Photopolymeric Volume Phase Holographic Gratings for the Nordic Optical Telescope

In this document are reported the specifications and the experimental measurements of the photopolymeric VPHGs produced for the ALFOSC (NOT) instrument.
The devices are indicated with the name BLUENOT (G#18), GREENNOT (G#19), REDNOT (G#20).

The following table contains the specifications of each GRISM:

	Central [nm]	Range [nm]	Dispersion [Å/px]	Resolution	apex angle A [°]	spectral length [mm]	lines/mm
BLUE	430	337 - 523	0,918	1129,18	24,8	30,40	1086
GREEN	562	443 - 687	1,212	1109,88	24,8	30,197	823
RED	788	576 - 1000	2,079	895,85	20.75	30,584	484

NOTES:

1) Considering a fixed parameter or the BK7 prism/s refractive index:
n_prism = 1.5273 @ 430 nm for the BLUE grating;
n_prism = 1.5178 @ 565 nm for the GREEN grating;
n_prism = 1.5122 @ 735 nm for the RED grating.

2) The length of the CCD used for this calculation is 30.72 mm.

Each couple of prisms has an AR coating (R< 0.5%) designed for the specific spectral range; namely in the range of usability of the grating: from 340 to 530 nm for the BLUENOT, from 440 to 700 nm for the GREENNOT and from 580 to 1000 for the REDNOT.

Each device (with the exception of the BLUENOT) has embedded also a order sorting filter to prevent the overlapping of the 2nd diffraction order (as reported in the composition scheme of Figure 1).

The BLUENOT device itself possess a cut-on wavelength of ca. 300 nm, so it doesn't need an order sorting filter.

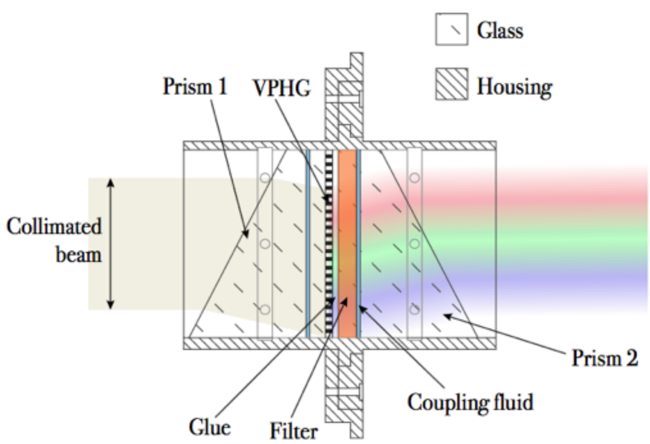

Figure 1: Scheme of the opto-mechanical elements of the GRISM devices.

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The specifications of the filters and the coupling fluids used to assemble the devices are reported in Table 1.

GRISM name	filter (type)	cut-on [nm]	fluid (type)	cut-on [nm]
BLUENOT	none	/	gel OCF-452	~ 300
GREENNOT	OG 420	420	cedar oil	~ 350
REDNOT	OG 550	550	cedar oil	~ 350

Table 1: Order sorting filters and matching index fluid used in the final devices.

The difference in the type of coupling fluid between the devices emerges from the compatibility of the absorption spectrum with the wavelength bandwidth of the grating. In the case of the BLUE GRISM, we used a particular coupling gel designed for UV application with a high transmittance even at 330 nm (60%/mm), the Nye OCF-452. For the other two, the common optical cedar oil has been chosen.

ZEMAX simulations

In Figures from 2 to 4 we have reported the ZEMAX images displaying how each device will disperse the light in the corresponding wave- length range.

REDNOT - GRISM #20

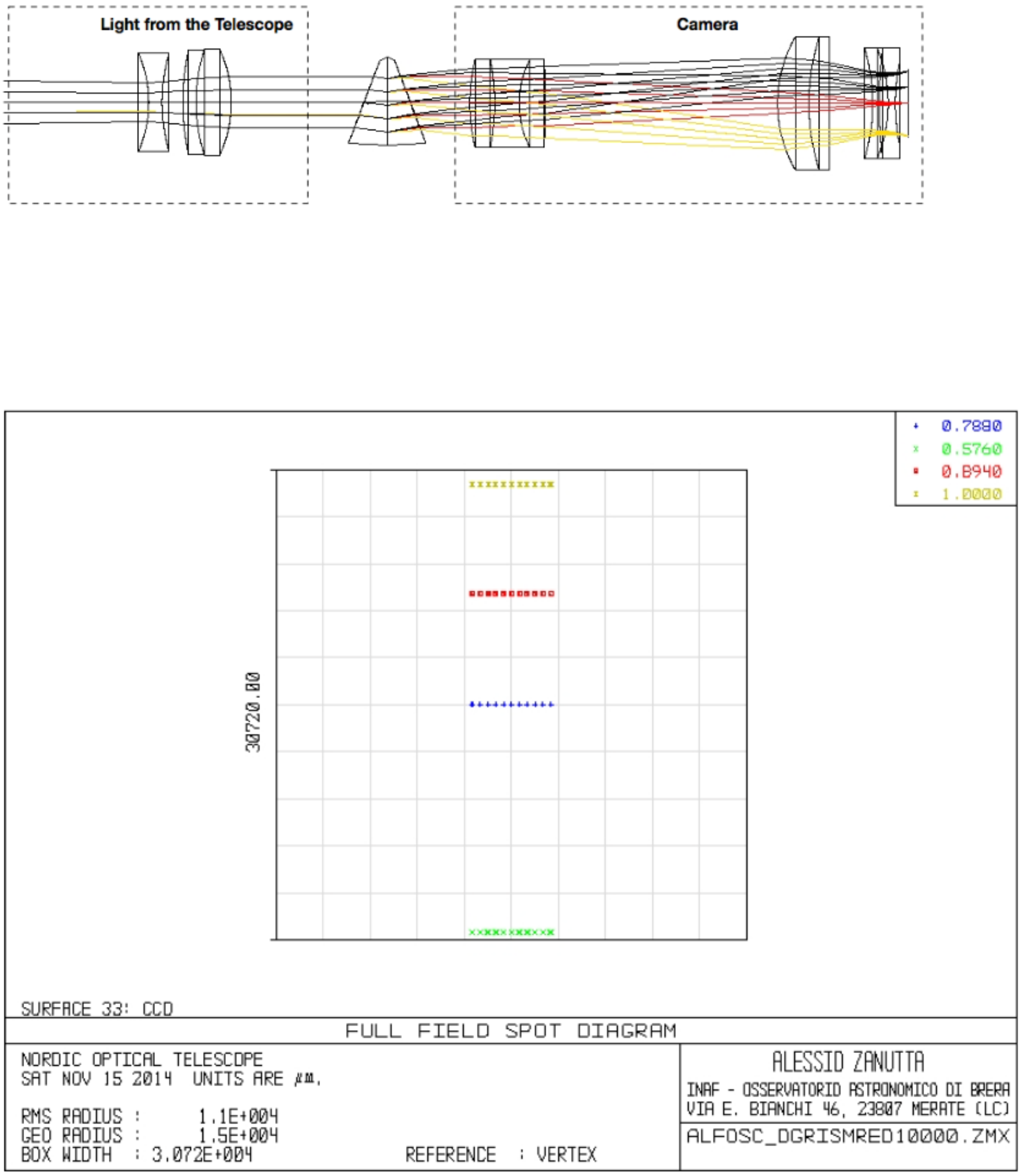

Figure 2: ZEMAX simulation of the REDNOT. Diffracted ray path inside the ALFOSC camera and imaged point at different wavelengths in the CCD focal plane.

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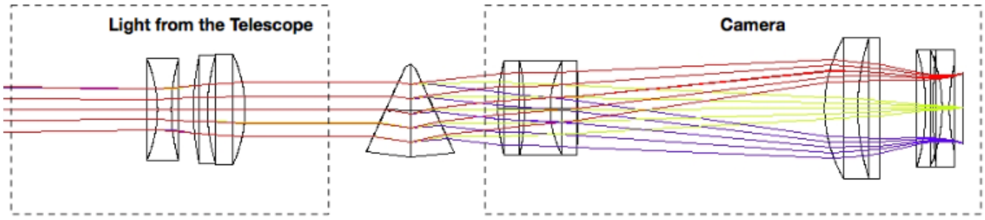
GREENNOT - GRISM #19



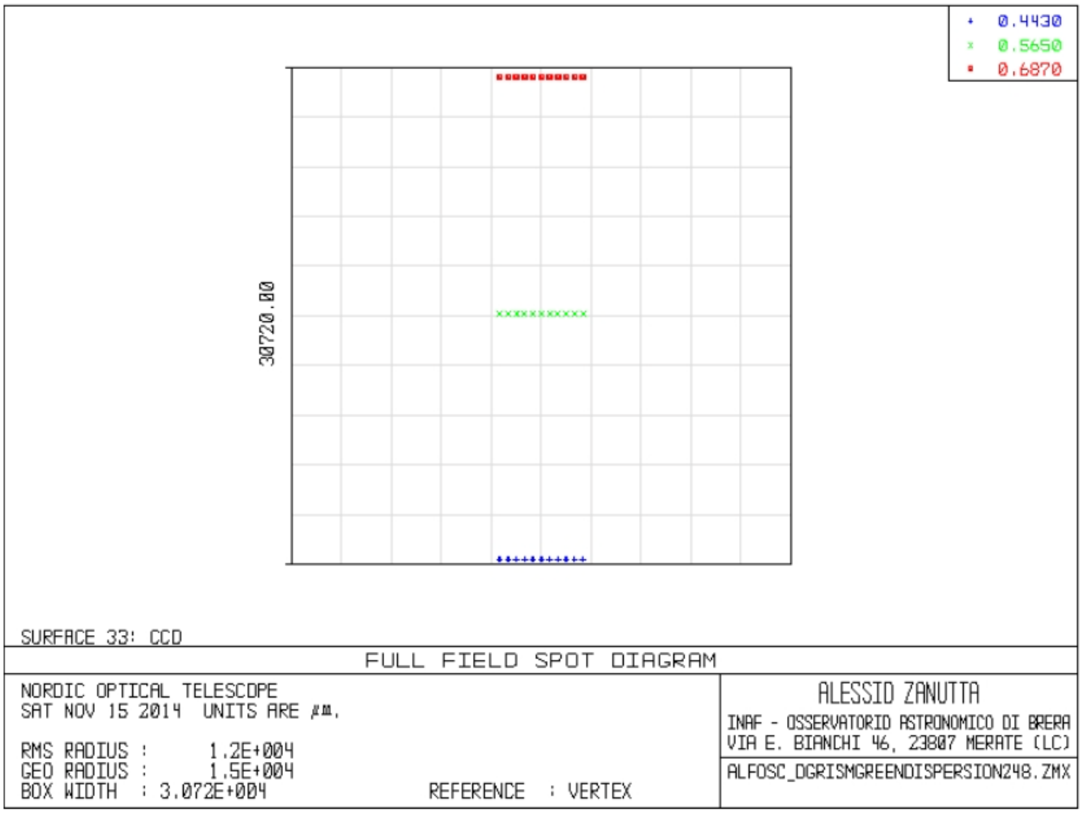


Figure 3: ZEMAX simulation of the GREENNOT. Diffracted ray path inside the ALFOSC camera and imaged point at different wavelengths in the CCD focal plane.

BLUENOT - GRISM #18

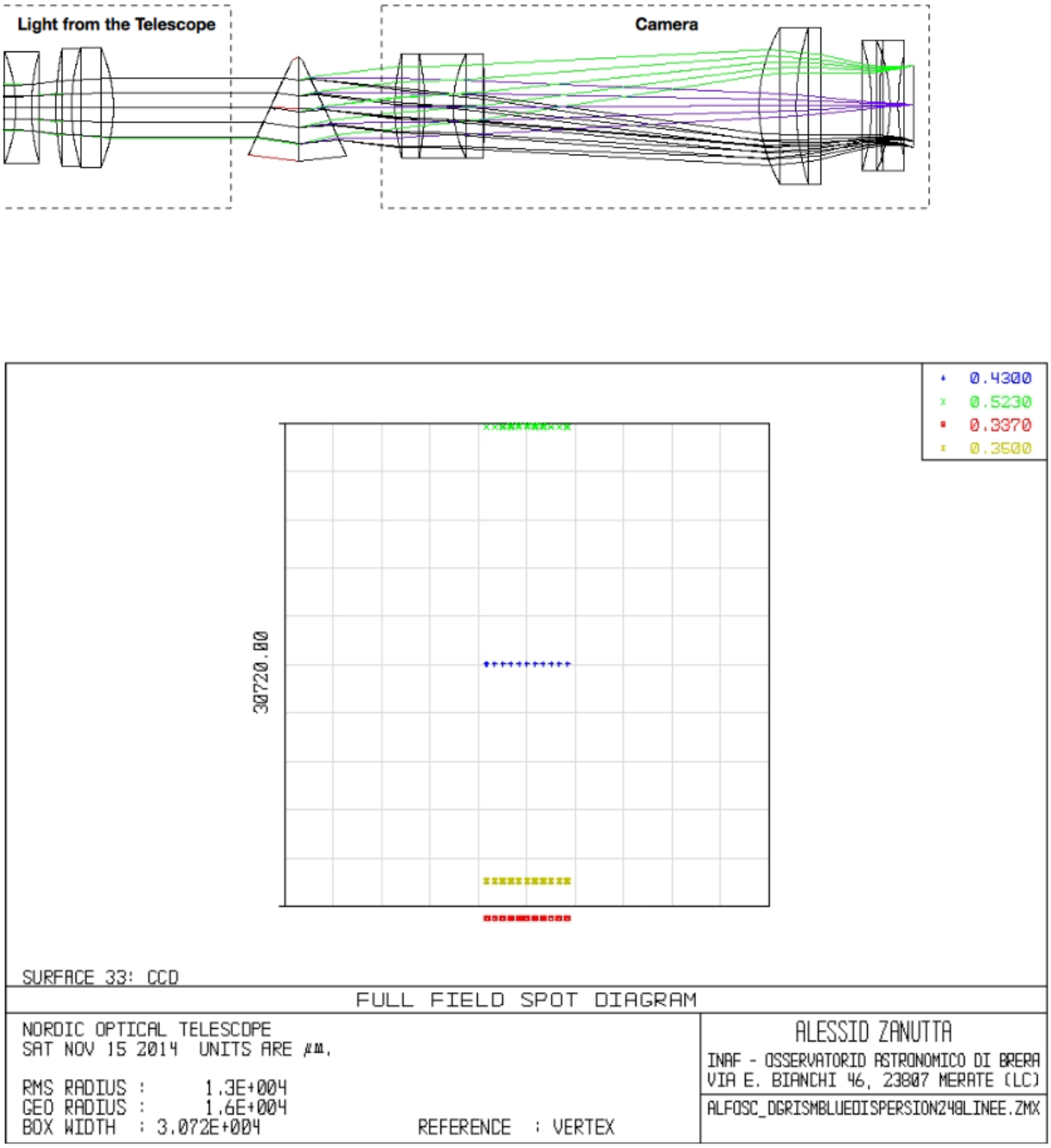


Figure 4: ZEMAX simulation of the BLUENOT. Diffracted ray path inside the ALFOSC camera and imaged point at different wavelengths in the CCD focal plane.

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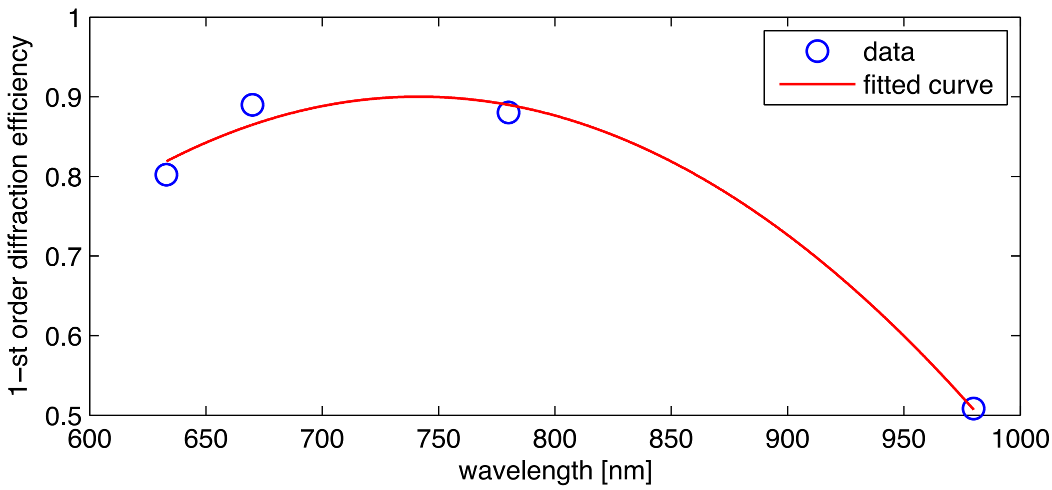
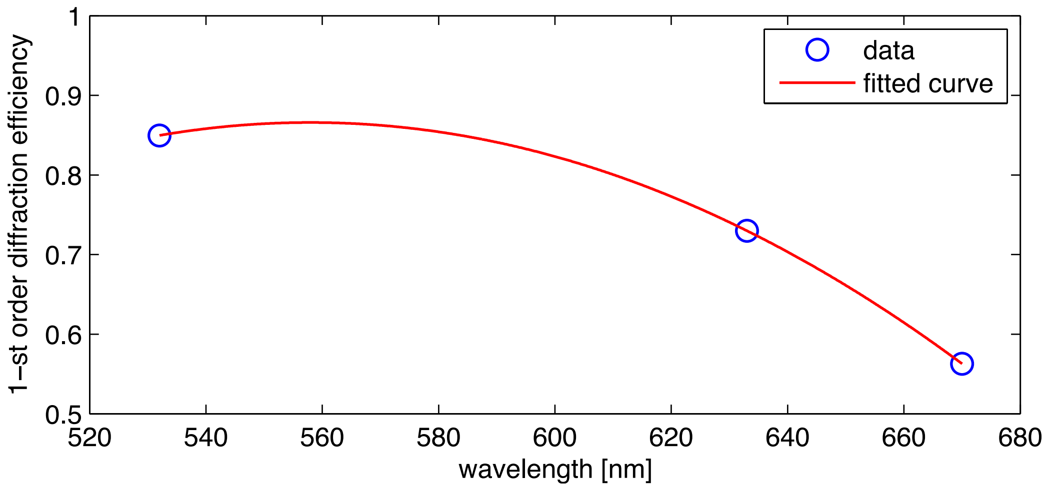
Efficiency measurements - *raw unpolarised data @ 0°*

After the alignment process, all the devices were verified in terms of efficiency measurements. In figures below are reported the curves of the three GRISMs constructed by joining singular wavelength measurements (monochromatic laser lines). The values were collected measuring the intensity of the diffracted beam after passing through the assembled devices at the normal incidence (so in the working condition of the device). We highlighted the trend with a polynomial fit that shows that the peak efficiency lies at the targeted undeviated wavelength. It is also evident how the efficiency exceeds the 80% for all the GRISMs. So large efficiencies are also clues that the reflection losses in the GRISM assembly were minimised.

REDNOT - GRISM #20



GREENNOT - GRISM #19



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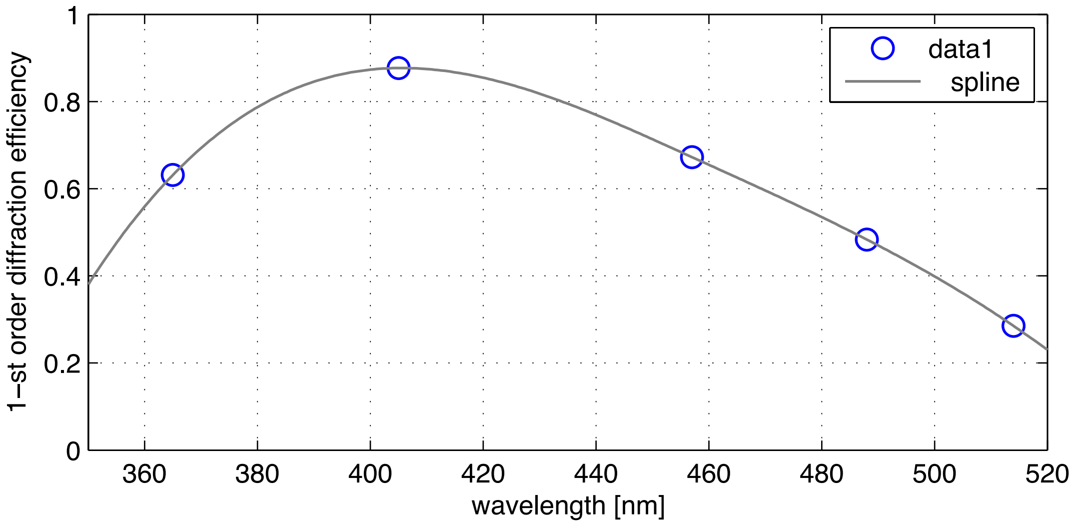
BLUENOT - GRISM #18



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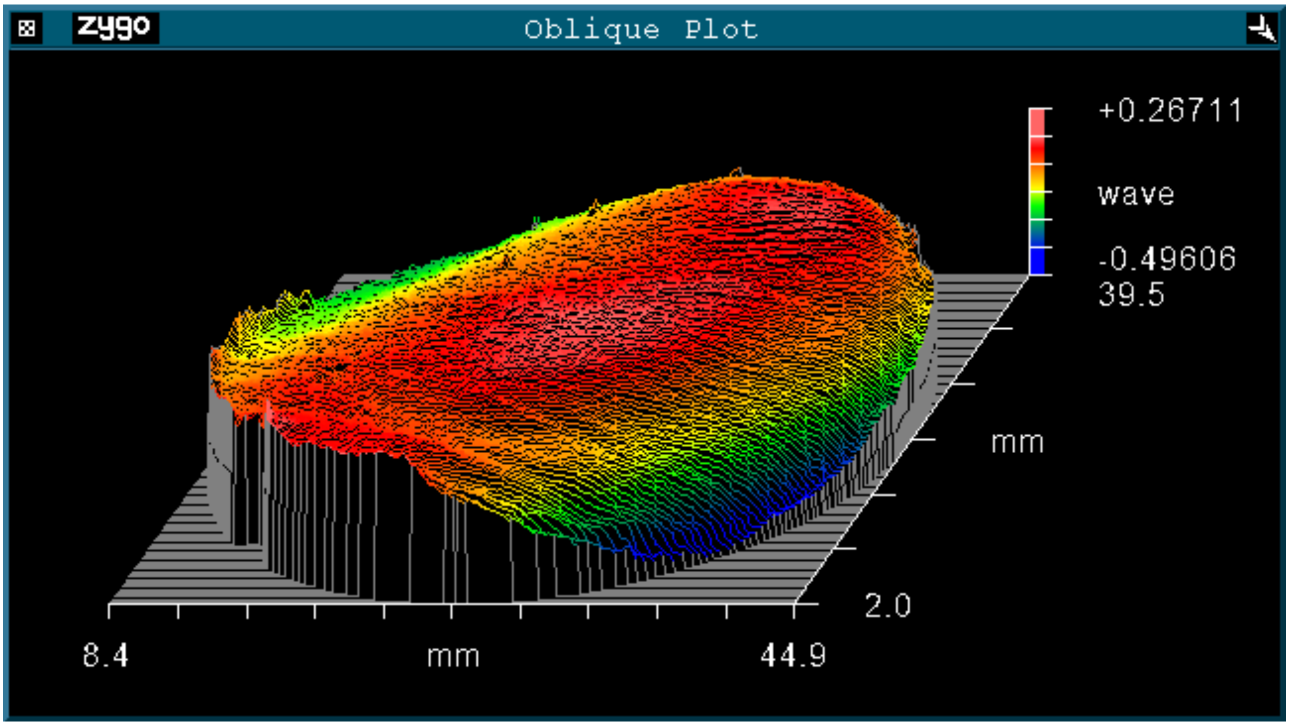
Interferometric measurements (@ 632,8 nm)

The latest measurements we carried on the devices, were the wavefront distortions. With a Zygo interferometer @ 632.8 nm, we measured the 1-st diffracted order wavefront emerging from the devices. The results, displayed in the figures below, show that the wavefront quality of all devices reaches ~ λ/10 rms with relative predominant power term.

REDNOT



PV 0.763 wave

rms 0.104 wave

Power -0.224 wave

Size X 36.5 mm

Size Y 37.5 mm

Removed:PST TLT

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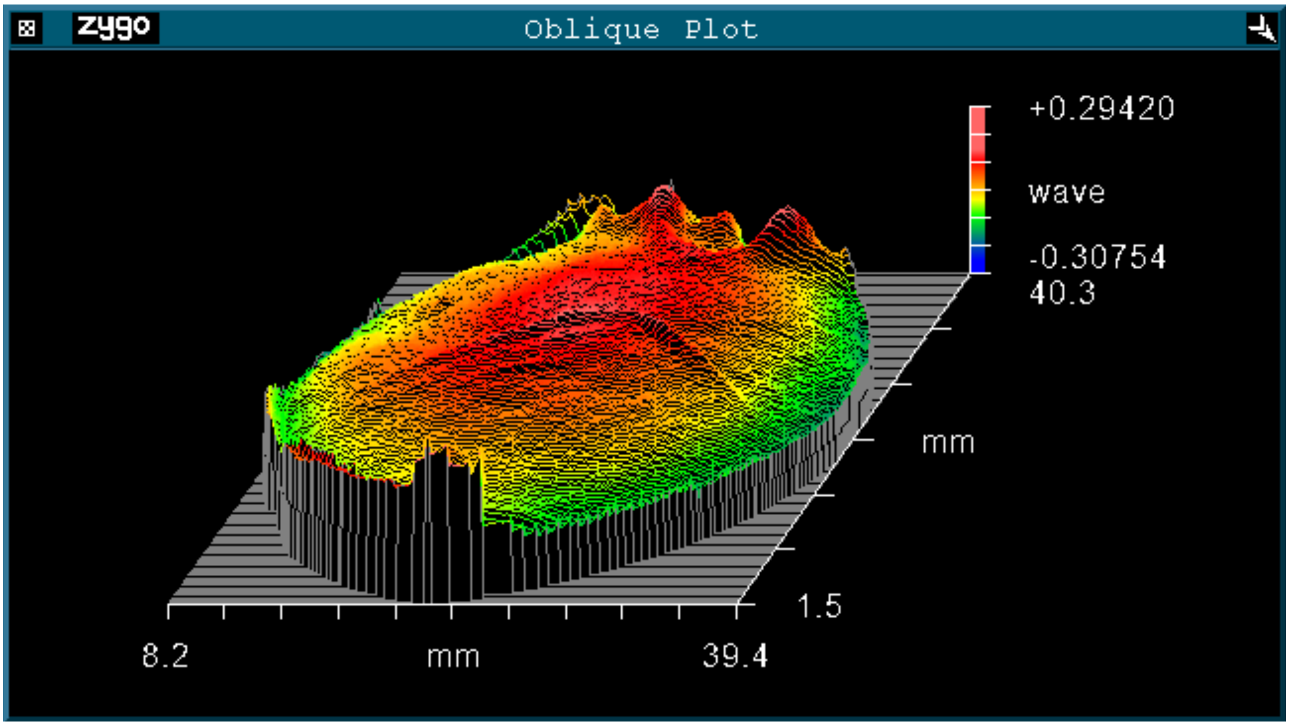
GREENNOT



PV 0.602 wave

rms 0.085 wave

Power -0.289 wave

Size X 31.2 mm

Size Y 38.8 mm

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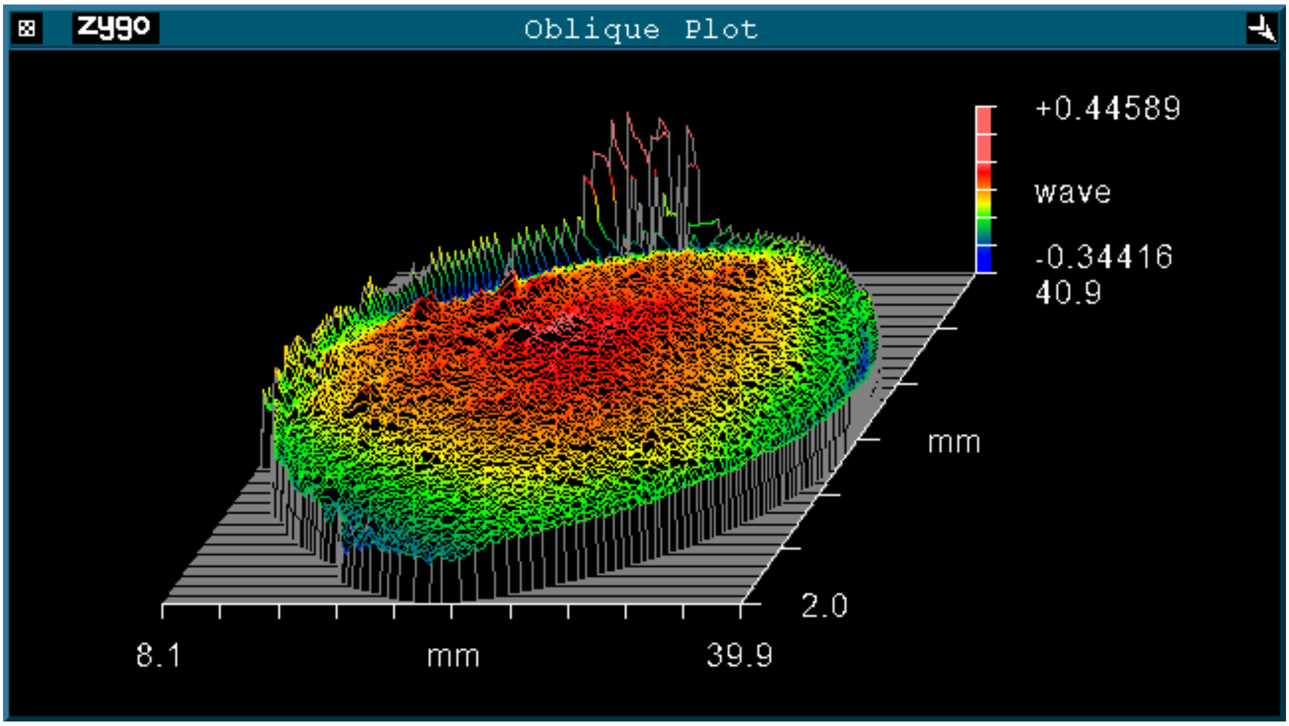
BLUENOT



PV 0.790 wave

rms 0.096 wave

Power -0.373 wave

Size X 31.8 mm

Size Y 38.9 mm

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Photo of the devices