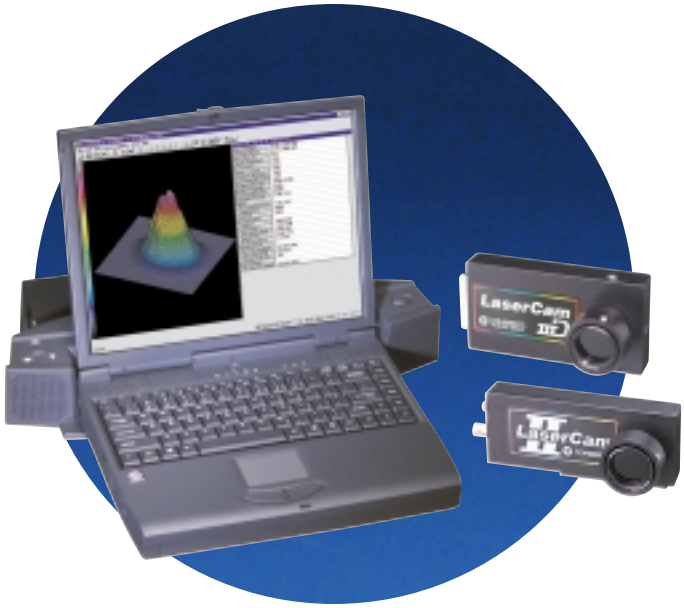
BeamView Analyzer

Laser Beam Diagnostic Systems

- *Digital and Analog Camera Systems*
- *Refined Windows® software*
- *Extensive selection of laser beam diagnostic optics*
- *High-speed PCI interface*
- *Turnkey systems and components*
- *Remote control interface*



The BeamView™ Analyzer systems have been the recognized leader in software, hardware and optical components for laser beam analysis. Constant product improvement from customer feedback, and innovation from beam analysis experts, have made the BeamView Analyzer products the first choice for laboratory, factory and field measurements.

There are two versions of the BeamView Analyzer: a digital version, and an analog camera version. Both versions have the same advanced software interface. Most applications are best handled by the Digital BeamView Analyzer system. In cases where the laser beam is large, from a fiber, a raw laser diode, or in wavelengths beyond 1100 nm, the Analog BeamView Analyzer system provides a selection of proven analog laser diagnostic cameras. For detailed descriptions of the digital and analog cameras, see the Beam Diagnostic Cameras section on page 65.

Digital BeamView Analyzer

The Digital BeamView Analyzer simplifies the setup and analysis of beams, due to the increased optical dynamic range over traditional analog-based video camera systems. Higher optical dynamic range means more accurate and consistent results. The Digital BeamView Analyzer utilizes Coherent's refined Windows® software and the 10-bit Digital LaserCam IIID. Coherent has engineered the LaserCam IIID specifically for laser diagnostics with 10-bit digital output and greater than 1200:1 optical dynamic range. The LaserCam IIID is available in 1/4-inch and 1/2-inch sensor format versions that are interchangeable and can be ordered separately as an option if more than one size is required for your needs (see page 68 for specifications).

The Digital BeamView Analyzer comes as a complete package ready to be incorporated into a PC-compatible computer platform. The system includes the LaserCam IIID, Digital BeamView Analyzer for Windows software, digital PCI interface card, cables and manual. The BeamView Analyzer can also be ordered as a turnkey diagnostics system in a laptop or desktop computer configuration. Laser diagnostic-grade image and attenuation optics are also available. See the Beam Diagnostic Accessories section on page 69.

Analog BeamView Analyzer

The Analog BeamView Analyzer with PCI framegrabber is for use with RS-170 and CCIR analog video cameras. With five standard analog diagnostic cameras available off the shelf (see page 67), and many more available, almost any beam can be analyzed. Advanced optics, attenuation and customized cameras allow wavelengths from 10-2200 nm, and beams from tens of microns to 30 mm by 40 mm, to be quantified. See the Beam Diagnostic Accessories section on page 69.

For custom BeamView Analyzer Systems that match your exact needs, please call your Coherent representative today.

www.Coherent.com • LMC.sales@coherent.com • (971) 327-2700

BeamView Analyzer

Digital PCI Interface Card

With LaserCam IIID digital cameras, the "framegrabber" is inside the camera. The interface card is the communication, control and image data storage for the camera. Coherent has developed the LaserCam IIID and interface card specifically for laser beam diagnostics. This system is optimized for high optical dynamic range and saturation levels best suited to laser beam analysis.

High-Speed Framegrabber

The framegrabber board, for interfacing the chosen analog camera to the controlling computer, has been specifically designed for capturing laser images from RS-170 or CCIR video cameras. The framegrabber can operate with up to four cameras connected. The software can select any one of the four to be operational. The standard version of the framegrabber board, the Beam Vision Support Module (BVSM), is configured as a 1/2-length, 32-bit PCI bus card for operation with Windows 98, ME, NT, 2000 and XP. It contains a 2-Mb Video RAM buffer, temperature stabilization and special synchronization and gate timing electronics for fast, accurate and correct image capture of CW or pulsed laser profiles.

Characterizing Pulsed Lasers

The BeamView Analyzer can easily capture, display and analyze pulsed laser images with three modes of operation to choose from. In the Auto mode, the capture is triggered by any incoming image with a peak intensity above a pre-selected trigger level. With Synchronous mode, the laser is synchronously triggered with a TTL pulse from the framegrabber board. With Asynchronous mode, the user provides a TTL pulse to the framegrabber to initiate capture of the laser image. These three triggering modes, when combined with the five capture modes (continuous, time interval, pulse count, on command, and single shot), allow for the capture of the image of almost any CW or pulsed laser (up to 10 kHz pulse repetition rate with the appropriate camera).

Remote Control and Data Transfer Interface

The BeamView Analyzer provides remote control and data transferred through the host computer's RS-232 port or a user-installed GPIB (IEEE-488.2) interface. A complete control and data transfer command set is provided to allow users to develop their own remote control application for the BeamView Analyzer.

Minimum Computer Requirements

- *Windows 98, ME, 2000, NT 4.0, or XP*
- *1 free PCI slot for 2/3-length card*
- *Pentium® 166 MHz*
- *64-Mb of RAM*
- *40-Mb free hard disk space*
- *SVGA graphics card and display*
- *Serial communication port (for remote operation)*

BeamView Analyzer Beam Diagnostics Systems

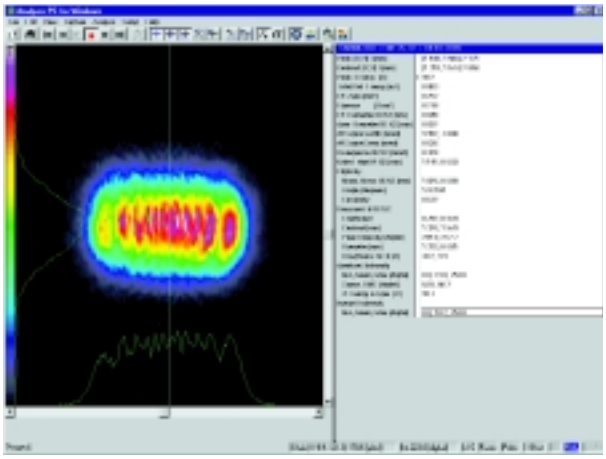
Part Number 120 VAC	Part Number 240 VAC	Description
33-6990-000*	33-7014-000*	Digital BeamView Analyzer and 1/4" Sensor LaserCam IIID
33-7006-000*	33-7022-000*	Digital BeamView Analyzer and 1/2" Sensor LaserCam IIID
33-2700-000		Analog BeamView Analyzer System with PCI Framegrabber/Interface Card**

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

** The Analog BeamView Analyzer System is not supplied with a camera. Please choose an analog camera from page 68.

BeamView Analyzer Software

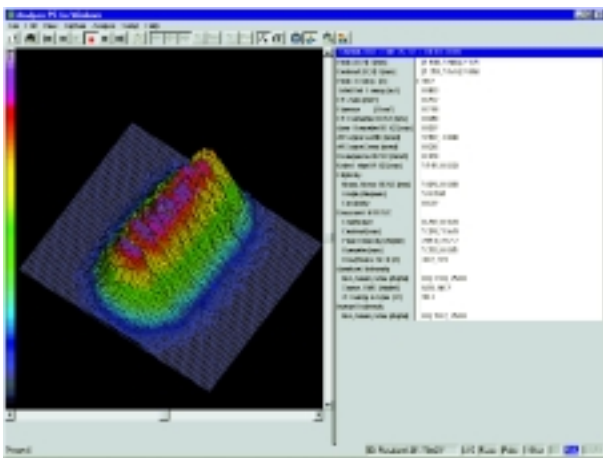
- *Over 25 numerical analysis functions*
- *28 different profile views*
- *13 image import and export formats*
- *Pass/Fail settings, alarms, configurable setups*
- *Refined, easy, intuitive interface*
- *Automatic background subtraction*



Beam Analysis and Statistics

The BeamView Analyzer software can determine the following parameters in a manner that is compatible with the International Standards Organization (ISO) guidelines for laser beam measurement: peak and centroid position of a beam, the beam ellipticity (and angular position of the ellipse and major/minor axes) and circularity, the D4σ diameters and widths of the beam (together with slit and knife-edge ISO equivalent beamwidth calculations), the Gaussian fit (coefficient, centroid and "roughness of fit"), the aperture fit and uniformity, the total/relative power in a beam, the peak power/energy density, and the percentage power within an aperture.

The system is not limited to analysis and display of ISO-defined parameters. Many other parameters can be chosen and appropriately displayed in the Results Area. There is great flexibility, because individual parameters can be selected for display or left out of view, units can be customized, minimum and maximum alarm limits can be set, and fault actions can be initiated by the alarms. Statistical analyses, standard profiles, pass/fail tests and QA procedures can be developed. The power and ease of use is best conveyed by our demonstration version of the software. The demonstration software comes with several stored images and can be customized to model anticipated measurement and diagnostic requirements. A free copy is available from your local Coherent representative, or download it from www.Coherent.com.

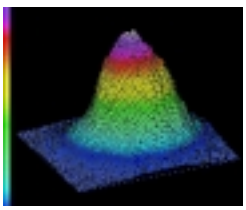


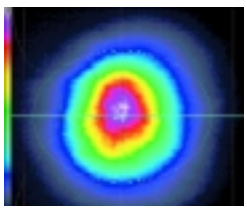
BeamView Analyzer display with 3D image and ISO-compatible results

2D and 3D Intensity Plots

The Run command switches the BeamView Analyzer from the Stop or Live Video mode to continuous operation, which provides capture, analysis and display of beam image data. In the view area of the computer monitor there is a choice of 2D or 3D images.

The 2D contour maps and the 3D isometric plots display laser beam intensity profiles in a choice of various color and gray-scale styles (fixed and autoscaling to a peak) and sizes (continuous zoom and pan control). The 2D maps can be shown with or without profiles (and Gaussian fit), reference position, variable aperture and rotatable crosshairs (with auto peak and auto centroid location). The 3D isometric plots can be displayed with transparent, hidden or solid wires, and can be rotated and viewed from different tilt angles.



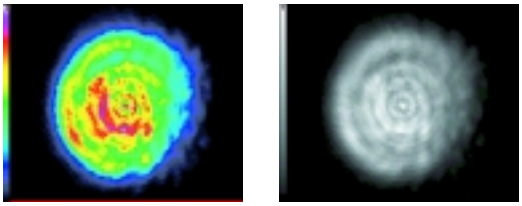


Choice of 3D and 2D images

BeamView Analyzer

Real-Time Laser Monitoring and Alignment

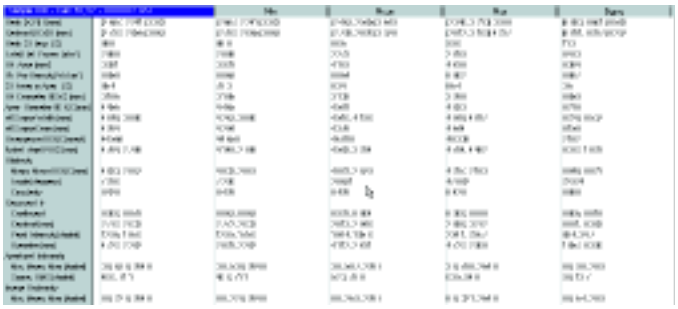
The Live Video mode provides a continuously updated image of the beam (~20 to 25 Hz, depending on the speed of the Pentium processor in the host computer), displayed in shades of gray or pseudo-color. This mode is ideal for monitoring the laser and observing changes in the form and structure of the beam as it is adjusted. It is also perfect for real-time tuning to achieve optimum beam profile quality and laser-cavity alignment. While operating in this mode, beam and statistical data are not displayed, but if Run is activated, the image is stored and can be further analyzed.



THE LIVE VIDEO MODE

Performance Optimization

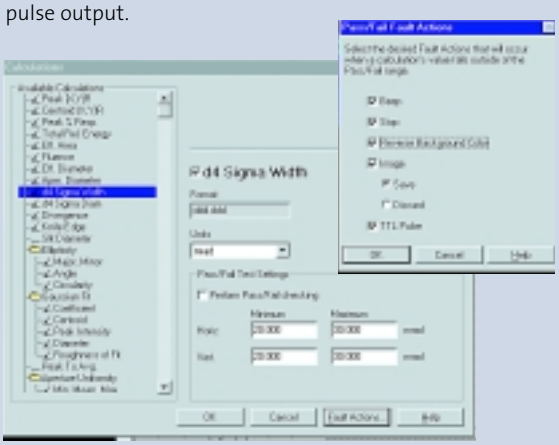
The BeamView Analyzer software provides several functions to insure that the system performance is optimized to take full advantage of the optical dynamic range available in the camera. This allows users to achieve maximum measurement accuracy. First, the Automatic A/D Offset and Gain adjust feature (analog systems only) insures the A/D converter on the framegrabber board is properly adjusted to match the maximum video signal and the background noise level for the analog camera being used. Second, the Automatic Background subtraction feature measures and stores the background noise "image" and automatically subtracts individual pixel noise levels from all subsequent laser images prior to analysis. Finally, the system can automatically monitor the background noise level to warn of any changes that may effect measurement accuracy.



CONTINUOUS ON-LINE STATISTICAL ANALYSIS DISPLAY

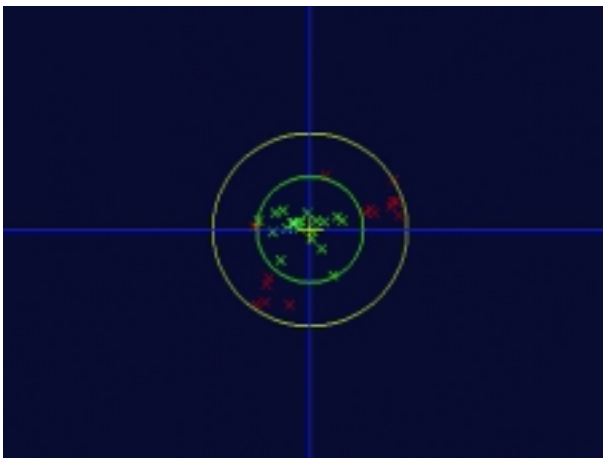
Pass/Fail Analysis

Pass/fail analysis allows simultaneous on-line monitoring of all or any of the analysis results against user-specified minimum/maximum (pass/fail) limits. All or a combination of the fault actions can be taken upon test failure: initiate visual alarm, initiate audio alarm, stop data capture, reject/save failed sample and production of a TTL trigger pulse output.



Beam Stability

The continuous on-line statistical analysis display shows results of all or a combination of functions and pass/fail parameters for all captured samples and accumulated results. The user can scroll through the analysis results of individual images, and also view the minimum, maximum and sigma (standard deviation) values. This makes the task of comparing individual samples to the time-dependent statistical data extremely easy. Thus, the jitter and stability of parameters, such as power, energy, pointing direction, ellipticity and beam size, etc., can be analyzed along with a polar beam wander plot.



POLAR WANDER PLOT SCREEN

BeamView Analyzer Software Features

Analysis, On-Line Pass/Fail Tests

- Centroid position/wander
- Peak intensity/position
- Peak energy/power density
- Relative energy/power
- Effective area
- Peak-to-average intensity
- Beam diameter/widths (selectable):
  - Second moment (d4Sigma)
  - Knife-edge
  - Slit
  - Aperture diameter
  - Effective diameter
- Divergence at % energy/power
- Gaussian fits with:
  - Correlation coefficient
  - Diameter
  - Centroid
  - Peak intensity
  - Fit roughness
- Ellipticity at intensity slice:
  - Major and minor axis diameter
  - Circularity (minor/major)
  - Axis orientation (rotation)
  - Auto align profiles to axis
- Aperture analysis for circular, square, rectangular and elliptical:
  - % energy/power in aperture
  - Uniformity in aperture
  - Aperture/diameter tracking
- Selectable calculation area
- On-line statistical analysis (all results):
  - Minimum, average, maximum
  - Sigma (standard deviation)
- Pass/Fail test with fault action (all results):
  - Ratio
  - Audio/visual alarms
  - Save/reject images
  - TTL pulse out
  - Stop data capture
- Image Averaging

Interactive Display Functions

- On-line help
- Control of cursors, profiles, aperture, position, rotation and size
- Run/stop data analysis
- Stored image paging
- Reference profile select
- Reference coordinate set
- Background subtract
- Live video on/off
- Zoom/pan size/position
- Image and profile autoscale modes
- Auto peak/centroid locate
- A/D converter control
- "Hot" function keys

Standard Graphics Feature

- Contour map with profiles/aperture overlay:
  - 220-color, 17-color, 220-gray shade or 15 colors with 13 shades
- Live video mode
- Profile/peak/centroid position cursor
- On/off axis simultaneous display of:
  - Position cursor
  - Cross-section profiles
  - Gaussian fit profiles
  - Reference profiles
  - Aperture overlay for:
    - Beam uniformity
    - % energy/power
- Calculation inclusion area display
- Rotatable color 3D isometric plot
  - 360°, 90° rotate/tilt
  - Hidden/transparent wire
  - Selectable wire density
  - Solid or single color
  - Auto rotate mode
- Graphic zoom and pan
- Auto-scale 2D or profile intensity
- Polar beam wander plot

Image Capture and Storage

- Pulsed or CW analysis
- 3 trigger modes:
  - Autotrigger to selected level
  - Asynchronous (trigger input)
  - Synchronous (trigger output)
- 3 resolution modes RS-170:
  - Frame (752 x 480 pixels)
  - Full-Field (376 x 240 pixels)
  - Half-Field (188 x 120 pixels)
- 5 capture modes:
  - Continuous
  - Time interval
  - Pulse count
  - On command
  - Single shot
- High-speed sample mode capture
- Image storage to:
  - Framegrabber video memory
  - PC hard drive
  - PC RAM drive
- Profile storage
- Capture area pan
- 4-channel (camera) analog video input
- Configuration storage with password protection
- Image data file formats in bin, img, bmp, eps, jpg, pct, pcx, png, psd, ras, tga, tif, and wpg
- Data file compression

Calibration Functions

- Fully automatic background map correction (pixel-by-pixel) with bias offset
- Automatic background monitor and alert
- Automatic A/D offset/gain set (analog BeamView Analyzer System)
- Optical scale factor (magnification)
- Far-field optic focal length
- Camera pixel size (Horz. and Vert.)
- Energy/power calibration factor

Beam Diagnostics 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 section on page 60 for more details). Coherent offers two digital and five standard analog cameras, which meet most laser measurement needs. However, 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 an 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 its 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 on page 69).

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's cost. The following pages will help guide these choices.

Beam Diagnostics Cameras

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 D4σ, 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).

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 repetition 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 repetition 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 limited optical dynamic range (typically 300:1) when operated as sensors for quantitative measurement of optical radiation. Digital cameras have a much larger optical dynamic range (over 2000:1), 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's 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 section on page 69.

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 section on page 72 for more details.)

Beam Diagnostics Cameras

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.

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

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-48

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, this 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.

C-64

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.

E-7290

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

Digital and Analog Camera Selection Chart

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. 6.4	Vert. 4.8	Horz. 3.6	Vert. 2.7	Horz. 6.4	Vert. 4.8	Horz. 3.6	Vert. 2.7	Horz. 8.8	Vert. 6.6	Horz. 6.4	Vert. 4.8	Horz. 12.5	Vert. 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	>2000:1		>2000:1		300:1		300:1		300:1		300:1		300:1	
CW Saturation (mW/cm² at 632.8 nm)	0.5		0.5		0.8		0.8		0.5		0.2		10	
Pulsed Saturation (nJ/cm² 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	

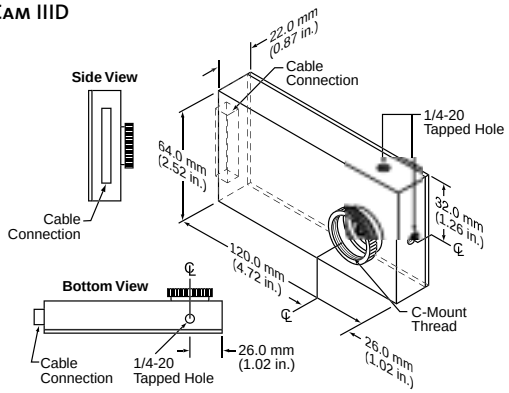
* The 1/4" version cannot be used with pulsed beams from 900-1100 nm.

** CW operation only.

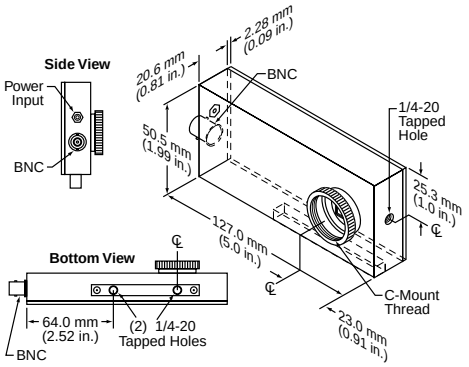
*** CCIR versions of some analog cameras are available.

Other camera configurations are available upon request.

LaserCam IIID



LaserCam II



BeamView Analyzer Beam Diagnostics Cameras

Part Number 120 VAC	Part Number 240 VAC	Description
33-3120-000	33-3138-000	1/2" Sensor LaserCam II and Power Supply
33-2965-000	33-2973-000	1/4" Sensor LaserCam II and Power Supply
33-3153-000	33-6701-000	C-48 and Power Supply
33-3162-000	33-6720-000	C-64 and Power Supply
33-3260-000	33-3765-000	E-7290 and Power Supply
33-6990-000*	33-7014-000*	Digital BeamView Analyzer and 1/4" Sensor LaserCam IIID
33-7006-000*	33-7022-000*	Digital BeamView Analyzer and 1/2" Sensor LaserCam IIID

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