Environnement et Changement climatique Canada
Environment and Climate Change Canada

Slope and Intercept Determination for the Brewer MKIII Spectrometer

The Canadian Brewer Spectrometer Network

Réseau Canadian de spectrophotometric – Brewer

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Version 1.1

Canada

Slope and intercept determination SOP for the BREWER MKIII SPECTROMETER

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Slope and Intercept Determination

The Slope and Intercept values describe a relation of the bottom micrometer step movement to the top micrometer step movement. The top micrometer movement per wavelength is determined by the dispersion file in use by the instrument.

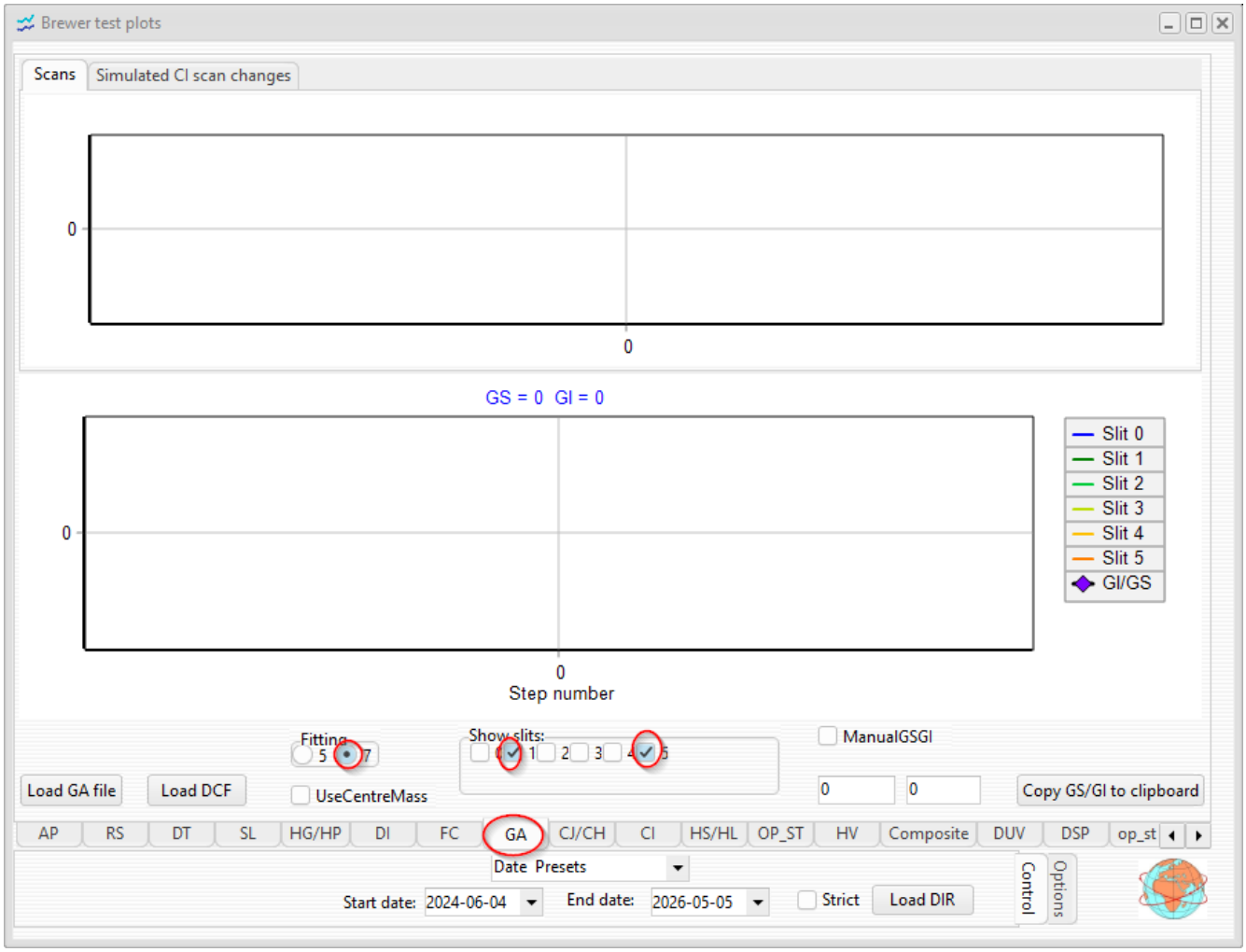
Note: Environment and Climate Change Canada (ECCC) currently uses Brewer Test Plots program (GA tab) to process a series of GA files, complete with the dispersion in use to collect an average Slope and intercept value. Only if the Slope or intercept value has changed significantly is any change applied. Brewer Test Plots is a software created by International Ozone Services (IOS) Inc. ECCC has access to Brewer Test Plots via a license from IOS Inc.

Collecting data to determine Slope and Intercept

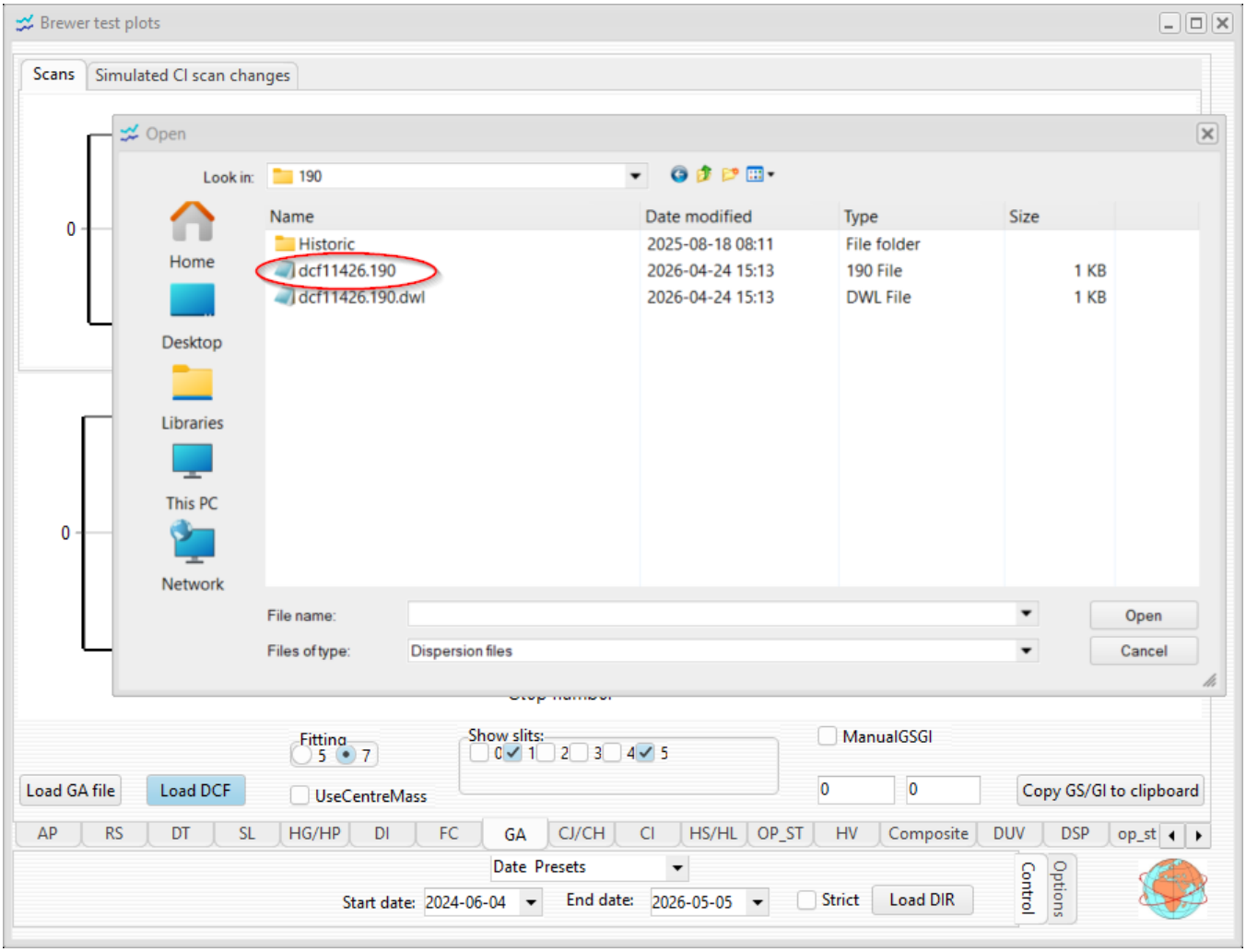
The schedule in use by the Brewer instrument must include GA measurements throughout the day or at least periodically throughout each week to provide data for review.

Process multiple GA files to determine Slope and Intercept.

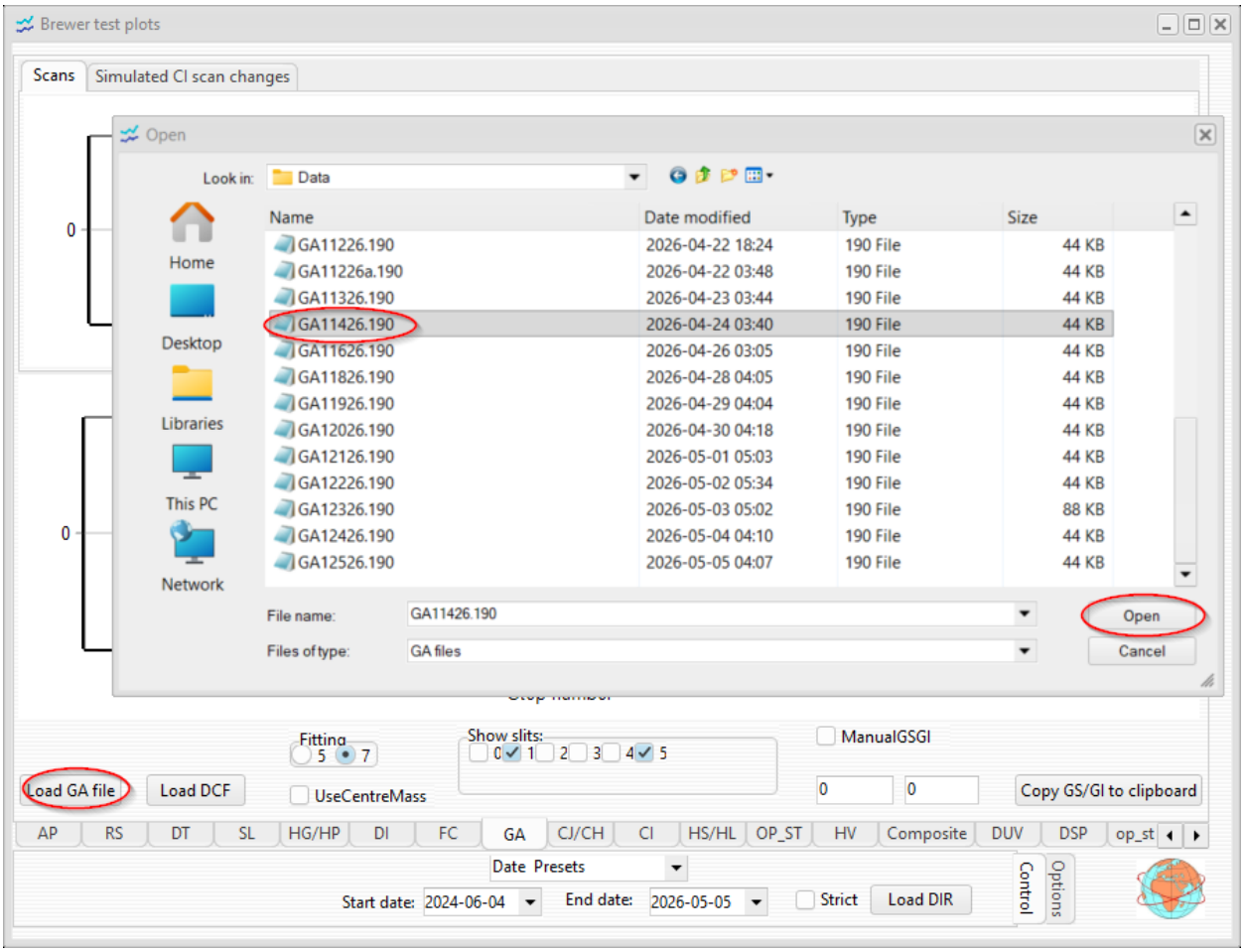
1. Open Brewer Test Plots and select the GA tab and check slits 1 and 5 and select a 7-position fitting.



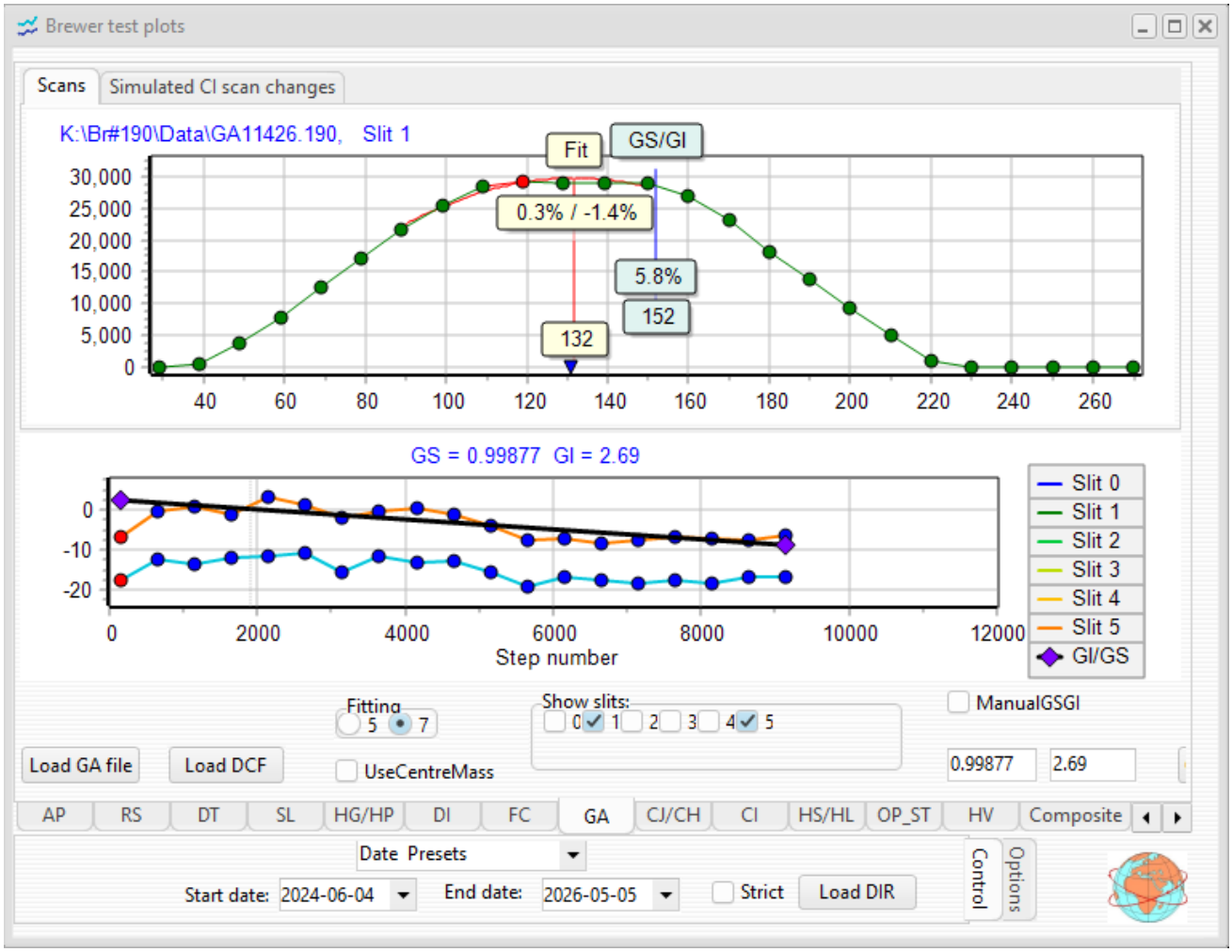
2. Select the dispersion in use while the GA measurements were taken for the instrument you are interested in.



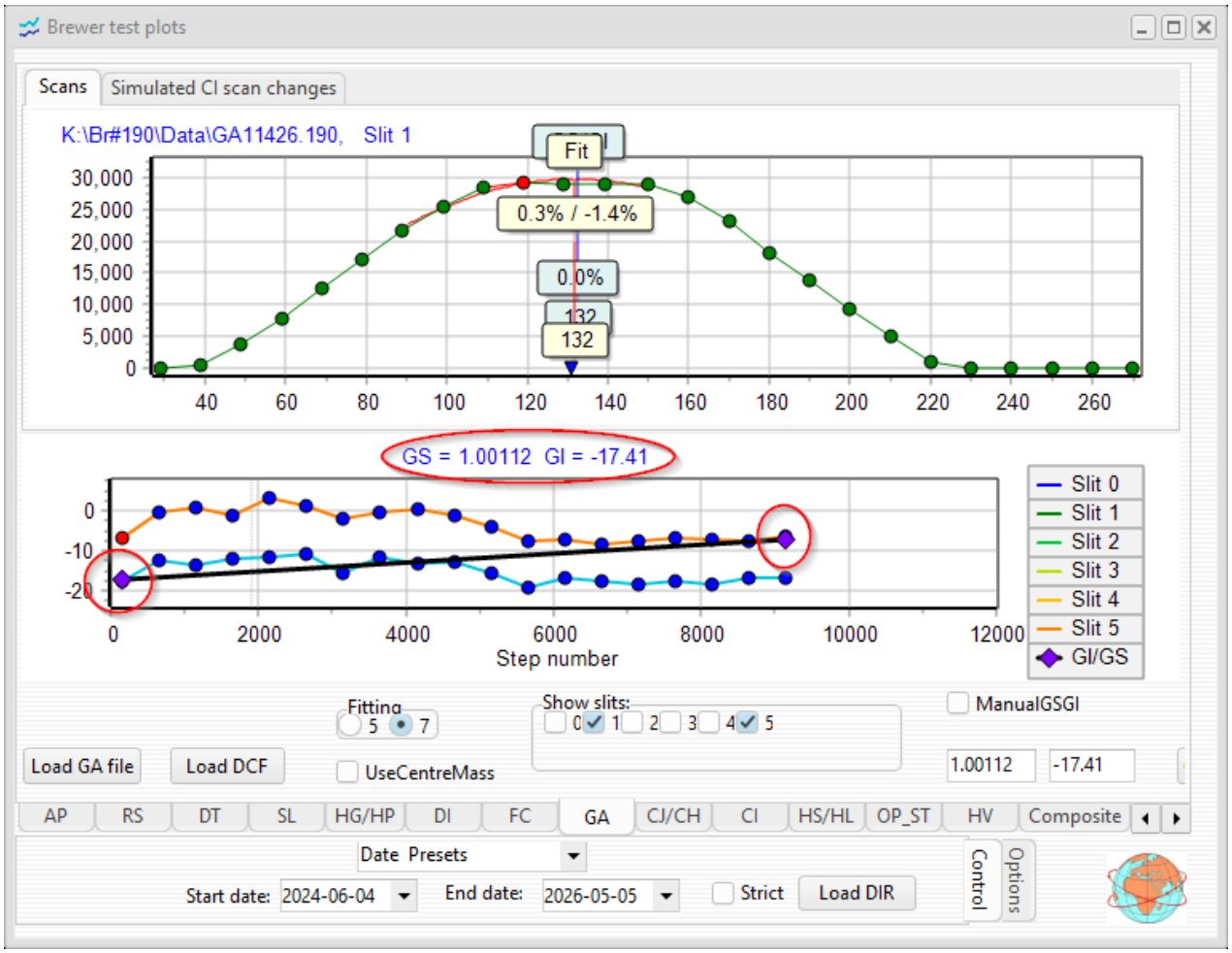
3. You will now open a series of GA files and determine the best Slope and intercept for each. Select the first file for Processing.



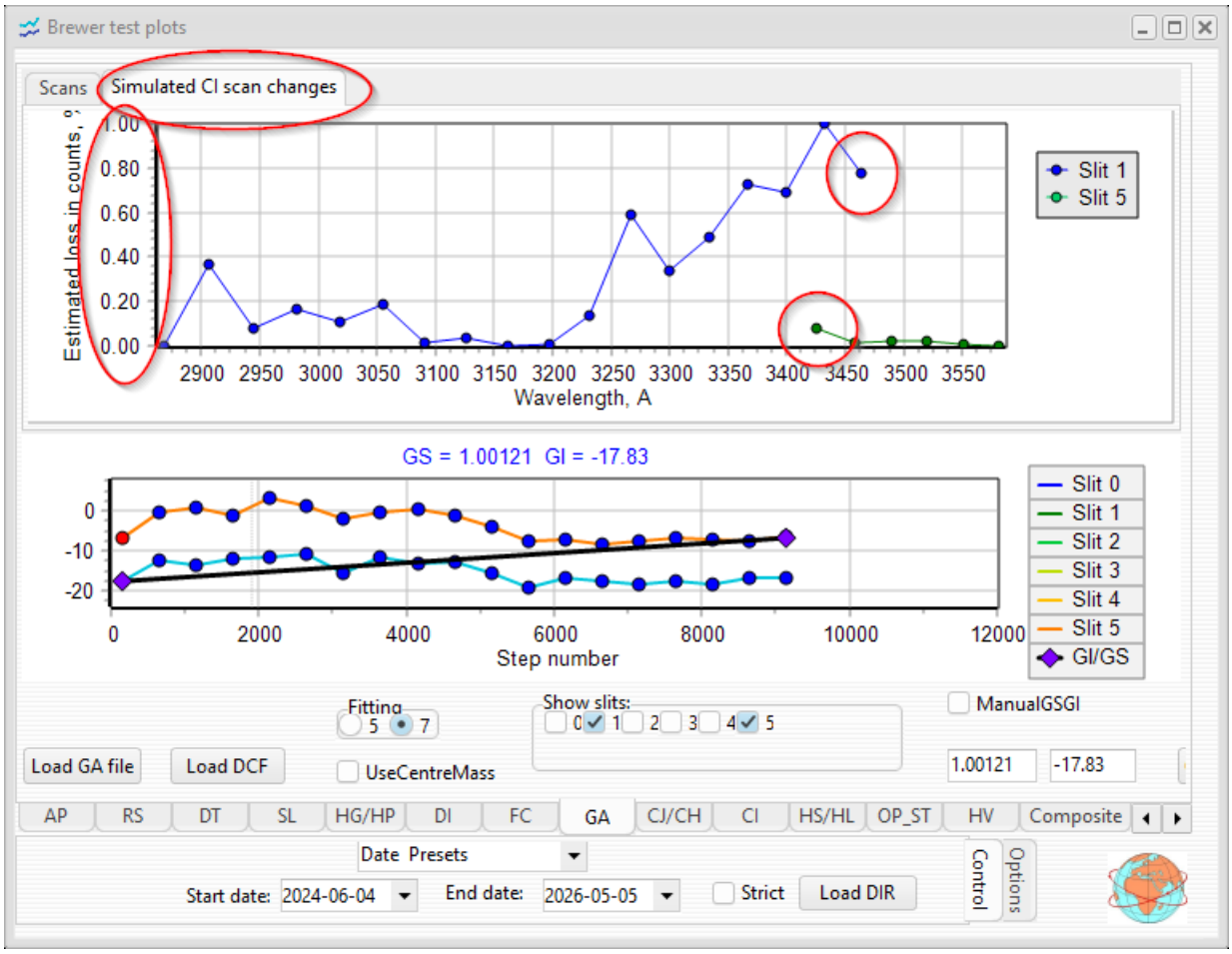
The software will show the Slope and intercept for both slit 1 and slit 5. Ideally, we want the slope and intercept values to agree best at the lowest wavelengths with slit 1 and agree best at the highest wavelengths at slit 5. Initially the plot may look like this:



The black Line on the plot can adjust the slope and intercept values which in turn affect signal throughput.

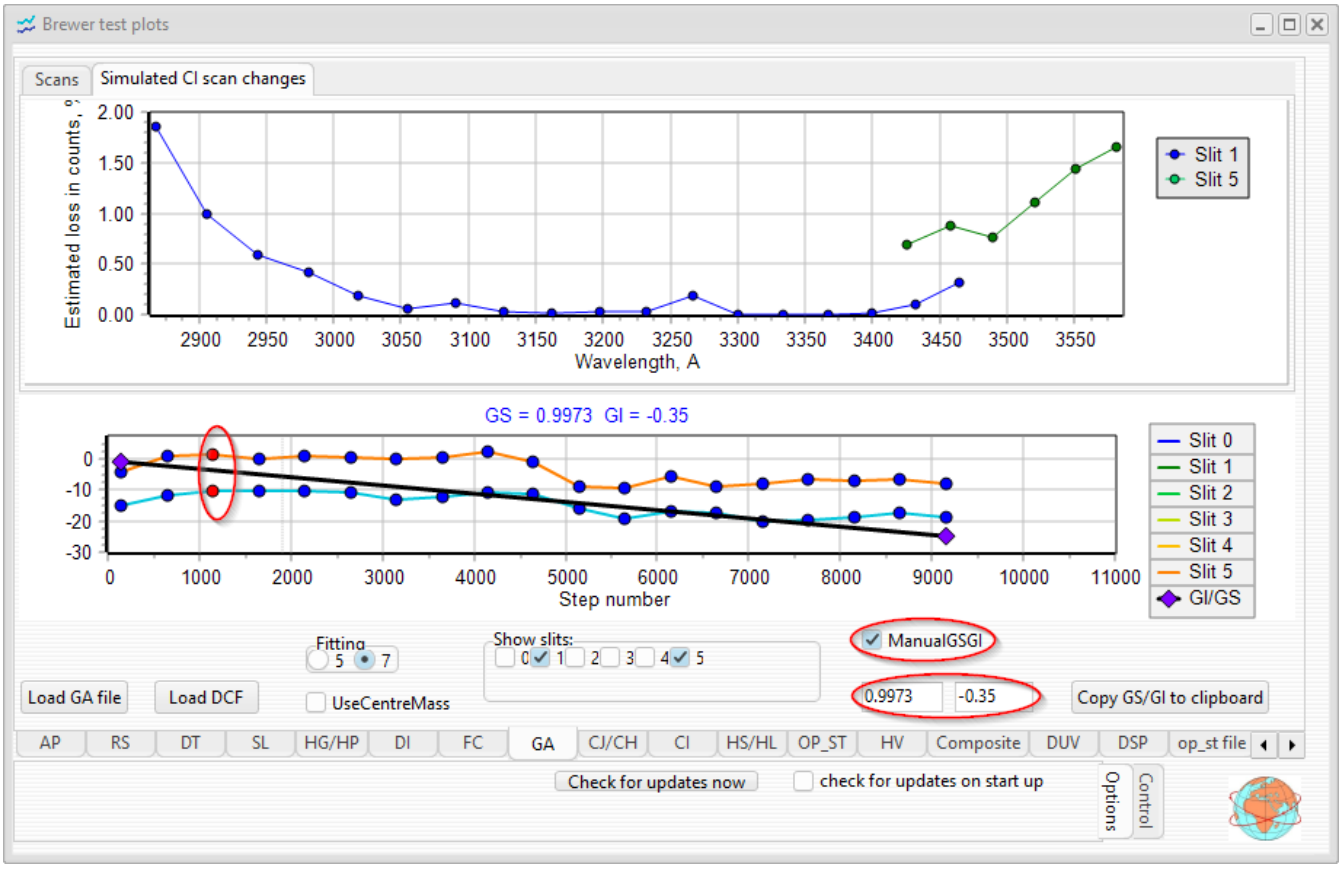


4. Now select the Simulated CI scan change tab.



This will indicate the percentage loss in counts due to the slope and intercept selected for the bottom micrometer. It also shows on the graph the throughput for slit one in blue and slit 5 in green. Please note, the smallest wavelengths have the weakest signal. Losses at this end are more important than losses at the highest wavelengths. Also note the change in signal when the instrument switches from slit 1 measurements below 350 nm (3500 A) and slit 5 measurements above 350nm. Though calculations can be made with a large deviation at this switch point, it has been standard practice to minimize the deviation in counts.

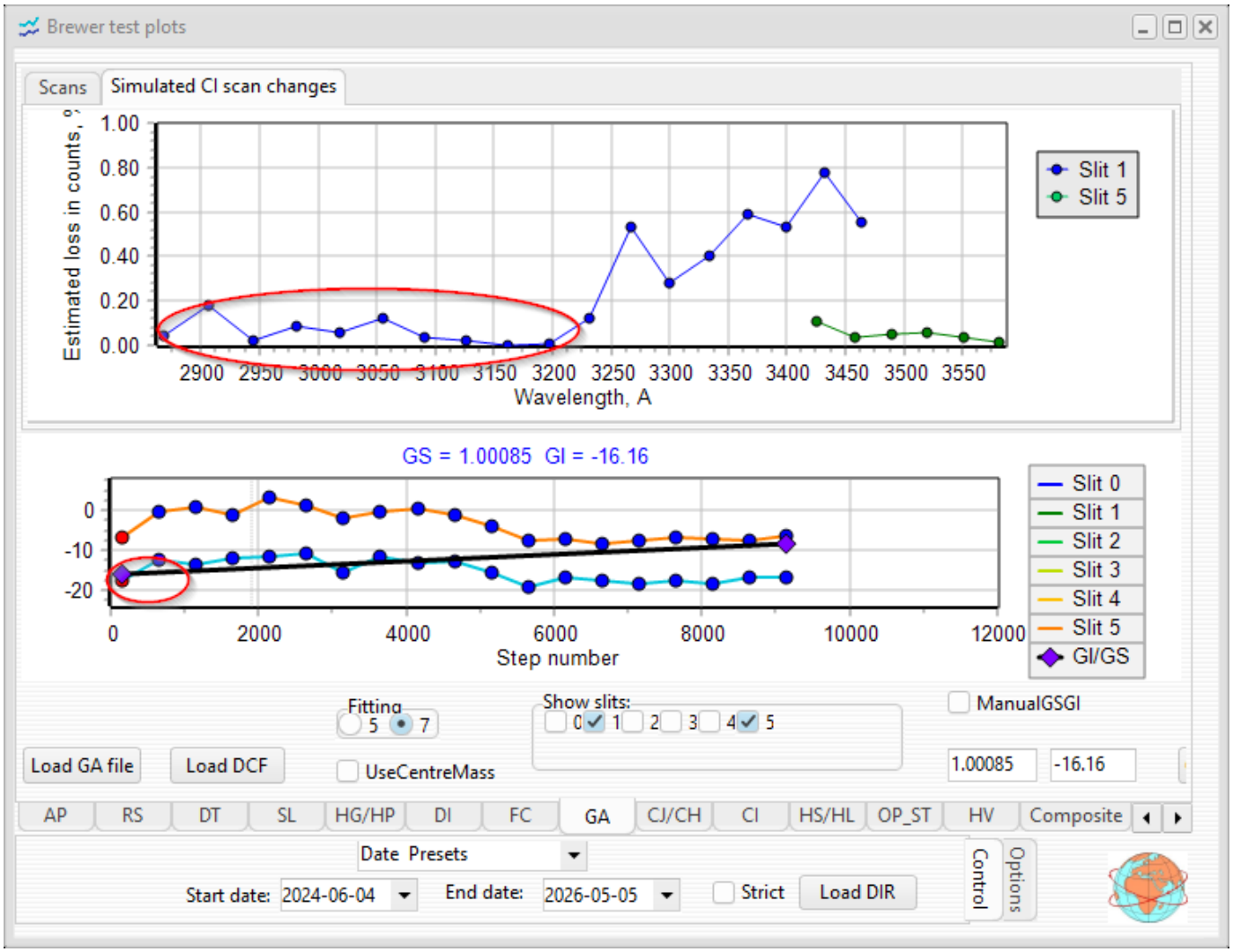
5. Another tool that can be used to determine the effect of the slope and intercept in use, is to manually insert slope and intercept values, and with the ManualGSGI button checked, click a slit 1 or slit 5 points on the graph. That will indicate the losses seen on that GS scan.



In this example, the near 2% loss at the lowest wavelengths is not critical but is concerning, and as seen by our results, can be improved. The losses at the highest wavelengths are of a lesser concern, due to the large signal seen in this area.

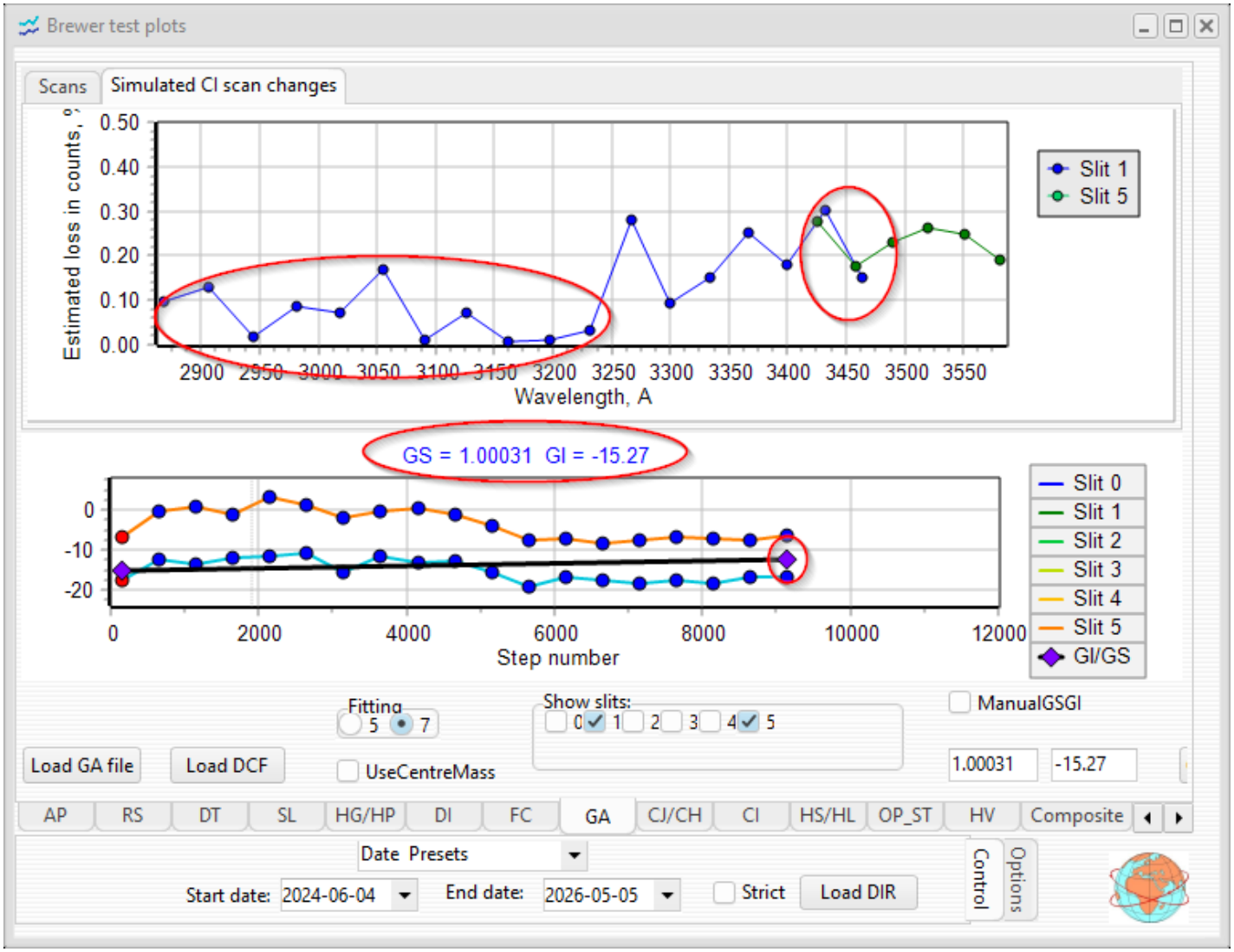
Incorrect Slope and intercept values will reduce overall throughput but also can affect the stability of various scanned measurements, such as the CJ scan.

6. Uncheck the ManualGSGI button. To minimize losses at the lowest wavelengths and reduce the amplitude between the slit 1 measurements the black line in the lower graph can be manipulated primarily from the left end of the black line.



In this case the left side of the black line was lowered slightly. Notice the effect. The percent loss in counts went from 0.2 – 0.4 % to 0.1-0.2%

7. To lower losses at the highest wavelengths and reduce the amplitude between the end of the slit one measurement and the start of the slit 5 measurement, the black line in the lower graph can be manipulated primarily from the right end of the black line with minor adjustments on the left end to maximize the throughput of the signal.



In this case, losses at the lowest wavelengths remain under 0.2% signal loss, while the overall loss is below 0.3%. This is an exceptional instrument. The loss value is somewhat dependant on how well the top and bottom mirror alignment agree with each other and if there are some slight differences in alignment the losses can be 1-2% (or slightly more) but still be acceptable.

8. Note the GS/GI (Grating Slope and Grating Intercept) values circled. These are the values we are interested in. Since these scans will not produce an identical response every time, we will process several GS files and record and average the results.
   Insert the values determined in a table to determine the average slope and intercept, the percent differences from previously used settings and record if the new values should be applied or not.

Grating Scan Test Table

9. The easiest way to table the grating scan results would be in an Excel spreadsheet, as depicted below.

Grating Scan Test - Brewer #190				
Grating Scans				
Analysis software:		Brewer Test Plots		
	File Date	Slope	Intercept	Maximum Estimated % Loss in Counts over Measurement Range
Original values		0.99730	-3.50	1.89
New values	GA11426.190	1.00031	-15.27	0.30
	GA11626.190	0.99974	-11.29	0.60
	GA11826.190	1.00000	-14.84	0.30
	GA11926.190	1.00033	-14.70	0.50
	GA12026.190	1.00029	-14.03	0.60
	GA12126.190	0.99987	-11.51	0.50
	GA12226.190	0.99985	-11.47	0.50
	GA12326.190	0.99995	-10.36	1.00
	GA12426.190	0.99982	-12.31	0.40
	GA12526.190	1.00063	-18.39	0.40
	GA13422.206	1.00000	-12.82	0.60
Mean values		1.00007	-13.36	0.52
% diff from previous		0.3%	282%	1.37%
Constants file updated?			Y	

The main determination to whether a slope and intercept should be applied are provided by the differences noted from the last calibration. In this case the slope is only 0.3% different to that was previously in use. If that was the only factor, the Slope/Intercept values would not be changed. Similarly, and of less importance, the throughput being increased by 1.37% also would not be enough to warrant changing the original values. The main consideration in this case is the change in intercept of over 280%. This substantial change warrants a change of both the slope and intercept.

If it is determined that the Slope and Intercept have changed since the last calibration and is to be applied, these values would be included into the instrument ICF file.