Filter Drawer
FD 900 M87 / FD 860 M87

User Manual
rev. 2022-07-29

ASTRODEVICE

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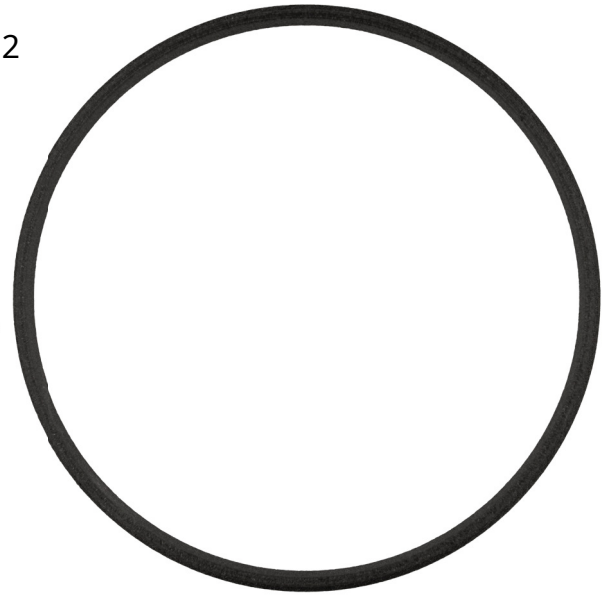

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Package contents:

1. Main body of the filter drawer
2. Side blinder
3. Filter sliders for 2” filters (2x)
4. Blind filter
5. Magnetic key
6. Calibration screws

First read the entire manual and make sure that everything is clear to you.
Only then start assembling the drawer.
If you have any questions, please contact Astrodevice.

Introduction

The filter drawer (fig. 1) is designed to work with Celestron RASA 8 telescope and ZWO ASI Pro cameras having 17.5 mm backfocus and 90 mm or 86 mm diameter*. Its installation requires unscrewing the original metal tilt plate from camera and unscrewing front glass window from the telescope.

Backfocus

The drawer has its own built-in backfocus adjustment mechanism (B1-B5). It consists of five pairs of threaded pins. Each pair surrounds one screw with which the drawer is mounted to the camera. Precise unscrewing of each pair of pins to an appropriate distance makes it possible to set a very precise, equal distance, with hundredths of a millimetre accuracy, between the top plane of the drawer (that is the one adjacent to the telescope) and the bottom plane adjacent to the camera. This resembles the tilt adjustment mechanism, but intentionally the backfocus adjustment has been separated and the tilt is adjusted with separate screws. This way you can set the base equal backfocus and then, without changint it, adjust tilt additionally.

With this mechanism, the drawer has been factory calibrated to 28.73 mm backfocus. If you follow all the instructions outlined here, there is a good chance that you will not need to adjust it.

So please **DO NOT change the position of (B1-B5) screw pairs without a clear need** - you could completely unbalance the factory calibration of the drawer. First install the drawer according to all instructions, check the result and only then

* FD 900 M87 drawer works with ASI 2600 MM/MC Pro, ASI 2400 MM/MC Pro and ASI 6200 MM/MC Pro. FD 860 M87 drawer works with ASI 071 MC Pro.

assess whether it is necessary to change the position of the calibration screws.

However if you ever need to change the position of these screws, read the further sections of this manual - there is a separate section with instructions on how to handle backfocus calibration.

Tilt adjustment

As mentioned above, the drawer is equipped with a separate tilt adjustment mechanism. It consists of three threaded pins (T1-T3) operating similarly to the original metal camera plate. The adjustment access to these bolts is possible from the top, through three holes (hT1-hT3).

Installation

The drawer is integrated with a large nut (N) for mounting the device on the telescope. Holes (hS1-hS5) have been provided in the inner part of the nut, to allow access to the mounting screws (S1-S5).

If you look at the drawer from the top, you can see that both the main part of the drawer and the rotating nut have semi-circular cutouts that allow access to the (hS1-hS5) and (hT1-hT3) screws. When you rotate the nut, obviously, its top-visible cutouts rotate with it. There is ONLY ONE reciprocal position for the nut and the main part of the drawer, where all the bolts are visible from the top. If you can’t see any of the bolts, keep turning the nut until you get to a position where all the bolts are accessible at the same time.

Note: You may encounter a situation where you cannot turn the nut. Clearly something will be blocking the rotation. The cause will be one or more of the screws protruding upwards - most likely one of (hS1-hS5) in a situation where you have not yet tightened the drawer to the camera. Just screw the screws in deeper and the problem will go away.

Magnets

In the inner part of the drawer there are small magnets that allow you to keep the filter sliders and blind filter in place. These accessories are also equipped with magnets.

Additional accessories

Filter sliders allow you to place 2” size mounted astrophotographic filters in them.

The blind filter allows you to expose dark frames without taking the camera away from the telescope.

The included side blinder allows you to cover the connection between the drawer and the camera and consequently prevent false sidelight from reaching the sensor.

The magnetic key allows you to easily get the filter slider or blind filter out of the drawer. Simply place the key against the front of the accessory and pull outward.

Usage

The device is designed to work in conditions of 0-40 degrees Celsius (32°F - 104°F).

High temperatures

Although PET-G is relatively robust, too high a temperature can lead to deformations. If you don’t even notice them, the micro structural changes can cause the device to become uncalibrated. Therefore, do not store or use the drawer at high temperatures. Adopt the rule of thumb that if it’s too hot for you, so is for the drawer.

Low temperatures

Our accessories have been successfully tested in temperatures as low as -20 degrees Celsius (-4°F). Although the use of the device in freezing temperatures is technically possible, there is a risk associated with the phenomenon of ice condensation. If water freezes in the crevices of the structure, ice can damage the accessory and lead to its destruction. Therefore, if you intend to use the drawer in freezing weather at your own risk, make sure that the environment is dry.

Under all conditions, work with the device should be personally supervised. Before use, make sure that the accessories and their threads are not damaged and that they are securely mounted. Never use a defective device.

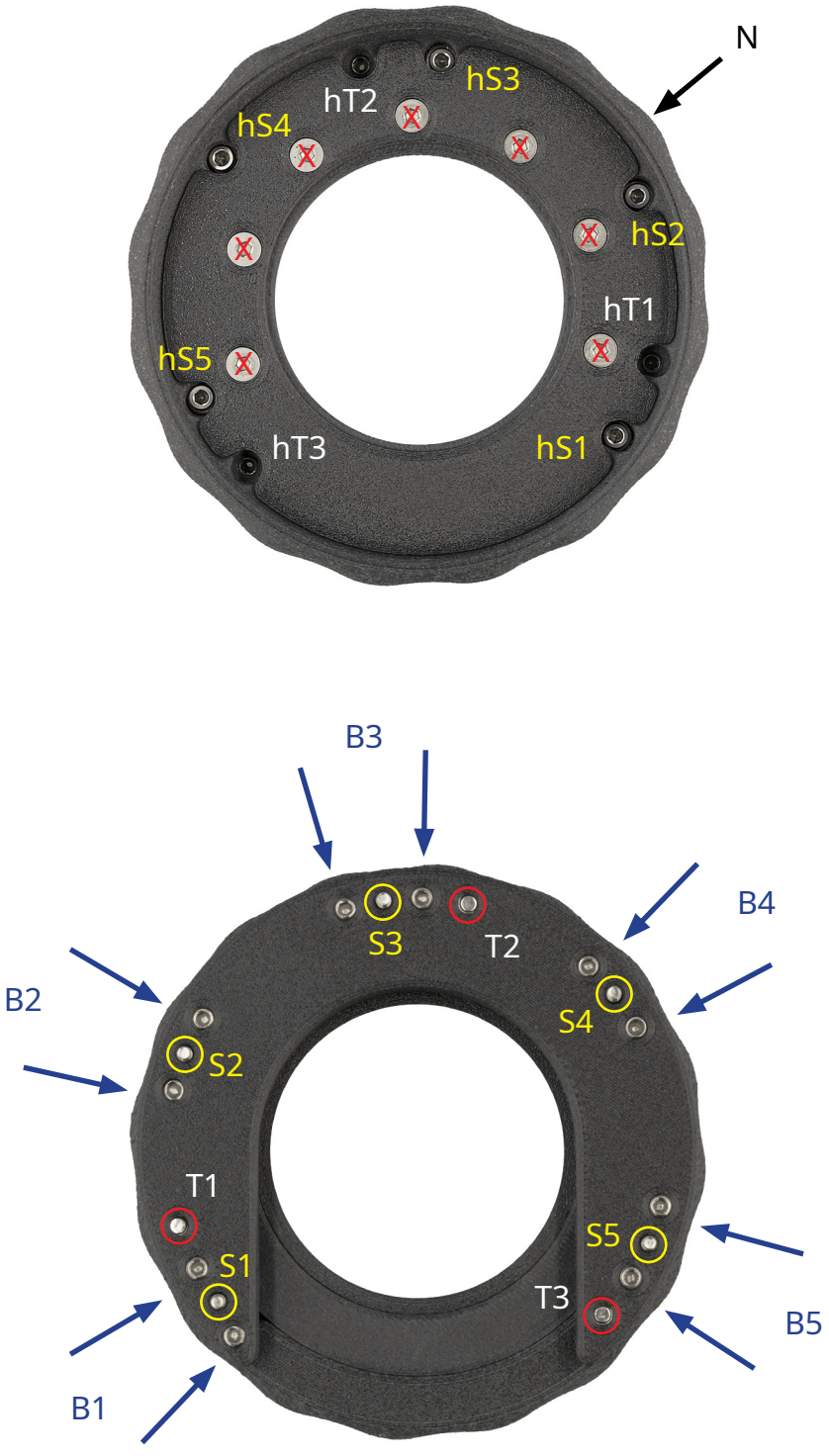

N
hS3
hT2
hS4
hS2
hT1
hS5
hT3
hS1
B3
B4
B2
S3
T2
S4
S2
T1
S5
S1
T3
B5
B1

fig. 1

Technology

The drawer was made with 3D printing technology using carbon fiber reinforced PET-G plastic. Refinement with this material significantly strengthens the construction and on the outside it manifests itself with a characteristic, slightly rough texture. The device also contains 7 construction screws (marked on fig. 1 with x) that MUST NOT be unscrewed. Unscrewing will lead to irreversible destruction of the drawer.

Some parts of the drawer are quite delicate, especially the filter slider edges and threads. Handle them gently and never tighten anything by force.

Setting up a telescope

1. **Remove the glass window from the front of the telescope.**

   See fig. 2.

The glass window affects the effective optical path length and it must not be used together with other filters.

2. **Make sure all screws visible in the front metal plane of the telescope stays back, that they do not protrude forward the surface.**

   See (fig. 2, yellow arrows).

The large nut integrated in the filter drawer fits tightly into the metal plane of the front of the telescope and, when tightened, must not press against any protruding part: screw, glass window or anything else. That's why ***glass window MUST BE UNSCREWED****. If anything were to stick out of the front plane, after the drawer is screwed on, the sensor backfocus would be incorrect, the image would be distorted and the* ***pressure caused by the tightening the nut could destroy the telescope****.*

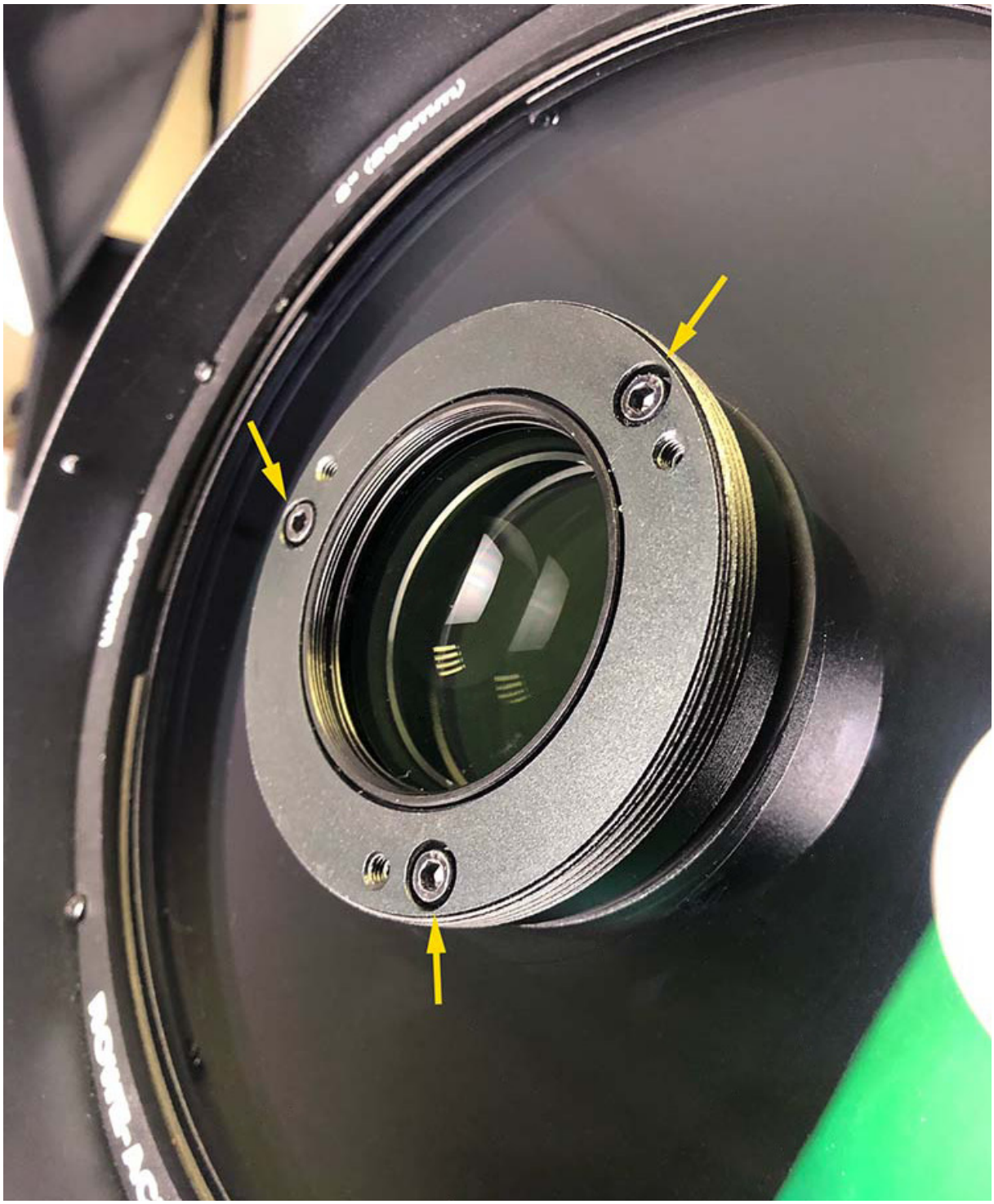


fig. 2

Installing the filter drawer

1. **Place the camera on a flat table with the tilt plate facing up.**

   See fig. 3.

2. **Remove the three screws holding the tilt plate.**

   Use 2 mm hex wrench, like the one provided with camera. See fig. 4.

3. **Remove the tilt plate.**

   Be careful, as tiny screws may fall. Secure them after removal so that they are not lost. See fig. 5.

4. **Place the filter drawer on the camera.**

   Direct the notch for the filter slider that it faces “up” direction. (fig. 6, compare arrow direction and position of small black silicone cap on camera). Imagine that the telescope is parked and the counterweight is pointing down. The camera is mounted so that the sensor is in the horizontal position. Then the drawer slot should be at the top.

The camera is heavy and the RASA telescope is very sensitive to sensor tilt. At the same time, the filter drawer has a cut-out for the filter slider and at the point of the cut-out, it cannot support the camera in case of micro-fall. Thus, the filter drawer should be placed so that, when it is attached to the telescope, there is always a solid part of the filter drawer rim at the bottom of the camera. For this reason, the drawer slot should be at the top. Then, even when the camera is rotated 90 degrees to a vertical frame, there will still be solid support at the bottom of the camera.

The drawer should be placed over the longer edge of the sensor to minimize the effect of the asymmetry of its shape on the image. This influence is greater the further away from the center of the frame, so where the drawer is inserted, the sensor should have its shorter axis (its longer edge should run across it).

5. **Tighten the drawer using holes on the inside of the telescope nut**.

   See fig.1, hS1-hS5 and fig. 7.

   Tighten it as far as it will go, but do not force it. First, tighten all the bolts gently so that the entire clamp sits evenly on the camera. Then tighten the bolts, trying to choose opposite ones alternately. On both sides of each screw you tighten, there are tilt adjustment screws on which the band rests against the camera. This way the clamp will not bend when you tighten it, but will reach the maximum limit set by the side metal tilt adjustment screws.

6. **Screw the camera with the mounted drawer onto the telescope.**

   Tighten it to the first stop, but do not force it. Tightening too much will compress the material, change the spatial shape of the optical path and adversely affect the image quality. The camera should be tightened without any play, as far as it will go, but in such a way that it can still be rotated with a quite low force.

7. **Screw the filter into the slider.**

   Hold the slider flat in one hand and put the filter on it. Gently start screwing. The filter should catch the thread under its own weight or just a very minimal press. There is no need to press down too hard.

All threads were tested before shipment. The device was screwed onto the telescope and three different filters were mounted to each of the filter sliders in turn. Testing filters were made by three different manufacturers using three different models of filter enclosures.

The fine threads made with 3D printing technology require a lot of delicacy and caution when screwing in the filter, so never tighten anything by force. If you can't screw the filter in, turn it back and try again until the thread catch the filter and allows gentle advancement. Once you have screwed the filter in, never force it all the way in. Be gentle.

8. **Insert the filter slider into the main body of the drawer.**

   The slider is symmetrical in the sense that you can insert it either side - with the thread towards the camera or vice versa. Due to the small amount of space, it may be difficult to get the slider out with bare hands. With the help of a magnetic key, however, you can easily deal with this. Just put the key against the protruding part of the drawer and pull outward (fig. 8). Alternatively, you can use a hex key. Insert it into the specially designed cut-out and pull the slider out of the drawer (fig. 9). Experience has shown that it is much easier to attach the slider and slide it out when the notch is facing the camera side and not the telescope side.

9. **Put on the band that protects the sensor from sidelight.**

   When taking pictures, the band should cover the filter drawer (fig. 10).
   To remove the filter slider, slide the band back.
   Finally, connect all the cables to the camera.

   That is all, you are now ready to take pictures.

fig. 3

fig. 4

fig. 5

fig. 6

fig. 7

fig. 8

fig. 9

fig. 10

Using front filter

The drawer allows to screw in an additional 2” filter on the front. Apart from the many possibilities offered by combining different filters at the same time, this solution is primarily intended to enable optical adjustment of the effective backfocus. The 28.73 mm backfocus recommended for RASA 8 works best with a narrowband filter. If you attach a broadband filter to the slider, the effective optical length may become slightly shorter. If you observe such an effect, you can screw in an additional UV/IR filter at the front, which works similarly to the original glass window that you have to unscrew from the telescope when using the slider. In this way you add an additional optical medium which extends the effective backfocus.

For more on the backfocus topic, see:

https://astrodevice.com/backfocus-and-tilt-general-discussion/

Backfocus calibration

In the case of the Celestron RASA 8 telescope, the effect visible in the pictures strongly depends on how parallel the sensor plane is to the front plane of the telescope. If the camera is not perfectly parallel, optical distortion is visible in the images. Stars in the corners are no longer point-like, their shape becomes egg-shaped. If in each corner the distortion is identical - the problem is most likely a matter of incorrectly set backfocus, but when in different corners the problem is of different magnitude - we most likely have to do with tilt. Most often the cause lies in the accessories connecting the telescope with the camera. Every production technology is subject to tolerance error and any assymetrical deviation from the assumed dimensions can cause tilt. Especially if the thickness of the accessory measured in different places of the circumference is even minimally different.

For more information on this topic, see:

https://astrodevice.com/backfocus-and-tilt-general-discussion/
https://astrodevice.com/filter-drawers-and-adapters-results-and-experiments/
https://astrodevice.com/troubleshooting/

For the reasons described above, it is extremely important to make sure that the front and back surfaces of the drawer are perfectly parallel to each other. To make this possible, Astrodevice drawers have an adjustment mechanism that allows precise calibration to the nearest hundredth of a millimeter.

To understand how the caclibration works, first of all note that the expected thickness of the drawer, from the plane that adjoins the camera to the plane that adjoins the telescope, should be 16.23 mm. With the original metal tilt plate removed from the camera having a thickness of 5.00 mm, the camera backfocus is 12.50 mm. Adding the 12.50 mm of camera backfocus to the 16.23 mm thickness of the drawer, we get the expected 28.73 mm. This is the distance the camera sensor will be from the front plane of the telescope.

In order to make the adjustment possible, the thickness of the drawer is

intentionally decreased by a few tenths of a millimeter and these missing few tenths are compensated by extending the pairs of screws (B1-B5) visible in fig. 1. Theoretically three screws would be enough as three support points, but when creating the Astrodevice drawer we decided to place as many as 10 screws - two on each side of each screw used for mounting the drawer to the camera. On the one hand, this averages out the calibration error that occurs when setting each screw and on the other hand, it provides solid support for each of the mounting screws.

The calibration consists in unscrewing each of the screws (B1-B5) in such a way that from its extended end to the top surface of the drawer the thickness is exactly 16.23 mm.

The measurement task is made more difficult by a large nut protruding upwards. It blocks access to the top surface of the drawer from the side. It is therefore not possible to easily use a caliper to measure the thickness and measuring with a micrometer screw is also difficult because of this. To solve this problem, special screws, supplied with the drawer, are used for calibration. Their length has been factory set using a micrometer. The length of the short screws is 16.77 mm and the length of the long screw is 33.00 mm. The idea behind the calibration is to place the short screws around the circumference on the top plane of the drawer and measure with the long screw if the distance between the bottom plane and the plane defined by the top screws is exactly 33.00 mm. We want this because the expected drawer thickness (16.23 mm) and the length of the short screws (16.77 mm) together should add up to the above value.

To perform the calibration you need to get two rigid planes. Their surfaces should be smooth and even and their thickness should be uniform. For example, two sheets of thick glass 10-20 cm wide. For convenience, we will refer to these surfaces as *glass plates* in the following description.

The initial calibration should be done first, and the calibration must be refined in subsequent steps.

Step 1 - Prepare the drawer

A. Look at fig. 1. Remove the mounting screws used to tighten the camera (S1-S5) from the drawer through the holes (hS1-hS5).

B. Screw the bolts used for tilting adjustment (T1-T3) inside the drawer. During calibration, these bolts must not extend beyond the bottom surface of the drawer.

C. Screw into the drawer the calibration screw pairs B2 and B4 and ONE screw each of B1, B3 and B5.

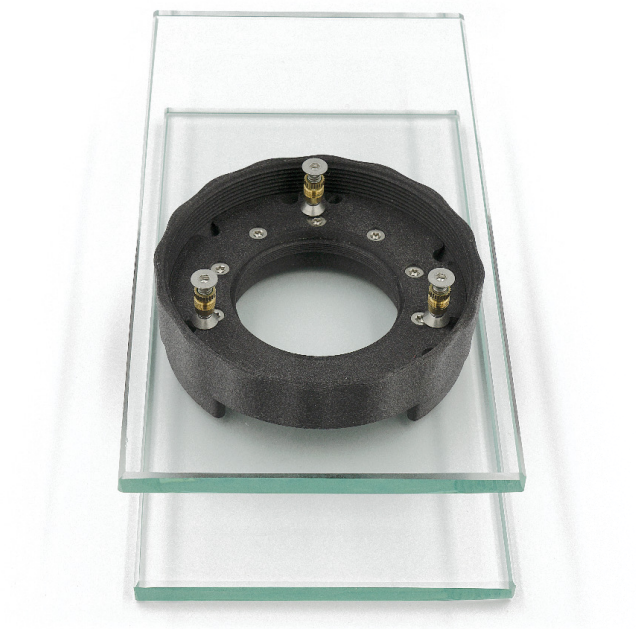
After the operation, only the screws marked in green in the figure below should protrude from the bottom surface of the drawer.

Step 2 - Preparing for measurement

A. Place the first glass plate on the table and place the drawer in the center of the plate.

B. Position three short screws around the circumference of the top surface of the drawer, spacing them evenly, every 120 degrees.

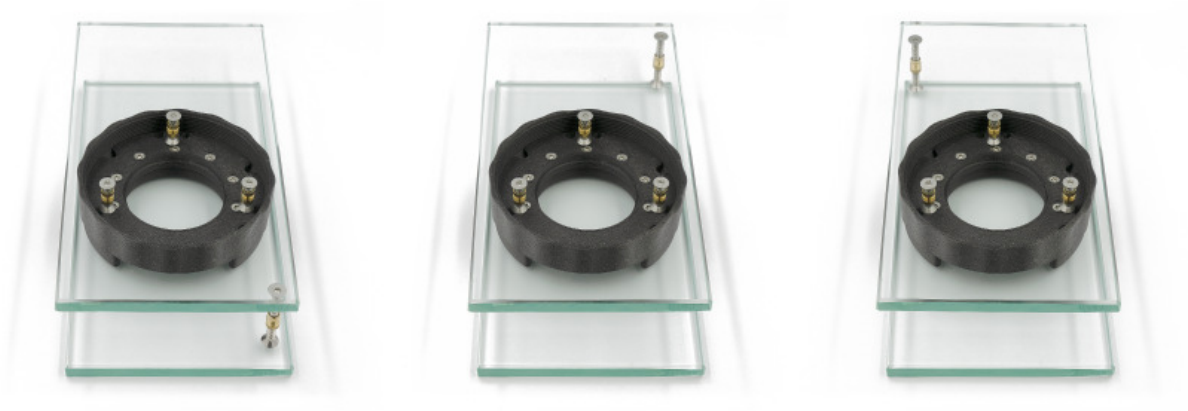
C. Place the second glass plate on top of the short screws.



Step 3 - Initial Calibration

Insert the long screw between the plates, startin in the first corer.

Repeat at each corner of the plate.



The screw should fit in the same way everywhere - neither too loose (once inserted you should not be able to tilt or rock it) nor too tight, by force. If the distance between the plates is right - the screw should slide in with a feeling of very minimal friction.

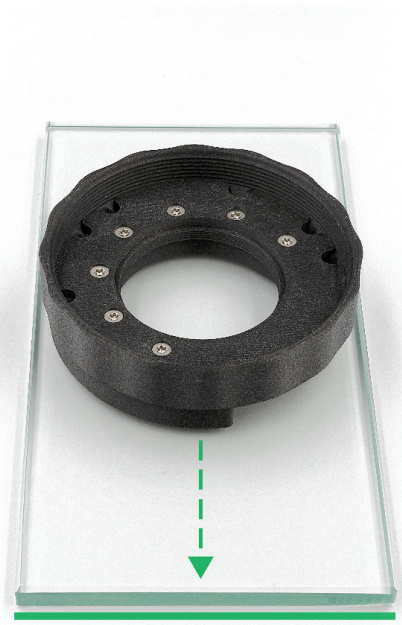
If in any corner the screw is too tight or too loose, remove the top glass plate, remove the short screws, screw in or out one of the protruding screws (the one closest to where the height is incorrect) and repeat the measurement (steps 2B, 2C, 3A).

Repeat this procedure until the long screw slides in everywhere in a similar manner.

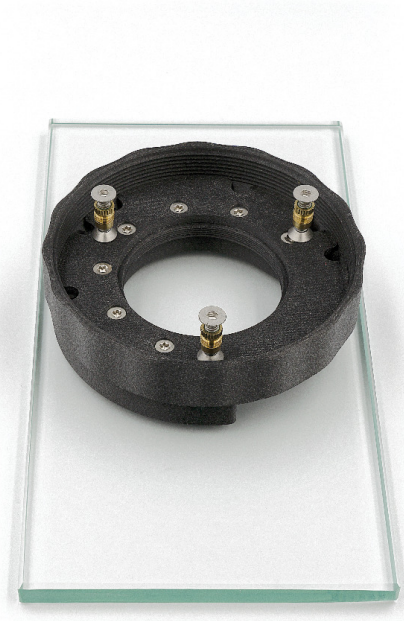
Step 4 - Fine Calibration

The procedure described in Step 3 provides the relatively parallel surfaces needed to facilitate further fine-tuning. Unfortunately, it is not sufficient on its own because of the error that dimensional imperfections in the glass plates themselves can introduce into the measurement. There is no guarantee that they have equal thickness everywhere and are ideally flat, and a deviation of a tenth of a millimeter matters a lot. Therefore, in order to minimize the error introduced by the plates, in the following part the measurements will be made in one and always in the same place. For each adjusting screw, measurements will be taken separately.

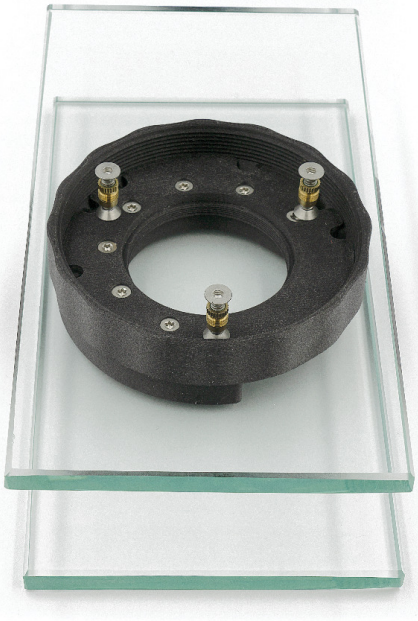
A. Place the first glass plate on the table and place the drawer in the center of the plate so that the first screw is pointing toward the selected edge of the plate.



B. Position three short screws around the circumference of the top surface of the drawer, spacing them evenly, every 120 degrees.



C. Place the second glass plate on the short screws.

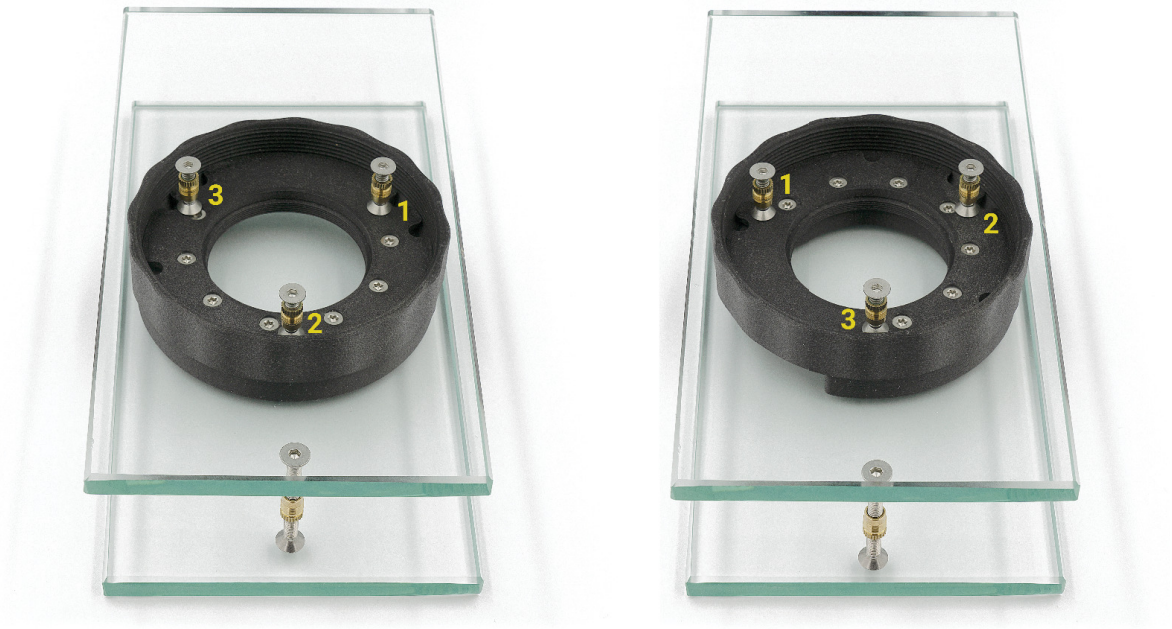


D. Insert the long screw between the plates, with the edge toward which the first bolt is pointing.

If the long screw enters too tightly or too loosely, remove the top plate, remove the short screws, screw in or out the protruding adjustment screw, and repeat steps B, C, and D until the long screw slides in with barely perceptible friction.

E. Repeat the whole procedure described in points A, B, C, D for the other two screws. To do this, after calibrating a given screw, you will have to rotate the drawer by an angle of 120 degrees so that the next screw is in place of the one previously measured.

With each step, make sure that both the drawer is always in the same place on the plate and the long screw is measured approximately in the same place. Keeping the same measurement parameters will minimize the error due to possible unevenness of the glass surface.

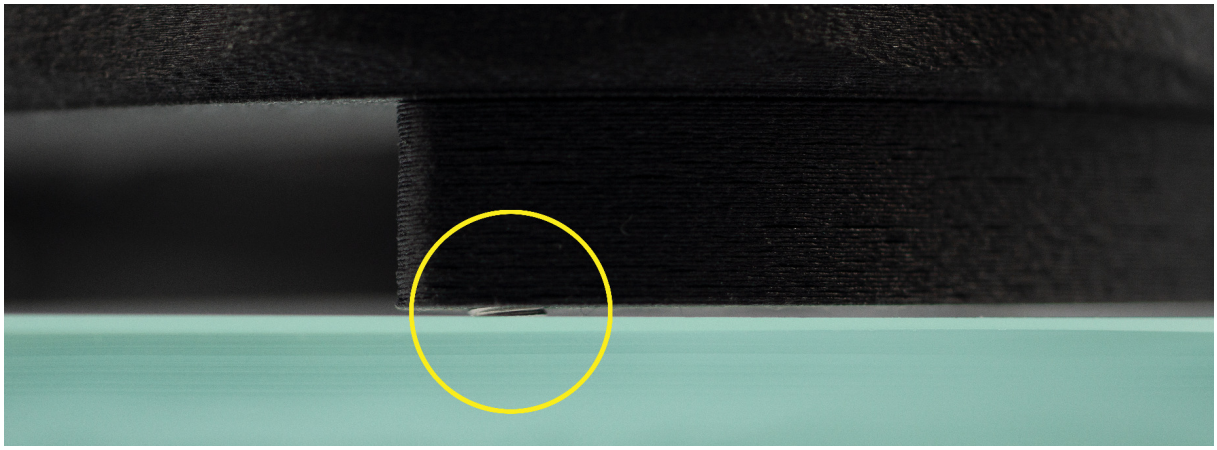


Step 5 - Tuning adjacent screws

Once you have the three main bolts out to the correct distance, align the bolts adjacent to them, which are the second of each pair.

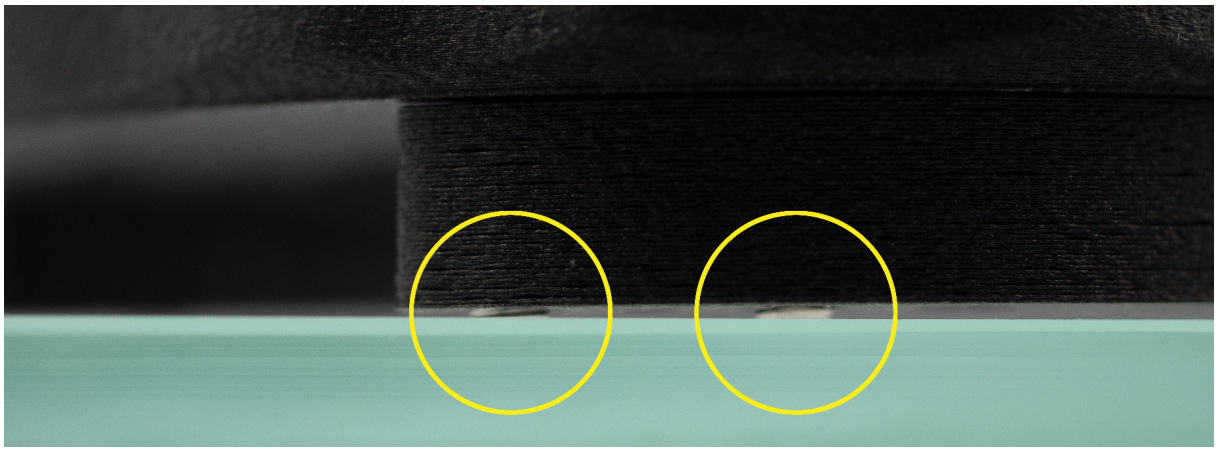
A. Place the first glass plate on the table and place the drawer in the center of the plate so that the first screw is pointing toward the edge of the plate.

B. Lift the glass plate with the drawer to eye level and look under the light. In the narrow gap between the drawer and the plate, you should see the extended screw that the drawer is supported by. You cannot yet see the adjacent screw because it is still screwed inside the drawer.



C. Remove the drawer from the plate and start adjusting the adjacent screw so it protrudes.

E. Repeat A, B and C until the second screw touches the plate.



Now repeat the procedure in step 4 making sure that still this pair of screws (now together) provides the correct height.

F. Repeat the above steps for the remaining two screws.

Step 6 - Tuning of screws S2 and S4

This step is similar to the previous step, but you need to tune-up both screws from pairs S2 and S4. Do this for each screw separately: First adjust the first screw of pair S4, then check its height according to the procedure in step 4, then adjust the second screw of pair S4, then the first screw of pair S5 and then the second screw of pair S5.

Finally, repeat the procedure described in step 4, checking each pair of screws in turn, to finally make sure that the height is the same at every point.

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