

HUMAN HEALTH

ENVIRONMENTAL HEALTH

RELIABLE RESULTS AND  
HIGH PERFORMANCE  
FOR DEMANDING  
SITUATIONS



**LAMBDA 650/750/850/950/1050**

Accessories for LAMBDA Series

  
**PerkinElmer**  
*For the Better*

## LAMBDA SERIES



### Two companies, one goal.

For close to thirty years, PerkinElmer and Labsphere® have provided state-of-the-art measurement systems for spectroscopy. Today, with the introduction of new technologies, we continue to develop new instruments and accessories to give you the measurement capabilities the market requires. We have maintained the quality systems you have grown to trust from two companies whose names are synonymous with quality and reliability in scientific instrumentation and spectroscopic measurements. This catalog shows our commitment to give you the equipment to make high quality spectroscopic measurements.



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## The LAMBDA High Performance Spectrometer Series

The PerkinElmer® LAMBDA™ High Performance Series of UV/Vis (LAMBDA 650 and LAMBDA 850) and UV/Vis/NIR (LAMBDA 750, LAMBDA 950 and the recently introduced LAMBDA 1050) Spectrometers provide a family of instruments designed for the most demanding applications.

The LAMBDA 850, LAMBDA 950 and LAMBDA 1050 are research grade spectrometers with unrivaled performance across the UV, Visible and NIR regions of the spectrum. These instruments are used extensively by research groups around the world and customers who need accurate measurement of their samples in a variety of ordinate modes. With the increased sensitivity of the LAMBDA 1050,

especially in the NIR region, users can now handle a wider range of demanding applications and measurements with more reliable results.

The LAMBDA 650 and LAMBDA 750 are instruments ideally suited for busy academic and industrial laboratories that perform measurement of liquids, gels, and solid materials and need flexibility of sampling along with high measurement performance. Accessories and detector modules can quickly and easily be interchanged to provide the optimum configuration for each measurement.

No aspect of the spectrometer design has been compromised, resulting in the highest performing UV/Vis and UV/Vis/NIR instruments available.

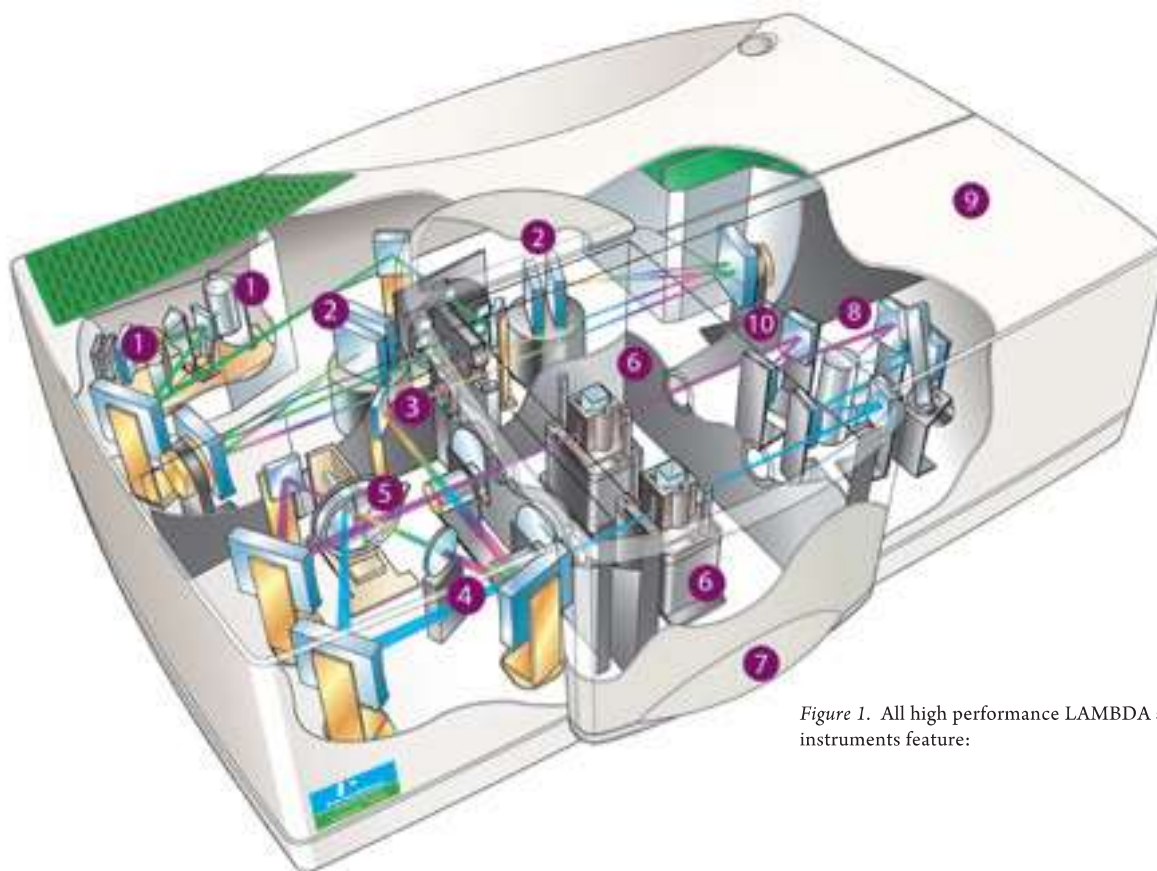


Figure 1. All high performance LAMBDA series instruments feature:

- 1. Deuterium and Tungsten Halogen Light sources**  
Prealigned and prefocused for quick replacement and maximum uptime. Source Doubling Mirror (LAMBDA 1050 only) for ultra-high sensitivity.
- 2. Double Holographic Grating Monochromators**  
For ultra-low stray light performance.
- 3. Common Beam Mask**  
Allows precise adjustment of beam height to match samples of different dimensions.
- 4. Common Beam Depolarizer (Optional)**  
Corrects for inherent instrument polarization to allow accurate measurements of birefringent samples.
- 5. Chopper**  
The four segment design provides individual blank readings for sample and reference, increasing measurement accuracy.
- 6. Sample and Reference Beam Attenuators**  
For extremely sensitive and accurate measurements on highly absorbing samples.
- 7. Largest Sample Compartment in the Industry**  
Allows easy access to a wide variety of sampling accessories and sample types.
- 8. High Sensitivity PMT and Temperature Stabilized PbS Detectors**  
Provides full range UV/Vis/NIR coverage from 175 to 3300 nm (LAMBDA 950).
- 9. Second Sampling Area**  
Houses a range of snap-in sampling modules including transmission optics (shown), 60 mm and 150 mm integrating spheres and the Universal Reflectance Accessory for high-precision absolute reflectance measurements.
- 10. High-sensitivity PMT, 3-stage Peltier Cooled InGaAs and Temperature Stabilized PbS Detectors**  
Provides full UV/Vis/NIR from 175 to 3300 nm (LAMBDA 1050 only).



## Spectroscopy Accessories

The high performance LAMBDA series provides the most convenient and flexible approach to sampling than any other UV/Vis and UV/Vis/NIR system available. The dual sample compartments facilitate flexibility of sampling. The primary sample compartment is used for a range of standard reflectance and transmission accessories and polarizers, while the second sample compartment is customizable to a variety of intelligent sampling modules such as integrating spheres, the General Purpose Optical Bench (GPOB), and the unique Universal Reflectance Accessory (URA).

### Integrating Spheres

The integrating sphere accessories conveniently snap into the spectrometer allowing collection of diffuse and specular transmission and reflectance measurements. Two sphere sizes are available: 150 mm and 60 mm. All spheres operate in double beam mode.

Integrating spheres are essential accessories for measuring the transmittance or reflectance of any sample that scatters light. Figure 2 shows a polymethyl methacrylate (PMMA) sample plate that is commonly used as a substrate for the measurement of UV transmittance of sunscreens. Figure 3 shows the transmittance of PMMA plates with surface roughnesses of 2  $\mu\text{m rms}$  and 6  $\mu\text{m rms}$  as measured on a LAMBDA instrument both with and without a 150 mm sphere accessory. Figure 3 shows the error, which will occur if the transmittance of a scattering sample is measured without an integrating sphere accessory. Both the 2  $\mu\text{m rms}$  and 6  $\mu\text{m rms}$  plates are the same thickness and material and should have roughly the same absorbance. As the surface roughness and therefore the level of scattering is increased, the measured absorbance without an integrating sphere is increased. Measurements with the sphere correctly measure the absorbance and the consistency between surface roughness.



Figure 2. An example of a frosted PMMA Plate.

### 150 mm Sphere Accessory

The 150 mm sphere is a research grade accessory offering the user a complete system for the measurement of diffuse reflectance, relative specular reflectance, and diffuse transmittance of both solids and liquids. In addition, because the port fraction is small (less than 5%), the 150 mm sphere allows color to be measured in accordance with CIE guidelines. A carefully designed baffle set prevents first strikes and the generation of erroneous data. The design provides space for optional accessories such as variable angle sample mounts, small spot kits and polarizers to be fitted, increasing

the flexibility of the accessory. Optional center mount accessories for the 150 mm sphere allow for diffuse reflectance measurement of opaque materials at varying angles of incidence, as well as “transflectance” (combined transmittance and reflectance measurements), of semi-opaque materials such as polymer films.

### 60 mm Sphere Accessory

The 60 mm sphere is a general purpose sphere for routine scattered transmittance and reflectance. It can also be used as a detection sphere, which is necessary for the measurement of samples that distort the beam geometry or accessories that are demanding to align such as VN and VW specular reflectance accessories.

### General Purpose Optical Bench (GPOB)

The GPOB can be configured, in a matter of minutes, to measure virtually any size or shape of sample in a wide variety of geometries. The GPOB facilitates the use of optical kits of mirrors, lenses, baffles, diaphragms, and a collection sphere to move light around the optical bench to collect the reflected or transmitted light of virtually any sample. The applications for this accessory are limitless.

### Other Accessories

A number of spectroscopy accessories are available that reside in the sample compartment of the spectrometer. Some of these accessories, such as the VN and VW specular reflectance accessories require careful optical alignment with the instrument's detector. Replacing the standard detector compartment with a collection sphere accessory greatly simplifies this alignment task. Entrance ports of the collection sphere provide large forgiving targets for the sample and reference beams.

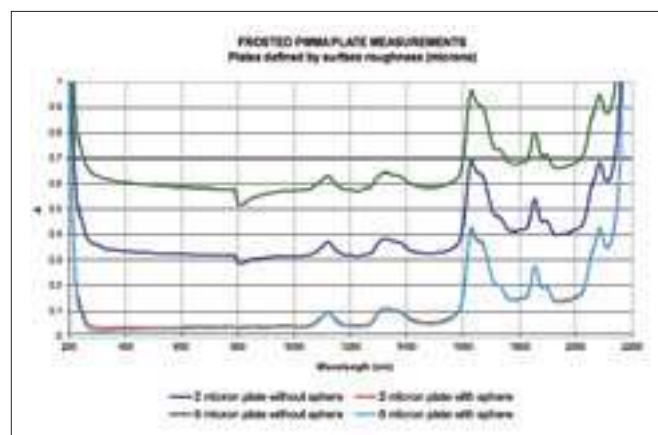


Figure 3. Frosted PMMA plate measurements, plates defined by surface roughness (microns).

## The Technology

While inexpensive spectrometers are typically used to measure the transmittance of clear solutions, instruments of the sophistication of the high performance LAMBDA series have multiple uses; the predominant being the characterization of solid materials.

**These measurements fall into 3 categories:**

**Transmittance measurement of scattering and non-scattering samples**

**Diffuse reflectance measurement of materials**

**Specular reflectance measurement of mirror-like materials in appearance.**

Each of these measurement categories are addressed by the high performance LAMBDA series of spectrometers and sphere-related accessories developed by Labsphere®.

## Transmittance Measurements

When measuring transmittance, scattering by the sample causes some of the transmitted beam to deviate from the optical path of the instrument, not making it to the instrument detector. This results in total transmittance measurements that are artificially low. By using an integrating sphere accessory, all of the light transmitted in the forward direction is collected. As illustrated in Figure 4, a true measure of the total transmittance can be achieved. The sample is placed in front of the sphere at the transmission port and the light passes through into the sphere. As shown in Figure 5, this configuration can be used to exclude the normally transmitted beam from the measurement (open reflectance port) and allow accurate measurement of the diffuse transmittance of the sample.

When obtaining the transmittance of a sample, such as a lens, which is a thick or curved sample that can cause the beam direction to deviate or cause the beam to diverge or converge, an integrating sphere is required. As the beam deviates from its path or changes in angle, some of the light may miss the instrument detector resulting in an artificially low transmittance measurement. An integrating sphere accessory allows for the complete sample beam to be collected even if its path deviates or if it diverges or converges. Integrating spheres also compensate for inhomogeneity of detectors as all of the detector area is always illuminated.

## Diffuse Reflectance Measurements

Reflectance of samples can be measured using either an integrating sphere or a specular reflectance accessory. Integrating spheres are used for samples with a significant diffuse reflectance component such as powders and other 'rough' materials.

Samples are placed at the back of the sphere and the light is reflected back off the sample and collected by the sphere. Measurements typically provide the total reflectance (Figure 6) but if required, the diffuse reflectance (specular excluded)

portion (Figure 7) can be measured independently. The latter measurement is achieved by allowing the specular component to exit the sphere through the open specular port.

## Specular Reflectance Measurements

Specular reflectance accessories measure the reflectance of samples that are extremely specular (mirror-like) in appearance and have extremely low or no diffuse content.

They are different from integrating spheres in that they occupy the sample compartment of the spectrometer rather than the detector area. The sample is mounted on the top of the accessory. These accessories measure the reflectance at a fixed, defined angle, e.g. 6, 45 or 80 degrees.

The measurements can be either relative to a calibrated standard such as an aluminum mirror or absolute, eliminating the need for a reference material.

The accessories in this brochure are very versatile; most can measure in two or more of the categories discussed.

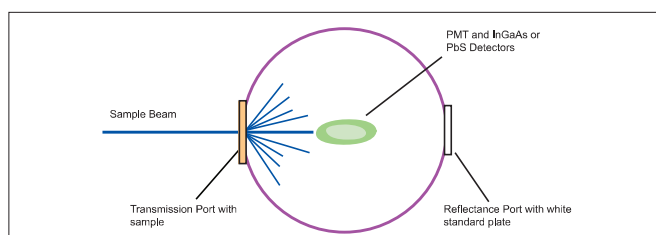


Figure 4. Total transmittance.

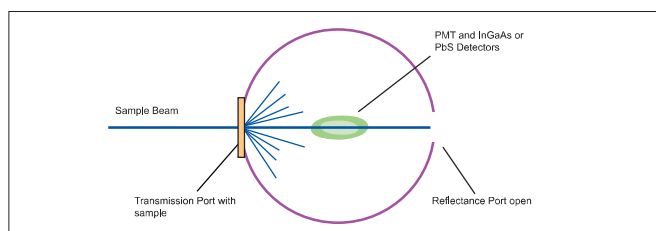


Figure 5. Diffuse transmittance.

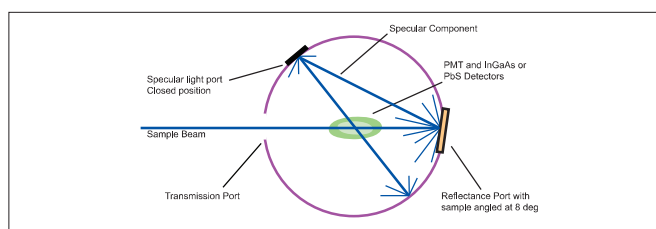


Figure 6. Total reflectance.

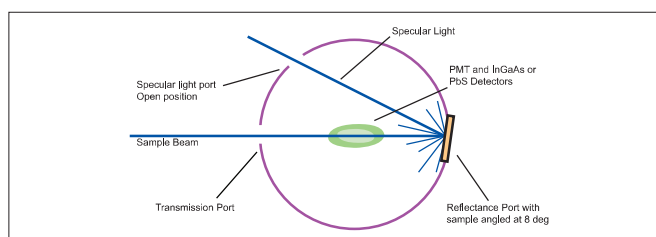


Figure 7. Reflectance specular excluded.

## PRODUCT SELECTION GUIDE

Part No.	Description															Page No.
		In Sample Compartment	In Detector Compartment	Solid Samples	Liquid Samples	Transmission	Reflectance	Absolute Specular Reflectance	Second Surface Refl. Incl.	Variable Angles	Diffuse Transmittance	Diffuse Reflectance	Specular Included/Excluded			
L6020322 (InGaAs) L6020204 (PBS)	150 mm Sphere	✓	✓	✓	✓ <sup>3</sup>	✓ <sup>1</sup>	✓ <sup>1</sup>	✓ <sup>1</sup>	✓	✓ <sup>1</sup>	✓	✓	✓	8		
PELA1000 PELA1002 (XXL)	150 mm Sphere (dual compartment)	✓	✓	✓	✓ <sup>3</sup>			✓ <sup>1</sup>	✓	✓ <sup>1</sup>	✓	✓	✓	9		
PELA1001	150 mm Sphere PbS (Downward looking)	✓	✓	✓	✓			✓ <sup>1</sup>	✓	✓ <sup>1</sup>	✓	✓	✓	9		
L6020323 (InGaAs) L6020203 (PbS) PELA1021 (Infragold®)	60 mm Sphere		✓	✓	✓	✓ <sup>1</sup>	✓ <sup>1</sup>	✓ <sup>1</sup>	✓	✓ <sup>1</sup>	✓ <sup>2</sup>	✓ <sup>2</sup>	✓	11		
L6020209	60 mm Sphere PbS (detector sphere)		✓	✓	✓	✓ <sup>1</sup>	✓ <sup>1</sup>	✓ <sup>1</sup>	✓	✓ <sup>1</sup>				11		
L6020328 (InGaAs) PELA1003	Optical Bench (GPOB) with 60 mm sphere	✓	✓	✓	✓	✓	✓	✓ <sup>4</sup>	✓ <sup>4</sup>	✓ <sup>4</sup>				12		
L6020358 (LAMBDA 1050) L6020202 (LAMBDA 950) L6020208 (UV/Vis)	Universal Reflectance Accessory (URA) 8-65° specular absolute, PbS		✓	✓		✓ <sup>1</sup>	✓	✓		✓				17		
N1016008 (8°) N1016030 (30°) N1016045 (45°) N1016060 (60°)	VN absolute specular reflectance	✓		✓			✓	✓						17		
B0086703 (6°) PELA1025 (45°) PELA1026 (80°)	Relative specular reflectance	✓					✓							16		
B0137314	Variable angle relative specular reflectance 15-70°	✓		✓			✓			✓				16		
B0152471	Variable angle directed transmittance 0-60°	✓		✓		✓				✓				15		

1. Using appropriate accessories in the standard sample compartment. Special accessories and holders options available.
2. Recommended for quality control. For accurate measurement of diffuse samples please use 150 mm sphere.
3. Special cuvette holders options available.
4. Special accessories or sample holders available.

## 150 mm Sphere Accessories

Of all of the PerkinElmer/Labsphere® accessories, the most familiar and versatile is the 150 mm integrating sphere. This accessory allows for users to make a wide variety of measurements using a single accessory.

This accessory is the primary instrument used in the characterization of the reflectance properties of optical materials worldwide. It is the standard accessory used by laboratories such as the National Institute of Standards and Technology (NIST®), the National Physical Laboratory (NPL), National Research Council (NRC), NITI (Taiwan), the Physikalisch-Technische Bundesanstalt (PTB) and Federal Institute for Materials Research and Testing (BAM), for the measurements of reflectance and diffuse transmittance of calibration standards, and in research and development.

The InGaAs 150 mm sphere (L6020322) has all the features of the PbS 150 mm sphere (L6020204), but the thermostatted PbS detector is replaced with a Peltier cooled extended range InGaAs detector. The InGaAs sphere is compatible with both the LAMBDA 950 and LAMBDA 1050 instruments. The InGaAs detector provides significantly higher sensitivity and signal-to-noise ratio, thus enabling the user to measure samples that are highly absorbing in the NIR wavelength range or that need small spectral slit widths.

Figure 8 shows a comparison between the signal-to-noise on a 3A OD sample with PbS and InGaAs detectors. The improvement in signal-to-noise with InGaAs detection is clear. The region below 860 nm (detector change point) is equivalent as both use the PMT but above the change point, the NIR data differ considerably. Calculation of the RMS noise over the region 900-2400 nm indicates a 30x improvement in signal-to-noise with InGaAs detection.

This improvement in detection can also be realized in an increase in analysis speed. Figure 9 shows spectra of nominally the same sample collected on PbS and InGaAs spheres. The data quality of the InGaAs detector is evident despite the spectrum being collected 10x faster (900 - 2500 nm InGaAs 26s vs. PbS 288s).



150 mm Spectralon® Integrating Sphere with three position small spot kit.

## Features

- Principle:  
Double Beam (active reference) mode in either specular included 8°/hemispherical or specular excluded geometry.
- Detectors:  
Extended Range PMT – PbS (L6020204)  
Extended Range PMT – InGaAs (L6020322)
- Wavelength Range:  
Reflectance: 200-2500 nm  
Transmittance: 190-2500 nm
- Absorbance Range:  
PMT: ca. 0-5 A  
Temperature Stabilized PbS: ca. 0-3 A  
3 stage Peltier cooled InGaAs: ca. 0-5 A
- Sample Size:  
Reflectance: Unlimited  
Transmittance: 20 cm high x 20 cm wide x 14 cm thick

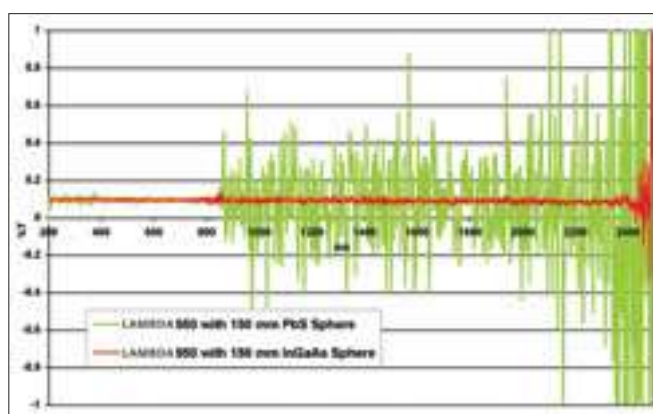


Figure 8. Noise comparison PbS vs. InGaAs at 3A and 0.1s integration time.

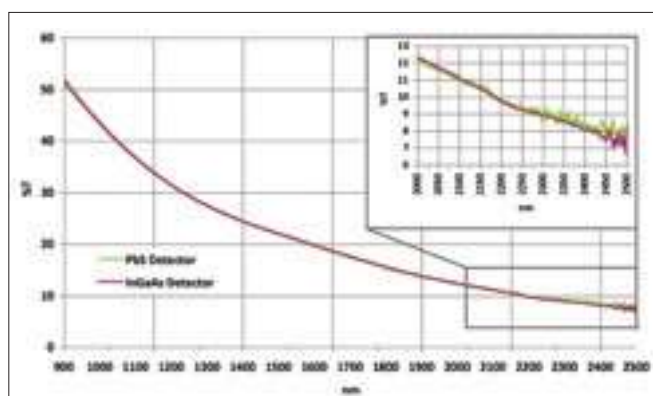


Figure 9. Analysis speed comparison PbS (288s) vs. InGaAs (26s) – 10x faster with InGaAs.

## 150 mm Sphere Accessories

### PELA1000 Dual Compartment Accessory

The PELA1000 150 mm Sphere Accessory is equipped with a 150 mm Spectralon® integrating sphere, transfer optics, a thermostatted PbS detector, with an extended range photomultiplier tube. The accessory operates in double beam (active reference) mode in either specular included (8°/hemispherical) or specular excluded geometry, and allows for a dual sample application.

The PELA1000 includes two 2-inch uncalibrated 99% reflectance standards.

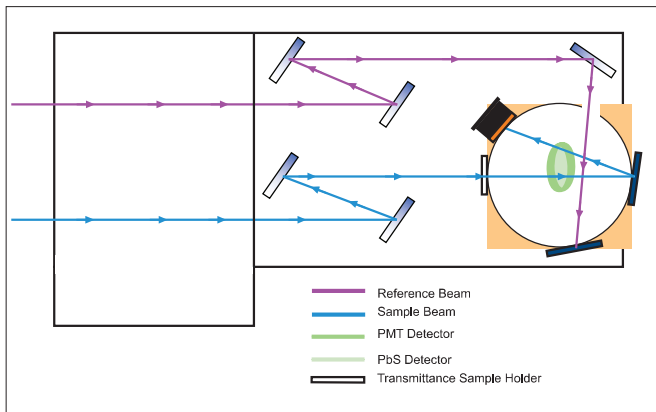


Figure 10a. 150 mm sphere beam path.

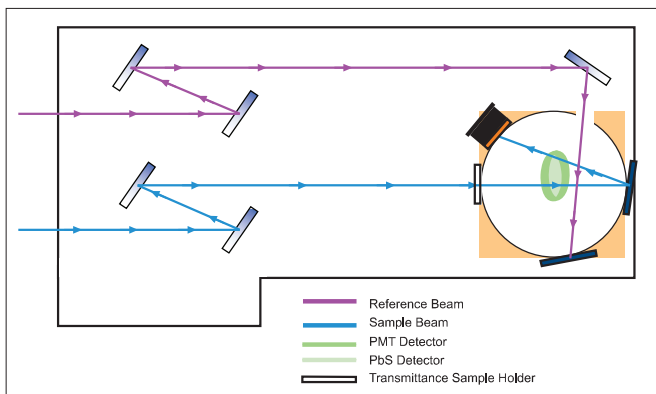


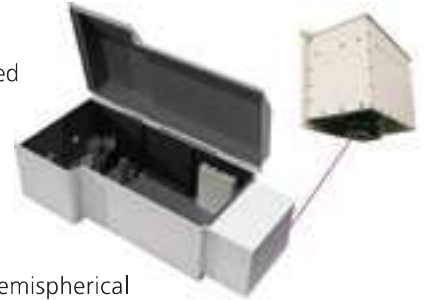
Figure 10b. 150 mm dual compartment sphere beam path.

### PELA1001 Downward Viewing 150 mm Sphere Accessory

The PELA1001 is designed for users who want to measure samples that must be held in a horizontal position. A few examples are powders, granular materials such as solids and large, irregular geological samples. The accessory finds wide use in the aerospace community and in agriculture for measurement of grains and spice mixtures.

The 150 mm Spectralon® Integrating Sphere is enclosed and attached to the side of the accessory, and it also has a port on the bottom of the sphere. Transmittance samples can be measured either in horizontal or vertical position.

Geometry of the accessory is fixed at 0°/hemispherical in transmittance and 8°/hemispherical in reflectance. The PELA1001 includes two 2-inch uncalibrated 99% reflectance standards.



### PELA1002 Large Sample Compartment

The PELA1002 is optically identical to the standard PELA1000 but features a large optical compartment, which allows for the transmittance measurement of samples up to 30 cm square. Typical applications for the PELA1002 include measurement of photographic paper, gel emulsions, and solar characterization of glass panels.

The PELA1002 includes two 2-inch uncalibrated 99% reflectance standards.





## 150 mm Sphere Accessories, continued

### Optional Components

- Reflectance Port Light Trap

**PELA9026** For diffuse transmittance measurement. Traps the light exiting the reflectance port eliminating errors due to back reflection. Efficient to 0.1%T. The trap fits into the ring of the sample holder.



- Center Mount Sample Holders

**PELA9038** A variable angle reflectance center mount holder for rigid samples. Maximum sample size is 35 - 40 mm square x 5 mm thick. A removable light trap is provided.

**PELA9039** For variable angle reflectance/transmittance center mount sample holder for thin film samples. Maximum sample size is 40 mm square x 8 mm thick.

**PELA9041** A center mount for holding a 1 cm<sup>2</sup> cuvette. For measuring absorbance of turbid liquids.



- Powder Sample Holder Set

**PELA9040** A manual powder press for pressing powders into a 3.2 cm powder cup.



- Small Spot Kits

**L6020211** 3-position (Transmission, Center mount, Reflectance) Small Spot Kit comprising of lens wheel for the sample beam that mounts in the sphere compartment and an iris assembly that mounts in the sample compartment.

**L6020313** Reflectance only Small Spot Kit comprising of single lens assembly for the sample beam to measure at the reflectance port.

**L6020316** Sample Compartment Iris Assembly comprising of an iris assembly that mounts in the sample compartment.

**L6020314** Reflectance Aperture Kit comprising of 3 Spectrafect® coated apertures (3, 6, 9 mm) that mount at the reflectance port to reduce the port diameter for small spots and small samples. Compatible with all 150 mm sphere accessories.



- Variable Angle Transmittance Sample Holder

**PELA9042** Includes sample holder and manual rotary stage kinematically positioned in front of the sphere for variable angle transmittance measurement of non-scattering samples.



- Adjustable Reflectance Support

**L6030329** For holding samples and reflectance standard in position. Fits on the reflectance port side. Height adjustable from 2 to 4 cm. This support is shipped with all integrating sphere accessories.



## 60 mm Integrating Spheres

### 60 mm Spectralon® Sphere Accessory

The 60 mm integrating sphere is suited to the routine analysis of diffuse samples compared to other samples of the same material. This is typically the case in QA/QC environments. Reflectance measurements include total and diffuse reflectance at a near-normal incident angle of 8°, and total and diffuse transmittance at normal (0°) incidence. Specular reflectance can be calculated from the total and diffuse reflectance measurements. The configuration is ideally suited as a collection sphere. Unlike the 150 mm sphere, the 60 mm sphere is prone to errors resulting from 'first strikes' on the detector due to the absence of baffles. These errors are very dependent on the specular / diffuse components of the sample. Samples with a high beam deflection will show significant errors.

Note also, the 150 mm sphere accessory is preferred over the 60 mm sphere accessory for color measurement as the 60 mm sphere does not support the port/area fraction recommended by International Commission on Illumination (CIE).



60 mm Spectralon® Sphere Accessory.

### 60 mm Infragold® Sphere Accessory

The 60 mm Infragold® Sphere Accessory (PELA1021) is designed for those who need to extend the range of their reflectance measurements from 1000 nm to beyond 2500 nm; the limit of Spectralon®. The Infragold® sphere allows the user to measure from 1000 nm up to 3200 nm.

The PELA1021 features a 60 mm Infragold® integrating sphere, transfer optics, and an integrated thermostatted PbS detector. The accessory is primarily for use in the near and near-mid IR.

Two 1-inch 94% uncalibrated Infragold® reflectance standards (UIRS-94-010) are included with the accessory.

## Features

- Principle:
  - Double Beam Operation
  - Plug and Play Operation
- Wavelength Range:
  - 200-2500 nm (Spectralon®)
  - 1000-3200 nm (Infragold®)
- Maximum Sample Size:
  - 60 mm Sphere Reflectance: 150 x 150 mm
  - 60 mm Sphere Transmittance: 120 x 150 mm
- Detectors:
  - Extended range PMT
  - 3-stage Peltier cooled InGaAs
  - Temperature stabilized PbS
- Absorbance Range:
  - PMT: ca. 0-5 A
  - Temperature Stabilized PbS: ca. 0-3 A
  - 3 stage Peltier cooled InGaAs: ca. 0-5 A

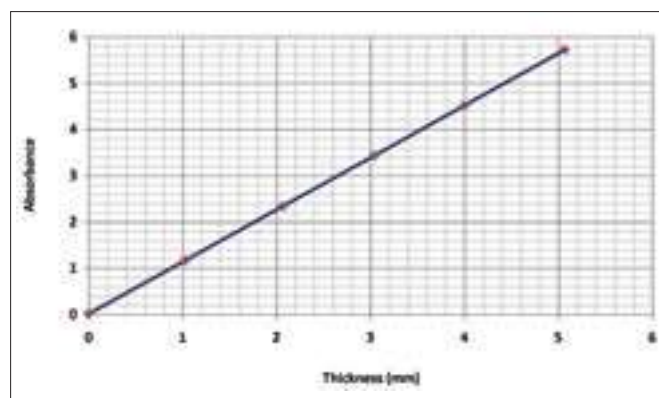
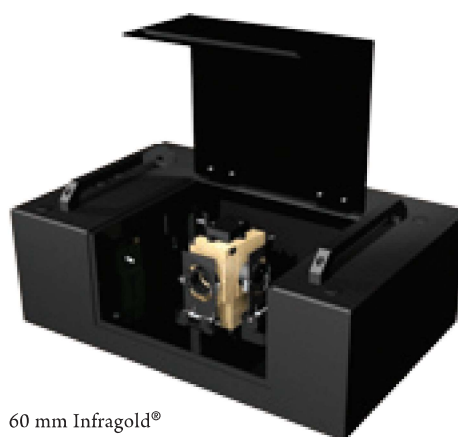


Figure 11. InGaAs sphere linearity (glass filters 1400-1500 nm).



60 mm Infragold® Sphere Accessory.

## General Purpose Optical Bench (GPOB)

The General Purpose Optical Bench (GPOB) is a versatile, dual compartment accessory featuring a 60 mm moveable Spectralon® collection sphere and a ruled optical bench that accepts a number of optional components which allow users to configure the incident light beam to perform measurement on a wide variety of samples.

The optional components, which include concave, convex and flat mirrors, lenses, iris diaphragms and sample mounts, can be located at any angle or placement needed for the measurement. Each component has a magnetized base that easily and securely snaps onto the optical bench. A delineated line pattern on the optical bench provides for precise alignment of the optional components.

Applications for the GPOB are limitless. The accessory can be configured to measure transmittance of large laser crystals or telephoto lenses or by adding a variable angle transmittance mount, the instrument can measure samples such as automotive glass at various incident angles. Optional component kits and example configurations are described in the following pages.

**Two (2) versions of the accessory are available:**

### InGaAs GPOB (L6020328)

The InGaAs GPOB includes a 60 mm collection integrating sphere, ruled optical bench, Peltier-cooled InGaAs detector and an extended range photomultiplier (PMT). The accessory is shipped with 6 mirrors: 2 of 1.5 x 1 inch toriod; 2 of 1.9 x 2.25 inch spherical convex; 2 of 2 x 2 inch spherical concave.

### PbS GPOB (PELA1003)

The PbS GPOB has all the features of the InGaAs GPOB but replaces the Peltier cooled InGaAs detector with a temperature stabilized PbS detector.

## Features

- Principle:
  - 60 mm moveable Spectralon® collection sphere
  - Ruled optical bench with reflectors, lenses, diaphragms and other optical elements to allow for various user specified measurement configurations
  - Long path optics
  - Variable angle transmittance
  - Specular reflectance
- Optical Systems:
  - Reflective collection optics
- Detectors:
  - Extended range PMT
  - Temperature stabilized PbS
  - 3-stage Peltier cooled InGaAs
- Wavelength Range:
  - 200-2500 nm
- Sample Size:
  - Maximum transmittance length 40 cm
- Absorbance Range:
  - PMT: ca. 0-5 A
  - Temperature Stabilized PbS: ca. 0-3 A
  - 3-stage Peltier cooled InGaAs: ca. 0-5 A



## GPOB Optional Component Kits

The GPOB offers a variety of component optical kits for measurement flexibility. The kits allow the user to move the incident light beam in different directions, collimate, focus or defocus the beam, hold samples in different positions, and collect the reflected or transmitted light in many different positions.

### Sample Holder Mount Kit

The PELA1005 Sample Holder Mount Kit consists of two cantilever sample holders with magnetic bases.

### Variable Angle Transmittance Sample Holder Kit

The PELA1006 Variable Transmittance Sample Holder Kit allows for holding samples at an accurate angle to the incident beam for measurement of transmittance. Samples can be up to 125 mm square and up to 10 mm thick. The maximum angle of incidence depends on the size and shape of the sample. Thin samples of ca. 50 mm square can be measured up to 80 degrees incidence.

### Lens Assembly Kit

The PELA1007 Lens Assembly Kit allows for the focusing of the beam to a small spot by means of a number of plano convex lenses and iris diaphragms. The lenses are mounted on magnetized bases for easy maneuvering and placement on the optical bench. Lenses are available in various focal lengths and may be purchased either in fused silica for use in the UV/Vis/NIR, or glass for Vis/NIR applications.

### Optical Bench Kit

The PELA1008 consists of three lens holders mounted on a magnetic optical rail.

### Fiber Optic Reference Feed Kit

The PELA1009 Fiber Optic Reference Feed Kit allows the reference beam to be introduced into the sphere via a flexible fiber optics bundle. This eliminates the need to use mirrors to direct the reference beam into the sphere, and allows a wider variety of geometries to be used.

### Light Trap Aperture Kit

The PELA1010 Light Trap Aperture Kit consists of black glass light traps and iris diaphragms specifically mounted for use with the GPOB.

### Specular Reflectance Kit

The PELA1011 Specular Reflectance Kit consists of six 5.08 cm diameter mirrors mounted on magnetized bases that can be easily placed on the base plate of the GPOB. Included are two square flat mirrors with  $\text{MgF}_2$  overcoat, two concave mirrors, and two convex mirrors. Focal length of the concave mirror is 127 mm, focal length of the convex mirror is 127 mm.

### Flat Mirror Kit

The PELA1012 Flat Mirror Kit consists of two 5.08 cm square inch plane mirrors on magnetic mounts.

### Short Focal Length Mirror Kit

The PELA1013 Short Focal Length Mirror Kit consists of a short focal length (20 mm) concave mirror on an adjustable base with a magnetic mount to allow for small spot incidence on curved samples.

### Beam Blocker Kit

The PELA1014 Beam Blocker Kit is an optically black beam blocker with a magnetic mount.

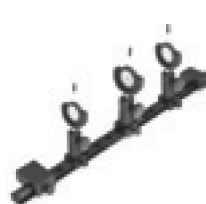
## GPOB OPTIONAL COMPONENT KITS



Sample  
Holder  
Mount  
Kit



Variable Angle  
Transmittance  
Sample Holder  
Kit



Optical  
Bench  
Kit



Fiber Optic  
Reference  
Feed Kit



## General Purpose Optical Bench Configurations

### Long Path Configuration

The GPOB comes configured to measure camera lenses and long, non-scattering samples such as glass and laser rods in the transmittance mode. Optional equipment that is desirable for these measurements may include sample holders and iris diaphragms.

Using the GPOB with a sample holding stand, the transmittance of a 200 mm telephoto lens is easily measured. This allows for analysis of coatings placed on lenses without disassembly into components.

### Variable Angle Transmittance Mount Configuration

The Variable Angle Transmittance Mount Kit allows for the measurement of non scattering samples at variable incident angles. With the addition of proper lenses or a mirror kit, angles near-grazing can be reached. Other useful optics include light traps to eliminate the reflected component of the incident beam and reduce stray light.

Using the GPOB with the variable angle transmittance mount, the transmittance through a sample of architectural glass can be determined. Such measurements are specified by both the U.S. Department of Energy and the Department of Transportation to determine minimum and maximum transmittances of glass used in buildings and automobiles.

### Specular Reflectance Configuration

The GPOB has the ability to measure virtually any specular material. By the use of various mirror and lens kits and with the ability to move the collection sphere into the path of the reflected beam, measurements of materials that, in the past, were impossible to measure on a spectrometer are now easily performed. By the use of the correct mirrors, one can configure any incident or collection angle, either in a relative or absolute mode. Shown in the diagram is the configuration used to measure the reflectance of a flat dichroic reflector using the General Purpose Optical Bench.

### Beam Splitter Characterization

With the use of the standard collection sphere, the transmitted component from each RGB color can be determined. The sample is stationary, and the sphere is rotated around the sample to collect each component. The components are the red, green and blue spectra and the total light transmitted in all the axes is the black spectrum (Figure 15). The GBOP collection sphere can be positioned in any axis relative to the sample, allowing collection of light from any plane of transmission without moving the sample, thereby allowing an accurate determination of the total light transmitted through the sample.

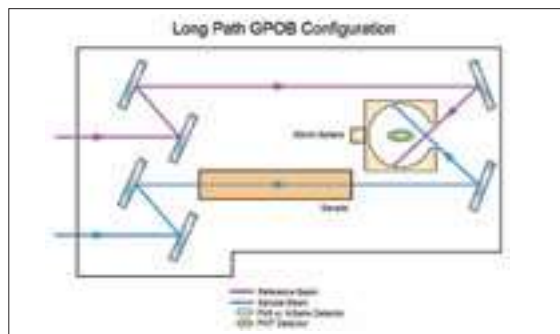


Figure 12. Long path configuration.

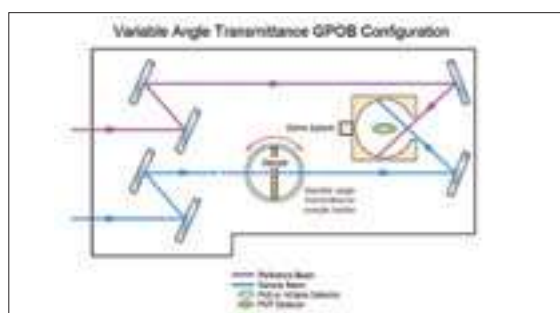


Figure 13. Variable transmittance mount configuration.

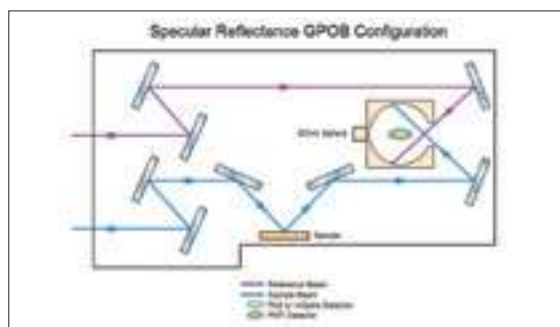


Figure 14. Specular reflectance configuration.

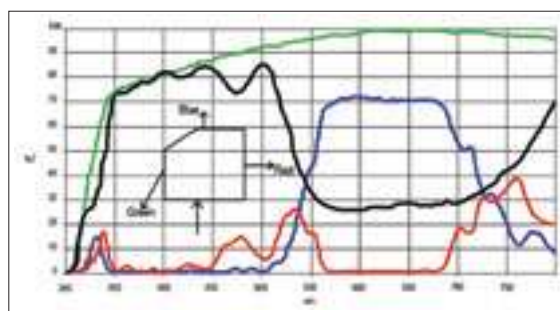


Figure 15. Beam splitter characterization.



Specular  
Reflectance  
Kit



Flat Mirror  
Kit



Short  
Focal  
Length  
Mirror Kit



Beam  
Blocker  
Kit

## Other Sphere Accessories

### 0°/45° Reflectance Accessory

Reflectance measurements using 0°/45° geometry are common in color analysis. The geometry is, by definition, specular excluded and is a good representation of the appearance of an object as viewed by an observer. While this geometry is very common in commercial colorimeters, the PELA1016 represents a research grade reflectometer in a 0°/45° geometry, allowing for measurement of color using the very narrow bandpass available with high end spectrometers.

Reflectance measurements using 0°/45° geometry are common in the measurement of paper products and in medical instrumentation, due to the ease of design and relative lack of maintenance. The PELA1016 provides researchers in those fields with an excellent test bench for sample measurement and instrument comparison. The accessory includes a 2-inch 99% uncalibrated reflectance standard.

The beampath of the 0°/45° reflectance accessory is shown in Figure 16.

### Features

- Principle:  
Measure samples in 0°/45° geometry  
Transfer optics provide normal, close to collimated illumination on reflectance sample  
Ellipsoidal ring mirror focuses the reflected radiation into a 50 mm collection sphere.
- Detectors:  
Extended range PMT  
Temperature stabilized PbS
- Wavelength Range:  
Reflectance only: 380-780 nm (references only allows calibrations over 380-780 nm wavelength range)
- Sample Size:  
Unlimited; sample port is external to sample compartment.

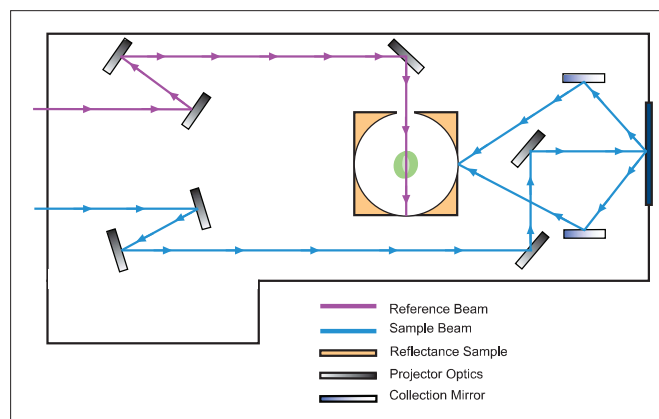


Figure 16. PELA1016 accessory beampath.



0°/45° Reflectance Accessory (PELA1016).



## Relative Specular Reflectance Accessories

There are three fixed angle relative specular accessories for measuring the relative specular reflectance of planar surfaces: a 6° near-normal accessory (B0086703), a 45° high angle accessory (PELA1025), and an 80° grazing angle accessory (PELA1026). A variable angle accessory is also available (B0137314).

Each fixed angle accessory fits in the sample compartment in either the sample or reference beam positions. Two accessories can be used, one in the sample and one in the reference beam, if a direct comparison is required. With the fixed 6° and 45° accessories, the sample is on an upward view and held in position by gravity on a 3-dot support.

The variable angle relative specular reflectance accessory allows for measurement of specular reflectance from samples at incident angles of 15° to 70° from normal.

The specular reflectance accessories require background correction with a suitable "blank" planar specular surface which is removed after establishing the 100% versus wavelength calibration. The sample data is a function of this blank specular surface. If the specular surface is a calibrated standard mirror, then the absolute reflectance of the samples can be determined automatically using the UV WinLab™ software. If the blank is a reference sample of established acceptability, a determination of the difference between the standard sample and measured sample is determined. Such a "pass/fail" situation is often all that is required in quality control and greatly simplifies testing.

Near normal (near 0°) measurements of specular reflectance are useful in the characterization of samples such as optical components. Measurements at 6° allow for this information to be produced.

Historically, 45° is a "textbook" angle and many examples in optics are demonstrated using this angle. Further, 45° is greater than the critical angle for glass and quartz/air interfaces; thus total internal reflection will occur at this angle of incidence.

As the angle of incidence is increased to near 90°, these angles are termed grazing angles and lower to higher index of refraction interfaces become excellent reflectors. For instance, automobile headlights are efficiently reflected off the surface of a wet road since they strike the air/water interface at near grazing angles. At 80°, approximately 50% of incident light is reflected and 50% is refracted at an air/glass interface.

Films and coatings on specular surfaces can be detected and analyzed as the angle of incidence approaches the grazing angle since the optical path through the film is considerably longer.

## Features

- Principle:  
Low cost alternatives to absolute specular reflectance accessories.  
  
Fixed angle 6° and 45° incidence offer upward viewing ports.  
  
Fixed angle 80° and variable angle (15°-70°) incidence mount sample vertically.
- Wavelength Range:  
175-3300 nm (190-2500 nm if using a collection sphere)
- Minimum Sample Size:  
Fixed angle 6° - 16 mm x 20 mm minimum or 22 mm diameter for spherical samples  
  
Fixed angle 45° - 20 mm x 20 mm minimum  
  
Fixed 80° - 30 mm x 30 mm minimum  
  
Variable Angle (15° - 70°) - 30 mm x 30 mm minimum, 55 mm x 55 mm maximum

## RELATIVE SPECULAR ACCESSORIES



45° High Angle  
Accessory  
(PELA1025)



80° Grazing Angle  
Accessory  
(PELA1026)



Variable Angle  
Reflectance  
Accessory  
(B0137314)



6° Near Normal  
Accessory  
(B0086703)

## Absolute Specular Reflectance Accessories

Five absolute reflectance accessories are available: a fixed 7.5° incident angle accessory utilizing the 'VW' optical geometry (PELA1029) and four accessories with the 'VN' optical geometry; 8° (N1016008); 30° (N1016030), 45° (N1016045) and 60° (N1016060).

The **VW Geometry** introduces two reflections at the sample. This is advantageous for samples with high reflectivity since the signal change to be measured is twice as large. However, the need for two reflections makes this unsuitable for small samples, especially at higher angles of incidence. It is also unsuitable for samples of low reflectance.

The **VN Geometry** allows a single reflection at the sample to be introduced without altering the direction of the output beam. This enables the coverage of the entire range from high reflectance to anti-reflectance coatings. The output beam is inverted between the two configurations which makes the accuracy critically dependent upon alignment and the beam and detector homogeneity.

The **Universal Reflectance Accessory (URA)** represents a breakthrough in multi-angle, high sensitivity absolute specular reflectance analysis. The URA dramatically improves upon traditional methods of analysis by automatically and reproducibly changing the angle with no adjustments to sample or optics, producing faster results. Previously multi-angle analysis often required 3 or 4 conventional accessories and many manual adjustments. This accessory is ideally suited to routine measurements on similar samples as experienced in quality control environments.

The accessories are termed "**absolute**" since they directly measure the reflectance of the sample (i.e., the optical path is identical for baseline and sample measurement except for the absence or presence of the sample).

Absolute reflectance accessories eliminate the need for reference mirrors and the potential pitfalls of relative methods. It is no longer necessary to deal with multiplication of the sample spectrum by the reference reflectance spectrum or with problems associated with the temporal stability and contamination of specular standards. The use of calibrated standard mirrors is not required to obtain absolute values of samples. However, the user may wish to verify the accessory is properly installed and aligned and that the entire system including the spectrometer is providing accurate data. In this situation, such standards allow the user to verify the system is performing accurately.

## Features

- Principle:
  - Fixed 7.5° utilizes VW geometry
  - Fixed 8°, 30°, 45° and 60° utilizes VN geometry
  - URA utilizes a modified version of the VN geometry.
  - Angles can be automated between 8°-65° in 0.5° steps.
- Wavelength Range:
  - 175-3300 nm (190-2500 nm if using a collection sphere)
- Minimum Sample Size:
  - Fixed angle VW – 20 mm x 20 mm
  - Fixed angle VN – 20 mm x 20 mm
  - URA – 10 mm x 10 mm

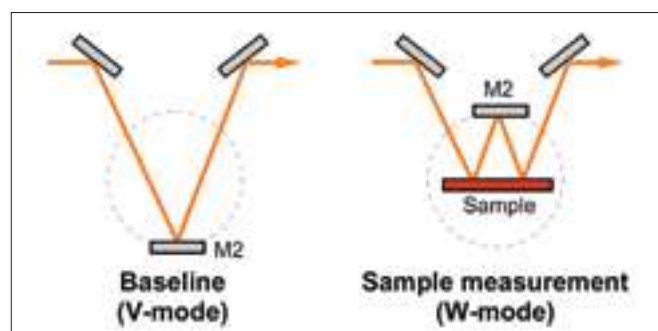


Figure 17. VW geometry.

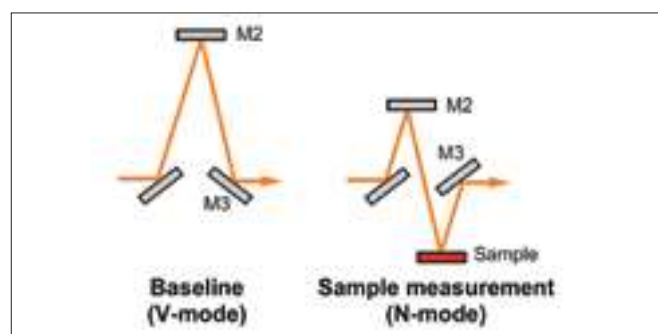
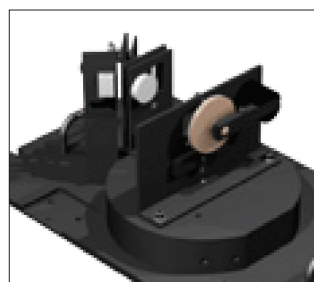


Figure 18. VN geometry.



Absolute Specular Reflectance Accessory.



Universal Reflectance Accessory.



## Optional Accessory Components

- **Uncalibrated Diffuse Reflectance Standards**

- L6020318 1.25" uncalibrated Spectralon® reflectance standard
- L6020319 2.00" uncalibrated Spectralon® reflectance standard

- **Calibrated Diffuse Reflectance Standards**

- PELA9057 1.25" calibrated Spectralon® reflectance standard  
250-2500 nm, reported each 50 nm. Disc provided with data  
each 1 nm.
- PELA9058 2.00" calibrated Spectralon® reflectance standard  
250-2500 nm, reported each 50 nm. Disc provided with data  
each 1 nm.

- **Calibrated Diffuse Reflectance Standards Sets**

For establishment of photometric accuracy and linearity in diffuse reflectance. Reflectance calibration is NIST® traceable. Calibrated 250-2500 nm reported each 50 nm. Disc included with data each 1 nm.

- PELA9010 Set of 4 calibrated 1.25" diameter diffuse reflectance standards,  
Reflectance Factors: 99%, 75%, 50%, 2%
- PELA9011 Set of 4 calibrated 2.00" diameter diffuse reflectance standards,  
Reflectance Factors: 99%, 75%, 50%, 2%
- PELA9012 Set of 8 calibrated 1.25" diameter diffuse reflectance standards,  
Reflectance Factors: 99%, 80%, 60%, 40%, 20%, 10%, 5%, 2%
- PELA9013 Set of 8 calibrated 2.00" diameter diffuse reflectance standards,  
Reflectance Factors: 99%, 80%, 60%, 40%, 20%, 10%, 5%, 2%

- **Calibrated Diffuse Color Standards Sets**

For establishment of photometric accuracy and linearity in diffuse reflectance mode. Calibration traceable to NIST® and NPL standards. Calibrated 250-2500 nm reported each 50 nm. Disc included with data each 1 nm.

- PELA9019 Set of 4 calibrated 2" diameter diffuse color standards.  
Set includes one each: orange, purple, cyan, and violet

- **Mirror Standards**

For relative specular reflectance correction. Calibration traceable to NIST®.

- B0071519 Uncalibrated Flat Al mirror 40 mm square with MgF<sub>2</sub> protective  
layer, 250-2200 nm data reported every 50 nm. Disc included with  
data every 1 nm.
- L6025022 Uncalibrated Flat Al mirror 30 mm square with MgF<sub>2</sub> protective  
layer, 250-2200 nm data reported every 50 nm. Disc included with  
data every 1 nm.
- B0505975 Calibrated Flat Al mirror 40 mm square with MgF<sub>2</sub> protective layer,  
250-2200 nm data reported every 50 nm. Disc included with data  
every 1 nm.
- N1010504 Disposable calibrated Flat Al mirror 40 mm square with MgF<sub>2</sub>  
protective layer, 250-2200 nm data reported every 50 nm.  
Disc included with data every 1 nm.



The LAMBDA 1050, 950 and 850 series spectrometers are the industry standard for ultra high performance, flexibility and convenience and are designed for analysis of coatings and component performance in both research and manufacturing. The new LAMBDA 1050 with its enhanced performance in the NIR range offers the highest sensitivity and resolution, ideal for the measurement of optical materials, including high performance glass and coatings.

The LAMBDA 650 and 750 are spectrometers ideally suited to the busy academic and industrial laboratories who need flexibility of sampling, along with high performance.

This brochure highlights a series of integrating sphere and related accessories specifically designed for the LAMBDA high performance series spectrometers, including:

- 150 mm Integrating Sphere Accessories
- 60 mm Integrating Sphere Accessories
- General Purpose Optical Bench Accessories
- 0°/45° Reflectance Accessories
- Relative Specular Reflectance Accessories
- Absolute Specular Reflectance Accessories
- Calibration Standards

For additional information visit [www.perkinelmer.com/new-limits](http://www.perkinelmer.com/new-limits)

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