HARPS

Templates Reference Guide

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4	01/03/2006	Several	EGGS mode added.

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Chapter 1

Introduction

HARPS is a spectrometer mainly dedicated to the search for extra-solar planets by means of the technique of precise radial velocity measurement. The instrument is described in [1], [2], [19] and [20]. The operations are described in [3]. HARPS is developed by a consortium headed by the Geneva Observatory. It is installed at the Coude room of the 3.6 meter telescope at La Silla, with an optical fiber link to the Cassegrain focus. Starting from period 77 a new instrument mode: EGGS, is offered [21].

The software for HARPS is developed as a collaboration between ESO La Silla (LSO) and the consortium. The following people have been involved in the preparation of this document:
Denis Mégevand, Danuta Sosnowska, Didier Queloz and Francesco Pepe, Gaspare Lo Curto.

1.1   Scope

This document describes in detail the templates needed for the scientific, calibration and maintenance operations of HARPS. The templates requirements are given in [3].

The design description and functional specifications of HARPS OS, ICS, OSS, DFS, DRS and MS will be described repectively in documents [6], [7], [8], [9] and [10].

The requirements coming from the hardware of the instrument, from the scientific goals to achieve and from the scientific operation by which it will be operated are described in [1] and [3]. The user requirements are described in [4] and [5].

The general requirements for the VLT software are given in [12] and the general specifications for the software which apply to all VLT instruments are given in [16] and [17] and quoted here when relevant.

The instrument operation and performances are described in the HARPS user manual [21].

Therefore the reader is supposed to be familiar with [1], [3], [4], [5], [19] and [21].

1.2   Applicable documents

The following documents, of the exact issue shown, form a part of this document to the extent speci-
fied herein. In the event of conflict between the documents referenced herein and the contents of this
document, the contents of this document shall be considered as a superseding requirement.

  [1] 3M6-SPE-HAR-33100-0002 1.0 21/06/2000 HARPS Tech. Requirements Spec.
  [2] 3M6-TRE-HAR-33100-0003 1.0 26/06/2000 HARPS PDAPR
  [3] 3M6-PLA-HAR-33100-0005 1.4 09/05/2001 HARPS Oper., Calib. and Maint. Plan
  [4] 3M6-TRE-HAR-33110-0001 1.4 08/05/2001 HARPS DFS SW User Req. & Design Report
  [5] 3M6-TRE-HAR-33110-0002 1.2 22/02/2001 HARPS OS/ICS SW Req. & Design Report
  [6] 3M6-TRE-HAR-33110-0003 1.0 11/06/2001 HARPS OS/ICS Design Description
  [7] 3M6-TRE-HAR-33110-0004 1.0 11/06/2001 HARPS OSS Design Description
  [8] 3M6-TRE-HAR-33110-0005 1.0 11/06/2001 HARPS DFS Design Description
  [9] 3M6-TRE-HAR-33110-0006 1.0 09/06/2001 HARPS DRS Design Description
[10] 3M6-TRE-HAR-33110-0007 1.0 10/06/2001 HARPS MS Design Description
[11] VLT-MAN-ESO-17240-2240 1.1 01/03/2001 Common SW for Templates User Man.
[12] VLT-SPE-ESO-10000-0011 2.0 30/09/1992 VLT SW Requirements Specs.
[13] VLT-PRO-ESO-10000-0228 1.0 10/03/1993 VLT SW Programming Standards
[14] VLT-PLA-ESO-00000-0006 2.0 21/05/1992 VLT SW Management Plan
[15] VLT-SPE-ESO-19000-1618 1.0 21/04/1999 Dataflow System Requirements Spec.
[16] VLT-SPE-ESO-17212-0001 2.0 12/04/1995 VLT INS SW Spec.
[17] VLT-SPE-ESO-17240-0385 2.1 15/07/1996 VLT INS Common SW Spec.
[18] GEN-SPE-ESO-19400-0794 1.1 25/11/1997 Data Interface Control Document

1.3   Reference documents

The following documents either are referenced in this document or describe concepts relevant to this
document.

[19] HARPS-Sys-Prop-ObsGe-0101 1.0   01/02/1999 HARPS Scientific Proposal
[20] HARPS-Sys-Prop-ObsGe-0102 1.0   01/02/1999 HARPS Technical Proposal
[21] 3P6-MAN-ESO-90100-0005   1.3   01/03/2006 HARPS User Manual
[22] VLT-MAN-ESO-19200-1644   1.3   20/06/1999 P2PP User Manual
[23] VLT-MAN-HAR-33110-xxxx   (in prep.)   P2PIC User Manual

1.4   Abbreviations and acronyms

 AT   Acquisition Template

BOB	Broker for Observation Blocks
HCFA	HARPS Cassegrain Fiber Adapter
CT	Calibration Template
DFS	Data Flow System
DRS	Data Reduction Software
EGGS	"Extra Good" General Spectroscopy
ESO	European Southern Observatory
HARPS	High Accuracy Radial-velocity Planetary Search
HLMS	High-Level Maintenance Software
HW	Hardware
I/O	Input/Output
ICD	Interface Control Document
ICS	Instrument Control Software
ICSDB	ICS OnLine Database
in prep.	in preparation
LSO	ESO Chile (La Silla)
MS	Maintenance Software
OB	Observation Block
OG	Observatoire de Genève
OS	Observation Software
OSS	Observation Support Software
P2PIC	Phase II Proposal from Input Catalog preparation tool
P2PP	Phase II Proposal Preparation System
PDAPR	Preliminary Design, Analysis and Performance Report
RV	Radial Velocity
SNR	Signal to Noise Ratio
Spec.	Specification(s)
SW	Software
TBD	To Be Defined
VLT	Very Large Telescope

1.5 Glossary

The following are defined in [16]:

Integration
Exposure
Observation
Observation sequence
Single Observation

The following are defined in [17]:

Template
Observation Block (OB)

1.6   Stylistic conventions

The following styles are used:

bold
>   in the text, for commands, filenames, pre/suffixes as they have to be typed.

italic
>   in the text, for parts that have to be substituted with the real content before typing.

`teletype`
>   for examples.

`<name>`
>   in the examples, for parts that have to be substituted with the real content before typing.

1.7   Template notation

In this document, the templates keywords will be given in the following notation:

Keyword Name	Parameter Range (default)	*Label*

A template name written as:

`HARPS_ech/eggs_acq_thosimult`

refers to both the base mode template:

`HARPS_ech_acq_thosimult`

and the high efficiency mode (EGGS) template:

`HARPS_eggs_acq_thosimult`

Chapter 2

Overview

This document describes the **Templates** defined for the scientific, calibration and maintenance operations of HARPS.

The templates are built of their **Template Signature File (.tsf)**, their **Reference File (.ref)** and their **Sequence File (.seq)**

The **Template Signature Files (.tsf)** contain the parameters — describing the configuration of the telescope, instrument and detector — that have to be set, including those to be specified by the observer during the Phase II of the observation preparation, through P2PP [22] or STS[23].

The **Reference Files (.ref)** contain the fixed parameters — describing the configuration of the telescope, instrument and detector.

The **Sequence Files (.seq)** contain the code, written in Tcl language, that is executed when the template is interpreted by the BOB.

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 contaning all the parameters necessary to define a single observation.

Beginning with the ESO period 77 there are two "families" of templates: the ones for the HARPS base mode insuring the highest radial velocity accuracy, which have prefix: `HARPS_ech_` and the ones for the EGGS mode, delivering a higher efficiency but a comparatively poor radial velocity accuracy: `HARPS_eggs_`.

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

2.1 Observation modes

The configuration of HARPS is simple, there are only two **Instrument modes** foreseen at this time: the HARPS base mode insuring the highest radial velocity accuracy and the EGGS mode, delivering

a higher efficiency [21] but a comparatively poor radial velocity accuracy. Observers willing to use the EGGS mode shall clearly specify their request in the proposal. The switch from the HARPS base mode and the EGGS mode can be done during the night with minimum overhead [21].

As mentioned in the introduction, HARPS is mainly dedicated to the search for exoplanets by the technique of precise radial velocity (RV) measurement. Aside from this base-line program, the instrument will be used for astero-seismology and classical spectroscopy. Moving devices in the HCFA define the instrument mode being used (fibre set) and the light sources for the fibres.

For both instrument modes three **Observation modes** have been identified in [3], defining different HCFA configurations:

1. Simultaneous wavelength reference,

2. spectroscopy,

3. I_2 cell spectroscopy.

The second observing mode may have two sub-modes, where only the fiber A or both fibers are fed with the telescope light. The I_2 program is currently under revision and is therefore not available (28-02-2006).

Observers define the instrument mode by the appropriate choice of the templates:

1. HARPS_ech_... for the HARPS base mode

2. HARPS_eggs_... for the high efficiency mode EGGS

The template set used for the HARPS base mode is duplicated for EGGS, all the parameteres being the same, with the only difference of the INS.MODE keyword which is defined within the template reference file (transparent to the user).

2.2 Exposure types

Three different **Exposure types** are specified in [3], according to the operation to be conducted:

1. Science exposures,

2. Calibration exposures,

3. Maintenance exposures.

2.3 Instrument setup

To achieve the instrument setup for the different observation and calibration modes, different parts can be moved in the HCFA (see table 2.1).

INS.OPTI2.NAME	HARPS|AUX	*Fiber Head Selector*
INS.OPTI3.NAME	IN|OUT	*Fiber Head Dust Cover*
INS.ADCS.NAME	IN|OUT	*Atmospheric Dispersion Corrector Slide*
INS.ADC1.MODE	OFF|AUTO	*ADC Prism 1*
INS.ADC2.MODE	OFF|AUTO	*ADC Prism 2*
INS.LAMP4.ST	T|F (ON|OFF)	*THAR1 Lamp*
INS.LAMP5.ST	T|F (ON|OFF)	*THAR2 Lamp*
INS.MIRR1.NAME	FIBA|BOTH|FIBB|NONE	*Calibration Mirror*
INS.OPTI4.NAME	IN|OUT	*I2 cell*
INS.OPTI5.NAME	NONE|TUN1|SPARE|I2CELL|THAR1|THAR2	*Calibration Lamp A Selector*
INS.OPTI6.NAME	NONE|TUN1|SPARE|I2CELL|THAR1|THAR2	*Calibration Lamp B Selector*
INS.ROT1.POS	0-2.132 (0)	*Neutral Density Filter Wheel*
INS.LAMP1.ST	T|F (ON|OFF)	*TUN1*
INS.LAMP2.ST	T|F (ON|OFF)	*Calibration I2 cell lamp*
INS.LAMP6.ST	T|F (ON|OFF)	*Calibration I2 cell heating*
INS.LAMP7.ST	T|F (ON|OFF)	*Scientific I2 cell heating*
DET1.WIN1.UIT1	Range TBD	*Exposure Time (sec)*
SEQ.NEXPO	1-100	*Number of Repeated Exposures*
DET1.READ.SPEED	<mode>	*CCD ReadOut Mode*
DET1.EXP.TYPE	NORMAL|DARK	*Exposure Type*

Table 2.1: The different devices that can be operated via templates and the corresponding DICD keywords.

When HARPS is in operation, the *Fiber Head Selector* is set either to the value "HARPS" (for the HARPS base mode) or to the value "AUX" for the EGGS mode; the *Fiber Head Dust Cover* is always removed (OUT).

The *Thorium-Argon Lamp 1* and the *Thorium-Argon Lamp 2* will be set up to the same value during the afternoon calibrations. The *Thorium-Argon Lamp 1* is the absolute reference lamp, and its use shall be minimized in order to prolong its life time. It will be ON only during calibrations and switched off afterwards. For baseline RV nights, the *Thorium-Argon Lamp 2* will be ON for the whole night. When an exposure uses one of the *Thorium-Argon Lamps* for the first time, there is a long (120s) warm-up delay. Because of this delay, the templates will not turn OFF the used lamp at the end, in order to permit the next template to set the same lamp ON without implying a physical action, and thus avoiding the long warm-up time.

For the exposures implying telescope light, the *Atmospheric Dispersion Corrector* is always inserted (INS.ADCS = IN) and the two prisms will be in "AUTO" mode. As it is irrelevant for the calibration exposures, it can be let in and thus set up for the whole night. When an exposure uses the *Atmospheric Dispersion Corrector*, it will not "really" set it.

Amongst the possibilities illustrated in table 2.2, only ten will be used and have corresponding templates for the science, calibration and maintenance exposures of HARPS. In addition, when lamp is the selected source, the <lamp> can be THAR1, THAR2 or TUN1.

The *Flat-field LED* used to illuminate directly the CCD and used in some technical exposures is driven

	TPL	Fiber A	Fiber B	**INS.MIRR1**	**INS.OPTI4**	**INS.OPTI5**	**INS.OPTI6**
1	Y	no light	no light	BOTH	OUT	NONE	NONE
2	Y	no light	lamp	BOTH	OUT	NONE	<lamp>
3		no light	lamp+I_2	BOTH	IN	NONE	<lamp>
4		no light	telescope	FIBA	OUT	NONE	NONE
5		no light	telescope+I_2	FIBA	IN	NONE	NONE
6	Y	lamp	no light	BOTH	OUT	<lamp>	NONE
7	Y	lamp+I_2	no light	BOTH	IN	<lamp>	NONE
8	Y	lamp	lamp	BOTH	OUT	<lamp>	<lamp>
9	Y	lamp+I_2	lamp+I_2	BOTH	IN	<lamp>	<lamp>
10		lamp	telescope	FIBA	OUT	<lamp>	NONE
11		lamp+I_2	telescope+I_2	FIBA	IN	<lamp>	NONE
12	Y	telescope	no light	FIBB	OUT	NONE	NONE
13	Y	telescope	lamp	FIBB	OUT	NONE	<lamp>
14	Y	telescope	telescope	NONE	OUT	NONE	NONE
15	Y	telescope+I_2	no light	FIBB	IN	NONE	NONE
16		telescope+I_2	lamp+I_2	FIBB	IN	NONE	<lamp>
17		telescope+I_2	telescope+I_2	NONE	IN	NONE	NONE

Table 2.2: Combination of all the different light injection possibilities and corresponding light paths. The first column TPL makes an inventory of defined templates.

directly by PULPO through a special type of exposure.

2.4   Templates classification

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

Acquisition templates   One acquisition template is defined for each observing mode or submode. This allows to completely configure the HCFA before guiding is started, avoiding disturbances due to moving devices crossing the guide camera optical path.

1. acquisition for accurate RV measurement (acq_thosimult)
2. acquisition for spectroscopy with I_2 (acq_I2cell)
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)

There are two sets of acquisition templates, for each of the instrument' modes. They are pre-ceeded by the prefix "ech" for the HARPS baseline mode (HARPS) and by the prefix "eggs" for the high efficiency mode (EGGS). The acquisition templates will define and store in the instrument database four keywords **TPL.NAME**, **INS.MODE**, **DPR.TECH** and **DPR.TYPE**, containing the type of observation and the information regarding the objects seen by the fibers. The observation templates will recover from the ICSDB these values, and send them to the header. The table 2.3 lists the content of these keywords for the different acquisition templates.

The **TPL.NAME** keyword contains the name of the acquisition template. This will be included

in the FITS header of the frame and used to trigger the adequate reduction recipe [9].

The **INS.MODE** keyword indicates the instrument mode, also this keyword will be included in the FITS header of the frame and used to trigger the adequate reduction recipe [9].

The **DPR.TECH** indicates if the frame contains an echelle spectra or a dark or flat-field image, and whether or not the Iodine cell is inserted.

The **DPR.TYPE** is composed of three 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, and the third one indicates either the spectral type of the star present in fiber A or the lamp illuminating fiber A,

For the calibration and technical templates not involving celestial objects, and thus not using acquisition templates, these keywords are also defined but don't need to be stored in the ICS database or retrieved and processed by another template. They will be provided directly to the header.

	Template=**TPL.NAME**	**INS.MODE**	**DPR.TECH**	**DPR.TYPE**
1	HARPS_ech_acq_thosimult	"HARPS"	"ECHELLE"	"STAR,WAVE,<spectral type>"
2	HARPS_ech_acq_I2cell	"HARPS"	"ECHELLE,ABSORPTION_CELL"	"STAR,DARK,<spectral type>"
3	HARPS_ech_acq_objA	"HARPS"	"ECHELLE"	"STAR,DARK,<spectral type>"
4	HARPS_ech_acq_objAB	"HARPS"	"ECHELLE"	"STAR,SKY,<spectral type>"
5	HARPS_eggs_acq_thosimult	"EGGS"	"ECHELLE"	"STAR,WAVE,<spectral type>"
6	HARPS_eggs_acq_I2cell	"EGGS"	"ECHELLE,ABSORPTION_CELL"	"STAR,DARK,<spectral type>"
7	HARPS_eggs_acq_objA	"EGGS"	"ECHELLE"	"STAR,DARK,<spectral type>"
8	HARPS_eggs_acq_objAB	"EGGS"	"ECHELLE"	"STAR,SKY,<spectral type>"

Table 2.3: The content of the Data Products Keywords describe the type of observation and the objects involved.

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

1. science exposure (obs_all)

The template name will be preceeded by either the prefix "ech" or "eggs" for the base mode and the high efficiency mode respectively.

Calibration templates The calibration templates set provides exposures to fully characterize HARPS

and obtain the best quality reduction of science exposures.

1. calibration of detector bias (cal_bias)
2. calibration of detector dark current (cal_dark)
3. calibration exposures for fiber A and B orders geometry taken separately (cal_tun)
4. calibration exposure for spectral flat field for both fibers (cal_tunAB)
5. calibration exposure of tungstene lamp in free settings (cal_tunUSER)
6. calibration exposure for wavelength calibration (cal_thoAB)
7. calibration exposure of continuum lamp with I_2 (cal_tunAI2)

A minimum set of calibration exposures is defined for automatic DRS needs in [3] as including cal_dark, cal_tun, cal_tunAB and cal_thoAB.

Similarly to the acquisition and the observation templates, the template name will be preceeded by either the prefix "ech" or "eggs" for the base mode and the high efficiency mode respectively.

Maintenance templates The following templates provide exposure to periodically examine the instrument performances and monitor the stability of these performances. Some are symetric 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 (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 efficiency of light path (tec_eff)

The technical templates are available for both instrument modes with the corresponding prefix ("ech" for HARPS and "eggs" for EGGS).

A detailed listing of all free and fixed keywords is given in Appendix A

Chapter 3

Acquisition templates

The acquisition templates 3.1, 3.2, 3.3 and 3.4 will be available to the observers in order to create their OBs both in the "HARPS'" and "EGGS" instrument modes. In order to select the proper instrument mode the observer will have to choose the appropriate template: "HARPS_ech_..." or "HARPS_eggs_...".

. The others will only be available to the staff for technical purposes.

As the acquisition template defines the type of observation in our scheme, thus the DRS recipe to be triggered, ans as there is no memory in the OS between two templates, each acquisition template will store it's name in the instrument database, where it will then be read back by the observation templates.

3.1 HARPS_ech/eggs_acq_thosimult

This is HARPS base-line acquisition template. The object is specified by the identification keywords:

TPL.NAME	"HARPS_ech/eggs_acq_thosimult"	*Observation Mode*
DPR.TECH	"ECHELLE"	*Observation Technique*
DPR.TYPE	"STAR,WAVE,<sp>"(G2V)	*Objects Type*
INS.MODE	"HARPS/EGGS"	*Instrument mode*
TEL.TARG.RADVEL	radvel ("NONE")	*Target Radial Velocity*

The three first keywords are stored in the ICS online database.

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

TEL.TARG.ALPHA	ra (000000.0)	*Target R.A.*
TEL.TARG.DELTA	dec (-850000.0)	*Target Decl.*
TEL.TARG.EQUINOX	year (2000)	*Coordinates Equinox*
TEL.TARG.PMA	pm ra (0 arcsec/year)	*Alpha Proper Motion*
TEL.TARG.PMD	pm dec (0 arcsec/year)	*Delta Proper Motion*

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

Then the optical paths are setup to have the target in fiber A and the proper Thorium-Argon lamp light in fiber B. The specified Thorium-Argon is already ON, and the other OFF, but their status 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. A verification is done that the lamp is on. If not, the operator is warned, and the templates exits.

```
if( INS.OPTI6.NAME == "THAR1" )
    {if( INS.LAMP4.ST != "T" )
        display_error
 exit
    INS.LAMP5.ST = "F"}
else
    {if( INS.LAMP5.ST != "T" )
        display_error
 exit
    INS.LAMP4.ST = "F"}
```

INS.MIRR1.NAME	FIBB	*Calibration Mirror*
INS.OPTI4.NAME	OUT	*I_2 cell*
INS.OPTI6.NAME	THAR1|THAR2	*Calibration Lamp B Selector*
INS.LAMP4.ST	T|F (ON|OFF)	*THAR1 Lamp*
INS.LAMP5.ST	T|F (ON|OFF)	*THAR2 Lamp*

The image of the technical CCD is saved, then a pop-up window asks the operator to click a button when the star is centered and the guiding active.

3.2   HARPS_ech/eggs_acq_I2cell

This is HARPS alternate high precision RV spectroscopic observation mode acquisition template.

TPL.NAME	"HARPS_ech/eggs_acq_I2cell"	*Observation Mode*
DPR.TECH	"ECHELLE, ABSORPTION-CELL"	*Observation Technique*
DPR.TYPE	"STAR,DARK,<sp>" (G2V)	*Objects Type and Spectral Type*
INS.MODE	"HARPS/EGGS"	*Instrument mode*
TEL.TARG.RADVEL	radvel ("NONE")	*Target Radial Velocity*

The three first keywords are stored in the ICS online database.

After the telescope preset to the specified RA and DEC, the I_2 cell is inserted, as the insertion of this

device could modify the position of an already centered star.

INS.OPTI4.NAME	IN	*I₂ cell*

The target is acquired, then the optical paths are setup to have the target in fiber A and no light in fiber B. The Iodine cell heating is switched ON.

INS.MIRR1.NAME	FIBB	*Calibration Mirror*
INS.OPTI6.NAME	NONE	*Calibration Lamp B Selector*
INS.LAMP7.ST	T (ON)	*I2cell Heating*

The image of the technical CCD is saved, then a pop-up window asks the operator to click a button when the star is centered and the guiding active.

3.3   HARPS_ech/eggs_acq_objA

This is HARPS simpler spectroscopic observation mode acquisition template.

TPL.NAME	"HARPS_ech/eggs_acq_objA"	*Observation Mode*
DPR.TECH	"ECHELLE"	*Observation Technique*
DPR.TYPE	"STAR,DARK,\<sp\>" (G2V)	*Objects Type and Spectral Type*
INS.MODE	"HARPS/EGGS"	*Instrument mode*
TEL.TARG.RADVEL	radvel ("NONE")	*Target Radial Velocity*

The three first keywords are stored in the ICS online database.

After the telescope preset to the specified RA and DEC, the target is acquired, the optical paths are setup to have the target in fiber A and no light in fiber B. The Thorium-Argon lamp is unused, but let ON in case it is needed later.

INS.MIRR1.NAME	FIBB	*Calibration Mirror*
INS.OPTI4.NAME	OUT	*I₂ cell*
INS.OPTI6.NAME	NONE	*Calibration Lamp B Selector*

The image of the technical CCD is saved, then a pop-up window asks the operator to click a button when the star is centered and the guiding active.

This template is also used for the technical exposure corresponding to the template **HARPS_ech/eggs_tec_eff**.

3.4   HARPS_ech/eggs_acq_objAB

This is HARPS spectroscopic with sky removal observation mode acquisition template.

TPL.NAME	"HARPS_ech/eggs_acq_objAB"	*Observation Mode*
DPR.TECH	"ECHELLE"	*Observation Technique*
DPR.TYPE	"STAR,SKY,<sp>" (G2V)	*Objects Type and Spectral Type*
INS.MODE	"HARPS/EGGS"	*Instrument mode*
TEL.TARG.RADVEL	radvel ("NONE")	*Target Radial Velocity*

The three first keywords are stored in the ICS online database.

After the telescope preset to the specified RA and DEC, the target is acquired, the optical paths are setup to have the target in fiber A and the sky light in fiber B. The Thorium-Argon lamp is unused, but let it ON in case it is needed later.

This template is also used for the technical exposure corresponding to the template **HARPS_ech/eggs_tec_eff**.

INS.MIRR1.NAME	NONE	*Calibration Mirror*
INS.OPTI4.NAME	OUT	I_2 *cell*

The image of the technical CCD is saved, then a pop-up window asks the operator to click a button when the star is centered and the guiding active.

Chapter 4

Observation template

HARPS detector system is composed of two CCD chips of 2k pixels by 4k pixels, one receiving the blue part and the other the red part of the spectrum. They are called "Linda" and "Jasmin".

CCD ReadOut Mode is a string <mode> defining simultaneously several CCD parameters according to table 4.1, where each chip is 2k per 4K pixels.

	CCD ReadOut Mode			Read Out			
		Binning	Gain	Port nbr/chip	Speed	Noise	time/chip
			(e^-/ADU)		(kps)	(e^-)	(s)
1	"50kHz,1,low"	1x1	0.6	1	50	3	180
2	"50kHz,2,low"	1x1	0.6	2	50	3	90
3	"416kHz,1,high"	1x1	1.4	1	416	6	22.6
4	"416kHz,2,high"	1x1	1.4	2	416	6	11.3
5	"625kHz,1,high"	1x1	2.2	1	625	9	18.8
6	"625kHz,2,high"	1x1	2.2	2	625	9	9.4

Table 4.1: Description of the CCD setups available. Only odd numbered ones are available to the observer

As the *CCD ReadOut Mode* will be passed to the DCS by the observation template and the observation mode will be fixed in the acquisition template, it is difficult to have it fixed for some modes and freely available for the others. It will thus be available, with a default value corresponding to the choosen mode for the baseline observation mode, i.e. simultaneous wavelength reference. The same default mode will be proposed for the calibration templates included in the minimum set defined in section 2.4, page 10. **Any change to these modes will be made by the observer under his own responsibility.** For the precise RV measurements, we strongly discourage the observer to change this value.

Due to a noisy port on the "Jasmin" chip, only the odd numbered modes of the table 4.1, which use

one port per chip, will be offered to the observers. The 50KHz and the 416 KHz modes have been properly characterized, so they are the main modes to use. The 625 KHz may be used for very short exposure, less demanding in precision. Mode 3 ("416kHz,1,high") is the default mode.

4.1   HARPS_ech/eggs_obs_all

The template reads the observation mode back from the ICS online database, where it was stored as the name of the acquisition template.

The keyword **TPL.NAME** is then computed to give a pseudo observation template name HARPS_ech/eggs_obs_XXXX, where XXXX is the last extension of the acquisition template name.

TPL.NAME	"HARPS_ech/eggs_obs_XXXX"	*Observation Mode*

It also reads back the **DPR.TECH** and the **DPR.TYPE** keywords, to pass them to the OS, 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".

DPR.CATG	"SCIENCE"	*Observation Category*
DPR.TECH	"<obs. technique>"	*Observation Technique*
DPR.TYPE	"<objA>,<objB>,<sp>"	*Objects Type and Spectral Type*
INS.MODE	"HARPS/EGGS"	*Instrument mode*

The exposure parameters are set:

Exposure Type is set to NORMAL for the scientific exposures. *CCD ReadOut Mode* (according to second column of table 4.1), *Exposure Time* (an integer whose range is still TBD) and *Number of Repeated Exposures* are set.

DET1.EXP.TYPE	NORMAL	*Exposure Type*
DET1.READ.SPEED	<mode>	*CCD ReadOut Mode*
DET1.WIN1.UIT1	<exptime>	*Exposure Time (sec)*
SEQ.NEXPO	1-1000	*Number of Repeated Exposures*

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

- For simultaneous wavelength reference exposures, the <density> is computed from the exposure time and the instrument mode.

- For the other modes, it is set to zero.

INS.ROT1.POS	0-2.132 (0)	*Neutral Density Filter Wheel*

The Atmospheric Dispersion Corrector is then set up. Its insertion is verified, then, according to the target position, the angles <angle1> and <angle2> for the two prisms are calculated and set by the OS.

This is done once per exposure to take into account the earth motion in case of multiple exposures.

INS.ADCS.NAME	IN	*Atmospheric Dispersion Corrector Slide*
INS.ADC1.MODE	AUTO	*Atmospheric Dispersion Corrector Prism 1*
INS.ADC2.MODE	AUTO	*Atmospheric Dispersion Corrector Prism 2*

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.

A beep signals to the operator the end of exposure.

The DRS is triggered by the DFS when all the exposures are archived.

Chapter 5

Calibration templates

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 of the frame(s).

5.1 HARPS_ech/eggs_cal_bias

This template implements the measurement of the electronic bias of the CCD, via a zero-length exposure of type DARK.

TPL.NAME	"HARPS_ech/eggs_cal_bias"	*Observation Mode*
DPR.CATG	"CALIB"	*Observation Category*
DPR.TECH	"IMAGE"	*Observation Technique*
DPR.TYPE	"BIAS,BIAS"	*Objects Type and Spectral Type*
INS.MODE	"HARPS/EGGS"	*Instrument mode*

The setup of the instrument is irrelevant as the *Exposure Type* of this exposure is set to DARK, leading the *Image Scrambler Shutter* and the EGGS fibre head shutter to remain closed. The instrument is set up in order to eliminate any possible parasit light.

The exposure parameters are set

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,

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which computes the bias via left and right overscanning each image during normal operations. This is repeated if *Number of Repeated Exposures* is greater than 1.

5.2   HARPS_ech/eggs_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.

TPL.NAME	"HARPS_ech/eggs_cal_dark"	*Observation Mode*
DPR.CATG	"CALIB"	*Observation Category*
DPR.TECH	"IMAGE"	*Observation Technique*
DPR.TYPE	"DARK,DARK"	*Objects Type and Spectral Type*
INS.MODE	"HARPS/EGGS"	*Instrument mode*

The exposure parameters are setup. 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 1. The <minexptime> is defined as 300 seconds. If the user chooses a smaller exposure time, a warning pop-up is displayed.

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 exposures are carried out: the CCD is flushed, then read again after <exptime> to achieve the proper exposure time. At the end of each exposure, the frame is archived, and a beep is emitted.

At the end of the template, the DRS is triggered to compute the mean dark level, scaled to one hour.

5.3   HARPS_ech/eggs_cal_tun

This template acquires the "flat" spectra which allow the DRS to calculate the location of the orders of the fiber A and fiber B, which are successively illuminated by the tungsten lamp.

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

INS.ROT1.POS	<density> (0)	*Neutral Density Filter Wheel*

The HCFA is then setup to allow, for the selected instrument mode, 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 meters, a virtual shutter cuts the power supply of their photomultipliers.

INS.SHUT1.ST	F (CLOSED)	*Exposure Meter Power Supply*
INS.MIRR1.NAME	BOTH	*Calibration Mirror*
INS.OPTI4.NAME	OUT	*I$_2$ cell*
INS.LAMP1.ST	T (ON)	*TUN1*
INS.OPTI5.NAME	TUN1	*Calibration Lamp A Selector*
INS.OPTI6.NAME	NONE	*Calibration Lamp B Selector*

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

TPL.NAME	"HARPS_ech/eggs_cal_tun"	*Observation Mode*
DPR.CATG	"CALIB"	*Observation Category*
DPR.TECH	"ECHELLE"	*Observation Technique*
DPR.TYPE	"LAMP,DARK,TUN"	*Objects Type and Spectral Type*
INS.MODE	"HARPS/EGGS"	*Instrument mode*

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

DET1.EXP.TYPE	NORMAL	*Exposure Type*
DET1.READ.SPEED	<mode>	*CCD ReadOut Mode*
DET1.WIN1.UIT1	2.8/2.0	*Exposure Time (sec)*
SEQ.NEXPO	1	*Number of Repeated Exposures*

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

The HCFA is then setup to allow the light from the *Tungstene Lamp* to feed the fiber B and no light in fiber A of the selected fibre set (instrument mode).

INS.OPTI5.NAME	NONE	*Calibration Lamp A Selector*
INS.OPTI6.NAME	TUN1	*Calibration Lamp B Selector*

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

TPL.NAME	"HARPS_ech/eggs_cal_tun"	*Observation Mode*
DPR.CATG	"CALIB"	*Observation Category*
DPR.TECH	"ECHELLE"	*Observation Technique*
DPR.TYPE	"DARK,LAMP,TUN"	*Objects Type and Spectral Type*
INS.MODE	"HARPS/EGGS"	*Instrument mode*

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

DET1.EXP.TYPE	NORMAL	*Exposure Type*
DET1.READ.SPEED	<mode>	*CCD ReadOut Mode*
DET1.WIN1.UIT1	2.8/2.0	*Exposure Time (sec)*
SEQ.NEXPO	1	*Number of Repeated Exposures*

The second exposure is carried out. After *Exposure Time*, the CCD is read out, the frame is then 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 Meters* is switched on, and the *TUN1 lamp* is switched off.

INS.SHUT1.ST	T (OPEN)	*Exposure Meter Power Supply*
INS.LAMP1.ST	F (OFF)	*TUN1*

A beep signals the end of the template.

5.4   HARPS_ech/eggs_cal_tunAB

This template will allow the flat-field spectrum and the blaze response of HARPS estimation. This template will be played right after the geometry calibration done with *HARPS_ech/eggs_cal_tun*.

TPL.NAME	"HARPS_ech/eggs_cal_tunAB"	*Observation Mode*
DPR.CATG	"CALIB"	*Observation Category*
DPR.TECH	"ECHELLE"	*Observation Technique*
DPR.TYPE	"LAMP,LAMP,TUN"	*Objects Type and Spectral Type*
INS.MODE	"HARPS/EGGS"	*Instrument mode*

The HCFA is setup to allow the light from the *Tungsten Lamp* to feed both fibers A and B of the selected fibre set (instrument mode).

INS.SHUT1.ST	F (CLOSED)	*Exposure Meter Power Supply*
INS.MIRR1.NAME	BOTH	*Calibration Mirror*
INS.OPTI4.NAME	OUT	*I$_2$ cell*
INS.OPTI5.NAME	TUN1	*Calibration Lamp A Selector*
INS.OPTI6.NAME	TUN1	*Calibration Lamp B Selector*
INS.LAMP1.ST	T (ON)	*TUN1*

The CCD is then set up.

SEQ.NEXPO	<Nexp>	*Number of Repeated Exposures*
DET1.EXP.TYPE	NORMAL	*Exposure Type*
DET1.READ.SPEED	<mode>	*CCD ReadOut Mode*
DET1.WIN1.UIT1	2.8/2.0	*Exposure Time (sec)*

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

INS.ROT1.POS	<density>	*Neutral Density Filter Wheel*

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

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

The Power Supply of the *Exposure Meters* is switched on, and the *TUN1 lamp* is switched off.

| INS.SHUT1.ST | T (OPEN) | *Exposure Meter Power Supply* |
| INS.LAMP1.ST | F (OFF) | *TUN1* |

A beep signals the end of the template.

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.

5.5   HARPS_ech/eggs_cal_tunUSER

A flatfield template with free exposure parameters to allow the user to handle he's own reduction needs.

TPL.NAME	"HARPS_ech/eggs_cal_tunUSER"	*Observation Mode*
DPR.CATG	"CALIB"	*Observation Category*
DPR.TECH	"ECHELLE"	*Observation Technique*
DPR.TYPE	"LAMP,LAMP,TUN"	*Objects Type and Spectral Type*
INS.MODE	"HARPS/EGGS"	*Instrument mode*

The HCFA is setup to allow the light from the *Tungsten Lamp* to feed both fibers A and B of the selected fibre set (instrument mode).

INS.SHUT1.ST	F (CLOSED)	*Exposure Meter Power Supply*
INS.MIRR1.NAME	BOTH	*Calibration Mirror*
INS.OPTI4.NAME	OUT	I_2 *cell*
INS.OPTI5.NAME	TUN1	*Calibration Lamp A Selector*
INS.OPTI6.NAME	TUN1	*Calibration Lamp B Selector*
INS.LAMP1.ST	T (ON)	*TUN1*

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

SEQ.NEXPO	<Nexp>	*Number of Repeated Exposures*
DET1.EXP.TYPE	NORMAL	*Exposure Type*
DET1.READ.SPEED	<mode>	*CCD ReadOut Mode*
DET1.WIN1.UIT1	2.8/2.0	*Exposure Time (sec)*

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

| INS.ROT1.POS | <density> | *Neutral Density Filter Wheel* |

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

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

The Power Supply of the *Exposure Meters* is switched on, and the *TUN1 lamp* is switched off.

INS.SHUT1.ST	T (OPEN)	*Exposure Meter Power Supply*
INS.LAMP1.ST	F (OFF)	*TUN1*

A beep signals the end of the template.

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

5.6   HARPS_ech/eggs_cal_thoAB

The Thorium-Argon calibration template used to compute with accuracy the wavelength geometry of each fiber.

TPL.NAME	"HARPS_ech/eggs_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*
INS.MODE	"HARPS/EGGS"	*Instrument mode*

The HCFA is setup to allow the light from a *Thorium-Argon Lamp* to feed both fibers A and B of the selected fibre set (instrument mode). The specified *Thorium-Argon Lamp* will not be switched ON, if already ON. To ensure that both fibers are fed by the light from the same lamp, the lamp selected for fiber A will guide the template to select the lamp for fiber B, and to illuminate the proper lamp.

```
if( INS.OPTI6.NAME == "THAR1" )
    {if( INS.LAMP4.ST != "T" )
        display_error
 exit
    INS.LAMP5.ST = "F"}
else
    {if( INS.LAMP5.ST != "T" )
        display_error
 exit
    INS.LAMP4.ST = "F"}
```

INS.MIRR1.NAME	BOTH	*Calibration Mirror*
INS.OPTI4.NAME	OUT	*I_2 cell*
INS.OPTI5.NAME	THAR1|THAR2	*Calibration Lamp A Selector*
INS.OPTI6.NAME	THAR1|THAR2	*Calibration Lamp B Selector*
INS.LAMP4.ST	T|F (ON|OFF)	*THAR1 Lamp*
INS.LAMP5.ST	T|F (ON|OFF)	*THAR2 Lamp*

The CCD is then set up for <Nexp> exposures of 40/15 seconds (for HARPS/EGGS).

SEQ.NEXPO	\<Nexp\>	*Number of Repeated Exposures*
DET1.EXP.TYPE	NORMAL	*Exposure Type*
DET1.READ.SPEED	\<mode\>	*CCD ReadOut Mode*
DET1.WIN1.UIT1	40/15	*Exposure Time (sec)*

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

INS.ROT1.POS	\<density\>	*Neutral Density Filter Wheel*

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

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

A beep signals to the operator the end of exposure.

The exposures are processed together at the end of the template by the DRS to extract the spectra, compute its accurate wavelength geometry, wavelength calibrate the thorium spectrum (which is then archived) and compute image quality and spectrograph resolution indicators.

5.7   HARPS_ech/eggs_cal_tunAI2

The I_2 observation mode calibration template.

TPL.NAME	"HARPS_ech/eggs_cal_tunAI2"	*Observation Mode*
DPR.CATG	"CALIB"	*Observation Category*
DPR.TECH	"ECHELLE,	
ABSORPTION-CELL"	*Observation Technique*	
DPR.TYPE	"LAMP,DARK,TUN"	*Objects Type and Spectral Type*
INS.MODE	"HARPS/EGGS"	*Instrument mode*

The HCFA is setup to allow the light from the *Tungstene Lamp* to feed the fiber A and the Iodine cell is inserted in the beam.

INS.SHUT1.ST	F (CLOSED)	*Exposure Meter Power Supply*
INS.MIRR1.NAME	BOTH	*Calibration Mirror*
INS.OPTI4.NAME	IN	*I_2 cell*
INS.OPTI5.NAME	TUN1	*Calibration Lamp A Selector*
INS.OPTI6.NAME	NONE	*Calibration Lamp B Selector*
INS.LAMP1.ST	T (ON)	*TUN1*

The CCD is then set up for \<Nexp\> exposures of 4.5 seconds.

SEQ.NEXPO	\<Nexp\>	*Number of Repeated Exposures*
DET1.EXP.TYPE	NORMAL	*Exposure Type*
DET1.READ.SPEED	\<mode\>	*CCD ReadOut Mode*
DET1.WIN1.UIT1	\<exptime\>	*Exposure Time (sec)*

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

INS.ROT1.POS	\<density\>	*Neutral Density Filter Wheel*

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

The exposure is carried out, the CCD is read out, the frame is archived, and the DRS is triggered to extract the wavelength calibrated I_2 spectrum.

The Power Supply of the *Exposure Meters* is switched on, and the *TUN1 lamp* is switched off.

INS.SHUT11.ST	T (OPEN)	*Exposure Meter Power Supply*
INS.LAMP1.ST	F (OFF)	*TUN1*

A beep signals the end of the template.

Chapter 6

Maintenance templates

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 allow to measure 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.

6.1   HARPS_ech_tec_dark

The dark exposure technical template for HARPS.

This template is very similar to the *HARPS_ech_cal_dark*

TPL.NAME	"HARPS_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 parasit light.

The exposure parameters are setup. The bias measurement is done by fixing the exposure time equal to 0.

DET1.WIN1.UIT1	<exptime>	*Exposure Time (sec)*
DET1.READ.SPEED	<mode>	*CCD ReadOut Mode*
DET1.EXP.TYPE	DARK	*Exposure Type*
SEQ.NEXPO	1	*Number of Repeated Exposures*

Then the exposure is carried out by flushing the CCD, waiting <exptime> and reading out the CCD. At the end of the 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 0, and the hot pixels mapping.

A beep signals to the operator the end of exposure.

6.2   HARPS_ech/eggs_tec_led

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

TPL.NAME	"HARPS_ech/eggs_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 enlighten the CCD by a LED, without going through the fibers and the spectrometer. Thus, all the devices are set up the same way as for dark exposure.

The exposure parameters are setup.

DET1.WIN1.UIT1	<exptime>	*Exposure Time (sec)*
DET1.READ.SPEED	<mode>	*CCD ReadOut Mode*
DET1.EXP.TYPE	NORMAL	*Exposure Type*
SEQ.NEXPO	1	*Number of Repeated Exposures*

Then 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.

A beep signals to the operator the end of exposure.

6.3   HARPS_ech/eggs_tec_tunA

Order localization and spectral flat-field with fiber A.

TPL.NAME	"HARPS_ech/eggs_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 HCFA is setup to allow the light from the *Tungstene Lamp* to feed the fiber A and no light in fiber B.

INS.MIRR1.NAME	BOTH	*Calibration Mirror*
INS.OPTI4.NAME	OUT	I_2 *cell*
INS.OPTI5.NAME	TUN1	*Calibration Lamp A Selector*
INS.OPTI6.NAME	NONE	*Calibration Lamp B Selector*
INS.LAMP1.ST	T (ON)	*TUN1*
INS.SHUT11.ST	F (CLOSED)	*Exposure Meter Power Supply*

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

DET1.WIN1.UIT1	<exptime>	*Exposure Time (sec)*
DET1.READ.SPEED	<mode>	*CCD ReadOut Mode*
DET1.EXP.TYPE	NORMAL	*Exposure Type*
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.

| INS.ROT1.POS | <density> | *Neutral Density Filter Wheel* |

The exposure is carried out, the CCD is read out, the frame is archived, and the DRS is triggered, which computes the geometry and profile (in the cross-dispersion direction) of the orders of the TUN1 spectrum in fiber A and the intensity of the Tungstene lamp.

The Power Supply of the *Exposure Meters* is switched on, and the *TUN1 lamp* is switched off.

| INS.SHUT11.ST | T (OPEN) | *Exposure Meter Power Supply* |
| INS.LAMP1.ST | F (OFF) | *TUN1* |

A beep signals the end of the template.

6.4   HARPS_ech/eggs_tec_tunB

Order localization and spectral flat-field with fiber B.

The template is the same as **HARPS_ech/eggs_tec_tunA** but for fiber B. The differences in the instrument setup are shown here:

TPL.NAME	"HARPS_ech/eggs_tec_tunB"	*Observation Mode*
DPR.CATG	"TEST"	*Observation Category*
DPR.TECH	"ECHELLE"	*Observation Technique*
DPR.TYPE	"DARK,LAMP,TUN"	*Objects Type and Spectral Type*
INS.OPTI5.NAME	NONE	*Calibration Lamp A Selector*
INS.OPTI6.NAME	TUN1	*Calibration Lamp B Selector*

6.5   HARPS_ech/eggs_tec_tunAB

Order localization and spectral flat-field with fibers A and B.

The template is the same as **HARPS_ech/eggs_tec_tunA** but for both fibers A and B. The differences in the instrument setup are shown here:

TPL.NAME	"HARPS_ech/eggs_tec_tunAB"	*Observation Mode*
DPR.CATG	"TEST"	*Observation Category*
DPR.TECH	"ECHELLE"	*Observation Technique*
DPR.TYPE	"LAMP,LAMP,TUN"	*Objects Type and Spectral Type*
INS.OPTI5.NAME	TUN1	*Calibration Lamp A Selector*
INS.OPTI6.NAME	TUN1	*Calibration Lamp B Selector*

6.6   HARPS_ech/eggs_tec_thoA

Wavelength calibration exposure on fiber A.

TPL.NAME	"HARPS_ech/eggs_tec_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 HCFA is setup to allow the light from the proper *Thorium-Argon Lamp* to feed the fiber A and no light on fiber B.

To ensure that only the proper lamp is on, the template will verify that the proper lamp is illuminated.

```
if( INS.OPTI5.NAME == "THAR1" )
    {if( INS.LAMP4.ST != "T" )
        display_error
 exit
    INS.LAMP5.ST = "F"}
else
    {if( INS.LAMP5.ST != "T" )
```

```
        display_error
 exit
    INS.LAMP4.ST = "F"}
```

INS.MIRR1.NAME	BOTH	*Calibration Mirror*
INS.OPTI4.NAME	OUT	*I_2 cell*
INS.OPTI5.NAME	THAR1|THAR2	*Calibration Lamp A Selector*
INS.OPTI6.NAME	NONE	*Calibration Lamp B Selector*
INS.LAMP4.ST	T|F (ON|OFF)	*THAR1 Lamp*
INS.LAMP5.ST	T|F (ON|OFF)	*THAR2 Lamp*

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

DET1.WIN1.UIT1	<exptime>	*Exposure Time (sec)*
DET1.READ.SPEED	<mode>	*CCD ReadOut Mode*
DET1.EXP.TYPE	NORMAL	*Exposure Type*
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.

INS.ROT1.POS	<density>	*Neutral Density Filter Wheel*

The exposure is carried out, the CCD is read out, the frame is archived, and 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 *Thorium-Argon Lamp* and the ThAr flux on the exposure meter.

A beep signals to the operator the end of exposure.

6.7   HARPS_ech/eggs_tec_thoB

Wavelength calibration exposure on fiber B.

The template is the same as **HARPS_ech/eggs_tec_thoA**, but for fiber B. The differences in the instrument setup are shown here:

TPL.NAME	"HARPS_ech/eggs_tec_thoB"	*Observation Mode*
DPR.CATG	"TEST"	*Observation Category*
DPR.TECH	"ECHELLE"	*Observation Technique*
DPR.TYPE	"DARK,WAVE,THAR1|THAR2"	*Objects Type and Spectral Type*
INS.OPTI5.NAME	NONE	*Calibration Lamp A Selector*
INS.OPTI6.NAME	THAR1|THAR2	*Calibration Lamp B Selector*

To ensure that only the proper lamp is on, the template will verify that the proper lamp is illuminated.

```
if( INS.OPTI5.NAME == "THAR1" )
```

```
    {if( INS.LAMP4.ST != "T" )
        display_error
 exit
    INS.LAMP5.ST = "F"}
else
    {if( INS.LAMP5.ST != "T" )
        display_error
 exit
    INS.LAMP4.ST = "F"}
```

6.8   HARPS_ech/eggs_tec_thoAB

Wavelength calibration exposure on fibers A and B.

The template is the same as **HARPS_ech/eggs_tec_thoA**, but for both fibers A and B. The differences in the instrument setup are shown here:

TPL.NAME	"HARPS_ech/eggs_tec_thoAB"	*Observation Mode*
DPR.CATG	"TEST"	*Observation Category*
DPR.TECH	"ECHELLE"	*Observation Technique*
DPR.TYPE	"WAVE,WAVE,THAR1|THAR2"	*Objects Type and Spectral Type*
INS.OPTI5.NAME	THAR1|THAR2	*Calibration Lamp A Selector*
INS.OPTI6.NAME	THAR1|THAR2	*Calibration Lamp B Selector*

To ensure that only the proper lamp is on, the template will verify that the proper lamp is illuminated.

```
if( INS.OPTI5.NAME == "THAR1" )
    {if( INS.LAMP4.ST != "T" )
        display_error
 exit
    INS.LAMP5.ST = "F"}
else
    {if( INS.LAMP5.ST != "T" )
        display_error
 exit
    INS.LAMP4.ST = "F"}
```

6.9   HARPS_ech/eggs_tec_eff

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

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

- **HARPS_ech/eggs_acq_objA**

- **HARPS_ech/eggs_acq_objAB**

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

The template reads back the observation mode back from the ICS online database, where it was stored as the name of the acquisition template. The keyword **TPL.NAME** is then computed to give a pseudo observation template name HARPS_ech/eggs_tec_XXXX, where XXXX is the last extension of the acquisition template name.

TPL.NAME	"HARPS_ech/eggs_tec_XXXX"	*Observation Mode*

It reads back also the **DPR.TECH** and the **DPR.TYPE** keywords, to pass them to the DRS through the OS.

DPR.CATG	"TEST"	*Observation Category*
DPR.TECH	"<obs. technique>"	*Observation Technique*
DPR.TYPE	"<objA>,<objB>,<sp>"	*Objects Type and Spectral Type*

The exposure parameters are then set.

DET1.WIN1.UIT1	<exptime>	*Exposure Time (sec)*
DET1.READ.SPEED	<mode>	*CCD ReadOut Mode*
DET1.EXP.TYPE	NORMAL	*Exposure Type*
SEQ.NEXPO	1	*Number of Repeated Exposures*

Then, the *Neutral Density Filter Wheel* is set according to the exposure time.

INS.ROT1.POS	<density>	*Neutral Density Filter Wheel*

The Atmospheric Dispersion Corrector is then set up. Its insertion is verified, then, according to the target position, the angles <angle1> and <angle2> for the two prisms are calculated and set by the OS.

INS.ADCS.NAME	IN	*Atmospheric Dispersion Corrector Slide*
INS.ADC1.MODE	AUTO	*Atmospheric Dispersion Corrector Prism 1*
INS.ADC2.MODE	AUTO	*Atmospheric Dispersion Corrector Prism 2*

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

A beep signals to the operator the end of exposure.

6.10   HARPS_ech/eggs_tec_free

This template permits the user to set the instrument completely freely. It is up of his own responsibility to set it correctly.

TPL.NAME	"HARPS_ech/eggs_tec_free"	*Observation Mode*
DPR.CATG	"TEST"	*Observation Category*
DPR.TECH	"ECHELLE"	*Observation Technique*
DPR.TYPE	""	*Objects Type and Spectral Type*

Appendix A

Templates signature files

The next pages list the Templates Signature Files (.tsf) which contains all the free parameters and the Reference Setup Files (.ref) with the fixed parameters needed to execute properly each template. The free parameters are shown with their range and default values.

It must be noticed that even when the exposure time **DET1.WIN1.UIT1** is fixed, it appears in the `.tsf` file, as BOB is expecting it there.

The keyword **SEQ.NEXPO** is passed separately by the `.seq` script to the **expose** function and thus cannot be set in the `.ref` file which is just passed to the OS. When this parameter is fixed, it may just be set in the `.seq` file. To be more coherent and flexible, we will put it in the `.tsf` file, to be read through the `.obd` file by the script.

HARPS_ech/eggs_acq_thosimult.tsf		
Parameter	Range (Default)	Label
DPR.TYPE	"STAR,WAVE,\<sp>" (G2V)	*Objects Type and Spectral Type*
TEL.TARG.RADVEL	radvel ()	*Target Radial Velocity*
TEL.TARG.ALPHA	ra (000000.0)	*Target R.A.*
TEL.TARG.DELTA	dec (-850000.0)	*Target Decl.*
TEL.TARG.EQUINOX	year (2000.0)	*Coordinates Equinox*
TEL.TARG.PMA	pm ra (0 arcsec/year)	*Alpha Proper Motion*
TEL.TARG.PMD	pm dec (0 arcsec/year)	*Delta Proper Motion*
INS.OPTI6.NAME	THAR1|THAR2 (THAR1)	*Calibration Lamp B Selector*

HARPS_ech/eggs_acq_thosimult.ref		
Parameter	Value	Label
INS.MODE	HARPS/EGGS	*Instrument Mode*
TPL.NAME	HARPS_ech/eggs_acq_thosimult	*Observation Mode*
DPR.TECH	"ECHELLE"	*Observation Technique*
INS.MIRR1.NAME	FIBB	*Calibration Mirror*
INS.OPTI2.NAME	HARPS	*Fiber Head Selector*
INS.OPTI3.NAME	OUT	*Fiber Head Dust Cover*
INS.OPTI4.NAME	OUT	*I_2 cell*

Computed by HARPS_ech/eggs_acq_thosimult.seq		
Parameter	Value	Label
INS.LAMP4.ST	T|F (ON|OFF)	*THAR1 Lamp*
INS.LAMP5.ST	T|F (ON|OFF)	*THAR2 Lamp*

HARPS_ech/eggs_acq_I2cell.tsf		
Parameter	Range (Default)	Label
DPR.TYPE	"STAR,DARK,\<sp\>" (G2V)	*Objects Type and Spectral Type*
TEL.TARG.RADVEL	radvel ()	*Target Radial Velocity*
TEL.TARG.ALPHA	ra (000000.0)	*Target R.A.*
TEL.TARG.DELTA	dec (-850000.0)	*Target Decl.*
TEL.TARG.EQUINOX	year (2000.0)	*Coordinates Equinox*
TEL.TARG.PMA	pm ra (0 arcsec/year)	*Alpha Proper Motion*
TEL.TARG.PMD	pm dec (0 arcsec/year)	*Delta Proper Motion*

HARPS_ech/eggs_acq_I2cell.ref		
Parameter	Value	Label
INS.MODE	HARPS/EGGS	*Instrument Mode*
TPL.NAME	HARPS_ech/eggs_acq_I2cell	*Observation Mode*
DPR.TECH	ECHELLE,ABSORPTION-CELL	*Observation Technique*
INS.MIRR1.NAME	FIBB	*Calibration Mirror*
INS.OPTI2.NAME	HARPS	*Fiber Head Selector*
INS.OPTI3.NAME	OUT	*Fiber Head Dust Cover*
INS.OPTI4.NAME	IN	*I_2 cell*
INS.OPTI6.NAME	NONE	*Calibration Lamp B Selector*
INS.LAMP7.NAME	T (ON)	*I2CELL Heating*

HARPS_ech/eggs_acq_objA.tsf		
Parameter	Range (Default)	Label
DPR.TYPE	"STAR,DARK,<sp>" (G2V)	*Objects Type and Spectral Type*
TEL.TARG.RADVEL	radvel ()	*Target Radial Velocity*
TEL.TARG.ALPHA	ra (000000.0)	*Target R.A.*
TEL.TARG.DELTA	dec (-850000.0)	*Target Decl.*
TEL.TARG.EQUINOX	year (2000.0)	*Coordinates Equinox*
TEL.TARG.PMA	pm ra (0 arcsec/year)	*Alpha Proper Motion*
TEL.TARG.PMD	pm dec (0 arcsec/year)	*Delta Proper Motion*

HARPS_ech/eggs_acq_objA.ref		
Parameter	Value	Label
INS.MODE	HARPS/EGGS	*Instrument Mode*
TPL.NAME	HARPS_ech/eggs_acq_objA	*Observation Mode*
DPR.TECH	"ECHELLE"	*Observation Technique*
INS.MIRR1.NAME	FIBB	*Calibration Mirror*
INS.OPTI2.NAME	HARPS	*Fiber Head Selector*
INS.OPTI3.NAME	OUT	*Fiber Head Dust Cover*
INS.OPTI4.NAME	OUT	*I_2 cell*
INS.OPTI6.NAME	NONE	*Calibration Lamp B Selector*

HARPS_ech/eggs_acq_objAB.tsf		
Parameter	Range (Default)	Label
DPR.TYPE	"STAR,SKY,<sp>" (G2V)	*Objects Type and Spectral Type*
TEL.TARG.RADVEL	radvel ()	*Target Radial Velocity*
TEL.TARG.ALPHA	ra (000000.0)	*Target R.A.*
TEL.TARG.DELTA	dec (-850000.0)	*Target Decl.*
TEL.TARG.EQUINOX	year (2000.0)	*Coordinates Equinox*
TEL.TARG.PMA	pm ra (0 arcsec/year)	*Alpha Proper Motion*
TEL.TARG.PMD	pm dec (0 arcsec/year)	*Delta Proper Motion*

HARPS_ech/eggs_acq_objAB.ref		
Parameter	Value	Label
INS.MODE	HARPS/EGGS	*Instrument Mode*
TPL.NAME	HARPS_ech/eggs_acq_objAB	*Observation Mode*
DPR.TECH	"ECHELLE"	*Observation Technique*
INS.MIRR1.NAME	NONE	*Calibration Mirror*
INS.OPTI2.NAME	HARPS	*Fiber Head Selector*
INS.OPTI3.NAME	OUT	*Fiber Head Dust Cover*
INS.OPTI4.NAME	OUT	*I_2 cell*

HARPS_ech/eggs_obs_all.tsf		
Parameter	Range (Default)	Label
SEQ.NEXPO	1-100 (1)	*Number of Repeated Exposures*
DET1.WIN1.UIT1	seconds (0)	*Exposure Time (sec)*
DET1.READ.SPEED	<mode>	*CCD ReadOut Mode*

HARPS_ech/eggs_obs_all.ref		
Parameter	Value	Label
INS.MODE	HARPS/EGGS	*Instrument Mode*
DPR.CATG	"SCIENCE"	*Observation Category*
DET1.EXP.TYPE	NORMAL	*Exposure Type*
DET1.EXP.NREP	1	*Number of Exposures*
DET1.WIN1.BINX	1	*Binning factor along X*
DET1.WIN1.BINY	1	*Binning factor along Y*
INS.ADCS.NAME	IN	*Atmospheric Dispersion Corrector Slide*
INS.ADC1.MODE	AUTO	*Atmospheric Dispersion Corrector Prism 1*
INS.ADC2.MODE	AUTO	*Atmospheric Dispersion Corrector Prism 2*

Computed by HARPS_ech/eggs_obs_all.seq		
Parameter	Value	Label
TPL.NAME	HARPS_ech/eggs_obs_XXXX	*Observation Mode*
DPR.TECH	"<obs. technique>"	*Observation Technique*
DPR.TYPE	"<objA>,<objB>,<sp>"	*Objects Type and Spectral Type*
INS.ROT1.POS	0-2.132 (0)	*Neutral Density Filter Wheel*

HARPS_ech/eggs_cal_bias.tsf		
Parameter	Range (Default)	Label
SEQ.NEXPO	1-100 (1)	*Number of Repeated Exposures*
DET1.READ.SPEED	<mode>	*CCD ReadOut Mode*

HARPS_ech/eggs_cal_bias.ref		
Parameter	Value	Label
INS.MODE	HARPS/EGGS	*Instrument Mode*
TPL.NAME	HARPS_ech/eggs_cal_bias	*Observation Mode*
DPR.CATG	"CALIB"	*Observation Category*
DPR.TECH	"IMAGE"	*Observation Technique*
DPR.TYPE	"BIAS,BIAS"	*Objects Type and Spectral Type*
DET1.EXP.TYPE	DARK	*Exposure Type*
DET1.EXP.NREP	1	*Number of Exposures*
DET1.WIN1.UIT1	0	*Exposure Time (sec)*
DET1.WIN1.BINX	1	*Binning factor along X*
DET1.WIN1.BINY	1	*Binning factor along Y*

HARPS_ech/eggs_cal_dark.tsf		
Parameter	Range (Default)	Label
SEQ.NEXPO	\<Nexp\>	*Number of Repeated Exposures*
DET1.WIN1.UIT1	\<mintime\>+	*Exposure Time (sec)*
DET1.READ.SPEED	\<mode\>	*CCD ReadOut Mode*

HARPS_ech/eggs_cal_dark.ref		
Parameter	Value	Label
INS.MODE	HARPS/EGGS	*Instrument Mode*
TPL.NAME	HARPS_ech/eggs_cal_dark	*Observation Mode*
DPR.CATG	"CALIB"	*Observation Category*
DPR.TECH	"IMAGE"	*Observation Technique*
DPR.TYPE	"DARK,DARK"	*Objects Type and Spectral Type*
DET1.EXP.TYPE	DARK	*Exposure Type*
DET1.EXP.NREP	1	*Number of Exposures*
DET1.WIN1.BINX	1	*Binning factor along X*
DET1.WIN1.BINY	1	*Binning factor along Y*

HARPS_ech/eggs_cal_tun.tsf		
Parameter	Range (Default)	Label
SEQ.NEXPO	1	*Number of Repeated Exposures*
DET1.WIN1.UIT1	seconds (TBD)	*Exposure Time (sec)*
DET1.READ.SPEED	<mode>	*CCD ReadOut Mode*

HARPS_ech/eggs_cal_tun.ref		
Parameter	Value	Label
INS.MODE	HARPS/EGGS	*Instrument Mode*
TPL.NAME	HARPS_ech/eggs_cal_tun	*Observation Mode*
DPR.CATG	"CALIB"	*Observation Category*
DPR.TECH	"ECHELLE"	*Observation Technique*
DET1.EXP.TYPE	NORMAL	*Exposure Type*
DET1.EXP.NREP	1	*Number of Exposures*
DET1.WIN1.BINX	1	*Binning factor along X*
DET1.WIN1.BINY	1	*Binning factor along Y*
INS.MIRR1.NAME	BOTH	*Calibration Mirror*
INS.OPTI2.NAME	HARPS	*Fiber Head Selector*
INS.OPTI3.NAME	OUT	*Fiber Head Dust Cover*
INS.OPTI4.NAME	OUT	*I_2 cell*
INS.LAMP1.ST	T (ON)	*TUN1*
INS.ROT1.POS	<density>	*Neutral Density Filter Wheel*

Computed by HARPS_ech/eggs_cal_tun.seq		
Parameter	Value	Label
DPR.TYPE	"LAMP|DARK,LAMP|DARK"	*Objects Type and Spectral Type*
INS.OPTI5.NAME	TUN1|NONE	*Calibration Lamp A Selector*
INS.OPTI6.NAME	TUN1|NONE	*Calibration Lamp B Selector*

HARPS_ech/eggs_cal_tunAB.tsf		
Parameter	Range (Default)	Label
SEQ.NEXPO	<Nexp>	*Number of Repeated Exposures*
DET1.WIN1.UIT1	<exptime>	*Exposure Time (sec)*
DET1.READ.SPEED	<mode>	*CCD ReadOut Mode*

HARPS_ech/eggs_cal_tunAB.ref		
Parameter	Value	Label
INS.MODE	HARPS/EGGS	*Instrument Mode*
TPL.NAME	HARPS_ech/eggs_cal_tunAB	*Observation Mode*
DPR.CATG	"CALIB"	*Observation Category*
DPR.TECH	"ECHELLE"	*Observation Technique*
DPR.TYPE	"LAMP,LAMP,TUN"	*Objects Type and Spectral Type*
DET1.EXP.TYPE	NORMAL	*Exposure Type*
DET1.EXP.NREP	1	*Number of Exposures*
DET1.WIN1.BINX	1	*Binning factor along X*
DET1.WIN1.BINY	1	*Binning factor along Y*
INS.MIRR1.NAME	BOTH	*Calibration Mirror*
INS.OPTI2.NAME	HARPS	*Fiber Head Selector*
INS.OPTI3.NAME	OUT	*Fiber Head Dust Cover*
INS.OPTI4.NAME	OUT	*I_2 cell*
INS.OPTI5.NAME	TUN1	*Calibration Lamp A Selector*
INS.OPTI6.NAME	TUN1	*Calibration Lamp B Selector*
INS.LAMP1.ST	T (ON)	*TUN1*
INS.ROT1.POS	<density>	*Neutral Density Filter Wheel*

HARPS_ech/eggs_cal_tunUSER.tsf		
Parameter	Range (Default)	Label
SEQ.NEXPO	1-100 (1)	*Number of Repeated Exposures*
DET1.WIN1.UIT1	seconds (TBD)	*Exposure Time (sec)*
DET1.READ.SPEED	<mode>	*CCD ReadOut Mode*

HARPS_ech/eggs_cal_tunUSER.ref		
Parameter	Value	Label
INS.MODE	HARPS/EGGS	*Instrument Mode*
TPL.NAME	HARPS_ech/eggs_cal_tunUSER	*Observation Mode*
DPR.CATG	"CALIB"	*Observation Category*
DPR.TECH	"ECHELLE"	*Observation Technique*
DPR.TYPE	"LAMP,LAMP,TUN"	*Objects Type and Spectral Type*
DET1.EXP.TYPE	NORMAL	*Exposure Type*
DET1.EXP.NREP	1	*Number of Exposures*
DET1.WIN1.BINX	1	*Binning factor along X*
DET1.WIN1.BINY	1	*Binning factor along Y*
INS.MIRR1.NAME	BOTH	*Calibration Mirror*
INS.OPTI2.NAME	HARPS	*Fiber Head Selector*
INS.OPTI3.NAME	OUT	*Fiber Head Dust Cover*
INS.OPTI4.NAME	OUT	*I_2 cell*
INS.OPTI5.NAME	TUN1	*Calibration Lamp A Selector*
INS.OPTI6.NAME	TUN1	*Calibration Lamp B Selector*
INS.LAMP1.ST	T (ON)	*TUN1*
INS.ROT1.POS	<density>	*Neutral Density Filter Wheel*

HARPS_ech/eggs_cal_thoAB.tsf		
Parameter	Range (Default)	Label
SEQ.NEXPO	1-100 (1)	*Number of Repeated Exposures*
INS.OPTI5.NAME	THAR1|THAR2	*Calibration Lamp A Selector*
DET1.WIN1.UIT1	<exptime>	*Exposure Time (sec)*
DET1.READ.SPEED	<mode>	*CCD ReadOut Mode*

HARPS_ech/eggs_cal_thoAB.ref		
Parameter	Value	Label
INS.MODE	HARPS/EGGS	*Instrument Mode*
TPL.NAME	HARPS_ech/eggs_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*
DET1.EXP.TYPE	NORMAL	*Exposure Type*
DET1.EXP.NREP	1	*Number of Exposures*
DET1.WIN1.BINX	1	*Binning factor along X*
DET1.WIN1.BINY	1	*Binning factor along Y*
INS.MIRR1.NAME	BOTH	*Calibration Mirror*
INS.OPTI2.NAME	HARPS	*Fiber Head Selector*
INS.OPTI3.NAME	OUT	*Fiber Head Dust Cover*
INS.OPTI4.NAME	OUT	*I_2 cell*
INS.ROT1.POS	<density>	*Neutral Density Filter Wheel*

Computed by HARPS_ech/eggs_cal_thoAB.seq		
Parameter	Value	Label
DPR.TYPE	"WAVE,WAVE,THAR1|THAR2"	*Objects Type and Spectral Type*
INS.OPTI6.NAME	THAR1|THAR2	*Calibration Lamp B Selector*
INS.LAMP4.ST	T|F (ON|OFF)	*THAR1 Lamp*
INS.LAMP5.ST	T|F (ON|OFF)	*THAR2 Lamp*

HARPS_ech/eggs_cal_tunAI2.tsf		
Parameter	Range (Default)	Label
SEQ.NEXPO	1-100 (1)	*Number of Repeated Exposures*
DET1.WIN1.UIT1	seconds (TBD)	*Exposure Time (sec)*
DET1.READ.SPEED	\<mode\>	*CCD ReadOut Mode*

HARPS_ech/eggs_cal_tunAI2.ref		
Parameter	Value	Label
INS.MODE	HARPS/EGGS	*Instrument Mode*
TPL.NAME	HARPS_ech/eggs_cal_tunAI2	*Observation Mode*
DPR.CATG	"CALIB"	*Observation Category*
DPR.TECH	ECHELLE,ABSORPTION-CELL	*Observation Technique*
DPR.TYPE	"LAMP,DARK,TUN"	*Objects Type and Spectral Type*
DET1.EXP.TYPE	NORMAL	*Exposure Type*
DET1.EXP.NREP	1	*Number of Exposures*
DET1.WIN1.BINX	1	*Binning factor along X*
DET1.WIN1.BINY	1	*Binning factor along Y*
INS.MIRR1.NAME	BOTH	*Calibration Mirror*
INS.OPTI2.NAME	HARPS	*Fiber Head Selector*
INS.OPTI3.NAME	OUT	*Fiber Head Dust Cover*
INS.OPTI4.NAME	IN	*I_2 cell*
INS.OPTI5.NAME	TUN1	*Calibration Lamp A Selector*
INS.OPTI6.NAME	NONE	*Calibration Lamp B Selector*
INS.LAMP1.ST	T (ON)	*TUN1*
INS.ROT1.POS	\<density\>	*Neutral Density Filter Wheel*

HARPS_ech_tec_dark.tsf		
Parameter	Range (Default)	Label
SEQ.NEXPO	1	*Number of Repeated Exposures*
DET1.WIN1.UIT1	seconds (TBD)	*Exposure Time (sec)*
DET1.READ.SPEED	\<mode\> (TBD)	*CCD ReadOut Mode*

HARPS_ech_tec_dark.ref		
Parameter	Value	Label
INS.MODE	HARPS	*Instrument Mode*
TPL.NAME	HARPS_ech_tec_dark	*Observation Mode*
DPR.CATG	"TEST"	*Observation Category*
DPR.TECH	"IMAGE"	*Observation Technique*
DPR.TYPE	"DARK,DARK"	*Objects Type and Spectral Type*
DET1.EXP.TYPE	DARK	*Exposure Type*
DET1.EXP.NREP	1	*Number of Exposures*
DET1.WIN1.BINX	1	*Binning factor along X*
DET1.WIN1.BINY	1	*Binning factor along Y*

HARPS_ech/eggs_tec_led.tsf		
Parameter	Range (Default)	Label
SEQ.NEXPO	1	*Number of Repeated Exposures*
DET1.WIN1.UIT1	seconds (TBD)	*Exposure Time (sec)*
DET1.READ.SPEED	\<mode\> (TBD)	*CCD ReadOut Mode*

HARPS_ech/eggs_tec_led.ref		
Parameter	Value	Label
INS.MODE	HARPS/EGGS	*Instrument Mode*
TPL.NAME	HARPS_ech/eggs_tec_led	*Observation Mode*
DPR.CATG	"TEST"	*Observation Category*
DPR.TECH	"IMAGE"	*Observation Technique*
DPR.TYPE	"FLAT,FLAT"	*Objects Type and Spectral Type*
DET1.EXP.TYPE	NORMAL	*Exposure Type*
DET1.EXP.NREP	1	*Number of Exposures*
DET1.WIN1.BINX	1	*Binning factor along X*
DET1.WIN1.BINY	1	*Binning factor along Y*

HARPS_ech/eggs_tec_tunA.tsf		
Parameter	Range (Default)	Label
SEQ.NEXPO	1	*Number of Repeated Exposures*
DET1.WIN1.UIT1	seconds (TBD)	*Exposure Time (sec)*
DET1.READ.SPEED	<mode> (TBD)	*CCD ReadOut Mode*

HARPS_ech/eggs_tec_tunA.ref		
Parameter	Value	Label
INS.MODE	HARPS/EGGS	*Instrument Mode*
TPL.NAME	HARPS_ech/eggs_tec_tunA	*Observation Mode*
DPR.CATG	"TEST"	*Observation Category*
DPR.TECH	"ECHELLE"	*Observation Technique*
DPR.TYPE	"LAMP,DARK,TUN"	*Objects Type and Spectral Type*
DET1.EXP.TYPE	NORMAL	*Exposure Type*
DET1.EXP.NREP	1	*Number of Exposures*
DET1.WIN1.BINX	1	*Binning factor along X*
DET1.WIN1.BINY	1	*Binning factor along Y*
INS.MIRR1.NAME	BOTH	*Calibration Mirror*
INS.OPTI2.NAME	HARPS	*Fiber Head Selector*
INS.OPTI3.NAME	OUT	*Fiber Head Dust Cover*
INS.OPTI4.NAME	OUT	*I_2 cell*
INS.OPTI5.NAME	TUN1	*Calibration Lamp A Selector*
INS.OPTI6.NAME	NONE	*Calibration Lamp B Selector*
INS.LAMP1.ST	T (ON)	*TUN1*
INS.ROT1.POS	<density>	*Neutral Density Filter Wheel*

HARPS_ech/eggs_tec_tunB.tsf		
Parameter	Range (Default)	Label
SEQ.NEXPO	1	*Number of Repeated Exposures*
DET1.WIN1.UIT1	seconds (TBD)	*Exposure Time (sec)*
DET1.READ.SPEED	<mode> (TBD)	*CCD ReadOut Mode*

HARPS_ech/eggs_tec_tunB.ref		
Parameter	Value	Label
INS.MODE	HARPS/EGGS	*Instrument Mode*
TPL.NAME	HARPS_ech/eggs_tec_tunB	*Observation Mode*
DPR.CATG	"TEST"	*Observation Category*
DPR.TECH	"ECHELLE"	*Observation Technique*
DPR.TYPE	"DARK,LAMP,TUN"	*Objects Type and Spectral Type*
DET1.EXP.TYPE	NORMAL	*Exposure Type*
DET1.EXP.NREP	1	*Number of Exposures*
DET1.WIN1.BINX	1	*Binning factor along X*
DET1.WIN1.BINY	1	*Binning factor along Y*
INS.MIRR1.NAME	BOTH	*Calibration Mirror*
INS.OPTI2.NAME	HARPS	*Fiber Head Selector*
INS.OPTI3.NAME	OUT	*Fiber Head Dust Cover*
INS.OPTI4.NAME	OUT	*I_2 cell*
INS.OPTI5.NAME	NONE	*Calibration Lamp A Selector*
INS.OPTI6.NAME	TUN1	*Calibration Lamp B Selector*
INS.LAMP1.ST	T (ON)	*TUN1*
INS.ROT1.POS	<density>	*Neutral Density Filter Wheel*

HARPS_ech/eggs_tec_tunAB.tsf		
Parameter	Range (Default)	Label
SEQ.NEXPO	1	*Number of Repeated Exposures*
DET1.WIN1.UIT1	seconds (TBD)	*Exposure Time (sec)*
DET1.READ.SPEED	<mode> (TBD)	*CCD ReadOut Mode*

HARPS_ech/eggs_tec_tunAB.ref		
Parameter	Value	Label
INS.MODE	HARPS/EGGS	*Instrument Mode*
TPL.NAME	HARPS_ech/eggs_tec_tunAB	*Observation Mode*
DPR.CATG	"TEST"	*Observation Category*
DPR.TECH	"ECHELLE"	*Observation Technique*
DPR.TYPE	"LAMP,LAMP,TUN"	*Objects Type and Spectral Type*
DET1.EXP.TYPE	NORMAL	*Exposure Type*
DET1.EXP.NREP	1	*Number of Exposures*
DET1.WIN1.BINX	1	*Binning factor along X*
DET1.WIN1.BINY	1	*Binning factor along Y*
INS.MIRR1.NAME	BOTH	*Calibration Mirror*
INS.OPTI2.NAME	HARPS	*Fiber Head Selector*
INS.OPTI3.NAME	OUT	*Fiber Head Dust Cover*
INS.OPTI4.NAME	OUT	*I_2 cell*
INS.OPTI5.NAME	TUN1	*Calibration Lamp A Selector*
INS.OPTI6.NAME	TUN1	*Calibration Lamp B Selector*
INS.LAMP1.ST	T (ON)	*TUN1*
INS.ROT1.POS	<density>	*Neutral Density Filter Wheel*

HARPS_ech/eggs_tec_thoA.tsf		
Parameter	Range (Default)	Label
SEQ.NEXPO	1	*Number of Repeated Exposures*
DET1.WIN1.UIT1	seconds (TBD)	*Exposure Time (sec)*
DET1.READ.SPEED	<mode> (TBD)	*CCD ReadOut Mode*
INS.OPTI5.NAME	THAR1|THAR2	*Calibration Lamp A Selector*

HARPS_ech/eggs_tec_thoA.ref		
Parameter	Value	Label
INS.MODE	HARPS/EGGS	*Instrument Mode*
TPL.NAME	HARPS_ech/eggs_tec_thoA	*Observation Mode*
DPR.CATG	"TEST"	*Observation Category*
DPR.TECH	"ECHELLE"	*Observation Technique*
DET1.EXP.TYPE	NORMAL	*Exposure Type*
DET1.EXP.NREP	1	*Number of Exposures*
DET1.WIN1.BINX	1	*Binning factor along X*
DET1.WIN1.BINY	1	*Binning factor along Y*
INS.MIRR1.NAME	BOTH	*Calibration Mirror*
INS.OPTI2.NAME	HARPS	*Fiber Head Selector*
INS.OPTI3.NAME	OUT	*Fiber Head Dust Cover*
INS.OPTI4.NAME	OUT	*I_2 cell*
INS.OPTI6.NAME	NONE	*Calibration Lamp B Selector*
INS.ROT1.POS	<density>	*Neutral Density Filter Wheel*

Computed by HARPS_ech/eggs_tec_thoA.seq		
Parameter	Value	Label
DPR.TYPE	"WAVE,DARK,THAR1|THAR2"	*Objects Type and Spectral Type*
INS.LAMP4.ST	T|F (ON|OFF)	*THAR1 Lamp*
INS.LAMP5.ST	T|F (ON|OFF)	*THAR2 Lamp*

HARPS_ech/eggs_tec_thoB.tsf		
Parameter	Range (Default)	Label
SEQ.NEXPO	1	*Number of Repeated Exposures*
DET1.WIN1.UIT1	seconds (TBD)	*Exposure Time (sec)*
DET1.READ.SPEED	<mode> (TBD)	*CCD ReadOut Mode*
INS.OPTI6.NAME	THAR1|THAR2	*Calibration Lamp B Selector*

HARPS_ech/eggs_tec_thoB.ref		
Parameter	Value	Label
INS.MODE	HARPS/EGGS	*Instrument Mode*
TPL.NAME	HARPS_ech/eggs_tec_thoB	*Observation Mode*
DPR.CATG	"TEST"	*Observation Category*
DPR.TECH	"ECHELLE"	*Observation Technique*
DET1.EXP.TYPE	NORMAL	*Exposure Type*
DET1.EXP.NREP	1	*Number of Exposures*
DET1.WIN1.BINX	1	*Binning factor along X*
DET1.WIN1.BINY	1	*Binning factor along Y*
INS.MIRR1.NAME	BOTH	*Calibration Mirror*
INS.OPTI2.NAME	HARPS	*Fiber Head Selector*
INS.OPTI3.NAME	OUT	*Fiber Head Dust Cover*
INS.OPTI4.NAME	OUT	*I_2 cell*
INS.OPTI5.NAME	NONE	*Calibration Lamp A Selector*
INS.ROT1.POS	<density>	*Neutral Density Filter Wheel*

Computed by HARPS_ech/eggs_tec_thoB.seq		
Parameter	Value	Label
DPR.TYPE	"DARK,WAVE,THAR1|THAR2"	*Objects Type and Spectral Type*
INS.LAMP4.ST	T|F (ON|OFF)	*THAR1 Lamp*
INS.LAMP5.ST	T|F (ON|OFF)	*THAR2 Lamp*

HARPS_ech/eggs_tec_thoAB.tsf		
Parameter	Range (Default)	Label
SEQ.NEXPO	1	*Number of Repeated Exposures*
DET1.WIN1.UIT1	seconds (TBD)	*Exposure Time (sec)*
DET1.READ.SPEED	<mode> (TBD)	*CCD ReadOut Mode*
INS.OPTI5.NAME	THAR1|THAR2	*Calibration Lamp A Selector*

HARPS_ech/eggs_tec_thoAB.ref		
Parameter	Value	Label
INS.MODE	HARPS/EGGS	*Instrument Mode*
TPL.NAME	HARPS_ech/eggs_tec_thoAB	*Observation Mode*
DPR.CATG	"TEST"	*Observation Category*
DPR.TECH	"ECHELLE"	*Observation Technique*
DET1.EXP.TYPE	NORMAL	*Exposure Type*
DET1.EXP.NREP	1	*Number of Exposures*
DET1.WIN1.BINX	1	*Binning factor along X*
DET1.WIN1.BINY	1	*Binning factor along Y*
INS.MIRR1.NAME	BOTH	*Calibration Mirror*
INS.OPTI2.NAME	HARPS	*Fiber Head Selector*
INS.OPTI3.NAME	OUT	*Fiber Head Dust Cover*
INS.OPTI4.NAME	OUT	*I_2 cell*
INS.ROT1.POS	<density>	*Neutral Density Filter Wheel*

Computed by HARPS_ech/eggs_tec_thoAB.seq		
Parameter	Value	Label
DPR.TYPE	"WAVE,WAVE,THAR1|THAR2"	*Objects Type and Spectral Type*
INS.OPTI6.NAME	THAR1|THAR2	*Calibration Lamp B Selector*
INS.LAMP4.ST	T|F (ON|OFF)	*THAR1 Lamp*
INS.LAMP5.ST	T|F (ON|OFF)	*THAR2 Lamp*

HARPS_ech/eggs_tec_eff.tsf		
Parameter	Range (Default)	Label
SEQ.NEXPO	1	*Number of Repeated Exposures*
DET1.WIN1.UIT1	seconds (TBD)	*Exposure Time (sec)*
DET1.READ.SPEED	\<mode\> (TBD)	*CCD ReadOut Mode*

HARPS_ech/eggs_tec_eff.ref		
Parameter	Value	Label
INS.MODE	HARPS/EGGS	*Instrument Mode*
DPR.CATG	"TEST"	*Observation Category*
DET1.EXP.TYPE	NORMAL	*Exposure Type*
DET1.EXP.NREP	1	*Number of Exposures*
DET1.WIN1.BINX	1	*Binning factor along X*
DET1.WIN1.BINY	1	*Binning factor along Y*
INS.ADCS.NAME	IN	*Atmospheric Dispersion Corrector Slide*
INS.ADC1.MODE	AUTO	*Atmospheric Dispersion Corrector Prism 1*
INS.ADC2.MODE	AUTO	*Atmospheric Dispersion Corrector Prism 2*
INS.ROT1.POS	\<density\>	*Neutral Density Filter Wheel*

Computed by HARPS_ech/eggs_tec_eff.seq		
Parameter	Value	Label
TPL.NAME	HARPS_ech/eggs_tec_XXXX	*Observation Mode*
DPR.TECH	"\<obs. technique\>"	*Observation Technique*
DPR.TYPE	"\<objA\>,\<objB\>,\<sp\>"	*Objects Type and Spectral Type*

FITS Keywords cross-reference matrix

Keyword	Template																				
U: user-defined value T: template computed F: fixed value –: irrelevant	acq_thosimult	acq_I2cell	acq_objA	acq_objAB	obs_all	cal_bias	cal_dark	cal_tun	cal_tunAB	cal_tunUSER	cal_thoAB	cal_tunA_I2cell	tec_dark	tec_led	tec_tunA	tec_tunB	tec_tunAB	tec_thoA	tec_thoB	tec_thoAB	tec_eff
TPL.NAME	F	F	F	F	T	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	T
DPR.TECH	F	F	F	F	T	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	T
DPR.TYPE	U	U	U	U	T	F	F	T	F	F	T	F	F	F	F	F	F	F	F	T	T
SEQ.NEXPO	–	–	–	–	U	U	F	F	F	U	U	U	F	F	F	F	F	F	F	F	F
TEL.TARG.RADVEL	U	U	U	U	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TEL.TARG.ALPHA	U	U	U	U	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TEL.TARG.DELTA	U	U	U	U	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TEL.TARG.EQUINOX	U	U	U	U	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TEL.TARG.PMA	U	U	U	U	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TEL.TARG.PMD	U	U	U	U	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TEL.GUIDE.MODE	U	U	U	U	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TEL.GS1.ALPHA	U	U	U	U	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
TEL.GS1.DELTA	U	U	U	U	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
DET1.WIN1.UIT1	–	–	–	–	U	F	U	F	F	U	F	U	U	U	U	U	U	U	U	U	U
DET1.READ.SPEED	–	–	–	–	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
DET1.EXP.TYPE	–	–	–	–	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
DET1.EXP.NREP	–	–	–	–	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
DET1.WIN1.BINX	–	–	–	–	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
DET1.WIN1.BINY	–	–	–	–	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
INS.MODE	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
INS.MIRR1.NAME	F	F	F	F	–	–	–	F	F	F	F	F	–	–	F	F	F	F	F	F	–
INS.ADCS.NAME	–	–	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	F
INS.ADC1.MODE	–	–	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	F
INS.ADC2.MODE	–	–	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	F
INS.OPTI2.NAME	F	F	F	F	–	–	–	F	F	F	F	F	–	–	F	F	F	F	F	F	–
INS.OPTI3.NAME	F	F	F	F	–	–	–	F	F	F	F	F	–	–	F	F	F	F	F	F	–
INS.OPTI4.NAME	F	F	F	F	–	–	–	F	F	F	F	F	–	–	F	F	F	F	F	F	–
INS.OPTI5.NAME	–	–	–	–	–	–	–	T	F	F	U	F	–	–	F	F	F	U	F	U	–
INS.OPTI6.NAME	U	F	F	–	–	–	–	T	F	F	T	F	–	–	F	F	F	F	U	T	–
INS.LAMP1.ST	–	–	–	–	–	–	–	F	F	F	–	F	–	–	F	F	F	–	–	–	–
INS.LAMP4.ST	T	–	–	–	–	–	–	–	–	–	T	–	–	–	–	–	–	T	T	T	–
INS.LAMP5.ST	T	–	–	–	–	–	–	–	–	–	T	–	–	–	–	–	–	T	T	T	–
INS.LAMP6.ST	–	–	–	–	F	F	F	F	F	F	F	F	F	T	F	F	F	F	F	F	F
INS.ROT1.POS	–	–	–	–	T	–	–	F	F	F	F	F	–	–	F	F	F	F	F	F	T

Show changes between V2 and V3