

# The CALIPER



## SPECIAL 25<sup>TH</sup> ANNIVERSARY EDITION

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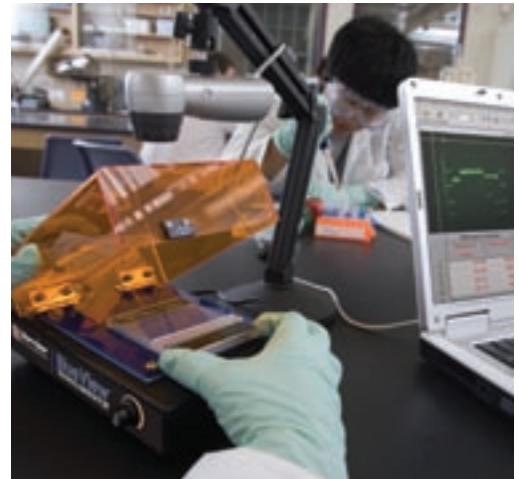
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## Vernier Makes Analysis of Gel Electrophoresis Easy and Affordable

Vernier brings its cutting-edge technology to your biotech lab! The new Blue Digital Bioimaging System allows you to illuminate your gels, capture the image digitally on your computer, and analyze the data using *Logger Pro* software. The Blue Digital Bioimaging System includes the BlueView Transilluminator™, Imaging Hood, ProScope digital USB camera with 1-10X lens, and a ProScope Stand.

- Our new BlueView Transilluminator uses super bright blue LEDs to illuminate DNA gel banding patterns, making it a safe and affordable alternative to ultraviolet transilluminators. The BlueView Transilluminator works well with the e-Gel® Pre-Cast Agarose Electrophoresis System utilizing SYBR Safe™ DNA gel stain or with ethidium bromide. Visit [www.vernier.com/biotech](http://www.vernier.com/biotech) for e-Gel and SYBR Safe purchasing information.
- The Imaging Hood eliminates glare or stray light for a great photo every time.
- The ProScope is a high-resolution, digital USB camera. A 1-10X lens is included.
- The adjustable ProScope Stand makes setup easy.



Setting up the Blue Digital Bioimaging System

One of the most exciting components of our entry into biotech education is the new Gel Analysis feature in *Logger Pro* (version 3.4.5 or newer). Once a tedious task, often ending with mediocre results, *Logger Pro* provides students with a fast, easy way to document and analyze digital gel images. Using a photo taken with a ProScope, your own digital camera, or just by inserting a photo from a file, *Logger Pro* helps your students create a standard curve and calculate the number of base pairs (molecular weight) for each experimental band in only a few minutes. Purchase the complete Blue Digital Bioimaging System or just the BlueView Transilluminator.

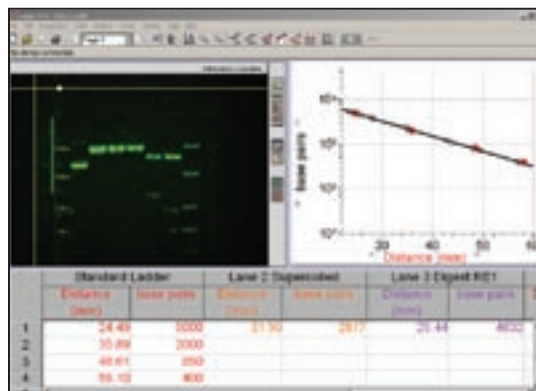
[www.vernier.com/biotech](http://www.vernier.com/biotech)

### Blue Digital Bioimaging System

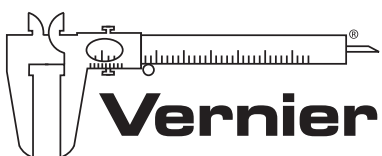
Order Code **BL-DBS** | \$835  
Includes BlueView Transilluminator, Imaging Hood, ProScope digital USB camera with 1-10X lens, and ProScope Stand (*Logger Pro* software not included).

### BlueView Transilluminator

Order Code **BLUE-VIEW** | \$399  
Includes BlueView Transilluminator only



Gel Analysis feature in *Logger Pro*



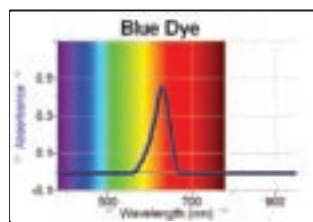
Measure. Analyze. Learn.™

# NEW It's Easy Being Green

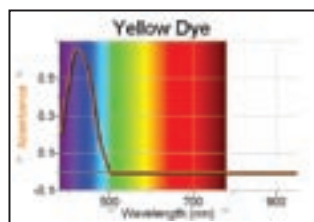
## Exploring Common Grocery Items with the Vernier Spectrometer

The new Vernier Spectrometer allows students to do a wide variety of new lab investigations. To highlight some of its many capabilities, we walked down to the nearest grocery store and picked up a few products to test. We analyzed the visible light absorbance spectrum of various food colorings to see if we could identify the FD&C dyes used in a popular brand of mouthwash. By comparing the "fingerprint" of the food colorings with the absorbance spectrum of mouthwash, it was easy to determine that the color of the mouthwash was a mixture of blue and yellow dyes, which was confirmed by the information on the label.

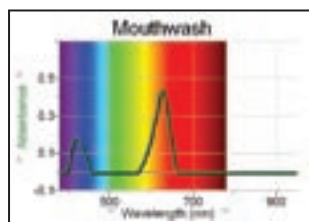
To complete our experiment, we mixed a bit of the blue and yellow food coloring solutions to try to mimic the green color of the mouthwash. We matched the color pretty closely, and the activity gave us a theme for this investigation—green liquids.



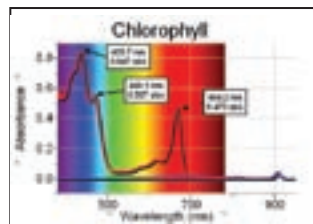
Blue dye



Yellow dye



Mouthwash

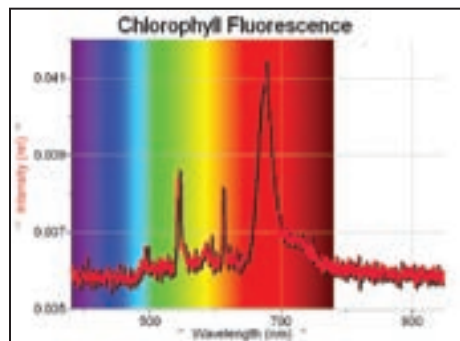


Chlorophyll absorbance

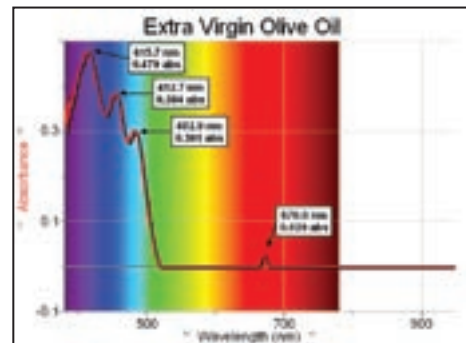
Next, we tackled some biochemistry. We bought some fresh spinach to add to our salad for a healthy lunch, and saved a few of the leaves. We then chopped up the spinach leaves and soaked them in ethanol for an hour, to extract chlorophyll. By filtering the liquid and diluting it with distilled water, we had our chlorophyll sample. We ran two tests. The first test was similar to the food dye/mouthwash investigation; we measured adsorbance as a function of wavelength. The results are shown to the left. Note the little bump in the graph,

just beyond 900 nm. We confirmed it to be caused by the ethanol in the sample.

One final test was done with the chlorophyll solution. Chlorophyll is fluorescent, and we wanted to see if the Vernier Spectrometer could detect it. To test fluorescence, which is light emission rather than absorbance, we removed the light source/cuvette holder from the spectrometer. Then we poured about 2 mL of the chlorophyll solution into a plastic cuvette with four clear sides. We sealed the cuvette with a plastic cap and placed it directly in front of the opening in the spectrometer. By positioning a pen light (also purchased at the grocery store) at a 90° angle to the spectrometer opening, we could not only see the faint orange-red glow of the fluorescing chlorophyll in the cuvette, but the Spectrometer detected it as well. The graph is shown here to the right.



Chlorophyll fluorescence



Olive oil

The noisy graph can be attributed to a few factors: primarily that room lights were dimmed but not completely turned off, a plastic cuvette was used (for convenience), and the light source was a fairly wide-beamed white light. The important point here is that with grocery store items and non-quantitative sample preparation, we were able to successfully measure the absorbance spectrum and the fluorescence of chlorophyll.

We wished to continue our chlorophyll investigation, so we wandered along another aisle in the grocery store and selected a couple of types of olive oil. It turns out that part of the color of olive oil is due to chlorophyll. We tested two grades: extra virgin (purported to have the maximum amount of chlorophyll of all grades of olive oil since it is derived from the first pressing of the olives) and light (alleged to contain no chlorophyll). More testing is needed, but our initial results are shown here.

Note that while the olive oil graph has some qualitative similarities to the chlorophyll samples described previously, it is not an exact replication of the chlorophyll absorbance peaks.

Lab write-ups for these activities are available online at [www.vernier.com/innovate/spectrometer](http://www.vernier.com/innovate/spectrometer)



Vernier Spectrometer  
Order Code V-SPEC | \$1199

# SensorDAQ for Engineering Education

*Vernier Collaborates with  
National Instruments*

**Available in December**

Vernier Software & Technology and National Instruments (NI), two of the most respected names in science and engineering, have collaborated to create a powerful, affordable, data-acquisition interface for use by engineering students. The Vernier SensorDAQ is a USB interface that provides an extremely easy connection to Vernier sensors, as well as a screw terminal connection for

customized data acquisition and control projects. SensorDAQ is used with NI's LabVIEW software, the industry standard graphical

development tool and the modern language of robotics and science.

SensorDAQ is designed for ease of use, while still providing the versatility and power required in engineering education. Four sensor channels (3 analog and 1 digital) make it easy to connect more than 50 different Vernier Sensors, including motion detectors, photogates, temperature probes, accelerometers, and force sensors. In addition, the screw terminal connector provides the versatility of custom connections to two general-purpose analog input channels, four digital input and output lines, and one analog output channel.

Vernier SensorDAQ provides students with hands-on opportunities to design, analyze, and control sensor-based systems and add excitement to high school and college engineering courses. Available in December for less than \$200. For more details, visit [www.vernier.com/sensordaq](http://www.vernier.com/sensordaq)



## **NEW** Infrared Thermometer *Measure Temperature Quickly and Without Contact!*

A new addition to our line of sensors is an infrared thermometer. The sensor works by measuring the infrared radiation emitted by objects. For most objects, you simply point the sensor at the object and read its temperature. Our Infrared Thermometer features automatic backlighting, simple ON/OFF operation, and laser sighting.



Order Code  
IRT-BTA | \$159

The laser sighting circle is a valuable feature because it allows you to see the area from which the measurement is being made. The sensor can be used as a stand-alone meter, or it can be connected to a data-collection interface, such as Vernier LabPro®, Go!® Link, CBL 2, and Vernier EasyLink®, allowing data to be recorded on a computer, Texas Instruments graphing calculator, or Palm Powered™ handheld. Below are some ideas for use of the sensor.

Available October 1, 2006. For more details, visit [www.vernier.com/probes/irt-bta.html](http://www.vernier.com/probes/irt-bta.html)

### Understanding Temperature

Temperature can be a difficult concept to understand. Our personal experiences complicate the situation. Imagine being a grade school student in a classroom on a hot day in September. Your arm touches the metal leg of the desk, and you discover that the metal is cold. When you touch the top of your desk, it's not cold. As a matter of fact, most of the objects in the room are not cold. The Infrared Thermometer is a perfect sensor for this teachable moment. A student could use it to discover that the temperature of the metal leg of the desk is the same as the desk top, which is the same as the temperature of the wall, door, textbook, etc. This knowledge helps students better understand temperature and equilibrium. This experiment could lead to a field trip to the school's parking lot. With the sun shining brightly on the cars, the students could compare the temperatures of the surfaces of cars. Are these temperatures the same, or does the color of the car make a difference? Is the surface of the car hot enough to fry an egg? Students could expand their exploration to compare temperatures of the lawn, concrete, and asphalt.



*Measuring temperature of the bird with the Infrared Thermometer*

### The Drinking Bird Demo

You are probably familiar with the "Drinking Bird" toy, shown above. The bird sits on a stand that allows it to rotate about a pivot point. After the head of the bird, which is covered with felt, is wetted, the bird oscillates about the pivot point while a liquid moves up and down a tube connecting the head and bottom of the bird. A number of concepts can be discussed when explaining the motion of the bird—center of gravity, vapor pressure, temperature, and equilibrium, among others. An important part of the explanation centers around understanding what happens to the temperature of the bird's head. Since the head is covered with moist felt, we can hypothesize that evaporation is occurring at the bird's head. Since evaporation is a cooling process, the head must be cooling, and the drop of vapor pressure in the bird's head contributes to the rise of the liquid in the tube. Without this sensor, you don't have direct evidence that the bird's head is cooling. With this sensor you can verify the hypothesis. We tried it and found that the temperature of the felt before adding water was 25°C. We measured the temperature again after wetting the head and letting the bird oscillate for 10 minutes. The temperature had dropped to 19°C.

# Logger Pro 3.4.6 Released

We are pleased to release another update to *Logger Pro*, our flagship application for Windows and Macintosh. In addition to collecting data from any combination of LabPros, Go! devices, Ohaus Scout Pro balances, and many video cameras, *Logger Pro* now supports the Wireless Dynamics Sensor System, Vernier and Ocean Optics Spectrometers, Ohaus Adventurer Pro balances, and many Garmin GPS units.

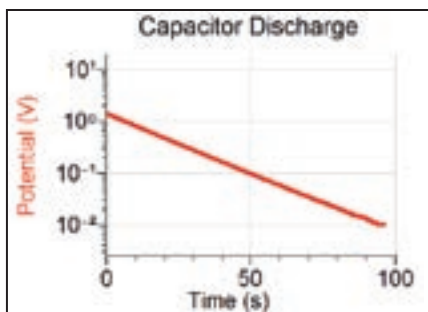
The new release is also a Universal Binary build for Macintosh, meaning that *Logger Pro* now runs natively on the new Intel-based Macs. Fast! The same build also runs natively on older PowerPC-based Macs running OS X 10.3 and newer.

Here are a few new features:

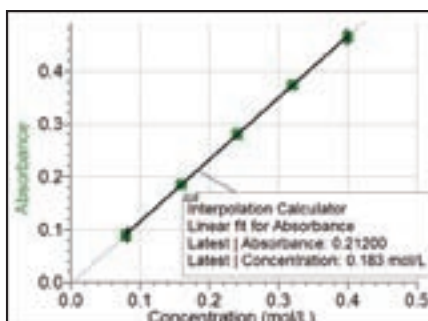
- Graphs can now have log axes or two Y axes.
- You can import data from another *Logger Pro* file, allowing the combination of results from many students.
- Time-offset curve fits are available. In a time-offset fit, the time is treated as zero at the beginning of a selected region of data. This allows simple interpretation of fit parameters.
- Simplified point-and-click synchronization of videos and data make it even easier to use videos with your sensor data.
- A distance-measuring tool makes it easy to analyze photos and videos.
- Video analysis now allows the tracking of more objects. Formerly the limit was three; now you can track as many as you like.
- Use the Interpolation Calculator to interpolate a curve fit's X-value based on a Y-value and subsequently display the values on the graph. The Interpolation Calculator is different from the interpolate function in that the Interpolation Calculator remains in place while the interpolate function moves with the mouse pointer.
- A new gel analysis feature has been added for DNA gel electrophoresis work. See cover story for details.

- Videos from DV (digital video) cameras are captured at a full 30 frames per second.
- Some models of Garmin Global Positioning System (GPS) units can be used as a data source both for live data collection and for remote data retrieval and subsequent analysis (Windows only).
- Export GPS data to Google Maps. GPS locations, and any associated sensor data, will be drawn on a Google map or satellite photo.
- New sample data files have been added.

*Logger Pro* 3.4.6 updates are free if you have any prior version of *Logger Pro* 3. Visit [www.vernier.com/download](http://www.vernier.com/download) for a free update. If you need a CD, give us a call, and we will send you one.



Logarithmic graph of capacitor discharge



Interpolation Calculator with Beer's law data

## DV Cameras: Cool Tools for Physics

*Logger Pro* has supported video capture for some time, but version 3.4.6 adds much improved support for DV (digital video) cameras. These cameras have Firewire or USB 2 connection to a computer, and offer a full 30 Hz frame rate. Image quality is quite good, and even inexpensive consumer cameras allow you to set a very fast shutter speed. You can get a basic DV camera for about \$300.

## About New Versions of Software...

Does it seem like there are new versions of *Logger Pro* all the time? That's because we are hard at work adding new features and supporting updated computer operating systems. Software written years ago may not work properly on new computers, and new hardware such as the Vernier Spectrometer or Wireless Dynamics Sensor System require new versions of *Logger Pro*. We listen carefully to your requests for new features, and we also fix occasional bugs. Do you have suggestions for new features? Write to [info@vernier.com](mailto:info@vernier.com). Give us a call if you have questions about updating to a newer version of *Logger Pro* or Graphical Analysis. If you have version 3 of either application, updates are free.

## SCIENCE HUMOR

HA!  
HA!  
HA!

What did the neutrino say to the earth?  
"Just passing through."

Old mathematicians never die; they just lose some of their functions.

Q: If sound does not travel in a vacuum, why is a vacuum so noisy?



The upgrade is a **FREE** download from our web site at [www.vernier.com/download](http://www.vernier.com/download)



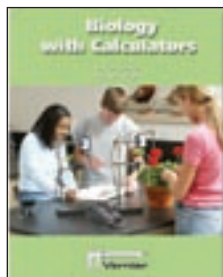
10 Years Ago in  
The **CALIPER**

We announced several new sensors: 3-Axis Accelerometer, Exercise Heart Rate Monitor, CO<sub>2</sub> Gas Sensor, Dual-Range Force Sensor, and Student Radiation Monitor.



# Calculator Data Collection

## Calculator Lab Books Support **EasyData**



We have just completed updating our calculator lab books to support the EasyData Application for TI-83 Plus and TI-84 Plus graphing

calculators. If you are purchasing a new book, you can find the EasyData versions on the included CD. If you already own the book and would like the updates, contact us, and we will gladly send you the updated book CD. If you haven't already made the switch to EasyData, now is the time. EasyData's intuitive user design makes this our best calculator data-collection software yet. Now that our labs support EasyData, it is a great time to make the switch.



Order Code **TI-ADC | \$14**

Are you using the TI-73 Explorer™ in your middle school math or science class? If so, you will want to check out the new book *Adventures in Data Collection with the TI-73 Explorer*, published by Texas Instruments. The 12 activities have students scan for treasure, explore racing cars, solve a mystery, and much more. There are bonus extensions with every activity that you can use with the TI-Navigator Classroom Learning System to extend learning and assess understanding. The book includes a CD with the activities in Word format so you can easily adapt them to use in your classroom. For more information, including a sample activity, visit our web site at [www.vernier.com/cmat/tib.html](http://www.vernier.com/cmat/tib.html)

**You will also need:**

**TI-73 Explorer Calculator** Order code **TI-73EX | \$66**

**CBR 2™ Motion Detector** Order code **CBR2 | \$93**

**CBL 2™ System** Order code **CBL2 | \$166**

Temperature Sensor, Light Sensor, & DataMate App – Included with CBL 2



**EasyData is a FREE download from our web site at [www.vernier.com/easydata](http://www.vernier.com/easydata)**

## Activities Exchange from Texas Instruments

Interested in activities that make use of TI graphing technology? Then you will want to check out Activities Exchange ([education.ti.com/exchange](http://education.ti.com/exchange)), a web-based repository for activities created by teachers, for teachers. You can find activities from TI EXPLORATIONS™ series of books, sample activities from Vernier lab books, and even activities based on the hit TV show Numb3rs. Many of the activities have been correlated to state and national standards.

Finding activities is easy, too. You can browse for activities by subject area or use the advanced search features to find activities that use a specific TI calculator or Vernier sensor. You can even submit your own favorite activities.

While you are there, be sure to check out the activity "Stride Pattern Analysis" submitted by Irina Lyublinskaya, Associate Director of the Discovery Institute at the College of Staten Island/CUNY. (Use the search code 6272.) Irina's activity is an

extension to the TI Forensics Book activity "Tracks of a Killer." Students investigate the relationship between a person's stride distance, speed, and height using a CBR 2™ and the Vernier EasyData App to determine which suspect vandalized their school. The activity even has instructions on how to use the TI-Navigator system to facilitate transferring individual student data to everyone in the class. (The TI Forensics lab manual is available from Vernier for \$25, order code TI-FOR.)

### DISCOVER TI NEIGHBORHOOD WORKSHOPS

Texas Instruments is continuing to offer workshops for teachers in select locations across the United States. These free workshops include sessions for science data collection, middle school math, algebra, geometry, and using the TI-Navigator Classroom Learning System. The science sessions are a great place to learn more about the latest data-collection technology for graphing calculators from TI and Vernier. The four remaining sites are:

- Nashville, TN      September 13, 2006      5:00-9:00 p.m.
- Shreveport, LA      September 30, 2006      8:00 a.m.-Noon
- Charlotte, NC      October 2, 2006      5:00-9:00 p.m.
- New York, NY      October 14, 2006      8:00 a.m.-Noon



Registration is required. For more information, visit <http://education.ti.com/us/discover>



## DAVE VERNIER'S 25 YEARS OF VERNIER SOFTWARE & TECHNOLOGY

In honor of our 25th anniversary, I was invited to do a talk at the American Association of Physics Teachers on the history of the company. Getting ready for this talk led me to reminisce on how data collection has evolved over the years.

# 1980s

### Game Port Interfacing with Apple II or IBM-Compatible (MS-DOS) computers

In the 80s, if you wanted to collect data with a computer, you purchased our software and in the accompanying manual you found instructions on how to build your own sensors from parts that could be purchased at local electronics stores. You plugged sensors into a connector that was really meant for joysticks that were used in games. After a few years, we started selling parts, so you did not have to make trips to Radio Shack. In the late 80s, we started selling assembled sensors (made in our garage).



Original Apple II

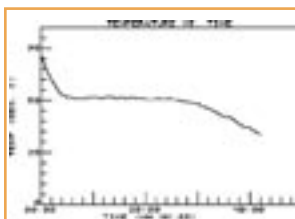


IBM MS-DOS computer



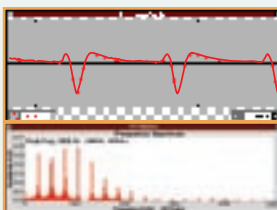
Temperature Plotter hardware

Temperature Plotter (MS-DOS graph)



# 1990s

MPLI hardware



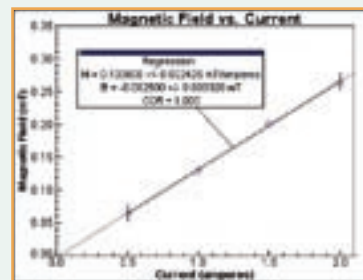
MPLI for Windows software (trumpet and its FFT)

### Data Collection with Macintosh and Windows computers using ULI and MPLI.

In about 1990, we introduced two popular interfaces: the Universal Lab Interface (ULI) and the MultiPurpose Lab Interface (MPLI), along with software to run on both Macintosh and Windows computers. We continued to develop curricular materials for using data-collection technology in the classroom from middle school through introductory college science classes.



ULI II hardware



Data Logger (ULI program) graph of magnetic field experiment

### Serial Box Interface and Calculator-Based Lab (CBL)

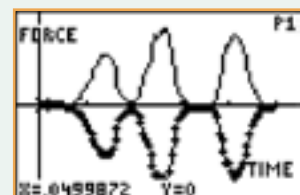
The ULI and MPLI interfaces were fine for physics teachers, but chemistry and biology teachers did not need as many features and wanted a lower price, so we developed the Serial Box Interface. (That was my favorite product name of all time. Many people ordered a Cereal Box Interface.) In 1994, Texas Instruments introduced the Calculator-Based Laboratory (CBL™). We worked closely with them to develop compatible sensors and curriculum.



Serial Box Interface



CBL



Newton's third law using a CBL



David Vernier with an Apple II



Go!Temp temperature probe



Vernier Dynamics Cart and Track System and Wireless Dynamics Sensor System

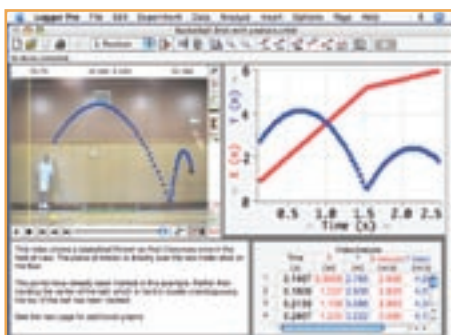
# EARLY 21<sup>ST</sup> CENTURY 2004-PRESENT

## Data Collection with Vernier LabPro

In 2000, we introduced LabPro, our lab interface for use with computers, TI graphing calculators, and Palm handhelds. We also introduced more and more powerful versions of Logger Pro software, with new features such as support for balances, spectrometers, GPS devices, and ProScopes. The addition of movies, video synchronization with data, and video analysis have been major improvements.



Vernier LabPro



Video analysis of a basketball shot

## Data Collection with Direct USB Sensors and Wireless Sensors

In 2004, we introduced our "Go!" line of products, with the goals of lowering the cost of data collection with computers and providing a solution for elementary schools. Free data-collection software was included with the sensor. We also introduced our "Easy" line of products, which plug directly into the USB port of a Texas Instruments calculator, lowering the total cost of data collection with calculators. Keeping up with the advancement of technology, in 2006 we added the Vernier Wireless Dynamics Sensor System, our first wireless sensor! We also introduced the Vernier Spectrometer, as well as the Vernier BlueView Transilluminator. Over the years, we have added a few new sensors every year, so that there are now more than 55. It has been a fascinating 25 years. What will the next 25 years bring? Thanks to all of you for your support over the years.

David Vernier



Wireless Dynamics Sensor System



Go!Link, Go!Temp, and Go!Motion



EasyTemp



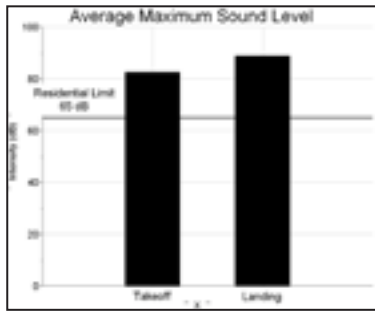
EasyLink



Vernier Spectrometer



BlueView Transilluminator



Sound levels of airplanes at take off and landing

Mario to measure the noise level at points along the flight path of Long Beach Runway 30 as their science project. Based on their research, they believed that planes landing would create a higher level of sound intensity compared to planes taking off. Equipped with our Sound Level Meters (order code SLM-BTA, \$209), they selected locations along the flight path and measured sound level intensities of planes during takeoff and landing. Since the experimental decibel levels exceeded the maximum allowable levels for residential areas, their report has added fuel to the airport noise debate in Long Beach. This has prompted a city councilman to suggest a stricter noise ordinance for the city and has given the boys valuable insight on how science impacts politics.

Note: Riley Wilson is the son of Bill and Margaret Wilson, owners of School Savers, a Vernier and Texas Instruments distributor ([www.schoolsavers.com](http://www.schoolsavers.com)).

## Investigating Airport Sound Levels

Anyone who lives along the flight path of a major airport knows that sound pollution is an unpleasant fact of life. Riley Wilson, Tim Horton, and Mario Bautista, 8th grade students at Hughes Middle School in Long Beach, California, know this all too well, often having instruction interrupted as planes fly over their school.

Airplane noise in the Long Beach area is a frequent topic of debate. This motivated Riley, Tim, and

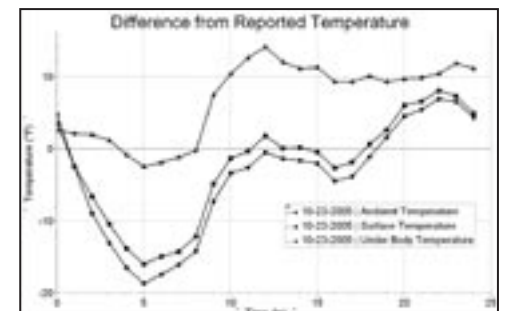
## Forensics Death Scene Investigation

Students at Susquehanna Township High School in Harrisburg, Pennsylvania, participated in a program where the students studied the life cycle of the blowfly and its relationship to the decomposition of a deer. This program motivated 9th grade student Drew Evans to do some further investigation for his science fair project.

Drew was intrigued with the effect that temperature had on the activity of the insects. Knowing that death scene investigations focus on determining time of death based on body temperature and insect activity and that forensic scientists rely on published temperature readings led Drew to this project. He hypothesized that the actual temperatures at a death scene would differ from temperatures recorded by the local weather agencies.

Drew worked with a local game warden to obtain a deer that had recently been hit by a car. Stainless Steel Temperature Probes were placed around the deer: one under the body, one against the body, and one several feet above the deer (to measure the ambient temperature). Twenty-four hour temperature readings were collected on multiple days with the deer located in different locations. The collected data were compared to the temperatures recorded at the local airport and made available through Penn State's web site. Drew found average differences in temperature ranging between 6.1°F (ambient) to 8.7°F (under the deer), which supported his hypothesis.

This investigation has given Drew a better understanding of the difficulties forensic scientists encounter when estimating time of death. Drew was awarded a gold medal for his first place finish in the Earth Science Senior Division of the Capital Area Science and Engineering Fair (an Intel Regional Science Fair).

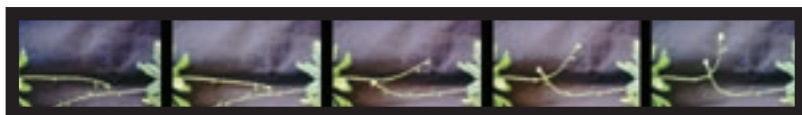


Temperature readings over a 24 hour period

## Measuring a Plant's Response to Gravity

Judy Day, with The Science House, a NC State University K-12 science outreach program, has developed an activity investigating a plant's response to gravity. Judy uses a ProScope USB digital microscope (order code BD-PSB, \$259) to record changes over time in a plant that has been placed on its side. For best results, Judy recommends using an Arabidopsis thaliana (the wild variety) having an inflorescence stem at least 10 cm long. Here is a brief description of Judy's procedure:

Before starting the experiment, place the plant upright, in a dark place for several hours to allow the stem to straighten. Gently mark one centimeter increments on the stem to allow tracking of the changes and to have known reference distances to use for video analysis. Bring the plant to the video location, and with the plant in its upright position, prepare to start the video. Using the time lapse feature of the video software, capture video images every three minutes for a 60 minute period. Gently lay the plant on its side, start the video, and watch the changes. **Note:** since the plant is sensitive to movement, move as little as possible during the setup.

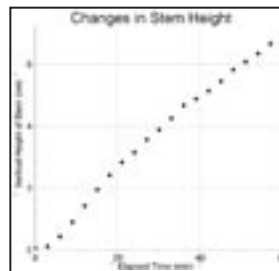


This is from a QuickTime movie of the plant's growth

Once you have your video, use the video analysis features in Logger Pro to measure the changes in the plant as it responds to gravity. The sample graph shows data that Judy obtained. Note the relatively uniform change in stem height over time.

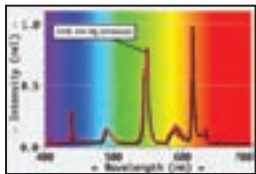
Judy also sent us some suggested extensions to try:

- Compare various points on the stem for movement.
- If the plant has multiple stems, trim the top of one stem and leave the other alone.
- Compare length of stem with range of movement.
- Compare other plants for rates of movement.
- Place the plant in a 4°C environment on its side for an hour; then move the plant to room temperature in an upright position. Record observations of movements of the plant.



Changes in stem height in response to gravity





Spectrum from a "green" fluorescent lamp

## Mercury Fingerprint

Did you know that even if a fluorescent lamp is labeled "green" it may still contain some mercury? We used a Vernier Spectrometer to study the emission spectrum of a modern fluorescent tube.

It had a very strong peak at 546 nm, one of the characteristic emission wavelengths of mercury. Dispose of your old lamps properly, even if they are marked as "green."

You can also use a cool new Logger Pro feature to compare spectra. There is a mercury spectrum in the Sample Data folder. If you collect an unknown spectrum and want to compare it to a known mercury spectrum, just superimpose the reference mercury data from the Sample Data folder using the new Import from Logger Pro file feature. Do the peaks line up?

## Send us Your Innovative Uses!

Do you find yourself reading our Innovative Uses articles and wish you could have your ideas published? Well, you can! Send us your ideas for innovative uses of Vernier data-collection technology, and we might publish your ideas in a future print or electronic newsletter. Entries should include your original data and images of the experiment setup. (Images that include students will require signed release forms prior to being published.) If we choose to publish your idea, we will send you a \$100 Vernier gift certificate. Send us your ideas today! Submit your ideas to [innovativeuses@vernier.com](mailto:innovativeuses@vernier.com)

## Students Monitor Classroom Conditions and Win Awards

Two groups of local science students from Westview High School, Beaverton, OR, recently won honors with projects using our sensors to monitor their school environment.

Julio Montano, Jose Perez, and Josean Perez used our temperature sensors to monitor classroom temperature and how it affects student attention span. The project won awards at the science fair. One of the science fair judges told the Environmental Protection Agency (EPA) about it, and the students were invited to Washington, DC to present their results at a forum.

Josh Goodman, of the Beaverton School of Science & Technology, won the top prize at the local science fair with a project checking the carbon dioxide levels in classrooms, and comparing them to recommended EPA guidelines.



More innovative uses at  
[www.vernier.com/innovate](http://www.vernier.com/innovate)

## Innovative Uses from the Journals

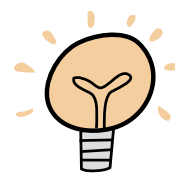
"Transient Behavior of the Driven RLC Circuit" by Michael C. Faleski, Delta College, Center, MI, in the May 2006 issue of *American Journal of Physics* explains how he is using LabPros to study RLC circuits powered by a battery in an introductory physics course.

"Teaching about Functions through Motion in Real Time" by Maria L. Fernández, Florida State University, in the February 2006 *Mathematics Teacher* gives a great explanation of how CBL 2 (or LabPro), along with a Motion Detector, can be used to teach students about functional relationships and the interpretation of graphs.

"Simplifying in the Motion of Coupled Oscillators Using the FFT" by Don Easton, Lacombe, Alberta, in the January 2006 issue of *The Physics Teacher* describes using LabPro and a Motion Detector to study two pendula connected together via a spring. The Logger Pro FFT feature makes understanding the motion easier.

"Phase-Space Orbits and the Ping-Pong Ball Impact Oscillator" by Peter Millet, James Schreve, and Peter Coxeter, Hamilton College, Clinton, NY, in the February 2006 issue of *The Physics Teacher* shows how to use Logger Pro and a Motion Detector to study the chaotic behavior of a ping-pong ball driven by a speaker.

"A Rolling Sphere Experiment" by Adam Niclescu, Virginia Commonwealth University, in the March 2006 issue of *The Physics Teacher* describes a detailed study of the rolling of a ball done through the use of Logger Pro and a Motion Detector.



innovative uses

20 Years Ago in  
The CALIPER

We included a report on the compatibility of our software with the new Apple II GS, and we announced Precision Timer II, the new, improved version of our Apple II photogate timing program.

# NEW Garmin eTrex Vista® Cx

Bringing USB GPS Support to Logger Pro

**GARMIN**  
eTrex Vista Cx

Order Code  
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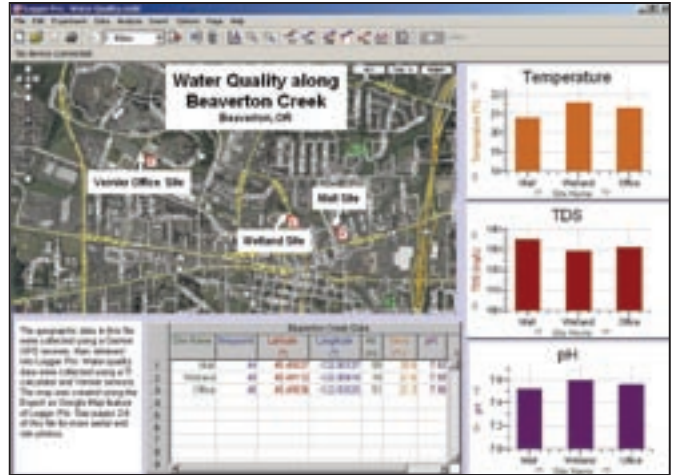


Garmin eTrex Vista Cx package includes:

- eTrex Vista® Cx
- 64 MB microSD card
- Database—Marine Point Database
- American Recreational Basemap
- MapSource® Trip & Waypoint Manager CD
- PC/USB interface cable
- Lanyard
- Bike clip—for use with handlebar or automotive mount
- Quick reference guide
- Owner's manual

The Garmin eTrex Vista Cx is the first GPS receiver to communicate with Logger Pro through USB (Logger Pro version 3.4.6 or newer, Windows only). The eTrex Vista Cx is loaded with popular features, including a barometric altimeter, electronic compass, sunlight-readable color screen and advanced GPS routing capabilities—all in a waterproof design. In addition, it comes with a blank 64 MB microSD card for storage of optional map detail.

When attached to a computer in the field, Logger Pro treats the Vista Cx as a sensor, collecting latitude, longitude, and altitude in real time. Without a computer, you can save waypoints, tracks, or routes on the Vista Cx, then retrieve the data into Logger Pro at a later time.



Logger Pro combines GPS data and water quality sensor data

Other Garmin GPS models also work with Logger Pro. This sample file can be found in Sample Data\Environmental Science.

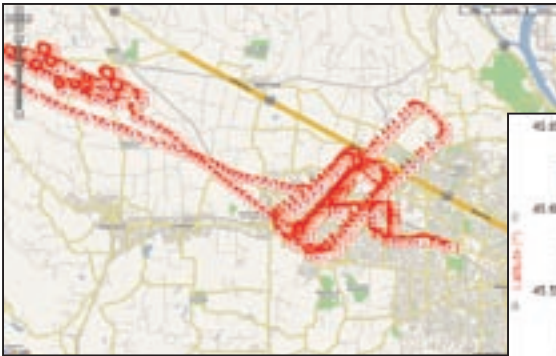
See [www.vernier.com/gps](http://www.vernier.com/gps) for a complete list.

## GPS Sample Data in Logger Pro 3.4.6

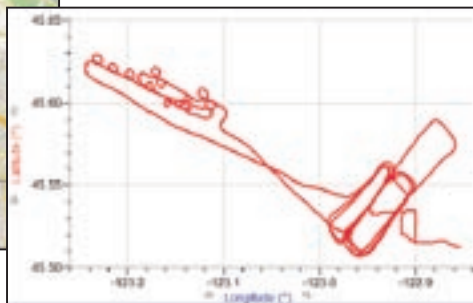
Once you update to Logger Pro 3.4.6, open the file Sample Data\Physics\GPS Sample Data\Test Flight. There you will find some data taken during a training flight taken by one of our engineers, who is also a student pilot. He used a GPS to record his position and altitude during a touch-and-go sequence, as well as some other interesting maneuvers.

Afterward he retrieved the data into Logger Pro. Using this sample data, you can try exporting the data to Google Maps; then you can superimpose satellite photos of the area beneath his flight and use other tools available on the Google web site.

Check it out—you'll be intrigued. How can you use this tool in your teaching?



A Logger Pro export of the data to Google Maps



Test flight data shown in Logger Pro

## New Online Purchasing Guide

Create a personalized recommendation of lab books, sensors, interfaces, software, and accessories to fit your needs. This interactive purchasing guide lets you customize your options according to the subject you teach, your budget, and curriculum. You can print your recommendation, request a formal quote, or order online.

Try the new online purchasing guide at [www.vernier.com/guide](http://www.vernier.com/guide)



For more information on Logger Pro 3.4.6 visit our web site at [www.vernier.com/lp](http://www.vernier.com/lp)

## Grants and more...

Have you been looking to add to your collection of Vernier technology but are wondering where the money might come from? Here are some grant opportunities and programs you can participate in. For even more opportunities, visit our web site at [www.vernier.com/grants](http://www.vernier.com/grants)

### Toyota TAPESTRY Grants

*Deadline for submission is January 18, 2007*

The TAPESTRY grants program offers 50 grants of up to \$10,000 each and a minimum of 20 mini-grants of \$2,500 each to current K-12 science teachers. Proposals must describe a project, including its potential impact on students in one of three categories—Environmental Science Education, Physical Science Applications, or Literacy and Science Education. For more information, visit [www.nsta.org/programs/tapestry](http://www.nsta.org/programs/tapestry)

### NCTM Connecting Mathematics to Other Subject Areas

*Deadline for submission is November 3, 2006*

The National Council of Teachers of Mathematics is awarding \$3,000 grants to current teachers of math in grades 9-12 who develop teaching materials that connect math to other subject areas. The focus of these materials should show the connectivity of mathematics to other fields or to the world around us. Any acquisition of equipment must support the proposed plan, but not be the primary focus of the grant. For more information visit [www.nctm.org/about/met/pappas.htm](http://www.nctm.org/about/met/pappas.htm)



## 2007 NSTA/Vernier Technology Award

*Deadline for submission is October 15, 2006*

The Vernier Technology Award is your opportunity to be honored for innovative uses of data-collection technology with your students. Seven awards are offered annually—three high school (grades 9-12), two middle school (grades 6-8), one elementary (grades K-5), and one college. The award consists of \$1,000 in cash, \$1,000 in Vernier data-collection technology, and up to \$1,000 in expenses to attend the 2007 NSTA conference in St. Louis. For more information or to download an application, visit [www.vernier.com/grants/nsta.html](http://www.vernier.com/grants/nsta.html)

### 2007 NABT Ecology/Environmental Science Teaching Award

*Deadline for submission is March 15, 2007*

Vernier is proud to once again sponsor the National Association of Biology Teacher's Ecology/Environmental Teaching Award for 2007. This award will be given to a secondary school teacher who has successfully developed and demonstrated an innovative approach in the teaching of ecology/environmental science and has carried his/her commitment to the environment into the community. Vernier's sponsorship of this award includes \$500 toward travel to the 2007 NABT National Conference in Atlanta, \$500 toward purchase of equipment, and \$500 of Vernier equipment. The recipient also receives a plaque to be presented at the national conference, and a one-year complimentary NABT membership. The application can be downloaded from the NABT web site, [www.nabt.org](http://www.nabt.org)


### Texas Instruments GraphiTI Contest

*Deadline for submission is November 3, 2006*

Show off your design talents with the GraphiTI Contest sponsored by Texas Instruments by creating a new calculator cover design for TI-84 Plus graphing calculators. If your design wins, you will receive a \$1,000 shopping spree, 30 TI-84 Plus Silver Edition graphing calculators, and a TI-Navigator™ classroom learning system. For more details, visit [www.84silver.com/win\\_graphiti.php](http://www.84silver.com/win_graphiti.php)

### Apple Trade-In and Recycle Program

Apple is offering a program in which schools can turn old computer and peripherals, regardless of manufacturer, into cash (where applicable). You can feel good knowing that Apple will recycle your old systems in an environmentally friendly way. Trade-in values fluctuate with market conditions. For more information visit [www.apple.com/education/shop/recycle](http://www.apple.com/education/shop/recycle)



**More grant information at**  
**[www.vernier.com/grants](http://www.vernier.com/grants)**



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# 2006 FALL HANDS-ON WORKSHOPS FOR TEACHERS OF SCIENCE + MATH

## Vernier Hands-On Workshops

Join us for one of our free, 4-hour, hands-on workshops to learn how to integrate our computer, calculator, and handheld data-collection technology into your chemistry, biology, physics, math, middle school science, physical science, and Earth science curriculum. The workshops include lunch or dinner and lab handouts. Contact us or visit our web site for up-to-date information and registration.

### This is a great opportunity for teachers who

- want to evaluate our award winning data collection technology;
- are new to data collection;
- need a refresher course on their Vernier equipment;
- want to learn from the experts.

### SEPTEMBER '06

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 Sept. 12 Dallas, TX  
 Sept. 13 Waco, TX  
 Sept. 14 Austin, TX  
 Sept. 16 San Antonio, TX  
 Sept. 18 San Antonio, TX  
 Sept. 19 Houston, TX  
 Sept. 21 McAllen, TX  
 Sept. 25 Norman, OK  
 Sept. 26 Tulsa, OK  
 Sept. 28 Springfield, MO  
 Sept. 30 St. Louis, MO

### OCTOBER '06

Oct. 23 Minneapolis, MN  
 Oct. 25 Madison, WI  
 Oct. 26 Milwaukee, WI  
 Oct. 28 Green Bay, WI

### NOVEMBER '06

Nov. 1 Naperville, IL  
 Nov. 2 Northbrook, IL  
 Nov. 4 Fort Wayne, IN  
 Nov. 6 Indianapolis, IN  
 Nov. 7 Louisville, KY  
 Nov. 8 Lexington, KY  
 Nov. 11 Stamford, CT  
 Nov. 13 Bridgeport, CT  
 Nov. 14 Waterbury, CT  
 Nov. 14 Cincinnati, OH  
 Nov. 15 Columbus, OH  
 Nov. 15 Providence, RI  
 Nov. 16 Worcester, MA  
 Nov. 16 Cleveland, OH  
 Nov. 18 Boston, MA  
 Nov. 18 Rochester Hills, MI



Workshop registration and details can be found at  
[www.vernier.com/workshop](http://www.vernier.com/workshop)

### FREE Hands-On Training at Conferences

Vernier will offer hands-on workshops at each of these conferences. For a full listing of our conference exhibits, check out our web site at [www.vernier.com/workshop](http://www.vernier.com/workshop)

New Jersey Science Convention, Somerset, NJ October 10-11  
 National Association of Biology Teachers, Albuquerque, NM, October 11-14  
 NSTA Midwestern Area Convention, Omaha, NE, October 19-21  
 NSTA Eastern Area Convention, Baltimore, MD, November 2-4  
 Science Teachers Association of New York State, Ellenville, NY, November 5-7  
 NSTA Western Area Convention, Salt Lake City, UT, December 7-9



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