PRODUCT NOTE

FT-IR SPECTROSCOPY

Spectrum GX Systems

Introduction

The PerkinElmer® Spectrum™ GX systems set new performance standards for demanding problem solving and research and development applications. The advanced design has been proven in thousands of industrial and academic laboratories, offering the unsurpassed sensitivity and stability that's essential for solving the toughest analytical problems. With a huge range of accessories, options and upgrades providing multi-range and multi-beam capabilities, Spectrum GX systems make sure that you meet tomorrow's needs today.

Interchangeable optics for specialized configurations

Every Spectrum GX has fully upgradeable, interchangeable optics to provide optimized performance from the Near-IR right down to the Far-IR region. Spectrum GX systems also offer more combinations of sources, beamsplitters and detectors than any other FT-IR system, ensuring that you have the power to handle tomorrow's challenging applications as well as today's tough problems.

Key Features

- Patented Dynascan™ interferometer for best-in-class stability and sensitivity
- Multi-range operation – Near-IR/ Mid-IR/Far-IR
- Up to four equivalent output beams
- Real-time atmospheric vapor correction
- Absolute Virtual Instrument (AVI) operation reduces measurement variation
- Fully validated Spectrum software
- 21 CFR Part 11 technical compliance

Up to four equivalent output beams

Spectrum GX's unique modular design means that any system can be configured to accommodate a maximum of four equivalent output beams. Extra output beams and sampling modules can be added as requirements change. A huge range of optical components includes 10 different, interchangeable beamsplitters, 10 detector types and dual iris aperture pre-optics for fine control of energy throughput, beam profile and spectral resolution.

All sampling accessories will give optimum performance in any one of the four sample compartments. GX configurations can also include major accessories such as our FT-Raman module, IR microscopes and the GC-IR interface.

Built-in intelligence

Each Spectrum GX configuration is displayed in a simple, interactive layout within the Spectrum software program (Figure 1). This shows the status of all key system components – including sources, beamsplitters and detectors – and allows the beam path to be changed with a single mouse click. Internal accessories such as iris apertures, filters and polarizers are easily controlled and adjusted by simply clicking on the instrument layout.

Increased measurement consistency

Spectrum GX's sealed and desiccated optical bench protects moisture-sensitive internal components from damage. Spectrum software also includes PerkinElmer's unique algorithm that removes the effects of atmospheric absorptions from spectra in real time (Figure 2).

Unlike other approaches which rely on subtractions of stored spectra, PerkinElmer's AVC (atmospheric vapor correction) routine models the effect of water and carbon dioxide in the air in real time, ensuring that these absorptions are removed even as laboratory conditions change. Controlling this unwanted source of variation greatly increases measurement consistency.

Absolute Virtual Instrument

The patented Absolute Virtual Instrument (AVI) protocol further increases measurement consistency by standardizing data against small variations in band position and line shape. Although FT-IR spectrometers use a reference laser, the wave number calibration and line shape are affected by differences in beam divergence and uniformity. This is true for all

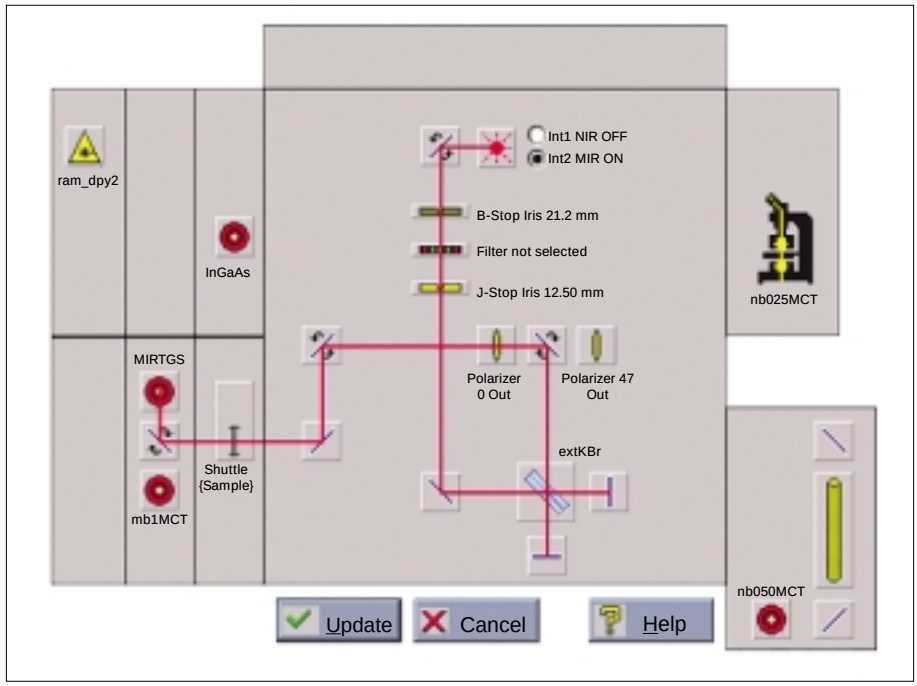


Figure 1. A multi-beam, multi-range configuration featuring a microscope, a GC-IR interface and a Raman accessory.

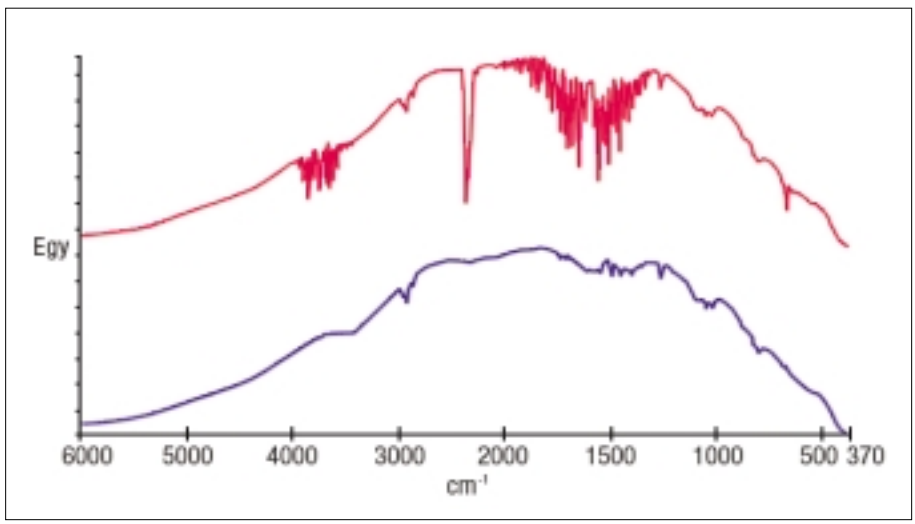


Figure 2. Background spectra with atmospheric vapor correction (lower spectrum) and without (upper spectrum).

FT-IR spectrometers. Differences can occur between instruments, when using different sampling accessories and when components are changed. AVI allows calibration and lineshape to be maintained. As an example, the use of AVI lowers the Standard Error of Prediction (SEP) for xylene concentration in the quantitative analysis of a liquid mixture (Figure 3).

Sample stations and accessories

- A **single sample compartment** with one or two detectors can be fitted to any port. Sample and detector areas are individually purgeable with quick-fit gas connectors. Far-IR sample compartments are sealed and desiccated.
- **Dual sample compartments** occupy both ports on either side of the optical unit. Each of the two compartments, which can be front or rear facing, can be fitted with one or two detectors.
- A **photoacoustic detector** can be mounted directly onto the base plate of any sample compartment. The scan speed of Spectrum GX systems can be varied in small steps, allowing depth-profiling of solid samples.
- **FT-IR microscope –** PerkinElmer's MultiScope™ and AutoIMAGE™ FT-IR microscopes can be mounted on any beam port. The MultiScope is a high-performance, low-cost problem solver which is equipped to handle a wide range of micro-samples in transmission, reflectance and Micro-ATR modes. For more demanding problem solving applications, the industry standard AutoIMAGE system (Figure 4) couples interactive multimedia technology with full automation and a high-throughput, permanently aligned optical design.

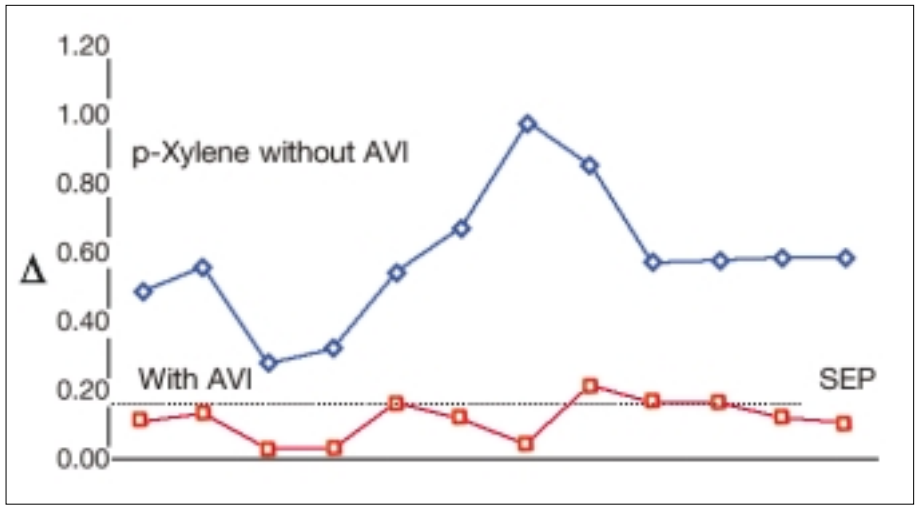


Figure 3. The AVI routine lowers the standard error of prediction in a quantitative analysis.

Figure 4. Spectrum GX system with AutoIMAGE microscope.

Spectrum software highlights

Sophisticated system diagnostics and status indicators monitor and display the status of all system components

Completely customizable screen layout adapts the user interface for individual users and analyses.

All data processing commands are fully validated. A CD containing details of all test protocols and results is available.

The Spectrum ES (Enhanced Security™) version provides technical compliance to the FDA's 21 CFR Part 11 regulations.

Set-up files and accessory configurator set all data collection parameters and hardware settings for any sampling accessory or application. For example, change from a Near-IR reflectance measurement to a Mid-IR microscopy analysis with a single mouse-click.

This simplifies operation and reduces analysis time. Both the MultiScope and AutoIMAGE systems can measure samples at a spatial resolution of better than 10 µm.

- A low-volume, light-pipe **GC-IR interface** can be fitted to occupy both ports on either side of the optical bench, or in a staggered configuration which occupies only one port.
- **Near-IR FT-Raman.** The high sensitivity Raman accessory is located on the rear left-hand side of the instrument and is available as a dedicated Raman spectrometer or a combined Raman/FT-IR instrument with up to three IR beam ports. The Raman accessory provides best-in-class sensitivity while the Near-IR operation reduces interference from fluorescence, extending the range of possible applications.

Outstanding performance

Spectrum GX systems incorporate technical innovation and attention to detail to ensure consistently high performance for the toughest applications. For example, key components are mounted on a cast aluminum, air damped, vibration isolated baseplate to provide immunity to mechanical and acoustic vibration as well as exceptional thermal stability. The temperature-stabilized, air-cooled Kanthal source provides highly stable IR output as well as long source life.

At the heart of the optical design is the patented Dynascan interferometer (Figure 5), which provides best-in-class stability, reliability and sensitivity. The balanced rotary mechanism is inherently stable, offers excellent vibration immunity and has no critical moving parts to wear out. It operates without the mirror tilt and shear that can cause poor short- and long-term stability (Figure 6) in conventional linear interferometer designs. Real-time dynamic alignment to correct for this tilt and shear is unnecessary in the Spectrum GX, simplifying the design and increasing reliability.

Different spectral ranges are easily accessible as beamsplitters are interchanged in seconds. Beamsplitter auto-recognition and rapid auto-alignment ensure that instrument parameters are automatically reset, making the system ready to use immediately after changeover.

Each Spectrum GX is rigorously tested to ensure that it meets or exceeds its guaranteed performance specifications. All Spectrum GX systems give signal-to-noise ratios of 45,000/1 rms, 9,000/1 p-p for a 5 second measurement and 180,000/1 rms, 36,000/1 p-p for a one minute measurement. Data is collected at 4 cm^{-1} spectral resolution with Beer-Norton apodization and the measurement time includes total scan and signal processing time. An example spectrum from an application that requires high sensitivity is shown in Figure 7.

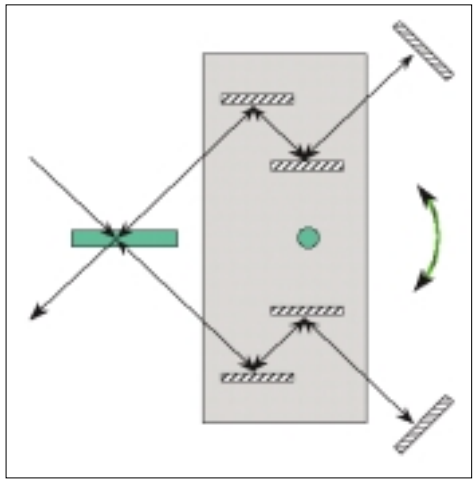


Figure 5. Spectrum GX's patented Dynascan interferometer.

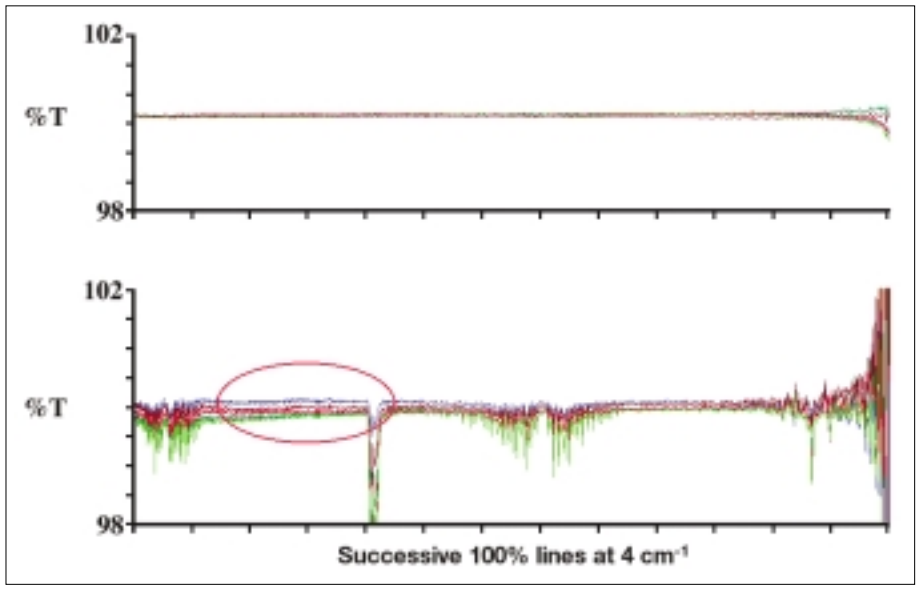


Figure 6. Successive 100% lines at 4 cm^{-1} show the excellent stability of the Spectrum GX (upper spectra) and the inherent drift associated with conventional linear interferometer designs (lower spectra). Note also the absence of atmospheric absorptions in the Spectrum GX data due to real-time correction.

Optical system

Sources

Mid/Far IR (10000 - 30 cm^{-1}), Near-IR (15000 - 1200 cm^{-1}) and dual (15000 - 30 cm^{-1}) internal sources. An additional port is available for external sources, emission measurements and Raman spectroscopy.

Beamsplitters

- Quartz Near-IR (15000 - 2700 cm^{-1})
- CaF_2 Near-IR (14000 - 1200 cm^{-1})
- Raman (12000 - 5000 cm^{-1})
- Wide-range KBr (10000 - 370 cm^{-1})
- Optimized KBr (7000 - 370 cm^{-1})
- Mid-IR CsI (6500 - 220 cm^{-1})
- Far-IR grid (720 - 30 cm^{-1})
- 6 micrometer Mylar film Far-IR (500 - 50 cm^{-1})
- 12 micrometer Mylar film Far-IR (250 - 30 cm^{-1})
- 25 micrometer Mylar film Far-IR (120 - 30 cm^{-1})

Detectors

- Narrow band InSb Near-IR (15000 - 3500 cm^{-1})
- InSb Near-IR (15000 - 1800 cm^{-1})
- FR-DTGS Near-IR (15000 - 2000 cm^{-1})
- FR-DTGS Mid-IR (KBr) (15000 - 370 cm^{-1})
- FR-DTGS Mid-IR (CsI) (15000 - 220 cm^{-1})
- FR-DTGS Far-IR (Poly) (720 - 30 cm^{-1})
- Narrow band MCT Mid-IR (10000 - 750 cm^{-1})
- Medium band MCT Mid-IR (10000 - 700 cm^{-1})
- Wide band MCT Mid-IR (10000 - 450 cm^{-1})

Image control system

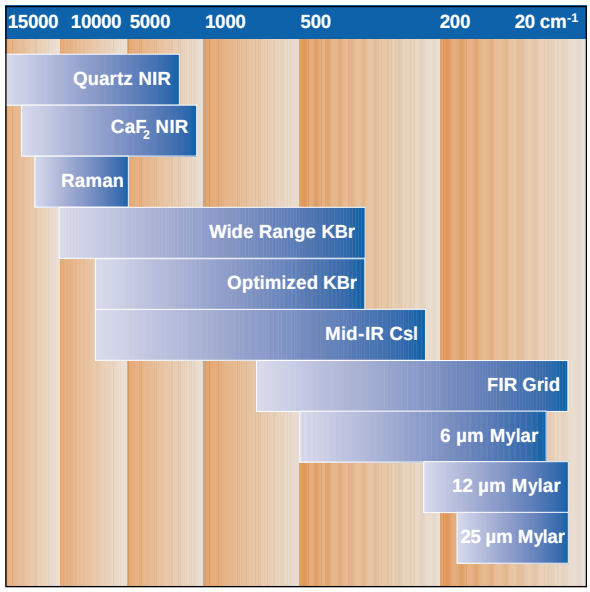
Fixed or software-controlled iris apertures available at B-stop and J-stop images.

- B-stop controls attenuation, keeping detector image size constant.
- J-stop controls beam divergence through the interferometer, allowing optimization of throughput for any resolution and range combination. Software controlled apertures may be adjusted in steps of 0.1 mm.

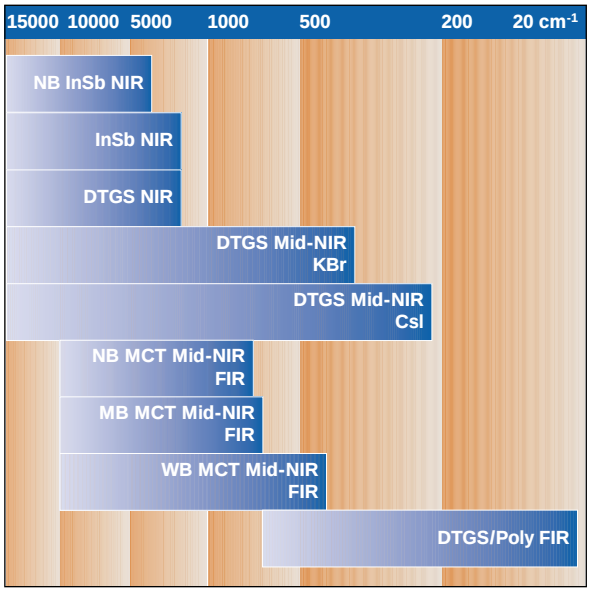
Optical accessories

Polarizers: KRS5 Mid-IR and polyethylene Far-IR wire grid polarizers can be fitted inside the optical unit. Software control of in/out and angle (±1˚).

Optical Filter Wheel: Up to seven filters to optimize signal-to-noise for specific ranges can be fitted to a software-controlled filter wheel.



Spectrum GX Beamsplitters



Spectrum GX Detectors

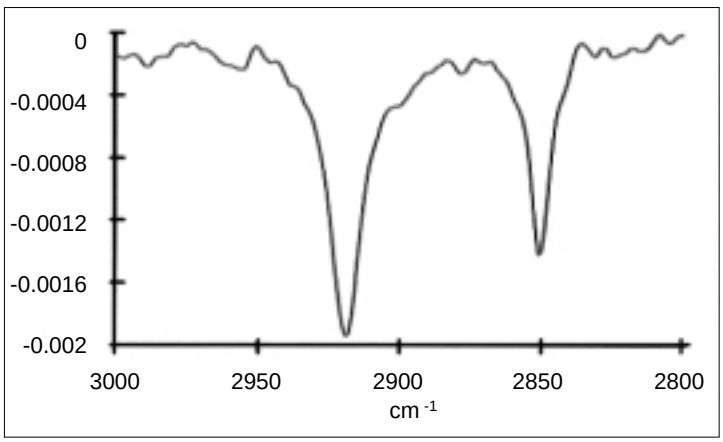


Figure 7. IR Reflection spectrum of a monolayer (~25A) of Cd Arachidate on Silica measured with p-polarized light and 30˚ angle of incidence.

Automatic Precision Validation (APV™)

Using two positions in the optical filter wheel, the APV accessory checks wavenumber repeatability, traceable to a NIST-certified material (SR1921) and ordinate repeatability against a transmission filter. The APV accessory is also available with sample compartment mounted reference materials.

Resolution

Better than 0.3 cm^{-1} standard, better than 0.15 cm^{-1} optional. The resolution is continuously variable up to 64 cm^{-1}.

Scan velocities

Continuously variable between 0.05 and 5.0 cm/sec.

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