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Superior imaging intensified CCD cameras

XXRapidFrame

Multiframing ICCD camera

Up to 8 channels

Up to 100 billion frames per second

Based on 4 Picos or 4 Quik E ICCD camera technology

UV enhanced system

PRISM AWARDS FINALIST

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XXRapidFrame
multi-channel ICCD camera

More detailed information

General structure of the XXRapidFrame
The multi-channel framing camera consists of a single optical input and a mirror based image splitter. The custom designed splitting optics divides the incoming light homogeneously into the individual channels. The intensified CCD channels are fully remote controllable by state-of-the-art electronics. This allows highly accurate timing control to capture ultra high speed phenomena.
The multi-channel framing camera is able to record up to optional eight images with a interframing delay down to 10ps (based on 4 Picos technology). This enables successive image sequences taken with a corresponding frame rate of up to 100 billion frames per second.

Ideal optical design for framing cameras
The customized optical design offers up to eight separate channels without compromising resolution, shading, or parallax. The mirror based image splitter ensures spectral independent intensity division. The UV enhanced image splitter enables measurements in ultraviolet spectral range down to 200nm.

Individual controllable ICCD channels
The XXRapidFrame is available based on the 4 Picos or on the 4 Quik E ICCD camera technology with the shortest gating time down to 0.2ns or 1.2ns, respectively. Each of the channels is equipped with a high resolution image intensifier and a high resolution CCD sensor.

Ultra high speed imaging
The ultra high shutter speed and the minimum interframing time of 0.01ns (based on 4 Picos technoloy) enables photographs of ultra high speed phenomena such as lightning emergence. Hence, the multi-channel framing camera XXRapidFrame offers the ultimate performance to scientists and engineers across all disciplines.

Highlights

Ultra high speed gating down to 200ps flat top

Highly accurate timing control down to 10ps

Spectral flat mirror based image splitter

UV enhanced custom image splitting optics

Ultra high resolution image intensifiers

Standard features and benefits

- Up to eight intensified CCD channels
- Respective channel parameter based on 4 Picos or 4 Quik E ICCD technology
- Ultra fast shutter speed down to 0.2ns (4 Picos) or 1.2ns (4 Quik E)
- Highly accurate timing control with step size of 10ps (4 Picos) or 100ps (4 Quik E)
- High resolution image intensifiers with optical system resolution of >60lp/mm
- Extreme low jitter: <10ps (4 Picos) and 20ps (4 Quik E)
- Spectral sensitivity from UV to red
- Perfectly spectral flat mirror image splitter
- Customized optical design ensures images free from ghosting, shading, distortion or parallax
- Brilliant sensitivity providing single photon detection
- High dynamic range (12bit resolution)
- High resolution CCD sensor with 1360 x 1024 pixel
- Comprehensive trigger options: TTL, high voltage or via optical fiber
- USB 2.0 output
- 4 Spec E Software for camera control, image readout, handling and storage
- Compact and light system design

Optional features

- Double frame readout in full resolution with a interframing delay per channel of 500ns
- UV enhanced mirror image splitter down to 200nm
- Multi spectral imagery enables multi spectral images
- Highest dynamic range (14 bit resolution)

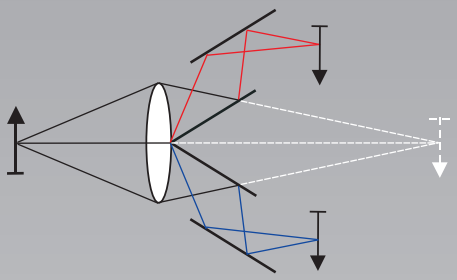
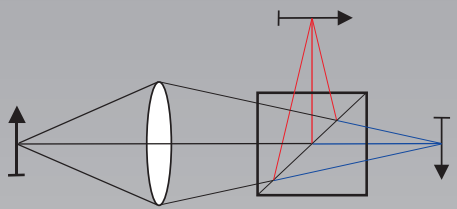
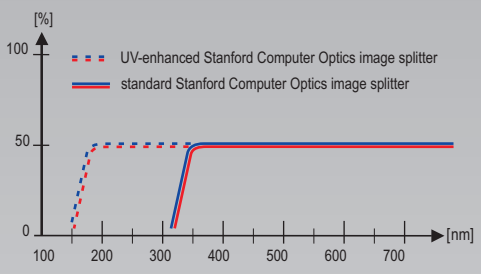
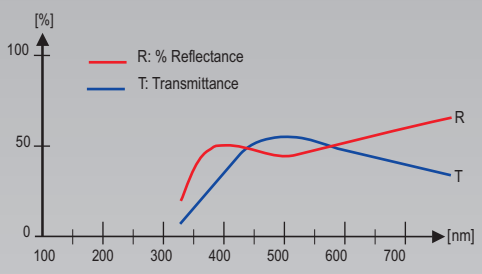
Images cover and backside: Consecutive image series of a high-voltage discharge development taken with a 3-channel XXRapidFrame framing camera. The individual channels are based on the 4 Quik E ICCD camera providing shortest gating times of 1.2ns. The image series is taken with inter-channel delay of 15ns

Mirror based image splitter

Best performance mirror based image splitter without compromising resolution and imaging quality.

Stanford Computer Optics developed and designed the mirror based image splitter to provide the best optical resolution and imaging quality with the multi-channel ICCD camera, XXRapidFrame. This customized image splitter does provide spectral flat response over the UV, VIS and IR and splits the incoming light equally between the attached channels. Hence, the mirror based image splitter has numerous advantages in comparison to competing solutions.

Image splitter comparison

Parameter	customized mirror based image splitter	semi transparent mirror image splitter
Optical layout		
Spectral splitting characteristics		
Advantages	+ flat spectral response + expandable to UV + light and compact + multi-spectral imagery	+ multi-spectral imagery
Disadvantages		- spectral response depending on the characteristics of the mirror - not expandabel to UV - heavy and large

UV enhanced image splitter

The standard mirror based image splitter enables measurements down to 350nm. Even if the downstream ICCD cameras are sensitive in the UV the light below 350nm just does not pass the image splitter. The UV enhanced mirror based image splitter enables in combination with the adequate photo-cathode measurements down to 200nm. It consist of a customized, in-house developed lens system including 6 lenses made of UV capable material like MgF2 and adequate mirror coatings.

Individual channel settings

The individual channels are equipped with technology based on the 4 Picos or 4 Quik E ICCD camera.

The 4 Picos and 4 Quik E provide highly accurate timing control with 0.2ns and 1.2ns minimum gating time, furthermore, the gating and delay time can be controlled with a step size of 0.01ns and 0.1ns, respectively.
Both ICCD cameras cover the spectral range from 180nm up to 900nm with the respective image intensifier. The customized design of the optical coupling lens guarantees in both cameras high sensitivity, high resolution, distortion free and vignetting free images. The CCD sensor can be chosen independently from the time setting.
All multi-channel framing cameras with four or less channels are equipped with fully functional, independent usable ICCD cameras. All intensified CCD channels within multi channel framing cameras with six and more channels are not removable from the housing.

Time settings

XXRapidFrame parameter	**based on 4 Picos***	**based on 4 Quik E***
Shortest gating time	0.2ns … 80s	1.2ns … 80s
Shortest interframing time	0.01ns … 80s	0.1ns … 80s
Timing control step size (gating and delay time)	0.01ns	0.1ns
Jitter	0.01ns	0.02ns
Double frame interframing time (two frames one channel)	500ns	500ns
Minimal dead time between multiple exposures	300ns	300ns
Trigger propagation delay	internal gate pulse: 67-72ns	
External trigger options	TTL, high voltage (100V) or optical fiber connector	

** More detailed information: www.stanfordcomputeroptics.com/products.html*

CCD sensor options (independent from time settings)

Parameter	**High resolution CCD sensor** (standard)	**Standard resolution CCD sensor** (optional)
Resolution (pixel)	1360 x 1024	780 x 580
Pixel size (µm)	4.7 x 4.7	8.3 x 8.3 (higher full well capacity)
Max. frame rate (full, 2x2, ROI)	8.8 / 14.8 / 20.7 fps	14.1 / 25.3 / 27.1 fps
Binning options	full frame, 2x2 (binning), ROI (region of interest)	
Dynamic range	12 or 14 bit	
Video gain (dB)	full and ROI: 0..20db; 2x2: 0..25db	
Chip readout	Correlated double sampling, dark current corrected	
Camera interface	USB 2.0	

Image intensifier options

Variety of high resolution image intensifiers

The image intensifiers are the key component of each intensified CCD channel of the XXRapidFrame. All of the image intensifier provide excellent, high resolution images. Further demands and requirements of the different applications can be met by the large variety of image intensifier options.

Diameter
The 18mm image intensifier provides higher shutter speed and higher specific resolution than the 25mm image intensifier. This makes the 18mm image intensifier to the standard and best suitable to most applications of the multi-channel ICCD camera XXRapidFrame. For the best spatial resolution with the drawback of slower shutter speeds the 25mm image intensifier is the preferred choice.

Photocathode
The photocathode material defines the sensitivity and the spectral characteristics of the image intensifiers. The different materials cover the spectral range from 200nm up to 1300nm. However, the overall spectral sensitivity of the XXRapidFrame is as well limited by the image splitter (see page 4).

Multi channel plate (MCP)
The single stage MCP features excellent signal gain and fits most applications of the ultra high speed framing camera. The V-stacked double MCP provides higher signal gain and is especially used for low light environments. The increased electron multiplication provide single photon detection with increased signal to noise ratio and reduced ion feedback noise.

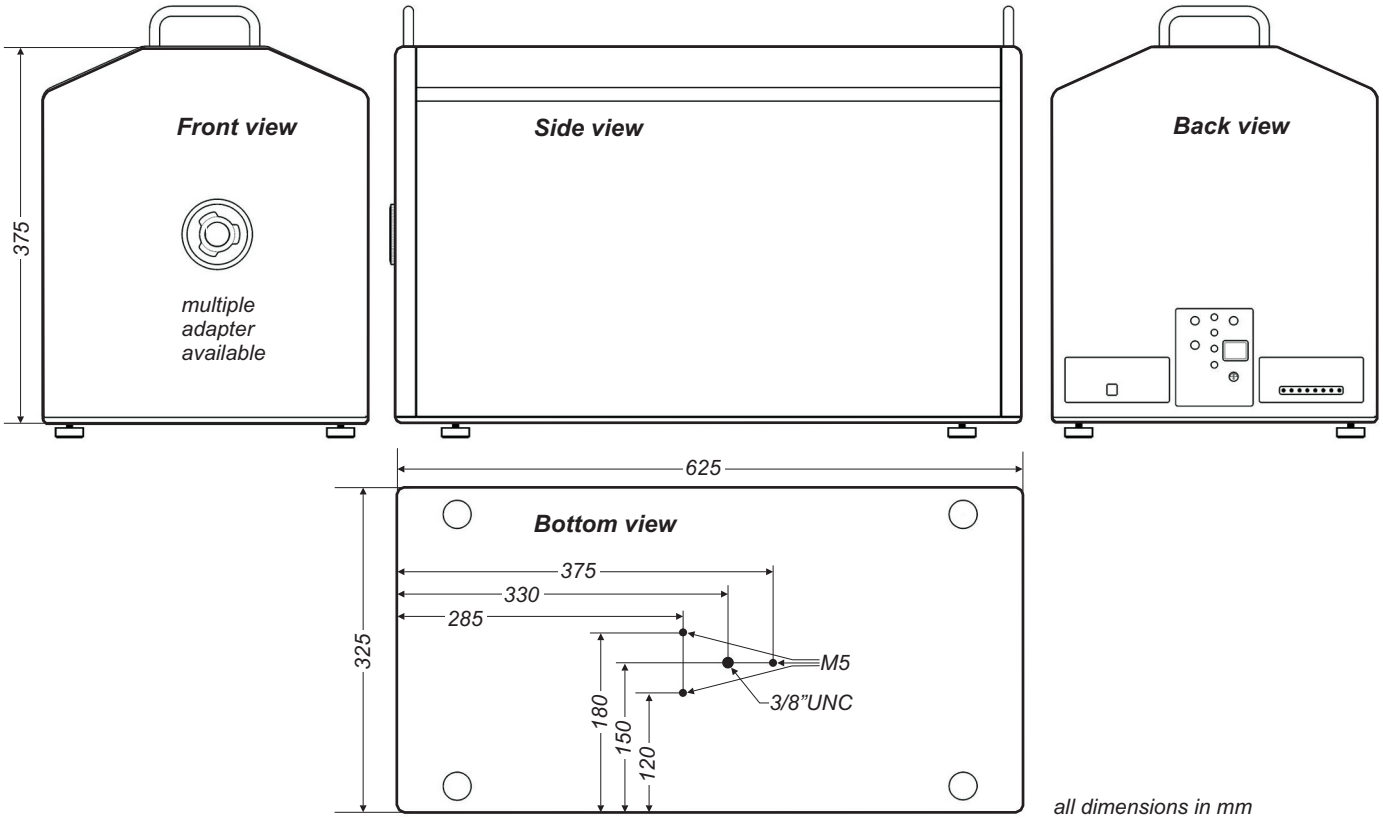
Phosphor screen
The P43 phosphor screen provides highest efficiency and excellent resolution and is hence the standard option for multi-channel ICCD framing cameras. The P46 phosphor screen provides fast decaying phosphorescence and enables double frames with each channel down to a interframing time of 500ns.

Multi spectral imagery
The multi-channel XXRapidFrame can be equipped with different types of image intensifiers at the individual channels. This enables for instance the simultaneously recording of multi-spectral images. Furthermore, the separate channels can be equipped with individual spectral filters for defined spectral range selection.

Image intensifier specifications (with XXRapidFrame)

Parameter	standard	optional
Diameter (imaging area)	**18mm** (14.4 x 10.8mm) only	
Photocathode	high QE UV	high QE blue, high QE green, high QE red
Multi Channel Plate	single stage	dual stage
Phosphor screen	P43	P46 (fast decay for double frames)
Gain control	high precision, remote control with 10bit resolution	
Input field of view	6 x 4.5mm	
CCD sensor coupling	customized 6 element F/0.8 relay lens No distortion! No shading! No vignetting! No pin cushion! No honey-comb pattern!	

Technical drawing



all dimensions in mm

Mechanical and environmental data

XXRapidFrame

Parameter	4 channels	6 channels	8 channels
Camera weight (all in one)	35kg / 77.2lb	39kg / 86.0lb	43kg / 94.8lb
Camera dimensions without lens	625 x 325 x 375mm (l x w x h)		
Camera mount	3/8" and M5 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)		
Voltage	90..260VAC		

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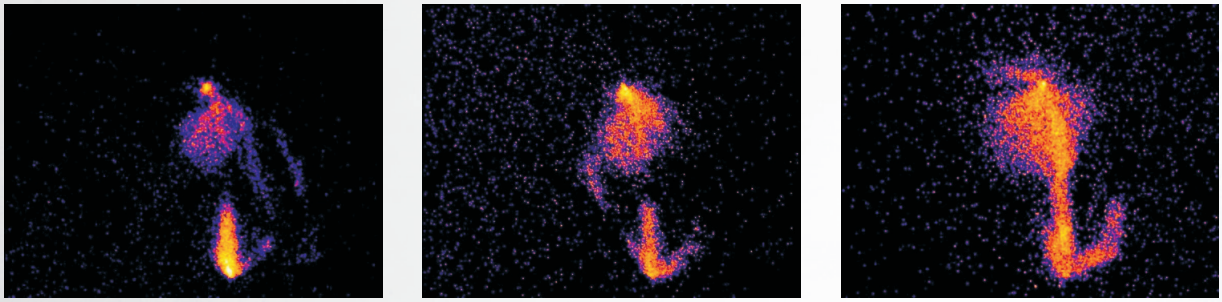

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