Acoustic Center Evaluation

Here we present a short description of a process that can be used to evaluate acoustic center of a loudspeaker.

Note: In order to produce these screen dumps, we had to make SEVERAL MLS measurements in a poor acoustic environment. Please note excellent repeatability of the SPL curves above 100Hz on ALL plots.

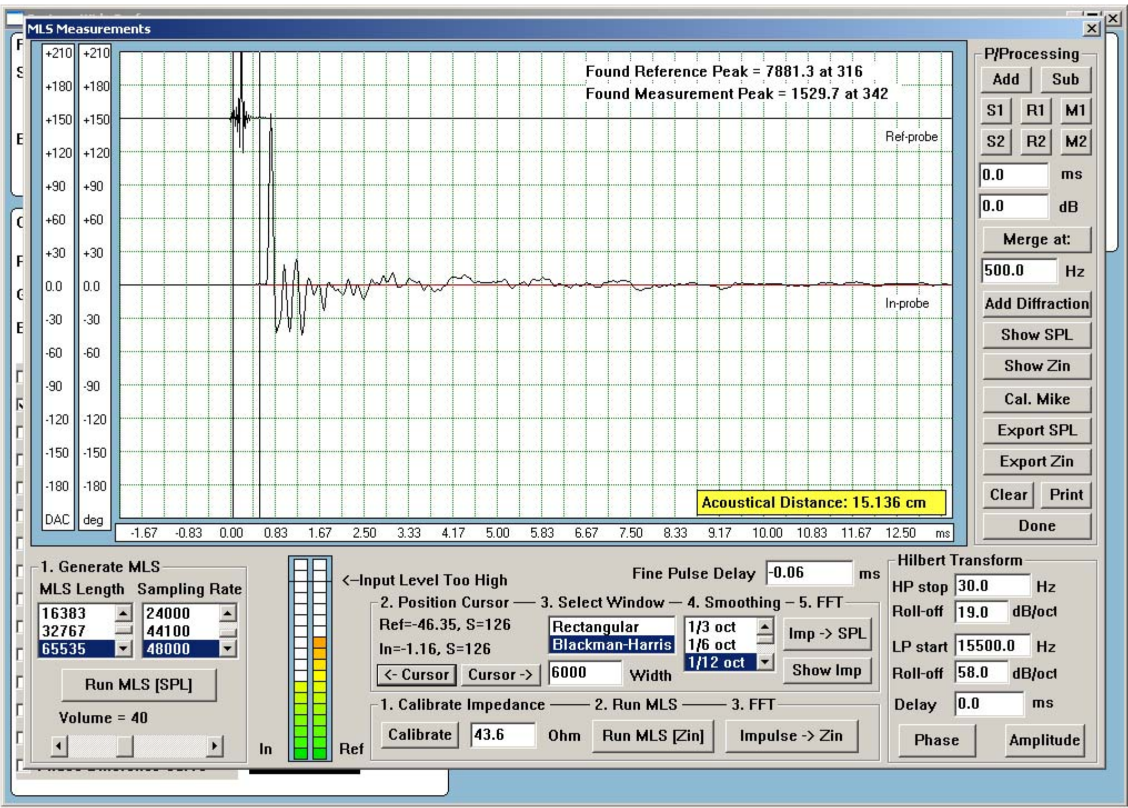

Figure 1. Impulse response of a 12” guitar speaker about measured 14.5cm away from the dust cap.

We started with recording the impulse response of a loudspeaker in a standard test set-up for SPL measurements.

1. The peak of the impulse was found to be at location 136.
2. The Time domain cursor was positioned at Peak-10 samples, that is at location 126.
3. HB Transform was run several times and parameters of the HBT adjusted so the amplitude response was overlapped in almost all visible screen area, except at the lowest and highest frequencies , so that SPL projection could be made into the further frequency extremes.

We ended up curves looking like the once on Figure 2.

1. As you can see, the FFT amplitude and HBT amplitude match very well and phase does not.
2. The HBT phase clearly rolls-off quicker than the FFT phase.
3. I am now going to use the HBT as a guidance in adding/subtracting extra delay from the FFT phase.

In the next step we adjusted Fine Pulse Delay to give me the best match, over the widest frequency range between FFT phase and HBT phase.

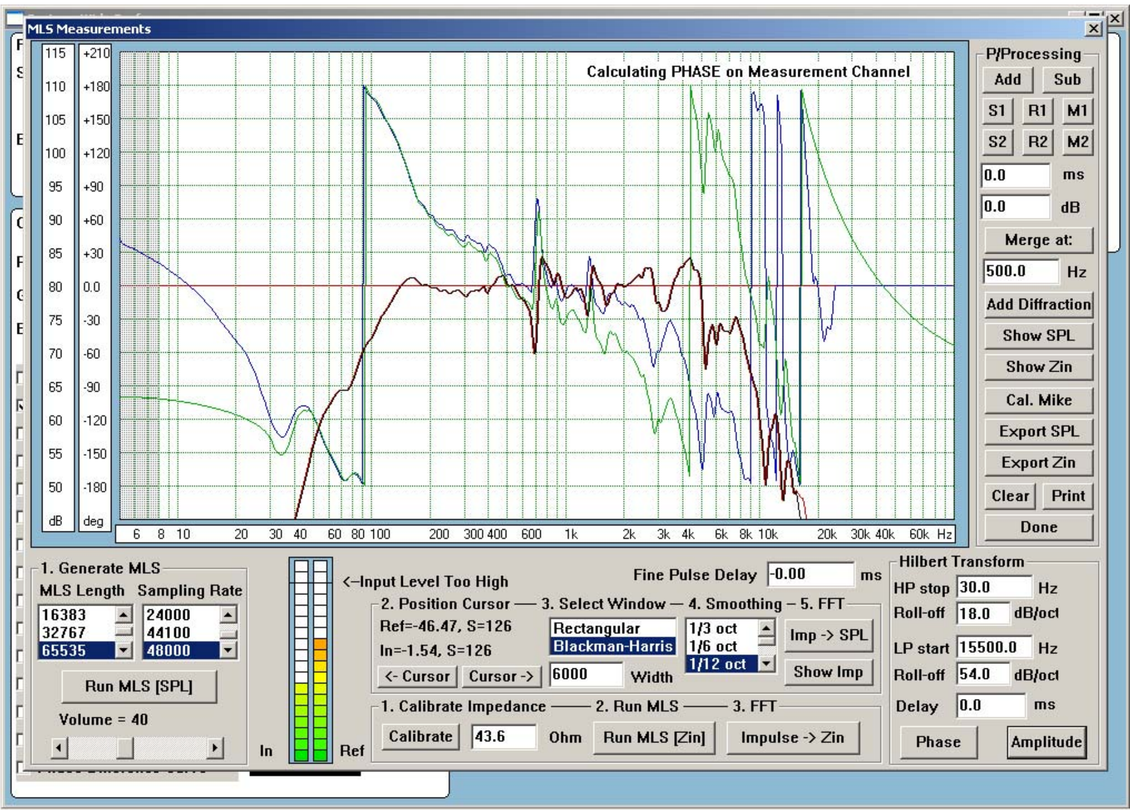

Figure 2. FFT and HBT amplitude match, but phase does not match.

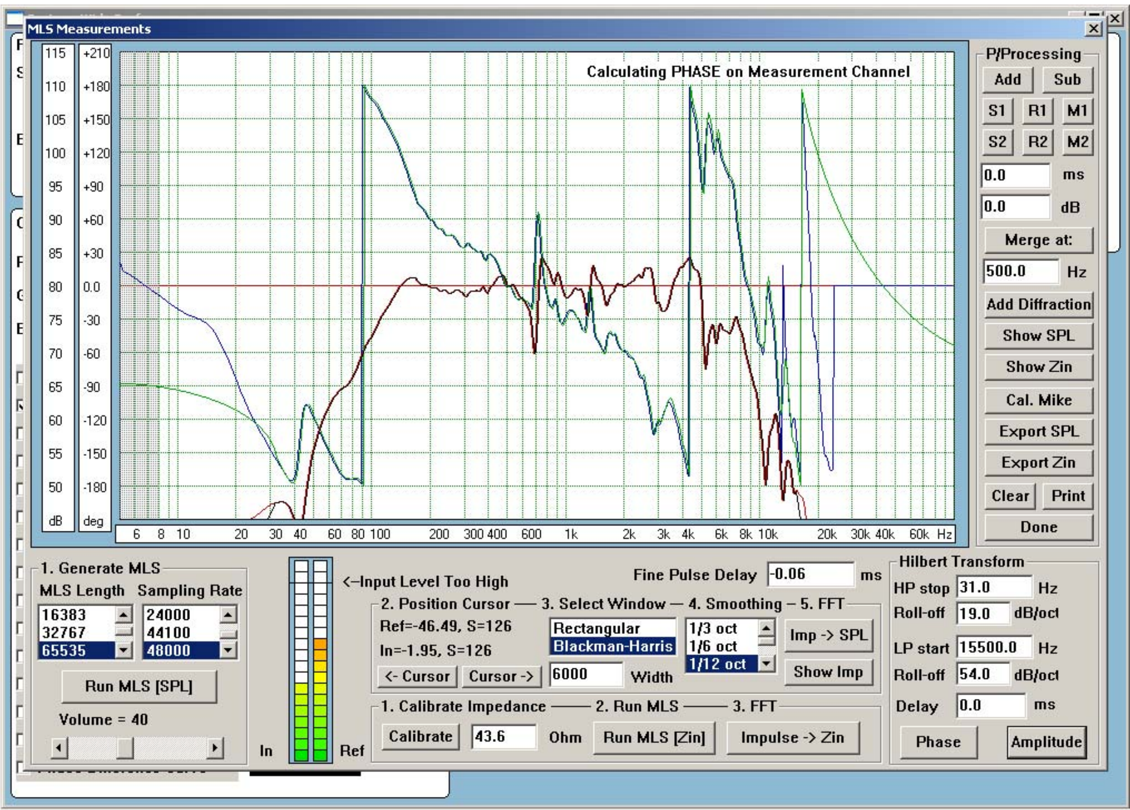

Figure 3. FFT phase and HBT phase match for Fine Pulse Delay = 0.06ms.

Please note, that HBT phase adjustments in the low end of the frequency range are not really influencing the AC measurement and the FFT phase is accurate enough here. I therefore try to overlap the BHT phase onto the FFT phase during each measurement. This is why you will see slightly different HBT parameters for low frequency end. As I mentioned, my acoustic environment was poor – this is why small changes were needed.

Having done the Fine Pulse Delay adjustments, we ended up with something like Figure 3. When you now flip to "Show Imp" screen, you can read the acoustic distance between speaker and the mike directly off the screen.

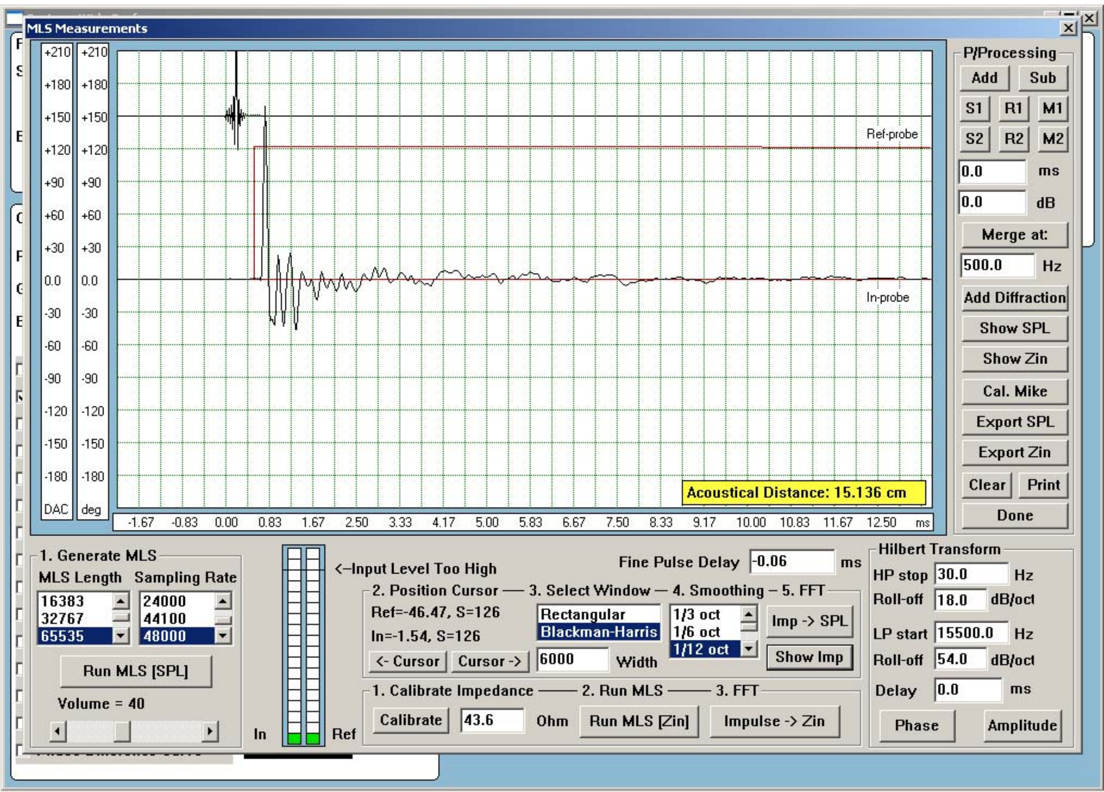

Figure 4 Reading acoustical distance directly from the screen

The total acoustic distance is now 151.36mm. The physical distance between the duct cap and the mike was 145.00 mm. **Therefore, the acoustic center for this loudspeaker is 151.36 – 145.00 = 6.36mm behind the duct cap.**

You can also calculate the Acoustic Center Offset from the mounting plane.
AC Offset: 151.36 – 91.0mm = 60.36mm (91.0mm is the physical distance from mike to the baffle).

This is very important to note, that

1. **Physical distance measurements between transducers,**
2. **SoundEasy results for AC measurements,**
3. **FFT phase plots and**
4. **HBT phase plots**

are all in logical agreement. If you can not obtain this type of figures, something went wrong. Now, if you place time cursor too far or too close to the impulse, you should see significant phase error.

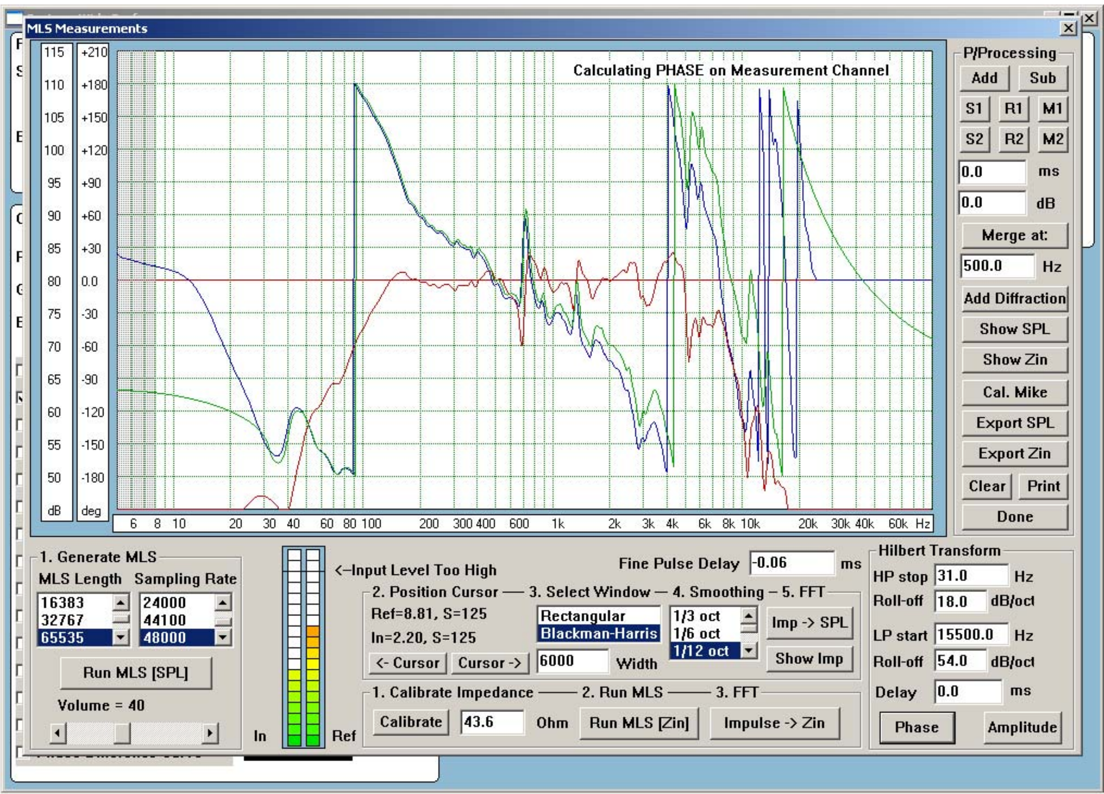

Figure 5. Time cursor 1 position to the left (too far). S=125.

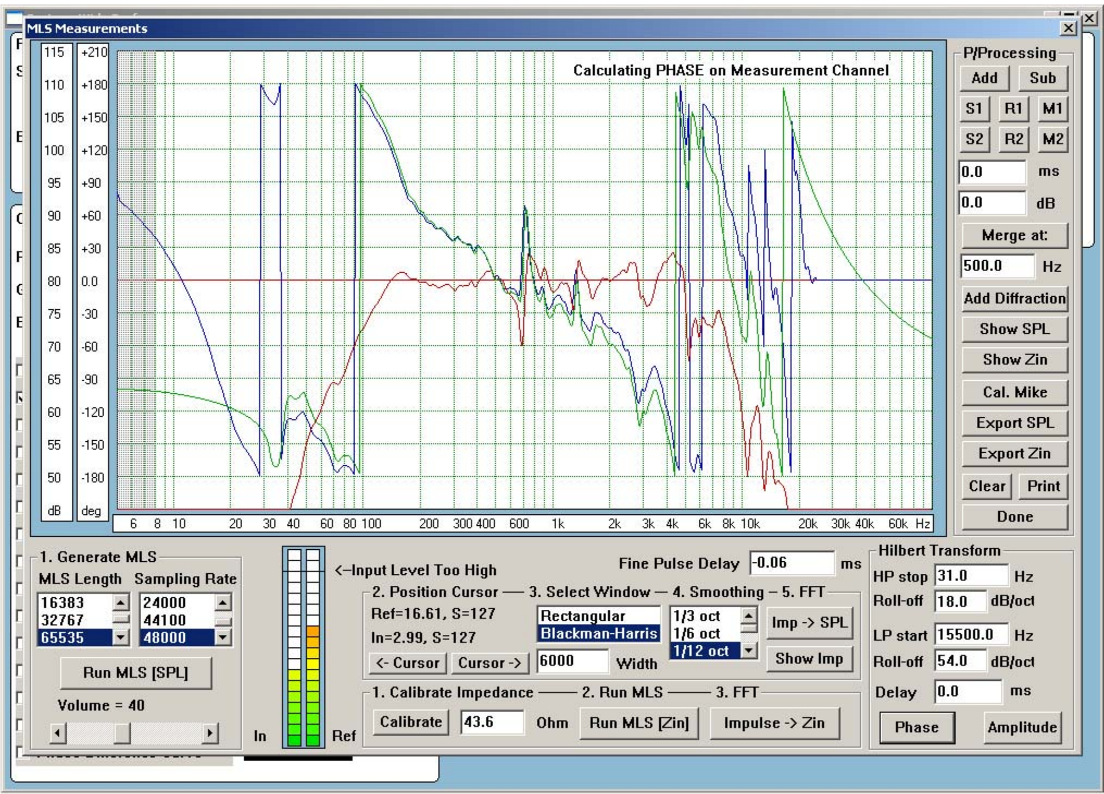

Figure 6. Time cursor 1 position to the right (too close). S=127.

Included below is a quick comparison between the phase responses obtained from HBT with included/excluded break-up region in the HBT assessment.

Using the Editor screen, we have created an imaginary speaker with SPL very similar to the one measured above. Then, we generated the HBT driving parameters looking at shape and roll-off of the last 10dB of the SLP curve visible above 15kHz. Our choice was: 17500Hz and 50dB/oct – see Figure 7.

In the next step, we visually estimated the average roll-off in the break-up region above 4.5kHz to be –24dB/oct - see Figure 8. Finally, we overlapped the two phase plots to see the difference – Figure 16.38.

We expected to see much larger deviations between the two and we were surprised to see how small the difference was. Please note, that this woofer should be crossed over below 2kHz, therefore, phase accuracy is quite good for both approaches. However, for best accuracy, we would recommend to include the break-up region in the HBT phase assessment. we would conclude, that for all cases, where the roll-offs can be properly estimated by visual inspection, the HBT offers very good minimum-phase reference for this driver. Finally, we included a plot of a 4-th order Butterworth filter to see where the phase wraps at higher frequencies. The phase is calculated from the filter elements (not HBT).

Once again, note the excellent agreement with HBT calculated on Figure 9 and phase response on Figure 10. Small differences (expected) are attributed to the irregular frequency response of the driver.

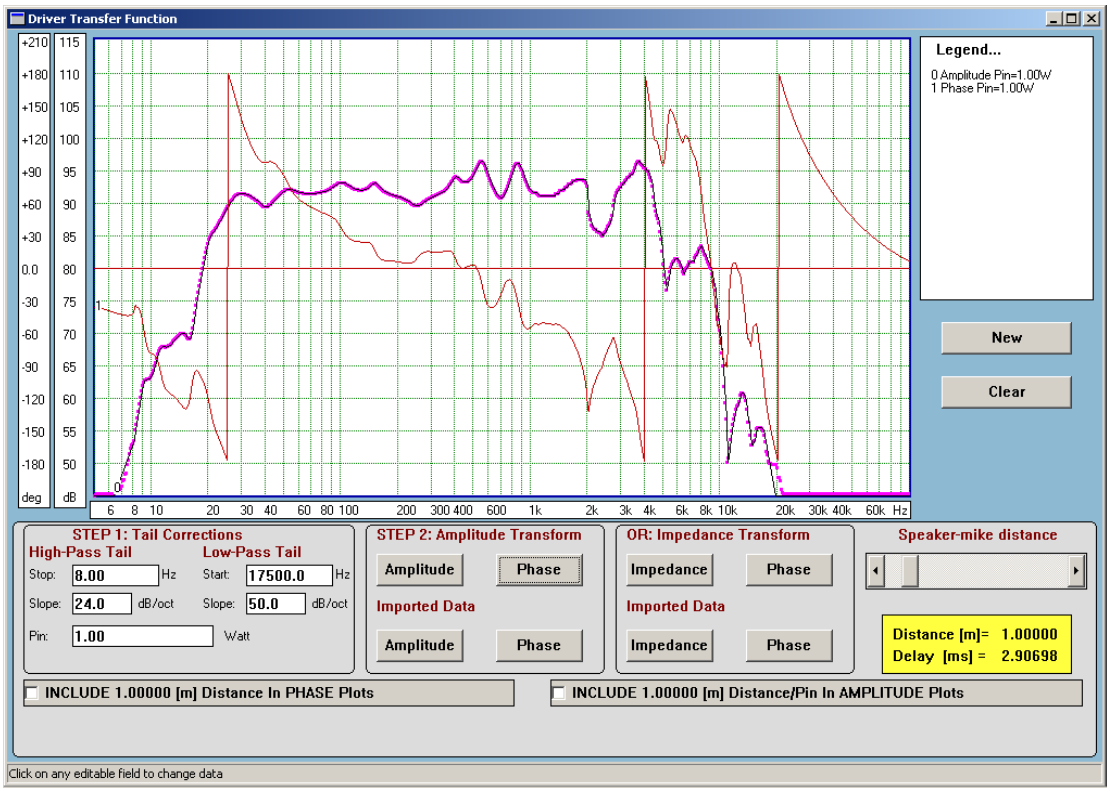

Figure 7. HBT encompassing the "break-up" region – 17500Hz and 50dB/oct

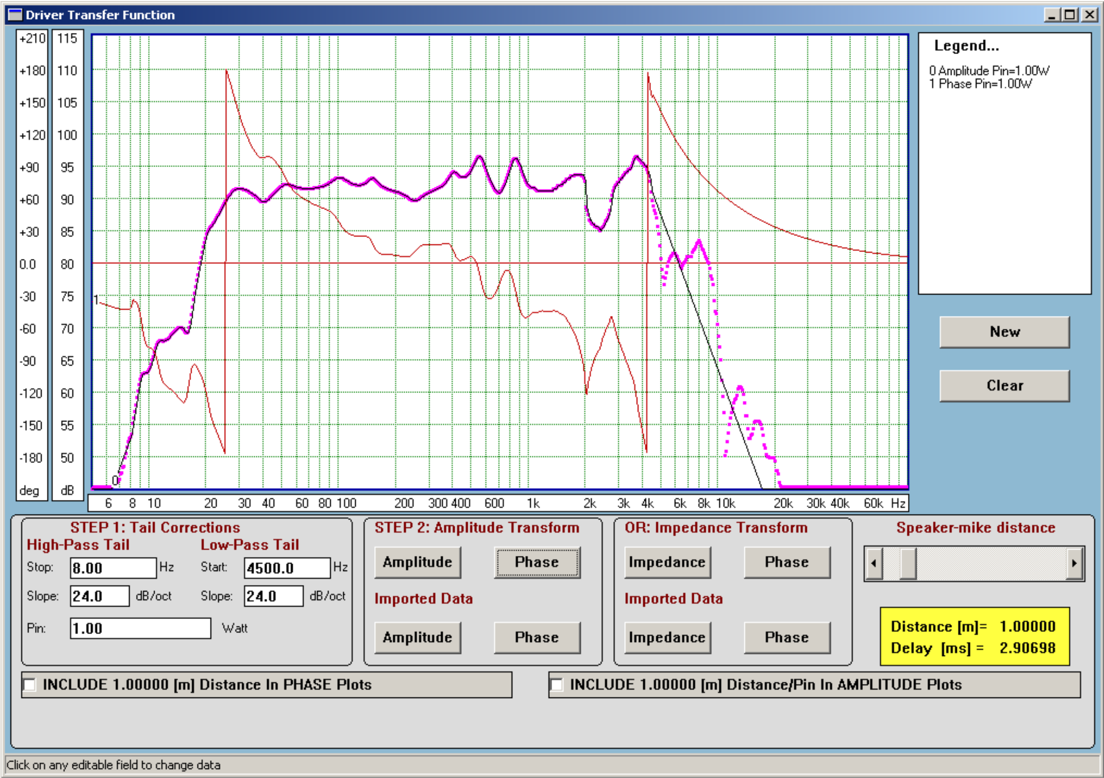

Figure 8. HBT smoothing out the "break-up" region – 4500Hz and 24dB/oct.

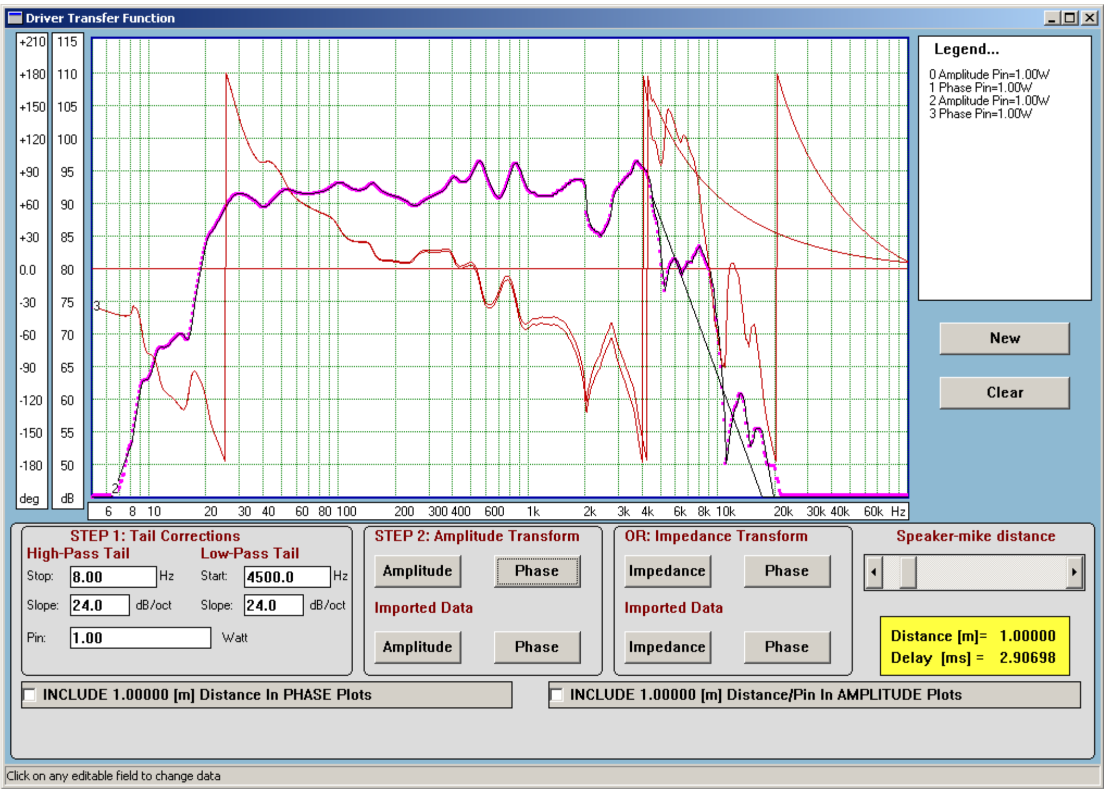

Figure 9. Direct comparison of the two HBTs – notice how small phase difference is up to the break-up region.

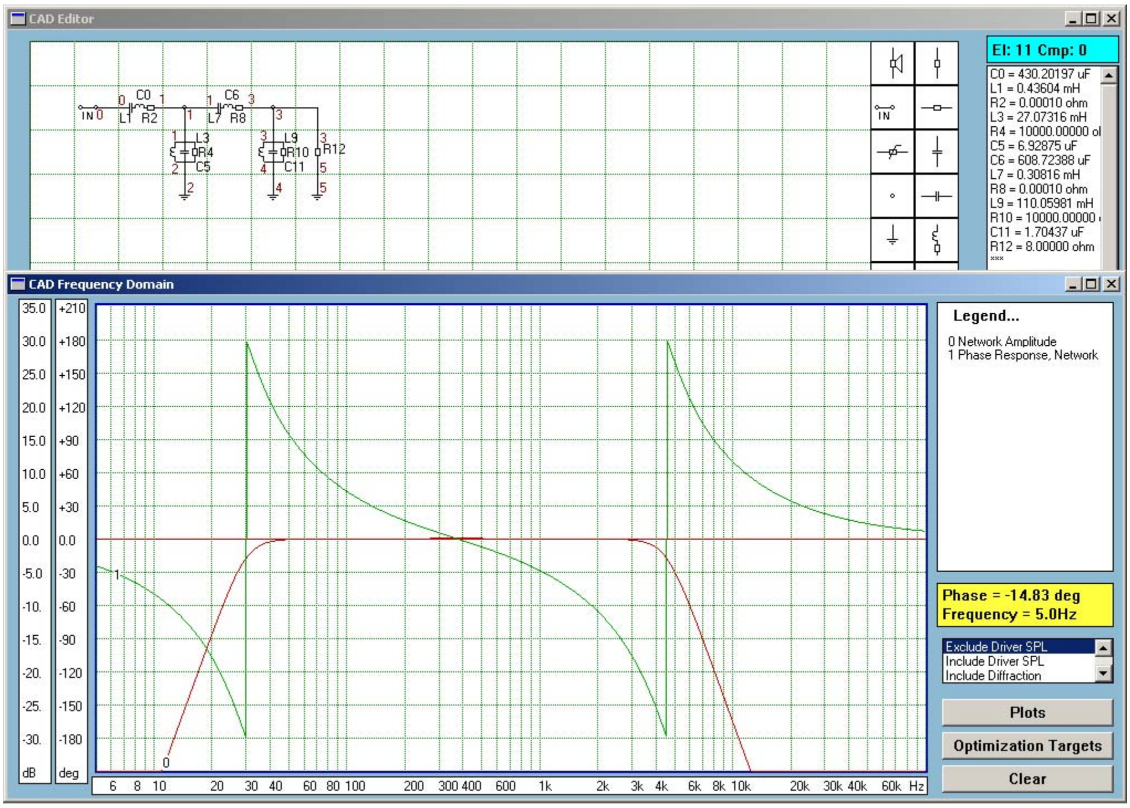

Figure 10. Phase response of 4-th order Butterworth BP filter – note transition ~ 4.5kHz, same as HBT.