SOFI Template Signature File Parameter Reference Guide

Chris Lidman, Jean-Gabriel Cuby & Leonardo Vanzi

LSO-MAN-ESO-40100-7

issue 1.0

This document describes the Template Signature File (TSF) parameters for the NTT instrument SOFI.

Prepared . . . . . . Chris Lidman, Jean-Gabriel Cuby and Leonardo Vanzi. . . . .

Approved . . . . . Olivier Hainaut. . . . . April, 2002 . . . .

Released . . . . . . Olivier Hainaut. . . . . April, 2002. . . . .

Change record

Issue/ Revision	Date	Section/Paragraph affected	Reason/Remarks
0.1	August 1998	All	Created
0.2	September 1998	All	Added TSF parameter defaults
0.3	December 1998	All	Added New Templates
0.4	January 1999	Spectroscopic TSFs	Added new grism ranges
1.0	August 2000	Imaging, Spectroscopy, Calibrations	Added new Templates
1.1	April 2002	Imaging	a few corrections

Contents

1 Introduction

1.1 Purpose & Scope

This document is intended to provide descriptions of the SOFI template signature file parameters to P2PP users.

1.2 Intended Audience

It is intended for P2PP users. It is not a technical manual.

1.3 Applicable Documents

Applicable Documents are:

P2PP User Manual - VLT-MAN-ESO-19200-1644/1.1A

SOFI User's Manual - LSO-MAN-ESO-40100-0003/1.1

SOFI Commissioning Report - N-TRE-ESO-710-105/1.0

1.4 Abbreviations and Acronyms

AT Acquisition Template

CT Calibration Template

OT Observation Template

P2PP Phase 2 Proposal Preparation

RTD Real Time Display

SOFI Son OF Isaac.

1.5 Acknowledgments

The SOFI templates were created by Jean-Gabriel Cuby and Jens Knudstrup.

Later revisions were made by Chris Lidman and Leonardo Vanzi.

Thanks to Oliver Hainaut who read and commented on various drafts of this document.

1.6 Release Notes

This is draft release 1.1

2 SOFI Templates: A Reference Guide

This section provides a summary of the currently released SOFI templates. It is assumed that the reader is already familiar with the capabilities of SOFI. Information about SOFI may be found on-line at the NTT Web site (http://www.ls.eso.org/).

Other unreleased, prototype templates may be available at the telescope. Contact the NTT Team (nttt@eso.org) for further information.

SOFI has three types of templates: Observation Templates (OT) for science observations, Calibration Templates (CT) for calibration exposures and Acquisition Templates (AT) for target acquisition.

SOFI templates are maintained by the NTT Team (nttt@eso.org).

2.1 General Points

Not all parameters have default values. In those cases where there is no default value, the value is "NODEFAULT".

IMPORTANT!

For those parameters that require a string to be entered, for example the target name or the exposure name, spaces and special characters must **NOT** be used, only letters, numbers and _ (underscore) are allowed.

2.2 SOFI Acquisition Templates

Acquisition Templates (AT) determine how a target field is acquired by the telescope.

2.2.1 SOFI_img_acq_Preset

This acquisition template does a simple telescope preset (i.e. pointing) to the coordinates of the Target associated with the Observing Block. The Differential tracking rates can be set using TEL.TARG.ADDVELALPHA and TEL.TARG.ADDVELDELTA. There is no operator intervention.

To save time, the instrument and detector can be set to values that will be used in the first Observation Template attached with this Observing Block. With the exception of NDIT which should be set to 1 to save time, unless a deep acquisition image is required

It is the best template to use when pointing is not critical. The NTT points with an error of 1 arc second. Most observers will use this template.

.

Parameter	Default	Description
DET.DIT	NODEFAULT	DIT - Detector Integration Time (secs)
DET.NDIT	NODEFAULT	NDIT - Number of DITs
INS.FILT1.ID	NODEFAULT	Filter wheel 1
INS.FILT2.ID	NODEFAULT	Filter wheel 2
INS.IMODE	NODEFAULT	Instrument Mode
TEL.TARG.ADDVELALPHA	0	Additional tracking vel in RA (arscec/sec)
TEL.TARG.ADDVELDELTA	0	Additional tracking vel in DEC (arscec/sec)
TEL.ROT.OFFANGLE	0	Rotation Offset on Sky (degrees).

2.2.2 SOFI_img_acq_MoveToPixell

This acquisition has two parts. First, it presets the telescope to the coordinates of the Target associated with the Observation Block. It then requests the operator to interact with the RTD so that the user-specified object is moved to a user-specified location on the array.

In order for objects to be clearly seen, the telescope does a small offset after the preset. The size and direction of the offset are template parameters (TEL.TARG.OFFSETALPHA and TEL.TARG.OFFSETDELTA). The operator is then prompted to store a fixed pattern that is subsequently subtracted from incoming images. After storing the fixed pattern, the telescope returns to the original position. At this point in time the operator can change DIT and NDIT. If the operator changes these values, the telescope offsets again and the operator is required to store another fixed pattern before the telescope returns to the nominal position. This loop can continue until the operator has identified the target.

To move the target from one position of the array to another, the operator simply draws an arrow on the screen with the left hand button of the mouse. At this point a window, which lists the pixel co-ordinates at the start and the end of the arrow, will appear. The operator can accept the offsets, cancel, or edit the co-ordinates directly. If the offsets are accepted, the telescope offsets by the desired amount. Finally, the operator is given the possibility to redraw the arrow for refining the position of the target if necessary. Once the operator is satisfied, the template finishes

Guiding is possible (defaulted to BoxToStar) if SEQ.COMBINED.OFFSET is set to T and if guiding is on before the start of the template.

The SEQ.PRESET parameter allows the user to use the functionality of the template without presetting the telescope. The parameter SEQ.SAVE allows to save an acquisition image but the overhead time increases

The interactive pop-up windows are usually displayed before new images have arrived on the RTD. Therefore, operators are strongly advised to carefully check that a new image has arrived before clicking on these windows (e.g. for storing a fixed pattern, for changing the DIT/NDIT configuration).

Parameter	Default	Description
DET.DIT	NODEFAULT	DIT - Detector Integration Time (secs)
DET.NDIT	NODEFAULT	NDIT - Number of DITs
INS.FILT1.ID	NODEFAULT	Filter wheel 1
INS.FILT2.ID	NODEFAULT	Filter wheel 2
INS.IMODE	NODEFAULT	Instrument Mode
TEL.TARG.OFFSETALPHA	0	Alpha Offset(arcsec)
TEL.TARG.OFFSETDELTA	0	Delta Offset (arcsec)
TEL.TARG.ADDVELALPHA	0	Additional tracking vel in RA (arcsec/sec)
TEL.TARG.ADDVELDELTA	0	Additional tracking vel in DEC (arcsec/sec)
TEL.ROT.OFFANGLE	0	Rotation Offset on Sky (degrees).
SEQ.COMBINED.OFFSET	F	Combined offsets (T/F)
SEQ.PRESET	T	Preset telescope (T/F)
SEQ.SAVE	F	Save acquisition image

2.2.3 SOFI_img_acq_MoveToSlit

This acquisition template is very similar to the SOFI_img_acq_MoveToPixel template. The selected slit is displayed on the RTD and is superimposed on the image of the field. In most cases, operators will use the option to move the selected object to the centre of the slit.

Since each slit has a different position on the detector, the operator has to explicitly include the slit name (i.e. the 0.6, 1 or 2 arc second slits) in the template. This is done via the INS.WHICHSLIT parameter.

There is no way of checking if the slit that is chosen in the Acquisition Template and the slit that will be used subsequently in the Observation Template are the same. It is, therefore, of utmost importance that the astronomer ensures that they are the same.

Since the spectroscopic modes use the large field objective, the instrument mode is not a parameter of the template.

Parameters	Default	Description
DET.DIT	NODEFAULT	DIT - Detector Integration Time (secs)
DET.NDIT	NODEFAULT	NDIT - Number of DITs
INS.FILT1.ID	NODEFAULT	Filter wheel 1
INS.FILT2.ID	NODEFAULT	Filter wheel 2
INS.WHICHSLIT	NODEFAULT	Which Slit
TEL.TARG.OFFSETALPHA	0	Alpha Offset (arcsec)
TEL.TARG.OFFSETDELTA	0	Delta Offset (arcsec)
TEL.TARG.ADDVELALPHA	0	Additional tracking vel in RA (arcsec/sec)
TEL.TARG.ADDVELDELTA	0	Additional tracking vel in DEC (arcsec/sec)
TEL.ROT.OFFANGLE	0	Rotation Offset on Sky (degrees).
SEQ.COMBINED.OFFSET	F	Combined offsets (T/F)
SEQ.PRESET	T	Preset telescope. (T/F)
SEQ.SAVE	F	Save acquisition image

2.2.4 SOFI_img_acq_Polarimetry

This acquisition template is very similar to the SOFI_img_acq_MoveToPixel template. The polarimetric mask is displayed on the RTD and is superimposed on the image of the field. Therefore, the offset can be defined so as to properly position the object into the transparent region of the mask.

Since the POLARIMETRY mode uses the large field objective, the instrument mode is not a parameter of the template.

Parameters	Default	Description
DET DIT	NODEFAULT	DIT - Detector Integration Time (secs)
DET NDIT	NODEFAULT	NDIT - Number of DITs
INS FILT1 ID	NODEFAULT	Filter wheel 1
INS FILT2 ID	NODEFAULT	Filter wheel 2
TEL TARG OFFSETALPHA	0	Alpha offset (arcsec)
TEL TARG OFFSETDELTA	0	Delta offset (arcsec)
TEL TARG ADDVELALPHA	0	Additional tracking vel in RA (arcsec/sec)
TEL TARG ADDVELDELTA	0	Additional tracking vel in DEC (arcsec/sec)
TEL ROT OFFANGLE	0	Rotation Offset on Sky(degrees).
SEQ COMBINED OFFSET	F	Combined offsets (T/F)
SEQ PRESET	T	Preset telescope. (T/F)

2.3 SOFI Observation Templates

2.3.1 SOFI_img_obs_AutoJitter

This observation template offsets the telescope between exposures according to a random pattern of offsets automatically determined within the template. It is ideal for long integrations on empty fields, and does not require a long list of offsets to be defined.

Parameter	Default	Description
DET EXP NAME	SOFI	Exposure Name
DET DIT	NODEFAULT	DIT - Detector Integration Time (secs)
DET NDIT	NODEFAULT	NDIT - Number of DITs
DET.WIN.NX	1024	Number of columns
DET.WIN.NY	1024	Number of rows
DET.WIN.STARTX	1	First column of window
DET.WIN.STARTY	1	First row of window
SEQ NEXPO	1	Number of exposures
INS FILT1 ID	NODEFAULT	Filter wheel 1
INS FILT2 ID	NODEFAULT	Filter wheel 2
INS IMODE	NODEFAULT	Instrument Mode
SEQ COMBINED OFSET	F	Combined Offset (T/F)
SEQ JITTER WIDTH	40	Jitter Box Width (arcsec)
SEQ RETURN	T	Return to Origin (T/F)

The offsets are distributed randomly within a box whose size is defined by SEQ.JITTER.WIDTH (in arc seconds), with the condition that the distance between any two points in a series of ten values is greater than a specified minimum. This is intentionally done to ensure that the 5 frames before and after any frame are not too close spatially and can be safely used for creating skies without residual objects for sky subtraction.

By default, there is no telescope offset before the first exposure. If SEQ.RETURN is set to true (T), the telescope slews back to its original position at the end of the template. If not, the telescope is not moved. Should be set to T if more exposure of the same field are taken without running the corresponding AT

If SEQ.COMBINED.OFSET is set to T and if guiding was started before the start of the template, guiding is Box ToStar.

The value of SEQ.JITTER.WIDTH corresponds to the full width of the box in which the offsets are generated. Defining too wide a box may lead poor image overlap. Conversely, too small a value may lead to poor sky subtraction near extended objects. Setting this parameter to zero is equivalent to staring.

2.3.2 SOFI_img_obs_AutoJtterOffset

This observation template allows the user to move the telescope alternatively between a single object and several offset skies. When pointing to the object, the position of the telescope is randomly distributed within a box of size SEQ.JITTER.WIDTH (in arcsec).

The offset skies are at a constant distance (defined by SEQ.SKYTHROW) from the original telescope position, but at an angle randomly distributed between 0 and 360 degrees (i.e. the offset skies are distributed on a circle surrounding the initial telescope position).

Parameter	Default	Description
DET EXP NAME	SOFI	Exposure Name
DET DIT	NODEFAULT	DIT - Detector Integration Time (secs)
DET NDIT	NODEFAULT	NDIT - Number of DITs
DET.WIN.NX	1024	Number of columns
DET.WIN.NY	1024	Number of rows
DET.WIN.STARTX	1	First column of window
DET.WIN.STARTY	1	First row of window
SEQ NEXPO	1	Number of exposures
INS FILT1 ID	NODEFAULT	Filter wheel 1
INS FILT2 ID	NODEFAULT	Filter wheel 2
INS IMODE	NODEFAULT	Instrument Mode
SEQ COMBINED OFSET	F	Combined Offset (T/F)
SEQ JITTER WIDTH	40	Jitter Box Width (arcsec)
SEQ RETURN	T	Return to origin (T/F)
SEQ SKYTHROW	300	Sky Offset Throw (arcsec)
SEQ ROTPUPIL	T	Pupil Rotation

By default, there is no telescope offset before the first exposure.

If SEQ.RETURN is set to true (T), the telescope slews back to its original position at the end of the template. If not, the telescope is not moved.

It is assumed that odd numbered exposures are of the object, and are consequently identified as SCIENCE frames. Even numbered exposures are assumed to be sky frames, and are consequently identified as OTHER.

If the number of exposures is even, (SEQ NEXPO)/2 pairs of object/sky frames are produced. If the number of exposures is odd, then an extra sky frame is taken, and (SEQ NEXPO + 1)/2 pairs of object/sky frames are taken. Users are encouraged to give the parameter “SEQ NEXPO” an even value.

Guiding is only possible for the object frames, if SEQ.COMBINED.OFFSET is set to true (T) and guiding is started before the template starts. By default, there is no guiding for the sky frames and consequently the offsets between the object and the sky positions are always non-combined.

The template provides the possibility of rotating the rotator between object and sky frames to eliminate pupil ghosts. All object frames have the same position angle. The technique has been tested and has proved efficient. It is recommended to set SEQ.ROTPUPIL to T, particularly in high background situations.

This template can also be used to observe small extended objects by setting the throw small enough so that the object is always within the field of view. In such a case, however, SEQ.ROTPUPIL should be set to false (F).

SOFI Templates: A Reference Guide

Using this template with SEQ.JITTER.WIDTH set to zero is equivalent to staring on the object.

2.3.3 SOFI_img_obs_Jitter

This observation template allows the user to offset the telescope between exposures according to a list of offsets. The offsets in the list are relative to the previous position, they are in RA and DEC and they are in arcsec.

Telescope offsets are defined as lists in SEQ.OFFSETALPHA.LIST and SEQ.OFFSETDELTA.LIST.

Offset lists of varying length can become extremely confusing. It is good practice to use either lists with a single value or lists of equal length.

If SEQ.COMBINED.OFSET is set to T and if guiding was started before the start of the template, guiding is Box To Star. Guiding is usually not used in short exposure images unless parallel image analysis is done. In this latter case at least 3 minutes must be spent in each offset position.

If SEQ.RETURN is set to true (T), the telescope slews back to its original position at the end of the template. If not, the telescope is not moved.

Parameter	Default	Description
DET EXP NAME	SOFI	Exposure Name
DET DIT	NODEFAULT	DIT - Detector Integration Time (secs)
DET NDIT	NODEFAULT	NDIT - Number of DITs
DET.WIN.NX	1024	Number of columns
DET.WIN.NY	1024	Number of rows
DET.WIN.STARTX	1	First column of window
DET.WIN.STARTY	1	First row of window
SEQ NEXPO	1	Number of exposures
INS FILT1 ID	NODEFAULT	Filter wheel 1
INS FILT2 ID	NODEFAULT	Filter wheel 2
INS IMODE	NODEFAULT	Instrument Mode
SEQ COMBINED OFSET	F	Combined Offset (T/F)
SEQ RETURN	T	Return to Origin (T/F)
SEQ OFFSETALPHA.LIST	NODEFAULT	RA offsets list (arcsec)
SEQ OFFSETDELTA LIST	NODEFAULT	DEC offset list (arcsec)

As an example the parameters:

Parameter	Value
SEQ NEXPO	10
SEQ OFFSETALPHA.LIST	0. 5. -10. 2.5 5.
SEQ OFFSETDELTA LIST	0. 5. -10. 2.5 5.

produces the following sequence of events

Frame #	ALPHA Offset	DELTA Offset
1	0.	0.
2	5.	5.
3	-10	-10
4	2.5	2.5
5	5.	5.
6	0.	0.
7	5.	5.
8	-10	-10
9	2.5	2.5
10	5.	5.

2.3.4 SOFI_img_obs_JitterOffset

This observation template is very similar to SOFI_img_obs_AutoJitterOffset. The only difference is that the user fully specifies the offsets in SEQ.OFFSETALPHA.LIST and SEQ.OFFSETDELTA.LIST.

Parameter	Default	Description
DET EXP NAME	SOFI	Exposure Name
DET DIT	NODEFAULT	DIT - Detector Integration Time (secs)
DET NDIT	NODEFAULT	NDIT - Number of DITs
DET.WIN.NX	1024	Number of columns
DET.WIN.NY	1024	Number of rows
DET.WIN.STARTX	1	First column of window
DET.WIN.STARTY	1	First row of window
SEQ NEXPO	1	Number of exposures
INS FILT1 ID		Filter wheel 1
INS FILT2 ID		Filter wheel 2
INS IMODE	NODEFAULT	Instrument Mode
SEQ COMBINED OFSET	F	Combined Offset (T/F)
SEQ RETURN	T	Return to origin (T/F)
SEQ OFFSETALPHA.LIST	NODEFAULT	RA offsets list (arcsec)
SEQ OFFSETDELTA LIST	NODEFAULT	DEC offset list (arcsec)
SEQ ROTPUPIL	T	Pupil Rotation

It is assumed that offsets are given so that the telescope alternates between object (odd numbered frames) and sky. The object frames are identified as SCIENCE, and the sky frames are identified as OTHER.

2.3.5 SOFI_img_obs_GenericImaging

This observation template has the flexibility to do any sequence of telescope offsets whether they be combined offsets (offsetting the telescope and guideprobe) or non-combined offsets (offsetting the telescope alone). With this flexibility comes complexity. This is a complex template and

is meant to cover situations that cannot be covered by the more specific templates, which are described later. You should only use this template if none of the other templates are suitable

Parameter	Default	Description
DET EXP NAME	SOFI	Exposure Name
DET DIT	NODEFAULT	DIT - Detector Integration Time (secs)
DET.WIN.NX	1024	Number of columns
DET.WIN.NY	1024	Number of rows
DET.WIN.STARTX	1	First column of window
DET.WIN.STARTY	1	First row of window
SEQ NEXPO	1	Number of Exposures
SEQ NDIT LIST	NODEFAULT	List of NDIT
INS FILT1 ID	NODEFAULT	Filter wheel 1
INS FILT2 ID	NODEFAULT	Filter wheel 2
INS IMODE	NODEFAULT	Instrument Mode
SEQ RETURN	T	Return to Origin Flag (T/F)
SEQ OFFSETALPHA LIST	NODEFAULT	RA offset list (arcsec.)
SEQ OFFSETDELTA LIST	NODEFAULT	DEC offset list (arcsec.)
SEQ OBSTYPE LIST	NODEFAULT	Observation type (S or O)
SEQ GUIDING LIST	NODEFAULT	Guiding (N, S or B)

Telescope offsets and guiding options are defined as lists in SEQ.OFFSETALPHA.LIST, SEQ OFFSETDELTA.LIST and SEQ.GUIDING.LIST. The offsets are relative to the previous position, they are in RA and DEC and they are in arcsec.

There are three guiding options: N, B or S. For option N, the offsets are non-combined. Option B stands for Box To Star. In this case the telescope offsets by first moving with a non-combined offset to the position where guiding was last enabled, and from there with a combined offset to the new position. Guiding is then started with Box To Star. Option S stands for Star To Box, and the offsets are handled as for B, except that guiding is resumed with Star To Box.

With large combined offsets, the guide probe may not be able to follow the one guide star. In such a case, the guiding system will automatically find another star, and resume guiding.

If any of the entries in SEQ.GUIDING.LIST are different from N, and if guiding is off at the beginning of the template, a pop up window prompts the operator to start guiding.

A list is also provided for NDIT (SEQ.NDIT.LIST), but not for DIT.

Additionally, the observation type can be defined for each image, and is entered as a list in SEQ.OBSTYPE.LIST. O stands for Object and S stands for Sky. This is to help the pipeline decide which frame is an image of the sky and which frame is an image of the object.

The total number of exposures is defined in SEQ.NEXPO. This number can differ from the number of elements in the aforementioned lists. Lists do not need to have the same length. If the number of exposures is larger than the number of elements in a list, the list is restarted from the beginning as many times as needed until the correct number of frames have been acquired.

At the end of the template, the telescope is returned to the original position, if SEQ.RETURN is set to true (T). If not, the telescope is not moved at the end of the template.

The lists can have any length; however having lists of different lengths can become extremely confusing. It is good practice to use either lists of one value, and/or lists of equal length. As an example, the parameters

Parameter	Value
SEQ NEXPO	10
DET.NDIT.LIST	3 2 1
SEQ OFFSETALPHA.LIST	0. 5. -10. 2.5 5.
SEQ OFFSETDELTA.LIST	0. 5. -10. 2.5 5.
SEQ OBSTYPE LIST	O S O S O
SEQ GUIDING LIST	N

produce the following sequence of events:

Frame #	NDIT	ALPHA Offset	DELTA Offset	OBSTYPE	GUIDING
1	3	0.	0.	O	N
2	2	5.	5.	S	N
3	1	-10.	-10	O	N
4	3	2.5	2.5	S	N
5	2	5	5	O	N
6	1	0	0.	O	N
7	3	5	5	S	N
8	2	-10	-10	O	N
9	1	2.5	2.5	S	N
10	3	5	5	O	N

2.3.6 SOFI_img_obs_AutoJitterArray

This template is very similar to SOFI_img_obs_Jitter, it allows to define a sequence of offsets in RA and DEC and to jitter randomly around each of the defined positions. It is useful to build maps of large areas of the sky

Parameter	Default	Description
DET EXP NAME	SOFI	Exposure Name
DET DIT	NODEFAULT	DIT - Detector Integration Time (secs)
DET NDIT	NODEFAULT	NDIT - Number of DITs
DET.WIN.NX	1024	Number of columns
DET.WIN.NY	1024	Number of rows
DET.WIN.STARTX	1	First column of window
DET.WIN.STARTY	1	First row of window
SEQ NEXPO	1	Number of exposures in the Array
SEQ.NJITT	1	Number of Jittered exposures around each Array position
SEQ.JITTER.WIDTH	40	Jitter Box Width (arcsec)
INS FILT1 ID		Filter wheel 1
INS FILT2 ID		Filter wheel 2
INS IMODE	NODEFAULT	Instrument Mode
SEQ COMBINED OFSET	F	Combined Offset (T/F)
SEQ RETURN	T	Return to origin (T/F)
SEQ OFFSETALPHA.LIST	NODEFAULT	RA offsets list (arcsec)
SEQ OFFSETDELTA LIST	NODEFAULT	DEC offset list (arcsec)

SEQ OFFSETALPHA.LIST and SEQ OFFSETDELTA LIST are used to define the map on the sky, the offsets are relative, the number of positions in the map is defined by the parameter SEQ.NEXPO. It is possible to randomly jitter around each position of the map within a box whose size is set by SEQ.JITTER.WIDTH. The number of jittered frames is SEQ.NJITT. The total number of frames acquired by this template will be SEQ.NEXPO x SEQ.NJITT.

A modified version of this template is called SOFI_img_obs_AutoJitterArray_1. It does the same thing as the original template but in a different order. Exposures are taken at the positions of the array as defined by the offsets lists, then the random offset is applied and the array pattern executed again.

2.3.7 SOFI_img_obs_Polarimetry

This observation template is used for polarimetry. Telescope offsets are defined in SEQ.OFFSETX.LIST and SEQ.OFFSETY.LIST and are defined along detector rows and columns in arcsec, so that the users can move the object easily along the strips of the polarimetric mask.

Additionally, all frames can be given an orientation relative to the previous position angle, by setting SEQ.ROT.OFFANGLE parameter (degrees). When the template starts, the instrument is rotated on the sky by SEQ.ROT.OFFANGLE, and remains at this position until the end of the template. After the last exposure, the instrument is rotated back to the original position.

With this scheme, it is possible for the user to sample the object and the sky as desired for one rotator position, and then restart the template with another orientation on the sky for another series of exposures. At least two different orientations, separated by 45 degrees, are required for computing the Stoke's parameters. This implies that the template is called at least twice within an Observation Block, or with two different Observation Blocks, both with two different rotator positions. The most likely situation will be to set SEQ.ROT.OFFANGLE to 0 degrees in the first template, and then to 45 degrees in the second template. Guiding is possible (defaulted to BoxToStar) if SEQ.COMBINED.OFSET is set to T and if guiding was started before the start of the template.

If SEQ.RETURN is set to true (T), the telescope slews back to its original position at the end of the template. If not, the telescope is not moved.

The instrument mode is not a parameter of this template.

Parameter	Default	Description
DET EXP NAME	NODEFAULT	Exposure Name
DET DIT	NODEFAULT	DIT - Detector Integration Time (secs)
DET NDIT	NODEFAULT	NDIT - Number of DITs
DET.WIN.NX	1024	Number of columns

Parameter	Default	Description
DET.WIN.NY	1024	Number of rows
DET.WIN.STARTX	1	First column of window
DET.WIN.STARTY	1	First row of window
SEQ NEXPO	1	Number of exposures
INS FILT1 ID	NODEFAULT	Filter name in wheel 1
INS FILT2 ID	NODEFAULT	Filter name in wheel 2
SEQ COMBINED OFSET	F	Combined Offset (T/F)
SEQ RETURN	T	Return to origin (T/F)
SEQ OFFSETX LIST	NODEFAULT	X offset list (arcsec)
SEQ OFFSETY LIST	NODEFAULT	Y offset list (arcsec)
SEQ ROT OFFANGLE	0	Rotator offset (degrees)

2.3.8 SOFI_spec_obs_AutoNodOnSlit

This observation template nods the telescope between two positions (A and B) along the slit. A cycle is a pair of AB or BA observations. Cycles are repeated on ABBA sequences. E.g. 3 cycles corresponds to an ABBAAB sequence, 4 cycles correspond to an ABBAABBA sequence, etc.

Parameter	Default	Description
DET EXP NAME	SOFI	Exposure Name
DET DIT	NODEFAULT	DIT - Detector Integration Time (secs)
DET NDIT	NODEFAULT	NDIT - Number of DITs
DET.WIN.NX	1024	Number of columns
DET.WIN.NY	1024	Number of rows
DET.WIN.STARTX	1	First column of window
DET.WIN.STARTY	1	First row of window
INS SMODE	NODEFAULT	Spectroscopic Mode
INS WHICHSLIT	NODEFAULT	Which Slit
SEQ COMBINED OFSET	F	Combined Offset (T/F)
SEQ JITTER WIDTH	40	Jitter Box Width (arcsec)
SEQ RETURN	T	Return to Origin
SEQ NODTHROW	60	Nod Throw(arcsec)
SEQ NINT	1	NINT - Number of frames at each position
SEQ NABCYCLES	1	Number of AB or BA cycles

The mean amplitude of the nod is defined by SEQ.NODTHROW (in arcsec). The first exposure (A) is done after offsetting the object along the slit by - (SEQ.NODTHROW)/2 arcsec, which can be either negative or positive. The second exposure (B) is therefore (SEQ.NODTHROW)/2 arcsec from the initial position along the slit.

In addition to nodding, random offsets can be added in the middle of a cycle. A sequence of 4 cycles with jittering will result in the following sequence:

$$A(B+\varepsilon_1)(B+\varepsilon_1)(A+\varepsilon_2)(A+\varepsilon_2)(B+\varepsilon_3)(B+\varepsilon_3)(A+\varepsilon_4)$$

where ε_N are random offsets. The random offsets are generated inside an interval defined by SEQ.JITTER.WIDTH (in arcsec). If SEQ.JITTER.WIDTH is set to zero, then the template will just nod between A and B.

If SEQ.COMBINED.OFSET is set to T and if guiding was started before the start of the template the telescope will guide with Box to Star. Guiding is recommended.

The template has been optimised to minimise overheads. After a telescope offset, one or more DITs are skipped. Otherwise, when the telescope is not moved between frames (i.e. when NINT > 1, or at the beginning of a new cycle) all DITs are kept.

At the end of the template, the telescope returns to the original position if SEQ RETURN is true (T). If not, the telescope is not moved at the end of the template.

The total number of frames corresponds to SEQ.NABCYCLES x SEQ.NINT x 2.

2.3.9 SOFI_spec_obs_AutoNodNonDestr

This template is identical to the previous one but the detector is read in the non destructive read out mode, it is useful for spectroscopy of very faint objects since the read out noise is smaller than in the double correlated read out mode. There are only 2 additional parameters with respect to the SOFI_spec_obs_AutoNodOnSlit

Parameter	Default	Description
DET NSAMP	4	Number of Samples
DET NSAMPIX	4	Sample Number per Reading

During the integration the signal is sampled a number of times defined by DET.NSAMP. The largest the number of samples the lowest the read out noise. However DET.NSAMP must not exceed 60, above this value in fact the glowing of the shift registers become the dominant source of noise. For long integrations DET.NSAMP between 20 and 40 is advisable. A way to further low the read out noise keeping DET.NSAMP small enough is to sample the video signal more than once. The number of sampling of the video signal is DET.NSAMPIX, 4 is a good number for this parameter. For long integrations DIT should not exceed 300 sec

2.3.10 SOFI_spec_obs_GenericSpectro

This observation template is for spectroscopy and has the flexibility to do any sequence of telescope offsets whether they be combined offsets (offset the telescope and guideprobe) or non-combined offsets (offset the telescope alone). With this flexibility comes complexity. This is a complex template and is meant to cover situations that cannot be covered by the SOFI_spec_obs_AutoNodOnSlit. You should only use this template if SOFI_spec_obs_AutoNodOnSlit is unsuitable.

Parameter	Default	Description
DET EXP NAME	SOFI	Exposure Name
DET DIT	NODEFAULT	DIT - Detector Integration Time (secs)
DET NDIT	NODEFAULT	NDIT - Number of DITs

Parameter	Default	Description
DET.WIN.NX	1024	Number of columns
DET.WIN.NY	1024	Number of rows
DET.WIN.STARTX	1	First column of window
DET.WIN.STARTY	1	First row of window
SEQ NEXPO	1	Number of Exposures
INS SMODE	NODEFAULT	Spectroscopic Mode
INS WHICHSLIT	NODEFAULT	Which Slit
SEQ RETURN	T	Return to Origin (T/F)
SEQ OFFSETX LIST	NODEFAULT	X offset list (arcsec)
SEQ OFFSETY LIST	NODEFAULT	Y offset list (arcsec)
SEQ.OBSTYPE.LIST	NODEFAULT	Observation Type (S or O)
SEQ.GUIDING.LIST	NODEFAULT	Guiding (N B or S)

Telescope offsets and guiding options are defined as lists in and SEQ.OFFSETX.LIST, SEQ.OFFSETY.LIST and SEQ.GUIDING.LIST. Telescope offsets are relative to the previous position, they are defined along detector lines (X) and columns (Y), and they are in arcsec. With the N-S direction along the X axis (N to the left-negative and S to the right-positive) and E-W along the Y axis (E down-negative and W up-positive)

There are three guiding options N, B or S. For option N, the offsets are non-combined. Option B stands for Box To Star. In this case the telescope offsets by first moving with a non combined offset to the position where guiding was last enabled, and from there with a combined offset to the new position. Guiding is then started with Box To Star. Option S stands for Star To Box, and the offsets are handled as for B, except that guiding is resumed with Star To Box.

With large combined offsets, the guide probe may not be able to follow the one guide star. In such a case, the guiding system will automatically find another star, and resume guiding.

If any of the entries in SEQ.GUIDING.LIST are different from N, and if guiding is off at the beginning of the template, a pop up window prompts the user to start guiding.

Additionally, the observation type can be defined for each image, and entered as a list in SEQ.OBSTYPE.LIST. O stands for Object and S stands for Sky.

This template allows slit scanning across an object by defining a list of offsets in the y direction (perpendicular to the slit direction).

This template cannot by nature be easily optimised. After each exposure, one or more DITs are skipped.

At the end of the template, the telescope is returned to the original position if SEQ.RETURN is set to true (T). If not, the telescope is not moved at the end of the template.

The lists can have any length; however having lists of different lengths can become extremely confusing. It is good practice to use either lists of one value, or lists of equal length.

2.3.11 SOFI_spec_obs_GenSpecNonDestr

This template is identical to SOFI_spec_obs_AutoNodNonDestr but for the Generic Spectroscopy.

2.4 SOFI Calibration Template

2.4.1 SOFI_img_cal_StandardSatr

This calibration template is intended for standard star observations in one filter. If standards have to be observed in different filters, this template has to be called as many times as necessary, with the appropriate filter defined in each template call.

The telescope can be offset so as to position the object at different positions on the array. Offsets are defined along detector rows and columns, and are entered into SEQ.OFFSETX.LIST and SEQ.OFFSETY.LIST. Offsets are in arcsec.

Guiding is possible (defaulted to BoxToStar) if SEQ.COMB.OFFSET is set to true (T) and if guiding was started before the start of the template.

If SEQ.RETURN is set to true (T), the telescope slews back to its original position at the end of the template. If not, the telescope is not moved.

Parameter	Default	Description
DET EXP NAME	SOFI	Exposure Name
DET DIT	NODEFAULT	DIT - Detector Integration Time (secs)
DET NDIT	NODEFAULT	NDIT - Number of NDITs
DET.WIN.NX	1024	Number of columns
DET.WIN.NY	1024	Number of rows
DET.WIN.STARTX	1	First column of window
DET.WIN.STARTY	1	First row of window
SEQ NEXPO	1	Number of exposures
INS FILT1 ID	NODEFAULT	Filter wheel 1
INS FILT2 ID	NODEFAULT	Filter wheel 2
INS IMODE	NODEFAULT	Instrument Mode
SEQ COMB OFFSET	NODEFAULT	Combined Offset (T/F)
SEQ RETURN	NODEFAULT	Return to Origin (T/F)
SEQ OFFSETX LIST	NODEFAULT	X offset list (arcsec)
SEQ OFFSETY LIST	NODEFAULT	Y offset list (arcsec)

2.4.2 SOFI_img_cal_Darks

This calibration template produces dark frames, both for imaging and spectroscopy. The instrument is set to the DARK mode, where both filter wheels and the grism wheel are in the closed position.

The number of frames is defined in SEQ.NEXPO. Dark frames can be taken with different DIT and NDIT values, defined as lists in SEQ.DIT.LIST and SEQ.NDIT.LIST.

Note that SEQ.DIT.LIST and SEQ.NDIT.LIST do not need to have the same length. If the number of exposures is larger than the number of elements in a list, then the list is restarted from the beginning, as many times as needed until the correct number of frames have been acquired.

This template should be used to take dark frames at the end of the night for all the detector integration times that have been used during the night, though it is not strictly necessary since the dark signal will be removed along with the subtraction of the sky background

Parameter	Default	Description
DET EXP NAME	SOFI	Exposure Name
DET.WIN.NX	1024	Number of columns
DET.WIN.NY	1024	Number of rows
DET.WIN.STARTX	1	First column of window
DET.WIN.STARTY	1	First row of window
SEQ NEXPO	1	Number of exposures
SEQ DIT LIST	NODEFAULT	List of DITs
SEQ NDIT LIST	NODEFAULT	List of NDITs

2.4.3 SOFI_spec_cal_Arcs

This calibration template takes arc spectra with the calibration unit. The calibration mirror is automatically inserted at the beginning of the template, and is automatically removed at the end.

The number of arc frames is defined by SEQ.NEXPO. Arc frames can be taken with different DIT and NDIT values, defined as lists with SEQ.DIT.LIST and SEQ.NDIT.LIST. SEQ.SPEC-TROMODELIST defines the spectroscopic mode, entered as a list with either B, R, Z, J, H, K or NB_1.061 standing for the available spectroscopic modes. In addition, different slits can be called sequentially, with SEQ.SLIT.LIST. The allowed values are 1, 2 or 0.6, for long_slit_1, long_slit_2 and long_slit_0.6 respectively. Finally, the arc lamps are entered into SEQ.LAMP.LIST. Valid values are N, Xe, Ne or B. N stands for None, Xe stands for Xenon, Ne stands for Neon, and B stands for Both, i.e. Xenon and Neon lamps simultaneously. Unlike SOFI_spec_cal_Flats, exposures with the lamp off are not associated to unique arc frames. A single exposure with the lamp off should prove sufficient.

Lists do not need to have the same lengths. If the number of exposures is larger than the number of elements in a list, then the list is restarted from the beginning, as many times as needed until the correct number of frames have been acquired.

There is no parameter checking for SEQ.SPECTROMODELIST or SEQ SLIT.LIST. Entering 0.99 into SEQ.SLIT.LIST will result in an error when the template is executed. Values of 1 or 1. or 1.0 are however accepted for long_slit_1

Parameter	Default	Description
DET EXP NAME	SOFI	Exposure Name
DET.WIN.NX	1024	Number of columns
DET.WIN.NY	1024	Number of rows
DET.WIN.STARTX	1	First column of window
DET.WIN.STARTY	1	First row of window
SEQ NEXPO	1	Number of exposures
SEQ DIT LIST	NODEFAULT	List of DITs
SEQ NDIT LIST	NODEFAULT	List of NDITs
SEQ SPECTROMODELIST	NODEFAULT	List of Spectroscopic modes (B or R)
SEQ SLIT LIST	NODEFAULT	Slit list: 1, 2 or 0.6
SEQ LAMP LIST	NODEFAULT	Arc lamp list (N, Xe, Ne, B)

2.4.4 SOFI_img_cal_DomeFlats and SOFI_img_cal_SpecialDomeFlats

Imaging dome flats are taken with these calibration template. For each element in SEQ.DIT.LIST and SEQ.NDIT.LIST, four images are taken: one with the dome lamp off, two with the dome lamp on and a fourth with the dome lamp off.

SOFI_img_cal_SpecialDomeFlats takes an additional set of images with the aperture wheel partially masking the array. These images are used to estimate the bias pattern. The reasons for using this template rather than the first are explained in the SOFI User's manual.

The intensity of the dome lamp is controlled manually.

Parameter	Default	Description
DET EXP NAME	SOFI	Exposure Name
DET.WIN.NX	1024	Number of columns
DET.WIN.NY	1024	Number of rows
DET.WIN.STARTX	1	First column of window
DET.WIN.STARTY	1	First row of window
SEQ NEXPO	1	Number of exposures
SEQ DIT LIST	NODEFAULT	List of DITs
SEQ NDIT LIST	NODEFAULT	List of NDITs
INS FILT1 ID	NODEFAULT	Filter wheel 1
INS FILT2 ID	NODEFAULT	Filter wheel 2
INS IMODE	NODEFAULT	Instrument Mode

2.4.5 SOFI_spec_cal_DomeFlats

Spectroscopic dome flats are taken with this calibration template. For each element in SEQ.DIT.LIST and SEQ.NDIT.LIST, four images are taken: one with the dome lamp off, two with the dome lamp on and a fourth one with the dome lamp off.

The intensity of the dome lamp is controlled manually.

Parameter	Default	Description
DET EXP NAME	SOFI	Exposure Name
DET.WIN.NX	1024	Number of columns
DET.WIN.NY	1024	Number of rows
DET.WIN.STARTX	1	First column of window
DET.WIN.STARTY	1	First row of window
SEQ NEXPO	1	Number of exposures
SEQ DIT LIST	NODEFAULT	List of DITs
SEQ NDIT LIST	NODEFAULT	List of NDITs

Parameter	Default	Description
SEQ SPECTROMODELIST	NODEFAULT	List of Spectroscopic modes (B or R)
SEQ SLIT LIST	NODEFAULT	Slit list: 1, 2 or 0.6

2.4.6 SOFI_spec_cal_NonDestrDomeFlats

In the spectroscopic observations it is important that the flat fields are taken with the same read out mode as the science frames. This is done with the template SOFI_spec_cal_NonDestrDomeFlats. It is not crucial that NSAMP and NSAMPIX are the same for the science frames and calibrations, in particular this is impossible when the DIT of the scientific exposure is long as it is usually the case. Good values for the parameters of the NonDestrDomeFlat templates are, in this case, DIT=10, NSAMP=6, NSAMPIX=4