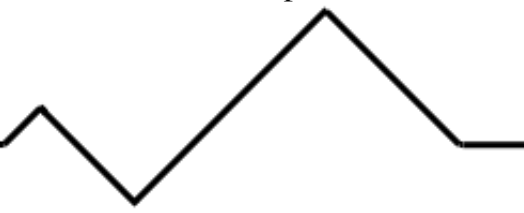


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John T. Lynch



Cryogenic Treatment of Trumpets

Some (Mostly) Qualitative Measurements

In December of 1999, [Wayne Tanabe](#), owner of [The Brass Bow Music Co.](#) in Arlington Heights, Illinois cryogenically treated ([Cryogenic Resonance Restoration™](#)) three trumpets of different makes and characteristics. The process used is described elsewhere. There were actually four trumpets in the set, one of which was not treated. All four instruments were sent to me before and after treatment for some (mostly) qualitative measurements, and the results of those tests are presented here.

The test that we did differed from what would happen if a customer sent an instrument to Wayne Tanabe for cryo-treatment in a crucial way. First all of the horns were sent to Wayne and he fully prepared them for the treatment, and then we did the "Before" tests. The prep included at least a thorough cleaning, probably in Wayne's ultrasonic cleaner, and perhaps other things that Wayne will tell us about. We did this to isolate the cryogenic process from any changes that might have occurred just from the prep. The way a cryogenic treatment is normally done, the customer would be unable to tell if a change was the result of the prep or freezing. I am quite sure that Wayne would correct any problems that he noticed in an instrument before returning it to the owner.

Their owners, all of whom participate in the electronic [Trumpet Players' International Network \(TPIN\)](#) listserver, volunteered the instruments. The instruments were:

Bach Strad ML180 37* (standard-weight body, lightweight bell), silverplate, s.n. 341,4xx. Weight 36.3 oz.

Benge, CG (Claude Gordon) Model, silverplate, s.n. 973,1xx. Weight 32.8 oz.

Besson, French Classic (Kanstul), silverplated, 0.462" bore, s.n. 5,5xx. Weight 37.9 oz.

Blackburn, ML removable bell model with 213A24 bell and 19-348 leadpipe, silverplated, s.n. 29x. Weight 40.4 oz.

All instruments were tested in alphabetical order, as they are listed here. I rather wish that we had also tested a Bel Canto, a Blessing, a Boosey & Hawkes, a Buescher and a Burbank.

As can be seen, the Benge is a lightweight at just over 2 lbs. and the Blackburn is fairly heavy at over 2 1/2 lbs. The French Besson Classic and the Bach are in the middle. The Ambronze™ bell on the Blackburn is the thickest that Blackburn makes (0.024"); however, my nearly identical Blackburn with the thinner 213Y20 (0.020") brass bell is still fairly heavy at 38.4 oz.

My expectation going into the experiment was that the acoustical properties of a trumpet are almost

completely determined by the a few features:

- The mechanical properties of the material, especially the bell, can effect the sound and projection by controlling the vibrational response of the instrument to the vibrations of the air inside. It was in this area that I thought that cryogenic treatment might play a role.
- The natural modes (resonances) are primarily determined by the size and shape of the interior volume of the bore, from the mouthpiece to the leadpipe. Of course, if other parts of the instrument have resonances then they may contribute also but these are most likely to be caused by broken braces, etc..
- The overall weight of the instrument, and especially the bell, will affect the way that the acoustical energy contained in the vibrating air column is eventually divided up between vibrations of the instrument (which are likely to be absorbed by the players hands) and the sound radiated out of the bell.
- The shape, and especially the diameter, of the bell largely determines how the acoustical power will be radiated from the bell. I didn't measure the diameter of the bells nor did I make any measurements that address this feature.

I have now been told that the instrument that was not treated was the Bach Strad, so for that instrument all before and after measurements should be the same. At the time I made the measurements I was in the dark as to what had been done to which.

I made three sets of measurements on each instrument before and after treatment. All measurements were made with the tuning slides pushed all the way in:

- I recorded (direct to disk) at a sampling rate of 32 kHz the sound produced by thumping each bell with my finger. I held each trumpet in front of a Shure BG 4.1 microphone with a finger through the bell bow and snapped the bell with my fingernail. Any change in the mechanical properties of the bells should be revealed by simply listening to the before and after pings. I have edited the original WAV files so that what you hear is the Bach, before and after; the Benge, before and after; the Besson; and finally the much harder Ambronze™ bell of the Blackburn has a very distinctive ring, both before & after. [Click here to hear the bells ring.](#) [294k]. I do not hear any before and after difference; however, my hearing is noise damaged, so some of you may hear a difference. In any case, very little happened to the stiffness or other properties of the bells due to cryogenic treatment.
- I measured the natural modes of each instrument (before & after) by inserting a 100 Hz to 2,000 Hz swept sine wave into a mouthpiece and measuring the acoustic pressure inside the drilled out throat of the same mouthpiece. I also placed a Shure BG 4.1 mic at the bell. The sweep took place over 10 seconds and I averaged over 5 sweeps to get nice mode plots. Additional averaging did not change the plots. Unfortunately I saved the plots only as bitmap images rather than as text files. Had I done the latter then I could have presented the before & after plots as overlays rather than separately, but I didn't think of it at the time. I have placed tick marks on each plot at 120 Hz and 2 x 120 Hz, etc. These mark the modes that can be associated with C below the staff (~240 Hz) and the other natural modes, as well as the nonexistent "fundamental" at ~120Hz.. The left channel comes from the pressure inside the mouthpiece and the right channel is from the Shure mic at the bell. Since the position of the latter is not controlled I doubt that it is of much use. ([Recording setup](#)) Here are the plots, before & after treatment.

Bach

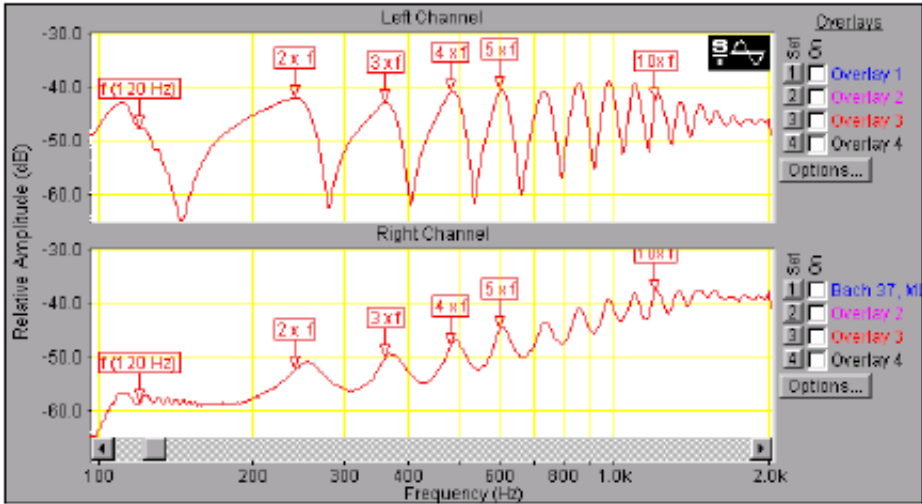


Figure 1 a, Bach, before

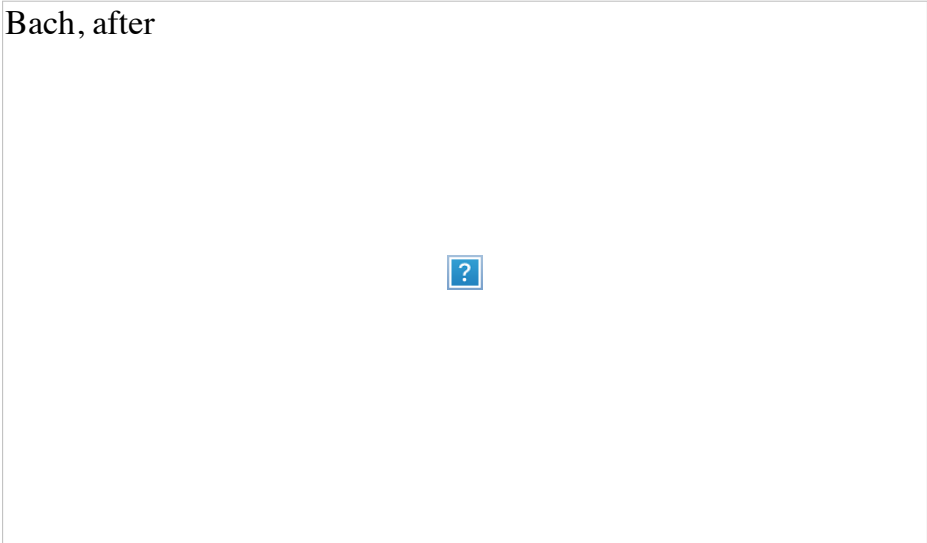


Figure 1 b, Bach, after

Benge

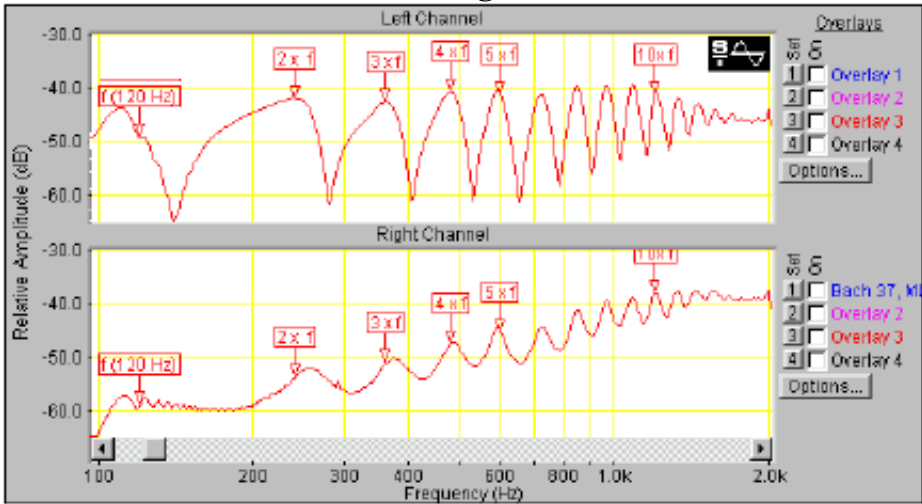


Figure 2 a, Benge CG, Before

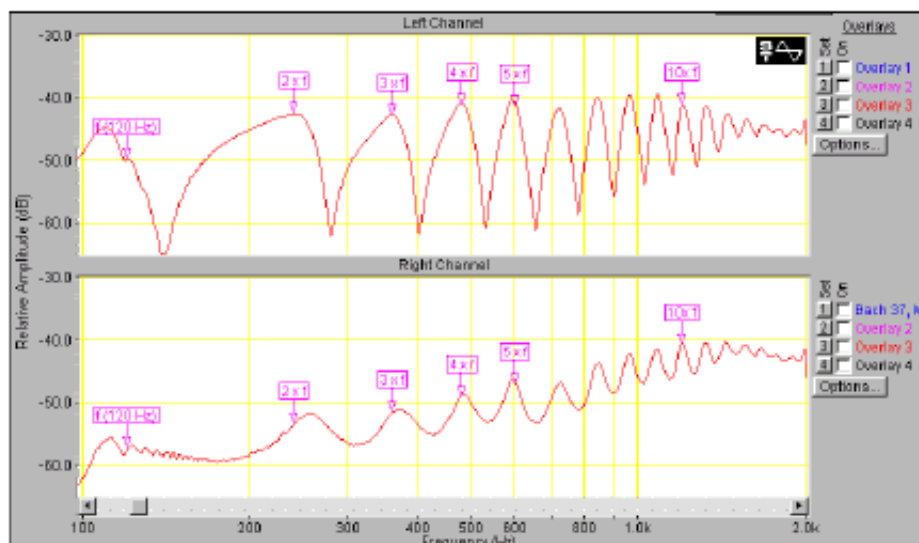


Figure 2 b, Bengé CG, after

Besson

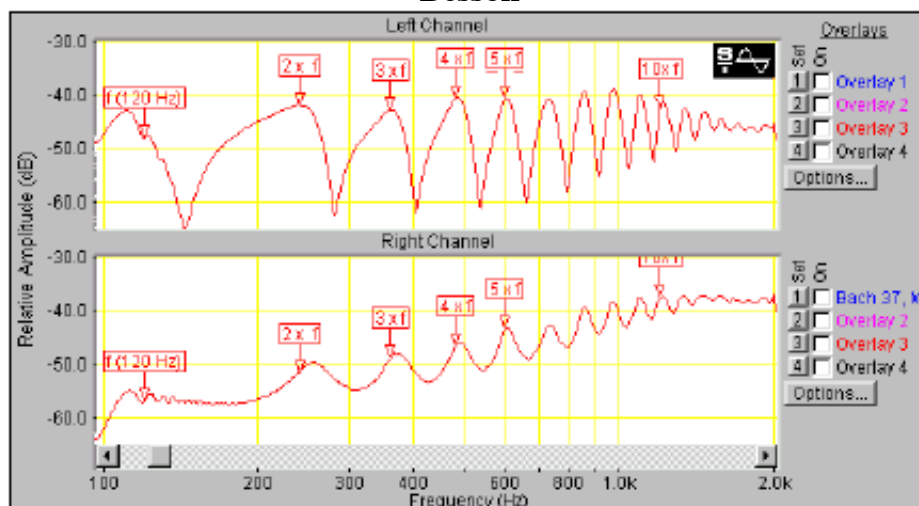


Figure 3 a, Besson, French Classic, before

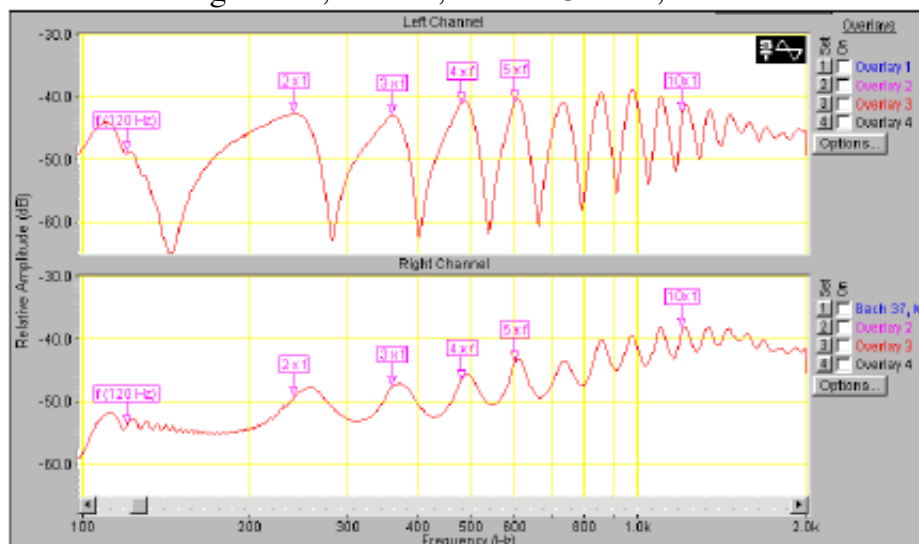


Figure 3 b, Besson, French Classic, after

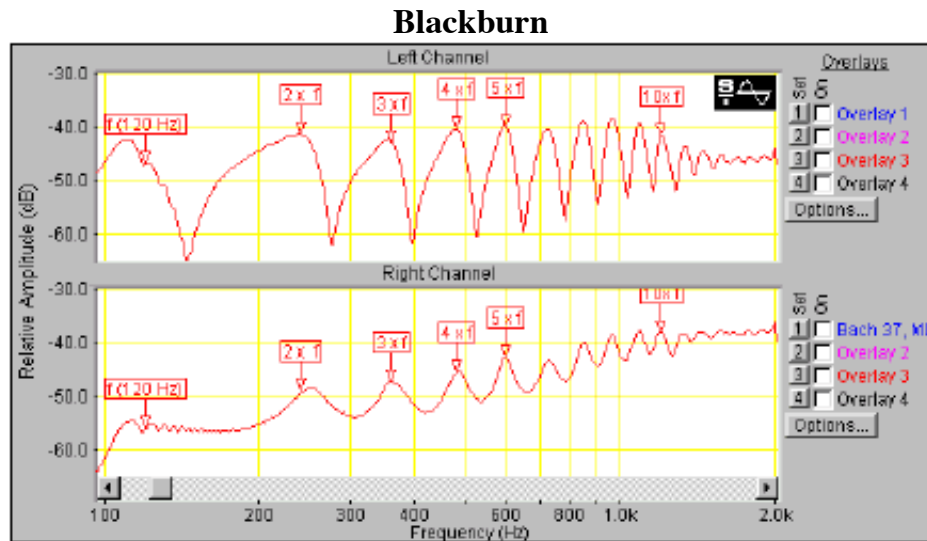


Figure 4 a, Blackburn, before

Blackburn, after

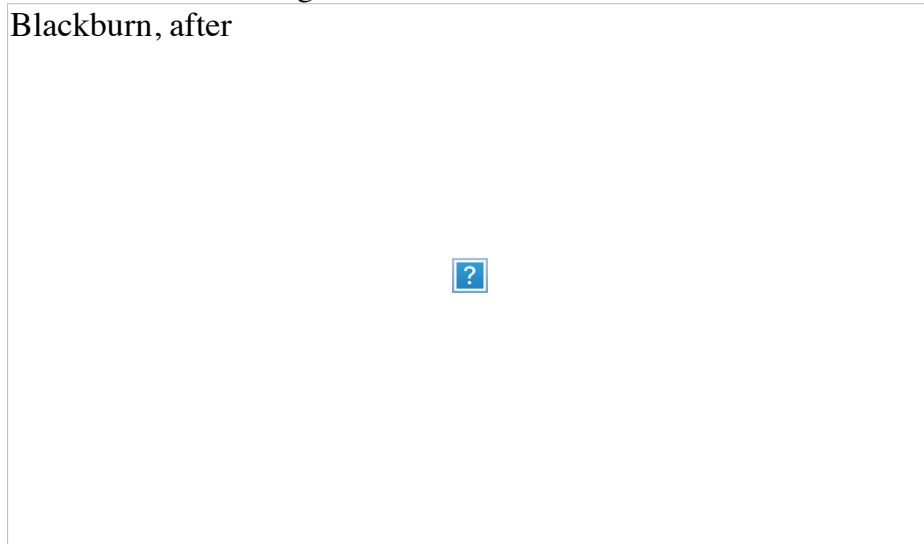


Figure 4 b, Blackburn, after

I really didn't expect to see any significant differences in the natural modes between before and after since such a measurement basically reveals the interior volume and shape of the bore of the instrument. If the stresses of the treatment had cracked some solder joints and caused leaks or broken a brace then additional resonances might have been set up or the original modes might have been disturbed, but that didn't happen.

The only differences that I noticed between the before and after plots is that the higher frequency modes (above $10 \times f$, which is associated with E above the staff) are stronger after treatment. The bad news is that they are also stronger in the Bach, which was not treated. I suspect that either I inadvertently moved an amplifier tone control between the tests or something just drifted a bit in the three weeks or so that elapsed. In any case, the change is less than 1 dB. My conclusion is that cryogenic treatment did not alter any of the natural modes of the instruments.

Since I have shown the plots of the modes, there are a few characteristics that can be seen that the reader may find interesting.

- A common feature is that the mode at $6 \times f$ (associated with G at the top of the staff) is a bit weaker than either the 4th line E or the (bad) Bb above. I have never found that a particularly hard note to hit, but it may be more of a problem to others. I have seen that in every plot of modes that I can remember making.
- For the Benge CG, the peak at $5 \times f$ (4th space E) is flat when compared to the other peaks, and that note does play flat. That is much more common on C than Bb trumpets, but as is the case with most Cs, the note has pretty good intonation when played with the 1-2 valve combination. On the other hand, the modes above $10 \times f$ are stronger on the Benge CG than the other instruments, possibly making it easier to play high. I do not know if this was a design trade-off or just happenstance.
- The Blackburn's natural modes are all a bit flat when compared to the other instruments. The reason is that it has a round tuning slide and the path length around such a slide is longer than around the more standard "squared-off" tuning slide.

Finally, I recorded direct to disk a 2nd line G and a top of the staff G on each trumpet using a Shure BG 4.1 microphone while playing my Stork 1.5C/ 22S mouthpiece. Each note was about three seconds long. I tried to make them all sound about the same (*mf*) loudness and have the same timbre. One thing that became immediately apparent was that the Blackburn had greater projection than the others did and in order to make the levels comparable, I blew it softer. I primarily attribute the greater projection to its significantly greater mass. From the recordings I made fast Fourier transforms (FFT), averaging over most of the 3 s tone, to display the spectral characteristics of each instrument, before & after. From my perspective, this was a wasted test, because the differences in the before & after spectra were clearly due to differences in the way I played, not to any changes that may have occurred during treatment. There were about three weeks between tests during which time I had a cold and finally an intestinal infection. I doubt that I could under the best of circumstances produce the same "blow" on different days well enough to uncover subtle differences in trumpets. Here are the before & after spectra for the Bach. From my experience, it looks to me as if I played louder "After". I can provide such plots for all four instruments, but I consider it a waste of bytes on Ralph Jones' server.

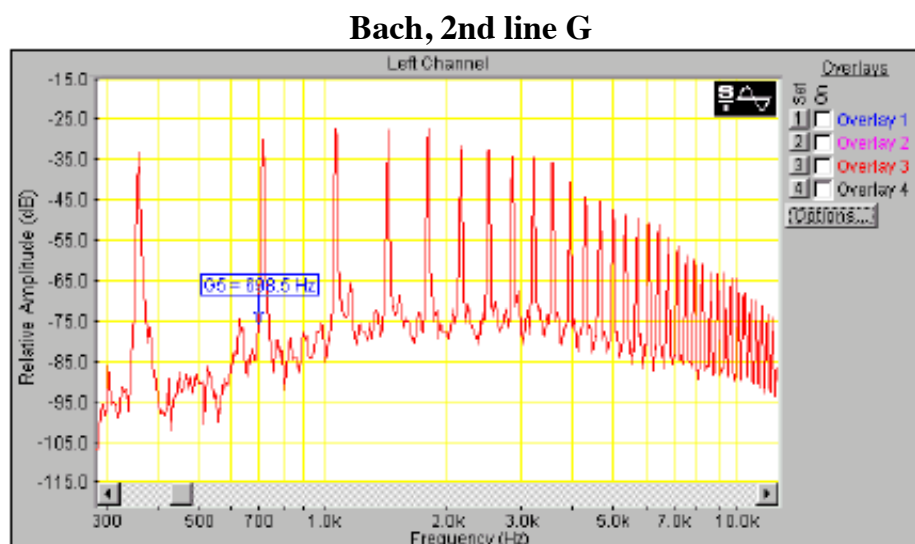


Figure 5 a. Bach, before, 2nd line G

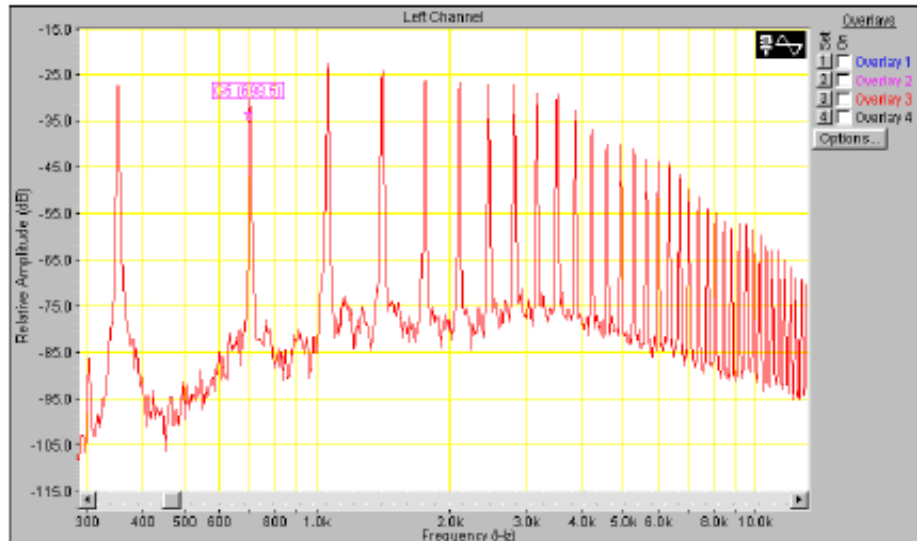


Figure 5 b. Bach, after, 2nd line G

Bach, top of staff G

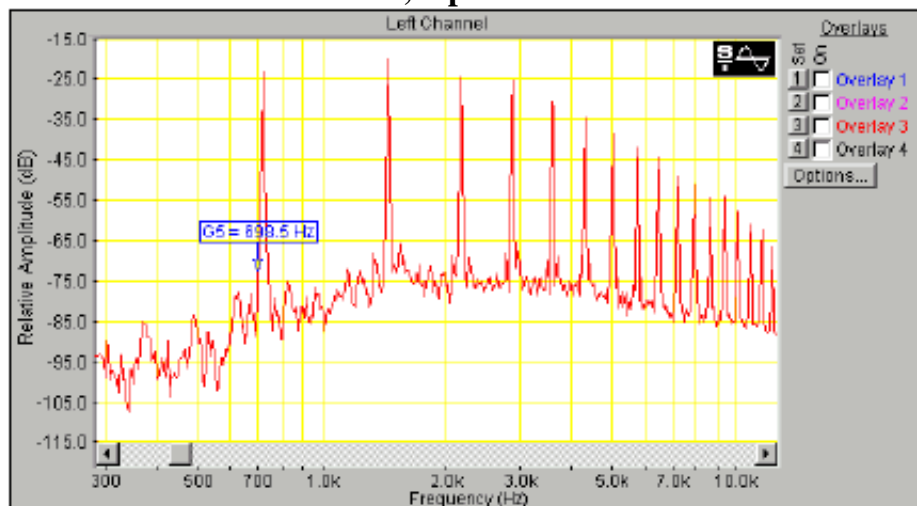


Figure 5 c. Bach, before, top of staff G

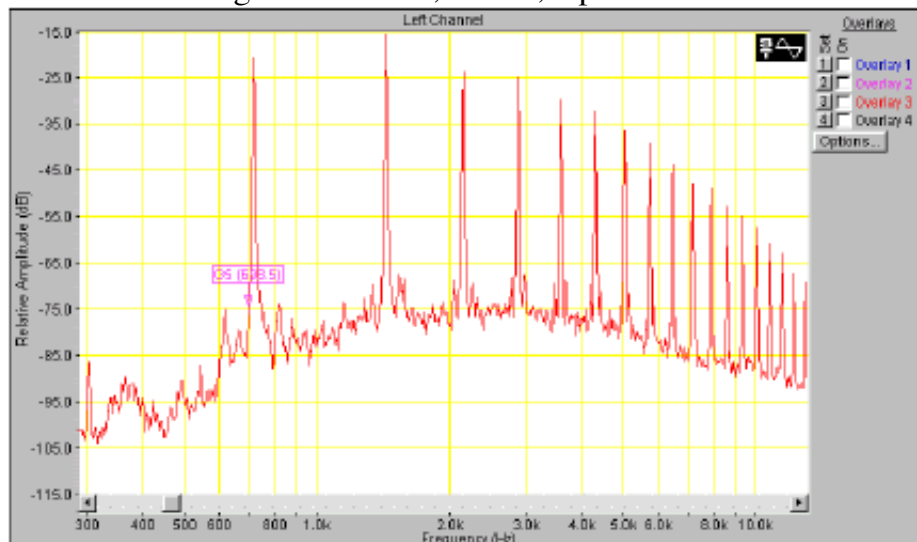


Figure 5 d. Bach, after, top of staff G

The reason that in the first of these plots the instrument is sharp is that I blew it several times to warm up a bit and to set the controls. The result was that the air inside was warm. Later, I got smarter and used other instruments than the one under test for those purposes.

Conclusion

I was unable to detect any differences in the instruments after cryogenic treatment that I could attribute to the treatment. It was my expectation in advance of the experiment that if there is an effect from the treatment then it would most likely be due to metallurgical changes in the properties of the instruments, especially the bells. Any such differences should be sensitively detected by the sound of the "ringing of the bells". I was unable to detect any such changes, but due to deficiencies in my playback system (el-cheapo self-powered PC speakers) and my noise damaged ears, I cannot rule out that effect. Readers of this may be able to hear an effect that I cannot.

I look forward to your comments.

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