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Very Large Telescope

HAWK-I
Template Reference Guide

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Change Record

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Contents

1 Introduction

1.1 Purpose and Scope

This document describes in some detail the observing, calibration and technical templates for HAWK-I. The tables and descriptions are based on the HAWK-I Instrument Package (IP) version 127.19.

1.2 Instrument Summary

HAWK-I is a wide-field ($7.5' \times 7.5'$), NIR (0.9-2.5 μm) camera operating only in direct imaging mode. To completely define an exposure users have only to specify the *target package*, that is target RA, Dec, and EPOCH, plus non-sidereal motion rates if any, and the instrument configuration: filter and exposure parameters (DIT, NDIT, NEXPO, and NOFFSETS).

1.3 Applicable and reference documents

1.3.1 Applicable documents

none

1.3.2 Reference documents

HUM	HAWK-I User's Manual	VLT-MAN-ESO-14800-3486
RD-1	HAWK-I Calibration Plan	VLT-PLA-ESO-14800-3214
P2PP	P2PP User's Guide	VLT-MAN-ESO-19200-1644

1.4 Abbreviations and acronyms

AD	Applicable Document
ADU	Analog-Digital Units
AO	Adaptive Optics
BOB	Broker of Observation Blocks
DCR	Double Correlated Read
DIT	Detector Integration Time
ESO	European Southern Observatory
ETC	Exposure Time Calculator
GSC	Guide Star Catalogue
HAWK-I	High Acuity Wide-field K-band Imager
NDIT	Number of DIT
NIR	Near Infra-Red
NDR	Non-Destructive Read
OB	Observing Block
OS	Observing Software
OT	Observing Tool
P2PP	Phase 2 Proposal Preparation tool
RRM	Rapid Response Mode

QE	Quantum Efficiency
RD	Reference Document
RON	Read Out Noise
RTD	Real Time Display
UT	Unit Telescope, VLT 8m telescope

2 Instrument Modes and Configurations

HAWK-I has only one (2) instrument mode: **direct imaging** and **fast photometry**.

Only the two filter wheels and detector can be configured/set-up in the instrument.

- **Filters:** 4 broad band, and 6 narrow band.
- **Detector:** set-up of the exposure time: DIT, NDIT, NEXPO.

3 Template Overview

This section provides a brief overview of the HAWK-I templates. Each template is described in more detail in the subsequent sections.

3.1 General remarks

All scientific and calibration observations with ESO instruments are prepared by building observing blocks (OBs) as a sequence of the available templates for the specific instruments. This is performed with the help of the phase 2 proposal preparation tool (P2PP). The scheduling of these OBs is done on the site with P2PP in visitor mode, and with a special Observing Tool (OT) in service mode. The execution of the OBs is then done with the broker of observing blocks (BOB). It will be convenient while reading this manual to have a copy of the P2PP Manual available that can be found at `http://www.eso.org/sci/observing/phase2/P2PPSurveys/P2PP3Documentation.html`

Observing blocks generally consist of an acquisition template, and a (small) number of user selected science or calibration templates. Notice that the target information is entered in what is called the *Target package* in the tabbed section located at the bottom of the P2PP tool window while the acquisition template describes 'how" to acquire the target. In addition, service mode OBs contain the observing constraints set and the scheduling information which are entered in the same tabbed section of P2PP. The observing templates which are described below are lists of keywords (parameters of the respective templates) that define the configuration and setup to be used for the respective observations.

Parameters are either available in P2PP for being set-up by the user, or they might be hidden from the user in P2PP (when the value is frozen to a default) in order to compact and to simplify the appearance of the parameter lists. Hidden parameters can not be changed by the users but could be modified in real time by the instrument operators. Since hidden parameters will be rarely changed during science observation runs, we might not provide an extensive explanation in the template reference section.

3.2 Acquisition and science templates

Unlike for many other ESO instruments there are only a few templates available for HAWK-I. The instrument works in a single observing mode: imaging. The templates are listed below, together with the short description of the functionalities.

The functionality of the acquisition and science templates is generally identical to the equivalent ISAAC (now decommisioned) SW imaging templates.

Table 1: Acquisition and science HAWK-I templates

acquisition templates	functionality	comment
HAWKI_img_acq_Preset	Simple telescope preset	recommended
HAWKI_img_acq_PresetRRM	Simple telescope preset	for RRM observations
HAWKI_img_acq_MoveToPixel	Interactive target acquisition	
HAWKI_img_acq_MoveToPixelRRM	Interactive target acquisition	for RRM observations
HAWKI_img_acq_FastPhot	Acquisition in windowed mode	
science templates		
HAWKI_img_obs_AutoJitter	imaging with jitter (no offsets)	recommended for low-density fields
HAWKI_img_obs_AutoJitterOffset	imaging with jitter and random sky offsets	recommended for extended objects
HAWKI_img_obs_FixedSkyOffset	imaging with jitter and fixed sky offsets	when random sky is not suited
HAWKI_img_obs_GenericOffset	imaging with user defined offsets	
HAWKI_img_obs_FastPhot	imaging in windowed mode	

When HAWK-I will be upgraded to make use of the adaptive secondary UT mirror (in 2015), an AO acquisition template will be added, if its functionality cannot be merged into the regular acquisition templates.

3.3 Calibration and technical templates

The calibration plan [RD-1] describes in more detail the procedure to acquire the calibration data required by the scientific observations.

The currently available calibration and technical templates are the following:

Table 2: Calibration and technical HAWK-I templates

calibration templates	functionality	comment
HAWKI_img_cal_Darks	series of darks	
HAWKI_img_acq_TwPreset	acquisition for flat-field	
HAWKI_img_cal_TwFlats	imaging twilight flat-field	at zenith, no tracking
HAWKI_img_cal_SkyFlats	imaging twilight flat-field	at empty fields, tracking only
HAWKI_img_cal_StandardStar	imaging of standard field	
technical templates		
HAWKI_gen_tec_StandBy	set system to mode Standby	
HAWKI_img_tec_IlluFrame	imaging of illumination field	
HAWKI_img_tec_Astrometry	imaging of astrometric field	
HAWKI_img_tec_Flexure	measuring instrument flexure/center of rotation	
HAWKI_img_tec_DetTest	detector test/monitoring	
HAWKI_img_tec_DetLin	detector linearity check	
HAWKI_img_tec_FilterWheel	filter wheel positioning accuracy	

The calibration templates are designed to obtain twilight flat-fields, dark frames, standard stars for all broad band filters (typically at the center of each detector). The technical templates are used to obtain illumination frames (by placing a standard star in several points of a regular grid on each detector), an astrometric/distortion solution (either by jittered images of a dense astrometric star cluster field, or the observation of a large astrometric field), and to characterize the detector. Two further technical templates are available to measure any flexure and misalignment with respect to the telescope optical axis (rotating the instrument while observing a stellar field), and to measure the positioning accuracy/reproducibility of the filter positioning. Other technical templates exist for instrument maintenance.

4 Template Description

4.1 Acquisition Templates

4.1.1 Introduction

Telescope presets can only be done via *acquisition templates*. Telescope presets move the telescope to the requested coordinates and allow the telescope operator to select a telescope guide star and start the active optics. Additionally, these templates set up the detector and the instrument. *Observation templates*, on the other hand, only deal with telescope offsets, and not with telescope presets. The `HAWKI_img_acq_MoveToPixel` acquisition template dumps an image to disk; the `HAWKI_img_acq_Preset` template does not. These dumped images are aimed at keeping track of the field position and orientation before starting the observation, and are part of the images distributed to users.

In general, it is not necessary for the acquisition and the subsequent observation templates to have the same `DIT` and `NDIT`.

4.1.2 `HAWKI_img_acq_Preset`

Table 3: Parameters of `HAWKI_img_acq_Preset`

HAWKI_img_acq_Preset.tsf			
To be specified:			
Parameter	Hidden	Range *(Default)*	Label
DET.DIT	no	1.6762..3600 *(NODEFAULT)*	DIT (secs)
DET.NDIT	no	1..1000 *(1)*	NDIT
INS.FILT.NAME	no	Ks H J Y BrG NB2090 CH4 NB1190 NB1060 H2 *(NODEFAULT)*	Filter Name
SEQ.PRESET	yes	T F *(T)*	Preset telescope?
TEL.AG.GUIDESTAR	no	NONE SETUPFILE CATALOGUE *(CATALOGUE)*	Telescope Guide Star Selection
TEL.GS1.ALPHA	no	*(0.0)*	RA of telescope guide star
TEL.GS1.DELTA	no	*(0.0)*	DEC of telescope guide star
TEL.ROT.OFFANGLE	no	-360.0..360.0 *(0)*	Position Angle on Sky (deg)
TEL.TARG.ADDVELALPHA	yes	-100..100 *(0)*	Add Velocity Alpha
TEL.TARG.ADDVELDELTA	yes	-100..100 *(0)*	Add Velocity Delta
TEL.TARG.ALPHA	no	*(NODEFAULT)*	
TEL.TARG.DELTA	no	*(NODEFAULT)*	
TEL.TARG.EQUINOX	no	-2000..3000 *(2000)*	Equinox
TEL.TARG.NAME	no	*(NODEFAULT)*	Name of the Target
TEL.TARG.OFFSETALPHA	no	-999..999 *(0.0)*	Alpha offset for the target (arcsec)
TEL.TARG.OFFSETDELTA	no	-999..999 *(0.0)*	Delta offset for the target (arcsec)
Fixed values:			
Parameter	Hidden	Value	Label

This template does a simple telescope preset. It is the easiest template to use when objects can be easily identified against the sky background. It should not be used if the user wants a pointing accuracy that is better than few arcsec.

The instrument parameters should be set to values used in the subsequent imaging template, in order to have the instrument already set-up for the start of the first science template. This will save time.

In general, one should not put objects of interest at the very center of the array, as the four quadrants are spaced by ~ 150 pixels.

Table **??** describes the parameters of this template.

No RTD image is dumped on disk at the end of this template.

If `TEL.AG.GUIDESTAR` is set to CATALOGUE, then the guide star selection is left to the telescope operator who will interactively identify a suitable guide star from the GSC2 (in which case the keywords `TEL.GS1.ALPHA` and `TEL.GS1.DELTA` will be ignored). If `TEL.AG.GUIDESTAR` is set to SETUPFILE then the user has to specify the guide star by providing its coordinates in the keywords `TEL.GS1.ALPHA` and `TEL.GS1.DELTA`.

4.1.3 `HAWKI_img_acq_PresetRRM`

Table 4: Parameters of `HAWKI_img_acq_PresetRRM`

HAWKI_img_acq_PresetRRM.tsf			
To be specified:			
Parameter	Hidden	Range *(Default)*	Label
DET.DIT	no	1.6762..3600 *(NODEFAULT)*	DIT (secs)
DET.NDIT	no	1..1000 *(1)*	NDIT
INS.FILT.NAME	no	Ks H J Y BrG NB2090 CH4 NB1190 NB1060 H2 *(NODEFAULT)*	Filter Name
SEQ.PRESET	yes	T F *(T)*	Preset telescope?
SEQ.RRM.REGISTER	yes	F T *(T)*	Register OB in RRM system
SEQ.RRM.VISITOR	no	F T *(F)*	Allow RRM activation in VISITOR mode
TEL.AG.GUIDESTAR	no	NONE SETUPFILE CATALOGUE *(CATALOGUE)*	Telescope Guide Star Selection
TEL.GS1.ALPHA	no	*(0.0)*	RA of telescope guide star
TEL.GS1.DELTA	no	*(0.0)*	DEC of telescope guide star
TEL.ROT.OFFANGLE	no	-360.0..360.0 *(0)*	Position Angle on Sky (deg)
TEL.TARG.ADDVELALPHA	yes	-100..100 *(0)*	Add Velocity Alpha
TEL.TARG.ADDVELDELTA	yes	-100..100 *(0)*	Add Velocity Delta
TEL.TARG.ALPHA	no	*(NODEFAULT)*	
TEL.TARG.DELTA	no	*(NODEFAULT)*	
TEL.TARG.EQUINOX	no	-2000..3000 *(2000)*	Equinox
TEL.TARG.NAME	no	*(NODEFAULT)*	Name of the Target
TEL.TARG.OFFSETALPHA	no	-999..999 *(0.0)*	Alpha offset for the target (arcsec)
TEL.TARG.OFFSETDELTA	no	-999..999 *(0.0)*	Delta offset for the target (arcsec)
Fixed values:			
Parameter	Hidden	Value	Label
DPR.CATG	yes	ACQUISITION	Data product category
DPR.TECH	yes	IMAGE	Data product technique
DPR.TYPE	yes	OBJECT	Data product type

This template is functionally identical to `HAWKI_img_acq_Preset` apart from having a few more parameters (see Table **??**) and it is intended for acquisition of RRM imaging OBs.

4.1.4 HAWKI_img_acq_MoveToPixel

Table 5: Parameters of HAWKI_img_acq_MoveToPixel

HAWKI_img_acq_MoveToPixel.tsf			
To be specified:			
Parameter	Hidden	Range *(Default)*	Label
DET.DIT	no	1.6762..3600 *(NODEFAULT)*	DIT (secs)
DET.NDIT	no	1..1000 *(1)*	NDIT
INS.FILT.NAME	no	Ks H J Y BrG NB2090 CH4 NB1190 NB1060 H2 *(NODEFAULT)*	Filter Name
SEQ.PRESET	yes	T F *(T)*	Preset telescope?
SEQ.SKYFLAT	no	T F *(T)*	Take initial sky frame?
SEQ.SKYOFFSET.ALPHA	no	*(10)*	RA offset to sky
SEQ.SKYOFFSET.DELTA	no	*(10)*	DEC offset to sky
TEL.AG.GUIDESTAR	no	NONE SETUPFILE CATALOGUE *(CATALOGUE)*	Telescope Guide Star Selection
TEL.GS1.ALPHA	no	*(0.0)*	RA of telescope guide star
TEL.GS1.DELTA	no	*(0.0)*	DEC of telescope guide star
TEL.ROT.OFFANGLE	no	-360.0..360.0 *(0)*	Position Angle on Sky (deg)
TEL.TARG.ADDVELALPHA	yes	-100..100 *(0)*	Add Velocity Alpha
TEL.TARG.ADDVELDELTA	yes	-100..100 *(0)*	Add Velocity Delta
TEL.TARG.ALPHA	no	*(NODEFAULT)*	
TEL.TARG.DELTA	no	*(NODEFAULT)*	
TEL.TARG.EQUINOX	no	-2000..3000 *(2000)*	Equinox
TEL.TARG.NAME	no	*(NODEFAULT)*	Name of the Target
Fixed values:			
Parameter	Hidden	Value	Label
DPR.CATG	yes	ACQUISITION	Data product category
DPR.TECH	yes	IMAGE	Data product technique
DPR.TYPE	yes	OBJECT	Data product type

This template presets the telescope and allows the operator to interactively center the field. In visitor mode, the interactive part of the template will be executed by the instrument operator under the supervision of the visiting astronomer. In service mode, it is mandatory that users send detailed information, including finding charts, for the field centering. It should be used when very precise, e.g. $<\sim 2-3''$, centering of the field is required; or to move a bright star to one of the gaps[1], etc.

In general, one should not put objects of interest at the very center of the array, as the four quadrants are spaced by ~ 150 pixels.

At the beginning of the template one `fixed pattern` image is acquired in an offset position defined by the `SEQ.SKYOFFSET.ALPHA` and `SEQ.SKYOFFSET.DELTA` parameters. The RTD is then set up to subtract this `fixed pattern` from all subsequently displayed images.

The integration time for the acquisition images is defined by the `DIT` and `NDIT` parameters. After the first target image is acquired, the observer can change `DIT` and `NDIT` interactively.

In the case of a fixed pattern: if `DIT` and/or `NDIT` are changed, the telescope offsets again and the observer is given the option to store another fixed pattern before the telescope returns to the nominal position. This loop can continue until the user has identified the target.

Once the observer is satisfied with the acquisition image, he/she is prompted for an offset to center the target. This is done interactively by drawing 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 user can either accept the offsets, cancel, or edit the co-ordinates directly. If the offsets are accepted, the telescope offsets by the desired amount and a new image

[1]The user nevertheless must check in the HAWKI User's Manual for the maximum brightness allowed, as this template can not be used if the bright star violates those limits.

is acquired. The user is given the possibility to refine the position if necessary. Once the user is satisfied, the template finishes.

If the parameter "SEQ.PRESET" is set to "F", then the telescope will not move. This can be useful in visitor mode to use the functionality of the template (setting-up the instrument, checking/refining the position) without having to fully preset the telescope again, and thus saving a little time.

N.B.: the interactive pop-up windows are usually displayed **before** new images have arrived on the RTD. Therefore, users 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 and NDIT).

The image displayed on RTD at the end of the template is saved to disk. See Table 5 for details.

4.1.5 HAWKI_img_acq_MoveToPixelRRM

An identical version for RRM observations is available (see Table‘6):

Table 6: Parameters of HAWKI_img_acq_MoveToPixelRRM

HAWKI_img_acq_MoveToPixelRRM.tsf			
To be specified:			
Parameter	Hidden	Range *(Default)*	Label
DET.DIT	no	1.6762..3600 *(NODEFAULT)*	DIT (secs)
DET.NDIT	no	1..1000 *(1)*	NDIT
INS.FILT.NAME	no	Ks H J Y BrG NB2090 CH4 NB1190 NB1060 H2 *(NODEFAULT)*	Filter Name
SEQ.PRESET	yes	T F *(T)*	Preset telescope?
SEQ.RRM.REGISTER	yes	F T *(T)*	Register OB in RRM system
SEQ.RRM.VISITOR	no	F T *(F)*	Allow RRM activation in VISITOR mode
SEQ.SKYFLAT	no	T F *(T)*	Take initial sky frame?
SEQ.SKYOFFSET.ALPHA	no	*(10)*	RA offset to sky
SEQ.SKYOFFSET.DELTA	no	*(10)*	DEC offset to sky
TEL.AG.GUIDESTAR	no	NONE SETUPFILE CATALOGUE *(CATALOGUE)*	Telescope Guide Star Selection
TEL.GS1.ALPHA	no	*(0.0)*	RA of telescope guide star
TEL.GS1.DELTA	no	*(0.0)*	DEC of telescope guide star
TEL.ROT.OFFANGLE	no	-360.0..360.0 *(0)*	Position Angle on Sky (deg)
TEL.TARG.ADDVELALPHA	yes	-100..100 *(0)*	Add Velocity Alpha
TEL.TARG.ADDVELDELTA	yes	-100..100 *(0)*	Add Velocity Delta
TEL.TARG.ALPHA	no	*(NODEFAULT)*	
TEL.TARG.DELTA	no	*(NODEFAULT)*	
TEL.TARG.EQUINOX	no	-2000..3000 *(2000)*	Equinox
TEL.TARG.NAME	no	*(NODEFAULT)*	Name of the Target
Fixed values:			
Parameter	Hidden	Value	Label
DPR.CATG	yes	ACQUISITION	Data product category
DPR.TECH	yes	IMAGE	Data product technique
DPR.TYPE	yes	OBJECT	Data product type

4.1.6 Fast Photometry Acquisition template

Table 7: Parameters of Fast Photometry Acquisition template

HAWKI_img_acq_FastPhot.tsf			
To be specified:			
Parameter	Hidden	Range *(Default)*	Label
DET.DIT	no	0.001..3600 *(NODEFAULT)*	DIT (secs)
DET.NDIT	no	1..1000 *(1)*	NDIT
INS.FILT.NAME	no	Ks H J Y BrG NB2090 CH4 NB1190 NB1060 H2 *(NODEFAULT)*	Filter Name
SEQ.BADAG	yes	T F *(F)*	Ignore AG
SEQ.BADAO	yes	T F *(F)*	Ignore AO
SEQ.PRESET	yes	T F *(T)*	Preset telescope?
SEQ.SKYFLAT	no	T F *(T)*	Take initial sky frame?
SEQ.SKYOFFSET.ALPHA	no	*(10)*	RA offset to sky
SEQ.SKYOFFSET.DELTA	no	*(10)*	DEC offset to sky
SEQ.WIN.NX	no	0..128 *(128)*	Number of columns for each window stripe
SEQ.WIN.NY	no	0..2048 *(2048)*	Number of rows for each window stripe
SEQ.WIN.STARTX	no	1..127 *(1)*	First column of window within a stripe
SEQ.WIN.STARTY	no	1..2047 *(1)*	First row of window within a stripe
TEL.AG.GUIDESTAR	no	NONE SETUPFILE CATALOGUE *(CATALOGUE)*	Telescope Guide Star Selection
TEL.GS1.ALPHA	no	*(0.0)*	RA of telescope guide star
TEL.GS1.DELTA	no	*(0.0)*	DEC of telescope guide star
TEL.ROT.OFFANGLE	no	-360.0..360.0 *(0)*	Position Angle on Sky (deg)
TEL.TARG.ADDVELALPHA	yes	-100..100 *(0)*	Add Velocity Alpha
TEL.TARG.ADDVELDELTA	yes	-100..100 *(0)*	Add Velocity Delta
TEL.TARG.ALPHA	no	*(NODEFAULT)*	
TEL.TARG.DELTA	no	*(NODEFAULT)*	
TEL.TARG.EQUINOX	no	-2000..3000 *(2000)*	Equinox
TEL.TARG.NAME	no	*(NODEFAULT)*	Name of the Target
Fixed values:			
Parameter	Hidden	Value	Label
DPR.CATG	yes	ACQUISITION	Data product category
DPR.TECH	yes	IMAGE	Data product technique
DPR.TYPE	yes	OBJECT	Data product type
TEL.TARG.OFFSETALPHA	no	0.0	Alpha offset for the target (arcsec)
TEL.TARG.OFFSETDELTA	no	0.0	Delta offset for the target (arcsec)

This is the acquisition template for the recently (as of P86) offered Fast Photometry mode. It is described in details in the User Manual. Table 7 summarises its properties.

4.2 Science Templates

The four science observing templates provide various strategies for the nodding between object and sky positions and for the jitter offsets between the images taken at the selected object and sky positions. The most simple and recommended templates are AutoJitter and AutoJitterOffset. AutoJitter will automatically take exposures in an AAAA sequence, where A refers to the OBJECT position. The GenericOffset template allows to specify any sequence of object and sky positions. The FixedSkyOffset also automatically takes exposures in an ABBA sequence with positions jittered with respect to each other, but nods to a fixed, user-defined, sky position. The respective A (object) positions are randomly jittered with respect to each other, and so are the respective B (sky) positions. FixedSkyOffset will take an ABBA... or an BAAB... sequence depending on whether `SEQ.OBSTYPE` is set to O or S respectively.

The common parameters to these templates are described here:

DET.DIT and DET.NDIT: are the user defined detector integration time (DIT) (for all exposures: target and sky) and the number of DITs (NDIT) to be *averaged*[2] by the electronics before the frame is written to disk. While the DIT is common to both object and sky, NDIT can be set independently for object and sky for all templates that move to a sky position.

Number of exposures per offset, SEQ.NEXPO: defines the number of exposures to be taken at *each* offset position. It can be set to values different from one (1) in the cases where more than one exposure shall be taken at each (on/off) position before nodding to the next (on/off) offset position. For typical applications, it remains set to one (e.g for classical ABBA sequences).

Number of AB or BA cycles, SEQ.NABCYCLES: defines how often the AB cycle is repeated. If set to one, the template will take a simple AB sequence (one offset). If set to two, it will take a ABBA (object, sky, sky, object) sequence. If set to three, it will take a ABBAAB sequence, an so on. For best sky subtraction, the number of cycles should be set to a value of two or larger.

Number of offset positions, SEQ.NOFFSET: the above number of AB cycles is replaced in the AutoJitter and GenericOffset template by the number of offset positions, NOFFSET. In the AutoJitter template, the offsets are determined randomly within a box. In the GenericOffset template, the offset positions are defined by the OFFSET1 and OFFSET2 lists. Typically, both lists will have the same length, if not, the shortest list (and maybe even the longest list) will repeat itself until NOFFSET frames have been obtained.

SEQ.FC.ST: This keyword controls whether to use software flexure compensation. During commisioning it was found that flexures were negligible so that the parameter is hidden and has the default value of "F" for all templates.

SEQ.FILEID: This parameter determine the string to be attached to the file names of the images in the instrument workstation. It is hidden so it can not be set by the user, it can only be set by the operator at Paranal.

[2] Note that the frames will contain the average of the NDIT exposures, NOT a sum, a fact that has to be kept in mind by the user when reducing the data.

SEQ.SHOW.GRAPH: This hidden parameter controls, at execution time, whether to display a utility window that shows the offsets that will be requested by the template. It keeps track of which offsets have been observed, and the current observation offset.

DET.SATLEVEL: This keyword controls the reading mode of the HAWAII_2RG arrays. It is defined as 60% (25,000 counts) of the detector full well.

SEQ.CATG: This keyword can be either SCIENCE or TECH, but for normal operation must be set only as SCIENCE.

Note that for all science templates, if the template is aborted, the telescope will return to origin (i.e. the position on sky at the beginning of the template, before any offset was performed).

4.2.1 `HAWKI_img_obs_AutoJitter`

Table 8: Parameters of `HAWKI_img_obs_AutoJitter`

HAWKI_img_obs_AutoJitter.tsf			
To be specified:			
Parameter	Hidden	Range *(Default)*	Label
DET.DIT	no	1.6762..3600 *(NODEFAULT)*	DIT (secs)
DET.NDIT	no	1..1000 *(1)*	NDIT
DET.SATLEVEL	no	-32768..40000 *(25000)*	SATLEVEL
INS.FILT.NAME	no	Ks H J Y BrG NB2090 CH4 NB1190 NB1060 H2 *(NODEFAULT)*	Filter Name
SEQ.CATG	no	TECHNICAL SCIENCE *(SCIENCE)*	Observation Category
SEQ.FC.ST	yes	T F *(F)*	Use flexure compensation?
SEQ.FILEID	yes	*(AutoJitter)*	Filename id
SEQ.JITTER.WIDTH	no	5..60 *(NODEFAULT)*	Jitter Box Width (arcsec)
SEQ.NEXPO	no	1..1000 *(NODEFAULT)*	Number of exposures per offset
SEQ.NOFFSET	no	1..1000 *(NODEFAULT)*	Number of offsets within a box
SEQ.POISSON	yes	1..100 *(10)*	Random throw generator
SEQ.RETURN	no	T F *(T)*	Return to origin?
SEQ.SHOW.GRAPH	yes	T F *(T)*	Show quick-look graphics?
Fixed values:			
Parameter	Hidden	Value	Label
DPR.CATG	yes	SCIENCE	Data product category
DPR.TECH	yes	IMAGE	Data product technique
DPR.TYPE	yes	OBJECT	Data product type

This 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 sparcely populated fields, and does not require a long list of offsets to be defined.

The offsets are distributed randomly within a box whose size is defined by the parameter `SEQ.JITTER.WIDTH` (in arc seconds), with the condition that the distance between any two points in a series of ten values (note `SEQ.POISSON`) is greater than a certain minimum. This is intentionally done to ensure that the 5 frames before and after any frame are spatially not too close and can be safely used for creating sky frames without residual objects for sky subtraction[3].

[3]The hidden `SEQ.POISSON` parameter plays a dual role here (note that it is not the seed for the random number generator). In the first place it gives the number of contiguous frames that will satisfy a minimum distance constraint, that is, the distance between any pair in the set of contiguous frames will be at least d_{min}. It is also

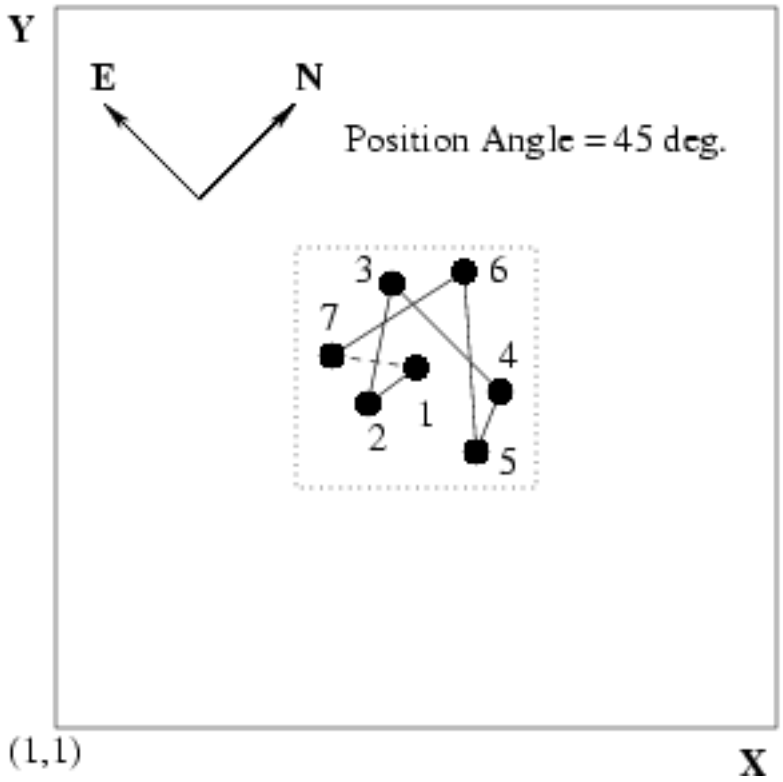

Figure 1: Illustration of the HAWKI_img_obs_AutoJitter template. The black dots represent the position of a star, which was originally at the center of the field.

The value of the SEQ.JITTER.WIDTH parameter corresponds to the **full width** of the square box in which the offsets are generated. Defining too wide a box may lead to poor image overlap. Conversely, too small a value may lead to poor sky subtraction near extended objects. A value of $\sim$ 30 arcsec or less is adequate for sparcely populated stellar fields. The minimum value is set to 5 arcsec. Note also that the mosaic gap is approximately 15″, so to ensure that all points on sky are sampled by a minimum number of observation the user should choose the SEQ.JITTER.WIDTH and the SEQ.NOFFSET parameters appropriately.

By construction, there is no telescope offset before the first exposure. The parameters for this template are summarised in Table 8, and illustrated in Fig. 1.

The total **integration** time (excluding overheads) is defined, in seconds, by:

DIT $\times$ NDIT $\times$ NEXPO$\times$ NOFFSET

used, together with the dimensions of the jitter box Sx and Sy, in the definition of d_{min}:

$$d_{min} = \sqrt{\frac{Sx \times Sy}{\texttt{SEQ.POISSON}\sqrt{2.}}}$$

For more detail see Devillard (1999; ASP 172, 333).

4.2.2 HAWKI_img_obs_AutoJitterOffset

Table 9: Parameters of HAWKI_img_obs_AutoJitterOffset

HAWKI_img_obs_AutoJitterOffset.tsf			
To be specified:			
Parameter	Hidden	Range *(Default)*	Label
DET.DIT	no	1.6762..3600 *(NODEFAULT)*	DIT (secs)
DET.SATLEVEL	no	-32768..40000 *(25000)*	SATLEVEL
INS.FILT.NAME	no	Ks H J Y BrG NB2090 CH4 NB1190 NB1060 H2 *(NODEFAULT)*	Filter Name
SEQ.CATG	no	TECHNICAL SCIENCE *(SCIENCE)*	Observation Category
SEQ.FC.ST	yes	T F *(F)*	Use flexure compensation?
SEQ.FILEID	yes	*(AutoJitterOffset)*	Filename id
SEQ.JITTER.WIDTH	no	5..60 *(NODEFAULT)*	Jitter Box Width (arcsec)
SEQ.NABCYCLES	no	0..100 *(NODEFAULT)*	Number of AB or BA cycles
SEQ.NDIT.OBJECT	no	1..1000 *(1)*	NDIT on OBJECT positions
SEQ.NDIT.SKY	no	1..1000 *(1)*	NDIT on SKY positions
SEQ.NEXPO	no	1..1000 *(NODEFAULT)*	Number of exposures per offset
SEQ.OFFS2B	yes	0..100 *(3)*	Constant offset for 2'nd B
SEQ.POISSON	yes	1..100 *(10)*	Random throw generator
SEQ.RETURN	no	T F *(T)*	Return to origin?
SEQ.SHOW.GRAPH	yes	T F *(T)*	Show quick-look graphics?
SEQ.SKYTHROW	no	0..1800 *(NODEFAULT)*	Sky Offset Throw
Fixed values:			
Parameter	Hidden	Value	Label
DPR.CATG	yes	SCIENCE	Data product category
DPR.TECH	yes	IMAGE	Data product technique

Figure 2 illustrates what the template does, and Table 9 list the involved parameters.

This template moves the telescope alternatively between 'object' and 'sky' positions. The 'object' positions of the telescope are randomly distributed around the object (initial telescope position) and within a box whose dimensions are set by the parameter SEQ.JITTER.WIDTH (in arcsec). The minimum value for this parameter is 5 arcsec. By default, there is no random jitter offset before the first exposure.

The 'sky' positions are at a constant distance (defined by the parameter Sky Offset Throw) from the original telescope position, but at an angle randomly distributed between 0 and 360 degrees (i.e. the 'sky' exposures are distributed on a circle surrounding the initial telescope position). The Number of AB or BA cycles defines the number of OBJECT-SKY (AB), or SKY-OBJECT (BA) cycles to be executed. These cycles are executed in ABBA sequences. E.g. if Number of AB or BA cycles is set to 3, 6 exposures will be taken in an ABBAAB sequence. Notice that in the part of the cycle where two Bs are next to each other it is necessary to offset the second sky field from the first. The offset for this second frame is determined by the keyword SEQ.OFFS2B, the telescope is offseted to the NE or SW depending on the sign of the value entered by an amount equal to SEQ.OFFS2B.

In addition, the template provides the flexibility to adjust the number of subintegrations (NDIT) separately for OBJECT and SKY frames. SEQ.NDIT.OBJECT defines the number of subintegrations on the object, and SEQ.NDIT.SKY defines the number of subintegrations on the sky.

The total **integration** time (excluding overheads) is defined, in seconds, by:
DIT $\times$ (SEQ.NDIT.OBJECT + SEQ.NDIT.SKY) $\times$ SEQ.NEXPO$\times$SEQ.NABCYCLES.

Thus, the total integration time on the sky and on the object can be adjusted so that the S/N on the object is optimised. Remember that the "1 minute per telescope position rule" here means that both (DIT$\times$SEQ.NDIT.OBJECT$\times$NEXPO) and (DIT$\times$SEQ.NDIT.SKY$\times$NEXPO) shall both exceed one minute of time.

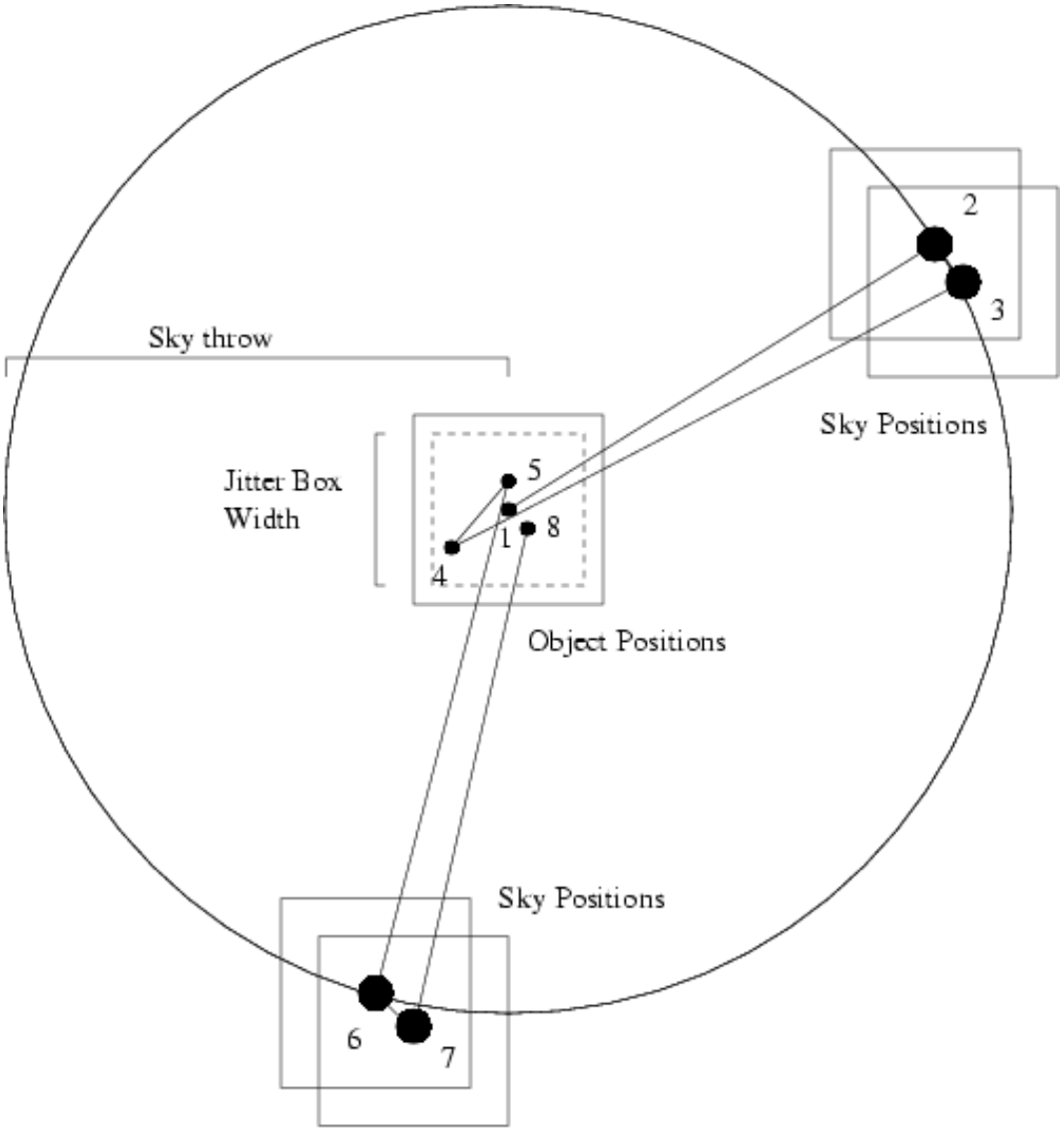

Figure 2: Illustration of the `HAWKI_img_obs_AutoJitterOffset` template. The black dots in the central square represent the position of a star, which was originally at the center of the field. The other squares represent the position of the SKY frames.

4.2.3 HAWKI_img_obs_FixedSkyOffset

Table 10: Parameters of HAWKI_img_obs_FixedSkyOffset

HAWKI_img_obs_FixedSkyOffset.tsf			
To be specified:			
Parameter	Hidden	Range *(Default)*	Label
DET.DIT	no	1.6762..3600 *(NODEFAULT)*	DIT (secs)
DET.SATLEVEL	no	-32768..40000 *(25000)*	SATLEVEL
INS.FILT.NAME	no	Ks H J Y BrG NB2090 CH4 NB1190 NB1060 H2 *(NODEFAULT)*	Filter Name
SEQ.CATG	no	TECHNICAL SCIENCE *(SCIENCE)*	Observation Category
SEQ.FC.ST	yes	T F *(F)*	Use flexure compensation?
SEQ.FILEID	yes	*(FixedSkyOffset)*	Filename id
SEQ.JITTER.WIDTH	no	5..60 *(NODEFAULT)*	Jitter Box Width (arcsec)
SEQ.NABCYCLES	no	0..100 *(NODEFAULT)*	Number of AB or BA cycles
SEQ.NDIT.OBJECT	no	1..1000 *(1)*	NDIT on OBJECT positions
SEQ.NDIT.SKY	no	1..1000 *(1)*	NDIT on SKY positions
SEQ.NEXPO	no	1..1000 *(NODEFAULT)*	Number of exposures per offset
SEQ.OBSTYPE	no	O S *(O)*	Type of first observation
SEQ.OFFSET.COORDS	yes	SKY DETECTOR *(SKY)*	Offset coordinate type selection
SEQ.POISSON	yes	1..100 *(10)*	Random throw generator
SEQ.RETURN	no	T F *(T)*	Return to origin?
SEQ.SHOW.GRAPH	yes	T F *(T)*	Show quick-look graphics?
SEQ.SKYOFFSET.ALPHA	no	*(10)*	RA offset to sky
SEQ.SKYOFFSET.DELTA	no	*(10)*	DEC offset to sky
Fixed values:			
Parameter	Hidden	Value	Label
DPR.CATG	yes	SCIENCE	Data product category
DPR.TECH	yes	IMAGE	Data product technique

This template moves the telescope alternatively between 'object' and 'sky' positions. The 'object' positions of the telescope are randomly distributed around the object (initial telescope position) and within a box whose dimensions are set by the parameter SEQ.JITTER.WIDTH (in arcsec). The minimum value for this parameter is 5 arcsec. The involved parameters are summarised in Table 10, while an illustration of what the template does in presented in Fig. 3.

The 'sky' positions are also randomly distributed around a fixed offset position (defined by the parameters SEQ.SKYOFFSET.ALPHA and SEQ.SKYOFFSET.DELTA) from the original (object) telescope position. The box dimensions of the random 'sky' positions are set by the parameter SEQ.JITTER.WIDTH (i.e. the 'sky' exposures are distributed in a box offset from the initial telescope position). By default, there is no random jitter offset before the first exposure.

The template allow the user to specify whether the starting observation will be on the object or on the sky, this is done with the keyword SEQ.OBSTYPE which should contain the type of the first observation.

The Number of AB or BA cycles defines the number of OBJECT-SKY or SKY-OBJECT cycles to be executed.These cycles are executed in ABBA sequences. E.g. if SEQ.NABCYCLES is set to 3, then 6 exposures will be taken in an ABBAAB sequence.

In addition, the template provides the flexibility to set independently the number of NDIT subintegrations for the OBJECT and SKY frames. SEQ.NDIT.OBJECT defines the number of subintegrations on the object, and SEQ.NDIT.SKY defines the number of subintegrations on the sky.

The total **integration** time (excluding overheads) is defined, in seconds, by:
DIT $\times$ (SEQ.NDIT.OBJECT+ SEQ.NDIT.SKY)$\times$NEXPO$\times$(SEQ.NABCYCLES).

Thus, the total integration time on the sky and on the object can be adjusted so that the S/N on the object is optimised. Remember that the "1 minute per telescope position rule" her means that

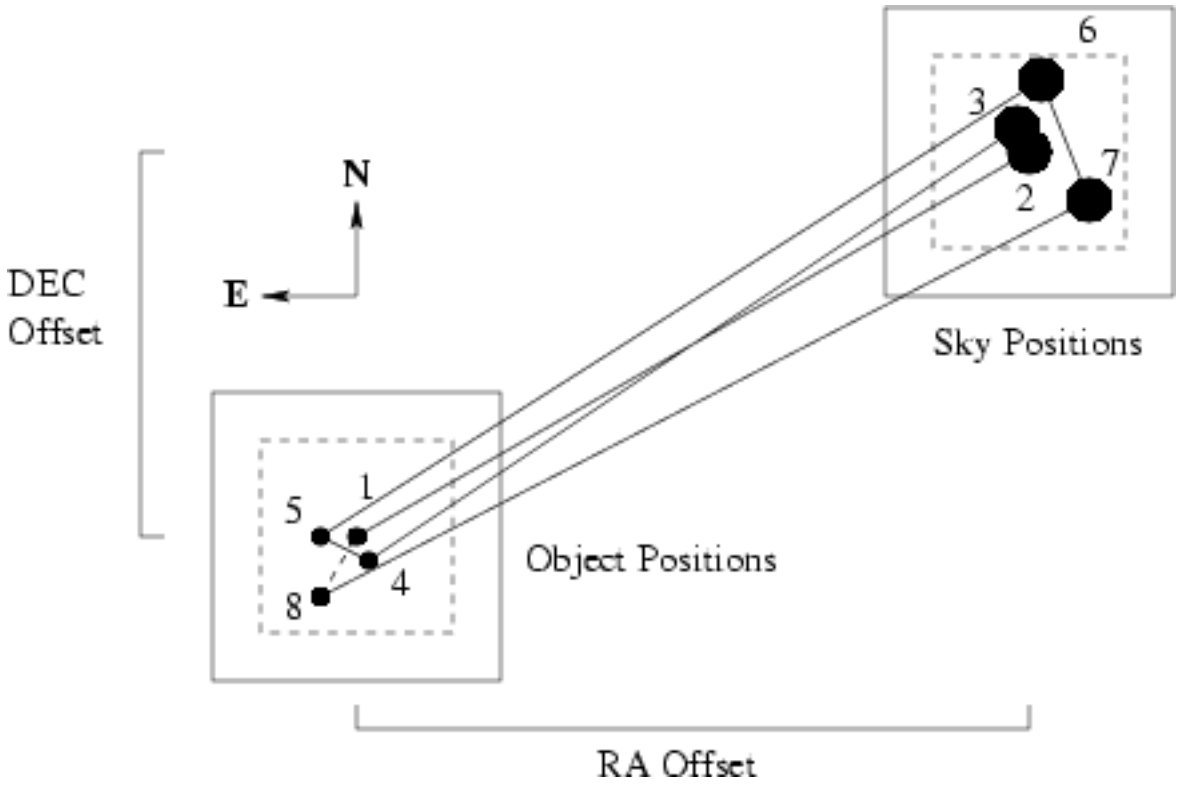

Figure 3: Illustration of the HAWKI_img_obs_FixedSkyOffset template. The black dots in the central square represent the position of a star, which was originally at the center of the field. The other square represents the mean position of the SKY frames.

both (DIT×SEQ.NDIT.OBJECT×NEXPO) and (DIT×SEQ.NDIT.SKY×NEXPO) shall both exceed one minute of time.

4.2.4 HAWKI_img_obs_GenericOffset

This template has the flexibility to do any sequence of telescope offsets, either in detector or sky coordinates. It is one of the most widely used templates (see Table 11).

Telescope offsets are defined as lists with the parameters SEQ.OFFSET1.LIST and SEQ.OFFSET2.LIST. The offsets are *relative* to the *previous position*[4], in RA and DEC or in X and Y depending on the SEQ.OFFSET.COORDS parameter, and they are defined in *arcsec*. Fig . 4 and 5 show how it works.

Additionally, the observation type can be defined for each image, and is entered as a list in the parameter SEQ.OBSTYPE.LIST. O stands for Object and assigns the DPR.CATG header keyword to SCIENCE. S stands for Sky and assigns the DPR.CATG header keyword to SKY.

The number of exposures per offset is defined in the parameter SEQ.NEXPO. The number of offsets to be performed is determined by SEQ.NOFFSET, it can be different from the number of elements in the aforementioned (offset) lists. Lists do not need to have the same length. If the number of offsets 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.

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

[4]Note that now in this HAWK-I does not differ anymore from the other ESO instruments

Table 11: Parameters of HAWKI_img_obs_GenericOffset

HAWKI_img_obs_GenericOffset.tsf			
To be specified:			
Parameter	Hidden	Range *(Default)*	Label
DET.DIT	no	1.6762..3600 *(NODEFAULT)*	DIT (secs)
DET.SATLEVEL	no	-32768..40000 *(25000)*	SATLEVEL
INS.FILT.NAME	no	Ks H J Y BrG NB2090 CH4 NB1190 NB1060 H2 *(NODEFAULT)*	Filter Name
SEQ.CATG	no	TECHNICAL SCIENCE *(SCIENCE)*	Observation Category
SEQ.FC.ST	yes	T F *(F)*	Use flexure compensation?
SEQ.FILEID	yes	*(GenericOffset)*	Filename id
SEQ.NDIT.LIST	no	*(NODEFAULT)*	List of NDITs
SEQ.NEXPO	no	1..1000 *(NODEFAULT)*	Number of exposures per offset
SEQ.NOFFSET	no	1..1000 *(NODEFAULT)*	Number of offsets
SEQ.OBSTYPE.LIST	no	O S *(NODEFAULT)*	Observation type list, O/S
SEQ.OFFSET.COORDS	no	SKY DETECTOR *(DETECTOR)*	Offset coordinate type selection
SEQ.OFFSET1.LIST	no	-600..600 *(NODEFAULT)*	List of X or RA offsets (arcsec)
SEQ.OFFSET2.LIST	no	-600..600 *(NODEFAULT)*	List of Y or DEC offsets (arcsec)
SEQ.RETURN	no	T F *(T)*	Return to origin?
SEQ.SHOW.GRAPH	yes	T F *(T)*	Show quick-look graphics?
Fixed values:			
Parameter	Hidden	Value	Label
DPR.CATG	yes	SCIENCE	Data product category
DPR.TECH	yes	IMAGE	Data product technique

parameter is not changed. The total number of images taken by this template is SEQ.NEXPO$\times$ SEQ.NOFFSET.

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

The total **integration** time is defined, in seconds, by:

$$\texttt{DIT} \times \texttt{NEXPO} \times \sum_{1}^{\texttt{NOFFSET}} \texttt{NDIT}(i)$$

where NDIT(i) are the elements of the List of NDIT.

4.2.5 Fast Photometry template

This template is used for windowed observations, and it is described in detailed in the user manual. It is offered only in BURST mode, both for service and visitor operations.

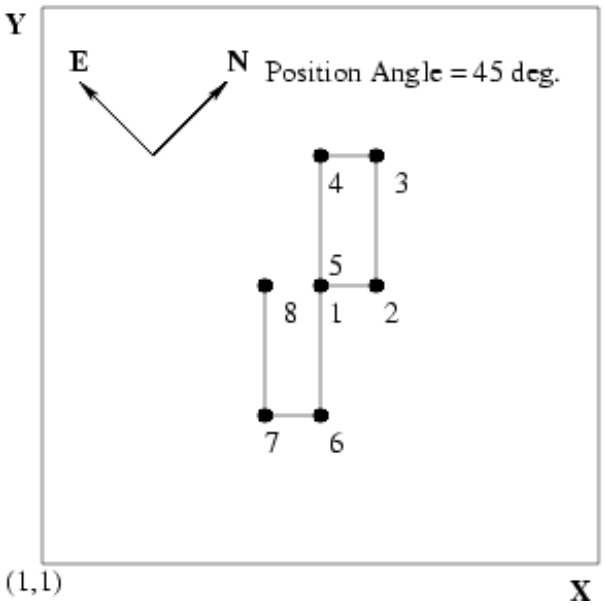

Figure 4: Illustration of the `HAWKI_img_obs_GenericOffset` template. The black dots represent the position of a star, which was originally at the center of the field. In this example, `SEQ.OFFSET.COORDS` is set to DETECTOR, and the the telescope is moved in X and Y according to the list of offsets.

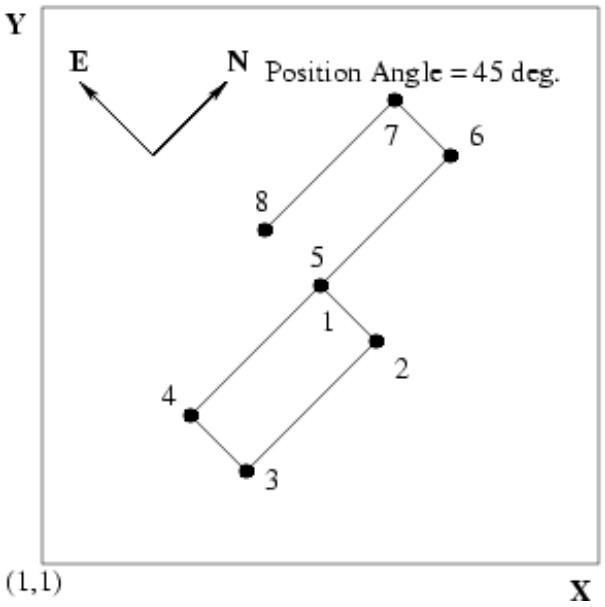

Figure 5: Illustration of the `HAWKI_img_obs_GenericOffset` template. The black dots represent the position of a star, which was originally at the center of the field. In this example, `SEQ.OFFSET.COORDS` is set to SKY, and the telescope is moved in RA and DEC according to the list of offsets (the stars move in the opposite direction).

Table 12: Parameters of Fast Photometry template

HAWKI_img_obs_FastPhot.tsf			
To be specified:			
Parameter	Hidden	Range *(Default)*	Label
DET.BURST.MODE	no	F T *(T)*	Toggle Burst Mode
DET.DIT	no	0.001..3600 *(NODEFAULT)*	DIT (secs)
DET.NCORRS.NAME	yes	NonDest NonDestNsamp Fowler FowlerNsamp *(NonDest)*	Non-destructive sampling readout mode name
DET.NDIT	no	1..1000 *(1)*	NDIT
DET.NDITSKIP	yes	0 *(0)*	DITs to skip
DET.NDSKIP	yes	0 *(0)*	Samples skipped per DIT
DET.SATLEVEL	no	-32768..40000 *(25000)*	SATLEVEL
INS.FILT.NAME	no	Ks H J Y BrG NB2090 CH4 NB1190 NB1060 H2 *(NODEFAULT)*	Filter Name
SEQ.BADAG	yes	T F *(F)*	Ignore AG
SEQ.BADAO	yes	T F *(F)*	Ignore AO
SEQ.CATG	no	TECHNICAL SCIENCE *(SCIENCE)*	Observation Category
SEQ.EVENT.DATE	no	*(0)*	Absolute date of future event
SEQ.EVENT.TIME	no	*(0)*	Absolute time of future event
SEQ.FILEID	yes	*(FAST)*	Filename id
SEQ.JITTER.WIDTH	no	0..60 *(NODEFAULT)*	Jitter Box Width (arcsec)
SEQ.NEXPO	no	1..1000 *(NODEFAULT)*	Number of exposures per offset
SEQ.NOFFSET	no	1..1000 *(NODEFAULT)*	Number of offsets within a box
SEQ.POISSON	yes	1..100 *(10)*	Random throw generator
SEQ.RETURN	no	T F *(T)*	Return to origin?
SEQ.SHOW.GRAPH	yes	T F *(T)*	Show quick-look graphics?
Fixed values:			
Parameter	Hidden	Value	Label
DPR.TECH	yes	IMAGE	Data product technique
DPR.TYPE	yes	OBJECT	Data product type

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4.3 Calibration Templates

With the exception of the StandardStar one, these templates are only available to the users on the mountain. They are used by the staff at Paranal to carry out the short amd medium term calibrations of the instruments.

A more detailed description of their utility can be found in [RD-1].

4.3.1 HAWKI_img_cal_Darks

Table 13: Parameters of HAWKI_img_cal_Darks

HAWKI_img_cal_Darks.tsf			
To be specified:			
Parameter	Hidden	Range *(Default)*	Label
SEQ.DIT.LIST	no	*(NODEFAULT)*	List of DITs
SEQ.FILEID	yes	*(Darks)*	Filename id
SEQ.NDIT.LIST	no	*(NODEFAULT)*	List of NDITs
SEQ.NEXPO	no	1..1000 *(1)*	NEXPO per DIT in list
Fixed values:			
Parameter	Hidden	Value	Label
DET.WIN.NX	yes	0	Number of columns
DET.WIN.NY	yes	0	Number of rows
DET.WIN.STARTX	yes	1	First column of window
DET.WIN.STARTY	yes	1	First row of window
DPR.CATG	yes	CALIB	Data product category
DPR.TECH	yes	IMAGE	Data product technique
DPR.TYPE	yes	DARK	Data product type

This template (see Table 13) acquires a number NEXPO of darks with specified DIT and NDIT (which should correspond to the DIT and NDIT of the exposure to correct for).

4.3.2 HAWKI_img_cal_TwFlats

Table 14: Parameters of HAWKI_img_cal_TwFlats

HAWKI_img_cal_TwFlats.tsf			
To be specified:			
Parameter	Hidden	Range *(Default)*	Label
SEQ.DIT.ADJUST	no	T F *(T)*	Adjust DIT?
SEQ.DIT.LIST	no	*(NODEFAULT)*	List of DITs
SEQ.FILEID	yes	*(TwFlats)*	Filename id
SEQ.FILT.LIST	no	*(NODEFAULT)*	Filter List
SEQ.NCYCLES	no	1..100 *(10)*	Number of cycles
SEQ.NDIT.LIST	no	*(NODEFAULT)*	List of NDITs
SEQ.NEXPO	no	1..1000 *(1)*	Number of exposures
Fixed values:			
Parameter	Hidden	Value	Label
DPR.CATG	yes	CALIB	Data product category
DPR.TECH	yes	IMAGE	Data product technique
DPR.TYPE	yes	FLAT	Data product type

This template (see Table 14) is the one currently used to obtain twilight flat frames for HAWK-I, with the telescope at zenith (and without tracking). It is typically started up to one hour before sunset if red narrow-band flat-field are needed. The template cycles through a series of filters to determine the best DIT and NDIT to obtain a high initial count level on the frames (i.e. $\sim$ 25000

ADUs). After this, exposures are taken cycling through the filters obtaining frames with fixed DIT and NDIT (and decreasing count levels). The pipeline processes the series of frames doing a linear regression for the count levels of each pixel versus the average count level of the frame. An image containing for each pixel the slope of the regression is the "flat field" frame.

4.3.3 HAWKI_img_acq_TwPreset

Table 15: Parameters of HAWKI_img_acq_TwPreset

HAWKI_img_acq_TwPreset.tsf			
To be specified:			
Parameter	Hidden	Range *(Default)*	Label
DET.DIT	no	1.6762..3600 *(NODEFAULT)*	DIT (secs)
DET.NDIT	no	1..1000 *(1)*	NDIT
INS.FILT.NAME	no	*(NODEFAULT)*	Filter Name
SEQ.PRESET	yes	T F *(T)*	Preset telescope?
TEL.AG.GUIDESTAR	yes	NONE SETUPFILE CATALOGUE *(NONE)*	Telescope Guide Star Selection
TEL.GS1.ALPHA	yes	*(0.0)*	RA of telescope guide star
TEL.GS1.DELTA	yes	*(0.0)*	DEC of telescope guide star
TEL.ROT.OFFANGLE	no	-360.0..360.0 *(0)*	Position Angle on Sky (deg)
TEL.TARG.ADDVELALPHA	yes	-100..100 *(0)*	Add Velocity Alpha
TEL.TARG.ADDVELDELTA	yes	-100..100 *(0)*	Add Velocity Delta
TEL.TARG.ALPHA	no	*(NODEFAULT)*	
TEL.TARG.DELTA	no	*(NODEFAULT)*	
TEL.TARG.EQUINOX	no	-2000..3000 *(2000)*	Equinox
TEL.TARG.NAME	no	*(NODEFAULT)*	Name of the Target
TEL.TARG.OFFSETALPHA	no	-999..999 *(0.0)*	Alpha offset for the target (arcsec)
TEL.TARG.OFFSETDELTA	no	-999..999 *(0.0)*	Delta offset for the target (arcsec)
Fixed values:			
Parameter	Hidden	Value	Label

This template does a simple telescope preset in view of taking twilight flats. The instrument parameters should be set to values used in the subsequent imaging template, so that the instrument will be already set-up for the start of the first science template.

No RTD image is dumped on disk at the end of this template.

No telescope guide star is used during twilight, thus that set of parameters is hidden. The guideprobe is parked automatically. Parameters are specified in details in Table 15.

4.3.4 HAWKI_img_cal_SkyFlats

This template takes images of "empty" fields during twilight to determine the flat-field while the telescope is only tracking (i.e. no offsets). See Table 16 for details.

4.3.5 HAWKI_img_cal_StandardStar

This template is used for imaging standard stars in order to determine the zero point of the photometry. It is similar to the HAWKI_img_obs_GenericOffset template (see Sect. **??**), but the DPR keywords are set appropriately for automatic pipeline reduction, i.e. DPR.CATG = CALIB, DPR.TYPE = STD, and DPR.TECH = IMAGE.

This template is used in combination with HAWKI_img_acq_Preset(see Sect. **??**).

Table 16: Parameters of `HAWKI_img_cal_SkyFlats`

HAWKI_img_cal_SkyFlats.tsf			
To be specified:			
Parameter	Hidden	Range *(Default)*	Label
DET.DIT	no	1.6762..3600 *(NODEFAULT)*	DIT (secs)
DET.NDIT	no	1..1000 *(1)*	NDIT
INS.FILT.NAME	no	*(NODEFAULT)*	Filter Name
SEQ.FILEID	yes	*(SkyFlats)*	Filename id
SEQ.NEXPO	no	1..1000 *(1)*	Number of exposures
Fixed values:			
Parameter	Hidden	Value	Label
DPR.CATG	yes	CALIB	Data product category
DPR.TECH	yes	IMAGE	Data product technique
DPR.TYPE	yes	FLAT	Data product type

Table 17: Parameters of `HAWKI_img_cal_StandardStar`

HAWKI_img_cal_StandardStar.tsf			
To be specified:			
Parameter	Hidden	Range *(Default)*	Label
DET.DIT	no	1.6762..3600 *(NODEFAULT)*	DIT (secs)
DET.NDIT	no	1..1000 *(1)*	NDIT
INS.FILT.NAME	no	Ks H J Y BrG NB2090 CH4 NB1190 NB1060 H2 *(NODEFAULT)*	Filter Name
SEQ.BADAO	yes	T F *(F)*	Ignore AO
SEQ.FILEID	yes	*(StandardStar)*	Filename id
SEQ.NEXPO	no	1..1000 *(NODEFAULT)*	Number of exposures per offset
SEQ.NOFFSET	no	1..1000 *(NODEFAULT)*	Number of offsets
SEQ.OFFSET.COORDS	no	SKY DETECTOR *(DETECTOR)*	Offset coordinate type selection
SEQ.OFFSET1.LIST	no	-600..600 *(NODEFAULT)*	List of X or RA offsets (arcsec)
SEQ.OFFSET2.LIST	no	-600..600 *(NODEFAULT)*	List of Y or DEC offsets (arcsec)
SEQ.RETURN	no	T F *(T)*	Return to origin?
SEQ.SHOW.GRAPH	yes	T F *(T)*	Show quick-look graphics?
Fixed values:			
Parameter	Hidden	Value	Label
DPR.CATG	yes	CALIB	Data product category
DPR.TECH	yes	IMAGE	Data product technique
DPR.TYPE	yes	STD	Data product type

Note that the template serves to determine the zero point only. It is not used to determine illumination corrections (see **??**). Thus, it is enough to observe the standard at one position; it is not necessary to "scan" each detector. Its parameters are listed in Table 17.

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4.4 Technical Templates

The technical templates serve to calibrate the instrument but cannot be used by the regular observer. Instead, they are executed at regular intervals to monitor the instrument or adjust/verify telescope or instrument parameters after an intervention.

4.4.1 HAWKI_gen_tec_StandBy

Table 18: Parameters of HAWKI_gen_tec_StandBy

HAWKI_gen_tec_Standby.tsf			
To be specified:			
Parameter	Hidden	Range *(Default)*	Label
INS.WHAT	no	DAY NIGHT CALIB *(DAY)*	
Fixed values:			
Parameter	Hidden	Value	Label

This template puts the system in mode standby. For the default value of the parameter INS.WHAT=DAY this means that the TCS is ignored and the instrument is set to standby. See Table 18.

4.4.2 HAWKI_img_tec_IlluFrame

Table 19: Parameters of HAWKI_img_tec_IlluFrame

HAWKI_img_tec_IlluFrame.tsf			
To be specified:			
Parameter	Hidden	Range *(Default)*	Label
DET.DIT	no	1.6762..3600 *(NODEFAULT)*	DIT (secs)
DET.NDIT	no	1..1000 *(1)*	NDIT
INS.FILT.NAME	no	*(NODEFAULT)*	Filter Name
SEQ.FILEID	yes	*(IlluFrame)*	Filename id
SEQ.GRID.SIZE	no	1..50 *(NODEFAULT)*	Offset grid size
SEQ.NEXPO	no	1..1000 *(1)*	Number of exposures
SEQ.OBSTYPE.LIST	no	O S *(NODEFAULT)*	Observation type list, O/S
SEQ.OFFSET.COORDS	yes	SKY DETECTOR *(DETECTOR)*	Offset coordinate type selection
SEQ.QUADRANTS	no	1..4 *(1 2 3 4)*	Selected quadrants
SEQ.RETURN	no	T F *(T)*	Return to origin?
SEQ.SHOW.GRAPH	yes	T F *(T)*	Show quick-look graphics?
Fixed values:			
Parameter	Hidden	Value	Label
DPR.CATG	yes	TECHNICAL	Data product category
DPR.TECH	yes	IMAGE	Data product technique
DPR.TYPE	yes	STD	Data product type

This template (see Table 19) determines the zero point variations as a function of position on the detector mosaic. It is used in combination with HAWKI_img_acq_Preset(see Sect. **??**) to point towards a stellar field (ideally containing a few hundred bright, uncrowded sources).

A series of exposures is taken in a N×N grid of offsets ($\sim$ 200 pix) during stable conditions. The resulting images are used to determine the relative photometry as a function of detector position. The user can select one or all quadrants.

4.4.3 HAWKI_img_tec_Astrometry

Table 20: Parameters of HAWKI_img_tec_Astrometry

HAWKI_img_tec_Astrometry.tsf			
To be specified:			
Parameter	Hidden	Range *(Default)*	Label
DET.DIT	no	1.6762..3600 *(NODEFAULT)*	DIT (secs)
DET.NDIT	no	1..1000 *(1)*	NDIT
INS.FILT.NAME	no	*(NODEFAULT)*	Filter Name
SEQ.FILEID	yes	*(Astrometry)*	Filename id
SEQ.NEXPO	no	1..1000 *(1)*	Number of exposures
SEQ.NOFFSET	no	1..1000 *(NODEFAULT)*	Number of offsets within a box
SEQ.OBSTYPE.LIST	no	O S *(O)*	Observation type list, O/S
SEQ.OFFSET.COORDS	no	SKY DETECTOR *(DETECTOR)*	Offset coordinate type selection
SEQ.OFFSET1.LIST	no	-600..600 *(NODEFAULT)*	List of X or RA offsets (arcsec)
SEQ.OFFSET2.LIST	no	-600..600 *(NODEFAULT)*	List of Y or DEC offsets (arcsec)
SEQ.RETURN	no	T F *(T)*	Return to origin?
SEQ.SHOW.GRAPH	yes	T F *(T)*	Show quick-look graphics?
Fixed values:			
Parameter	Hidden	Value	Label
DPR.CATG	yes	TECHNICAL	Data product category
DPR.TECH	yes	IMAGE	Data product technique
DPR.TYPE	yes	ASTROMETRY,OBJECT	Data product type

The astrometric solution is determined in two steps. In the first step, the average distortion solution is determined using the astrometry template described in this section and originally fol-

lowing the method outlined in Anderson et al. (2006, A&A 454, 1029) [see RD-2] . Now , a new pipeline recipe has been developed in house, and is part of the public HAWKI pipeline (http://www.eso.org/sci/software/pipelines/hawki/hawki-pipe-recipes.html).

In a second step, the absolute scale and flexures are determined (see below **??**).

This template is used in combination with `HAWKI_img_acq_Preset` (see Sect. **??**). Any astrometric field can be used. The template performs 25 large (200 pix) offsets with 5 exposures of 60s in J at each offset. Parameters are described in Table 20.

4.4.4 `HAWKI_img_tec_Flexure`

Table 21: Parameters of `HAWKI_img_tec_Flexure`

HAWKI_img_tec_Flexure.tsf			
To be specified:			
Parameter	Hidden	Range *(Default)*	Label
DET.DIT	no	1.6762..3600 *(NODEFAULT)*	DIT (secs)
DET.NDIT	no	1..1000 *(1)*	NDIT
INS.FILT.NAME	no	*(NODEFAULT)*	Filter Name
SEQ.ANGLE.START	no	-180..180 *()*	
SEQ.ANGLE.STEP	no	1..100 *()*	
SEQ.ANGLE.STOP	no	-240..240 *()*	
SEQ.FILEID	yes	*(Flexure)*	Filename id
SEQ.NEXPO	no	1..1000 *(1)*	Number of exposures
SEQ.OBSTYPE.LIST	no	O S *(O)*	Observation type list, O/S
SEQ.RETURN	no	T F *(T)*	Return to origin?
Fixed values:			
Parameter	Hidden	Value	Label
DPR.CATG	yes	TECHNICAL	Data product category
DPR.TECH	yes	IMAGE	Data product technique
DPR.TYPE	yes	ASTROMETRY,STD	Data product type

This template determines the absolute scale and flexure, as the second step of the astrometry calibration. It is used in combination with `HAWKI_img_acq_Preset` (see Sect. **??**). It points towards a standard astrometric field, configures the instrument, and acquires one (1) image per position angle of the telescope adapter/rotator, as it scans the angles from `SEQ.ANGLE.START` to `SEQ.ANGLE.END` in steps of `SEQ.ANGLE.STEP`. Typically, this is part of the earthquake procedures, and it is described in Table 21.

4.4.5 `HAWKI_img_tec_DetTest`

The characteristics of the detectors, such as read-out noise, dark current, bad pixels, linearity, persistence, etc, are monitored periodically. This can be achieved with the calibration templates listed above (in particular with `HAWKI_img_cal_Darks`).

However, several characteristics, such as linearity and conversion factor, require a set of internal flat-fields with various illumination in order to be determined. This is the purpose of this template. Note, however, that HAWK-I has no internal calibration source, i.e. the images are acquired on the dark Nasmyth screen using the Ks filter (see Table 22).

4.4.6 `HAWKI_img_tec_FilterWheel`

This template is used to exercise the filter wheel, and it is part of the daily instrument startup sequence. It was originally meant to determine the reproducibility of the filter wheel positioning,

Table 22: Parameters of `HAWKI_img_tec_DetTest`

HAWKI_img_tec_DetTest.tsf			
To be specified:			
Parameter	Hidden	Range *(Default)*	Label
INS.FILT.NAME	no	*(NODEFAULT)*	Filter Name
SEQ.DARKS.NEXPO	no	0..100 *(0)*	Number of dark exposures
SEQ.DET.DIT.LIST	no	*(1)*	List of DITs
SEQ.DET.DIT.NSTEPS	no	*(1)*	Number of DIT steps for each DIT LIST entry
SEQ.DET.DIT.STEPS	no	*(0)*	DIT steps for each DIT LIST entry
SEQ.DET.NDIT.LIST	no	*(1)*	List of NDITs
SEQ.DET.NDIT.NSTEPS	no	*(1)*	Number of NDIT steps for each NDIT.LIST entry
SEQ.DET.NDIT.STEPS	no	*(0)*	NDIT steps for each NDIT.LIST entry
SEQ.FILEID	yes	*(DetTest)*	Filename id
Fixed values:			
Parameter	Hidden	Value	Label
DPR.CATG	yes	TECHNICAL	Data product category
DPR.TECH	yes	IMAGE	Data product technique
DPR.TYPE	yes	FLAT	Data product type

recording thermal images of the Nasmyth screen. In the absence of e.g. a pinhole array to analyse the filter wheel reproducibility properly, the data taken are then used to monitor the instrument's transparency (throughput). The used set of parameters is summarised in Table 23.

Table 23: Parameters of `HAWKI_img_tec_FilterWheel`

HAWKI_img_tec_FilterWheel.tsf			
To be specified:			
Parameter	Hidden	Range *(Default)*	Label
DET.DIT	no	1.6762..3600 *(NODEFAULT)*	DIT (secs)
DET.NDIT	no	1..1000 *(1)*	NDIT
SEQ.FILEID	yes	*(FilterWheel)*	Filename id
SEQ.FILT1.LIST	no	Ks H J Y BrG OPEN *(NODEFAULT)*	Filter 1 List
SEQ.FILT2.LIST	no	NB2090 CH4 NB1190 NB1060 H2 OPEN *(NODEFAULT)*	Filter 2 List
SEQ.NEXPO	no	1..1000 *(1)*	Number of exposures
Fixed values:			
Parameter	Hidden	Value	Label
DPR.CATG	yes	TECHNICAL	Data product category
DPR.TECH	yes	IMAGE	Data product technique
DPR.TYPE	yes	FLAT	Data product type

One can give a list of filters for both filter wheel (FW) 1 and 2. The template starts working through the list given for FW1. It sets a filter (e.g. J) and takes an image then move back to the filter defined as first in that list and moves back (i.e to J) and takes another image. It was originally meant to test the filter wheel reproducibilty but not having e.g. a pinhole array, it is not possible. Instead we use this to take "internal flats" to monitor the transparency of the optics. Once the OB ran through the list of FW1, it then repeats the same procedure for FW2. At the

end, it leaves the system in the dark position.

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