dicam pro
intensified digital 12 bit CCD camera system

- fast shutter down to 3 ns
- excellent sensitivity of the system allows single photon detection
- 12 bit dynamic range
- high resolution MCP–image intensifier & CCD (1280 x 1024 pixel)
- exposure times from 3 ns – 1000 s
- spectral sensitivity from UV to NIR
- PCI interface board “plug & play”
- binning (horizontal & vertical)
- thermoelectrical cooling of CCD image sensor down to –12 °C
- optical or electrical triggering
- various MCP photocathodes – S20, S25, GaAs, GaAsP
- two discrete images with an interframing time of 500 ns (PIV)
- multiple exposures
- serial high speed data transfer via fiber optic link (FOL)
- free software camware and software development kit included

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a.e.s adept electronic

adept electronic solutions

The Machine Vision and Imaging Speciaists

Perth: +61 (08) 9242 5411
Sydney: +61 (02) 9979 2599
Melbourne: +61 (03) 9555 5621
Email: adept@adept.net.au
Web: http://www.adept.net.au

dicam pro

This is a high speed intensified CCD camera system with gating times down to 3 ns. With its 12 bit dynamic range and a high resolution CCD image sensor it features an excellent signal–to–noise–ratio and the ability of single photon detection. The system is suited for applications in environments with high electromagnetic disturbances. A high speed serial fiber optic data link connects the system to the PC. The camera can be triggered by light or electrical input. This intensified digital CCD camera system is perfectly suited for demanding high and ultra speed camera applications, such as spray imaging, laser induced fluorescence imaging or ballistics.

technical data

	unit	setpoint	dicam pro
resolution (hor x ver) [1]	pixel		1280 x 1024
pixel size (hor x ver)	µm²		6.7 x 6.7
sensor format / diagonal	inch / mm		2/3" / 11.0
peak quantum efficiency	%	depends on photocathode material	up to 50
full well capacity	e^-		25 000
image sensor			ICX085AL
dynamic range	dB	CCD + camera	69.3
dynamic range A/D [2]	bit		12
readout noise	e^- rms	@ pixel scan rate 12.5MHz	7 .. 8
imaging frequency, frame rate	fps	@ full frame	8
pixel scan rate	MHz		12.5
A/D conversion factor	e^- / count		5
spectral range	nm	depending on photo cathode material of MCP	160 .. 1300
exposure time	s	3 ns +/– 25 % FWHM [3]	3 ns .. 1000 s
anti–blooming factor		@ 100 ms exposure time	> 1000
smear	%		< 0.005
binning horizontal	pixel		1, 2, 4, 8
binning vertical	pixel		1, 2, 4, 8, 16, 32
region of interest	pixel		down to 32 x 32
extinction ratio		@ 1 ms exposure time	1 : 2000
non–linearity (differential)	%	full temperature range (CCD sensor)	< 1
uniformity darkness DSNU [4]	count	@ 90 % center zone (CCD sensor)	1
uniformity brightness PRNU [5]	%	typical (CCD sensor)	0.6

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technical data

	unit	setpoint	dicam pro
trigger, auxiliary signals			electrical (TTL level) and optical (FOL) trigger
power consumption	W		51
power supply	VAC		90 .. 260
mechanical dimensions camera (w x h x l)	mm³		120 x 180 x 340
weight	kg	camera	8
operating temperature range	°C		+5 .. +40
operating humidity range	%	non condensing	10..90
storage temperature range	°C		–20 .. +70
optical input			Nikon F–mount, c–mount or special mounts
optical input window			fused silica (others on request)
data interface			PCI local bus, Rev. 2.1, burst rate 132 MByte/s
CE certified			yes
cooled CCD temperature	°C		–12
cooling method			2 stage Peltier cooler with forced air cooling
interframing time	ns	minimum	500
photocathode material			S20, S25, GaAs, GaAsP, others on request
phosphor screen material			P43, P46
image intensifier pitch distance	µm		6
image intensifier MCP [6] type			single stage MCP
image intensifier diameter	mm		18 or 25
image intensifier system resolution	lp/mm	@ 5% MTF [7] typical (depends on phosphor)	> 50
shortest gating time	ns		3

[1] horizontal versus vertical
[2] Analog–to–Digital–converter
[3] due to MCP intensifier performance tolerances
[4] dark signal non–uniformity
[5] photo response non–uniformity
[6] multi channel plate
[7] modulation transfer function

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image intensifier	type	HighRes MCP (6µm channel)
	output window	glass
pwr & gating supply	phosphor voltage	6 .. 7.5 kV internally adjusted, ripple ±15 mV
	MCP voltage	0 .. 1100 V externally adjustable, ripple ±1 mV
	photocathode voltage	on: –180 V off: + 80 V
	two modes can be selected:	
	ultrafast gating mode:	minimum pulse width 3ns
	highrate gating mode:	minimum pulse width 20 ns, maximum pulsing frequency 2 MHz (in bursts)
optical coupling	“ultra speed tandem lens” between image intensifier & CCD transmission efficiency > 20 % vignetting < 3 % resolution > 60 lp/mm distortion free scaling rates: different assemblies for the adaptation of SVGA CCD image sensors to 18 or 25 mm image intensifiers are available	
system data	sensitivity	> 100 counts/photo–electron with P43 phosphor > 25 counts/photo–electron with P46 phosphor this corresponds to < 1 µLux (at 20 ms exposure time)
	resolution	up to 1000 lines

gate unit

ultra fast gating mode:

exposure times:	3, 5, 10, 20, 25, 30 ns, 30 ns .. 100 ns (10 ns steps), 100 ns .. 1 s (20 ns steps) 1 s .. 1000 s (1 µs steps)
delay times:	0 ns .. 50 ns (1 ns steps), 50 ns .. 100 ns (5 ns steps), 100 ns .. 1 s (20 ns steps) 1 s .. 1000 s (1 µs steps)
maximum pulsing frequency:	3 kHz

highrate gating mode:

exposure times:	20 ns .. 1000 s (20 ns steps)
delay settings:	0 ns .. 1000 s (20 ns steps)
maximum pulsing frequency:	2 MHz

intrinsic delay (trigger input – shutter) is appr. 50 ns
jitter (< 100 ns exposure time) < 0.5 ns
jitter (> 100 ns exposure time) < 5 ns

exposure modes

single exposure for ultra fast gating, multiple exposure function: (delay + exposure) x 1 .. 256

multi exposure for free programmable multiple exposures: (delay 1 + exposure 1,.., delay 10 + exposure 10) x 1 .. 256

double shutter function for two full resolution images, each exposure time 20 ns .. 1 s (20 ns steps), each delay time 20 ns .. 1 s (20 ns steps)

interframing time between two images depends on phosphor decay time, the minimum delay time is 500 ns

camera interface

data transfer	fiber optic link (FOL), double SC connector, length 10 m .. 1500 m
control output	active while “photocathode on”, TTL level, BNC connector
trigger input	electrical trigger (TTL level, BNC connector), light active or light pulse trigger(SC connector)
shutter disable	high speed TTL input (for disabling the shutter), BNC connector

software

camware software for camera control, display, storage and printing of image data under WindowsXP, WindowsNT, Windows2000, Vista and later; software development kit (SDK) with demo software for the above mentioned operating systems; TWAIN driver

phosphor data

phosphor	phosphor decay (typ.) to..		typical efficiency
	..10 %	..1 %	
P43	1 ms	4 ms	100 %
P46	0.2 – 0.4 µs	2 µs	30 %

photocathode characteristics

photo cathode material	peak wavelength [nm]	quantum efficiency at peak wavelength [%]	equivalent background input (EBI) [W/cm²]	dark counts [s^{-1}/cm²]
S20 (multialkali)	430	14 .. 18	$3 \cdot 10^{-14}$	1500
S25 (extended red multialkali)	600	8.3 .. 9.3	$2 \cdot 10^{-14}$	10 000
GaAs	530 – 750	23	$4 \cdot 10^{-14}$	30 000
GaAsP	480 – 530	50	$2 \cdot 10^{-14}$	10 000

(data courtesy of Hamamatsu Photonics)

spectral response of MCP

Spectral sensitivities of different MCP photocathode materials:
S20 (multialkali)
S25 (extended red multialkali)
GaAs
GaAsP

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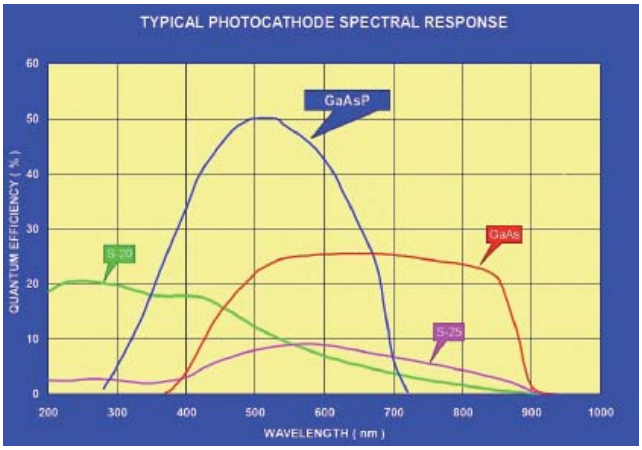
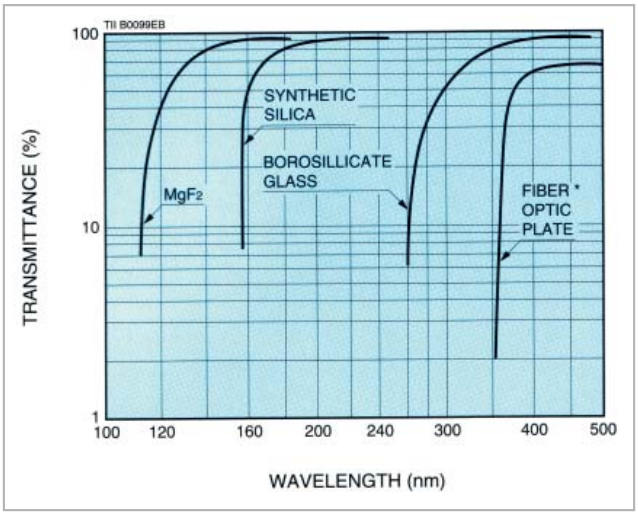
Hamamatsu Photonics,
Herrsching, Germany,
www.hamamatsu.de



Typical transmittance of MCP input window materials



areas of application

- particle image velocimetry (PIV)
- fluorescence imaging
- high resolution microscopy
- spray imaging
- flame analysis
- short time physics
- bioluminescence / chemoluminescence
- low light level imaging
- time resolved spectroscopy
- luminescence spectroscopy
- spectroscopy
- fast flow analysis
- ballistics
- electrophoresis
- LIF laser induced fluorescence
- combustion imaging
- fusion plasma
- Laser induced breakdown spectroscop (LIBS)
- pressure sensitive paint (PSP)

Analysis of carburation in engines by laser induced fluorescence, example: 2D distribution of fuel in a Diesel engine.

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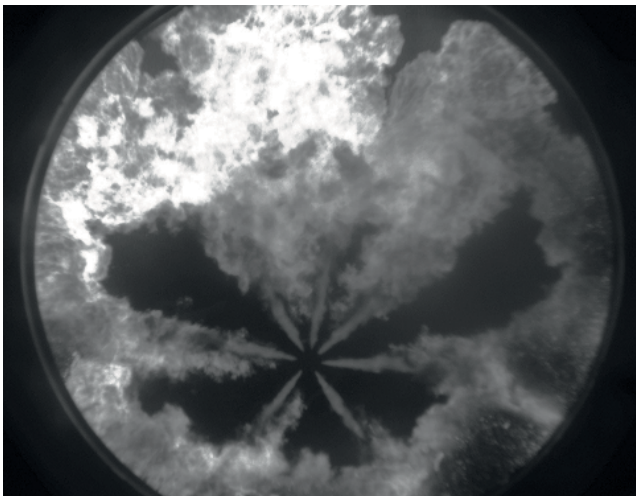

Analysis of spray vaporization with laser induced fluorescence (LIF).

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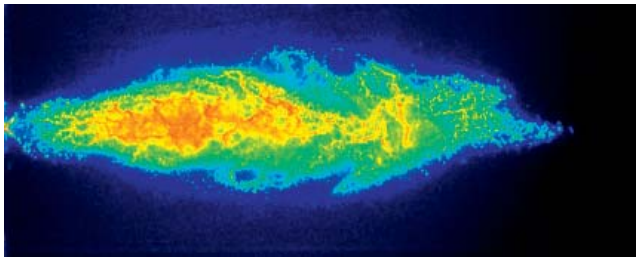

OH-PLIF (planar laser induced fluorescence) – turbulent flame front structure visualization. An OH-radical is used as tracer of the flame front with OH-PLIF single shot measurements (single shot: 8 ns laser pulse).

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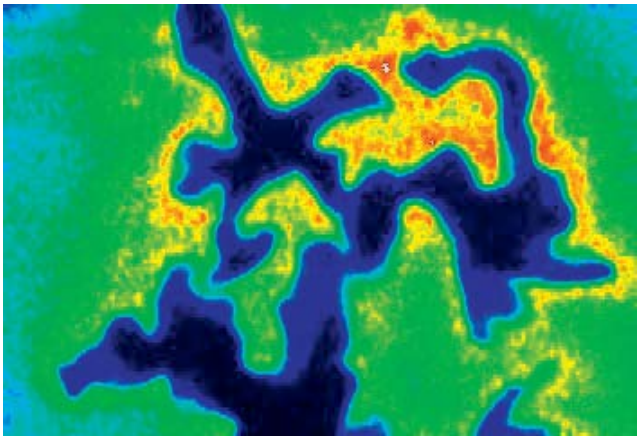

contact

The Cooke Corporation
6930 Metroplex Drive
Romulus, Michigan 48174
USA
tel 248 276 8820
fax 248 276 8825
info@cookecorp.com
www.cookecorp.com

PCO AG
Donaupark 11
93309 Kelheim, Germany

fon +49 (0)9441 2005 50
fax +49 (0)9441 2005 20
info@pco.de
www.pco.de

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