Spex 1934C

Phosphorimeter

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Instruction Manual

1934D PHOSPHORIMETER

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1.0 DESCRIPTION

The SPEX Phosphorimeter is an accessory to the Fluorolog-2 Series of Spectrofluorometers that adds a programmable pulsed excitation source and selectable gating of signal from the photomultiplier tube (PMT). This provides time-discrimination capability to sort out competing luminescence emissions on the basis of their lifetimes.

Because the duration of each exciting pulse from the phosphorimeter is very short (about 3 microseconds), lamp interference during acquisition of decay curves in minimized. This allows the researcher to follow the decay of samples an order of magnitude faster than conventional systems that depend on mechanical choppers.

The phosphorimeter consists of three main modules: an illuminator, a phosphorimeter control module and a reference amplifier module. The reference channel circuitry is housed in the phosphorimeter control module.

The illuminator housing, or flash lamp, operates at rates up to 33 pulses per second. Each lamp pulse is triggered by a signal from the control module. When the start of the actual light output is sensed, a signal is sent to the phosphorimeter control module for timing purposes.

The phosphorimeter control module houses the signalgating circuitry that intercepts the sample signal from the pulse-counting emission photomultiplier tube (PMT), collects a selected, time-delimited portion of the signal, and later passes it to the DM3000. The reference amplifier module houses the fast amplifier for the reference channel.

A typical sequence of data-taking begins with a flash from the pulsed lamp, which is sensed by the control module as time zero (see Figure 1). The radiation enters the excitation spectrometer where it is dispersed. A selected wavelength band is passed on to excite the sample. After a delay, the sample emits luminescence that passes through the emission spectrometer to the PMT. The signal from the PMT is collected by the control module for a preset length of time. Any signal that arrives before or after this time is ignored. This sequence of excitation, delay, and sampling is repeated for each lamp flash and the signal is accumulated for a predetermined number of exciting pulses before the data is sent to the DM3000. The data can be manipulated by the DM3000's firmware routines or by user-designed programs.

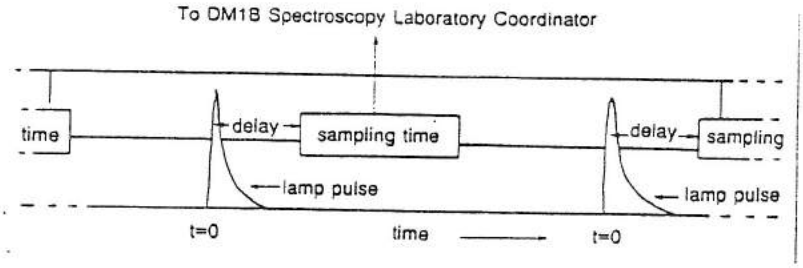


Figure 1 Phosphorimeter event sequence

This sequence of events is controlled by the DM3000 through four phosphorimeter parameters - Delay After Flash, Sample Window, Flash Rate and Number of Flashes. These appear as additional Data Acquisition Parameters under the Define Experiment menu when the phosphorimeter hardware option is enabled. The signal collected during the sample time may be integrated over as many as 999 lamp flashes before the data is sent to the DM3000. The delay between excitation pulses of the sample and opening of Sample Window can be set from 0 to 10,000 milliseconds in 0.001 millisecond increments. The rate at which excitation pulses are delivered can be as high as 33 flashes per second.

The Delay After Flash parameter can be varied as a function of time to produce a decay curve (Figure 2). Spectra can be scanned to isolate different phosphorescing components based on the lifetime of the luminescence species present in the sample (Figure 3 and 4). These two techniques together can be used to produce three-dimensional plots. For example, you can plot successive scans with varying delay times, as shown in Figure 5. Each contour then isolates the species in a particular slice of time.

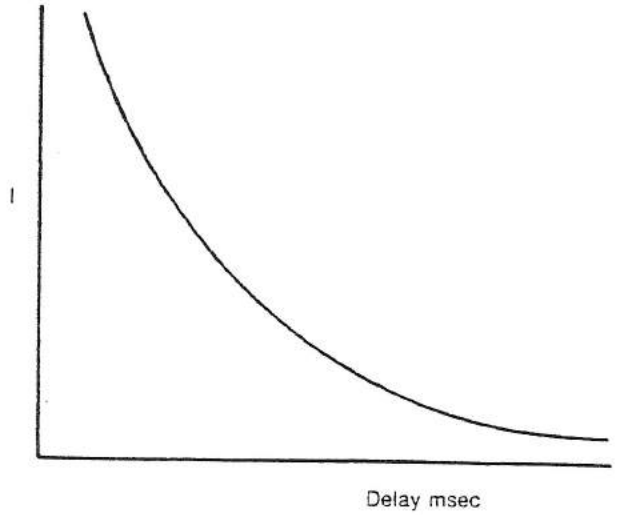


Figure 2 Decay curve produced by plotting intensity as a function of delay time

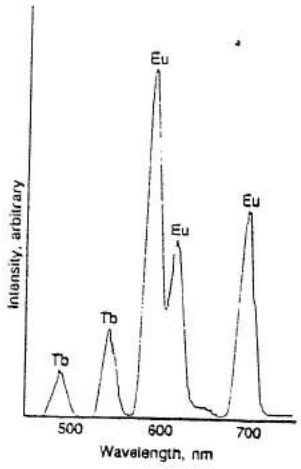


Figure 3 Emission spectrum from a mixture of $EuCl_3$ and $TbCl_3$ with a 10 us delay time

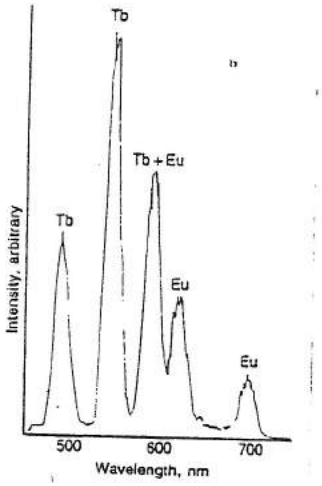


Figure 4 Emission spectrum from a mixture of $EuCl_3$ and $TbCl_3$ with a 40 us delay time

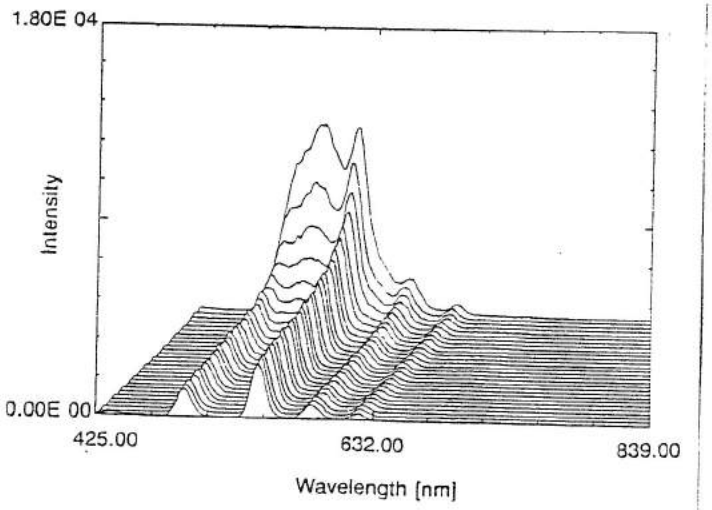


Figure 5 3-D plot of phosphorescence spectra for a mixture of terbium and uranyl with varying delay times

7. Connect the rectangular end of the 8-ft. round power cable with the 9-pin D connector to the REFERENCE PREAMP POWER connector phosphorimeter control module. Connect the other end of the PREAMP POWER connector on the reference amplifier module.

Connecting The Sample Channel

8. Disconnect the BNC connector from the DM302. Install the BNC "T'connector. Reattach BNC connector to one side of the T. Reattach BNC connector end of 8' cable to other side of "T" and 15-pin end to sample power connector on the control module.

Connecting The Phosphorimeter To The DM3000

9. Connect one end of the RS232 cable (25 pin 'D') to the RS232 communication connector on the Phosphorimeter Control Module. Connect the other end of the RS232 cable to COM 1 (or COM 2) on the D3000. (Note 1) it may be necessary to use a 9-pin to 25-pin adapter cable 2) refer to Appendix B if it is necessary to use COM 2 instead of COM 1).

3.0 OPERATION

3.1 Start-up Procedure

1. Before turning on the DM3000, turn on the illuminator, the control module and all peripheral devices. Then on the DM3000.

2. When the phosphorimeter control module is first turned on, it will display its firmware revision level in the front panel LED's for a few seconds. All LED'S will then go out and the phosphorimeter will wait for the DM3000 to initiate self-testing. Hardware errors will not be reported (Appendix A) until the DM3000 attempts to initialize the RS232 link.

3. To use the DM3000 with a cw source without disconnecting the phosphorimeter control module from the DM302, the phosphorimeter control module must be turned on.

4. To activate the phosphorimeter, go to the Set Defaults, Optional Hardware menu. Use the space bar to show Yes on the Phosphorimeter line, then press the Enter key to actually make the selection. Move the scroll bar to Go and press then Enter key to initiate the installation. (Note: to always have the DM3000 start with Phosphorimeter enabled, move the scroll bar to Save Defaults (on the Set Defaults menu) the press Enter.

The SPEX phosphorimeter also has reference channel to monitor the output of the pulsed lamp. When used in the ratio mode, this reference signal will cancel out variations in lamp intensity to produce corrected excitation spectra or to compensate for time-dependent variations.

2.0 INSTALLATION

The phosphorimeter has three main modules: the illuminator, the phosphorimeter control module and the reference amplifier module.

CAUTION: Before installing these units, turn off the power to the DM3000 and all peripherals.

The pulsed-lamp illuminator contains the xenon flash lamp and the lamp power supply. It is installed in place of the normal continuous-wave illuminator at the entrance slit of the excitation spectrometer.

Connecting The Illuminator

1. Slide the xenon lamp illuminator housing aside.

2. Carefully slide the illuminator opening over the entrance slit of the excitation spectrometer. Adjust the feet on the bottom of the illuminator so that no strain is exerted on the slit. Replace the cover on the flash lamp.

3. Connect the round cable with the 9-pin D connector between the LAMP TRIGGER connector on the phosphorimeter control module and LAMP TRIGGER connector on the illuminator module.

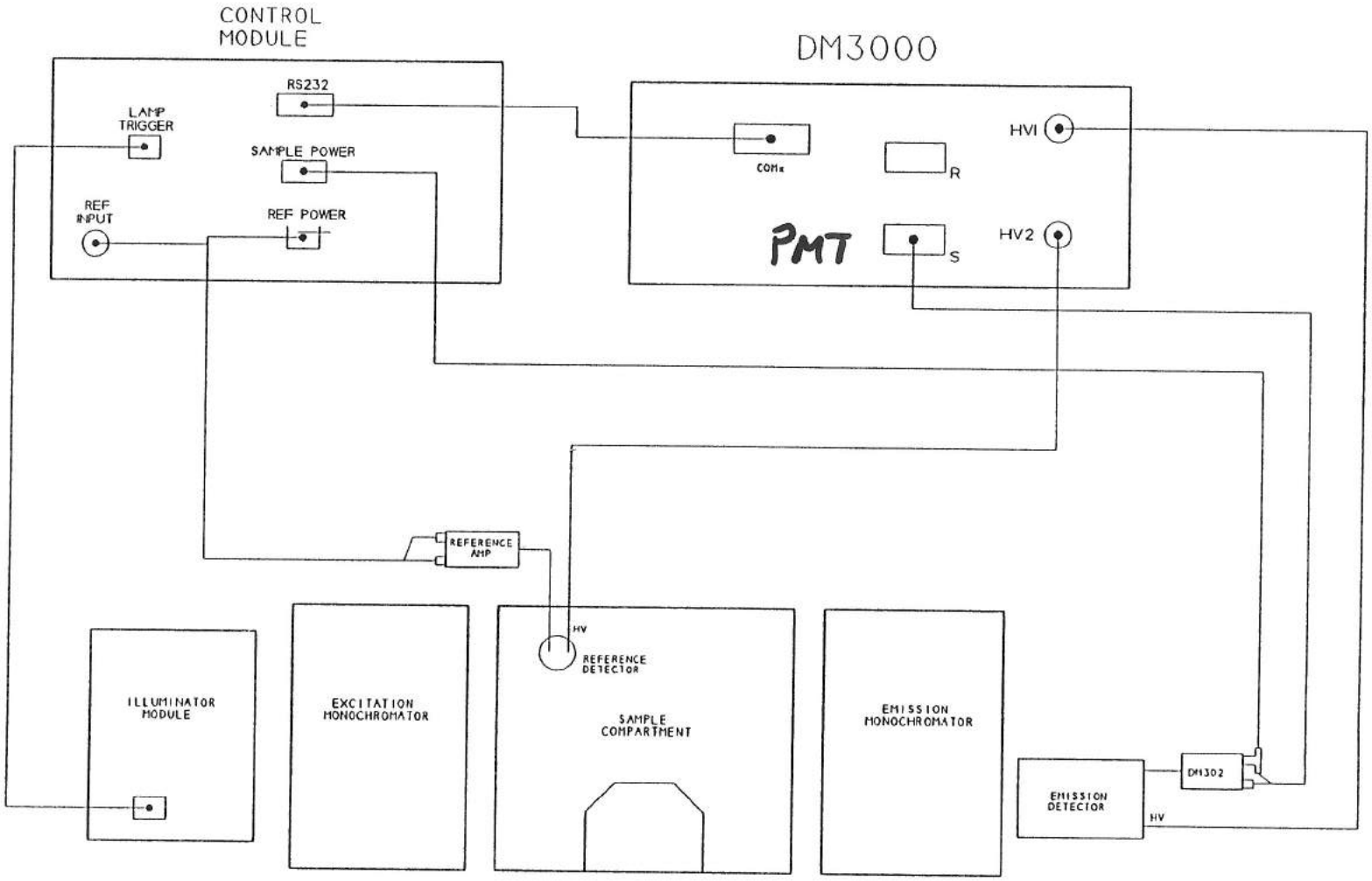
4. Connect the illuminator power cable to the proper line voltage.

Connecting The Reference Channel

Note: For the reference channel to work properly, a cuvette filled with rhodamine (reference quantum counter) must be inserted into the reference holder in the sample module (see the Fluorolog manual for information on how to prepare the rhodamine solution)

5. Disconnect the BNC (to the reference detector) from the INPUT connector of the DM303. Connect this cable to the IN connector on the reference amplifier module.

6. Connect one end of an 8-ft BNC cable to the OUT connector on the reference amplifier module. Connect the other end of the REFERENCE INPUT connector on the phosphorimeter control module.



Cable Connections for 1934D Phosphorimeter

TM9

3.2 REFERENCE DETECTOR

1. The reference detector, located in the sample module, uses the Fluorolog 2 reference quantum counter. The DC Data Acquisition Module (DM303) is replaced by an analog detector module which contains a reference amplifier module. The output of this module is scaled in the phosphorimeter control module, then reported to the DM3000.

   The reference detector monitors the excitation radiation. It is integrated for fixed window independent of parameters governing acquisition of the emission (sample) signal. This window is opened before the lamp flash is triggered and remains open for a time sufficient to include the entire flash. Timing of the window raises less than one micro second from flash to flash.

2. If the high voltage applied to the reference detector is too large, both the photomultiplier and reference amplifier can be saturated, leading to an apparent 0 signal. To avoid this problem, adjust the reference high voltage (HV2) while monitoring Reference signal level in the status window (section 3.4)

   Set the excitation monochromator to the wavelength of maximum lamp intensity expected for excitation and synchronous scans (usually about 390nm), or to the excitation position for emission scans. (To set the excitation monochromator, enter the desired position in monochromator 1: Move to X, then press the Enter key to start monochromator movement.)

3. Once the monochromator is positioned, set HV2 to 150 to 200 volts, then slowly increase it until the Reference Input Value is from 12,000 to 14,000. The maximum possible signal on the reference channel is 16,128, so a value of 12-14,000 should maximize dynamic range of the result. (After determining an optimum high voltage, remember to make sure that this value is also entered into the Define Experiment Windows).

3.3 Controlling the Phosphorimeter from the DM3000

Operation of a DM3000F with a phosphorimeter is similar to operation with a continuous lamp. Excitation, emission, and synchronous scans are all available. The only differences are additional parameters required to control the phosphorimeter.

3.3a Acquisition Modes

Available acquisition modes can be viewed by pressing the Help (F1) key while on the Acquisition Mode line in a Data Acquisition Parameters window. Normally, the choices will be:

s	- sample signal only
r	- reference signal only
s & r	- both sample and reference signals; two result files are generated
s/r	- ratio of sample to reference signal

Modes can be selected from the Help window by pressing Enter when the scroll bar is on an appropriate mode, from the Acquisition Mode line by pressing spacebar until the desired mode is displayed then pressing Enter, or by directly typing in the desired mode.

NOTE: The phosphorimeter will not operate in a chopped mode (F222 systems).

3.3b Delay After Flash

The Delay After Flash parameter sets the time, in milliseconds, between the start of the lamp flash and the beginning of data acquisition (opening of the SAMPLE WINDOW). This delay can be between 0 and 10,000 milliseconds, in increments of 0.001 millisecond. The sample delay from one flash to the next will vary by less than 0.001 millisecond.

The Delay After Flash should be long enough so that fluorescence emission and lamp decay have occurred. The result spectrum will represent the phosphorescence spectrum.

3.3c Sample Window

The SAMPLE WINDOW parameter sets the duration of signal acquisition in milliseconds. The sample window can be set between 0.01 and 10,000 milliseconds, in increments of .001 millisecond.

The SAMPLE WINDOW opens when the Delay After Flash ends (see Figure 1). When the SAMPLE WINDOW is open, the signal that enters the control module is counted and integrated for subsequent output to the DM3000. After the preset time, the SAMPLE WINDOW closes and the signal is ignored.

If you want to record fluorescence emissions, set Delay After Flash to zero.

3.3d Number of Flashes

The Number of Flashes parameter sets the number of flashes (lamp pulses) that will contribute to each data point. Number of Flashes can be set from 1 to 999. The signal collected during the sampling time is integrated over the number of lamp pulse before the data is passed to the DM3000.

3.3e Flash Rate

Flash Rate sets the repetition rate of the pulse lamp. Flash rate must be between 0.05 and 33 flashes/second, and in addition, must be slow enough that the Sample Window will be completed before another flash begins. Alternatively, Flash Rate can be set to 0 and the DM3000 will determine the maximum allowable rate. Accuracy in timing of Flash Rate is +/- 1 millisecond.

NOTE: Maximum flash rate can be calculated as:

$$\text{Rate} < \frac{1000}{\text{Delay After Flash} + \text{Sample Window} + 10}$$

where Delay After Flash and Sample Window are in milliseconds

3.4 System Status

The effect of possible phosphorimeter parameters can be viewed in the System Status Window (F9) without having to run a scan. All results displayed are for single flashes of the lamp. Delay After Flash and Sample Window have the same range as described in Section 3.3. Time Between Flashes is controlled by the system clock in the DM3000 rather than the more accurate clock in the phosphorimeter control module, and is accurate to 0.1 second. Allowable values for Time Between Flashes vary from 0.1 to 20 seconds in increments of 0.1 seconds. Time Between Flashes must also be greater than Delay After Flash plus Flash Window (in seconds).

System Status is particularly useful for determining the best setting for reference detector high voltage (HV2).

3.5 Emission Scans and Time Discrimination

3.5a Scanning an Emission Spectrum

To scan an emission spectrum with the phosphorimeter, use the following procedure.

1. Go to the Define Experiment, Emission Scan, Data Acquisition Parameters Window.

2. Enter the number of times the scan is to be repeated and averaged (Number of Scans), the Start, End, and Increment wavelengths.

3. Enter Delay After Flash. The type of results you can expect for varying delay are shown in Figure 3 and 4. In general, when viewing phosphorescence, a delay of at least 0.05 milliseconds (50 microseconds) will discriminate against lamp pulse decay. As shown in Figure 6, the main component of the lamp pulse has a lifetime in the 3 microsecond range, but there is a long tail on the curve which does not fall below 1% of the peak height until after 20 microseconds. Setting a delay of 50 microseconds will discriminate against lamp pulse decay, fluorescence and stray light.

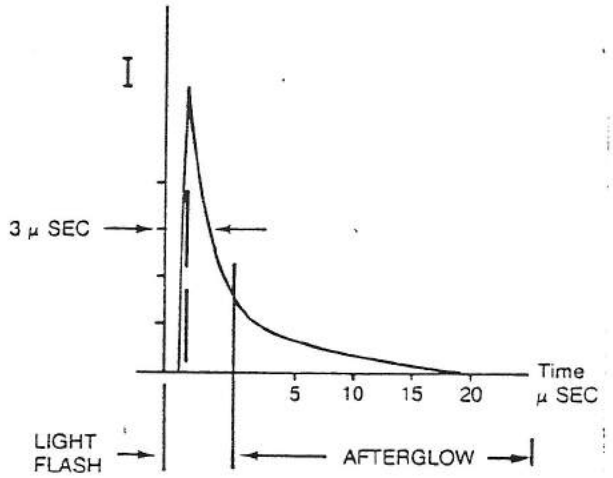


Figure 6 Pulse-lamp output

4. Set the SAMPLE WINDOW to cover about 5 to 10 lifetimes of the luminescence you wish to record. (An alternative technique is to make the window a fraction (e.g. 1/2 or 1/3) of the lifetime and vary the delay to take individual slices. If the lifetime is unknown, start with a small SAMPLE WINDOW, then increase it until good spectra are obtained.

   If the SAMPLE WINDOW is too long, the background signal will continue to be recorded after the luminescence has decayed. This will add unnecessary noise to the signal. If the sample window is too short, second and third lifetime components may be missed. To obtain the best spectra when two or more long-lived species are present, it may be necessary to vary the Delay After Flash and the SAMPLE WINDOW.

5. Enter the Flash Rate. In general the value that will give the maximum repetition rate to accumulate data quickly can be calculated using the formula given in section 3.3e. Alternatively, Flash Rate can be set to 0 and the DM3000 will calculate the maximum rate.

NOTE: Flash Rate must be 0 or between 0.05 and 33 Hz.

6. Enter the Number of Flashes you wish to record. The more flashes accumulated, the more events that will contribute to your data and therefore increase the signal-to-noise ratio. The primary effect is similar to increasing the integration time under normal operation.

7. Enter Excitation Position and select an Acquisition Mode.

NOTES: a) All fields have default values, so you only need only enter those values which will be changed.

b) Auto zero does not work in release 2.40.

8. Press the Esc key to return to Emission Scan menu. Select the High Voltage menu to check that the high voltages specified match those previously determined (section 3.2.2).

9. Press the Esc key to return to Emission Scan menu. Select Specify Axis Titles. The titles shown will appear on any plot or graph of the data.

10. Press the Esc key to return to Emission Scan menu. Select Run Experiment. Enter all File Name for the result of the experiment. Optionally, enter a File Title to help describe the file (for viewing in directory displays).

NOTE: Step 8 and 9 are optional.

11. Select GO and press the Enter key to begin acquiring data. Data are automatically displayed as the scan progresses.

3.5b An Example: Obtaining the Emission Spectrum of a Sample

To familiarize yourself with the operation of the phosphorimeter, run an emission scan on a sample of 100 ppm uranyl nitrate in 10% phosphoric acid (H_3PO_4) by volume. Set the excitation wavelength to 295 nm by entering 295 for the excitation position parameter in Data Acquisition Parameters window. Set start to 450 nm, End to 650 nm, and Increment to 1 nm. Suggested slit settings are 1.5 nm for the emission monochromator and 5mm for the excitation monochromator.

Set:

Delay After Flash to 0.05 msec.,
Sample Window to 0.1 msec.,
Flash Rate to 33, and
Number of Flashes to 100.

3.6 Excitation Scans

Scanning an excitation spectrum is analogous to scanning an emission spectrum (Section 3.5), but now the emission spectrometer is kept stationary on an emitting peak while the excitation spectrometer is scanned. The reference detector enables the excitation scan to be corrected automatically for the wavelength-dependent variations of the pulse lamp and the gratings in the excitation spectrometer.

3.7 Synchronous Scans

Scanning a synchronous spectrum is analogous to scanning excitation or emission spectra (Sections 3.5 and 3.6) but now both spectrometers are scanned with a constant offset between them. Start and End parameters refer to the excitation spectrometer. The reference detector enables the synchronous scan to be automatically corrected for wavelength dependent variations of the pulse lamp and grating(s) in the excitation spectrometer.

4.0 DETERMINATION OF ERROR CODES

4.1 Error Reporting

Phosphorimeter errors are reported by both the DM3000 and the phosphorimeter control module. Errors reported by the DM3000 are a limited set and are explained by the text in the error window which appears. When an error window appears, check the LED's on the front of the phosphorimeter control module to determine the phosphorimeter's error state.

NOTE: If an error occurs during a scan, the DM3000 will attempt to continue the scan by restarting the phosphorimeter.

4.2 Interpretation of Display

The eight LED displays on the front panel of the phosphorimeter control module will light in a particular combination when hardware, software, or operator errors are detected. The source of the error is identified in hexadecimal code. The eight LEDs are divided into two sections, each section revealing one digit of the code. Individual codes are decoded as follows:

LED Display	o	o	o	o		o	o	o	o
light is on	8	4	2	1		8	4	2	1
light is off	0	0	0	0		0	0	0	0

To determine the first digit of the error code, add the values of the lit LEDs on the left side. Find the corresponding hexadecimal equivalent from Table 1. Follow the same procedure with the four rightmost LEDs to determine the second digit.

Example:

(*=lit, o=not lit)	*	*	o	*		*	o	*	0
Decimal values	8	4	0	1		8	0	2	0
Total	13					10			
Hexadecimal equivalents (from Table 1)	D					A			

Decimal	Hex	Decimal	Hex
0	0	8	8
1	1	9	9
2	2	10	A
3	3	11	B
4	4	12	C
5	5	13	D
6	6	14	E
7	7	15	F

Table 1 - Hexadecimal equivalents of decimal numbers

The errors that the codes represent are listed in Appendix A. Most of the errors are hardware errors (for example, a board must be replaced) that cannot be corrected by the operator.

After determining the error code, call the SPEX service department for assistance if the problem can be corrected.

The following error codes indicate problems which can sometimes be corrected by the operator.

Error Code	Problem	Possible Remedy
40	No sample board	Check that a sample board is present and properly installed.
60	No reference board	Check that a reference board is present properly installed.
92	No flash detected	Check that the illuminator is plugged in and turned on. Check that the illuminator cover is on tight (there is a safety interlock)

5.0 TROUBLESHOOTING GUIDE

Problem	Possible Remedy
There is no signal or the signal level is low	Check that the High Voltage is on and at the proper level (when the high voltage is on the background of the HV (F10) key is on.)
	Check that the cables are connected properly.
	Check that the illuminator is aligned.
The reference signal saturates the reference detector	Check that the cuvette with the rhodamine B solution is present

6.0 FLASH LAMP REPLACEMENT

The flash lamp in the phosphorimeter illuminator typically has a half-intensity life of more than 10 million flashes. When it must be replaced, follow the procedure outlined below.

IMPORTANT: THE ILLUMINATOR CONTAINS SEVERAL HIGH VOLTAGE SOURCES.

TO AVOID POSSIBLE FATAL SHOCKS, THE FOLLOWING SAFETY PRECAUTIONS SHOULD BE OBSERVED.

BEFORE REMOVING THE LAMP COVER, UNPLUG THE POWER CORD AND WAIT FOR AT LEAST ONE MINUTE WHILE THE INTERNAL CAPACITORS DISCHARGE. FAILURE TO DO THIS COULD RESULT IN SEVERE INJURY CAUSED BY ELECTRIC SHOCKS.

NEVER OPERATE THE LAMP WITH THE COVER REMOVED.

6.1 Lamp Replacement Procedure

Only handle the lamp when wearing clean gloves or using a paper towel. The skin oils from your hands can degrade the UV performance of the lamp and shorten the life of the lamp.

1. Unplug the power cable from the illuminator and wait at least one minute.

2. Remove the screws holding the lamp cover in place, then remove the lamp cover.

3. Remove the lamp from the socket by pulling upward with a steady motion.

4. Align the pins of the new lamp with the lamp socket then push the lamp firmly into place. If the lamp tilts, realign the pins.

5. Replace the cover on the lamp. Never operate it without the cover.

6. For optimum results, you should check the alignment and focus of the the lamp.

6.2 Lamp Alignment and Focusing Procedure

To align and focus the lamp, you will need a flathead screwdriver and a focusing target. You can make the target by tracing the outlines in Figure 7. After cutting them out, roll the rectangular one (A) from the short end to make a tube with a 3.5-inch diameter. Tape the circular cut-out (B) to one end of this tube. The focusing target is now ready to use.

The objective of the alignment procedure is to get the light image as close as possible to the center of the target (marked with an X). The objective of the focusing procedure is to obtain the sharpest light image possible.

During parts of this procedure, the lamp must flash rapidly.

Select the system Status Window (F9) and set the Time Between Flashes to 0.1

1. Tape the target to the exit port of the illuminator.

2. Turn on the illuminator. Observe where the light image is on the target. If the image is on the X, no alignment is necessary and you can go directly to step 8.

3. Unplug the illuminator, then remove the cover.

4. Loosen the two screws that hold the lamp socket in place so that the socket can move easily in circular motion in the horizontal plane.

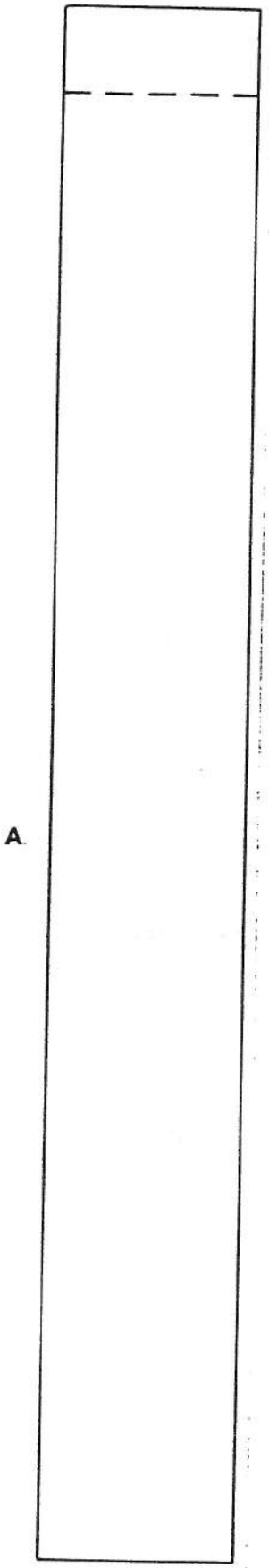
5. If the light image was high on the target, move the lamp socket forward toward the exit slit. If the lamp image was low on the target, move the lamp away from the exit slit. Replace the illuminator cover and plug in the power cord.

6. Turn on the illuminator and observe where the image is located on the target.

7. If the image is centered, proceed to step 8. If the light image is not yet centered, unplug the illuminator and wait at least one minute. Remove the cover. Repeat steps 5 and 6 until the image is centered. Note the sharpness of the image.

8. After the image is centered, turn off the illuminator and wait for one minute. Tighten the two screws that hold the lamp socket in place. Plug in the illuminator.

9. If the image was not sharp, the lamp must be focused. Insert a straight blade screwdriver into the opening in the back panel of the illuminator. Turn the screw to move the lamp up and down until the sharpest image is obtained.



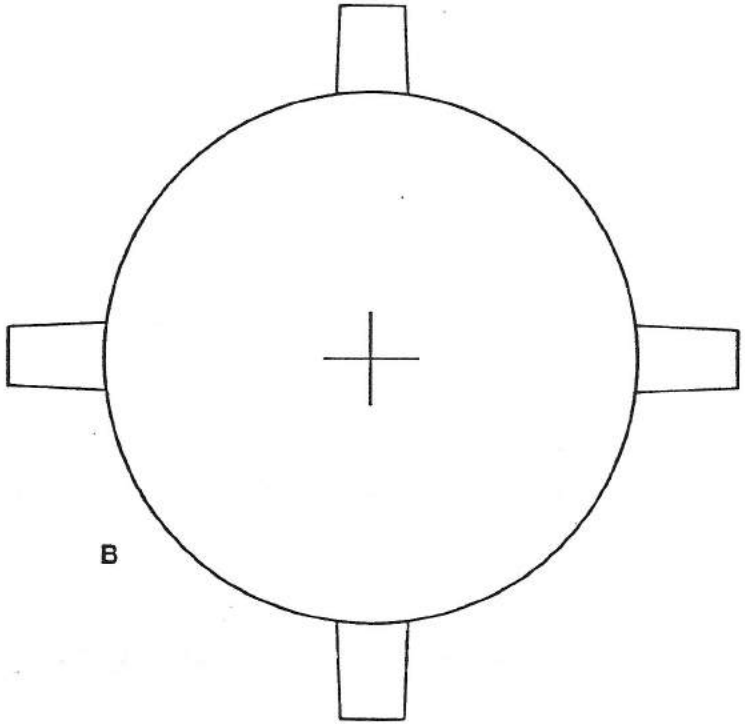


Figure 11
Focusing Target

7.0 SPECIFICATIONS

Lamp - UV xenon flash tube

Flash Rate - 0.05 to 33 flashes/second

Flash Duration - 3 microseconds, typical, measured at 1/2 peak amplitude

Delay After Flash - variable from 0 to 10,000 milliseconds in 1 microsecond increments, 4 significant digits

Sample Window - variable from 0.01 to 10,000 milliseconds in 1 microsecond increments, 4 significant digits.

Flashes/Data Point - variable from 1 to 999 flashes

Power Requirements - 115/230V, 50/60 Hz, 50W

Precision - 32 bits pulse-counting

Appendix A - Error Codes

Communications Board Errors

21 Reset is bad
22 Flops are bad
23 Irq flop on
24 Ready flop on
25 Select flop on
26 Busy flop on
27 Stobe relay closed or sense shorted low
28 Str relay off or busy low short at interface
29 Set relay off or busy low short at interface
2A Str relay or sense bad
2B Select stuck off or busy high short at interface
2C Busy low short
2D Str relay off
2E Str relay on
2F Str sense bad
30 Irq flop off
31 Ready flop off
32 Select flop off
33 Busy flop off

Sample Board Errors

40 No sample board
41 Control regs bad
42 Too many irqa's
43 B side won't clear
44 A side won't clear
45 Timer gate on
46 Test count error
47 Timer out of range
48 A counter flaky
49 B counter flaky
4A Counters won't stop
4B Clear is bad
4C Timer gate is on
4D Test gate bad (no stop)
4E Irqa stuck low
4F AD chip busy at PU
50 AD chip too busy
51 AD ready too soon
52 AD never ready
53 AD data non zero high byte
54 AD data not within 1 count
55 AD data not within 1 count
56 HAD chip too busy
57 HAD ready too soon
58 HAD never ready
59 AD data not all high

Reference Board Errors

60 No reference board
61 Control regs bad
62 Too many irq's
63 B side won't clear
64 A side won't clear
65 Timer gate on
66 Test count on
67 Test count error
68 A counter flaky
69 B counter flaky
6A Counters won't stop
6B Clear bad
6C Timer gate is on
6D Test gate bad (can't stop)
6E Irqa stuck low
6F RAD chip busy at PU
70 AD chip too busy
71 AD ready too soon
72 AD never ready
73 AD data not zero high byte
74 AD data not zero low byte
75 AD data not within 1 count
76 HAD chip too busy
77 HAD chip ready too soon
78 HAD never ready
79 AD data not high

Timer Control Board Errors

80	Error output not clear; circuit board is missing
81	Side 1 of U11 won't clear
82	U6 output won't set
83	Ctr -5 won't clear (get back to zero)
84	Ctr -4 won't clear (get back to zero)
85	Ctr -3 won't clear
86	Ctr -2 won't clear
87	Ctr -1 wont clear
88	Side 1 of U11 output can't be set or clocked
89	Side 2 of U9 won't clear
8A	Side 2 of U11 won't set
8B	U6 output -2 not functional
8C	Samp not clear
8D	Delay not set
8E	Samp not set
8F	Samp not clock
90	Flash not set
91	Flash not clear
92	No flash check illuminator power
93	Bin strt ctr5
94	Bin strt crt4
95	Bin strt ctr3
96	Bin strt ctr2
97	Bin strt ctr1
98	E bin ct ctr5
99	E bin ct ctr4
9A	E bin ct ctr3
9B	E bin ct ctr2
9C	E bin ct ctr1
9D	E binary rate
9E	E 1 MHz rate
9F	E 100 KHz rate
A0	E 10 KHz rate
A1	E 1 KHz rate
A2	E 100 Hz rate
A3	E out inactive
A4	Too many flashes
A5	9513 busy too long
F7	IRQ full
F8	FIRQ full
F9	RES error
FA	Nmi error
FB	Sw3 error
FC	Sw2 error
FD	Sw1 error
FE	IRQ error
FF	FIRQ error

Appendix B - Modification of Phosphorimeter Parameters

Some parameters affecting phosphorimeter operation can be changed by editing the text file ARRAY.INI, which is located in directory \DM3000F\RUN. This file is shared by the phosphorimeters and array detectors (available only with DM3000R software). In particular the array attached flag must be o, and phosphorimeter attached flag must be 1.

The only parameters whose modification will affect operation are com port and baud rate.

Valid values for com port are (all upper case letters):

```
COM 1
COM 2
```

Valid values for baud rate are 9600 and 19200.

```
;all ver >= 2.4   4/12/88        rdw
'NOTE all lines must be 80 characters or less !!!!!!!
;NOTE  semi-colon  is  the comment delimiter  in  the  spirit  of
  assembler,
;ie skip to end of line

-5 -5 ; extra variables extra_x, extra_y (normal values are 0,0)
      ; extra_x (-5, 90), extra_y (-5, 26)

; added 7/29/87 array detector information
;  unit  we have is 4.032mhz, 1024 pixels, db25 rs232  only  pins
   2,3,7

0         ;array attached flag (0-> not there, 1-> is there,  -1->
           fake it)

;added 4/12/88 phosphorimeter information
;db25 rs232 only pins 2,3,7 required, others optional.

  1      ;phos attached flag (0-> not  there, 1-> is there, -1->
          fake it)
         ;NOTE either array or phos may be attached, NOT both.

COM1     ; com port for either detector, use COM1  or COM2
19200    ; phos <= 19.2K standard baud 9600, could be higher

ST-100   ;model number of detector EXPECTED
4.032    ;or 8.064 Mhz speed of detector
1024     ;or 512 number of pixels (should be less than 4097)
0.025    ;pixel spacing in mm
```

Typical contents of ARRAY.INI