



# SolarSpectrum H-alpha-Filter

## Baader Planetarium Telecentric Systems



### Manual and Application Tipps

Thank you for your purchase of a SolarSpectrum H-alpha-filter with matching telecentric system. The various SolarSpectrum-filter only differ in the filter size and their control unit, so we describe them altogether in this manual.

This manual also describes the various telecentric systems which are used to match the filter to different telescopes

For best results, we recommend that you spend a few minutes reading this manual before using the filters and telecentric systems.



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# BAADER PLANETARIUM

Zur Sternwarte 4 • D-82291 Mammendorf • Tel. +49 (0) 8145 / 8089-0 • Fax +49 (0) 8145 / 8089-105  
www.baader-planetarium.com • kontakt@baader-planetarium.de • www.celestron.de

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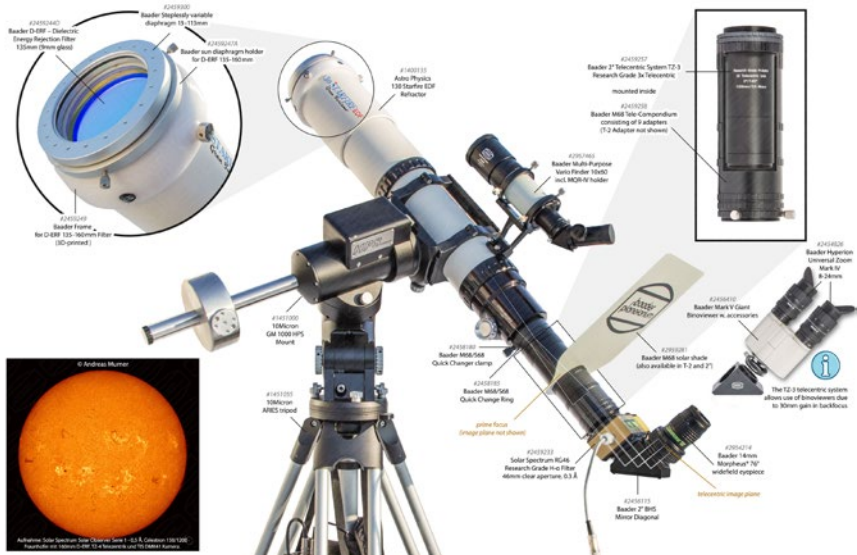
# Quick Start



**Attention: The H-alpha filter is sensitive to frost and *must* not be stored below 0 °C. It may be used at temperatures down to -10 °C as long as the heating element is active; we recommend to insulate the filter at cold temperatures.**

In this manual we will describe the possible configurations of your new SolarSpectrum filter in detail. In general, you will probably have talked with your dealer before purchase, so that you will already have a set matched to your telescope. Then it is easy to use it for observing the sun:

1. Place the Dielectric Energy Reflecting Filter (D-ERF) on your telescope
2. Cover or remove finder scopes, guide scopes and other optics that may be present on your telescope, or install suitable solar filters on them
3. Connect the telecentric to the H-alpha-filter
4. Connect the telezentric together with the H-alpha-filter at your telescope
5. Install star diagonal, eyepiece and extension tubes behind the H-alpha-filter
6. Connect the control unit to the H-alpha filter and connect it to the power supply. The display shows how the filter is heating up until it reaches its operating temperature. The display either goes from negative values to 0 (= operating temperature), or the two displays (current and target temperature) approach the same temperature – depending on the controller used
7. Point the telescope at the sun and wait, until the filter has reached its operating temperature. Wait a couple of minutes, until the whole filter is on the same temperature
8. Have fun!

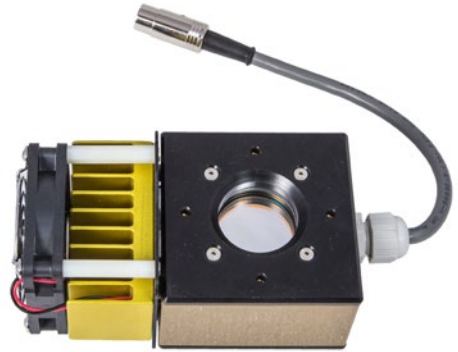


Sample configuration of a SolarSpectrum H-alpha-filter

# The SolarSpectrum Filters

## Solar Spectrum Observer Series 1,5 25 mm clear aperture, 0,3-0,65Å

- Solar Observer Filter Serie 1,5: Standard-Filter with a clear aperture of 25 mm. Shows the full sun disc up to effective focal lengths of approx. 2200 mm
- Different halfbandwidths available depending on the model
- includes pre-installed adapter set:
  - 2x 2" SolarSpectrum Universal Flange #2958240
  - 1x 2" a to T-2i Reducer #2958242
  - 1x 2" a to T-2a Adapter #1508035
  - 2x T-2 T-2 Dust caps (#2904000, #2904010)
- Power supply: 12V/5A, 5,5 mm / 2,1 mm plug, tip positive
- Requires a D-ERF front filter



## Solar Spectrum Advanced Solar Observer 32 mm clear aperture, 0,3-0,65Å

- Advanced Solar Observer Filter: Standard-Filter with a clear aperture of 32 mm. Shows the full sun disc up to effective focal lengths of approx. 2700 mm
- Different halfbandwidths available depending on the model
- includes pre-installed adapter set:
  - 2x 2" SolarSpectrum Universal Flange #2958240
  - 1x 2" a to T-2i Reducer #2958242
  - 1x 2" a to T-2a Adapter #1508035
  - 2x T-2 T-2 Dust caps (#2904000, #2904010)
- Power supply: 12V/5A, 5,5 mm / 2,1 mm plug, tip positive
- Requires a D-ERF front filter



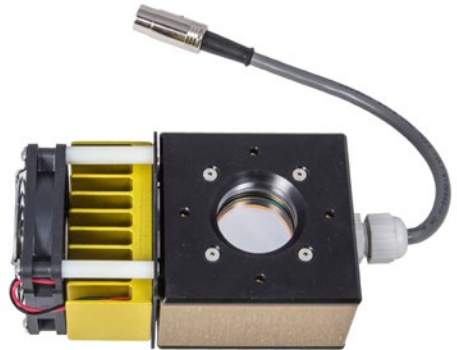
## Solar Spectrum Research Grade RG18 18 mm clear aperture, 0,30Å

- Research Grade Filter RG 18: 18 mm clear aperture, selected quality with extremely uniform H-alpha image over the entire image field. Shows the full sun disc up to effective focal lengths of approx. 1600 mm
- Halfbandwidth 0.30 + 0.10/- 0.05 Angström
- Focal ratio: f/40 +10/-5
- includes pre-installed adapter set:
  - 2x 2" SolarSpectrum Universal Flange #2958240
  - 1x 2"a to T-2i Reducer #2958242
  - 1x 2"a to T-2a Adapter #1508035
  - 2x T-2 T-2 Dust caps (#2904000, #2904010)
- Power supply: 12V/5A, 5,5 mm / 2,1 mm plug, tip positive
- Requires a D-ERF front filter



## Solar Spectrum Research Grade RG32 32 mm clear aperture, 0,3-0,65Å

- Research Grade Filter RG 32: 32 mm clear aperture, selected quality with extremely uniform H-alpha image over the entire image field. Shows the full sun disc up to effective focal lengths of approx. 2700 mm
- Different halfbandwidths available depending on the model
- includes pre-installed adapter set:
  - 2x 2" SolarSpectrum Universal Flange #2958240
  - 1x 2"a to T-2i Reducer #2958242
  - 1x 2"a to T-2a Adapter #1508035
  - 2x T-2 T-2 Dust caps (#2904000, #2904010)
- Power supply: 12V/5A, 5,5 mm / 2,1 mm plug, tip positive
- Requires a D-ERF front filter



## Solar Spectrum Research Grade RG46 46 mm clear aperture, 0,3-0,65Å

- Research Grade Filter RG 46: 46 mm clear aperture, selected quality with extremely uniform H-alpha image over the entire image field. Shows the full sun disc up to effective focal lengths of approx. 4200 mm
- Different halfbandwidths available depending on the model
- includes pre-installed adapter set:
  - 2x 2" SolarSpectrum Universal Flange #2958240
  - 1x 2" a to T-2i Reducer #2958242
  - 1x 2" a to T-2a Adapter #1508035
  - 2x T-2 T-2 Dust caps (#2904000, #2904010)
- Power supply: 12V/5A, 5,5 mm / 2,1 mm plug, tip positive
- Requires a D-ERF front filter



## Baader SunDancer II 19 mm clear aperture, 0,6±0,1Å

- Silently heated H-alpha-Filter with integrated 3x telecentric system with integrated 2 nm blocking filter. Half-width (FWHM) of  $0.6\pm 0.1\text{Å}$  at an effective focal ratio of f/30
- Resistant to ageing: The dielectric coating of the blocking filter and the airtight storage of the SolarSpectrum Etalon filter in oil prevent the ageing process
- Shows the full sun disc up to effective focal lengths of approx. 600 mm
- Shows prominences and solar surface details for visual observations as well as for photography and bino-viewers
- For telescope with 80 mm aperture or less, no additional D-ERF (energy rejection filter) is necessary
- Userfriendly electrical temperature control; additional micrometer screw for observing fast changes in the blue wing of the H-alpha-line
- Steckmaß: 2", 1,25"
- Power supply: 12V/3A, 5,5 mm / 2,1 mm plug, tip positive



The SunDancer II by Baader Planetarium uses an Etalon by Solar Spectrum. It is only available as a complete set with the SunDancer II 3x Telecentric (TZ-3S) and an integrated blocking filter. It is also compatible with the SunDancer II Telecentric TZ-4S #1363080, when the original blocking filter is installed in the TZ-4S. For further information, please see the separate manual of the SunDancer II.

# Scope of delivery

The scope of delivery of the SolarSpectrum filters consists of the actual H-alpha filter, the control unit and the pre-installed 2" or T-2 (M42x0.75) adapters listed above.

The control boxes are made individually to fit the filter and may vary in appearance.

In addition, the following parts are absolutely necessary:

- A telecentric system to operate the filter at approximately  $f/30$  and to achieve a parallel beam of light, which is necessary for the H-alpha-filter to work properly. For filters with an FWHM narrower than  $0.5\text{\AA}$ , an even slower  $f$ /ratio is recommended.
- An energy reflecting filter to save the filter system from the solar heat.
- A power supply



## Power Supply

If possible, power is supplied via the separately available Baader OTP 60W: Outdoor Telescope Power Supply 60W with protective-disconnect elbowed plug #2457630. It supplies 12.8V at 5 A.

If no power outlet is available, the filter can be operated with an optional battery pack for mobile use. The Celestron Power-Tank LiFePO<sub>4</sub> 12V DC/ USB 5V/ 84,4Wh #821041 works fine. Remember that the cable must be tip positive.



Baader OTP 60W: Outdoor Telescope Power Supply 60W with protective disconnect elbowed plug #2457630



Celestron PowerTank LiFePO<sub>4</sub> 12V DC/ USB 5V/ 84,4Wh #821041

**Tip experienced DIY-constructors:** A sufficiently strong power supply can power both mount and filter through a Y-cable, which keeps your cable management clean and easy.

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

# Preparations

## Choosing an Energy Rejection Filter

A Dielectric Energy Reflection Filter (D-ERF) protects the H-alpha-filter from the intense heat of the sun. In principle, it is a plano-optically polished filter that only allows red light close to 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 objective. A white-light solar filter (e.g. made of AstroSolar film) cannot be used for this purpose, as it also darkens the H-alpha line, which is already weaker than the rest of the solar light.



Energy Rejection Filters with up to 180 mm aperture can be made individually for your telescope and be combined with a steplessly variable diaphragm or a fixed aperture diameter

You can find a selection of suitable filters on [baader-planetarium.com/derf](http://baader-planetarium.com/derf); a matching filter cell can e.g. be 3D-printed by yourself or several commercial 3D-printers.

These D-ERF filters also serve as IR blocking filters and reflect the incoming 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 so 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. Placing several D-ERFs next to each other in order to use more aperture despite having a secondary mirror also does not give satisfactory results in practice. Please note that the H-alpha filter must be mounted tilted by about 3° when placed off-centre.

A suitable filter cell specifically for your telescope can only be made by us 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. You can find instructions on how to construct your own mount at [baader-planetarium.com/derf](http://baader-planetarium.com/derf).

The filter should be placed as close as possible in 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!

**Tip:** Our TriBand telescopes are based on Schmidt-Cassegrain telescopes with apertures of 8", 9¼" and 11". These telescopes do not need an additional energy protection filter, it is already integrated in the coating of the Schmidt plate.



## The Telecentric System and Suitable Telescopes

The SolarSpectrum H-alpha filters require a telecentric system (telecentric for short) to provide an optimal image. Similar to a barlow lens, a telecentric increases the focal length and the effective focal ratio of the telescope by the respective factor, but unlike a barlow, it also ensures a parallel beam of light. For a telescope that would have f/30 by default or would be brought to this focal ratio with a barlow, there is no way that a parallel beam of light would result without a telecentric! A slightly conical beam of light with f/30 would deliver a weaker contrast with an etalon with  $0.5 \text{ \AA}$  transmission width (FWHM) – as if the filter had a FWHM of  $0.7 \text{ \AA}$  or even less. Only a telecentric system provides this perfectly parallel beam of light, which is essential for the unrestricted function of an etalon.

The SolarSpectrum filters require an effective focal ratio of at least f/30. For filters with  $0.5\text{-}0.7\text{\AA}$ , you will achieve the best results with a focal ratio between f/30 and f/35; for even narrower filters with a half-width below  $0.5\text{\AA}$ , you should use a focal ratio between f/35 and f/45. The focal ratio of your telescope thus determines which telecentric system you need. With many telescopes, such focal ratios can only be achieved even with telecentrics if the telescope lens is additionally stopped down.

If you cannot achieve the necessary focal ratio with the available telecentrics, it is better to stop down the telescope in front of the objective to f/30 or slower instead of using the filter with artificially enlarged half-width. For this purpose we offer the steplessly variable iris diaphragm 13-113 mm (#2459300). It has elaborately white-painted blades so that no unnecessary heat is generated close to the lens. A fixed, white-painted iris diaphragm can easily be made yourself and attached with Velcro in front of the D-ERF, for example, as in the picture on the right.

Optical systems 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).



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



Light path of a 6" refracting telescope, which is expanded to f/30 with a Barlow lens (light coming from the left).



Light path of a 6" refracting telescope, which is expanded to f/30 with a telecentric system (light coming from the left).

# The Telecentric Systems

## About Magnification and Working Distance of Telecentric Systems

Unlike a barlow lens, behind which the beam of light widens, a telecentric provides a parallel beam of light. This is necessary for the proper functioning of an H-alpha filter (which requires at least  $f/30$  and a parallel beam of light). The second advantage of this design is that the distance between camera/eyepiece and telecentric can also be significantly changed without noticeably affecting the image.

In practice, you don't have to match this distance perfectly. The 2" Research Grade TZ-3 #2459257 is calculated for a working distance of 250 mm  $\pm$ 10 mm, so that it also works perfectly with a bino-viewer. A greater distance is no problem.

Please note: In principle, you can also use an eyepiece very close behind the telecentric or the H-alpha filter mounted behind it. Then, however, you will not only see the image of the sun, but also the sealent and other structures within the naturally grown etalon filter, which have no influence on the final image at the correct working distance, but can be visible as streaks if the distance is too short.

Unlike a barlow lens, you cannot change the image scale by changing the working distance. For a higher magnification (as far as it fits the pixel size of the camera), we recommend the Telecentric System TZ-4 #2459256 (230 mm working distance) or the SunDancer TZ-4S #1363080 (120 mm working distance) instead of an additional barlow lens. Unlike standard Barlow lenses, these telecentrics are also optimised for H-alpha observation.



SunDancer TZ-4S #1363080 (left) and TZ-4 #2459256 (right)

Please note that the 2" Research Grade TZ-3 #2459257 and the telecentric systems TZ-4 #2459256 and TZ-2 #2459255 (discontinued) are not barlow lenses and are optimised for a Strehl of 99% at the H-alpha line of 656.3 nm, but not for other wavelengths.

The SunDancer telecentrics TZ-3S #1363070 and TZ-4S #1363080 are achromatic systems that can also be used as barlow lenses.

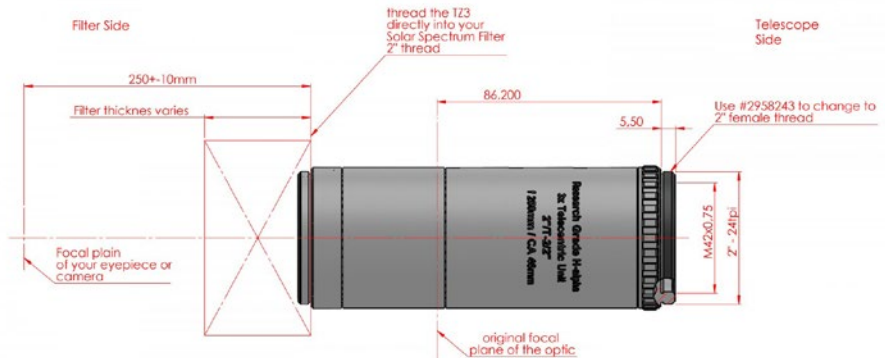


The clear aperture of the SunDancer TZ-3S #1363070 (27,5 mm, left) and TZ-4S #1363080 (36 mm, right)

## 2" Research Grade TZ-3 Telecentric System

#2459257

- Research Grade Telecentric Unit, featuring an oversized pick up expanding lens set and 2" (50.8mm) threads on both sides
- T-2 Adapter and 2" m/f inverter ring are both included as standard accessories
- 46 mm clear aperture at the H-alpha-filter entrance side – suitable for research grade SolarSpectrum H-alpha filters
- Large working distance of 250 mm for optimized focal length reduction with a telecompressor and suitable room for adapting a binocular viewer
- Aplanatic, with 3x focal length extension to achieve a parallel f/30 beam in conjunction with ~f/10 optics systems – free of field curvature
- The original focus point of the telescope is ~86 mm behind the end of the telecentric system
- Primarily calculated and produced for H-alpha at 656,3 nm, delivering 99% Strehl (definition brightness) depending on the used telescope system
- Diffraction limited design with about 80% Strehl also at 396 nm (CaK)



## Telecentric System TZ-4

#2459256

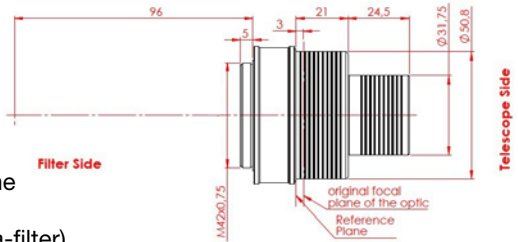
- Telecentric with 2" outer diameter and T-2 threads on both sides
- Aplanatic, with 4x focal length extension to achieve a parallel f/30 beam in conjunction with ~f/7,5 optics systems – free of field curvature
- Primarily calculated and produced for H-alpha at 656,3 nm, delivering maximum Strehl (definition brightness)
- Working distance to camera sensor: 230 mm
- The original focus point of the telescope is ~93 mm behind the end of the telecentric system



## SunDancer II Telecentric System TZ-3S

# 1363070

- Achromatic 3x telecentric system with **yellow** sleeve, also suitable for white light and planetary photography
- Four-lens optical design, BBAR (Broad-Band Anti-Reflection) coating – gives you f/30 at telescopes with f/10
- Anti-reflective thread and blackened lens edges
- Clear aperture: 27,5 mm on the camera side
- Image circle 27,5 mm in a distance of 96 mm from the base of the T-2 thread
- 1¼" and 2" nose piece with 1¼" filter thread, T-2 thread on the camera side
- Working distance: 96 mm from the base of the T-2-thread without an additional H-alpha-filter (65 mm from the base of the T-2-thread of the SunDancer II H-alpha-filter due to the glass path of the H-alpha-filter)

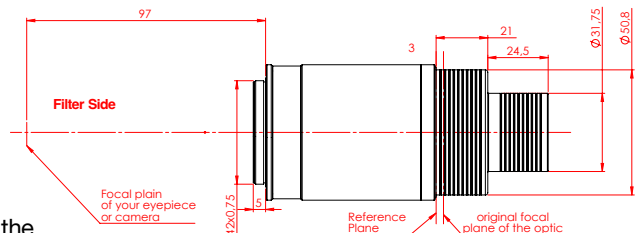


Please note: The TZ3-S is also part of the Baader SunDancer II H-alpha filter. There, it also contains a additional blocking filter with 19 mm diameter, so that this H-alpha-filter can be used at telescopes up to an aperture of 80 mm without an additional D-ERF, and has got a **red** sleeve for better distinction.

## SunDancer II Telecentric System TZ-4S

# 1363080

- Short achromatic 4x telecentric system with **violet** sleeve, also suitable for white light and planetary photography
- four lens optical design, BBAR (Broad-Band Anti-Reflection) coating – gives you f/30 at telescopes with f/7,5
- Anti-reflective thread and blackened lens edges
- Clear aperture: 36 mm on the camera side
- Image circle 36 mm in a distance of 97 mm from the base of the T-2 thread
- 1¼" and 2" nose piece with 1¼" filter thread, T-2 thread on the camera side, filter cell for the 19 mm blocking filter of the SunDancer II
- Working distance: 97 mm from the base of the T-2-thread without an additional H-alpha-filter (70 mm from the base of the T-2-thread of the SunDancer II H-alpha-filter)



The TZ4-S is compatible with the blocking filter of the SunDancer II H-alpha filter. The 37 mm aperture also allows use with larger H-alpha filters with additional blocking/energy rejecting filter.

# Additional Optical Accessories

## 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 over-magnification. Due to the telecentric system, you reach high magnifications very quickly and end up in over-magnification very soon with common eyepieces. The over-magnification would cause a sensitive loss of sharpness.

**Please note:** Although the telecentrics have an ideal working distance, the systems are very good-natured due to the parallel beam path, and you usually do not need an additional extension tube in front of the eyepiece clamp for visual use – star diagonal and H-alpha filter usually already provide sufficient distance. Even a bino-viewer can be used without an additional glass path corrector.

We recommend eyecups with a foldable stray light shade, as they are also included in the scope of delivery of our Hyperion and Morpheus eyepieces. An observation cloth that is white on the outside and black on the inside or a sun shield (for T-2: #2959279, for 2": #2959280, for M68: #2959281, see application picture on page 3) also helps to suppress stray light and increase contrast.

### Maximizing the Field of View

The maximum size of the field of view is determined by the clear apertures of both H-alpha-filter and telecentric system. Especially at the smaller H-alpha filters, the entire sun is therefore only visible to telescopes with a short focal length. Do not forget that the focal length is increased by the respective factor due to the telecentrics. Per metre of focal length, the Sun has a diameter of about one centimetre.

2" eyepieces allow lower magnifications and thus a brighter image, plus often a more comfortable viewing behaviour and an even slightly larger field of view than 1¼" eyepieces can offer. The field stop diameter of 2" eyepieces is up to 47 mm, compared to about 28 mm for 1¼" eyepieces.

Typical long focal length eyepieces provide the following exit pupils (EP) at f/30:

	<i>Classic Ortho 32mm</i> 1¼" – #2954132	<i>Hyperion 36mm</i> 2" – #2454636	<i>Celestron Omni 40mm</i> 1¼" – #810246	<i>Celestron Omni 56mm</i> 2" – #810248
EP at f/30	1 mm	1,2 mm	1,3 mm	1,9 mm

### The Highest Magnification

The rule of thumb that the maximum magnification corresponds to twice the aperture diameter in millimetres does not apply for H-alpha observations. At magnifications beyond an exit pupil of 0.7-0.8 mm, the image quality suffers, which is due to both the deep red wavelength used and the optimisation of most optics to the green wavelength range in the middle of the spectrum.

## Reducer

The telecentric system gives you a slow focal ratio of about  $f/30$ , so that quite high magnifications and exit pupils of 1-2 mm are already achieved with common long focal length eyepieces.

In principle, smaller magnifications (but *not* a larger field of view – this is determined by the clear aperture of the H-alpha filter and the telecentric system!) are possible through a reducer, in order to use the telescope even with strongly visible air turbulence. However, the distance to the reducer must be maintained for it to work as expected. For visual use, a long focal length eyepiece is therefore easier to handle than a reducer.

The use of a telecompressor is much more interesting when using modern CMOS cameras, whose small pixels harmonise better with faster focal ratios or shorter focal lengths, and which show a larger field on the given sensor size when used with a telecompressor. The following telecompressors are available for photography:

- Research Grade H-alpha 0.4x Telecompressor 2" for Solar Spectrum #2459260
- H-alpha 0.7x Telecompressor 2" for Solar Spectrum #2459259

Please note that the field of view is limited by the diameter of the H-alpha filter in front of the reducer. A reducer compresses the entire image so that vignetting can occur on larger sensors – the 0.4x telecompressor in particular reduces the image so much that only a field of view up to 16 mm diagonal is in focus. For connection see page 21.

## Star Diagonals

On most telescopes, a star diagonal is necessary for comfortable viewing. For best quality, we recommend Baader BBHS® zenith prisms or BBHS® zenith mirrors with astro-sital mirror material (glass ceramic with zero expansion coefficient) and 1/10 surface quality. Avoid dielectric mirrors, as the numerous layers can lead to undesirable effects such as loss of contrast. Therefore, only use mirrors that use silver or aluminium as the mirror material.

You can use both 1¼" and 2" star diagonals. The installation is always done behind the SolarSpectrum H-alpha filter.

# Getting started

**Always install the D-ERF in front of the telescope  
before you install the H-alpha-filter and point the telescope at the sun.**

The SolarSpectrum filters can be screwed directly to the respective telecentric system via the T-2 thread. Optionally, a Baader TQC/TCR Heavy duty T-2 Quick Changing System #2456322 can also be used to make it easier to attach and align the filter, especially when the telecentric is screwed to the telescope. If the telecentric (especially the Research Grade TZ-3) has an SC thread, you can also unscrew the T-2-adapter on the telescope-side of the SolarSpectrum H-alpha filter. This is recommended especially for SolarSpectrum filters with more than 42 mm aperture to avoid vignetting by the T-2 system.

Depending on the model, there are several ways to install the telecentric system:

- **Using a 2" eyepiece clamp:** TZ-2, TZ-3 and TZ-4 can be used at 2" eyepiece clamps via the T-2-thread with the 2" / T-2 (M48) nosepiece with Safety Kerfs #2458130. With the SC-thread of the TZ-3, you can also use the 2" Safety Kerf nosepiece with 2" filter thread #2408156. TZ3-S and TZ4-S already provide a standard 2" nose piece integrated in their housing. For a better grip, we recommend clamps with a clamping ring like our ClickLock® eyepiece clamps.
- **Using a screw connection at the telescope:** This is recommended for the longer telecentric systems TZ-2, TZ-3 and TZ-4. You can use the T-2-thread, in the case of the TZ-3, there is also an SC-thread available. If you are using a Baader Diamond SteelTrack® focuser, you can replace its eyepiece clamp with one of the following threaded adapters:
  - Diamond Steeltrack® S58 to T-2 BDS-Adapter #2957202
  - Diamond Steeltrack® S58 to M48 BDS-Adapter #2957204
  - Diamond Steeltrack® S58 to M68a BDS-Adapter #2957206
- **Using the Tele-Kompendium:** At telescopes with M68-thread, you can insert the telecentric systems TZ-2, TZ-3 and TZ-4 also in the M68 Tele-Kompendium #2459258. The telecentric system is screwed into the telescope-side of the Tele-Kompendium, the H-alpha-filter can be attached with an included 2"/T-2-nosepiece at the end of the Tele-Kompendium. The large diameter of the M68-system carries even heavy loads without twisting.

Especially for the longer telecentric systems, we recommend a screw connection to the telescope to avoid tilting.



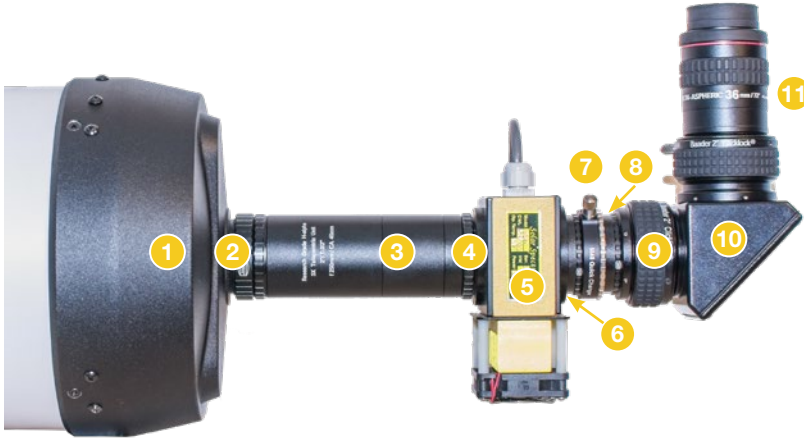
M68 Tele-Kompendium #2459258 with telecentric system TZ-4 #2459258





## Example Configuration for SolarSpectrum H-alpha-Filter – visual use, M48-System

For very large H-alpha filters, it is worth using the M48 system and 2" eyepieces to make use of the entire field of view without vignetting caused by 1¼" eyepieces or T-2 adapters. Smaller H-alpha filters can also be used with 2" accessories, but here the filter diameter limits the visible field of view.

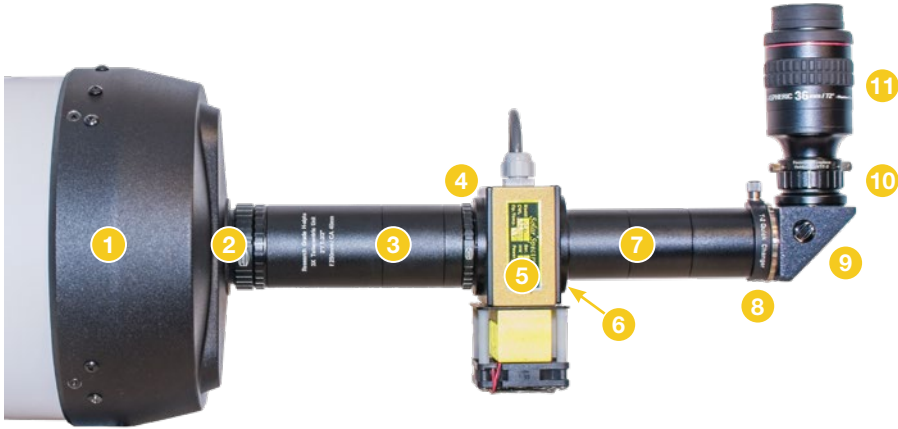


The 2" Research Grade TZ-3 #2459257 has a back focus of 250 mm, although there is some flexibility due to the parallel beam of light. We recommend the following setup for 2" eyepieces:

- 1 E.g. TriBand Schmidt-Cassegrain with SC-thread
- 2 #2958243 Baader Ultrashort 2" / 2" Thread-Inverter-Ring, included with the TZ-3
- 3 #2459257 2" Research Grade TZ-3 Telecentric System (3-times extension of the focal length),
- 4 #2958244 Baader Reducing-Ring 2"i / T-2a, with 1.5 mm optical length, included with the TZ-3 – to attach SolarSpectrum-Filters with T-2-thread. Not needed for SolarSpectrum-filters with female SC-thread.
- 5 SolarSpectrum-Filter with female SC-thread on both sides. Filters which only have T-threads on the eyepiece side need in addition the reducing piece M48a / T-2i #2958553, cf. 6
- 6 #2454834 2"a / M48i Zero-length reducing piece (zero optical length) and #2958555 Conversion Ring M48a/M48a. If your filter has got a fixed male T-2-thread, you need Reducing piece M48a / T-2i #2958553 instead.
- 7 #2958593 Baader Heavy Duty M48 Quick Changing System, length 15 mm \*
- 8 2 pieces #2958610 Baader M48 extension tube 10 mm
- 9 #2956248 Baader 2" ClickLock M48i Eyepiece Clamp, length 36,5 mm \*
- 10 Prism diagonal, e.g. #2456117 Baader 2" BBHS® Prism Star Diagonal
- 11 Eyepiece, z.B. #2454636 36 mm Hyperion Aspheric 2" Eyepiece

\*) When using the eyepiece clamp 9, the quick changer 7 can be replaced with M48 extensions, or vice versa. Instead of using 9, the nosepieces of our 2" star diagonals can also be screwed directly onto a M48 extension tube.

## Example Configuration for SolarSpectrum H-alpha-Filter – visual use, T-2-System



For smaller H-alpha-filters with a diameter of 38 mm or less, an adaptation with the T-2-System and a 1¼" or 2" eyepiece clamp can be used.

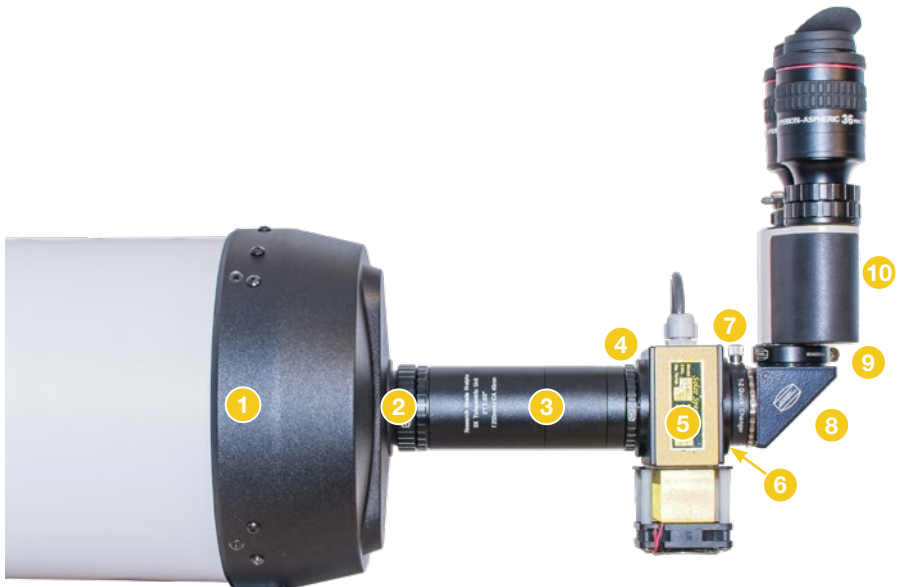
- ① E.g. TriBand Schmidt-Cassegrain with SC-thread
- ② #2958243 Baader Ultrashort 2" / 2" Thread-Inverter-Ring, included with the TZ-3
- ③ #2459257 2" Research Grade TZ-3 Telecentric System (3-times extension of the focal length),
- ④ #2958244 Baader Reducing-Ring 2" / T-2a, with 1.5 mm optical length, included with the TZ-3 – to attach SolarSpectrum-Filters with T-2-thread. Not needed for SolarSpectrum-filters with female SC-thread.
- ⑤ SolarSpectrum-Filter with female SC-thread on both sides.
- ⑤ SolarSpectrum-Filter with T-2-threads. Filter with SC-thread can be attached directly to the telecentric system, without ④
- ⑥ #1508035 Baader Adapter 2" (male) / T-2 (male) – only for SolarSpectrum-filters with female SC-thread, included with the SolarSpectrum-filters
- ⑦ Recommended: 3x #1508153 Baader T-2 / 40 mm Extension Tube
- ⑧ #2456322 Baader TQC/TCR Heavy duty T-2 Quick Changing System
- ⑨ T-2 prism diagonal, e.g. #2456095 Baader T-2 Star Diagonal (Zeiss) Prism with BBHS® coating
- ⑩ T-2 eyepiece clamp, e.g. Baader Focusing Eyepiece Holder 1¼" / T-2 #2458125, Baader 2" to 1¼" ClickLock Reducer (T-2 part #15B) #2956214 or Baader 2" ClickLock T-2 (M42i x 0.75) clamp #2956242
- ⑪ Eyepiece, e.g. #2454636 36 mm Hyperion Aspheric 2" eyepiece – can be used as 2"-eyepiece as well as 1¼"-eyepiece

**Please note:** The perfect working distance of the TZ-3 is 250±10 mm, but in practice the system is very good-natured.

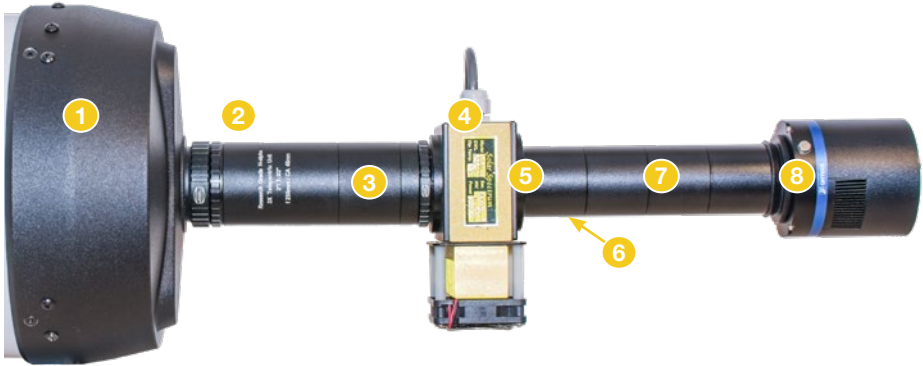
## Example Configuration for SolarSpectrum H-alpha-Filter – Bino-Viewer

- 1 E.g. TriBand Schmidt-Cassegrain with SC-thread
- 2 #2958243 Baader Ultrashort 2" / 2" Thread-Inverter-Ring, included with the TZ-3
- 3 #2459257 2" Research Grade TZ-3 Telecentric System (3-times extension of the focal length),
- 4 #2958244 Baader Reducing-Ring 2"i / T-2a, with 1.5 mm optical length, included with the TZ-3 – to attach SolarSpectrum-Filters with T-2-thread. Not needed for SolarSpectrum-filters with female SC-thread.
- 5 SolarSpectrum-Filter with T-2-threads. Filter with SC-thread can be attached directly to the telecentric system, without 4
- 6 #1508035 Baader Adapter 2" (male) / T-2 (male) – only for SolarSpectrum-filters with female SC-thread, included with the SolarSpectrum-filters
- 7 #2456322 Baader TQC/TCR Heavy duty T-2 Quick Changing System
- 8 T-2 prism diagonal, e.g. #2456095 Baader T-2 Star Diagonal (Zeiss) Prism with BBHS® coating
- 9 #2456313A Baader Heavy Duty T-2 QuickChanger (T-2 part #06A) for bino-viewers with Zeiss dovetail. Not necessary for binoviewers with T-2 knurled slip ring
- 10 Bino-viewer, e.g. #2454636 MaxBright II or #2456410 Mark V Großfeld (Giant)-Binocular, to be used without glasspath corrector

In this configuration, the generous working distance of the TZ-3 shines, and you can observe the sun with both eyes.



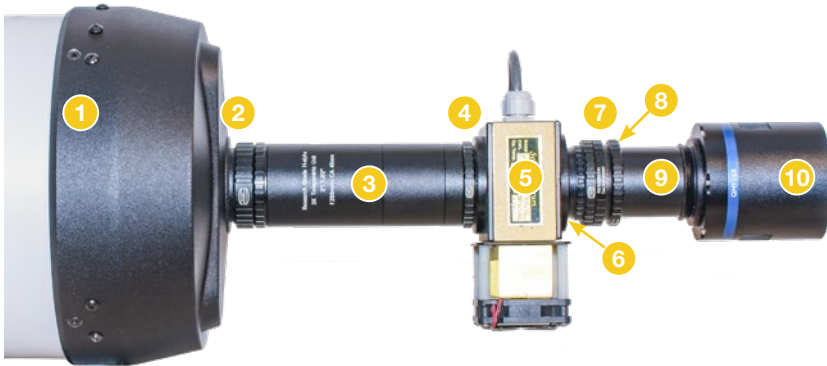
## Example Configuration for SolarSpectrum H-alpha-Filter – for Photography without Reducer



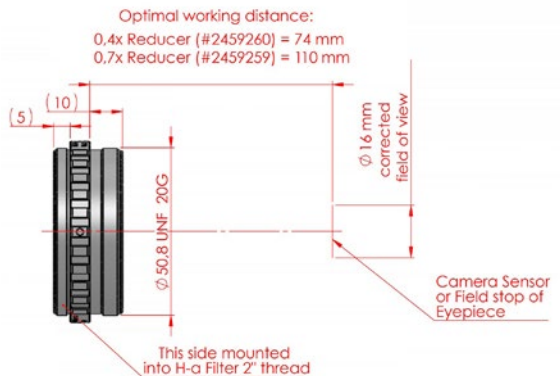
- 1 TriBand Schmidt-Cassegrain with SC-thread
- 2 #2958243 Baader Ultrashort 2" / 2" Thread-Inverter-Ring, included with the TZ-3
- 3 #2459257 2" Research Grade TZ-3 Telecentric System (3-times extension of the focal length),
- 4 #2958244 Baader Reducing-Ring 2"i / T-2a, with 1.5mm optical length, included with the TZ-3 – to attach SolarSpectrum-Filters with T-2-thread. Not needed for SolarSpectrum-filters with female SC-thread.
- 5 SolarSpectrum-Filter with T-2-threads. Filter with SC-thread can be attached directly to the telecentric system, without 4
- 6 #1508035 Baader Adapter 2" (male) / T-2 (male) – only for SolarSpectrum-filters with female SC-thread, included with the SolarSpectrum-filters
- 7 T-2-extensions to set up the camera's working distance. The back focus of the TZ-3 is 250 mm  $\pm$ 10mm. E.g. for a camera with 17 mm back focus and a circa 60 mm long H-alpha-Filter as shown above, you can use 4x #1508153 Baader T-2 / 40 mm Extension Tube.
- 8 Monochrome Camera

**Please note:** You can also integrate a camera tilter or an ADC into the stack of T-2-extensions 7 to avoid Newtonian rings in your images. Cameras with M48-thread can be adapted with a T-2-adaptor or using the M48-system as described on page 17.

## Example Configuration for SolarSpectrum H-alpha-Filter – for Photography with a Reducer



- 1 TriBand Schmidt-Cassegrain with SC-thread
  - 2 #2958243 Baader Ultrashort 2" / 2" Thread-Inverter-Ring, included with the TZ-3
  - 3 #2459257 2" Research Grade TZ-3 Telecentric System (3-times extension of the focal length),
  - 4 #2958244 Baader Reducing-Ring 2"i / T-2a, with 1.5 mm optical length, included with the TZ-3 – to attach SolarSpectrum-Filters with T-2-thread. Not needed for SolarSpectrum-filters with female SC-thread.
  - 5 SolarSpectrum-Filter with T-2-threads. Filter with SC-thread can be attached directly to the telecentric system, without 4
  - 6 In addition *only* for SolarSpectrum-Filters which only have a T-2-thread: #2958110 Baader T-2 Conversion Ring and #2958244 Baader Reducing-Ring 2"i / T-2a, with 1.5 mm optical length. Not necessary for SolarSpectrum-filters with SC-thread
  - 7 #2459259 SolarSpectrum 0.7x Telecompressor 2" with 110 mm back focus  
or  
#2459260 SolarSpectrum Research Grade H-alpha 0.4x Telecompressor 2" with 74 mm back focus
- Please note the adjacent diagram for the correct orientation of the reducer.
- 8 #2958244 Baader Reducing Ring 2"i / T-2a, with 1.5 mm optical length
  - 9 T-2-extension(s) to set the working distance for your camera
  - 10 Monochrome camera



## Example Configuration for SunDancer TZ3-S and TZ4-S



Baader SunDancer II with 2" BBHS star diagonal #2456117  
for connection to the 2" SC-Clicklock #2956220

The Baader SunDancer TZ-3S #1363070 with 115 mm backfocus and TZ-4S #1363080 with 120 mm backfocus have a combined 2"/1¼" nosepiece. For photographic use, a #2956220 SC / HD 2" clicklock can be connected directly to the telescope. For visual use, an additional star diagonal in front of the telecentric is recommended. The SolarSpectrum H-alpha-filter can be adapted to the T-2-thread of the telecentric system. Please note the smaller aperture of the TZ-3S and the working distance. It is no problem if the distance is increased.

### Baader SunDancer II H-alpha-Filter

The SunDancer II H-alpha filter #2456117 uses a modified version of the TZ-3, where the blocking filter is pre-installed in the TZ3-S, so that it can be used instantly on telescopes with up to 80 mm of aperture. To use the SunDancer II with the TZ4-S, this blocking filter must be moved from the TZ3-S to the TZ4-S. The connection of eyepieces, cameras or reducers is done according to the manual of the SunDancer II.

You can find further information about using the SunDancer II H-alpha-filter in its own, detailed manual.

SolarSpectrum filters do not require an additional block filter when using the TZ3-S or TZ4-S and a D-ERF.



Um den SunDancer II H-alpha-Filter mit der TZ-4S zu verwenden (links), muss der silberne schimmernde Blockfilter aus der roten TZ-3S (rechts) in die TZ-4S umgebaut werden.



SunDancer II H-alpha-filter with bino-viewer and star diagonal in front of the filter

## Example Configuration for Baader FlipMirror II

If you use the telescope both photographically and visually, working with a flip mirror such as the Baader FlipMirror II star diagonal #2458055 ① becomes particularly convenient. With a flick of the wrist, you can switch between eyepiece and camera. The flip mirror is mounted behind the H-alpha filter via the T-2 thread. An eyepiece can be brought into the same focus position as the camera sensor with the Baader Focusing Eyepiece Holder 1¼" / T-2 #2458125, so that it is not necessary to refocus when looking through the eyepiece. The working distance for the camera sensor at the straight port and for the field diaphragm of the eyepiece at the top port is identical in each case.

With the T-2 quick-release system #2456322 ②, the flip mirror or camera can be rotated into a convenient position, even when the H-alpha filter is screwed tightly onto the telescope.

The SunDancer II with integrated TZ-3S has an ideal working distance of 65 mm, the folding mirror can be screwed directly onto the SunDancer unit. The 2" Research Grade TZ-3 #2459257 has a working distance of 250 mm, here we recommend additionally two pieces #1508153 Baader T-2 / 40 mm Extension Tube.



The Flip Mirror II behind a Baader SunDancer II (above) and a SolarSpectrum Filter (below, without the additional 40 mm T-2-extensions).

# Operation and Calibration

## The Functions of the Control Box

The H-alpha filter is calibrated for f/30 when it leaves the factory. When the filter is correctly calibrated for your system, all you have to do is to connect the control box to the H-alpha filter and then connect it to a 12V power source. The electronics will then bring the filter up to operating temperature and automatically switch it off if it should get too hot. All filters are set at the factory; depending on your telescope, you may be able to fine-calibrate later.

Depending on the model, you will receive a control box with either one or two displays.



The control box display shows either the difference from the factory set temperature, or it shows target and actual temperature. If your particular setup requires a different operating temperature, you will find instructions in the chapter "Calibrating the Filter".

As soon as the display shows a stable "0" or the target and actual temperatures are identical, the filter is ready for operation. If the telescope is pointed at the sun, it takes about three to five minutes until the filter is in temperature equilibrium.

Older control boxes in particular are calibrated to the operating temperature instead of "0". If you have any questions about this, contact our support.

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 control box from the power source.

### Changing the Target Temperature

You can easily change the temperature of the filter and thus the position of its transmission window (see also page 26). Increasing the temperature shifts the maximum to the longer-wavelengths in red wing of the H-alpha line; decreasing it shifts it to the blue wing



At the control box with one display, the display shows the difference to the operating temperature. On the left during heating up, on the right after reaching the target temperature.





This control box with two displays shows the current temperature in red on the left and the target temperature in green on the right. Some models show "0" on the right and the deviation from the target temperature on the left. On the left during heating up, on the right after reaching the target temperature.

in the shorter-wave spectral range. A change of 10.0 degrees shifts the transmission maximum by about 1 angstrom, which is also the maximum possible change.

At the control box with *one* display, 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 target temperature (displayed as a deviation from the factory-set value).

At the control box with *two* displays, press the up arrow to increase the temperature or the down arrow to decrease it. If necessary, confirm with the SET key. After a few seconds, the display stops flashing and the filter is tempered to the new setpoint. Make a note of the factory preset value.

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

## Using a Neutral Density Filter

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

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.

We recommend the following filters:

- Single Polarizing Filter: 1¼" #2408343; 2" #2408342
- Neutral Density Filter ND 0,6 (T=25%): 1¼": #2458343; 2": #2458321
- Neutral Density Filter ND 0,9 (T=12,5%): 1¼": #2458344; 2": #2458322



Polarizing and Neutral Density filters dim the light for a better perception of details.

## Setting the Temperature

The working temperature of the filter and thus the position of the central wavelength can be adjusted via the 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.

To change the working temperature, perform the following steps:

1. Wait until the filter has reached its target temperature and displays the numerical value "0", or the target and actual temperatures are the same. Give it some time, so that the whole area of the filter is at the same temperature
2. Press once UP ↑ or DOWN ↓ to get into the programming mode. The display of the target temperature starts to blink. Press UP ↑ to increase the temperature, or DOWN ↓ to decrease it. Confirm the new value with SET; if you are using the controller type with one display, the value will be used automatically if you don't press a key for a couple of seconds.
3. Although you can change the value by up to 10°, but only a small change is necessary for a visible change.

Increasing the temperature results in a shift of the wavelength towards the longer wavelengths in the red part of the spectrum. On the other hand, decreasing the temperature moves the central wavelength towards the shorter wavelengths in the blue part of the spectrum. In the blue wing of the H-alpha-line, you can observe fast, high-energy changes on the surface of the sun.

The new value is also stored when you cut the power supply.

**Please note:** The filter temperature is influenced by the incoming heat of the sun. If the filter wasn't pointed at the sun for some time, the temperature needs some time to compensate for the additional heat of the sun once it is pointed onto the sun again. After about 30 to 60 seconds (depending on the filter diameter) it will be back to the desired wavelength.

## Calibrating the Filter

The SolarSpectrum filter are calibrated at the factory for f/30 and should give the best image when the display of the temperature difference is at "0", or if actual and target temperature are the same. 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. 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 the sun in the blue wing of the H-alpha line.
2. Increase the target temperature by 1.0 degree (corresponding to 0.1 Å) and give the filter a couple of minutes to stabilise again.
3. 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.**

### 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 star diagonal can also cause tilting.

## Determining the perfect Distances

The configurations on page 16ff are example configurations which work pretty good in most cases due to the parallel beam of light and the nonproblematic behaviour of the telecentric systems. Nevertheless, even a telecentric system has got an ideal working distance to which you should keep to  $\pm 10$  mm for the best results. It is:

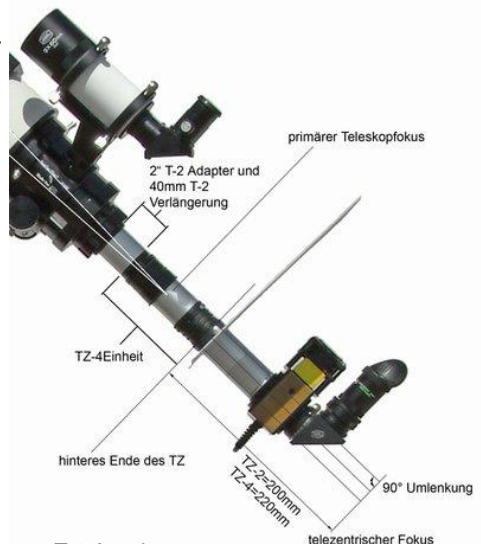
- Telecentric System TZ-2 #2459255: 200 mm (no longer in production)
- 2" Research Grade TZ-3 Telecentric System #2459257: 250 mm
- Telecentric System TZ-4 #2459256: 230 mm
- SunDancer II Telecentric System TZ-3S #1363070: 115 mm
- SunDancer II Telecentric System TZ-4S #1363080: 120 mm

The mechanical distance with an H-alpha filter installed varies, because the glass path is not the same in all filters. To find the perfect distances for your system, perform the following steps:

1. Fix the D-ERF in front of the telescope and place the telecentric system in the focuser. Do not look through the telescope!
2. Place an extension tube behind the telescope, which is as long as the ideal working distance of your telecentric system (measured from the bottom of the T-2-thread). It can be made of T-2-extensions, or simply from cardboard. Put a piece of paper at its end as projection screen.
3. Now use the focuser of your telescope to achieve a sharp image of the sun on the projection screen. Once you have reached focus, don't change the focuser position.
4. Now place the H-alpha-filter with all adapters behind the telecentric system. Focus by moving the eyepiece – for smaller corrections, we recommend Baader Focusing Eyepiece Holder 1¼" / T-2 #2458125, for larger corrections, you need to add or remove T-2-extensions.

The focus position of cameras and eyepieces is not standardized, but you don't need a higher precision than  $\pm 10$  mm. All remaining corrections can then be done with the focuser of the telescope.

This must be done only once if you write down the configurations or keep the necessary adapters together. If you are using one of the smaller (planetary) cameras which fit into the 1¼" focuser, we recommend the Stop Ring 1¼" #1905131 to always bring it to the same focus position as your eyepieces.



# Cleaning and Maintenance

In general, the principle "less is more" applies to the cleaning of all optics!

**The lens system of the telecentric system** usually doesn't need much care. An occasional cleaning is all that is needed – and all the less often if the optics are stored carefully with the dust caps on.

Over time, dust may accumulate on the outer lenses. Great care is required to avoid damaging the optics. If dust has settled on the lens, remove it with a camel hair brush or with compressed air from a pair of bellows – do not use compressed air from a can, as that may contain additives. Blow on the lens at a shallow angle for a few seconds. For further removal of stuck dirt, use Optical Wonder Fluid from Baader Planetarium and a soft cloth (Kleenex (!) – no other brand!) to remove any remaining residue.

Wipe from the centre of the lens outwards. Do not rub in circles! Never spray the cleaning fluid onto the lens! Otherwise liquid could flow between the lenses. Put the liquid on a cloth and then treat the lens with the cloth.

Occasionally, dew condenses on a lens, especially when it is brought into a warm room. Then do not cover the lens until the moisture has evaporated.

After a night of observation, always inspect the telescope the next day to see

if any residual moisture has remained on the optical surfaces. If necessary, allow the telescope to air open and only then close it dust-tight again.

## **The H-alpha-Filter must not be cleaned mechanically!**

For cleaning, you must only use a pair of bellows – never use compressed air from a can! You must never attempt to clean the H-alpha-filter mechanically by swiping or rubbing.



[www.baader-planetarium.com/optical-wonder](http://www.baader-planetarium.com/optical-wonder)

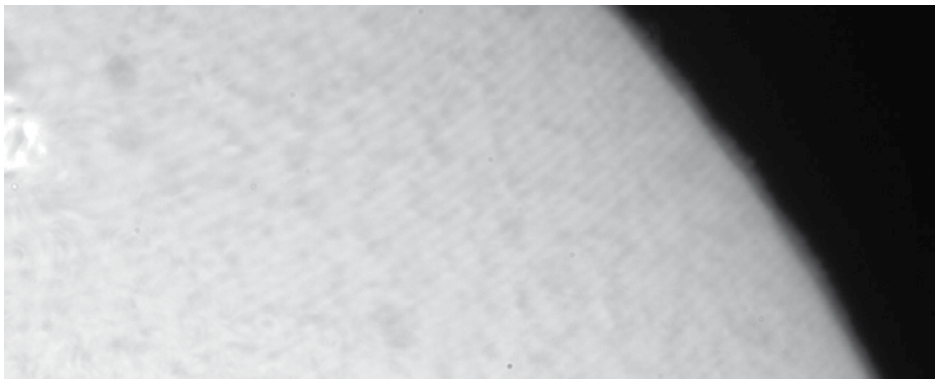


**Attention: The H-alpha filter is sensitive to frost and *must not* be stored below 0 °C. It may be used at temperatures down to -10 °C as long as the heating element is active; we recommend to insulate the filter at cold temperatures.**

# Tips for Observing the Sun

A larger solar telescope makes special demands on observation conditions. Please take note of the following tips:

- Let the telescope cool down well. Avoid that the sun moves out of the centre of the image and illuminates and heats the inner walls of the tube. Do not turn the telescope out of the sun during observation breaks, as then only one side of the telescope will heat up unevenly. It is better to cover it. If you are observing from an observatory, simply close the roof or dome slit so that the telescope is completely in the shade.
- Wait for moments of good seeing. The large aperture leads to a high minimum magnification, so that disturbing influences of bad seeing become visible, which are not noticeable in smaller instruments. Observe the local conditions at your observation site during the course of the day; the air is usually calmest in the morning.
- Keep your distance. Especially for photography, you can set up the control PC at a greater distance behind the telescope. Even sitting next to the telescope can have a negative effect on local seeing.
- Use a good glare shield. Both good eyecups and an observation cloth which is white on the outside and black on the inside and which is pulled over your head are very effective in blocking stray light and increasing the perception of detail.
- Avoid too small exit pupils when observing in H-alpha. The rule of thumb that the maximum magnification is twice the telescope aperture in millimetres (i.e. an exit pupil of 0.5 mm) does not apply to H-alpha observation because of the longer wavelength. If the exit pupil is much smaller than about 0.8-0.7 mm, the image contrast will eventually break down.
- Use a double polarising filter or a single circular polarising filter to suppress reflections. Some light attenuation can also make it easier to perceive faint structures.
- Some monochrome cameras show conspicuous Newtonian rings on H-alpha filters, which cannot be eliminated even by flats. They are caused by interference in the camera. Sometimes they only appear when observing with (or without) a reducer. There are two ways to eliminate them:



Newtonian rings are caused by interferences in a monochrome camera (here: ZWO ASI120MM).

1. A tilter can tilt the camera so far that no more interference occurs. However, it may be necessary to tilt the camera so much that, with large sensors, even at  $f/30$ , parts of the sensor are no longer in the focal plane.
  2. An ADC (Atmospheric Dispersion Corrector) can also effectively eliminate the Newtonian rings and is better suited for this than a tilter. Make sure that the ADC has sufficient free aperture.
- When photographing solar structures, it can be useful to use guiding with an autoguider even for the sun, so that the structures remain centred in the image for a long time. You can connect a guiding camera via the VarioFinder with a suitable solar filter (see p. 19). Software such as SharpCap offers the option of "feature tracking" to also track sunspots.
  - Take flats to compensate for dirt on the sensor or on the telescope.

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Zur Sternwarte 4 • D-82291 Mammendorf • Tel. +49 (0) 8145 / 8089-0 • Fax +49 (0) 8145 / 8089-105  
[www.baader-planetarium.com](http://www.baader-planetarium.com) • [kontakt@baader-planetarium.de](mailto:kontakt@baader-planetarium.de) • [www.celestron.de](http://www.celestron.de)

