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Musical Acoustic Comparative Study between the Double Top and Lattice Bracing guitar models by

Fernando Mazza

Abbreviated Version

Study conducted by Enrique Mateu, guitarist, and music producer,
commissioned by Fernando Mazza.

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Construction

Lattice Bracing and Double Top guitar models.

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In this musical acoustic study, the guitars being compared are the Double Top and Lattice Bracing models by luthier Fernando Mazza.

Both guitars have the soundboard constructed in an identical manner. The sides are made up of six layers of Santos Rosewood with a central layer of maple with crossed grain to generate more rigidity in the structure.

The back of these guitars is double with a nomex core. This wood and nomex composite provides rigidity without increasing the weight of the back.

The laminated soundboard increases the rigidity of the entire guitar structure, allowing the vibration energy emitted by the strings to be absorbed more intensely in the soundboard than in the rest of the guitar structure.

The bridge of the guitar is smaller than that of a traditional guitar to reduce weight and facilitate the mechanical movement of the soundboard.

Both the Lattice and Double Top models studied here have Red Cedar soundboards.

The tuners are Schaller Grand Tune and the fretboards are ebony with 20 frets on both models.

All measurements were taken using Knobloch Actives CX Carbon Medium High 400ADC strings.

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Lattice Bracing Model

This model features an extremely thin soundboard, also made of cedar or spruce wood (the one used for the study is cedar), with a lattice-like pattern in the shape of diamonds, set at a specific angle, made of balsa wood and inserted into an identical recess in the soundboard. Directly above the lattice, there is an identical structure made of carbon fiber, which is also vacuum-glued. In the photo, you can see this type of soundboard unfinished, as it does not yet have the carbon fiber.

Volume and Projection

All these measurements were conducted using Knobloch Actives CX Carbon Medium High 400ADC strings installed on both guitars.

It's worth noting that in these measurements, 0.0 decibels, dB from now on, denotes maximum volume, and -infinity, -∞ from now on, signifies the absence of sound. This means that -1.3 dB represents more volume than -2.5 dB. Conversely, -1.5 dB indicates lower sound pressure than -0.2 dB. The closer to 0.0 dB, the higher the sound pressure.

The graph illustrates a chromatic scale from the lowest note (E2) to the highest (C6) on both the Double Top and Lattice Bracing guitars. It also depicts the sound pressure (volume in decibels) of the six open strings.

For this test, two microphones were positioned 54 cm from the instrument, at the guitar's soundhole level, in an A/B configuration with an 18 cm spacing between them.

In this graph, it's evident that there is a volume difference between the Lattice Bracing and Double Top models of up to +3 dB in the bass strings and +4.8 dB in the trebles. This is a significant difference in favor of the Lattice Bracing model in terms of sound power.

From a balance perspective, the Lattice Bracing model emphasizes the trebles more, whereas in the Double Top model, the bass and trebles seem more balanced.

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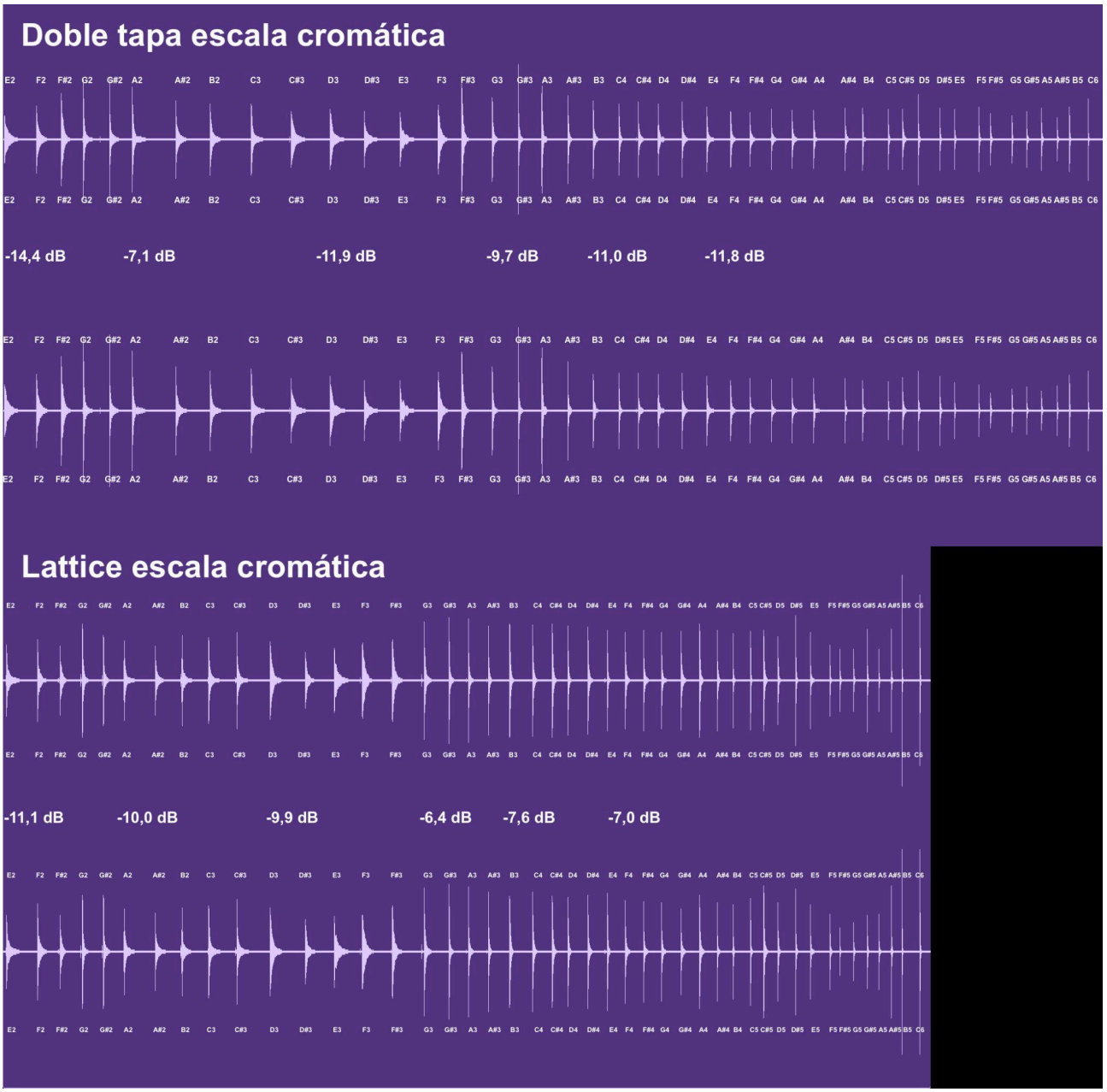

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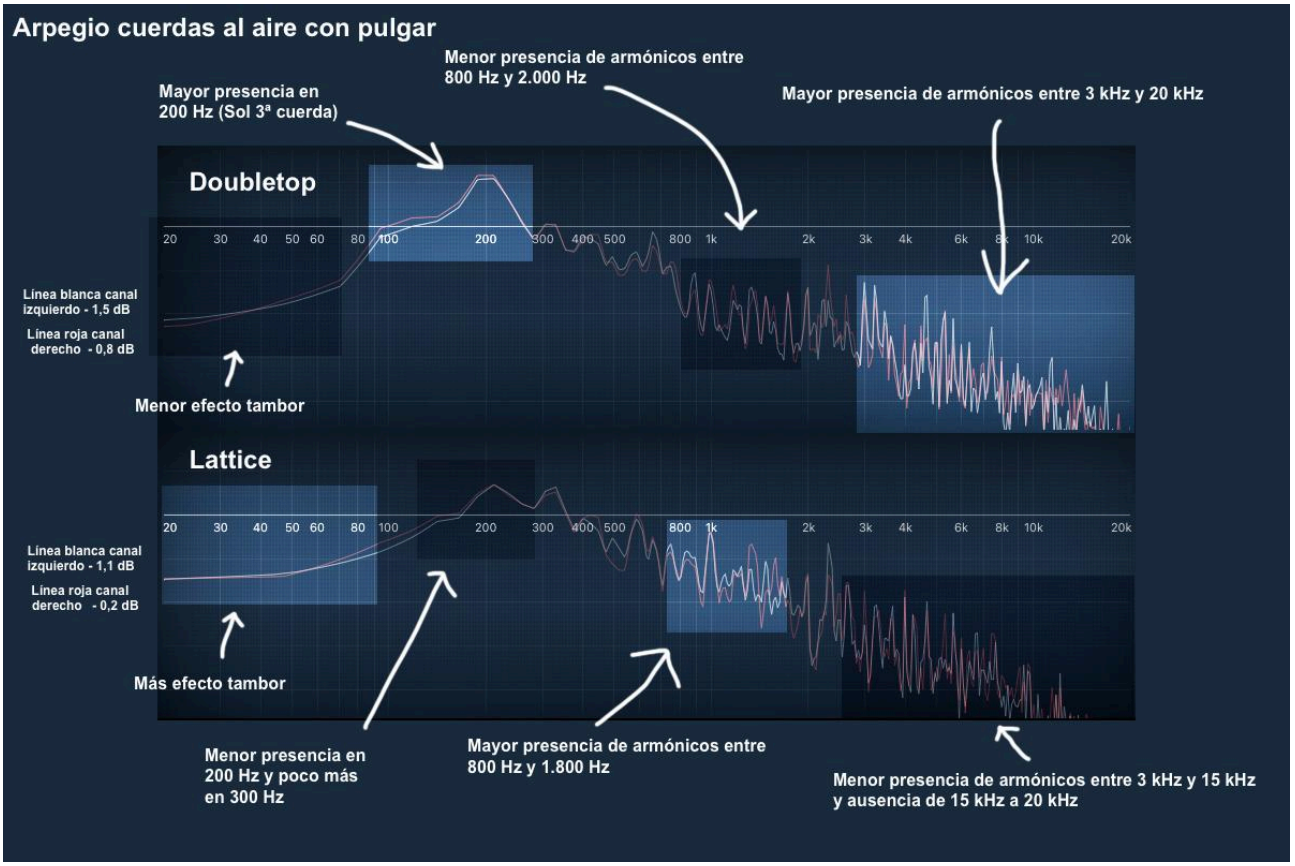
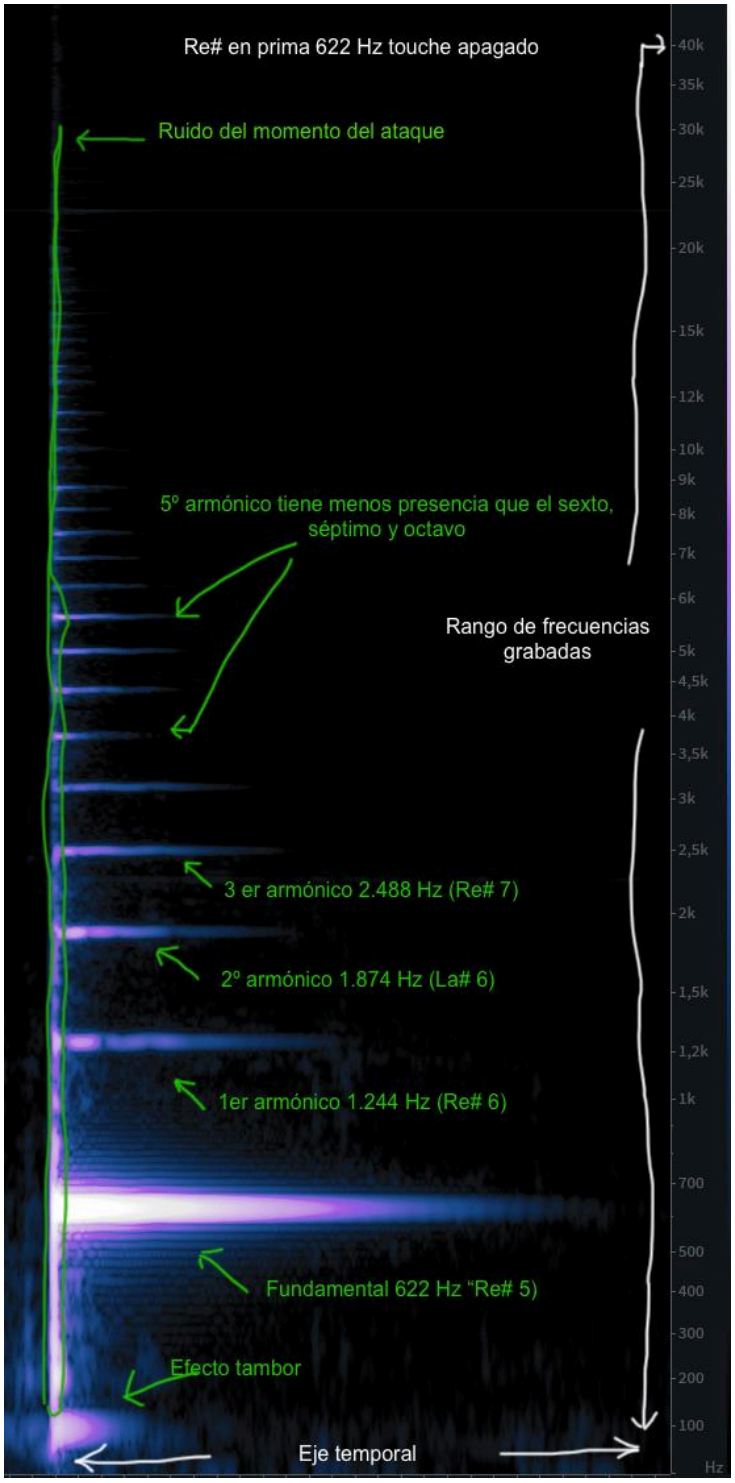
Timbre

Timbre is defined by the behavior of harmonics. In the following figure, you can observe the analysis of the harmonics of a strummed chord with open strings, recorded with two microphones positioned 54 cm away, at the guitar's soundhole level, in an A/B configuration with an 18 cm spacing between them.



The 'x' axis represents the frequency range in Hertz from 20 to 20 kHz (20,000 Hz), and the 'y' axis represents the volume. The white line represents the left channel (microphone positioned aiming under the bridge), and the red line represents the right channel (microphone positioned aiming under the end of the fretboard).

From a timbral perspective, it's noticeable that the Double Top guitar offers greater presence in the low frequencies (from 70 to 200 Hz) and in the high frequencies (from 3



kHz to 20 kHz) compared to the Lattice Bracing, where mid-range frequencies (from 800 Hz to 1,800 Hz) predominate.

This boost in the Lattice model of frequencies from 800 Hz to 1,800 Hz is what some refer to as 'nasal sound'. On the other hand, the lower presence in the Lattice of frequencies between 3 kHz and 15 kHz is what some describe as 'sweet sound'.

The Double Top model provides a more balanced sound between mid and high frequencies, offering a tone closer to the traditional, with greater transparency and definition.

In reference to the so-called drum effect, the noise produced when fingers or a plectrum strike the strings in plucked string instruments, which is clearly visible in this image, seems to be slightly more pronounced in the Lattice Bracing model.

It should be clarified that this noise is more noticeable the closer the microphones are placed to the instrument, both due to the proximity effect and the natural loss of low frequencies over distance.

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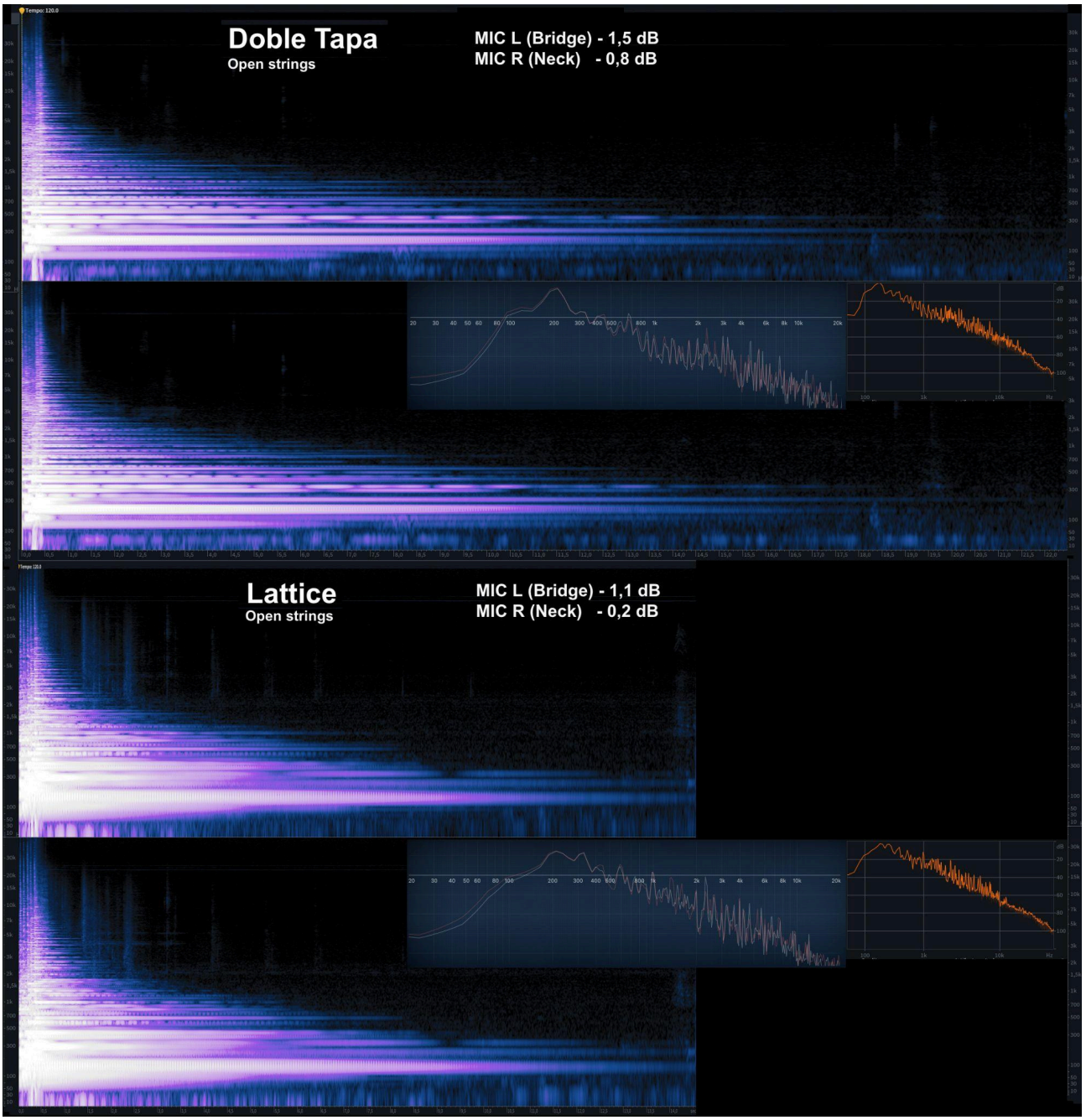

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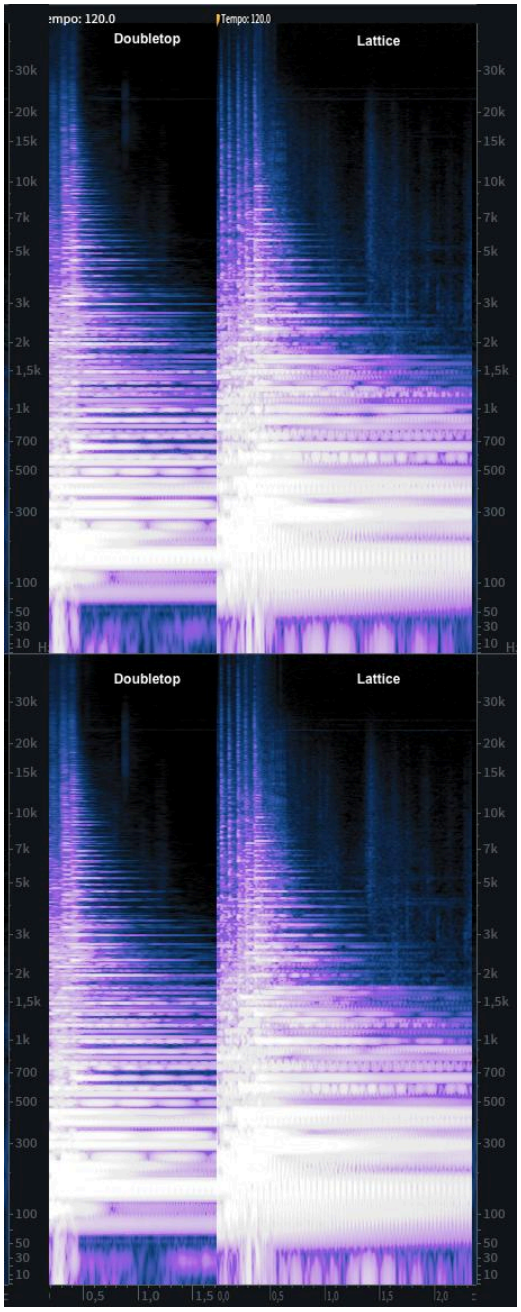

In the previous image and the one on the left, we can observe the behavior of the harmonics in both instruments when playing a chord.

Not only is there an enhancement of mid-range frequencies in the Lattice Bracing model, presumably due to the use of carbon fiber on the Australian bracing, but also a greater definition of the harmonics in the Double Top model, whereas in the Lattice Bracing model they appear more blended, with less definition, as if they were 'out of focus'.

This latter observation is particularly evident in the left image.

To interpret the spectrogram, we need to consider that on the left and right, frequencies range from 0 Hz to 40,000 Hz (humans only hear from 20 to 20,000 Hz), representing the 'y' axis. The 'x' axis represents time in seconds. The color white represents the maximum energy (volume) from 0.0 to -42.0 dB, purple represents average volume from -42.0 dB to -64.0 dB, blue represents low volume from -64.0 dB to -100.0 dB, and black represents an appreciable absence of sound.

In the following tests, we will observe the response of both instruments when modifying the plucking area: "touche" when plucking the string over the end of the fingerboard; "mouth" when plucking over the beginning of the soundhole (the area closest to the bridge), and "ponticello" when plucking near the bridge. For these tests, the strings were always plucked with the same finger (middle) using the 'rest stroke' technique to minimize the human factor. Recorded with a microphone 50 cm from the instruments.

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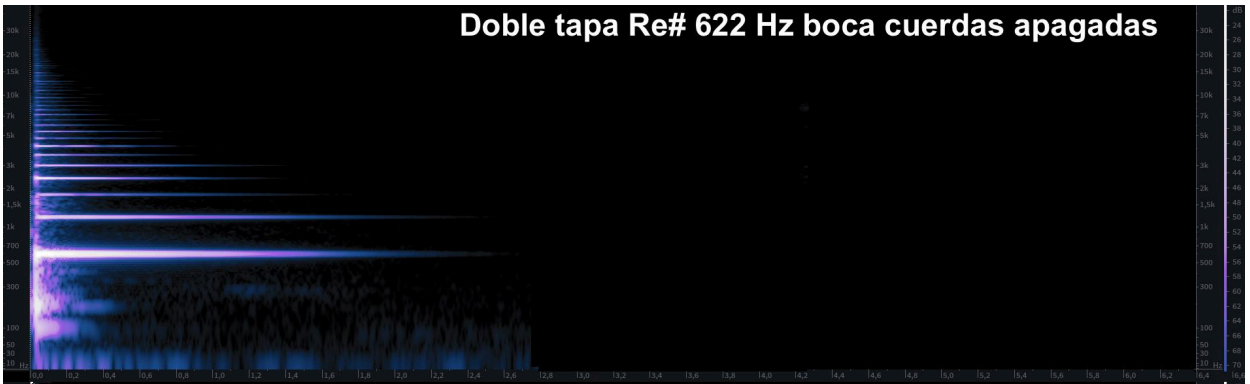

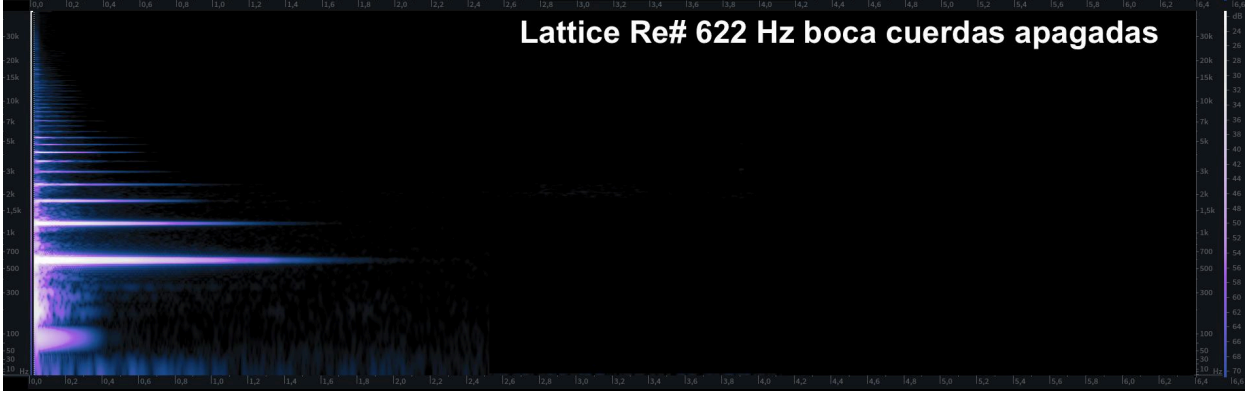

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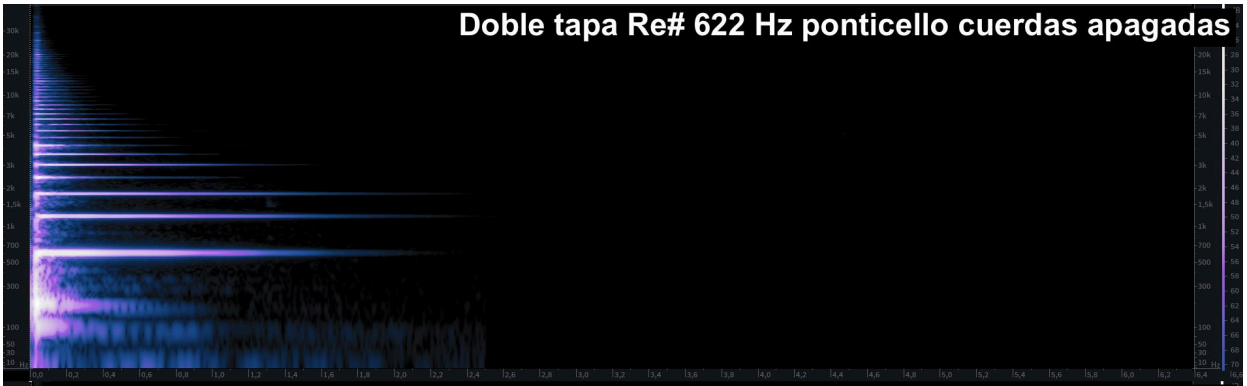

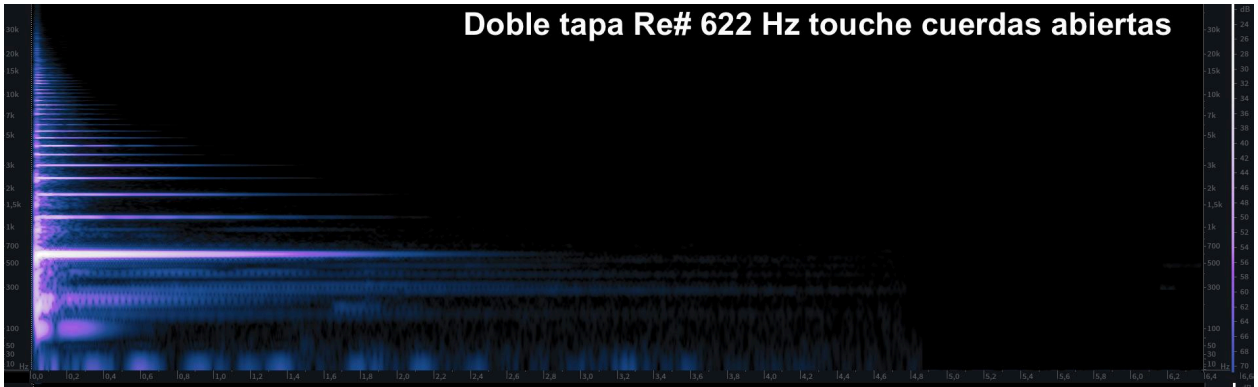

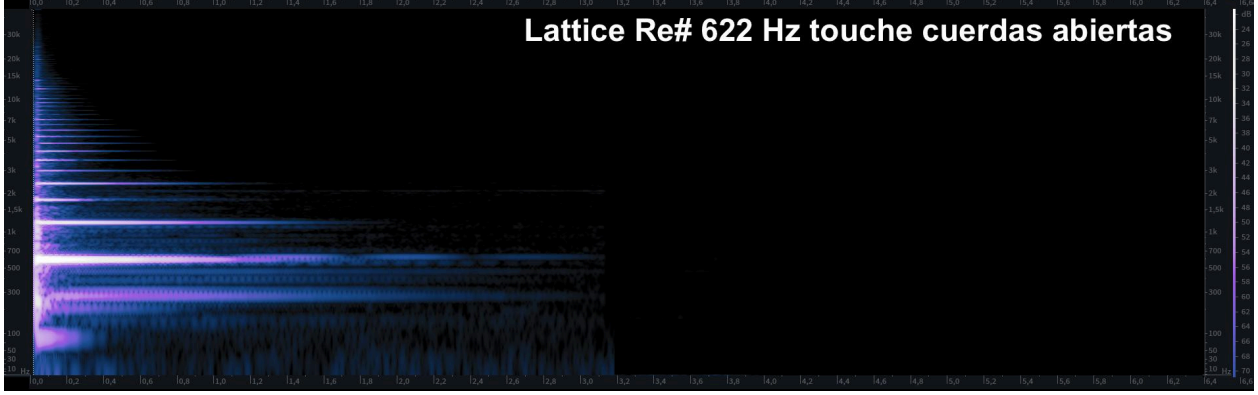

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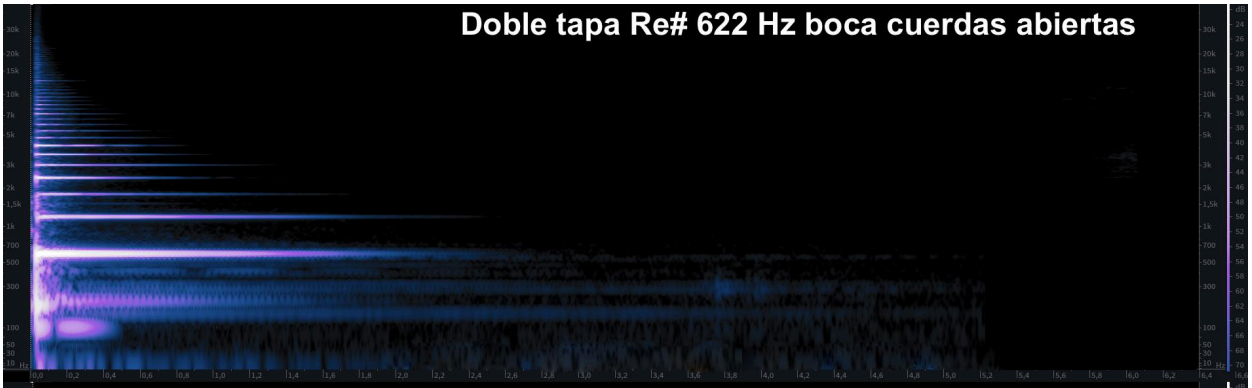

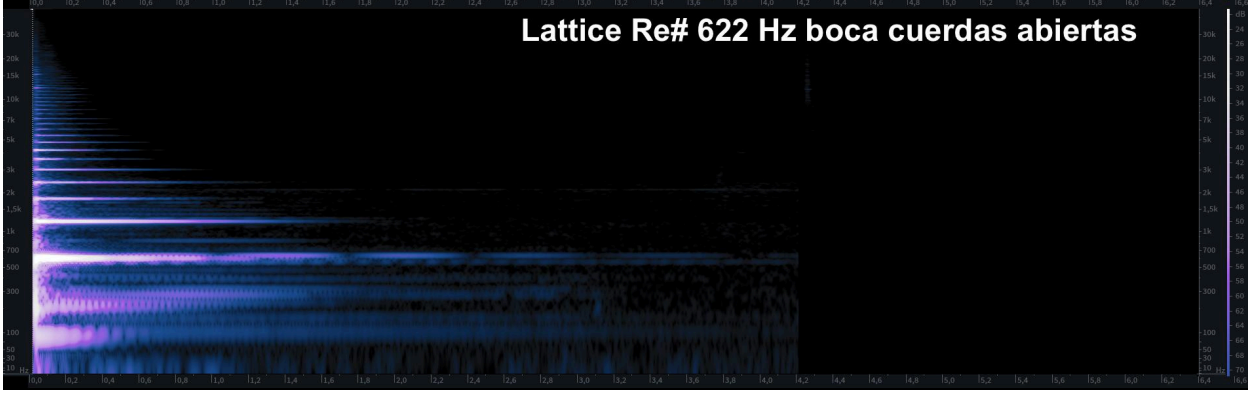

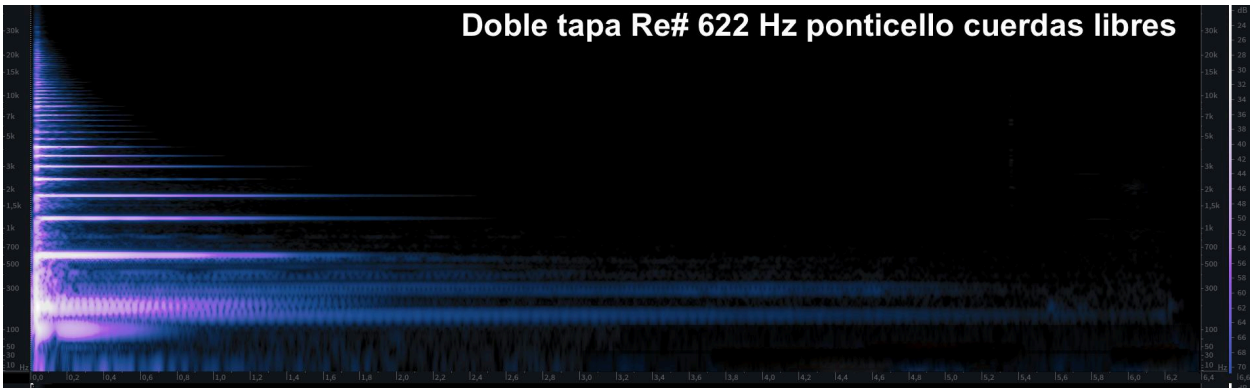

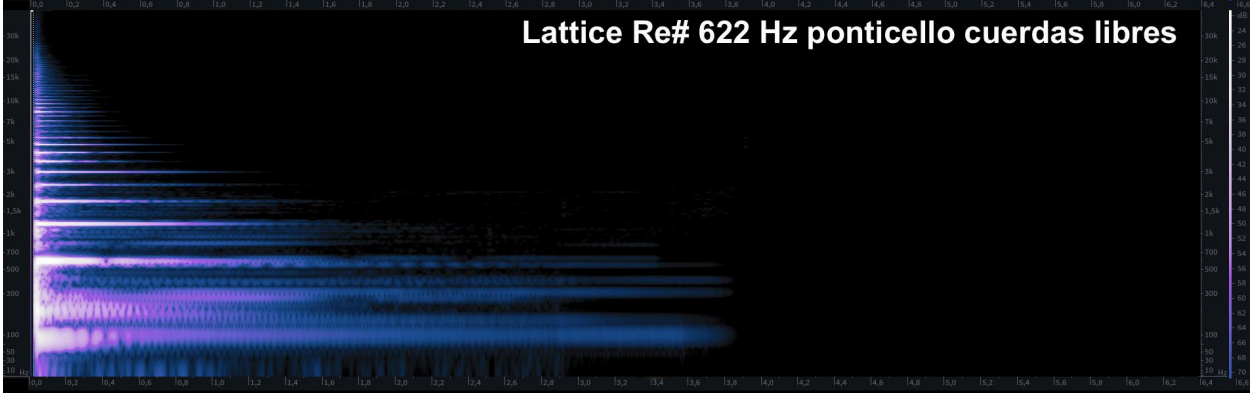

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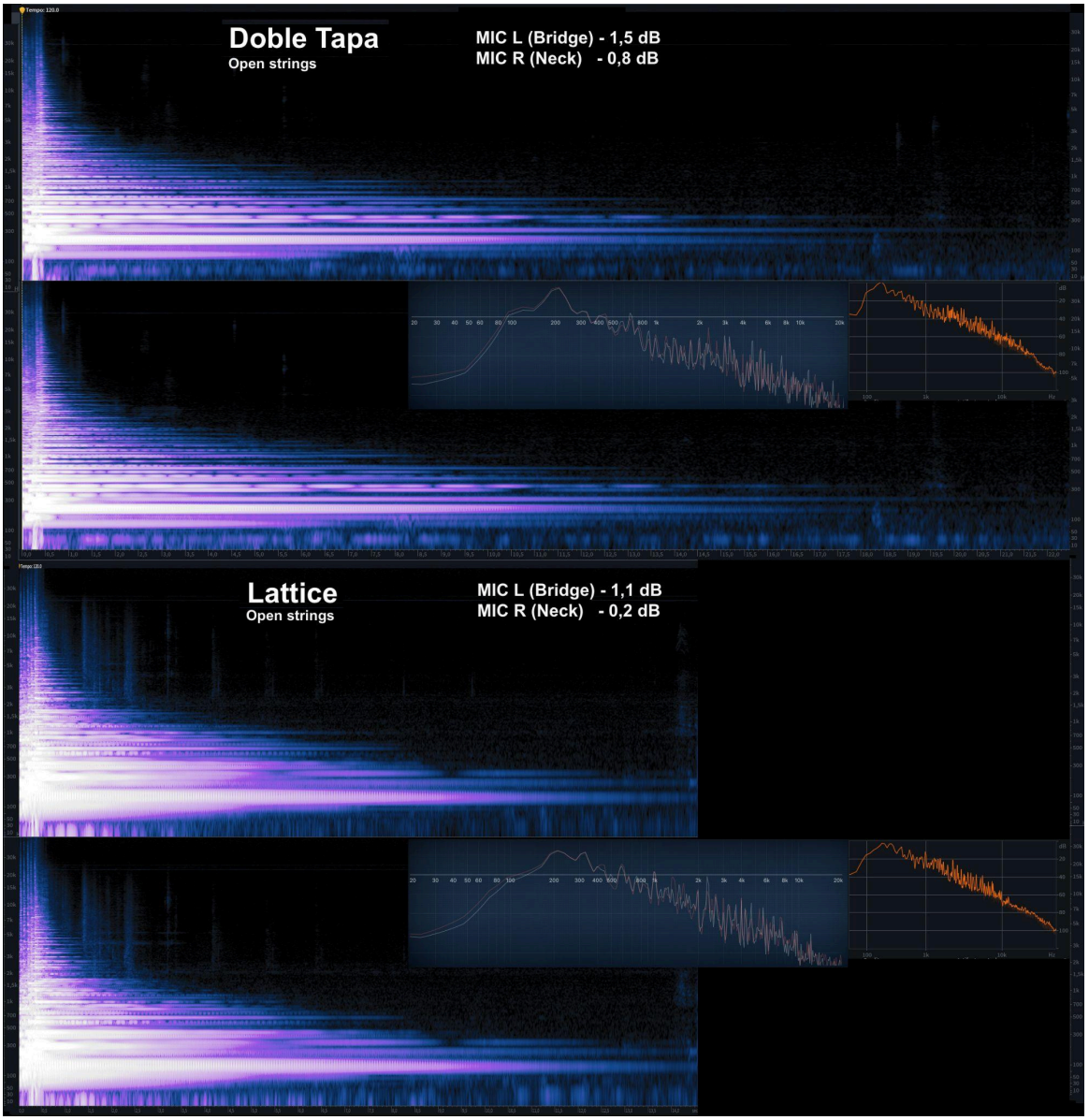
In these graphs, we can observe how the Double Top model responds slightly better to timbre changes than the Lattice Bracing model, although both guitars respond well to these nuances.

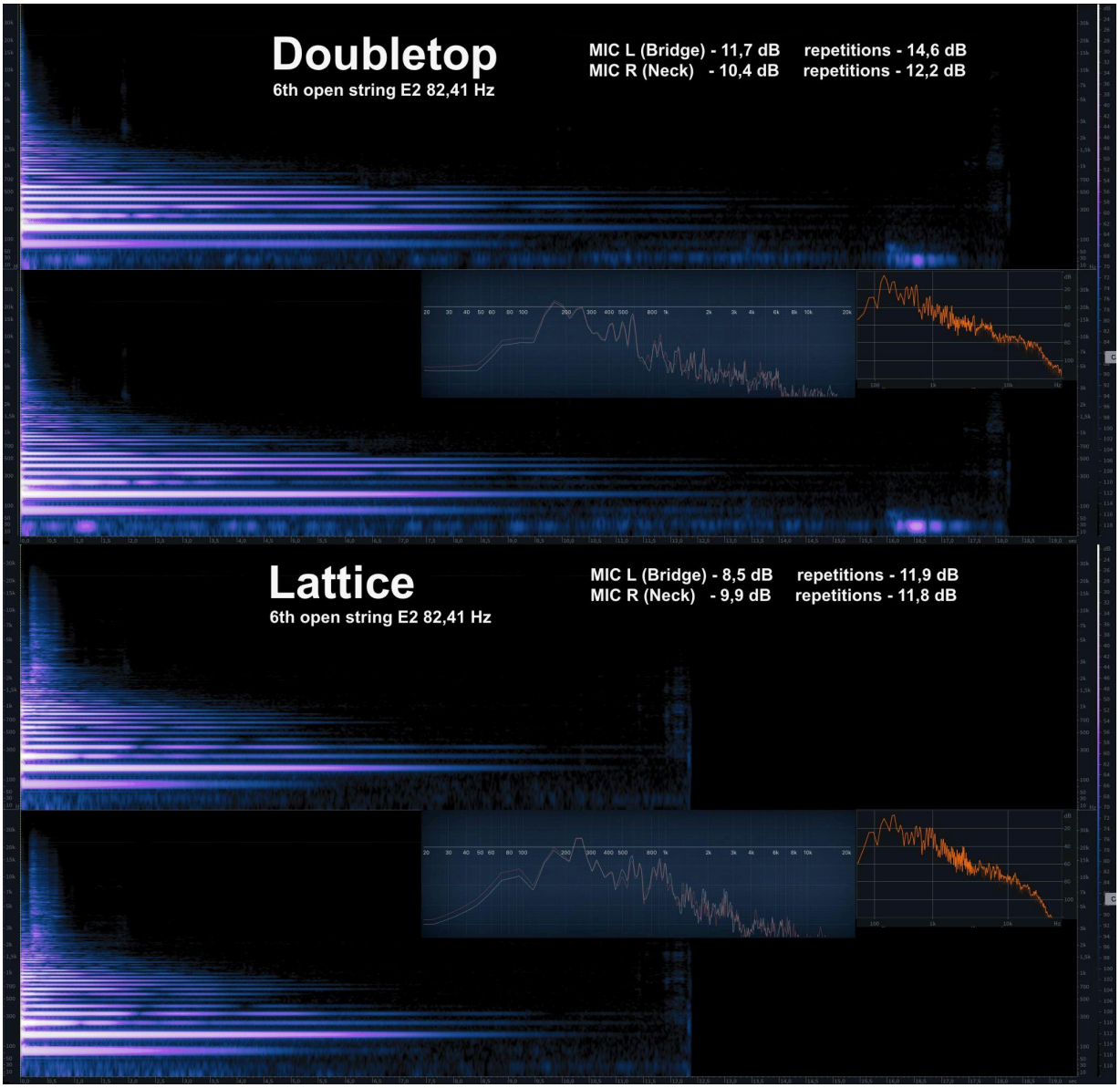
Sustain and decay

Now, let's analyze the graphs from the perspective of sustain and decay of the sound, which refers to the resonance and the time the strings remain vibrating.



In the previous graph, two aspects are clearly observed: Firstly, the Double Top model provides greater sustain compared to the Lattice Bracing model, and secondly, the decay or drop of harmonics is more pronounced in the Lattice.

In the following images, we will analyze this behavior for individual strings.



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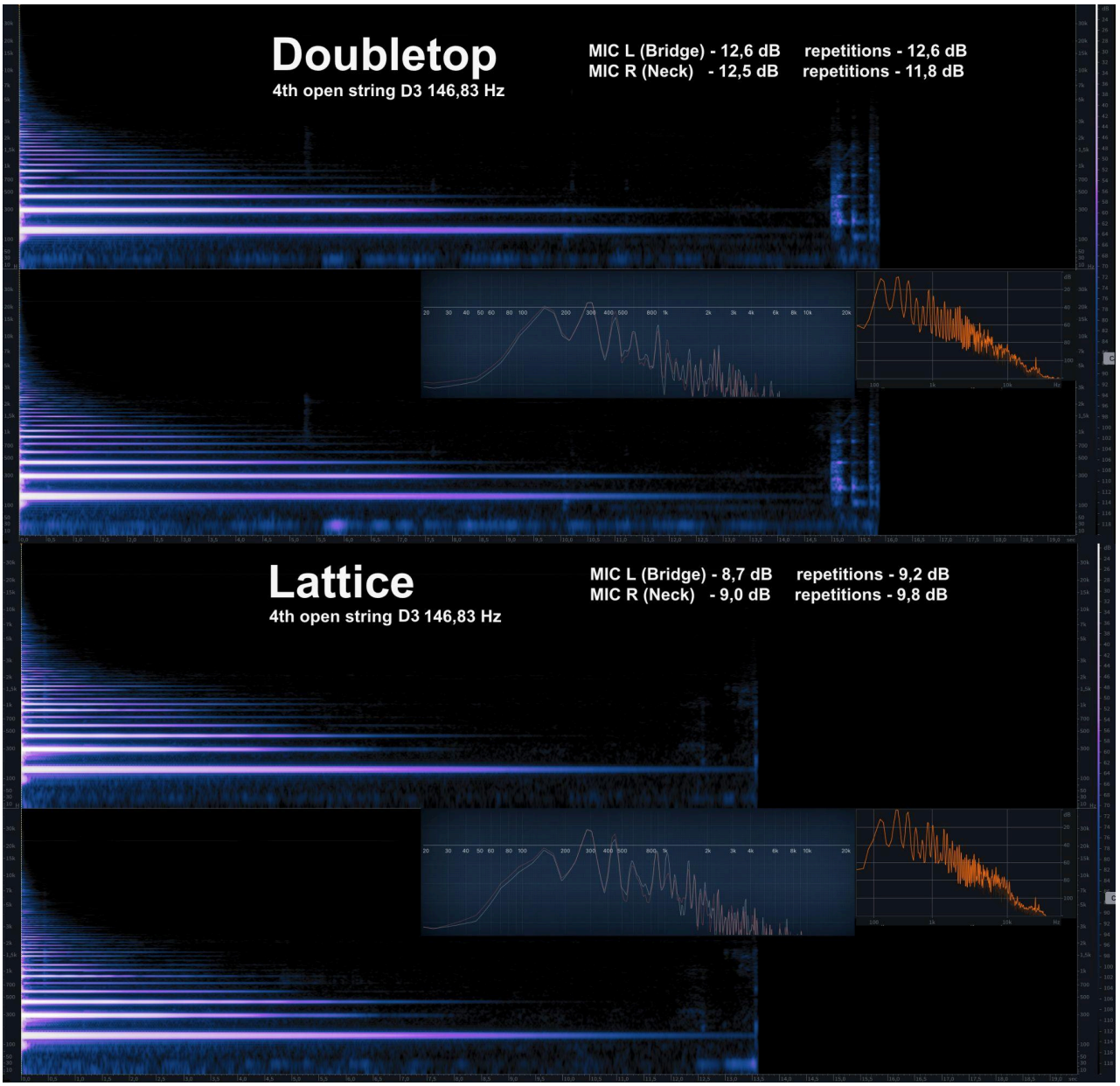

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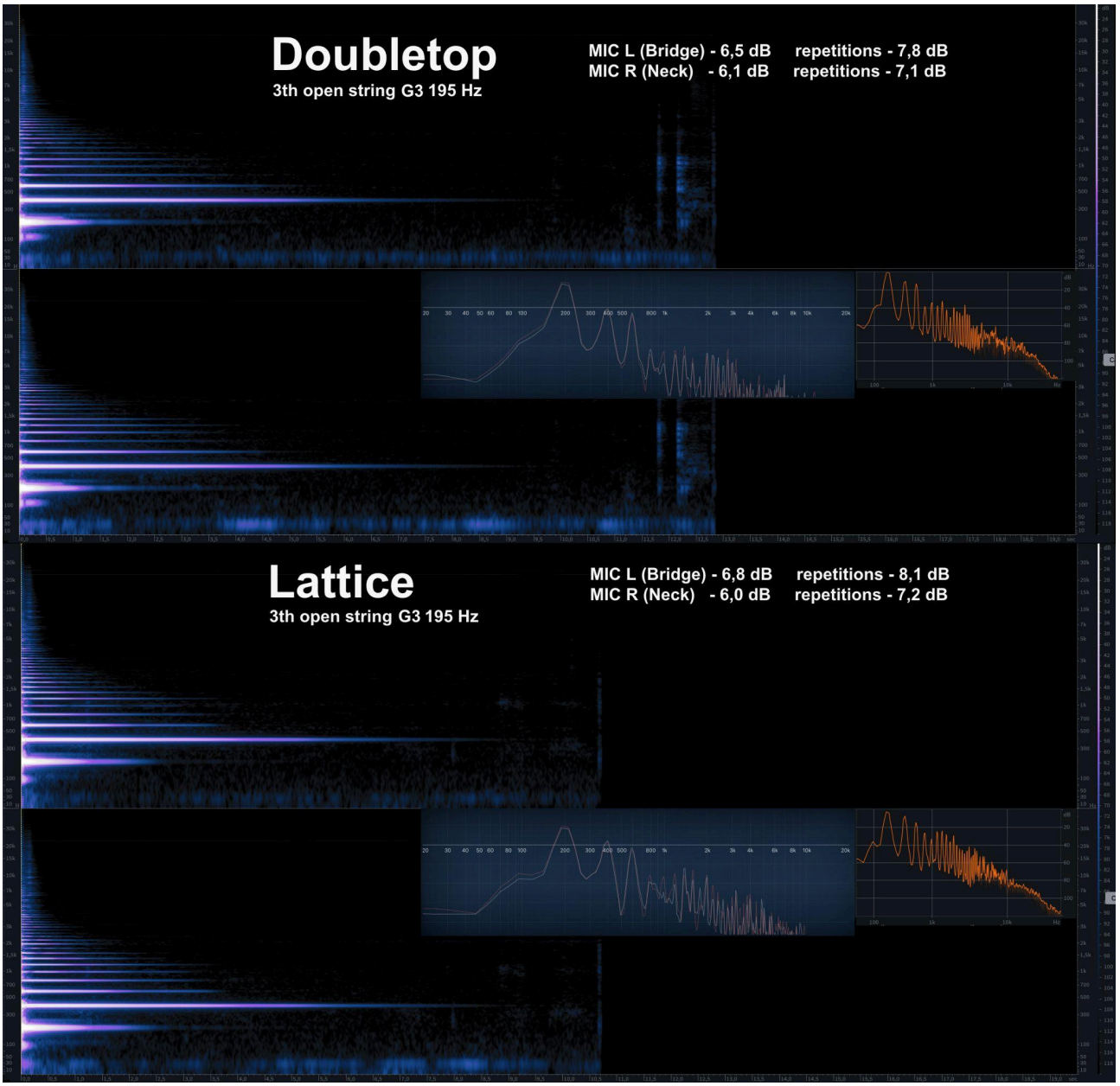

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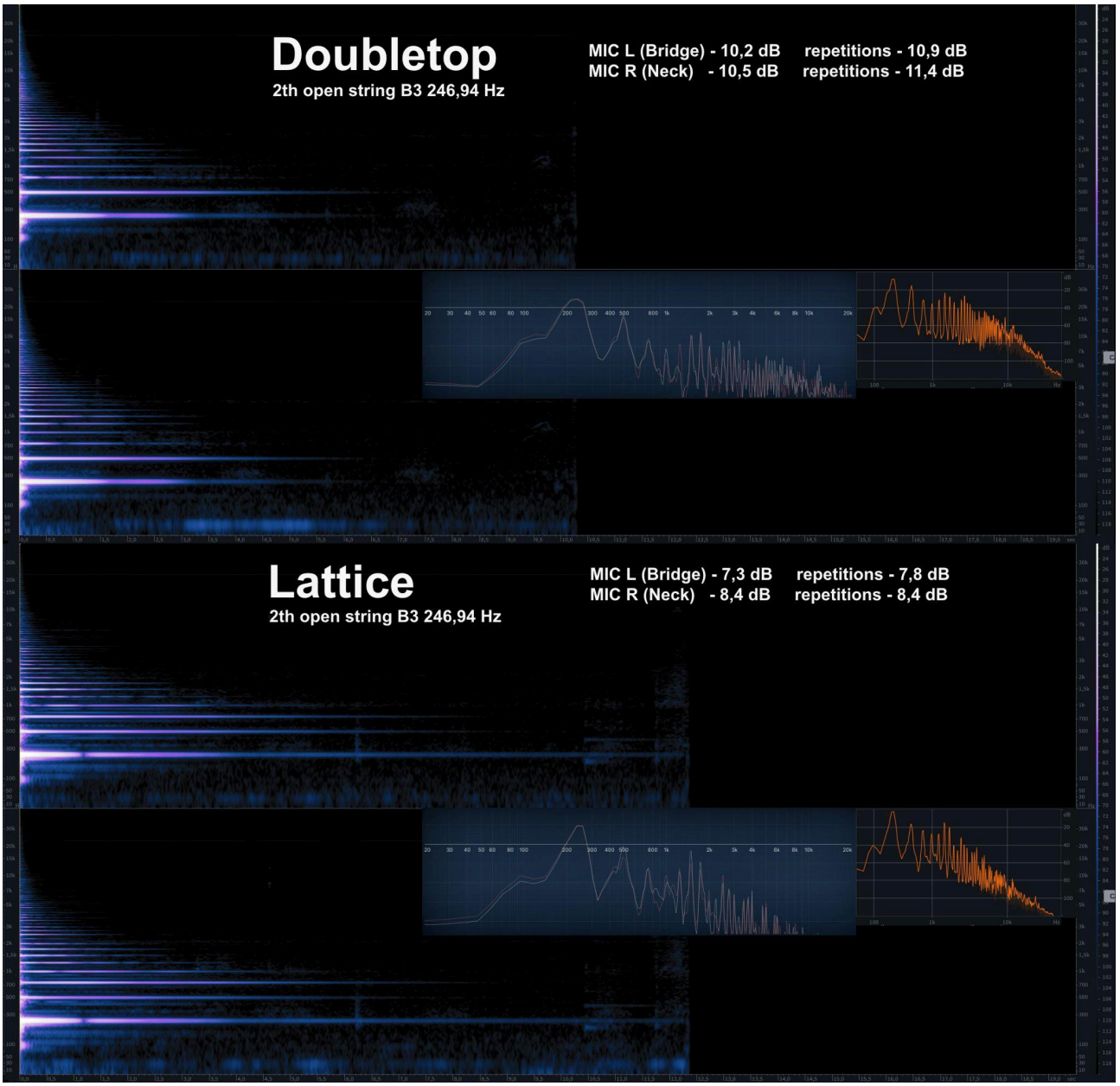

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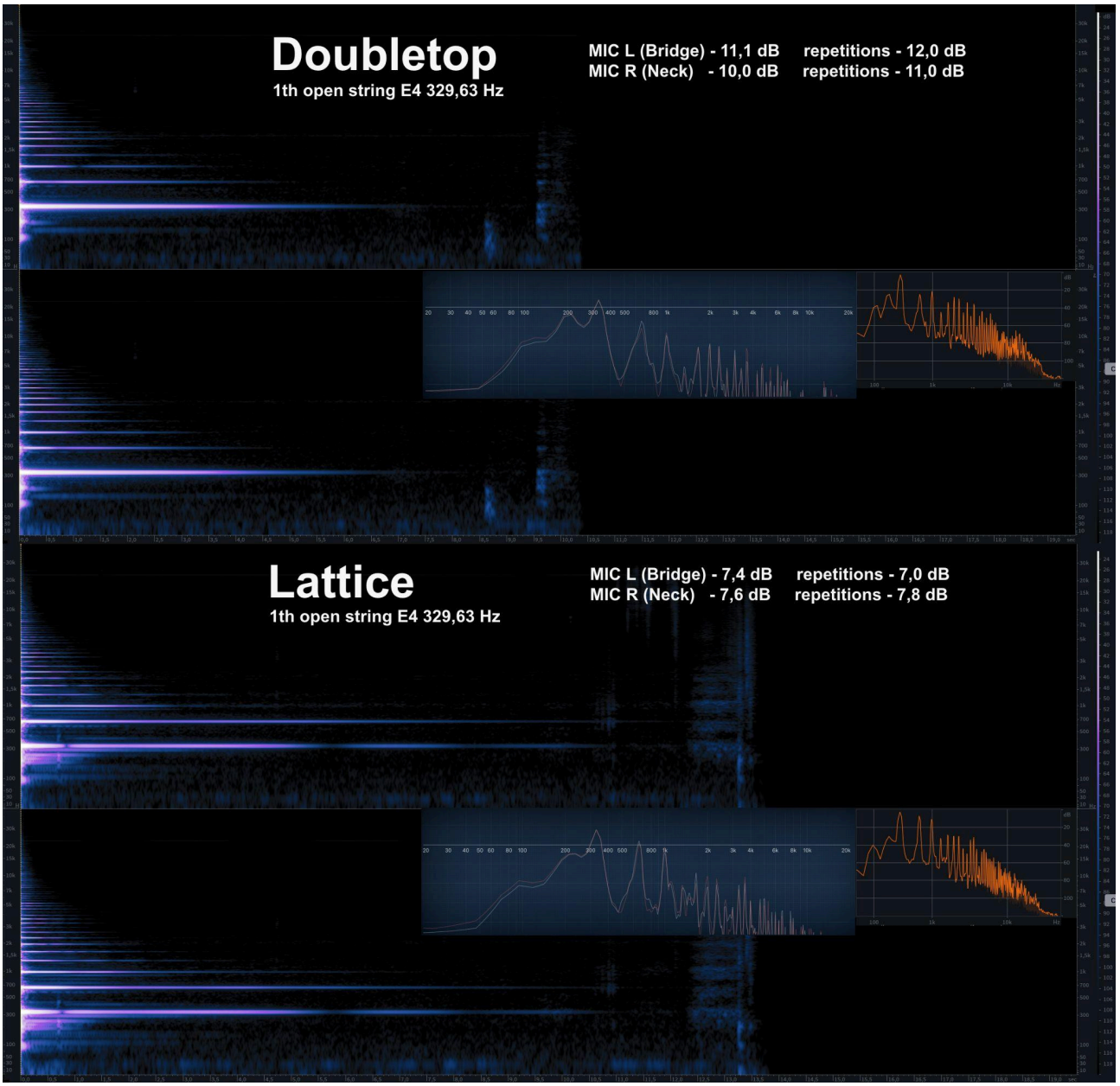

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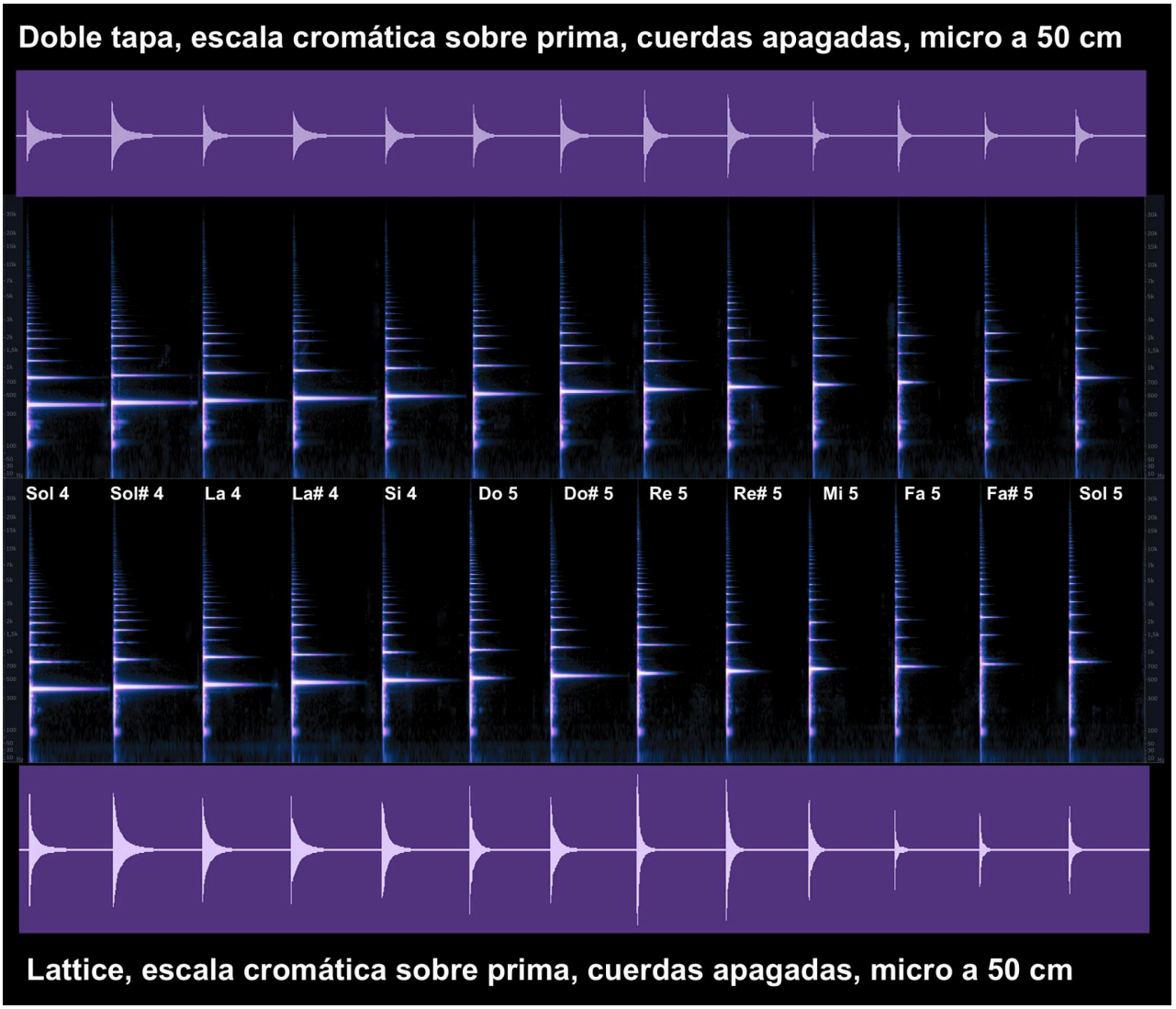
Analyzing the results of the six previous tests, it can be observed that the Double Top model exhibits greater sustain in the bass strings, while the Lattice Bracing model excels in the trebles. However, the decay in the harmonics remains better in the Double Top across all registers.

It's also essential to consider a psychoacoustic effect: As demonstrated clearly in all tests, the Lattice Bracing model boasts notably higher sound power than the Double Top. Logically, with more initial volume, one would expect the resonance to last longer under equal conditions. In other words, if we play forte on the same instrument, the strings would vibrate longer than if we played pianissimo. However, despite the Lattice emitting more power, the sound dissipates earlier. Additionally, considering that the harmonics also fade sooner in the Lattice, the final impression is that, even though the trebles may have more sustain, the Double Top always provides the sensation of much more sustain and longer decay in the harmonics, akin to what some describe as a "piano-like sound."

In the following graph, we'll observe the behavior of both instruments across a chromatic scale on the first string, starting from G#4 to G#5.

In this image, it's evident that from A#4 onwards, the Double Top once again exhibits greater sustain than the Lattice while maintaining its harmonics. Moreover, it's noticeable that the Lattice still emits much more volume than the Double Top.

It's worth noting that on the first string, the drum effect seems slightly more pronounced in the Double Top model than in the Lattice Bracing. However, this difference is minimal. Nonetheless, in the other strings, as previously observed, it's the Lattice Bracing that has slightly more presence.



Feelings and Summary

This study was conducted exclusively using one guitar of each model, so the results are based on these two instruments. If the study were conducted with ten guitars of each model, there might be slight variations, but not very significant.

The aim is to outline general trends between two models that utilize distinct construction systems in their soundboards, giving them different personalities.

Both models are, in appearance and aesthetics, practically identical.

In terms of weight, both are around 1.8 kilograms, with the Double Top being slightly heavier.

Regarding action, they are practically identical, although the neck thickness of the Lattice Bracing model is thinner, making it more comfortable to play.

The Lattice Bracing model surprises and impresses with its quick response to musical gestures, nuanced dynamics, and responsiveness to legatos, vibratos, etc.

On the other hand, the Double Top model seems to demand a bit more effort from the player to respond to musical gestures and nuances, although it responds better to changes in timbre between touche, boca, and ponticello.

Comparatively speaking, both guitars are extremely comfortable and versatile, but the Lattice Bracing model gives the impression of requiring less effort. This is likely due to the extremely thin soundboard, which responds like the skin of a drum to the slightest gesture.

In terms of volume, the Lattice Bracing has been able to emit up to 5 decibels more in some of the tests compared to the Double Top. However, it's worth noting that the Double Top emits more volume than any conventional guitar.

The timbre of the Double Top is more defined, transparent, and balanced, allowing each string to be better understood in chords and arpeggios. The timbre of the Lattice Bracing is more nasal and has less brightness, which makes it blend better by losing presence in the high frequencies and enhancing the midrange.

From the perspective of sustain and decay in the harmonics, the Double Top performs much better. Only in the trebles does the Lattice Bracing slightly improve.

In summary, these are two top-class guitars with distinct characteristics. Depending on the style and needs of the musician, one may be more appealing than the other. However, for someone looking to tackle different styles, the best option is to have both models since each offers features that the other cannot provide.

For a more in-depth study, you can refer to the following link https://inexart.com/wp-content/uploads/2024/04/Comparativa-Doble-tapa-y-Lattice-de-Fernando-Mazza-EN-.pdf and watch two videos, one more musical and the other more technical, to hear the differences and draw your own conclusions. Here are their YouTube links:

- Double Top vs Lattice Bracing Fernando Mazza's guitar / Enrique Mateu (producer and guitarist) https://youtu.be/4m7t5VJTFnA
- Double Top guitar vs Lattice Bracing guitar technical video. Fernando Mazza (luthier) / Enrique Mateu (producer and guitarist) https://youtu.be/lKe-aEtE1XA

Study Characteristics

The study was conducted using DPA 4011A microphones, Millennia HV-3C preamps, Apogee Ensemble converters, Logic X Pro software, and iZotope applications.

The microphones were positioned in the specified areas for each test. For all measurements, the samples were repeated up to a dozen times to minimize human error.

Study conducted by guitarist and music producer Enrique Mateu at his Estudio Paraíso between February and April 2024.