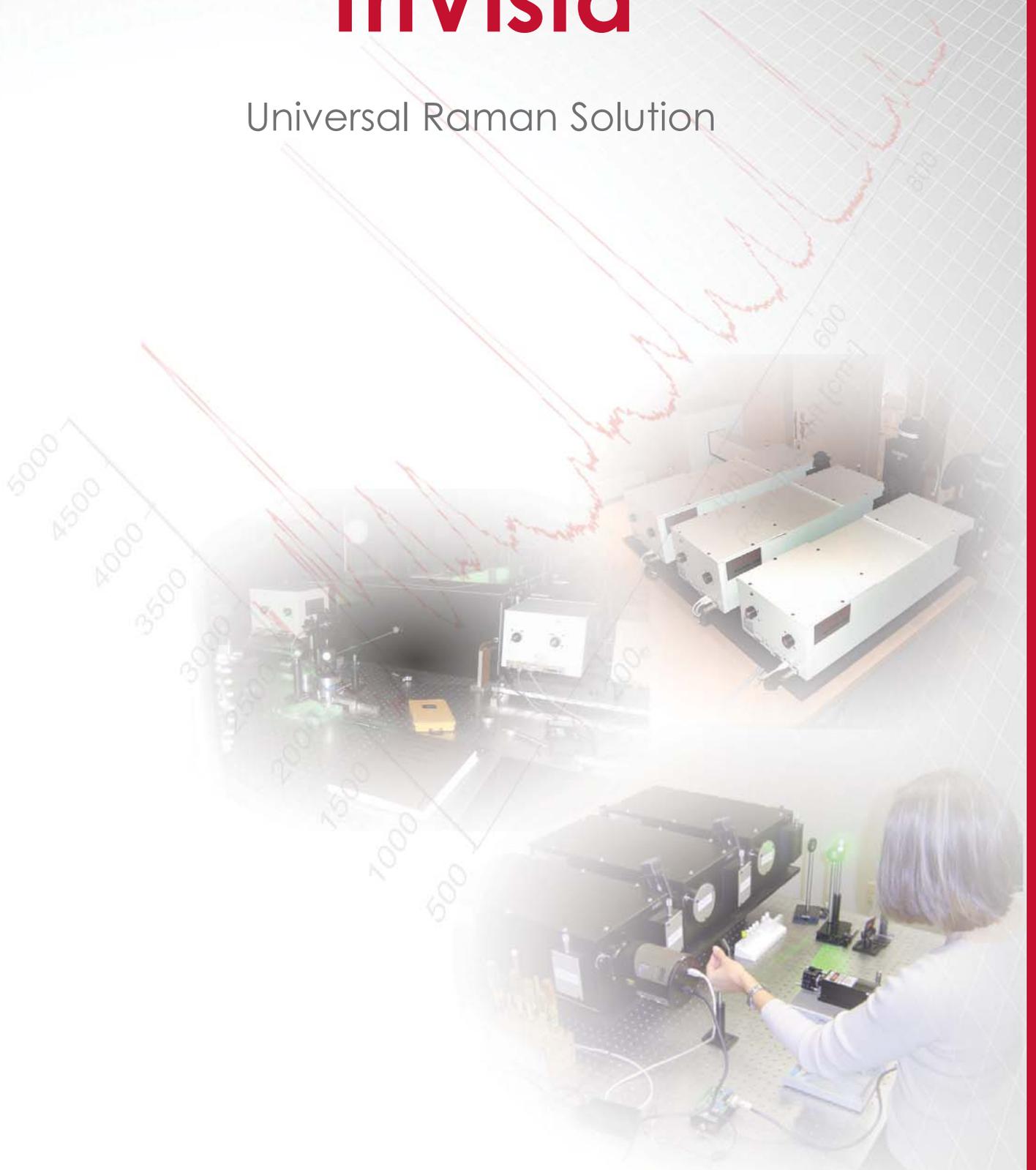


Princeton Instruments

ACTON

TriVista

Universal Raman Solution



Why choose the Princeton Instruments/Acton TriVista?

Overview

Raman Spectroscopy systems can be derived from several dispersive components depending on the level of performance required. For many applications the common notch filter spectrometer arrangement can be used successfully, but for higher performance or unmatched flexibility the triple spectrometer is the most effective tool. Notch filter/ Single Spectrometer arrangements are acceptable for routine measurements. However, even with the best notch filters; the accepted low frequency limitation is around 50-100 cm^{-1} from the Raleigh line in the visible/NIR. When higher performance in the form of better stray light rejection or the ultimate in resolution is required, the triple spectrometer is the only solution.

Low Frequency Raman Bands are Measurable as Close as 5cm^{-1} to the Laser Line

The stray light rejection of the TriVista in triple subtractive mode enables low frequency measurements down to as close as 5cm^{-1} to the Raleigh line. The resolution of the TriVista in triple additive mode allows for spectral resolutions of 0.008nm (0.22cm^{-1}) @ 600nm with three 1800 g/mm gratings. Even higher resolutions are attainable using higher groove density gratings. The TriVista 777 has the highest resolution of any commercially available triple spectrometer in both additive and subtractive mode.

Flexibility Redefined

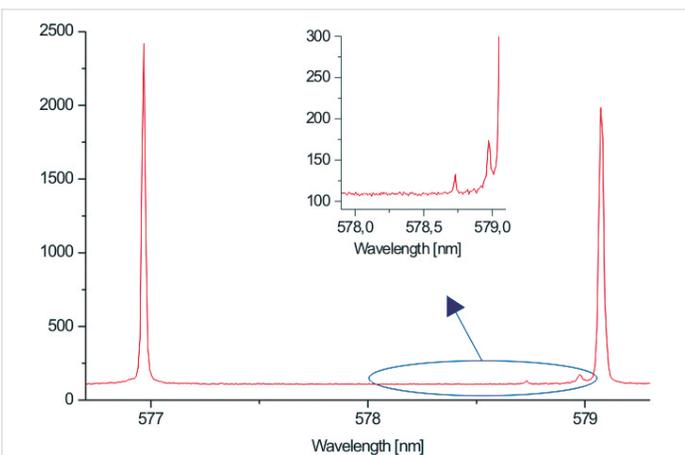
The TriVista is *the* most flexible triple spectrometer commercially available. Its thoughtful design

enables a wide variety of spectroscopy experiments from UV Raman to photoluminescence to be accessible at the one time. This is due to the TriVista's unique feature that all three stages can be operated independently. Each experiment can be accessed by a simple mouse-click through an intuitive software interface which also incorporates a powerful EasySwitch feature (patent pending) to switch between additive and subtractive modes. Easy reconfiguration is possible as a single, double spectrometer or several combinations thereof without removing any of the components from the pre-aligned baseplate.

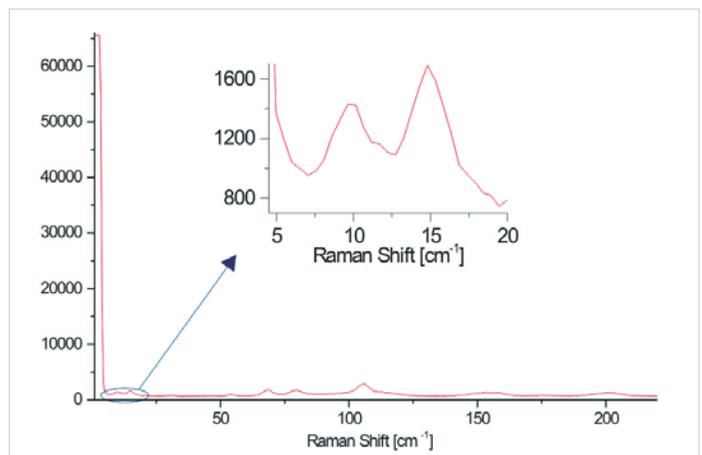
The use of multiple laser wavelengths makes the TriVista a cost effective flexible tool for any Raman or multiexperiment lab. Consider the investment in several notch filters, which will need to be replaced in time, vs. the inherent tuneability of a triple spectrometer, which will give you many years of stable performance.

The Highest Signal-to-Noise Ratio Commercially Available

Triple spectrometers are generally known as being less efficient than single stage spectrometers due to the additional optical surfaces. Although this is true, PI/Acton proprietary coating technology aides in recovering some of that lost light. PI/Acton's enhanced reflective coatings help achieve higher light throughput and greater overall system efficiency; especially in multiple reflection optical systems. In spectroscopy, higher throughput results in superior detection capabilities.



TriVista offers excellent spectral resolution in additive mode.*



Suberb Stray Light Rejection in Subtractive Mode*

*Data taken with TriVista 555.

Unbeatable Precision and Accuracy

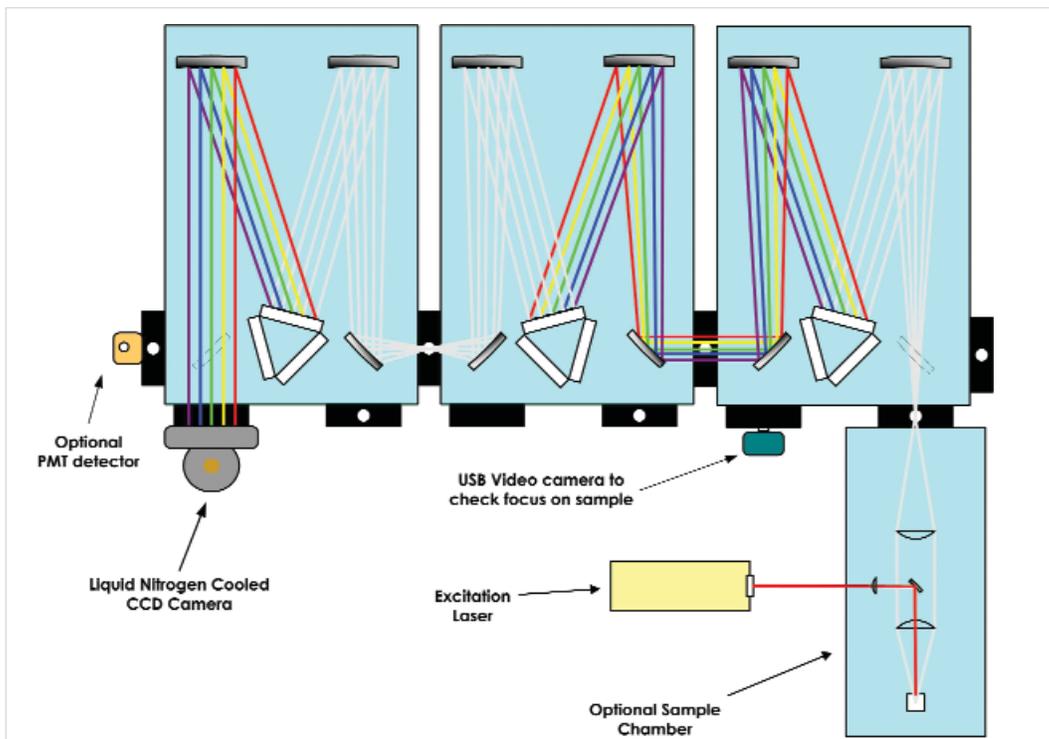
The TriVista uses cutting edge technology to deliver performance and flexibility unmatched in the industry; a true research grade instrument! Direct drive technology provides the ultimate in precision movement while rigid construction provides the rock solid accuracy and repeatability our customer has come to expect.

Unmatched Performance

At the heart of TriVista, is the industry leading Princeton Instruments/Acton SpectraPro series spectrometers. They are known for superb resolution, stray light suppression, excellent imaging and ruggedness. The TriVista can operate from 200 nm up to 2.2 μ m. Spectral resolution can be as low as 3 picometers over the entire range. Extreme stray light rejection allows Raman spectra to be captured as close as 5 wavenumbers from the Rayleigh line.

Features and Benefits at a Glance

Extreme stray light rejection	Allows detection of low frequency Raman bands.
Uncomparable resolution	Minute structural changes can be investigated
Modular design, operates as three individual spectrometers or as combinations of single and double spectrometers	Easy configuration for multiple applications
Proprietary ARC2000 coating provides 3%-7% more reflectivity PER OPTIC than any other system.	Higher throughput resulting in superior detection capabilities.
Integrated operation through intuitive, yet powerful software interface	Easy experimental set-up, faster results. Easy switching between additive and subtractive modes.
Multiple entrance and exit options	Allows connection to a large range of available accessories and detectors.
Offered with standard 0.5 meter or 0.75 meter configuration	Choice of systems to suit experimental requirements



Typical Experimental Setup

Additive and Subtractive modes of TriVista

The TriVista spectrometer can be used in single, double and triple configurations. Single configuration (Fig 1A) means all three stages can be used simultaneously and independently for three different projects. Typically, the TriVista is utilized as a double or triple system (Fig 1B, C) when the light beam is passed sequentially through 2 or 3 stages and the gratings coherently move together with very high precision. Some common reasons researchers choose a double or triple system are the high spectral resolution and the high stray light rejection. These important parameters can be accomplished by utilizing different modes of TriVista operation:

1. Additive mode gives high spectral resolution and high linear dispersion.
2. Subtractive mode gives high stray light rejection.

Easy Switch between Additive and Subtractive Modes

The TriVista software enables the user to switch between additive and subtractive modes with ease. This is accomplished by changing the direction of grating's rotation. In additive mode both gratings G_1 and G_2 synchronously rotate clockwise adding dispersion to each other. In subtractive mode grating G_1 rotates clockwise but the grating G_2 synchronously rotates counter-clockwise precisely canceling dispersive action of the grating G_1 .

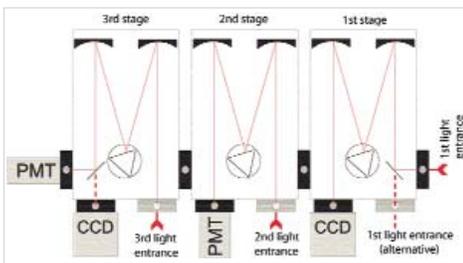


Figure 1A

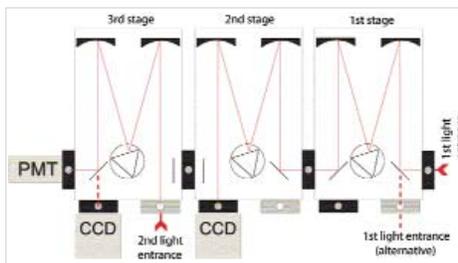


Figure 1B

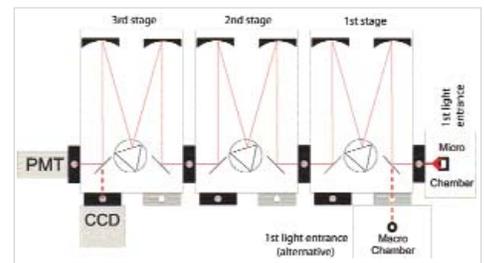
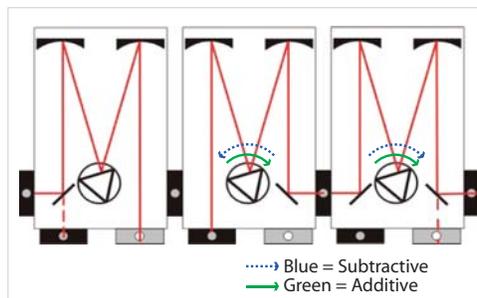


Figure 1C



EasySwitch feature

Results accomplished with each mode of operation

Modes	Double Additive	Double Subtractive	Triple Additive	Triple Subtractive
Primary effect	High resolution	High stray light rejection	Best resolution	Best stray light rejection
Sec. effect	High stray light rejection (with PMT and narrow slit $S_{2,3}$)	-	High stray light rejection (with PMT and narrow slit $S_{2,3}$)	-
CCD	Y	N	Y	Y
PMT	Y	Y	Y	Y

Additive mode

In this mode, the gratings on all 3 stages contribute to positive light dispersion (Fig. 2A). Polychromatic light enters the first stage of the instrument through the slit S_1 . Grating G_1 disperses the light. Slit $S_{1,2}$ acts as a bandpass filter, as it passes through only a narrow portion of the spectrum which is further dispersed on the grating G_2 . Light passing through the slit $S_{2,3}$ is dispersed for a third time on the grating G_3 and is projected on detector D. The dispersion of the TriVista in additive mode is defined by adding dispersions of each stage. If all three stages have the same gratings and focal lengths the dispersion simply equals the dispersion of any single stage. Let us consider the TriVista555 as an example where the focal length for all three stages equal 500 mm and 1200 g/mm gratings are used on each stage. A single 500 mm stage with 1200 g/mm grating has a nominal linear dispersion of 1.7 nm/mm. In the triple configuration, additive mode linear dispersion of TriVista555 is approximately equal to 0.5 nm/mm for the center of the visible spectral range. When working with a PMT, slit $S_{2,3}$ can be kept as narrow as 10 microns, Providing the ability to achieve high resolution and high stray light rejection simultaneously.

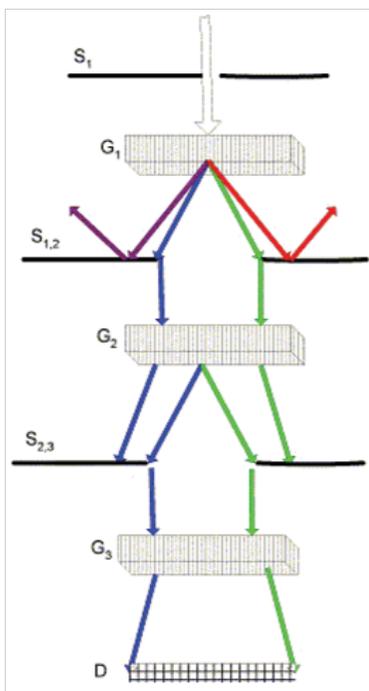


Figure 2A

Subtractive mode

Excellent stray light rejection with a CCD detector can be achieved when subtractive mode is used. In this mode, the first and the second stages of spectrometer work as a tunable bandpass filter, cutting out a desirable portion of spectrum and projecting it onto the CCD (Fig. 2B). Polychromatic light enters the first stage through the entrance slit S_1 and is dispersed by the grating G_1 . Slit $S_{1,2}$ again acts as a bandpass filter passing only the light between wavelengths λ_1 and λ_2 . The grating G_2 recombines all the dispersed light and focuses it into the middle of the slit $S_{2,3}$, reproducing the polychromatic light limited to the spectral range between wavelengths λ_1 and λ_2 . Grating G_3 disperses this light and projects it onto the detector. Slit $S_{1,2}$ in subtractive mode is usually relatively wide opened to allow a desirable spectral range λ_1 - λ_2 to pass through. But the slit $S_{2,3}$ is normally very narrow which assures high stray light rejection. Gratings G_1 and G_2 in subtractive mode must match in groove density and therefore their dispersion actions totally cancel each other. They act as a very sharp bandpass filter allowing for Raman measurements very close to the laser line. In this sense, spectral resolution of the TriVista is entirely defined by the spectral resolution of the third stage depending on slit $S_{2,3}$ width, grating G_3 groove density and the third stage focal length. It is possible to use either a CCD or a PMT detector with the TriVista in subtractive mode. However, the CCD is preferred due to the reduced time required to take measurements.

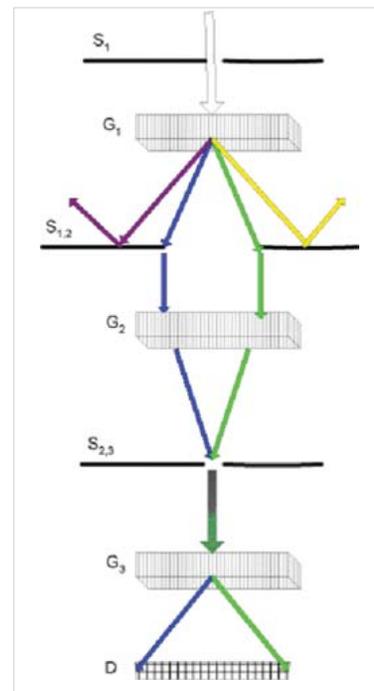


Figure 2B

Operational

Software

“Ease of use” further sets the TriVista apart from other triple spectrometer designs. Both beginners and expert users appreciate the intuitive, yet powerful interface of the TriVista software. It is based on the renowned Princeton Instruments’ WinSpec and gives full control over the spectrograph calibration, grating selection and motion, as well as operation of Princeton Instruments CCD detectors and Acton Research SpectraHub for single point detectors. The individually optimized calibrations can be stored and recalled for every possible spectrometer configuration. Multiple levels of software control, user level with full control of the system and easily reversible calibration control, and a more advanced supervisor control with full control over the system.

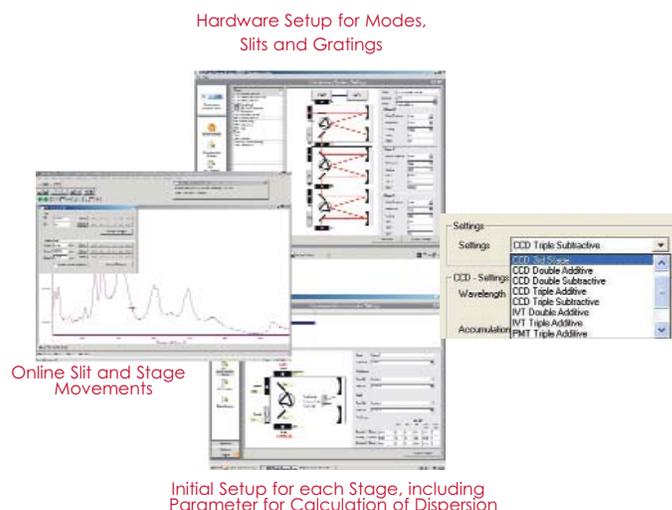


Figure 5: Easy to use software gives full control over TriVista and detector operation

Expertise YOU Can Count On

The TriVista is designed by spectroscopists with years of experience creating custom solutions. Our application scientists are eager to discuss your individual experiment needs and suggest the optimum system configuration. Whether it is the

selection of appropriate gratings to optimize spectral resolution and coverage or the choice of detectors and accessories, you can rely on our team of experts to design the proper system to meet your application needs.

Accessories

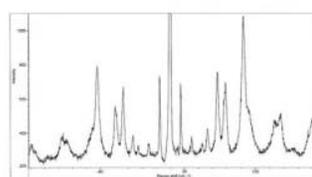
Sample Chambers

An analytical, multipurpose sample chamber is available for use with liquid, gas or solid samples. Features include x, y, z sample movement, multipass mirrors, retro collecting mirrors, f/2 UV entrance optics, holder for polarizers, analyzer interference filters, scramblers, quarter-wave plates, holographic notch filters, iris and slit option for stray light suppression and a goniometry head option.



Stokes/Anti-Stokes

A Stokes/Anti-Stokes accessory is available for the TriVista, which is designed to allow low frequency measurements of both Stokes and Anti-Stokes data. The interchangeable stop allows for maximum throughput, rejection, or no rejection. For even more flexibility, there are a variety of stop plates included with the Stokes/Anti-Stokes accessory.



Modes and Specs

Mode of Operation: Subtractive
Detector Used: Spec-10 Camera with 20 µm Pixel (Spec-10:100 or 400)

Gratings in Subtractive 2nd Stage	Grating in Spectrograph Stage	Total CCD coverage	Total CCD coverage	Bandwidth per 20 µm CCD pixel	Bandwidth per 20 µm CCD pixel	Min. Distance to Rayleigh line
(l/mm)	(l/mm)	(cm ⁻¹)	(nm)	(cm ⁻¹)	(nm)	(cm ⁻¹)
900	900	860	25	1.445	0.036	12
900	1800	550	10.5	0.6	0.018	10
1800	1800	370	10.5	0.6	0.018	8
1800	2400	370	10.5	0.4	0.011	4

Mode of Operation: Additive
Detector Used: Spec-10 Camera with 20 µm Pixel (Spec-10:100 or 400)

Gratings in Subtractive 2nd Stage	Grating in Spectrograph Stage	Total CCD coverage	Total CCD coverage	Bandwidth per 20 µm CCD pixel	Bandwidth per 20 µm CCD pixel	Min. Distance to Rayleigh line
(l/mm)	(l/mm)	(cm ⁻¹)	(nm)	(cm ⁻¹)	(nm)	(cm ⁻¹)
900	900	370	10.5	0.44	0.015	150
1800	1800	160	4	0.18	0.005	125
1800	2400	120	3	0.15	0.004	100

Mode of Operation: Additive
Detector Used: Single Point Detector

Gratings in Additive 2nd Stage	Grating in Spectrograph Stage	Resolution	Resolution	Min. Distance to Rayleigh line
(l/mm)	(l/mm)	(cm ⁻¹)	(nm)	(cm ⁻¹)
900	900	0.5	0.015	6
1800	1800	0.3	0.005	3
1800	2400	0.2	0.004	2

Aperture, Transmission, and Resolution

System	TriVista 555		TriVista 557		TriVista 777	
	additive	subtractive	additive	subtractive	additive	subtractive
Focal Length (mm)	1.500	500	1.750	750	2.250	750
No. of Mirrors	10	10	10	10	10	10
No. of Gratings	3	3	3	3	3	3
Grating Size (mm)	64 x 84	64 x 84	64 x 84	64 x 84	64 x 84	64 x 84
Transmission (%) (92% per mirror & 70% per grating)	15	15	15	15	15	15
Aperture	F/5.9	F/5.9	F/5.9	F/5.9	F/9.8	F/9.8
Resolution (nm) (1800 gr/mm, 10 µm slits, at 500 nm)	0.005	0.015	0.0046	0.010	0.0033	0.010
Resolution (cm ⁻¹) (1800 gr/mm, 10 µm slits, at 500 nm)	0.21	0.6	0.17	0.4	0.13	0.4

Overall Dimensions

TriVista 555: 3.23 ft long (985 mm) 1.97 ft wide (600 mm) 1.15 ft high (350 mm)
 TriVista 557: 3.44 ft long (1050 mm) 2.62 ft wide (800 mm) 1.15 ft high (350 mm)
 TriVista 777: 3.44 ft long (1050 mm) 2.62 ft wide (800 mm) 1.15 ft high (350 mm)

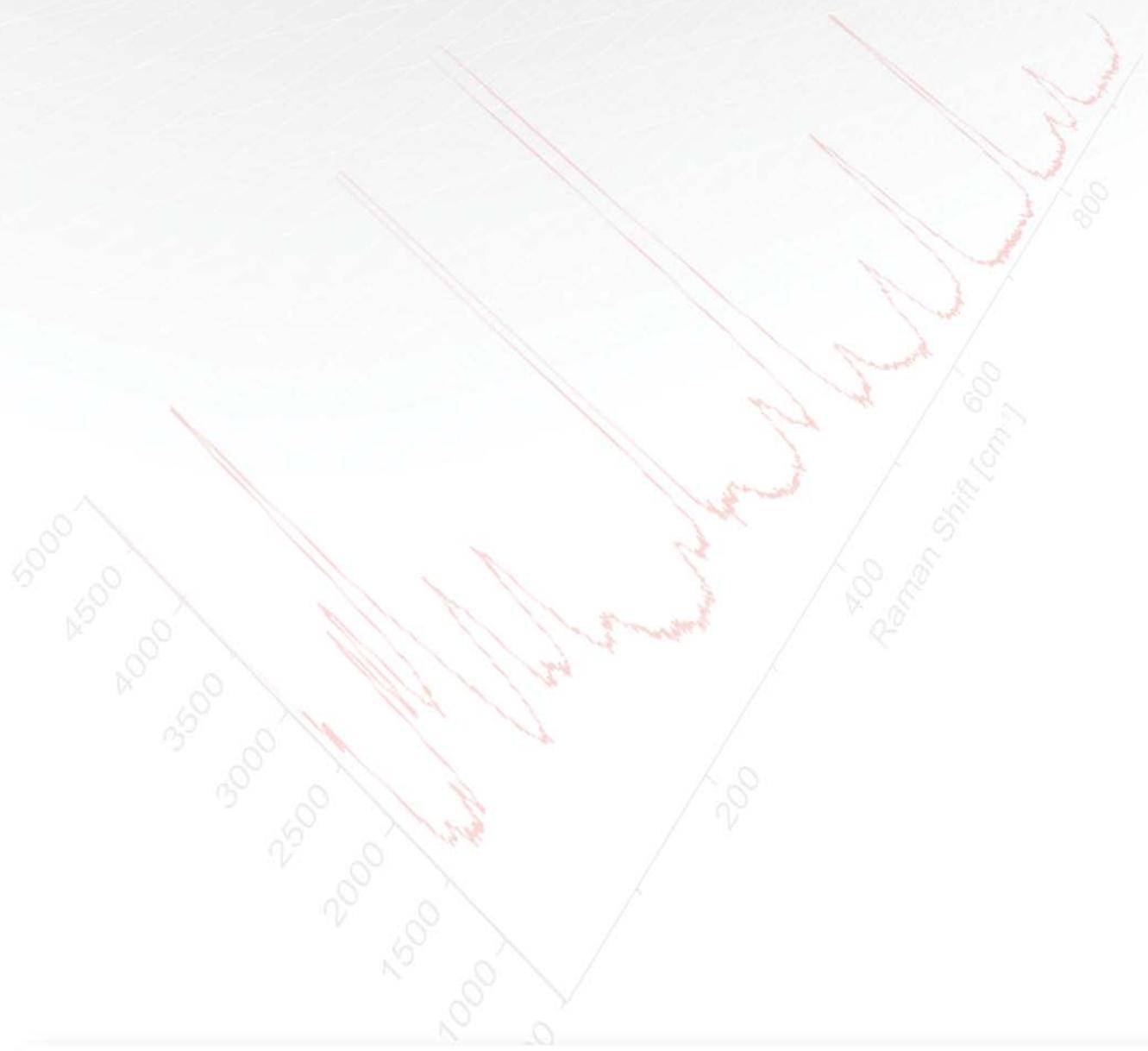
Weight

TriVista 555: ≈ 225 lbs (102 kg)
 TriVista 557: ≈ 250 lbs (113 kg)
 TriVista 777: ~ 300 lbs (136 kg)

Facilities

110 VAC @ 3 Amps max





Princeton Instruments



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