



shaping the future of optics

Telecentric inspection with tunable optics

Optotune EL-16-40-TC with Moritex MML2-HR110

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Summary

- Large z-range of **5.5mm** with 5 dpt lens
- **No** added vignetting
- **No** distortion
- **No** loss of resolution
- **No** orientation dependence
- **Small, linear** magnification change



Measurement setup



Dalsa Genie TS C1920 with
CMV2000 sensor

Optical assembly (next slide)

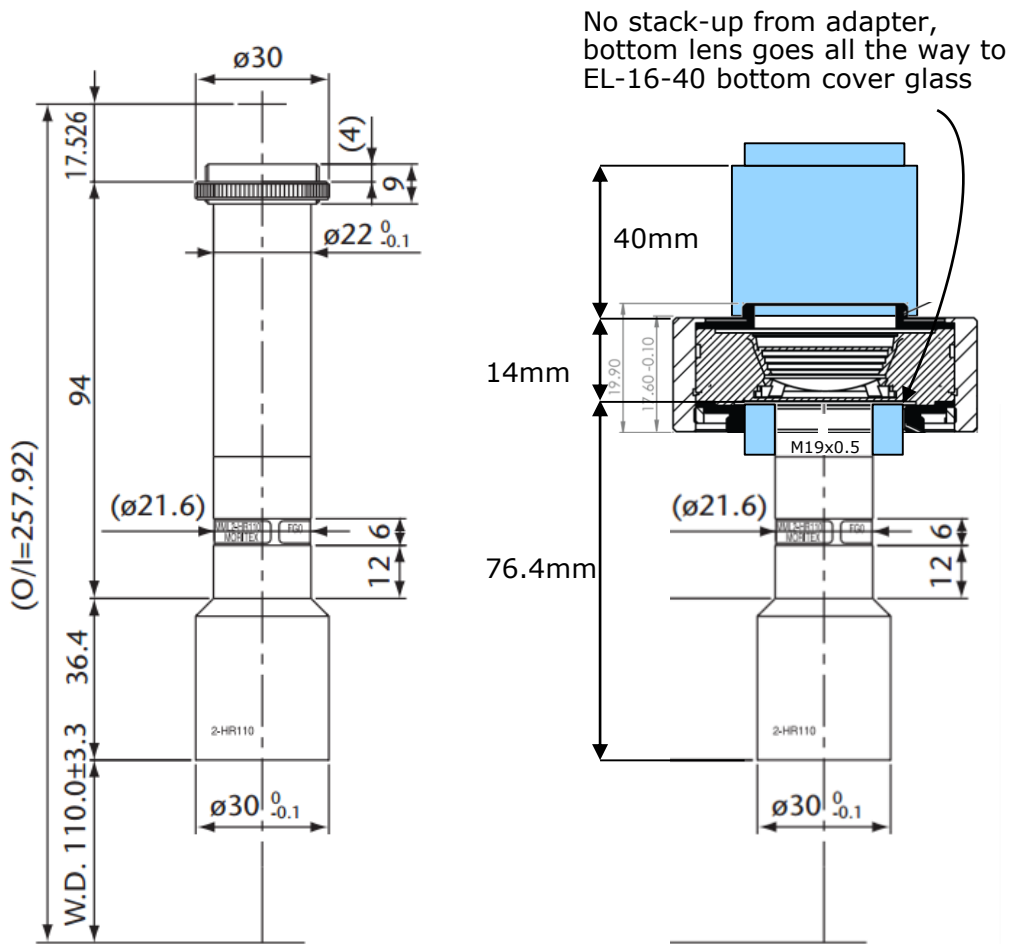
Homogenous LED back-lighting

Targets etched on glass from IMT

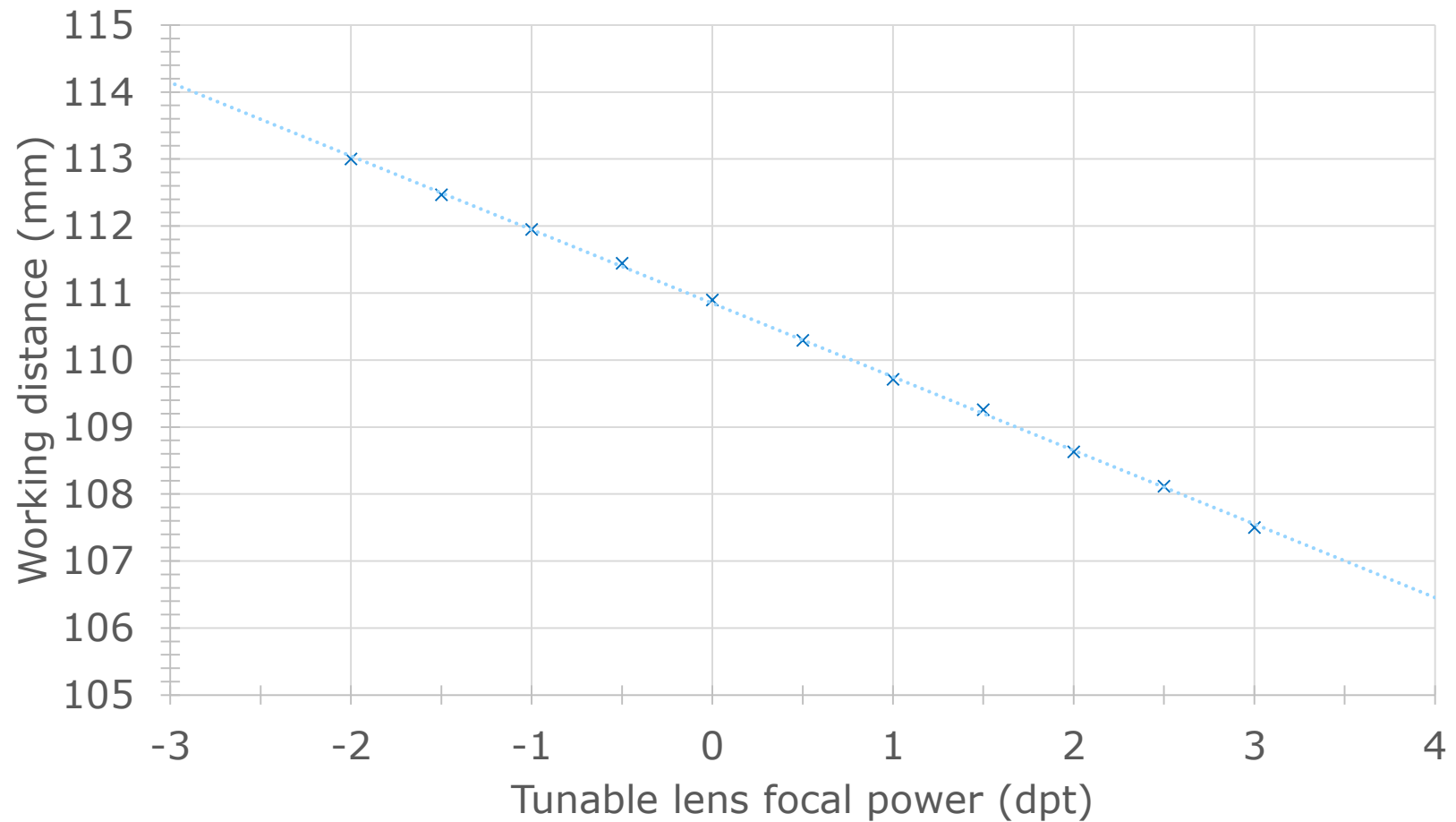
Optical solution



All components available off-the-shelf, except for M19x0.5 adapter

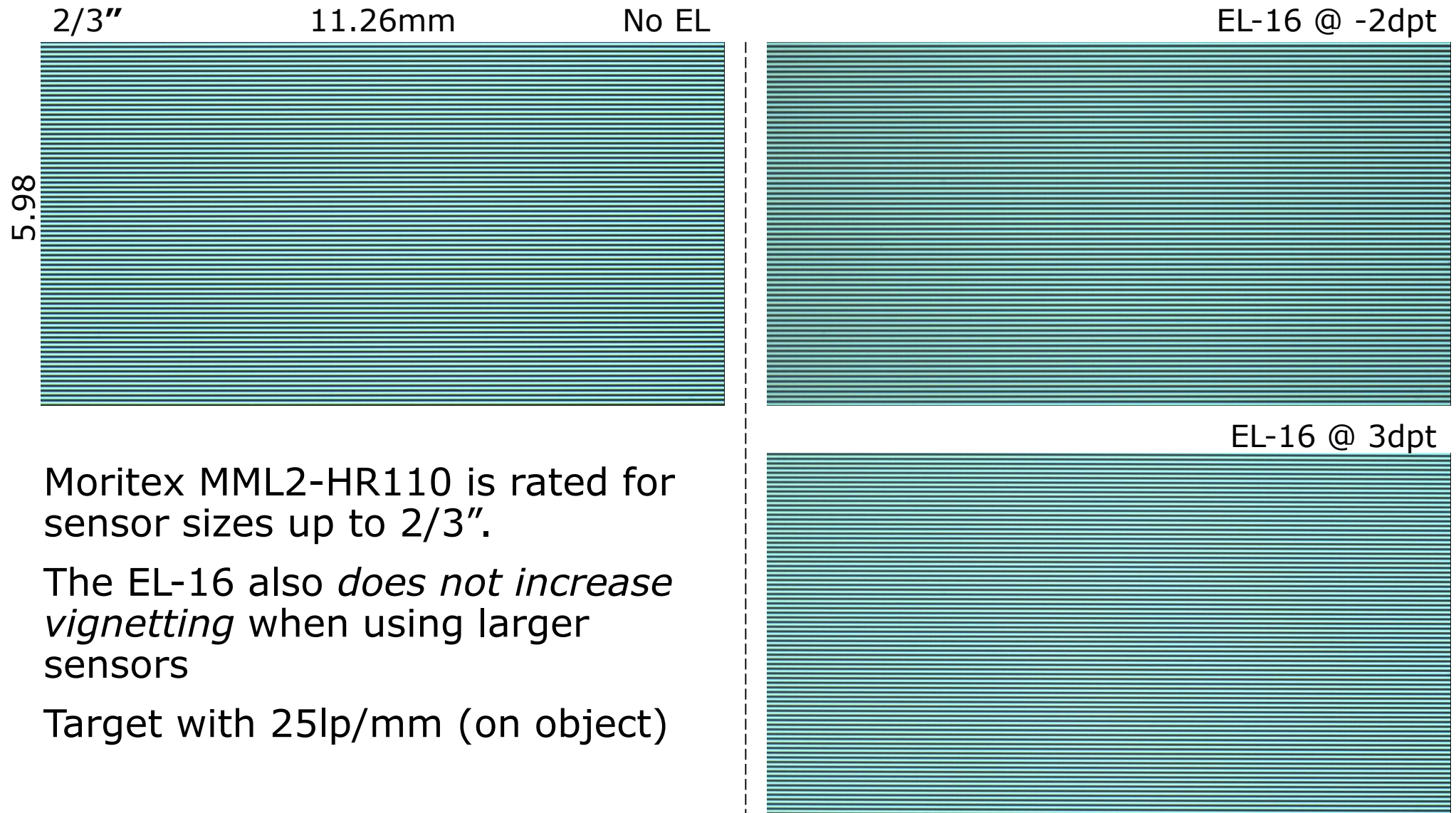


5.5mm WD change over specified tuning range of -2 to +3dpt



× EL-16-40-TC (measured) EL-16-40-TC (linear fit)

No vignetting added, no change in distortion

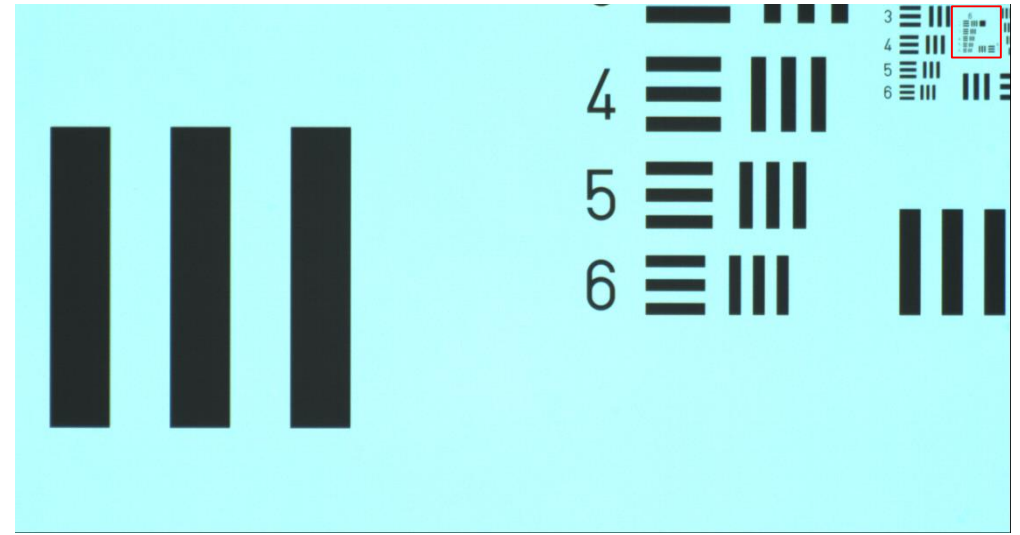
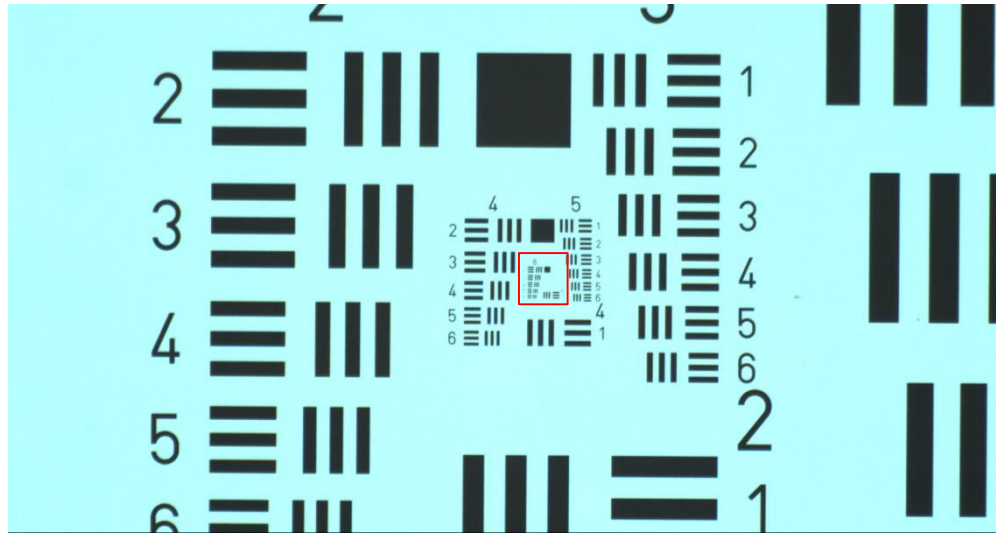


Moritex MML2-HR110 is rated for sensor sizes up to 2/3".

The EL-16 also *does not increase vignetting* when using larger sensors

Target with 25lp/mm (on object)

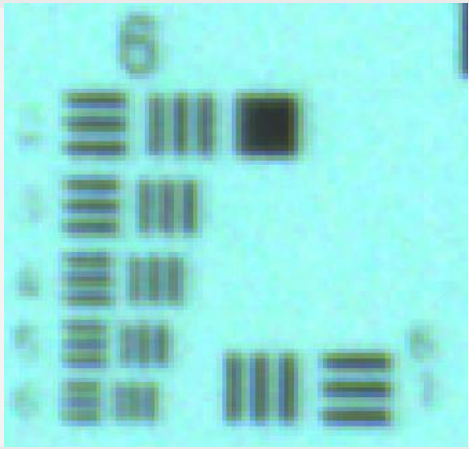
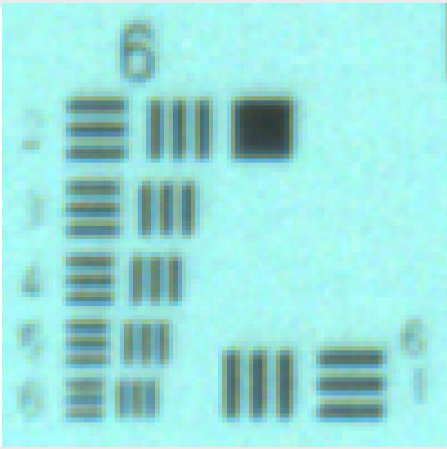
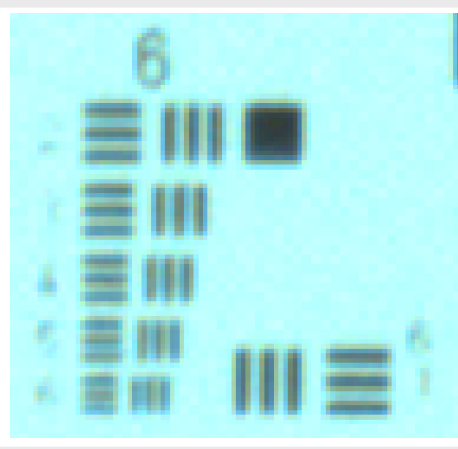
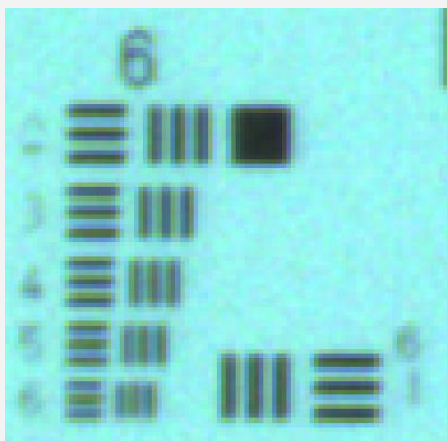
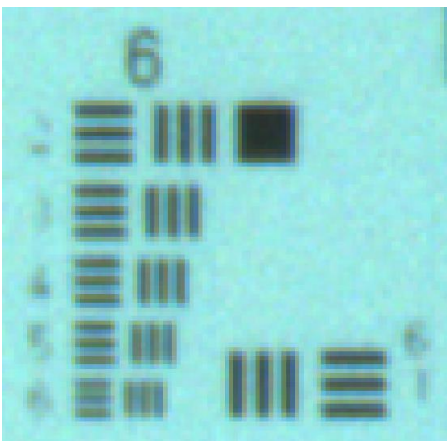
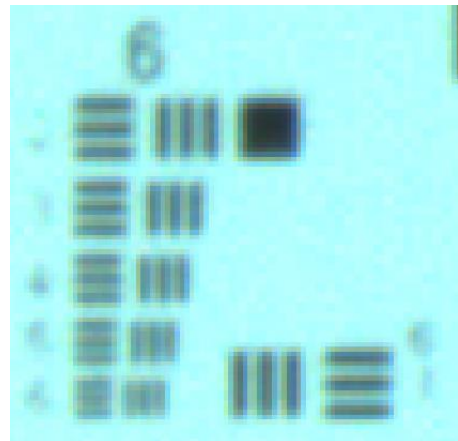
Resolution measurement with USAF targets



Showing complete image with EL-16-40 @ -2dpt

No resolution loss



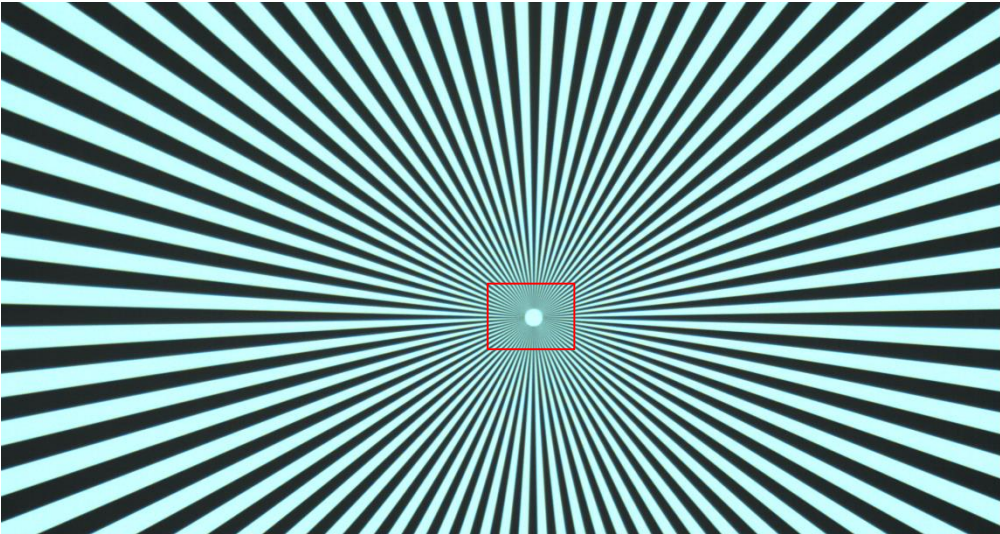
	No EL	EL-16 @ -2dpt	EL-16 @ 3dpt
Center			
Corner			
Exposure time:	9.2ms	9.0ms	10.0ms

Note: differences in brightness are mainly due to small differences in exposure time

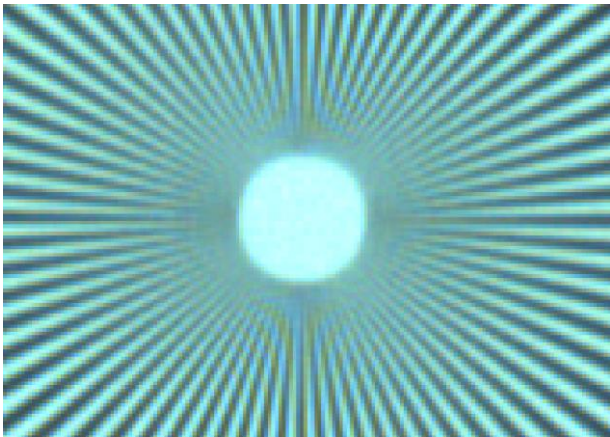
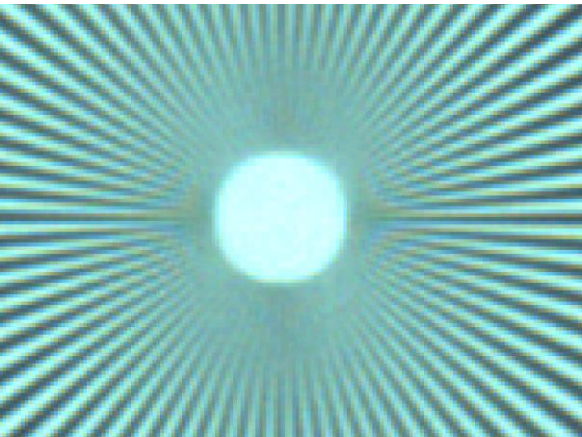
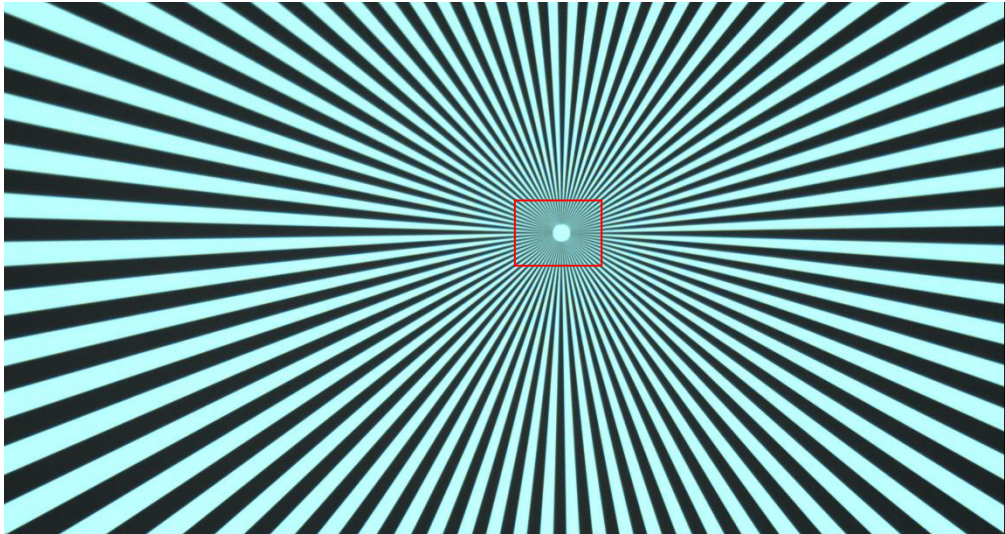
Orientation of optical axis has no influence on image quality



EL-16 @ 3dpt, optical axis vertical



EL-16 @ 3dpt, optical axis horizontal

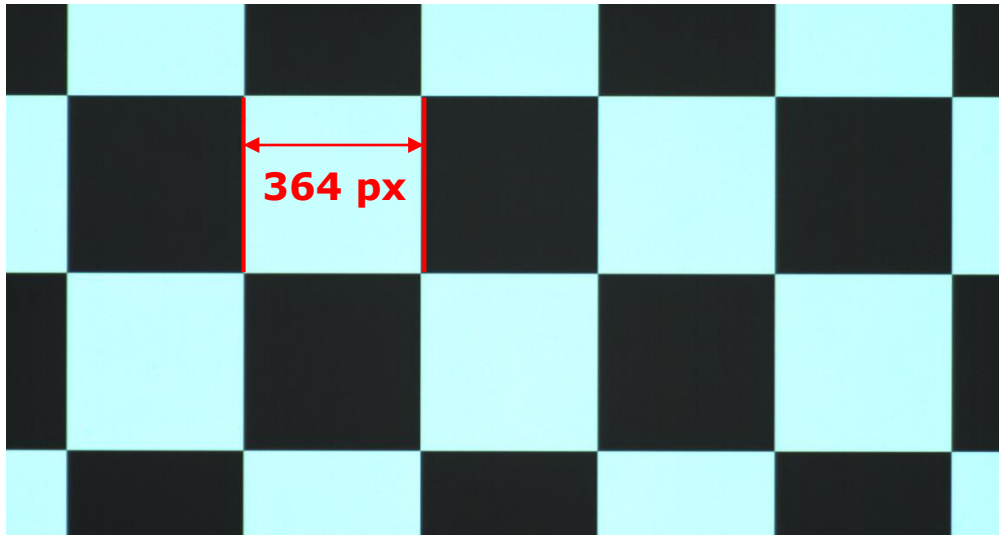


Magnification of 2x is achieved with 40mm spacer



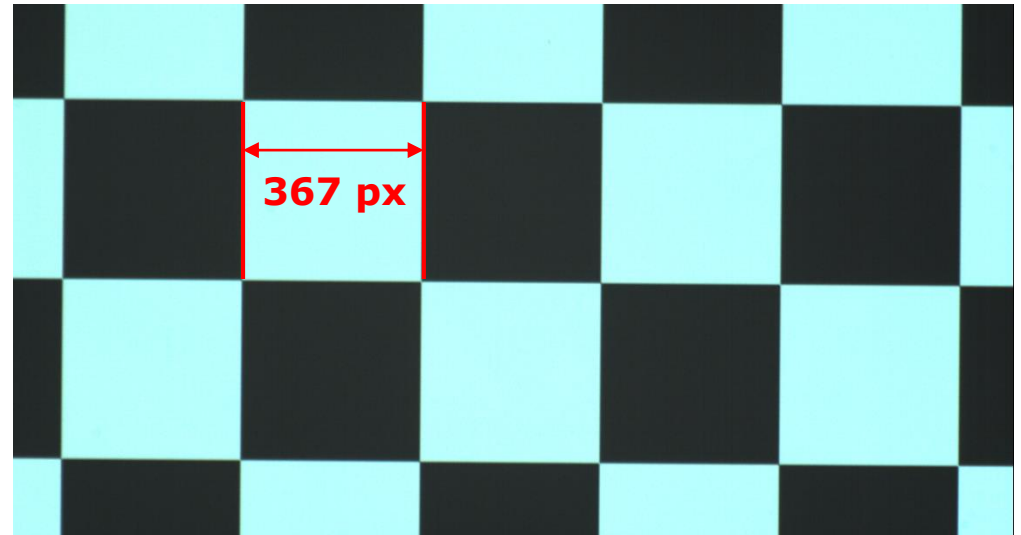
No EL, 110mm WD

2.00x magnification



EL-16 @ 0dpt, 111mm WD

2.02X magnification



Note: It is easily possible to change magnification by varying the distance between camera and lens assembly

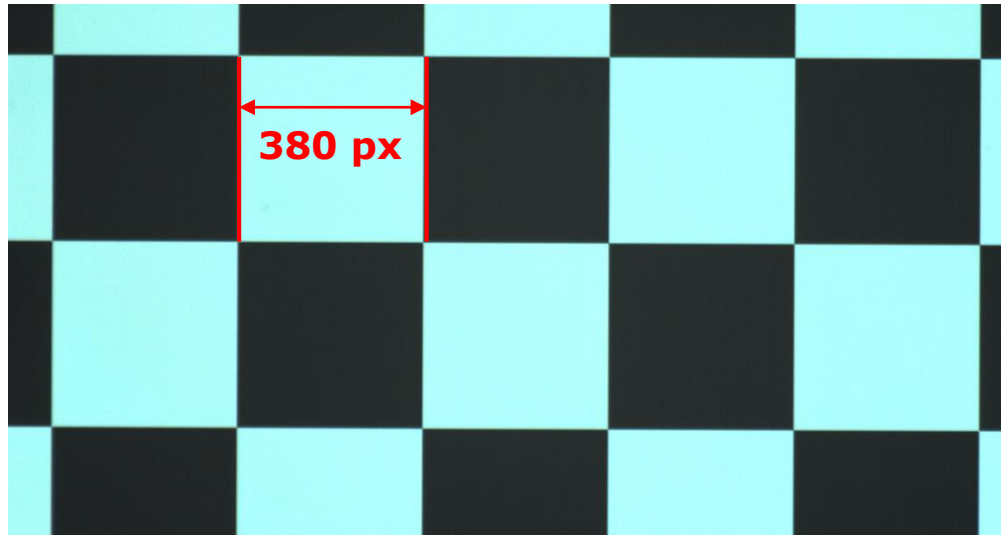
Note: Checker board pitch on target is 1.00mm

7.9% magnification change over 5.5mm z-range



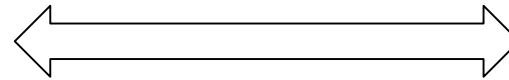
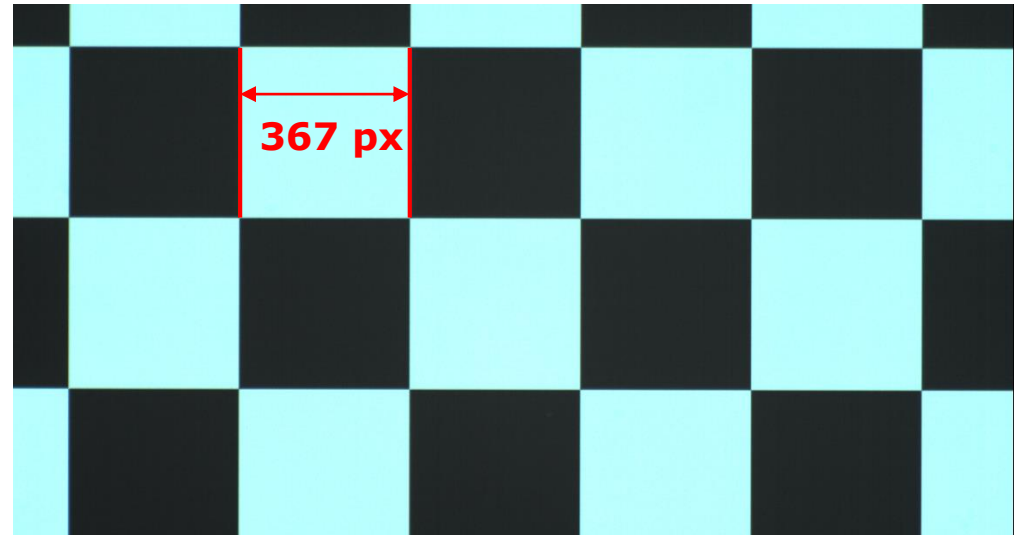
EL-16 @ -2dpt, 113mm WD

2.09X magnification



EL-16 @ 3dpt, 107.5mm WD

1.93X magnification



7.9% magnification change
over total 5.5mm Z-range

The magnification change is reproducible and linear and can thus easily be compensated in software.

Note: Checker board pitch on target is 1.00mm

Magnification change can be reduced by cutting bottom lens

By shortening the bottom lens it is possible to position the EL-16-40-TC closer to the aperture stop and thus reduce magnification change to probably $\sim 3\%$

No stack-up from adapter, bottom lens goes all the way to EL-16-40 bottom cover glass

