



SpecterView™ APPLICATIONS FOR LASER DEVELOPMENT

The high-speed, reconfigurable SpecterView camera from Southern Vision Systems is an ideal tool for laser development and diagnostics. SpecterView's reconfigurable nature allows independent quantitative spatial, spectral, or temporal measurements to be made with the same device without having to re-align. The large-area CMOS sensor is resistant to blooming so that small nuances in laser output can still be measured in close proximity to high light levels. High-repetition rate measurements (such as from a copper vapor laser) can be made and logged for quality assurance using the external trigger and user-adjustable delay. The high sensitivity and dynamic range enable detection of weak emissions (such as super-fluorescence below threshold) as well as characterization of spectral lines in the presence of a large emission background. SpecterView contains no dispersive elements itself but easily fixtures to grating or prism spectrometers through its C-mount interface for spectral measurements.

Specific examples of application to laser development can be broken down into three areas – spatial, temporal, and spectral measurements. Some examples are:

SPATIAL:

- ♦ **Characterization of output laser profile during lab or field alignment.** Real-time image processing on-board the camera allows for subtle measurements of a weak output profile such as that obtained prior to lasing. For example, clipping of an argon-ion laser by a sagging cathode will produce a halo to one side of the output beam. By building a virtual photodetector the ratio of light in the halo to that within the central beam can be measured and displayed graphically to facilitate alignment.
- ♦ **Diagnostics at multiple wavelengths.** The NIR sensitivity (3% QE at 1- μ m) of the CMOS sensor lends itself to semiconductor laser development. Not only can unit-to-unit variations be measured but performance over time logged as well. UV measurements are limited by the glass lid to >400-nm.
- ♦ **Accurate angular measurements.** Using the position-sensitive detection mode of SpecterView, very small variations in a laser's Poynting vector can be recorded. Single-mode lasers (such as pulsed Littman or external cavity semiconductor lasers) exhibit a small angular shift when jumping from one lasing mode to the next. Often, these shifts can be used in a feedback loop to force single-mode operation by tuning a grating or other dispersive element. SpecterView's 500Hz update rate is sufficiently fast for most feedback applications.

TEMPORAL:

- ♦ **Pulse-shape measurements.** SpecterView can sample a small area anywhere in its field-of-view at 500-kHz providing sufficient bandwidth for many pulse-width measurements. In doing so it effectively emulates analog photodiode with an oscilloscope display. The image sub-sampling eases alignment constraints and the external trigger allows synchronization with pulsed lasers.
- ♦ **Profile evolution.** By imaging with the minimum shutter speed of 2-usec, video imagery of the threshold dynamics of the laser profile can be logged. Line-scan mode records 10-bit information without binning and a user-defined delay relative to external trigger allows accurate determination of the observation time.

- ◆ **Absorption spectroscopy.** SpecterView's Virtual Photodetector Mode lets users create their own custom photo-detector. Since photo-detectors are matched best when fabricated on the same substrate, a two-element photo-detector can be defined to sample the incident beam to an absorption cell on one half and the transmitted beam on the other. The two integrated signals can be ratio-ed to give a real-time readout (at 500Hz) of the absorption signal.
- ◆ **Time-of-flight experiments.** Using linescan mode the time decay of an excited state (such as in flowing afterglow experiments) can be captured by recording the emission profile versus column. The ability to call the dynamically-linked libraries controlling the camera from within third-party software such as Labview, MatLab, or Mathematica allow for user-defined processing of the image information. The USB-2 interface means no frame-grabber card is needed.

SPECTRAL:

- ◆ **Emission spectra logging.** Although SpecterView has no dispersive elements, it can monitor the exit plane of a monochromator to capture emission spectra by emulating a linescan imager. The external trigger and image sub-sampling allow control over time and location of emitting sample. For example, only a portion of an ablation plume may be sampled for neutral emission following multi-photon sample ablation.
- ◆ **Laser emission locked to an absorption cell.** Many tasks call for locking a laser source to a reference absorption cell during high-resolution measurements. The high-speed digital nature of the signals from SpecterView combined with the user-adjustable delay can keep the laser emission line locked to the dithered absorption signal. As an example, a ratio-ed absorption signal like that described above can be sampled from Virtual Photodetector Mode synchronously with the dithered signal similar to phase-locked-loop operation. The f/2.8 lens supplied with SpecterView accepts standard 2" filters.
- ◆ **Increase dynamic range with custom configurations.** Many high-resolution spectrometers have curved output slits that limit the dynamic range achievable with rectilinear array detectors. Virtual Photodetector Mode allows the user to create a line-scan imager with curved "slits" that match the output slit.

CUSTOM APPLICATIONS

With its extensive computational capability, SpecterView can perform complex image processing algorithms at rates up to 500-frames-per-second inside the camera. Examples of these include image masking, neural network implementation, convolution, contrast enhancement, smoothing, and edge enhancement. One potential application is the calculation of the laser line-width based on the free-spectral-range of an etalon. This calculation can be performed at rates up to 500Hz on multiple fringe patterns present at the same time. Another application is pattern-matching the transverse output modes of a laser to determine lasing characteristics. Applications previously limited by the processing time for mega-pixel images are now limited only by imagination