Solar System Filter Wheel

DAYSTAR FILTERS

Introduction:

Congratulations on your purchase of a DayStar Filters **Solar System Filter Wheel.** Please read the following important instructions before using the filter.

Cautions & Warnings:

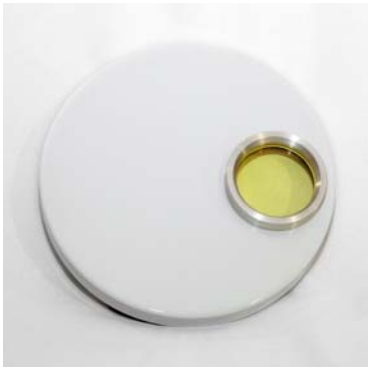
Solar Observing with a telescope is sensitive to certain risks. Caution and care of the telescope and filter is advised in assembly, use and dismantling at all times. Telescope owners must use caution when affixing the filter to the telescope never to point any telescope at the sun without the solar filter safely installed first. While observing, owners must take care and caution that all parts of the filter and telescope assembly are properly affixed and that no pieces have been opened, tampered with or removed. Owners must also use caution when the telescope is being dismantled for the day to assure solar filters are never removed while the telescope is pointed at the sun. Responsible owners will be prudent to inform guest or novice observers of the special nature of the telescope configuration so not to imply that telescopic observing of the sun is safe without proper filtration.

The DayStar Filters **Solar System Filter Wheel** will arrive installed with 2 aluminum end plates. The outer, aluminum end plates are affixed with Phillips head screws and are designed for owners to remove themselves. These plates allow owners to configure the filter as best suits the telescope application. Larger, black aluminum end plates, are affixed with allen-headed screws and should never be removed outside of the DayStar Filters Laboratory. These end plates hold the optical components in under slight pressure. Should these plates be removed and pressure released, both minor and major damage to the optical components can occur.

There are no user-serviceable parts inside the end plates of the Solar System Filter Wheel. Solar System Filter Wheels are tamper evident and filters which have had their housings opened will be void of warranty coverage. To reduce the risk of electrical shock, do not disassemble the Solar System Filter Wheel. This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Solar System Filter Wheels are subject to premature ageing in hot and humid environmental conditions. Solar System Filter Wheels are best if stored inside the provided weatherproof sealed case whenever not in use. Whenever possible, owners should maintain desiccant anti-humidity packs inside the case so as to minimize impact from seasonal changes in ambient humidity.

Installation and Application:



Solar System Filter Wheels may be applied on refractor, SCT, or Maksutov reflector telescopes. DayStar does not currently suggest application on Dobsonian or Newtonian telescopes. Smaller, Maksutov telescopes will use application methods common to Refractor telescopes. All **Solar System Filter Wheels** in any application require both an approximately F/30 light cone and Energy Rejection to protect the telescope from overheating.

SCT Telescope Configuration:

SCT Telescopes employ a front mounted Energy RejectSolar System Filter Wheel (ERF) with an **off-axis** opening of **reduced aperture**. By reducing the aperture, the focal ratio of your SCT will be increased from the native F/6 to F/10 to an ~F/30 beam. Because the SCT has a central obstruction from the secondary, we need to move the opening off-axis. Now the beam that exits the SCT telescope will be smooth and parallel when it reaches the rear mounted DayStar **Solar System Filter Wheel**. Aperture reduction does not change your overall focal length. Your image size will remain the same as before the aperture was reduced. Only resolution will be reduced. Typical apertures of SCT telescopes reduced for use with DayStar **ION Filters** are 60mm or greater. Please see our website at www.DayStarFilters.com for the correct ERF for your SCT Telescope.

The DayStar **Solar System Filter Wheel** can be affixed to the rear of the SCT telescope with an adapter typical to photo applications from SCT to T-thread. For those who don't own this part, we stock it as part number: **GF2SCTT.** It is a small snout with male T-threads on one end and a female "jingly ring" on one end which allows you to orient the DayStar **Solar System Filter Wheel** (or camera) on the back of the SCT thread. See our adapters and snouts page for more information about the **GF2SCTT** http://www.daystarfilters.com/AdapterSnouts.shtml

The DayStar **Solar System Filter Wheel** will thread to the GF2SCTT via female T-threads on its "sun side" plate.

Due to the off axis ERF, light entering the Filter Wheel will be coming into the filter at 1.9° off the telescope's central axis, which unless corrected will cause the filter passband to shift off the target wavelength. Therefore, always use a Wedge plate on the front of an Ion when using an SCT telescope. See part number: Q3GWTF on our adapter plates web page: http://www.daystarfilters.com/AdapterPlates.shtml

When you order your DayStar **Solar System Filter Wheel**, we will ask what telescope it is to be mounted on. If the answer is SCT, then a Wedge plate is supplied at no extra cost with the filter order - mounted to your DayStar **Solar System Filter Wheel** at our factory.

Once the DayStar Filter is attached to the Telescope, the orientation of the filter must be aligned to the orientation of the ERF opening. With light and faceplate facing up at the 12:00 position, the ERF hole must orient down to the 6:00 position. If in doubt, dial the ERF 360° to find the orientation that provides the best contrast.

The rear plate on the DayStar **Solar System Filter Wheel** has a male SCT thread just like your SCT telescope. You may use all of the same accessories, diagonals, visual backs or camera adapters that you did before installation of your DayStar **Solar System Filter Wheels**.

REFRACTOR Telescope Configuration:

When applying the **Solar System Filter Wheel** on refractors telescopes, the focal ratio of the telescope must be considered and altered to become F/30. There are two ways of reaching F/30. Either the telescope's clear aperture can be reduced or a negative Barlow lens (preferably a Tele Vue Powermate Barlow) can be added before the DayStar **Solar System Filter Wheel**

For F/8 telescopes, a 4X Powermate will make F/32
For F/11 telescopes a 2.5X Powermate will make F/27.5
For F/15 telescopes, a 2X powermate will make F/30

Aperture reduction also works in a similar way

A 150mm F/8 telescope reduced to 75mm is now F/16
The **Solar System Filter Wheel** offers limited field of view in telescopes operated above 75mm in clear aperture, so aperture reduction is a good choice with the **Solar System Filter Wheel**

Refractor configuration includes energy rejection by means of a front-mounted colored glass ERF, which blocks all light below 500nm. Some refractor owners opt for Energy RejectSolar System Filter Wheel application by means of UV/IR cut filter mounted toward the rear of the telescope instead. This topic will be addressed specifically in higher detail below.

Assembly order of the DayStar **Solar System Filter Wheel** on a refractor telescope has special considerations. Typically, a DayStar Quantum or ION would be installed after a the diagonal and powermate. However, the size and weight of the DayStar Solar System Filter Wheel is too heavy to arrange this practically. Instead, we recommend that a spacer be added after the telescope OTA or focuser, prior to the DayStar Solar system filter wheel. We recommend this spacer be of approximate size of 100mm or 4 inches in length. This represents the typical focus travel of a 2" diagonal.

Energy Rejection and The UV/IR cut filter

Multiple wavelengths require that energy rejection be considered.
Red ERF glass will not pass light below 600nm. That means that a filter wheel with NA Sodium or He D3 line filters, or Ca II K or Ca II H line filters must consider an alternative front mount energy rejection filter. There currently exists no front mount Energy Rejection filter which can pass the entire visual spectrum from Calcium to Hydrogen Alpha.

For those Filter Wheel owners with only Hydrogen and Sodium and or Helium filters in the 500nm range, a yellow colored glass filter is a good choice. Yellow colored glass blocks all light below 500nm but will pass yellow light from the Na and He D3 lines.

For this reason, we strongly suggest application of the UV/IR cut filter as means for energy rejection for filter wheel owners who use Calcium or Hydrogen Beta filters at this time. Certain refractor telescope owners may choose to employ a UV/IR Cut filter for means of energy rejection INSTEAD of any front mounted colored glass ERF filter. Not all refractor telescopes may use this option. The UV/IR cut filter is a dielectric coated filter that reflects UV and IR light like a mirror. It does not absorb light and therefore is not susceptible to heat gain or expansion like colored glass ERF's are.

Applied correctly, the UV/IR cut filter acts similarly to a Herschel Wedge, reflecting much of the spectrum back out of the telescope, while passing a smaller percentage of light. In the case of the UV/IR cut filter, the light which is allowed to pass is the entire visible spectrum.

UV/IR Cut filter shown threaded on the end of the 4X Powermate on a DayStar Solar System Filter Wheel. Also shown is the 4X powermate with PMT adapter.

**IT MUST BE NOTED THAT A UV/IR CUT FILTER IS NOT SUFFICIENT FILTRATION FOR SOLAR VIEWING ALONE. **
Because the UV/IR Cut filter acts as a mirror, it is best inserted in the light path prior to any other optical element which might encounter concentrated light. For example, the UV/IR cut filter may be threaded onto the front snout of the forward section of a diagonal mirror. Most diagonals offer filter threading in their front end. If a powermate or barlow encounters concentrated light before the diagonal, then the UV/IR cut filter should be threaded onto the lead end of that element.

Unwanted light which hits the UV/IR cut filter is then reflected back out the front of the telescope, arriving at the objective lens at nearly the same unfocused beam as it does coming through the front side.

UV/IR cut filters are available at many telescope dealerships in a variety of brands and manufacturers in 1.25" or 2" sizes. The size of the UV/IR cut filter should match the element on which it is to be screwed. Most often, this is a 2" diagonal filter or a 2" TeleVue 4X Powermate.

Instances where the UV/IR cut filter should not be applied include:
- Oil Spaced Triplets. We are uncertain of the effects of high amounts of solar energy on the oil used in spacing these triplets.
- Petzval Refractors. Any telescope with lenses positioned in the light path where the UV/IR cut filter may not be inserted before are unsafe applications of this technology.
- SCT or reflector telescopes. SCT and reflector telescopes encounter concentrated light on the secondary optics. Concentrated light on a secondary would cause overheating of that element, cracking and/or possible failure of its adhesive.
- In general, if a telescope owner is uncertain or uncomfortable with the application of UV/IR cut filters on the rear of the telescope, then it is best to revert to the standard DayStar Colored glass front mount Energy Rejection pre-filter.

Solar System Filter Wheel Operation

The **Solar System Filter Wheel** was designed for simplicity in operation. Once the Solar System Filter Wheel is installed on the telescope, use the following steps:

1: Plug in the **Solar System Filter Wheel** with the included 24VDC power adapter*. A yellow light will come on.

2: Wait the approximately 8-12 minutes until the filter has reached the correct temperature. The light will turn green. When the light is green, the filter is on band and ready for observing.

Solar System Filter Wheel electronic controls:

The **Solar System Filter Wheel**,has 2 operation modes. Position change mode and CWL wing shift mode. When the filter wheel is in Position change mode, the readout will present the identification of the respective cavity. For example, Ha 0.3 or HeD3.
When in position change mode, the **Solar System Filter Wheel** shifts cavity positions with the red or blue button. It should be noted that the filter wheel will only move from positions 1-4, but must then stop. The wheel cannot move from position 4 directly again to position 1. It must stop at position 4 and back up and return to position 3 and so forth.

To switch between modes, press both red and blue buttons at the same time.

When in Wing shift mode, the Solar system Filter Wheel will display the CWL of the filter cavity which is in view. For example, 6562.8A. In order to shift wavelength, press either the red or blue button until the readout blinks. Once blinking, either red or blue button will cause the target wavelength to raise or lower respectively. The Quantum can only travel 1.0Å above or below 6562.8Å. Each time the target wavelength is changed, the filter will restart the 8 minute delay and the light will turn yellow again. It is possible that on a hot day, your filter may never cool down enough to travel 1.0Å below Halpha. If this happens, your readout will not lower to the desired target wavelength and naturally the light will stay yellow. This doesn't alter the operation of your DayStar. Your ambient temperature is just too high to shift this far below Halpha.

It should also be noted that because each filter cavity is heated to a slightly different temperature, on warm days, the heat from one cavity can affect temperature of another cavity. This can cause the light of one cavity to change from green to yellow. This depicts a condition of slight variation in target vs actual temperature. It is unlikely that this condition would cause a filter to truly leave the desired wavelength. A 17°F change in temperature is needed to move the wavelength 1.0Å and all filter cavities are typically within 17° of one another.

*The Included 24VDC power adapter converts 110-240VAC to 24VDC. Owners will note that the box includes a variety of various outlet plug style choices for application in most any country worldwide.

About Seeing Limitations and Resolution

Solar observing seeing conditions vary greatly from nighttime conditions. During the daytime, radiant heating from the sun affects seeing significantly. Characterized by turbulence or shimmering as seen over a hot street, seeing can cause significant impact on quality of solar observations.

- Bad seeing is caused by air of different temperatures mixing. This typically happens within the lowest 10 feet of air. It occurs most often over pavement, dark objects, rooftops and sometimes trees.
- High cirrus clouds or “scuzz” will cause scattering of sunlight in the high atmosphere which often makes for bad viewing conditions. A classic sign of high cirrus clouds is the inability to achieve focus, or the need to “chase focus”.

- A jet-stream moving overhead can also hurt seeing conditions even on a clear day.

DayStar Filters are high power viewing platforms and this high resolution can be susceptible to seeing issues. Solar Observers using high powered, high resolution telescopes and DayStar filters should heed daytime seeing. While many of these conditions are beyond our control, observing in an area with ideal conditions, without pavement in the direction of viewing, and on days with no high cirrus will offer best results. Grass is the best environment for daytime seeing stability.

Each observing location offers different behavior for daytime seeing cells at different times of the day, as the air through which one views changes with movement of the sun. Some locations benefit from best seeing in the morning, while many have best seeing in the afternoon. Because most heat variation between air and ground surfaces occurs within the first 10 feet above the ground, often a high observing platform will offer superior seeing. This might include a second story deck which overlooks grass.

Eyepiece Selection

Daystar Recommends Tele Vue Plossl series eyepieces of 32mm, 40mm and 55mm.

Remember that at F/30, a high powered eyepiece can exceed Dawes' limit. Observers will find best results with an eyepiece which is 32mm or greater to avoid this. Eyepieces of higher power will result in a fuzzy disk without the ability to focus well.

We have tested a number of eyepieces over the years. Most recently in the spring of 2011, we performed a comprehensive eyepiece comparison between various brand names and eyepiece styles. Naglers, zooms, radians and other "fast" eyepieces typically perform very badly on DayStar applications.

Other brands do offer Plossl eyepieces in 32-50mm and they can give a respectable performance in lieu of a Tele Vue. We have also found some of the very old wide field "Erfle" eyepieces aren't bad for an experienced observer. It should be noted that repeatedly in side-by-side tests, we found Tele Vue brand Plossl eyepieces to offer the highest contrast, most even view and widest exit pupil. In Solar Observing, contrast is achieved by control of scattering. Tele Vue Plossls stand out in superior design. Furthermore, the adjustable eye cup offers additional contrast by allowing the user to dark adapt during sunny days.

Eyepiece features we found to increase performance include:
- "Fully Multicoated"
Of those eyepieces which did better than others, those marked "fully multicoated" offered better views from less internal scattering.
- Blackened optical edges
Tele Vue and other eyepieces which performed better all had blackened edges of their optical elements. This also reduces internal scattering within the eyepiece.

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