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Optotune tunable optics for Laser processing

Enabling 3D laser processing, beam wobbling and inline inspection

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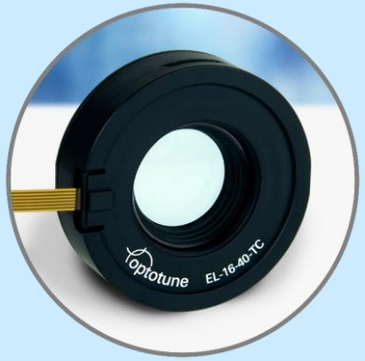
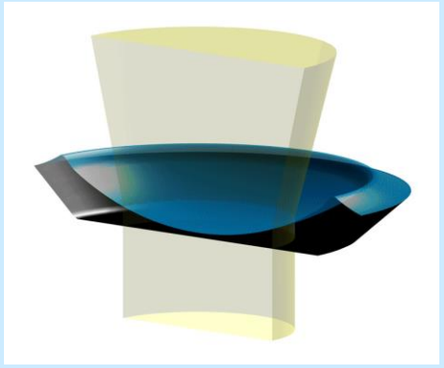
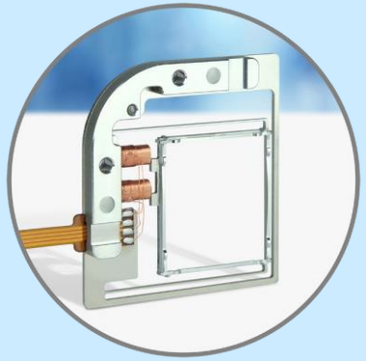
Optotune provides four core product lines

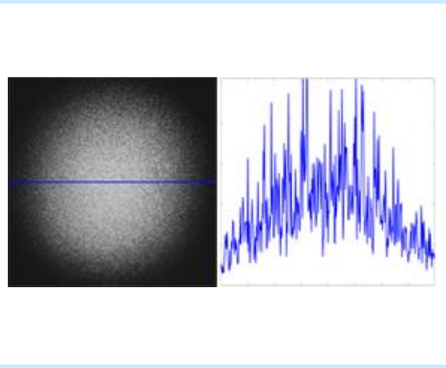
Focus tunable lenses



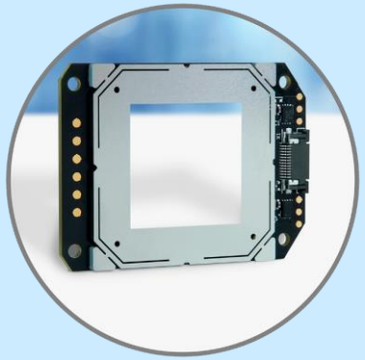


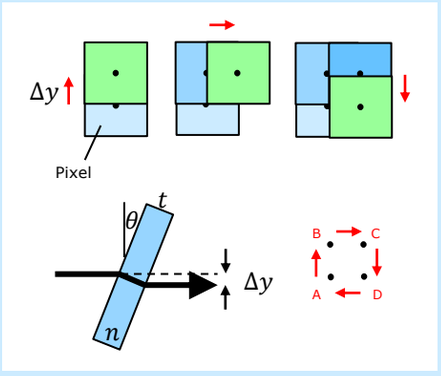
Laser speckle reducers



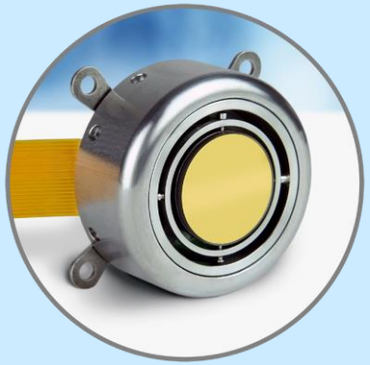


Beam shifting devices





Beam steering devices (2D mirrors)



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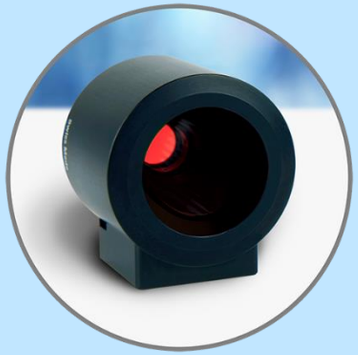
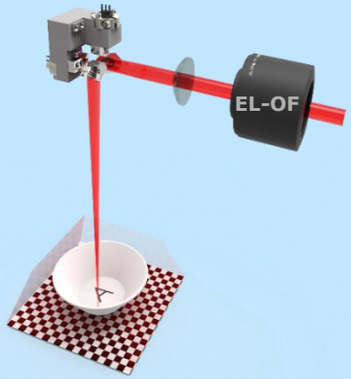
Optotune products in Laser processing applications

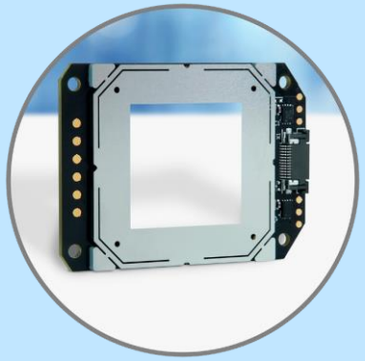
2.5 & 3D laser processing

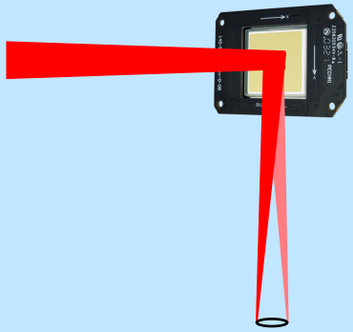




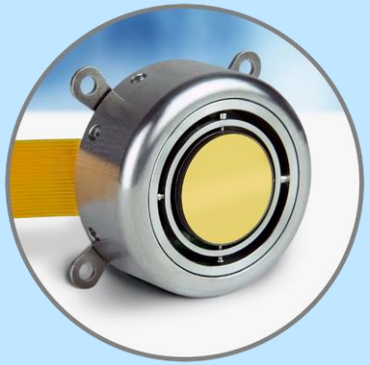
Inline inspection and AF

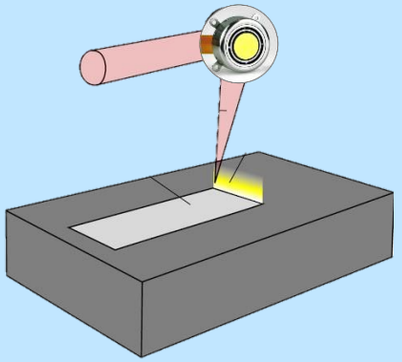
High precision 2D beam control





2D mirrors for beam steering





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Products, applications and benefits

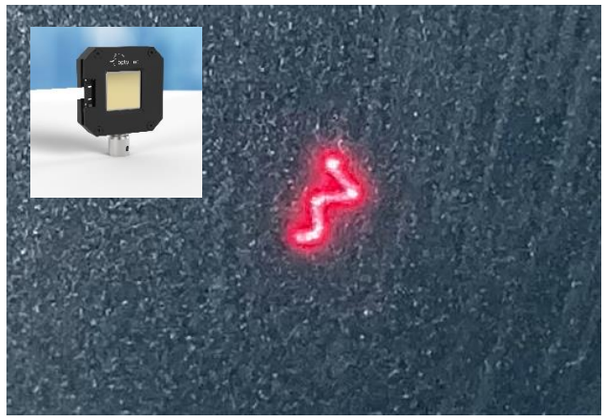
EL-10-42: 3D laser lens

- Laser beam focusing
- High-end laser marking
- Medical lasers

Benefits: large z-range, green and NIR, high repeatability, lifetime, compact, fast

FMR: Fine steering 2D mirror

- Laser soldering
- Laser beam realignment
- Laser welding / cutting



Benefits: high angular resolution, fast, 2D programmable, small, low weight, customizable

EL-16-40: Imaging lens

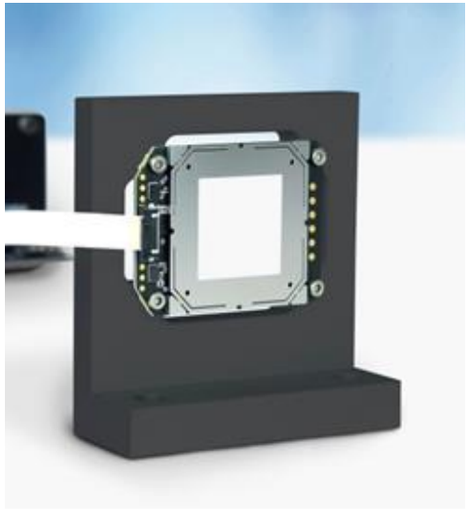
- Laser process inspection (both low and high power)

Benefits: compact, fast, durable, AF, distance measurement, easy to integrate in most camera systems

Products, applications and benefits

BSW: Beam shifting window

- Fibre coupling
- Colour cameras
- Hyperspectral imaging

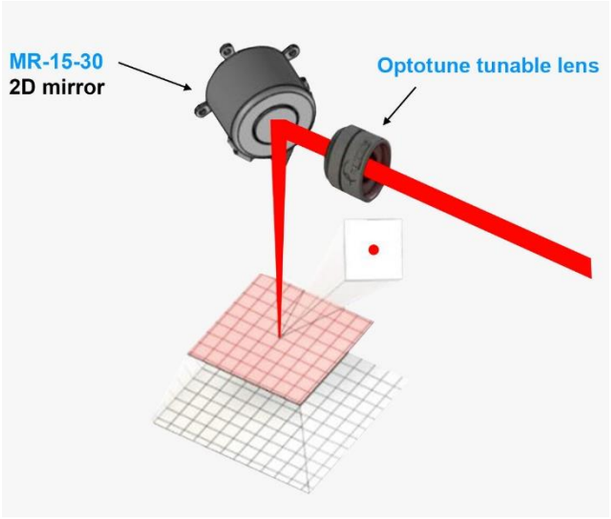


Benefits: 2-axis beam shifting, precise, fast, high transmission, lifetime

MR: Large angle 2D mirror

- < 1 W 2D beam steering
- Free space communication
- Potential for higher power

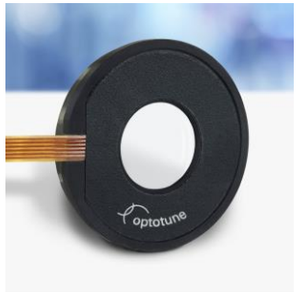
(tunable lens not compulsory)



Benefits: large angle, large mirror, compact package, built-in feedback, 1 optical surface for 2 DOF, lifetime

WIP: EL-7-20 / EL-12-30

- Small dpt range laser processing < 50 W



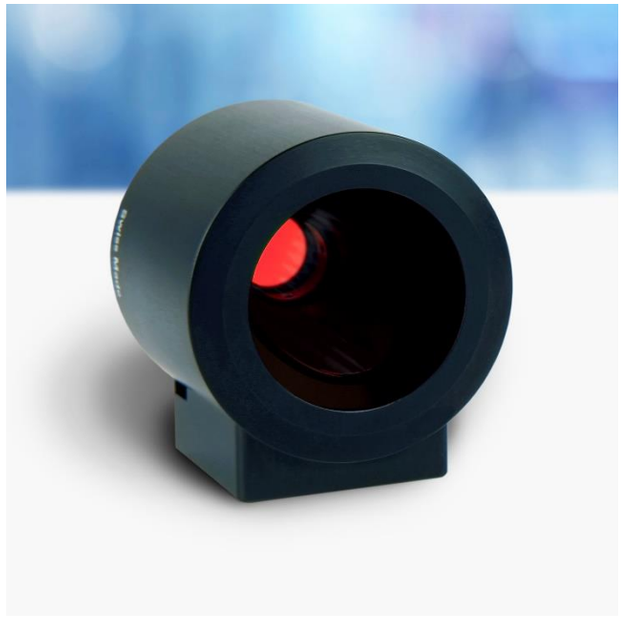
Benefits: fast, low thermal sensitivity, plano-convex to plano-concave, low power consumption, lifetime

EL-10-42-OF specs in the NIR and at 532nm

Product	**EL-10-42-OF-NIR** **EL-10-42-OF-532**	unit
Clear aperture	10	mm
Maximum operating average laser power @ NIR (950-1100 nm) @ 532 nm	 50 20	W
Optical power: tuning range	-2.0 to +2.0	dpt
Optical power: repeatability	typical: < 0.02 max: < 0.04	dpt
Optical power: long term stability 8h		
Wavelength range (NIR)	950 – 1100	nm
Wavefront error @ 1064 nm @ 532 nm	 < 0.15 < 0.3	λ RMS
Transmission NIR (950-1100 nm) @ 532 nm	 > 94 % > 95 %	
Long term radiation damage @ 1064 nm: 40 mJ /cm2 at 20 kHz	No effect after 2000 h	
Damage threshold @ 1064 nm: 125 ns-pulsed at 50 kHz 10 ps-pulsed at 50 kHz	 2.6 2.05	J/cm^2
Response time with EL-E-OF-A analog board	80% step: 12 20% step: 6	ms
Response time with Scaps digital board	80% step: 8 20% step: 4.5	ms
Focal length resolution	Continuous (depends on control electronics)	
Lifecycles (10%-90% sinusoidal)	> 1‘000‘000‘000	

Typical parameters in a marking system with f = 160 mm f-theta lens

Max z-tuning range	100	mm
Repeatability (10%-90% step)*	typical: < 500 max: < 1000	µm
Long term drift over 8h*		



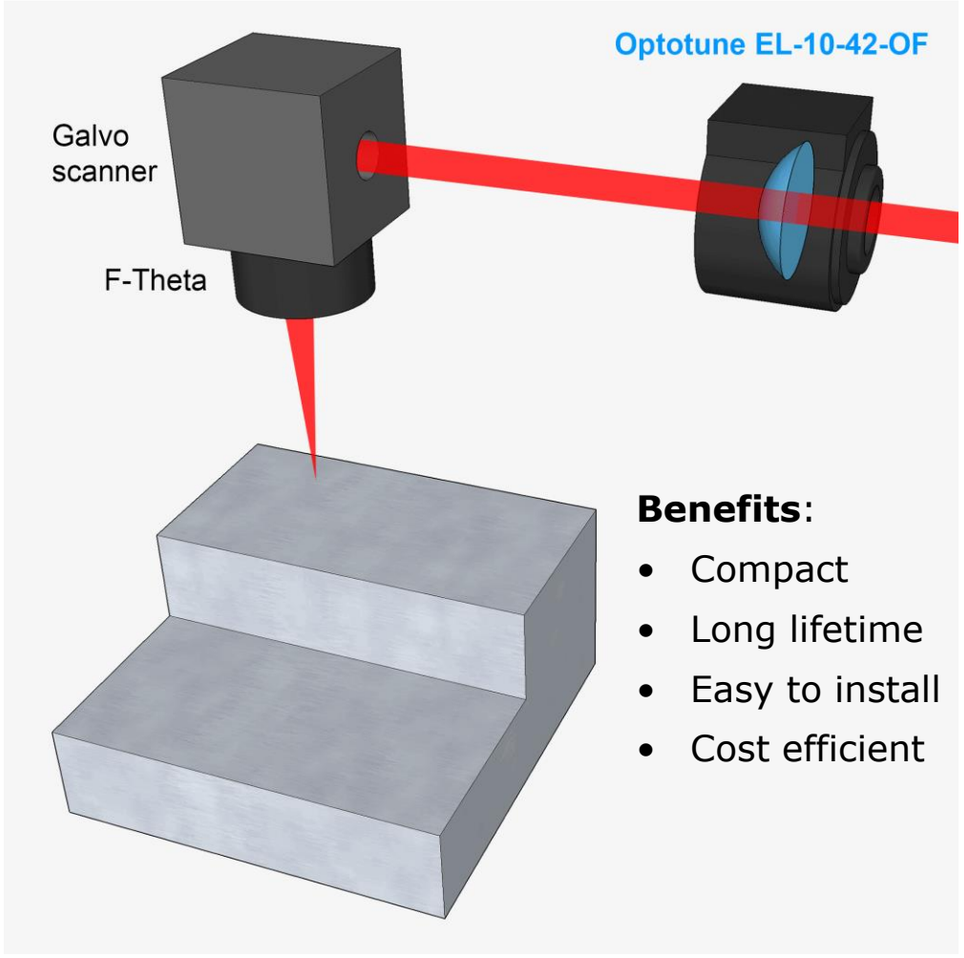
All EL-10-42-OF lenses undergo extensive OQC tests including laser testing

Analog and digital drivers for EL-10-42-OF

	EL-E-OF-A (2.5D)	SCAPS Optotune-DSD-2-O (3D)
		
		XY2-100 integration by USB calibration interface Only one power supply Thermal Control and lens status signal
Interface	Analog 0-5V	Digital XY2-100, X-Y bi-directional Scaps interface
Controller	Microprocessor based	FPGA based
Intelligence	Standard PID control	Model based drive algorithm
80% step response	12ms	8ms
Demonstrated processing speed on 45deg slope (160mm F-Theta)	0.7m/s	6m/s
Suitable operation	Z-Stepping for 2D processing	True 3D processing

2.5D and 3D laser processing with EL-10-42-OF

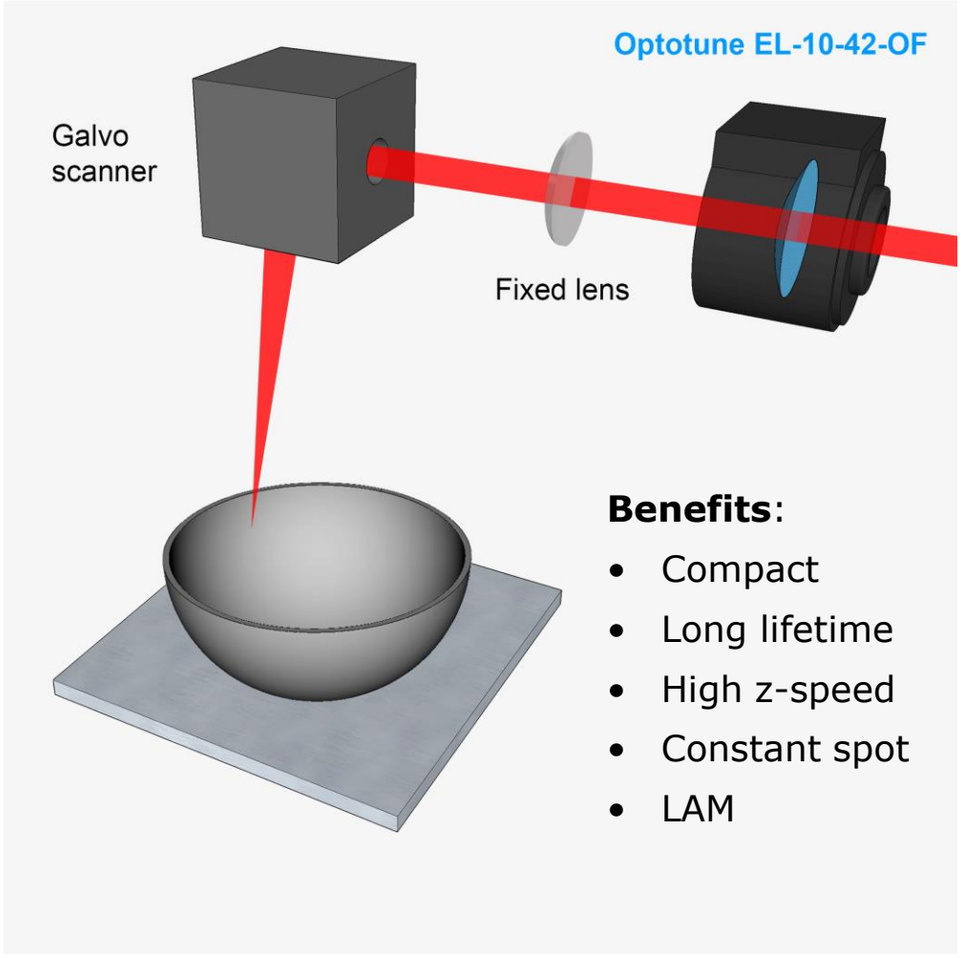
2.5D Z-stepping



Benefits:

- Compact
- Long lifetime
- Easy to install
- Cost efficient

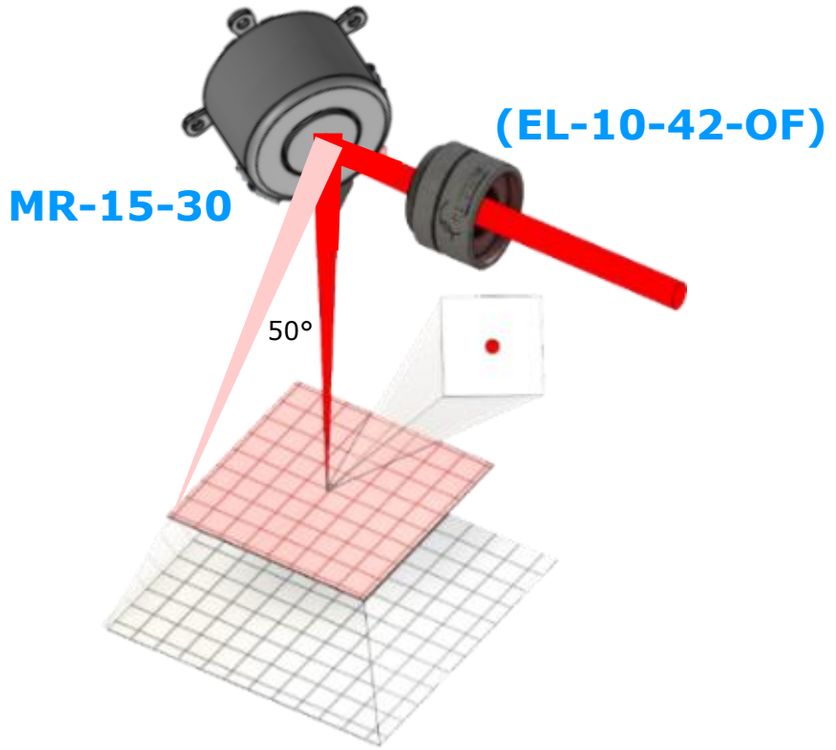
3D laser focus control



Benefits:

- Compact
- Long lifetime
- High z-speed
- Constant spot
- LAM

Low-power laser applications with MR mirrors



MR-15-30 (quasi-static)	
Mirror size	15 mm
Mechanical tilt – fast axis (half angle)	25°
Full-scale bandwidth – fast axis	20 Hz
Mechanical tilt – slow axis (half angle)	25°
Full-scale bandwidth – slow axis	20 Hz
Mech. Repeatability RMS typical	30-100 µrad
Footprint	30x14.5
Position feedback	yes
Laser power	up to 1 W

MR-10-30 (resonant)	
Mirror size	10 mm
Mechanical tilt – fast axis (half angle)	12.5°
Full-scale bandwidth – fast axis	280 Hz
Mechanical tilt – slow axis (half angle)	25°
Full-scale bandwidth – slow axis	20 Hz
Mech. Repeatability RMS typical	30-100 µrad (slow axis)
Footprint	30x14.5
Position feedback	yes
Laser power	up to 1 W

Benefits:

- Large angle
- Small footprint
- Single optical surface

Applications:

- Laser templating
- Free space communication
- Low-power beam steering

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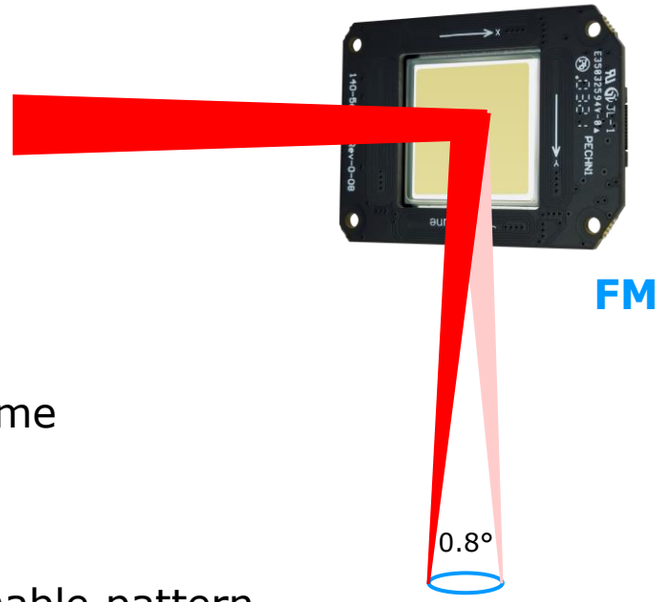
High-power, fine laser steering with FMR mirrors



FMR-20

Benefits:

- Compact
- Long lifetime
- Fast
- Precise
- Programmable pattern

Applications:

- Laser cutting and welding
- Laser soldering, cleaning and ablation
- Laser cavity alignment (Q-switching)
- Point and shoot / raster (lissajous) scanning

FMR-20	
Mirror size	20 x 20 mm
Mechanical tilt angle (p-p)	0.4°
Motion pattern	2D programmable
Bandwidth	250 Hz @ 0.26° p-p
Mirror coating	Au, dielectric, custom
Laser wavelength	UV, VIS, NIR, IR
Laser power	Several kW*
Position feedback	Open loop
External sensor for feedback	Can be added
Power consumption	< 4W
Size (width x height x depth)	47 x 35 x 3.65 mm
Weight	9 g

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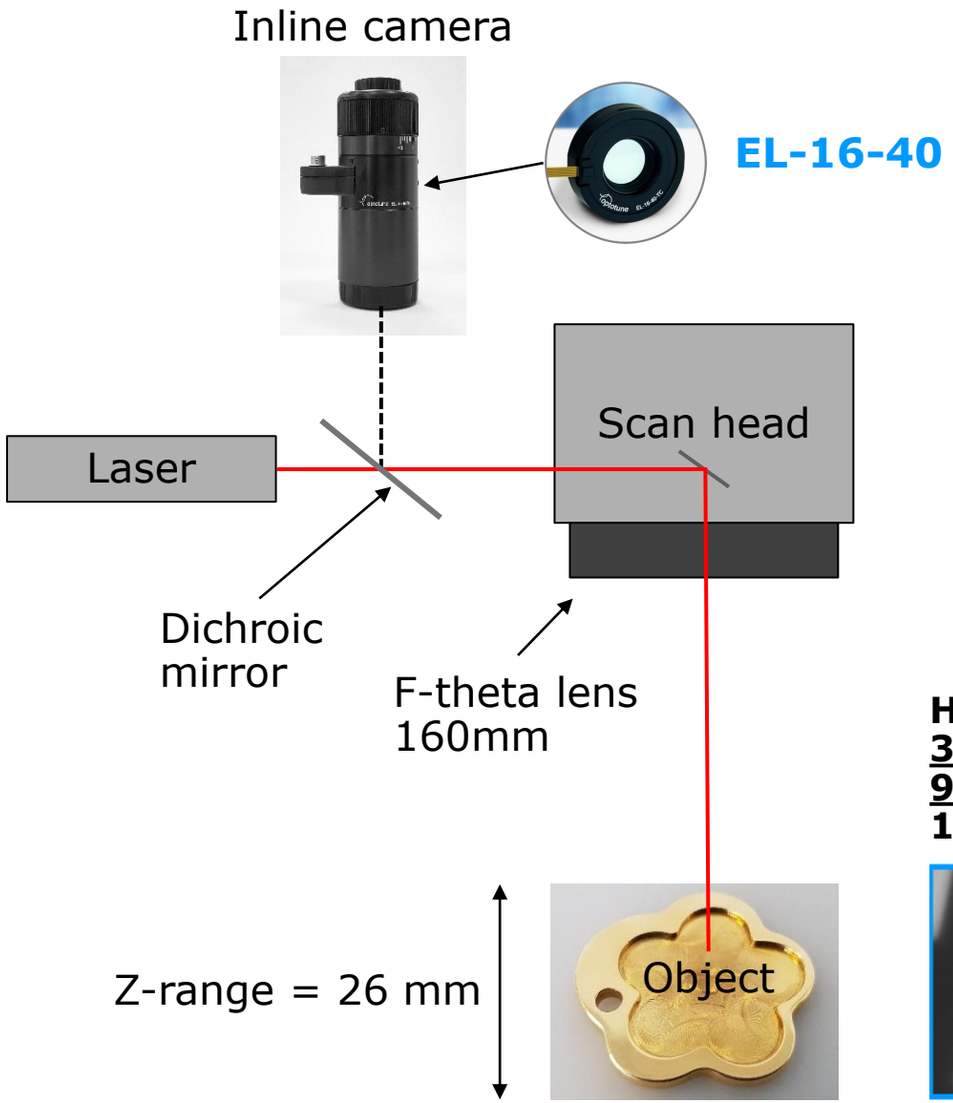
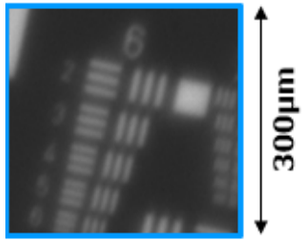
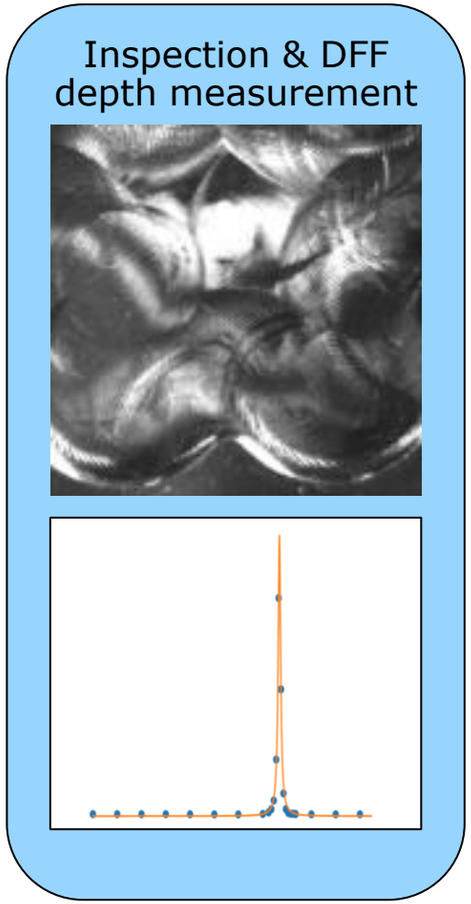
Inline inspection with Distance measurement using EL-16-40



High resolution:
<u>30 lp/mm (image)</u>
<u>9 µm on object</u>
10 mm scan head aperture





Depth from focus: A focus tunable lens in conjunction with an autofocus algorithm can reliably measure distance to an arbitrary object in less than a second

Inline inspection up to 50W using EL-10-42-OF

Inline camera
(fixed optics)

Laser

Dichroic mirror

Scan head

No f-theta lens

3

2

1

10 cm

Marking field

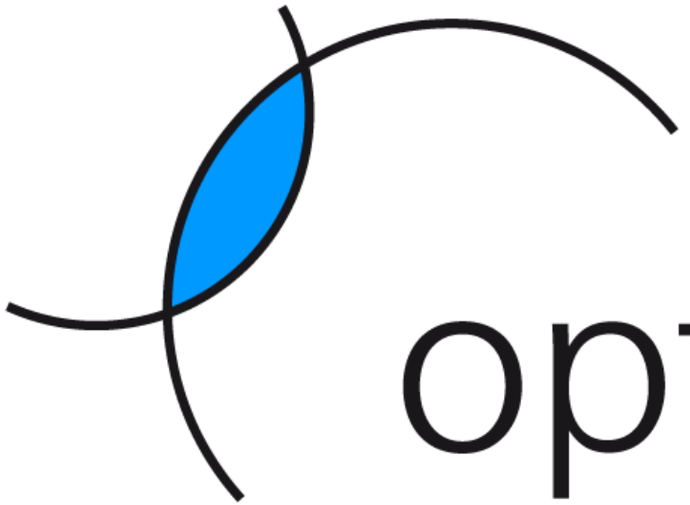
10 cm

Uniform resolution of 30 lp/mm (image) across marking field

EL-10-42-OF

One lens, two functions:

- Laser marking
- Camera inspection



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shaping the future of optics