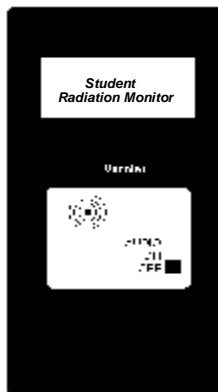


# Student Radiation Monitor

## (Order Code SRM-BTD or SRM-DG)

The Student Radiation Monitor is used to monitor beta and gamma radiation. This portable radiation detector can be used in the classroom lab or in the field. It consists of a Geiger-Mueller tube mounted in a small, rugged case. The Student Radiation Monitor allows students to

- detect the presence of a source of radiation.
- monitor counts/interval (rate) as different thicknesses of a particular type of shielding are placed between the Geiger-Mueller tube of the Student Radiation Monitor and a beta or gamma source.
- compare the effect of different types of materials to shield beta or gamma radiation.
- set up a histogram with a very long run time to show students how initial “randomness” of data develops into a “bell-shaped” curve.
- measure radiation of common radioactive materials, such as lantern mantels or old Fiestaware.
- monitor variation in background radiation at different elevations.
- monitor radioactivity in the environment over long periods of time.
- monitor counts per interval (rate) from a beta or gamma radiation source as a function of the distance between the source and the Student Radiation Monitor.



This document describes the use of both the SRM-BTD and SRM-DG Radiation Monitors. Each of these radiation monitors includes a cable that allows the monitor to be connected to a data-collection interface.

The cable that accompanies the SRM-BTD Radiation Monitor has a small 3.5 mm (micro-miniature) stereo jack on one end and a white rectangular British Telecom (BT) plug on the other end. This cable is used to directly connect the SRM-BTD to the Vernier LabPro® interface or to the Texas Instruments CBL 2™.

The cable that accompanies the SRM-DG has a small 3.5 mm (micro-miniature) stereo jack on one end and a quarter-inch stereo plug on the other end. The SRM-DG will plug directly into a ULI II. Contact us if you want to use this radiation monitor with the original ULI.

NOTE: This product is to be used for educational purposes only. It is not appropriate for industrial, medical, research, or commercial applications.

## Using the Student Radiation Monitor with a Computer

This sensor can be used with a Macintosh® or PC computer and either the Vernier LabPro or Universal Lab Interface. Here is the general procedure to follow when using the Student Radiation Monitor with a computer:

1. Connect the Student Radiation Monitor to the appropriate port on the interface.
2. LabPro and SRM-BTD:
  - Plug the 3.5 mm stereo jack end of the cable into the Student Radiation Monitor
  - Plug the white British Telecom end of the cable into DIG 1 on the interface.ULI and SRM-DG:
  - Plug the 3.5 mm stereo jack end of the cable into the Student Radiation Monitor.
  - Plug the quarter-inch stereo plug into DG 1 on the ULI II. The SRM-DG can also be used with the original ULI with the proper cable. Contact us for details.
3. Start the data-collection software on the computer.
4. Open an experiment file in *Logger Pro*, and you are ready to collect data.

## Using the Student Radiation Monitor with TI Graphing Calculators

This sensor can be used with a TI graphing calculator and the LabPro or CBL 2 interfaces. Here is the general procedure to follow when using the Student Radiation Monitor with a graphing calculator:

1. Load a data-collection program into your TI graphing calculator using your TI-GRAPH LINK™ or TI Connect software and cable. If you are using the Student Radiation Monitor with LabPro or CBL 2, load the DataRad program. This program can be found on the Vernier web site ([www.vernier.com](http://www.vernier.com)).
2. Use the link cable to connect the interface to the TI graphing calculator. Firmly press in the cable ends.
3. Connect the Student Radiation Monitor to the data-collection interface. Plug the 3.5 mm stereo jack end of the cable into the Student Radiation Monitor. Plug the white British Telecom end of the cable into DIG 1 on the interface.
4. Turn on the calculator. Start the data-collection program and proceed to the main screen.
5. Your equipment is now ready to collect data. (You may want to change data collection modes. The exact procedure will depend upon the calculator program you are using.)

## Using the Student Radiation Monitor with a Palm Powered™ device

This sensor can be used with a Palm OS handheld and the LabPro. Use the following general setup procedure:

1. Connect the Palm OS handheld, LabPro, and the Student Radiation Monitor.
2. Start Data Pro.
3. Tap New, or choose New from the Data Pro menu. The Student Radiation

Monitor is not identified automatically. You will need to tap SETUP and select the sensor.

- Return to the Main screen.
- You are ready to collect data.

### Specifications

- Sensor:** Halogen quenched glass Geiger-Mueller (GM) tube. The wall density of the GM tube is  $50 \text{ mg/cm}^2$
- Power:** One 9-volt alkaline battery provides a battery life of 500 hours. Low battery condition is indicated when count light is dimmed.
- Sound:** An audio beeper indicates radiation events. This feature can be muted.
- Visual:** The red LED count light indicates radiation events.
- Dimensions:**  $30 \times 80 \times 150 \text{ mm}$  ( $1.2 \times 3.2 \times 5.9 \text{ in}$ )
- Weight:** 200 g (7 oz) with battery installed
- Data Output:** Sensor output and cable pinouts are available on our web site, [www.vernier.com](http://www.vernier.com)
- Audio output:** The 2.5 mm mono jack produces 8-volt AC coupled output suitable for amplifier input, tape recorder input, or RS232-compatible interface to personal computers.

### How the Student Radiation Monitor Works

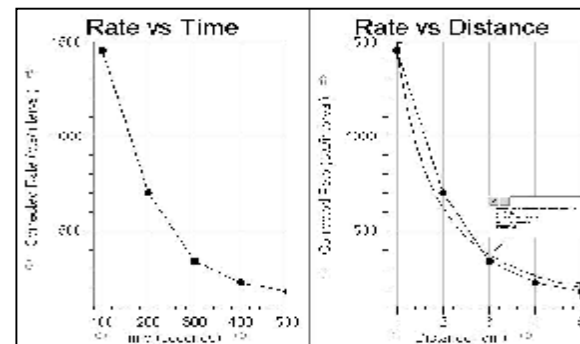
The sensor in the Student Radiation Monitor is a glass Geiger-Mueller (GM) tube that can detect beta and gamma radiation. Because the glass sensor is visible through a window in the instrument's rear panel, the ionization of the gases in the tube can be observed when exposed to a radioactive source in a darkened room. The instrument has exceptional sensitivity to beta radiation for a detector in its price class. That makes it suitable for studies of common environmental sources of radioactivity, such as radon gas daughters Potassium-40 in biological samples and Cesium-137 from nuclear weapons testing in wood ash. Note: The Student Radiation Monitor cannot be used for detection of alpha particles; nearly all alpha particles are absorbed by the window covering the Geiger-Mueller tube. The instrument can interface with a LabPro, ULI, or CBL 2. Since it has a flashing red LED, it can be used independent of the interface in the field as a visual indicator of radiation levels.

### Using the Student Radiation Monitor in Your Classes

Here are some examples of how the Student Radiation Monitor can be used in a science class.

### Counts/Interval vs. Distance Studies

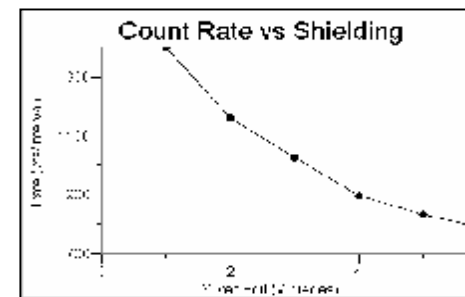
The data in the two graphs below were collected by monitoring gamma radiation at various distances from a Student Radiation Monitor. Data were collected with the run intervals set at 100 seconds. After each 100 second interval, the source was moved one centimeter further from the source. Since distance is proportional to time ( $300 \text{ seconds}$  in the first graph corresponds to  $3 \text{ cm}$  in the second graph;  $400 \text{ seconds}$  to  $4 \text{ cm}$ , etc.), a new distance column was made using *time* divided by 100. The curved fit shown corresponds to distance raised to the  $-2$  power (inverse squared).



*Counts/interval vs. time and distance*

### Counts/Interval vs. Shielding Studies

The data shown here were collected by monitoring gamma radiation with an increasing number of pieces of silver foil placed between the source and a Student Radiation Monitor. Data was collected with the run interval set at 100 seconds. After each 100 second interval, another piece of silver foil was placed between the source and the Student Radiation Monitor. Since the number of pieces is proportional to time ( $300 \text{ seconds}$  corresponds to 3 pieces of foil,  $400 \text{ seconds}$  to 4 pieces of foil, etc.), a new column, pieces of silver foil, was made using *time* divided by 100.



*Counts/interval vs. thickness of filter*

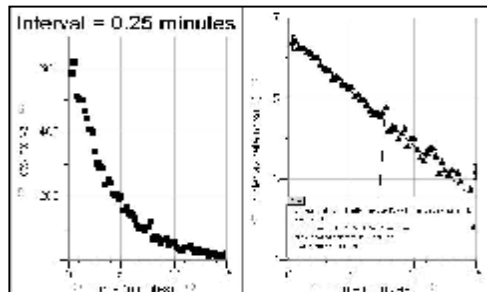
## Half-life Determination (counts/interval vs. time)

Using a daughter isotope generator, it is possible to generate isotopes with a relatively short half-life. A solution that selectively dissolves a short half-life daughter isotope is passed through the generator. The linear plot of natural log of decay rate vs. time can be used to determine the half-life of the daughter isotope, using the formula

$$\ln 2 = k \cdot t_{1/2}$$

where  $k$  is the decay rate constant and  $t_{1/2}$  is the half-life of the daughter isotope (in minutes).

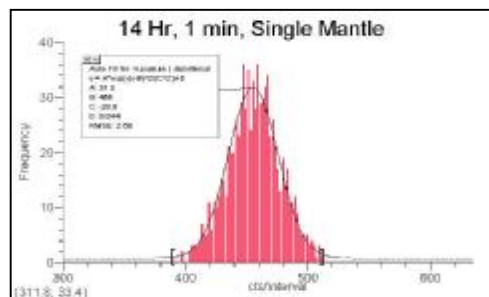
In the plot of natural log of decay rate vs. time, the decay rate constant,  $k$ , is equal to  $-m$ . Using the slope value of  $m = -0.217$  in the example here, the half-life was calculated to be 3.19 minutes.



Half-life determination

## Histogram Data Analysis

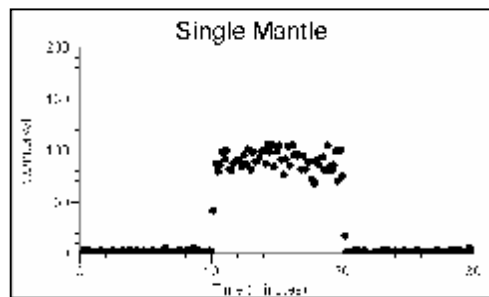
For an easy in-class experiment, set up a histogram with a very long run time and start data collection. Whenever the graph “overflows” the top of the graph, it will automatically be rescaled. This data collection shows students how initial “randomness” of data develops into a “bell-shaped” curve. A gamma radiation source was used.



A distribution graph

## Lantern Mantels

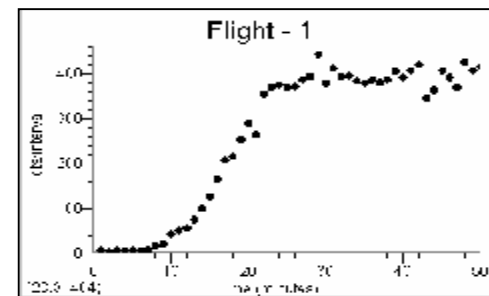
This graph shows a study of old and new Coleman mantle lanterns. These mantles formerly contained thorium and were often used for radiation demonstrations. In the early 1990s, Coleman changed the production methods and now the mantles are not radioactive.



New and old lantern mantles

## Background Radiation

Here is an experiment performed in the days before airlines insisted that you turn off your personal computer before takeoff. It shows the counts/interval between takeoff and the time the plane reached its cruising altitude of 39,000 ft.



Radiation during an airline flight

## Curricular Materials

*Nuclear Radiation with Computers and Calculators* by John Gastineau

This book has six experiments written for the Vernier Radiation Monitor and Student Radiation Monitor. Each of the six experiments has a computer version (for LabPro or ULI), a calculator version (for LabPro or CBL 2), and Palm OS version (for LabPro). The Nuclear Radiation CD included with the book contains the word-processing files for all student experiments.

## Radioactive Sources

If you don't have radiation sources, you may be able to obtain pre-1990 Coleman lantern mantles or other brands of lantern mantles (for a weak source of Thorium). You may also be able to find pottery, watches, clocks, or minerals that are moderately radioactive.

For something more active, order radioactive minerals from any of these scientific supply houses:

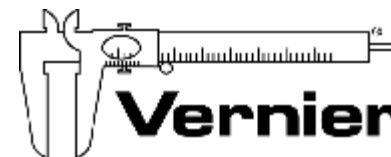
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[www.flinnsci.com](http://www.flinnsci.com)

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[www.spectrumtechniques.com](http://www.spectrumtechniques.com)

Canberra Industries  
800 research Parkway  
Meriden, CT 06450  
Phone (203) 235-1347  
[www.canberra.com](http://www.canberra.com)

## Warranty

Vernier warrants this product to be free from defects in materials and workmanship for a period of five years from the date of shipment to the customer. This warranty does not cover damage to the product caused by abuse or improper use.



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