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Schneider Kreuznach PYRITE 4.0-80 C-LF-SD with EL-16-40-TC-VIS-5D

Zürich, March 2022

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Summary

- Almost Nyquist limited performance in the center for short WDs
- Resolution drops towards large WDs
- Good correlation with the MTFs on the datasheet
- Very good mono- and polychromatic performances

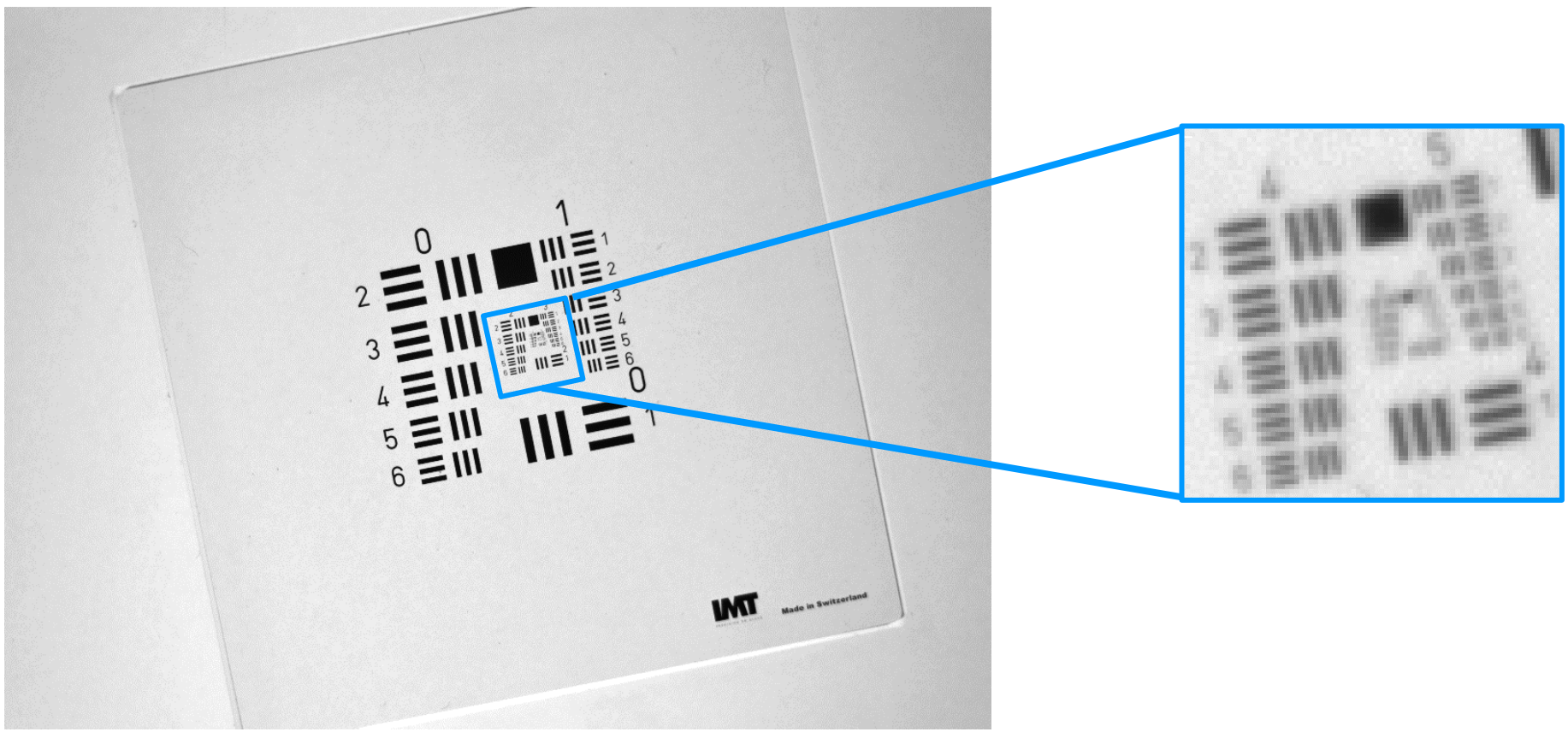
- Significant coma in Horizontal optical axis at F/4, slightly better at F/5.6

Test setup

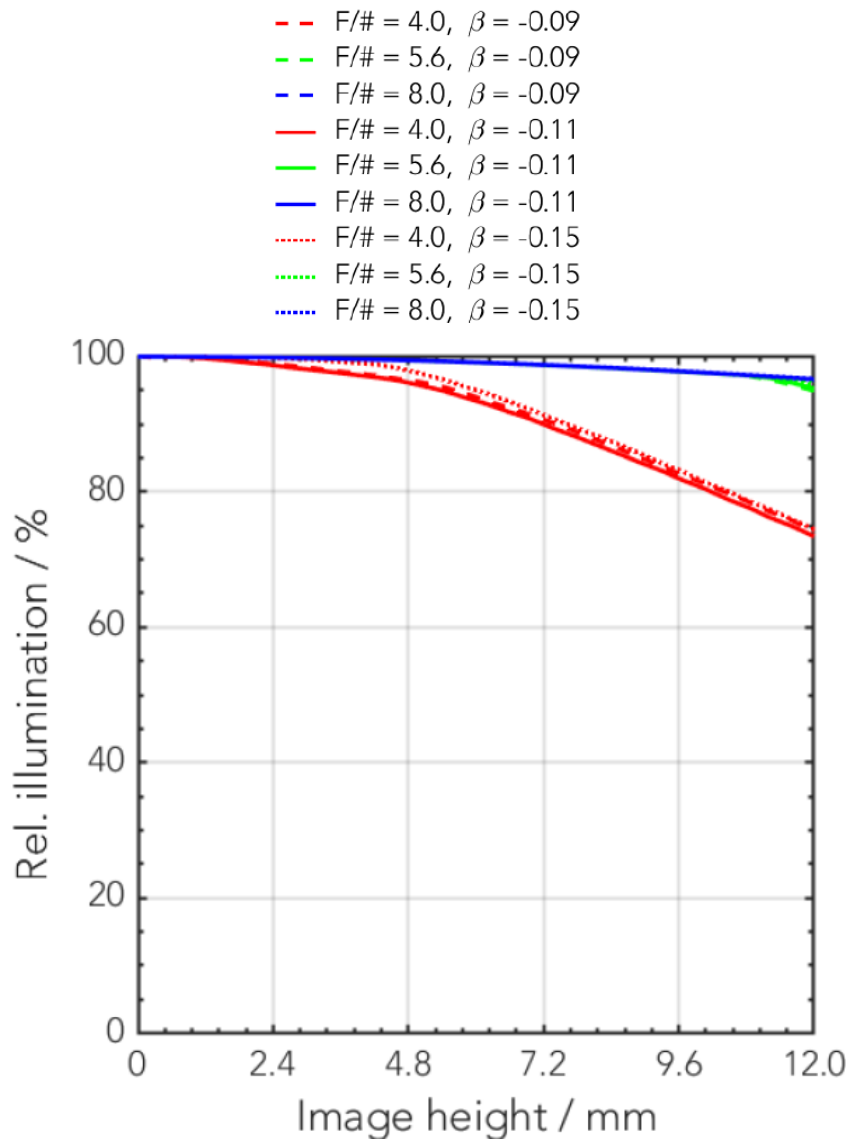
Camera:	1.1" (IDS UI-3200SE-M) 4104x3006 pixels, 3.45 um px
Lens:	PYRITE 4.0-80 C-LF-SD with EL-16-40-TC-VIS-5D embedded
F/#	4-32
Driver:	Optotune Lens Driver 4
Target:	Transparent USAF target
Light:	White backlight
Optical axis:	Vertical

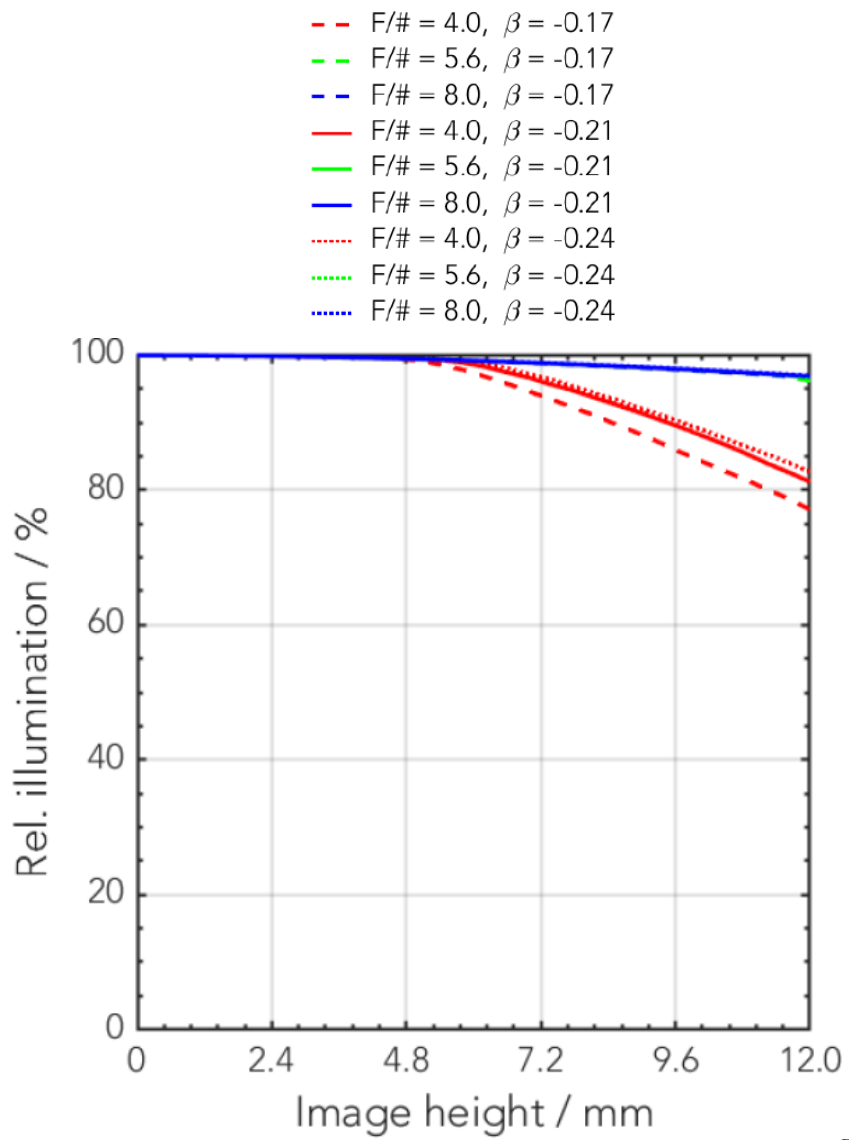
Method for image evaluation

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



Relative illumination plots (β = magnification)





0 dpt, 640 mm WD F#/4

Camera

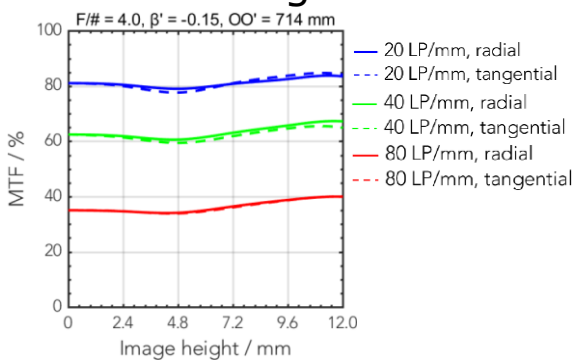
Sensor size = 4104x3006 pixels

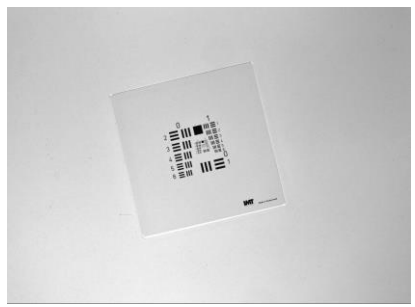
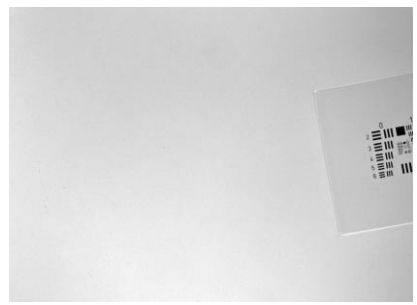
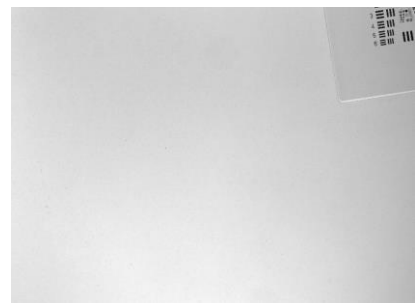
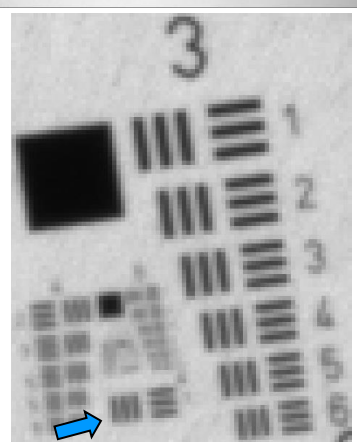
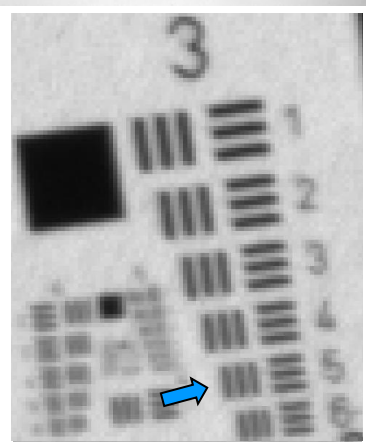
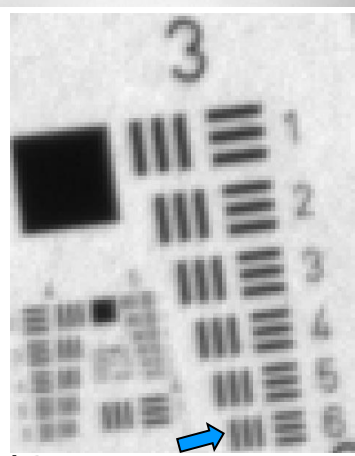
Nyquist limit = 144 lp/mm

Pixel size = 3.45 um

Light

White background illumination



	Center	Edge	Corner
			
			
USAF element:	4/1	3/5	3/6
Line width (um):	31.25	39.37	35.08
Lp/mm (object):	16	13	14
Magnification:	0.139	0.139	0.139
Lp/mm (image):	**115**	**91**	**102**

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-0.73 dpt, 870 mm WD F#/4

Camera

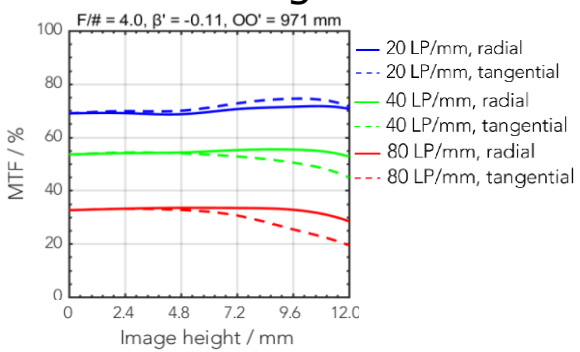
Sensor size = 4104x3006 pixels

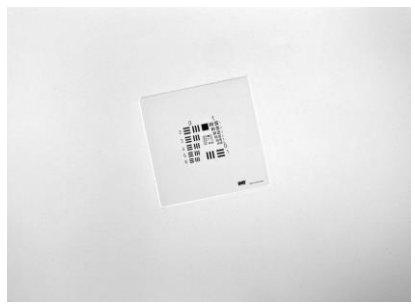
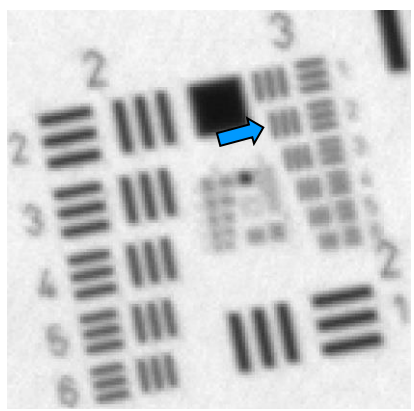
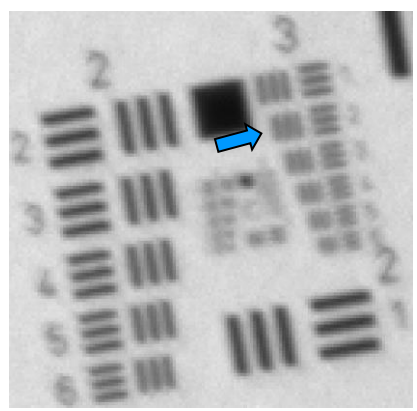
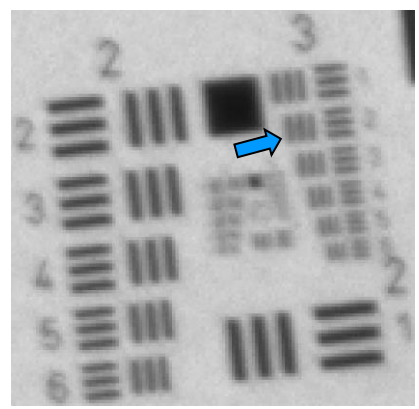
Nyquist limit = 144 lp/mm

Pixel size = 3.45 um

Light

White background illumination



	Center	Edge	Corner
			
			
USAF element:	3/2	3/2	3/2
Line width (um):	55.68	55.68	55.68
Lp/mm (object):	9	9	9
Magnification:	0.104	0.104	0.104
Lp/mm (image):	**87**	**87**	**87**

2.75 dpt, 310 mm WD F#/4

Camera

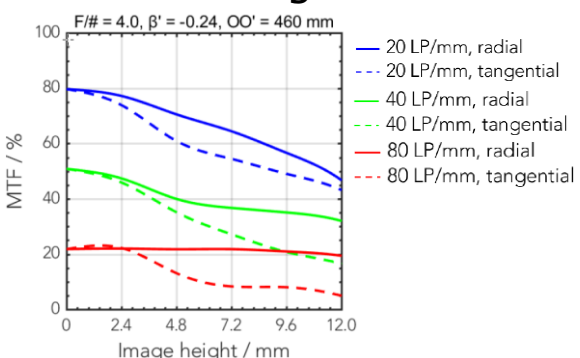
Sensor size = 4104x3006 pixels

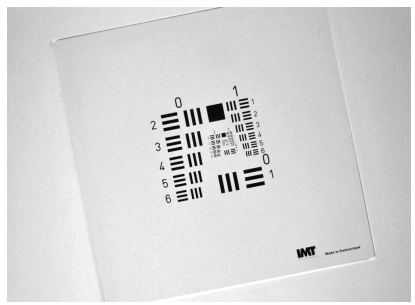
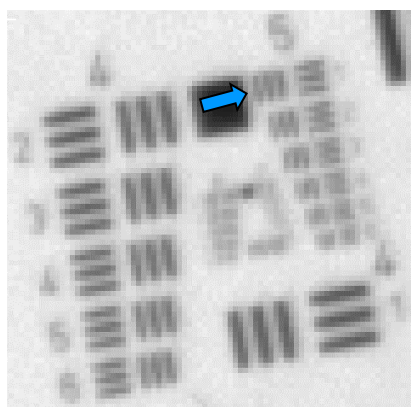
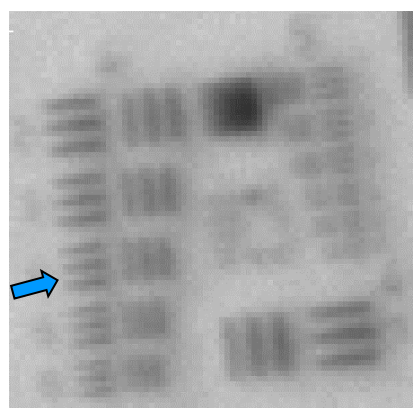
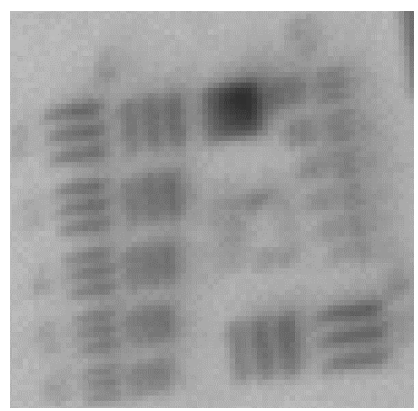
Nyquist limit = 144 lp/mm

Pixel size = 3.45 um

Light

White background illumination



	Center	Edge	Corner
			
			
USAF element:	5/1	4/4	4/4
Line width (um):	15.63	22.1	22.1
Lp/mm (object):	32	23	23
Magnification:	0.256	0.256	0.256
Lp/mm (image):	**125**	**89**	**89**

2.75 dpt, 310 mm WD F#/5.6

Camera

Sensor size = 4104x3006 pixels

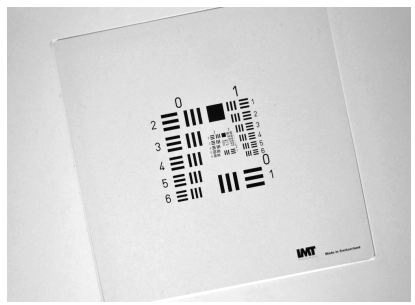
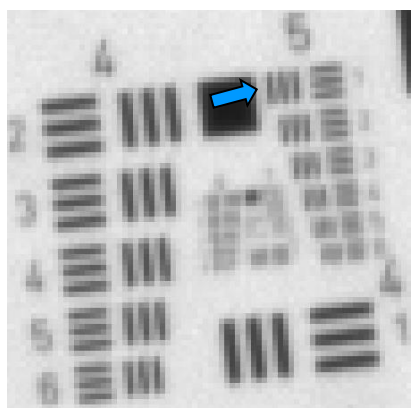
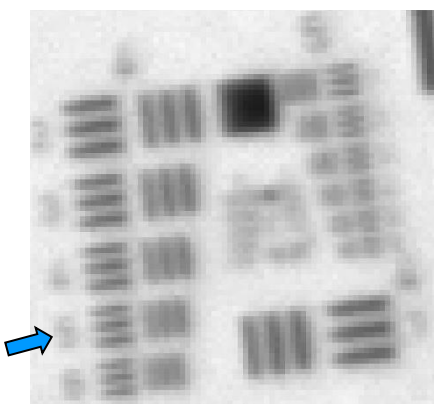
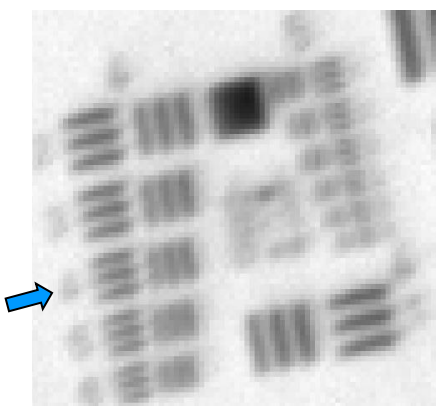
Nyquist limit = 144 lp/mm

Pixel size = 3.45 um

Light

White background illumination

20 LP/mm, radial
20 LP/mm, tangential
40 LP/mm, radial
40 LP/mm, tangential
80 LP/mm, radial
80 LP/mm, tangential

	Center	Edge	Corner
			
			
USAF element:	5/1	4/5	4/4
Line width (um):	15.63	19.69	22.1
Lp/mm (object):	32	25	23
Magnification:	0.256	0.256	0.256
Lp/mm (image):	**125**	**99**	**89**

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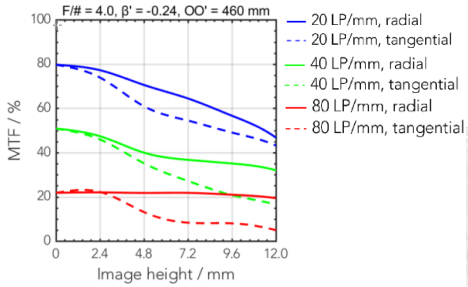
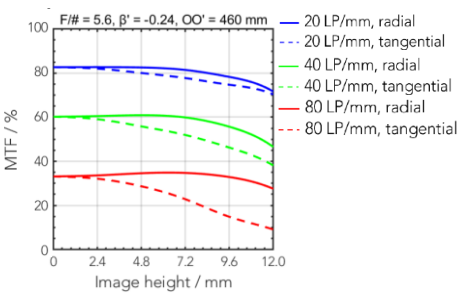
Comparison: Vertical Optical axis @ 310 mm WD, F#/4 vs. F#/5.6

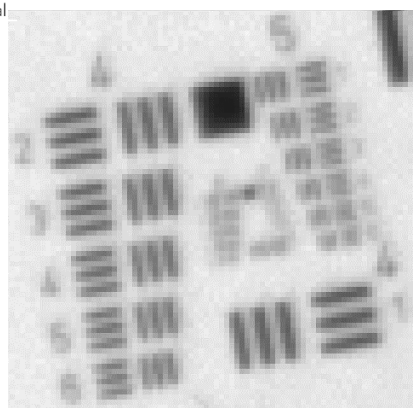


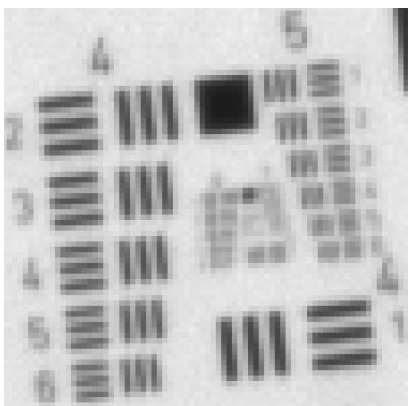
F#/4



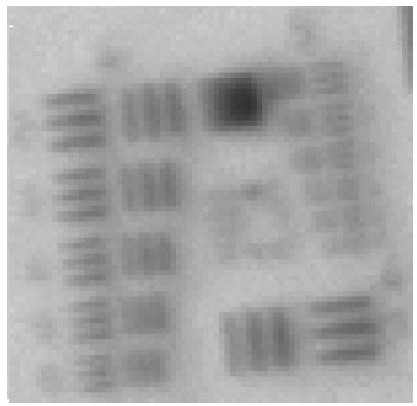
F#/5.6

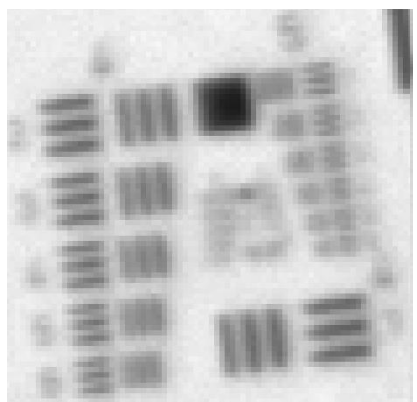
Center



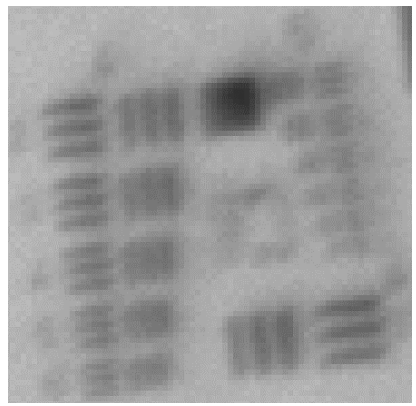


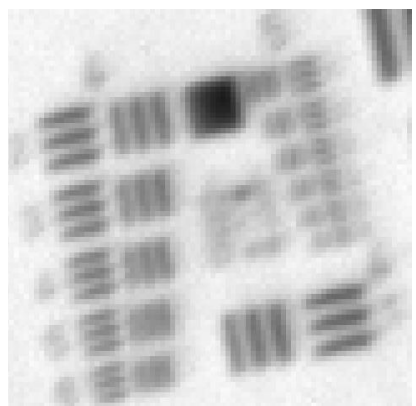
Edge





Corner





Horizontal Optical Axis, @-0.73 dpt, 870 mm WD, F#/4 Strong Coma

Camera

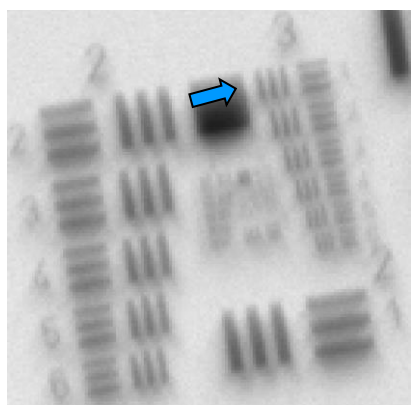
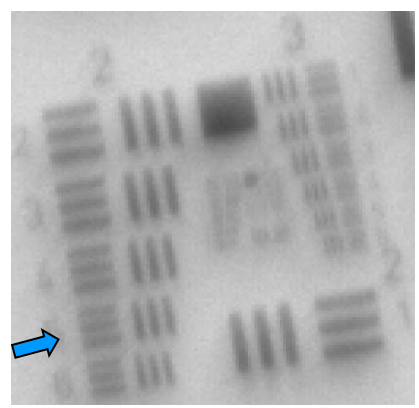
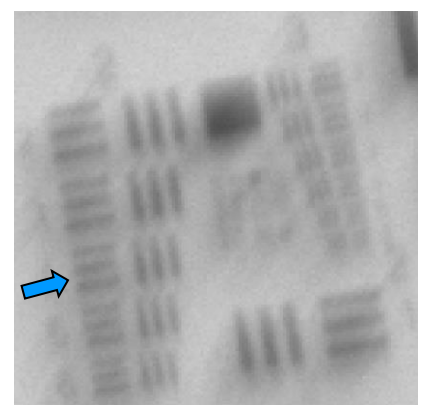
Sensor size = 4104x3006 pixels

Nyquist limit = 144 lp/mm

Pixel size = 3.45 um

Light

White background illumination

	Center	Edge	Corner
			
			
USAF element:	3/1	2/5	2/4
Line width (um):	62.5	78.75	88.39
Lp/mm (object):	8	6	6
Magnification:	0.104	0.104	0.104
Lp/mm (image):	**77**	**61**	**55**

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Horizontal Optical Axis, @-0.73 dpt, 870 mm WD, F#/5.6
Better contrast

Camera

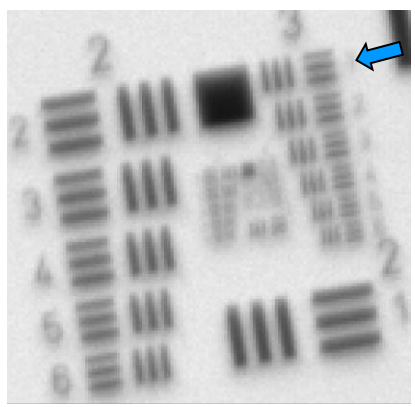
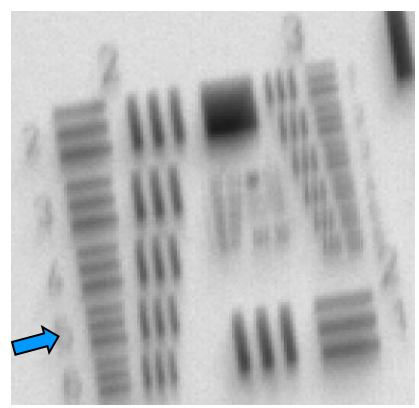
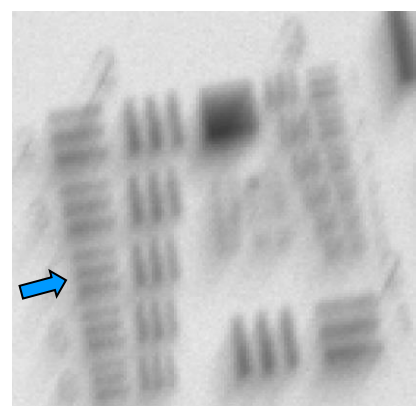
Sensor size = 4104x3006 pixels

Nyquist limit = 144 lp/mm

Pixel size = 3.45 um

Light

White background illumination

	Center	Edge	Corner
			
			
USAF element:	3/1	2/5	2/4
Line width (um):	62.5	78.75	88.39
Lp/mm (object):	8	6	6
Magnification:	0.104	0.104	0.104
Lp/mm (image):	**77**	**61**	**55**

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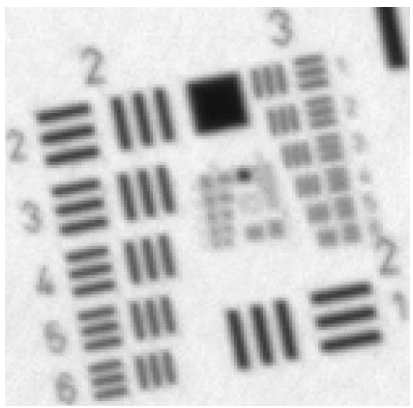
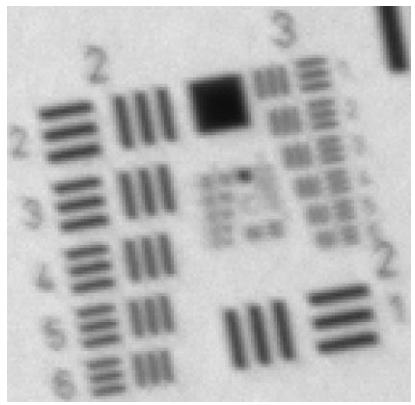
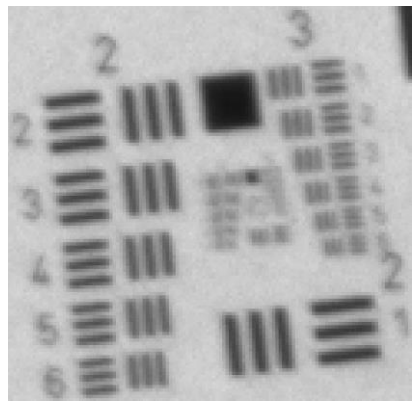
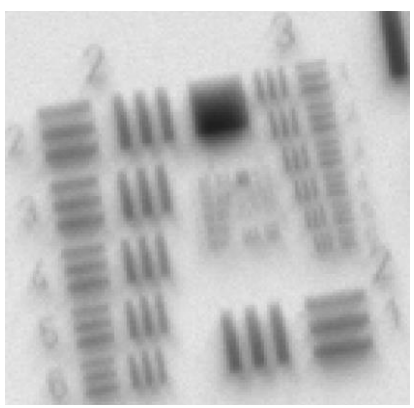
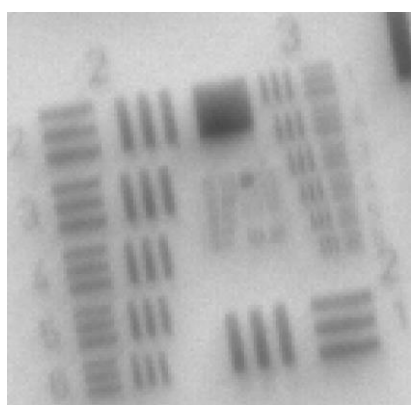
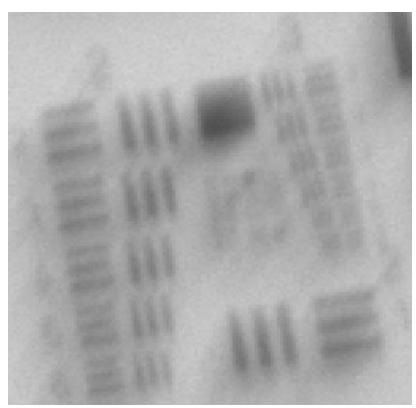
Comparison: Vertical vs. Horizontal Optical axis @ 870 mm WD, F#/4

	Center	Edge	Corner
Vertical			
Horizontal			

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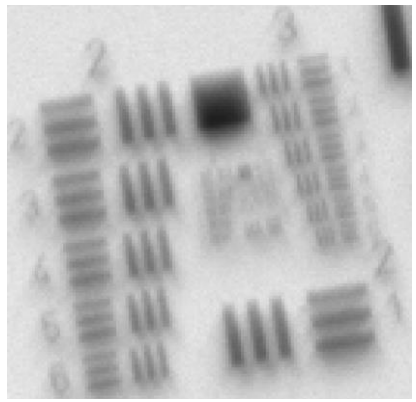
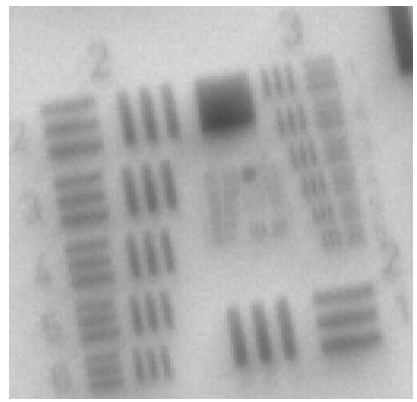
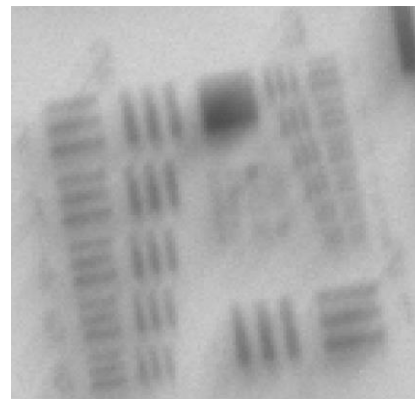
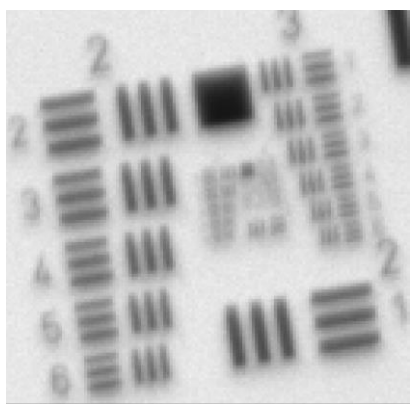
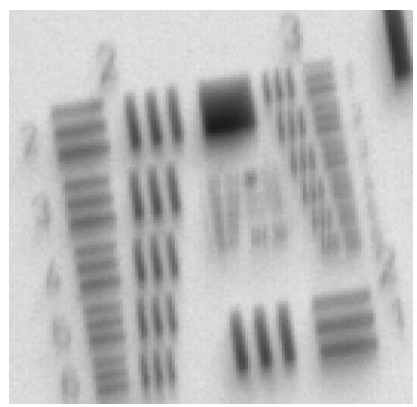
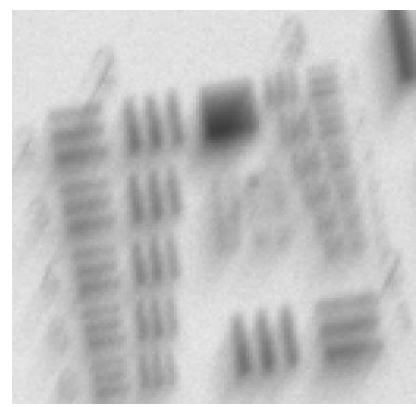
Comparison: Horizontal Optical axis @ 870 mm WD, F#/4 vs. F#/5.6

	Center	Edge	Corner
F#/4			
F#/5.6			

0 dpt, 640 mm WD F#/4

Camera

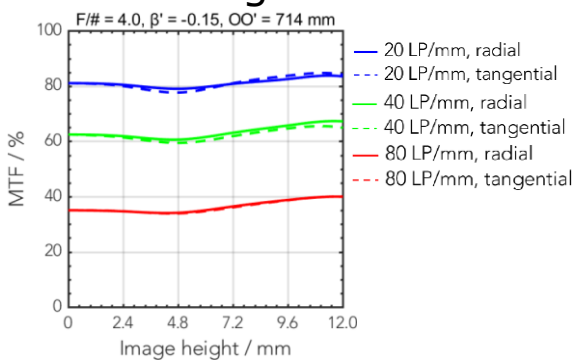
Sensor size = 4104x3006 pixels

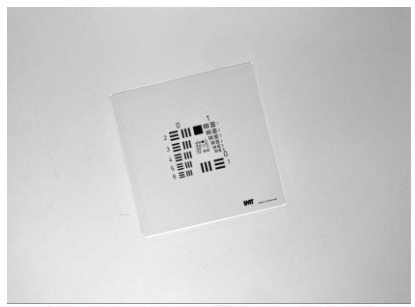
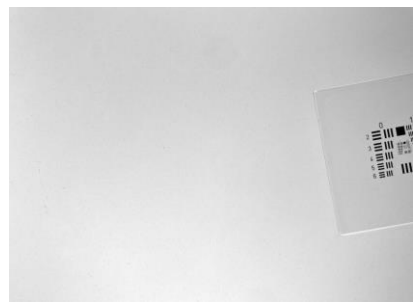
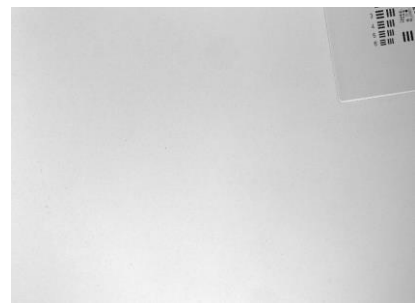
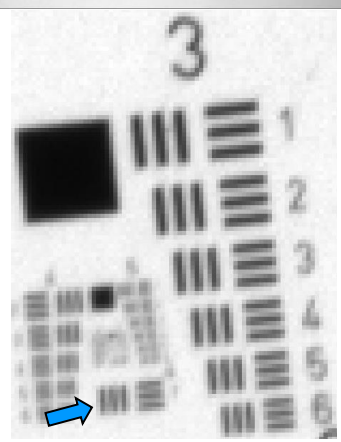
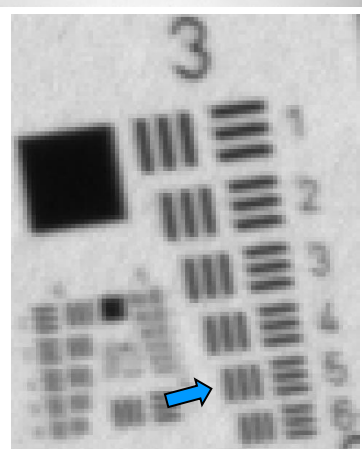
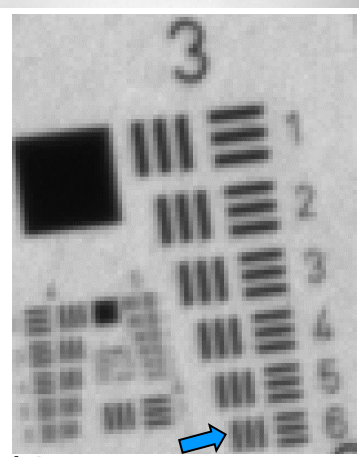
Nyquist limit = 144 lp/mm

Pixel size = 3.45 um

Light

Red background illumination



	Center	Edge	Corner
			
			
USAF element:	4/1	3/5	3/6
Line width (um):	31.25	39.37	35.08
Lp/mm (object):	16	13	14
Magnification:	0.139	0.139	0.139
Lp/mm (image):	**115**	**91**	**102**

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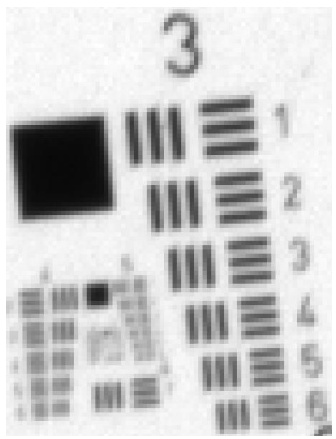
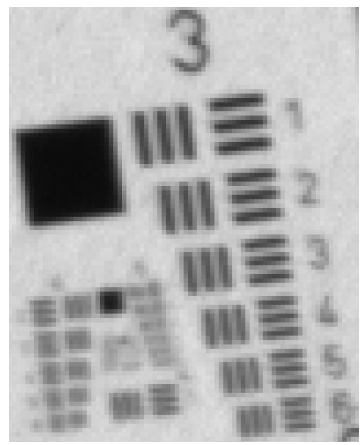
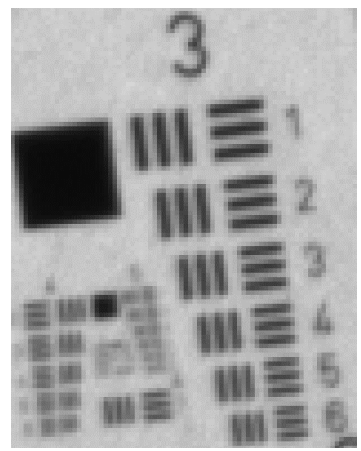
Comparison Red vs. White light

	Center	Edge	Corner
Red			
White