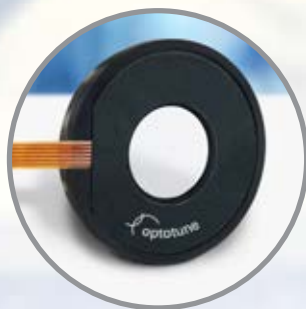




Focus Tunable Lenses



Shaping the future of optics



“Optotune’s mission is to enhance people’s lives through innovation in dynamic light control.”

“Optotune’s vision is to be the solution of choice for optical systems that need dynamic light control.”

Dr. Manuel Aschwanden
CEO



Established in Switzerland in 2008 and privately owned



28 sales partners and distributors in 30 countries



250 employees in Switzerland, Slovakia, Taiwan and Korea



More than 1 million products sold worldwide



R&D spend exceeding 25% of revenue



Industrial, medical, AR/VR and automotive markets



5000 m2 production & cleanroom capacities exceeding 300 Ku/year



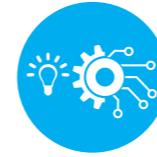
Innovative award winning products

“We make optical innovation happen”

Core competences



Patented optical technology: Optotune combines optics with smart actuation techniques to enable compact and reliable solutions for dynamic light control. Thanks to our highly innovative and patented technology, our customers are able to deliver cutting-edge products across several markets.



In-depth research capabilities: Optotune is continuously investing in material characterization and testing to deliver state-of-the-art products that solve the most challenging applications such as high-frequency vibration environments or ultra-portable systems.



Scalable manufacturing: having different manufacturing sites at various levels of automation enables our customers to access our products with a top-class delivery performance from sampling through to mass production in class 1000 cleanrooms.



360° design skills: from optics simulation in Zemax to mechanical and electrical design to software, our R&D team enables our customers to access a one-stop-shop for our liquid lenses and optical actuators.



Application & customer support team: application diversity in fast changing markets has increased the challenge to identify the appropriate solution; our application engineering team will carry out extensive feasibility studies to select the right Optotune products to solve your challenge.



Custom design: demanding applications have often specific requirements (coatings, optical power ranges, dimensional constraints, certificates), which call for customization. Optotune's know-how in design, manufacturing and quality assurance enables the delivery of future-proof custom products.





Liquid lenses overview



Electrically tunable lenses

Optotune provides a range of electrically tunable lenses - also known as liquid lenses - which are based on its proprietary shape-changing design to provide fast and reliable focus control. Our ELs are available in different sizes, focal power and wavelength ranges (from 400 to 2500nm). Compact designs with FPC connection cables are available for integration into optical systems. Some models also feature industrial versions with mounting threads and robust Hirose connectors.

Key features:

- Response time of few milliseconds
- Low dispersion (Abbe# $V > 100$)
- Lifetime > 1 billion cycles
- High repeatability < 0.1 dpt



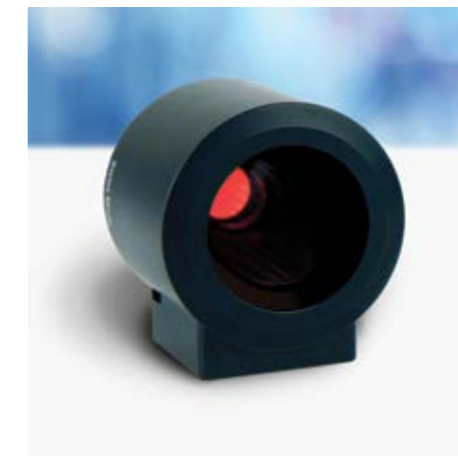
EL-16-40-TC with thread adapters (industrial version)

Product	Focal power range (dpt)	Clear aperture (mm)	Outer diameter (mm)	Rise / settling time (ms)	Repeatability (dpt)
EL-3-10	-13 to +13	3	10	1 / 4	N/A
EL-10-42	-2 to +2	10	42	2 / 8	< 0.02
EL-12-30	-6 to +10	12	30	3 / 10	< 0.1
EL-16-40-TC	-10 to +10	16	40	5 / 25	< 0.1

For detailed information about Optotune's liquid lenses, please visit www.optotune.com/focus-tunable-lenses



EL-3-10



EL-10-42



EL-12-30



ELM series

Optotune has co-designed with its optics partners a series of lens modules developed around its electrically tunable lenses. This results in an optically optimized and integrated solution that simplifies the design of vision systems.

Within the ELM series, there are two subcategories: fixed focal length lenses (**ELM-F series**) and telecentric lenses (**ELM-T series**).

ELM-F series

The ELM-F series consists of fixed focal length lenses specifically designed to accommodate Optotune's electrically tunable lenses in the optical path.

The series, which is in continuous expansion, currently supports S-mount and C-mount cameras up to a sensor size of 1.1" with focal lengths ranging from 5 to 300mm.

Key features:

- Fully tested and integrated modules
- Low f-numbers without vignetting
- Most compact solutions



ELM-25-2.8-18-C

Product	Focal length (mm)	F#	Pixel size (um)	Camera sensor format	Mount	Connector
ELM-5-5.0-7-S	5	5.0	2.2	1/2.5"	S-mount	FPC
ELM-16-5.4-8-S	16	5.4	1.8	1/2.3"	S-mount	FPC
ELM-12-2.8-18-C	12	2.8	2.4	1.1"	C-mount	Hirose
ELM-25-2.8-18-C	25	2.8	2.4	1.1"	C-mount	Hirose
ELM-35-5.6-14-C	35	5.6	3.0	2/3"	C-mount	Hirose
ELM-35-5.6-16-C	35	5.6	3.0	1"	C-mount	Hirose
ELM-35-3.5-16-C-NIR	35	3.5	3.0	1"	C-mount	FPC
ELM-50-2.8-16-C	50	2.8	3.0	1"	C-mount	Hirose
ELM-50-3.8-16-C-NIR	50	3.8	3.0	1"	C-mount	FPC
ELM-75-4.0-8-C	75	4.0	3.45	1/2"	C-mount	FPC
ELM-150-7.5-11-C	150	7.5	5.0	2/3"	C-mount	Hirose
ELM-300-10.0-11-C	300	10.0	8.0	2/3"	C-mount	Hirose



ELM series

ELM-T series

The ELM-T series is made of telecentric lenses designed to accommodate Optotune's electrically tunable lenses in the optical path. This optimized design preserves telecentricity and near constant magnification. Magnification change is linear with the working distance and can be easily calibrated out.

This series currently supports magnifications ranging from 0.133x up to 4x and camera sensor formats from 1/2" inch up to 35mm.

Key features:

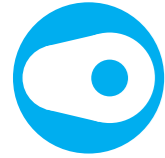
- Image distortion-free
- No loss of resolution
- No vignetting
- Tested and integrated modules



EL-16-40 + S5VPJ0303

Product	PMAG	F#	Camera sensor format	Working distance (mm)	Mount	Manufacturer
S5VPJ1860	0.133x	7	1"	79.7 - 434.1	C-mount	Sill
TCALP43F-0267-208	0.26x	7.5	4/3"	195.0 - 220.0	F-mount	Linkhou
TCALP1-05-110	0.50x	7.2	1"	106.0 - 122.0	C-mount	Linkhou
EO 36-192	0.75x	10	2/3"	85.0 - 99.0	C-mount	EO
VS-THV1-110/S-LQL1	1x	10	1"	106.1 - 120.0	C-mount	VST
S5VPJ0627	1.5x	18	1"	152.4 - 172.3	C-mount	Sill
VS-THV3-110/S-LQL1	2x	9.6	1"	105.4 - 115.6	C-mount	VST
S5VPJ0426	2.5x	25	35mm	94.8 - 104.6	M42	Sill
S5VPJ0420	3x	25	35mm	91.2 - 101.2	M42	Sill
VS-TCH4-65-LQL1	4x	17.5	2/3"	64.7 - 65.3	C-mount	VST

Selection of lenses representative of the ELM-T series, for a full list, please visit www.optotune.com/telecentric-lenses



Tunable lenses with optical feedback

The electrically focus-tunable EL-10-42-OF lens features an integrated proprietary optical feedback (OF) mechanism optimized for 2.5D and 3D laser processing applications. The EL-10-42-OF sets the highest standards for spot quality and speed for large marking areas and volume.

Key features:

- Large z-range and large area marking (LAM)
- Fast and precise z-axis control
- Constant and small spot size
- Compact form factor and low weight
- Easy integration with analogue/digital control
- Coaxial visual inspection



EL-10-42-OF-NIR

Product	Focal power range (dpt)	Wavelength range (nm)	Max laser power (W)	Clear aperture (mm)	Outer diameter (mm)	Rise / settling time (ms)	Repeatability (dpt)
EL-10-42-OF-NIR	-2 to +2	950 - 1100	50	10	42	2 / 8	0.02
EL-10-42-OF-532	-2 to +2	532	20	10	42	2 / 8	0.02

For detailed information about Optotune's EL-10-42-OF, please visit www.optotune.com/el-10-42-of-lens



Manual lenses

The Optotune ML-20-37 manually focus-tunable lens is designed to have its lens curvature change between convex (+18 dpt), flat (0 dpt) and concave (-18 dpt) by the rotation of the outer adjustment ring. The rotation mechanism is extremely durable (>100'000 rotations), linear and low in torque, allowing for easy and reliable motorization that reaches a repeatability of typically 0.1 dpt.

The ML-20-37 is available with and without C-mount adapter.

Key features:

- Large optical power range of 36 dpt
- Zero holding power
- Easy to motorize



ML-20-37-VIS-36D-C

Product	Range of optical power (focal length)	C-mount	Cover glass coating	Wavefront error*
ML-20-37-VIS-36D	-18 dpt (-55mm) to +18 dpt (+55mm)	no	400 - 700nm	<0.19 / 0.95
ML-20-37-VIS-36D-C	-18 dpt (-55mm) to +18 dpt (+55mm)	yes	400 - 700nm	<0.19 / 0.95

For detailed information about Optotune's ML-20-37, please visit www.optotune.com/ml-20-37-lens



Focus tunable lenses

Traditional optics are focused through a mechanical movement of the lenses, which is adjusted depending on the object distance. This presents several downsides:

- Limited focusing speed
- Need for a motor to change focus, which increases size and complexity
- High maintenance and calibration cost
- Limited cycle life due to wear and tear of mechanics

Optotune's proprietary focus tunable lenses overcome the limitations of traditional lenses and deliver the state-of-the-art solution to solve applications that require fast focusing.

Key advantages

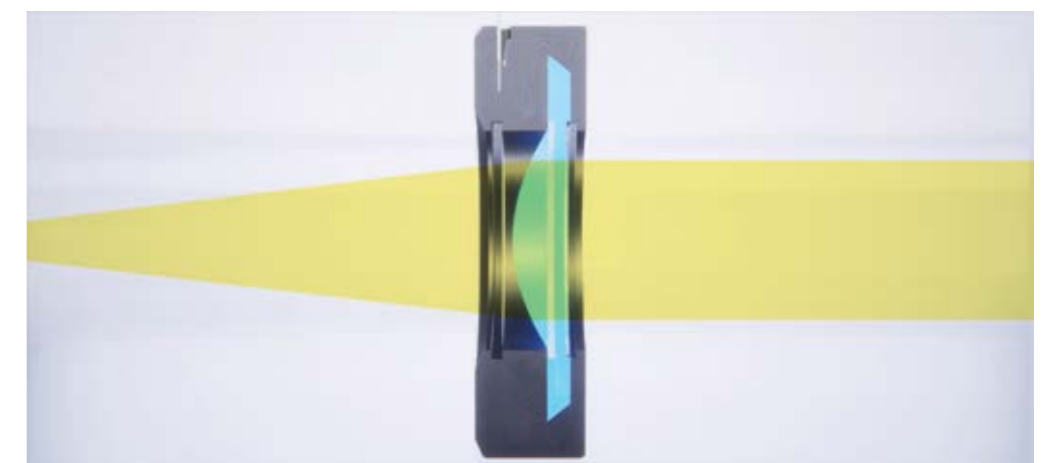
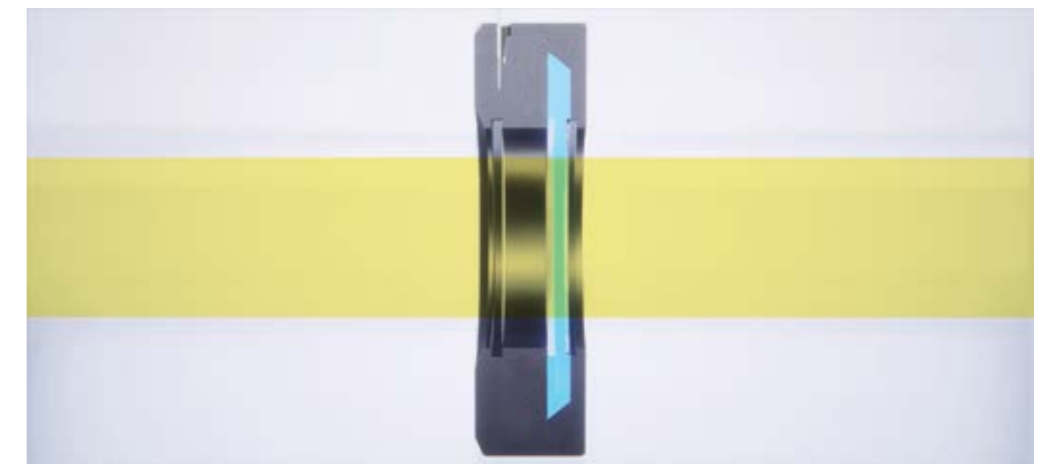
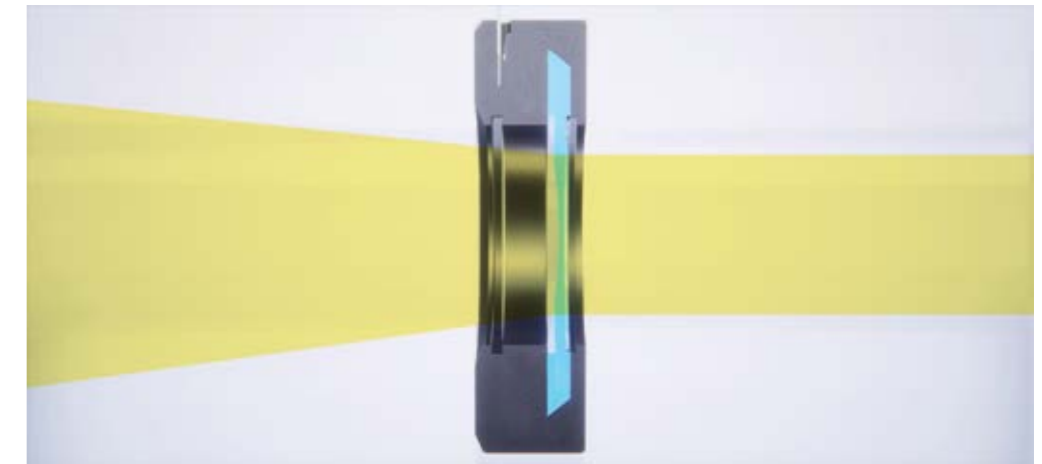
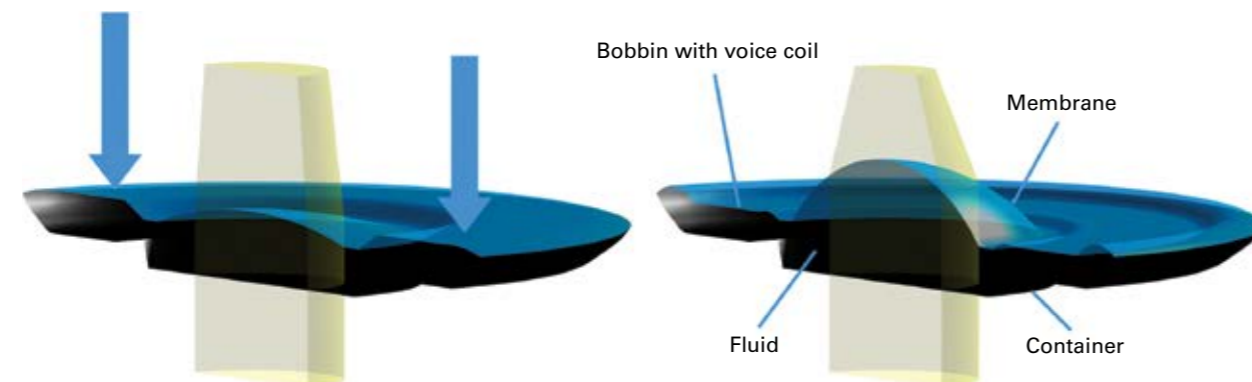
The key advantages of this technology compared to traditional optics are:

- Fast-focusing speed in few milliseconds
- Compact and robust design
- High reliability (more than a billion cycles)
- Cost-effectiveness

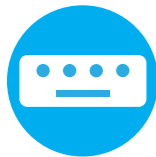
As a result, Optotune's focus tunable lenses have become a key component for numerous applications in industrial, medical, and consumer industries.

Working principle

The core element of Optotune's focus tunable lenses consists of a container, which is filled with an optical liquid and sealed off with a thin, elastic polymer membrane. A voice-coil actuator pushes liquid into the center of the polymer membrane and deflects it. As a result, the radius of the lens can assume different configurations (from concave to flat to convex) and thus change the optical power of the lens itself. The actuator is usually current controlled, and in some cases built-in temperature sensing, position sensing or optical feedback are used to achieve high repeatability.



Controllers overview



Controllers

Optotune's focus tunable lenses are controlled by current. Off-the-shelf controllers are available that provide the necessary current to the specific product and offer advanced software control options, such as temperature compensation and response time optimization. Controllers range from compact portables, R&D development kits to 24/7 industrial operation solutions.

Product	EL-E-4	EL-E-4i	ICC-4C	ECC-1C	EL-E-OF-A-2	SCAPS DSD-2
Applications	Portable systems, R&D	Portable systems, R&D	Industrial 24/7 operation	Connect to cameras or embedded systems	R&D, industrial & medical lasers	R&D, industrial & medical lasers
Current range	-290 to + 290 mA	-290 to + 290 mA	-500 to +500 mA	300 to +300 mA	0 – 300 mA (ADC resolution 16 bit)	0 – 300 mA
Interfaces	USB, UART, Analog 0-5 V	USB, UART, Analog 0-5 V	USB, Ethernet, UART, I2C, Analog 0-10V	UART, I2C, Analog 0-10V, GPIO	Analog 0-5V	USC3 / XY2-100 scanner cards, USB
SDKs	C#, LabVIEW, Python	C#, LabVIEW, Python	C#, Python	Triniti SDK, C#, C++, VB	C#, Python	SCAPS DSD-2 GUI
Supply voltage	5 V	5 V	24 V	24 V	5-24V	24 V
Connection	FPC	Hirose	Hirose	Hirose	Hirose	-
Channels	1	1	4	1	1	1
Standards	CE, RoHS	CE, RoHS	CE, RoHS	CE, RoHS	CE, RoHS	CE, RoHS



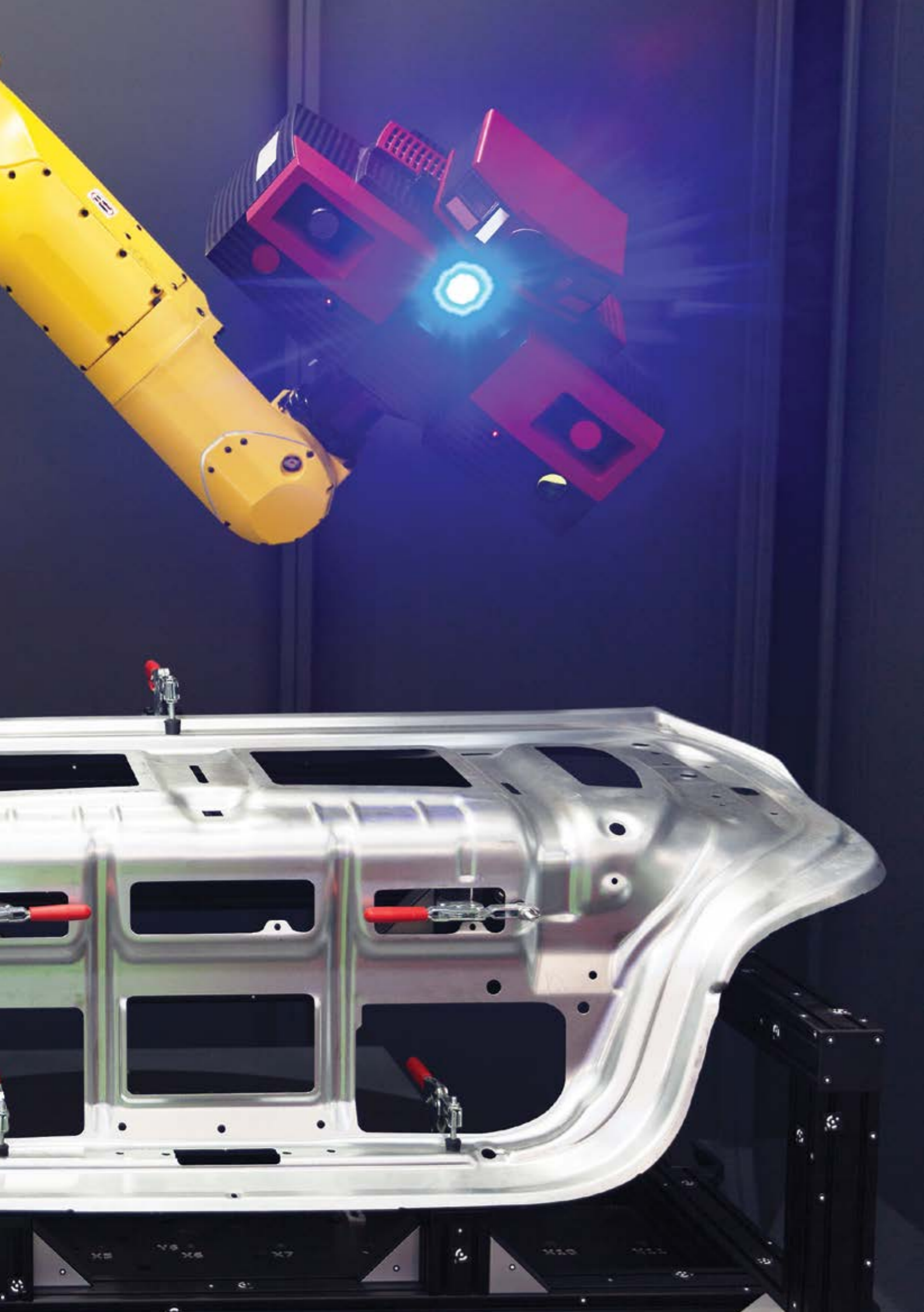
Above: The Optotune ICC-4C-500 four channel controller



Lens controller compatibility

Product	EL-E-4	EL-E-4i	ICC-4C	ECC-1C	EL-E-OF-A-2	SCAPS DSD-2
EL-3-10-FPC	●		+			
EL-12-30-TC	●		+			
EL-16-40-TC (FPC)	●		+	●		
EL-16-40-TC (Hirose)		●	●			
ELM-F (FPC)	●		+			
ELM-F (Hirose)		●	●	●		
ELM-T (Hirose)		●	●	●		
EL-10-42-OF-NIR					●	●
EL-10-42-OF-532					●	●

+ Compatible with extension kit



Applications



Robotics inspection

The challenge:

Robots are taking more and more space within our factories and they are now used both in production and inspection processes, the necessity of fast and precise focus on the on-board vision system is becoming key to increase the throughput and reduce the yield loss due to undetected defects.

Optotune's solution:

Optotune liquid lenses with fast response time (within 20ms), high repeatability and life time of more than 1 billion cycles are the perfect solution for the on-board vision system of your robot to quickly change the focus of your camera sensor and enable defect detection during the inspection process. Simply move your camera closer to the object and refocus to increase the magnification!

EL product family advantages:

- Fast focus within milliseconds
- Large working distance range
- Remote focus control
- High repeatability
- Long life time

Applications with similar challenges:

- Barcode reading
- Bottle inspection
- Package sorting

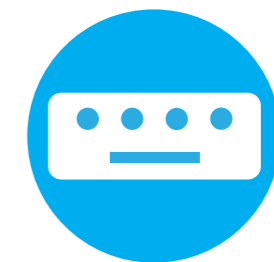
Products:



ELM-F series



EL-16-40



+ Controller



Applications



Dermatoscopes

The challenge:

Handheld scientific devices (including medical devices) are expanding their presence in several key fields thanks to their transportability and ease of use. To achieve these features, it is key to obtain sharp images in rapid succession with a compact, ergonomic, and lightweight device that offers a satisfying user experience.

Optotune's solution:

Optotune liquid lenses have a small form factor, are lightweight (circa 1.25g), are fast with a response time of 4ms, and offer an impressive lifespan of more than 1 billion cycles. Optotune liquid lenses are the perfect solution to integrate into handheld medical devices. Which, when integrated, allow for medical practitioners to rapidly change diopter focus, allowing for the fast analysis of visual samples in the field.

EL product family advantages:

- No vibration
- Fast focus within milliseconds
- Large working distance range
- Lightweight
- Long lifespan

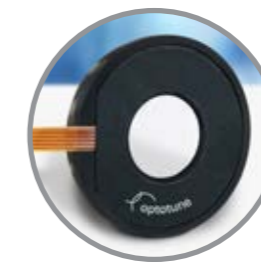
Applications with similar challenges:

- Portable telescopes
- Portable microscopes

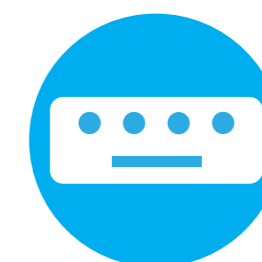
Products:



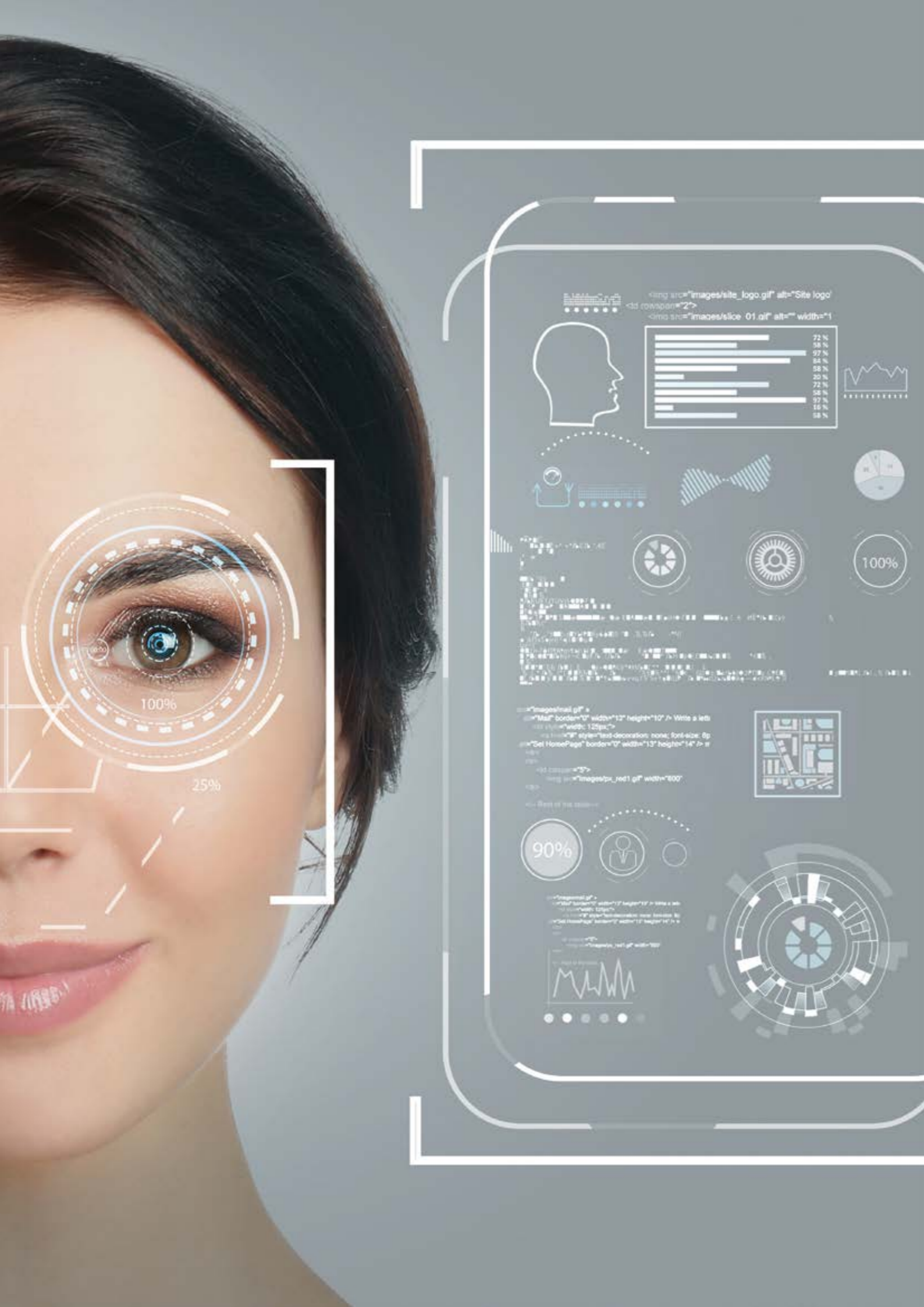
EL-3-10



EL-12-30



+ Controller



Applications



Iris recognition

The challenge:

Iris recognition devices are increasingly being incorporated into daily lives and working environments, such as financial transactions, home security systems, surveillance, and border control. Due to a large number of people approaching recognition devices at different speeds and distances, a wide working distance range and a fast vision system - with the ability to quickly refocus within milliseconds - is required. A major concern is also to protect the human eye and not to damage the retina, therefore it is preferable to work in the infrared spectrum.

Optotune's solution:

Optotune liquid lenses with NIR coating, offer a fast response time (down to 4ms), a large working distance range, up to a billion cycles, and are optimized for iris recognition devices. When integrated into systems, they allow for safe and speedy iris recognition within milliseconds.

EL product family advantages:

- NIR coating
- Fast focus within milliseconds
- Large working distance range
- High repeatability

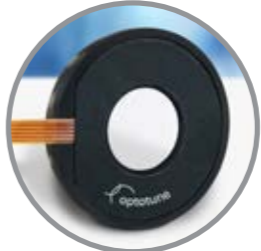
Applications with similar challenges:

- Face recognition
- Biometric devices

Products:



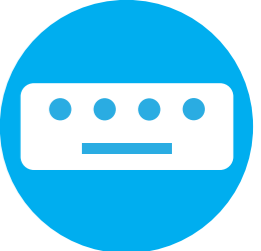
EL-3-10



EL-12-30



ELM-F series



+ Controller



Applications



3D laser processing

The challenge:

Traditional z-axis laser processing such as marking and engraving rely on bulky and expensive mechanical optics to adjust the focus plane. In addition, f-theta lenses are relied upon to perform the optical field flattening. Furthermore, f-theta lenses are for the most part unable to cover large marking areas and offer a constant spot size.

Optotune's solution:

Optotune's EL-10-42-OF liquid lens with integrated optical feedback removes the need for cumbersome laser optics and f-theta lenses. The EL-10-42-OF allows for the fast processing of large x-y and z distances and does not require an f-theta lens. Unlike its competitors, the EL-10-42-OF is able to achieve optical field flattening whilst maintaining the laser spot at a constant size.

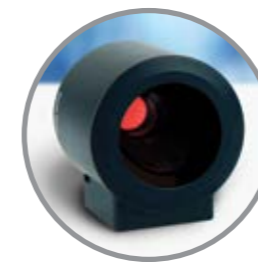
EL-10-42 product family advantages:

- Laser power up to 50 W
- Fast z-axis control in large volumes
- Repeatability as small as 0.02 dpt
- Easy integration with analogue and digital (XY2-100) controllers
- Compact form factor and low weight

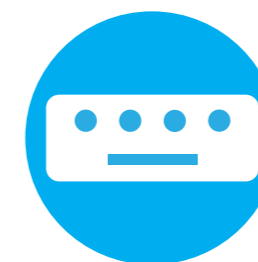
Applications with similar challenges:

- 3D printing / Additive manufacturing
- Medical / Ophthalmology
- Micromachining
- Laser projection templating

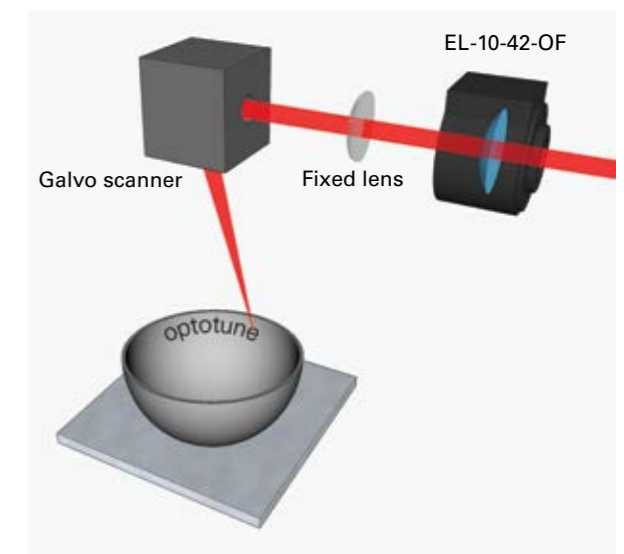
Products:



EL-10-42-OF-NIR



+ Controller





Applications



Wide-field microscopy

The challenge:

Fast Z focusing and image stability have always been a difficult trade off in microscopy applications, particularly to acquire 3D information (DFF) or to compute images with extended depth of field (EDOF). Current technologies such as stepper motor Z actuators or piezo positioners are impacting the throughput in the life science business because of slow speed (stepper motor Z actuators) or because of the small travel and vibration (piezo positioners). It has always been necessary to combine the two different technologies to overcome these bottlenecks, increasing the complexity and the cost of the system.

Optotune's solution:

Optotune focus tunable liquid lenses provide a versatile, compact and cost-effective solution to overcome this challenge. Thanks to the absence of translational mechanics, liquid lenses have the possibility to focus within few milliseconds combining coarse and fine focusing range, ensuring no vibrations.

EL product family advantages:

- Fast Z stacking
- No vibrations
- Large working distance range

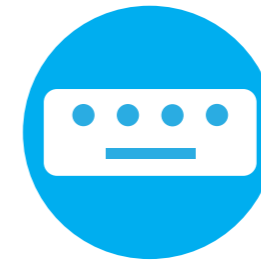
Applications with similar challenges:

- Confocal Microscopy
- 3D Light Sheet microscopy
- Spectroscopy
- Digital holographic Microscopy

Products:



EL-16-40



+ Controller



Contact us



Application evaluation, sales, and support

Optotune, with its core competencies and years of experience in challenging applications, is able to assist its customers at the early stages of their product development through feasibility studies and custom designs. Furthermore, our comprehensive approach ensures support not only in the design and production phase, but also during the entire product life cycle.

Feasibility studies:

Optotune supports you to evaluate the feasibility of your application and solve it through your setup with Optotune's products. Our application engineers are available to guide your team through the initial challenges and obtain the best possible results within the shortest time-frame.

Product customization:

Our application and engineering teams support you in drafting the specifications to design the best product for your challenges; throughout the mechanical and optical design simulation our team guides you step-by-step to enhance your current optical setup.

After-sales support:

Optotune provides its customers with an on-going product support throughout the life cycle of the application. Our team of engineers can assist you and support you at every step of your product development.

How can we support you? Tell us more about your application.



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ONE MILLION LENSES IN ONE



OPTOTUNE EL-16-40 LIQUID LENS

THE SWISS SHAPE SHIFTER - FROM CONCAVE TO CONVEX IN JUST A FEW MILLISECONDS