



shaping the future of optics

# Optotune

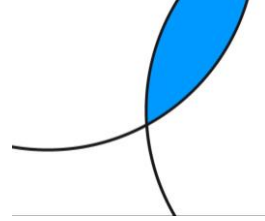
## Machine Vision portfolio introduction

April 2023

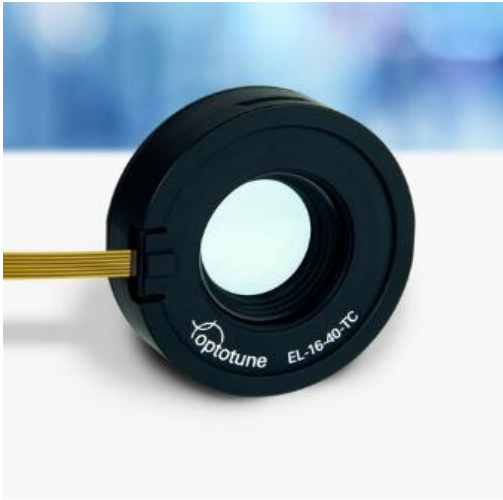
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# Product Portfolio

Our solutions for Machine Vision



## Focus tunable lenses



- Fast autofocus
- Fast detection
- Image stacking

## Beam steering devices

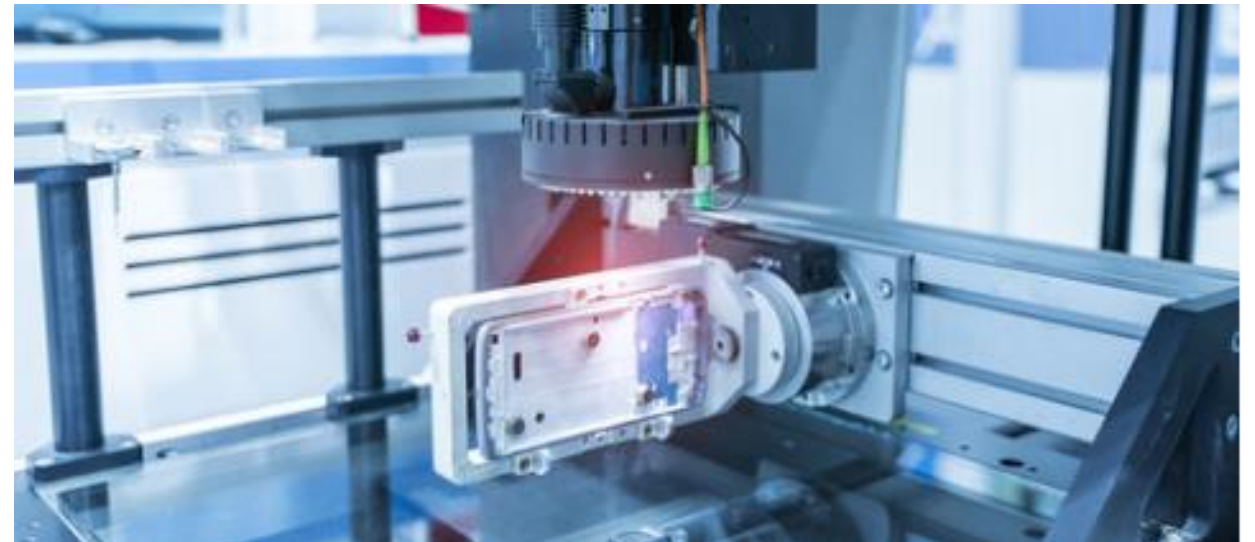


- Sole reflection
- Wide angular range
- Compact

## Beam shifting devices

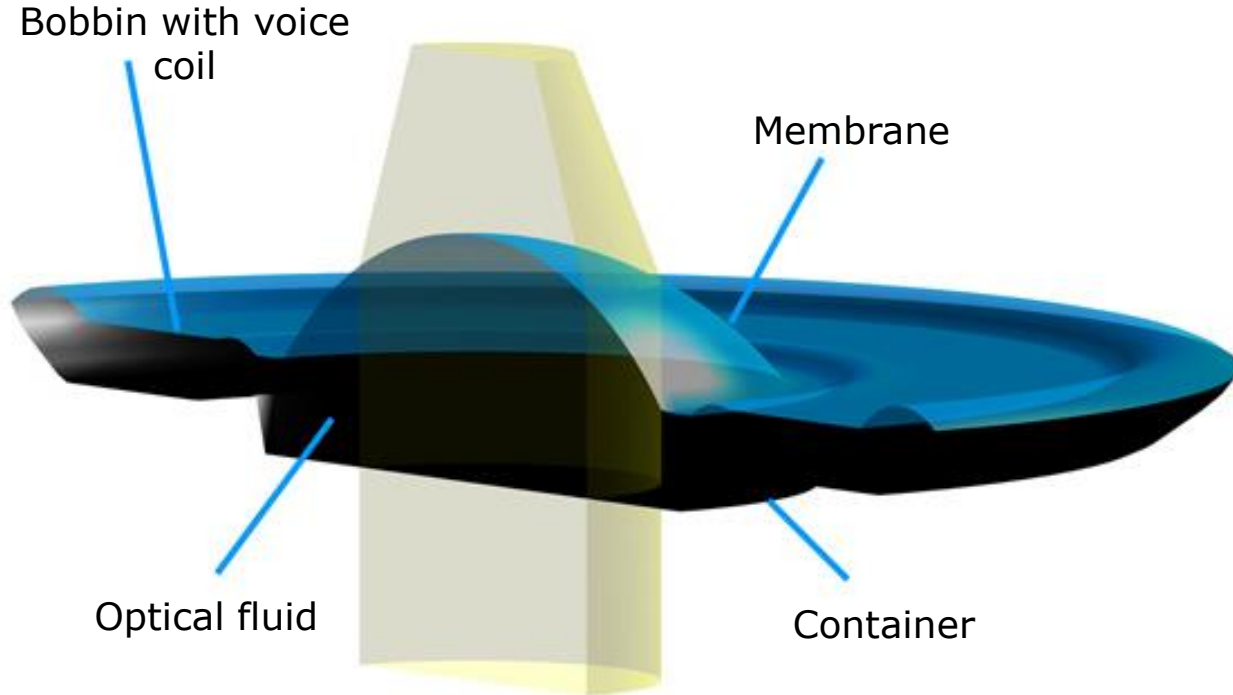
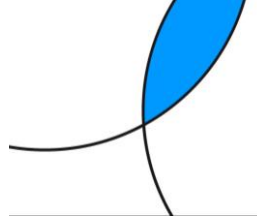


- Fast transition time
- Reliable over time
- Beam shifts up to 4.8um

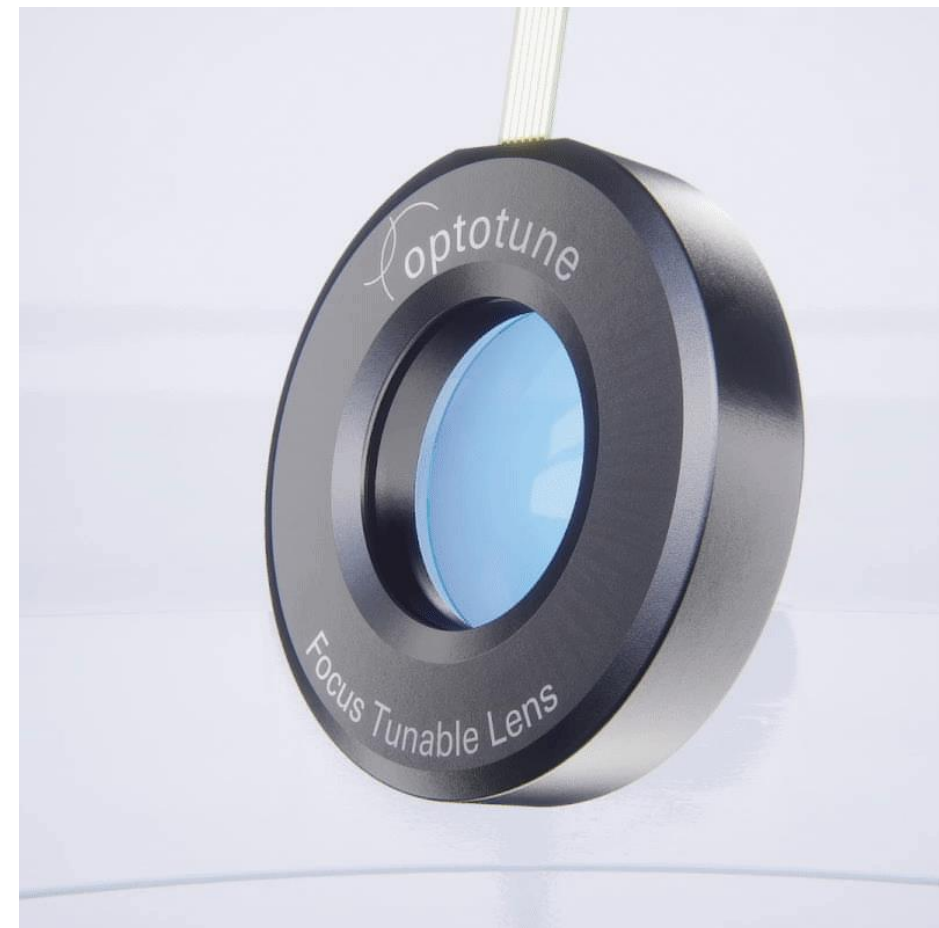


# Working Principle

Membrane with fluid and actuator

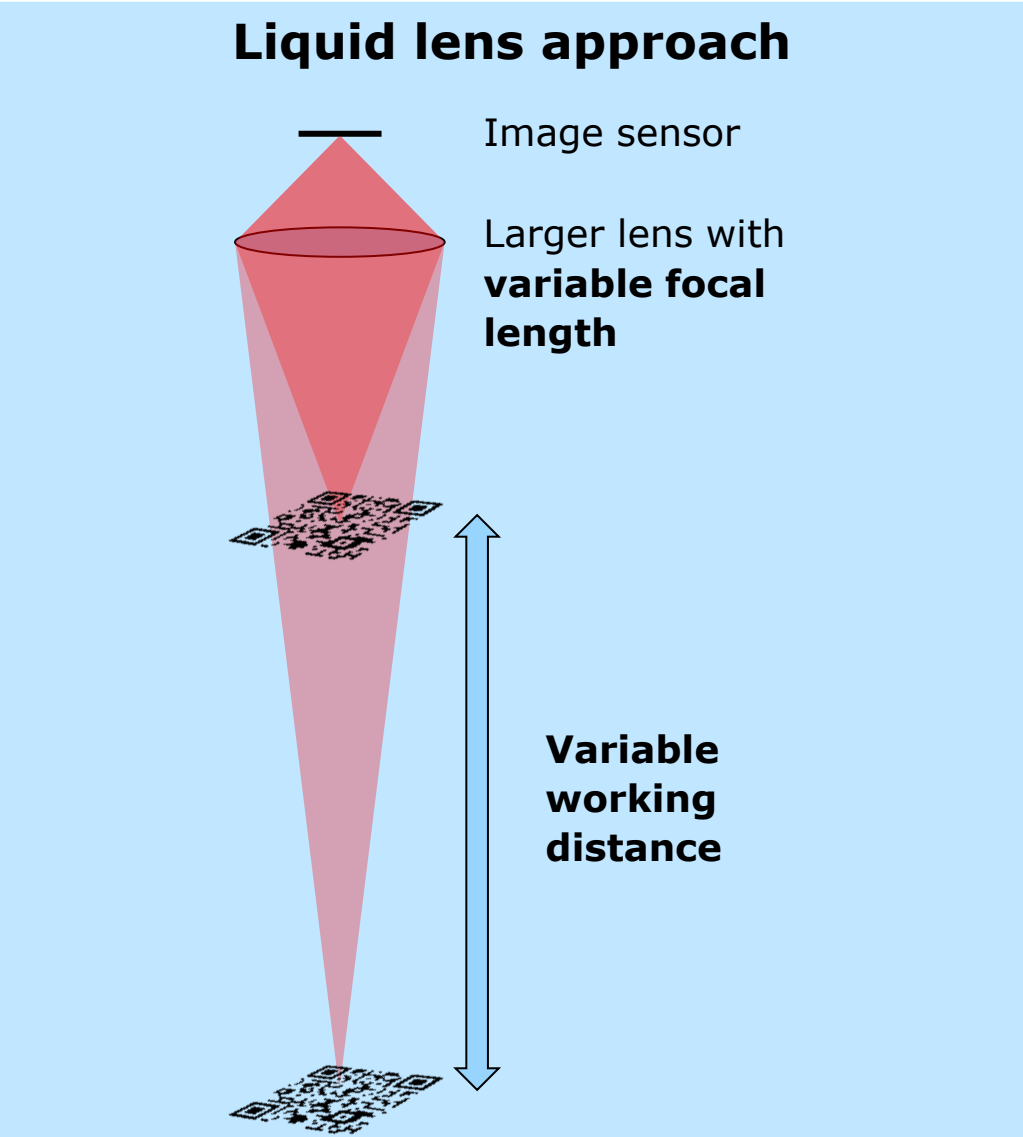
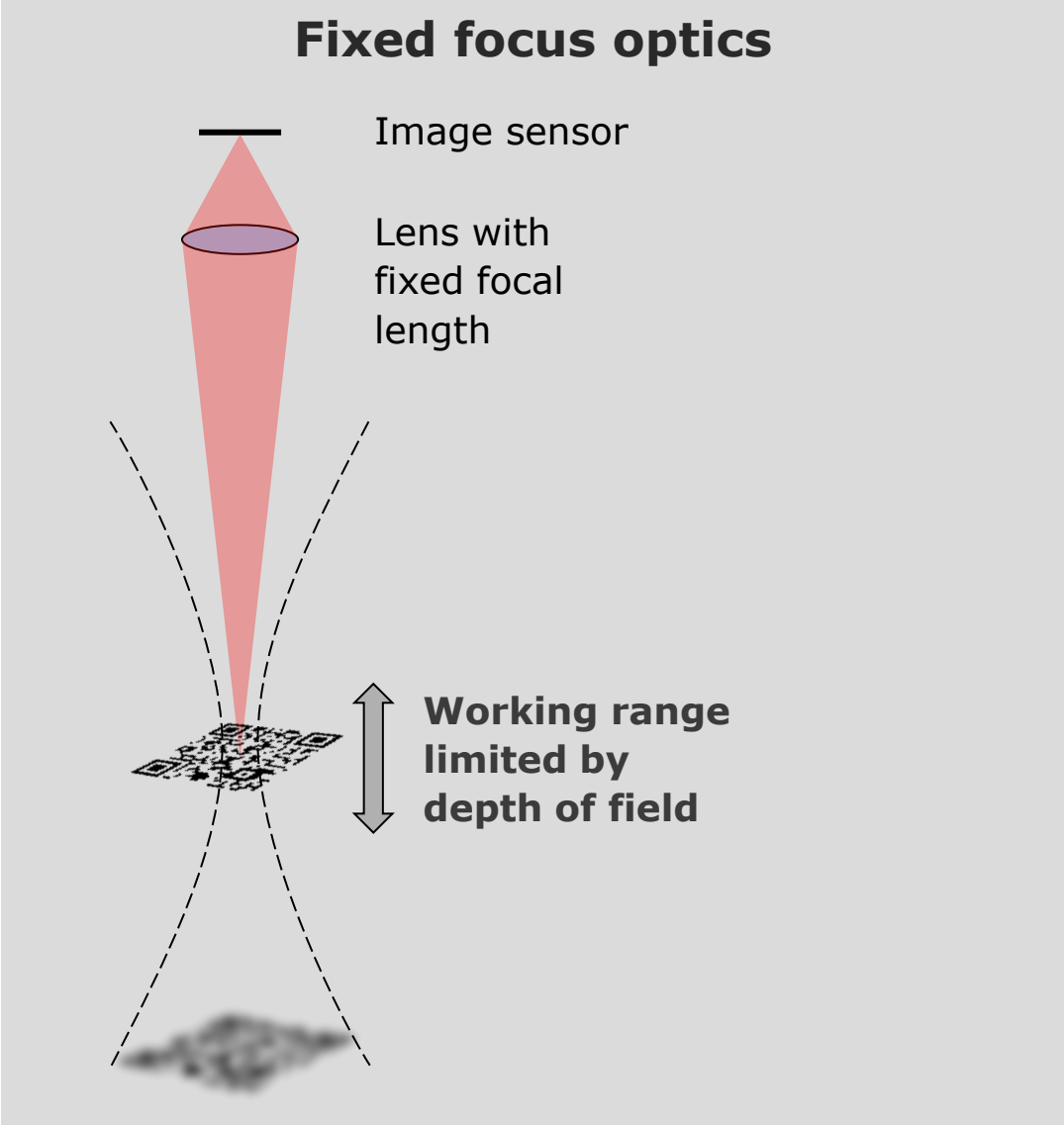


In action:  
How current influences the membrane shape

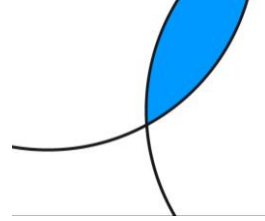


See also: <https://www.optotune.com/tunable-lenses>

# The ideal focusing solution for machine vision

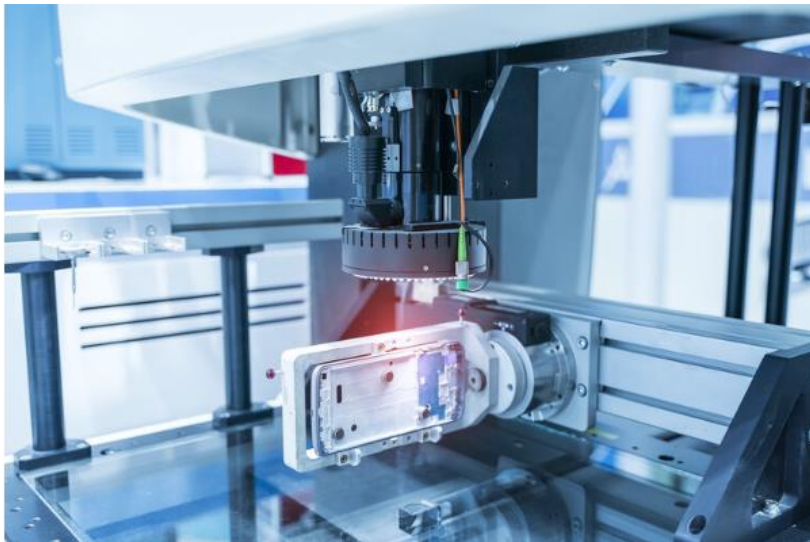


# The natural way to focus: Like your eyes but faster!



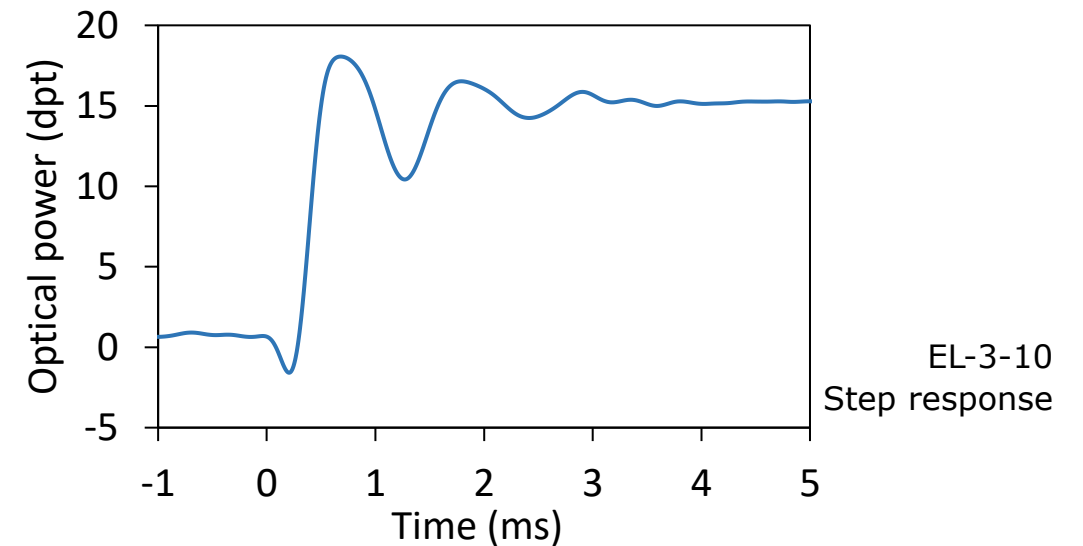
## Specifications

- Apertures from 3 to 30mm
- Large working distance range
- Low dispersion (Abbe#  $V > 100$ )
- $> 10^9$  cycles
- High repeatability  $< 0.1$  dpt
- Response time of few milliseconds

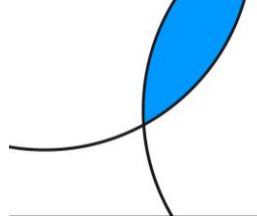


## Benefits

- Sensor sizes 1/3" to 40mm supported
- Maximum flexibility with low f-numbers
- No color aberrations
- Long Lifetime
- One-time calibration
- Higher throughput



# Both off-the-shelf lens combinations and integrated, optimized designs are available



## Off-the-shelf lenses



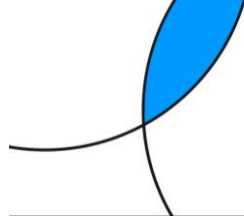
+


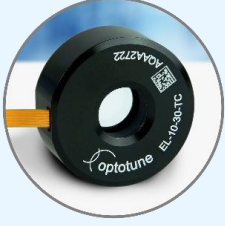





## Optimized designs



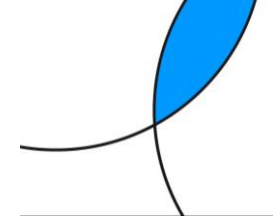
# Our liquid lenses for machine vision applications








	EL-3-10-TC	EL-10-30-TC	EL-10-30-C(i)	EL-12-30-TC	EL-16-40-TC
					
Focal power range (dpt)	-13 to +13	+8 to +20	-1.5 to +3.5 +5 to +10	-6 to +10	-2 to +3
Clear aperture (mm)	3	10	10	12	16
Outer diameter (mm)	10	30	30	30	40
Gravity-induced coma single liquid version ( $\lambda$ RMS)*	<0.05	0.4	0.2	0.175	0.43
Gravity-induced coma GC version ( $\lambda$ RMS)*	<0.05	NA	NA	<0.05	<0.05
Status of GC version	Not needed	Not planned	Not planned	Samples available, MP in 2023	Samples available, MP Q4 2022

\* Measured over 80% of the clear aperture @530nm

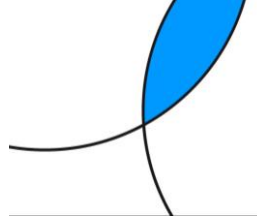
# Lens controllers for easy integration



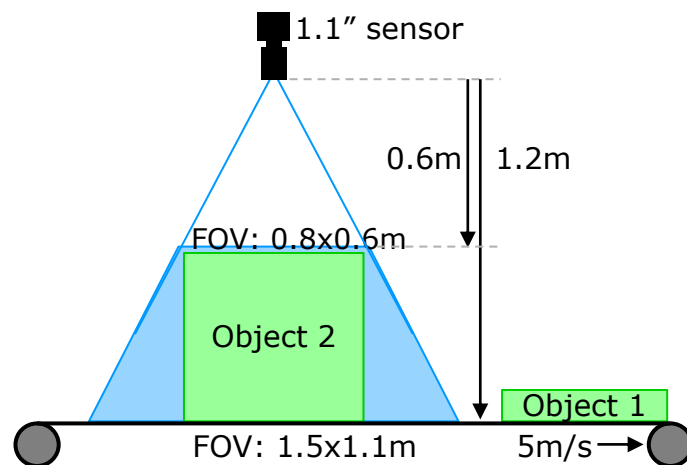
	<b>EL-E-4</b>	<b>EL-E-4i</b>	<b>ICC-4-C</b>	<b>Gardasoft CL-180</b>	<b>ECC-1C</b>
					
Application	R&D, portable systems	R&D, portable systems	Industrial 24/7 operation	Industrial 24/7 operation	OEM
Current range (mA)	-290 to + 290	-290 to + 290	-500 to +500	-400 to +400	-300 to +300
Supply Voltage (V)	5	5	24	24	5-24V
Interfaces	USB	USB	USB, Ethernet, Analog 0-10V, UART, I2C	GigE, RS232, Analog 0-10V	I2C, UART, Analog 0-10V
Connection	FPC	Hirose	Hirose	Hirose	Hirose
Channel(s)	1	1	4	1	1
SDKs	C#, LabVIEW, Python	C#, LabVIEW, Python	C#, C++, Python	Trinita SDK, C#, C++, VB	C#, Python



# Lens module example: 12 mm lens with integrated EL-16-40 by VST



**ELM-12-2.8-18-C**



## High resolution and large field of view

- Ideal for code reading and OCR applications e.g. in logistics

## Working distance range from 250mm to infinity

- Best MTFs between 500 to 1000mm
- High optical leverage (1.13m/dpt)

## Resolution (for 2.4um pixels)

- Image center at Nyquist limit (up to 208 lp/mm)
- Image corners between 90-168 lp/mm
- Best resolution at F/5.6

## Image quality

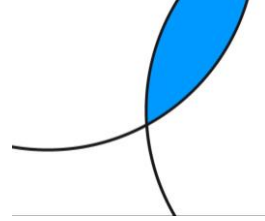
- No vignetting up to 1.1" format at F/2.8
- Barrel distortion, which can be corrected digitally

## Resources

[Test report](#)

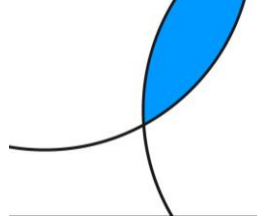
# Current solutions

## To focus along Z-axis



	Motorized Z	Piezo Z	Focus Tunable Lens	
				
Price	\$\$	\$\$\$	\$	3x cheaper than piezo's
Speed	+	+++	+++ (100Hz)	100x faster than motorized Z
Travel Range	+++	+	++	e.g. 600 μm with 40x objective
Compactness	+	++	+++	No table-top controller
Vibrations	+	+	+++	No vibrations
Thermal Drift	+	+	+++	Temp. comp. sensor

# Typical applications & market potential



## Entocentric (fixed focal length) lenses



Package sorting



Bin picking



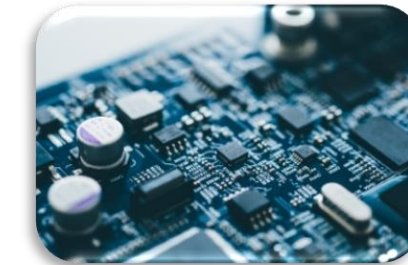
Contact lens inspection



Robot vision



Bottle inspection



Electronics inspection



Medical

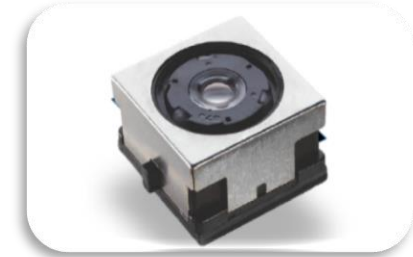


Jewel inspection

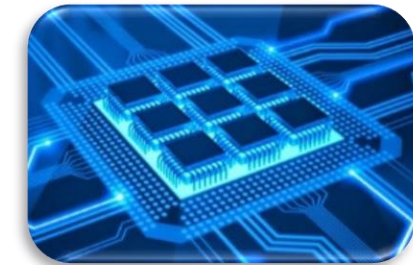


Solar Panels

## Telecentric lenses



CCM inspection



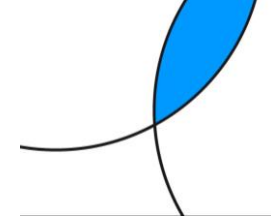
IC inspection



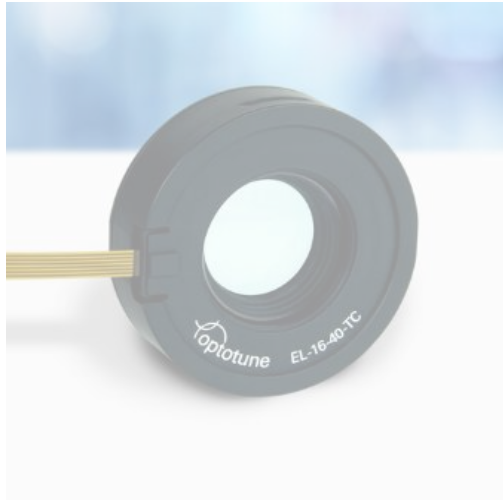
Particle Counting

# Product Portfolio

Our solutions for Machine Vision

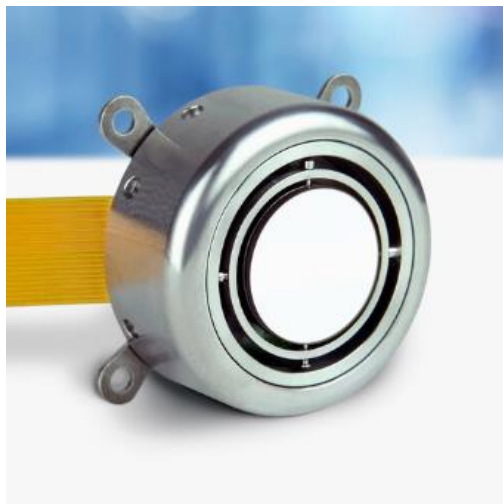


## Focus tunable lenses



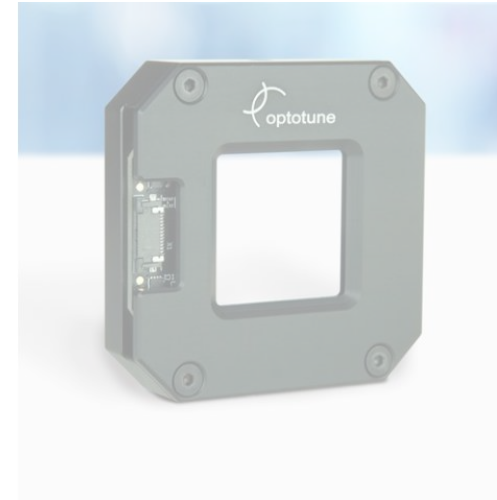
- Fast autofocus
- Fast detection
- Image stacking

## Beam steering devices

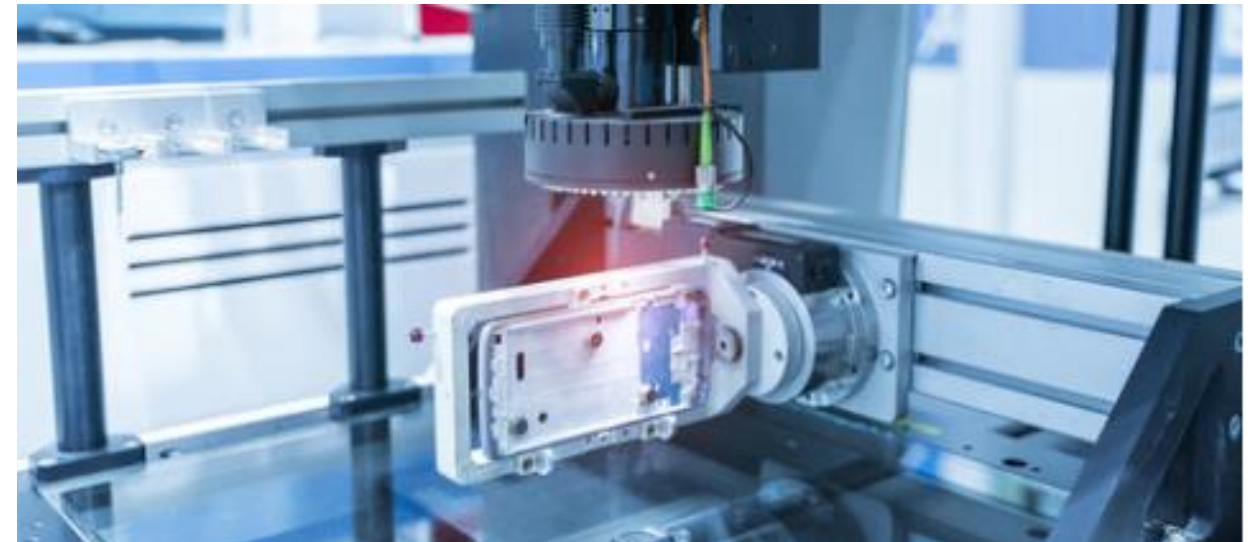


- Sole reflection
- Wide angular range
- Compact

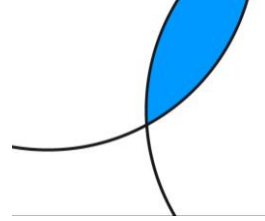
## Beam shifting devices



- Fast transition time
- Reliable over time
- Beam shifts up to 4.8um



# Optotune's fast steering mirrors



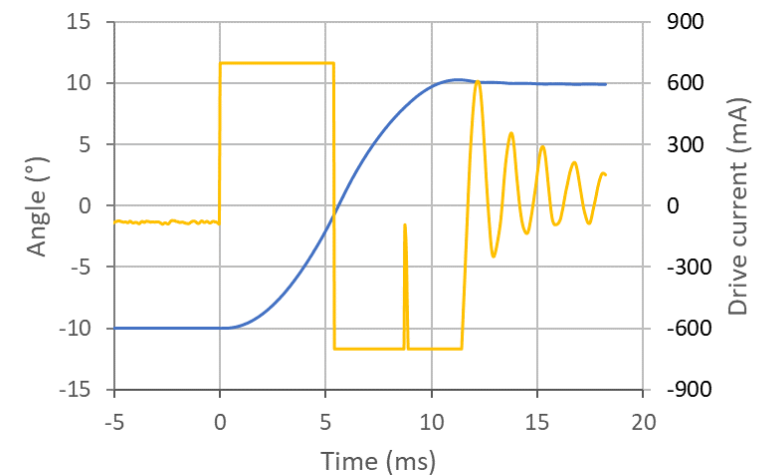
## Specifications

- 2D deflection with a single reflective surface
- Large scanning angle of +/-25°
- Rotation point close to center of mass
- >1B cycles with robust voice-coil actuation
- High repeatability of 40  $\mu$ rad (optical feedback)
- Response time of few milliseconds



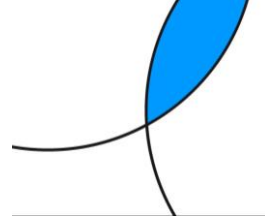
## Benefits

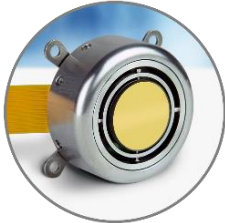

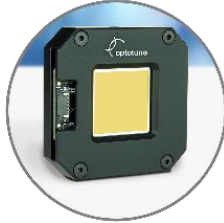

- Most compact scanning solution
- Field of view up to 100°
- Insensitive to shock & vibrations
- Long Lifetime
- Accurate closed loop control
- Vector scanning, point & shoot with high throughput



MR-15-30  
Step response

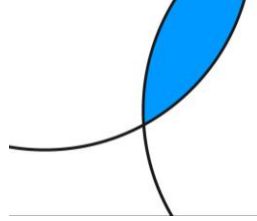
# Optotune has extended its mirror portfolio

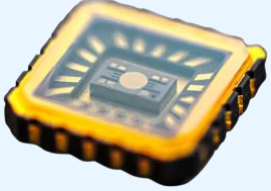

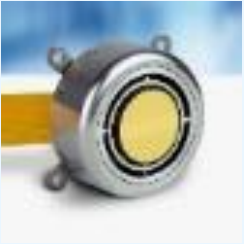


	<b>MR-15-30</b>	<b>MR-10-30</b>	<b>FMR-20</b>	<b>MR-50</b>
				
# axis	2D	2D	2D	1D
Mirror size	Ø15 mm	Ø10 mm	20x20 mm <sup>2</sup>	55x50 mm <sup>2</sup>
Mechanical tilt – 1. axis (half angle)	25°	12.5°	0.2°	30°
Full-scale bandwidth – 1. axis	20 Hz	250 Hz	250 Hz	10 Hz (triangular)
Mechanical tilt – 2. axis (half angle)	25°	25°	0.2°	--
Full-scale bandwidth – 2. axis	20 Hz	20 Hz	250 Hz	--
Mech. Repeatability RMS	40 µrad	40 µrad (1. axis)	--	600 µrad estimated
Resolution	22 µrad	22 µrad	4 µrad	150 µrad
Footprint	30x14.5	30x14.5	50.8 x 50.8 x 12	67.5 x 70 x 45
Position feedback	yes	yes	no	yes

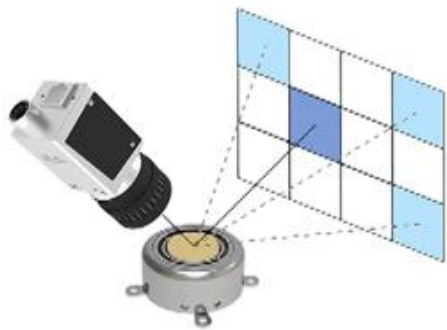
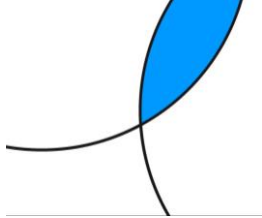
# Current solutions

## To steer your beams



	<b>MEMS</b>	<b>Galvos</b>	<b>Fast Steering Mirrors</b>
			
Real 2D	Yes	No (2x 1D)	Yes
Mirror size	3-7 mm	5-30 mm	15 mm/10 mm
Package size	15-30 mm	60-240 mm	30 mm
Mech. half angle	5-11 deg	10 deg	25 deg
Repeatability	10-500 microrad	2-15 microrad	40 microrad
Full stroke frequency	100-300 Hz	300-600 Hz	20 Hz

# Typical applications & market potential



Area of Interest



Surveillance



Traffic sign monitoring

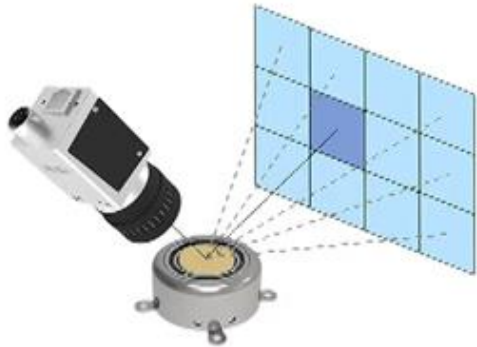
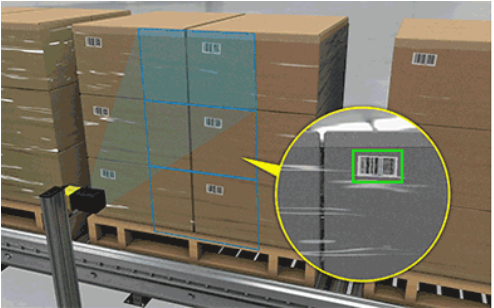


Image stitching



Driver attention monitoring

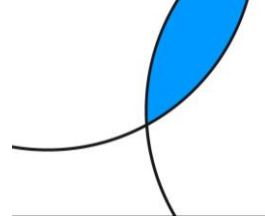


FOV expansion

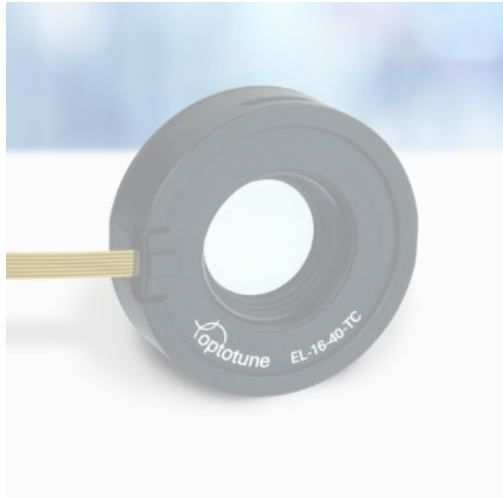


# Product Portfolio

Our solutions for Machine Vision



## Focus tunable lenses



- Fast autofocus
- Fast detection
- Image stacking

## Beam steering devices

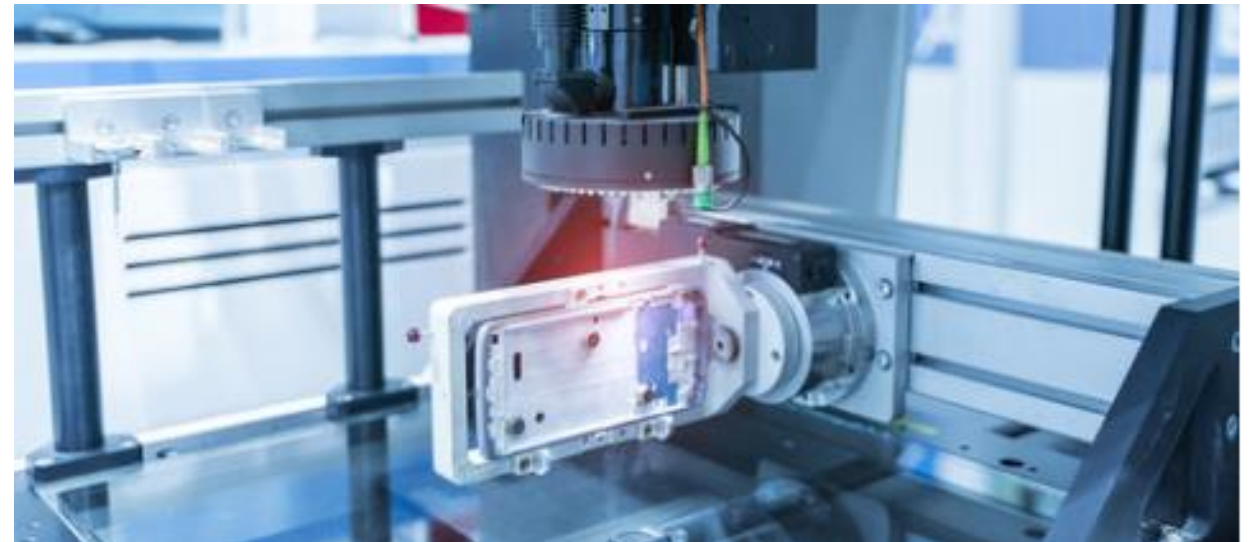


- Sole reflection
- Wide angular range
- Compact

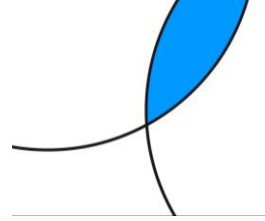
## Beam shifting devices



- Fast transition time
- Reliable over time
- Beam shifts up to 4.8um



# Beam shifting windows for resolution enhancement



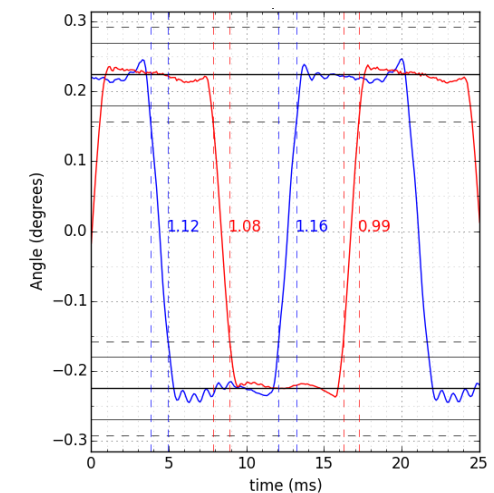
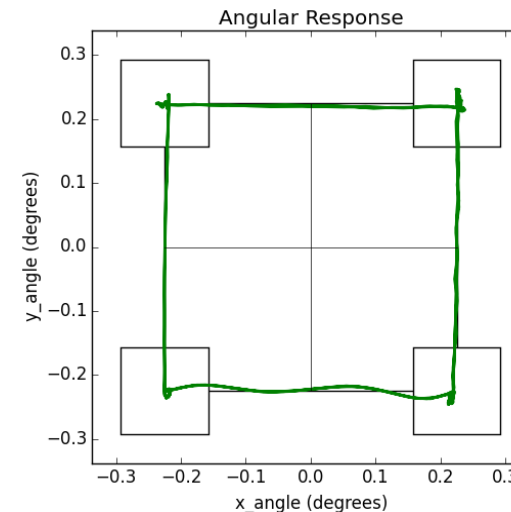
## Specifications

- Clear apertures from 9 to over 40 mm
- Tilt angle up to  $0.9^\circ$ , beam shifts up to  $5.4 \mu\text{m}$
- Transition times down to 1ms
- Beam shift accuracy of 10%, pre-calibrated
- Acoustic noise below 20 dBA at 30cm
- Lifetime beyond 20'000 hours

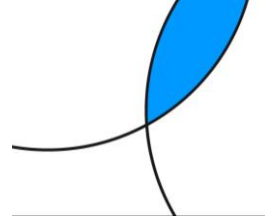


## Benefits

- Several DLP and image sensor sizes supported
- Pixel sizes of up to  $10.8 \mu\text{m}$  supported
- Little light loss during switching
- Consistently high optical performance
- Silent operation
- Suitable for 24/7 operation



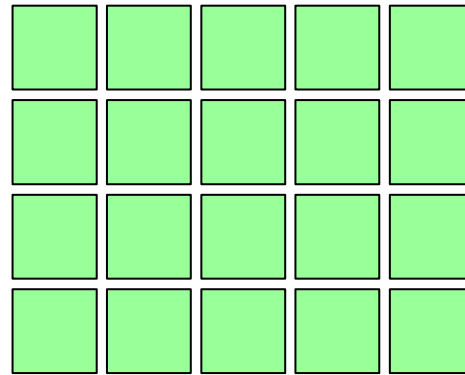
# Extended Pixel Resolution (XPR) principle



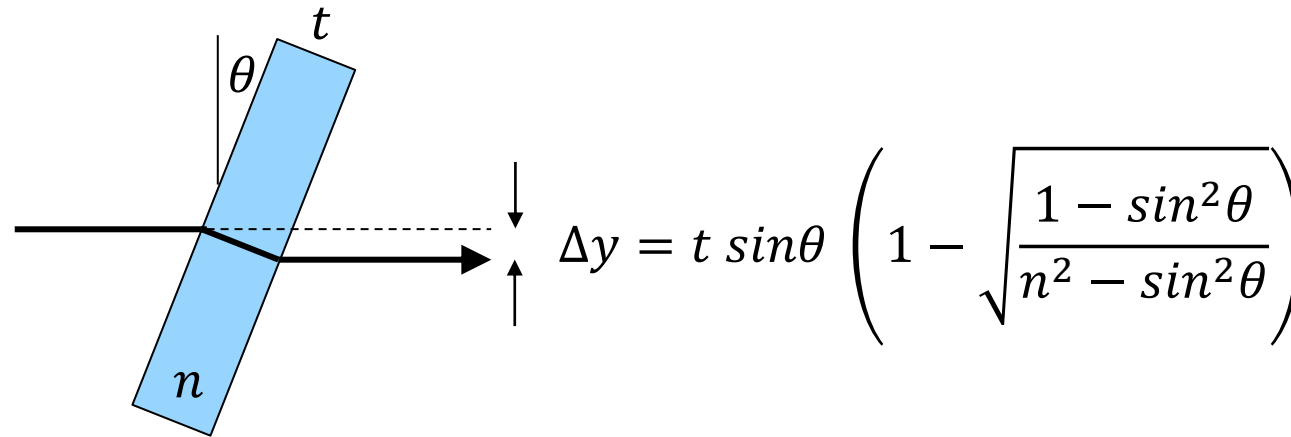
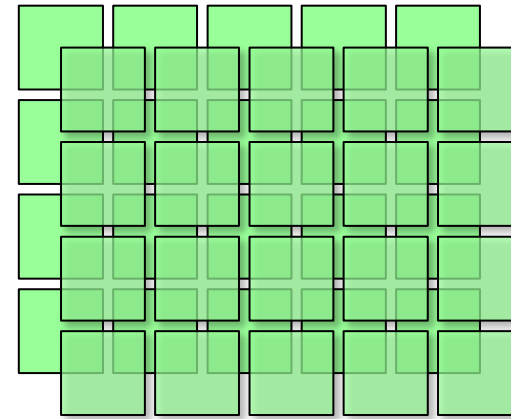
**Resolution increase with 1D shift**

**Image shift**

Native resolution  
e.g. 1280x720

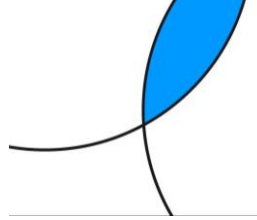



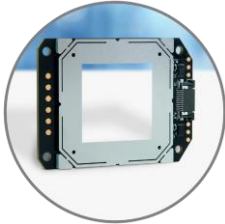
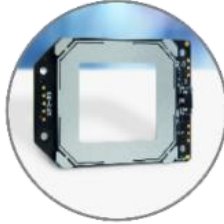

Increased resolution  
e.g. 1920x1080



Example: A 0.7mm thick BK7 window tilted by 1° achieves a shift of 4μm

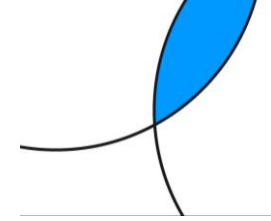
# XPR overview

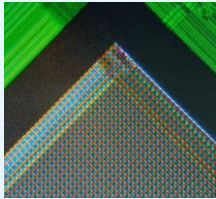

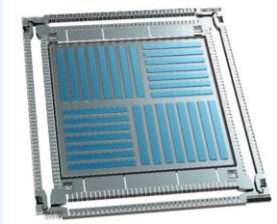
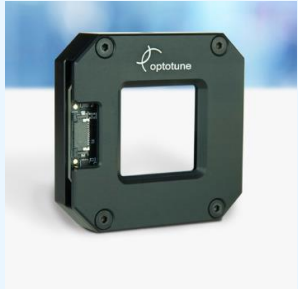


	<b>XPR-9-2P</b>	<b>XPR-20-4P</b>	<b>XPR-33-4P</b>	<b>XPR-4X-4P</b>
				
Clear aperture size	9x5 mm	20x20 mm	33x31 mm	Custom designs up to 55 mm
Window tilt angle (standard operation)	0.9°	0.2°	0.3°	0.3°
Beam shift in transmission	3.8 μm (diagonal)	2.7 μm in X & Y	3.8 μm in X & Y	5.4 μm in X & Y
Transition time	1.0 ms	1.2 ms	1.4 ms	1.1ms
Applications	Pico projectors, HMDs	4K Laser TV, 3D printers	High-lumen 4K projectors	Digital cinema, 3D printers

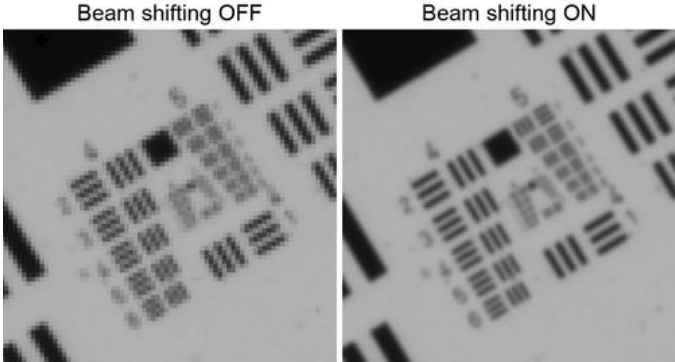
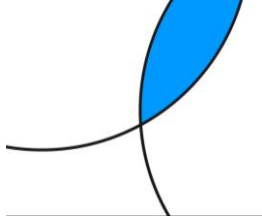
# Current solutions

## To increase camera resolution

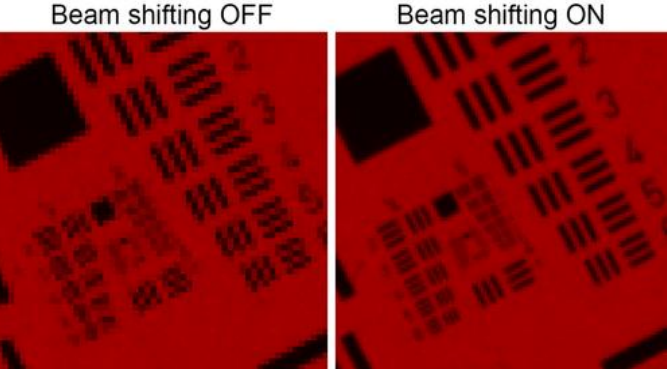


	Smaller pixels	Larger Sensor, bigger optics	Sensor shift	Image shift	
					
Frame rate	++	++	+	+	
Light sensitivity (signal to noise)	-	+	+	+	Larger pixels can be used
Flexibility (VIS, SWIR, IR)	-	-	+	++	Can be integrated into objective, or miniaturized into camera
Price	\$ - \$\$	\$\$	\$ - \$\$	\$ - \$\$	
Price of compatible optics	\$	\$\$	\$	\$	

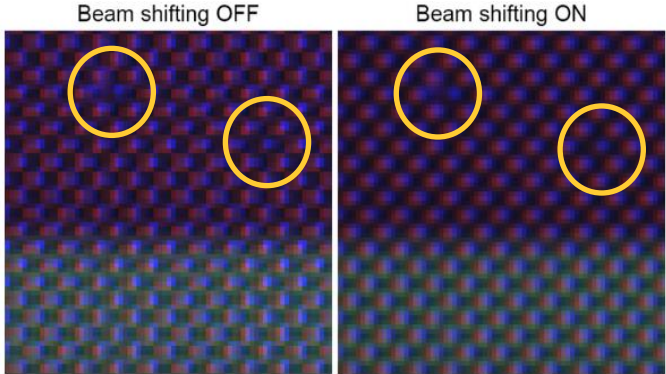
# Typical applications & market potential



High resolution (monochrome)



High resolution (color camera)



Display inspection



3D printing



3D scanning

ONE MILLION LENSES IN ONE



**OPTOTUNE EL-16-40 LIQUID LENS**

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