

# Princeton Instruments

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## Optimizing Your NIR Spectroscopy Setup

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Princeton Instruments

High-sensitivity, low-noise Princeton Instruments OMA V™ InGaAs detectors have been engineered to take full advantage of well-established spectrometer and laser technologies. The spectral range afforded by these 1.7- $\mu\text{m}$  and 2.2- $\mu\text{m}$  detectors reduces biofluorescence and increases the penetration depth for applications such as quantum dot luminescence, fluorescence, and NIR Raman.

### Selecting a Detector

The key to optimizing an NIR system is to choose the OMA V detector and spectrograph that best meet experiment requirements.

Standard 512-pixel and 1024-pixel OMA V linear photodiode arrays have the same active area. However, because the 1024 models fit twice as many pixels into the same length, they take twice as long to read out. Although fitting more pixels into the same active area reduces the readout rate, the smaller pixels afford better spectral resolution (see Figure 1).

### Selecting a Spectrometer

Understanding the grating effects associated with the mechanical scanning limits of the spectrometer is essential. Important considerations include the relationships between grating, dispersion (nm/mm), blaze efficiency, resolution, and spectrometer focal length. Matching the input optics to the same optical plane as the OMA V is critical to data collection. Princeton Instruments can assist you in determining the optimal configuration for your application.

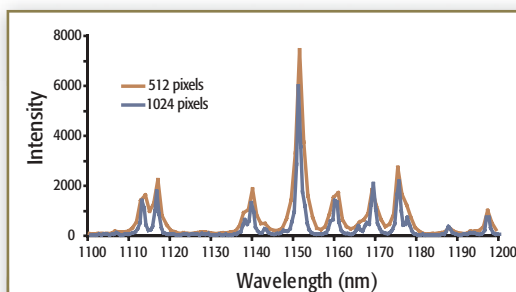
### Thermal Background Radiation

Thermal background radiation from the environment is a major noise source. This phenomenon increases exponentially (approximately) at longer wavelengths. Its wavelength dependence is governed by the Planck Law of Blackbody Radiation.

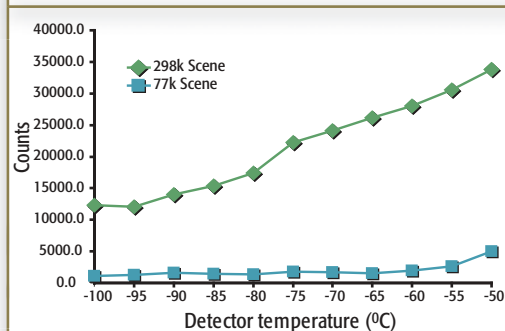
At 1.7  $\mu\text{m}$ , and especially at 2.2  $\mu\text{m}$ , the thermal background radiation of normal room temperature makes a significant contribution to the total signal. Since the red edge of the sensitivity shifts as the device is cooled, and the background radiation increases at longer wavelengths, we can expect the detected background radiation to decrease as the device is cooled (see Figure 2).

### Eliminating Thermal Background Radiation

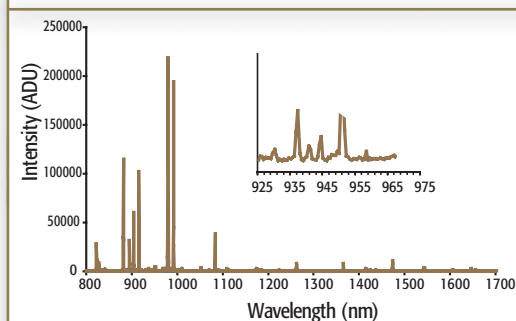
Princeton Instruments has designed a cooled "snout" that is inserted into the spectrometer to eliminate the effects of thermal



**Figure 1.** The same region of the neon spectrum, as recorded with both a 512-pixel and a 1024-pixel OMA V detector. The system setup utilized a 0.3-m Acton Research spectrograph with a 150-groove/mm grating blazed at 500 nm. The 1024-pixel device clearly provided superior results, resolving many more peaks in the spectrum than the 512-pixel device.



**Figure 2.** The green line represents the 100-s integration of a room-temperature Lambertian source. The blue line shows the same integration time of a cryogenic Lambertian source. Thus, we can conclude that the primary contributor to apparent dark current is actually thermal background radiation from the environment.



**Figure 3.** Spectral data acquired using a 512-pixel, 1.7- $\mu\text{m}$  OMA V detector. A xenon light source and a 0.3-m Acton Research spectrograph with a cooled "snout" were utilized.

background radiation. The snout is a series of optics placed inside an LN-filled dewar with either an interference filter or a cooled, long-pass filter to further limit the spectral bandwidth. This configuration allows the OMA V to view only the focusing mirror of the spectrometer, thereby eliminating thermally generated background radiation from the environment and allowing much lower levels of signal to be detected (see Figure 3).

The OMA V also supports two software-selectable gain settings, one for high sensitivity (low light levels) and another for high dynamic range (high light levels). This feature enables the same detector to be used for NIR Raman and absorbance measurements.

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