

## **Custom lens solutions: Boosting precision in high-tech industries**

Magnus Greger  
Lead Business Unit Industry  
Schneider-Kreuznach



# Magnus Greger

## Lead of Business Unit Industry at Schneider-Kreuznach

- Lead of Business Unit Industry since 2021
- Studies in physical technologies
- Career started as an optical engineer
- Developed and tested high-end lenses and optomechanical systems for industrial, photographic and cinematographic applications





Founded in 1913 by Joseph Schneider | Headquarters in Bad Kreuznach, Germany  
Worldwide offices in Los Angeles, New York, Shenzhen, Hongkong and Singapore

# Fully vertically integrated manufacturing



**Development**



**Manufacturing**



**Module integration**

Optical design

Mechanical design

Components

Coating

Assembly

Quality inspection

# Industrial lenses

## Different vendors

Schneider-Kreuznach



Tamron



Kowa



Ricoh



Nikon



Why are custom optics still needed with a wide range of COTS lenses available in the market?

## 4 Main reasons for custom optics



**Match application**



**Costs**



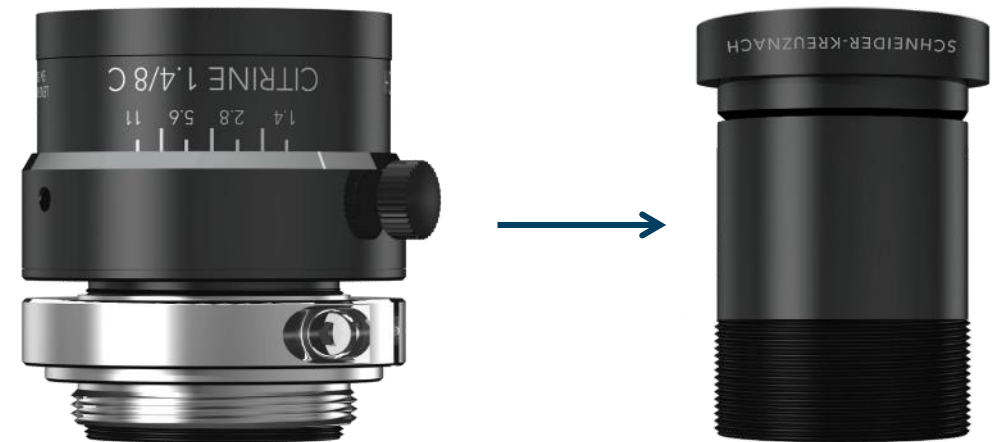
**Boost performance**



**Unique optical requirements**

## Match application – example 1

- Limited space
- Harsh environment
- Weight requirements



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# JAMES WEBB SPACE TELESCOPE

space  
TELESCOPE



# Costs: Example USPS project

## COTS

- Optimized for a wide range of applications
- Limited change control
- Limited control over performance
- Easy availability
- No upfront costs
- Non-cost-optimized product

## Custom

- Specific optimization for given application
- Full control over change control process
- Guaranteed performance level
- Initial development phase
- NRE costs
- Cost-efficient product



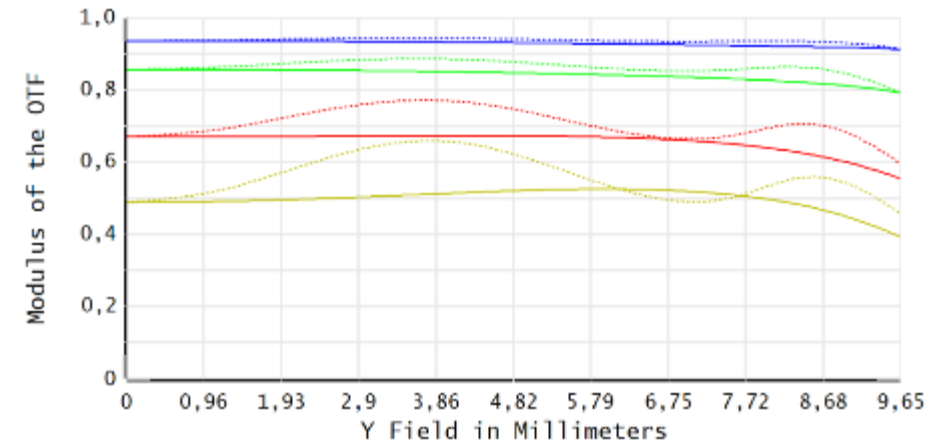
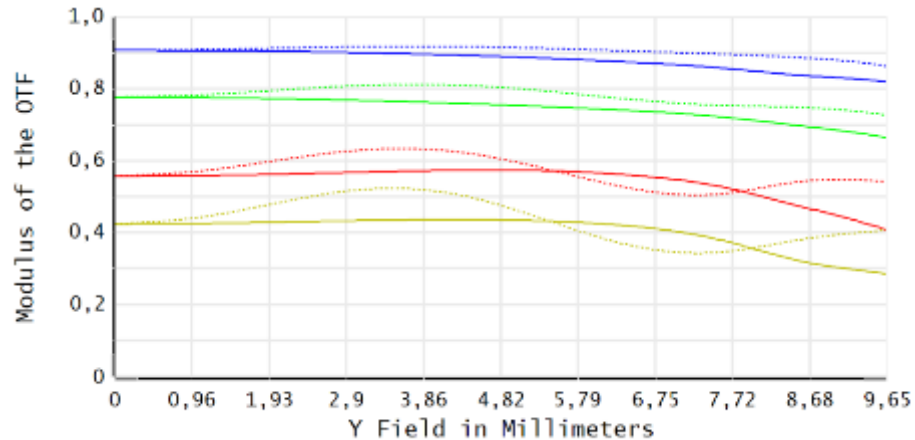
# Boost performance – example 1: Optimize COTS lens to application

## Optimization of standard lens for working distance and spectral range

Minor modifications already lead to a significantly higher performance for a specific application.

Standard lens at WD = 950 mm and 450 nm

Optimized Lens at WD = 950 mm and 450 nm

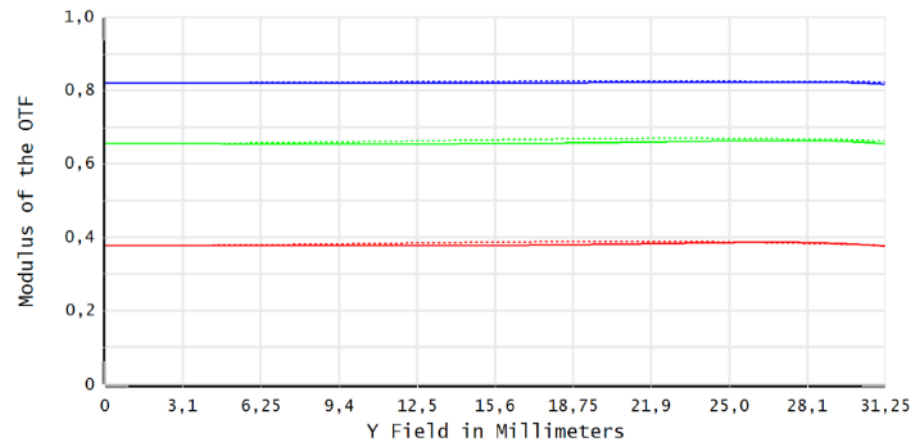


# Unique requirements: High magnification lenses

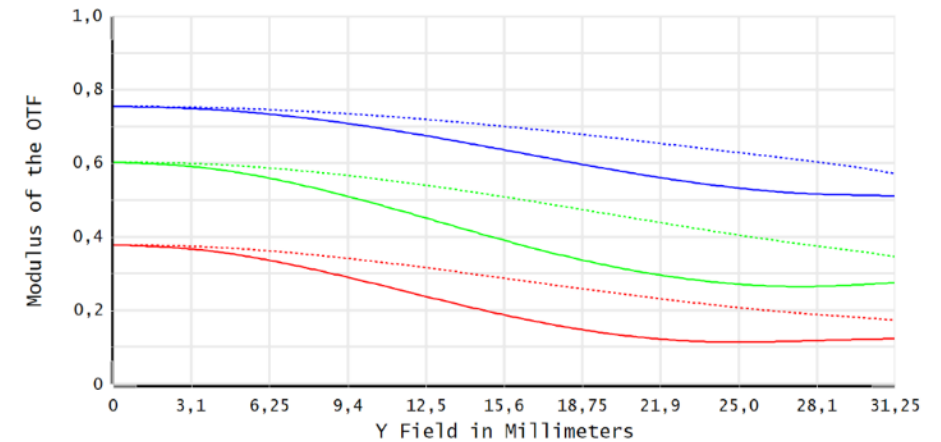
## Optimized exactly to the point

High magnification lenses are extremely precise instruments, optimized for diffraction limited performance at their nominal magnification.

DIAMOND 3.5x Lens at nominal magnification 3.5x



DIAMOND 3.5x lens at 3.0x



# Unique requirements: Custom 180° fisheye

## Fisheye lens for large format sensors

### Unique requirements

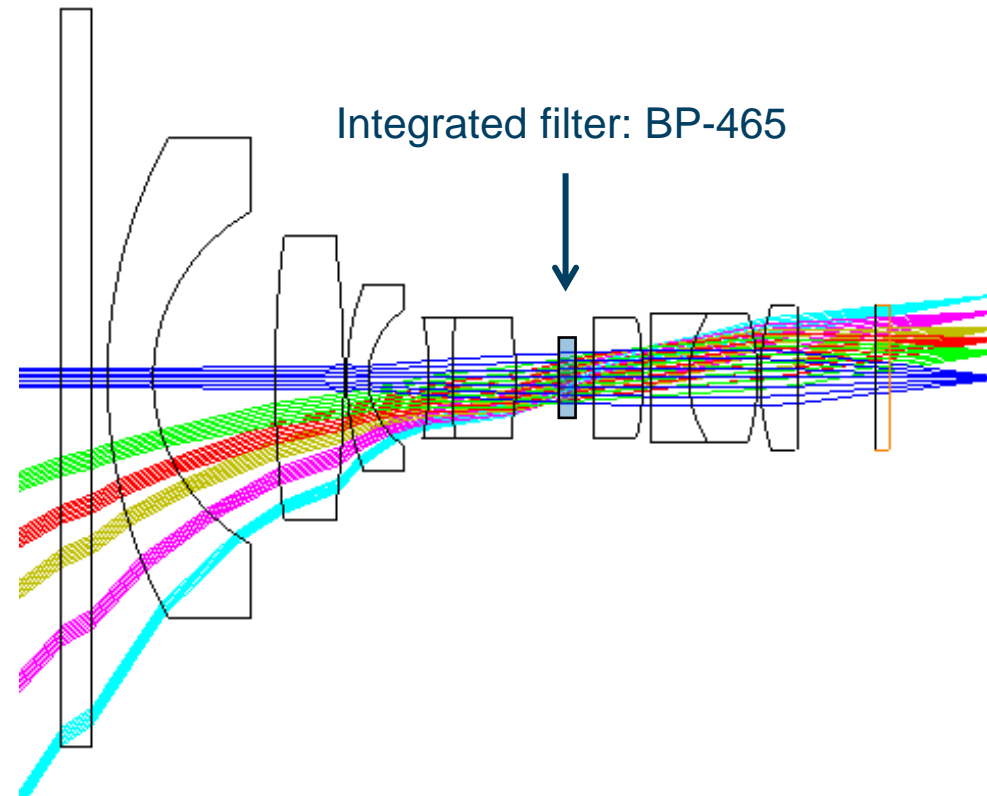
- 180° field of view
- S35 sensor format
- High resolution
- Low distortion
- 3D measurement application
- Thermal robustness
- Stray light and Ghost Image optimization



## Unique requirements: Filter inside a lens

### CITRINE 1.8/4.8

- BP-465 integrated filter
- 3D measurement application
- Weight savings
- Better temperature performance



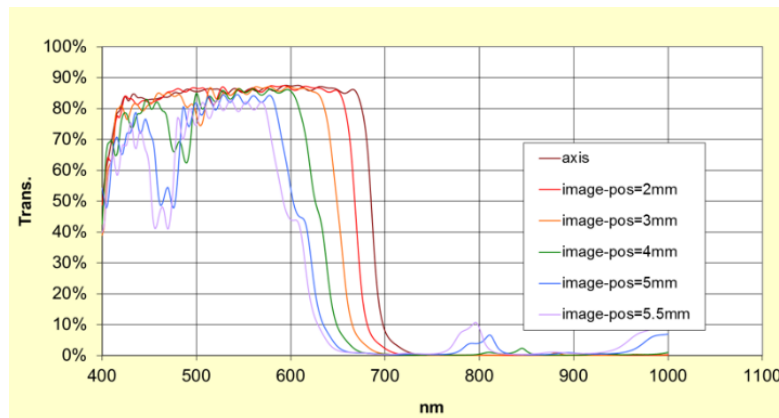
# Front filter glass

## Blueshift of interference filters

The characteristics of an interference filter depends on the angle of incidence of the incoming light.

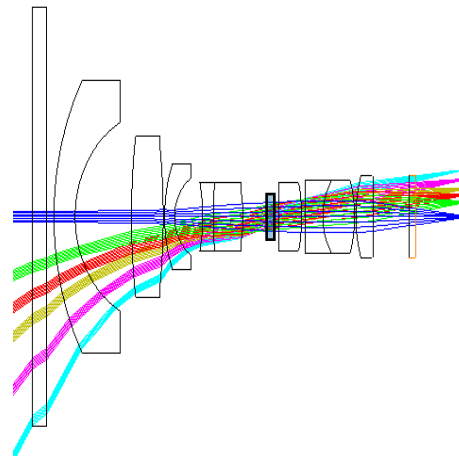
The steeper the angle the more the filter characteristics moves to shorter wavelengths (blue shift).

Transmission: IR-Cut in front of lens

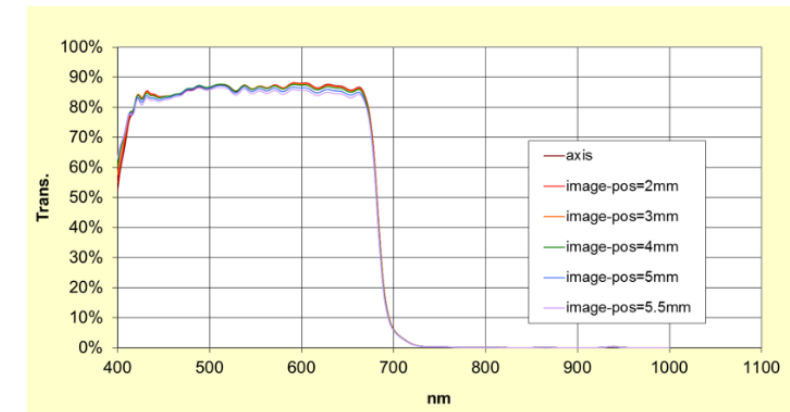


- max. angle of incidence: 47.8°
- max. blueshift: 93 nm

Lens Cinegon 1.8/4.8



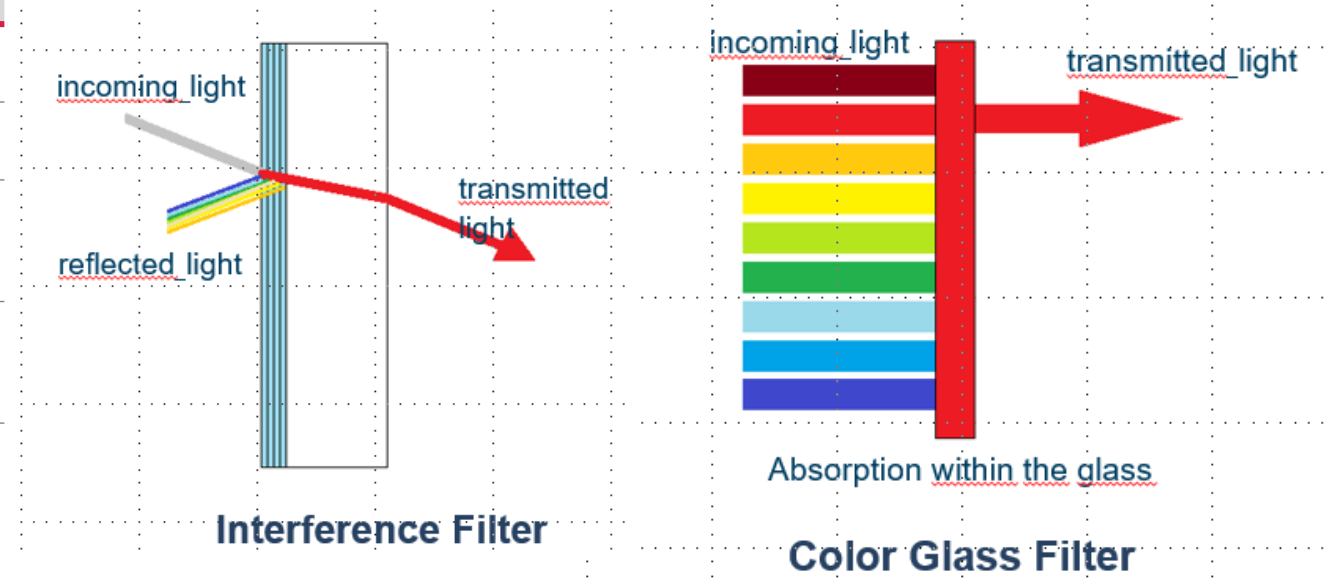
Transmission: IR-Cut inside the lens



- max. angle of incidence: 8.6°
- max. blueshift: 1 nm

# Interference filter vs. color glass filter

Interference filter	Color glass filter
Coated glass	Colored glass
Reflective	Absorbing
Steep cut-on and cut-off edges	Stable cut-on edge, soft cut-off
Narrow bands possible	Independent from Angle of incidence
Higher transmission, better blocking	Only certain types available
High Angle of incidence causes blue shift	



# Unique requirements: Allen Institute

## Unique requirements

- Magnification: 10x
- Numerical aperture: 0..5
- Sensor diagonal: 67 mm
- Wavelength range: 435 nm – 780 nm
- Resolution: Diffraction limited
- 4-color channel camera setup

## Advantages of custom optics

Unique optical solution allowing to reduce image capturing time by factor of 48 with unparalleled optical resolution





# Unique requirements: Display inspection lens

## Unique requirements

- <10% as built MTF margin from diffraction limit
- Three color channels in same focus
- Sub- $\mu\text{m}$  defect detection requirement
- Large sensor format
- No distortion



# Contact us

## Magnus Greger

Lead of Business Unit Industry

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