The Frankintar

By Richard Jaouen

On the 18th of February 2026, The Looth Group presented a program called “Misconceptions in Lutherie” featuring Martino Quintavalla, Simone Bonanomi, Andrea Corsini or Hub Of Acoustics for short. The presentation was on sound hole size and $T(1,1)_1$ frequencies. They were able to show that, on their demonstration guitar, $T(1,1)_1$ could be shifted to lower frequencies by making the sound hole smaller. They did this by snapping 3D printed rings into the sound hole and thus decreasing it’s diameter by a measured amount. By using the equation for Helmholtz frequency, they showed that as the hole gets smaller, the instrument’s $T(1,1)_1$ frequency decraeses.

$$f_h = \frac{c}{2\sqrt{\pi}}\sqrt{\frac{R}{Sh\alpha}}$$

Also, as the volume of the air space increases, the instrument’s $T(1,1)_1$ frequency decraeses. This is achieved by higher sides or bigger instruments. They also used 3D printed tornavoz to show that they too shifted the top $T(1,1)_1$ frequencies. A summary of the changes to $T(1,1)_1$ in their test guitar is as follows:

- Soundhole diameter: + 0.4 Hz/mm
- Sides height: +0.25 Hz/mm
- Tornavoz: -0.4 Hz/mm

Michael Bashkin pointed out that altitude also effected the $T(1,1)_1$ value, so if you don’t like your present frequency move to a different altitude!

A few years ago, I built a guitar with adjustable sound hole, side port and side weights. I did extensive testing (tapping) and amassed a lot of data. Obviously, the results are for this classical guitar but they may be relevant to other stringed

instruments. All tapping was done in a seated playing position. I tested different styles and I feel this is the most pertinent to real life (whatever that is).

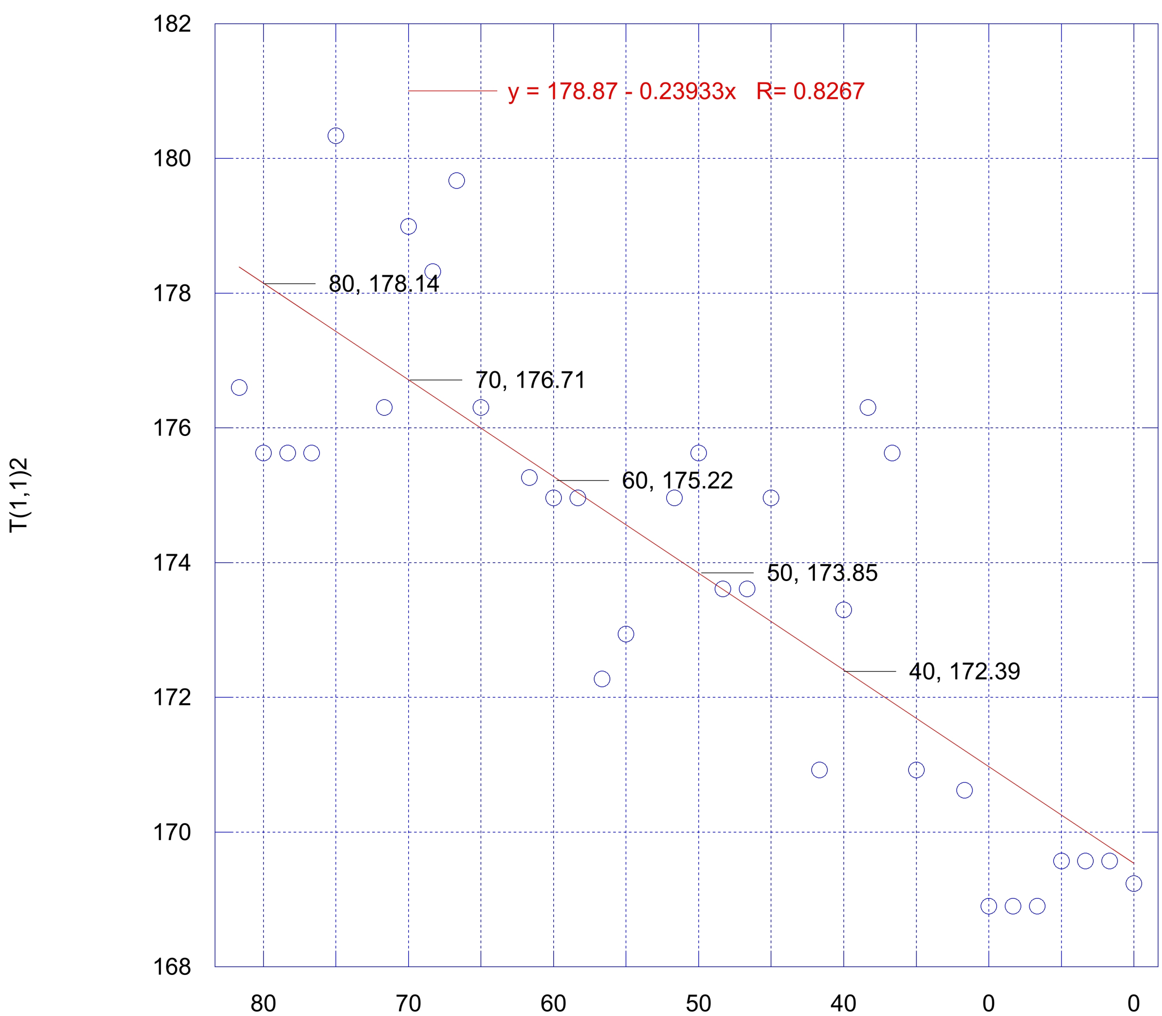
It's interesting to note that the great classical guitarist Pablo Sainz Villegas uses a contoured pillow to rest his guitar on. This will stabilize the sides so he is essentially moving $T(1,1)_2$ as well as $T(1,1)_3$ a little bit. I digress. I don't think it makes any difference how you hold the guitar while tapping, as long as you are consistent.

Before I go any further, let me tell you how I do my testing. Attached to my computer is a DaytonAudio directional microphone which is powered by a MouKey filter that gets rid of any line interference (ie; 60 cycle). I use a 25 cm stick to position the guitar in front of the mic. Usually I use a "bouncy ball" on a stick to tap.[5] On occasion I'll use a knuckle, reflex hammer or whatever is in reach. Finally, I keep track of accuracy with a tuning fork.

There have been multiple articles written about side ports.[see references] For simplicity, I will call top holes "holes" and holes anywhere else "ports" to distinguish between the two. As I was saying, there have been many articles written on ports and the one by Carruth is the most thorough and informative.[2] I'll try to fill in some of the information gaps and answer some of the questions I've run into.

While Simone et al showed in their demonstration showed that small changes in the top hole don't effect the $T(1,1)_2$. we know from Gore[4] that the uncoupled top resonance is found by blocking the sound hole and tapping to find $T(1,1)_2$. When I made the sound hole smaller over a wide range, I made $T(1,1)_2$ shift to lower frequencies.

T(1,1)2 vs hole2

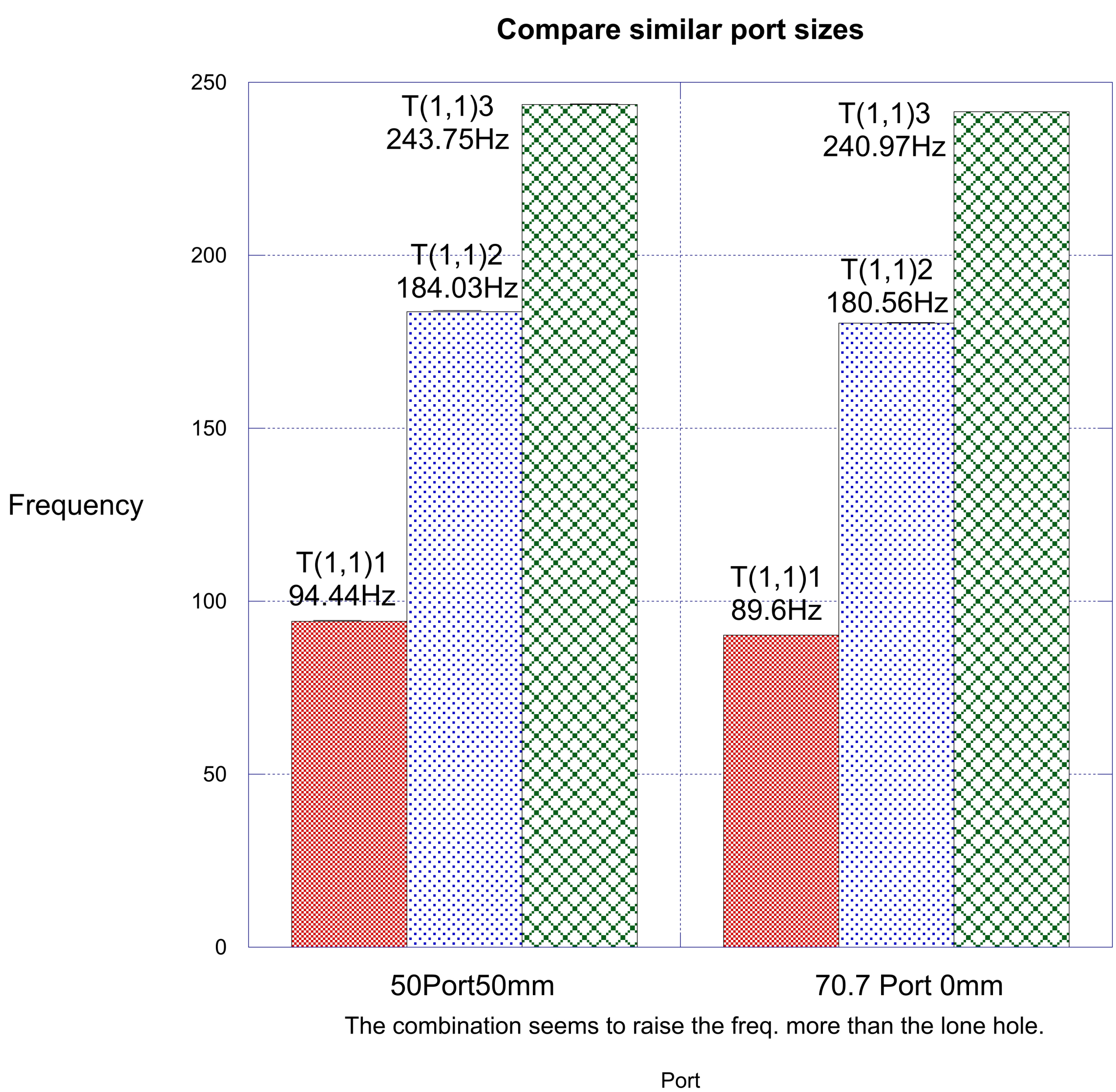


T(1,1)2 changes about 0.15 Hz/ mm hole increase over a large range

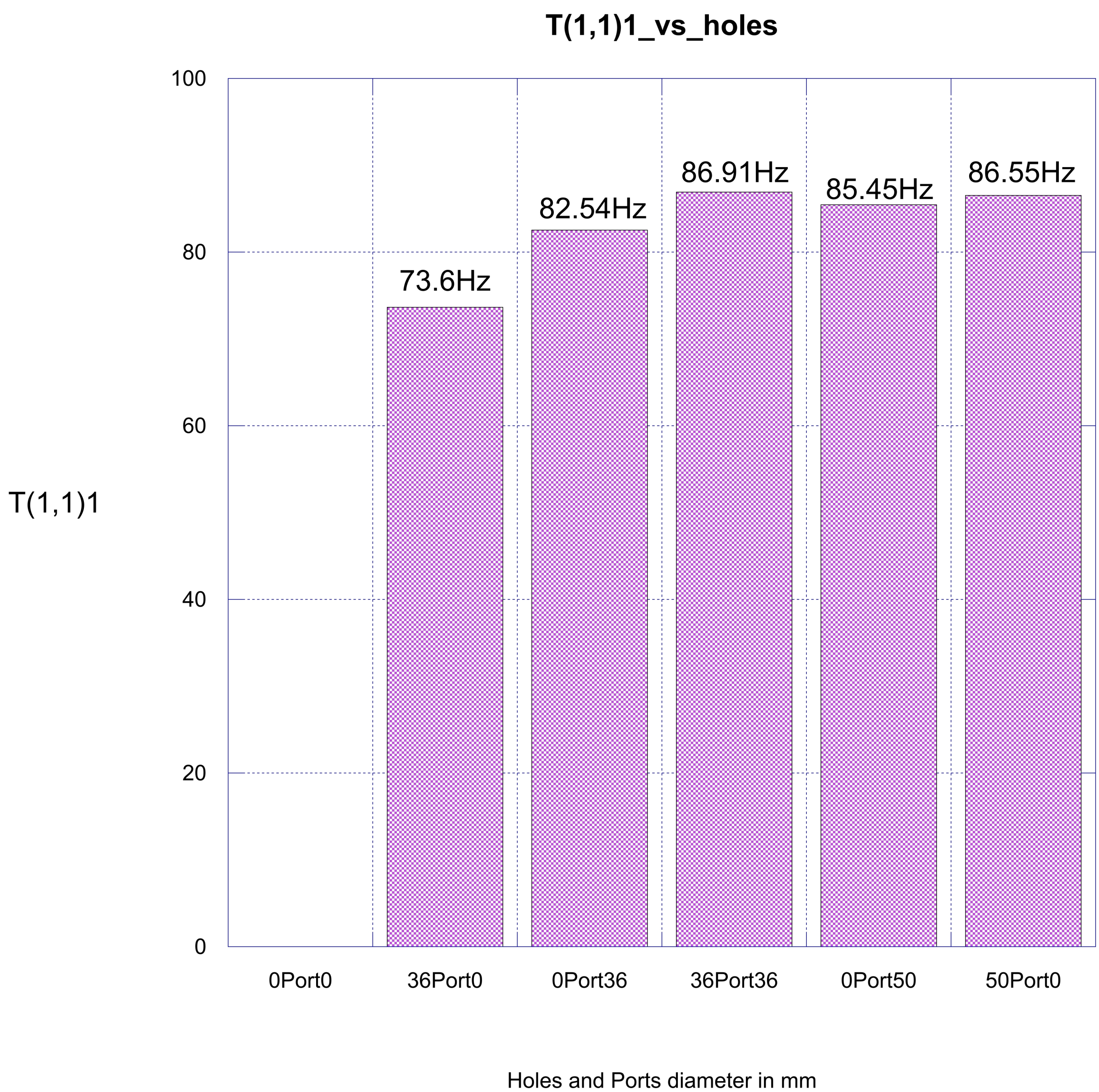
Hole size

The T(1,1)$_2$ frequency shift isn't linear and is small at normal sound hole sizes.

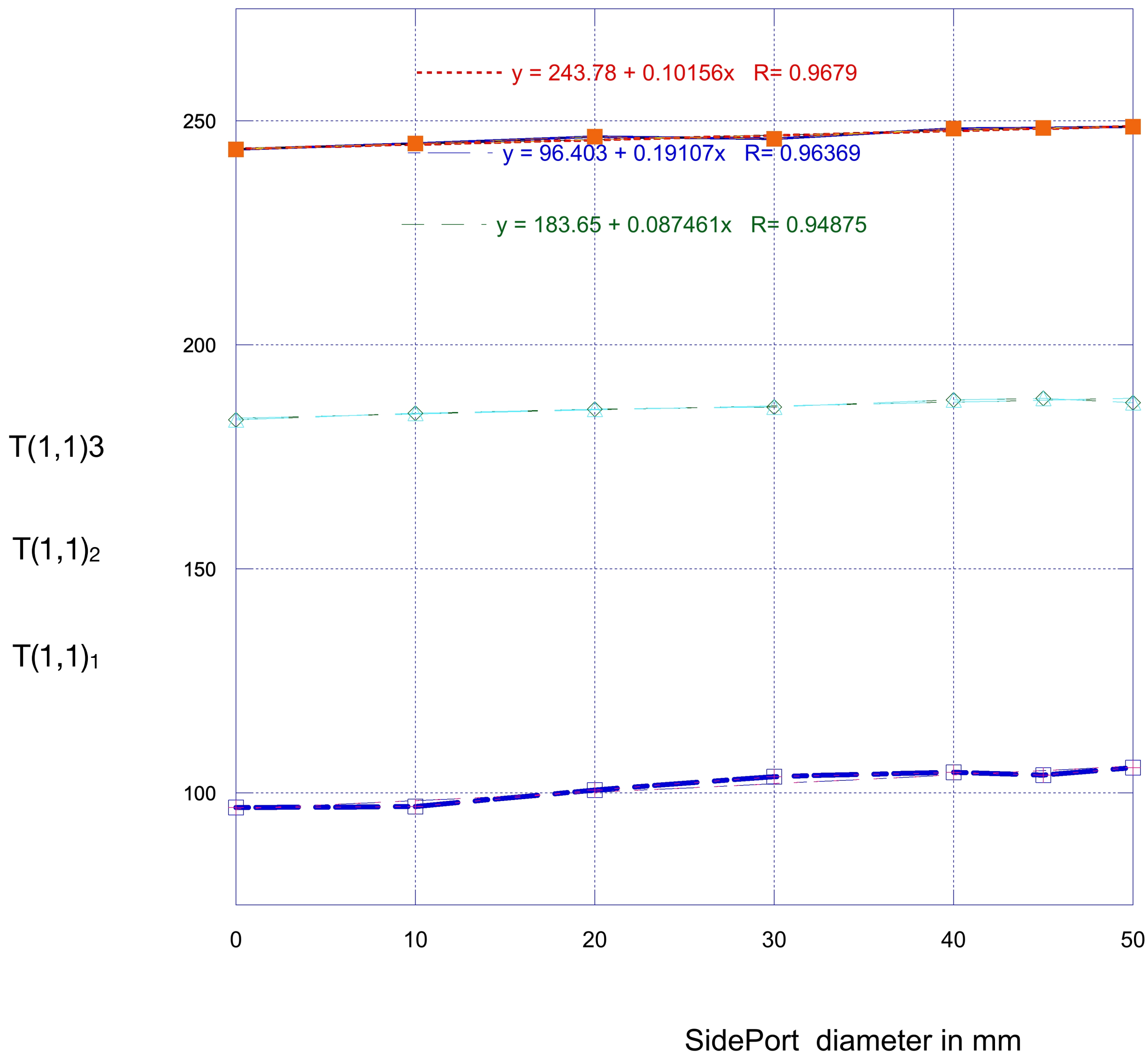
The question arises as to why the T(1,1)$_1$ frequency shifts with sound hole changes. Could it be, at least partially, because we are changing the top mass? Could it, at least partially, be due to changing the length of the edge? Hub Of Acoustics group show a shift of a few hertz by rounding the sound hole edges.They attribute this to lowering the "friction" at the edge. I think it has something to do with edge wave defraction, but though I've contemplated experiments to show this, I haven't done much but think. I digress. If the T(1,1)$_1$ shifts were due to mass change, then the shifts would be an R^2 function, but they are not. If one were to make a sound hole and a sound port with a combined area equal to a sound hole alone, one would see a greater shift in T(1,1)$_1$ than with the lone hole. This means that the mass change on the top is negligible to the frequency shift.



At this point, I should point out that ports also change $T(1,1)_2$. More on that later. If the edge length is a determining factor then a side port of size x should be the same as a sound hole size x. The last two bars on the graft compare a 50mm sound hole to a 50mm sound port. The difference is greater than my maximum error allowance.



So what does the sound port do? It shifts all of the $T(1,1)_x$ frequencies.



According to my friend Chris Jenkins there is a sweet spot where the side port works best with the top hole. He works this out with trial and error. For my guitar it would seem the curves flatten somewhere around a diameter of a round port of 30-40 mm. I haven't investigated this relationship and I'm not sure it's pertinent to most builders.

Players are mixed on their feelings on ports. Many feel that they can hear what they are playing better. Studies by Mottola seem to dispute this claim.[7] “Installing a Side Port with a Sliding Door” by David Freeman shows a clever way to fine tune frequencies.[4] This may not only be useful for moving frequencies in static situations, but also to compensate for altitude changes. No more having to move!

In conclusion, sound ports can be a useful tool for luthiers. They can be used to fine tune $T(1,1)_{1\&2}$ frequencies, compensate for altitude changes, add to a player experience or just look neat.

References:

1) Cyndy Burton, "There's a Hole in the Bucket", American Lutherie, #91,2007…Nice little history of side ports

2) Alan Carruth,"The "Corker" Guitar: A Sideport Experiment", American Lutherie, #94,2008…. Very thorough and well done.

3) Neville Fletcher, Thomas Rossing, "the Physics of Musical Instruments", 2nd Ed.,2005

4)David Freeman, “Installing a Side Port with a Sliding Door”, American Lutherie, #154, 2025

5) Trevor Gore with Robbie O’Brien, “Introduction to Modal Tuning”,2019, self published.

Trevor Gore, Gilet, Contemporary Guitar Design and Build” 2nd Ed. 2016.

6) Andrea Corsini, Simone Bonanomi, Martino Quintavalla, “Misconceptions in Lutherie”, The Looth Group, Feb. 18, 2026

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