PV320 Frequently Asked Questions for Laser Applications (and their answers.)

How is the technology used in the PV320 different from other thermal imaging product technologies?

There are a several distinct technologies of thermal imaging available today. Most of the newer camera designs are based on a focal plane array (FPA) that is a two-dimensional array of infrared detectors used to create an image. (Earlier systems used either a single element detector or a small array of detectors and scanned the scene across the detectors with rotating mirrors). The PV320 utilizes an uncooled FPA as its infrared detector. Other popular FPA technologies include both uncooled (microbolometer) and cooled (platinum silicide, indium antimonide, mercury cadmium telluride) FPA systems. The advantage of uncooled systems is system lifetime and cost, (Cooled sensor systems need to be chilled to temperatures as low as 77°K which requires the use of an expensive and highly intricate cryogenic system).

Why is the PV320 known as an "uncooled" imager even though it has a cooler on its thermal sensor?

In infrared imaging technology, the term "uncooled" refers to detector arrays that operate at or near room temperature. The term "uncooled" is used to distinguish this technology from the historical norm, which is to use detectors that only operate at cryogenic temperatures, e.g., the temperature of liquid nitrogen (77°K) or lower. The PV320 utilizes a focal plane array detector that operates near room-temperature (295°K). A single-stage thermoelectric cooler (TEC) in the detector package maintains the room-temperature operation of the detector over varying ambient temperatures.

What uncooled technology is used in the PV320 and how does it compare with other uncooled imaging technologies?

Two basic uncooled detector types have emerged today, ferroelectric detectors and microbolometers. Ferroelectrics have been developed by Raytheon and GEC Marconi; microbolometer technology has been developed by Honeywell and others. Ferroelectric detector technology (as used in the PV320) takes advantage of a ferroelectric phase transition in certain dielectric materials. At and near this phase transition, the electric polarization of the dielectric is a strong function of temperature; small fluctuations of temperature in the material cause large changes in polarization. Then, if the sensor is maintained at a temperature near the ferroelectric phase transition and if the optical signal is modulated (with a synchronous chopper), then, an infrared image can be readout that reflects the scene temperatures. Microbolometer arrays, on the other hand, consist of detectors made from materials whose electrical resistivity changes with temperature. Each detector is part of a readout circuit that measures the resistance of the element as a signal.

What is an uncooled BST array?

The PV320 IR Imagers are based on an uncooled ferroelectric BST array. BST is a ceramic material consisting of barium, strontium and titanium salts. The nominal desired composition is $Ba_{0.66}Sr_{0.34}TiO_3$. Because ferroelectrics retain their electric polarization after application and removal of an electric field, their polarization depends on temperature.

How does one use the PV320L cameras to perform beam profiling?

In general, coherent laser beam profiles can be viewed in four ways:

Method 1: Commonly, the collimated laser beam is set up to impinge directly onto the imaging detector of the PV320. The advantage of this method is a direct observation of the beam without the effects of intermediary lenses that can distort shape and uniformity.

Method 2: Alternatively, a magnifying lens can be used between the laser and the PV320. The advantage of this method is that the beam can be easily magnified before observation. In addition, non-collimated beams can also be viewed - and the image focused onto the detector.

Method 3: A partially reflecting first-surface mirror can be used to reflect a portion of the collimated laser beam onto the imaging detector. The advantage of this method is that the PV320's faceplate is not directly in the path of a possible intense beam and consequently is better protected.

Method 4: A fourth method is to focus the laser beam onto a diffusing surface (such as a white card) and to use an objective lens on the front of the PV320 to focus on this diffuse reflection of the laser beam. The advantage of this method is that it not only protects the PV320's detector from possible damage from the laser beam, but also allows the user to easily magnify the beam without affected the beam itself.

How do the PV320A, PV320L and PV320T cameras differ?

The PV320A utilizes a unique chopper mechanism that makes it much more resilient to ambient temperature fluctuations. In addition, the PV320A "highlights" hot and cold objects by intensifying their edge contrast thereby improving spot detection but not permitting quantification. The PV320L cameras are designed so that they can be used to quantify their output signal. Consequently, the image grey-levels can be related to the temperature of an object or to the power density of a laser beam. The PV320T cameras are radiometrically calibrated and consequently provide the user with non-contact object temperature information.

What is the spectral sensitivity of the PV320L?

Spectral sensitivity of the PV320 cameras is affected by several factors:

1) Material and coating of the objective lens used: We offer a variety of infrared lenses that consist of germanium. (Germanium is transparent to wavelengths longer than about 2µm). Lens coatings for 2-14µm or optimized for 8-12µm are available.
2) Material and coating of detector window: Most of the PV320 models utilize a silicon window transparent to wavelengths longer than about 1.1µm. However, the PV320L2Z/E models utilize a non-fringing zinc selenide window transparent to wavelengths longer than about 0.6µm.
3) Detector sensitivity: The PV320 detector has its own characteristic response to different infrared wavelengths as shown on the chart below:

PV320L2Z Typical Spectral Sensitivity		
Wavelength	**Minimum µW/cm²**	**Maximum mW/cm²**
640nm (HeNe)	150	15
2.7µm	50	5
5.0 µm	150	15
10.6µm (CO_2)	30	3

What is the readout process for the PV320 sensor?

The PV320 utilizes a 320x240 array of capacitors. The entire array is read every 16.67ms (for the 60Hz model). The integration time for each pixel is also 16.67ms wherein the pyroelectric current is integrated for that period. It is important to note that the integration period for all pixels in a row are coincident; the period for the different rows are staggered with respect to other rows. The integration period for a given row essentially coincides with the time the edge of a chopper blade transition occurs.

Each pixel has its own preamp. The temperature of each pixel oscillates in response to the chopper blade opening and closing. The changing temperature causes a changing polarization that in turn results in a current flow in the external circuit around each pixel (satisfying Gauss' Law). The output of each pixel preamp is a voltage representing the charge that has flowed through the detector circuit since the last reset (which is synchronized with the last change in chopper phase, i.e. open-to-shut or shut-to-open). (The preamps have reset capacitors that are initiated after each read). The pixel preamps are connected (by switches) to column sense amplifiers in synchronism with the video scanning signal. These switches are controlled by row-select clocks that close all the switches for the pixels in a row at the same time during a row read-time. The row select clocks are cycled one after the other down the array in synchronism with the edge of the chopper as it is scanned down the array. That is, when the row select clocks for row N are closed, the preamps for that row are connected to the column sense amplifier inputs. The outputs of the column sense amplifiers are connected to a common line through multiplexer switches, which are cycled one at a time during the time row N is being read out. The output line of the multiplexer is connected to the input of a buffer amp that drives the multiplexed signal off the sensor.

How does one use the PV320L2 to image laser pulses?

The PV320L2 can be used to image both CW and pulsed laser beams. Though not ideal for use with pulsed lasers, the following are three possible methods available for imaging:

1) To view individual laser pulses, the pulses must occur at *exactly* the camera's frame rate of 30Hz (25Hz for PAL cameras) and at precisely the right moment (when the chopper is fully open). Since the PV320 has a Genlock feature, the camera can be synchronized with an external 30Hz source that also drives the laser.
2) If the laser's pulse repetition frequency is much higher than the camera's frame rate, then the pulse stream will appear as a CW beam and the results will be integrated for the field period. For example, if the pulse repetition frequency were 1000Hz, each frame would be the result of the contribution of 32-33 pulses.
3) If the laser pulses occur randomly and a single pulse-per-frame is desired, it may be possible to record sequential frames (either with a real-time video segment frame grabber or simply by video recording the output). Then, the desired frame can be located and studied. However, it is important to note that if the laser pulses when the PV320's chopper is in front of (or partially blocking) the array, a full image will not be obtained.