

Photron



1.3-Megapixel CMOS Image Sensor:
1280 x 1024 pixels at 4,800fps
1080 x 800 pixels at 6,000fps

Maximum Frame Rate:
750,000fps (Multi type 750K)
200,000fps (Multi type 200K)

Global Electronic Shutter:
Minimum shutter speed 3.9 μ s independent of frame rate (Multi type 750K only: to 1 μ s dependent on frame rate selection)

Internal Recording Memory:
8GB, 16GB, or 32GB per channel

Optional FASTDrive High Capacity Non-Volatile Data Storage:
2TB high-speed solid state drive for long time record function or PC-less operation

Built in DAQ:
Integrated 2 channel DAQ
2Msps (Mega samples per second)

Compact and Lightweight Camera Heads:
70mm (H) x 69mm (W) x 151.4mm (D)
2.76" (H) x 2.72" (W) x 5.96" (D)
Weight: 0.98Kg (2.1 lbs.)

Dual head high-speed camera system with long recording time option

The FASTCAM Multi is a unique high-speed camera system supporting one or two camera heads providing 1.3Mpixel resolution at 4,800fps - a mix of monochrome and color camera head types may be used. Coupling of the camera heads to the system processor is via innovative 10m hybrid fiber optic cables that are less susceptible to electrical noise and high magnetic fields. Special bulkhead connectors permit mounting of the camera or processor within an enclosed space. Up to 5 cables may be linked to extend the operating distance to a total of 50 meters.

The compact and lightweight heads are sealed for operation in locations where high levels of dust or particle contaminants may be present, and the implementation of Micro Four Thirds (MFT) lens technology supports remote lens control via Photron FASTCAM Viewer (PFV) software of not only aperture and focus but also zoom.

Precise synchronization of images acquired by the two camera heads is managed by the FASTCAM Multi processor, including incorporation of two channels of analog data acquisition for sampling of external data from a range of sensors such as accelerometers, strain gauges, voltage probes, etc. The processor design also ensures that images are held securely in the event that either one of the camera heads is destroyed or a cable is cut during recording.

As an option, the processor may be fitted with an interface for the FASTDrive removable SSD drive. With a capacity of 2TB storage for each camera head it is possible to capture 20 minutes of uncompressed data with 1-megapixel resolution at 1,000fps. The FASTCAM Multi may also be configured to automatically download images from internal memory to this SSD drive via the remote keypad for PC-less operation.

The proprietary CMOS sensor technology utilized in the FASTCAM Multi delivers high light sensitivity (ISO 10,000 mono, ISO 5,000 color excl. IR response), and thanks to the small (10 μ m) pixel pitch of the FASTCAM Multi's 12-bit sensor, the camera is capable of utilizing 1" C-mount lenses without vignetting.

PC-less operation via the optional remote keypad and HDMI or HDSDI video output round out a distinctive set of features that make the FASTCAM Multi well-suited for many different applications including microscopy, detonation and explosives testing, off board automotive safety testing and more.



Light Sensitivity:

Expressions of light sensitivity in high-speed cameras can be confusing as a variety of differing measurement techniques are used. Photron publishes light sensitivity figures for its products using the ISO 12232 Ssat Standard.

FASTCAM Multi	ISO 12232 Ssat
Monochrome models	ISO 10,000
Color models	ISO 5,000

ISO 12232 Ssat values published by Photron for both monochrome and color cameras are measured excluding infrared sensitivity as defined by the ISO standard measurement procedure ISO 14524.

Monochrome sensors used in the FASTCAM Multi are supplied without an IR absorbing filter, extending the camera spectral response beyond 900nm. When the sensitivity of the FASTCAM Multi camera is measured to tungsten light including near IR response an equivalent value of ISO 25,000 is obtained.

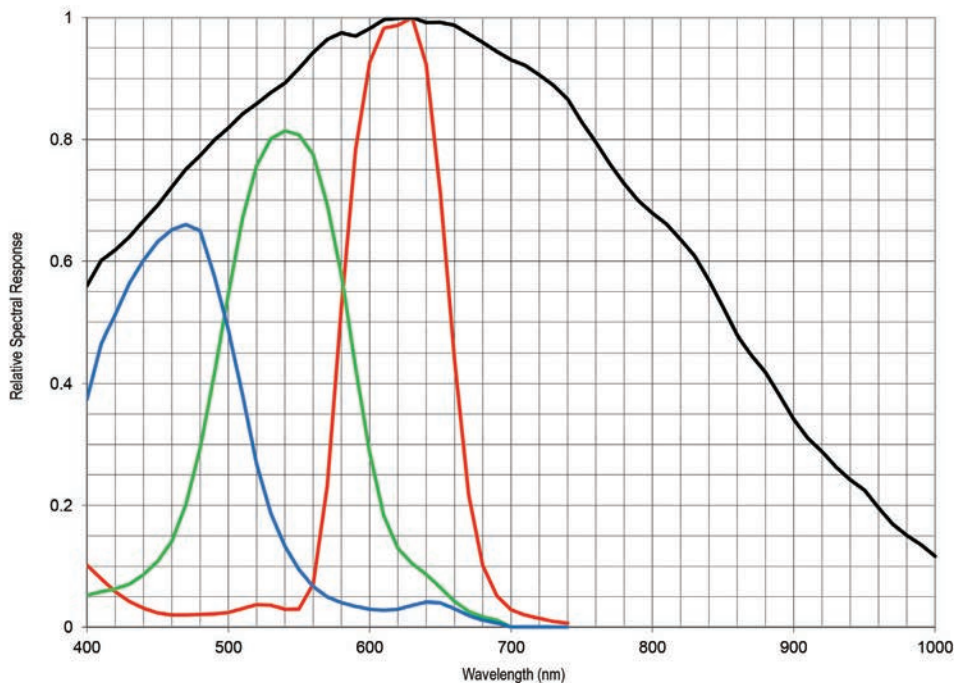
Image Sensor:

The FASTCAM Multi system uses an advanced CMOS image sensor optimized for light sensitivity and high image quality that is unique to Photron.

A 10-micron pixel pitch gives a sensor size at full image resolution of 12.8 x 10.24mm (diagonal 16.39mm).

Sensor Type	Proprietary Design Advanced CMOS
Maximum Resolution (pixels)	1280 x 1024 pixels
Sensor Size / Diagonal	12.80 (H) x 10.24mm (V) / 16.39mm (D)
Pixel Size (microns)	10µm x 10µm
Quantum Efficiency	62.6% at 630nm
Fill Factor	80%
Color Matrix	Bayer CFA (single sensor)
ISO 12232 Ssat sensitivity	ISO 10,000 monochrome ISO 5,000 color (monochrome sensor equivalent ISO 25,000 including near IR response)
Shutter	Global Electronic Shutter down to 1µs independent of frame rate

FASTCAM Multi Relative Spectral Response Curves - Monochrome and Color



Camera Performance Specifications

Model	FASTCAM Multi
Full Frame Performance	4,800fps 1280 x 1024 pixels
Maximum Frame Rate	750,000fps
Minimum Exposure	Global electronic shutter to 1 μ s selectable independent of frame rate
Dynamic Range (ADC)	12-bit monochrome 36-bit color
Memory Capacity Options	8GB: 4,363 frames at full resolution 16GB: 8,733 frames at full resolution 32GB: 17,471 frames at full resolution
Memory Partitions	Up to 64 memory segments
Region of Interest	Selectable in steps of 128 pixels (horizontal) x 8 pixels (vertical)
Integrated DAQ	2 channel, non-insulated, single coupling, +/-10V 2.2 Msps (Mega samples per second), 12-bit AD
Trigger Inputs	Selectable +/- TTL 5V and switch closure
Trigger Delay	Programmable on selected input / output triggers: 100ns resolution
Input / Output	Input: Trigger (TTL/Switch), sync, ready, event, IRIG Output: trigger, sync, ready, rec, exposure, IRIG_1PPS
Input Impedance	50 Ω
Trigger Modes	Start, end, center, manual, random, random reset, random center, random manual
Time Code Input	IRIG-B
External Sync	+/- TTL 5Vp-p Variable frequency sync
Camera Control Interface	High-speed Gigabit Ethernet or Remote Keypad
Image Data Display	Frame rate, shutter speed, trigger mode, date/time, status, real time / IRIG time, frame count, resolution
Saved Image Formats	JPEG, AVI, TIFF, BMP, RAW, MOV, and FTIF - Images can be saved with or without image data and in 8-bit,16-bit or 36-bit depth of sensor where supported
Supported OS	Microsoft Windows operating system including: 7, 8, 8.1, 10 (32/64-bit)

Frame rates above 225,000fps may be subject to export control regulations in some areas

Removable Data Storage Options:

FASTCAM Multi is optionally available with an interface for the 2TB FASTDrive removable SSD drive.

This interface can benefit the user in two ways:

PC-less operation: By rapidly transferring the camera memory to the SSD, multiple events may be captured without the delays associated with download of data to a PC.

Long Record Time operation: By directly streaming to the FASTDrive SSD it is possible to greatly extend recording time. At 1,000fps with 1-megapixel resolution the 2TB FASTDrive media has enough capacity for 20 minutes recording of 12-bit uncompressed data.

In both cases, recorded data can then be directly accessed while coupled to the camera or the SSD media may be removed and inserted into the portable FASTDock station connected to any Windows PC

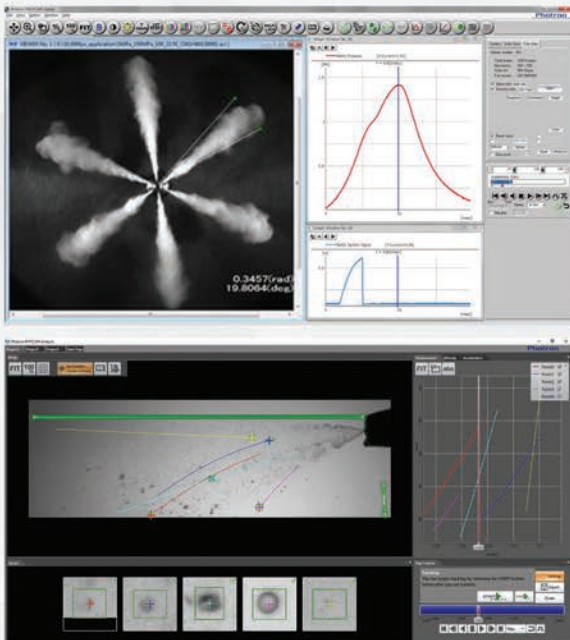


Camera Operation Features

Frame Synchronization	Accurate frame synchronization with other cameras and with external and unstable frequencies.
Memory Partitions	Up to 64 memory segments allow multiple events to be stored in camera memory before downloading, with automatic progression to the next available partition.
Low Light Mode	Operation at minimum frame rate with separately adjustable shutter time to allow easy camera set-up and focus in ambient lighting.
IRIG Phase Lock	Enables multiple cameras to be synchronized together with other instrumentation equipment to a master external time source.
Internal Delay Generator	Allows programmable delays to be set on input and output triggers, 100ns resolution.
Event Markers	Up to ten user entered event markers to define specific events within the recorded image sequence .
Automatic Download	The system can be set to automatically download image data to the control PC and, when download is complete to re-arm in readiness for the next trigger with automatically incremented file names.
Software Binning	Virtual pixel binning (2x2, 4x4 etc.) allows increased light sensitivity with reduced image resolution without changing camera field of view.
FASTDrive	Optional 2TB solid state drive (SSD) memory pack provides ultra high data rate transfer to removable media as well as realtime transfer for long recording times.

Software Operation Features

Image Calibration	2D image calibration allows the measurement of distance and angle from the image. A calibration grid overlay can be superimposed on the image.
Image Overlay	A stored reference image may be overlaid on the live image to allow accurate camera positioning to achieve the same view as a previous test.
Import of Multiple Image Sequences	Multiple image sequences can be loaded and simultaneously replayed. Timing of image sequences can be adjusted to create a common time reference. Time based synchronization allows images captured at different frame rates to be synchronized.
High Dynamic Range Mode	Making use of the full sensor dynamic range, HDR mode allows enhanced detail in both light and dark areas of an image to be displayed simultaneously.
Motion Detector	In order to highlight subtle changes in an image, Motion Detector allows a reference image to be subtracted from a recorded sequence. Details including propagation of shock waves and surface changes during impact can be visualized using the feature.
Line Profile	A line profile representing grey levels along a line drawn across any region of the image is displayed. In live mode the Line Profile can be used to ensure optimum image focus is achieved.
Histogram	A histogram displaying grey levels within a user-defined image area is displayed. In live mode the Histogram can be used to ensure that optimum exposure levels are set for the scene being recorded.



Photron FASTCAM Viewer:

Photron FASTCAM Viewer software (PFV) has been designed to provide an intuitive and feature rich user interface for the control of Photron high-speed cameras, data saving, image replay and simple motion analysis. Advanced operation menus provide access to features for advanced camera operation and image enhancement. Tools are provided to allow image calibration and easy measurement of angles and distances from image data. Also included are a C++ SDK and wrappers for LabView and MATLAB®.

An optional software plug-in module provides synchronisation between Photron high-speed cameras and data acquired through National Instruments data acquisition systems. Synchronised data captured by the DAQ system provides waveform information which can be viewed alongside high-speed camera images.

Photron FASTCAM Analysis:

PFV software allows image sequences to be exported directly to optional Photron FASTCAM Analysis (PFA) Motion Analysis software. This entry level Motion Analysis software with an on screen 'step by step guide' function launches automatically from Photron FASTCAM Viewer software, and provides automated tracking of up to 5 points using feature or correlation tracking algorithms for the automated analysis of motion within an image sequence.

External Frame Synchronization:

The FASTCAM Multi can be fully synchronized with an external event to allow the timing of when each individual image is captured to be precisely referenced. The camera can be accurately synchronized to unstable frequencies allowing complex events such as combustion in rapidly accelerating or decelerating engines to be recorded and studied.

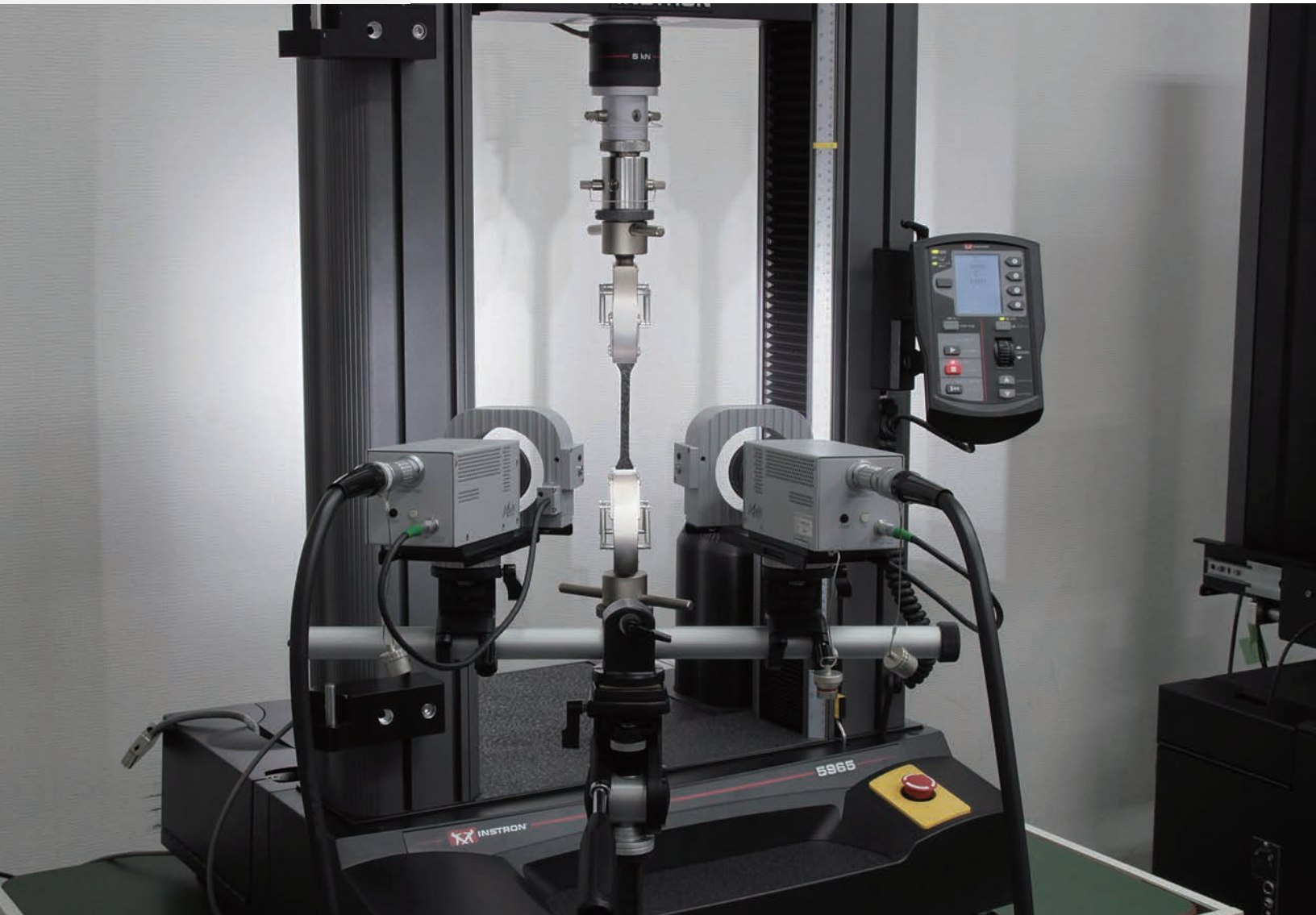
Record During Download Operation:

FASTCAM Multi recording memory can be divided into multiple active sections. The user can record an on-going event in one memory partition while at the same time downloading a previously recorded image sequence from a second partition in order to improve workflow and optimize camera operation.

MULTI							
Resolution (h x v pixels)	Frame Rate Max fps	8GB		16GB		32GB	
		Frames	Time (sec)**	Frames	Time (sec)**	Frames	Time (sec)**
1280 x 1024	4,800	4,363	0.91	8,733	1.82	17,471	3.64
1280 x 1000	5,000	232	0.05	4,469	0.89	8,943	1.79
1280 x 800	6,250	2,791	0.45	5,587	0.89	11,179	1.79
1280 x 720	6,400	3,101	0.48	6,208	0.97	12,421	1.94
1280 x 616	8,000	3,624	0.45	7,256	0.91	14,519	1.81
896 x 488	10,000	6,536	0.65	13,084	1.31	26,181	2.62
1280 x 312	16,000	7,156	0.45	14,326	0.90	28,665	1.79
1280 x 248	20,000	9,003	0.45	18,023	0.90	36,063	1.80
1280 x 120	40,000	18,607	0.47	37,248	0.93	74,531	1.86
1280 x 56	80,000	39,872	0.50	79,818	1.00	159,709	2.00
1280 x 32	100,000	69,777	0.70	139,682	1.40	279,492	2.79
1280 x 248	200,000	93,036	0.47	186,242	0.93	372,656	1.86
640 x 8	800,000	558,216	0.70	1,117,457	1.40	2,235,938	2.79

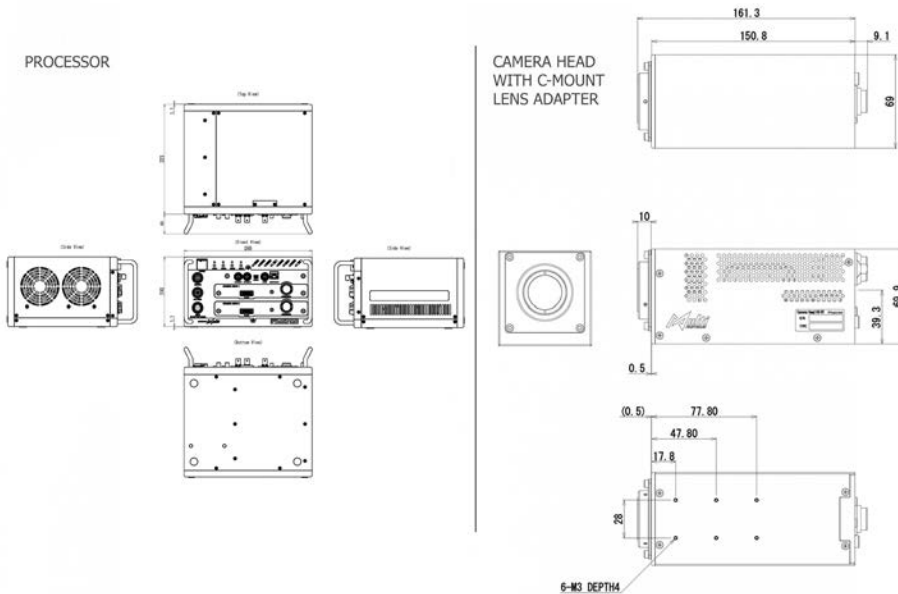
* Specifications subject to change without notice.

** Recording time is an estimate and may be different depending on recording conditions and settings.



Mechanical and Environmental Specifications

Mechanical	
Lens Mount	F-mount (G-type lens compatible) and C-mount provided - Optional lens mounts available include Micro Four Thirds (MFT) remote control mount
Camera Mountings	1 x M3, 1x.25 , 1x.375
External Dimensions	
Main Unit (excluding protrusions)	260mm (H) x 140mm (W) x 223mm (D) 10.24" (H) x 5.51" (W) x 8.78" (D)
Camera Head (excluding protrusions)	69mm (H) x 70mm (W) x 151.4mm (D) 2.72" (H) x 2.76" (W) x 5.96" (D)
Weight	
Main Unit	7.8kg (17.2lbs)
Camera Head	0.98kg (2.1lbs)
Power	
AC Power (with supplied adapter)	100 to 240V AC 200W, 50 to 60Hz
DC Power	20 to 34V, 180VA
Main Unit Environmental	
Operating Temperature	0 to 45C, 32° to 104° F
Storage Temperature	-20 to 60C, -4° to 140° F
Humidity	85% or less (non-condensing)
Operational Shock	Tested to 25G, 11ms, 6-axes, 10 times/axis
Cooling	Internal fan cooling (fan-off mode supported)
Camera Head Environmental	
Operating Temperature	0 to 45C, 32° to 104° F
Storage Temperature	-20 to 60C, -4° to 140° F
Humidity	85% or less (non-condensing)
Operational Shock	Tested to 25G, 11ms, 6-axes, 10 times/axis
Cooling	Internal fan cooling (fan-off mode supported)



Remote Control Keypad:

An optional hand-held remote control keypad is available to enhance field operation. The keypad provides the operator with local control of all primary camera functions to simplify camera set-up and allow operation without PC connection.

Nikon G-Type Compatible Lens Fitting:

The FASTCAM Multi camera is equipped with an objective lens mount compatible with readily available Nikon G-type lenses. Controls provided within the lens mount allow the control of lens aperture on lenses without external iris control.

Micro Four Thirds (MFT) Lens Mount Option:

An optional lens mount supporting Micro Four Thirds (MFT) lenses is available for the FASTCAM Multi, providing remote control of lens aperture, focus and zoom through Photron PFV software.

Operation Environments:

The 'sealed body' design of the FASTCAM Multi ensures optimum air flow and prevents dust and corrosive particles from being ingested within the camera body where they can damage sensitive electronics. The fans may be disabled during recording for any vibration sensitive measurements.

The FASTCAM Multi camera has been extensively tested to ensure operation for extended periods in ambient temperatures up to 45 degrees C.

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