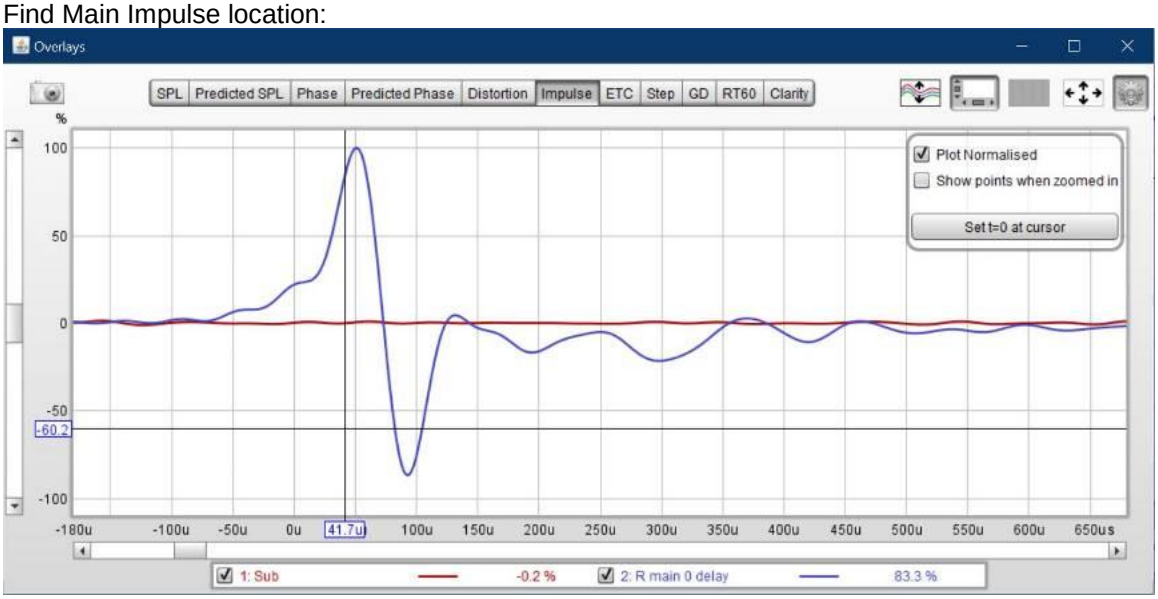
REW analysis process to determine the driver delay needed for good phase tracking across the XO range.

1. For this example; 2 measurements (1 Sub & 3 Main at 0 ms delay) from Post-18 data was selected. The other measurements were deleted. Main and Sub were both measured full range with acoustic timing applied to the measurements. REW v5.20 Beta 8 was used for this example as it includes some useful features.

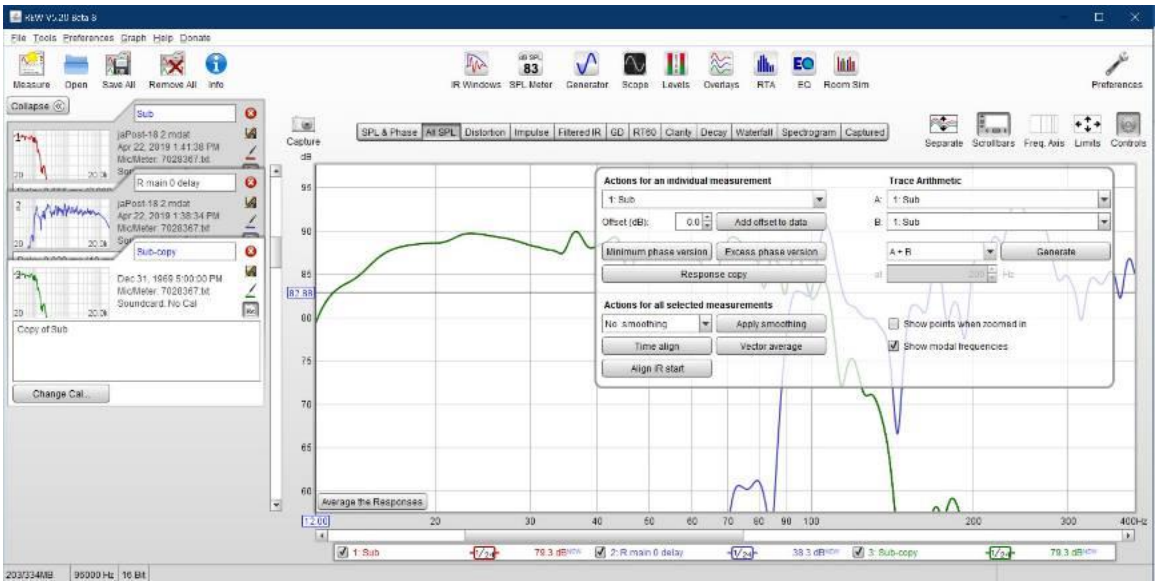
2. Using 'overlay/impulse' window find the Main impulse and place cursor near the initial rise or first peak of the impulse and select 'Set t=0 at Cursor'.
   [Always use the higher frequency driver for this shift so the phase can be properly interpreted. In this case t=0 was already at a good location, but this step was included because this is often not the case.]

   Find Main Impulse location:

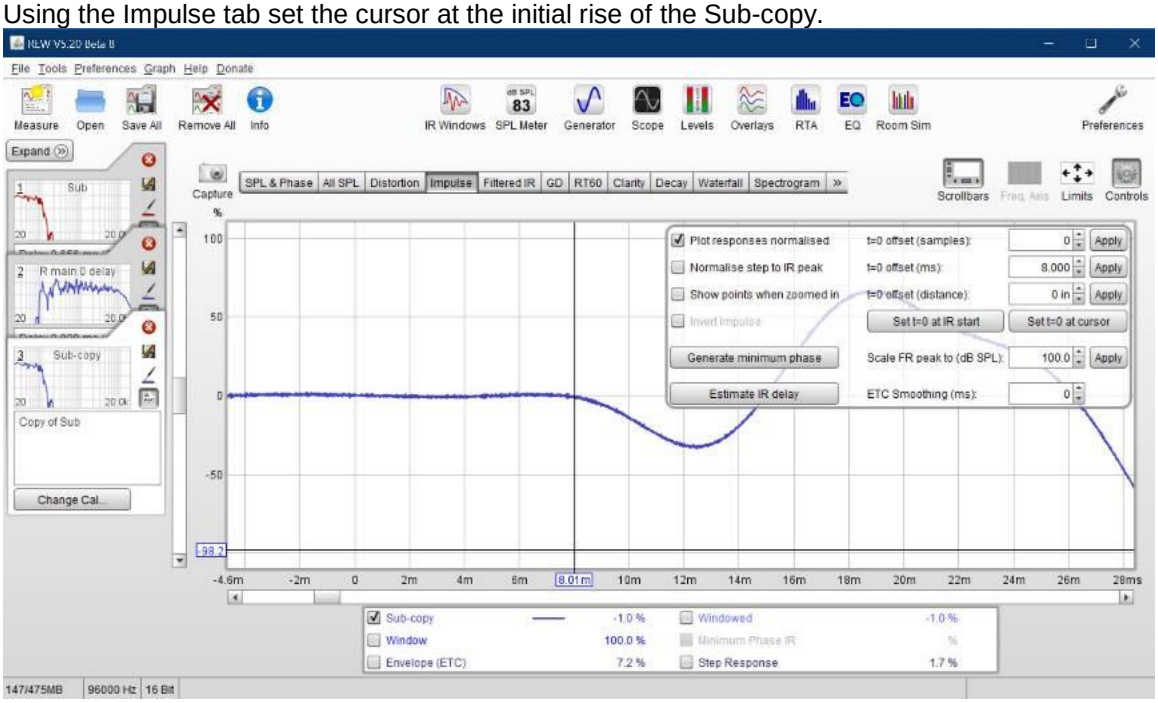


   Reset t=0 with both drivers selected.

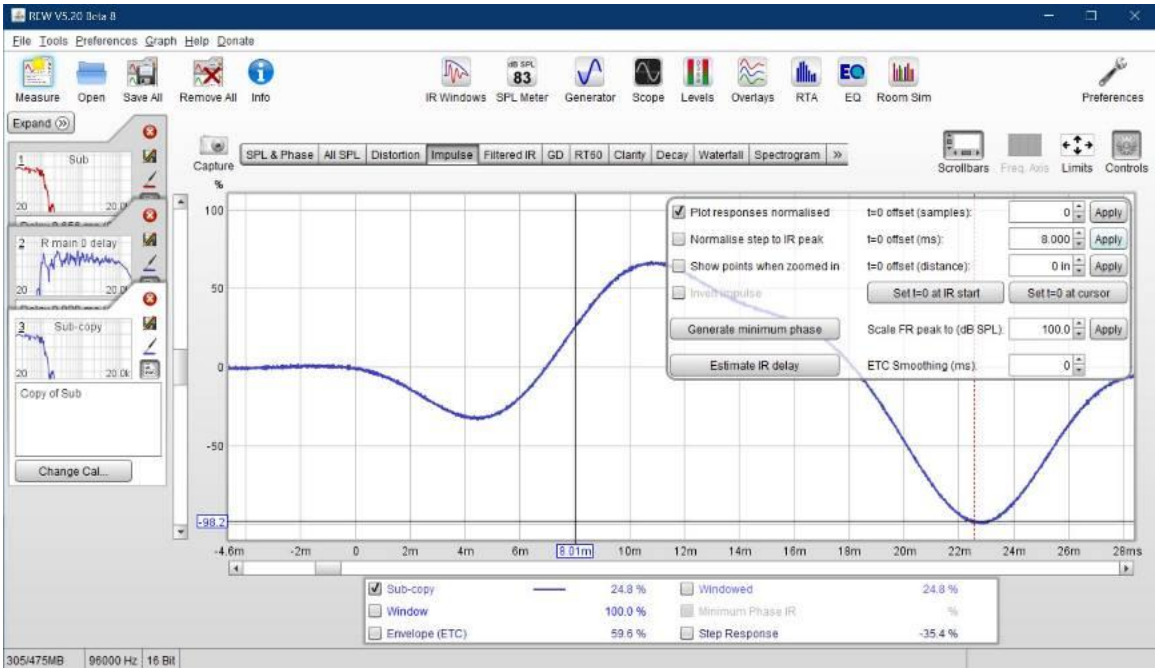
3. Copy the Sub measurement using: 'All SPL/Controls/Response Copy'.



4. Using the Impulse tab set the cursor at the initial rise of the Sub-copy.



Then shift the Impulse by that amount using either ‘set t=0 at cursor’ or ‘t=0 offset (ms) to get:



5. Open ‘overlay/SPL’ and note the frequency range of the XO. In this case it’s roughly 80 – 150 Hz. Set the smoothing to 1/48 octave for all measurements.

6. Open ‘overlay/Phase’ and deselect the Sub measurement.

7. Open ‘IR Window’, Enter 0.0 into the ‘Window Ref Time’ and select ‘Apply Windows To All’ to see:

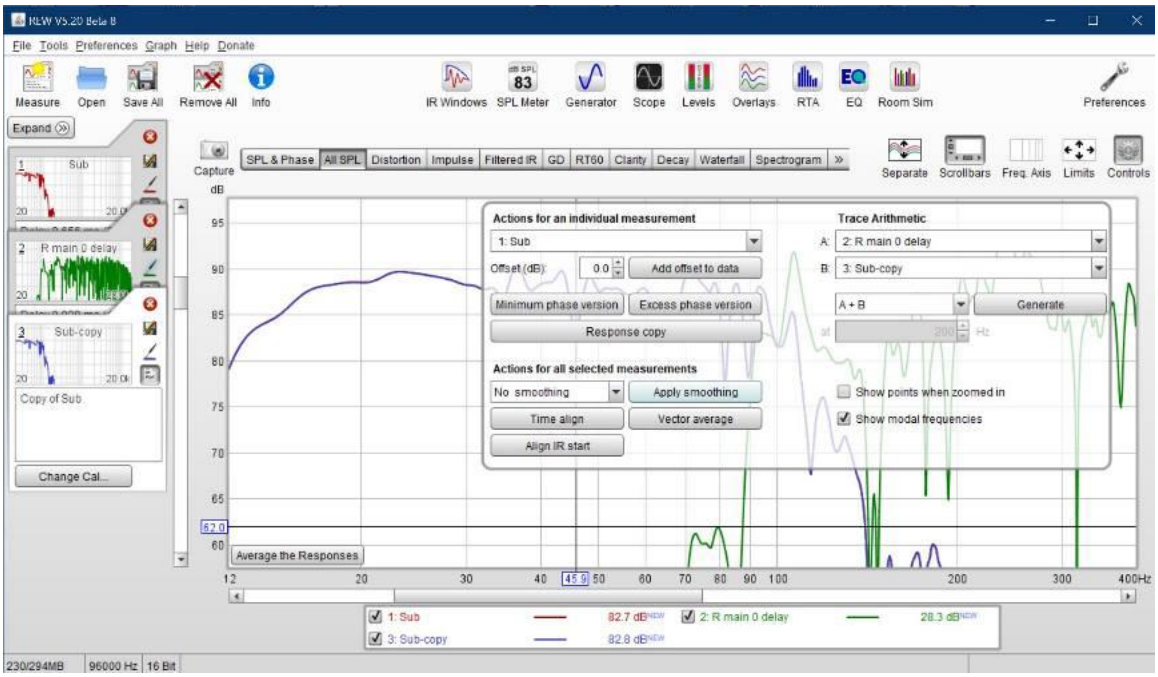
The phase tracking of the Main and Sub-copy with this impulse positioning is very good. It starts to diverge at the low end so some minor adjustment to the Sub-copy impulse position may be indicated. First however let’s remove some the room impact on this phase relationship.

8. Check ‘Add frequency dependent window’ and Enter 10 into the box and select ‘Apply Windows To All’ to see:

Removing some of the late arriving room impact improves the tracking somewhat. We can set it to 5 cycles and even lower and the tracking still appears very good. There is a strong hint that possibly the Sub-copy is inverted relative to the Main as the low end of the XO appears to be roughly 180° apart different at most settings. This suggest there may be a better fit with Sub-copy impulse inverted from this setting. This can be investigated in the impulse tab by selecting ‘Invert Impulse’. Then the Impulse be shifted again as needed to find the closest phase tracking. For these low frequency XOs it often difficult to select between several possible settings. So long as the 2 Impulses are not moved too far from each other; any setting that provides good SPL reinforcement in the XO range is a good one.

9. Let’s see how this setting looks for SPL support: Uncheck the ‘Frequency Dependent Window’ and select ‘Apply Windows To All’.

10. View the ‘All SPL’ tab. Select the Main and Sub-copy and A + B in the ‘Trace Arithmetic’ section of the control panel:



Now select ‘Generate’ to create the full range SPL with this relative timing.

11. View the 'Overlay/SPL' window and set 1/3 or 1/6 smoothing to see how much SPL support there is in the XO range.

As we expected when viewing at the phase tracking, there is better SPL support above the XO point than there is well below it.

12. So now let's assume we have made several changes to the Sub-copy impulse location to evaluate several timings for both the original polarity and the inverted polarity of the Sub-copy and settled on the best compromise setting. To determine the delay change needed: View 'Overlays/impulse' and select only the Sub and Sub-copy traces. Zoom to see both traces in detail. Use 'Ctrl-right button drag' in Windows OS to measure the relative change in distance of the Sub-copy impulse. In this case Sub-copy Impulse measures 8 ms less delay than the Sub Impulse.

[I usually measure between steep zero crossings like this rather than from peak to peak as it is more accurate. I move this impulse 8 ms and here I measured 7.947 ms. A 1 ms shift is not very significant at this low frequency.]

13. To make this setting in the sound system either reduce the Sub delay by 8 ms or increase all the Mains delays by 8 ms. Measure the system with this new setting to confirm that no mistakes were made in the analysis. The results should be identical.