Environnement et Changement climatique Canada
Environment and Climate Change Canada

Ultraviolet Calibration SOP for the Brewer Spectrometer

The Canadian Brewer Spectrometer Network

Réseau Canadian de spectrophotometric – Brewer

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Version 2.1

Canada

UV Calibration – Brewer Spectrometers

A UV calibration is performed to establish the absolute spectral sensitivity of the Brewer spectrometer. This calibration is used to convert outdoor UV measurements to calibrated mW/m^2nm values. The following is a step by step SOP detailing the procedure used in a UV calibration.

Note: Environment and Climate Change Canada (ECCC) uses LampsPro to process the collected instrument data. LampsPro is a software created by International Ozone Services (IOS) Inc. ECCC has access to LampsPro via a license from IOS Inc.

Pre-Calibration

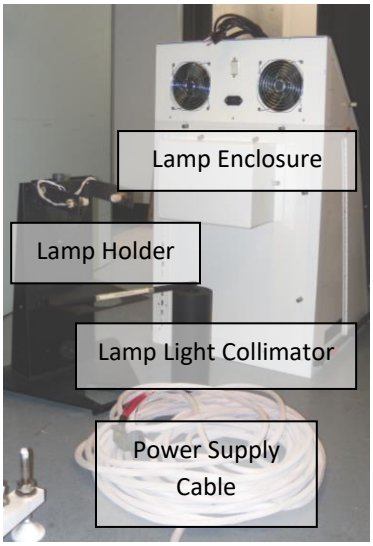
Prior to performing the UV calibration, the brewer must be operationally stable and in good working order. As a minimum the following pre-calibration tests should be performed and deemed to have passed before the UV calibration can proceed. Valid Dispersion Calibration,

- Valid Dispersion Calibration,
- Confirm the current UVR file being used has a maximum responsivity between 3000-9000. See the Appendix for more detail; changes are not made if this is an “as found calibration”.
- Print out A/D monitor (AP),
- Slit Mask Run/Stop test (RS),
- Photomultiplier Dead Time test (DT),
- Grating Synchronization (HP, for MKIII Brewer only),
- Mercury Wavelength Calibration (HG)
- Standard lamp test (SL).

The following string *pdporew1hphgsldtrsappd* can be used to evaluate the current condition of the Brewer. Refer to Kipp & Zonen Instruction Manual for test descriptions and how to interpret results. Adjustment and changes to optimize the brewer should be performed at this point. Note: If any of these changes effect the dispersion of this instrument, a dispersion calibration will need to be rerun prior to the UV calibration.

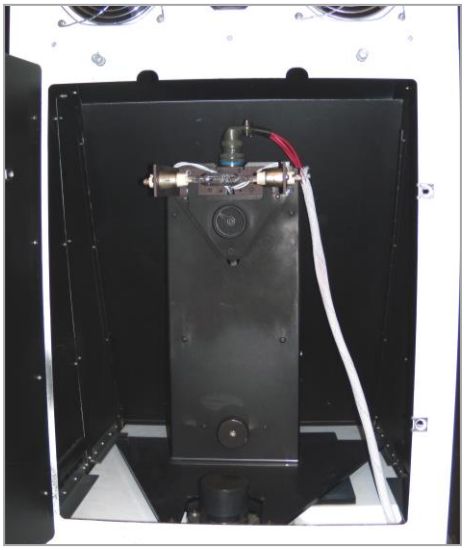
Equipment Required

- Four 1kW DXW NIST traceable lamps,
- One 1kW DXW test lamp,
- Lamp enclosure and power cord,
- Lamp holder,
- Lamp light collimator,
- Collimator guide,
- Fixed length ruler,
- Power supply and DVM,



- Power supply cable,
- Kimwipes.

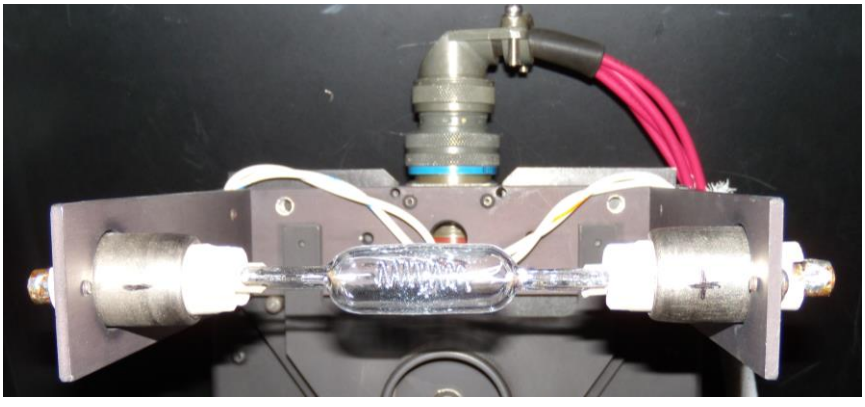
Calibration Setup and Lamp Installation

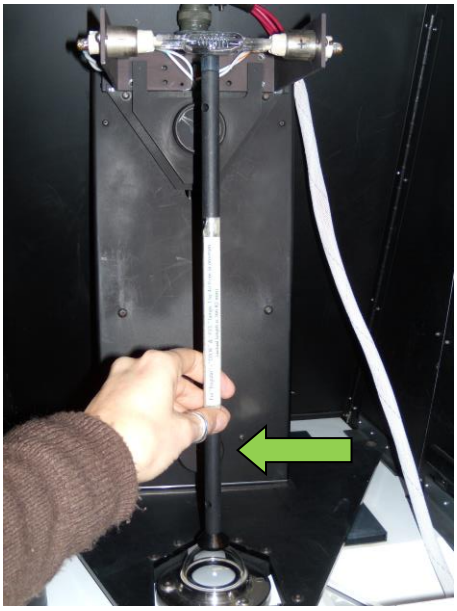


1. Install a protective cap over the Brewer's UV dome.
2. Place the UV lamp enclosure housing on top of the brewer and open the access door.
3. Attach the fans power cord to the enclosure and then plug into a power outlet.
4. Carefully insert the lamp holder into the enclosure and orientate as illustrated in the photos.
5. Connect the power supply cord to the lamp holder.

> Do not touch the lamps with bare hands; use a Kimwipe or powder free gloves when handling the lamps.

6. Carefully insert the UV lamp being used (a test lamp is used first) into the lamp holder contacts. Match the polarity of the lamp and holder (i.e. the + side of the lamp is inserted into the + side of the lamp holder contacts). The contacts are spring loaded and will have to be expanded to receive the lamp.
7. Once the lamp is secured by the contacts, rotate the lamp around so that the flat ends are parallel to the top surface of the Brewer and the lamps' glass bulge points to the back of the lamp stand.





8. Remove the protective cap from the UV dome.

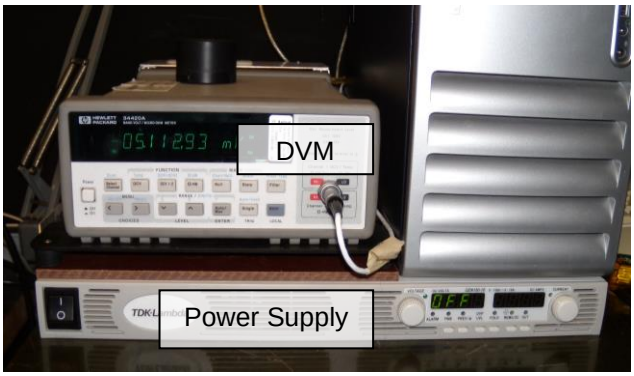
9. Using the fixed length ruler adjust the distance of the lamp to the UV dome to 40 cm. The base of the ruler is placed on the top-center of the UV dome and the height of the lamp to the dome is adjusted by rotating the knob pointed to in the photo. The ruler is moved back and forth (front and back) while the lamp height is adjusted so that the top of the ruler barely makes contact with the bottom of lamp.

10. Once the lamp is in position use a Kimwipe wetted with alcohol to clean the UV dome. Next install the lamp light collimator over the UV dome and put in place the concentrator guide. The guide is held in position by two screws and slides over the top of the collimator.

11. Close the door to the enclosure.

12. Turn the exhaust fans on.

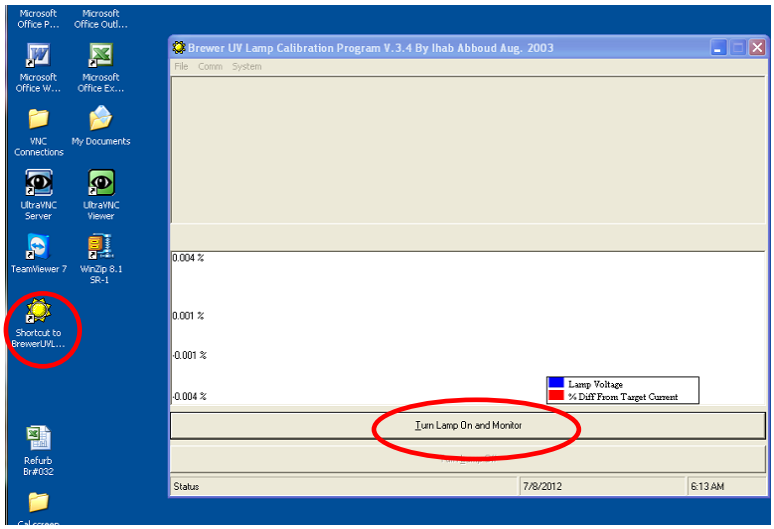
13. Turn on the power supply and DVM.



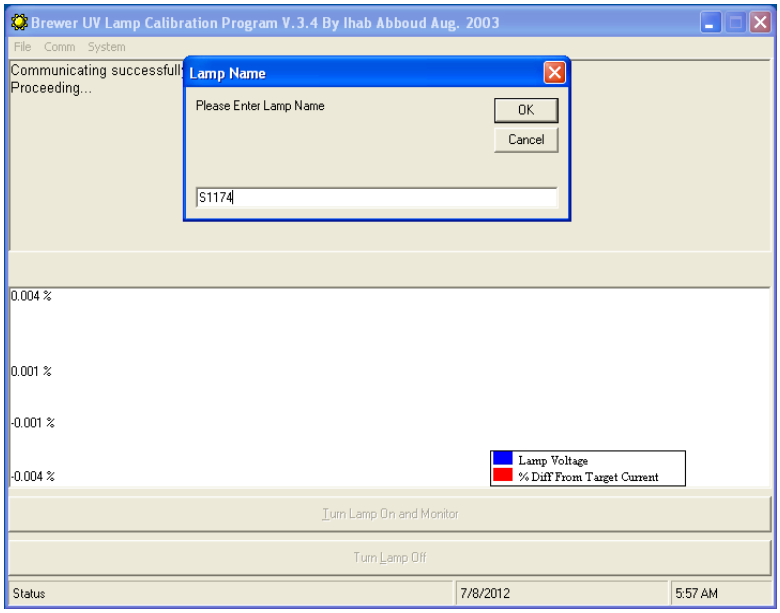
UV Lamp Power Up and Control

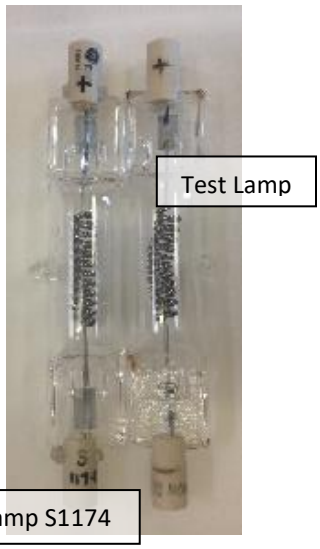
14. The UV lamp is controlled by the *Brewer UV Lamp Calibration Program*. On the computer controlling the lamp, double click on the icon *Shortcut to Brewer UVL…* (Circled in red). After the program initializes, a control window will open.

15. Click on the *Turn Lamp On and Monitor* button.

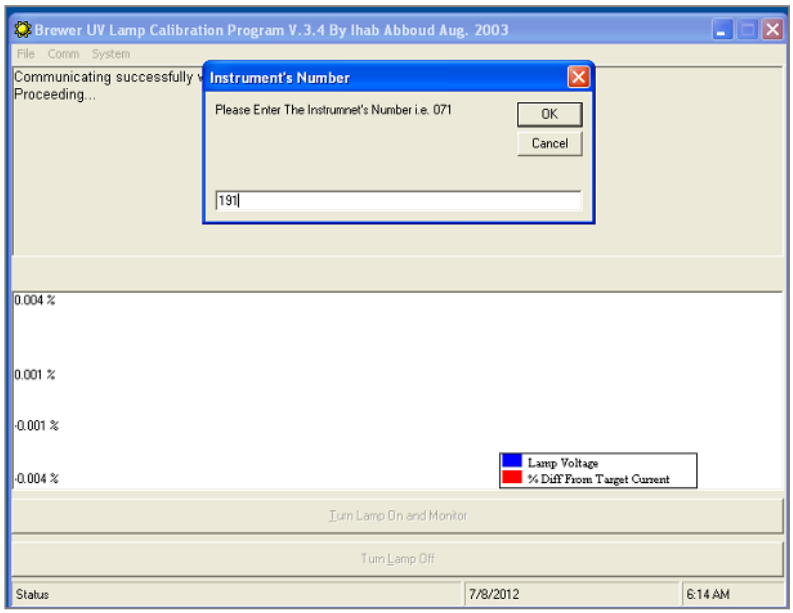


16. A new window will open prompting for the UV lamp identification number. Type the id number and click *OK*. In this example lamp *S1174* is used, if using a test lamp type *test* when prompted (the lamp id number is always preceded with an *S*).

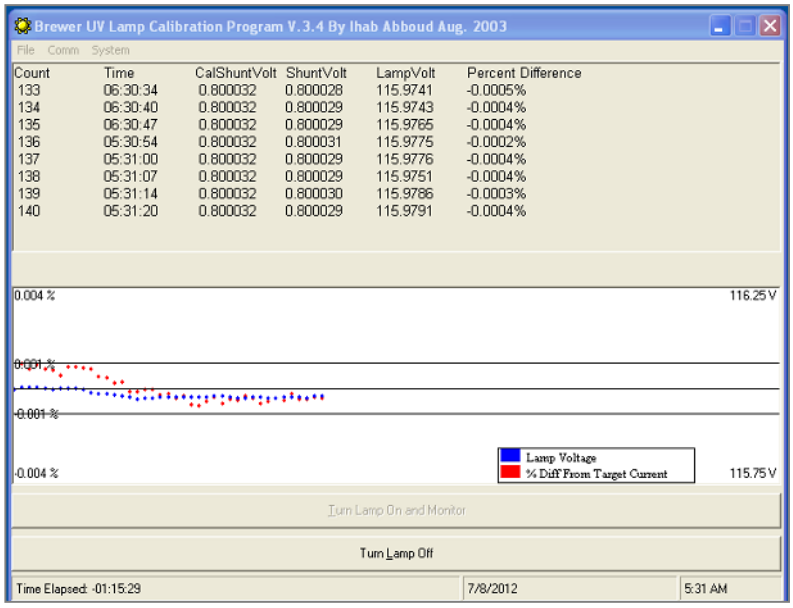




17. Following the lamp id entry a new window will open prompting for the Brewer identification number. Enter this number and click *OK*. In this case Brewer 191 is being calibrated.



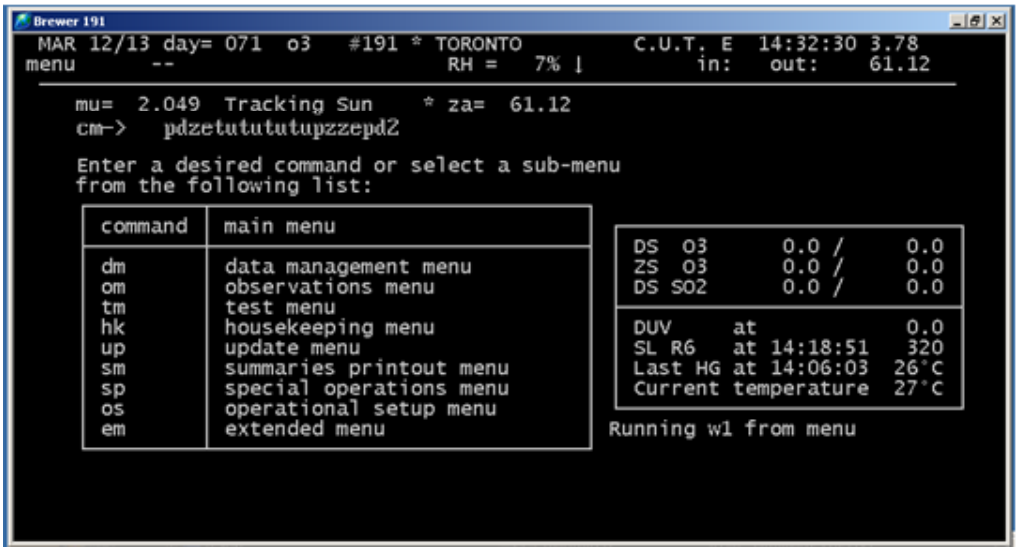
18. The *Brewer UV lamp calibration program* controls the voltage supplied to the lamp in the enclosure. The voltage is adjusted to maintain a constant current to the lamp. Once the lamp is powered, allow the lamp to warm up for approximately 10 minutes. A stable power trace as illustrated below should be attained before the start of any UV related test.



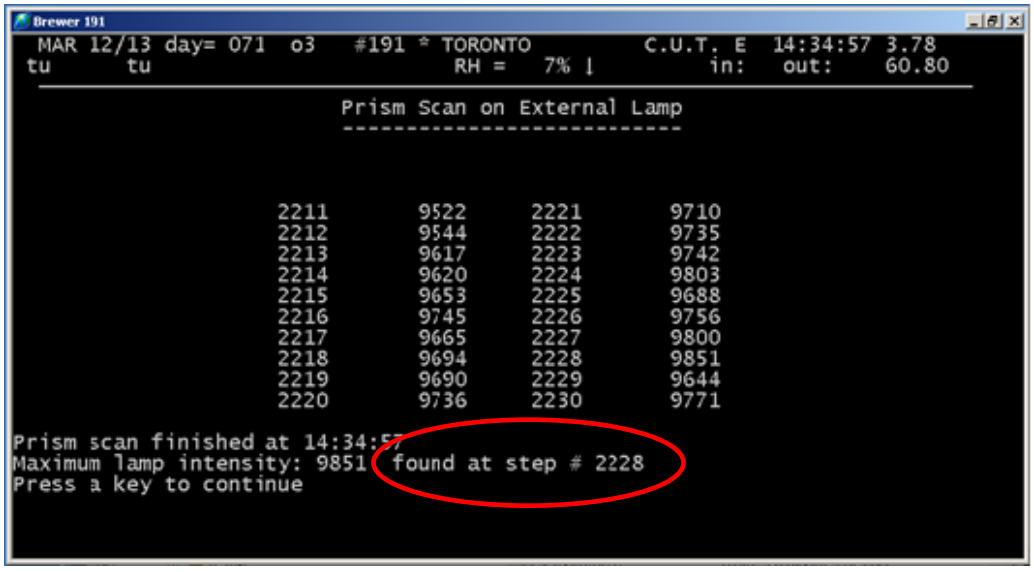
19. While the test lamp is warming up perform the UV calibration preparation command string for the brewer model being tested (i.e. pdporehgsldtrsappd for a single and pdporew1hphgsldtrsappd for a double). Confirm the tests in the preparation command string have passed before proceeding to the calibration lamps. For more information refer to the UV Calibration Procedure Command String Summary table, pg. 11.

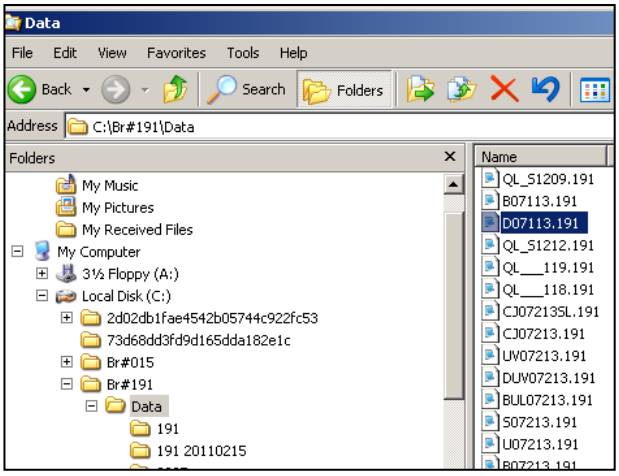
TU Test (prior to UV Calibration)

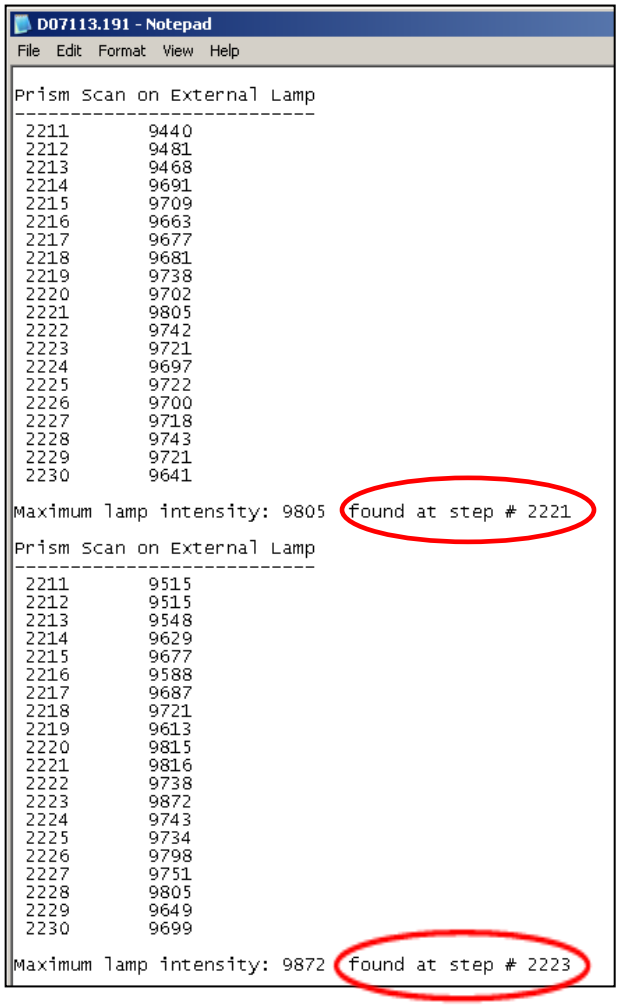
20. Prior to performing an UV calibration the *zenith UV position set point* constant in the *CF* file is confirmed. This is performed using a UV 1kW DXW **test** lamp which has been installed in the enclosure and allowed to warm up and stabilize. The string command used to perform the *tu* test is entered and started from the Brewer command window. The *tu* string command is pdzetutututupzzepd2.



21. The *TU* test determines the step position of the zenith prism for which the light intensity is at a maximum through slit one of the spectrometer. An example of the maximum intensity found at step # is circled in red below.





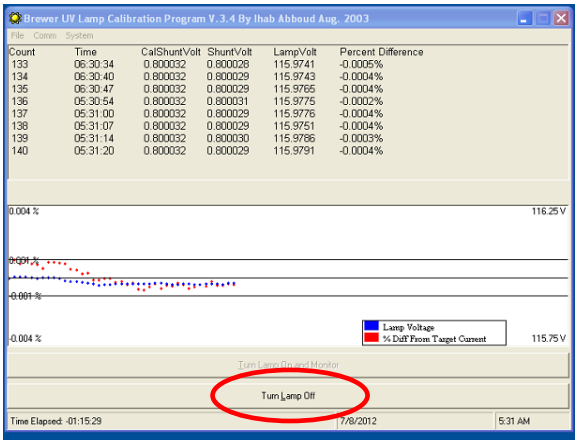


22. Following the completion of the *TU* test, open the TU-TEST.191 file and scroll to the date of the *TU* results.

23. Calculate the average *found at step #* for the eight zenith scans and compare this value to the *zenith UV position set point* constant in the *CF* file. If the difference between the new and currently being used zenith UV position value is 1 step, change the offset value used in the *CF* file to the new value. When changing this value, DO NOT create a new ICF file.

24. Exit to the main Brewer command window.

25. Turn off the test lamp from the Brewer *UV Lamp Calibration Program* window by clicking on the *Turn Lamp Off* button.



26. Allow the test lamp to cool before removing the lamp from the lamp holder.

27. Once the lamp has been removed, remove the collimator guide and the lamp light collimator from the enclosure.

Note: If the zenith discrepancy is >1, there is potentially an issue with the physical zenith positioning hitting the hard stop. As an example, if the discrepancy is 3, reduce the zenith position offset by 3 and re-run the *tu* test.

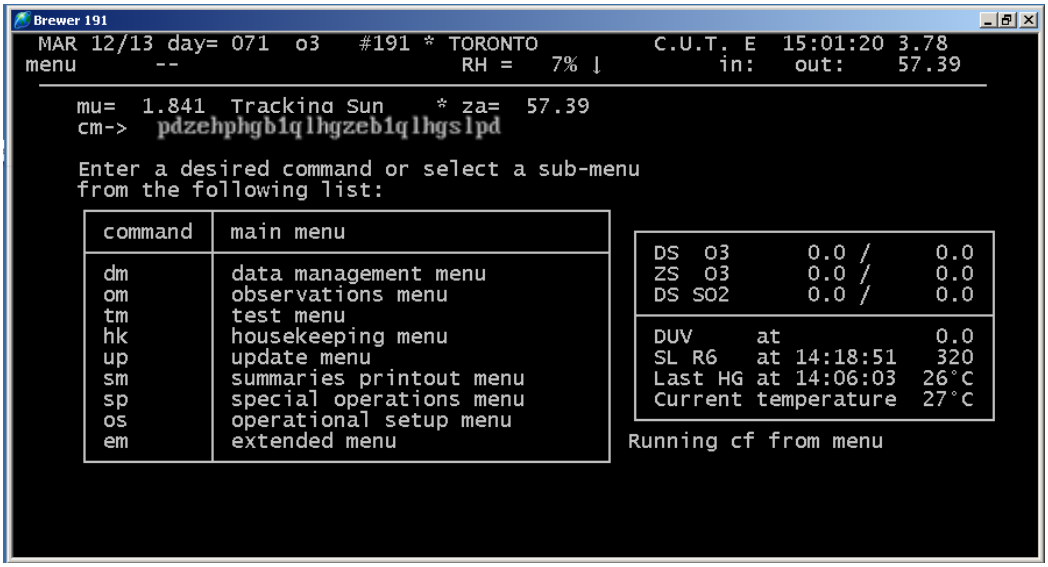
UV Calibration

28. Install the first 1kW DXW NIST traceable lamp into the lamp holder. Rotate and position the lamp 40 cm from the UV dome. With an alcohol wetted Kimwipe clean the UV dome and install the lamp light collimator and collimator guide. Shut and secure the enclosure door and turn the exhaust fans on. (Steps 9-11)

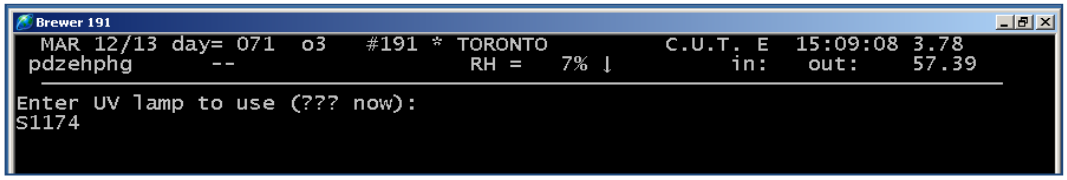
29. Turn on the UV lamp by repeating steps 15-18.

30. Start by pressing the Ctrl-ScrLk keys to interrupt the DosBox. Next press the Ctrl-Home keys to clear the screen. Then type run and press enter to restart the DosBox.

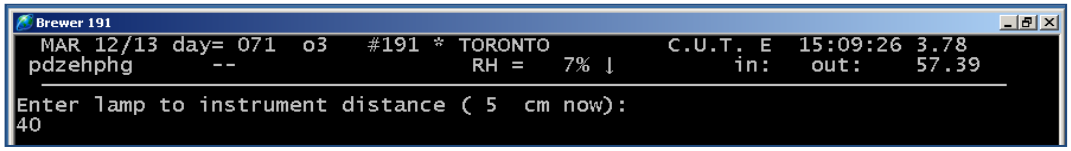
31. When the lamp is warm and stable enter the UV Calibration test string into the Brewer command window, *pdzehphgb1qlhgzeb1qlhgslpd* and press enter (an *hp* is add before the first *hg* when calibrating MKIII Brewers).



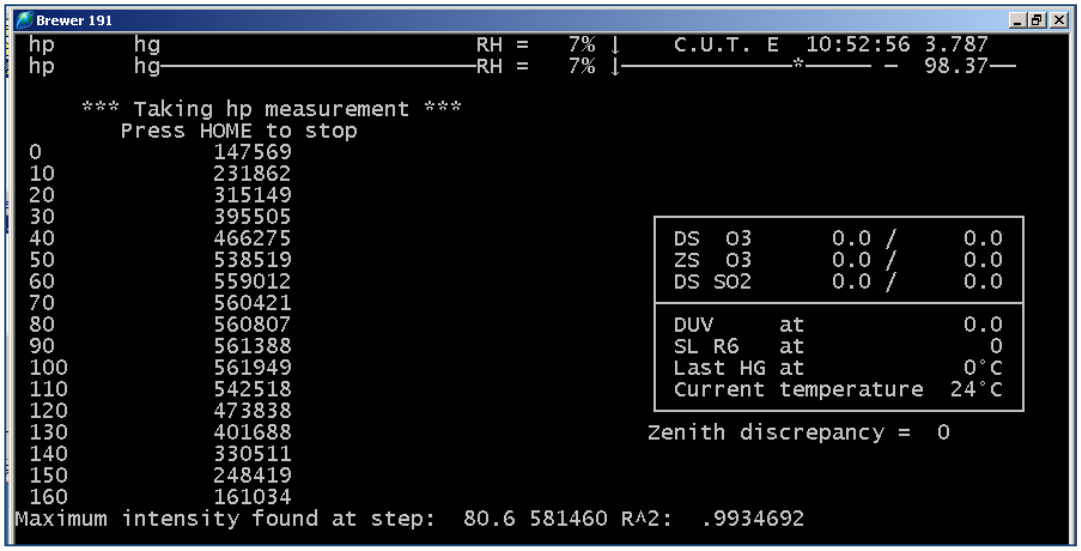
32. The UV Calibration test string requires additional data to be input into the Brewer command window. Enter the lamp id number (include an S before the lamp number) and press enter.



33. Next type the distance from the lamp to the UV dome and press enter. In this case 40 cm is the distance.



35. To qualify as a valid UV calibration the zenith discrepancy must be zero and the *hp* should be 79.9 +/- 5 steps. The *hg* tests before and after the *ql* scans must be within 2 steps and one degree Celsius. To analyse these tests, open the D file corresponding to the test date and either confirm or invalidate qualification.



36. If the temperature or *hp* test invalidates the corresponding *ql* scan, re-run the test (i.e. *pdhphgb1qlhgpd*). If a valid UV calibration results, turn off the lamp using the Brewer UV Lamp Calibration Program window by clicking on the *Turn Lamp Off* button.

37. Allow the test lamp to cool (a minimum of 5 minutes) before removing the lamp from the lamp holder.

38. Once the lamp has been removed, remove the collimator guide and the lamp light collimator from the enclosure

39. Install the next 1kW DXW NIST traceable lamp into the lamp holder. Rotate and position the lamp 40 cm from the UV dome. With an alcohol wetted Kimwipe clean the UV dome and install the lamp light collimator and collimator guide. Shut and secure the enclosure door and turn exhaust fans on. (Steps 9-11)

40. Repeat the lamp set-up, start up and data validation procedures until all the required lamps have been tested.

UV Calibration Procedure Command String Summary

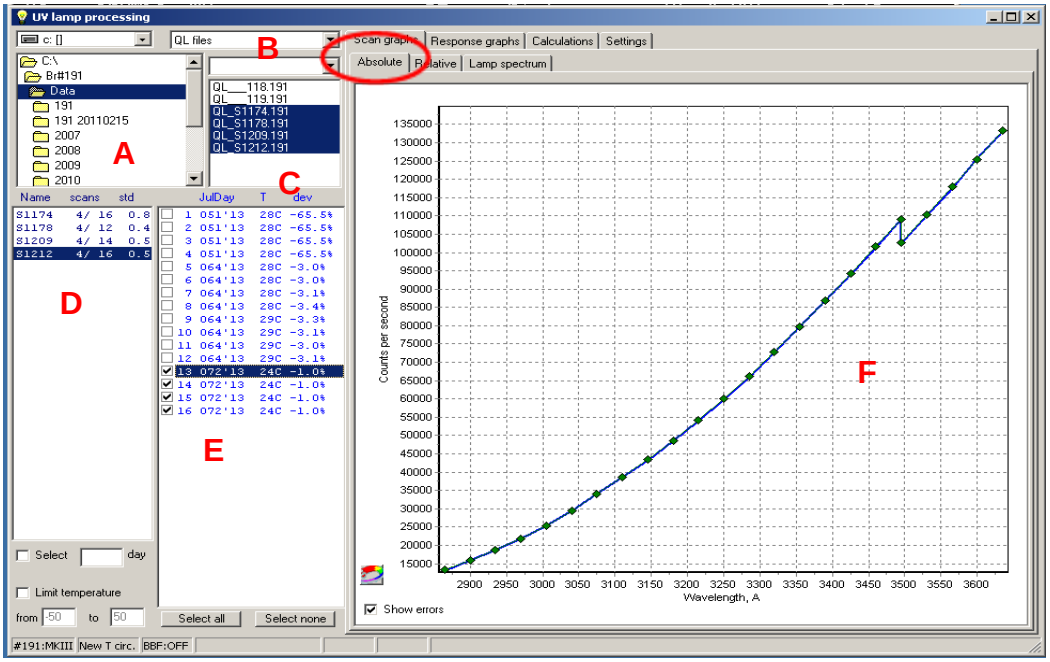
1.	UV calibration preparation for single brewers	pdporehgsldtrsappd
	UV calibration preparation for double brewers	pdporew1hphgsldtrsappd
2.	TU test, Zenith prism optimization for single brewers	pdzetutututupzzepd2
	TU test, Zenith prism optimization for double brewers	pdzetupzzepd8
3.	UV calibration for single brewers	pdzehgb1qlhgzeb1qlhgslpd
	UV calibration for double brewers	pdzehphgb1qlhgzeb1qlhgslpd

Note: Remember to turn off the tracker in the IC file of the Brewer being tested.

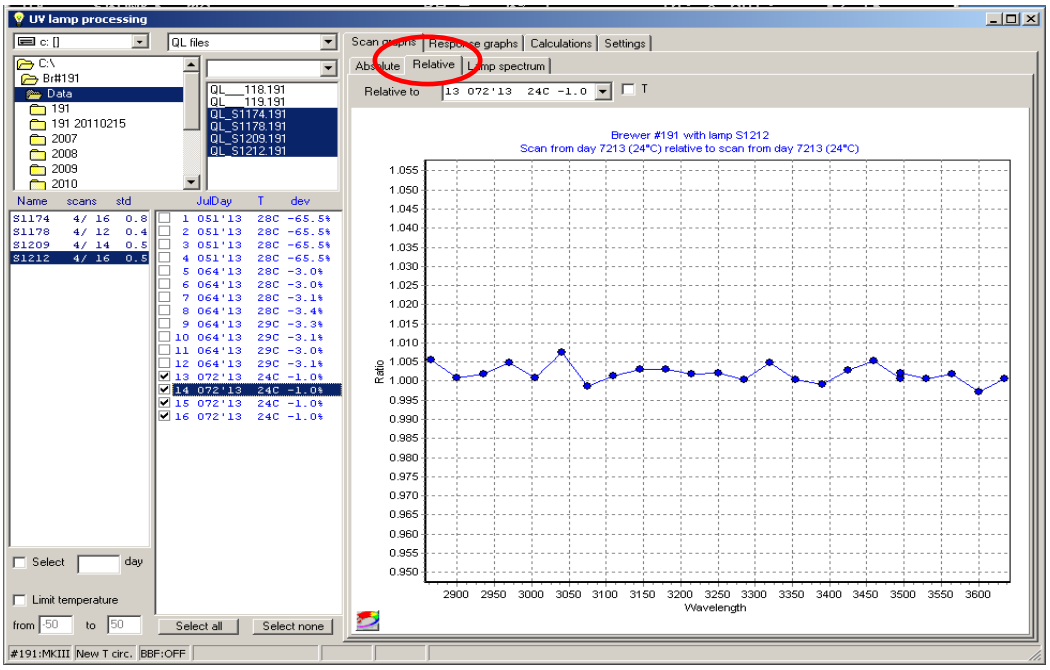
Data Analysis of QL Scans

41. Double click on the *LampPro.exe* icon to initialize the UV lamp processing application.

42. In section **A** navigate to the folder containing the QL files. In area **B** click on the arrow and select *QL files*. Highlight the QL files for the lamps used during the UV calibration in section **C**. The lamps selected from section **C** will populate the window in area **D**. Click on each of the lamps in area **D** and check mark the validated scans for the appropriate Julian Day in area **E** to be used. To view the absolute scan of a particular lamp in area **F**, click on the absolute tab, then select the lamp (**D**) and lamp scan/s (**E**).

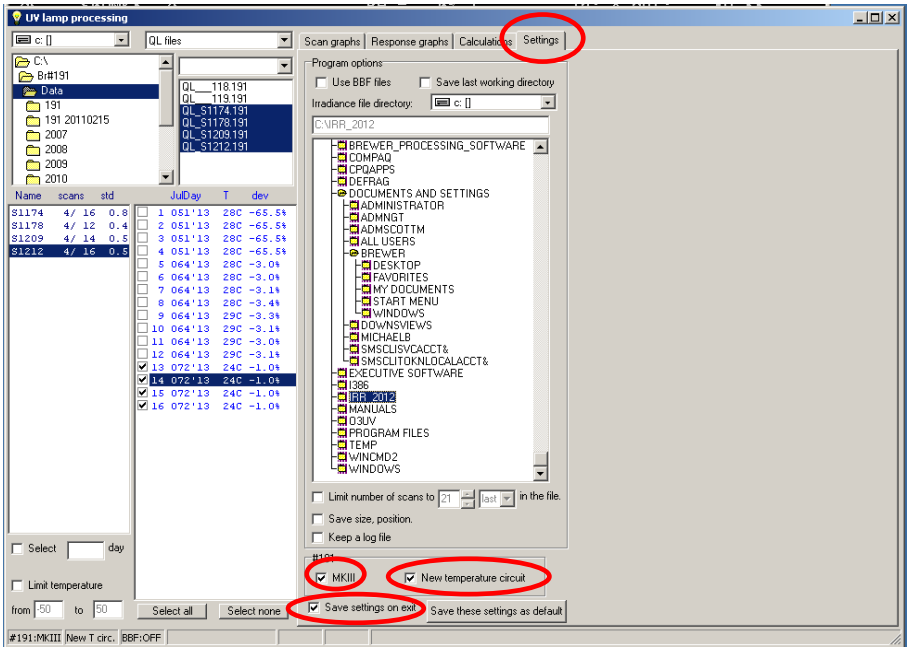


43. To view a specific lamp scan relative to another scan of the same lamp, click on the *Relative* tab and select the scan to compare. In this example, scan 14 is relative to scan 13. Scan 14 is ~ 0.5% different from scan 13.

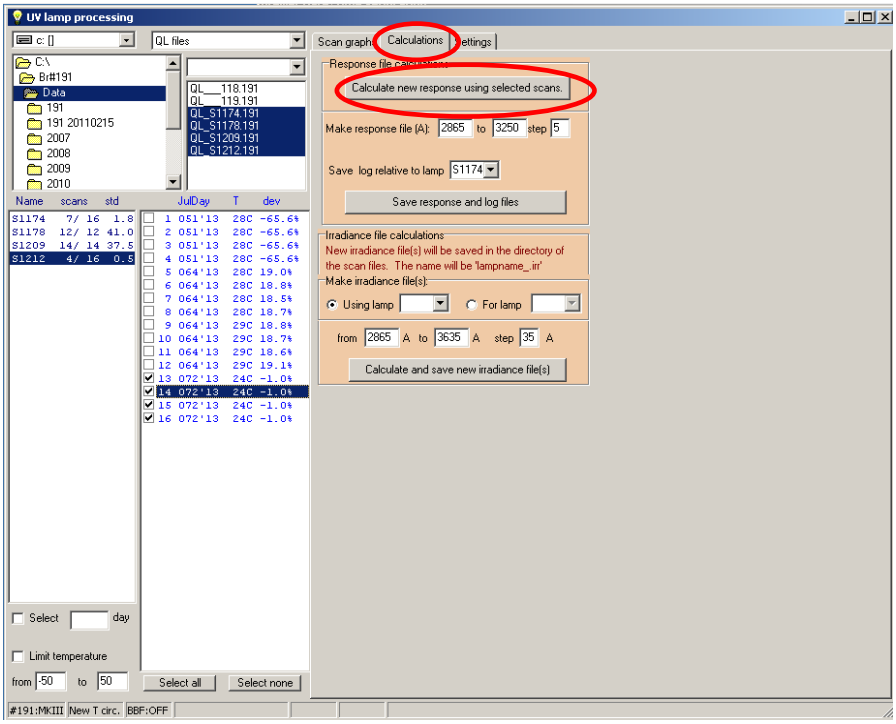


Creating an UV Response File

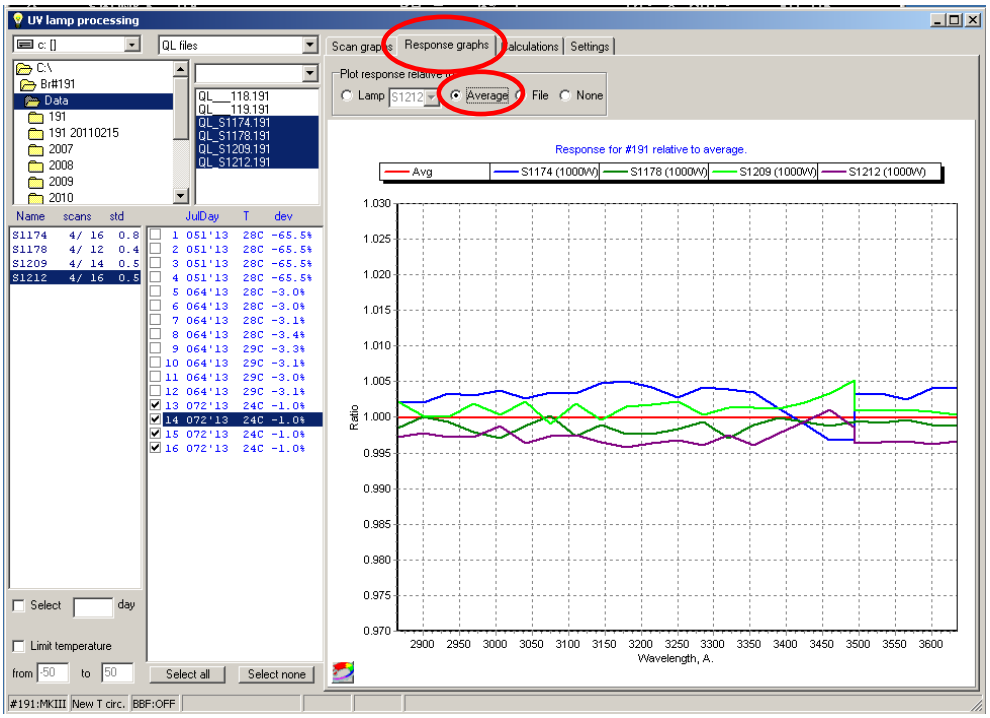
44. Click on the settings tab in the UV lamp processing application. Point to the Irradiance file directory. Check mark the boxes *MKIII*, *New temperature circuit* and *Save settings on exit* if applicable.



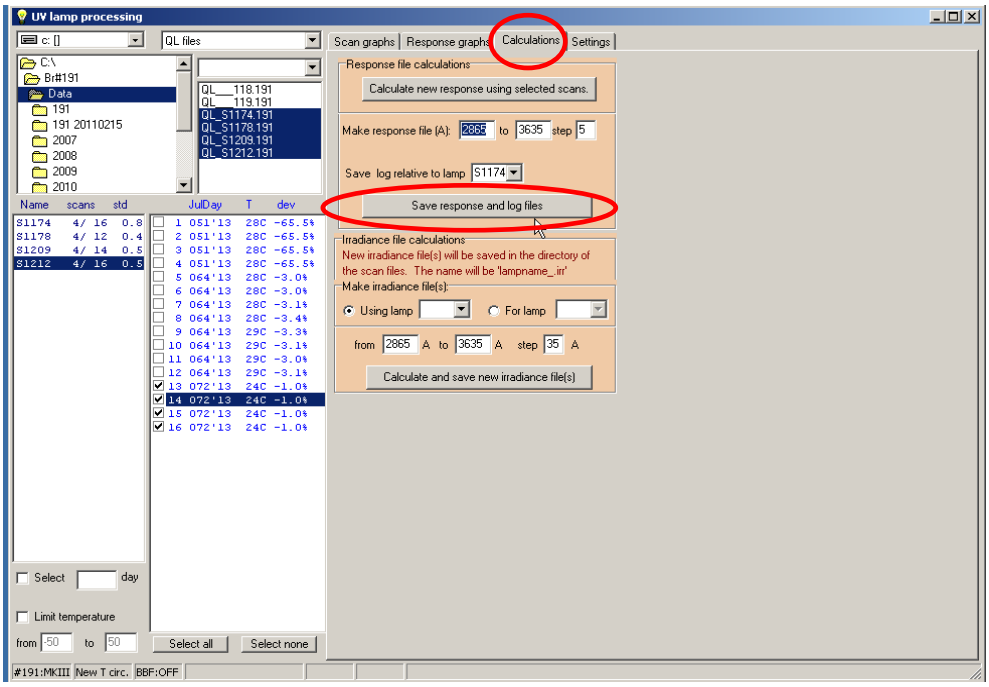
45. Click the *Calculations* tab and then click the *Calculate new response using selected scans* button.



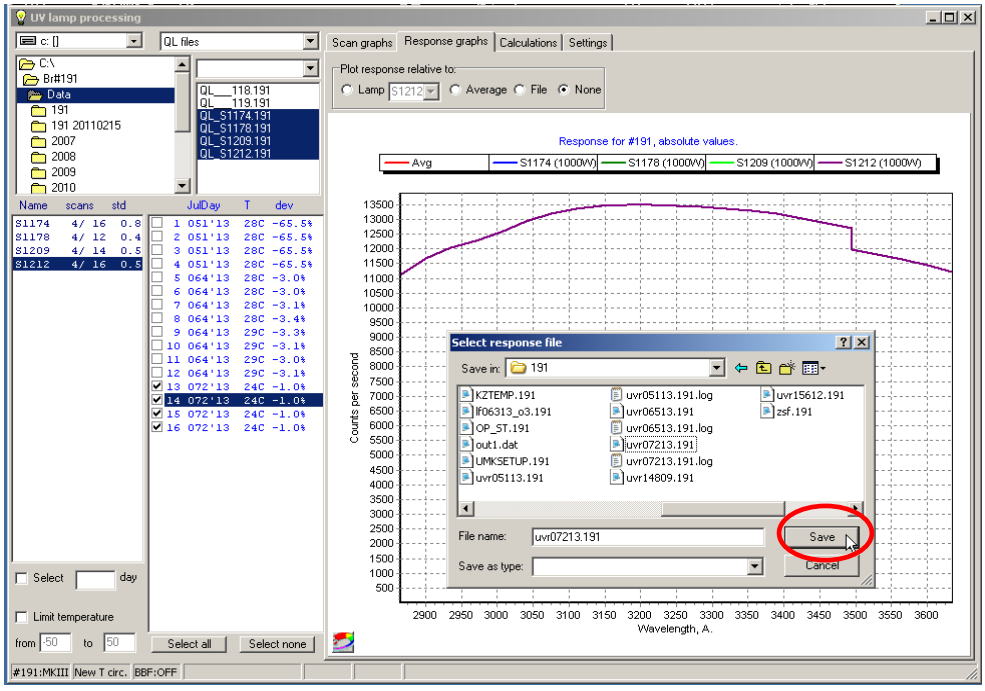
46. Click the *Response graph* tab and the *Average* option. The Brewers spectral response for each lamp relative to the average of the lamps tested is displayed. In this example, every lamp is within 0.5% of the average. This signifies a good agreement of the lamps.



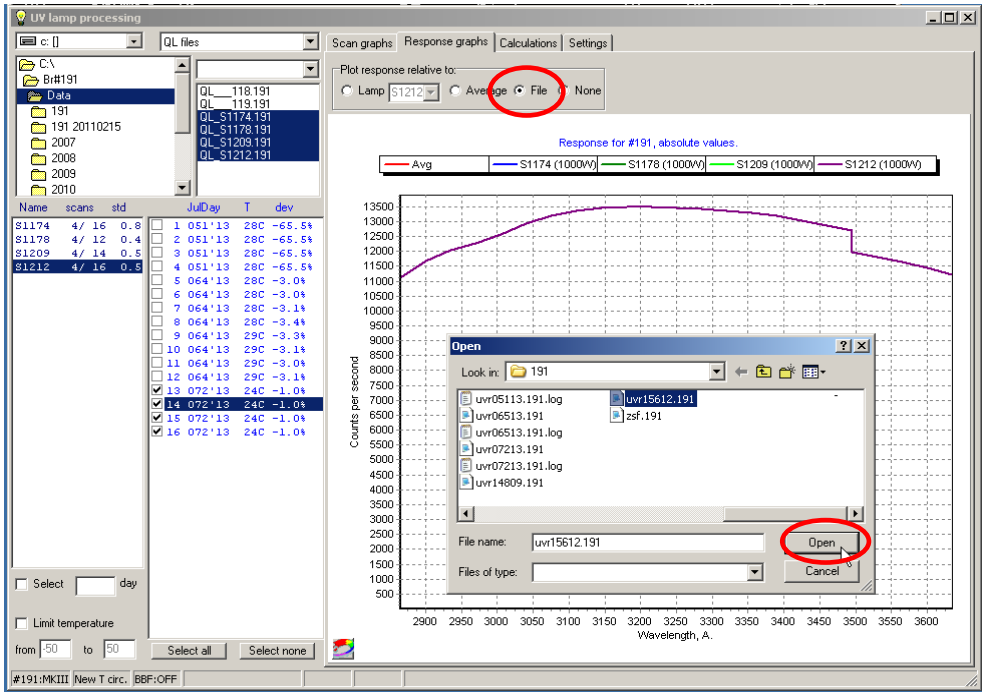
47. To save the newly created UVR file, click on the *Calculations* tab and then the *Save response and log files* button.



48. The *UV Lamp processing graph* will change and a save window will open. Save the UVR file in the instrument # folder (i.e. 191 constants file) with the Julian day and year it was created (uvr072.191) and click the *save* button.

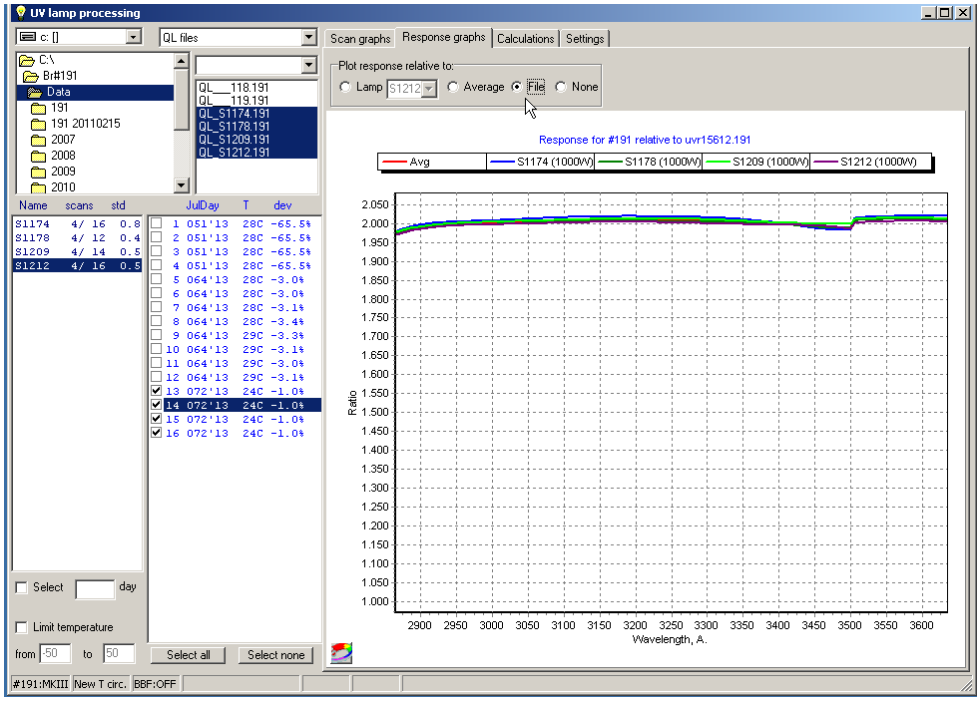


49. To compare the new UVR file to the UVR file currently in use by the Brewer program, click on the *file* option in the *Response graphs* tab. An open file window will activate. Simply choose the UVR file you would like to compare and then click the *Open* button.



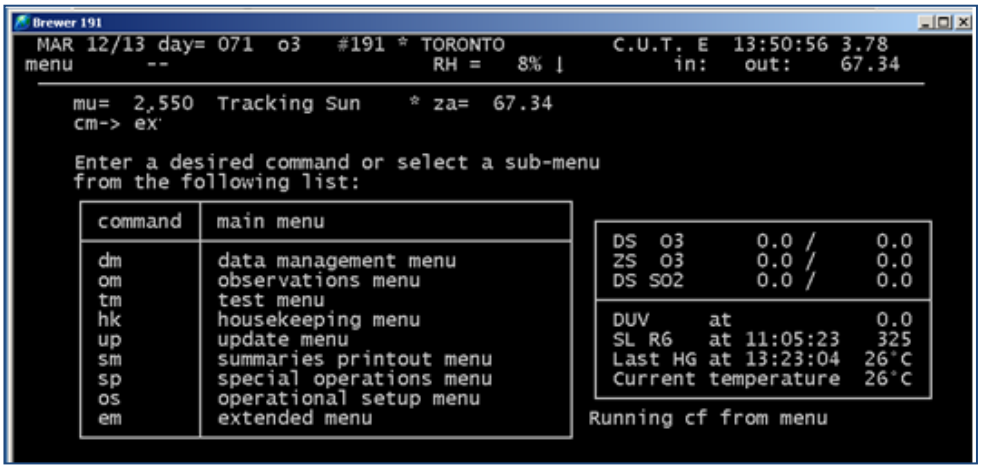
50. The resulting graph is a ratio of the newly calculated Brewer response relative to the UVR file chosen for comparison. In this example the Brewer response has doubled.

Note: The results obtained in this example are unique in the fact that the instrument may not have been set-up correctly at the factory. A 100% increase in UV response is not the norm. Normally the change in response is +/- 2%.

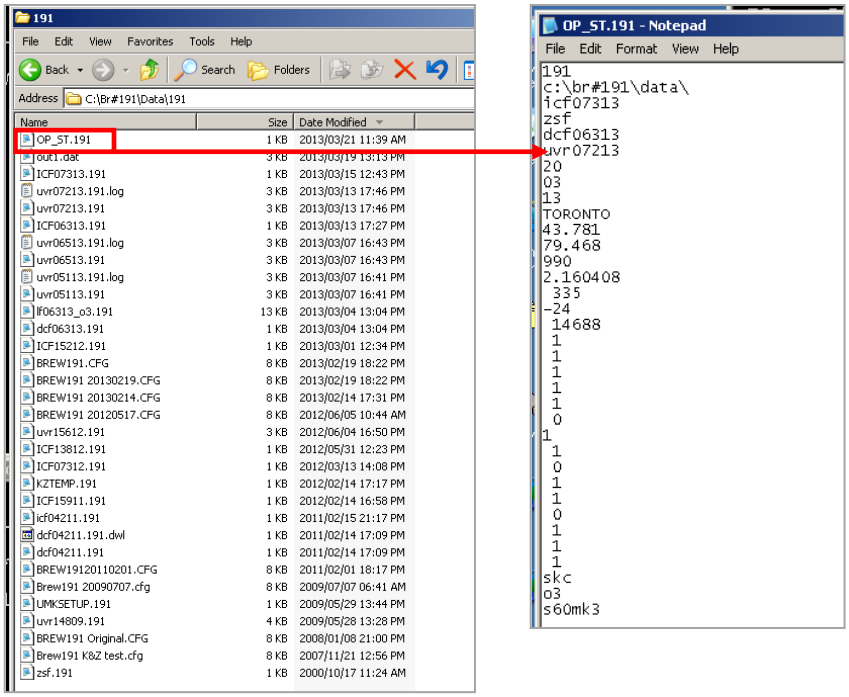


51. When a UVR is validated the Brewer's *op_st* file will have to be changed to reflect the new UVR file. In order for the Brewer to use this new file the Brewer command window must be closed prior to changes in the op_st file.

52. While the Brewer command window is in menu mode, type *ex* on the command line and press enter. The command window should now be closed.



53. Using the Brewer computer open the op_st file (e.g. op_st.191) and change the uvr file name to reflect the newly created file (eg.uvr07213.191). Save changes to op_st file and close.



54. The Brewer command window can now be re-opened.

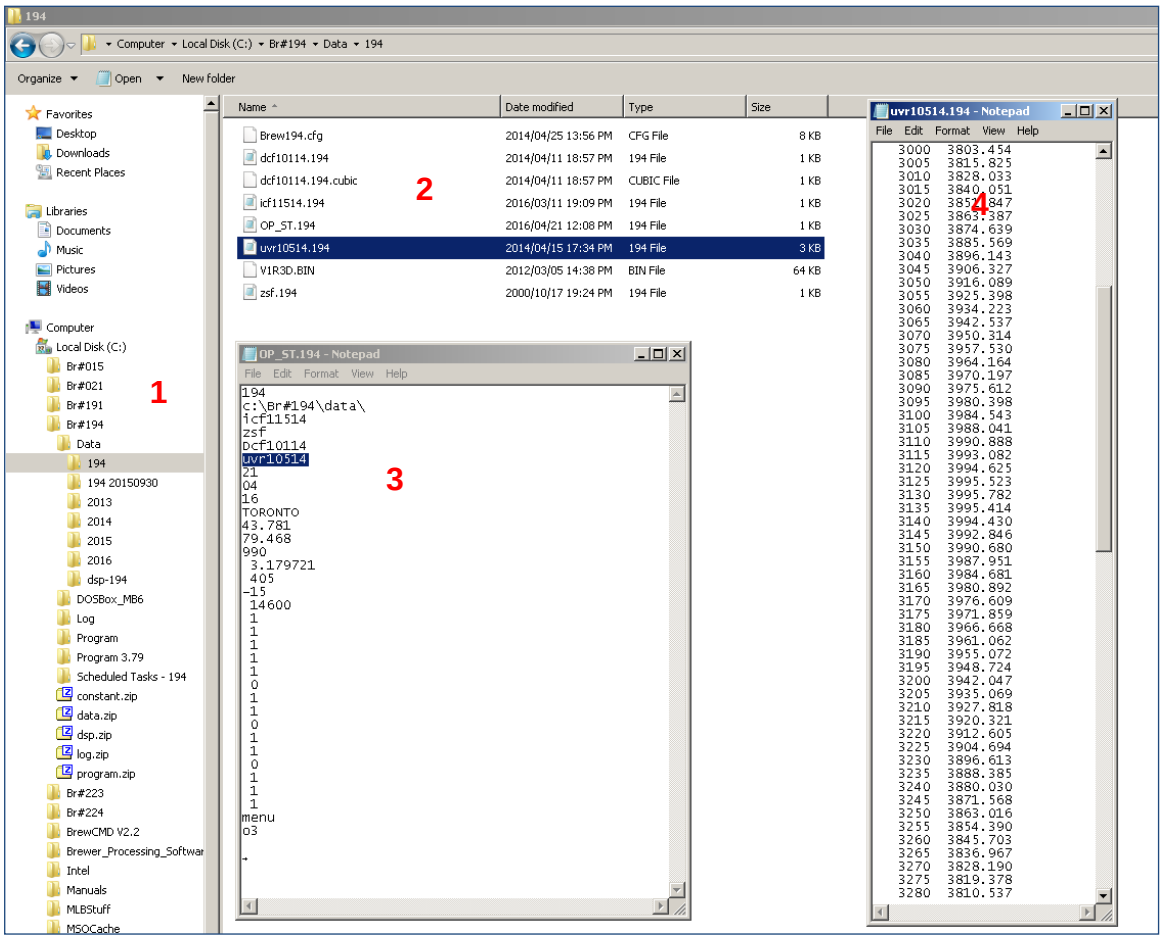
Appendix

Confirming UVR file Responsivity

1. Using the computer controlling the Brewer being investigated, open the appropriate Brewer folder then its Data folder and then its numerical operational folder. Next open the OP_ST.### file to view the current UVR file in use. In this example Brewer 194 is the instrument being investigated.

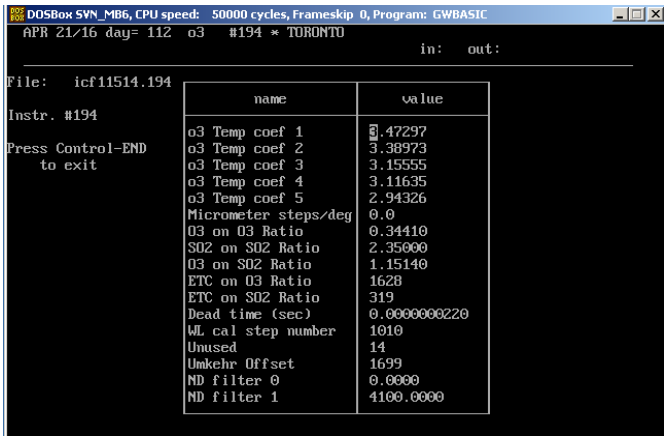
2. In the same folder open the current UVR file and scroll through the data and identify the largest value in the second column.

3. The value determined above should be in the range of 3000-9000 regardless of the Brewer model. If the value is outside of this range the filter wheel referenced in the brewers *ifc* file will need to be changed.

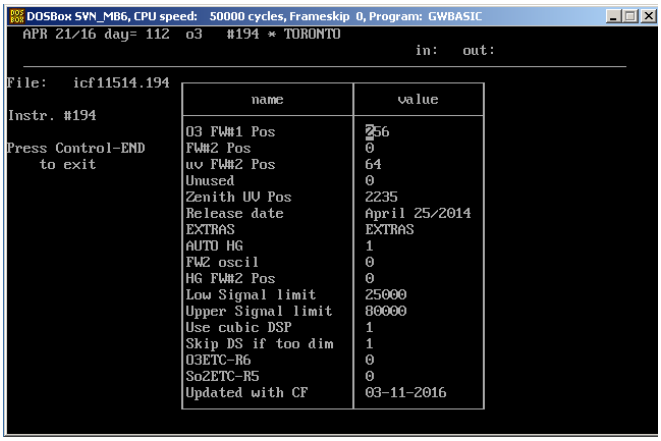


4. The filter wheel positon is changed by accessing the Brewers constants file.

5. Access the constants file (*cf*) by typing cf on the cm -> line and then pressing enter. The instruments icf file will now be displayed.



6. Use the keyboard to arrow down until the UV FW#2 Pos is displayed and the Dos cursor is over the UV FW#3 Pos value. In the example below the current UV FW#2 Pos is 64. If the maximum value in the UVR file was greater than 9000, increase the UV FW#2 Pos value by 64 to 128. If the maximum value in the UVR file was less than 3000, decrease the UV FW#2 Pos value by 64 to 0.



7. Press Ctrl-End to exit the icf file. If changes were made save the changes when prompted.