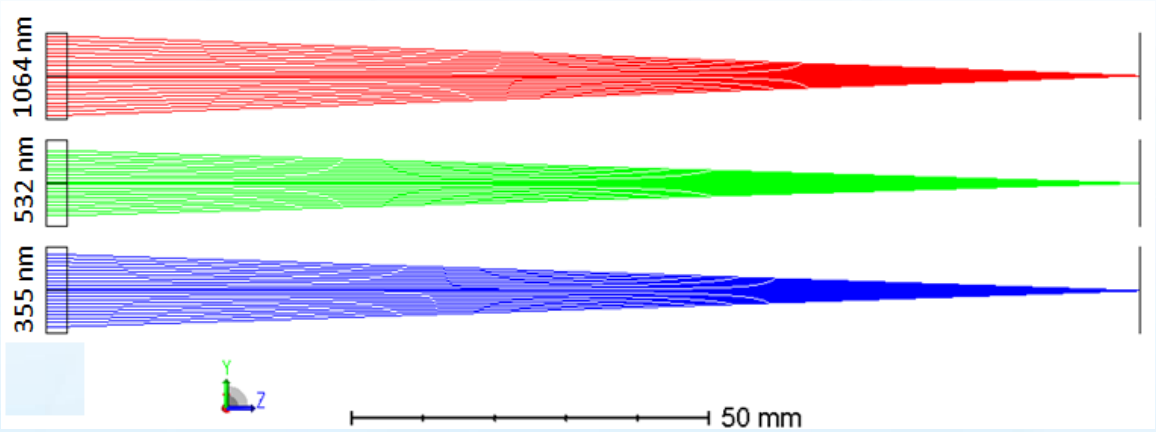
Diffractive Achromat



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1. Introduction

Many laser material processing applications are developed for an optimal wavelength such a UV glass drilling, IR sintering and visible ablation of copper. Laser harmonics allow for quick switching between the IR, Visible and UV spectrum. There is a clear market need for universal machines that can utilize different wavelengths for different processes with high precision and without interruption of continuous work.

To answer this need, Holo/Or has developed a diffractive achromatic lens which includes spherical and chromatic aberrations correction for high power lasers for Nd:YAG laser and its harmonics.

A regular refractive focusing lens based solution has chromatic aberrations and depending on the NA of the system it may also have spherical aberrations.

One solution to these aberrations can be a doublet/triplet achromatic lens with a specific combination of materials with different refractive index in order to achieve diffraction limited performance for desired wavelengths. The disadvantages of this solution include:

- not compact
- thermal focus shift
- low laser damage threshold due to use of lens materials with limited LDT and bonding

There are no effective refractive Achromats for triple wavelengths 355nm, 532nm and 1064nm in the market, which makes the diffractive Achromat unique.

Holo/Or's diffractive Achromat offers diffraction limited performance due to no aberrations, compactness (window singlet), much lower thermal sensitivity, has a high laser damage threshold (Fused Silica material), as well as being suitable for ultrashort pulsed applications.

The diffractive Achromat works perfectly for all of the designed wavelengths so that the operation wavelengths can be switched and system will continue to operate optimally without any adjustments. The diffractive Achromat is also useful in applications requiring two or three wavelengths to be focused in the same focal point simultaneously.

This type of achromatic diffractive lens is also called a Multi-Order Diffractive Lens ("MOD lens").

2. Advantages and disadvantages table

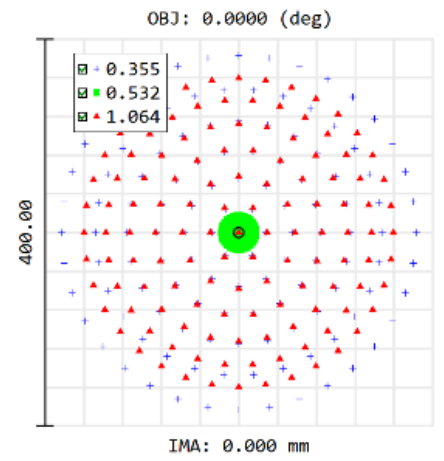
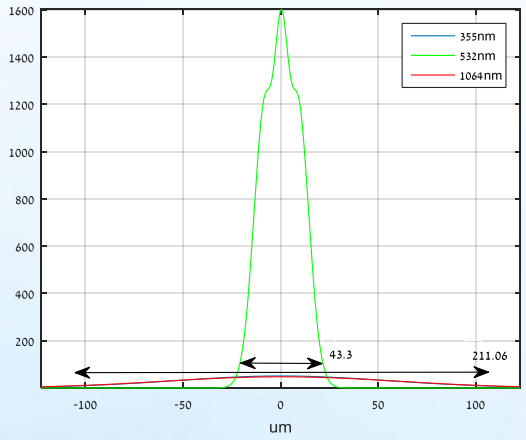
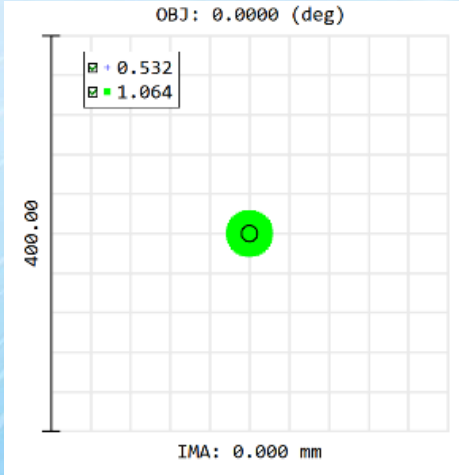
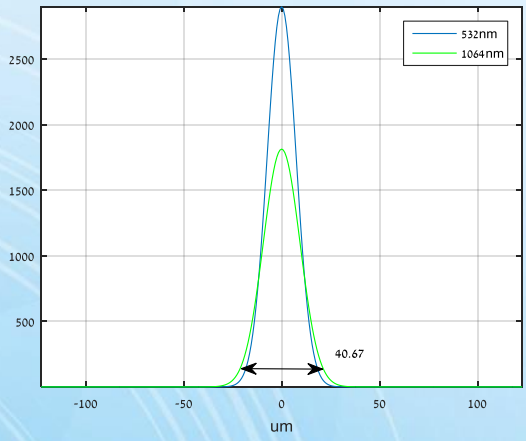
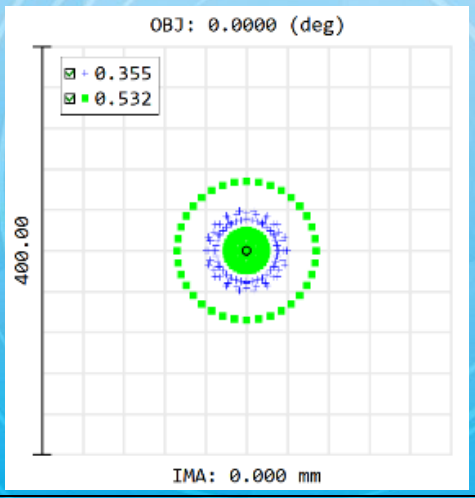
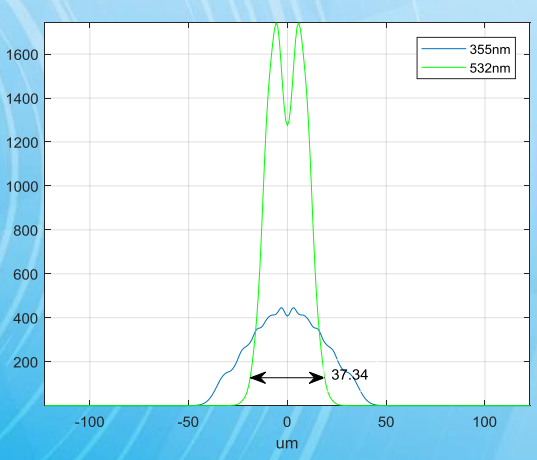
Parameters/Solution	Regular Fused Silica Lens	Refractive Achromat	Diffractive Achromat
Spherical aberrations correction	✗	✓	✓
Chromatic aberrations correction	✗	✓	✓
Compact	✓	✗	✓
Coefficient of thermal defocus	-21.1	Depends on used materials	1.1
Laser damage threshold (LDT)	High	Low	High
High Efficiency	Close to 100%	Close to 100%	>90% for designed wavelengths

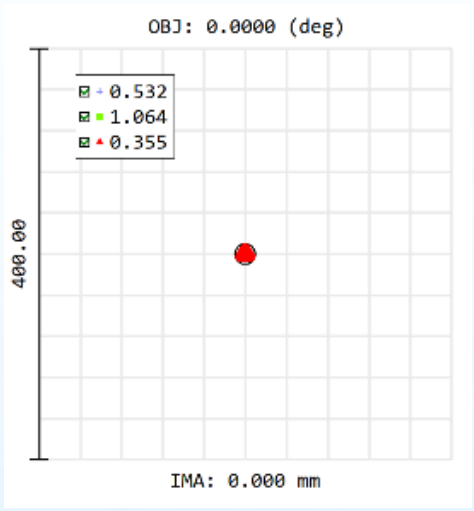
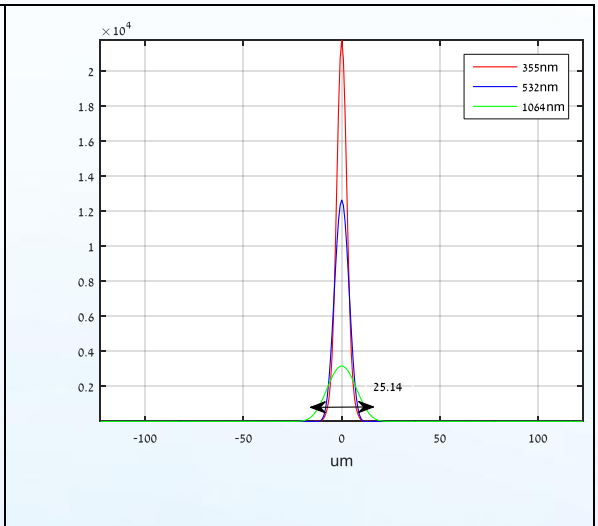
3. Standard Product Specifications

Holo/Or offers the Triple Wavelength TW-001-UQI-Y-A which has a focal length of 150mm and has diffraction limited spot size for 355, 532 and 1064nm wavelengths. Other sizes and EFL values are available on demand.

PN	Focal Length [mm]	Element Thickness [mm]	Element Diameter [mm]	Clear Aperture	Material	Wavelengths [nm]
TW-001-UQI-Y-A	150	3	15	12 mm	Fused Silica	355, 532 and 1064

4. Simulation comparisons between different solutions for EFL 150mm & incident Gaussian beam with diameter 8mm

	Spot Diagram (Zemax software)	Peak Power
Regular lens FS		
YAG-BBAR Refractive Achromat (corrected for 500-1100nm wavelengths so 355nm cannot be used)		
UV-to-NIR Corrected Triplet (corrected for 193-1000nm wavelengths so 1064nm cannot be used)		

Diffractive Achromat		

As can be seen above, peak power for the diffractive Achromat is ~ X3 higher than the YAG-BBAR refractive Achromat corrected for 500-1100nm and is ~ X25 higher than the UV-to-NIR Corrected Triplet.

Moreover, the diffractive Achromat is corrected for triple wavelength 355nm, 532nm and 1064nm and has no equivalent in the market.