duty cycle overhead, which for spectropolarimetry is a factor of 3.7 (for a detailed description of the overheads see the Appendix.) We stress that the exposure time to be given here is the on-source time. All the additional overheads will be automatically computed by the phase-2 tool (and shown in the summary page). See the Appendix for a complete list of the overheads associated to CanariCam observations.

N repeats: number of times the exposure should be repeated.

Offsets: The offsets between spectra along the slit, expressed in arcseconds. Note that these offsets refer to the creation of a dithering pattern, not to the nodding. Offset values are given as a space-separated array. Within a template, each offset will be added to the previous one. If the requested number of spectra (N repeats) is greater than the number of offsets (or if no offsets at all are given) the telescope

will remain in the last position as many times as needed. At the end of each template, the telescope is sent back to the starting position.

At the bottom of the form there is one final parameter to be defined:

Number of times the templates should be repeated: This refers to the number of repetitions of all the templates within the OB. It is important to understand that this parameter is not meant to repeat the full OB, rather it is meant to allow the repetition of sequences of templates, for instance taking series of images alternating two filters.

Submit: Once you are happy with the values that you have filled, the submit button takes you to the next page in the Phase-2 completion process. The next steps consist of uploading an optional finding chart (Section 2.7), uploading an ephemeris file in the case of non-sidereal targets (Section 2.8) and filling in a readme file with further information (Section 3.3).

2.3. Creating an observing block for CIRCE

CIRCE is a near-IR imager for the GTC provided by the University of Florida, operating in the classical J, H, and Ks bands. Both direct broad band imaging and polarimetry are offered. OB definition is straightforward in both cases.

2.3.1. Target definition

Once the observing mode has been selected in the Phase-2 summary page (see Figure 2), the following acquisition information, common to both imaging and polarimetry modes must be provided (see Figure 30).

Target Name: This is a string defining the target name. It does not have to be unique but for archiving purposes it is better if it is. Special characters and spaces are not allowed.

Observing Priority: This is a number between 1 and 9 defining the Observing Block priority, being 1 the maximum priority. The night astronomer will attempt to execute first the OBs with higher priority.

Coordinates (J2000): Target coordinates in the format HH:MM:SS.SS (-)DD:MM:SS.S. Note that positive declination must be written without the + sign. It is required that you enter the coordinates with the exact number of decimals (i.e. 2 for the right ascension and 1 for the declination).

Proper Motion: Target proper motion values in milli-arcseconds per year. This field can be left empty. (see Appendix A.8 for details in the proper motion definition).

Non Sidereal Target: This flag shall be used for Solar System targets. If selected, later you will be asked to enter an Ephemeris file.

Field of View Position Angle: The field of view position angle in degrees. This indicates the angle of the detector vertical axis with respect to the North. Angles are assumed to be positive from North to East. By default the instrument field of view is assumed to have North up and East to the left. For instance, a value of 90 degrees means that the images will have West up and North to the left.

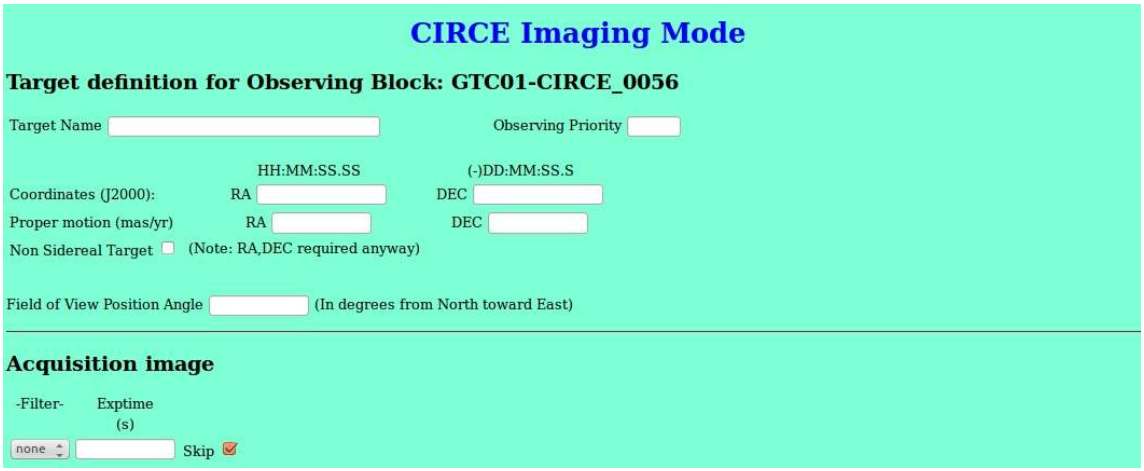


Figure 30*: CIRCE target definition form.*

2.3.2. CIRCE Broad-Band Imaging

Once the target definition data have been filled, you have to decide whether you need accurate positioning of the target in the field of view. If yes, then you must define an **acquisition image**. Remove the "skip" flag set by default, select the desired filter from the pull down list, and enter the exposure time in seconds. Please remember the pointing error of GTC is of few arcsecs. If this pointing precision is insufficient for your purposes, then you must definitely define an acquisition image.

Template: After filling the target definition parameters and acquisition image if necessary, one or more templates defining the scientific exposure(s) must be filled.

Filter and exptime: select the filter and set the exposure time in seconds. This is the exposure time for a single frame.

N exp: in the near-IR, exposure times are usually below one minute. Thus on faint targets requiring long exposures, several images will be necessary. You also want to apply offsets between images in order to eliminate cosmetic defects of the detector. Three parameters give you full control of this. First the "N exp" parameter specify the number of exposures (each of "exptime" seconds) to be obtained at a given sky position. N**ote that "N exp" exposures will be obtained at each offset position. This is different from the behaviour of the same parameter appearing on OSIRIS Phase 2**.

Also note that to reduce overheads, the "N exp" exposures will be stored as separate extentions of a single FITS file. Data will be obtained using the "N ramps" read out mode as described in the circe web pages. This means that "N ramps" will be set equal to "N exp". For best result we suggest to set "N exp" either to 1 or 3. In the first case you will get as many FITS files as the requested number of exposures, in the second case you will get 1 FITS every three images. Larger values of "N exp" would imply stering for a long time to the same position of the sky, which is inconvenient owing to the rapidly varying behavior of the IR background.

Offset Mode: To properly dither you requested sequence of images you either select a predefined pattern (Figure 31) or write a list of offset. We **warmly suggest the use of a predefined pattern** in such a way avoiding to write long lists of numbers that would be confusing and error prone.

The possible options for the "Offset Mode" parameter are:

- **User defined:** This option allow you to enter whatever sequence of offsets you desire. Offsets in RA and DEC are given as a space separated list of values. Offsets are given in arcsec and are **cumulative**, thus for instance to obtain the same 3 positions of Pattern 3 below, enter in the "offset RA" field: 0 9 -3 , and in the "offset DEC" field: 0 3 -9. To obtain the positions of pattern 5, enter: 0 4 6 -14 -6 and 0 10 -14 -6 14.

- **Using a predefined pattern:** the predefined pattern will place the telescope at the positions listed below, where values are expressed in arcsec and the first (0,0) position corresponds to the telescope preset position. As you can see in Fig. 31 offsets are arranged on a square pattern covering by default a -10 to 10 arcsec range. If you prefer larger or smaller offsets, you can modify the size of the square writing in the "offset RA" field a number that will be interpreted as the new size for the square. For instance, if you enter 25 in the field "offset RA", offsets will cover the -25 to 25 arcsec range. The positions for the other patterns are as follow:

- **Pattern 3** = (0,0); (9,3); (6, -6)

- **Pattern 5** = (0,0); (4,10); (10,-4); (-4,-10); (-10,4)

- **Pattern 7** = (0,0); (4,10); (7,3); (10,-4); (-4,-10); (-7,3); (-10,4)

- **Pattern 9** = (0,0); (4,10); (7,3); (10,-4); (3,-7); (-4,-10); (-7,-3); (-10,4); (-3,7)

- **Pattern 11**= (0,0); (4,10); (7,3); (10,-4); (3,-7); (-4,-10); (-7,-3); (-10,4); (-3,7); (-5,2); (5,2)

- **Pattern RND**= this option allow you to ask for a random generated list of offsets. In this case two values must be entered in the field "offset RA". The first is used as before to control the range covered by the offsets, while the second number gives the desired number of offsets. For instance if "offset RA"= 20 9, then 9 random offsets will be generated ranging from -20 to 20 arcsec.

As you might have noticed, for the predefined pattern the first offset is always 0,0, which means the first exposure is taken at the telescope pointing position. However, in the "user defined" offset list you are allowed to specify a non-zero initial offset and, of course, in the random generated pattern the first offset will be in general non zero.

Please note that ***at the end of each template the telescope is moved back to the preset position***, in this way consecutive tamplates using the same offset pattern will repeat the very same positions on the sky.

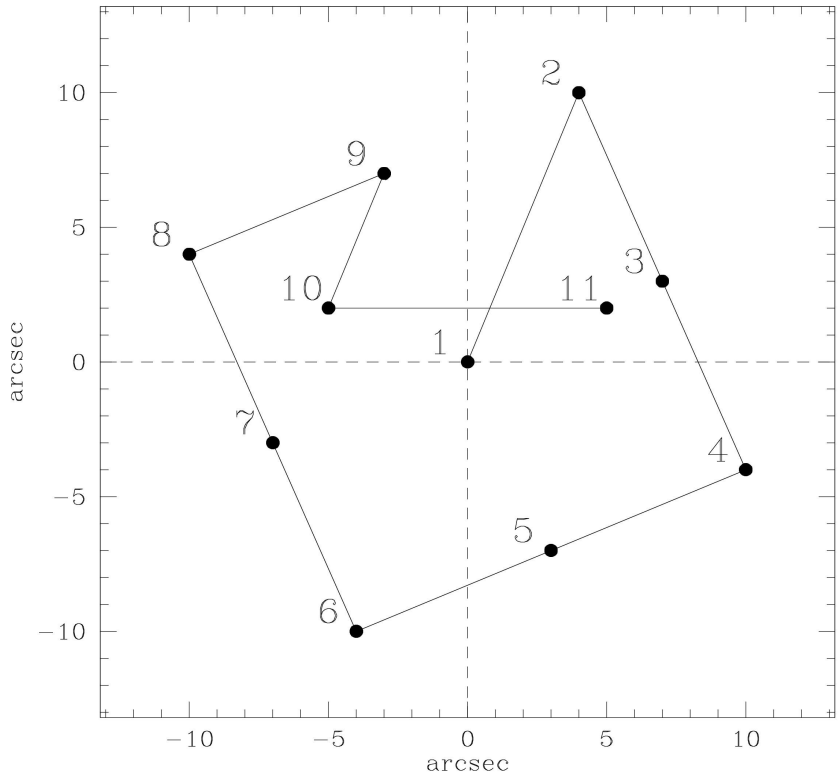


Figure 31: *The positions followed by the predefined patterns, beside pattern 3, are arranged following a tilted centered square. This ensures objects never fall twice on the same line or column. Of the 11 positions showed here, Pattern 5 uses positions 1, 2, 4, 6, 8. Pattern 7 uses positions 1, 2, 3, 4, 6, 7, 8. Pattern 9 uses positions from 1 to 9. Finally Pattern 11 uses all of them.*

N loop: Finally, there is one third parameter to control the sequence of exposures to be obtained. Once the offset pattern is defined, "N loop" defines the number of times this pattern has to be repeated. For instance if you need a total integration time of 30 minutes, and the exptime is set to 1 minute, you can use "N exp"=1, "Pattern 5" and set nloop=6. Of course, a "user defined" 10 position pattern and nloop=3 would also do the trick. Note that setting for instance "N exp"=3, "Pattern 5" and "N loop"=2 would achieve the same result more efficiently because less offsets are required to complete the sequence.

Also note that the sky emission varies rapidly in the infrared, thus for best sky subtraction you must balance the values of "N exp" and "N loop", to avoid remaining too long on the same position of the sky. According to our experience, the best approach is to set "N exp"=3, and then set "N loop" accordingly.

Defines as many templates as needed, selecting for each one the appropriate parameters.

Repeater: Once you have defined all the templates, you can further specify that you want to repeat all the templates a certain number of times. This last parameter is set on the box appearing just below the template list. For instance, if you want to alternate 20 times imaging in the H and J bands to follow the flux evolution of your target, defines only 2 templates and set this parameter to 20, obtaining in this way 20 execution of the H and 20 of the J band templates.

Once you are satisfy with your template(s) definition, submit the form and continue filling the OB providing the finding chart and, if appropriate, the list of ephemerids.

Example 1:

Imagine you want to take 15 seconds images in J band, in a 4 position "User defined" dithering pattern, repeating the pattern 3 times, for a total of 12 images. Then fill the first template as follow:

Filter=J, exptime= 15, Nexp= 1, Offset Mode= "User defined", Offset RA= 0 10 0 -10, Offset Dec= 0 0 10 0, N loop= 3

Note that the above dithering pattern will place the object on the corners of a square 10 arcsec on a side, with the first exposure at the pointing position being the lower left corner.

Example 2:

To take the same images as in the previous example, but with the pointing position at the center of the dithering square, fill the OB like this:

Filter=J, exptime= 15, N exp= 1, Offset Mode= "User defined", Offset RA= 5 -10 0 10, Offset Dec= 5 0 -10 0, N loop= 3

Note this time in the first image the target will be placed in the upper right corner of the square.

Example 3:

Take a series of 45 images of 30 s each in H-band, taking 3 images in each offset position, using "Pattern 3" for dithering, scaled to be twice as big as the default values, repeated 5 times:

Filter=H, exptime=30, N exp=3 , Offset Mode= "Pattern 3", Offset RA=20 Offset dec="" , N loop=5

Note as the "Offset RA" is set to 20 to scale the pattern to range from -20 to 20 arcsec, while the "Offset DEC" is left empty (any value in it will be neglected). N loop is set to 5 thus we will get 3*3*5 = 45 exposures.

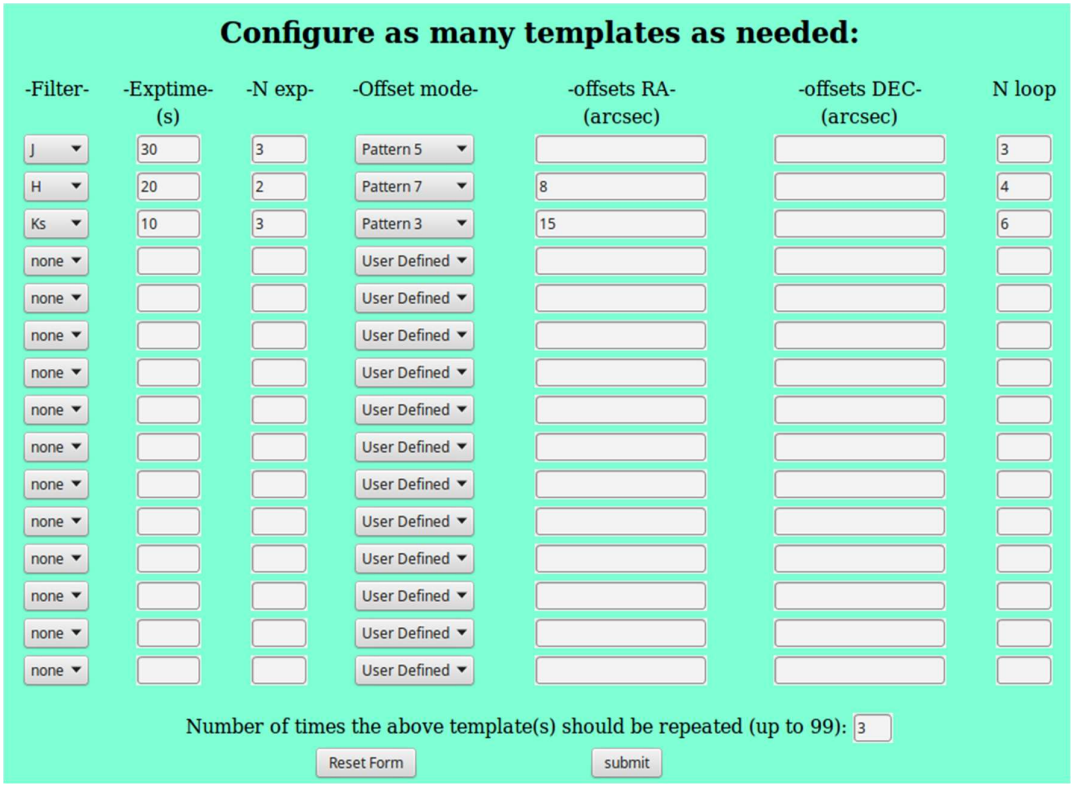


Figure 32: *The CIRCE science template form. In this particular case 3 templates have been filled. The first template asking 3x5x3=45 images in J band each of 30s on source, the second 2x7x4=56 images in H band each of 20s, and the third 3x3x6=54 images in Ks band each of 10 s. Note also the use of predefined patterns for dithering. In the first template the offset pattern is not scaled, while in the second one it is limited to the -8 to 8 arcsec range, and in the third one it is enlarged to cover a -15 to 15 arcsec range. Finally, the repeater parameter, at the bottom, is set to 3, meaning all the above will be repeated three times, resulting in a grand total of 465 images. Due to the meaning of "N exp", these images will correspond to 183 FITS files.*

2.3.3. CIRCE Polarimetry mode

Once the target definition data have been filled, you define the parameters for the **acquisition image:** select the desired filter from the pull down list, and enter the exposure time in seconds. In polarimetry mode the acquisition image is mandatory due to the small field of view (12x12 arcsec).

Template: After filling the target definition parameters and acquisition image, one or more templates defining the scientific exposure(s) must be filled.

Filter and exptime: select the filter and set the exposure time in seconds. Note CIRCE optical design is such that the four images needed to compute the Stokes parameter are obtained at once. Thus, the exposure time entered here is the total integration time on source **for a single exposure**.

N exp: in the near-IR, exposure times are usually below one minute. Thus on faint targets requiring long exposures, several images will be necessary. You also want to apply offsets between images in order to eliminate cosmetic defects of the detector. Three parameters give you full control of this. First the "N exp" parameter specify the number of exposures (each of "exptime" seconds) to be obtained at a given sky position. N**ote that "N exp" exposures will be obtained at each offset position. This is different from the behaviour of the same parameter appearing on OSIRIS Phase 2**.

Also note that to reduce overheads, the "N exp" exposures will be stored as separate extensions of a single FITS file. Data will be obtained using the "N ramps" read out mode as described in the CIRCE web pages. This means that "N ramps" will be set equal to "N exp". For a better result we suggest to set "N exp" either to 1 or 3. In the first case you will get as many FITS files as the requested number of exposures, in the second case you will get one FITS every three images. Larger values of "N exp" would imply steering for a long time to the same position of the sky, which is inconvenient owing to the rapidly varying behavior of the IR background.

Offset Mode: To properly dither your requested sequence of images you either select a predefined pattern or write a list of offset. We **warmly suggest the use of a predefined pattern** in such a way avoiding to write long lists of numbers that would be confusing and error prone. Due to the limited field of view (12x12 arcsec) covered in polarimetric mode, the possible options for the "Offset Mode" are restricted to the following options:

- **Pattern 5** = (0,0); (3,3); (-6,0); (0,-6); (6,0) centered square.
- **Pattern 3_ew** = (0,0); (3,0); (-6,0) East-West.
- **Pattern 3_ns** = (0,0); (0,3); (0,-6) North-South.
- **User Defined patterns.**
- **Random pattern.**

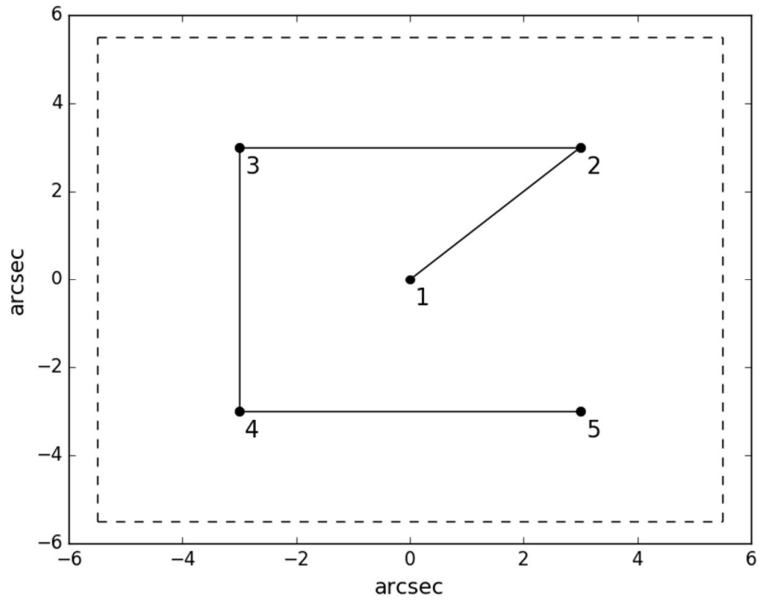


Figure 33: *The default 5 positions pattern for CIRCE polarimetry mode.*

The predefined pattern will place on the detector at the listed x,y positions, where values are expressed in arcsec and the first (0,0) position corresponds to the telescope preset position. As you can see in Figure 33, offsets of Pattern 5 are arranged on a square covering a -6 to 6 arcsec range, Patterns 3 place the target on a E-W or N-S line, over a -3 to 3 range (Figure 34) . If you prefer larger or smaller offsets, you can modify the size of the square writing in the "offset RA" field a number that will be interpreted as the new size for the square. For instance, if you enter 10 in the field "offset RA", offsets will cover the -10 to 10 arcsec range.

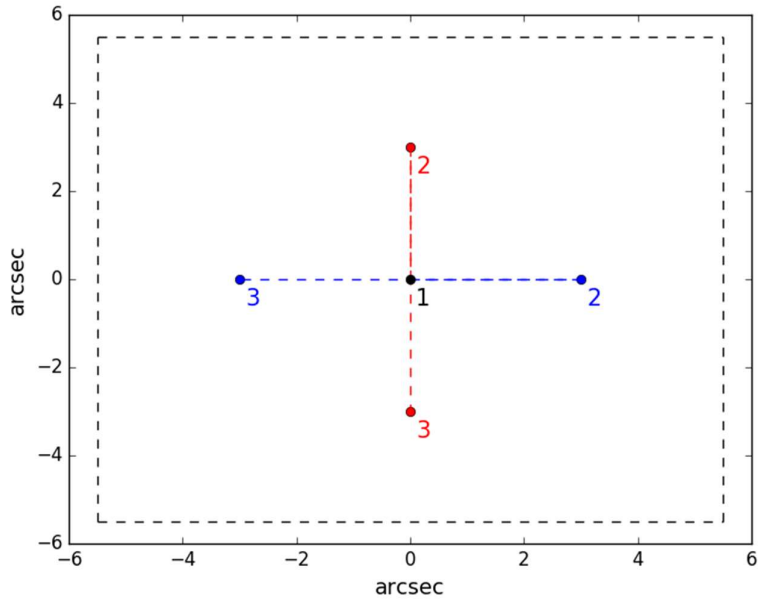


Figure 34: *The three positions pattern for CIRCE polarimetry mode. The first exposure will have the target at the center of the field of view, then right and left or up and down according to whether East-West or North-South pattern is selected.*

By default, the 5 positions pattern is selected. The meaning of the user defined and random pattern is as for imaging mode.

Please note that ***at the end of each template the telescope is moved back to the preset position***, in this way consecutive tamplates using the same offset pattern will repeat the very same positions on the sky.

N loop: Finally, there is one third parameter to control the sequence of exposures to be obtained. Once the offset pattern is defined, "N loop" defines the number of times this pattern have to be repeated. For instance if you need a total integration time of 30 minutes, and the exptime is set to 1 minute, you can use "N exp"=1, "Pattern 5" and set nloop=6. Of course, a "user defined" 10 position pattern and nloop=3 would also do the trick. Note that setting for instance "N exp"=3, "Pattern 5" and "N loop"=2 would achieve the same result more efficiently because less offsets are required to complete the sequence.

Also note that the sky emission varies rapidly in the infrared, thus for best sky subtraction you must balance the values of "N exp" and "N loop", to avoid remaining too long on the same position of the sky. According to our experience, the best approach is to set "N exp"=3, and then set "N loop" accordingly.

Defines as many templates as needed, selecting for each one the appropriate parameters.

Repeater: Once you have defined all the templates, you can further specify that you want to repeat all the templates a certain number of times. This last parameter is set on the box appearing just below the

template list. For instance, if you want to alternate 20 times imaging in the H and J bands to follow the flux evolution of your target, defines only 2 templates and set this parameter to 20, obtaining in this way 20 execution of the H and 20 of the J band templates.

Once you are satisfy with your template(s) definition, submit the form and continue filling the OB providing the finding chart and, if appropriate, the list of ephemerids.

Example 1:

Imagine you want to take 15 seconds images in J band and 20 seconds in H band, with the default 5 position dithering pattern, repeating the pattern 3 times, for a total of 15 images for each band. Then fill the first two template as follow:

Filter=J, exptime= 15, Nexp= 1, Offset Mode= "Pattern 5", N loop= 3

Filter=H, exptime= 20, Nexp= 1, Offset Mode= "Pattern 5", N loop= 3

Note that fields "offset RA" and "offset DEC" are left empty.

2.4. Creating an observing block for EMIR

EMIR is a near-IR wide-field imager and medium-resolution multi-object spectrograph for the GTC, operating in the bands Y, J, H, and Ks.

Two distinct detector setup modes are available to define the exposure time of any EMIR exposition. To the "traditional one", where the **total** integration time is the basic parameter to control the details of the sub-exposures, now the possibility to specify the exposure time of individual exposures is also offered. The mode to be used is selected clicking on a "Switch" button that appears on the upper right part of each observing mode form (Figure 35).

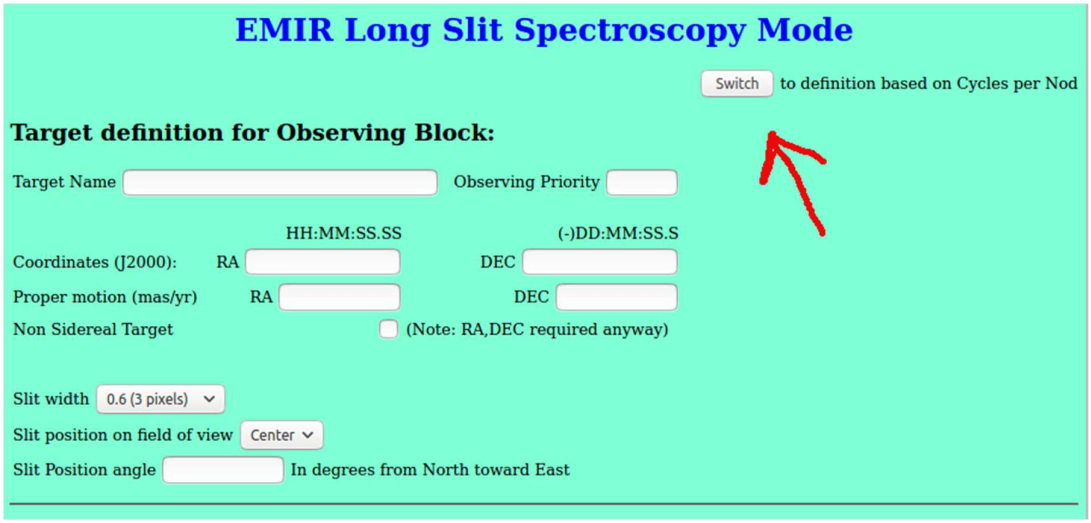


Figure 35: *Position of the button used to switch between the two available detector setups, one based on total on-source time and one based on individual frame time setup.*

2.4.1. Target definition

Once the observing mode has been selected in the Phase-2 summary page (see Figure 2) the following acquisition information, common to both modes, must be provided.

Target Name: This is a string defining the target name. It does not have to be unique but for archiving purposes it is better if it is. Special characters and spaces are not allowed.

Observing Priority: This is a number between 1 and 9 defining the Observing Block priority, being 1 the maximum priority. The night astronomer will attempt to execute first the OBs with higher priority.

Coordinates (J2000): Target coordinates in the format HH:MM:SS.SS (-)DD:MM:SS.S. Note that positive declination must be written **without** the + sign. It is required that you enter the coordinates with the exact number of decimals (i.e. 2 for the right ascension and 1 for the declination).

Proper Motion: Target proper motion values in milli-arcseconds per year. This field can be left empty. (see Appendix A.8 for details in the proper motion definition).

Non Sidereal Target: This flag shall be used for Solar System targets. If selected, later you will be asked to enter an Ephemeris file.

Field of View Position Angle: The field of view position angle in degrees. This indicates the angle of the detector vertical axis with respect to the North. Angles are assumed to be positive from North to East. By default the instrument field of view is assumed to have North up and East to the left. For instance, a value of 90 degrees means that the images will have West up and North to the left.

2.4.2. EMIR imaging

Science templates: After filling the target definition parameters and acquisition image if necessary, one or more templates defining the scientific exposure(s) must be filled.

According to the exptime setup mode selected, you will have to fill one of these two templates:

Configuration based on total on-source time:

Figure 36: *EMIR imaging mode science template for setup based on Total on-source time.*

Filter: Select the desired filter for your observation.

Total Exptime: Set the exposure time in seconds. This is the **on-source** exposure time for the whole template, which can be quite long. To cope with the strong background typical of the near-IR, internally the phase 2 tool will divide the requested on-source exposure time into several short exposures, each one of a certain duration (see next parameter). These exposures will be taken in one or more positions of the sky, according to the desire dithering pattern. Note, as described below, that the Total Exptime must be a multiple of the duration of a single exposure.

Single integration time: As usual when observing in the infrared, the total on-source exposure time is split into several short exposures of T_single seconds each. In the case of EMIR, due to the calibration

specifics of the detector, only a pre-defined set of T_single exposure-time is available. These are summarized in the Table 3, along with the corresponding readout modes.

Please use one of these values to define how long the detector will integrate in a single exposure.

Note that the T_single selected here will be used together with the selected dithering pattern (see next parameter) in order to define the total number of exposures that will be obtained. More details are given here:

http://www.iac.es/proyecto/emir/pages/observing-with-emir/observing tools/efficiencycalculator.php

This further implies that the total on-source time must necessarily be a multiple of T_single times the number N of dithering positions. **In the case you enter inconsistent values, the Phase 2 tool will warn you, and offer some possible alternatives.**

Offset Pattern: The total on-source exposure time will be splitted into several exposures to cope with the strong and rapidly variable infrared background. Three options are available: Pattern 1, Pattern 4, Pattern 7. As the name suggest, pattern 1 has only one position, that is all sub-images will be taken on the same position of the sky, while Pattern 4 and 7 use four and seven different positions on the sky, respectively. The positions will be distributed as shown in Figure 37. Pattern 1 uses only the central position, Pattern 4 uses the central position and the 3 position on the smaller circle, and Pattern 7 uses all of them.

Offset Size: this parameter defines the maximum amplitude of the dithering pattern, in arcsec. That is, in the case Pattern 4 was selected this parameter defines the radius of the small circle shown in figure, while in the case of Pattern 7 the parameter defines the radius of the large circle. For Pattern 1 this parameter is irrelevant.

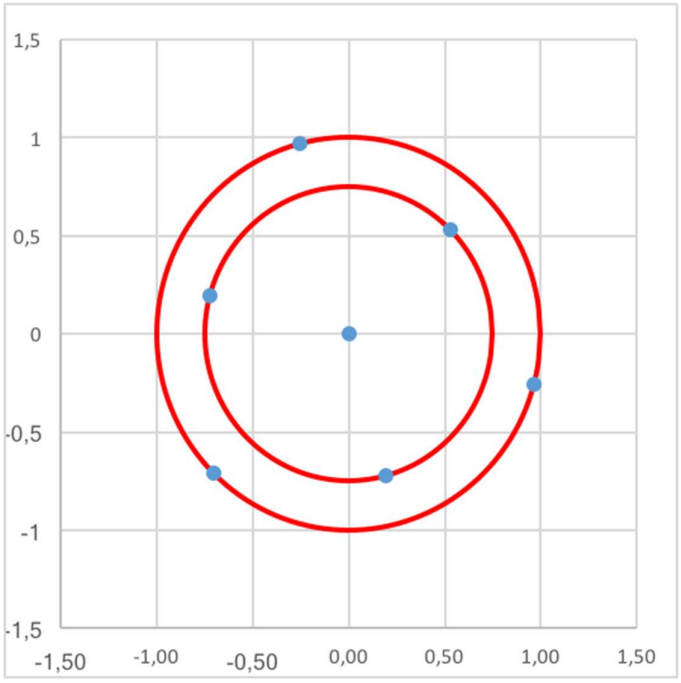


Figure 37*: EMIR predefined pattern positions. Pattern 1 uses only the central position. Pattern 4 uses the center and the three positions on the smaller circle, while pattern 7 uses all of them. Note the small circle has radius 0.75 times the one of the big circle. The radius of the circles is defined by the "Offset Size" parameter.*

Sky: flag defining whether sky frames will be obtained as part of the template. If the requested science needs off-source images to be obtained, for instance because your target covers a significant fraction of the EMIR field of view, then select this flag and fill the following 3 fields **Offset RA, Offset Dec, and Offset Size**, which specify the offset the telescope has to make with respect to the preset position in order to reach the sky position. This offset can be of several arcmin. The offset size allows you to specify the size of the dithering pattern which can be different from the one used for the target. All these three values are given in arcsec. Note the very same amount of time will be spent on the sky as for the science target.

Configuration based on individual frames (T_single):

Figure 38: *Science template for imaging mode based on exptime of individual frames (T_single).*

Starting with semester 2020B, the user is offered the possibility to fine tune their exposure sequence, basing the configuration on individual frame time, rather then the total on-source time.

If this mode is selected, the following information are needed:

Filter: filter to be used.

Number of cycles: this is the number of times the group of exposures defined by the three following parameters will be repeated.

Exposures per Nod: Number of individual exposures that will be obtained in each sky position of the selected pattern (see the following parameters).

Single Integration time: This is the exposure time in seconds for each individual frame, the same as T_single define above. This is the smallest unit in which your template will be divided. The time have to be selected from the provided closed list.

Offset Pattern: this is the offset pattern the telescope will use in order to provide good sky subtraction for your science frames (Figure 37). Three patterns are available:

- Pattern 1: this really is a single pointing, the telescope will not move among different frames, and all your individual exposures, each of T_single seconds, will be obtained in the very same sky position.

- Pattern 4: the telescope will take exposures in 4 different position on the sky. Before moving to the next pattern position, a number of exposures defined by "Exposure per Nod" will be obtained. Calling ABCD the four position of this pattern, if "Exposure per Nod"=2, then the following sequence of exposures will be obtained: AABBCCDD. Each exposure will be of T_single seconds. If "Number of cycles" is greater than 1, then this sequence will be repeated as many time as requested.

- Pattern 7: this is selected be default. It is as pattern 4, but with 7 position. The behavior of the system is exactly the same.

Offsets size: This parameter defines the separation in arcseconds of the position of the selected pattern. Precisely, this is the radius of the largest circle defining the positions of Pattern 7. With this definition, you are sure that your target will not move in any direction more than this quantity from the preset position.

Number of repetitions: at the bottom of the form, you have to specify one final parameter used to control the execution of your OB. The list of filled templates can be repeated as many time as indicated. For instance, in order to alternate grisms while monitoring a variable source. By default this parameter is set to 1.

Some configuration examples:

- **Example 1:** 3 cycles, 2 exp per nod, 10 s exptime, pattern 4

  According to this, in total 3*2*4 = 24 exposures are requested, each with 10s of integration.

  You will get this sequence of images: AABBCCDD-AABBCCDD-AABBCCDD.

  The total on-source time is 240s.

- **Example 2:** 2 cycle, 1 exp per nod, 15 s exptime, pattern 7

  In this case 2*1*7=14 images are requested, each of 15 s.

  This sequence of images will be: ABCDEFG – ABCDEFG, each image of 15s of integration.

  Total on-source time is 210s.

- **Example 3:** 3 cycle, 1 exp per nod, 10 s exptieme, pattern 1

  Selecting pattern 1 there is degeneragy among cycles and nods, so this is equivalent to ask

  1 cycle, 3 exp per nod 10 s exptieme, pattern 1

  In both cases the result is a list of three exposures (3*1*1 or 1*3*1) of 10s each,

  all obtained in the same position of the sky.

  Total on-source time is 30 s.

Table 3: EMIR readout modes.

Readout Mode	***Exposure times in seconds***
Correlated Double Sampling (CDS)	1.5, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15
Ramps (5 points/samples)	20, 30
Ramps (10 points/samples)	60, 120, 160, 200, 240, 280, 320, 360, 420, 480, 540, 600, 900, 1200

2.4.3. EMIR Long Slit Spectroscopy (default ABBA mode)

Beside the parameter for target definition defined above, you have to select the slit width and the slit location on the field of view . By default the slit will be placed on the center of the FOV, but if you prefer the spectrum to extend more on the **red** or **blue**, you might select the slit to be placed by one arcmin to the **left** or to the **right** of the center, respectively.

The last parameter to define is the slit position angle (which is given in degrees from north toward east following the astronomical standard), in the range -90 to 90. Write "999" for parallactic angle.

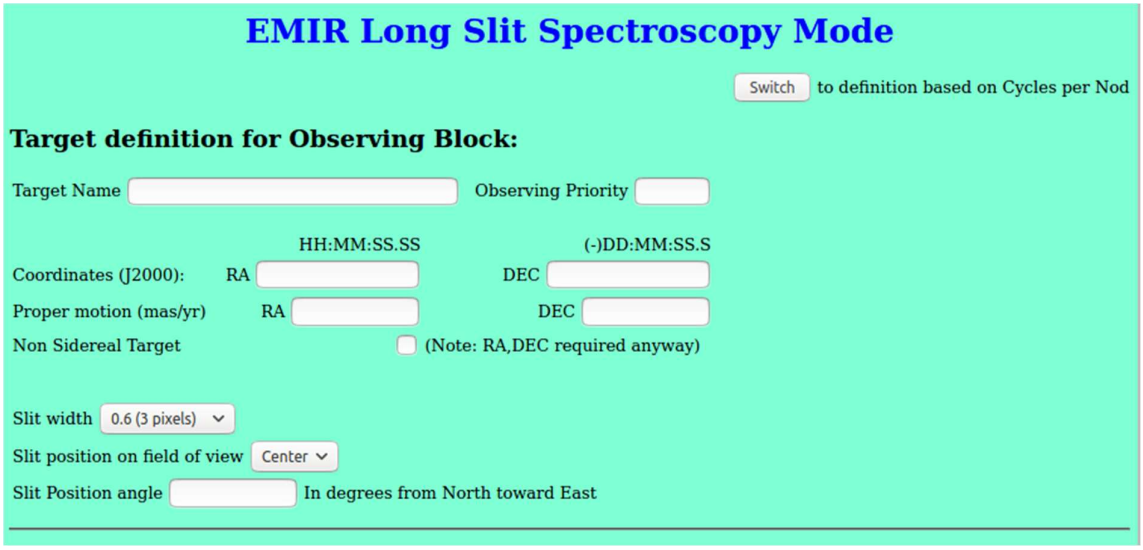


Figure 39: *Upper part of the EMIR Long Slit Spectroscopy mode definition form. Note the "Switch" button on the upper right.*

Target Acquisition: For spectroscopy it is mandatory to define an acquisition image and a through slit image. The parameters to define for these two images are simply the filter and the total exptime. Note that is mandatory to use one of the imaging filters available in EMIR.

As part of the through slit image you can define a blind offset to be applied **after** a bright reference target has been acquired. This is necessary in order to make spectroscopy of very faint target. This offset is, as usual, specified in arcsec.

Science Template: After filling the target definition parameters and acquisition and through slit images, one or more templates defining the scientific exposure(s) must be filled.

According to the exptime setup mode selected, you will have to fill one of these two templates:

Configuration based on total on-source time:

Figure 40: *Science template for long slit spectroscopy, in the case of total exptime configuration mode.*

Grism: Select the desired grism for your observation.

On Source Exptime: Set the total exposure time in seconds. This is the **on-source** exposure time for the whole template, which can be quite long. To cope with the strong and variable background typical of the near-IR, internally the phase 2 tool will divide the requested on-source exposure time into several short exposures, each one of a certain duration (see next parameter), and arrange the exposure on a ABBA sequence. The EMIR efficiency calculator will evaluate the best way to divide the total requested time, which can result in sequences like ABBA or AABBBBAA, or AAABBBBBBAAA and so on, repeated as many time as needed. To have full control on the number of exposures on each position, please use the other configuration mode based on T_single. Note that the On Source Exptime must be a multiple of the duration of a single integration time.

Single integration time: As usual when observing in the infrared, the total on-source exposure time is splitted into several short exposures of T_single seconds each. In the case of EMIR, due to the calibration specifics of the detector, only a pre-defined set of T_single exposure-time is available. These are summarized in the Table 3. Please use one of these values to define how long the detector will integrate in a single exposure.

Note that the T_single selected here will be used together with the selected dithering pattern (see next parameter) in order to define the total number of exposures that will be obtained. More details are given here:

http://www.iac.es/proyecto/emir/pages/observing-with-emir/observing tools/efficiencycalculator.php

This implies that the total on-source time must necessarily be a multiple of T_single times the number N of dithering positions. **In the case you enter an inconsistent value, the Phase 2 tool will warn you, and offer some possible alternatives.**

Initial offset: this parameter, usually set to zero, defines an initial offset in arcsec to be applied **before** the first A exposure is taken. Thus, after the object has been acquired at the center of the slit, you have the possibility to displace the whole ABBA pattern using this parameter.

ABBA throw: This parameter defines the separation in arcsec along the slit between A and B positions. By default, A position will appear above B position in the focal plane image. If the inverse situation is required (that is, B position appearing above A position by moving the target in the opposite direction), ABBA throw must be expressed as a negative number.

Configuration based on individual frames (T_single):

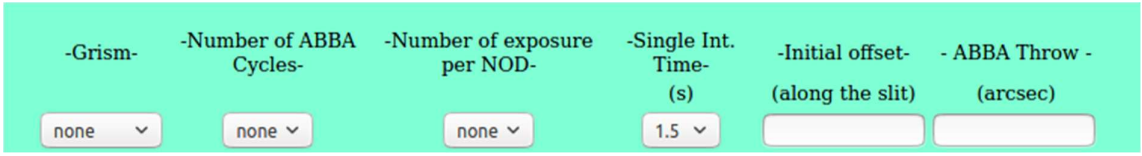


Figure 41: *Science template for EMIR long slit mode, in the case T_unique exptime is selected.*

Grism: Select the desired grism for your observation.

Number of cycles: this is the number of times a complete on-source off-source ABBA sequence is to be repeated.

Number of exposures per NOD: Number of individual exposures that will be obtained in each position of the ABBA pattern. For instance, if this parameter is set to 2, the sequece of frames will be AABBBBAA.

Single Integration time: This is the exposure time in seconds for each individual frame. This is the smallest unit in which your template will be divided, and is the basic parameter to define the total onsource time. The time have to be selected from the provided closed list.

Initial offset: this parameter, usually set to zero, defines an initial offset along the slit in arcsec to be applied **before** the first A exposure is taken. Thus, after the object has been acquired at the center of the slit, you have the possibility to displace the whole ABBA pattern using this parameter.

ABBA throw: This parameter defines the separation in arcsec along the slit between A and B positions. By default, the A position will appear above the B position in the focal plane image. If the inverse situation is required (that is, B position appearing above A position by moving the target in the opposite direction), ABBA throw must be expressed as a negative number.

Number of repetitions: at the bottom of the form, you have to specify one final parameter used to control the execution of your OB. The list of filled templates can be repeated as many time as indicated. For instance, in order to alternate grisms while monitoring a variable source. By default this parameter is set to 1.

Some configuration examples:

- **Example 1:** on-source time = 1200s, Single int. time= 60s

  This will result in a series of 30s on-source and off-source exposures, arranged in a ABBA pattern or AABBBBAA etc. . The pattern will be repeated as many time as needed to complete the requested total time. It is supposed that both the A and B positions are usefult for science and contributes to the total integration time.

- **Example 2:** 3 cycles, 2 exp per nod, 100 s exptime,

  According to this, in total 3*4*2 = 24 exposures are requested, each with 100s of integration.

  You will get this sequence of images: AABBBBAA-AABBBBAA-AABBBBAA.

  The total exposure time (besides overheads) is 2400 (assuming both the A and B position are useful for science and add to the total time).

2.4.4. EMIR Long Slit Spectroscopy Sky mode

This is a variant of the standard long slit spectroscopy mode, to be used when off-slit spectra are needed, usually for proper sky subtraction. This mode works as the normal long slit mode and the reader should be referred to the corresponding section. The only difference in the science template are the last two parameter that defines the sky offsets. This is:

Sky offset RA and DEC: define the offset needed, in arcsec, to reach the position where to take off-slit spectra, usually for sky background subtraction. This offset can be large, even several arcminutes, though the values are given in arcsec. Note that the very same amount of time will be spent on the sky as for the science target.

2.4.5. EMIR Long Slit Spectroscopy Telluric mode

This is a variant of the standard long slit mode meant to observe telluric standard stars needed for calibrating your data, reducing overheads. This is possible because standard stars are bright and therefore can be acquired skipping the full frame acquisition image, in this way the time to move the slitlets that form the long slit is saved. **OBs for this mode are identical to the one for regular long slit mode and you should refer to that section for further details. Selecting this mode, you "inform" the system that a special acquisition sequence has to be followed, nothing else**.

2.4.6. EMIR Multi-Object Spectroscopy mode

The preparation of OBs for this observing mode requires the initial preparation of an instrument focal plane setup, which is done with a external tool:

http://www.iac.es/proyecto/emir/pages/observing-with-emir/observing-tools/osp.php

Once you have defined the MOS configuration and saved the corresponding files, you are ready to prepare your Observing Block. The three files strictly needed are:

1.- XML file (with the [RA, Dec] definitions of the slits);

2.- Wide CSU file. This CSU definition should have ".csu" extension, and serves to configure the instrument in order to acquire finely/accurately the reference/fiducial stars. It usually defines the

same position as for science purposes but with, at least, wider opened slits for the aforementioned stars;

3.- CSU file. This is the CSU configuration for science purposes (with the appropriate width for all slits). It should have ".csu" extension too.

So, select EMIR MOS Spectroscopy and you will be required to upload the configuration file you just created.

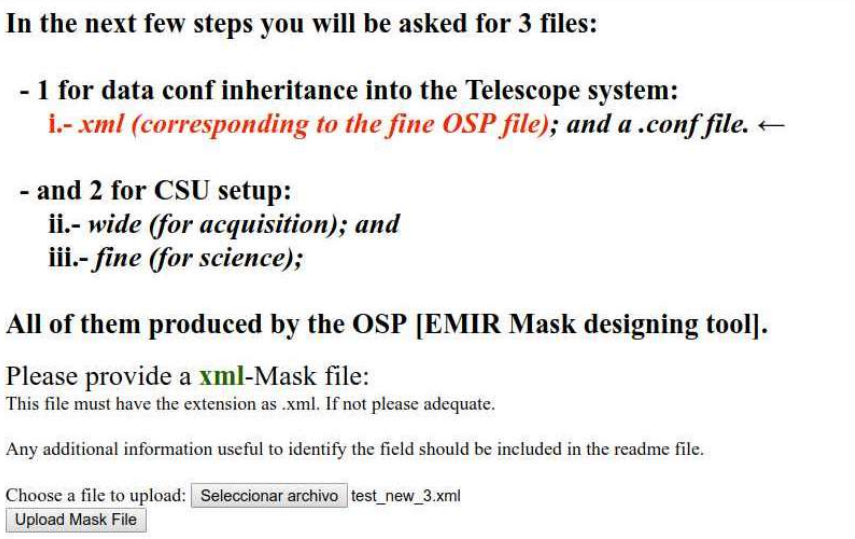


Figure 42*: EMIR MOS files uploading window.*

Additionally, the .CONF file produced by the OSP can be also uploaded to include extra information to be incorporated to the image keywords. **This file is not mandatory, so the user can skip this step.**

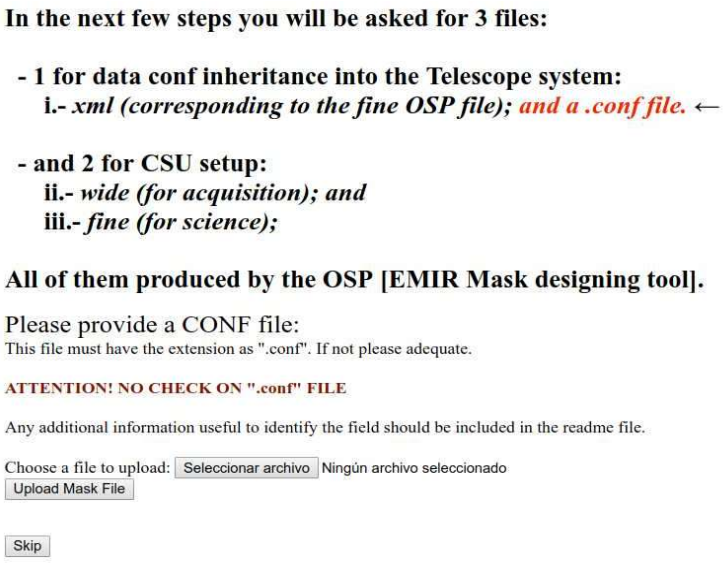


Figure 43*: EMIR .conf file uploading window.*

It is necessary to the check the files generated by the OSP in advance, by using the facility tool OSP2CSUv8.py available at EMIR OSP webpage. This check would look for inconsistencies between the different files and will prevent possible problems during the observatations. Also, **this script will produce a .png file that has to be included as finding chart in EMIR MOS observations** (see Section 2.8).

Phase2 system shall parse the CSU file and extract the info corresponding to celestial coorditionates and orientation in the sky. Hence it is needed from the user the info corresponding to TargetName, Priority, exptime for the acquisition, etc.. Press continue to access to the following form to include these:

Target Name: This is the name that will appear in image header. It does not have to be unique, but for later handling it is better if it is. Special characters and spaces are not allowed.

Observing Priority: A number between 1 to 9, being 1 the maximum priority. The night astronomer will attempt to execute first the OBs with higher priority.

Through Mask Image Acquisition: After pointing the telescope to the target, an image of the requested field is taken with the wide CSU configuration to perform the centering by detecting the reference/ fiducial stars. The parameters to define for this image are simply the filter and the exptime. Note that is mandatory to use one of the imaging filters available in EMIR.

Science Template: After filling the target definition parameters and acquisition and through slit images, one or more templates defining the scientific exposure(s) must be filled. According to the detector setup definition mode selected, there are possible two cases:

Configuration based on total on-source time:

Grism: Select the desired grism for your observation.

On Source Exptime: Set the exposure time in seconds. This is the **on-source** exposure time for the whole template, which can be quite long. To cope with the strong background typical of the near-IR, internally the phase 2 tool will divide the requested on-source exposure time into several short exposures, each one of a certain duration (see next parameter). These exposures will be taken in one or more positions of the sky, according to the desire dithering pattern. Note, as described below, that the On Source Exptime must be a multiple of the duration of a single exposure.

Single integration time: As usual when observing in the infrared, the total on-source exposure time is splitted into several short exposures of T_single seconds each. In the case of EMIR, due to the calibration specifics of the detector, only a pre-defined set of T_single exposure-time is available. These are summarized in the Table 3. Please use one of these values to define how long the detector will integrate in a single exposure.

Note that the T_single selected here will be used together with the selected dithering pattern (see next parameter) in order to define the total number of exposures that will be obtained. More details are given here:

http://www.iac.es/proyecto/emir/pages/observing-with-emir/observing tools/efficiencycalculator.php

This implies that the total on-source time must necessarily be a multiple of T_single times the number N of dithering positions. **In the case you enter an inconsistent value, the Phase 2 tool will warn you, and offer some possible alternatives.**

Configuration based on individual frames (T_single):

Grism: Select the desired grism for your observation

Number of cycles: this is the number of times a complete on-source off-source ABBA sequence is to be repeated.

Number of exposures per NOD: Number of individual exposures that will be obtained in each position of the ABBA pattern. For instance, if this parameter is set to 2, the sequece of frames will be AABBBBAA.

Single Integration time: This is the exposure time in seconds for each individual frame. This is the smallest unit in which your template will be divided, and is the basic parameter to define the total onsource time. The time have to be selected from the provided closed list.

Initial offset: this parameter, usually set to zero, defines an initial offset along the slit in arcsec to be applied **before** the first A exposure is taken. Thus, after the object has been acquired at the center of the slit, you have the possibility to displace the whole ABBA pattern using this parameter.

ABBA throw: This parameter defines the separation in arcsec along the slit between A and B positions. By default, the A position will appear above the B position in the focal plane image. If the inverse situation is required (that is, B position appearing above A position by moving the target in the opposite direction), ABBA throw must be expressed as a negative number.

Number of repetitions: at the bottom of the form, you have to specify one final parameter used to control the execution of your OB. The list of filled templates can be repeated as many time as indicated. For instance, in order to alternate grisms while monitoring a variable source. By default this parameter is set to 1.

2.4.7. EMIR Multi-Object Spectroscopy Sky mode

This is a variant of the standard Multi-Object Spectroscopy mode, to be used when off-slit spectra are needed. This mode works as the normal Multi-Object Spectroscopy mode and the reader should be referred to the corresponding section. The only difference in the science template are the last two parameter that defines the sky offsets. This is:

Sky offset RA and DEC: define the offset needed, in arcsec, to reach the position where to take off-slit spectra, usually for sky background subtraction. This offset can be large, even several arcminutes, though the values are given in arcsec. Note that the very same amount of time will be spent on the sky as for the science target.

2.4.8. EMIR Multi-Object Spectroscopy Telluric mode

This is a variant of the standard MOS mode meant to observe telluric standard stars needed for calibrating MOS data, reducing overheads. This is possible because standard stars are bright and therefore can be acquired skipping the full frame acquisition image, saving the time needed to move the slitlets.

Considering that in MOS mode each given slit covers a wavelength range that depends on the slit position, taking one single spectra of the standard with the slit placed at the center (like for longslit spectroscopy), will not cover the full wavelength range covered by a generic MOS configuration. Thus, **in this mode two spectra of the standard will be obtained: one with the slit placed at the extreme left, and a second one with the slit at the extreme right.** All in one frame. In this way it is guarantee the full wavelength range a MOS configuration might cover, it is recovered. The duration of the OB will be the same as for longslit telluric mode with the time devoted to the target duplicated.

This mode uses a predefined MOS configuration (see Figure 44), so **no mask design is required.** However, **note that for this configuration nodthrow must be defined as -7.4 arcsec in order to execute ABBA pattern properly within the two slits**. The rest of details in this mode are identical to the one for regular long slit mode and you should refer to that section for further details. Selecting this mode, you only "inform" the system that a special acquisition sequence has to be followed, nothing else.

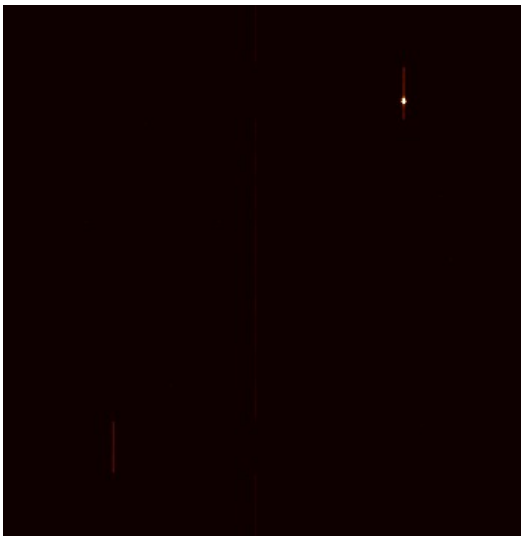


Figure 44*: EMIR MOS Telluric configuration by using 5 arcsecs wide placed at two decentered positions in the FOV, in order to cover the full wavelength range required.*

2.5. Creating an observing block for HiPERCAM

HiPERCAM is a high-speed camera for the study of rapidly variable objects. It allows obtaining 5 images simultaneously in each of the u' g' r' i' z' bands, at rates of over 1000 frames per second. The detectors have a FoV of 2.8 x 1.4 arcmin (3.1 arcmin across the diagonal) and employ custom-made frame-transfer CCDs, with 4 low noise outputs (4.5e-) and essentially zero dark current at temperature of 180K. It was designed and constructed by the Universities of Sheffield, Warwick, Durham, and the UKATC, to be used as a visitor instrument at GTC.

HiPERCAM **do have a single mode of observation, imaging.** The parameter to define an OB are defined using a dedicated tool, external to the GTC phase-2 tool, thus the preparation of an observing block is trivial.

2.5.1. Target configuration

The Observations with HiPERCAM requires the initial installation of **hcam-finder**. **hcam_finder** provides a Python script hfinder for observation planning with HiPERCAM on the GTC. It allows you to generate finding charts as well as specify the instrument setup you require, that can be loaded directly to the GUI, whilst providing an estimate of observing cadence, exposure time and S/N estimates. The tool can be download at:

http://hcam-finder.readthedocs.io/en/latest/

IMPORTANT: From Semester 2023B, the COMPO system for acquiring a star outside the standard FOV for HiPERCAM is available. **For those users requesting the use of COMPO, note that the latest release for hcam_finders and finder (v1.3.0) is needed**, while older versions will still produce valid setup when COMPO is not required.

All the information regarding the use of the tool and the instrument setup can be found in the HiPERCAM documentation web page:

http://hcam-finder.readthedocs.io/en/latest/usage.html

http://hcam-finder.readthedocs.io/en/latest/hipercam.html

Once you have produced the finding chart and the instrument setup, and saved them on two files called, let say, *hipercamfindingchart.jpg* and *hipercamsetup.json* respectively, you are ready to prepare your observing block. **We kindly encourage the PIs to use the finding chart produced by the hcam_finder tool.**

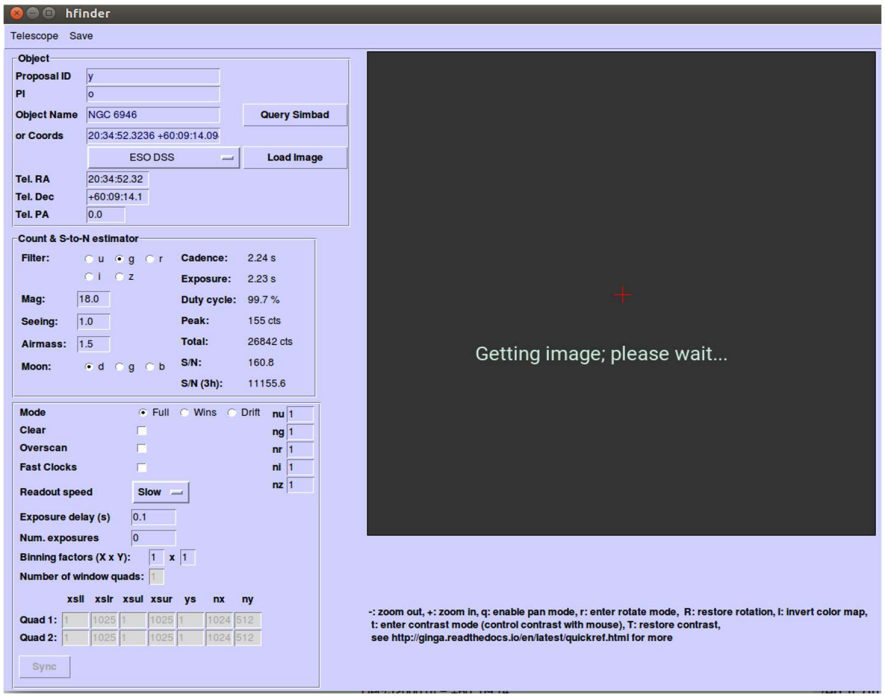


Figure 45*: hcam_finder GUI.*

2.5.2. HiPERCAM Imaging

Once the observing mode has been selected in the Phase-2 summary page (see Figure 2), the IP only have to upload the .json file generated via hcam_finder tool:

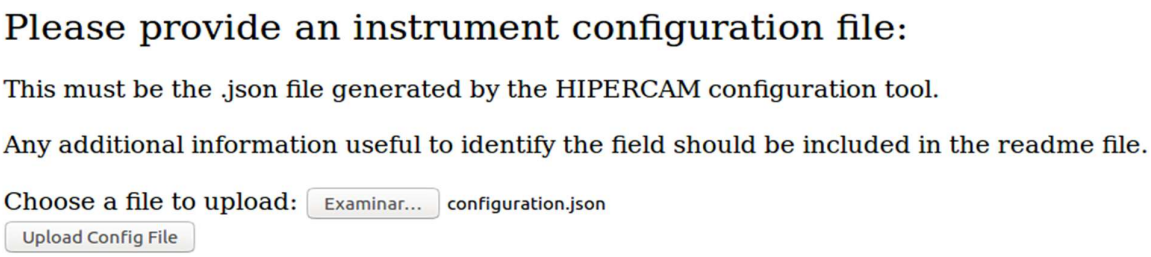


Figure 46*: HiPERCAM .json file uploading window.*

Once the file has been uploaded the following acquisition information must be provided (see Figure 43).

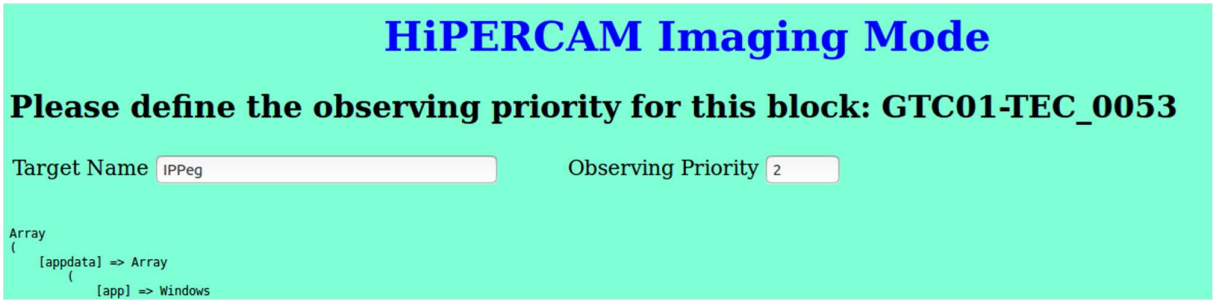


Figure 47*: HiPERCAM Imaging mode definition form.*

Target Name: This is a string defining the target name. It does not have to be unique but for archiving purposes it is better if it is. Special characters and spaces are not allowed.

Observing Priority: This is a number between 1 and 9 defining the Observing Block priority, being 1 the maximum priority. The night astronomer will attempt to execute first the OBs with higher priority.

Submit: Once you are happy with the values that you have filled, the submit button takes you to the next page in the Phase-2 completion process. The next steps consist of uploading a finding chart (Section 2.7), uploading an ephemeris file in the case of non-sidereal targets (Section 2.8) and filling in a README file with further information (Section 3.3).

In the particular case of HiPERCAM, information given in the README file is crutial for a proper OB execution at the telescope. User should be aware to include the following information:

- ***Maximum cycle time or maximum integration times*** allowed in the different filters.
- ***Timing information for the different targets***, in order to execute the observations in the allocated period, that info is requested in UTC for queue scheduling purposes.

2.6. Creating an observing block for MEGARA

MEGARA is an optical integral-field Unit (IFU) and multi-object spectrograph (MOS) designed for the GTC. The MEGARA IFU mode will offer a fibre bundle covering 12.5 arcsec x 11.3 arcsec with a spaxel size of 0.62 arcsec, which makes use of 100 μm-core optical fibres. The MEGARA MOS will allow observing up to 100 objects in a region of 3.5 arcmin x 3.5 arcmin around the IFU bundle. Eight of these bundles will be devoted to the determination of the sky during the observation with the IFU, so only 92 of these positioners will be available for MOS observations.

Both the IFU and MOS capabilities of MEGARA will provide intermediate-to-high spectral resolutions (R~5,500, 12,000 and 20,000 respectively for the LR, MR and HR modes).

2.6.1. MEGARA LCB mode (IFU)

Preparing an OB for the integral field (IFU) mode of MEGARA is straightforward. The IFU includes 567 fibers covering a total area of 12.5x11.3 arcsec^2. Each fiber having a diameter of 0.62 arcsec. The fibers are located at the center of the MOS field of view. It is recommended to have a look to MEGARA manual for additional technical details. The information needed to complete the Phase 2 are:

Target Name: This is the name that will appear in image header. It does not have to be unique, but for later handling it is better if it is. Special characters and spaces are not allowed.

Observing Priority: a number between 1 to 9, being 1 the maximum priority. The night astronomer will attempt to execute first the OBs with higher priority.

Coordinates (J2000): Target coordinates in the format HH:MM:SS.SS (-)DD:MM:SS.S. Note that positive declinations must be written without the + sign. It is required that you enter the coordinates with the exact number of decimals (i.e. 2 for the right ascension and 1 for the declination).

Proper Motion: If appropriate enter proper motion values in milli-arcseconds per year. This field can be left empty. (see Appendix A.8 for details in the proper motion definition).

Non-Sidereal Target: Activate this flag for solar system targets. If selected, later you will be asked to enter a file of coordinates.

Use only HALF FOV: a specific characteristic of the IFU is that the fibers are arranged on the slit so that adjacent fibers comes from different half of the FOV. In this way covering half of the FOV it is possible to double the distance between adjacent spectra on the CCD. During extraction, this ensure the wings of the PSF do not overlap. Thus, if you have important faint targets close to bright ones, it might be convenient to use this option, sacrificing half FOV.

In Situ calibrations: MEGARA spectrograph is permanently installed on the GTC Nasmyth-A platform, so there really is no need to calibrate your science frames with the telescope on the same position as for the science exposures. However, if you really have a reason to do so, just select this flag to include these calibrations. Obviously, **this has a big impact on the overhead of your observations** (300 s will be considered by default to get in situ trace maps, if arc lamps are also requested the time devoted to these will be charged to the program once the observations are executed).

Field of view position angle: By default the IFU field of view is oriented so to have the North up and East on the left. However, the instrument can be oriented at any angle. Write in this field the desired position angle in degrees, starting from North toward East. Angles are assumed to be positive from North to East. For instance, a value of 90 means that you will have West up and North left.

Acquisition image: a short exposure spectra can be used to center the field, after image reconstruction by the pipeline. At present, when observing with MEGARA, a pointing error correction is performed after each presetting of the telescope (using the guide star as reference), ensuring the residual pointing error to be much smaller than the MEGARA IFU field-of-view. Thus, the acquisition image is un-necessary and by default this step is skipped. If, however, you consider absolutely mandatory to take this acquisition image, just un-select the skip flag and select a grism, that can be different from the one used for science, and an exposure time in seconds.

Science templates: for each science template you have to select the desired volume phase hographic grism, the exposure time in seconds of each exposure, and the number of exposures **N exp**. Different grism can be selected as part of the same OB.

Number of repetitions: at the bottom of the form, you have to specify one final parameter used to control the execution of your OB. The list of filled templates can be repeated as many time as indicated. For instance, in order to alternate grisms while monitoring a variable source. By default this parameter is set to 1.

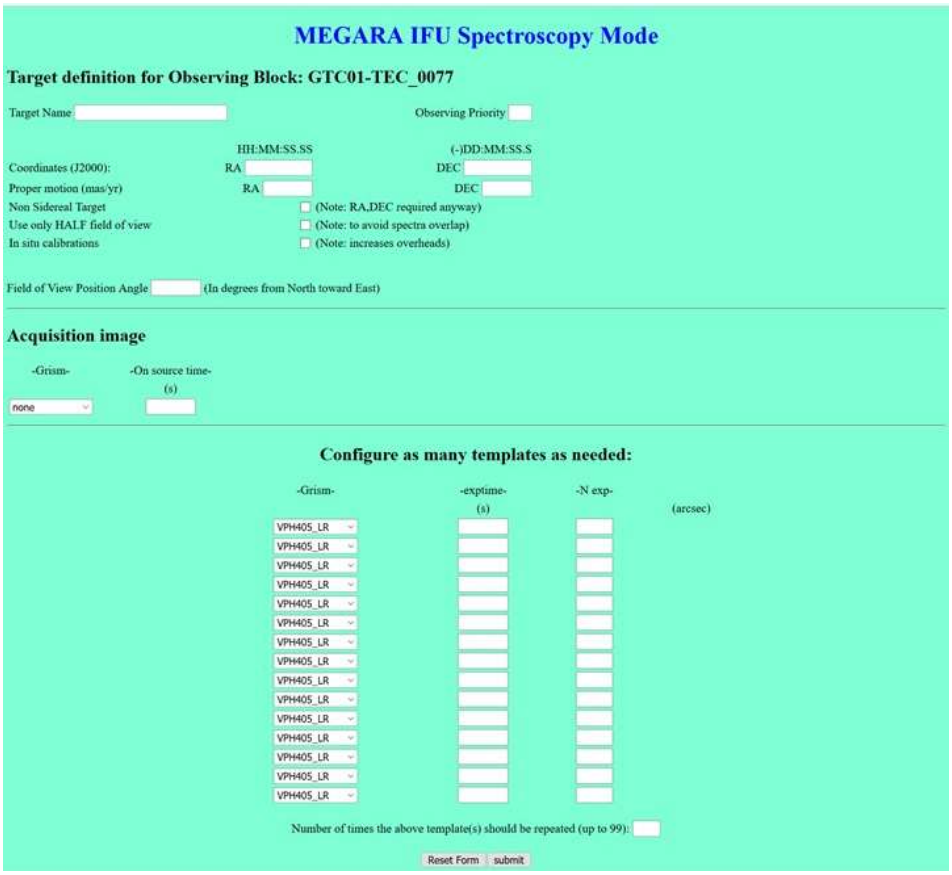


Figure 48*: MEGARA IFU mode definition form.*

2.6.2. MEGARA Multi-Object Spectroscopy mode

The preparation of OBs for this observing mode requires the initial preparation of an instrument focal plane setup, which is done with a separate java tool:

http://www.gtc.iac.es/instruments/megara/config/megara-fmat-3.3.0.zip

Once you have defined the MOS configuration and saved it on a file called, let say, *fieldOne.meg*, you are ready to prepare your Observing Block.

So, select MEGARA MOS Spectroscopy and you will be required to upload the configuration file you just created. At this time, an internal check is made to ensure the file is not corrupted or have been modified. If everithing is correct, you will be informed so, a few info extracted from the file will be displayed. It is important to double check the right setup file was uploaded. Then press continue. To access the following form where to fill in:

Target Name: This is the name that will appear in image header. It does not have to be unique, but for later handling it is better if it is. Special characters and spaces are not allowed.

Observing Priority: a number between 1 to 9, being 1 the maximum priority. The night astronomer will attempt to execute first the OBs with higher priority.

In Situ calibrations: MEGARA spectrograph is permanently installed on the GTC Nasmyth-A platform, so there really is no need to calibrate your science frames with the telescope on the same position as for the science exposures. However, if you really have a reason to do so, just select this flag to include these calibrations. Obviously, **this has a big impact on the overhead of your observations** (300 s will be considered by default to get in situ trace maps, if arc lamps are also requested the time devoted to these will be charged to the program once the observations are executed).

Science templates: for each science template you have to select the desired volume phase hographic grism, the **exposure time** in seconds of each exposure, and the number of exposures **N exp**. Different grism can be selected as part of the same OB.

Number of repetitions: at the bottom of the form, you have to specify one final parameter used to control the execution of your OB. The list of filled templates can be repeated as many time as indicated. For instance, in order to alternate grisms while monitoring a variable source. By default this parameter is set to 1.

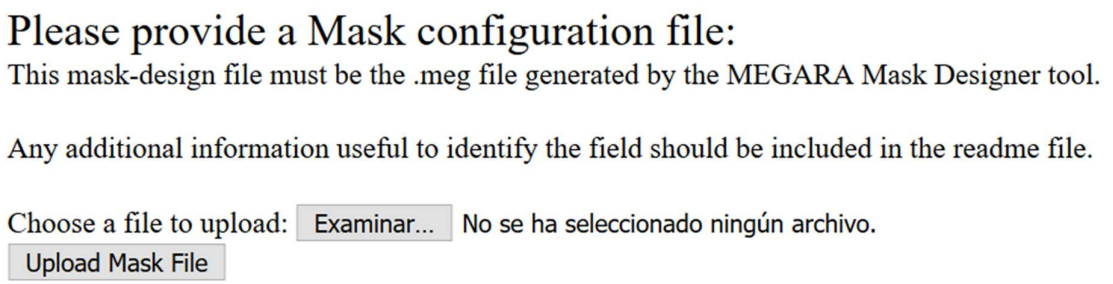


Figure 49*: MEGARA .meg file uploading window.*

2.7. Creating an observing block for HORuS

The High Optical Resolution Ultra-stable Spectrograph (HORuS) is a high-resolution spectrograph on GTC. HORuS has a FWHM resolving power of about 25,000. It collects light at the Nasmyth focal plane, shared with OSIRIS, using a 3x3 IFU (2.3x2.3 arcsec) with microlenses, into optical fibers that form a pseudo-slit at the spectrograph entrance, providing almost continuous coverage between 380 and 690 nm.

To start filling an OB just click on the HORuS Spectroscopy Mode in the OSIRIS section. You must provide some information that is common to all the observations, with some other specific items depending on the science object.

2.7.1. Target definition

Target Name: This is a string defining the target name. It does not have to be unique but for archiving purposes it is better if it is. Special characters and spaces are not allowed.

Observing Priority: This is a number between 1 and 9 defining the Observing Block priority, being 1 the maximum priority. The night astronomer will attempt to execute first the OBs with higher priority.

Coordinates (J2000): Target coordinates in the format HH:MM:SS.SS (-)DD:MM:SS.S. Note that positive declinations must be written without the + sign. It is required that you enter the coordinates with the exact number of decimals (i.e. 2 for the right ascension and 1 for the declination).

Proper Motion: Target proper motion values in milli-arcseconds per year. This field can be left empty. (see Appendix A.8 for details in the proper motion definition).

For the only observing mode of HORuS a reference position on the OSIRIS CCD has been adopted as the location where targets will be placed. Initially, objects are placed at the coordinate (250,1046) of the OSIRIS CCD1. Once on this position, an offset is applied to center the object in the HORuS IFU, that correspond to the coordinate (106,1043) on OSIRIS CCD1.

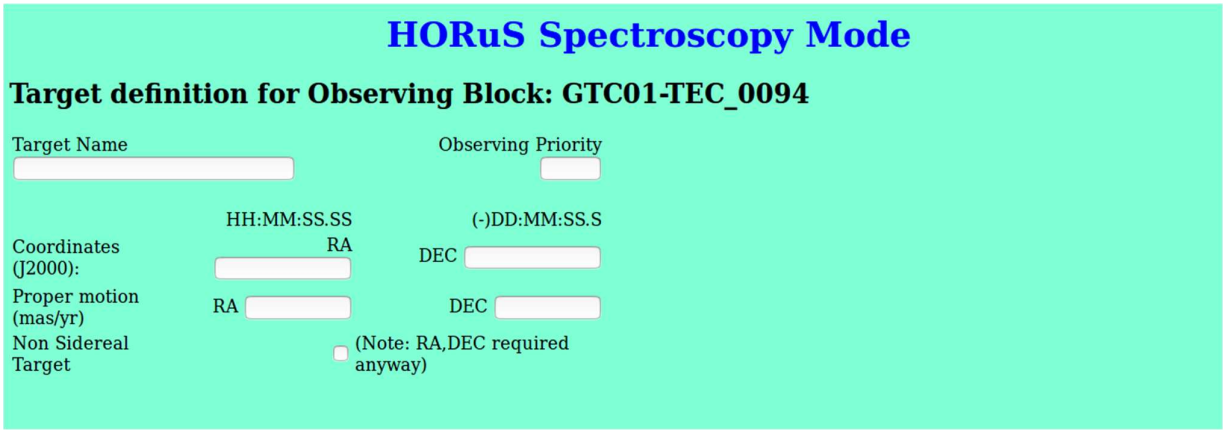


Figure 50: *Target definition for the case of HORuS Spectroscopy.*

2.7.2. HORuS Spectroscopy Mode

In addition to the fields described in section 2.7.1. the following parameters are needed. Then, at least one template must be filled in, to define the details of the science exposures associated to the OB (Figure 51).

Acquisition Image (with OSIRIS): To center the target at the pixel (250,1046) of the OSIRIS CCD1 an acquisition image is required. The parameters to define the acquisition image are:

- Filter: A pull down menu allow the selection of the filter to be used (Sloan g is preferred and appears as default option as this is centered in the HORuS wavelength coverage).
- Exptime: Integration exposure time in seconds.

Science templates: Each template allows the user to define a series of one or more exposures to be taken with a given exposure time, and readout mode. The parameters to be configured are:

- The exposure time in seconds.
- The number of exposures, "N exp", in the series.
- The CCD binning. The standard mode for spectrocopy, 8 x 2, binning, is preselected. The binning 1x1 is only suggested for bright objects.

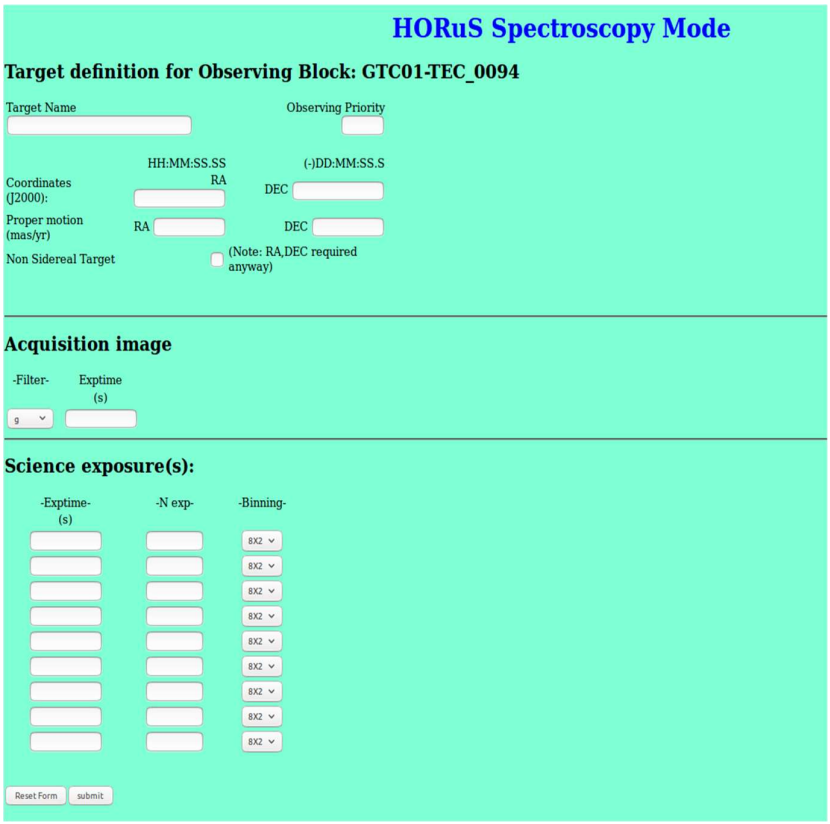


Figure 51: *Form to prepare an OB for HORuS Spectrocopic mode.*

Submit: Once you are happy with the values that you have filled, the submit button takes you to the next page in the Phase-2 completion process. The next steps consist of uploading a finding chart (Section 2.8.), and filling in a README file with further information (Section 3.3.).

2.8. Uploading the finding chart

The finding chart is always required for OSIRIS observations, even for non-sidereal targets, and **must be in JPEG, GIF, or PNG format with a maximum size of 1 Mb.** The finding chart is optional for CanariCam observations, due to its small FOV.

Please, bear in mind that the astronomer that is going to perform the observations is likely not to be familiar with the target regions. Hence, the following information must be clearly indicated in the finding chart, to facilitate the work at the telescope:

- The target(s) must be clearly marked (but not covered by the marking sign).
- In case of spectroscopic observations it is helpful to indicate the slit orientation.
- The orientation of the field must be clearly marked, e.g. using a compass indicating North and East or using a coordinate grid.
- The size of the field of view (or the scale of the figure) must be indicated. It is important that the FOV is large enough (e.g. a minimum of 4x4 arcmin) to contain enough stars to be easily recognizable in the acquisition images with OSIRIS. If a detailed view of the target is needed (e.g. because it may have a complex morphology), for instance, to center the target on a slit, a zoom into the target with much smaller FOV can also be very helpful. This zoomed image of the field can be added as an inset in the main chart, or a single composite chart may be created using different zooms. In the case of spectroscopic observations, a graphical representation of the slit overlaid on the FOV image can also be of great help. In general, any graphical information that facilitates the identification of the field is much appreciated.
- The filter in which the image was taken should be indicated. Keep in mind that objects might have very different luminosities in different bands, thus the ideal option is to try matching the finding chart to the filter of the acquisition image.

In the particular case of EMIR Multi-Object Spectroscopy observations, it is mandatory to include as finding chart the .png file produced by the facility tool OSP2CSUv8.py, available at EMIR OSP webpage, either in combination or not with the direct output of the OSP tool.

While the finding chart can be attached to the OB at any time, the OB is not considered complete until a finding chart has been uploaded. Incomplete OBs are shown in red in the list of existing OBs. We do understand that in some cases it makes no sense to prepare a finding chart, for instance for moving objects or very bright stars. The Phase-2 tool will allow you to submit to GTC incomplete OBs and the support astronomer will decide whether this is OK.

Once the finding chart has been successfully uploaded, the OB is complete and you have the opportunity to go back to the summary page where you can start a new OB or modify an existing one.

2.9. Uploading the ephemeris file

According to whether the non-sidereal flag is ON, to complete an OB you need to upload a file of ephemerides. Lists can be in any format as long as the coordinates of the target during the observing season are clearly provided. The file must be a plain text file.

3. Managing the observing blocks

Every time an OB is created it is permanently stored on the GTC server with no files created in your machine. As soon as you create an OB, the Phase-2 summary page will be modified, displaying a table listing certain observational parameters specific of each existing OB (Figure 52). From the proposal summary page it is also possible to perform certain actions: to modify and inspect an OB, to duplicate and delete OB(s). These actions are described in more detail in the following sections. Finally, a README file with further information about the whole proposal can also be accessed from the proposal summary page.

3.1. The OB summary table

The first line of information that appears in the summary is the total time used in all OBs, including overheads (see Figure 52). If this time exceeds the granted time, a warning message will appear. The summary table shows the following parameters for each block:

- **Column 1**: OB identification number. The tool attempts to create a sequential list, filling the gaps that may result from deleting OBs. However, it is irrelevant whether the list is sequential or not. The button is color coded to give some additional information specific to the OB. A yellow button means the OB is complete but still waiting approval by GTC staff. A red button means the OB is incomplete, usually missing the finding chart when this is required. A green button means the OB is complete and validated by GTC staff, ready to be executed at the telescope.
- **Column 2**: Target name.
- **Column 3**: Right ascension (HH:MM:SS.SS)
- **Column 4**: Declination (DD:MM:SS.S)
- **Column 5**: A short string specifying the observing mode, with the following (obvious) meaning:

  Osiris Broad Band Imaging = osiris_BB

  Osiris Long-Slit Spectroscopy = osiris_LSS

  Osiris Long-Slit Spectroscopy Sky = osiris_LSS_sky

Osiris Multi-object Spectroscopy = osiris_MOS

Osiris Multi-object Spectroscopy Sky = osiris_MOS_sky

Osiris Tunable-Filter Imaging = osiris_TF

Osiris Tunable-Filter Scan = osiris_TFscan

CanariCam Imaging = canaricam_IMA

CanariCam Spectroscopy = canaricam_SPE

CanariCam Polarimetry = canaricam_POL

CanariCam Spectropolarimetry = canaricam_SPOL

Circe Imaging = circe_IMA

Circe Polarimetry = circe_POL

Emir Imaging = emir_IMA

Emir Long-Slit Spectroscopy = emir_LSS

Emir Long-Slit Spectroscopy Telluric = emir_LSS_telluric

Emir Long-Slit Spectroscopy Sky = emir_LSS_sky

Emir MOS Spectroscopy = emir_MOS

Emir MOS Spectroscopy Sky = emir_MOS_sky

Emir MOS Telluric = emir_MOS_telluric

Hipercam Imaging = hip_IMA

Megara IFU = megara_IFU

Megara MOS = megara_MOS

HORuS Spectroscopy = HORuS

- **Column 6**: Basic observing instrument configuration information (filters/grisms)
- **Column 7**: Flag showing if a finding chart (FC) has been provided. N/A stands for "not applicable", which can only occur with CanariCam, where the finding chart is optional.
- **Column 8**: Flag showing whether the target is non-sidereal, or not.
- **Column 9**: Flag showing whether a text file with ephemeris has been provided in the case of non-sidereal targets.
- **Column 10**: Length of the OB in seconds, including all overheads (see the Appendix for a detailed description of the overheads).
- **Column 11**: The user defined priority of the observation from 1 (highest) to 9 (lowest).

- **Column 12**: Image Quality (IQ) requirement in arcseconds for the OB. This is only appli- cable to CanariCam observations where the requirements from the Phase-1 can be *relaxed* due to the wide variation in conditions that can occur between the 10 and 20-micron windows. In the case of OSIRIS observations this cell will be filled with a - minus sign.

- **Column 13**: Precipitable water vapor (PWV) requirement in millimeters for the OB. This is only applicable to CanariCam observations where the requirements from the Phase-1 can be relaxed due to the wide variation in conditions that can occur between the 10 and 20-micron windows. In the case of OSIRIS observations this cell will be filled with a - minus sign.

- **Column 14**: Flag indicating if an OB has been executed or not. This cell will be filled with four possible values:

  "-" indicating the OB has not yet been observed.

  "P.Q.C." meaning data have been taken and are Pending Quality Control.

  "DATE" a date in the DD-MM-YYYY format. This is the date of OB execution, meaning the OB has been successfully completed and data delivered to the PI. Please note this is the date corresponding to the start of the night, irrespectively of whether the OB was executed before or after midnight.

  "A.D." meaning the OB was executed out of specifications and data have not passed quality control. The obtained frames, however, have been delivered to the PI as Additional Data. OB marked like this are still in the observing queue and if possible repeated.

Figure 52: *The bottom part of the phase-2 summary page as it appears after a number of OBs have been created.*

3.2. Inspect or Modify OBs

At any time you can inspect or modify your OBs. This is done through the same interface used to create a new OB. In the table showing the list of OBs (see Figure 52) you can click the button with the OB number to display and edit the details of that OB. Please keep in mind that changes are stored only after hitting the Apply Changes button. You can use the back button of your web browser to simply inspect an OB without making any changes. If changes are applied, it is not necessary to upload again the finding chart, if you had already uploaded one. You can decide whether to retain the existing one or change it. The same is true for the file of ephemeris. If either the finding chart or the ephemeris text file has changed, you should make sure that the browser is not displaying an old version of them from the local cache. In this case you may think the files have not been uploaded when they have actually been uploaded.

3.2.1. Duplicate an existing OB

This button allows you to duplicate an OB by filling the box with the full OB number, i.e. including all leading zeros (e.g. 0007). Also, a single OB can be duplicated N times by filling the box with the full OB number and the number of duplications requested (e.g. 0001x4 to duplicate 4 times). The number assigned to the newly created OB will be the smaller available, that is to say that if there is a gap in the number list, it will be filled.

3.2.2. Delete one or more OB(s)

This button allows you to delete one or more OBs (removing also the finding chart and ephemerides file from the server, if they were included). To minimize the risk of accidentally deleting an OB, it is necessary to write down explicitly the full OB number to be deleted, i.e. including all leading zeros (e.g. 0003), and then you will be asked to confirm the deletion. It is possible to delete several OBs in one go, providing a space separated list of numbers, also in this case with all leading zeros. For instance to delete OB 3, 12, and 5, just enter 0003 0012 0005.

3.2.3. Copy an OB to another program

Some time it might be useful to move an OB from one program to another, normally in order to retrieve an unexecuted OB from a previous semester. This button provides this functionality. Just enter the number of the OB you want to copy, and select the destination program from the provided list, which includes only your program that are **unlocked**, you cannot move OBs to locked programs. Only one OB at the time can be copied.

3.2.4. Create OBs from an input list

One additional way to create OBs is to use an input list. To cope with the large number of instrument / observing mode combinations, and considering a given OB can be quite complicate, this tool is a sort of duplicating OBs rather than creating them from scratch, with the additional flexibility to change few

parameters: target name, RA, DEC, proper motion on RA y DEC, Position Angle, and finding chart. To use this tool follow these simple steps:

1) First of all create an OB to be used as template for all the new ones. There is no restriction on the type of OB to be used as template.

2) Then prepare a plain text file called "**phase2.tab**" (this name is mandatory), which will include one line for each new OB you want to create. Each line will contain **7 comma separated** values: target name, right ascension, declination, proper motion on RA, proper motion on DEC, field of view position angle, and finding chart name. Here is some examples:

```
Object1 , 10:10:10.10 , 20:30:40.23, 150, 75.3, 45.03, chartOne.jpg
NGC9999 , 10:20:30.40 , -20:30:40.23, 12.2, 0.3, 5.03, galaxy.jpg
QSO_1720-20 , 17:20:30.40 , -20:50:40.23, 0, 0, -45.67, lastChart.jpg
. . .
```

Please note all spaces will be ignored. The format for the coordinates, proper motion, as well as position angle must conform with the phase 2 standard. If the proper motion is not known or zero, simply write 0 in the corresponding columns as shown in the example above. The last column gives the name of the file containing the finding chart associated to the OB. In the case several OBs share the same finding chart, just repeat the name. Lines with less than 5 columns will be ignored, as well as extra columns.

3) Finally create a tar file including the **phase2.tab** table and **all the finding charts**. If a finding chart is shared by two or more OBs, include it only once. While there is no explicit limit on the number of lines to be included in the list, the tar file is limited to 100 Mb. Zip or gzip compression is not allowed.

Once you have created the template OB and the tar file, hit the "**Create OBs from a list**" button to access the multi-OBs creation form. At this time you are given the opportunity to select the OB that will be used as template. Select the tar file and hit again "**Create OBs from a list**". If the format of the file is correct, one new OB will be created for each correct line in the table.

We stress that all OBs will be identical to the template (except for the 6 parameters you are allowed to change). You can, however, use the same tar file more than once to circumvent this limitation.

3.3. The README file

The final step in order to complete the Phase-2 is to prepare a README file with additional information. This file is accessed by clicking on the Fill/Modify README file button from the summary page. Note this file is **very important** for the night astronomer to understand the purpose, method and objective of the observations. Also bear in mind that most probably the astronomer executing the observations will not be your contact support astronomer for the Phase-2 preparation, with who you may have discussed at length all the details of your observations. It is in the README file where you have the opportunity to directly instruct the astronomer who is going to actually execute the observations. Hence, the README file is the place where you can give all the information that you think may be helpful and relevant to the successful completion of the observations. Please prepare the README file with great care, fully describing any non-standard actions that the astronomer has to take during observations. Also bear in mind that this is not the place to repeat what you had already written in the original Phase-1 application. The README file is thought to include information relevant to the observations like, for instance, if there is a very bright star nearby the science target that you want to place outside the field

of view, or that a certain instrument position angle should be avoided to prevent charge bleeding from a bright target to affect your science target, etc.

The README file is divided in four main parts:

1. **Are observations time critical?** If your observations can be executed successfully at any time during the semester, then answer NO to this question and leave this section empty. Otherwise, answer YES and highlight all the time critical aspects of your observations. For instance, that you want to monitor a variable source and only one of your OBs should be executed every week. Or that you are interested in observing an eclipsing binary star during the eclipse, so that only certain dates are useful, also including in this section the list of useful dates. Or that your observations must be executed at the same time as other telescope or satellite is observing the same target, also in this case you must provide a list of useful dates. etc.

2. **Are targets non-sidereal?** If at least one of your targets is a Solar System moving object you must answer YES to this question. That is to say, at least one OB has an ephemeris file attached to it. Please include here whatever information you think will be useful for the night astronomer to know. If there are not non-sidereal targets at all in your proposal, the answer to this question shall be NO.

3. **Are special calibrations required?** As part of the normal observing procedure in queue-observing mode, whenever possible, the observatory will take a number of standard calibrations for the general use of programs that are executed during the night. These standard calibrations are summarized in the following list:

    - Photometric standard star with OSIRIS in broad-band imaging mode, in the Sloan filters (u, g, r, i and z), in the standard readout mode, i.e. readout speed 200 kHz and binning 2x2. Note that this standard may not necessarily be close (similar coordinates) to any of the science targets observed during the night. The standard star will be placed at the standard pointing position.

    - Spectrophotometric standard star observations with OSIRIS in long-slit spectroscopy mode for any of the grisms used during the night, using the 2.5 arcsec slit, and using the standard detector readout mode, i.e., readout speed 200 kHz and binning 2x2. Note that this standard may not necessarily be close (similar coordinates) to any of the science targets observed during the night. The standard star will be placed at the standard pointing position for long-slit spectroscopic mode.

    - OSIRIS bias using the standard detector readout mode.

    - Sky flats with OSIRIS in broad-band imaging mode, in the Sloan filters (u, g, r, i and z), in the standard readout mode. If for some reasons (i.e. bad weather conditions at twilight) the sky flats series cannot be obtained, a series of sky flats from the previous/next days will be provided.

    - Dome flats for narrow-band imaging mode when using Order Sorter filters for OSIRIS tunable filter. When possible, a sky flat series will be also attempted, but this is not ensured.

- Arc Lamps / Spectral Flats spectra with OSIRIS in Long-Slit Spectroscopy / Multi-Object Spectroscopy mode for any of the grisms/slit combination used during the night, using the standard detector readout mode.
- Dome flats for tunable-filter imaging or tunable-filter scan observations with OSIRIS, using the standard readout mode.
- Mid-IR standard star observations with CanariCam in imaging mode, with the Si5-11.6 and Q1-17.65 filters. Note that this standard may not necessarily be close to any of the science targets observed during the night.
- NIR standard star observations with CIRCE in imaging mode, with the J, H and Ks filters. Note that this standard may not necessarily be close to any of the science targets observed during the night.
- NIR standard star observations with EMIR in imaging mode, with the Y, J, H and Ks filters. Note that this standard may not necessarily be close to any of the science targets observed during the night.
- Arc Lamps / Spectral Flats spectra with EMIR in long-slit spectroscopy mode for any of the grisms/slit combination used during the night.
- Spectrophotometric standard star observations with MEGARA in IFU mode for any of the VPHs used during the night using the standard detector readout mode. Note that this standard may not necessarily be close (similar coordinates) to any of the science targets observed during the night.
- Arc Lamps / Spectral Flats spectra with MEGARA in IFU mode / Multi-Object Spectroscopy mode for any of the grisms/slit combination used during the night.

You can answer NO to the above question if the standard calibrations serve your purpose.

Other night-time calibrations will have to be explicitly defined as observing blocks and the time will be charged to the observing program. Since in these cases the observations are already defined as OBs you may still answer NO to the above question in the README file, for instance in cases like:

- OSIRIS+ photometric and spectro-photometric standard stars calibrations with non-standard binning.
- Spectro-photometric standard star observations for tunable-filter imaging or tunable-filter scan observations with OSIRIS+, using the standard readout mode.
- Mid-IR standard star observations with CanariCam in imaging mode with any filter other than the Si5-11.6 and Q1-17.65.
- Mid-IR standard star observations with CanariCam in spectroscopy mode.
- CIRCE standard stars calibrations with non-standard readout speed.
- EMIR imaging standard stars with narrow band filters.
- Telluric standard stars with EMIR in long slit / MOS spectroscopy mode.

If your program requires any calibrations that are not standard and cannot be defined as OBs, the answer to the question must be YES and you can provide a description of what you need. Some examples are:

- Any OSIRIS+ calibration frames (bias, arcs, flat fields) taken with non-standard binning.
- OSIRIS+ dark exposures.
- OSIRIS+ observations in imaging mode with a window using only a small area of the detector.
- Especially large series of bias or flat field exposures.
- Specific calibration targets or calibrations required at a specific moment during the night. In this case, it is also necessary to define the calibrations as OBs.

We finally note that in classical visitor mode the PI is responsible for defining all necessary calibrations.

4. **Description.** In this final section you describe all those aspects of the observations that did not find place in the previous sections. Again, bear in mind that this is what the night astronomer will have available at the time of observing so clearly highlight everything you feel is important for her/him to know. For instance if you want the OBs to be executed in a specific order following a sequence, or something similar, it should be declared/clarified here. Also comments like "please before moving to target YYY complete all blocks relative to target XXX" are very useful to achieve the desired science.

The Phase-2 tool allows to save preliminary version of the README file, coming back to modify it as many time as needed hitting the Fill/Modify README file button at the bottom part of the Phase-2 summary page.

3.4. Submitting the Phase 2 to GTC science operation

Once you are satisfied with your OBs and the README file, you are ready to submit the Phase-2 to GTC science operation and close the Phase-2 process. This is done in two steps, first click on the Fill/Modify README file button that is at the bottom of the Phase-2 summary page. Then, at the bottom of the README file form select the option "Save readme" and SUBMIT Phase-2 to GTC Science Operations, and then press "Continue". Once you close the Phase-2 process the proposal will be locked and no further changes will be possible.

For your convenience, the Phase-2 tool allows inspection of the OBs of locked proposal at any time, but no changes will be made on the GTC database. If you realize that you really need to modify an already completed Phase-2, or you have closed it by mistake, you have to contact your support astronomer that will provide to unlock it.

This last phase of locking the proposal triggers an assessment of the OBs by GRANTECAN personnel, and only when the OBs are verified then observations will be scheduled for their execution.

APPENDIX

A.1. OSIRIS+ Overheads

Each observation has associated some fixed overheads that cannot be avoided. Because of that, the user must be aware that certain actions might "cost" a lot in terms of time compared to others. Users are encouraged to minimize the overheads charged to their project. In particular, the use of non-standard readout mode and binning implies that the observatory will have to take, for instance, photometric standards in that particular setup. This time will be charged to the project, while standard calibrations are taken free of charge.

In the case of OSIRIS+ the Phase-2 preparation tool will include the following overheads:

- Ten minutes are charged to all OSIRIS+ observing blocks for telescope presetting, focusing, and target acquisition (guiding included).
- Thirty seconds for each setup of OSIRIS+ (for instance to change a filter or a mask).
- Ten seconds for each telescope offset.
- For imaging with the Tunable Filters, 10 additional minutes are charged for filter wavelength calibration.
- The overhead charged for each exposure according to CCD readout speed and binning is given in the following table:

Speed	***Binning***	***Time***	
200 kHz	2X2	21 seconds	(default readout mode)
200 kHz	2X1	32 seconds	
200 kHz	1X1	42 seconds	

As an example, Figure 53 shows a possible OB for OSIRIS LSS mode, asking for an acquisition image, through slit image, blind offset, and 7 exposures. The total duration of this OB is:

pointing	600 sec
setup acquisition image	30 sec
exptime acq. image	15 sec
readout acquisition	21 sec
Setup through slit image	30 sec
exptime through slit	15 sec
readout through slit	21 sec
blind offset	10 sec
setup first template	30 sec
(exptime+readout)*nexp	(100+21)*3
offsets	10*3
setup second template	30 sec
(exptime+readout)*nexp	(700+21)*4
offsets	10*4
---	---
Total duration	4119 seconds

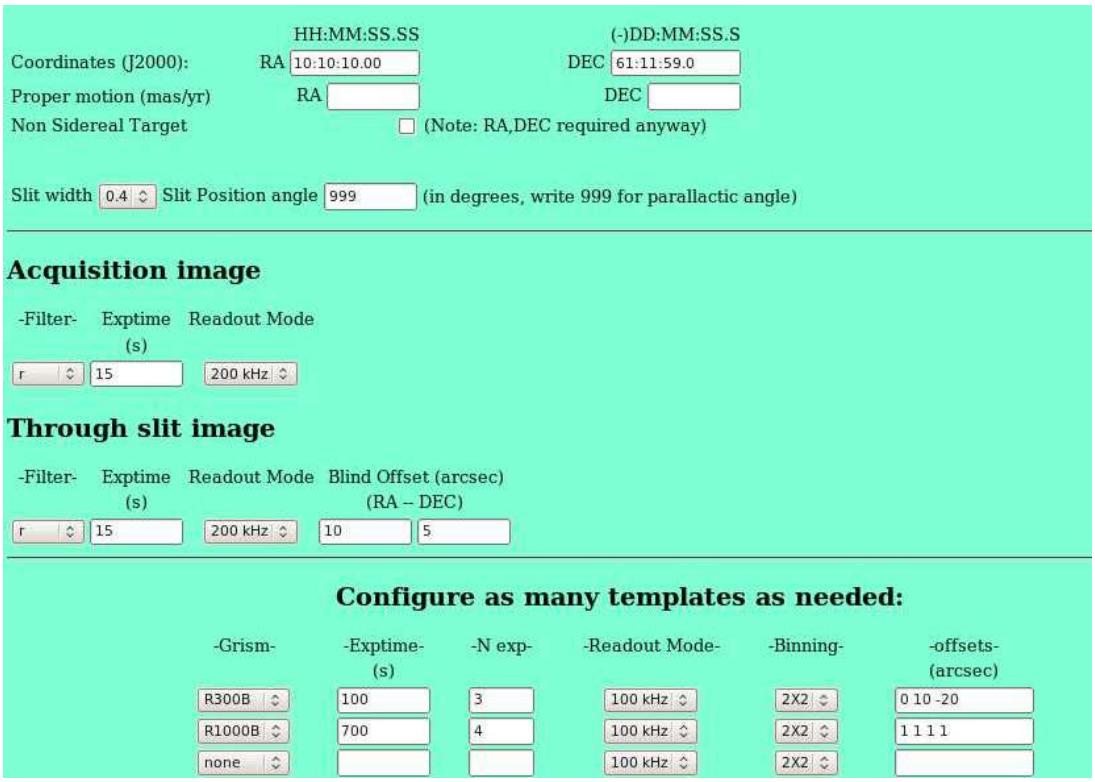


Figure 53: *Example of OSIRIS+ spectroscopic OB.*

A.2. CanariCam Overheads

Each observation has associated some fixed overheads that cannot be avoided. CanariCam has particularly high overheads due to the intrinsic nature of mid-infrared observations. Users are encouraged to minimize the overheads charged to their project. In the case of CanariCam the Phase-2 preparation tool will include the following overheads:

- All CanariCam observing blocks are charged 10 minutes for telescope presetting, focusing, and target acquisition (guiding included).
- For each instrument setup 30 seconds are charged (for instance to change a filter). Ten seconds are charged for each telescope offset.
- The time-loss factor in imaging and polarimetry modes is 3.1 times. That is, to integrate 1 minute on source, the total observing time needed is 3.1 minutes.
- The time-loss factor in spectroscopy and spectropolarimetry modes is 3.7. That is, to integrate 1 minute on source, the total observing time needed is 3.7 minutes.

As an example, Figure 54 shows a possible OB for CanariCam imaging mode, asking for an acquisition image and blind offset, and 7 exposures. The duration of this OB is:

pointing	600 sec
setup acquisition image	30 sec
exptime acq. image	60*3.1 sec
blind offset	10 sec
setup first template	30 sec
exptime*nexp	200*3.1*3 sec
offsets	10*3 sec
setup second template	30 sec
exptime*nexp	100*3.1*4 sec
offsets	10*4 sec
---	---
Total duration	4056 seconds

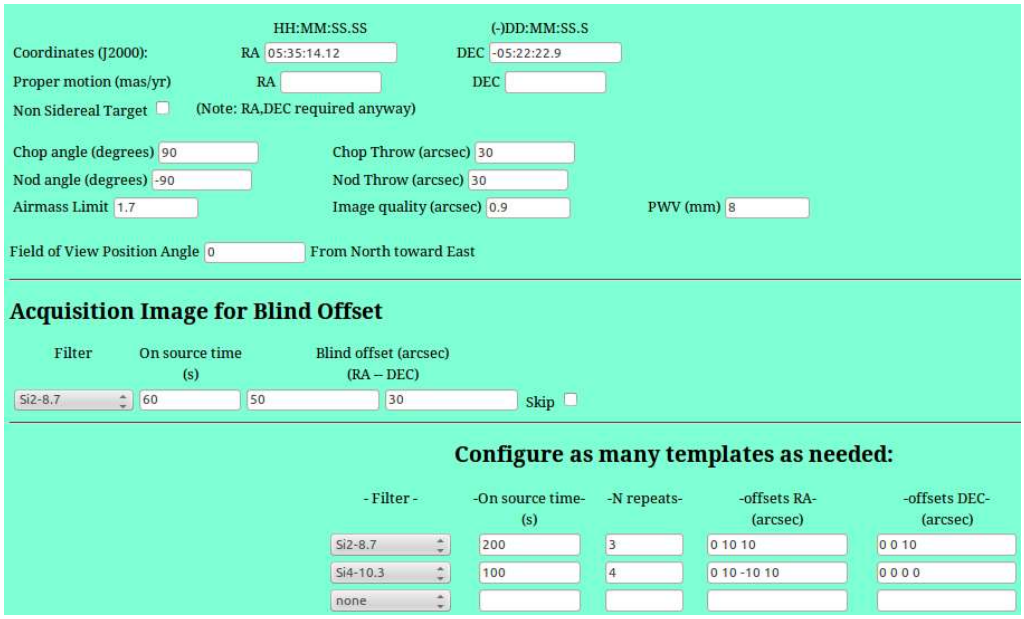


Figure 54: *Example of CanariCam imaging mode observations used for computing the OBs total duration.*

A.3. CIRCE Overheads

Each observation has associated some fixed overheads that cannot be avoided. Because of that, the user must be aware that certain actions might "cost" a lot in terms of time compared to others. Users are encouraged to minimize the overheads charged to their project. In particular, the use of non-standard modes implies that the observatory will have to take, for instance, photometric standards in that particular setup. This time will be charged to the project, while standard calibrations are taken free of charge.

In the case of CIRCE the Phase-2 preparation tool will include the following overheads:

- Ten minutes are charged to all CIRCE observing blocks for telescope presetting, focusing, and target acquisition.
- Ten seconds for each setup of CIRCE (for instance to change a filter)
- Five seconds for each telescope offset.
- Nine seconds for each CCD readout.

As an example, the total duration of the observation outlined in Figure 55 is 3638 seconds, computed as follow (note the first science template ask for a total of 12 images, while the second ask for 15):

pointing	600 sec
setup acquisition image	10 sec
exptime acq. image	20 sec
readout acquisition image	9 sec
setup first template	10 sec
(exptime+readout)*N exp*Nloop	(20+9)*3*4*3
offsets	5*4*3
setup second template	10 sec
(exptime+readout)*N exp*Nloop	(15+9)*5*3*5
offsets	5*3*5
---	---
Total duration	3638 seconds.

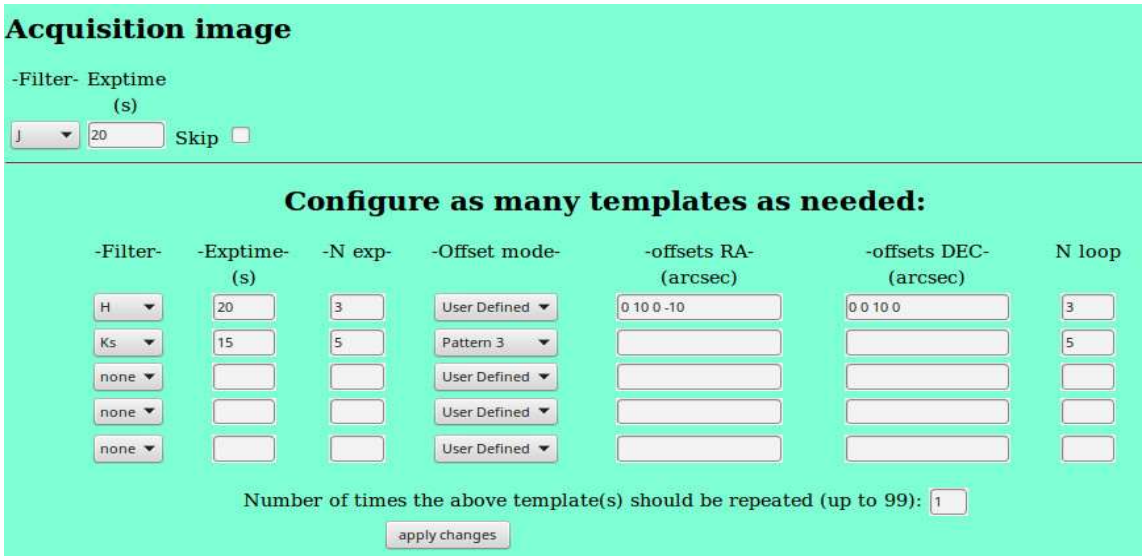


Figure 55: *Example of CIRCE observing block used for computing the overheads.*

A.4. EMIR Overheads

In the case of EMIR the Phase-2 preparation tool will include the following overheads:

- Ten minutes are charged to all EMIR observing blocks for telescope presetting, focusing, and target acquisition.
- Ten additional minutes will be added in long slit spectroscopy mode to account for the extra time to setup the focal plane mask (that needs to be done in certain predefined rotator orientations). This overhead is not included neither in long slit spectroscopy telluric standard mode or MOS spectroscopy mode, as the CSU is already configured in these modes.
- For each EMIR setup, sixty seconds are charged for changing a filter, while two minutes are considered for changing a grism.

- **Duty-cycles are 2 in imaging and 1.3 both in long slit and MOS spectroscopy with the new EMIR H2RG detector**. This is applied to the requested on-source exposure time, to take into account the readout of all subimages and telescope offsetting. The resulting overhead is the same for both possible detector configuration modes.

As an example, the total duration of the observation outlined in Figure 56 is 1760 seconds, computed as follows (acquisition and through slit of 4 seconds each, science spectrum of 240s):

pointing	600 sec
focal plane setup	600 sec
filter setup	60 sec
acquisition image	4 sec
filter setup	60 sec
throughslit image	4 sec
grism setup	120 sec
first science template	240*1.3 sec
----------	----------
Total duration	1760 seconds

In the case this same OBs would have asked also for sky exposures (imaging mode with "sky" flag active, or "Long slit spectroscopy Sky" mode), then it would be 240*1.3 seconds longer, that is 2072 s, because the same amount of time devoted to the science target is devoted to the sky.

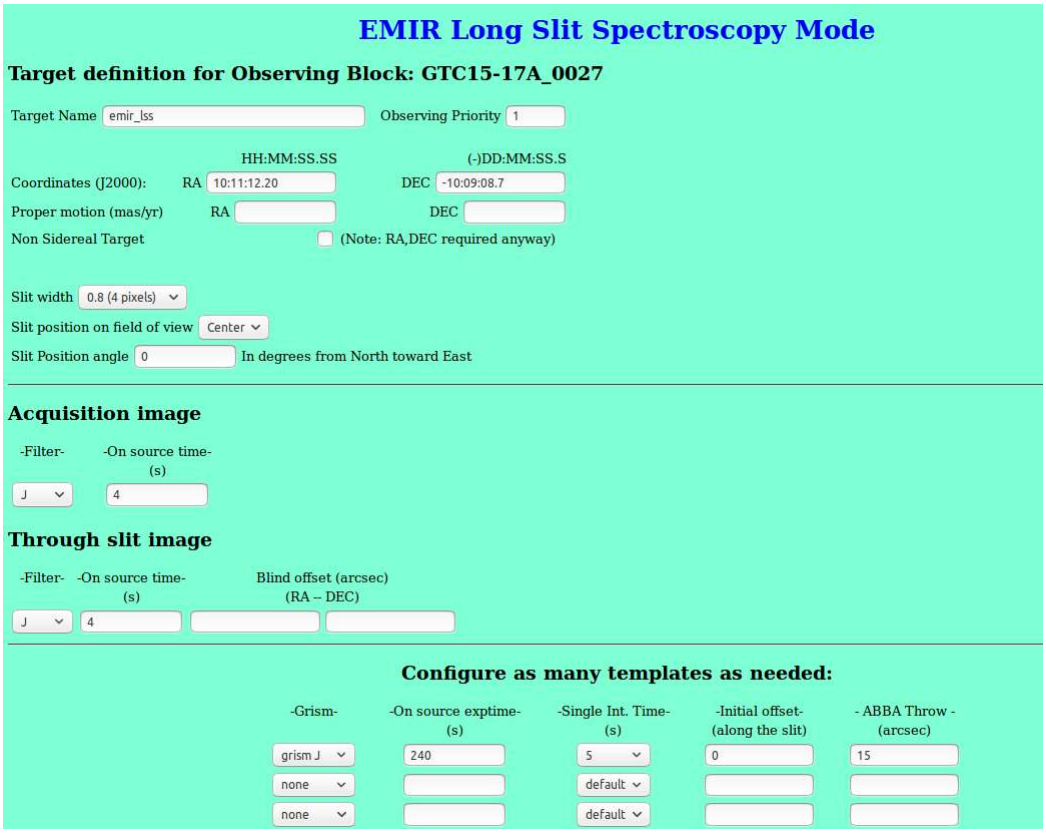


Figure 56: *Example of EMIR observing block used for computing the overheads.*

A.5. HiPERCAM Overheads

In the case of HiPERCAM, only ten minutes are charged to all observing blocks for telescope presetting, focusing, and target acquisition (i.e., to define observing windows).

A.6. MEGARA Overheads

In the case of MEGARA the Phase-2 preparation tool will include the following overheads:

- All MEGARA observing blocks are charged 10 minutes for telescope presetting, focusing, and target acquisition.
- In MOS mode, 5 additional minuted are required for the MOS setup.
- In the case the "half field of view" flag is active, 30 additional seconds are included to set up the covering mask.
- In the case the "in situ calibration" flag is active, 300 seconds are added by default to get in-situ trace maps. Note that the MEGARA spectrograph is sitting on one of the GTC Nasmyth-A platform, thus in general it is not necessary to calibrate right after the observation witht the telescope aiming at the target. However, if you chose to select this option to obtain also arc lamps, the exact amount of time required for the calibration, which is grism dependent, will be accounted for and charged to the program after completion of the OB. In some cases this can result in much more than the 5 minutes charged by default.
- For each instrument setup 30 seconds are charged (for instance to change the VPH).
- One CCD read out takes 53 seconds.

For instance, to complete the observation described in Figure 53, the OB duration is as follow:

pointing in IFU mode	600 s
half field plate setup	30 s
In situ calibrations	300 s
setup acquisition image	30 s
exptime+readout	60+53 s
Setup first template	30 s
(exptime+readout)*nexp	(600+53)*3 s
Setup second template	30 s
(exptime+readout)*nexp	(300+53)*1 s

(The time required for the two templates if furter multiplied by 2, because at the bottom of the form the "repeater" is set to 2).

Total duration time 5817 seconds

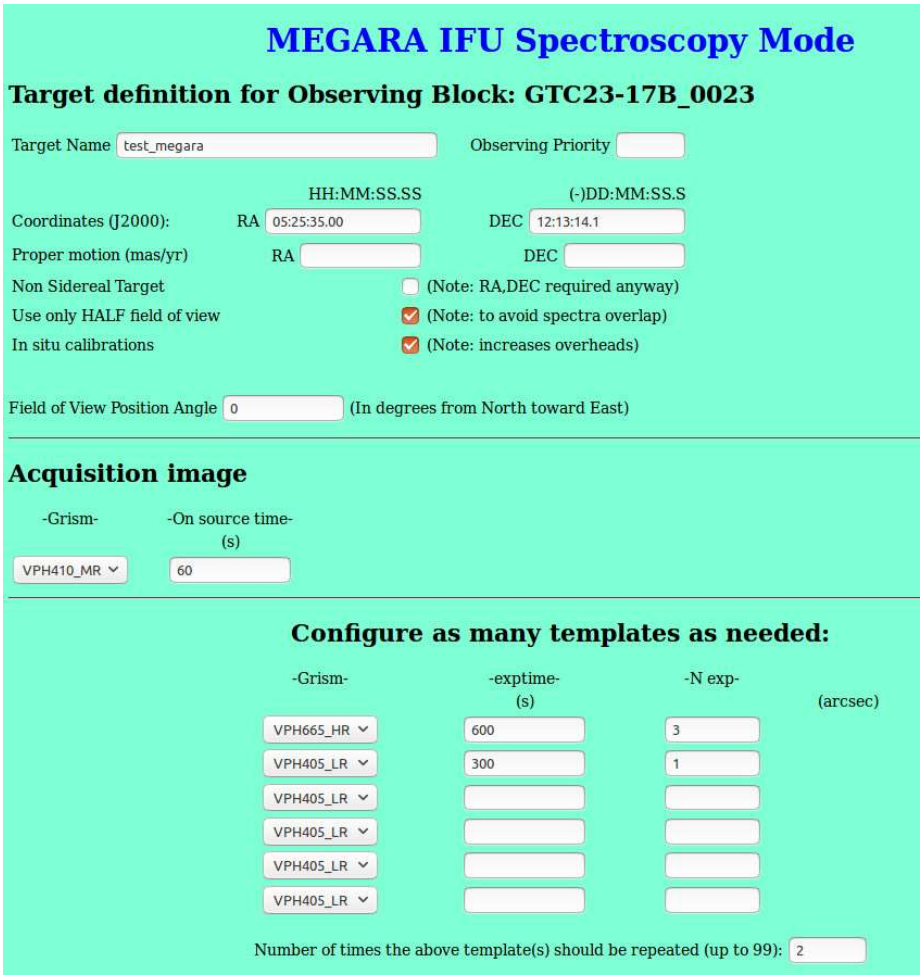


Figure 57: *Example of MEGARA observing block used for computing the overheads.*

A.7. HORuS Overheads

In the case of HORuS the Phase-2 preparation tool will include the following overheads:

- Ten minutes are charged to all observing blocks for telescope presetting, focusing, and target acquisition.

- Additionally, the time recquired for obtaining an OSIRIS image for centering in HORuS spectrograph will be considered with their associated overheads (that is, 30 s for setup and 21 s of readout time).

- The overhead charged for each exposure according to detector binning is given in the following table:

Binning	***Time***	
8X2	5 seconds	(default readout mode)
1X1	50 seconds	

A.8. Proper Motion definition

Note that most star catalogs, including Tycho2, quote proper motion on-the-sky (PmRA*, or PmRA*cos(Dec)) in mas/yr, while the SLALIB routines used by the GTC pointing software assume just PmRA in coordinates (i.e. with no cos(Dec) projection onto the sky). Therefore, please **check the proper motion definition assumed in the catalog used for the target coordinates definition**, especially in those high proper motion objects.