HOW MIC PLACEMENT AFFECTS TONE

The Effect of Various Close Microphone Placements on the Reproduced Timbre of Some Acoustic Musical Instruments

by Bruce Bartlett

Suppose you're going to mike a fiddle, upright bass, or a guitar. Which mic should you choose? Where should you place it?

Your mic technique has a powerful effect on the sound of your recordings and your amplified sound through a PA system. In this article we'll look at how mic choice and placement affect the sound you pick up from various acoustic instruments. To get a good sound, you need to start with an excellent mic and mount it on your instrument where it sounds good.

Which Mic Should I Use?
If you want an accurate or natural sound, first go for a microphone with a wide, flat frequency response. Such a mic reproduces the true timbre of the instrument -- its fundamental frequencies and harmonics, and how loud they are relative to each other.

The Bartlett Spark microphone is a miniature condenser mic with a basically flat frequency response from 40 Hz to 20 kHz. It covers the entire range of frequencies that most acoustic musical instruments produce. With its omnidirectional (all-around) pickup pattern, it captures all the parts of the instrument more evenly than a directional mic would do -- such as cardioid or supercardioid mic. Also, an omni michas less handling noise and wind noise than a cardioid mic.

The Effect of Close Miking
Miking an instrument up close, or on its surface, can color its tone quality as heard through a PA system. If you mike very close, you might hear a bassy or honky tone instead of a natural sound. Why? Most musical instruments are designed to sound best at a distance, at least 1 foot away. The sound of an instrument needs some space to develop. A mic placed a foot or two away tends to pick up a well-balanced, natural sound. That is, it picks up a blend of all the parts of the instrument that contribute to its character or timbre.

Think of a musical instrument as a loudspeaker with a woofer, midrange, and tweeter. If you place a mic a few feet away, it will pick up the sound of the loudspeaker accurately. But if you place the mic close to the woofer, the sound will be bassy. Similarly, if you mike close to an instrument, you emphasize the part of the instrument that the microphone is near. The tone quality picked up very close may not reflect the tone quality of the entire instrument.

Suppose you place a mic next to the sound hole of an acoustic guitar, which resonates around 80 to 100Hz. A microphone placed there hears this bassy resonance, giving a boomy timbre that does not exist at a greater miking distance. To make the guitar sound more natural when miked close to the sound hole, you need to roll off the excess bass on your mixer, or use a mic with a bass rolloff in its frequency response.

Usually, you get a natural sound if you put the mic as far from the source as the source is big. That way, the mic picks up all the sound-radiating parts of the instrument about equally. For example, if the body of an acoustic guitar is 18 inches long, place the mic 18 inches away to get a natural tonal balance. If this sounds too distant or hollow, move in a little closer.

In PA situations, however, miking at that distance can cause feedback because you need to turn up the microphone quite a bit to hear it. The Spark Mic is meant to be mounted directly on the

surface of the instrument, so it picks up a loud sound. Then you don't need to turn up the mic so much, and feedback is less likely to happen.

Where Should I Place the Mic?
Suppose you mount a mic on an instrument. If you move the mic left, right, up, or down, you change the tone quality. In one spot, the instrument might sound bassy; in another spot, it might sound natural, and so on. So, to find a good mic position, simply place the mic in different locations—and listen to the results—until you find one that sounds good to you.

Why does moving the mic change the tone quality? A musical instrument radiates a different tone quality in each direction. Also, each part of the instrument produces a different tone quality.

It pays to experiment with all sorts of mic positions until you find a sound you like. There is no one right way to place the mics because you place them to get the tonal balance you want.

Miking Experiments With Acoustic Instruments
To determine some useful mic locations on an acoustic guitar, Bartlett Microphones engineers ran extensive measurements of the spectrum of an acoustic guitar as picked up in various mic locations. The spectrum of a musical instrument is its output level vs. frequency - its fundamental frequencies and harmonics, and their relative levels.

To establish a natural-sounding reference, we recorded an acoustic guitar with a lab-reference omni mic one foot away (ACO Pacific 7062PH). This mic has a ruler-flat frequency response. At the same time, we recorded with the Spark Mic on the guitar. We placed the Spark Mic in various locations, and measured the guitar's spectrum (fundamental and harmonic frequencies). Finally , we compared the reference spectrum to that of the Spark Mic.

The results show the differences in bass, midrange and treble between the reference mic one foot away and the Spark Mic on the guitar. They describe the timbre or tone quality picked up in various mic placements. We also ran listening tests with 10 trained listeners and musicians. They described how each mic placement sounded compared to the reference.

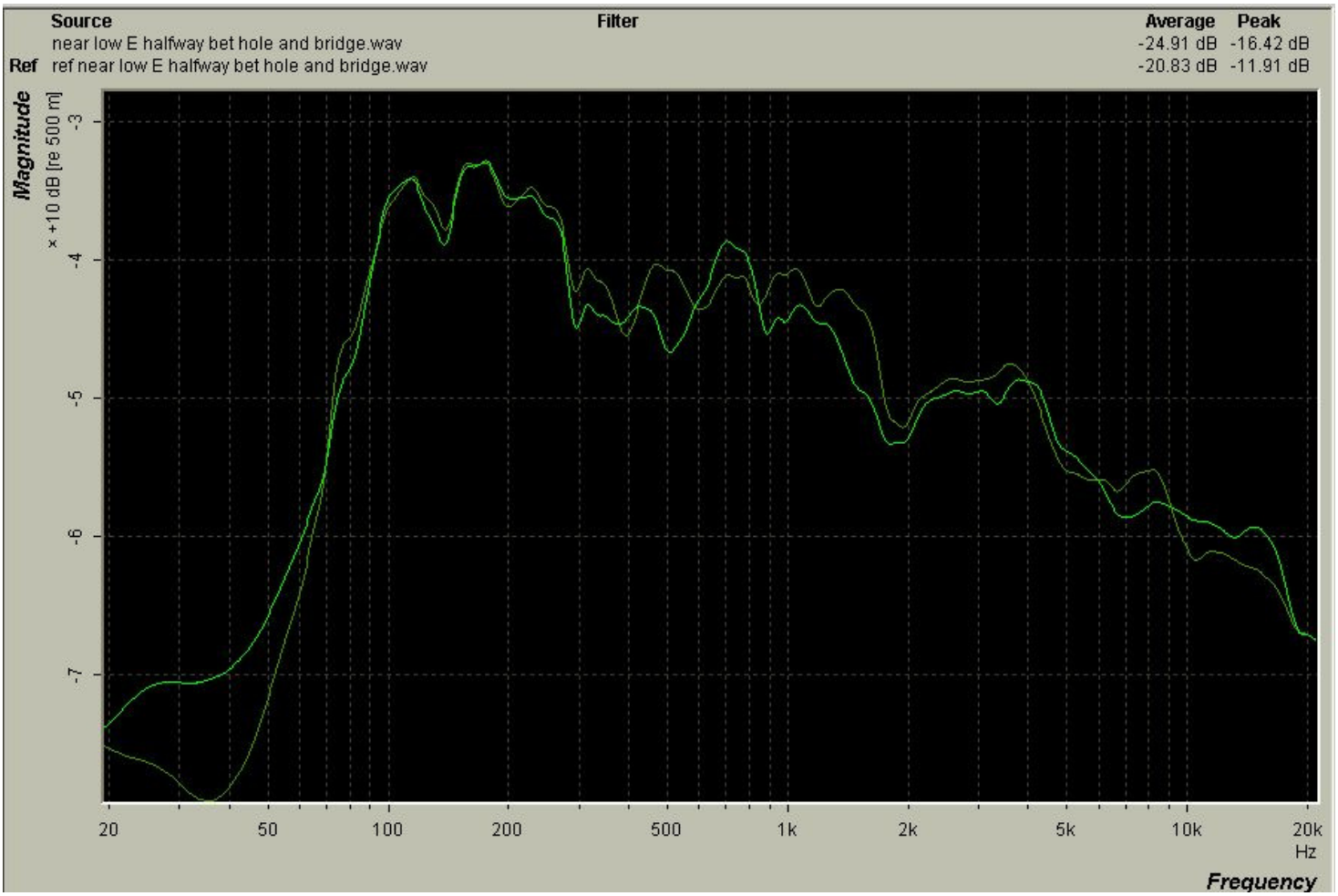
The results shown in the research paper are for one guitar. Since every guitar is different, these measurements are meant to indicate general trends, and do not apply the same to every guitar.

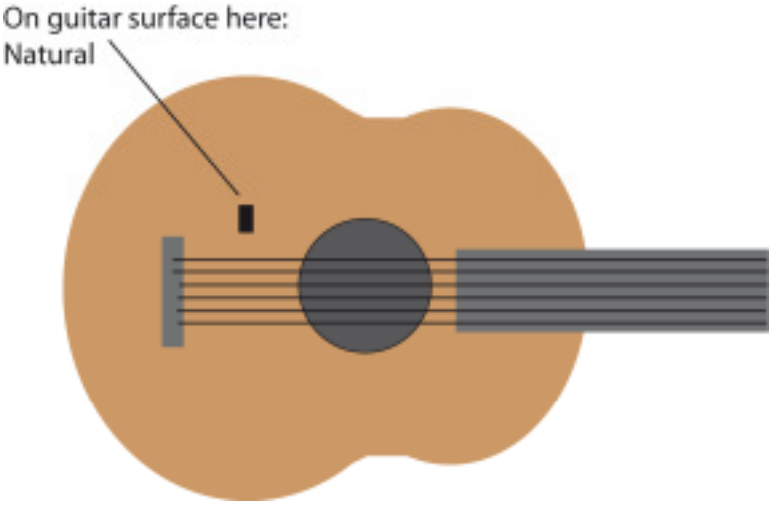
We repeated this experiment for other musical instruments: a mandolin, open-back banjo, resonator banjo, fiddle, and upright bass. Again, every instrument is different, so these measurements are not identical for every instrument, but they do show general trends.

In the screen capture on the next page, we superimposed the reference mic spectrum and the Spark Mic spectrum on the same graph. You can see in the graph how mic placement affects the spectrum, which affects the timbre you hear.

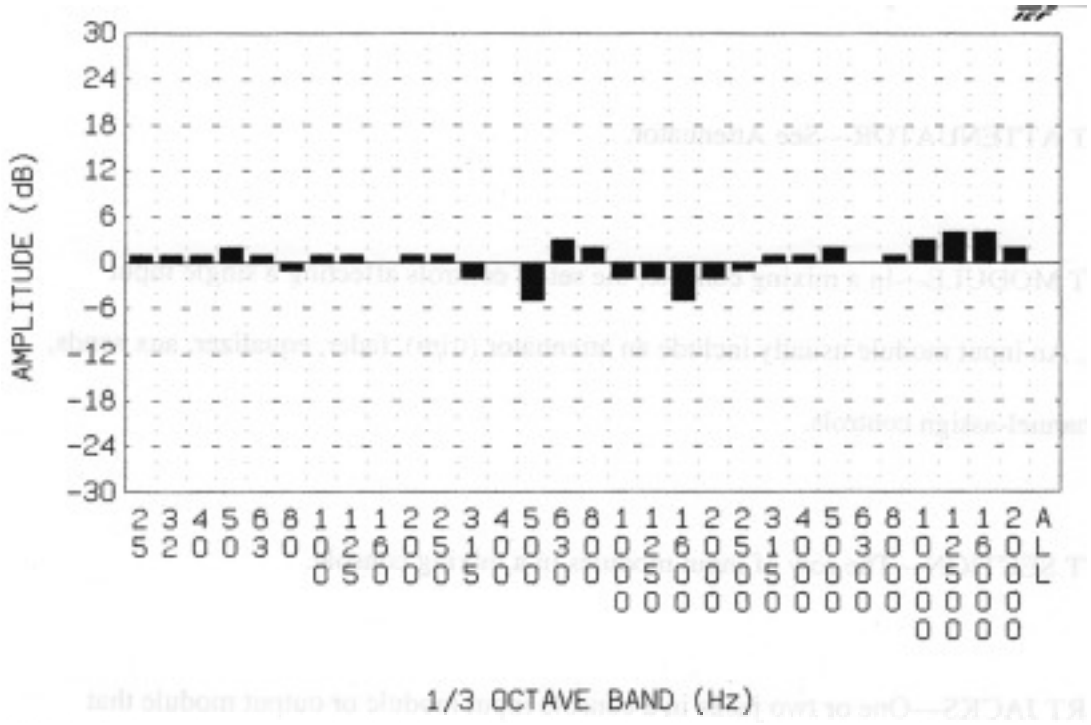
Please scroll down -- each page contains one graph.

GUITAR. The Spark Microphone is near the low E string, halfway between the sound hole and the bridge. Its spectrum is a fairly good match to the reference, so its sound is natural or hi-fi. The red curve is the flat-response reference mic 1 foot out front, and the yellow curve is the Spark mic. Each horizontal line is + or - 10 dB relative to the adjacent line.



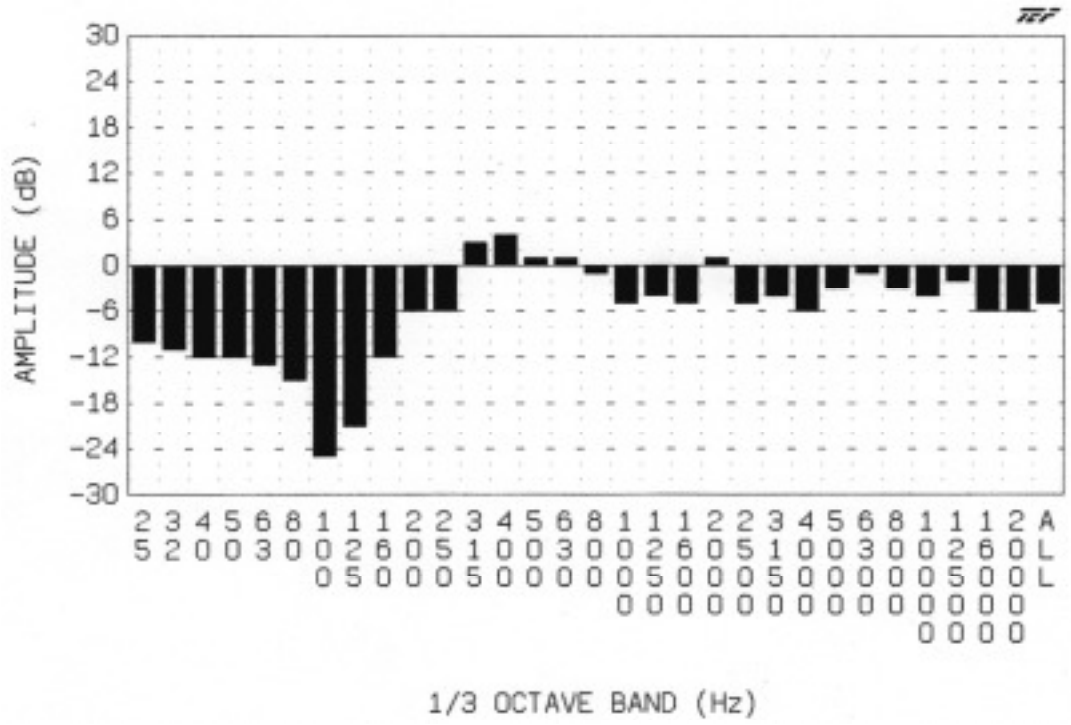


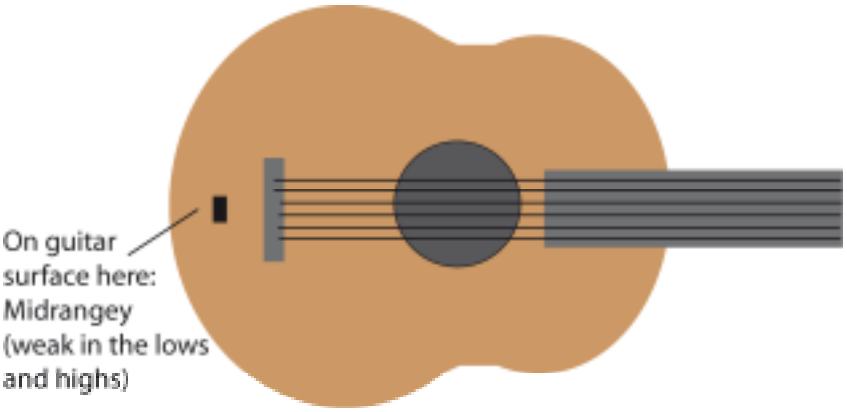
The graph below is the **difference** between the two curves you saw before. It is the difference between the reference spectrum and the close-miked spectrum, for a mic placement near the low E string and halfway between the sound hole and bridge. The differences between the two are slight, so the close-miked sound in that position is natural or hi-fi.



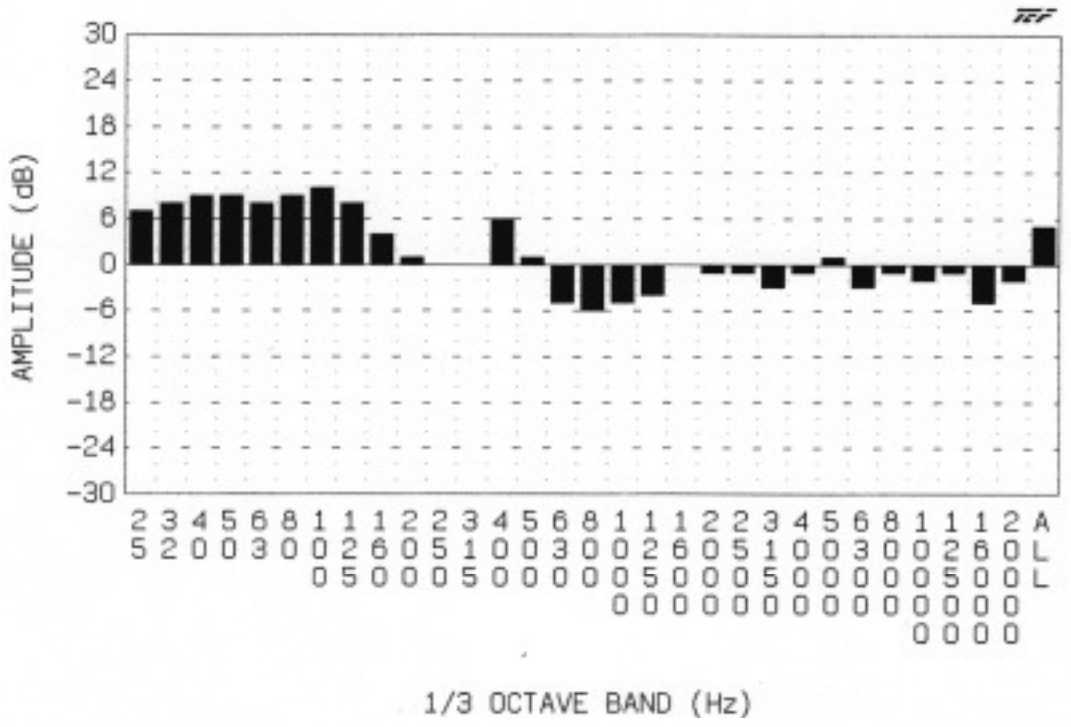
All the following graphs show the difference between the reference spectrum and the close-miked spectrum. In other words, the graphs show how the sound changes when you move the mic from 1 foot out front, onto the instrument's surface, in various locations.

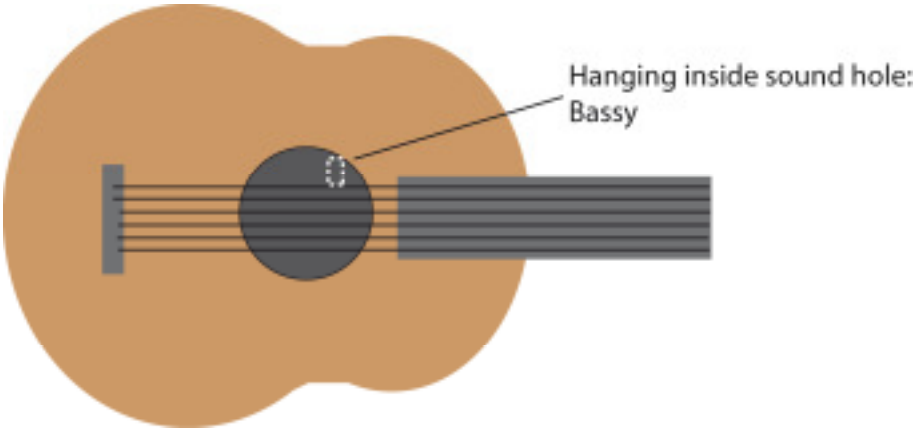
GUITAR. Mic on guitar body halfway between the bridge and the edge of the guitar. The sound is midrangey -- thin or weak in the bass, and diminished in the treble, as shown by the reduced output below 300 Hz and above 1 kHz.



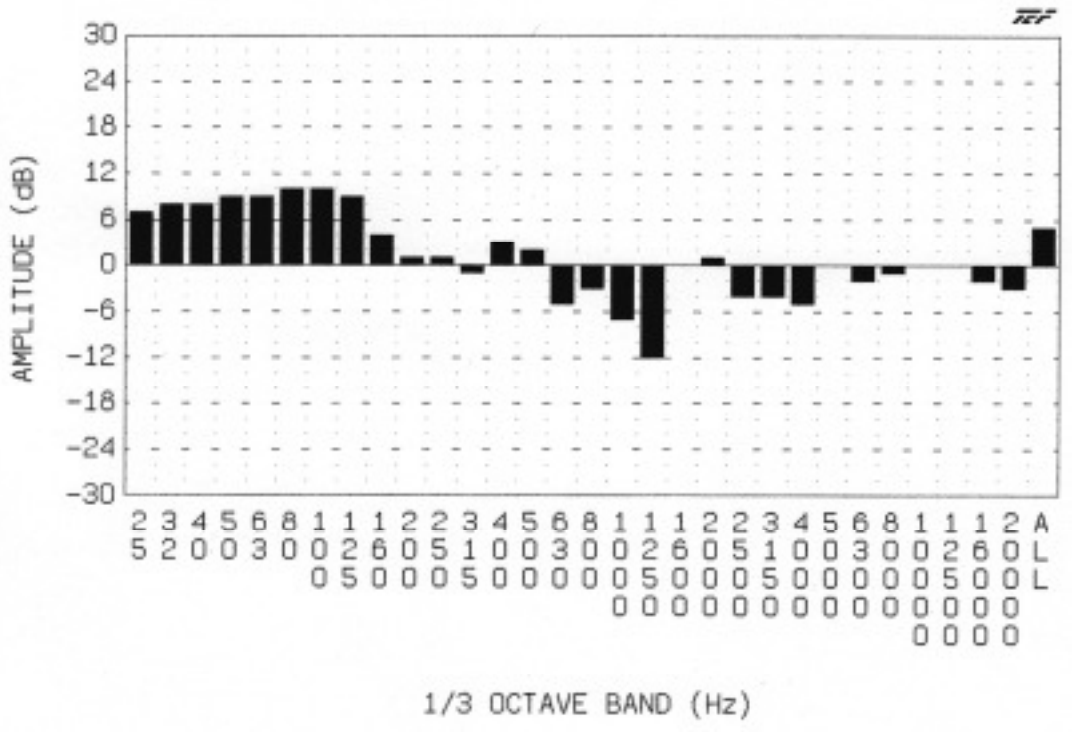


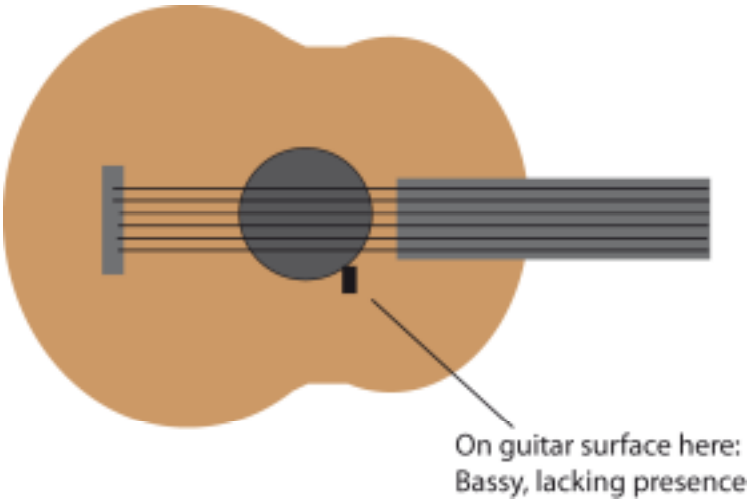
GUITAR. Mic 1 inch inside the soundhole, 1/2 inch below the strings. The sound is bassy because the low frequencies below 200 Hz are emphasized in the sound hole. Also, the mids and highs are reduced, giving a dull or dark sound.



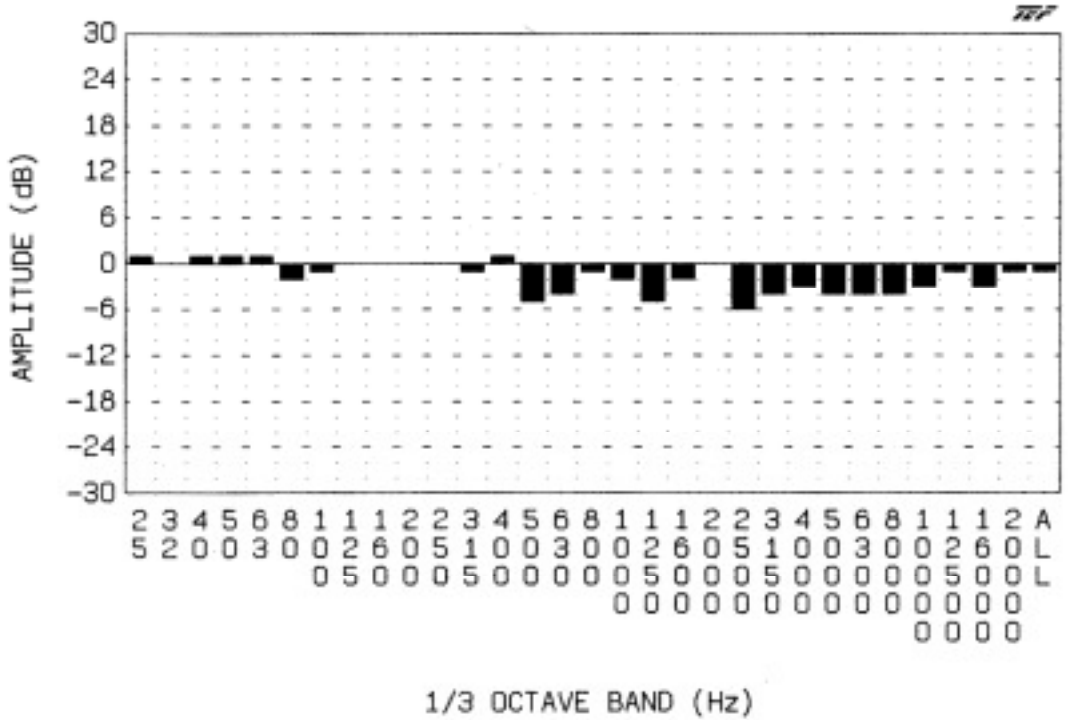


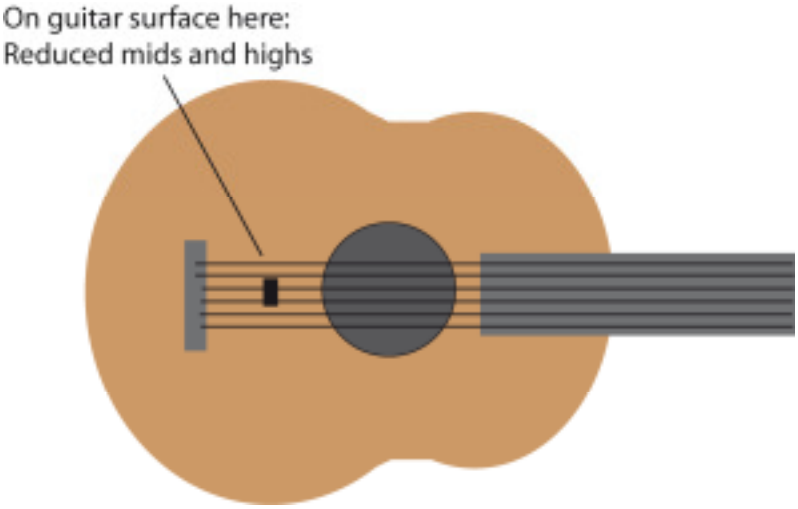
GUITAR. Mic next to bottom edge of sound hole. The sound is bassy due to the emphasis below 200 Hz. Also, it is lacking in presence due to the weaker output around 1 kHz and 4 kHz.



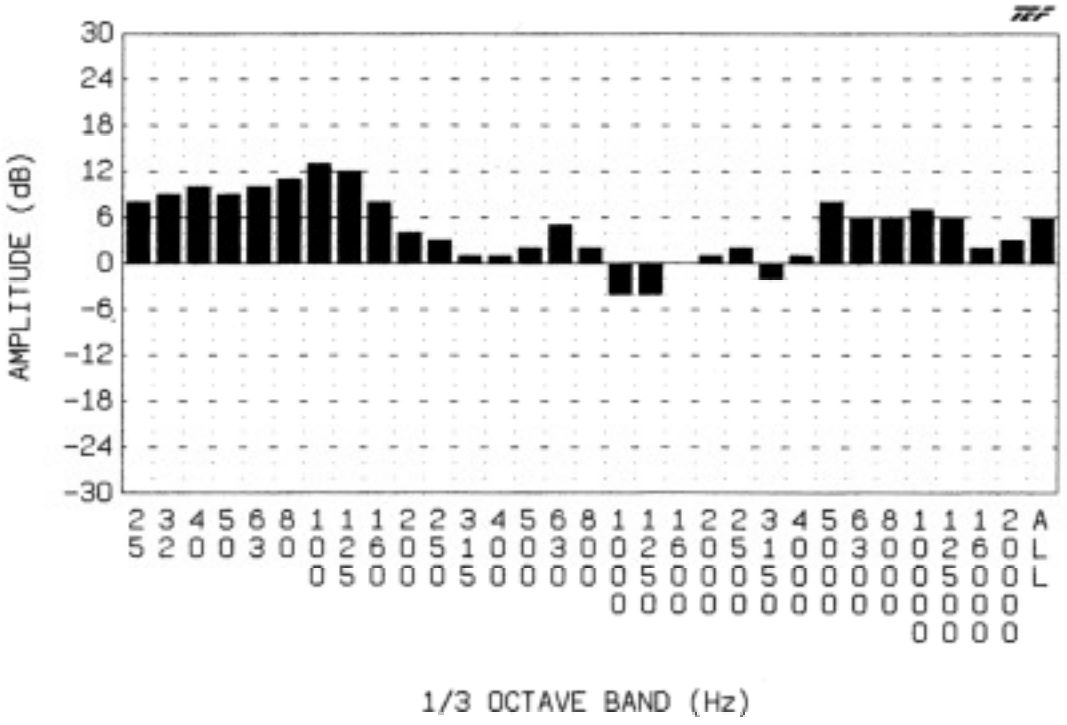


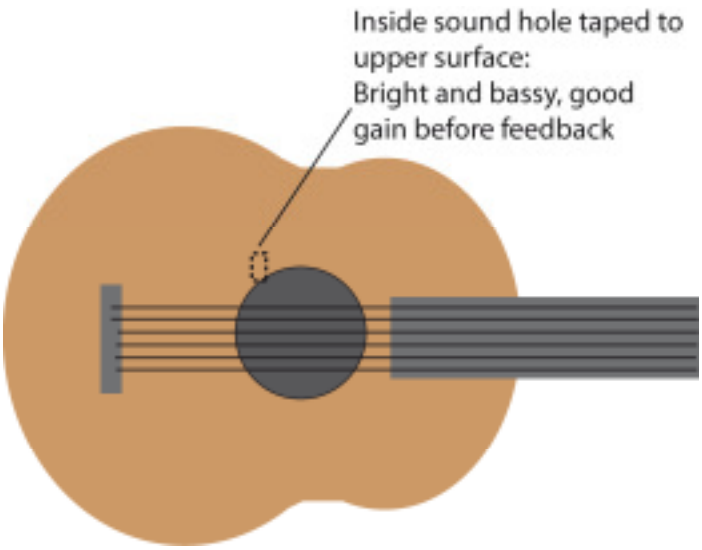
GUITAR. Mic under strings between sound hole and bridge. Sounds fairly similar to reference but with reduced mids and highs.





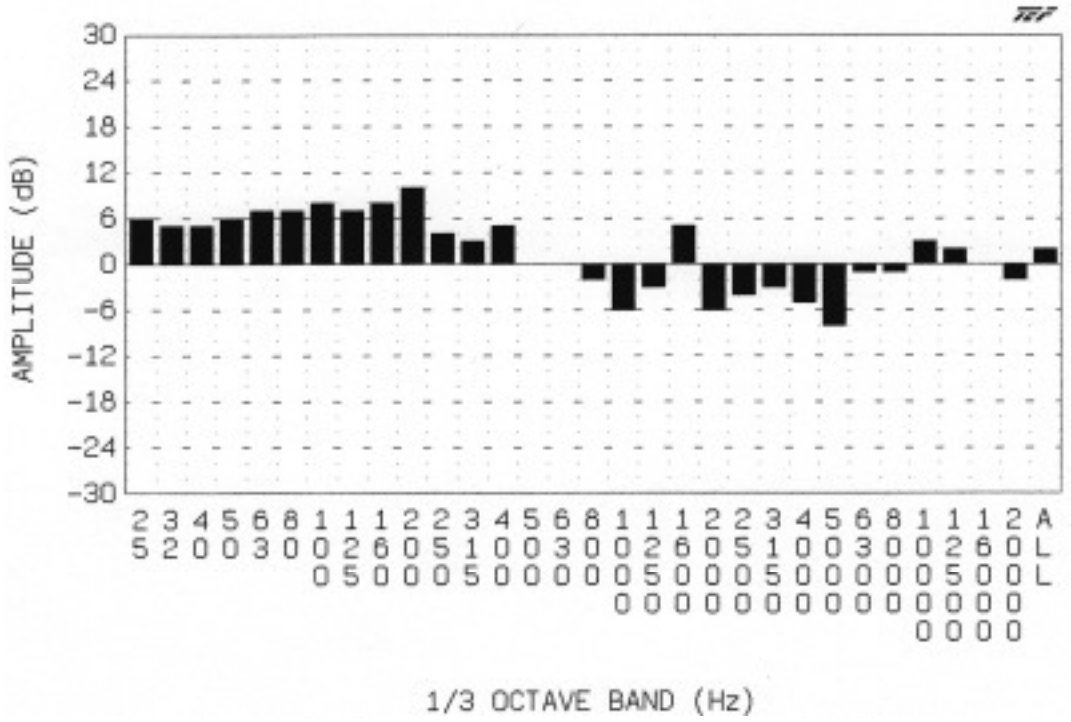
GUITAR. Mic just inside the sound hole, mic touching the underside of the front surface, at 8 o'clock relative to the fingerboard. The sound emphasizes the bass below 200 Hz and emphasizes the treble above 4 kHz. The guitar picked up here is relatively loud, so the gain-before-feedback is good.

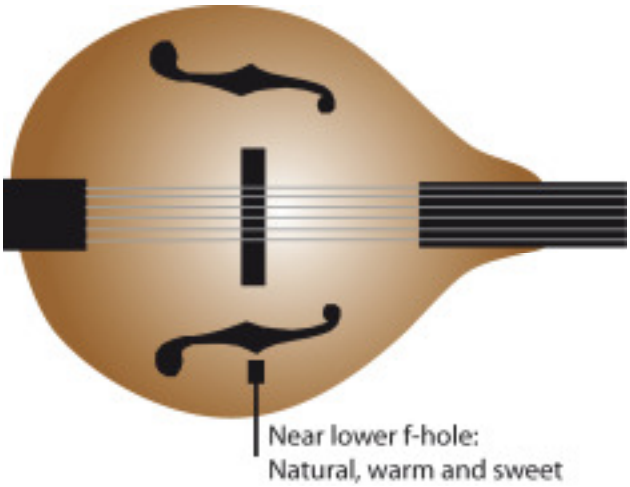




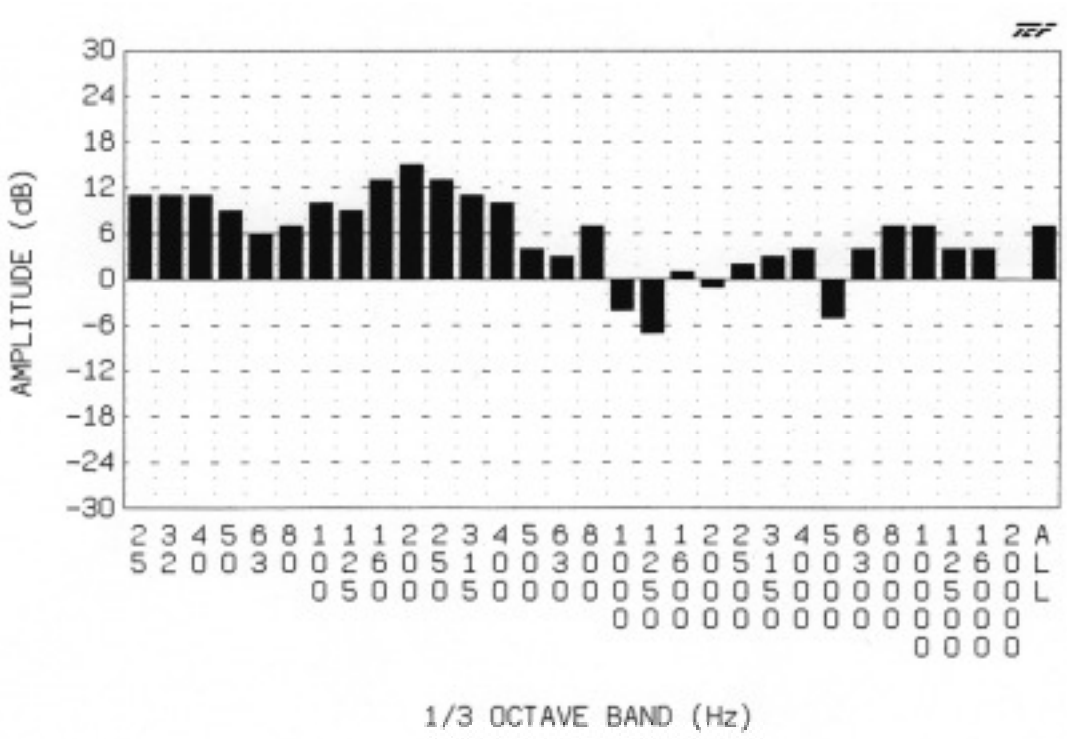
We repeated this experiment for other musical instruments: a mandolin, banjo, resonator banjo, fiddle, and upright bass. Again, every instrument is different, so these measurements are meant to show general trends and do not apply exactly to every instrument. Please scroll down to see more graphs.

MANDOLIN. Microphone close to bottom f-hole. The sound is warm due to the emphasis below 500 Hz. Also, it is "sweet" due to the lack of harsh-sounding midrange frequencies from about 800 Hz to 6 kHz. Although the spectrum of this mic placement does not match that of the reference mic 1 foot out front, the close placement actually was preferred over the reference in listening tests.



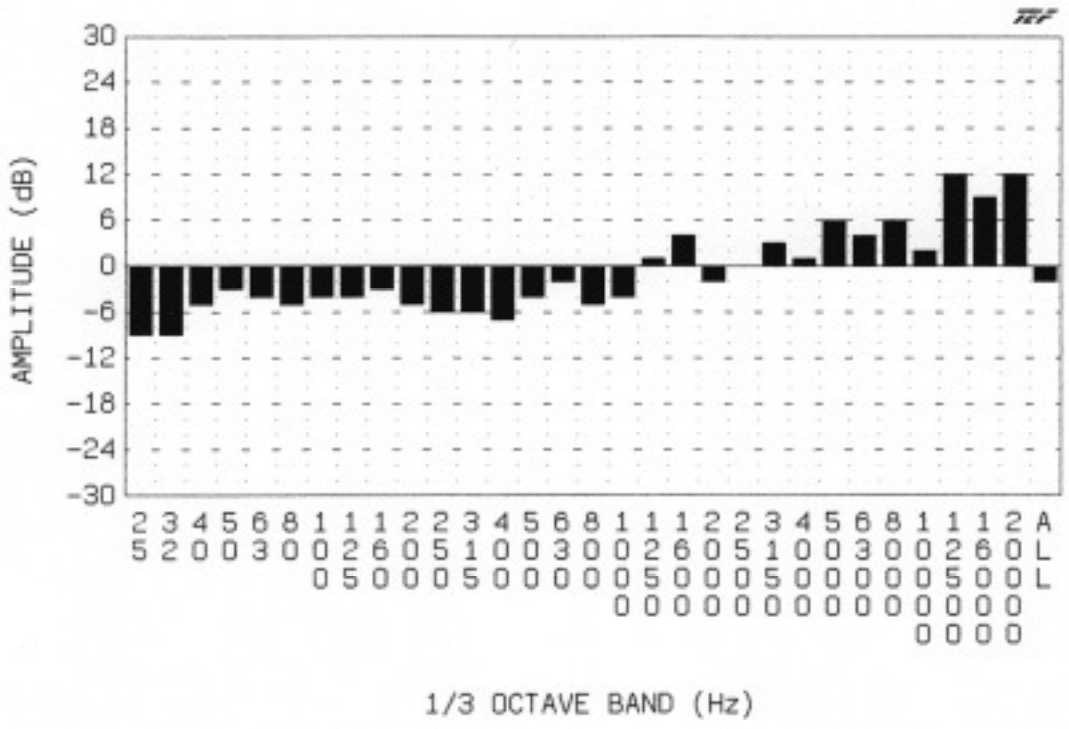


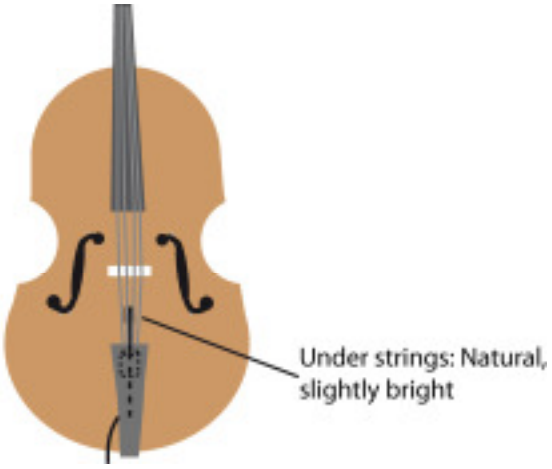
MANDOLIN. Mic inside f-hole, inside the body of the instrument. The sound is bassy due to the extreme boost below 1kHz. With some bass and treble cut on your mixer's EQ, this position could sound pretty good and offers excellent gain-before-feedback. We tried other mic positions on the mandolin but they all sounded thin (weak in the bass).



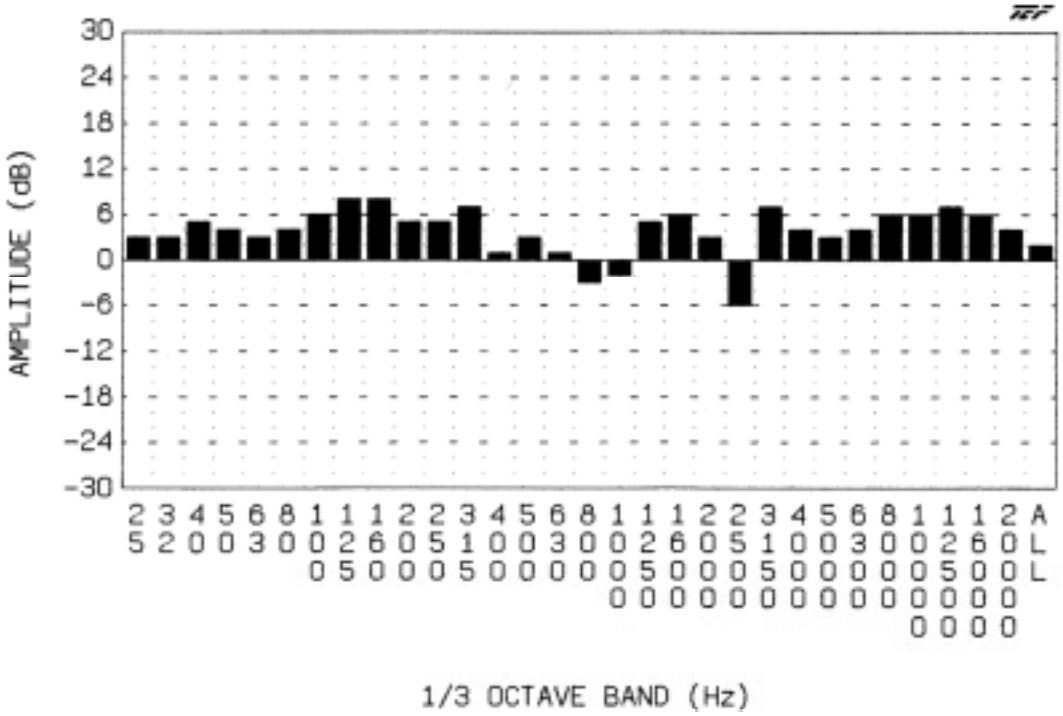
Inside body through f-hole: Bassy and bright but good gain-before-feedback. Sounds good if you turn down lows and highs.

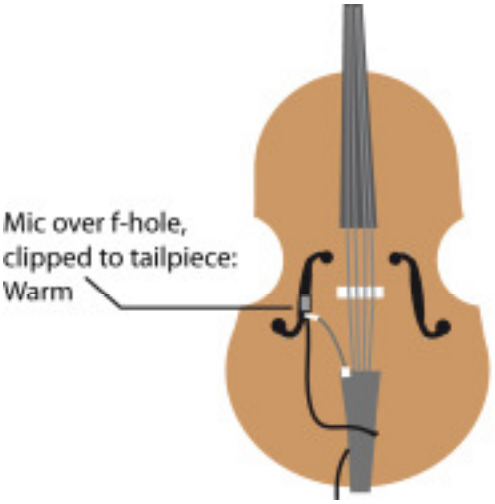
FIDDLE. Mic floating between bridge and tailpiece. The sound is bright due to the emphasis above 3 kHz. The sound is also a little thin because of the reduced output below 1 kHz. This was measured with a flat-response Spark Mic. The Bartlett Fiddle Mic is rolled off at high frequencies to give a more natural sound in this miking position.



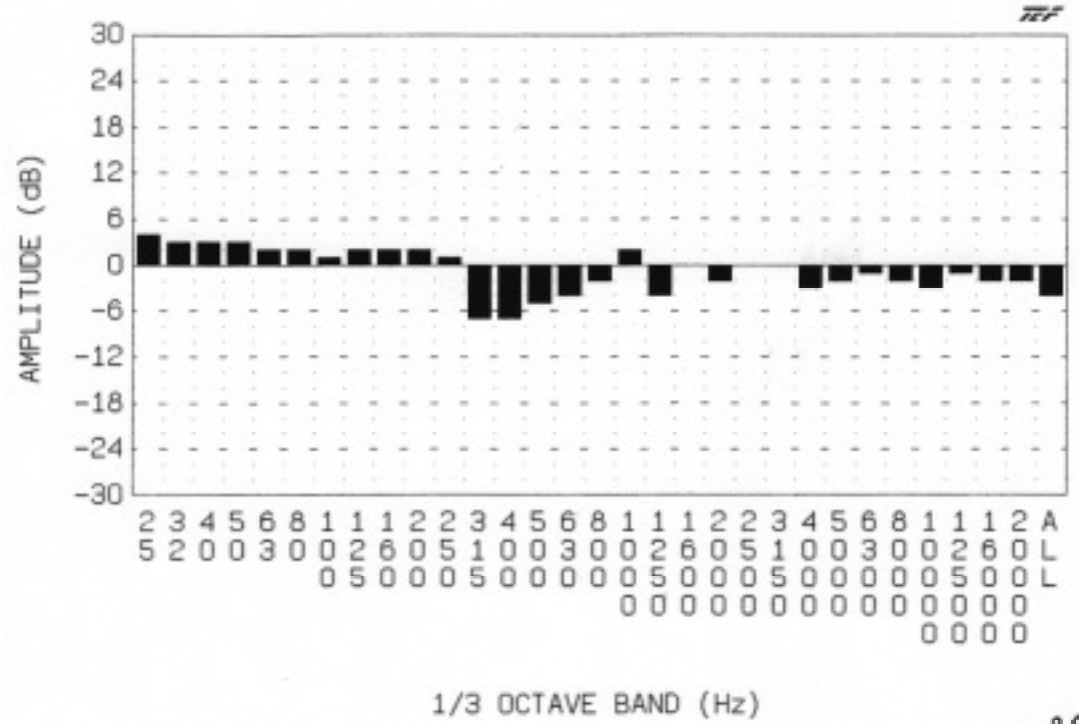


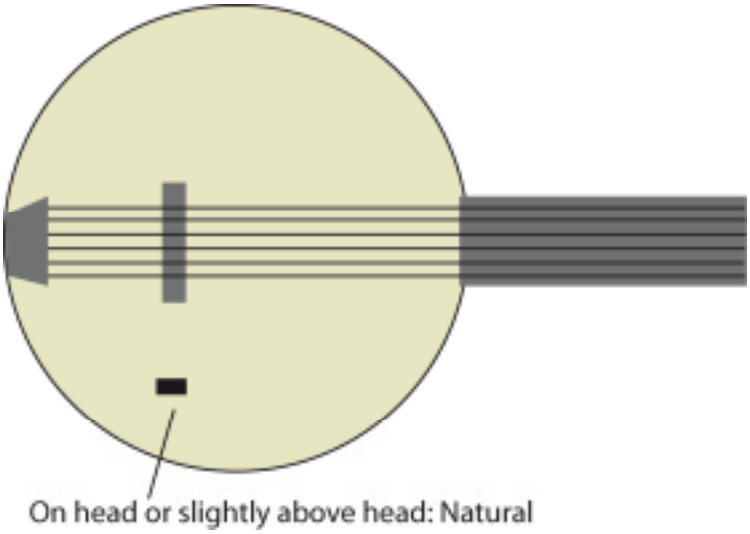
FIDDLE: Mic over low f-hole. The sound is warm due to the emphasis below 400 Hz. Although the highs around 10 kHz are emphasized with the flat-response mic used in this measurement, the rolled-off high end of the Bartlett Fiddle Mic compensates, creating a more natural sound.



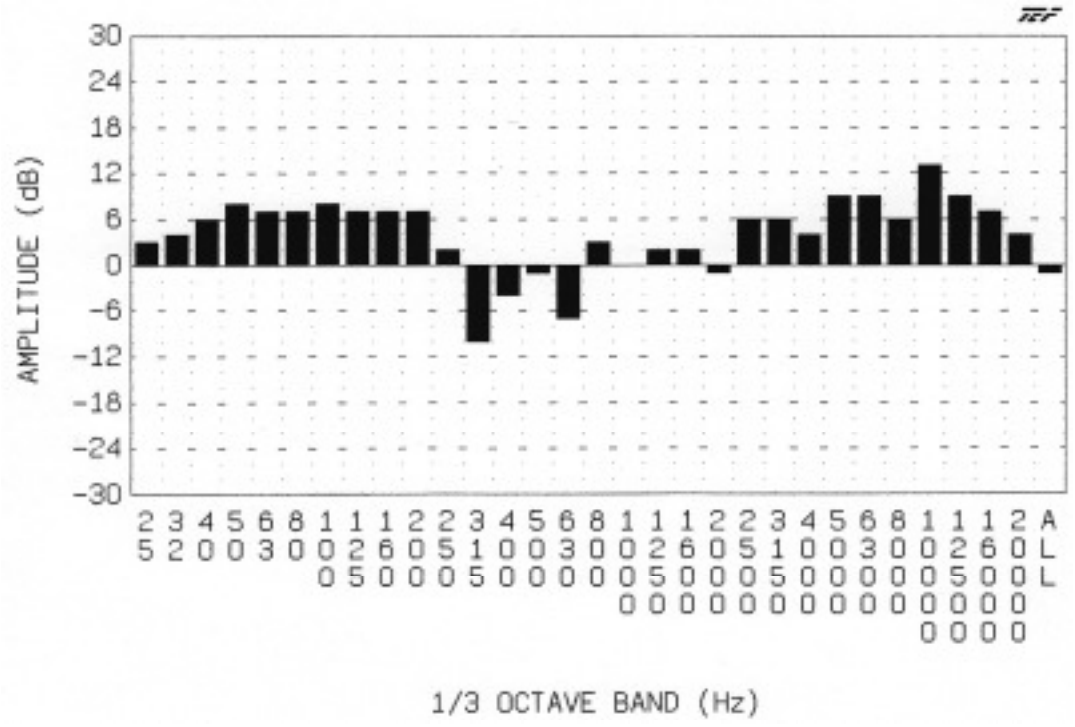


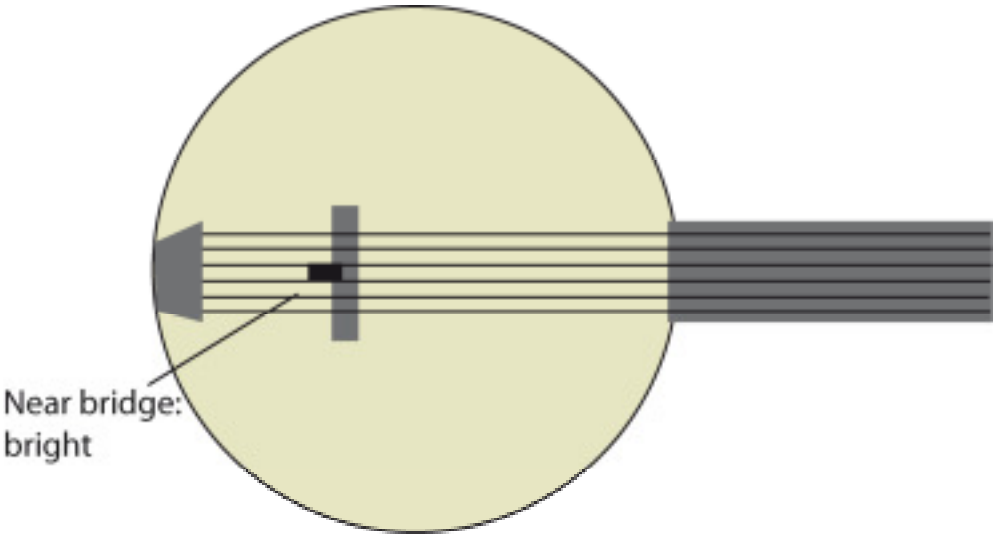
BANJO: Mic halfway between bridge and bottom edge. The close-mic spectrum matches the reference mic spectrum fairly well, so the sound here is natural or hi-fi. The emphasis below 150 Hz makes the sound a little "thumpy".



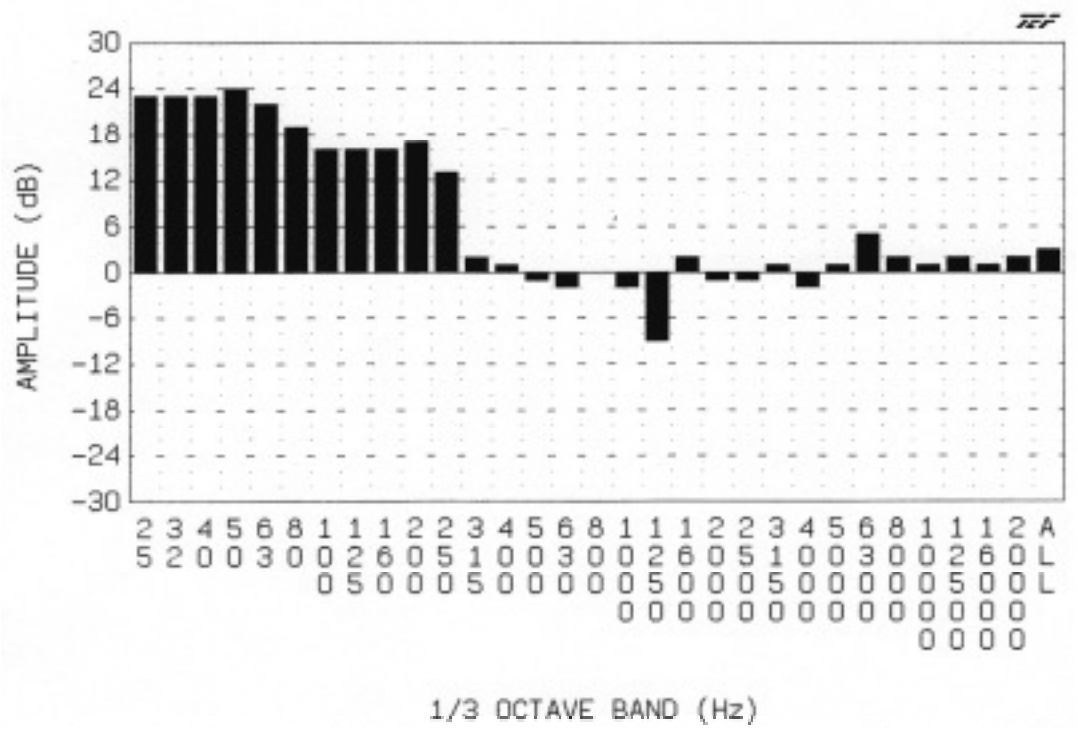


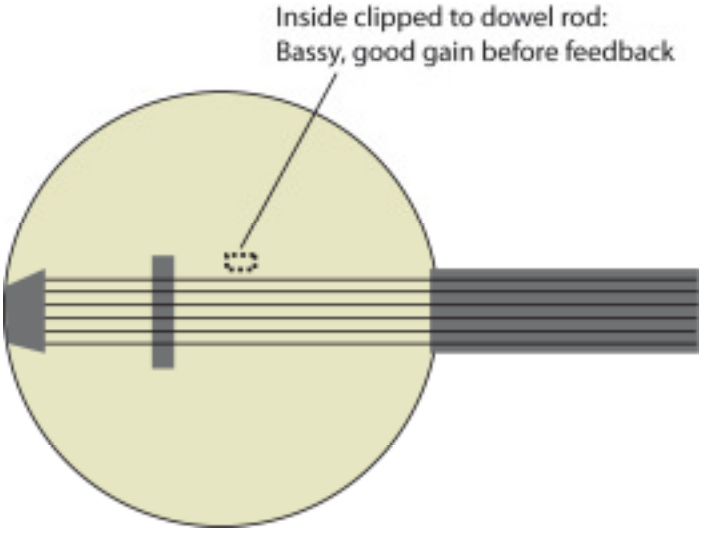
BANJO: Mic near bridge. The sound is bright due to the high-frequency emphasis above 2 kHz, and thumpy due to the low-frequency boost below 250 Hz. If you want to put a mic here, a good choice would be the Spark Fiddle mic, which rolls off the highs and lows.



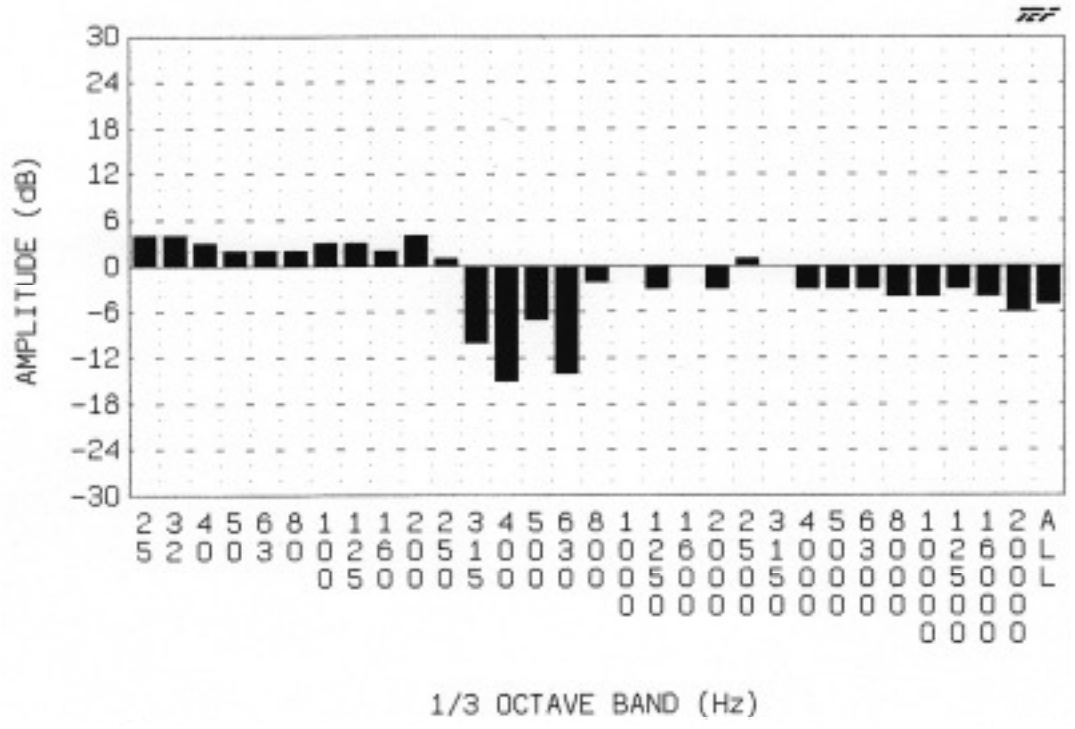


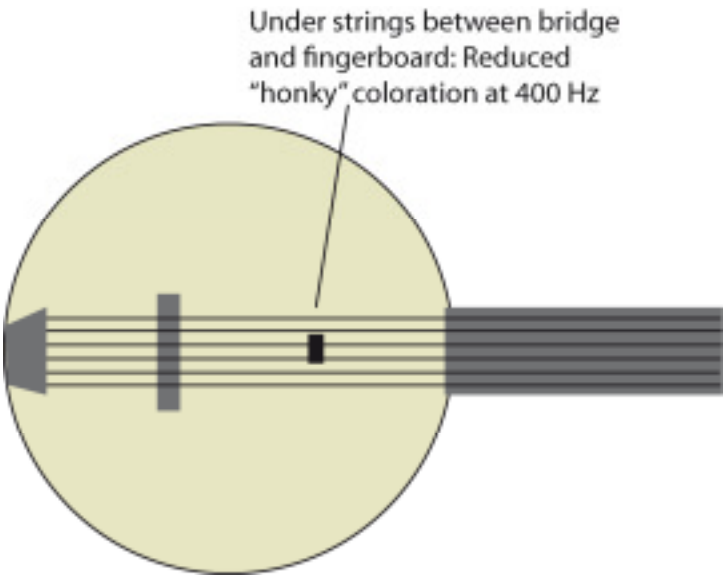
BANJO: Mic on dowel rod inside the banjo. The sound is bassy due to the extreme boost below 400 Hz. With some low-frequency cut at your mixer's EQ, this could sound good and provides good gain-before-feedback.



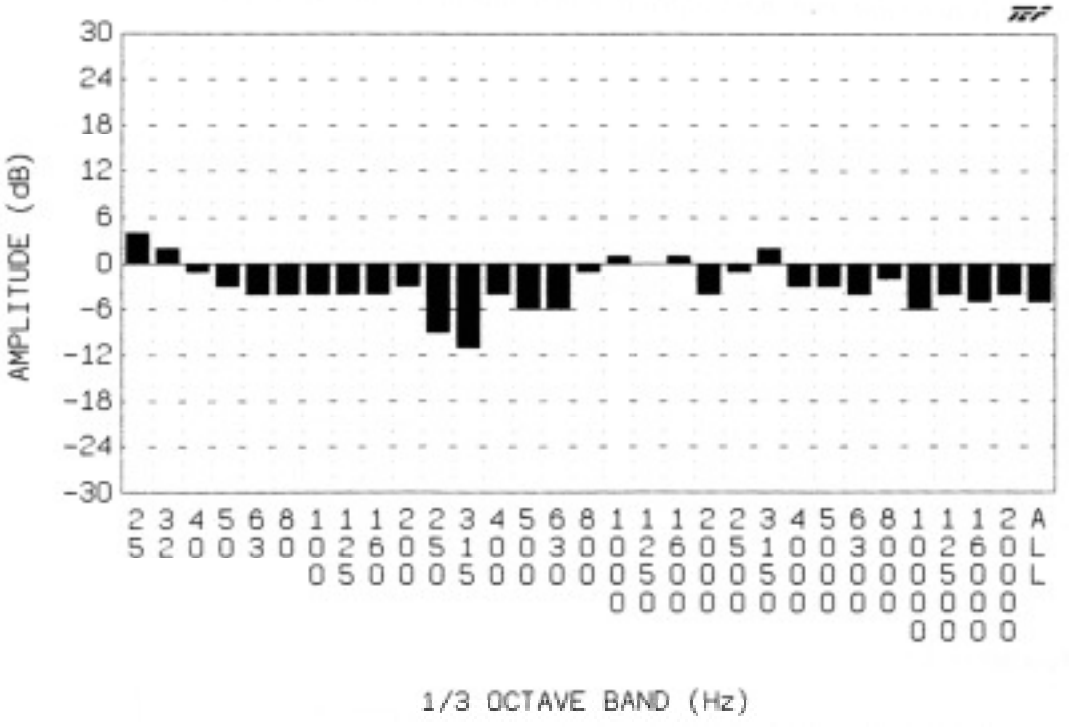


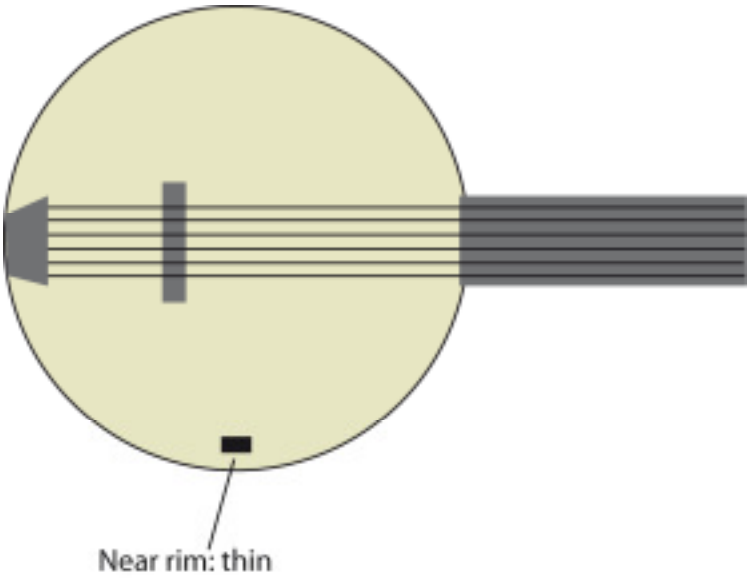
BANJO. Mic under strings between bridge and fingerboard. This position removes the "honky" sound of the banjo that is centered around 400 Hz.



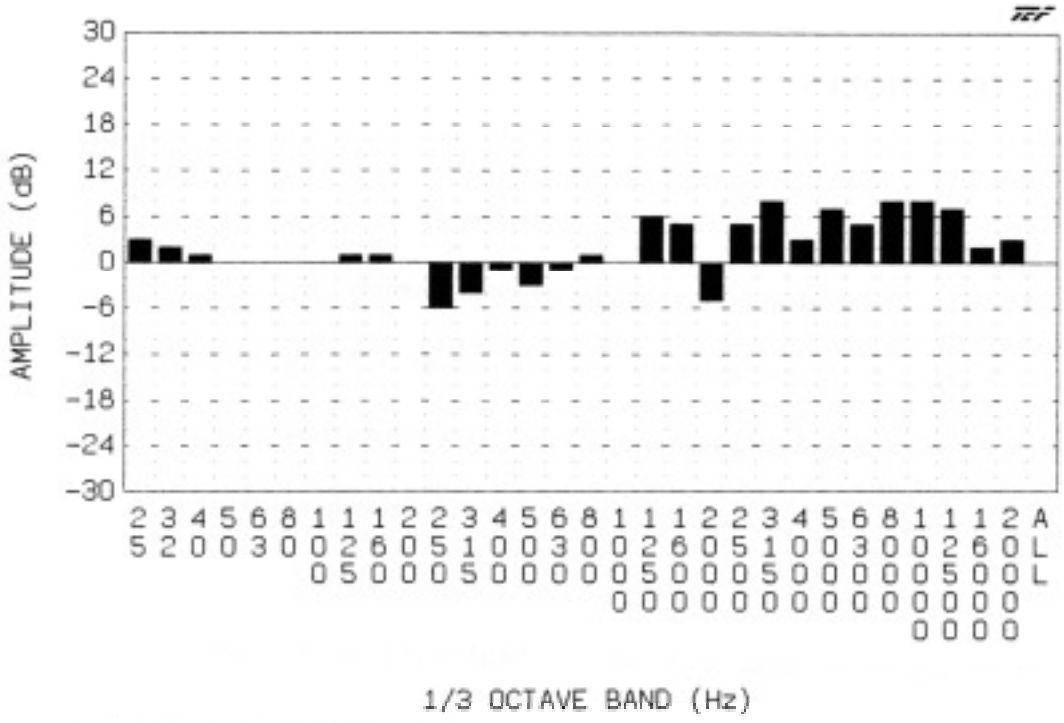


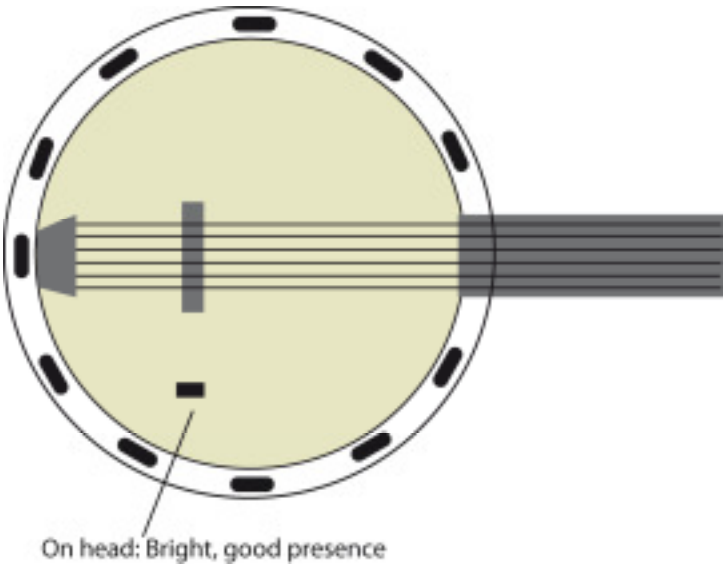
BANJO. Mic near the bottom rim. The sound is thin (weak in the bass) due to the reduced output below 800 Hz.



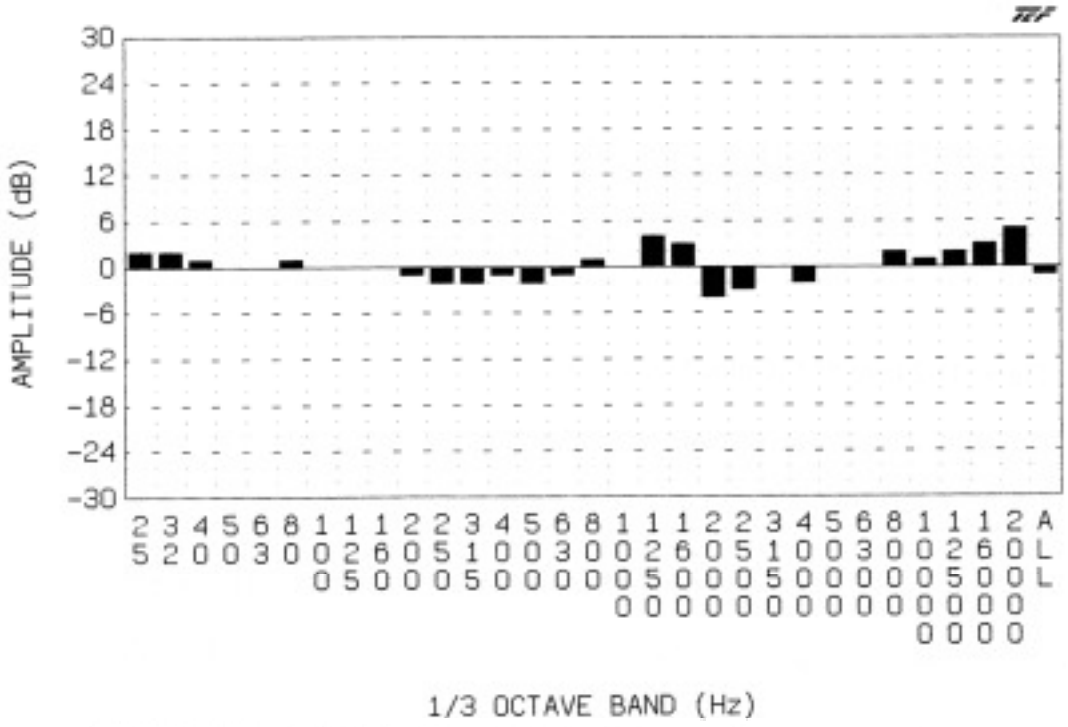


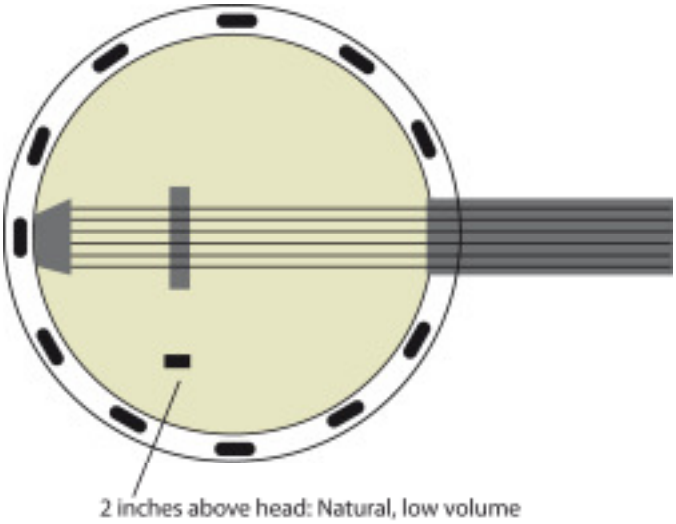
RESONATOR BANJO. Mic on the head, halfway between bridge and lower rim. The sound is a little thin (weak in the lows) and bright (strong in the highs).



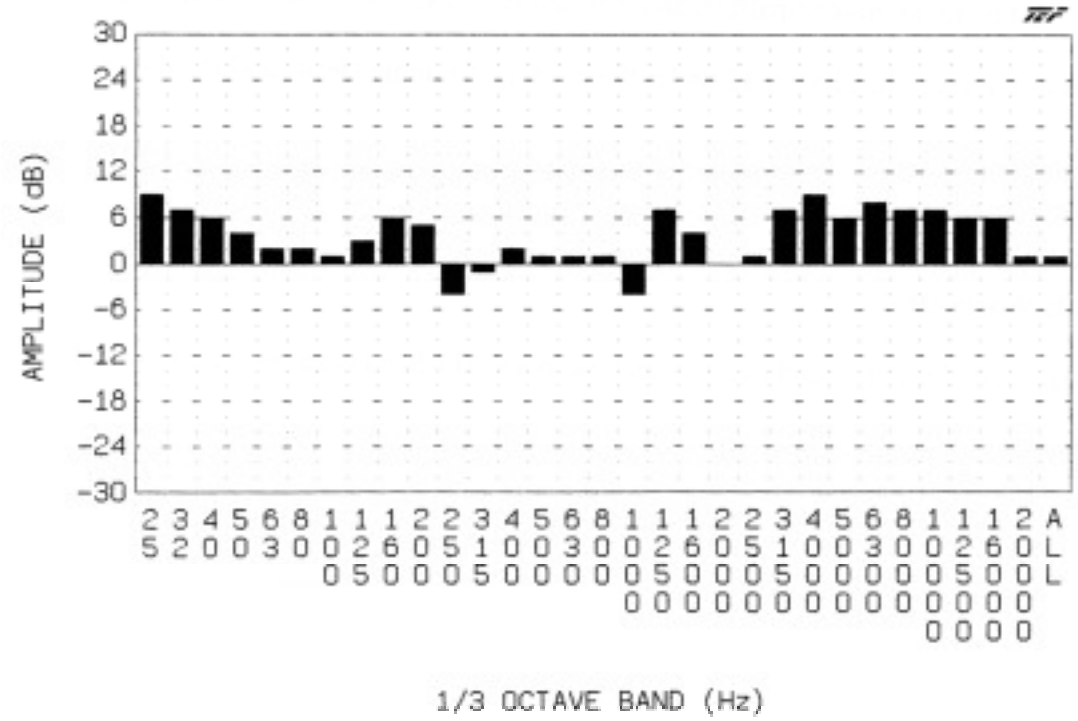


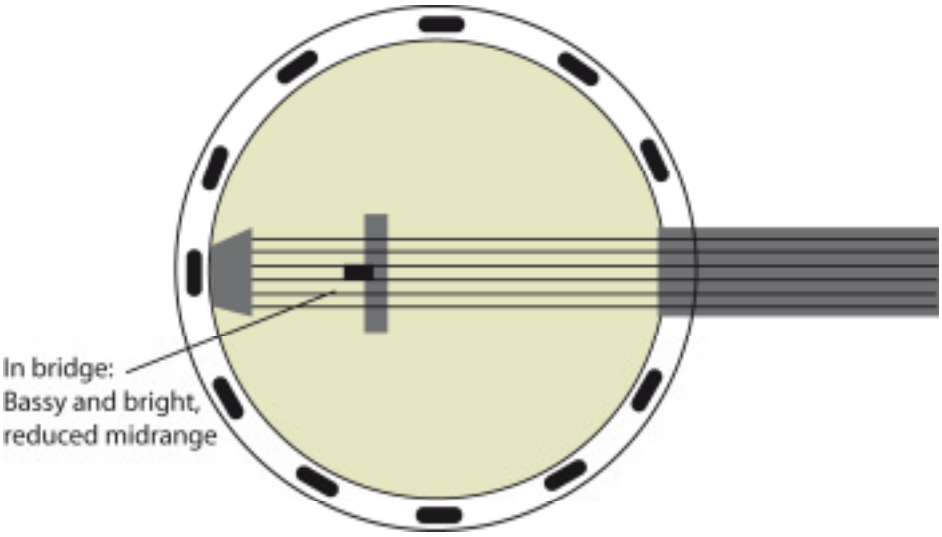
RESONATOR BANJO. Mic mounted 2 inches over the head between the bridge and lower rim. The sound here is natural because the spectra of The Spark mic and the reference mic are similar. The gain-before-feedback is not as good here as mounting the mic directly on the head.



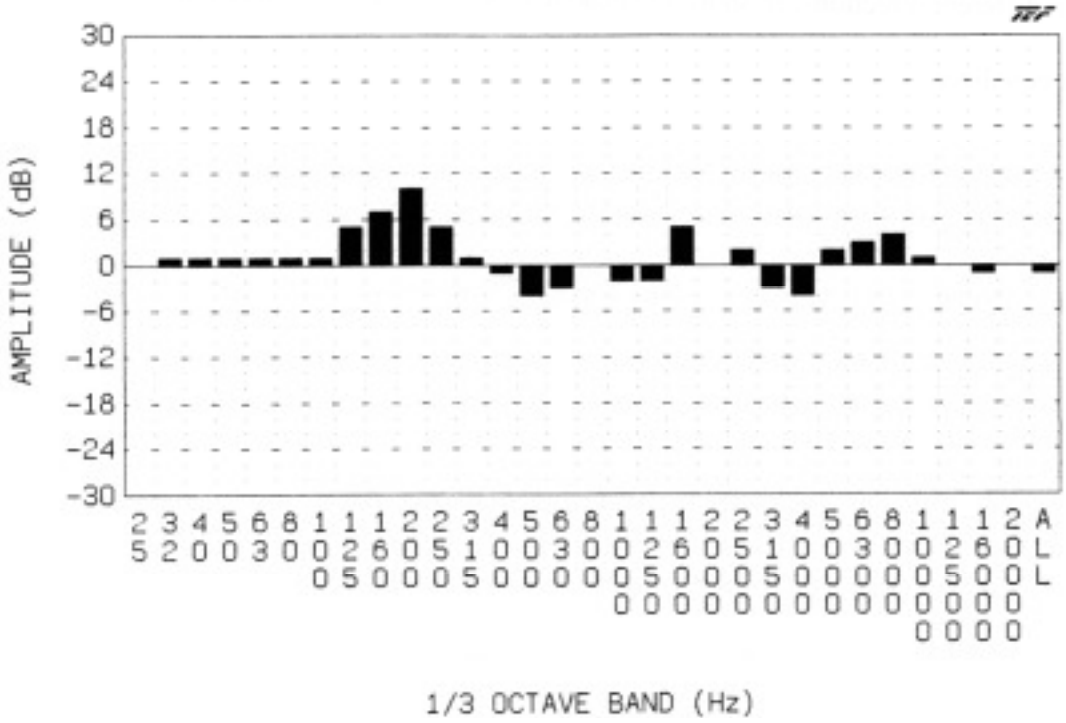


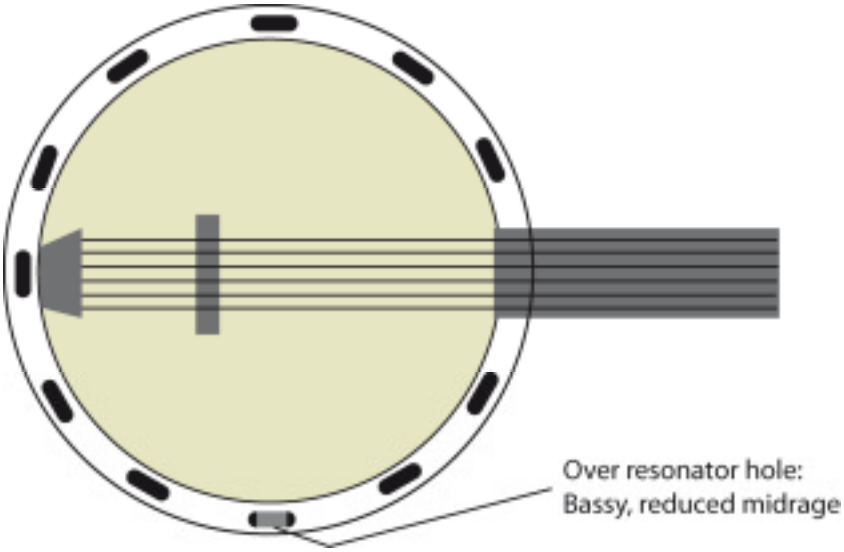
RESONATOR BANJO: Mic in bridge. This position sounds bright (trebley) due to the emphasis above 3 kHz.



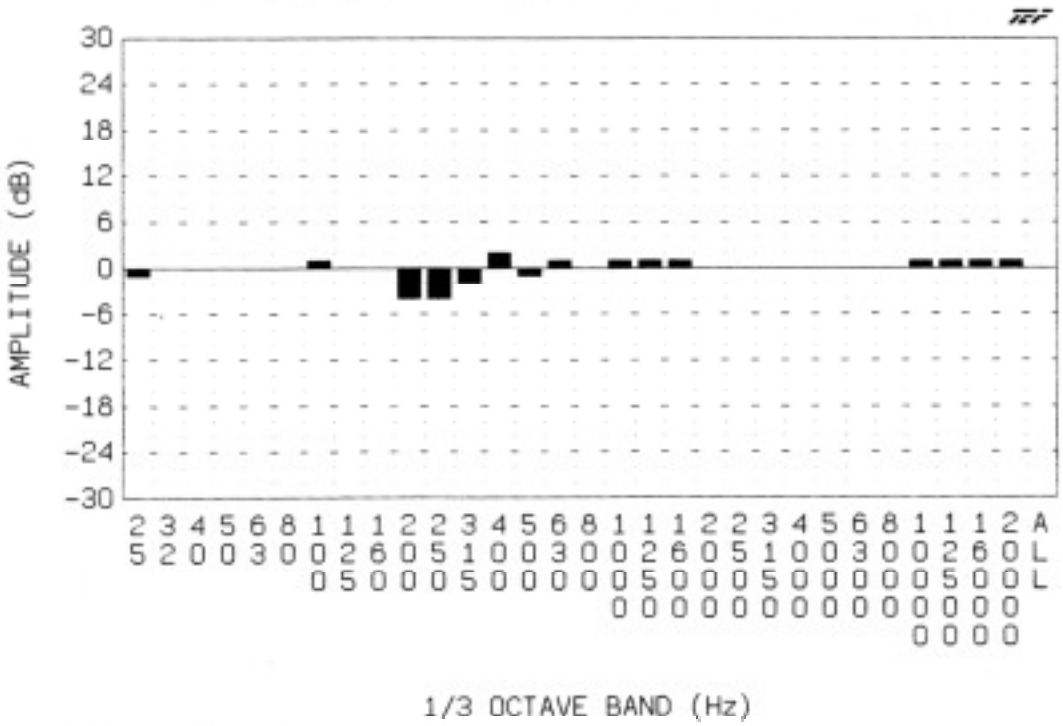


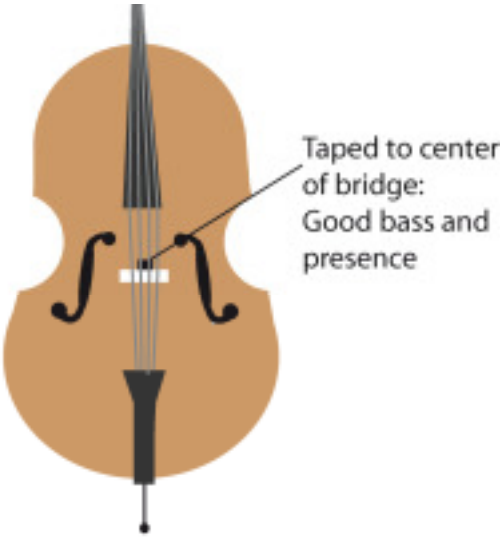
RESONATOR BANJO. Mic over the bottom resonator hole. The sound here is warm due to the boost below 300 Hz. The close-up mic also sounds less "honky" than the reference mic because the bump at 500 Hz is reduced.



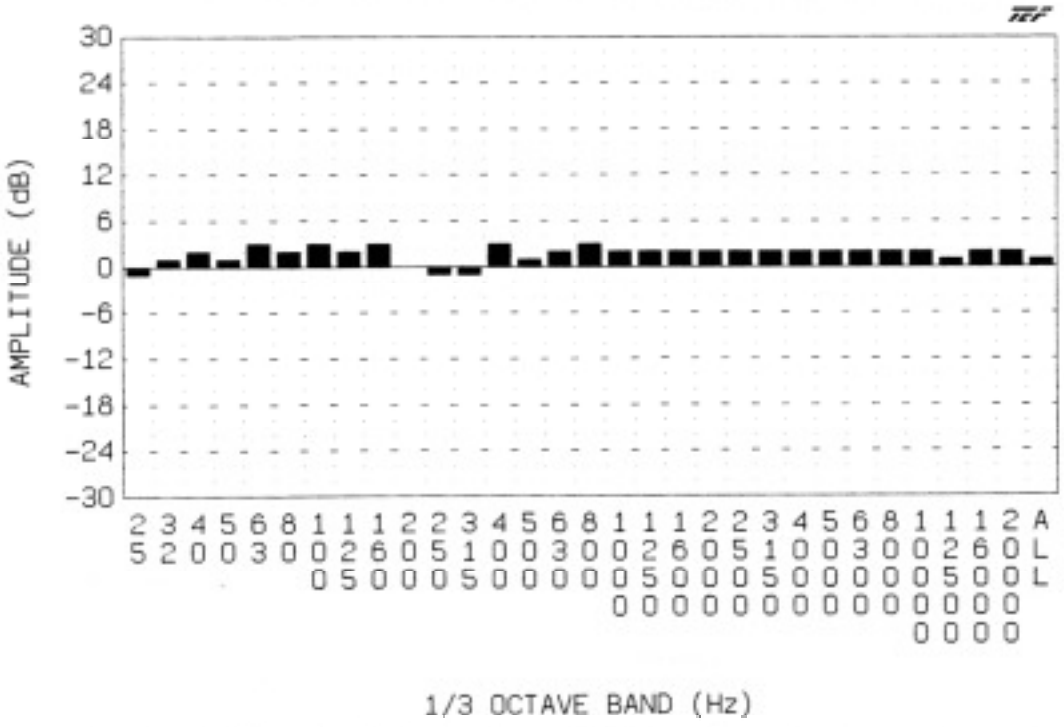


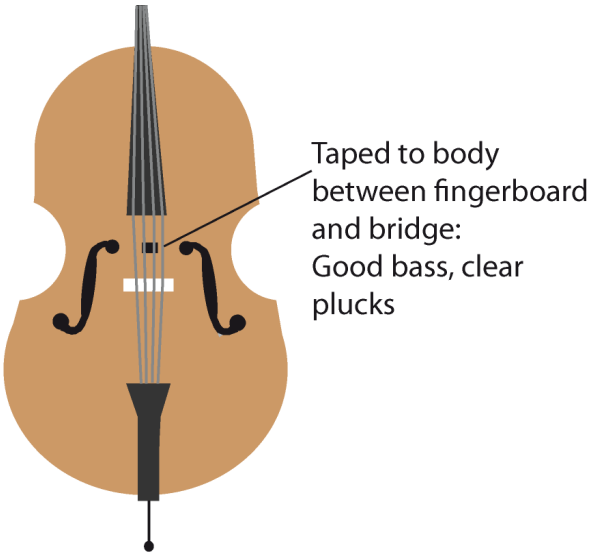
UPRIGHT BASS. Mic taped to center of bridge. The sound here is similar to the reference but has a little more definition, presence or clarity because the boomy area around 200 Hz is reduced.



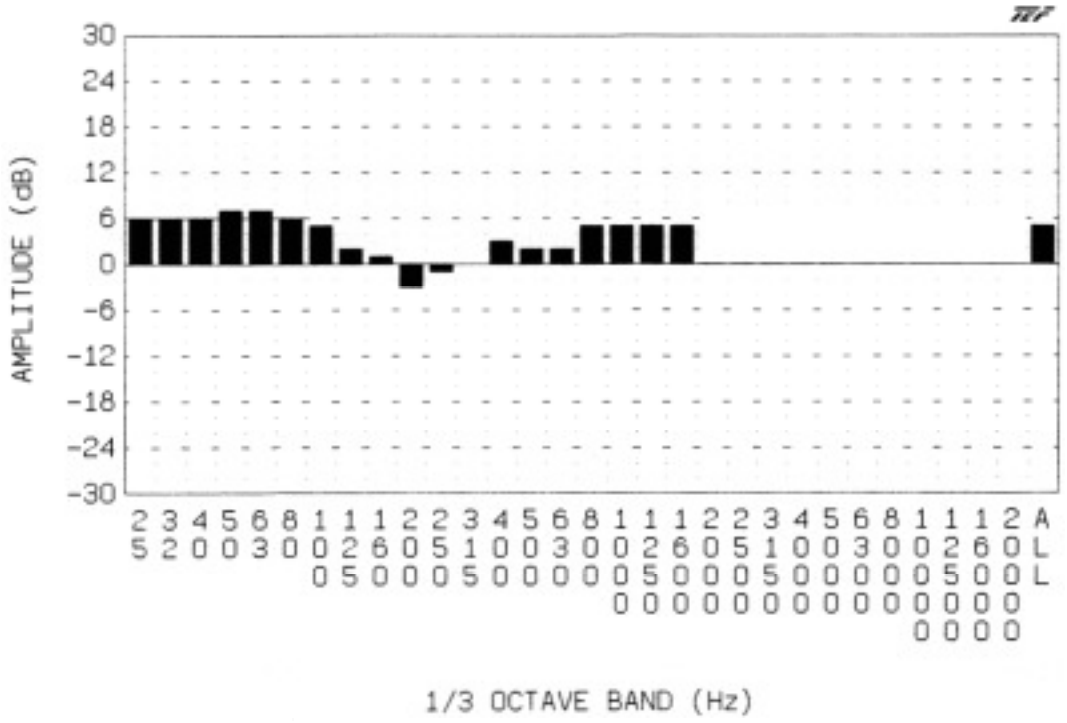


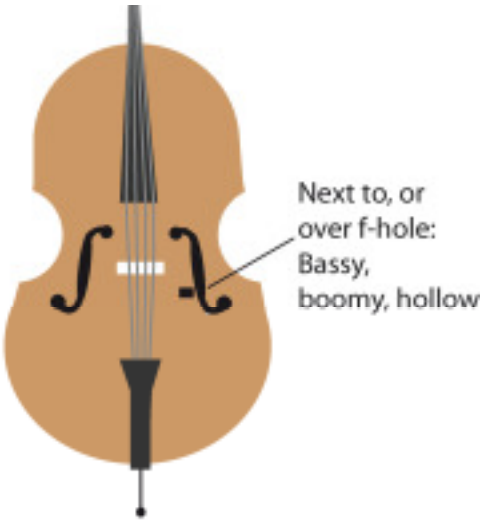
UPRIGHT BASS. Mic between end of fingerboard and bridge. This sounds full in the bass, and the plucks around 400-1600 Hz are emphasized.



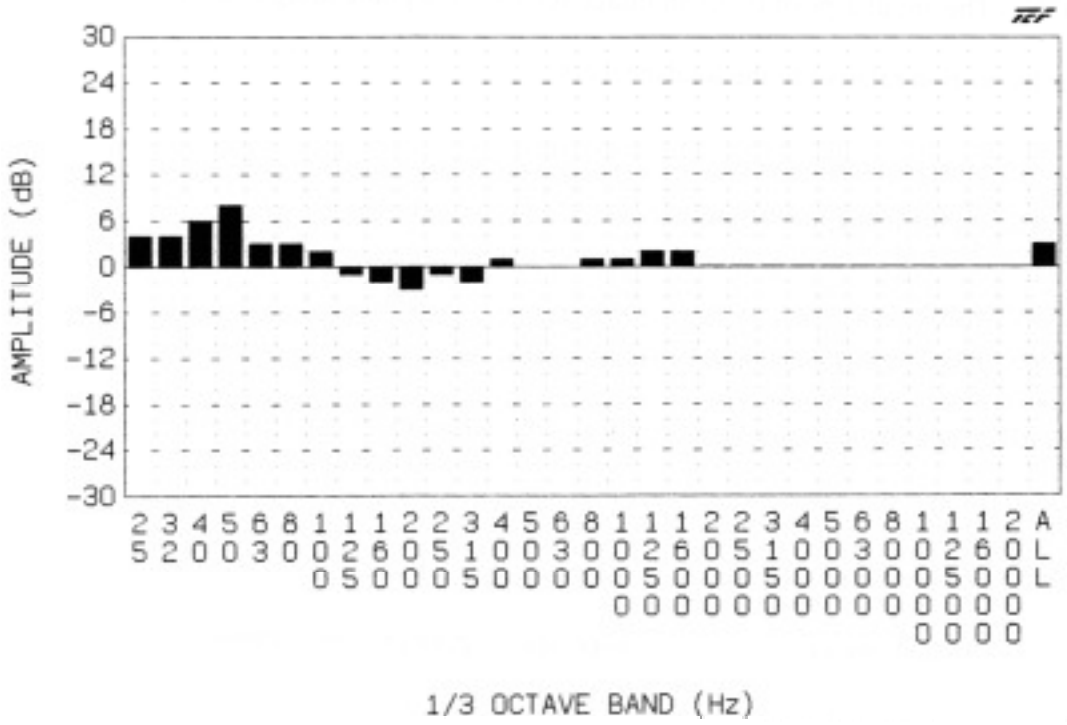


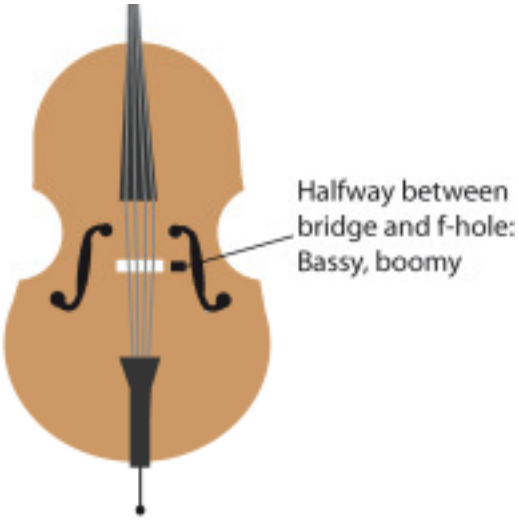
UPRIGHT BASS. Mic next to treble f-hole. Bassy and boomy, hollow sounding. This is due to the low-frequency boost of the f-hole below 180 Hz, and the bump at 500 Hz. This might be a useful miking location if your instrument is weak in the low notes. The data above 2 kHz was removed because the signal level was so low, it was near the noise floor and was inaccurate.





UPRIGHT BASS. Mic halfway between bridge and treble f-hole. Bassy and boomy. This is due to the low-frequency boost of the f-hole below 100 Hz. This might be a useful miking location if your instrument is weak in the low notes. The data above 2 kHz was removed because the signal level was so low, it was near the noise floor and was inaccurate.





By using an accurate microphone and placing it carefully, you can convey the beautiful timbre of your instrument to your audience.