Environnement et Changement climatique Canada
Environment and Climate Change Canada

Dispersion Calibration SOP for the Brewer Spectrometer

The Canadian Brewer Spectrometer Network

Réseau Canadian de spectrophotometric – Brewer

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Version 2.1

Canada

Dispersion Calibration – Brewer Spectrometers

A dispersion calibration is performed to determine the relationship between the micrometer movement (steps) and the UV wavelengths passing through the exit slits of the slit mask. The UV spectrum of three different lamp sources, mercury, zinc and cadmium are scanned (PMT counts vs. wavelength) and the peak width and peak max are determined. With the use of dispersion specific software the coefficients for ozone and sulphur dioxide are calculated using this spectral data.

The following is a step by step SOP detailing the dispersion calibration procedure.

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

Pre-Calibration

Prior to performing the dispersion calibration, the brewer must first be operationally stable and in good working order. A series of test are run and are compared to the historical data of this instrument to determine the brewer's current operational state.

As a minimum the following pre-calibration tests should be performed and deemed to have passed before the dispersion calibration can proceed.

- Status and Control (ST) for Iris and filter wheels,
- Zero zenith prism (ZE),
- Slit Mask Motor Timing Test (SH) ,
- Print out A/D monitor (AP),
- Slit Mask Run/Stop test (RS),
- Photomultiplier Dead Time test (DT),
- Grating Synchronization (HP, for MKIII Brewers only),
- Mercury Wavelength Calibration (HG),
- Standard lamp test (SL),
- Confirm gradient offset (GA, for MKIII Brewers only),
- High voltage test (HV).

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.

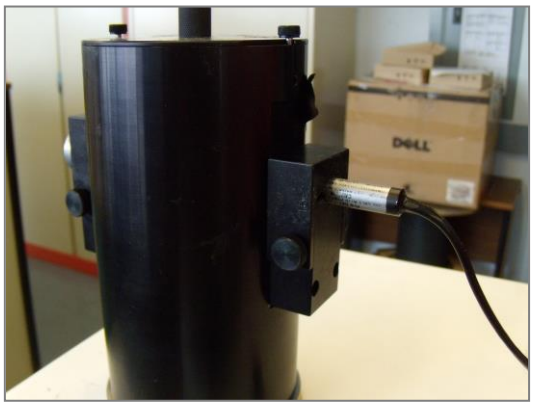
Dispersion Calibration Procedure

Equipment Required

- Mercury vapour lamp and power supply,

- Cadmium vapour lamp and power supply,
- Zinc vapour lamp and power supply,
- Lamp cradle housing,
- UV protective glasses and Kimwipes.

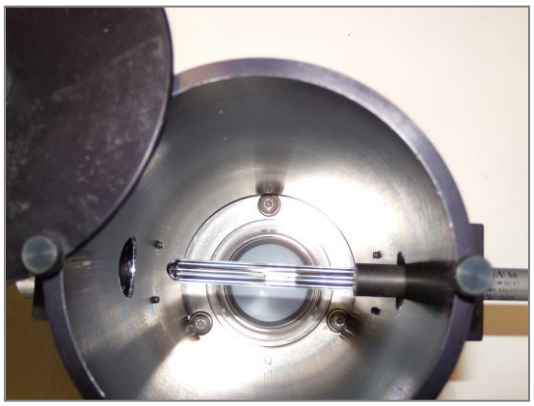
Equipment Setup



1. Place and center lamp housing over the top of the UV dome.

2. Remove the lamp appropriate storage plug from the lamp housing by loosening the two side screws and lifting the lamp holder (in the case of the mercury lamp, remove the smaller of the two plugs) and carefully slide in the lamp.

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



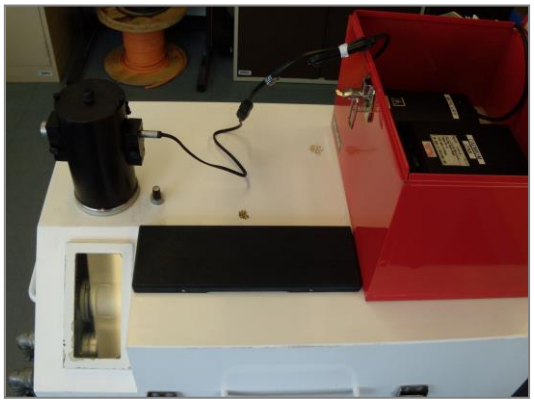
3. Reinstall the lamp holder.

4. Plug the lamp into its specific power supply, plug the power supply into an outlet and turn on.

5. **<u>While wearing UV safety glasses</u>** loosen the top lid screws and slide open the lid of the lamp housing. Orientate the lamp so that the greatest light intensity is directed towards the UV dome and that the lamp is centered over the dome.

6. Secure the lamp in the housing by retightening the side screws while holding the lamp in place.

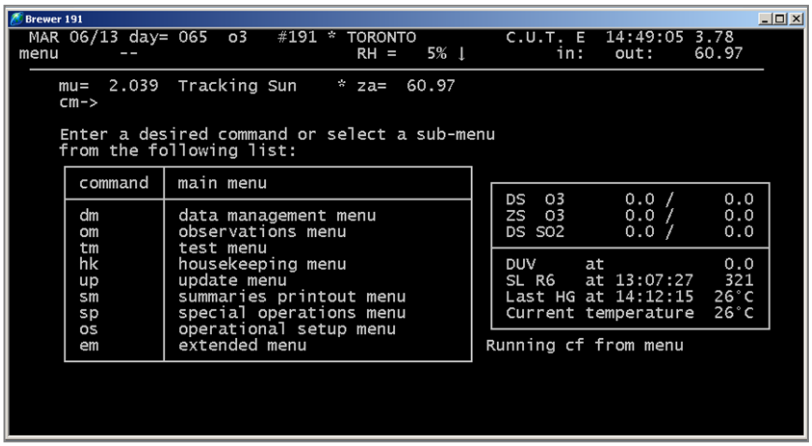
7. Slide the housing lid closed and retighten the screw.



8. Remove UV safety glasses.

9. Return to the computer of the Brewer being tested.

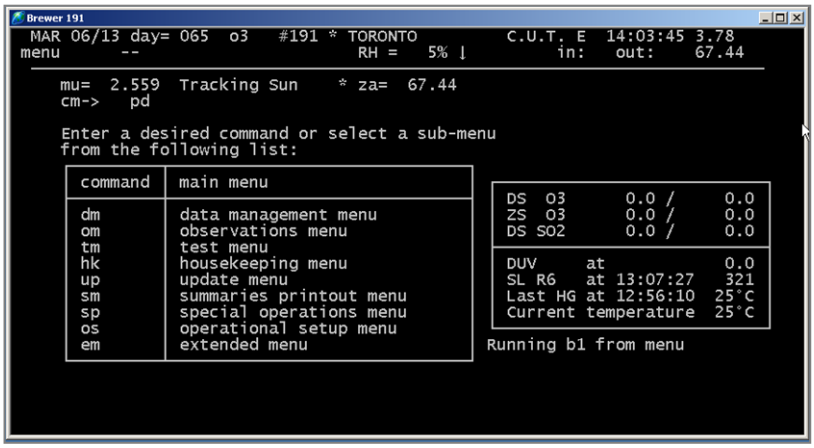
10. If the brewer is mounted on a tracker, turn the trackers azimuth function off via the IC command in the instruments DOSBOX window.



this SOP Brewer 191 is the instrument being calibrated.

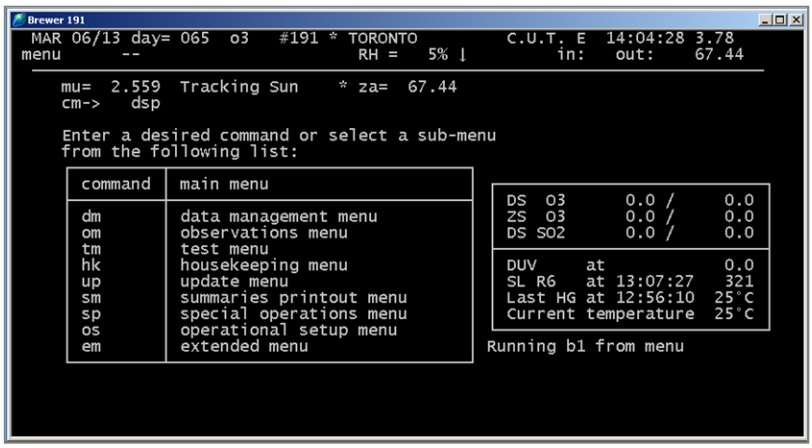
Dispersion Initialization

11. Begin the dispersion calibration routine from the home brewer control screen. For the purposes of

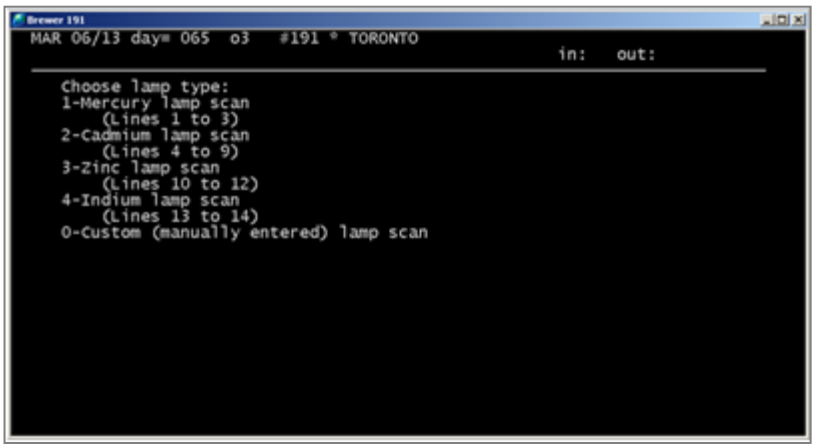


12. Start by pressing the *Ctrl-ScrLk* keys to interrupt the DosBox. Next press the *Ctrl-Home* keys to clear the screen. Then *type run* and press *enter* to restart the DosBox.

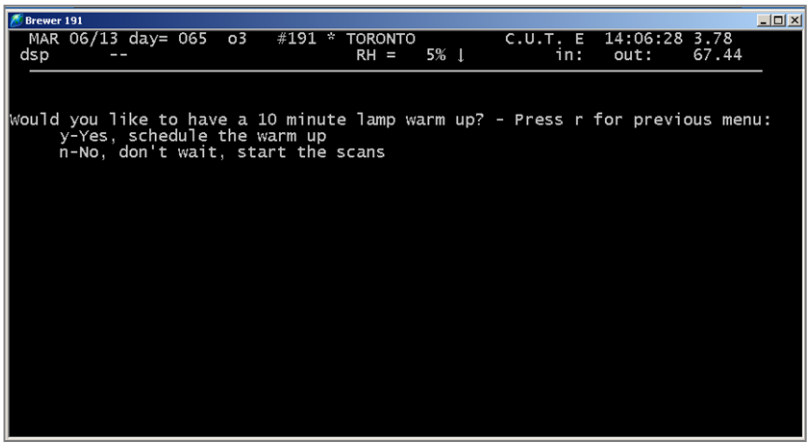
13. From the command line, type *pd* (the pd command writes the data file into the Brewers D file) and then press enter.



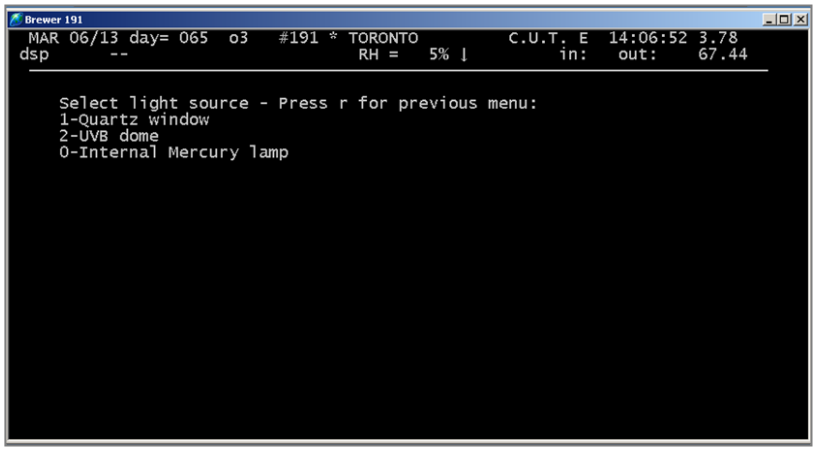
14. Next type *dsp* and press enter.



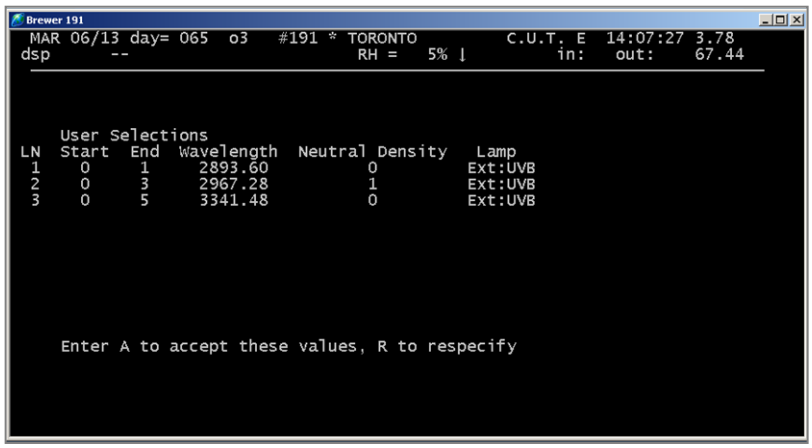
15. Press the number associated with the lamp being used.



16. Press *y* or *n* and then press *enter* (n is pressed only if the lamp has been on for a minimum of 10 minutes).



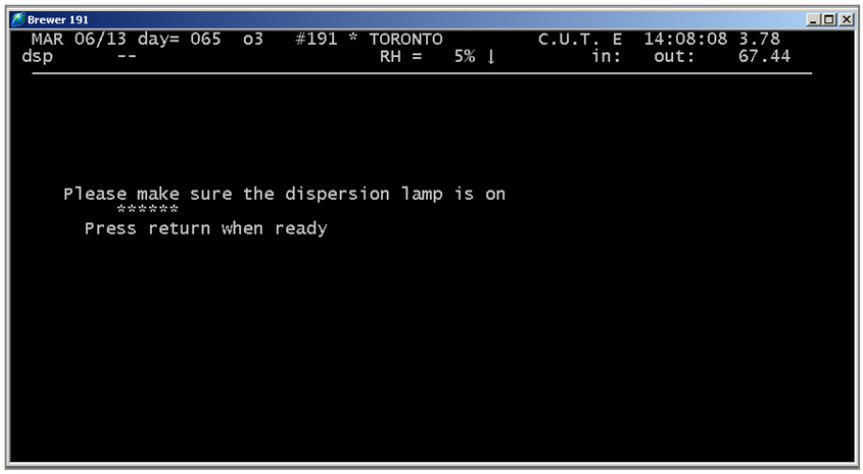
17. Press *2* to select UV Dome and then *enter*.



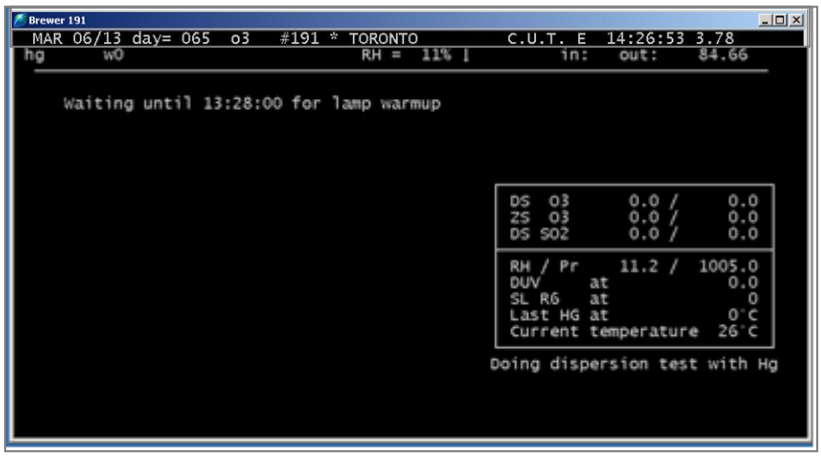
18. If the program determined wavelengths correspond with the table below, press *A*, if not press *R* to correct

Note: The wavelengths used to conduct dispersion calibrations for single brewers (S) and double brewers (D) are tabled below. The DSP calibration script automatically determines the wavelengths that will be used based on the brewer model being tested.

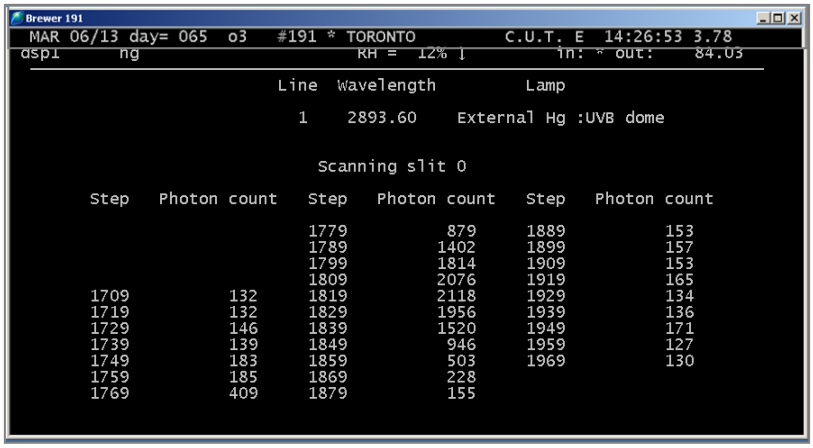
Lamp Type	Line (LN)	Starting Slit	Ending Slit	Wavelength AU	Brewer Model
Hg	1	0	1	2893.600	S, D
Hg	2	0	3	2967.280	S, D
Hg	3	0	5	3341.480	D
Cd	4	0	5	3080.820	S, D
Cd	5	0	5	3133.167	S, D
Cd	6	0	5	3261.055	S, D
Cd	7	0	5	3403.652	D
Cd	8	1	5	3499.950	D
Cd	9	5	5	3611.630	D
Zn	10	0	5	3018.360	S, D
Zn	11	0	5	3035.780	S, D
Zn	12	0	5	3282.330	S, D



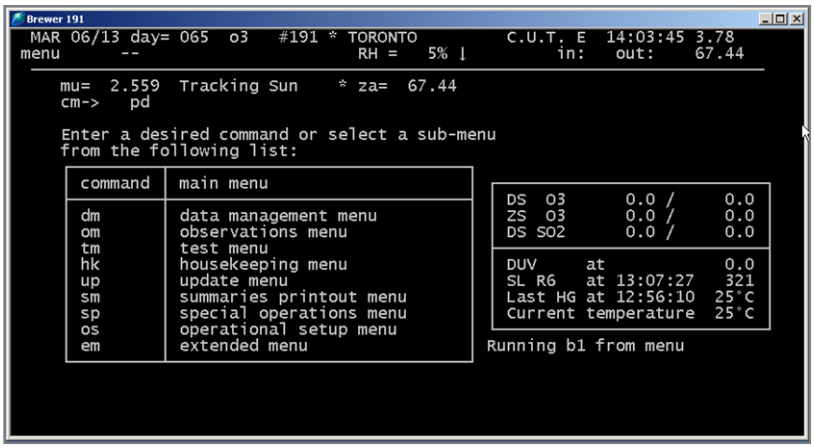
19. Press *enter* when ready.



20. An example of the brewer screen while waiting for a dsp test to start.

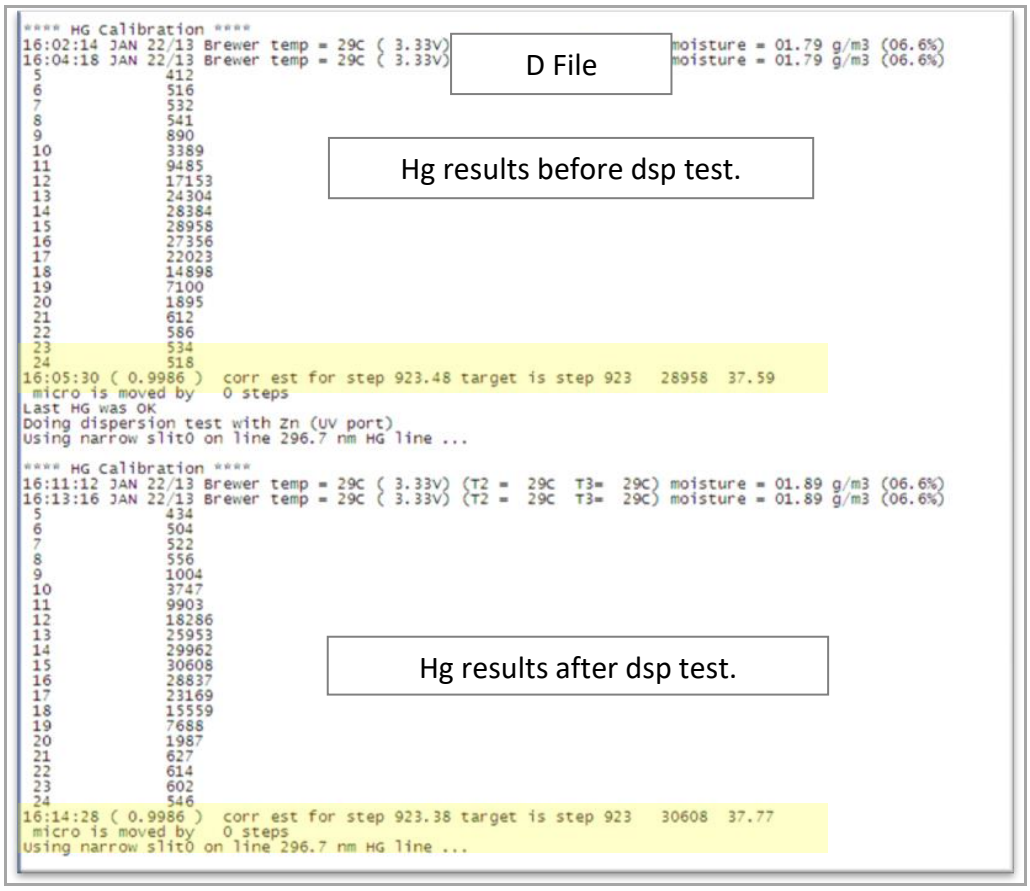


21. Typical screen display during a dsp test. Note: The highest counts should be near the middle of the scan, center portion of the center column.



22. Once the dsp test has completed the brewer will return to menu mode. Type *pd* and then press enter to write the dsp results to the D file.

23. Using the most recent D file confirm that the Hg's have "passed" and that there is not a step difference greater than one from the offset to the target number of steps. If this is not the case, do not proceed with the remaining lamps until the cause in discrepancy has been corrected. The lamp that was tested will again have to be re-run. The D file is located in the instruments data directory.




```
**** HG Calibration ****
16:02:14 JAN 22/13 Brewer temp = 29C ( 3.33V)                    moisture = 01.79 g/m3 (06.6%)
16:04:18 JAN 22/13 Brewer temp = 29C ( 3.33V)                    moisture = 01.79 g/m3 (06.6%)
 5              412
 6              516
 7              532
 8              541
 9              890
 10             3389
 11             9485
 12             17153
 13             24304
 14             28384
 15             28958
 16             27356
 17             22023
 18             14898
 19             7100
 20             1895
 21             612
 22             586
 23             534
 24             518
16:05:30 ( 0.9986 )  corr est for step 923.48 target is step 923   28958  37.59
 micro is moved by   0 steps
Last HG was OK
Doing dispersion test with Zn (UV port)
Using narrow slit0 on line 296.7 nm HG line ...

**** HG Calibration ****
16:11:12 JAN 22/13 Brewer temp = 29C ( 3.33V) (T2 =  29C  T3=  29C) moisture = 01.89 g/m3 (06.6%)
16:13:16 JAN 22/13 Brewer temp = 29C ( 3.33V) (T2 =  29C  T3=  29C) moisture = 01.89 g/m3 (06.6%)
 5              434
 6              504
 7              522
 8              556
 9              1004
 10             3747
 11             9903
 12             18286
 13             25953
 14             29962
 15             30608
 16             28837
 17             23169
 18             15559
 19             7688
 20             1987
 21             627
 22             614
 23             602
 24             546
16:14:28 ( 0.9986 )  corr est for step 923.38 target is step 923   30608  37.77
 micro is moved by   0 steps
Using narrow slit0 on line 296.7 nm HG line ...
```

24. If the before and after dispersion Hg are within one step, turn off the lamp that was tested, allow it to cool then remove and store it safely.

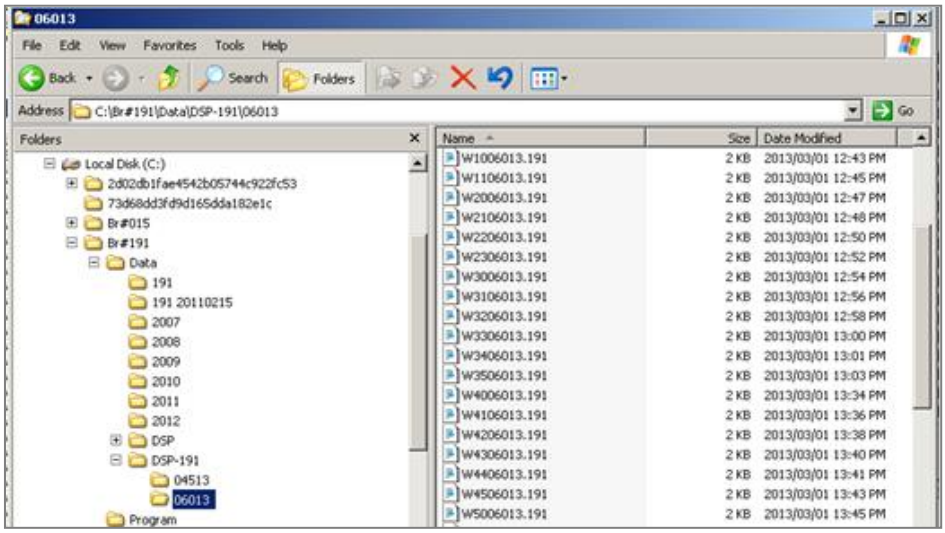
25. Repeat the above procedures for the remaining lamps.

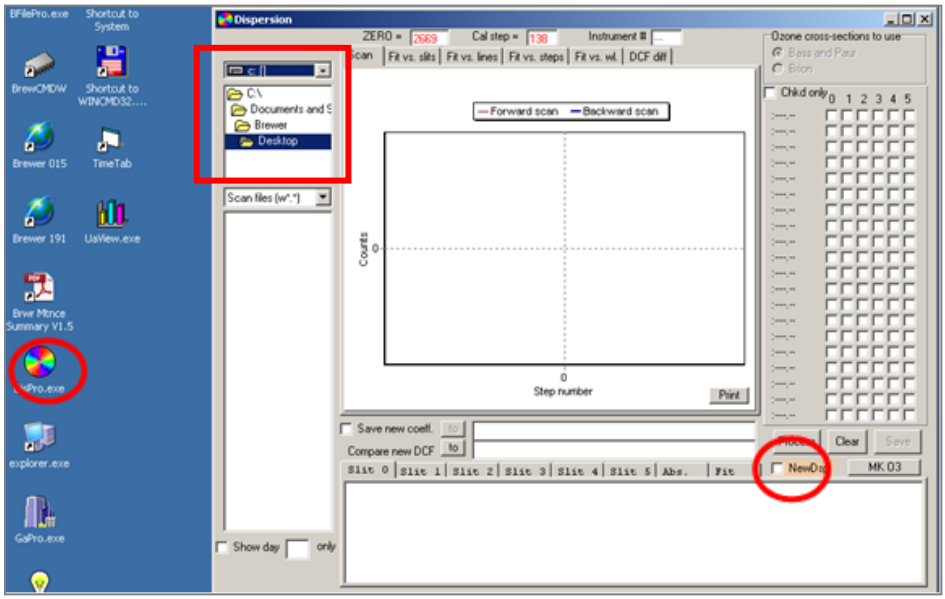
Take note that the cadmium and zinc lamps both have Max Output Ports; these ports are directed towards the UV dome.

26. Once completed, return the equipment to its storage case and close. Also, return the Brewer and tracker to its normal operation.

Dispersion Calibration Analysis

The dispersion files created are located in the instrument's data folder (e.g. using #191, C:\BR#191\Data\DSP-191\06013). The last folder is identified using the Julian day and year the dispersion test was run. The dispersion files are analysed using the DisPro.exe program.





27. Double click on the *DisPro.exe* icon to initialize the dispersion data processing program.

28. Next activate the *NewDisp* field by pressing the alt key and checking the newly created box. When checked, the program uses a cubic function to create a best fit curve and when unchecked a quadratic equation is used.

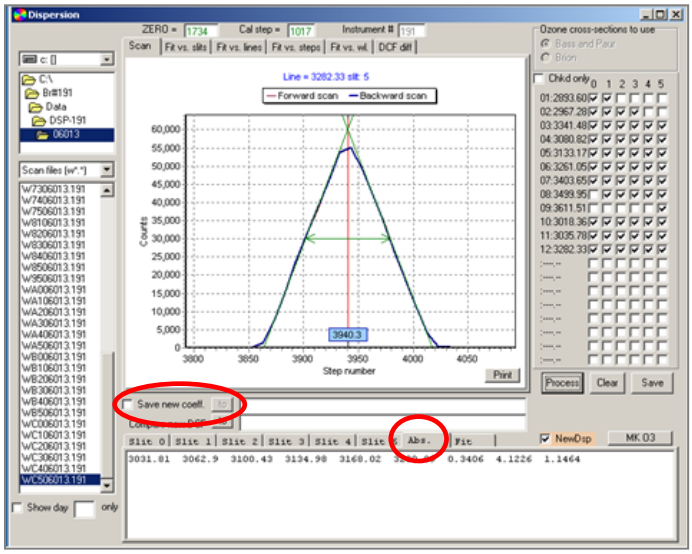
29. Using the top left window of the *DisPro* program, navigate to the folder containing the dispersion calibration files just created. Click on the top *w*.** file and use your computer's keyboard down arrow to add all the files to the analysis. Adding these scans will place a check mark into its corresponding slit and wavelenght box located to the right of the graphing area.

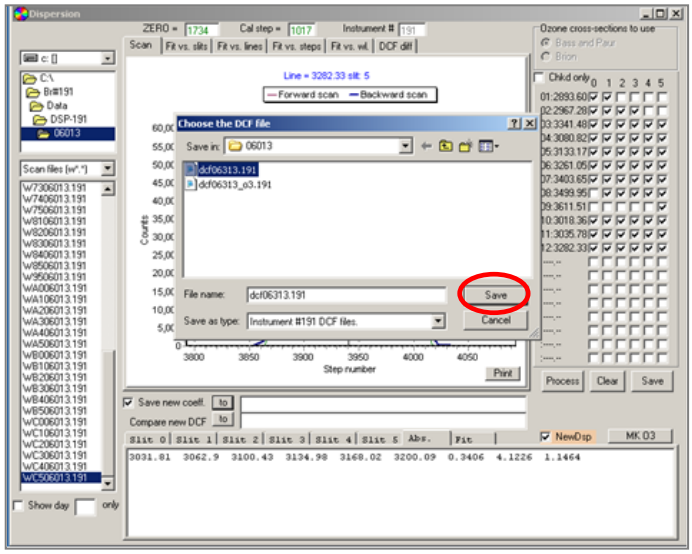
Note, if a check box is outlined in red without a check mark this would indicate that the scan was too poor to include in the data set.

30. Next click on the *Process* button. Note, this program has built in scan disqualifiers and these scans will have a red box around the checkmarks created. If there are disqualified scans following processing, simply uncheck the box corresponding to the poorest scan first (use the Fit vs slits and the Fit vs lines tabs to determine the poorest scan corresponding to one of the red boxes) and reprocess. By removing the poorest scan first and only one at a time the reprocessed data set may now include scans that were previously identified as being suspect. Continue this until there are no more red boxes.

31. Following the data processing the final wavelenghts for this dispersion calibration are displayed in the bottom window/tabs. In particular the Abs. (absorption) tab displays the calculated wavelengths for each slit. An indicator of a good data set is the wavelength value for slit 5 (6th value from the left) which should be close to 3200, otherwise there may be issues with the brewer insturment (0.065 difference from 3200 indicates a 1 step difference from ideal).

32. At this point a calibration dcf file is created. To save this file check the *Save new coeff* box and click on the *to*: button next to it.

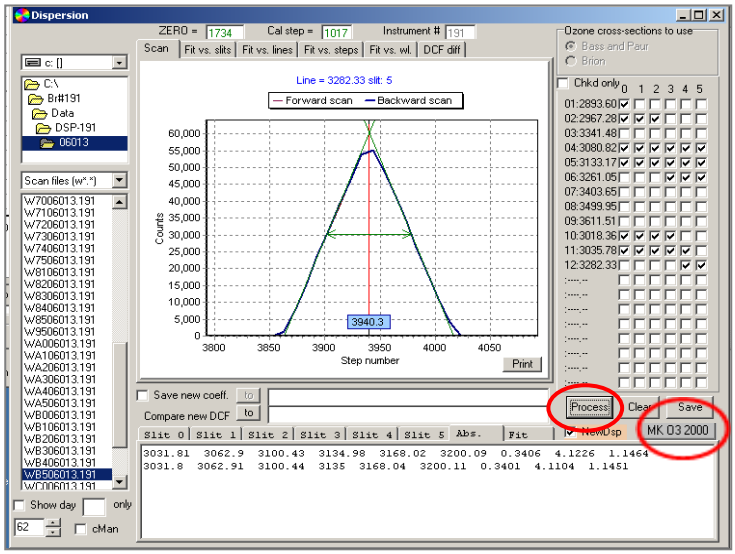


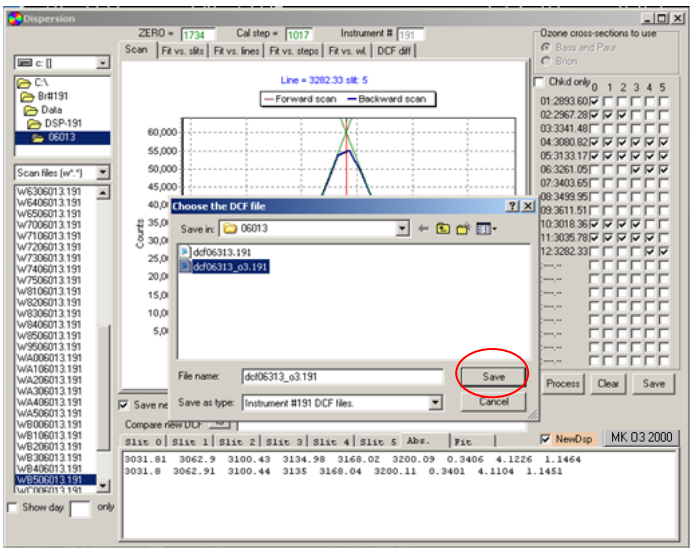


33. Name the dcf file with the julian day and year it was created (eg. dcf06313.191) and save in the same folder as above (eg. C:\BR#191\Data\DSP-191\06313) and click *Save* in the dcf file name window. Next click on the *Save* button below the checked slits to save the dcf file to the folder previously identified. Note a line fit (lf) file is also produced during the creation of the dcf file. Files created include, dcf*.*, dcf*.*.cubic, dcf*.*.dwl, lf*.*, lf*.*.dat.

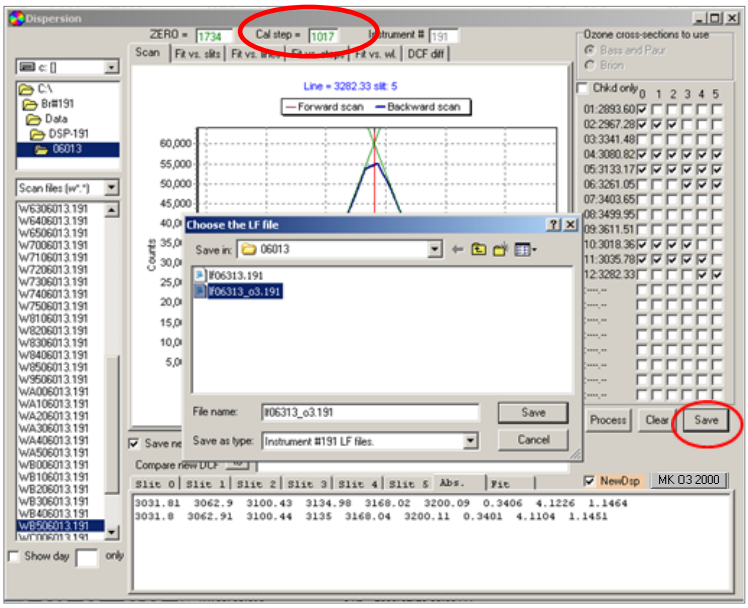
34. To calculate the ozone absorption coefficient, uncheck the *NewDisp* box and click on the *MK O3* button (which will change to read MK O3 2000) then recheck the NewDisp box. The

software will optimize the wavelenghts to use in this calculation. Next press the *process* button and a new dcf ozone file will be created. Do not re click the MK O3 2000 button to reprocess if an error is discovered, click on MK O3 2000 until MK O3 is displayed and restart the dispersion analysis from the beginning.

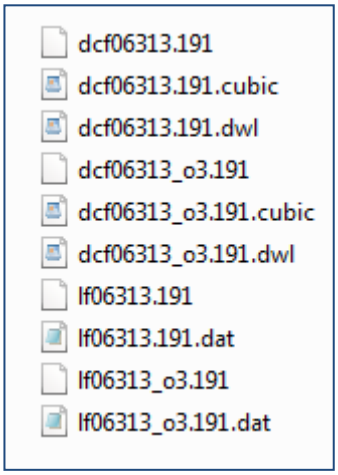




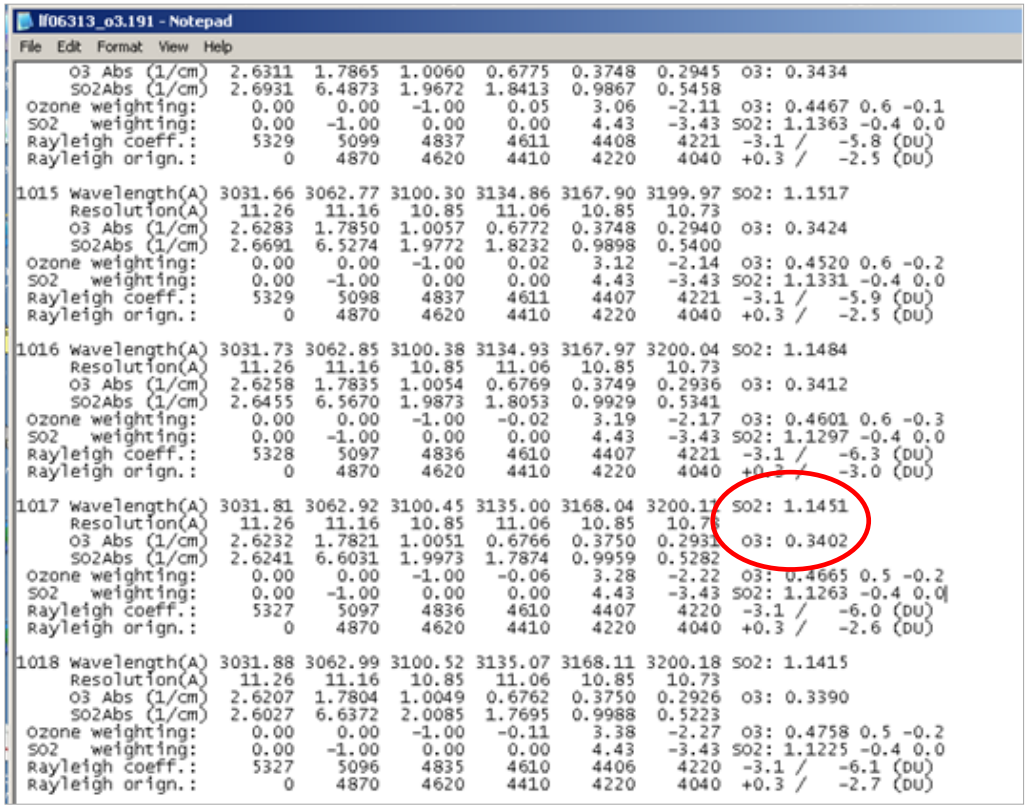
35. Name the dcf o3 file with the julian day and year it was created (eg. dcf06313 _o3.191) and save in the same folder as above (eg. C:\BR#191\Data\DSP-191\06313) and click save in the dcf file name window. Next click on the Save button below the checked slits to save the dcf o3 file to the folder previously identified. Note a line fit ozone(lf o3) file is also produced during the creation of the dcf o3 file. Files created include, dcf*_o3.*, dcf*_o3.*.cubic, dcf*_o3.*.dwl, lf*_o3.*, lf*_o3.*.dat.



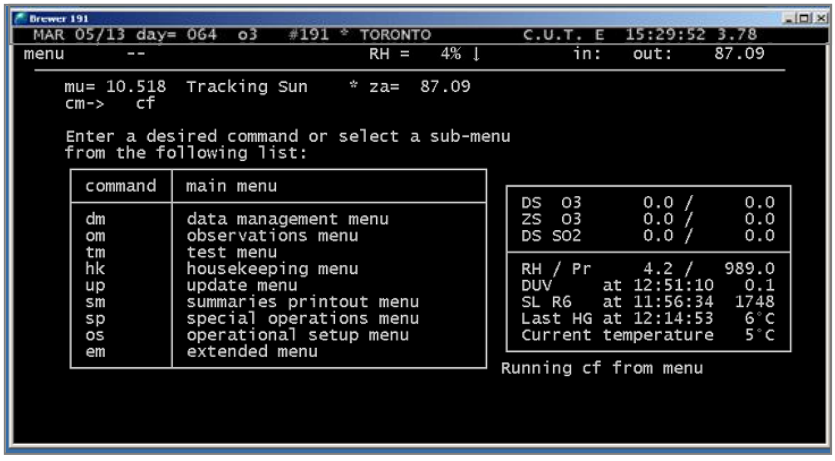
Files Created



36. Open the ozone line fit file just created (lf06313_o3.191) and scroll down to the cal step number used in the dispersion test (circled in red above, 1017). Note the O_3 ansd SO_2 absorbtion coefficient (circled in red below). Note: The correct cal step must be confirmed with sun scan tests and the O_3 and SO_2 absorbtion coefficients corresponding to the correct cal step must be used and entered into the *cf* brewer file.



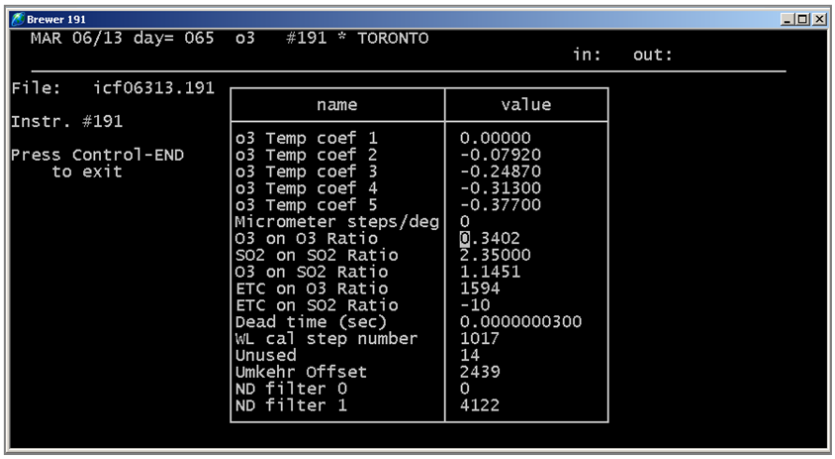
37. From the menu screen, type the command *cf* to open the cf file used by the brewer being tested.



38. Arrow down to the *O3 on O3 Ratio* line and compare the 'just' calculated ozone absorption coefficient with the coefficient in the 'old/current' icf file. If the difference relative to the

original is greater than 1%, change this value to the newly calculated ozone absorption coefficient.

39. The *O3 on SO2* constant is also changed to the value calculated in the lf file above.



40. Exit out of this window by pressing control-end.

41. Save the new icf file with the julian day and year it was created (icf06313.191)

42. Exit out of the home screen window by typing *ex* and pressing enter. The control window should now be closed.

43. Open the op_st file (eg. Op_st.191) and change the dcf and ifc file names to reflect the newly created files (eg. dcf06313.191 and icf06313.191). Save changes to op_st file.