C220-E007

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SHIMADZU

HPV-2
Hyper Vision

Shimadzu
High-Speed Video Camera


HYPER VISION

HPV-2 Hyper Vision

SHIMADZU High-Speed Video Camera

The world's leader in ultra-high-speed, high resolution recordings

The high-speed video camera is an important tool for recording and visualizing high speed phenomena. It is used in a variety of fields, including materials failure, electric discharge, combustion, fluid dynamics, and sports science.
Recent scientific advances demand ultra-high recording speeds that are dramatically higher than conventional recording speeds.
The HPV-2 High-speed Video Camera incorporates Shimadzu's dedicated CCD that revolutionizes the concept of high-speed video recording. It achieves world-leading ultra-fast video recording speeds of up to one million frames per second.
The HPV-2 opens the doors to a new world of high-speed recording.

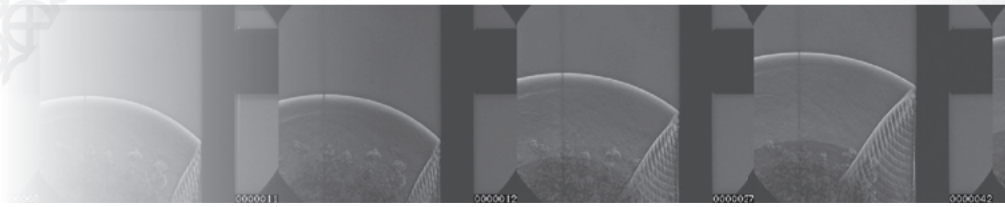
Contents

Ultra-high-speed video recording at up to one million frames per second

The camera is equipped with the newly developed IS-CCD image sensor*, which incorporates image storage on the sensor chip. It is the world's first sensor that permits ultra-high-speed recording of images at up to one million frames per second (fps).

This is the propagation of a shock wave after an explosion recorded at 1,000,000 fps. The resulting shock wave is continuously reflected from the sawtooth-shaped boundary surface, resulting in a ripple-like expansion pattern.

(Images provided by Prof. Takayama, Tohoku University)

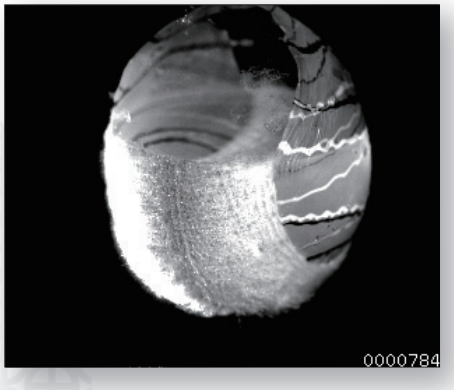


▲ After recording 12 μs ▲ 42 μs

Ultra-high speed and high spatial resolution

Unlike conventional high-speed video cameras, where image resolution drops off as recording speed increases. The HPV-2 maintains an excellent 312×260-pixel resolution at all recording speeds, up to one million frames per second, allowing detailed analysis of ultra-fast phenomena.

Image of a bursting balloon containing water recorded at 125,000 fps. Despite the extremely high recording speed, details of the water surface remaining in mid-air are visible at high spatial resolution.

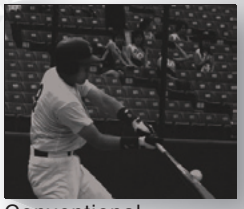


High-sensitivity CCD captures a wide range of high-speed phenomena

A highly sensitive image sensor is essential for capturing ultra-high-speed images in each frame's extremely short exposure time. The IS-CCD high-sensitivity design expands the light sensitive area of each pixel, which permits recording under lowlight conditions and, in turn, simplifies subject illumination.

Even under a cloudy sky, the point of impact between a bat and baseball can be recorded at 2,000 fps without artificial lighting.

(Images provided by NHK, Japan Broadcasting Corporation)



Conventional

Images from the HPV-2

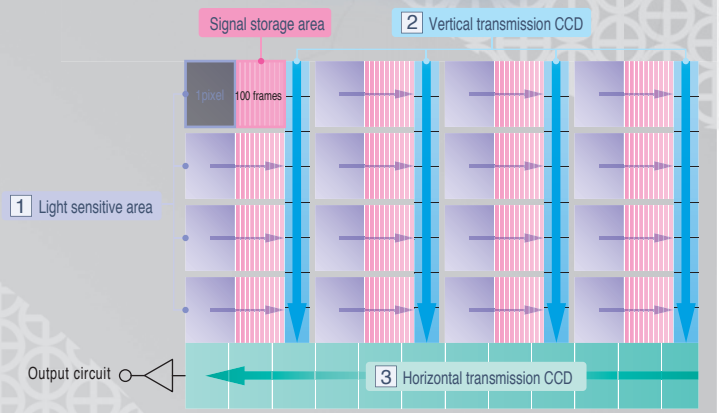
* Patent 3704052 (The IS-CCD image sensor was jointly developed in collaboration with Prof. Takeharu Etoh of Kinki University.)

▲ 72 µs

The IS-CCD (In-situ Storage Image Sensor) achieves ultra-high-speed, high resolution recording

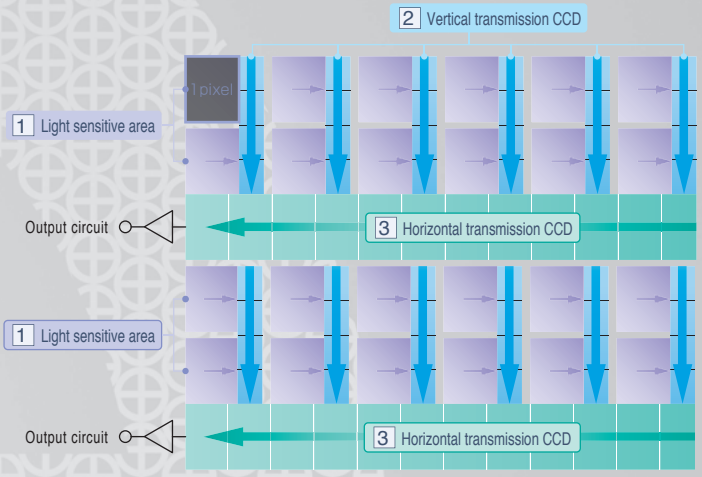
IS-CCD

The key feature of the newly developed IS-CCD is that the signal storage areas for the recorded images are incorporated within the chip.
With the IS-CCD, light entering the light sensitive areas during a recording is converted into an electrical signal, and is then transmitted in sequence to the storage areas, as shown by the arrows from 1 in the figure atsight. Electrical signals exceeding the number of storage areas are shunted to the board. After recording is complete, the stored electrical signals are transmitted sequentially from 2 to 3 recreating images for output. Since the sequential transmission required conventional CCDs is avoided, there is no limitation on the speed of the output circuit, and no pixel dropout. This enables high-speed recording, theoretically limited only by the CCD transfer speed.



Conventional high-speed recording CCD

With a conventional high-speed video camera, the high-speed recording CCD is equipped with a number of output circuits, as shown by the figure at right.
With this sort of CCD, high-speed recording is achieved by parallel output from multiple output circuits, based on sequential load transmission from 1, 2 and 3 in the figure. Since there is a limit on the number of possible output circuits, the highest speeds achievable are in the order of 10,000 fps.
To increase recording speed a smaller number of pixels may be used but this decreases resolution proportionally.



The HPV-2 has application in many fields.

The HPV-2 enables for the first time the visualisation of ultra-high-speed phenomena in fields such as science, engineering, medical research, and quality improvement.

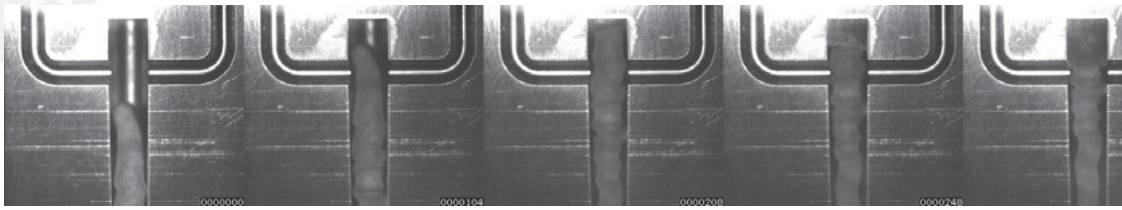
Applications

- Scientific and technological fields, including hypervelocity, fluid dynamics, explosions, electrical discharges, and materials failure.
- Industrial fields, including internal combustion engines, inkjet printers, wire bonding, machine tools, and sports equipment development.
- High-speed phenomena at micro-scales, including the life sciences and micromachines.

Ultra-high-speed injection molding

Recording speed: 125,000 fps

This example shows ultra-high-speed injection molding.
The images show the metal cavity being filled with liquid resin at ultra-high speeds.



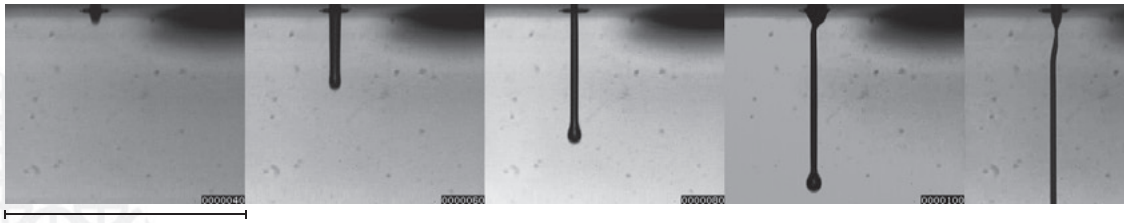
(Images provided by Prof. Yokoi of Tokyo University)

5mm

Inkjet Printed

Recording speed: 250,000 fps

This example shows the discharge of inkjet droplets. The images show the production of ink drops and satellite droplets during discharge, as well as the behavior of the meniscus at the nozzle port following discharge.

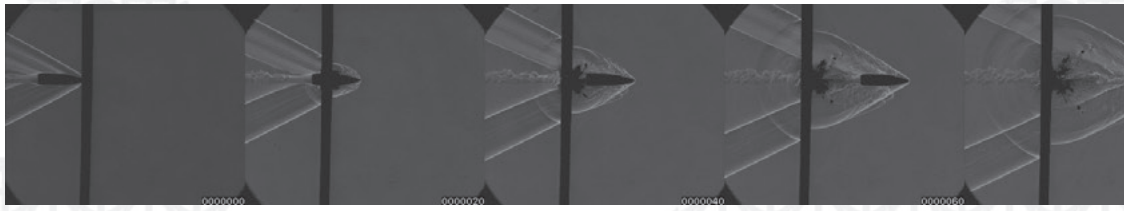


1.2mm

Hypervelocity Impact

Recording speed: 500,000 fps

This example shows a high-speed flying object, recorded using Schlieren photography. The images show how the high-speed flying object penetrates an obstruction. The shock wave generated as the object exceeds the speed of sound is clearly evident.

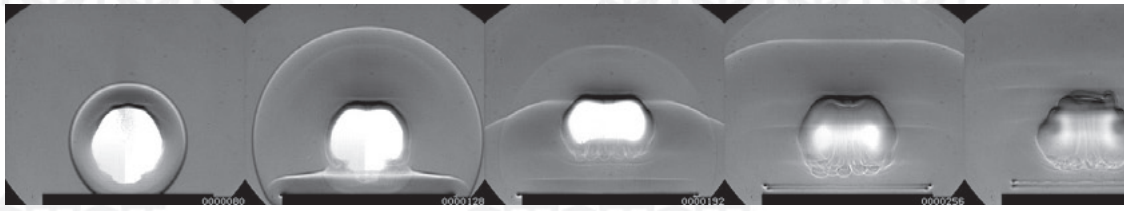


(Images provided by Prof. Kleine, The University of New South Wales)

Laser propulsion

Recording speed: 63,000 fps

This example shows laser plasma, recorded by Schlieren photography.
The images show the plasma bubble created by the pulse laser.
The corresponding shockwave is clearly evident.

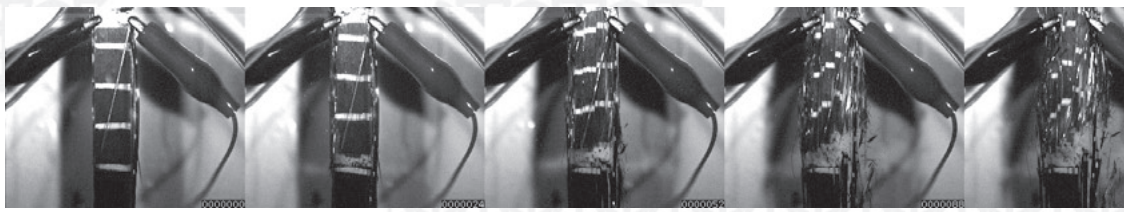


(Photos provided by Prof. Sasou, Nagoya University)

Observation of materials failure during a CFRP static tensile test

Recording speed: 250,000 fps

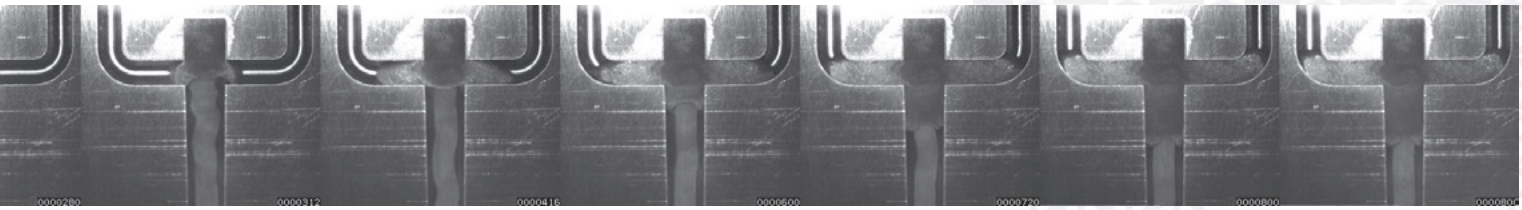
This example shows the failure of a carbon-fiber reinforced plastic (CFRP) 0-angle, unidirectional material. The images show the development of cracks orthogonal to the fibers in the material. The subsequent setting up of tears along the direction of the fibers is faithfully reproduced.

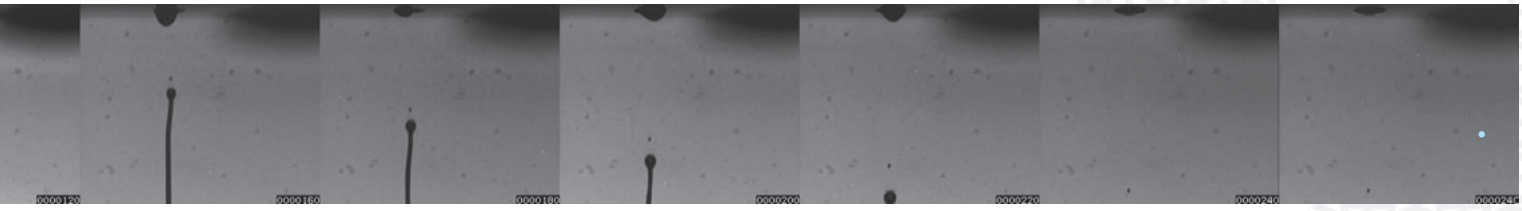


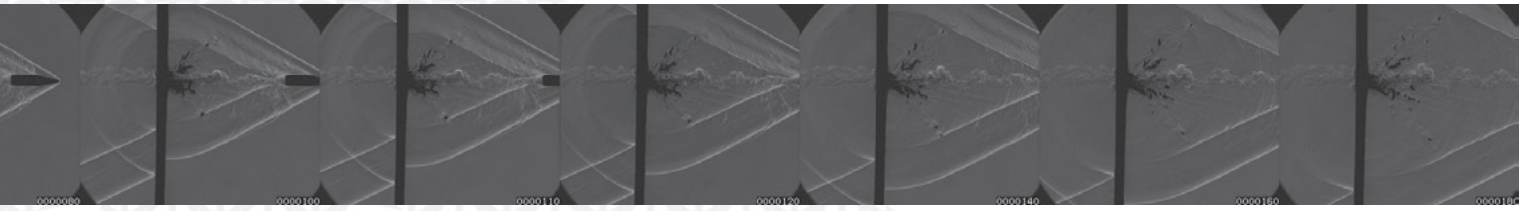
(Source:JAXA)

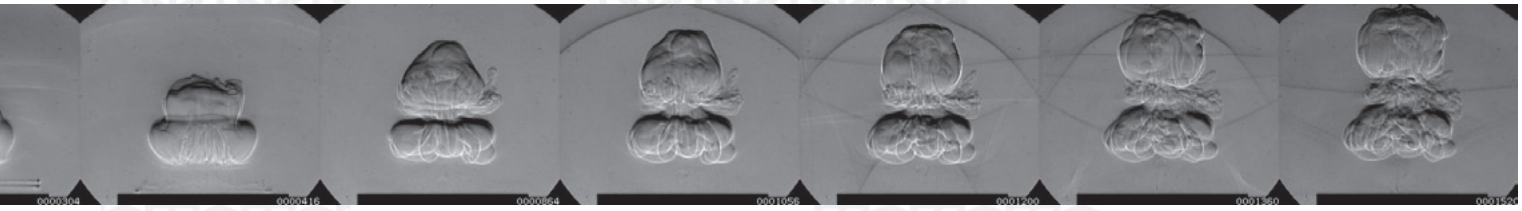
Some Specific Examples :

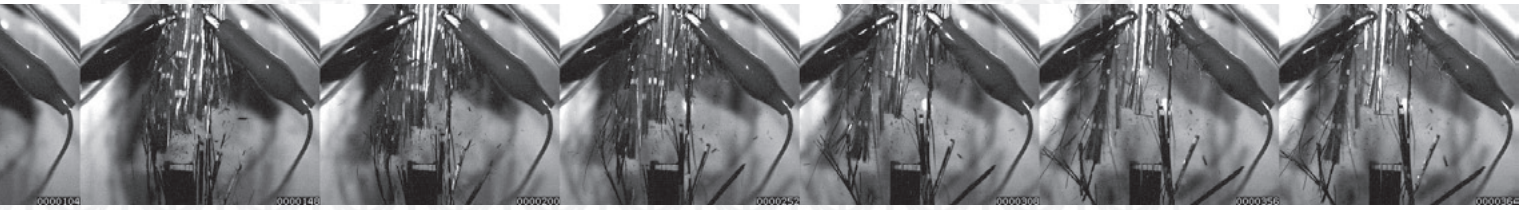
Rail guns / High-speed flying objects / Space debris / Tensile testing of compound materials and chains / Compression testing of glass and concrete / High-speed compression testing of plastic bottles / Explosions / Propagation of explosion shockwaves / Combustion propagation in combustion engines / Fusion of solid helium by ultrasound / Paint peeling from shocks / Crack propagation in glass / Peeling of solder bumps / Wire bonding / Turning on lathes / Grinding







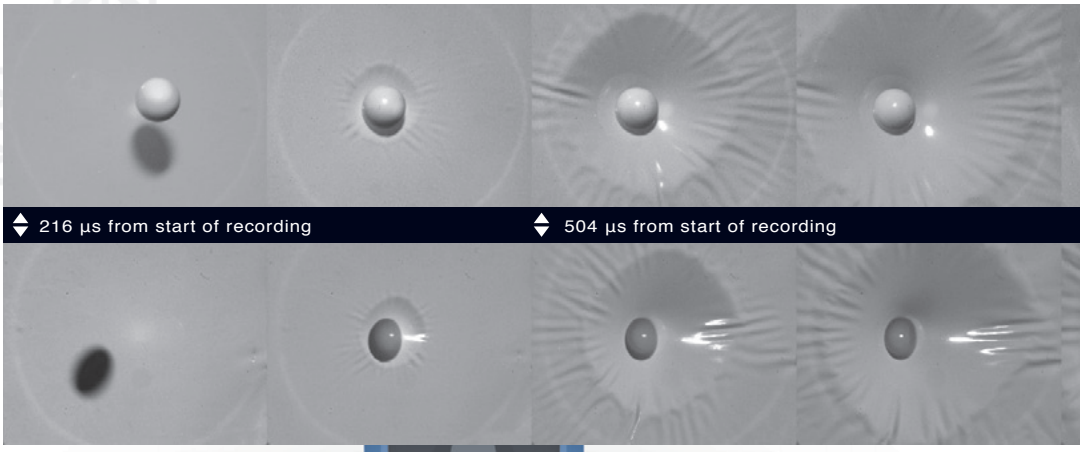




Synchronous recording supports phenomenological analysis from a variety of angl

Since phenomena can be recorded synchronously from multiple directions, the HPV-2 enables multidimensional phenomenological analysis.

Ballistic Impact

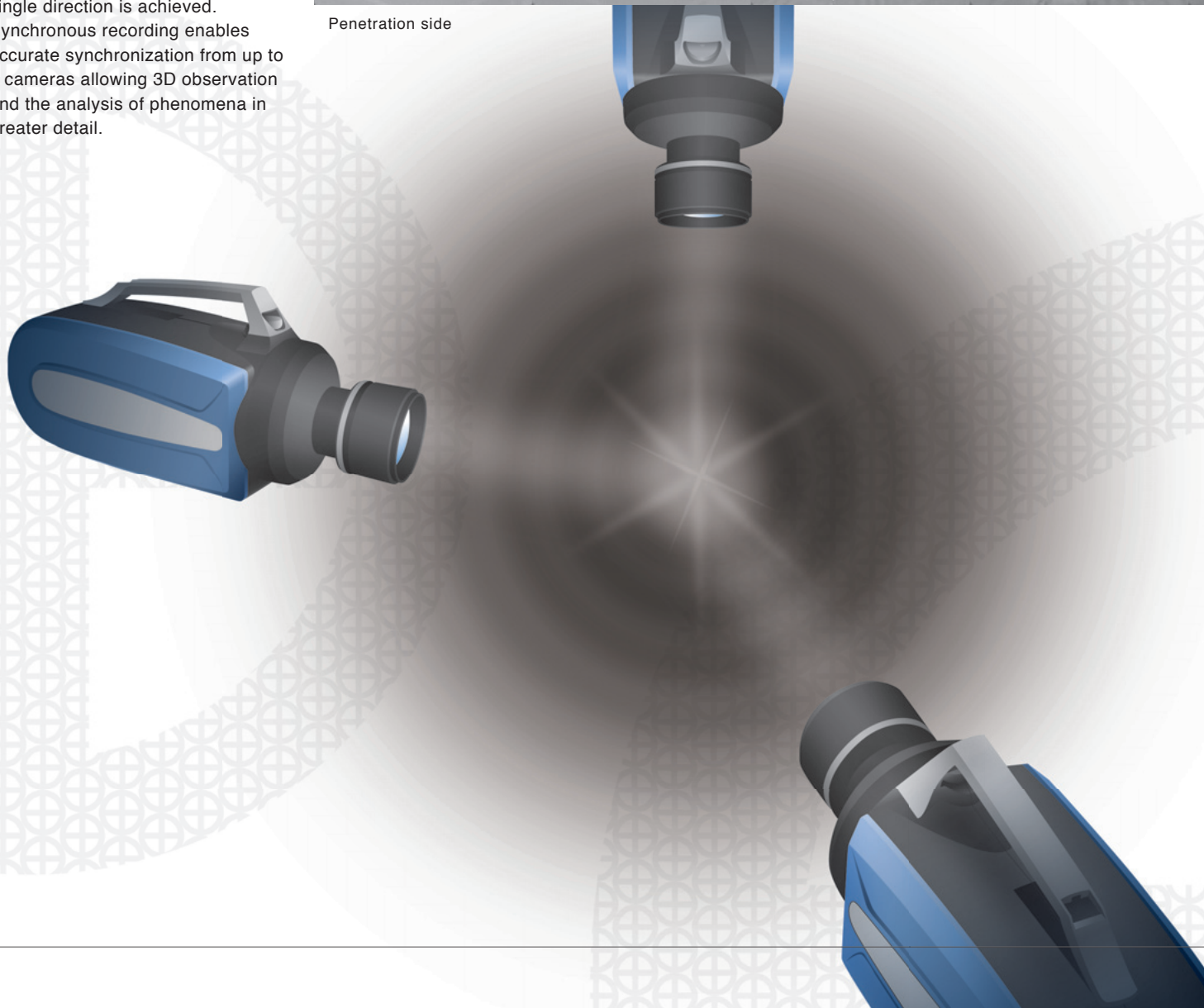


Penetration side

The penetration of plastic film by a high-speed flying object.

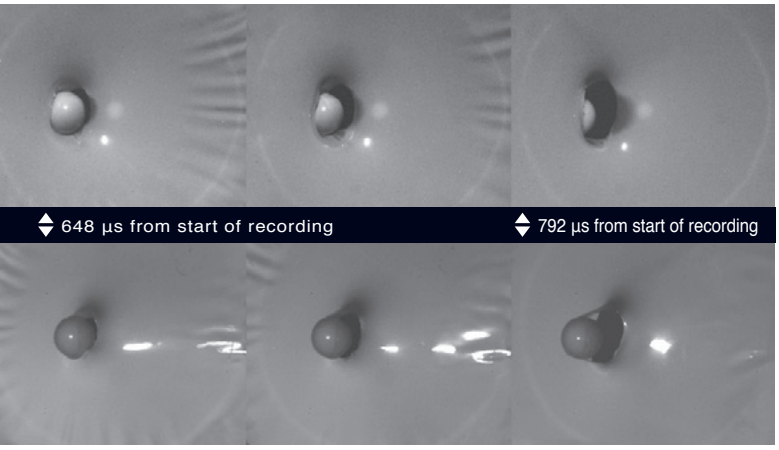
Recording speed:125,000 fps

The high-speed flying object (resin bullet: speed approx. 50 m/s) penetrating the plastic film was recorded synchronously from both sides of the film using two HPV-2 cameras.
A multidimensional phenomenological analysis, impossible with images taken from a single direction is achieved.
Synchronous recording enables accurate synchronization from up to 4 cameras allowing 3D observation and the analysis of phenomena in greater detail.

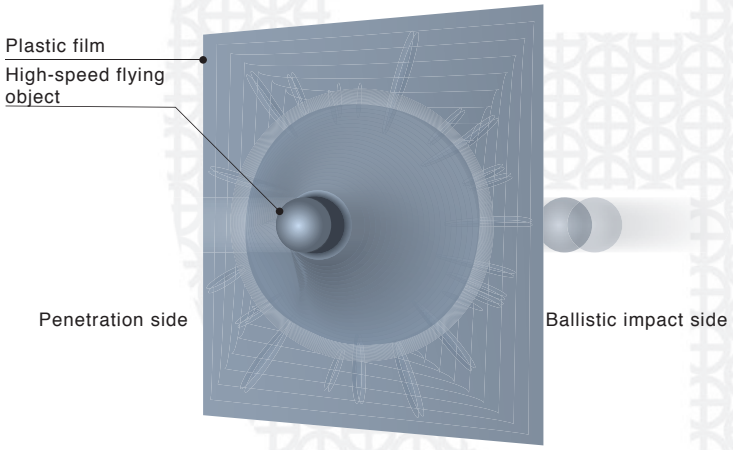


es.

Instant of ballistic impact



Instant of penetration



User-friendly, multi-functional software

Only a few settings are needed to begin recording, thanks to intuitive software included on the control PC. The images can be saved in a variety of formats including AVI, BMP, JPEG, TIFF and 16-bit TIFF.

The live motion function means special external monitors are not required.

With synchronous recording, 4 sets of recording conditions can be configured from a single PC.

The direct USB link from camera to PC enables for camera control and data transmission.

Remote-capable interface

By using the optional interface extension unit, recordings can be made at a distance from the photography site, for safety or convenience.

Major Specifications

High-Speed Video Camera Hyper Vision HPV-2

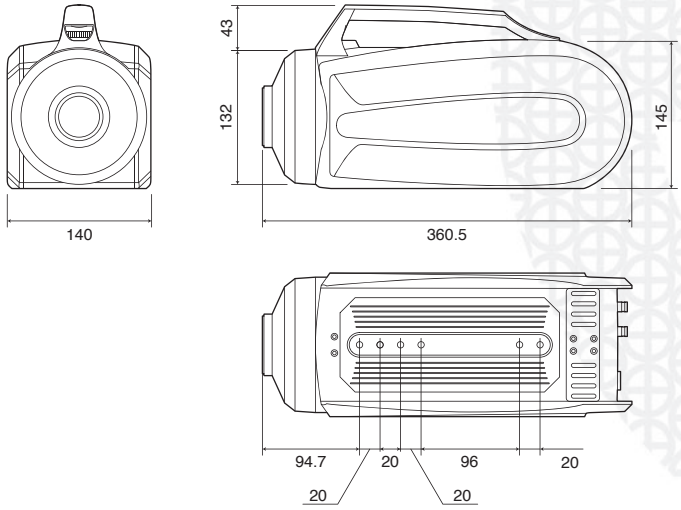
Camera Head	
Lens Mount	Nikon F mount
Image Sensor	IS-CCD image sensor
Resolution	312 (horizontal) × 260 (vertical) pixels
Color / Gradations	Monochrome, 10 bits [1]
Recording Speed [2]	1M fps, 500k fps, 250k fps, 125k fps, 63k fps, 31k fps, 16k fps, 8k fps, 4k fps, 2k fps, 1k fps, 500 fps, 250 fps, 125 fps, 63 fps, 30 fps (fps: frames per second)
Frame Capacity	100 frames
Exposure Time	Select 1/2, 1/4, 1/8, or OFF (3/4) of recording intervals (1/ 2, 1/4, and OFF only for exposure times of 1 µs) [3]
External Trigger Input	TTL level (5 V), positive or negative, switch closure (normally open)
Synchronous Recording	Synchronous recording with up to 4 units
Interface	USB 2.0 (Hi-Speed)
External Monitor Output	NTSC output, or PAL output, selected at time of shipment
Optional Output	Special brightness control signal output, special trigger unit control output
Clock Output	TTL level (5 V)
Recording Mode	Normal recording (external, internal trigger), programmed recording, continuous trigger, test exposure
Trigger Point Settings	Trigger point configurable from any frame
Data Memory Format	10-bit dedicated format, BMP, AVI, JPEG, TIFF (16-bit format supported)
Power unit	
Power Ratings	100 V to 120 V / 220 V to 240 V, 50/60 Hz, 150 VA
Required Specifications for Control PC	
OS	Windows Vista Business Edition [4]
CPU	Intel Core™ 2 Duo (1.8 GHz) or faster
RAM	2 GB or more
HDD	60 GB or more
Screen Size	13.3-inch WXGA (1280 x 800) or better
Interface	USB 2.0 [5]
External Recoding Device	DVD-ROM & CD-R/RW drive
Other Peripherals	Mouse or other pointing device
Environmental Conditions	
Operating Temperature Range	5°C to 40°C
Operating Humidity Range	35% to 75% RH with no condensation
Size / Weight	
Camera Head	140 (W) mm x 145 mm (H) x 360 mm (D) approx. 5.3 kg [140 mm (W) x 175 mm (H) x 360 mm (D) including handle]
Power Unit	150 mm (W) x 124 mm (H) x 336 mm (D) approx. 3.2 kg
Interface Cable Length	Approx. 5 m (The cable length accommodates the optional unit.)
Others	
Standard Ratings	CE Class B compatible

1) 10 bit is used to identify the data format, however data precision is not guaranteed.
2) The recording speed is a reference value.
3) These exposure times are rough indications and are not guaranteed as exact exposure ratios for all photographic speeds.
4) Windows® is a registered trademark of Microsoft Corporation in the US and other countries.
5) Does not guarantee operation of all types of connectable devices. The IS-CCD used in this product will contain certain defective pixels, however this does not mean the product is defective or damaged. Also, depending on the photographic conditions used, (lighting, etc.) image coarseness, blur or extreme lightness/darkness may occur. These are due to the characteristics of the IS-CCD and do not mean the product is defective or damaged.

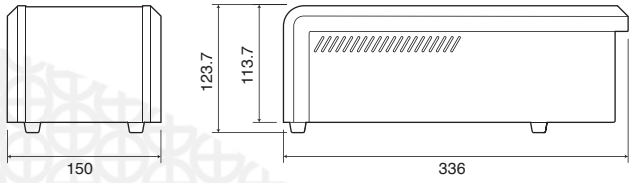
For details, please refer to the S229-0019 specifications.

External dimensions

Camera head



Power unit



Unit: mm

JQA-0376

Founded in 1875, Shimadzu Corporation, a leader in the development of advanced technologies, has a distinguished history of innovation built on the foundation of contributing to society through science and technology. We maintain a global network of sales, service, technical support and applications centers on six continents, and have established long-term relationships with a host of highly trained distributors located in over 100 countries. For information about Shimadzu, and to contact your local office, please visit our Web site at **www.shimadzu.com**

SHIMADZU

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