



shaping the future of optics

Optotune ELM-16-3.1-18-C

Test report

October 2025
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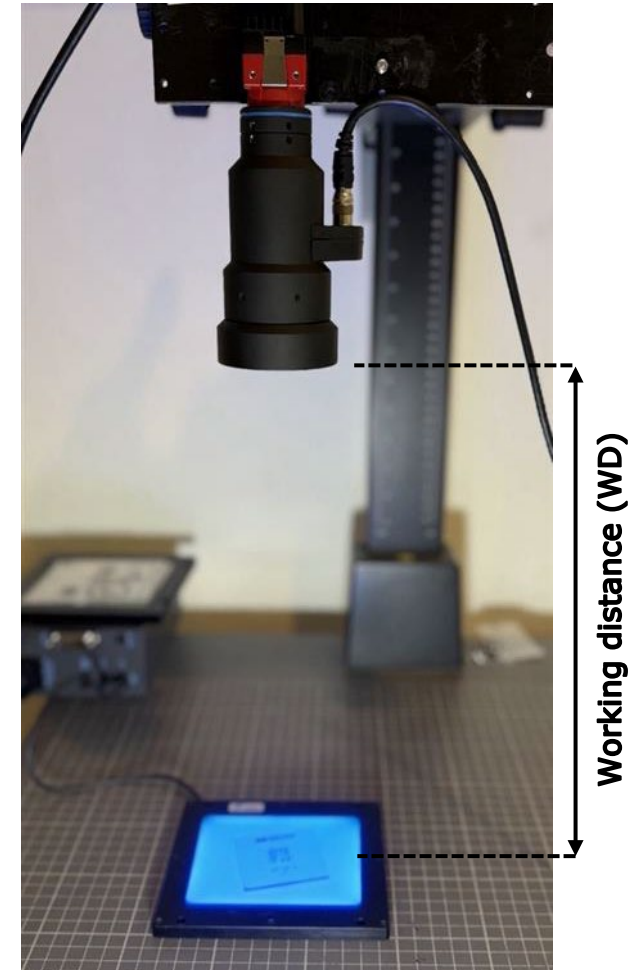
Summary

- **Working distance (WD) range of 200mm-Inf (Shorter WD possible with a spacer)**
- **Performance close to the Nyquist rate of 2.74 μ m pixel size**
 - Resolution >175 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 2dpt range**
- **Very negligible field curvature and distortion**
 - Only 1.6% of geometrical distortion measured
- **Vignetting level of \sim 37%: reasonable for such a wide-angle lens**
- **10% resolution degradation due to the gravity-coma for horizontal optical axis**
- **Very good polychromatic performance**
 - Performance very similar between white and blue backlights

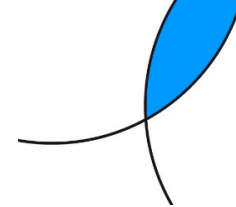


Test Setup

Camera:	Alvium 1800 C-2040 1.1" 4512 x 4512 px Pixel size = 2.74 μ m Nyquist rate = 182 lp/mm C-mount
Lens:	ELM-16-3.1-18-C
Tunable lens:	EL-12-30-TC-VIS-16D SN: CGAM1817
Orientation:	Vertical Optical Axis
Driver:	ECC-1C SN: CXAB1413, FW: 2.0.741648
Target:	USAF chrome target, positive
Light:	White backlight (LED1-FLS-110x110W) Blue backlight



ELM-16-3.1-18-C Datasheet



Lens module specifications

	EL-12-30-TC-VIS-16D	EL-7-20-TC-VIS-14D	
Effective focal length		16.3	mm
F/# (fixed)	3.1	4.0	
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	58.3	°
	Horizontal	42.7	°
	Vertical	42.7	°
Back focal length (BFL)		9.67	mm (in air)
Optical distortion		<2.0	%
Pixel size (recommended)		2.74	μm
Wavelength range		420-900	nm
Relative illumination	>71	>87	%
Max chief ray angle		10.1	°
Working distance (WD) range ¹		200 to inf	mm
Optimal WD		500	mm
WD at 0 dpt		inf	mm
Mount		C-mount	
Filter thread		M55 x 0.5	
Connector type		Hirose (6 pins)	
Total track length (TTL)		137.6	mm
Dimension (Φ x L)		63.0 x 127.9	mm
Weight		501	g
Operating temperature		-20 to +65	°C
Storage temperature		-40 to +85	°C

Focus tunable lens specifications

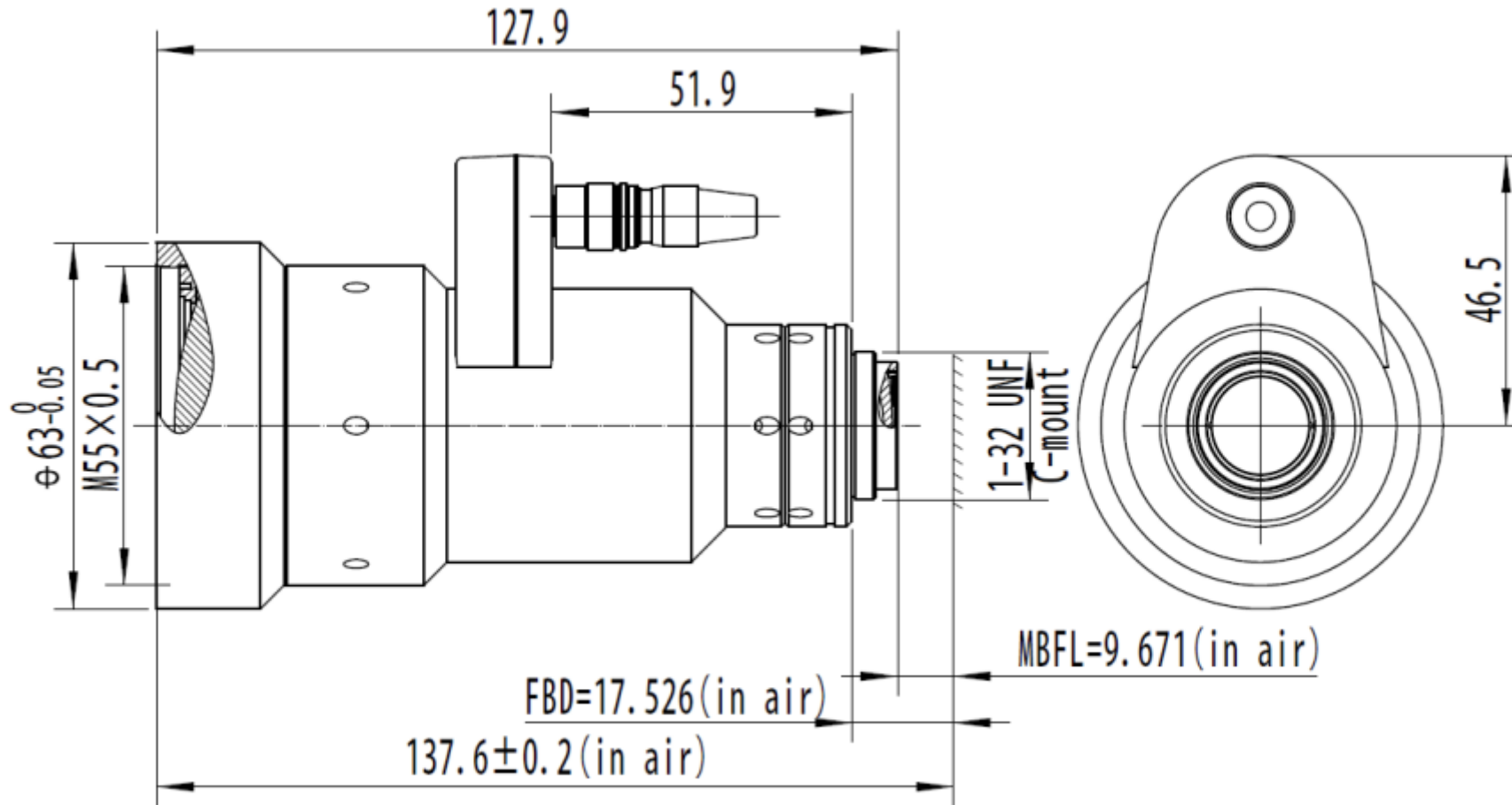
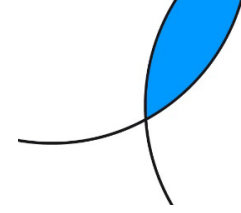
	EL-12-30-TC-VIS-16D	EL-7-20-TC-VIS-14D	
Focal power range (@25°C)	-6 to +10	-6 to +8	dpt
Focal power range for module WD range		0.0 to +2.0	dpt
Temperature sensor and EEPROM		Yes	
Control current (typical)		-250 to +250	mA
Max. control current		-300 to +300	mA
Motor coil resistance @ 30°C	15	12	Ω
Absolute 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 ² C SCL	6	
Pin 6	I ² 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 ² C SCL	TTL	
Pin 4	UART Rx / I ² C SDA	TTL	
Pin 5	GND	-	
Pin 6	Vcc	5-24V	

Mechanical drawing



Field of view with 1.1" sensor

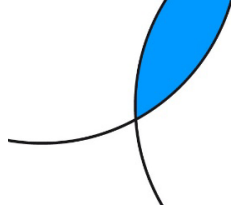
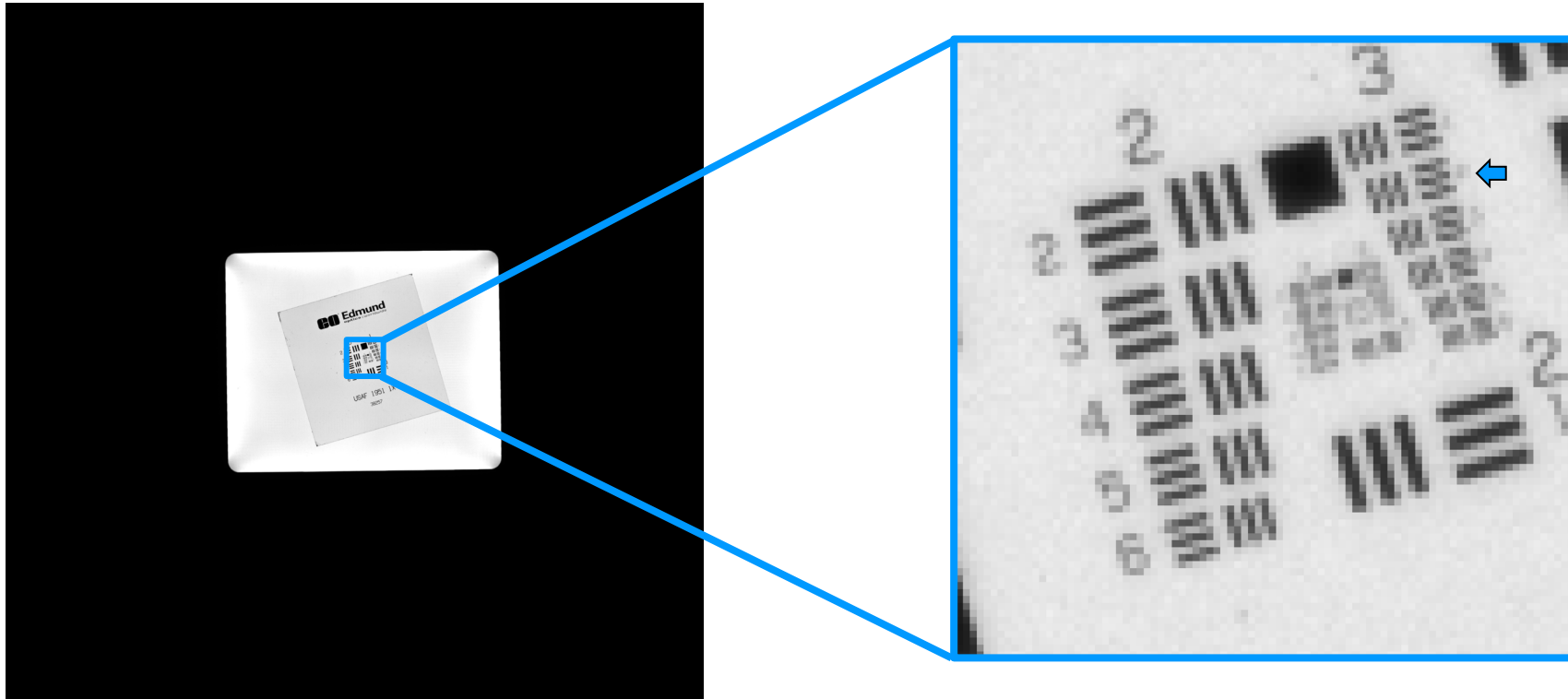


Image size (2.74 μm pixel size):

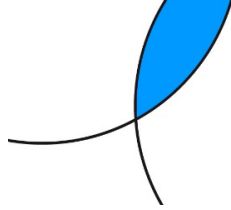
- Width = 12.4 mm
- Height = 12.4 mm
- Diagonal = 17.5 mm

Image evaluation

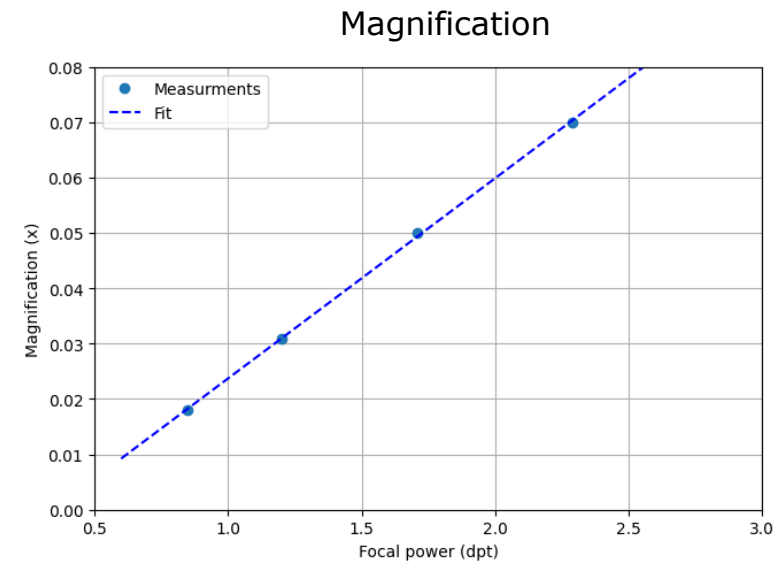
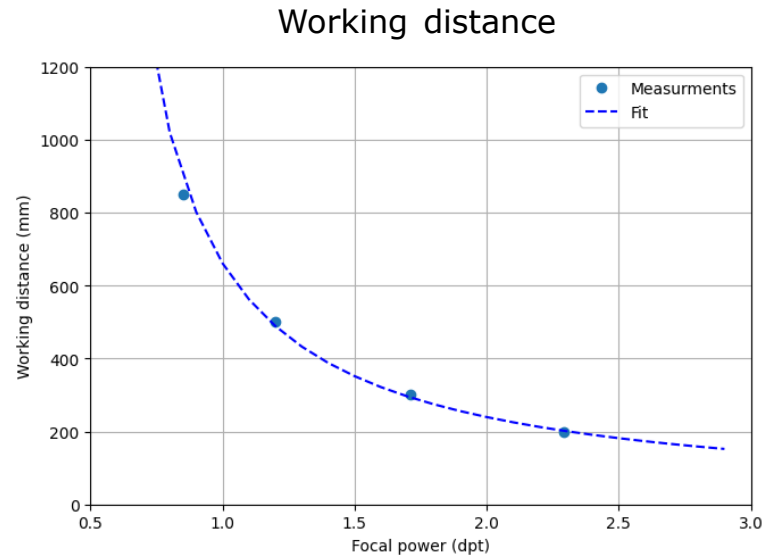
- All the images are taken at Gain 0, and without gamma correction
- The intensity of illumination is controlled to adjust the histogram of the images
- After acquisition, images are zoomed in to show the resolution-limited element



Working distance, Magnification

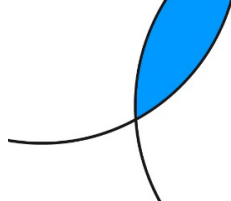


- Magnification and working distance of this ELM is very well aligned with an ento-centric lens



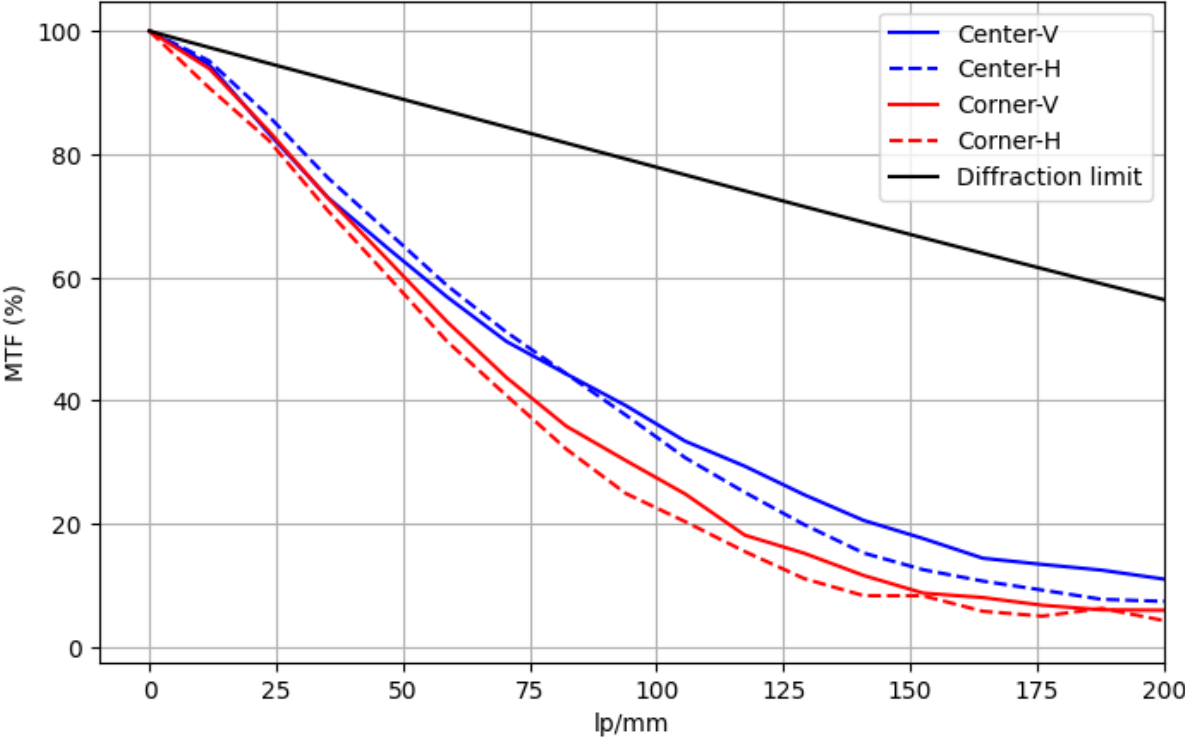
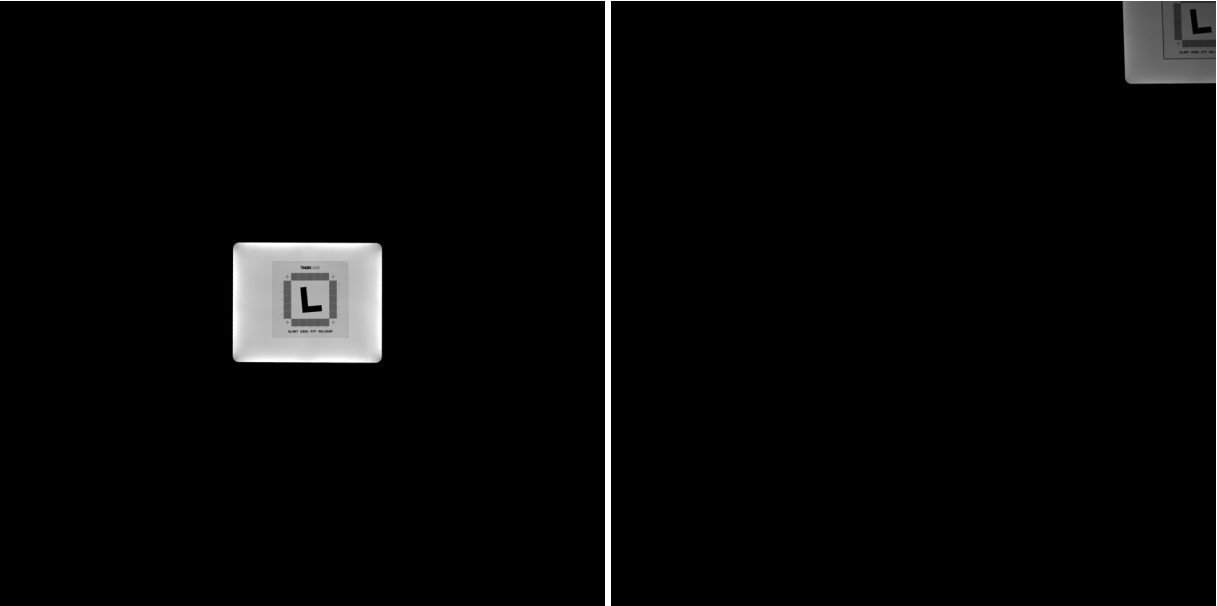
- * Measured with blue LED backlight
- * Magnification measured at the center of the image

Slanted-Edge MTF



Center

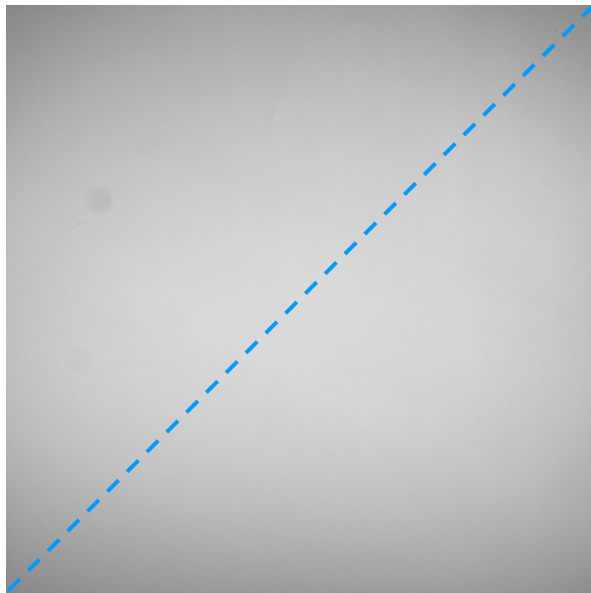
Corner



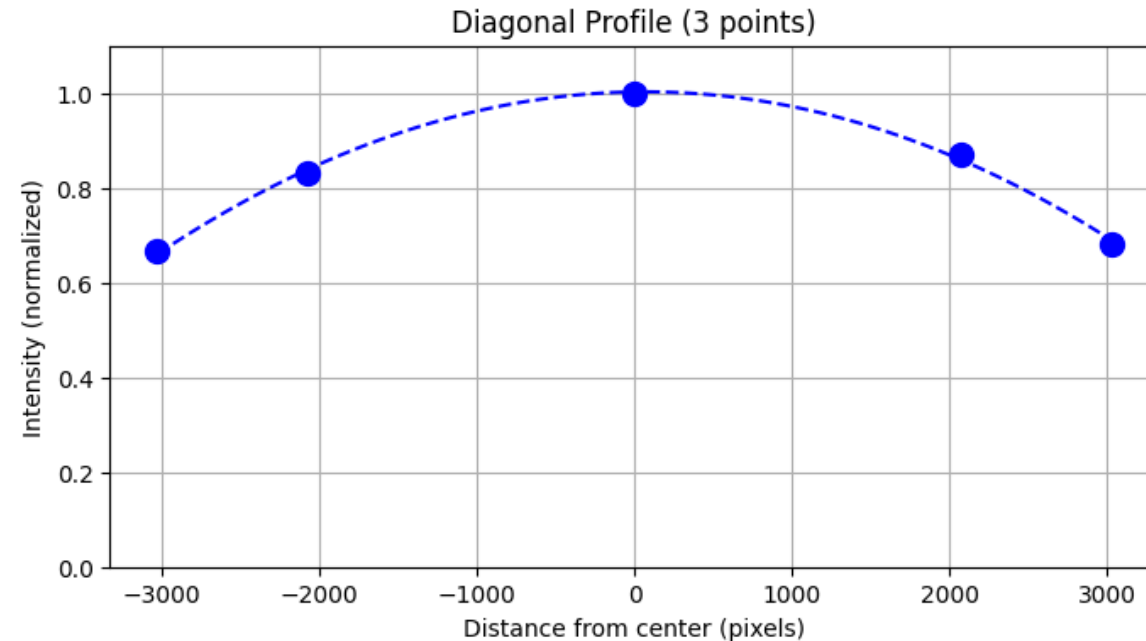
*Images taken with the blue LED at WD 500mm

Relative illumination

- Vignetting of this ELM is 0.67EV (37%) for 1.1" sensor
- There is a negligible dependence to the focal power/WD for the vignetting

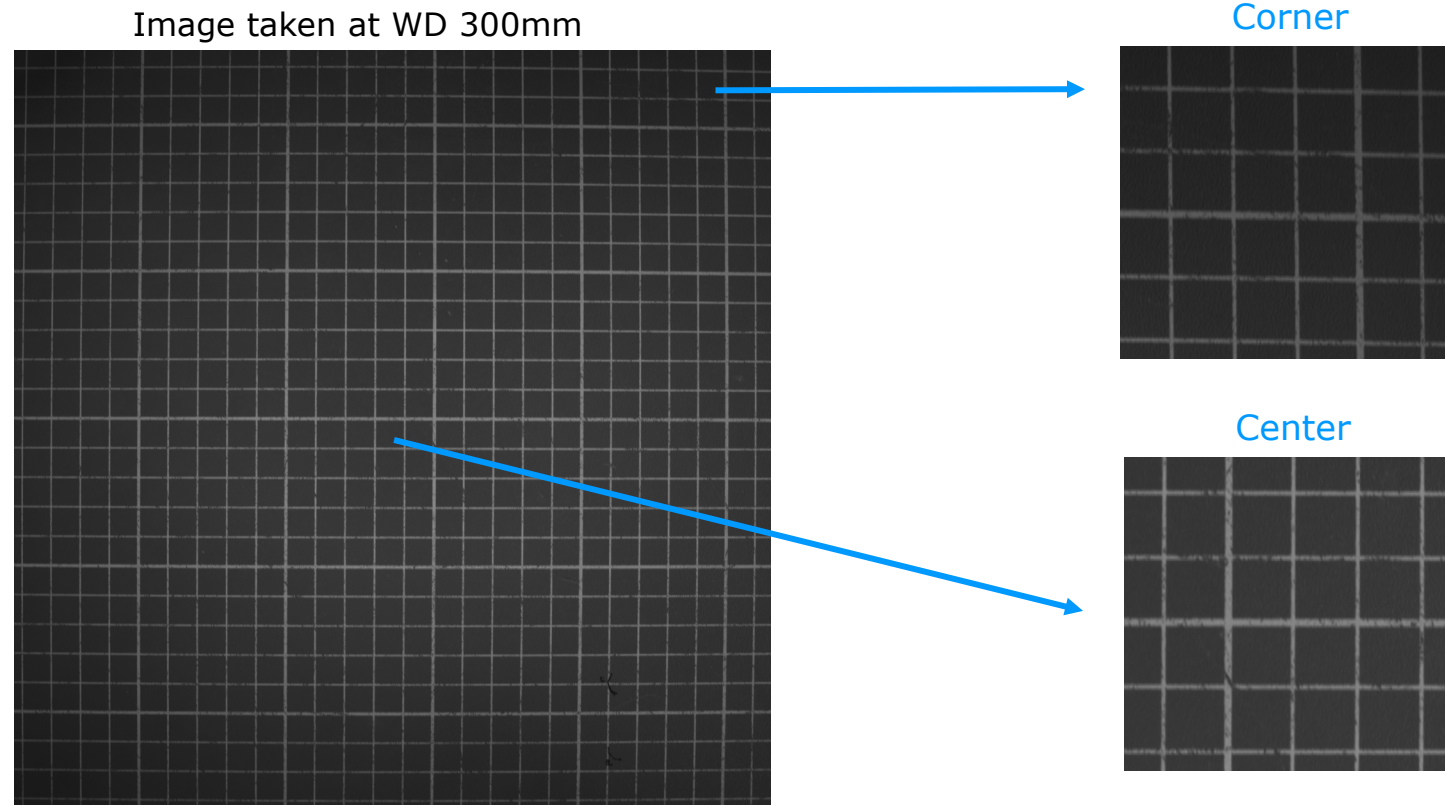


*Image taken at WD 300mm

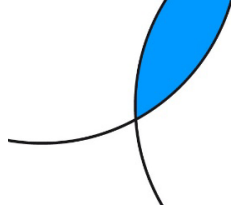


Distortion and field curvature

- We see some distortion but no field curvature
- Geometrical distortion value: **1.6%**



WD 850 mm: +0.85dpt, Blue light Performance is close to Nyquist limit



Camera

Sensor size = 4512 x 4512 px

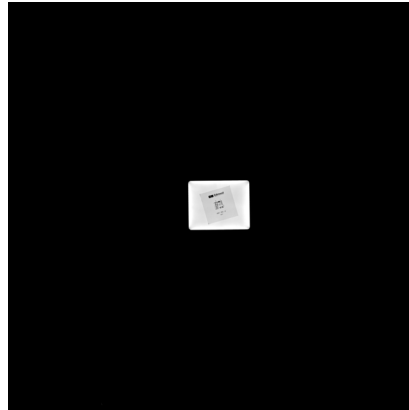
Pixel size = 2.74 μm

Nyquist limit = 182 lp/mm

Light

Blue background illumination

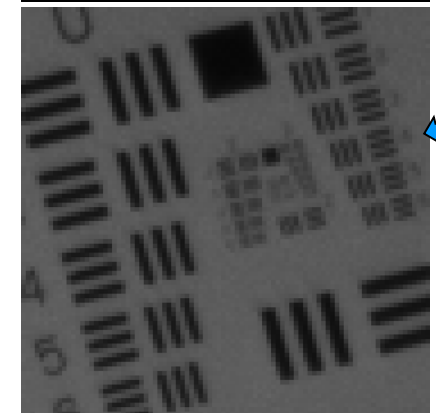
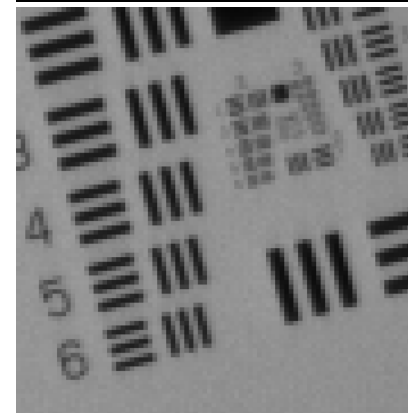
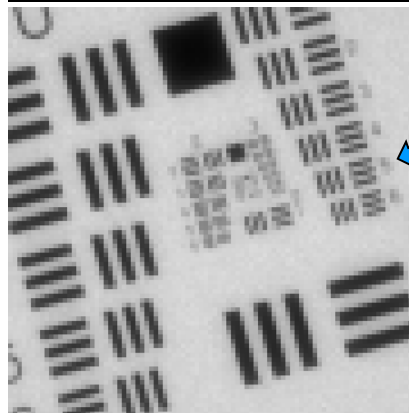
Center



Edge



Corner

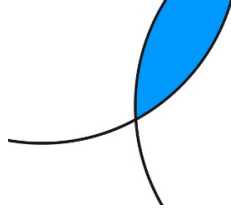


USAF element:	1/5
Line width (μm):	157.49
Lp/mm (object):	3
Magnification:	0.018
Lp/mm (image):	176

USAF element:	1/5
Line width (μm):	157.49
Lp/mm (object):	3
Magnification:	0.019
Lp/mm (image):	167

USAF element:	1/4
Line width (μm):	176.78
Lp/mm (object):	3
Magnification:	0.019
Lp/mm (image):	149

WD 500 mm: +1.20dpt, Blue light Performance is close to Nyquist limit



Camera

Sensor size = 4512 x 4512 px

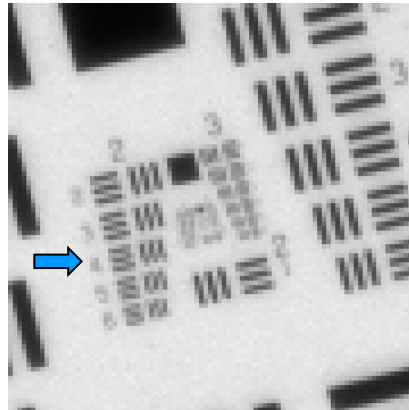
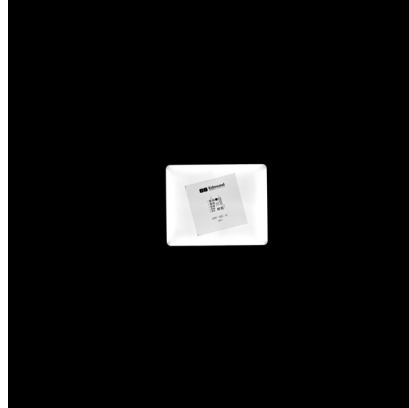
Pixel size = 2.74 μm

Nyquist limit = 182 lp/mm

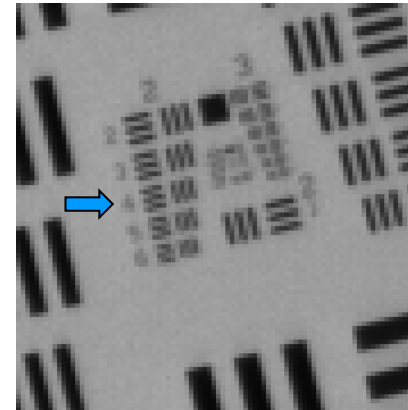
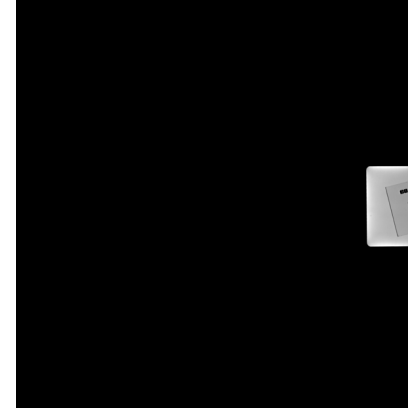
Light

Blue background illumination

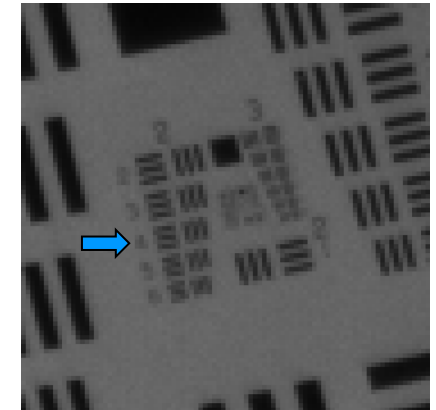
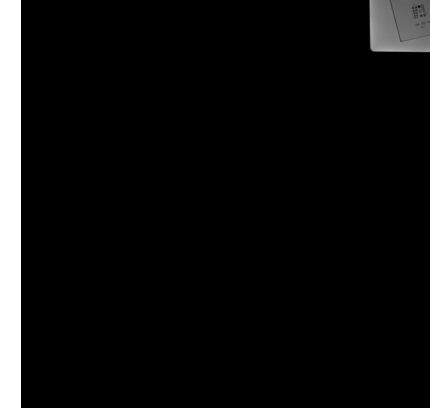
Center



Edge



Corner

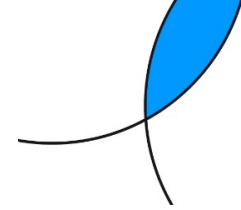


USAF element:	2/4
Line width (μm):	88.39
Lp/mm (object):	6
Magnification:	0.031
Lp/mm (image):	182

USAF element:	2/4
Line width (μm):	88.39
Lp/mm (object):	6
Magnification:	0.032
Lp/mm (image):	177

USAF element:	2/4
Line width (μm):	88.39
Lp/mm (object):	6
Magnification:	0.032
Lp/mm (image):	177

WD 300 mm: +1.71dpt, Blue light Performance is close to Nyquist limit



Camera

Sensor size = 4512 x 4512 px

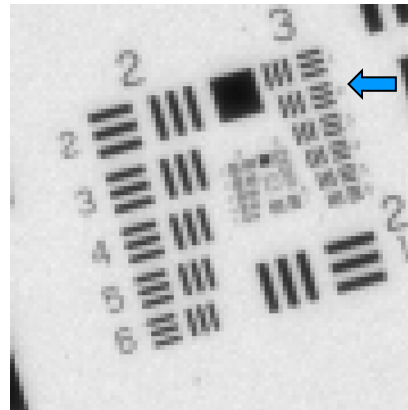
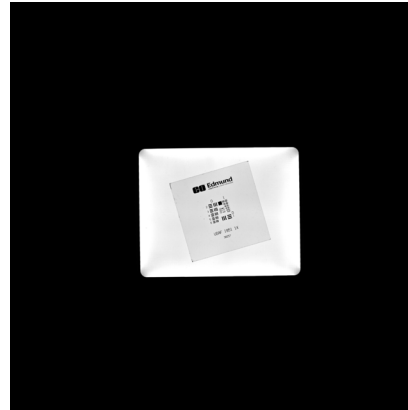
Pixel size = 2.74 μm

Nyquist limit = 182 lp/mm

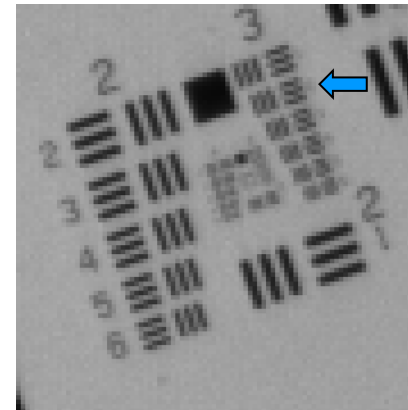
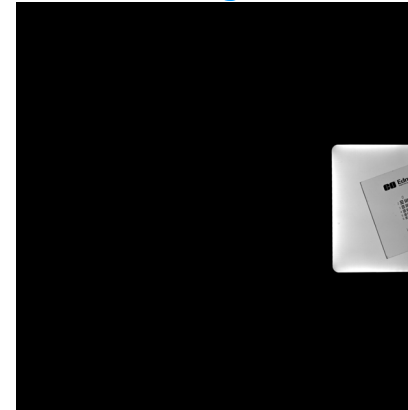
Light

Blue background illumination

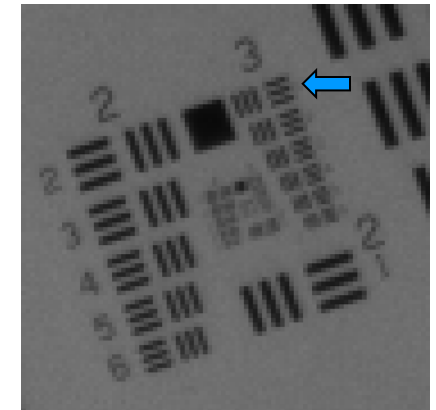
Center



Edge



Corner

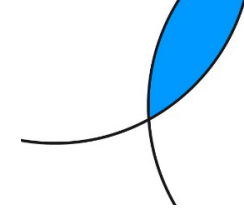


USAF element:	3/2
Line width (μm):	55.68
Lp/mm (object):	9
Magnification:	0.050
Lp/mm (image):	180

USAF element:	3/2
Line width (μm):	55.68
Lp/mm (object):	9
Magnification:	0.051
Lp/mm (image):	176

USAF element:	3/1
Line width (μm):	62.5
Lp/mm (object):	8
Magnification:	0.051
Lp/mm (image):	157

WD 200 mm: +2.29dpt, Blue light Performance is close to Nyquist limit



Camera

Sensor size = 4512 x 4512 px

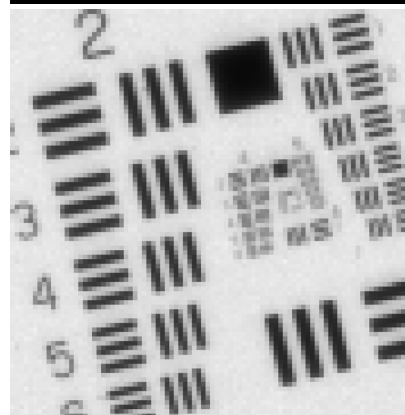
Pixel size = 2.74 μm

Nyquist limit = 182 lp/mm

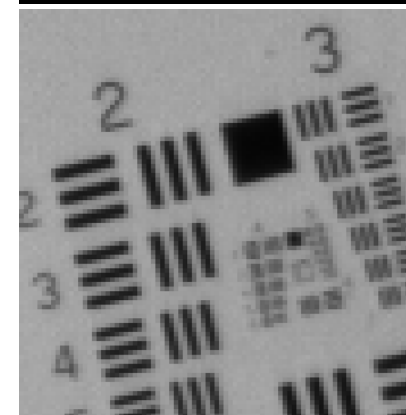
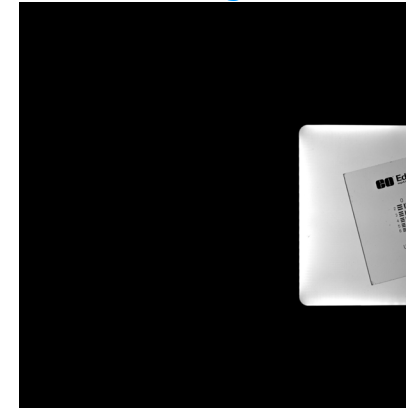
Light

Blue background illumination

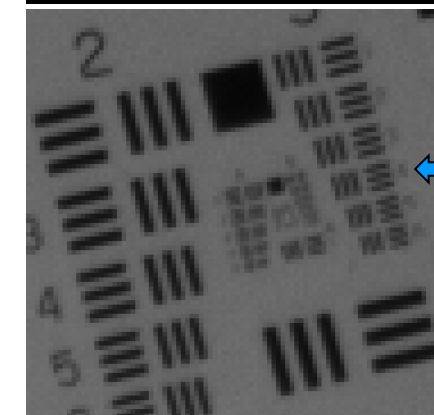
Center



Edge



Corner



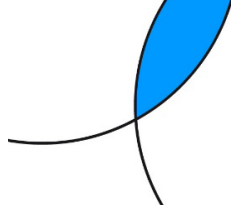
USAF element:	3/5
Line width (μm):	39.37
Lp/mm (object):	13
Magnification:	0.070
Lp/mm (image):	181

USAF element:	3/4
Line width (μm):	44.19
Lp/mm (object):	11
Magnification:	0.071
Lp/mm (image):	159

USAF element:	3/4
Line width (μm):	44.19
Lp/mm (object):	11
Magnification:	0.071
Lp/mm (image):	159

Polychromatic performance: White LED vs. Blue LED

WD 500mm, +1.20dpt

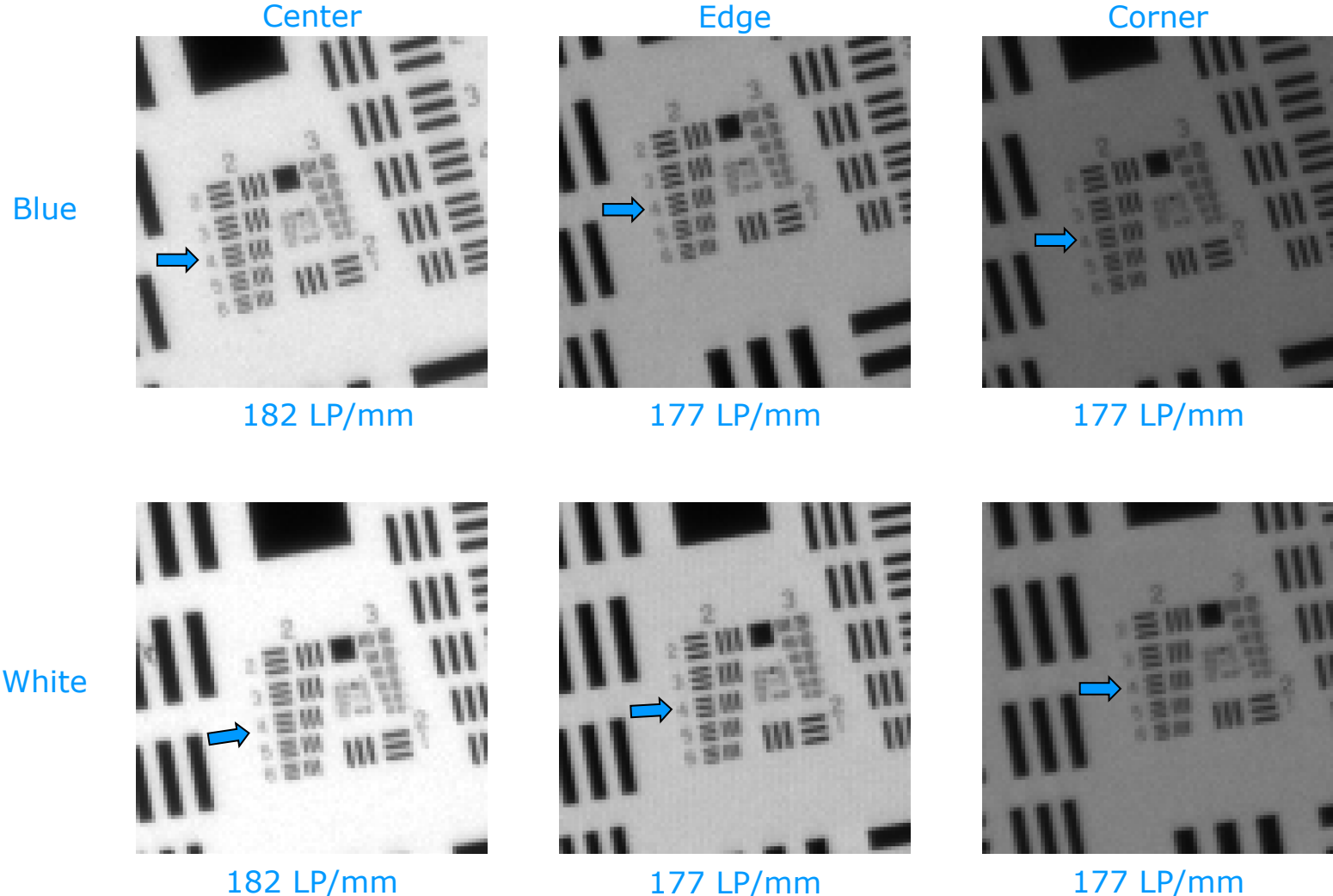


Camera

Sensor size = 4512 x 4512 px

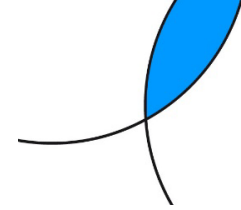
Pixel size = 2.74 μm

Nyquist limit = 182 lp/mm



Vertical vs. Horizontal optical axis

WD 500mm, +1.20dpt, White LED



Camera

Sensor size = 4512 x 4512 px

Pixel size = 2.74 μm

Nyquist limit = 182 lp/mm

Light

White background illumination

EL-12-30 Gravity coma: 0.175 λ

