NIR and Mid-IR Spectrometers

Full Range of Options from 900-3400 nm

We offer two great technologies for your NIR (900-2500 nm) and Mid-IR (900-3400 nm) application needs:

- **NIRQuest® Spectrometers**
  Feature a fixed optical bench, fiber input and an InGaAs array of detector elements. Array-based systems are a must for capturing transient phenomena and are recommended for high speed acquisition in general.

- **SIR-Series Spectrometers**
  These rotating grating (scanning) spectrometers use a stepper motor with optical encoder to rotate a grating through 45,000 steps. The detector is fixed in placed and because of its large area, has exceptional optical resolution and signal to noise. SIRs can be used with optical fibers or in free-beam mode using direct-attach lenses.

NIR and Mid-IR Spectrometer Models at a Glance

With NIRQuest and SIR Spectrometers, you can opt for the standard, default configuration or mix and match gratings, slits and other accessories for a custom setup:

Type	Wavelength Range	Models	Best for These Application Needs
Array-based	800-1600 nm	NIRQuest512-XR	Response at Shortwave NIR wavelengths (<900 nm)
Array-based	900-1700 nm	NIRQuest512	Optimum response at ~1600 nm and good optical resolution (~3.0 nm FWHM)
Array-based	1100-1900 nm	NIRQuest512-1.9	Good response from 1100-1900 nm with good optical resolution ~3.1 nm (FWHM)
Array-based	900-2050 nm	NIRQuest256-2.1	Good response at higher wavelengths (peak detector response ~1900 nm) and optical resolution <8.0 nm (FWHM)
Array-based	900-2200 nm	NIRQuest512-2.2	Good response across 900-2200 nm without sacrificing optical resolution performance (~4.6 nm FWHM)
Array-based	900-2500 nm	NIRQuest512-2.5	Good optical resolution (~6.3 nm FWHM) and low dark noise at long integration times
Array-based	900-2500 nm	NIRQuest256-2.5	Good response at higher wavelengths (peak detector response ~2200 nm) and optical resolution <10.0 nm (FWHM)
Scanning	900-2600 nm	SIR-2600	Good optical resolution and SNR performance, especially for characterizing lasers
Scanning	1300-3400 nm	SIR-3400	Good optical resolution and SNR performance at longer wavelengths, especially for characterizing lasers

Tech Tip: NIR Wavelength Calibration

Spectrometer wavelength calibration sources are useful tools for maintaining calibration in your spectrometer. For NIRQuest, use our AR-1 Argon Source (696-1704 nm) or XE-1 Xenon Source (916-1984 nm), which have atomic emission lines that extend into the NIR. With a wavelength calibration source, you can recalibrate your spectrometer using a spreadsheet program such as Microsoft Excel or a calculator that performs third-order polynomial regressions.

NIRQuest Spectrometers

Near-Infrared Measurements for Nearly Anything

NIRQuest Spectrometers

These small-footprint spectrometers cover various ranges from 900-2500 nm and are ideal for demanding applications ranging from moisture detection and chemical analysis to high-resolution laser and optical fiber characterization. Each NIRQuest spectrometer model is preset with optical bench and grating options appropriate for a wide range of NIR applications. We also offer a full range of slit, filter and grating options to optimize your setup for higher resolution needs or other performance requirements.

Features

- Choice of multiple spectrometer options for optimizing setups across the range from 800-2500 nm.
- Wide range of gratings, slits and accessories for maximum flexibility
- External hardware triggering function for capturing data when and external event occurs or to trigger and event after data acquisition

Physical	NIRQuest512-XR	NIRQuest512	NIRQuest512-1.9
Dimensions (mm):	182 x 110 x 47	182 x 110 x 47	182 x 110 x 47
Weight:	1.18 kg (2.6 lb.)	1.18 kg (2.6 lb.)	1.18 kg (2.6 lb.)
Optical Bench			
Entrance aperture (standard):	25 µm	25 µm	25 µm
Entrance aperture (custom options):	10 µm, 50 µm, 100 µm and 200 µm (or no slit)	10 µm, 50 µm, 100 µm and 200 µm (or no slit)	10 µm, 50 µm, 100 µm and 200 µm (or no slit)
Grating options (standard):	Grating NIR3, 150 l/mm, 900-1700 nm	Grating NIR3, 150 l/mm, 900-1700 nm	Grating NIR3, 150 l/mm, 900-1700 nm
Grating options (custom):	NIR10, NIR11, NIR12, NIR13 and NIR14	NIR10, NIR11, NIR12, NIR13 and NIR14	NIR10, NIR11, NIR12, NIR13 and NIR14
Longpass filter:	OF1-CGA-780 filter (standard); non-fluorescing, transmits >1000 nm	OF1-RG830 longpass NIR filter (optional)	OF1-CGA1000 (standard); non-fluo-rescing, transmits >1000 nm
Fiber optic connector:	SMA 905 to 0.22 numerical aperture single-strand optical fiber	SMA 905 to 0.22 numerical aperture single-strand optical fiber	SMA 905 to 0.22 numerical aperture single-strand optical fiber
Spectroscopic			
Wavelength range:	800-1600 nm w/Grating NIR3	900-1700 nm w/Grating NIR3	1100-1900 w/Grating NIR3
Optical resolution (FWHM):	~3.1 nm w/25 µm slit	~3.1 nm w/25 µm slit	~3.1 nm w/25 µm slit
Signal-to-noise ratio at full signal:	>15000:1 @ 100 ms integration; >13000:1 @ 1000 ms integration	>15000:1 @ 100 ms integration; >13000:1 @ 1000 ms integration	>15000:1 @ 100 ms integration; >13000:1 @ 1000 ms integration
A/D resolution	16-bit	16-bit	16-bit
Dark noise:	6 RMS counts @ 100 ms	6 RMS counts @ 100 ms	6 RMS counts @ 100 ms
	12 RMS counts @ 1 s	12 RMS counts @ 1 s	12 RMS counts @ 250 ms
Dynamic range:	150M (system); 15K:1 for a single acquisition	150M (system); 15K:1 for a single acquisition	7.5M (system); 10K:1 for a single acquisition
Integration time:	1 ms -120 seconds	1 ms -120 seconds	1 ms -1 second
Noise Equivalent Power:	0.5pW	0.5pW	10.0pW
Electronics			
Power consumption:	USB power +5V, 0.5 A maximum; DC input jack +5V, 3 A maximum	USB power +5V, 0.5 A maximum; DC input jack +5V, 3 A maximum	USB power +5V, 0.5 A maximum; DC input jack +5V, 3 A maximum
Data transfer speed:	Full scan to memory every 5 ms with USB 2.0 port	Full scan to memory every 5 ms with USB 2.0 port	Full scan to memory every 5 ms with USB 2.0 port
Inputs/outputs:	External trigger input + single strobe output	External trigger input + single strobe output	External trigger input + single strobe output
Trigger modes:	4 modes	4 modes	4 modes
Connector:	30-pin connector	30-pin connector	30-pin connector

NIRQuest Spectrometers

Specifications Comparison Table

Physical	NIRQuest256-2.1	NIRQuest512-2.2	NIRQuest512-2.5	NIRQuest256-2.5
Dimensions (mm):	182 x 110 x 47	182 x 110 x 47	182 x 110 x 47	182 x 110 x 47
Weight:	1.18 kg (2.6 lb.)	1.18 kg (2.6 lb.)	1.18 kg (2.6 lb.)	1.18 kg (2.6 lb.)
Optical Bench				
Design:	f/4, symmetrical crossed Czerny-Turner	f/4, symmetrical crossed Czerny-Turner	f/4, symmetrical crossed Czerny-Turner	f/4, symmetrical crossed Czerny-Turner
Entrance aperture (standard):	25 µm	25 µm	25 µm	25 µm
Entrance aperture (custom options):	10 µm, 50 µm, 100 µm and 200 µm (or no slit)	10 µm, 50 µm, 100 µm and 200 µm (or no slit)	10 µm, 50 µm, 100 µm and 200 µm (or no slit)	10 µm, 50 µm, 100 µm and 200 µm (or no slit)
Grating options (standard):	Grating NIR2, 100 l/mm, 900-2050 nm	Grating NIR2, 100 l/mm, 900-2050 nm	Grating NIR1, 75 l/mm, 1075-2500 nm	Grating NIR1, 75 l/mm, 1075-2500 nm
Grating options (custom):	NIR2, NIR3, NIR10, NIR11, NIR12 and NIR13	NIR2, NIR3, NIR10, NIR11, NIR12 and NIR13	NIR2, NIR3, NIR10, NIR11, NIR12 and NIR13	NIR2, NIR3, NIR10, NIR11, NIR12 and NIR13
Order-sorting filter:	Yes (standard w/NIR2)	Yes (standard w/NIR2)	Yes (standard w/NIR1)	Yes (standard w/NIR1)
Longpass filter:	OF1-RG830 longpass NIR filter (optional)	OF1-RG830 longpass NIR filter (optional)	OF1-RG830 longpass NIR filter (optional)	OF1-RG830 longpass NIR filter (optional)
Collimating and focusing mirrors:	Gold-coated for enhanced NIR reflectivity	Gold-coated for enhanced NIR reflectivity	Gold-coated for enhanced NIR reflectivity	Gold-coated for enhanced NIR reflectivity
Fiber optic connector:	SMA 905 to 0.22 numerical aperture single-strand optical fiber	SMA 905 to 0.22 numerical aperture single-strand optical fiber	SMA 905 to 0.22 numerical aperture single-strand optical fiber	SMA 905 to 0.22 numerical aperture single-strand optical fiber
Spectroscopic				
Wavelength range:	900-2050 nm w/Grating NIR2	900-2200 nm w/Grating NIR2	900-2500 nm w/Grating NIR1	900-2500 nm w/Grating NIR1
Optical resolution (FWHM):	~7.6 nm w/25 µm slit	~5.0 nm w/25 µm slit	~6.3 nm w/25 µm slit	~ 9.5 nm w/25 µm slit
Signal-to-noise ratio at full signal:	10000:1 @ 100 ms integration	10000:1 @ 100 ms integration	10000:1 @ 100 ms integration	7500:1 @ 10 ms integration
A/D resolution	16-bit	16-bit	16-bit	16-bit
Dark noise:	6 RMS counts @ 100 ms	6 RMS counts @ 100 ms	16 RMS counts @ 10 ms	8 RMS counts @ 10 ms
	12 RMS counts @ 250 ms	12 RMS counts @ 250 ms	24 RMS counts @ 30 ms	12 RMS counts @ 30 ms
Dynamic range:	15M (system); 10K:1 for a single acquisition	7.5M (system); 10K:1 for a single acquisition	100K (system); 7.5K:1 for a single acquisition	500K (system); 7.5K:1 for a single acquisition
Integration time:	1 ms-2 s	1 ms-1 s	1 ms – 30 ms	1 ms-60 ms
Noise Equivalent Power:	5.0pW	10.0pW	100.0pW	25.0pW
Electronics				
Power consumption:	USB power +5V, 0.5 A maximum; DC input jack +5V, 3 A maximum	USB power +5V, 0.5 A maximum; DC input jack +5V, 3 A maximum	USB power +5V, 0.5 A maximum; DC input jack +5V, 3 A maximum	USB power +5V, 0.5 A maximum; DC input jack +5V, 3 A maximum
Data transfer speed:	Full scan to memory every 5 ms with USB 2.0 port	Full scan to memory every 5 ms with USB 2.0 port	Full scan to memory every 5 ms with USB 2.0 port	Full scan to memory every 5 ms with USB 2.0 port
Inputs/outputs:	External trigger input + single strobe output	External trigger input + single strobe output	External trigger input + single strobe output	External trigger input + single strobe output
Breakout box compatibility:	Yes	Yes	Yes	Yes
Gated delay:	Yes, with external hardware trigger delay	Yes, with external hardware trigger delay	Yes, with external hardware trigger delay	Yes, with external hardware trigger delay
Connector:	30-pin connector	30-pin connector	30-pin connector	30-pin connector
Temperature and Thermoelectric Cooling				
Temperature limits (environmental):	10-35 ºC (0-90% non-condensing)	10-35 ºC (0-90% non-condensing)	10-35 ºC (0-90% non-condensing)	10-35 ºC (0-90% non-condensing)
TEC setpoint (software controlled):	Control at -20 ºC (up to 45 ºC below ambient)	Control at -20 ºC (up to 45 ºC below ambient)	Control at -20 ºC (up to 45 ºC below ambient)	Control at -20 ºC (up to 45 ºC below ambient)
TEC stability:	'+/-0.5 ºC of set temperature in <1 minute; typical long-term stability +/-0.1 ºC	'+/-0.5 ºC of set temperature in <1 minute; typical long-term stability +/-0.1 ºC	+/-0.5 ºC of set temperature in <1 minute; typical long-term stability +/-0.1 ºC	'+/-0.5 ºC of set temperature in <1 minute; typical long-term stability +/-0.1 ºC

NIRQuest Spectrometers

Optical Bench Options for Your Custom NIRQuest Spectrometer

Each NIRQuest® model is available as a standard configuration comprising some combination of InGaAs array detector, grating, order-sorting filter and 25 µm slit. In addition, you can customize your NIRQuest by mixing and matching optical bench accessories with the assistance of an Ocean Optics Applications Scientist. Here are your options:

Detectors

Each NIRQuest Spectrometer uses a different Hamamatsu InGaAs-array detector and comes with a preconfigured combination of that detector and optical bench components. If you wish to customize your setup – for example, change the slit size – you'll need to itemize the components, beginning with these detector options:

Item	Description
NQ256-2.1	NIR Spectrometer, 900-2100 nm, 256-element InGaAs array
NQ256-2.5	NIR Spectrometer, 900-2500 nm, 256-element InGaAs array
NQ512-XR	NIR Spectrometer, 800-1600 nm, 512-element InGaAs array
NQ512	NIR Spectrometer, 900-1700 nm, 512-element InGaAs array
NQ512-1.9	NIR Spectrometer, 1100-1900 nm, 512-element InGaAs array
NQ512-2.2	NIR Spectrometer, 900-2200 nm, 512-element InGaAs array
NQ512-2.5	NIR Spectrometer, 900-2500 nm, 512-element InGaAs array

Fixed Entrance Slits

Our entrance slits are rectangular apertures that are 1 mm tall and come in various widths. The standard NIRQuest configuration has a 25 µm slit. Here are your other options:

Slit	Description	Pixel Resolution (approximate), by Model	
		NIRQuest512 Models	NIRQuest256 Models
SLIT-10	10 µm width x 1 mm height	1.3 pixels	1.5 pixels
SLIT-25	25 µm width x 1 mm height	2.0 pixels	1.7 pixels
SLIT-50	50 µm width x 1 mm height	2.3 pixels	2.0 pixels
SLIT-100	100 µm width x 1 mm height	4.2 pixels	2.5 pixels
SLIT-200	200 µm width x 1 mm height	7.9 pixels	4.0 pixels

Order-sorting and Longpass Filters

Order-sorting filters and longpass filters are installed in the optical bench. Order-sorting filters are standard with all NIRQuest models except the NIRQuest512. For custom NIRQuest orders, you'll need to specify the appropriate OSF filter (see table). The OF1-RG830 is a longpass filter recommended for custom configurations with Grating NIR1, Grating NIR2 or Grating NIR3 (with an NQ512 Spectrometer). OF1-RG830 is not recommended in setups with a 10 µm slit.

Item	Description
OSF-NIRQUEST256-2.1	Order-sorting filter, installed, for custom NIRQUEST256-2.1 configurations
OSF-NIRQUEST256-2.5	Order-sorting filter, installed, for custom NIRQUEST256-2.5 configurations
OSF-NIRQUEST512-xx	Order-sorting filter, installed, for custom NIRQUEST512 configurations; contact an Applications Scientist for details
OF1-RG830	Longpass filter, installed, transmits >830 nm; recommended for custom NIR-Quest configurations with Grating NIR1, Grating NIR2 or Grating NIR3

NIRQuest Spectrometers

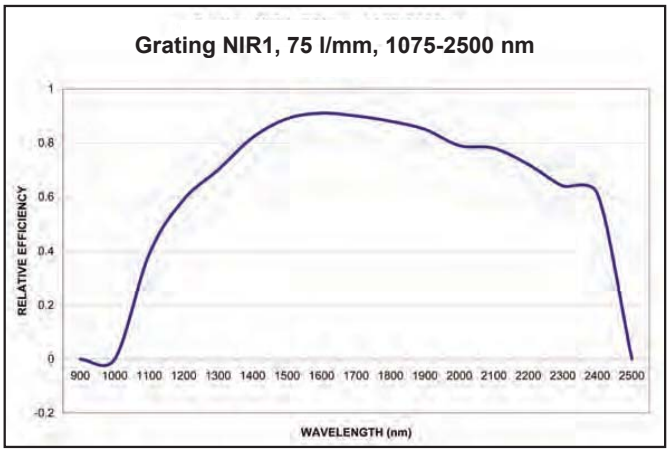
Choosing the Right Grating

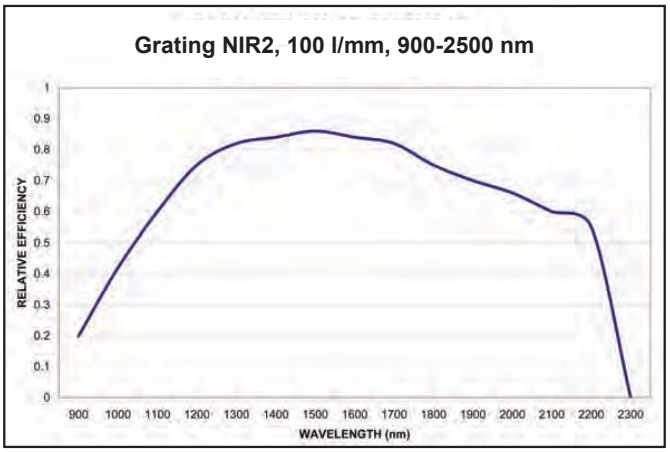
Grating Options

Customized NIRQuest Spectrometers are available with a choice of multiple gratings. With each grating, you consider its groove density (which helps determine the resolution), its spectral range (which helps determine the wavelength range) and its blaze wavelength (which helps determine the most efficient range).

Grating	Intended Use	Groove Density (lines/mm)	Spectral Range	Blaze Wavelength	Best Efficiency (>30%)
NIR1	NIRQuest256-2.5	75	1600 nm	1700 nm	1075-2500 nm
NIR2	NIRQuest256-2.1, NIRQuest256-2.5, NIRQuest512-2.2	100	1200 nm	1600 nm	900-2050 nm
NIR3	NIRQuest256-2.1, NIRQuest256-2.5, NIRQuest512, NIRQuest512-1.9, NIRQuest512-2.2, NIRQuest512-XR	150	~800 nm	1100 nm	900-1700 nm
NIR10	NIRQuest256-2.1, NIRQuest256-2.5, NIRQuest512, NIRQuest512-1.9, NIRQuest512-2.2, NIRQuest512-XR	300	350-380 nm	1200 nm	750-2200 nm
NIR11	NIRQuest256-2.1, NIRQuest256-2.5, NIRQuest512, NIRQuest512-1.9, NIRQuest512-2.2, NIRQuest512-XR	400	240-290 nm	1600 nm	980-2500 nm
NIR12	NIRQuest256-2.1, NIRQuest256-2.5, NIRQuest512, NIRQuest512-1.9, NIRQuest512-2.2, NIRQuest512-XR	500	160-220 nm	1370 nm	900-2500 nm
NIR13	NIRQuest256-2.1, NIRQuest256-2.5, NIRQuest512, NIRQuest512-1.9, NIRQuest512-2.2, NIRQuest512-XR	600	100-180 nm	1200 nm	800-2500 nm
NIR14	NIRQuest512, NIRQuest512-1.9, NIRQuest512-XR	1000	50-90 nm	1310 nm	900-1700 nm

Additional grating options, adjustments to starting and ending wavelengths and similar customization may be available. Also, spectral range can vary by starting wavelength. With the exception of NIRQuest512-XR, starting wavelengths should be set at ≥ 900 nm. Please contact an Applications Scientist for details.





For more grating curves, see next page.

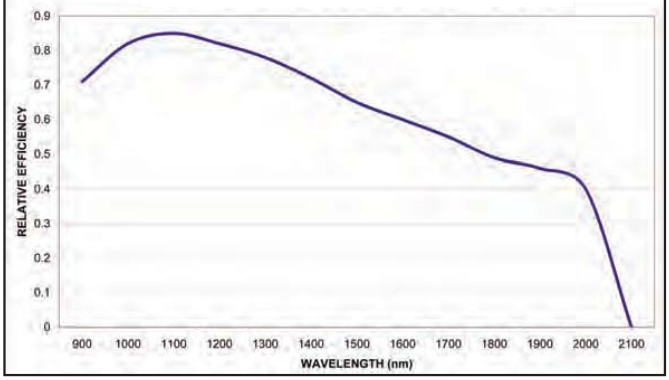
Technical Tip

Gratings and slits are fixed in place and can only be replaced at our manufacturing facility. That's why it's important to consider all the variables involved in system performance, including detector and grating response, slit size and other bench accessories. Our Applications Scientists have configured thousands of spectrometers for all sorts of applications and can offer invaluable consultation as you consider your application.

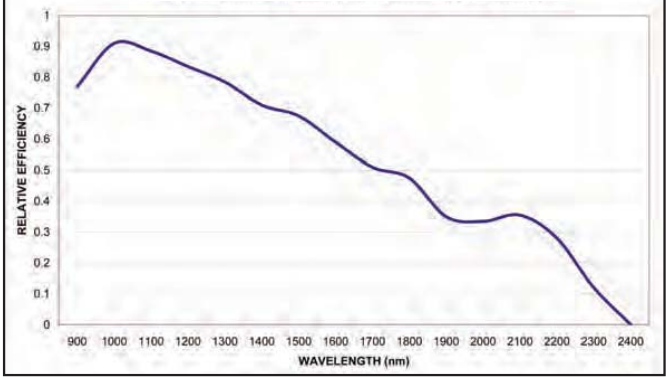
NIRQuest Spectrometers

NIRQuest Grating Efficiency Curves

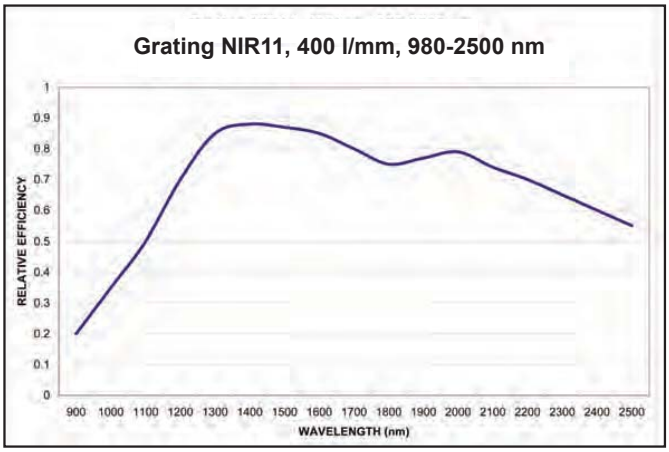
Grating NIR3, 150 l/mm, 900-1700 nm



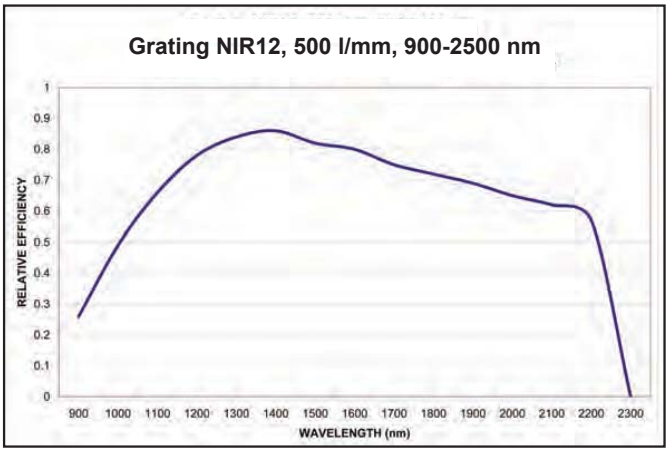
Grating NIR10, 300 l/mm, 750-2200 nm



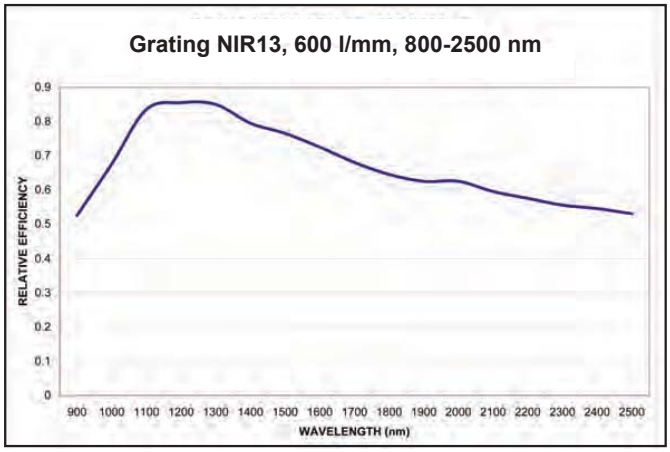
Grating NIR11, 400 l/mm, 980-2500 nm



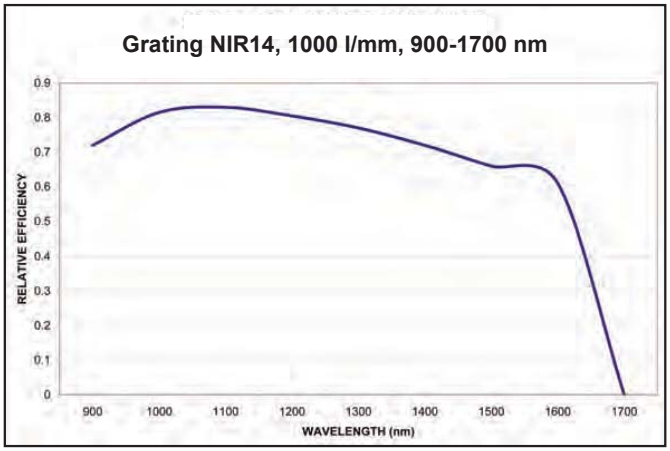
Grating NIR12, 500 l/mm, 900-2500 nm



Grating NIR13, 600 l/mm, 800-2500 nm



Grating NIR14, 1000 l/mm, 900-1700 nm

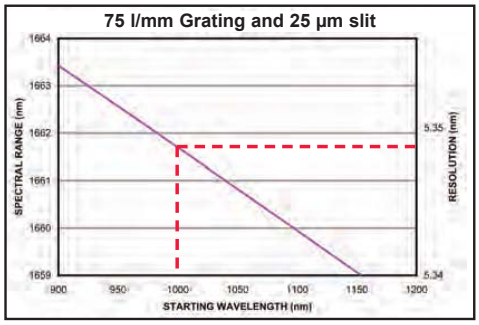


NIRQuest User-Configured Spectrometers

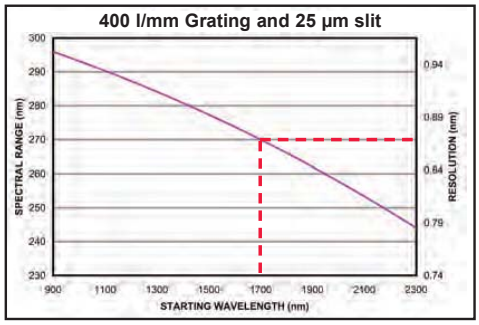
Predicted Ranges and Resolution

Predicted Ranges and Resolution

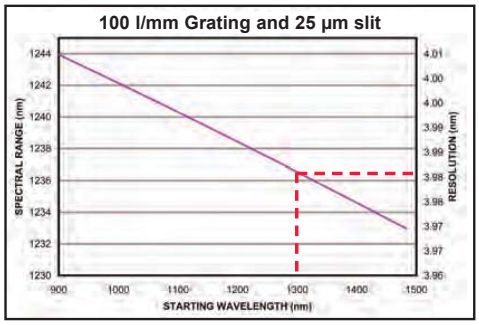
These graphs demonstrate the range and resolution of a NIRQuest512 model spectrometer with a 25 µm slit.



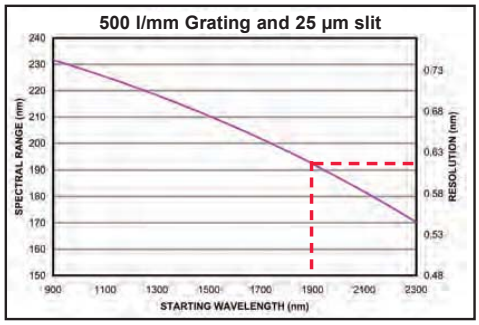
Example:
If the starting wavelength is 1000 nm, then the range is ~1662 nm, providing a 1000-2662 nm wavelength range and 5.34 nm resolution.



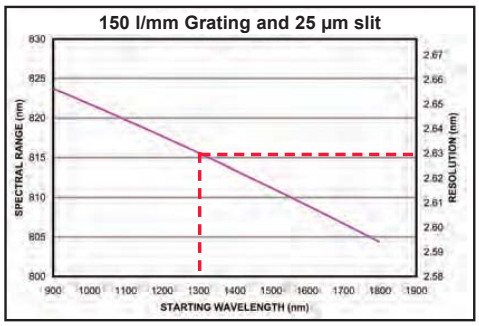
Example:
If the starting wavelength is 1700 nm, then the range is ~270 nm, providing a 1700-1970 nm wavelength range and 0.85 nm resolution.



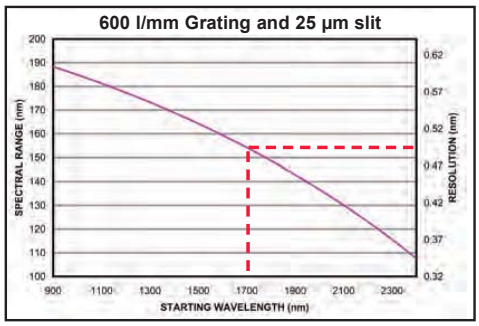
Example:
If the starting wavelength is 1300 nm, then the range is ~1236 nm, providing a 1300-2536 nm wavelength range and 3.98 nm resolution.



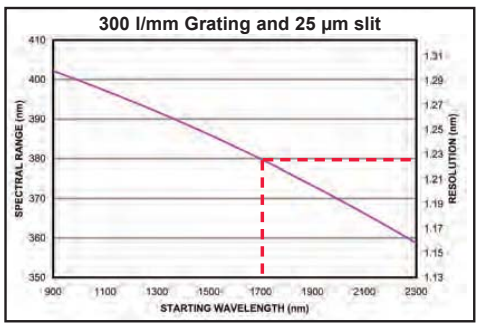
Example:
If the starting wavelength is 1900 nm, then the range is ~192 nm, providing a 1900-2092 nm wavelength range and 0.62 nm resolution.



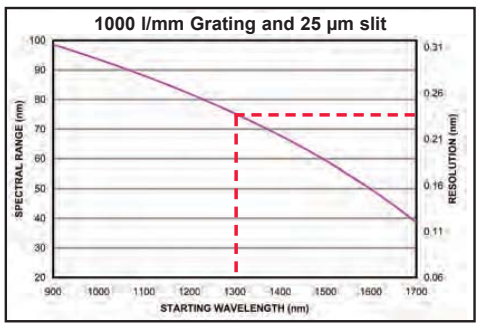
Example:
If the starting wavelength is 1300 nm, then the range is ~815 nm, providing a 1300-2115 nm wavelength range and 2.63 nm resolution.



Example:
If the starting wavelength is 1700 nm, then the range is ~154 nm, providing a 1700-1854 nm wavelength range and 0.49 nm resolution.



Example:
If the starting wavelength is 1700 nm, then the range is ~380 nm, providing a 1700-2080 nm wavelength range and 1.23 nm resolution.



Example:
If the starting wavelength is 1300 nm, then the range is ~74 nm, providing a 1300-1374 nm wavelength range and 0.24 nm resolution.

Application Notes

High-resolution NIR Analysis

New detector and optical bench options make it possible to configure near-infrared spectrometer setups for high-resolution applications such as laser and optical fiber characterization. Our NIRQuest Series spectrometers cover various segments of the 900-2500 nm region and serve a variety of application needs.

Introduction

Near-infrared spectroscopy is a common analytical technique for chemistry and process control, where typical applications include identification of species and determination of water and fat content. In applications like those, absorbance peaks are often broad and optical resolution requirements of lesser concern than performance parameters such as low noise and high sensitivity.

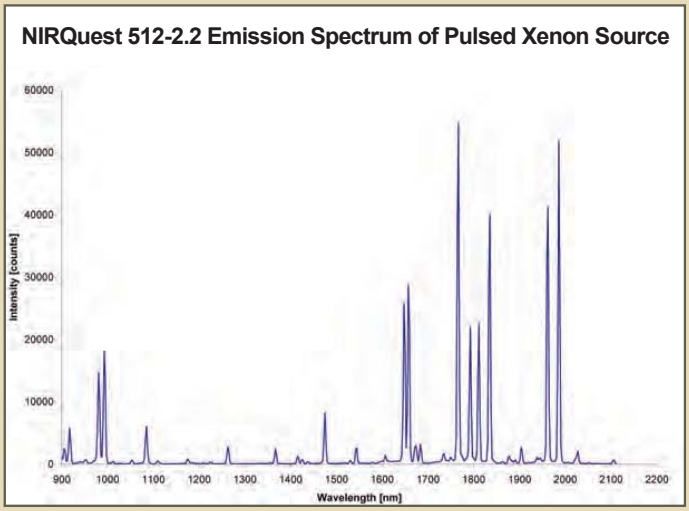
Yet there also are a number of NIR applications where optical resolution of <5.0 nm (FWHM) or better is critical. Characterization of laser lines – including, for example, solid state lasers at <1064 nm and at wavelengths from 1020-1050 nm, as well as semiconductor lasers with response in the 900-1800 nm range – often require even better optical resolution. Optical fiber characterization is another high-resolution NIR application.

Experimental Conditions

To test the optical resolution performance of our NIRQuest512-2.2 Spectrometer, which has a Hamamatsu G9206-512W InGaAs-array detector and is responsive from 900-2200 nm, we measured the spectrum of a xenon source used for spectrometer wavelength calibration. The low-pressure gas-discharge source has a number of closely aligned emission lines in the region from ~820-2000 nm, making it a good choice for our experiment.

The NIRQuest512-2.2 was configured with a 100 lines/mm grating set to 900-2050 nm, with a 25 µm slit and gold-coated collimating and focusing mirrors for enhanced reflectivity. This is the standard bench configuration for the NIRQuest product line, which includes models for 900-1700 nm, 900-2050 nm, 900-2200 nm and 900-2500 nm. Additional grating options and slit sizes are available for custom setups.

We used a 50 µm VIS-NIR optical fiber to collect signal from the xenon source. (For optimum results, we recommend the use of a 50 µm diameter or smaller optical fiber with all of our spectrometer wavelength calibration sources.) NIRQuest512-2.2 integration time was set to 350 ms and spectral averaging set to 5.



The closely aligned peaks of a xenon source used for spectrometer wavelength calibration can be distinguished with the high-resolution NIRQuest NIR spectrometer.

Results

The spectrum from the xenon calibration source illustrates that optical resolution of ~4.6 nm (FWHM) is possible with the NIRQuest512-2.2 in its standard configuration (above). What's more, even better optical resolution is possible in a NIRQuest512-2.2 configured with a grating that has a narrower spectral bandwidth. For example, a NIRQuest512-2.2 with a 600 l/mm grating set over a 100-nanometer bandwidth and configured with a 25 µm slit would yield optical resolution of <0.5 nm (FWHM). Resolution would improve even more with a 10 µm slit, but at the expense of throughput. For most laser applications, that's likely to be an acceptable trade-off.

Conclusions

New NIR detectors and optical bench options allow researchers to experience high optical resolution performance in the region from 900-2500 nm. This elevates the versatility of smaller footprint, more modular NIR spectrometers for applications previously thought to be out of reach.

In addition, NIRQuest has external hardware triggering functions that allow users to capture data when an external event occurs, or to trigger an event after data acquisition. This can be especially useful for synchronizing a laser event to spectral acquisition and for capturing data from automated processes or from devices that flash synchronously.