dicam pro
intensified digital 12bit CCD camera system

- fast shutter down to 3ns (optional 1.5ns)
- excellent sensitivity of the system allows single photon detection
- 12bit dynamic range
- high resolution MCP-image intensifier & CCD (1280x1024pixel)
- exposure times from 3ns (optional 1.5ns) – 1000s
- spectral sensitivity from UV to NIR
- PCI interface board “plug & play”
- binning (horizontal & vertical)
- thermo-electrical cooling (Peltier) of CCD image sensor down to -12°C
- optical or electrical triggering
- various MCP photocathodes - multialkali, S20, GaAs, GaAsP
- two discrete images with an interframing time of 500ns (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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dicam pro

This is a high speed intensified CCD camera system with gating times down to 1.5ns. With its 12bit 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 SVGA
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
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	3ns +/- 25% [3]	3ns..1000s (optional 1.5ns..1000s)
anti-blooming factor		@ 100ms 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		@ 1ms 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

trigger, auxiliary signals			TTL level, light 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
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	>60
shortest gating time	ns		3 (optional 1.5)

[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
	all leading manufacturers available	
pwr & gating supply	phosphor voltage	6..7.5kV internally adjusted, ripple ±15mV
	MCP voltage	0..1100V externally adjustable, ripple ±1mV
	photocathode voltage	on: -180V off: + 80V
	two modi can be selected:	
	ultrafast gating mode:	minimum pulse width 3ns (optional 1.5ns)
	highrate gating mode:	minimum pulse width 20ns, maximum pulsing frequency 2MHz (in bursts)
optical coupling	“ultra speed tandem lens” between image intensifier & CCD collimator lens f2.5/100mm output lens f1.0/33mm or f1.4/46mm (depending on CCD) transmission efficiency > 20% vignetting < 3% resolution > 60lp/mm distortion free scaling rates: different assemblies for the adaptation of SVGA CCD image sensors to 25mm image intensifiers are available: 25mm image intensifier to SVGA CCD sensor 1:2.17	
system data	sensitivity	>100 counts/photo-electron with P43 phosphor >25 counts/photo-electron with P46 phosphor this corresponds to <1µLux (at 20ms exposure time)
	resolution	up to 1000 lines

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gate unit	ultra fast gating mode:	
	exposure times:	3, 5, 10ns..(in 5ns steps) ..30ns.. (in 10ns steps) ..100ns.. (in 20ns steps) ..1000s
	delay times:	0ns.. (in 1ns steps) ..50ns.. (in 5ns steps).. 100ns.. (in 20ns steps) ..1000s
	maximum pulsing frequency: 3kHz	
	optional:	min. exposure time 1.5ns
	highrate gating mode:	
	exposure times:	20ns.. (in 20ns steps).. 1000s
	delay settings:	20ns.. (in 20ns steps).. 1000s
	maximum pulsing frequency: 2MHz intrinsic delay (trigger input – shutter) is appr. 50ns jitter (<100ns exposure time) <0.5ns jitter (>100ns exposure time) <5ns	
exposure modi	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 20ns.. (in 20ns steps).. 1s each delay time 20ns..(in 20ns steps)..1s	
	interframing time between two images depends on phosphor decay time, the minimum delay time is 500ns	
camera interface	data transfer	fiber optic link (FOL), double SC connector, cable length 10m..1500m
	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 Windows9x, ME, XP, WindowsNT, Windows2000; 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	1ms	4ms	100%
P46	0.2 - 0.4µs	2µs	30%

photocathode characteristics

photo cathode material	peak wavelength [nm]	quantum efficiency at peak wavelength [%]	equivalent background input (EBI) [W/cm²]	dark counts [s^{-1}/cm^2]
S20 (multialkali)	430	14..18	$3 \cdot 10^{-14}$	1500
S25 (multialkali)	600	8.3..9.3	$2 \cdot 10^{-14}$	10 000
GaAs	830	23	$4 \cdot 10^{-14}$	30 000
GaAsP	500	50	$2 \cdot 10^{-14}$	10 000

(data courtesy of Hamamatsu Photonics)

spectral response of MCP

Spectral sensitivities of different MCP photocathode materials:
S25 (multialkali) > [-04] & [-08]
S20 (multialkali) > [-01] & [-05]
GaAs > [-61]
GaAsP > [-64]

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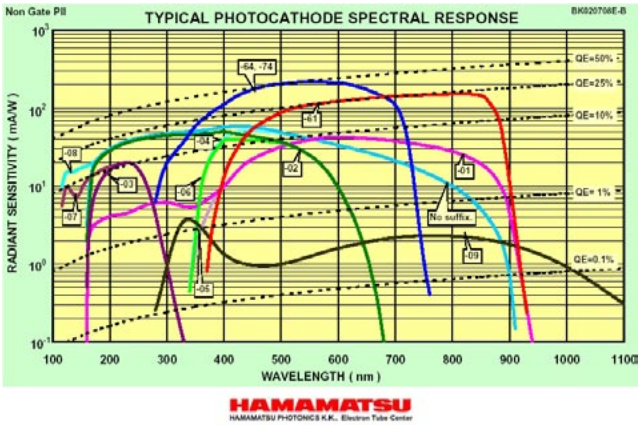
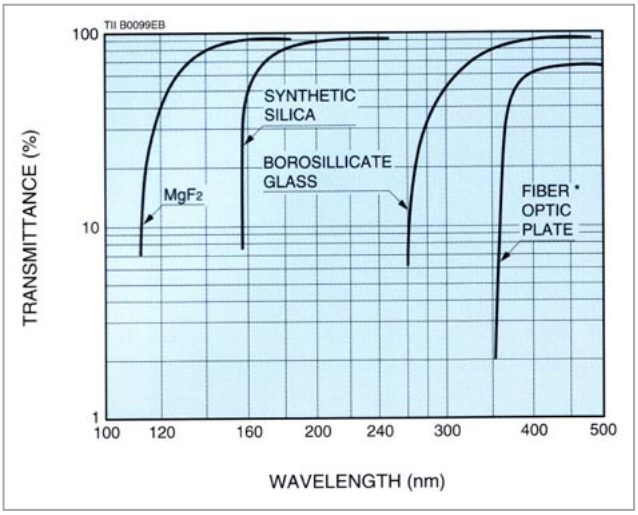
Hamamatsu Photonics,
Herrsching, Germany,
www.hamamatsu.de



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

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

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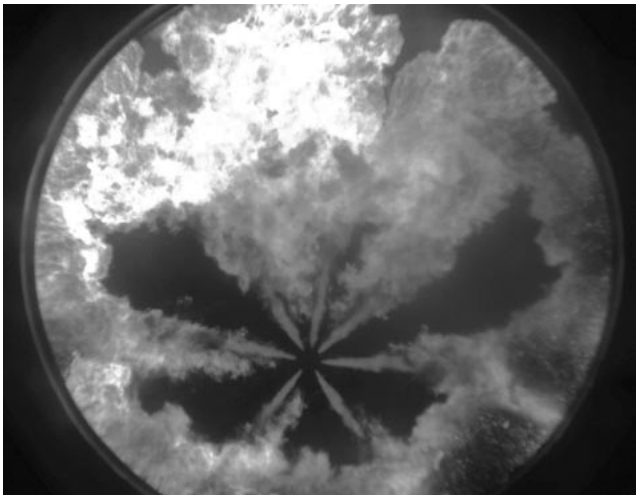

Analysis of spray vaporization with laser induced fluorescence (LIF).

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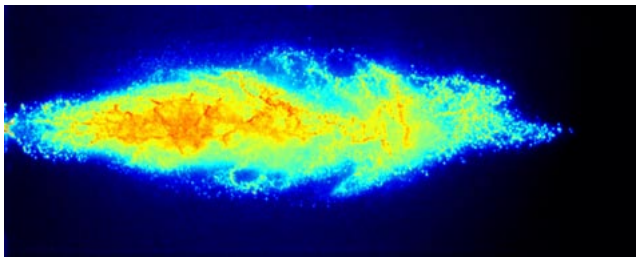

OH-PLIF (planar laser induced fluorescence) - turbulent flame front structure visualization. An OH-radical is used as tracer of the flame front with OH-PLIF single shot measurements (single shot: 8ns laser pulse).

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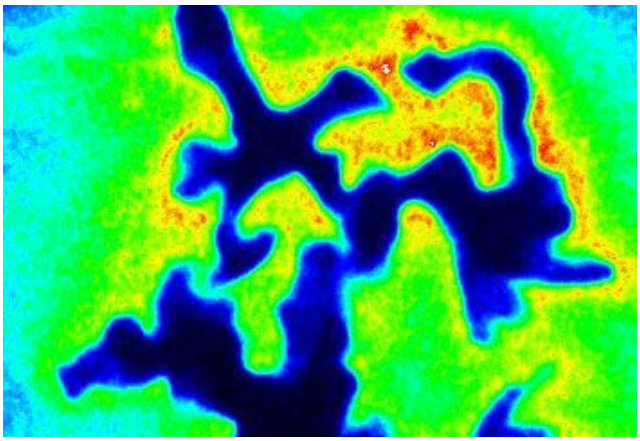

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