



6<sup>TH</sup> November 2014

# Inspection, optical measurement and illumination solutions for the automotive parts manufacturing industry

**M. Castelletti** – *Product Manager*

# Table of contents

1

**Who we are**

2

**Optics and Illumination basis**

3

**Application Cases**

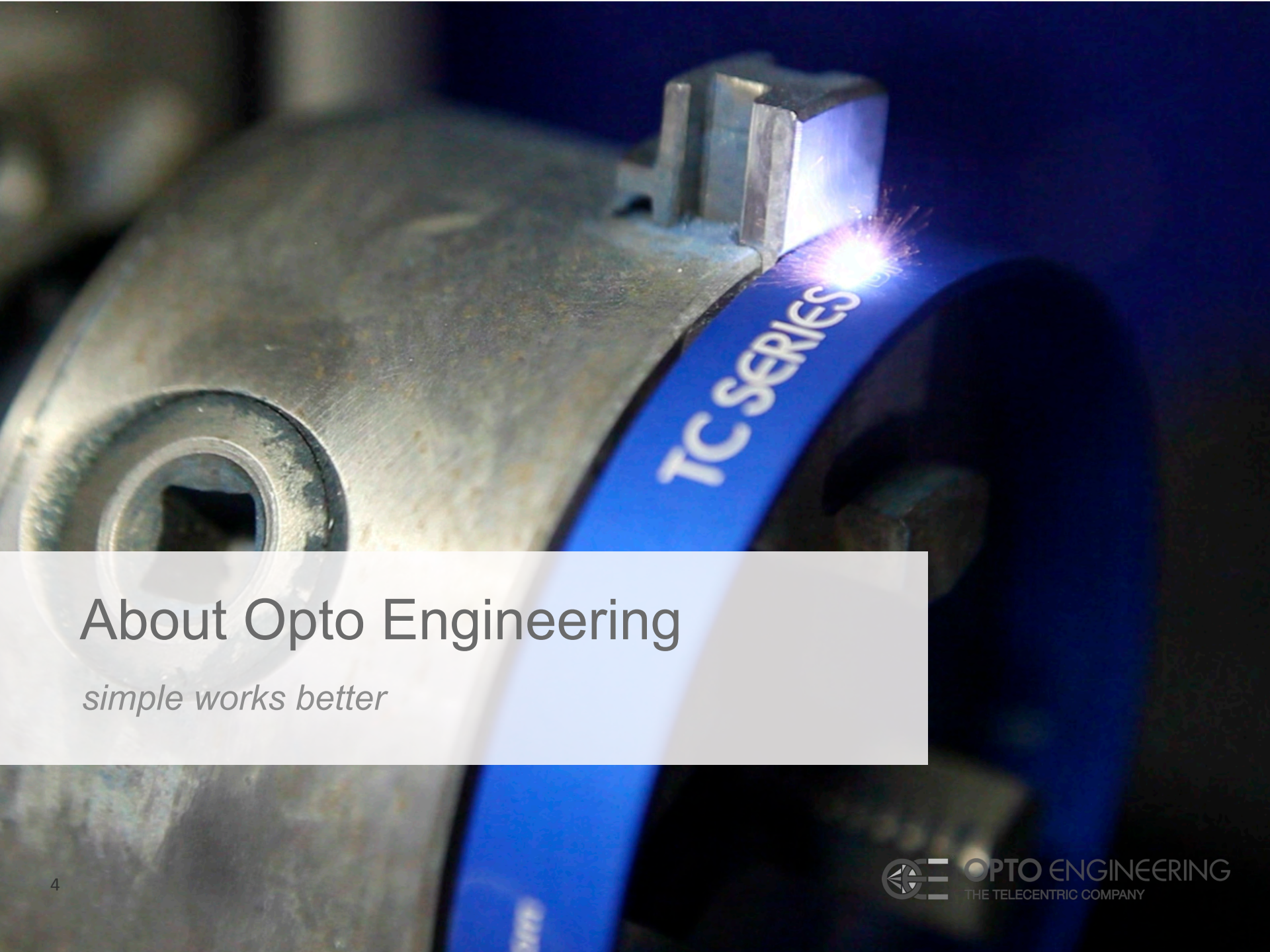


# Table of contents

**1 Who we are**

**2 Optics and Illumination basis**

**3 Application Cases**



TC SERIES

# About Opto Engineering

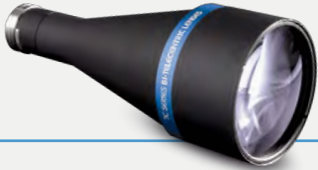
*simple works better*



# About Opto Engineering

## WHO WE ARE

Opto Engineering designs and manufactures optical and illumination systems for the machine vision industry since 2002.



**Telecentric**

2003



**360° optics**

2009



**Zoom**

2011



**Illuminators**

2014



# Global presence

# Table of contents

1

Who we are

2

Optics and Illumination basis

3

Application Cases

# Introduction

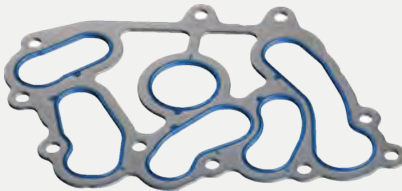
## CRITICAL AUTOMOTIVE PARTS



Crank shaft



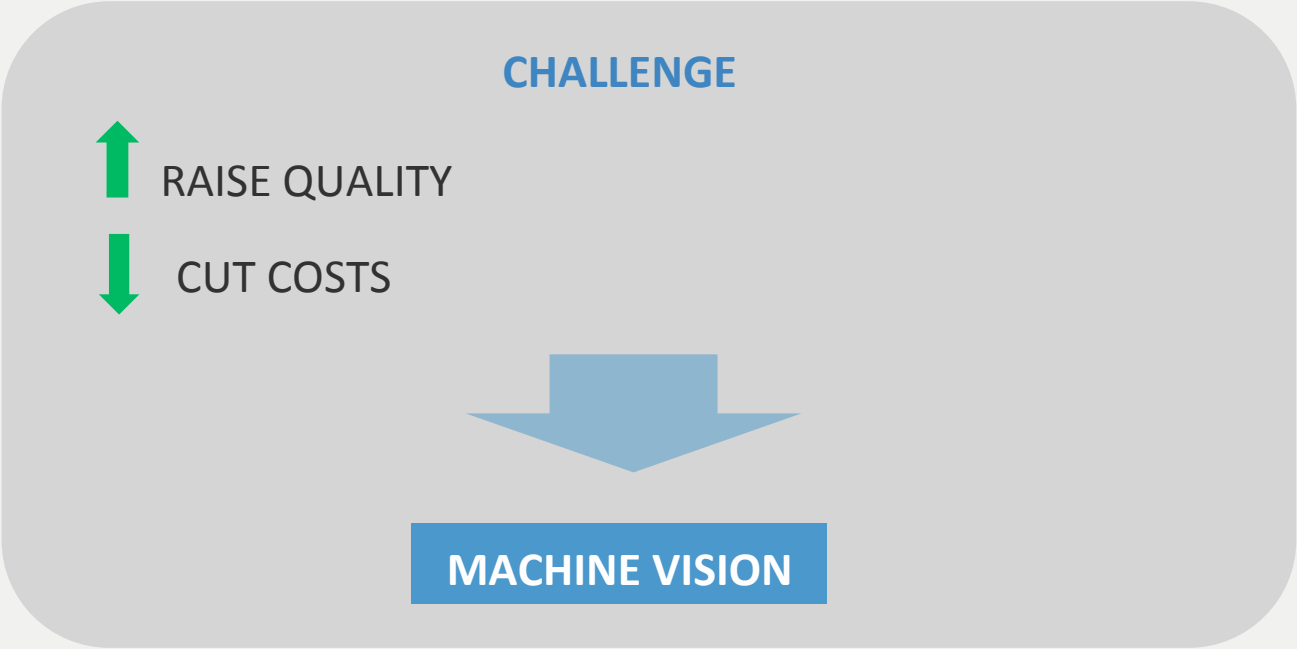
Connecting rod



Gasket



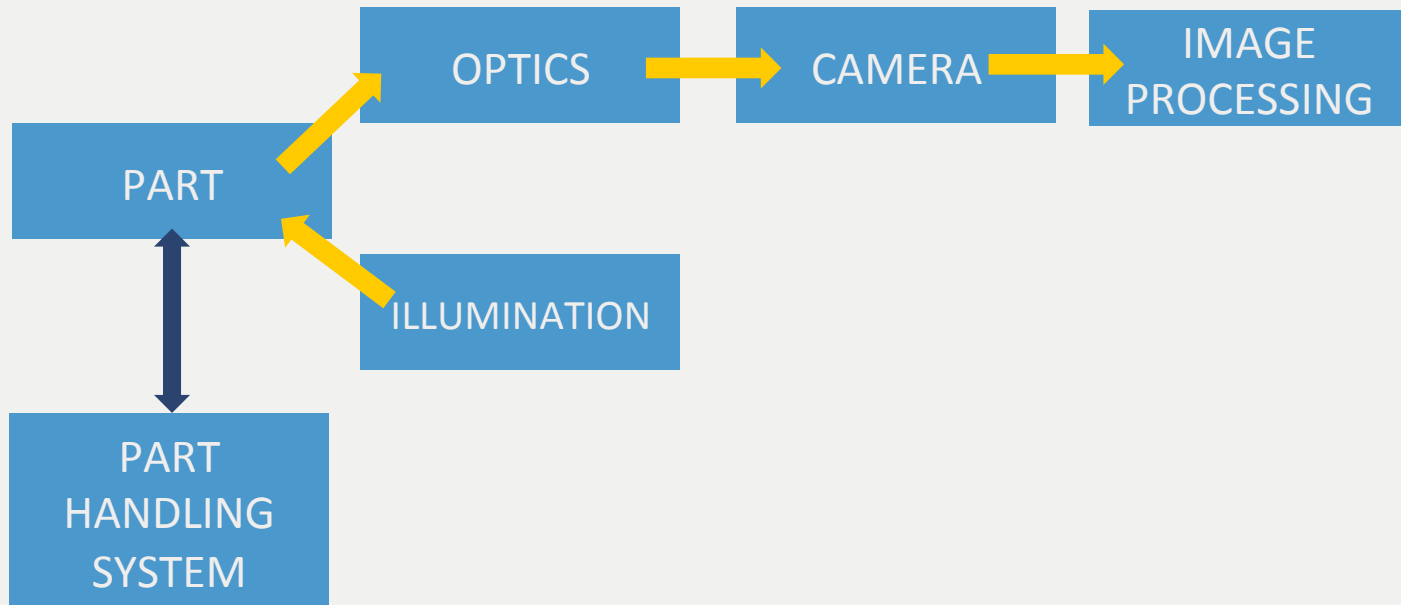
O-ring





# Introduction

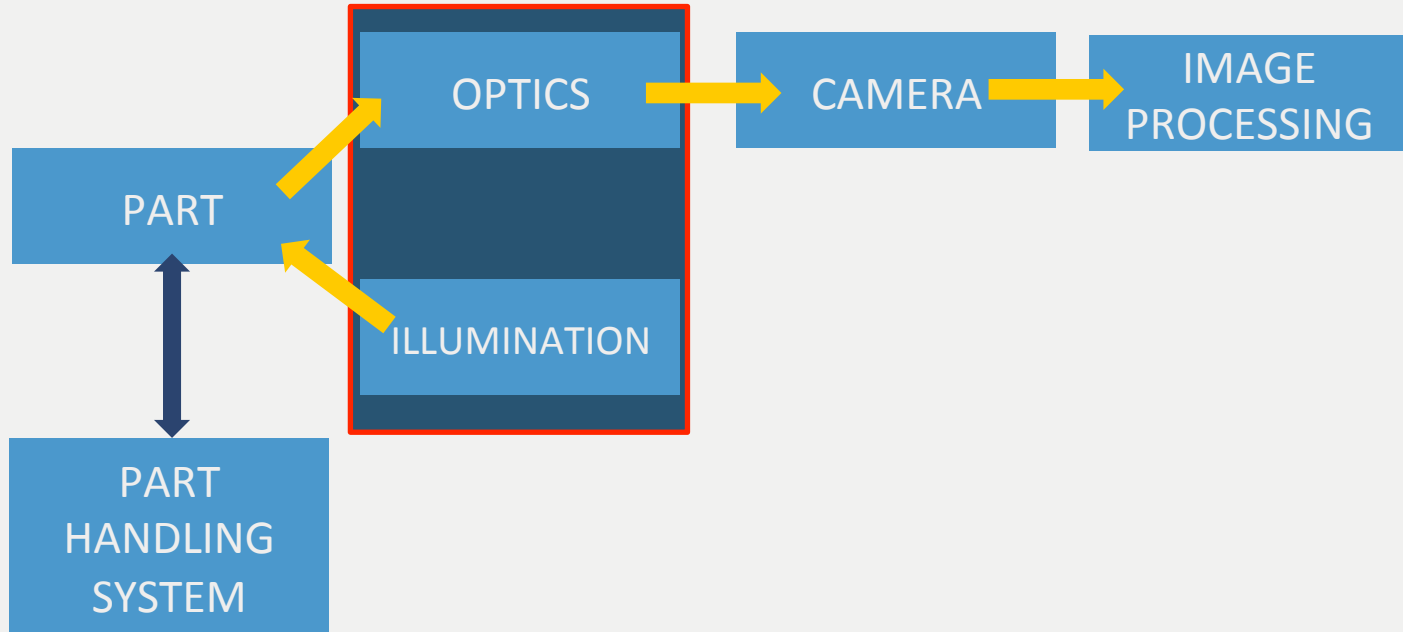
## MACHINE VISION SYSTEM – KEY COMPONENTS



Machine vision systems are like a chain: *only as strong as their weakest link*

# Introduction

## MACHINE VISION SYSTEM – KEY COMPONENTS



Machine vision systems are like a chain: *only as strong as their weakest link*

**IT'S ALL ABOUT LIGHT**

**Optics and illumination can often be the limiting factor in a system's performance**

# Optics – basic lens types

**ENTOCENTRIC**

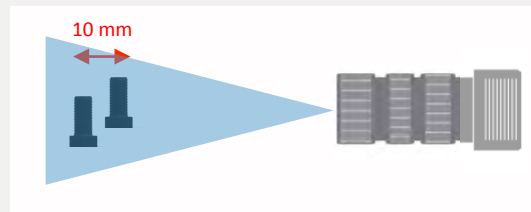
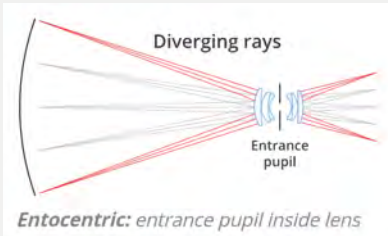
**TELECENTRIC**

**PERICENTRIC**



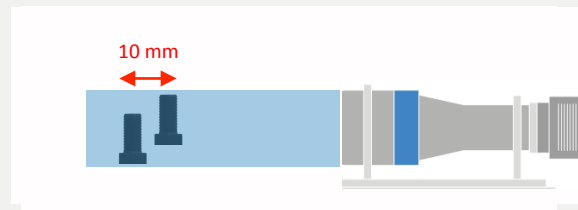
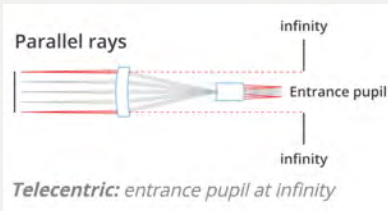
# Optics – basic lens types

## ENTOCENTRIC



# Optics – basic lens types

## TELECENTRIC



Telecentric lenses are required for any dimensional measurement imaging application

# Optics – basic lens types

## TELECENTRIC

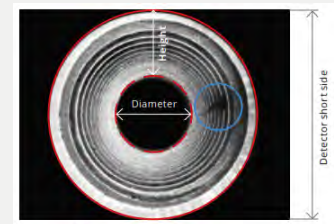
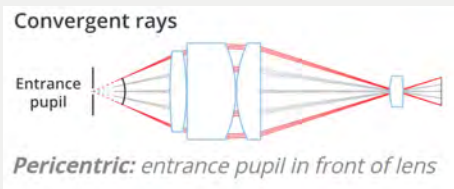
### WHEN TELECENTRIC LENSES SHOULD BE USED

- When a thick object (thickness  $> 1/10$  FOV diagonal) must be measured
- When different measurements on different object planes must be carried out
- When the object-to-lens distance is not exactly known or cannot be predicted
- When holes must be inspected or measured
- When the profile of a piece must be extracted
- When the image brightness must be very even
- When a directional illumination and a directional “point of view” are required



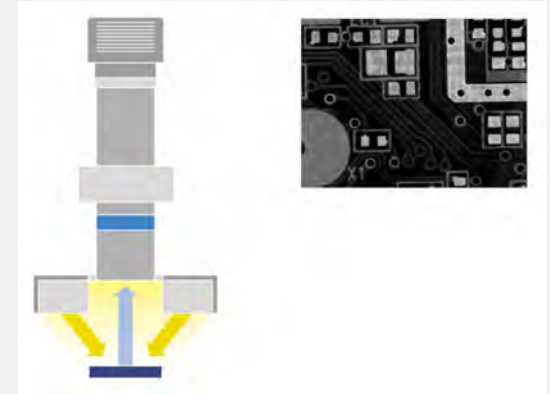
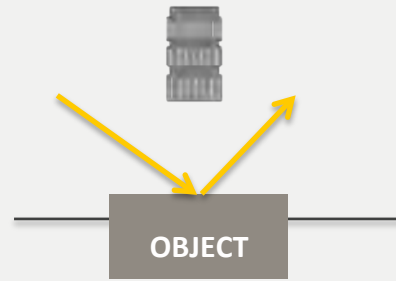
# Optics – basic lens types

## PERICENTRIC

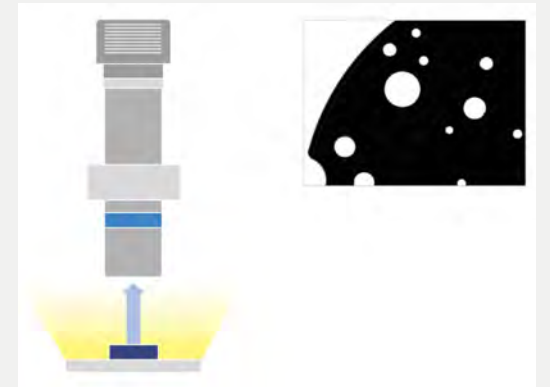
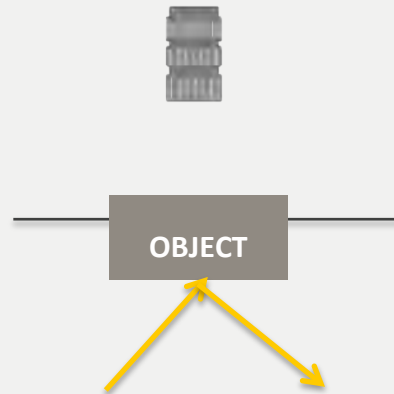


# Illumination – basic illumination techniques

FRONT LIGHT ILLUMINATION



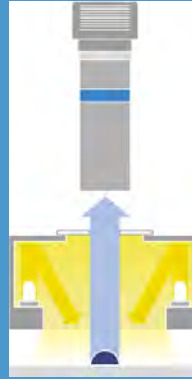
BACK LIGHT ILLUMINATION



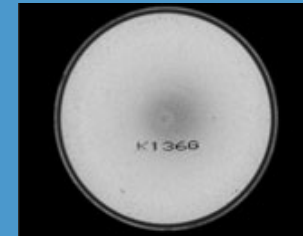
# Illumination – basic illumination techniques

FRONT LIGHT ILLUMINATION

BACK LIGHT ILLUMINATION



**DIFFUSED DOME- Bright field**



For complex shapes with curved and shiny surfaces



**LOW ANGLE RING LIGHTS- Dark field**



To enhance surface features or textures

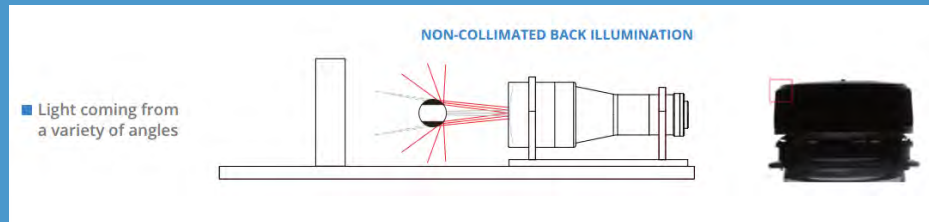


# Illumination – basic illumination techniques

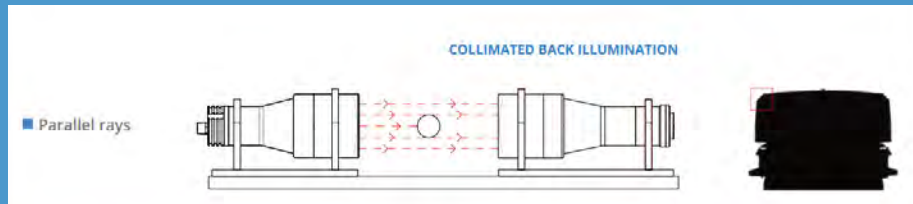
FRONT LIGHT ILLUMINATION

BACK LIGHT ILLUMINATION

## DIFFUSED BACKLIGHT



## TELECENTRIC BACKLIGHT



- Border effects removal - Enhanced Field Depth

# Table of contents

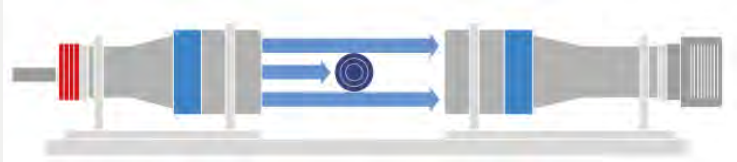
**1** Who we are

**2** Optics and Illumination basis

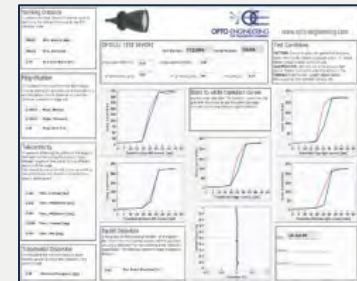
**3** Application Cases

# Applications – CASE 1

PRODUCT: Telecentric lens + telecentric illuminator



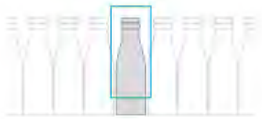
- BI telecentricity
- Nearly zero distortion
- Excellent resolution
- Simple and robust design (fixed aperture)
- Detailed test report with measured optical parameters
- Matching telecentric illuminator





# Applications – CASE 1

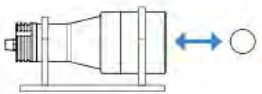
Product: Telecentric lens + telecentric illuminator



- **High speed** production lines  
The high throughput allows for shorter exposure times



- **Silouetting** and for detecting edges and defects  
Elimination of blurred edges caused by diffuse reflections



- **Increased distance** between object and illumination source



- **Precision measurements**  
where accuracy, repeatability, and throughput are key factors

- **Complete light coupling**  
very high signal-to-noise ratio
- **Border effects removal**  
collimated rays are typically much less reflected
- **Field depth and telecentricity improvement**  
Collimated illumination geometry increases a telecentric lens natural field depth

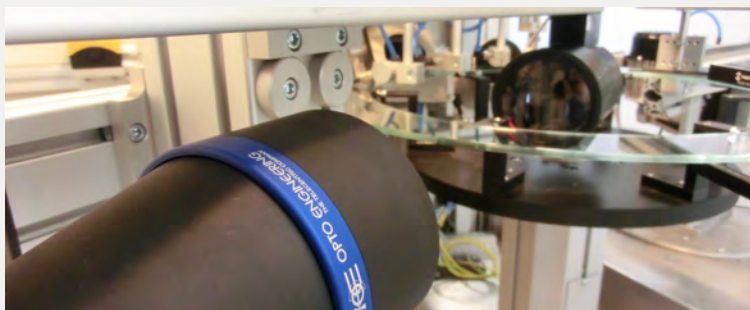
# Applications – CASE 1

PRODUCT : Telecentric lens + telecentric illuminator



## Application: Videochek VVC811

Measuring and sorting of low-size turned or pressed parts wherever high throughput is required with very high accuracy



Turned pressed parts flat formed part

| VVC811             |   |
|--------------------|---|
| Camera             | 5 MP CCD Matrix B/W   |
| Resolution         | Up to 2452 x 2054 pixels  |
| Accuracy           | Depending on camera resolution and image areas size, e.g.<br>32x24 mm < 0,01 mm with 780 x 580 pixels<br>32 x 24 mm < 0,003 mm with 2452 x 2054 pixels, each with subpixel factor 4 |
| Performance        | Up to 700 parts /min (depending on part size and feeding system)  |
| Rotary table drive | Programmable servo drive with safety clutch   |
|                    | Factory calibration certificate   |
|                    | Granite / aluminium sandwich design   |

Inspection images with scanings



Measuring value display

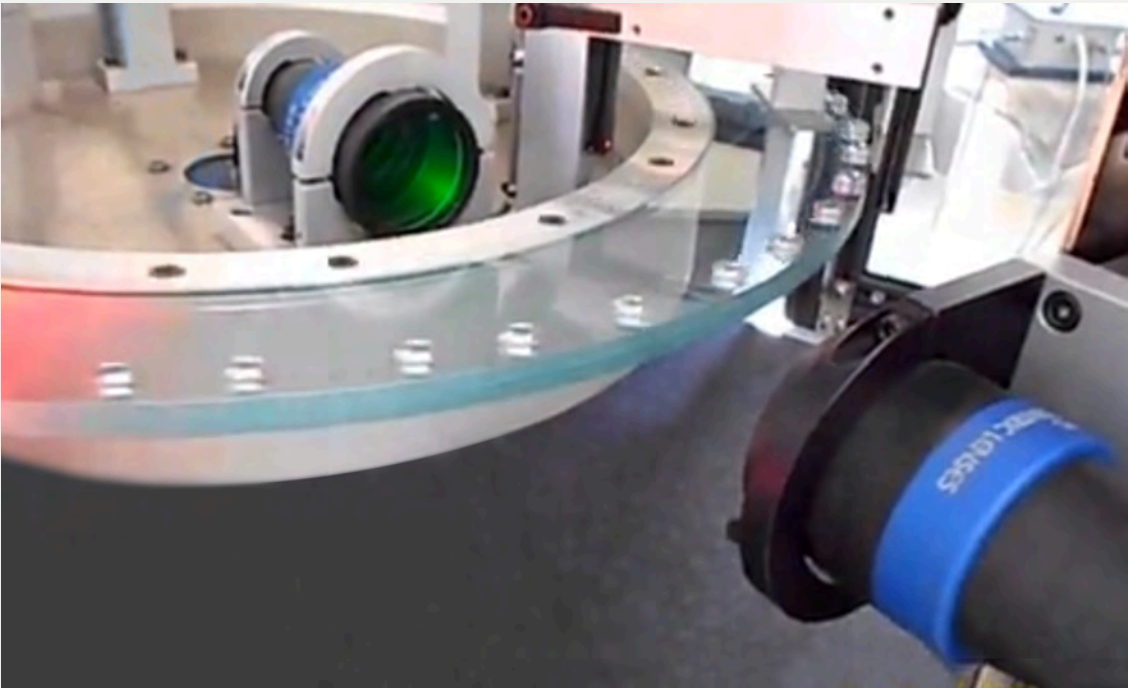
Image courtesy VESTER Elektronik

# Applications – CASE 1

Product: Telecentric lens + telecentric illuminator

**Application:**

Inspection Machine for nuts with rotary glass table

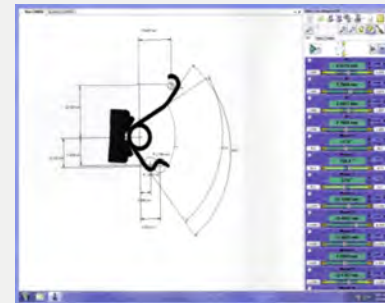
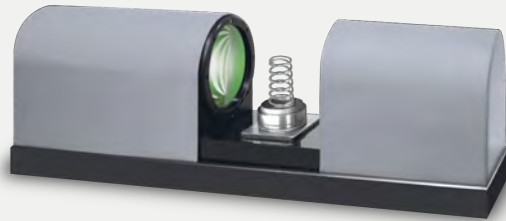


# Applications – CASE 1

Product: Telecentric lens + telecentric illuminator

## Application

OFF LINE optical devices for coil / spring measurement



| Model | Field of View | Test Accuracy    | Smallest allowable thickness |
|-------|---------------|------------------|------------------------------|
| A     | 61 x 51 mm    | 0.008 mm + 0.05% | 0.15 mm                      |
| B     | 90 x 75 mm    | 0.01 mm + 0.05%  | 0.25 mm                      |
| C     | 138 x 115 mm  | 0.01 mm + 0.05%  | 0.3 mm                       |



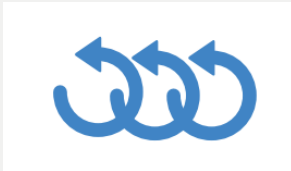
# Applications – CASE 2

Product: TCZR072

8X 4 STEP MOTORIZED BI-TELECENTRIC ZOOM LENS FOV: 72 mmm



One of the most important parameters in specifying motorized zoom lenses is:



## MAGNIFICATION REPEATABILITY

Magnification repeatability shows to what extent the lens will achieve:

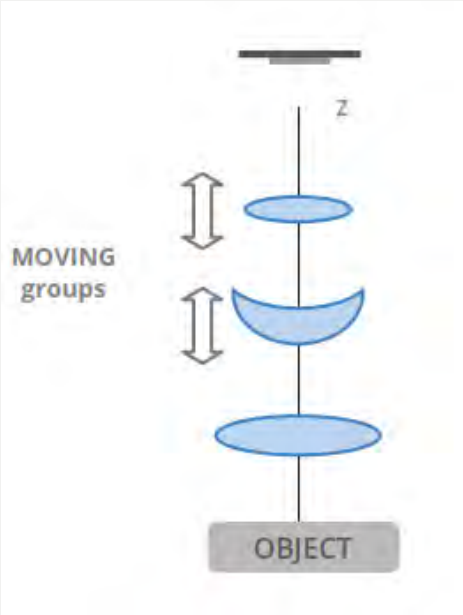
the same magnification over a number of zoom cycles

# Applications – CASE 2

Product: TCZR072  
8X 4 STEP MOTORIZED BI-TELECENTRIC ZOOM LENS FOV: 72 mm



Conventional zoom



Magnification change achieved through  
Lens displacement along the axial position



Uncertainty about the lens position along the z axis  
limits to the lens position resolution along the z axis



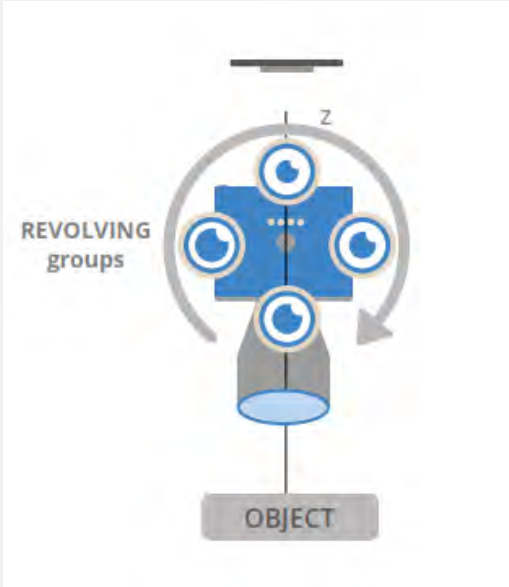
**UNCERTAINTY**  
about  
magnification repeatability

# Applications – CASE 2

Product: TCZR072  
8X 4 STEP MOTORIZED BI-TELECENTRIC ZOOM LENS FOV: 72 mmm



TCZR



Magnification change achieved through  
Internal carousel



No uncertainty  
about the lens position along the z axis



UNMATCHED REPEATABILITY  
MAGNIFICATION CONSTANCY

# Applications – CASE 2

Product: TCZR072

8X 4 STEP MOTORIZED BI-TELECENTRIC ZOOM LENS FOV: 72 mmm



PERFECT MAGNIFICATION CONSTANCY  
**No need of re-calibration,after zooming**

EXCELLENT IMAGE CENTER STABILITY  
**Each magnification maintainsits FOV center**

PERFECT PARFOCALITY  
**No need of refocusing when changing magnification**

**4X FLEXIBILITY**  
**Provides 4 different magnifications**



**Ease of use**  
**Increased reliability**  
**Time saving**

# Applications – CASE 2



**Product: TCZR072**

**8X 4 STEP MOTORIZED BI-TELECENTRIC ZOOM LENS FOV: 72 mm**

## Application: V-CAD Rapid

Optical device for the measuring of 2D geometries in back and surface lights for the measurement of length, diameter, distance, radii, angle, thread, groove, contour generation, CAD comparison...



| SPECS V-CAD RAPID              |   |
|--------------------------------|---|
| Objective                      | Telecentric 4-step motorised zoom lens  |
| Field of View X/Y              | 4 different fields of view for spot-on measurement<br>65.5 x 55 mm - 32.5 x 27.5 mm - 16 x 13.5 mm - 8 x 6.5 mm |
| Magnification                  | 0,125x – 0,25x - 0,5x – 1,0 x   |
| Depth of field                 | 45,0 mm – 11,0 mm – 2,80 mm – 0,70 mm   |
| Focus length Z                 | 50 mm   |
| Working Distance               | 150 mm  |
| Repeatability                  | 0,001 mm  |
| Length measurement uncertainty | $E2 = 3.5 + (L/50 \text{ mm}) \mu\text{m}$  |



## Application

- Piston rings
- Bar steel, wire
- Cutting tools for wood
- Wooden parts
- Turned parts
- Rubber sealing profile  
(also with metal part inside)
- Plastic profiles
- Aluminium profiles
- Springs
- Circuit boards
- Extrusion dies

*Image courtesy Schneider MessTechnik*



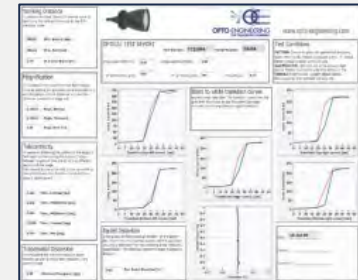
# Applications – CASE 3

Products: TC4K090 + LTCL4K090-G

Flat telecentric lenses and illuminators for 4k linescan cameras  
FOV = 90 mm



- **Compact design**  
UNIQUE “Flat” shape for easy integration
- **High telecentricity & low distortion**
- **Detailed test report** with measured optical performances
- Dedicated 45° mirror accessories
- **Enhanced field depth** when TC4K + LTCL4K are combined



# Applications – CASE 3

Products: TC4K090 + LTCL4K090-G

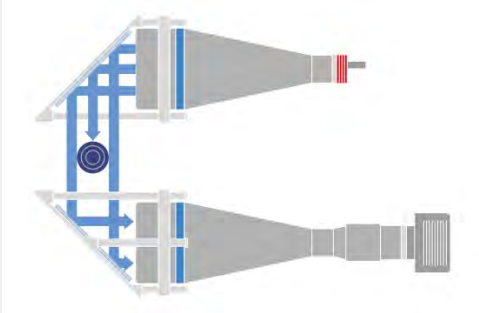
Flat telecentric lenses and illuminators for 4k linescan cameras  
FOV = 90 mm



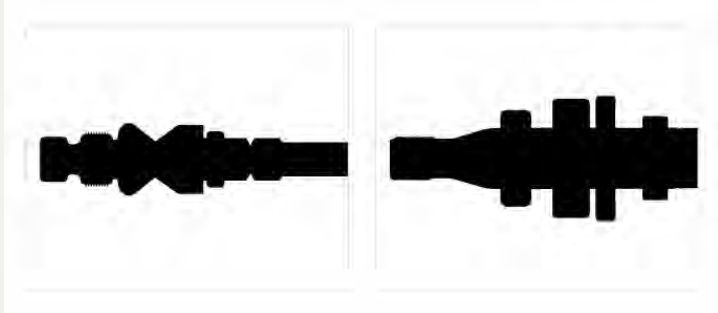
**Application:**  
SHAFT MEASURING MACHINE  
Optical device for crank shafts, gear shafts, cylinder liners/sleeves measurement



### SCHEMATICS



### IMAGES



# Applications – CASE 4

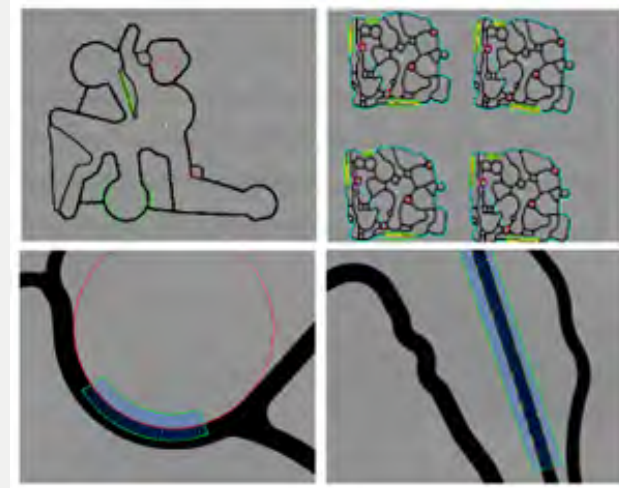
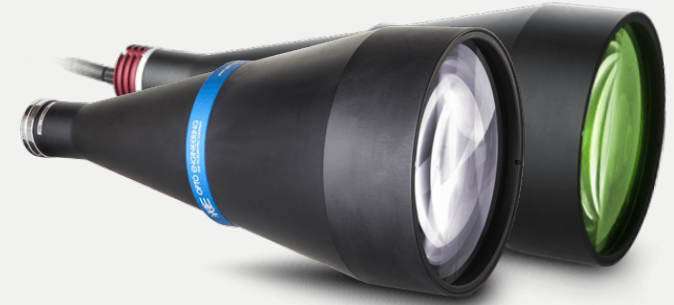
**PRODUCT:** Telecentric lens TC12096 + Collimated Illuminator LTCLHP096-G

**APPLICATION:**

Automatic visual inspection machines for sealings (circular and complex pieces) rubber gaskets, plastic items, metal parts and most other components



| SPECS  |                |
|--|----------------|
| Field of View  | 500x500 mm     |
| Max. sample dimension OD                             | Ø500 mm        |
| Min sample dimension OD                              | Ø 1,8 mm       |
| Min ID dimension                                     | Ø 0,8 mm       |
| Min CS dimension                                     | Ø 0,5 mm       |
| Resolution   | 0,001 mm       |
| Accuracy for size less than 90 mm ( $\pm 3$ sigma)   | $\pm 0,009$ mm |
| Accuracy for size bigger than 90 mm ( $\pm 3$ sigma) | $\pm 0,020$ mm |
| Max sample thickness                                 | 30 mm          |



# Applications – CASE 5

**PRODUCT: Dome + Low angle illumination system LTDMLAB2-WW**

Illumination area  $\varnothing = 60$  mm

## **Two independent illumination units in one single solution**

Dome unit for homogeneous illuminations and low angle unit for dark field lightning can be independently operated.

## **Ultra-high power light output and strobe mode only operation**

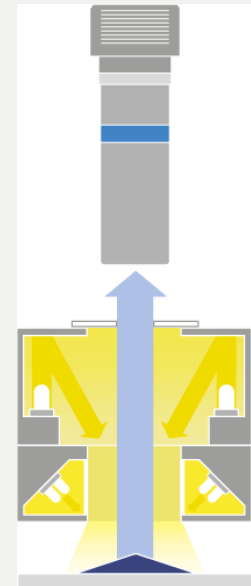
For the inspection of fast moving object and extended LED lifetime.

## **Rugged industrial design with built-in industrial connector**

For easy integration into any machine vision system.

## **Compatible LTDV strobe controllers available**

For easy and appropriate power, control and synchronization of the illuminator.



# Applications – CASE 5

**PRODUCT:** Dome + Low angle illumination system LTDMLAB2-WW

Illumination area  $\varnothing = 60$  mm

**APPLICATION:** SURFACE INSPECTION OF RUBBER, PLASTIC AND METAL SEALINGS

Type of check: - Cuts – Scratches - Inclusions - Haloes



**OBJECT**



**IMAGE**

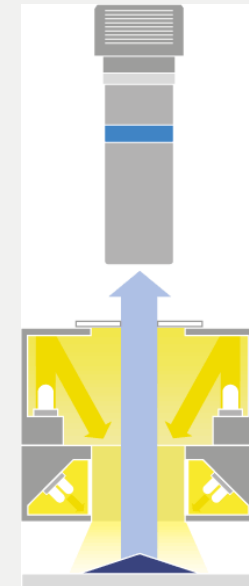
mix



dome



low angle



# Applications – CASE 5

**PRODUCT:** Dome + Low angle illumination system LTDMLAB2-WW

Illumination area  $\varnothing = 60 \text{ mm}$

**APPLICATION:** SURFACE INSPECTION OF RUBBER, PLASTIC AND METAL SEALINGS

Type of check: - Cuts – Scratches - Inclusions - Haloes



**OBJECT**

**IMAGE**



**mix**

