

# SPIRou User Manual

Version 0.0.1

For AT-4

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## Abstract

This is the guide to installing, running, and using the SPIRou DRS.

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# Introduction

Some text here

## Notes

- This installation assumes you are running bash on a Linux machine.
- There is no need for root access needed for any of these steps.
- The python modules required for this DRS to run (more up-to-date versions are NOT supported) will make current versions of python not work. It is currently recommended that an isolated version of python be used with this version of the DRS (see Section 1.5).
- Variables inside { } are defined in Section 1.2 and used throughout to mean “replace with valued defined in Section 1.2”.
- The following denotes a line of text that is to be edited (in a file):

```
VARIABLE_NAME="Variable Value"
```

- The following denotes a console command to run:

```
echo "HelloWorld!"
```

- The following denotes a python command to run:

```
>>> print("HelloWorld!")
```



## Chapter 1

# Pre-Installation

This file is just for use with the current installation files (version 43), the author does not recommend that this is the final set-up procedure, nor that any of the ‘modifications’ to the original source code applied here should be used in any final version of the DRS (better solutions should be found).

### 1.1 Prerequisites

Before one can use the DRS pipeline one must follow the followings steps before installing the pipeline.

1. Add variables to the system environment (Section [1.2](#))
2. Setup and check the folder structure (Section [1.3](#))
3. Make sure Fortran and C back-ends are installed (Section [1.4](#))
4. Install an isolated, clean version of python (Section [1.5](#))
5. Install required python modules - exact version not older not newer (Section [1.6](#))

There is no need for root access for any of the following steps.

### 1.2 Adding variables to the system environment

This can be done one of two ways. The first root (Section [1.2.1](#)) is via a setup file and will allow you to switch on and switch of the environmental variables (to avoid clashes with other programs and to keep ones environment clean). Note with this method you will have to source the setup script before installing or running this code (each time the environment changes) or add the activation to your bashrc. This route is recommended. Otherwise you can follow the second root (Section [1.2.2](#)) and hard-code variables to your ‘.bashrc’ file.

### 1.2.1 Using a setup script

Open up ‘env\_setup.sh’ and edit the following lines. You will find a copy of ‘env\_setup.sh’ in Appendix A.

1. Set the instrument name {INSTRUMENT\_NAME}
2. Directory in which all SPIROU files go {DATA\_ROOT}
3. Define installation folder name {INSTALL\_ROOT}
4. Define data folder name {DATA\_ROOT}
5. Define raw path {DATA\_ROOT\_RAW}
6. Define reduced path {DATA\_ROOT\_REDUCED}
7. Define calibDB path {DATA\_ROOT\_CALIB}
8. Define msg path {DATA\_ROOT\_MSG}
9. Define tmp path {DATA\_ROOT\_TMP}
10. Define python version {PYTHON\_VERSION}
11. Define python directory (i.e. result of command "which python") {PYTHON\_DIR}
12. Define GSL path (default paths if installed may be /usr/local/include/gsl or /opt/gsl) {GSL\_DIR}

i.e. these lines in ‘env\_setup.sh’.

```
INSTRUMENT_NAME="SPIROU"
DIR="/data/spirou/drs"
INSTALL_ROOT="$DIR/INTROOT"
DATA_ROOT="$DIR/data"
DATA_RAW_ROOT="$DATA_ROOT/raw/"
DATA_ROOT_REDUCED="$DATA_ROOT/reduced/"
DATA_ROOT_CALIB="$DATA_ROOT/calibDB"
DATA_ROOT_MSG="$DATA_ROOT/msg/"
DATA_ROOT_TMP="$DATA_ROOT/tmp/"
PYTHON_VERSION="2.7"
PYTHON_DIR="$DIR/python/miniconda2/"
GSL_DIR="$DIR/c-libraries/gsl"
```

where any pre-defined variable can be used with a preceding \$ sign (to avoid repetition - coloured above in red).

### 1.2.2 Adding variables to .bashrc file

Open ‘~.bashrc’ in your favourite text editor.

Add the following to it:



```

export INSTRUMENT={INSTRUMENT_NAME}
export DRS_DATA_RAW={DATA_ROOT_RAW}
export DRS_DATA_REDUC={DATA_ROOT_REDUCED}
export DRS_CALIB_DB={DATA_ROOT_CALIB}
export DRS_DATA_MSG={DATA_ROOT_MSG}
export DRS_DATA_WORKING={DATA_ROOT_TMP}
export TDATA={DATA_ROOT}

export INTROOT={INSTALL_ROOT}
export PATH={INSTALL_ROOT}/bin:{PYTHON_DIR}/bin/:$PATH
export PYTHONPATH=./:{PYTHON_DIR}/lib/python{PYTHON_VERSION}/site-packages/:{INSTALL_ROOT}/bin
export DRS_LOG=1
export PYTHON_INCLUDE_DIR="{PYTHON_DIR}/lib/python{PYTHON_VERSION}/site-packages/numpy/core/
include"
export GSL_INCLUDE_DIR={GSL_DIR}/include
export GSL_LIBRARY_DIR={GSL_DIR}/lib

```

where:

- `{INSTRUMENT_NAME}` = Set the instrument name
- `{DATA_ROOT}` = Directory in which all SPIROU files go
- `{INSTALL_ROOT}` = Define installation folder name
- `{DATA_ROOT}` = Define data folder name
- `{DATA_ROOT_RAW}` = Define raw path
- `{DATA_ROOT_REDUCED}` Define reduced path
- `{DATA_ROOT_CALIB}` = Define calibDB path
- `{DATA_ROOT_MSG}` = Define msg path
- `{DATA_ROOT_TMP}` = Define tmp path
- `{PYTHON_VERSION}` = Define python version
- `{PYTHON_DIR}` = Define python directory (i.e. result of command "which python")
- `{GSL_DIR}` = Define GSL path (default paths if installed may be /usr/local/include/gsl or /opt/gsl)

### 1.3 Setup up and check file structure

Make sure the following folders are created:

```

mkdir {DIR}
mkdir {DIR}/{INSTALL_ROOT}/bin
mkdir {DATA_ROOT}
mkdir {DATA_RAW_ROOT}
mkdir {DATA_ROOT_REDUCED}
mkdir {DATA_ROOT_CALIB}
mkdir {DATA_ROOT_MSG}
mkdir {DATA_ROOT_TMP}

```

i.e. for the above ‘env\_setup.sh’ this would be

```
mkdir "/data/spirou/drs"
mkdir "/data/spirou/drs/INTROOT/bin"
mkdir "/data/spirou/drs/data"
mkdir "/data/spirou/drs/data/raw"
mkdir "/data/spirou/drs/data/reduced"
mkdir "/data/spirou/drs/data/calibDB"
mkdir "/data/spirou/drs/data/msg"
mkdir "/data/spirou/drs/data/tmp"
```

## 1.4 Fortran and C back-end installation

### 1.4.1 Checking Fortran/C back-ends

!!!! TODO !!!! design checks for Fortran and C, or do we just say that installation requires Fortran and C to be install (Installing Fortran and C will require root access). !!!!

Please check whether Fortran and C are installed. In addition to C you will need the C package ‘GSL’, check that it is installed (default paths may be: /usr/local/include/gsl or /opt/gsl). If it is not installed please follow the instructions in Section 1.4.2.

### 1.4.2 Installing GSL back-ends without root access

To install GSL without root us the following steps:

1. download from <http://ftpmirror.gnu.org/gsl/>

```
wget http://ftpmirror.gnu.org/gsl/gsl-1.16.tar.gz
```

2. create the {GSL\_DIR} (from above)

```
mkdir {GSL_DIR}
```

3. untar the GSL files

```
tar -xvf gsl-1.16.tar.gz
```

4. change to untarred directory

```
cd gsl-1.16/
```

5. configure the installation dir for GSL

```
./configure prefix={GSL_DIR}
```

6. build the GSL installation

```
make
```

7. install the GSL installation

```
make install
```

## 1.5 Install isolated version of Python

As the current DRS requires specific versions of modules to run we recommend a isolated version of python (as to not interfere with your system or running other python codes). Python installation must meet the following specifications:

- numpy 1.8.2 (versions later than 1.8.2 are unsupported)
- scipy 0.14
- matplotlib 1.3.1
- pyfits 3.2.4

Hence installing Miniconda (a minimal version of the anaconda python distribution) is the easiest way to achieve this in an isolated environment (as not to destroy any current/system version of python). See section 1.5.1 for Miniconda install instructions.

### 1.5.1 Installing Miniconda

To install Miniconda follow the steps below:

1. download miniconda from here: <https://conda.io/miniconda.html>

```
wget https://repo.continuum.io/miniconda/Miniconda2-latest-Linux-x86_64.sh
```

2. run bash script

```
bash Miniconda2-latest-Linux-x86_64.sh
```

Note: choose Miniconda installation directory to match `{PYTHON_DIR}` above  
 Note: if you wish to activate this environment/use other python installations do not add Miniconda2 install location to PATH in `~/.bashrc`

3. add `{PYTHON_DIR}` to FRONT of PATH environment (temporarily).

```
export PATH={PYTHON_DIR}/bin:$PATH
```

4. check that we are using the correct version of python/conda/pip

```
which python
```

Should read:

```
{PYTHON_DIR}/bin/python
```

or

```
{PYTHON_DIR}/bin/python{PYTHON_VERSION}
```

similarly for

```
which conda
which pip
```

which should read:

```
{PYTHON_DIR}/bin/conda
```

and

```
{PYTHON_DIR}/bin/pip respectively
```

## 1.6 Install required python modules

### 1.6.1 Installation

1. install numpy with miniconda

```
conda install numpy==1.8.2
```

```

Fetching package metadata .....
Solving package specifications: .

Package plan for installation in environment /scratch/bin/miniconda2/test:

The following NEW packages will be INSTALLED:

  libgfortran: 1.0-0
  numpy:       1.8.2-py27_1

The following packages will be UPDATED:

  conda:         4.3.21-py27_0 --> 4.3.27-py27hff99c7a_0

Proceed ([y]/n)? y
```

2. install scipy with miniconda

```
conda install scipy==0.14
```

```

Fetching package metadata .....
Solving package specifications: .

Package plan for installation in environment /scratch/bin/miniconda2/test:

The following NEW packages will be INSTALLED:

  scipy:        0.14.0-np18py27_0

The following packages will be UPDATED:

  conda-env:    2.6.0-0 --> 2.6.0-h36134e3_1

Proceed ([y]/n)? y
```

3. install matplotlib with miniconda

```
conda install matplotlib==1.3.1
```

```

Fetching package metadata .....
Solving package specifications: .

Package plan for installation in environment /scratch/bin/miniconda2/test:
```

The following NEW packages will be INSTALLED:

```

cairo:      1.12.18-0
dateutil:   2.4.1-py27_0
freetype:   2.4.10-0
libpng:     1.5.13-1
matplotlib: 1.3.1-np18py27_1
pixman:     0.26.2-0
py2cairo:   1.10.0-py27_2
pyqt:       4.10.4-py27_0
pytz:       2017.2-py27hcac29fa_1
qt:         4.8.5-0
sip:        4.15.5-py27_0

```

The following packages will be DOWNGRADED:

```

pyparsing:  2.1.4-py27_0      --> 2.0.1-py27_0

```

Proceed ([ y ]/ n ) ? y

- download pyfits 3.2.4 from [http://www.stsci.edu/institute/software\\_hardware/pyfits/Download](http://www.stsci.edu/institute/software_hardware/pyfits/Download)

```
wget https://pypi.python.org/packages/source/p/pyfits/pyfits-3.2.4.tar.gz
```

- install pyfits with pip

```
pip install pyfits-3.2.4.tar.gz
```

### 1.6.2 Checking installed module versions

Before we continue we should check python and module installation.

- run python

```
python
```

Inside python run following commands

```

>>> import numpy
>>> import matplotlib
>>> import scipy
>>> import pyfits

```

Test the version with:

```

>>> numpy.__version__
1.8.2
>>> matplotlib.__version__
1.3.1
>>> scipy.__version__
0.14.0
>>> pyfits.__version__
3.2.4

```

## Chapter 2

# Installation

This is just for use with the current installation files (version 43), the author does not recommend that this is the final set-up procedure, nor that any of the ‘modifications’ to the original source code applied here should be used in any final version of the DRS (better solutions should be found).

### 2.1 Activate environment

If you followed the steps in [1.2.1](#) please follow this section, if however you followed the steps in [1.2.2](#) continue to Section [2.2](#).

Before running the installation (or before running the code) one must run the following:

```
source env_setup.sh
```

Output should look like this:

```
=====
Environmental setup for SPIRou Pipeline
=====
Setting up environment
Set up for {INSTRUMENT}
- Python located at: {PYTHON_DIR}
- GLS located at: {GSL_DIR}
- data located at:
  {DATA_ROOT}
  {DATA_RAW_ROOT}
  {DATA_ROOT_REDUCED}
  {DATA_ROOT_CALIB}
  {DATA_ROOT_MSG}
  {DATA_ROOT_TMP}

Done
```

Note to deactivate type

```
source env_setup.sh --clean
```

## 2.2 Downloading the install scripts

Minor modifications need to be made to the code to allow a isolated version of GSL to be used. If and only if your GSL is installed to ‘/opt/gsl/’ will the code install correctly with out this modification.

The other steps are as in the original installation procedure.

1. change directory to {DIR}

```
{DIR}
```

2. download source code for spirou, location should be {DIR}/spirou

```
svn co https://svn.lam.fr/repos/spirou/trunk spirou
```

1. change directory to source files

```
cd {DIR}/spirou/src
```

2. find and change {DIR}/spirou/src/C/setup.py

- a) Below the line {PYTHON\_INCLUDE\_DIR} = os.getenv('{PYTHON\_INCLUDE\_DIR}') add the following:

```
gsl_include_dir = os.getenv('GSL_INCLUDE_DIR')
gsl_library_dir = os.getenv('GSL_LIBRARY_DIR')
```

- b) Find and replace all instances of

```
include_dirs = [python_include_dir, '/opt/gsl/include'],
```

with

```
include_dirs = [python_include_dir, gsl_include_dir],
```

- c) Find and replace all instances of

```
library_dirs = ['/opt/gsl/lib'],
```

with

```
library_dirs = [gsl_library_dir],
```

## 2.3 Running installation scripts

run installation scripts

```
./hardrsInstall SPIROU 2.7
./scriptInstall SPIROU 2.7
```

## 2.4 Updating local version

The code currently uses ‘Subversion’ (SVN) to monitor the different versions of the code that is under development. To update a local version of the DRS:

1. Go inside the {DIR}/spirou folder:

```
cd \{DIR\}/spirou
```

2. Type:

```
svn update
```

You will then receive information on the DRS version.

3. Then you need to re-install the DRS. This will rewrite all codes in the {INSTALL\_ROOT} folder.

Reinstall the DRS using:

```
cd src
./hardrsInstall SPIROU 2.7
./scriptInstall SPIROU 2.7
```

You are now ready to work with the latest version.

## 2.5 Adding new files to the shared DRS

Note: this is only to be done if your new functions are running correctly.

1. Go inside the {DIR}/spirou folder:

```
cd \{DIR\}/spirou
```

2. run the update on the svn

```
svn update
```

3. copy your modifications into the source code:

```
cp {modified file} src/{location of new file}
```

4. Add the file to the list of pending SVN files:

```
svn add src/{location of new file}
```

5. once all new files are added, commit to releasing the modifications to the SVN:

```
svn commit -m 'modification of {file name}'
```

### 2.5.1 Useful links about subversion

:

Presentation: [http://multithread.org/files/presentations/subversion/subversion\\_tutorial.pdf](http://multithread.org/files/presentations/subversion/subversion_tutorial.pdf) Book: <http://svnbook.red-bean.com/> Introduction to subversion: [https://dev.nozav.org/intro\\_svn.html](https://dev.nozav.org/intro_svn.html)



## Chapter 3

# Using the DRS

### 3.1 Running the code

To run the DRS python (assuming `env_setup` is activated, see Section 2.1) type:

```
DRS_{INSTRUMENT} -m
```

i.e.

```
DRS_spirou -m {PROGRAM NAME} {FOLDER} {FILES}  
DRS_spirou -m cal_DARK_spirou {YYMMDD} {FileNames*}
```

instead of python

Note: location of script should be `{DIR}/{INSTALL_ROOT}/bin/DRS{INSTRUMENT}` i.e. for 'cal\_DARK\_spirou' in the `{DATA_RAW_ROOT}/YYMMDD` directory one would result in something like the following:

```
DRS_spirou -m cal_DARK_spirou YYMMDD FileNames*
```

```
19:44:52.5 - || *****  
19:44:52.5 - || * SPIROU (@) Geneva Observatory ()  
19:44:52.5 - || *****  
19:44:52.5 - || (dir_data_raw)      DRS_DATA_RAW=/data/spirou/drs/data/raw/  
19:44:52.5 - || (dir_data_reduc)     DRS_DATA_REDUCE=/data/spirou/drs/data/reduced/  
19:44:52.5 - || (dir_drs_config)    DRS_CONFIG=/data/spirou/drs/INTROOT/DRS_SPIROU/config/  
19:44:52.5 - || (dir_calib_db)      DRS_CALIB_DB=/data/spirou/drs/data/calibDB  
19:44:52.5 - || (dir_data_msg)      DRS_DATA_MSG=/data/spirou/drs/data/msg/  
19:44:52.5 - || (print_log)         DRS_LOG=1          %(0: minimum stdin-out logs)  
19:44:52.5 - || (plot_graph)        DRS_PLOT=NONE          %(def/undef/trigger)  
19:44:52.5 - || (used_date)         DRS_USED_DATE=undefined  
19:44:52.5 - || (working_dir)       DRS_DATA_WORKING=/data/spirou/drs/data/tmp/  
19:44:52.5 - ||                   DRS_INTERACTIVE is not set, running on-line mode  
19:44:52.5 - |-c:[...]Now running : -c on file(s): dark_dark...  
19:44:52.5 - |-c:[...]On directory /data/spirou/drs/data/raw/20170811  
19:44:52.5 - |-c:[...]ICDP loaded from: /data/spirou/drs/INTROOT/DRS_SPIROU/config/  
          hadmrICDP_SPIROU.py  
19:44:52.5 - * |-c:[...]Now processing Image TYPE DARK with -c recipe  
19:44:52.5 - |-c:[...]Reading Image /data/spirou/drs/data/raw/20170811/dark_dark02d.fits  
19:44:52.5 - |-c:[...]Image 2048x2048 loaded
```

## 3.2 Working example of the code for SPIrou

### 3.2.1 Overview

For this example all files are from:

```
spirou@10.102.14.81:/data/RawImages/H2RG-AT4/AT4-04/2017-07-10_15-36-18/ramps/
```

Will also need current WAVE file from here:

```
spirou@10.102.14.81:/data/reduced/DATA-CALIB/spirou_wave_ini3.fits
```

This assumes a correct setup using all variables as in previous sections i.e.:

```
INSTRUMENT_NAME="SPIROU"
DIR="/data/spirou/drs"
INSTALL_ROOT="$DIR/INTROOT"
DATA_ROOT="$DIR/data"
DATA_RAW_ROOT="$DATA_ROOT/raw/"
DATA_ROOT_REDUCED="$DATA_ROOT/reduced/"
DATA_ROOT_CALIB="$DATA_ROOT/calibDB"
DATA_ROOT_MSG="$DATA_ROOT/msg/"
DATA_ROOT_TMP="$DATA_ROOT/tmp/"
PYTHON_VERSION="2.7"
PYTHON_DIR="$DIR/python/miniconda2/"
GSL_DIR="$DIR/c-libraries/gsl"
```

All files from

```
spirou@10.102.14.81:/data/RawImages/H2RG-AT4/AT4-04/2017-07-10_15-36-18/ramps/
```

must be placed in a folder named '20170710' in `{DATA_RAW_ROOT}` (`/data/spirou/-drs/data/raw`).

Starting with RAMP files and ending with extracted orders and calculated drifts we need to run six codes:

1. `cal_DARK_spirou.py` (See Section 6.2)
2. `cal_loc_RAW_spirou.py` ( $\times 2$ ) (See Section 6.3)
3. `cal_SLIT_spirou.py` (See Section 6.4)
4. `cal_FF_RAW_spirou.py` ( $\times 2$ ) (See Section 6.5)
5. (add `spirou_wave_ini3.fits` to `calibDB`)
6. `cal_extract_RAW_spirouAB.py` and `cal_extract_RAW_spirouC.py` (many times)  
(See Section 6.6)
7. `cal_DRIFT_RAW_spirou` (See Section 6.7)

### 3.2.2 Command-by-command run through

We next list the exact commands used to go from the RAMPs to the extract orders and calculated drifts.

1. Change to the `{DIR}` directory

```
cd DIR
```

2. Activate the environment (in bash only if not using the ‘.bashrc’ method)

```
source env_setup.sh
```

3. Check that environment is active (only if using ‘env\_setup.sh’ and if not using the ‘.bashrc’ method).

```
echo $DRS_ACTIVE
```

result should be = 1

4. run the dark extraction on the ‘dark\_dark’ file:

```
DRS_spirou -m cal_DARK_spirou.py 20170710 dark_dark02d406.fits
```

5. run the order localisation on the ‘dark\_flat’ files:

```
DRS_spirou -m cal_loc_RAW_spirou.py 20170710 dark_flat02f10.fits dark_flat03f10.fits
dark_flat04f10.fits dark_flat05f10.fits dark_flat06f10.fits
```

6. run the order localisation on the ‘flat\_dark’ files:

```
DRS_spirou -m cal_loc_RAW_spirou.py 20170710 flat_dark02f10.fits flat_dark03f10.fits
flat_dark04f10.fits flat_dark05f10.fits flat_dark06f10.fits
```

7. run the slit calibration on the ‘fp\_fp’ files.

```
DRS_spirou -m cal_SLIT_spirou.py 20170710 fp_fp02a203.fits fp_fp03a203.fits fp_fp04a203.
fits
```

8. run the flat field creation on the ‘dark\_flat’ files:

Note: if using same files as above you will get an error message when running the file. To solve this open the ‘master\_calib\_SPIROU.txt’ file located in {DATA\_ROOT\_CALIB}. Edit the unix date in the line that begins ‘TILT’ so that it is less than the unix date on rws ‘ORDER\_PROFIL\_AB’ (i.e. change it from 1499707515.0 to 1499705515.0).

i.e. the ‘master\_calib\_SPIROU.txt’ file should look go from

```
DARK 20170710 dark_dark02d406.fits 07/10/17/16:37:48 1499704668.0
ORDER_PROFIL_C 20170710 dark_flat02f10_order_profil_C.fits 07/10/17/17:03:50 1499706230.0
LOC_C 20170710 dark_flat02f10_loco_C.fits 07/10/17/17:03:50 1499706230.0
ORDER_PROFIL_AB 20170710 flat_dark02f10_order_profil_AB.fits 07/10/17/17:07:08 1499706428.0
LOC_AB 20170710 flat_dark02f10_loco_AB.fits 07/10/17/17:07:08 1499706428.0
TILT 20170710 fp_fp02a203_tilt.fits 07/10/17/17:25:15 1499707515.0
```

to this:

```
DARK 20170710 dark_dark02d406.fits 07/10/17/16:37:48 1499704668.0
ORDER_PROFIL_C 20170710 dark_flat02f10_order_profil_C.fits 07/10/17/17:03:50 1499706230.0
LOC_C 20170710 dark_flat02f10_loco_C.fits 07/10/17/17:03:50 1499706230.0
ORDER_PROFIL_AB 20170710 flat_dark02f10_order_profil_AB.fits 07/10/17/17:07:08 1499706428.0
LOC_AB 20170710 flat_dark02f10_loco_AB.fits 07/10/17/17:07:08 1499706428.0
TILT 20170710 fp_fp02a203_tilt.fits 07/10/17/17:25:15 1499705515.0
```

```
DRS_spirou -m cal_FF_RAW_spirou.py 20170710 dark_flat02f10.fits dark_flat03f10.fits
dark_flat04f10.fits dark_flat05f10.fits dark_flat06f10.fits
```

9. run the flat field creation on the ‘flat\_dark’ files:

```
DRS_spirou -m cal_FF_RAW_spirou.py 20170710 flat_dark02f10.fits flat_dark03f10.fits
flat_dark04f10.fits flat_dark05f10.fits flat_dark06f10.fits
```

10. Currently we do not create a new wavelength calibration file for this run. Therefore we need to get one from here:

```
spirou@10.102.14.81:/data/reduced/DATA-CALIB/spirou_wave_ini3.fits
```

then place it in the `{DATA_ROOT_CALIB}` folder. You will also need to edit the ‘master\_calib\_SPIROU.txt’ file located in `{DATA_ROOT_CALIB}`. Add the following line to ‘master\_calib\_SPIROU.txt’

```
WAVE 20170710 spirou_wave_ini3.fits 07/10/17/17:03:50 1499706230.0
```

and the ‘master\_calib\_SPIROU.txt’ should look like this:

```
DARK 20170710 dark_dark02d406.fits 07/10/17/16:37:48 1499704668.0
ORDER_PROFIL_C 20170710 dark_flat02f10_order_profil_C.fits 07/10/17/17:03:50 1499706230.0
LOC_C 20170710 dark_flat02f10_loco_C.fits 07/10/17/17:03:50 1499706230.0
ORDER_PROFIL_AB 20170710 flat_dark02f10_order_profil_AB.fits 07/10/17/17:07:08 1499706428.0
LOC_AB 20170710 flat_dark02f10_loco_AB.fits 07/10/17/17:07:08 1499706428.0
TILT 20170710 fp_fp02a203_tilt.fits 07/10/17/17:25:15 1499705515.0
FLAT_C 20170710 dark_flat02f10_flat_C.fits 07/10/17/17:03:50 1499706230.0
WAVE 20170710 spirou_wave_ini3.fits 07/10/17/17:03:50 1499706230.0
```

11. run the extraction files on the ‘hcone\_dark’, ‘dark\_hcone’, ‘hcone\_hcone’, ‘dark\_dark\_AHC1’, ‘hctwo\_dark’, ‘dark\_hctwo’, ‘hctwo-hctwo’, ‘dark\_dark\_AHC2’ and ‘fp\_fp’ files:

```
DRS_spirou -m cal_extract_RAW_spirouAB.py 20170710 hcone_dark02c61.fits hcone_dark03c61.
fits hcone_dark04c61.fits hcone_dark05c61.fits hcone_dark06c61.fits
```

```
DRS_spirou -m cal_extract_RAW_spirouC.py 20170710 dark_hcone02c61.fits dark_hcone03c61.
fits dark_hcone04c61.fits dark_hcone05c61.fits dark_hcone06c61.fits
```

```
DRS_spirou -m cal_extract_RAW_spirouAB.py 20170710 hcone_hcone02c61.fits hcone_hcone03c61.
fits hcone_hcone04c61.fits hcone_hcone05c61.fits hcone_hcone06c61.fits
```

```
DRS_spirou -m cal_extract_RAW_spirouC.py 20170710 hcone_hcone02c61.fits hcone_hcone03c61.
fits hcone_hcone04c61.fits hcone_hcone05c61.fits hcone_hcone06c61.fits
```

```
DRS_spirou -m cal_extract_RAW_spirouAB.py 20170710 dark_dark_AHC102d61.fits
dark_dark_AHC103d61.fits dark_dark_AHC104d61.fits dark_dark_AHC105d61.fits
dark_dark_AHC106d61.fits
```

```
DRS_spirou -m cal_extract_RAW_spirouC.py 20170710 dark_dark_AHC102d61.fits
dark_dark_AHC103d61.fits dark_dark_AHC104d61.fits dark_dark_AHC105d61.fits
dark_dark_AHC106d61.fits
```

```
DRS_spirou -m cal_extract_RAW_spirouAB.py 20170710 hctwo_dark02c61.fits hctwo_dark03c61.
fits hctwo_dark04c61.fits hctwo_dark05c61.fits hctwo_dark06c61.fits
```

```
DRS_spirou -m cal_extract_RAW_spirouC.py 20170710 hctwo_dark02c61.fits hctwo_dark03c61.
fits hctwo_dark04c61.fits hctwo_dark05c61.fits hctwo_dark06c61.fits
```

```
DRS_spirou -m cal_extract_RAW_spirouAB.py 20170710 dark_hctwo02c61.fits dark_hctwo03c61.
fits dark_hctwo04c61.fits dark_hctwo05c61.fits dark_hctwo06c61.fits
```

```
DRS_spirou -m cal_extract_RAW_spirouC.py 20170710 dark_hctwo02c61.fits dark_hctwo03c61.
fits dark_hctwo04c61.fits dark_hctwo05c61.fits dark_hctwo06c61.fits
```

```
DRS_spirou -m cal_extract_RAW_spirouAB.py 20170710 hctwo-hctwo02c61.fits hctwo-hctwo03c61.
fits hctwo-hctwo04c61.fits hctwo-hctwo05c61.fits hctwo-hctwo06c61.fits
```

```
DRS_spirou -m cal_extract_RAW_spirouC.py 20170710 hctwo-hctwo02c61.fits hctwo-hctwo03c61.
fits hctwo-hctwo04c61.fits hctwo-hctwo05c61.fits hctwo-hctwo06c61.fits
```

```
DRS_spirou -m cal_extract_RAW_spirouAB.py 20170710 dark_dark_AHC202d61.fits
dark_dark_AHC203d61.fits dark_dark_AHC204d61.fits dark_dark_AHC205d61.fits
dark_dark_AHC206d61.fits
```

```
DRS_spirou -m cal_extract_RAW_spirouC.py 20170710 dark_dark_AHC202d61.fits
dark_dark_AHC203d61.fits dark_dark_AHC204d61.fits dark_dark_AHC205d61.fits
dark_dark_AHC206d61.fits
```

```
DRS_spirou -m cal_extract_RAW_spirouAB.py 20170710 fp_fp02a203.fits fp_fp03a203.fits
fp_fp04a203.fits
```

```
DRS_spirou -m cal_extract_RAW_spirouC.py 20170710 fp_fp02a203.fits fp_fp03a203.fits
fp_fp04a203.fits
```

12. run the drift calculation on the 'fp\_fp' files:

```
DRS_spirou -m cal_DRIFT_RAW_spirou.py 20170710 fp_fp02a203.fits fp_fp03a203.fits
fp_fp04a203.fits
```

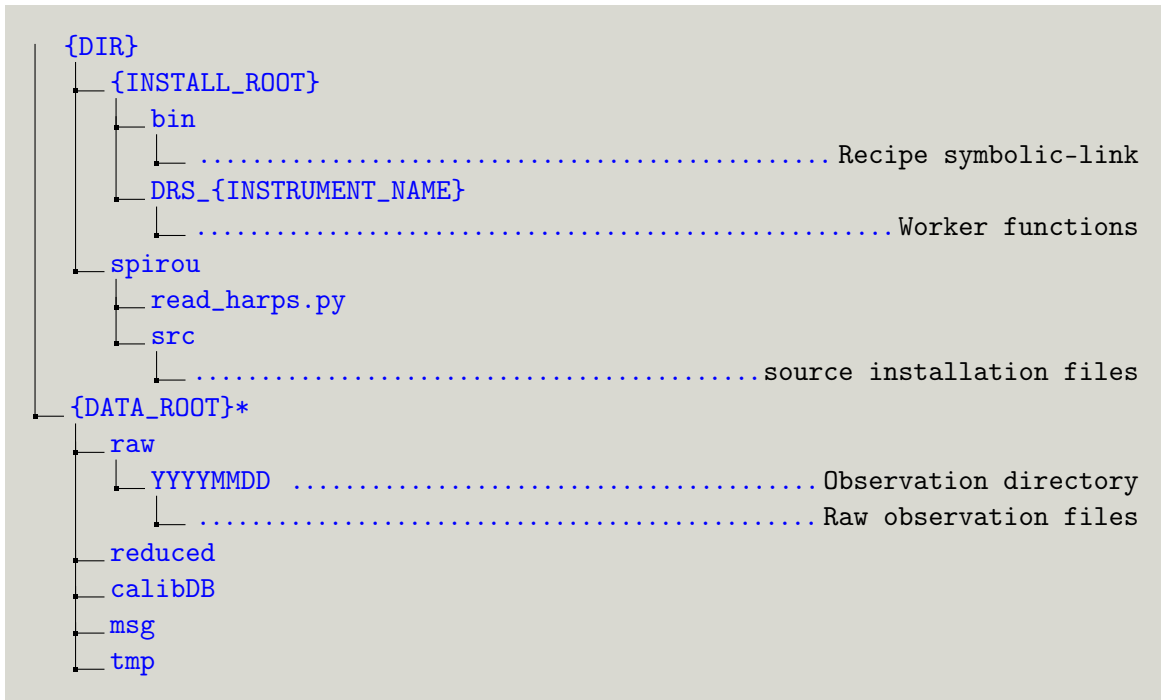
## Chapter 4

# Data Architecture

Below we describe the data architecture, first by providing the installed file structure in a tree diagram (4.1), and then describing individual directories.

### 4.1 Installed file structure

The file structure should look as follows:



\* Note that this is the recommended file structure and raw, reduced, calibDB, msg and tmp can be changed using the `{DATA_ROOT_RAW}`, `{DATA_ROOT_REDUCED}`, `{DATA_ROOT_CALIB}`, `{DATA_ROOT_MSG}`, and `{DATA_ROOT_TMP}` variables in 1.2.

i.e. for the given ‘env\_setup.sh’ (Appendix A) this would be:

```

/data/spirou/drs
├── INTROOT/
│   ├── bin
│   │   └── ..... Recipe symbolic-link
│   ├── DRS_SPIROU
│   │   └── ..... Worker functions
│   └── data
│       ├── raw
│       │   ├── YYYYMMDD ..... night_repository
│       │   └── ..... Raw observation files
│       ├── reduced
│       ├── calibDB
│       ├── msg
│       ├── tmp
│       └── spirou
│           ├── read_harps.py
│           ├── src
│           └── ..... source installation files

```

## 4.2 The {INSTALL\_ROOT} directory

The {INSTALL\_ROOT} contains all the installed recipes, worker functions and configuration files needed to run the DRS. The file structure is set up as below:

```

/data/spirou/drs
├── {INSTALL_ROOT}
│   ├── bin
│   │   └── ..... Recipes
│   └── DRS_SPIROU

```

### 4.2.1 The bin directory

The bin directory is located in the {INSTALL\_ROOT} directory. This contains symbolic links to the DRS recipes.

### 4.2.2 The DRS\_SPIROU directory

The DRS\_SPIROU directory contains all the worker functions and configuration files for the DRS. The file structure is as follows:

```

DRS_SPIROU
├── C
│   └── .....The C programs and setup.py
├── config
│   └── .....The config files
├── docs
├── fortran
│   └── .....The fortran programs and install.csh
├── man
├── python
│   ├── C-modules
│   ├── f2pymodules
│   ├── Modules
│   └── Recipes
└── util

```

The C and Fortran functions are found in their own directories. The configuration files are explained in Section 4.5.

The python directory contains the translation of the C and fortran functions into python (C-modules and f2pymodules directories).

The functions ‘startup.py’ and ‘startup\_recipes.py’ are called automatically by the recipes.

‘python.csh’ is the custom python environment for the DRS.

The python modules are explained in Section 5 and the recipes are explained in Section 6.

### 4.3 The {DATA\_ROOT} directory

This is the directory where all the data should be stored. The default and recommended design is to have {DATA\_ROOT\_RAW}, {DATA\_ROOT\_REDUCED}, {DATA\_ROOT\_CALIB}, {DATA\_ROOT\_MSG}, and {DATA\_ROOT\_TMP} as sub-directories of {DATA\_ROOT}. However as in Section 1.2 these sub-directories can be defined elsewhere.



### 4.3.1 The raw and reduced data directories

The raw observed data is stored under the `{DATA_ROOT_RAW}` path, the files are stored by night in the form YYYYMMDD.

The file structure can be seen below:

```
{DATA_ROOT_RAW}
├── YYYYMMDD .....night_repository
│   ├── .....Raw observation files
│   ├── dark_dark{name}.fits
│   ├── dark_flat{name}.fits
│   ├── flat_dark{name}.fits
│   └── fp_fp{name}.fits
```

## 4.4 The calibration database directory

```
{DATA_ROOT}
├── calibDB or {DATA_ROOT_CALIB}
│   ├── master_calib_SPIROU.txt
│   └── .....The calibration fits files
```

The calibDB contains all the calibration files that pass the quality tests and a test file 'master\_calib.txt'. It is located at `{DATA_ROOT_CALIB}` or if this is not defined is located by default at the `{DATA_ROOT}` directory.

Each line in this file is a unique calibration file and lines are formatted in the following manner:

```
{key} {night_repository} {filename} {human readable date} {unix time}
```

where

- `{key}` is a code assigned for each type of calibration file. Currently accepted keys are:
  - DARK - Created from cal\_DARK\_spirou
  - ORDER\_PROFIL\_{fiber} - Created in cal\_loc\_RAW\_spirou
  - LOC\_C - Created in cal\_loc\_RAW\_spirou
  - TILT - Created in cal\_SLIT\_spirou
  - FLAT\_{fiber} - Created in cal\_FF\_RAW\_spirou
  - WAVE - Currently manually added
- `{night_repository}` is the raw data observation directory (in `{DATA_ROOT_RAW}`) normally in the form YYYYMMDD.

- `{filename}` is the filename of the calibration file (located in the calibDB).
- `{human readable date}` is the date in DD/MM/YY/HH:MM:SS format taken from the header of the file that created the calibration file (using the header keyword ‘ACQTIME1’).
- `{unix time}` is the time (as in `{human readable date}`) but in unix time (in seconds).

An example working master\_calib\_SPIROU.txt is shown below (assuming the listed files are present in `{DATA_ROOT_CALIB}`)

```
DARK 20170710 dark_dark02d406.fits 07/10/17/16:37:48 1499704668.0
ORDER_PROFIL_C 20170710 dark_flat02f10_order_profil_C.fits 07/10/17/17:03:50 1499706230.0
LOC_C 20170710 dark_flat02f10_loco_C.fits 07/10/17/17:03:50 1499706230.0
ORDER_PROFIL_AB 20170710 flat_dark02f10_order_profil_AB.fits 07/10/17/17:07:08 1499706428.0
LOC_AB 20170710 flat_dark02f10_loco_AB.fits 07/10/17/17:07:08 1499706428.0
TILT 20170710 fp_fp02a203_tilt.fits 07/10/17/17:25:15 1499705515.0
FLAT_C 20170710 dark_flat02f10_flat_C.fits 07/10/17/17:03:50 1499706230.0
WAVE 20170710 spirou_wave_ini3.fits 07/10/17/17:03:50 1499706230.0
```

## 4.5 The configuration files

Some text here.

## Chapter 5

# The Modules

Some text here

### 5.1 The Module directory

This contains all the python worker files for the DRS. The file structure is as below.

```
{DIR}
├── {INSTALL_ROOT}
│   └── DRS_SPIROU
│       └── python
│           └── Modules
│               ├── hadgtVISU
│               │   └── .....hadmrVISU module files
│               ├── hadmrBACK
│               │   └── .....hadmrBACK module files
│               ├── hadmrBIAS
│               │   └── .....hadmrBIAS module files
│               ├── hadmrCDB
│               │   └── .....hadmrCDB module files
│               ├── hadmrDARK
│               │   └── .....hadmrDARK module files
│               ├── hadmrEXTOR
│               │   └── .....hadmrEXTOR module files
│               ├── hadmrFITS
│               │   └── .....hadmrFITS module files
│               ├── hadmrFLAT
│               │   └── .....hadmrFLAT module files
│               ├── hadmrLED
│               │   └── .....hadmrLED module files
│               └── hadmrLOCOR
│                   └── .....hadmrLOCOR module files
```



## 5.2 spirouBACK

spirouBACK.py contains functions to calculate the detector background

## 5.3 spirouCDB

spirouCDB.py: contains functions for the calibrations database (infos for master\_calib.txt, and to copy files in the caliDB directory)

## 5.4 spirouEXTOR

spirouEXTOR.py: contains function for the ordres extraction

## 5.5 spirouFITS

spirouFITS.py: contains functions to read FITS file and copy keywords

## 5.6 spirouLOCOR

spirouLOCOR.py: contains functions for order localization

## 5.7 spirouRV

spirouRV.py: contains functions to compute radial velocity

## 5.8 spirouVISU

spirouVISU.py: contains functions for visualization

## Chapter 6

# The Recipes

### 6.1 The Recipe directory

These are symbolically linked under `{INSTALL_ROOT}/bin`. A list of all current recipes is below:

```
{DIR}
├── {INSTALL_ROOT}
│   ├── DRS_SPIROU
│   │   ├── python
│   │   │   └── Recipes
│   │   │       ├── cal_BIAS_spirou.py
│   │   │       ├── cal_CONTAM_spirou.py
│   │   │       ├── cal_DARK_spirou.py
│   │   │       ├── cal_DRIFT_E2DS_spirou.py
│   │   │       ├── cal_DRIFT_RAW_spirou.py
│   │   │       ├── cal_extract_RAW_spirouAB.py
│   │   │       ├── cal_extract_RAW_spirouALL.py
│   │   │       ├── cal_extract_RAW_spirouC.py
│   │   │       ├── cal_FFPOL_spirou.py
│   │   │       ├── cal_FF_RAW_spirou.py
│   │   │       ├── cal_FF_spirou.py
│   │   │       ├── cal_loc_ONE_spirou.py
│   │   │       ├── cal_loc_RAW_spirou.py
│   │   │       ├── cal_SLIT_spirou.py
│   │   │       ├── cal_TH_spirou.py
│   │   │       ├── cal_WAVE_spirou.py
│   │   │       ├── db_get_files_spirou.py
│   │   │       ├── db_reduce_star_spirou.py
│   │   │       ├── db_update_spirou.py
│   │   │       ├── Install.csh
│   │   │       └── mai_cal_drift_spirou.py
```

```
— mai_compute_drift_spirou.py
— mai_config_wavecal_spirou.py
— mai_make_flux_template_spirou.py
— mai_plot_drift_spirou.py
— obj_ONE_spirou.py
— obj_TH_spirou.py
— obj_TWO_spirou.py
— obj_WAVE_spirou.py
— off_make_bis_spirou.py
— off_make_ccf_spirou.py
— off_make_execCAL_spirou.py
— off_make_execOBJ_spirou.py
— off_make_exec_spirou.py
— off_make_S_spirou.py
— off_visu_bis_spirou.py
— off_visu_ccf_spirou.py
— off_visu_dark_spirou.py
— off_visu_e2ds_spirou.py
— off_visu_rvo_spirou.py
— off_visu_s1d_spirou.py
— off_visu_SN_spirou.py
— ske_recipe_spirou.py
— test_cal_loc_ONE_spirou.py
— visu_RAW_spirou.py
```

## 6.2 cal\_DARK\_spirou

Dark with short exposure time ( 5min, to be defined during AT-4) to check if read-out noise, dark current and hot pixel mask are consistent with the ones obtained during technical night. Quality control is done automatically by the pipeline (see Section 7.1).

!!!! TODO !!!! Once written up the new version update this description !!!!

### 6.2.1 Summary of procedure

1. adds defined 'dark\_dark' files together
2. resizes the image
3. calculates the fraction of dead pixels [full, blue part, red part]
4. calculates median dark level [full, blue part, red part]
5. calculates threshold of dark level to retain
6. removes dead pixels by setting them to 0
7. does some quality control
8. updates calibDB with key "DARK"

### 6.2.2 Running cal\_DARK\_spirou

To run cal\_DARK\_spirou type:

```
cal_DARK_spirou.py night_repository filenames
```

Note: filenames must start with 'dark\_dark'

### 6.2.3 Example working run

An example run where everything worked is below:

```
DRS_spirou -m cal_DARK_spirou.py 20170710 dark_dark02d406.fits

20:44:08.3 - ||DRS SPIROU v (interactive mode)
20:44:08.3 - || *****
20:44:08.3 - || * SPIROU @(#) Geneva Observatory ()
20:44:08.3 - || *****
20:44:08.3 - ||(dir_data_raw) DRS_DATA_RAW=/scratch/Projects/SPIRou_Pipeline/data/raw/
20:44:08.3 - ||(dir_data_reduc) DRS_DATA_REDUC=/scratch/Projects/SPIRou_Pipeline/data/reduced
/
20:44:08.3 - ||(dir_drs_config) DRS_CONFIG=/scratch/Projects/SPIRou_Pipeline/INTRoot/
DRS_SPIROU/config/
20:44:08.3 - ||(dir_calib_db) DRS_CALIB_DB=/scratch/Projects/SPIRou_Pipeline/data/calibDB
20:44:08.3 - ||(dir_data_msg) DRS_DATA_MSG=/scratch/Projects/SPIRou_Pipeline/data/msg/
20:44:08.3 - ||(print_log) DRS_LOG=1 %(0: minimum stdin-out logs)
```



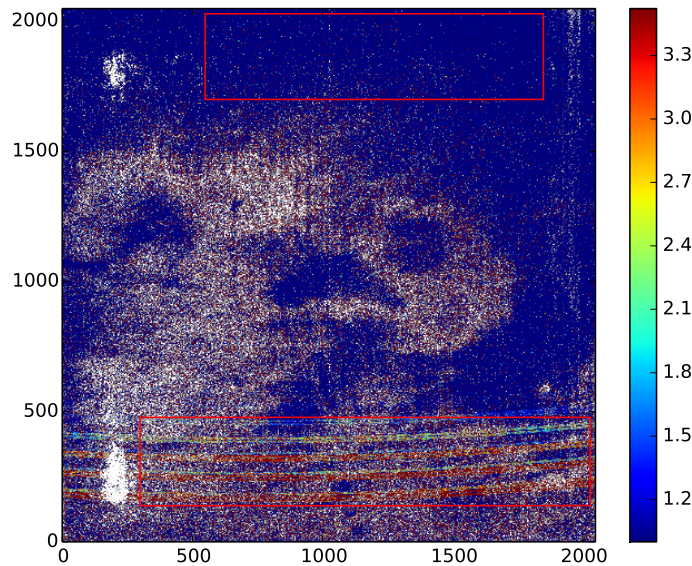
```

20:44:08.3 - |(plot_graph)      DRS_PLOT=NONE          %(def/undef/trigger)
20:44:08.3 - |(used_date)       DRS_USED_DATE=undefined
20:44:08.3 - |(working_dir)    DRS_DATA_WORKING=/scratch/Projects/SPIrou_Pipeline/data/tmp/
20:44:08.3 - ||          DRS_INTERACTIVE is set
20:44:08.3 - * |-c:|Now running : -c on file(s): dark_dark02d406.fits
20:44:08.3 - |-c:|On directory /scratch/Projects/SPIrou_Pipeline/data/raw/20170710
20:44:08.3 - |-c:|ICDP loaded from: /scratch/Projects/SPIrou_Pipeline/INTRoot/DRS_SPIROU/config/
      hadmrICDP_SPIROU.py
20:44:08.3 - * |-c:|Now processing Image TYPE DARK with -c recipe
20:44:08.3 - |-c:|Reading Image /scratch/Projects/SPIrou_Pipeline/data/raw/20170710/
      dark_dark02d406.fits
20:44:08.4 - |-c:|Image 2048x2048 loaded
20:44:08.6 - * |-c:|Dark Time = 597.489 [s]
20:44:08.8 - |-c:|Doing Dark measurement
20:44:10.1 - * |-c:|Whole det : Frac dead pixels= 14.7 % - Median= 0.35 ADU/s - Percent[5:95]=
      0.08-99.57 ADU/s
20:44:10.2 - * |-c:|In Blue part: Frac dead pixels= 1.0 % - Median= 0.15 ADU/s - Percent[5:95]=
      0.09-0.53 ADU/s
20:44:10.3 - * |-c:|In Red part : Frac dead pixels= 20.5 % - Median= 2.11 ADU/s - Percent[5:95]=
      0.18-232.09 ADU/s
20:44:10.4 - * |-c:|Total Frac dead pixels (N.A.N) + DARK > 100.0 ADU/s = 18.9 %
20:44:11.1 - * |-c:|QUALITY CONTROL SUCCESSFUL - Well Done -
20:44:11.1 - |-c:|Saving Dark frame in dark_dark02d406.fits
20:44:12.2 - |-c:|Saving Bad Pixel Map in dark_dark02d406_badpixel.fits
20:44:13.0 - * |-c:|Updating Calib Data Base with DARK
20:44:13.0 - * |-c:|Recipe -c has been succesfully completed

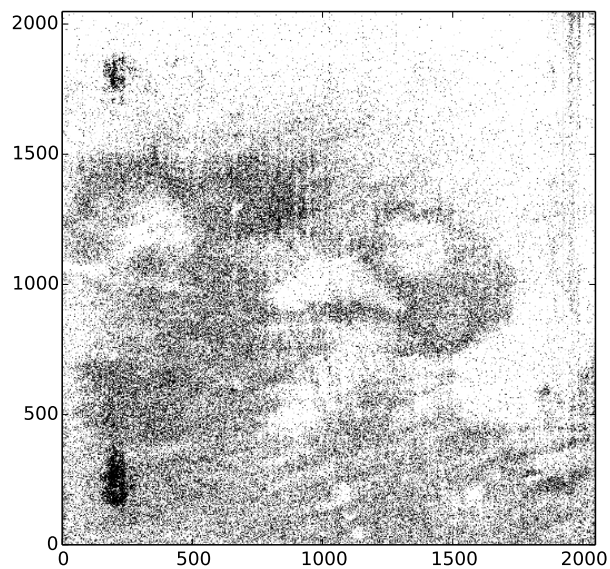
```

#### 6.2.4 Interactive mode

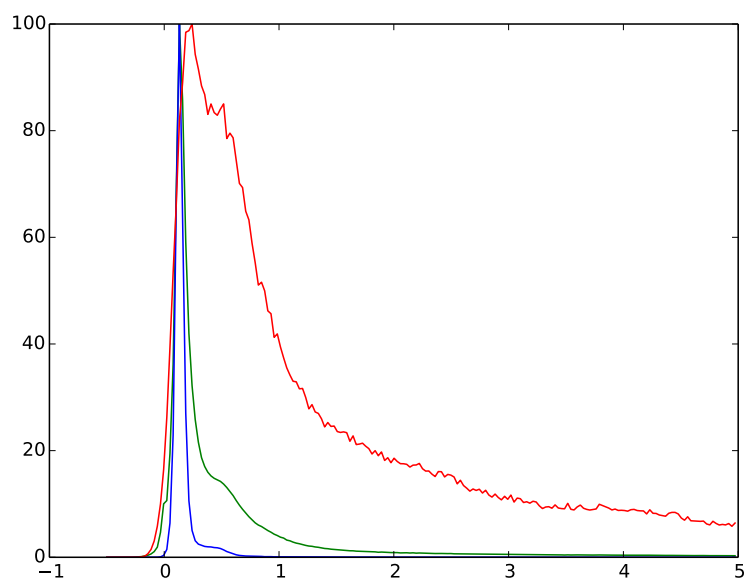
In interactive mode three figures will also appear (see figures 6.1, 6.2, and 6.3).



**Figure 6.1** The image with overplot red and blue regions (red rectangles).



**Figure 6.2** The bad pixel mask, bad pixels have a value=1 (in black) and good pixels have a value=0 (in white).



**Figure 6.3** Histograms of the image regions, the full image (in green), the blue section (in blue) and the red section (in red).

### 6.3 cal\_loc\_RAW\_spirou

Locates the orders on the ‘dark\_flat’ or ‘flat\_dark’ images.

!!!! TODO !!!! Once written up the new version update this description !!!!

#### 6.3.1 Summary of procedure

1. adds all defined ‘dark\_flat’ or ‘flat\_dark’ files together
2. corrects for darks
3. resizes the image
4. constructs ‘order\_profile’ image
5. locates the central pixel of each order
6. steps out in large steps along the order (toward beginning and end)
7. fits the position of each order (using a small 2D box around each fit point)
  - includes a rejection of bad points (while loop)
8. fits the width of each order (using a small 2D box around each fit point)
  - includes a rejection of bad points (while loop)
9. saves the ‘order\_profile’ image (with a superposition of the fit orders as zero values)
10. does some quality control
11. updates calibDB with key “LOC\_{fiber}” where {fiber} = [AB, C] etc

#### 6.3.2 Running cal\_loc\_RAW\_spirou

To run cal\_loc\_RAW\_spirou type:

```
cal_loc_RAW_spirou.py night_repository filenames
```

Note: filenames must start with ‘dark\_flat’ or ‘flat\_dark’

#### 6.3.3 Example working run

An example run where everything worked is below (for ‘dark\_flat’ files):

```

DRS_spirou -m cal_loc_RAW_spirou.py 20170710 dark_flat02f10.fits dark_flat03f10.fits

||DRS SPIROU v (interactive mode)
16:15:58.5 - || *****
16:15:58.5 - || * SPIROU (#) Geneva Observatory ()
16:15:58.5 - || *****
16:15:58.5 - ||(dir_data_raw) DRS_DATA_RAW=/scratch/Projects/SPIrou_Pipeline/data/raw/
16:15:58.5 - ||(dir_data_reduc) DRS_DATA_REDUC=/scratch/Projects/SPIrou_Pipeline/data/reduced
/
16:15:58.5 - ||(dir_drs_config) DRS_CONFIG=/scratch/Projects/SPIrou_Pipeline/INTROOT/
DRS_SPIROU/config/
16:15:58.5 - ||(dir_calib_db) DRS_CALIB_DB=/scratch/Projects/SPIrou_Pipeline/data/calibDB
16:15:58.5 - ||(dir_data_msg) DRS_DATA_MSG=/scratch/Projects/SPIrou_Pipeline/data/msg/
16:15:58.5 - ||(print_log) DRS_LOG=1 %(0: minimum stdin-out logs)
16:15:58.5 - ||(plot_graph) DRS_PLOT=NONE %(def/undef/trigger)
16:15:58.5 - ||(used_date) DRS_USED_DATE=undefined
16:15:58.5 - ||(working_dir) DRS_DATA_WORKING=/scratch/Projects/SPIrou_Pipeline/data/tmp/
16:15:58.5 - || DRS_INTERACTIVE is set
16:15:58.5 - |-c:[...]|Now running : -c on file(s): dark_flat02f10.fits dark_flat03f10.fits
16:15:58.5 - |-c:[...]|On directory /scratch/Projects/SPIrou_Pipeline/data/raw/20170710
16:15:58.5 - |-c:[...]|ICDP loaded from: /scratch/Projects/SPIrou_Pipeline/INTROOT/DRS_SPIROU/
config/hadmrICDP_SPIROU.py
16:15:58.5 - |-c:[...]|Reading file: /scratch/Projects/SPIrou_Pipeline/data/raw/20170710/
dark_flat02f10.fits
16:15:58.5 - |-c:[...]|Image 2048x2048 loaded
16:15:58.6 - * |-c:[...]|Adding frames
16:15:58.6 - |-c:[...]|Reading File: /scratch/Projects/SPIrou_Pipeline/data/raw/20170710/
dark_flat03f10.fits
16:15:59.0 - |-c:[...]|Doing Dark Correction using /scratch/Projects/SPIrou_Pipeline/data/
calibDB/dark_dark02d406.fits
16:15:59.4 - |-c:[...]|Image format changed to 2035x1930
16:16:01.4 - |-c:[...]|Saving processed raw frame in dark_flat02f10_order_profil_C.fits
16:16:01.8 - * |-c:[...]|Updating Calib Data Base with ORDER_PROFIL_C
16:16:01.9 - * |-c:[...]|Maximum flux/pixel in the spectrum: 220526.1[e-]
16:16:01.9 - * |-c:[...]|Average background level: 0.46[%]
16:16:02.3 - |-c:[...]|Searching order center on central column
16:16:02.3 - * |-c:[...]|On fiber C 36 orders have been detected on 1 fiber
16:16:02.4 - |-c:[...]|ORDER: 0 center at pixel 88.0 width 11.8 rms 0.058
16:16:02.4 - |-c:[...]| - center fit rms/ptp/sigrms: 0.058/0.175/3.0 with 0 rejected points
16:16:02.4 - |-c:[...]| - width fit rms/ptp/ptp%: 0.393/0.889/8.081 with 0 rejected points
16:16:02.4 - |-c:[...]|ORDER: 1 center at pixel 135.3 width 11.7 rms 0.067
16:16:02.4 - |-c:[...]| - center fit rms/ptp/sigrms: 0.067/0.196/2.9 with 0 rejected points
16:16:02.4 - |-c:[...]| - width fit rms/ptp/ptp%: 0.393/0.908/8.256 with 0 rejected points
16:16:02.4 - |-c:[...]|ORDER: 2 center at pixel 182.1 width 11.9 rms 0.057
16:16:02.4 - |-c:[...]| - center fit rms/ptp/sigrms: 0.057/0.138/2.4 with 0 rejected points
16:16:02.4 - |-c:[...]| - width fit rms/ptp/ptp%: 0.376/0.939/8.156 with 0 rejected points
16:16:02.4 - |-c:[...]|ORDER: 3 center at pixel 228.5 width 11.9 rms 0.052
16:16:02.4 - |-c:[...]| - center fit rms/ptp/sigrms: 0.052/0.179/3.5 with 0 rejected points
16:16:02.4 - |-c:[...]| - width fit rms/ptp/ptp%: 0.386/0.921/8.376 with 0 rejected points
16:16:02.4 - |-c:[...]|ORDER: 4 center at pixel 274.3 width 11.7 rms 0.058
16:16:02.4 - |-c:[...]| - center fit rms/ptp/sigrms: 0.058/0.189/3.2 with 0 rejected points
16:16:02.4 - |-c:[...]| - width fit rms/ptp/ptp%: 0.385/0.908/8.256 with 0 rejected points
16:16:02.4 - |-c:[...]|ORDER: 5 center at pixel 319.8 width 11.7 rms 0.054
16:16:02.4 - |-c:[...]| - center fit rms/ptp/sigrms: 0.054/0.140/2.6 with 0 rejected points
16:16:02.4 - |-c:[...]| - width fit rms/ptp/ptp%: 0.409/0.796/7.237 with 0 rejected points
16:16:02.4 - |-c:[...]|ORDER: 6 center at pixel 364.8 width 11.7 rms 0.057
16:16:02.4 - |-c:[...]| - center fit rms/ptp/sigrms: 0.057/0.149/2.6 with 0 rejected points
16:16:02.4 - |-c:[...]| - width fit rms/ptp/ptp%: 0.357/0.926/7.595 with 0 rejected points
16:16:02.4 - |-c:[...]|ORDER: 7 center at pixel 409.6 width 11.6 rms 0.054
16:16:02.4 - |-c:[...]| - center fit rms/ptp/sigrms: 0.054/0.146/2.7 with 0 rejected points
16:16:02.4 - |-c:[...]| - width fit rms/ptp/ptp%: 0.414/0.882/8.015 with 0 rejected points
16:16:02.4 - |-c:[...]|ORDER: 8 center at pixel 454.1 width 11.5 rms 0.059
16:16:02.4 - |-c:[...]| - center fit rms/ptp/sigrms: 0.059/0.151/2.5 with 0 rejected points

```

```

16:16:02.4 - | -c:[...] | - width fit rms/ptp/ptp%: 0.434/0.805/7.319 with 0 rejected points
16:16:02.4 - | -c:[...] | ORDER: 9 center at pixel 498.2 width 11.6 rms 0.058
16:16:02.4 - | -c:[...] | - center fit rms/ptp/sigrms: 0.058/0.180/3.1 with 0 rejected points
16:16:02.4 - | -c:[...] | - width fit rms/ptp/ptp%: 0.429/0.833/7.575 with 0 rejected points
16:16:02.4 - | -c:[...] | ORDER: 10 center at pixel 542.2 width 11.3 rms 0.066
16:16:02.4 - | -c:[...] | - center fit rms/ptp/sigrms: 0.066/0.162/2.5 with 0 rejected points
16:16:02.4 - | -c:[...] | - width fit rms/ptp/ptp%: 0.437/0.886/7.761 with 0 rejected points
16:16:02.4 - | -c:[...] | ORDER: 11 center at pixel 586.0 width 11.4 rms 0.071
16:16:02.4 - | -c:[...] | center fit converging with rms/ptp/sigrms: 0.071/0.210/3.0
16:16:02.4 - | -c:[...] | - center fit rms/ptp/sigrms: 0.068/0.150/2.2 with 1 rejected points
16:16:02.4 - | -c:[...] | - width fit rms/ptp/ptp%: 0.453/0.834/7.579 with 0 rejected points
16:16:02.5 - | -c:[...] | ORDER: 12 center at pixel 629.7 width 11.5 rms 0.065
16:16:02.5 - | -c:[...] | - center fit rms/ptp/sigrms: 0.065/0.159/2.4 with 0 rejected points
16:16:02.5 - | -c:[...] | - width fit rms/ptp/ptp%: 0.459/0.804/6.727 with 0 rejected points
16:16:02.5 - | -c:[...] | ORDER: 13 center at pixel 673.3 width 11.3 rms 0.065
16:16:02.5 - | -c:[...] | - center fit rms/ptp/sigrms: 0.065/0.177/2.7 with 0 rejected points
16:16:02.5 - | -c:[...] | - width fit rms/ptp/ptp%: 0.420/0.861/7.826 with 0 rejected points
16:16:02.5 - | -c:[...] | ORDER: 14 center at pixel 717.0 width 11.5 rms 0.065
16:16:02.5 - | -c:[...] | - center fit rms/ptp/sigrms: 0.065/0.192/3.0 with 0 rejected points
16:16:02.5 - | -c:[...] | - width fit rms/ptp/ptp%: 0.469/0.840/7.638 with 0 rejected points
16:16:02.5 - | -c:[...] | ORDER: 15 center at pixel 760.7 width 11.2 rms 0.069
16:16:02.5 - | -c:[...] | - center fit rms/ptp/sigrms: 0.069/0.185/2.7 with 0 rejected points
16:16:02.5 - | -c:[...] | - width fit rms/ptp/ptp%: 0.442/0.858/7.802 with 0 rejected points
16:16:02.5 - | -c:[...] | ORDER: 16 center at pixel 804.6 width 11.3 rms 0.056
16:16:02.5 - | -c:[...] | - center fit rms/ptp/sigrms: 0.056/0.158/2.8 with 0 rejected points
16:16:02.5 - | -c:[...] | - width fit rms/ptp/ptp%: 0.451/0.871/7.917 with 0 rejected points
16:16:02.5 - | -c:[...] | ORDER: 17 center at pixel 848.7 width 11.3 rms 0.062
16:16:02.5 - | -c:[...] | - center fit rms/ptp/sigrms: 0.062/0.185/3.0 with 0 rejected points
16:16:02.5 - | -c:[...] | - width fit rms/ptp/ptp%: 0.447/0.931/7.756 with 0 rejected points
16:16:02.5 - | -c:[...] | ORDER: 18 center at pixel 893.2 width 11.2 rms 0.067
16:16:02.5 - | -c:[...] | - center fit rms/ptp/sigrms: 0.067/0.174/2.6 with 0 rejected points
16:16:02.5 - | -c:[...] | - width fit rms/ptp/ptp%: 0.392/0.915/7.623 with 0 rejected points
16:16:02.5 - | -c:[...] | ORDER: 19 center at pixel 938.0 width 11.2 rms 0.063
16:16:02.5 - | -c:[...] | - center fit rms/ptp/sigrms: 0.063/0.189/3.0 with 0 rejected points
16:16:02.5 - | -c:[...] | - width fit rms/ptp/ptp%: 0.437/0.841/7.005 with 0 rejected points
16:16:02.5 - | -c:[...] | ORDER: 20 center at pixel 983.4 width 11.4 rms 0.076
16:16:02.5 - | -c:[...] | center fit converging with rms/ptp/sigrms: 0.076/0.215/2.8
16:16:02.5 - | -c:[...] | - center fit rms/ptp/sigrms: 0.073/0.171/2.3 with 1 rejected points
16:16:02.5 - | -c:[...] | - width fit rms/ptp/ptp%: 0.423/0.954/7.949 with 0 rejected points
16:16:02.5 - | -c:[...] | ORDER: 21 center at pixel 1029.4 width 11.3 rms 0.075
16:16:02.5 - | -c:[...] | - center fit rms/ptp/sigrms: 0.075/0.193/2.6 with 0 rejected points
16:16:02.5 - | -c:[...] | - width fit rms/ptp/ptp%: 0.414/0.893/7.446 with 0 rejected points
16:16:02.5 - | -c:[...] | ORDER: 22 center at pixel 1076.2 width 11.0 rms 0.076
16:16:02.5 - | -c:[...] | - center fit rms/ptp/sigrms: 0.076/0.191/2.5 with 0 rejected points
16:16:02.5 - | -c:[...] | - width fit rms/ptp/ptp%: 0.372/0.951/7.927 with 0 rejected points
16:16:02.5 - | -c:[...] | ORDER: 23 center at pixel 1123.9 width 11.0 rms 0.076
16:16:02.5 - | -c:[...] | - center fit rms/ptp/sigrms: 0.076/0.171/2.3 with 0 rejected points
16:16:02.5 - | -c:[...] | - width fit rms/ptp/ptp%: 0.332/0.965/8.041 with 0 rejected points
16:16:02.5 - | -c:[...] | ORDER: 24 center at pixel 1172.7 width 11.0 rms 0.082
16:16:02.5 - | -c:[...] | - center fit rms/ptp/sigrms: 0.082/0.197/2.4 with 0 rejected points
16:16:02.5 - | -c:[...] | - width fit rms/ptp/ptp%: 0.322/0.931/9.309 with 0 rejected points
16:16:02.6 - | -c:[...] | ORDER: 25 center at pixel 1222.7 width 11.0 rms 0.083
16:16:02.6 - | -c:[...] | - center fit rms/ptp/sigrms: 0.083/0.170/2.1 with 0 rejected points
16:16:02.6 - | -c:[...] | - width fit rms/ptp/ptp%: 0.320/0.938/9.376 with 0 rejected points
16:16:02.6 - | -c:[...] | ORDER: 26 center at pixel 1274.2 width 11.0 rms 0.066
16:16:02.6 - | -c:[...] | - center fit rms/ptp/sigrms: 0.066/0.159/2.4 with 0 rejected points
16:16:02.6 - | -c:[...] | - width fit rms/ptp/ptp%: 0.331/0.982/9.815 with 0 rejected points
16:16:02.6 - | -c:[...] | ORDER: 27 center at pixel 1327.4 width 10.7 rms 0.075
16:16:02.6 - | -c:[...] | - center fit rms/ptp/sigrms: 0.075/0.185/2.5 with 0 rejected points
16:16:02.6 - | -c:[...] | - width fit rms/ptp/ptp%: 0.405/0.958/9.578 with 0 rejected points
16:16:02.6 - | -c:[...] | ORDER: 28 center at pixel 1382.6 width 10.9 rms 0.067
16:16:02.6 - | -c:[...] | - center fit rms/ptp/sigrms: 0.067/0.169/2.5 with 0 rejected points
16:16:02.6 - | -c:[...] | - width fit rms/ptp/ptp%: 0.297/0.876/8.760 with 0 rejected points

```

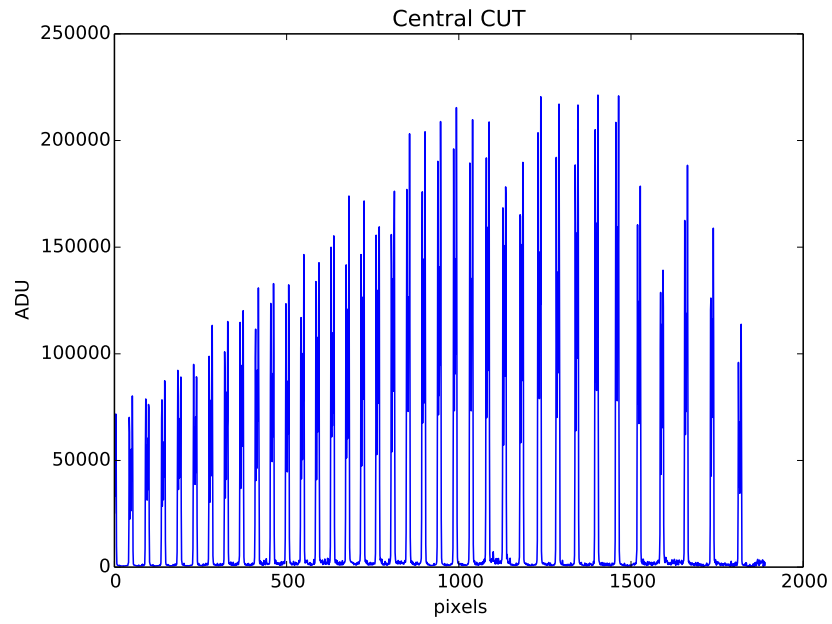
```

16:16:02.6 - |-c:[...]|ORDER: 29 center at pixel 1440.0 width 10.8 rms 0.062
16:16:02.6 - |-c:[...]| - center fit rms/ptp/sigrms: 0.062/0.180/2.9 with 0 rejected points
16:16:02.6 - |-c:[...]| - width fit rms/ptp/ptp%: 0.364/1.051/8.824 with 0 rejected points
16:16:02.6 - |-c:[...]|ORDER: 30 center at pixel 1500.1 width 10.7 rms 0.060
16:16:02.6 - |-c:[...]| - center fit rms/ptp/sigrms: 0.060/0.184/3.1 with 0 rejected points
16:16:02.6 - |-c:[...]| width fit converging with rms/ptp/ptp%: 0.362/1.006/10.064
16:16:02.6 - |-c:[...]| - width fit rms/ptp/ptp%: 0.348/0.917/8.160 with 1 rejected points
16:16:02.6 - |-c:[...]|ORDER: 31 center at pixel 1563.2 width 10.6 rms 0.064
16:16:02.6 - |-c:[...]| - center fit rms/ptp/sigrms: 0.064/0.200/3.1 with 0 rejected points
16:16:02.6 - |-c:[...]| - width fit rms/ptp/ptp%: 0.407/0.799/7.990 with 0 rejected points
16:16:02.6 - |-c:[...]|ORDER: 32 center at pixel 1629.8 width 10.6 rms 0.066
16:16:02.6 - |-c:[...]| - center fit rms/ptp/sigrms: 0.066/0.176/2.7 with 0 rejected points
16:16:02.6 - |-c:[...]| - width fit rms/ptp/ptp%: 0.406/0.993/9.930 with 0 rejected points
16:16:02.6 - |-c:[...]|ORDER: 33 center at pixel 1700.3 width 10.6 rms 0.079
16:16:02.6 - |-c:[...]| center fit converging with rms/ptp/sigrms: 0.079/0.233/3.0
16:16:02.6 - |-c:[...]| center fit converging with rms/ptp/sigrms: 0.075/0.229/3.0
16:16:02.6 - |-c:[...]| center fit converging with rms/ptp/sigrms: 0.072/0.205/2.9
16:16:02.6 - |-c:[...]| - center fit rms/ptp/sigrms: 0.069/0.193/2.8 with 3 rejected points
16:16:02.6 - |-c:[...]| - width fit rms/ptp/ptp%: 0.438/0.943/9.425 with 0 rejected points
16:16:02.6 - |-c:[...]|ORDER: 34 center at pixel 1775.7 width 10.4 rms 0.194
16:16:02.6 - |-c:[...]| center fit converging with rms/ptp/sigrms: 0.194/1.728/8.9
16:16:02.6 - |-c:[...]| - center fit rms/ptp/sigrms: 0.067/0.167/2.5 with 1 rejected points
16:16:02.6 - |-c:[...]| width fit converging with rms/ptp/ptp%: 0.566/3.326/47.516
16:16:02.6 - |-c:[...]| - width fit rms/ptp/ptp%: 0.447/0.921/7.754 with 1 rejected points
16:16:02.6 - |-c:[...]|ORDER: 35 center at pixel 1856.3 width 10.5 rms 0.297
16:16:02.6 - |-c:[...]| center fit converging with rms/ptp/sigrms: 0.297/2.351/7.9
16:16:02.6 - |-c:[...]| center fit converging with rms/ptp/sigrms: 0.168/1.475/8.8
16:16:02.6 - |-c:[...]| center fit converging with rms/ptp/sigrms: 0.065/0.212/3.3
16:16:02.6 - |-c:[...]| - center fit rms/ptp/sigrms: 0.061/0.162/2.7 with 3 rejected points
16:16:02.6 - |-c:[...]| width fit converging with rms/ptp/ptp%: 0.606/3.294/47.051
16:16:02.6 - |-c:[...]| width fit converging with rms/ptp/ptp%: 0.501/2.459/30.733
16:16:02.6 - |-c:[...]| - width fit rms/ptp/ptp%: 0.431/0.944/9.444 with 2 rejected points
16:16:02.6 - * |-c:[...]|On fiber C 36 orders geometry have been measured
16:16:02.6 - * |-c:[...]|Average uncertainty on position : 65.01 [mpix]
16:16:02.6 - * |-c:[...]|Average uncertainty on width : 401.10 [mpix]
16:16:02.6 - |-c:[...]|Saving localization information in file: dark_flat02f10_loco_C.fits
16:16:03.3 - |-c:[...]|Saving FWHM information in dark_flat02f10_fwhm-order_C.fits
16:16:03.9 - |-c:[...]|Saving localization image with superposition of orders in file:
dark_flat02f10_with-order_C.fits
16:16:04.2 - * |-c:[...]|QUALITY CONTROL SUCCESSFUL - Well Done -
16:16:04.7 - * |-c:[...]|Updating Calib Data Base with LOC_C
16:16:04.7 - * |-c:[...]|Recipe -c has been successfully completed

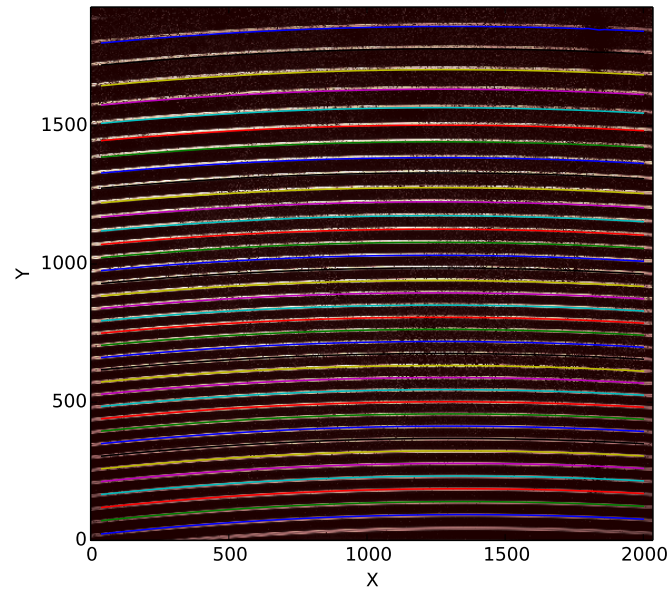
```

### 6.3.4 Interactive mode





**Figure 6.4** Pixel number (across order) against flux value of central pixel.



**Figure 6.5** Image with fits to each order.

## 6.4 cal\_SLIT\_spirou

Finds the tilt of the orders.

!!!! TODO !!!! Once written up the new version update this description !!!!

### 6.4.1 Summary of procedure

1. adds all fp\_fp files together
2. corrects for dark
3. resizes the image
4. extracts the orders (no weight no tilt)
5. works out the tilt for each order using the location and width
6. saves the tilt to file
7. should do some quality control
8. updates calibDB with key “TILT”

### 6.4.2 Running cal\_

To run cal\_ type:

```
cal_SLIT_spirou.p night_repository filenames
```

Note: filenames must start with ‘fp\_fp’

### 6.4.3 Example working run

An example run where everything worked is below:

```
DRS_spirou -m cal_SLIT_spirou.py 20170710 fp_fp02a203.fits fp_fp03a203.fits fp_fp04a203.fits

||DRS SPIROU v (interactive mode)
16:26:55.3 - || *****
16:26:55.3 - || * SPIROU (#) Geneva Observatory ()
16:26:55.3 - || *****
16:26:55.3 - || (dir_data_raw) DRS_DATA_RAW=/scratch/Projects/SPIRou_Pipeline/data/raw/
16:26:55.3 - || (dir_data_reduc) DRS_DATA_REDUC=/scratch/Projects/SPIRou_Pipeline/data/reduced
/
16:26:55.3 - || (dir_drs_config) DRS_CONFIG=/scratch/Projects/SPIRou_Pipeline/INTROOT/
DRS_SPIROU/config/
16:26:55.3 - || (dir_calib_db) DRS_CALIB_DB=/scratch/Projects/SPIRou_Pipeline/data/calibDB
16:26:55.3 - || (dir_data_msg) DRS_DATA_MSG=/scratch/Projects/SPIRou_Pipeline/data/msg/
16:26:55.3 - || (print_log) DRS_LOG=1 %(0: minimum stdin-out logs)
16:26:55.3 - || (plot_graph) DRS_PLOT=NONE %(def/undef/trigger)
16:26:55.3 - || (used_date) DRS_USED_DATE=undefined
16:26:55.3 - || (working_dir) DRS_DATA_WORKING=/scratch/Projects/SPIRou_Pipeline/data/tmp/
16:26:55.3 - || DRS_INTERACTIVE is set
```



```

16:26:55.3 - |-c:[...]Now running : -c on file(s): fp_fp02a203.fits fp_fp03a203.fits
fp_fp04a203.fits
16:26:55.3 - |-c:[...]On directory /scratch/Projects/SPIrou_Pipeline/data/raw/20170710
16:26:55.3 - |-c:[...]ICDP loaded from: /scratch/Projects/SPIrou_Pipeline/INTROOT/DRS_SPIROU/
config/hadmrICDP_SPIROU.py
16:26:55.4 - |-c:[...]Calibration file: fp_fp02a203_tilt.fits already exists - not copied
16:26:55.4 - |-c:[...]Calibration file: dark_flat02f10_loco_C.fits already exists - not copied
16:26:55.4 - |-c:[...]Calibration file: dark_flat02f10_order_profil_C.fits already exists -
not copied
16:26:55.5 - |-c:[...]Calibration file: flat_dark02f10_order_profil_AB.fits already exists -
not copied
16:26:55.5 - |-c:[...]Calibration file: spirou_wave_ini3.fits already exists - not copied
16:26:55.5 - |-c:[...]Calibration file: dark_dark02d406.fits already exists - not copied
16:26:55.5 - |-c:[...]Calibration file: dark_flat02f10_flat_C.fits already exists - not copied
16:26:55.5 - |-c:[...]Calibration file: flat_dark02f10_loco_AB.fits already exists - not
copied
16:26:55.5 - |-c:[...]Reading File: /scratch/Projects/SPIrou_Pipeline/data/raw/20170710/
fp_fp02a203.fits
16:26:55.5 - |-c:[...]Image 2048x2048 loaded
16:26:55.6 - * |-c:[...]Adding frames
16:26:55.6 - |-c:[...]Reading File: /scratch/Projects/SPIrou_Pipeline/data/raw/20170710/
fp_fp03a203.fits
16:26:55.6 - |-c:[...]Reading File: /scratch/Projects/SPIrou_Pipeline/data/raw/20170710/
fp_fp04a203.fits
16:26:55.9 - |-c:[...]Doing Dark Correction using /scratch/Projects/SPIrou_Pipeline/data/
calibDB/dark_dark02d406.fits
16:26:56.2 - |-c:[...]Image format changed to 2035x1930
16:26:56.7 - * |-c:[...]Nb pixels morts = 611716 / 15.58 %
16:26:56.7 - |-c:[...]Reading localization parameters of Fiber AB
16:26:57.0 - |-c:[...]Order 0 : Tilt = 4.70 pixel sur 37.0 = -7.24 deg
16:26:57.2 - |-c:[...]Order 1 : Tilt = 4.60 pixel sur 37.4 = -7.02 deg
16:26:57.4 - |-c:[...]Order 2 : Tilt = 4.50 pixel sur 36.8 = -6.97 deg
16:26:57.6 - |-c:[...]Order 3 : Tilt = 4.30 pixel sur 36.4 = -6.74 deg
16:26:57.8 - |-c:[...]Order 4 : Tilt = 4.20 pixel sur 36.8 = -6.52 deg
16:26:58.0 - |-c:[...]Order 5 : Tilt = 4.20 pixel sur 36.0 = -6.65 deg
16:26:58.2 - |-c:[...]Order 6 : Tilt = 4.00 pixel sur 36.1 = -6.33 deg
16:26:58.4 - |-c:[...]Order 7 : Tilt = 4.00 pixel sur 35.7 = -6.40 deg
16:26:58.6 - |-c:[...]Order 8 : Tilt = 3.90 pixel sur 36.7 = -6.07 deg
16:26:58.8 - |-c:[...]Order 9 : Tilt = 3.80 pixel sur 36.1 = -6.01 deg
16:26:59.0 - |-c:[...]Order 10 : Tilt = 3.60 pixel sur 35.7 = -5.76 deg
16:26:59.3 - |-c:[...]Order 11 : Tilt = 3.60 pixel sur 35.7 = -5.75 deg
16:26:59.5 - |-c:[...]Order 12 : Tilt = 3.50 pixel sur 35.9 = -5.57 deg
16:26:59.7 - |-c:[...]Order 13 : Tilt = 3.30 pixel sur 35.8 = -5.27 deg
16:26:59.8 - |-c:[...]Order 14 : Tilt = 3.30 pixel sur 35.9 = -5.25 deg
16:27:00.0 - |-c:[...]Order 15 : Tilt = 3.20 pixel sur 35.4 = -5.17 deg
16:27:00.2 - |-c:[...]Order 16 : Tilt = 3.10 pixel sur 35.5 = -4.99 deg
16:27:00.3 - |-c:[...]Order 17 : Tilt = 3.00 pixel sur 35.4 = -4.85 deg
16:27:00.5 - |-c:[...]Order 18 : Tilt = 2.90 pixel sur 35.1 = -4.73 deg
16:27:00.7 - |-c:[...]Order 19 : Tilt = 2.80 pixel sur 35.1 = -4.57 deg
16:27:00.8 - |-c:[...]Order 20 : Tilt = 2.70 pixel sur 34.9 = -4.42 deg
16:27:01.0 - |-c:[...]Order 21 : Tilt = 2.60 pixel sur 34.6 = -4.29 deg
16:27:01.2 - |-c:[...]Order 22 : Tilt = 2.50 pixel sur 34.9 = -4.09 deg
16:27:01.3 - |-c:[...]Order 23 : Tilt = 2.40 pixel sur 34.2 = -4.01 deg
16:27:01.5 - |-c:[...]Order 24 : Tilt = 2.30 pixel sur 34.9 = -3.77 deg
16:27:01.7 - |-c:[...]Order 25 : Tilt = 2.20 pixel sur 34.7 = -3.63 deg
16:27:01.8 - |-c:[...]Order 26 : Tilt = 2.00 pixel sur 34.2 = -3.35 deg
16:27:02.0 - |-c:[...]Order 27 : Tilt = 2.00 pixel sur 34.5 = -3.32 deg
16:27:02.2 - |-c:[...]Order 28 : Tilt = 1.80 pixel sur 34.2 = -3.01 deg
16:27:02.3 - |-c:[...]Order 29 : Tilt = 1.70 pixel sur 34.0 = -2.86 deg
16:27:02.5 - |-c:[...]Order 30 : Tilt = 1.60 pixel sur 33.6 = -2.73 deg
16:27:02.7 - |-c:[...]Order 31 : Tilt = 1.40 pixel sur 34.0 = -2.36 deg
16:27:02.8 - |-c:[...]Order 32 : Tilt = 1.40 pixel sur 33.5 = -2.40 deg
16:27:03.0 - |-c:[...]Order 33 : Tilt = 1.10 pixel sur 32.4 = -1.94 deg

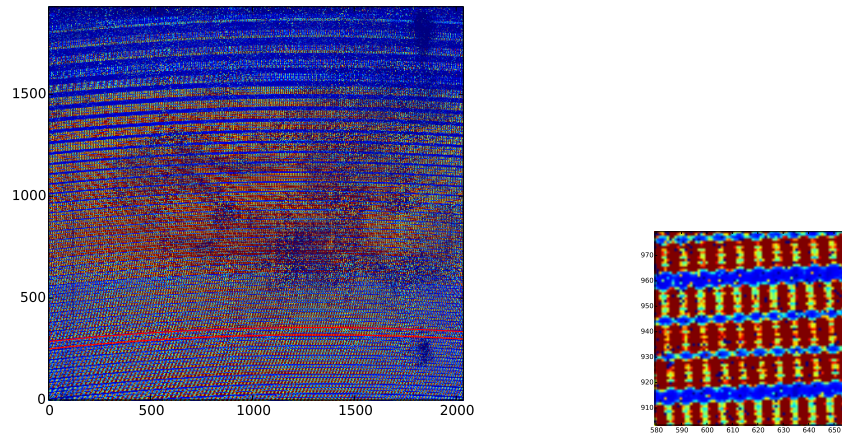
```

```

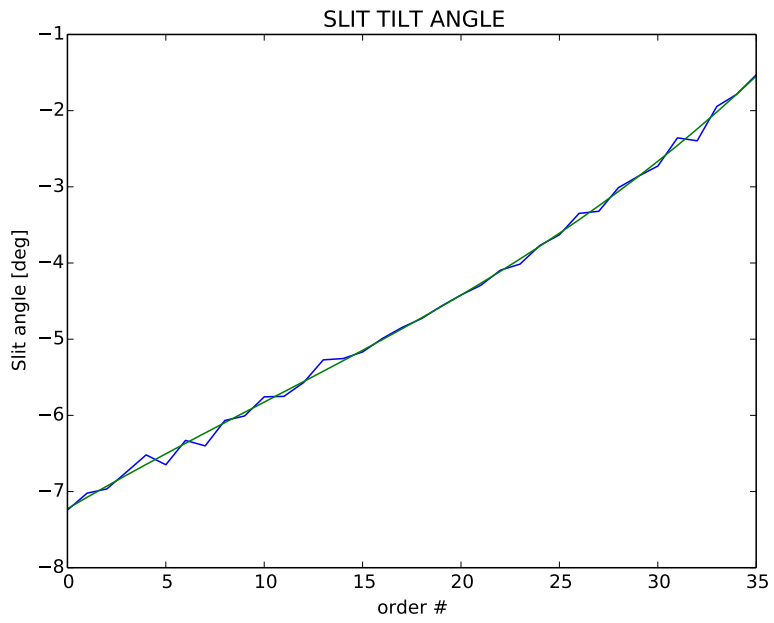
16:27:03.2 - |-c:[...] |Order 34 : Tilt = 1.00 pixel sur 32.1 = -1.79 deg
16:27:03.3 - |-c:[...] |Order 35 : Tilt = 0.90 pixel sur 33.7 = -1.53 deg
16:27:03.3 - * |-c:[...] AB|Tilt dispersion = 0.069 deg
16:27:03.6 - |-c:[...] |Saving tilt information in file: fp_fp02a203_tilt.fits
16:27:05.2 - * |-c:[...] |Updating Calib Data Base with TILT
16:27:05.2 - * |-c:[...] |Recipe -c has been successfully completed

```

#### 6.4.4 Interactive mode



**Figure 6.6** Left: The full ‘fp\_fp’ image. Right: Zoom in on a section of the ‘fp\_fp’ image showing the tilt.



**Figure 6.7** Slit aginle as a function of order number.

## 6.5 cal\_FF\_RAW\_spirou

Creates the flat fields.

!!!! TODO !!!! Once written up the new version update this description !!!!

**Note:** if using same files in Section 3.2 you will get an error message when running the file. To solve this open the ‘master\_calib\_SPIROU.txt’ file located in {DATA\_ROOT\_CALIB}. Edit the unix date in the line that begins ‘TILT’ so that it is less than the unix date on rws ‘ORDER\_PROFIL\_AB’ (i.e. change it from 1499707515.0 to 1499705515.0). i.e. the ‘master\_calib\_SPIROU.txt’ file should look go from

```
DARK 20170710 dark_dark02d406.fits 07/10/17/16:37:48 1499704668.0
ORDER_PROFIL_C 20170710 dark_flat02f10_order_profil_C.fits 07/10/17/17:03:50 1499706230.0
LOC_C 20170710 dark_flat02f10_loco_C.fits 07/10/17/17:03:50 1499706230.0
ORDER_PROFIL_AB 20170710 flat_dark02f10_order_profil_AB.fits 07/10/17/17:07:08 1499706428.0
LOC_AB 20170710 flat_dark02f10_loco_AB.fits 07/10/17/17:07:08 1499706428.0
TILT 20170710 fp_fp02a203_tilt.fits 07/10/17/17:25:15 1499707515.0
```

to this:

```
DARK 20170710 dark_dark02d406.fits 07/10/17/16:37:48 1499704668.0
ORDER_PROFIL_C 20170710 dark_flat02f10_order_profil_C.fits 07/10/17/17:03:50 1499706230.0
LOC_C 20170710 dark_flat02f10_loco_C.fits 07/10/17/17:03:50 1499706230.0
ORDER_PROFIL_AB 20170710 flat_dark02f10_order_profil_AB.fits 07/10/17/17:07:08 1499706428.0
LOC_AB 20170710 flat_dark02f10_loco_AB.fits 07/10/17/17:07:08 1499706428.0
TILT 20170710 fp_fp02a203_tilt.fits 07/10/17/17:25:15 1499705515.0
```

### 6.5.1 Summary of procedure

1. adds all ‘dark\_flat’ or ‘flat\_dark’ files together
2. corrects for darks
3. resizes the image
4. possible background subtraction?
5. extracts the orders using tilt and weight
6. calculates the blaze
7. calculates the flat field, (flat = extraction / blaze)
8. stores the flat fields
9. does some quality control
10. updates calibDB with key "FLAT\_{fiber}" where {fiber} = [AB, C] etc

### 6.5.2 Running cal\_FF\_RAW\_spirou

To run cal\_FF\_RAW\_spirou type:

```
cal_FF_RAW_spirou.py night_repository filenames
```

Note: filenames must start with 'dark\_flat' or 'flat\_dark'

### 6.5.3 Example working run

An example run where everything worked is below:

```
DRS_spirou -m cal_FF_RAW_spirou.py 20170710 dark_flat02f10.fits dark_flat03f10.fits
dark_flat04f10.fits dark_flat05f10.fits dark_flat06f10.fits

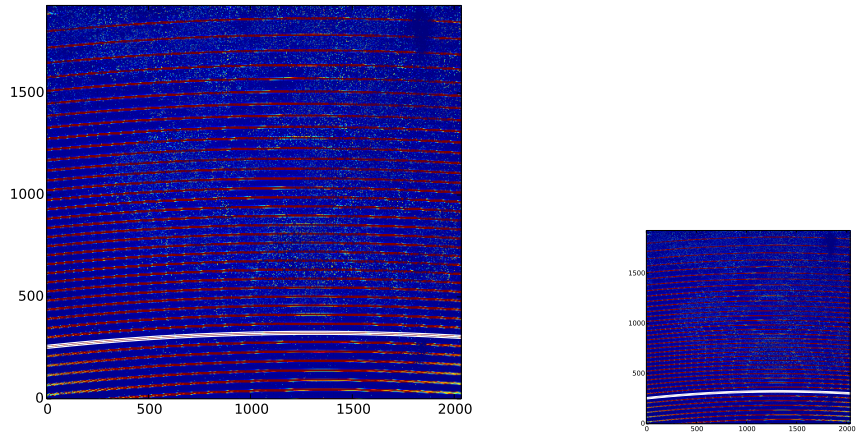
||DRS SPIROU v (interactive mode)
16:49:40.5 - || *****
16:49:40.5 - || * SPIROU (#) Geneva Observatory ()
16:49:40.5 - || *****
16:49:40.5 - ||(dir_data_raw) DRS_DATA_RAW=/scratch/Projects/SPIRou_Pipeline/data/raw/
16:49:40.5 - ||(dir_data_reduc) DRS_DATA_REDUC=/scratch/Projects/SPIRou_Pipeline/data/reduced
/
16:49:40.5 - ||(dir_drs_config) DRS_CONFIG=/scratch/Projects/SPIRou_Pipeline/INTROOT/
DRS_SPIROU/config/
16:49:40.5 - ||(dir_calib_db) DRS_CALIB_DB=/scratch/Projects/SPIRou_Pipeline/data/calibDB
16:49:40.5 - ||(dir_data_msg) DRS_DATA_MSG=/scratch/Projects/SPIRou_Pipeline/data/msg/
16:49:40.5 - ||(print_log) DRS_LOG=1 %(0: minimum stdin-out logs)
16:49:40.5 - ||(plot_graph) DRS_PLOT=NONE %(def/undef/trigger)
16:49:40.5 - ||(used_date) DRS_USED_DATE=undefined
16:49:40.5 - ||(working_dir) DRS_DATA_WORKING=/scratch/Projects/SPIRou_Pipeline/data/tmp/
16:49:40.5 - || DRS_INTERACTIVE is set
16:49:40.5 - |-c:[...]|Now running : -c on file(s): dark_flat02f10.fits dark_flat03f10.fits
16:49:40.5 - |-c:[...]|On directory /scratch/Projects/SPIRou_Pipeline/data/raw/20170710
16:49:40.5 - |-c:[...]|ICDP loaded from: /scratch/Projects/SPIRou_Pipeline/INTROOT/DRS_SPIROU/
config/hadmrICDP_SPIROU.py
16:49:40.5 - * |-c:[...]|Now processing Image TYPE: UNKNOWN with -c recipe
16:49:40.6 - |-c:[...]|Calibration file: dark_dark02d406.fits already exists - not copied
16:49:40.6 - |-c:[...]|Calibration file: fp_fp02a203_tilt.fits already exists - not copied
16:49:40.6 - |-c:[...]|Reading File: /scratch/Projects/SPIRou_Pipeline/data/raw/20170710/
dark_flat02f10.fits
16:49:40.6 - |-c:[...]|Image 2048x2048 loaded
16:49:40.6 - * |-c:[...]|Adding frames
16:49:40.6 - |-c:[...]|Reading File: /scratch/Projects/SPIRou_Pipeline/data/raw/20170710/
dark_flat03f10.fits
16:49:40.7 - |-c:[...]|Doing Dark Correction using /scratch/Projects/SPIRou_Pipeline/data/
calibDB/dark_dark02d406.fits
16:49:41.0 - |-c:[...]|Image format changed to 2035x1930
16:49:41.5 - * |-c:[...]|Nb pixels morts = 568533 / 14.48 %
16:49:41.5 - * |-c:[...]|Maximum average flux/pixel in the spectrum: 73264.1[ADU]
16:49:41.5 - |-c:[...]|Reading tilt slit
16:49:41.5 - |-c:[...]|C|Reading localization parameters of Fiber C
16:49:41.6 - |-c:[...]|C|Reading order profil of Fiber C
16:49:42.1 - |-c:[...]|On fiber C order 0: S/N= 685.6 - FF rms= 4.68 %
16:49:42.7 - |-c:[...]|On fiber C order 1: S/N= 709.3 - FF rms= 4.81 %
16:49:43.3 - |-c:[...]|On fiber C order 2: S/N= 733.7 - FF rms= 4.75 %
16:49:43.8 - |-c:[...]|On fiber C order 3: S/N= 759.2 - FF rms= 4.86 %
16:49:44.4 - |-c:[...]|On fiber C order 4: S/N= 780.7 - FF rms= 4.94 %
16:49:44.9 - |-c:[...]|On fiber C order 5: S/N= 811.4 - FF rms= 5.03 %
16:49:45.5 - |-c:[...]|On fiber C order 6: S/N= 842.1 - FF rms= 5.11 %
16:49:46.0 - |-c:[...]|On fiber C order 7: S/N= 875.4 - FF rms= 5.23 %
16:49:46.6 - |-c:[...]|On fiber C order 8: S/N= 893.9 - FF rms= 5.37 %
16:49:47.2 - |-c:[...]|On fiber C order 9: S/N= 916.4 - FF rms= 6.07 %
16:49:47.7 - |-c:[...]|On fiber C order 10: S/N= 928.3 - FF rms= 8.02 %
```

```

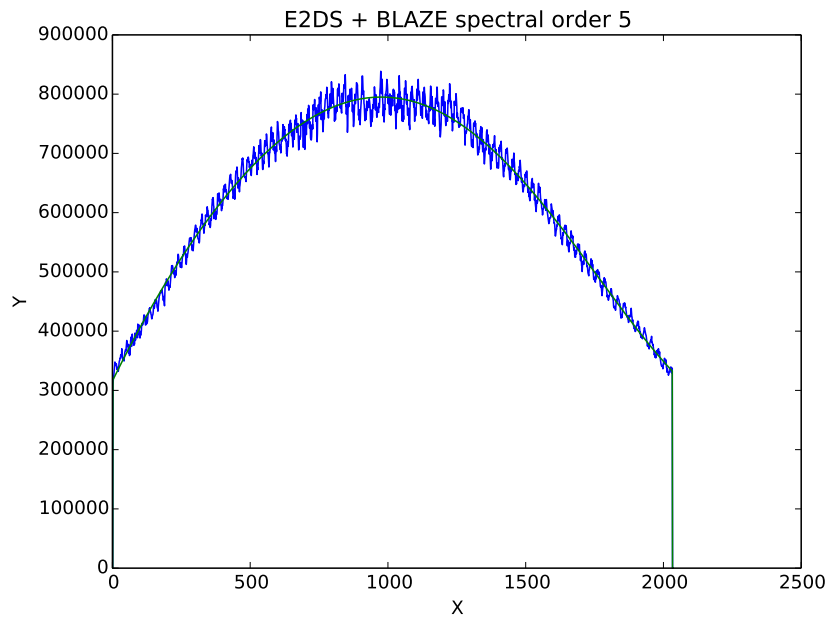
16:49:48.3 - |-c:[...] |On fiber C order 11: S/N= 912.5 - FF rms= 6.84 %
16:49:48.8 - |-c:[...] |On fiber C order 12: S/N= 961.8 - FF rms= 5.94 %
16:49:49.4 - |-c:[...] |On fiber C order 13: S/N= 1004.9 - FF rms= 5.97 %
16:49:49.9 - |-c:[...] |On fiber C order 14: S/N= 1022.5 - FF rms= 6.15 %
16:49:50.5 - |-c:[...] |On fiber C order 15: S/N= 1045.5 - FF rms= 6.18 %
16:49:51.1 - |-c:[...] |On fiber C order 16: S/N= 1053.4 - FF rms= 6.14 %
16:49:51.6 - |-c:[...] |On fiber C order 17: S/N= 1085.8 - FF rms= 6.23 %
16:49:52.2 - |-c:[...] |On fiber C order 18: S/N= 1103.0 - FF rms= 6.28 %
16:49:52.7 - |-c:[...] |On fiber C order 19: S/N= 1134.8 - FF rms= 6.77 %
16:49:53.3 - |-c:[...] |On fiber C order 20: S/N= 1150.4 - FF rms= 6.43 %
16:49:53.9 - |-c:[...] |On fiber C order 21: S/N= 1144.2 - FF rms= 6.42 %
16:49:54.4 - |-c:[...] |On fiber C order 22: S/N= 1139.6 - FF rms= 6.39 %
16:49:55.0 - |-c:[...] |On fiber C order 23: S/N= 1161.3 - FF rms= 6.52 %
16:49:55.5 - |-c:[...] |On fiber C order 24: S/N= 1137.8 - FF rms= 9.11 %
16:49:56.1 - |-c:[...] |On fiber C order 25: S/N= 1131.4 - FF rms= 9.39 %
16:49:56.6 - |-c:[...] |On fiber C order 26: S/N= 1113.7 - FF rms= 7.97 %
16:49:57.2 - |-c:[...] |On fiber C order 27: S/N= 1161.7 - FF rms= 6.04 %
16:49:57.7 - |-c:[...] |On fiber C order 28: S/N= 1153.9 - FF rms= 6.07 %
16:49:58.3 - |-c:[...] |On fiber C order 29: S/N= 1178.2 - FF rms= 5.89 %
16:49:58.9 - |-c:[...] |On fiber C order 30: S/N= 1150.4 - FF rms= 5.92 %
16:49:59.6 - |-c:[...] |On fiber C order 31: S/N= 1024.1 - FF rms= 5.60 %
16:50:00.3 - |-c:[...] |On fiber C order 32: S/N= 945.1 - FF rms= 5.60 %
16:50:01.0 - |-c:[...] |On fiber C order 33: S/N= 1030.4 - FF rms= 5.70 %
16:50:01.6 - |-c:[...] |On fiber C order 34: S/N= 957.7 - FF rms= 8.21 %
16:50:02.2 - |-c:[...] |On fiber C order 35: S/N= 753.1 - FF rms= 8.11 %
16:50:02.4 - |-c:[...] |Saving blaze spectrum for fiber: C in dark_flat02f10_blaze_C.fits
16:50:03.1 - |-c:[...] |Saving FF spectrum of Fiber C in dark_flat02f10_flat_C.fits
16:50:04.2 - * |-c:[...] |Updating Calib Data Base with FLAT_C
16:50:04.2 - * |-c:[...] |Recipe -c has been successfully completed

```

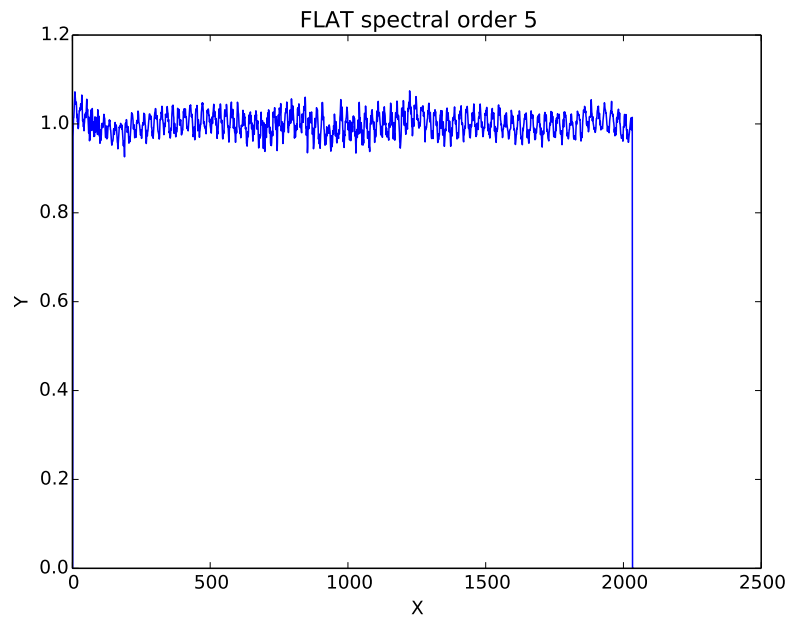
### 6.5.4 Interactive mode



**Figure 6.8** Left: the full processed image with one order fit highlighted. Right: Zoom in of the highlighted order fit.



**Figure 6.9** The extracted highlighted order from Figure 6.8. Overplotted is the blaze fit (in cyan).



**Figure 6.10** The flattened order for highlighted order from Figure 6.8.

## 6.6 cal\_extract\_RAW\_spirou

Description here.

!!!! TODO !!!! Once written up the new version update this description !!!!



## 6.7 cal\_DRIFT\_RAW\_spirou

Description here.

!!!! TODO !!!! Once writen up the new version update this description !!!!

## **6.8 Currently unused**

### **6.8.1 cal\_loc\_ONE\_spirou**

Some text here

### **6.8.2 cal\_FF\_spirou**

Some text here

### **6.8.3 cal\_WAVE\_spirou**

Some text here

### **6.8.4 cal\_FP\_spirou**

Some text here

### **6.8.5 cal\_FF\_spirou.py**

Some text here

## Chapter 7

# Quality Control

### 7.1 cal\_DARK\_spirou

### 7.2 cal\_loc\_RAW\_spirou

Some text here

### 7.3 cal\_SLIT\_spirou

Some text here

### 7.4 cal\_FF\_RAW\_spirou

Some text here

### 7.5 cal\_extract\_RAW\_spirou

Some text here

### 7.6 cal\_DRIFT\_RAW\_spirou

Some text here

## Appendix A

### Source code for environmental setup file

```
#!/bin/bash
# activate using:
#   source env_setup.sh
# Use --clean to restore environment
# i.e.
#   source env_setup.sh --clean

# -----
# EDIT THESE PARAMETERS
# -----
# Set the instrument name
INSTRUMENT_NAME="SPIROU"
# Directory in which all SPIROU files go
DIR="/scratch/Projects/SPIrou_Pipeline"
# Define installation folder name
INSTALL_ROOT="$DIR/INTROOT"
# Define data folder name
DATA_ROOT="$DIR/data"
# Define raw path
DATA_ROOT_RAW="$DATA_ROOT/raw/"
# Define reduced path
DATA_ROOT_REDUCED="$DATA_ROOT/reduced/"
# Define calibDB path
DATA_ROOT_CALIB="$DATA_ROOT/calibDB"
# Define msg path
DATA_ROOT_MSG="$DATA_ROOT/msg/"
# Define tmp path
DATA_ROOT_TMP="$DATA_ROOT/tmp/"
# Define python version
PYTHON_VERSION="2.7"
# Define python directory (i.e. result of command "which python")
PYTHON_DIR="/scratch/Projects/SPIrou_Pipeline/miniconda2"
# Define GSL path
GSL_DIR="/scratch/Projects/SPIrou_Pipeline/c-libraries/gsl"

# -----
# DO NOT EDIT PAST THIS POINT
# -----
echo " ===== "
echo "   Environmental setup for DRS Pipeline   "
echo " ===== "

# get arguments
CLEAN="0"
for i in "$@"; do
```

```

case $i in
  --clean) CLEAN="1";;
  *) echo "Invalid argument"; exit 1;;
esac
done

if [ "$CLEAN" = "1" ]; then
  if [[ -z "${DRS_ACTIVE}" ]]; then
    if [ "$DRS_ACTIVE" != 1 ]; then
      echo "    No need to clean - environment clean"
      echo ""
      echo "    Done"
      exit
    fi
  fi
  echo "    Cleaning environment"
  export PATH=$OLDPATH
  export PYTHONPATH=$OLDPYTHONPATH
  unset OLDPATH
  unset DRS_ACTIVE
  unset OLDPYTHONPATH
  unset INTROOT
  unset DRS_LOG
  unset PYTHON_INCLUDE_DIR
  unset GSL_INCLUDE_DIR
  unset GSL_LIBRARY_DIR
  unset INSTRUMENT
  unset DRS_DATA_RAW
  unset DRS_DATA_REDUCE
  unset DRS_CALIB_DB
  unset DRS_DATA_MSG
  unset DRS_DATA_WORKING
  unset TDATA
else
  echo "    Setting up environment"
  # Backup old path and python path for clean
  OLDPATH=$PATH
  OLDPYTHONPATH=$PYTHONPATH
  export OLDPATH
  export DRS_ACTIVE=1
  export OLDPYTHONPATH

  # User specific environment and startup programs
  export INTROOT="$INSTALL_ROOT"
  export PATH="$INSTALL_ROOT/bin":"$PYTHON_DIR/bin":"$PATH"
  export PYTHONPATH=".:$PYTHON_DIR/lib/python$PYTHON_VERSION/site-packages":"$INSTALL_ROOT/bin"
  export DRS_LOG=1
  export PYTHON_INCLUDE_DIR="$PYTHON_DIR/lib/python$PYTHON_VERSION/site-packages/numpy/core/
    include"
  export GSL_INCLUDE_DIR="$GSL_DIR/include"
  export GSL_LIBRARY_DIR="$GSL_DIR/lib"

  #SPIROU DRS and DATA environment variables
  export INSTRUMENT=$INSTRUMENT_NAME
  export DRS_DATA_RAW=$DATA_ROOT_RAW
  export DRS_DATA_REDUCE=$DATA_ROOT_REDUCED
  export DRS_CALIB_DB=$DATA_ROOT_CALIB
  export DRS_DATA_MSG=$DATA_ROOT_MSG
  export DRS_DATA_WORKING=$DATA_ROOT_TMP
  export TDATA=$DATA_ROOT

  echo "    Set up for $INSTRUMENT"
  echo "    - Python located at: $PYTHON_DIR"

```

```
echo "      - GLS located at: $GSL_DIR"
echo "      - installation located at: $INSTALL_ROOT"
echo "      - data located at:"
echo "          $DATA_ROOT"
echo "          $DATA_ROOT_RAW"
echo "          $DATA_ROOT_REDUCED"
echo "          $DATA_ROOT_CALIB"
echo "          $DATA_ROOT_MSG"
echo "          $DATA_ROOT_TMP"
echo " "
fi
echo "      Done"
```