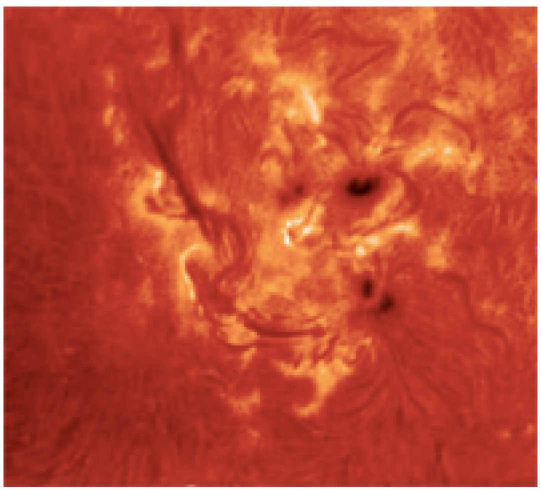
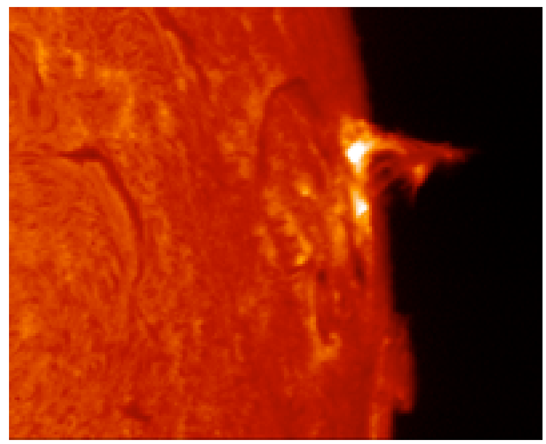
Company Seven
Astro-Optics Division

The DayStar™ Filter
An Operating Manual





Hydrogen-Alpha Series: ATM and UNIVERSITY (Oven Models)

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The DayStar™ Hydrogen-Alpha Filter
An Operating Manual by Company Seven

MODEL: ATM **SERIAL No. U-1804** **BANDPASS: 0.6 Å**

ON BAND DIAL SETTING **5.0 (High Contrast)**, DO NOT EXCEED **9.0** SETTING

NOMINAL SETTINGS FOR FILTERS WITH OPTIONAL ±1.0Å OFF-BAND TUNING:

-1.0 Å SHIFT INTO BLUE: DIAL SETTING = **1.0** For Extensive Doppler Work

+1.0 Å SHIFT INTO RED: DIAL SETTING = **8.0** For Extensive Doppler Work

You have purchased a filter that can introduce you to another world. Please take a few minutes to read this manual keeping in mind that this will help you to progress much more rapidly than you might otherwise.
Martin Cohen, Company Seven

I. An Introduction to Solar Observing and Hydrogen Alpha Light:

DayStar filters are uniquely designed to transmit a narrow section of the solar spectrum while reflecting or absorbing undesirable parasitic light. To accomplish this white light (produced by a combination of colors) must be broken down into its constituent form to produce a rainbow of colors. Each color is measured in Angstrom units, each representing $1x10^{-10}$ meters. The symbol for Angstrom is Å. The human eye can discern colors within the rainbow from about 3800Å in the violet through to about 7000Å in the crimson. Within sun light the continuous spectrum visible in white light is interrupted by a series of black bands called absorption lines; these lines are primarily created by cool absorbing gases located in the Sun's upper photosphere or chromosphere. In order to observe phenomena interacting with hydrogen or calcium, very precise optical filtration is required. Company Seven can support studies of most portions of the solar spectrum.

Left: The Sun as seen through a "White Light" Filter.

The photosphere is the visible surface of the Sun that amateur astronomers are most familiar with. The visible surface of the Sun is not a solid surface, but it is actually a layer of the gas ball that is about 100 km thick; this is relatively thin compared to the 700,000 km radius of the Sun. The photosphere is readily observed with relatively inexpensive solar filters several of which we offer. When observing the center of the disk of the Sun we look straight in and see some hotter and brighter regions. When one observes the limb of the solar disk that light has taken a slanting path through this layer and we only see through the upper, cooler and dimmer regions. This explains the limb darkening that appears as a darkening of the solar disk near the limb. A number of features can be observed in the photosphere with a simple telescope equipped with a suitable "White Light" filter with a metal coated glass or polymer element, designed to reduce the intensity of sunlight to comfortable levels, and to eliminate or attenuate harmful portions of the spectrum.

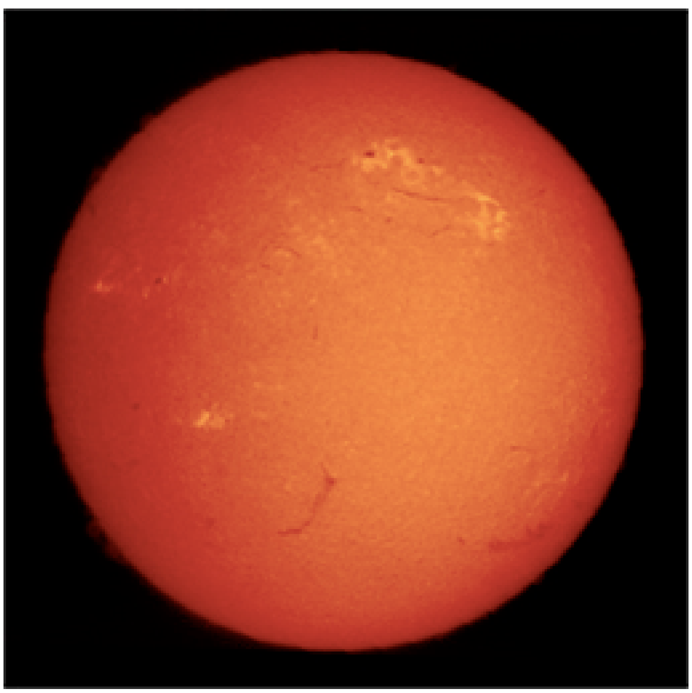
Depending on the nature of the coating or metal used to make the filter the Sun may appear white, blue, yellow (as shown above), or orange red. The features visible in a white light filter may include 1. dark sunspots, 2. the bright faculae, and 3. granules. One can also measure the flow of material in the photosphere using the Doppler effect. These measurements reveal additional features such as supergranules as well as large-scale flows and a pattern of waves and oscillations.

The chromosphere appears as "peach fuzz" surrounding the Sun. This is an irregular layer above the Sun's photosphere where the temperature rises rapidly from 6000° C to about 20,000° C. At these higher temperatures the hydrogen emits light that gives off a deep red color (H-alpha emission). The chromosphere derives its name (color-sphere) from these phenomena. This colorful emission can also be seen in prominences that erupt and then project to beyond the limb of the sun into the black background of space. Prominences may be safely observed by the naked eye during total solar eclipses.

However, when the Sun is studied through a spectrograph or a filter that is engineered to isolate the H-alpha emission, then many more features are revealed including: the chromospheric network of magnetic field elements, bright plage around sunspots, dark filaments across the disk, and prominences beyond the limb.

The most commonly used portion of the spectrum for serious studies of the Sun is in the red portion of the solar spectrum, specifically at the line of Hydrogen Alpha located at 6562.81Å. At its half intensity point, this line is only 1.20Å wide. Consider that a 0.5Å bandpass filter is passing only about 1/8000 of the frequency band of visible light! Providing optical filtration in this order of dimension is most demanding, and DayStar is among the few manufacturers who has historically proved to be able to do this consistently well, and with good durability and longevity of the filter system.

DayStar Hydrogen Alpha Filters



DayStar monochromator filtration technology progressively isolates a prominent absorption line from the rest of the spectrum, and then transmits it through to an eyepiece, camera, or sensor. Delivering high purity filtration for solar observing involves relatively new and innovative thin film coating technologies; to fill this need DayStar has developed a computerized controlled laser assist coating process. This and other technology improvements over the recent decades has made it possible to produce higher quality components to meet the increasing needs of our customers.

Sunlight passes through a series of critical filter elements including: an anti-reflection coated optically flat window, narrow band blocking filter, an etalon window, a Fabry-Perot solid space crystal (carefully produced in house by DayStar), a second etalon window, broad band trimming filter, and another AR coated optically flat window.

Left: Sun a shown in a DayStar Hydrogen Alpha filter.

II. The DayStar Filter System Components:

The DayStar Calcium K-Line, T-SCANNER™, ATM and UNIVERSITY filter systems each have two primary components: the Filter Body, and an Energy Rejection Prefilter (ERF).

All optical interference filters are sensitive to changes in temperature. The Bandpass will shift towards the longer wavelengths with an increase in temperature, or towards the shorter wavelengths with a decrease in temperature. The standard DayStar filter shifts at a rate of 1.0 Å per 16.8 degrees F change. The narrower the filter bandwidth is, then the more precisely the temperature must be regulated.

Therefore, each DayStar Calcium K-Line, ATM and UNIVERSITY filter is installed in a cylindrical temperature regulated oven allowing ±0.05 Å on band control. Considering the absorption band is only 1.2 Å wide at its half intensity point, such control is absolutely required. The Calcium K-Line, ATM and University filter models employ an integral heater and controller to precisely regulate the temperature of the filter elements, therefore your instrument will have a power cord and control dial attached to the filter housing.

The DayStar Filter Body:

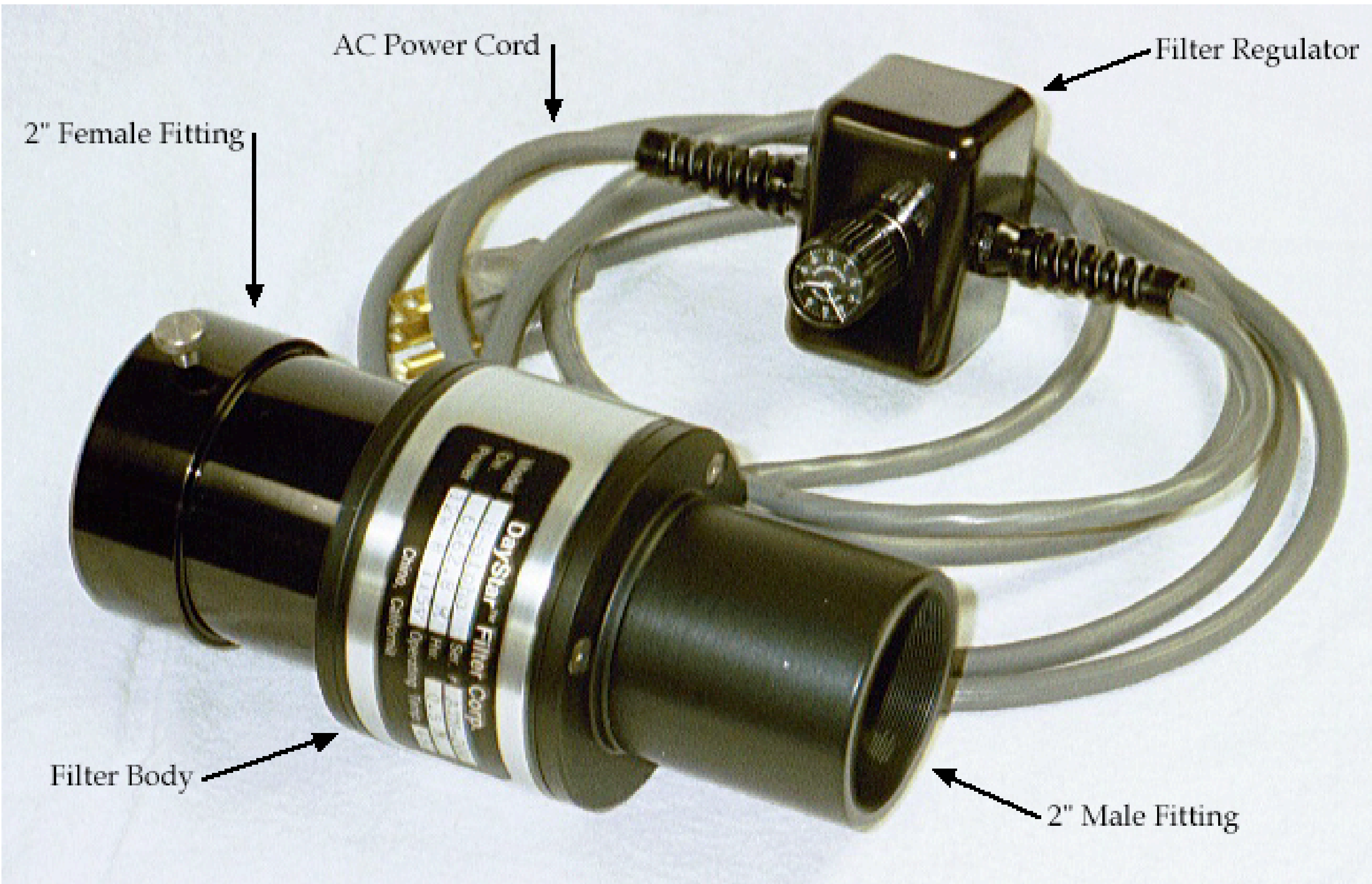
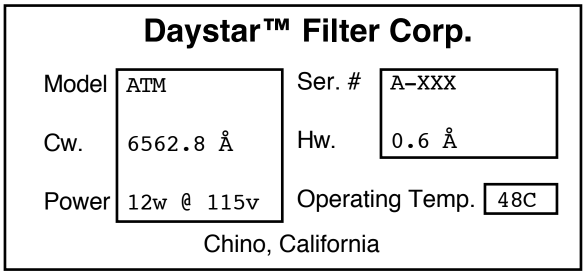


Illustration 3: DayStar Filter Body with Flanges installed at each end.
Note the optional two inch Male and Female fittings which are threaded into the Filter Body Flanges.

The standard Calcium K-Line, ATM and University Filter Body has a clear 32mm aperture, **although other apertures are available by special order**. This filter body accepts bolt on parallel or wedge shaped accessory mounting flanges. These flanges will be selected based on the telescope on which the DayStar filter is to be employed. The filter must be equipped with the appropriate optional mounting hardware and flanges to attach the system onto a telescope. And the filter must also be provided with those fittings necessary to accept the visual or imaging accessories. The DayStar filter body as typically furnished by Company Seven is provided with Flanges to install the filter onto and to accept either 1.25 or 2 inch diameter "slip on" fittings, or with Questar or Celestron fittings, or what custom fittings are specified. Company Seven offers a good selection of hardware, with the expertise to recommend what may be appropriate for your needs.

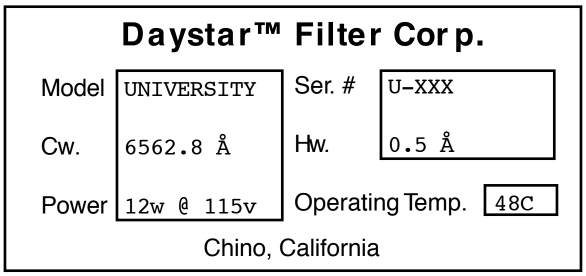
DAYSTAR FILTER BODY SPECIFICATIONS

Diameter:	3.00" (76mm)
Body Length:	2.00" (52mm)
Weight:	Approximately 1.0 pound (0.453 kg)
Power:	12-30 W at 115V AC, 50-60Hz 60Hz (a converter from 220 volt to 115 may be required)
Power Cord:	Three wire grounded, 6.6 feet (2.0 meters) long.



Cw. = Central wavelength in Angstroms
Power = Wattage and Voltage requirements
Ser. = Serial Number
Hw. = Width of Bandpass in Angstroms
Operating Temp. = Nominal Temperature required to achieve the Hw. This can be adjusted at the dial on the power cord.

Illustration 4: Label on a DayStar Filter (ATM Model Label shown)



Cw. = Central wavelength in Angstroms
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Ser. = Serial Number
Hw. = Width of Bandpass in Angstroms
Operating Temp. = Nominal Temperature required to achieve the Hw. This can be adjusted at the dial on the power cord.

Illustration 5: Label on a DayStar Filter (University Model Label shown)

The DayStar filter power cords are provided with a precisely calibrated, ten turn knob pot for adjusting the oven temperature thereby optimizing contrast. This is also used for setting the optional ± 1.0 Å off band tuning for research applications includingDoppler work. The proper dial setting for “On Band” is specified at the top of Page 3 of this manual. For models suitably equipped the proper dial setting for this filter “Off Band Shift into the Blue” is also specified at the top of Page 3 of this manual, the proper setting for “Off Band Shift into the Red ” is specified too. **These settings are specific to each instrument and may vary from one filter to another.** The suggested Peak Setting (usually 9.0) should never be exceeded or damage to the filter may result!

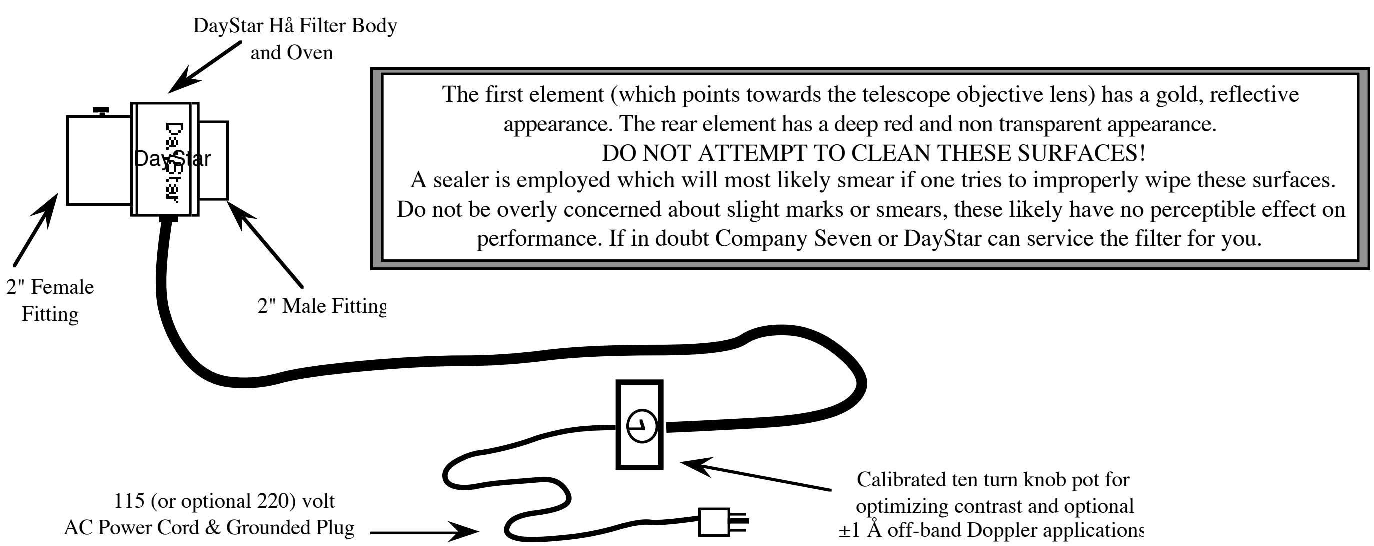


Illustration 6: Arrangement of DayStar ATM, UNIVERSITY model filter.

The Energy Rejection Filter (ERF):

The Energy Rejection Filter (ERF) sometimes called a "pre filter" is an essential component of a DayStar Hydrogen-Alpha system. Each is a custom engineered glass filter of a specific deep red color, mounted into a cell that is attached over the front of the telescope to cut down about 80% of the off band solar energy. More importantly, the ERF is a component designed to assist in the elimination of ultraviolet solar energy.

The filter is so precisely ground plane parallel, and smoothly polished so that the transmitted wave front as provided by Company Seven will not exceed one quarter wave Peak to Valley at 6563 Å (Angstroms). **No other Energy Rejection Filter should be substituted.**

The DayStar Hydrogen-Alpha filter is engineered to work best with a system providing an f30 beam. This is nearly parallel light. The f30 ratio may be obtained from a telescope by either:

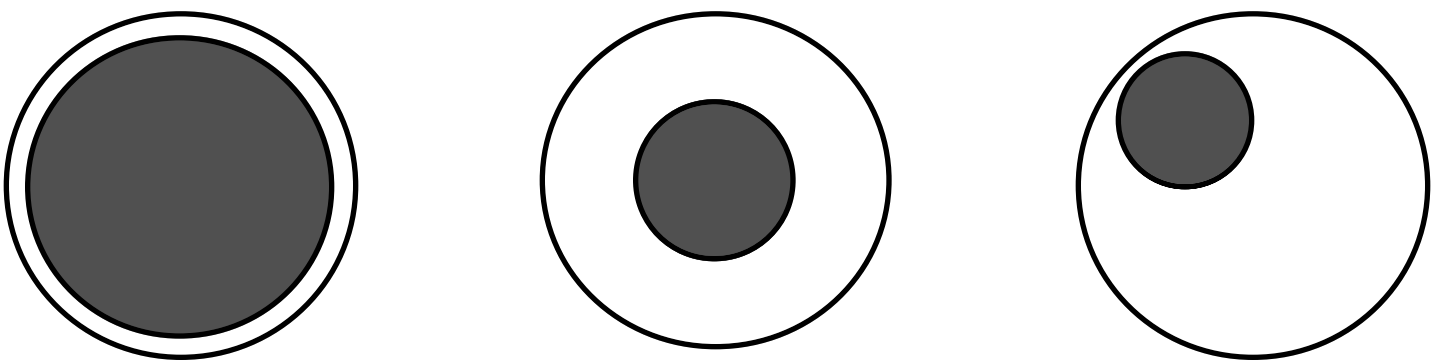
1. choosing to employ a telescope that by design is an f30 system, or

2. stopping down the aperture of a telescope. For example, a six inch f15 refractor stopped down to a three inch aperture becomes f30, reducing a telescope's effective aperture by half doubled the Focal Ratio. The ERF aperture may be calculated to shape the cone of light passing through the telescope into a f30 beam.

3. employing and ERF with optional optical elements to shape the beam into the f30 cone.

Earth's atmosphere only rarely permits seeing conditions as good as 1 arc second. So observers will rarely benefit from employing apertures much larger than 4 inches, or as much as 7 to 9 inches under the best of skies. Furthermore, the cost or availability of a large ERF may become limiting factors. The ERF may not by design need to cover the full aperture of the telescope. A partial aperture filter may be installed so that it is positioned in the center ("on axis") of unobstructed telescopes such as the refractor; this is to say that an eight inch aperture refractor may use an ERF only less than eight inches in aperture. Most observers will prefer to employ the largest practical aperture ERF in order to provide better resolution; this may show more detail than a smaller ERF depending on local "seeing" conditions. However, while Company Seven does often manufacture filters for operation of 13 cm to 15cm apertures (and occasionally larger), our experience shows stunning results may be obtained employing apertures as small as 80mm.

Note however, that telescopes with a central obstruction including the Cassegrain or Newtonian would require an "off axis" filter so that light from the filter is not obstructed by the central obstruction, or by its' supports. And so for example, 14 inch Schmidt Cassegrain telescope may employ a five-inch filter off axis.



Front view of a Full Aperture Pre Filter

Front view of a On Axis Partial Aperture Pre Filter

Front view of a Off Axis Partial Aperture Pre Filter

Illustration 7: Three possible arrangements of the Energy Rejection Filter.

For example a 6 inch (15cm) aperture 90 inch (2,286mm) focal length f15 refractor would require a 3" (76mm) diameter ERF. The 90 inch focal length divided by the three-inch aperture provides the nominal f30 ratio.

In another example (illustrated at right) an 8 inch (20cm) aperture 80″ (2,032mm) focal length f10 Cassegrain telescope would require a 2.7 inch (68mm) diameter ERF. That ERF installed over the front cell would cut the effective aperture to 3 inches. The ERF element must be precisely positioned off-axis in such a manner that the ERF is not blocked by the Secondary obstruction, and so that the ERF does not extend to beyond the periphery of the telescope Primary Mirror.

Illustration 8: Celestron C-8 with DayStar Filter and Off Axis Prefilter attached.

In addition to the Filter Body and ERF other optional accessories including a matched Telecentric beam shaping lens, a Barlow (negative lens), or other device may be employed to form the beam of light exiting the telescope into the f30 cone. By increasing the effective focal length through the use of a diverging lens one may employ a larger aperture ERF. However diverging (Barlow) lenses alone are rarely the best solution since it is the *Angle of Divergence* of the light is the most critical characteristic of the f30 beam. This is why Company Seven offers several Telecentric lenses, some matched to a negative element.

For example: a 6 inch (15cm) aperture 90 inch (2,286mm) focal length f15 refractor telescope using a DayStar Hydrogen-Alpha filter could use a 3 inch (76mm) diameter ERF to attain an f30 beam. However, if we employ a 1.5X Barlow lens then the 6 inch f15 telescope becomes an f22.5, 135- inch effective focal length system. To get this telescope to f30 divide 135 by 30 and this will suggest the need for a 4.5-inch diameter ERF.

Keep in mind that a Barlow lens produces varying effects depending on the accessory used. A Barlow is a diverging lens placed before the focal plane. The farther behind the Barlow lens an accessory is positioned, the greater the image is enlarged. We sell a 2 inch 2X Barlow lens of first quality that actually averages 1.7X when an ocular is attached directly into the Barlow, but 2.3X when a 2-inch mirror diagonal is placed between the ocular and the Barlow lens.

Astro-Physics	Avg. EFL	Prefilter	w/2X Barlow
4" Starfire	826mm	1.08″	2.17″
12cm ED	1006	1.32	2.64
5" Starfire	1045	1.37	2.74
5"f12 S.P.	1045	1.37	2.74
5.1" EDT	1045	1.37	2.74
6" Starfire	1415	1.86	3.71
6"f12 S.P.	1800	2.36	4.72
7" Starfire	1665	2.19	4.37
8.1" EDF	1576	2.07	4.14
TeleVue			
Oracle 3″	563mm	0.74†	1.48
Solaris 2.4″	1750	2.40	†
85	560mm	0.73†	1.5
Genesis	500	0.66†	1.31
101	550	0.7†	1.4
102	880	1.2	2.4

Celestron	Avg. EFL	Prefilter	w/2X Barlow
C-5 - 5″	1250	1.64*	3.28†* (1.5″*)
C-8 - 8″	2000	2.62	5.25†* (2.5″*)
C-11 - 11″	2800	3.67*	7.35†* (3.5″*)
C-14 - 14″	3910	5.13*	10.26†* (4.5″*)
Meade Instruments			
2080 - 8″	2000	2.62*	5.25†* (2.5″*)
2120 - 10″	2500	3.28*	6.56†* (3.0″*)
Questar			
3-1/2	1280	1.68†*	3.36*~ (1.25″*)
7	2413	3.17†*	6.33*~ (2.5″*)
Other typical refractors			
80mm - 3.1″	900mm	1.18"	2.36″
102mm - 4″	900mm	1.18"	2.36″
6″f15	2286	3.00	6.00

Table. 1 Examples of calculated prefilter diameters for some of the popular telescope we sell.
EFL = Average Effective Focal Length, † = Not Suggested, * = Off Axis Filter

III. Field of View as a Consideration

The Sun appears in the sky as an object about 1/2 degree in angular diameter. In order to be able to view the entire disk of the sun in an eyepiece, or image it onto a CCD or film (without "mosaic" composition) one will have to consider the image size provided by the complete system. In order to understand this better consider the following examples:

Configuration A. Company Seven uses our Astro-Physics 13cm (5.1 inch) f8 Apochromat refractor for solar observing. This telescope has a 41.3 inch (1048 mm) focal length. With a 5 inch ERF, the telescope remains f8. To attain a nominal f30 beam we may employ either a 2X Barlow with Extension Tube with a Telecentric beam shaping element to produce an approximate f32 nearly parallel 165 inch/4,192mm effective focal length.

To calculate how our telescope will perform visually, we can use the following two formulas:

1. Magnification = Effective Focal Length of Telescope / Focal Length of Eyepiece

2. Actual Field of View (Degrees) = (57.3*Eyepiece Field Stop Dia. in mm)/Effective Focal Length of Telescope

Understanding a TeleVue 55mm Plossl eyepiece has a 46.00mm diameter Field Stop (yes we actually measure these things), one can quickly surmise the operating magnification will be 76X. And the Actual Field of View will be 0.63 Degree. This will produce a nice view of the Sun with enough surrounding space to easily accommodate prominences, and nicely compose the disk of the Sun against the black background (or space).

If we choose to use a TeleVue 31mm Nagler eyepiece (82 degree apparent Field of View), then with it's Field Stop of 41.63mm and Magnification of 135 X, we will observe 0.57 Degrees - nearly the Field of View shown by the 55mm Plossl but at 1.8X the magnification!

A less accurate but quick formula for those lacking Field Stop details of the eyepiece would be:

3. Actual Field of View (Degrees) = Magnification / Eyepiece Apparent Field

In this example the 31mm Nagler should provide a Field of View of 0.61 Degrees. This formula is less accurate in that it does not factor the degree of distortion common to wide-angle eyepieces.

Since the limit of Field Stop diameters is reached at about 46mm, a telescope with an effective focal length of more than 4,200mm can not show the full solar. Photographic and video field of view may be similarly calculated to aid the decision making process.

Configuration B. Again using our Astro-Physics 13cm f8 Apochromat for this example, we may employ a TeleVue 2X "Powermate" lens (a 2X Barlow with Telecentric beam shaping element) to produce about an f17 – 85.3 inch (2,167mm) effective focal length. The Telecentric lens shapes the beam to exit the Powermate with an angle of divergence that approximates a nearly parallel beam, this is quite satisfactory for use with the DayStar filter. And this gives the added advantages of requiring less hardware and extensions on the telescope focuser, and allows us to operate the telescope at lower magnifications to "back off" so to speak on sessions with marked atmospheric turbulence.

Using a TeleVue 55mm Plossl eyepiece in configuration B the operating magnification will be only 39X, and the Actual Field of View will be 1.22 Degrees. This will produce a low enough magnification view of the Sun to diminish some of the adverse distractions posed if the atmosphere is turbulent.

If we choose a TeleVue 31mm Nagler eyepiece (82 degree apparent Field of View), then with it's Magnification of 70 X we will observe 1.1 Degrees – again nearly the Field of View shown by the 55mm Plossl but at 1.8X the magnification. One will choose a higher magnification eyepiece like the TeleVue 22mm Panoptic or 22mm Nagler to show a closer view of the full disk of the Sun.

IV. Installing the DayStar Filter

1. The DayStar filter may be attached on to the telescope focuser. Be aware that certain telescope optical tubes (particularly Newtonian designs) place the focuser where there may not be enough “back focus” to accept accessories such as the DayStar system. This is done to minimize the deleterious effects of using a larger secondary mirror. This may require that you to employ a Barlow lens to project the image out farther, or reposition the telescope primary mirror closer to the secondary mirror.

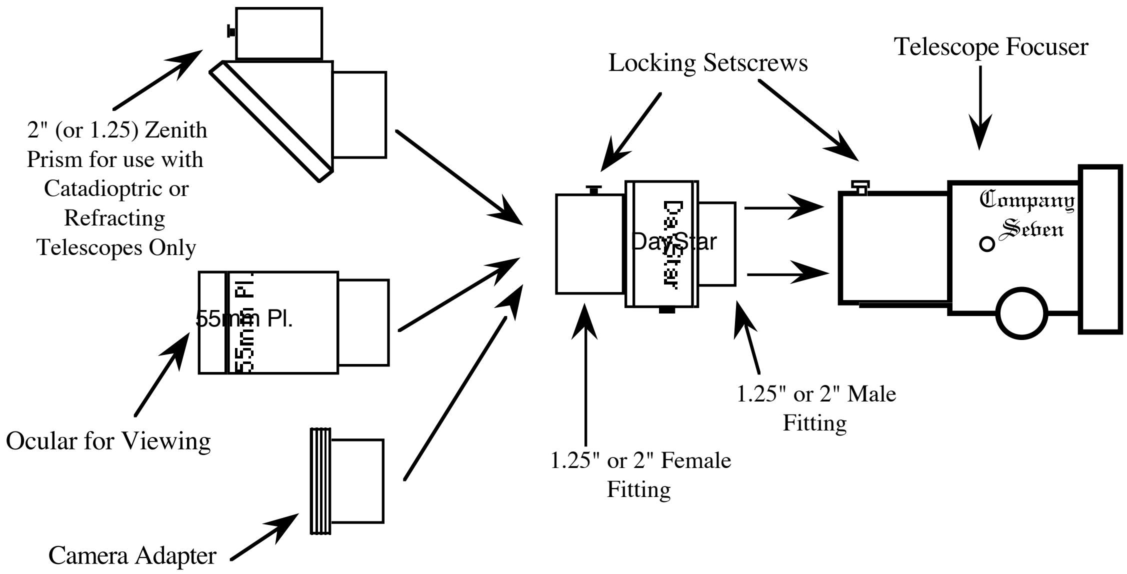


Illustration 9: Installation of DayStar Filter onto telescope focuser.

Refracting telescope optical tubes are usually manufactured to a length that anticipates attachment of a variety of accessories onto the telescope. This may require use of an extension tube between the focuser and the filter body to achieve proper focus. Most suggested variations are shown in the illustrations No. 8, 9, and 11.

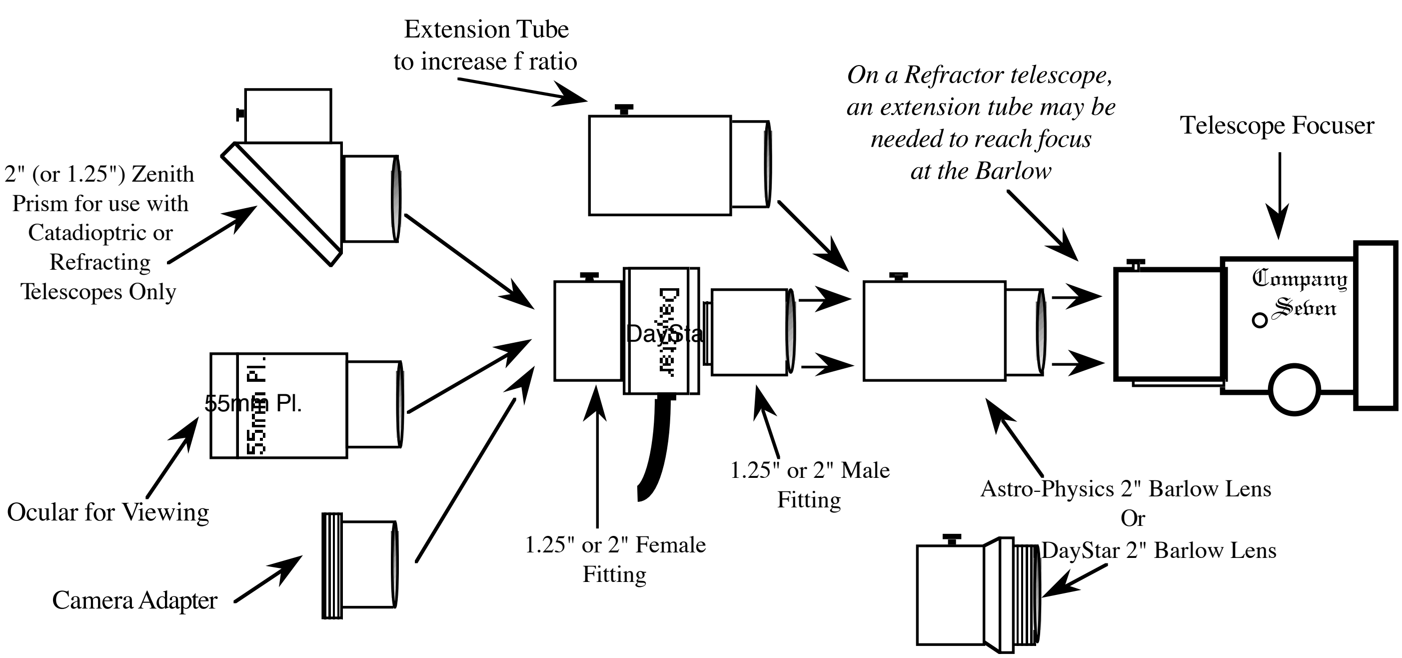


Illustration 10: Installation of DayStar Filter with Barlow (Telenegative) Lens onto telescope focuser.

If the filter is to be used on a telescope with an **off axis** ERF then a flange must be installed that incorporated a specific degree of wedge to offset the field curvature encountered in the off axis filtered telescope. The filter body must be rotated so that the wide portion of the wedge corresponds to the position of the off axis ERF. It does not matter if these are at 12 o'clock, 3 o'clock, etc. as long as both index features are at the same position.

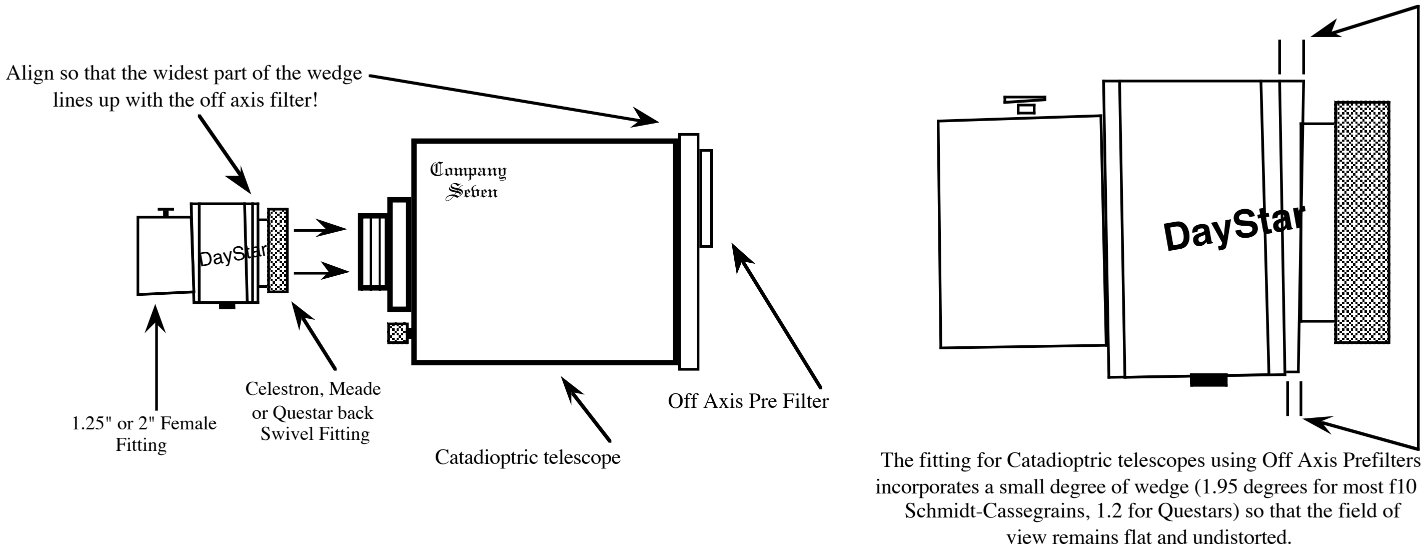


Illustration 11: (Above) Installation on telescope with off axis filters is shown.

A flange with wedge is mandatory for use with an off axis ERF. No wedge is required for on axis ERF. Since the degree of wedge may vary from one off axis filtered telescope design with another, consult with Company Seven prior to moving a filter from one off axis filtered telescope to another telescope.

Use of the Astro-Physics Barlow & Telecentric Lens

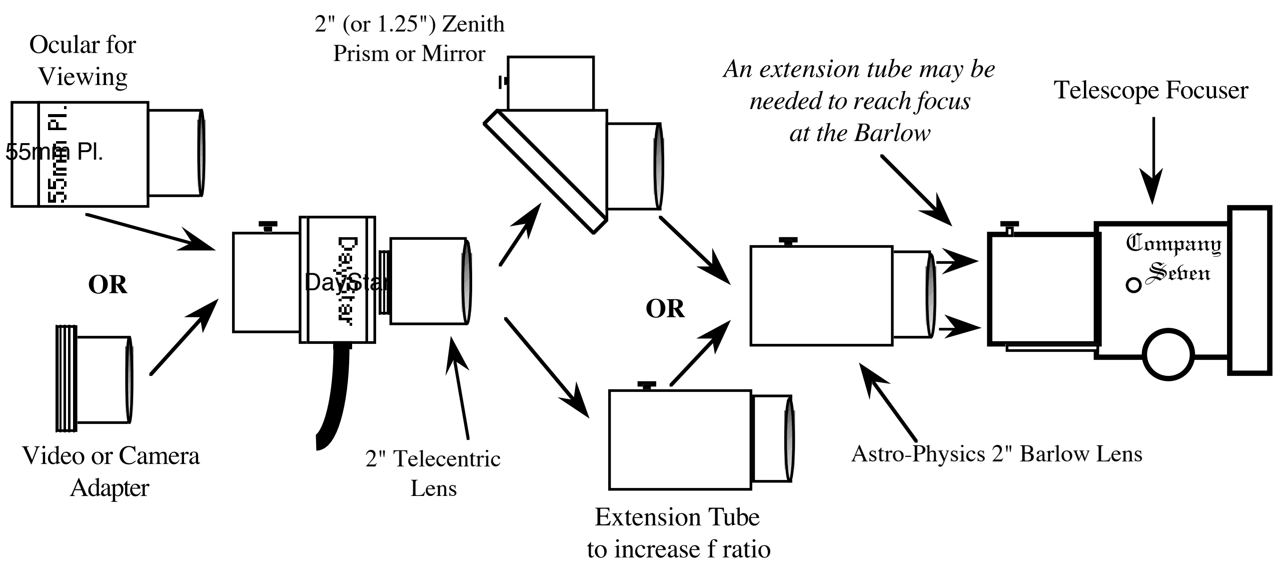


Illustration 12: Installation of DayStar filter using Astro-Physics Telecentric and Barlow Lenses.

If a 2 inch diagonal is to be used then it should be placed ahead of the DayStar Filter, directly into the 2 inch Barlow (or extension tube) and secured at this time. Never place the diagonal behind the DayStar filter with the Telecentric lens in place. If the 2 inch diagonal is not used, then insert the Astro-Physics extension tube (to add projection from the Barlow) into the Barlow lens.

V. Placing the DayStar Filter Into Service

1. Set up the telescope, Polar Align the mount, and then turn the telescope tracking clock drive "ON". If the drive is so equipped set the drive corrector to track at the "Solar Rate".

2. Install the telescope onto the mount, and adjust balance anticipating the loading of accessories. Be careful to keep a lens cover in place, or position the tube assembly so that the telescope does not point to the Sun.

3. If the telescope has a finderscope, then completely cover the finder objective lens. The Questar finder may have its own solar filter, dial it into place. This will preclude the possibility that someone may accidentally view through the finder at the Sun. It is also possible that the finder telescope optics may be damaged by unfiltered exposure to the Sun.

4. Position the telescope optical tube so that it is pointing upward, but not directly at the Sun.

5. Lock the Mount Clutches (R.A. and Decl.) to prevent the unbalanced telescope from swinging out of control during set up.

6. Remove the telescope objective lens cover. Slip or thread the DayStar ERF over the front of the telescope. Some care should be taken that the felt spacers that may line the inner lid of the ERF are not dislodged or otherwise damaged. Rather than pushing the filter onto place we suggest that a rotating motion (clockwise and counterclockwise) be used to slide the ERF into place. The fit should be firm to prevent the filter from falling off, but should not require excessive force to place or remove it. You may add or shave some felt to alter the fit.

7. Attach the visual or photographic accessories to the DayStar filter. Then attach the filter onto the telescope focuser. Company Seven suggests use of a strap to prevent the DayStar filter from falling to the ground if someone accidentally turns the wrong knob; this strap may be attached from the filter to the finderscope.

8. If using the ATM or UNIVERSITY H-alpha filter model: **ROTATE THE KNOB ON THE OVEN CONTROLLER TO THE DIAL SETTING SUGGESTED ON THE FIRST PAGE OF THIS OPERATING MANUAL. DO NOT EXCEED THE PEAK RATED SETTING UNDER ANY CIRCUMSTANCE!**

9. Establish a reliable power supply and plug the DayStar filter into the power supply. The filter oven will require time (15 to 30 minutes) to attain proper operating temperature. This time will vary with the difference between ambient temperature and the nominal 48 degrees C provided by the filter oven.

10. The easiest way to find and center the Sun in the eyepiece or accessory field of view is to point the telescope up and towards the sun. Observe the shadow cast onto the ground by the telescope, and adjust the telescope until the shadow cast by the telescope covers the smallest area. This should put the sun very close to if not directly in the field of view of the telescope.

11. Gradually focus the telescope looking through the eyepiece. When optimum focus is achieved, you may have to lock the focuser to prevent the weight of the DayStar filter pulling the drawtube out of focus.

As the filter oven warms up to the nominal temperature, you may find it interesting to observe the sun as the filter's pass band moves through the blue wing of the H-alpha. The chromospheric network and prominences will become visible, and will gradually change their appearance. As the filter goes "on band" then the solar features will be revealed at maximum contrast.

Company Seven suggests you acquire an observing hood, or at the least a wide brim hat or baseball cap to cut the glare and distraction from the eyepiece as you observe the Sun. This will dramatically increase the comfort you experience, and the details you can see.

VI. Application Notes

Brief Notes About Easy Polar Alignment for Solar Observing

This is a quick and dirty solution for those who want to polar align a telescope equatorial mount during the day and is unsure of how to find true North. A magnetic compass, and a level are all that is needed.

1. Set the telescope mount so that the Declination (DEC) axis setting indicates 90 minus your latitude. For example Washington, D.C. is at about 39 degrees, and so we'll set the mount to read 51 degrees.

2. Lock the DEC axis and adjust the latitude of the mount until the tube is level; a level may be placed onto the tube.

3. Unlock the telescope tube, set it to 90, then move the mount left or right until the polar axis lines up with Polaris, or magnetic north on the compass.

4. Magnetic North varies east or west of true north depending on your location. One can do better to factor in the variance (Magnetic Deviation). For example, Washington D.C. is now about 11 degrees west. This information is readily found in local topographic or air charts, or on the Internet.

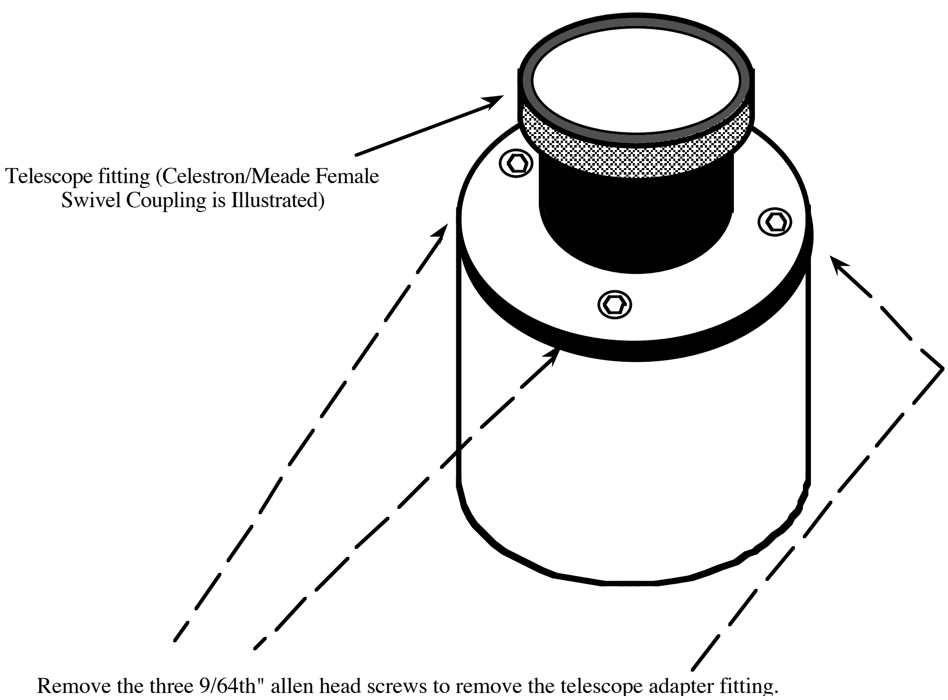
Use of A DayStar Filter on More than One Telescope Design

DayStar filters may be used with more than one telescope without changing hardware if:

a. the filter is to be used on a similar design telescope such as on a Celestron C-8 and a C-11 with off axis ERF incorporating a similar degree of wedge Flange to offset the field curvature encountered in the off axis filtered telescope. In a case such as this there is no need to change the fittings, although a different prefilter will probably be required.

b. if the filter is used on any telescopes which use **an on-axis** (full or partial aperture) ERF.

Changing DayStar Flanges



Customers may purchase the required DayStar filter flanges and associated fittings from Company Seven.

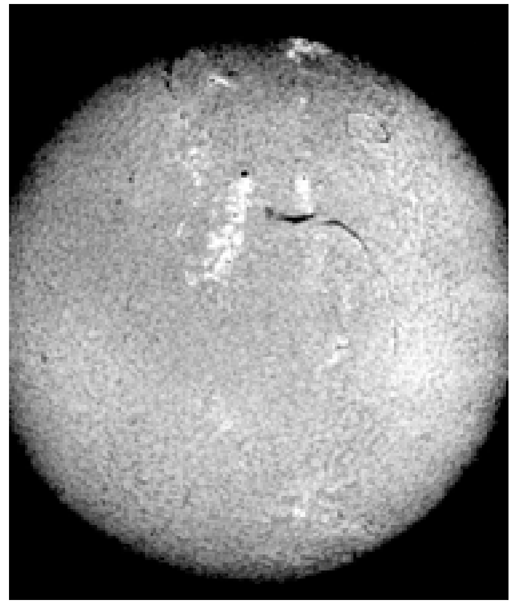
Three 9/64th inch Allen head screws holds each flange in place. These may be removed and the correct flange installed. Be sure the screws are each only hand tight.

It is suggested that to minimize the inconvenience, the customer retain a 2 inch or 1.25 inch female accessory fitting on the filter and change only the telescope coupling.

Illustration 13: DayStar Filter Flange Fitting.

Notes on Using the DayStar H-alpha Filter For Photography

A film camera or a CCD video system may be attached to the DayStar filter to produce Filtergrams. The camera of choice is a 35mm Single Lens Reflex (SLR), preferably one with interchangeable finder and focusing screen (Nikon F3 or F4 , Olympus OM-1, etc.) or a Digital camera. Illustrations 9, 11 and 12 of this manual illustrate where to place the eyepiece, an optional 2" camera adapter may be attached in place of the eyepiece.

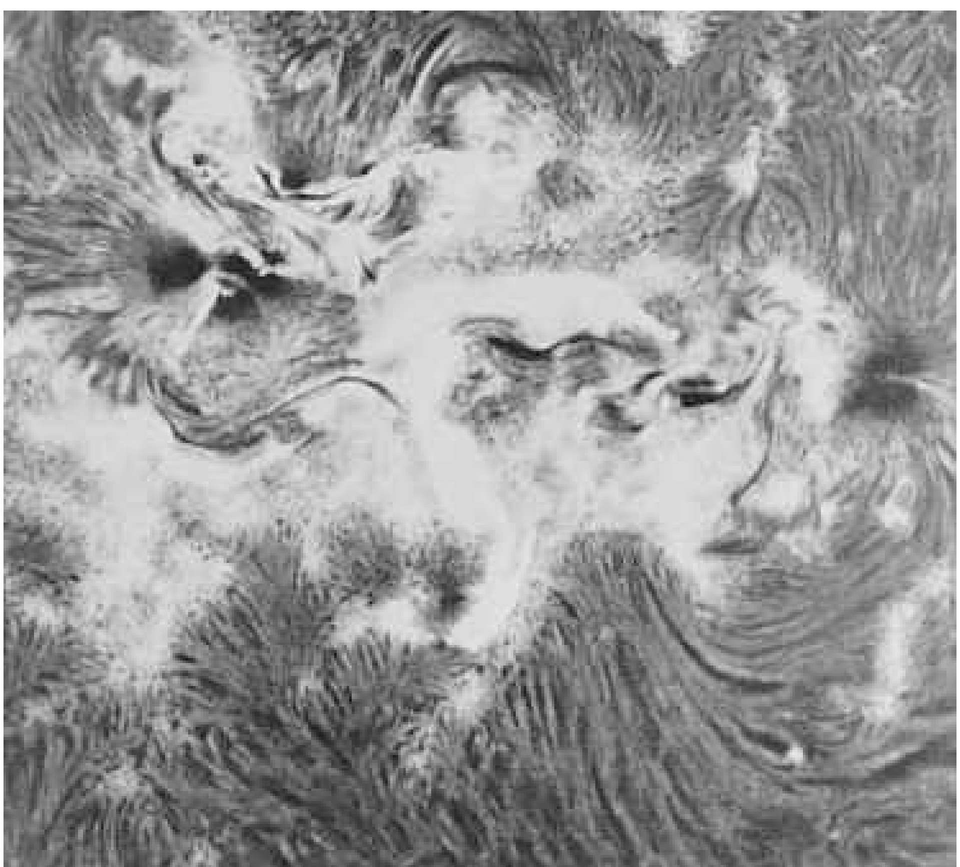


In order to facilitate obtaining a good focus we suggest the use of a bright clear focusing screen such as that recommended by the camera manufacturer for photomicrography. After focusing the telescope through the camera viewfinder, lock the telescope focuser drawtube (if so equipped). Then lock the camera mirror in the "up" position to reduce the possibility of mirror travel causing vibration during the exposure. The camera meter may be used to set the shutter speed, or one may prefer to bracket and take several exposures; some faster and some with slower shutter speeds. To have a higher degree of success, it is suggested that the focus positions be bracketed - varied slightly in and out of what appears to be nominal.

To trigger the camera a remote control or cable release should be used. If so equipped the camera self timer release mechanism may be used to trigger the exposure when the atmosphere is exceptionally steady.

Atmospheric turbulence may show as regular or periodic "mirage" blurring details. Therefore, while the mirror on the camera is locked up, a second telescope may be employed (with a safe solar filter) to monitor the atmosphere as it passes across the Sun's image. When the "period" of the turbulence is at its lowest, then the photo may be triggered.

A good film for high resolution photography of the Sun is Kodak 2415 Technical Pan, a fine grain black and white negative film with good dynamic range. A good exposure time to begin with (on an f30 system) is about 1/30th second; this is good for prime focus solar disk detail. A slower speed such as 1/2 second may result in washed out detail on the solar disk, but it will reveal prominences and solar disk edge details better. Technical Pan is best developed in Kodak "D-19" developer for approximately 4 minutes at 1:1 dilution, 68º F. You may wish to adjust this as your experience indicates to vary the degree of contrast. For printing the negatives, a #4 or #5 grade of paper in a high gloss finish will show the best detail.



The DayStar Filter images may also be recorded with a video camera. Since there are so many technical concerns it is best to contact Company Seven for specific advice. However our basic advice is to select a high-resolution black and white or color video camera with at least a 2/3 inch chip (for the widest field of view), with controllable electric shutter, and interchangeable lens ability.

Calculating Size of the Sun's Image

In order to help one predict what format of film or CCD to employ, and determine the approximate coverage of the Sun on the respective format. The formulas to derive Sun's size are:

h = (Theta*F)/K
Theta = K*(h/F)
F = (K*h)/Theta

h = the linear height in mm of the image at prime focus of an objective or a telephoto lens
Theta = the object 's angular height (angle of view) in units corresponding to K
F = the effective focal length (focal length times Barlow magnification) in mm
K = a constant with a value of 57.3 for Theta in degrees, or 3438 in minutes of arc, or 206265 for seconds of arc (the number of the respective units in a radian)

The first formula yields image size of the Sun as approximately 1% of the effective focal length (Theta/K = 0.5/57.3 = 0.009).

The second formula can be used to find the angle of view (Theta) for a given film frame size (h) and lens focal length (F). For example: the 24 mm height, 36 mm width, and 43 mm diagonal of 35 mm film yields an angle of view of 27 degrees, 41 degrees, and 49 degrees for a 50-mm lens.

The third formula can determine effective focal length (F) required for a given film frame size (h) and angle of view (Theta).

VII. Maintenance of the DayStar Filter

The DayStar filter body should never be disassembled for any reason. This will void the warranty, and will result at the least in misalignment, if not severe damage to the filter. Periodically inspect the filter. One technique is that while observing with the system in place, rotate the filter body only - contaminants observed to move while the filter rotates would indicate there is some reason to take further action with the filter.

The best cleaning practice is to prevent the filter from accumulating dust or other contaminants. Store the filter with covers on both ends, and or in a sealed container. The container should be stored in a dry, cool area; it is advised that a desiccant packet be stored in this container with the filter to help to preclude Fungal activity.

Keep the exterior clean by wiping it with a soft, lint-free cloth. Pay special attention to in sure the fittings on the telescope and the filter are kept clean. If dust appears on the filter elements, a bulb aspirator may blow these particles off; do not use “Dust-Off” or similar compressed gas cans; simply use the large bulb aspirator. Should a smudge appear, it may be cleaned with alcohol and a soft tissue or sterile white cotton ball or swab.

If simple cleaning efforts fail then please return the unit for service to either Company Seven, or to DayStar.

VIII. Warranty of the DayStar Hydrogen-Alpha Filter

Used as directed, the DayStar Hydrogen-Alpha filter is guaranteed for TEN (10) years from date of delivery from Company Seven. Should the filter become inoperative due to optical or electronic failure, DayStar or Company Seven will repair the filter, or replace it at our discretion with an equivalent filter at no cost to the customer.