The Olis® Line of Cary-based Spectrophotometers

Move to the Modern with the Best of the Past

Fifty years after the Cary 14 was introduced, this extraordinary UV/Vis/NIR spectrophotometer remains the best of the best, with only the smallest exceptions. Its sister, the Cary 17, is an optically identical peer.

An Olis 14/17 – built from a Cary from your laboratory or from our storehouse – provides you with absolutely best optical performance at half the price of a brand-new alternative.

The spectral range is 185-2600 nm, photometric accuracy is ± 0.0005 AU/hour, and stray light is less than 0.001%, among other distinctions.

One can use an Olis 14/17 exclusively for scanning UV/Vis/NIR absorbance, or one can add hardware for circular dichroism and fluorescence. Accessories for stopped-flow, automatic titration, pressure-dependent, temperature-dependent, angle-dependent, and other processes are made by Olis and third party suppliers.

After the Olis modernization, the outstanding optics of the classic Cary monochromators are now supported by all-new Olis electronics and mechanical components. All instrument control, data acquisition, and data handling are supported by the Windows® SpectralWorks™ software package.

Standard Components

- Prism + grating F/8 Cary monochromator
- Original photomultiplier tubes throughout the UV/Vis region and PbS detector throughout NIR
- Air cooled 50 or 100 watt tungsten lamp for Vis/NIR and air cooled 30 watt deuterium lamp for UV
- Lamp power supplies incorporated into Olis control box
- All electronics by Olis, Inc.
- Olis SpectralWorks data acquistion/instrument control software package
- Olis GlobalWorks data handling and analysis software
- DELL® Pentium® computer (latest model, desk or laptop) and 17" color monitor
- HP® LaserJet® or DeskJet® printer (latest model)
- Surge protected multistrip electrical outlet/control panel

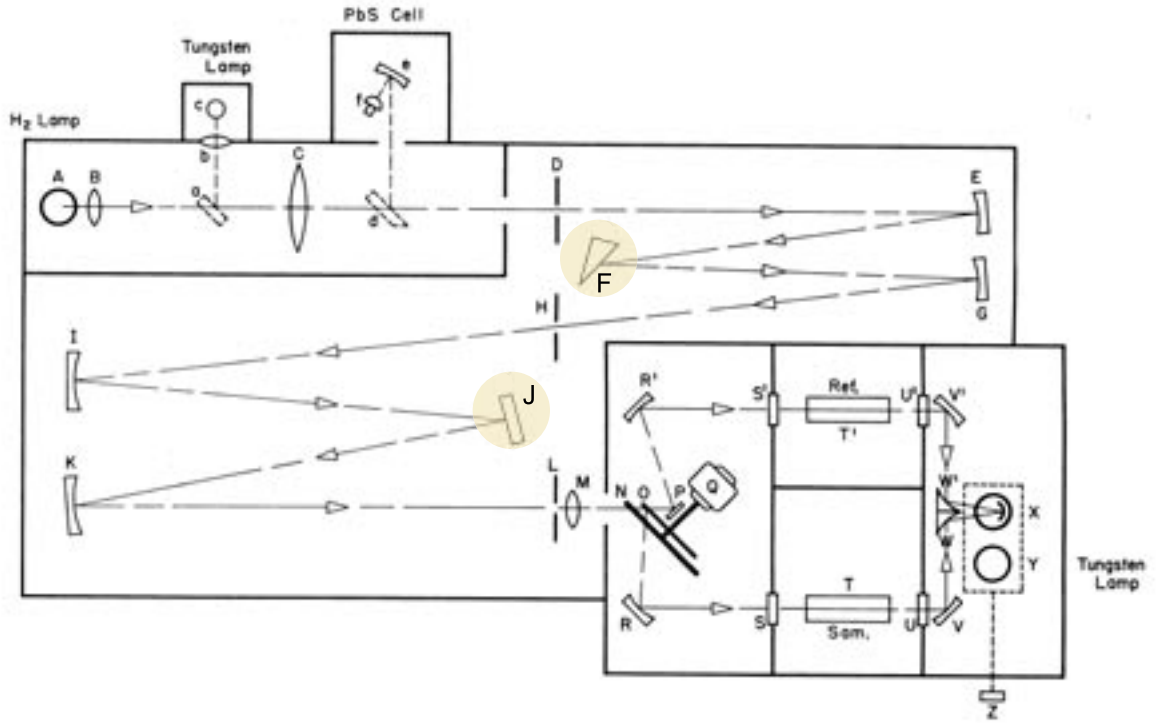
Components to Add or Substitute:

- Stopped-flow mixer, Olis or other
- Olis DSM CD Module
- Diffuse reflectance accessory, Cary, Harrick, or custom
- Scattered transmission accessory, Cary or Vertex
- Titrator, Olis
- Peltier cell holder, Olis, QNW
- Vertex™ variable angle thin film holder
- InGaAs detectors for NIR work to 2500 nm

Other Carys Modernized:

- Cary 15
- Cary 16
- Cary 60 / 61
- Cary 118

Diagram of Cary 14 & 17 Prism Grating Optical System



The arrows on the optical diagram trace the path of the ultraviolet and visible radiation through the instrument. Radiation from the deuterium or tungsten lamp is directed to the monochromator entrance slit **D** by appropriate lenses and mirrors. From mirror **E** it travels to prism **F** where it is refracted, then to mirror **G** which reflects it to variable width intermediate slit **H**. Mirror **I** reflects the radiation to grating **J** and from there the monochromatic beam is directed to mirror **K** and exits the monochromator through slit **L**. Semicircular mirror **O**, driven by motor **Q**, chops the beam at 30 Hz and alternately sends the half beam to the reference and half to the sample. Elements **V**, **V1**, **W**, and **W1** pass the separated beams to the phototube. The light pulses of the two beams are out of phase with each other so that the phototube receives light from only one beam at a time.

The photomultiplier for UV/Vis work is shown at **x** and the NIR detector for 700-2600 nm is shown at **Y**. The detection-selector, **Z**, is automated in the Olis models.

Diagram and text taken from original Cary documentation.

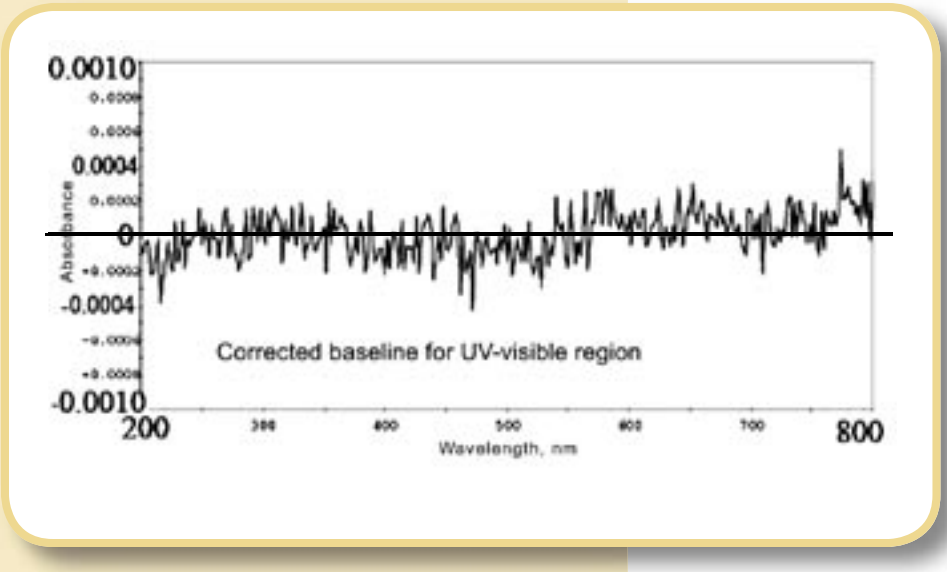
Technical Specifications*

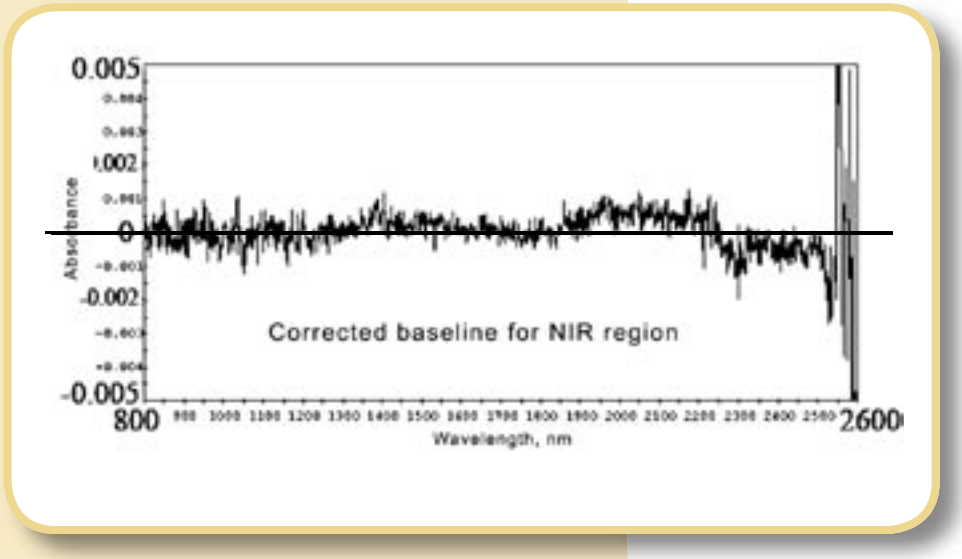
Wavelength Range	
• Cary Models 14 & 17	185-2600 nm (with a select few extending up to 3000)
• Cary Models 15 & 118	185-800 nm
• Cary Model 16	170-700 nm
Optical System	
• Cary Models 14, 17, 60, 61	prism + grating
• Cary Models 15, 16, 118	prism + prism
Photometric Noise	< ± 0.0001 ABS units throughout UV/Vis
Drift	± 0.005 ABS units/hour
Lifetime	Minimum of 10 years, with potential for many decades of uninterrupted utility
Wavelength Drive Speed	Arbitrary, from 40 nm/sec to very slow
Data Sampling Interval	Arbitrary; from 50 nsec to arbitrarily long
Light Source Changeover	Computer controlled and user selectable
Stray Light	< 0.0001%
Photometric System	Side-on photomultiplier tubes for the UV/Vis and PbS for NIR; linear current to voltage transducer; 16 bit A/D/A converter; and Olis software
Photometric Value Presentation	Digital number on screen with realtime presentation for data being collected
Photometric Accuracy	± 0.001 ABS units to 2.0 ABS and ± 0.003 from 2.0 to 3.0 ABS
Photometric Repeatability	Better than < + 0.001 ABS units
Auto-Zero Adjustment	Fully under computer control
Baseline Stability	<0.001 ABS units/hour after initial warm-up
Baseline Correction	Automatic with all incoming records once baseline is collected
Baseline Flatness	± 0.001 ABS units/hour after initial warm-up
Data Storage Mode	3D scans stored as single file in default Olis binary (.ols); right click for Excel® (.xls) or ASCII (2D)
Repetitive Scanning	As a function of time, temperature, pressure, or other process
Monochromator	Premium quality dual beam, prism + grating F/8 monochromator
Light Source	Air cooled 50 or 100 watt tungsten for Vis/NIR and air cooled 30 watt deuterium for UV. A high intensity lamp (650 watt) for use in the NIR is available as option. The CD and stopped-flow versions use ozone producing 150 watt xenon arc lamps.
Detector	R955 PMT for UV/Vis and PbS for NIR; InGaAs for NIR CD, fluoresence
Sample Compartment	Large (10 x 10 x 10 cm) which houses standard 1 cm^2 cuvette holders (two) for true sample and reference acquisition; or CD module
Power Requirements	110 and 220 V models are available
Dimensions	4’ x 2’ x 3’
Weight	~ 150 kg
Ambient Requirements	Normal laboratory conditions. N_2 is used for flushing chamber during UV scanning

* Taken from original Cary 14 information. Parameters will vary slightly for the other Carys.

Technical Specifications

One of the more appreciated changes to the original spectrophotometer is the new mode of producing a flat baseline. (Many tedious hours have been spent adjusting the MULTIPOT system in the Cary 14!) With the Olis system, one scans a spectrum without sample present, stores this value, then the computer subtracts the 'baseline' (background) record from all incoming raw data. Baseline flatness of better than ± 0.001 absorbance units is achieved from modernized Cary units.





Modernizing Your Cary Spectrophotometer

Since the late 1970's, Olis has built premium quality optical benches based on the optics and housings of classic Cary monochromators. The results are optically superb, yet affordable. UV/Vis, UV/Vis/NIR, CD, absorbance, fluoresence, spectrophotometers. Prices are consistently about half of the replacement cost of optically competitive models.

Often, the owner of a Cary invites Olis to modernize his instrument. The alternative is a completely modernized unit from the units Olis has purchased and/or taken as trade-in*.

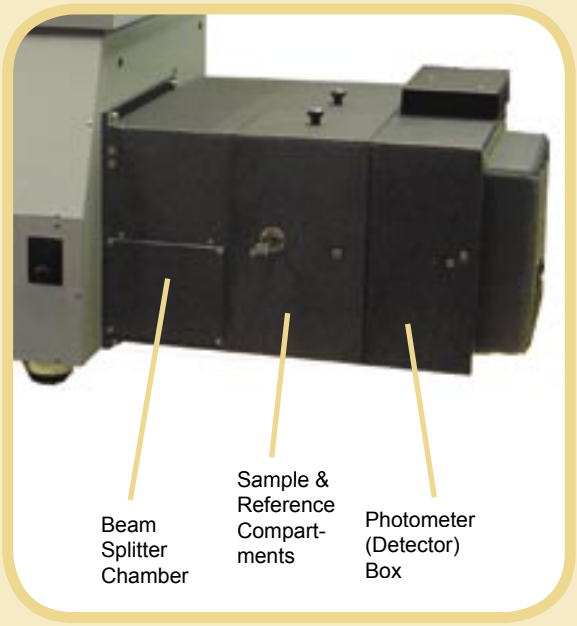
Both choices mean a new life for a superb optical system and huge cost savings to you.

Original Cary 14 Spectrophotometer

After Olis modernization

* Help us keep these extraordinary instruments in use by contacting Kristi for any Cary headed to surplus or disposal.

Typical Modernization Procedure



After removing hundreds of pounds of circa 1960s circuitry, the multi-pot unit, and all other original contol/ recording hardware, we add:

1. A stepping motor under the monochromator, coupled to the wavelength drive input shaft with a zero-backlash chain. The new motor and monochromator drive ratio result in wavelength steps to half an angstrom (0.05 nm) with a maximum scan rate of approximately 20 nm/second.

2. A second 200 step/revolution stepping motor to the slit width mechanism; it is with this motor that the Olis computer system controls system gain and adjusts spectral resolution. The original, noisy mechanical slit moving mechanism is replaced with a new, quiet one.

3. An optical detector at the chopper wheel to provide a signal to the computer that is synchronous with the switching of the measuring light between sample and reference cuvettes.

4. The original PMT is replaced with a new one with superior noise, dark current, and high gain performance. This new PMT has extended UV and extended NIR response, as well. The original high voltage power supply is replaced with a programmable high voltage photomultiplier socket assembly.

5. A precision input electrometer operational amplifier is mounted in the photomultiplier chamber to act as a photocurrent to voltage converter. The amplifier produces one volt output per ten nanoamperes of photocurrent.

6. We replace the original UV/Vis lamps with new air-cooled deuterium and tungsten lamps and modern regulated power supplies. We replace these stable lamps with a high intensity light source (e.g., xenon arc lamp) for maximum illumination power when fluorescence or circular dichroism work will be done.

7. An external Olis control box, which interfaces between the monochromator and the recording computer, houses the rest: lamp power supplies, motor drives, calibration circuitry, and Windows communication hardware (including two 16 bit A/D/A converter chips).

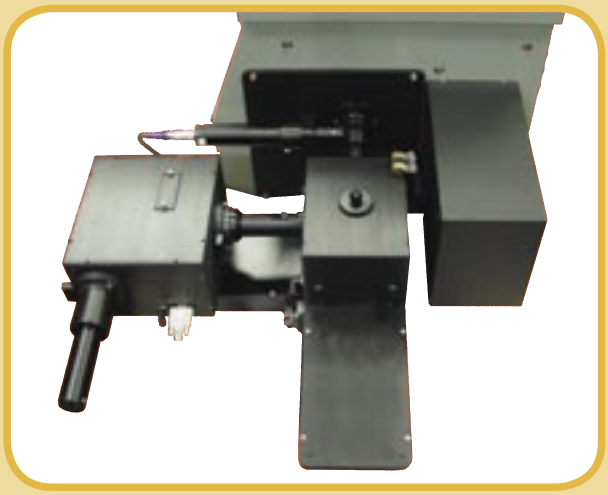
8. The stripped and simplified instrument is fitted with a new front panel and top. The sample chambers are sandblasted and anodized.

9. Multi-position cell holders, photolyzing flash photolysis accessories, stopped-flow mixing units, magnetic stirring blocks, automatic titrators, Peltier cells, high pressure cells, and other ‘sample holders’ can be added by Olis or the laboratory personnel.

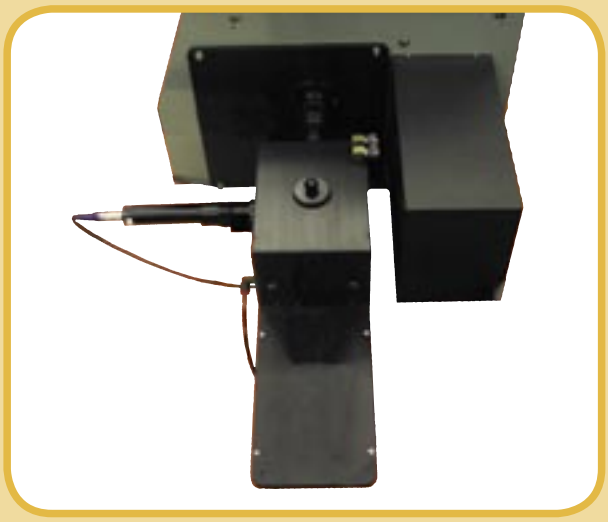
Fluorescence Configurations

Fluorescence and fluorescence detected CD (FDCD, next page) can be added to an Olis modernized Cary. Generally, the Cary monochromator will be used as the excitation monochromator, providing its entire 185-2600 nm range for the excitation beam. The emission monochromator can be the Olis single grating monochromator, shown here, or emission can be detected directly at the detector positioned 90 degrees to the excitation source (lower photo).

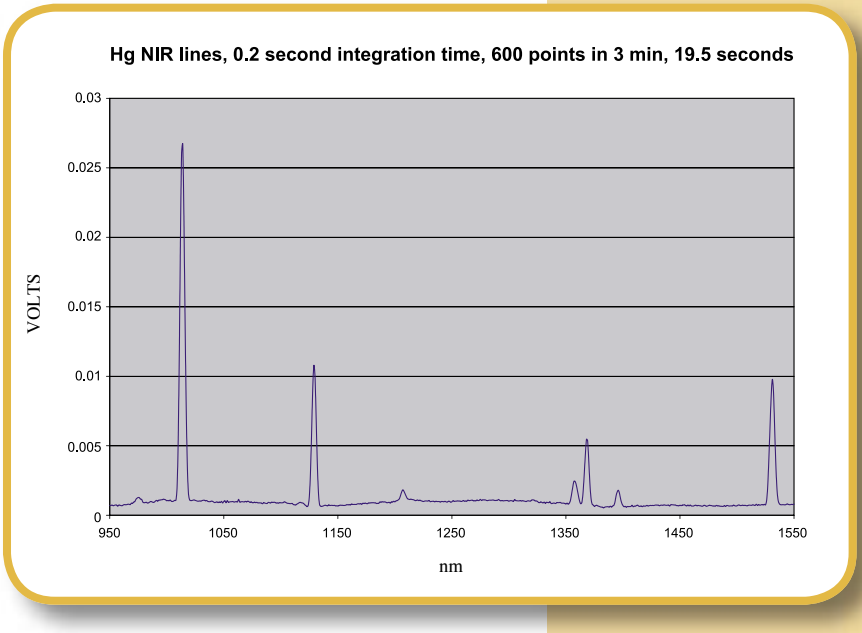
The emission wavelengths supported by the Olis single grating monochromator module will be UV/Vis, Vis/NIR, or NIR optimized. That is, the monochromator's grating will be selected for the emission wavelengths needed. The detector will be a UV/Vis or Vis/NIR photomultiplier tube, or a UV/Vis photon counting detector, or a fast response InGaAs detector for NIR. The spectrum show below of the NIR mercury lines in overhead fluorescent lights were acquired with the InGaAs detector.



Emission Monochromator



Emission through Filter



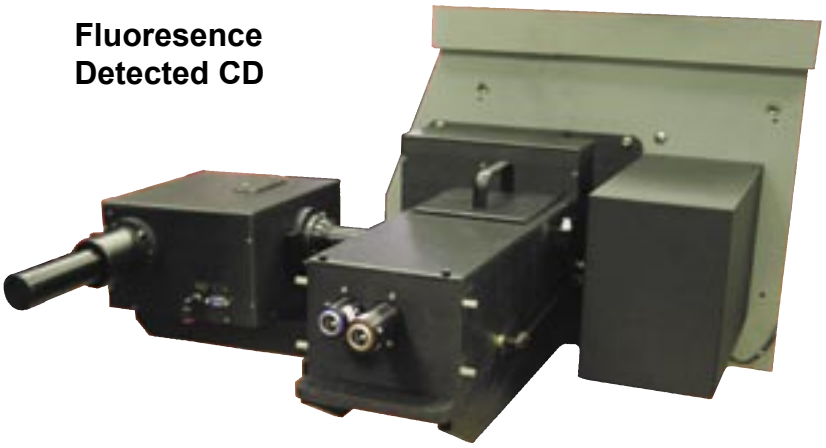
Circular Dichroism Configuration

Olis DSM 17 CD
Spectrophotometer

The Olis DSM 17 UV/VIS CD
The components that transform the Cary spectrophotometer into a dual beam Olis CD include the 150 watt Suprasil® xenon arc lamp and the self contained Olis DSM CD module (facing page).

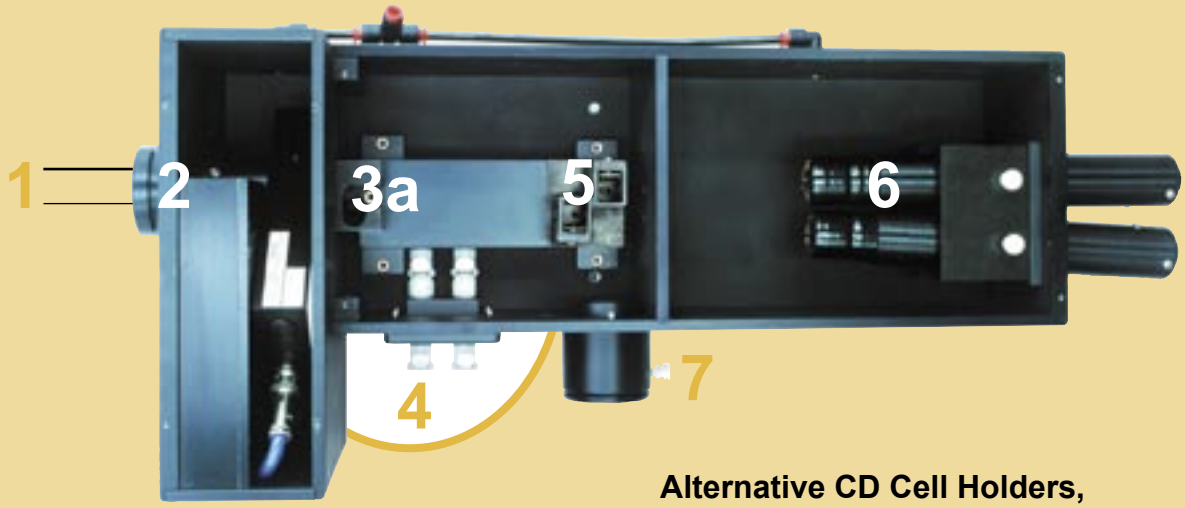
The standard spectral range is 185-800 nm, slightly red shifted from the other two Olis DSM CDs, which support scanning to ~170 nm. The Olis DSM 17 CD's spectral range is extended easily and economically to 1700 nm with only the replacement of the pair of PMTs for InGaAs detectors. Done as easily, but at a higher cost, is extending the utility to 2600 nm.

Fluoresence Detected CD



Emission monochromator addition with digital photon counting detector.

Physical Layout of CD Module



Alternative CD Cell Holders, Peltier Thermoelectric

3b

3c

1 Incoming beam from monochromator.

2 Magnesium fluoride polarizer/beam splitter splits the light beam (**1**) into two linearly polarized beams each orthogonal to the other. Angle of divergence can be as small as 1° and as wide as 5°; standard divergence is 3° putting beams of light 3.5 mm apart at the center of the cylindrical cell holder (**3a**). Also, the 50 kHz Hinds PEM-90, which modulates each beam at 50 kHz rate, out of phase with each other. The two beams modulate/ toggle between RCP and LCP 50 times per millisecond.

3a CD Cuvette holder, useful with both rectangular and cylindrical CD cuvettes. Jacketed for temperature regulation with circulating fluid (shown in chamber, **3a**) or Peltier (shown outside chamber, **3b**).

3c **Olis Twin Position Peltier Cell Holder** Two CD samples can be scanned simultaneously, which is used mainly for long thermal melts; samples are in a twin CD/2 rectangular cell holder in position 5 within the chamber (optional).

4 Water lines to cuvettes **3a** & **5**, so that a digital or manual temperature can be achieved using a water bath.

5 **Optional** 1 cm^2 rectangle cell holders for rectangular cuvette for absorbance, fluorescence, and CD/2; jacketed for temperature regulation with circulating fluid.

6 Two detectors optimized for the desired UV/Vis or Vis/NIR region. Each detector has its own amplifier circuitry and its own high precision A/D converter.

7 Port for detector for Fluorescence Detection CD, absorbance, and/or for photolyzing flash.

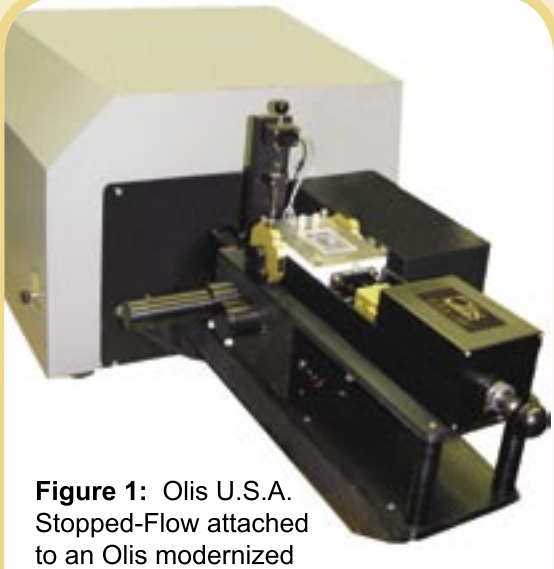


Figure 1: Olis U.S.A. Stopped-Flow attached to an Olis modernized Cary 14

Decades of experience with all types of stopped-flows[1] prepared us to design an Olis model which incorporates what is most utilitarian from them all. The traditional Ball-Berger mixer and pneumatic drive systems are used, as is the horizontal orientation of the drive syringes[2].

Olis USA Stopped-Flow

Mount an Olis USA stopped-flow mixing unit to add millisecond mixing to the Olis modernized Cary.

The original three chambers – beam splitter, sample compartment, and photometer box (see page 6) – are removed and replaced with a unified module comprised of a mounting plate, stopped-flow mixing unit, sample compartment, and detectors. The mounting plate bolts exactly where the original beam splitting chamber did; the rest of the stopped-flow hardware is bolted to it.

Other hardware changes are the addition of a high speed A/D (choose the 2 MHz or 20 MHz models) and (optionally) changing from the default deuterium and tungsten lamps to a higher intensity 75 or 150 watt Xenon arc lamp.

The Olis USA stopped-flow will provide much faster mixing and much higher intensity signal than a low cost, but easily implemented, umbilical cord type stopped-flow (such as an RX 2000). However, Olis software supports use of any device which sends or receives a TTL pulse. One could use an umbilical cord type mixing apparatus with an Olis spectrophotometer without making any A/D or lamp changes.

Uniquely, Olis stopped-flows have ceramic valves, rendering them impervious to temperature extremes, corrosives, and gas exchange. Also unique to Olis stopped-flows is a safety interlock system which prevents misfiring of the stopped-flow, ensuring against loss of sample and damage to the hardware or operator.

Figure 2: Olis U.S.A. Stopped-Flow on Stopped-Flow Stand

Footnotes

[1] In 1969, Olis founder, Richard J. DeSa, published the first paper on computerized stopped-flow spectroscopy with his postdoctoral advisor, Quentin Gibson. The paper, “A Practical Automatic Data Acquisition System for Stopped-flow Spectrophotometry (Computers and Biomedical Research, 1969, 2:494-505) describes the authors’ use of computers to analyze and store fast kinetic data. The “stopped-flow spectrophotometer” is introduced and described in “Rapid Mixing: Stopped Flow,” Chapter 6, volume XVI in Methods in Enzymology; this chapter is still the best introduction to the technique we have seen and a “must read” reference for everyone new to stopped-flow mixing. Since its founding in the mid-1970s, Dr. DeSa’s company has computerized hundreds of stopped-flows, ranging from homemade models to the most sophisticated commercial version.

[2] Vertical orientation of these syringes has presumed advantages. In practice, horizontal syringes are easier to see and to work with, so we stayed with the classic horizontal orientation.

Titrator

Exclusive four syringe titrator for use with highest quality cuvettes with pathlengths of arbitrary length and diameter, making it ideal for use with a range of spectrometers. Features complete mixing outside of measuring cell, volumes based on pathlength. Fully arbitrary detection ratios among enzyme, substrate, inhibitor, and buffer and user-selectable delay times between mixing and measurement. All mixing is computerized infusion/withdrawal cycles from the storage syringe to measuring cell.

Two syringe and ambient models are also available.

Olis Four-Syringe Peltier Titrator

Cuvette Holder, Peltier

The cell holders follow an ASCII script, which is read by the Olis SpectralWorks software package. This script identifies which cells are used and how much time is spent at each cell before moving to the next. Scans are made between cell positions.

QNW TLC 50

Single (shown here) and twin holders (see 3c, page 9) for rectangular 1 cm² cuvettes are available. These Quantum Northwest (QWN) units have built-in stirring in each cell and a temperature range of -55 to +105 ° C, with ± 0.02 ° C precision.

Linear and turret Peltier cell holders are provided by QNW for Olis, Inc., both equipped with built-in magnetic stirring. Not shown are multiple position Peltier cell holders.

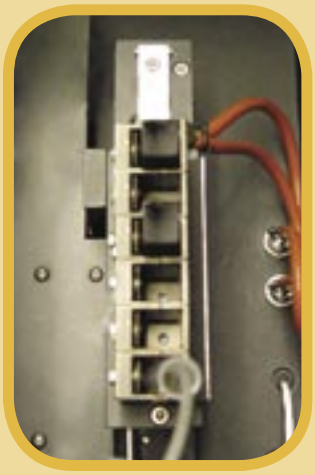
QNW Peltier Cell Holders

Four, Six, and Ten Position Cell Holders

Olis makes multiple position cell holders which are thermoregulated when used with a manual (analog) or computer controllable (digital) water bath. The temperature range is determined by the chosen water bath. When the water bath comes from Olis, it will be a compact model by Julabo, with a temperature range of -26 to + 200° C.

Both Olis and QNW cell holders (above) support use of 1 cm² cuvettes; microvolume cells are compatible, too, when optional spacers are used to ensure thermal contact.

Olis Jacketed Cell Holders

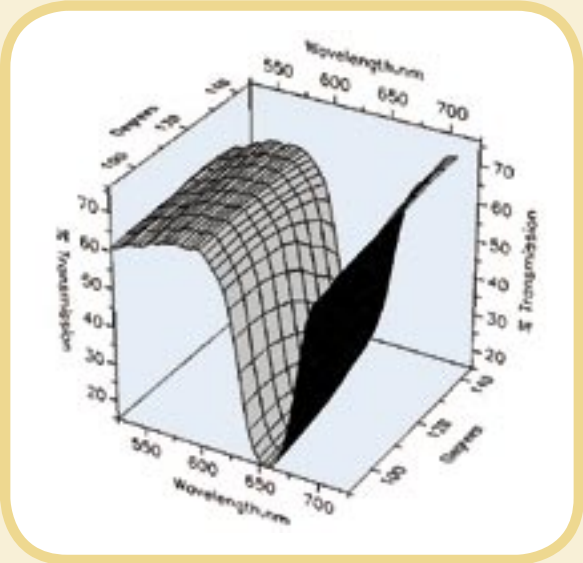


Vertex Variable Angle Specular Reflectance Accessory

The Olis computerized Vertex works by rotating the sample about a plane 5° to 85° with a 1° resolution. The “angle of incidence” (AOI) is specified through the Olis software and can vary in either direction in a linear or nonlinear way during the course of the experiment.

The Vertex holds the sample in a single spring loaded clamp. Samples can be irregular in shape and up to 5 mm thick.

Light is reflected by, and not transmitted though, the sample. Thus, this “specular reflectance” is not suited for use in fluorescence measurements.



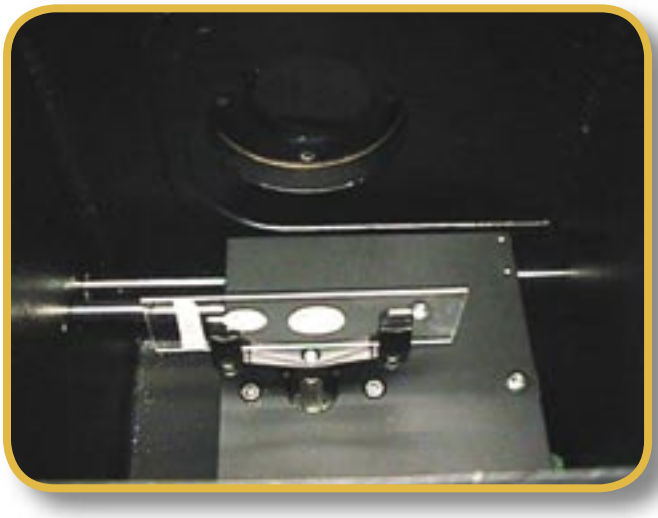
Spectra supplied by Harper lab,
USC Lokar Hydrocarbon Center

Olis Variable Angle Specular Reflectance during rotation

Olis Thin Film Holder

The solid sample (often presented on a microscope slide or similar substrate) is positioned at 45° or 60° or some other suitable angle for light transmission through the sample. (Reflection is not measured.)

The accessory can be computer-controlled to step in integral angles with 1° resolution and 180° capability. The sample can be 0.5 x 0.5” or 1.5 x 1.5” and any shape with a thickness up to 5 mm.



Olis®

SpectralWorks™

Every step of setting up the experiment through final storage of the results is done with the Olis SpectralWorks software package.

Through this Windows XP compatible program, one sets the spectral range, scan speed, and accessories to be controlled. Parameters can be changed individually or collectively with easily produced Protocol files.

Raw data from both sample and reference channels can be viewed at any time; processing of these signals is available as abs, Δ abs, %T, volts, mdeg, or other unit.

A split screen is often employed so that both spectra and kinetics can be viewed side by side; a dynamic slicing option allows viewing of 'scan at time x' as well as 'kinetics at wavelength y.' Within this comprehensive data acquisition/instrument control program is all of the functionality of GlobalWorks, our data analysis program. Here, you will find all data processing algorithms for simple 2D analysis (e.g., smoothing, derivation, peak finder, integration, secondary structure determination) as well as algorithms for fitting kinetic and equilibrium 3D data sets.

Data are saved as Olis binary files; with a right click of the mouse, ASCII, Excel, and JPG files can be produced.

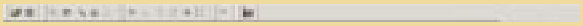
Both the Pentium PC hardware and the Olis SpectralWorks software are included in the purchase price of an Olis spectrophotometer. Laptops are available with some models.

Exploded View of SpectralWorks Screen

Title Bar

Menu Bar

Tool Bar

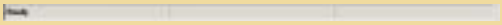


Data Collection Tabs

Instrument Settings

Data Display

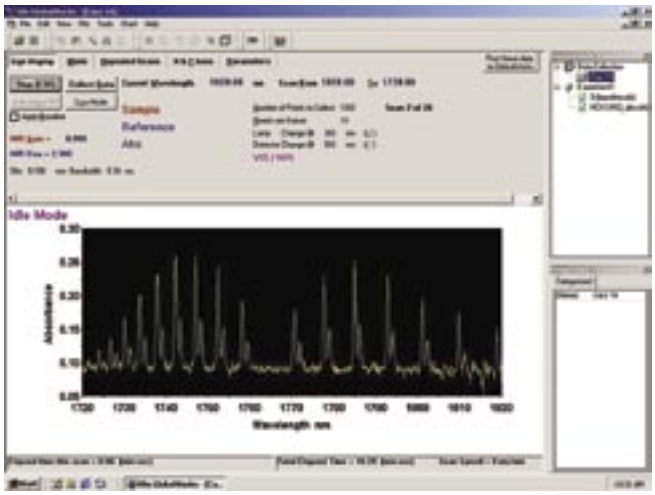
Status Bar



Experiment Window

Properties Window

Page from Olis SpectralWorks Manual



Live Display
Displays current instrument settings and collection of data.

This is an example page from the manual which shows the user interface one interacts with while setting up the instrument for data acquisition; the spectra shown are of benzene vapor acquired on an Olis 17.

Pull-down menus, fill-in-the-blank numbers, and click-on tabs are used on this **Live Display** page. The “Live Display” tab is depressed (notice its slightly lighter color than that of the **Mode, Repeated Scans, X & Y Axes,** and **Parameter** tabs). Because of this, certain instrument parameter choices are presented to the operator.

Numeric values for “Scan From ____ to ____” are inputted directly. Selection of “Apply Baseline” is done by clicking the box next to the choice. The Parameter tab will allow access to optionally used accessories. And so on.

Boxes to the right of the graph contain file name and file specification information. (See previous page for an exploded view of this screen.)

SLITWIDTH AND BANDWIDTH
The current slit width and resulting bandwidth are reported here. When **Data Reduction Mode** is set to **Single Beam**, the user can assign these values. Otherwise, slit width is adjusted to compensate for changing light intensities.

CURRENT WAVELENGTH
The current wavelength is displayed here and will update during a scan. The wavelength range is 185-2600 nm and is changed by clicking on the value. *The keystroke shortcut for changing Current Wavelength is **W**.*

LIVE SIGNAL DISPLAY
During data collection and live mode the current sample, references, and absorbances are displayed here. The calculation data will depend on the **Data Reduction Mode** set in the **Operational Modes** tab. Values will be continuously updated when the instrument is in **Live Mode**.

SCAN RANGE
Starting and ending scan wavelengths are displayed and entered here. The acceptable wavelength range is 185-2600 nm, and it is generally advisable to scan down from the higher wavelength.
*The keystroke shortcuts for entering the starting and ending wavelengths are **F** and **T** respectively.*

Data Processing with Olis SpectralWorks Software

Olis SpectralWorks software includes a long list of useful data processes for single data-sets including:

Apply Constant
Average Scans Within Dataset
Average Points
Convert Volts to Absorbance
Correct Fluorescence
Convert CD Units
Dilution Correction
Derivative
Digital Filter
Fourier Transform
Integration
Interpolate
Normalize
Peak Finder
RC Filter
Reverse X Axis Data Array
Reverse Y Axis Data Array
Reverse Axes Data Array
Swap Axes
Synthesize New Dataset
Trim Points
Take Reciprocal
CDSSTR
CONTINLL
SELCON3
Inverse Spectrum

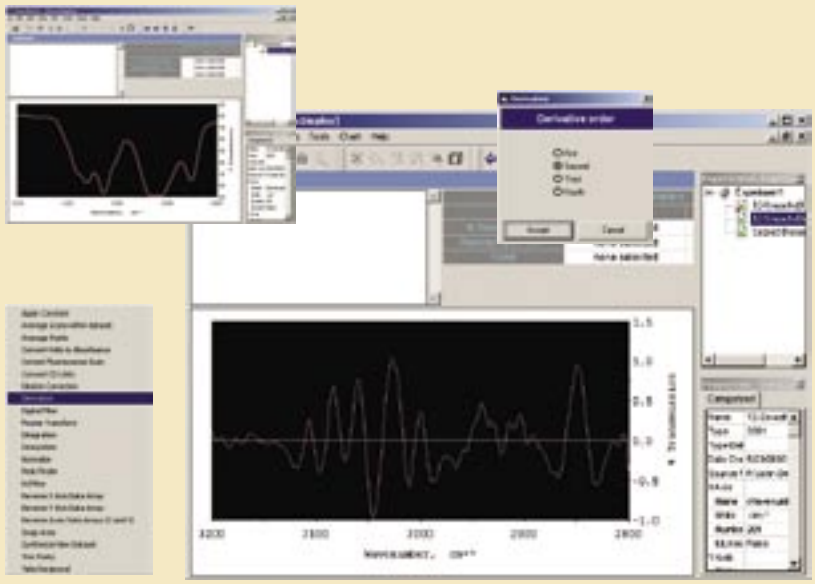
Olis SpectralWorks software also includes data processes for working with multiple datasets:

Add Selected Datasets
Subtract Selected Datasets
Average Selected Datasets
Multiply Selected Datasets
Apply Constant
Normalize
Concatenate
Anisotropy
Polarization
Corrected Scans
Build 3D Dataset from 2D

SpectralWorks™

All Olis Instruments operate with extremely similar versions of Olis SpectralWorks™ software

This composite image shows the spectrum (upper left), the data processing choices (lower left), selection of 1-4 order derivative (upper right), and the final screen with the second derivative calculated and plotted.



See the Olis GlobalWorks document for full details on global, 3D, algorithms utilizing SVD and Matrix Exponentiation.

"You know, it has been 20 years on that machine—wow! I don't have any instrument in my lab that has survived for that length of time."

Dr. Paul Hoffman, University of Virginia, on the endurance of his upgraded Cary 14

"We have been extremely happy with the quality and speed of the service and the advice that we have been given by Olis over the years, and we are absolutely confident that we shall continue to feel the same way in the future."

Dr. Joseph Michl, University of Colorado

"The original instrument has provided satisfactory experimental results....The Olis upgrade completely eliminated the need for those parts of the instrument [which were problematic] promising increased instrument reliability. The result should be a dependable instrument with known characteristics and computer controlled data collection, manipulation, and storage at a fraction of the cost of a new instrument."

Dr. Karl D. Straub, Duke University

Olis Modernized Cary 118

Olis

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