

UVEX Motorized
PF0079
User Manual



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Introduction

Welcome to the world of Spectroscopy with your UVEX!

It was a great pleasure to design this instrument, and now we hope that you'll take a lot of pleasure to use it for observing stars and other sky objects.

The UVEX is a compact spectroscope, specially designed for small telescope (say up to 0.3m) – but you can also use it opportunistically use it on bigger instruments. It opens to you new windows on the Universe, from UV to IR domain.

This is a multi-purpose instrument: you can install it on different telescopes, use different gratings, different slits. It is the perfect instrument for exploring the sky.

Because the UVEX is made only with mirrors, you should prefer to use it with a pure mirror telescope (ie Newton, Ritchey-Chretien, or Cassegrain optics). This way you'll have a fully achromatic setup.

This documentation only describes technical elements of the UVEX. If you need more general information about spectroscopy (how to obtain a high-quality star spectrum), please refer to the book "Successfully Starting in Astronomical Spectroscopy"¹.

Francois COCHARD
March 2021

¹ "Successfully Starting in Astronomical Spectroscopy – a practical guide", François Cochard, EDP Sciences, 2018, ISBN 978-2-7598-2026-9

1 Presentation of the UVEX

1.1 Out of the box

Your UVEX is shipped within a box.
Here are the elements that you'll find in the case
(See picture 1.1)

- UVEX spectroscope
- Calibration cable
- A flyer that indicates where you can find this Documentation
- Tool set:
 - crosshead screwdriver (Phillips PH00)
 - hexagonal screwdriver (2 mm)
 - hexagonal wrenches (1.5, 2.5 and 3 mm)
- spare screws



Figure 1.1 – All the elements in the box

1.2 Overview of the UVEX

In the pictures below (fig. 1.2), you'll see the different elements of the UVEX:

- Slit & telescope beam input
- Main camera output
- Camera adapter
- Cylindrical lens position screw
- Cylindrical lens locking screw
- Motors module

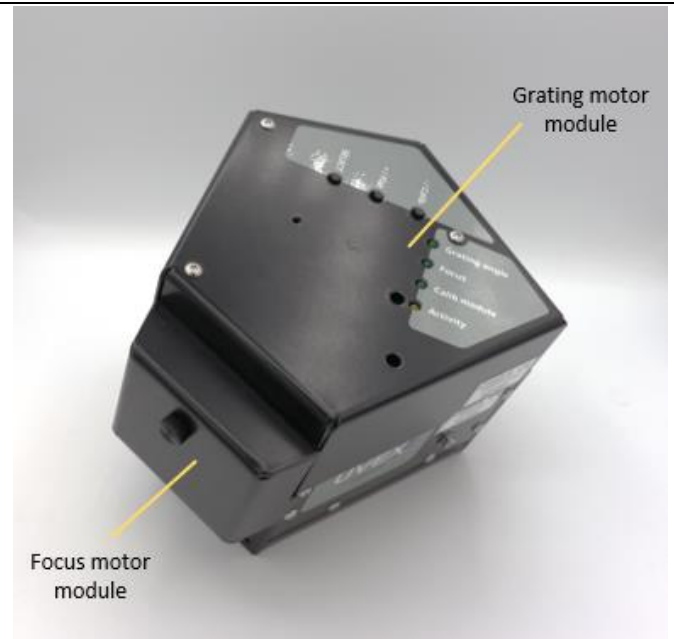


Figure 1.2 – Overview of the UVEX (1)

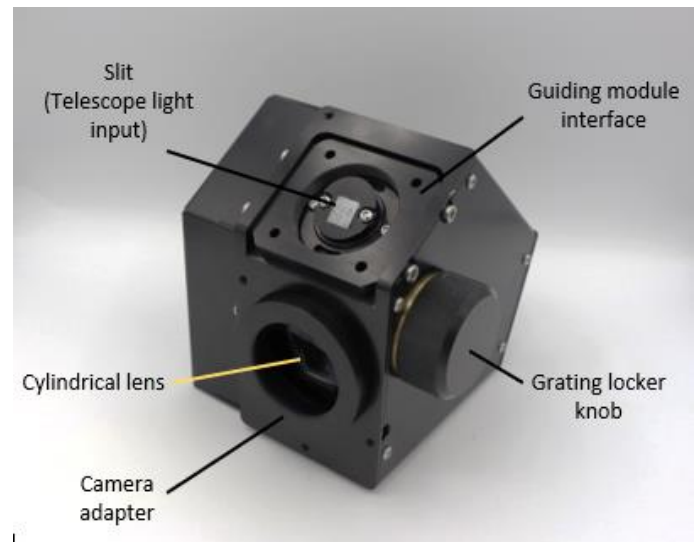


Figure 1.2 – Overview of the UVEX (2)



Figure 1.2 – Overview of the UVEX (3)

1.3 Optical Architecture

The UVEX is based on a crossed Czerny-Turner architecture. It is made of two spherical mirrors (M1 = collimator mirror and M2 = objective mirror), and the diffraction grating. See optical schematic 1.5.

The input slit makes a thin and controlled light source at the spectroscope input.

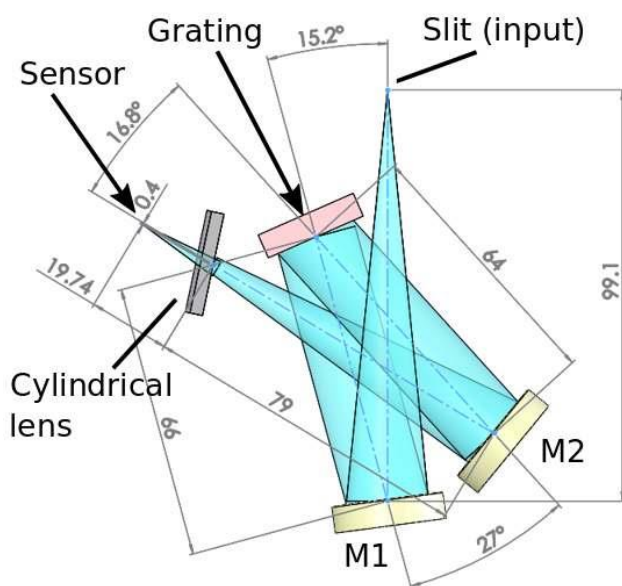


Figure 1.3 – Optical schematic

This is the usage of two mirrors for main optics that makes the UVEX to go far in blue (UV) and red (IR) ends; a mirror is purely achromatic.

The grating angle can be changed easily, to select the central wavelength you want to observe. And you can also change the grating to change the actual resolution of the instruments (standard grating is 600g/mm, other grating is optional - 150, 300, 1200 and 1800g/mm).

This schematic has a natural astigmatism that gives a wide spectrum on the camera sensor plane. To avoid this affect, and concentrate more light on each pixel, we've added a cylindrical lens at the end of the light path (close to the main camera).

1.4 Steps for Starting with The UVEX

When you receive your UVEX and start using it, we recommend to follow these steps (described in detail in next chapter):

- Install your camera on the UVEX, and take first spectra on a table. Use any light source you've around (sky, ambient light).
- Play with the different tunings (rotation of the camera, focusing the spectrum, tuning the cylindrical lens).
- Then install the Guiding and calibration modules.
- Put an optics in front of the UVEX, and run a full observation (including reference images and data reduction).
- Once all is under control, you can install the UVEX on your telescope and start observing for real.

Always keep in mind that the telescope and the spectroscope are two different devices that must be put under control before attaching them together – it will be much simpler.

We recommend to use the Demetra-UVEX software² (the version of Demetra dedicated to the UVEX) for all your observations and tests. This software includes all features to make your work easy during tuning, acquisition and data reduction. Of course, you can also use any software that you want, since the UVEX will create standard images.


² Demetra-UVEX is free, and can be downloaded on Shelyak website <https://www.shelyak.com>

2 Installing & Tuning the Instrument

In this chapter, we give details on the installation of each element around the UVEX.

2.1 Attaching the Camera

The acquisition camera is attached to the UVEX thanks to a special adapter (included in the UVEX)³. The adapter ensures that the sensor (CCD or CMOS) is exactly in the image focal plane of the UVEX. It also allows the tuning of the camera rotation in such a way that the spectrum is precisely horizontal in the image – this is much better for the data processing, and then the quality of the final result.

 *Note about the camera backfocus. Because of the optical architecture of the UVEX, the camera must have a short back-focus (max 13mm). Make sure that your camera fits this need. If not, you won't be able to focus the spectrum properly.*

Follow these steps:

- The camera adapter is attached to the UVEX with three M4 headless screws around (see fig. 2.1 to 2.3). First loosen these headless screws and remove the adapter (use a Hex wrench or screw-driver of 2.5mm); see fig. 2.4.
- Attach the adapter to the camera. Tighten it firmly (not too much however!).
- Install the camera on the UVEX, making sure that the orientation of the camera is correct (see fig. 2.5).
- Tighten the three screws around the adapter. Make sure that the camera is strongly attached to the UVEX. There must be NO movement of the camera when the telescope will move around the sky.



Figure 2.1 – First screw of the camera adapter

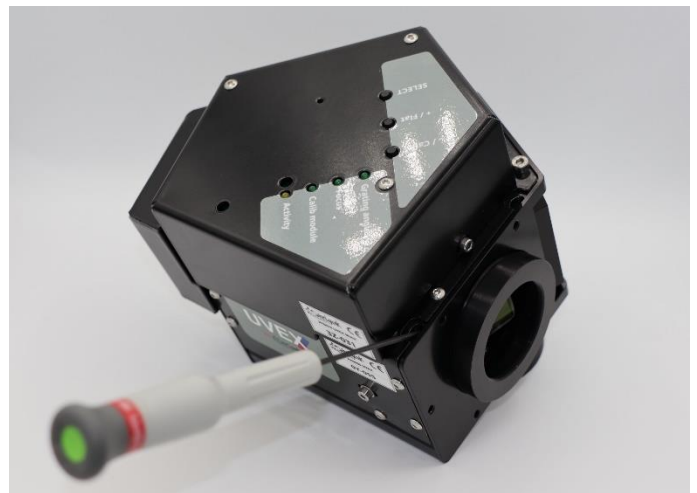


Figure 2.2 – Second screw of the camera adapter



Figure 2.3 – Third screw of the camera adapter

³ Different adapters are available for Atik, QHY and ZWO cameras. The standard adapter is the ZWO one.



Figure 2.4 – Third screw of the camera adapter

💡 To make sure that the camera orientation is correct, you can proceed as follows:

- Rotate the camera roughly; the sensor longest dimension must be in the optical plane of the instrument.
- check with taking images that the spectrum is properly oriented: the blue part must be to the left, and the red part to the right. A single way to check this is to (very) slightly move the grating angle from blue to red; the spectrum must move in the screen toward the left.
- Precisely adjust the camera orientation to make the spectrum is exactly horizontal in the image.



Figure 2.5 – Orientation of the camera

2.2 Attaching the guiding module

The UVEX is shipped with a guiding module Adapter⁴. This adapter attaches the UVEX to the Guiding module, and then to the telescope. It also gives an easy access to the slit, if you need to change it or clean it.

The adapter is attached to the UVEX with 4 (M4) screws on the sides (Figure 2.6).

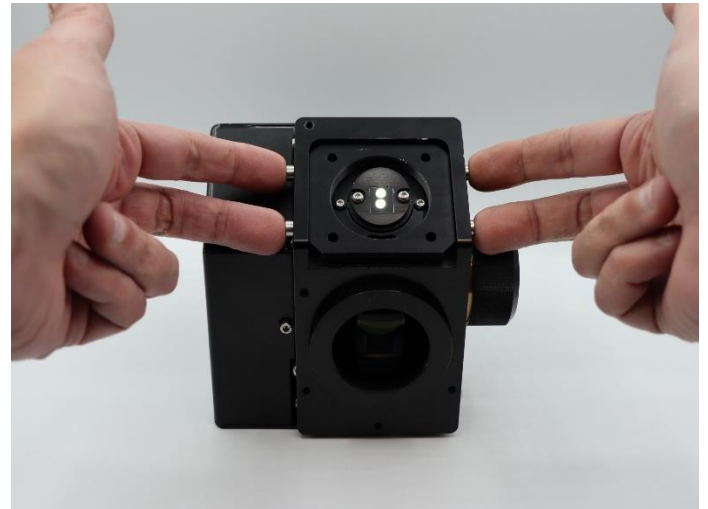


Figure 2.6 – Screws to remove the guiding module adapter

Follow these steps:

- Remove the 4 screws around the adapter (Figure 2.6).
- Remove the adapter (fig. 2.7).
- Attach the adapter to the Guiding Module, using 4 screws (M4 x 12 mm), making sure the the screws heads are hidden in the adapter (the adapter is not symmetrical). See fig. 2.8.
- Make sure that the slit cap is removed!
- Attach back the adapter to the UVEX, and tighten the 4 screws firmly (fig. 2.9). The Guiding module and the UVEX must be strongly attached together, to prevent any movement when the telescope will around the sky.

⁴ Guiding and calibration modules are not part of the UVEX, they must be bought separately



Figure 2.7 – Removing the guiding module adapter



Figure 2.8 – Install the adapter onto guiding module



Figure 2.9 – Assemble the guiding module and the UVEX

2.3 Focusing the cylindrical lens.

As explained in section 1.3, we've added a cylindrical lens to compensate most part of the natural astigmatism of the Czerny-Turner architecture. Without this lens, the spectrum of a star would be vertically large and fuzzy.

For best results - ie a star spectrum must be a thin line - the cylindrical lens must be focused on your camera. You can clearly see the cylindrical lens before installing the camera. The lens is mounted on a holder that can slide over few millimeters. The holder is locked by a side screw, and there is a headless screw inside the chassis to stop the holder (see fig. 2.10).



Figure 2.10 – Tuning the cylindrical lens

The simplest way to evaluate the cylindric lens focusing is to take continuous spectra of the sky, during daylight (preferably with an optics in front of the UVEX - you can do it directly on the telescope), and look at the top & bottom borders of the spectrum; they must be as sharp as possible.

During a star observation, a proper focusing gives a sharp (thin) spectrum.

Thus, proceed this way to focus the cylindrical lens:

- Loosen the locking screw,
- Move the headless screw until the right position, while taking spectra continuously,
- Tighten the locking screw while pushing toward the headless screw.

2.5 Changing the grating.

The UVEX is shipped with a 600g/mm grating, but there are other grating densities available (150, 300, 1200 and 1800g/mm). Changing the grating will change the dispersion of the instrument, thus its resolution. It will also have a direct effect on the wavelength domain covered by your camera (the lower the resolution, the larger the domain).



The grating surface is very fragile. Make sure that it will never be touched; a single fingertip can damaged it definitely.

Changing the grating is a simple operation, that can be done even when the UVEX is installed on the telescope. Follow these steps:

→ Loosen, then remove the grating cap (black button on the opposite side of the index). No tool is required, see fig. 2.11) and 2.12.



Figure 2.11 – Untighten the grating cap



Figure 2.12 – Remove the grating cap

→ Remove gently the grating holder, and put it immediately in a protection box. Make sure that no dust can cover the grating surface, and make sure to never put your finger on the optical surface. See fig. 2.13 and 2.14.

→ Install the new grating in the UVEX. The grating surface direction is given by the flat surface in the grating holder. This helps you to give the right direction: rotate the grating holder to make the flats surface roughly towards the counter-button (focus). See fig. 2.15 and 2.16

→ The grating module orientation is keyed: rotate the holder until its position is locked.

→ Each grating come with its own vernier, to adapt the spectrum scale to the actual grating.



Figure 2.13 – Remove the grating



Figure 2.14 – Put the grating in its box



Figure 2.15 – Check the grating direction



Figure 2.16 – Install the new grating



The balancing of the mount must be preferably made after all the cables are in place.



Figure 2.17 – The UVEX on the telescope

2.6 Installation on the telescope.

Once the camera and the guiding module (and probably the calibration module) are attached to the UVEX, all this assembly can be attached to the telescope, using for instance the 2" nose piece adapter (see fig. 2.17).

Make sure that the UVEX is firmly attached to the telescope, to prevent the UVEX to drop down to the ground when the telescope will point toward the zenith. It is highly recommended to wire the UVEX to the telescope for better security.

When all the elements are in place, carefully balance the mount in the two axis. When the breaks of your mount are loosen, the telescope must stay in place, in any position.

3 Using the UVEX

Once the instrument is properly installed, it is time to start with stars observations. Understanding the detailed process for making high quality spectroscopic observations are out of the scope of this document, but we'll cover here all practical points you need to know for the UVEX.

We recommend the usage of the Demetra software for acquisition and data reduction. It gives all the features to help you during your observing session.

Important note: Demetra does not handle the telescope control (pointing, and autoguiding). You'll have to use your preferred tool for this function.

A good solution that we often use at Shelyak is PHD2⁵.

3.1 Focusing the spectrum.

The first point to tune when you observe is the focus of the spectrum. The focus is tuned by the motor, at the opposite of the telescope input. The best way to measure the focus point is to take calibration light spectra (Ar-Ne lamp in the Alpy calibration module), and measure the FWHM. There is no internal focal reducer in the UVEX, then the slit images size (ie the calibration lines width, measured with the FWHM) are of same width than the slit itself. For instance, in basic conditions, with a 23 μm slit and an ASI183 camera (pixels of 2.4 μm in bin 1x1), you should get lines FWHM close to 10 μm ($23 / 2.4 = 9.58$).

Once the focus point is found, you can record the numerical value for later use (see chapter 5).

Note: Because of the fast beam coming from the calibration module, the optical quality of the calibration lines are better on the left end (blue side) than of the right end (red) of the spectrum⁶.

Then, when you select a calibration line to measure its FWHM, you should prefer a line in the middle of the image, or in the left half of the image.

3.2 Selection of the central wavelength.

The UVEX has the capability to rotate the grating, to cover a large wavelength range. Selecting the central wavelength is done by turning grating motor on the UVEX side.

"DEMETRA" or "USIS Controller" help you to select the right angle (see chapter 5).



Make sure that the index is somewhere in the visible range define by the grating you use.

If the index is out of this visible range, you'll get a dark image instead of a spectrum.

Important note: if you're selecting a 'red' region of the spectrum (say above 750nm), there may be some order overlapping. For instance, the second order of a 400 nm wavelength is mixed with the first order at 800 nm. Depending on your target (and your science goal) this may have a large effect on your observation. To avoid this problem, you may have to install an order filter behind the UVEX slit (refer to Appendix C).

3.3 Tuning the exposure time.

This is not specific to the UVEX, but when starting the observation of a new target (star), you must select carefully your exposure time. The highest image the better – at the absolute condition to not saturate the image.

When you'll observe faint targets, you'll never face this issue, but for starting with your instrument, we recommend to observe bright stars; in this case you may quickly saturate your camera.

Demetra includes several tools to check that there is no saturation and to help you choosing the best exposure time.

⁵ PHD2 is free and Open Source, available for Windows, Linux and Mac. See <https://openphdguiding.org/>

⁶ This image quality level only affects the calibration lines, and has no effect on the wavelength calibration precision.

4 UVEX Motors – How it works

4.1 Overview of the module.

The UVEX Motors module includes three main features:

- Control the UVEX focus position, to get the best resolution of your instrument. The focus tuning is usually made while taking continuous calibration frames.

- Control the grating angle, to select the central

Wavelength of your spectra.

- Control the Calibration module, and select which light source you send to the spectroscope ('sky' for stars, 'dark' for dark and bias frames, 'flat' for flat frames and 'calibration' for calibration frames).

The control of the calibration module is almost equivalent to the SPOX⁷ module. If you are using the UVEX Motors module, you don't need any SPOX device.

The grating angle can be controlled either in degrees (this is the physical angle from 0th order), or in wavelength. If you're giving orders in wavelength (which is the 'natural' way), you must first make sure that the grating density (i.e. 600g/mm) is properly set. This is because the central wavelength for a given angle directly depends on grating density.

Once installed on your UVEX spectroscope, the UVEX Motors module looks like in fig.4.1.

You will find 3 connectors:

- Power supply, 12V, standard connector 5.5x2.5mm (positive in the center).
- USB port, for connection to the computer (remote control)¹;
- Calibration module control.

On the top face (in the above picture), you'll see three buttons and four LEDs for manual control. These buttons & LEDs are mainly used when installing and testing the module. Once the installation is done, the normal usage is through the

computer. The LEDs will show the activity of the module, even when used remotely.

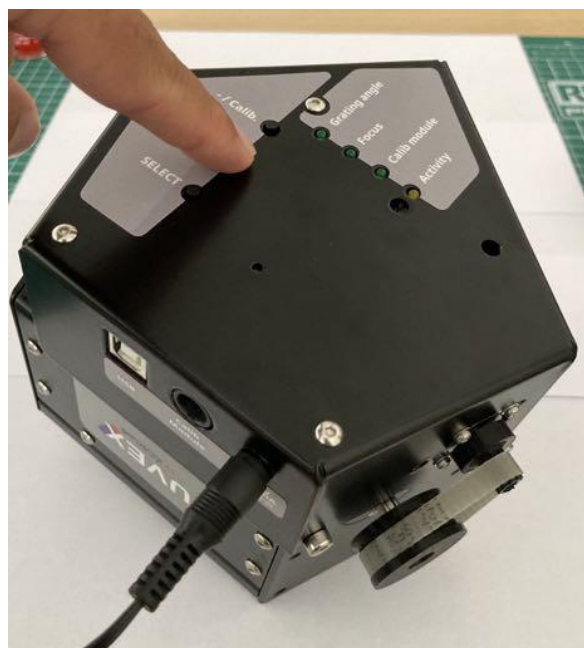


Figure 4.1 –UVEX with the Motors module

4.2 Some technics.

The UVEX Motors module uses two stepper motors. The first one is to control the UVEX focus position and the second one to control the grating angle.

The module is controlled by a dedicated electronic board, powered by a Raspberry Pi Pico microcontroller. The connection with the computer uses the Pico USB port.

There is no "Reference Position" sensor. Instead, we permanently keep the current position of the motors in memory (as soon as the power supply is interrupted, the current position is stored in EEPROM). Then, as soon as the motors positions are calibrated, the system knows where the motors are.

The UVEX grating can rotate indefinitely: there is no mechanical stopper. The calibration consists in looking for the 0th order in the spectrum image, and once it is in the middle of the image, you can calibrate the position to 0°.

⁷ SPOX is a Shelyak external device to control calibration lamps.

The focus position has a mechanical range of 8mm. In this case, there are mechanical stopper in both directions, but there is NO RISK to damage any element if you go up to these ends. The worst that can happen is to lose the calibration (this is easy to redo). The right process is then to find the best focus position, and the calibrate it to the position 4 mm (the middle of the range 0 - 8 mm).

We'll show in chapter 'Controlling the UVEX Motors module' the difference ways to control it; the most basic one is to use the 'USIS controller' software (running under Windows).

The communication between your computer and the UVEX Motors module uses the USIS protocol. This is a serial protocol fully documented. This means that if the standard elements that we provide (USIS controller software or Demetra) do not cover your needs, you can develop your own tools, with no restriction. Refer to chapter "Appendix G: USIS protocol".

When the UVEX Motors module is installed, we keep all the access to UVEX spectroscopy itself:

- 3 screws around the camera adapter ring, to tune the camera orientation.
- 2 screws to fine tune the M1 mirror angle (for an optimal optical quality).

With the UVEX Motors you can activate or tune the position of the motors with the buttons on the box (you need the power supply to be connected).

We've made possible to upgrade the firmware of the module – even remotely. More details are given in Appendix F: Updating the firmware.

Note: if you only plug the USB connector, the Pico micro-controller will start, and you can exchange orders with it, but you'll not be able to move the motors (a remote order to move a motor will return an error message 'No Power Supply').

5 Controlling the UVEX Motors module.

In this chapter, we'll see the different ways to control the UVEX Motors module. Our intention is to provide quick and easy ways for people looking for an off-the-shelf solution, but we also want to cover any special case; we know that an observatory is an assembly of many different elements, and each configuration has its own constraints.

We'll start with controlling the UVEX Motors module using buttons and LEDs, because this is the first one you face when installing the module. Note that in this case, only the power supply is required (USB and calibration module connectors can be left free).

Then, the basic way to - remotely - control the UVEX Motors module is to use the USIS Controller software, that you can find on Shelyak Instruments website⁸.

The most recommended configuration is to use Demetra, which includes the USIS Controller feature.

The advantage is that you can control the UVEX transparently during your acquisitions.

Directly using the USIS protocol to control the UVEX Motors module is the most advanced solution. This is also, the most powerful to precisely adapt the control to your own setup.

Depending on the demand, we'll work on ASCOM and INDI drivers, to easily integrate the UVEX Motors in existing software (ASCOM is for Windows, where INDI is for Linux). Please tell us if you have any feedback on this.

5.1 Manual control.

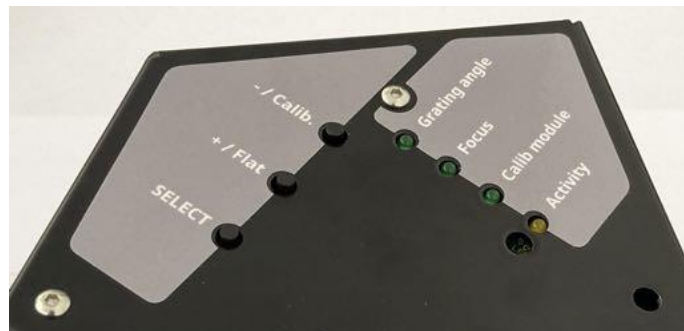


Figure 5.1 – Buttons and LEDs for hand control

During the installation of your UVEX Motors module, or for testing purpose, you need to have a local control on the module. This can be done using the buttons and LEDs on the module itself.

There are three buttons on the top face:

- "Select" button is to switch from one feature to the next one: "Grating angle", "Focus", and "Calib module". The selected feature is displayed by the matching green LED. When you push on the "Select" button, the system will switch to the next feature.

- "+/Flat" button will either rotate the motor in Up direction (when Grating angle or Focus are selected), or activate the Flat lamp (if Calib module is selected).

- "-/Calib" button will either rotate the motor in Down direction (when Grating angle or Focus are selected), or activate the Calibration lamp (if Calib module is selected).

The Activity yellow LED indicates that an action is on-going (when a motor is rotating, or a calib module change is requested).

Both motors (Grating angle and Focus) need to be calibrated the first time you use them. It can be done by pushing on 'Select' button for 5 seconds.

The motor position will be then calibrated to the position "0". The usual process to calibrate is then as follows:

1. Grating angle calibration.

- Take continuous images of the main camera, to see the spectrum. Choose for instance 0.5

⁸ <https://www.shelyak.com>

exposure time (and adapt it to see the spectrum, without saturation).

- Select the 'Sky' light source, and make sure that some light is entering in the UVEX slit. You can also use the Flat lamp to do this (but preferably not the Calibration lamp).

- Select the Grating angle feature.

- Move step by step the grating angle until you can see the 0th order (sharp emission line) in the middle of your image (see below).

- Then push for 5 seconds on the "Select" button, to calibrate the module to the position "0".

- The grating angle is now calibrated.

2. Focus position calibration.

- Remove the Focus motor gear cover.

- Rotate the Focus axis (tightening direction) until it is mechanically stopped. Then, release the axis by an half-round.

- Select the Focus feature.

- Then push for 5 seconds on the "Select" button, to calibrate the module to the position "0".

- The focus position is now calibrated.

Of course, when moving the motors using the buttons, you cannot see the actual position of the motors.

But the module keeps this information in memory, and you can get the information from the computer when it is connected.

5.2 Remote control.

Remote control of the UVEX Motors module is the usual way to work. Let's see the different possible ways to do it.

5.2.1 Using the "USiS controller software".

The "USIS controller" software module is available in the Shelyak Instruments website (<https://www.shelyak-instruments.com/Web/Logiciel/UsisController/>). It runs under Windows (win 10 or above). Download the setup file (the name is like 'Setup USIS

Controller XXX.exe'), and run it (double-click for instance) to install it. The first step is like (fig.5.2).

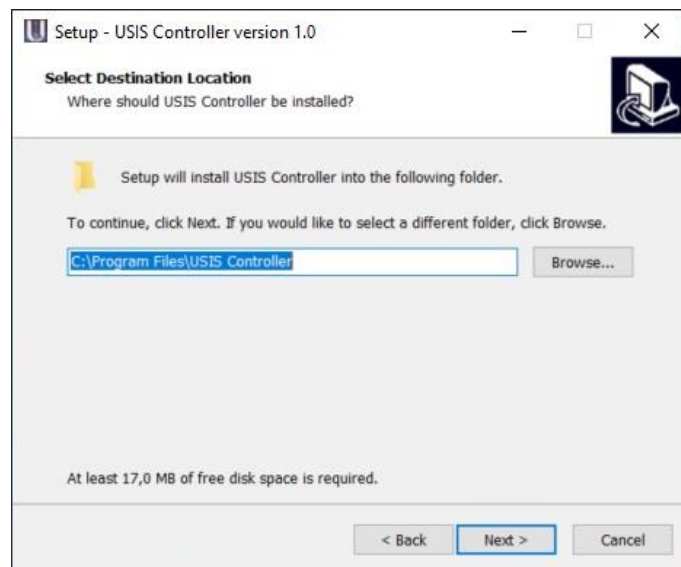


Figure 5.2

The software is called "USIS controller"⁹. You can start it by clicking on the 'USIS controller' icon. The initial window is like (fig. 5.3).



Figure 5.3

⁹ We give this name because it uses the USIS protocol in a generic way. In the Future, the same software could control other USIS devices.

In the “Device” menu, select “UVEX Motors” fig. 5.4.

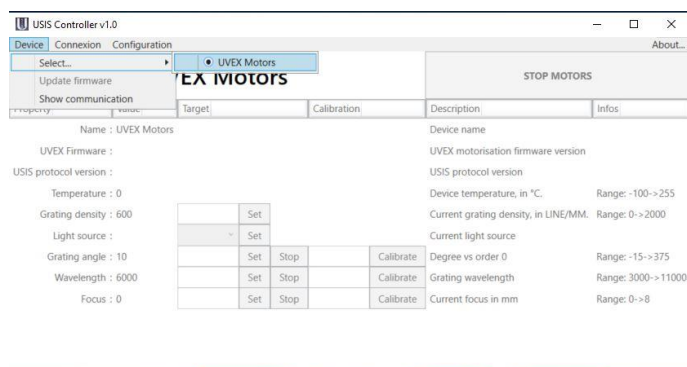


Figure 5.4

Then, go to the ‘Connexion’ menu, and select the serial port on which you’ve connected the USB cable for the UVEX Motors module (fig. 5.5).

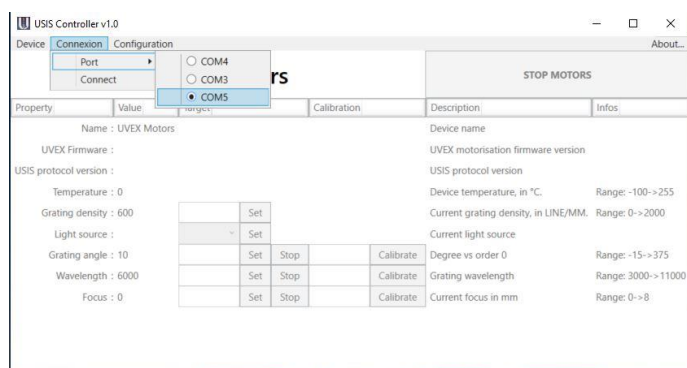


Figure 5.5

When the configuration is made, you can click on “Connect” button (still in “Connexion menu”, fig. 3.6).

When the connexion is done, you can see all the UVEX Motors module properties (fig. 3.7).

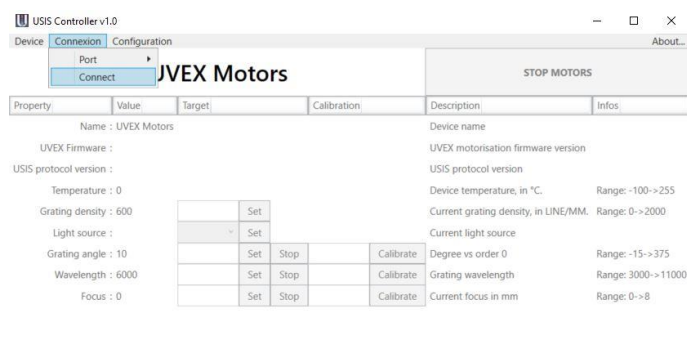


Figure 5.6

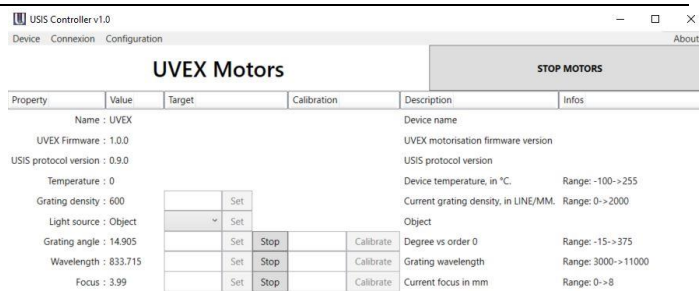


Figure 5.7

Each line refers to a property. For each property, you get the name, its current value (in real time, the value is updated every few seconds), the target if you want to change a property (like the grating angle or the focus position), the calibration value (for properties that can be calibrated).

If you want to change a property (grating angle for instance), just enter the target value you want, and click on ‘set’ button.

5.2.2 Using DEMETRA.

Demetra is the recommended software to operate your UVEX. It is designed and edited by Shelyak Instruments. It covers from spectra acquisition to data reduction, and manages your whole observing session.

Demetra is free. You’ll find all the details on Shelyak website, for download and installation. To use it with UVEX and UVEX Motors module, download the ‘UVEX’ version (7.3.0.0 or above). Demetra includes the same feature as the USIS controller for UVEX. Then all the information of the previous section (5.2.1) is applicable with Demetra.

The advantage of using Demetra with the UVEX Motors module is that the device is controlled transparently. For instance, if you take a Calibration frame, Demetra will automatically switch the light source to Calibration light.

Demetra can manage several devices during the acquisition. The UVEX Motors module is such a device. You can go to the main window, and activate the USIS device. This will add some more data in the acquisition window.

5.2.3 Using USIS protocol.

If, for any reason, you don't want (or cannot) use the USIS Controller or Demetra, you can use directly the USIS protocol. This is the basic protocol used to communicate between the computer and the UVEX Motors module.

You'll find more details about the USIS protocol in appendix G. And the USIS specification can be found in this repository:

<https://github.com/FrancoisCochard/USIS-Protocol>.

This USIS protocol can be used in different ways for instance, you can write the commands on a serial terminal (like putty, minicom, or others). You can also write high level functions in any language (we worked with Python commands during the development of the UVEX Motors module).

6 Appendix

Appendix A: technical specifications.

Dimensions :

— Dimensions of the UVEX: see fig. A.5, next.
These dimensions are not including the acquisition camera nor the Guiding and calibration modules.

Weight:

— Weight UVEX without camera: **1.45 kg**
— Weight UVEX with camera (ASI 183MM Pro), calibration module, guiding module and guiding camera (ASI 174 Mini): **2.53 kg**

Power supply:

— Power supply: 12V (1A min).
— Power supply connector: 5.5 / 2.5 mm (standard audio-video connector). Positive in the center.

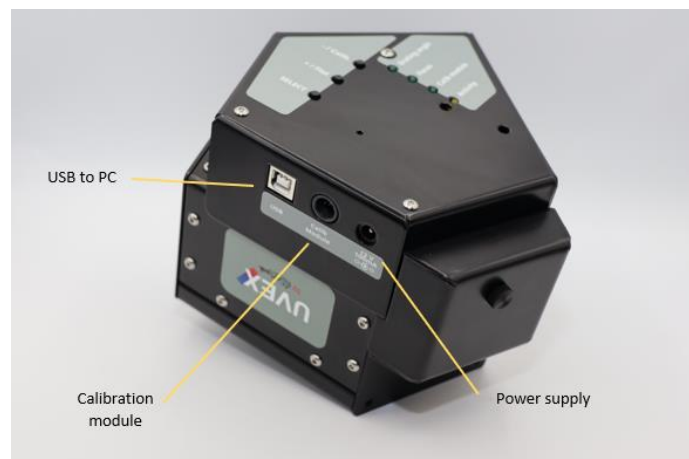


Figure A.1

Gratings:

The UVEX is shipped with a 600 l/mm grating, but you can change it to get other resolutions. You can use optional gratings of 150, 300, 1200 and 1800 l/mm gratings. The following table gives you the Resolution Power R^{10} for the different gratings.

Note: these are theoretical resolutions (calculated at F/6.5), with the standard slit (width 23 μ m). A wider slit reduces the resolution.

	Grating (l/mm)				
lambda (nm)	150	300	600	1200	1800
350	210	399	824	1748	2863
450	273	530	1100	2364	3947
550	338	671	1397	3044	5217
650	404	821	1715	3798	6738
750	467	944	1973	4501	N/A
850	548	1067	2230	N/A	N/A
950	596	1189	2488	N/A	N/A

Figure A.2 – Theoretical resolutions

Spectrum length:

The spectrum physical lens on the sensor is \approx 20mm.

Slit:

The UVEX is shipped with a multiple position slit: 25 μ m, 50 μ m, 100 μ m and 300 μ m. There are also a 25 μ m hole position (mainly for test purposes) and a 'slitless' position (3 mm hole).

When used with the guiding module, the slit must be replaced by the one coming with the guiding module. This is a mirror slit. Different slits width can be bought at Shelyak.

¹⁰ The resolution power R is given by $R = \lambda/\Delta\lambda$, where λ is the wavelength.

Main camera attachment & back-Focus:

The main camera (by opposition to the guiding camera) is attached to the UVEX thanks to a special adapter. The standard UVEX includes an adapter for ZWO cameras (such as ASI183 or ASI294). Other adapters are available at Shelyak Instruments for QHY and Atik cameras.

Because of the compact optical layout, there is a strong constraint on the camera back focus: it must be of 13mm maximum.

Telescope attachment:

The UVEX is attached to the telescope through the guiding module. But in addition, the guiding module adapter (shipped with the UVEX) includes a female T-mount thread (M42 x 0.75 mm), that can be used to attach any optics or device (see fig. A.3).

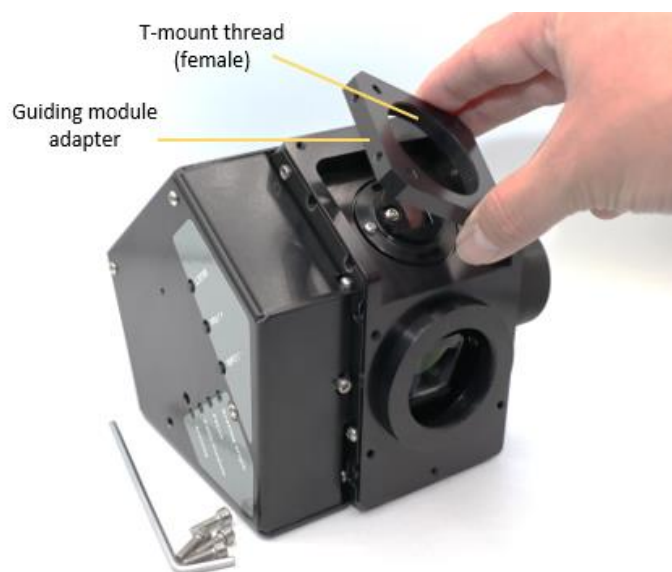


Figure A.3 – Telescope adapter

Tripod thread:

Close to the counter-button, you have a 'Kodak thread' to attach a tripod, to use the UVEX in a laboratory (see fig. A.4).



Figure A.4 – Tripod thread

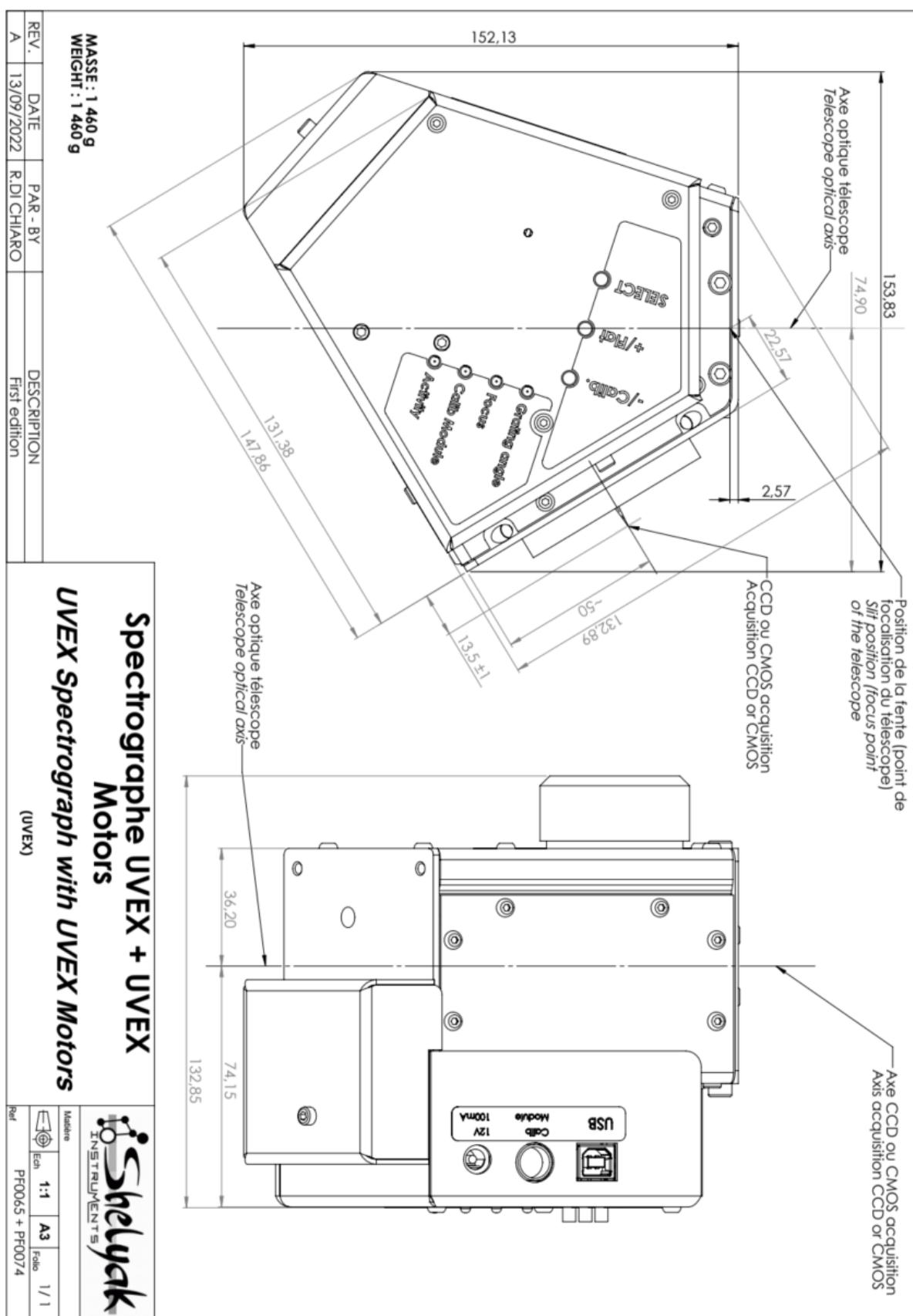


Figure A.5 – Dimensions of the UVEX

Appendix B: changing the slit

You can easily access and change the slit of the UVEX.

First, you can loosen the 2 small screws attaching the slit itself, and rotate it to the position you choose. After the slit selection, we recommend to take images to control that the emission or absorption lines are vertical.



In normal conditions, the spectrum (direction of the dispersion) must be perfectly horizontal in your image and the lines – if you've an extended light source – must be perfectly vertical. The perpendicularity between the spectrum dispersion and the lines is achieved if the slit is exactly parallel to the grating lines (grooves). If you rotate a little bit the slit, then the lines will be slanted in your spectrum. Reversely, if you want to make the lines perfectly perpendicular to the dispersion direction, adjust precisely the slit orientation.

Second, you can change the whole slit, and replace it, for instance, by a mirror-slit (this is the case for use with the guiding module). See fig. B.1, B.2 and B.3.

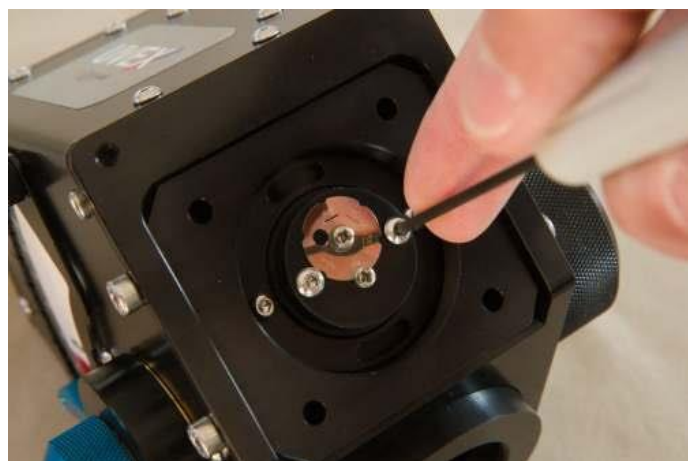


Figure B.1 – Remove the slit holder screws



Figure B.2 – Remove the slit holder

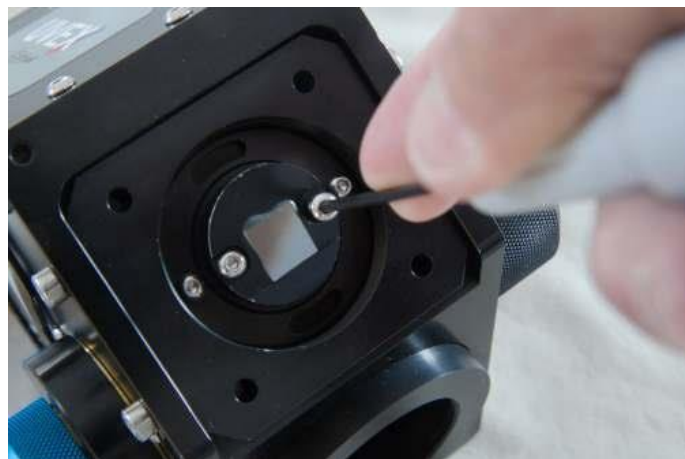


Figure B.3 – Tighten the screw for the new slit

In any case, after changing the slit, you must refocus the spectrum – or at least check it is OK.

Third, you can return the external slit holder (After removing the slit holder) to install a fiber optic connector (available in option at Shelyak). See figure B.4 and B.5.



Figure B.4 – Remove the external slit holder



Figure B.5 – Return the external slit holder to install a fiber connector

Appendix C: installing the order filter.

If you observe in far red or even in IR with the UVEX, there is a risk that the blue light at second order overlaps your spectrum. This is a very common issue, for any grating spectroscopes. The solution to avoid this is to use a filter that will cut all light below 500nm. Such filter is available at Shelyak Instruments.

The UVEX can hold such an order filter, right after the slit. To install it, proceed as follows:

→ Remove the external slit holder (see fig. C.1).



Figure C.1 – Remove the external slit holder

→ Install the filter (this is a 1/2" diameter - see fig. C.2 and C.3).



Figure C.2 – Install the filter

→ Put and tighten (gently!) the locking ring (see fig. C.4 and C.5).



Figure C.3 – Install the filter



Figure C.4 – Install the locking ring



Figure C.5 – Tighten the locking ring

Appendix D: screws functions.

The UVEX contains a lot of screws; of course each of them has a precise function. Some screws can be manipulate for tuning, but the other must not be loosen or removed – they are part of the structure of the instrument.

In the below pictures, we've shown all screw that could be manipulated with no (major) risk. All the other screws must not be removed.

We've indicated with colors the different functions:

- Telescope attachment (blue).
- Cylindrical lens focus (purple).
- Cover opening (red).
- M1 tilt tuning (yellow).
- Dismantling the UVEX Motors module (green).



Figure D.2 – UVEX screws



Figure D.1 – UVEX screws



Figure D.3 – UVEX screws

Important Note: You never need to 'open the box' of the UVEX. But if you cannot resist (or if you really need to), first remove the grating cap, then the grating itself. After that, you can simply remove 9 screws (in red in these pictures) and slide it gently.

Appendix E: tuning M1 mirror tilt.

In normal conditions, you should never have to tune the M1 mirror tilt, because the instrument is tuned in our factory. But we never and we prefer to give you all the details to do it if needed.

All the UVEX optics is contained in a plane, and then the spectrum is 'absolutely' symmetric vertically (across the dispersion direction). Of course, nothing is really perfect, and the even if all optical and mechanical parts are of high quality, we cannot ensure only by construction that the whole optics is perfectly planar. Then, we've given some tuning room to the M1 mirror (see the optical layout in section 1.3) to make all the elements exactly in a plane.

The symptom, if the M1 tuning is not perfect is that the spectrum of an extended source will not be exactly symmetrical. For instance, if you take a spectrum of the Sky (with a telescope or any optics in front of the slit), the spectrum is sharp in the central part, but less sharp on top and bottom edges. The M1 tuning will affect this symmetry. Then if you can see that the sharpest part of the spectrum is not exactly at the center of the spectral band, you can improve this with M1 tilt.

The M1 mirror is mounted on a holder that allows a rotation around its center (see CAD views inside the UVEX fig. E.1 and E.2).

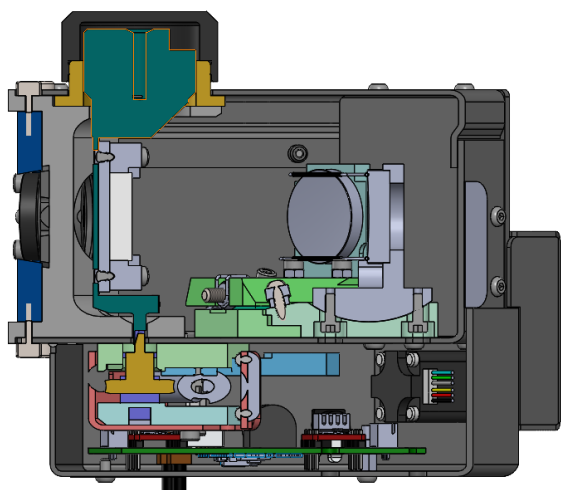


Figure E.1 – Inside the UVEX

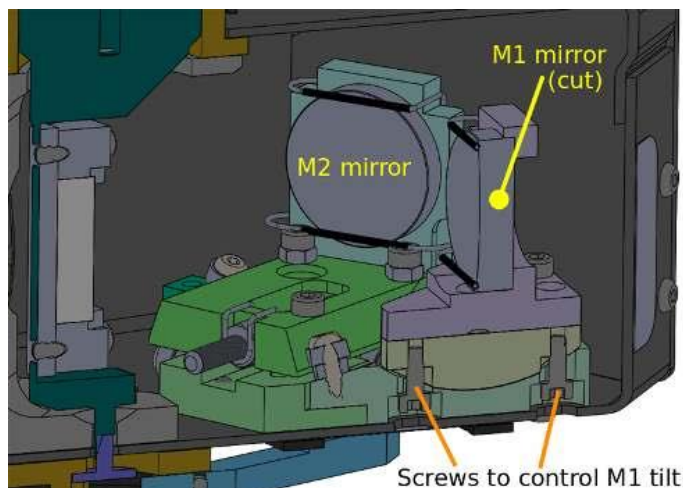


Figure E.2 – Inside the UVEX

You can control the rotation of the M1 mirror by the two external screws showed on fig. E.3.

Important note: Use a 2.5 mm BTR key



Figure E.3 – Screws to control M1 tilt angle

Be very careful when doing this tuning. The mirror angle is very sensitive.

Appendix F: Updating the firmware.

We all know that software is never perfect, and we could also add some new features in the future. Then this is important to be able to update the UVEX firmware. You can do that locally (when you're close to the instrument), or remotely.

The UVEX Motors module is powered by a Raspberry Pi Pico controller¹¹. Then, the way to update the firmware is given by the Pico rules. You can download the latest firmware version from the Shelyak website (UVEX product page)¹². This is a file with .uf2 extension.

Appendix F-1: Local update.

The principle is quite simple: you can start the Pico in 'Bootsel' mode, which is the firmware upload mode. To do it, you've to press the "Bootsel" button while plugging in the power supply. This button can be accessed by using a thin tool (like a paper clip for instance), through the small hole in the middle of the main face of the Motors module (fig. F.1).

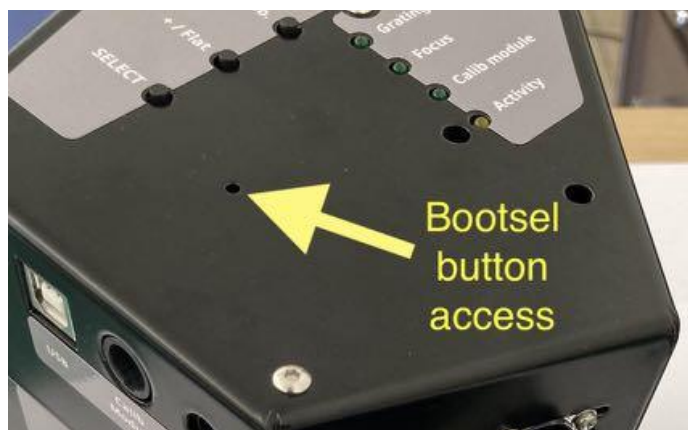


Figure F.1

When you enter in "Bootsels" mode, the Pico appears in your file manager (whatever the operating system). At this stage, you can simply drag and drop the .uf2 file in the Pico. When the transfer

is done, the Pico disappears from the file manager. You can restart the Pico by unplugging the power supply and the USB cable and re-plug them¹³.

Appendix F-2: Remote update.

When you're far away from your UVEX instrument, you cannot press the "Bootsels" button for real. But we've added a 'hidden' command in the USIS protocol to reboot automatically the Pico in "Bootsels" mode.

The USIS command is:

SYSTEM;REBOOT*

Running this command will have the same effect as pressing the "Bootsels" button. This command is also included in the "USIS Controller" software (and then in the Demetra software). In the USIS Controller, you can select the Device menu and click on 'Update firmware' (fig. F.2).

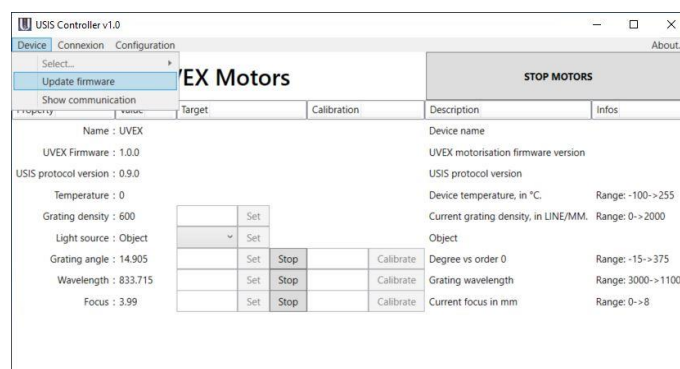


Figure F.2

This will make the Pico appear in the file manager. The example in fig.F.3. shows a Windows case.

Again, after the download is completed, the Pico disappears from the file manager and you must restart it by switching off and on the power supply. The latest firmware version is now up and running.

¹¹ <https://www.raspberrypi.com/products/raspberry-pi-pico/>

¹² <https://www.shelyak.com>

¹³ Remember that the USB cable is enough to supply the Pico itself. To actually switch off the Pico power supply, you must unplug both USB and power supply cables.

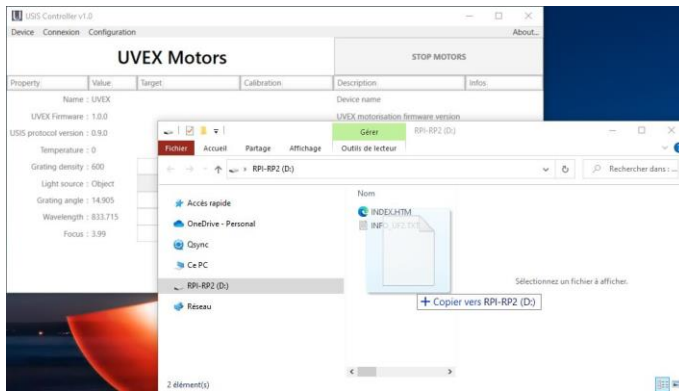


Figure F.3

Appendix G: USIS protocol.

The USIS protocol is designed to control any spectroscopy device in a standard way. This is a fully documented Open-Source protocol. You can find all the details (specification and library for developers) on the USIS GitHub page:

<https://github.com/FrancoisCochard/USIS-Protocol>

A USIS device includes a list of properties, that can be read or changed by using a few sets of commands.

The UVEX Motors device fully complies to USIS protocol, and offers the following properties:

- FOCUS_POSITION gives the current position of the UVEX focus.
- GRATING_ANGLE gives the current grating Angle from the 0th order.
- GRATING_WAVELENGTH is the conversion of the grating angle to actual central wavelength. Of course, both GRATING_ANGLE and GRATING_WAVELENGTH are closely linked together.
- GRATING_DENSITY gives the current grating density (lines per mm). When you change the grating (to change the resolution power of your UVEX), you must set the GRATING_DENSITY accordingly. Note that this value is only used to convert the grating angle to wavelength and vice-versa. If you only work with the grating angle, the grating density is not important. But if you control the grating angle through the wavelength (which is the 'normal' way), then the grating density must be properly filled, and updated each time you change the UVEX grating.
- LIGHT_SOURCE gives the current light source. It can be 'Sky' (when observing a star), 'Dark' (for bias and dark frames), 'Calibration' or 'Flat'.
- TEMPERATURE gives the current temperature inside the UVEX Motors module. This can be useful to precisely adjust the focus position while the temperature significantly changes. This is a read-only property.
- Several other properties are available, like the firmware version, USIS module name, and so on. Refer to the USIS specification for more details.

The protocol is a serial communication on the USB port. It can be used by sending commands on the serial port, and listen to the replies. This can be done by using a serial console (like Putty under Windows, or minicom under Linux). It can also be used to integrate the control of the UVEX in any high-level language (C++, Python, JS, and so on). There is no limitations.

The USIS protocol purpose is not limited to the UVEX Motors module, but we want to offer a standard way to control any spectroscopes properties. The protocol is open, and fully documented. It can be used by any hardware and software developers in spectroscopy environment.

Here is an example of an order sent to the UVEX Motors module (to ask for the grating angle position):

GET;GRATING_ANGLE;VALUE*43

and the reply could be:

M00;GRATING_ANGLE;VALUE;OK;14.9053*78

Which means that the grating angle is currently at 14.90° from the 0th order.

An interesting feature in USIS protocol is that you can introspect the whole device, to list automatically all available properties. Refer to the USIS page for all the details about the USIS protocol.