HET High Resolution Spectrograph Advisory

HRS filter replacement

Phillip MacQueen - 10 October 2007

Issue

The HRS has been using filters that are not anti-reflection coated, resulting in a total light loss of approximately 9% from the two air-glass surfaces of the filters.

Issue resolution

A new set of anti-reflection coated filters has been installed and commissioned as of September 18th, 2007. One of the earlier filter types has been retired, and two new filter types have been introduced. The performance of both the old and new filters has been characterized. An improvement in HRS throughput of 5-6% has resulted for most wavelengths and configurations.

Performance changes

Figures 1 through 6 show the transmission as a function of wavelength for the 6 new filters. Also shown on each figure is the bandwidth of the one or more HRS configurations that use the filter.

Figures 7 through 10 show the gain in HRS throughput for each of the four original filter types. The gain is the ratio of the AR coated filter transmission to the non-AR coated filter transmission.

The filter set now includes WG345 and GG375. These have been added to enhance the throughput of the violet end of the HRS bandwidth, while still providing good blocking as described in the following section.

Background

The two HRS grating cross dispersers are always used in their first diffraction order, and the HRS filters are used to suppress the second diffraction order from the cross dispersers. Without the filter, the intended first order light of a given wavelength is contaminated by second order light of half that wavelength. The form of the contaminating second order light is echelle diffraction orders with twice the echelle order number as the intended light.

The filter is predetermined for each HRS cross disperser configuration, and is inserted automatically when a cross dispersion configuration is selected. The table on the following page gives the default filter as a function of the preferred HRS cross disperser settings.

Background (cont.)

Configuration	Default Filter	Blue Wavelength	Central Wavelength	Red Wavelength
316g5936	GG400	4100	5936	7838
316g6948	GG475	5095	6948	8860
316g7940	OG550	6114	7940	9861
316g8991	RG645	7109	8991	10917
600g4739	None	3751	4739	5732
600g4739B	WG345	3751	4739	5732
600g5271	GG375	4275	5271	6263
600g5822	GG375	4814	5822	6793
600g6302	GG475	5316	6302	7278

The throughput performance of each of the new filters is slightly poorer than anticipated, with the GG475 and RG645 filters having the least uniform throughput gains as a function of wavelength. The difficulty in anti-reflection coating these filters arises because the refractive index of filter glass as a function of wavelength is poorly known compared to optical glasses. As a result, it is difficult to design and apply broadband multi-layer anti-reflection coatings, and they are only available at a reasonable price on a best effort basis. The GG475 filter was remade once in order to get the current filter, and the RG645 filter might get remade also.

Configuration 316g5936 cannot be fully blocked over its entire bandwidth because its bandwidth is very nearly one octave, and filters do not cut on sharply enough to allow both full transmission at the blue limit, and full blocking at the red limit. Some second order contamination results at wavelengths longer than 750 nm with the default filter. A new GG435 filter might be implemented to provide the option of fully blocking the red end of 316g5936 at the cost of increasing the blue limit to 440 nm.

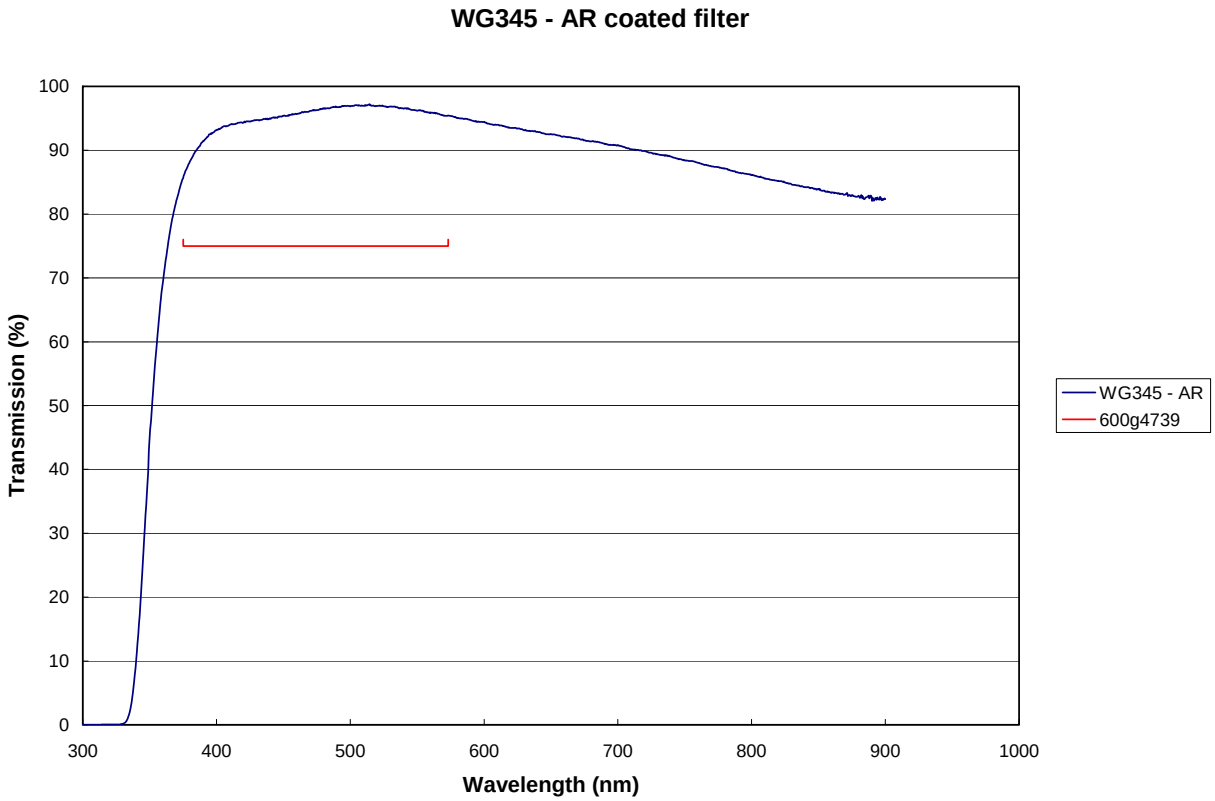

Figure 1: transmission as a function of wavelength for the AR coated WG345 filter

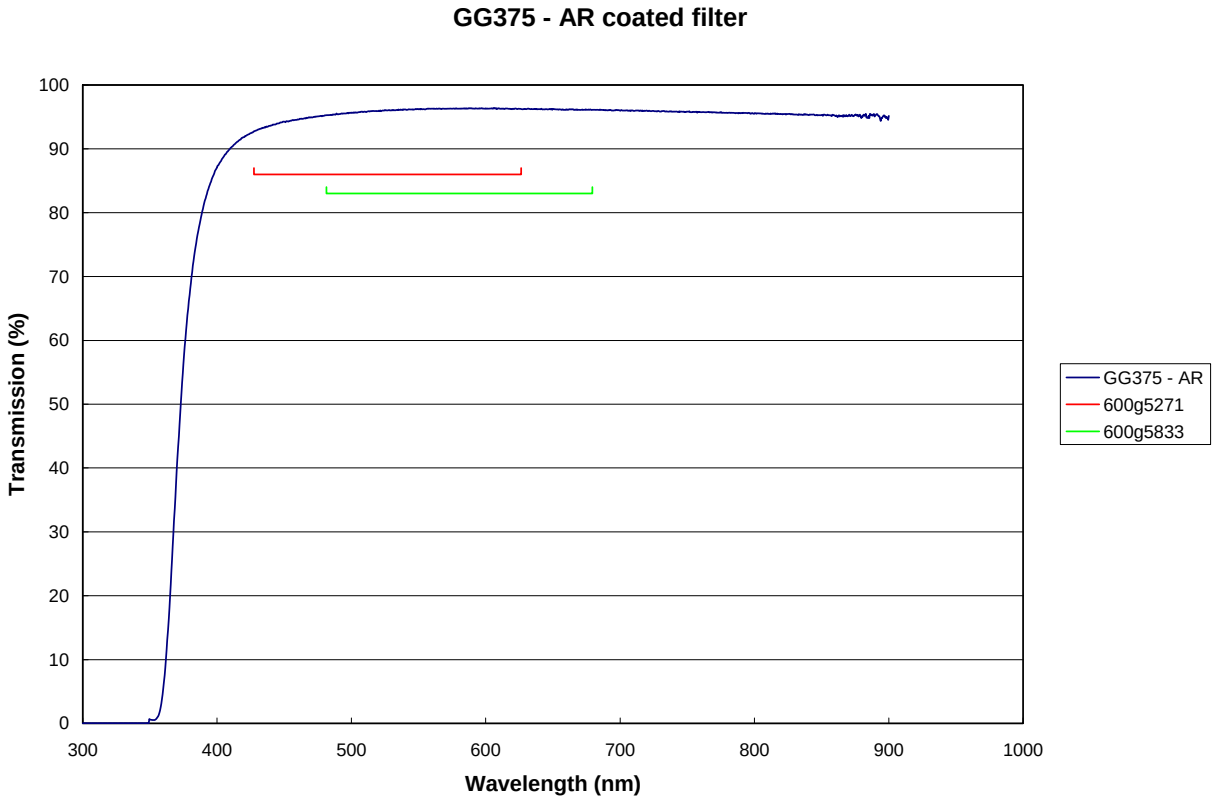

Figure 2: transmission as a function of wavelength for the AR coated GG375 filter

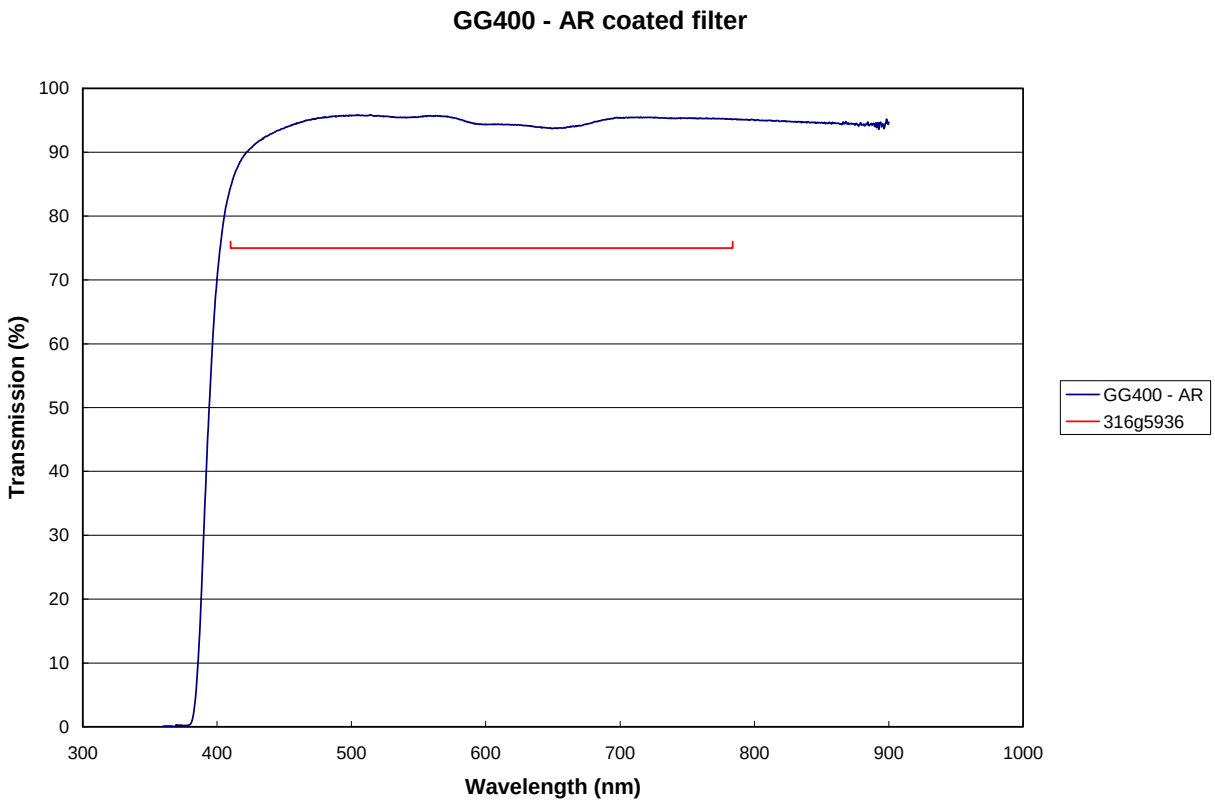

Figure 3: transmission as a function of wavelength for the AR coated GG400 filter

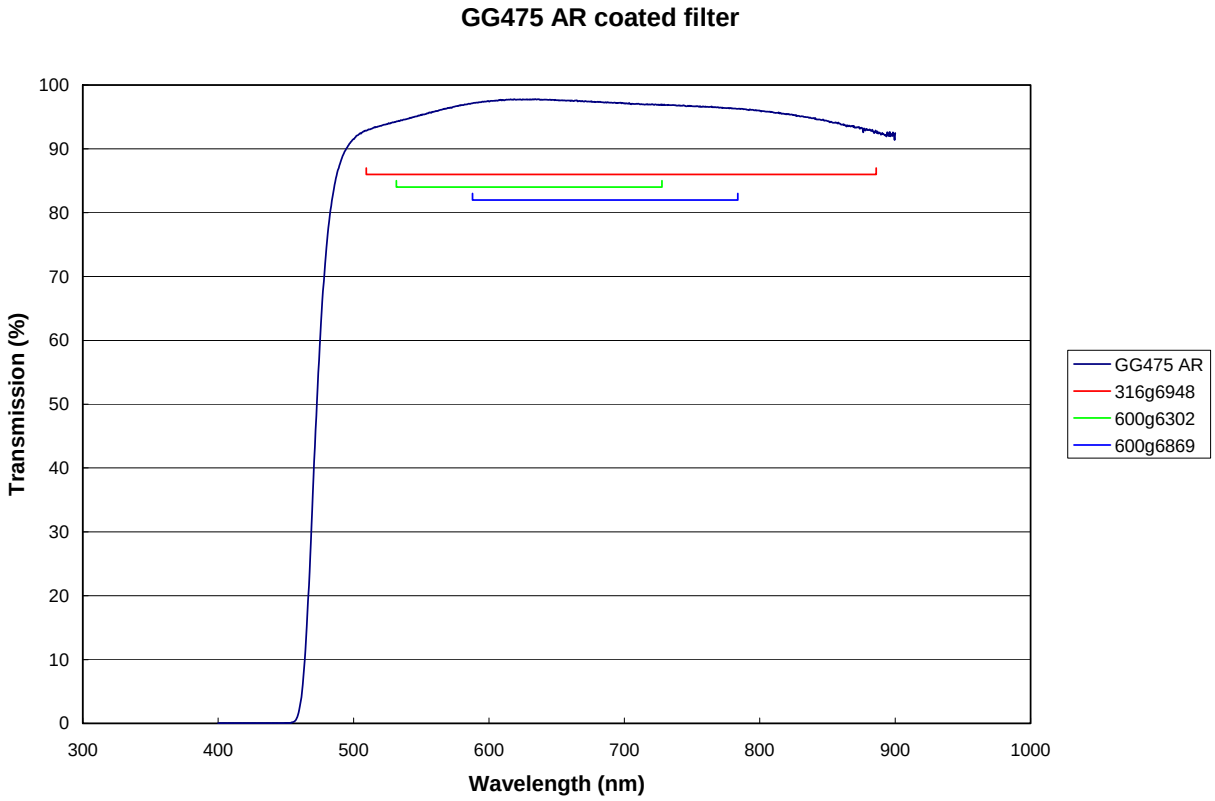

Figure 4: transmission as a function of wavelength for the AR coated GG475 filter

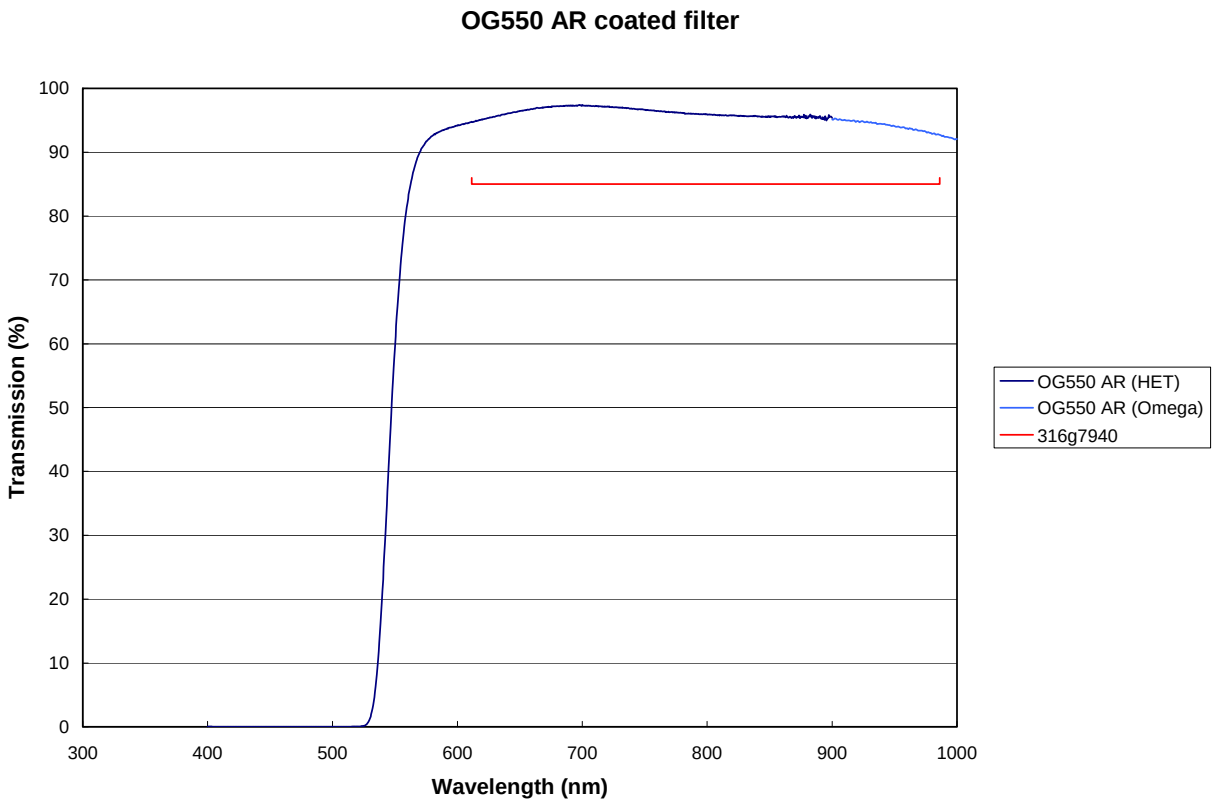

Figure 5: transmission as a function of wavelength for the AR coated OG550 filter

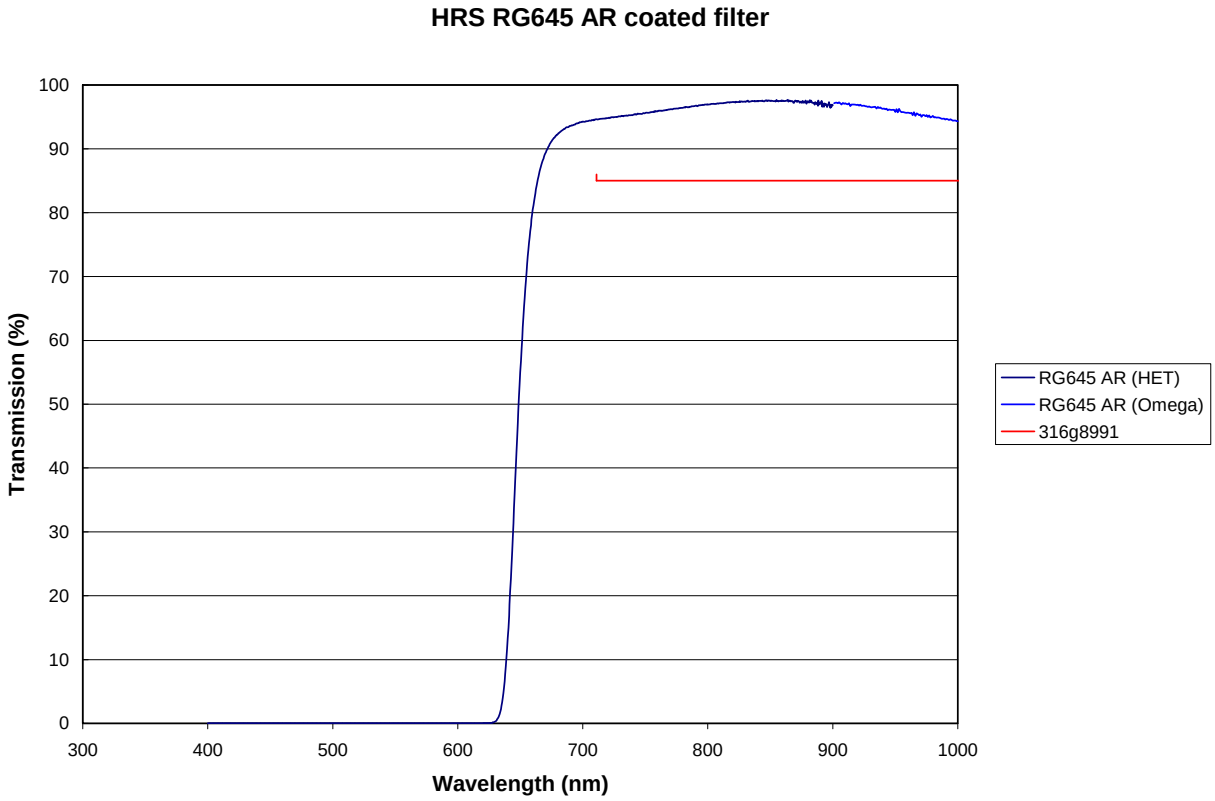

Figure 6: transmission as a function of wavelength for the AR coated RG645 filter

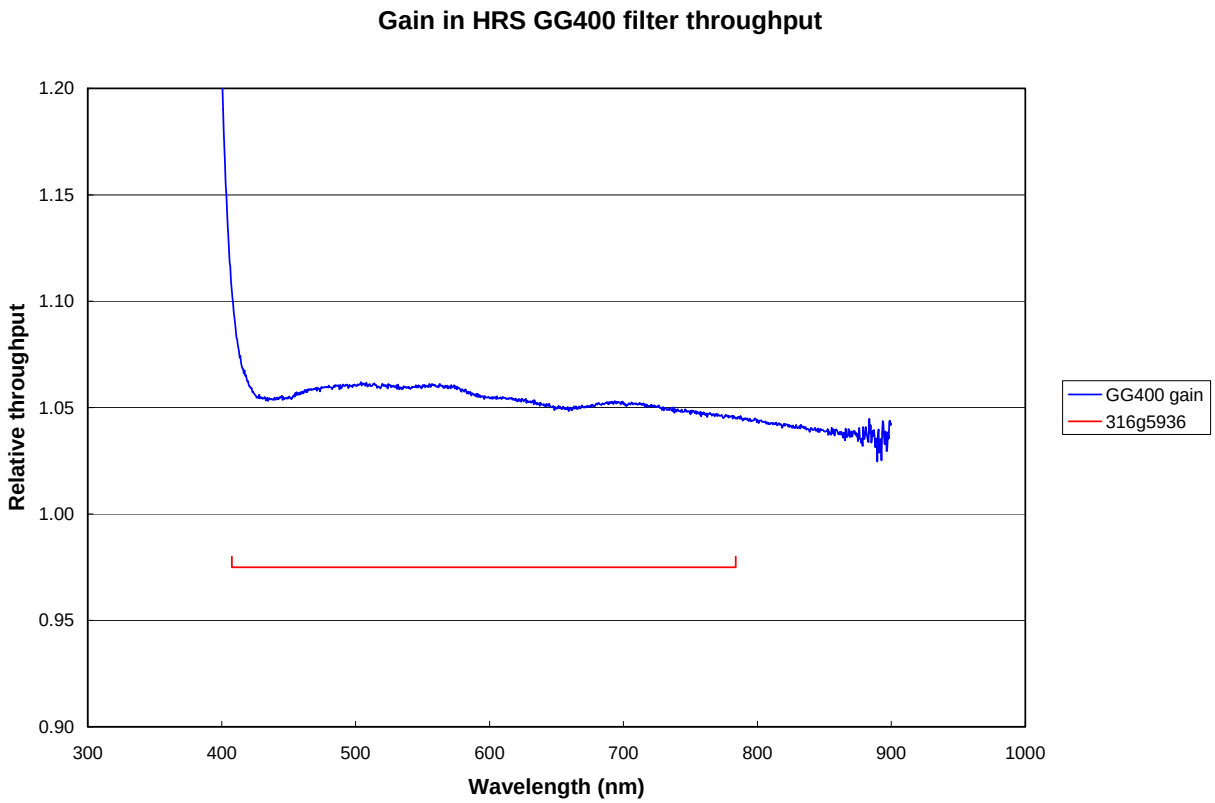

Figure 7: the throughput of the new AR coated GG400 filter relative to the non-AR-coated filter

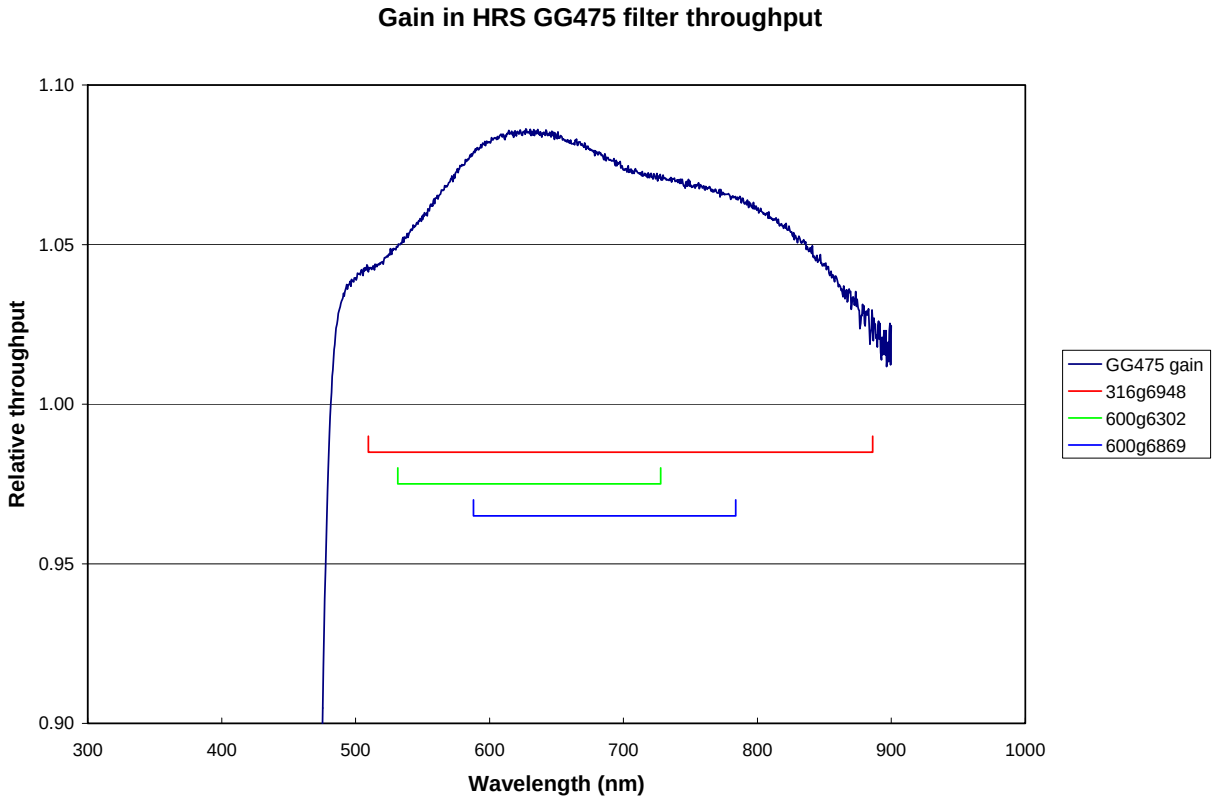

Figure 8: the throughput of the new AR coated GG475 filter relative to the non-AR-coated filter

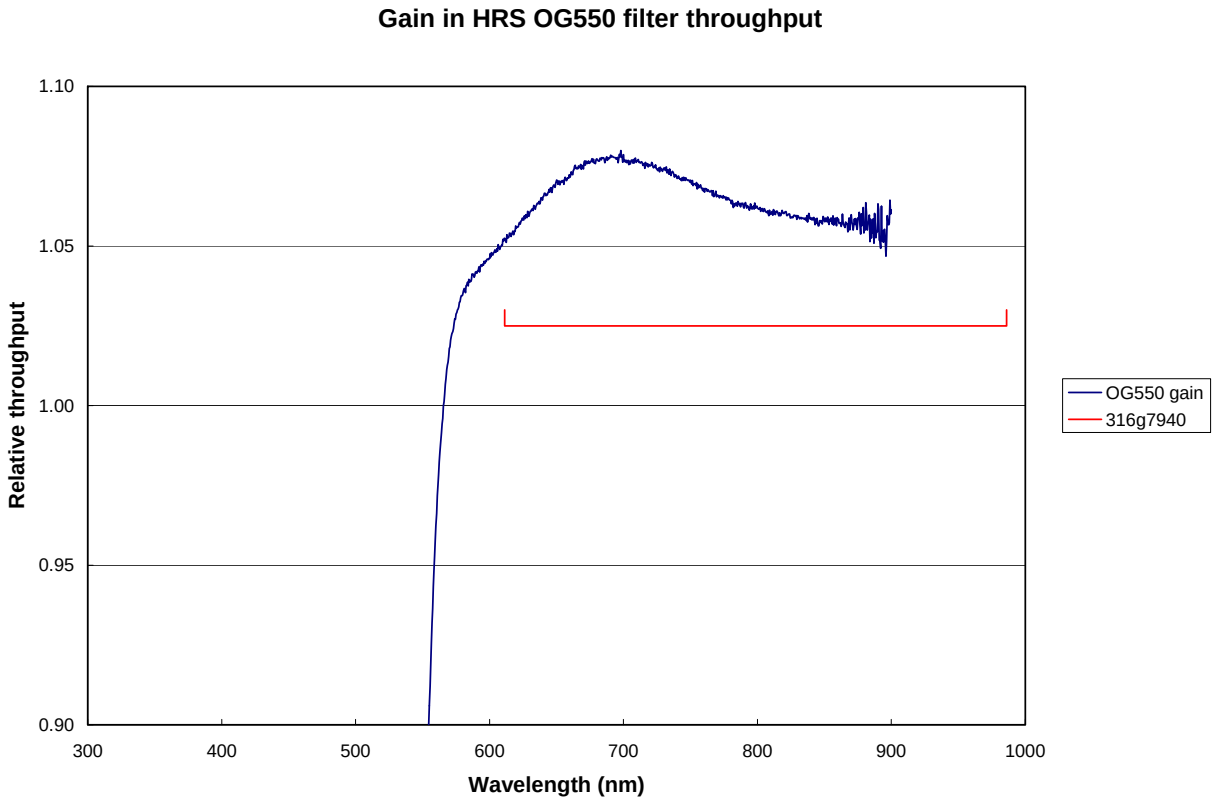

Figure 9: the throughput of the new AR coated OG550 filter relative to the non-AR-coated filter

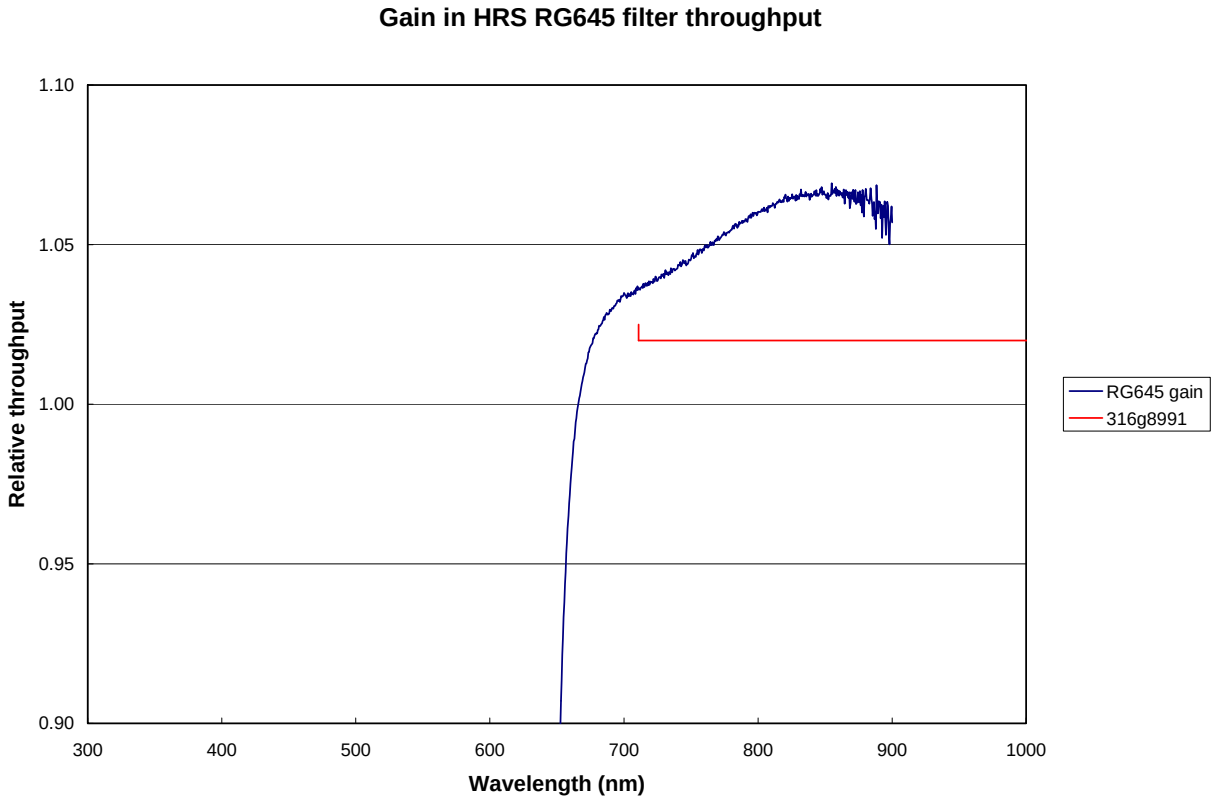

Figure 10: the throughput of the new AR coated RG645 filter relative to the non-AR-coated filter