Calibration Report on Brewers #033, #157, #183, #185 at Izaña – Sept. 20-27, 2010

I. Introduction and Instrument Status:

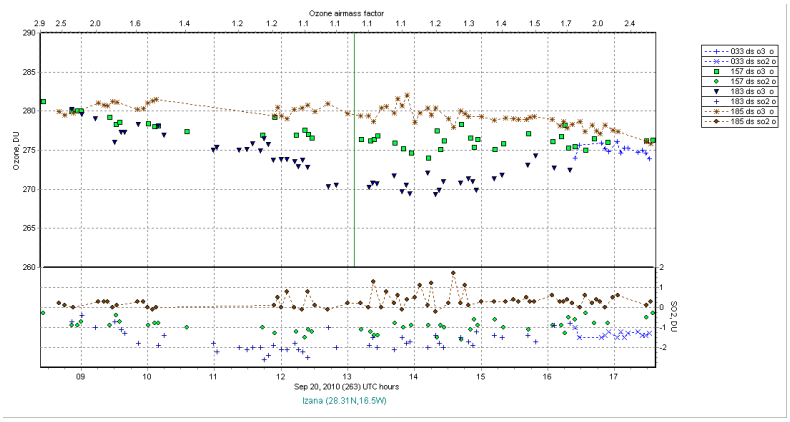
The ozone calibration and servicing of four AEMET Brewer Spectrophotometers was completed by Mr. Martin Stanek from International Ozone Services Inc. (IOS). Mr. David Godoy from AFC Ingenieros S.A. completed the UV calibration and provided support during this period. The traveling standard instrument #017 along with local standard #185 were used as the ozone calibration references.

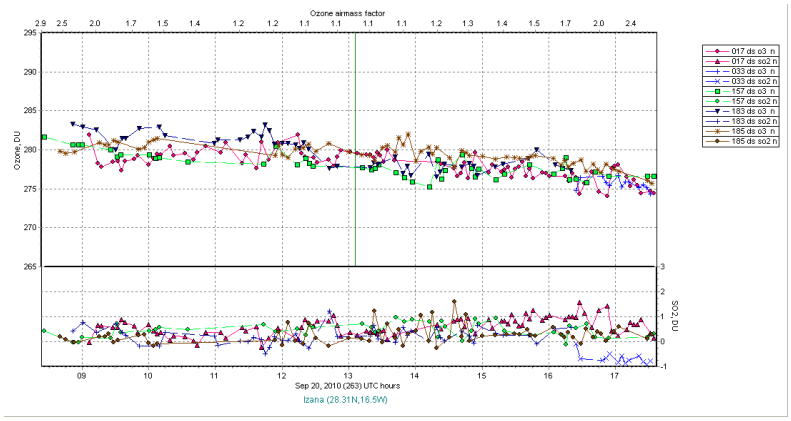
These Brewers appear to have operated well in the past year as monitored by the Standard Lamp (SL), DT and RS test results that have been reasonably stable. However this calibration resulted in some unexpected adjustments being recommended to the final constants.

II. Ozone Test Results:

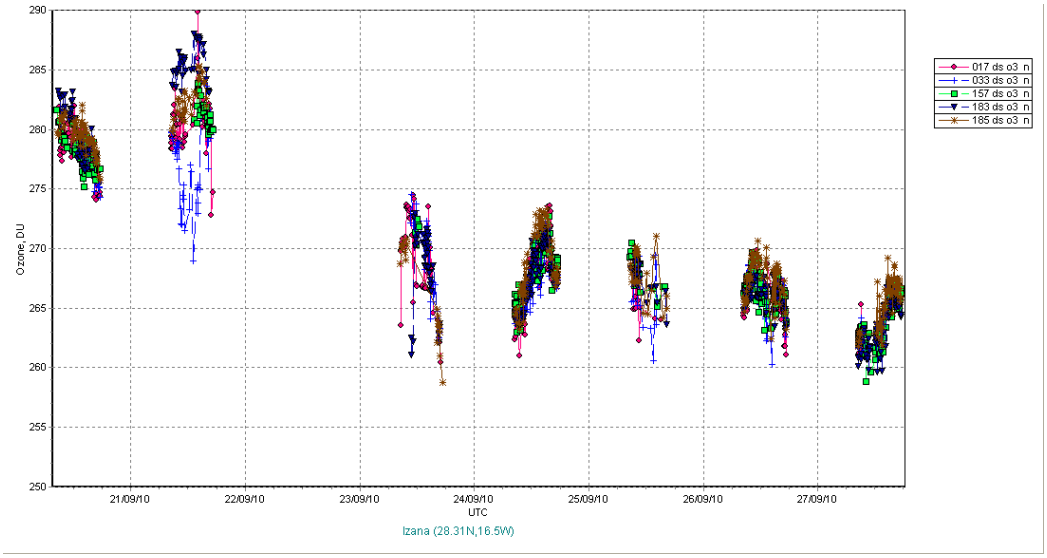
The weather co-operated reasonably well for 4 of the 8 days for direct sun observations and UV scans. Dispersion tests (dsp) were completed on each instrument using the internal mercury and an external cadmium spectral lamps to check the wavelength accuracy for UV scanning, ozone operating wavelengths, absorption coefficients and slit functions.

Below is a graph of the ozone/SO_2 results from the first day of the local instruments before any corrections were made and then the re-processed final results (in second graph), which also includes data from #017. The ozone results from #157 were lower initially while the SL ratios had increased since the last calibration but the lamp had been changed. Then the R6 ratio went up 5 units and when applied to the ozone ETC the ozone comparison improved for the rest of this visit. The final ETC value was 1605 and is the same as the previous 5 years. #183 had low ozone results initially and so it's ozone ETC constant had to decreased 20 units while it's SL ratio had increased 10 units from the last calibration.





Below are the final ozone results of all the comparison data collected, using the final recommended constants. #033 had only a few measurements near the end of the first day and its small change in SL ratios when applied to ETC constants produced good comparative results after a cal step adjustment. Note on the second day the reason for the lower values from #033 are believed to be due the low wavelength cal step setting of 916 which was adjusted to step 920 after a series of sun scan tests were collected.



New temperature coefficients were calculated for #183 after request from the user to hopefully improve stability. The new coefficients are 0, -0.01637, 0.03818, 0.20944, -0.17612 for slits 1 to 5 respectively. They were used in this processing from day 266 and increased the R6/R5 ratios by 15/30 units. Furthermore after servicing of this instrument these ratios decreased by 25/15 units before the new coefficients were applied. This is believed to be due to humidity change effects to the spectrometer and/or photomultiplier tube. For #183 the SL ratios shown in first the line below are initial values with no zero temperature coefficients and the second set are final values with the new coefficients.

III. Summary of results and changes:

Instrument	#033	#157	#183	#185
SL ratios 2010 - initial -> final	2265 / 4235	345/575 -> 350/590	350/600 -> 335/600	311 / 450
SL ratios change from 2009	-5 / -40	+12 / 10	+ 15 / 40 (tc=0)	+ 1 / 10
ETC constants 2010 (chg?)	3570/3850 (-5, -60)	1600/170->1605/180	1590/100 ->1596/220	1574 / 80
ETC constants last cal 2009	3575 / 3910	1605 / 243	1610 / 250	1574 / 80
Cal step (old / new)	916 / 920	1026	1021 / 1023	284
Absorption Coeff's (change)	.3365 / 1.1362	.3397 / 1.15	.3415 / 1.146	0.3422 / 1.1495
ICF file recommended	icf26310.033	icf26310.157	icf26610.183	icf20010.185
DCF file recommended	dcf27900.033	dcf25601.157	dcf20206.183	dcf20204.185
DT present/last/setting	37 / 38 / 40	23 / 25 / 32	23 / 23 / 26	30 / 30 / 33
GS const. (change?)	n / a	.998 / -10 (n/c)	.990 / 18 (chg)	.995 / 2.5 (n/c)
CI scan on SL to 2007 scan	~+35%	+10%	-8 to -4%	+ 5 -> +3%
CZ on 2967.28A hg - , FHHB	2967.14, 6.1	2967.23, 6.3	2967.21, 6.3	2967.26, 6.3
Repairs made	ze to sl adj'd slightly	mic 2 cleaned,	new tc's, gasket	align ZE, mic 1 adj'd
New UV resp - INM lamps	uvr26510.033	uvr26610.157	uvr26510.183	uvr26610.157

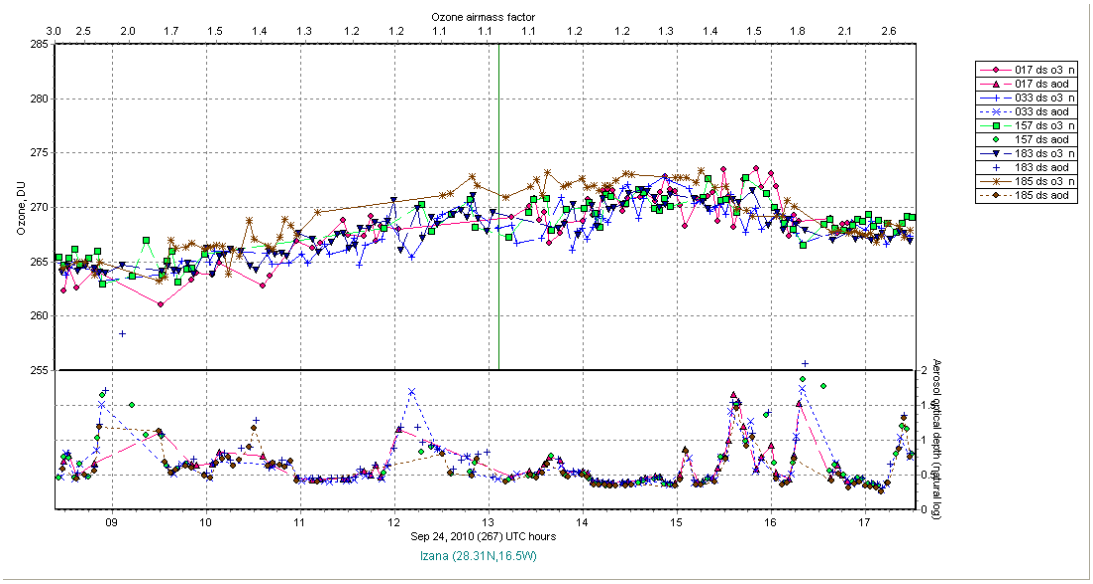
IV. Servicing and Software changes and Recommendations:

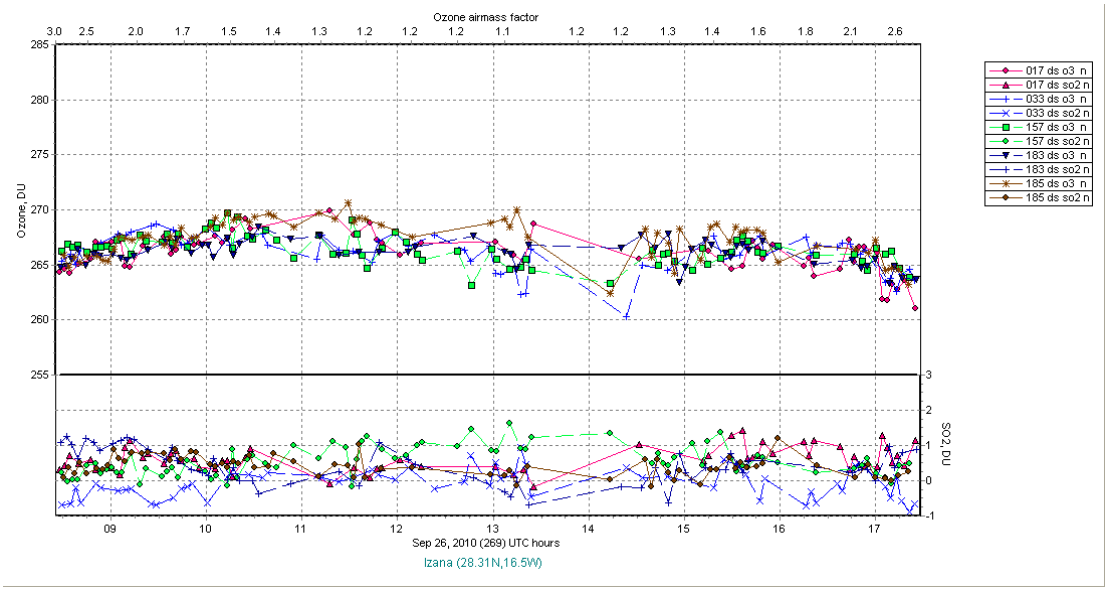
There were no serious servicing issues with any the instruments. The zenith motor was adjusted slightly on #185 and the second micrometer on #157 needed extra cleaning and lubrication due to rusting effects. The cover gasket and desiccant was replaced in #183 and then the SL ratios shifted on day 265.

The cal step shift that occurred in #033 sometime in the past year - could probably be reduced with improved focusing of the spectrometer mirror. It is assumed that this shift was caused by lamp aging and/or changing of the Hg lamp. When the Hg lamp is changed some sun scan data should be collected to determine proper cal step setting.

Instrument #185 still often provides slightly higher ozone results when the neutral density #4 is selected for direct sun measurements. It is unfortunate that improved filters have not been obtained that have proper neutral density values for this and many other Brewers.

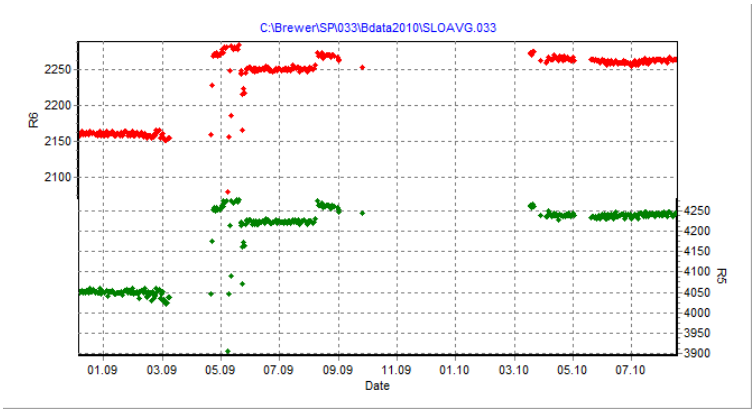
Below are the final results for Sept. 24 that also shows the AOD results using previous AOD constants. Next graph is from Sept. 26 data that includes the SO_2 results using the final ETC constants.

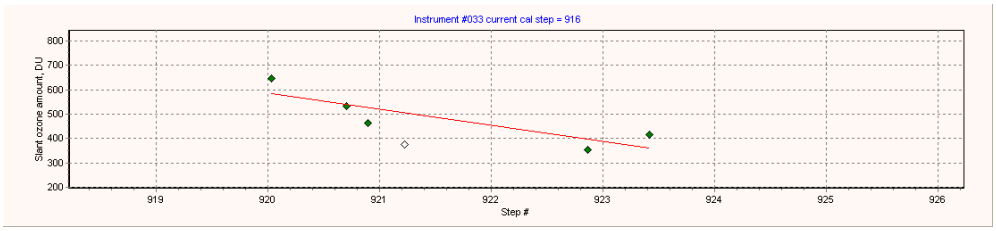


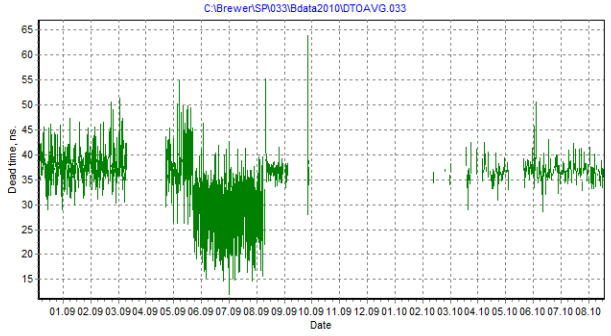


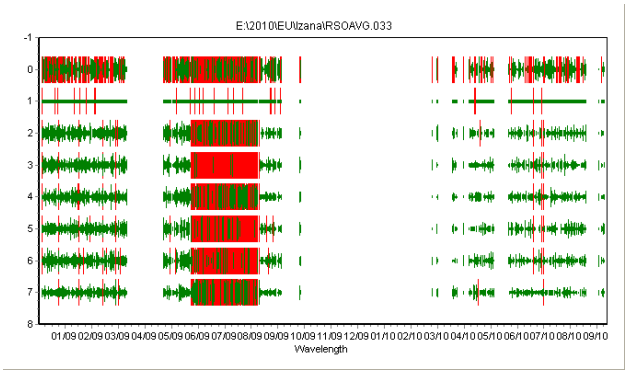
V. Graphs of SL, SC, DT, RS, CZ and CI results for the MKII Brewer #033:

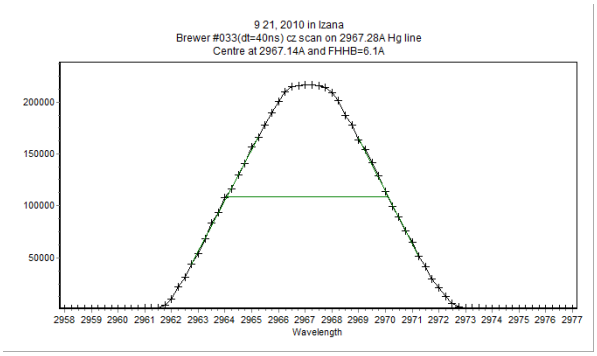
There is 5 months of data missing in the graphs below, from the last calibration (Sept./09) and then this instrument was operated in Madrid where it showed quite stable lamp test results. The initial sun scan results in first graph below showed that the cal step setting of 916 should be adjusted to 920. The last graph shows final and previous SL CI scans, note the higher intensity level now.

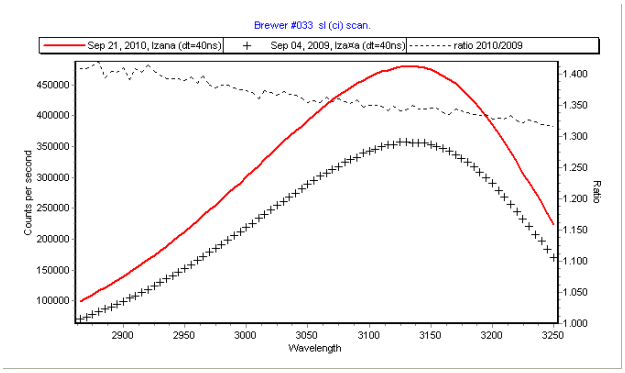






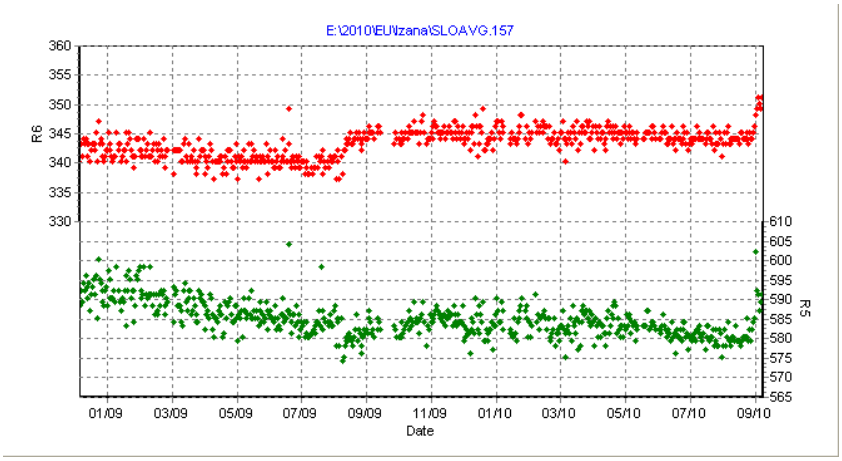


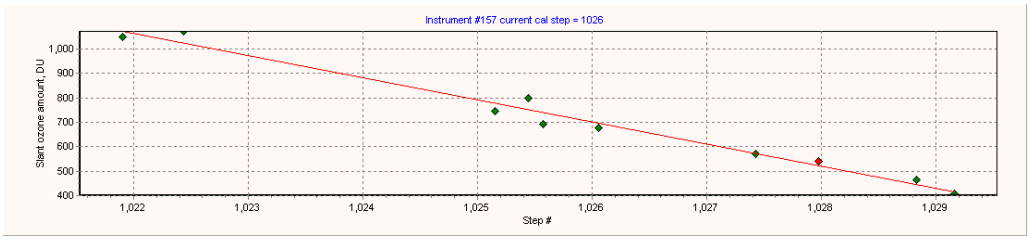


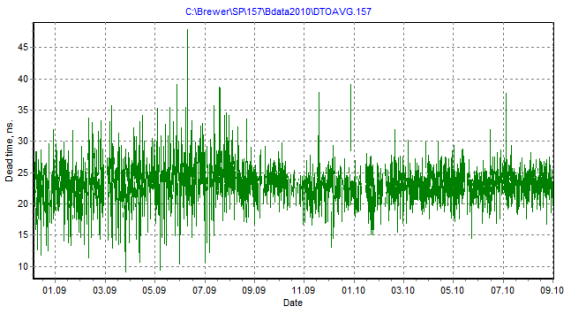


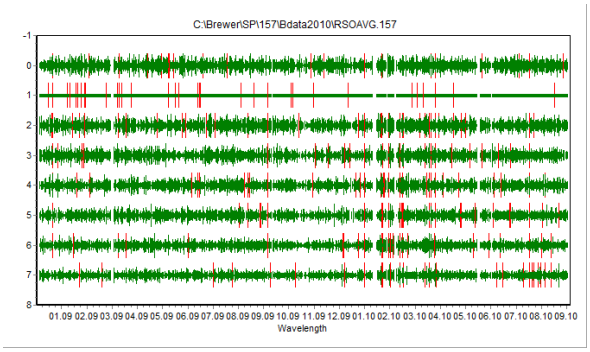
VI. Below are graphs of MKIII Brewer #157 of SL, SC, DT, RS, CZ and CI results:

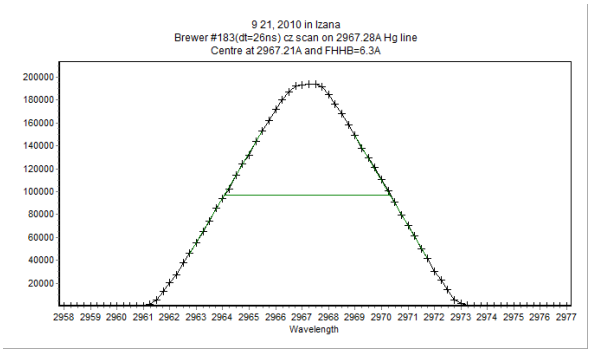
In the past year the lamp test results from #157 have continued to be quite stable but during this visit the SL ratios increased slightly and the ETC constants were adjusted accordingly. The sun scan results show cal step 1026 is still the proper position. The last graphs show the CZ scan of Hg lamp line and comparison of SL CI scans from now to last year.

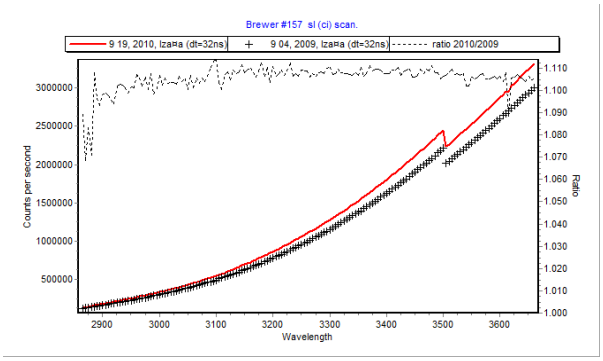






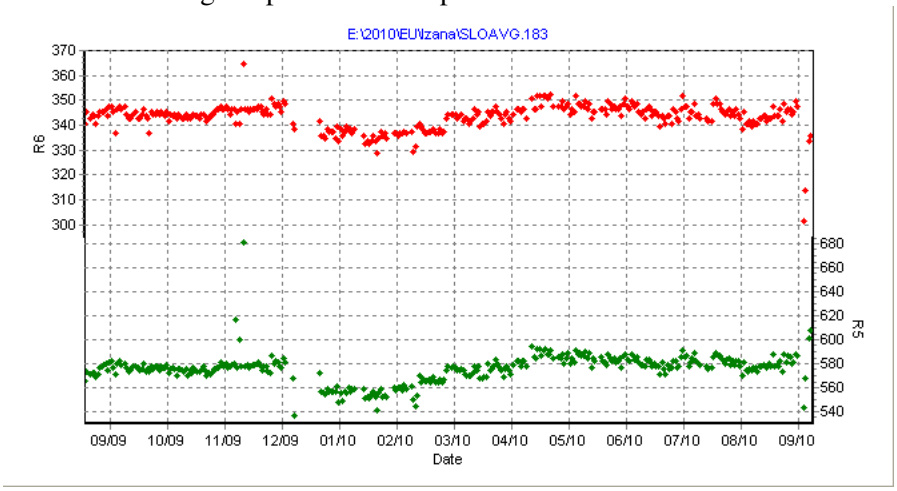


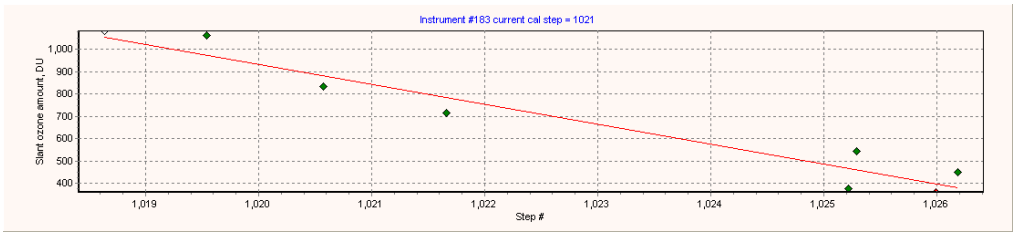


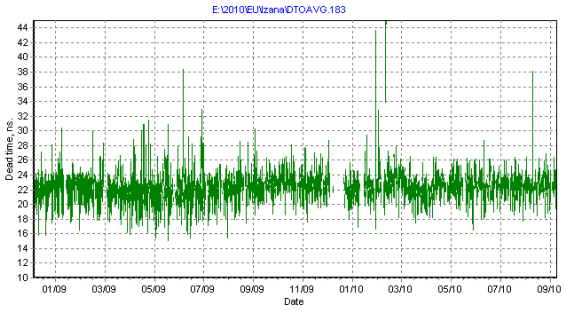


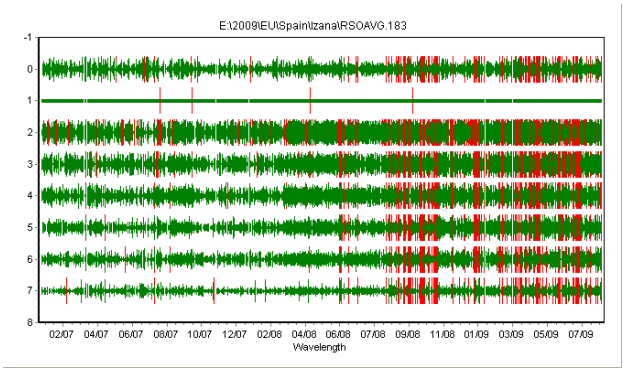
VII. Below are graphs of SL, SC, DT, RS, CZ and CI test results from the MKIII Brewer #183:

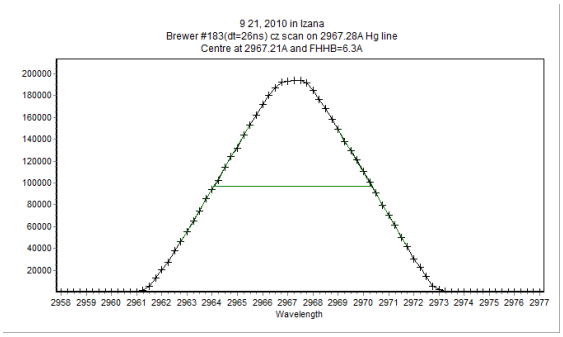
Note the more stable SL ratios and DT/RS results in the past year. It was determined that there was a slight temperature dependence in SL ratios and so revised temperature coefficients were put into. The sun scan results show that the cal step setting of 1021 should be increased to step 1023 and this was done. The last graphs show the CZ scan of Hg lamp line and comparison of SL CI scans from now to last year.

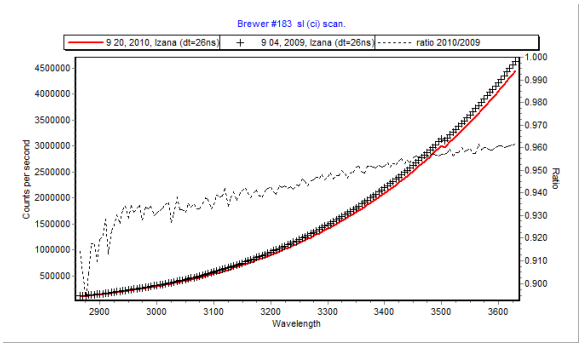












VIII. Below are graphs of SL, SC, DT, RS, CZ and CI test results from the MKIII Brewer #185:

All of the test results below show quite good stability. The instrument had traveled to El Arenosillo and Arosa in the past year. The sun scan results show cal step 284 is still the proper setting for Hg calibration tests. The next graphs of DT and RS results are normal and then the CZ scan of Hg lamp line and comparison of SL CI scans from now to last year.