



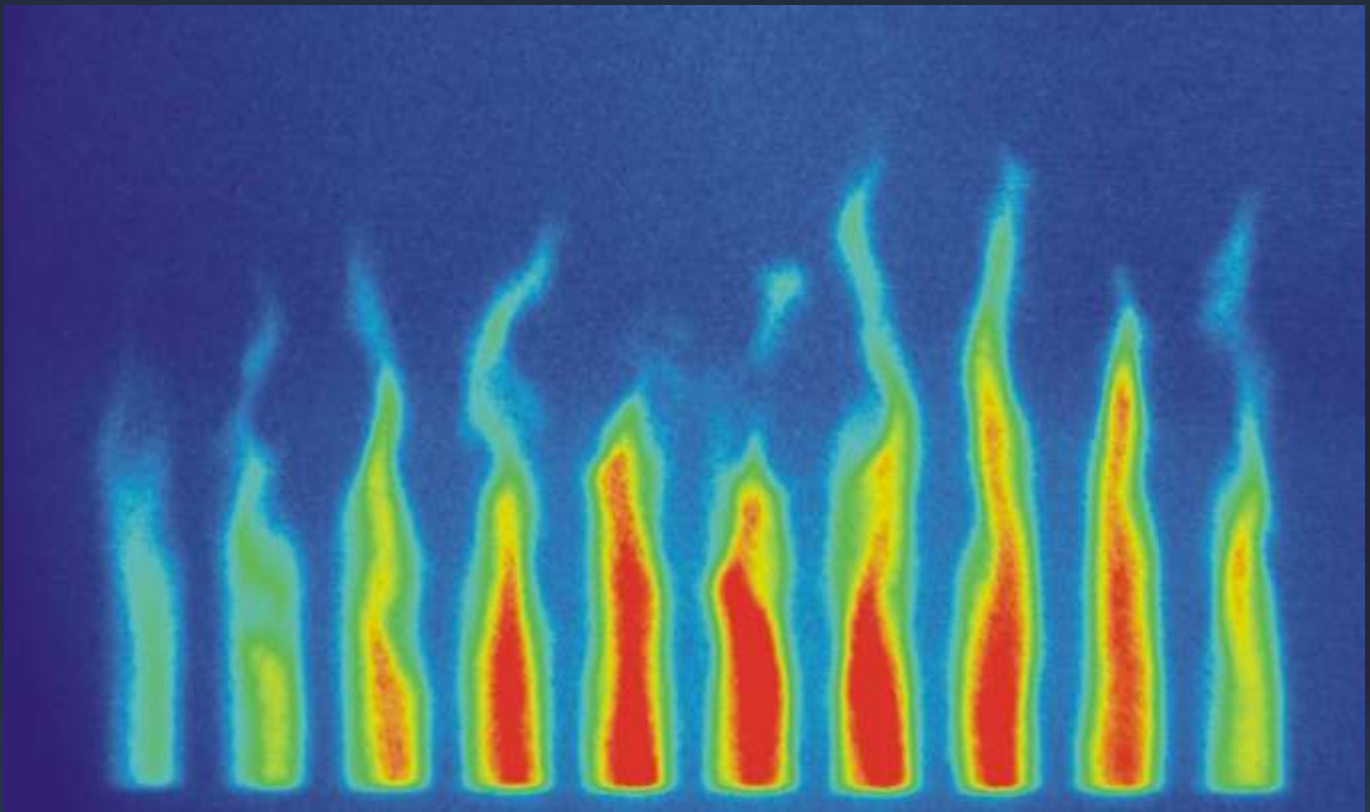
**STANFORD
COMPUTER
OPTICS**

Superior imaging intensified CCD cameras



Quantum Leap

The image intensifier module for continuous or gated operation providing high speed shutter.



- ❑ High resolution image intensifier
- ❑ Shortest gating time down to 200ps
- ❑ Excellent for high-speed video cameras
- ❑ Time/Gain Module for remote control

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STANFORD COMPUTER OPTICS



Superior imaging intensified CCD cameras

Quantum Leap

Available as non-gateable or gateable Version

The Quantum Leap is a stand alone image intensifier module, which upgrades your existing setup to a full-fledged intensified imaging system. It comprises the image intensifier, pulse amplifier, high-voltage power supply and a selectable output coupling lens.

Non-gateable or gateable version

The Quantum Leap is available as non-gateable or gateable version, where the gateable Quantum Leap provides a minimal gate time of either 1.2ns or 200ps. The compact design of all Quantum Leap models hosts everything needed for operation.

High speed with excellent signal amplification

Image intensifiers are providing an unique combination of intensifying low light images and a high speed shutter. This makes them the perfect tool in combination with high speed video cameras or multiple exposure applications like particle imaging velocimetry (PIV).

Easy integration and flexibility

With the integrated output coupling lens the image intensifier module can be easily connected with various cameras. Several output coupling lenses are available to ensure the best imaging quality with the particular used detector size.

Highest flexibility with Time & Gain Module

By default the photocathode gating of the image intensifier is activated using an external TTL signal and the signal gain is set manually. With the optional available Time & Gain Module the image intensifier gain, the gating and delay time can be controlled remotely via software.

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Cover: Image sequence of the Triplex-plasma source taken with a corresponding frame rate of 1 million frames per second. Further details on page 11. Figure reprinted with permission of the Universität der Bundeswehr in Munich.



Standard features and benefits

- Non gateable or gateable version
- Shortest gate time down to 1.2ns or 200ps
- Single stage 18mm image intensifier
- High resolution image intensifiers with optical system resolution of >60lp/mm
- Spectral sensitivity from UV to IR (S20, S25) (depends on type of image intensifier)
- Brilliant sensitivity providing single photon detection
- Improves image contrast and S/N ratio
- Adjustable MCP-voltage for 50db dynamic range in signal amplification
- Various customized distortion free coupling lenses between image intensifier and CCD sensor
- Only 12V power supply necessary
- Compact and light system design

Optional features

- 25mm image intensifier
- Dual stage multi-channel plate (MCP) for highest signal gain and single photon detection
- Adapters for various spectrometer
- Vacuum flange for UHV connection
- Time & Gain Module providing:
 - Full remote control via RS232 of signal gain, gate and delay time
 - Internal digital delay generator
 - Multiple trigger options: 3x input; 3x output
 - Multiple exposure operation with gate repetition rate up to 200kHz, 2MHz (optional) and 5MHz (on request)
 - incl. Parameter control software equal to camera control of the 4 Spec software
 - optional LabVIEW API for Time & Gain Module

Highlights

High resolution image intensifier

Build in pulse amplifier and high-voltage power supply

Maximal gate repetition rate 5MHz (on request)

Up to 25mm output image diameter

Excellent for high-speed video cameras



Time settings

High accuracy timing control of the high speed shutter

The Quantum Leap is available as non-gateable or gateable version, where the gateable Quantum Leap provides a minimal gate time of either 1.2ns or 200ps. By default all Quantum Leap models provide manual adjustability of the signal amplification and the photocathode gating can be switched by an external TTL signal.

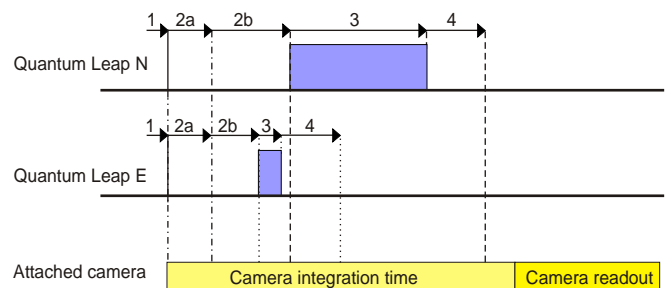
In combination with the Time/Gain Module the gateable versions of the Quantum Leap are fully remotely controllable. The integrated digital delay generator provides highly accurate timing control with 100ps and 10ps step sizes of the gating and delay time. Furthermore, the Time/Gain Module enables multiple exposure operation modes and external triggering.

Time settings

Parameter	Quantum Leap	Quantum Leap N	Quantum Leap E
Gating time [step size]	non gateable	1.2ns ... 80s [100ps]	200ps ... 80s [10ps]
Delay time [step size]	not applicable	0.1ns ... 80s [100ps]	10ps ... 80s [10ps]
Jitter	not applicable	<20ps	<10ps
Gate repetition rate (burst mode)	not applicable	3.3MHz	
Gate repetition rate (continuous mode)	not applicable	200 kHz (2MHz optional, 5MHz on request)	
Trigger propagation delay	not applicable	standard with external gate pulse: 30-35ns optional with Time/Gain module: 60-65ns	
Gain control	manual	standard: manual with potentiometer optional with Time/Gain module: digital via RS232	
Gate control	not applicable	standard: external TTL pulse optional with Time/Gain module: digital via RS232	

Operation showcase with a high frame rate video camera

The Time & Gain Module synchronizes the Quantum Leap with the connected camera using an adequate TTL signal as trigger. The trigger pulse follows an intrinsic delay time. Then the remotely adjustable delay time elapses before the shutter opens for an also remotely adjustable gating time. After the gating time the attached camera should further integrate during the luminous period of the phosphor screen.



Legend:

- 1) external trigger signal (from attached camera)
- 2a) intrinsic delay 35ns or 65ns
- 2b) adjustable delay time: Quantum Leap N: 0;100ps-80s, step size 100ps
Quantum Leap E: 0;10ps-80s, step size 10ps
- 3) adjustable gate time: Quantum Leap N: 1.2ns-80s, step size 100ps
Quantum Leap E: 200ps-80s, step size 10ps
- 4) luminous period of the phosphor screen



Optical input & output options

Various output image sizes by selectable coupling lens

Flexible intensified imaging extension

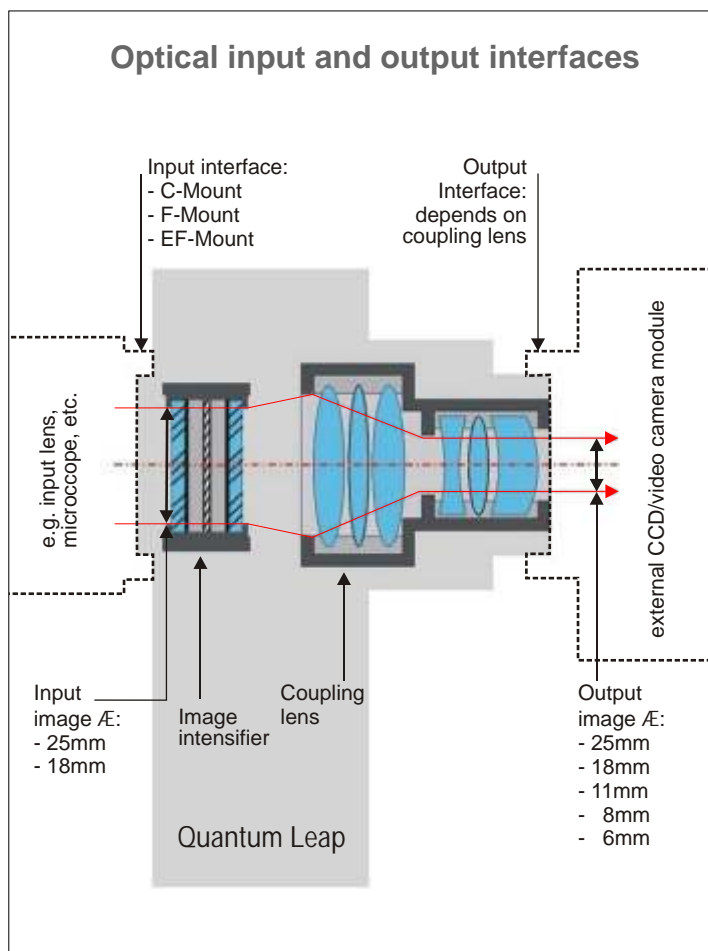
The Quantum Leap image intensifier module can be adapted between any optical device e.g. input lens or microscope and any detector. The input image is amplified by the image intensifier which also provides the high speed shutter functionality. The output is imaged on the sensor by the coupling lens.

Various input and output interfaces

The image intensifier module provides multiple input options to meet the requirements of the different optical devices on which the Quantum Leap can be connected. The input interface of the Quantum Leap provides by default a C-mount connector. Various adapters for e.g. F-mount (Nikon) or EF-mount (Canon EOS) are available.

Superior distortion free image quality

The output coupling lenses provide the flexibility of alternative sensor sizes in combination with high coupling efficiency and superior image quality. The output image is distortion- and vignetting-free and shows no honeycomb pattern. Depending on the detector size of the connected camera the suitable coupling lens in combination with the convenient diameter of the image intensifier can be chosen in the table below.



Output coupling lens

Output image diameter	Sensor size	Coupling lens magnification	Image intensifier Diameter	Output interface
25mm	1" CCD chip or large format CMOS sensor	1 : 1	25mm	F-mount Optional: C-mount
18mm	1" CCD chip or large format CMOS sensor	1 : 1	18mm	F-mount optional: C-mount
11mm	2/3" CCD chip	2.2 : 1	25mm	C-mount only
8mm	1/2" CCD chip	2.2 : 1	18mm	C-mount only
		3.1 : 1	25mm	C-mount only
6mm	1/3" CCD chip	3.1 : 1	18mm	C-mount only

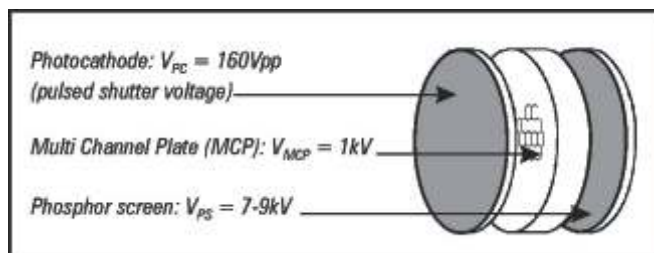
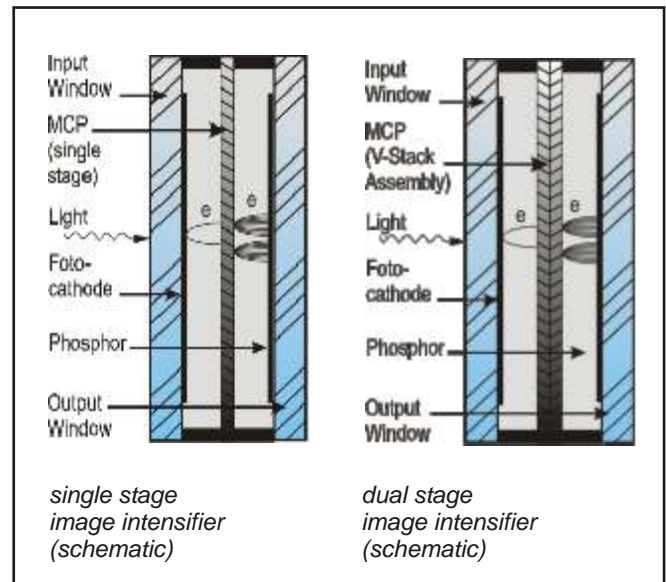
High performance image intensifier

Guidance to make the right choices in order to get the most suitable image intensifier.

The image intensifier is a key component of each ICCD camera. This section deals with the fundamental characteristics of image intensifiers and their options. Different applications of ICCD cameras have different demands and requirements on the camera and thus on the image intensifier.

Following questions need to be addressed

- What are the spectral characteristics of illumination?
→ Does determine the suitable photocathode.
- What spatial resolution is necessary?
→ Does determine the size of the image intensifier.
- How fast need to be the shutter/shortest gating time?
→ Highest shutter speed does have some constrains to e.g. size of the image intensifier.
- How much light is there?
→ Dual stage MCP's have better performance at low light environments.
- High speed or low light imaging?
→ Does determine the suitable phosphor screen.



First the incoming photon releases an electron in the photocathode, second the electron is accelerated and amplified to an electron avalanche within the multi-channel plate (MCP), third the accelerated electrons are converted into photons by the phosphor screen.

Photocathodes

	Type	Nb	Spectral range	
Standard	S20	I	UV - VIS	approx. 165 - 820nm
	S25	II	VIS - IR	approx. 350 - 920nm
Optional	S20 (MgF2)	III	UV - VIS	approx. 110 - 820nm
	Broadband	IV	UV - IR	approx. 190 - 920nm
	Solar Blind	V	UV	approx. 180 - 340nm
	S1	VI	IR	approx. 700 - 1300nm



Image intensifier specifications

Diameter

The diameter of the image intensifier is one key parameter. The 18mm image intensifier provides high shutter speed and a higher specific resolution than the 25mm image intensifier. This makes the 18mm image intensifier to the standard and most suitable to many applications of ICCD cameras. If you are looking for the best spatial resolution with the drawback of slower shutter speeds the 25mm image intensifier is the preferred choice.

Shutter speed

The shutter speed is limited by the speed of light since any electromagnetic signal does not travel faster. Due to this physical constraint the shutter of the 25mm image intensifier is slower.

Input window

The standard input window is made of quartz. This limits the UV spectral range below 165nm. The optional Magnesium Fluoride (MgF2) window enables measurements down to 110nm.

Photocathode

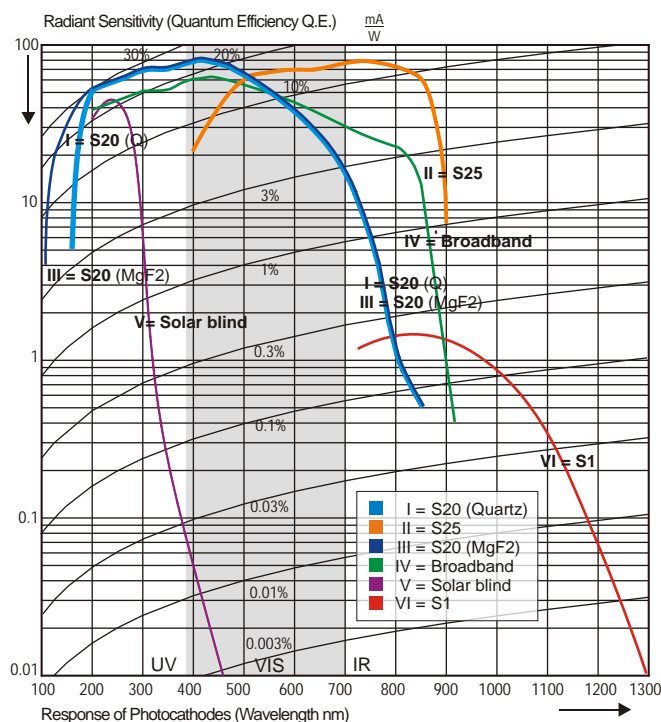
Photocathodes define the sensitivity and the spectral response of the image intensifier.

Phosphor screen

There are three important considerations in choosing a luminous (phosphor) output screen.

1. spectral emission range
2. efficiency
3. phosphor decay time

The P43 phosphor screen has a higher efficiency, however, a longer decay time. For fast applications e.g. double frame mode with interframing time of 500ns the P46 phosphor screen is necessary to avoid ghost images from the previous exposure.



Multi-channel-plate (MCP)

Image intensifiers can be equipped with single or double stage MCP's. The single stage MCP features excellent signal gain and fits most applications of the ultra high speed ICCD cameras.

The V-stacked double MCP's are especially used for extreme low light environments. The increased electron multiplication provide single photon detection with increased signal to noise ratio and reduced ion feedback noise. Therefore, the double MCP is mainly used for long exposure measurements and extreme low light applications

Phosphor screen

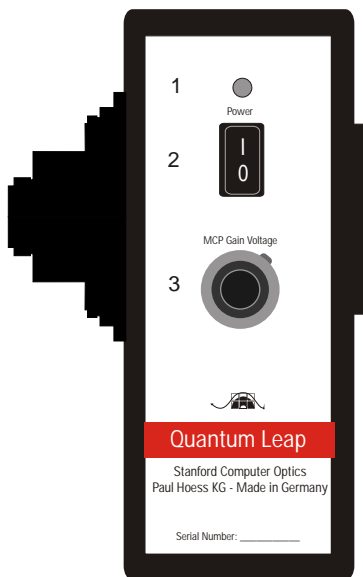
Type	Composition	Efficiency	Decay time		Emission spectral range
			90% to 10%	10% to 1%	
P43	Gd ₂ O ₂ S:Tb	185 ph/e @6kV	1.5ms	3.3ms	360 - 680nm
P46	Y ₃ Al ₅ O ₁₂ :Ce	90 ph/e @6kV	0.2μs	10μs	490 - 620nm

Micro-channel-plate (MCP)

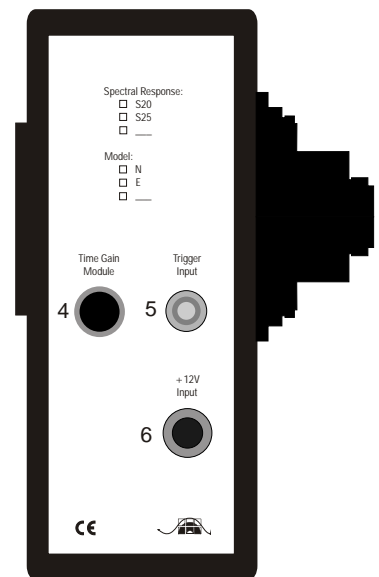
Type	Electron multiplication	S/N ratio	Notice
Single stage	up to 10 ³	very good	best image quality
Double stage	up to 10 ⁶	excellent	highest sensitivity

Connection options

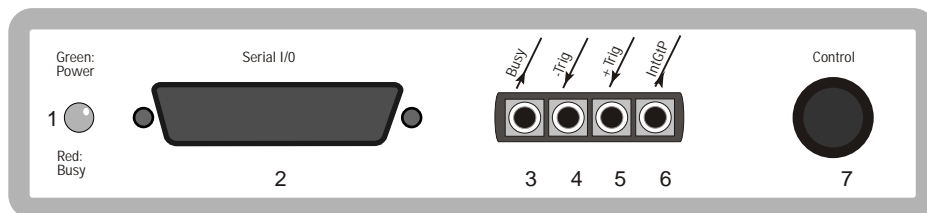
Quantum Leap non gateable and gateable



- 1 LED signal; green: power on
red: shutter (gate) open
(Quantum Leap busy)
- 2 Power ON/OFF switch
- 3 Manual adjustable signal gain;
Manual adjustable resistance to
set the the signal gain of the
image intensifier by varying the
high-voltage MCP gain.
- 4 Connector of the Time/Gain
Module; The link with the
Time/Gain Module enables the
remote control of the signal gain,
gating and delay time
- 5 TTL input signal;
External TTL signal to control the
photocathode gating.
- 6 Power supply socket;
Supply voltage 12V
approx. 1A without cooling
with cooling approx. 2.5A max.



I/O Connectors: Time & Gain Module (optional)



1 LED
green: Power on
red: shutter (gate) open
(Quantum Leap busy)

2 RS232 interface
RS232 output socket
for connection with a
PC or Laptop

3 Busy
TTL output signal; this timing
circuitry busy signal can be
used as an external trigger for
a camera or any external
instrument.
It is an active low signal.

4 -Trig
TTL input trigger; Input for
external trigger on negative
edge $\pm 20V$ max. for short time
periods transition at 1.3V.

5 +Trig
TTL input trigger; Input for
external trigger on positive
edge $\pm 20V$ max. for short time
periods transition at 1.3V.

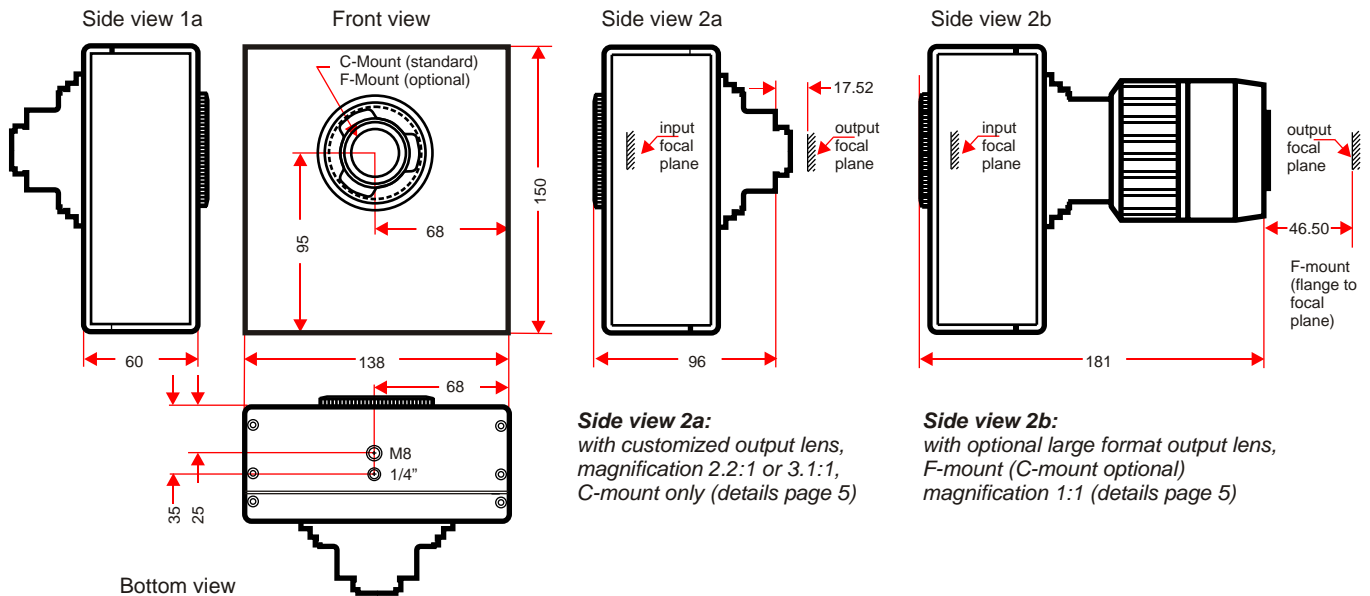
6 IntGtP - TTL output signal
Gate monitor output provides
reliable timing information on
actual gating occurrence with
internal time generator or
external gating pulse.

7 Time & Gain output
Output socket for the link with
the Quantum Leap



Dimensions

Quantum Leap - compact and light design



Side view 2a:
with customized output lens,
magnification 2.2:1 or 3.1:1,
C-mount only (details page 5)

Side view 2b:
with optional large format output lens,
F-mount (C-mount optional)
magnification 1:1 (details page 5)

Mechanical and environmental data

Parameter	Quantum Leap Module	Time & Gain Module
Weight (all in one)	1.8kg / 4lb	0.3kg / 1.8lb
Dimensions (camera without lens)	60 x 136 x 150mm (l x w x h)	240 x 140 x 40mm (l x w x h)
Camera mount	1/2" and M8 mounting holes	
Operating humidity	25..95%, non condensing	
Operating temperature	0°C - 50°C / 32°F - 122°F	
Performance specification	10°C - 40°C / 50°F - 104°F	
Operating limits	-10°C - 50°C / 14°F - 122°F	
Shock and vibration	60g accel. shock, 7g Vibration (11 - 200Hz), excludes MCP in direct frontal impact	
Voltage	90..260VAC	

Extended warranty on all products from Stanford Computer Optics

2 years on mechanics and electronics
Stanford Computer Optics Inc. warrants all new products to be free from defects in materials and workmanship for 24 months from the date of dispatch.

1 year on image intensifier
Image intensifiers are subject to the original manufacturer's warranty conditions. It comprises a warranty of 12 months. In case of any defect the Paul Hoess KG or Stanford Computer Optics Inc. will assist for repair or replacement.

Warranty restriction
Warranties do not cover normal wear, misuse, negligence or accident. They do not apply to goods which have been misused, altered, inadequately maintained, stored incorrectly, or negligently installed or serviced.

Quantum Leap Serie

Customize the optimum Quantum Leap image intensifier module for you application

The Quantum Leap enables the customization to the requirement and needs of your experiment and many detector systems. Please follow the indicated four step process to get the most suiting stand-alone image intensifier module for your application.

Customize your Quantum Leap in 4 steps:

1. Select the required gate operation
2. Select the optimum image intensifier
3. Choose the ideal output coupling lens
4. Pick the required accessories

1. Gate operation

Choose the required gate operation for your experiment.

Non-gateable: This module is only recommendable for applications with known illumination.

Gateable down to 1.2ns:

This gating time provides superior images in combination with high speed video cameras.

Gateable down to 200ps:

The fastest shutter is available for research on ultra high speed physical phenomena.

2. Image intensifier

2.1. Diameter

- 18mm or
- 25mm

2.2. Photocathode

- S20UV (B) or S25 (H)
- others on request
- see details on page 6
- input window: quartz or MgF2 on request

2.3. Multi-channel plate (MCP)

- single or
- dual stage (optional)

2.4. Phosphor screen

- P43 standard
- P46 optional (for dual frame mode)

3. Coupling lens

The output coupling lens is the optical link between the image intensifier and the detector system.

Choose the optimal coupling lens for best imaging quality and optimal sensor coverage. See details on page 5.



Please contact our sales team to get assistance and further details to these options.

4. Selection of optional accessories and adapters

Item-No.	Name of product	Description
LA-TG-...	Time & Gain Module	TGN (min. gate time 1.2ns) or TGE (min. gate time 200ps)
LA-LMA-...	lens mount adapter	selection of adapter for various lens mount systems (e.g. F-mount, EOS) providing full aperture and reduced stray light by black anodized aluminum
LA-SGA-...	spectrograph adapter	selection of adapter for all common spectrograph manufacturer e.g. Acton, Horiba and Jobin Yvon, others on request
LA-VF	vacuum flange	customized flange to connect the ICCD camera to any vacuum tube
LA-SMB-BNC	SMB-BNC	SMB - BNC adapter cables in any length
LA-IOL-...	input objective lens	various input objective lenses e.g. Pentax UV lens 25mm, F2.8-16; Pentax UV lens 78mm, F3.8-16F3.8-1, others on request



Applications

Quantum Leap intensifier module provides user-friendly intensified imaging for applications in many different fields of research

Velocity map imaging

e.g. by H. S. Chung, et al., from the Seoul National University, Korea: J. Chem. Phys., Vol. 114, 2001

Raman line imaging

e.g. by C. R. Howle, et al., from the Defence Science and Technology Lab, United Kingdom: Proc. SPIE 7116, Optically Based Biological and Chemical Detection for Defence IV, 2008

Photodissociation dynamics

e.g. by K. S. Lee, from the Advanced Institute of Science and Technology, Korea: The Journal of Chemical Physics, Vol. 122, 2005

Adaptive optics

e.g. D. L. McKenna, et al. from the Steward Observatory, United States: Proc. SPIE 4839, Adaptive Optical System Technologies II, 2003

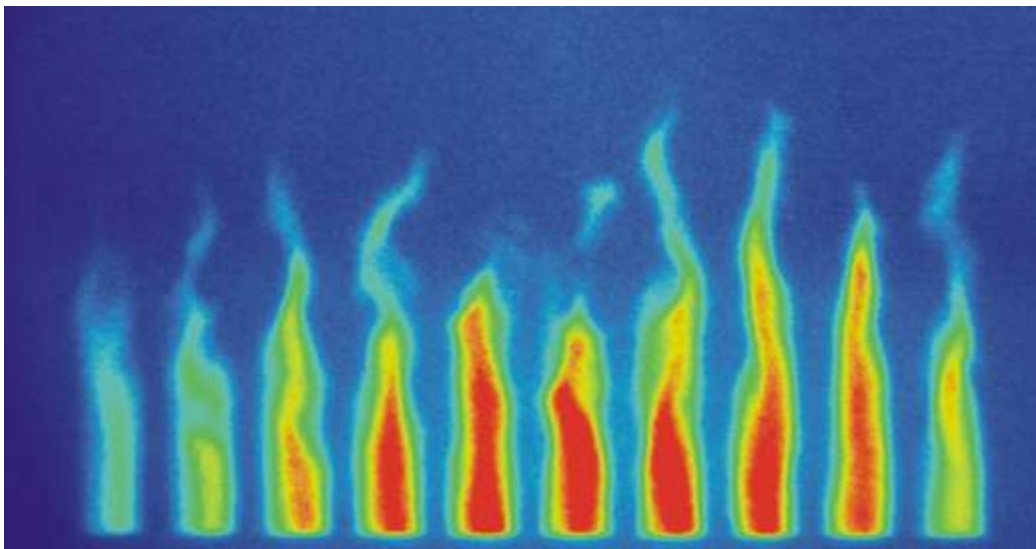


Image sequence with 1 million frames per second (fps) using a rotating mirror high speed camera.

S. Kirner from the Universität der Bundeswehr in Munich used the stand-alone image intensifier module, Quantum Leap, to construct a rotating mirror ultra-high speed camera which enables image sequences of up to 1 million fps.

Image sequence of the Triplex-plasma source taken with a corresponding frame rate of 1 million frames per second. The image of the plasma source was moved along the image intensifier using a rotating mirror. The Quantum Leap provides 10 shutter openings with

1MHz repetition rate. The triplex-plasma source is a multi cathode plasma source which ensures the independent formation of multiple electric arcs and a steady plasma. Figure reprinted with permission of the Universität der Bundeswehr in Munich.

Designed for high speed video cameras

The Quantum Leap image intensifier module is specially designed for the usage in combination with a high speed video cameras. This combination ensures sharp and clear images of ultra fast processes like hyper-velocity impacts.

Outstanding imaging quality can be achieved with the stand-alone image intensifier, Quantum Leap. It amplifies the incoming light signal so that the shutter (gate) time can be reduced to overcome any image smear or blur. Furthermore, the highly accurate timing control of the Quantum Leap allows the precise synchronization of the high speed shutter with external devices like Lasers.



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Quantum Leap

The modular high speed
image intensifier module for
continuous or gated operation

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