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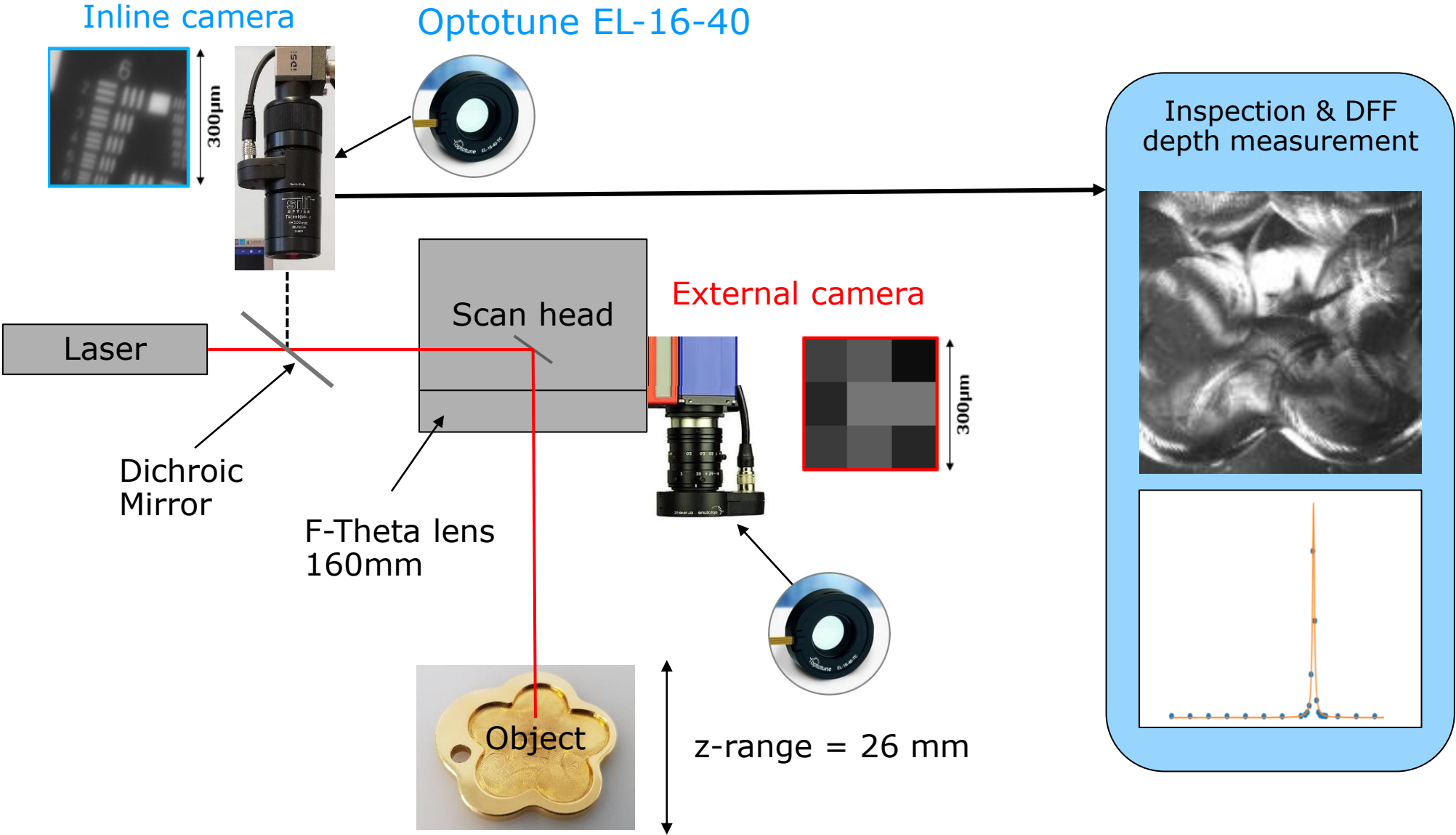
# Sill Optics S5VPJ0303 + EL-16-40

Variable focus for laser processing inline inspection through galvo scan head and f-theta lens

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# Inline inspection and Depth from Focus (DFF) applied to laser processing applications



# Summary



- Z-range of 26mm achieved with -2 to +3 dpt
  - At nominal WD of 144mm (@0dpt)
  - Optical leverage is  $\sim 5$ mm per diopter
- No vignetting
- HFOV of 4mm achieved with 2/3" sensor
- 4.4 $\mu$ m resolution on the object
- Note: f-theta lens is optimized for 1064nm, while this test was done with red light



# Test setup without galvo mirrors

C-mount camera: UI-3080CP-M  
2/3", 2464 x 2056 @ 3.45um

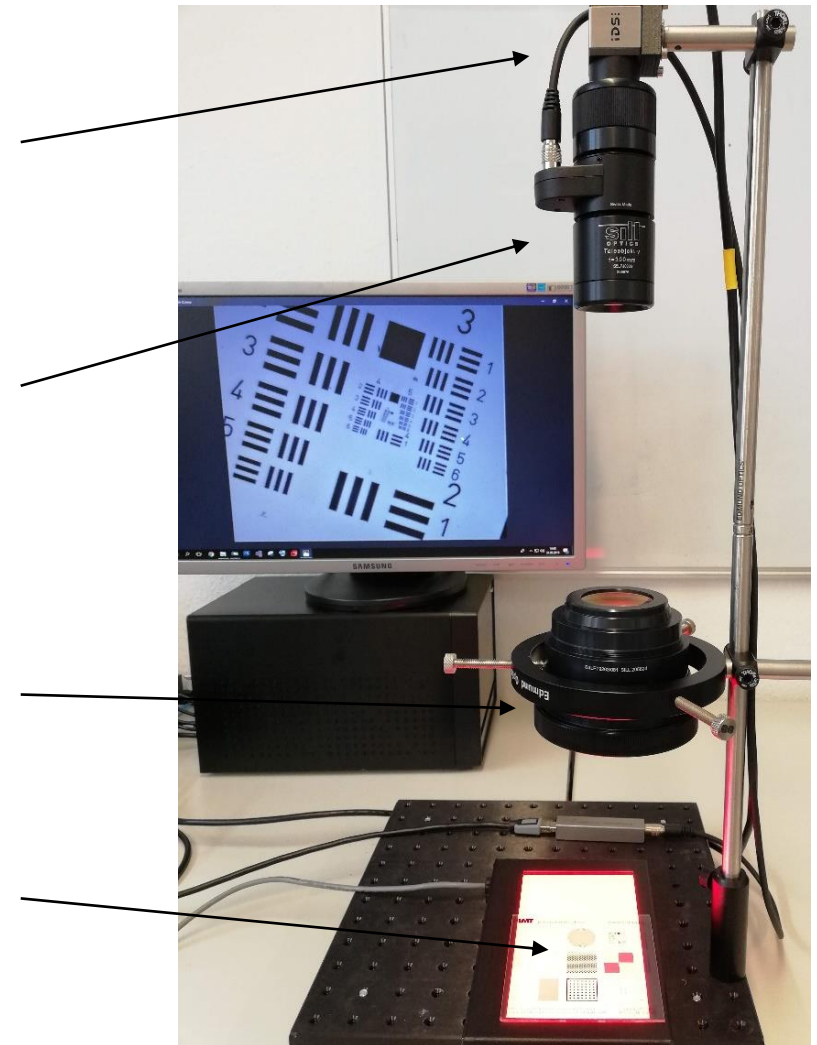
Telelens:

- Sill Optics S5VPJ0303 300mm lens
- [Optotune EL-16-40-TC-VIS-5D-M42](#) integrated

F-theta lens:

Sill Optics S4LFT9263/081 160mm focal length

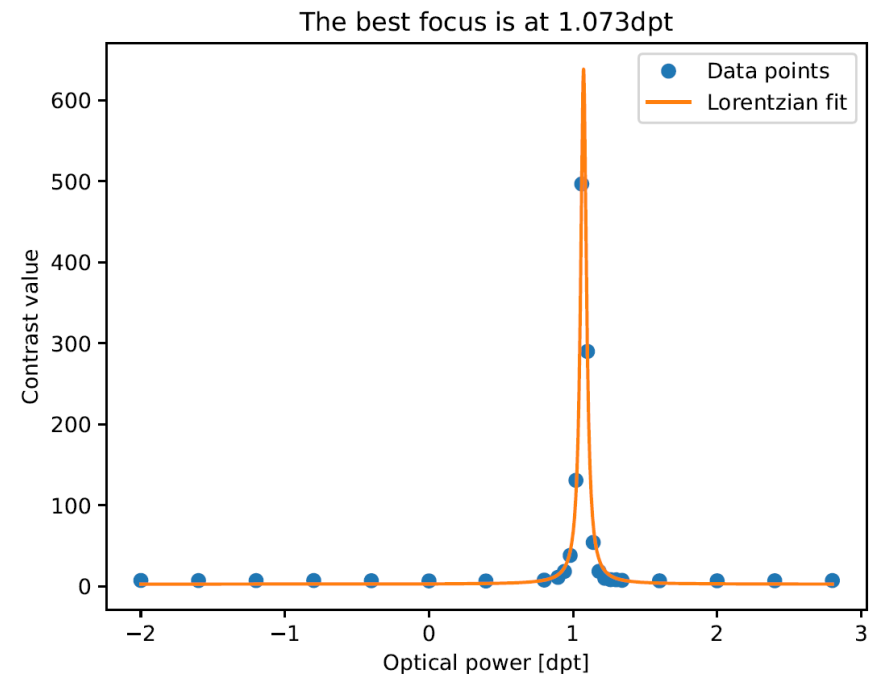
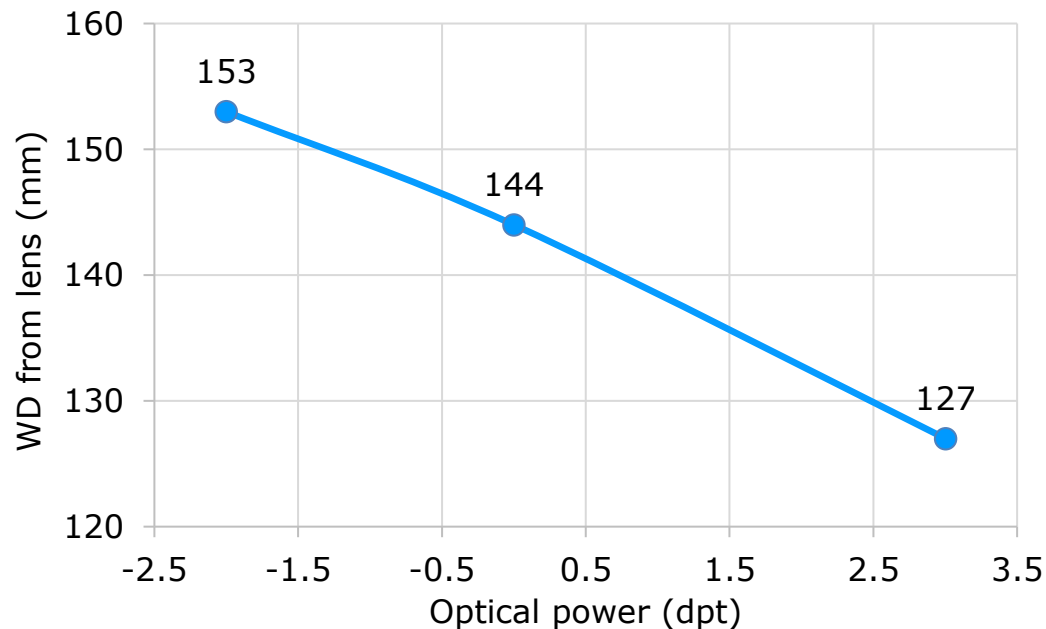
Test targets with red LED back light



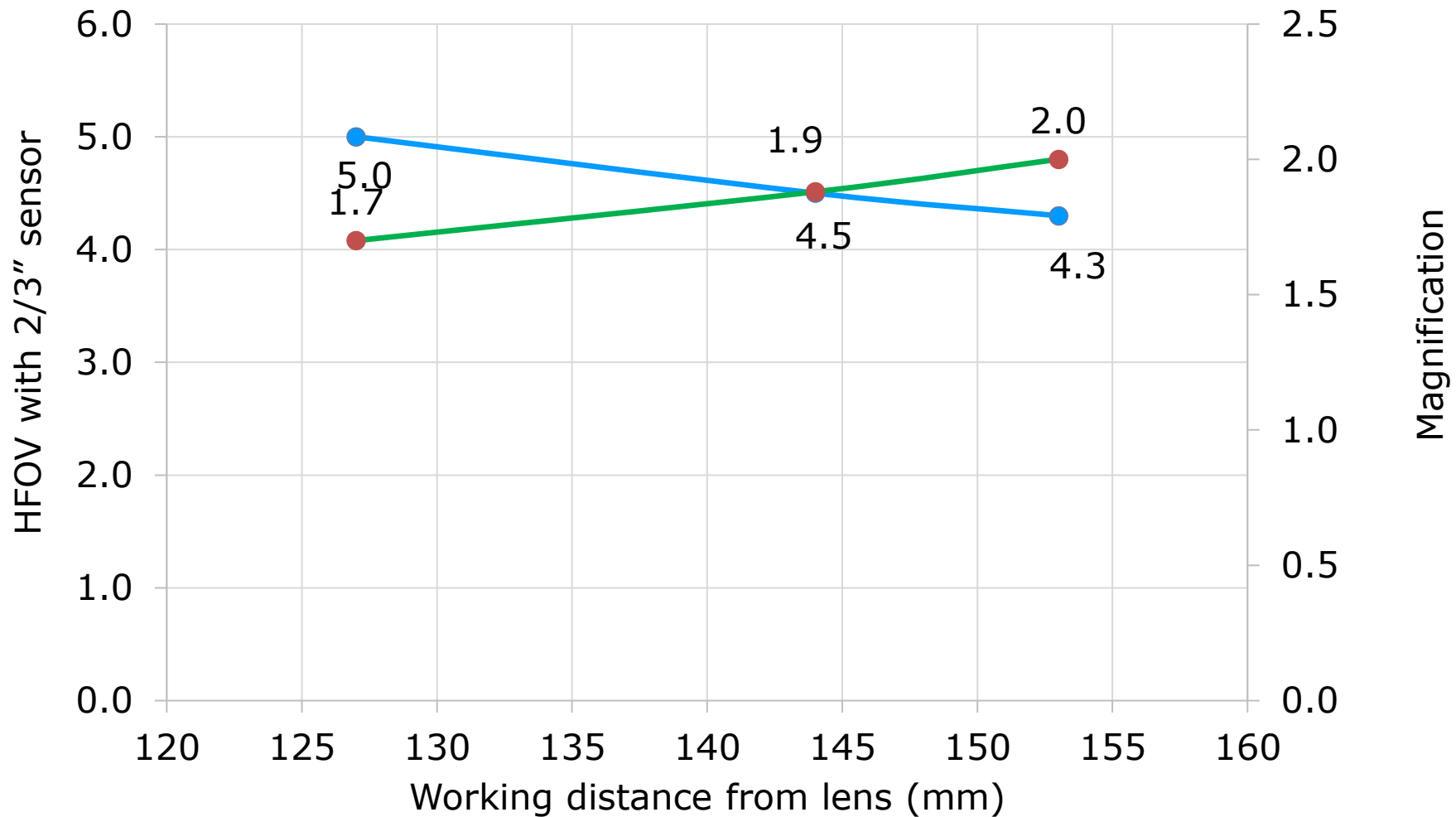
# Working distance range of 26mm with autofocus accuracy of 50 $\mu$ m



- Working distance range of 26mm achieved with -2 to +3 diopters
  - Optical leverage:  $\sim 5$  mm per diopter
- Repeatability of the autofocus is  $\sim 0.01$  diopter
  - Corresponding accuracy of the distance measurement is  $\sim 50$   $\mu$ m

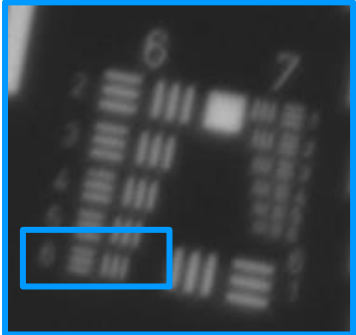
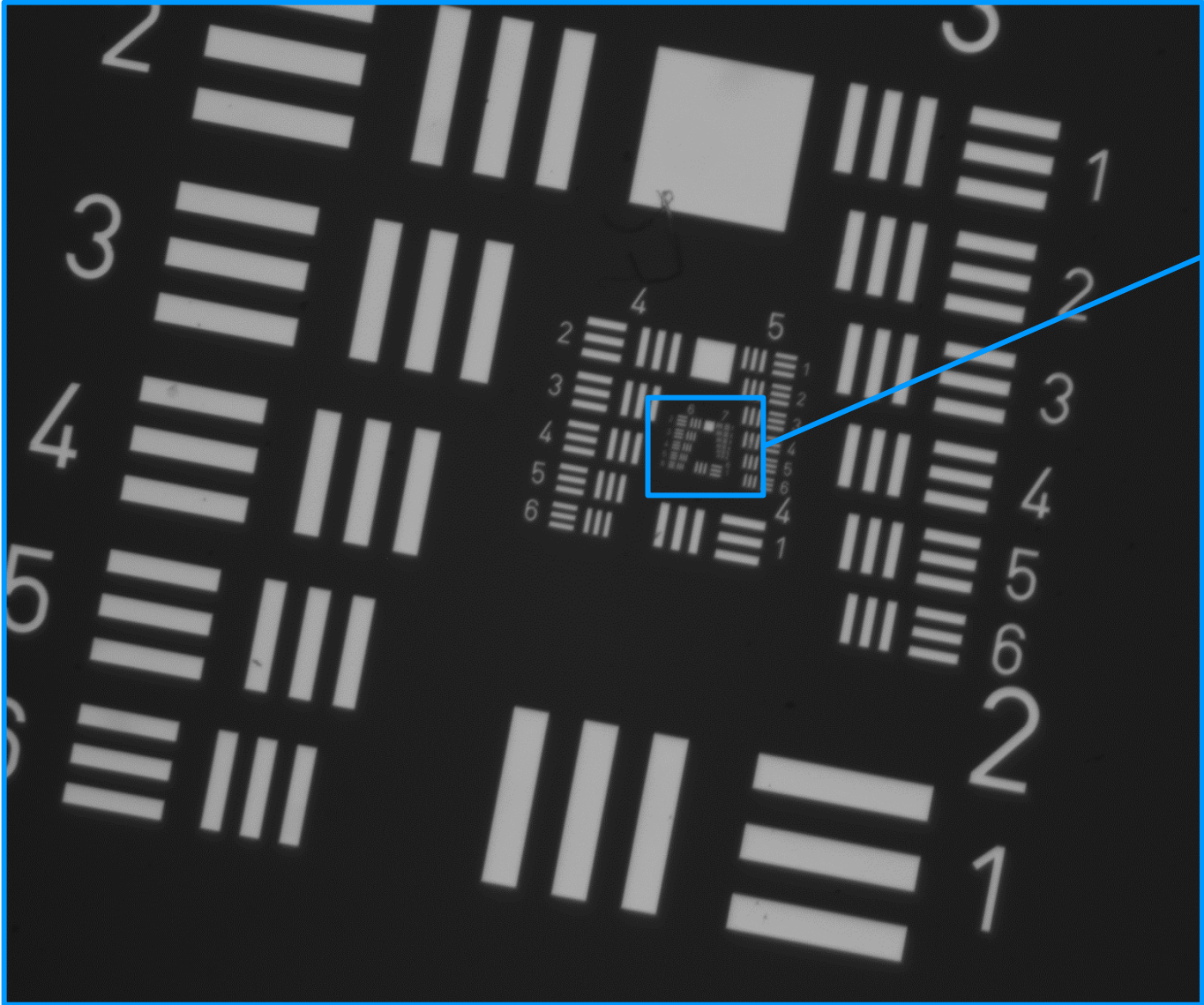


# Magnification changes with 1% per mm from 1.7x to 2.0x over the 26mm z-range



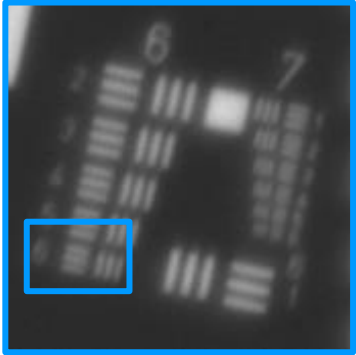
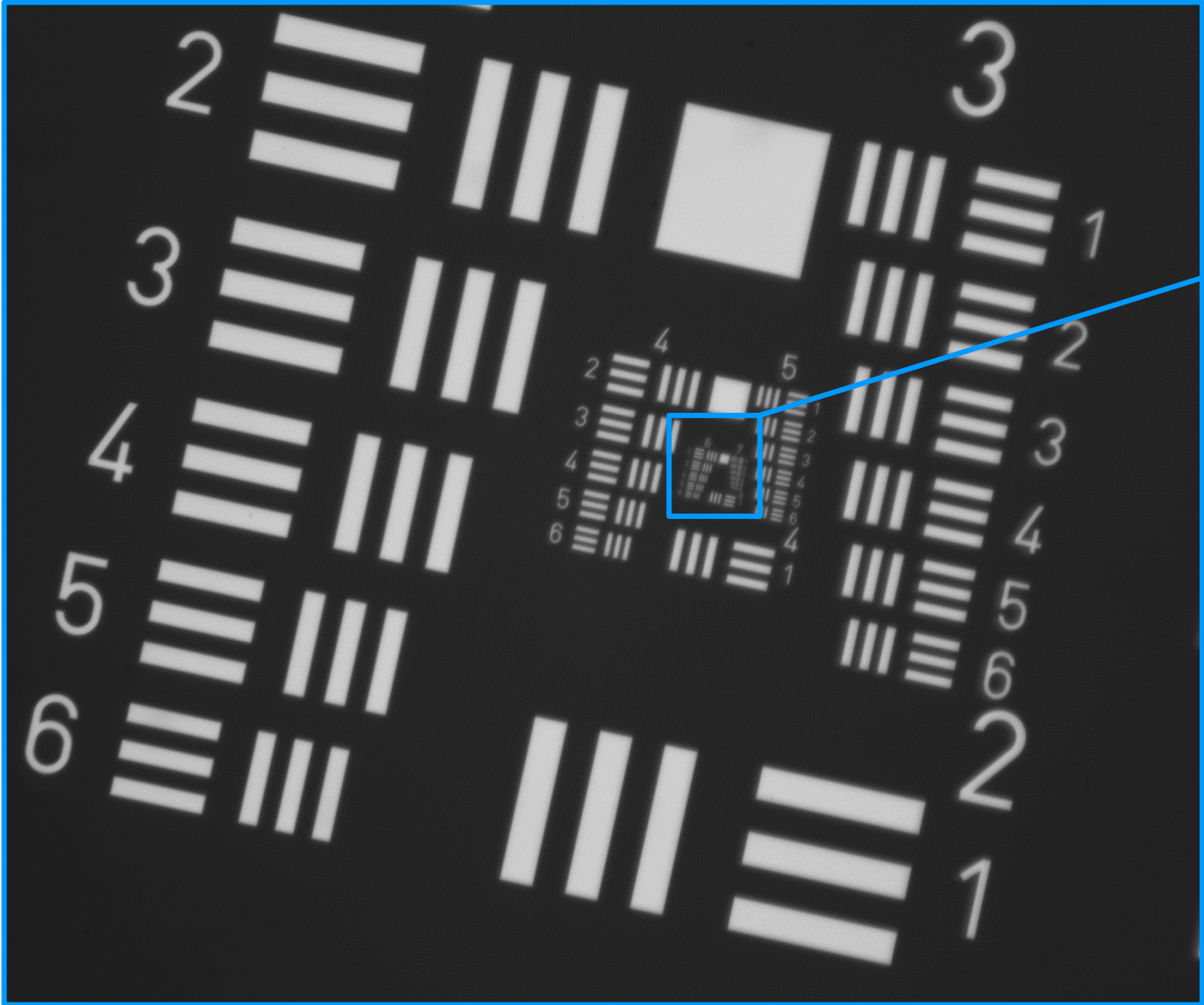


# Sample image at 153mm working distance



USAF element:	6/6
Line width (um):	4.38
Lp/mm (object):	114
Magnification:	2.024
<b>Lp/mm (image):</b>	<b>56</b>
Nyquist limit:	145
Pixel size (um):	3.45

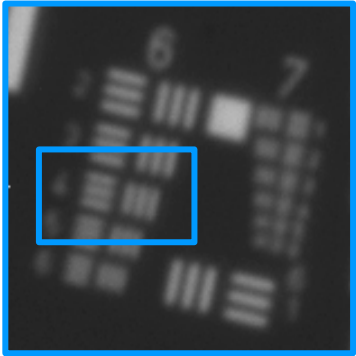
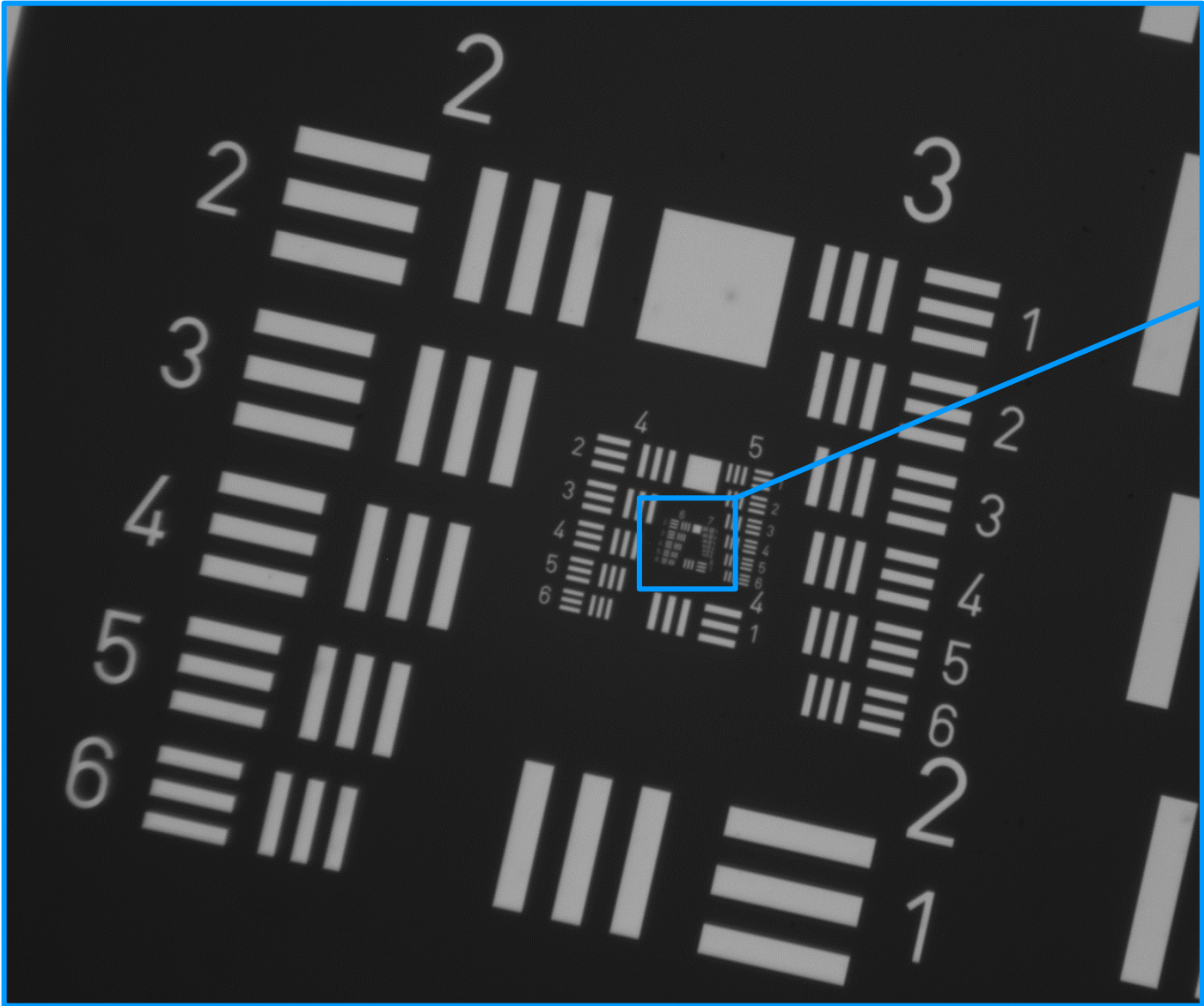
# Sample image at 144mm working distance



USAF element:	6/6
Line width (um):	4.38
Lp/mm (object):	114
Magnification:	1.889
<b>Lp/mm (image):</b>	<b>60</b>
Nyquist limit:	145
Pixel size (um):	3.45



# Sample image at 127mm working distance



USAF element:	6/3
Line width (um):	6.2
Lp/mm (object):	81
Magnification:	1.700
<b>Lp/mm (image):</b>	<b>47</b>
Nyquist limit:	145
Pixel size (um):	3.45