Edmund Optics 2x 0.13 NA, Ultra Compact Objective + EL-16-40-20D-C
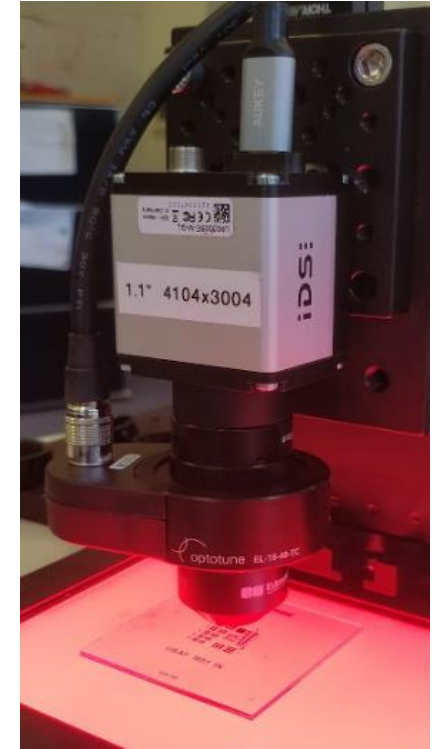
Test Report

June 2020

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Summary

Compact and cost effective focusing solution achieving >1mm z-range @ 5x magnification

➢ FOV @ 0 dpt 2.8 mm → PMAG = 5x

➢ Z-range = 1.29 mm

➢ WD @ 0 dpt ≈ 6.9 mm

➢ Max. PMAG change (@ 10 dpt) ≈ 9%

➢ Optical leverage = 0.065 mm/dpt

➢ Only minor drop in image quality @-10 dpt towards the corners

➢ Best performance with monochromatic light

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Test setup

Camera: IDS 1.1'' 4104x3004 sensor with
                      3.45 µm pixel size

Extension tube: 15 mm

Optotune lens: EL-16-40-20D-C-1 (ANAA1105)

Imaging lens   Edmund Optics 2x 0.13 NA objective

Driver: Optotune Lens Driver 4i

Target: USAF chrome target, transparent
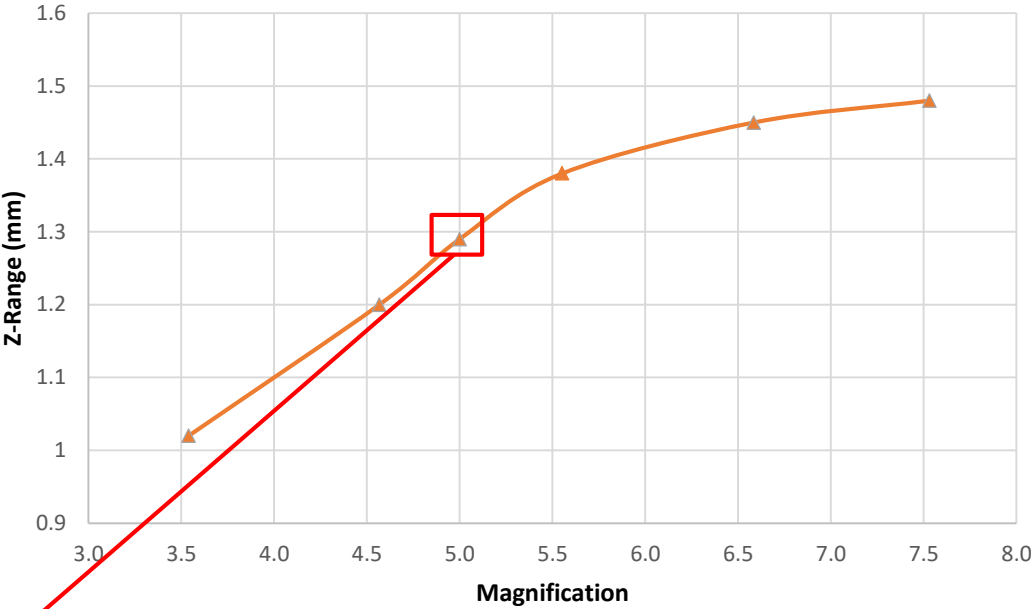   one

Light: Red light

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Z-Range vs. Magnification (different tube lenghts)

Z-range increases with Magnification

Magnification vs. Tube length

$y = 0.1001x + 3.5511$
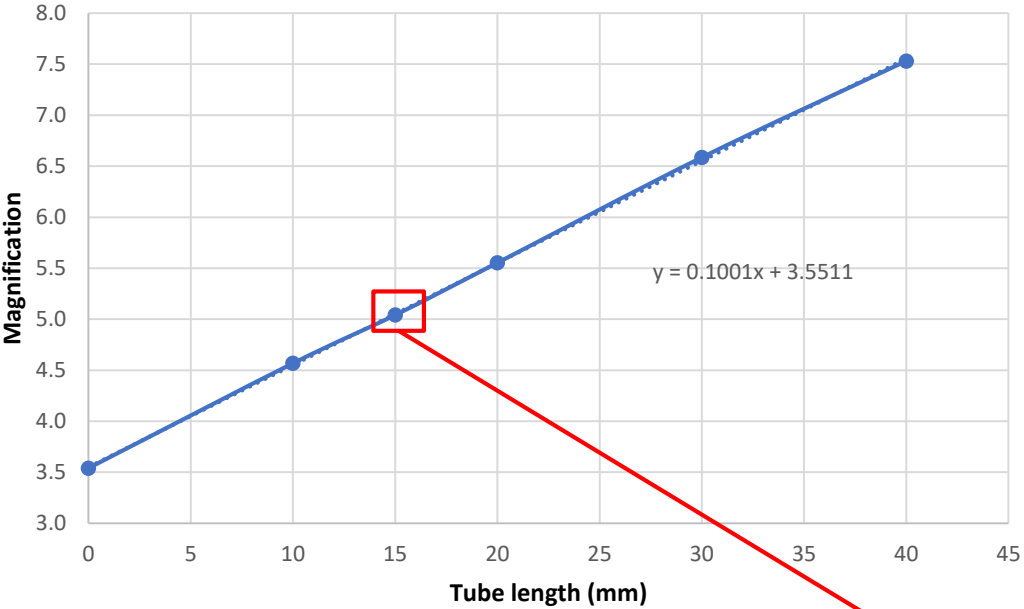
Z-Range vs. Magnification

This test report

N.B. Thickness of EL-16-40 (17.6 mm) needs to be added to the tube length to obtain the total length after the objective lens

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Benchmark without Optotune lens
WD 6.95 mm, FOV 2.78 mm
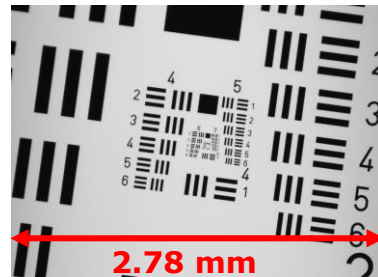
Camera
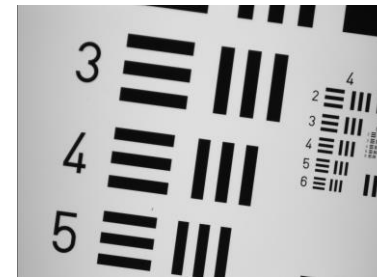
Sensor size = 4104x3004 pixels

Nyquist limit = 145 lp/mm

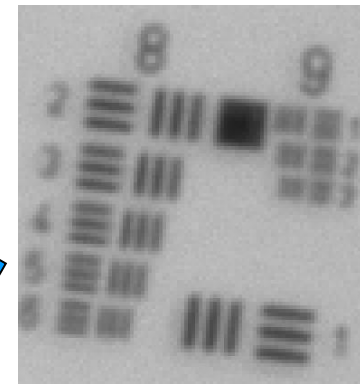Pixel size = 3.45 um

Light

Red background illumination
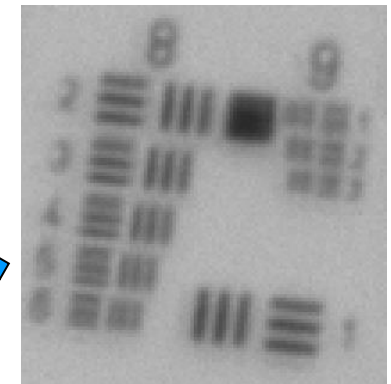
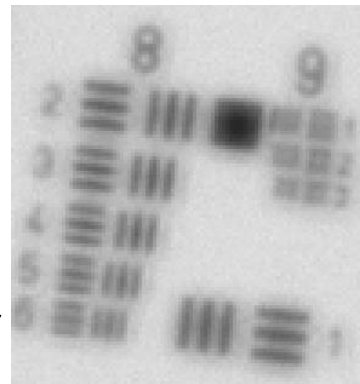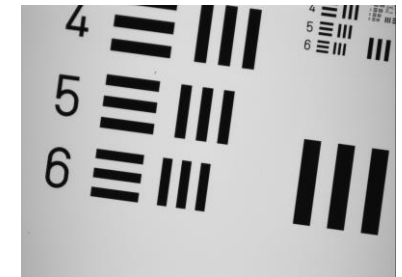
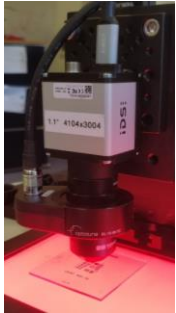|	**Center**	**Edge**	**Corner**
USAF element:	8/6	8/6	8/5
Line width (um):	1.1	1.1	1.23
Lp/mm (object):	455	455	407
Magnification:	5.106	5.106	5.106
Lp/mm (image):	**89**	**89**	**80**

Note: 17 mm spacer added to compensate for length of EL-16-40 lens

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WD 6.9 mm @ 0 dpt, FOV 2.81 mm

Camera

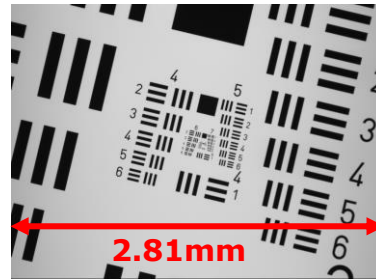Sensor size = 4104x3004 pixels

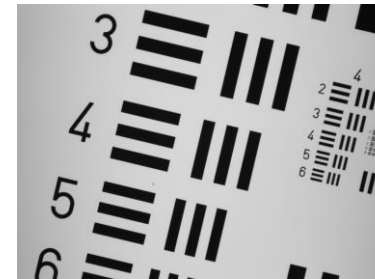Nyquist limit = 145 lp/mm

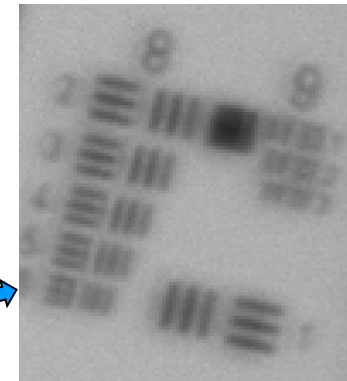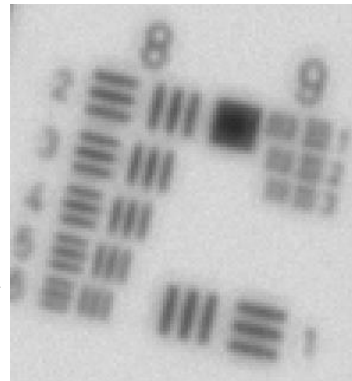Pixel size = 3.45 um

Light

Red background illumination

Center

Edge

Corner

2.81mm
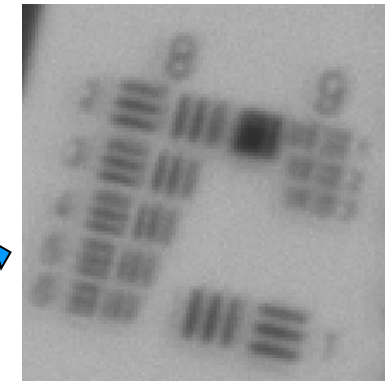
	Center	Edge	Corner
USAF element:	8/6	8/6	8/5
Line width (um):	1.1	1.1	1.23
Lp/mm (object):	455	455	407
Magnification:	5.056	5.056	5.056
Lp/mm (image):	**90**	**90**	**80**

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Almost no drop in image quality with and without Optotune lens

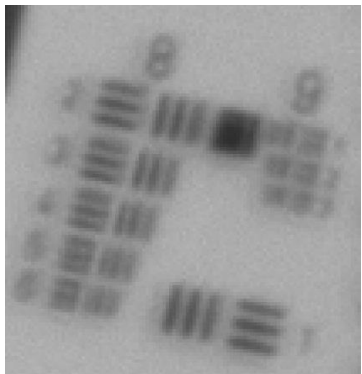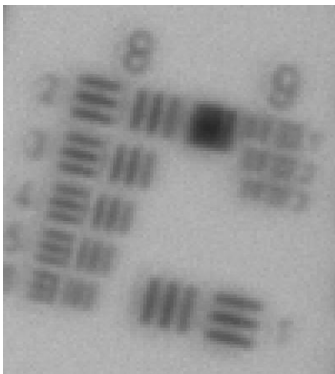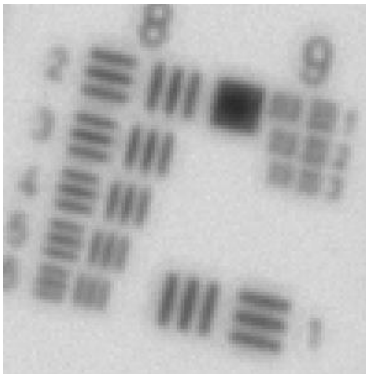|	**Center**	**Edge**	**Corner**
Without Optotune lens			
With Optotune lens (@ 0 dpt)			
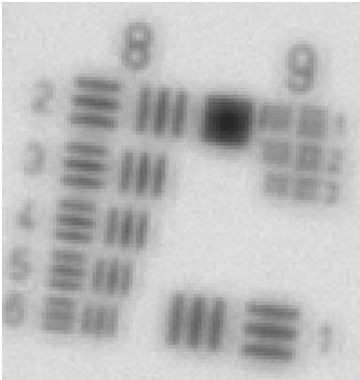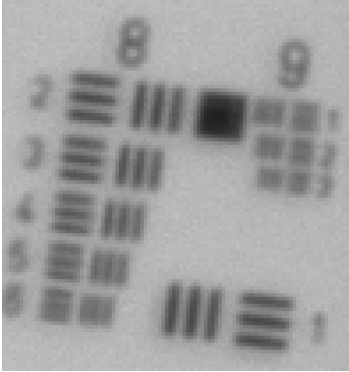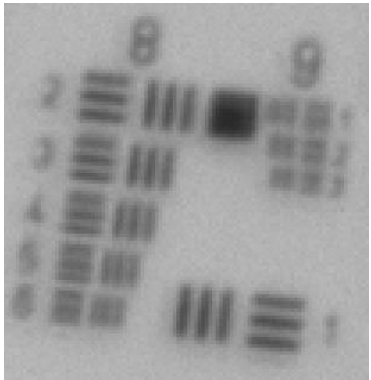
Note: 17 mm spacer added to compensate for length of EL-16-40 lens

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WD 6.15 mm @ 10 dpt, FOV 3.09 mm

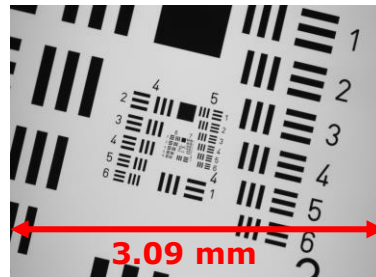**Camera**

Sensor size = 4104x3004 pixels
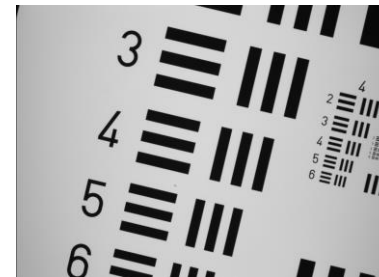
Nyquist limit = 145 lp/mm

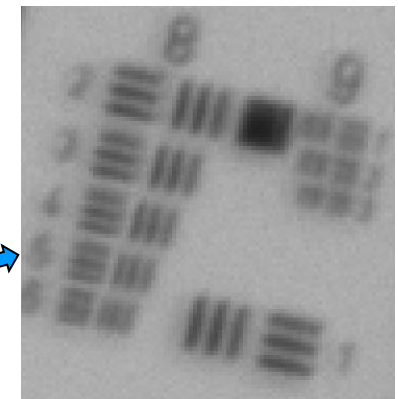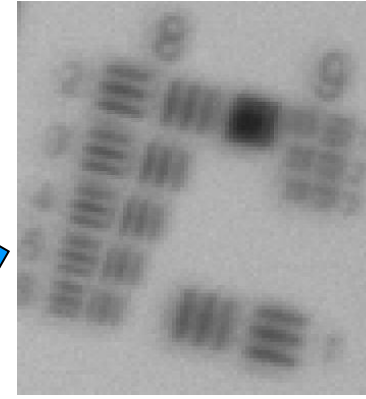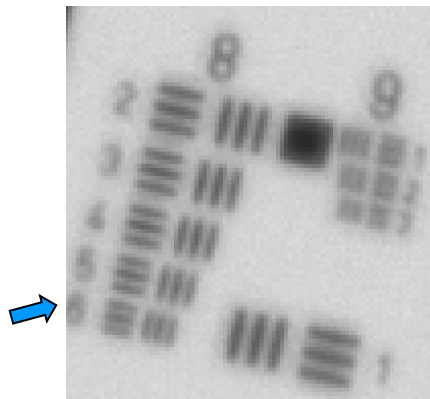Pixel size = 3.45 um

Light

Red background illumination

	Center	Edge	Corner
USAF element:	8/6	8/5	8/5
Line width (um):	1.1	1.23	1.23
Lp/mm (object):	455	407	407
Magnification:	4.659	4.659	4.659
Lp/mm (image):	**98**	**87**	**87**

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WD 7.45 mm @ -10 dpt, FOV 2.6 mm

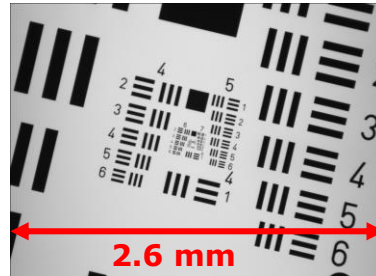**Camera**

Sensor size = 4104x3004 pixels
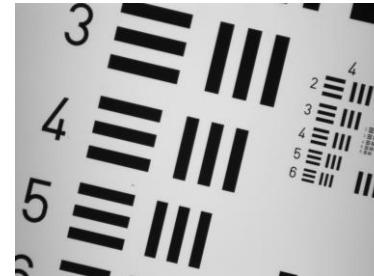
Nyquist limit = 145 lp/mm

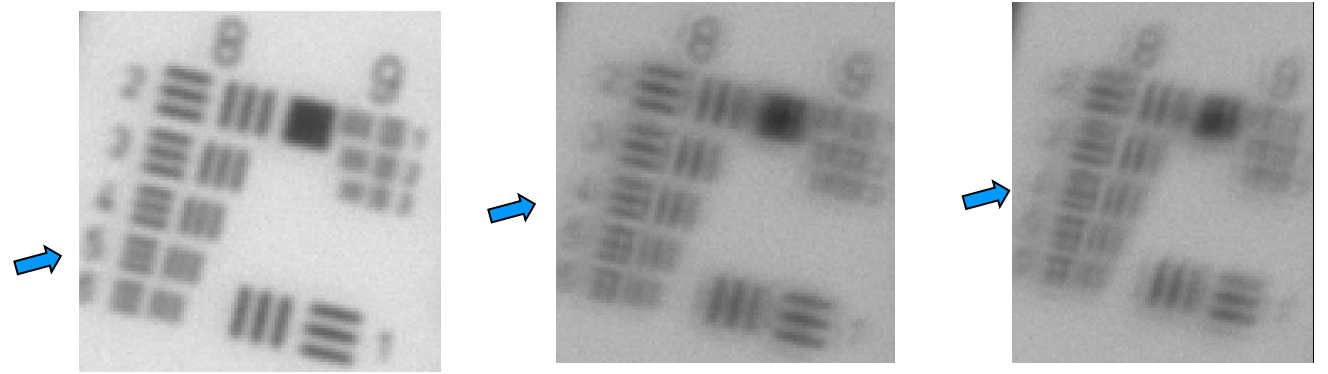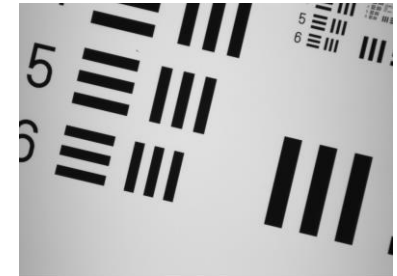Pixel size = 3.45 um

Light

Red background illumination

	Center	**Edge**	**Corner**
USAF element:	8/5	8/4	8/3
Line width (um):	1.23	1.38	1.55
Lp/mm (object):	407	362	323
Magnification:	5.453	5.453	5.453
Lp/mm (image):	**75**	**66**	**59**

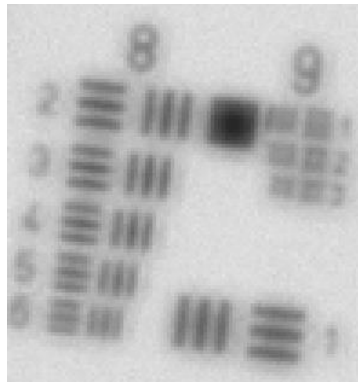optotune

Test setup

Camera: IDS 1.1'' 4104x3004 sensor with 3.45 µm pixel size

Extension tube: 15 mm

Optotune lens: EL-16-40-20D-C-1 (ANAA1105)

Imaging lens   Edmund Optics 2x 0.13 NA objective

Driver: Optotune Lens Driver 4i

Target: USAF chrome target, transparent one

Light: White light

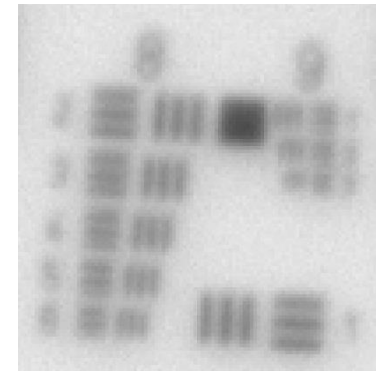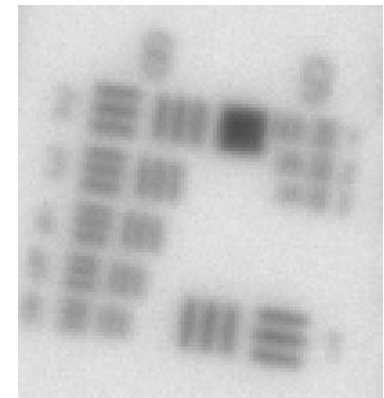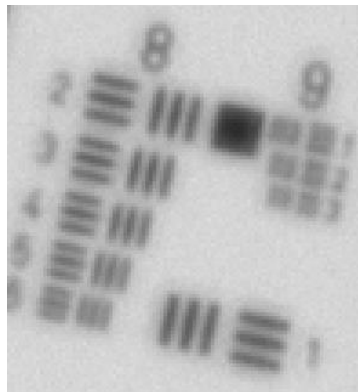optotune

Best performance with monochromatic light

Center

Center

Without Optotune lens

With Optotune lens (@ 0 dpt)

Note: 17 mm spacer added to compensate for length of EL-16-40 lens

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WD 6.9 mm @ 0 dpt, FOV 2.81 mm
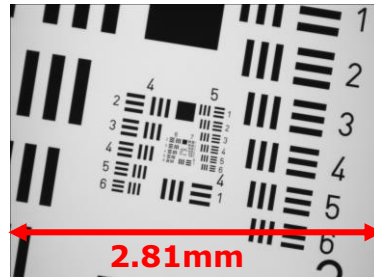
Camera

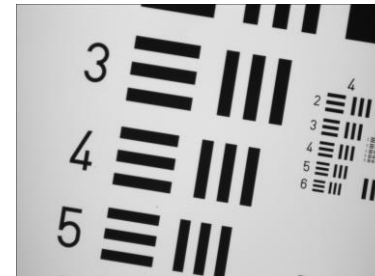Sensor size = 4104x3004 pixels

Nyquist limit = 145 lp/mm

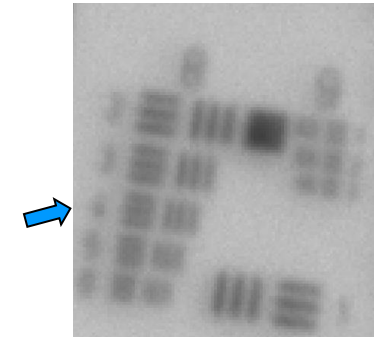Pixel size = 3.45 um
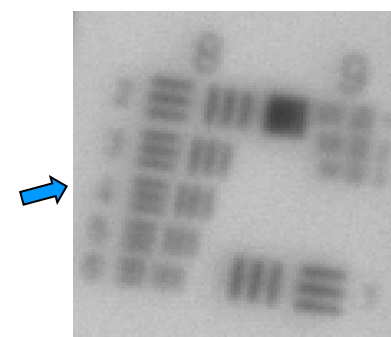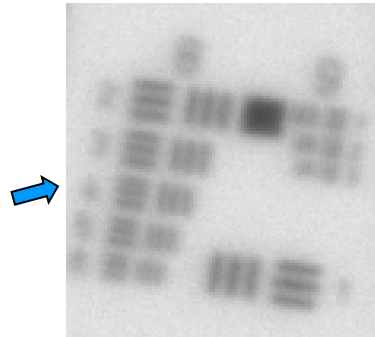
Light

White background illumination
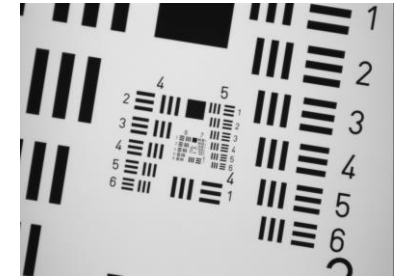
	Center	Edge	Corner
USAF element:	8/4	8/4	8/4
Line width (um):	1.38	1.38	1.38
Lp/mm (object):	362	362	362
Magnification:	5.056	5.056	5.056
Lp/mm (image):	**72**	**72**	**72**

Almost no drop in image quality with and without Optotune lens also with white light

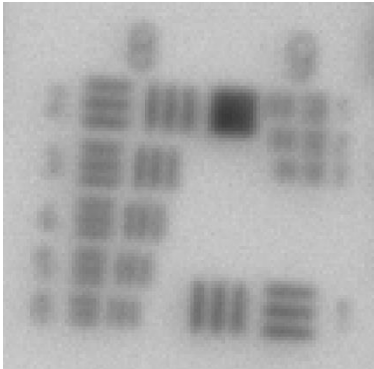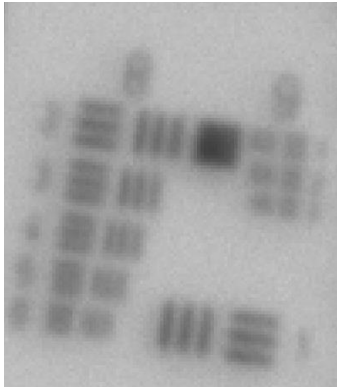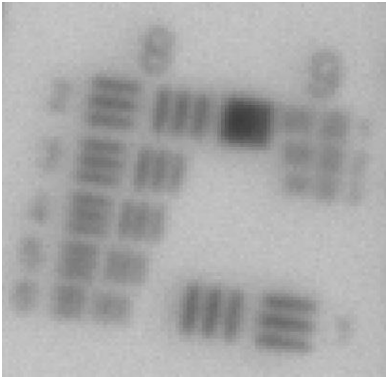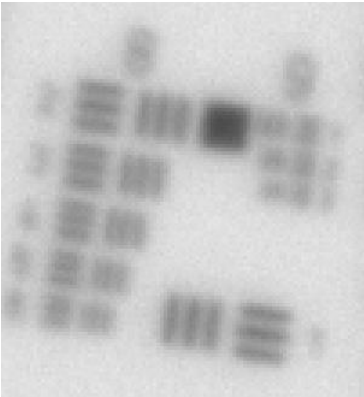|	Center	Edge	Corner

Without Optotune lens

With Optotune lens (@ 0 dpt)

Note: 17 mm spacer added to compensate for length of EL-16-40 lens

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Magnification change: 1.3% per 100um of WD

HFOV, Mag @ WD

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