Spectrometer Assembly Instructions

Mechanical assembly draft | Optical alignment to follow

This guide covers the mechanical assembly of the spectrometer through enclosure closure. Sensor focus, sensor-to-light-path alignment, and final grating alignment are intentionally reserved for a later calibration procedure using a light source and the spectrometer software.

1. Identify the spectrometer case

Begin by identifying the spectrometer case and locating the two brass threaded inserts installed in its base.

Figure 1. Interior of the spectrometer case showing the two pre-installed brass threaded inserts.

The two brass inserts are already installed in the case and are threaded for #4-32 screws. You do not need to install the inserts yourself. They will be used for mounting components during a later assembly step.

Assembly note: Leave the inserts in place. Their exact use will be identified in the relevant step later in this guide.

2. Identify the kit hardware

Before beginning assembly, identify the supplied fasteners and separate them by size. The rows below are numbered from the back of the layout (the top of the photograph) toward the front (the bottom of the photograph).



Fastener identification (back to front)

Row 1 – Back: 4 × #8 screws. Secure the top cover of the spectrometer enclosure.

Row 2: 2 × #4-32 screws + 2 flat washers. One screw-and-washer set mounts the sensor holder; the other mounts the diffraction-grating slide holder.

Row 3: 4 × #2-56 screws. Secure the sensor-module PCB inside its 3D-printed holder.

Row 4: 4 flat washers. Use one with each #2-56 screw.

Row 5: 4 × #2-56 nuts. Secure the four sensor-module screws from the back of the holder.

Row 6 – Front: 4 lock washers. Use one with each #2-56 screw. These are installed next to the screw heads.

Figure 2. Complete kit fastener set arranged from the back row to the front row.

Sensor PCB fastener order: from the screw head toward the nut, install the #2-56 screw, lock washer, flat washer, holder/PCB, and #2-56 nut. Do not substitute #2-56 and #4-32 hardware; they are different sizes.

3. Identify the sensor module kit components

Before assembling the sensor module, lay out the supplied components and check them against the inventory below. Keep the small hardware together until you are ready to install it.

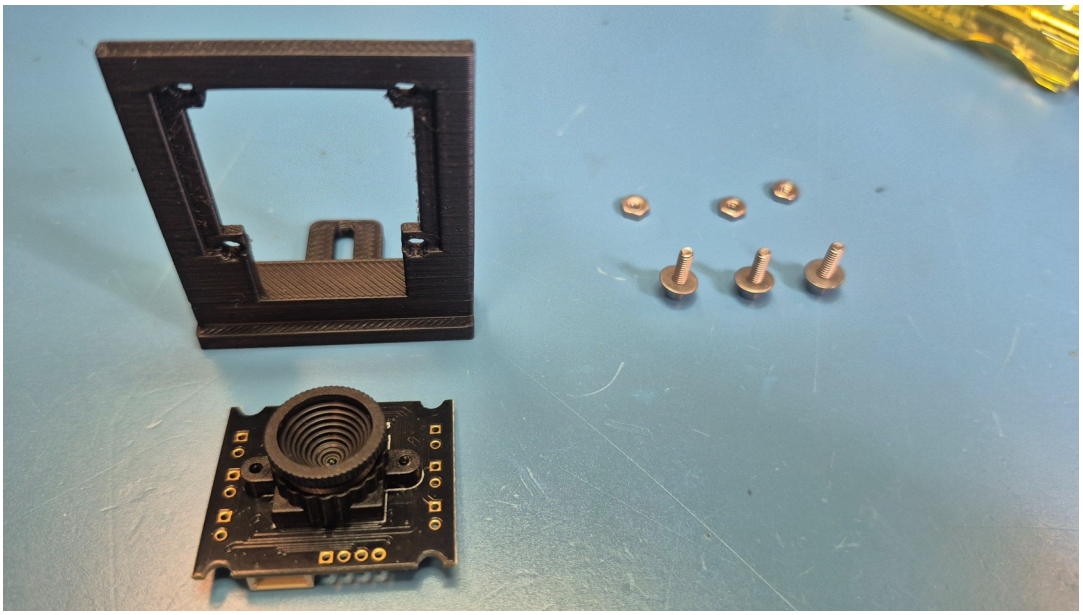


Figure 3. Sensor module kit components, including the 3D-printed holder, sensor module PCB, and mounting hardware.

Component	Qty.	Description
Sensor module PCB	**1**	Sensor board with the lens assembly mounted.
3D-printed sensor module holder	**1**	Frame that supports the sensor module.
#2-56 screws	**4**	Machine screws for the sensor module assembly.
Washers	**4**	One supplied for each screw.
Lock washers	**4**	One supplied for each screw.
#2-56 nuts	**4**	One supplied for each screw.
#4-32 case-mounting screw	1	Secures the completed sensor holder to the spectrometer case.
Case-mounting washer	1	Fits under the head of the #4-32 mounting screw.

Hardware identification: The four small PCB fasteners are #2-56. The separate case-mounting hardware consists of a #4-32 screw and washer, used to attach the completed sensor holder to a threaded insert in the spectrometer case. These sizes are not interchangeable.

4. Install the sensor module in its holder

With the sensor module kit components identified, install the sensor module PCB in the 3D-printed holder. The holder has four mounting points that align with the four mounting holes on the PCB.

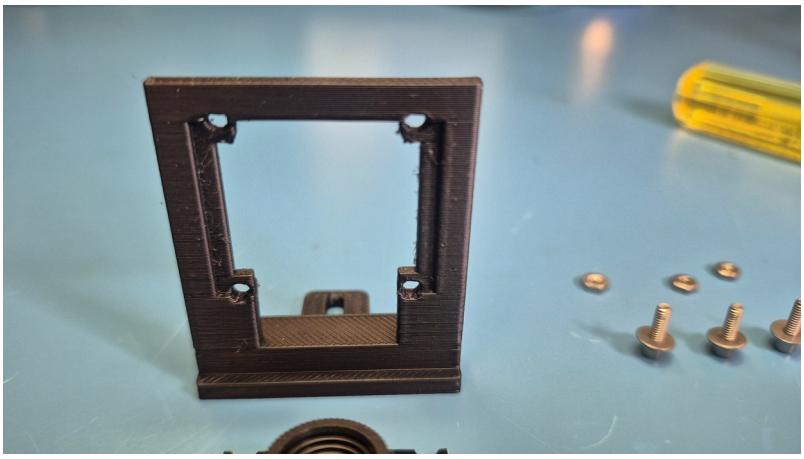


Figure 4. Sensor module holder before the PCB is installed.

1. **Insert the PCB.** Place the sensor module PCB into the slot in the holder. Orient it so the lens assembly faces through the large front opening, then align the PCB mounting holes with the four mounting points in the holder.
2. **Prepare the screws.** For each of the four #2-56 screws, place a lock washer onto the screw first, followed by a flat washer. Keep this order for all four fasteners.
3. **Attach the PCB.** From the front (lens) side of the holder, insert each screw through the holder and the aligned PCB mounting hole. From the back of the holder, install a #2-56 nut onto each screw.
4. **Tighten gently.** Secure all four mounting points, tightening each screw only enough to hold the PCB firmly in place. Do not overtighten.
5. Connect the USB cable. Plug the USB cable into the connector on the sensor module PCB before installing the completed sensor assembly in the case. The connector is keyed and fits only in the correct orientation. Position the plug so the red wire is on the same side shown in the reference photo. If the connector does not seat easily, stop and check its orientation; do not force it.

Fastener order (front to back): screw head → lock washer → flat washer → holder and PCB → #2-56 nut.

> **Important:** Do not overtighten the screws. Excessive force can damage the sensor PCB or the 3D-printed holder.

Completed sensor module installation

Use the views below to check the completed installation. The lens assembly should face out through the holder opening, and all four #2-56 nuts should be installed on the back. Confirm that the USB cable is connected and that the red wire is positioned as shown in the cable-orientation photo.

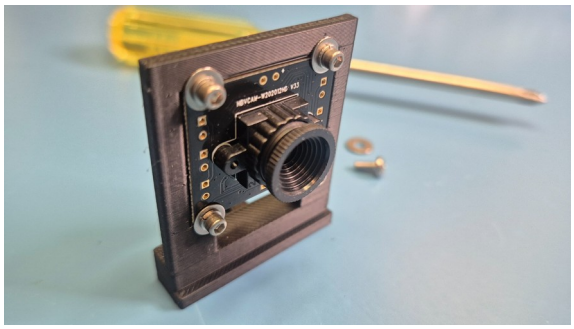


Figure 5. Front view showing the lens assembly and screw heads.

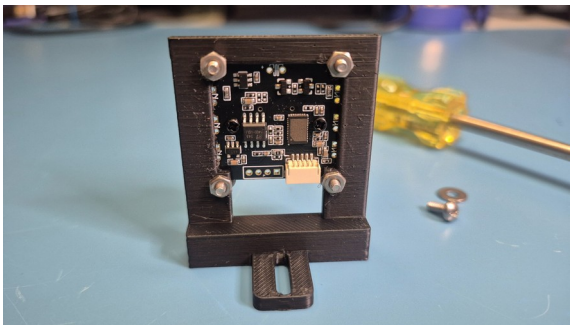


Figure 6. Rear view showing the four #2-56 retaining nuts.

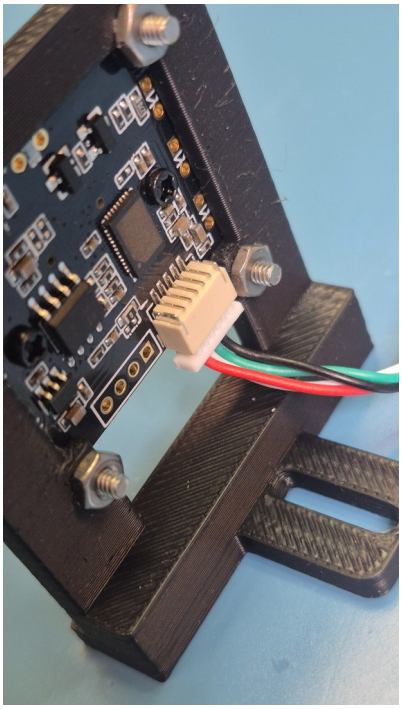


Figure 7. Close-up of the USB connector installed on the sensor PCB. The red wire is positioned as shown.

5. Mount the sensor assembly in the spectrometer case

After securing the sensor PCB in its 3D-printed holder and connecting the USB cable, mount the completed sensor assembly to the spectrometer case. Use the separate #4-32 case-mounting screw and washer supplied for this step.

1. **Position the holder.** Place the sensor assembly in the spectrometer case. Align the slotted mounting tab on the holder with the pre-installed #4-32 brass threaded insert in the case.
2. **Install the mounting hardware.** Place the flat washer under the head of the #4-32 screw. Pass the screw through the holder mounting slot and thread it into the brass insert in the case.
3. **Set the preliminary angle.** Position the sensor assembly at approximately a 45-degree angle, as shown in the photograph. This is only a starting position; the focus and final sensor angle will be adjusted later in the assembly process.

4. Secure the assembly. Tighten the #4-32 screw enough to hold the holder in its preliminary position. Do not overtighten or treat this angle as the final optical alignment.

Important: Use the #4-32 screw and washer to attach the sensor holder to the case. The smaller #2-56 screws are only for securing the sensor PCB inside its holder. The approximately 45-degree position is temporary; final focus and angle adjustments come later.

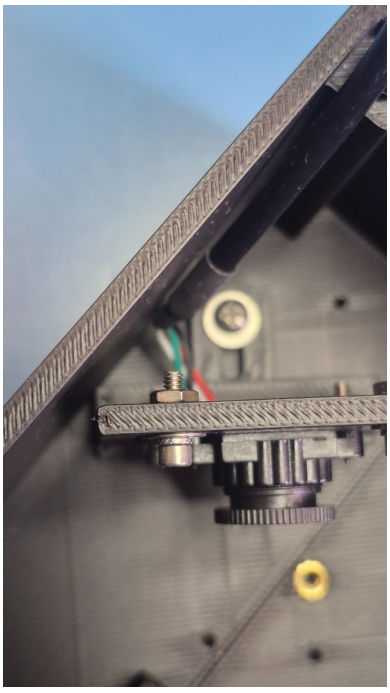


Figure 8. Side view of the sensor holder secured in the case, showing the mounting hardware.



Figure 9. Interior view of the sensor assembly in its preliminary position inside the case.

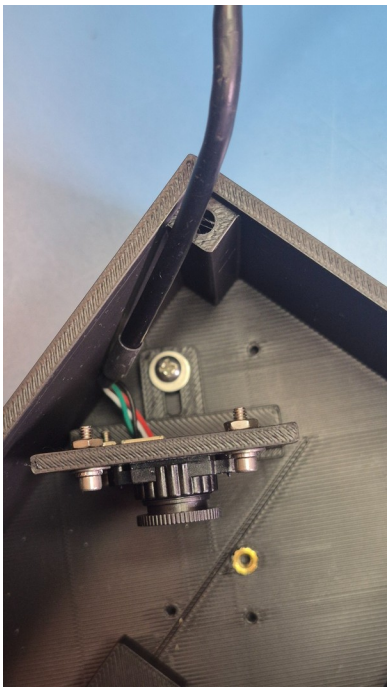


Figure 10. USB cable routed into the spectrometer case while the sensor assembly is mounted.

6. Assemble the diffraction grating slide

The diffraction grating assembly consists of the 1000 lines/mm linear diffraction grating slide, the 3D-printed slide holder, and a #4-32 mounting screw with a flat washer. Assemble the slide and holder before installing the completed assembly in the spectrometer case.

Component	Qty.	Description
1000 lines/mm diffraction grating slide	1	Linear diffraction grating slide with a printed wavelength scale.
3D-printed grating slide holder	1	Frame with a top-loading slot and a lower mounting tab.
#4-32 screw	1	Used with the flat washer to mount the completed grating-slide holder in the case.
Flat washer	1	Used with the #4-32 mounting screw.

Assembly procedure

1. **Prepare the holder.** Position the 3D-printed holder upright with the narrow loading slot along the top edge and the curved mounting tab at the bottom, as shown in the first reference photo.
2. **Orient the grating slide.** Hold the slide by its outer edges. Face the printed wavelength scale (300–700 nm) toward the front, matching the orientation shown in the photographs.
3. **Insert the slide.** Carefully guide the slide into the pocket through the slot at the top of the holder. Keep the slide centered from side to side as it enters the frame.
4. **Seat the slide fully.** Push the slide down gently and evenly until its lower edge reaches the bottom of the holder pocket. Check that it is centered and square in the frame, with the grating window aligned with the large opening and the wavelength scale visible below it.
5. **Set aside the mounting hardware.** Keep the #4 screw and washer with the completed grating-slide assembly. They will be used when the holder is mounted in the spectrometer case.

Handling tip: Hold the grating slide by its outer edges. Avoid touching or scratching the clear grating area. Do not force the slide into the holder; remove it and realign it if it does not slide smoothly.



Figure 11. The 3D-printed holder and 1000 lines/mm grating slide before assembly.



Figure 12. Begin inserting the grating slide through the slot at the top of the holder.



Figure 13. The grating slide is centered in the holder and pushed farther into the pocket.



Figure 14. Completed grating-slide assembly with the slide fully seated in the holder.

Check before proceeding

The grating slide should sit evenly in the holder without being tilted or pinched. Confirm that it is fully seated and that the printed wavelength scale remains visible as shown. The completed holder is now ready for its later mounting step.

Optional Upgrade: Glass-Mounted 1000 Lines/mm Diffraction Grating

Some kits include an optional glass-mounted 1000 lines/mm diffraction grating instead of the standard flexible slide-film grating. In this upgraded version, the grating film is sandwiched between two rigid glass panels. The glass supports the film and helps keep the grating flat during handling and use.

Advantages of the glass-mounted grating

- Rigid support: the two glass panels help prevent the grating film from bending or flexing like the standard slide-film grating.
- Stable grating surface: the rigid construction helps maintain a consistent, flat grating surface.
- Visual installation reference: the first photo shows the glass-mounted grating in its holder, positioned relative to the sensor; the second shows the glass-grating assembly by itself.

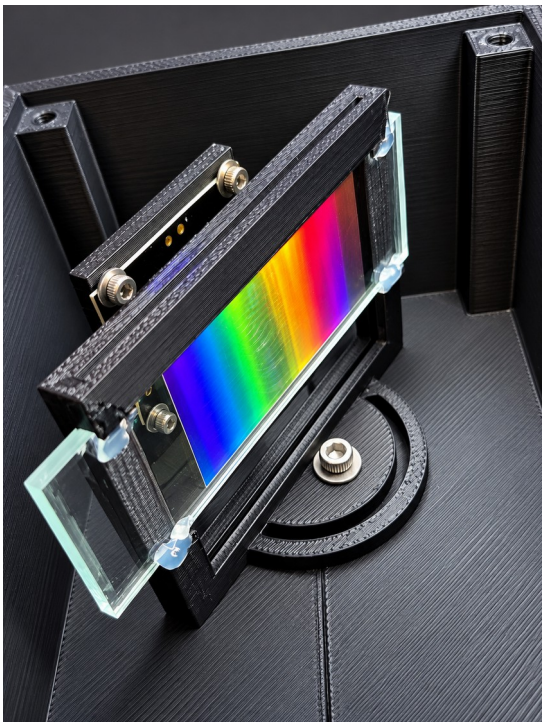


Figure 15. Glass-mounted grating installed in its holder, shown in relation to the sensor.

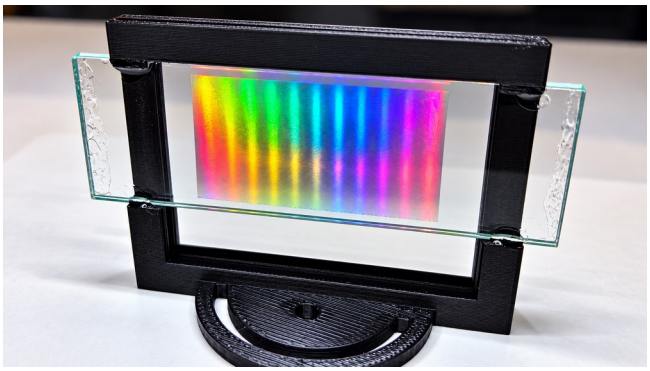


Figure 16. The optional glass-mounted 1000 lines/mm diffraction grating by itself.

If your kit includes this upgrade, use the glass-mounted grating assembly supplied with it in place of the standard slide-film grating. Use Figure 15 to identify the upgraded assembly and its position relative to the sensor. Follow the mounting features and hardware provided with the glass-grating assembly; do not force it into the standard slide-film holder.

Optional upgrade only: If your kit contains the standard flexible slide-film grating, continue with the standard grating-slide instructions and ignore this optional-upgrade section.

7. Mount the diffraction-grating assembly in the spectrometer case

For the standard slide-film version, install the completed grating-slide holder inside the spectrometer case using the pre-installed #4-32 brass threaded insert, the #4-32 mounting screw, and the flat washer. If your kit includes the optional glass-mounted grating, use the glass assembly and its matching mounting frame/hardware as shown in the optional-upgrade photos; do not try to fit the glass assembly into the standard slide-film holder.

Standard slide-film grating: mounting procedure

1. **Position the holder.** Place the completed grating-slide holder inside the spectrometer case. Align its mounting tab/slot with the pre-installed #4-32 brass threaded insert in the case.
2. **Install the screw and washer.** Place the flat washer under the head of the #4-32 screw. Pass the screw through the holder's mounting slot and thread it into the brass insert. Start the screw by hand to avoid cross-threading.
3. **Set the preliminary angle.** Position the grating-slide holder at approximately 45° relative to the case base, as shown in the reference photographs. This is a temporary starting position, not the final optical alignment.
4. **Secure the holder temporarily.** Tighten the screw only enough to keep the holder in position. Do not overtighten; the angle will need to be adjusted during the optical alignment procedure.

Important - preliminary position only. The approximately 45° angle is only for initial assembly. Final grating-slide alignment will be performed later using a light source and the spectrometer software. Do not attempt to establish the final angle at this stage.

Check before proceeding

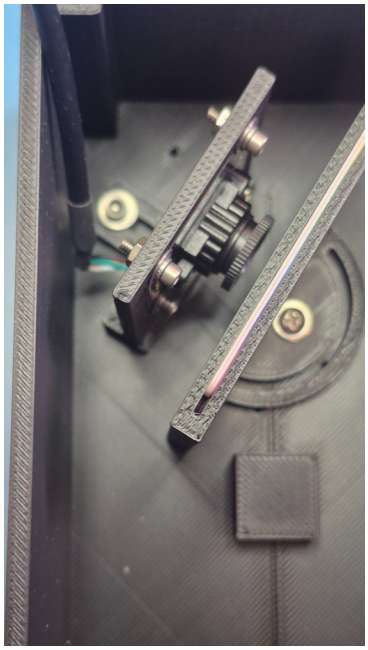
For the standard slide-film version, confirm that the grating-slide holder is attached to the correct #4-32 insert, the washer is under the screw head, and the holder remains at approximately 45°. The slide should remain fully seated in its holder, with the grating window unobstructed. Leave final angle adjustment for the later light-source and software alignment procedure.

Reference photographs

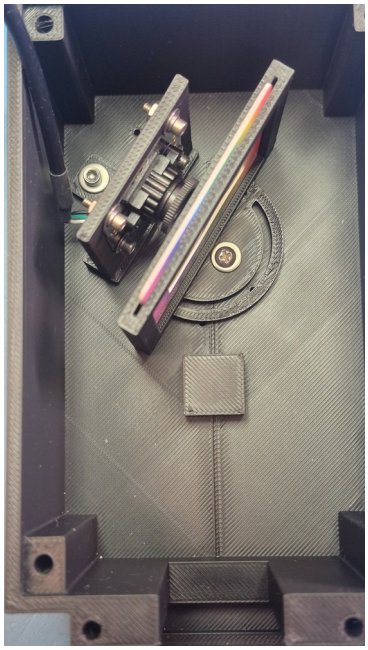
The following reference views will show the mounting point, fastener, and temporary position.



Close-up of the grating-slide holder and its central mounting fastener.



Side view showing the grating-slide holder and sensor module at their temporary positions.



Overall interior view showing the grating-slide assembly positioned inside the case.

8. Install the 1 mm slit plate

Locate the 1 mm slit plate and its matching slot in the spectrometer assembly. The slit is intentionally offset from the center of the plate, and the plate also has a small rectangular indent. Both features determine the correct installation orientation.

Installation

1. **Check the plate orientation.** Before inserting the plate, identify the slit opening and compare the distance from the slit to the two opposite edges.
2. **Position the short offset upward.** Orient the plate so the shorter distance between the slit and the edge is at the top. Do not install the plate upside down.
3. Insert the slit plate. Place the plate into its matching slot while keeping the shorter offset at the top and the rectangular indent facing inward, toward the inside of the spectrometer. Seat the plate carefully and do not force it if it does not fit easily.

Orientation is critical: the shorter offset from the slit to the edge of the plate must face UP, and the rectangular indent must face inward toward the inside of the spectrometer.

Check before proceeding

Before continuing, confirm that the slit plate is fully seated, the shorter offset is at the top, and the rectangular indent faces inward toward the inside of the spectrometer. These orientation features are important for correct installation. Final optical alignment will be completed later.

9. Fit the interchangeable slit-bay cover

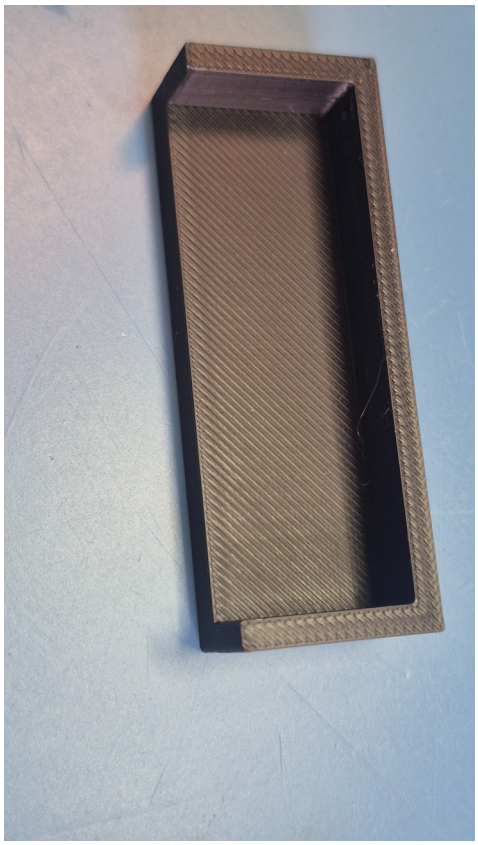
The interchangeable (swappable) slit bay has a separate cover that fits over the top of the bay. This cover is retained by a snug friction fit and does not use screws or other fasteners.

Installation

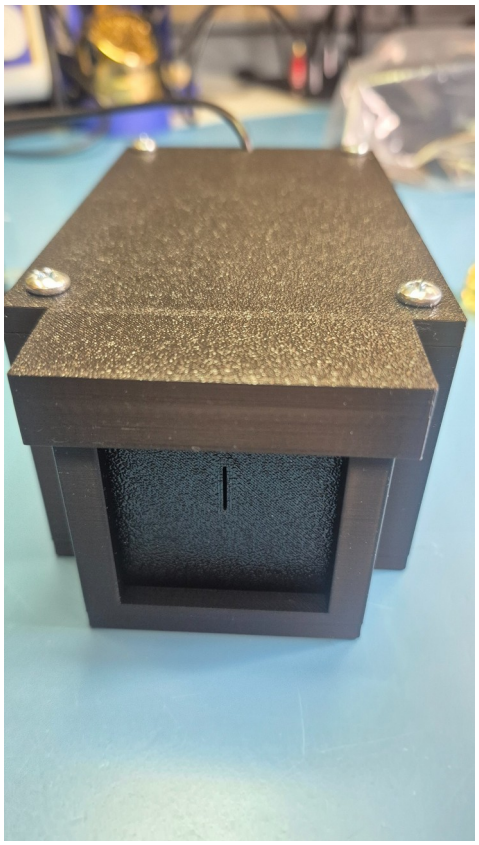
1. **Position the cover.** Align the cover with the top of the interchangeable slit bay, using the reference photographs to match its orientation.
2. **Press the cover into place.** Press it gently and evenly onto the top of the bay until it sits snugly in place. The cover is held by friction; no screws are required.
3. **Check the fit.** Confirm that the cover sits evenly and securely on the bay, as shown in the completed reference view. Do not force it if it does not align correctly; lift it off and check its position before trying again.

No screws are used for this cover. It should fit snugly by friction alone. Do not add screws or force the cover into place.

Reference photographs



The interchangeable slit-bay cover before installation.



Front view of the slit-bay cover seated in place by friction.

10. Close the spectrometer enclosure

Once the internal components and the interchangeable slit-bay cover are in place, close the spectrometer body with the top lid. The lid is secured with four #8 screws.

Lid installation

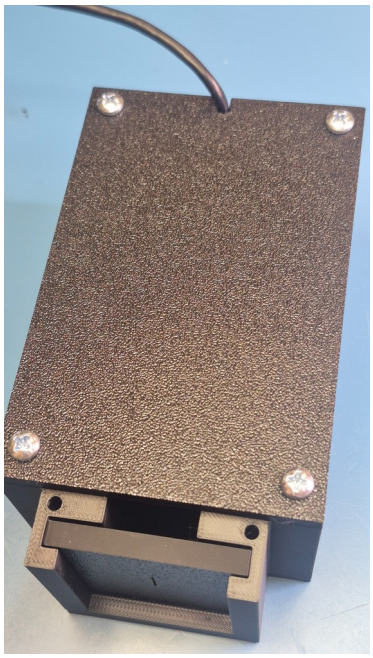
1. **Position the top lid.** Place the lid over the body enclosure and align it with the case edges. Check that the four lid holes line up with the corresponding mounting holes in the enclosure.
2. **Install the four screws.** Insert one #8 screw through each of the four holes in the lid. Start each screw carefully so it engages correctly.
3. **Tighten the screws.** Using a Phillips screwdriver, tighten the four screws evenly until the lid is seated against the enclosure. Do not overtighten; excessive force may damage the 3D-printed case or screw mounting points.

Do not overtighten. Tighten only enough to secure the lid firmly and close the enclosure. The screws do not need to be forced tight.

Reference photographs



Top lid positioned on the enclosure before the four screws are installed.



Completed enclosure with all four #8 lid screws installed.

11. Mechanical assembly checkpoint

The mechanical assembly described in this guide is now complete. Before moving on, check the following items:

- The sensor PCB is secured in its holder with all four #2-56 screw, lock-washer, washer, and nut sets.
- The USB cable is connected to the sensor PCB, with the red wire oriented as shown in the reference photograph.
- The sensor holder is attached to the case with the #4-32 screw and washer and remains at its temporary angle of approximately 45°.
- The supplied diffraction-grating assembly (standard slide-film or optional glass-mounted upgrade) is securely installed at its temporary angle of approximately 45°.
- The 1 mm slit plate is fully seated, with the shorter offset facing upward and the rectangular indent facing inward.
- The interchangeable slit-bay cover is seated by friction; no screws are used for this cover.
- The top lid is secured with all four #8 screws, tightened with a Phillips screwdriver without overtightening.

Optical alignment and focus are not covered in this stage.

The following work will be completed in a later calibration procedure using a suitable light source and the spectrometer software:

- Focus the sensor module.
- Align the sensor with the incoming light path.
- Align the diffraction grating with the sensor and the light path.
- Set and secure the final sensor and grating angles after the optical alignment is complete.

Important: The approximately 45° positions are temporary mechanical starting positions, not final optical settings. Do not treat the spectrometer as focused, aligned, or calibrated until the later light-source/software procedure is completed.

Part 2 – Calibration and Optical Alignment

This section begins the optical setup and calibration process. The first task is to open a live view from the sensor so the camera image can be monitored while the lens is focused. Sensor focus, alignment with the light path, and final grating alignment will be documented in the following steps.

1. Set up VLC for live camera viewing

VLC media player provides a live view from the spectrometer's USB camera, allowing you to see the sensor image while adjusting focus. VLC is free to download from the Microsoft Store.

1. **Connect the camera.** Plug the sensor module's USB cable into a USB port on your Windows computer.
2. **Open VLC.** Launch VLC media player on your Windows computer.
3. **Open the capture-device settings.** In VLC, select Media > Open Capture Device, then choose the Capture Device tab.
4. **Set the capture mode.** Set Capture mode to DirectShow.
5. **Select the camera.** Under Video device name, choose HD Camera, as shown in the screenshot. If your computer displays a different name, choose the video device corresponding to the spectrometer sensor.
6. **Set the audio device.** Leave Audio device name set to Default. The spectrometer does not use audio, so there is no need to change this setting.

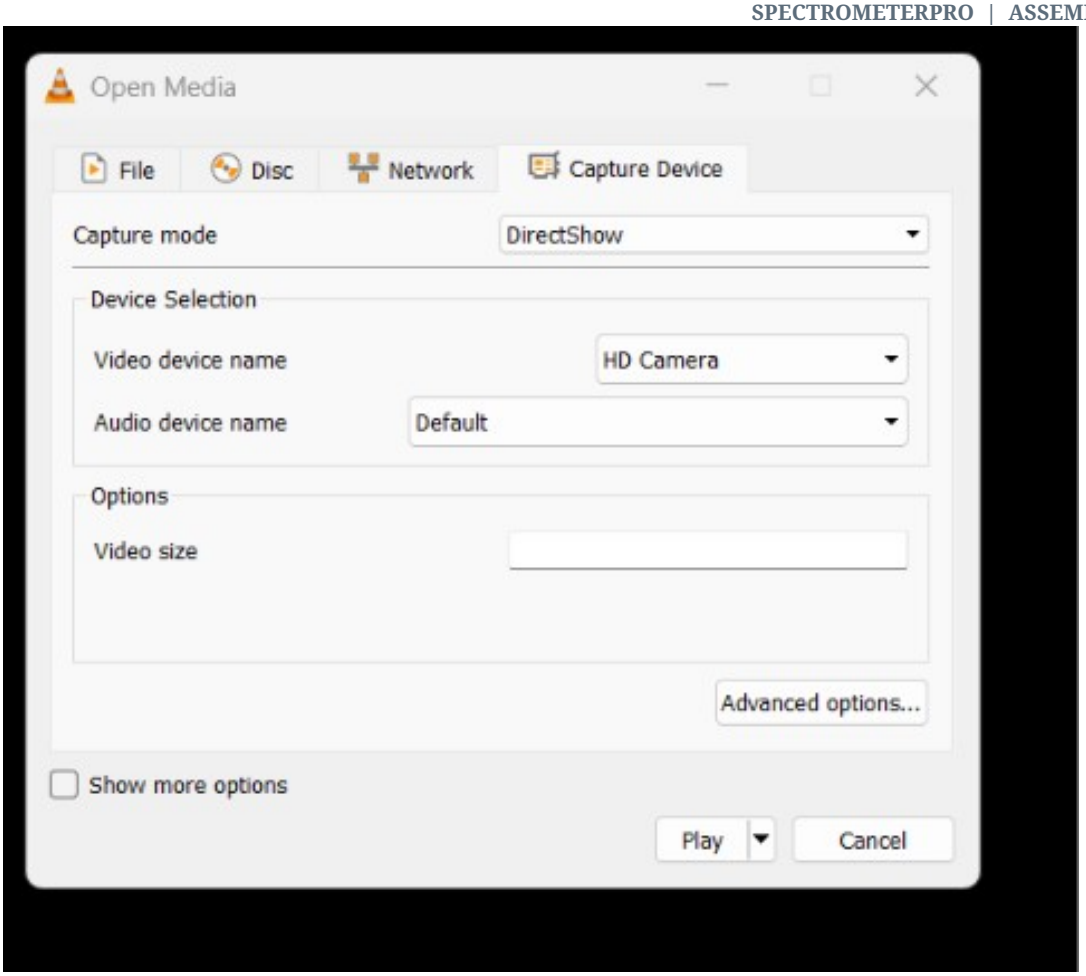


Figure 17. VLC Capture Device settings: DirectShow mode, HD Camera selected, and Audio device left at Default.

7. **Start the live preview.** Select Play at the bottom of the capture-device window. VLC should open a live view from the sensor camera. Keep this preview visible while adjusting the lens focus.

2. Focus the sensor lens

After the live camera preview is running in VLC, perform an initial, rough focus of the sensor lens. Keep the sensor assembly at its temporary mounting angle of approximately 45°. The goal at this stage is simply to make a target at the correct working distance reasonably clear; final fine focus will be performed after the diffraction-grating slide has been installed.

1. **Secure the sensor assembly.** Fasten the sensor assembly in the spectrometer case using its #4-32 mounting screw and washer. Set the assembly at approximately 45°, as described in the mechanical assembly section. This is a temporary position for focusing.
2. **Position a target.** Place a suitable target approximately 3 inches from the front of the sensor lens. In the reference view, the indicated corner is about 3 inches from the lens; any clearly visible target at roughly this distance is suitable for the initial focus. The diffraction-grating slide can also be used as a convenient target, as shown in the other reference view.
3. **Adjust the focus.** While watching the live image in VLC, slowly turn the focusing ring around the camera lens. Make small adjustments until the target appears reasonably clear and its

details are readable in the preview. This is only an initial focus; do not spend time trying to achieve the final sharpest focus yet.

4. **Check the result.** Confirm that the target is clear enough to see in the VLC preview. Leave the sensor assembly at its temporary angle and do not change the optical alignment during this step. After the diffraction-grating slide is installed, you will return to the lens and perform the final fine-focus adjustment.

Important: This is a preliminary focus only. Final fine focus will be completed after the grating slide is installed. Do not attempt to finalize the sensor-to-light-path alignment or the diffraction-grating angle yet; those adjustments will be covered in the later optical-alignment steps using a light source and software.



Figure 18. The indicated case corner is approximately 3 inches from the sensor lens and can be used as a distance reference when choosing an initial-focus target.



Figure 19. Example of using the diffraction-grating slide as a target while viewing the live image in VLC; final fine focus is performed after the slide is installed.

3. Position the grating slide and 1 mm slit plate

With the sensor's initial focus set, install the diffraction-grating slide assembly in the spectrometer case. Position the slide holder at approximately a 45-degree angle, as shown in the reference photograph. This is a preliminary position only; the final grating angle will be adjusted during optical alignment.

1. Secure the grating slide. Fasten the grating-slide holder to the case using its #4-32 screw and washer. Set the holder at approximately 45 degrees. Tighten the screw only enough to keep the holder in position; the angle must remain adjustable for the later alignment procedure.

2. Install the interchangeable slit plate. Insert the swappable 1 mm slit plate into the slit-plate bay. Follow the orientation described in the mechanical assembly section: the shorter offset faces upward, and the rectangular indent faces inward toward the inside of the enclosure. Make sure the plate is fully seated.



Figure 20. The grating-slide holder and sensor module positioned inside the case. Set the grating slide at approximately 45 degrees as a starting point; final alignment will be performed later.

4. Prepare the fluorescent light source and Theremino software

For the next calibration stage, use a fluorescent light as the light source. Have the Theremino application installed and ready on your Windows computer before proceeding.

1. Download Theremino. Obtain the Theremino application either from the SpectrometerPro website or from the official Theremino website. Use version 3.1 for the calibration procedure described in this manual.

2. Open Theremino. Start the Theremino application (version 3.1). The following calibration steps will use the application to view and adjust the spectrometer response.

3. Aim the slit toward the light source. With the 1 mm slit plate installed, point the slit directly toward the fluorescent light. Keep the top of the spectrometer enclosure open for now; this makes it easier to access the internal components during alignment.

4. Set the room lighting. A dimly lit room is preferred, but it is not essential at this stage. Because the enclosure is open, some stray light may enter the spectrometer. Minor light leakage is acceptable during this initial setup and does not need to be eliminated yet.

Note: Keep the grating-slide holder near its preliminary 45-degree position for now. The final sensor focus, sensor-to-light-path alignment, and grating angle will be adjusted in the following calibration steps using the fluorescent light source and Theremino software.

5. Check spectrum orientation and refine focus

Once Theremino is running and the spectrometer slit is aimed at the fluorescent light, a spectrum should appear in the video window. Because the enclosure top is still open, some stray light may be visible in the image. This is expected during the initial alignment and is not a problem at this stage.

Check the color orientation. The spectrum should run from blue on the left to red on the right. If the blue lines appear on the right and the red portion appears on the left, select the FLIP option in Theremino. The display should then match the orientation shown in Figure 21.

Locate the reference corner. In Figure 22, the blue circle marks the same inside corner of the spectrometer enclosure that was used earlier as the approximately 3-inch focusing target. Find this corner in the Theremino video image. It should appear in roughly the same position relative to the first blue line as shown in the reference image. Use this as a visual positioning reference.

Fine-adjust the lens focus. The initial focus should already be close. While watching the Theremino video window, make small adjustments to the focusing ring around the sensor lens. Aim for crisp, well-defined edges between the adjacent color bands, so the spectrum appears clearly focused rather than blurred or blended.

Keep the mechanical angles adjustable. Do not treat the current approximately 45-degree grating position as final. This step is for checking the spectrum orientation and refining the sensor-lens focus; any remaining sensor-to-light-path or final grating-angle adjustments will be covered in the following alignment steps.

Important: If the spectrum is reversed, correct it with FLIP before judging its position or focus. Do not try to correct reversed colors by rotating the sensor or grating holder.

PHOTO 21 - THEREMINO VIDEO WINDOW	PHOTO 22 - REFERENCE CORNER
Figure 21. Theremino video window showing the expected spectrum orientation: blue on the left and red on the right.	Figure 22. The circled enclosure corner is the same approximately 3-inch reference used for initial sensor focusing; compare its position with the first blue line.

Checkpoint: Continue only when the spectrum is displayed in the correct orientation and the color bands are reasonably sharp. Final optical alignment and wavelength calibration are not yet complete.

6. Adjust the spectrum sampling window

Once the sensor is focused and the colored spectral lines are reasonably sharp, adjust the orange selection window in Theremino. This window identifies the horizontal strip of the camera image that the software uses to calculate the spectrum displayed in the graph below.

1. **Adjust Start Y.** This setting moves the orange window up or down in the camera image. Change the value until the window is vertically centered over the row of spectral lines.
2. **Adjust Size Y.** This setting controls the vertical height of the orange window, measured in pixels. Set it wide enough vertically to include the spectral lines, but avoid including unnecessary areas above and below them.
3. **Center the window on the spectrum.** The orange window should run through the colored lines from blue to red. The spectrum graph below is generated from the image area inside this window, so its position and height affect the data Theremino reads.

Example settings: The reference screenshot shows Start Y = 31 and Size Y = 12. These are example values only; your best settings may be different depending on the camera image and the position of the spectrum.

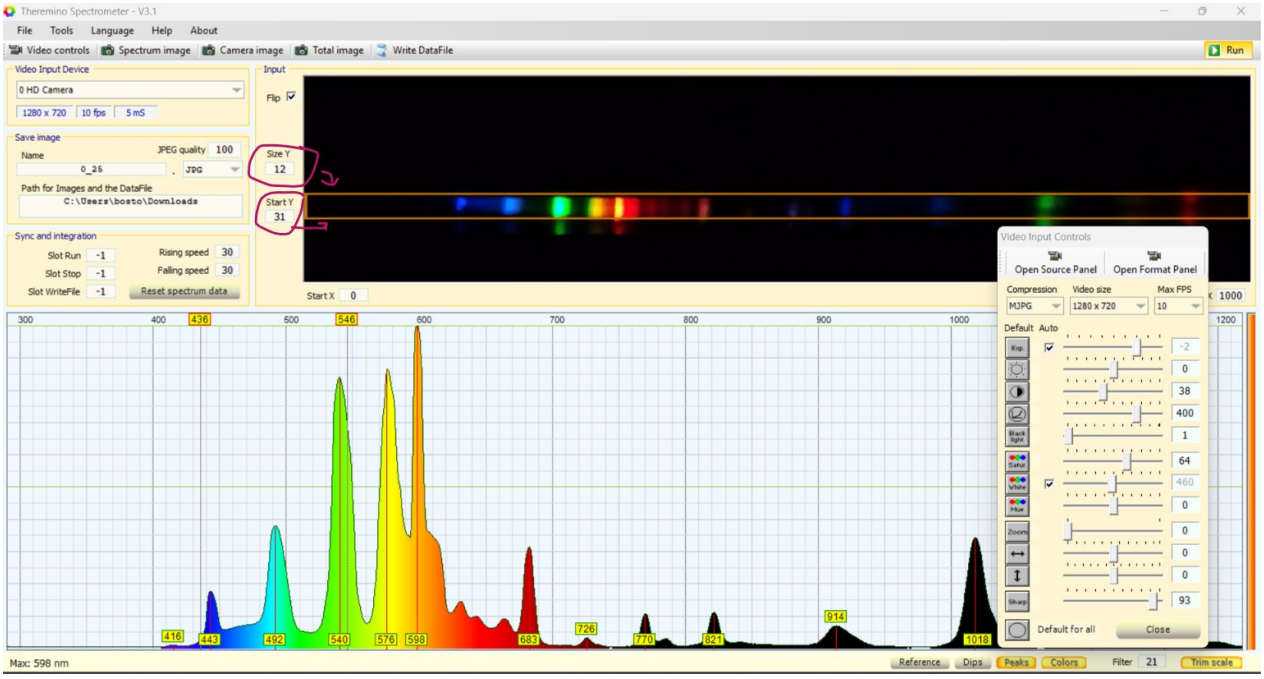


Figure 23. Theremino spectrum selection window. Start Y moves the window vertically; Size Y sets its height in pixels. Center the orange window over the spectral lines.

Check before continuing: Confirm that the orange window is centered over the colored spectral lines and that the spectrum graph below displays the expected colored peaks. Fine alignment of the sensor and grating will be covered in the next calibration steps.

7. Match the wavelength reference markers to the mercury emission lines

After centering the orange sampling window over the spectrum, set the two wavelength reference points using Theremino's fluorescent-lamp preset. This preset uses two well-known mercury emission lines commonly seen in fluorescent lamps: 436 nm (blue-violet) and 546 nm (green).

1. **Load the fluorescent reference points.** In Theremino, open Tools > Trim points > Fluorescent 436 546. The software will display two wavelength reference markers, labeled 436 and 546, on the spectrum graph.
2. **Align the 436 nm marker.** Use the mouse to drag the 436 nm reference marker horizontally until its vertical guide line coincides with the blue-violet spectral peak.
3. **Align the 546 nm marker.** Drag the 546 nm reference marker horizontally until its vertical guide line coincides with the green spectral peak. Make sure each marker is matched to the correct peak; do not swap them.

Reference note: The values 436 nm and 546 nm are wavelengths, measured in nanometers (nm), rather than frequencies.

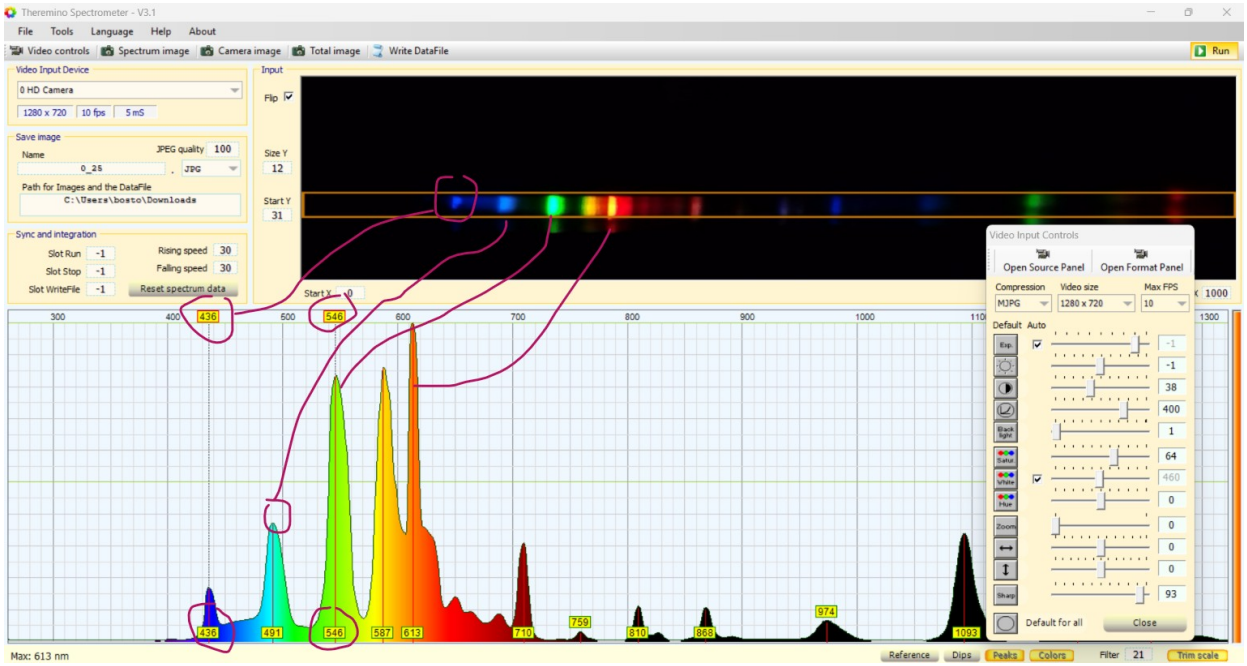


Figure 24. Theremino wavelength-reference markers at 436 nm and 546 nm. Drag each marker horizontally to align it with the corresponding blue-violet or green mercury emission peak.

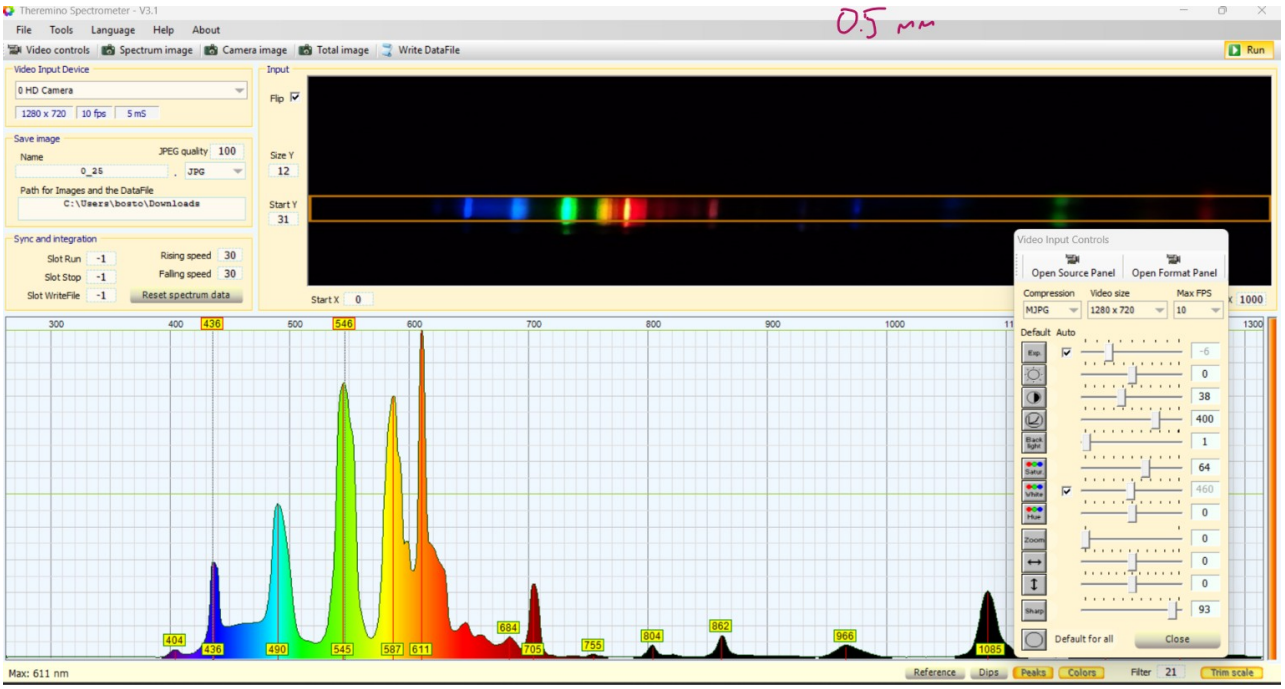
Check before continuing: Confirm that the 436 nm marker is aligned with the blue-violet peak and the 546 nm marker is aligned with the green peak. These reference points establish the fluorescent-lamp wavelength calibration for the next adjustment steps.

8. Optimize the spectrum using the 0.5 mm slit plate

After the wavelength reference markers have been aligned, replace the 1 mm slit plate with the interchangeable 0.5 mm slit plate. The narrower slit improves spectral resolution and helps separate nearby emission lines. Aim the slit at the fluorescent light source as before.

The spectrum should now show narrower, more clearly separated peaks. Depending on the camera exposure and video settings, however, the brightest peaks may still appear overly intense or run together. The video controls can be adjusted to make the individual spectral features easier to distinguish.

Figure 25. Example spectrum with the 0.5 mm slit plate installed, before the final video-control adjustments.



9. Adjust the camera video controls

In Theremino, click Video controls at the upper-left of the window to open the Video Input Controls panel. Use the controls below to reduce excessive peak intensity and improve the definition of the spectral lines.

1. **Disable automatic exposure.** In the Exposure (Exp.) row, clear the Auto checkbox so that exposure can be set manually.
2. **Set exposure.** Move the Exposure slider until its displayed value is −2.
3. **Set brightness.** Set Brightness to 0.
4. **Set contrast.** Increase Contrast to 45.
5. **Set saturation.** Reduce Saturation to 43.

The screenshots show the spectrum before and after these adjustments. The final result should have distinct, well-separated spectral peaks with clearly defined edges and without excessive brightness obscuring the peak shapes. The numerical settings above are the recommended starting settings shown for this setup.

Figure 26. Final Theremino video-control settings and the resulting spectrum with the 0.5 mm slit plate.



Calibration complete. The spectrometer is now calibrated and ready for use. Close the Video Input Controls panel when finished. The top cover can be installed for normal operation.

Optional display setting. You may also reduce Saturation all the way to 0. This changes the video image to black and white and reduces visual noise, making the spectral peaks easier to inspect. That is perfectly acceptable after calibration is complete, because display colors are no longer needed for the calibrated spectral analysis.