

pco.dicam C1 LX

intensified 16 bit **sCMOS** camera

1^{channel}
intensified
sCMOS

intensified
sCMOS technology
2048 x 2048 pixel

106 fps
@ full resolution

10G fiber optic
data interface



exposure time 51 ns
with 25 mm intensifier

double image mode
with 300 ns interframing time

pco.

An Excelitas Technologies Brand



As an expansion to our well established pco.dicam C1 family, we are now adding the **pco.dicam C1 LX** model, which is based on 25 mm image intensifiers. For applications which do not challenge the absolute technical limits in intensified imaging, the new pco.dicam C1 LX is a budget friendly alternative to the high end versions pco.dicam C1 and pco.dicam C1 UHS. Building on the proven technology of our established hardware platform the pco.dicam C1 LX gives you full access to the world of true optical gated imaging. Its S20 photo cathode matches most application requirements.

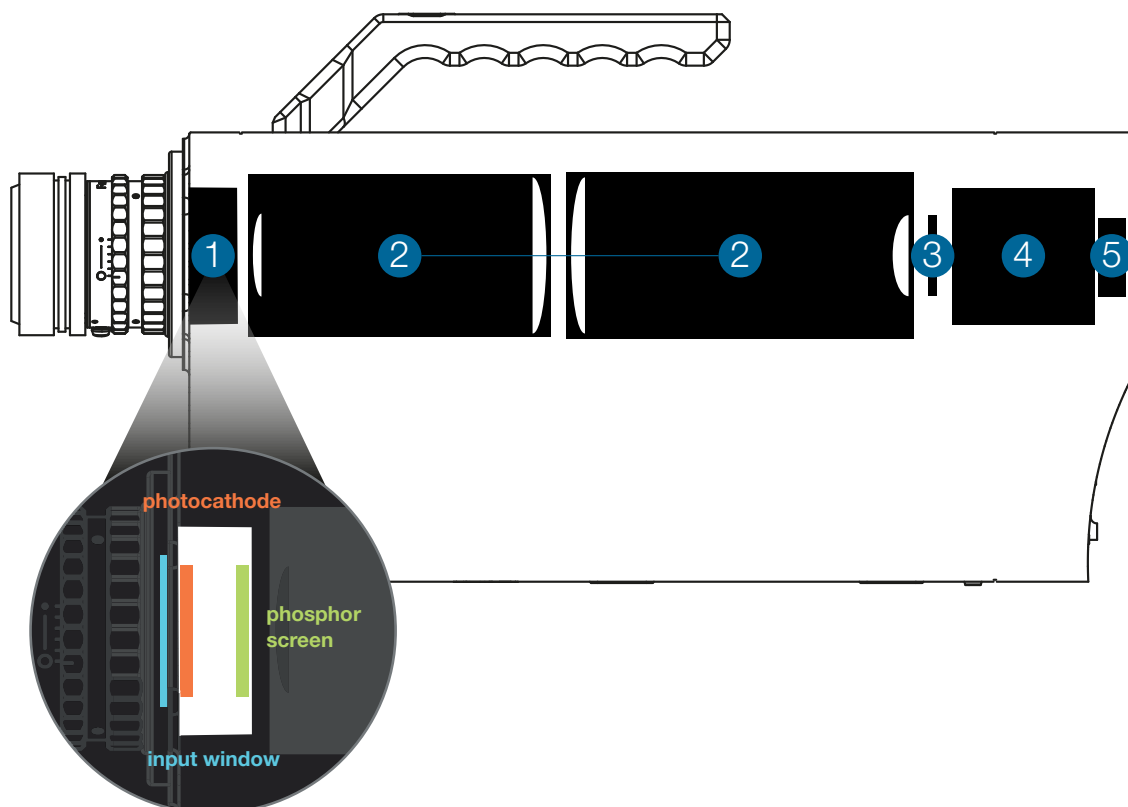
Adapted from the high end versions is the optical coupling of the 25 mm image intensifier to the 16 bit sCMOS sensor via an efficient tandem lens. Single photons are detected using exposure times down to 51 ns with up to 106 fps at full 4 MPixel resolution. The 10G fiber optic based data interface (CLHS FOL) guarantees you uncompressed and robust 16 bit data transfer in real time via optical fiber over virtually any distance.

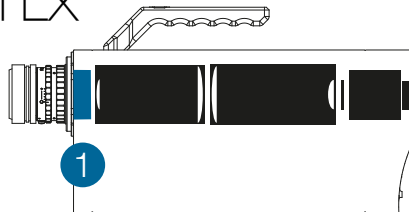
features & benefits

106 fps @ full 4.2 MPixel resolution	high frame rates at high resolution for imaging of dynamic processes
1.1 e⁻ readout noise	lowest readout noise of any gated intensified camera system
16 bit digitization	taking advantage of the higher dynamic range possible from high-end image intensifiers
25 mm high resolution image intensifier	doubles the optical resolution of conventional 18 mm image intensifiers
optical coupling via ultra-speed tandem lens	outstanding image quality with high transmission efficiency and no artifacts
tandem lens with 0.53 : 1 image scaling	full 25 mm diameter of intensifier output is imaged (lossless) onto an sCMOS sensor
10G fiber optic based data interface	fiber optic interface virtually covers any distance without deploying additional interface converters or signal amplifiers with immunity to EMI
880 MByte/s image data rate	highest sustained image data rate of any intensified camera system on the market; no limitations for recording duration
double image mode with 300 ns interframing time	two consecutive full resolution images with a configurable minimum interframing time of 300 ns
4.2 MPixel sCMOS sensor	overcomes CCD limitations in terms of speed and sensitivity
enhanced extinction ratio gating	fast MCP gating for improved extinction ratio for the blue and uv part of the spectrum
additional optical trigger input	robust trigger transmission over long distance in EMC critical environments
selected highly homogeneous image intensifiers	integrated best image intensifier quality available on the market
< 50 ns trigger to exposure start delay	ultra fast camera reaction to trigger event
51 ns gating with 25 mm intensifier	captures fast transient phenomena
extensive and highly precise IN/OUT signaling	allows for perfect synchronization in any experimental setup as timing master or slave
configurable delay in steps of 1 ns	flexible adaptation to synchronization needs

camera components overview

- 1 image intensifier
- 2 optical coupling lens system
- 3 sCMOS image sensor
- 4 camera system
- 5 10G fiber optic based interface





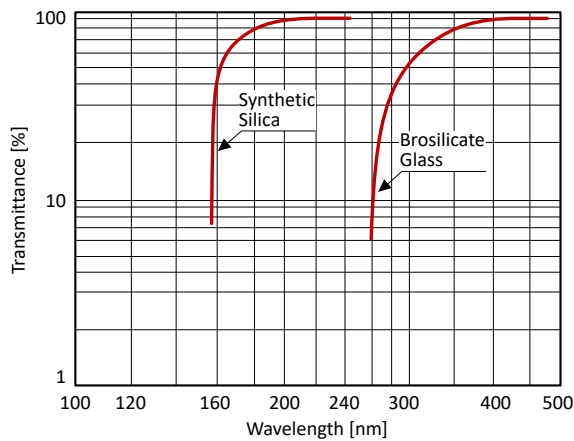
technical specifications

» **image intensifier**

type	HighRes micro channel plate (MCP) 6 µm channel
input window	synthetic silica
photocathode material	S20
image intensifier pitch distance	6 µm
image intensifier MCP type	single stage low resistance MCP for high strip current
MCP operational modes	continuous gated for enhanced extinction ratio
image intensifier diameter	25 mm
phosphor screen material	P46
output window	glass
image intensifier system resolution	> 50 lp/mm @ 5 % MTF typical
shortest gating time	51 ns

» **image intensifier input window**

Typical transmittance of image intensifier input window materials.

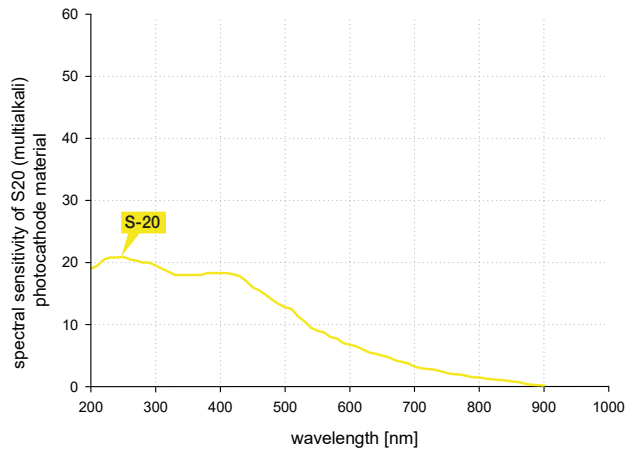


data courtesy of Hamamatsu Photonics

To make use of the good UV sensitivity of S20 photocathode material, the standard input window is made of synthetic silica for transmission down to 180 nm.

» photocathode quantum efficiency

Spectral sensitivities of different photocathode material:
S20 (multialkali)



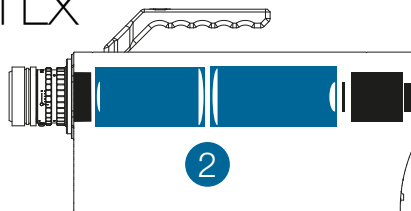
data courtesy of Hamamatsu Photonics

photocathode material	peak wavelength [nm]	typical quantum efficiency at peak wavelength [%]	dark counts [s ⁻¹ /cm ²]
S20 (multialkali)	250	20	1500

data courtesy of Hamamatsu Photonics

» image intensifier phosphor

phosphor	phosphor decay (typ.) to..		peak emission	typical efficiency
	.. 10 %	.. 1 %		
P46	0.2 - 0.4 μs	2 μs	530 nm	30 %

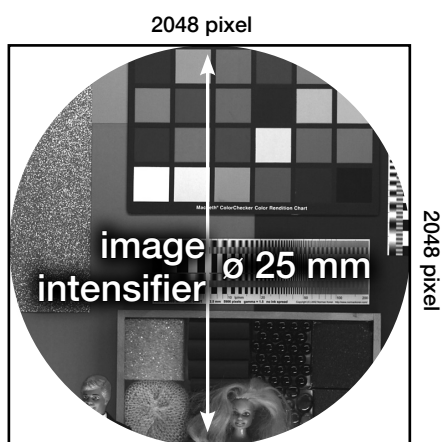


technical specifications

» **optical coupling lens system**

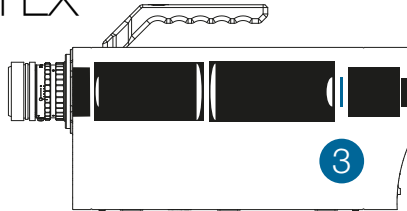
“ultra-speed tandem lens” between image intensifier & sCMOS

transmission efficiency	> 30 %
vignetting	< 3 %
resolution	> 60 lp/mm
scaling rates	$\beta=0.53$ for 25 mm intensifier



The projected image circle is completely covered by 2048 x 2048 6.5 μm pixels of the sCMOS detector – cf. image left. There is no “waste” of valuable intensifier area. As a consequence the four corners of the sCMOS sensor remain black. For a fast scan of just a few vertically centered lines – the camera module allows you to achieve more than 7.000 fps for such a ROI - the full line length of 2048 pixels is available.

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technical specifications

» sCMOS image sensor

type of sensor	scientific CMOS (sCMOS)
resolution (h x v)	2048 x 2048 active pixel
pixel size (h x v)	6.5 µm x 6.5 µm
sensor format / diagonal	13.3 mm x 13.3 mm / 18.8 mm
shutter mode	single image double image
MTF¹	76.9 lp/mm (theoretical)
fullwell capacity	15,000 e ⁻ for P46 phosphor
readout noise²	1.1 med / 1.5 rms e ⁻ single image 2.2 med / 2.5 rms e ⁻ double image
dynamic range	13,600 : 1 (82.7 dB) for P46 phosphor
quantum efficiency	57 % for P46 peak emission @ 530 nm
spectral range	300 nm ... 1000 nm
dark current³	< 0.6 e ⁻ /pixel/s @ 7 °C
DSNU	1.0 rms e ⁻
PRNU	< 0.6 %
anti blooming factor	1 : 10,000

» frame rate table⁴

	C1 LX
2048 x 2048	106 fps
2048 x 1024	210 fps
2048 x 512	414 fps
2048 x 256	807 fps
2048 x 128	1535 fps
2048 x 64	2795 fps
2048 x 32	4739 fps
2048 x 16	7266 fps
1920 x 1024	199 fps
1600 x 1200	180 fps
1280 x 1024	210 fps
640 x 480	441 fps
320 x 240	858 fps

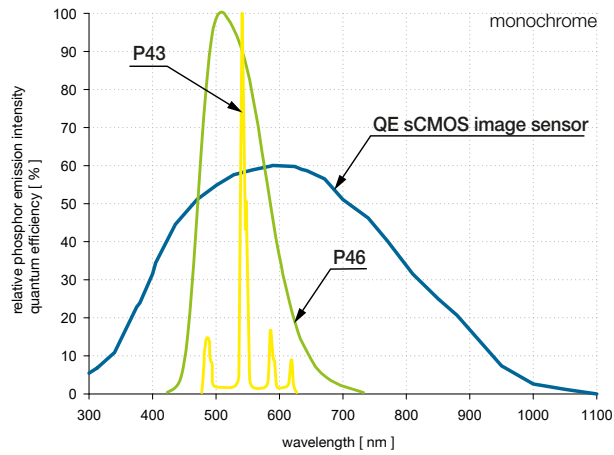
¹ Modulation transfer function.

² The readout noise values are given as median (med) and root mean square (rms) values due to the different noise models, which can be used for evaluation. All values are raw data without any filtering.

³ Measurements with dark current compensation.

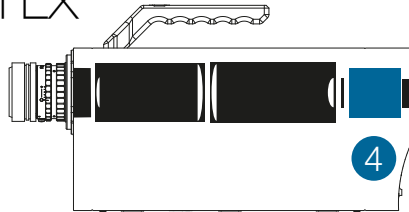
⁴ Exposure time < 1 µs.

» perfect fit: phosphor emission vs. sCMOS quantum efficiency



This chart describes the spectral situation for the internal imaging of the image intensifier's phosphor output screen to the sCMOS sensor of the camera detector module. This imaging is done by the highly efficient tandem lens system.

Please note: The spectral sensitivity relevant for your experiment is solely determined by the QE curve of the photocathode material of the image intensifier (page 5).



technical specifications

» camera system

frame rate	106 fps @ 2048 x 2048 pixel
dynamic range A/D⁵	16 bit
pixel scan rate	286.0 MHz
binning horizontal	x1, x2, x4
binning vertical	x1, x2, x4
region of interest (ROI)	horizontal: steps of 4 pixels vertical: steps of 1 pixel
non-linearity	< 1 %
cooling method	+ 7 °C stabilized, 1 stage peltier with forced air (fan)
input signals	optical trigger (FOL), electrical trigger, arm input (TTL level, BNC connectors), gate disable (high-speed TTL input, BNC connectors)
output signals	gate/expos out monitor, user monitor output (TTL level, BNC connectors)
time stamp	in image (1 µs resolution)

» exposure modes

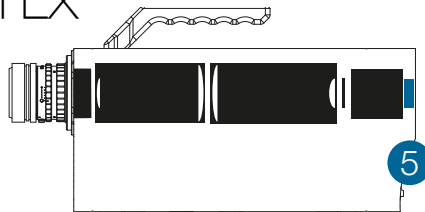
single image mode

exposure times	variable 51 ns ... 250 ns (1 ns steps), 250 ns ... 1 s (10 ns steps)
delay times	0 ns ... 250 ns (1 ns steps), 250 ns ... 1 s (10 ns steps)
maximum repetition... ...with external gating	200 kHz sustained, 3.3 MHz burst
insertion delay	
trigger input to exposure out	19 ns
trigger input to optical open	49 ns
jitter	
trigger input to exposure out	35 ps rms
trigger input to optical open	150 ps rms

double image mode

exposure times	60 ns ... 1 ms (in 10 ns steps)
delay settings	0 ns ... 10 ms (in 10 ns steps)
interframing time	300 ns ... 10 ms (in 10 ns steps)

⁵ The high dynamic signal is simultaneously converted at high and low gain by two 11 bit A/D converters and the two 11 bit values are sophisticatedly merged into one 16 bit value.



technical specifications

» camera interface

data transfer	Camera Link HS, FOL cable, frame grabber (Single F2, 1X1, S10)
maximum cable length	10 km (CLHS FOL)
input signals	optical trigger (FOL), electrical trigger, arm input (TTL level, BNC connectors), gate disable (high-speed TTL input, BNC connectors)
output signals	gate/expos out monitor, user monitor output (TTL level, BNC connectors)



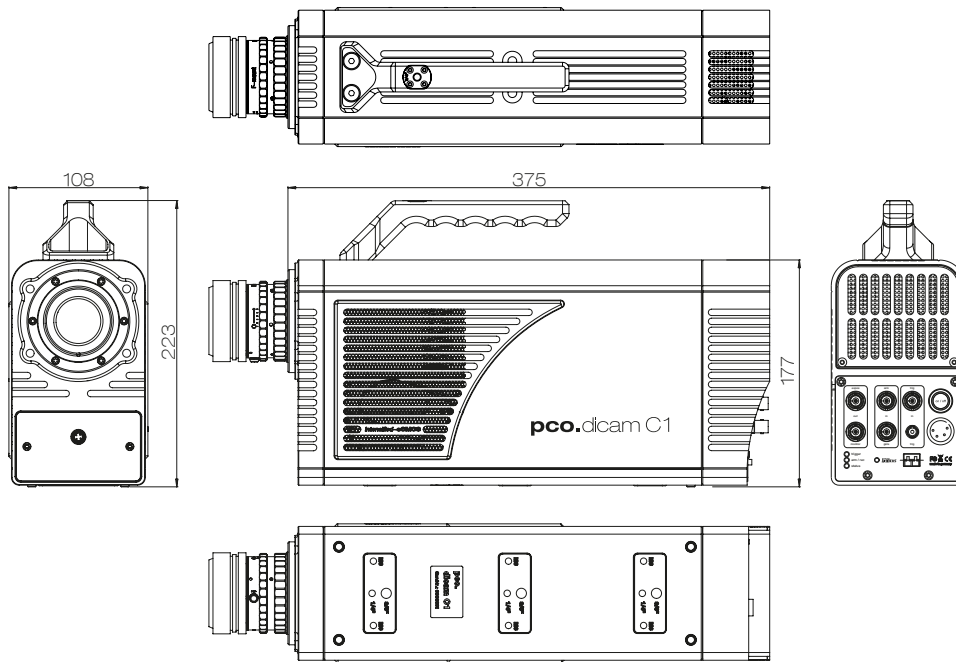
» general camera system

power supply	18 ... 28 VDC
power consumption	35 ... 40 W
weight	7 kg
operating temperature	+ 10 °C ... + 40 °C
operating humidity range	10 % ... 80 % (non-condensing)
storage temperature range	- 10 °C ... + 60 °C
optical mount	F-mount
vacuum mount (optional)	sealed camera front attaches to vacuum equipment
maximum cable length	10 km (CLHS FOL)
CE / FCC certified	yes

technical specifications

» dimensions

F-mount and C-mount lens changeable adapter. All dimensions are given in millimeter.



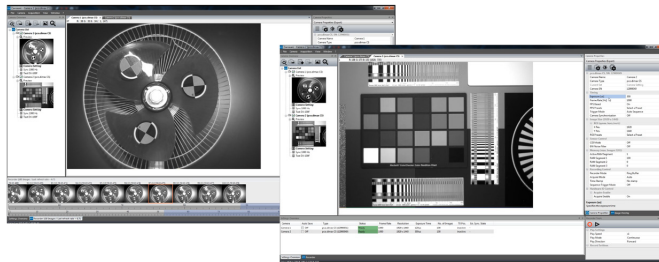
» camera view



» applications

laser induced incandescence (LII) | shock wave physics | laser induced breakdown spectroscopy (LIBS)
particle image velocimetry (PIV) | time resolved spectroscopy | plasmaphysics | laser induced fluorescence (LIF)
ballistics | combustion

» software



With pco.camware you control all camera settings, the image acquisition, and the storage of your image data. The pco.sdk is the complementary software development kit. It includes dynamic link libraries for user customization and integration on Windows PC platforms. Drivers for popular third party software packages are also available for you.

All these items like pco.camware, pco.sdk, and third party drivers are free to download at www.excelitas.com

» third party integrations



customization

» possible combinations

photocathode	input window	phosphor
S20 selected	synthetic silica	P46

selected quality specified for 25 mm diameter area corresponding to full 2048 x 2048 pixel sCMOS sensor resolution, extinction ratio 10 times higher than standard grade, image intensifiers with S20 photocathode exclusively come in selected grade quality. Contact our technical sales team for further details on the two quality grades

» select interface

type of fiber optic interface (CLHS FOL) module in camera and frame grabber

SM SFP+ up to 10 km

MM SFP+ up to 300 m

FOL cable length default: 10 m

ordering information

pc_o.dicam C1 LX 85108001019 pc_o.dicam C1 LX, 25 mm, S20, P46, selected

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An Excelitas Technologies Brand

address: Excelitas PCO GmbH
Donaupark 11
93309 Kelheim, Germany

phone: +49 (0) 9441 2005 0

mail: pco@excelitas.com

web: www.excelitas.com/pco



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