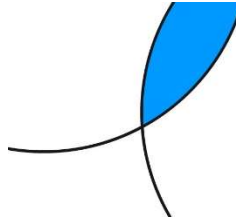




ELM-50-3.5-18-C

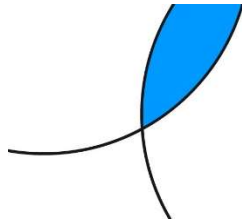
Summary



- **Working distance (WD) range of 200mm-Inf**
- **Performance close to the Nyquist rate of 2.74 μ m pixel size**
Resolution >150 lp/mm for WD range of >300 across the field
Resolution >180 lp/mm under certain conditions
- **For short WDs (<300mm) a 5mm spacer is recommended**
- **Very negligible field curvature and distortion**
Magnification and resolutions stays constant across the field
- **Very negligible vignetting (<2%)**
- **Resolution degrades (~20%) due to the gravity-coma for horizontal optical axis**
- **Very good polychromatic performance**
Performance very similar between white and blue backlights



ELM-35-3.5-18-C Datasheet



Lens module specifications

Effective focal length	50	mm
F/#	3.5	(Fixed)
Maximum sensor format	1.1	inch
Maximum image circle (Φ)	18	mm
Lifecycles (10-90% sinusoidal)	>1'000'000'000	cycles
FOV (at max sensor format)	Diagonal	20 °
	Horizontal	16 °
	Vertical	12 °
Back Focal Length	11.557	mm
Optical Distortion	< 0.1	%
Pixel size recommended	2.74	µm
Wavelength range	486-656	nm
Relative illumination at 100%F	> 90	%
Max chief ray angle	-	°
Working distance range	200 - infinity	mm
Mount	C-mount	
Total Track Length	84.35	mm
Dimension (Φ x L)	47x81	mm

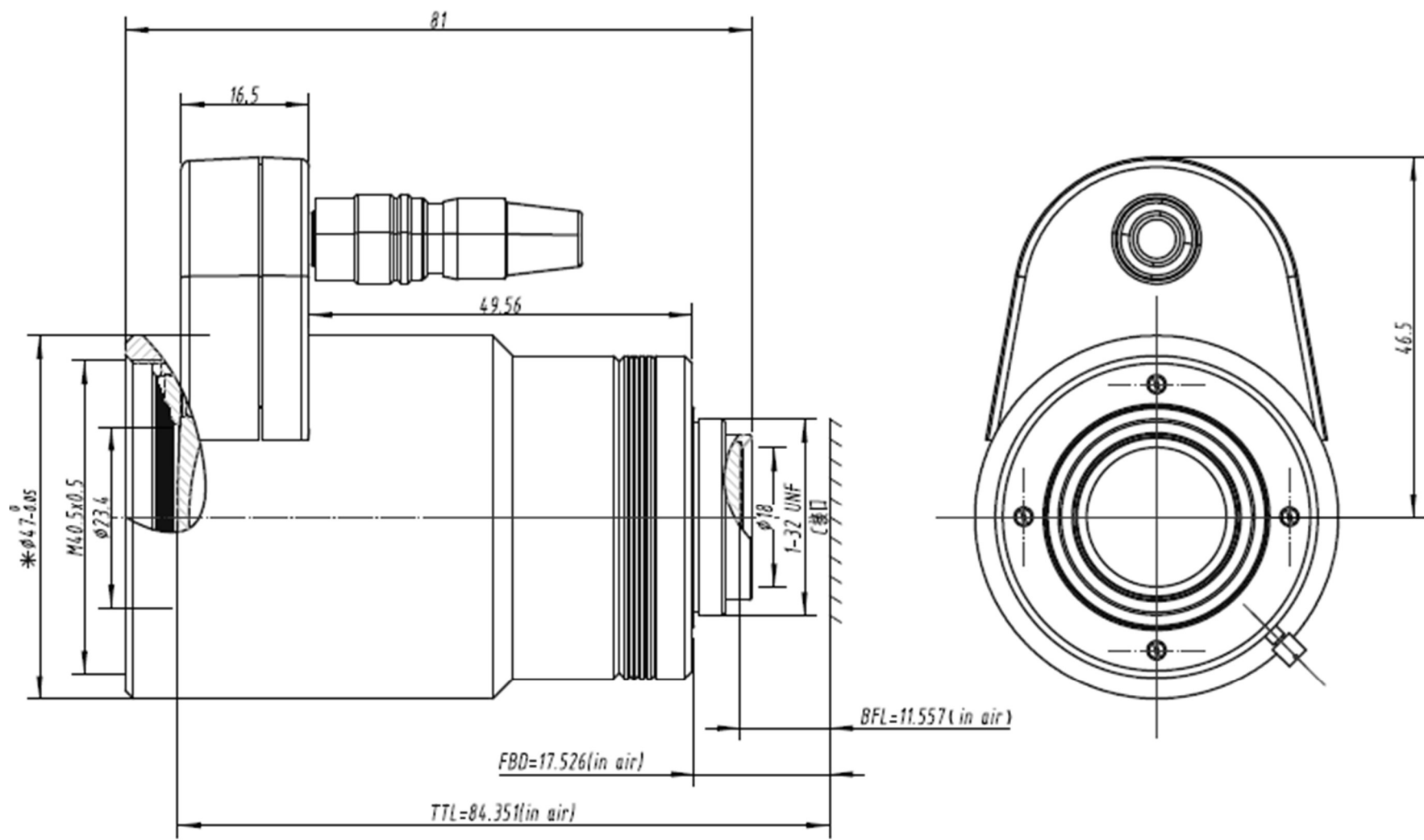
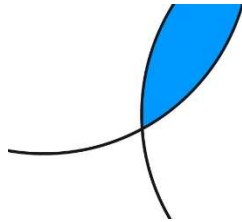
Focus tunable lens specifications

EL-12-30-TC-VIS-16D

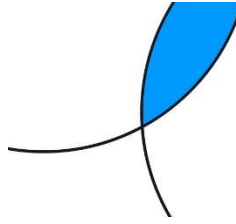
Focal power range (@30°C) ³	-6 to +10	dpt
Wavefront error (at 525 nm & 0 mA) Optical axis vertical / horizontal	<0.15/<0.23	λ _{RMS}
Operating temperature	-20 to +65	°C
Storage temperature	-40 to +85	°C
Temperature sensor & memory	MAX31875R2TZS+T	

Electrical specifications

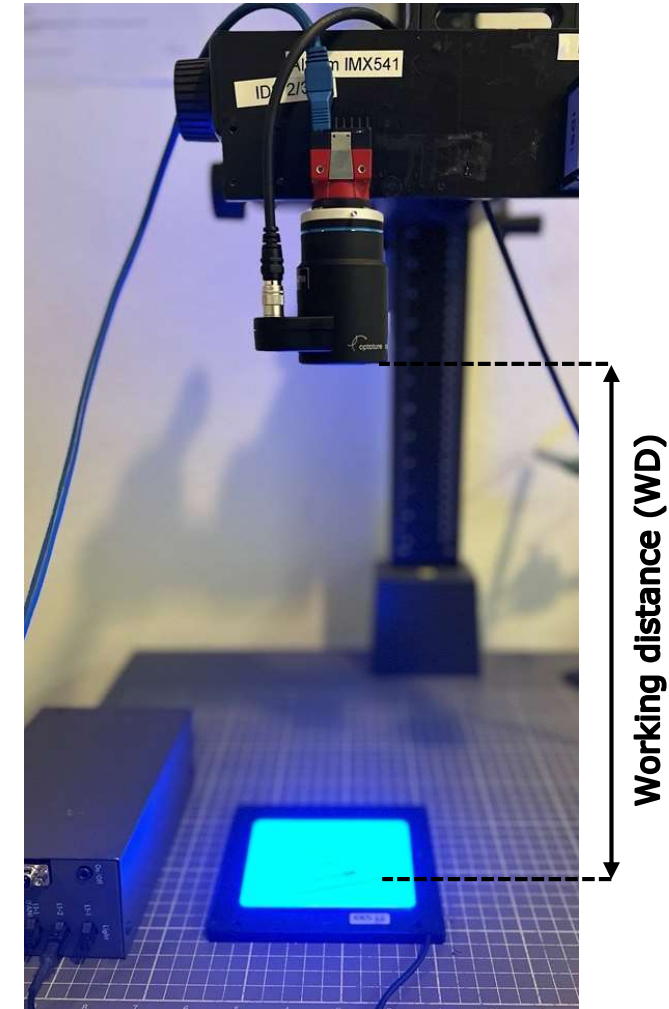
Control current (typical)	-250 to +250	mA
Absolute max. control current	-300 to 300	mA
Power consumption	0.55 (+/- 60 mA) 0.940 (max. at 250 mA)	W
Motor coil resistance @ 30°C	15	Ω
Absolute maximum voltage (coil)	6	V
Absolute maximum voltage (temp. sensor)	4	V



Test Setup



Camera:	Alvium 1800 C-2040 1.1" 4512 x 4512 px Pixel size = 2.74 μm Nyquist rate = 182 lp/mm C-mount
Lens:	ELM-50-3.5-18-C (Hitronics)
Tunable lens:	EL-12-30-TC-VIS-16D SN: CGAJ4790
Orientation:	Vertical Optical Axis
Driver:	ECC-1C SN: CXAB0261, FW: 2.0.741433
Target:	USAF chrome target, positive
Light:	White backlight (LED1-FLS-110x110W) Blue backlight



Field of view with 1.1" sensor

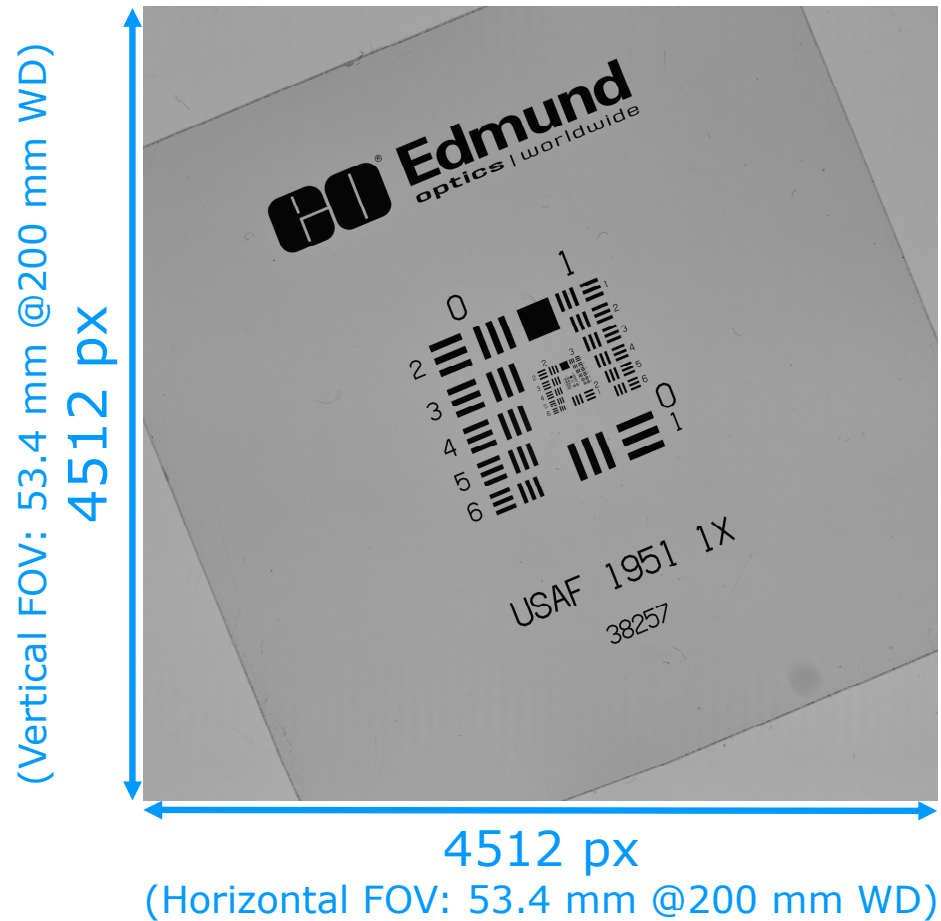
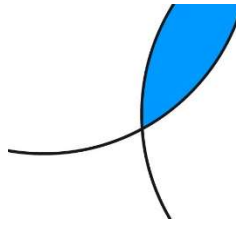
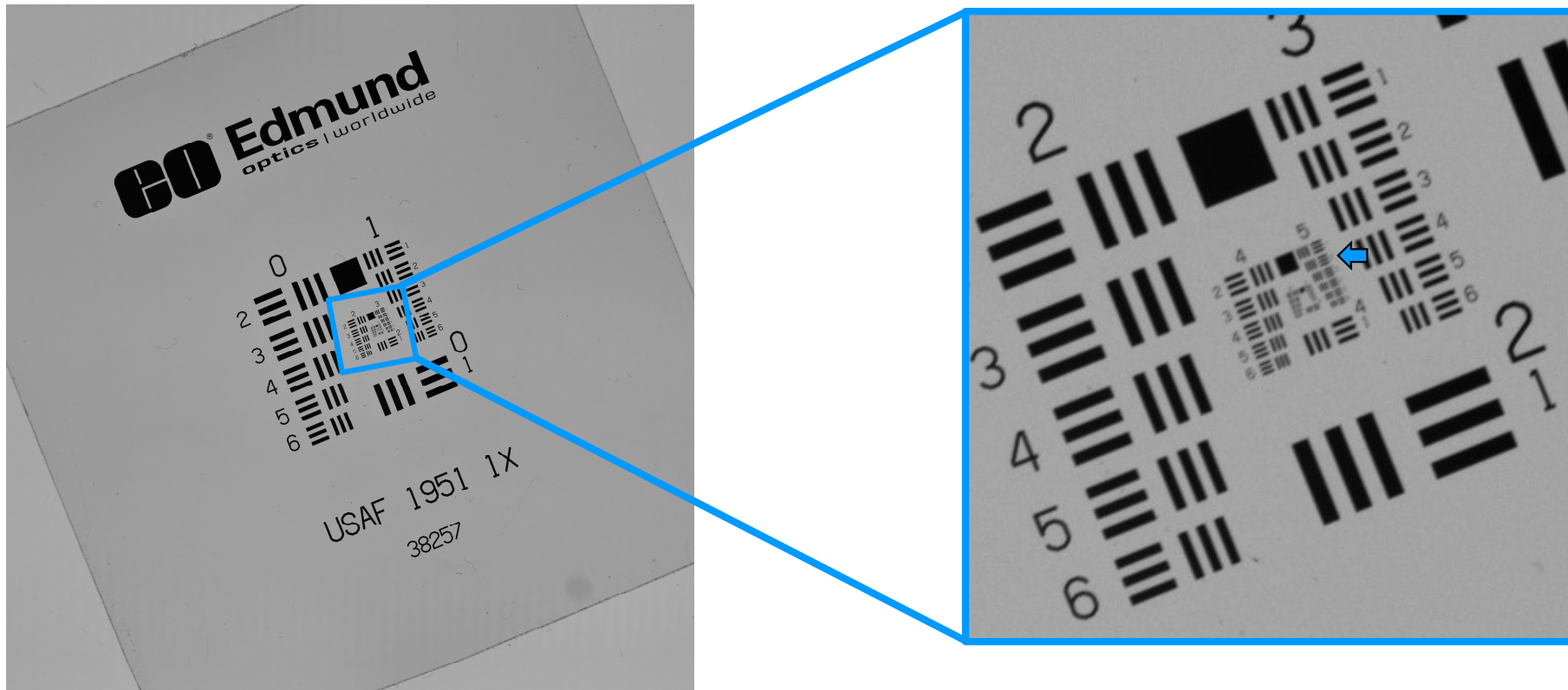


Image size (2.74 μm pixel size):

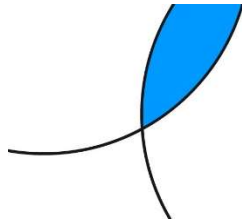
- Width = 12.4 mm
- Height = 12.4 mm
- Diagonal = 17.5 mm

Image evaluation

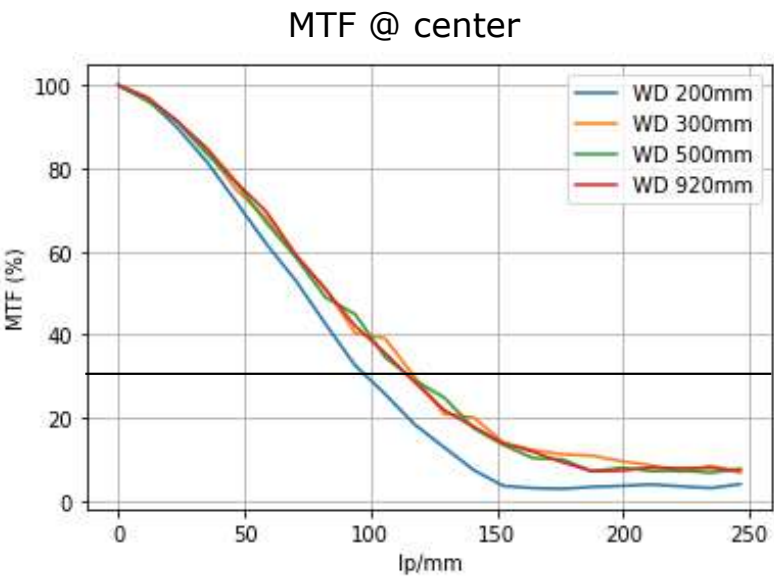
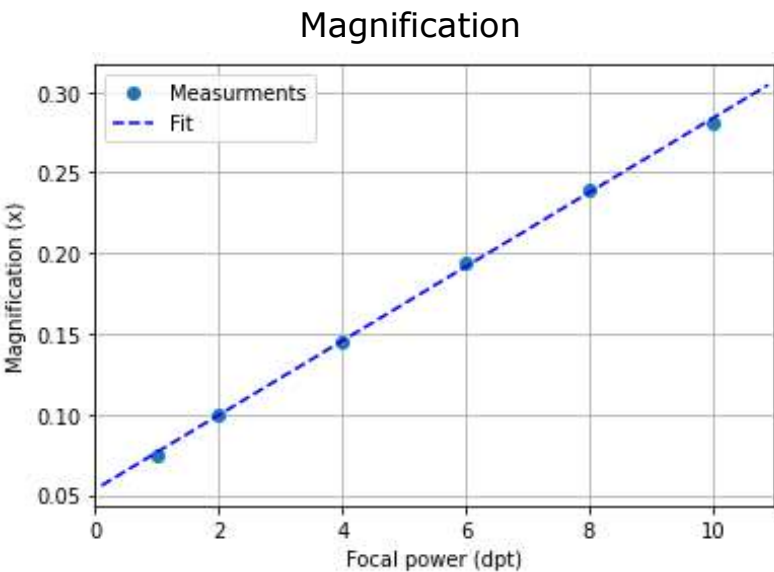
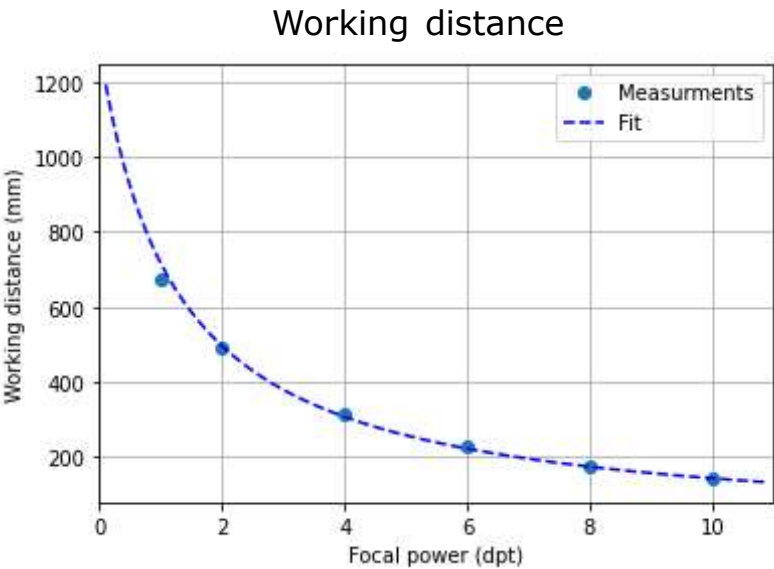
- All the images are taken at Gain 0, and without gamma correction
- The intensity of illumination is controlled to adjust the histogram of the images
- After acquisition, images are zoomed in to show the resolution-limited element



Working distance, Magnification, and MTF

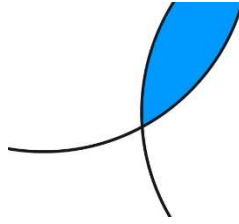


- Magnification and working distance of this ELM is very well aligned with an ento-centric lens



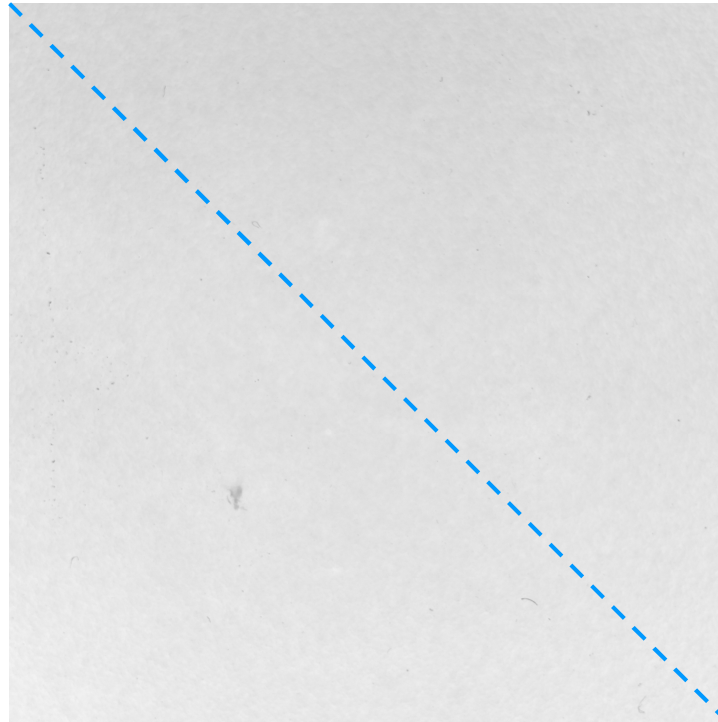
- * Measured with blue LED backlight
- * Magnification measured at the center of the image
- * Slanted-Edge method is used to extract MTF data

Relative illumination



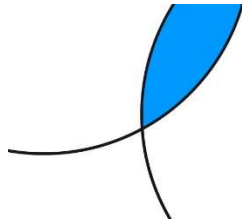
- Vignetting of this ELM is 0.028EV (1.9%) for 1.1" sensor
- A 5mm spacer is used for the test at 200mm and 300mm
- There is a negligible dependence to the focal power/WD for the vignetting

Image taken at WD 200mm, +3.15dpt



WD 920 mm: +0.18dpt, Blue light

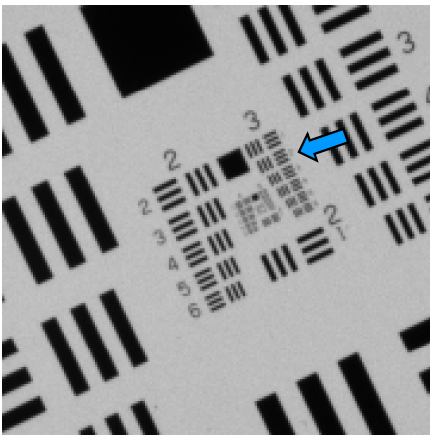
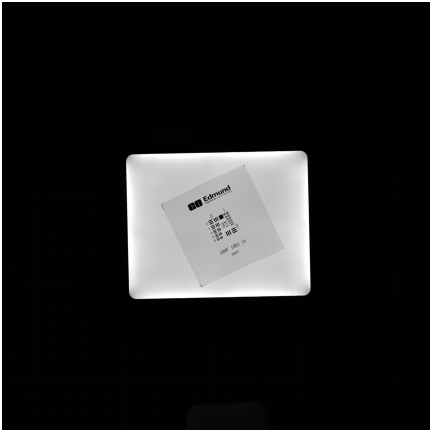
Performance is close to Nyquist limit



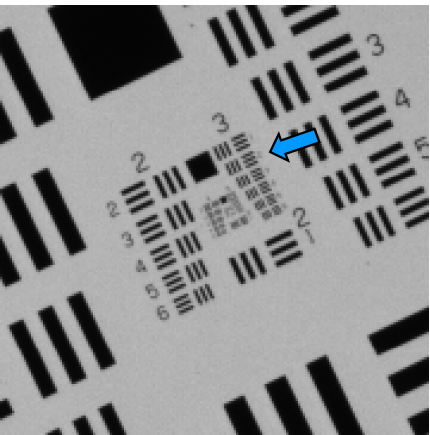
Camera
Sensor size = 4512 x 4512 px
Pixel size = 2.74 μ m
Nyquist limit = 182 lp/mm

Light
Blue background illumination

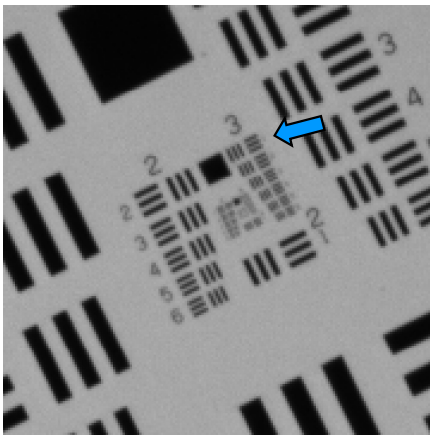
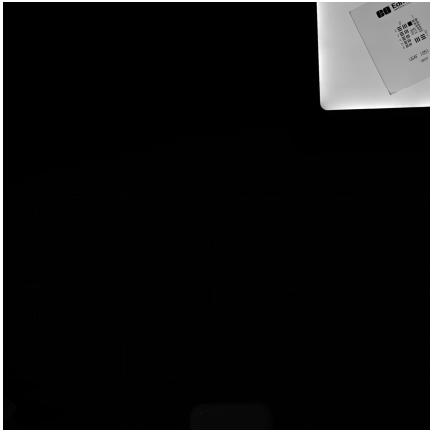
Center



Edge



Corner



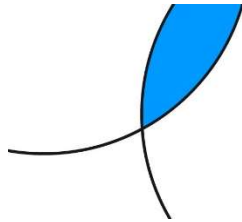
USAF element: 3/2
Line width (μ m): 55.68
Lp/mm (object): 9
Magnification: 0.053
Lp/mm (image): 169

3/2
55.68
9
0.054
166

3/1
62.5
8
0.054
148

WD 500 mm: +1.92dpt, Blue light

Performance is close to Nyquist limit



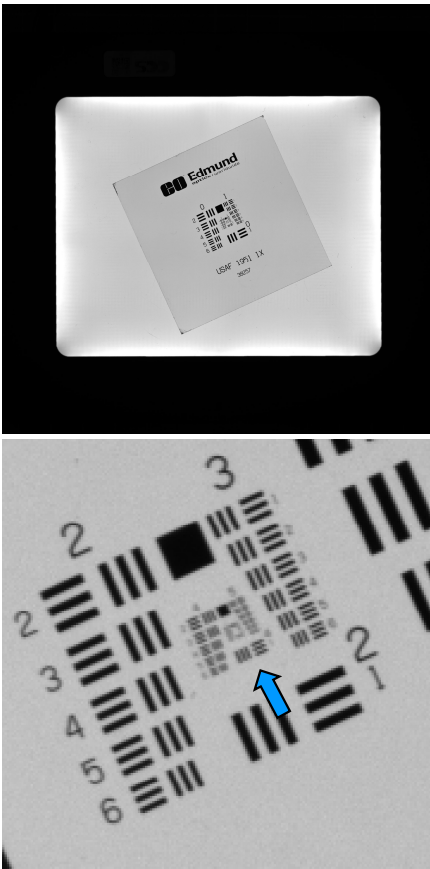
Camera

Sensor size = 4512 x 4512 px
Pixel size = 2.74 μ m
Nyquist limit = 182 lp/mm

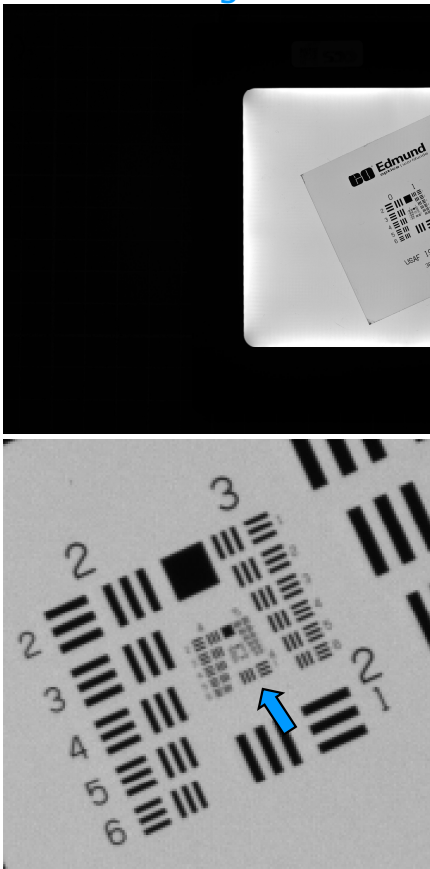
Light

Blue background illumination

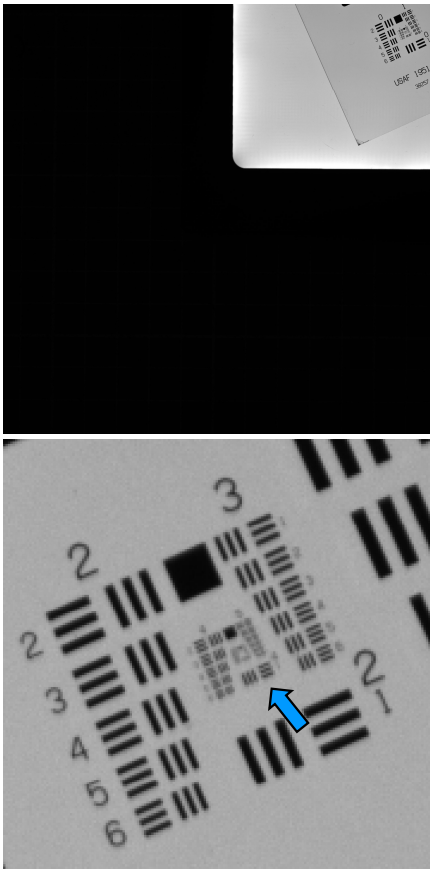
Center



Edge



Corner



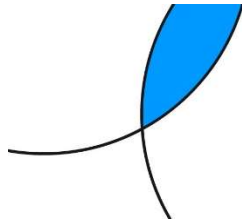
USAF element: 4/1
Line width (μ m): 31.25
Lp/mm (object): 16
Magnification: 0.092
Lp/mm (image): 174

4/1
31.25
16
0.094
170

4/1
31.25
16
0.094
170

WD 300 mm: +0.54dpt, 5mm Spacer, Blue light

Performance is close to Nyquist limit



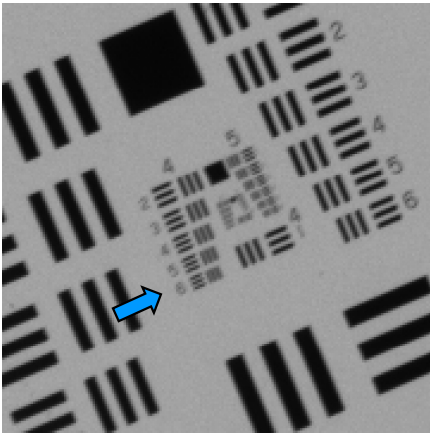
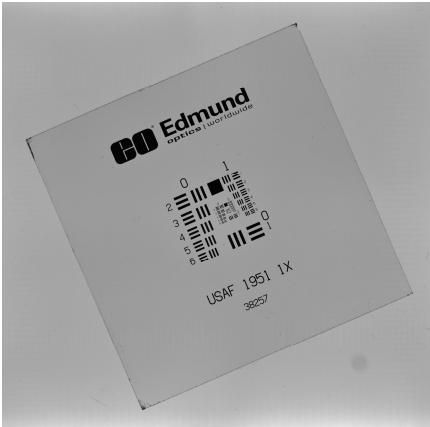
Camera

Sensor size = 4512 x 4512 px
Pixel size = 2.74 μm
Nyquist limit = 182 lp/mm

Light

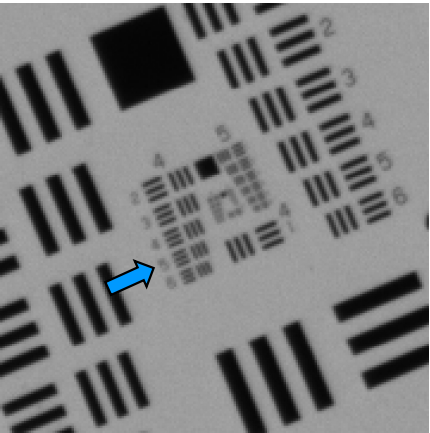
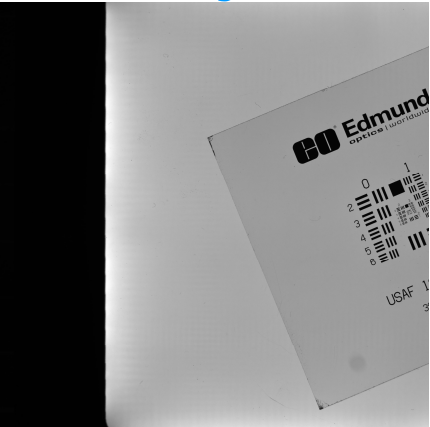
Blue background illumination

Center



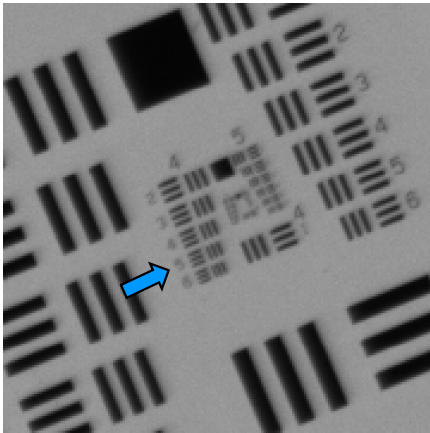
USAF element: 4/6
Line width (μm): 17.54
Lp/mm (object): 29
Magnification: 0.157
Lp/mm (image): 182

Edge



USAF element: 4/5
Line width (μm): 19.69
Lp/mm (object): 25
Magnification: 0.158
Lp/mm (image): 161

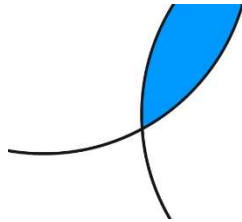
Corner



USAF element: 4/5
Line width (μm): 19.69
Lp/mm (object): 25
Magnification: 0.160
Lp/mm (image): 159

WD 200 mm: +3.09dpt, 5mm Spacer, Blue light

Performance is close to Nyquist limit



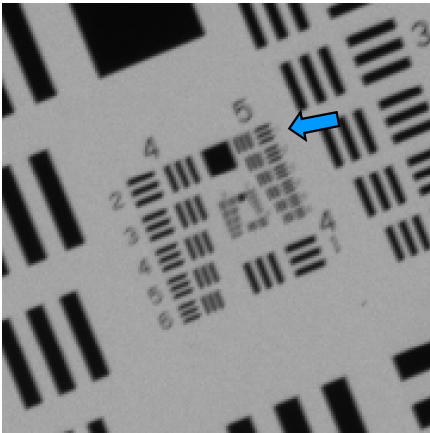
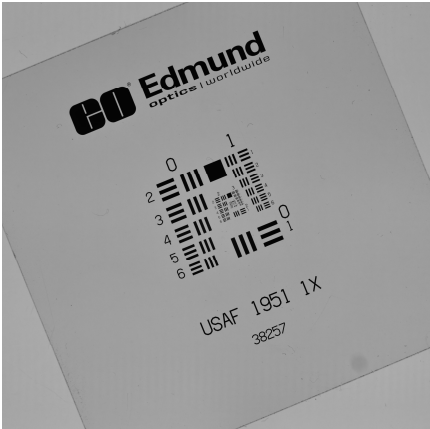
Camera

Sensor size = 4512 x 4512 px
Pixel size = 2.74 μ m
Nyquist limit = 182 lp/mm

Light

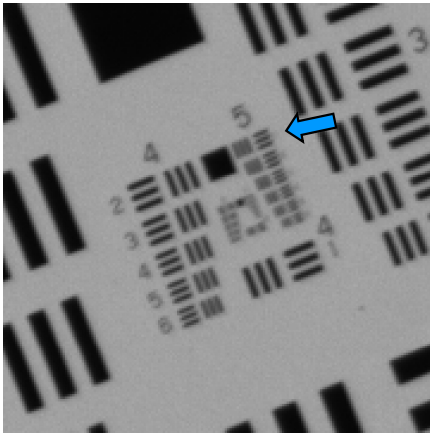
Blue background illumination

Center



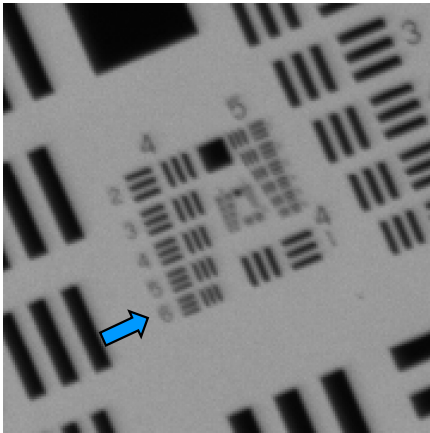
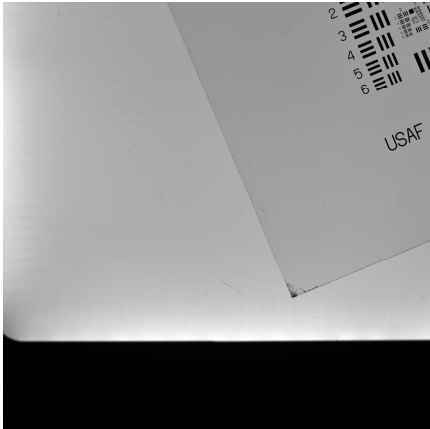
USAF element: 5/1
Line width (μ m): 15.63
Lp/mm (object): 32
Magnification: 0.232
Lp/mm (image): 138

Edge



5/1
15.63
32
0.235
136

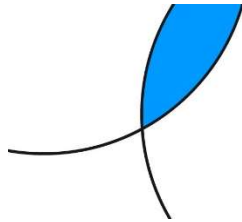
Corner



4/6
17.54
29
0.235
121

Polychromatic performance: White LED vs. Blue LED

WD 300mm, +0.54dpt, 5mm Spacer

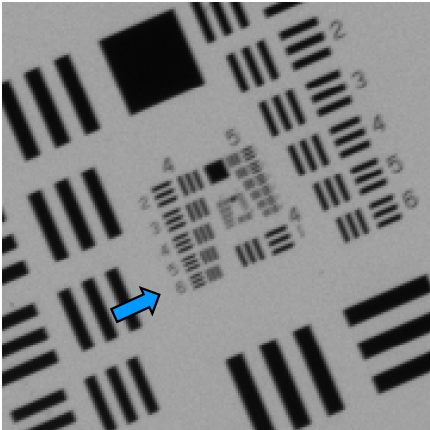


Camera

Sensor size = 4512 x 4512 px
Pixel size = 2.74 μm
Nyquist limit = 182 lp/mm

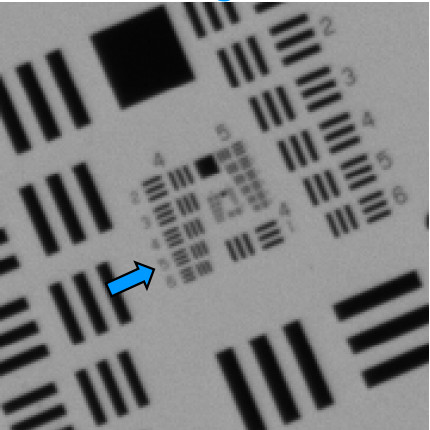
Blue

Center



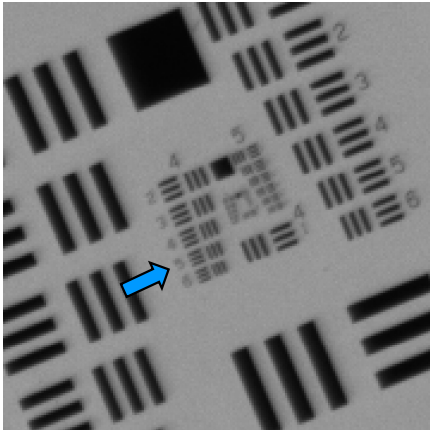
182 LP/mm

Edge



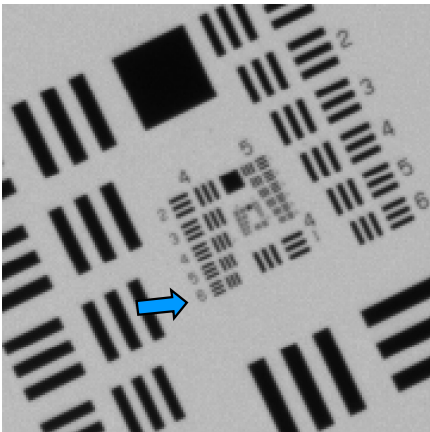
161 LP/mm

Corner

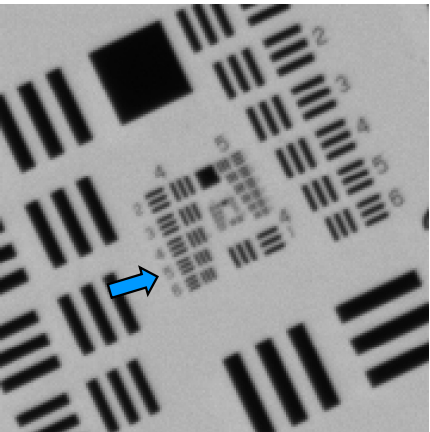


159 LP/mm

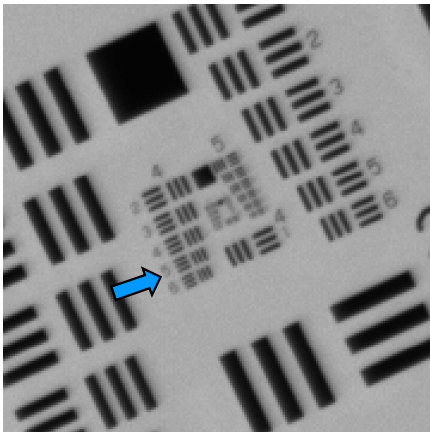
White



182 LP/mm



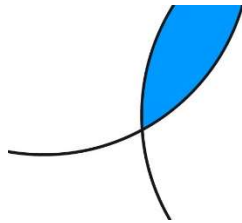
161 LP/mm



159 LP/mm

Vertical vs. Horizontal optical axis

WD 300mm, +0.54dpt, 5mm Spacer, White LED



Camera

Sensor size = 4512 x 4512 px
Pixel size = 2.74 μm
Nyquist limit = 182 lp/mm

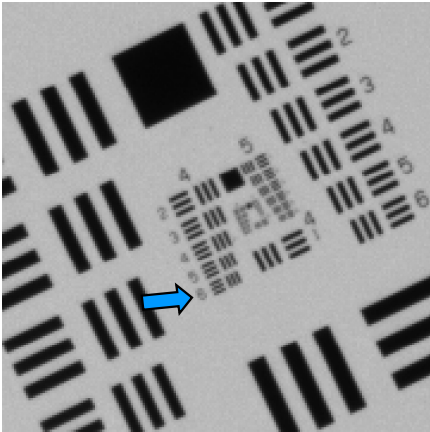
Light

White background illumination

EL-12-30 Gravity coma: 0.18λ

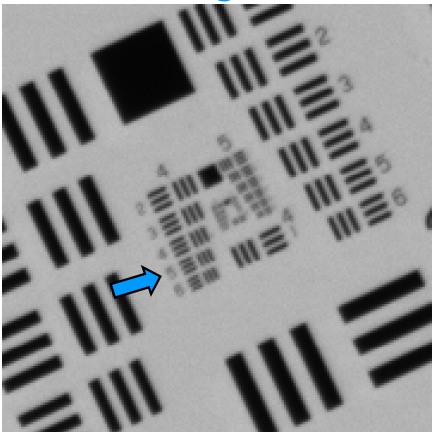
Vertical OA

Center



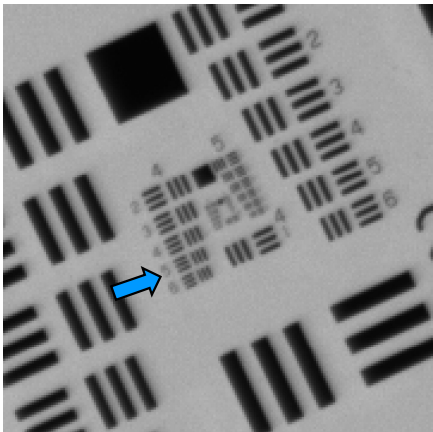
182 LP/mm

Edge



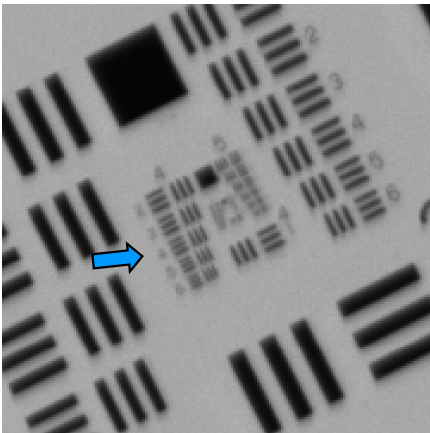
161 LP/mm

Corner

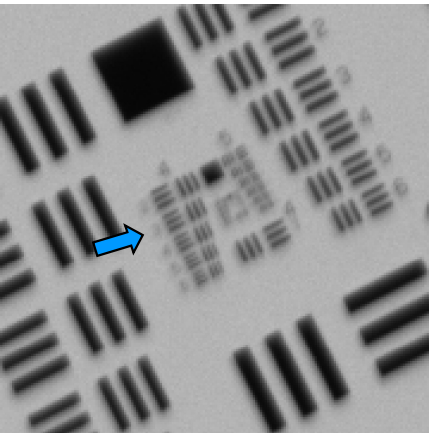


159 LP/mm

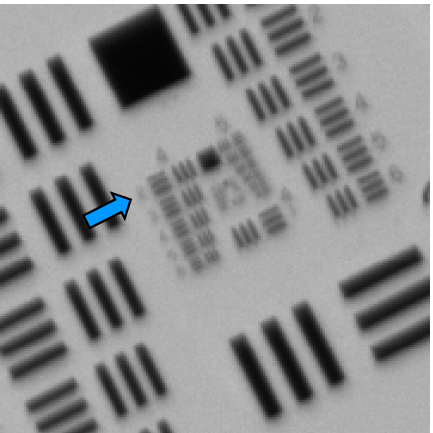
Horizontal OA



144 LP/mm



128 LP/mm



112 LP/mm