

Modular Fourier Transform Infra-Red Spectrometer (FT-IR) Solution



- Modular design to meet various measurement requirements
- Wide spectral coverage; 14,000 to 700 cm^{-1} (700 nm to 14 μm)
- High resolution; up to 0.5 cm^{-1} (0.02 nm at 700 nm and 0.02 μm at 14 μm)
- Powered by MIRLab™ software
- Interchangeable detectors and IR sources for flexibility and adaptability to a myriad of applications

The Oriel FTIR Building Block solution has been designed for routine analytical applications for an FT-IR as well as non-traditional applications where modular design is required for flexibility in the optical path. This solution was designed specifically for researchers and OEMs who want an instrument easily adaptable to their special needs, at an economical price, and without compromising performance. The MIR8035 scanner has selectable resolution starting with 0.5 cm^{-1} , improved signal to noise ratio, and a very broad spectral range depending on choices of sources, optics, detectors, and beam splitters. The MIR8035 scanner is commanded by MIRLab™, a software package that provides sophistication for routine analysis and allows for custom routines to control the system. The scanner ships with a Windows 10 laptop with the software pre-installed.

The Components

Oriel utilized a modular approach when designing the FT-IR solution. We made the components that restrict the use of FT-IR instruments (sources, detectors, and sample compartments) interchangeable, so there's no need to tear down the entire system when measurement requirements change – simply switch out the component(s). A complete FT-IR Spectrometer solution includes:

- IR Source or sample
- MIR8035 scanner
- Beam splitter and window
- Detection system
- MIRLab software

How Does it Work?

Fig. 1 illustrates how the FT-IR solution works. Very simply, the scanner modulates the radiation from the source or sample; the electronics board (in the scanner) digitizes the analog signals from the detection system and sends them to a computer through a USB 2.0 interface; and the MIRLab software is used for instrument control and data handling.

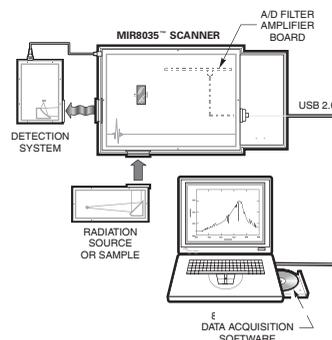
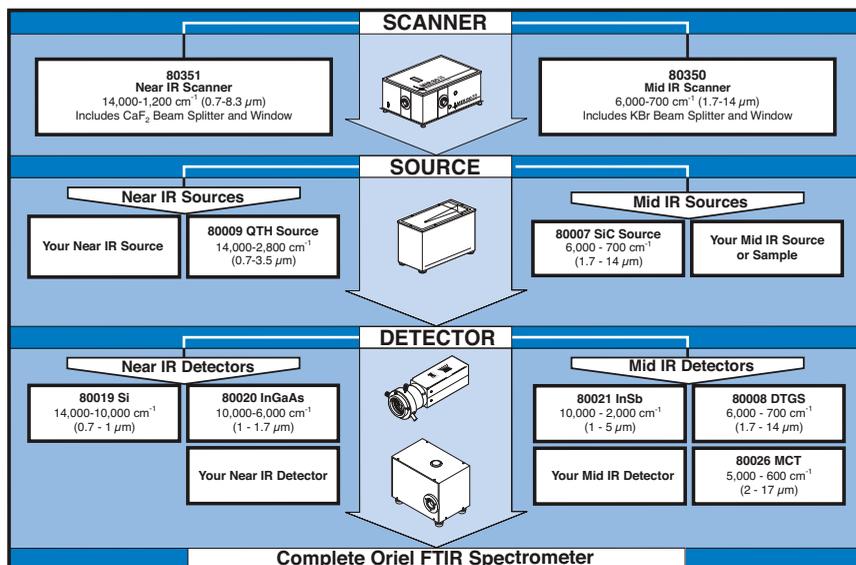


Fig. 1 The heart of the FT-IR solution is the scanner.



Configurations of the FT-IR

The flexibility of the modular FTIR Spectrometer solution allows users to choose either an Oriel or their own Source and Detector to complete the FTIR system. The flow chart above provides a quick reference to which detectors and sources are offered from Oriel. For questions, please contact a Newport Technical Sales Engineer at 1-877-835-9620 or sales@newport.com.

Optical Layout

The MIR8035 uses a scanning Michelson Interferometer. Our optical layout includes corner cubes and a retro-reflector. The unique layout is immune to tilt and shift as the retro-reflector and beam splitter are mounted together, providing accurate alignment while desensitizing the system to vibrations and temperature variations. This "unibody" approach to the beam splitter makes for easy interchangeability with minimal realignment required.

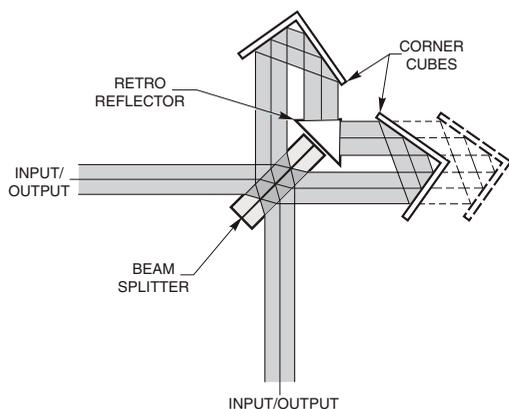


Fig 2. Optical layout includes corner cubes and a retro-reflector mounted to a beam splitter

Software - About MIRLab

We didn't limit the flexibility of the Oriel MIR8035 FT-IR scanner to its hardware; the software is also flexible. MIRLab is a powerful Windows™ based instrument control, data acquisition, and processing application, included with every instrument. For convenience, the software has been preinstalled on a Windows 10 laptop.

Software - Configuring Parameters

Set-up screens for parameter setting and data display are easy, intuitive, and friendly. Users can choose to display the data as an interferogram or one of many spectral options: single beam, transmittance, or absorbance, with abscissa in wavenumber or wavelength units. Previously acquired data can be retrieved for viewing or further manipulation.

Software - Extensive Mathematical Functions

MIRLab's Spectral Calculator enables extensive mathematical calculations on collected data. With a few intuitive keystrokes, standard deviation, absorbance, average and ratio spectra, as well as signal to noise ratio can be calculated, to name only a few functions.

Accessories for Oriel FT-IR Spectrometers

- Convenient benchtop accessory compartment
- Fiber coupling accessories to simplify beam collection and delivery

Below is a list of standard accessories to simplify measurements with the 8035 FTIR scanner.

Accessory Compartment

The 80070 Accessory Compartment holds FT-IR sampling accessories at the proper optical height between the 8035 Scanner and Detector. Use it with any Oriel FT-IR Detector. The 80007 SiC Source, 80009 QTH Source, or custom source is needed at the input of the Scanner, to complete the system.

Fiber Coupling Accessories

To carry the modulated output from the 8035 scanner to a sample, or to carry sample radiation to the 8035, we offer two fiber coupling accessories and various IR single core fibers. The 80040 Fiber Coupler has an SMA fiber connector and a collecting mirror; it accepts SMA terminated fibers. The 80033 is similar to the 80040 but has X-Y translation for precise coupling, and does not include the fiber adapter. Choose between the 80041 SMA and 80043 11 mm Oriel ferrule, to complete the 80033 Fiber Coupling Accessory.

IR Fibers

We offer Chalcogenide and Polycrystalline fibers in 250 to 900 μm core diameters. Transmission for Chalcogenide is 2 - 6 μm and the Polycrystalline is 4 - 18 μm .

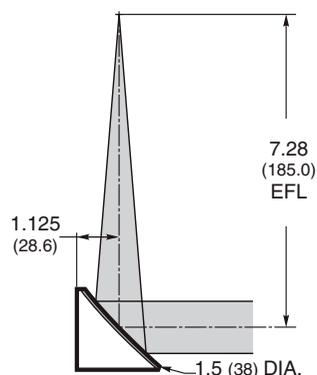
Collection Optics

We offer the off-axis parabolas that are part of our 8035 scanners and detectors, as stand alone collecting optics.

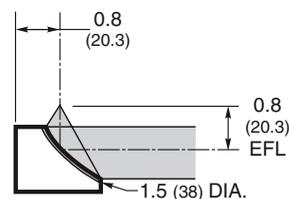
Parabolas

Fig. 10 illustrates the off-axis parabolas we use in the 8035 scanners, detectors, and bench accessory. We offer them separately for those who wish to use them as collection optics. All parabolas are coated with gold to enhance IR reflectance.

MODEL 80121



MODEL 80122



MODEL 80120

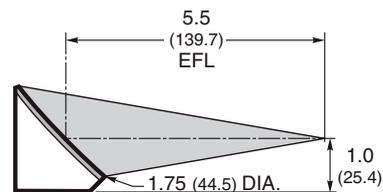


Fig. 10 Off-axis parabolas

Oriel[®] Light Source Offerings for FT-IR Solution

Broadband IR Sources

For applications where a broadband source is required, we offer the 80009 QTH and 80007 SiC Sources. See Figs. 8 and 9 for spectral curves.

- Gold coated optics enhance IR output
- Designed for low light ripple output

Specifications

	80009 QTH	80007 SiC
Spectral Range	14,000 to 2,800 cm^{-1} (0.7 – 3.5 μm)	6,000 to 700 cm^{-1} (1.7 – 14 μm)
Collimated Beam Diameter	38 mm	38 mm
Light Ripple	0.10% peak to peak	0.10% peak to peak
Power Supply AC Input	85 - 264 VAC, 47 - 63 Hz	85 - 264 VAC, 47 - 63 Hz

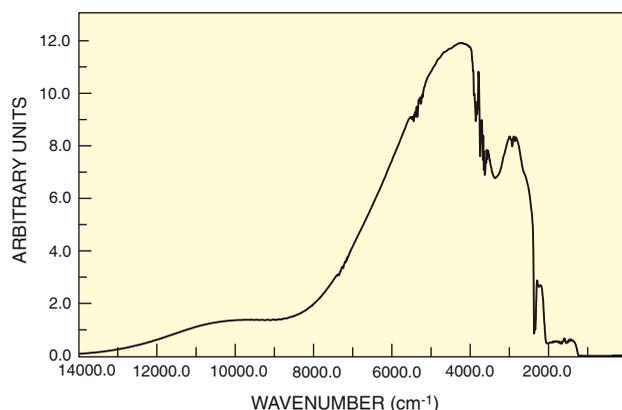


Fig. 8 Spectrum of 80009 QTH Source taken by 8035 with a CaF_2 beam splitter and 80008 DTGS Detector

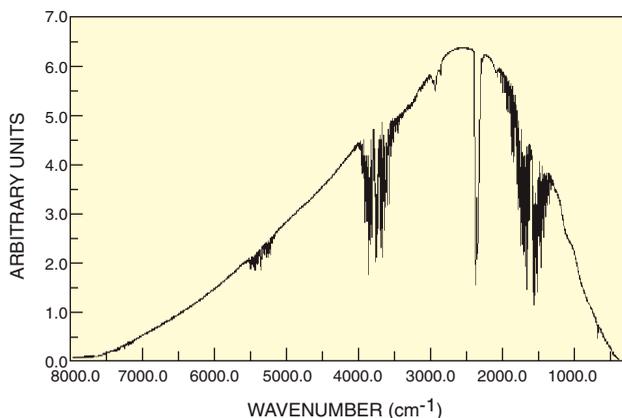


Fig. 9 Spectrum of 80007 SiC Source taken by 8035 with a KBr beam splitter and 80008 DTGS Detector

Quartz Tungsten Halogen (QTH) Infrared Light Source

The 80009 is a complete quartz tungsten halogen (QTH) infrared light source that provides a smooth continuum from 14,000 to 2,800 cm^{-1} (0.7 to 3.5 μm). Its 1.5-Inch Series female output flange allows the source to be coupled to a variety of items, including the FT-IR Spectrometer Building Blocks. An off-axis parabolic reflector is integrated into the design, rather than a condenser lens. IR refractive optics are expensive and have transmittance limitations. Using this type of reflector provides several advantages. Its gold coating enhances IR reflectance. The focal point is displaced from the mechanical axis, giving full access to the reflector focus area. The 80009 produces a 34.5 mm (1.36 inch) diameter collimated output beam with 1° divergence, full angle. A hose fitting is provided to purge the source with nitrogen, if desired. The 80009 includes a 20-watt QTH lamp and a stand-alone power supply designed to minimize light ripple. A 1 m (3.3 ft.) long cable connects the source to its power supply. 20W QTH lamp model 6319 is the appropriate replacement for this source.

Silicon Carbide (SiC) Infrared Light Source

The 80007 is a complete silicon carbide (SiC) infrared light source that provides a smooth continuum from 6,000 to 400 cm^{-1} (1.7 to 25 μm). Its 1.5-Inch Series female output flange allows the source to be coupled to a variety of items, including FT-IR Spectrometer Building Blocks. An off-axis parabolic reflector is integrated into the design, rather than a condenser lens. IR refractive optics are expensive and have transmittance limitations. Using this type of reflector provides several advantages. Its gold coating enhances IR reflectance. The focal point is displaced from the mechanical axis, giving full access to the reflector focus area. The 80007 produces a 34.5 mm (1.36 inch) diameter collimated output beam with 1° divergence, full angle. A hose fitting is provided to purge the source with nitrogen, if desired. The 80007 includes a 24-watt SiC emitter and a stand-alone power supply designed to minimize light ripple. A 1 m (3.3 ft.) long cable connects the source to its power supply. 24W SiC IR emitter model 80030 is the appropriate replacement for this source.

SCANNER

PARAMETER	80350	80351
Function	Spectral analyzer	
Configuration	Main unit is an enclosed and purgeable chamber with KBr or CaF ₂ input/output windows, containing an interferometric modulator	
Interferometer	90° Michelson interferometer with corner cube reflectors and retroprism	
Exit Beam Divergence	1 degree in full angle	
Beam Splitter	KBr for near to far infrared	CaF ₂ for near to mid infrared
Spectral Range	6,000 - 700 cm ⁻¹ (1.7 - 14 μm)	14,000 - 1200 cm ⁻¹ (0.7 - 8.3 μm)
Aperture (inch [mm])	1.5 [38]	
Throughput	7 x 10 ⁻³ (cm ² Sr) for acceptance angle corresponding to 1 cm ⁻¹ resolution	
Resolution ¹	Selectable from 0.5 - 64 cm ⁻¹ in 8 steps; resolution corresponds to 0.02nm at 700nm and 0.02 μm at 14 μm	
Scanning Mirror Speed at 40 kHz (laser modulation frequency)	6.33 mm/s	
Scanning Mirror Speed at 25 kHz (laser modulation frequency)	3.956 mm/s	
Scanning Mirror Speed at 15 kHz (laser modulation frequency)	2.373 mm/s	
Scanning Mirror Speed at 5 kHz (laser modulation frequency)	0.791 mm/s	
HeNe Laser Phase Tolerance	90° +/- 3	
Reference Signal	Two HeNe laser sinusoidal interferograms in-quadrature for scanner control and data acquisition	
ZPD Point	Scanning mirror can be finely adjusted by the software to get ZPD point exactly in the middle of a scan; this position will be maintained with zero error as long as the unit is powered up	
Interferogram	Double sided	
Oversampling	1X, 2X, 4X	
Wave Number Accuracy	0.01 cm ⁻¹	
Wave Number Resolution	0.5 cm ⁻¹	
Signal to Noise	1000:1 at 2500 cm ⁻¹ , 4 cm ⁻¹ resolution, 1 scan sample/1 scan reference, using DTGS detector	
Optical Axis Height - Bottom of Baseplate to Center of Aperture (inch [mm])	2.88 [73.1]	

GENERAL

Dimensions (inch [mm])	16.5 x 11.8 x 8.0 [419 x 300 x 203]
Weight (lbs [kg])	37 [17]
AC Voltage Input	84 - 264 VAC; 47 - 63 Hz
Operating Temperature Range	15°C to 40°C, relative humidity cannot exceed 30%
Storage Temperature Range	0°C to 50°C, relative humidity cannot exceed 30%
Coupling	1.5 inch series male flanges

DATA ACQUISITION

PARAMETER	80350	80351
Computer Interface	USB 2.0	
Hardware Internal	16 bit A/D converter with 250 kHz throughput	
Sample Frequency	160 kHz - 20 kHz with 4X oversampling 40 kHz - 5 kHz without oversampling	
Main Amplifier	No gain control	
Low / High Pass Filters	93 Hz low pass filter (5 kHz) and 80 kHz high pass filter (40 kHz)	
Software	MIRLab	
Selectable Units	μm, nm, cm ⁻¹ , MHz, eV, kcal/mol, kJ/mol, and K	
Type of Data Presentation	Interferogram, single beam, transmittance	

SOFTWARE FUNCTION

PARAMETER	80350	80351
Set Scan Parameters	Speed, resolution, oversampling on/off, bi-directional data acquisition on/off	
Scanner Calibration	Fine adjustment of ZPD and delay of A/D converter triggering signals	
Set FFT Parameters	Type of apodization, zero fill, parameters for phase correction and scaling	
Calculations	Basic mathematic operations, Blackbody curve	
Save Data File Format	LabView	

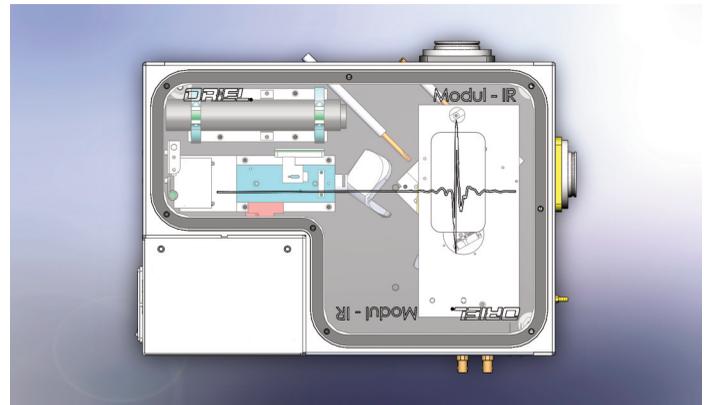


Fig. 3 Schematic drawing of the Oriel 8035 Scanner

Oriel® Detector Offerings for FT-IR Solution

Silicon and InGaAs Detectors for Oriel FT-IR Spectrometers



Model 80019 Silicon Detector.

- Si and InGaAs models
- Includes focusing lens with XY adjustment

This family of photodiode detectors covers the near infrared region, 14,000 to 6,000 cm^{-1} (0.7 to 1.7 μm). We offer a Silicon and an InGaAs detector. The 80019 Silicon Detector has excellent stability and sensitivity over the range of 14,000 - 10,000 cm^{-1} . The 80020 InGaAs Detector has a spectral range of 10,000 - 6,000 cm^{-1} . These are the preferred detectors for Overtone Spectroscopy.

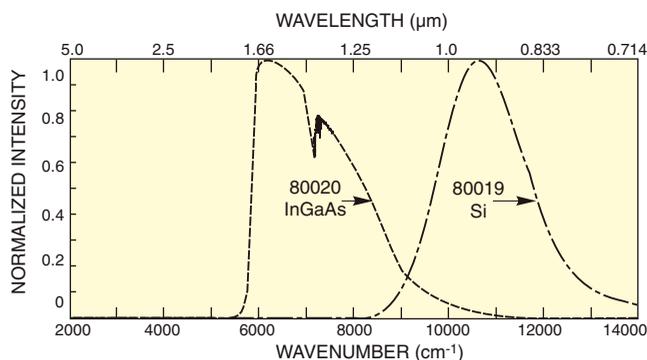


Fig. 4 Spectrum of 1273 K blackbody captured with InGaAs and Si Detectors, CaF_2 beam splitter and the 8035 scanner

Specifications - 80019 Si + 80020 InGaAs

	80019 Silicon Detector	80020 InGaAs Detector
Responsivity Range	14,000 - 10,000 cm^{-1} (0.7 - 1 μm)	10,000 - 6,000 cm^{-1} (1 - 1.7 μm)
Detector Element Size	1 mm diameter	1mm diameter
Window Material	BK7	BK7
Preferred Beam Splitter	CaF_2	CaF_2
Typical D^* (cm $\text{Hz}^{1/2} \text{W}^{-1}$)	1×10^{14}	1×10^{12}
Operating Bandwidth (with amplifier)	100 Hz to 40 kHz ¹	100 Hz to 40 kHz ¹
Transimpedance gain (V/A)	Selectable from 10^4 to 10^9	Selectable from 10^4 to 10^9

¹ Gain Dependent

DTGS Detector for Oriel FT-IR Spectrometers



Model 80008 DTGS Detector at output of 8035 scanner

- Broadest spectral response, 6,000 to 700 cm^{-1}
- Room temperature operation

DTGS Detectors are sensitive from 6,000 to 700 cm^{-1} (1.7 to 14 μm), the usable range of the KBr beam splitter. This detector exhibits large, spontaneous electrical polarization effects. Incident radiation alters the polarization which generates the electrical signal. We optimize this detector for our 80007 SiC Source; fine gain adjustments can be made via an internal potentiometer.

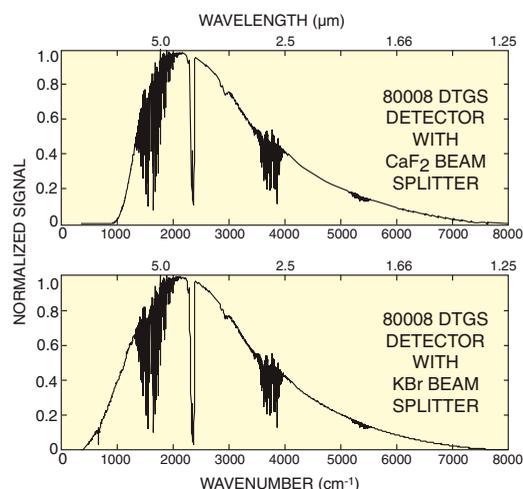


Fig. 5 Spectrum of 1273 K blackbody captured with 80008 DTGS Detector, CaF_2 beam splitter was used to acquire the top measurement; a KBr beam splitter was used for the bottom measurement.

Specifications - 80008 DTGS Detector

Responsivity Range	6,000 - 700 cm^{-1} (1.7 - 14 μm)
Detector Element Size	1.3 mm diameter
Window Material	KBr
Preferred Beam Splitter	KBr
Typical D^*	1.5×10^9 to 3.5×10^9
Operating Bandwidth (with amplifier)	100 Hz to 40 kHz

MCT Detectors for Oriel FT-IR Spectrometers



Model 80026 MCT Detector

- High sensitivity
- Broad spectral response, 5,000 to 600 cm^{-1}

The 80026 is a liquid nitrogen cooled MCT detector. It has a broad spectral response, close to that of DTGS, but is sensitive to signals ~100X weaker. It also acquires data about 8X faster than DTGS. The 80026 comes with an industry standard, 8 hour dewar. It has a two stage, low noise amplifier. The first stage has three settings: LOW (gain of 10), MED (gain of 30), and HIGH (gain of 100). The second stage provides AC coupling and 10X amplification.

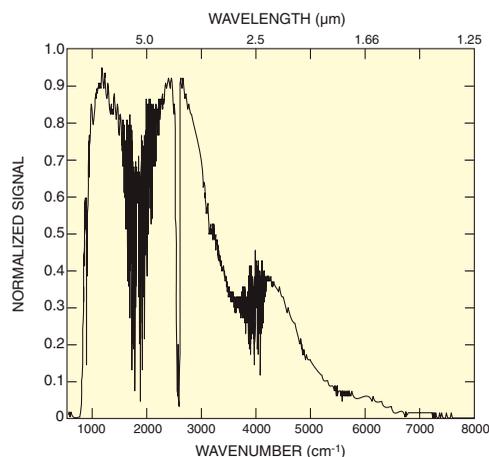


Fig. 6 Spectrum of 1273K blackbody captured with the 80026 MCT Detector, KBr beam splitter and the 8035 Scanner.

Specifications - 80026 MCT Detector

Responsivity Range	5,000 - 600 cm^{-1} (2 - 17 μm)
Detector Element Size	1x1 mm
Window Material	ZnSe
Preferred Beam Splitter	KBr
Typical D* (Peak)	5×10^{10}
Operating Bandwidth (with amplifier)	100 Hz to 40 kHz

InSb Detectors for Oriel FT-IR Spectrometers



Model 80021 InSb Detector

- Liquid nitrogen cooled detector
- Excellent performance in the 10,000 to 2,000 cm^{-1} range

The 80021 InSb Detector is a photovoltaic detector which approaches the maximum theoretical limit of sensitivity for background limited applications. This detector is ideal for background sensitive radiometry applications. It requires liquid nitrogen cooling. Holding time for LN_2 exceeds four hours.

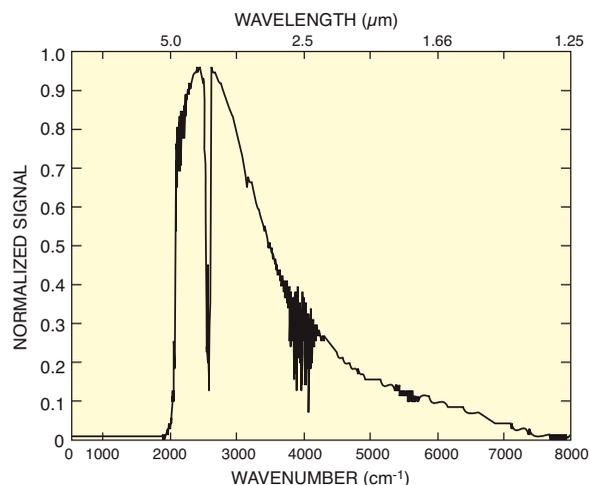


Fig. 7 Spectrum of 1273 K blackbody captured with 80021 InSb Detector, CaF_2 beam splitter and the 8035™ Scanner

Specifications - 80021 InSb Detector

Responsivity Range	10,000 - 2,000 cm^{-1} (1 - 5 μm)
Detector Element Size	1x1 mm
Window Material	Sapphire
Preferred Beam Splitter	CaF_2
Typical D*	3×10^{11}
Operating Bandwidth (with amplifier)	100 Hz to 40 kHz

Ordering Information

Scanners

Oriel 8035™ scanners include a beam splitter, two windows, and MIRLab™ software

Model	Beam Splitter & Window Material	Spectral Range
80350	KBr	6,000 - 700 cm ⁻¹ (1.7-14 μm)
80351	CaF ₂	14,000 - 1,200 cm ⁻¹ (0.7-8.3 μm)

Replacement Beam Splitters

Model	Material	Spectral Range
80004	KBr	6,000 - 700 cm ⁻¹ (1.7-14 μm)
80005	CaF ₂	14,000 - 1,200 cm ⁻¹ (0.7-8.3 μm)

Replacement Windows (set of two)

Model	Material	Spectral Range
80010	KBr	6,000 - 700 cm ⁻¹ (1.7-14 μm)
80011	CaF ₂	14,000 - 1,200 cm ⁻¹ (0.7-8.3 μm)

Broadband IR Sources (includes lamp or emitter)

Model	Source Type	Spectral Range
80007	SiC Emitter	6,000 to 700 cm ⁻¹ (1.7 - 14 μm)
80009	QTH Lamp	14,000 to 2,800 cm ⁻¹ (0.7 - 3.5 μm)

Replacement Source Components

Model	Description
80030	24 W SiC Emitter
6319	20 W Quartz Tungsten Halogen Lamp

Off-Axis Parabolas

Model	Effective Focal Length
80120	5.5" (139.7 mm)
80121	7.28" (185.0 mm)
80122	0.8" (20.3 mm)

Detectors

Model	Detector Type	Usable Spectral Range
80019	Si	14,000 - 10,000 cm ⁻¹ (0.7 - 1 μm)
80020	InGaAs	10,000 - 6,000 cm ⁻¹ (1 - 1.7 μm)
80021	InSb	10,000 - 2,000 cm ⁻¹ (1 - 5 μm)
80008	DTGS	6,000 - 700 cm ⁻¹ (1.7 - 14 μm)
80026	MCT	5,000 - 600 cm ⁻¹ (2 - 17 μm)

Accessories

Model	Description
80070	Accessory Compartment
80033	Fiber Coupler, Universal (requires adapter)
80040	Fiber Coupler, SMA with X-Y Adjustment
80041	SMA Adapter for 80033
80043	11 mm Ferrule Adapter for 8033

Fiber Optic Cables

Model	Fiber Material	Transmittance Range	Core Diameter (μm)	Length feet (m)
80060	Chalcogenide Glass (CIR)	2 - 6 μm	500	5 (1.5)
76905	Chalcogenide Glass (CIR)	2 - 6 μm	250	3 (1)
76906	Chalcogenide Glass (CIR)	2 - 6 μm	400	3 (1)
76907	Chalcogenide Glass (CIR)	2 - 6 μm	500	3 (1)
76908	Polycrystalline (PIR)	4.0 - 18 μm	400	3 (1)
76909	Polycrystalline (PIR)	4.0 - 18 μm	630	3 (1)
76910	Polycrystalline (PIR)	4.0 - 18 μm	900	3 (1)



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DS-011506 ILX 11/18