Demetra eShel
User documentation
DC0034

Rev	Date	Who	What
A-0.2	20/10/2019	F. Cochard	First draft
A-0.3	13/11/2019	F. Cochard	Add images

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Important : this documentation is written for the **eShel** version of Demetra, but it is also valid for **Whoppshel** users.Any specific element to the **Whoppshel** is written in blue.

Introduction

Demetra is developed by Shelyak Instruments as an aid to operate the eShel spectroscope. Its purpose is to produce - within a single tool, from acquisition to data reduction – fully calibrated spectra.
It is designed to help everyone from beginners starting in spectroscopy to experienced users. It gives all the required tools in the field. Getting a calibrated spectrum requires the user to collect several sets of images. Demetra guides the user through this process, by listing for each observation all the required images.
Demetra is available in French and English.
The key features of Demetra are:

- All in one software: from raw spectra acquisition to final result.
- Control of the eShel calibration module, for bias, offset, flat and calibration images.
- Observing session management: color coding for missing data, management of observations as data sets, integrated session log file...
- Open & standard image files format.
- Fully automated data processing… but also fully transparent step by step working (no hidden black box!).
- Useful tools available at the observing stage (real time profile display, saturation alert…).
- *Very flexible: you can use only part of the software (acquisition, session management, data reduction).*

Recommended path to start working with Demetra

This documentation follows a step by step presentation. We recommend to follow this path:

- Install the software on your computer. The installation comes with two sets of demo files.

- Read the General Overview below, and discover the Demetra interface.

- Play with the first set of demo files, all the way through to the data reduction of these files. In this demo set, all parameters are properly set, then you can run the data reduction with only few clicks.

- Then, work with the second set of demo files. This demo set contains new data, and you'll have to properly tune the process parameters to complete the data reduction.

- Then, run your own observations, to produce your own fully processed files.

Of course, you can jump directly to the chapter you want, but this documentation is written to help you follow the process from the beginning to the final result (calibrated spectrum).

Technical phase and Observing phase

When working with an eShel spectroscope, there are clearly two phases : one for tuning the instrument ; only one time. And one for using it. As long as there is no change in the instrument (removing the camera or the fiber, for instance) the parameters remains valid.

We invite you to spend some time to properly tune the Demetra parameters, in such a way that the data reduction is fast and easy. This is the *Technical phase*: it must be done by an experienced user. This phase must be done during daylight, to work in comfortable conditions.

Once it is properly tuned, the eShel spectroscope is really easy to use, and you can focus to your observations. During this phase, Demetra helps you to get all the proper images you need for a high quality observation.

Requirements

Demetra works under Windows 7 (or above), 64 bits.

If you want to acquire your own spectra using the Demetra acquisition software you will need to install the ASCOM platform. It is not required if you only wish to manage and process existing images.
You need an eShel spectroscope, or images coming from this instrument. Your acquisition camera must be connected under ASCOM platform (i.e. the appropriate ASCOM driver for your camera).

Installation

The installation is simple: just click on the .exe file, and follow the instructions.

You can change the software language (to French or English) in the configuration menu. To take the change into account, you must then quit & *restart Demetra*.

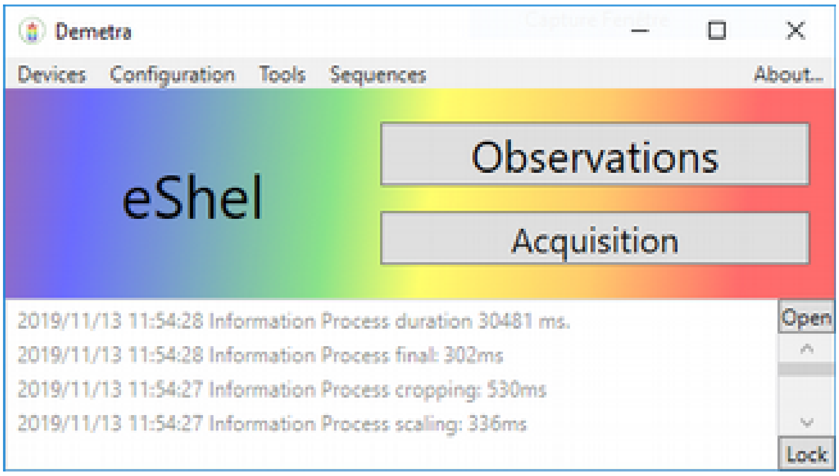
Depending on your usage of Demetra, install the ASCOM platform (see above).

Most of parameters are saved at the end of a working session: when you launch again Demetra, you'll recover your previous parameters.

General Overview

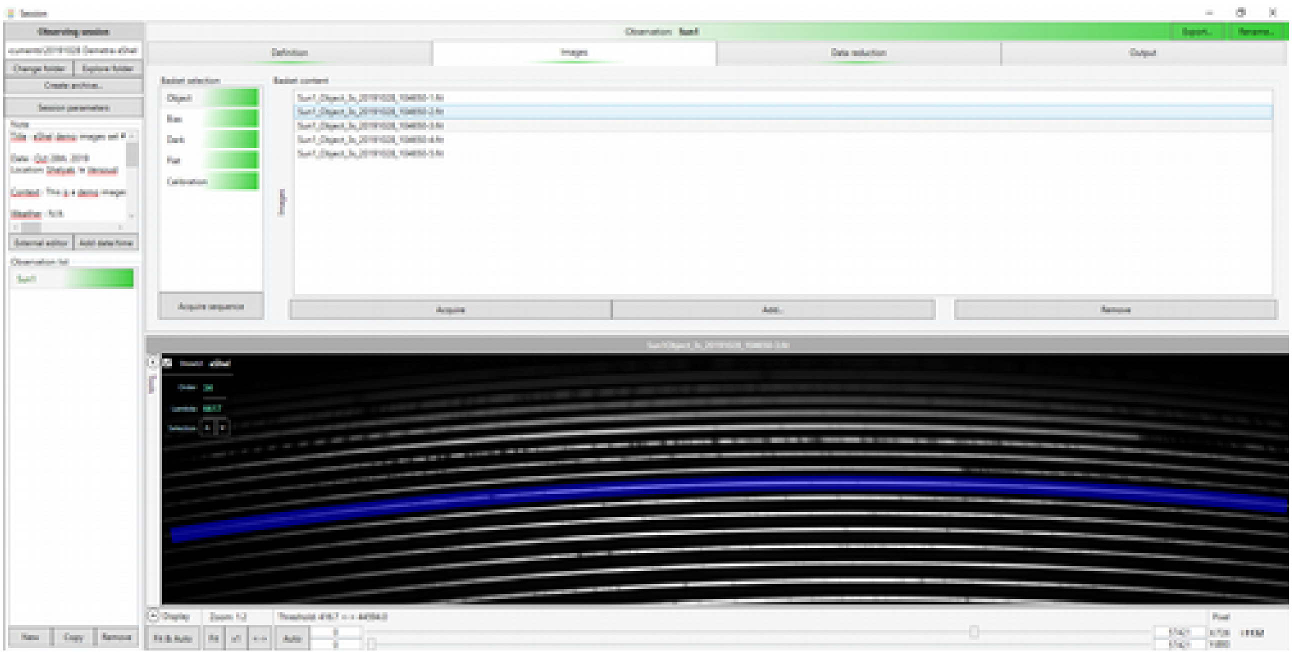
When you launch Demetra, you see a small window with menus, two buttons (Observations and Acquisition) and a log area:

The log is useful for understanding what recently occurred. The complexity level of messages displayed in this area can be changed in the configuration menu, and the log can be exported in a text file (click on button « open »): it may help our support developers to understand some behaviors or difficulties.



Demetra is made of two modules: **Observations** and **Acquisition**.
Both modules can be used separately, but Demetra realizes its full potential when they are used together.

The main module is « **Observations** ». This manages the various observations made in a complete observing session. Click on the Observations button to open this window:

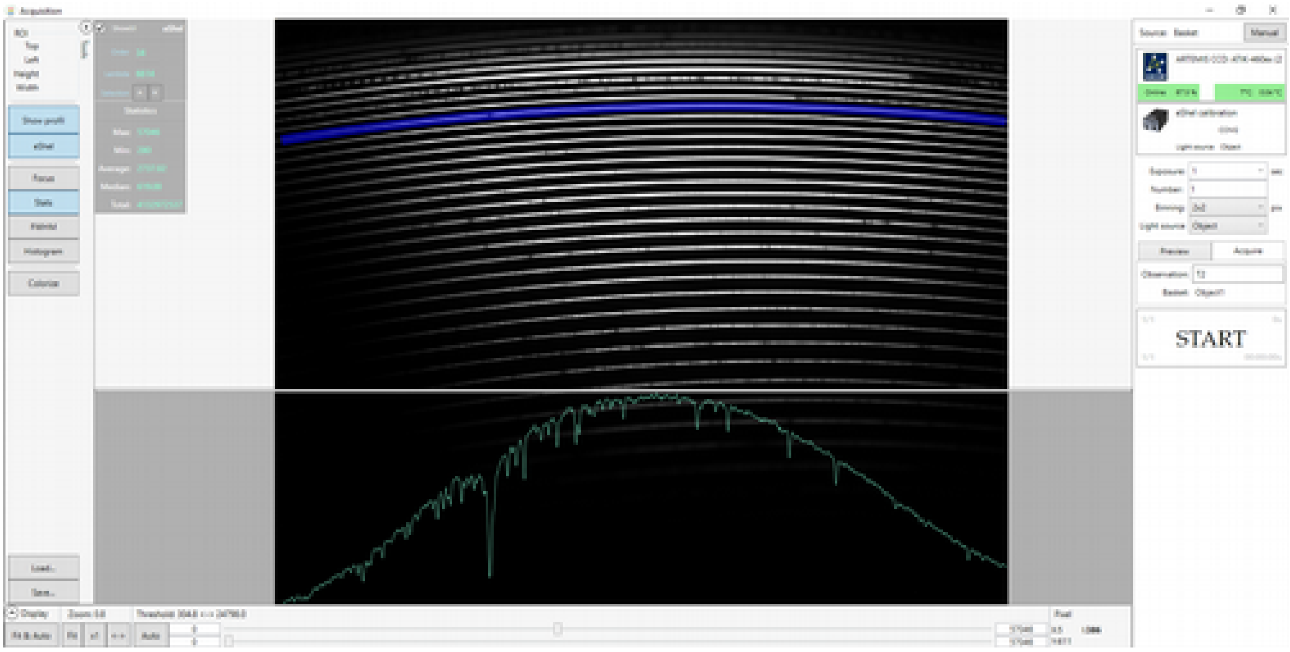


An **observation** is a set of data (images & parameters) related to a given astronomical target, that allows you to create a high quality spectroscopic profile.

An **observing session** is a set of observations. It is for instance an observing night, or a mission. The idea is that a session is made with a given instrument, at a given location (observing site) and by a given observer. When you change at least one of these parameter, you should open a new session.

All data for an observing session is stored in a **single directory**, which is defined at the top left area of the Observations window. You can change this directory: changing the directory means that you're changing to a new session (but it can also be used to re-open a previous session).

The **Acquisition** module manages the image acquisition from your eShel. This controls the camera and the acquisition settings: exposure time, number of exposures, binning. It also provides useful visual functions such as a real time profile display, shown below:



Demetra utilizes a simple **color coding** for processing all the stages to tell you where you must put your attention.

Green = all is fine, this is the normal status.

Orange = the process will work, but it is not optimal – you should examine closer.

Red = some key data are missing before you can move forward.

This is a general statement in Demetra: when everything is green, you have finished your spectroscopic observations, and *you can go to bed* !

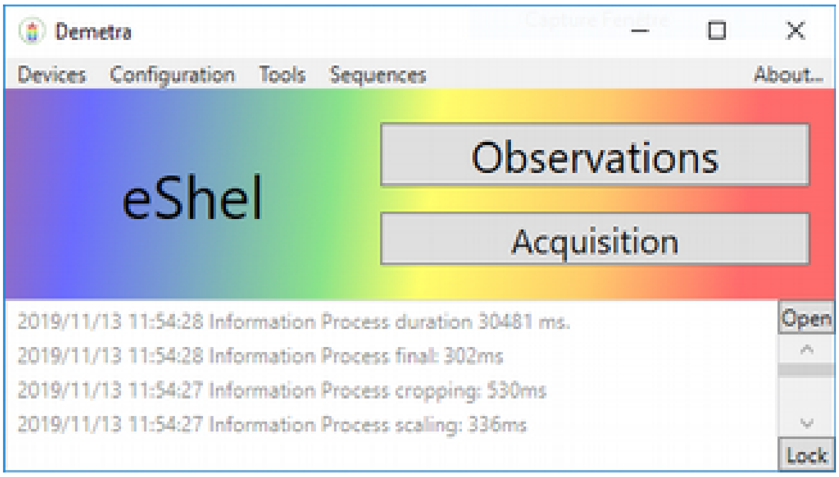
The core of a Demetra observation is the **data reduction** process. Data reduction is the sequence of operations that must be performed on the raw data in order to extract a calibrated spectrum. With Demetra, the process is the core, and the images acquisitions must fit the process requirements. This ensures huge benefits in terms of fast processing, accuracy and standards.

Quick start with the demo files #1

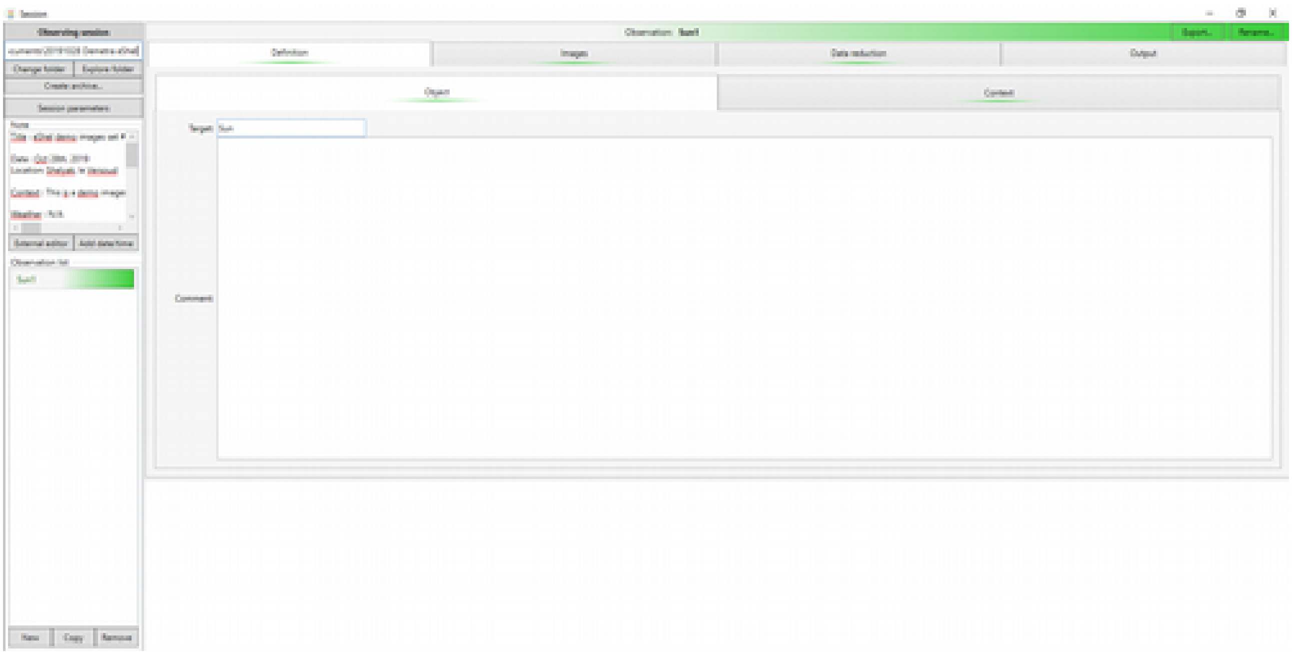
Using the Demo files is the simplest way to discover the Demetra interface, and run your first data reduction. You *don't need* to have a spectroscope connected to your PC for this step.

1 Discover the user interface

When you run Demetra for the first time, it opens the demo session folder, containing real observations.
Run Demetra. You will see the main window.



Click on the « Observations » button. You will see the demo session:



It contains one observation of the Sun.

First, you will see that the demo files are located in a specific directory (like ...Documents\Demetra Demo). You can open this directory through a file explorer, but also directly from the button « Explore folder ». All the files of this session are in this directory.

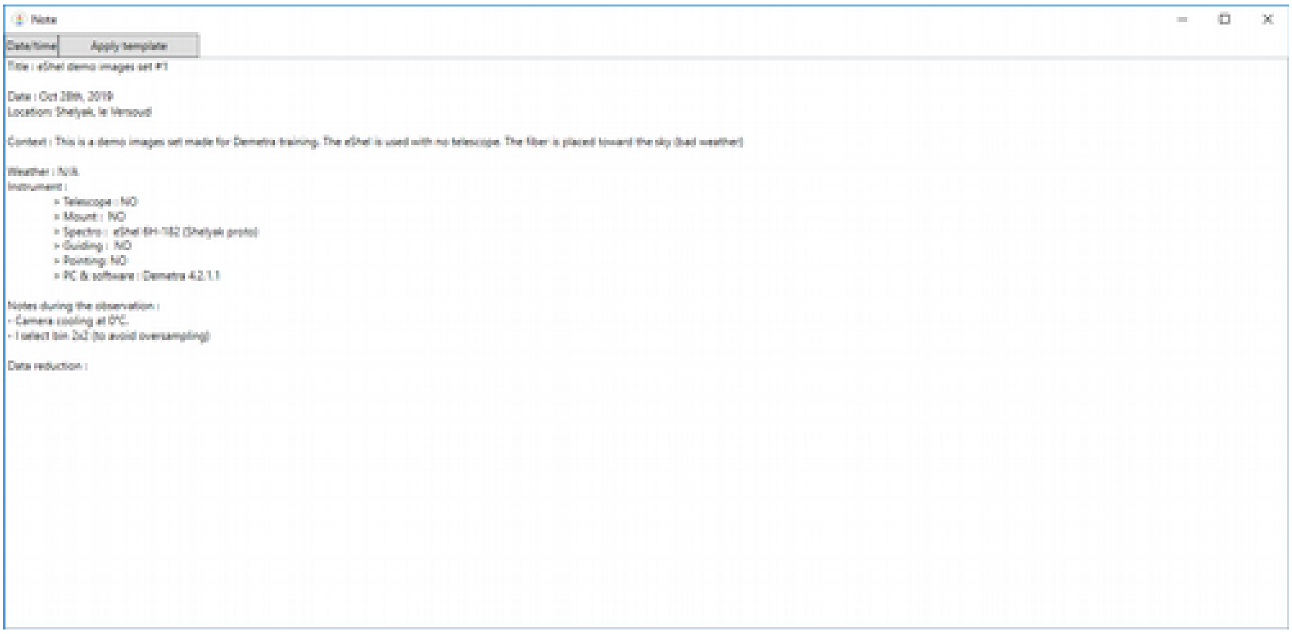
2 General parameters

Click on the « Session parameters » button, in the left top corner: Demetra shows the general parameters for the session: observer's name, observing site, instrument, and process (eShel in our case).

You can see the details of the site and the instrument, by clicking on « details » drop down button.

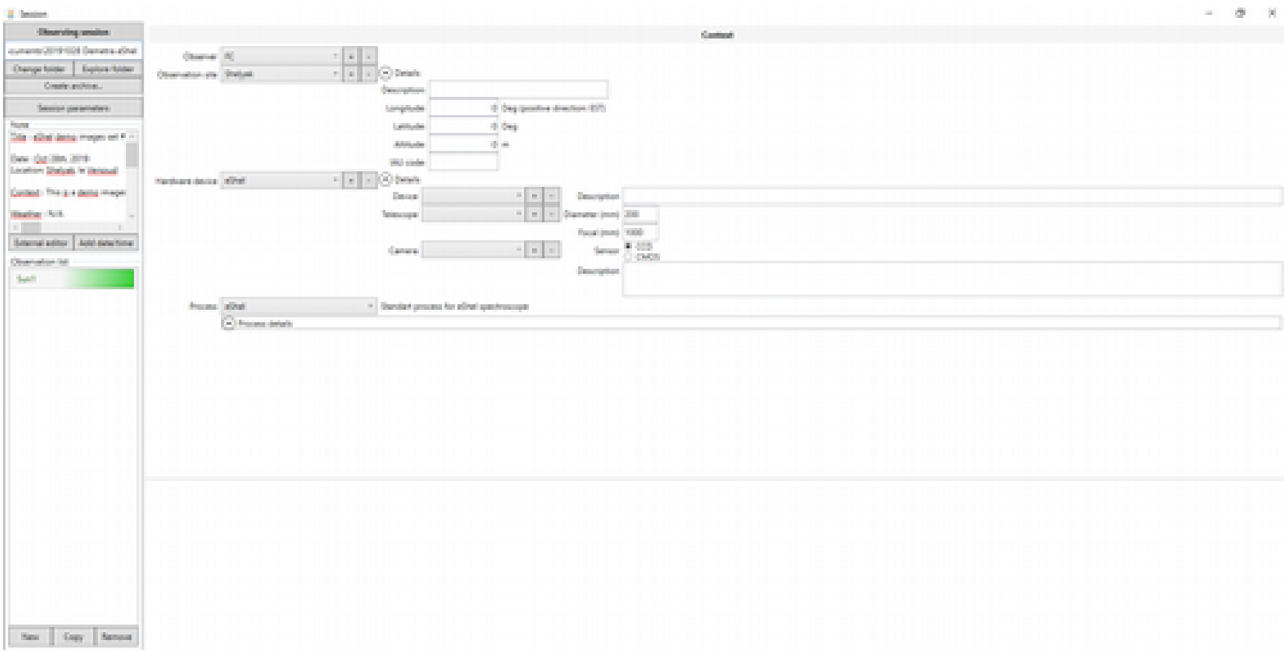
All these parameters may be edited. These details are recorded in the resulting FITS files header.

Below the « Session parameters » button, you will find the Notes area. This is the Observer’s log file for the session. It shows all the details entered by the observer about the observing session. You can open the Notes file in a wider format by clicking on the button « External editor » button:

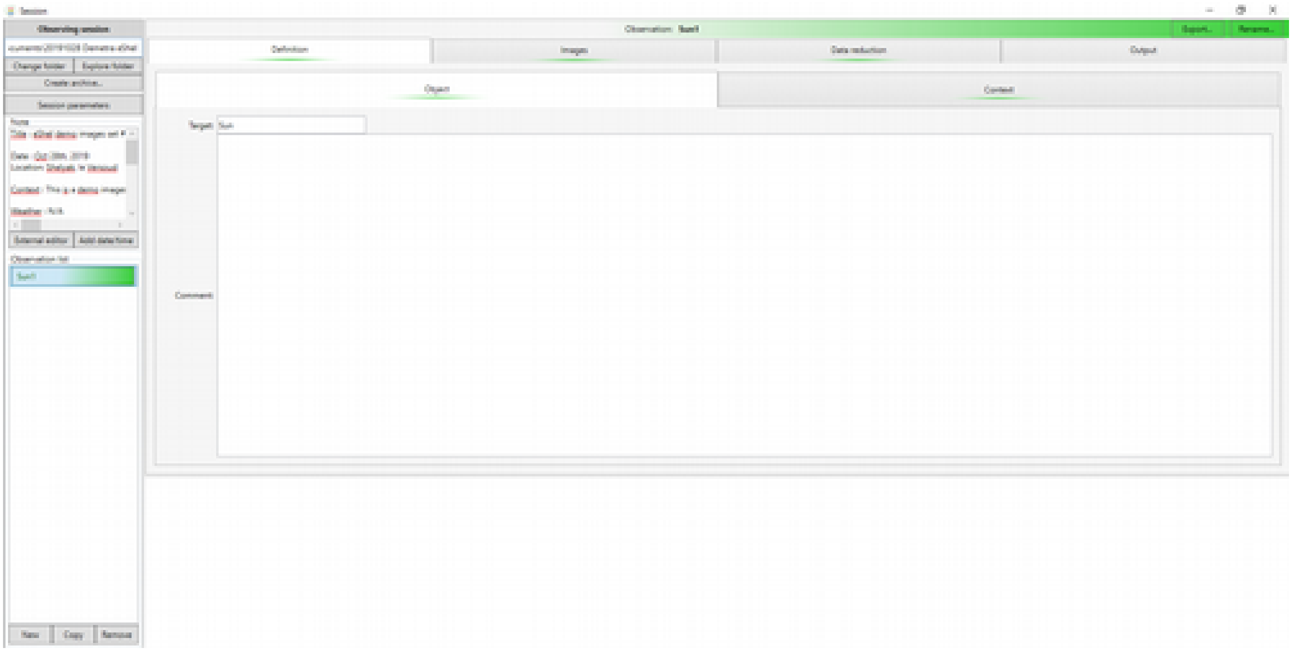


3 Playing with the Sun observation

Now, let’s look at the Sun observations. As you can see, this observation is green. It means that they are fully complete, with all data needed to obtain a good result.

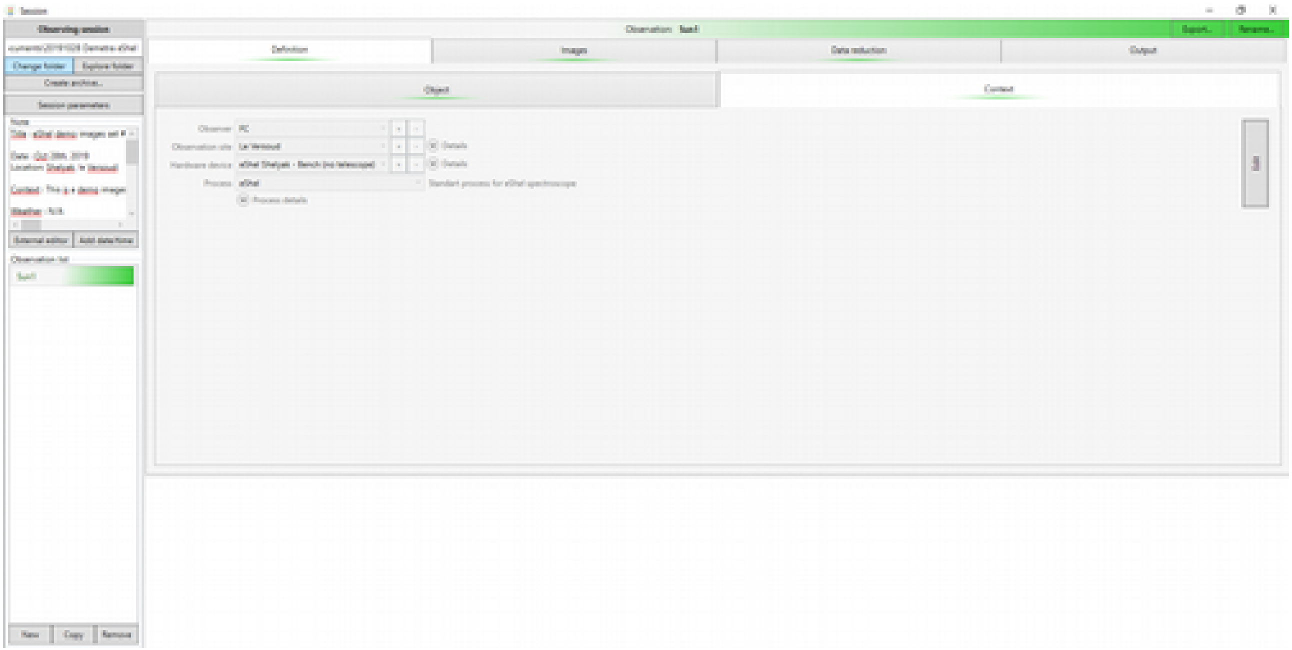


Click on the Sun observation. The right part of the main Demetra window is now populated with several tabs:



All these tabs contain the various information and processing for this observation of Arcturus.

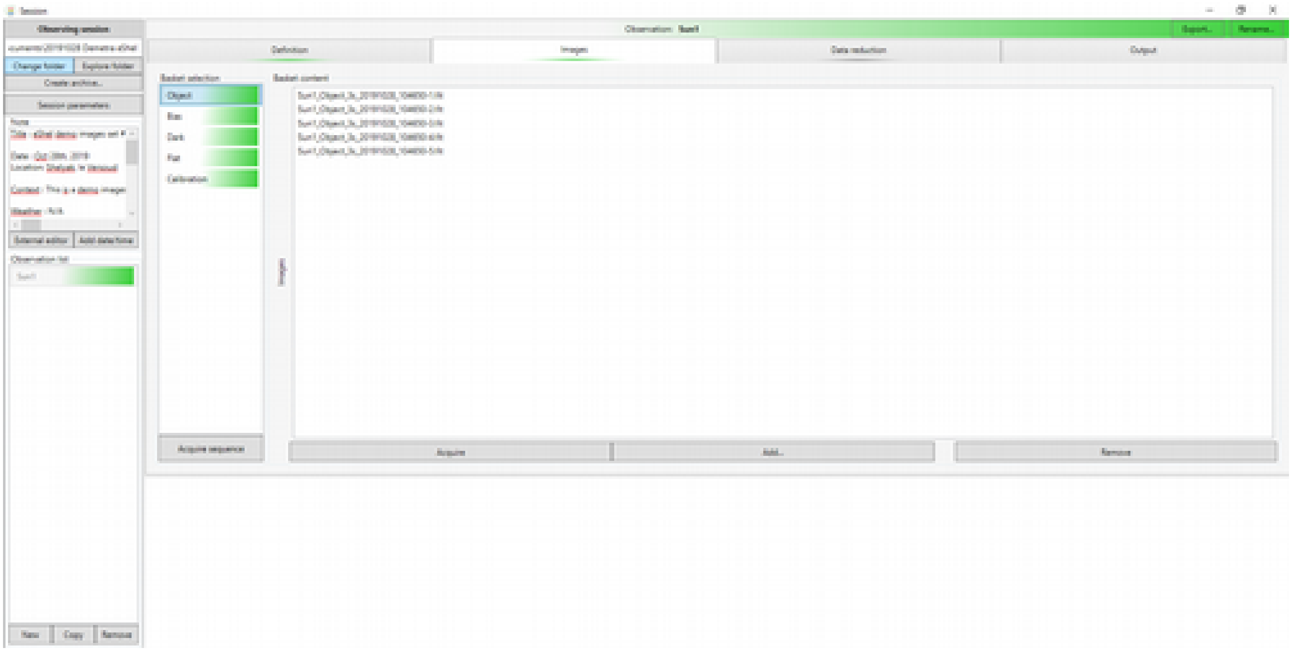
In the « Definition » tab, you have a description of the observed object (here, the Sun – see picture above) and a copy of the context when the observation was made (Observer, Site, Instrument and Process):



These data are frozen, because they refer to already established parameters (defined the the “session parameters” window). However, you can still edit them by clicking on the « edit » button on the right.

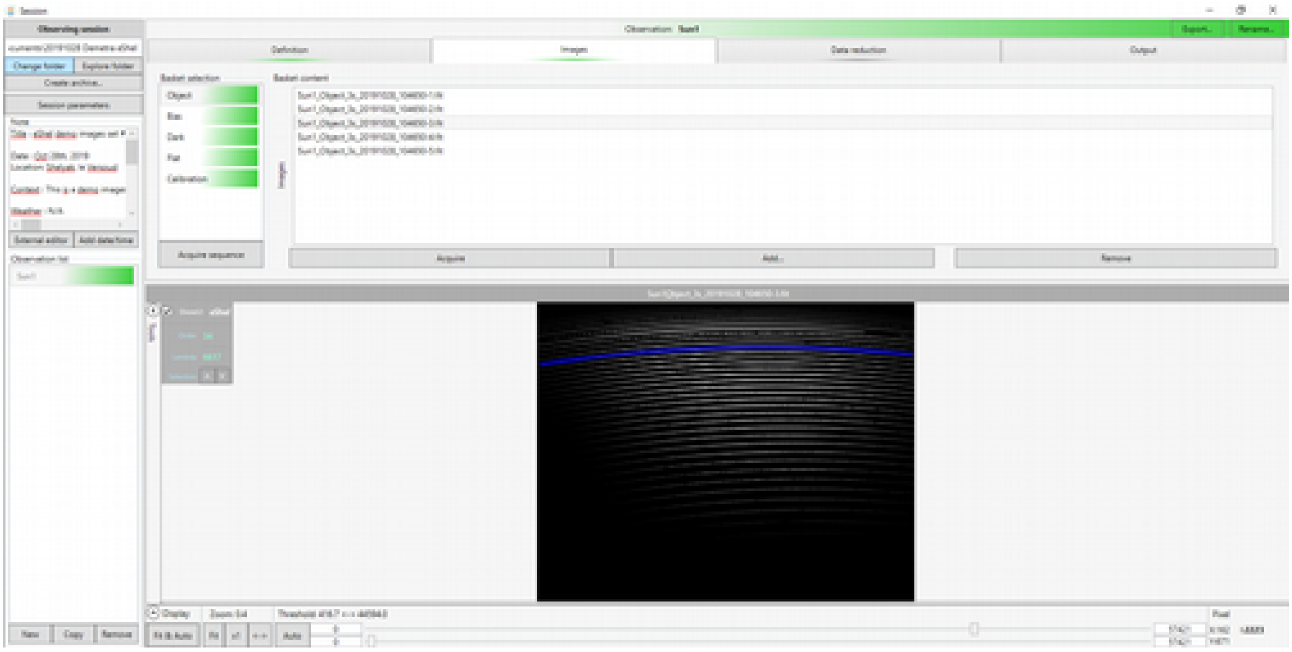
4 Images linked to an observation

The second tab, « Images » lists all the images linked to this observations:



You can see various « images baskets »: Object (for target images), Offset (Bias), Dark, Flat and Calibration. Each basket contains a set of images. For instance, in the above picture, the Object basket contains 7 raw images of the Sun spectrum. You can click on each basket to see the images contained inside.

Double-left-click on any of the Object image, for instance the image #3 (Sun1_Object_3s_20191028_104650-3.fit). It opens in the bottom part of the screen. To display it properly, click on the button « Fit & auto », in the left bottom corner:



5 Image viewer

The Lower half of the frame is the viewer for Demetra. You can display the images in the way you want using the bottom row of buttons, and some intuitive mouse movements.

The Fit & Auto buttons displays the full image and tunes the visualization thresholds to properly see the spectrum. You can do these to operations (fit and auto) with matching buttons. You can also display the image using the full wide of the image area, using the ↔ button. (This is useful, because an eShel spectrum is made of horizontal lines in the image frame). You can also display the image at full scale 1:1 (one pixel on the screen displays one pixel of the raw image).

In addition, you can zoom in/out the image using the mouse wheel whilst pressing the 'ctrl' key. And you can move the image by using ctrl key and moving the mouse with the left button depressed.

You can move the image vertically simply with the mouse wheel.

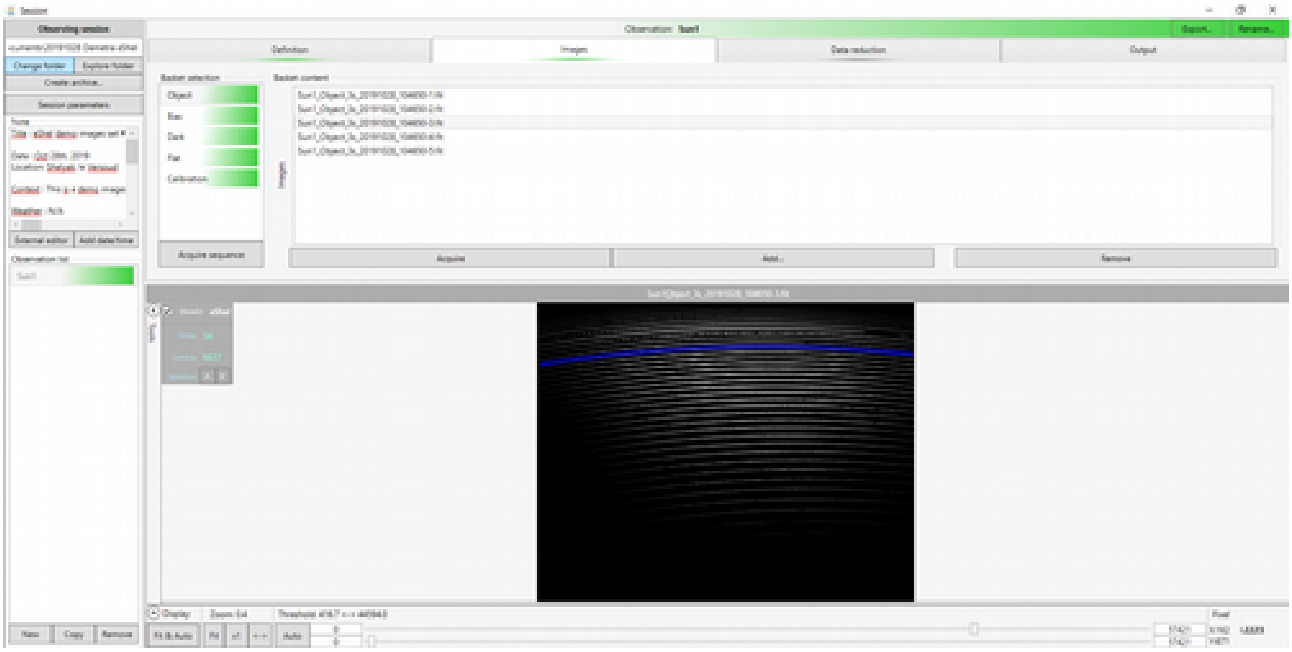
You have two scroll bars to change the visualization thresholds. On left and right of each of them, you have the min/max value displayed for each bar – you can edit them, of course.

In the bottom right corner of the frame, the X & Y position of the cursor is shown, as well as the intensity of the pixel under the cursor.

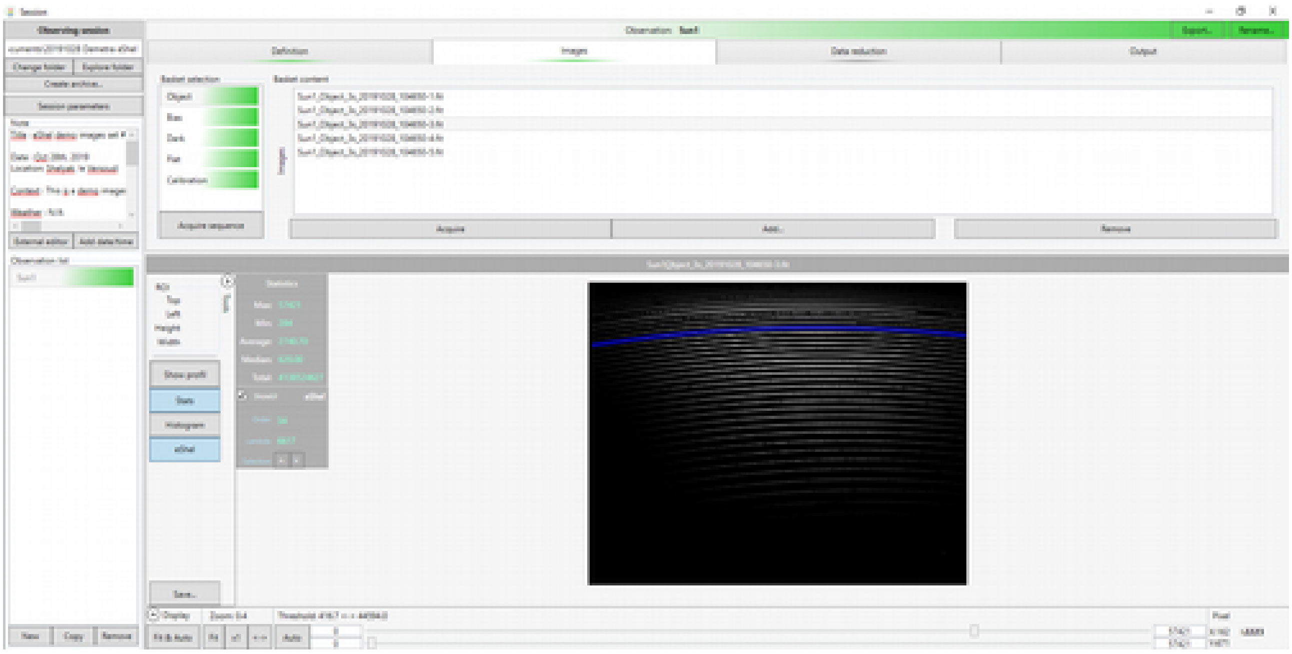
There is one blue band surrounding one of the order. This area is used for local measurements, for instance the visualization thresholds when you click on the **Auto** button.

You can change the selected order, with the keys in the top left toolbox.

An important point here: most of the tools are displayed transparently above the image, but you can still see the image beneath. This is the « **Head-up display** » (HUD) style of Demetra.

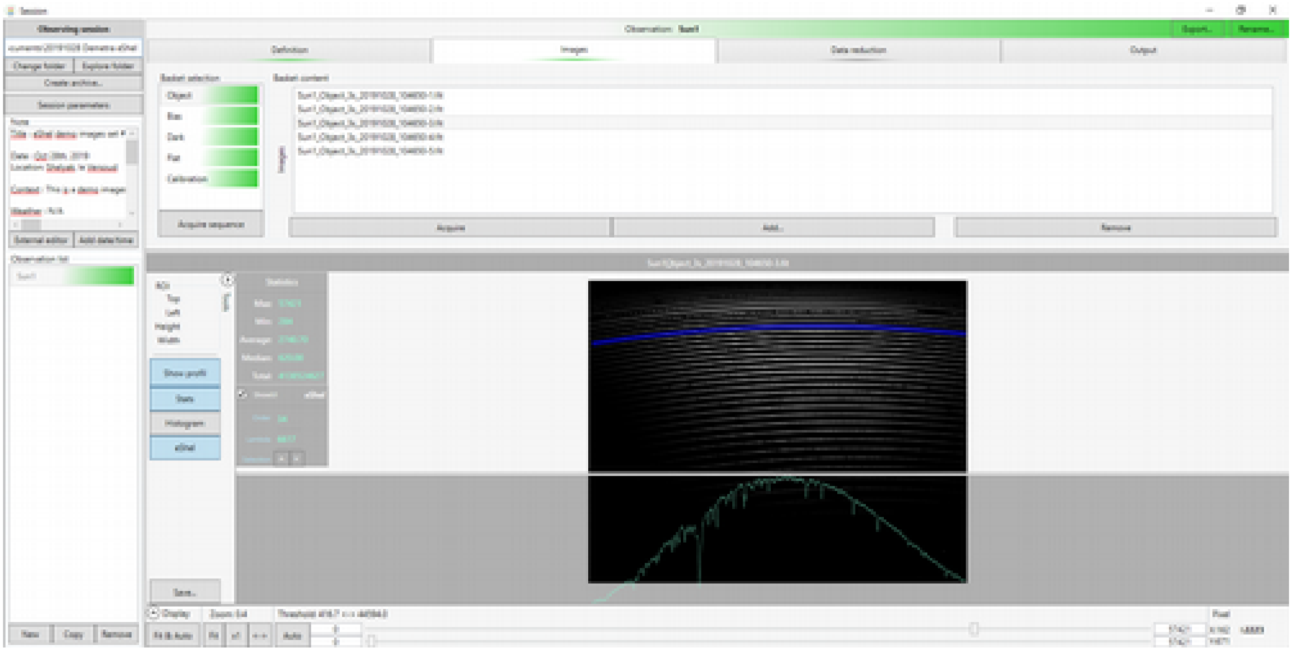


Let’s continue with the image viewer. On the left of the image, you have a « Tools » bar. Click on it to display it:

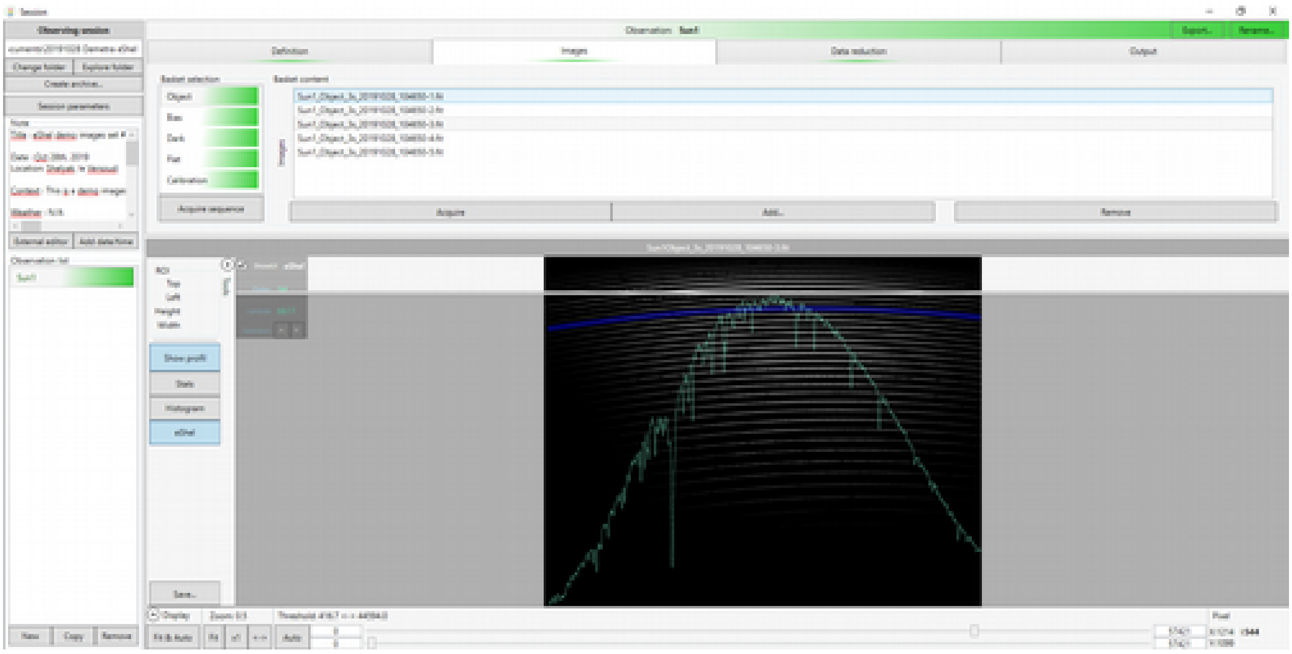


The eShel tool is already activated – this is the tool used to select an order in the image. When you deactivate it, it disappears from the the image.

« Show profile » displays a quick profile of the spectrum:

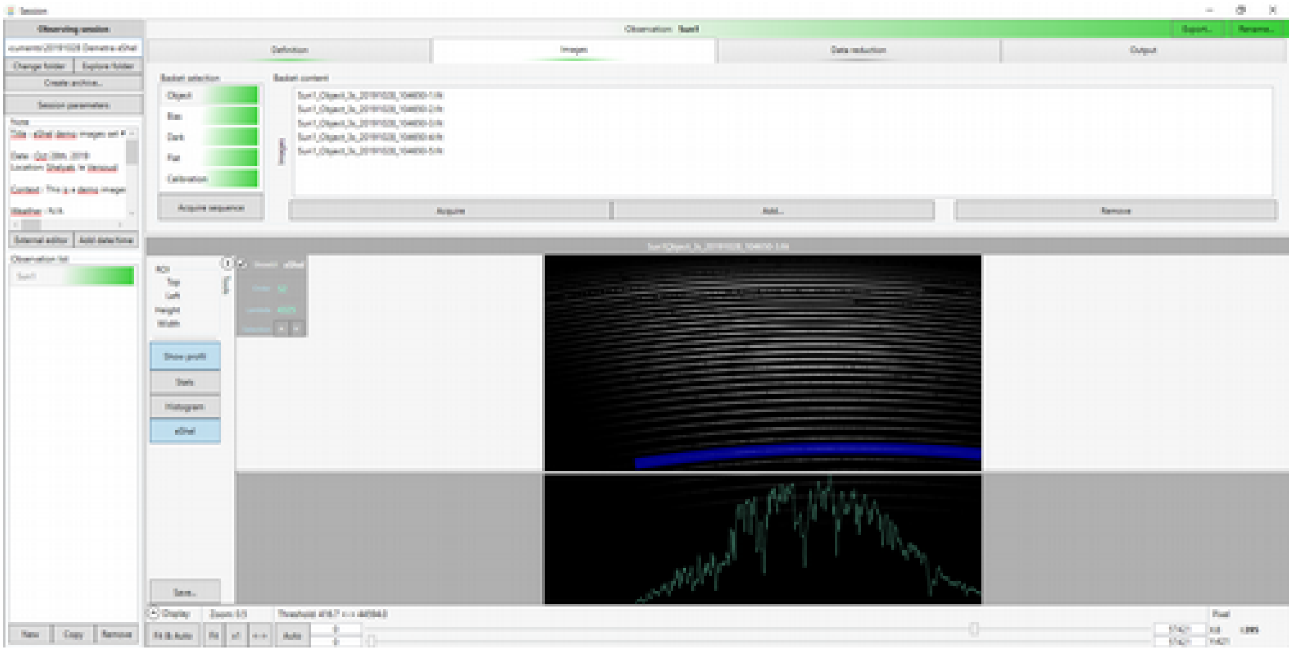


This graph is simply calculated as the sum of each column in the blue area of the image. No more processing is made here, it is only provided to give a quick view of the spectrum profile. You can change the vertical size of the profile: just click-and-drag and drop the top white line of the profile area.



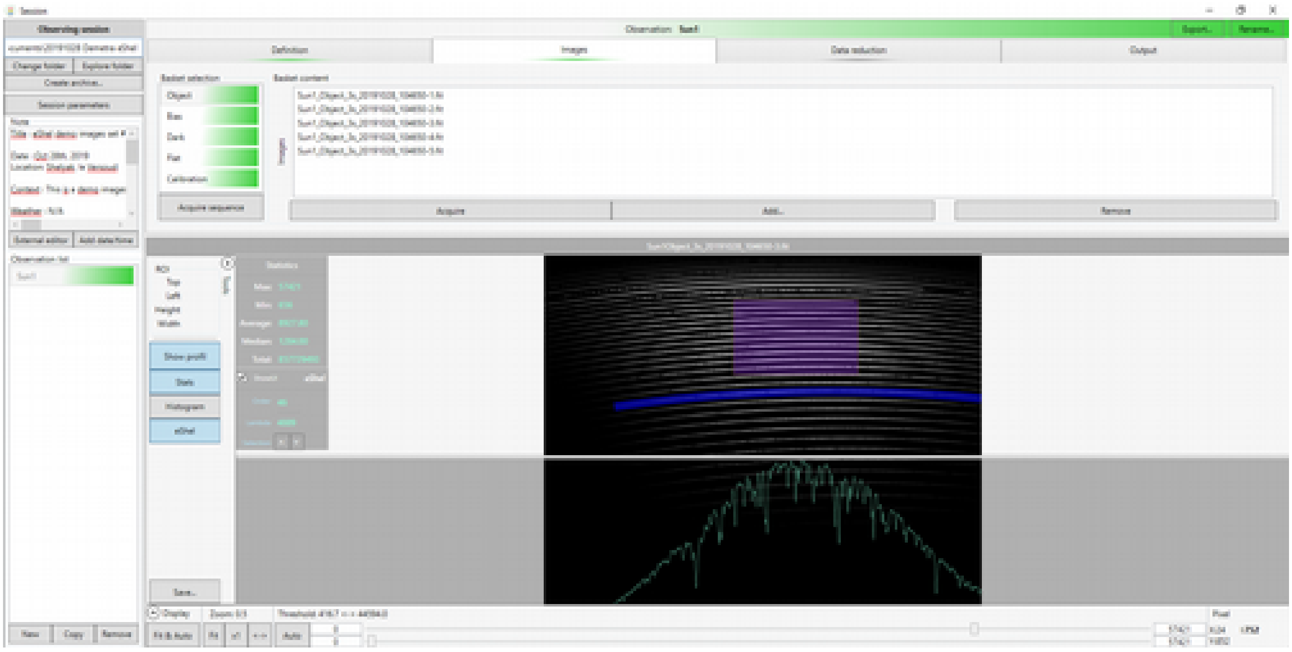
You can also change the order that is displayed, using the arrows in HUD area (the value – order 34 in the current image – is the physical order number.

Then you can scan all the orders to show the quick profile for each order.



Another tool is « Stats ». This displays key statistics ***in the whole image***:

However, if you need to show statistics – or even other information – for another region, then, you can select a rectangle anywhere you want to display that information. Simply select a rectangle by click & hold, dragging the mouse and releasing the button at the opposite corner. The rectangle area is shown in purple superimposed on the screen, see below:



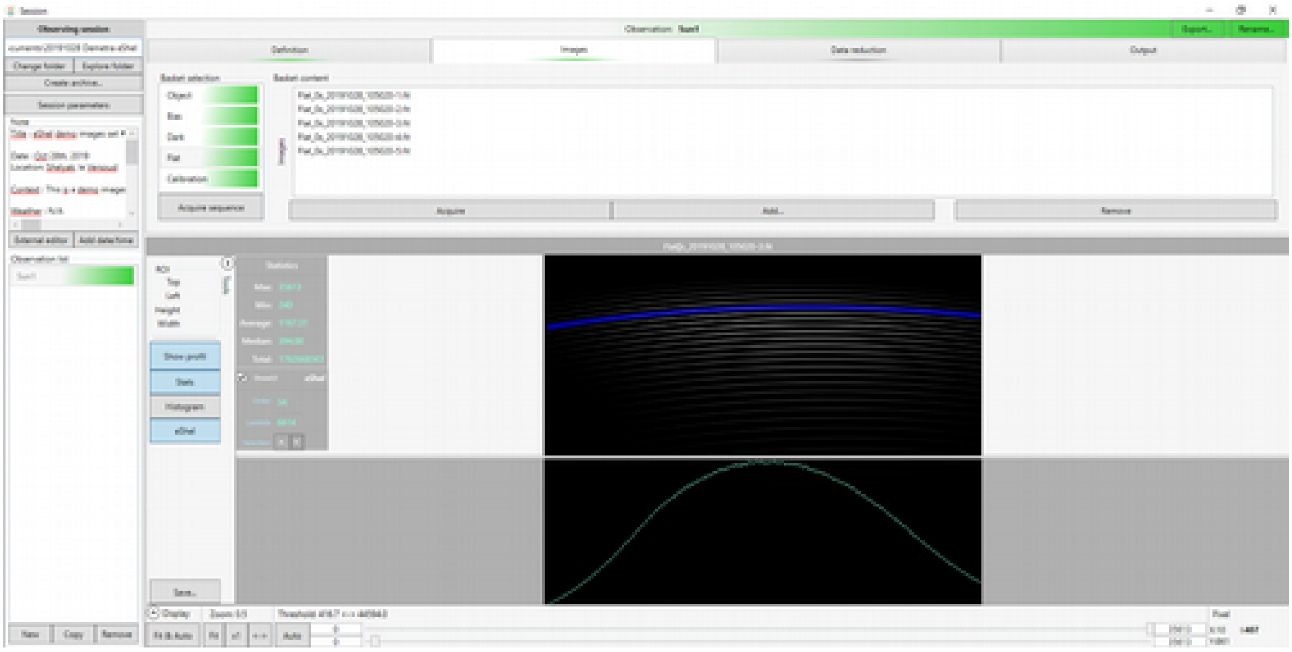
When the rectangle is selected, the statistics tool displays the statistics inside the rectangle, not in the whole image anymore.

By right-clicking inside the rectangle, you can select several options:

- Fit: displays the region in full size in the image area
- Thresholds: adapts the visualization thresholds to the region
- Statistics: show the statistics inside the area (same as in the stats tool)
- FWMH: measures the FWMH of the emission lines inside the region (only works if you select a small region around the line)
- Remove selection: cancels the rectangle

You can also cancel the rectangle by **double-clicking** anywhere in the image area, outside of it. Note that you need to erase the selection rectangle before creating a new one.

All these tools to manipulate images can be used on any of the available images. For instance, you can look at one flat image (just double-click on the image you want to display):

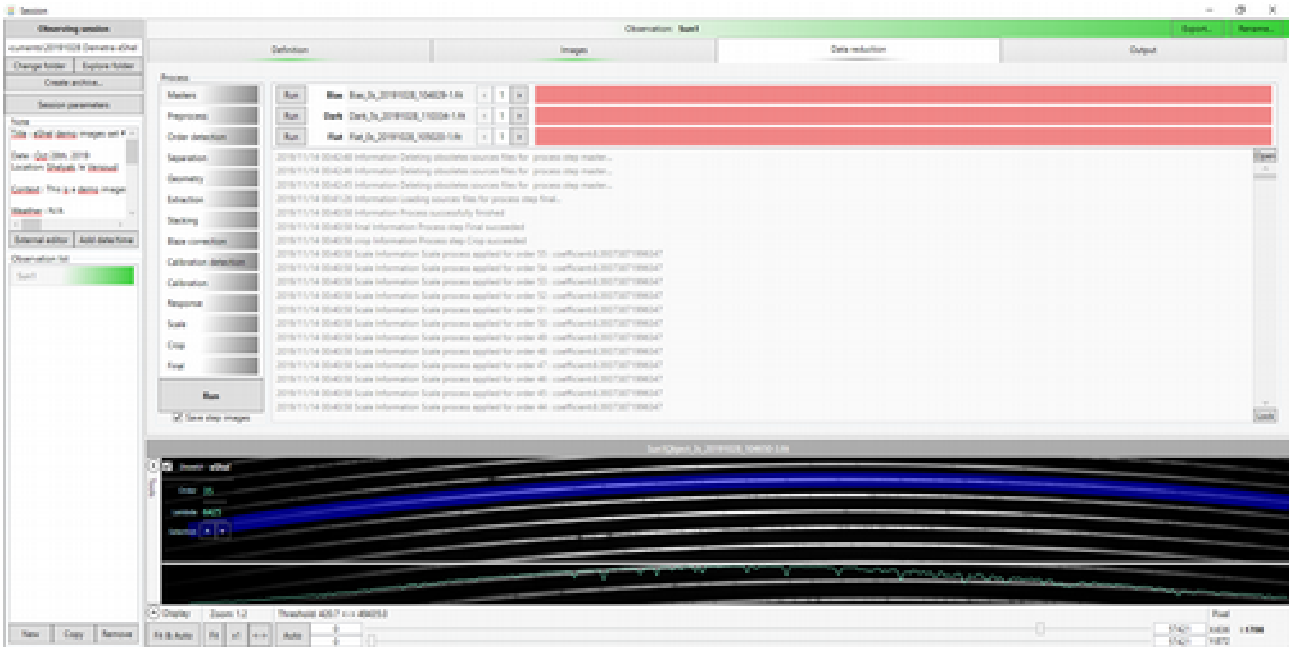


In the demo observations, all the baskets are green. This means that all baskets are properly filled with the required files. If one basket were empty, then it would be displayed red, as well as for the whole observation.

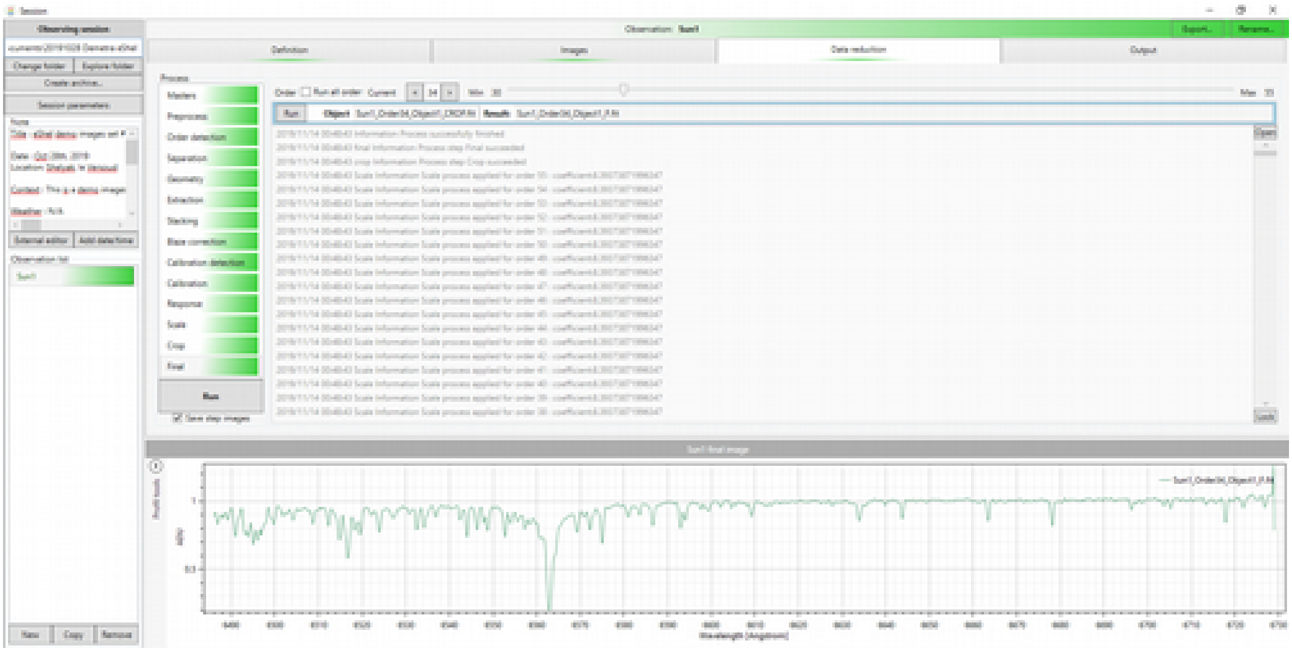
6 Data reduction

When an observation is green, all required images are collected to run the data reduction. The data reduction is the sequence of operations that starts from the raw images and then transform them into a calibrated spectral profile. Demetra includes all the operations that perfectly matches the images acquired with an eShel.

Then, we can now switch to the **Data reduction tab**.

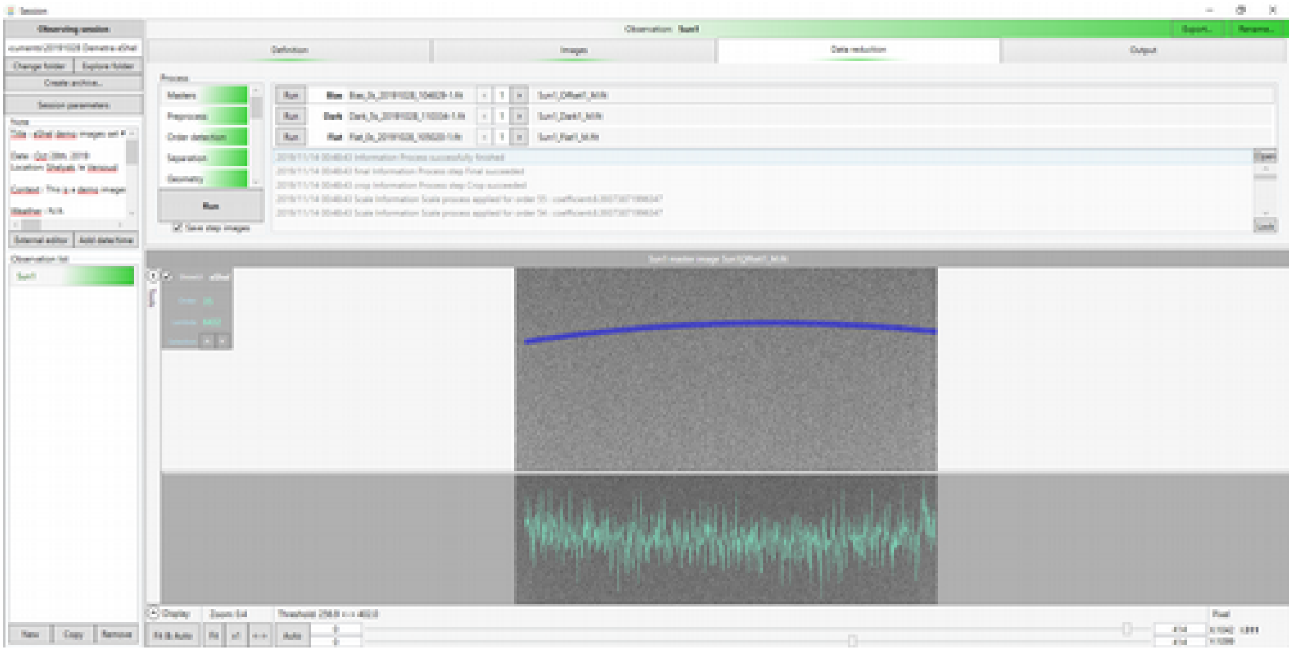


In this new window, there is the list of all the data reduction steps (Masters, Preprocess, and so on). At this stage, all the steps are gray, which means that they are not completed yet.
Demetra allows you to run these step one at a time, in sequence. But the entire process can also be done in one click: to do this, click on the button «Run», at the lower end of Process list.
For this first images set, run the whole process in one click (Run button).
All the steps will turn green, one after the other as the procedure progresses.
At the end, when the whole data reduction is done (all steps are green), you will then see the calibrated spectrum in the image area:



Even when a 1D profile is displayed in the bottom viewing area, you can play with the graph: fit, zoom, and so on. You can also select a rectangle in the graph, to zoom in the selected area. Note that you can zoom only horizontally or vertically with the mouse wheel – just put the cursor on the X axis or on the Y axis while rolling the wheel.

You can now go back to each step, and examine its effect: each operation lists the images *before* and *after* the operation in the upper area of the Data Reduction window. To the left are the images input at the start of the process step and on the right are the resulting images. These 'results' then become the 'inputs' to the next stage of the process. And of course you can double-click on each image to display it in the bottom area. For instance, you can look at one offset image in the Master step (the first one), and compare with the median resulting image (ArcturusOffset_M.fit). We immediately see the effect of the Median operation: the result is much less noisy.



Here is a summary of operations made for each data reduction step:

- **Masters:** Demetra takes the raw bias, dark and flat images, and calculate the median of each serie. This improves the Signal to Noise Ratio (SNR) for these images.

- **Preprocess:** Demetra corrects the star spectrum images from the bias, dark and flat. It also detects and manages any hot pixels. This retains only the signal from the target star, and removes most of the camera instrumental effect.

- **Order detection**: Demetra detects all the orders available in the image. This calculates the position and profile equation for each order.

- **Separation**: Demetra splits all the orders in dedicated images, and makes them flat (horizontal), using the actual profile of each order.

- Geometry: Demetra applies a slant angle to each order, to take into account any optical effect (fiber optic image).

- Extraction: Demetra extracts the spectral profile from each star spectrum image. This is the change from 2D images to 1D profile.

- Stacking: Demetra stacks all the spectral profiles. This improves the SNR of the result.

- **Blaze correction**: Demetra corrects each order profile from the blaze effect (lower level in the order edges). This is based on the flat image.

- Calibration detection: Demetra detects which is the central wavelength for two selected orders. This will be required for the automatic calibration of each order. Note that the central wavelength of any individual order can be deducted from the result of these two orders.

- Calibration: Demetra uses the calibration images (made with the ThAr lamp) to define the dispersion law of the spectrum for each order, and applies it to the result. From now on, the spectrum horizontal axis is given in physical wavelength. Also, Demetra re-samples the spectrum to have a linear dispersion (necessary to share the result with others).

- Response: Demetra corrects the spectrum from the instrumental response. This response must be calculated with a reference star (see below).

- Scale: Demetra scales the spectrum according to a given wavelength area rescaled around the value 1. This avoids huge values for the spectrum, the Y axis now represents a relative energy (there is no physical unit in this axis).

- **Crop:** Demetra crops each order to its useful spectral domain.

- **Final:** this is the final step of the process, to show the result (no actual data processing).

The whole data reduction process is a complex operation, but is made easy in Demetra because it gives it all the information it needs to run it smoothly.

Note: *As soon as you change a parameter, you must re-run the reduction steps*. Then, all the steps, from the one modified, become gray again (they are considered as not done yet).

7 Instrumental & atmospheric response correction

Partie à reprendre

One critical step in the reduction process is the instrumental correction. In few words, the spectral profile measured for the target star is deeply affected by the instrument; for instance the grating of the spectroscope and/or the CCD sensor have their own spectral response. Also, the atmosphere changes the star spectrum significantly as seen from the Earth and this depends on the altitude of the object in the sky.

Instrumental & atmospheric correction is a complex subject, but the simplest way to do it is to observe~~d~~ a well known object under the same conditions are your target, and compare it with reference spectra. (Reference spectra are available in the literature and many are stored in Demetra's database). The ratio between the theoretical and observed spectra produces your instrumental & atmospheric~~-~~response profile.

Demetra includes a tool to calculate this response profile – we'll see later on how to use it. At this point, just note that for the Sun demo observation reduction, Demetra uses a response profile named *XXXX*.fits . You can see it in the parameters of the « Response » step, and display it.

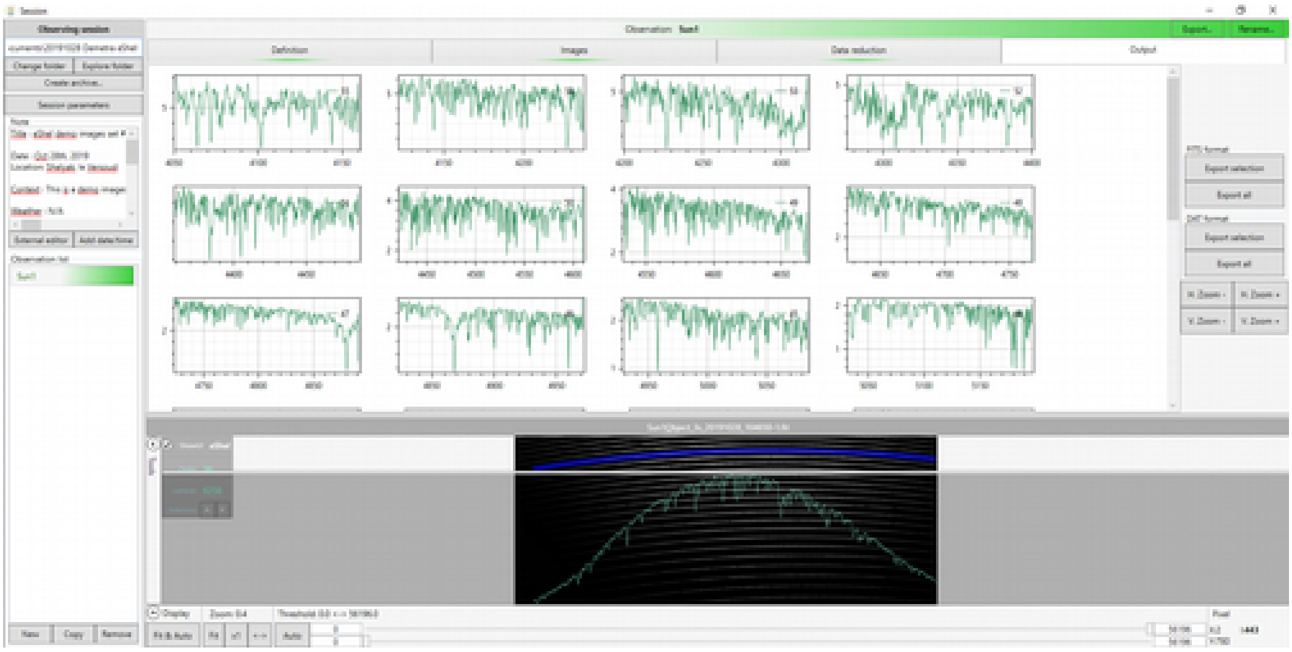
8 Result

The resulting file of the data reduction for the order 34 (for instance) – the actual result of the observation – is named Sun1_Order34_Object1_F.fit. This name, automatically generated by Demetra is made up from the Observation name (Sun1).

Once the data reduction is done for Sun1, the « Data Reduction » tab becomes green, and the observation name (in the observation list) is surrounded by dark green. This way, you can quickly see from the observations list which one is already processed and which aren't.

9 Output tab

The last tab in the observation is the Output. It is very intuitive, and allows you to show the result in several formats. When you're looking at an observation made after a long time, this is probably the most useful, the one which deals directly with the final result.



How data are stored

All raw images, which are pure FIT files, are NEVER modified by Demetra. A raw image remains a raw image, and no change is applied after its acquisition.

All the details that define an observation (context, list of images, position of the horizontal bands, reduction parameters, and so on) are stored in an xml editable file. Its name contains the observation name, appended by .obs.srl. For the Sun1 observation, this name is Sun1.obs.srl. You can find it in the session directory, and open it with any text editor (it is made for human reading). You can edit it … but if you do so, there is a significant risk that you break the consistency of the file. Make sure to backup the file before any change.

All the images generated by Demetra during the data reduction are saved in the same directory, with a file extension linked to its operation. For instance, the dark master image for Sun1 is named Sun1_Dark1_M.fit (_M stands for

Master).

If you don’t want Demetra to save these intermediate files (to save room on the hard disk drive, for instance), then unselect the tick « Save interm. Images », below the reduction steps list, and re-run the reduction process. Note that if you do so, you cannot edit the process step by step anymore – because this edition requires to go back to intermediate images.

During the data reduction process, the log area is filled with all the details of this process. The same text is saved in the session directory under the name Sun1.processlog.1.txt.

Setting the parameters for the demo files #2

With the Demo files set #1, all the parameters are properly set. It shows how the system works in usual conditions, during observations.

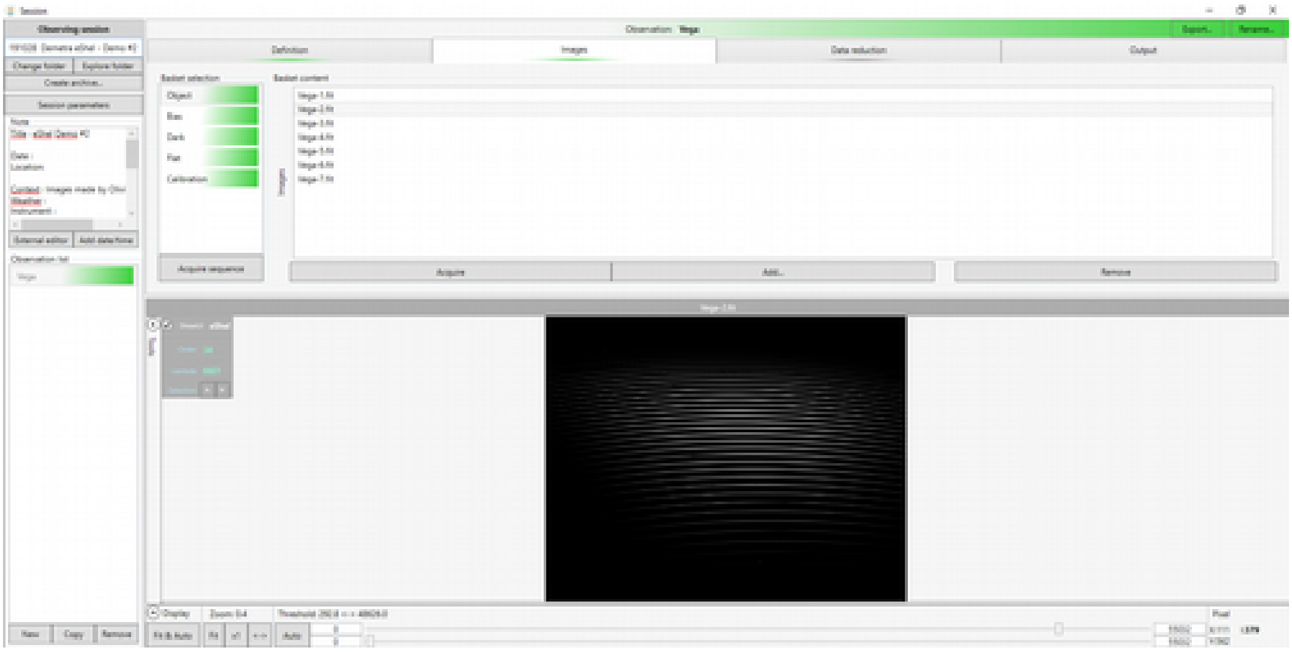
We will now switch to the demo files #2, which contains different images, for which the parameters are not set yet. This is the situation that you’ll face when you’ll acquire and process your own images for the first time.

The demo files #2 contains an observation of Vega, made by Olivier Garde.

To change the working session, click on the “Change folder” button, in the top left corner of the Observation window, and select the folder “Demo files #2”.

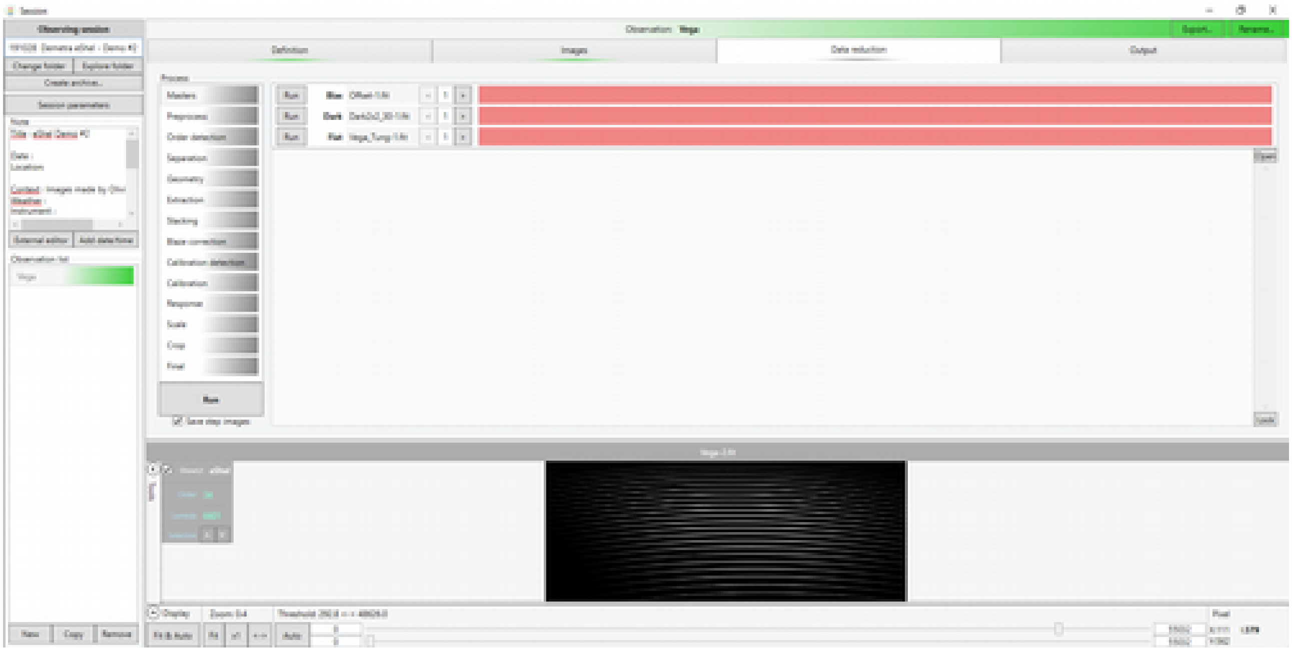
The whole context of Demetra is now updated. You can look at the new images of the Sun, taken in different conditions from demo files #1.

In the next chapters, you’ll see how to set all the parameters.

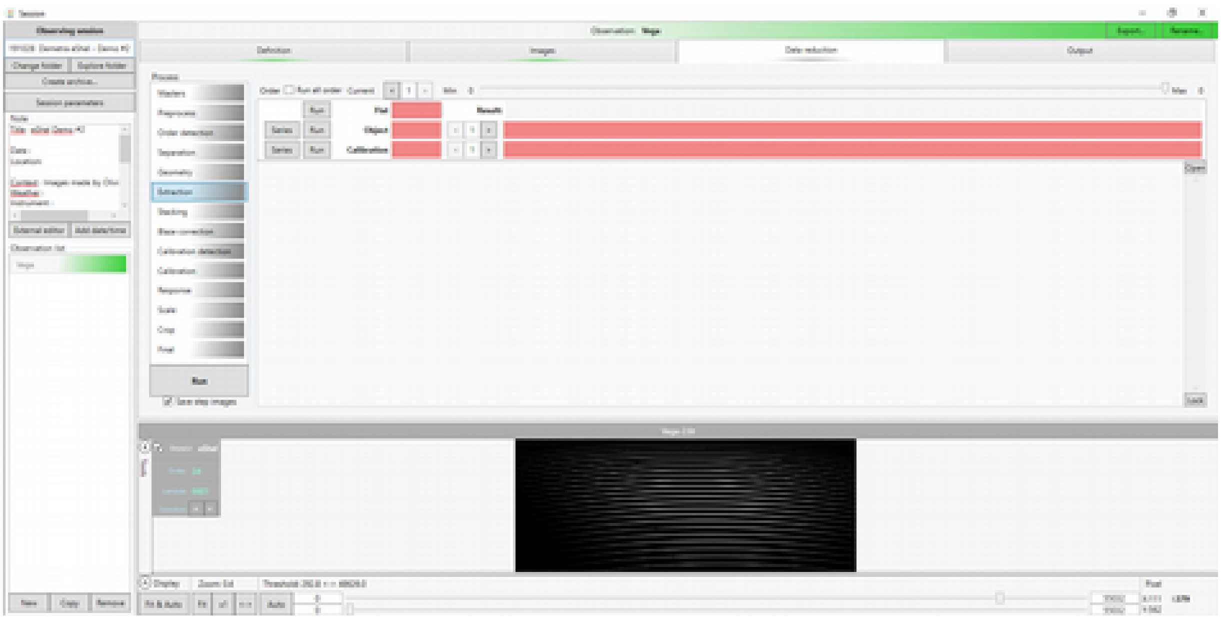


Setting the reduction parameters

Let’s go step by step through the data reduction process, to setup properly the parameters. For each step, you can run the operation manually. You can also do it automatically, with the Run button, but the process will stop before the end – because all the parameters are not set properly.

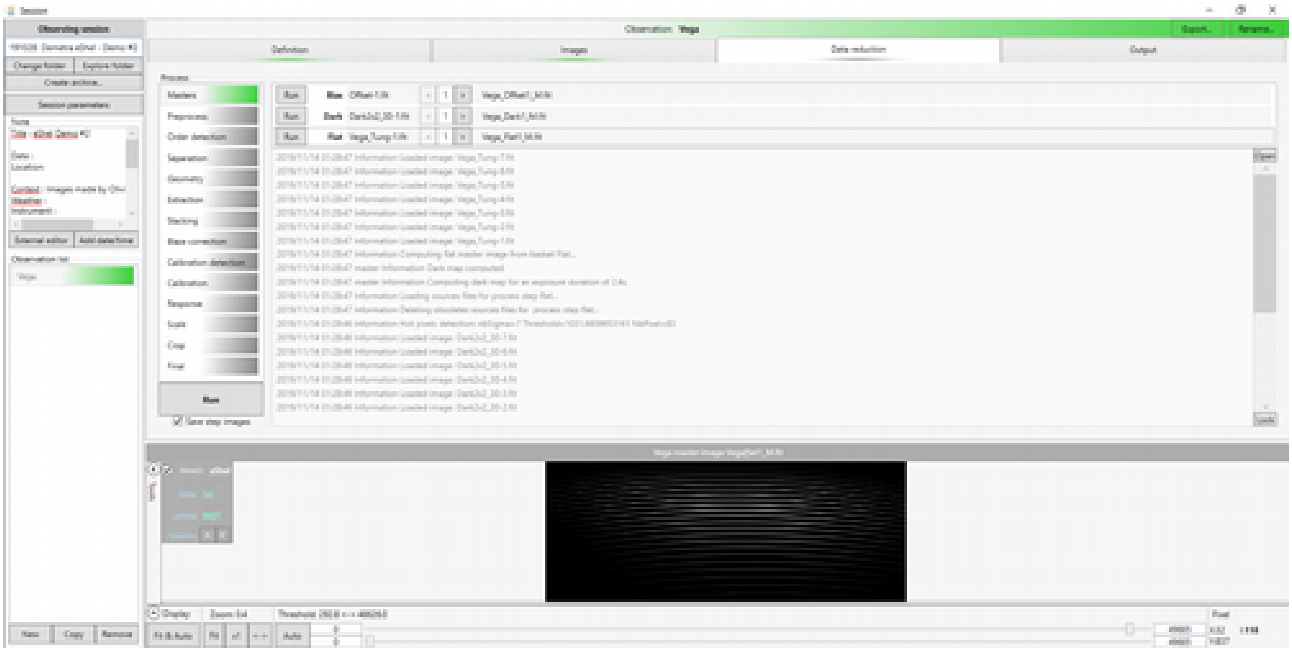


Note that depending on the step, you can run a single operation, or run a series (for all images of a basket), or in some cases even run all the orders at once (by selecting the tick “run all orders”). See for instance the step “Extraction” :



1 Masters

There is no parameter for this step. Click on "run" buttons, and the step becomes green.



2 Preprocess

There is no parameter for this step.

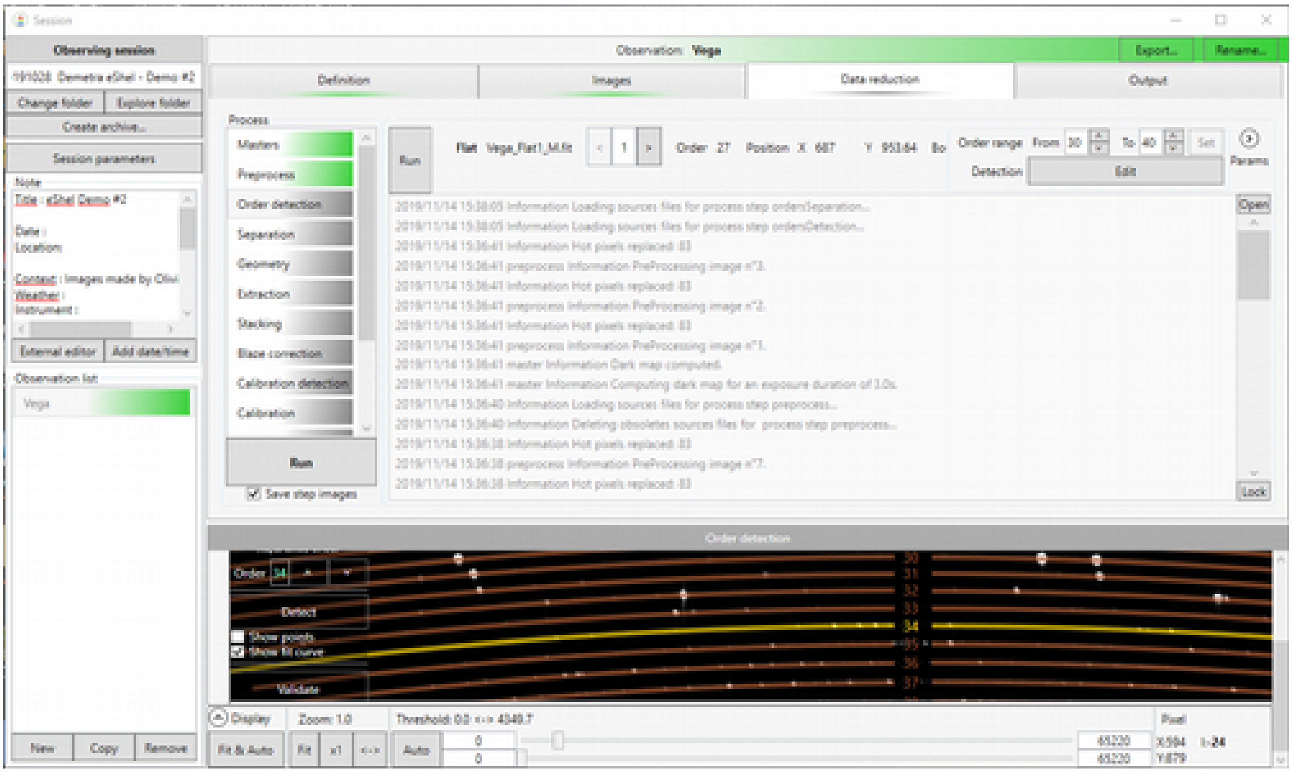
3 Order detection

In this step, we must define the "Reference order". And the orders range to process.

The reference order makes the relation between a physical order of the grating and its geometric position in the image. It is also the first order to be processed, and gives a reference to all calculations. With the eShel, we usually use the order 34 – which contains the Ha line (6563A) as the reference order. Note that the order numbering matches the *physical* order. If Ha line is contained in the order 34, this is by construction of the eShel spectroscope, and specially of the echelle grating.

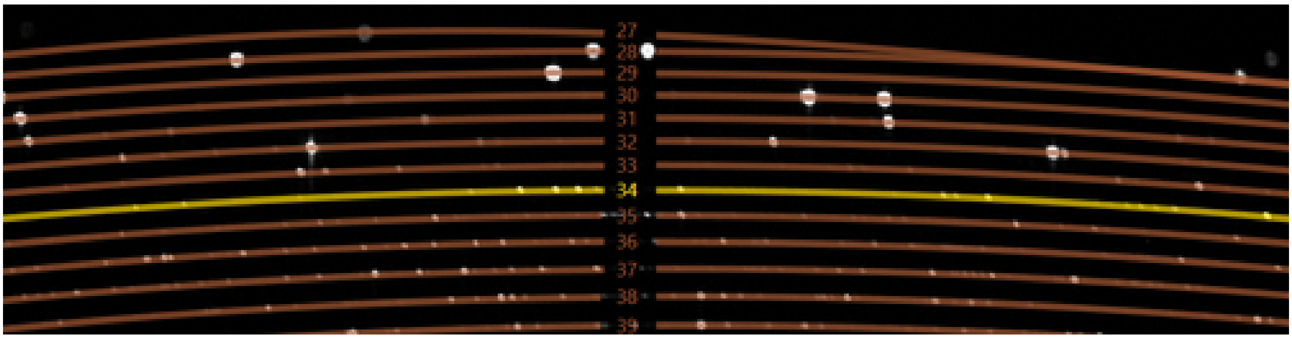
Note for Whoppshel users : the Ha line is included in the order 52.

Click on the "Params button", on the right end of the order detection area. Then, click on the **Edit** button, to show the order detection window, with the calibration image loaded.

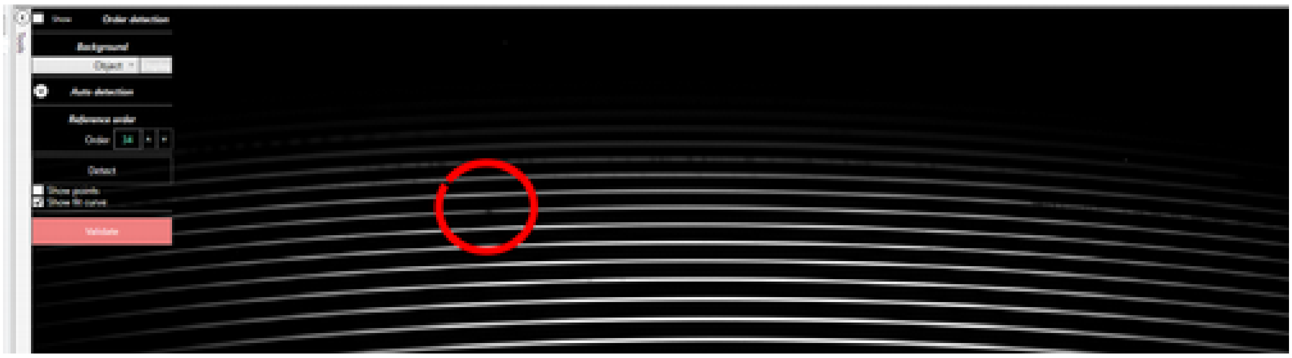


Click on the “Detect” button. A warning says that the reference order is not defined. Then, it displays all the orders detected in the image (the detection is actually based on Flat images).

The reference order is the Yellow one. You can move it from one order to the other, with the up and down keys. The order 34 is the one with this pattern :



If this is easier for you, you can do the selection with the target spectrum ; for instance, in the Vega spectrum, Ha line is easy to recognize. To do it, click on the drop-down menu in the top left corner, then select “Object” in the list, and click on the button “Display”:



When it is properly set, click on the “Validate” button.

Then, check that the orders range is set, say from 30 to 55. You can reduce this range if you want to save some process time.

Note for Whoppshel users : you should cover from order 50 to 84.

4 Separation

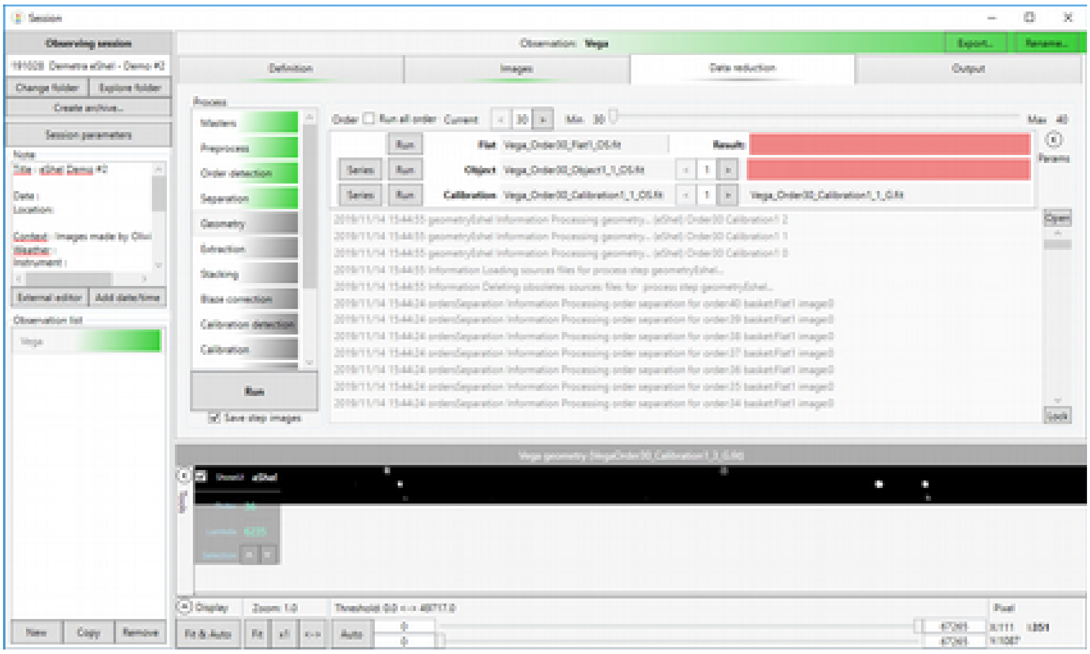
There is no parameter for this step.

5 Geometry

Here, you have to tune the slant angle for each individual order.

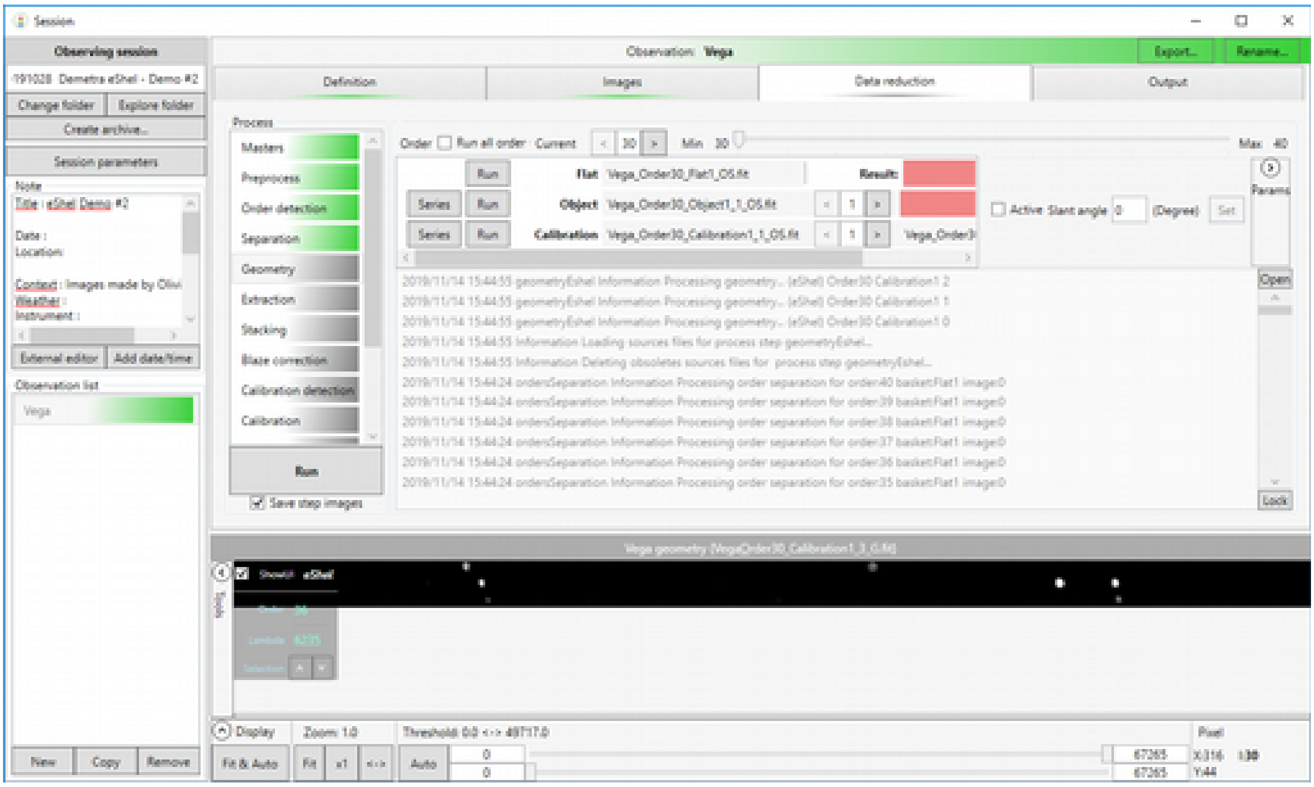
Important note: you can drop this step by doing no correction in a first step. The quality of the result (spectrum resolution) might be not optimal, but the process can go on.

Use the ThAr calibration image. Run the first order (only this one):

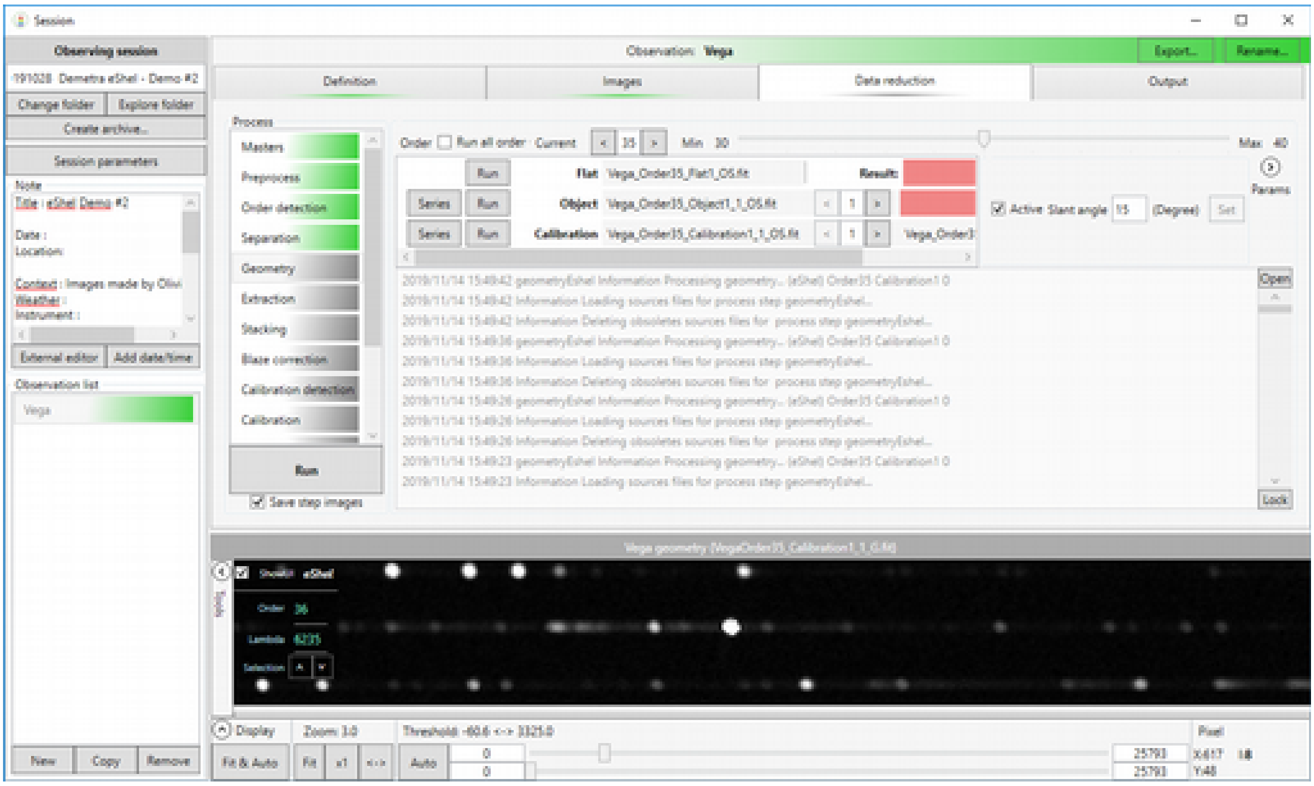


Demetra displays the order in the bottom part of the screen:

Open the parameters panel (top right corner).



You can define a slant angle, to make the lines as much round as possible.



If you consider there is no need for a correction (it is usually the case for middle orders), then deactivate the option.

Proceed the same way for each order. Then, you can run all the images (flat, target and calibration).

6 Extraction

There is no parameter for this step. Each 2D image is converted in 1D profile.

7 Stacking

There is no parameter for this step.

8 Blaze correction

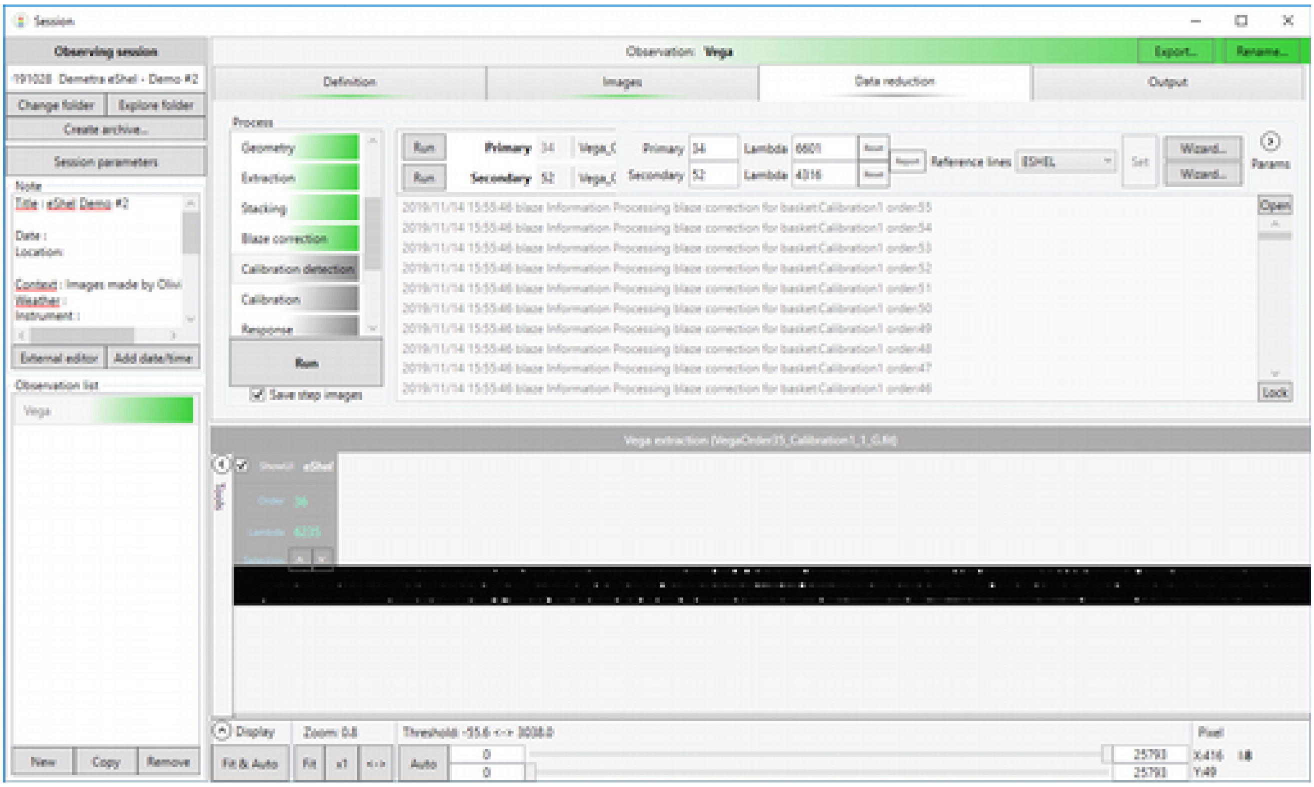
There is no parameter for this step.

9 Calibration detection

This is a critical step. You must help Demetra to define the spectral range for two selected orders. These orders must be far from each other, to prevent any extrapolation error. For the eShel, we recommend to use orders 34 (where is Ha) and 52. For the Whoppshel, we recommend to use orders 52 (where is Ha) and 82.

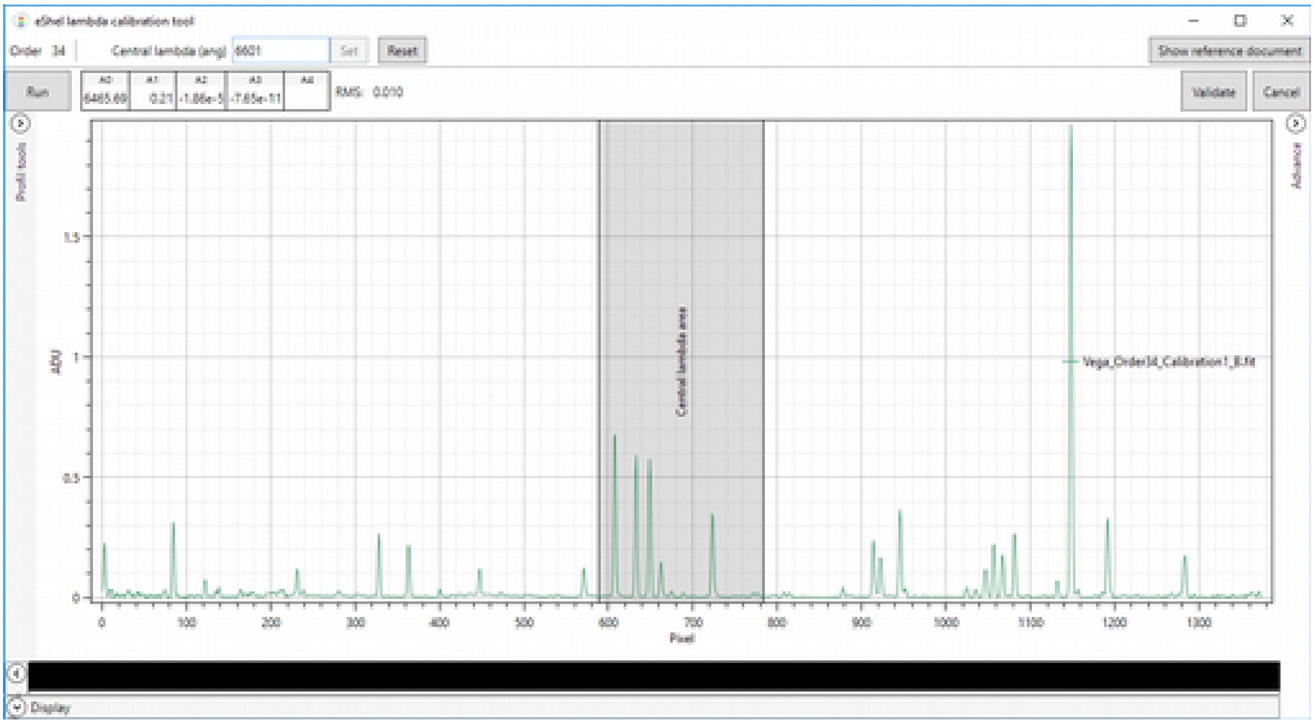
Open the parameters panel (top right corner).

Select the two orders (say 34 and 52):



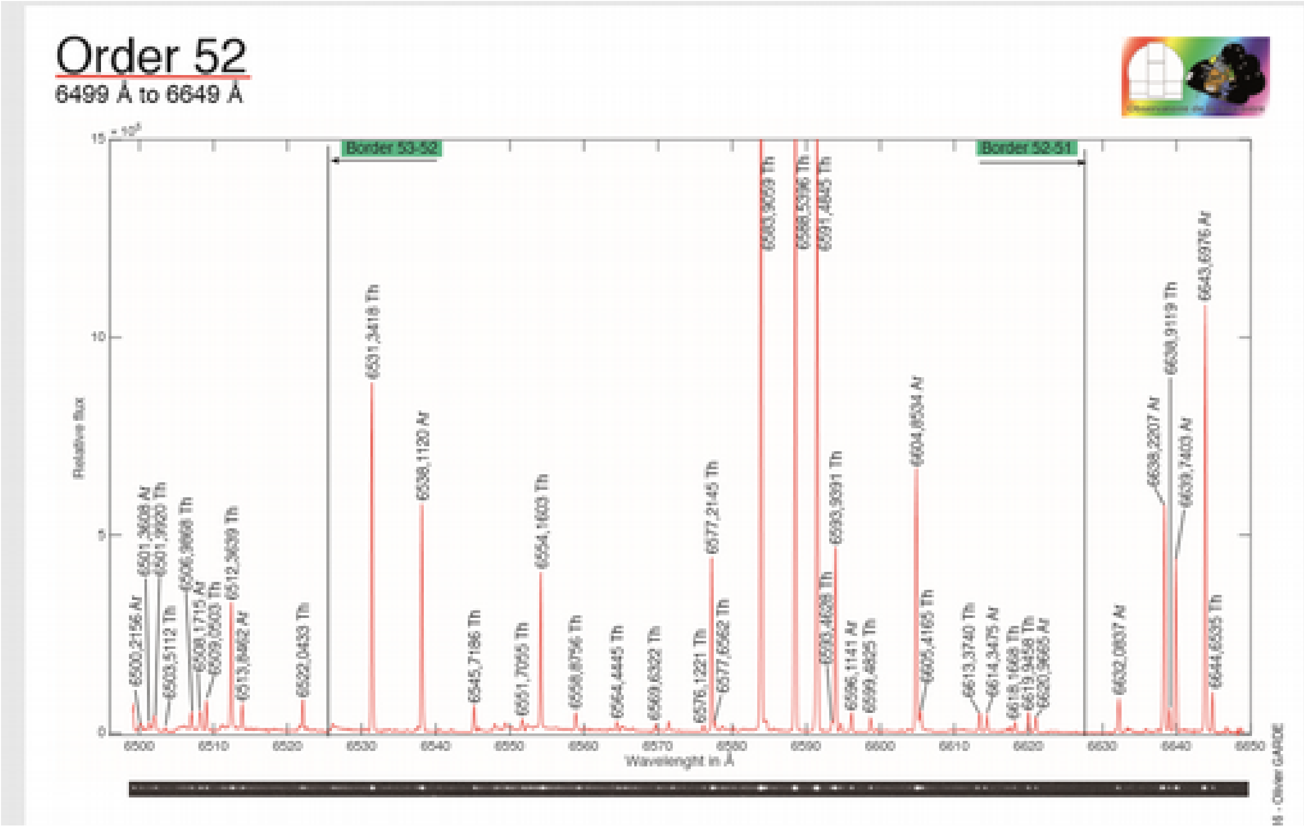
The theoretical central value for each order is automatically displayed (here, 6601 A and 4316 A). You can change the selected orders; in this case click on “set” button to validate the new values.

Open the wizard for the first selected order (“Wizard” button in top right corner). This opens a new window. Now, your mission is to define the central lambda (top left value). Actually you must give one wavelength (lambda, in Angstrom) that is in the gray area in the middle of the image.



To help you in this step, there is a reference atlas available: click on “Show reference” button (top right corner). This opens a PDF files with detailed spectrum of the ThAr lamp. This document has been made from Whoppshel data, but it is also valuable for the eShel (don’t take care of the orders numbering).

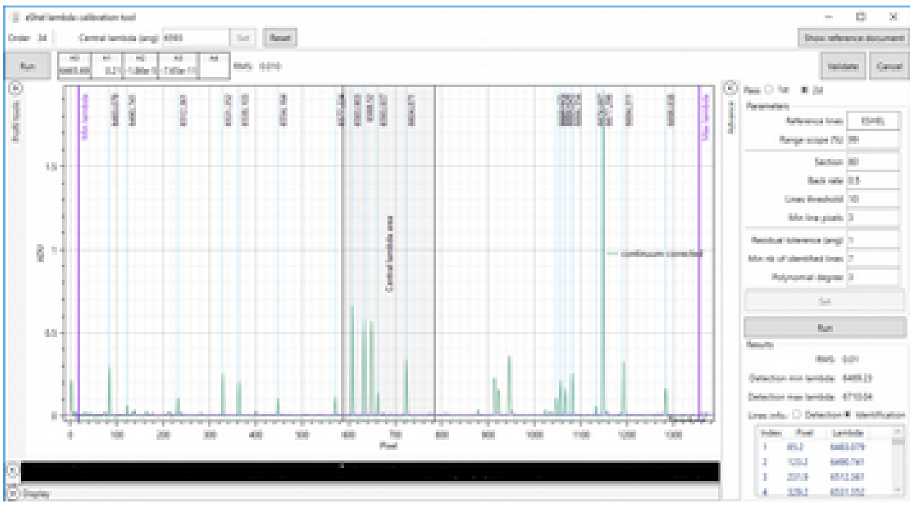
How to do this ? This is easy. The theoretical value (6601 A in our case) is not that far from reality. Then, you can look for the pattern in the gray area in the reference atlas, close to the theoretical value. In our case, the actual pattern is this one (see page 10 of the atlas):



We can recognize the central pattern, that gives us the actual pattern around this wavelength. The value for this order is ~6593 A.

Enter the real value in the top left field and click “Set” to validate this value. Then Run the calculation (“Run” button, in top right corner). You should see a very low RMS (0.01 or lower), which confirms that the calibration pattern of the whole spectrum have been recognized.

Also, you can see all the reference lines detected in the spectrum, by opening the “advanced tool” in the right. All the reference lines match with clear line in the spectrum; this is an another confirmation for a good calibration.

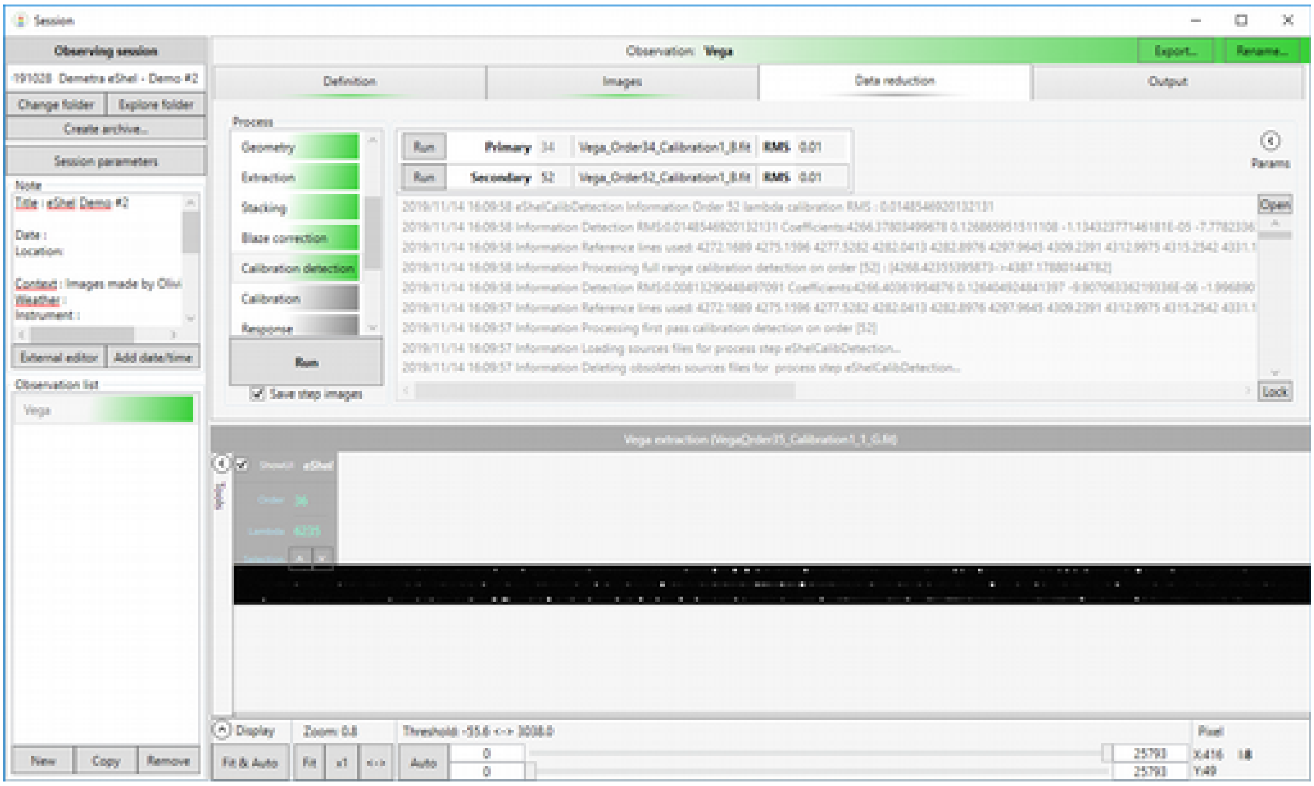


If the calculation does not succeed, you should have either no result, or a very bad RMS (> 0.1), and you'll see that the reference lines do not match with stron lines in the spectrum. In this case, see the appendix A.

Once it is completed, click on "Validate" button and exit the Wizard window.

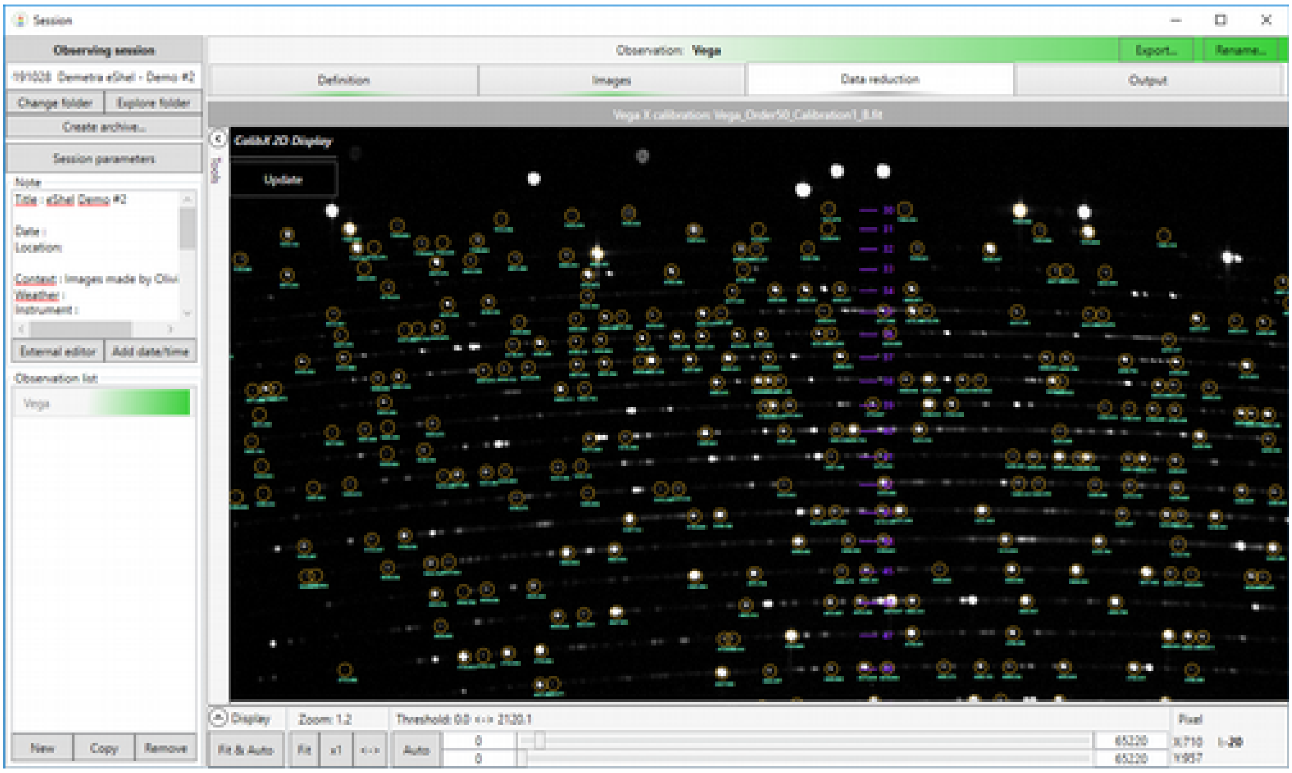
Do the same operation with the other selected order.

When the two selected orders are calibrated, you've done the most complex part of the job.



10 Calibration

Once the two selected orders are properly calibrated, the calibration of each order is quite automatic. Then, you can run all the orders, and see the result thanks to the "Show calibration" tool (click on Show calibration button in to right corner). The image shows a circle for each ThAr reference line; you can immediately check (visually) that each circle surrounds a calibration line.



If, for some reason, the calibration does not work (or does not work for all the orders), refer to Appendix A (to be written !).

11 Response

The response curve correction is optional. If you choose to apply it, open the parameters panel, select the "Response curve" tick and select your response curve correction file. This file is a FITS file, with a spectrum covering the whole bandwidth of the eShel spectrum.

See in Appendix B how to create this Response curve using the Demetra tool.

12 Scale

The scale operation is optional.

It multiplies the whole spectrum (all orders) with a given value, to make all the relative intensities easily readable. The multiplication factor is calculated in such a way that the average spectrum area given in parameters (open the parameters panel, in top right corner) equals to 1. Then select the portion of your spectrum (it must be fully included in the actual spectrum) and click on set. Then run all the orders ("Run" button).

13 Crop

This operation is also optionnal. It crops each order to given values that you can select (order per order) in the parameters panel (top right button). When you modify a value, click on "Set" button to validate.

Chose the crop values in such a way that all the order is of good quality, removing the too noisy part at the ends.

Once you have selected the values for each order, you can run all the orders.

Demetra folders

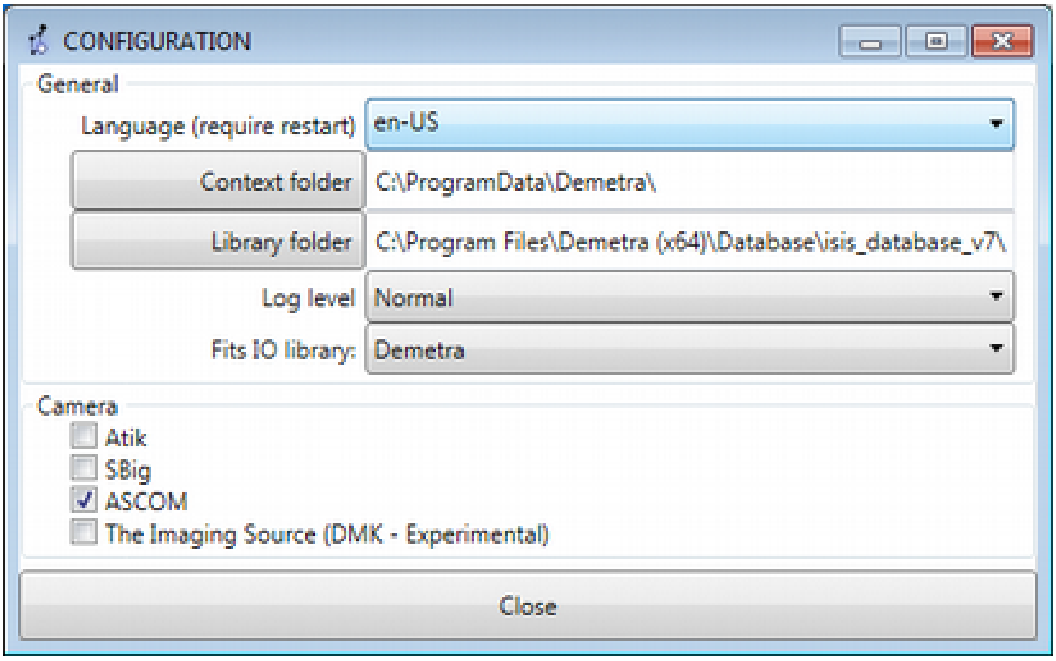
Demetra works with a few key folders. It can be useful to understand them.

1 Installation folder

Demetra software is installed in the directory C://Programs/Demetra (x64). Normally, you should never need to work in this directory.

2 Context folder

Some data have to be recorded in a safe directory, to be reused at any time. For instance, the context information (observer, instrument, observing site…), or the calibration reference files. This directory is defined in the configuration panel (main Demetra window). By default, it is in C://ProgramData/Demetra.



If you want to totally reset Demetra, you can simply remove this directory – be careful, you will lose all data you've updated since the Demetra installation. If Demetra cannot find this directory, or if it is empty, then it will re-create it with default values.

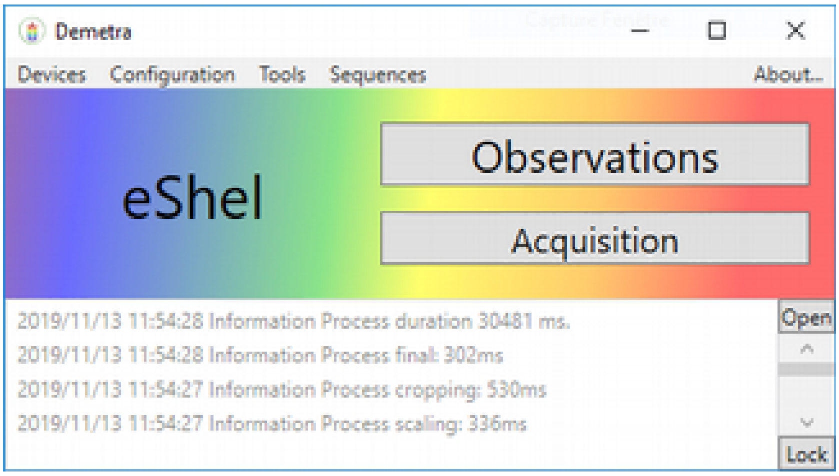
3 Session folder

A Demetra observing session folder is equivalent to a folder on disk. This is necessary and important to keep observing data simple. If you want to archive a whole observation, then simply archive the matching directory. In some cases, you can use images that are available in another directory – for instance if you have a dark library somewhere else. In this case, Demetra copies the files you want to import into the session directory, so as to always comply to

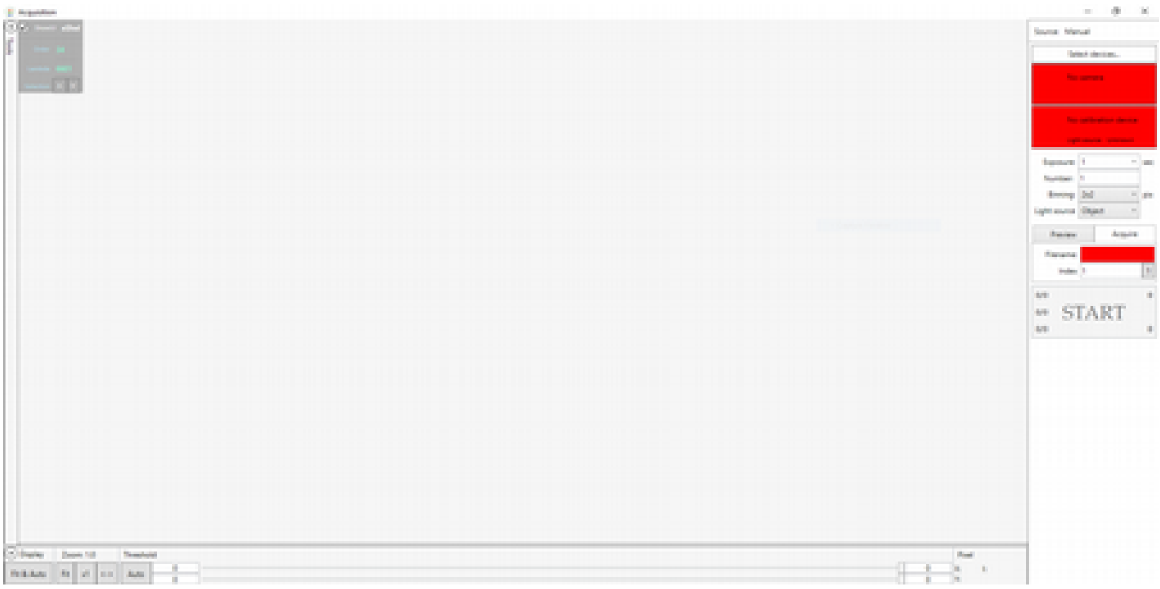
the rule: session = directory.
If you want to switch to a previous session, click on the « Change folder » button, in the top left corner of the Observations module. You will immediately recover the full context for this session.

Images acquisition

Demetra not only manages your observations and processes your spectra, it also includes a tool for image acquisition. This tool specially fits the needs for spectroscopy. Let's look how it works.
In the main Demetra window, click on « Acquisition » button:



This opens a new window, with a wide display area:

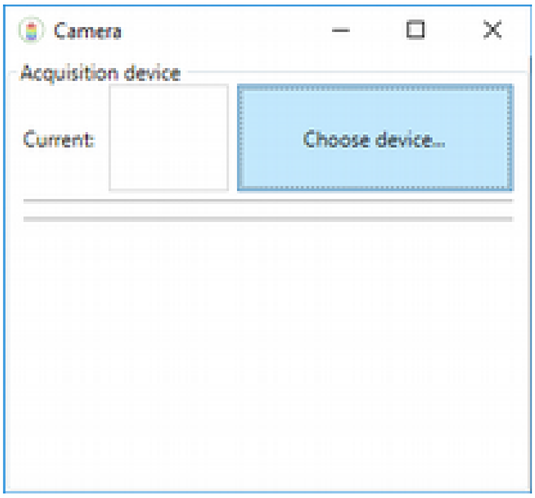


You're already familiar with the style of display area: its interface is exactly the same as for the image viewer in the Observations module. The right panel is new: this is the camera & calibration control box. As usual in Demetra, the color coding is simple: when it's red, pay attention! When the red box under « Select Devices » is red, it means there is no camera connected.

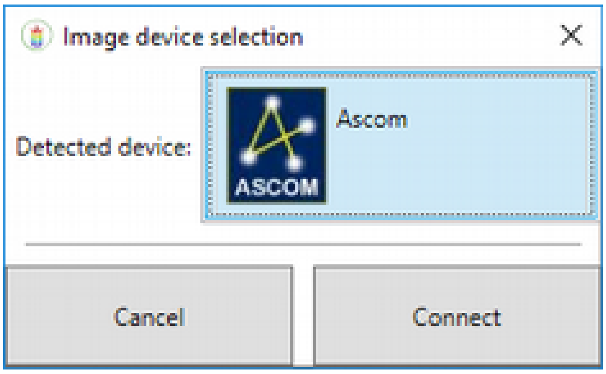
1 Connecting the camera

To connect your acquisition camera to your computer, and turn it on,

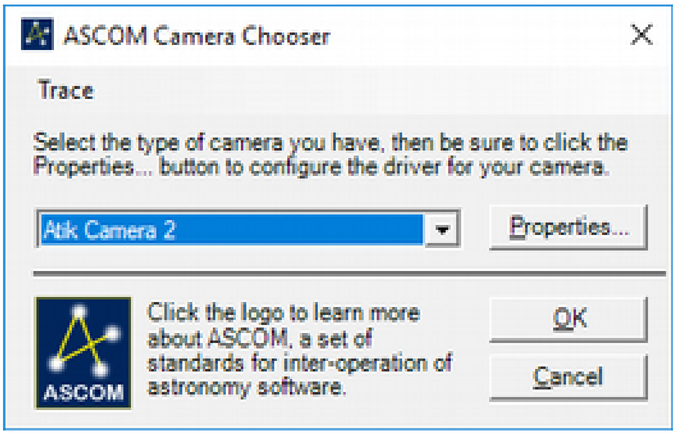
click on the red button which opens the camera connection window:

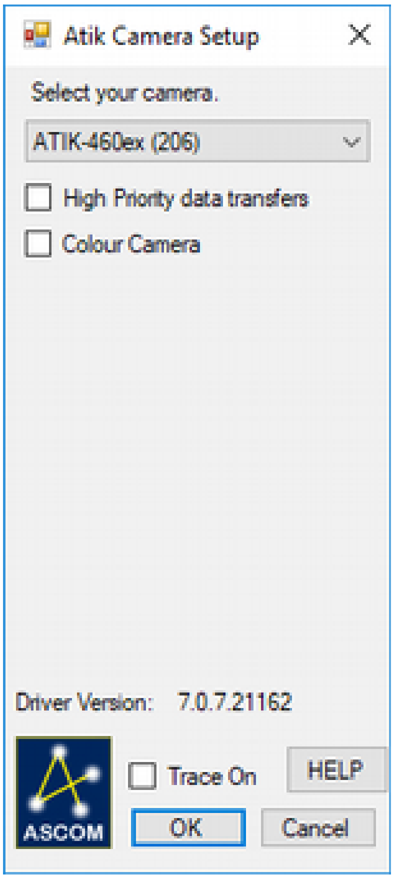


Click on the « Choose device » button. You can select the ASCOM device:



Click on ASCOM, then on Connect. This the opens the standard ASCOM connection window, in which you can select your camera (Atik camera 2 in our case). Then, click on properties button and select your actual camera:





Go to the connection, and finish with OK. The camera is now connected and shown under the « Selected devices » area. In our case, we've connected an Atik 460EX camera:

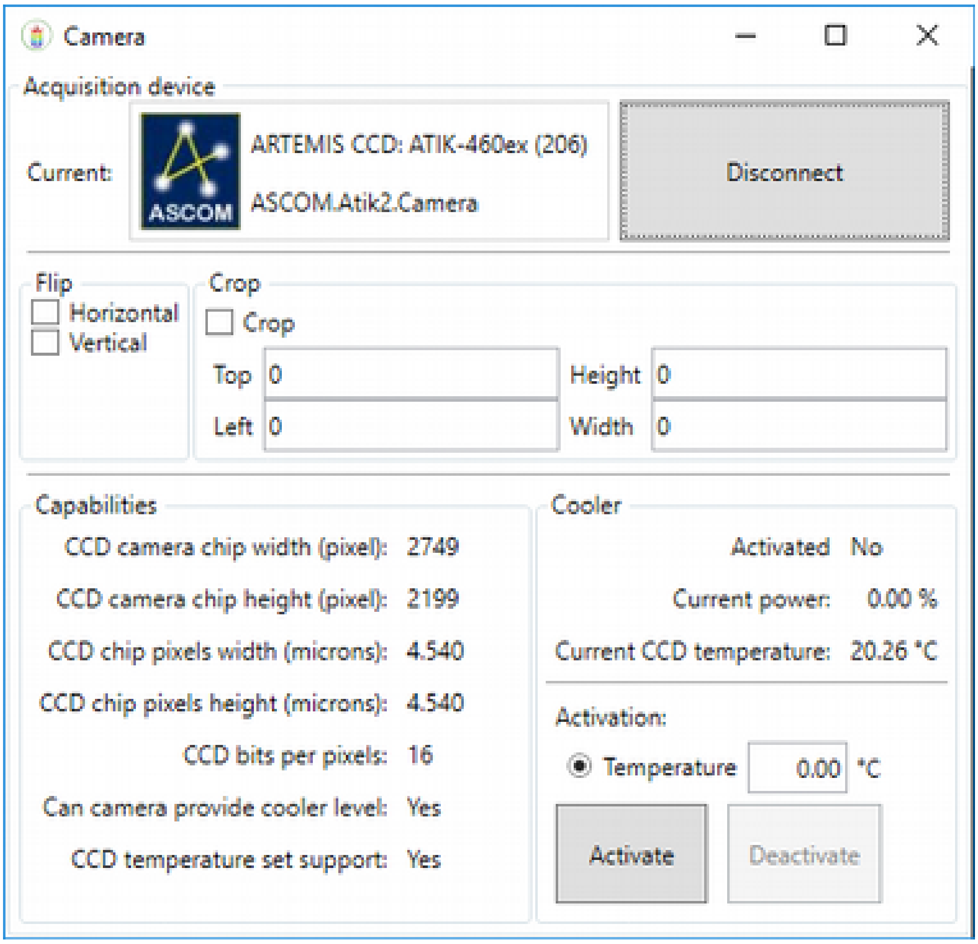
Once you’ve connected your camera, Demetra remembers it. Then, the next time you will connect again this camera to your computer and run Demetra, the camera will be automaticall conected. The detailed process is this one: Demetra remembers the last connected camera, and at each start-up, it tries to connect it again. If the camera is actually present, then the connection is automatic.

Demetra remembers the last connected camera, and at each start-up, it tries to connect it again. If the camera is actually present, then the connection is automatic.

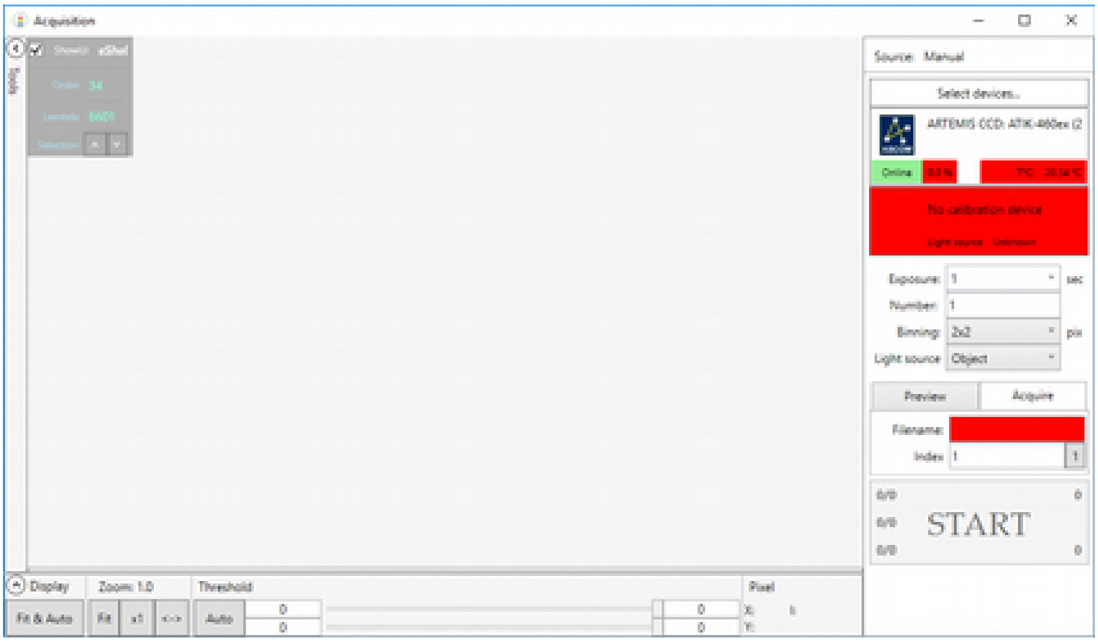
2 Camera temperature control

As you can see above, there is still a red statement below the ASCOM logo. Again, it suggests to pay attention to this. The Atik 314 camera is a cooled camera. The red statement says that the camera cooling is off, which is not normal.

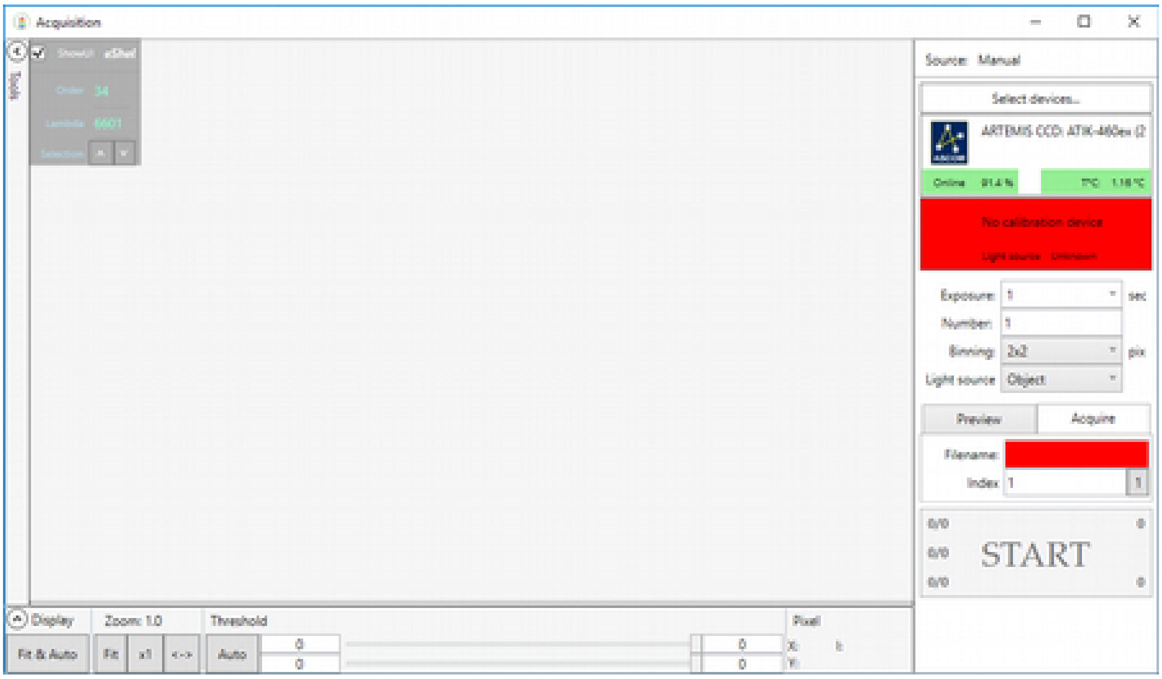
Go back to the camera connection window, select a target temperature for the camera, say 0°C, and click on « Activate » button:



Now, the acquisition window shows that the camera cooling is now on:



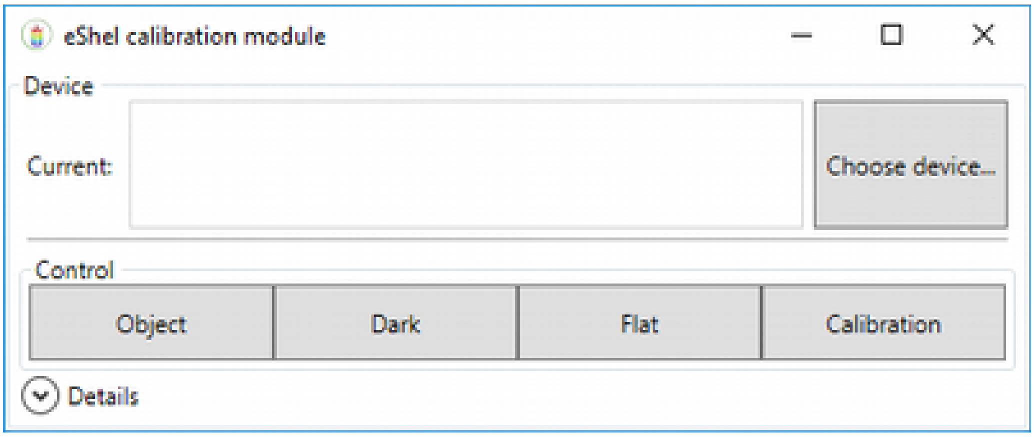
The cooling power and temperature remains red until the camera temperature target is reached. After a few minutes: everything becomes green.



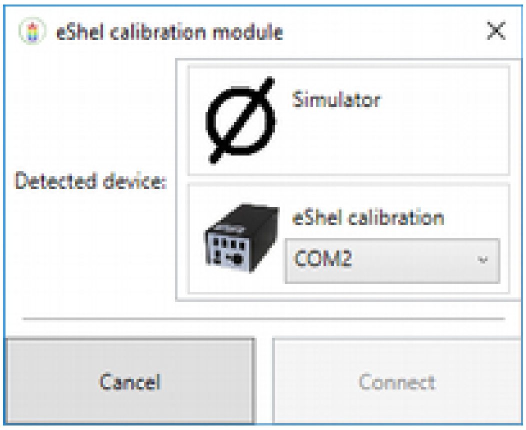
Of course, if during the observations, for any reasons the cooling fails and the target temperature is lost, then you would be immediately alerted by these red areas again.

3 Connecting the Calibration Module

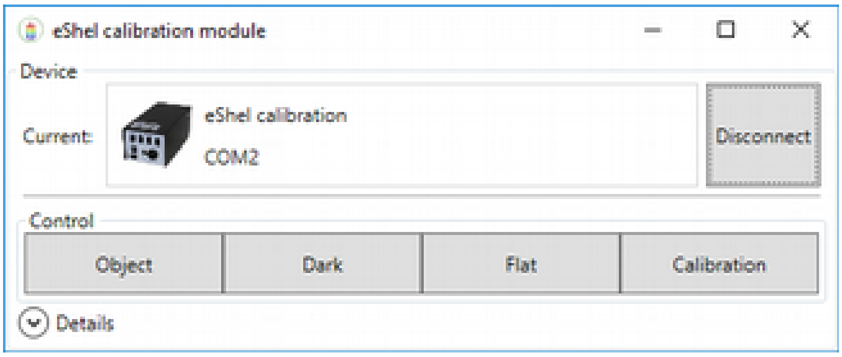
Demetra also manages the eShel calibration module. Simply switch the module on, and connect it to your computer with a Serial-USB adapter cable. Then, click on the calibration box button (which is red so far). It opens the calibration module connection window:



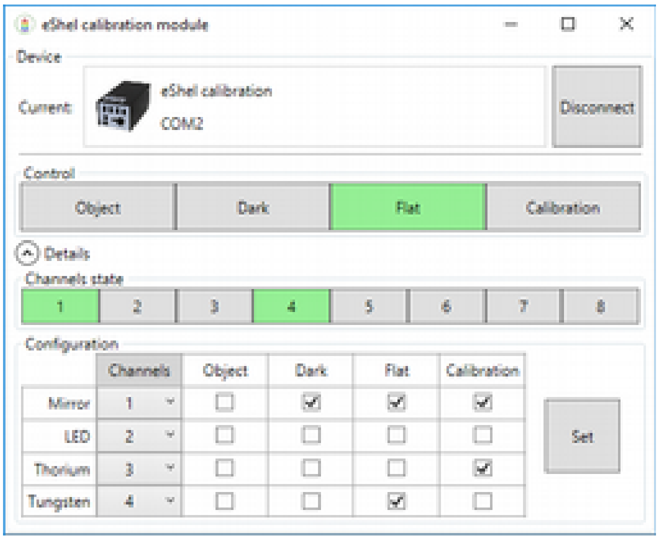
Click on "choose device", and select the eShel calibration module (make sure the COM port is the right one):



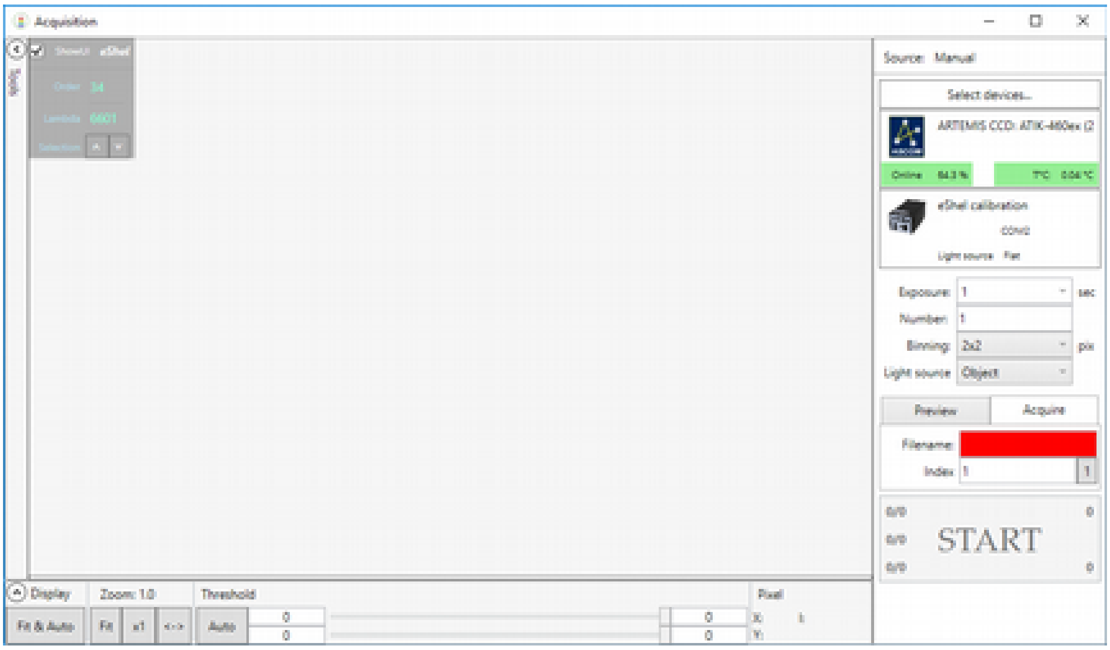
The calibration module is now displayed, and you can control the different modes ; when you select one mode, it actually controls the calibration module.



You can also look at the details of the calibration box. As soon as you select one mode, you can see which relay of the calibration box is activated:



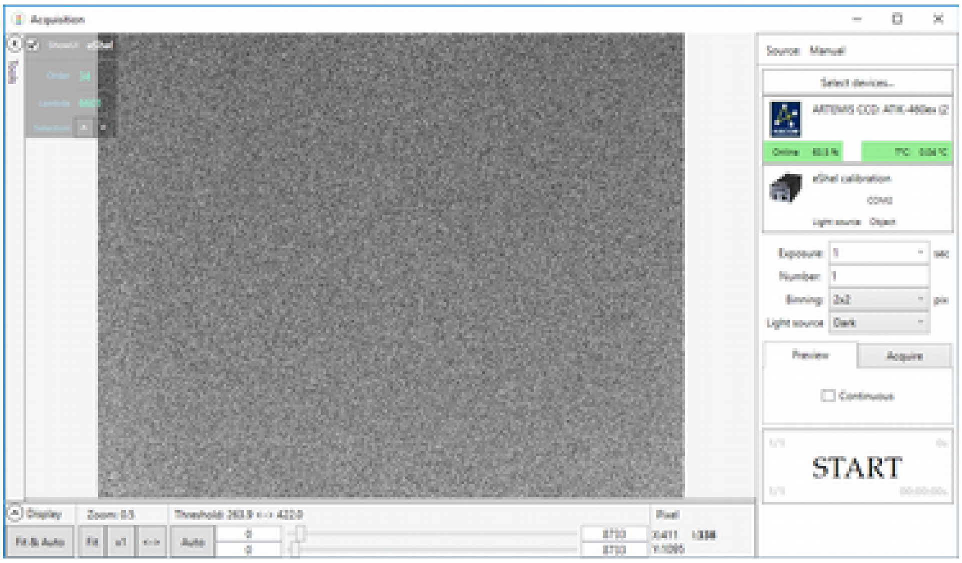
Once the calibration box is properly connected, you can see in the acquisition window that everything is fine:



4 Taking images

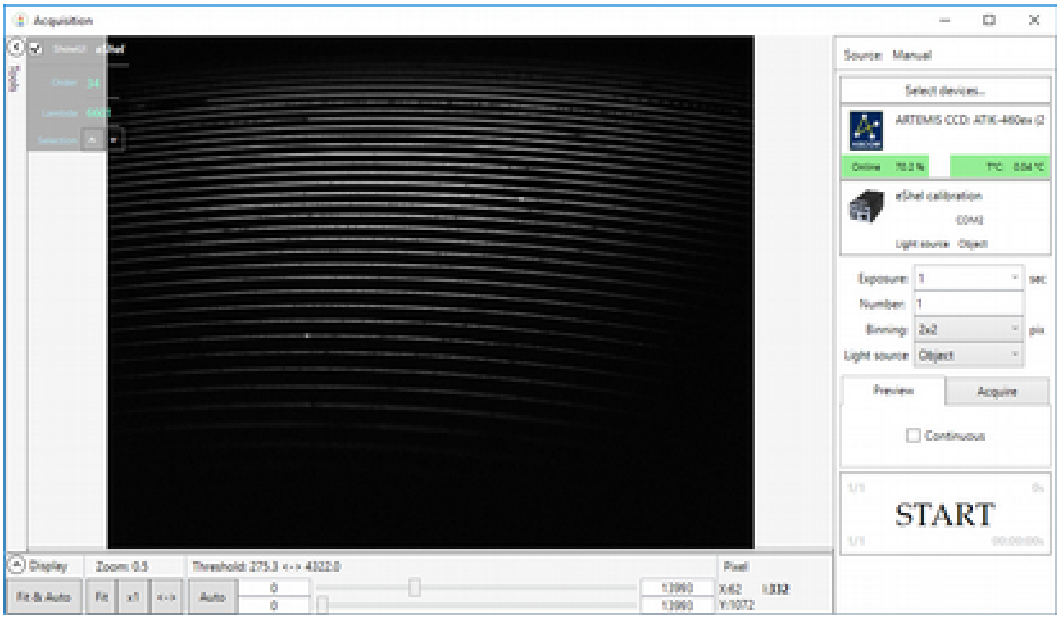
The camera and calibration modules are now connected and fully operational: we can start with some acquisitions. As for any camera control software, you can select the exposure time (in seconds), the number of images you want to acquire, and the binning (default is 1x1). But you can also select the type of image you want to take (object, dark, flat , calibration). This controls the calibration box accordingly.
Select the Preview tab.

Demetra includes a preview mode (the image is not saved), or to acquire (image is saved). If you want to acquire & save, give a root name for your file – the remaining red area in the acquisition module is because there is no file name. Usually, at the beginning, for tuning or testing the instrument, we start with preview images. Then, when all is Ok, we can acquire images.
In the preview mode, you can obtain a steady stream of continuous images; this is useful during tuning – for instance when you're focusing the camera.
The image below is a dark preview image (select the dark mode before starting the exposure):



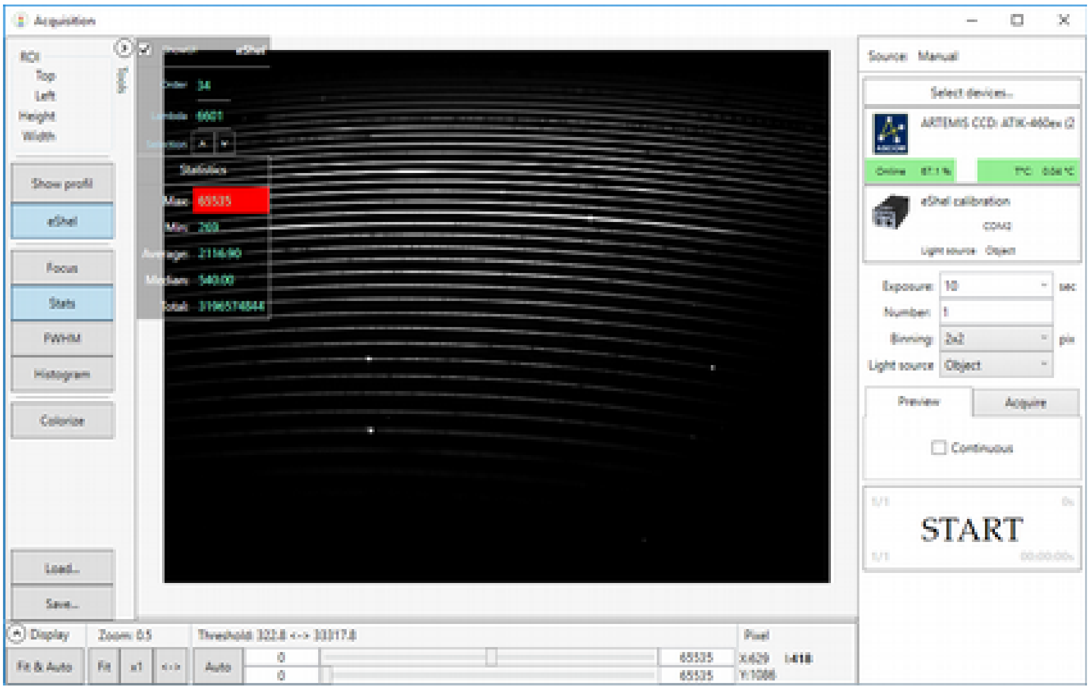
As already indicated, the viewing area of this window is the same as in the "observations" module. You can move or zoom the image, display tools, select an area in the image, and so on – please refer to section 6.5.

Of course, you can also take an object image. Here is a Sun image (added with some room light):



5 Saturation detection

Demetra detects when there is a saturation in the image. Let's do a quick demonstration. Activate the "Stats" tool. Then, the stats for the image are displayed in HUD mode. Then take a long exposure (say 10 to 30s), that saturates the CCD. You'll see that Demetra will detect the saturation:



Demetra shows two red areas, indicating that the image is saturated! This function is useful during the observations: if at any time an image is saturated – even partially – Demetra issues a clear warning.

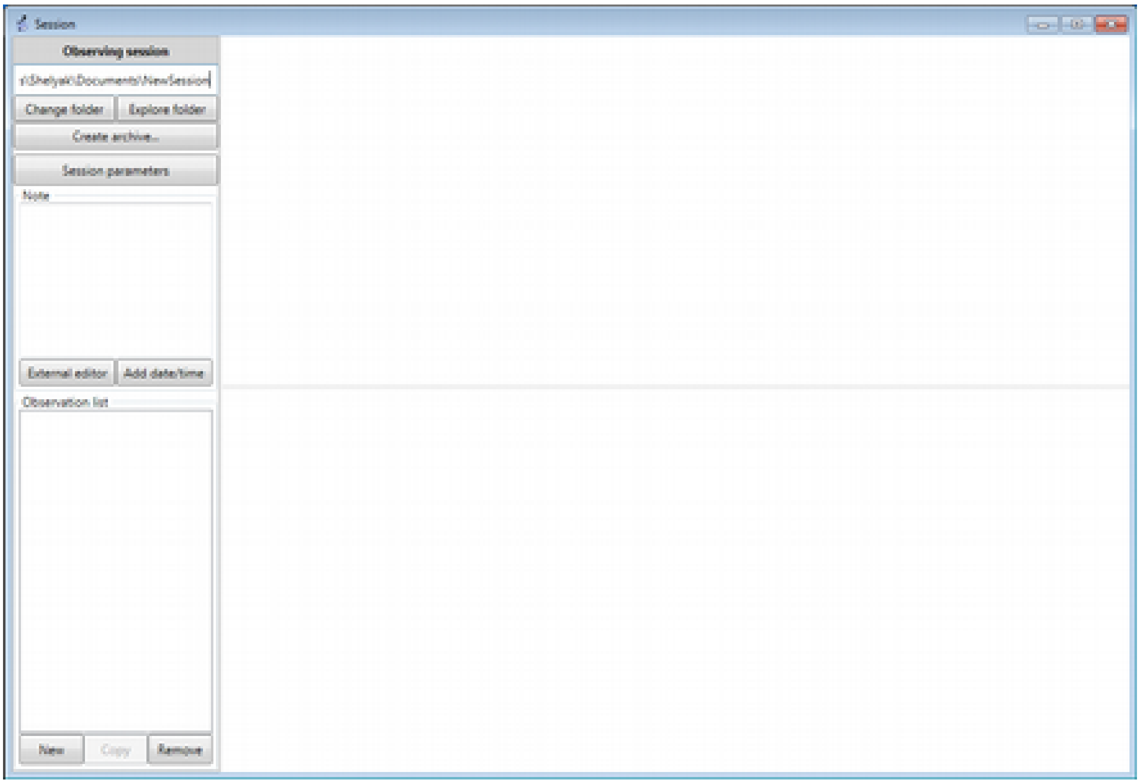
Make your own observations

You’re now familiar with the way Demetra manages your observations and acquisitions. It is time to do your own observations. From now, you need to have an eShel spectroscope attached to your computer.

1 Create a new observing session

For Demetra, all the files from an observing session are stored in a specific directory. Then, creating a new observing session is easy: just **create a new empty directory**, and tell Demetra where this directory is. On top left corner of the Observations module, click on the « Change folder » session and select your new session directory (you can indeed create the directory at this point).

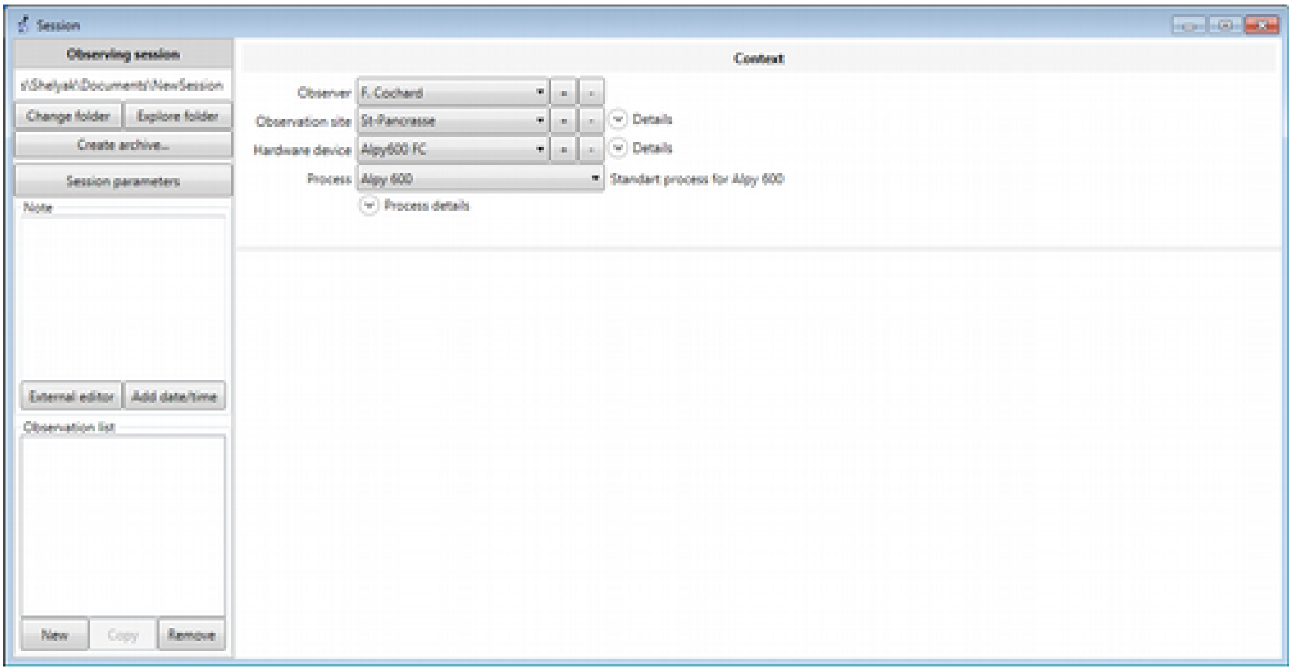
For instance, let’s create a new folder called *NewSession* in the Document directory, and let’s change Demetra session to this folder. Demetra is now blank:



You can check that the new session folder is empty by clicking on Explore folder.

2 General parameters

When you start a new session, the first thing to do is to setup the general parameters: Observer(s), Observation site, and Instrument (hardware device).



Demetra retains in its memory the previous data for each type of information (Observer, Site, Instrument): you can select them from the drop-down list for each item. You can of course create new entries (use button « + »), or delete an old one, no more useful (button « - »).
For Site and Instrument, you can (should!) add details, by clicking on the details arrows.

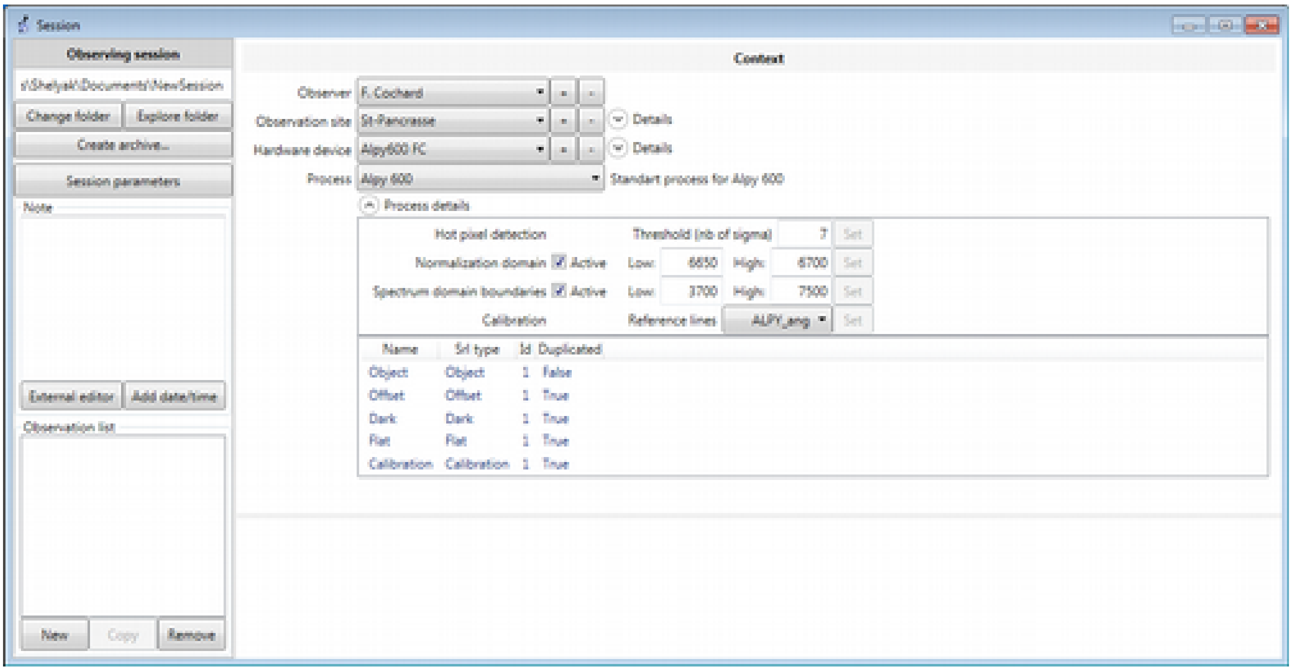
<u>Filling the general parameters is important, because these data will be duplicated in all the FIT files generated by Demetra, during acquisition and/or data reduction.</u>

3 Process selection

Because you're working with an eShel spectroscope, you should select the "eShel" process (this is the default value).

This is the Process which defines which images are required to go up to a valuable result. It defines the image baskets that are linked to each observation.

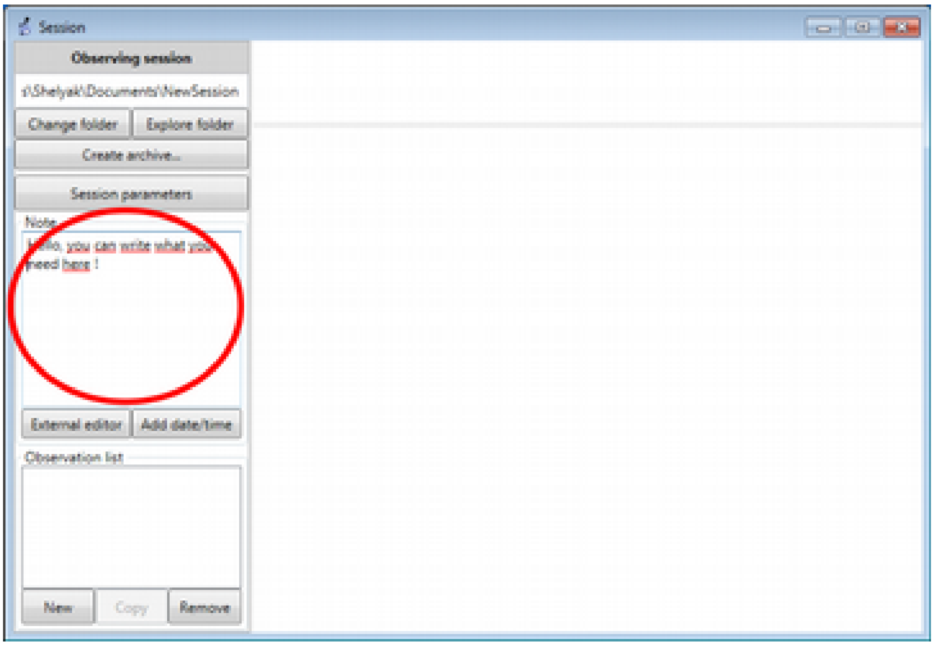
Look at the Process details (click on the « Process details »arrow):



Some parameters are editable here (most of them can also be edited in the different process steps). These values should be Ok for an eShel.

4 Creating the log file

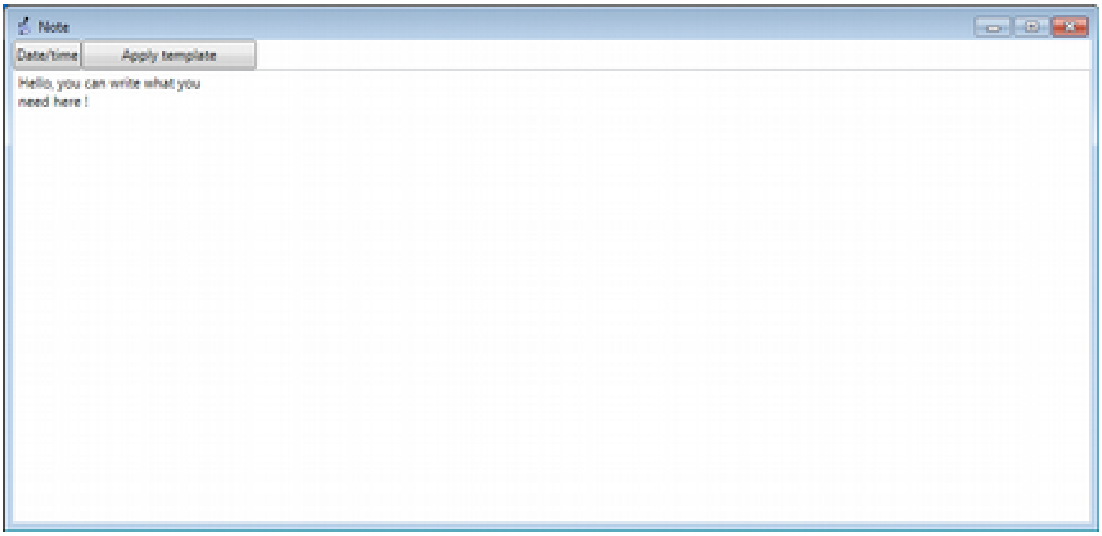
A log tool is embedded in Demetra. It is so important to be able to keep some notes during the observing sessions. You can write any comment at any time in the small notes window in the Observation tool:



Below this Notes area, there are two buttons. « External editor » opens the Notes in a full page editor, which can be more comfortable if you want to write copious notes!.

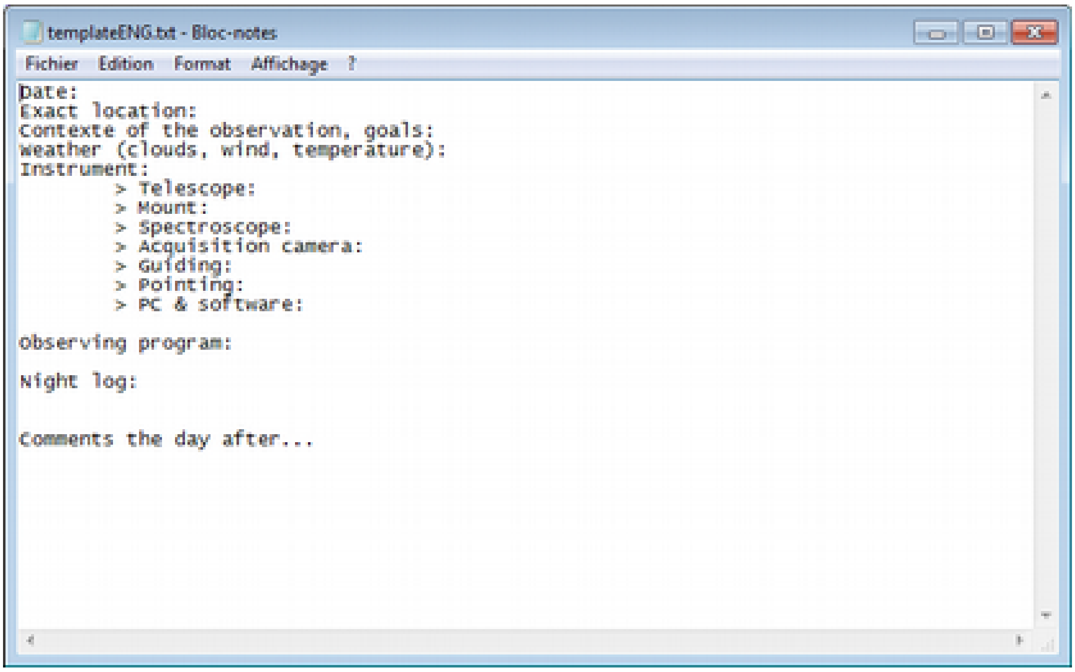
« Add date/time » is a quick tool to stamp what you write with date and time. Each time you click on it, current date and time are written where the cursor is. This is extremely useful for time-stamping events.

Open the external editor (by clicking on « External editor » button):

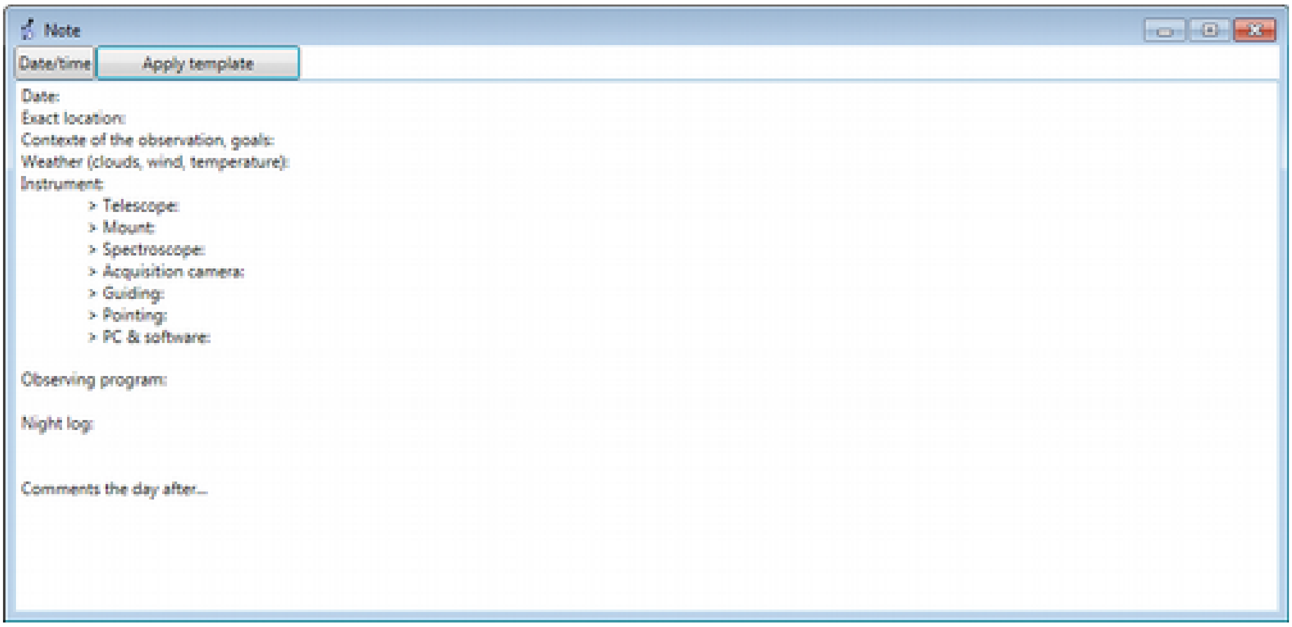


You will see, of course, exactly the same text as in the Observation window, and you still have the Date/time button.

In addition, you have another button « Apply template ». This makes Demetra load a pre-defined template file. For instance, the default template file looks like this:



This file is stored in the C:/ProgramData/Demetra directory. Of course, you can edit (or duplicate) it to make your own template file (this is a basic text file). Then, you can load it in Demetra, using the « Apply template » button, and fill it with the proper data. It is useful not to forget any important information to note:



There is no « save » button in the Demetra log file. This is because as soon as you write something in the notes window, it is written on the disk – no risk of forgetting to saving the file at the end of the night !

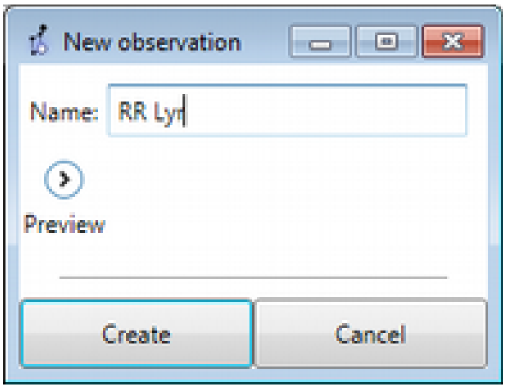
5 Creating a new observation

Everything is now ready for starting the observations.

At the beginning, the Observations list is empty. Click on « New » in the bottom corner of the Observations list: a new window pops-up, asking for an observation name. Give the name you want: the only condition is that it is unique (ie if you observe the same star 10 times in a row, then give an index to each of them: RRLyr-1, RRLyr-2, RRLyr-3, end so on).

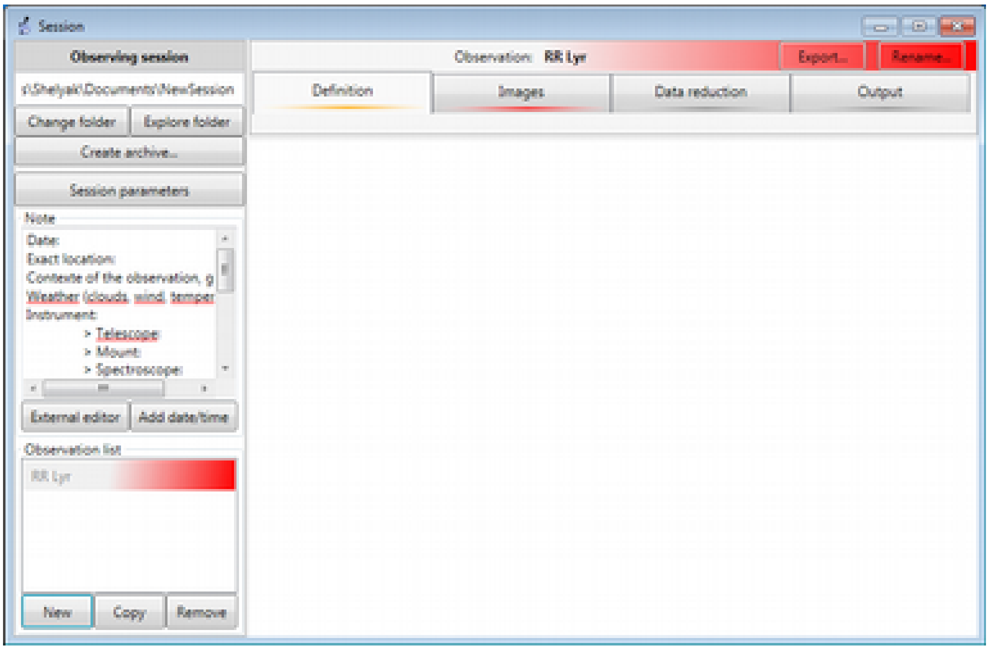
Be careful: an observation is a set of images & parameters that gives a consistent calibrated spectrum at the end of the process ; this is not a single image. If you decide to acquire 12 exposures of 300s for a single object – because you need such a total exposure time to get the right SNR – then, this is a single observation. In the above example (RRLyr-1, RRLyr-2, RRLyr-3…), we're talking about successive observations i.e. we'll produce as many spectra as the number of observations. RR Lyrae is a good example of a star that requires, at some special instances to be observed many times, to show the quick evolution of the spectrum.

The name of the observation will be used for all the files created and linked to this observation.



If you click on Preview, you'll have a reminder of all the context parameters for the observation.

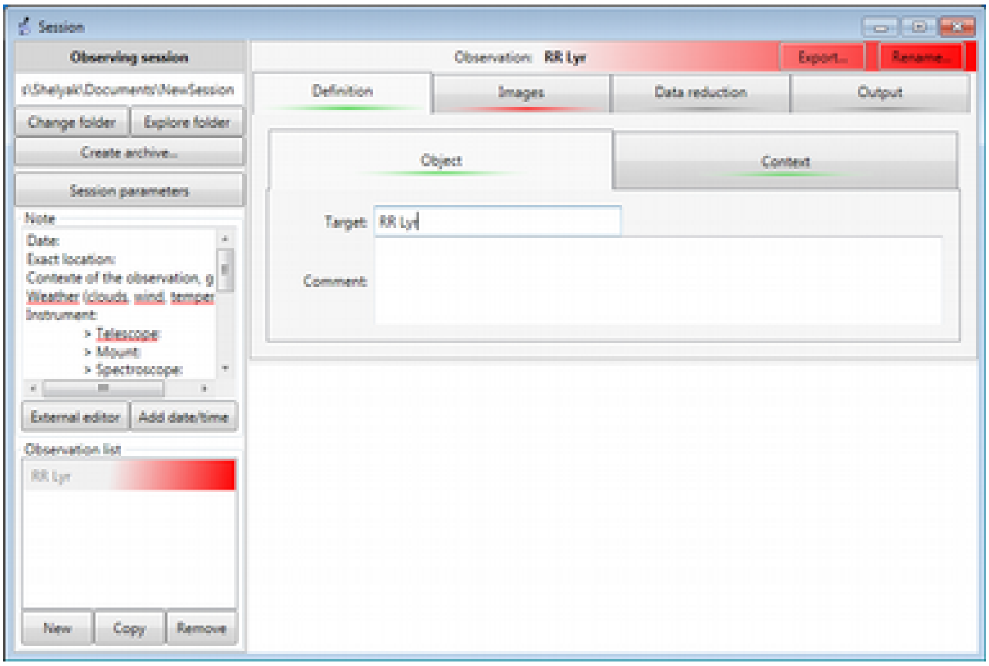
Click on « Create » to validate the observation name. You can now see the new observation in the main window:



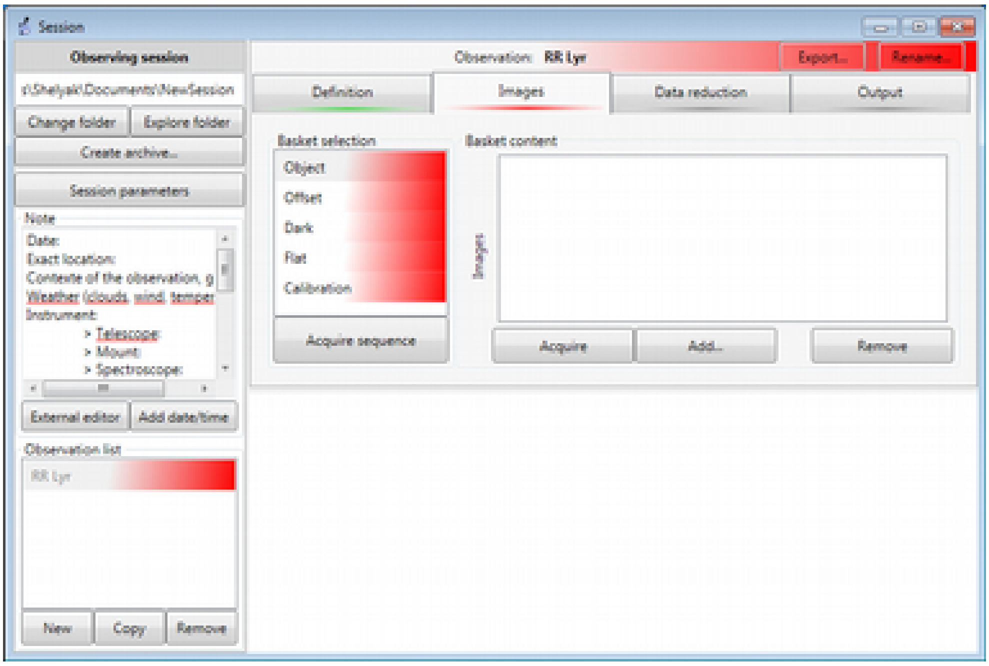
As you can see, the observation is RED, which means that elements are missing – this is normal, because we just created it. The color coding helps you to see where the missing elements are: the « Definition » tab is yellow, and the « Images » tab is red. This is where to put your attention.

In the Definition tab, the only missing data is the name of the target. This is usually the same as the observation, but it may differ (think about the RR Lyr time series above: observation names are different, but the target name is always RR Lyr).

Fill the Target name properly, and the « Definition » tab becomes green:



The, switch to the « Images » tab. Here, all the baskets are red:



Of course, this is normal again, because we've collected no image yet.

6 Add or acquire?

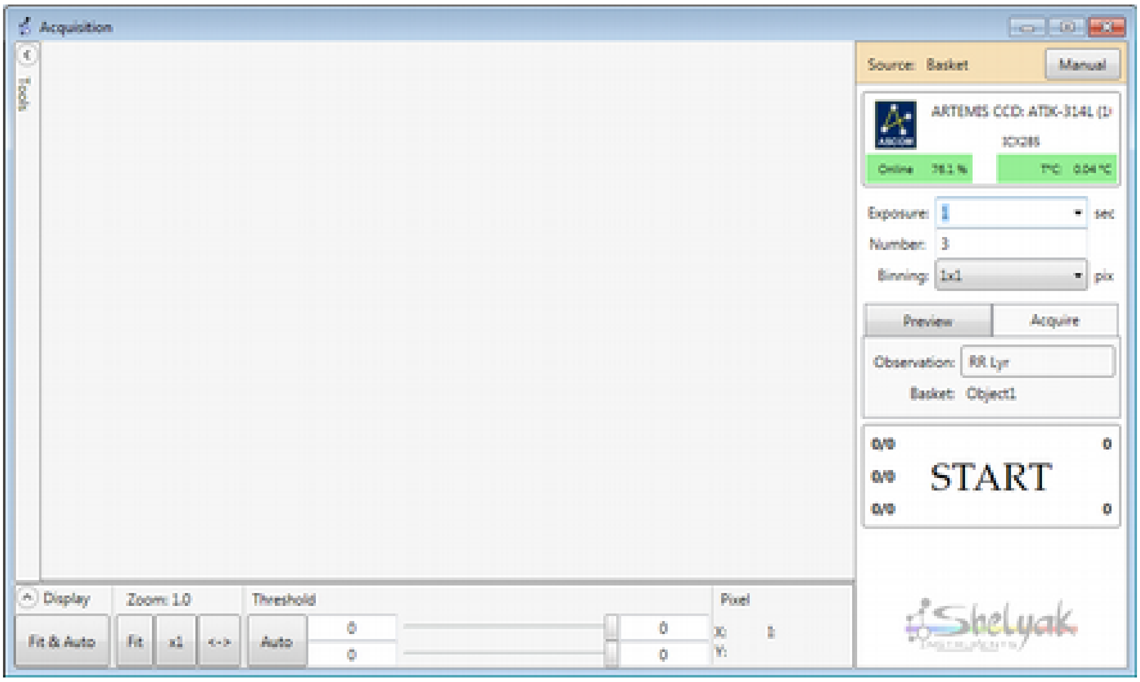
There are two ways to put images in a basket: either you read it from your computer (if you already made the actual observation in the past), or you acquire it from the camera (which is the usual way to work with Demetra).

To add existing files from your computer, click on « Add... » button, and select them from the correct folder. Reminder: if you select files that are not stored in the current session directory, then the files are be *copied* in the session folder.

There is no constraint on the files names: all the files that are in the basket will be processed by Demetra.

You must fill all the baskets, one after the other, before the whole observation area turns green.

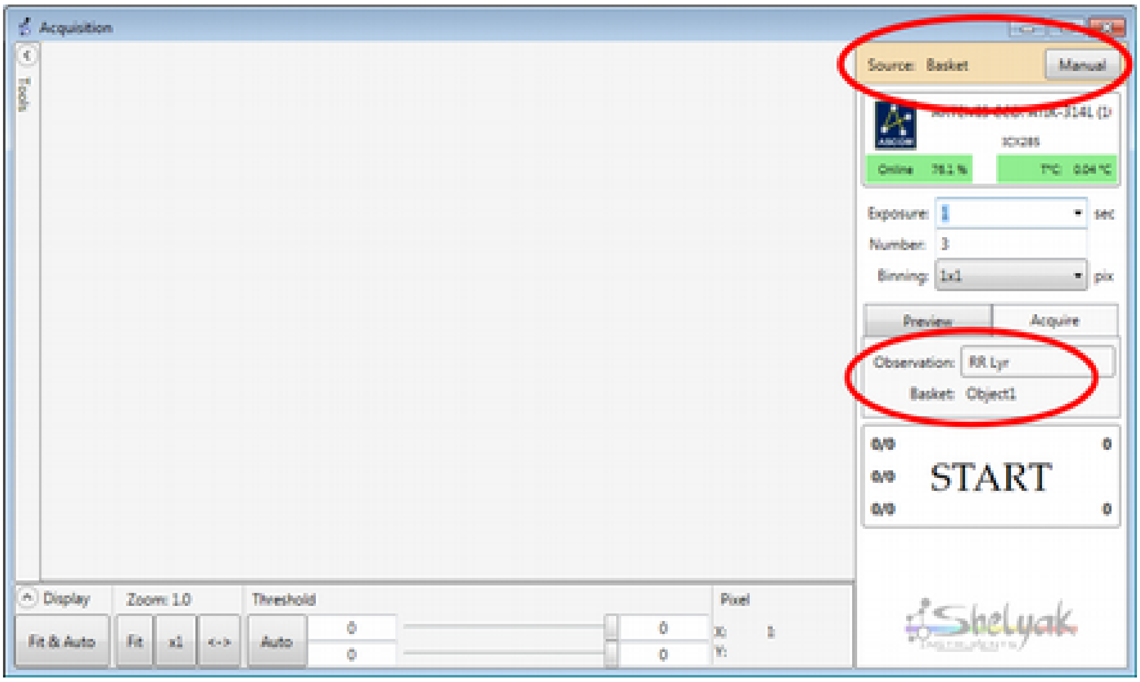
Of course, if you want to acquire images from your Alpy 600, just click on "Acquire" button (for instance, in the Object basket). This opens the Acquisition module, of course:



We've seen in the chapter 7 how to use this acquisition module. But there are some differences with what was seen so far:

- In the top right corner, you can see the mention "source : basket". This means that the acquisition module is under the basket control and some data are prefilled.

- Above the start button, you have the name of the observation, and the basket that will be filled:



Thanks to this connection between Observation and Acquisition modules, when you'll launch the acquisition, they will be directly sent to the correct basket.

<u>Some key tips here</u> :

- The naming of the generated files is automatic (based on the observation's name), you don't need to care about this.

- If you want to recover the control of the acquisition module (from the observation), click on the "Manual" button, in the source area (top right corner).

- When you're in the acquisition module, you can switch back to the Observations by clicking on the Observation name (above the "Start" button).

- If you've put some files in a basket by mistake, you can always remove them – by clicking on "Remove" button under the files list of the basket (or select them, and press "Suppr" key).

- The only condition needed to make a basket green is to have at least one file in it. At this stage, Demetra does not make any control in the file itself.

- You can use the Acquisition module to get most of the images (Object, flat, calibration), and use the "Add" option for files which do not require to be made at each session (bias and darks).

We recommend to go up to the end of the first observation (ie, fill all the baskets of the first observation) before switching to the next observation – you will save time.

7 Blue band around one order

As soon as you have tuned the process parameters (specially the step "orders detection), Demetra can show a quick profile of any order. The displayed order is the one marked with a blue band.

This ROI band is used for the "Show profile" and "Stats" tools (calculations are only made inside the blue band).

Data reduction

Because your own setup is different from the one used for the demo images, you need to tune the process parameters in order to get a fully processed spectrum. This is exactly the same process as in section 9.

1 Data reduction for other observations

When you've reduced the data for the reference star, you can repeat the same process automatically for all the observations of your session. This is the other real power of the Demetra software. The whole automated process becomes quickly repeatable without manual intervention. Because nothing changed during the session (tuning parameters, camera, and so on), all the parameters remain the same. Then calculation is immediate: you can run all of them in one click (the General “Run” button, below the reduction steps).

Conclusion

It is now your turn to run wonderful observations. Demetra will help you to make these observations fast and easy – and help you to concentrate on the most important factor: the science that you can do with your eShel spectroscope.

Share your results with the community !

François Cochard

November 2019

Appendix A - More about the calibration

Appendix B - Creating a Response Curve profiles

End of the document.