SUNDANCER II

Manual
and Application Tipps

Thank you for your purchase of the Baader SunDancer II H-alpha filter! It is a high quality product for solar observation. When observing the sun, always exercise due caution and follow the safety instructions.

For best results, we recommend that you spend a few minutes reading this manual before using the SunDancer II.




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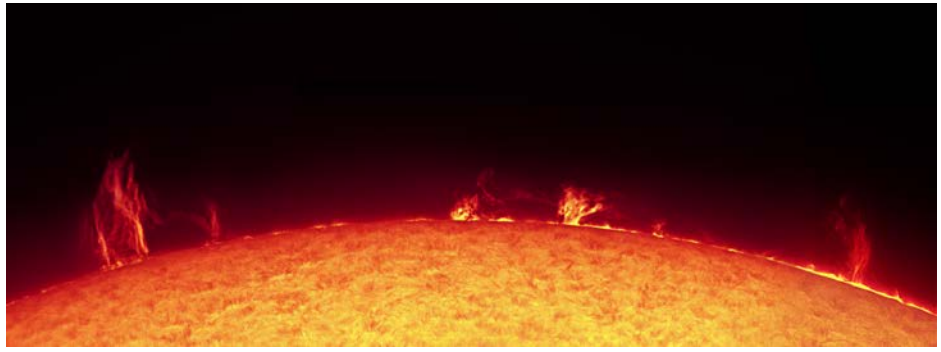
Baader SunDancer II H-Alpha-Filter

Congratulations on your purchase of the SunDancer II from Baader Planetarium.
It is a compact H-alpha filter that integrates a 3x telecentric system, a blocking filter and a heated H-alpha etalon from SolarSpectrum in two separable housings. It has been designed with safety and ease of use in mind, combined with an extremely age-resistant construction and a high-quality filter. The most important features are:

- H-alpha filter with a half-width (FWHM) of 0.6±0.1Å at an effective focal ratio of f/30; shows prominences and solar surface details.
- Integrated 3x telecentric system with 2nm Half-Bandwidth (FWHM) blocking filter. The TZ3-system is suitable up to 35 mm field of view without vignetting. Optimal for telescopes with f/10, recommended up to about f/8 and usable up to about f/6.5. On optics faster than f/10, the FWHM (Full Width at Half Maximum) increases
- Easy change of the transmission line by turning the micrometer screw to observe fast solar events in the blue wing of the H-alpha line (Doppler shift)
- Resistant to ageing: The dielectric coating of the blocking filter (instead of the usual silver coating) and the airtight storage of the Etalon filter in oil prevent the ageing processes of simpler filter designs. With proper treatment, the filter will retain its performance for many years
- 25 mm Etalon from SolarSpectrum – with 23 mm aperture behind 19 mm aperture baffle
- Removable focusable 1¼" eyepiece clamp and T-2 thread for connecting cameras
- On telescopes with up to 80 mm aperture and a focal ratio of f/8 or slower, it can be operated without an additional D-ERF energy protection filter in front of the objective – tested for 10 hours on the Baader-Apo 95 at f/6.1
- Electrical temperature control: the filter automatically heats up to its optimum operating temperature as soon as it is connected to the power supply
- Low power consumption: Via the supplied main adapter or, in mobile use, via an optional rechargeable battery pack
- Wide operating temperature range: -10 to +40° C; storage temperature not below 0° C



All in one!

An H-alpha filter system consists of several elements:

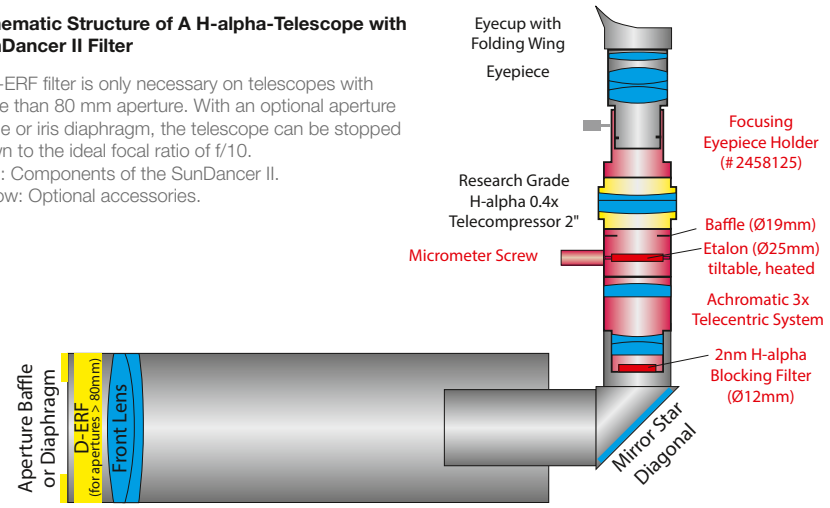
- The **etalon filter** is the actual H-alpha filter. As an interference filter, it cancels out all wavelengths except the H-alpha line. Its filter effect depends on the filter thickness and is automatically controlled by the temperature control.
- The **telecentric system** provides the parallel beam of light path which is necessary for the etalon to function properly. A Barlow lens or even a telescope with f/30 provides the necessary focal ratio, but *not* the necessary parallel beam of light.
- The **blocking filter** reflects the incident sunlight just in front of the etalon and the telecentric. This protects the etalon from excessive heat. In addition, an etalon also transmits wavelengths that are many times the desired transmission line; these are also blocked by the blocking filter.
- The **D-ERF energy rejection filter** is mounted in front of the telescope and protects the filter system from unnecessary solar energy by allowing only red light to pass.

SunDancer II at a telescope with mirror star diagonal.
Hand control and power supply are stored in the yellow bag.

With the SunDancer II, the etalon, telecentric system and blocking filter form one unit; on telescopes with a maximum aperture of up to 80 mm, the energy protection filter can be omitted if necessary (see chapter "Choosing a Dielectric Energie Rejection Filter"). The result: easier handling and lower entry costs!

Schematic Structure of A H-alpha-Telescope with SunDancer II Filter

A D-ERF filter is only necessary on telescopes with more than 80 mm aperture. With an optional aperture baffle or iris diaphragm, the telescope can be stopped down to the ideal focal ratio of f/10.
Red: Components of the SunDancer II.
Yellow: Optional accessories.



Scope of Delivery

of the SunDancer II

1. SunDancer II H-alpha-filter unit comprising the blocking filter, 3x telecentric system and focusing eyepiece holder *# 2458125*
2. Temperature control box (hand control)
3. Power supply (with international adapters)
4. Carrying case
5. Baader Utility Bag *# 2954201*

Preparations

Choosing a Dielectric Energy Rejection Filter

A Dielectric Energy Reflection Filter (D-ERF) is used to protect the actual H-alpha filter from the intense solar energy. In principle, it is a plano-optically polished filter that only allows red light in the vicinity of the H-alpha line to pass and thus ensures that the actual H-alpha filter does not become too hot. It does not have to be as narrow-banded as the actual H-alpha filter; however, the same demands are made on its surface accuracy as on the telescope objective. A white-light solar filter (e.g. made of AstroSolar film) cannot be used for this purpose because it also darkens the H-alpha line, which is weaker than the rest of the solar radiation.

Energy protection filters up to 180 mm aperture can individually made for your telescope, if necessary also with adjustable iris diaphragm or fixed aperture diaphragm.

On all telescopes with more than 80 mm aperture as well as on telescopes with secondary mirrors (e.g. Newtons or Schmidt-Cassegrains), a D-ERF protective filter (not included in the scope of delivery) is absolutely necessary for long-term observations (more than five minutes). A selection of suitable filters can be found at *baader-planetarium.com/derf*; a suitable 3D-printed lens mount can be created by yourself or by various service providers.

These D-ERF filters also serve as UV and IR blocking filters and reflect the incident sunlight instead of absorbing it. If you want to use a smaller D-ERF filter diameter on an obstructed telescope to simultaneously stop it down to a more favourable focal ratio, choose the diameter of the D-ERF in such a way that it sits off-centre next to the secondary mirror in the optical path. Otherwise you will lose aperture if the secondary mirror sits behind the D-ERF. Do not try to put several smaller D-ERFs next to each other in order to use more aperture despite having a secondary mirror – this also does not give satisfactory results.

A suitable mount specifically for your telescope can be made by us only if you purchase a complete system consisting of D-ERF and H-alpha filter. However, this is relatively expensive due to the design and production time. For a quotation we need the diameter of the mount with an accuracy of 1/10 mm. Instructions on how to construct your own mount can be found at *baader-planetarium.com/derf*.

The filter should be mounted as close as possible to the front of the lens so that no warm layers of air can accumulate between the lens and the filter and impair the image quality. Always make sure that the filter is firmly seated to avoid it dropping from the telescope!

Usage without an Energy Rejection Filter

With telescopes with an aperture of 80 mm or less *and* a focal ratio of f/8 or slower, the SunDancer II can be used without an energy protection filter (ERF) in front of the telescope objective. This makes it a particularly inexpensive and safe system for H-alpha solar observation, as you only need one accessory and do not run the risk of forgetting the D-ERF front filter.

The concentrated, reflected solar radiation in front of an 80 mm telescope without D-ERF in front of the objective.
Without a D-ERF, never look into the telescope from the front!

However, only the observer *behind* the eyepiece is safe. When using the telescope without D-ERF, the tightly bundled light beam is first reflected inside the tube at the front block filter before the telecentrics and is then deflected out of the telescope towards the front again. Therefor when using the telescope without a D-ERF, make sure that no one can look into the telescope from the front. The risk is highest with low-mounted, short-focal length telescopes pointed at a low-elevation sun. The photo shows the glistening bright reflected light beam in front of an 80 mm objective.

You can also use D-ERF filters on smaller telescopes, as they protect the inside of the tube from the heat of the sun. This has no influence on the function of the SunDancer II, but it may affect the tube entrance and thus the possible maximum magnification.

The Telecentric System and Thoughts about the Telescope

The SunDancer II has a built-in 3x telecentric system with an integrated blocking filter. Similar to a Barlow lens, the telecentric system triples the focal length and effective focal ratio of the telescope, but unlike a Barlow, it also ensures a parallel beam path. There is no way that a parallel light beam would result without a telecentric even in a native f/30-telescope or in a telescope would be brought to this focal ratio with a Barlow! A slightly conical beam path with f/30 would give a weaker contrast with an etalon with 0.5 Å FWHM – comparable to a filter 0.7 Å FWHM or less. Only a telecentric system delivers this perfectly parallel beam path, which is essential for the unrestricted function of an etalon.

The SunDancer II is optimized for an effective focal ratio of f/30, i.e. for telescopes working natively with f/10. It can be operated on telescopes up to about f/8 (giving an effective focal ratio of f/24) without too much increase in half-width.

The filter can also be used on faster telescopes with the restrictions mentioned above. However, with an effective focal ratio of f/20 or faster (i.e. on f/6.6 telescopes), it is mandatory to mount a Baader D-ERF filter in front of the lens. In addition, the target

Light beam of a 6" lens telescope, which was extended to f/30 with a barlow lens

Light beam of a 6" lens telescope, which was extended to f/30 with a telecentric system

The SunDancer II consists of two parts (plus the 1¼" eyepiece clamp). On the left is the actual H-alpha filter, i.e. the etalon with the heating element and the micrometer screw. To the right, in the 3x telecentric system, the integrated block filter can be seen in the entrance opening.

temperature of the filter must be increased (see section "Calibrating the Filter"), and the half-width increases to more than 1 Å instead of the usual 0.6±0.1Å, as already mentioned. This will cause many details on the solar surface to disappear. For best results, it is better to stop down the telescope in front of the lens to f/8 or slower than to use the filter with artificially enlarged half-width. For this purpose we offer the stepless adjustable iris diaphragm 13-113 mm *(#2459300)*. It has elaborately white-painted blades so that no unnecessary heat is generated close to the lens. A simple, white-painted baffle can easily be made yourself and attached with Velcro in front of the D-ERF, for example, as in the picture on the right.

A D-ERF can be stopped down with a simple baffle

Telescopes with a slower focal ratio can also be used, but due to the longer focal length they quickly reach minimum magnifications that can rarely be used during the day (due to air turbulence or exit pupil).

The telecentric of the SunDancer II also contains a blocking filter. It shimmers golden when you look into the SunDancer from the telescope side. This block filter is absolutely necessary to protect the actual H-alpha filter from solar radiation.

Although the telecentric system can be seperated from the etalon, the SunDancer II must only be used in combination with the included telecentric system!

The modular design of the SunDancer II allows it to be used with other telecentrics (and an additional blocking filter!).

The 3x telecentric system with integrated blocking filter is only available combined with the SunDancer II.

Attention: Using it with a telecentric without this additional block filter would destroy the etalon just as much as using it without D-ERF on larger telescopes than 80 mm.

The 3x telecentric *(#1363070)* is also available without blocking filter, e.g. for use on other H-alpha filters. The blocking filter is not available separately.

A 4x telecentric with integrated blocking filter is planned in the long term, the existing blocking filter of the TZ-3 must then be mounted in the TZ-4.

The 3x telecentric system *(#1363070)* without blocking filter is also available separately.

Eyepieces

In principle, you can use any eyepiece that provides a sharp, high-contrast image. Special H-alpha eyepieces are mainly corrected for the red part of the spectrum and may not provide a similarly sharp image as in H-alpha when observing white light. Long focal length eyepieces still provide a bright image even at the ideal focal ratio of f/30 for an H-alpha filter and avoid to high magnifications. Exceeding the highest useful magnification would cause a sensitive loss of sharpness.

Note: Because of the telecentric, the system is very tolerant concerning working distances. Even a bino-viewer can be used without an additional glass path corrector.

1 You can use any 1¼" eyepiece via the focusable 1¼" eyepiece clamp *(#2458125)* included in the scope of delivery. We recommend eyecups with a foldable side light shade. An observation cloth that is white on the outside and black on the inside also helps to suppress stray light and increase contrast.

The telecentric allows you to reach high magnifications very quickly and end up in over-magnification very quickly with common eyepieces. The blocking filter in front of of the telecentric has a diameter of 12 mm. The etalon itself has a diameter of 23 mm with a 19 mm baffle on the eyepiece-side.

Long focal length 1¼" eyepieces have field stop diameters up to about 28 mm. This field stop diameter covers the available image circle of the SunDancer II.

The use of 2" eyepieces is nevertheless profitable, as it allows lower magnifications and thus a brighter image, plus often a more comfortable viewing behaviour and an even slightly larger field of view. You have two options for using 2" eyepieces:

2 Replace the 1¼" eyepiece clamp *(#2458125)* included in the scope of delivery with the optional Baader 2" ClickLock T-2 (M42i × 0.75) clamp *(#2956242)*. For 1¼" eyepieces, you will then need an adapter such as the Baader 2" to 1¼" ClickLock reducer *(#2956214)*.

3 Screw the optional Expanding Ring T-2f / M48m *(#2458110)* into the 2" filter thread of the nosepiece of your eyepiece. This way you have a "theft-proof" connection, which is especially useful for public use when the eyepiece is rarely changed.

Choosing a Star Diagonal

In principle, the SunDancer II can be used on any telescope that is suitable for solar projection. When using a D-ERF energy protection filter, catadioptric systems can also be used, as well as Newtonian telescopes stopped down to a suitable focal ratio. Make sure that the secondary mirror does not cause any additional obstruction and mount the D-ERF off-centre.

The SunDancer II at a 8" Triband SC where the D-ERF is part of the Schmidt corrector plate.

The focus position when using the 2" sleeve corresponds approximately to that with a normal eyepiece.

On most telescopes, a star diagonal is necessary for comfortable viewing. Mirrors are preferable to prisms, as the sunlight does not then pass through the glass of the prism heating it up. For best quality, we recommend Baader BBHS® star diagonals with astro-sitall mirror material (glass ceramic with zero expansion coefficient) and 1/10 l surface finish.

You can use both 1¼" and 2" star diagonals but it is mandatory to mount the mirror in front of the SunDancer (i.e. between the SunDancer and the telescope's focuser).

Power Supply

If operating the SunDancer II from the mains, it is recommended that the power is supplied via the included Baader OTP II 19W: Outdoor Telescope Power Supply 19W with right-angle plug *(# 2457615)*. It supplies 12.8V at 1.5A.

If no power outlet is available, the SunDancer II can be operated with an optional battery pack for mobile use. The Celestron PowerTank Lithium LT 12V DC/ USB 5V/ 73,3Wh *(# 821038)* has proven itself. Please note the correct polarity: The positive pole is on the inside (tip positive).

The hand control can be used inside of the yellow utility bag, where it is protected from direct sunlight.

Tip for experienced DIY builders: A sufficiently strong 12V power source can, if necessary, supply both the mount and the SunDancer II via an optional Y-cable, which makes for a very tidy setup.

Caution: Do not reverse the polarity of the power supply. If possible, use the supplied power supply or cables with reverse polarity protection. Damage caused by reverse polarity is not covered by the warranty.

Observing with the SunDancer II

The parts of the SunDancer II

1. SunDancer II
2. Micrometer screw for quick finetuning of the Etalon
3. Three locking screws for the eyepiece
4. Locking screw for fine focuser
5. Connection cable to hand control
6. Hand control (temperature control box)
7. Connection cable to SunDancer II
8. Connection port for 12V power cable (on the back; power supply is not shown)

Connecting to the telescope

1. Do not point the telescope at the sun yet. First put a light-proof cover in front of all optics that are not used (finder, guide scopes etc).
2. If necessary, install the D-ERF energy protection filter in front of the telescope.
3. Remove the dust cap from the 1¼" socket of the SunDancer II.
   Caution: If you use a 2" eyepiece clamp and point the SunDancer II at the sun with the 1¼" dust cap still on, the plastic will evaporate and may deposit on the optics of the telescope or on the blocking filter and destroy them!
4. Place the SunDancer II in the eyepiece clamp or the star diagonal (1¼" or 2") of the telescope and secure it.
5. Connect the temperature control box to the SunDancer II via the 8-pin plug connection.
6. Connect the temperature control box to the 12V power supply or an optional battery pack. Note the correct polarity: the positive pole is on the inside (tip positive). The supplied power cable and that of the Celestron $LiFePO_4$ PowerTanks are correctly polarised and not interchangeable.
7. Pay attention to the cable management: make sure that nobody can get caught on the cables and that the cables are not be under tension when the telescope moves. You can store the power supply unit and control box in the supplied yellow utility bag shown on page 10. Attach the bag to the mount in such a way that the cables cannot interfere or come under tension. The optional Celestron PowerTank can be connected to the tripod legs so that it does not interfere. The control box should not be in direct sunlight.

8. As soon as the control box is powered, it automatically heats the filter up to the necessary operating temperature. The display shows the temperature difference to the set point; when the value 0 is shown, the filter is ready for operation. After about five minutes, the temperature control has stabilized and you can fine-tune it if necessary (see the following chapter "Filter calibration").
9. While the filter heats up, you can can insert an eyepiece, point the telescope at the sun and observe. Due to the longer focal length caused by the telecentric, the sun must be positioned exactly so that it can be seen in the eyepiece.
10. The micrometer screw tilts the etalon a maximum of 3° from the optical axis. This has two functions:
(1) You can check the setting of the H-alpha line without changing the temperature of the filter. To do this, turn the micrometer screw sensitively and without using force clockwise all the way in, as far as it will go, and the H-alpha structures on the sun should be clearly visible. The scale itself is only for orientation, the stop does not have to correspond to the 0 position.
(2) The micrometer screw is used for fast Doppler-event observations: For example, if a prominence is moving quickly towards you, this may be enough for the H-alpha line of that structure to shift so far into the blue part of the spectrum that you need to readjust – this can be done quickly and easily with the micrometer screw or by decreasing the temperature, which takes a little bit more time, but keeps the filter in the ideal tilting angle.

The micrometer screw can tilt the filter to easily observe the blue wing of the H-alpha-line

Note: After about three to five minutes the filter is in temperature equilibrium, before that slight changes in the image are possible due to readjustment.

Note: Observe the operating temperature of 0 to +40° C. At lower temperatures, the filter must be thermally insulated so as not to overload the heating.

The Functions of the Temperature Control Box

Once the filter has been correctly calibrated to your system (see chapter Calibrating the Filter on page 16), you only need to connect the temperature control box to the SunDancer II and then to a 12V power source. The electronics will then bring the filter up to operating temperature and automatically switch it off if it becomes too warm.

The display of the control box shows the difference from the factory set temperature. If your particular setup requires a different operating temperature, please refer to the chapter "Filter calibration" for instructions.

As soon as the display shows a stable "0", the filter is ready for operation. When the telescope is pointed at the sun, it takes about three to five minutes for the filter to reach temperature equilibrium.

The display shows the temperature difference to the ideal operating temperature. Above shortly after powering up, below once the operating temperature is reached

The filter has a temperature sensor that switches off the heating if the filter becomes too hot. In this case, the heating element is automatically switched off and will not be reactivated until the filter has cooled down to 25 °C and the control box has been disconnected from the mains.

To switch off, simply disconnect the temperature control box from the power source.

Changing the Operation Temperature

You can easily change the temperature of the filter and thus the position of its transmission window. Increasing the temperature shifts the maximum to the longer-wavelength red wing of the H-alpha line; decreasing it shifts it to the blue wing in the shorter-wavelength spectral range. A change of 10.0 units shifts the transmission maximum by about 1 angstrom, which is also the maximum possible change.

Press the up arrow to increase the temperature or the down arrow to decrease it. After a few seconds, the display changes to the current value and the filter is tempered to the new setpoint (displayed as a deviation from the factory-set temperature value).

The new setpoint remains stored. So the next time you use it, the control box will always show the last set value.

Note: For quick observations in the blue wing of the H-alpha line, you can also use the micrometer screw.

Using a Neutral Density Filter

The difference in brightness between the prominences and the solar disk is very large, and it can be helpful, especially when observing with a large exit pupil, to screw a neutral density filter into the eyepiece. This makes the structures on the solar disk more visible to the eye, while the prominences become less visible. You can achieve the same effect with a single polarising filter that you screw into the eyepiece. Then, as when used with a Herschel prism, the image brightness can be adjusted by rotating the eyepiece in its eyepiece clamp.

How strong the effect is depends on the respective system as well as on your own eyes. In principle, the image brightness can also be adjusted simply by increasing the magnification; however, this presupposes that the air turbulence permits higher magnifications at all.

Polarizing and Neutral Density Filters dim the brightness, which may lead to better visibility of details in the eyepiece

We recommend the following filters:

- Polarising filters: 1¼" *#2408343; 2" #2408342*
- Neutral density filters (grey filters) ND 0.6 (T=25%): 1¼" *#2458343; 2": #2458321*
- Neutral density filters (grey filters) ND 0.9 (T=12.5%): 1¼": *#2458344; 2": #2458322*

Using a Telecompressor

Especially on long focal length telescopes, very high minimum magnifications are achieved through the 3x telecentric. With a telecompressor, the focal length can be significantly reduced again. The SolarSpectrum Research Grade H-alpha 0.4x Telecompressor 2" *(#2459260)* has proven itself. It has SC threads on both sides and can be used both photographically and visually. Its ideal working distance is 74 mm with a corrected field of view of 16 mm diameter.

SunDancer II with Telecompressor

To screw it onto the T-2 connection thread of the SunDancer II, you need:

1) Reducing-Ring 2"i / T-2a, with 1.5mm optical length *#2958244*.
2) SolarSpectrum Research Grade H-alpha 0.4x telecompressor 2" *#2459260*
3) Reducing-Ring 2"i / T-2a, with 1.5mm optical length *#2958244*
4) T-2 Conversion Ring *#2958110*

You will need additional adapters to place an eyepiece or a camera in the desired distance. The included focusable 1¼" eyepiece clamp *(#2458125)* has an optical length of 29-35.5 mm. For the ideal working distance of 74 mm you still need a

5) T-2 / 40 mm Extension Tube *#1508153*

On the other hand, for a camera, the necessary adapters depend on the backfocus of the camera.

The ideal distance will give you a reducing factor of 0.4x. However, the telecompressor can also be used with a shorter distance, in which case the compression factor changes. Instead of the 1¼" eyepiece clamp, the Baader 2" ClickLock T-2 (M42i x 0.75) clamp *(#2956242)* with 36.6 mm optical length can also be used.

Above are the necessary parts to connect the telecompressor to the SunDancer II, on the right they are fully assembled.

Note: The maximum field of view is limited by the 19 mm aperture behind the etalon; the telecompressor can only reduce this image circle. As a rule of thumb for the size of the solar disk, it appears about 10 mm in diameter per metre of telescope focal length. Therefore with the built-in 3x telecentric, the whole sun disc (with prominences) can be viewed in telescopes with a native focal length of up to about 600 mm.

Note: On obstructed systems, the "secondary mirror shadow" becomes visible when the exit pupil of the telescope becomes larger than the aperture of your own eye pupil. This is more noticeable during the day than at night, as the pupil then opens less wide. Using a dark observation hood during daytime observations helps your pupil to open wider.

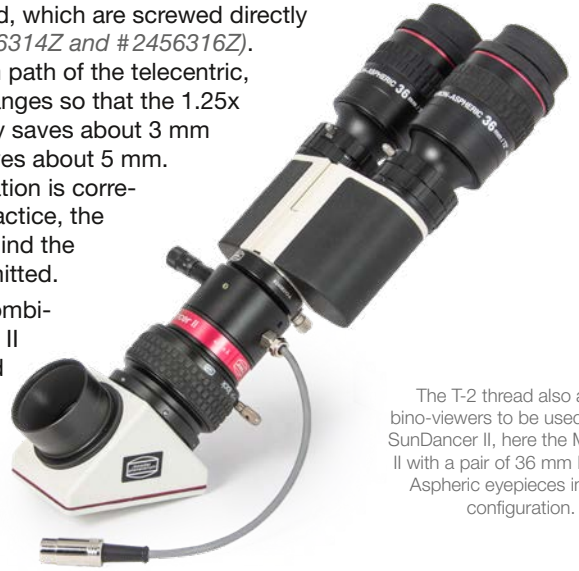
Using a Bino-Viewer

The sun is particularly impressive in a bino-viewer; the relaxed binocular vision allows details to be seen even better.

Compared to the standard 1¼" eyepiece clamp, a bino-viewer only needs about one centimetre more back focus thanks to the use of a telecentric system, and a glass path corrector is superfluous. To use a bino-viewer with T-2 connection, simply screw the T-2 coupling nut onto the T-2 thread of the SunDancer II instead of the 1¼" eyepiece socket. If you are using the binocular attachment with Zeiss micro bayonet, screw the Baader TQC Heavy Duty T-2 Quick Coupler *(#2456313A)* or the T-2 Standard Quick Coupler with Zeiss Micro Bayonet *(#2456313)* onto the SunDancer II.

In this configuration, only the glass path correctors for Zeiss ring dovetail can be used, which are screwed directly into the binocular *(#2456314Z and #2456316Z)*. Due to the parallel beam path of the telecentric, however, their effect changes so that the 1.25x glass path corrector only saves about 3 mm back focus; the 1.7x saves about 5 mm. The change in magnification is correspondingly small – in practice, the glass path corrector behind the telecentric should be omitted.

Please note that the combination of the SunDancer II with telecompressor and glass path corrector in front of a binocular attachment does not work – and would be useless as you reduce the focal length only to increase it right away again.


The T-2 thread also allows bino-viewers to be used with the SunDancer II, here the MaxBright II with a pair of 36 mm Hyperion Aspheric eyepieces in 1.25" configuration.

Calibrating the Filter and Settings of the Temperature Control Box

Setting the Temperature

The target temperature of the filter and thus the position of the central wave length of the transmission window can be adjusted via the temperature control box. This serves on the one hand to calibrate the filter to your individual system (see the following chapter "Filter calibration"), and on the other hand for finetuning to observe the red or the blue wing of the H-alpha line. For observations in the blue wing, you can also simply use the micrometer screw so that the filter is set exactly to the H-alpha line.

To change the target temperature, proceed as follows:

1. Wait until the filter has reached its stable operating temperature and displays the numerical value "0".
2. Press UP or DOWN once to enter the programming mode. The display "0.0" flashes. Now press UP to increase the temperature or DOWN to decrease it. If no key is pressed for a few seconds, the new setpoint is accepted.
3. The value can be changed by a maximum of 10.0 degrees. A change of 10.0 degrees shifts the central wavelength by about 1 angstrom (1Å, equals 0.1 nm).
4. An increase in the setpoint value corresponds to a shift of the central wavelength into the longer focal length, i.e. the red region of the spectrum. A decrease shifts it accordingly to the shorter wavelengths, or the blue range of the spectrum. In the blue wing of the H-alpha band, they can observe the rapid, high-energy changes on the solar disk.

The new value is stored even if you disconnect the power supply. The display always refers to the factory preset target temperature.

Note: The filter temperature is influenced by the incident solar heat. If the filter is not pointed at the sun for some time, the transmission line shifts into the blue range of the spectrum. As soon as the telescope is pointed at the sun again, the heating compensates for the additional solar energy, and after 30 to 60 seconds it is back to its original wavelength.

Note: For best imaging and to avoid reflections, the filter should not be tilted. The micrometer screw is used for *quick* observations of Doppler effects; the H-alpha line should be adjusted via the temperature.

Calibrating the Filter

The SunDancer II has been calibrated at the factory and should give the best image when the micrometer screw has been turned clockwise as far as it will go without applying force and the heater has reached the preset target temperature, so that the temperature difference display is also at "0". After about three to five minutes of solar observation, the filter has reached temperature equilibrium and you can assess its performance.

For optimal performance on your particular system, you should calibrate the filter to compensate for differences in aperture ratio, energy rejection filter and more. This should require only small corrections to the factory setting, which was set at an effective focal ratio of f/30. To do this:

1. Turn the micrometer screw clockwise as far as it will go (without applying force).
2. Set the temperature control box to a value of -5.0 as described above in the chapter "Setting the temperature". Give the filter 3 to 5 minutes to stabilise and observe the sun exactly in the centre of the image of the filter. You should now see it in the blue wing of the H-alpha line.
3. Increase the target temperature by 1.0 degree (corresponding to 0.1 Å) and give the filter a couple of minutes to stabilise again.
4. Increase the target temperature until you see the sun with the best contrast. The solar disk is then darkest and you have centred the filter exactly on the H-alpha line.

Increasing the target temperature moves the filter to the red wing, decreasing it moves it to the blue wing. **A change of more than ±10 degrees is not advisable. Increasing the temperature too much can destroy the filter.**

Tilting the Filter

With the micrometer screw, you can tilt the filter up to 3° off the optical axis to quickly shift the central wavelength into the blue wing. If the image improves when you tilt the filter, this may have two causes:

1. The filter line is in the red wing of the H-alpha line at target temperature.
2. The micrometer allows the filter to be tilted past the neutral position.

The set point of the target temperature should be adjusted to give the best image when the micrometer screw is turned gently clockwise to the stop. Then you can tilt the filter towards shorter waves, into the blue wing of the H-alpha band, by turning the micrometer screw back. In the blue wing, you can better observe rapid, high-energy changes on the sun.

Troubleshooting

If the filter does not deliver the expected contrast, it is usually because it is not aligned exactly to the optical axis. Even with a tilt of 0.5°, the filter can no longer work as desired. A tilt can be compensated for to a small extent by increasing the target temperature, but this also increases its half-value width.

In case of tilting, first check whether your focuser tube is correctly adjusted or whether it has play and gives way under load. Simple clamping screws on the focuser or zenith mirror can also cause tilting.

Photography

In total, you have three options for connecting a camera to the SunDancer II. For the best imaging quality, you should pay attention to the working distance of 65 mm, although the system also works well at other distances. A deviation from the ideal working distance will affect the magnification and image quality, although the system has proven to be quite docile. The working distance is also long enough for use with a DSLR.

1¼" Video Modules/Planetary Cameras

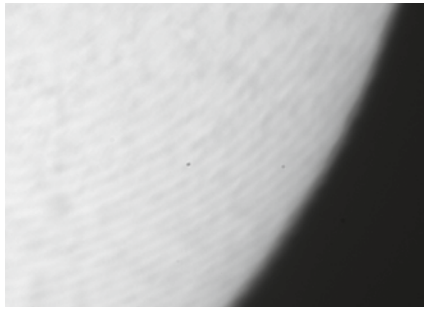
A modern imaging camera like the ones used for planetary photography is the first choice for obtaining high-resolution images of details on the solar surface or in the photosphere. To maintain the optimal working distance, you can place T-2 extension sleeves between the eyepiece clamp of the SunDancer II and the actual filter unit. Simply unscrew the eyepiece clamp to expose the T-2 thread.

The focusable eyepiece clamp has an overall length of 29 - 35.5 mm. Which extension sleeves you need depends on the sensor position of the camera – on some models the sensor is in the 1¼" socket, on others behind it. On *baader-planetarium.com* you will find various extension sleeves, including among others:

- T-2 extension tube 40 mm *# 1508153*
- T-2 extension tube 15 mm *# 1508154*
- T-2 extension tube 7,5 mm *# 1508155*
- VariLock 29, lockable T-2 ExtensionTube 20-29 mm with spanner tool *# 2956929*

A planetary camera with 1¼" plug-in sleeve. A 40 mm T-2 extension sleeve provides the ideal working distance of 65 mm.

If possible, use a stop ring to reproduce the position of the camera over and over again. If no stop ring is included with your camera, you can use the 1¼" stop ring *(# 1905131)* for this purpose. It can also be used to make the camera parfocal with an eyepiece, if necessary in conjunction with the 1¼" extension tube with 1¼" filter thread on both sides *(# 1905130)*.



Interference pattern of a monochrome camera.

Monochrome cameras are more suitable because they are more sensitive to light and allow shorter exposure times. In addition, all pixels are used in this way; in colour cameras with an RGGB matrix, only a quarter of the pixels are sensitive at all to the deep red H-alpha light.

With some monochrome cameras, interference patterns occur between the protective glass and the sensor during H-alpha photography. This is a problem of the camera and not of the filter; the fringe patterns rotate with you when you turn the camera. In this case, it can help to tilt the camera or make a flat, but this is not trivial with such a narrow band filter. Another possibility might be to tilt the filter. Within certain limits, the filter tilt can be compensated again by the temperature control, so that the H-alpha line is hit again even with a tilted filter.

SunDancer II with Baader M68-Tilter and adapters

You can use a tilting unit like our Baader M68-Tilter *# 2458170* to tilt the camera very precisely behind the filter and remove the interference pattern.

However, this problem does not occur with all cameras, so there is no patent remedy for it. We have had good experience with the monochrome cameras made by QHY.

DSLR and CCD Cameras

If you unscrew the focusable eyepiece clamp, you can connect astronomical cameras with T-2 threads as well as DSLR and mirrorless system cameras via the T-2 thread (M42 × 0.75); you can find suitable T-adapters for the respective camera bayonet at *baader-planetarium.com*.

Via the Expanding Ring T-2f / M48m *(# 2458110)*, you can also use M48 camera adapters and Baader Planetarium's Wide-T rings to avoid mechanical vignetting on full-frame cameras.

A DSLR with a standard T-ring still needs a 10mm T-2 extension. A standard T-ring has an overall length of 55 mm - here using the example of a mirrorless Micro Fourthirds camera with the Micro Fourthirds T-ring *# 2408330* (with 19 mm extension).

Here, too, you should observe the ideal working distance of 65 mm. An SLR camera with a standard T-ring has a flange focal distance of 55 mm; with the T-2 internal thread ring 10 mm *(# 2958110)* and the T-2 reversing ring adapter T-2 to T-2 *(# 1508025)*, you will achieve the ideal distance of 65 mm; you will also achieve good results with the T-2 quick-change system *(# 2456322)* with 15 mm construction length. Mirrorless system cameras and astronomical cameras have a shorter flange focal length and require different extension tubes, depending on the model.

Tip: In principle, black-and-white cameras are better suited for H-alpha solar photography, because the Bayer matrix of a colour camera means that three quarters of the pixels cannot perceive red light at all.

Tip: The surface of the sun and the prominences have very different brightnesses and normally cannot both be exposed correctly in one shot - the solar disk is much brighter. If the green channel of your colour camera is also slightly sensitive to red light, you can try to expose on the prominences and use only the weaker green channel for the solar disk.

Telecompressor

The already mentioned 0.4x telecompressor 2" *(#2459260)* can also be used photographically. If the telecompressor is adapted to T-2 as described before, its ideal working distance is still 73.5 mm. A DSLR or system camera with a standard T-ring has a flange focal distance of 55 mm. The remaining 18.5 mm can be bridged with T-2 extensions, e.g. as in the picture on the right with

A DSLR with 0,4x telecompressor and T-2 quick-changer

- TQC/TCR Heavy duty T-2 Quick Changing System *#2456322* – 15 mm, optionally additionally
- 3x T-2 fine-adjustment ring (1 mm – gold) made of aluminium *#2457913* or
- T-2 adjustment/spacer-rings (set of 15) *#2458102*

The distance does not have to be kept exactly, but the compression factor changes with the distance.

Afocal Photography

Finally, the possibility of photographing with the camera through the eyepiece should be mentioned – even if this option combines the worst of both worlds: a large lens stack and a colour camera. This makes it more of a feasibility study, but it may offer the chance to photograph the entire sun even with a smaller camera sensor without having to buy a telecompressor. If you see the entire sun in the eyepiece, you can capture the image with a camera – ideally even with your smartphone. Better is a camera whose fixed focal length lens has a filter thread that can be connected to the M43 thread of our Hyperion and Morpheus eyepieces via our Hyperion-DT rings. For this you need a lens that you bring as close as possible to the objective without the lenses touching each other. The objective focal length depends on the size of the solar image in the eyepiece.

Even this possible in principle: an MFT camera with a 12mm lens overlooks almost the entire field of view of a Hyperion 36mm eyepiece.

In practice, the method has some disadvantages and is only useful with fixed focal length lenses; however, if you already have a sufficiently short focal length lens, it can temporarily be an alternative to buying a full-frame camera or a telecompressor.

The telecompressor delivers much better results and is much easier to use, at a comparable price to a fixed focal length lens.

Storage and Maintenance

As long as you handle the filter with care like any other precision optical instrument and use the dust caps when not in use, it requires no special care.

Caution: The filter must not be stored permanently below +4° C, otherwise the filter stack will freeze out and be irreparably damaged. Store it dry and dust-free at room temperature.

The filter should be used at an ambient temperature of 0 to +40° C; at lower temperatures it must be additionally thermally insulated so as not to overload the heating.

Safety information

Finally, we would like to urge you once again to observe all safety precautions when observing the sun. This includes:

- Never leave the telescope unattended
- Always cover all viewfinders and other optics that are not in use.
- Ensure that the energy protection filter is held securely in place.
- Set the tracking of the mount to the speed of the sun instead of the star.
- Remember sunscreen for yourself when observing for long periods.

Technical Data

- Operating temperature: 0 to +40° (below 0° only with insulation).
- Storage temperature: +4 to +50°C, ideally at room temperature. Protect from frost!
- FWHM: 0.6±0.1 Ångström, shows chromosphere and prominences
- 3x telecentric with built-in block filter, optimal for refractors up to f/10, recommended up to f/8 and usable up to f/6.5
- Usable up to 80 mm aperture without additional D-ERF energy filter
- Blocking filter: 2nm Half-Bandwidth (FWHM) and 12 mm diameter
- Diameter of the etalon: 25 mm, with 23 mm free aperture and 19 mm eye-side baffle
- Ideal working distance for photography: 65 mm from the base of the T-2 thread
- Connection on telescope side: 2" and 1¼" plug-in sleeve
- Connection on eyepiece side: 1¼" with fine focusing; T-2
- With telescopes up to approx. 600 mm focal length, the entire solar disk is visible

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