

# 360° VIEW OPTICS



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## The perfect solution for your machine vision inspection challenges.

One of the most recurring needs in the machine vision industry is to be able to fully inspect an object with as few cameras as possible. This request is becoming more and more common in a variety of markets, like the beverage, pharmaceutical and automotive industries.

**Opto Engineering® designed a line of incredible 360° optics** where one image is enough to view the top and side of an object or the inside of a cavity.

**Most of these special optics are unique designs patented by Opto Engineering®,** with exceptional build quality and unmatched optical performance.



Refer to specific datasheets available at [www.opto-e.com](http://www.opto-e.com) for product compliancy with regulations, certifications and safety labels.





# PC series

Pericentric lenses for 360° top and lateral view with just one camera



## KEY ADVANTAGES

### Just one camera

No need for multiple cameras placed around and over the object.

### Fast image analysis

No image matching software is needed as the picture is not segmented.

### Single point of view

No perspective effects typical of multi-image systems.

### Smooth on-line integration

Inspected parts pass unobstructed in the free space below the lens.

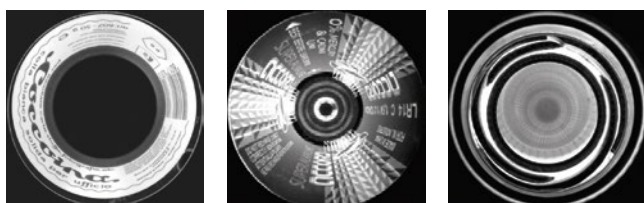
**PC pericentric lenses** are unique optics designed to perform complete inspection of objects up to 60 mm in diameter, quickly and reliably.

The innovative design allows one camera to see **the top and lateral surfaces** of an object in perfect focus all in one image. This allows you to greatly simplify the layout of the vision system, with no need for multiple cameras, lenses or mirrors.

The term pericentric comes from the specific path of the light rays: the lateral surface of the object appears to be wrapped around the top face, making the PC series ideal for cylindrical objects which are very common in the beverage and pharmaceutical industry.

Typical applications include bottleneck thread inspection, and data matrix reading - the code will always be properly imaged regardless of its position.

## Sample images taken with PC optics



## FULL RANGE OF COMPATIBLE CAMERAS



Area scan cameras

p. 196-205

## DEDICATED COMPATIBLE OBLIQUE RINGLIGHTS



LTRN 210x20, LTRN 245x25

p. 148-151

**NEW** - High power version:  
LTRNHP210x20, LTRNHP245x25

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## DEDICATED CLAMPING MECHANISMS FOR PCxx030XS



CMHO080

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## FULL RANGE OF COMPATIBLE STROBE CONTROLLERS

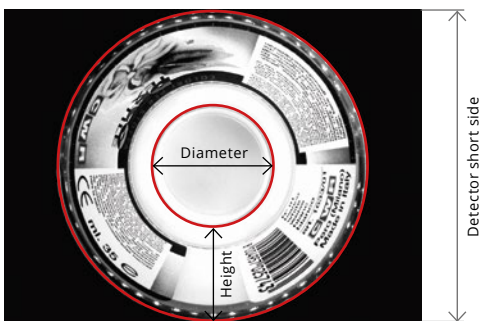
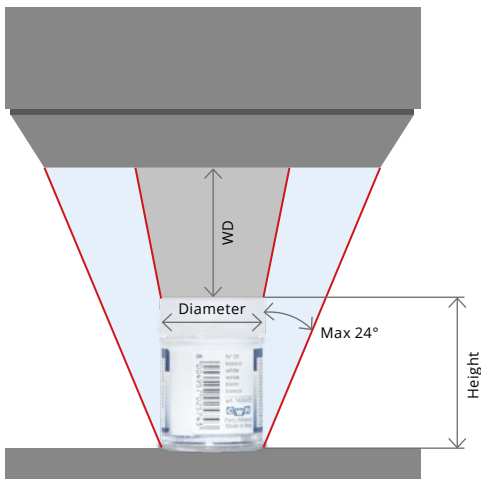
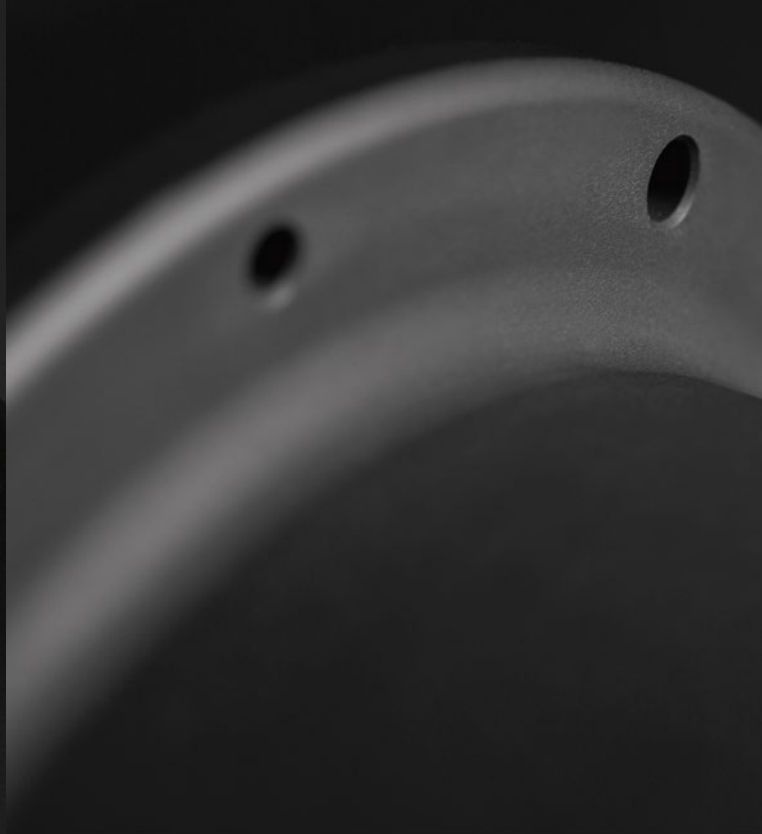


LTDV series

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## SETUP

Please refer to our website for setup instructions.  
[www.opto-e.com](http://www.opto-e.com)



$$r (\%) = \frac{\text{Side view height (px)}}{\text{Detector short side (px)}} * 100$$



Unwrapped image.

**PC optics** are designed to work with 1/3", 1/2" and 2/3" detectors. These detectors ensure the most appropriate optical magnification factor to achieve the field depth required by high resolution 3D pericentric imaging.

The image of the top of the object and its sides are inscribed into the short side of the camera detector.

The smaller the object diameter, the larger the object height which can be inspected, while short objects can be inspected over a larger diameter.

The tables below show possible combinations of object diameters and heights along with the appropriate working distance and recommended F-number; the "r" parameter for each configuration is also listed.

The "r" parameter is the ratio between the side view height (the circular crown thickness) and the detector short side. It provides information about side view resolution. The higher the "r" value, the higher the resolution that can be achieved in the side view.



# PC series

Pericentric lenses for 360° top and lateral view with just one camera



## EXTENDED RANGE

Compact PC xx030XS lenses for inspection of objects with diameter down to 7.5 mm.

Part number		PC 13030HP	PC 12030HP	PC 13030XS	PC 12030XS	PC 23030XS
<b>Detector type</b>		<b>1/3"</b>	<b>1/2"</b>	<b>1/3"</b>	<b>1/2"</b>	<b>2/3"</b>
Image circle	Ø (mm)	3.6	4.8	3.6	4.8	6.6
<b>Field of view</b>	<b>(diam x height)</b>					
Min	(mm x mm)	20 x 60	20 x 60	7.5 x 5	10 x 5	15 x 5
Typical	(mm x mm)	30 x 30	30 x 30	30 x 30	30 x 30	30 x 30
Max	(mm x mm)	60 x 20	60 x 20	55 x 20	55 x 15	55 x 12
<b>Optical specifications</b>						
Wavelength range	(nm)	450 .. 650	450 .. 650	450 .. 650	450 .. 650	450 .. 650
Working distance	(mm)	20 .. 80	20 .. 80	20 .. 85	20 .. 80	20 .. 80
CTF @ 50 lp/mm	(%)	> 30	> 25	> 40	> 30	> 25
F/#		4-16	4-16	4-16	4-16	4-16
<b>Mechanical specifications</b>						
Diameter (max)	(mm)	197	197	116	116	116
Length	(mm)	448	448	378	378	378
Weight	(g)	6800	6800	2950	2950	2950
Mount		C	C	C	C	C



PC23030XS + compatible LTRN210x20 ringlight and CMHO080 clamping mechanics.



## Field of view selection chart

### PC 13030HP field of view

Diam. (mm)	Height (mm)	WD (mm)	F/#	r (%)	Height (mm)	WD (mm)	F/#	r (%)	Height (mm)	WD (mm)	F/#	r (%)	Height (mm)	WD (mm)	F/#	r (%)	Height (mm)	WD (mm)	F/#	r (%)	Height (mm)	WD (mm)	F/#	r (%)
20	7	79	16	10	13	79	8	20	20	65	16	26	30	61	12	30	40	55	14	34	60	25	16	37
25	8	71	4	17	17	63	12	21	25	55	16	26	38	40	14	30	50	30	16	30				
30	10	65	4	13	20	55	8	19	30	42	12	25	45	35	12	29								
40	13	52	6	12	27	43	12	20	40	27	12	25												
50	17	36	6	13	33	20	8	15																
60	20	23	4	11																				

### PC 12030HP field of view

Diam. mm	Height (mm)	WD (mm)	F/#	r (%)	Height (mm)	WD (mm)	F/#	r (%)	Height (mm)	WD (mm)	F/#	r (%)	Height (mm)	WD (mm)	F/#	r (%)	Height (mm)	WD (mm)	F/#	r (%)	Height (mm)	WD (mm)	F/#	r (%)
20	7	76	16	10	13	70	24	15	20	65	24	28	30	55	16	32	40	45	24	32	60	27	24	35
25	8	72	12	11	17	63	12	18	25	54	16	28	38	40	16	32	50	29	16	32				
30	10	66	12	11	20	56	12	19	30	45	16	25	45	30	16	35								
40	13	54	6	11	27	36	16	20	40	27	24	23												
50	17	32	12	13	33	20	16	18																
60	20	22	12	11																				

### PC 13030XS field of view

Diam. (mm)	Height (mm)	WD (mm)	F/#	r (%)	Height (mm)	WD (mm)	F/#	r (%)	Height (mm)	WD (mm)	F/#	r (%)	Height (mm)	WD (mm)	F/#	r (%)	Height (mm)	WD (mm)	F/#	r (%)	Height (mm)	WD (mm)	F/#	r (%)
7.5	5	85	16	19																				
10	5	84	16	14	10	77	16	20																
15	5	75	6	10	10	70	8	15	15	65	16	20	20	60	16	22	25	54	16	24	32	45	16	28
20	10	62	8	12	20	52	14	18	30	42	14	22	40	32	16	26								
25	5	62	6	6	15	52	12	15	25	42	12	19	35	32	12	24	45	22	12	27				
30	10	52	4	9	20	42	8	17	30	32	8	20	40	22	16	23	50	12	16	27				
35	5	48	4	7	15	38	4	12	25	28	8	16	35	18	8	20	42	10	12	22				
40	10	38	4	9	20	28	4	13	30	20	8	16	37	10	16	19								
45	5	34	6	7	15	30	6	9	25	20	8	12	35	10	16	15								
50	5	25	4	8	15	20	6	9	25	10	8	13												
55	10	20	6	6	20	10	8	10																

### PC 12030XS field of view

Diam. mm	Height (mm)	WD (mm)	F/#	r (%)	Height (mm)	WD (mm)	F/#	r (%)	Height (mm)	WD (mm)	F/#	r (%)	Height (mm)	WD (mm)	F/#	r (%)
10	5	82	18	18												
15	5	73	16	14	15	63	16	23								
20	5	66	16	9	10	61	16	14	20	51	16	22				
25	10	56	12	10	20	46	16	18	30	36	16	23				
30	10	48	8	10	20	38	16	15	30	28	16	20	40	18	16	24
35	5	48	12	5	15	38	12	12	25	28	12	17	35	18	16	21
40	10	37	14	8	20	27	16	13	30	17	16	17				
45	10	32	8	7	20	22	8	12	30	12	16	16				
50	10	25	10	7	20	15	16	12								
55	5	23	16	5	15	13	16	10								

### PC 23030XS field of view

Diam. mm	Height (mm)	WD (mm)	F/#	r (%)	Height (mm)	WD (mm)	F/#	r (%)	Height (mm)	WD (mm)	F/#	r (%)	Height (mm)	WD (mm)	F/#	r (%)
15	5	78	8	12	15	68	16	19								
20	10	62	16	12	20	52	16	18								
25	10	57	8	10	20	47	12	16	30	37	16	21				
30	15	45	8	12	25	35	12	17	35	25	16	20	45	13	16	23
35	10	45	16	8	15	40	16	11	25	30	16	15				
40	10	38	12	8	20	30	12	13	30	20	16	17				
45	10	33	16	7	20	23	16	11								
50	10	25	16	5	20	15	16	11								
55	12	12	16	6												

# PCCD series

Catadioptric lenses for 360° top and lateral view with just one camera



## KEY ADVANTAGES

### 360° imaging of small objects

Parts down to 7.5 mm in diameter can be imaged.

### Extra wide lateral view angle

Object sides are viewed at an angle approaching 45°.

### Compactness

The lens can be easily integrated in any system.

### Perfect chromatic correction

For RGB camera applications and color inspection.

## ACCESSORY

PCCDLFAT Field of view extender for inspection of objects with diameter > 25 mm.

**PCCD series** are catadioptric lenses exclusively developed and manufactured by Opto Engineering® to enable the 360° side view of small objects. Their innovative optical design, based on a catadioptric system, makes it possible to image objects with diameters as small as 7 mm.

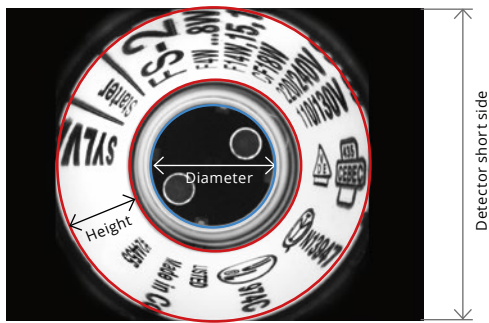
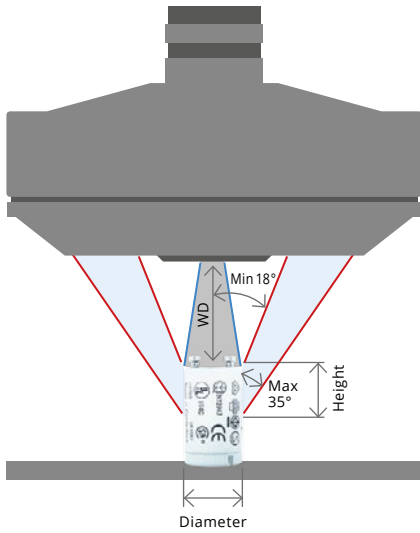
The sides of the object are imaged through the catadioptric system, while the top surface is directly imaged onto the center of the detector.

The compactness and high resolution of these lenses make them ideal to inspect components like pharmaceutical containers, plastic caps, pre-forms, bottlenecks, screws and other threaded objects. PCCD series can work either with 1/2", 1/3" and 2/3" detectors. The sides of the object being inspected are observed over a wide view angle, approaching 45° at its maximum; this feature makes it possible to inspect complex object geometries from a convenient perspective.

Part number		PCCD 013	PCCD 012	PCCD 023
<b>Detector type</b>		<b>1/3"</b>	<b>1/2"</b>	<b>2/3"</b>
Image circle	∅ (mm)	3.6	4.8	6.6
<b>Field of view</b>	<b>(diam x height)</b>			
Min	(mm x mm)	7.5 x 5	7.5 x 5	7.5 x 5
Typical	(mm x mm)	15 x 10	15 x 10	15 x 10
Max	(mm x mm)	25 x 17	25 x 17	25 x 17
Extended with PCCDLFAT	(mm x mm)	35 x 26	35 x 26	35 x 25
<b>Optical specifications</b>				
Wavelength range	(nm)	450 .. 650	450 .. 650	450 .. 650
Working distance	(mm)	28 .. 53	28 .. 53	24 .. 47
Working distance with PCCDLFAT	(mm)	5 .. 11	5 .. 11	5 .. 11
CTF @ 50 lp/mm	(%)	> 35	> 30	> 30
F/#		6 - 24	8 - 32	8 - 24
<b>Mechanical specifications</b>				
Diameter	(mm)	143	143	143
Length	(mm)	110.5	110.5	110.5
Weight	(g)	980	990	990
Mount		C	C	C

## Sample images taken with PCCD optics





$$c(\%) = \frac{\text{Top view diameter (px)}}{\text{Detector short side (px)}} * 100$$



Unwrapped image.

### Field of view selection chart

#### PCCD 013 field of view

Diameter (mm)	Height (mm)	WD (mm)	F/#	c (%)
7.5	5.0	53	24	11
10	6.7	49	16	15
15	10.0	42	12	22
20	13.3	35	8	30
25	16.7	28	6	37

#### Extended FOV with PCCDLFAT

30	22	11	8	36
35	26	5	8	37

#### PCCD 012 field of view

Diameter (mm)	Height (mm)	WD (mm)	F/#	c (%)
7.5	5.0	53	32	13
10	6.7	49	24	17
15	10.0	42	16	25
20	13.3	34	12	33
25	16.7	28	8	42

#### Extended FOV with PCCDLFAT

30	22	11	8	37
35	26	5	8	37

#### PCCD 023 field of view

Diameter (mm)	Height (mm)	WD (mm)	F/#	c (%)
7.5	5.0	47	24	12
10	6.7	45	24	16
15	10.0	38	16	24
20	13.3	30	12	32
25	16.7	24	8	40

#### Extended FOV with PCCDLFAT

30	22	14	8	37
35	25	10	8	45

FULL RANGE OF COMPATIBLE CAMERAS		
	Area scan cameras	p. 196-205
DEDICATED COMPATIBLE OBLIQUE RINGLIGHTS		
	LTRN165x45, LTRN245x35 <i>NEW</i> - High power version: LTRNHP165x45	p. 148-151 p. 152
DEDICATED ACCESSORIES		
	Clamping mechanics: CMHO PCCD	p. 229
	FOV extender: PCCDLFAT	p. 246
FULL RANGE OF COMPATIBLE STROBE CONTROLLERS		
	LTDV series	p. 256

The image of the external walls of the object, captured through the catadioptric system, is inscribed into the short side of the camera detector within a circular crown. On the other hand, the top of the object is directly imaged onto the central part of the detector area: both the lateral and top view of the object are in perfect focus at the same time.

The tables show possible combinations of object diameters and heights along with the appropriate working distance and recommended F-number; the "c" parameter for each configuration is also listed.

The "c" parameter describes the dimension of the top view image: it is calculated as the ratio between the central top view diameter and the short side of the detector. The typical ratio between the object height and its diameter is 2/3 which means that, for a given object diameter (i.e. 15 mm), the recommended inspection height will be around 67% of the diameter (10 mm). However, this parameter can be modified to accommodate for different aspect ratios (up to 100%) by adjusting the lens working distance, focus and F-number.

### PCCD accessories



PCCD optics are complemented by a full set of accessories, including:

**CMHO PCCD:** dedicated clamping mechanics designed to securely hold catadioptric lenses.

**LTRN series:** specific LED ring illuminators (LTRN165x45).



**PCCDLFAT** is an accessory designed to extend the FOV of PCCD optics and inspect objects with even larger diameters (beyond 25 mm). This accessory can be easily mounted on PCCD optics by the user: simply remove the pre-assembled protective window and replace it with PCCDLFAT.



# PCHI series

Hole inspection optics for 360° inside view in perfect focus



## KEY ADVANTAGES

### Perfect focusing of holed objects

Both the walls and the bottom of cavities are imaged in high resolution.

### Inside inspection from the outside

No need to put an optical probe into the hole.

### Very high field depth

Objects featuring different shapes and dimensions can be imaged by the same lens.

### Wide view angle

Sample surfaces are acquired by the lens under a convenient perspective to clearly display their features.

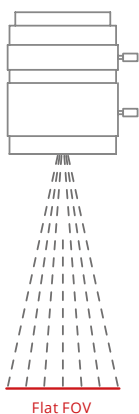
**PCHI optics** have been developed by Opto Engineering® to easily inspect holes, cavities and containers. Unlike common optics or so called "pinhole lenses" which can only image flat fields of view, hole inspection optics are specifically designed to image both the bottom of a hole and its vertical walls.

Thanks to the large view angle (>82°) and innovative optical design, these lenses are compatible with a wide range of object diameters and thicknesses. Hole inspection optics are the perfect solution to inspect a variety of different object shapes such as cylinders, cones, holes, bottles or threaded objects.

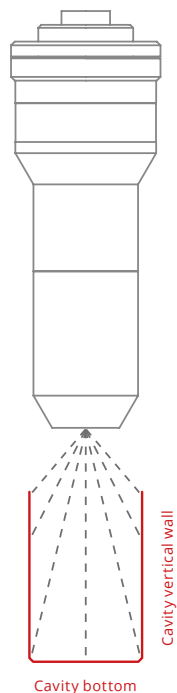


PCHI023 + compatible LTRN075x45 ringlight.

Common lens



Hole inspection optics



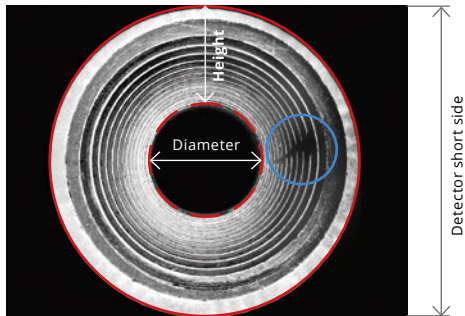
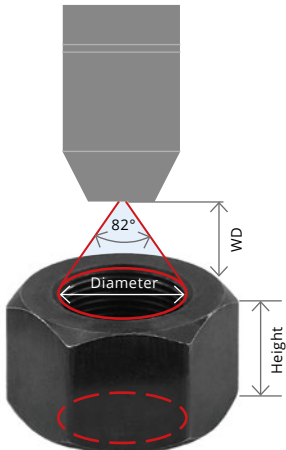
## Sample images taken with PCHI optics



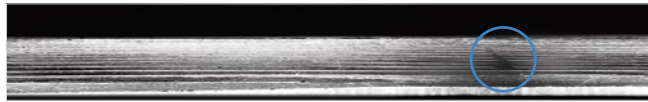
Perfect focusing is maintained throughout the entire depth of a hole.

Conical cavity inspection is possible from both sides.

Square, polygonal or irregular cross section objects can be inspected.



$$r (\%) = \frac{\text{Side view height (px)}}{\text{Detector short side (px)}} * 100$$



Unwrapped image.

### Field of view selection chart

PCHI 013, PCHI 012 and PCHI 023 field of view

Hole diameter (mm)	High res. imaging		Normal res. imaging		WD (mm)
	Cavity height (mm)	r (%)	Cavity height (mm)	r (%)	
10	6	23.5	10	28	5
15	8.5	22.5	14.5	29	6.5
20	13	26.5	22	32.5	9
25	18	26	31	33	11
30	22	26	37	32	14
40	31	26.5	53	32	18
50	40	27	68	32	23
60	50	28.5	85	32.5	29
70	60	28	102	33	35
80	75	29.5	120	34	41
100	97	30	155	34.5	52
120	120	31	190	35	62

Part number	PCHI 013	PCHI 012	PCHI 023	
<b>Detector type</b>	<b>1/3"</b>	<b>1/2"</b>	<b>2/3"</b>	
Image circle	Ø (mm)	3.6	4.8	6.6
<b>Field of view 1</b>	<b>(diam x height)</b>			
Min	(mm x mm)	10 x 10	10 x 10	10 x 10
Max	(mm x mm)	120 x 190	120 x 190	120 x 190
<b>Optical specifications</b>				
Wavelength range	(nm)	450 .. 650	450 .. 650	450 .. 650
Working distance	(mm)	5 .. 62	5 .. 62	5 .. 35
CTF @ 50 lp/mm	(%)	> 40	> 40	> 30
wF/# 2		4.7	5.8	8.3
<b>Mechanical specifications</b>				
Diameter	(mm)	28.0	28.0	28.0
Length	(mm)	102.0	104.0	108.5
Weight	(g)	250	250	250
Mount		C	C	C

- 1 Cameras with CS- to C-mount adapters, filters or protective windows in front of the sensor or other mechanical constraints in the C-mount can limit the focus range of PCHI0xx lenses. Contact us to check compatibility with your specific camera.
- 2 Working F-number (wF/#): the real F-number of a lens when used as a macro.

FULL RANGE OF COMPATIBLE CAMERAS		
	Area scan cameras	p. 196-205
DEDICATED COMPATIBLE RINGLIGHTS		
	LTRN 075 x45 <i>NEW</i> - High power version: LTRNHP075x45	p. 148-151 p. 152
	LTLAB2-x	p. 146
FULL RANGE OF COMPATIBLE STROBE CONTROLLERS		
	LTDV series	p. 256

PCHI optics can image cavities whose diameters and thicknesses span over a wide range of values.

For a given hole diameter, the table on the left lists the maximum cavity height allowed for both high resolution imaging (small pixel sizes) and normal resolution imaging (>5 micron pixels) applications; the "r" ratio indicates how much of the detector area gets covered by the image of the hole inner walls.

The listed working distance values ensure that the object image is exactly inscribed into the short side of the detector, thus maximizing "r" ratio and image resolution.

# PCBP series

Boroscopic probes for panoramic cavity imaging and measurement from inside



## KEY ADVANTAGES

### Inspection of cavities from inside

Hidden internal features and defects are clearly viewed.

### High resolution

The catadioptric design enables the detection of tiny defects over a very wide view angle.

### Flaw detection

Coarse deformations revealed using direct illumination.

### Surface defect enhancement

Mixing direct and indirect illumination makes it possible to emphasize tiny and scarcely visible defects.

## FULL RANGE OF COMPATIBLE CAMERAS



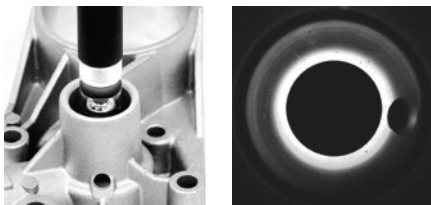
Area scan cameras

p. 196-205

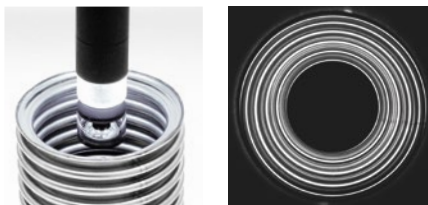
**PCBP probes** are used to inspect holed objects such as engine parts, containers and tubes whose hidden features can only be controlled by introducing a probe into the cavity. The catadioptric (refracting + reflecting) optical design ensures much higher resolution than fiber-based probes and enables the

complete 360° inner view of the entire cavity. Boroscopic probes are intended to be handled by a robot arm or S.C.A.R.A. in order to scan even the deepest cavities. Built-in illumination keeps the device very compact and makes it suitable for simple 3D applications by means of panoramic triangulation techniques.

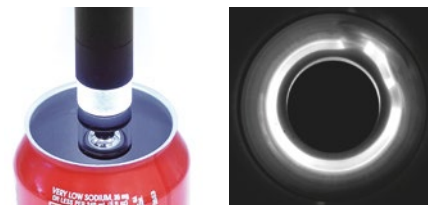
## Sample images taken with a PCBP optics



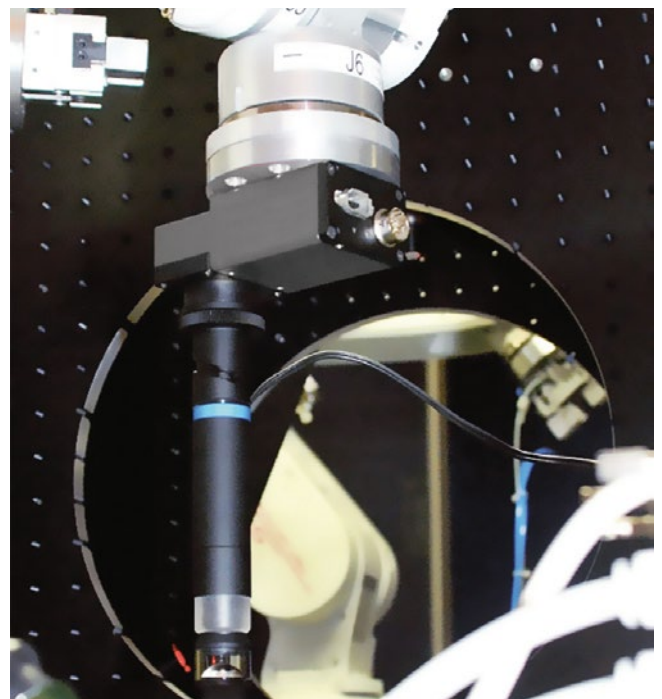
Inspection of holed parts of an engine.

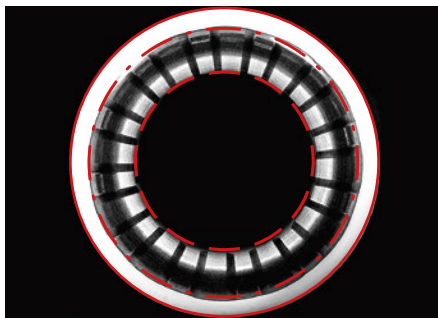
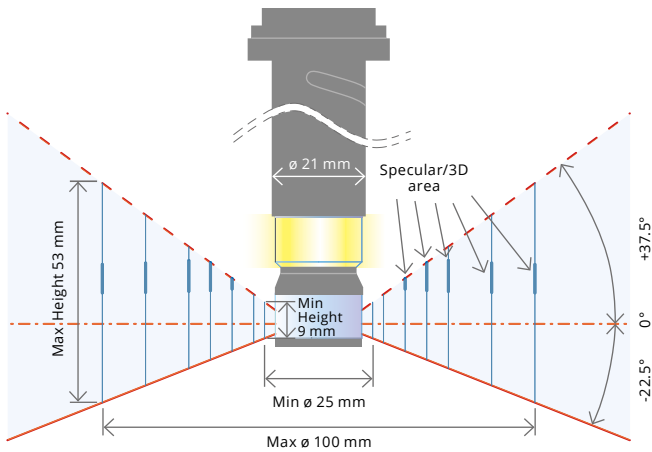


Tube scanning for integrity inspection.



Defect and impurities detection inside containers.





Unwrapped image.

PCBP probes can image cavities whose diameter ranges from 25 mm to 100 mm and over: the table below shows the inspection range allowed.

Inspection area	
Diameter (mm)	Height (mm)
25	9
30	12
40	18
50	23
60	29
80	41
100	53

An integrated LED source illuminates the cavity both diffusely and directly (specular illumination). The diagram on the left shows the different illumination areas. Diffused illumination is used for defect detection and component inspection.

Direct/specular illumination can be efficiently used to check for surface deformation on metal and highly reflective objects as well as to measure the hole diameter.

The image of the cavity covers around 50% of the detector height; the continuous red line indicates the bottom view of the cavity (-22.5°), the dashed line shows the upper view (+37.5°) while the dash-dotted line refers to the lateral view (0°).

Part number		PCBP 013	PCBP 012
<b>Detector type</b>		1/3"	1/2"
Image circle	Ø (mm)	3.6	4.8
<b>Field of view</b>	<b>(diam x height)</b>		
Min	(mm x mm)	25 x 9	25 x 9
Max	(mm x mm)	100 x 53	100 x 53
<b>Optical specifications</b>			
Wavelength range	(nm)	450 .. 650	450 .. 650
Viewing angle	(deg)	60	60
CTF @ 50 lp/mm	(%)	> 25	> 20
F/#		14	16
<b>Mechanical specifications</b>			
Diameter	(mm)	21	21
Length	(mm)	167	137
Weight	(g)	113	92
Mount		C	C
<b>Electrical specifications</b>			
LED Voltage	(V)	16 .. 24	16 .. 24
LED Power	(W)	< 2.0	< 2.0



The LED illumination device is integrated into the unit. The optical tip of the probe **PCBPTIP** can be easily replaced in case of damage.



The best focus is achieved by means of a lockable focusing mechanism. Power supply cables exit the device nearby the C-mount.

# PCPW series

Polyview optics for multiple side views in one image



## KEY ADVANTAGES

### Just one camera

No need for multiple cameras placed around and over the object.

### Wide viewing angles

45° side view makes otherwise hidden features visible.

### Complete surface inspection

Both inner and outer object surfaces can be imaged in one shot.

### Very high resolution

Even the tiniest defects can be detected.

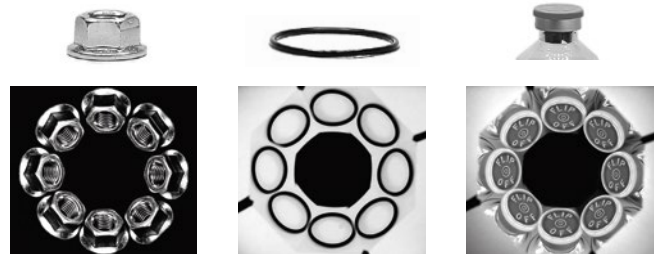
**PCPW optics** provide eight different views of the side and top surfaces of an object.

The wide view angle (45°) enables the inspection of the side features of an object (for example the threads of a screw or a nut) otherwise impossible to acquire with a single camera.

Both the external walls of an object and its top can be imaged at the same time, while internal surfaces of holed objects can be completely inspected from the outside. A combined view of the internal and external surfaces is possible and an image displaying both the inner walls and the bottom of a cavity can be obtained.

In addition to these unique features, PCPW optics also ensures excellent image resolution and image brightness.

## Sample images taken with PCPW optics



Part number		PCPW 013	PCPW 012	PCPW 023
<b>Detector type</b>		1/3"	1/2"	2/3"
Image circle	Ø (mm)	3.6	4.8	6.6
<b>Max object diameter for SIDE inspection</b>				
Height 20 mm	(mm)	30	30	30
Height 5 mm	(mm)	50	50	50
<b>Max object diameter for SIDE + TOP inspection</b>				
Height 10 mm	(mm)	30	30	30
<b>Optical specifications</b>				
Wavelength range	(nm)	450 .. 650	450 .. 650	450 .. 650
Working distance	(mm)	20 .. 40	20 .. 40	20 .. 40
CTF @ 50 lp/mm	(%)	> 60	> 50	> 40
F/#		4-12	6-16	8-16
<b>Mechanical specifications</b>				
Diameter	(mm)	140	140	140
Length	(mm)	224	224	224
Weight	(g)	990	990	990
Mount		C	C	C



**DEDICATED COMPATIBLE OBLIQUE RINGLIGHTS**

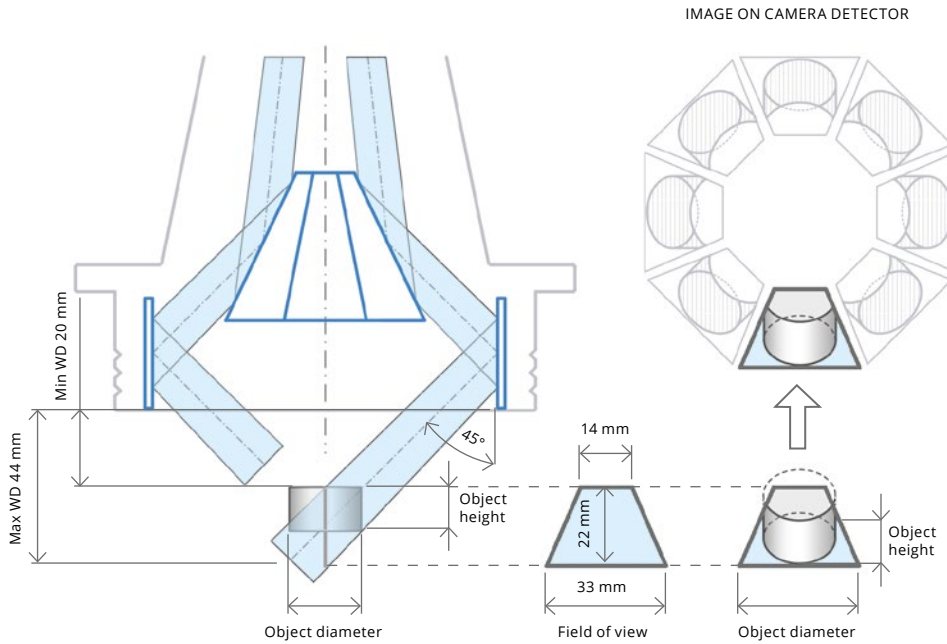
	LTRN 050 x45	p. 150
	LTRN 245 x45	p. 150

**FULL RANGE OF COMPATIBLE CAMERAS**

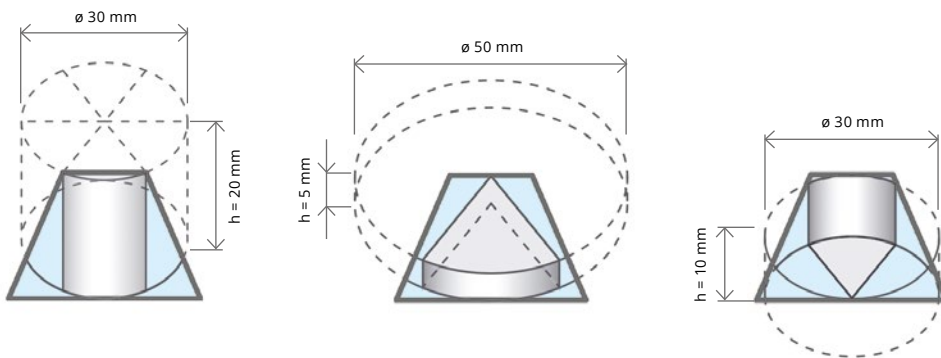


Area scan cameras

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The diagram shows how PCPW optics image a cylindrical object. The object is observed at 45° from eight different points of view. Eight different trapezoidal fields of view are obtained: all the object features included in such a trapezoid will be imaged on the corresponding image portion. The 45° view angle allows both the sides and the top of a cylindrical object to be imaged. If the object is a hollow cylinder (hole or cavity), the inner wall of the cavity will be imaged instead of the top, thus enabling both outer and inner side inspection.



When the object height is maximum (20 mm) up to 30 mm diameter objects can be inspected.

Up to 50 mm diameter objects can be inspected, provided their thickness doesn't exceed 5 mm.

Combined view of both the inner sides and the bottom of a cavity is possible when objects are up to 30 mm diameter and 10 mm height.

**Maximum field of view**

In order to perform a complete 360° inspection, each of the eight image portions should image at least 1/6 of the cylindrical surface; this condition ensures a good overlapping between two different lateral views, since part of the object features will be shared by two neighboring image portions.

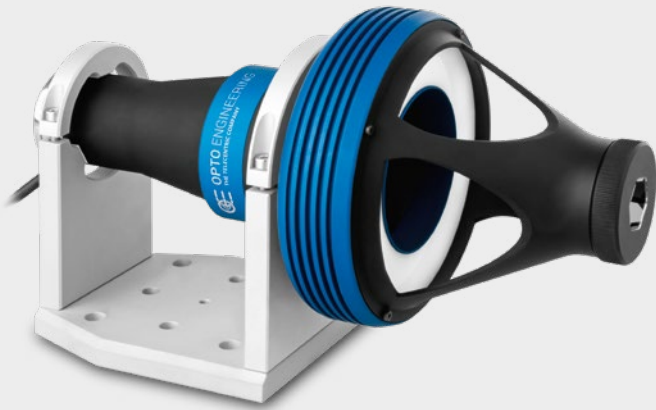
Part number		LTRN 050 W 45
Light color		white, 6300 K
<b>Dimensions</b>		
Outer diameter	(mm)	54.0
Inner diameter	(mm)	15.2
Height	(mm)	18.0
Weight	(g)	30.0
Mount		threaded retaining ring
Voltage	(V, DC)	24
Power	(W)	3
Compatible PC lenses		PCPW 0xx, PCHI 0xx
Other compatible lenses		TC 23 00x, MC3-03X



**LTRN 050 W 45** is a small LED ring illuminator compatible with different products and suitable for a variety of inspections. This illuminator is also perfectly suitable for illuminating the inner sides of a cavity imaged by a Polyview lens; the illuminator flange is threaded to fit PCPW series inner mounting interface.

# PCMP series

Micro-polyview optics for 3D measurement and imaging of small parts



## KEY ADVANTAGES

### Small parts lateral imaging

Inspection of objects whose size ranges from 1 to 10 mm.

### Measurement capability

The top and the lateral views show the same magnification.

### High field depth

The top and the lateral views are imaged without significant defocusing.

**PCMP optics** are 3D, multi-image lenses designed to completely measure and inspect objects whose dimensions range from 1 to 10 mm, such as electronic components, solder paste and micro-mechanical components. Six different lateral views are provided by an array of mirrors interfaced to a bi-telecentric lens; the top of the object is directly imaged at the center of the field of view.

The lateral views feature exactly the same magnification and the images remain in perfect focus even when the object is displaced from its nominal position. All the views can be used to precisely measure the dimension of components from different angles.

The PCMP series integrates LED illumination optimized for this specific assembly.

## CUSTOM FEATURES

- different number of views
- different view angles
- asymmetric or special mirror arrays can be supplied upon request.

Part number		PCMP 012	PCMP 023
<b>Detector type</b>		<b>1/2"</b>	<b>2/3"</b>
Image circle	Ø (mm)	4.8	6.6
<b>Max object inspection height</b>			
With diameter 2.5 mm		6	6
With diameter 5 mm		4.5	4.5
With diameter 7.5 mm		3	3
With diameter 10 mm		1	1
<b>Optical specifications</b>			
Wavelength range	(nm)	450 .. 650	450 .. 650
Working distance	(mm)	1.5 .. 5	1.5 .. 5
CTF @ 50 lp/mm	(%)	> 40	> 40
wF/# <b>1</b>		8	8
<b>Mechanical specifications</b>			
Diameter	(mm)	119	119
Length	(mm)	262	262
Weight	(g)	980	980
Mount		C	C
<b>Electrical specifications</b>			
Illuminator voltage	(V, DC)	24	24
Illuminator power	(W)	18	18

Camera phase adjustment feature is available **upon request**.

**1** Working F-number (wF/#): the real F-number of a lens when used as a macro.

The suggested working distance ranges from 1.5 to 5 mm. The best focus can be achieved by adjusting the number of spacers in the C-mount interface or by vertically positioning the illuminator+mirror assembly.

The image orientation can be adjusted by simply rotating the mirror cage or the whole assembly.

The top and side views show exactly the same magnification; however the side views appear to be compressed because of the perspective angle. Thanks to telecentric imaging such compression is purely linear and therefore very easy to calibrate.

## FULL RANGE OF COMPATIBLE CAMERAS



Area scan cameras

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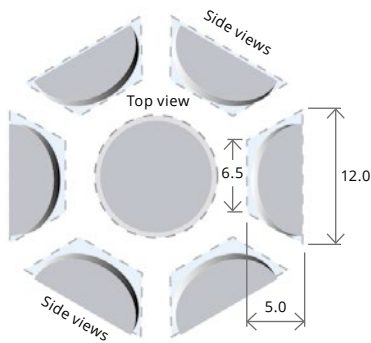
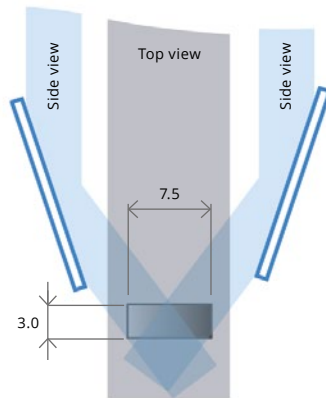
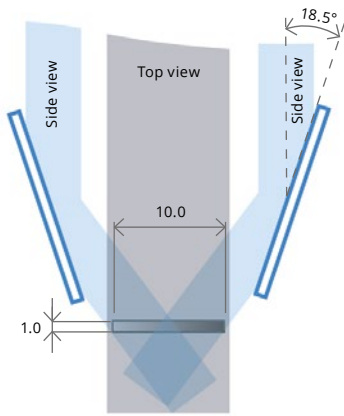


IMAGE ON CAMERA DETECTOR

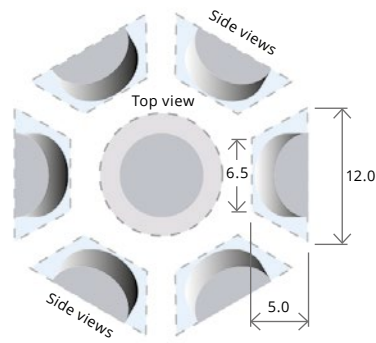


IMAGE ON CAMERA DETECTOR

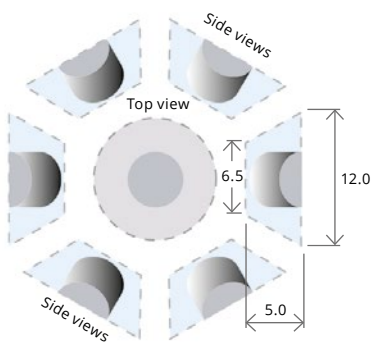
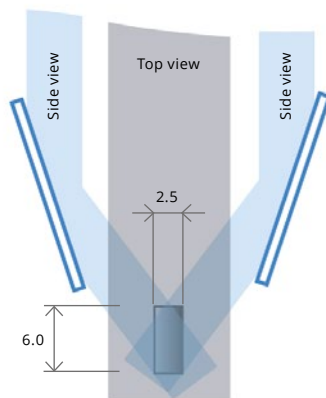
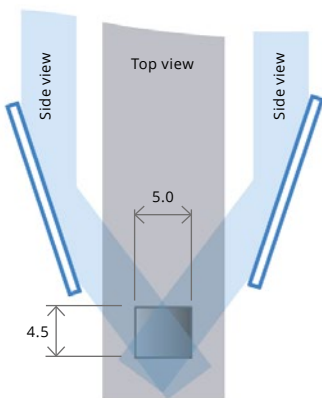


IMAGE ON CAMERA DETECTOR

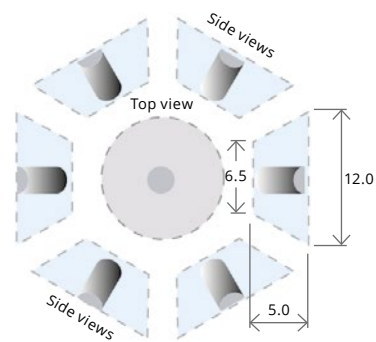


IMAGE ON CAMERA DETECTOR

## Application examples

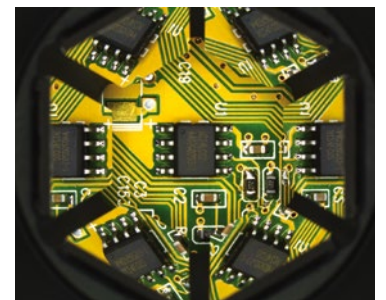
### Mechanical components inspection

Thread integrity, pitch and diameter can be verified and measured.



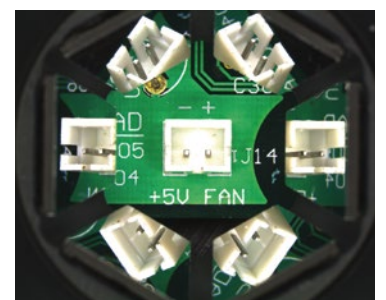
### SMD components inspection

Integrated circuit position, rotation, pin integrity and bonding can be checked.



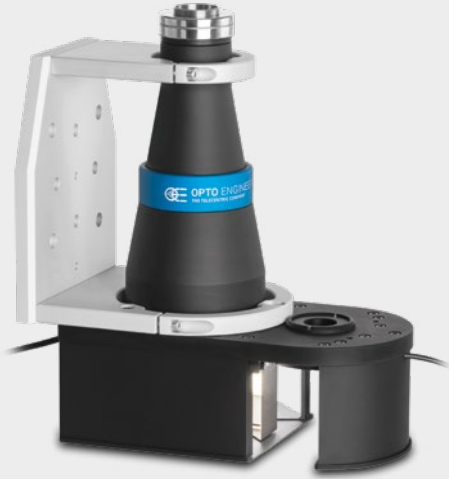
### Electronic connector check

Presence/absence, alignment and length of pins can be precisely measured.



# TCCAGE series

Bi-telecentric system for multiple side imaging and measurement at 90°



## KEY ADVANTAGES

### 90° lateral imaging

The four orthonormal views allow you to see object features that are hidden from the top.

### Long and thin object inspection

The characteristic aspects ratio of the four image segments perfectly fits long and thin objects.

### Built-in illumination

The device also incorporates two different light sources, for back and direct illumination.

### Suitable for measurement

Telecentric optics makes this module perfect for any multiple-measurement application.

**TCCAGE** is an integrated optomechanical system designed to fully inspect and measure parts from the side without any need of rotation. Four orthonormal views of an object are provided by a bi-telecentric lens through an array of mirrors.

Each view is exactly at 90° with respect to the neighboring views; this optical layout ensures complete coverage of the object lateral surface.

Furthermore, telecentric imaging makes the system insensitive to off-centered parts and therefore suitable for measurement applications.

TCCAGE is the perfect solution for inspecting parts whose features would be hidden when looked at from the top and for all those applications where an object must be inspected or measured from different sides.

Two different illumination devices are built into the system to provide either backlight or direct illumination.

## NEW

Camera phase adjustment feature added for easy and hassle-free integration.

Part number		TCCAGE 12048	TCCAGE 23048	TCCAGE 12096	TCCAGE 23096
<b>Detector type</b>		<b>1/2"</b>	<b>2/3"</b>	<b>1/2"</b>	<b>2/3"</b>
Image circle	Ø (mm)	4.8	6.6	4.8	6.6
<b>Max object diameter</b>	(mm)	8	8	16	16
<b>Max object height</b>	(mm)	32	32	68	68
<b>Optical specifications</b>					
Wavelength range	(mm)	450 .. 650	450 .. 650	450 .. 650	450 .. 650
CTF @ 50 lp/mm	(%)	> 40	> 40	> 40	> 40
wF/# <sup>1</sup>		8	8	8	8
<b>Mechanical specifications</b>					
Width	(mm)	111	111	179	179
Length	(mm)	192.8	192.8	347	347
Height	(mm)	248	248	405	424
Weight	(g)	2700	2700	9111	9154
Mount		C	C	C	C
Camera phase regulation <sup>2</sup>		Yes	Yes	Yes	Yes
<b>Electrical specifications</b>					
Ring illumination voltage	(V, DC)	24	24	24	24
Ring illumination power	(W)	3	3	3	3
Back illumination voltage	(V, DC)	24	24	24	24
Back illumination power	(W)	9	9	15	15

<sup>1</sup> Working F-number (wF/#): the real F-number of a lens when used as a macro.

<sup>2</sup> Indicates the availability of an integrated camera phase adjustment feature.



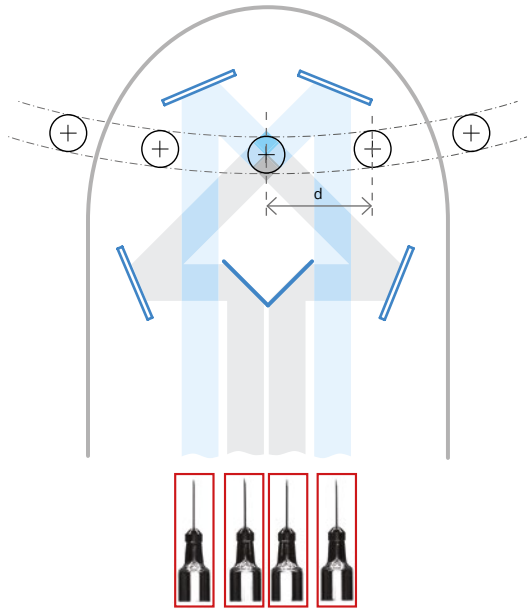


FULL RANGE OF COMPATIBLE CAMERAS



Area scan cameras

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### Sample images taken with TCCAGE



### Working principle

A bi-telecentric lens observes the object from four different positions through a mirror assembly, ensuring that the optical path is the same for all four view points.

The four views are equally spaced by 90° and partially overlapped, obtaining complete coverage of the object lateral surfaces.

The system can thus tolerate off-centered components without any significant decay of the image quality thanks to the telecentric optics, which ensures that magnification is maintained in each image segment. The system is designed so as to allow components to pass unobstructed through the mirror cage, for in-line applications.

When TCCAGE system is used for in-line inspection, consider the following minimum distance “d” between two consecutive objects in order to avoid image overlapping

$$\begin{aligned} \text{TCCAGE xx048} & \quad d \text{ (mm)} \cong 25 + \varnothing_{\text{object}} / 2 \\ \text{TCCAGE xx096} & \quad d \text{ (mm)} \cong 50 + \varnothing_{\text{object}} / 2 \end{aligned}$$

### Illumination geometry

TCCAGE series integrates both direct and backlight illumination. Direct illumination (yellow cone in the drawing) is provided by a ring illuminator placed on the top of the part that can be used to enhance surface defects.

Back lighting (indicated by the yellow arrow) is obtained by means of a diffuse source which illuminates the object through the mirror system; this type of illumination is suggested for measurement purposes or to inspect transparent objects.

### Additional port

TCCAGE is provided with an extra port placed right above the object. This port can be used to inspect the top of the part using an additional lens and camera system (for example a PCHI hole inspection lens, a macro or TC lens). The port can also accommodate other types of illuminators.

