

Overview of Weighted Averaging Program

Version 1d allows the implementation of weighted averaging into the Master System. The weighting procedure was selected from several types methods used to reduce noise, that were tested and which are reported in the article on weighted averaging which is available on our website. Since the article discusses the approach and methods in depth, this overview will address issues that may arise during the actual utilization of the process by users of the MASTER System.

Master_v1d .exe is the executable that should be used to collect data, while Demo_v1d.exe should be used to review .cnt datafiles that have been previously saved.

Choose "Load Protocol" from the Demo_v1d "Main" screen. The pa1 parameters now have their own screen. Choose "continue" to go to the pa2 screen. In addition to the recording parameters available in the last version of the program, there is now an additional section called "Averaging". The User can select "normal averaging" or "Weighted Averaging". If "Weighted Averaging" is selected then the user must decide what frequency range will be used in the generation of the noise estimate. In our paper we used a frequency range of 70-110 Hz and so this is the setting shown here. Our ASSRs occur at rates of between 80 and 100 in the experiments that were examined in the paper. If a user is testing ASSRs in the 40-50 Hz range or the 160-200 Hz range, then a different frequency range can be evaluated by changing the filter accordingly.

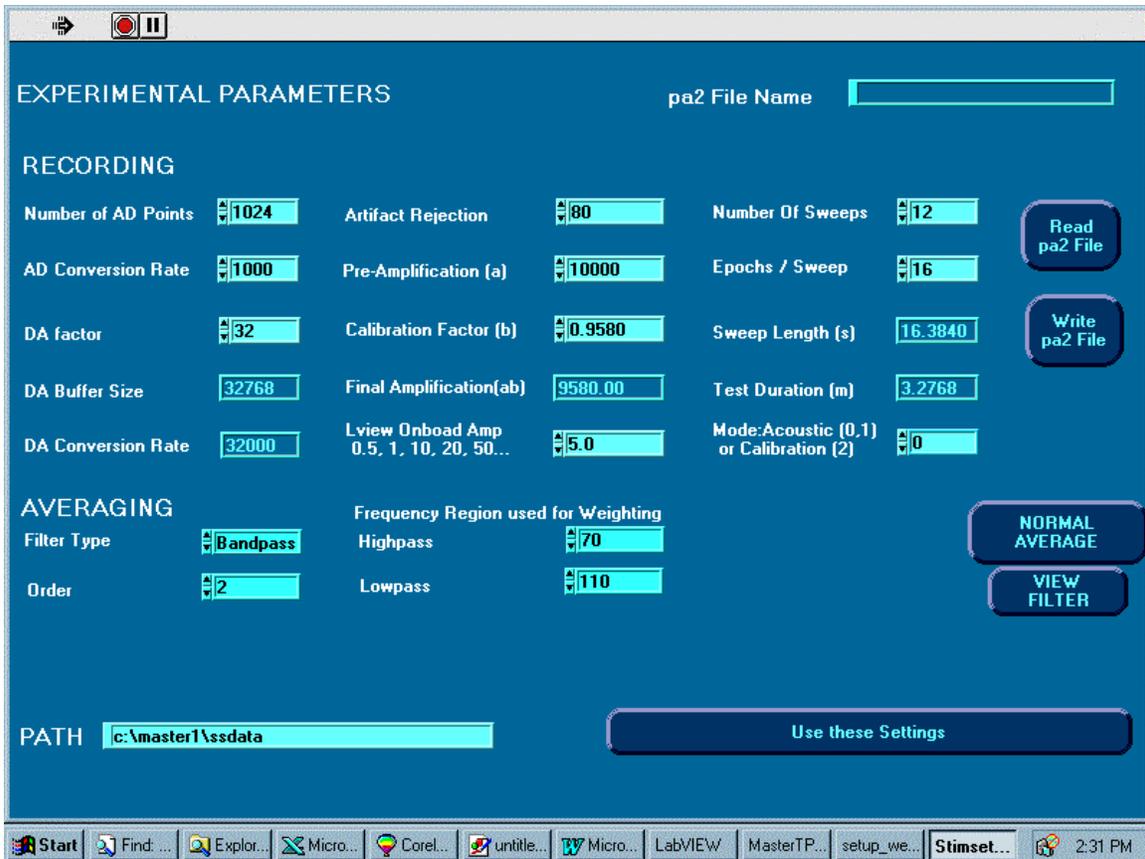


Figure 1: New Pa2 Screen, with parameters for weighted averaging in lower section.

In order to view the noise region that will be used in the estimate of background noise, the user can click on “view filter”. Do this now.

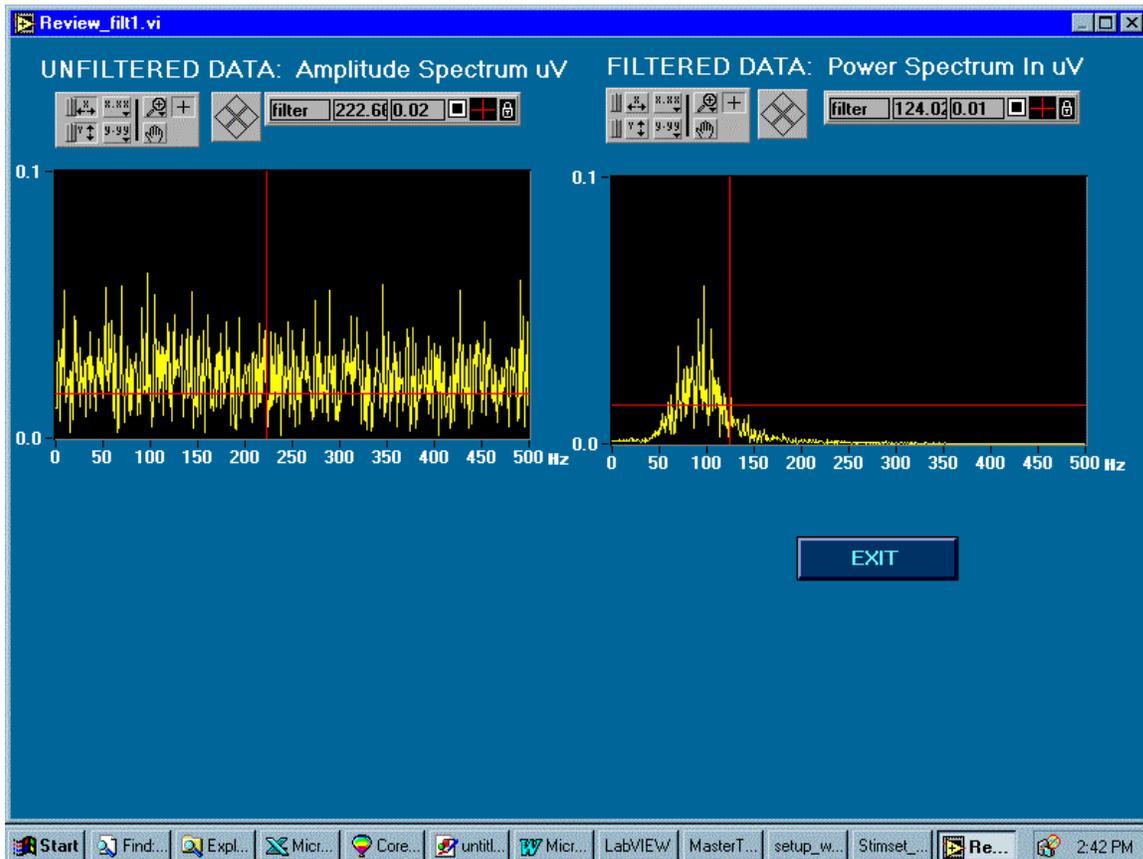


Figure 2: View_Filter Screen, showing power spectrum before and after filtering.

The view filter screen shows the power spectrum of white noise sampled at 1000Hz both before and after filtering. The filters will adapt to any rate that the user chooses for the A/D of the EEG, but, for demonstration of the filter characteristics, 1000 Hz is used. Each time the user chooses “View Filter” a new set of random data is generated, so the filtered spectrum will not look exactly identical each time the user chooses to view the filter characteristics.

When you are done viewing the filter characteristics choose “Exit”

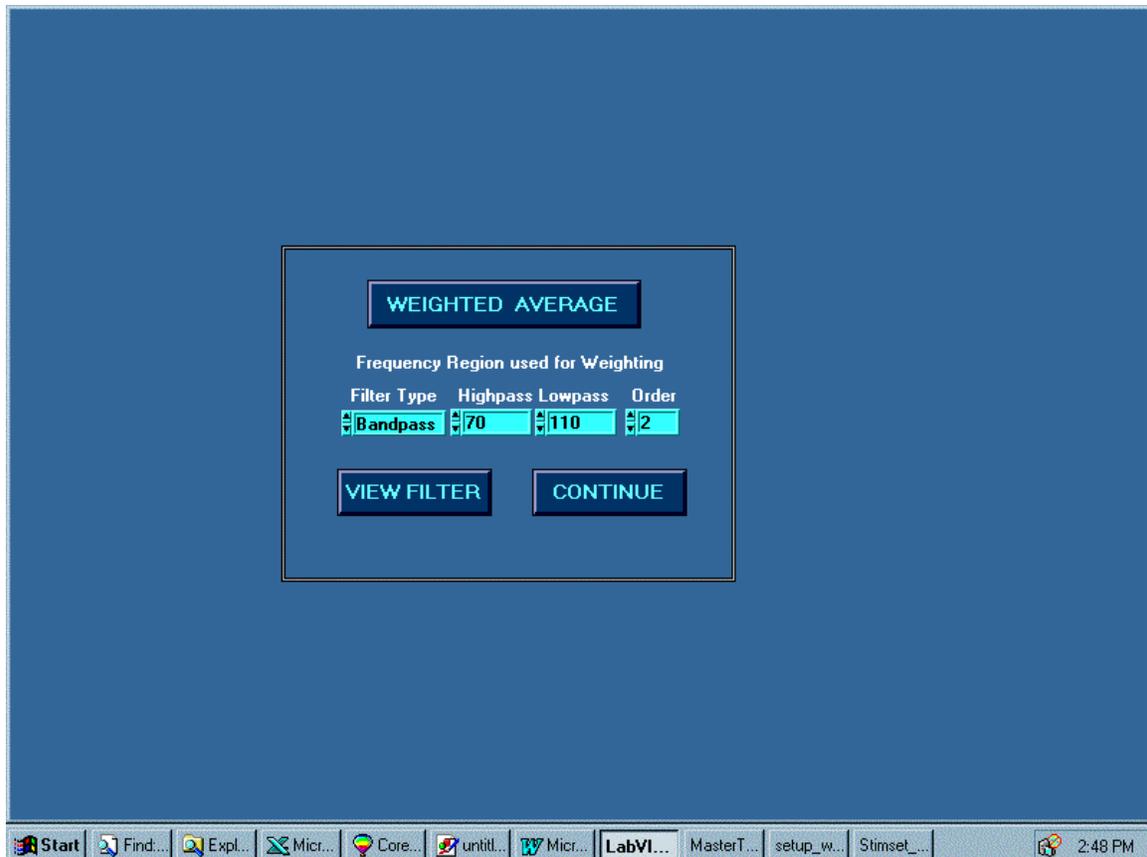


Figure 3: Adjust_Filter Screen, showing parameters used in filtering.

If the filter characteristics were acceptable then press continue, however if you want to experiment with new characteristics you can change the filter in this screen and then select "View Filter" to look at the power that will be relied upon for the "noise estimate" during the weighting of the data.

Note: this is only the filter viewing screen, the actual filter parameters must be changed on the pa2 screen prior to starting your data collection.

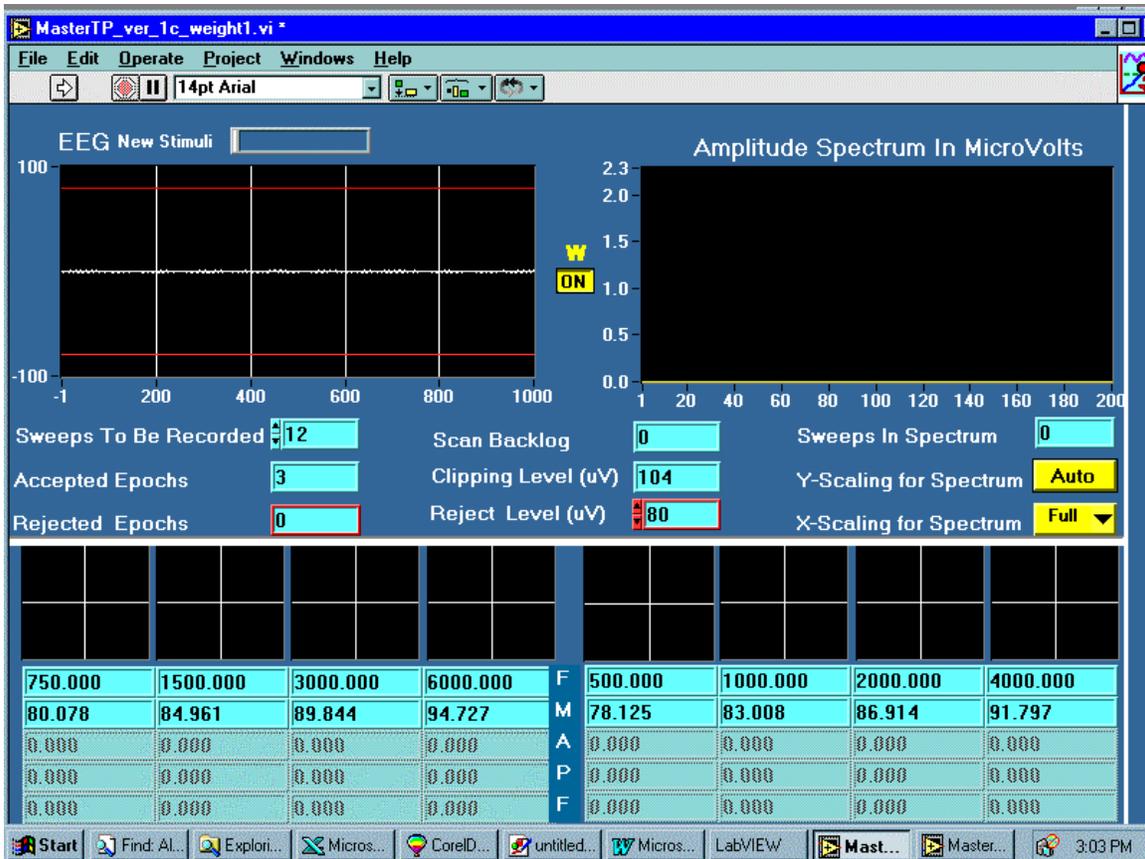


Figure 4: New Data Collection Screen, showing yellow “W” in “On” state.

The data collection screen for ver.1d now has a Yellow “W” in the middle of the screen. The text below the “W” will read “ON” when weighting has been chosen and will be “Off” when normal averaging is occurring. You should not push this control during data collection, but rather should collect the entire dataset with weighting set to “On” or “Off.”

When using the Demo_v1d.exe software, you must now routinely choose either “normal” or “weighted averaging”.

Weighting Program Utilization Issues

There are several questions that users will likely have when starting to use the weighting program.

1. Will weighting affect the phase and amplitude of the ASSRs?

Weighting will not affect the phase of the ASSRs that you collect. Filtering is only used to obtain a variance estimate for the weighting factors (one for each epoch). The weighting factors (noise estimates) are multiplied with the raw (unfiltered) data to obtain the weighted epochs. Accordingly, no phase shifts will occur in your data. With respect to amplitude of the responses, these may be decreased very slightly by the weighting procedure (1-2%), but the noise background will be decreased considerably more (see article).

2. If I choose weighted averaging and then want to look at the raw, unweighted average, can I get the original data back?

Weighted averaging only affects the average spectrum. The .cnt files, where raw data can be saved at the end of a recording session, will always include only raw, unweighted, data. However, if you are only collecting .dat files, then you will only have copies of the weighted spectrum, and the raw spectrum cannot be re-computed from this data.

Because the .cnt files will always contain the raw data, users can always use the review software (Demo_v1d.exe) to create weighted or unweighted averages.

3. Is weighted averaging always better than normal averaging, in terms of producing an increased number of responses that reach significance.

On average, weighting will produce a better SNR than normal averaging. Weighting works best for subjects who occasionally produce short segments of noisy data. If a subject is noisy during an entire recording, then weighting may not help that much (see article). The two figures below are a good case in point:



Figure 5: Normal Averaging, 64 epochs

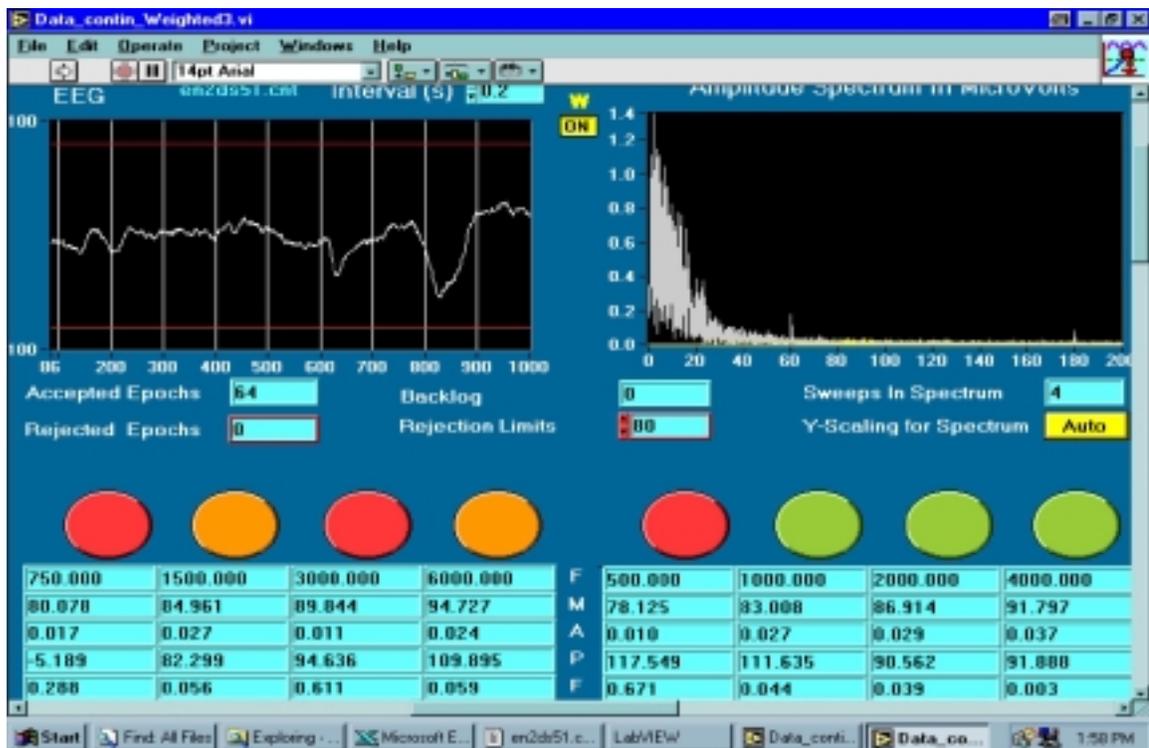


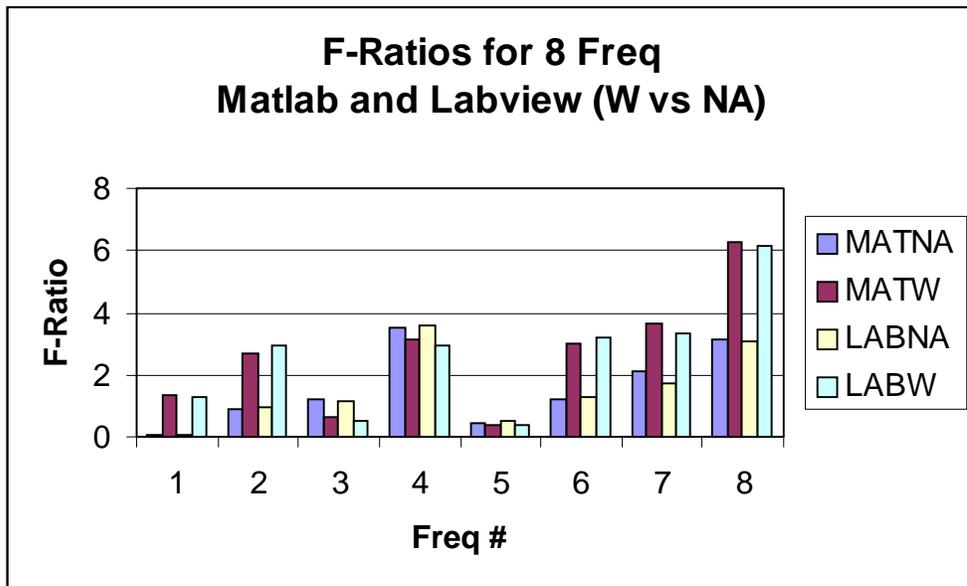
Figure 6: Weighted Averaging, 64 epochs

Figures 5 and 6 are instructive. Weighted averaging produced a quieter spectrum (aka a better SNR) which led to 3 responses becoming significant rather than just one, as occurred for normal averaging. However, weighted averaging also caused the response at 4000 Hz to become non-significant, whereas with normal averaging the response was significant. In other words, , on average, weighting causes more responses to become significant, rather than causing significant responses to fail to reach significance. At intensities near 30 dB SPL, about 3 times the number of responses become significant, compared to those that turn from significant to non-significant.

In addition to the new Demo_v1d.exe files, we are also putting a Matlab file on the website for those of you who want to play with different averaging techniques. Master is written in LabVIEW. There will be minor differences in the data that you process with Matlab and the MASTER system, mostly due to round-off errors, however, you should expect very similar findings using either software program to analyze your data, as can be seen in the following graph which shows the results of the 64 epochs used to generate the other figures in this overview. Notice the F-Ratios which represent the SNR for the responses to the 3rd and 4th carrier frequencies decreased a bit with weighting (as was seen to occur between figures 5 and 6.) This can be seen better on the computer screen image of this file rather than a black and white printout.

Good Luck!

Sasha John & Terry Picton



Data Key:

MATNA: Matlab results using Normal Averaging.

MATW: Matlab results using Weighted Averaging.

LABNA: LabVIEW results using Normal Averaging.

LABW: LabVIEW results using Weighted Averaging.