



Cary 8454 and Cary 60 UV-Vis-NIR Systems

Routine Analyses for Liquids
and Solids

Dr. David Troiani
UV-Vis, Fluo & FTIR
Application Scientist
Agilent Technologies



Presentation Outline

1. Agilent's Molecular Spectroscopy Portfolio
2. Cary 8454 and Cary 60, Why Two?
3. Cary 8454: Rapid Liquid Analyses
4. Cary 60: Scan What No Others Can
5. Showcase of Current Applications
6. Conclusion, Questions & Answers



Section 1

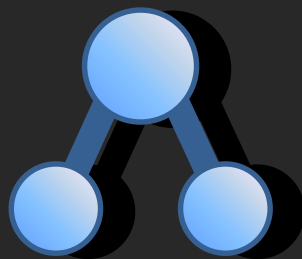
Agilent's Molecular Spectroscopy Portfolio



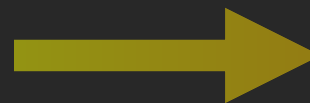
Fundamental Idea Behind Molecular Spectroscopy



Light Source



Sample



Detector

We shine light on stuff and see what happens.



Molecular Spectroscopy Product Line

Ultraviolet-Visible-Near Infrared Spectroscopy



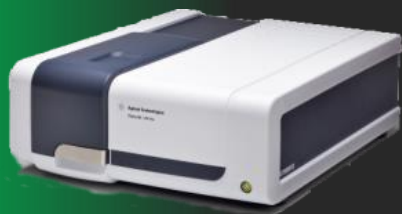
Cary 8454 UV-Vis-NIR



Cary 4000 UV-Vis
Cary 5000 UV-Vis-NIR
Cary 6000i UV-Vis-NIR



Cary 100 UV-Vis
Cary 300 UV-Vis



Cary 60 UV-Vis-NIR



Cary 7000 UMS UV-Vis-NIR

Entry Level

High-End



Agilent Technologies

Agilent Molecular Spectroscopy
Slide 5

Molecular Spectroscopy Product Line

Fourier Transform Infrared Spectroscopy



Handheld and
Portable FTIR
Products



Cary 630 FTIR



Cary 660 + 610
Microscope FTIR



Cary 670 + 620 FPA
Imaging Microscopy FTIR

Entry Level

High-End



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Agilent Molecular Spectroscopy
Slide 6

Molecular Spectroscopy Product Line

Fluorescence Spectroscopy

Entry Level



Cary Eclipse

High-End



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Agilent Molecular Spectroscopy
Slide 7

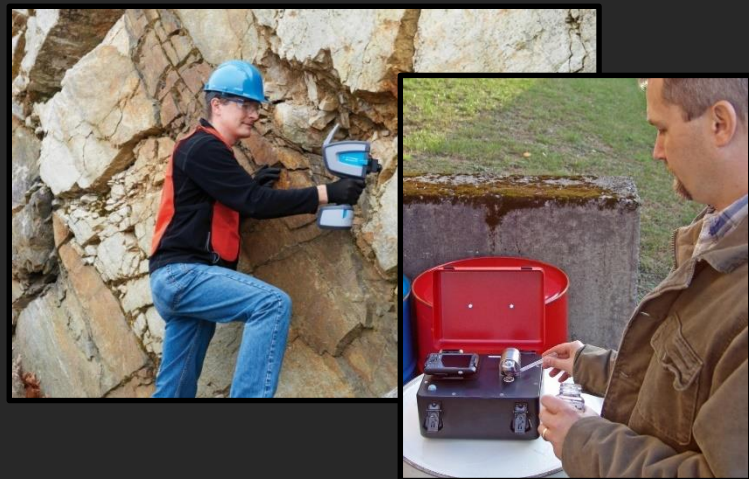
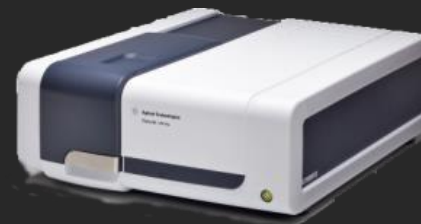
Who is Cary?

- Howard H. Cary **designed first commercial UV-Vis** in 1946 with George Down and William C. Miller
- Formed "Applied Physics Corp", later renamed "**Cary Instruments**" **when acquired by Varian** in 1966
- Many years later, **Varian was acquired by Agilent** in 2009



Examples of Cary Systems' Unique Features

- Cary 60's Xenon Flash Lamp **can last 10+ years, super fast 3 second scans**



- Hand held point and shoot, **mobile FTIR products that can go anywhere**

- Cary 7000 UMS **revolutionized multi angle analyses**



Section 2

Cary 8454 and Cary 60, Why Two?



The Answer: They Are Both Awesome

- Agilent's 8453 UV-Vis-NIR system was a staple in many pharmaceutical laboratories for a long time
- Varian's Cary 50 UV-Vis-NIR system was a flagship in R&D, academia and production environments
- When Agilent acquired Varian in 2009, couldn't pick one over the other, both were equally awesome thus both were kept
- Since then, both systems have been upgraded to the Agilent Cary 8454 and Agilent Cary 60



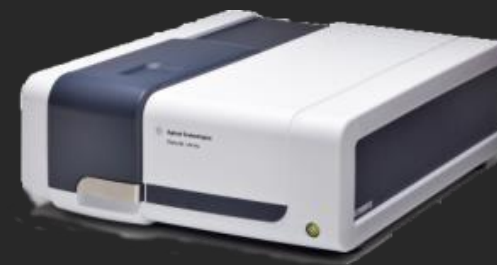
Cary 8454 and Cary 60 Similarities



Both do UV-Vis-NIR analyses

Identical wavelength range (190-1100 nm)

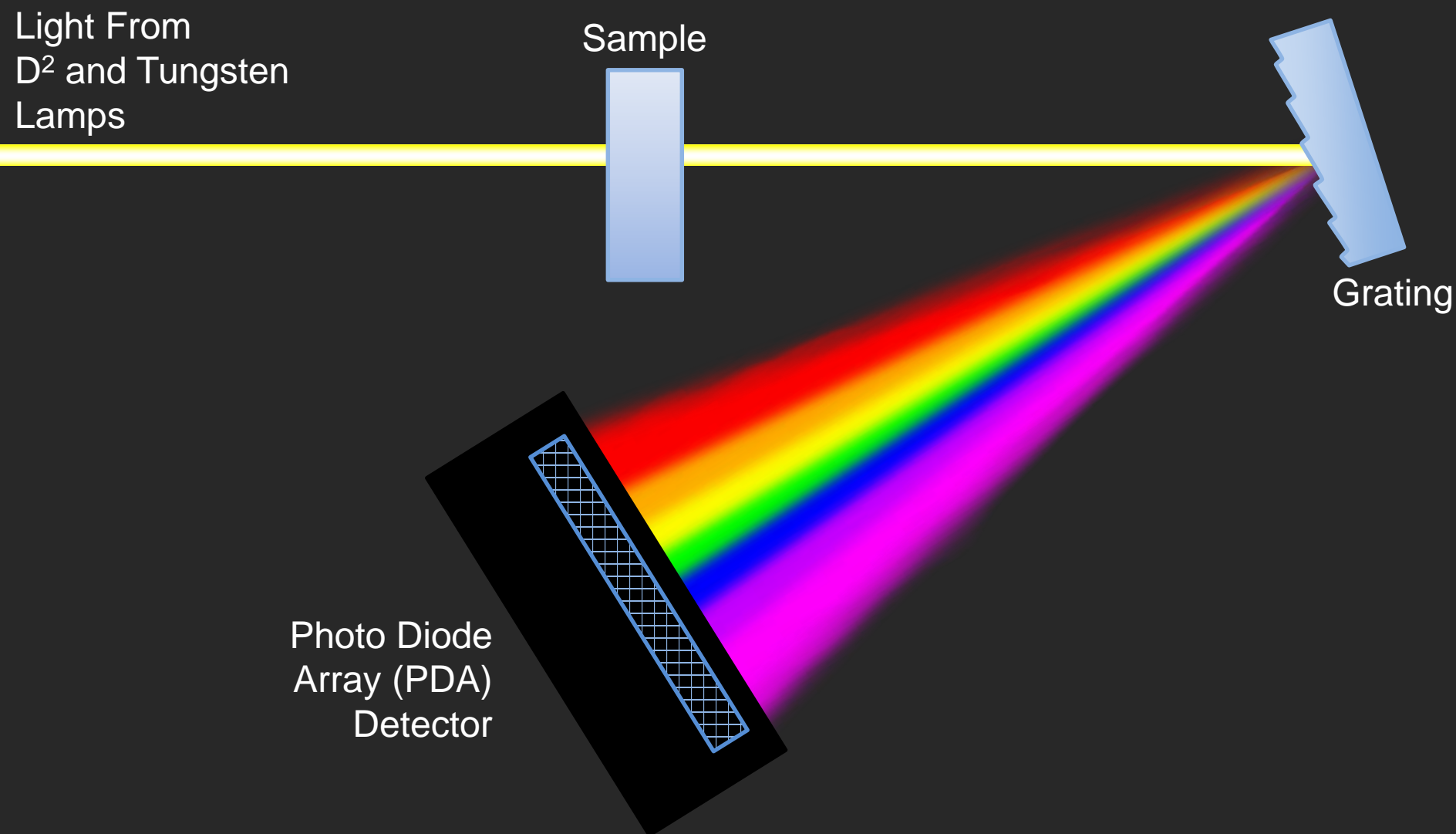
Roughly the same size



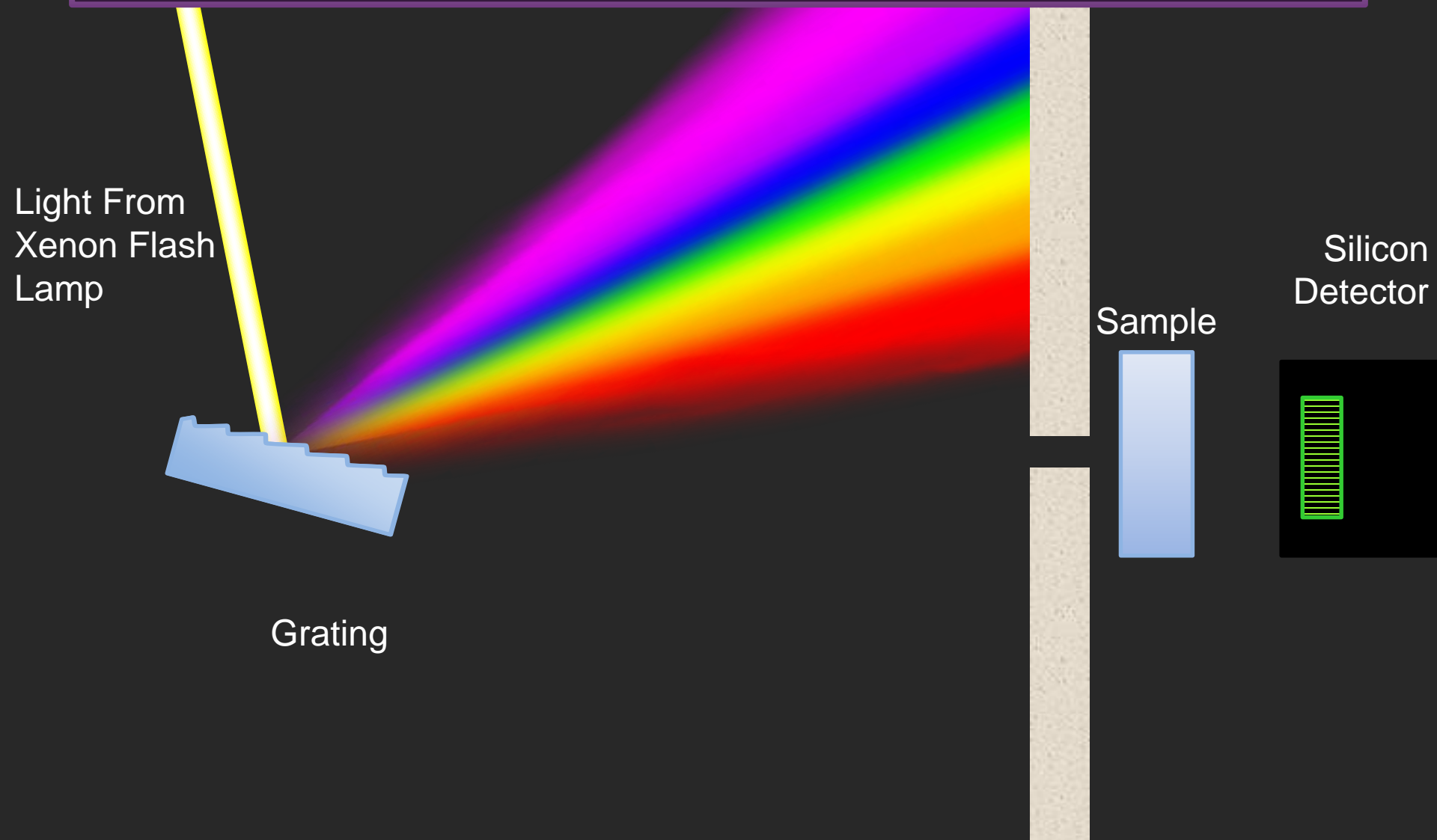
The Similarities End Here



Cary 8454: Photodiode Array System



Cary 60: Monochromator System



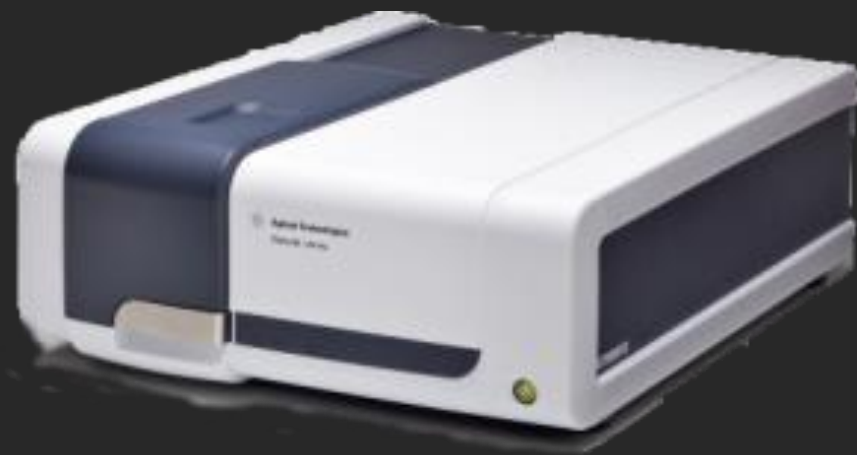
Have Instrument, Will Analyze



Cary 8454

Super Speed

Acquire entire spectrum in less than 1 sec
Aimed at high liquid sample throughput
Great for QC, pharma, quick assays



Cary 60

Super Performance

Acquire entire spectrum as fast as 3 secs
Amazing performance for entry level
Excellent for both liquid and solid samples








Section 3

Cary 8454: Rapid Liquid Analyses



What Are Our Measurement Requirements?

-  • **Speed:** Full spectrum needs to be acquired quickly
-  • **Rapid Result Readout:** Absorbances of interest should be easy to read all at once
-  • **Calculations:** Beer-Lambert law curves and other simple calculations should be straight forward to set up
-  • **Accessories:** Depending on level of desired throughput, accessories such as autosamplers and multicell holders may be required
-  • **Low Maintenance:** Hardware should have minimal moving parts, little to no maintenance



Cary 8454: Speed



Spectral bandwidth of 1 nm. Gives excellent spectral resolution for liquid sample analysis and meets international Pharmacopoeia compliance regulations

Photo diode array detector: Acquire a complete spectrum in as little as 0.1 seconds to analyze multiple wavelengths simultaneously

Reverse optical design: All light goes through the sample for excellent throughput, signal-to-noise and sensitivity

- At
- At
- At

Wave



Cary 8454: Rapid Result Readout

Task

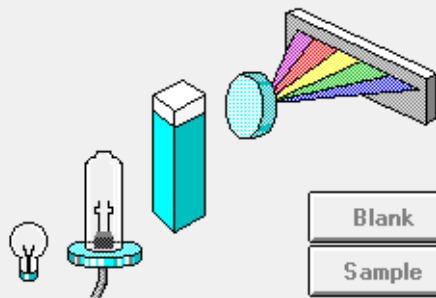
Fixed Wavelengths

Setup ...

Sampling

Manual

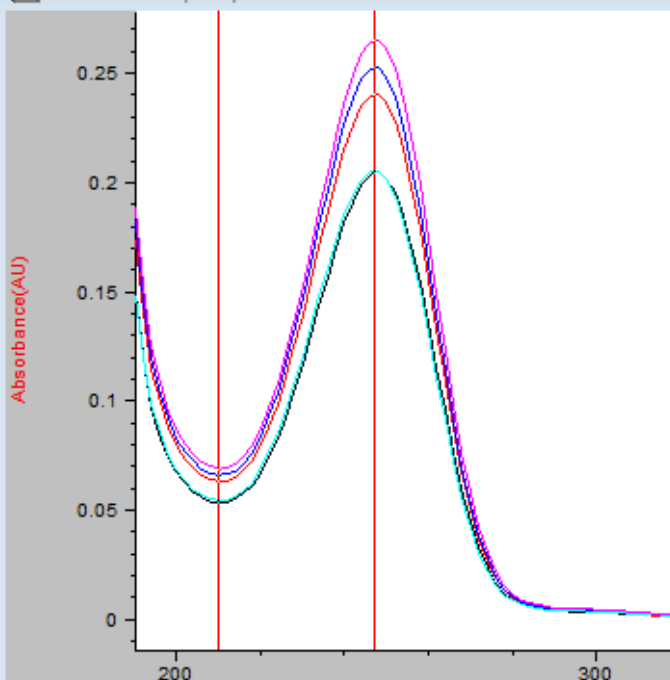
Setup ...



Blank

Sample

Overlaid Sample Spectra



Sample/Result Table

Show Sample Info

Last Spectrum

Remove S

#	Name	Abs<210nm>	Abs<247nm>
1	Sample 1	5.3757E-2	0.20419
2	Sample 2	6.3232E-2	0.24001
3	Sample 3	6.6010E-2	0.25235
4	Sample 4	5.4398E-2	0.20497
5	Sample 5	6.9016E-2	0.26488

- Quickly view specific absorbances of all spectra for up to 6 wavelengths

- Automatically pick peaks and valleys using the "peaks/valleys" task



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Cary 8454: Calculations

- Enter Excel style equations using absorbance data from up to 6 wavelengths

Ratio/Equation Parameters

Wavelengths

Use wavelength(s): WL1: 260 WL2: 280 WL3: 800 WL4: WL5: WL6: nm

Calculation

Name: My equation Equation (WL1,...,WL6, Wt, V, +, -, /, *, ...): $[(WL1 / WL2) - WL3] * 7.25$ Unit: penguins

☐ Use Weight (Wt), Volume (V) Weight: Volume: Unit:

☐ Prompt for sample information

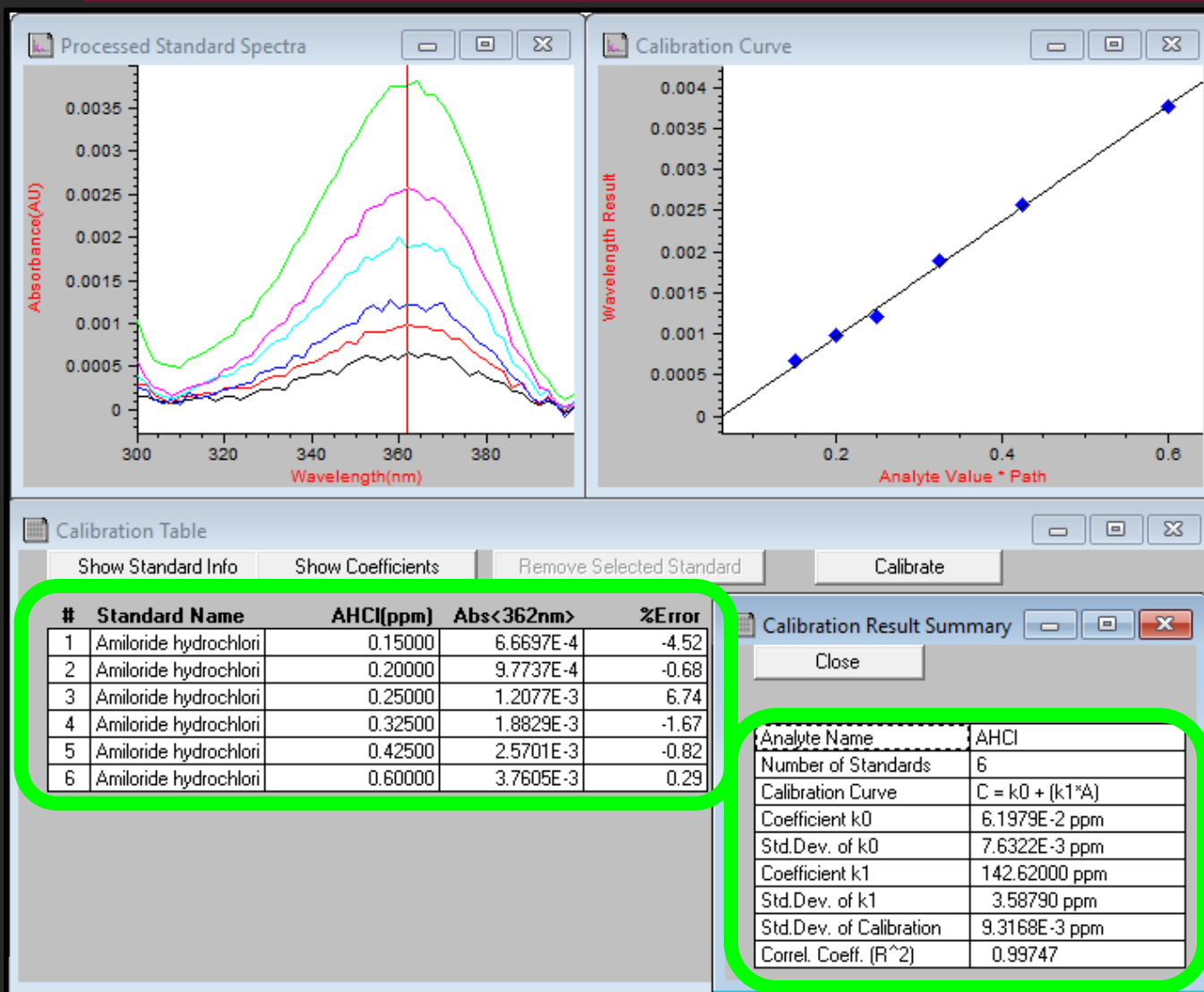
Data type: Absorbance

Display spectrum: From: To: nm

OK Cancel



Cary 8454: Calculations



- All Beer-Lambert calibration curve information is visible at once

- Concentrations are easily entered and edited directly in concentration column

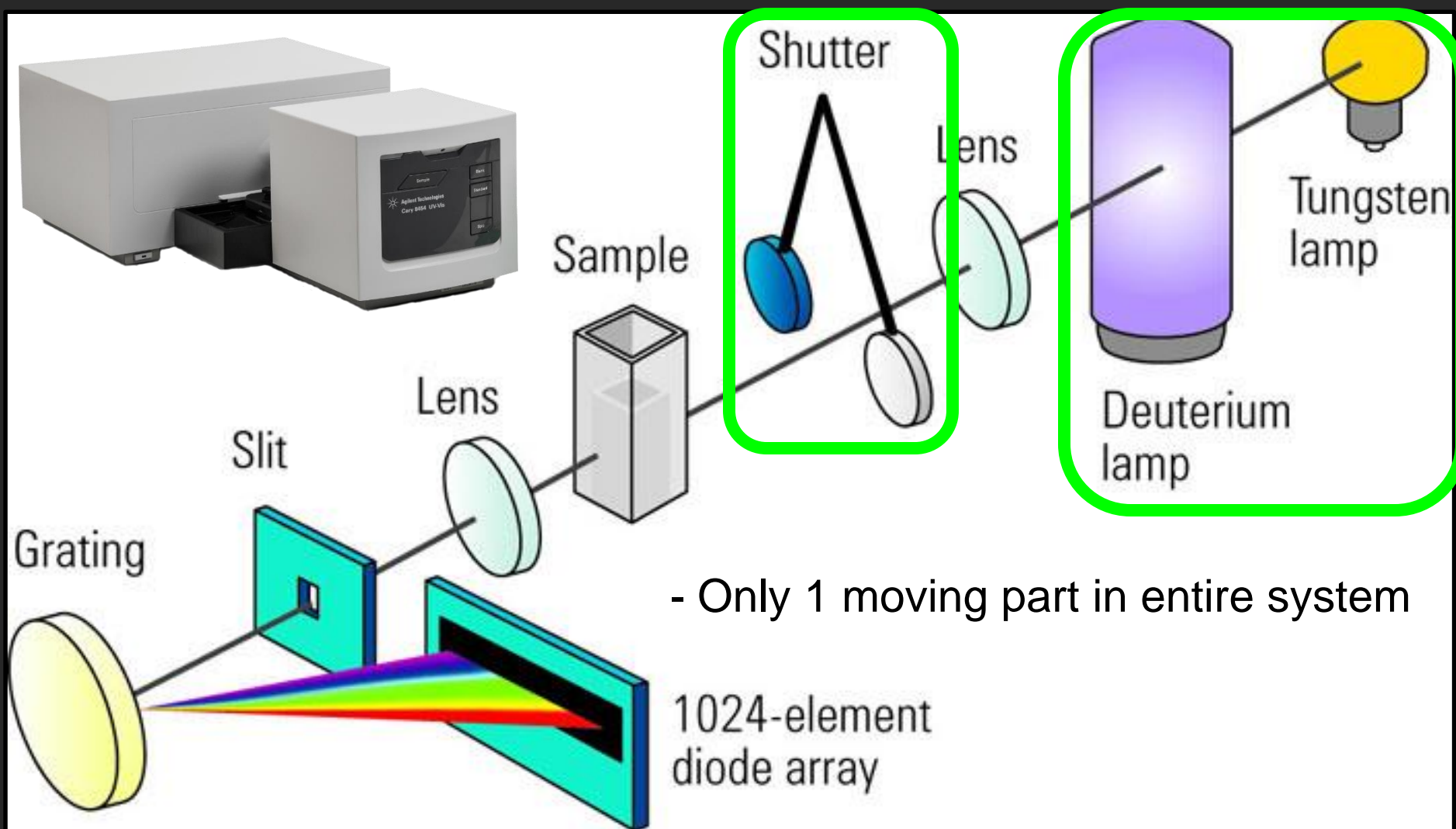
Cary 8454: Accessories



- High throughput accessories available, 8 cell multicell holder, sipper system, XY autosampler



Cary 8454: Maintenance



Cary 8454: Rapid Liquid Analyses



- **Speed**



- **Rapid Result Readout**



- **Calculations**



- **Accessories**



- **Low Maintenance**



Section 4

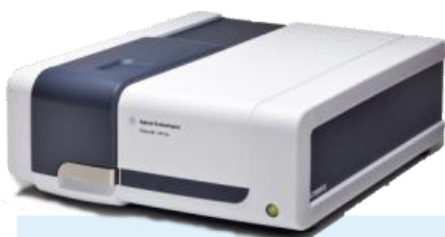
Cary 60: Scan What No Others Can

What Are Our Measurement Requirements?

- **Performance:** Excellent sensitivity and high photodynamic range to measure both liquids and solids
- **Software Flexibility:** Vastly differing samples means software should have multiple easy to use predefined protocols in place to meet everyone's needs
- **Calculations:** Software should allow for heavy customization, robust scripting support for complex calculations and multi-stage determinations
- **Accessories:** Analyzing any type of liquid or solid, should have as many accessories available as possible
- **Low Maintenance:** Hardware should have minimal moving parts, little to no maintenance

Cary 60: Performance

Photometric noise



500 nm, 1 s SAT

At 0 Abs

< 0.00002 Abs

At 1 Abs

< 0.00012 Abs

At 2 Abs

< 0.0011 Abs

260 nm, 1 s SAT

At 0 Abs

< 0.00002 Abs

24,000 nm/min maximum scan rate

Allows complete spectral range scanning in under 3 seconds ideal for fast kinetics or high sample throughput.

- Excellent photometric range and very low noise floor (5th decimal place!)

maximum measurement rate

excellent data fitting.

Photometric range up to 4 Abs

Permits the analysis of highly turbid sample concentrations (optical density preparation (dilution) requirements).

Non-measurement phase stepping wavelength drive

Means that sample and reference measurements are taken at the same wavelength ensuring that no peak is missed.

- Combined with full spectra scan in as low as 3 sec, result is unparalleled performance for entry level market



Common Customer Question on "Linearity"

Does the photometric range mean that the Cary 60 is linear from 0 to 4 absorbance units?

- There are two aspects of "Linearity"
- First, **Detector Linearity**:
Is 1 abs really 1 abs, 2 abs really 2 abs, etc...
- In this regard, Cary 60's detector is indeed linear to 4 absorbance units
- Second, **Beer-Lambert Linearity**:
Linearity of concentration curves



From Your Favorite Chemistry Textbook: Beer-Lambert Law

$$A = \epsilon \cdot C \cdot L$$

A = Absorbance

ϵ = Molar Absorptivity Coeff.

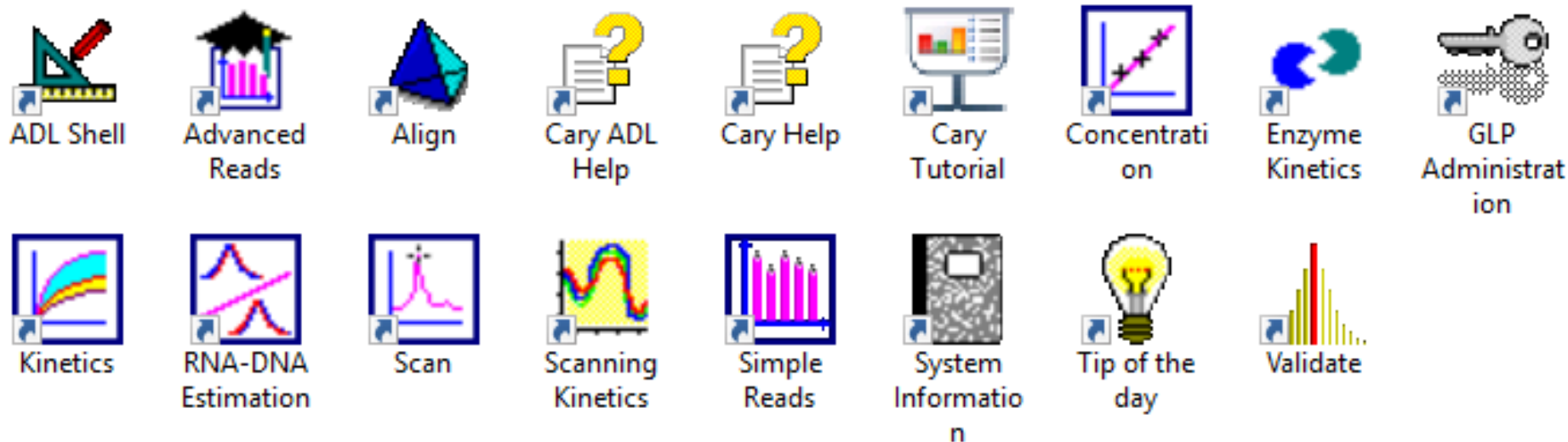
C = Concentration

L = Pathlength

- A physical law that states **concentration and absorbance are linearly dependent**
- Due to **secondary effects at high concentrations** (dimer formation, inner filter effect, reabsorption, etc...), law states **linearity only holds true from 0 to ~1.0 absorbance units**
- Ergo, **Beer-Lambert linearity is not dependent on instrumentation**, but on physical and chemical properties of molecules



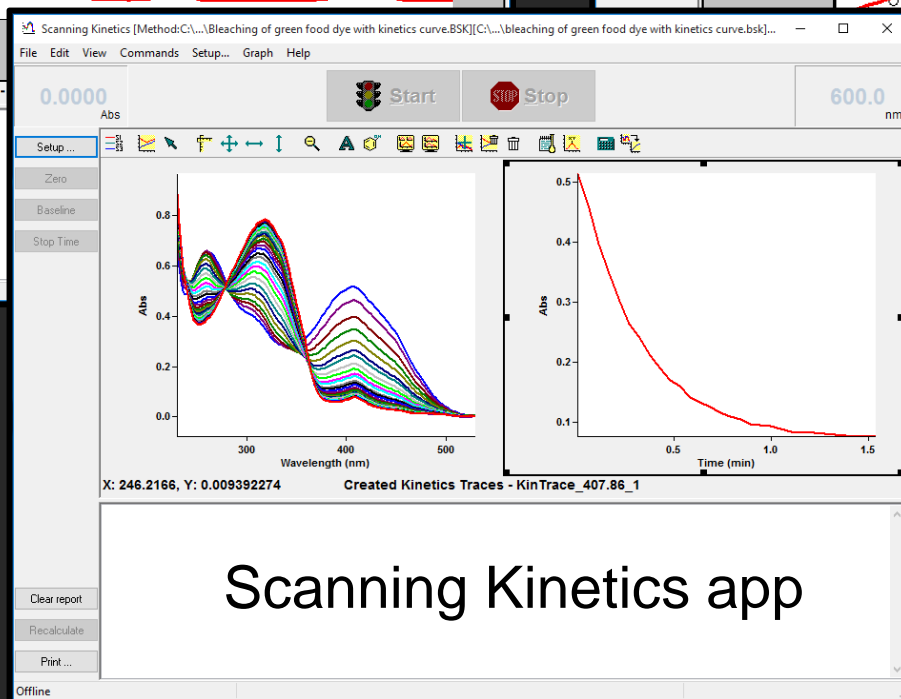
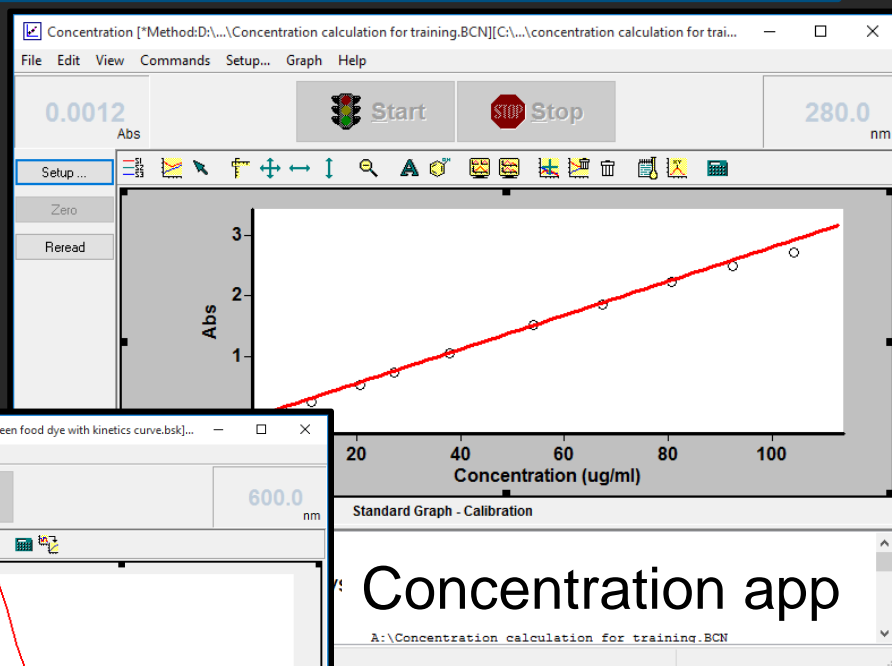
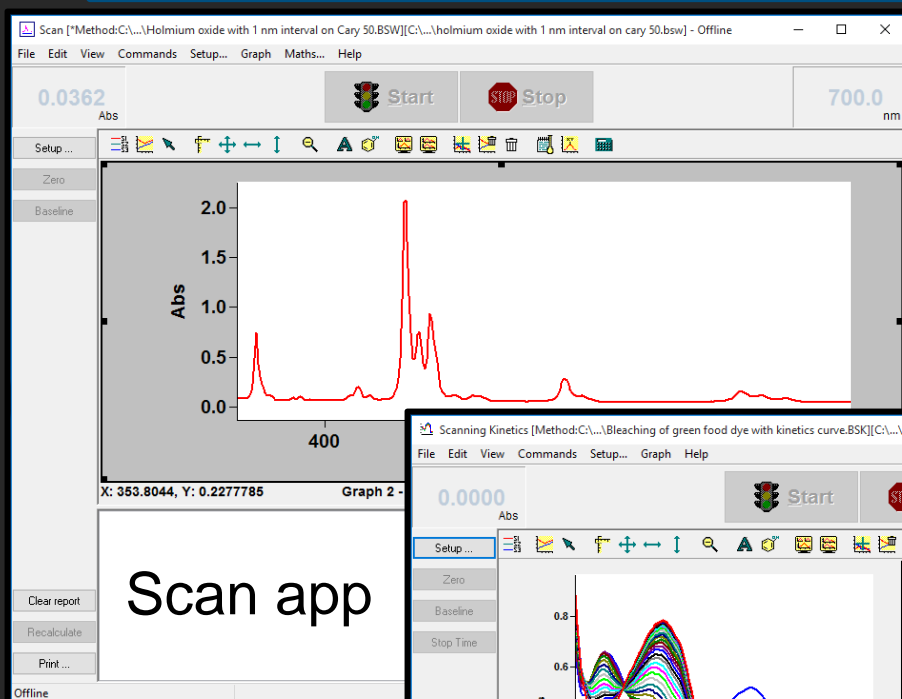
Cary 60: Software Flexibility



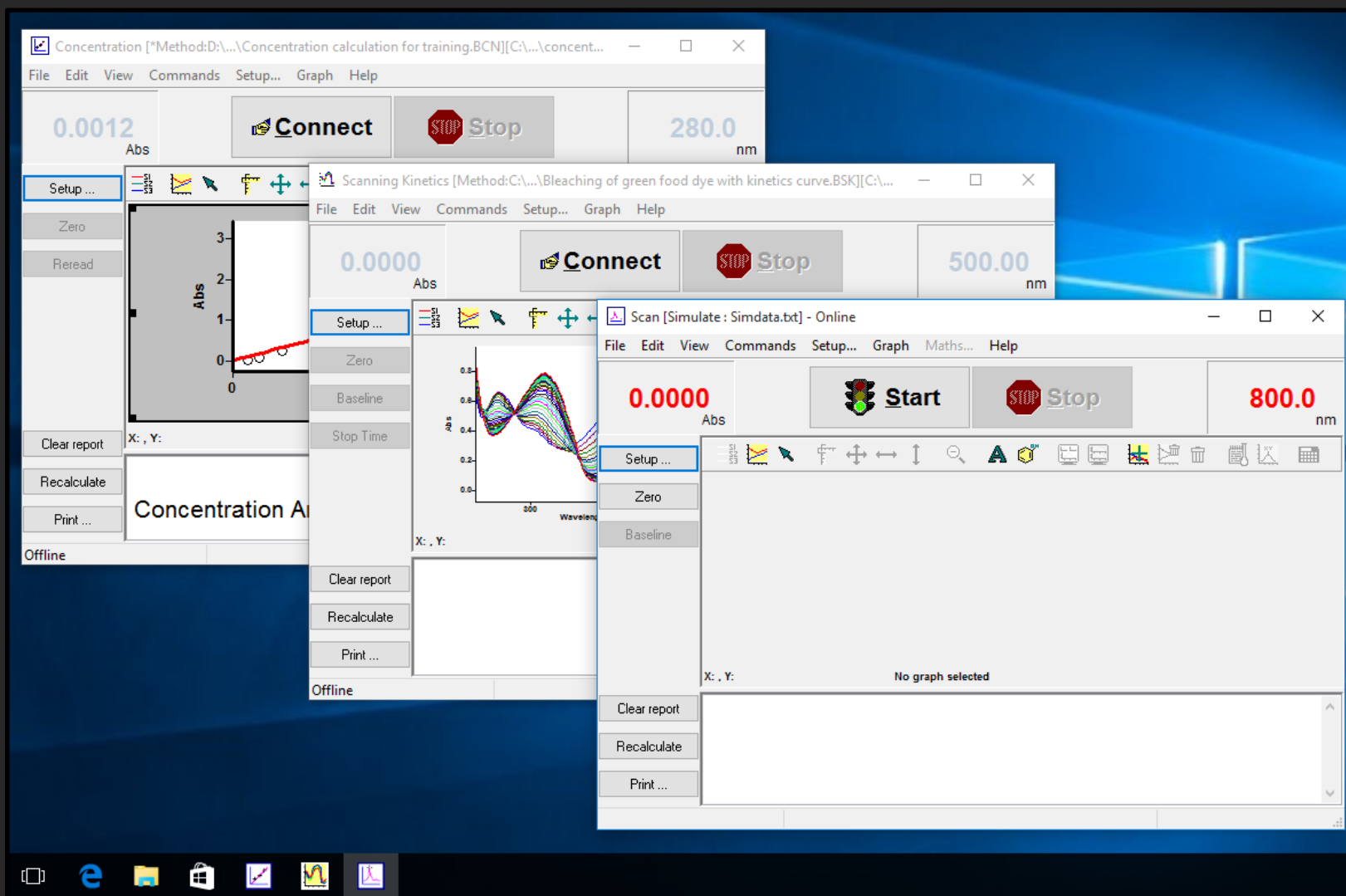
- Cary WinUV software comes as **a full suite of apps**
- **"We have an app for that"**, different apps for different situations, much like apps on our smart phones
- **All apps have near identical interface**, software retraining when switching between apps is almost zero



Cary 60: Software Flexibility



Cary 60: Software Flexibility



Cary 60: Calculations

- For handling any kind of far out experiment, software should have seriously robust customization capabilities
- Cary WinUV's solution: **Application Development Language (ADL)**
- To fully grasp what ADL can do, let's first take a look at other offerings:



- **Competitor Macros**

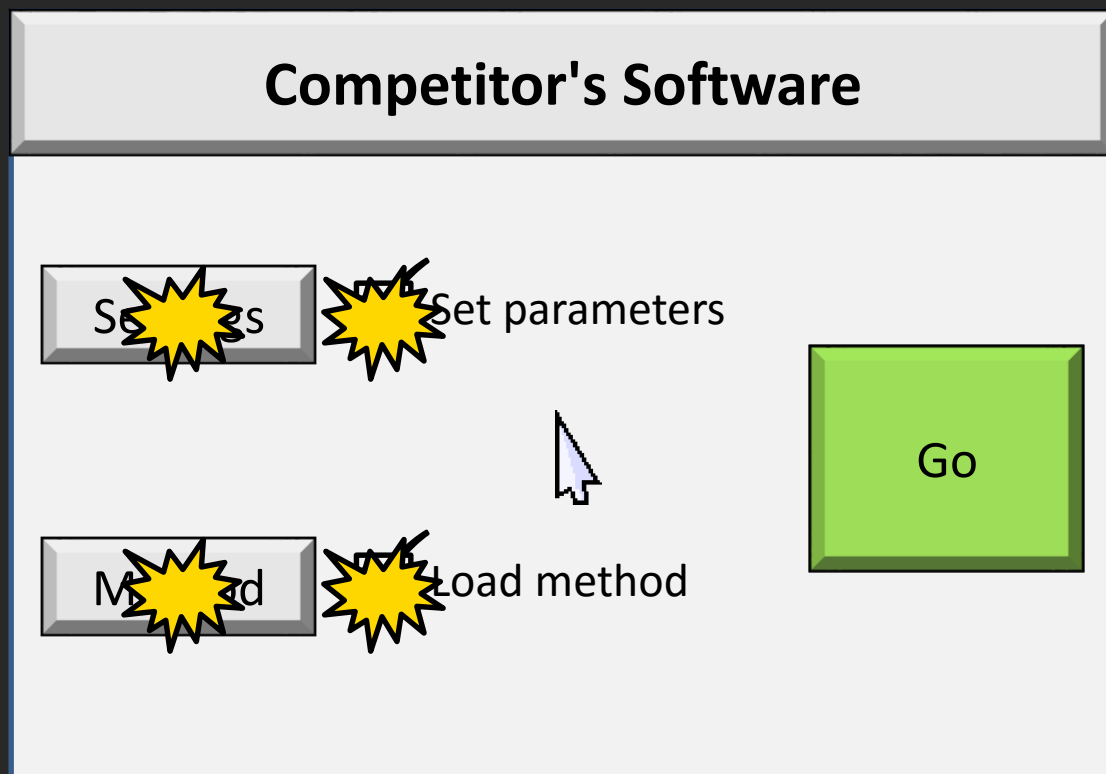
- **Competitor Scripting**



Competitor Macros

- **Macros**

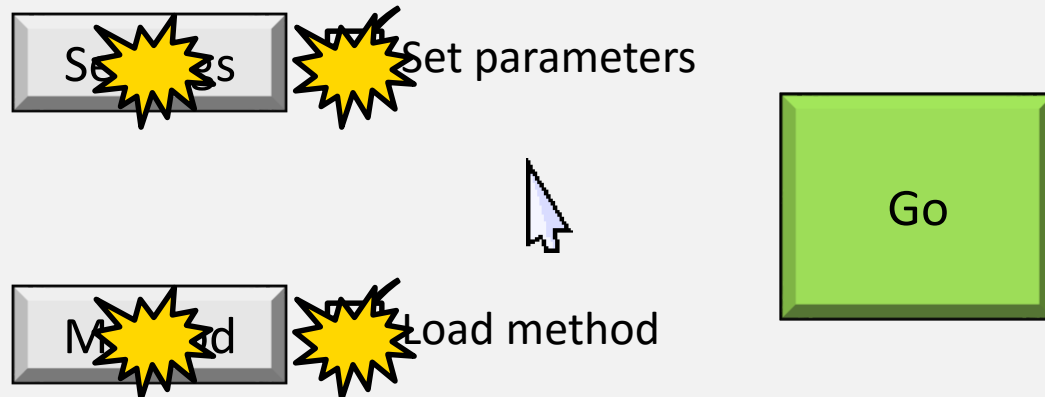
- A series of prerecorded mouse clicks



Competitor Scripting

```
Script.txt - Notepad
File Edit Format View Help
StartScript
Click.do ("Settings")
NextClick
Click.checkbox ("Set Parameters")
NextClick
Click.do ("Methods")
NextClick
Click.checkbox ("Load Method")
NextClick
Click.do ("Go")
Endscript
```

Competitor's Software



Scripting

- Text commands that mimic a series of prerecorded mouse clicks



The ADL Difference

- ADL is an **interpreter language**, not a macro or a script
- Very similar to the Visual Basic language, the Cary WinUV software suite itself is coded in ADL
- **ADL comes included with all versions of Cary WinUV**, ADL Shell app is used to create ADLs
- Create **entirely new graphical user interfaces** with as new windows, radio buttons, **automate** complex calculations, etc...
- Since not everyone likes to program, Agilent's application scientists are here to help customers develop their own ADLs

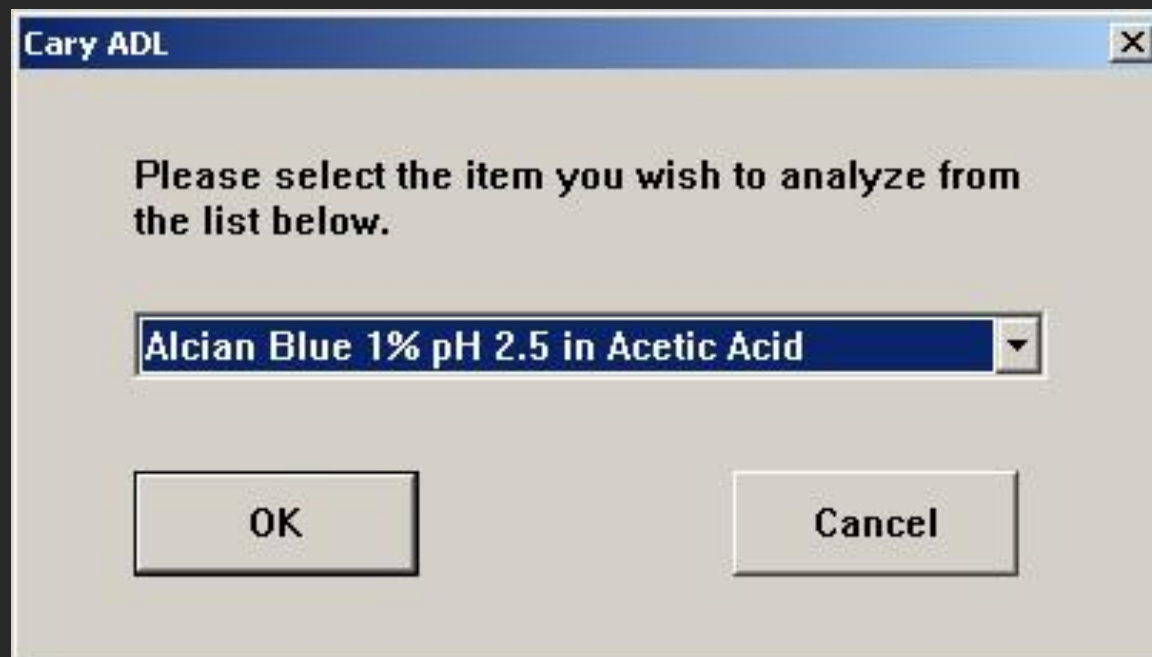


ADL in Action

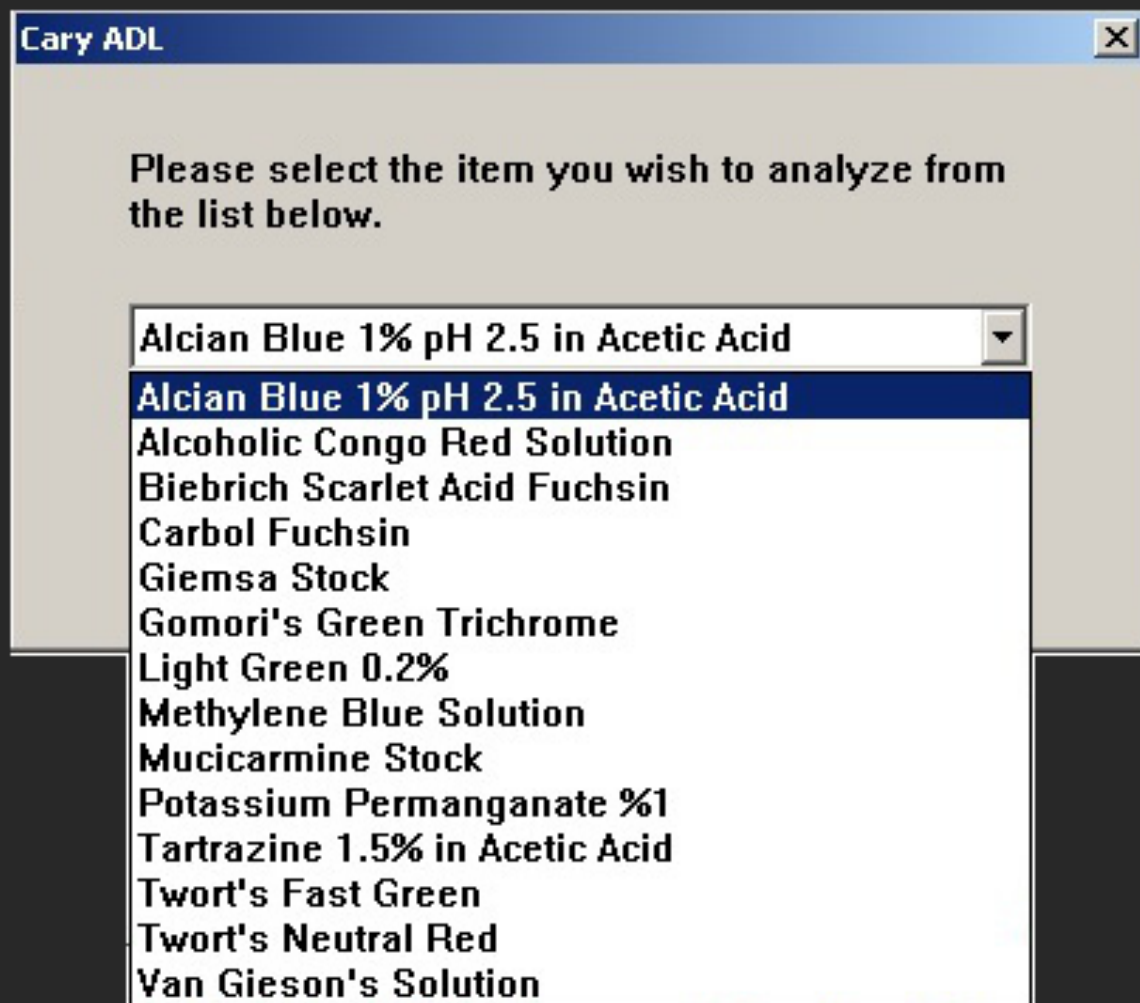
Listen, I've got 100 operators, they all can't learn the WinUV software, I need a simple drop-down menu from which these operators can choose an analysis, have the software walk them through it step by step, perform calculations and automatically spit out a result, oh and I want to be able to easily add items to this menu later on.



ADL in Action: Simplified Interface with a Menu



ADL in Action: Simplified Interface with a Menu



ADL in Action: Simplified Interface with a Menu

Cary ADL [X]

Item Number:	100645
Spec Revision:	002
Item Name:	Alcian Blue 1% pH 2.5 in Acetic Acid
Peak 1 Wavelength Range:	609 nm to 615 nm
Peak 1 Absorbance Range:	0.45 abs. units to 0.6 abs. units
Peak 2 Wavelength Range:	Not applicable.
Peak 2 Absorbance Range:	Not applicable.

If this information is correct, please click OK.

OK **Cancel**

Now that's a spicy
meatball David!



ADL in Action

Your software's good, but I want more control over temperature ramps. I need to do forward and reverse ramps, recording temperatures from 4 cuvette probes at the same time, custom reporting, a ton of other stuff, oh and the data should be easy to import into Excel.



ADL in Action: More Temperature Control Options

Multi-Temperature Step Function v1.8, Dr. David Troiani, Agilent Technologies

Enter sample name

Enter a single wavelength OR

Enter one wavelength range using a hyphen {-}

200-800

Instrument Parameters

Averaging time
(sec)

0.1

Data interval
(nm)

1.0

Slit bandwidth
(nm)

2.0

Zero

(only useful for single
wavelength analyses)

Baseline

(only useful for analyses
over a wavelength range)

Y Axis Units

☒ Absorbance

☐ % Transmittance

Temperature Controls

Start (oC)

25.0

Increment (oC)

5.0

Final (oC)

50.0

Temperature
stabilization time (sec)

15.0

☐ Forward and reverse temperature ramping

Temperature Monitor

☒ Controller block unit

☐ Cuvette probe 1

☐ Cuvette probe 2

☐ Cuvette probe 3

☐ Cuvette probe 4

Cycle Mode

☐ Use cycle mode

Number of
cycles

Time between
cycles (min)

File name for saving and
loading parameters

MTStepSettings01.txt

Save Parameters

Load Parameters

Start Analysis

Cancel

Save Graphed Data

Save Report

NOTE: Data written to the report is CSV formatted for easy importing into Microsoft Excel.
To export the report as a CSV file, select "File > Export Report" from the WinUV window.



ADL in Action: More Temperature Control Options

Sample Name: My Sample
Date : 6/7/2017
Time : 21:53:54

Wavelength Rng: 800-200 nm
Averaging time: 0.1 sec
Data Interval : 1 nm
Slit Bandwidth: 2 nm

Data below are shown in Absorbance Units.

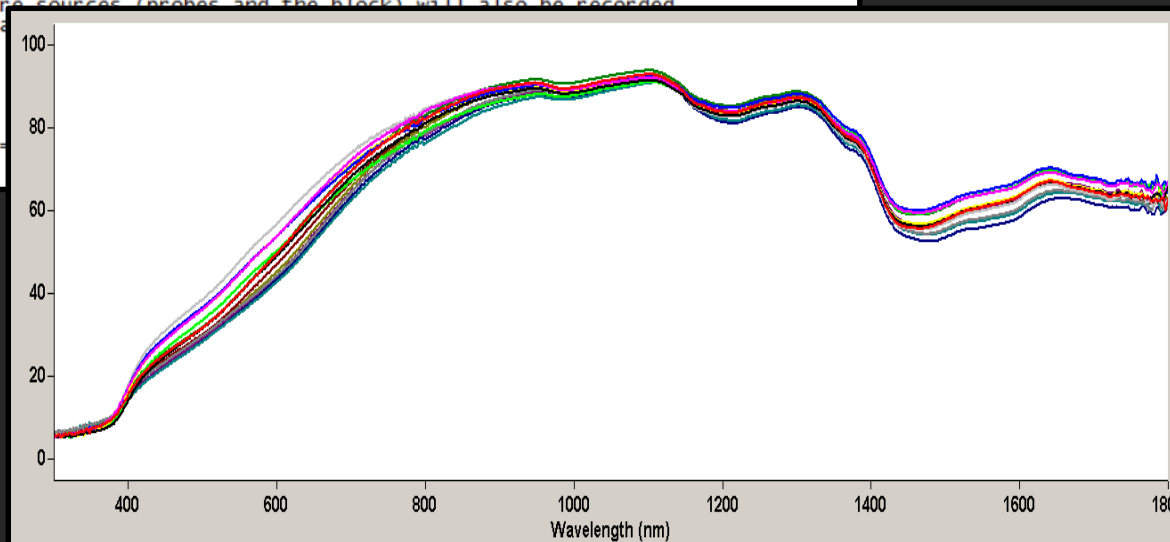
Starting Temp : 25 oC
Temp Increment: 5 oC
Final Temp : 50 oC
Stabilize time: 15 sec

Forward and reverse temperature ramping has been selected.

Temperatures are monitored and recorded from the controller block unit.
All other temperature sources (probes and the block) will also be recorded.
Temperatures below a

cycle mode is ON.
Num of cycles : 4
Cycle Delay : 0.1

Cycle # 1



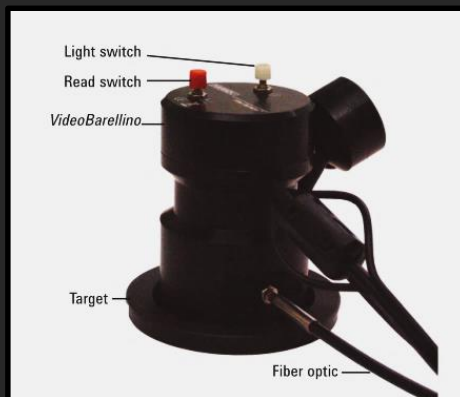
This is amazeballs
David!



Cary 60: Accessories



**Peltier Temperature
Controller**



**Video Barrelino
Remote DRA**



**Fiber Optic
Dipping Probe**



**18-Cell
Thermostated
Multicell Holder**



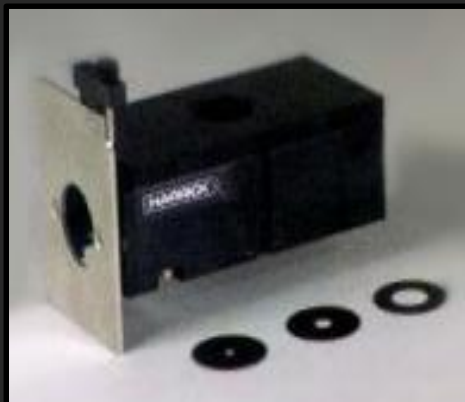
**Rapid Mixing
Accessory**



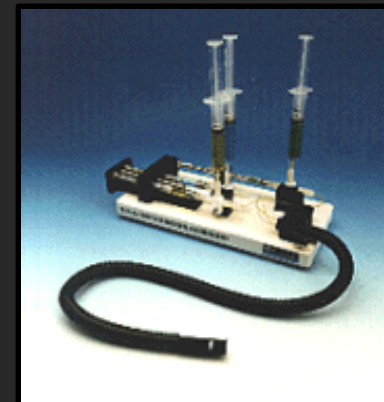
Cary 60: Accessories



Solid Sample Holder



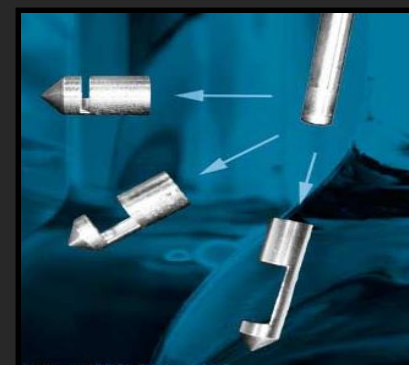
Fixed Angle Specular Reflectance



Stopped Flow Accessory



Micro Volume Tray Cell



**Variable Tip Length
Handheld Fiber Optic Probes**



Cary 60: Accessories



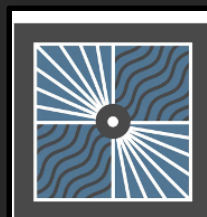
**Long Pathlength
Cells and Holders**



**Cary 60 Car Cigarette
Lighter Power Inverter**



Examples of Third Party Accessory Developers



QUANTUM
N · O · R · T · H · W · E · S · T

AppliedPhotophysics
More Time for Science



Scientific Products

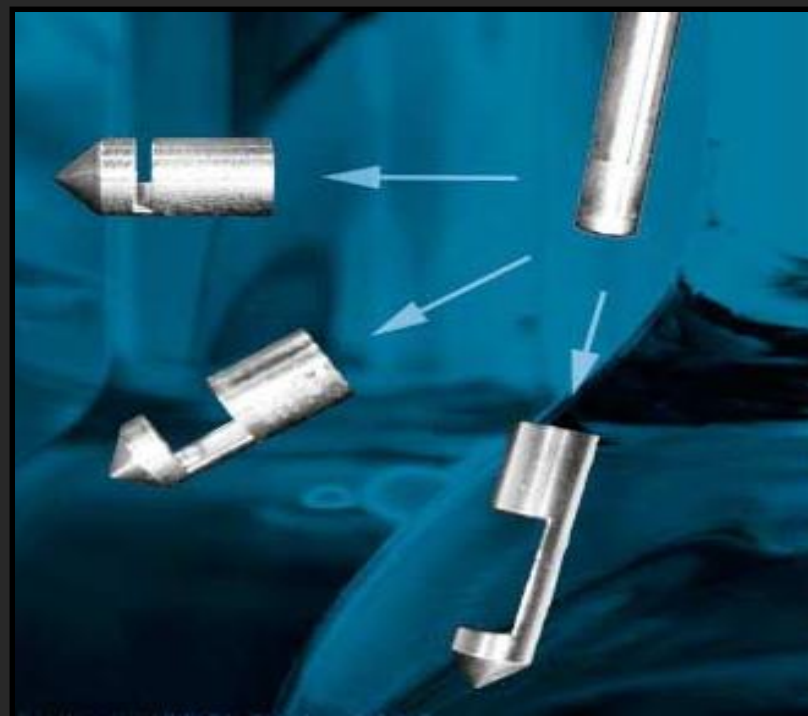
Solutions in Optical Spectroscopy



Agilent Technologies

Agilent Molecular Spectroscopy
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Example: Fiber Optic Probes



- Fiber optic dipping probe for **rapid walk up liquid analyses, no more cuvettes!**
- Handheld fiber optic probes with different pathlength tips for **measuring directly from large production mixing vats**



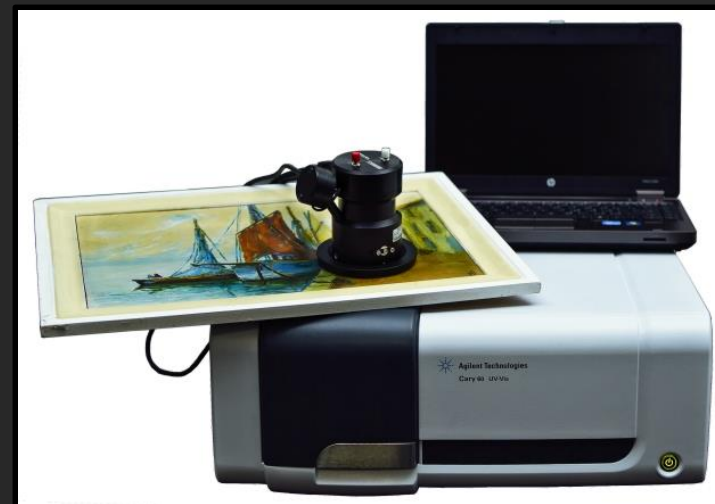
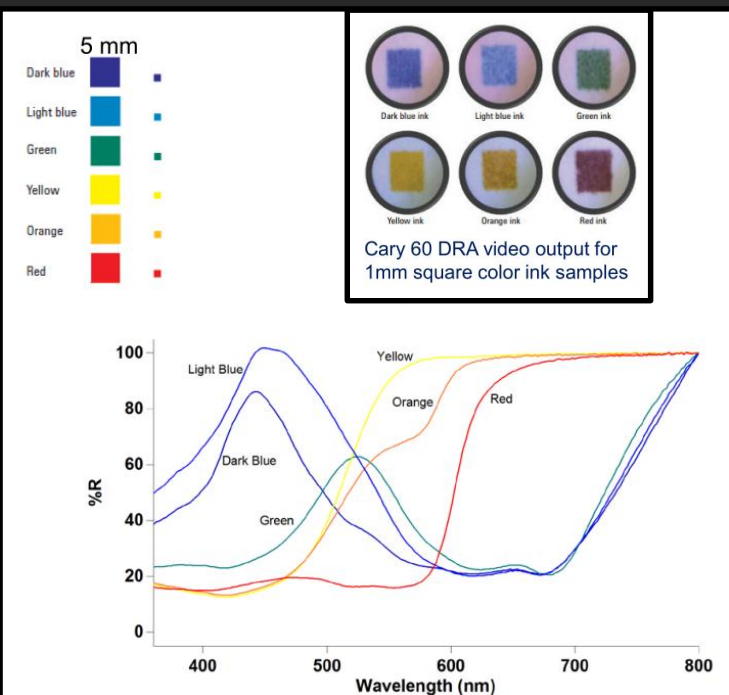
Example: Microvolume Analysis

- Tray cell accessory can easily be employed for **small volume analyses** down to as low as **4 uL of sample volume!**
- Works just like a Nanodrop, only far more accurate and reproducible
- Pipette a droplet of liquid, place cap over droplet, start the scan
- Easily removed from the sample compartment for quick cleaning



Example: Remote Diffuse Reflectance Array (DRA)

- Remote DRA is tethered to Cary 60, can be brought right up to large samples
- Measure diffuse reflectance from solid samples directly in a non-destructive fashion

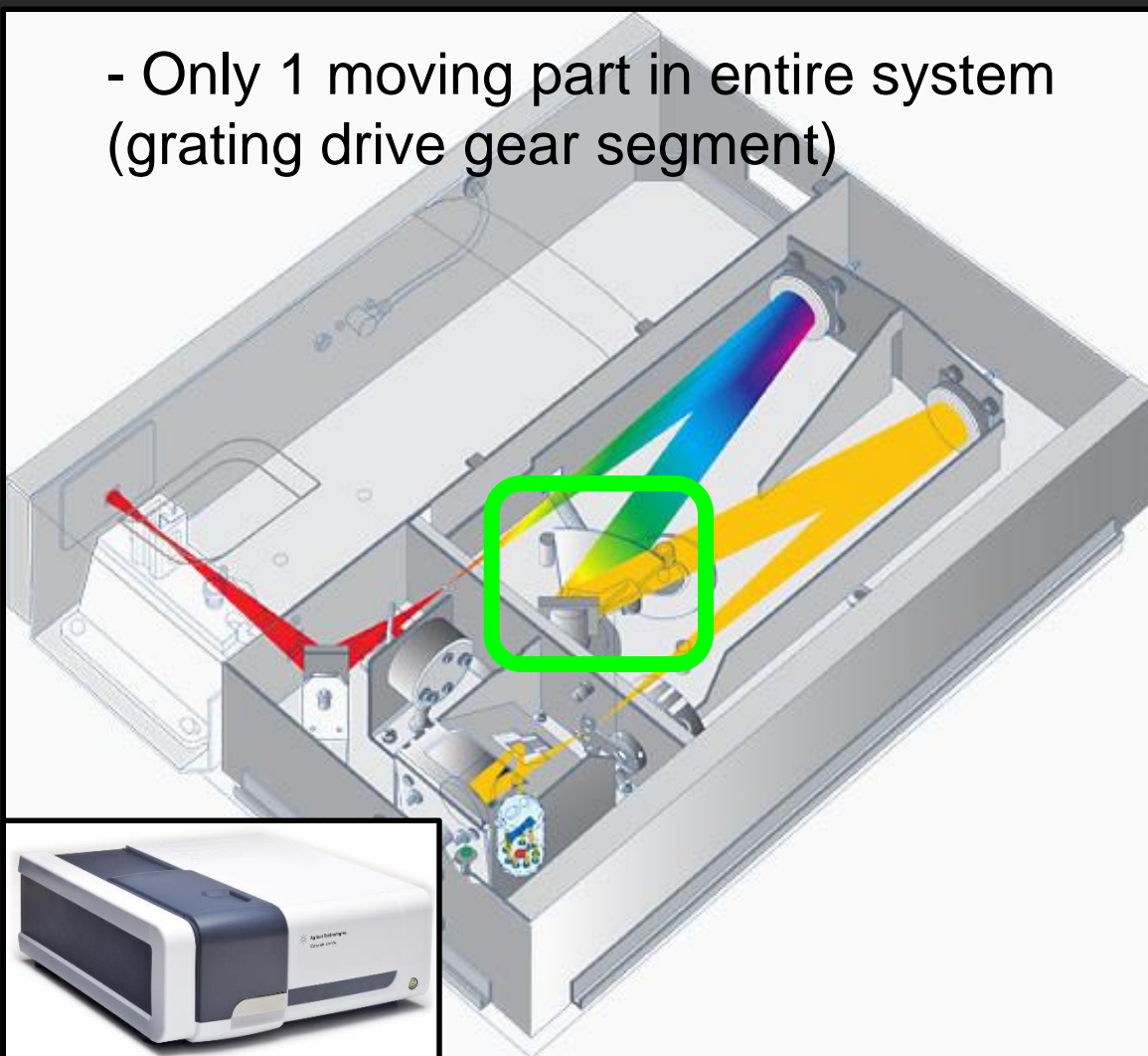


- Remote DRA even has a visible camera to take snapshots of sampling area

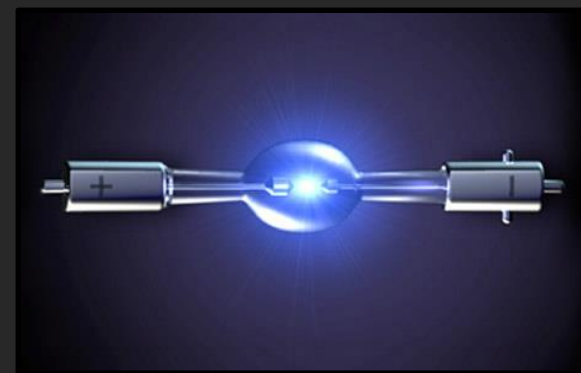


Cary 60: Maintenance

- Only 1 moving part in entire system (grating drive gear segment)



- Unique Xenon Flash Lamp lasts 10+ years, you won't be changing this one very often



Cary 60: Scan What No Others Can



- **Performance**



- **Software Flexibility**



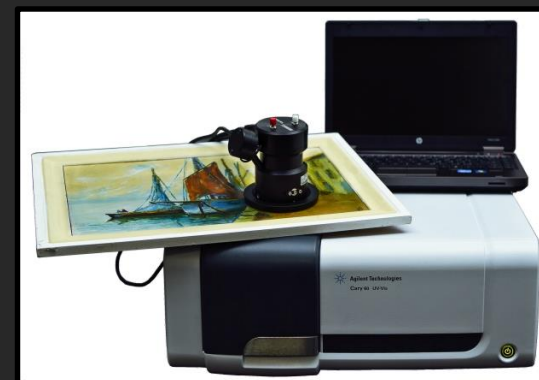
- **Calculations**



- **Accessories**



- **Low Maintenance**



Agilent Technologies

Agilent Molecular Spectroscopy
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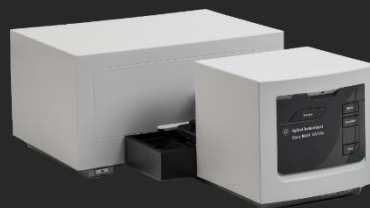
Section 5

Showcase of Current Applications

Current Cary 8454 and Cary 60 Applications

Drug Development

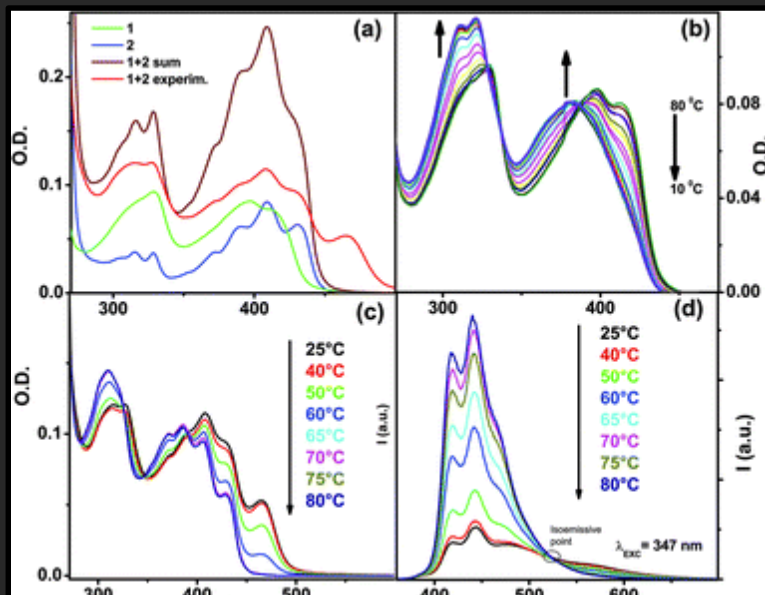
- Pharmaceutical assays
- Health supplement industry



Cary 8454
with Peristaltic Sipper
and Dissolution

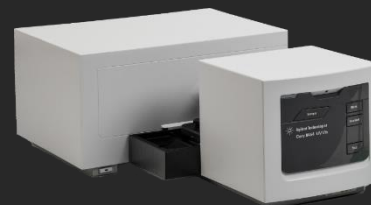


Current Cary 8454 and Cary 60 Applications

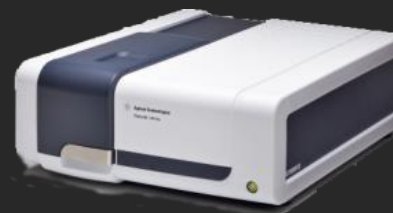


Analysis of Chemical Processes

- Reaction kinetics
- Chemical process monitoring
- Microvolume analysis (to 4 μ L!)
- Wineries and distilleries



Cary 8454



Cary 60
with various
accessories

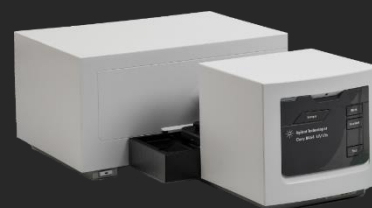
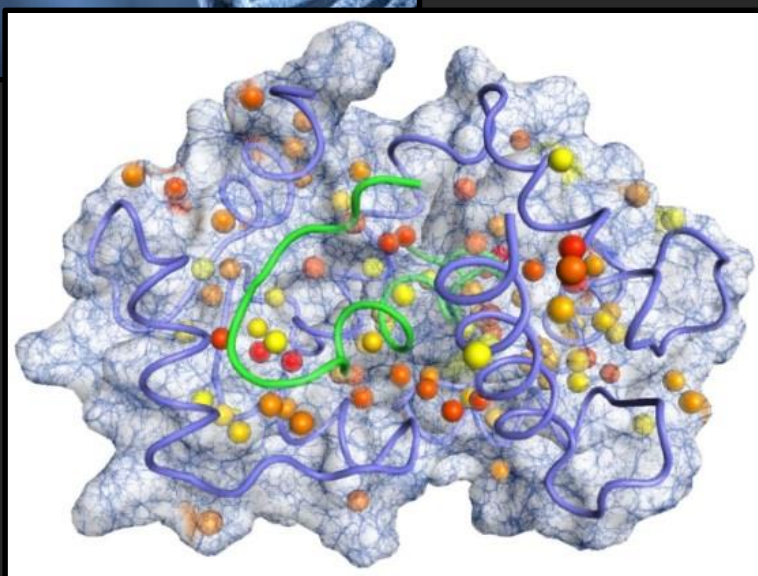


Current Cary 8454 and Cary 60 Applications



DNA, RNA and Protein Analysis

- DNA and RNA quantitation
- Protein denaturation



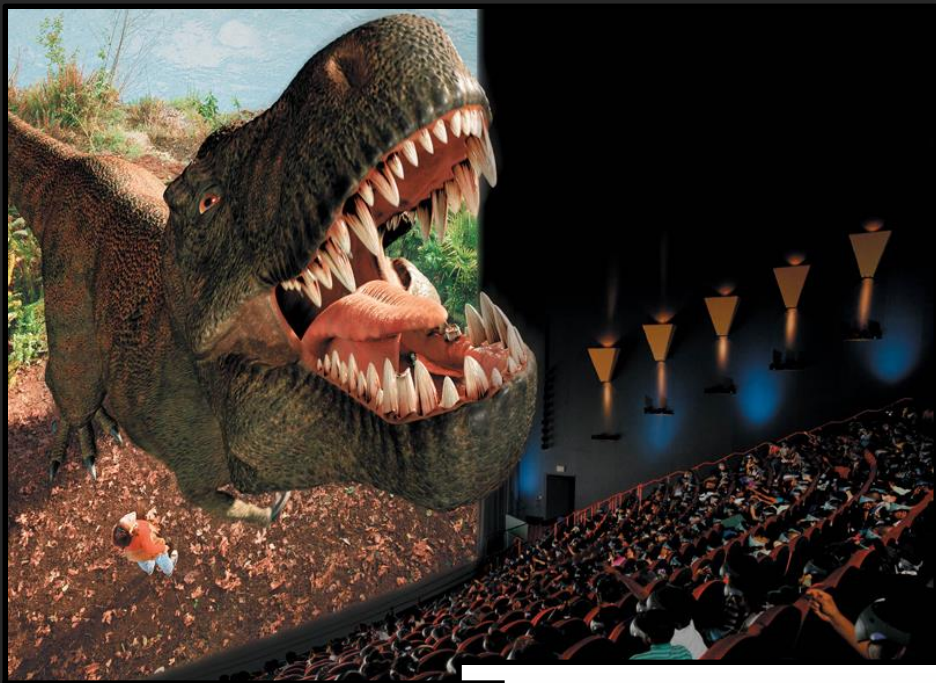
Cary 8454



Cary 60
with Peltier
temperature
controlling devices

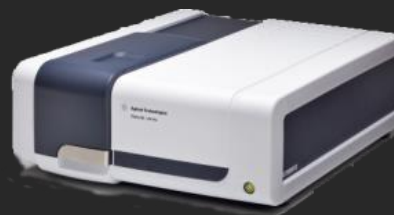
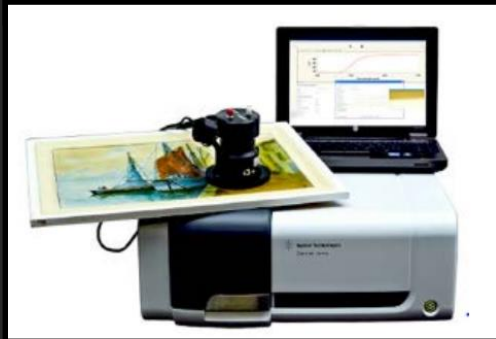


Current Cary 8454 and Cary 60 Applications



Lights, Color, Video, and Special Effects

- Silicon wafers for IMAX3D filters
- CIE L*a*b color determination
- Diffuse reflectance
- Art Conservation
- Screens for mobile devices



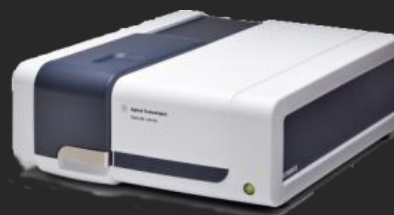
Cary 60
with various
accessories



Current Cary 8454 and Cary 60 Applications

Optical Engineering and Optical Components

- Notch filters
- Bandpass filters
- Cutoff filters
- Mirrors



Cary 60
with various
accessories



Section 6

Conclusion, Questions & Answers

Thank You For Attending

Any Questions?
david.troiani@agilent.com



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