



# HARPS-N

## Templates Reference Guide

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# Chapter 1: Introduction

## 1.1 Introduction

HARPS-N will be a copy of the ultra-precise radial-velocity spectrograph HARPS developed by a consortium headed by the Geneva Observatory (hereafter **OG**) located on the 3.6-m ESO telescope at the La Silla Observatory in Chile and it shall be used to follow-up, by radial velocity, the “hot” candidates delivered by the Kepler satellite. Given the known period and phase, and the extreme Doppler-precision of HARPS-N, it will be possible, for the first time, to confirm and characterize Earth-mass planets. The project, as well as the present contract, is lead and conducted by OG.

The software for HARPS North is developed as a collaboration between Geneva Observatory, ATC and TNG.

## 1.2 Scope of the Document

This document describes in detail the templates needed for the scientific, calibration and maintenance operations of HARPS North. The templates requirements are given in "HARPS North Operation, Calibration and Maintenance Plan".

The FITS keywords names have to follow the HARPS-N Dictionary [AD-1].

## 1.3 Documents

### 1.3.1 Applicable Documents

AD-1	OG-DID-HAN-13-0002	HARPS-N Dictionary	2.0	14.04.2011
AD-2				

### 1.3.2 Applicable Drawings

AD-3				
AD-4				

### 1.3.3 Reference Document

RD-1				
RD-2				

### 1.3.4 Reference Drawings

RD-3				
RD-4				



## 1.4 Acronyms

AD	Applicable Document
CCD	Charge-Couple Device (detector)
HCA	Harvard Center for Astrophysics
ESA	European Space Agency
ESO	European Southern Observatory
EUR	Euro
FA	Final Acceptance
FDR	Final Design Review
FRD	Focal-Ratio Degradation
HARPS	High-Accuracy Radial-velocity Planet Searcher
HU	Harvard University
ODR	Optical Design Review
OG	Observatoire de Genève
PA	Provisional Acceptance
PDR	Preliminary Design Review
PO	Purchase Order
NEF	Northern Earth Facility
RD	Reference Document
SOW	Statement of Work
TBC	To Be Confirmed
TBD	To Be Defined
TNG	Telescopio Nazionale Galileo (La Palma, Canary Islands)
TRS	Technical Requirements Specification
WHT	William Herschel Telescope (La Palma, Canary Islands)



# Chapter 2: Overview

## 2.1 Introduction

This document describes the Templates for scientific, calibration and maintenance operations of HARPS North. Their syntax is based on the ESO Templates, but their definition is more for the information/description purpose than the real use.

According to the ESO standards, there are three parts for each template:

- **Template Signature File** (.tsf) with description of keywords to be defined by the user in the moment of observation execution.
- **Reference File** (.ref) with the values of keywords defined for each template; they can't be changed by the user.
- **Sequence File** (.seq) with the template execution procedure.

The templates are the building bricks of the observation and calibration Observation Blocks. An observation block is the quantum of observation, i.e. a data structure containing all the parameters necessary to define a single observation.

Furthermore, some templates are defined to handle the maintenance operations needed to maintain the high quality of the instrument and ensure the data accuracy.

Even if there's no need to use ESO templates to make the instrument running, their definition facilitates however the comprehension of the instrument and the Short Time Scheduler functioning.

## 2.2 Observation modes

The configuration of HARPS-N is simple and there is therefore only one instrument mode foreseen, but several observation modes have been defined:

- observation with simultaneous wavelength reference
- observation with simultaneous sky background
- observation with science fiber only

## 2.3 Exposure types

There are three different exposure types:

- science exposures
- calibration exposures
- maintenance exposures

## 2.4 Instrument setup

To achieve the instrument setup for different observation and calibration modes, different parts can be moved. Some devices are setup to the same value during the whole night (see Table 1) and other can be changed for each exposure (see Table 2). The flat-field LED used to illuminate directly the CCD and used in some technical exposures is driven directly by PULPO through a special type of exposure (**HARPN\_ech\_tec\_led**).

device name	device position	device description
INS.DUST.ST	T F (CLOSED OPEN)	Fiber Head Dust Cover
INS.LAMP2.ST	T F (ON OFF)	THAR1 Lamp
INS.LAMP3.ST	T F (ON OFF)	THAR2 Lamp

Table 1: Devices keeping their value during the whole night

device name	device position	device description
INS.MIRR.POS	FIBA BOTH FIBB NONE	Calibration Mirror
INS.OPTI1.POS	NONE TUN THAR1 THAR2 SPH1 SPH2	Calibration Lamp A Selector
INS.OPTI2.POS	NONE TUN THAR1 THAR2 SPH1 SPH2	Calibration Lamp B Selector
INS.ROT1.DST	<density>	Neutral Density Filter Wheel
INS.LAMP1.ST	T F (ON OFF)	Tungsten Lamp
INS.LAMP4.ST	T F (ON OFF)	Integrating Sphere Source 1
INS.LAMP5.ST	T F (ON OFF)	Integrating Sphere Source 2

Table 2: Devices set up for an exposure

## 2.5 Templates classification

These HARPS-N templates are split in four groups according to the function to be performed:

### 2.5.1 Acquisition templates

One acquisition template is defined for each observing mode or submode. This allows the complete configuration before guiding is started, as this latter will possibly be disturbed by a moving device crossing its optical path.

Furthermore, the measurement of the optical efficiency of the instrument through each fiber (maintenance templates **HARPN\_ech\_tec\_eff**) is done by measuring a standard star in fiber A, with the sky or dark in fiber B. To achieve these configurations, the two last acquisition templates will also be used.

1. acquisition for accurate RV measurement with *ThAr lamp* (acq\_thosimult)
2. acquisition for accurate RV measurement with one of the *Integrating Sphere Sources* (acq\_wavesimult)
3. acquisition for spectroscopy of object only on fiber A (acq\_objA)
4. acquisition for spectroscopy of object on fiber A and sky on fiber B (acq\_objAB)

The observation template will define three keywords **TPL.NAME**, **DPR.TECH** and **DPR.TYPE**, containing the type of observation and the information regarding the objects seen by the fibers. Then, it will send them to the header. Their values depend on the preceding acquisition template. The Table 3 lists the content of these keywords for the different acquisition templates.

Fiber A	Fiber B	INS.MIRR	INS.OPTI1	INS.OPTI2
no light	no light	BOTH	NONE	NONE
no light	lamp	BOTH	NONE	<lamp>
no light	telescope	FIBA	NONE	NONE

lamp	no light	BOTH	<lamp>	NONE
lamp	lamp	BOTH	<lamp>	<lamp>
lamp	telescope	FIBA	<lamp>	NONE
telescope	no light	FIBB	NONE	NONE
telescope	lamp	FIBB	NONE	<lamp>
telescope	telescope	NONE	NONE	NONE

**Table 3: Combination of different light injection possibilities and corresponding light paths. <lamp> can be TUN1, THAR1, THAR2, SPH1 or SPH2.**

The **TPL.NAME** (or **ACQ.NAME** TBD) derives its value from the name of the acquisition template. The result will be "HARPN\_ech\_obs\_<config>" or "HARPN\_ech\_tec\_<config>", where <config> is the acquisition method (thosimult, wavesimult, objA or objAB). It will be included in the FITS header of the frame and used to trigger the adequate reduction recipe.

The **DPR.TECH** indicates if the frame contains an echelle spectrum or a dark or flat-field image. The **DPR.TYPE** is composed of up to four fields, where the first one shows what kind of object did illuminate the fiber A, the second shows what kind of object did illuminate the fiber B during the exposure, the third one indicates either the spectral type of the star present in fiber A or the lamp illuminating fiber A, and the fourth one describes the source used in fiber B (see Table 4).

For the calibration and technical templates not involving celestial objects, and thus not using acquisition templates, these keywords are also defined. They will be provided directly to the header.

Template = TPL.NAME	DPR.TECH	DPR.TYPE
HARPN_ech_acq_thosimult	"ECHELLE"	"STAR,WAVE,<spectr type>,'THAR1 THAR2'"
HARPN_ech_acq_wavesimult	"ECHELLE"	"STAR,WAVE<spectr type>,'SPH1 SPH2'"
HARPN_ech_acq_objA	"ECHELLE"	"STAR,DARK,<spectr type>"
HARPN_ech_acq_objAB	"ECHELLE"	"STAR,DARK,<spectr type>"

**Table 4 The content of the Data Products Keywords describe the type of observation and the objects involved**

## 2.5.2 Observation templates

As the complete configuration of the instrument has been done by the acquisition template, there is only one observation template, whose goal is to define the exposure characteristics and to launch it. The only instrument function still to be configured at that stage is the lamp attenuator whose value is function of the exposure time.

1. science exposure (obs\_all)

## 2.5.3 Calibration templates

The calibration templates set provides exposures to fully characterize HARPS-N and obtain the best quality reduction of science exposures.

1. calibration of detector bias level and readout noise (cal\_bias)
2. calibration of detector dark current (cal\_dark)
3. calibration of the detector flat field (cal\_led)
4. calibration of the focus (cal\_focus)
5. calibration exposure for fiber A orders geometry (cal\_tunA)
6. calibration exposure for fiber B orders geometry (cal\_tunB)

7. calibration exposure for spectral flat field for both fibers (cal\_tunAB)
8. calibration exposure of tungsten lamp in free settings (cal\_tunUSER)
9. calibration exposure for wavelength calibration with *ThAr lamp* (cal\_thoAB)
10. calibration exposure for wavelength calibration with one of the *Integrating Sphere Sources* (cal\_waveAB)
11. calibration exposure for *ThAr lamp* pollution measurement (cal\_thoB)
12. calibration exposure for *Integrating Sphere Source* pollution measurement (cal\_waveB)
13. calibration of the spectrometric standard (cal\_skyflat)

A minimum set of calibration exposures is defined for automatic DRS needs as including cal\_dark, cal\_tun, cal\_tunAB, cal\_thoAB (cal\_waveAB) and cal\_thoB (cal\_waveB).

### 2.5.4 Maintenance templates

The following templates provide exposures to periodically examine the instrument performances and monitor the stability of these performances. Some of them are symmetric with respect to the calibration templates, some are new:

1. technical exposure for bias and dark current measurement (tec\_dark)
2. technical flat-field exposure of the CCD using a *LED* (tec\_led)
3. technical exposure for fiber A orders geometry (tec\_tunA)
4. technical exposure for fiber B orders geometry (tec\_tunB)
5. technical exposure for spectral flat-field (tec\_tunAB)
6. technical exposure for wavelength solution A (tec\_thoA)
7. technical exposure for wavelength solution B (tec\_thoB)
8. technical exposure for wavelength solution AB (tec\_thoAB)
9. technical exposure for *Integrating Sphere Source* on fiber A (tec\_waveA)
10. technical exposure for *Integrating Sphere Source* on fiber B (tec\_waveB)
11. technical exposure for *Integrating Sphere Source* on both fibers (tec\_waveAB)
12. technical exposure for efficiency of light path (tec\_eff)
13. technical exposure for free configuration (tec\_free)

## Chapter 3: Acquisition template

### 3.1 Introduction

As the acquisition template defines the type of observation in our scheme, thus the DRS recipe to be triggered. All the telescope keywords are defined here.

### 3.2 HARPN\_ech\_acq\_thosimult

This is the HARPS-N baseline acquisition template. The object is specified by the identification keywords:

keyword name	keyword value	keyword description
TPL.NAME	"HARPN_ech_acq_thosimult"	Observation Mode
DPR.TECH	"ECHELLE"	Observation Technique
DPR.TYPE	"STAR, WAVE, <sp>(G2V)"	Objects Type
TEL.TARG.RADVEL	<radvel> "NONE"	Target Radial Velocity

The telescope will be preset to the specified RA and DEC, i.e.:

keyword name	keyword value	keyword description
TEL.TARG.ALPHA	<ra> (000000.0, format TBD)	Target R.A.
TEL.TARG.DELTA	<dec> (-850000.0, format TBD)	Target Decl.
TEL.TARG.EQUINOX	<equinox> (2000)	Coordinates Equinox [year]
TEL.TARG.EPOCH	<epoch> (2000)	Epoch expressed as year
TEL.TARG.PMA	<pm ra> (0)	Alpha Proper Motion [arcsec/year]
TEL.TARG.PMD	<pm dec> (0)	Delta Proper Motion [arcsec/year]

The target is acquired automatically or interactively by the operator if it is problematic for the automatic acquisition, e.g. too faint, double or extended object.

Then the optical paths are setup to have the target in fiber A and the proper *ThAr lamp* light in fiber B. The specified *ThAr lamp* is already ON, and the other OFF, but their statuses are verified. To ensure that only the used lamp is on, the lamp selection for fiber B will guide the template to illuminate the proper lamp. The lamp is verified to be switched on. If not, the operator is warned, and the template exits.

keyword name	keyword value	keyword description
INS.MIRR.POS	FIBB	Calibration mirror
INS.OPTI2.POS	THAR1 THAR2	Calibration Lamp B Selector
INS.LAMP2.ST	T F (ON OFF)	THAR1 Lamp
INS.LAMP3.ST	T F (ON OFF)	THAR2 Lamp

The image of the technical CCD is saved and the operator is asked to confirm when the star is centered and the guiding active.

### 3.3 HARPN\_ech\_acq\_wavesimult

This is HARPS-N another baseline acquisition template. The object is specified by the identification keywords:

keyword name	keyword value	keyword description
TPL.NAME	"HARPN_ech_acq_wavesimult"	Observation Mode
DPR.TECH	"ECHELLE"	Observation Technique
DPR.TYPE	"STAR, WAVE, <sp>(G2V)"	Objects Type
TEL.TARG.RADVEL	<radvel> "NONE"	Target Radial Velocity

The telescope will be preset to the specified RA and DEC, i.e.:

keyword name	keyword value	keyword description
TEL.TARG.ALPHA	<ra> (000000.0, format TBD)	Target R.A.
TEL.TARG.DELTA	<dec> (-850000.0, format TBD)	Target Decl.
TEL.TARG.EQUINOX	<equinox> (2000)	Coordinates Equinox [year]
TEL.TARG.EPOCH	<epoch> (2000)	Epoch expressed as year
TEL.TARG.PMA	<pm ra> (0)	Alpha Proper Motion [arcsec/year]
TEL.TARG.PMD	<pm dec> (0)	Delta Proper Motion [arcsec/year]

The target is acquired automatically or interactively by the operator if it is problematic for the automatic acquisition, e.g. too faint, double or extended object.

Then the optical paths are setup to have the target in fiber A and one of the *Integrating Sphere Sources* in fiber B. The *ThAr lamp* is unused, but left ON in case of later use.

keyword name	keyword value	keyword description
INS.MIRR.POS	FIBB	Calibration mirror
INS.OPTI2.POS	SPH1 SPH2	Calibration Lamp B Selector
INS.LAMP4.ST	T F (ON OFF)	Integrating Sphere Source 1
INS.LAMP5.ST	T F (ON OFF)	Integrating Sphere Source 2

The image of the technical CCD is saved and the operator is asked to confirm when the star is centered and the guiding active.

### 3.4 HARPN\_ech\_acq\_objA

This is the HARPS-N simpler spectroscopic observation mode acquisition template. The object is specified by the identification keywords:

keyword name	keyword value	keyword description
TPL.NAME	"HARPN_ech_acq_objA"	Observation Mode
DPR.TECH	"ECHELLE"	Observation Technique



DPR.TYPE	"STAR, DARK, <sp>(G2V)"	Objects Type
TEL.TARG.RADVEL	<radvel> "NONE"	Target Radial Velocity

The telescope will be preset to the specified RA and DEC, i.e.:

keyword name	keyword value	keyword description
TEL.TARG.ALPHA	<ra> (000000.0, format TBD)	Target R.A.
TEL.TARG.DELTA	<dec> (-850000.0, format TBD)	Target Decl.
TEL.TARG.EQUINOX	<equinox> (2000)	Coordinates Equinox [year]
TEL.TARG.EPOCH	<epoch> (2000)	Epoch expressed as year
TEL.TARG.PMA	<pm ra> (0)	Alpha Proper Motion [arcsec/year]
TEL.TARG.PMD	<pm dec> (0)	Delta Proper Motion [arcsec/year]

The target is acquired automatically or interactively by the operator if it is problematic for the automatic acquisition, e.g. too faint, double or extended object.

Then the optical paths are setup to have the target in fiber A and no light in fiber B. The *ThAr lamp* is unused, but left ON in case of later use.

keyword name	keyword value	keyword description
INS.MIRR.POS	FIBB	Calibration mirror
INS.OPTI2.POS	NONE	Calibration Lamp B Selector

The image of the technical CCD is and the operator is asked to confirm when the star is centered and the guiding active.

This template is also used for the technical exposure corresponding to the template **HARPN\_ech\_tec\_eff**.

### 3.5 HARPN\_ech\_acq\_objAB

This is the HARPS-N spectroscopic with sky removal observation mode acquisition template. The object is specified by the identification keywords:

keyword name	keyword value	keyword description
TPL.NAME	"HARPN_ech_acq_objAB"	Observation Mode
DPR.TECH	"ECHELLE"	Observation Technique
DPR.TYPE	"STAR, SKY, <sp>(G2V)"	Objects Type
TEL.TARG.RADVEL	<radvel> "NONE"	Target Radial Velocity

The telescope will be preset to the specified RA and DEC, i.e.:

keyword name	keyword value	keyword description
TEL.TARG.ALPHA	<ra> (000000.0, format TBD)	Target R.A.
TEL.TARG.DELTA	<dec> (-850000.0, format TBD)	Target Decl.
TEL.TARG.EQUINOX	<equinox> (2000)	Coordinates Equinox [year]
TEL.TARG.EPOCH	<epoch> (2000)	Epoch expressed as year
TEL.TARG.PMA	<pm ra> (0)	Alpha Proper Motion [arcsec/year]
TEL.TARG.PMD	<pm dec> (0)	Delta Proper Motion [arcsec/year]

The target is acquired automatically or interactively by the operator if it is problematic for the automatic acquisition, e.g. too faint, double or extended object.

Then the optical paths are setup to have the target in fiber A and sky light in fiber B. The *ThAr lamp* is unused, but left ON in case of later use.

<b>keyword name</b>	<b>keyword value</b>	<b>keyword description</b>
INS.MIRR.POS	NONE	Calibration mirror

The image of the technical CCD is saved and the operator is asked to confirm when the star is centered and the guiding active.



## Chapter 4: Observation template

### 4.1 Introduction

The observation template defines mainly the *Exposure Time*, *Number of Repeated Exposures* and *CCD ReadOut Mode*. *CCD ReadOut Mode* is a string defining simultaneously several CCD parameters - TBC. The CCD read out modes are TBD. There will be a default read out mode, which can be changed by the user on his own responsibility.

### 4.2 HARPN\_ech\_obs\_all

The keyword **TPL.NAME** (or **ACQ.NAME** TBD) is computed to give a pseudo observation template name **HARPS\_ech\_obs\_XXXX**, where XXXX is the last extension of the acquisition template name.

The **DPR.TECH** and the **DPR.TYPE** keywords are passed to the FITS header, in order to inform the DRS about the kind of object acquired by the acquisition template, as well as the technique of observation. The **DPR.CATG** is set to "SCIENCE".

keyword name	keyword value	keyword description
TPL.NAME	"HARPN_ech_obs_XXXX"	Observation Mode
DPR.TECH	<observation technique>	Observation Technique
DPR.TYPE	"<objA>,<objB>,<sp>,<lamp>"	Objects Type
DPR.CATG	"SCIENCE"	Observation Category

The exposure parameters are set:

*Exposure Type* is set to NORMAL for the scientific exposures. *CCD ReadOut Mode*, *Exposure Time* and *Number of Repeated Exposures* are set.

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	<exptime>	Exposure Time [sec]
SEQ.NEXPO	1-100	Number of Repeated Exposures

Then, the *Neutral Density Wheel* angular position is set:

- For simultaneous wavelength reference exposures, the <density> is computed from the exposure time.
- For the other modes, it is set to zero.

keyword name	keyword value	keyword description
INS.ROT1.DST	<density> (0)	ND filter wheel 1 density
INS.ROT1.DST	<density> (0)	ND filter wheel 2 density

**SEQ.NEXPO** defines how many exposures are now processed with the following scheme:  
The exposure is carried out. After *Exposure Time*, the CCD is read out, the frame is archived. The DRS is triggered by the DFS when all the exposures are archived.

## Chapter 5: Calibration templates

### 5.1 Introduction

For most of the calibration templates, the set of free parameters is limited and optimal values will be substituted to achieve best performance. The reduction recipe is indicated in the following sections, but the DRS is neither part of the template, nor triggered by the OS, but rather by the DFS after archiving the frame(s).

### 5.2 HARPN\_ech\_cal\_bias

This template implements the measurement of the electronic bias level and readout noise of the CCD, via zero-length exposure of type BIAS.

keyword name	keyword value	keyword description
TPL.NAME	"HARPN_ech_cal_bias"	Observation Mode
DPR.CATG	"CALIB"	Observation Category
DPR.TECH	"IMAGE"	Observation Technique
DPR.TYPE	"BIAS,BIAS"	Objects Type and Spectral Type

The setup of the instrument is irrelevant as the *Exposure Type* of this exposure is set to DARK, leading the *Image Scrambler Shutter* to remain closed. Anyhow, the setup of the instrument is set up in order to eliminate any possible parasite light.

The exposure parameters are set.

keyword name	keyword value	keyword description
DET1.EXP.TYPE	DARK	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	0	Exposure Time [sec]
SEQ.NEXPO	1-100	Number of Repeated Exposures

Then the exposure is carried out: the CCD is flushed, then read again to achieve an exposure time of zero, then the frame is archived. No generic processing is done through this exposure by the DRS. The bias is computed via left and right over-scanning of each image during normal operations. This is repeated if *Number of Repeated Exposures* is greater than one.

### 5.3 HARPN\_ech\_cal\_dark

This template implements the measurement of the dark current of the CCD. The setup of the instrument is the same as for the bias exposure.

keyword name	keyword value	keyword description
TPL.NAME	"HARPN_ech_cal_dark"	Observation Mode
DPR.CATG	"CALIB"	Observation Category
DPR.TECH	"IMAGE"	Observation Technique
DPR.TYPE	"DARK,DARK"	Objects Type and Spectral Type

The exposure parameters are set. The same setup as for the bias measurement is used, except that the exposure time will be minimized by <minexptime>, and the number of exposure is fixed to one. The <minexptime> is defined as 300 seconds. If the user chooses a smaller exposure time, a warning pop-up is displayed.

keyword name	keyword value	keyword description
DET1.EXP.TYPE	DARK	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	<exptime> >= 300	Exposure Time [sec]
SEQ.NEXPO	1	Number of Repeated Exposures

Then the exposure is carried out: the CCD is flushed and read again after <exptime> to achieve the proper exposure time. At the end of each exposure the frame is archived. At the end of the template the DRS is triggered to compute the mean dark level, scaled to one hour.

## 5.4 HARPN\_ech\_cal\_led

Flat-field exposure with a non-zero light level.

keyword name	keyword value	keyword description
TPL.NAME	"HARPN_ech_cal_led"	Observation Mode
DPR.CATG	"CALIB"	Observation Category
DPR.TECH	"IMAGE"	Observation Technique
DPR.TYPE	"FLAT,FLAT"	Objects Type and Spectral Type

The spectrometer is configured in order to illuminate the CCD with a LED, without going through the fibers and the spectrometer. Thus, all the devices are set up the same way as for the dark exposure.

The exposure parameters are setup.

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	<exptime>	Exposure Time [sec]
SEQ.NEXPO	1	Number of Repeated Exposures

An exposure of type LED is carried out. The CCD is read out and the frame is archived and processed by the DRS to compute the contamination level of the CCD, estimate the gain, the linearity and map the bad pixels.

## 5.5 HARPS\_ech\_cal\_tunA

This template allows the DRS to calculate the location of the orders of fiber A, which is illuminated by the *Tungsten Lamp*.

The *Neutral Density Filter Wheel* angular position corresponding to a fixed <density>, usually equal to zero is set.

keyword name	keyword value	keyword description
INS.ROT1.DST	<density> (0)	ND filter wheel 1 density
INS.ROT2.DST	<density> (0)	ND filter wheel 2 density

The fiber positions are then set to allow the light from the *Tungsten Lamp* to feed the fiber A and no light in fiber B. The high flux emitted by the *Tungsten Lamp* may damage the detectors of the exposure meter, so a virtual shutter cuts the power supply of their photomultipliers.

keyword name	keyword value	keyword description
INS.PWR1.ST	F (CLOSED)	Exp Meter 1 power supply
INS.PWR2.ST	F (CLOSED)	Exp Meter 2 power supply
INS.MIRR.POS	BOTH	Calibration Mirror
INS.OPTI1.POS	TUN	Calibration Lamp A Selector
INS.OPTI2.POS	NONE	Calibration Lamp B Selector
INS.LAMP1.ST	T (ON)	Tungsten Lamp

The identifiers of the object for the first exposure are fixed.

keyword name	keyword value	keyword description
TPL.NAME	"HARPN_ech_cal_tunA"	Observation Mode
DPR.CATG	"CALIB"	Observation Category
DPR.TECH	"ECHELLE"	Observation Technique
DPR.TYPE	"LAMP,DARK,TUN"	Objects Type and Spectral Type

The CCD is then set up for a single NORMAL exposure.

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	4.5	Exposure Time [sec]
SEQ.NEXPO	1	Number of Repeated Exposures

The exposure is carried out. After *Exposure Time*, the CCD is read out, the frame is archived and processed by the DRS, which computes the geometry and the profile (in the cross-dispersion direction) of the orders of the tungsten spectrum in fiber A.

The *Power Supply* of the *Exposure Meter* is switched on and the *Tungsten Lamp* is switched off.

keyword name	keyword value	keyword description
INS.PWR1.ST	T (OPEN)	Exp Meter 1 power supply
INS.PWR2.ST	T (OPEN)	Exp Meter 2 power supply
INS.LAMP1.ST	F (OFF)	Tungsten Lamp



## 5.6 HARPS\_ech\_cal\_tunB

This template allows the DRS to calculate the location of the orders of fiber B, which is illuminated by the *Tungsten Lamp*.

The *Neutral Density Filter Wheel* angular position corresponding to a fixed <density>, usually equal to zero is set.

keyword name	keyword value	keyword description
INS.ROT1.DST	<density> (0)	ND filter wheel 1 density
INS.ROT2.DST	<density> (0)	ND filter wheel 2 density

The fibers positions are set to allow the light from the *Tungsten Lamp* feed fiber B and no light in fiber A. The high flux emitted by the *Tungsten Lamp* may damage the detectors of the exposure meter, so a virtual shutter cuts the power supply of their photomultipliers.

keyword name	keyword value	keyword description
INS.PWR1.ST	F (CLOSED)	Exp Meter 1 power supply
INS.PWR2.ST	F (CLOSED)	Exp Meter 2 power supply
INS.MIRR.POS	BOTH	Calibration Mirror
INS.OPTI1.POS	NONE	Calibration Lamp A Selector
INS.OPTI2.POS	TUN	Calibration Lamp B Selector
INS.LAMP1.ST	T (ON)	Tungsten Lamp

The identifiers of the object for the second exposure are fixed.

keyword name	keyword value	keyword description
TPL.NAME	"HARPN_ech_cal_tunB"	Observation Mode
DPR.CATG	"CALIB"	Observation Category
DPR.TECH	"ECHELLE"	Observation Technique
DPR.TYPE	"DARK,LAMP,TUN"	Objects Type and Spectral Type

The CCD is then set up again for a single NORMAL exposure.

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	4.5	Exposure Time [sec]
SEQ.NEXPO	1	Number of Repeated Exposures

The exposure is carried out. After *Exposure Time*, the CCD is read out, the frame is archived and processed by the DRS, which computes the geometry and the profile (in the cross-dispersion direction) of the orders of the tungsten spectrum in fiber B.

The *Power Supply* of the *Exposure Meter* is switched on and the *Tungsten Lamp* is switched off.

keyword name	keyword value	keyword description
INS.PWR1.ST	T (OPEN)	Exp Meter 1 power supply
INS.PWR2.ST	T (OPEN)	Exp Meter 2 power supply
INS.LAMP1.ST	F (OFF)	Tungsten Lamp

## 5.7 HARPN\_ech\_cal\_tunAB

This template will allow the measurement of the flat-field and the blaze response of HARPS-N. This template will be executed right after the geometry calibration done with **HARPN\_ech\_cal\_tun**.

keyword name	keyword value	keyword description
TPL.NAME	"HARPN_ech_cal_tunAB"	Observation Mode
DPR.CATG	"CALIB"	Observation Category
DPR.TECH	"ECHELLE"	Observation Technique
DPR.TYPE	"LAMP,LAMP,TUN"	Objects Type and Spectral Type

The fibers positions are set to allow the light from the *Tungsten Lamp* feed both fibers A and B.

keyword name	keyword value	keyword description
INS.PWR1.ST	F (CLOSED)	Exp Meter 1 power supply
INS.PWR2.ST	F (CLOSED)	Exp Meter 2 power supply
INS.MIRR.POS	BOTH	Calibration Mirror
INS.OPT1.POS	TUN	Calibration Lamp A Selector
INS.OPT2.POS	TUN	Calibration Lamp B Selector
INS.LAMP1.ST	T (ON)	Tungsten Lamp

The CCD is then set up.

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	4.5	Exposure Time [sec]
SEQ.NEXPO	<Nexp>	Number of Repeated Exposures

Then the *Neutral Density Filter Wheel* angular position corresponding to a fixed <density>, usually equal to zero is set.

keyword name	keyword value	keyword description
INS.ROT1.POS	<density> (0)	ND filter wheel 1 density
INS.ROT2.POS	<density> (0)	ND filter wheel 2 density

**SEQ.NEXPO** defines how many exposures are now processed with the following scheme:

The exposure is carried out, the CCD is read and the frame is archived.

The *Power Supply* of the *Exposure Meter* is switched on and the *Tungsten Lamp* is switched off.

keyword name	keyword value	keyword description
INS.PWR1.ST	T (OPEN)	Exp Meter 1 power supply
INS.PWR2.ST	T (OPEN)	Exp Meter 2 power supply
INS.LAMP1.ST	F (OFF)	Tungsten Lamp

At the end of the template, the exposures are processed by the DRS to compute the background level, the flat-field spectrum and the blaze response.

## 5.8 HARPN\_ech\_cal\_tunUSER

A flat-field template with free exposure parameters to allow the user to handle his own reduction needs.

keyword name	keyword value	keyword description
TPL.NAME	"HARPN_ech_cal_tunUSER"	Observation Mode
DPR.CATG	"CALIB"	Observation Category
DPR.TECH	"ECHELLE"	Observation Technique
DPR.TYPE	"LAMP,LAMP,TUN"	Objects Type and Spectral Type

The fibers positions are set to allow the light from the *Tungsten Lamp* feed both fibers A and B.

keyword name	keyword value	keyword description
INS.PWR1.ST	F (CLOSED)	Exp Meter 1 power supply
INS.PWR2.ST	F (CLOSED)	Exp Meter 2 power supply
INS.MIRR.POS	BOTH	Calibration Mirror
INS.OPTI1.POS	TUN	Calibration Lamp A Selector
INS.OPTI2.POS	TUN	Calibration Lamp B Selector
INS.LAMP1.ST	T (ON)	Tungsten Lamp

The CCD is then set up for <Nexp> exposures of duration <exptime>

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	<exptime>	Exposure Time [sec]
SEQ.NEXPO	<Nexp>	Number of Repeated Exposures

Then the *Neutral Density Filter Wheel* angular position corresponding to a fixed <density>, usually equal to zero is set.

keyword name	keyword value	keyword description
INS.ROT1.DST	<density> (0)	ND filter wheel 1 density
INS.ROT2.DST	<density> (0)	ND filter wheel 2 density

**SEQ.NEXPO** defines how many exposures are now processed with the following scheme:  
The exposure is carried out, the CCD is read and the frame is archived.

The *Power Supply* of the *Exposure Meter* is switched on and the *Tungsten Lamp* is switched off.

keyword name	keyword value	keyword description
INS.PWR1.ST	T (OPEN)	Exp Meter 1 power supply
INS.PWR2.ST	T (OPEN)	Exp Meter 2 power supply
INS.LAMP1.ST	F (OFF)	Tungsten Lamp

At the end of the template the exposures are processed together by the DRS to extract the spectra.

## 5.9 HARP<sub>N</sub>\_ech\_cal\_thoAB

The Thorium-Argon calibration template used to accurately compute the wavelength calibration of each fiber.

keyword name	keyword value	keyword description
TPL.NAME	"HARP <sub>N</sub> _ech_cal_thoAB"	Observation Mode
DPR.CATG	"CALIB"	Observation Category
DPR.TECH	"ECHELLE"	Observation Technique
DPR.TYPE	"WAVE,WAVE,THAR1 THAR2"	Objects Type and Spectral Type

The fibers positions are set to allow the light from a *ThAr lamp* feed both fibers A and B. The specified *ThAr lamp* will not be switched ON, if already ON. To ensure that needed lamps are switched on, their statuses are tested before starting the exposure.

keyword name	keyword value	keyword description
INS.MIRR.POS	BOTH	Calibration Mirror
INS.OPT1.POS	THAR1 THAR2	Calibration Lamp A Selector
INS.OPT2.POS	THAR1 THAR2	Calibration Lamp B Selector
INS.LAMP2.ST	T F (ON OFF)	THAR1 Lamp
INS.LAMP3.ST	T F (ON OFF)	THAR2 Lamp

The CCD is then set up for <Nexp> exposures of 15 seconds.

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	15	Exposure Time [sec]
SEQ.NEXPO	<Nexp>	Number of Repeated Exposures

Then the *Neutral Density Filter Wheel* angular position corresponding to a fixed <density>, usually equal to zero is set.

keyword name	keyword value	keyword description
INS.ROT1.POS	<density> (0)	ND filter wheel 1 density
INS.ROT2.POS	<density> (0)	ND filter wheel 2 density

**SEQ.NEXPO** defines how mane exposures are now processed with the following scheme:

The exposure is carried out, the CCD is read and the frame is archived.

At the end of the template the exposures are processed together by the DRS to extract the spectra, perform wavelength calibration (which is then archived) and compute image quality and spectrograph resolution indicators.

## 5.10 HARP\_N\_ech\_cal\_waveAB

The Integrating Sphere Source calibration template used to accurately compute the wavelength calibration of each fiber. Several configurations are possible with this template, depending on which source is providing the absolute wavelength reference on fiber A (either *ThAr* or another *Integrating Sphere Source*). On fiber B, one of two *Integrating Sphere Sources* can be used.

keyword name	keyword value	keyword description
TPL.NAME	"HARP_N_ech_cal_waveAB"	Observation Mode
DPR.CATG	"CALIB"	Observation Category
DPR.TECH	"ECHELLE"	Observation Technique
DPR.TYPE	"WAVE,WAVE,SPH1 SPH2"	Objects Type and Spectral Type

The fibers positions are set to allow the light from *ThAr lamp* or one of the *Integrated Sphere Sources* feed fibers A and B. The used *Integrated Sphere Source* has to be ON and warmed-up. To ensure it the template checks the status of the lamp and exits if not satisfied.

keyword name	keyword value	keyword description
INS.MIRR.POS	BOTH	Calibration Mirror
INS.OPTI1.POS	THAR1 THAR2 SPH1 SPH2	Calibration Lamp A Selector
INS.OPTI2.POS	SPH1 SPH2	Calibration Lamp B Selector
INS.LAMP2.ST	T F (ON OFF)	THAR1 Lamp
INS.LAMP3.ST	T F (ON OFF)	THAR2 Lamp
INS.LAMP4.ST	T F (ON OFF)	Integrated Sphere Source 1
INS.LAMP5.ST	T F (ON OFF)	Integrated Sphere Source 2

The CCD is then set up for <Nexp> exposures of <ExpTime> duration.

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	<exptime>	Exposure Time [sec]
SEQ.NEXPO	<Nexp>	Number of Repeated Exposures

Then the *Neutral Density Filter Wheel* angular position corresponding to a fixed <density>, usually equal to zero is set.

keyword name	keyword value	keyword description
INS.ROT1.DST	<density> (0)	ND filter wheel 1 density
INS.ROT2.DST	<density> (0)	ND filter wheel 2 density

**SEQ.NEXPO** defines how many exposures are now processed with the following scheme:  
The exposure is carried out, the CCD is read and the frame is archived.

At the end of the template the exposures are processed together by the DRS to extract the spectra, perform wavelength calibration (which is then archived) and compute image quality and spectrograph resolution indicators.

The details of the wavelength calibration are TBD.

## 5.11 HARP<sub>N</sub>\_ech\_cal\_thoB

The Thorium-Argon calibration template on fiber B used to measure the ThAr light pollution.

keyword name	keyword value	keyword description
TPL.NAME	"HARP <sub>N</sub> _ech_cal_thoB"	Observation Mode
DPR.CATG	"CALIB"	Observation Category
DPR.TECH	"ECHELLE"	Observation Technique
DPR.TYPE	"NONE,WAVE,THAR1 THAR2"	Objects Type and Spectral Type

The fibers positions are set to allow the light from a *ThAr lamp* feed fiber B. The specified *ThAr lamp* will not be switched ON, if already ON. To ensure that needed lamp is switched on, its status is tested before starting the exposure.

keyword name	keyword value	keyword description
INS.MIRR.POS	BOTH	Calibration Mirror
INS.OPT1.POS	NONE	Calibration Lamp A Selector
INS.OPT2.POS	THAR1 THAR2	Calibration Lamp B Selector
INS.LAMP2.ST	T F (ON OFF)	THAR1 Lamp
INS.LAMP3.ST	T F (ON OFF)	THAR2 Lamp

The CCD is then set up for an exposure of duration <exptime>.

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	<exptime>	Exposure Time [sec]
SEQ.NEXPO	1	Number of Repeated Exposures

Then the *Neutral Density Filter Wheel* angular position corresponding to a fixed <density>, usually equal to zero is set.

keyword name	keyword value	keyword description
INS.ROT1.DST	<density> (0)	ND filter wheel 1 density
INS.ROT2.DST	<density> (0)	ND filter wheel 2 density

The exposure is carried out, the CCD is read and the frame is archived.

At the end of the template the exposures are processed together by the DRS to calculate the measured ThAr light pollution.

## 5.12 HARP\_N\_ech\_cal\_waveB

The Thorium-Argon calibration template on fiber B used to measure the pollution from one of the *Integrating Sphere Sources*.

keyword name	keyword value	keyword description
TPL.NAME	"HARP_N_ech_cal_waveB"	Observation Mode
DPR.CATG	"CALIB"	Observation Category
DPR.TECH	"ECHELLE"	Observation Technique
DPR.TYPE	"NONE,WAVE,FP COMB"	Objects Type and Spectral Type

The fibers positions are set to allow the light from one of the *Integrating Sphere Sources* feed fiber B. The specified light source will not be switched ON, if already ON. To ensure it is switched on and warmed-up, its status is tested before starting the exposure.

keyword name	keyword value	keyword description
INS.MIRR.POS	BOTH	Calibration Mirror
INS.OPTI1.POS	NONE	Calibration Lamp A Selector
INS.OPTI2.POS	SPH1 SPH2	Calibration Lamp B Selector
INS.LAMP4.ST	T F (ON OFF)	Integrating Sphere Source 1
INS.LAMP5.ST	T F (ON OFF)	Integrating Sphere Source 2

The CCD is then set up for an exposure of duration <exptime>.

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UT1	<exptime>	Exposure Time [sec]
SEQ.NEXPO	1	Number of Repeated Exposures

Then the *Neutral Density Filter Wheel* angular position corresponding to a fixed <density>, usually equal to zero is set.

keyword name	keyword value	keyword description
INS.ROT1.DST	<density> (0)	ND filter wheel 1 density
INS.ROT2.DST	<density> (0)	ND filter wheel 2 density

The exposure is carried out, the CCD is read and the frame is archived.

At the end of the template the exposures are processed together by the DRS to calculate the measured *Integrated Sphere Source* pollution.

### 5.13 HARP<sub>N</sub>\_ech\_cal\_skyflat

The skyflat calibration template is used to measure the relative efficiency of both fibers. It is equivalent to the **HARP<sub>N</sub>\_ech\_obs\_all** template, but should be preceded by the acquisition of the sky on both fibers, i.e. the **HARP<sub>N</sub>\_ech\_acq\_objAB** template.

keyword name	keyword value	keyword description
TPL.NAME	"HARP <sub>N</sub> _ech_cal_skyflat"	Observation Mode
DPR.TECH	"ECHELLE"	Observation Technique
DPR.TYPE	"SKY, SKY"	Objects Type
DPR.CATG	"CALIB"	Observation Category

The exposure parameters are set: *Exposure Type* is set to NORMAL. *CCD ReadOut Mode*, *Exposure Time* and *Number of Repeated Exposures* are set.

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	<exptime>	Exposure Time [sec]
SEQ.NEXPO	1-100	Number of Repeated Exposures

Then, the *Neutral Density Wheel* angular position is set to zero.

keyword name	keyword value	keyword description
INS.ROT1.DST	0	ND filter wheel 1 density
INS.ROT1.DST	0	ND filter wheel 2 density

**SEQ.NEXPO** defines how many exposures are now processed with the following scheme: The exposure is carried out. After *Exposure Time*, the CCD is read out, the frame is archived. The DRS is triggered by the DFS when all the exposures are archived.

### 5.14 HARP<sub>N</sub>\_ech\_cal\_eff

This calibration exposure is done with the light of photometric standard star in fiber A and either no light or sky in fiber B and allows to measure the total efficiency of the system. This template is a kind of observation template, and thus needs to follow the acquisition template: **HARP<sub>N</sub>\_ech\_acq\_objA**.

The **DPR.TECH** and the **DPR.TYPE** keywords are passed to the FITS header, in order to inform the DRS about the kind of object acquired by the acquisition template, as well as the technique of observation.

keyword name	keyword value	keyword description
TPL.NAME	"HARP <sub>N</sub> _ech_cal_eff"	Observation Mode
DPR.TECH	"ECHELLE"	Observation Technique
DPR.TYPE	"<objA>,NONE,<sp>"	Objects Type
DPR.CATG	"CALIB"	Observation Category



The exposure parameters are set:

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	<exptime>	Exposure Time [sec]
SEQ.NEXPO	1	Number of Repeated Exposures

Then, the *Neutral Density Filter Wheel* is set according to the exposure time. I guess in this case we do not want to have it at all, so should be set to zero.

keyword name	keyword value	keyword description
INS.ROT1.DST	<density> (0)	ND filter wheel 1 density
INS.ROT2.DST	<density> (0)	ND filter wheel 2 density

The exposure is carried out. After *Exposure Time*, the CCD is read out, the frame is archived. It is processed by the DRS to compute the optical efficiency of the spectrometer through the fiber illuminated by the star and the response of the *Exposure Meter* for this path.

## 5.15HARPN\_cal\_focus

The template allowing the focus adjustment of the telescope. A **SEQ.NEXPO** number of exposures is taken changing the focus by a defined value (**TEL.FOCUSSTEP**). The best (according to exposure meter) is chosen and the telescope is configured with. The frames are not archived - TBC.

keyword name	keyword value	keyword description
TPL.NAME	"HARPN_ech_cal_focus"	Observation Mode
SEQ.NEXPO	<Nexp>	Number of repeated exposures
SEQ.NSAMPLES	<Nsamples>	Number of exposure meter samples
TEL.FOCU.STEP	<FocusStep>	Telescope Focus Offset

## Chapter 6: Maintenance templates

### 6.1 Introduction

The technical templates will allow the analysis of the performances of HARPS, from a very global point of view.

The reduction recipe is indicated in the following sections, but the DRS is neither part of the template, nor triggered by the OS, but rather by the DFS after archiving of the frame(s). Each template allows measuring several parameters.

These parameters will be stored in the Instrument Performance Database in order to allow technical staff to follow the instrument drifts or problems.

### 6.2 HARPN\_ech\_tec\_dark

The dark exposure technical template for HARPS-N. This template is very similar to the HARPN\_ech\_cal\_dark.

keyword name	keyword value	keyword description
TPL.NAME	"HARPN_ech_tec_dark"	Observation Mode
DPR.CATG	"TEST"	Observation Category
DPR.TECH	"IMAGE"	Observation Technique
DPR.TYPE	"DARK,DARK"	Objects Type and Spectral Type

The setup of the instrument is irrelevant as the Exposure Type of this exposure is set to DARK, leading the Image Scrambler Shutter to remain closed. Anyhow, the setup of the instrument will be fixed to eliminate any possible parasite light.

The exposure parameters are setup. The bias measurement is done by fixing the exposure time equal to zero.

keyword name	keyword value	keyword description
DET1.EXP.TYPE	DARK	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	<exptime>	Exposure Time [sec]
SEQ.NEXPO	1	Number of Repeated Exposures

Then the exposure is carried out: the CCD is flushed and read again after <exptime> to achieve the proper exposure time. At the end of each exposure the frame is archived and processed by the DRS to compute the dark current of the CCD, the dark counts on exposure meters, the biases if <ExpTime> is zero and the hot pixels mapping.

### 6.3 HARPN\_ech\_tec\_led

Flat-field exposure with a non-zero light level.

keyword name	keyword value	keyword description
TPL.NAME	"HARPN_ech_tec_led"	Observation Mode
DPR.CATG	"TEST"	Observation Category
DPR.TECH	"IMAGE"	Observation Technique
DPR.TYPE	"FLAT,FLAT"	Objects Type and Spectral Type

The spectrometer is configured in order to illuminate the CCD with a LED, without going through the fibers and the spectrometer. Thus, all the devices are set up the same way as for the dark exposure.

The exposure parameters are setup.

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	<exptime>	Exposure Time [sec]
SEQ.NEXPO	1	Number of Repeated Exposures

An exposure of type LED is carried out. The CCD is read out and the frame is archived and processed by the DRS to compute the contamination level of the CCD, estimate the gain, the linearity and map the bad pixels.

### 6.4 HARPN\_ech\_tec\_tunA

Order localization and spectral flat-field with fiber A.

keyword name	keyword value	keyword description
TPL.NAME	"HARPN_ech_tec_tunA"	Observation Mode
DPR.CATG	"TEST"	Observation Category
DPR.TECH	"ECHELLE"	Observation Technique
DPR.TYPE	"LAMP,DARK,TUN"	Objects Type and Spectral Type

The fibers positions are set to allow the light from the *Tungsten Lamp* feed fiber A and no light in fiber B.

keyword name	keyword value	keyword description
INS.PWR1.ST	F (CLOSED)	Exp Meter 1 power supply
INS.PWR2.ST	F (CLOSED)	Exp Meter 2 power supply
INS.MIRR.POS	BOTH	Calibration Mirror
INS.OPTI1.POS	TUN	Calibration Lamp A Selector
INS.OPTI2.POS	NONE	Calibration Lamp B Selector
INS.LAMP1.ST	T (ON)	Tungsten Lamp

The CCD is then set up for a single NORMAL exposure.

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	<exptime>	Exposure Time [sec]
SEQ.NEXPO	1	Number of Repeated Exposures

Then the *Neutral Density Filter Wheel* angular position corresponding to a fixed <density>, usually equal to zero is set.

keyword name	keyword value	keyword description
INS.ROT1.DST	<density> (0)	ND filter wheel 1 density
INS.ROT2.DST	<density> (0)	ND filter wheel 2 density

The exposure is carried out, the CCD is read and the frame is archived. Then the DRS is triggered. It computes the geometry and profile (in the cross-dispersion direction) of the orders of the *Tungsten Lamp* spectrum in fiber A and the intensity of the *Tungsten Lamp*.

The *Power Supply* of the *Exposure Meter* is switched on and the *Tungsten Lamp* is switched off.

keyword name	keyword value	keyword description
INS.PWR1.ST	T (OPEN)	Exp Meter 1 power supply
INS.PWR2.ST	T (OPEN)	Exp Meter 2 power supply
INS.LAMP1.ST	F (OFF)	Tungsten Lamp

## 6.5 HARPN\_ech\_tec\_tunB

Order localization and spectral flat-field with fiber B. The template is the same as HARPN\_ech\_tec\_tunA but for fiber B.

keyword name	keyword value	keyword description
TPL.NAME	"HARPN_ech_tec_tunB"	Observation Mode
DPR.CATG	"TEST"	Observation Category
DPR.TECH	"ECHELLE"	Observation Technique
DPR.TYPE	"DARK,LAMP,TUN"	Objects Type and Spectral Type

The fibers positions are set to allow the light from the *Tungsten Lamp* feed fiber A and no light in fiber B.

keyword name	keyword value	keyword description
INS.PWR1.ST	F (CLOSED)	Exp Meter 1 power supply
INS.PWR2.ST	F (CLOSED)	Exp Meter 2 power supply
INS.MIRR.POS	BOTH	Calibration Mirror
INS.OPTI1.POS	NONE	Calibration Lamp A Selector
INS.OPTI2.POS	TUN	Calibration Lamp B Selector
INS.LAMP1.ST	T (ON)	Tungsten Lamp

The CCD is then set up for a single NORMAL exposure.

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	<exptime>	Exposure Time [sec]
SEQ.NEXPO	1	Number of Repeated Exposures

Then the *Neutral Density Filter Wheel* angular position corresponding to a fixed <density>, usually equal to zero is set.

keyword name	keyword value	keyword description
INS.ROT1.DST	<density> (0)	ND filter wheel 1 density
INS.ROT2.DST	<density> (0)	ND filter wheel 2 density

The exposure is carried out, the CCD is read and the frame is archived. Then the DRS is triggered. It computes the geometry and profile (in the cross-dispersion direction) of the orders of the *Tungsten Lamp* spectrum in fiber A and the intensity of the *Tungsten Lamp*.

The *Power Supply* of the *Exposure Meter* is switched on and the *Tungsten Lamp* is switched off.

keyword name	keyword value	keyword description
INS.PWR1.ST	T (OPEN)	Exp Meter 1 power supply
INS.PWR2.ST	T (OPEN)	Exp Meter 2 power supply
INS.LAMP1.ST	F (OFF)	Tungsten Lamp

## 6.6 HARPS\_ech\_tec\_tunAB

Order localization and spectral flat-field with fibers A and B. The template is the same as **HARPN\_ech\_tec\_tunA** but for both fiber A and B.

keyword name	keyword value	keyword description
TPL.NAME	"HARPN_ech_tec_tunAB"	Observation Mode
DPR.CATG	"TEST"	Observation Category
DPR.TECH	"ECHELLE"	Observation Technique
DPR.TYPE	"LAMP,LAMP,TUN"	Objects Type and Spectral Type

The fibers positions are set to allow the light from the *Tungsten Lamp* feed fiber A and no light in fiber B.

keyword name	keyword value	keyword description
INS.PWR1.ST	F (CLOSED)	Exp Meter 1 power supply
INS.PWR2.ST	F (CLOSED)	Exp Meter 2 power supply
INS.MIRR.POS	BOTH	Calibration Mirror
INS.OPTI1.POS	TUN	Calibration Lamp A Selector

INS.OPTI2.POS	TUN	Calibration Lamp B Selector
INS.LAMP1.ST	T (ON)	Tungsten Lamp

The CCD is then set up for a single NORMAL exposure.

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	<exptime>	Exposure Time [sec]
SEQ.NEXPO	1	Number of Repeated Exposures

Then the *Neutral Density Filter Wheel* angular position corresponding to a fixed <density>, usually equal to zero is set.

keyword name	keyword value	keyword description
INS.ROT1.DST	<density> (0)	ND filter wheel 1 density
INS.ROT2.DST	<density> (0)	ND filter wheel 2 density

The exposure is carried out, the CCD is read and the frame is archived. Then the DRS is triggered. It computes the geometry and profile (in the cross-dispersion direction) of the orders of the *Tungsten Lamp* spectrum in fiber A and the intensity of the *Tungsten Lamp*.

The *Power Supply* of the *Exposure Meter* is switched on and the *Tungsten Lamp* is switched off.

keyword name	keyword value	keyword description
INS.PWR1.ST	T (OPEN)	Exp Meter 1 power supply
INS.PWR2.ST	T (OPEN)	Exp Meter 2 power supply
INS.LAMP1.ST	F (OFF)	Tungsten Lamp

## 6.7 HARPN\_ech\_tec\_thoA

Wavelength calibration exposure on fiber A.

keyword name	keyword value	keyword description
TPL.NAME	"HARPN_ech_cal_thoA"	Observation Mode
DPR.CATG	"TEST"	Observation Category
DPR.TECH	"ECHELLE"	Observation Technique
DPR.TYPE	"WAVE,DARK,THAR1 THAR2"	Objects Type and Spectral Type

The fibers positions are set to allow the light from a *ThAr lamp* feed the fiber A and no light in fiber B. To ensure that only the proper lamp is on, the template will verify that the proper lamp is switched-on.

keyword name	keyword value	keyword description
INS.MIRR.POS	BOTH	Calibration Mirror
INS.OPTI1.POS	THAR1 THAR2	Calibration Lamp A Selector

INS.OPTI2.POS	NONE	Calibration Lamp B Selector
INS.LAMP2.ST	T F (ON OFF)	THAR1 Lamp
INS.LAMP3.ST	T F (ON OFF)	THAR2 Lamp

The CCD is then set up for a single exposure of duration <exptime>

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	<exptime>	Exposure Time [sec]
SEQ.NEXPO	1	Number of Repeated Exposures

Then the *Neutral Density Filter Wheel* angular position corresponding to a fixed <density>, usually equal to zero is set.

keyword name	keyword value	keyword description
INS.ROT1.DST	<density> (0)	ND filter wheel 1 density
INS.ROT2.DST	<density> (0)	ND filter wheel 2 density

The exposure is carried out, the CCD is read and the frame is archived. It is processed by the DRS to compute the geometry of the wavelength solution, the "zero point" of the wavelength solution, the spectral resolution of the spectrograph, the intensity of the *ThAr lamp* and the ThAr flux on the *Exposure Meter*.

## 6.8 HARPN\_ech\_tec\_thoB

Wavelength calibration exposure on fiber B. The template is the same as HARPN\_ech\_tec\_thoA, but for fiber B.

keyword name	keyword value	keyword description
TPL.NAME	"HARPN_ech_cal_thoB"	Observation Mode
DPR.CATG	"TEST"	Observation Category
DPR.TECH	"ECHELLE"	Observation Technique
DPR.TYPE	"DARK,WAVE,THAR1 THAR2"	Objects Type and Spectral Type

The fibers positions are set to allow the light from a *ThAr lamp* feed the fiber B and no light in fiber A. To ensure that only the proper lamp is on, the template will verify that the proper lamp is switched-on.

keyword name	keyword value	keyword description
INS.MIRR.POS	BOTH	Calibration Mirror
INS.OPTI1.POS	NONE	Calibration Lamp A Selector
INS.OPTI2.POS	THAR1 THAR2	Calibration Lamp B Selector
INS.LAMP2.ST	T F (ON OFF)	THAR1 Lamp
INS.LAMP3.ST	T F (ON OFF)	THAR2 Lamp

The CCD is then set up for a single exposure of duration <exptime>

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	<exptime>	Exposure Time [sec]
SEQ.NEXPO	1	Number of Repeated Exposures

Then the *Neutral Density Filter Wheel* angular position corresponding to a fixed <density>, usually equal to zero is set.

keyword name	keyword value	keyword description
INS.ROT1.DST	<density> (0)	ND filter wheel 1 density
INS.ROT2.DST	<density> (0)	ND filter wheel 2 density

The exposure is carried out, the CCD is read and the frame is archived. It is processed by the DRS to compute the geometry of the wavelength solution, the "zero point" of the wavelength solution, the spectral resolution of the spectrograph, the intensity of the *ThAr lamp* and the ThAr flux on the *Exposure Meter*.

## 6.9 HARP\_N\_ech\_tec\_thoAB

Wavelength calibration exposure on fibers A and B. The template is the same as **HARP\_N\_ech\_tec\_thoB**, but for both fibers A and B.

keyword name	keyword value	keyword description
TPL.NAME	"HARP_N_ech_cal_thoAB"	Observation Mode
DPR.CATG	"TEST"	Observation Category
DPR.TECH	"ECHELLE"	Observation Technique
DPR.TYPE	"WAVE,WAVE,THAR1 THAR2"	Objects Type and Spectral Type

The fibers positions are set to allow the light from a *ThAr lamp* feed both fibers A and B. To ensure that both fibers are fed by the same lamp, the lamp selected for fiber A will guide the template to select the lamp for fiber B and to switch-on the proper lamp.

keyword name	keyword value	keyword description
INS.MIRR.POS	BOTH	Calibration Mirror
INS.OPT1.POS	THAR1 THAR2	Calibration Lamp A Selector
INS.OPT2.POS	THAR1 THAR2	Calibration Lamp B Selector
INS.LAMP2.ST	T F (ON OFF)	THAR1 Lamp
INS.LAMP3.ST	T F (ON OFF)	THAR2 Lamp

The CCD is then set up for a single exposure of duration <exptime>

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	<exptime>	Exposure Time [sec]



SEQ.NEXPO	1	Number of Repeated Exposures
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Then the *Neutral Density Filter Wheel* angular position corresponding to a fixed <density>, usually equal to zero is set.

keyword name	keyword value	keyword description
INS.ROT1.DST	<density> (0)	ND filter wheel 1 density
INS.ROT2.DST	<density> (0)	ND filter wheel 2 density

The exposure is carried out, the CCD is read and the frame is archived. It is processed by the DRS to compute the geometry of the wavelength solution, the "zero point" of the wavelength solution, the spectral resolution of the spectrograph, the intensity of the *ThAr lamp* and the ThAr flux on the *Exposure Meter*.

## 6.10HARPN\_ech\_tec\_waveA

*Integrating Sphere Source* calibration exposure on fiber A.

keyword name	keyword value	keyword description
TPL.NAME	"HARPN_ech_cal_waveA"	Observation Mode
DPR.CATG	"TEST"	Observation Category
DPR.TECH	"ECHELLE"	Observation Technique
DPR.TYPE	"WAVE,DARK,SPH1 SPH2"	Objects Type and Spectral Type

The fibers positions are set to allow the light from one of the *Integrating Sphere Sources* feed the fiber A and no light in fiber B. To ensure that the light source is on, the template will verify it before starting the exposure.

keyword name	keyword value	keyword description
INS.MIRR.POS	BOTH	Calibration Mirror
INS.OPTI1.POS	SPH1 SPH2	Calibration Lamp A Selector
INS.OPTI2.POS	NONE	Calibration Lamp B Selector
INS.LAMP4.ST	T F (ON OFF)	Integrated Sphere Source 1
INS.LAMP5.ST	T F (ON OFF)	Integrated Sphere Source 2

The CCD is then set up for a single exposure of duration <exptime>

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	<exptime>	Exposure Time [sec]
SEQ.NEXPO	1	Number of Repeated Exposures

Then the *Neutral Density Filter Wheel* angular position corresponding to a fixed <density>, usually equal to zero is set.

keyword name	keyword value	keyword description
INS.ROT1.DST	<density> (0)	ND filter wheel 1 density
INS.ROT2.DST	<density> (0)	ND filter wheel 2 density

The exposure is carried out, the CCD is read and the frame is archived. It is processed by the DRS to compute the geometry of the wavelength solution, the "zero point" of the wavelength solution, the spectral resolution of the spectrograph and the intensity of the *Integrated Sphere Source* fluxes on both *Exposure Meters*.

## 6.11 HARP\_N\_ech\_tec\_waveB

*Integrated Sphere Source* calibration exposure on fiber B. The template is the same as HARP\_N\_ech\_tec\_waveA, but for fiber B.

keyword name	keyword value	keyword description
TPL.NAME	"HARP_N_ech_cal_waveB"	Observation Mode
DPR.CATG	"TEST"	Observation Category
DPR.TECH	"ECHELLE"	Observation Technique
DPR.TYPE	"DARK,WAVE,SPH1 SPH2"	Objects Type and Spectral Type

The fibers positions are set to allow the light from one of the *Integrated Sphere Sources* feed the fiber B and no light in fiber A. To ensure that the light source is on, the template will verify it before starting the exposure.

keyword name	keyword value	keyword description
INS.MIRR.POS	BOTH	Calibration Mirror
INS.OPT1.POS	NONE	Calibration Lamp A Selector
INS.OPT2.POS	SPH1 SPH2	Calibration Lamp B Selector
INS.LAMP4.ST	T F (ON OFF)	Integrated Sphere Source 1
INS.LAMP5.ST	T F (ON OFF)	Integrated Sphere Source 2

The CCD is then set up for a single exposure of duration <exptime>

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	<exptime>	Exposure Time [sec]
SEQ.NEXPO	1	Number of Repeated Exposures

Then the *Neutral Density Filter Wheel* angular position corresponding to a fixed <density>, usually equal to zero is set.

keyword name	keyword value	keyword description
INS.ROT1.DST	<density> (0)	ND filter wheel 1 density
INS.ROT2.DST	<density> (0)	ND filter wheel 2 density

The exposure is carried out, the CCD is read and the frame is archived. It is processed by the DRS to compute the geometry of the wavelength solution, the "zero point" of the wavelength solution, the spectral resolution of the spectrograph and the intensity of the *Integrated Sphere Source* fluxes on both *Exposure Meters*.

## 6.12 HARP\_N\_ech\_tec\_waveAB

Integrated Sphere Source calibration exposure on fibers A and B. The template is the same as **HARP\_N\_ech\_tec\_waveB**, but for both fibers A and B.

keyword name	keyword value	keyword description
TPL.NAME	"HARP_N_ech_cal_waveAB"	Observation Mode
DPR.CATG	"TEST"	Observation Category
DPR.TECH	"ECHELLE"	Observation Technique
DPR.TYPE	"WAVE,WAVE,SPH1 SPH2"	Objects Type and Spectral Type

The fibers positions are set to allow the light from one of the *Integrated Sphere Sources* feed both fibers A and B. To ensure that the light source is on, the template will verify it before starting the exposure.

keyword name	keyword value	keyword description
INS.MIRR.POS	BOTH	Calibration Mirror
INS.OPT1.POS	SPH1 SPH2	Calibration Lamp A Selector
INS.OPT2.POS	SPH1 SPH2	Calibration Lamp B Selector
INS.LAMP4.ST	T F (ON OFF)	Integrated Sphere Source 1
INS.LAMP5.ST	T F (ON OFF)	Integrated Sphere Source 2

The CCD is then set up for a single exposure of duration <exptime>

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	<exptime>	Exposure Time [sec]
SEQ.NEXPO	1	Number of Repeated Exposures

Then the *Neutral Density Filter Wheel* angular position corresponding to a fixed <density>, usually equal to zero is set.

keyword name	keyword value	keyword description
INS.ROT1.DST	<density> (0)	ND filter wheel 1 density
INS.ROT2.DST	<density> (0)	ND filter wheel 2 density

The exposure is carried out, the CCD is read and the frame is archived. It is processed by the DRS to compute the geometry of the wavelength solution, the "zero point" of the wavelength solution, the spectral resolution of the spectrograph and the intensity of the *Integrated Sphere Source* fluxes on both *Exposure Meters*.

### 6.13 HARP<sub>N</sub>\_ech\_tec\_eff

This technical exposure is done with the light of photometric standard star in fiber A and either no light or sky in fiber B.

This template is a kind of observation template, and thus needs to follow one of the acquisition templates:

- HARP<sub>N</sub>\_ech\_acq\_objA
- HARP<sub>N</sub>\_ech\_acq\_objAB

according to the desired light sources for fibers A and B.

The keyword **TPL.NAME** (or **ACQ.NAME** TBD) is computed to give a pseudo observation template name **HARP<sub>N</sub>\_ech\_tec\_XXXX**, where **XXXX** is the last extension of the acquisition template name.

The **DPR.TECH** and the **DPR.TYPE** keywords are passed to the FITS header, in order to inform the DRS about the kind of object acquired by the acquisition template, as well as the technique of observation.

keyword name	keyword value	keyword description
TPL.NAME	"HARP <sub>N</sub> _ech_tec_XXXX"	Observation Mode
DPR.TECH	<observation technique>	Observation Technique
DPR.TYPE	"<objA>,<objB>,<sp>"	Objects Type
DPR.CATG	"TEST"	Observation Category

The exposure parameters are set:

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	<exptime>	Exposure Time [sec]
SEQ.NEXPO	1	Number of Repeated Exposures

Then, the *Neutral Density Filter Wheel* is set according to the exposure time. I guess in this case we do not want to have it at all, so should be set to zero.

keyword name	keyword value	keyword description
INS.ROT1.DST	<density> (0)	ND filter wheel 1 density
INS.ROT2.DST	<density> (0)	ND filter wheel 2 density

The exposure is carried out. After *Exposure Time*, the CCD is read out, the frame is archived. It is processed by the DRS to compute the optical efficiency of the spectrometer through the fiber illuminated by the star and the response of the *Exposure Meter* for this path.

### 6.14 HARP<sub>N</sub>\_ech\_tec\_free

This template allows the user to set the instrument completely freely. It is up the user's responsibility to set it correctly.

keyword name	keyword value	keyword description
TPL.NAME	"HARPN_ech_tec_free"	Observation Mode
DPR.TECH	"ECHELLE"	Observation Technique
DPR.TYPE	""	Objects Type
DPR.CATG	"TEST"	Observation Category

The exposure parameters are set:

keyword name	keyword value	keyword description
DET1.EXP.TYPE	NORMAL	Exposure Type
DET1.READ.SPEED	<mode>	CCD ReadOut Mode
DET1.WIN1.UIT1	<exptime>	Exposure Time [sec]
SEQ.NEXPO	<Nexp>	Number of Repeated Exposures

Then, other parameters are set as shown in the following table:

keyword name	keyword value	keyword description
INS.ROT1.DST	<density> (0)	ND filter wheel 1 density
INS.ROT2.DST	<density> (0)	ND filter wheel 2 density
INS.MIRR.POS	"BOTH FIBA FIBB NONE"	Calibration Mirror
INS.OPTI1.POS	"THAR1 THAR2 SPH1 SPH2"	Calibration Lamp A Selector
INS.OPTI2.POS	"THAR1 THAR2 SPH1 SPH2"	Calibration Lamp B Selector

The exposure is carried out. After *Exposure Time*, the CCD is read out, the frame is archived. It is processed by the DRS.