Calibration Report on Brewers #033, #157, #183, #185 - Izaña, Spain - September 18-24, 2005

I. Introduction and Instrument Status:

International Ozone Services Inc. (IOS) with the help of AFC Ingenieros, S.A. completed the ozone and UV calibration and service of four INM Brewer instruments at Izaña. There is now a triad of MKIII instruments here - #157, #183 and #185, a new instrument. #185 was used here as the main calibration reference along with #017 from Canada. Both had just been at the El Arenosillo RBCC-E campaign.

The original MKIII Brewer #157 has operated well in the past years. The ozone results were high by ~1% to the reference instruments. Standard Lamp (SL) ratios R6/R5 were still at 2001 values of 338/580. The lamp had been changed twice in the past year and this makes tracking the stability more difficult.

Brewer #033, a MKII instrument has been operated at sea level in Santa Cruz during the past four years and was re-located here for this calibration. It was working well and its SL ratios had increased as shown below. The ozone results were quite good with the SL corrections to ETC constants.

Brewer #183 was working well but had endured a severe shock late last year and the SL ratios shifted as listed below. New absorption coefficients from dispersion test last year were not in use in real time but were found once again to be proper. The ozone results from #183 were quite good with SL corrections to ETC constants but were later adjusted a little less.

II. Summary of results and changes:

Instrument	#033	#157	#183	#185
SL ratios 2005	2142 / 4033	338 / 580	366 / 703	310 / 442
SL ratios change from 2004	+40 / +80	n/c but lamp chg'd	-20 / -50	0 / 0
ETC constants 2005 (chg?)	3440/3650 (+50/75)	1605/243 (+21/33)	1640/335 (-10/-35)	1574 / 80
ETC constants last cal	3390 / 3575	1584 / 210	1650 / 370	1587 / 134
Cal step (change?)	921 -> 919	1027 -> 1026	285 (n/c)	284 (n/c)
Absorption Coeff's	.3365/1.1362	.3397/1.15	.3405/1.146	.3410/1.1445 new
ICF file recommended	icf26505.033	icf26305.157	icf26205.183	icf25905.185
DCF file recommended	Dcf27900.033	dcf25601.157	dcf26004.183	dcf26405.185
DT present/last/setting	40 / 40 / 40	33 / 32 / 32	22 / 26 / 26	31 / 32 / 33
GS const. (change?)	n/a	.998, -10 (n/c)	.9928/8 (new)	.995 / 2.5 (n/c)
CI with SL	+30% to 25403	- 8% to 25403	-20% ->~ +6%	n/a
CZ on 2967 / 3341 Hg lines	ok, .62nm	ok, .63nm/.57nm	ok, .61nm/.55nm	ok, .63nm/.56nm
Repairs made	siting switches	tracker ac plug	tracker fixed	n/c
New UV response	uvr26405.033	uvr15305.157	uvr26405.183	uvr26605.185

III. Final ETC constants and Ozone Test Results:

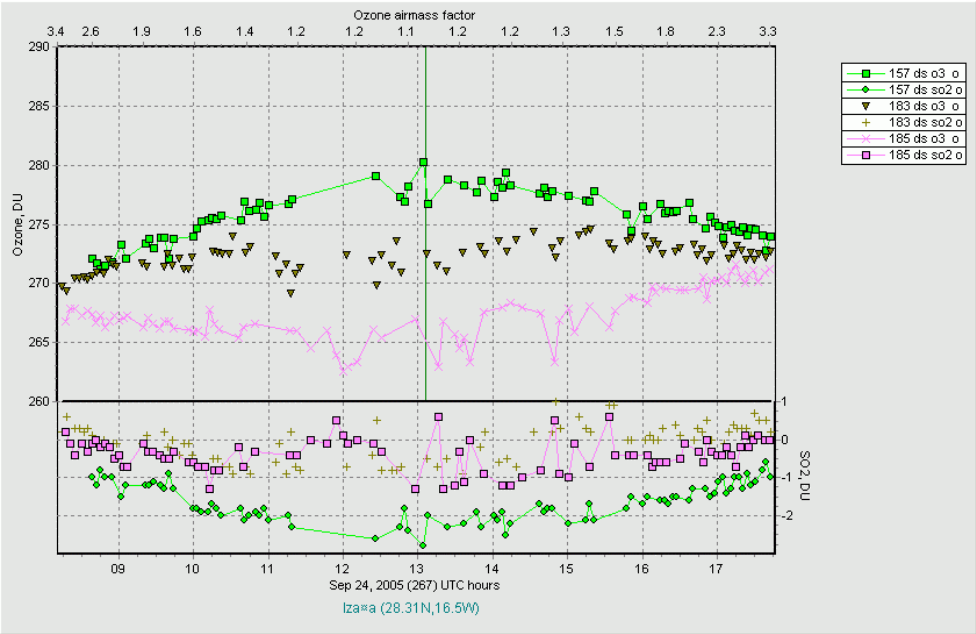
The weather co-operated very well for the 6 days and many direct sun observations (up to 100/day) as well as many simultaneous UV scans were collected.

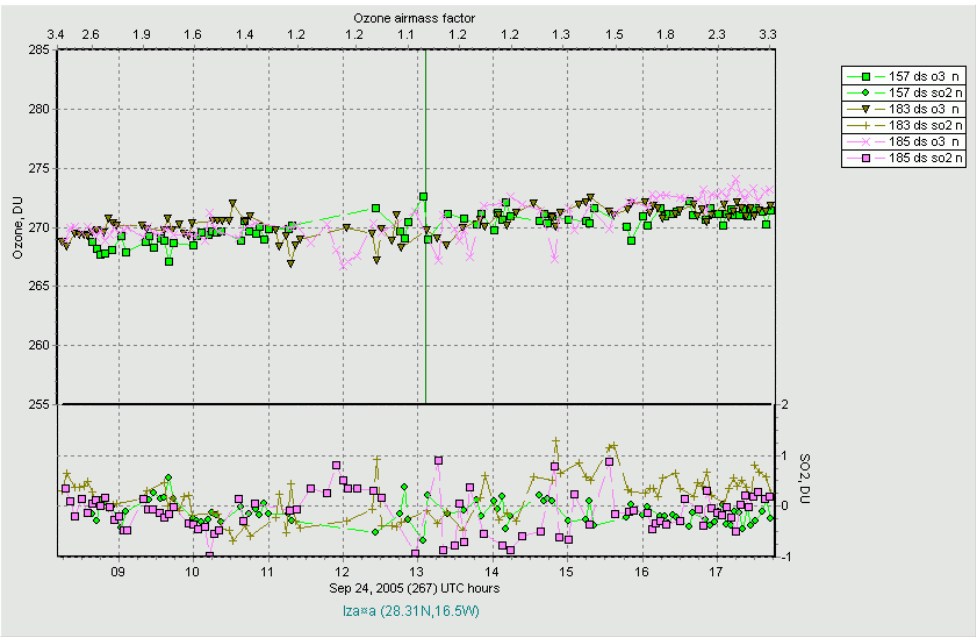
For #185, the ETC constants of 1574/80 were established by IOS mainly after analysis of some summer day files from Izaña. There are many days of stable ozone but it would have been better if more direct sun measurements were taken each day. The factory calibration from 2004 was poor due to limited airmass range. The ETC constants from this September calibration period averaged 1563/40. The measurements using neutral density (n.d.) filter #4 are limited and noisy due to lower intensity. It is most noticeable in the SO_2 results. This filter or #3 or all should be replaced to reduce filter oscillation periods when doing DS measurements.

The traveling standard #017 had to have its photomultiplier tube replaced in El Arenosillo in early September and it was re-calibrated against #185 and #145 from Canada. With this Izaña data the constants were refined to absorption coefficients to 0.338/1.13 and ETC's to values of 3240/3260. It will be checked more extensively next spring versus the MSC triad and #145 when conditions are satisfactory.

For #157, the ETC constants of 1605/243 were established using the same methods as #185 above and its data normally has much less noise.

For #183, the ETC constants of 1640/335 were finalized by comparison to #185 and #157. The tracker operation is suspected to have been affecting the ozone data sometimes. This instrument has the same noise problem as #185 when n.d. filter #4 is selected. It is especially noticeable in the SO_2 results, see below the results for September 24 with original and final constants. Note the good ozone agreement throughout the day in the second graph.

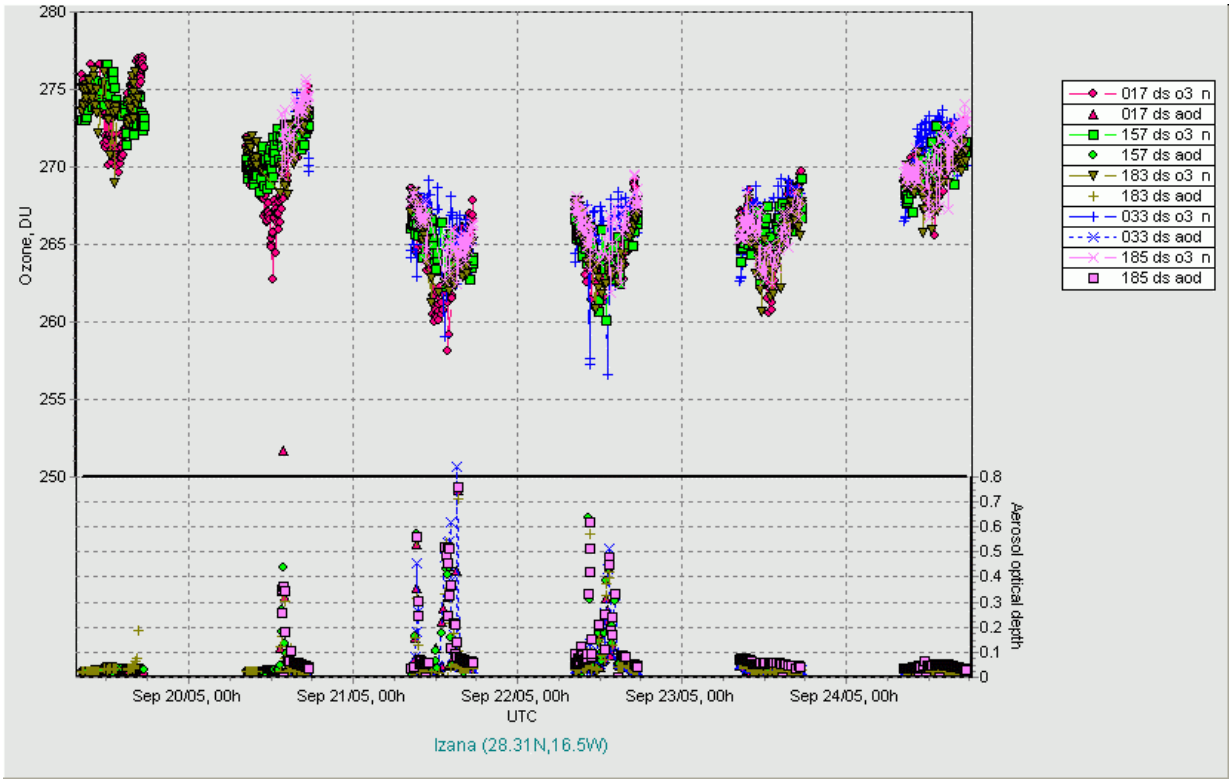




Recommendations:

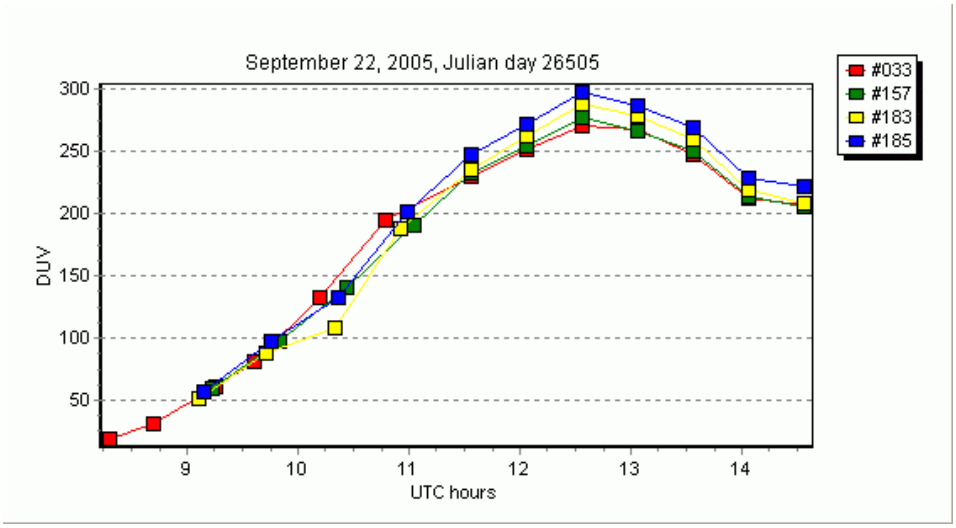
Evaluate the neutral density filters on #183 and #185 and replace some or all if necessary. The use of the higher filter when oscillation is encountered can be controlled by a setting in the V376 software. Some FI tests needs to be completed when this routine is fixed for new electronics instruments. More direct sun measurements should be programmed into schedules next year routinely to confirm ETC constants with improved Langley plots.

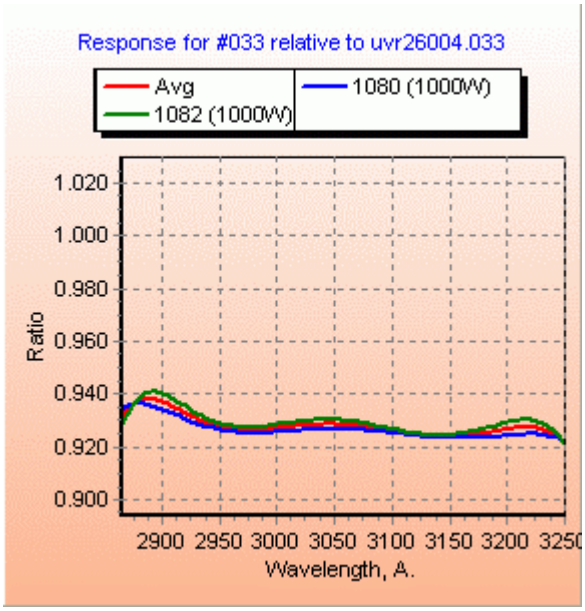
Below are the final ozone results of the ozone comparison data collected, using the recommended constants listed on page 1. Note the quite stable ozone levels and low aerosol optical depth (AOD) results on most days.

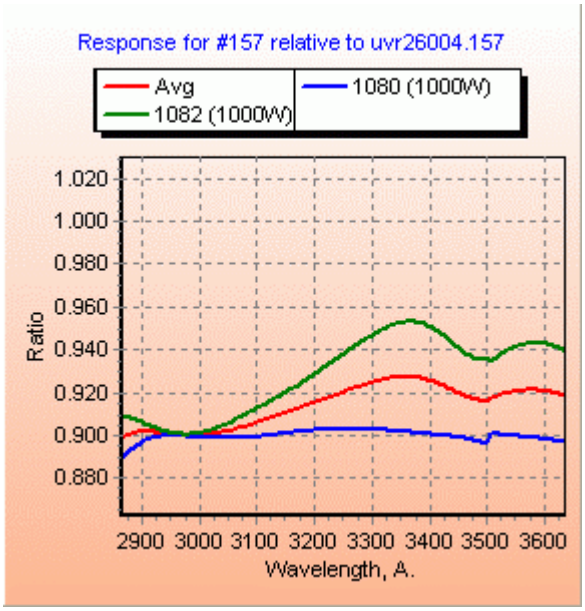


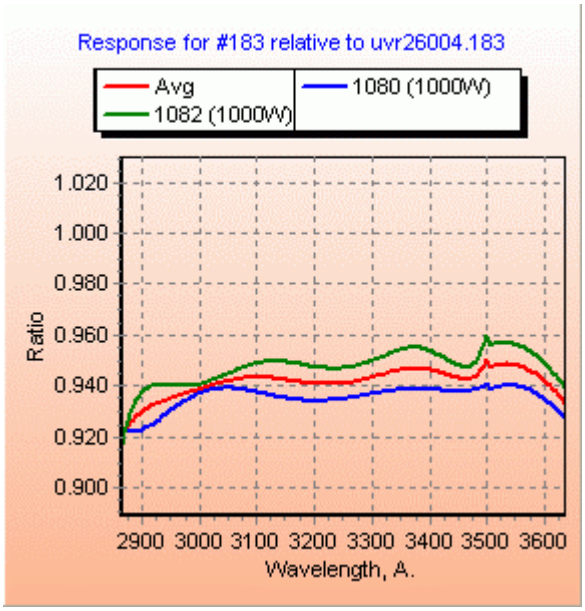
IV. UV calibration results:

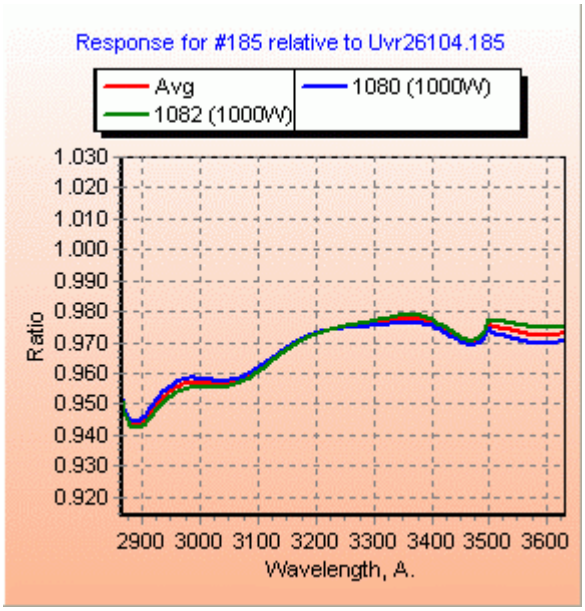
Two local 1000w lamps (1080, 1082) were used this year for UV calibrations and the new response results were calculated and compared to response files from 2004. The new response files for #033 was ~7% lower while #183 – was ~5% lower than 2004 files as shown on next page. The data from lamp 1082 on #157 was poor with strange change on this day (264) as shown. The data from day 153 produced better results and was 9% lower than 2004 file. In the graph below of real time DUV results from day 265, note the slightly lower values from the other instruments compared to #185, using its factory calibration. The other 3 instruments were using their 2004 response files from these same lamps. The customer advised that the UV instability of #183 reported last year is now believed to be due to poor cosine response of the diffuser configuration.











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. #183 was using its original dispersion from 2002. The 2004 file (dcf26004), that had been recommended last year was installed during this visit since the 2005 file was very similar. Results for #033 and #157 compared well to previous results. It is recommended that the new file (dcf26405) for #185 be put into use since it is believed improved accuracy would be achieved between 3350-3500. This is due to the use of 3499 Cd line in the IOS process while the factory method does not.

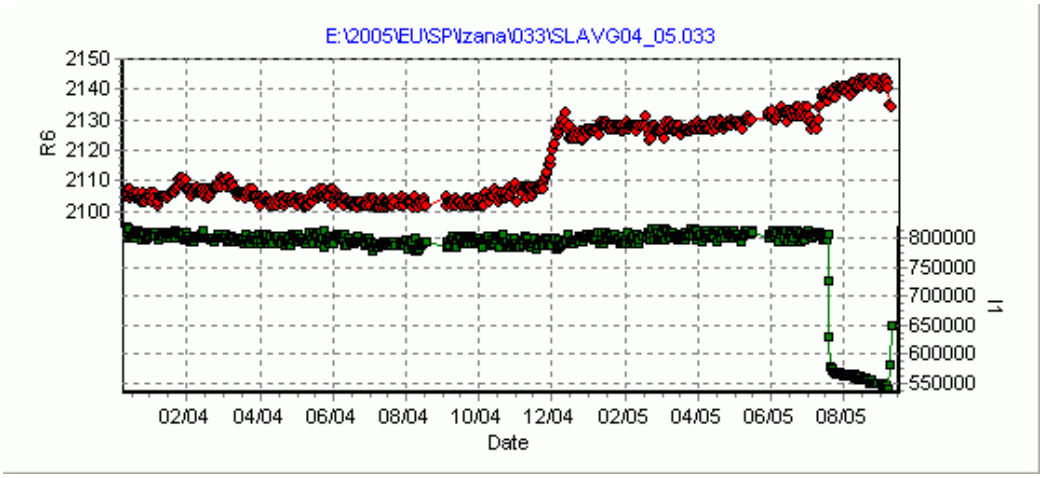
V. Servicing and Software changes:

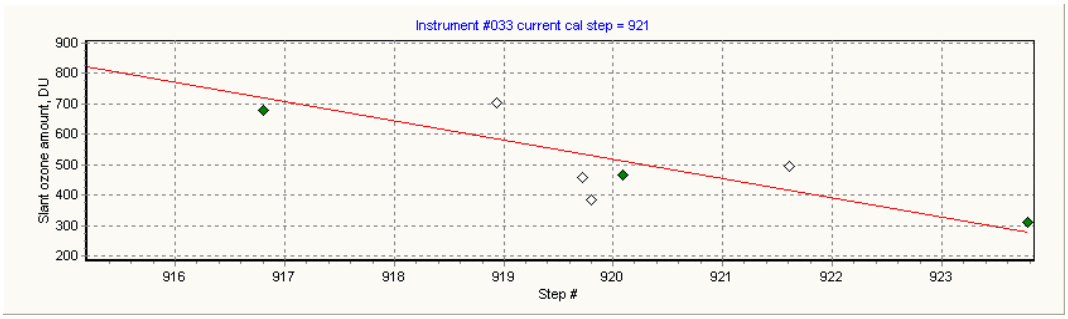
Cleaning and lubrication as required was done to micrometer gears and pushrod bearings. The shock mount seals on all instruments were found to be good. The center spindle of the tracker of #183 was replaced the first day and this improved tracking greatly. The most recent software control programs (V376 from IOS) were installed but some failures were encountered, and so only #183 was left using this software that provides real time AOD results.

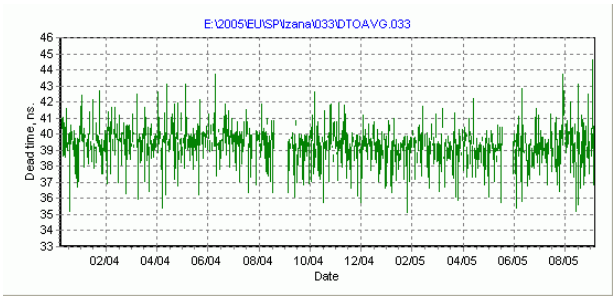
VI. Izaña Brewers report 2005 Graphs:

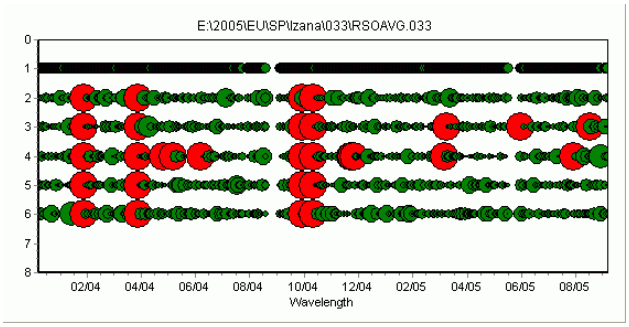
Below are the MKII #033 graphs of SL ratios, SC, DT, RS, CZ, CI test results.

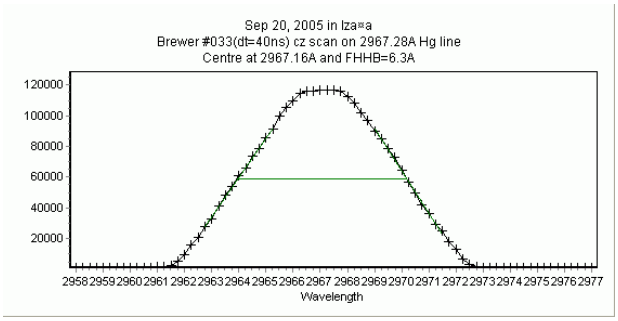
Note the shift in SL ratio R6 that indicates the ETC constants should be adjusted to correct ozone results. The lamp was changed recently and intensity dropped and so the power was increased to the lamp so that the intensity F1 is now ~650K counts. The sun scan results show the proper cal step is now 919 from 921. The other tests have remained stable and normal.

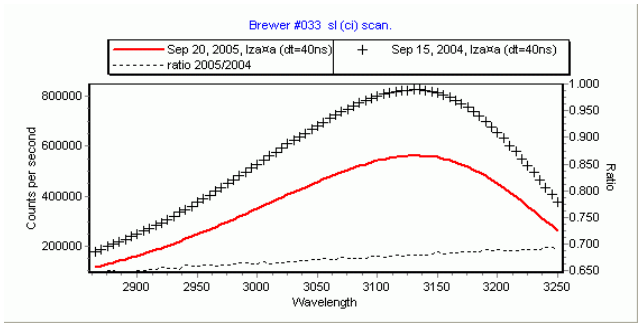






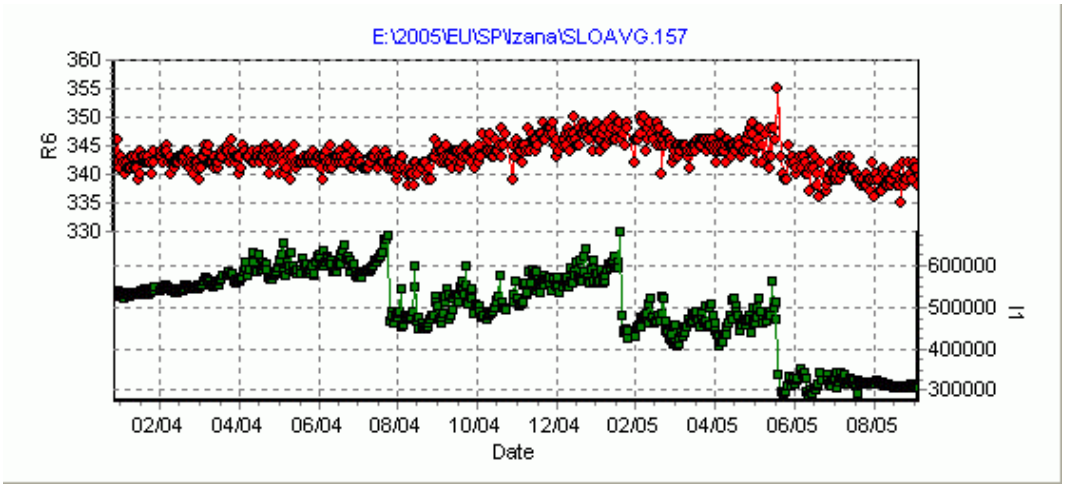


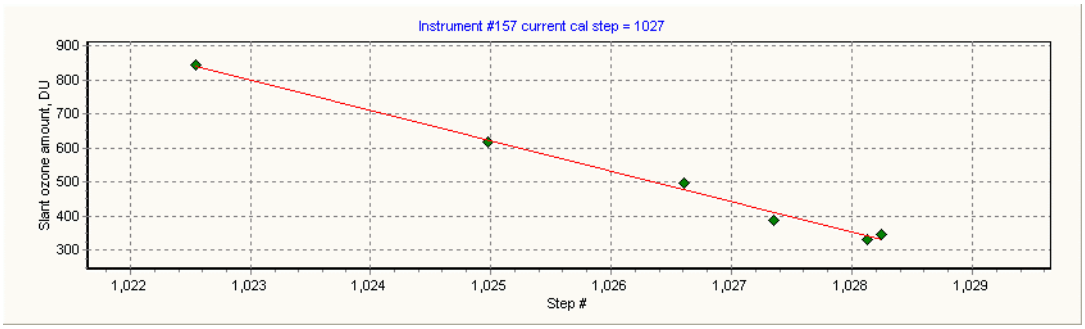


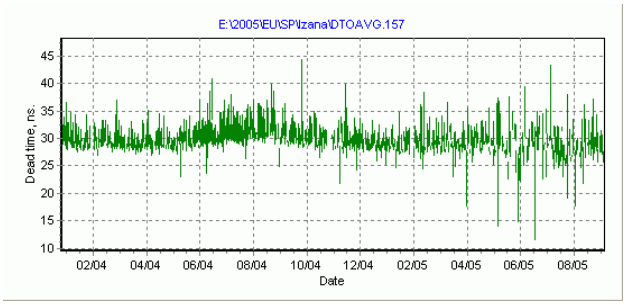


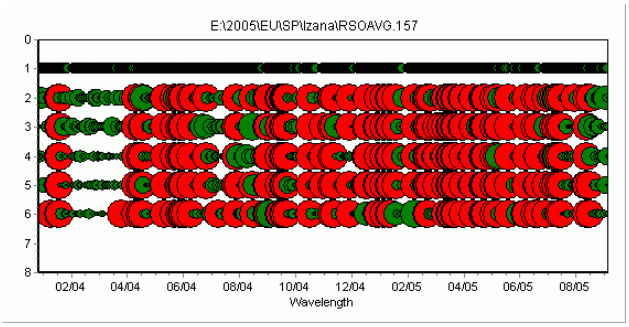
Below are graphs of MKIII Brewer #157 of the SL, SC, DT, RS, CZ results.

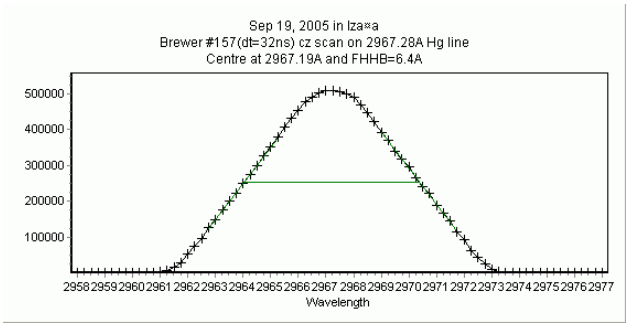
The shifts in intensity F1 in SLOAVG file below are when lamp was changed. The sun scan results show cal step 1026 is best position. The other tests have continued to be stable and normal.

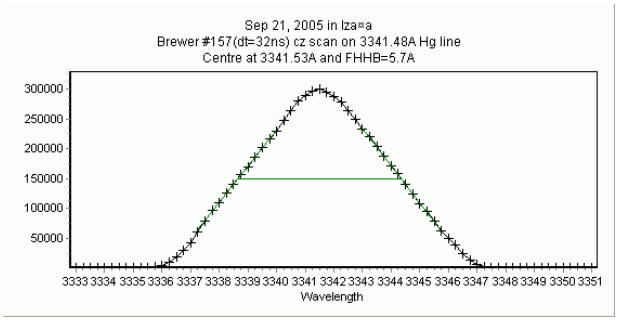






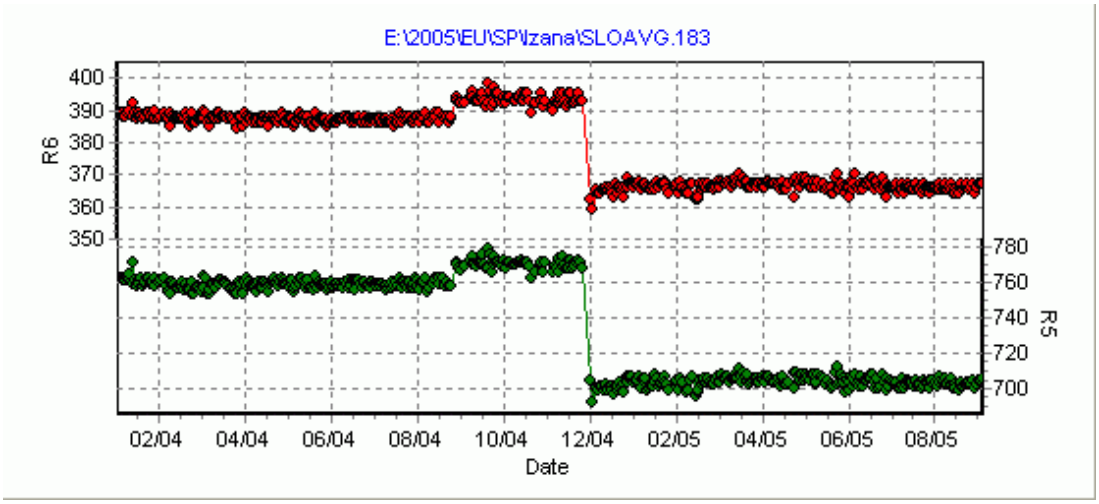


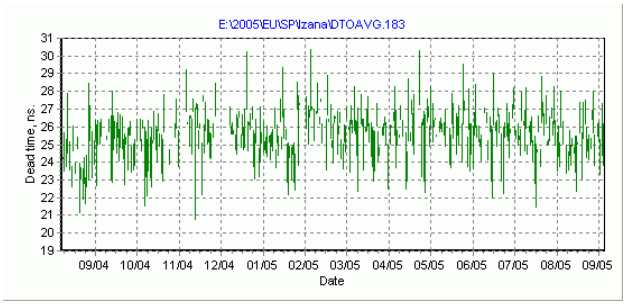


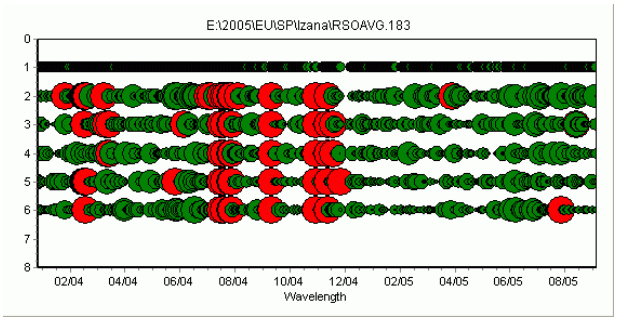


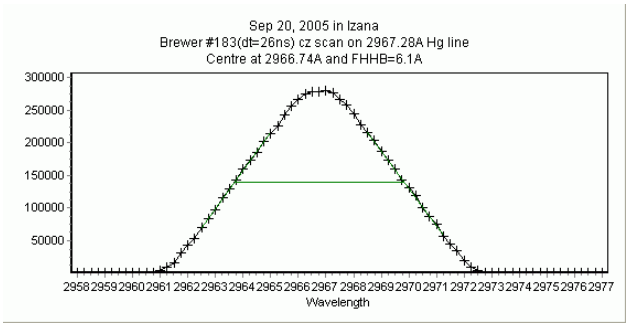
Below are graphs of SL, SC, DT, RS, and CZ test results from the MKIII Brewer #183.

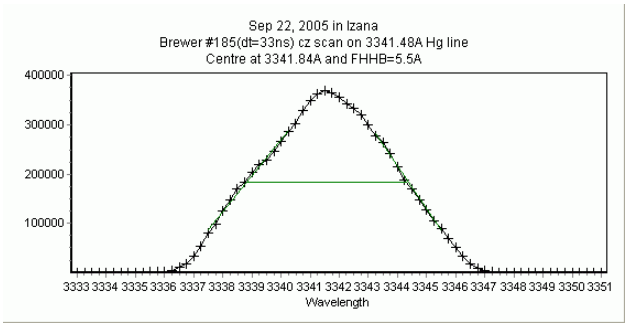
Note the shift in SL ratios late last year due to shock. This shock did not affect performance or other tests and note the RS tests improved slightly. The sun scan results show cal step 285 is still proper and the CZ scans are still normal and the same as last year.











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

All show quite good stability or are normal except for bump on left side of CZ 3341 scan which was unusual and showed up on #183 as well.