



shaping the future of optics

## **Optotune ELM-35-5.4-18-C**

### **Test report**

November 2025  
Amir Saba, Application Engineer

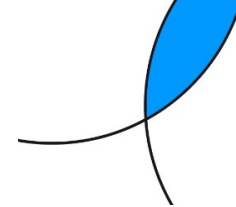
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# Summary

- **Working distance (WD) range of 200mm-Inf (Shorter WD possible with a spacer)**
- **Performance close to the Nyquist rate of 2.74 $\mu$ m pixel size**
  - Resolution >170 lp/mm for center of the image across the WD tuning range
  - Resolution  $\geq$ 150 lp/mm across the field and WD tuning range
- **FP-sensitivity: 200mm-Inf WD with only 4.1dpt range**
- **Very negligible field curvature and distortion**
  - Distortion is <1%
- **Negligible vignetting (~13%)**
- **No resolution degradation due to the gravity-coma for horizontal optical axis**
- **Very good polychromatic performance**
  - Performance very similar between white and blue backlights



# ELM-35-5.4-18-C Datasheet



## Lens module specifications

	EL-12-30-TC-VIS-16D	EL-7-20-TC-VIS-14D	
Effective focal length		34.5	mm
F/# (fixed)	3.2	5.4	
Maximum sensor format		1.1	inch
Maximum image circle (Φ)		18	mm
Lifecycles (10-90% sinusoidal)		>1'000'000'000	cycles
FOV for 1.1" sensor	Diagonal	28.9	°
	Horizontal	20.5	°
	Vertical	20.5	°
Back focal length (BFL)		13.53	mm (in air)
Optical distortion	<0.27	<0.22	%
Pixel size (recommended)		2.74	μm
Wavelength range		420-900	nm
Relative illumination	>92	>90	%
Max chief ray angle	3.1	3.5	°
Working distance (WD) range <sup>1</sup>		200 to inf	mm
Optimal WD		500	mm
WD at 0 dpt		1980	mm
Mount		C-mount	
Filter thread		M31.5x0.5	
Connector type		Hirose (6 pins)	
Total track length (TTL)		130.75	mm
Dimension (Φ x L)		47.0 x 113.2	mm
Weight		470	g
Operating temperature		-20 to +65	°C
Storage temperature		-40 to +85	°C

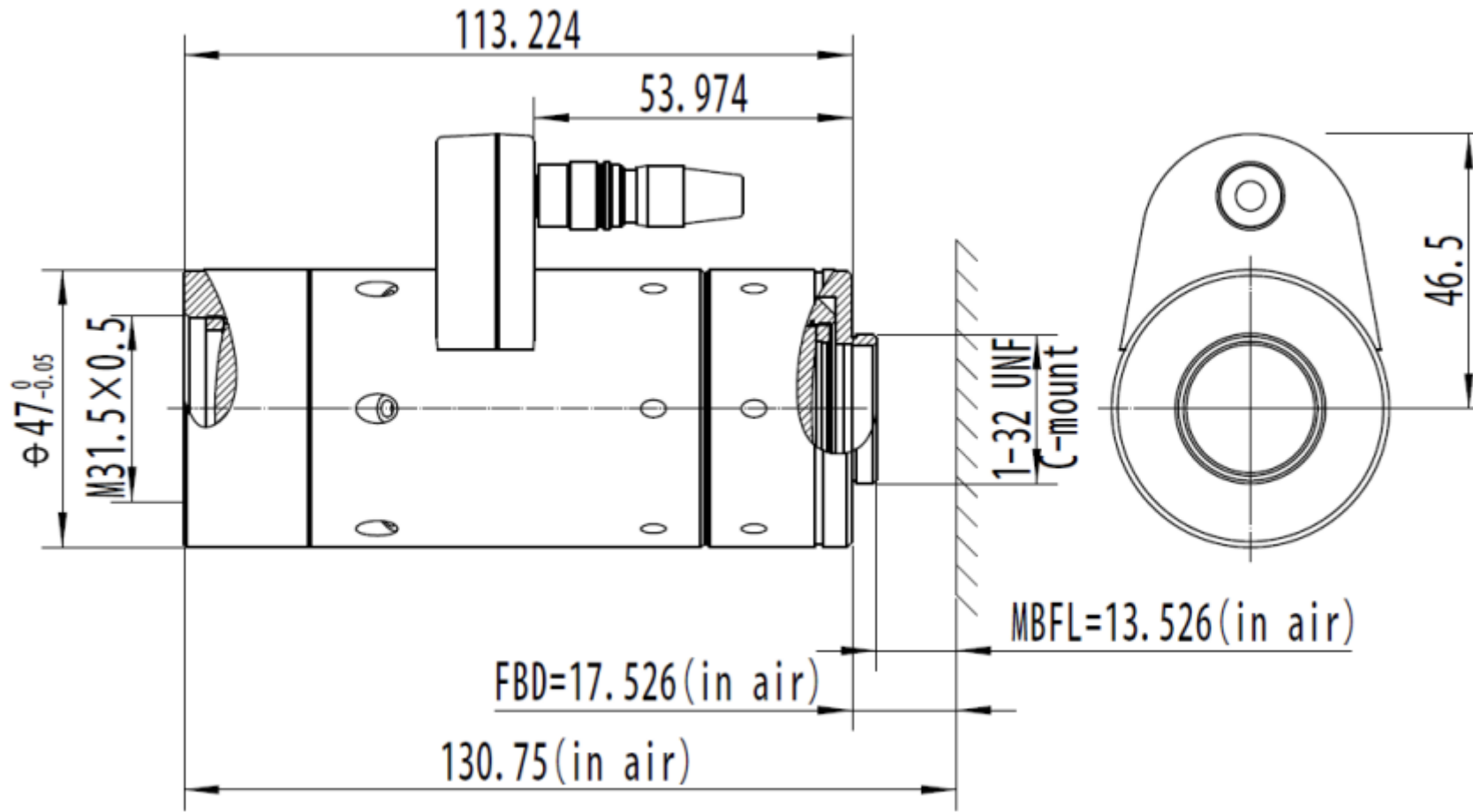
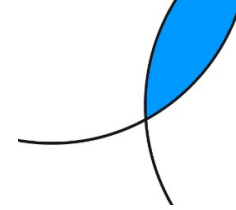
## Focus tunable lens specifications

	EL-12-30-TC-VIS-16D	EL-7-20-TC-VIS-14D	
Focal power range (@25°C)	-6 to +10	-6 to +8	dpt
Focal power range for module WD range		-0.5 to 3.7	dpt
Temperature sensor and EEPROM		Yes	
Control current (typical)		-250 to +250	mA
Max. control current		-300 to +300	mA
Motor coil resistance @ 30°C	15	12	Ω
Absolute maximum voltage (coil)	6	6	V

## Electrical layout

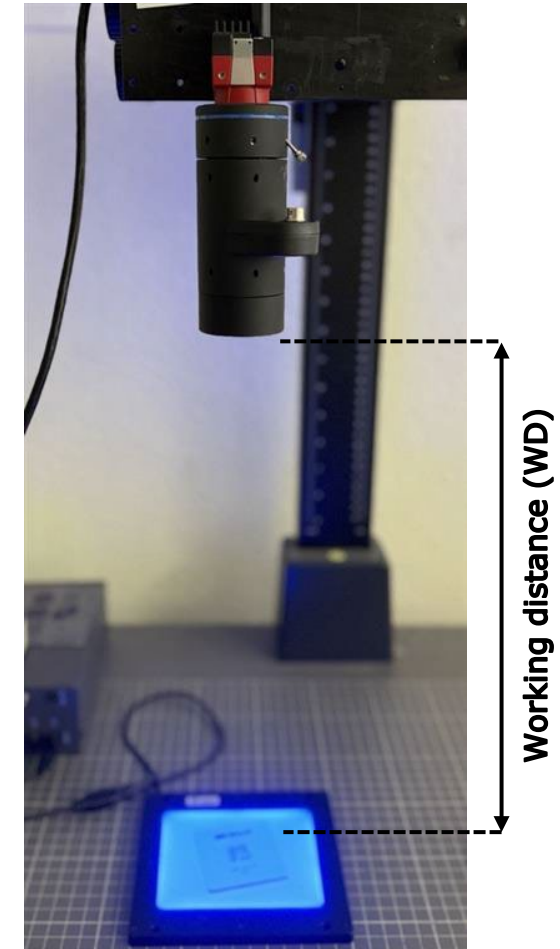
Hirose connector (HR10G-7R-6PB)	Function	Sensor pins	
Pin 1	Control current +	-	
Pin 2	Control current -	-	
Pin 3	Ground	1-4	
Pin 4	Vcc (3.0-3.7V)	8	
Pin 5	I <sup>2</sup> C SCL	6	
Pin 6	I <sup>2</sup> C SDA	5	
Hirose connector (HR10G-7R-6SB)	Function	Value	
Pin 1	GPIO Trigger	-	
Pin 2	Analog In	0-10V	
Pin 3	UART Tx / I <sup>2</sup> C SCL	TTL	
Pin 4	UART Rx / I <sup>2</sup> C SDA	TTL	
Pin 5	GND	-	
Pin 6	Vcc	5-24V	

# Mechanical drawing



# Test Setup

<b>Camera:</b>	Alvium 1800 C-2040 1.1" 4512 x 4512 px Pixel size = 2.74 $\mu\text{m}$ Nyquist rate = 182 lp/mm C-mount
<b>Lens:</b>	ELM-35-5.4-18-C
<b>Tunable lens:</b>	EL-7-20-TC-VIS-14D SN: DHAA0249
<b>Orientation:</b>	Vertical Optical Axis
<b>Driver:</b>	ECC-1C SN: CXAB1454, FW: 2.0.741648
<b>Target:</b>	USAF chrome target, positive
<b>Light:</b>	White backlight (LED1-FLS-110x110W) Blue backlight



# Field of view with 1.1" sensor

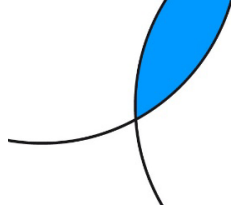
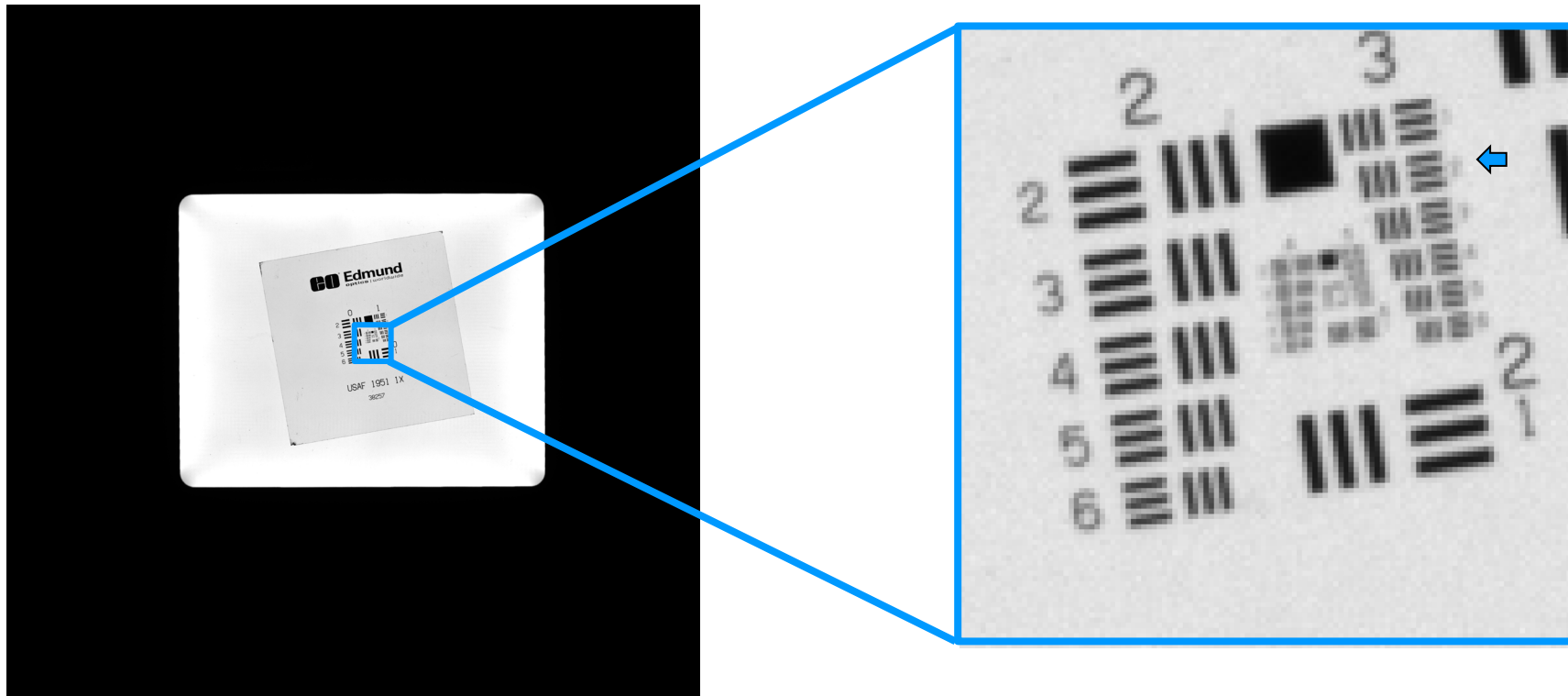


Image size (2.74  $\mu\text{m}$  pixel size):

- Width = 12.4 mm
- Height = 12.4 mm
- Diagonal = 17.5 mm

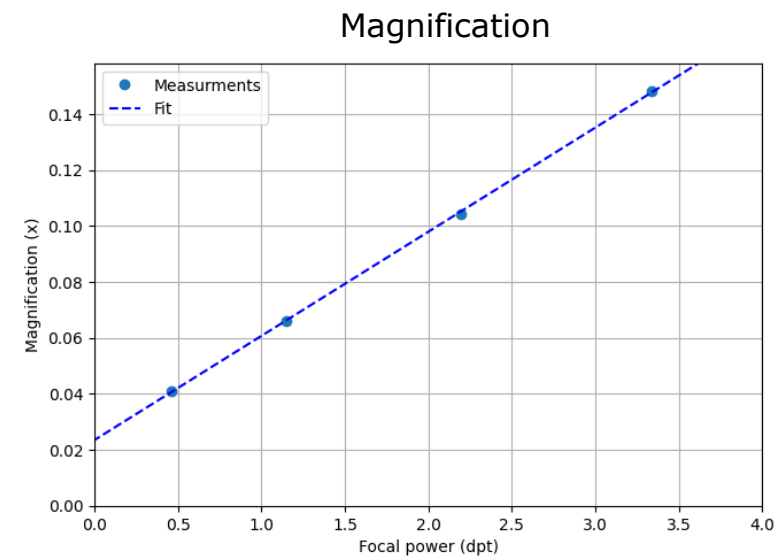
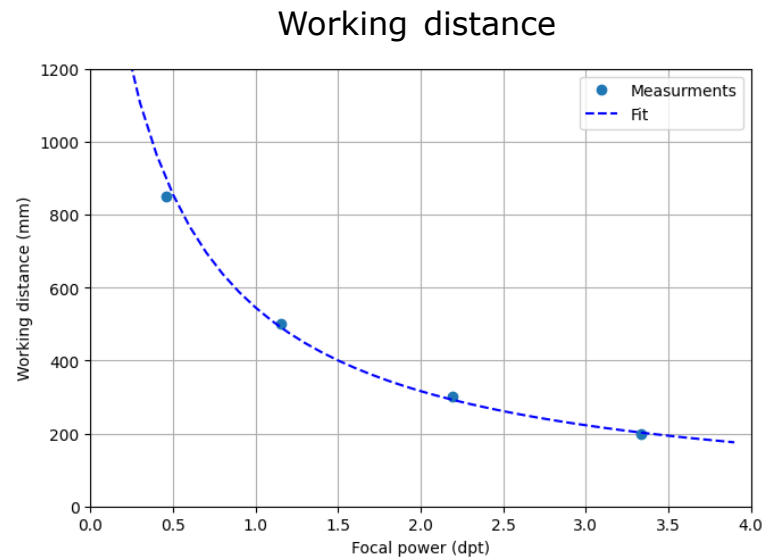
# Image evaluation

- All the images are taken at Gain 0, and without gamma correction
- The intensity of illumination is controlled to adjust the histogram of the images
- After acquisition, images are zoomed in to show the resolution-limited element



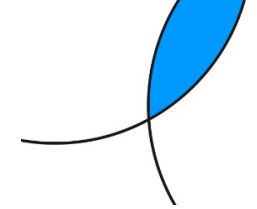
# Working distance, Magnification

- Magnification and working distance of this ELM is very well aligned with an ento-centric lens



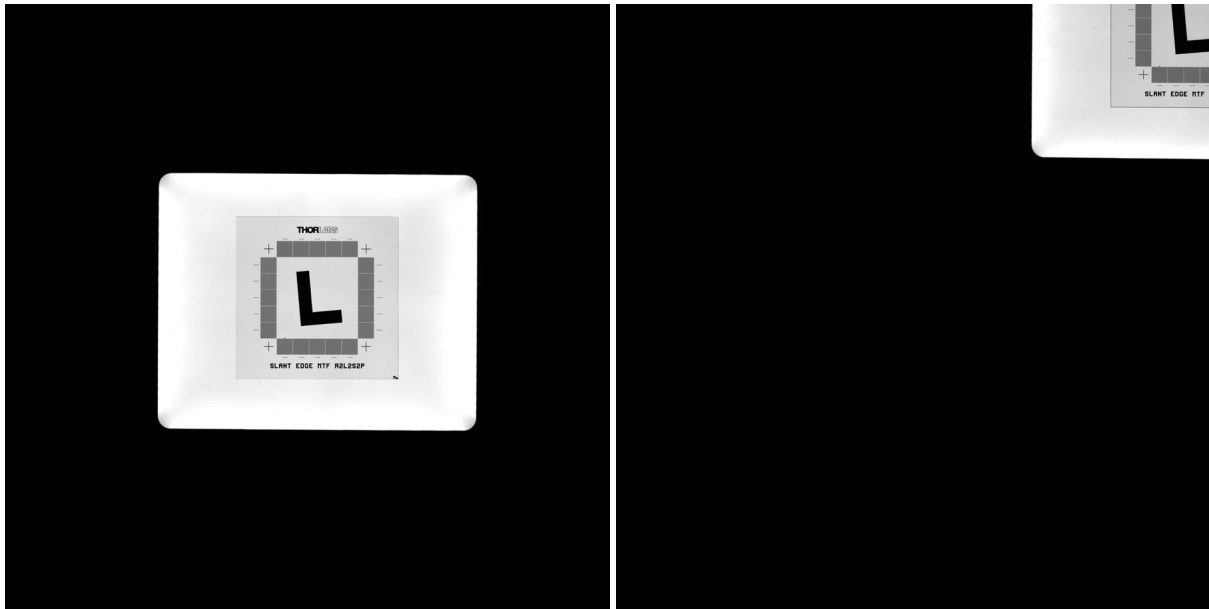
- \* Measured with blue LED backlight
- \* Magnification measured at the center of the image

# Slanted-Edge MTF

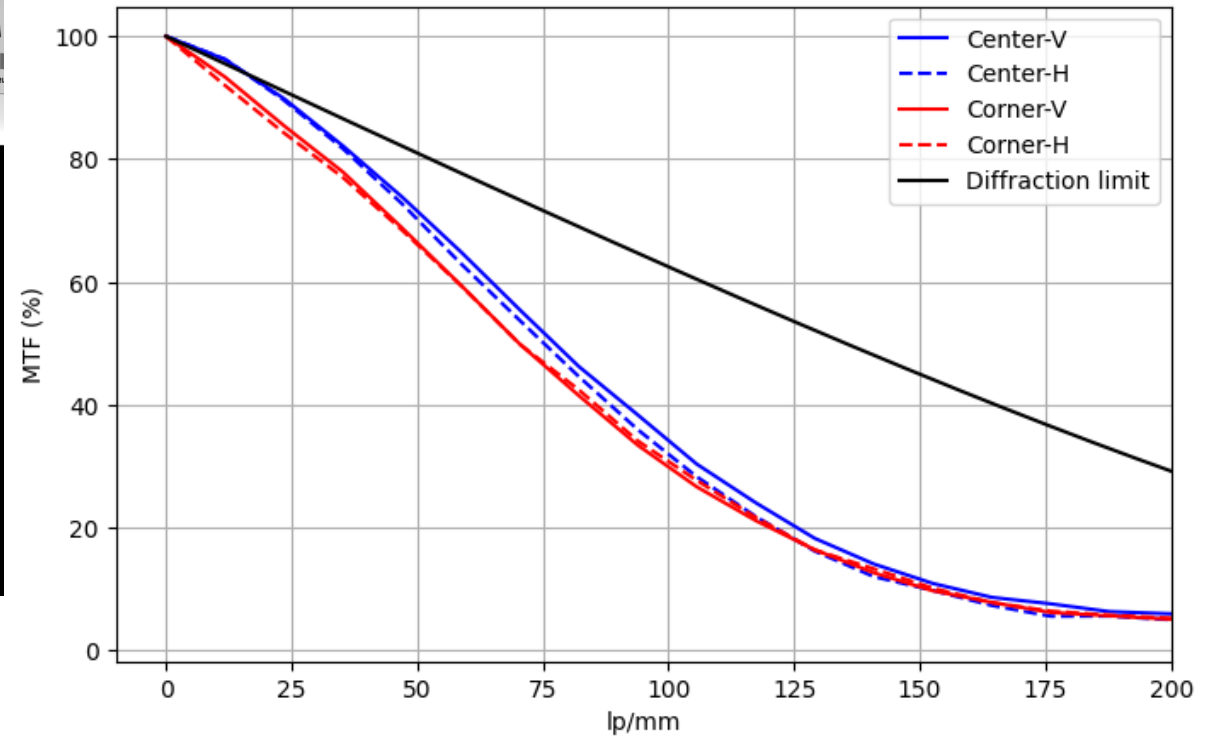


Center

Corner

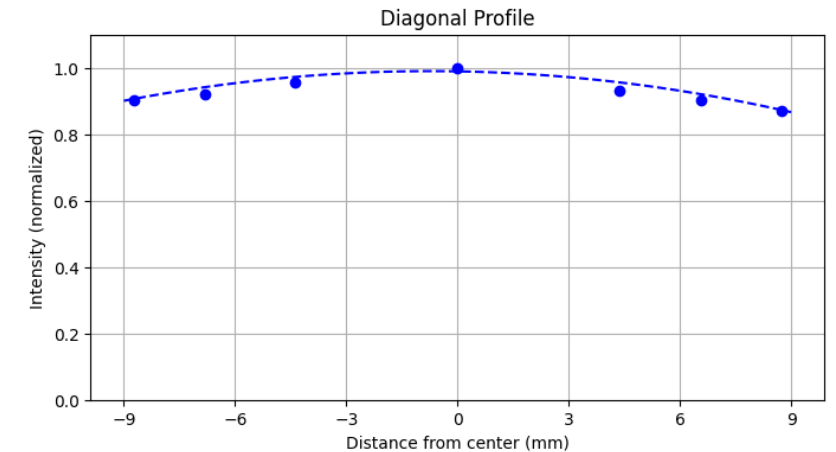
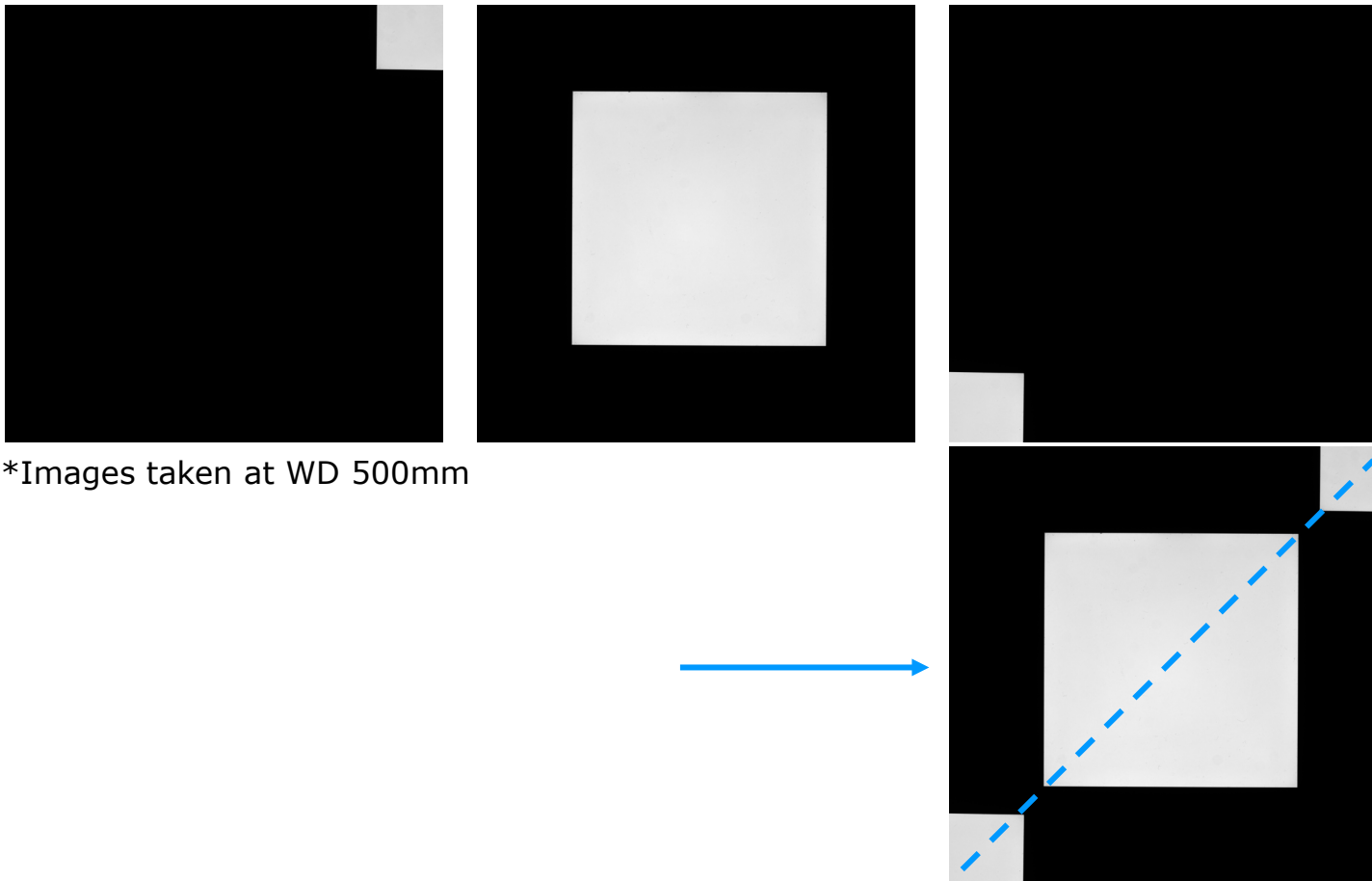


\*Images taken with the blue LED at WD 500mm



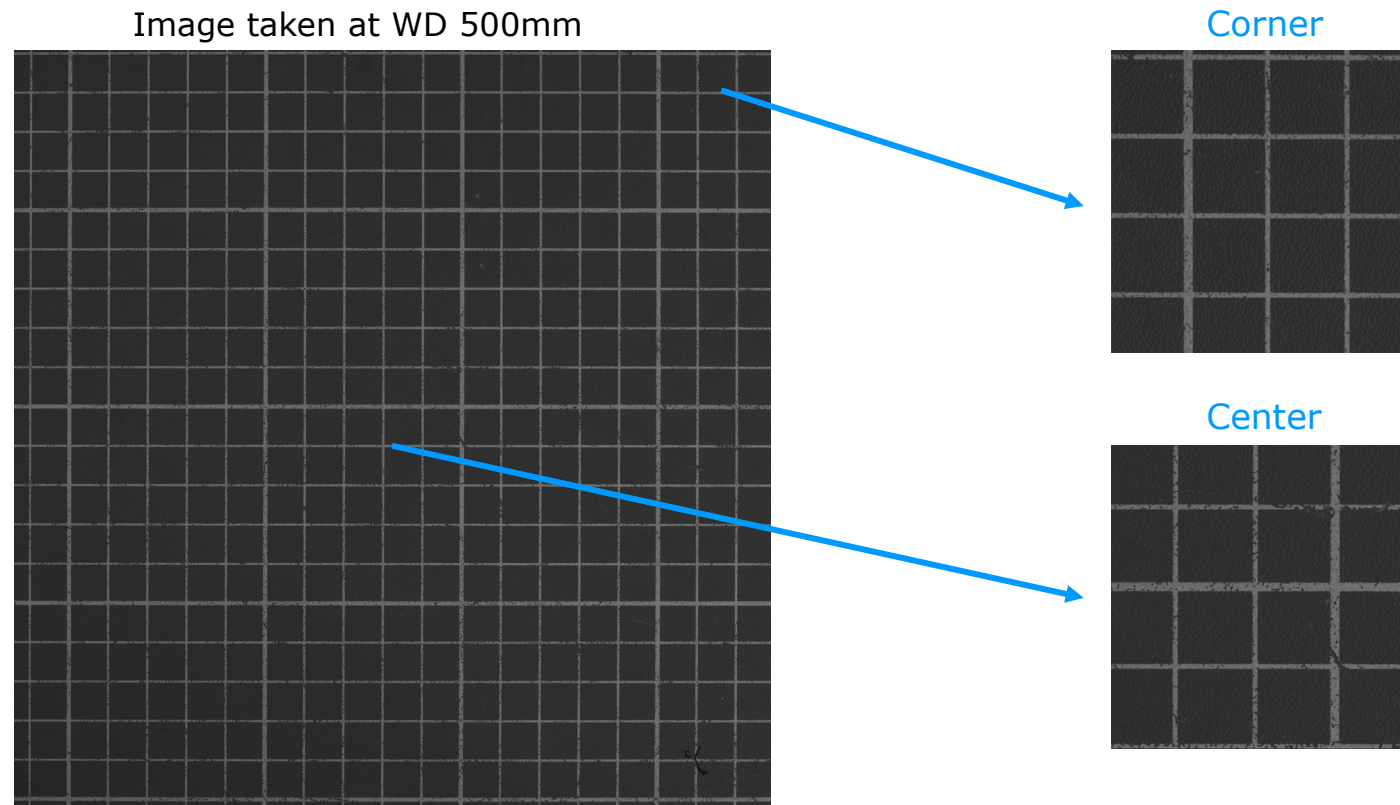
# Relative illumination

- Due to the wide-angle FOV, we did image stitching for multiple measurements with a uniform LED
- Vignetting of this ELM is 0.2EV (13%) for 1.1" sensor
- There is a negligible dependence to the focal power/WD for the vignetting

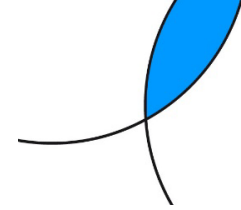


# Distortion and field curvature

- We see some distortion but no field curvature
- Geometrical distortion value:  $\leq 1\%$



# WD 850 mm: +0.44dpt, Blue light Performance is close to Nyquist limit



## Camera

Sensor size = 4512 x 4512 px

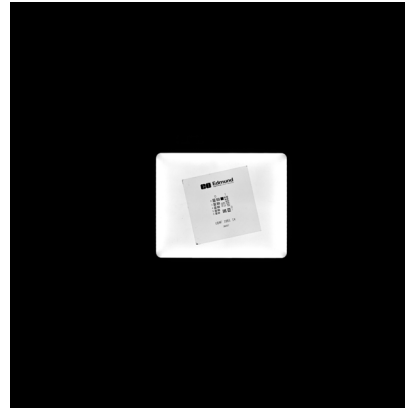
Pixel size = 2.74  $\mu\text{m}$

Nyquist limit = 182 lp/mm

## Light

Blue background illumination

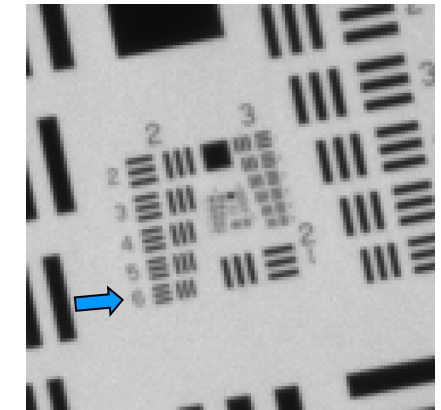
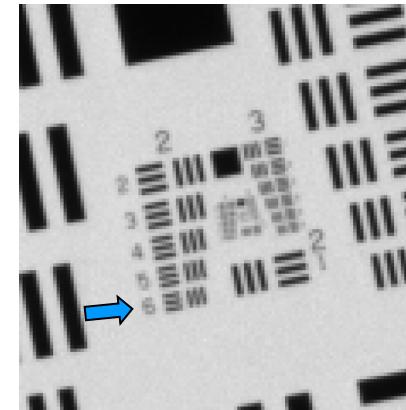
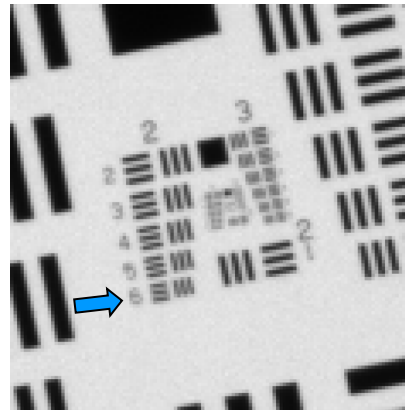
Center



Edge



Corner

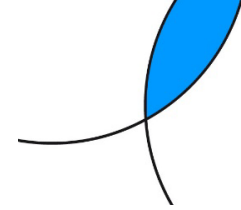


USAF element:	2/6
Line width ( $\mu\text{m}$ ):	70.15
Lp/mm (object):	7
Magnification:	0.041
<b>Lp/mm (image):</b>	<b>174</b>

USAF element:	2/6
Line width ( $\mu\text{m}$ ):	70.15
Lp/mm (object):	7
Magnification:	0.041
<b>Lp/mm (image):</b>	<b>174</b>

USAF element:	2/6
Line width ( $\mu\text{m}$ ):	70.15
Lp/mm (object):	7
Magnification:	0.041
<b>Lp/mm (image):</b>	<b>174</b>

# WD 500 mm: +1.15dpt, Blue light Performance is close to Nyquist limit



## Camera

Sensor size = 4512 x 4512 px

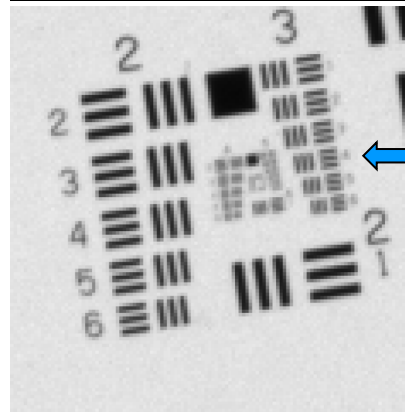
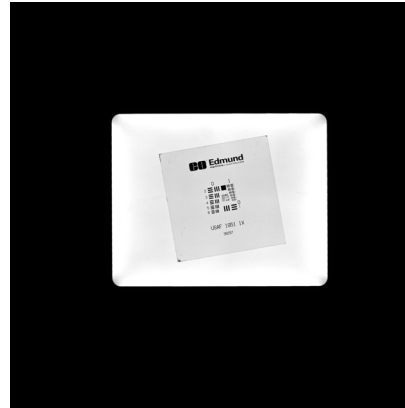
Pixel size = 2.74  $\mu\text{m}$

Nyquist limit = 182 lp/mm

## Light

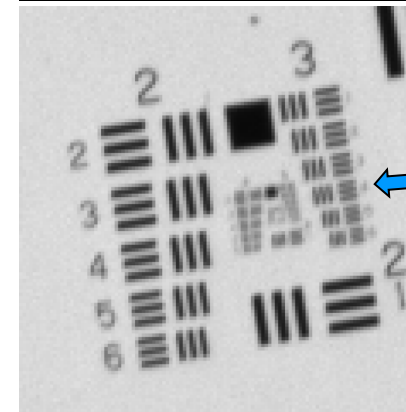
Blue background illumination

Center



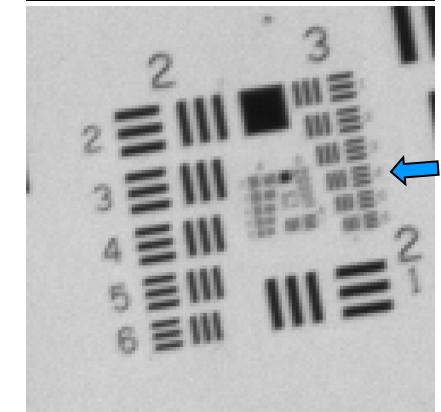
USAF element:	3/4
Line width ( $\mu\text{m}$ ):	44.19
Lp/mm (object):	11
Magnification:	0.066
<b>Lp/mm (image):</b>	<b>171</b>

Edge



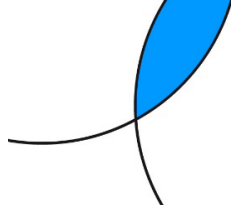
USAF element:	3/4
Line width ( $\mu\text{m}$ ):	44.19
Lp/mm (object):	11
Magnification:	0.066
<b>Lp/mm (image):</b>	<b>171</b>

Corner



USAF element:	3/4
Line width ( $\mu\text{m}$ ):	44.19
Lp/mm (object):	11
Magnification:	0.066
<b>Lp/mm (image):</b>	<b>171</b>

# WD 300 mm: +2.19dpt, Blue light Performance is close to Nyquist limit



## Camera

Sensor size = 4512 x 4512 px

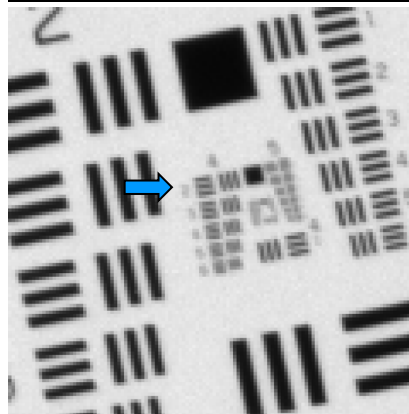
Pixel size = 2.74  $\mu\text{m}$

Nyquist limit = 182 lp/mm

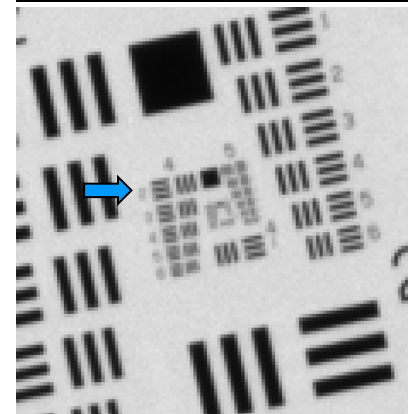
## Light

Blue background illumination

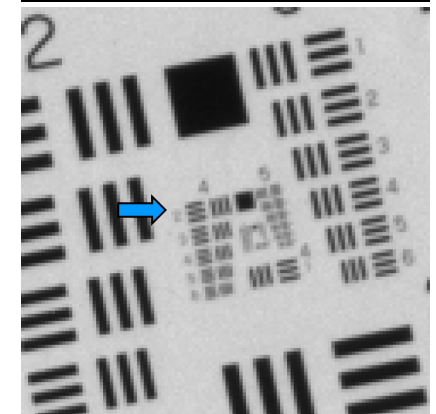
Center



Edge



Corner

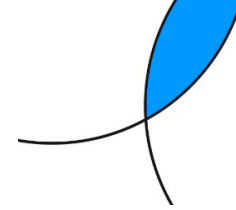


USAF element:	4/2
Line width ( $\mu\text{m}$ ):	27.84
Lp/mm (object):	18
Magnification:	0.104
<b>Lp/mm (image):</b>	<b>172</b>

USAF element:	4/2
Line width ( $\mu\text{m}$ ):	27.84
Lp/mm (object):	18
Magnification:	0.104
<b>Lp/mm (image):</b>	<b>172</b>

USAF element:	4/2
Line width ( $\mu\text{m}$ ):	27.84
Lp/mm (object):	18
Magnification:	0.104
<b>Lp/mm (image):</b>	<b>172</b>

# WD 200 mm: +3.36dpt, Blue light Performance is close to Nyquist limit



## Camera

Sensor size = 4512 x 4512 px

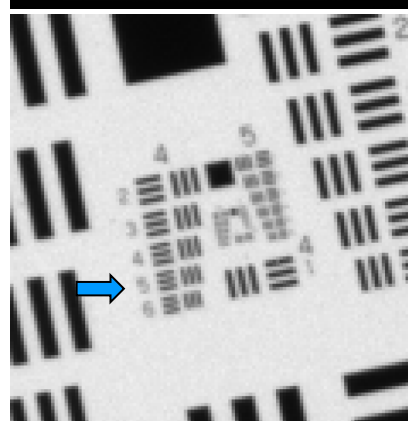
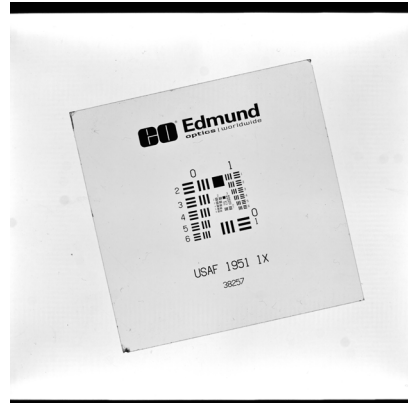
Pixel size = 2.74  $\mu\text{m}$

Nyquist limit = 182 lp/mm

## Light

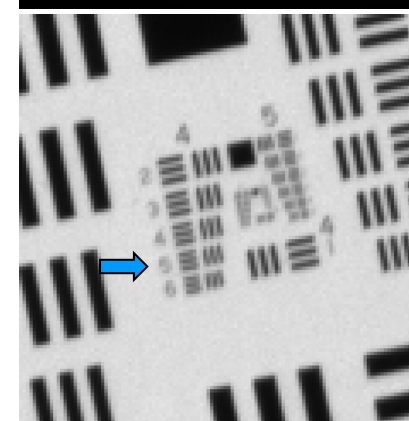
Blue background illumination

Center



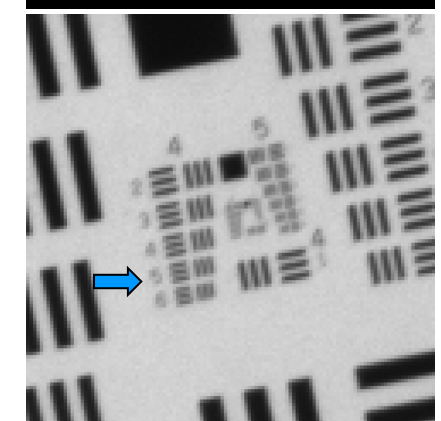
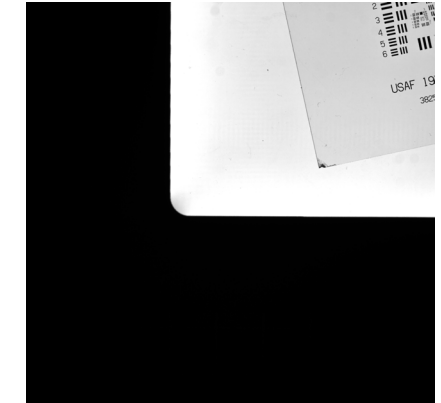
USAF element:	4/5
Line width ( $\mu\text{m}$ ):	19.69
Lp/mm (object):	25
Magnification:	0.148
<b>Lp/mm (image):</b>	<b>171</b>

Edge



USAF element:	4/5
Line width ( $\mu\text{m}$ ):	19.69
Lp/mm (object):	25
Magnification:	0.148
<b>Lp/mm (image):</b>	<b>171</b>

Corner



USAF element:	4/5
Line width ( $\mu\text{m}$ ):	19.69
Lp/mm (object):	25
Magnification:	0.148
<b>Lp/mm (image):</b>	<b>171</b>

# Polychromatic performance: White LED vs. Blue LED

## WD 500mm, +1.15dpt

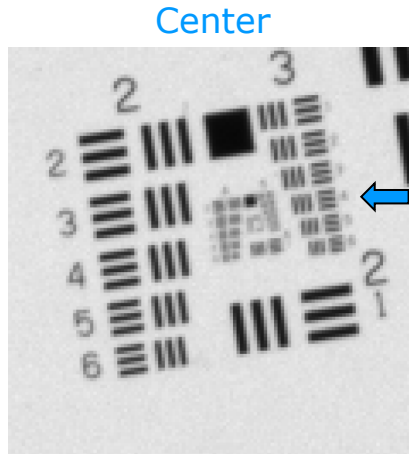
### Camera

Sensor size = 4512 x 4512 px

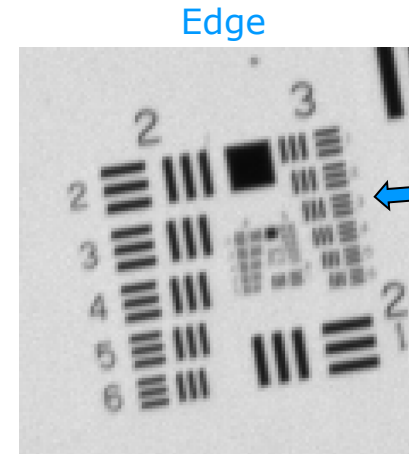
Pixel size = 2.74  $\mu\text{m}$

Nyquist limit = 182 lp/mm

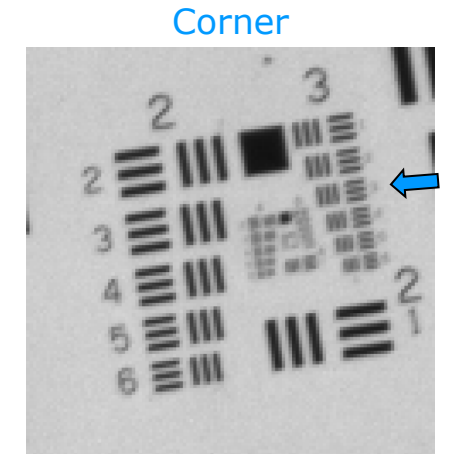
Blue



171 LP/mm

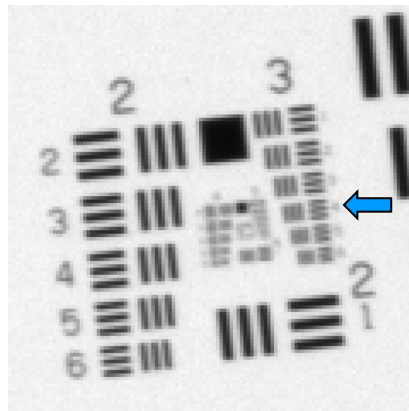


171 LP/mm

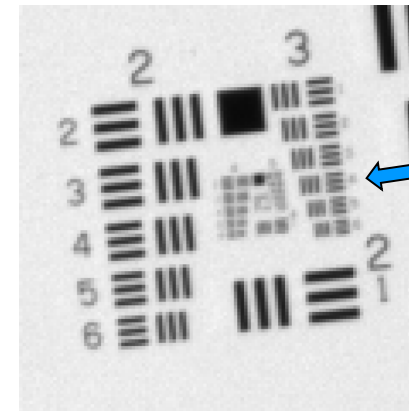


171 LP/mm

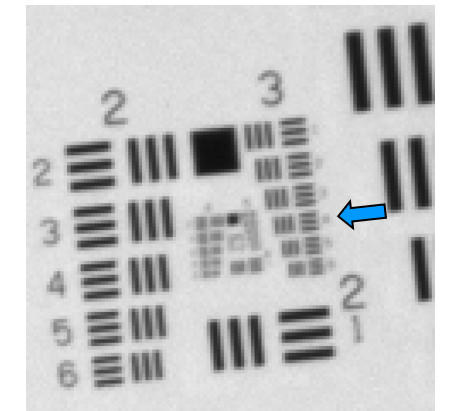
White



171 LP/mm



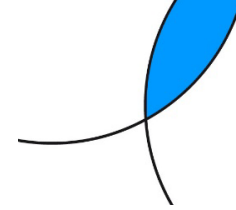
171 LP/mm



171 LP/mm

# Vertical vs. Horizontal optical axis

## WD 500mm, +1.15dpt, White LED



### Camera

Sensor size = 4512 x 4512 px

Pixel size = 2.74  $\mu\text{m}$

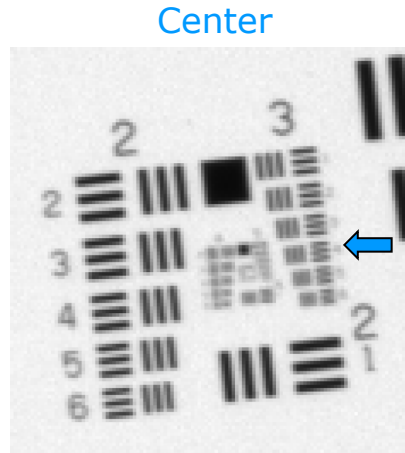
Nyquist limit = 182 lp/mm

### Light

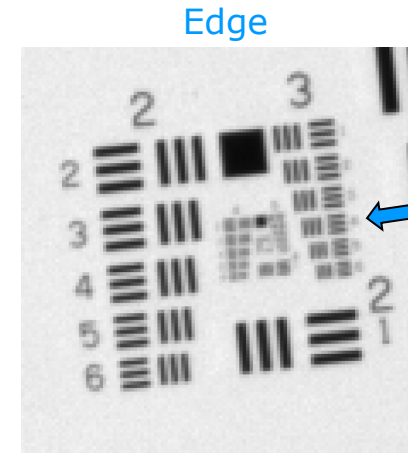
White background illumination

EL-7-20 Gravity coma:  $0.05\lambda$

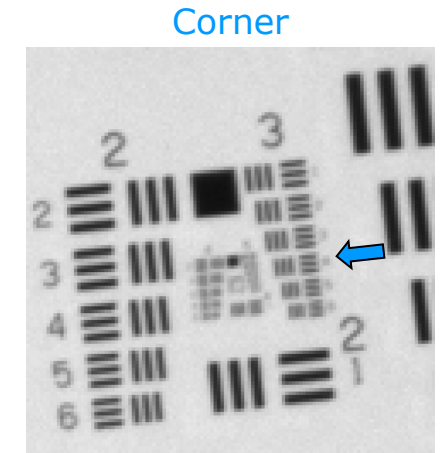
Vertical OA



171 LP/mm

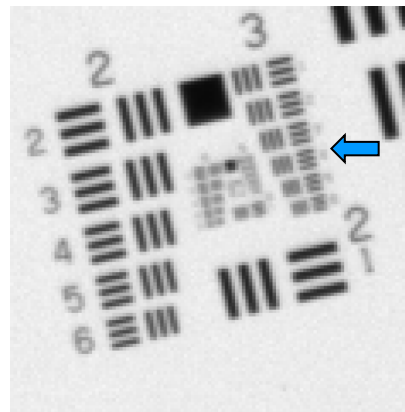


171 LP/mm

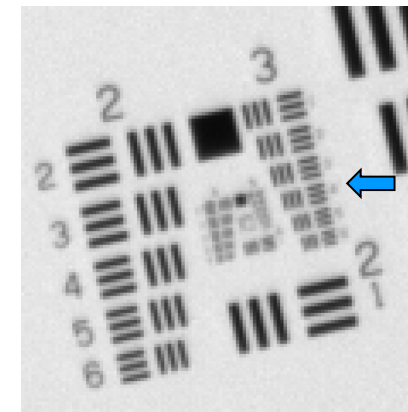


171 LP/mm

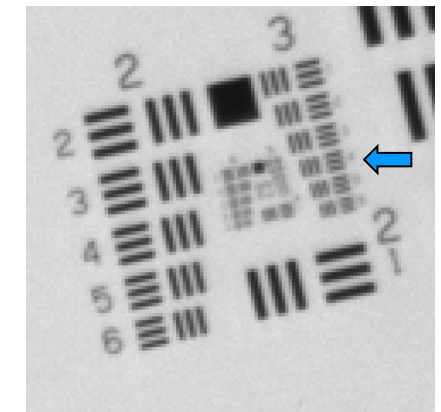
Horizontal OA



171 LP/mm



171 LP/mm



171 LP/mm