

Navitar Zoom module with 5x objective and Optotune EL-16-40 for fast focusing

May 2022

Dr. Gustavo Ciardi, Application Engineer

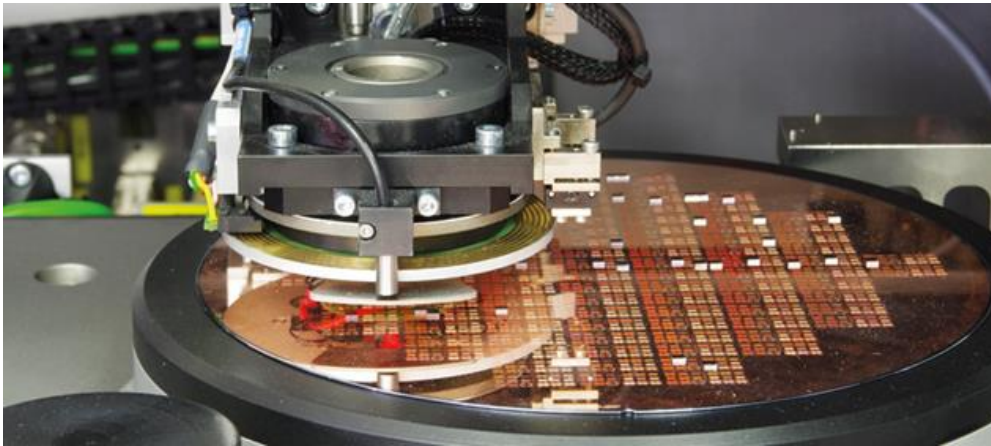
Optotune Switzerland AG | Bernstrasse 388 | CH-8953 Dietikon | Switzerland
Phone +41 58 856 3011 | www.optotune.com | info@optotune.com

Summary

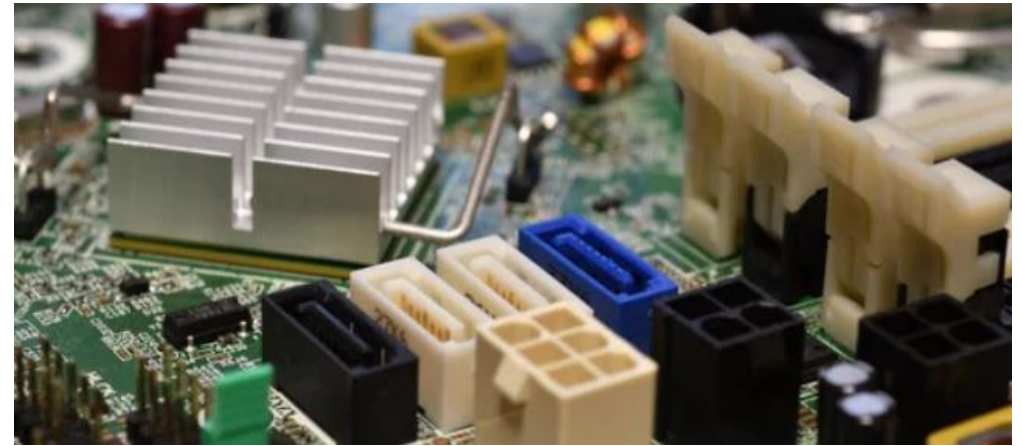
- **Very large zoom range** when coupled with the 5x Mitutoyo objective
 - From about 1.7x to 11x
- **Zoom System is parfocal:** changing the zoom setting does not require refocusing
- Only minor magnification change when refocusing with liquid lens
- **Very large Z-range** of about 9 mm (-2 to +3 dpt) at both minimum and maximum zoom setting
- **No optical performance difference** with or without liquid lens
- Slightly better contrast with mono- vs. polychromatic light

Modular microscope for industrial inspections

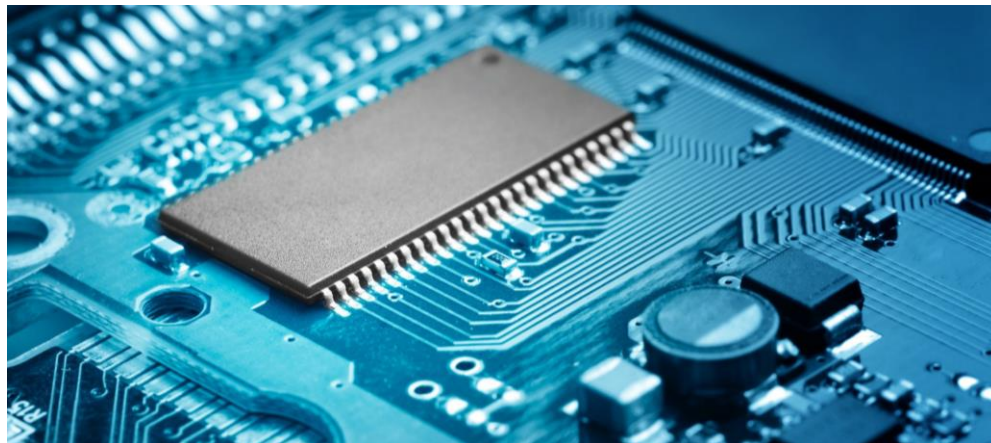
Wafer inspection



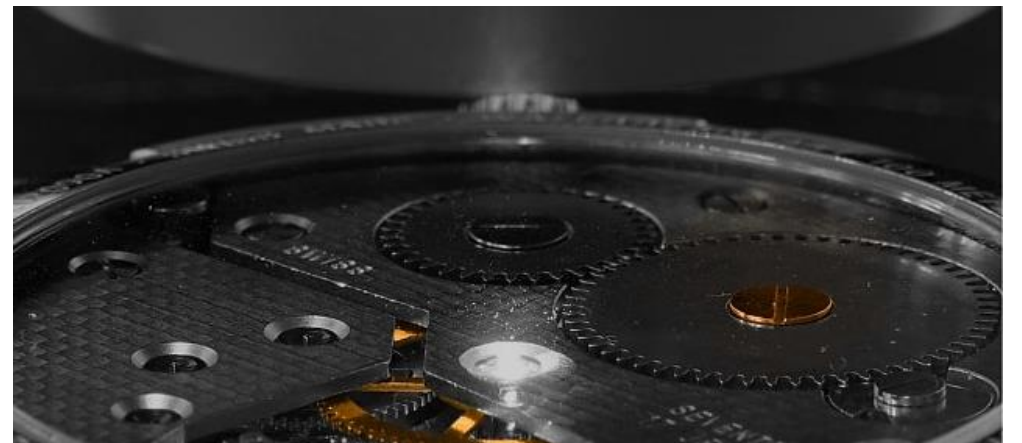
Electronic inspection



PCB inspection



Precise mechanic inspection

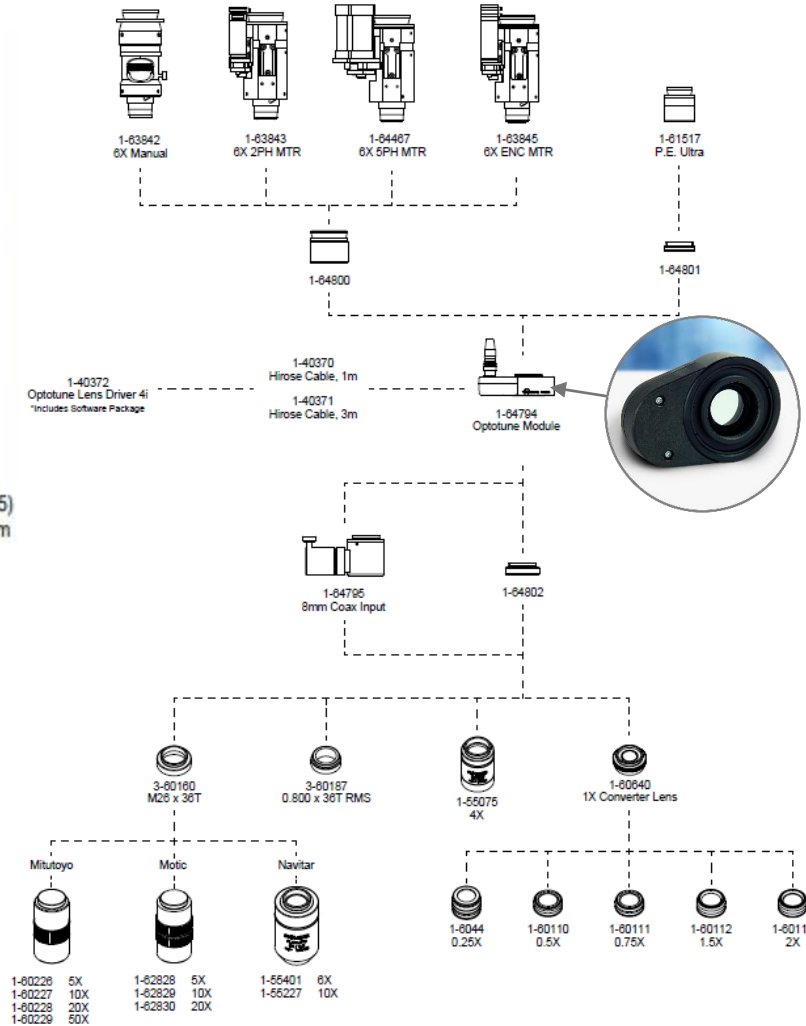


Navitar industrial microscope

NAVITAR Tunable Lens Focus Module for Zoom 6000 System



Optotune Module (Navitar 1-64805) with Zoom 6000 Motorized System



Zoom system

- Modular solution for microscopy

Compatible with microscope objectives

- Up to 50x

Also suitable for fixed magnifications

System diagram & detailed spec sheet available:

- <https://navitar.com/products/imaging-optics/optotune-module/optotune-zoom-6000-system-components/>

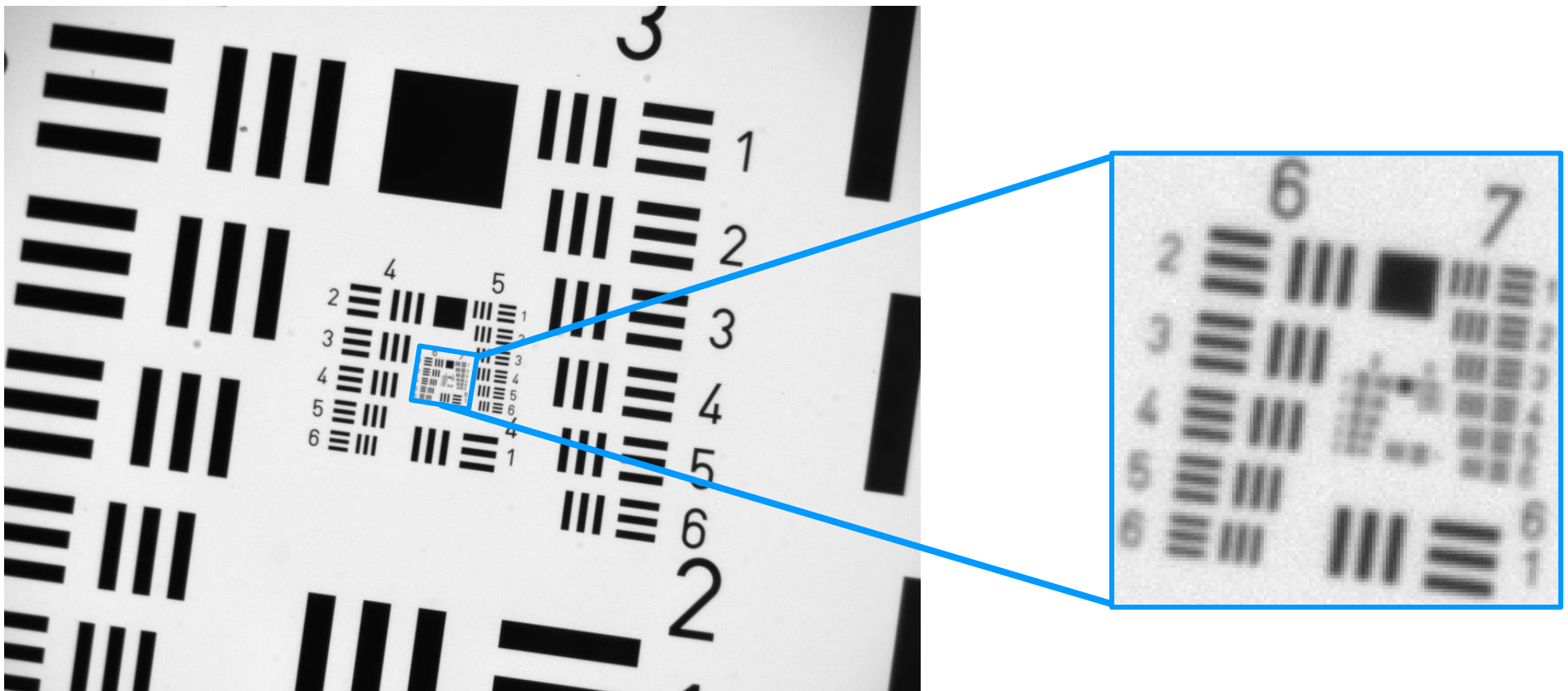
Test setup



Camera:	1/1.8" Basler 2048x1536 pixels 3.45 um pixel size
Lens:	Navitar Zoom Module with 5x Mitutoyo objective
Tunable lens:	EL-16-40-TC-VIS-5D-1-C (ANAB3284) WFE @ 0 mA = 0.11 λ RMS @532 nm
NA:	0.14
Driver:	ICC-4C
Target:	Transparent USAF target
Light:	Red/white backlight
Optical axis:	Vertical

Method for image evaluation

- After acquisition, images are zoomed in to show resolution limited element



Minimum zoom setting: no difference in image quality or vignetting with or without liquid lens

Camera

Sensor size = 2048x1536 pixels

Nyquist limit = 144 lp/mm

Pixel size = 3.45 μm

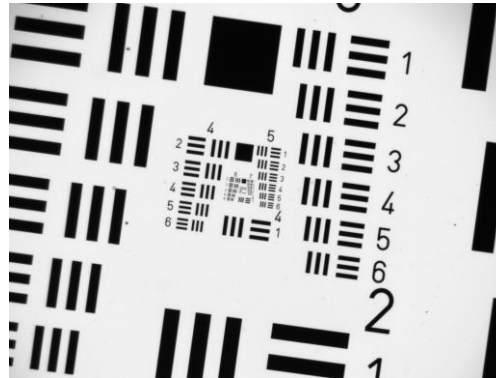
Light

Red background illumination

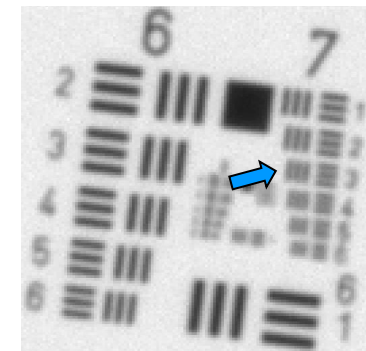
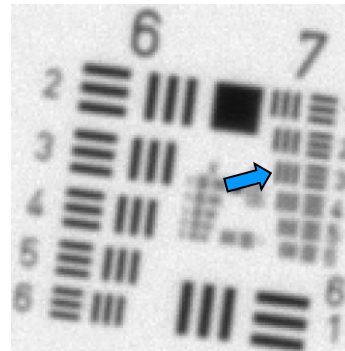
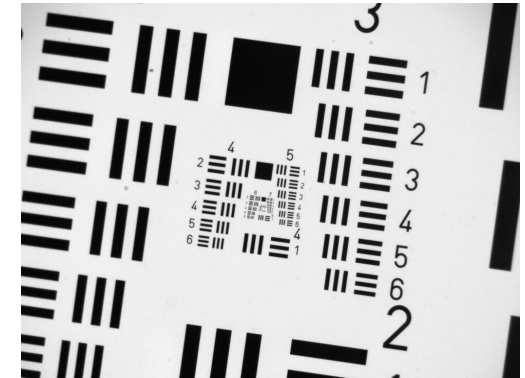
Z-range = 9 mm

17.5 mm of spacer added to compensate for liquid lens thickness

No liquid lens



With Liquid lens



USAF element:	7/3
Line width (μm):	3.1
Lp/mm (object):	161
Magnification:	1.716
Lp/mm (image):	94

USAF element:	7/3
Line width (μm):	3.1
Lp/mm (object):	161
Magnification:	1.716
Lp/mm (image):	94

Maximum zoom setting: no difference in image quality with or without liquid lens

Camera

Sensor size = 2048x1536 pixels

Nyquist limit = 144 lp/mm

Pixel size = 3.45 μm

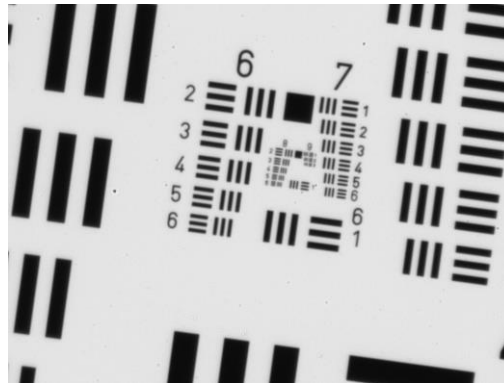
Light

Red background illumination

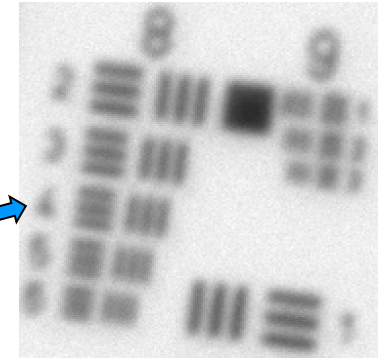
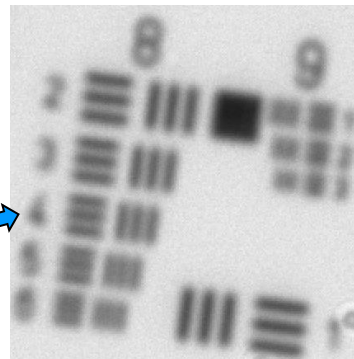
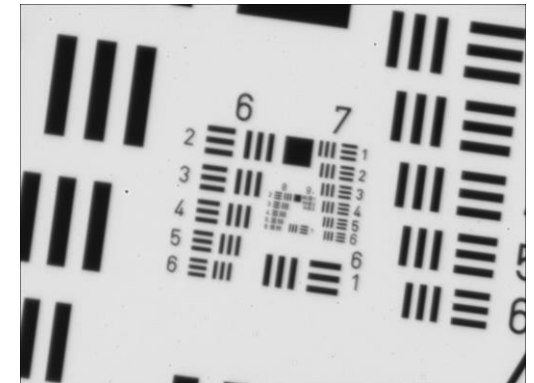
Z-range = 8.7 mm

17.5 mm of spacer added to compensate for liquid lens thickness

No liquid lens



With Liquid lens



USAF element:	8/4
Line width (μm):	1.38
Lp/mm (object):	362
Magnification:	11.103
Lp/mm (image):	33

USAF element:	8/4
Line width (μm):	1.38
Lp/mm (object):	362
Magnification:	11.103
Lp/mm (image):	33

Minimum zoom setting @0 dpt, 350 mm WD

Camera

Sensor size = 2048x1536 pixels

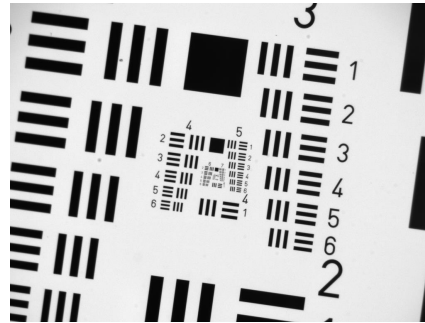
Nyquist limit = 144 lp/mm

Pixel size = 3.45 μm

Light

Red background illumination

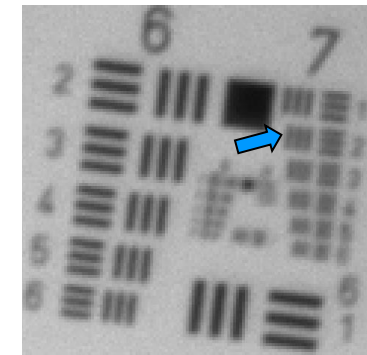
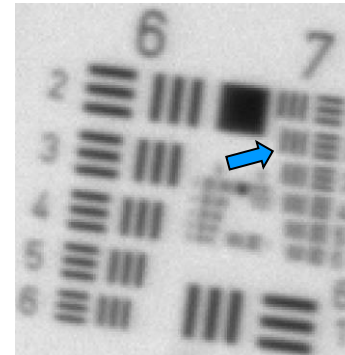
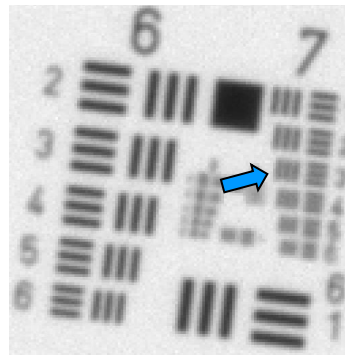
Center



Edge



Corner



USAF element: 7/3
 Line width (μm): 3.1
 Lp/mm (object): 161
 Magnification: 1.716
Lp/mm (image): 94

7/2
 3.48
 144
 1.716
84

7/2
 3.48
 144
 1.716
84

Minimum zoom setting @3 dpt, 346 mm WD

Camera

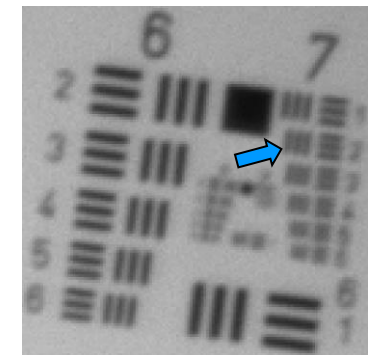
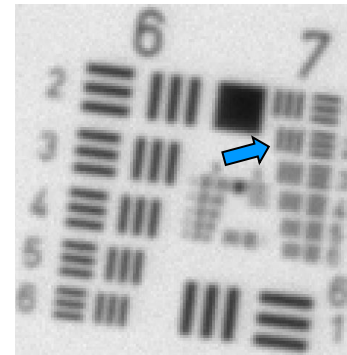
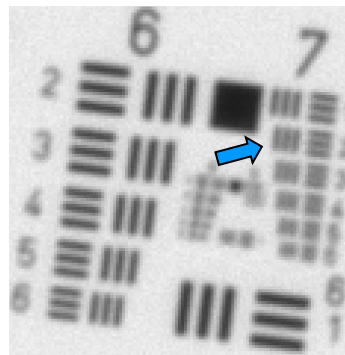
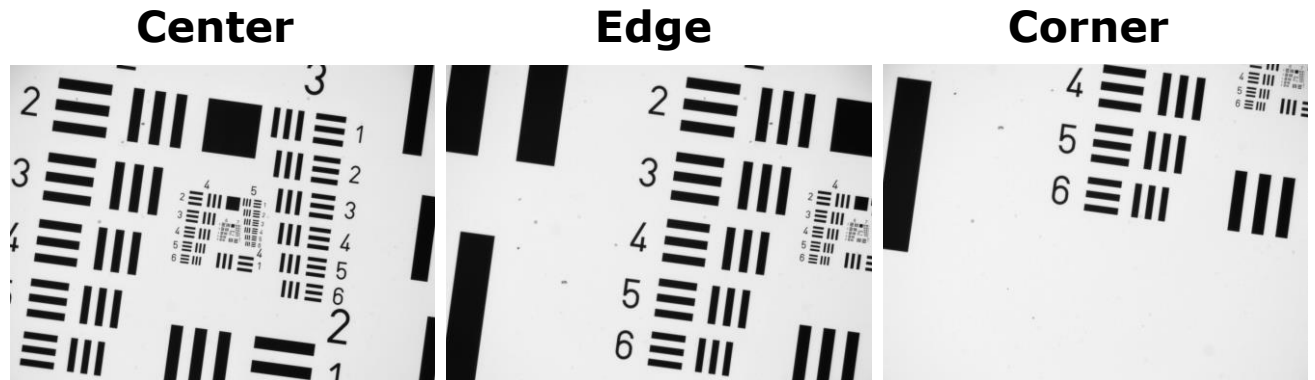
Sensor size = 2048x1536 pixels

Nyquist limit = 144 lp/mm

Pixel size = 3.45 μ m

Light

Red background illumination



USAF element: 7/2
Line width (μ m): 3.48
Lp/mm (object): 144
Magnification: 1.605
Lp/mm (image): 90

7/2
3.48
144
1.605
90

7/2
3.48
144
1.605
90

Minimum zoom setting @-2 dpt, 355 mm WD

Camera

Sensor size = 2048x1536 pixels

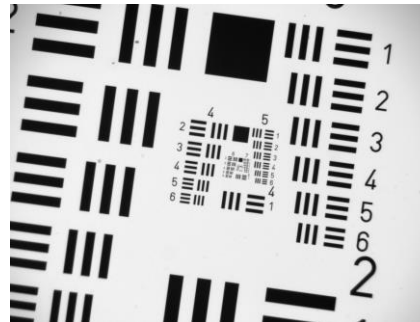
Nyquist limit = 144 lp/mm

Pixel size = 3.45 μm

Light

Red background illumination

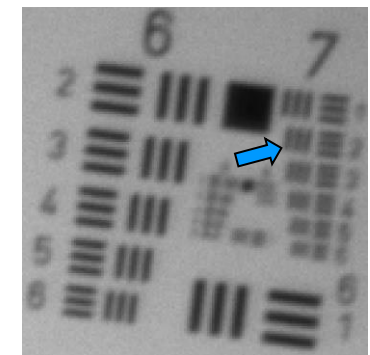
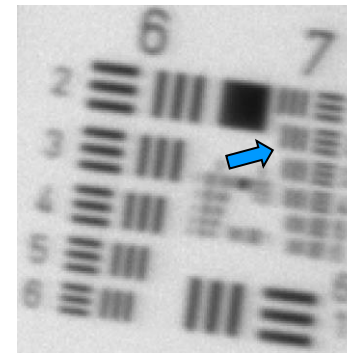
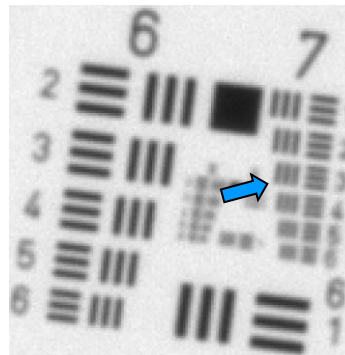
Center



Edge



Corner



USAF element: 7/3
 Line width (μm): 3.1
 Lp/mm (object): 161
 Magnification: 1.859
Lp/mm (image): 87

7/2
 3.48
 144
 1.859
77

7/2
 3.48
 144
 1.859
77

Maximum zoom setting @0 dpt, 355 mm WD

Camera

Sensor size = 2048x1536 pixels

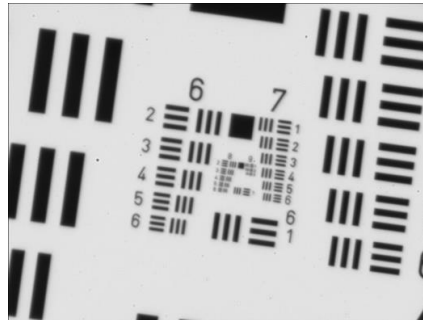
Nyquist limit = 144 lp/mm

Pixel size = 3.45 μm

Light

Red background illumination

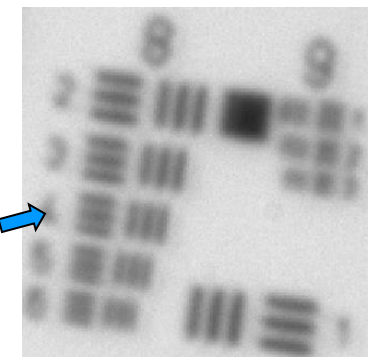
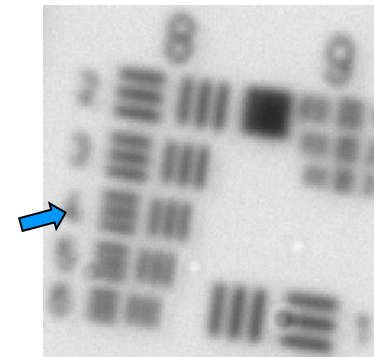
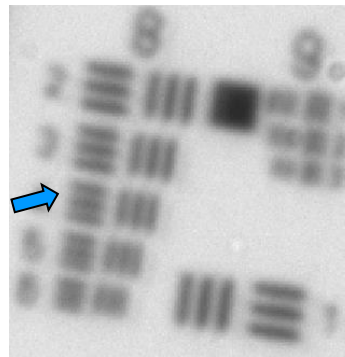
Center



Edge



Corner



USAF element: 8/4
Line width (μm): 1.38
Lp/mm (object): 362
Magnification: 11.203
Lp/mm (image): 32

8/4
1.38
362
11.203
32

8/4
1.38
362
11.203
32

Maximum zoom setting @3 dpt, 346 mm WD

Camera

Sensor size = 2048x1536 pixels

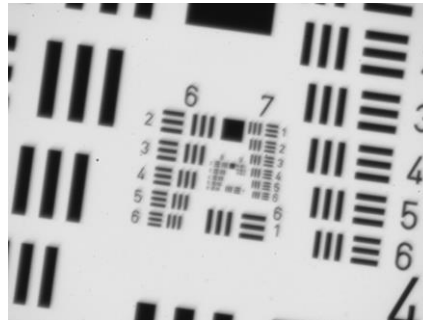
Nyquist limit = 144 lp/mm

Pixel size = 3.45 μm

Light

Red background illumination

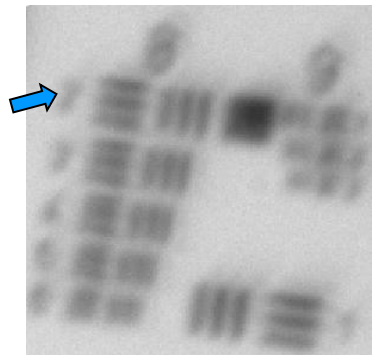
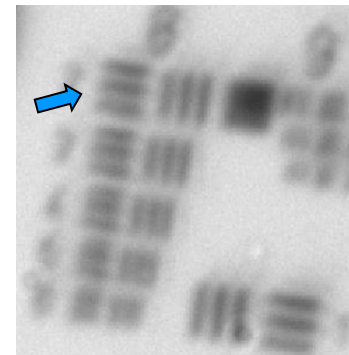
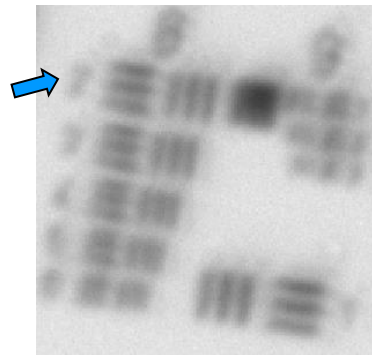
Center



Edge



Corner



USAF element:	8/2	8/2	8/2
Line width (μm):	1.74	1.74	1.74
Lp/mm (object):	287	287	287
Magnification:	10.211	10.211	10.211
Lp/mm (image):	28	28	28

Maximum zoom setting @-2 dpt, 355 mm WD

Camera

Sensor size = 2048x1536 pixels

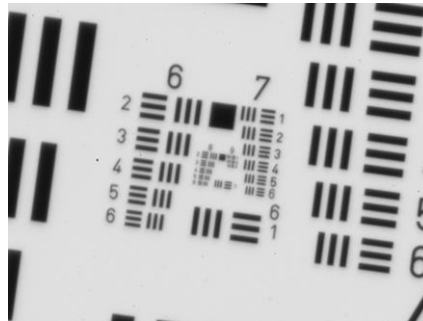
Nyquist limit = 144 lp/mm

Pixel size = 3.45 μm

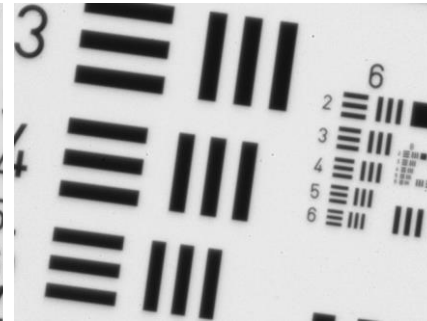
Light

Red background illumination

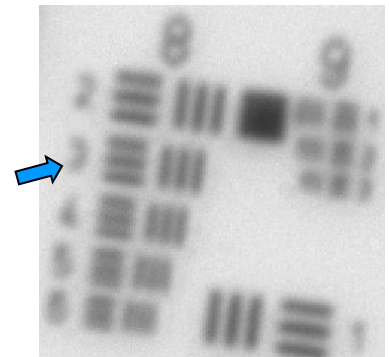
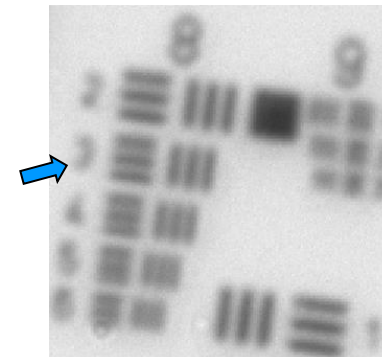
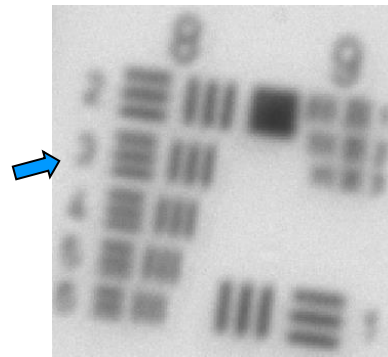
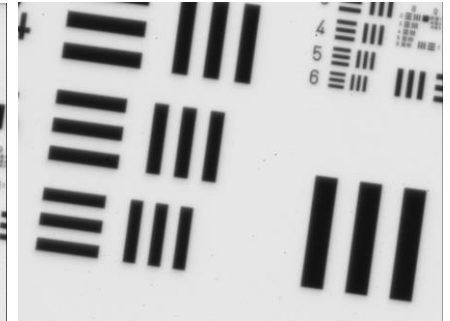
Center



Edge



Corner



USAF element: 8/3
 Line width (μm): 1.55
 Lp/mm (object): 323
 Magnification: 11.897
Lp/mm (image): 27

8/3
 1.55
 323
 11.897
27

8/3
 1.55
 323
 11.897
27

Minimum zoom setting: white vs red light

Slightly better contrast with monochromatic light

Camera

Sensor size = 2564x2056 pixels

Nyquist limit = 144 lp/mm

Pixel size = 3.45 μm

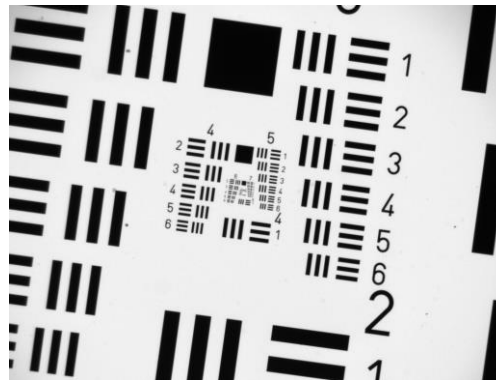
Light

White background illumination

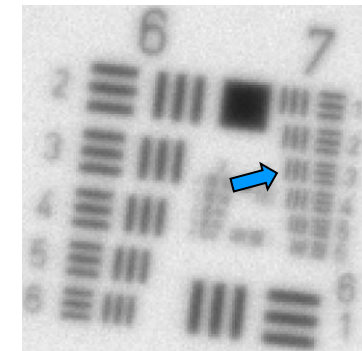
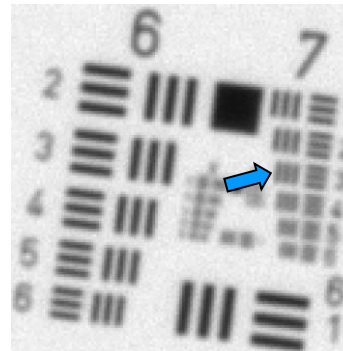
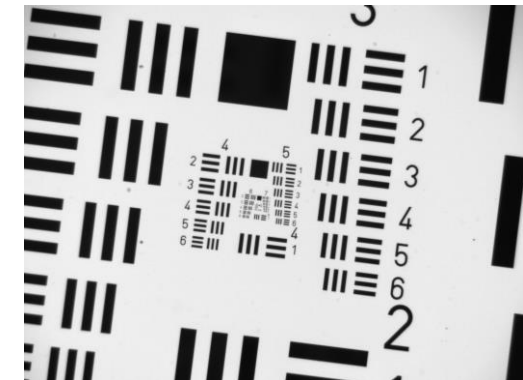
Z-range = 9 mm

17.5 mm of spacer added to compensate for liquid lens thickness

Red light



White light



USAF element:	7/3
Line width (μm):	3.1
Lp/mm (object):	161
Magnification:	1.716
Lp/mm (image):	94

USAF element:	7/3
Line width (μm):	3.1
Lp/mm (object):	161
Magnification:	1.716
Lp/mm (image):	94

Maximum zoom setting: white vs red light

Slightly better contrast with monochromatic light

Camera

Sensor size = 2564x2056 pixels

Nyquist limit = 144 lp/mm

Pixel size = 3.45 μm

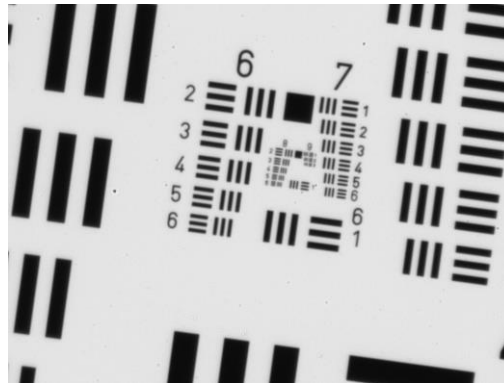
Light

White background illumination

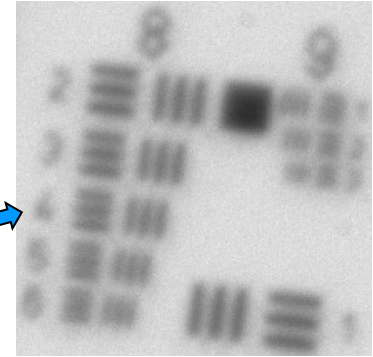
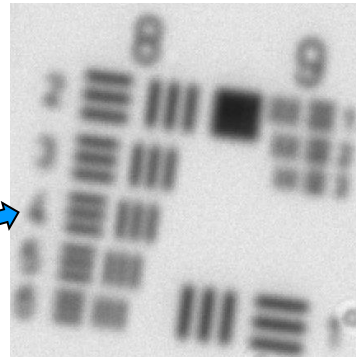
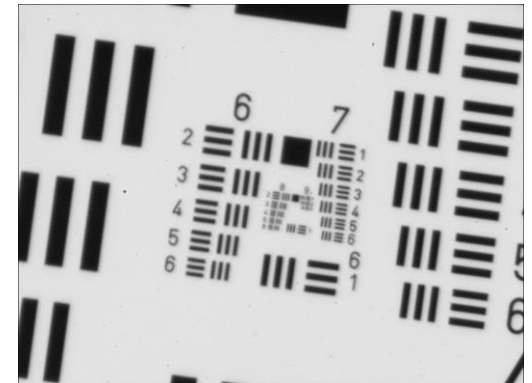
Z-range = 9 mm

17.5 mm of spacer added to compensate for liquid lens thickness

Red light



White light



USAF element:	8/4
Line width (μm):	1.38
Lp/mm (object):	362
Magnification:	11.103
Lp/mm (image):	33

USAF element:	8/4
Line width (μm):	1.38
Lp/mm (object):	362
Magnification:	11.103
Lp/mm (image):	33