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Find the *Coherent LaserCam II-1/2* at our website: ***Click HERE***

Beam Diagnostic Cameras

Digital and Analog Versions



- **Specifically built (or modified) for laser beam diagnostics**
- **CW operation and single pulse capture rates to 10 kHz**
- **Resolution to 5 µm**
- **Camera specifications and operational parameters pre-loaded into BeamView™ Analyzer software**
- **High optical dynamic range**

The BeamView™ Analyzer Laser Beam Diagnostic Systems are mated to either a digital or analog camera for sampling the laser beam (see the **BeamView™ Analyzer** brochure for more details). Coherent offers two digital and five standard analog cameras which meet most laser measurement needs, but other cameras are available upon request. All Coherent cameras are specifically built or modified for beam diagnostic use. They have been selected for low noise, maximum linearity and uniformity of response. Each camera is tested and calibrated in our ISO 9002 Certified Calibration Lab. All analog cameras come in a RS-170 (60 Hz field rate) version, but in some circumstances, a CCIR (50 Hz frame rate) camera may be preferred. These cameras are available upon request.

Cameras that are used for laser beam diagnostics typically have Charge Coupled Device (CCD) sensors or Vidicon tube sensors. CCD sensors have a two-dimensional array of discrete pixels over the image area. Vidicon tubes scan the image plane with an electron beam to determine the image intensity distribution. When possible, use a CCD camera due to their overall better performance. There is a selection of four different standard Coherent CCD cameras that have been built or modified for beam diagnostics. They cover optical wavelengths from 190 nm to 1100 nm. These cameras offer a range of resolution and features to meet almost all diagnostic needs. For wavelengths longer than 1100 nm, there is one standard Vidicon camera and several special order cameras. For wavelengths shorter than 190 nm, special Extreme-UV Profiler optics are available (see **Beam Diagnostic Accessories** brochure).

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All standard CCD cameras accept C-Mount optics and accessories and are delivered without a glass/plastic window in front of the sensor array. Such windows are liable to distort the optical beam. However, a Low Distortion Face Plate (LDFP) filter is supplied with each camera. The LDFP is a laser grade ND filter glass specified and polished for diagnostics use. It is mounted in a C-Mount ring and provides sufficient attenuation of room light so that the camera can be used with the lights on. **For operation below 400 nm, the LDFP must be removed.**

The selection and specification charts on the back page provide the information needed to select an appropriate camera for your needs. To aid selection, consider the most important factors which determine the choice of a camera. These are the laser wavelength, the power density or peak intensity, the laser beam size to be viewed, the resolution required, the laser operating cycle (CW or pulsed) and the camera cost. The following pages will help guide these choices.

Beam Size

The beam size, or range of sizes, is one of the first factors to consider when selecting a camera. In order to image the entire beam properly, the $1/e^2$ beam diameter should be no more than 80% of the **minimum active sensor dimension**. Such a criterion usually provides sufficient image area for sensing the image periphery and allows space for beam wander during measurement or alignment procedures. However, for critical beam measurement, such as $D_4\sigma$, the $1/e^2$ diameter should not cover more than half of the sensor height or width.

The primary determinant of the minimum beam diameter which can be adequately measured is the spatial measurement accuracy. Fewer sensor elements in the beam image will result in less accurate measurements. For example, 40 pixels across the beam image will provide the resolution for precision beam diameter measurements. Thus, the **minimum beam sizes** in the selection chart on the back page are based on this criterion. The smallest beam to be measured should cover at least 40 CCD sensor pixels (or their equivalent Vidicon processing elements).

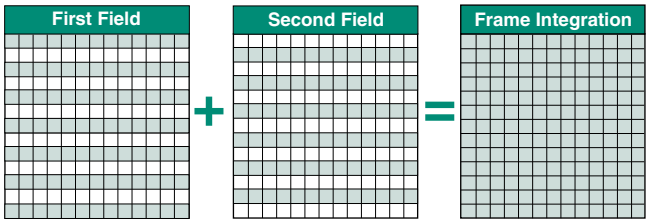
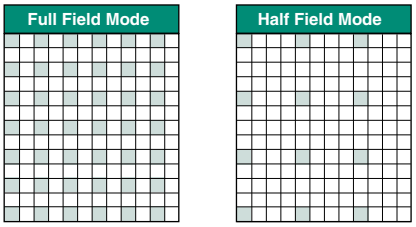


Figure of Interlaced Operation

Aquisition Modes and Image Resolution

Unfortunately, it is not possible to immediately judge a camera's maximum effective image area and resolution from the total sensor area and the pixel spacing, respectively. This is because the pixel information is electronically acquired in methods which in some modes does not access all the pixels in the array. With **Interline transfer** cameras, such as the LaserCam II, all pixel information is acquired every cycle of the camera (1/30 s). With **frame integration** cameras, only the information from alternating rows of pixels are acquired during one cycle (1/60 s), and the information from the other rows are acquired on the next cycle. This is called **interlaced operation** (see the figure above).

It is sometimes desirable to work in **full field** and **half field** modes (with both interline transfer and frame integration cameras) to be able to acquire less pixels from the sensor array, but process the information faster. This was important with older and slower computers, but with faster modern computers it is possible to fully acquire all the sensor information, process it, and display a profile image updating in **real time** (~10-25 Hz).



However, for the highest image acquisition rate, the **full field** and **half field** modes are still used. With **full field** operation, only alternate pixels on alternate lines are sampled. With **half field** operation, only every fourth pixel on every fourth line is sampled (see the figure below). Such operation clearly speeds up information processing, but lowers the resolution. Thus, there are three common image resolution modes for camera based beam diagnostics: **Frame** (752 x 480), **Full Field** (376 x 240), and **Half Field** (188 x 120).

Operation with Pulsed Lasers

Extra care must be expended when selecting a camera for use with pulsed rather than CW lasers. This is because there can be interactions between the timing of the pulses of the laser and the timing of the electronic acquisition of the optically-induced information on the sensor pixels.

The LaserCam II and LaserCam IIID cameras can capture pulsed beam images in frame mode (every pixel) up to a maximum pulse rate of 30 Hz. The frame integration cameras can only capture pulsed beam images in full field and half field modes up to a maximum pulse rate of 60 Hz.

If the camera is to be used for analysis of single pulses at greater than 60 Hz repetition rate, then a camera with an electronic shutter is recommended. The speed of the shutter is then the determining factor in the rep rate that can be sampled. By adjusting the shutter to a shorter interval than the time between pulses, single pulses can be sampled. For instance; a 1 ms shutter time can be used to sample a single pulse in a 1 kHz or less rep rate laser pulse train.

Note that for 900-1100 nm wavelengths, the 1/4" LaserCam II and LaserCam IIID cameras are limited when used with CW lasers because of image ghosting.

Optical Dynamic Range

All analog video cameras have a very limited optical dynamic range (typically 200:1 to 300:1) when operated as sensors for quantitative measurement of optical radiation. Digital cameras have a much larger optical dynamic range (over 1200:1) due to lower noise achieved by the integral digitizing electronics located in the camera itself. The optical dynamic range is the ratio of the maximum to the minimum optical signal levels that can be incident on the sensor to achieve a linear response. The maximum linear response typically occurs at ~80% of the photosaturation level and the minimum response corresponds to the illumination level at which the signal can be distinguished from the background noise.

Beam Attenuation

Optical attenuators are used to reduce the laser intensity to match the camera response range. The optics must be laser grade substrate, properly specified and polished so that the beam is not distorted by the introduction of the attenuation. We offer attenuation optics designed to these specifications and packaged for use with our cameras. Typical attenuations are 1:1 to 400,000:1, but even larger attenuations are possible. Suggested configurations delivering up to a 25 billion to 1 ratio of laser grade optical attenuation are illustrated in the **Beam Diagnostic Accessories** brochure.

Highlighted Analog Camera Features



LaserCam II 1/2" CCD
(33-3120 for 120 VAC and 33-3138 for 240 VAC)
Excellent camera for beams up to 4 mm in the 190-1100 nm wavelength range. This is an interline transfer camera that will allow frame mode (all pixels) to be used for pulsed beams in the entire 190-1100 nm range. This is accomplished through a custom CCD mask that eliminates ghosting from pulsed beams in the 900-1100 nm range.

LaserCam II 1/4" CCD
(33-2965 for 120 VAC and 33-2973 for 240 VAC)
Preferred camera for small beams in the 190-1100 nm wavelength range. This is an interline transfer camera that will allow frame mode (all pixels) to be used for pulsed beams up to 900 nm.

C-48 Camera 2/3" CCD
(33- 3153 for 120 VAC, 33-6701 for 240 VAC)
Large CCD array camera for 190-1100 nm operation with the widest dynamic range and excellent overall performance. The C-48 Camera has the large-area sensor and electronics integrated in a single traditional package, but there is no shutter. This camera is very popular.

C-64 1/2" Camera CCD
(33-3162 for 120 VAC, 33-6720 for 240 VAC)
Excellent camera for 190-1000 nm operation with good resolution and dynamic range. Where space is a problem, camera has a small sensor head and simple shutter. The C-64 camera consists of a remote sensor package and a table top control unit.

E-7290 Camera
(33-3260 for 120 VAC, 33-3765 for 240 VAC)
The camera of choice for operation in the infrared between 1100 and 1800 nm. Note that the E-7290 vidicon camera operates at a maximum of 1 Hz for pulses. For operation at higher pulse rates and in the infrared beyond 1100 nm, consult your local Coherent sales office.

For further specifications, see the Comparison and Selection of Cameras on the back page, or call your local Coherent representative.

For 10-355 nm Operation

The spectral range of cameras can be extended to wavelengths shorter than what the camera alone can respond to by converting the wavelength with an image plate system that does not distort the beam and is designed for use with cameras and lasers. The Extreme UV Beam Profiler Optic will allow imaging of a beam in the wavelength range of 10-355 nm. (See the **Beam Diagnostic Accessories** brochure for more details.)



Digital and Analog Camera Selection Chart

For a more detailed description of cameras, see the **Beam Diagnostic Cameras** brochure.

Camera Name	LaserCam IIID 1/2"		LaserCam IIID 1/4"		LaserCam II 1/2"		LaserCam II 1/4"		C-48		C-64		E-7290	
Format* **	Digital Interline Transfer CCD 736(H) x 484(V)		Digital Interline Transfer CCD 736(H) x 484(V)		Analog RS-170 Interline Transfer CCD		Analog RS-170 Interline Transfer CCD		2/3" Analog RS-170 Frame Integration CCD		1/2" Analog RS-170 Frame Integration CCD		Analog RS-170 Vidicon	
Wavelength Range	190-1100 nm		190-1100 nm*		190-1100 nm		190-1100 nm*		190-1100 nm		190-1000 nm		400-1800 nm (400-2200 nm Optional)	
Maximum Active Sensor Area (mm)	**Horz.**	**Vert.**	**Horz.**	**Vert.**	**Horz.**	**Vert.**	**Horz.**	**Vert.**	**Horz.**	**Vert.**	**Horz.**	**Vert.**	**Horz.**	**Vert.**
	6.4	4.8	3.6	2.7	6.4	4.8	3.6	2.7	8.8	6.6	6.4	4.8	12.5	9.4
Digitized Resolution:														
Frame Mode (µm)	8.5	9.8	4.8	5.5	8.4	9.8	4.8	5.6	11.5	13.5	8.5	9.8	17.3	19.5
Full Field Mode (µm)	17	19.6	9.6	11	16.8	19.2	9.6	11.3	23	27	17	19.6	34.6	39
Half Field Mode (µm)	34.1	39.3	19.2	22	33.6	39.2	19.2	22.6	46	54	34	39.2	69.2	78
Minimum Beam Size (mm)	0.34	0.40	0.19	0.22	0.34	0.40	0.19	0.22	0.46	0.54	0.34	0.40	0.69	0.78
Dynamic Range	>1200:1		>1200:1		250:1		250:1		300:1		250:1		300:1	
CW Saturation (mW/cm^2 at 632.8 nm)	0.5		0.5		0.8		0.8		0.5		0.2		10	
Pulsed Saturation (nJ/cm^2 at 632.8 nm)	9.1		9.1		9.1		9.1		9.1		6.5		1000	
Electronic Shutter (ms)	30, 60-1500 (continuous adjustment)**				16.6 (open shutter), 10, 8, 4, 2, 1, 0.5, 0.25, 0.1				N/A		16.6, 1, 0.5		N/A	
Field Rate (Hz)	60		60		60		60		60		60		60	

* The 1/4" version cannot be used with pulsed beams from 900-1100 nm. ** CW operation only. *** CCIR versions of some analog cameras are available. Other camera configurations are available upon request.

LaserCam IIID

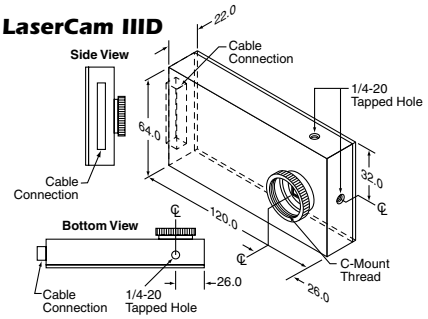


The LaserCam IIID Digital Camera is included with the purchase of the Digital BeamView™ Analyzer System. Additional digital cameras can be ordered as an option.

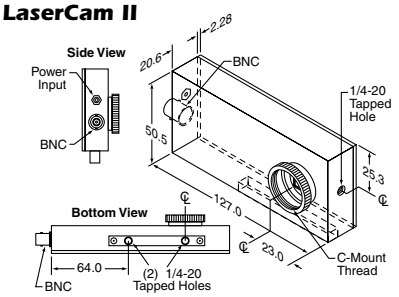
All Analog Beam Diagnostic Cameras are factory configured for use with the Analog BeamView™ Analyzer System.

ISO 9002 Certified

LaserCam IIID



LaserCam II



Dimensions in mm

Beam Diagnostic Cameras

Catalog Number 120 VAC	Catalog Number 240 VAC	Description
33-6990*	33-7014*	Digital BeamView Analyzer and 1/4" Sensor LaserCam IIID
33-7006*	33-7022*	Digital BeamView Analyzer and 1/2" Sensor LaserCam IIID
33-3120	33-3138	1/2" Sensor LaserCam II and Power Supply
33-2965	33-2973	1/4" Sensor LaserCam II and Power Supply
33-3153	33-6701	C-48 and Power Supply
33-3162	33-6720	C-64 and Power Supply
33-3260	33-3765	E-7290 and Power Supply

* Includes digital camera and interface card, software, manual and cables. Analog cameras are not compatible with the Digital BeamView Analyzer.

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