

XX *RapidFrame*



Standard Features

- Three or Four intensified CCD channels (4 Picos or 4 Quik E)
- Total of 3/6 or 4/8 frames from one trigger
- Fastest shutter down to 0.2ns (based on 4 Picos ICCD cameras) in single mode
- Jitter < 10ps
- Ultra fast recording of up to 4 full frame resolution images with 0.01ns interframing time
- Double shutter/frame and multiple exposures (each module)
- Perfectly spectral flat image splitter
- Single Photon detection
- Spectral Sensitivity of photocathodes from UV - NIR (220 - 1300nm)
- USB2.0 or analog output
- High Dynamic Range: 14 Bit (>36 Bit with 4 Spec E spectroscopy software)
- Effortless Image/Data storage and retrieval
- Internal or external trigger
- Free Terminal software "ready-to-use"

Specifications

Unique Features	XXRF based on 4 Picos	XXRF based on 4 Quik E
Shortest gating time each module	0.2ns	1.2 ns typically*
Jitter	< 0.01ns	< 0.01ns
Multiple exposures, „dead“ time between exposures	any sequence 0.3 μ s	
Double Frames	500ns minimum interframe time	
Gate repetition rate	3.3MHz burst, 200kHz continuous (each)	
Intensifier output coupling	customized distortion free f/0.8 relay lens	
Image Splitter	Spectrally flat mirror system	

* Minimum gate time 1.2ns typically (depends on manufacturer and specimen)

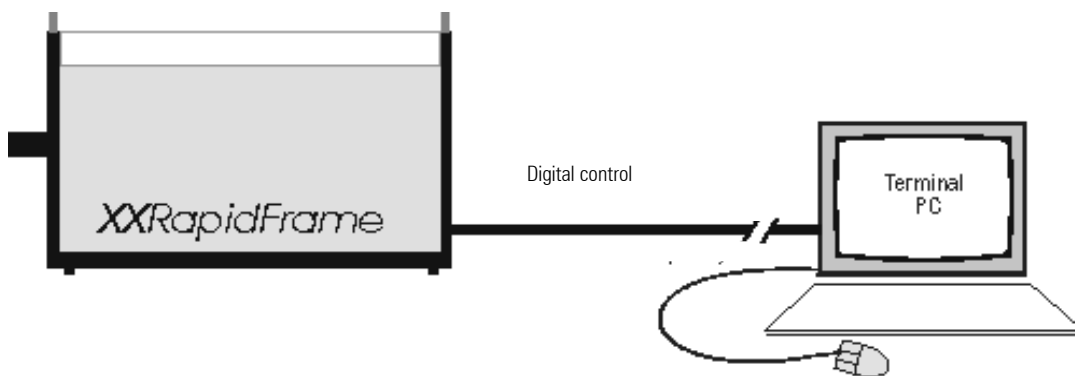
Special emphasis was laid on the utmost precision of the timing control of the system

The XXRapidFrame ultra high speed digital imaging system opens a new range of timing capabilities. The timing precision (jitter) is four times more accurate than that of dedicated delay generators (e.g. DG535) the minimum gate/delay times and gate/delay time steps are ≥ 100 times shorter than previous "state of the art" systems.

Exact reproducible digital setting of delay and exposure times is standard.

Very high system integration permits compact physical size of the XXRapidFrame camera. Distortion free imaging due to advanced proximity focused MCP (Micro Channel Plate) image intensifier, a optimized custom designed f0.8 relay coupling lens, and the use of highest quality CCD array for best sensitivity and resolution results in superior total optical performance.

14 Bit High Dynamic Range can be increased with 4 Spec E Spectroscopy PC Software up to >36 Bit (11 orders of magnitude) with multiple frames integrated.

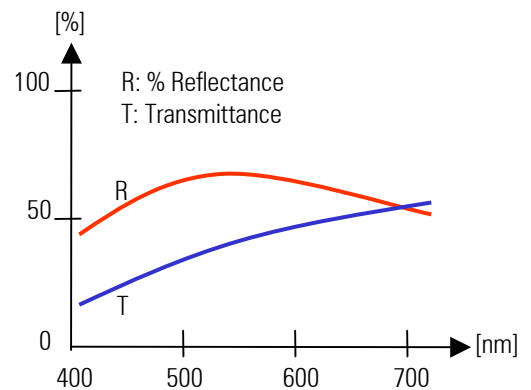
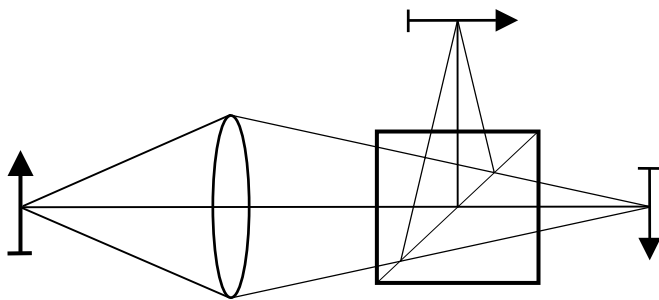


Digital or Analog Data

Image Splitting Concepts

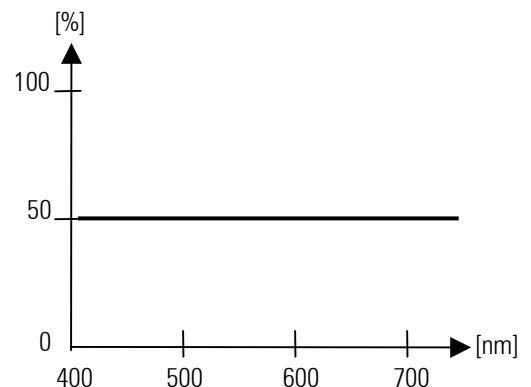
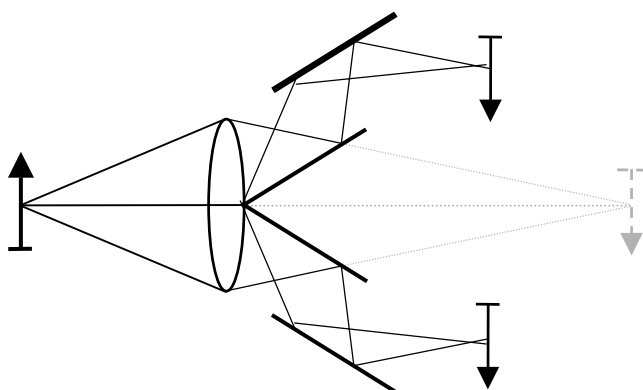
The wide spread semitransparent image splitting setup does not provide equal spectral distribution to both channels. Our spectrally flat Mirror Image Splitter does have identical amount of light of all wavelengths to all channels.

Semi transparent image splitter



The "conventional" method used to split an image into two identical secondary images of both lower intensity uses a cubic or pellicle beam splitter. It leads to a non predictable intensity ratio because the original image is usually not monochromatic. Therefore the photon flux at every single pixel is determined by the ratio of the integrals of the spectral distribution weighted with the R/T ratio of the beam splitter. Any wavelength change in between frames, e.g. as a function of temperature, will modify the splitting ratio. Such resulting images cannot be numerically corrected

Mirror image splitter



Using totally reflective mirrors for all sub images yields the intensity division in between the subs being only a function of the geometry of the mirrors. This approach is easily extended into the UV spectral region. A filter placed in each channel's optical path to produce e.g. a three-color image of an experiment. With different delay times in the various channels it could also be used to retrieve 3-D spatial information.

Image Intensifier

Image Intensifier specifications	
Image intensifier type (proximity focused MCP)	single stage (standard), dual stage (optional)
Phosphor material	P43, P46
Image intensifier diameter (mm)	18mm standard, 25mm optional
Image area of the relay lens	18mm MCP: 14.4 x 10.8mm, 25mm MCP: 20 x 15mm
Wavelength range, subject to window design	165 – 920nm (quartz, standard), 165 – 1300nm (optional)
Spectral Sensitivity of MCP (nm)	220..1300nm, depends on the type of the photocathode
Quantum Efficiency (Q.E.) (see curves below)	depends on the type of the MCP, up to 35%
Gain (4k steps) ($V_{MCP} \leq 1000V/1480V$) control via RS 232 digital setup	single stage MCP: 4×10^4 dual stage MCP: 4×10^6
Coupling phosphor (MCP → CCD)	customized 6 element f/0.8 relay lens No distortion! No vignetting! No pin cushion!

Spectral Sensitivity of Photo cathodes (Wavelength in nm)					
Standard 18 mm			Standard 25 mm		
S20UV	B	approx. 165 - 820nm	S20	C	approx. 165 - 820nm
Broadband	J	approx. 190 - 920nm	S25	F	approx. 200 - 840nm
S25 IR (Super S25)	H	approx. 350 - 920nm	Optional 25 mm		
Optional 18 mm			Enhanced S20	D	approx. 165 - 820nm
S20 UV(MgF2)	A	approx. 110 - 820nm	Enhanced S25 (glass)	I	approx. 270 - 900nm
S1	E	approx. 700 - 1300nm	Solar Blind (CsTe)	G	approx. 180 - 340nm

Deviations of up to $\pm 25\%$ from the above typical spectral sensitivity curves are possible. The position of the curves can vary $\pm 20\text{nm}$. The input window material limits the spectral response of the photocathode in the shorter wavelengths. The window materials and their transmission limits are: quartz (165nm), MgF2 (110nm).

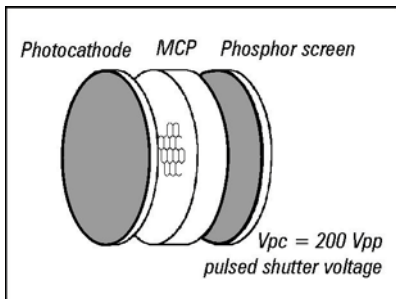
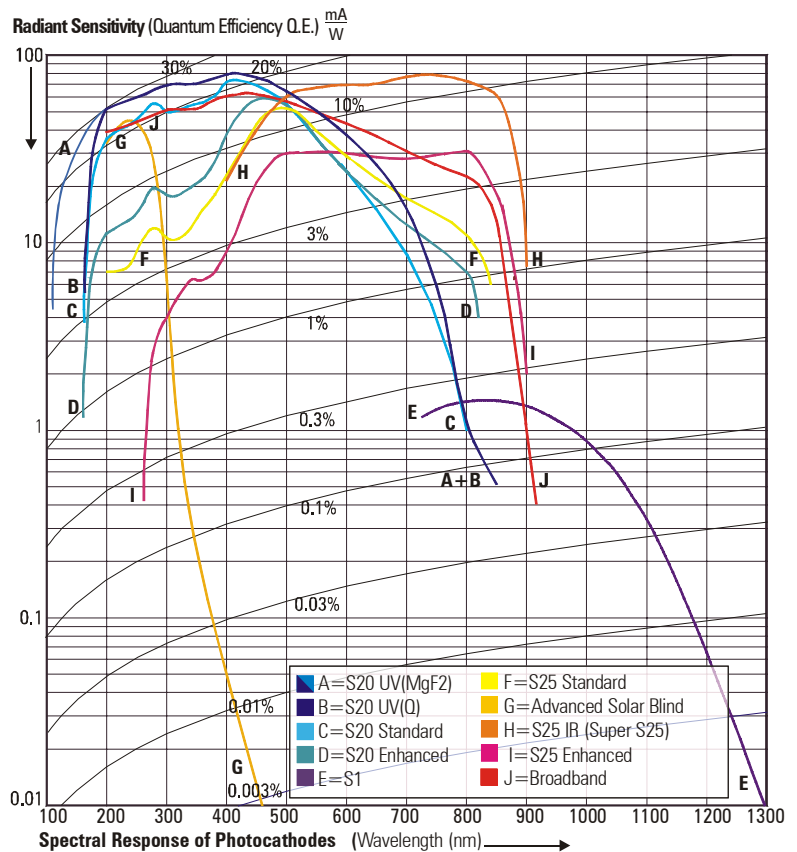


Image intensifier and shutter (schematic)



CCD-Readout Unit

CCD Video Chip	Analog Output		Standard Resolution CCD	High Resolution CCD
	USA, Japan	Elsewhere		
Analog or digital output	analog EIA (RS 170)	analog CCIR	digital 12 or 14 Bit	digital 12 or 14 bit
Resolution (pixel)	768 x 494	752 x 582	780 x 580	1360 x 1024 (1x1) 580 x 512 (2x2) 456 x 342 (ROI)
Pixel size	8.4 x 9.8 μ m	8.6 x 8.3 μ m	8.3 x 8.3 μ m	4.7 x 4.7 μ m
Imaging frequency (analog) Frame rate (digital)	30/60Hz	25/50Hz	12bit/14bit: 33.8/60.8/67.0 fps	12bit/14bit: 10.6/17.9/20.9 fps
Dynamic Range A/D (Bit)	14 Bit, up to 21 Bit (with 4 Spec E spectroscopy software) in one frame, all lines binned			
Video Gain	0...25dB, automatic or manually adjustable through computer RS 232 interface		Full Frame, ROI: 0..20dB Binning: 0..25dB	
Binning vertical (pixel)	Software		1 (full frame) ,2 (Binning) pixel, ROI	
Binning horizontal (pixel)	Software		1 (full frame) ,2 (Binning) pixel, ROI	
Image Sensor	ICX..AL			
Chip Readout	Correlated double sampling, dark current corrected			
Output	1V _{PP} (75 Ω), composite video, either RS 170/EIA or CCIR			
Scan Mode	Field/Frame, selectable through computer RS 232 interface. ICCD camera 4 Picos or 4 Quik E may be Genlocked or supply Fsync-pulse to operate as master clock.			
Gamma	1 or .45, selectable through computer RS 232 interface			
Internal Synchronization	Free run mode			
External Synchronization	by negative edge TTL pulse (Vinit)			

Mechanical & Environmental Data, Power Requirements

XXRapidFrame (based on 4 Picos or 4 Quik E)	Three Channels	Four Channels
Camera dimensions, without lens (l x w x h)	650 x 350 x 350 mm	650 x 350 x 400mm
Camera weight (all in one) (kg / lb)	25kg / 55lb	32kg / 70b
Camera mount (at the bottom plate of the camera)	3/8" x 20 and M8 mounting hole	
Operating Humidity (%)	25..95%, non condensing	
Operating temperature (°C / °F)	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	60 g accel. shock, 7g Vibration (11 – 200Hz)	
Voltage	90..260VAC	

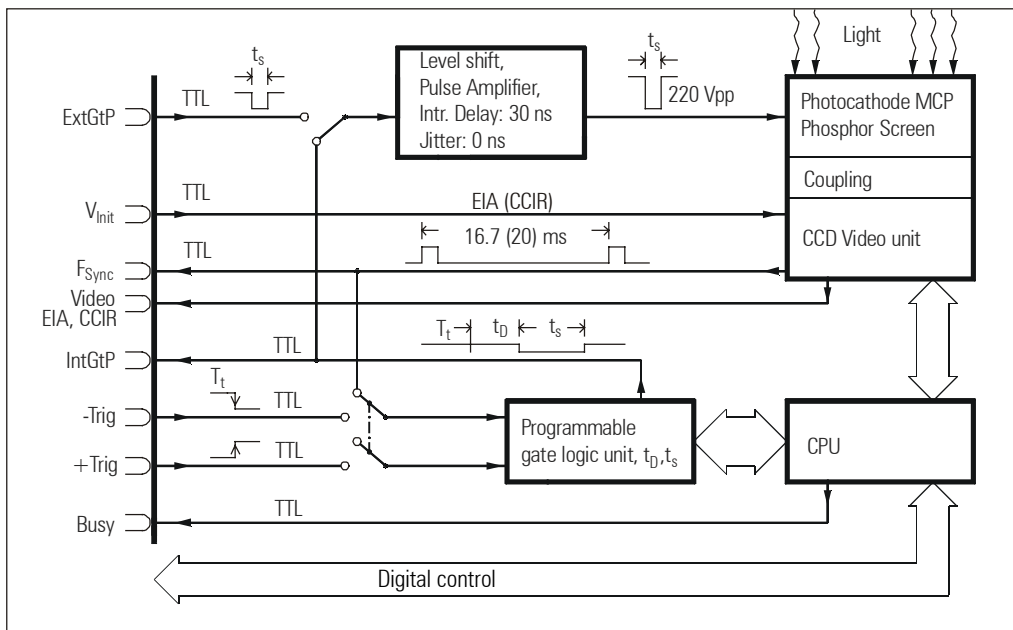
Shutter control

The advanced, digitally controlled shutter delay feature is the perfect match for your laser, range gating, flow analysis, or many other high speed applications. It is operational in 'scattered light' environments, underwater or for highest speed multi-instrument sequential image acquisition. Multiple direct images with a repetition/ delay time setting as short as $0.3\mu\text{s}$ can be synchronized with ease to any external TTL source.

Internal exposure control	XXRapidFrame P	XXRapidFrame E
Time (t_s) and delay (t_D) of the gate pulse, or multiple exposure with CPU internally digital programmable	$t_s = 0.2\text{ns} \dots 80\text{s}$, min. steps 10ps $t_D = 0 \dots 80\text{s}$, min. increments 10ps	$t_s = 1.2\text{ns}^* \dots 80\text{s}$, min. steps 100ps $t_D = 0 \dots 80\text{s}$, min. increments 0.1ns
Trigger propagation delay	<50ns, less than 10ps jitter	
Initializing	-Trig, +Trig, or FSync	
Multiple Exposure	Any sequence, $0.3\mu\text{s}$ "dead time" between exposures	
Double Frames	500ns inter frame time	

* minimum gate time 1.2ns typically, depends on manufacturer and specimen.

External exposure control	XXRapid Frame P	XXRapidFrame E
Control of the camera internal Pulse E amplifier via ExtGtP (TTL Pulse) input: Shutter continuous from:	$t_s = 0.2\text{ns} \dots \infty$, t_D, ∞ t, t_D determined by external device	$t_s = 1.2\text{ns}^* \dots \infty$, t_D, ∞ t, t_D determined by external device
Trigger propagation delay	< 45ns, no jitter	



Shutter control (schematic for analog output model)

XXRapid Frame

digital or analog output

*25mm Standard: S20 or S25

**18mm Standard: S20 or Super S25

Optional: Enhanced S25, Enhanced UV S20, S1, Solar Blind

Two photo cathode window materials may be ordered depending upon the required response..

	XXRF-E (4QuikE)	XXRF-Edig (4QuikE/dig)		XXRF-P (4Picos)	XXRF-Prdig (4Picos/dig)					
Standard										
Gating Speeds from 1.2ns typically $\rightarrow \infty$	■	■								
Gating Speeds from 0.2ns $\rightarrow \infty$				■	■					
Image Intensifier with 18mm MCP	■	■		■	■					
Image Intensifier with 25mm MCP	□	□		□	□					
Image Intensifier with Single stage MCP	■	■		■	■					
Image Intensifier with V-stack dual stage MCP	□	□		□	□					
Jitter > 0.01ns	■	■		■	■					
Lens Coupling	■	■		■	■					
High Efficiency customized f/0.8 relay lens	■	■		■	■					
Multiple Exposures	■	■		■	■					
Double Frames, 500ns interframe time	□	□		□	□					
Shutter dead time 0.3 μ s	■	■		■	■					
Integrated Single Trigger Discriminator (STD)	■	■		■	■					
Analog CCD video output 3 channels only EIA 768 x 494 pixel or CCIR, 752 x 582 pixel	■			■						
Standard Resolution CCD, 12bit, 780 x 580 pixel		■			■					
Standard Resolution CCD, 14bit, 780 x 580 pixel		□			□					
High resolution CCD, 12bit, 1360 x 1024 pixel		□			□					
High resolution CCD, 14bit, 1360 x 1024 pixel		□			□					
USB 2.0 (standard up from 4 channels)		■			■					
Terminal Software and printed manual	■	■		■	■					
Additional Options										
Image Intensifier with Special Photocathodes	□	□		□	□					
Nikon F-mount Adapter	□	□		□	□					

■ standard □ optional

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Applications

Physical Sciences

Plasma temperature and density analysis
 Plasma flow analysis
 Combustion analysis
 Synchrotron radiation
 Laser induced fluorescence

Biological Sciences

Cancer research
 Fundus imaging spectroscopy
 X-ray detection
 Luminescence
 Time resolved fluorescence

High Speed Imaging

Dynamic Schlieren Phenomena
 Shock tubes
 Range gating

Low Light Imaging

Thomson Scattering
 Raman Spectroscopy
 Glow Discharge Spectroscopy
 Semiconductor failure analysis



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