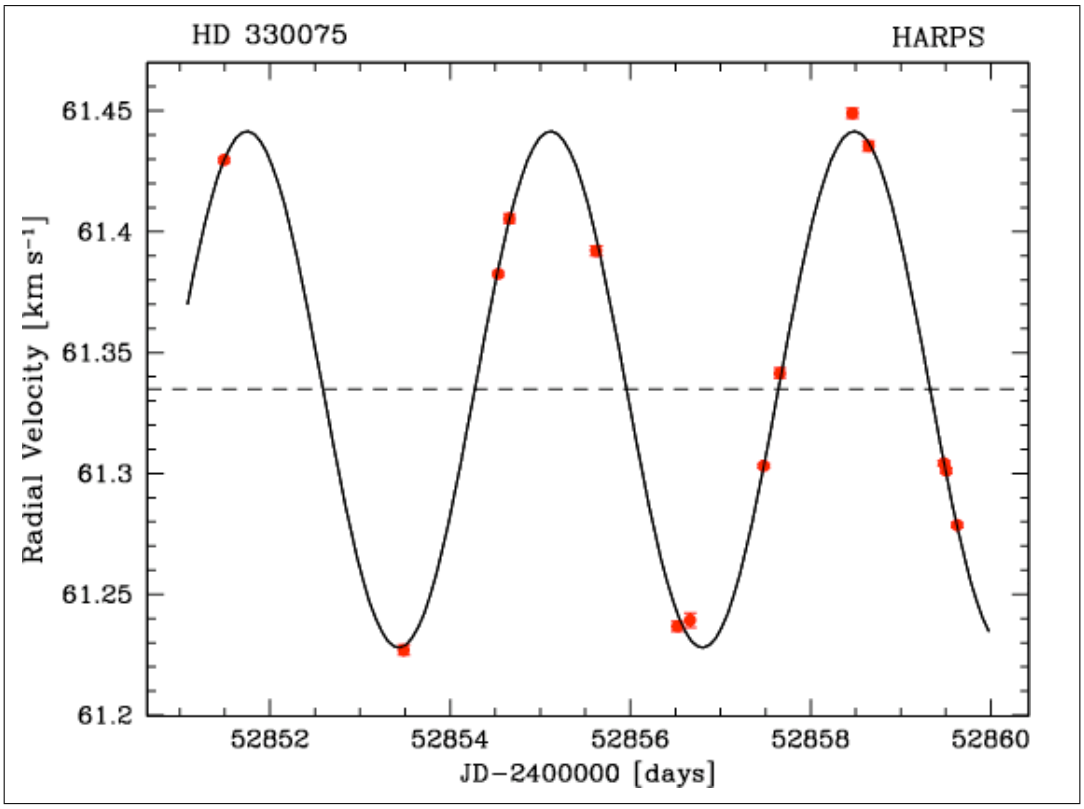
HARPS cookbook

Version 3.0



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Chapter 1

Introduction

This cookbook is meant for Support Astronomers and Telescope Operators, which are responsible for the good functioning of the system. Visiting astronomers should refer to the user manual only. In this cookbook there is no mention (and there will not be) about p2pp or OT, of which the reader is assumed to be knowledgeable. The reader should refer to the "Template reference manual" or the "User manual" for further details. As every cookbook this is a growing being, it will be updated as the instrument goes through its upgrades, and as new problems develops and new solutions are found.

Good Luck !

Chapter 2

Revisions

ISSUE	DATE	SECTION/PAGE AFFECTED	REASONS/INITIATION DOCUMENTS/REMARKS
0.1	17.09.03	all	new document
0.5	30.10.03	all	more details added
1.0	24.02.04	DFS, Backup, Pipeline	updated to new backup and pipeline mode
1.1	24.05.04	all	updated to upgraded software + general review for P74.
1.2	14.05.05	all	updated to upgraded software + general review for P76.
2.0	10.08.07	all	updated for P80
3.0	16.09.09	all	updated for La Silla 2010 +
3.0	30.11.10	Sec.13.7, 15.1	

Chapter 3

Acronyms

LCU	Logic Control Unit
LSO	La Silla Observatory
SciOps	Scientific Operations
IP	Instrument Package
ADC	Atmospheric Dispersion Corrector
HE	Harps Enclosure
IB	Isolation Box
VV	Vacuum Vessel
DMD	Data Managment Division
DRS	Data Reduction Software
SWC	La Silla Software team
DAU	Data Archiving Unit (software)
STS	Short Time Scheduler
OH	Observation Handler
CCS	Central Control Software
DFS	Data Flow System
HCFA	HARPS Cassegrain Fibre Adapter
ICS	Instrument Control Software
DCS	Detector Control Software
BOB	Broker for Observing Blocks
OB	Observing Block
GTO	Guarantted Time Observations
EGGS	Extra Good General Spectrosscopy
HAM	High Accuracy Mode

Chapter 4

The Instrument - a brief overview.

This chapter is not intended to give a full overview of the instrument, but only of those aspects which might be relevant to the support astronomer ot the telescope operator on her/his day to day work. For a full overview of the instrument the reader has to refer to the User Manual or to specific HARPS documentation

`http://www.eso.org/sci/facilities/lasilla/instruments/harps/`

It has been demonstrated over several years, by HARPS' predecessors ELODIE and CORALIE that the main strength of a RV machine is its stability, attainable if the instrument is in a strictly temperature controlled environment and if the index of refraction of the medium where light propagates inside the spectrograph does not change. The easiest way to accomplish this goal is to place the spectrograph under vacuum. In this way air pressure and humidity changes are not an issue anymore.

HARPS can operate in two modes: "HAM" and "EGGS". The "HAM" mode is the base mode of the instrument, it achieves Radial Velocity (RV) precision of 1m/s or better ([**?**]). The "EGGS" mode is intended for very faint objects, for which the achievable RV accuracy is limited by the photon noise. The "HAM" mode uses an image scrambler to increase the stability of the spectrum on the CCD; the scrambler, which attenuates the incoming flux by $20\% - 25\%$ is at the entrance window of the spectrograph. The "EGGS" mode, aiming to efficiency rather than RV accuracy, does not use the image scrambling, and the fibres are fed to the spectrograph via a vacuum feed-through.

4.1 The spectrograph

The HARPS spectrograph follows the white pupil design of [**?**]. Projectors, grating, cross dispersion prism and triple pass collimator, are all under vacuum ($p < 10^{-2}mb$), enclosed in a vacuum vessel (VV), contained in a isolation box placed inside the HARPS enclosure in the west wing of the 3.6m telescope Coudeé floor. The vacuum of the vessel is generally pumped every two days. Pumping procedures are described in 3M6-MAN-HAR-33102-0011 and are carried out by the trained TIOs when the VV pressure rises above $10^{-2}mb$. Duty of the support astronomer is also making sure these limits are not overlooked. **Pumping operations should never be performed while observations or calibrations are running,** as vibrations may influence the Instrument Response Function (IRF).

The instrument is supposed to be operated at $17C$, the HARPS enclosure temperature is set to $15C$ and a heater inside the isolation box supplies the power to keep the instrument stable at the desired temperature. Temperature stability of the instrument is well within $0.005C$ RMS. The only sensor which measures a lower temperature is the Detector Head BOdy (DHBO), which measures about $16.5C$, being directly in contact with the cryogenics of the detector.

Property	Jasmin (red)	Linda (blue)
CTE vertical (50 kpx/s)	0.999992	0.9999991
CTE horizontal (50 kpx/s)	0.999991	0.9999990
CTE vertical (416 kpx/s)	0.9999997	0.99999991
CTE horizontal (416 kpx/s)	0.9999995	0.9999990
Non-linearity	not available	$< \pm 0.298\%$
Read out noise (50 kpx/sec)	$2.87 \pm 0.1 e^-$	$2.76 \pm 0.09 e^-$
Read out noise (416 kpx/sec)	$7.05 \pm 0.23 e^-$	$5.5 \pm 0.16 e^-$
Conversion factor (50 kpx/sec)	$0.63 \pm 0.02 e^-/ADU$	$0.62 \pm 0.02 e^-/ADU$
Conversion factor (416 kpx/sec)	$1.42 \pm 0.04 e^-/ADU$	$1.4 \pm 0.04 e^-/ADU$
Dark current at $-110C$	not measured	not measured
Quantum efficiency	peak 82% at 440nm	peak 85% at 460nm
Cosmetics	science grade (grade 1)	science grade (grade 1)

Table 4.1: CCD parameters as measured on the bench.

4.2 The Detectors

The detector is a mosaic of two 4k x 2k CCD, of which one is optimized for the blue. It uses the standard E.S.O. cryostat. Operating temperature of the detector is 148.16K, which rises by 0.05K when reading out in the "normal" mode. The following table shows the main characteristics of the detectors as they were measured on the bench (not in the noisier environment of the 3.6m telescope).

Readout time (4296x4096 px)	50 kpx/s: 180s, 416 kpx/s: 23 s
Mosaic flatness (peak-to-peak)	$15 \mu m$
CCD parallelism	12'
Chip to chip gap	$1215 \pm 45 \mu m$

Each chip is read by a single port. It would be in principle possible to read each chip with two ports, but this mode is not well characterized yet and is therefore not offered.

4.3 The spectral format

HARPS is a full cross - dispersed spectrograph, and it can fully display 71 orders, from order 161 (central wavelength 3802.5A) to order 89 (6877.6A). Order 115 (central wavelength 5323.1A) is lost in the gap between the 2 CCDs. Its average resolving power across the orders is 110000. Its resolution element is about 3.5 pixels.
When looking at the Real Time Display (RTD) the incoming spectrum, it has to be taken into account that the orders get more separated as the wavelength goes toward the red.

4.4 The readout and control electronics

HARPS is read out by a FIERA system and controlled by FIERA and PULPO, like many other ESO instruments. The HAM shutter and the EGGS shutter are independent and are controlled by the same PULPO. To achieve this (PULPO can control only one shutter at a time), a digital switch (ACROMAG digital channel in the calibration unit rack) has been introduced; it should be activated at instrument mode change. The switch can be controlled from the ICS panel, and its status is read out in the OS panel. A patch panel, located in the upper part of the

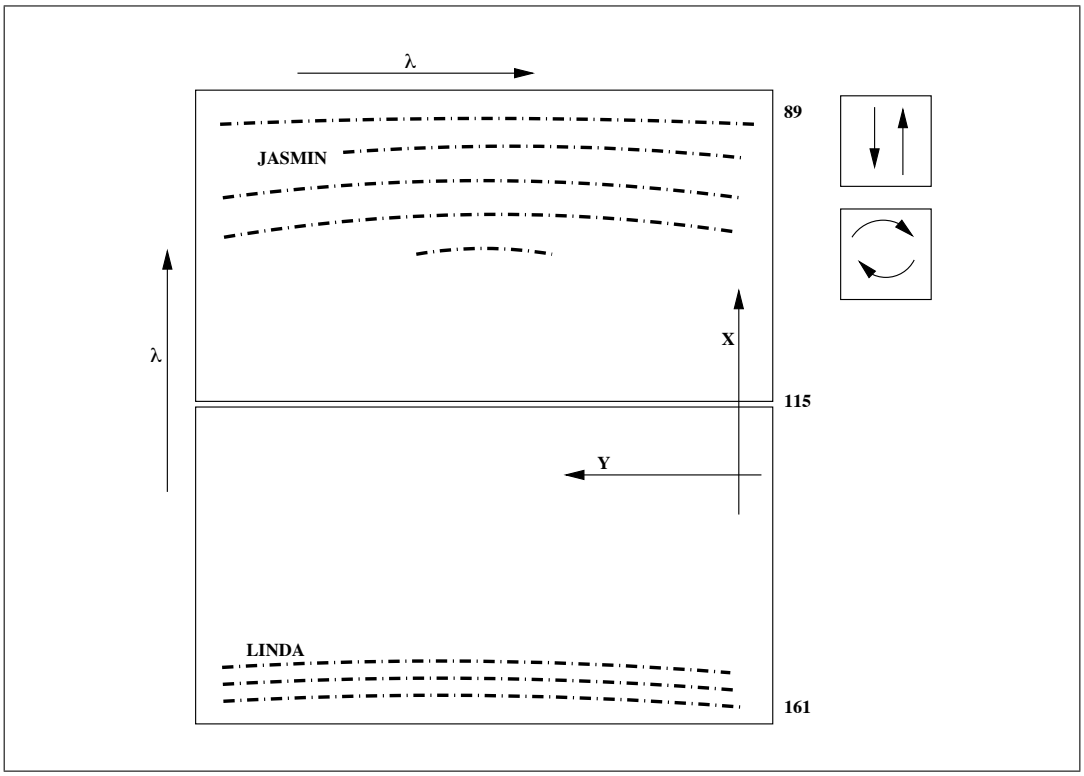

Figure 4.1: Spectrum visualization over the CCDs.

Vacuum Vessel/Detector Unit rack, (VV/DU) gives manual control over the shutter selection.

4.5 Vacuum Vessel/Detector Unit rack

The instrument cryogenic and vacuum control rack is in the HARPS room, in the back of the HARPS enclosure. It monitors and controls various relevant quantities like the vacuum pressure in the HARPS vacuum vessel or in the detector cryostat, the CCD temperature, the spectrograph temperatures, the heating of the DHBO to avoid strong temperature gradients inside the spectrograph which would jeopardize its stability and performance. Some relevant items with their readings are listed below:

- Cooling: -170C
- CCD temp.: -125C (148.16K) with heating
- Warm N_2 at output: +10C
- Sorption pump: -180C
- CCD heater: 21.4V, 159mA, 3.4W (from AGILENT E3641A).

These values are all read on devices installed in the Vacuum Vessel/Detector Unit (VV/DU) rack which is located behind the HARPS emclosure. If any of these measurements are not within 1% of the specified values warn the TIO and the Instrument Scientist.

4.6 Calibration Unit

HARPS calibration lamps are located in a rack in the HARPS room (to the left of the main entrance door). From there, the light is delivered via two calibration fibers into the HARPS Cassegrain Fiber Adapter (HCFA), reflected via a movable mirror into either (or both or none) of the two "science" or "reference" fibers which finally drive the light inside the spectrograph.

This unit houses three ThAr lamps:

- ThAr1 (lamp4) is only used for the wavelength calibration of the science fibre. Its use is kept to the absolute minimum.
- ThAr2 (lamp5) is used for the wavelength calibration of the sky fibre and to measure spectral drifts induced by changes of the instrument profile during the night.
- ThAr3 (lamp3) is the absolute reference against which all ThAr lamps are calibrated. It is used only by the instrument scientist once per period for a cross-calibration sequence. It should not be used for any other purpose.

In case ThAr2 breaks during the night, a new ThAr lamp should be installed and new wavelength calibration frames should be acquired (30 minutes downtime). The lamps ThAr1 and ThAr3 should not be touched. Alternatively the user could continue the observing program without simultaneous Th reference.

The unit also houses one tungsten lamp and a free slot designed to support an incoming fiber optic whose light is then focussed on the calibration fibers going to the HCFA. This unit could be used for the laser comb, the Fabry Perot calibration systems, or could also be used to host a iodine cell between the entrance and the exit fiber. Current settings for the lamps as of 16-09-2009 are:

ThAr 1	ThAr 2
10.0mA	8.0mA

The actual current setting should be verified in the web page:

`http://www.eso.org/sci/facilities/lasilla/instruments/harps/inst/monitoring/thar_histo`

which is always up to date; the cookbook could be obsolete on this respect. HARPS lamps are enumerated in the ICS panel according to the following scheme:

lamp1 Tungsten lamp
lamp2 CU iodine cell heating (disabled)
lamp3 ThAr3 (Never use)
lamp4 ThAr1 (use 10 min. per day maximum)
lamp5 ThAr2 (to be used during the night in simultaneous Th referece mode)
lamp6 tungsten lamp (once illuminating the CU iodine cell)

There is nothing that, in typical working conditions, a support astronomer should work on in the calibration unit nor in general in the HARPS room at all. Moreover the HARPS enclosure is locked; the following persons have the code to open the room: Gaspare Lo Curto, Peter Sinclaire. In any case opening has to be authorized by the Instrument Scientist or the HARPS consortium (Francesco Pepe).

4.7 Fiber links

There are two fiber links of two fibers each: one carries the calibration light (ThAr or tungsten or tungsten I_2 absorbed) from the calibration unit in the HARPS room to the movable mirror in the HARPS Cassegrain Fiber Adapter (HCFA) via a set of two identical (by design) fibers. The second carries the light from the "science" (A) or the "reference" (B) fibers from the HCFA to the spectrograph. The "science" or the "reference" fibers are defined with respect to their use in the "Simultaneous ThAr" observation mode, in which the "science" fiber carries the star light and the "reference" fiber carries the ThAr light for use as a reference to detect overnight drifts of the ThAr lines over the detectors. These two fibers are also referred as fiber A (science) and fiber B (reference) in various instrument's panels.

4.8 The HARPS Cassegrain Fiber Adapter (HCFA).

The HCFA is the only section of the instrument which contains moving parts (apart the detector shutter just outside of the vacuum vessel). These parts are:

- Dust cover:
  Status: IN/OUT
  Actor(s): acquisition/calibration templates, ICS, OS
- ADC:
  Status: IN/OUT, ON/OFF
  Actor(s): acquisition templates, ICS
- Movable mirror for calibration light injection.
  Status: NONE, BOTH, FIBA, FIBB
  Actor(s): acquisition/calibration templates, ICS
- Density wheel
  Status: Continuous movement.
  Actor(s): observation template, ICS
- HCFA iodine cell
  Status: IN/OUT and ON/OFF
  Actor(s): acquisition/calibration templates, ICS

4.9 Read out modes and read out noise.

Binning of the CCDs is not available. Two readout modes are available: "slow" ($104kHz$, $< 3e^-$ readout noise) and "normal" ($416kHz$, $5e^-$ and $6e^-$ readout noise, depending on the detector). Readout times are 87s for the "slow" mode and 23s for the "normal" one. Detector bias is extremely stable.
Dark current of the detector is on average $0.5 \pm 0.2e^-/hour$; it is generally not useful to take dark frames.

4.10 Exposure meters

Two exposure meters recollect the light reflected by the grating gap. Each exposure meter measures the light from one of the two fibers. The peak values for the photomultiplier collecting

Magnitude	Expected counts/s
3	2850000
4	1134500
5	452000
6	180000
7	71600
8	28500
9	11346
10	4517
11	1800
12	716
13	285

Table 4.2: Exposure meter expected counts (channel A).

the light from fiber A, in number of counts per second depends from the star' magnitude and the night conditions. The values in table 4.10 were obtained with a seeing of 1" and airmass lower than 1.3 on solar type stars.

It should be periodically verified that these values are achieved, as a confirmation of the good health of the instrument.

4.11 Handy data

4.11.1 Accuracy

The accuracy of HARPS is such that with a S/N of 1 (at 550nm) a RV accuracy of 100m/s is attainable. Consider that:

$$RV_{accuracy} \approx 100/(S/N)$$

(this takes into account photon noise only). This number is shown by the pipeline in the "Reduction Information" window.

4.11.2 Efficiency

We can obtain a S/N of 50 for a 1 minute exposure on a G star of magnitude $M_v = 8$. This will be enough to give a RV accuracy of 2m/s.

Chapter 5

Operation modes

HARPS can operate in two main modes, available since the start of period 72:

- High Accuracy Mode with Simultaneous ThAr reference method (1m/s short term accuracy demonstrated)
- Classical fibre spectroscopy (without Simultaneous ThAr)
- High efficiency mode (EGGS fiber)
- Circular and linear polarimetry.

Each of these modes has dedicated acquisition templates. The "science" template (`HARPS_ech_obs_all`) is the same for all modes. Its tasks are to open and close the shutter according to the exposure time and the number of repeated exposures requested and to set up the neutral density filter wheel according to the exposure time. The acquisition templates, apart from pointing the telescope and waiting for the guiding to be started, takes charge to set up the instrument (mirror, fiber positions).

5.1 Simultaneous ThAr reference method

This is the mode for which the instrument was designed. It guarantees the specified 1m/s Radial Velocity (RV) accuracy on the short term (one night). In this mode one of the ThAr lamps (by default ThAr2, lamp5) is illuminating the "reference" fiber (B) via a movable mirror while the "scientific" fiber (A) is collecting the star light. Changes in the Instrument Response Function (IRF) would be reflected in shifts in the ThAr lines and used to correct the stellar spectra. Any relative movement of the ThAr lines from one fiber with respect to lines from the other fiber would be a killer for this technique. Relative line movements have been measured when moving the telescope in extreme positions. A peak to peak shift of 0.4m/s has been measured. This might be connected to an injection problem but it does not jeopardize the accuracy of the instrument.
The neutral density wheel insures that the equivalent exposure time (density 0) of the detector to the ThAr light from the reference fiber is 40s. It has a dynamic range of 2.132 dex. Exposures with times shorter than 40s will have proportionally less ThAr photons, but the photon noise of the ThAr is such that the error it introduces in the RV measurement is below 1m/s for exposures as short as 1s. For an exposure time of 5400s the density filter is set at its maximum density, and larger exposure times risk to start to saturate relevant lines. One more drawback of using the simultaneous ThAr mode with faint objects requiring large exposure times is the contamination of the signal via ThAr light. It has been measured that the cross talk between the two fibers

is of the order of 0.2% - 0.5%. The recommended procedure for observations of faint objects is to place the scientific exposure in between two calibration ThAr exposures and interpolate any IRF changes. This is possible thanks to the extraordinary stability demonstrated by the instrument ($< 1m/s$ over one night). The limiting factor in RV accuracy for faint objects is the photon noise.
About 10000 identified lines from the ThAr spectra are used as reference to the science spectra. The ThAr lamp warm-up time is 120s. In this mode the ThAr lamp is on the all night. It is advised to turn on the lamp at the beginning of the afternoon calibrations and to turn it off only at the end of the night.

5.1.1 Templates

The acquisition and the science templates are:

`HARPS_ech_acq_thosimult`
`HARPS_ech_obs_all`

The acquisition template verifies that the ThAr lamp is on (if it is off it pops up an error message), turns off other calibration lights (if needed), retracts the iodine cell to its parking position (if needed), opens the dust cover (if needed) and moves the fiber mirror into the appropriate position to reflect the ThAr light into the reference fiber and leaves the science fiber free to acquire light from the star (if needed). It also moves in the ADC (if needed) and sets its rotation angle depending on the airmass. The observation template sets the neutral density filter wheel to a value which depends upon the exposure time. For this reason is strongly recommended **NOT TO CHANGE THE EXPOSURE TIME FROM THE ICS/DCS AFTER THE EXPOSURE HAS STARTED.**This operation would indeed change the exposure time, but would NOT consequently change the density of the density wheel, causing over or under-exposed reference spectra which will compromise the RV accuracy for that particular exposure.

5.1.2 Calibrations

Standard calibrations for this mode are:

Templates	Exp. time	# Exp.	Type of calibration
HARPS_ech_cal_bias	0	1	
HARPS_ech_cal_tun	8s	1	order localization
HARPS_ech_cal_tunAB	8s	5	flat fielding
HARPS_ech_cal_thoAB	40s	2	wavelength calibration, drift
HARPS_ech_cal_I2AB	1s	5	cross check the drift and the zero point.

Iodine cell is not available as of 21-06-2005), therefore the last template is not used.

5.2 Classical fibre spectroscopy

In the standard spectroscopic mode HARPS can be used as a one-fiber instrument or with one fiber on the object (A) and one fiber on sky (B). Unfortunately it is not possible to visualize at the same time both fibers on the guide camera. There are therefore two indirect ways to be sure a star is not falling in fiber B when performing object+sky observations:

1. Read the number of counts in the exposure meter.
2. Offset the telescope by 114″E and check whether a star is falling in fiber A.

The last option takes into account the orientation of the two fibers (E-W), their relative distance (16mm) and the telescope plate scale ($7.12''/mm$).

When no sky reference is required the "object only" template should be used. In this way all lamps are turned off and the calibration mirror is moved to cover fiber B.

5.2.1 Templates

The acquisition and the science templates are:

```
HARPS_ech_acq_objA (object only)
HARPS_ech_acq_objAB (object + sky)
HARPS_ech_obs_all
```

5.2.2 Calibrations

Specific calibrations for this mode are:

Templates	Exp. time	# Exp.	Type of calibration
HARPS_ech_cal_bias	0	1	
HARPS_ech_cal_tun	8.0s	1	order localization
HARPS_ech_cal_tunAB	8.0s	5	flat field
HARPS_ech_cal_thoAB	40s	2	wavelength calibration

5.3 High efficiency method (EGGS)

This mode can be used when observing faint targets. Its radial velocity accuracy is limited to 10m/s (RMS) due mainly to injection instabilities. The RV precision of faint targets will be mostly limited by photon noise, and the use of EGGS could be an advantage. As of today (16-09-2009) the "sky" fiber of EGGS is not available. Users should be very careful when observing close to the moon (¡60 degrees) because in such cases the moon light might influence the computed radial velocity. In extreme cases two CCF dips will be visible, one of them measuring the Sun' radial velocity. Due to the instrument stability, and the limited RV precision of EGGS, it is not necessary to use the simultaneous calibration with EGGS. The template is however made available.

5.3.1 Templates

The acquisition and the science templates are:

```
HARPS_eggs_acq_thosimult
HARPS_eggs_acq_objA (object only)
HARPS_eggs_acq_objAB (object + sky)
HARPS_eggs_obs_all
```

5.3.2 Calibrations

Specific calibrations for this mode are:

Templates	Exp. time	# Exp.	Type of calibration
HARPS_eggs_cal_bias	0	1	
HARPS_eggs_cal_tun	4.0s	1	order localization
HARPS_eggs_cal_tunAB	4.0s	5	flat field
HARPS_eggs_cal_thoAB	20s	2	wavelength calibration

5.4 Polarimetry

The details of the polarimetric observations are yet to be defined. The polarimetric unit is installed in place of the decommissioned iodine cell unit. Polarimetric templates will be finalized at the time of the second and last commissioning of the mode.

```
HARPS_pol_acq_cir (circular polarimetry)
HARPS_pol_acq_lin (linear polarimetry)
HARPS_pol_obs_all
```

5.4.1 Calibrations

Calibrations for the polarimetric mode have yet to be detailed. At the moment only the localization template is available, which moves the polarimetric unit in the beam when performing the order localization measurements.

```
HARPS_pol_cal_tun
```

We should expect a flat field template as well.

5.5 Calibration - general

The `HARPS_ech_cal_tun` tamplate takes a tungsten lamp frame illuminating fibers A and B in turn for order localization (2 frames). This is especially useful when using the HARPS pipeline and the simultaneous ThAr operation mode. Suggested exposure time: 8s
A series of "flat field" exposures is recommended before the beginning of each night. These are taken via the `HARPS_ech_cal_tunAB` template. They are used for flat fielding and for deblazing. Suggested exposure time: 8s The `HARPS_ech_cal_thoAB` template exposes both fiber A and fiber B to the ThAr lamp. Templates to expose only one fiber are not available. Suggested exposure time: 40s

Exposure times half when using the EGGS mode
All calibration templates are first summed up and then processed if the `EXPNO` keyword is greater than 1. If several calibration frames from the same template should be procssed individually an OB should be prepared containing as many templates of the wanted kind as many exposures as desired.

The optimum templates sequence for RV determination can be generated in one go from the Short Term Scheduler (STS) by the "ADD OB" $-->$ "Calibrations" $-->$ "Standard RV calibrations". This sequence takes about 10 minutes to execute. When using P2PP the OB can be found ready in the directory: `IMPEX/HARPS`.
Technical templates will not be discussed in this version of the cookbook.

Chapter 6

Autoguider and Dynamic centering

To reach the required accuracy of 1m/s guiding performance should be excellent. Guiding should be done on the fiber's center with an accuracy better than 0.05″. This implied the development of a dynamic centering algorithm, as the apparent position of the fiber on the guide camera changes by few pixels (up to 5) in the course of the night, depending on environment temperature and on telescope position on the sky.

6.1 Dynamic centering configuration panel

In order for the algorithm to calculate and apply the corrections the configuration parameters have to be properly set:

delta	5
cuts	5
number of images	4
center accuracy	0.05”
monitor time	30s
before guid. monitor time	10s
error values	MEAN
save integrated matrix	ON
save partial integrated matrix	ON
save period	60s

The “Logging” option should stay OFF, as it is not yet working.

A document describing the dynamic centering system is in preparation. All the paramters are set to the proper values by default when the “Dynamic centering configuration panel” is started.

6.2 Guiding with HARPS

Once the telescope has reached position and the target is visible

1. Press the button *”Image Stat”* in the E3P6 Real Time Display panel
2. Click on the target star
3. Press the button *”Centering”*

4. Click on the target star

5. Start guiding

6. After the autoguider stabilized verify that the star is properly centered (within 1 pixel) on the fibre

   a If the star is not centered on the fibre stop guiding and center it using the *"Set Reference"* button and the *"Set box and reference"* option form the newly opened panel.

   b Start guiding

6.3 Find the fiber (afternoon)

To find the fiber in the afternoon place the calibration mirror in the encoder position 24000 from the ICS, turn on the ThAr2 lamp and look into the guide camera. The fiber should show up very clearly within the beam spot.

An alternative way is to illuminate the cage or the dome and observe the fiber in the diffuesd light.

6.4 Integrated guide image display

The display of the integrated guide image should be running on the `whaldrs2` computer. It is started either via the command: "`guide_ima1.csh`" or using the full startup command: "`start_drs.csh`" which starts the pipeline, the guide display and the logfile (in the `w3p6off`) simultaneously. The software will wait for the shutter to open, save the first integrated image as bias and subtract it from the following images. It does not work properly when the exposure times are lower than 20 seconds.

6.5 Autoguider troubleshooting

6.5.1 Guide image not refereshing in the whaldrs

Two option, if option 1 does not work try option 2:

1. press `ĉ` on the midas terminal window;

2. press `ĉ` twice and restart the task using the `guide_ima1.csh` command.

6.5.2 Object "centering"

If the option "centering" in E3P6 real Time Display fails a re-start of the autoguider panel should be tried. If this fails a restart of the autoguider environment will be needed. This could be done by using the "scanei" GUI from the cam@w3p6tcs.

6.5.3 Autoguider RTD image frozen

If the autoguider gets frozen try the sequence:

- In the Autoguider panel: press *"Stop exposure"*
- In the Autoguider panel: press *"Start exposure"*

Try this few times (acknowledging the eventual error messages that appear (after having carefully read them). If this does not get the autoguider RTD image to refresh from a cam@w3p6tcs terminal issue the command:

```
e3p6StartTCCDs ia
```

This re-initializes the slit viewer camera. A *"Start exposure"* is needed afterwards.

6.5.4 Autoguider crashes

In case the autoguider crashes "seriously" the LCU might have to be set to "ONLINE" ("Telescope Status" panel). Alternatively the LCU might have to be rebooted (from the l3p6img panel which is always opened):

```
lccReboot 1
```

If this still does not work do a power cycle in the cage.

Once the LCU is back online, in a cam@w3p6tcs terminal, one of the commands:

```
e3p6StartTCCDs all
e3p6StartTCCDs ia
e3p6StartTCCDs ag
```

has to be issued: the option *"all"* initializes both CCDs, the option *"ia"* initializes the slit viewer only (IMG) and the *"ag"* option initializes the guide probe CCD (TEC).

Chapter 7

Temperatures

Nominal HARPS temperatures are displayed below.
The columns are: sensor number, average value, RMS, description.
Althought temperatures should be very stable seasonal variations are possible. Also in the event of a major temperature change (HE access, IB opening etc.) temperatures can settle to a value which is different from the one indicated below. However STABILITY is what matters. Average values should be taken as an indication only, while RMSs should be used as a reference for the achieavable stability.

```
1  1.25831E+01 7.04746E-01 HCFA air temperature
2  1.00000E+02 1.00000E+00 HFCA iodine cell
3  1.71512E+01 3.52044E-03 VV inside top
4  1.70537E+01 2.97402E-03 VV inside bottom
5  1.70662E+01 2.61348E-03 VV inside right
6  1.71320E+01 2.33444E-03 VV inside left
7  1.70782E+01 2.51152E-03 VV inside Detector side
8  1.71678E+01 2.74362E-03 VV inside Collimator side
9  1.70571E+01 6.19159E-03 Image Scrambler inside VV
10 1.69263E+01 2.39130E-03 CFC inside VV
11 1.70681E+01 2.30685E-03 Opt. Bench top-Detector
12 1.70801E+01 2.22594E-03 Opt. Bench bottom-Detector
13 1.71340E+01 2.59454E-03 Opt. Bench top-left
14 1.71013E+01 2.25165E-03 Opt. Bench bottom-Collimator
15 1.70759E+01 2.57443E-03 Opt. Bench top-right
16 1.71092E+01 2.07345E-03 Opt. Bench bottom-right
17 1.71103E+01 2.33778E-03 Opt. Bench top-Collimator
18 1.70949E+01 2.19697E-03 Opt. Bench bottom-left
19 1.71193E+01 6.41038E-03 Opt. Bench Spare 1
20 1.70808E+01 8.53253E-03 VV inside Spare 1 - not conn.
21 1.70395E+01 8.21601E-04 Fiber Exit
22 1.71268E+01 7.55074E-04 Collimator
23 1.70746E+01 5.95255E-04 Echelle Grating
24 1.70594E+01 5.88542E-04 Grism
25 1.69950E+01 7.68836E-04 Camera Optics Detector side
26 1.70202E+01 7.12106E-04 Camera Optics Collimator side
27 1.64575E+01 5.39160E-03 Detector-Head body back
28 1.70462E+01 6.03910E-03 Detector-Head holding ring
29 1.70312E+01 1.23344E-03 VV outside Foot S2
```

```
30 1.52844E+01 2.41509E-01 Air-Coude room W
31 1.52367E+01 1.37326E-02 Air-HARPS Enclosure
32 1.70632E+01 6.78161E-03 Air-HARPS Isolation Box
33 1.73640E+01 6.92407E-03 Air-through Fan 4 IB
34 1.69616E+01 7.24101E-03 Image Scrambler outside VV
35 1.63337E+01 1.45622E-02 CFC outside VV
36 1.70603E+01 1.30416E-02 VV outside Detector side
37 1.71183E+01 1.89779E-03 VV outside Collimator side
38 1.70934E+01 1.35055E-03 Spectrograph Spare 2
39 0.00000E+00 0.00000E+00 spare
40 1.48150E+02 1.48296E-02 CCD control reference
41 1.48205E+02 1.45562E-02 CCD secondary
42 1.70045E+01 3.12804E-03 Isolation box control reference
43 1.70093E+01 2.71379E-03 Isolation box secondary
```

Chapter 8

Alarms

The configuration file which contains the alarm levels is:

`wharps:/vlt/insroot/SYSTEM/COMMON/CONFIGFILES/hamcfgINS.cfg`

The same file contains the sensors dictionary, allowing to associate INS.TEMPXX keywords with the proper sensor (PAYYY, PBYYY, etc.).
The command to start the alarm display is:

`alrmDisplay`

and has to be started from the wharps computer.

Chapter 9

Software

Software developed on purpose by the HARPS consortium are the HARPS pipeline (DRS), the STS (Short Term Scheduler) and the archiving software (DAU) used to write DVDs or USB disks.

9.1 The STS (Short Term Scheduler)

The STS can be used alternatively to P2PP, and will be done so by the consortium's observers. STS and P2PP can run at the same time, it will be BOB (through the "Configure" $->$ "Environment" setting) who decides from where to take the next OB. The STS is run from w3p6dhs (harps, xxxxxxxx) from the directory /home/harps/RUN_STS via the command

```
/home/harps/RUN_STS> sts.csh ccs eng
```

The "eng" option gives access to the technical templates; the "ccs" option to the "ccs". Default is "noccs". Other available options are: "recover", to recover the last session after a crash, and "time" to plan the observations taking into account the start of the night and the exact hour of execution of each OB. When using the "time" option, OBs cannot be executed unless the time constraint of the STS is released (Sun at -12 degree). STS is supposed to run on a single user mode only. If STS refuses to start check whether there is another session running. You can do this with a "ps -def — grep sts" command or by checking whether the file "lock-sts" exists in the /home/harps/RUN_STS directory. If a session exited abnormally there might be a "lock-sts" file even if there is no STS running. In this case delete the file and restart STS.

The STS works in a sequential way. An OB which has been executed cannot be modified or deleted. It can only be copied into another OB located in the future.

Observing blocks can be loaded from a catalog (a ASCII file with .cat extension). Before doing "Send" from the catalog always click on the OB, in the STS window, after which the new object has to be inserted.

Once the OB has been fetched from STS to BOB it will open and start automatically. This cannot be avoided as it is due to a hardcoded flag present in all templates. This will change once DMD in Garching will get the "Auto Run" option of BOB running. For GTO runs it is common to set BOB in "Autofetch" mode.

The STS has its own "exposure time calculator". Once the scientific OB is generated, select it with a mouse click and press the buttom "Calc. Texp". This will calculate the exposure time for the requested SNR and insert it in the OB. The parameters of this exposure time calculator

could be set from the scroll down menu of the STS panel: `File -> Configure`. Exposure time is calculated to supply the requested SNR at order 111, centered at 551nm,

The STS also has an "eXtended exposure Time Calculator" (XTC), to which a buttom from the panel is associated. Form this panel is possible to set the seeing, airmass and the order for which the SNR is requested. The exposure time calculated by the XTC has to be entered by hand in the OB in the main STS panel.

Fields whose background is in white can be modified with keyword strokes, field whose background is in yellow cannot be modified.

Apart from the instructions given above, mostly the STS is self explanatory. The next release of the cookbook will explain the STS in more detail.

Remind, when going from P2PP to STS, to change the BOB configuration: BOB $->$ Configuration $->$ Environment $->$ set the OH process to "sts" or "p2pp".

9.2 Pipeline (DRS)

The pipeline was fully developed for the "Simultaneous ThAr" mode. The best accuracy is achieved for G, K and early M stars, for which spectral templates are available. The pipeline needs an initial guess of the RV of the object for maximum accuracy. It reads the RV and the spectral type fields in the template and delivers a fully reduced spectrum (bias subtracted, cosmics removed, flat fielded, de-blazed, wavelength calibrated) and the calculated RV. Processing time is about 30s per frame. For best RV accuracy the "initial guess RV" has to be known within 1-2Km/s. If this is not the case, the spectra can be reprocessed offline using the RV calculated at the first iteration. When the RV is not known a priori, the initial "guess" `-99999` should be used; the pipeline will start an iterative process to compute the RV. However this method does not permit to reach the highest RV accuracy (error of the order of few m/s). The highest accuracy is reached by specifying the RV within 1-2km/s from its true value. Tools for offline reprocessing of the data are also available (*offdrs*).

To start the pipeline simply start the trigger, online or offline from *harps@whaldrs2*:

```
trig.csh online
```

Default is offline. Alternatively use the command:

```
start_drs.csh
```

this command will start the pipeline, the guiding monitoring software, the log file and the panel with the telescope and Moon information.

It is also possible to start all the online software from the scroll down menu actuated by the left button of the mouse.

During online data processing the order 138 is plotted for a quick, visual quality check, and finally the correlation function.
Three windows represent the Graphic User Interface (GUI) of the HARPS pipeline:

- the information window,
- the file-list window
- and the detail window.

In the file-list window file names are colored depending on their status:
black: not processed

blue : processing
red : aborted
dark green: processed but a problem was encountered (tungsten too strong, too weak, etc.)
light green: processed and o.k.
yellow: waiting end of exposures sequence to sum, then process.

After the reduction of the afternoon calibration frames a quality check is performed. If the new calibration sequence passes the quality check, the calibration database is updated; otherwise a pop up window will appear and a message from the "Message" window of the pipeline will say that the database was not updated and the old calibrations will be used. A failure of the quality check is a rare event, and it should be understood what the problem was. However, time permitting, the calibration sequence should be repeated.

Calibration files are processed only after the end of the OB. If $N_{exp} > 1$ the frames are first summed and then processed. This is not the case for science frames nor for the HARPS_ech_cal_USER template.

After the pipeline trigger is started, the user will see scrolling by all the messages and results of the pipeline, with a display of order 138 popping up for every new reduced spectrum.

9.3 Pipeline output

The pipeline output is saved in

`whaldrs2(harps,xxxxxxxx):/data/reduced/yyyy-mm-dd`

This directory contains the reduced calibration frames with the extensions explained below and a set of ASCII file with extension .tbl which summarize the status of the instrument. It also contains the reduced frames in .e2ds (extracted 2 dimensional) fits format. In this format each line corresponds to a spectral order. The frame has 72 lines (there is also a line for the order lost in the gap).

The raw calibration frames, through the pipeline, generate several reduced frames with extension:

Template	Extension	Purpose
cal_tun	loco	order localization
cal_tun	fwhm	FWHM of the order
cal_tun_AB	blaze	blaze function
cal_tun_AB	flat	flat field (5)
cal_th_*AB*	wave, e2ds	wavelength solution

In the "/data/calibDb" directory there are the reference ThAr frames, in .e2ds format (produced with the .wave files). There is also the list of valid calibration files: master_calib.txt. This file is updated automatically after a successful calibration sequence and should be cleaned up periodically.
All reduced files have in their fits headers the raw frame header + several DRS keywords: localization of orders, flat of orders, S/N of orders, drift from latest ThAr, number of cosmics, baryocentric earth RV, coefficients of the dispersion solution.

9.3.1 Tables

In the same place

`whaldrs(harps,xxxxxxxx):/data/reduced/yyyy-mm-dd`

are saved the output tables:

- HARPS...ccf.tbl: many obvious entries (cpp=$< e^- > /order$, contrast=% of line depth to quasi continuum, RV is in unit of Km/s); One .tbl file for each science frame.
- cal_BIAS_result.tbl: bias1: blue CCD, bias2: blue overscan, bias3: red CCD, bias4: red overscan.
- cal_FF_results.tbl: Signal to Noise and FF RMS for three different orders.
- cal_TH_result.tbl: mean: mean of residuals in millipixels
  rms: RMS of residuals in millipixels
  err: error in zero point (millipixel)
  RMS: RMS of order in 3 CCD slices
  drift: drift in m/s respect to former measurement
  rflux: flux ratio with former file
  cosmics: number of pixels affected by cosmic rays.
- cal_DARK_result.tbl: mean dark (electron/hr)
- CCF_results.tbl: is the summary of all the HARPS...ccf.tbl files.

Aside the HARPS...ccf.tbl and CCF_results.tbl files, files with keyword "new" can be found: HARPS...newccf.tbl, NEWCCF_results.tbl. They are generated by the offline drs (offdrs.csh).

9.3.2 Pipeline configuration

The pipeline configuration file is in whaldrs:INTROOT/drs/config/hadmrICDP.py. ICDP stands for Instrument Configuration Data Pool. Be extra careful with this file as it might affect the results of the calibration files and all the pipeline. Always consult with the instrument scientist and the consortium before changing anything.

9.3.3 Offline

All pipeline recipes can be started from the command line:

`recepit_name subdir_name(/data/raw/...) filename1 filename2 ...`

The recipe "ske_recipe.py" returns useful information and prints out the HARPS environment variables.

The trigger can be run offline, by calling it with the command: `trig.csh` (omitting the `online` option. In this case the user will have to browse through the files and choose what to process. Alternatively, it can be run as:

`trig.csh "online yyyy-mm-dd"`

In this way it will process all the data from the night yyyy-mm-dd provided the filenames are not lister in the logfile: /data/msg/yyyy-mm-dd.r. Removal of this file could be necessary to reprocess one night of data.

Another tool is the offline DRS, started with the command: `offdrs.csh`. It can be used to recalculate the correlation coefficients after a different "guess" RV is assumed. New correlation

tables (with new RV) will be generated and saved in /data/reduced/yyyy-mm-dd/... This tool is especially useful when the approximate RV of the object is not known a priori (within 1-2 Km/s). In this case after the first iteration the correlation function will be displayied and the user will be allowed, by using the *offdrs* to re-do the RV calculation with a better initial guess point. This procedure could be iterated.

9.4 GUIDE monitoring software

A quality check for the guiding can be performed by a software developped in La Silla and running on the whaldrs2 machine, in the harps account. To start it simply type

```
guide_ima1.csh
```

This command can be executed form any directory in the harps@whaldrs account. At present it only fetches the partial integrated image from the cam@w3p6tcs:/vltdata/tmp/ directory (in ASCII format), converts it in fits, and store the .fits file in the `/data/reduced/yyyy-mm-dd/` directory with the name of the corresponding science frame as root. In this way it is possible to see easily which guiding frames corresponds to which science frame. In the future this software will measure the position of the fiber in the integrated frame and issue warnings if the fiber is off center. This feature is not yet available as of today (30-05-2004).

9.5 Instrument monitoring software

A series of scripts is devoted to monitor bias, readout noise, dark current, tungsten lamp flux, Thorium lamp flux and Thorium line drift over one night. Moreover daily nitrogen consumption and vacuum losses by the vacuum vessel are monitored. The master script, which starts all the dependent ones is: "moni.csh"; being installed in the $INTROOT/bin directory can be executed from everywhere under the harps account on the whaldrs2 machine. The output is immediately published on the web in the HARPS -¿ Instrument monitoring page.
Installation instructions are presented in this manual.
Generally the script "moni.csh" runs via a cron job wich executes in the "nice -20" mode during the day, every day.

9.6 Alarms

There are two alarm software for HARPS. One is VLT compliant and displays the alarms on the wharps monitor as they arrive. The support astronomer and the telescope operator should make sure this panel is alway open. The command to start it is:

```
alrmDisplay
```

The second software is custom made and runs on the *whaldrs2* computer. It checks some relevant parameters like CCD temperature, grating temperature and CFC pressure and if any of these values are out of range it e-mail ls-360, the instrument scientist and the Geneva HARPS project scientist: Francesco Pepe. The mailing list is in the file: $INTROOT/MONI/ALARMS/maillist.txt.

9.7 Online software startup and shutdown

Two scripts are available for this task. They start up and shutdown the DRS pipeline, the software which displays the guide star in the *whaldrs2* computer and start or stop the logfile display in the *w3p6off* machine. The two scripts are:

`start_drs.csh`
`shutdown_drs.csh`

The startup script checks that the processes are not running. If they are running it shuts them down before to re-start them.

9.8 In house scripts

There is a set of available scripts for maintenance:

- efficiency: runs on the raw data, it requires the date of interest (* can be used), the object and the magnitude to plot its number of counts divided by the predicted number of counts in the exposure meters for its magnitude.
- fiber_drift: runs on the cal_TH_result.tbl files and calculates RMS(driftA-driftB). The final product is a plot in postscript format on the web. No input arguments.
- fiber_flux: runs on the cal_FF_result.tbl files. Calulates the flux B/A. The final product is a plot in postscript format on the web. No input arguments.
- temp_mon: plots the various temperatures and post them on the web. If no input is given it will process all temperatures and will look into all available logfiles.
- scroll_log: reads the relevant header keywords of the raw data files and builds a logfile. The file log.txt contains a copy of the logfile.
- statistics: get shutter statistics for HARPS. Inputs: yyyy-mm, this will compute the total shutter time for the month
- split_BACKUP.csh: mimicks GASGANO. Copies all files related to one program plus all the calibrations, tables and logfiles in the directory `whaldrs:/data/BACKUP/PID/yyyy-mm-dd` ready to start backup. USAGE: split_BACKUP PID yyyy-mm-dd This program is now superseeded by the new version of the DAU (Data Archiving Unit) software.

All these scripts need the "gethead" command from ECLIPSE, in alternative the "dfits" and "fitsort" can do the job. Mind that with the present version of ECLIPSE the gethead command does not work with multiextension fits files. The scripts are currently using the gethead.pl script by J. Pritchard to accomplish the task.

They are cmm-archived in the `harpsops` module.

9.8.1 DVD writing - related scripts

There are five scripts available to prepare DVD images and to burn DVDs. This might be useful when recovering a backup, doing a backup for a service service program or when duplicating DVDs.

- `make_img.csh`: generates the image of data stored in a directory.
- `write_dvd.csh`: burns an image on DVD.
- `write_dvd_off.csh`: burns an image on DVD from the w3p6off computer.
- `make_dvd.csh`: generates the image of one directory and burn it on DVD.

- `copy_img.csh`: duplicates a DVD.

To see the usage of these commands just type the command name on the command line:

```
whaldrs2 harps:~/ 1025 > make_dvd.csh
Usage: make_dvd.csh <label> <image_filename> <directory_to_backup>
```

They are cmm-archived in the `harpsops` module.

9.9 (Some) Relevant keywords

In the exposure fits header:

```
HIERARCH ESO INS DET1              : Exposure meter in fiber A
HIERARCH ESO INS DET2              : Exposure meter in fiber B
```

Chapter 10

Data Flow and archiving

The HARPS data are sent from the instrument machine to the w3p6dhs, from which are dispatched to the NGAS system for archiving and to the pipeline machine whaldrs2 for processing. At the moment only raw data go to NGAS, this should change soon, allowing raw and reduced data in the archive.

In order for the pipeline to run correctly the data subscriber should run on the whaldrs2 computer. Remind that **the data subscriber does not start automatically at boot**. All issues related to the data subscriber should be worked out from the pipeline@whaldrs2 account (password is the same as for the harps user) To verify that the data subscriber is running correctly login in the pipeline account and check the processes that are running:

```
whaldrs2 harps > ps -def | grep dhs
pipeline  2013     1  0 Feb18 ?        00:04:39 dhsSubscribe -dhshost w3p6dhs -d
pipeline  2046     1  0 Feb18 ?        00:03:38 vcsolac -dhshost whaldrs2 -dhsdat
pipeline  2111     1  0 Feb18 ?        00:04:33 dhs -dhsdata /data/reduced -logp
```

in the case above the data subscriber is running correctly. If the three listed processes (or any of them) do not show up there is a problem. In this case the best option is to stop the data subscriber:

```
pipelineControl stop
```

verify that the three processes disappear; if not kill them by hand. Restart the data subscriber:

```
pipelineControl start
```

Verify that the processes are running. If not call SWC.

Chapter 11

Backup

Genrally backup of the service programs are made in Garching, and backups of the "standard" visitor programs are made by DHA personnel in La Silla, provided a backup requst has been submitted. GTO observer will require the backup to be made on a USB disk they supply. A dedicated software: `dau.csh` should be used for this purpose. The visiting astronomer should communicate which media prefers.

GTO backups are done from the machine where all data are: harps@whaldrs2. The software to be used in this case is the DAU (Data Archiving Unit):

```
/home/harps>dau.csh    (it could also be started from the scroll down menu via the mouse
```

the panel is shown in the figure below:

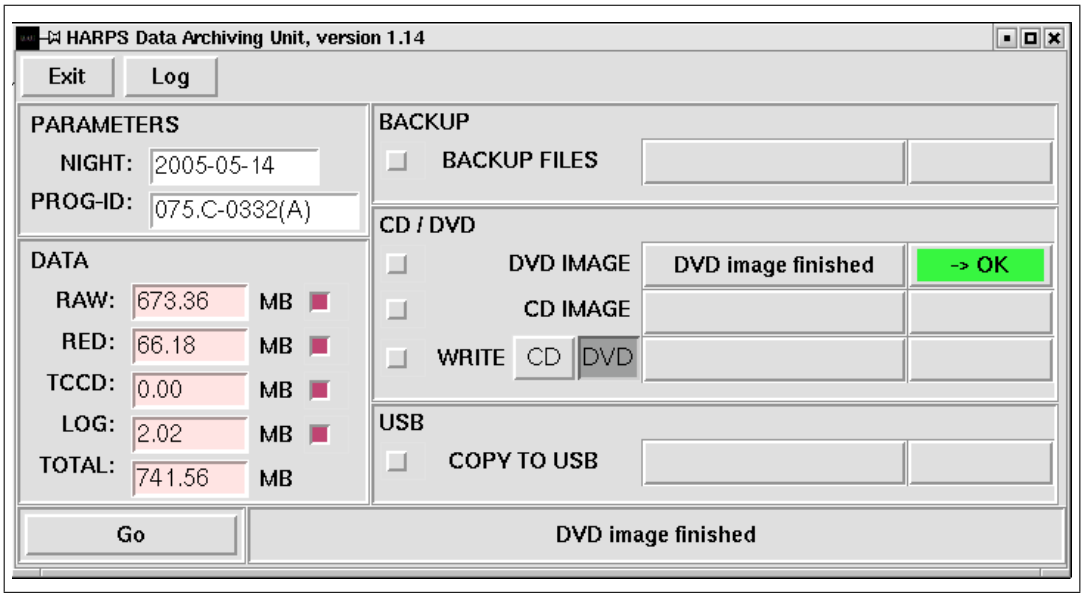

Figure 11.1: The DAU panel. Green boxes signal succesful completion of the actions, red boxes indicate a failure.

The first step in the proper use of the software is the definition of the night to be backed up. Mouse click on the field "NIGHT", enter the date (the background should become grey) and press `Return`. Wait for the background to become white again.
Next step is the definition of the program ID. Enter the full program ID, in the form e.g. `072.C-0488(E)`. Then follow the same procedure as for the "NIGHT" field. **the program ID should not be entered if it is not a shared night** (i.e. no service, no second visitor).

To define an action to be done the proper radio buttons should be pressed. The "DATA" subpanel on the left side defines the kind of data to be processed.
The panel to the right defines the actions to be performed on the data. Once the actions are defined pressing the "GO" button starts them. The bottom right part of the panel describes the action taking place. Green ("OK") flags signal succesful completion of the task, red flags ("KO") indicate unsuccesful completion.

The "BACKUP" action is obviously mandatory for every type of backup. It copies the data from the `/data/raw/` and `/data/reduced` directories to the `/data/raw/BACKUP/` and `/data/reduced/BACKUP/` respectively.

One problem of this software is that it does not refresh the panel while it is processing the data. This means that if a window is placed above the panel and then moved away the panel will stay blank. Patience is recommended in this case. Backup of a full night might take up to thirty minutes.

11.1 The backup in steps

A full night can be easily backed up using the DAU software. Raw and reduced frames are copied from the
`/data/raw/yyyy-mm-dd` and `/data/reduced/yyyy-mm-dd`
in `/data/BACKUP/raw/yyyy-mm-dd` and `/data/BACKUP/reduced/yyyy-mm-dd` directories if the program ID is not specified. Otherwise the destination directories are:
`/data/BACKUP/raw/yyyy-mm-dd_PPP.A-XXXX(A)` and `/data/BACKUP/reduced/yyyy-mm-dd_PPP.A-XXX`
A soft link to the data is created in `/data/DAU_TMP` or `/data/DVD` depending from the media chosen.

Steps (this works from harps@whaldrs):

1. If it is not already running, start the DAU software: `dau.csh`
2. Select the night to back up by typing the date in the date field (use the format: `yyyy-mm-dd`). The background color of the field will become grey. After pressing return wait for it to become white again. Do the same for the PROG-ID field. Use a format like: `072.C-0488(E)`. When backing up a complete night the "PROG-ID" field does not need to be filled.
3. Select the radio button corresponding to the type of files to be backed up ("DATA" subpanel), typically select all data products.
4. Press the "BACKUP" radio button ("BACKUP FILES", right side of the panel).
5. Press the "Go" button. At the bottom right of the panel a message describes the action taking place.
6. To back up the data on DVD select the "DVD - CREATE IMAGE" and press "Go". The image is created in the directory `/data/DVD/`. To write the image on the DVD is necessary to use a command line:

   ```
   /home/harps>write_dvd_off.csh <full_path_filename>
   ```

   Use of the full path for the filename is necessary. The computer that will actually burn the DVD is `w3p6off`; the DVD writer is in the *top shelf*. This is necessary because the DVD burning success rate of the whaldrs computer is only 30%. Presumibly this has to do with the kernel being used and should be solved at the next upgrade of the computer foreseen in 2005.

7. To back up on USB make sure a USB disk is mounted. Select the “USB - COPY TO USB” button and press “Go”.

8. Backed up data have to be removed by hand when needed (to be coordinated with the instrument scientist).

It is also possible to generate a DVD directly from the command line using the scripts described in section 9.8.1

Approximate time needed for backup on DVD or USB: 30 minutes.

The whaldrs2 /data disk has 450GB usable. The `/data/BACKUP/` directory should be cleand by the instrument scientist on average every month of operation of the instrument.

Chapter 12

Day TIO task list

Below is a schematic task list for the day TIO. Standard items such as introduction to the Visiting Astronomer (V.A.), start P2PP etc. are excluded from the list as they are well known to all TIOs.

1. Depending on the kind of program (using STS or not) you might have to do the backup on the USB disk of the user using the DAU interface (see section "Backup").
2. Verify (from the HARPS telemetry panel or the HARPS ICS sensor panel that can be started via the user menu from wharps) that the vacuum vessel pressure is in the acceptable range ($< 10^{-2} mbar$) and estimate whether it will stay in that range for the whole night, considering that the leak rate is on average of $3.5 \cdot 10^{-2} mbar/day$. If this is not the case start the vacuum vessel pumping procedure. This is better done in the morning, having more time available for pumping and re-equilibration of the system. Pumping for one hour is generally enough to restore the proper pressure. Pumping for longer time will progressively (but not significantly, mind the exponential trend) improve the vacuum, but should be avoided, as it worns out the pump with only a marginal benefit.
3. Be informed on whether the program requires either the EGGS or the HAM fibers, and whether it requires use of simultaneous ThAr.
4. Make sure there is sufficient available disk space in the following disks (40GB for a dense asteroseismology night, 10GB for a dense "normal" night):
   `whaldrs2:/data/`
   `wharps:/vlt/insroot/SYSTEM/DETDATA/`
5. Start the pipeline trigger and the guide monitoring software (from harps@whaldrs2: start_drs.csh or use the scroll down menu).
6. Verify the alarm display is running.
7. Start up the STS (from harps@w3p6dhs:RUN_STS/ issue the command `sts.csh ccs`) or P2PP or OT, depending on the kind of run. If the user uses the STS, suggest to execute the "Save list" command (from a button in the main STS panel). This will allow recovery of the list in case of a really bad crash of the STS.

12.1 OT queues

Three queues were generated in the OT to contain OBs used for health checks and calibrations. The queues are:

3p6_HARPS_Sphot_Std	spectrophotometric standards
3p6_HARPS_Health_Checks	health checks: darks, sky spectrum and Na saturated stars
3p6_HARPS_Calibrations	standard HAM and EGGS calibrations

The queue of spectrophotometric standards could be enriched with more new, bright standards.

Chapter 13

Problems

13.1 HARPS telemetry not started

From the command line on the *wharps* machine issue the command: `fcdTelemetry` and from the panel press the `Start` button.

13.2 Stop & start the HARPS environment

When the instrument seems misbehaving erratically:

```
vccEnvStop -e wharps
vccEnvStart -e wharps
```

13.3 Stop & start the detector environment

When the detector software seems not to start properly:

```
rlogin whafcd -l harps (usual PW)
vccEnvStop -e whafcd
vccEnvStart -e whafcd
exit
```

13.4 Earthquakes

An earthquake of intensity 6.2 Richter, with epicenter within 200km generated a misalignment equivalent to $\approx 3m/s$, i.e. 56nm in the system.

13.5 OH communication problems

Verify that the "Communication with OH" (BOB $->$ Configure $->$ Environments) status events is ON. If it is on and the problem persists check that there are not 2 BOBs, STS, p2pp's running at the same time. Next step is to close all BOBs, OTs, P2PPs, STSs and to stop and restart the environment:

```
vccEnvStop -c wharps
vccEnvStart -c wharps
```

When this problem occurs when using the STS, the log file in the w3p6dhs computer under the directory ~/harps/RUN_STS/ grows very fast, up to tens of GB in few hours. Once the communication is started again this file, if very large, should be removed to free disk space.

13.6 System hanging

This case includes BOB not closing properly the OB tree structure after the end of the exposure, setup not being performed, general system mis-behaviour. This could be due to a crash of the process *haoControl*. Using the `ccsPerfMon` or the `ps -def | grep haoControl` commands verify whether the *haoControl* process is running. If it is not running start it with the command: `haoControl Start` or from the menu using the `Start OS Software` option.

13.7 Pipeline freezes

This is typically due to a corrupted file that cannot be processed. Most likely the packaging of the header was not completed. In this case the file could be recovered (see next section). The HARPS pipeline will not be able to process these files and will freeze. The workaround is to stop the pipeline, rename the corrupted file and restart the pipeline:

```
shutdown.csh
cd /data/raw/yyyy-mm-dd
mv filename.fits filename.fits.bad
start_drs.csh
```

This operation must be conducted from the "harps" account, and NOT from the "harusr" account. In parallel an attempt should be made to recover the corrupted file (see next section). After these operations, a complete restart of the pipeline is needed.

The pipeline can also freeze due to the error message `calibDB locked`. If it happens delete the file `/data/calibDB/lock_calibDB`.

13.8 Packing of raw files failed

This could happen when the *haoControl* process fails. The raw data files are not properly formed, the header is not constructed and is generally broken in several pieces, in files with extensions *.det, .TCS*. Moreover quite often in this cases some information will be missing (*OBS, TPL* keywords or more). If all the information could be recovered it could be worth to attempt to re-build the raw file. This can be done following the steps:

1. construct the fits header in an ASCII file:
   (a) in the instrument machine `wharps` copy the fits header of a healthy file:

   ```
   psotooDfits healthy_file.fits > my_header.hdr
   ```

   (b) without changing the total number of characters nor the order of the keywords, edit the file *my_header.hdr* and update all the relevant keywords with the value appropriate to the header to be re-build;
2. use the command `psotooFFMerger` to merge the header to the raw data file:

   ```
   psotooFFMerger -f HARPS_ech_obs_all_XXXX.fits -d ALL -h "my_header.hdr" \
   -o end_file.fits
   ```

The command `psotooFFMerger` works by default in the `DETDATA` directory, the absolute path should be specified if working from any other directory;

3. verify the file generated with the previous command contains all the information and the format is correct (multi-extension fits file for HARPS); mind that the relevant time stamp for the HARPS pipeline is stored in the keyword: `DATE-OBS`;
4. change the permission of the file to `-r--r--r--`;
5. create a directory containing only the files to be broadcasted by the DFS;
6. using the absolute path issue the command:

   ```
   sendFiles my_directory
   ```

7. verify the files are being transferred in the *DHS* computer.

The process to re-build the fits header with all the relevant information can be quite time consuming, therefore care has to be taken in avoiding, when possible, occurence of the problem. In case of doubt, check that the *haoControl* process is running before starting a new OB.

13.9 STS OB colors not changing with execution status

Verify that the "Communication with OH" (BOB $->$ Configure $->$ Environments) status events is ON.

13.10 STS crashes

In case of a crash of the STS restart it with the option:

```
sts.csh ccs recover
```

This command will open the STS with the last list of observations prepared by the user and will take into account observations that were already executed. In case of a real nasty crash, the observing list might or might not be recovered.

13.11 Bias structures

In few occasions strong bias structures have been noticed (RMS>30ADU, peak to peak up to 50ADU). This happened in September 2003, December 2003 and Februayr 2004 up to now. Althought it might be a coincidence, it seems that leaving FIERA for about 15 minutes off cures the problem.

13.12 Fiber centering

A bad fiber centering impacts heavily on the RV accuracy. For example, a de-centering of 0.5" (2 pixels in the slit viewer camera) introduces a 3m/s error in the RV determination.

13.13 Focus

A bad focus also impacts the RV accuracy, apart from the collected flux. 30 encoder units (0.3mm) of defocus introduce an RV error of the order of 1m/s.

Chapter 14

Software installation (including pipeline and IP)

Relevant modules are:

haotsf	IP
hassts	STS
hardrs	DRS (pipeline)
haftrig	trigger
hapython	Python for DRS
hafdau	DAU: local backup
harpsops	GUIDE & integrated guide image reconstruction
harpsops	MONI & various tools, mostly instrument monitoring.
harpsops	WHALDRS_OPS & various tools, mostly instrument monitoring.

14.1 Instrument Package (IP)

Best is to check the web site:

`http://www.ls.eso.org/sci/facilities/lasilla/sciops/team_only/operations/astro/ip.html`

which is updated whenever needed.

14.2 STS

- Log in w3p6dhs as harmgr
- cd /CURRENTLY_MOD/
- cmmCopy hassts
- cd hassts/src
- ./hasstsIstall

When installation is succesfull the output that should appear is:

```
w3p6dhs harmgr:~/CURRENTLY_MOD/hassts/src 516 > ./hasstsInstall
STS will be installed under the user harmgr
STS installed
Check /tmp/sts.out for eventual errors
```

It is usefull indeed to chack for obvious error messages the /tmp/sts.out file.

14.3 DRS (pipeline)

- Log in whaldrs2 as harmgr
- cd /HARPSSources
- cmmCopy hardrs
- cd hardrs/src
- ./hardrsInstall

When installation is succesfull the output should look like:

```
- source directory:  /home/harmgr/HARPSSources/hardrs_1.6/src
- target directory:  /home/harmgr/INTROOT/DRS
- rm previous installation
- create sub-dir: config docs fortran python
- make fortran modules:
   fitpoly
   fitgaus
   fitpoly2dw
   fitpolyw
   statis
   extract
   newbervmain
   earthrv
   correlbin
   e2dstos1d
 Installation fortran module(s) completed
- make scripts
- making python exec
13:48:25.2 -   || ****************************************
13:48:25.2 -   || * HARPS DRS @(#)Geneva Observatory v1.6
13:48:25.2 -   || ****************************************
13:48:25.2 -   ||(dir_data_raw)      HAR_DATA_RAW=/data/raw/
13:48:25.2 -   ||(dir_data_reduc)    HAR_DATA_REDUC=/data/reduced/
13:48:25.2 -   ||(dir_drs_config)
HAR_DRS_CONFIG=/home/harmgr/INTROOT/DRS/config/
13:48:25.2 -   ||(dir_calib_db)      HAR_CALIB_DB=/data/calibDB/
13:48:25.2 -   ||(dir_data_msg)      HAR_DATA_MSG=/data/msg/
13:48:25.2 -   ||(print_log)         HAR_LOG=1
13:48:25.2 -   ||(plot_graph)        HAR_PLOT=NONE
13:48:25.2 -   |ske_recipe|Now running : ske_recipe on file(s):
13:48:25.2 -   |ske_recipe|On directory /data/raw/
13:48:25.2 -   |ske_recipe|ICDP loaded from:
/home/harmgr/INTROOT/DRS/config/hadmrICDP.py
13:48:25.2 - * |ske_recipe|Void recipe for test
Installation completed
```

14.4 Trigger

- Log in whaldrs2 as harmgr
- cd /HARPSSources
- cmmCopy haftrig
- cd haftrig/src
- ./haftrigInstall

When installation is succesfull he output should look like:

```
whaldrs2 harmgr:~/HARPSSources/haftrig/src 1012 > ./haftrigInstall
Trigger will be built for Linux operating system
Offline DRS will be built for Linux operating system
Source code is in the directory:
/diska/home/harmgr/HARPSSources/haftrig/src
ln: ‘/home/harmgr/INTROOT/bin/trig.csh’: File exists
ln: ‘/home/harmgr/INTROOT/bin/offdrs.csh’: File exists
Trigger is installed under the user harmgr
Offline DRS is installed under the user harmgr
```

14.5 Python

Differently from the other installations the root password is needed.

- Log in whaldrs2 as harmgr
- cd /HARPSSources
- cmmCopy hapython
- cd hapython/src
- more README

The README file details how to proceed for the installation. Below the Linux installation is described (whaldrs2 runs Linux):

```
as harmgr
define INTROOT:
> export INTROOT=~harmgr/INTROOT
> mkdir ~harmgr/INTROOT
> mkdir ~harmgr/INTROOT/bin
Ensure that the python is pointing to the python 2.2. If
this is not
the case:
> alias python python 2.2 (put into .bashrc)
define the PYTHONPATH (e.g. in the .bash_profile)
> export PYTHONPATH=/home/harmgr/INTROOT/Python-2.2/lib/python2.2/site-packages:\
/home/harmgr/INTROOT/Python-2.2/lib/python2.2:/home/harmgr/INTROOT/\
Python-2.2/lib/python2.2/lib-dynload
```

```
> ./hapythonInstall.Linux
as root do:
> ln -s
$INTROOT/Python-2.2/lib/python2.2/site-packages/Numeric
/usr/lib/python2
.2/site-packages/Numeric
> ln -s
$INTROOT/Python-2.2/lib/python2.2/site-packages/Numeric.pth
/usr/lib/pyt
hon2.2/site-packages/Numeric.pth
```

14.6 DAU

- Log in whaldrs2 as harmgr
- cd /CURR_MOD
- cmmCopy hafdau
- cd hafdau/src
- ./hafdauInstall

When installation is succesfull he output should look like:

```
whaldrs2 harmgr:~/CURR_MOD/hafdau/src 1038 > ./hafdauInstall
DAU will be built for Linux operating system
Source code is in the directory:
/diska/home/harmgr/CURR_MOD/hafdau/src
chmod: changing permissions of ‘/data/DAU_TMP’: Operation not permitted
chmod: changing permissions of ‘/data/DVD’: Operation not permitted
chmod: changing permissions of ‘/data/DLT’: Operation not permitted
```

Do not be worried about the “Operation not permitted” message. This is a minor bug in the installation procedure that is going to be corrected soon. Installation is however fully functional.

14.7 GUIDE monitoring

The guiding monitoring software running on the harps@whaldrs account is installed by the following procedure:

- Log in whaldrs2 as harmgr
- cd /CURR_MOD
- cmmCopy harpsops
- cd harpsops/src
- ./guideInstall

After a succesfull installation the output should look like:

```
- source directory:  /diska/home/harmgr/CURR_MOD/harpsops/src/GUIDE
- target directory:  /home/harmgr/INTROOT/GUIDE
- rm previous installation
ln: '/home/harmgr/INTROOT/bin/guide_ima.csh': File exists
ln: '/home/harmgr/INTROOT/bin/copy.csh': File exists
ln: '/home/harmgr/INTROOT/bin/fitsheader.csh': File exists
ln: '/diska/home/harmgr/midwork/partial.prg': File exists


GUIDE installation completed
```

14.8 Instrument monitoring (MONI)

The instrument monitoring software running on the harps@whaldrs account is installed by the following procedure:

- Log in whaldrs2 as harmgr
- cd /CURR_MOD
- cmmCopy harpsops
- cd harpsops/src
- ./moniInstall

14.9 Miscellanea useful software (WHALDRS_OPS)

The instrument monitoring software running on the harps@whaldrs account is installed by the following procedure:

- Log in whaldrs2 as harmgr
- cd /CURR_MOD
- cmmCopy harpsops
- cd harpsops/src
- ./whaldrs_opsInstall

After a succesfull installation the output should look like:

```
whaldrs2 harmgr:~/CURR_MOD/harpsops/src 1111 > moniInstall
- source directory:  /diska/home/harmgr/CURR_MOD/harpsops/src/MONI
- target directory:  /home/harmgr/INTROOT/MONI
- rm previous installation
ln: '/home/harmgr/INTROOT/bin/moni.csh': File exists
ln: '/home/harmgr/INTROOT/bin/bias.csh': File exists
ln: '/home/harmgr/INTROOT/bin/dark.csh': File exists
ln: '/home/harmgr/INTROOT/bin/ff_flux.csh': File exists
ln: '/home/harmgr/INTROOT/bin/th_flux.csh': File exists
ln: '/home/harmgr/INTROOT/bin/drift.csh': File exists
```

```
ln: ‘/home/harmgr/INTROOT/bin/rates.csh’: File exists
ln: ‘/home/harmgr/INTROOT/bin/all.csh’: File exists
ln: ‘/home/harmgr/INTROOT/bin/warn1.csh’: File exists
ln: ‘/home/harmgr/INTROOT/bin/pid_backup.csh’: File exists
ln: ‘/home/harmgr/INTROOT/bin/start_drs.csh’: File exists
ln: ‘/home/harmgr/INTROOT/bin/shutdown_drs.csh’: File exists
ln: ‘/diska/home/harmgr/midwork/plot_bias.prg’: File exists
ln: ‘/diska/home/harmgr/midwork/plot_dark.prg’: File exists
ln: ‘/diska/home/harmgr/midwork/plot_ff.prg’: File exists
ln: ‘/diska/home/harmgr/midwork/plot_th.prg’: File exists
ln: ‘/diska/home/harmgr/midwork/plot_drift.prg’: File exists
ln: ‘/diska/home/harmgr/midwork/plot_rate.prg’: File exists


MONI installation completed
```

Disregard the warnings, as they refer to the fact that soft links were already existing. If the package is installed for the first time on a new disk these warning would not show up.
Installing the package also installs the alarm task (which send alarms to a set of relevant people), the backup request task (which announces in the morning the list of executed programs by e-mail) and the *"start_drs.csh"* and *"shutdown_drs.csh"* commands.

After the installation verify whether the tasks are in the cron list:

```
[harps@whaldrs2 ~]$ crontab -l
33 13 * * * /bin/nice -20 /diska/home/harmgr/INTROOT/bin/moni.csh
5,25,45 * * * * /bin/nice -20 /diska/home/harmgr/INTROOT/bin/warn1.csh
04 11 * * * /bin/nice -20 /diska/home/harmgr/INTROOT/bin/pid_backup.csh
```

If this is not the case, contact the Instrument Scientist. The Instrument Scientist (apart the LSO and Geneva software engineers) is the only person allowed to manage cron jobs in the whaldrs2 computer.

Chapter 15

HARPS contact persons

Garching			
Gaspare Lo Curto	all issues	glocurto@eso.org	6346
Geneva			
Francesco Pepe	all issues	Francesco.Pepe@unige.ch	+41 22 379 2396
Michel Fleury	mechanics	michel.fleury@unige.ch	+41 22 379 23 26
Christophe Lovis	pipeline	Christophe.Lovis@unige.ch	+41 22 379 2407
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Danuta Sosnowska	STS, DAU	Danuta.Sosnowska@unige.ch	+41 22 379 23 95

HARPS contact persons private phone numbers for real emergencies are listed in an envelope attached to the wall in the HARPS room, just on top of the desk. Please, keep them confidential.

Chapter 16

Accounts

wharps	harps	xxxxxxxx
wharch	harps	xxxxxxxx
whadrs	harps	xxxxxxxx
w3p6dhs	harps	xxxxxxxx
MTS	laSill@	ph@se2

P2PP	52036	nutella
OT	0	OHS4good