INFORMATION ABOUT FILTERS AND FILTERCELLS FROM BAADER PLANETARIUM

The variety of uses for filters in amateur astronomy has considerably increased during the last decade, enabled by both more accurately manufactured optical accessories, and, above all, by the "digital revolution".

In the old days, color filters for visual planetary observations were not screwed in the front part of the eyepiece, but were simply placed between the eyepiece and the eye. Plane-parallelism of these filter glasses was not important, because they were not in the optical path of the telescope.

Today, filters are placed in the optical path of the telescope, even well in front of the focal plane. This definitely requires some degree of plane parallelism and accurate production of the filter glasses.

Every single cell mounted filter delivered to our customers is cut as a round disc, in 11⁄4" or 2" size, and then is polished plane to a quarter wavelength on both sides on a computer numerically controlled polisher. After that, the polished blanks are submitted to the costly coating procedures. This sequence is also used for all unmounted filters.

We deliberately avoid cutting filters from larger sheets, because the coating layers can be damaged at the edges and suffer from microscopic fissures. That lets moisture penetrate and the filters are subject to "ageing". In particular, this applies to many of the complex dielectric coatings needed for nebular filters, UV/IR blocking filters and emission line filters. Damage to multilayered filters at the edge results in greater damage than to a single antireflection coating. As our filters are not cutouts, **every individual filter disc can then be coated,** but not right to the edges. This seals the filter, and no moisture can penetrate into the coating layers. Hence, even the most expensive narrow-band filters are free from ageing, and can be carefully cleaned without hesitation and as often as necessary.

Our UV/IR blocking filters were exposed for 1 hour to boiling water at the company B+W (Schneider Kreuznach, Germany). This accelerated ageing test corresponds to approximately 5 years of filter ageing in actual use. **In contrast to cut filters, our edge-sealed filters showed no ageing and above all no changes to the measured transmissivity at different wavelengths.**

The commercial disadvantage of this technology lies in the fact that we cannot produce any filter size by simply cutting it from a sheet. For custom-made filters in a requested size we need a minimum production run of 250 pieces.

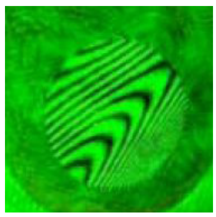
Filters mounted in front of the telescope, e.g., our filters D-ERF for solar observation, must be substantially more precise, so that the focal image suffers no critical optical distortion; they are plane-parallel polished and afterwards optically fine-polished to a 1/10 wavelength accuracy.

- This high optical quality ensures that the wave front of the incoming light beam deforms while passing through the filter by no more than the 1/4 or 1/10 wavelength surface variation.
- The optical fine polish also reduces any light scattering from the incoming wave front.

High quality optical filters are not cheap. Hence, it is also no surprise if observers complain about „unaccountable" picture deterioration when using cheap filters in front of binoculars, telecompressors or Barlow lenses, either visually or photographically. The higher the magnification, the softer and more blurred the picture appears when using a cheap filter, for both visual and photographic observations.

In the manufacturing process **great emphasis is placed on guaranteeing that a Baader filter must be bought only once by the customer,** because it will be optimally usable for all use kinds of astronomical observations now AND in the future.

Ever since we began producing our own filters and series of filters, we have checked the quality of a wide cross-section of „cheap filters" from different manufacturers (see picture on the right).



Interferogramm of a Neodymium Filter from an overseas supplier

Many filter manufacturers - mainly in Asia – apparently still take the view that a filter is used only close to the focal plane, and that, hence, a homogeneous glass substrate is not necessary and that it need not be polished fine optically.

They say that if only one cosmetically flawless, smooth glass surface is required, it is not necessary to achieve a high degree of plane-parallel polish. They further believe it is adequate to cut filters from a big stained glass sheet – usually in the format 20x20 cm – and to so-called "raw polish" the filter on both sides. With this process, the glass surface is slightly molten and all saw scratches and surface inaccuracies are invisibly levelled. **But so-called „raw-polished" glass surfaces are completely irregular and deform the wave front of the light significantly!**

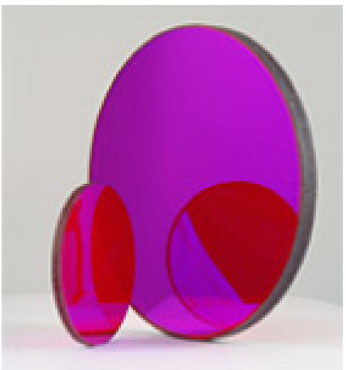
The "polished" sheet is coated as the whole, and afterwards the filters are cut out in the desired size. This production method for filters is drastically less expensive than the substantially more sophisticated manufacturing of a Baader filter. In addiition, different sized filters can be cut on demand, reducing inventory costs.

Such a "cheap filter" with irregular glass surfaces MUST always be screwed directly into the eyepiece; otherwise sharpness and definition are reduced, above all when doing observations at high magnification or long-focus photography with an inserted Barlow lens.

ABOUT D-ERF FILTERS

Using a SolarSpectrum filter (or any other etalon-based H-alpha filter) in conjunction with a „regular old-style“ ERF-filter, i.e. one not equipped with our proprietory IR-reflector coating, leaves the standard red ERF-filter wide open to the complete IR-spectrum. This can produce a substantial amount of heat at focus - cooking the etalon over the years.

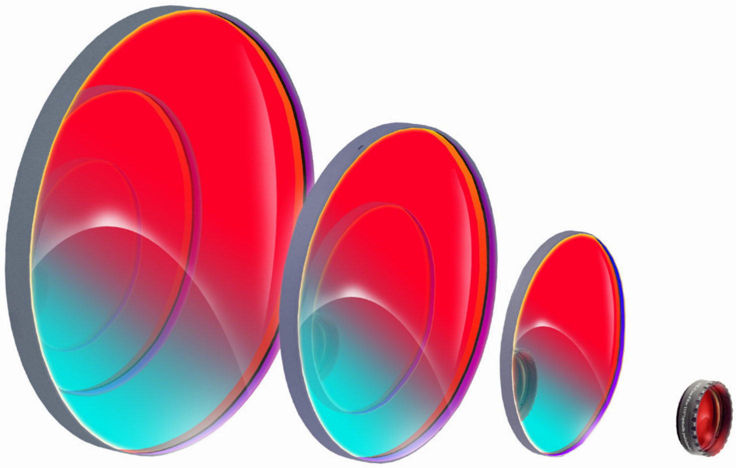
Our new 43-layer dielectric DWDM-coating delivers a „COOL“-beam of pure red light, with a HBW of 45 nm! The glass substrate in this case is no longer any kind of soft and streaky colored absorption glass, but clear BK7 of the highest homogeneity, fine-optically polished to the quality grade of the objective-lens surfaces, and with all the reflection performance coatings on one side. This reflects all the unwanted spectrum from 280 nm up to 1500 nm, while leaving open just that 45nm-wide spectral window around H-alpha. It is hellishly difficult to design such a performance coating, as well as the counterside anti-reflection multicoating, in such a way that no coating-induced stress builds up inside the glass substrate. If these coatings systems on either side of the plate are not done exactly right, to cancel out the stresses induced by the coating layers, the plane-parallel surfaces may easily be distorted, meaning the 1/10 wave flat plate deforms into an irregular curved substrate that acts as a (bad) lens. Our D-ERF filter-layers are designed with the utmost care, applied with the world‘s most advanced optical coating machines, and the final filters are all inspected and passed in autocollimation on our Carl Zeiss optical bench.



This level of care retains the full-aperture resolving power of the telescope lens while dramatically reducing the thermal energy that goes through the telescope to the Solar Spectrum filter. This not only is the main reason for a dramatic reduction of heat stress within the telescope, but also greatly reduces the thermally-induced seeing effects as well.

Old style ERF-RG-filters transmit all the energy in the IR, while just absorbing the energy in the visual below 610 nm - causing a heat plume in front of the telescope objective. The difference in heat buildup (measured at a distance of 4“ prior to focus) between a regular red-glass ERF-filter and our clear glass, high-tech dielectric coated D-ERF-filter is about 70 °C. And, since all the unwanted light is not absorbed but reflected back into the sky, no heat builds up in front of the telescope aperture.

The Solar Spectrum filter itself has a blocking filter built into the front window of the filter stack, which also performs as heat blocker. But, if the body of the unit is connected to the telescope

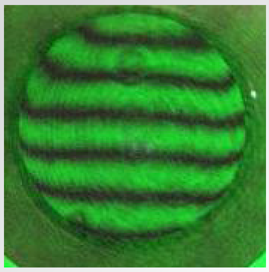


the wrong way around, all the IR-energy will go right into the elaborate stack of polarisation filters and the etalon and - in the worst case scenario - may melt the polarizers or boil the immersion liquid inside a.s.f.

All these problems are completely absent with the use of our D-ERF pre-filter, because the light exiting trough the telescope into the rear side filter is „cool“. So no possible way exists to damage an etalon-based H-alpha filter when using it in the wrong orientation.

Today we offer unmounted D-ERF-filters from stock in the most common sizes from 95 mm up to 180 mm in diameter. For some scientific projects we even made D-ERF-filters as large as 290mm in diameter - but the production difficulty and the resulting price is outrageous.

ABOUT BAADER FILTERCELLS

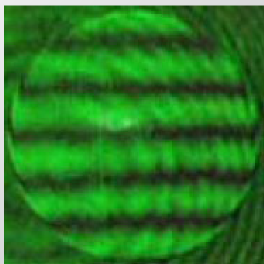


Interferogramm of a tightly locked Baader filter glass

After putting flawlessly performing filter blanks into the standard tightly-screwed filter cells, **interferometer measurements revealed drastic deformations caused by the stresses of assembly.**

That‘s why all our filters are no longer tightly fixed but held spring-loaded in the filtercell. The filter glass may ever so slightly „clatter“ in the cell, but that neither affects the image quality nor shows a displacement in the final image. **A stress-free filter, not tightly fixed in its filtercell, is not a fault and entirely intentional.**

Visual observations and astrophotographs obtained with Baader filters are among the best achieved worldwide by amateur astronomers. You may find typical examples using our emission line filters and LRGB filters online at:
http://panther-observatory.com/



Interferogramm of a loosely mounted Baader filter glass

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