

Procedure for optimizing the photomultiplier tube high voltage in a Mk IV Brewer spectrophotometer

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Introduction

A Mk IV Brewer spectrophotometer utilizes a photomultiplier tube (PMT) with the cathode set to a potential in the range 1100 to 1800 volts. In order to provide the highest quality data possible the PMT high voltage (HV) must be set to an optimum value which maximizes photon count rates while minimizing dark count rates. The optimum PMT HV is found by performing the HV test. For specific information on the HV test the reader is referred to the Brewer Operator's Manual and the Acceptance Manual or Final Test Record for the particular instrument.

It has been found that the optimum PMT HV may change over time as the tubes age or when modifications or adjustments are made to a Brewer. The National Ultra Violet Monitoring Center (NUVMC) normally performs an HV test during an annual Brewer site visit based on various diagnostic considerations. Initial and final spectral response calibrations are required if the HV test is performed.

Equipment

Mk IV Brewer spectrophotometer
Hex wrench set (English sizes)
Digital Multi-Meter (DMM) with positive and negative leads
Small flat-head screwdriver

Purpose

This Standard Operating Procedure (SOP) outlines the NUVMC technique for optimizing the PMT high voltage in a Mk IV Brewer spectrophotometer.

Procedure

1. Perform an initial spectral response calibration on the instrument before altering the PMT HV. The NUVMC has an SOP for performing this procedure.
2. If the Brewer is still running in schedule exit the schedule by pressing the Home key when the message "Press Home to abort schedule" appears on the computer screen.
3. Give the "HG" command at the Brewer Home screen command line and observe if the scan is successful. A successful scan is one at which the peak HG counts are found at step number 15 as appearing on the computer monitor.
4. Place a protective cover on the quartz dome on the top of the Brewer outer cover.
5. Remove the Brewer outer cover by loosening the four latches and lifting the cover up. Never remove the cover during inclement weather and try to pick the driest, wind free day possible. The NUVMC moves Brewers indoors for this work whenever possible.
6. Locate the secondary power supply (SPS) in the upper right hand corner of the instrument as viewed from the quartz window side. The SPS consists of an electronic card mounted in a slot with several voltage test point leads that are labeled.

7. Remove the vented cover to the SPS by loosening the two 9/64" hex head bolts at one end and removing the 7/64" hex head bolt located in the middle of the cover.
8. Place the DMM leads into the plugs labeled "HV" and "ground" on the secondary power supply. Set the DMM to the DC voltage setting. The number read on the DMM is 1/200 of the high voltage value at the PMT.
9. **IMPORTANT;** Record the current SPS HV value in the log book before proceeding.
10. Give the "HV" command at the Brewer Home screen command line. The program will prompt the user to enter some initial information before beginning the HV test.
11. Enter the PMT number, which is usually labeled on the side of the PMT cylinder. Press the "Enter" key.
12. Enter the pre-amplifier discriminator voltage. Check the Brewer Acceptance Manual or Final Test Record to find the value set at the factory. If the value has been changed it should be well documented in the Brewer log book. Typically the value is 30mV. The number is used solely as a file header so it is not critical for the performance of the HV test. Press the "Enter" key.
13. Enter the minimum test voltage desired. Normally 900 volts is used. Press the "Enter" key.
14. Enter the maximum test voltage desired. Normally 1800 volts is used. Press the "Enter" key.
15. Enter the voltage increment desired. Normally 50 volts is used. Press the "Enter" key.
16. Locate the potentiometer screw on the secondary power supply board labeled R202. This screw controls the output voltage to the PMT. Turn the screw CCW using the flathead screwdriver until the voltmeter reads -4.5 volts; this corresponds to -900 volts at the PMT.
17. Press the "Enter" key at the computer to initiate the HV test. Photon counts are measured at the dark count channel, the mercury wavelength channel and the slit 1 channel and are recorded to the HV data file.
18. After counts are recorded at a particular increment the computer will prompt the user to increase the voltage by the appropriate amount. Use the screwdriver to adjust the potentiometer in the CW direction before pressing the "Enter" key.
19. Repeat step 18 as prompted by the computer, increasing the display on the voltmeter by the appropriate amount via the R202 screw (0.25 volts on SPS =50 volts to PMT). The computer will return to the Home menu after readings have been made at all the voltages.

20. Retrieve the HVDDDY.### file from the \bdata directory.
21. Plot the slit 1 intensity values on a logarithmic ordinate scale versus the high voltage values. On the same chart and scale plot the dark count values versus the high voltage values. Also on the same chart plot the ratio of the wavelength one values to dark count on a normal ordinate scale as a secondary axis. The optimum set point for the high voltage is a point at which the photon counts are maximized while the dark count is minimized. Normally the ratio plot will have a plateau just above the point where the signal to noise ratio is minimized and the set point is normally chosen at the lower end of the plateau. Consult the Brewer Acceptance manual or Final Test Record for the particular instrument to compare the new results to the factory results to help determine the new set point.
22. Once the optimum HV set value is determined, turn the R202 potentiometer to the appropriate position so that the DMM reads 1/200 of the value, e.g. -6.5 volts on the DMM to obtain -1300V on the PMT.
23. Give the "AP" command at the Brewer Home screen command line. Determine if the HV readout on the screen matches the desired HV set on the SPS.
24. Replace the SPS cover and tighten down the three hex head bolts.
25. Give the "HG" command at the Brewer Home screen command line and observe if the scan is successful. A successful scan is one at which the peak HG counts are found at step number 15 as appearing on the computer monitor.
26. Replace the Brewer outer cover and secure the four latches, ensuring that the outer cover is mounted evenly all the way around the Brewer case. Remove the quartz dome protector.
27. Perform a final spectral response calibration on the instrument before collecting UV data.

For further information or advice concerning this SOP please contact the NUVMC at the University of Georgia at <http://oz.physast.uga.edu>