ALTO SAXOPHONE MOUTHPIECE PITCH AND ITS RELATION TO JAZZ AND CLASSICAL TONE QUALITIES

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To Mom and Dad

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CHAPTER 1: INTRODUCTION

Since its invention in the mid-nineteenth century, the saxophone has been utilized in a wide array of musical settings. The instrument has become an accepted member of the classical woodwind section, as well as a highly employed solo voice within the traditional orchestra and wind ensemble. The technical virtuosity of the saxophone is often exploited in both classical solo and saxophone quartet works. In addition, it continues to thrive in other genres, especially jazz. The saxophone section functions as a primary component of the big band, and saxophonists are commonly found in small group and solo jazz performance.

The contemporary saxophonist needs to be able to function in a variety of musical situations. There is an increasing demand put upon saxophonists to perform in both the classical and jazz idioms. Because of the saxophone's infrequent employment in the traditional orchestra, often the working classical saxophonist will also be required to play jazz to make a living. This demand requires that saxophone instructors teach in both styles.

There are several aspects of performance practice that are inherently different between the classical and jazz saxophone. These aspects include but are not limited to notation, articulation and improvisation. The aforementioned areas of performance practice are definite. Classical and jazz tone quality, on the other hand, remains an area that is much less defined, and a frequent point of discussion. Probably more so than any wind instrument, the saxophone employs a vast spectrum of acceptable tone qualities.

What some might consider an acceptable classical tone quality may be dismissed as a jazz tone quality, and vice versa.

In the matter of tone production, classical saxophonist Eugene Rousseau (1978, 7) documents that a characteristic alto saxophone tone quality will be produced if, when playing on the saxophone mouthpiece alone, an A5 (A=880) is produced. A5 refers to the A between C5 and C6. The alto saxophone mouthpiece alone has a playable range of approximately one octave, from C5 to C6. This being said, A5 is a relatively high pitch within the available range. Producing a jazz tone quality is somewhat more elusive. Oftentimes, students are simply told that if they are able to 'hear' the desired tone quality in their head, they will be able to produce it. They are told to listen to recorded models that have great sounds, and to try to reproduce the sound that they desire. Most certainly, there is no substitute for listening to professional musicians for the fine-tuning of tone quality, capturing nuance, and style. However, in many cases, establishing a more basic starting point is necessary.

Jazz and Classical Tone Qualities

As stated earlier, the spectrum of acceptable jazz tone quality is quite broad. This may be in part due to the way in which jazz developed. Unlike the classical saxophone tradition, which mainly developed in the conservatory and university systems, jazz had its beginnings outside of the classrooms. Many early jazz saxophonists were self-taught or learned through an apprentice/mentor model. The young jazz musician was expected to learn solely through listening and emulating. With the inclusion of jazz education in the university or college setting, it has become necessary to analyze methods and procedures more carefully.

Classical saxophone tone quality is somewhat narrower in its acceptable range. Words to describe a classical tone quality may be focused, consistent, round and warm. While jazz saxophone tone quality may have some of the same descriptors, generally the spectrum begins at a classical tone quality and moves toward one that is richer in harmonic content. This can be perceived as edgier, brasher, more colorful, having more buzz and perhaps even louder.

Statement of the Problem

Teachers of young saxophonists starting to play jazz commonly encounter the following problem. Usually, the student will purchase a jazz mouthpiece thinking that it will magically create a jazz tone. They think that if they approach the mouthpiece the same way as they do their classical mouthpiece (or mouthpiece that came with the instrument), that it should produce an acceptable tone quality. Students are often surprised when instead they produce a thin tone quality and random squeaks. Teachers can frequently address this problem by having the student remove the mouthpiece from their instrument and play on the mouthpiece alone. As mentioned earlier, the technique of having a student play an A5 on the mouthpiece alone is commonly used in teaching classical tone quality. Frequently, a student who is squeaking randomly on the mouthpiece will be playing at a pitch level that is *higher* than the A5 desired for a classical tone quality. Remember that the alto saxophone mouthpiece alone has a practical range of one octave, from a C5 to C6. Therefore, the jazz student who is getting a pitch that is higher than an A5 is actually playing on the uppermost extreme of the mouthpiece range. Quite often, by lowering the mouthpiece pitch the student will put an end to the squeaks, and gain more control over the mouthpiece.

This has been a topic of several recent conversations among saxophonists. In fact, it has been a point discussed by saxophonists on the listserv of the North American Saxophone Alliance. However, insufficient scientific documentation exists relative to mouthpiece pitch and characteristic jazz tone quality. One of the reasons for this may be that the range of acceptable jazz tone qualities is much broader than the range of acceptable classical tone qualities. Nevertheless, creating a general guideline will be beneficial. By doing so, a studio teacher can establish a starting point from which a student can develop their own jazz tone quality.

Mouthpiece Pitch

Mouthpiece pitch is manipulated by a combination of embouchure and tongue placement. To a certain extent, simply loosening and tightening the embouchure's hold on the mouthpiece will lower and raise the resulting pitch. However, loosening the embouchure alone will not allow the saxophonist to achieve the full octave of available pitches. Tongue placement becomes of great importance in the overall pitch manipulation. Raising and lowering the front quarter of the tongue, much in the same way as one does to change pitch while whistling, will change the mouthpiece pitch. By combining these two techniques, the full octave of pitches can be produced. As the embouchure is loosened and the tongue position is lowered, more air must be used to produce a steady tone. The lessening of pressure used to make the reed vibrate is in turn made up for by an increase in air volume. This increase in air volume and decrease in mouthpiece pressure not only produces a lower pitch, but also one with an increase in buzz.

As mentioned earlier, many young jazz saxophonists who are struggling with their sound play higher on the mouthpiece than the prescribed classical mouthpiece pitch level. It is also very common for a beginning jazz student to not be able to hold a steady pitch when playing the mouthpiece alone. The inability to hold a steady pitch on the mouthpiece alone translates to an uneven tone and intonation problems on the saxophone. For this reason, all saxophone students, both jazz and classical, would benefit from practicing playing all pitches available on the mouthpiece. By doing so, they gain an understanding of the muscles required to both change pitch and maintain a steady pitch.

Playing higher on the mouthpiece requires less air, and that air is more constricted, or focused. Similarly, playing lower on the mouthpiece requires more air and produces a sound that is richer in harmonic content. If the desired jazz tone quality were in fact richer in harmonic content, playing a lower mouthpiece pitch would then produce a more characteristic jazz tone quality. Generating a higher mouthpiece pitch for a jazz tone quality would therefore be counterproductive.

The Experiment

The purpose of this experiment is to answer the following questions:

1. Is there a correlation between mouthpiece pitch and tone quality achieved? Specifically, does playing a lower pitch on the mouthpiece produce a more jazz-like tone quality?
2. Is there a correlation between mouthpieces used and tone quality achieved?
3. If these correlations do exist, does one factor seem to have a greater influence on tone quality?

Ten saxophonists were used in this study. The same instrument was used by each of the test subjects. Each saxophonist produced an A440 using a Selmer S80 C* mouthpiece (a classical mouthpiece), after generating an A5 on the mouthpiece alone. Then, the saxophonist produced an A440 using that same mouthpiece, but after having produced an Eb5 (a tritone below) on the mouthpiece alone. These procedures were repeated three times, with three additional mouthpieces: a Selmer S90 (classical mouthpiece), a Meyer 6M (jazz mouthpiece) and a Claude Lakey 4*4 (jazz mouthpiece). These sounds were recorded, and processed by a spectrum analyzer. The spectral analysis of these sounds created a clear visual representation of the sounds, and therefore allowed further comparison and analysis.

It was also necessary to compare these sounds with both jazz and classical reference sounds. Three jazz reference sounds and three classical reference sounds were recorded and analyzed in the same manner as the test sounds. The reference sounds were those of saxophonists with expertise in the jazz and classical fields, and were generated using their personal equipment with no orientation toward a mouthpiece pitch. The reference subjects were simply asked to produce an A440 on their personal equipment, maintaining what they considered to be their personal jazz or personal classical tone quality. By comparing the test sounds to the reference sounds, we should be able to accurately answer the questions outlined in this experiment.

CHAPTER 2: REVIEW OF PEDAGOGY

Currently, there is insufficient published research data concerning a mouthpiece pitch relation to both classical and jazz tone production. Mouthpiece pitch is a topic that has been addressed by several authors, but generally not as something that should change for different styles of playing. This lack of evidence is what prompted this writer to further investigate. The idea of changing mouthpiece pitch for varying styles of playing was first introduced to the writer by Dr. Michael Jacobson, Professor of Saxophone at Baylor University in Waco, Texas. The reason for introducing the topic was to help develop a distinct sound for both classical and jazz playing. Prior to this introduction, the writer had difficulty maintaining the desired classical tone quality when playing classical music, as well as maintaining the desired jazz tone quality when playing in a jazz setting. Through intense mouthpiece pitch study for approximately two months, the writer was able to differentiate between the voicing and two embouchure settings needed for the two styles of playing. In order to achieve a classical tone quality, the writer would first produce an A5 on the mouthpiece alone as a reference for voicing. In the same manner, an Eb5 was used as a reference pitch for a jazz tone quality. Throughout any given practice session, the mouthpiece pitch would be rechecked for accuracy. From this point forward, the writer began using mouthpiece pitch study in practice and pedagogically with students who struggled similarly. While teaching these two distinct embouchure settings, no pertinent literature to support this pedagogy was found. There were, however, several colleagues who agreed with this notion of having two different settings, and some who even used mouthpiece pitch to illustrate the difference between the two settings.

Although there is no literature that scientifically validates mouthpiece pitch and its correlation to a classical versus a jazz tone quality, there is literature dealing with saxophone tone production that is crucial to understand as a foundation, which supports this pedagogical technique. The documents reviewed in this chapter address one or more of the following related topics: tonal concept, embouchure formation, oral cavity manipulation, mouthpiece pitch, mouthpiece and reed selection, and pedagogical distinctions between classical and jazz tone quality. The following material will be organized according to the above topics.

Tonal Concept

"Beauty in any art is much easier to recognize than to describe, and this is doubly true of a musical tone" (Teal 1963, 45). Musical tone is difficult to put into terms. This may be one of the reasons that it is infrequently specifically addressed in writings about the saxophone. In his treatise, *The Art of Saxophone Playing,* Larry Teal discusses saxophone tone quality in great detail. Teal states that we as saxophonists "have learned to identify certain elements in tone quality by a host of adjectives: 'mellow, edgy, cool, warm, refined, raw,' etc. Proof that we are all hearing the same thing is not at all conclusive, as the aesthetic senses of the listener and the performer are certainly affected differently." Teal continues by defining some of these commonly used terms related to tone:

Intensity. The energy of the sound produced. Depends on the degree of efficiency with which the available air stream is used, and is directly proportional to the amount of breath support.

Resonance. The degree of utilization of the breath support by the generating mechanism (mouthpiece and reed). The point at which this mechanism goes into its most efficient air stream-vibration relationship is known as the *point of resonance*. This point gives the tone projection without the necessity of great volume, and may be identified by a ringing quality in the tone. Support of the air column and embouchure position are vital factors in controlling the degree of resonance.

Core. A term often used to refer to a tonal center. Core is an ingredient of resonance, and is necessary to contribute stability of intonation and solidity to the tone.

Edge. The prominence of higher partials in the tone, which produces projection but introduces a buzzy quality. A certain amount of edge is desirable, and the proportion is a matter of musical judgment. Edge in a tone is influenced by the mouthpiece-reed relationship.

Color. A term used to describe the tone as dark or bright, and which includes all the colors of the spectrum. A bright sound emphasizes the higher partials, while a dark sound dampens them. Total elimination of the upper partials is unmusical to the human ear (e.g., the electronically-produced radio time signal.

Timbre. The general relationship of the various overtones. It is this characteristic which allows us to distinguish between tones of musical instruments, or different types of tones on the same instrument (47-48).

Although Teal describes tonal terminology in great detail, he does not specifically define an excellent saxophone tone. In fact, Teal mentions that an excellent sounding tone to one person may sound poor to another. According to Teal (48), “Imitation has no equal in awakening the tonal concept. All of the words in the dictionary cannot substitute for the hearing of a fine tone. . .”

The Art of Saxophone Playing covers tonal concept with the greatest depth, however, other saxophonists do mention the topic. In his treatise on saxophone altissimo study, *Top Tones for the Saxophone,* Sigurd Rascher refers to tone imagination in the following way:

All musical activity is the outcome of a balance between vivid, colorful and exact tone imagination and skillful tone production. Without a precise

> concept of the music to be reproduced, we are unable to render it in a convincing manner. Incomplete command of tone production and control makes it impossible to project the experience of our inner ear fully. Therefore, the student must develop his inner ear as much as he practices his instrument (Rascher 1977, 8).

This idea of developing a good tonal concept in order to produce a good tone quality is echoed in the writings of Bob Mintzer and Eugene Rousseau. In an article from the *Leblanc Bandsman* (n.d.), Rousseau recommends that saxophone students listen to good saxophonists, if not live then at least through recordings. Mintzer furthers this thought by adding the importance of seeking live performance opportunities (Mintzer 1994, 62-63).

Embouchure Formation

The term *embouchure* is used to describe the muscles involved in forming a seal around the mouthpiece. In terms of this writing, embouchure does not include the oral cavity, as it will be covered more fully in a later section. Embouchure formation is discussed in a number of saxophone writings. According to Larry Teal, the embouchure should be visualized as a "wheel" in which all sides are receiving equal amounts of pressure (Teal 1963, 41). All sources reviewed mentioned similar concepts, with several references to syllabic formations of an "o" or "oo" (Galladoro 1956, 6; Luckey 1992, 3; Mule 1950; Westphal 1983, 15). Several sources also define the embouchure as "circular" (Luckey 1992, 3; Mauk 1986, 6; Rousseau 1978, 7). Trent Kynaston (1973, 56) describes the pressure needed similar to the pressure achieved by a rubber band, with equal pressure coming from all angles. Yet another alliteration describes the muscles as to be used in the same manner as whistling (Smith 1974, 77).

Sources were in agreement that the top teeth should touch the mouthpiece. Only one source (Gallodoro 1956, 7) mentioned the possibility of a double-lip embouchure, where both the top and bottom lips cover the teeth prior to coming in contact with the mouthpiece. This was only mentioned as a possibility and was deemed impractical for the average player. Some disagreement was found regarding the amount of pressure to be exerted on the top of the mouthpiece by the teeth. While one source claims that because the upper teeth serve as a major point of contact, indentation marks on the top of the mouthpiece should be found (Smith 1974, 76), another recommends testing the correctness of the embouchure by lifting the top teeth from the mouthpiece while playing (Kynaston 1973, 56). Frederick Westphal (1983, 15) notes that "the upper teeth rest, but do not press, on the top of the mouthpiece".

As to the placement of the embouchure on the mouthpiece, sources recommend taking in 3/8" to 1/2" mouthpiece on alto and 1/2" or more on tenor (Luckey 1992, 3; Westphal 1983, 15). No mention of specific mouthpiece placement for soprano and baritone is made, although one source simply states that the lip should meet the mouthpiece at the point where the reed separates from the mouthpiece (Smith 1974, 75).

Two authors assert that the saxophone embouchure should remain the same for the entire normal range of the saxophone (Kynaston 1973, 56; Mauk 1986, 6). It is agreed upon by several authors that experimentation plays a significant role in the refining of embouchure, and that this experimentation is best guided under thoughtful supervision (Galladoro 1956, 7; Smith 1974, 78; Teal 1963, 44).

Oral Cavity Manipulation

For the purposes of this writing, the oral cavity includes the mouth, tongue and throat. As stated in the text, *Voicing*:

> The role of the vocal tract in wind instrument performance has been often misunderstood and therefore too frequently ignored causing it to remain outside of traditional pedagogy. The real potential of an understanding and mastery of this kind is slowly but consistently finding its way into various pedagogical sequences (Sinta and Dabney 1992, 3).

Although the above statement is true, several sources do note oral cavity manipulation as having a significant role in tone production. Several sources (Kynaston 1973, 56; Faub n.d.; Mintzer 1994, 1; Rousseau, n.d.) mention an open or relaxed throat as necessary to proper tone production on the saxophone. Kyle Horch, a contributing writer to *The Cambridge Companion to the Saxophone,* agrees that it is essential to have an open throat, but argues that this may not be the most useful way to conceptualize the matter. He writes:

> Musicians often speak of the necessity of having an open throat. For most of the course of the trachea this is no problem; our lives depend on an open trachea and it is actually quite impossible to close it. The danger area is at the top of the throat, where the trachea opens into the back of the oral cavity. Here, it is possible to have a sensation of 'closing' the throat. To avoid this, some players try to imagine the throat as being as open as when yawning. Personally, I try to have my throat feel as open and relaxed during blowing as it was during the inhalation of the previous breath.
>
> In my experience, however, the real culprit in most internal bottlenecks is actually the tongue, which can easily arch either backwards out over the throat opening, or up toward the roof of the mouth. The syllable method is a useful tool in creating practice models. The tongue position used in saying vowel sounds such as AH and OO allows an unobstructed airflow, as opposed to, for example, EE or IH, which cause the tongue to rise, narrowing the flow and changing the character of the vocal tone from an open, relaxed quality to a more restricted, intense quality (Horch 1998, 78).

In his lecture titled *The Role of the Oral Cavity and Throat in Saxophone Tone Production and Pitch* at the 2002 North American Saxophone Alliance Biennial Conference, Rick VanMatre also argues that the notion of 'opening your throat' can be confusing. He also mentions experimenting with vowel sounds as a means to finding the proper tongue position for good tone production.

Voicing (1992), by Donald Sinta and Denise Dabney, is one of the most familiar texts among saxophonists pertaining to oral cavity manipulation. The main purpose of studying oral cavity manipulation, or "voicing", is to acquire the skills necessary to perform in the altissimo register of the saxophone, according to the authors. However, the authors believe that studying voicing can have other benefits:

> The skills acquired through the study of voicing will undoubtedly aid the saxophonist in improving tone quality, intonation, and overall control of the instrument. The oral cavity is a significant timbre influence and pitch control mechanism as well as a variable in resource exploration (Sinta and Dabney 1994, 3).

In another familiar saxophone text, *Developing a Personal Saxophone Sound,* saxophonist Dave Liebman discusses tongue position in great detail. He agrees that using syllables to conceptualize tongue placement can be helpful, but argues that language can vary in different geographical regions, making this somewhat problematic. An emphasis is placed on the importance of the hump or back portion of the tongue. He writes:

> Imagine that the mouth cavity is like a cave with air entering at one end (from the throat passage) and exiting at the other end into the mouthpiece. The position of the hump portion of the tongue is crucial because of its effect upon air resistance, which in turn influences the final velocity of the air stream. Much like any body of disturbance in the middle of our imagined cave, we have to consider what the best position would be for the desired result. . . . The optimum position for this "disturbing" body or tongue hump is somewhere in the middle of the oral cavity, allowing the air stream to go above, below and around it (Liebman 1994, 23).

He continues by mentioning that this placement of the hump of the tongue in the middle of the oral cavity also reduces the risk of closing the throat, an area of concern for many of the authors.

In a lecture presented at a conference of public music teachers, Robert Faub, former Professor of Saxophone at Crane Music School at the State University of New York, Potsdam stated:

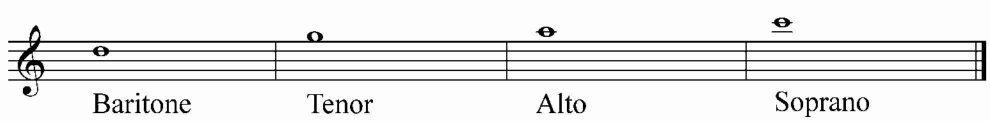
> Throat and tongue position, upper palate, nasal cavity- all of these areas are crucial to sound production. The oral cavity is what makes each of us sound unique, much more so than equipment. Be careful of playing the "equipment game"- while good equipment is essential, we must not loose sight of the fact that we have the utmost control over the resonating chamber that matters most (our own), yet this concept is rarely taught to young students (Faub n.d.).

Faub continues and echoes several other saxophonists by maintaining that forming syllables can be used as a tool to teach tongue placement.

Mouthpiece Pitch

References to playing on the mouthpiece alone were made by several authors (Faub n.d.; Luckey 1992, 3; Rousseau n.d.; Rousseau 1978, 7; Sinta and Dabney 1992, 6-7; VanMatre 2002). In *Saxophone High Tones* (1978, 7), Eugene Rousseau suggests the following mouthpiece pitches for the four most common saxophones:

Figure 2.1



Rousseau contradicts his own recommendation in a prior article in the *Leblanc Bandsman* (n.d.), where he asserts that the baritone saxophonist should play at a mouthpiece pitch level of Eb instead of D. The concept of playing on the mouthpiece alone to gain control over tone quality is attributed to Santy Runyon (1907-2003), a saxophone teacher, performer and mouthpiece maker (Luckey 1992, 3).

Mouthpiece and Reed Selection

Tip openings generally increase from classical to jazz mouthpieces, as does the length of lay, or distance between the tip and the point at which the reed meets the mouthpiece. This creates an increase in the distance that the reed is capable of traveling, and requires a softer reed (Roach 1998, 89). Baffle height effects the brightness or darkness of the tone (Liebman 1994, 34), and in conjunction with the chamber size controls tone color of the mouthpiece (Roach 1998, 90). According to Teal (1963, 17), the material from which a mouthpiece is constructed has very little influence on tone quality if all other factors remain. However, Liebman argues that material indeed does affect the tone. In addressing mouthpiece material, he states:

> Their characteristic and tonal properties are unique to each material and must be tested and learned through experience. In general, the metal mouthpieces have a more brilliant, compact sound and feel to them (Liebman 1994, 35).

It is agreed upon that reed strength must be proportionate to the tip opening of the mouthpiece. However, one writer suggests that jazz players may find it beneficial to use a differently cut reed than that of classical players. He states:

> The increased compression generated by many jazz and rock mouthpieces (particularly ones with a high baffle) is inclined to produce ‘squeaks’ (super high uncontrolled notes) at unpredictable moments, particularly when such a mouthpiece is used with classic, thin-tipped French reeds. Thus, the ‘American’

> style of reed is favoured by many jazz and rock players; it has a thicker tip and a flatter heart which impart a greater stability and aggression of tone at the expense of some refinement (Roach 1998, 90).

<u>The Difference Between a Classical and Jazz Tone Quality</u>

The majority of texts reviewed did not make a distinction between jazz and classical tone quality. However, a few texts elaborate on this very matter. In the *Cambridge Companion to the Saxophone*, contributing writer David Roach explains his opinion:

> The main difference between a jazz or rock player's embouchure and that of a classical player is the positioning of the lower lip; in classical playing it is more common for the lower lip to be slightly curled over the lower teeth providing the firmness necessary to control pitch and sound in that style, however in general, jazz and rock players turn the lip outwards. . . . The sound is broadened, allowing many more partials to appear in the tone; the reed vibrates more freely in the mouth, and more of the lower lip comes into contact with the rest of the reed, providing a different quality of damping. This creates a suitably more relaxed feel to the tone. . . (Roach 1998, 88)

Roach also states that while tone concepts are different, classical and jazz saxophonists share many of the same techniques. Robert Faub addresses this issue differently. While he believes that there is an embouchure difference between classical and jazz playing, he states that this is because the classical embouchure is a "non-changing" embouchure, while the jazz embouchure is a more flexible one. He further suggests that the resulting color changes that occur in the jazz tone quality are desirable in that style (Faub n.d.).

Some of the most relevant material found in relation to the difference between a jazz and classical tone quality and mouthpiece pitch was found in Rick VanMatre's presentation at the North American Saxophone Alliance Conference. In this presentation, VanMatre relates tone quality to mouthpiece pitch. He gives the same recommendations as Rousseau (1978, 7) for basic mouthpiece pitch, but also states that jazz saxophonists generally play at a much lower pitch level than classical saxophonists. He states:

> Generally, a higher basic pitch level allows you to pull out the mouthpiece farther and produces a more stable, centered, and refined sound. A lower pitch allows you to push in the mouthpiece farther and produces a bigger, louder, more flexible sound. . . . This difference is as important, or probably more important than embouchure in creating the idiomatic jazz tone.
>
> The basic pitch level is different in classical and jazz, but within each art form, the principles are the same. If the oral cavity and throat, along with embouchure pressure, produce a pitch that is too high, the tone will be small. . . All saxophonists reach their own personal compromise on this basic pitch level continuum, and this is a major factor in determining their sound (e.g. John Coltrane vs. Eddie Lockjaw Davis) (VanMatre 2002).

VanMatre also notes that the pitches given are just guidelines. He believes that the saxophonist should experiment to find the tone that they wish to create.

Conclusions

Upon review of documented pedagogy, it is apparent to the writer that saxophone tone quality and the factors that influence it are important and frequent points of discussion among saxophonists. Tone concept itself is something that is often discussed, but is difficult to put into words. Tone concept is often described as personal, although most saxophonists agree that there is a fundamental difference between a jazz and classical saxophone tone quality. Because of the intangible nature of conceptualizing tone quality, saxophone teachers often address other aspects of playing that affect tone. Embouchure, oral cavity manipulation, mouthpiece pitch, mouthpieces and reeds have all been subjected to experimentation. Saxophonists believe that each of these factors influence tone quality, but in varying degrees. While one saxophonist might believe that the embouchure has the greatest impact on tone quality, another might feel that oral cavity manipulation will create the most change. It is necessary to develop scientific data to support or refute these assertions, and therefore validate the pedagogy used.

It would be impossible for one study to delve into each aspect of tone production. However, it is the opinion of this writer that further investigation into the area of mouthpiece pitch and how it relates to a classical and jazz tone quality will be valuable. Although this has been discussed, a serious lack of scientific data exists. Therefore, a scientifically based project such as this one will provide the evidence necessary to support the pedagogy of some, and illuminate techniques to others.

CHAPTER 3: METHODOLOGY

Materials

To maintain consistency in the study, all subjects were asked to use the same saxophone and the same four mouthpieces. The saxophone used was a Selmer Super Action Series II, serial # 580724. The four mouthpieces used in this study were a Selmer C*, a Selmer S90 (190 facing), a Meyer 6M medium chamber hard rubber mouthpiece, and a Claude Lakey 4*4 hard rubber mouthpiece. The Selmer C* and Selmer S90 represent two commonly used classical saxophone mouthpieces. The Meyer 6M and Claude Lakey 4*4 represent two common jazz saxophone mouthpieces.

An assortment of new Vandoren reeds was available to the saxophonists. For obvious health reasons, the subjects did not use the same reed. Between each subject, all mouthpieces were disinfected.

All subjects were recorded on the same day, on the stage of the Tryon Festival Theatre in the Krannert Center for the Performing Arts on the campus of the University of Illinois at Urbana-Champaign. To minimize the influence of the room, several large drapes were used around the performer. To insure a minimum level of distortion, the recording engineer used high quality recording equipment (Nuemann U87 microphone, True Systems Precision 8 microphone amplifier). All subjects were recorded to digital audiotape (DAT).

Subjects

The subjects involved with this study were either graduate or undergraduate saxophone students at the University of Illinois at Urbana-Champaign at the time of recording. All subjects were music majors, studying classical saxophone repertoire with Professor Debra Richtmeyer. The breakdown of the ten subjects is as follows: three subjects pursuing a Doctor of Musical Arts in saxophone performance, one subject pursuing a Master of Music in saxophone performance, three subjects pursuing a Bachelor of Music in saxophone performance and three subjects pursuing a Bachelor of Music Education. Four subjects were female and six were male.

It was stressed to the participants that jazz performance was not a prerequisite. Therefore, the range of prior jazz experience was from very little to professional. It was also explained to participants that prior experience playing on the saxophone mouthpiece alone and/or relating mouthpiece pitch to tone quality was not necessary.

Reference Subjects

Reference subjects were needed to provide reference classical and reference jazz tone qualities. In this study, three reference classical tone qualities and three reference jazz tone qualities were used. The reference subjects were chosen from the original ten subjects, three reference classical players and three reference jazz players. Only one reference subject provided both a classical and jazz tone quality. The remaining four reference subjects provided either a classical or a jazz tone quality.

Reference subjects were chosen because of their level of performance experience in the desired idiom. All reference subjects can be considered highly qualified. When performing reference pitches, subjects were asked to use their personal equipment (reed, mouthpiece and saxophone). They were asked to play one audio take of A=440 for a duration of three to five seconds, twice, with a brief pause between the tones. Unlike the test subjects, reference subjects were asked to do this without playing on their mouthpiece alone. They were asked to produce what they considered to be a classical or jazz tone quality, respectively. Reference tone qualities were recorded on the same day, in the same room, and in the same manner as all other data collected in this study.

Procedures

Subjects signed up for a 30-minute time slot in which they were to be recorded. Each subject was recorded individually, with only the recording engineer and researcher present. Upon arrival, subjects were asked to warm up the instrument, using the Selmer C* mouthpiece. When the subject was sufficiently warmed up, they were asked to play an F# (concert A=440 or A4) on the alto saxophone. Using this pitch as a reference, they were then asked to remove the saxophone mouthpiece and produce an A5 on the mouthpiece alone. Subjects were asked to spend as much time as necessary to become comfortable with the mouthpiece pressure, air speed and air direction associated with achieving this pitch on the mouthpiece. Once comfortable with these factors, the subject was asked to place the mouthpiece onto the receiver of the saxophone, and again play the F# (concert A4) on the saxophone, this time aiming to keep their mouthpiece pressure, air speed and air direction the same as when playing on the mouthpiece alone. They were asked to play two successive tones, lasting three to five seconds, with a brief pause between. In the event that a subject did not feel his or her tone quality was a consistent representation of the mouthpiece pitch, they were permitted to re-record their sample. However, all recorded samples were used in this study, including those that subjects would have discarded because of inconsistency.

Once the subject's saxophone sound was recorded using the Selmer C* at the mouthpiece pitch level of A5, this procedure was duplicated using the Selmer S90, Meyer 6M and Claude Lakey 4*4 mouthpieces, respectively. At the end of these procedures, each subject had recorded a minimum of eight tones, or two blows on the four different mouthpieces. All tones to this point were to be produced with the same mouthpiece pressure, air speed and air direction as required producing an A5 on the mouthpiece alone.

The subject was now asked to once again place the Selmer C* onto the receiver of the saxophone and play a C (concert Eb=311.1 or Eb4). Using this pitch as a reference, they were then asked to remove the saxophone mouthpiece and produce an Eb5 on the mouthpiece alone. The subject was again asked to spend as much time as necessary to become comfortable with the mouthpiece pressure, air speed and air direction associated with achieving this pitch on the mouthpiece. They were then asked to return the mouthpiece to the saxophone and play an F# (concert A4), this time focusing on maintaining the embouchure pressure, air speed and air direction associated with producing the Eb5 on the mouthpiece alone. As with the previous sounds, this saxophone sound was recorded a minimum of two times. An illustration of the tones recorded by a sample subject (Subject 1) can be seen in the following table:

Table 3.1

Subject 1: Test Sounds

Subject #	Take #	Blow	Mouthpiece	Voicing
1	3	1	S80	A
1	3	2	S80	A
1	4	1	S90	A
1	4	2	S90	A
1	5	1	Meyer	A
1	5	2	Meyer	A
1	6	1	Lakey	A
1	6	2	Lakey	A
1	7	1	S80	Eb
1	7	2	S80	Eb
1	8	1	S90	Eb
1	8	2	S90	Eb
1	9	1	Meyer	Eb
1	9	2	Meyer	Eb
1	10	1	Lakey	Eb
1	10	2	Lakey	Eb

As coined by Donald Sinta (Sinta and Dabney 1992, 2), *voicing* "refers to the awareness of the muscles and soft flexible tissue in the oral cavity and vocal tract." In this case, it is referring specifically to the manipulation of those muscles to produce either an A or an Eb on the mouthpiece alone.

Statistical Analysis

The recorded sounds were now to be converted into a pictorial representation. This version of the data would be useful in differentiating between the sounds. First, the sounds needed to be translated into Audio Interchange File Format (AIFF). After this translation, the files were separated from the original audio takes that included multiple blows, into new audio takes that contained only one blow per take. These takes were then edited, eliminating the silence that preceded and followed each blow, as well as the attack and decay of each blow. Because the purpose of this study was to compare sound, not decay or attack, it was determined that eliminating these factors would be beneficial.

Next, the edited files were analyzed using a computer program named *Mac the Scope*, developed by the Channel D Corporation (available to download or as a time-limited demonstration version at www.channld.com). *Mac the Scope* is an audio analysis software program for use with Macintosh computer systems, the computer systems used by both the researcher and recording engineer. *Mac the Scope* includes a spectrum analyzer within its program, which was used to convert the saxophone tones into spectra.

Because it was desirable to use as much of the duration of the sound as possible, the ‘continuous linear averaging mode’ and ‘averaging overlap mode’ were employed. In the continuous linear averaging mode, each frame is weighted as one, averaging with the total number of frames that have been acquired. In other words, the tone in its entirety was taken into consideration, rather than just a slice of the tone. This produced an overall picture of the sound over its full duration. By using the averaging overlap mode, the software overlapped consecutive time records (or pieces of the sound over time) and processed each input record twice. This in turn minimized the effect of signal attenuation, or weakening of the signal from weighting functions.

The ‘vector trace display mode’ was chosen for ease of reading. In the vector trace display mode, line segments connect all measurement points. This results in a clear, interpolated picture. The spectrum was displayed using Cosine 4 as its weighting function. Cosine 4 was one of several weighting functions to choose from. The writer chose this particular weighting function because of the clarity with which it displayed the spectra, with progressive humps representing the overtones. The axis designated volume in decibels versus frequency in Hz. Two samples of spectra created using the above terms are shown below. The samples are of two different subjects, playing the same frequency on the saxophone, using the same mouthpiece:

Figure 3.1

<u>Subject 2, S80-A, Take 12, Blow 2:</u>

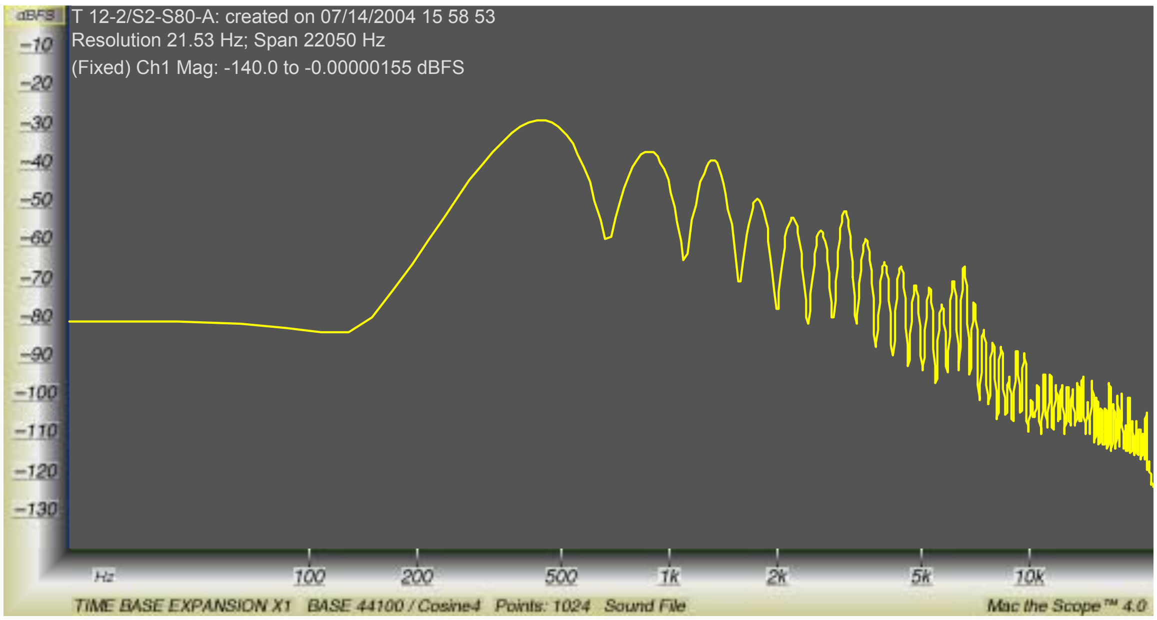
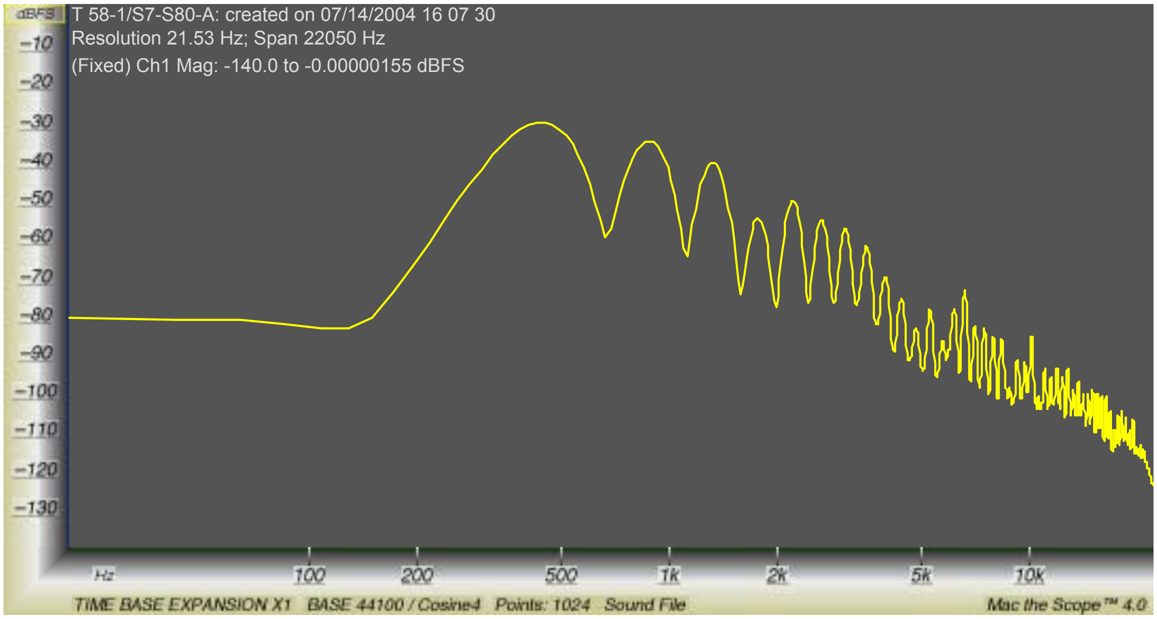


Figure 3.2

<u>Subject 7, S80-A, Take 58, Blow 1:</u>



By using *Mac the Scope* in the described manner, it was possible to produce clear representations of the fundamental tones, and the resulting overtones present in the sound. Note that the leftmost peak in the picture is the fundamental tone, A=440. Notice that the horizontal axis denotes pitch, measured in Hz. Each subsequent peak represents the next partial in the overtone series.

Saxophone tones of the same frequency are sometimes difficult to describe accurately in terms of difference merely by timbre. Using a spectrum, it is quite easy to see the exact harmonic content of each tone, making it much easier to distinguish between different tones. The two above tones are obviously similar in quality. The overall shape of the sound is very similar, with the fundamental tone being the strongest and its overtones gradually tapering. However, some significant differences in timbre are detectable. Notice that the first spectrum tapers until the seventh partial, where it spikes slightly. The second spectrum tapers more rapidly through the fourth partial, and spikes on the fifth. These differences provide a visual representation of the differences in timbre that the ear hears.

In this study, the spectra clearly provided a platform for discussion. The spectra could easily be compared visually. However, a more precise method of comparison was desired. Through a partnership with the University of Washington Electrical Engineering department, the researcher was able to obtain numbers to represent the distances between test sounds and reference sounds. Luca Cazzanti, a doctoral candidate in electrical engineering at the University of Washington, calculated these numbers.

In order to compute these numbers, Cazzanti first recalculated the spectra using *MATLAB* (available at www.mathworks.com), which is a commercial programming language specialized for the analysis of signals. *MATLAB* is a common computer-programming environment for signal processing. Next, Cazzanti used *MATLAB* to calculate the distance between test spectra and reference spectra. The sounds were originally recorded at a sampling frequency of 44100Hz, the standard compact disc recording frequency. The maximum bandwidth this sampling frequency can accommodate is 44100/2, or 22050Hz. Therefore, the spectra were compared up to 22050Hz, using 1025 frequencies spanning the bandwidth of 0-22050Hz. This required computations approximately every 21.5 Hz.

The distances of test spectra to references were calculated using the Itakura-Saito (I-S) distance formula. Assuming that a reference spectrum is X and a test spectrum is Y, the I-S distance is:

$$\sum_{i=0}^{1024} \left[\frac{y_i}{x_i} - \log \left(\frac{y_i}{x_i} \right) - 1 \right]$$

In calculating this distance, *i* is the index denoting one of the 1025 frequencies. Using this formula, one number is obtained from two vectors (spectra). Many in the acoustic processing community think that the I-S distance best captures how sounds compare to one another in a way that resembles how people hear sounds. Simple distance calculations, where overtones are the only points that are compared, do not describe sound similarity as accurately. As stated earlier, the I-S distance takes into consideration frequencies approximately every 21.5 Hz. A simple distance calculation of two tones at A=440 would only compare two points between 0Hz and 880Hz (440 Hz and 880Hz). Using this more precise calculation, there are 41 points between 0Hz and 880 Hz that are compared. The I-S distance has been employed in speech coding applications (Buzo, 146), and has been used successfully to compare speech recordings for automatic, computer-based speaker recognition.

These distances were then compared using the 1-Nearest Neighbor (1-NN) method. The following table illustrates one test pitch's relation to all references using the I-S distance. The smaller that the I-S distance is, the more closely the sounds relate to one another. Therefore, the smallest number representing the I-S distance is considered to be the closest distance, or nearest neighbor. JR1 and CR1 correlate to Jazz Reference Subject 1 and Classical Reference Subject 1, respectively. The nearest neighbor, or closest relative reference pitch to Subject 6, Take 50, Blow 1 is boldfaced and underlined:

Table 3.2

Itakura-Saito Distances for Subject 6, S80-A, Take 50, Blow 1:

	CR-1	CR-2	CR-3	JR-1	JR-2	JR-3
Blow 1	888.27	454.76	**191.58**	820.14	955.83	1511.03
Blow 2	1364.52	451.11	626.86	613.88	1221.8	1604.6
Blow 3	920.88					

As illustrated in the above table, the test pitch given by Subject 6 on Take 50, Blow 1 is most closely related to the reference pitch given by Classical Reference Subject 3, Blow 1. Because this pitch is most closely associated with a classical reference pitch, it is then labeled a classical tone quality. It can therefore be determined that when Subject 6 plays at a mouthpiece pitch level of A on an S80 mouthpiece, the resulting tone quality will be closer to a classical tone quality than to a jazz tone quality. The Itakura-Saito distance is a helpful compilation of data when discussing the comparison of these sounds.

CHAPTER 4: PRESENTATION OF DATA

Classical vs. Jazz Tone Quality

Describing the difference between a classical and jazz tone quality is inherently problematic. Classical tone qualities tend to be more similar in nature than jazz tone qualities. A simple calculation involving the reference tone qualities used in this study supports this assertion. First, the Itakura-Saito (I-S) distance of each classical reference to all other classical references was calculated. Then, the same process was repeated for each of the jazz references. As explained in the previous chapter, the I-S distance is a much more detailed method of measurement than measuring the distances between the overtones alone. The tones in this study were measured for comparison 1025 times within a span of 22050 Hz, or approximately every 21.5 Hz. The formula for the Itakura-Saito distance is shown on p. 28.

In the following tables CR1 and JR1 stand for Classical Reference Subject 1 and Jazz Reference Subject 1, respectively. The number after the comma refers to the specific blow of each subject. These tables show a comparison of reference tones to each other, not from test tones to reference tones. When comparing the tones to each other, tone A is compared to tone B, and then tone B is compared to tone A. When relating this data to the I-S formula, the row headings are X and the column headings are Y. Note that the distances are not symmetrical. For example, when looking at the data in rows, the distance from CR1, 1 to CR1, 2 is not the same as the distance between CR1, 2 to CR1, 1. This is true of the I-S distance in general, and is not specific to the data in this study. Each row in the following tables contain the distances from each row heading to all other references; each column contains the distances from each column heading to all other references. The results were as follows:

Table 4.1

Itakura-Saito Distances Among Classical References

	CR1, 1	CR1, 2	CR1, 3	CR2, 1	CR2, 2	CR3, 1	CR3, 2
CR1, 1	0	311.09	229.46	1776.86	1573.15	8338.55	16737.42
CR1, 2	1272.34	0	3172.2	5309.39	5267.32	18008.66	30872.77
CR1, 3	109.71	440.72	0	1227.43	948.21	7279.15	15730.95
CR2, 1	16594.7	18602.79	20231.98	0	93.04	9283.29	36951.93
CR2, 2	19318.33	21351.47	23014.54	135.03	0	11516.15	45234.65
CR3, 1	3969.79	3685.44	4462.19	475.83	539.59	0	420.67
CR3, 2	2513.74	2166.19	2637.62	724.64	745.08	100.04	0

Table 4.2

Itakura-Saito Distances Among Jazz References

	JR1, 1	JR1, 2	JR2, 1	JR2, 2	JR3, 1	JR3, 2
JR1, 1	0	1919.73	950.1	4181.54	958.99	4607.07
JR1, 2	1082.31	0	664.21	1286.92	1963.23	10275.64
JR2, 1	6585.74	3594.52	0	4285.79	5416.95	29466.24
JR2, 2	62457.28	17542.06	3388.78	0	30542.47	58667.28
JR3, 1	10947.54	61775.42	15991.71	41966.14	0	4094.48
JR3, 2	21372.73	71290.74	23241.27	41984.32	870.59	0

Next, the average distance between each reference and all other references of its kind (classical if a classical reference, for example) were computed, providing one number for each sound. Lastly, the classical reference numbers were averaged and the jazz reference numbers were averaged. These calculations produce a mean Itakura-Saito distance of 7415.80 for the classical reference sounds and 15093.66 for the jazz reference sounds. The difference between these numbers justifies the assertion that classical tone qualities are more similar in nature than jazz tone qualities.

The fact that acceptable jazz tone quality can be found on a much broader spectrum than classical adds to the complexity of separating the two. However, it can be said that in general, jazz tone qualities are richer in harmonic content than classical tone qualities. Note the differences in the two spectra below. The first spectrum represents a classical reference sound, and the second represents a jazz reference sound. As with all tones in this study, the sounding pitch is A440:

Figure 4.1

<u>Example of a Classical Reference Tone Quality</u>

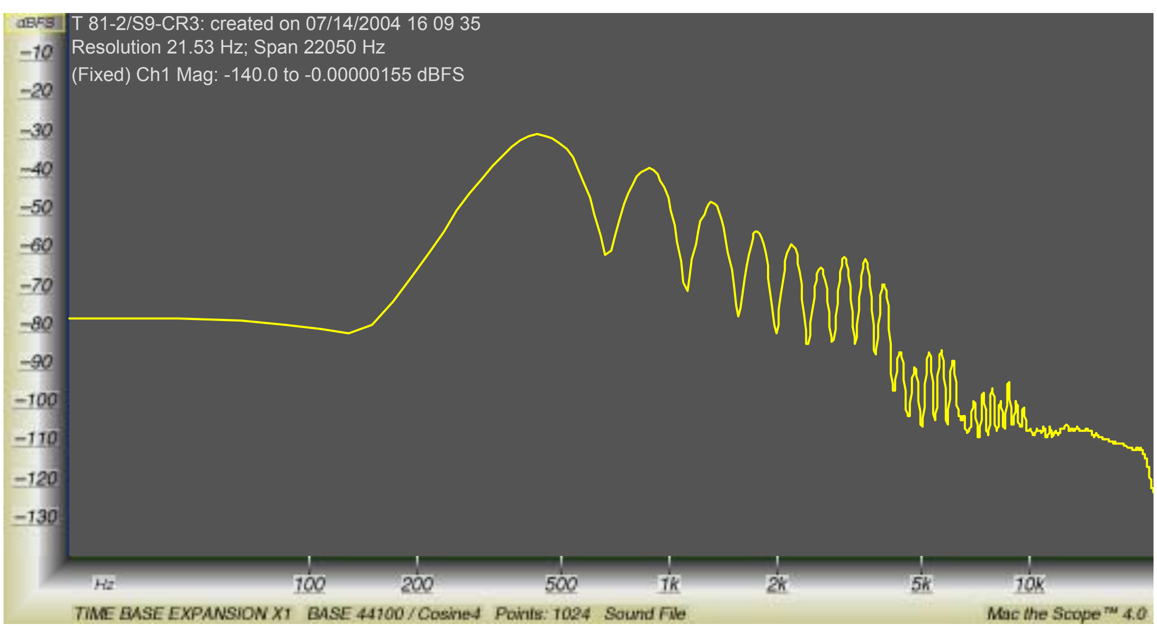
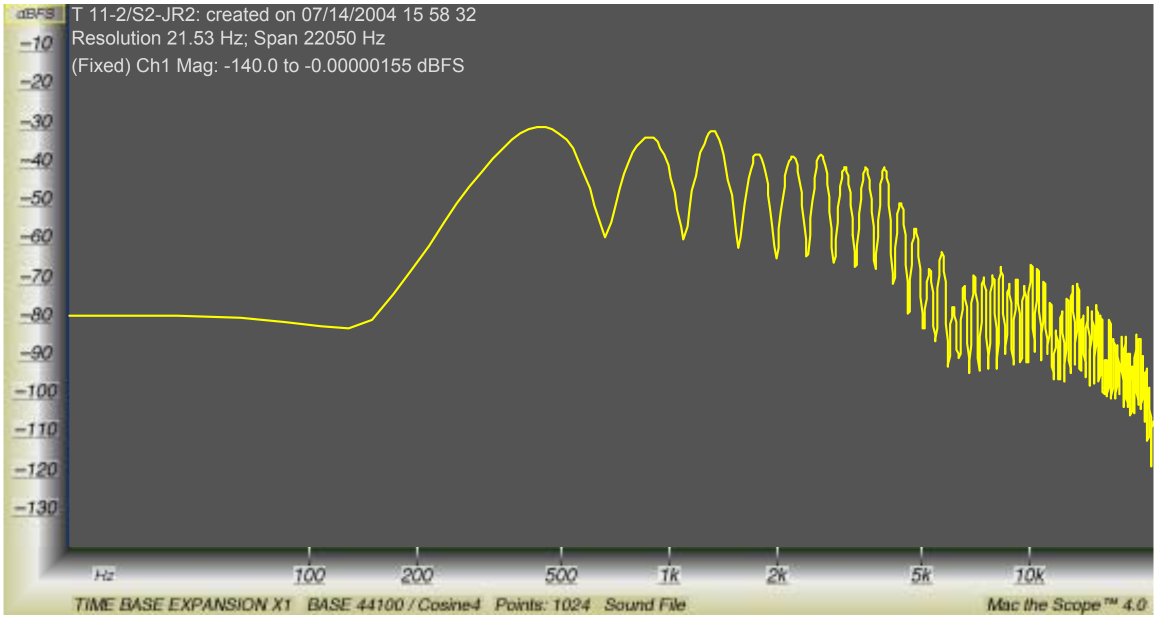


Figure 4.2

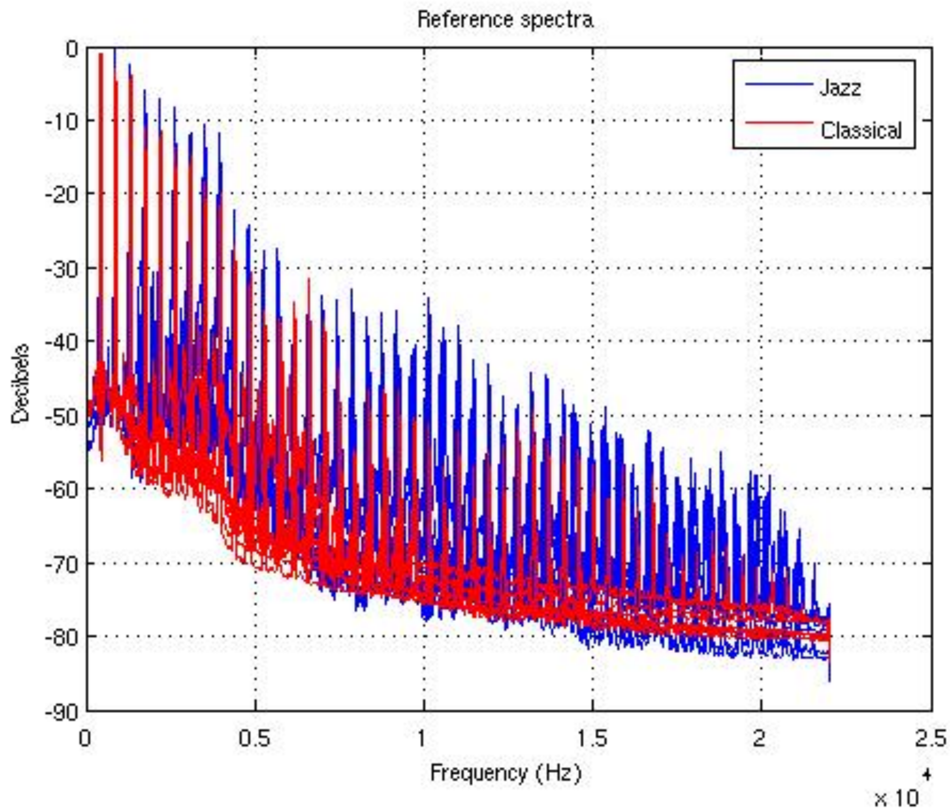
<u>Example of a Jazz Reference Tone Quality</u>



The fundamental of the classical tone quality is quite strong, with all overtones tapering as they ascend. The tapering is very gradual until the tenth partial, where it dips dramatically in comparison. Near the 10k Hz level, the harmonics become negligible. The fundamental of the jazz tone quality is also strong, however, the following eight harmonics are considerably strong as well. Tapering begins at the tenth partial, but at a much higher decibel level than in the classical tone quality. Harmonics remain significant throughout the reading of this spectrogram. The above clearly illustrates harmonics as the primary difference between two particular reference sounds. Below is a graphic representation of all thirteen reference sounds given in this study:

Figure 4.3

Correlation of Classical Reference Spectra to Jazz Reference Spectra



As labeled, the blue traces represent jazz references, while the red traces represent classical references. It is also apparent by this graph that harmonics are the primary distinction between classical and jazz tone qualities. As frequency increases, the partials of the jazz tone qualities remain at a much higher decibel level those of the classical tone qualities. With little exception, the harmonics of the jazz tone qualities consistently surpass the classical harmonics. This is consistent with the notion that jazz tone qualities are generally richer in harmonic content.

Comparison of Voicing

As stated in the introduction, *voicing* shall refer to the manipulation of the muscles in the oral cavity in order to produce a given pitch on the mouthpiece. An A voicing will refer to the voicing required to produce an A5 on the mouthpiece. For purposes of this study, an A voicing may be viewed as a classical voicing. By the same token, an Eb voicing will refer to the voicing required to produce an Eb5 on the mouthpiece. Similarly, an Eb voicing may be viewed as a jazz voicing. Voicing refers to the approach to the saxophone mouthpiece, and has no correlation to the actual mouthpiece used.

By measuring the Itakuro-Saito distance of each test pitch to each reference pitch, we can determine each test pitch's relation to the references. When comparing these numbers, we can then determine the closest match. After choosing the closest match, we can then assert whether the test pitch should be considered a classical tone quality or a jazz tone quality. 87 test pitches were collected at the A voicing. Of the 87 collected, 58 matched most closely to a classical reference pitch. 101 test pitches at the Eb voicing were collected. 80 of the 101 matched most closely to a jazz reference pitch.

Table 4.3

Comparison of A5 and Eb5 Voicing

Voicing	# of Takes	Classical Match	Jazz Match
A	87	58 (66.67%)	29 (33.33%)
Eb	101	21 (20.79%)	80 (79.21%)

It becomes apparent that with a 66.67% success rate for classical and a 79.21% success rate for jazz, that playing at the prescribed mouthpiece pitch level for either classical or jazz is desirable. The combined success rate of this method is 73.4%. At this point, the mouthpiece voicing of either A or Eb was the only consideration. The actual mouthpiece used was not taken into account. Breaking down the results by mouthpieces further improved the success rate. When examining the following table, remember that the S80 and S90 mouthpieces are considered classical mouthpieces and the Meyer and Lakey are considered jazz mouthpieces.

Table 4.4

Comparison of Voicing By Mouthpiece

Mouthpiece	Voicing	# of Takes	Classical Match	Jazz Match
S80	A	20	16 (80%)	4 (20%)
S80	Eb	22	5 (22.73%)	17 (77.27%)
S90	A	20	16 (80%)	4 (20%)
S90	Eb	22	6 (27.27%)	16 (72.73%)
Meyer	A	21	10 (47.62%)	11 (52.38%)
Meyer	Eb	27	2 (7.41%)	25 (92.59%)
Lakey	A	26	16 (61.54%)	10 (38.46%)
Lakey	Eb	30	8 (26.67%)	22 (73.33%)

The S80 mouthpiece had an overall success rate of 78.57%, followed by the S90 at 76.19%, the Meyer at 72.92% and the Lakey at 67.86%. Mouthpiece facing plays an important part in the overall sound and was considered. Facing refers to the tip opening, and is measured in thousands of an inch. Typically, a smaller facing translates to more control, but less volume and projection. A larger facing translates to an increase in volume and projection, but a decrease in control. The facings of the mouthpieces used in this study are as follows:

Table 4.5

Facing Sizes of Mouthpieces Used in Study Measured in Thousands of an Inch

Mouthpiece	Facing
Selmer S80	67
Selmer S90	67
Meyer 6M	75
Claude Lakey 4*4	80

Jazz mouthpieces generally have larger tip openings than classical mouthpieces, and the mouthpieces used in this study are no exception. Looking back to the overall success rates of the mouthpieces, it can be seen that they generally decrease as the facing increases (S80-78.57%, S90-76.19%, Meyer-72.92%, and Lakey-67.86%). This is consistent with the decrease in control offered with larger tip openings. In other words, because the Lakey is the most difficult mouthpiece to control, it stands to reason that it would be the hardest mouthpiece to produce an accurate, consistent pitch on alone. This may have led to difficulty for the subjects to produce the desired voicing when the mouthpiece was placed on the saxophone, and in turn caused the most errors to be produced on the Lakey.

By taking the mouthpiece voicing out of the equation, we find the ability of each mouthpiece to generate the desired sound, regardless of the player's approach. The S80 and S90 mouthpieces are considered classical mouthpieces. By averaging all of the classical matches among the S80 and S90 mouthpieces at either the A or Eb pitch level, we find that in this study, these mouthpieces produced classical tone qualities 52.5% of the time. Similarly, when averaging the jazz matches among the jazz mouthpieces, it is found that the Meyer and the Lakey produced a jazz tone quality 64.19% of the time. Therefore, the combined success rate of the four mouthpieces is 58.35%. This is significant in that it proves that mouthpiece pitch, at a success rate of 73.4%, makes more of a difference than the mouthpiece itself.

When playing the correct mouthpiece pitch on the correct mouthpiece (that is, playing with an A voicing on a classical mouthpiece or Eb voicing on a jazz mouthpiece), success rates improve further. The S80 and S90 mouthpieces are considered classical mouthpieces, and the Meyer and Lakey are considered jazz mouthpieces. When taking both the voicing and the mouthpiece into consideration, the Meyer leads with a 92.59% success rate. Following are the S80 and S90, both at a success rate of 80%. The Lakey performed at a rate of 73.33%. The total success rate of playing the correct mouthpiece pitch on the correct mouthpiece is 81.48%.

Furthermore, when playing a classical mouthpiece pitch on a classical mouthpiece, a classical sound results 80% of the time. When playing a jazz mouthpiece pitch on a classical mouthpiece, a classical sound results only 25% of the time. It then follows that one is 3.2 times more likely to produce a classical tone quality on a classical mouthpiece by producing an A on the mouthpiece than by producing an Eb on the mouthpiece.

In the same manner, when playing a jazz mouthpiece pitch on a jazz mouthpiece, a jazz sound results 82.96% of the time. When playing a classical mouthpiece pitch on a jazz mouthpiece, a jazz tone quality results only 45.42% of the time. Hence, one is 1.8 times more likely to produce a jazz tone quality on a jazz mouthpiece by producing an Eb on the mouthpiece than by producing an A.

In summation, playing the correct mouthpiece alone (using either voicing) proved to be successful 58.35% of the time. Playing the correct voicing (on any mouthpiece) was successful 73.4% of the time. However, the greatest success rate was found when playing the correct voicing on the correct mouthpiece. This yielded a rate of 81.48%. Consequently, one can deduce that voicing makes a greater difference in overall tone quality than the mouthpiece itself. In fact, subjects in this study were 1.26 times more likely to produce the desired tone quality with the correct approach to any mouthpiece than they were when playing the correct mouthpiece alone. When combining these two factors, though, one is very likely to produce the desired tone quality.

Errors

As with any scientific experiment, errors occurred. It is important to discuss these errors and determine reasons why the errors may have occurred. The overall success rate for this experiment was 73.4%, and therefore had an error rate of 26.6%. For clarity, errors will be categorized either classical errors or jazz errors. Classical errors will refer to those errors produced when using a classical voicing (A5), and jazz errors will refer to those produced when using a jazz voicing (Eb5). It is important to remember that there was no way to insure that the voicing used to produce a pitch on the mouthpiece was retained when performing on the saxophone. Mouthpiece pitches were always produced first to give the subject a frame of reference. However, it is possible that alterations in voicing were made inadvertently by the subject.

Because the discussion of errors must include mention of individual subject's test sounds it is important to keep the following in mind:

1. Subjects 1, 3 and 9 provided Classical References 1, 2 and 3 respectively.
2. Subjects 1, 2 and 5 provided Jazz References 1, 2 and 3 respectively.
3. Reference sounds were given before test sounds. Reference sounds were given on personal equipment, with no orientation to mouthpiece pitch.
4. Subject 1 gave both Classical and Jazz References.

<u>Classical Errors</u>

Eight of the twenty-nine classical errors were produced using a classical mouthpiece. Two subjects, Subject 3 and Subject 5, produced all eight of these errors. These eight errors comprised all of the classical test sounds on classical mouthpieces given by these two subjects. One could argue that it is probable that these two subjects changed their voicing slightly each time they played a classical voicing on a classical mouthpiece. Furthermore, all of Subject 5's test sounds voiced at an A5 were errors. A second argument could be that Subject 5 was never secure playing at this higher pitch level. It is also interesting to note that Subject 5 provided one of the jazz reference sounds, and this reference sound was recorded immediately preceding the classical test sounds. Another piece of information may prove to be more helpful in explaining these errors, however.

Seven of these eight errors most closely match Jazz Reference 2. This is particularly interesting because of another piece of information. Subject 3 (one of the subjects in question) provided Classical Reference 2. Of the five other reference subjects (two classical and three jazz), sounds provided by Classical Reference 2 matched most closely to sounds provided by Jazz Reference 2. It is also interesting to note that eighteen of the twenty-nine classical errors made on any mouthpiece (or 62%) most closely match Jazz Reference 2. Jazz Reference 2 only provided one third of the jazz reference sounds, so 62% of the classical errors matching this reference is significant. It may be valid to argue that although the reference provided was jazz, the sound retained more of the elements of a classical tone quality than other jazz references. Note the jazz references on the following pages:

Figure 4.4

Jazz Reference 1, Blow 1

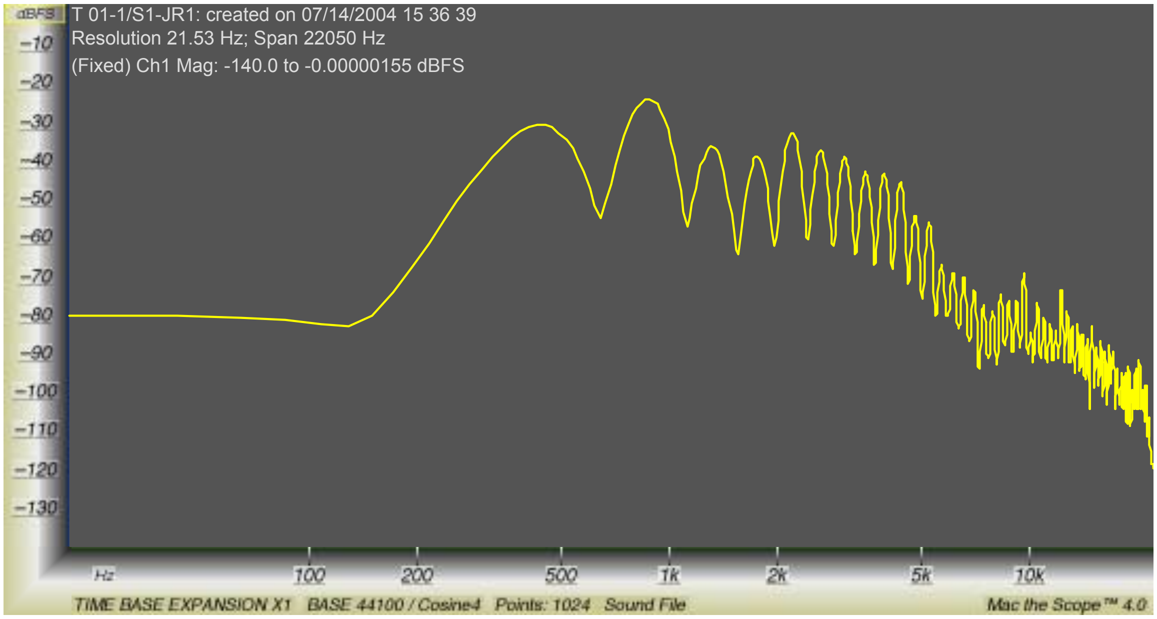


Figure 4.5

Jazz Reference 2, Blow 1

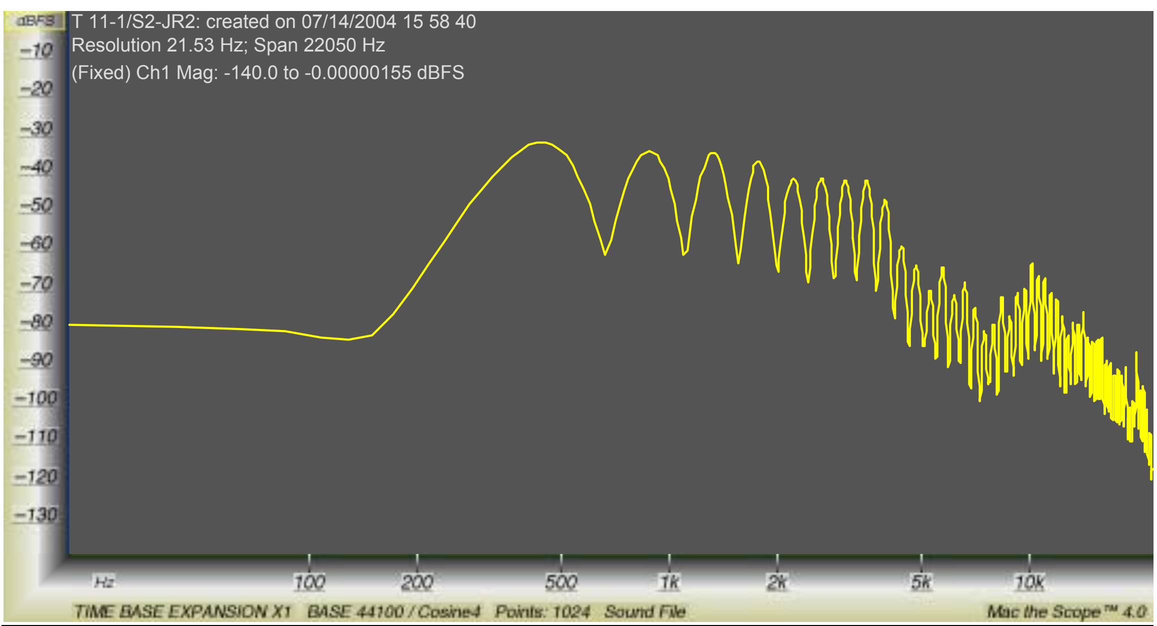
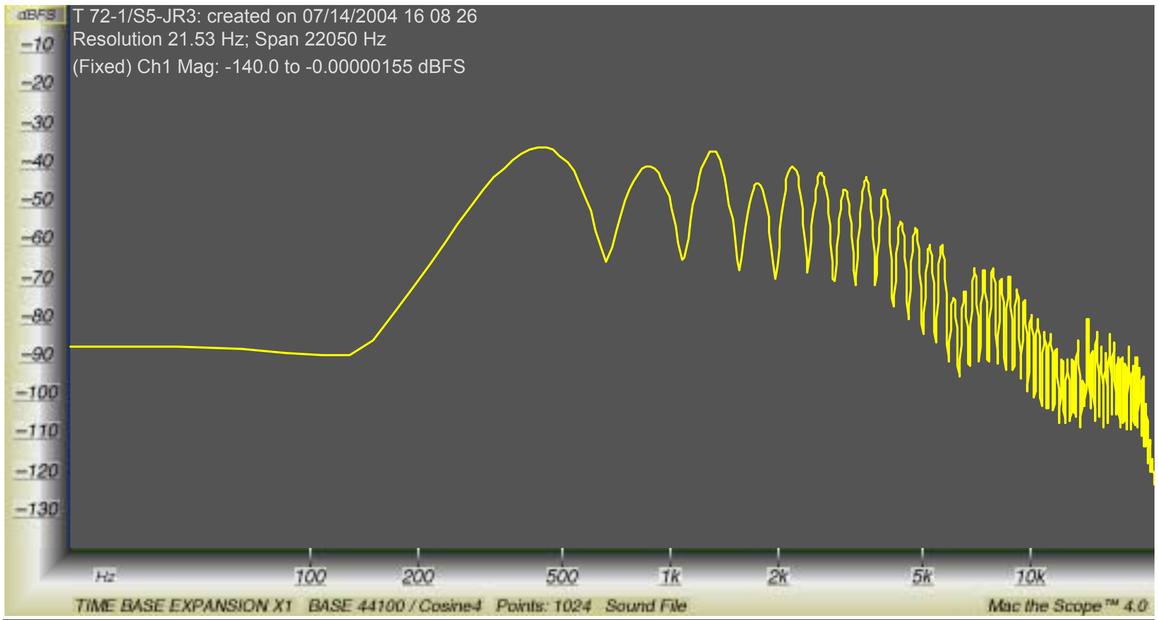


Figure 4.6

<u>Jazz Reference 3, Blow 1</u>



Note that Jazz Reference 2, although at a strong decibel level throughout, exhibits a more gradual tapering of the harmonics. The spectrograms of Jazz Reference 1 and 3 are much more jagged in nature. Although this gradual tapering is not nearly as severe as that of a typical classical tone quality, it is nonetheless a tapering rather than a jagged line. Therefore, the argument that 62% of the errors most closely match Jazz Reference 2 because this jazz tone quality is the closest relative of a classical tone quality deserves consideration.

There is one other perspective to consider when examining classical errors. Twenty-one of the twenty-nine errors occurred when trying to play an A5 on a jazz mouthpiece. It is possible to reason that this happened because of a natural tendency to lean toward a jazz voicing on a jazz mouthpiece. It is plausible that the subjects in question lowered their voicing slightly when performing on the saxophone, causing their tone quality to more closely imitate a jazz tone quality.

Jazz Errors

The jazz errors can be explained in similar terms to the classical errors. Of the twenty-one incorrectly classified sounds, eight came from one person, Subject 8. These eight sounds comprise all of Subject 8's test sounds using an Eb voicing. As with the classical errors, it is probable that Subject 8 did not maintain the appropriate voicing when performing on the saxophone. This is a particularly interesting hypothesis when considering the Meyer mouthpiece. Subject 5 provided the only two jazz errors on this mouthpiece. If it is true that the subject did not actually play an Eb on the mouthpiece, and by doing so would have achieved a jazz tone quality, the success rate could have been 100%.

As with the classical errors, most jazz errors matched one particular reference. Twelve jazz errors, or 57% matched Classical Reference 1. This reference gave only three of the seven or 43% of the classical references. This is significantly lower than 57%. Using the same reasoning as the classical errors, it may be that this reference's sound, although classical in nature, retains some elements of a jazz tone quality. The fact that this reference supplied both a classical and jazz reference is noteworthy, too. Obviously, the reference was comfortable playing either style, but one can question whether features of one sound may have been present in the other.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

Research questions were posed in the first chapter to outline the purpose of this study. With the information that has now been compiled, we are able to adequately answer these questions.

Question #1: Is there a correlation between mouthpiece pitch and tone quality achieved? Specifically, does playing a lower pitch on the mouthpiece produce a more jazz-like tone quality?

There is most definitely a correlation between mouthpiece pitch and tone quality achieved. As the research illustrated, 66.67% of the test sounds collected using the voicing of A5 on the mouthpiece created a classical tone quality. 79.21% of the test sounds collected using the voicing of an Eb5 on the mouthpiece created a jazz tone quality. Overall, the correlation between mouthpiece pitch and tone quality in this study is 73.4%. These findings are significant, and do suggest a connection between mouthpiece pitch and tone quality achieved.

Furthermore, the research suggests that playing lower on the mouthpiece does generally produce a more jazz-like tone quality. An Eb5 is significantly lower than an A5 (a tritone lower). This is a significant enough difference to ascertain that any sound generated on the saxophone after producing an Eb5 on the mouthpiece alone should be played with a lower voicing than one generated after producing an A5 on the mouthpiece alone. Of course, there is no way to insure that subjects performed on the saxophone with the same voicing used to produce a given pitch on the mouthpiece. But, the difference between the A5 and Eb5 is considerable enough to deduce that subjects most likely played these mouthpiece pitches differently. With an overall success rate of 79.21%, the research suggests that saxophonists are 3.81% more likely to generate a jazz tone quality than a classical tone quality when playing lower than an A5 (an Eb in this case) on the mouthpiece.

Question #2: Is there a correlation between mouthpieces used and tone quality achieved?

In relation to the second question, the research shows that there is indeed a correlation between mouthpiece used and tone quality achieved. When examining the ability of the mouthpieces to produce the desired tone quality, regardless of the player's approach, we find a success rate of 58.35%.

Question #3: If these correlations do exist, does one factor seem to have a greater influence on tone quality?

With a total success rate of 73.4%, playing the correct voicing (on any mouthpiece) makes a greater difference in overall tone quality than playing the correct mouthpiece alone. However, playing the correct voicing on the correct mouthpiece yielded a rate of 81.48%. The desired tone quality is most likely to be generated by combining the above factors.

<u>Limitations</u>

In retrospect, several factors may have inadvertently affected the results of this study. Most significantly, the subjects were not thoroughly introduced to the mouthpiece pitch concept. Subjects were told in advance that they would be asked to generate different pitches on the mouthpiece alone, but no effort was made to insure saxophonists were comfortable doing so. When aiming for either an Eb or an A on the mouthpiece several subjects struggled. One subject in particular, Subject 10, could not produce an Eb on the S80 mouthpiece. The lowest pitch that this subject was capable of generating was an E. In some respects, the fact that the subjects had varying ability to generate the full octave of available pitches on the mouthpiece makes this study more realistic. Because mouthpiece pitch is not typically taught in relation to a jazz tone quality, students may not have experience playing on the mouthpiece alone. Some inexperienced players may have difficulty achieving the full octave range, and/or maintaining a steady pitch on the mouthpiece. The successful results of this study can be weighted even more heavily upon contemplation of this issue.

When teaching this method of tone production, the researcher recommends at least one month of intense mouthpiece pitch study. It is suggested that the student begin each practice session by practicing the full range of the mouthpiece. If the student has never practiced on the mouthpiece alone, it may be necessary to work on extending the mouthpiece range over a period of time. Next, the subject should voice the desired pitch on the mouthpiece several times before practicing on the saxophone. Periodically throughout the practice session it would be necessary for the student to remove the mouthpiece and check the pitch level. If at this point the student's mouthpiece pitch varies from the desired mouthpiece pitch, it would be necessary to practice the full range of the mouthpiece again before zeroing in on the desired mouthpiece pitch. The process of checking and rechecking mouthpiece pitch levels should be repeated each practice session. Logically, it would follow that if a subject were to have practiced voicing the mouthpiece at a particular pitch level for a significant period of time before the date of recording, the results of this study would have most likely improved.

The fact that the subjects did not necessarily feel comfortable with the mouthpieces chosen, may have also limited the capabilities of this study. These were not made available to the saxophonists to practice with before the testing date, and may or may not have been mouthpiece types that they had played before. Obviously, if a saxophone teacher had a jazz saxophone student who was having difficulty achieving their desired tone quality, the student would have practiced with their mouthpiece. Again, if the subjects were given time to practice the mouthpieces to be used in the study, it becomes questionable if fewer errors would have occurred.

One final possible limitation of this study was the spectrum of saxophone subjects. All subjects used in this study were students at the same university, studying under the same teacher. Undoubtedly, each saxophonist had elements of their playing that were unique. However, being in the same environment and studying with the same pedagogue, they must have shared some common elements in their approach to the saxophone. Whether these factors were actual limitations of this study is not known. More data would need to be collected and compared against the data of this study to make this judgment. Replication of this study, using students from different saxophone studios and teachers would be helpful in determining if this influenced the results.

Recommendations for Further Research

The results of this study support the pedagogical implication that by generating a low pitch on the mouthpiece alone, a saxophonist can more accurately approximate a jazz tone quality than they can by generating a high pitch on the mouthpiece. This piece of information may prove to be helpful in the instruction of very young saxophonists. Because this study was conducted using collegiate saxophonists involved in intense private study and daily involvement with colleagues, it can be deduced that the subjects had a more acute awareness of the muscles in their oral tract than that of the average beginning saxophonist. A study involving young or inexperienced subjects would be valuable. It would be beneficial to determine if the concept of mouthpiece pitch manipulation is ascertainable by the most novice saxophonist.

This study involved alto saxophone mouthpiece pitch, but did not address the mouthpiece pitch levels of the soprano, tenor or baritone saxophones. As these saxophones are commonly used in both big band and solo jazz performance, it would be beneficial to replicate the study for each of these instruments. One could use the same principal as in the alto mouthpiece pitch study. The mouthpieces could be voiced at the mouthpiece pitch level for classical playing that is outlined in Eugene Rousseau's *High Tones for Saxophone* (1978), C for soprano saxophone, G for tenor saxophone, and D for baritone saxophone. These mouthpiece pitches can be seen in Figure 2.1.

The saxophone sound associated with the classical mouthpiece pitch should be recorded first, followed by the sound associated with a mouthpiece level that is significantly lower. The researcher believes that a study of this nature would have similar results as the current study.

Another study that may prove to provide data of interest would be one involving a much wider range of mouthpieces. Two common classical alto saxophone mouthpiece brands not used in this study are Vandoren and Rousseau. There are several acceptable sizes of these mouthpieces, as well as sizes of Selmer mouthpieces that were untested. Because the spectrum of jazz tone quality is much broader than that of the classical saxophone, there is a much wider array of jazz mouthpieces. Included among jazz mouthpieces are Beechler, Morgan, Berg Larsen, and Otto Link. Although hard rubber mouthpieces were used exclusively in this study, jazz mouthpieces are commonly composed of metal as well as hard rubber. Different studies could be conducted comparing the effect of mouthpiece facing, chamber size, material, and brand. One separate study may be organized to test the effect of the A and Eb voicing on a series of one particular brand of mouthpieces. For example, Selmer makes a series of alto saxophone mouthpieces in different facings from B* to G. This is Selmer's notation for facing sizes from 58-91 thousandths of an inch. It would be fruitful to not only determine a difference between the A and Eb voicing on these mouthpieces, but also to find if there was a point at which either voicing became more difficult. In other words, discover if there was a defining turning point between the jazz and classical facings of the mouthpiece.

The final study that this writer recommends is one that involves the full chromatic range of available pitches on the saxophone mouthpiece. Only two pitches were utilized in this study, A5 and Eb5. These two pitches were chosen because they represented a significant distance within the approximate octave of available alto saxophone mouthpiece pitches, and they happened to be the pitches utilized by the writer. Certainly, there are classical saxophonists that produce pitches other than A5 on the mouthpiece, just as there are jazz saxophonists who produce mouthpiece pitches other than Eb5. This study used these two pitches consistently for clarity in the results. The research clearly proved that generating an A5 on the mouthpiece alone creates a different saxophone tone quality than when generating an Eb5 on the mouthpiece. It also proved that the tone quality produced when generating an Eb5 on the mouthpiece is more closely associated to a typical jazz tone quality than to a typical classical tone quality. What it did not define is what difference each chromatic tone on the mouthpiece makes on the overall tone quality achieved.

While the suggested studies would broaden the knowledge of effects mouthpiece pitch on tone production, this research proved to define a fundamental concept. When striving unsuccessfully for an alto saxophone jazz tone quality, removing the saxophone mouthpiece to check the mouthpiece pitch may be of help. If the mouthpiece pitch is equal to or higher than the A5 recommended for a classical tone quality, often simply lowering the mouthpiece pitch will assist the player in approximating the desired sound. Although this does not in any way replace the ear as the ultimate judge of tone quality, it does provide a point of departure.

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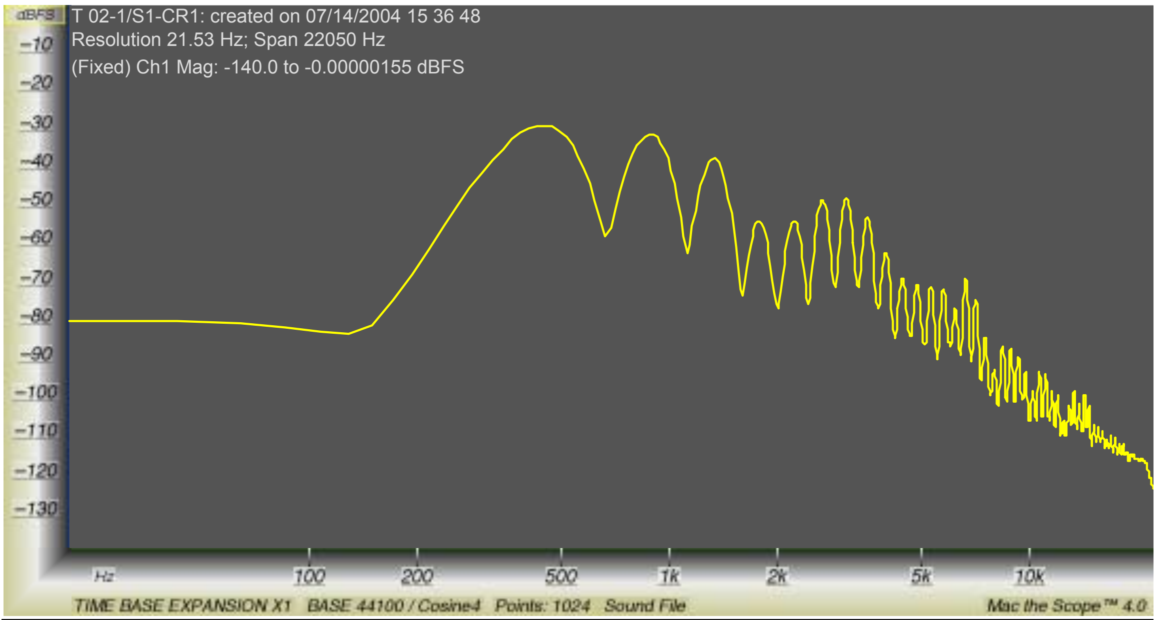
APPENDIX A: SPECTRAL ANALYSIS OF REFERENCE PITCHES

Classical Reference 1, Take 2, Blow 1:



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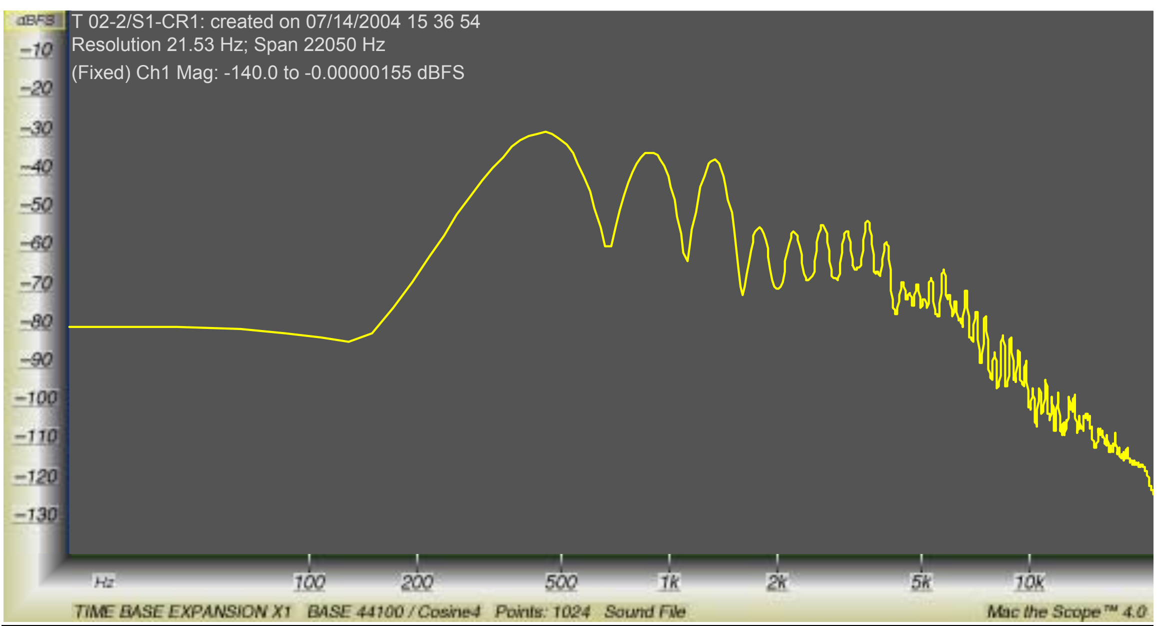

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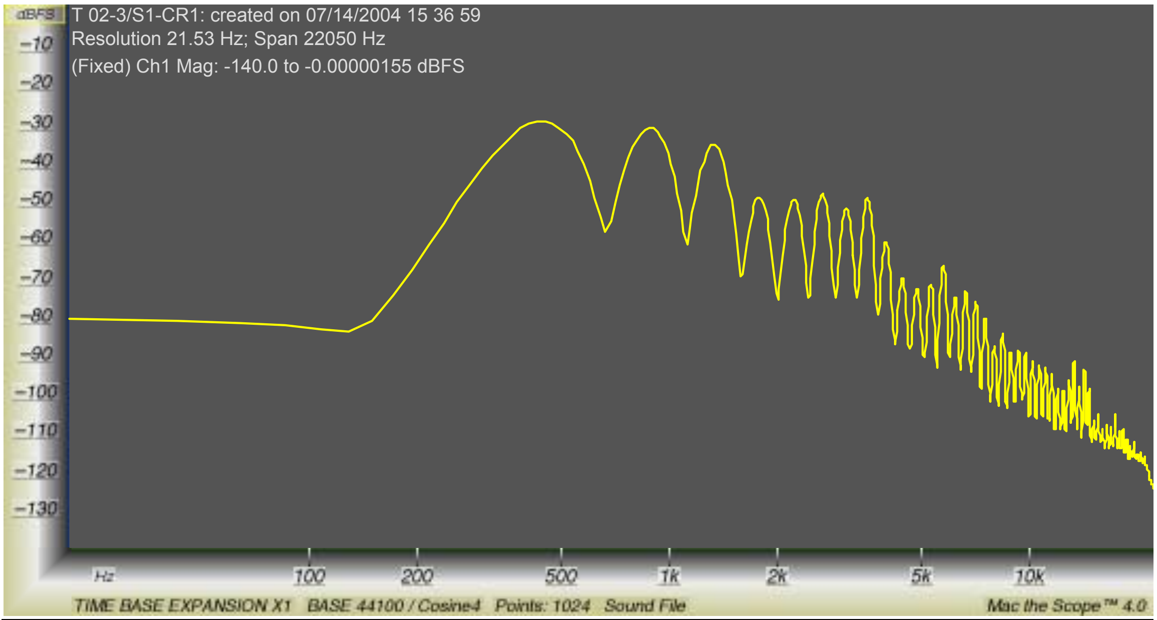

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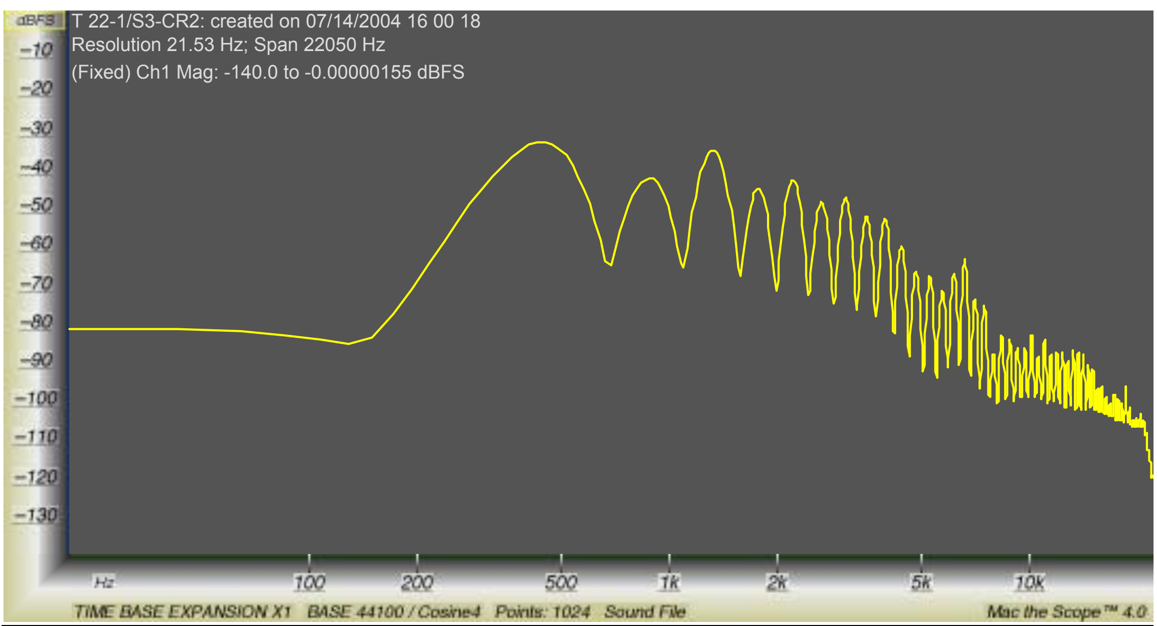

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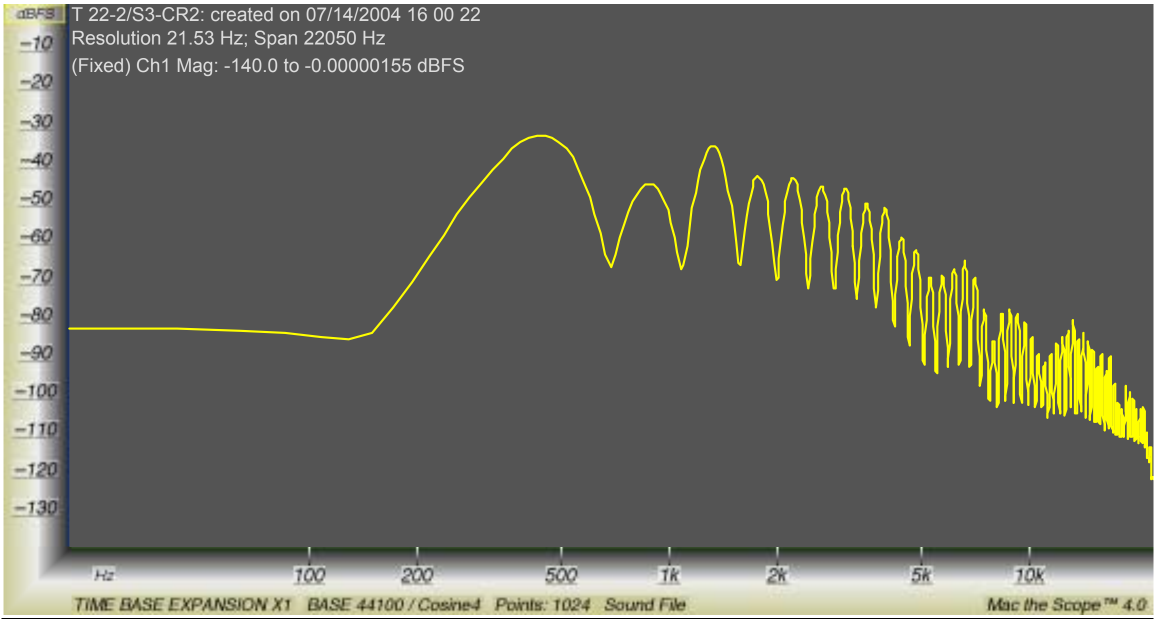

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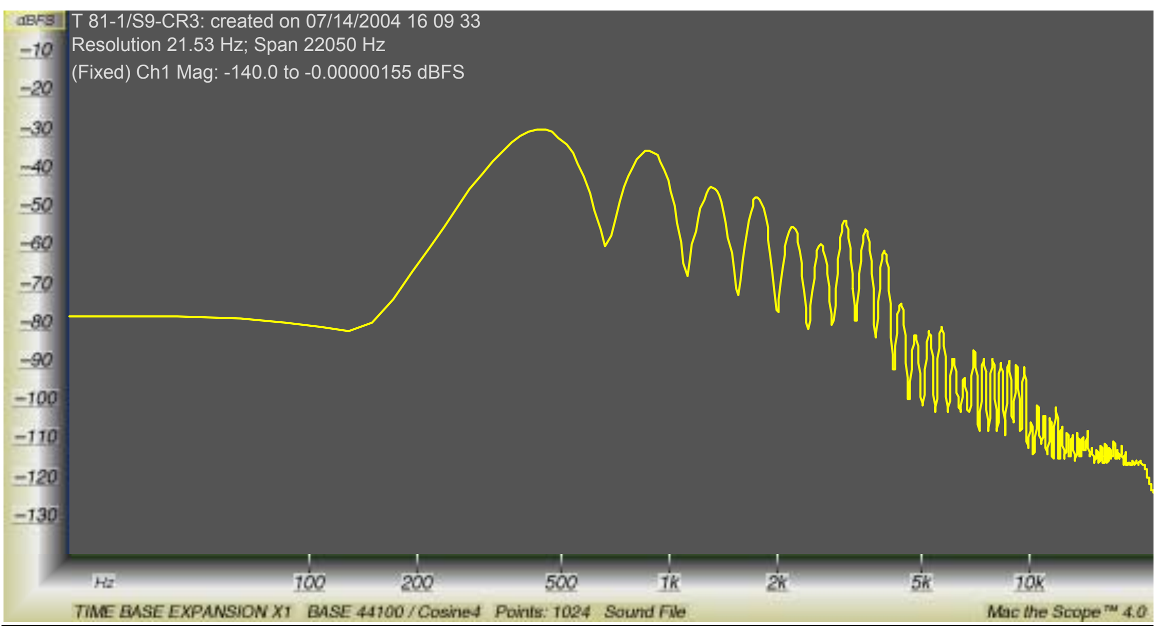

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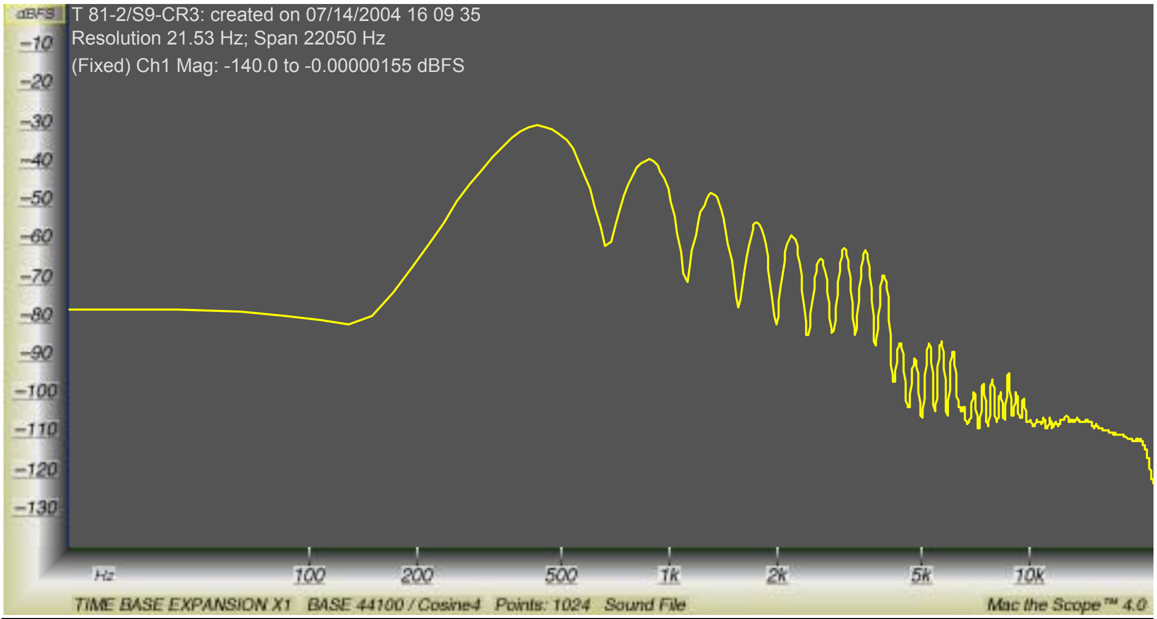

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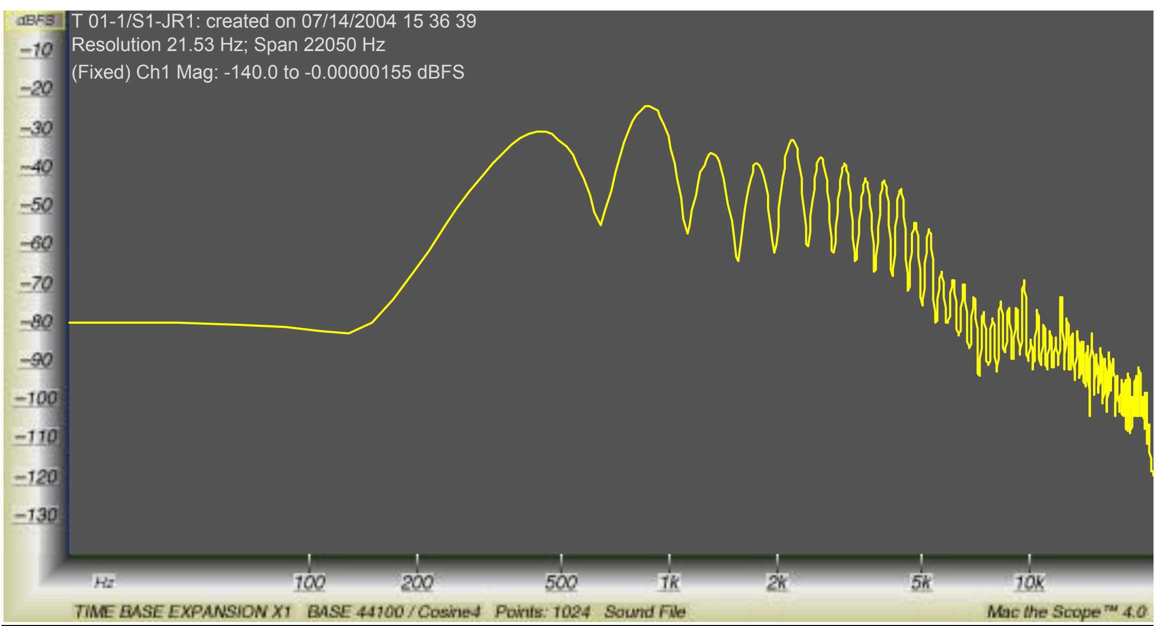

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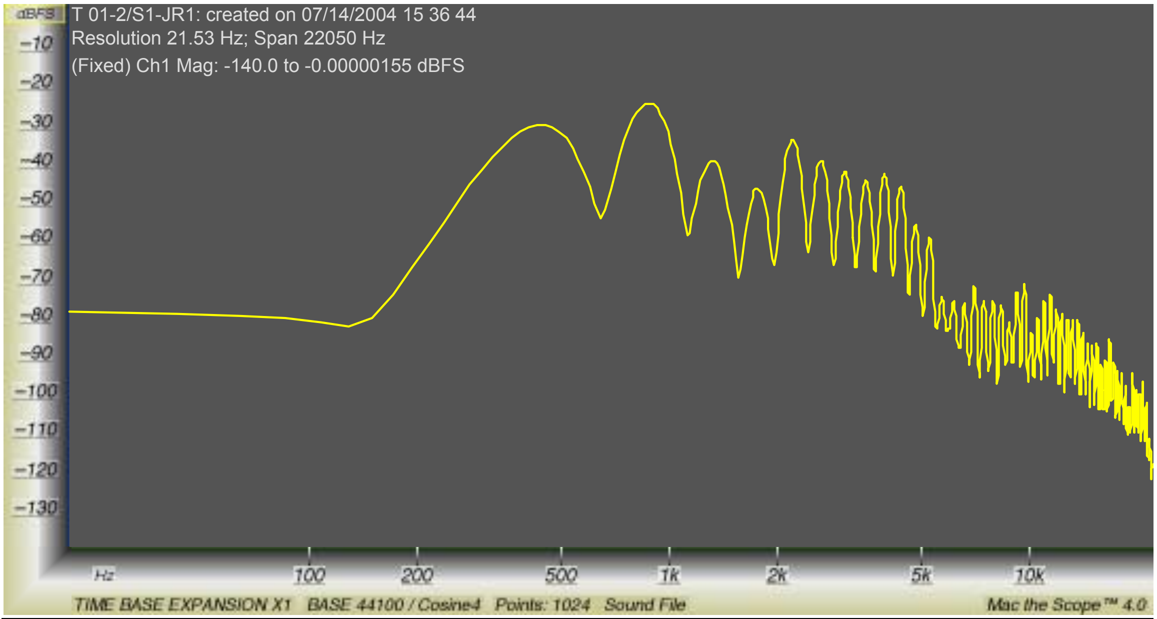

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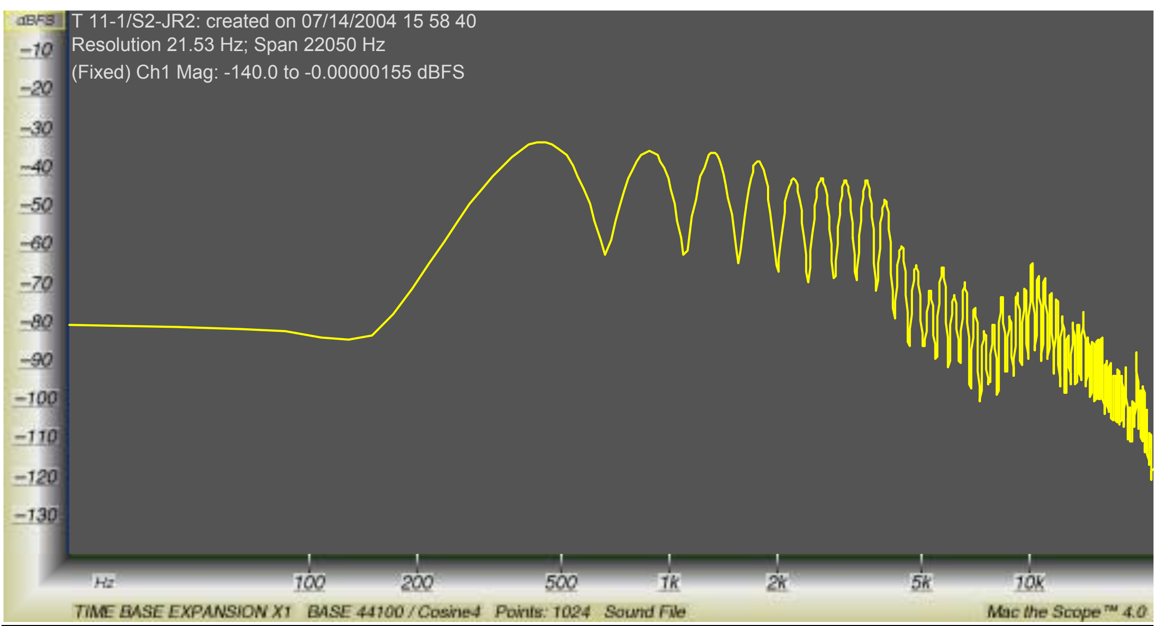

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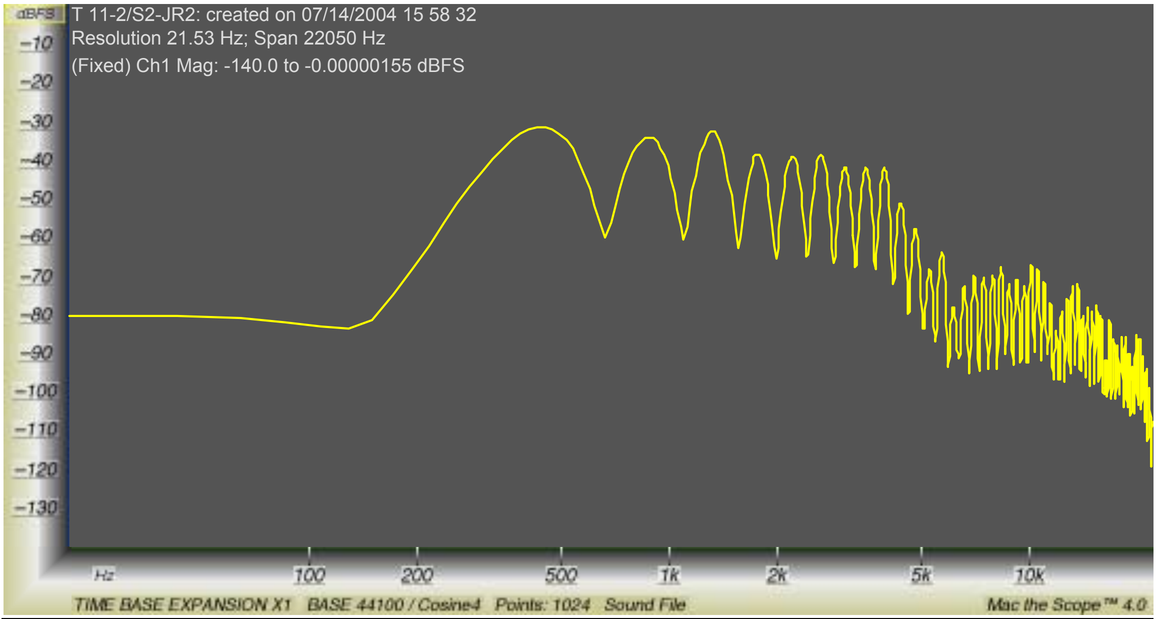

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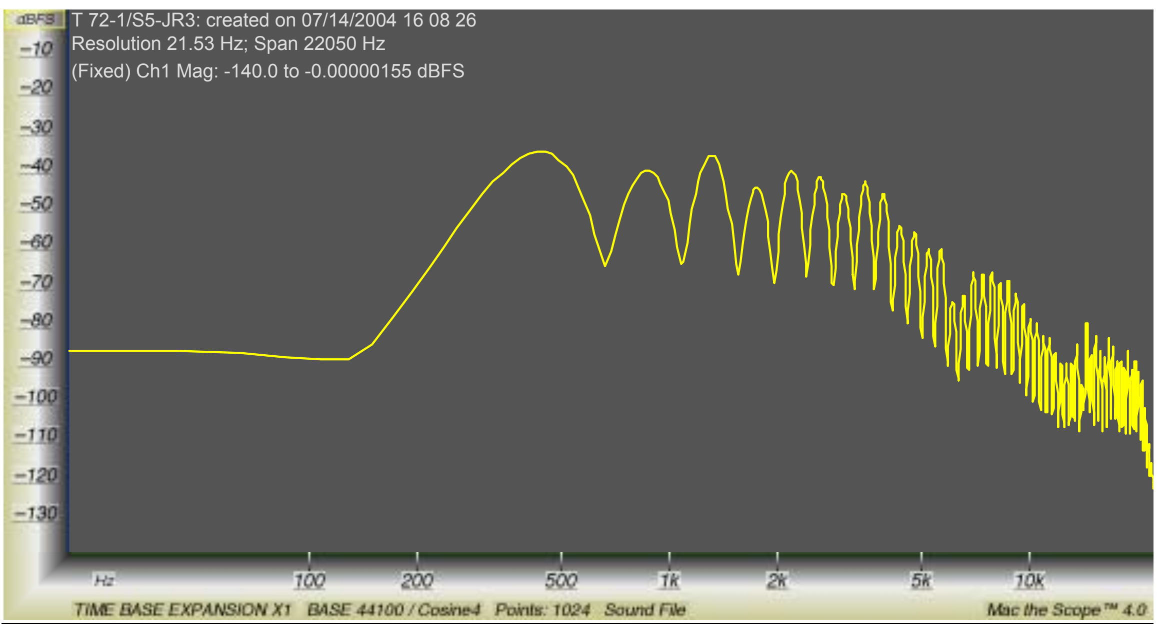

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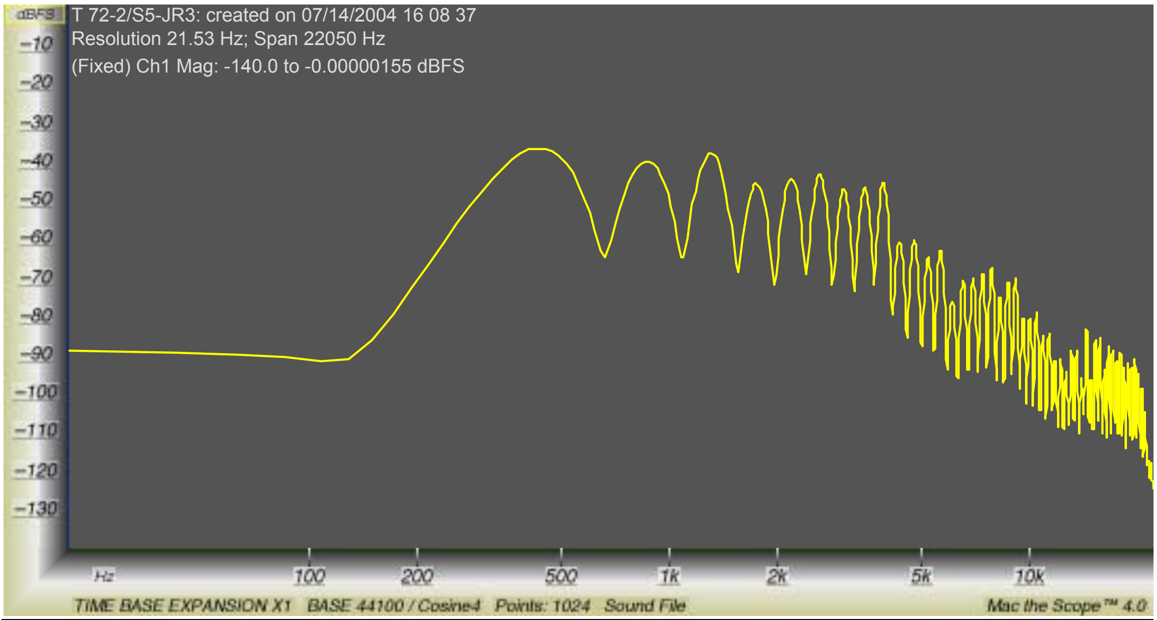

APPENDIX B: SPECTRAL ANALYSIS OF SAXOPHONE TONE QUALITY USING SELMER S80 MOUTHPIECE AT MOUTHPIECE PITCH LEVEL OF A5

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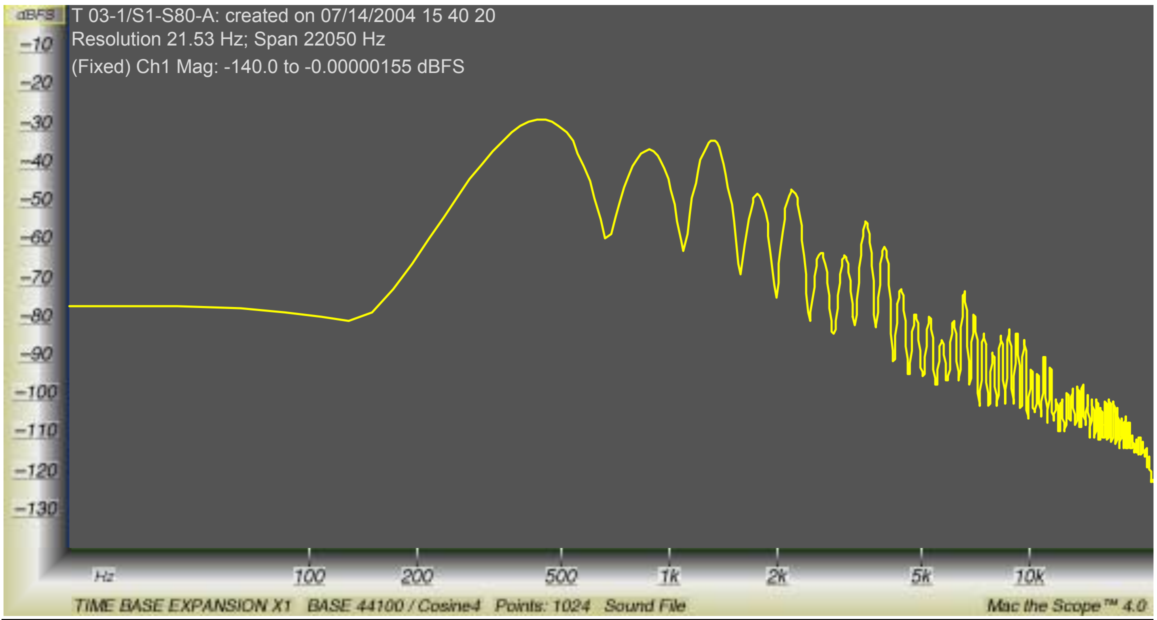

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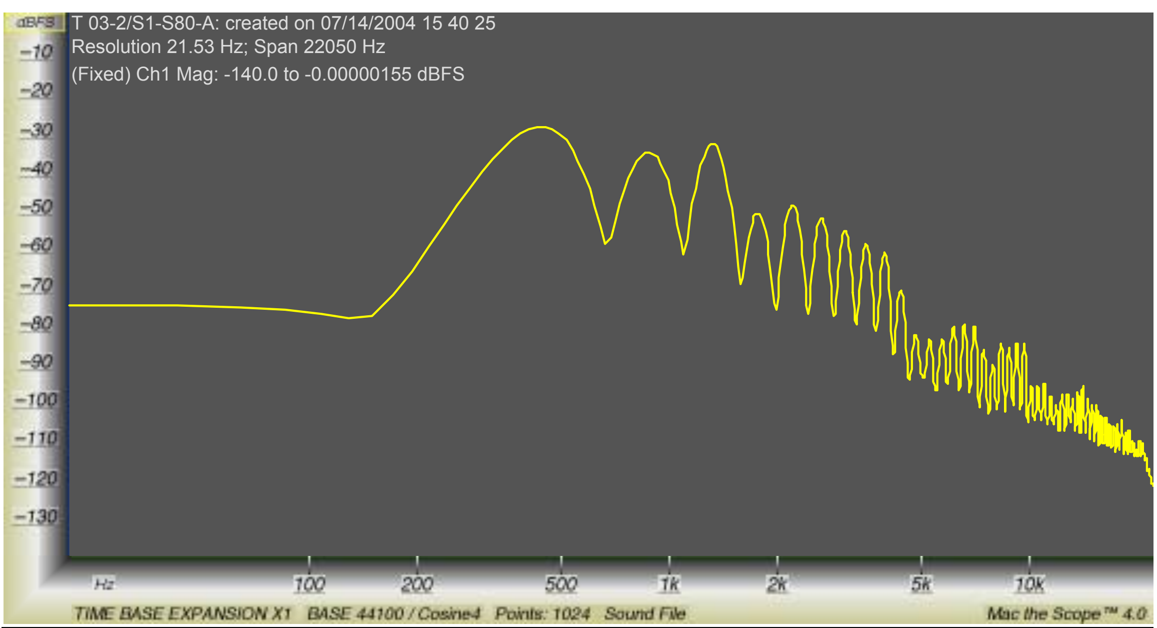

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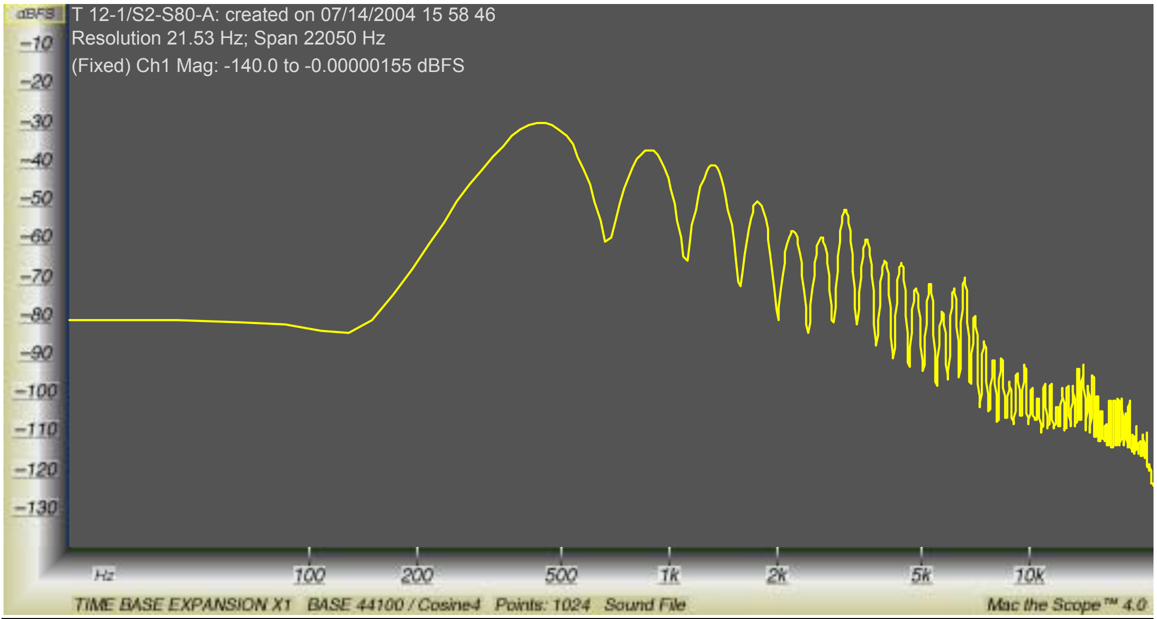

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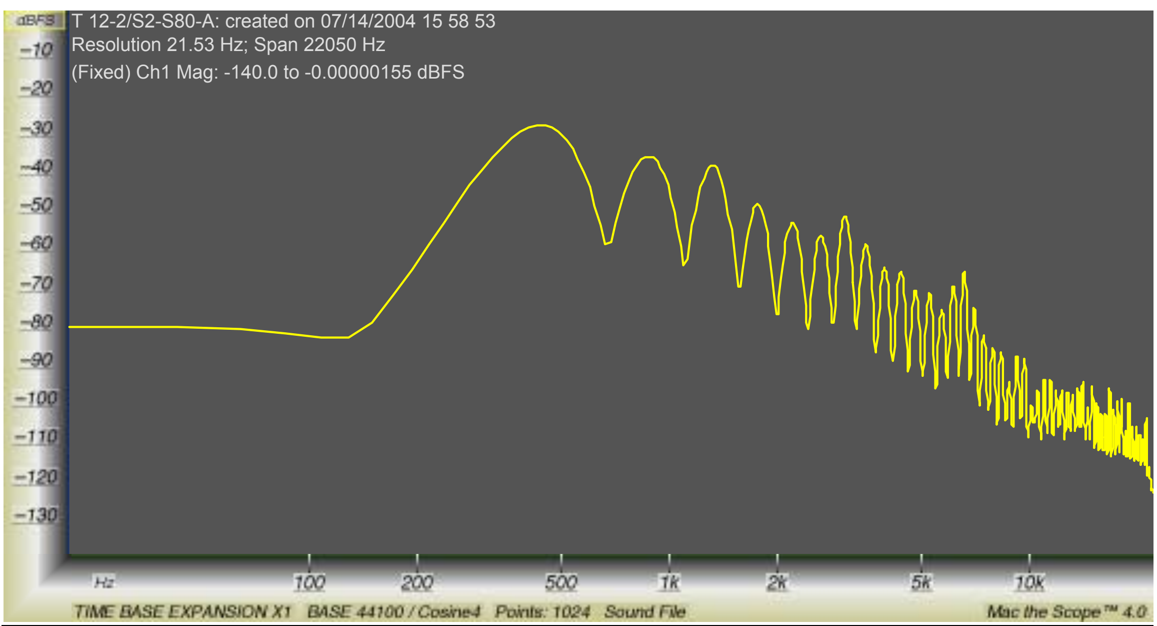

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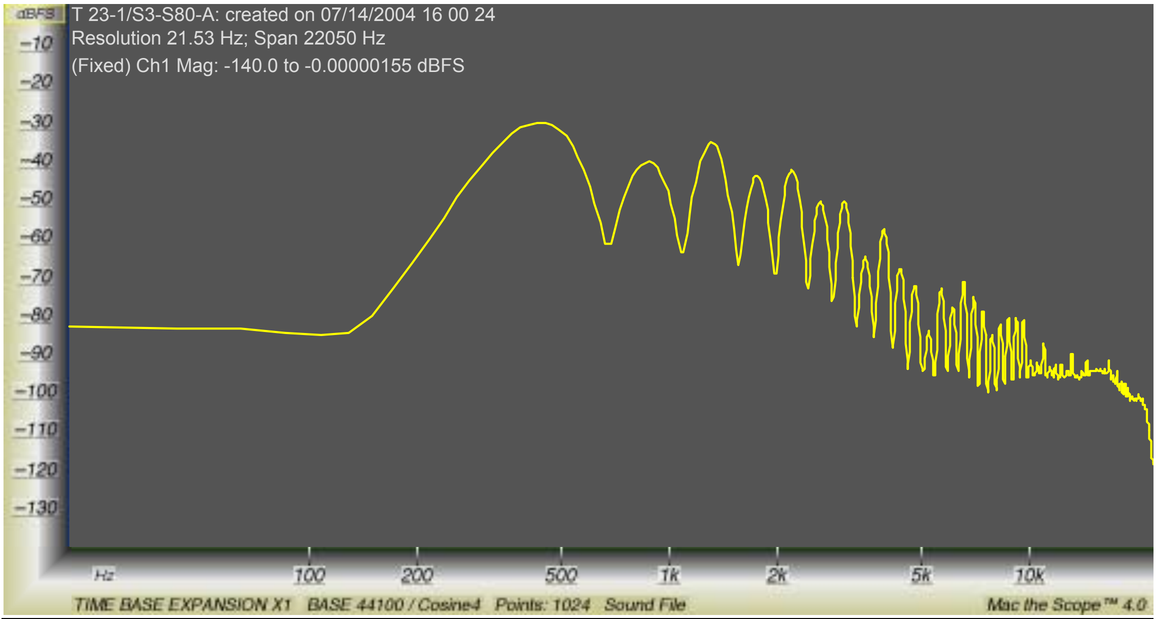

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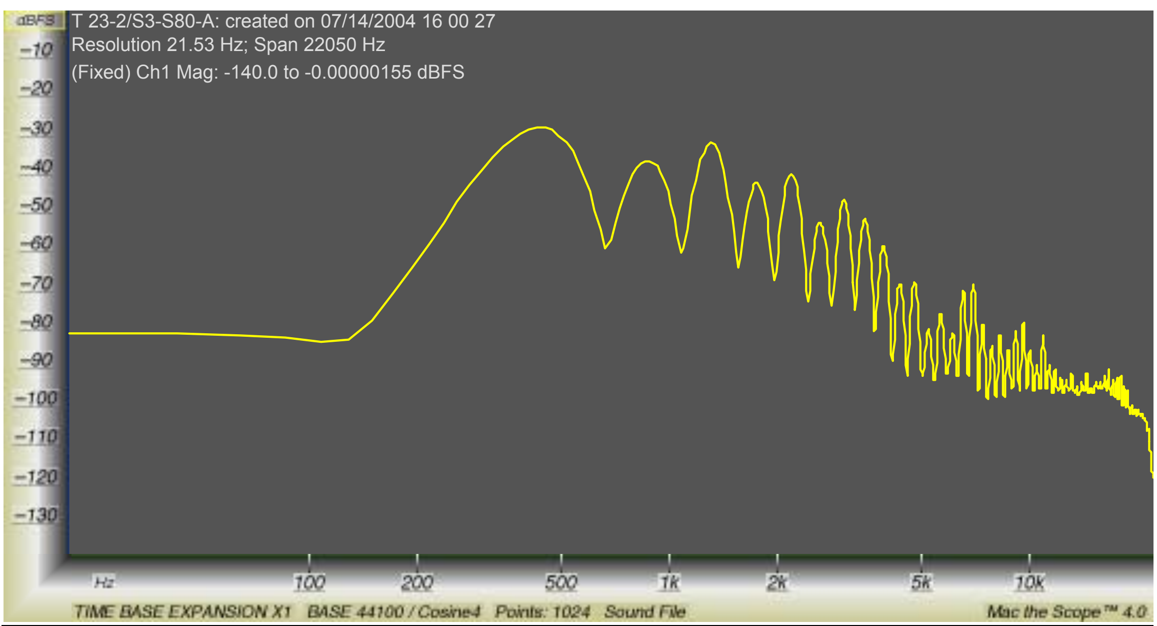

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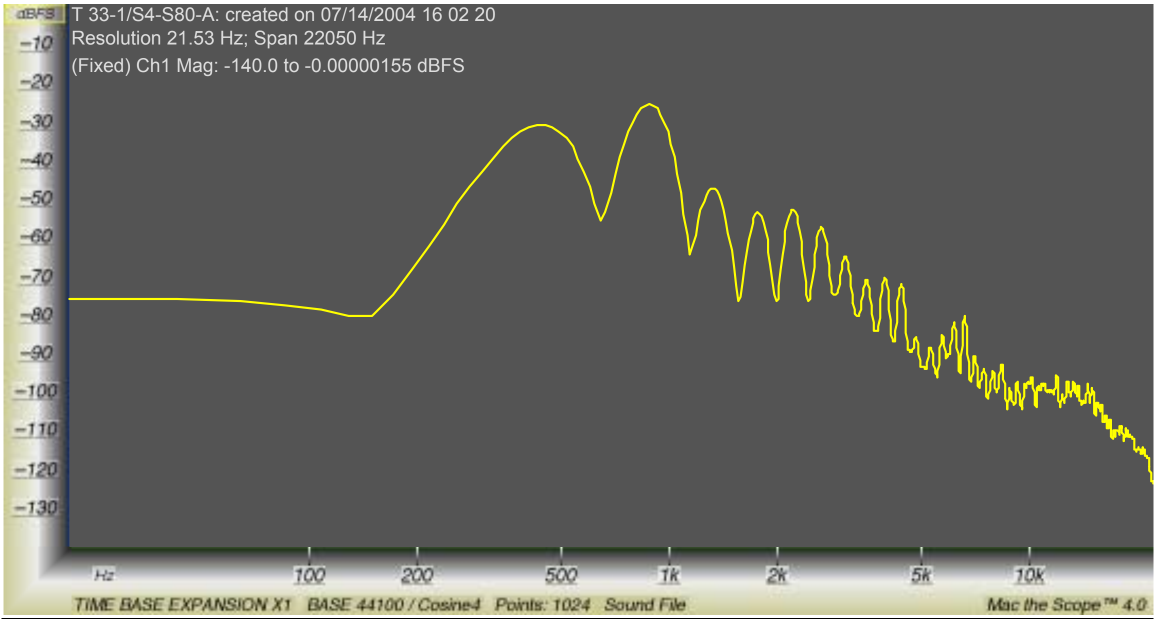

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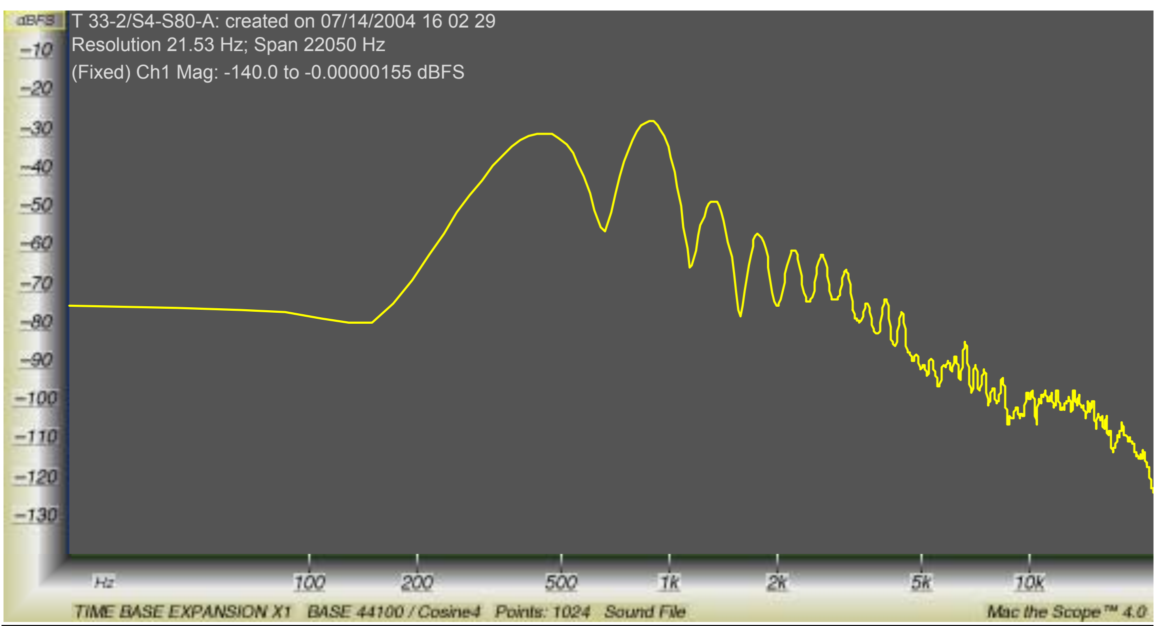

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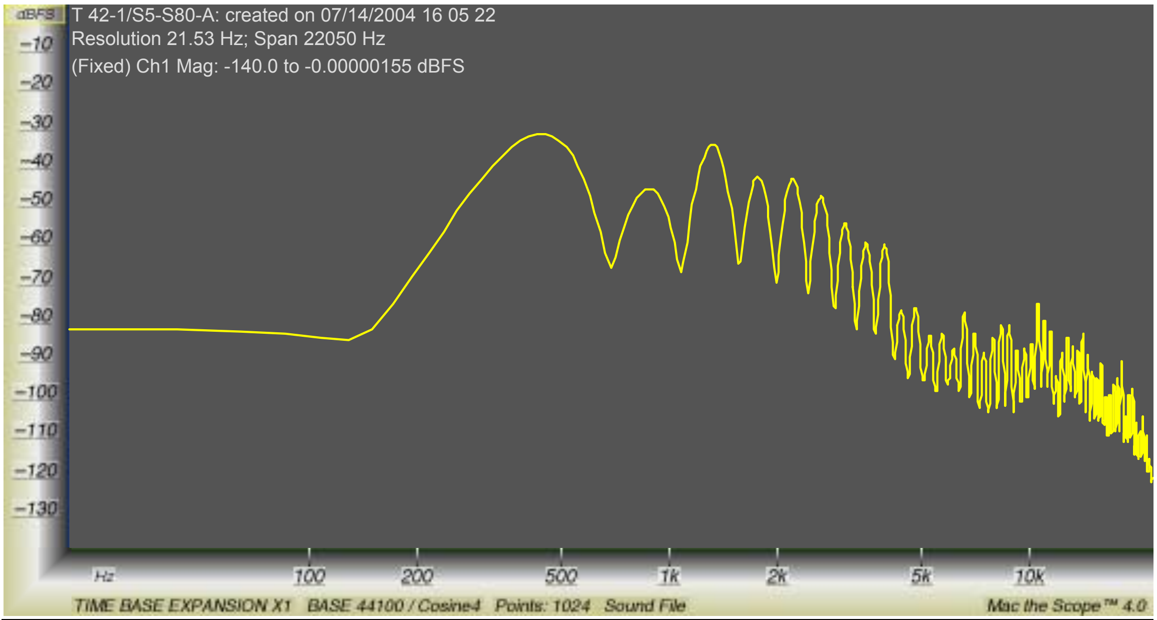

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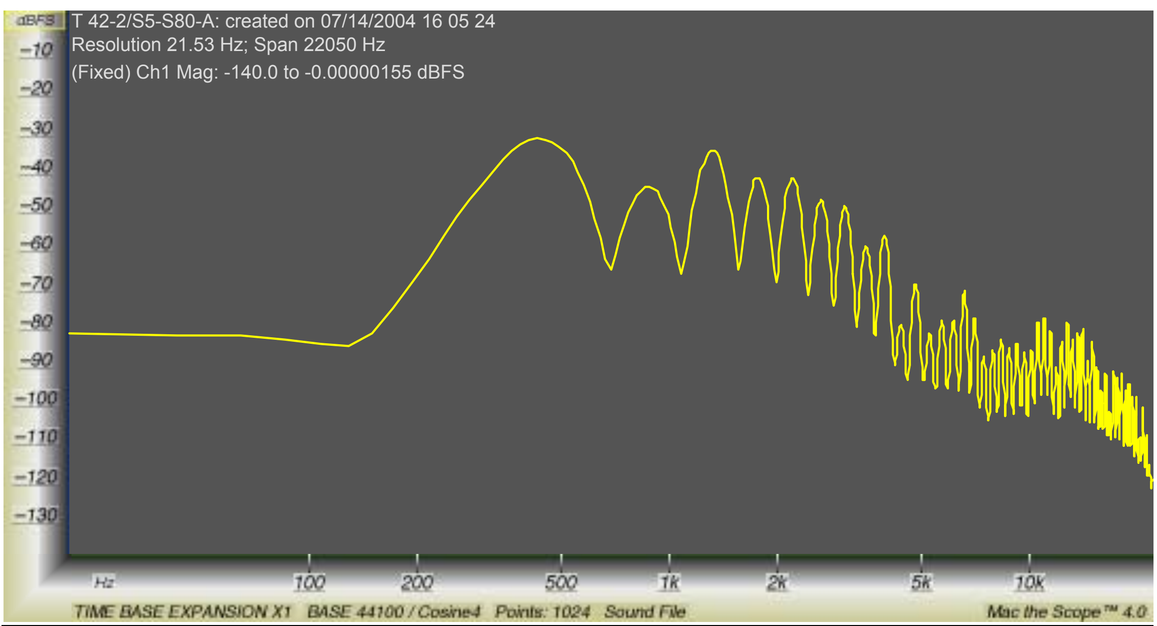

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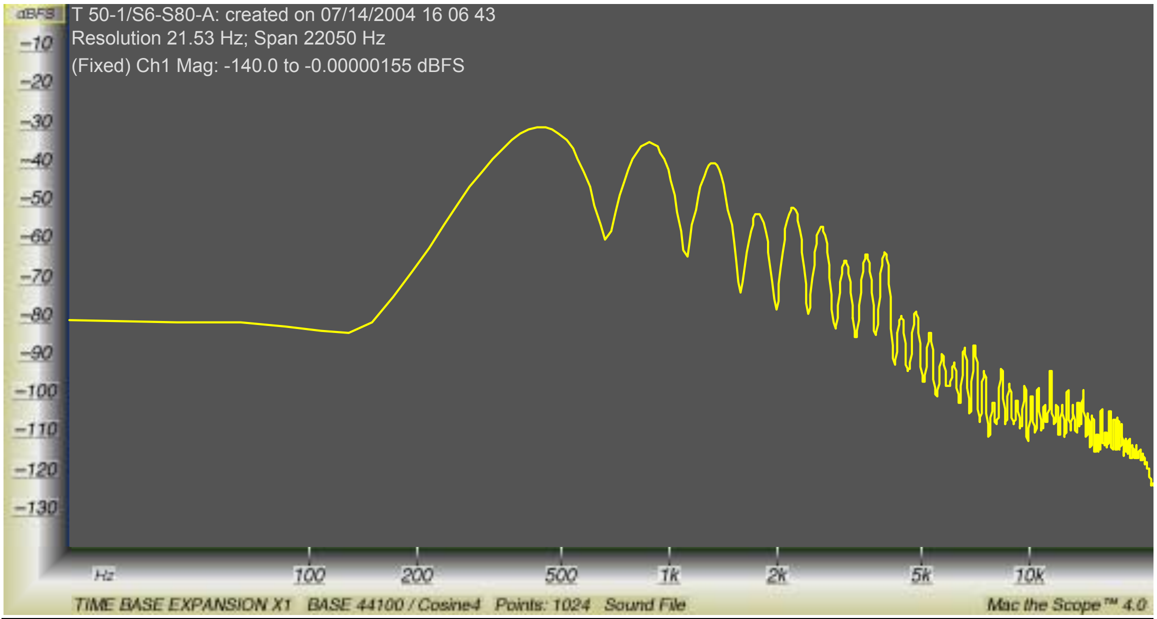

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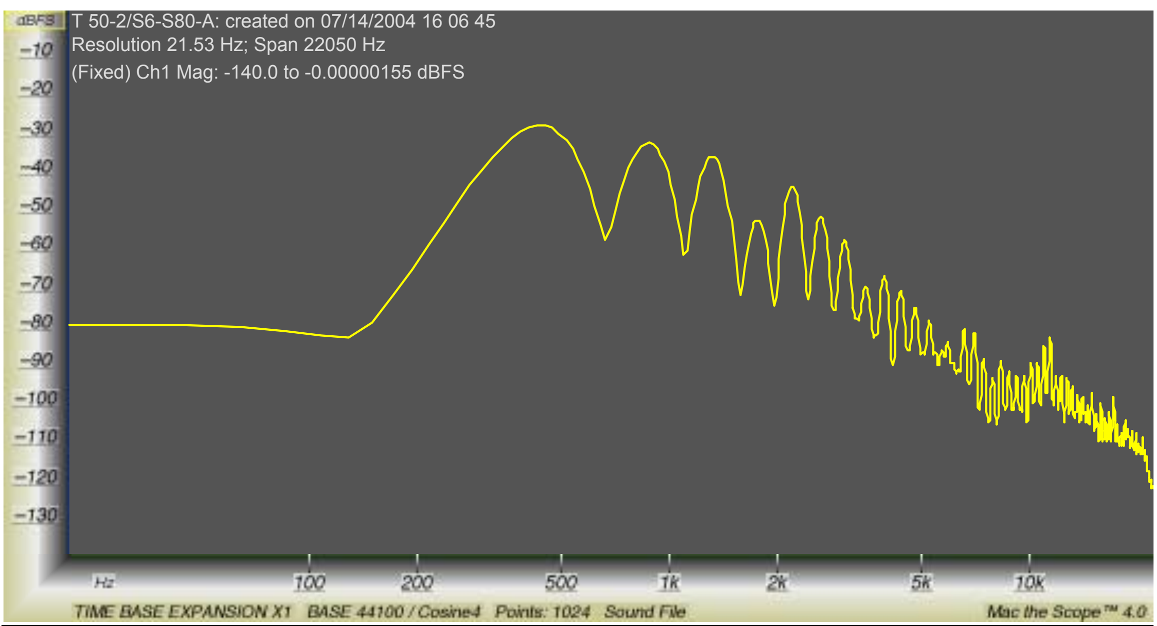

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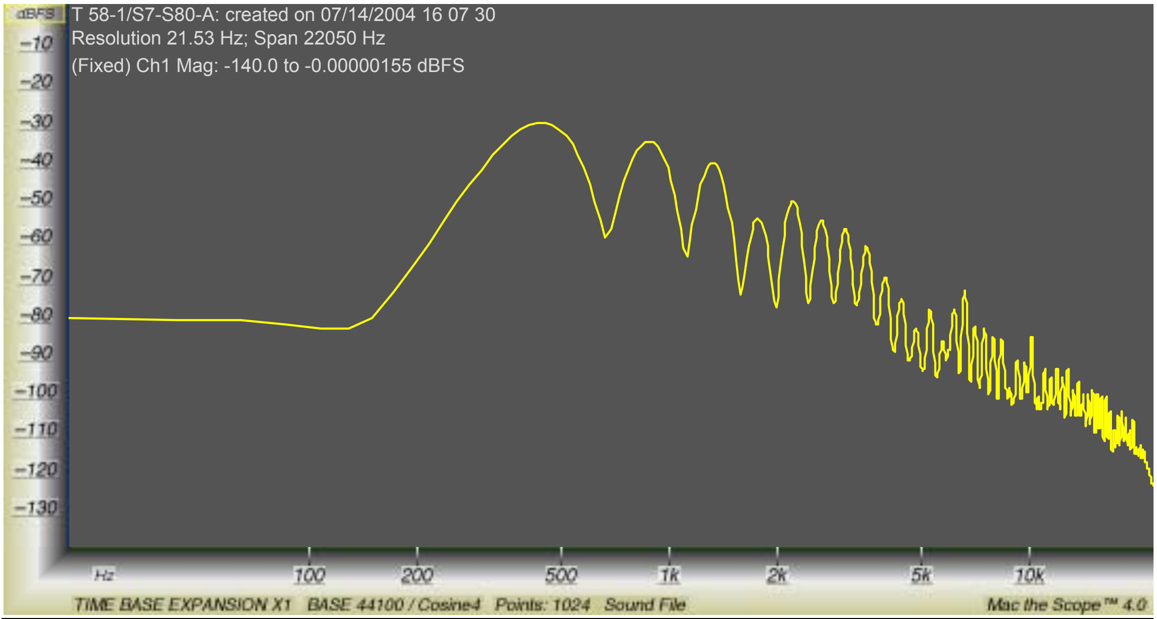

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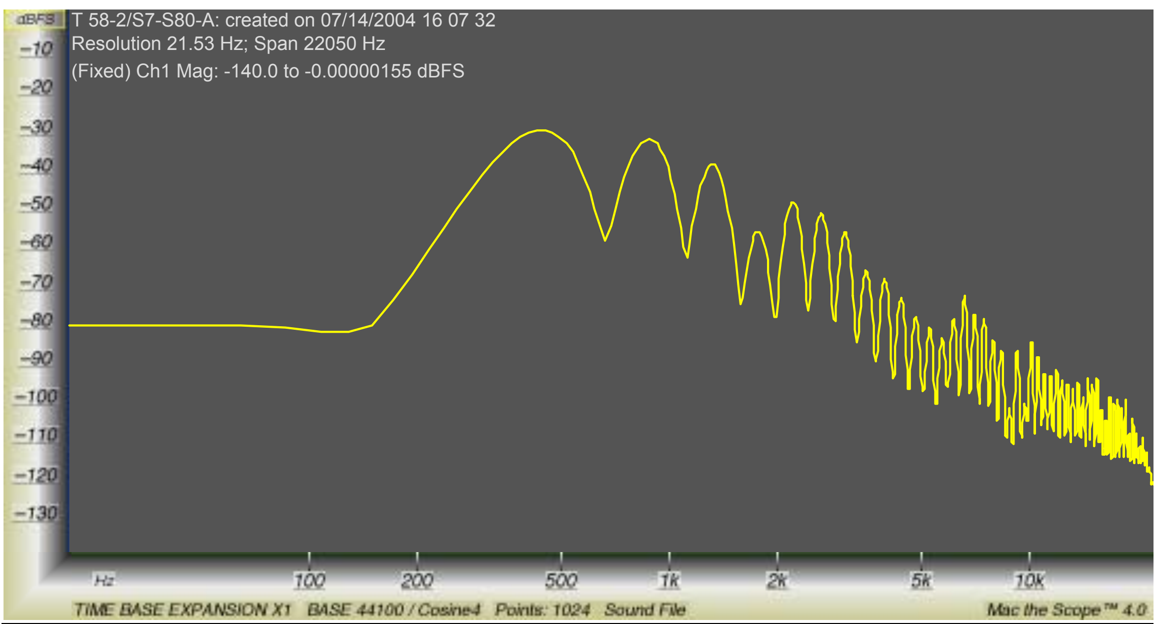

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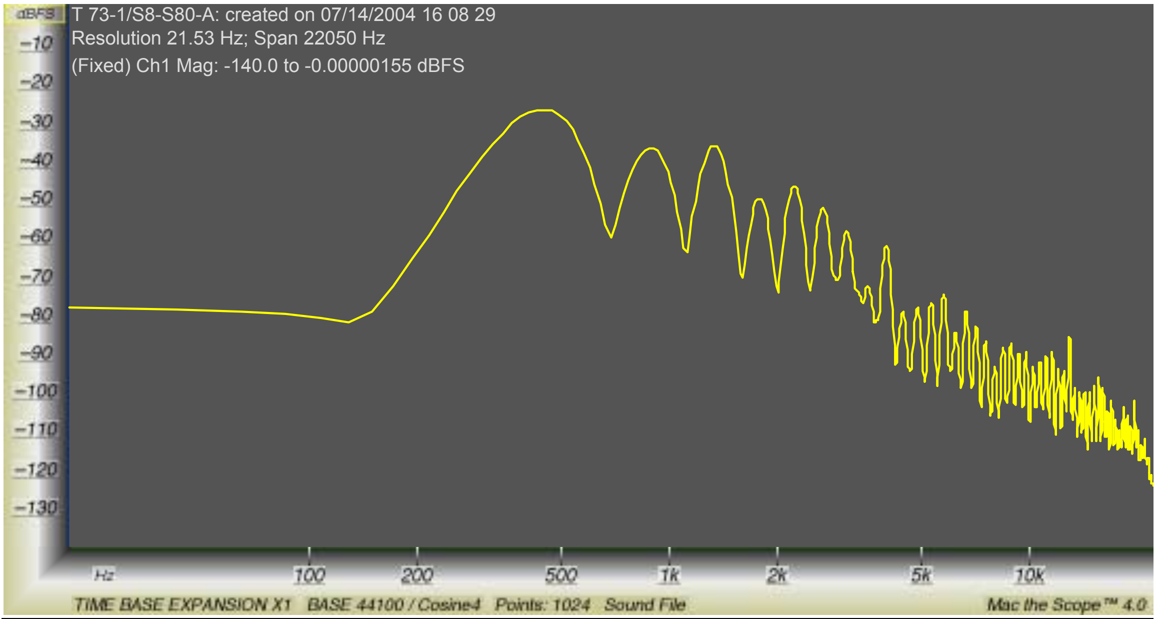

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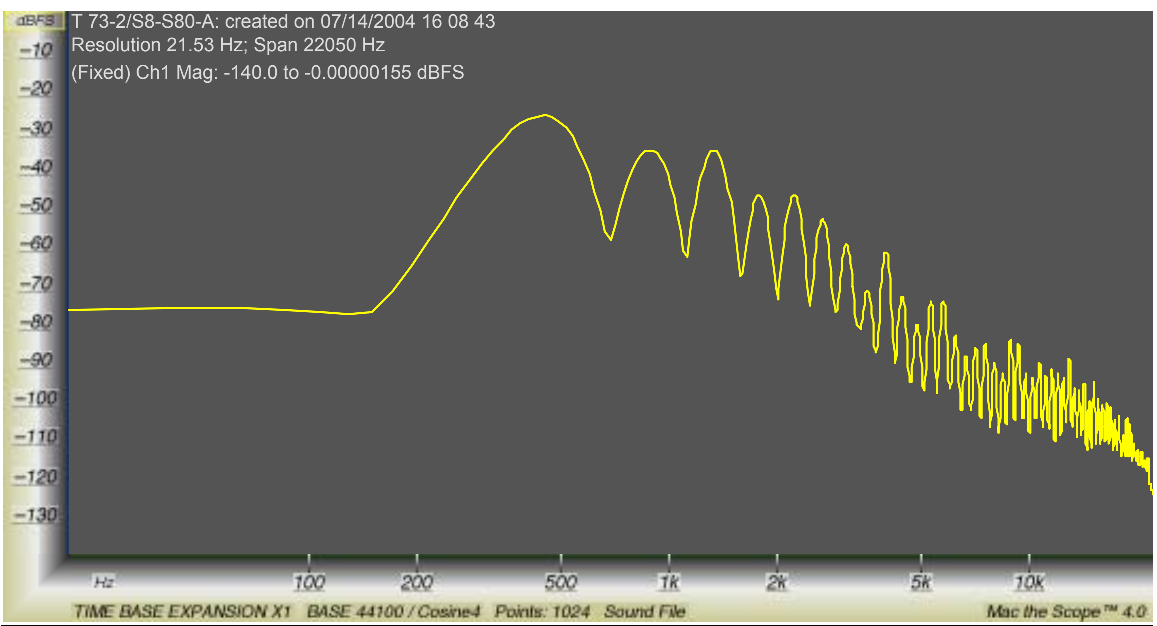

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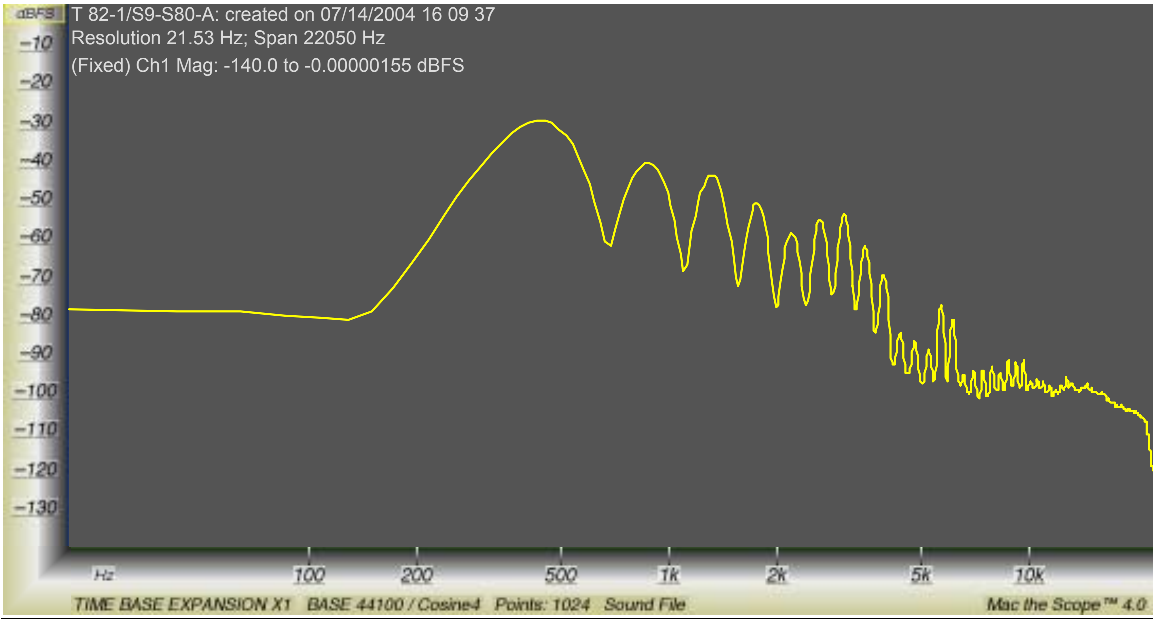

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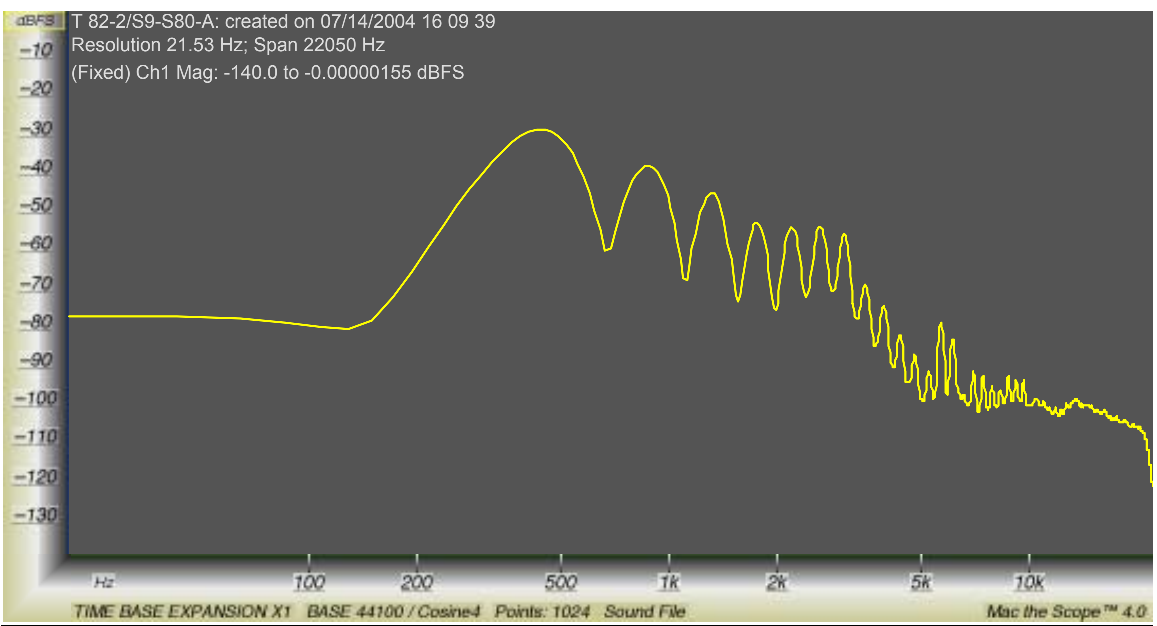

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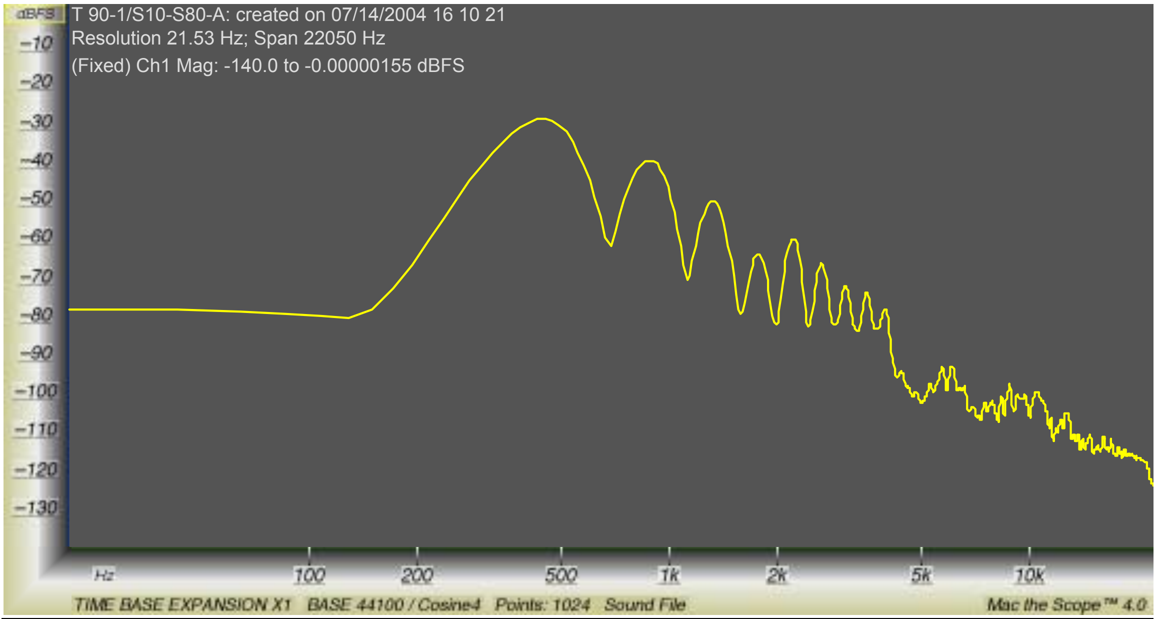

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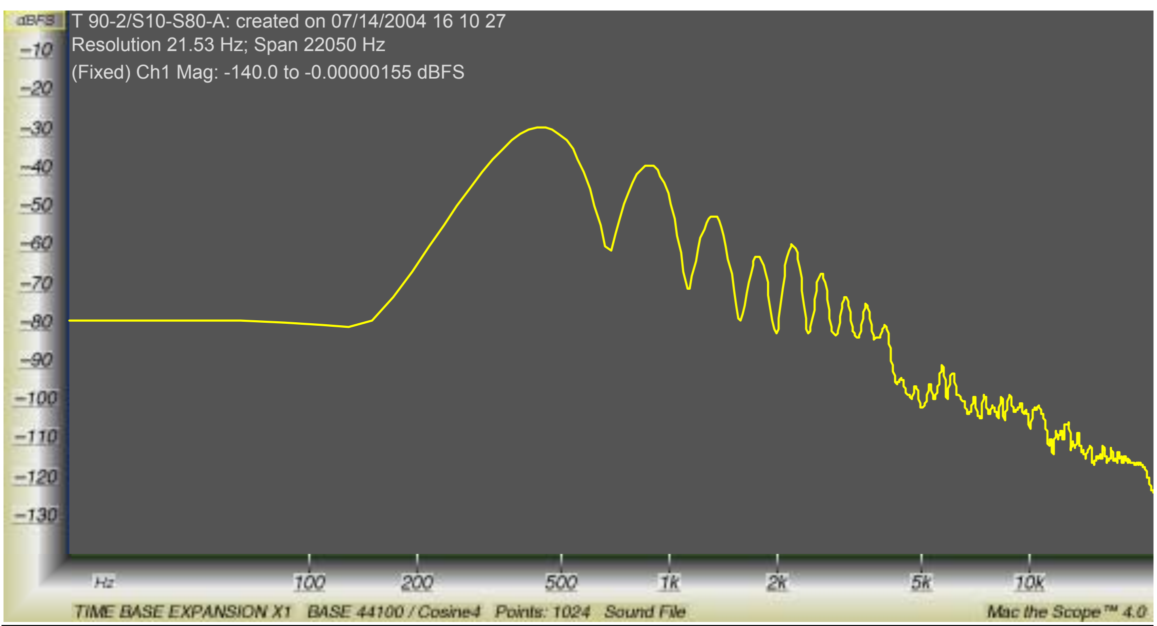

APPENDIX C: SPECTRAL ANALYSIS OF SAXOPHONE TONE QUALITY USING SELMER S90 MOUTHPIECE AT MOUTHPICE PITCH LEVEL OF A5

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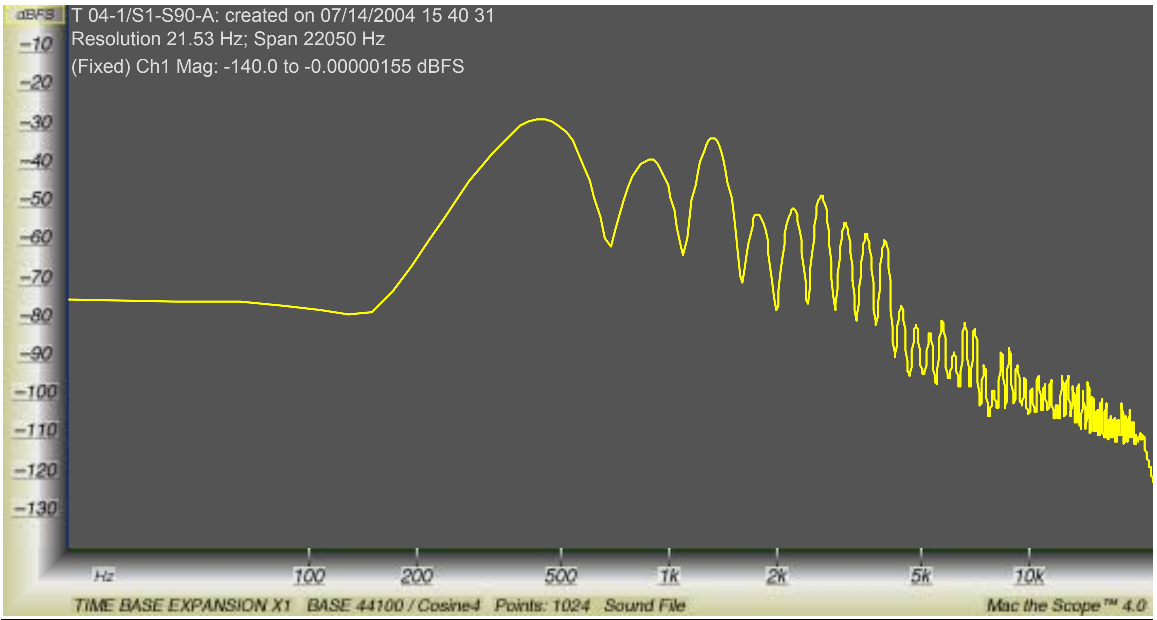

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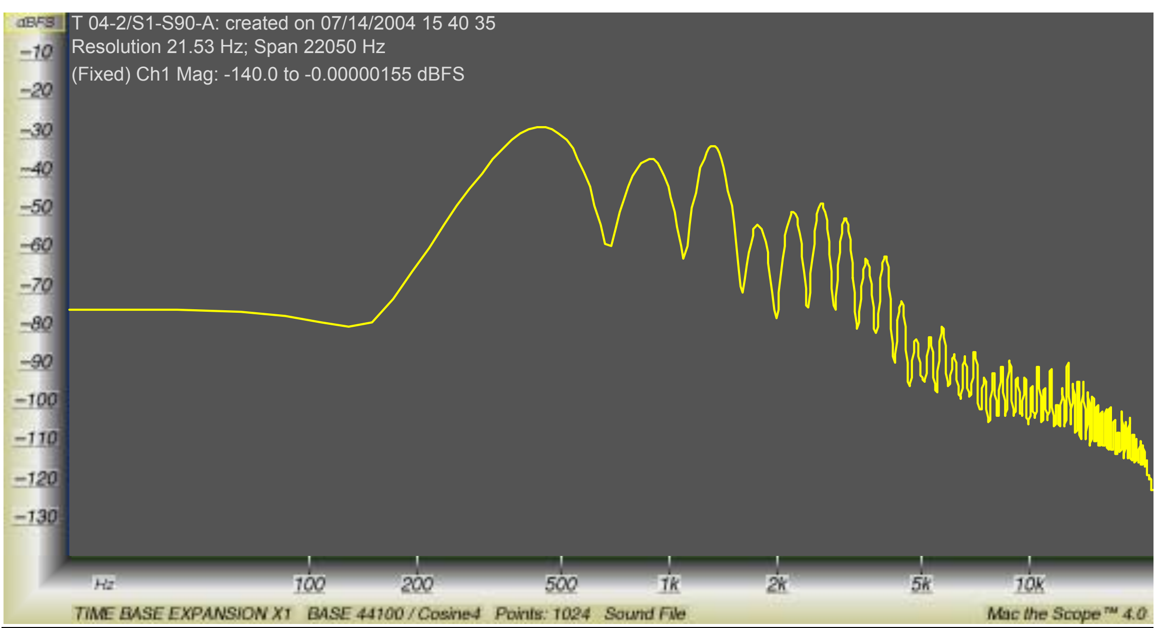

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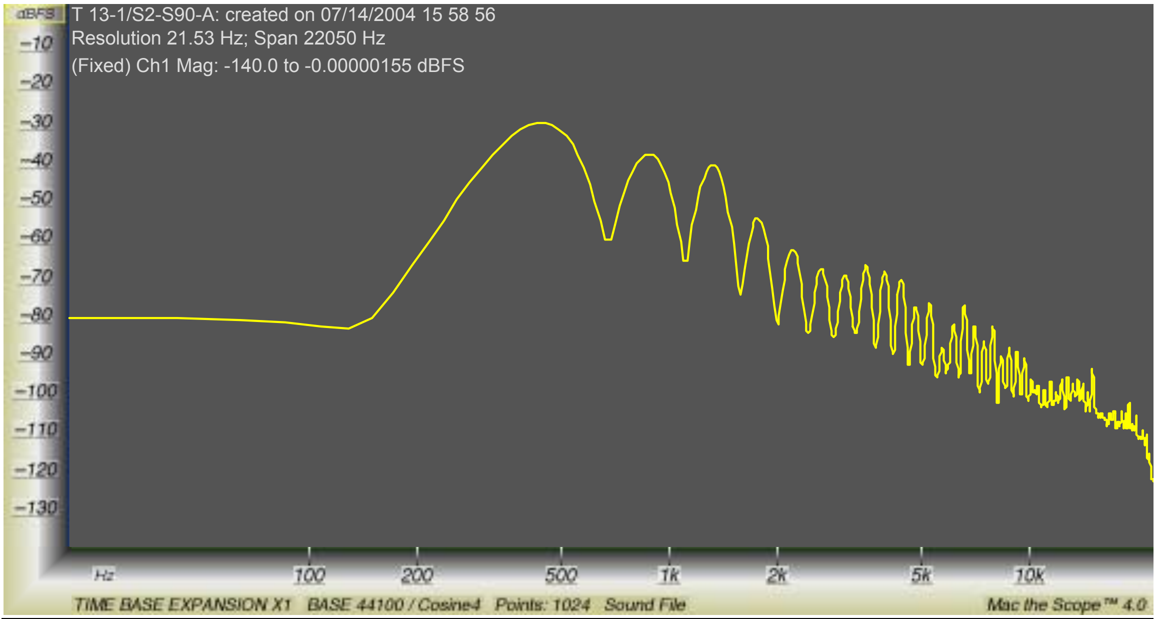
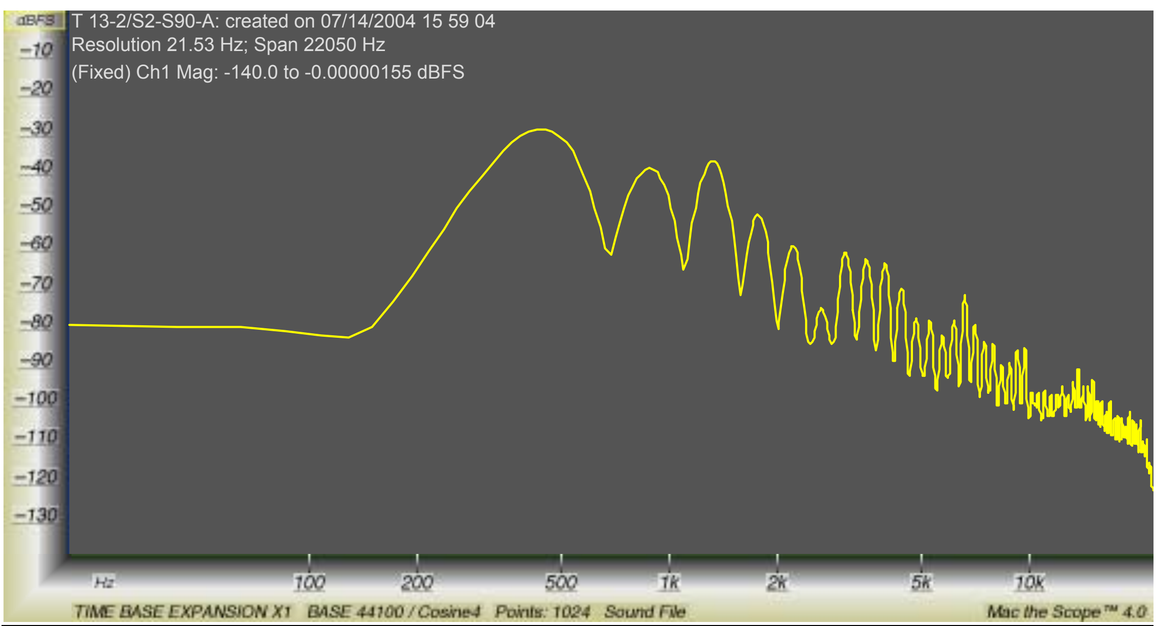
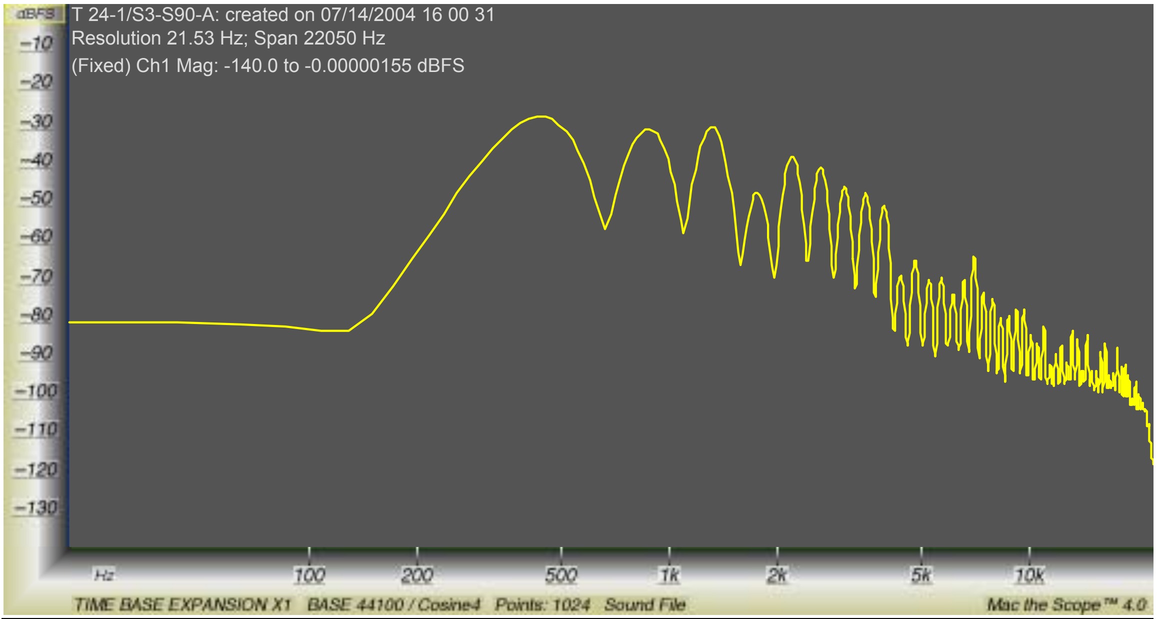


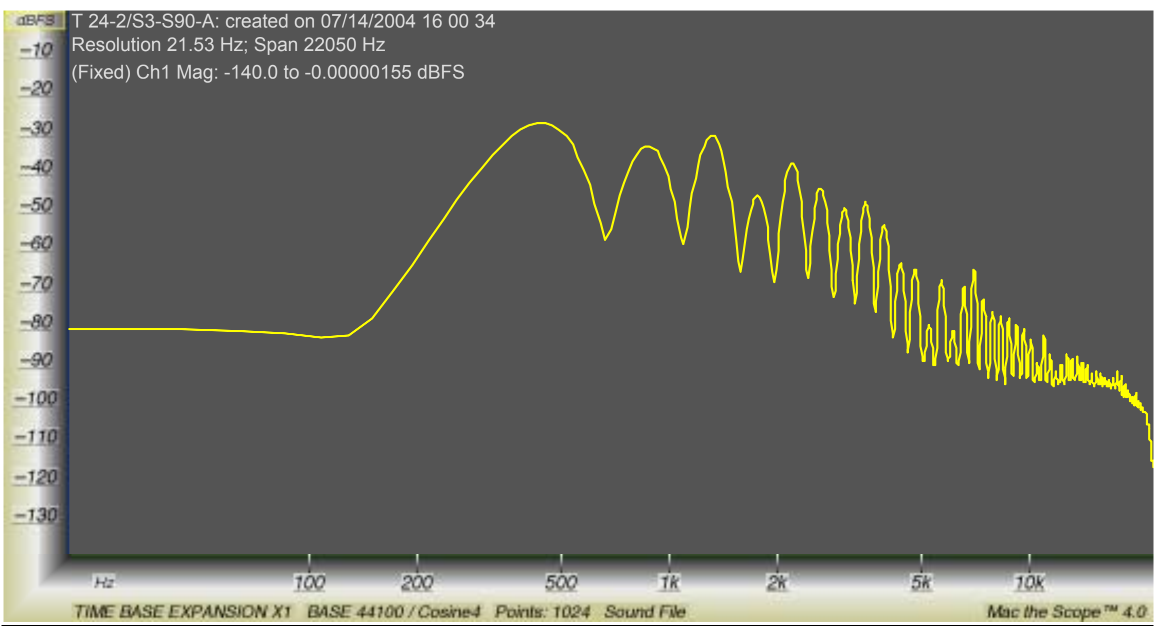
Subject 2, S90-A, Take 13, Blow 2:



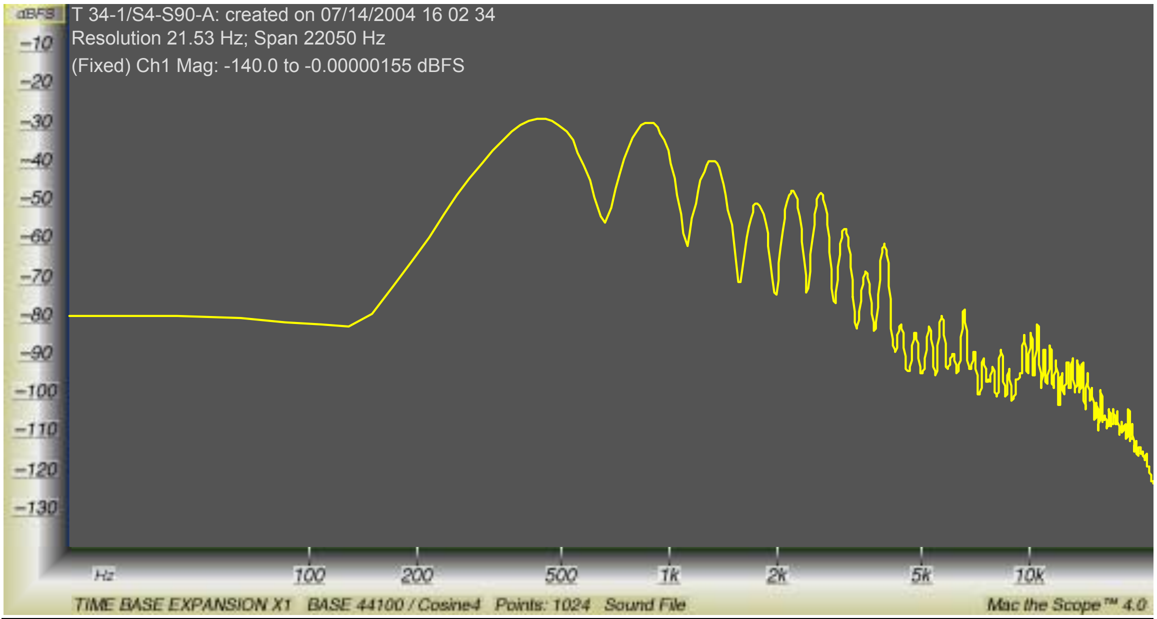
Subject 3, S90-A, Take 24, Blow 1:



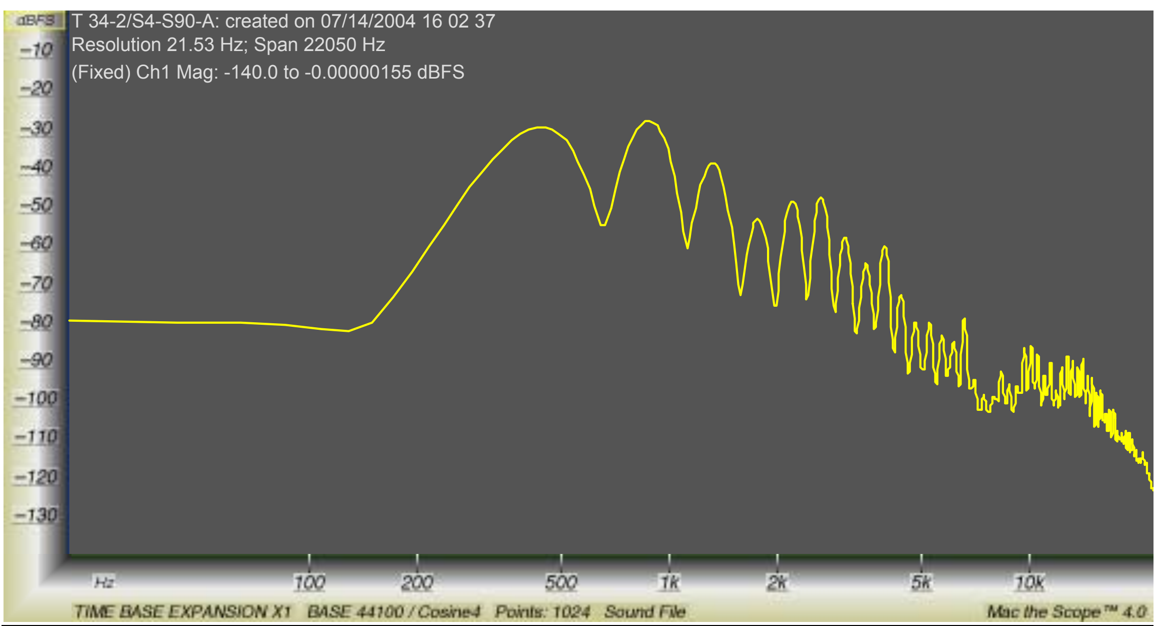
Subject 3, S90-A, Take 24, Blow 2:



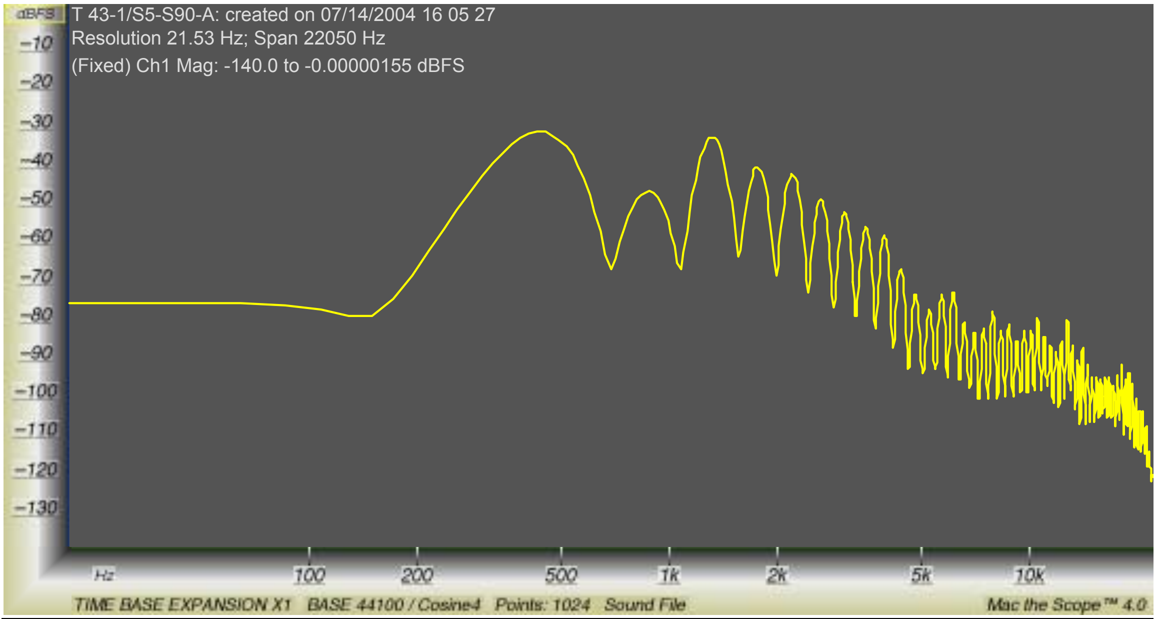
Subject 4, S90-A, Take 34, Blow 1:



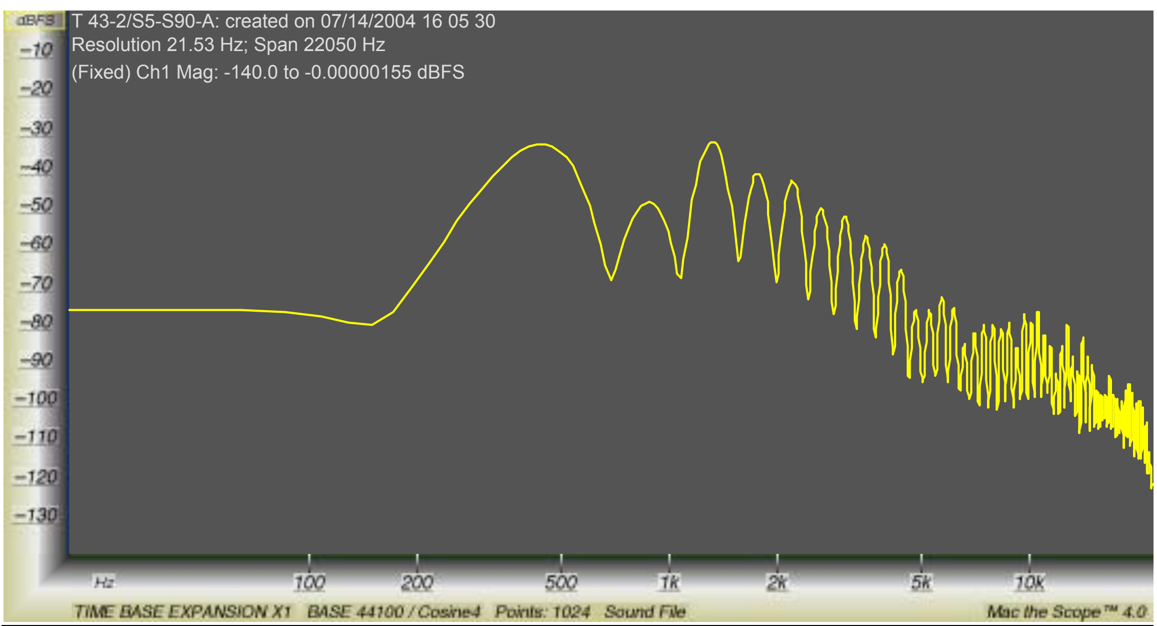
Subject 4, S90-A, Take 34, Blow 2:



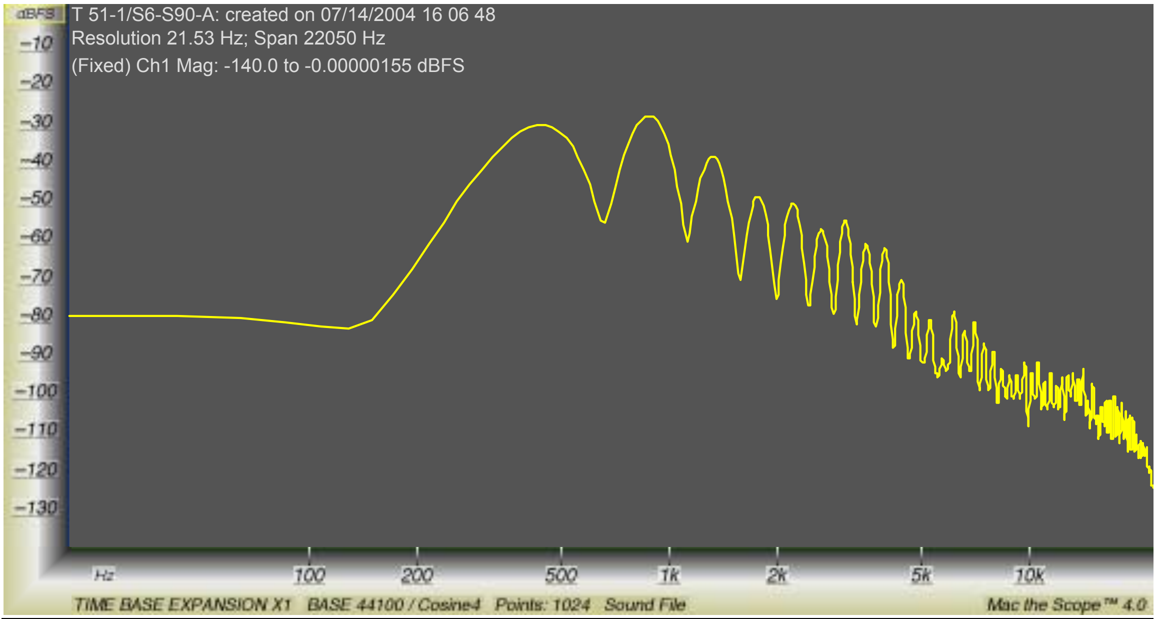
Subject 5, S90-A, Take 43, Blow 1:



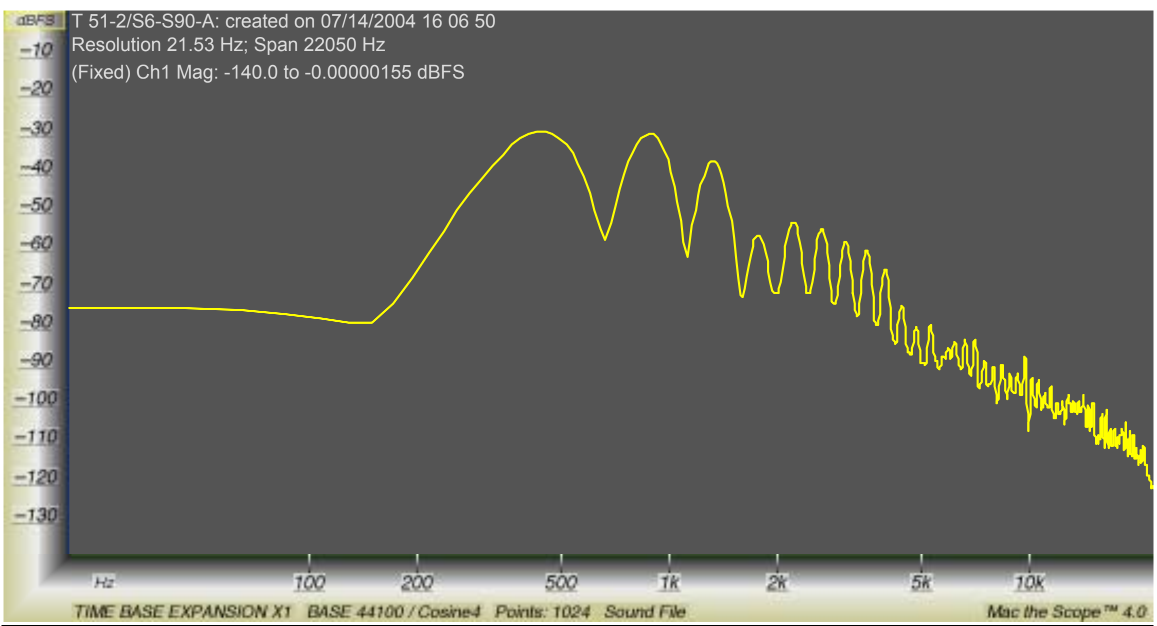
Subject 5, S90-A, Take 43, Blow 2:



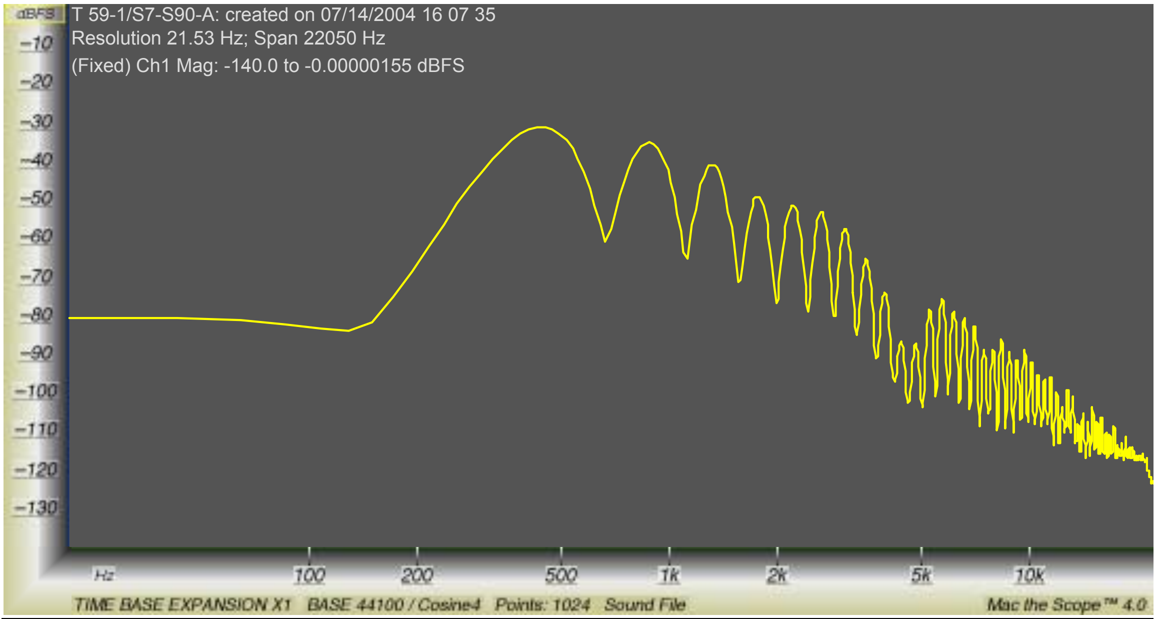
Subject 6, S90-A, Take 51, Blow 1:



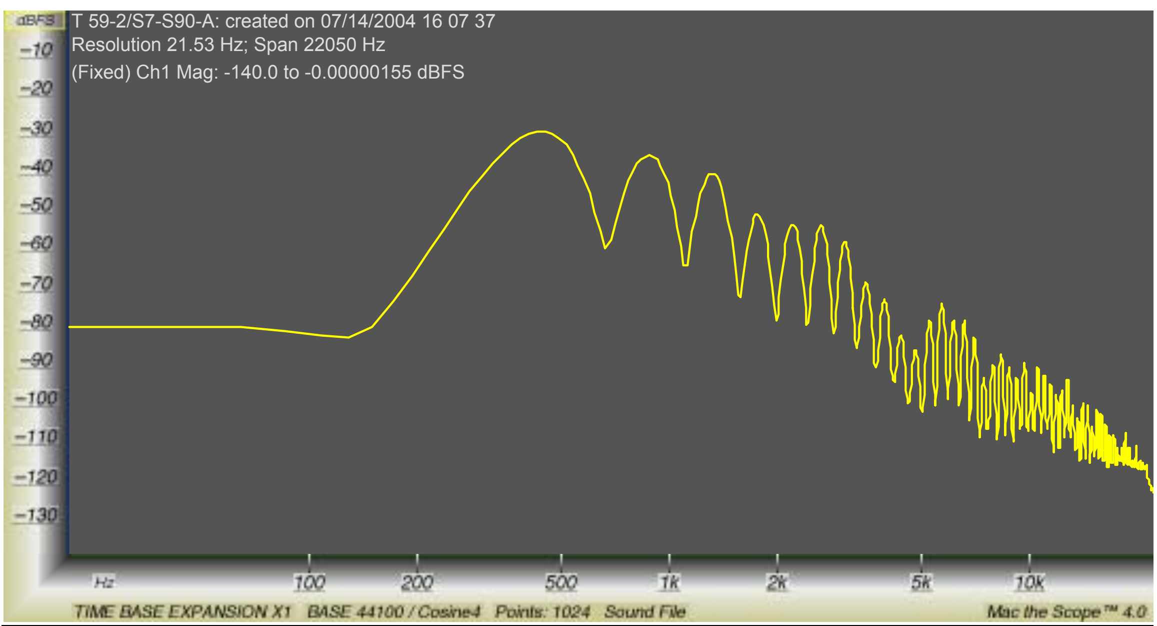
Subject 6, S90-A, Take 51, Blow 2:



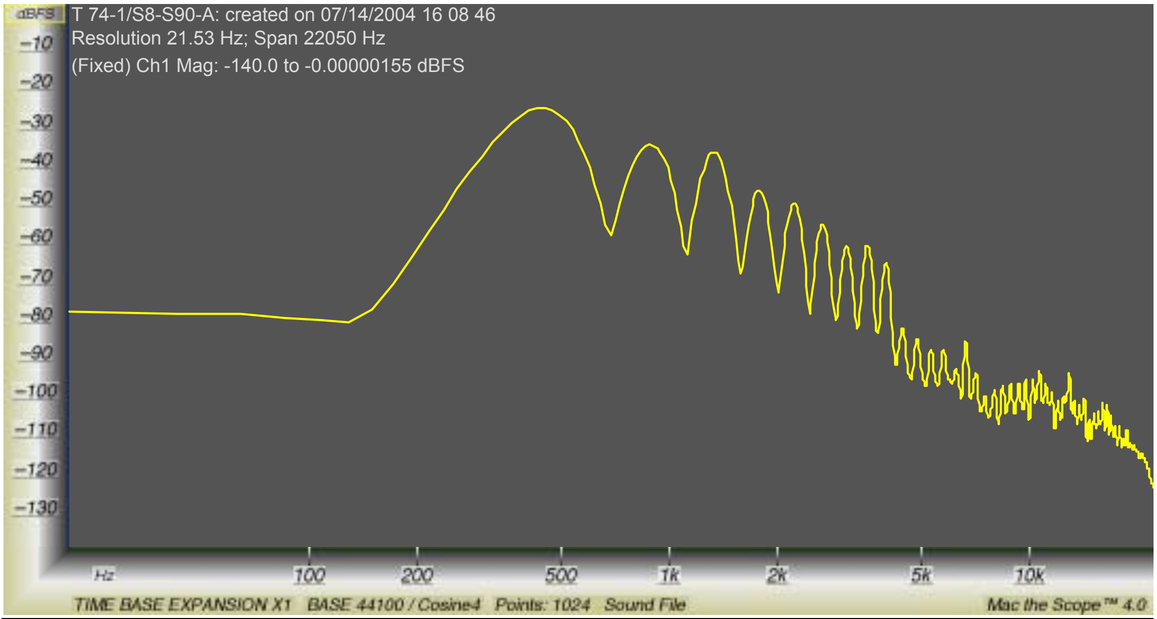
Subject 7, S90-A, Take 59, Blow 1:



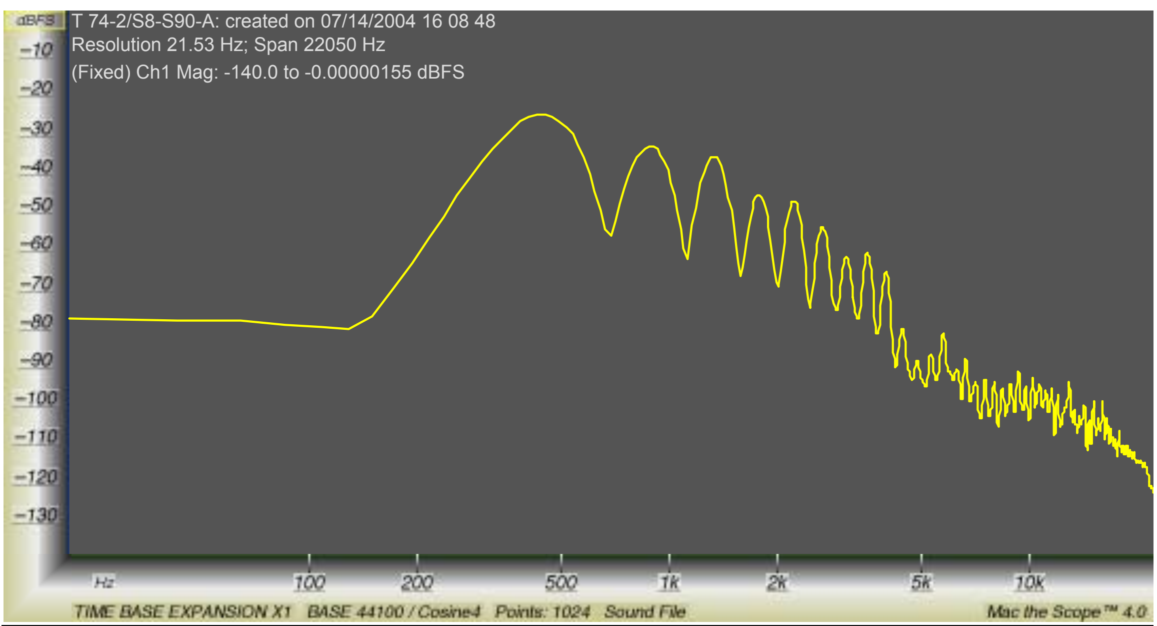
Subject 7, S90-A, Take 59, Blow 2:



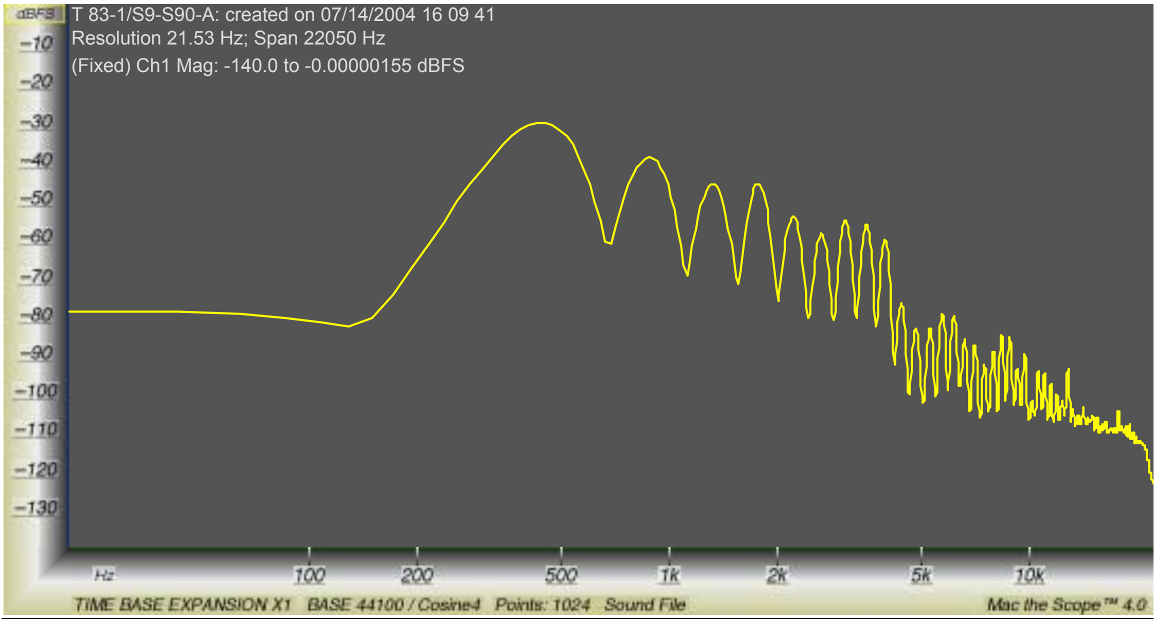
Subject 8, S90-A, Take 74, Blow 1:



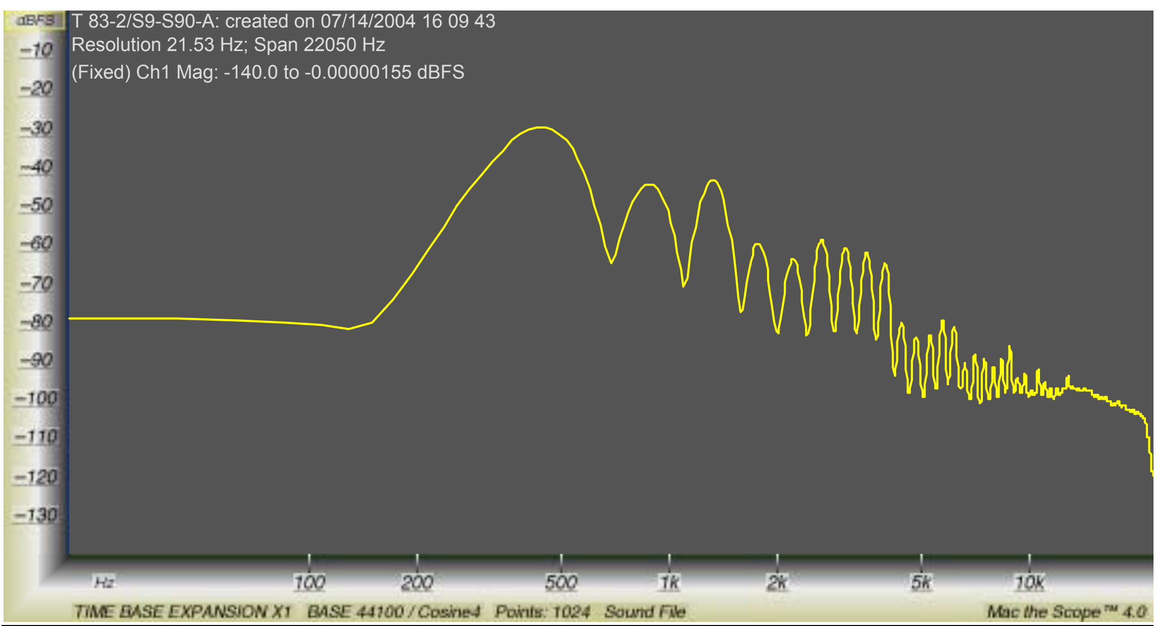
Subject 8, S90-A, Take 74, Blow 2:



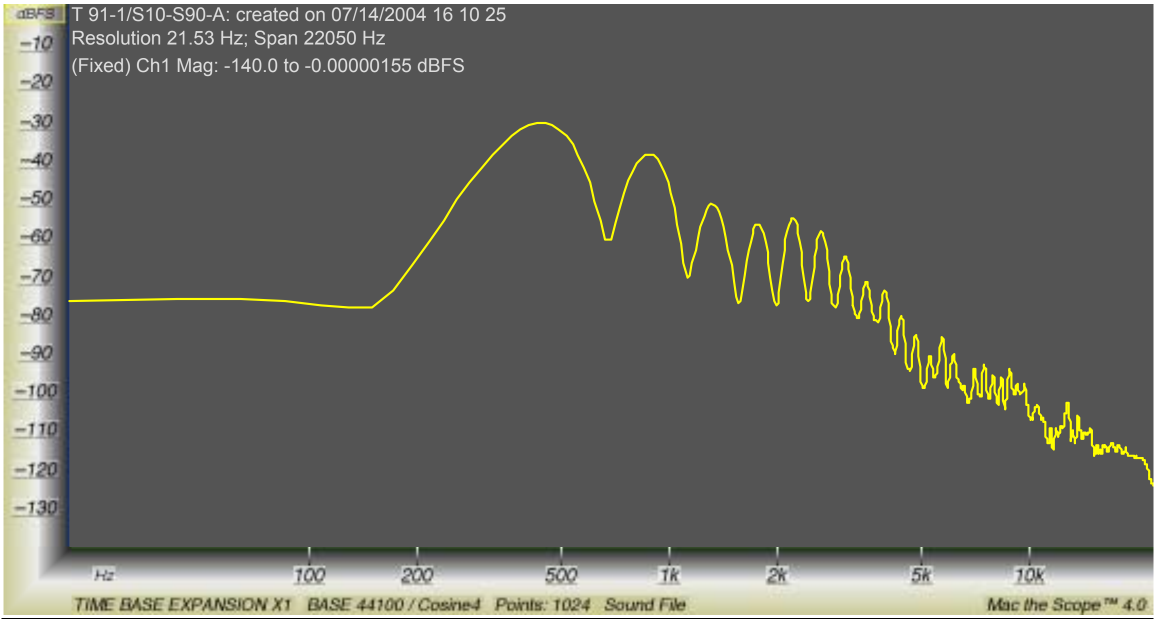
Subject 9, S90-A, Take 83, Blow 1:



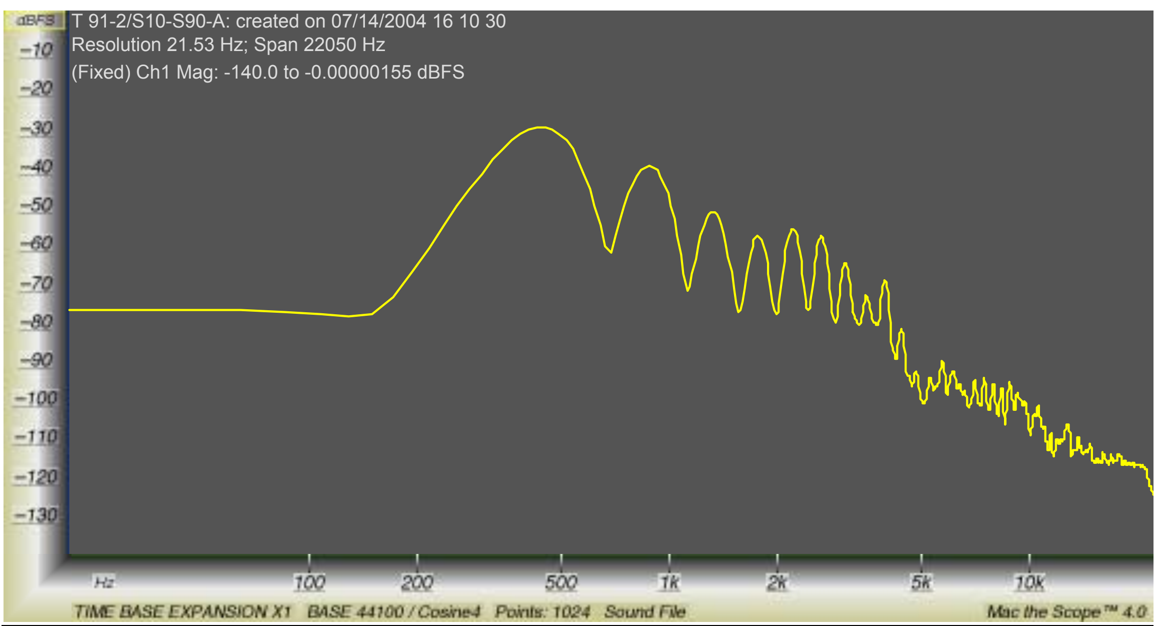
Subject 9, S90-A, Take 83, Blow 2:



Subject 10, S90-A, Take 91, Blow 1:

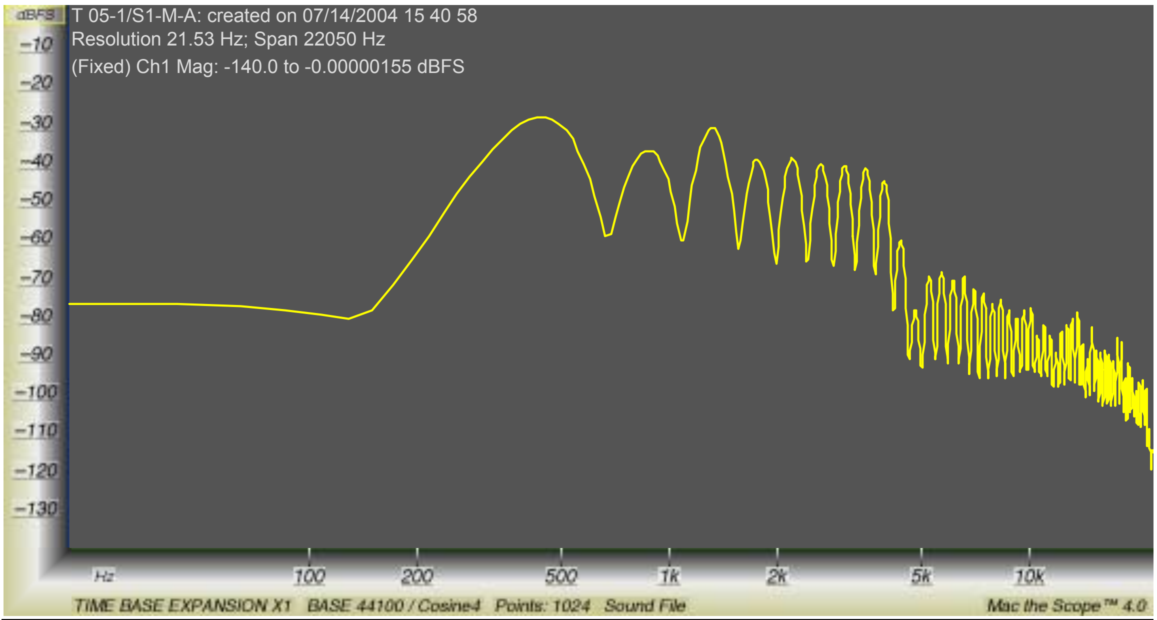


Subject 10, S90-A, Take 91, Blow 2:

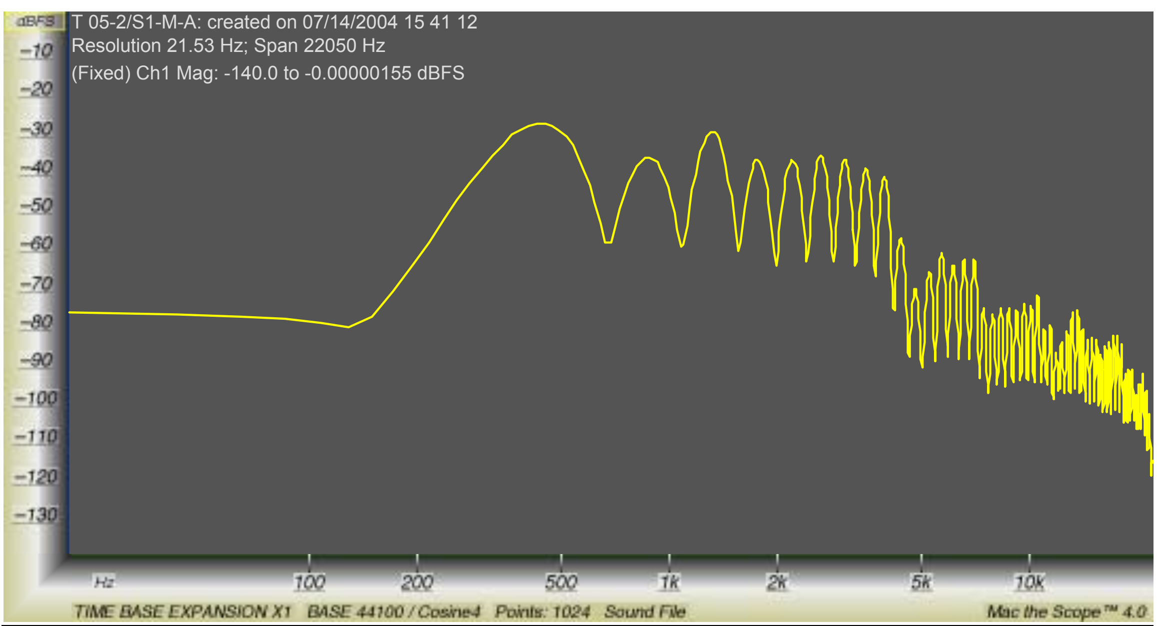


APPENDIX D: SPECTRAL ANALYSIS OF SAXOPHONE TONE QUALITY USING MEYER 6M MOUTHPIECE AT MOUTHPIECE PITCH LEVEL OF A5

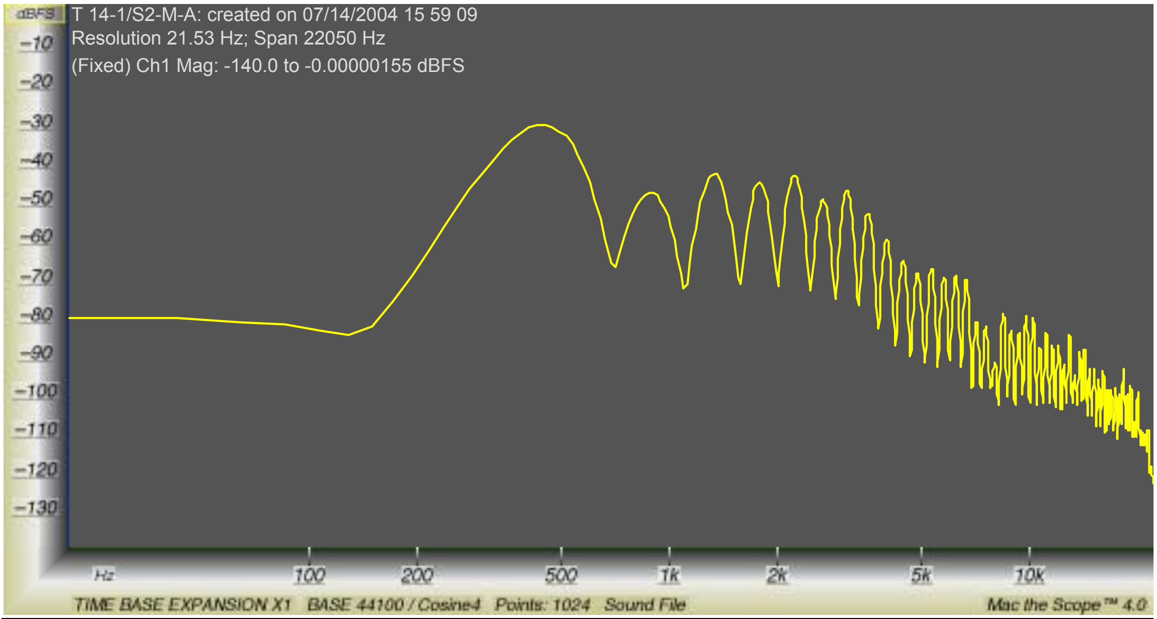
Subject 1, Meyer-A, Take 5, Blow 1:



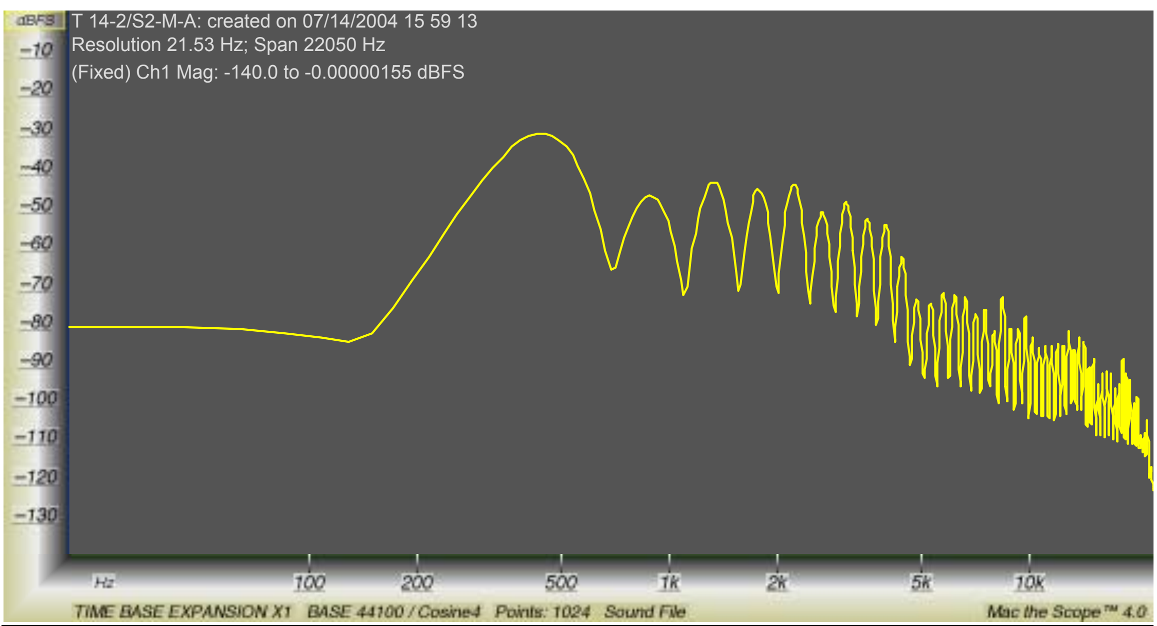
Subject 1, Meyer-A, Take 5, Blow 2:



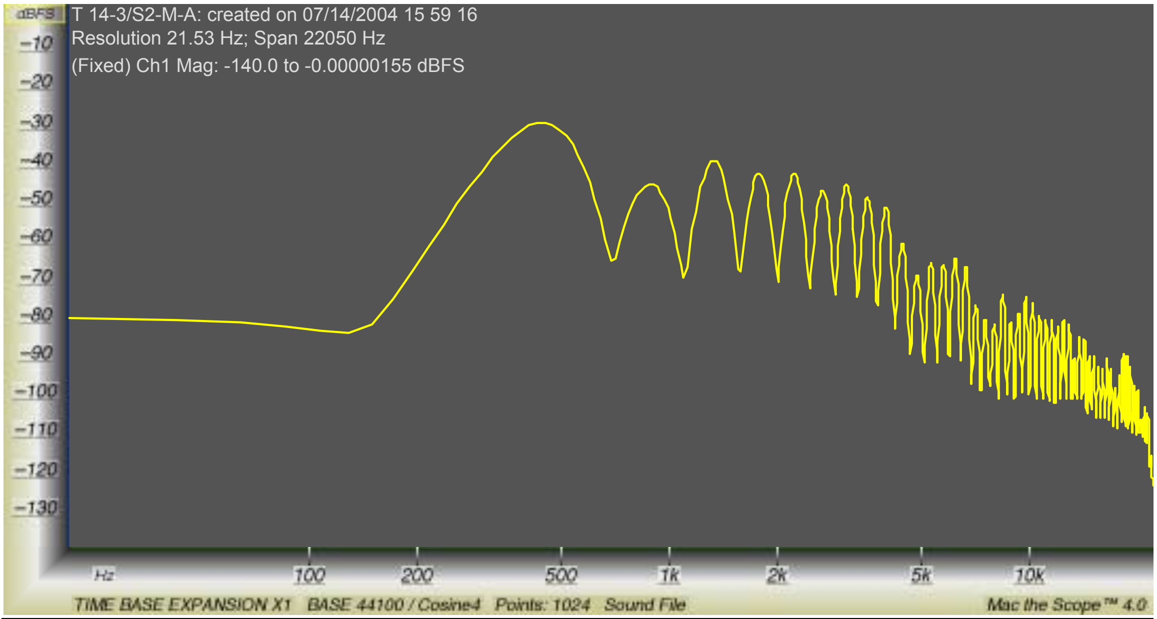
Subject 2, Meyer-A, Take 14, Blow 1:



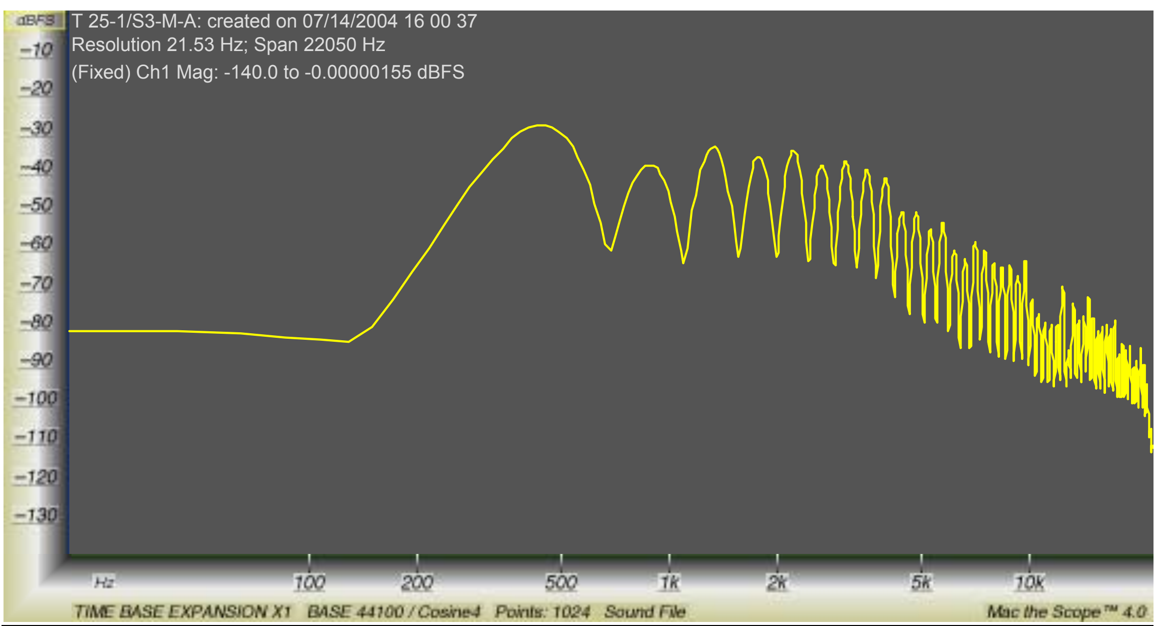
Subject 2, Meyer-A, Take 14, Blow 2:



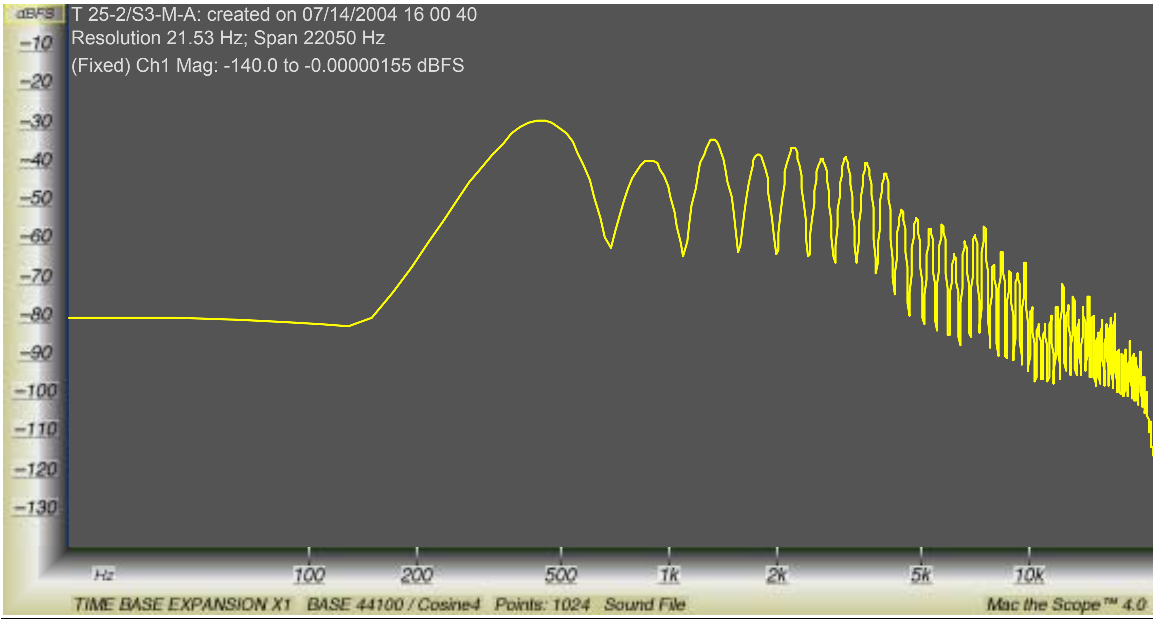
Subject 2, Meyer-A, Take 14, Blow 3:



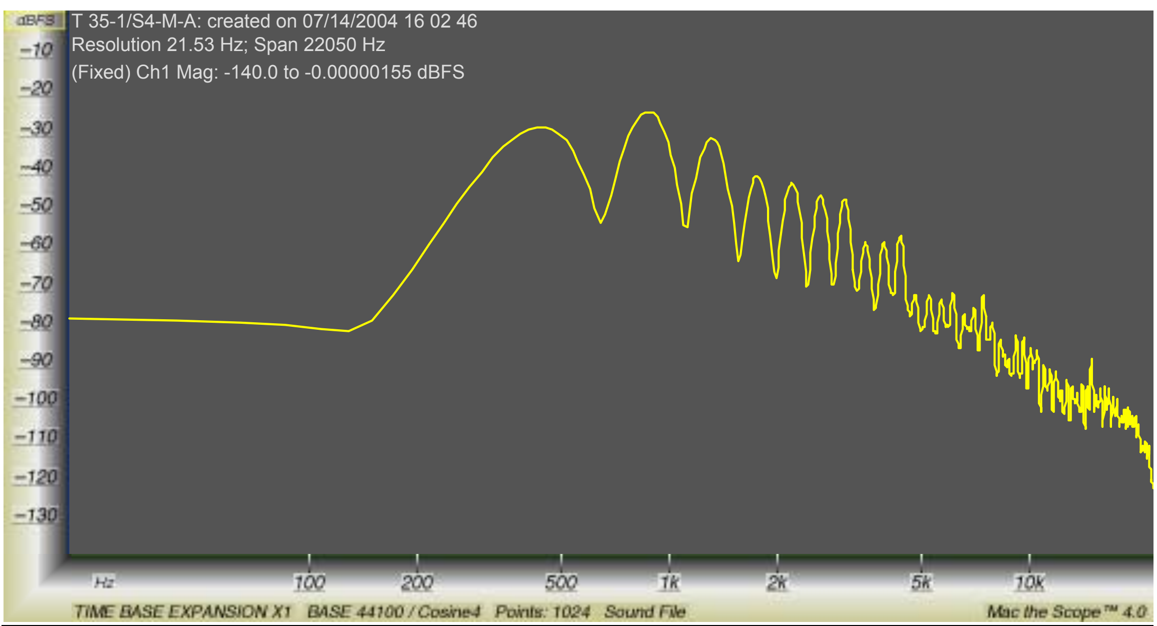
Subject 3, Meyer-A, Take 25, Blow 1:



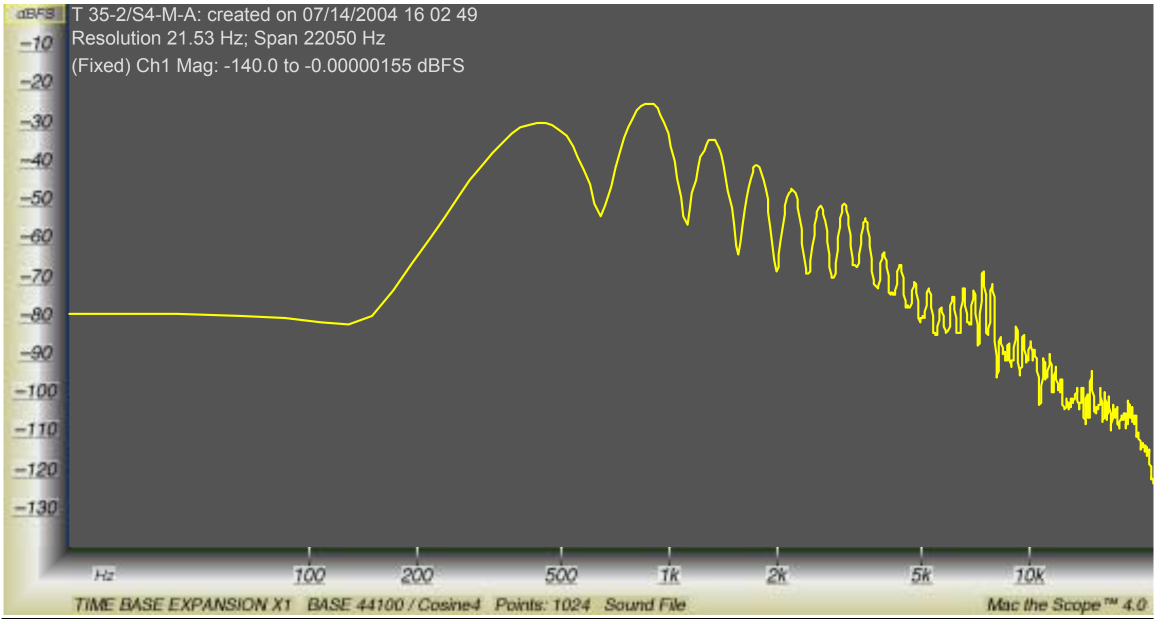
Subject 3, Meyer-A, Take 25, Blow 2:



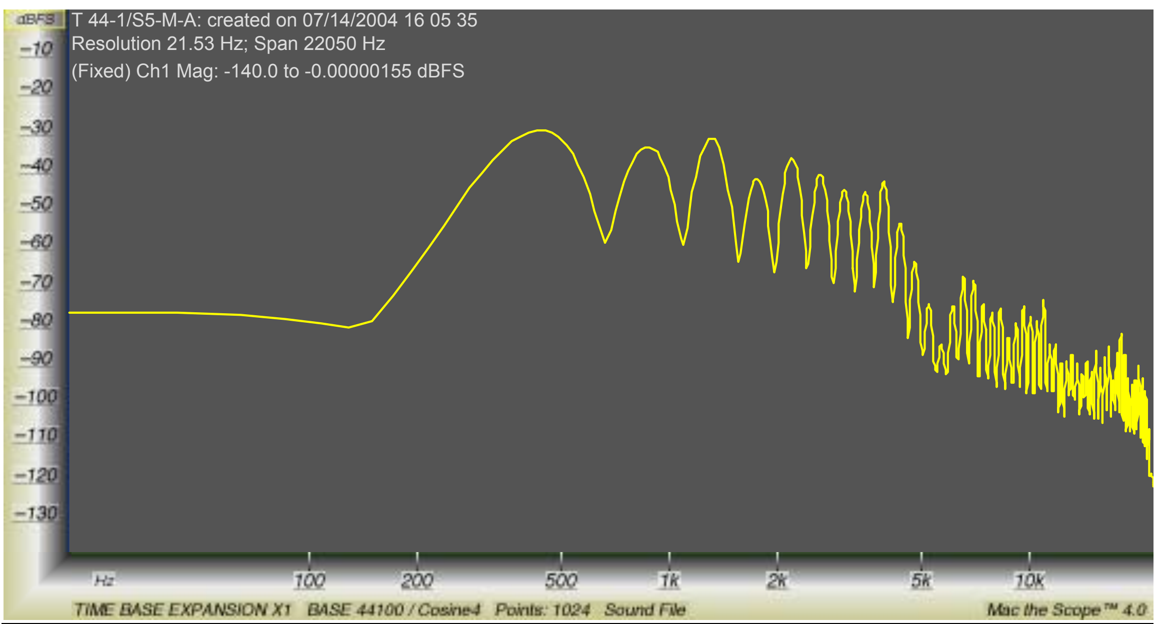
Subject 4, Meyer-A, Take 35, Blow 1:



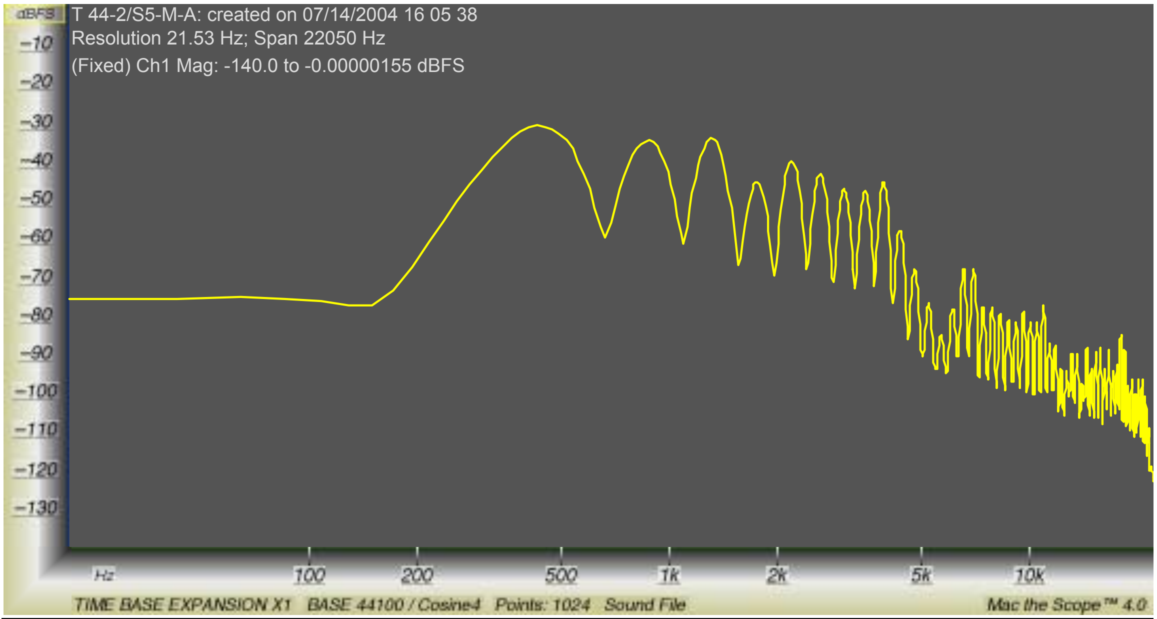
Subject 4, Meyer-A, Take 35, Blow 2:



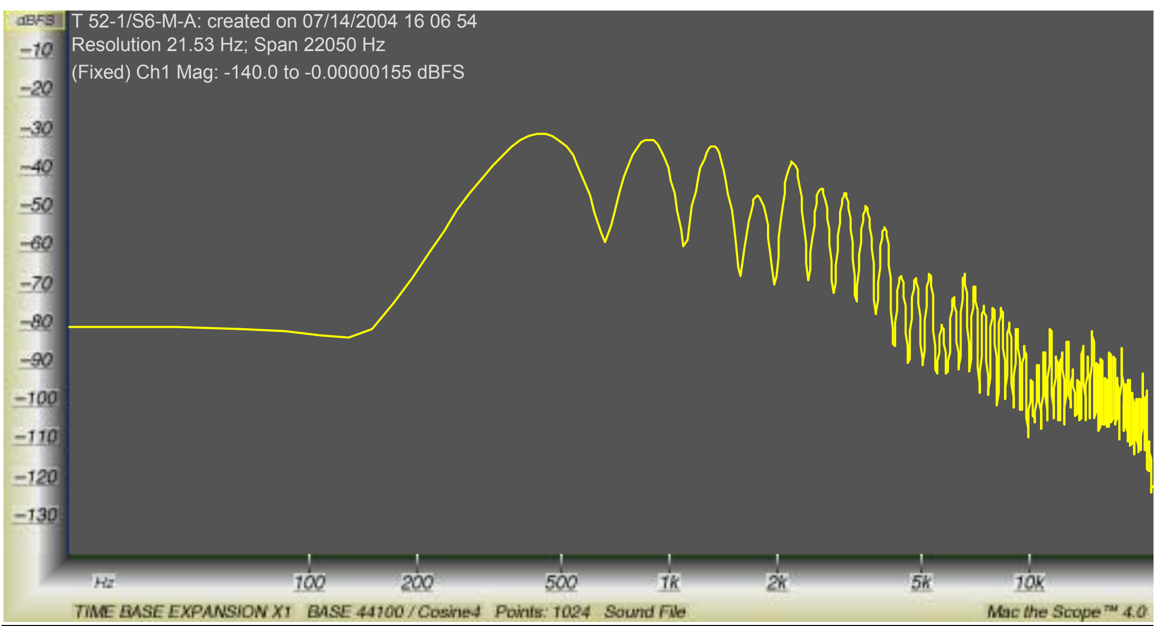
Subject 5, Meyer-A, Take 44, Blow 1:



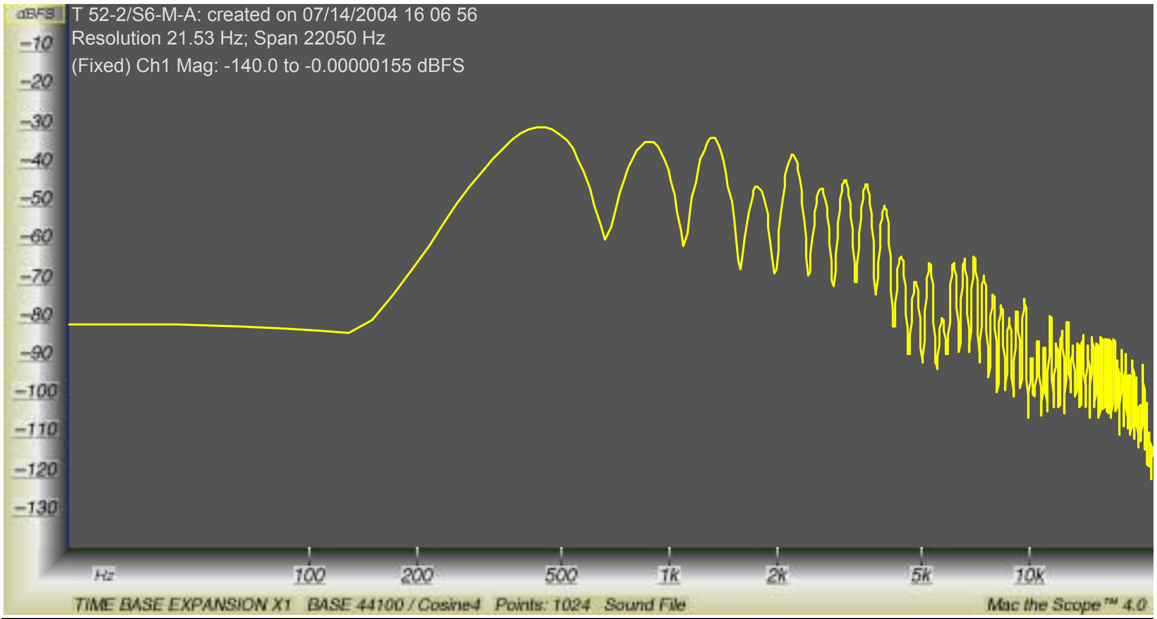
Subject 5, Meyer-A, Take 44, Blow 2:



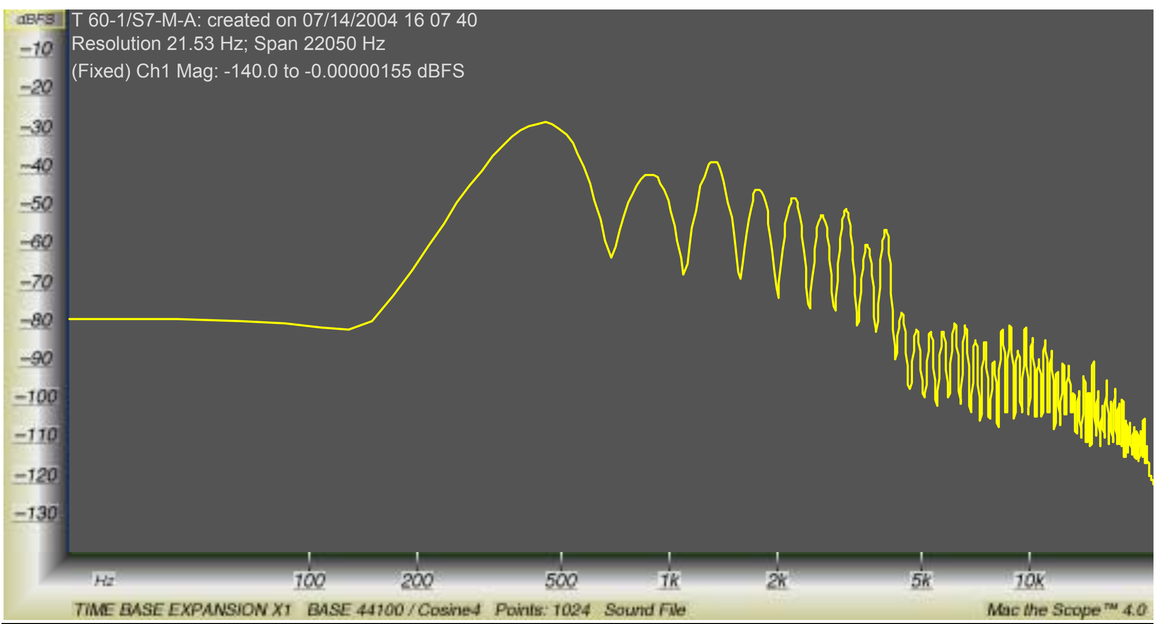
Subject 6, Meyer-A, Take 52, Blow 1:



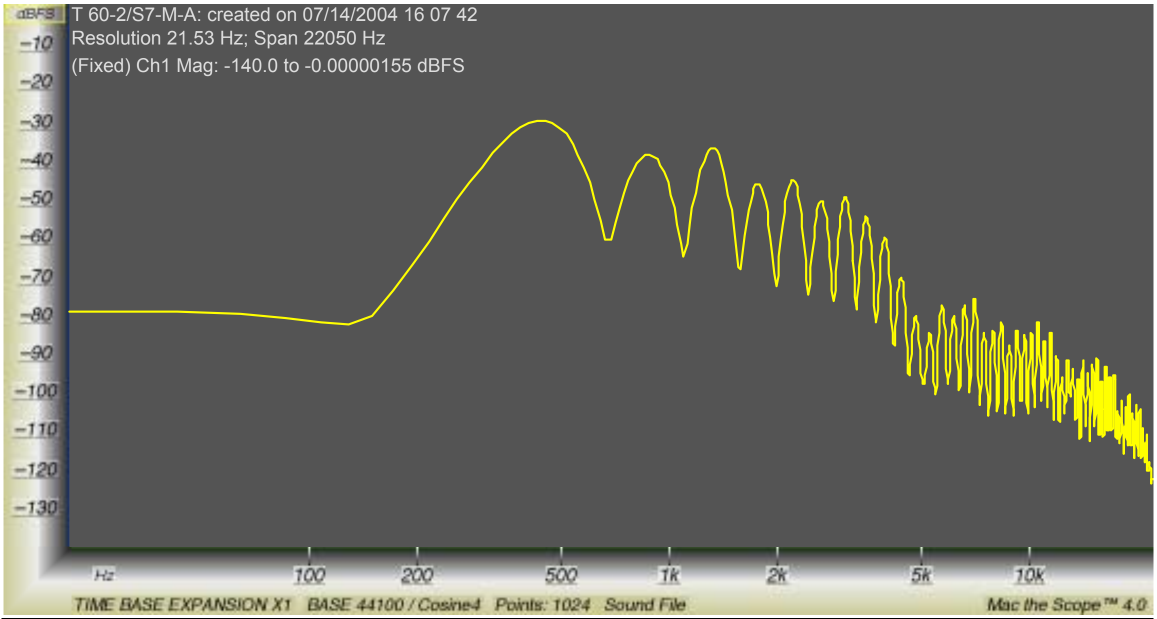
<u>Subject 6, Meyer-A, Take 52, Blow 2:</u>



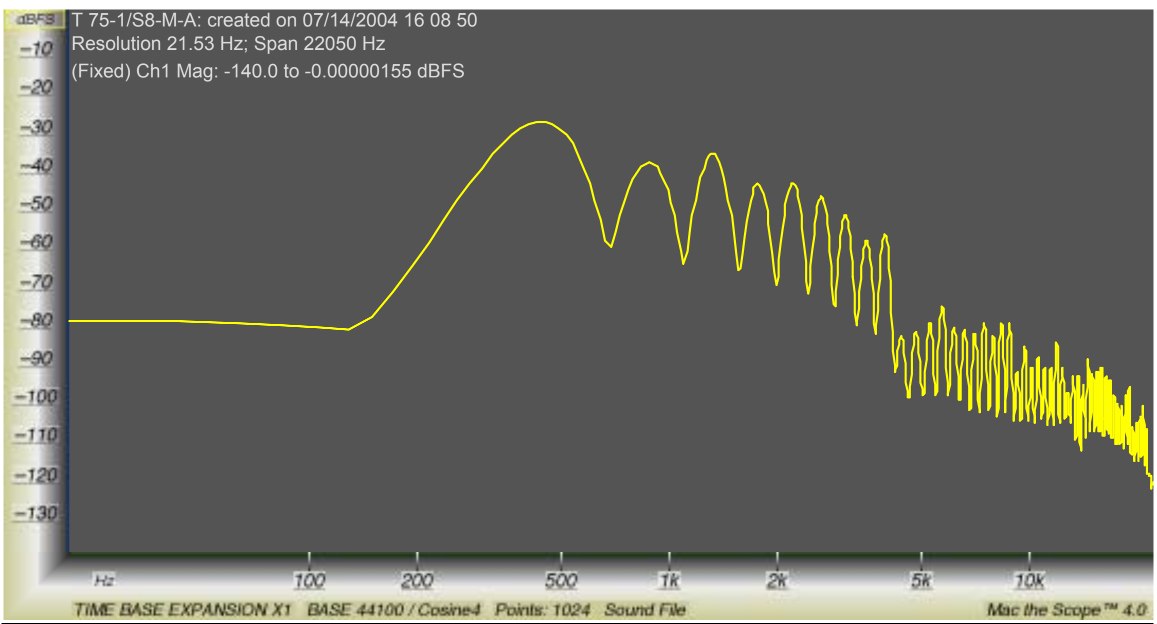
<u>Subject 7, Meyer-A, Take 60, Blow 1:</u>



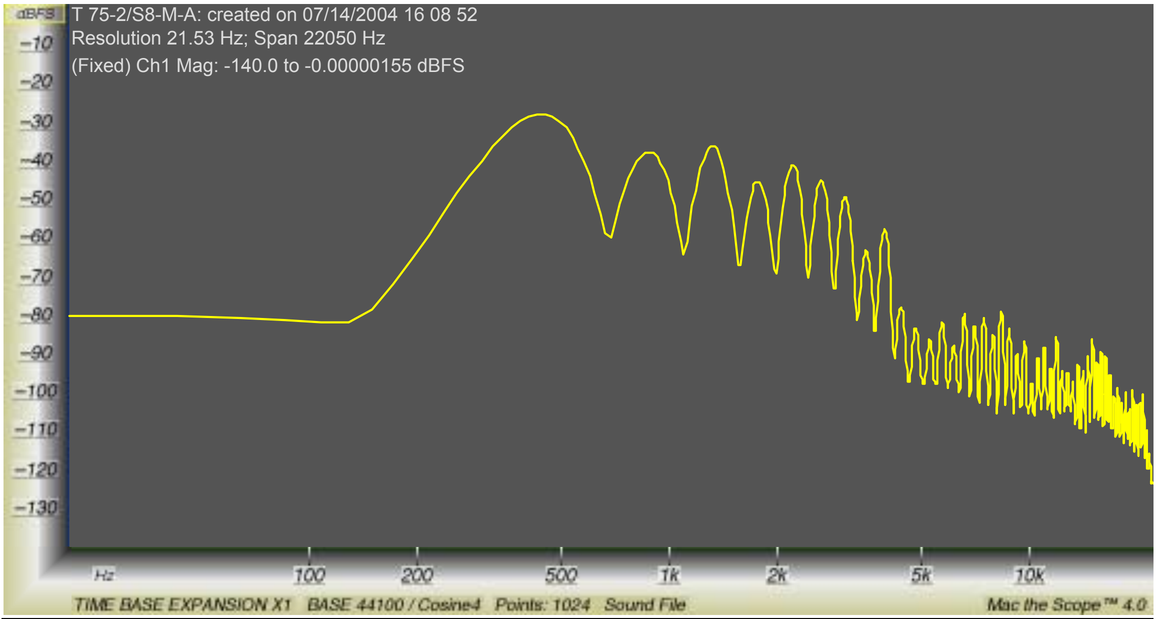
Subject 7, Meyer-A, Take 60, Blow 2:



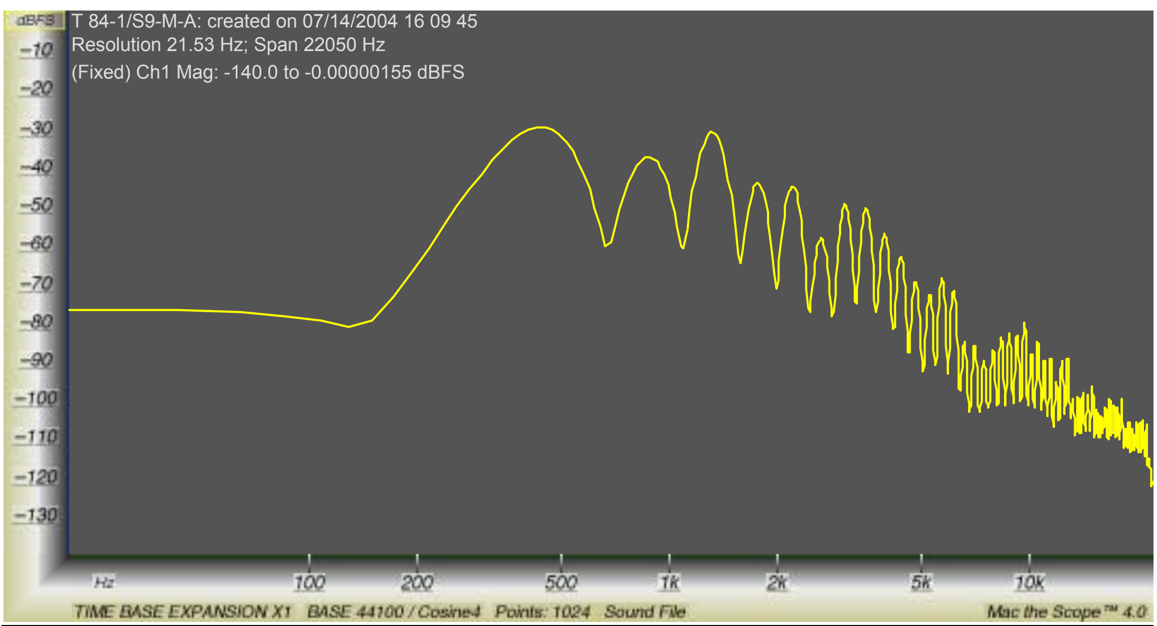
Subject 8, Meyer-A, Take 75, Blow 1:



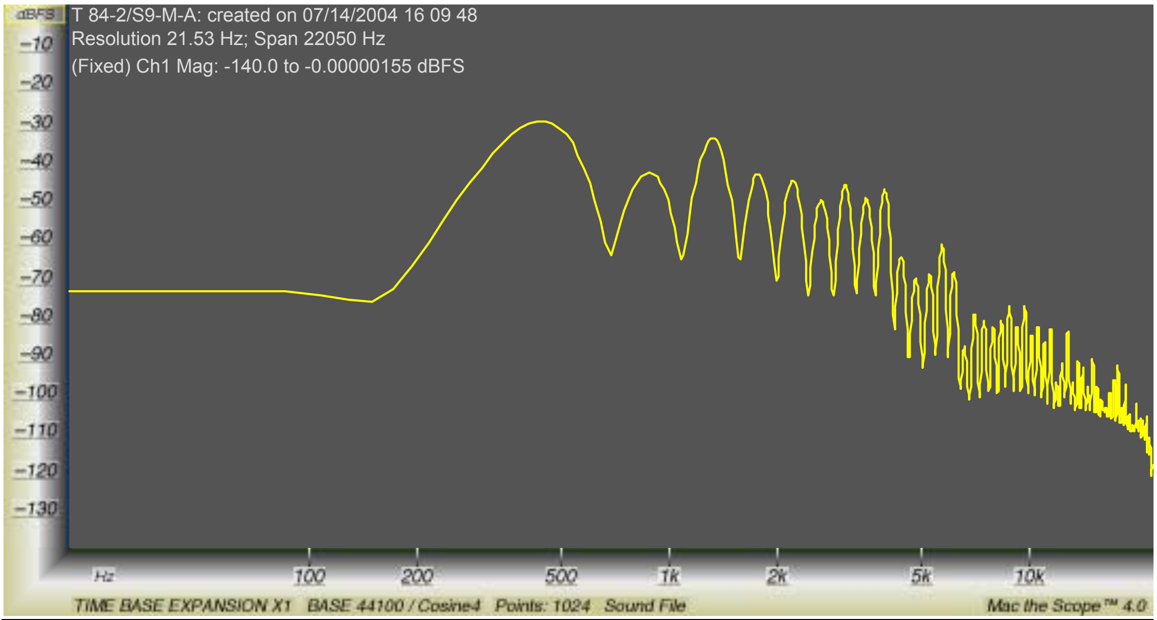
Subject 8, Meyer-A, Take 75, Blow 2:



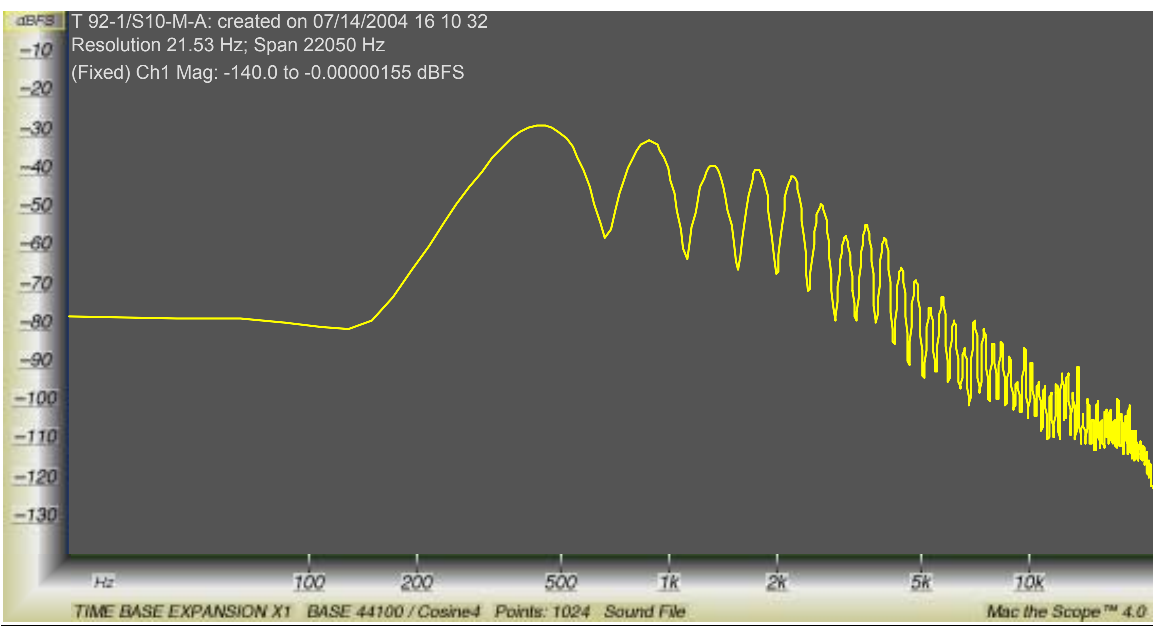
Subject 9, Meyer-A, Take 84, Blow 1:



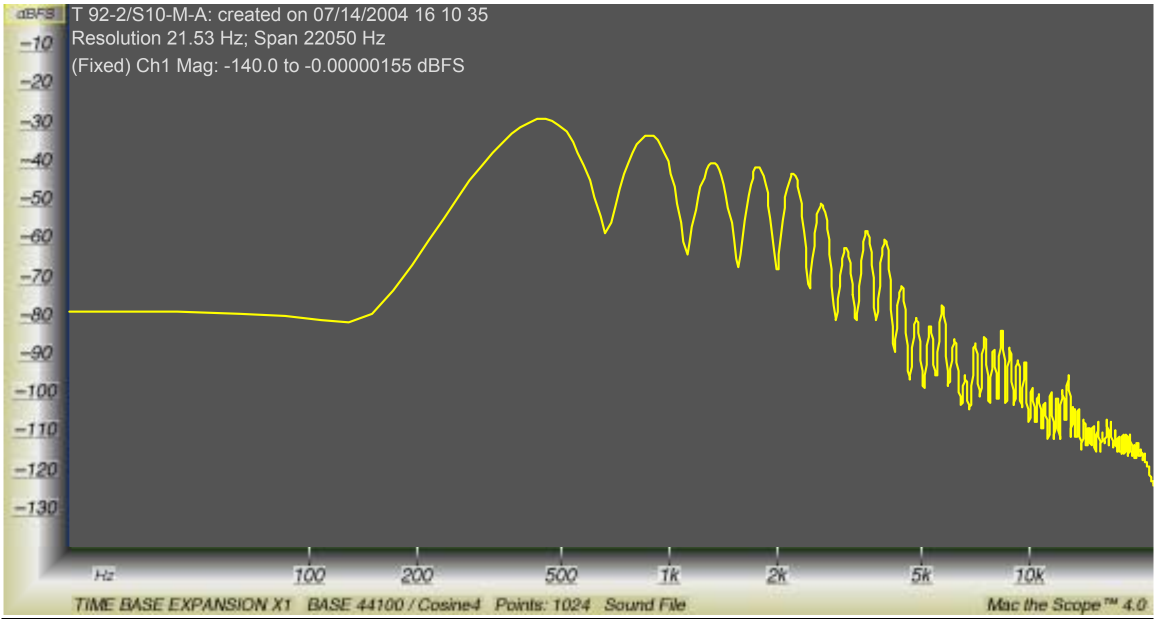
Subject 9, Meyer-A, Take 84, Blow 2:



Subject 10, Meyer-A, Take 92, Blow 1:

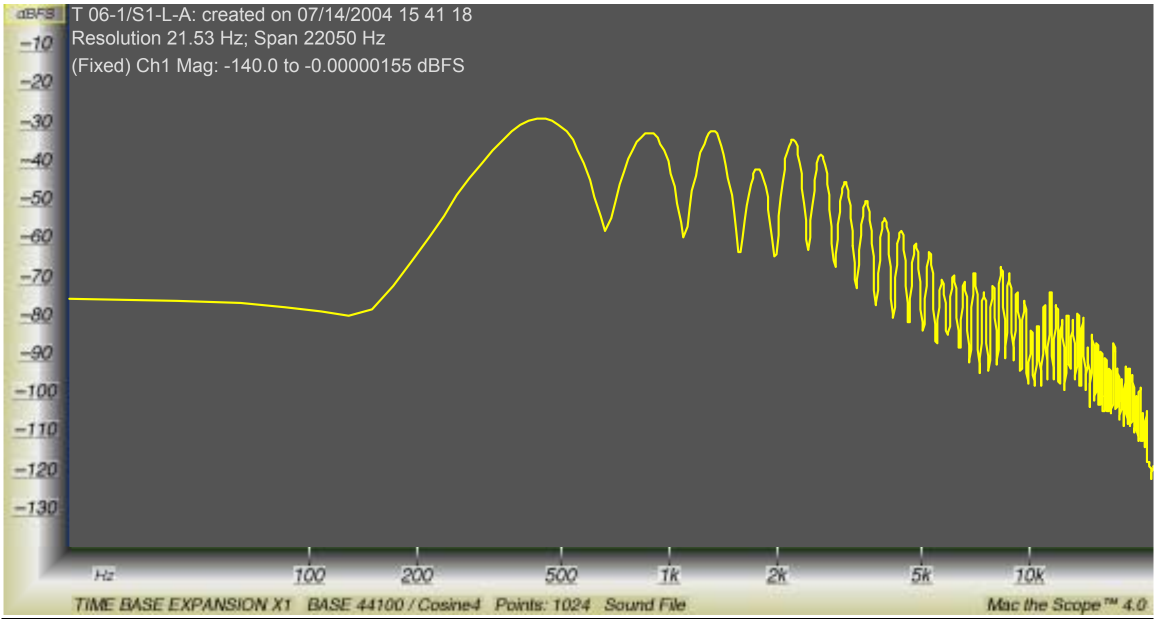


Subject 10, Meyer-A, Take 92, Blow 2:

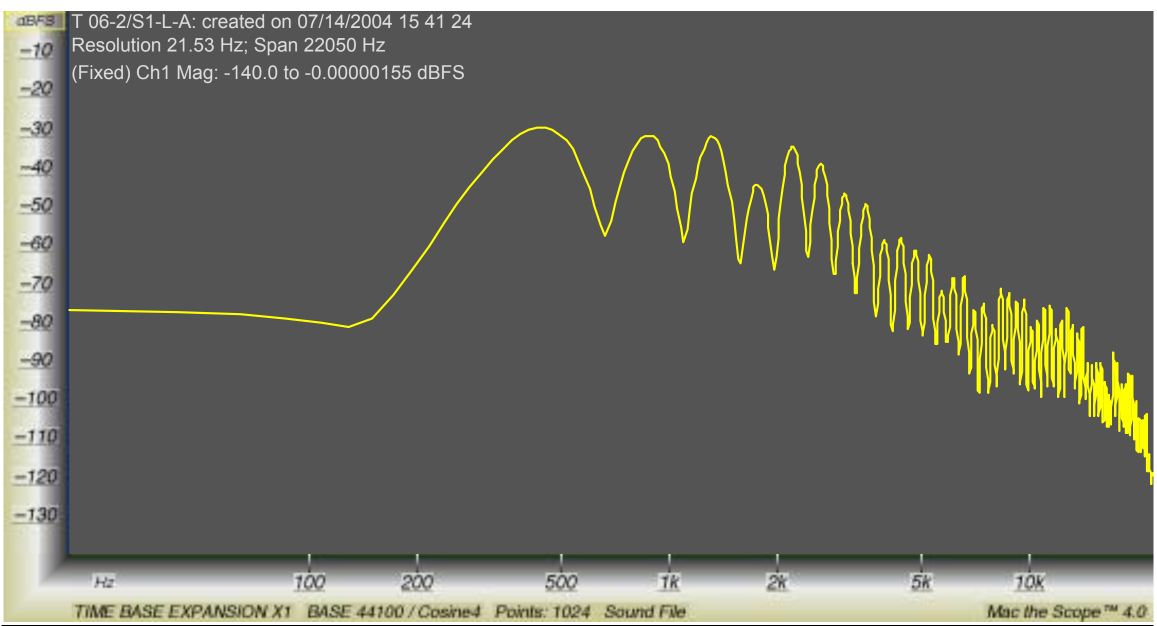


APPENDIX E: SPECTRAL ANALYSIS OF SAXOPHONE TONE QUALITY USING CLAUDE LAKEY 4*4 MOUTHPIECE AT MOUTHPIECE PITCH LEVEL OF A5

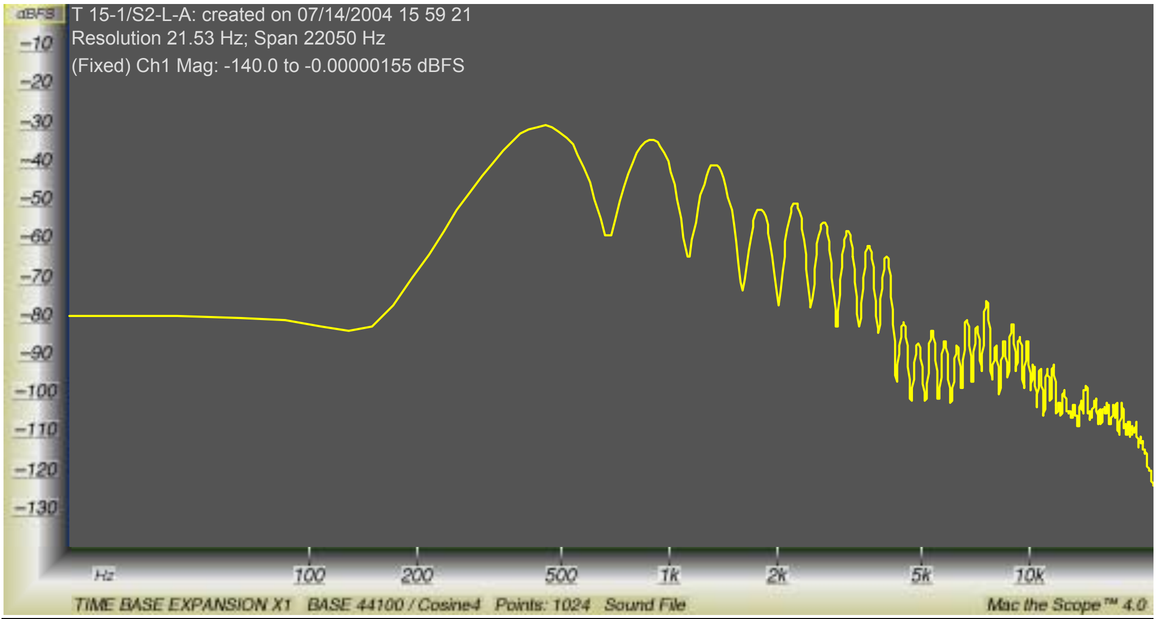
Subject 1, Lakey-A, Take 6, Blow 1:



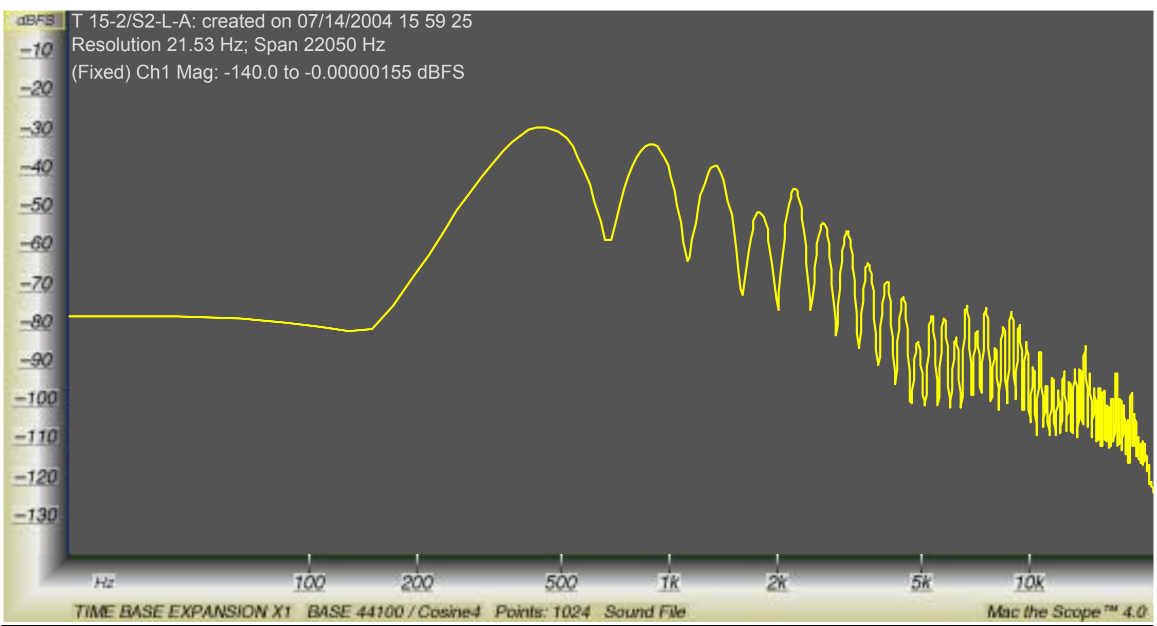
Subject 1, Lakey-A, Take 6, Blow 2:



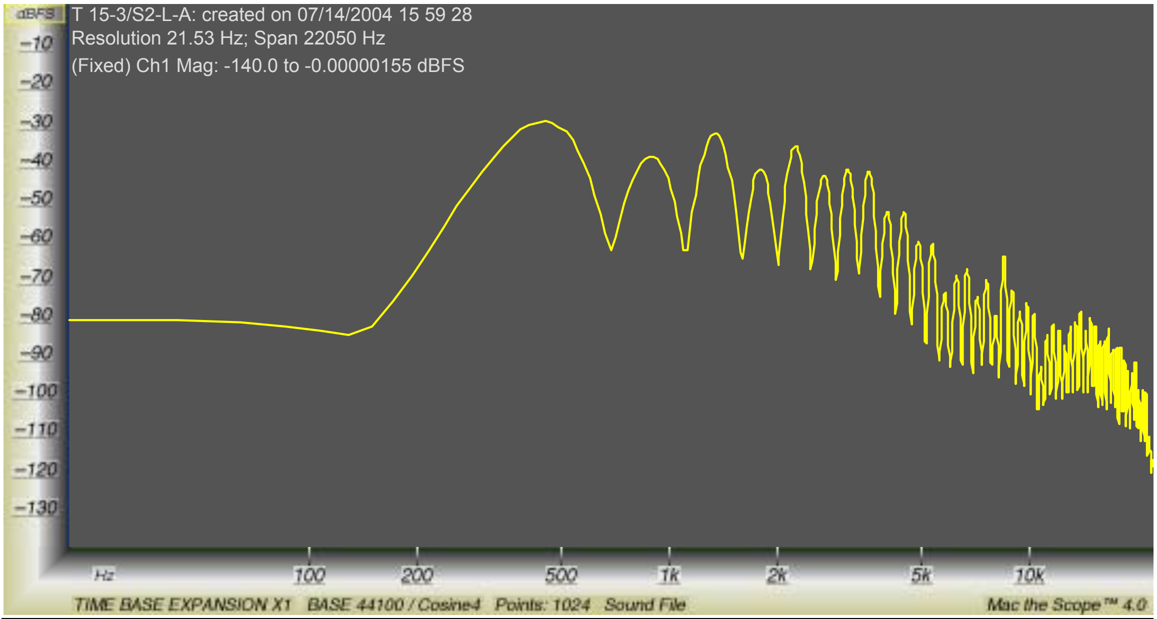
Subject 2, Lakey-A, Take 15, Blow 1:



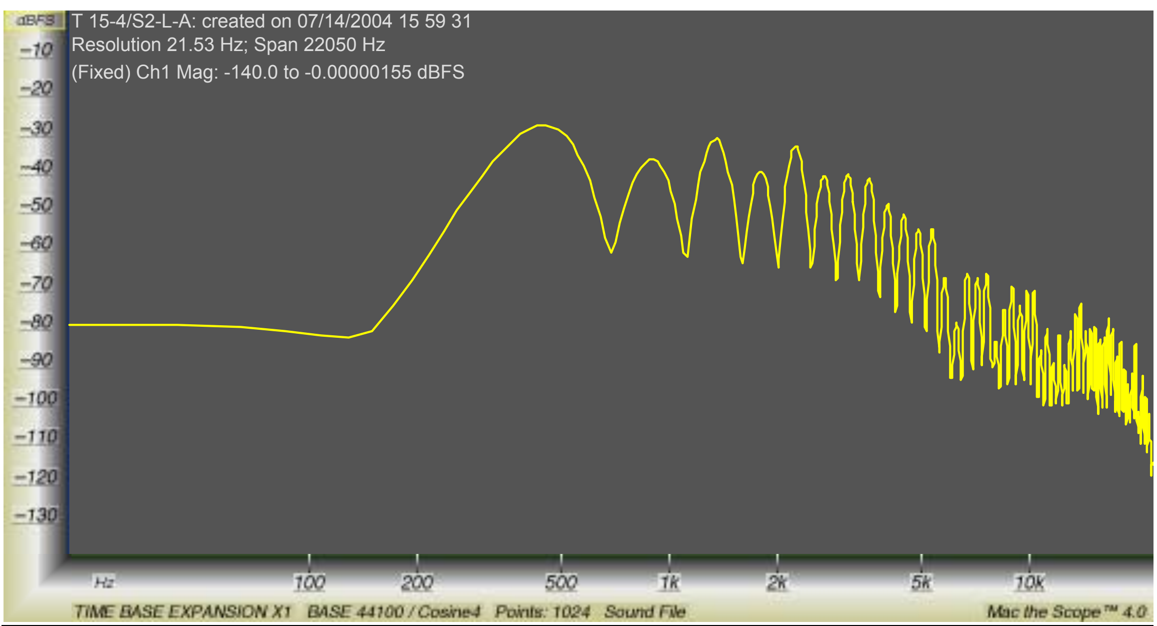
Subject 2, Lakey-A, Take 15, Blow 2:



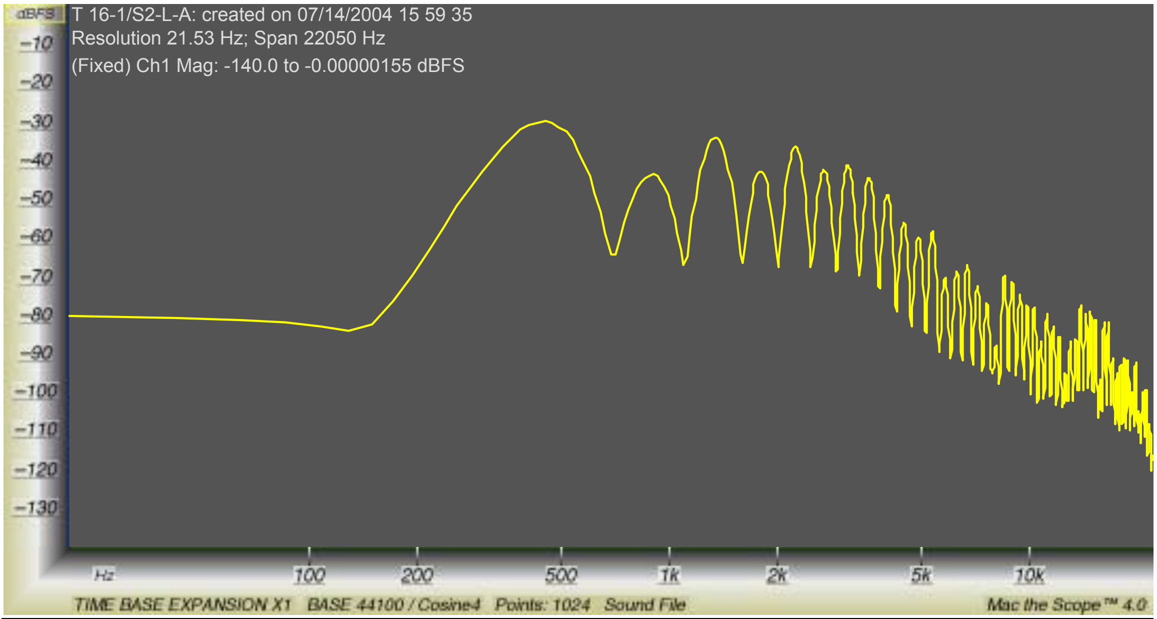
Subject 2, Lakey-A, Take 15, Blow 3:



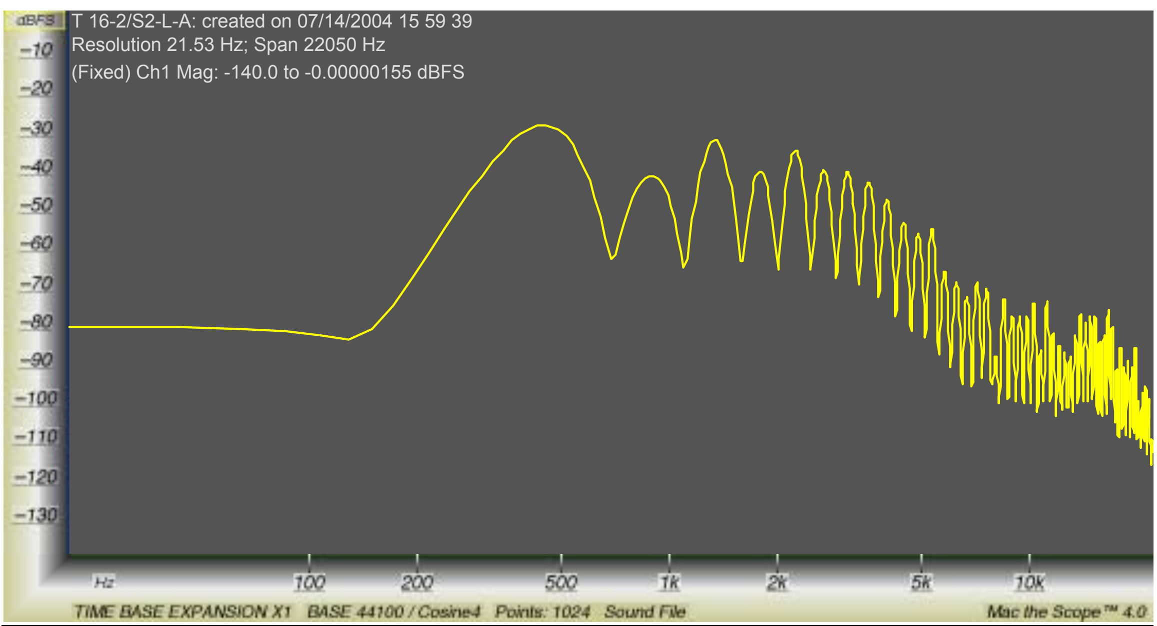
Subject 2, Lakey-A, Take 15, Blow 4:



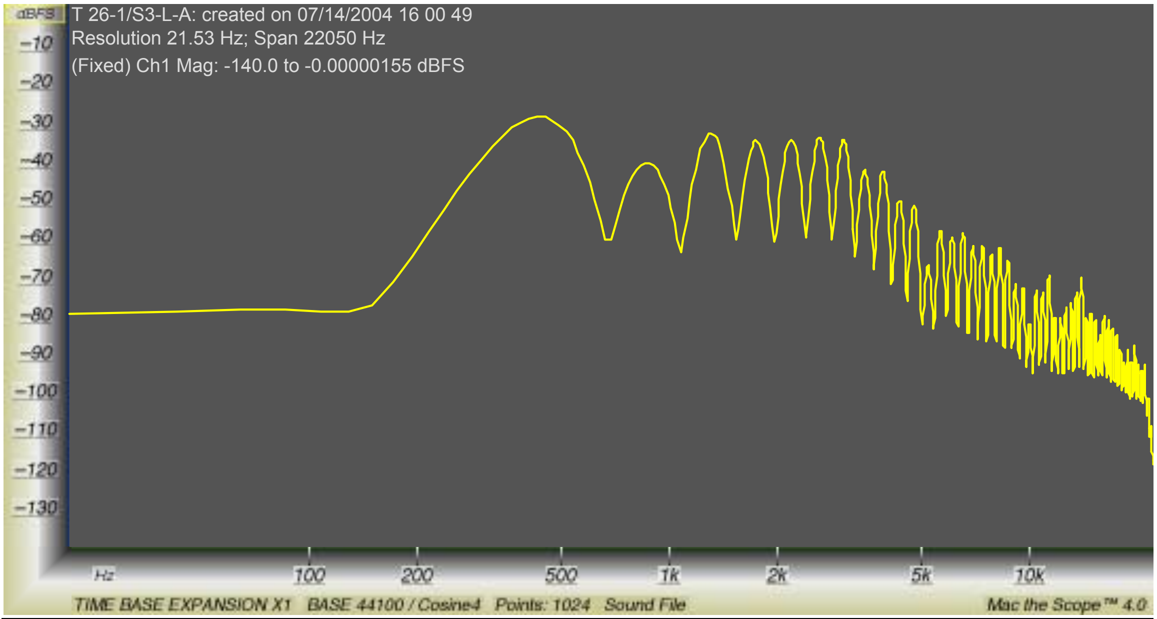
Subject 2, Lakey-A, Take 16, Blow 1:



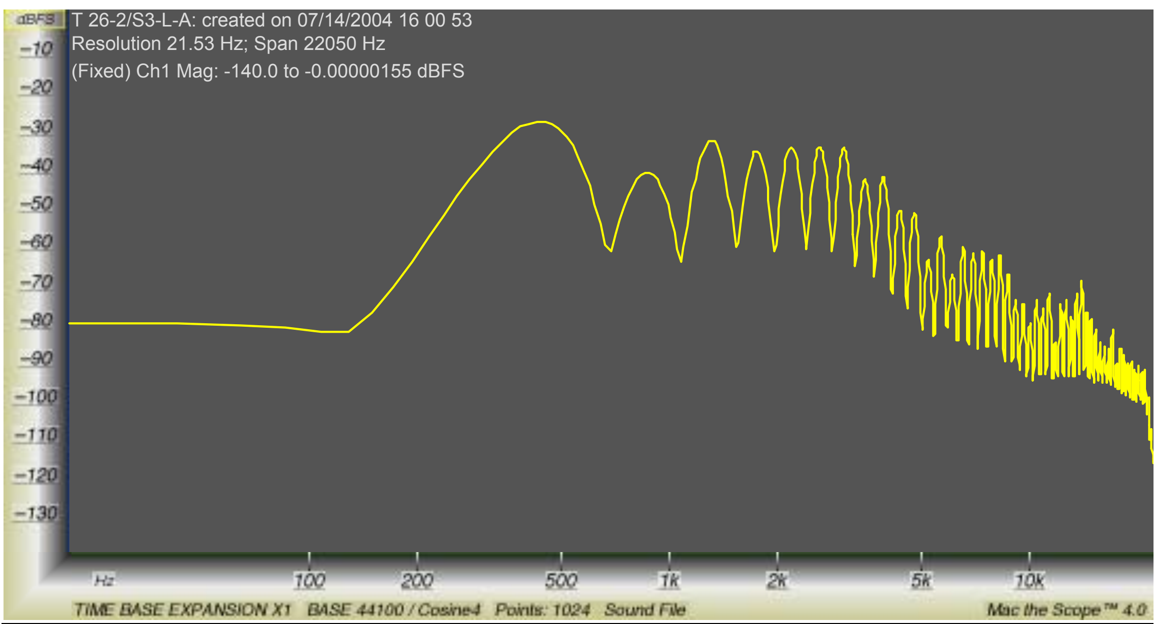
Subject 2, Lakey-A, Take 16, Blow 2:



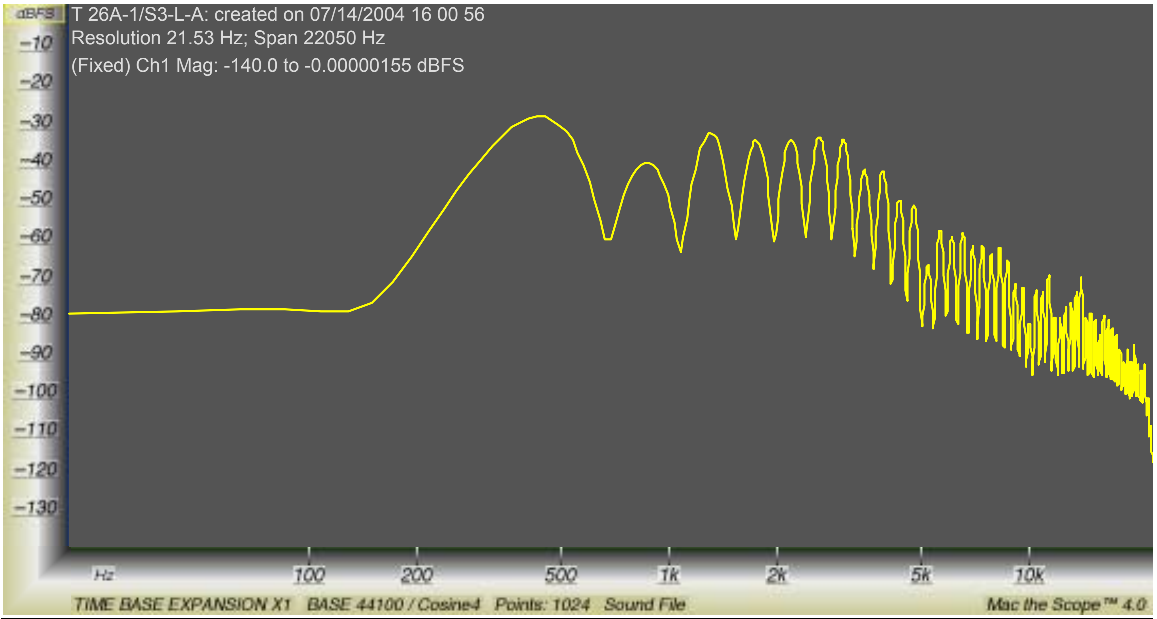
Subject 3, Lakey-A, Take 26, Blow 1:



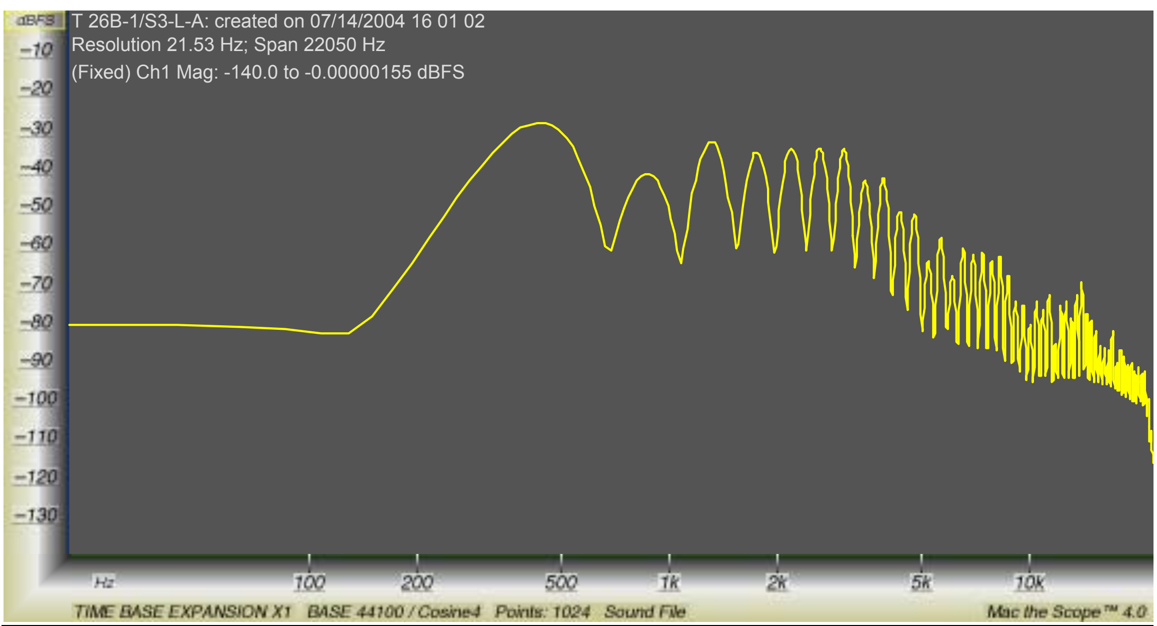
Subject 3, Lakey-A, Take 26, Blow 2:



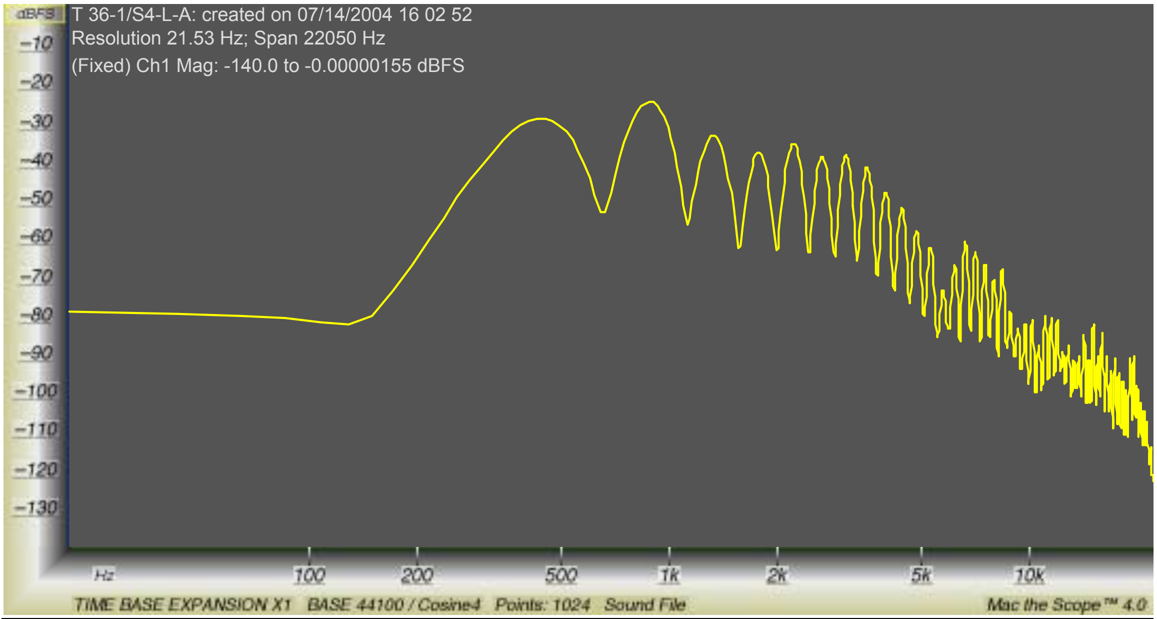
Subject 3, Lakey-A, Take 26A, Blow 1:



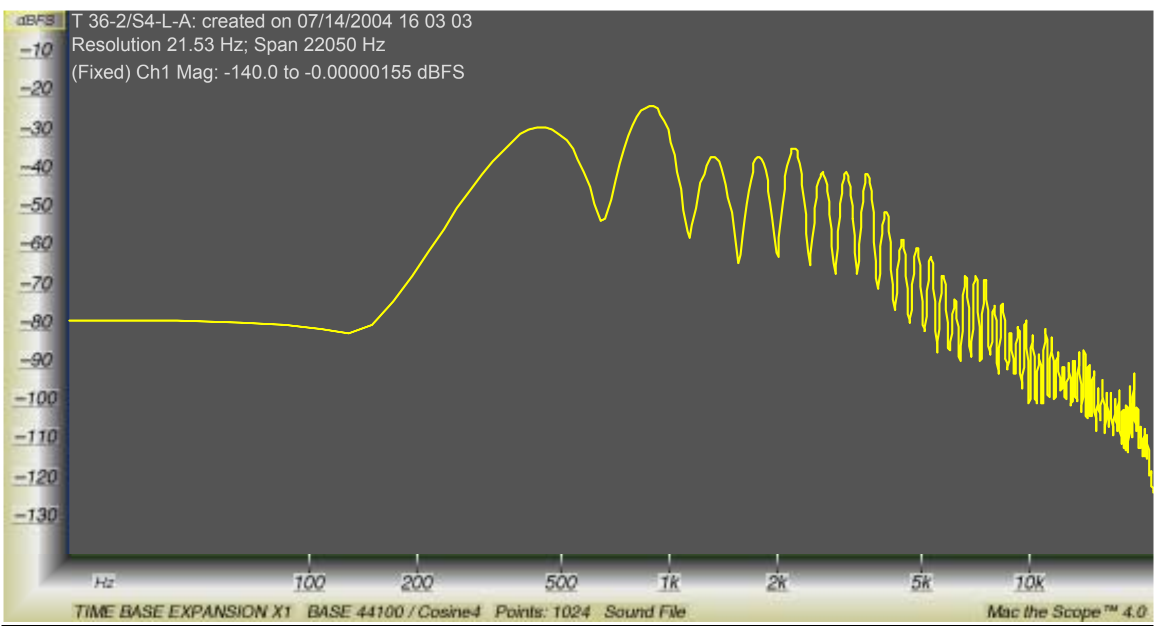
Subject 3, Lakey-A, Take 26B, Blow 1:



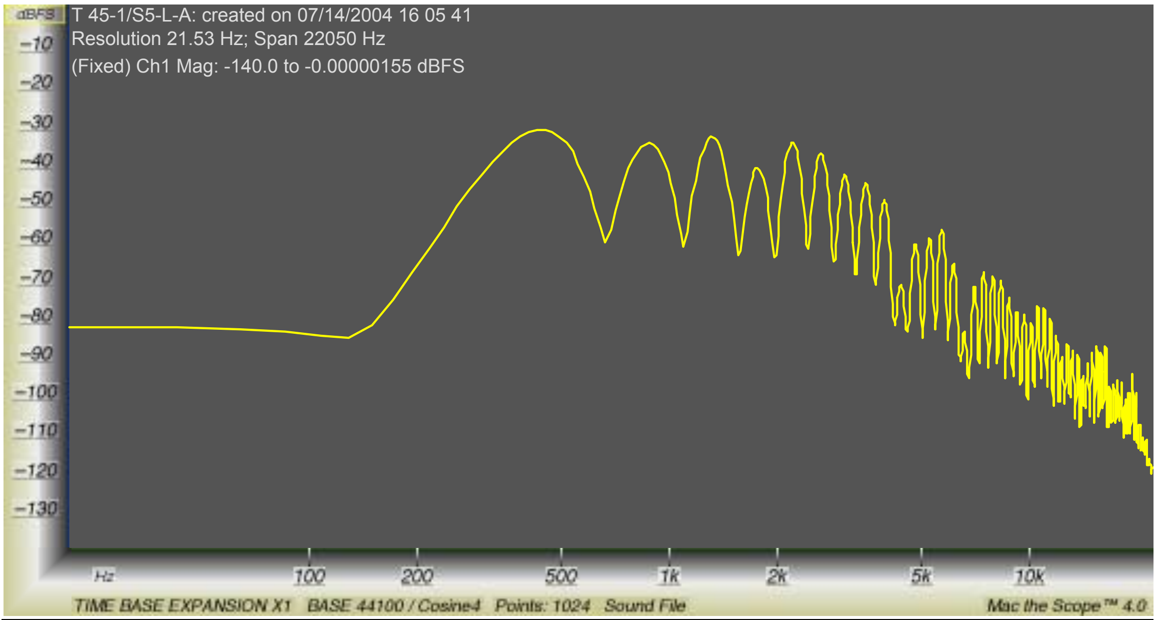
Subject 4, Lakey-A, Take 36, Blow 1:



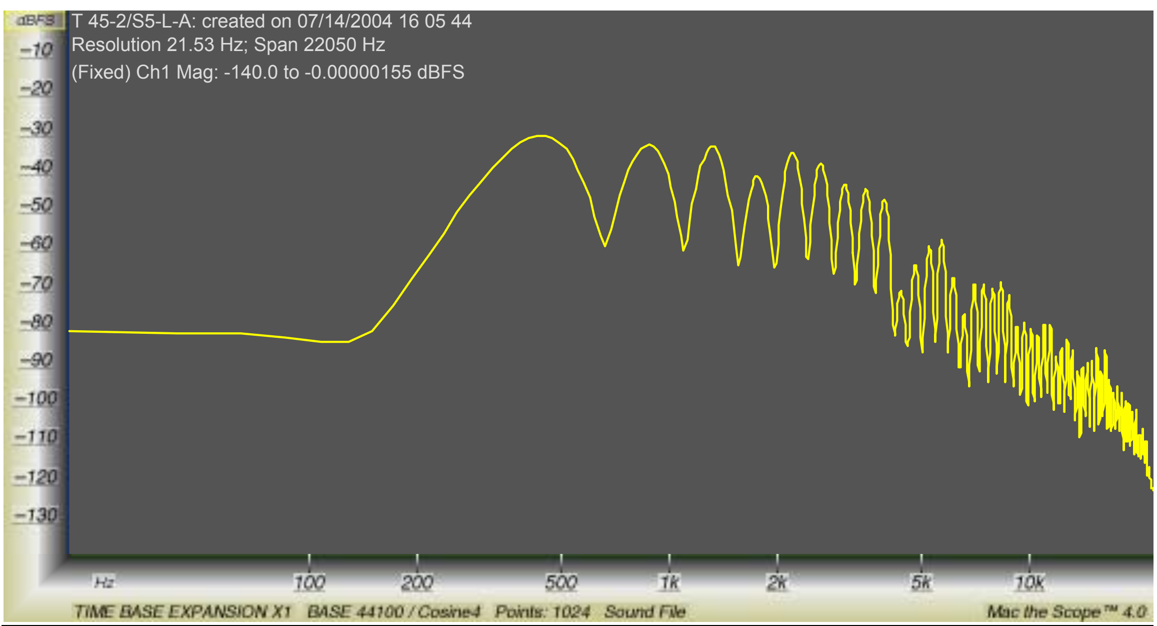
Subject 4, Lakey-A, Take 36, Blow 2:



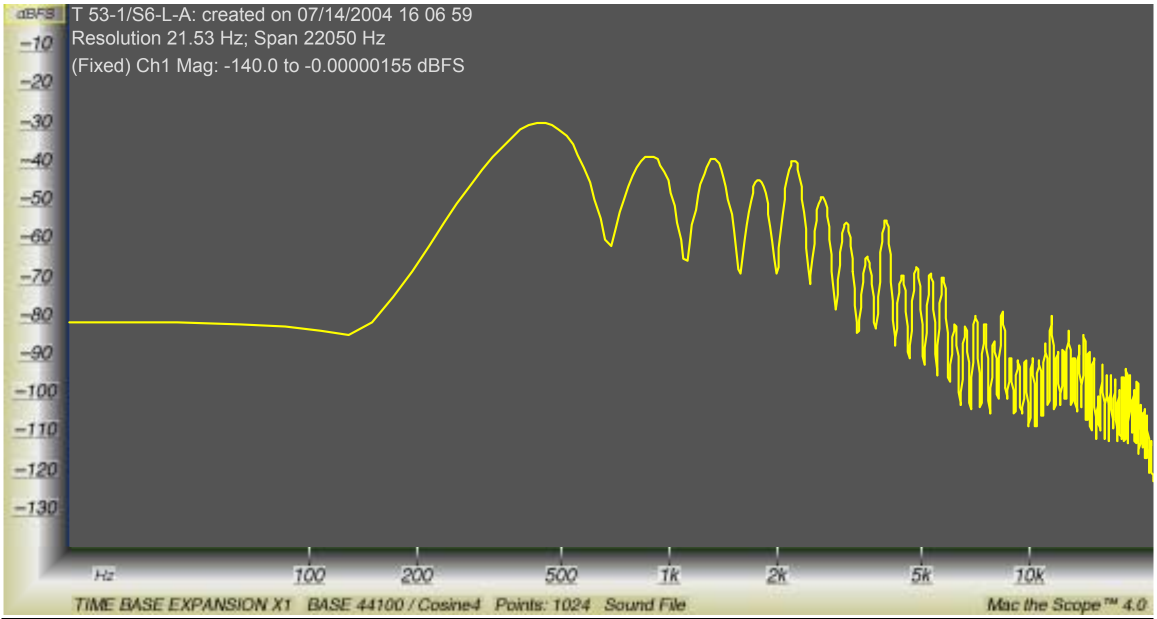
Subject 5, Lakey-A, Take 45, Blow 1:



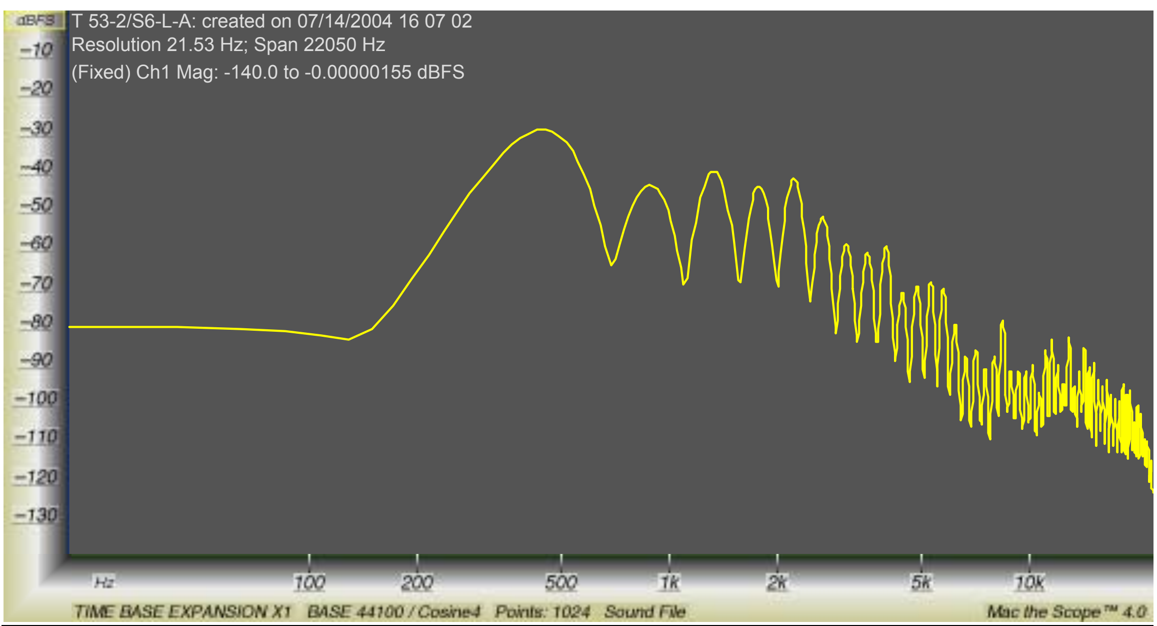
Subject 5, Lakey-A, Take 45, Blow 2:



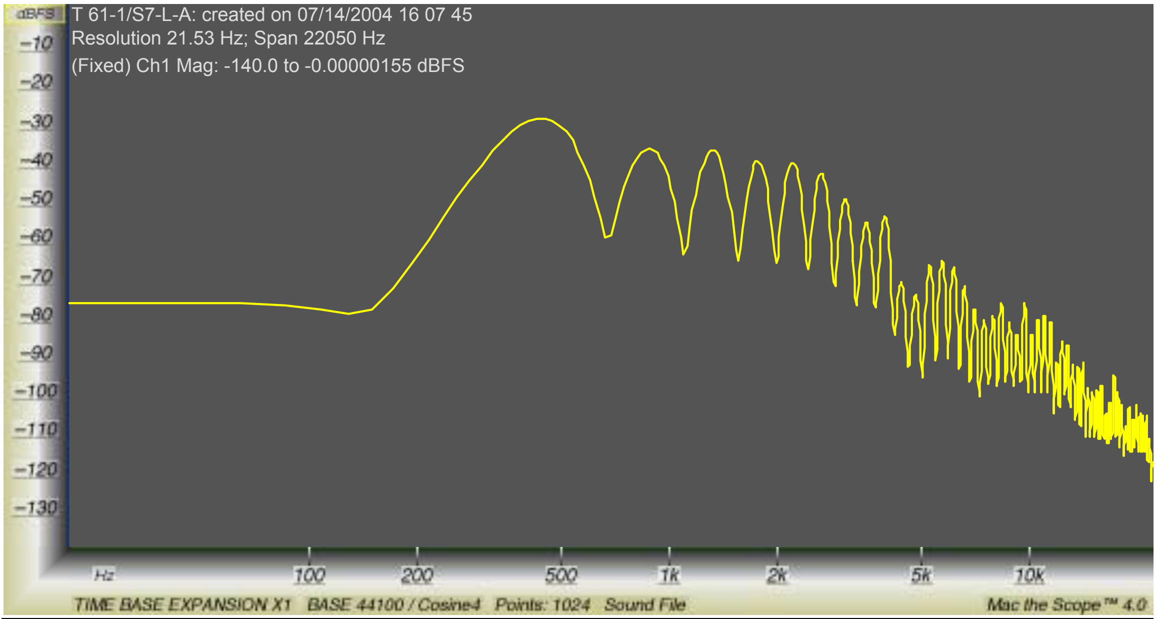
Subject 6, Lakey-A, Take 53, Blow 1:



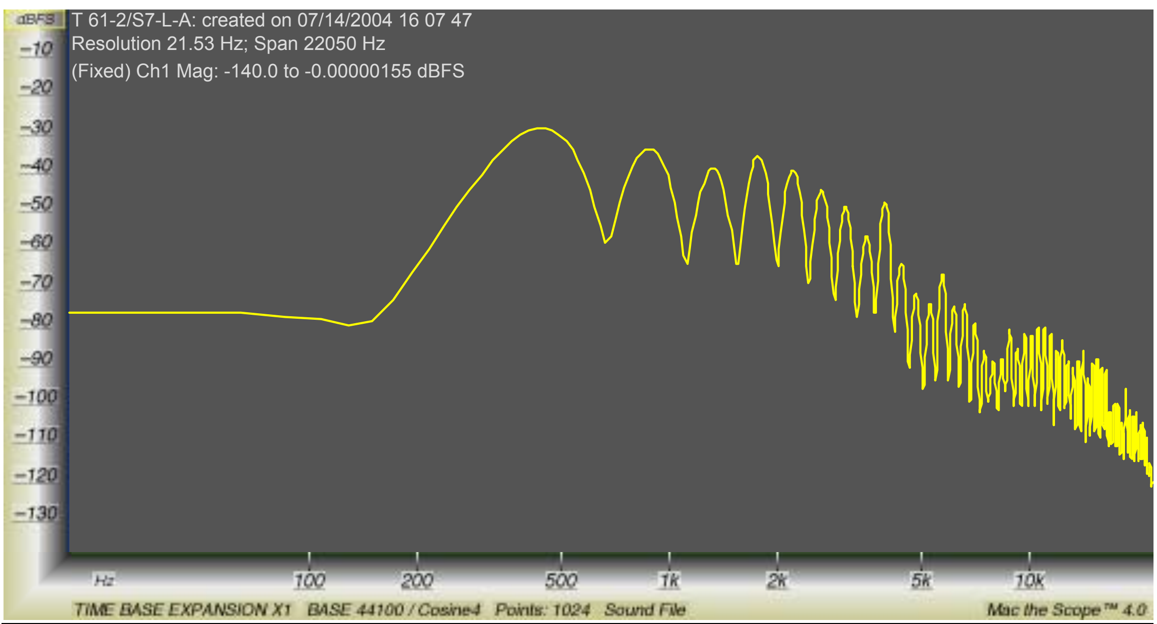
Subject 6, Lakey-A, Take 53, Blow 2:



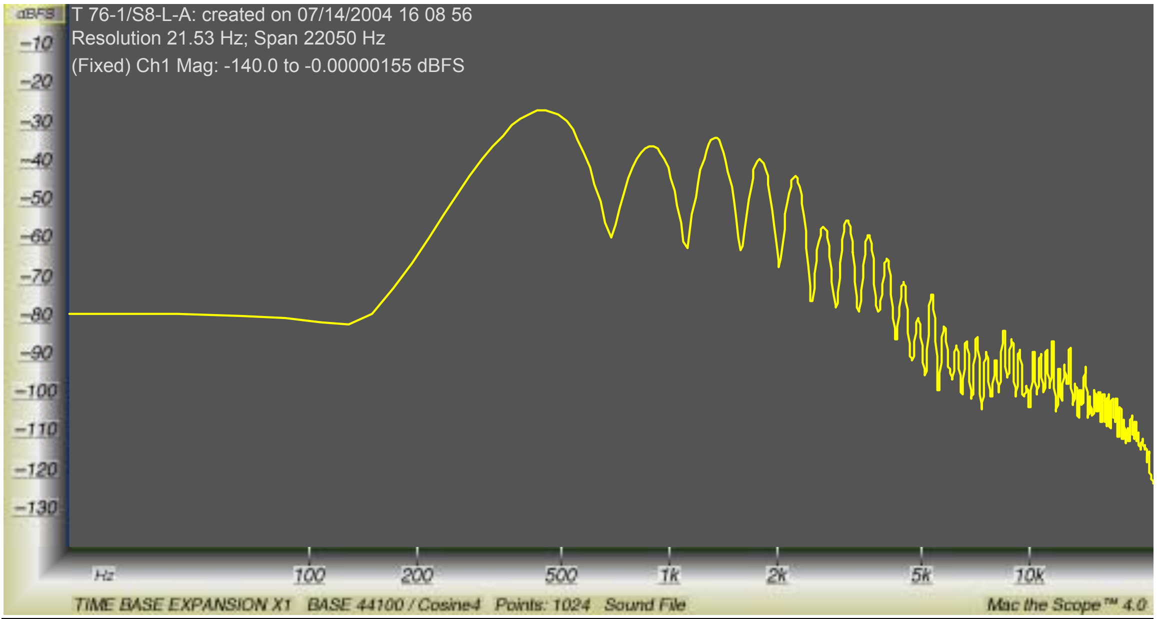
Subject 7, Lakey-A, Take 61, Blow 1:



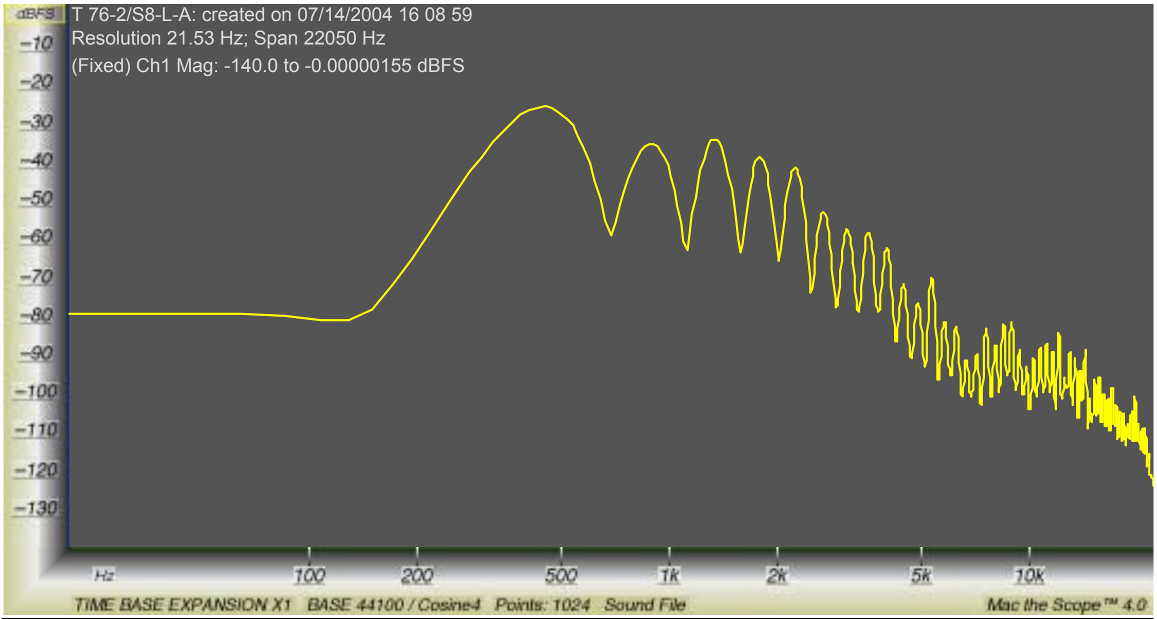
Subject 7, Lakey-A, Take 61, Blow 2:



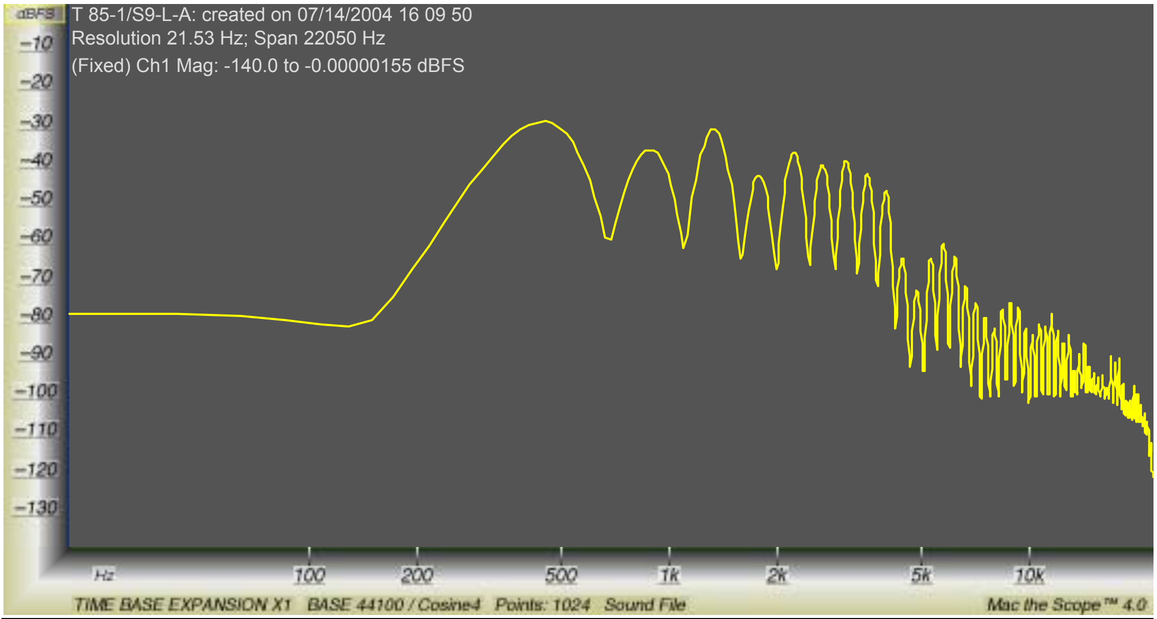
Subject 8, Lakey-A, Take 76, Blow 1:



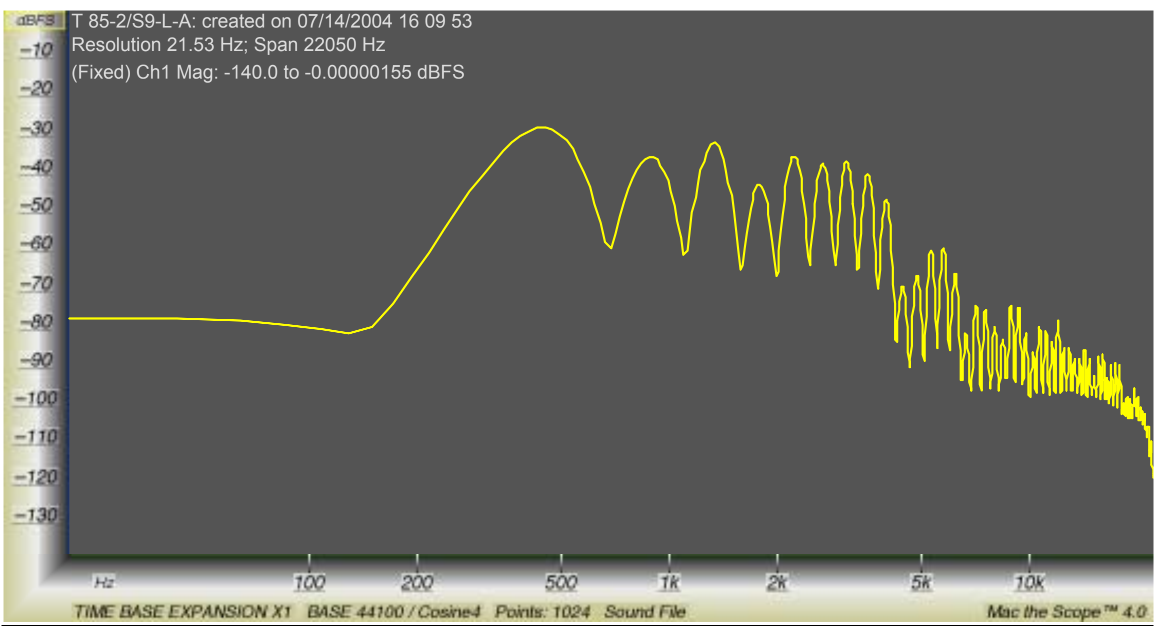
Subject 8, Lakey-A, Take 76, Blow 2:



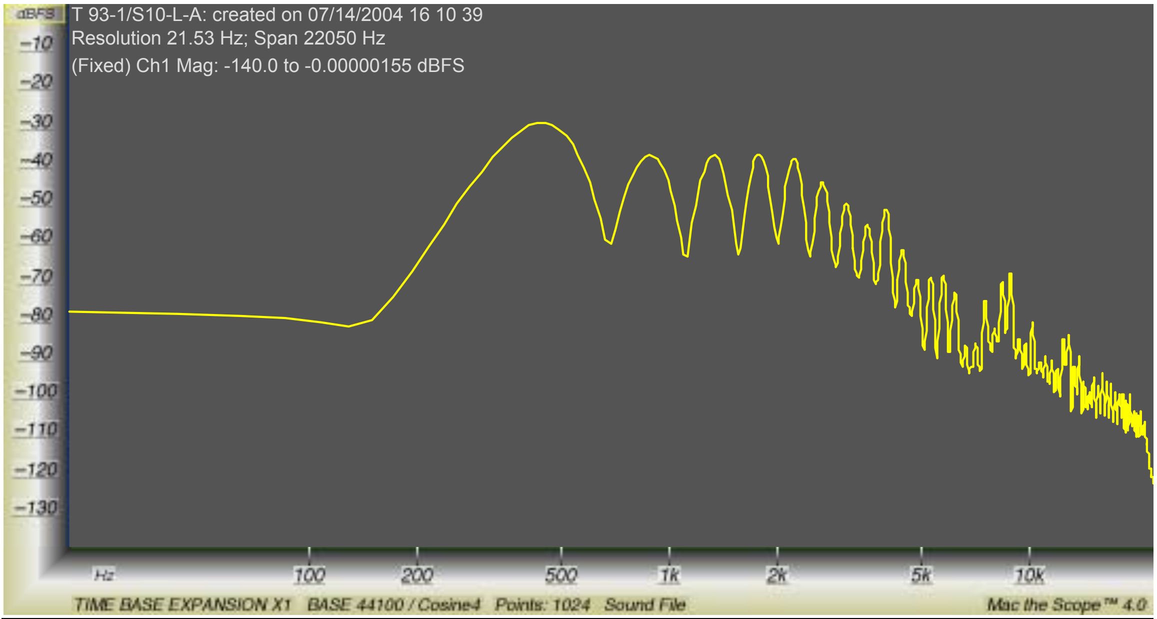
Subject 9, Lakey-A, Take 85, Blow 1



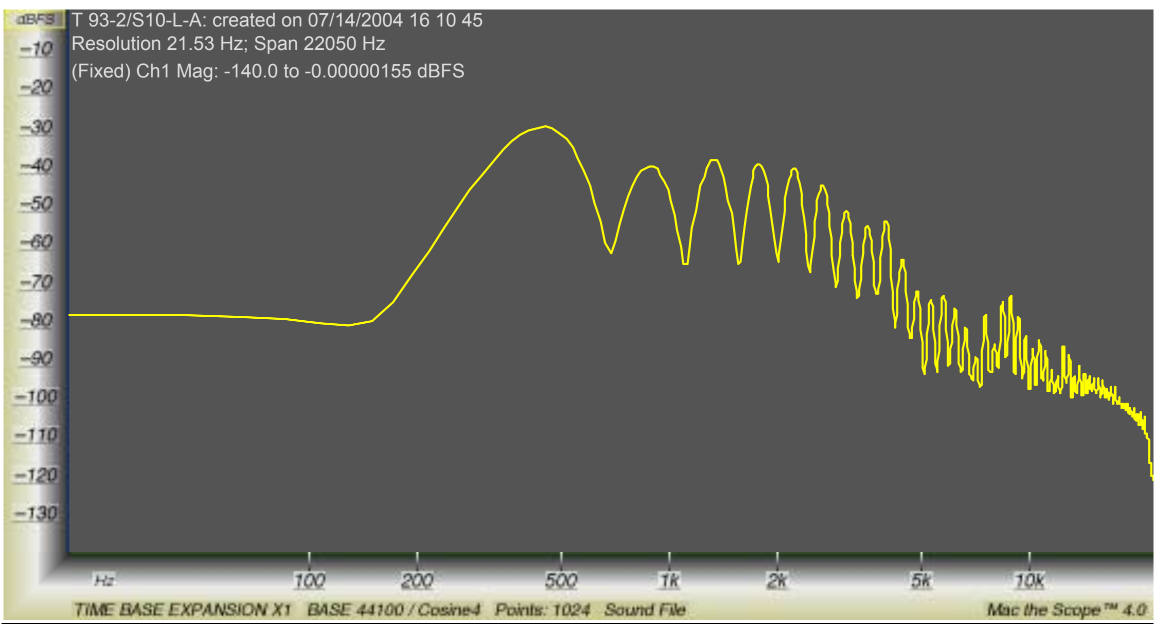
Subject 9, Lakey-A, Take 85, Blow 2;



Subject 10, Lakey-A, Take 93, Blow 1:

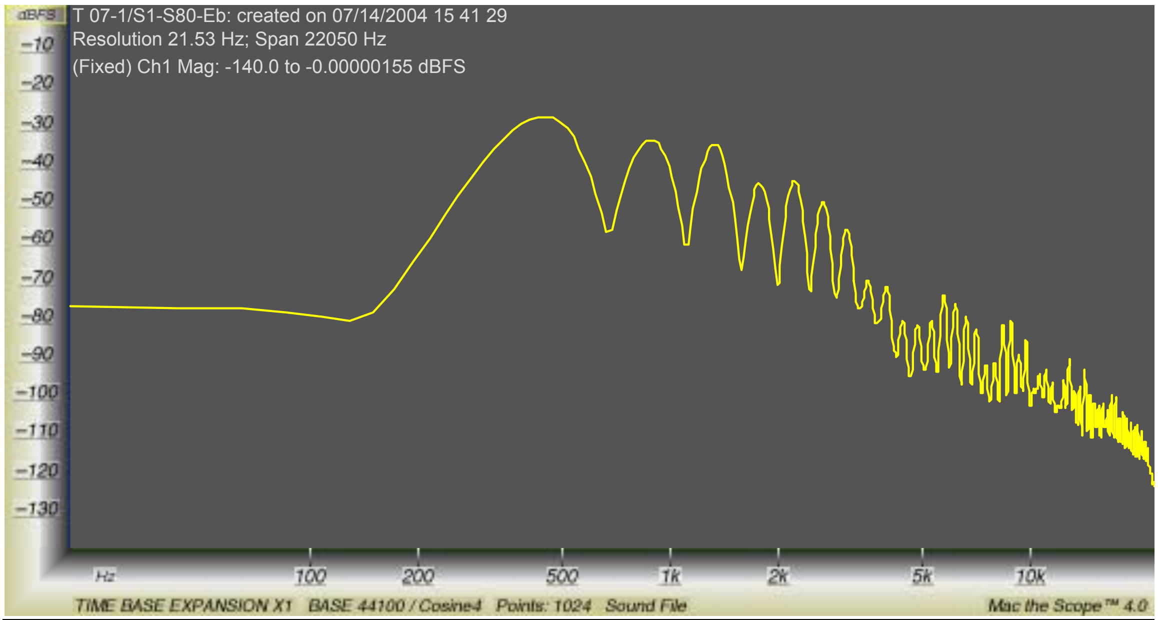


Subject 10, Lakey-A, Take 93, Blow 2:

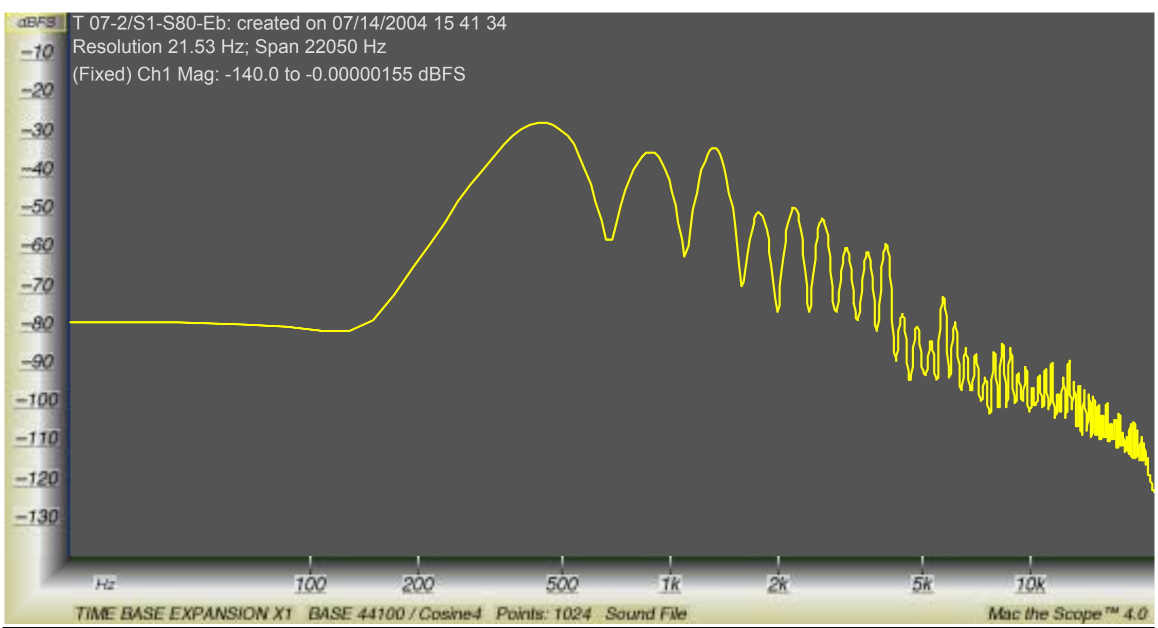


<u>APPENDIX F: SPECTRAL ANALYSIS OF SAXOPHONE TONE QUALITY USING SELMER S80 MOUTHPIECE AT MOUTHPIECE PITCH LEVEL OF Eb5</u>

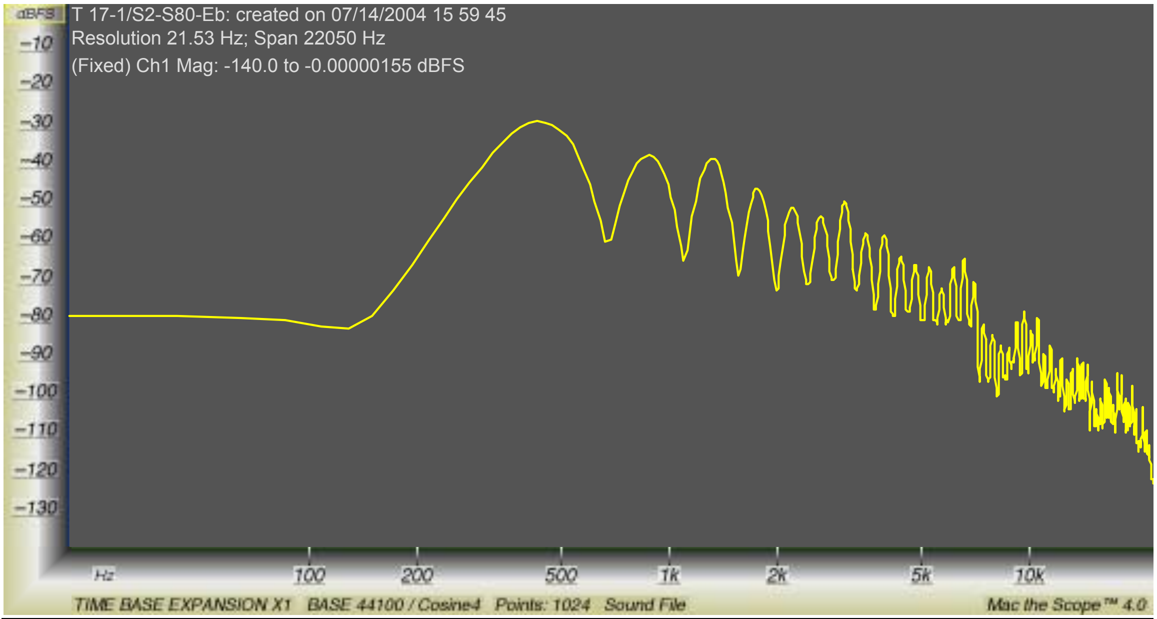
Subject 1, S80-Eb, Take 7, Blow 1:



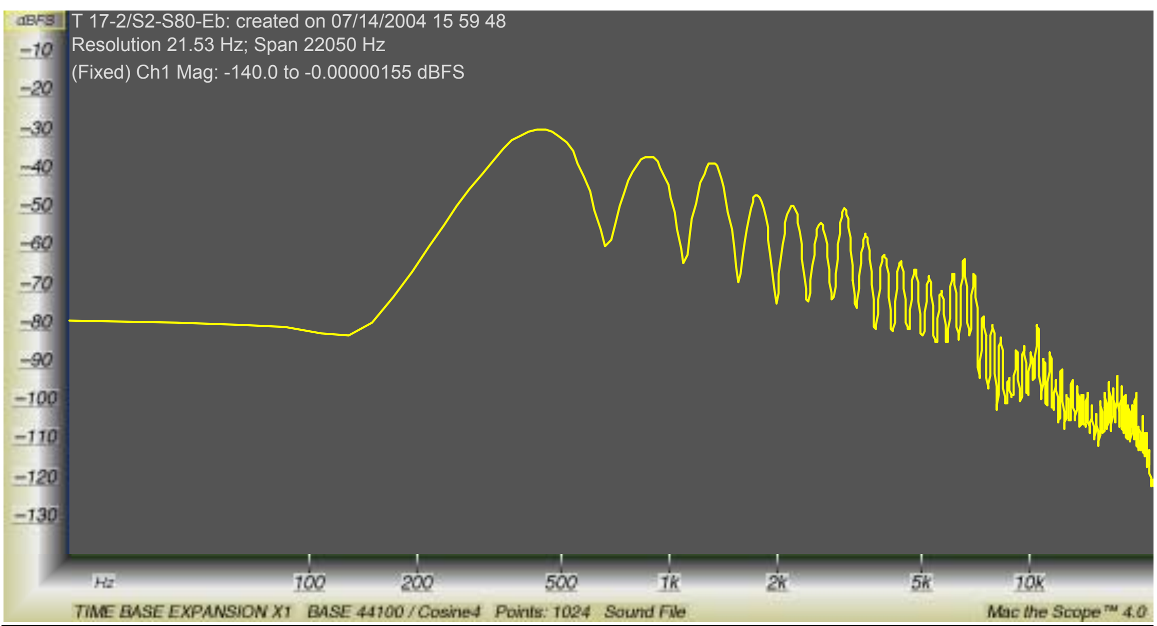
Subject 1, S80-Eb, Take 7, Blow 2:



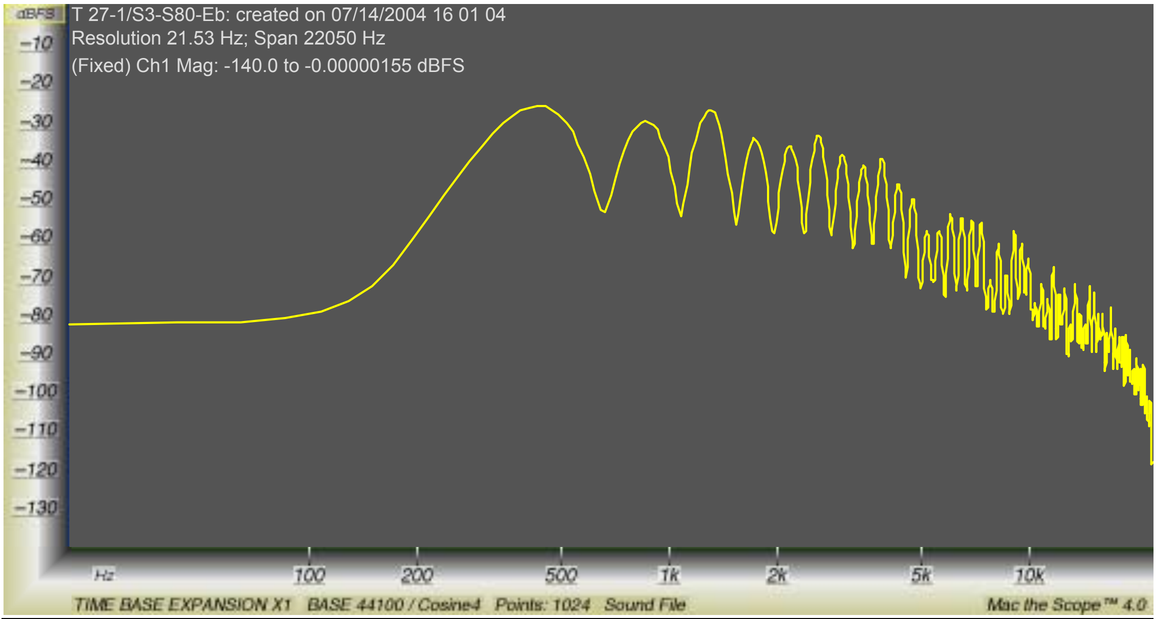
Subject 2, S80-Eb, Take 17, Blow 1:



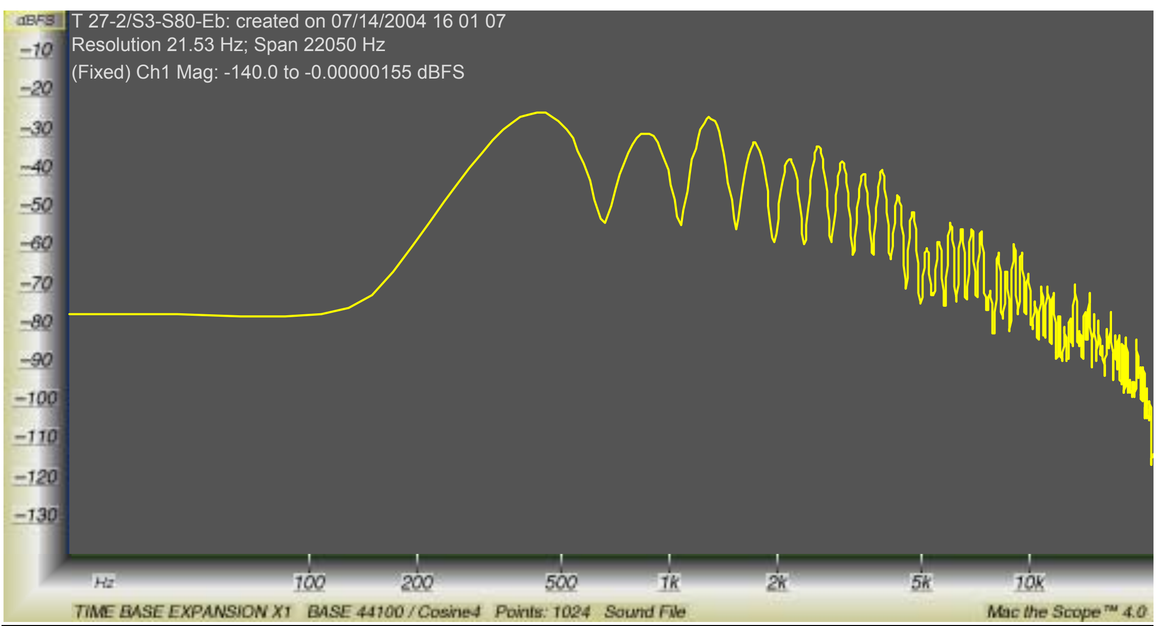
Subject 2, S80-Eb, Take 17, Blow 2:



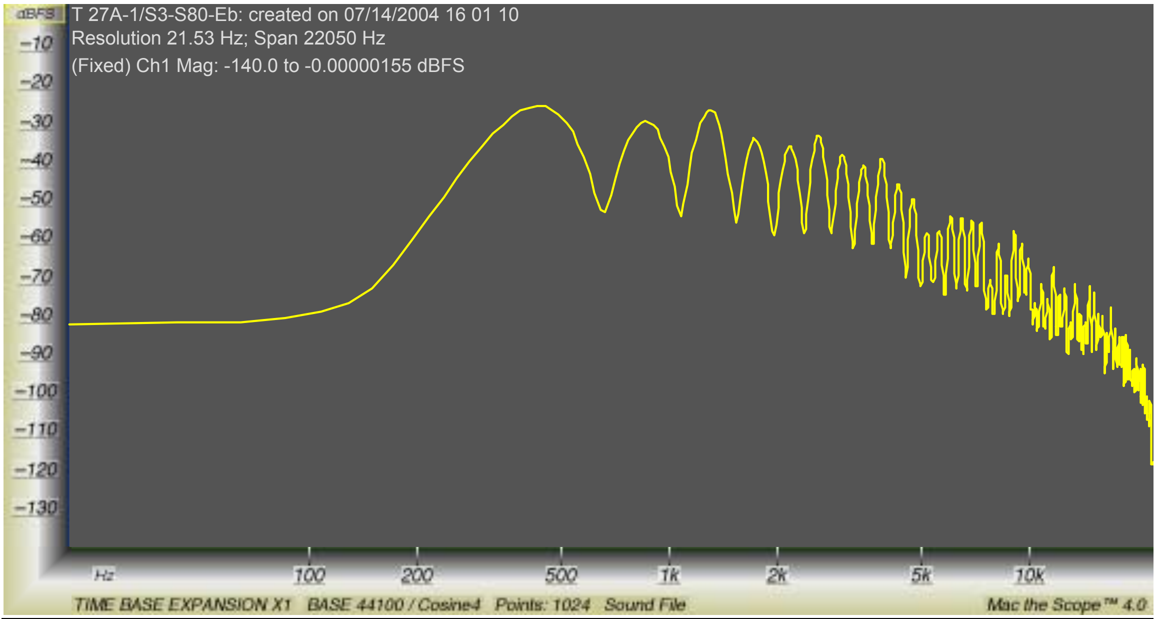
Subject 3, S80-Eb, Take 27, Blow 1:



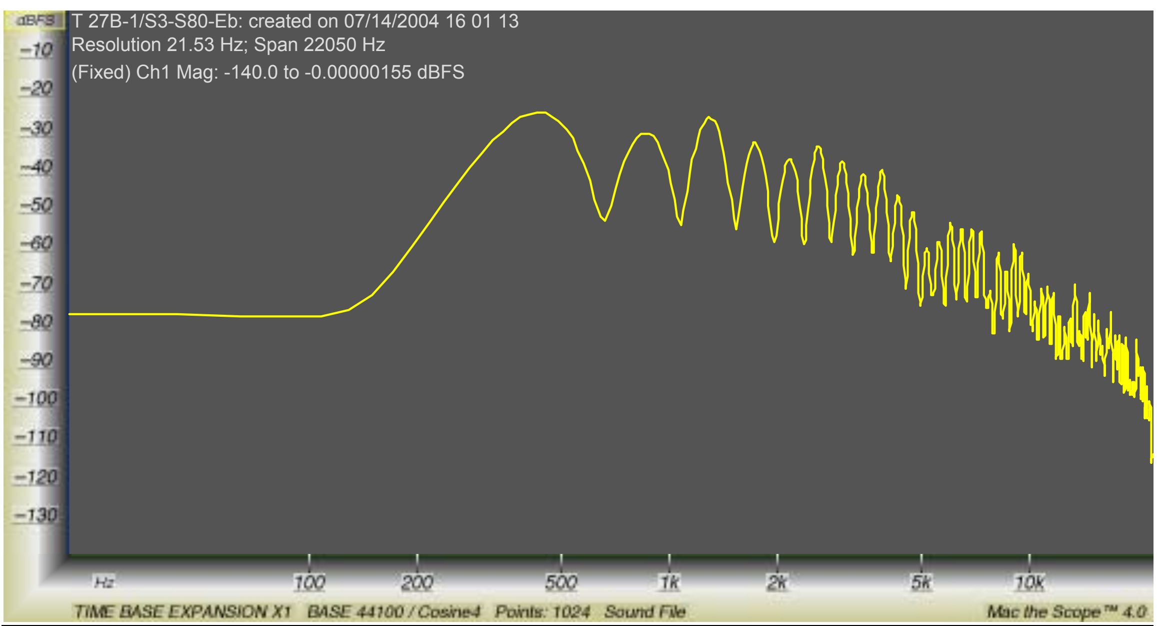
Subject 3, S80-Eb, Take 27, Blow 2:



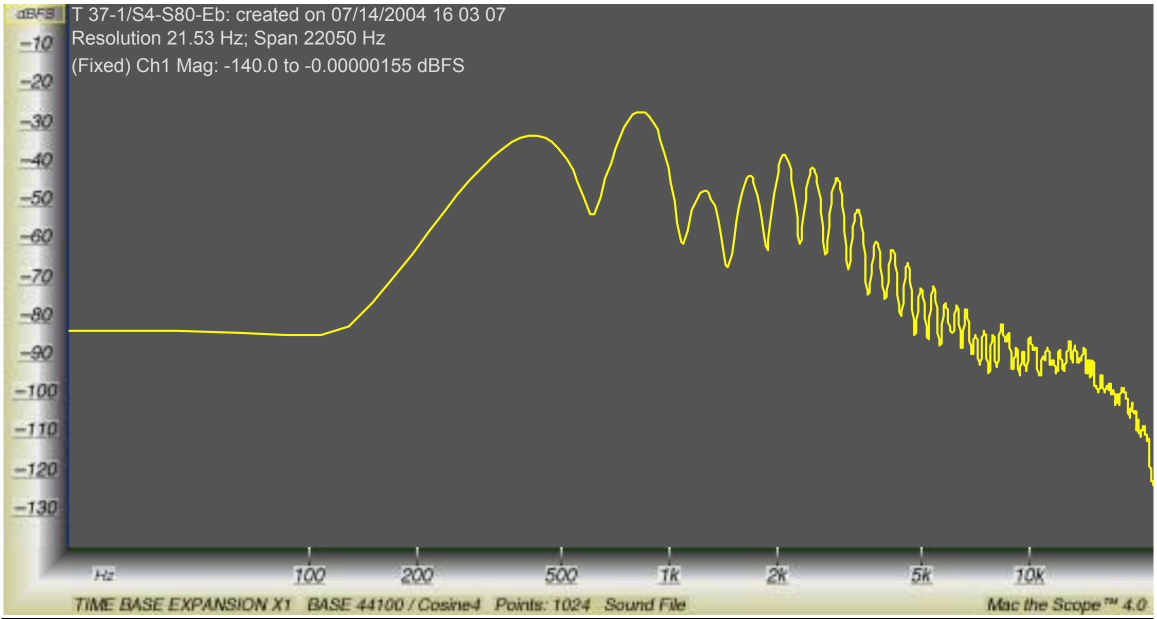
Subject 3, S80-Eb, Take 27A, Blow 1:



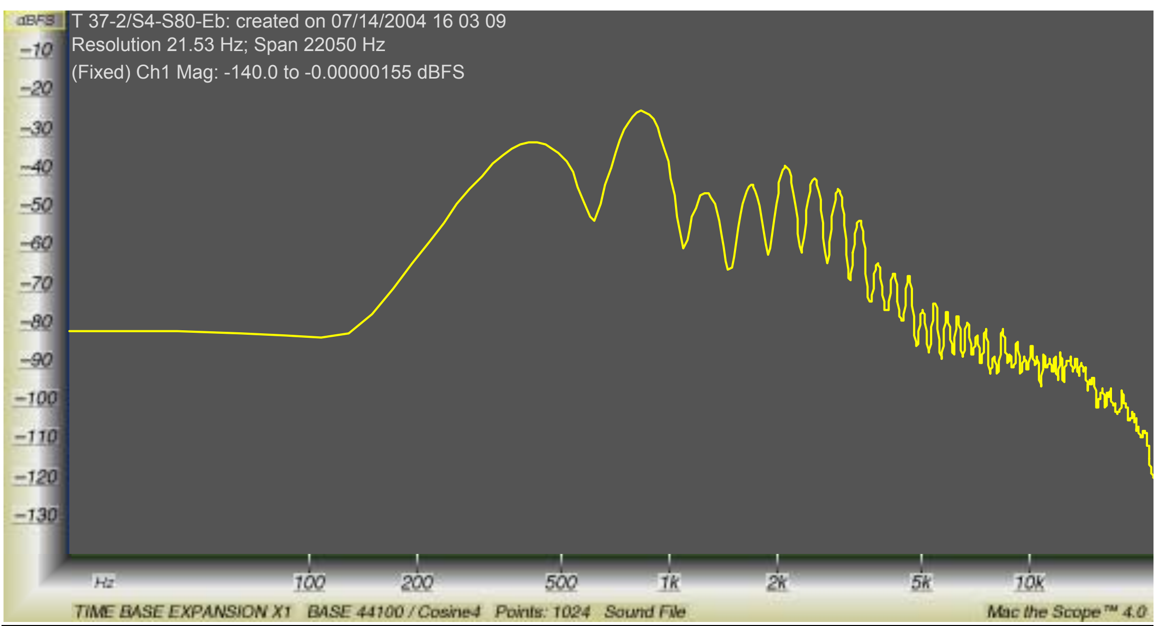
Subject 3, S80-Eb, Take 27B, Blow 1:



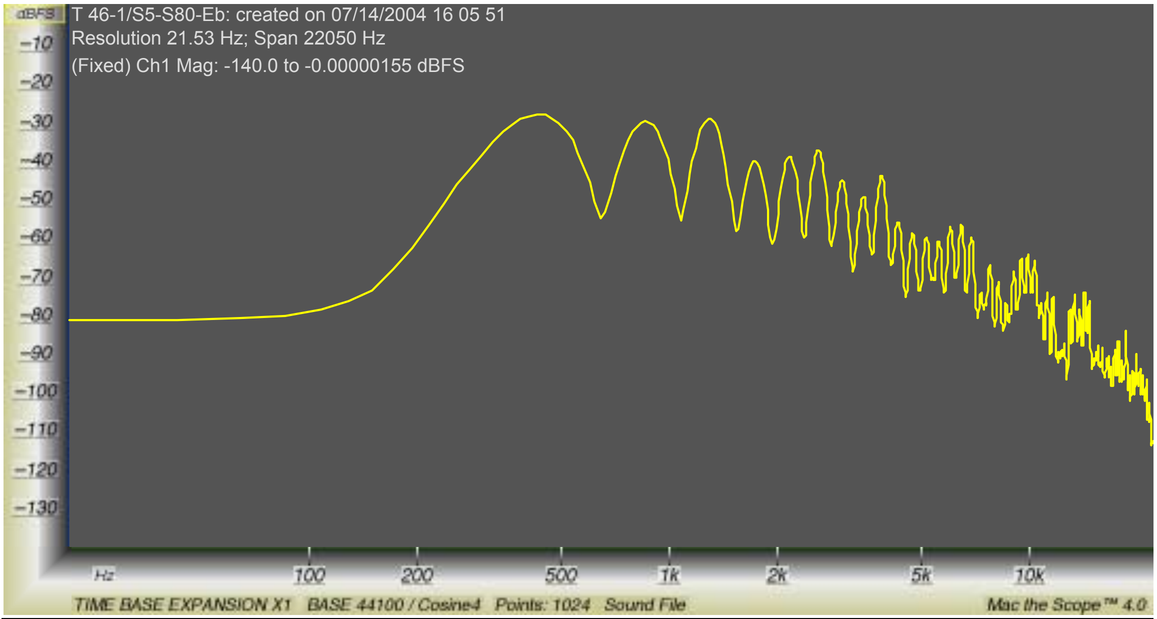
Subject 4, S80-Eb, Take 37, Blow 1:



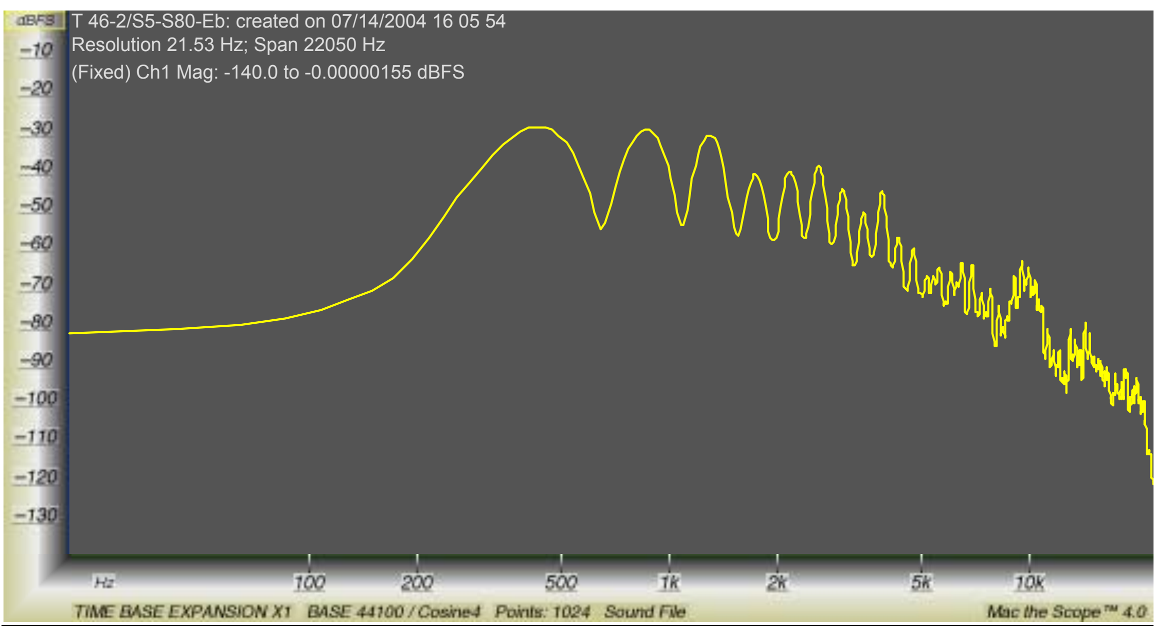
Subject 4, S80-Eb, Take 37, Blow 2:



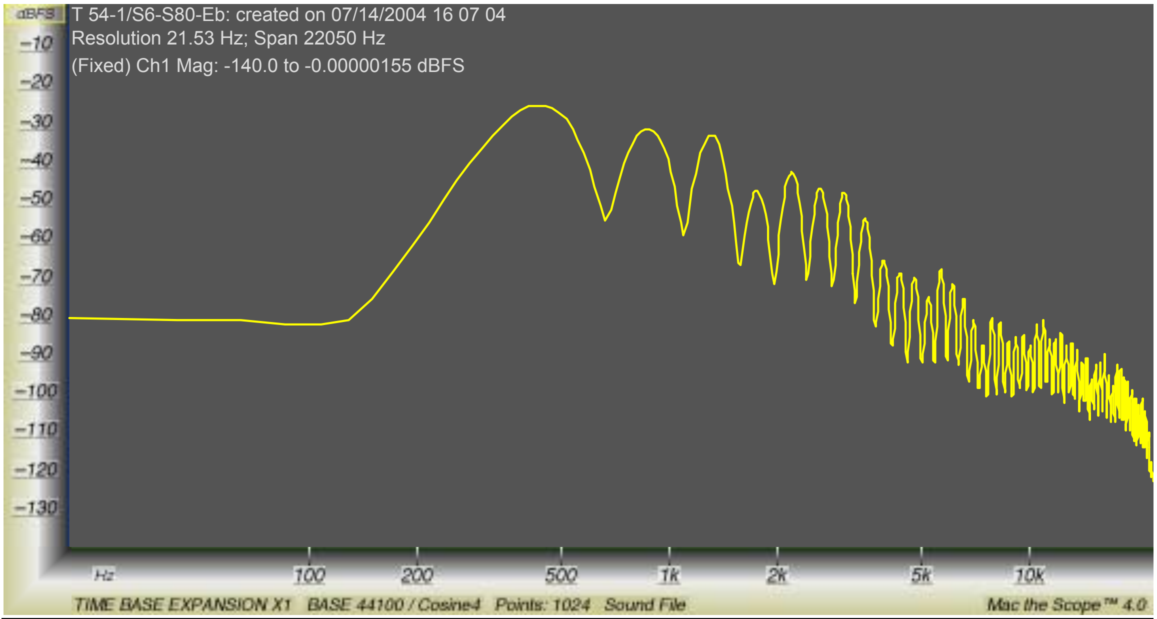
Subject 5, S80-Eb, Take 46, Blow 1:



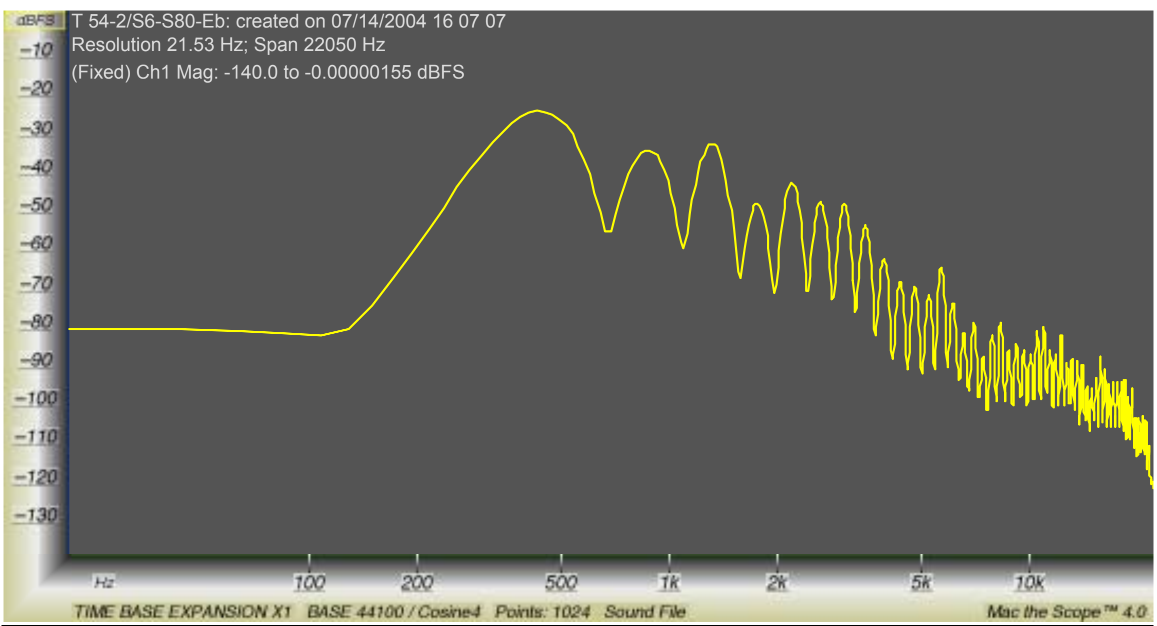
Subject 5, S80-Eb, Take 46, Blow 2:



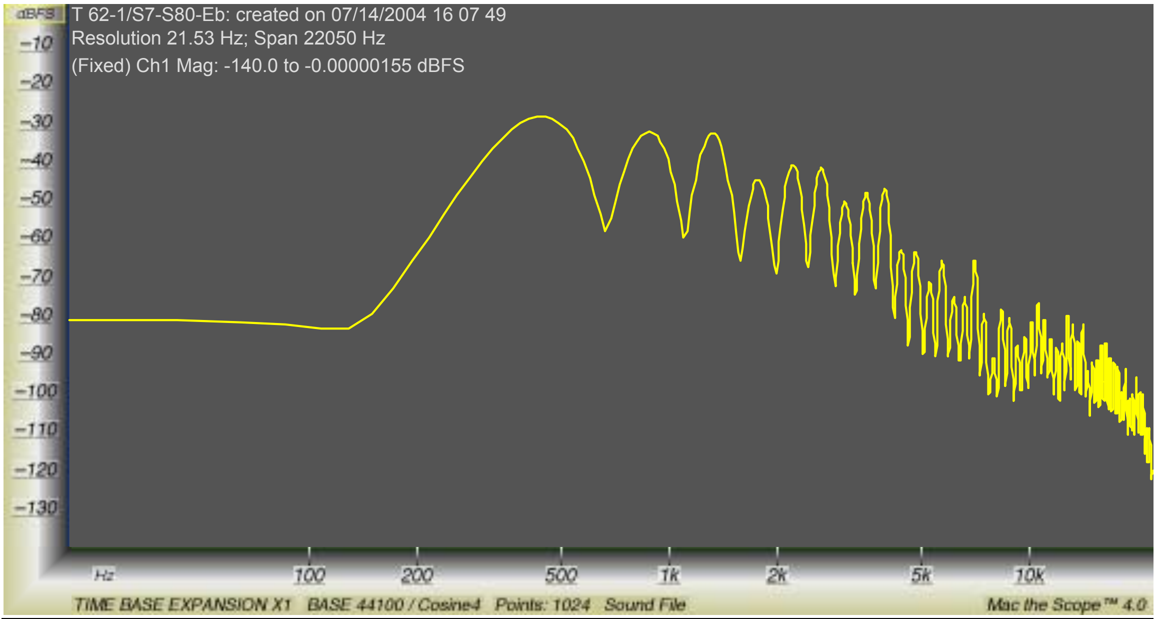
Subject 6, S80-Eb, Take 54, Blow 1:



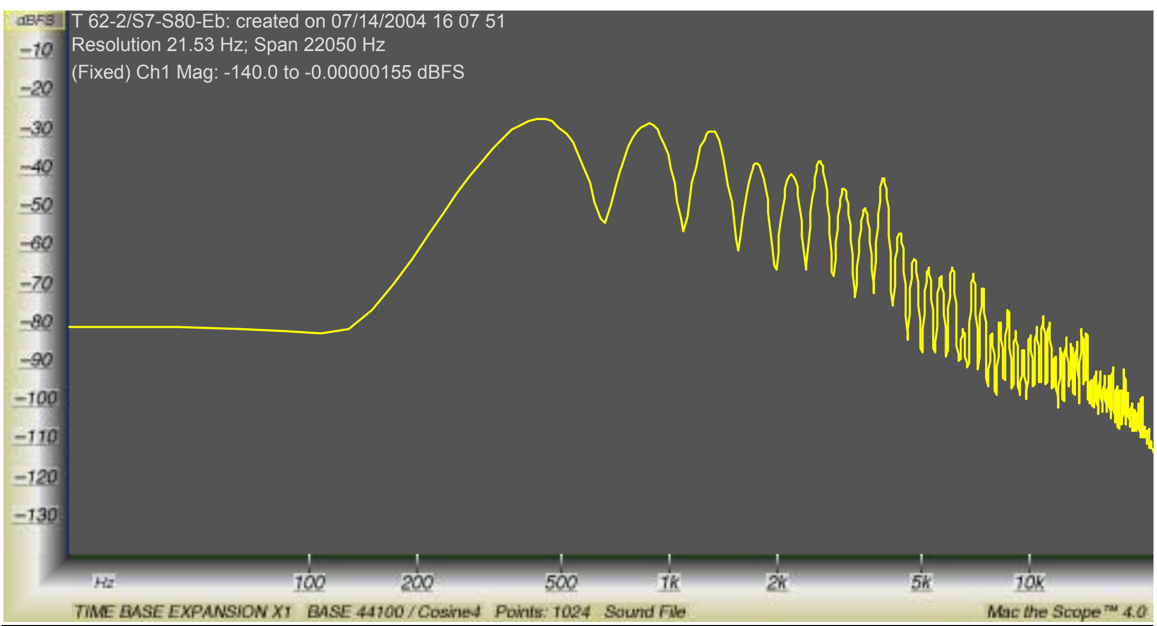
Subject 6, S80-Eb, Take 54, Blow 2:



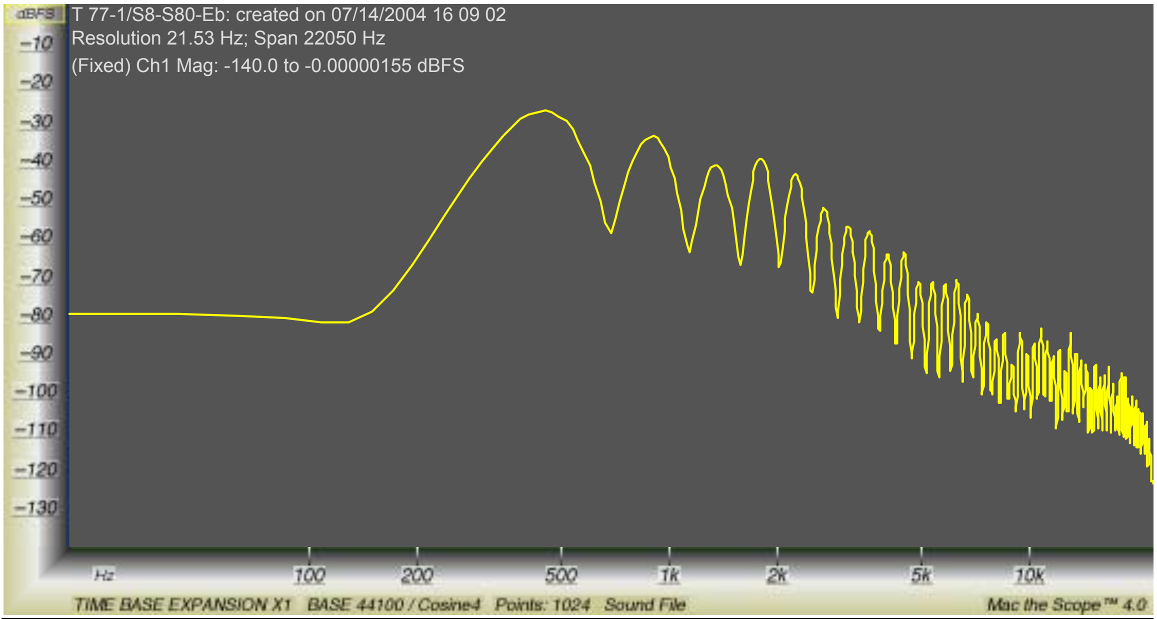
Subject 7, S80-Eb, Take 62, Blow 1:



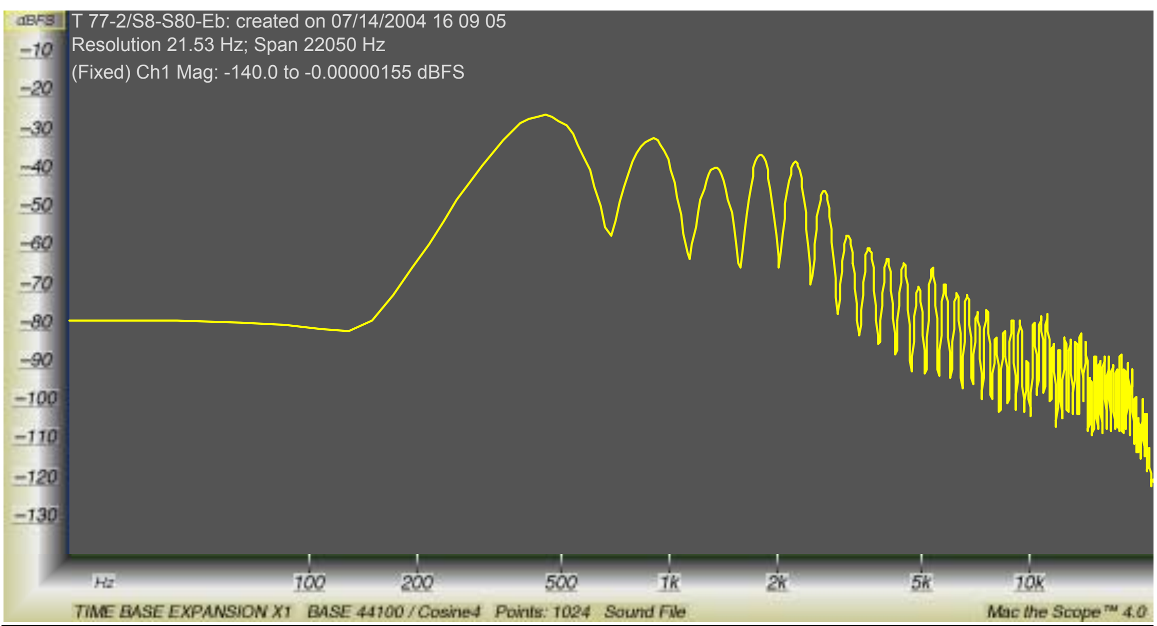
Subject 7, S80-Eb, Take 62, Blow 2:



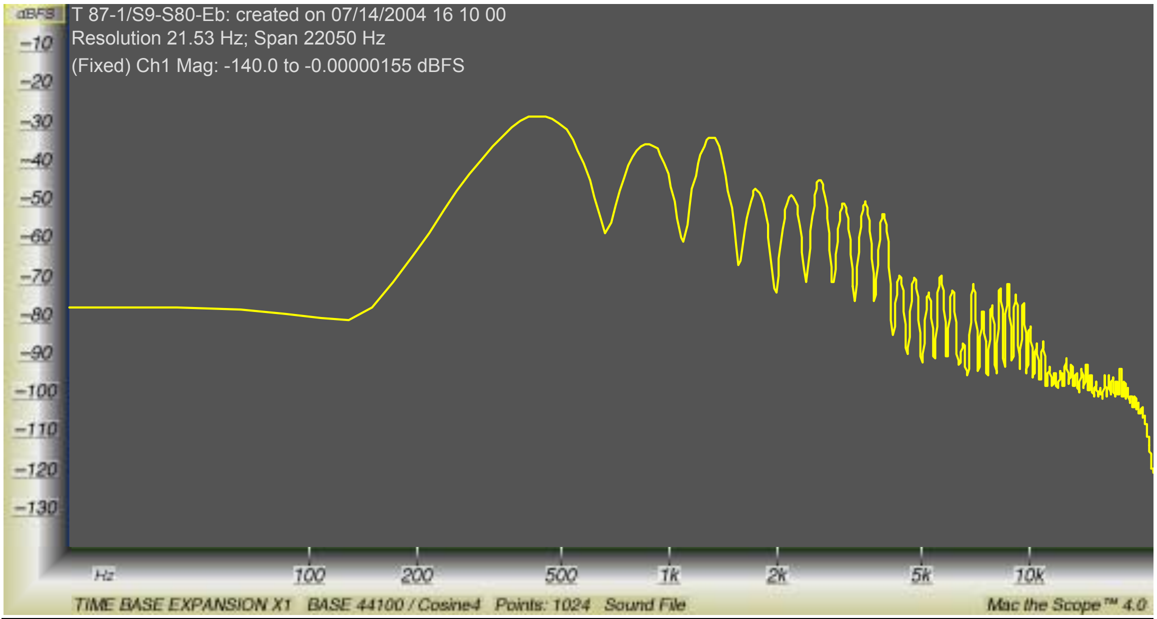
Subject 8, S80-Eb, Take 77, Blow 1:



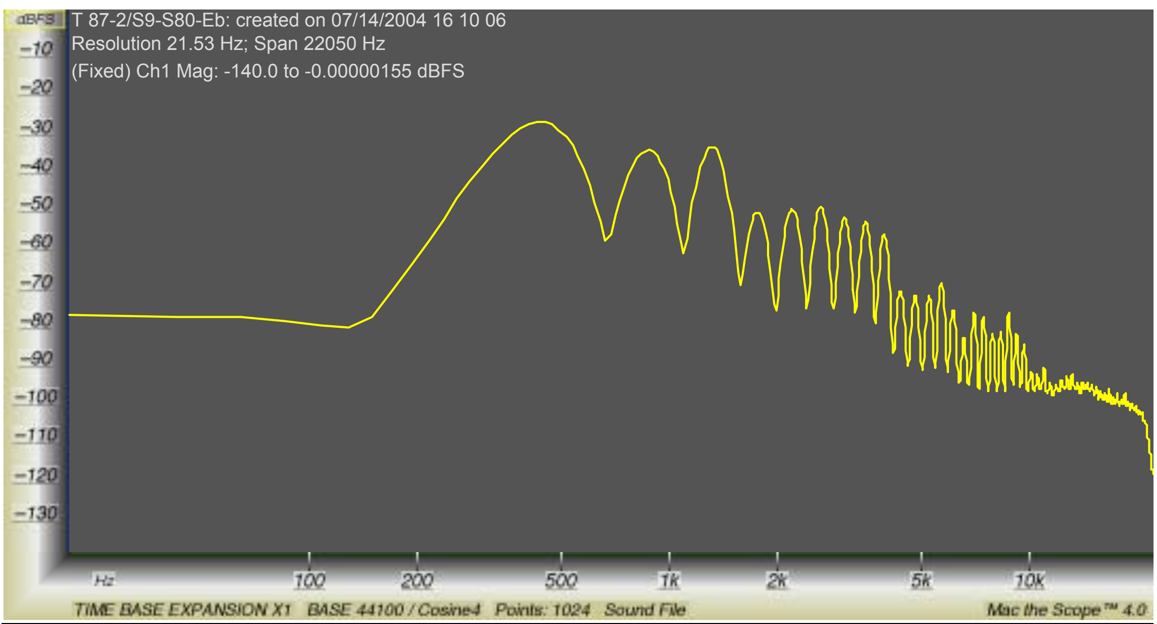
Subject 8, S80-Eb, Take 77, Blow 2:



Subject 9, S80-Eb, Take 87, Blow 1:

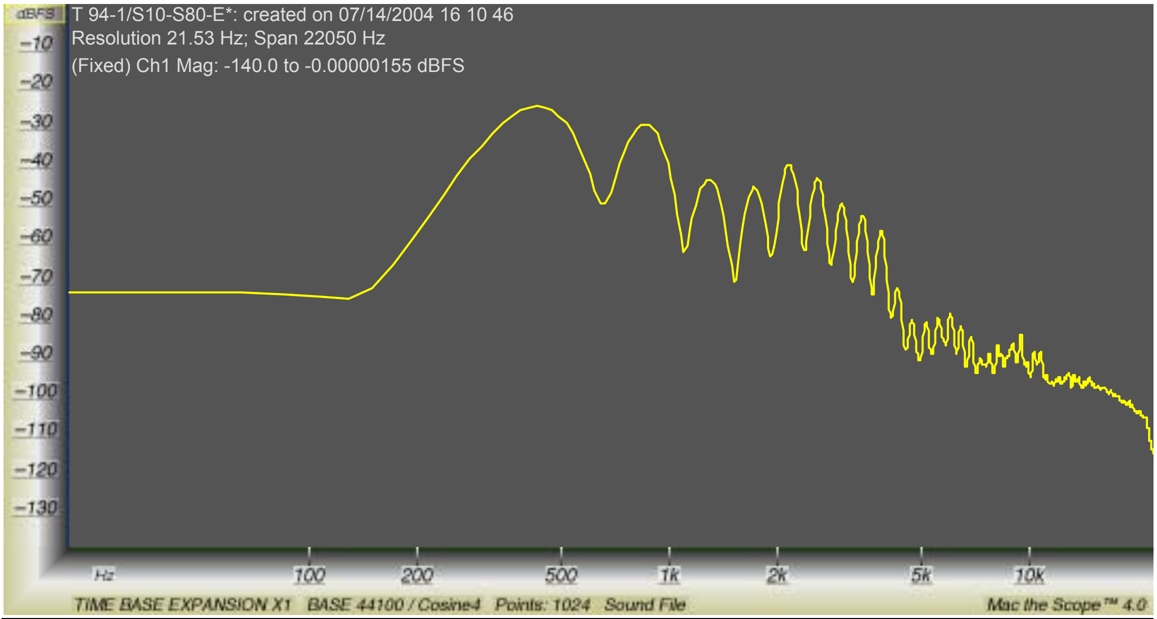


Subject 9, S80-Eb, Take 87, Blow 2:

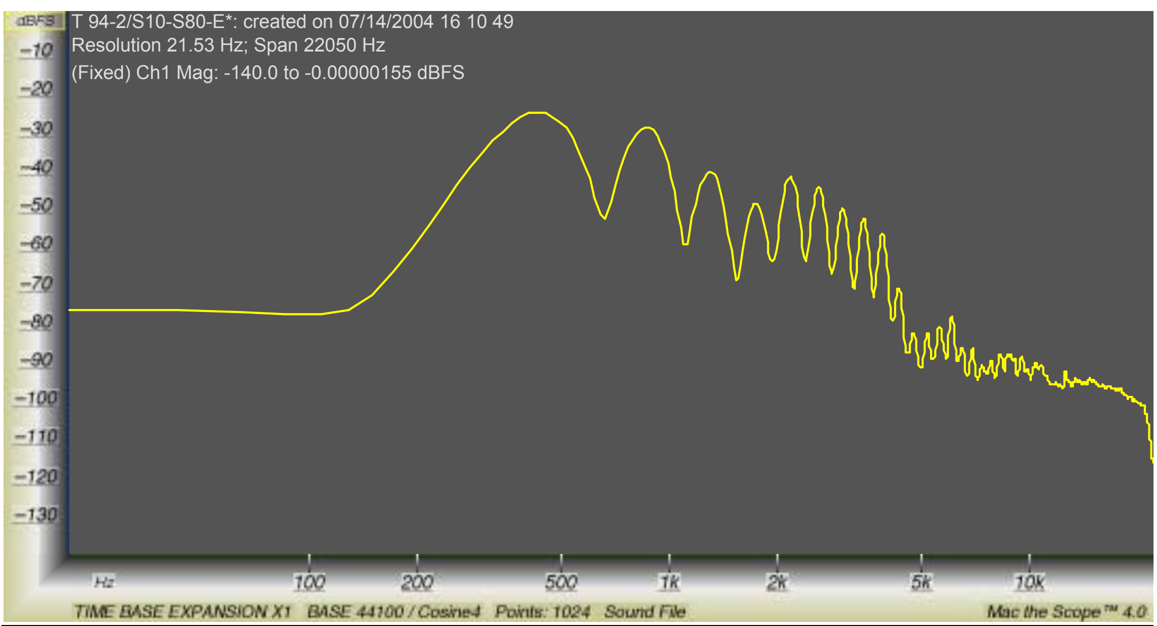


Subject 10 was unable to produce an Eb on the S80 mouthpiece. Therefore, this subject's tones are labeled E*, meaning that the subject was able to reach an E, but barely.

Subject 10, S80-E*, Take 94, Blow 1:

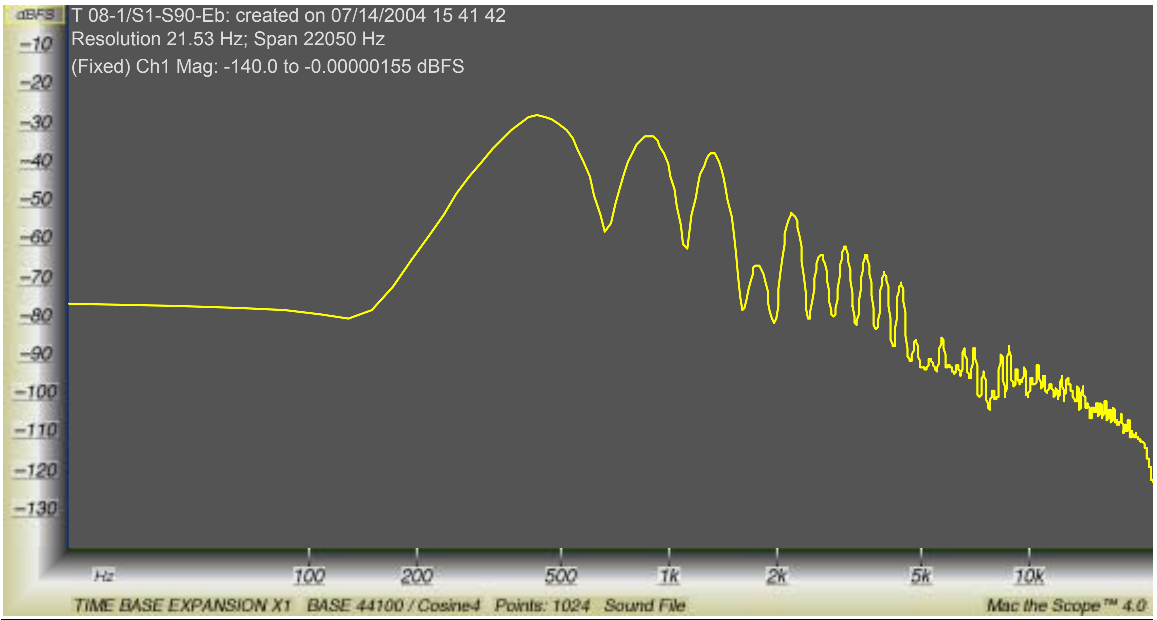


Subject 10, S80-E*, Take 94, Blow 2:

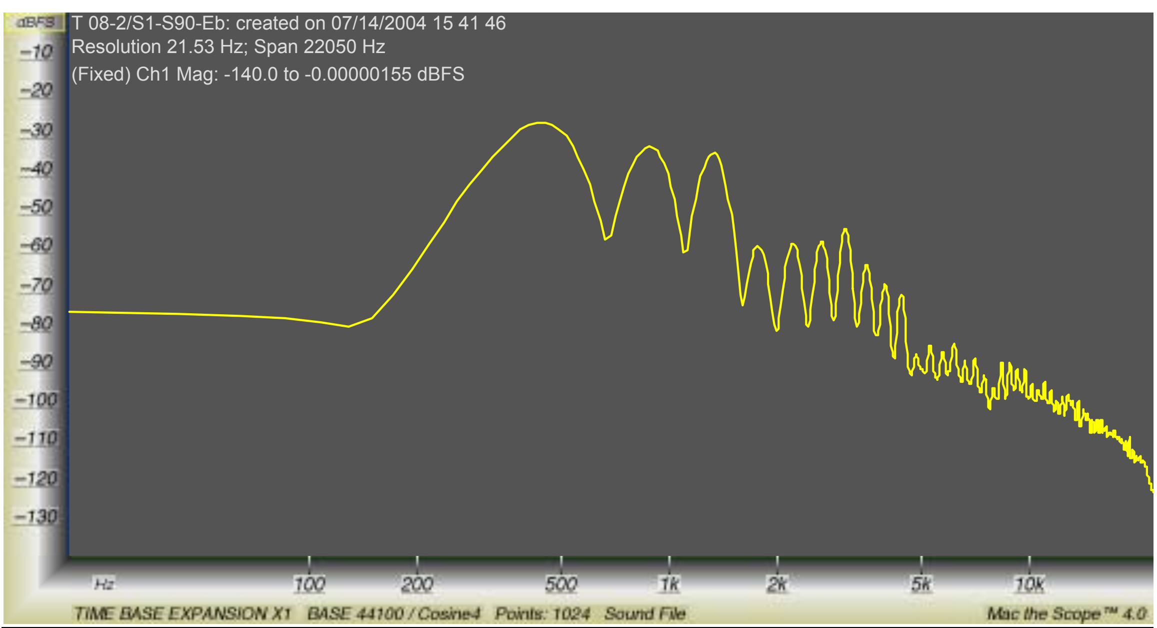


APPENDIX G: SPECTRAL ANALYSIS OF SAXOPHONE TONE QUALITY USING SELMER S90 MOUTHPIECE AT MOUTHPICE PITCH LEVEL OF Eb5

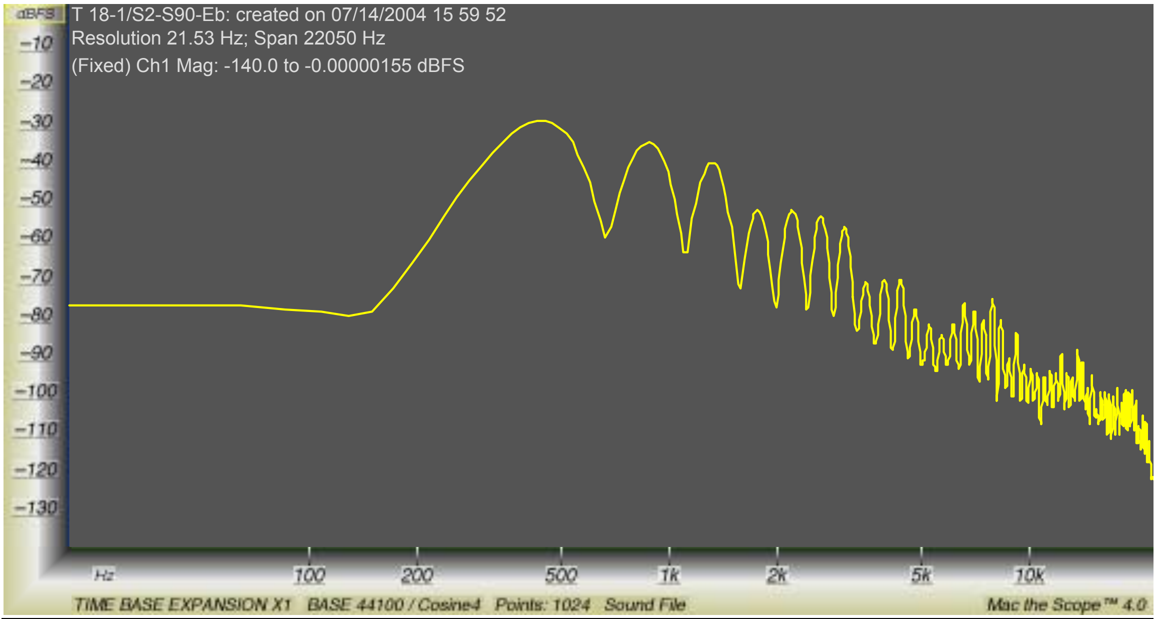
Subject 1, S90-Eb, Take 8, Blow 1:



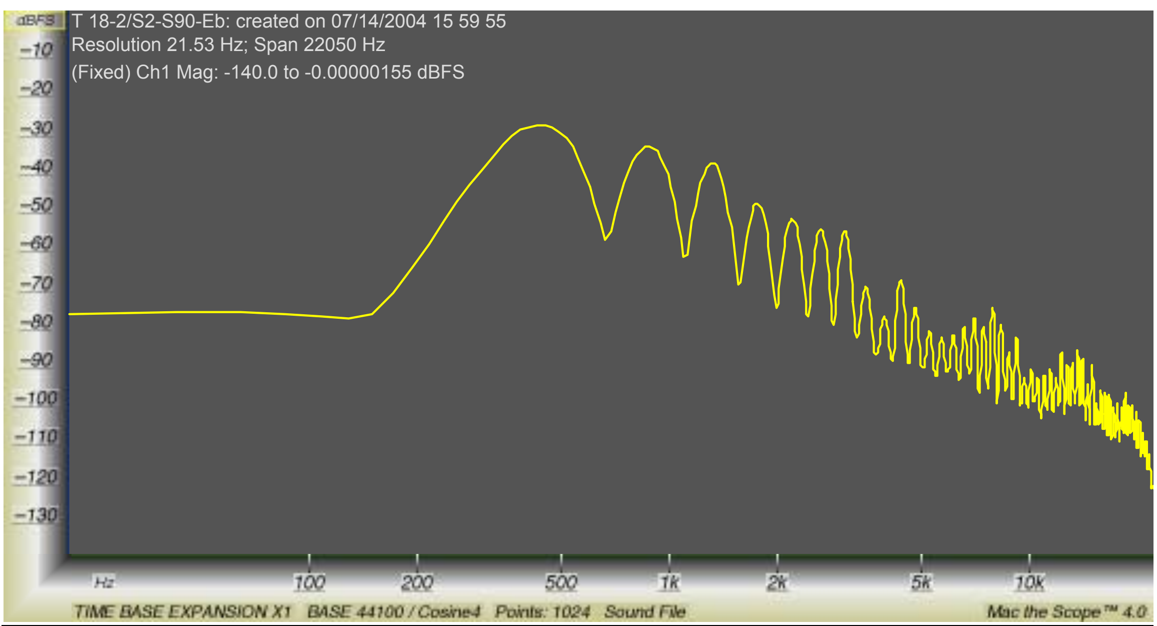
Subject 1, S90-Eb, Take 8, Blow 2:



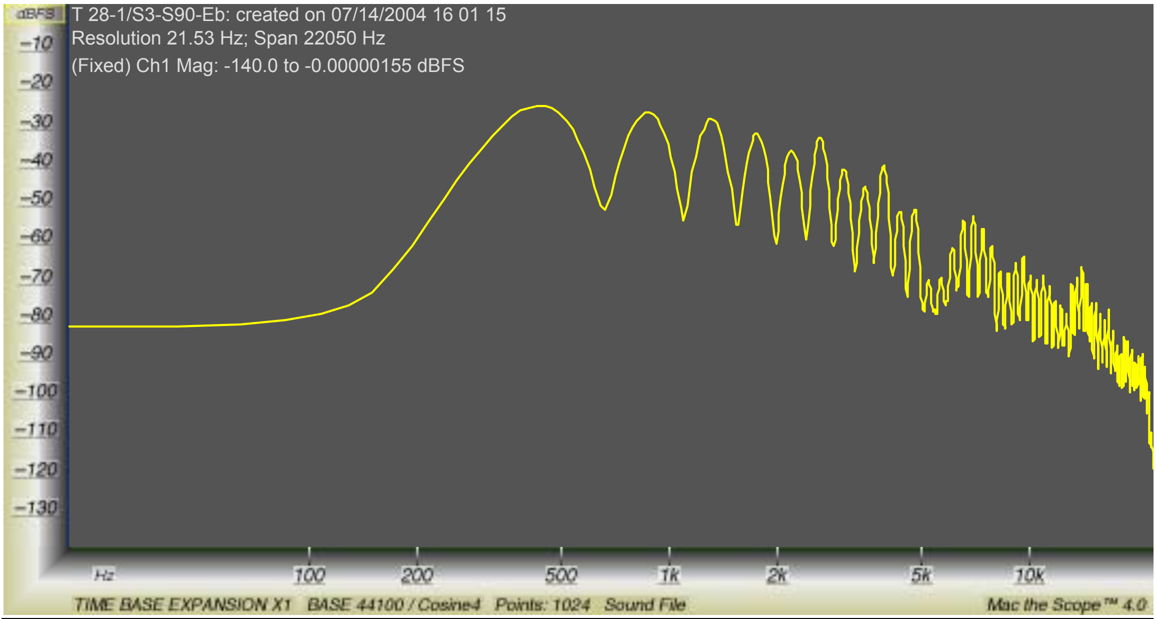
Subject 2, S90-Eb, Take 18, Blow 1:



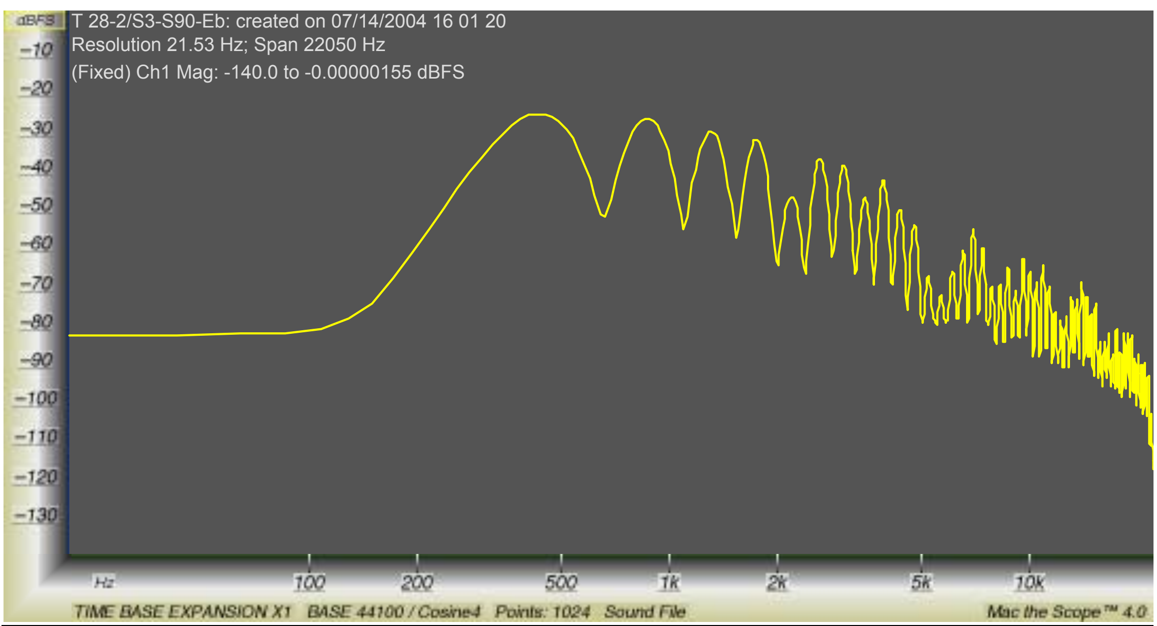
Subject 2, S90-Eb, Take 18, Blow 2:



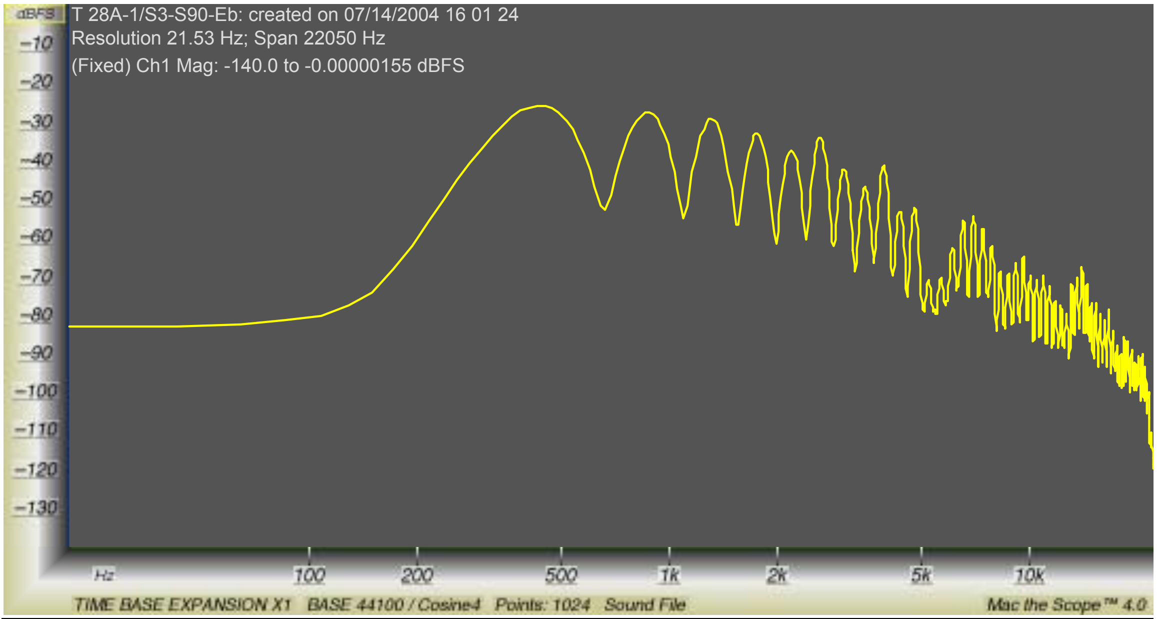
Subject 3, S90-Eb, Take 28, Blow 1:



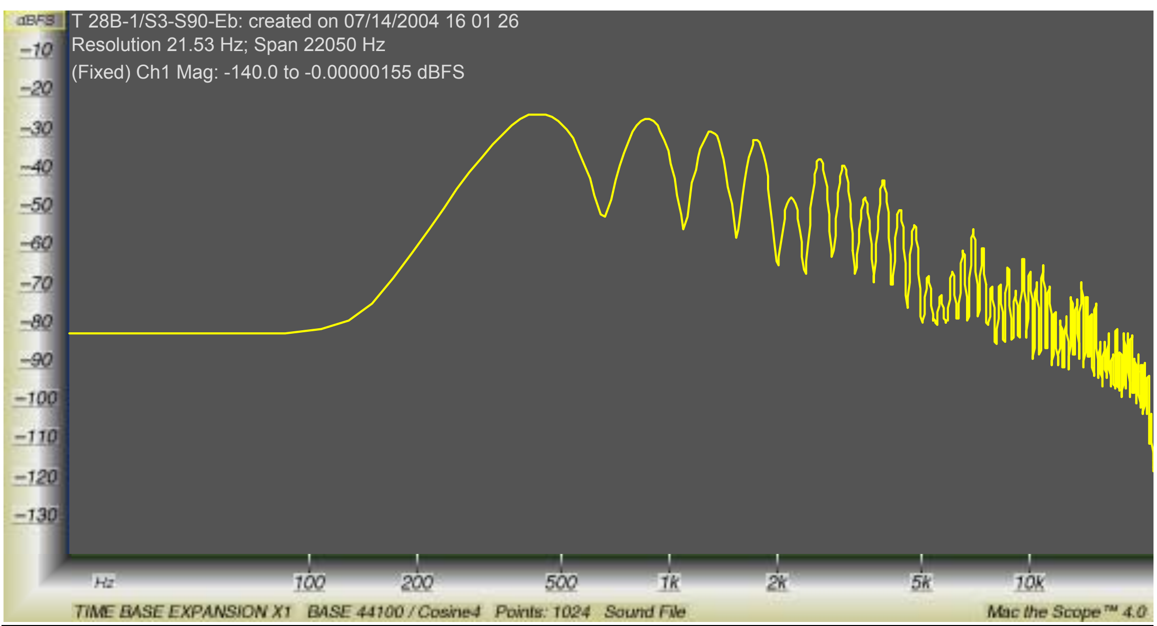
Subject 3, S90-Eb, Take 28, Blow 2:



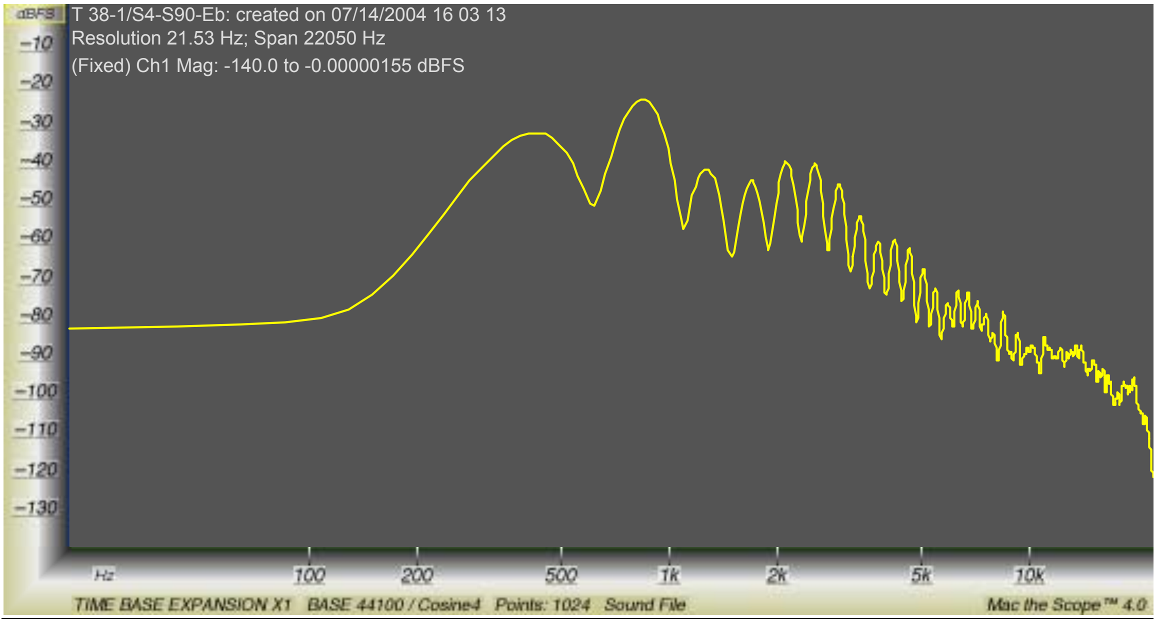
Subject 3, S90-Eb, Take 28A, Blow 1:



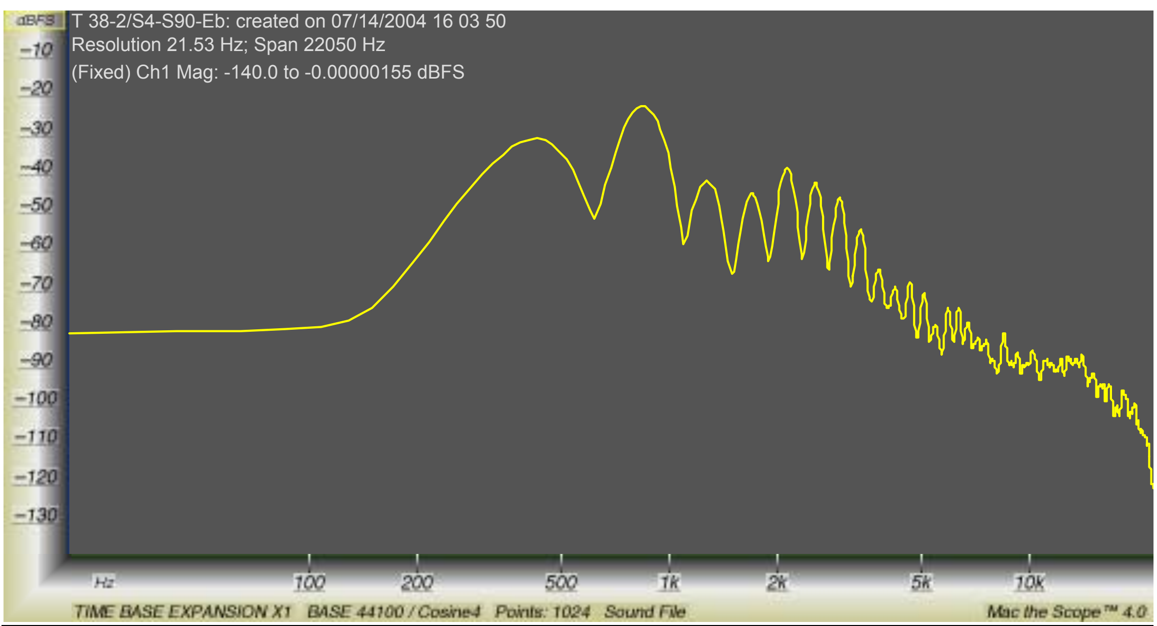
Subject 3, S90-Eb, Take 28B, Blow 1:



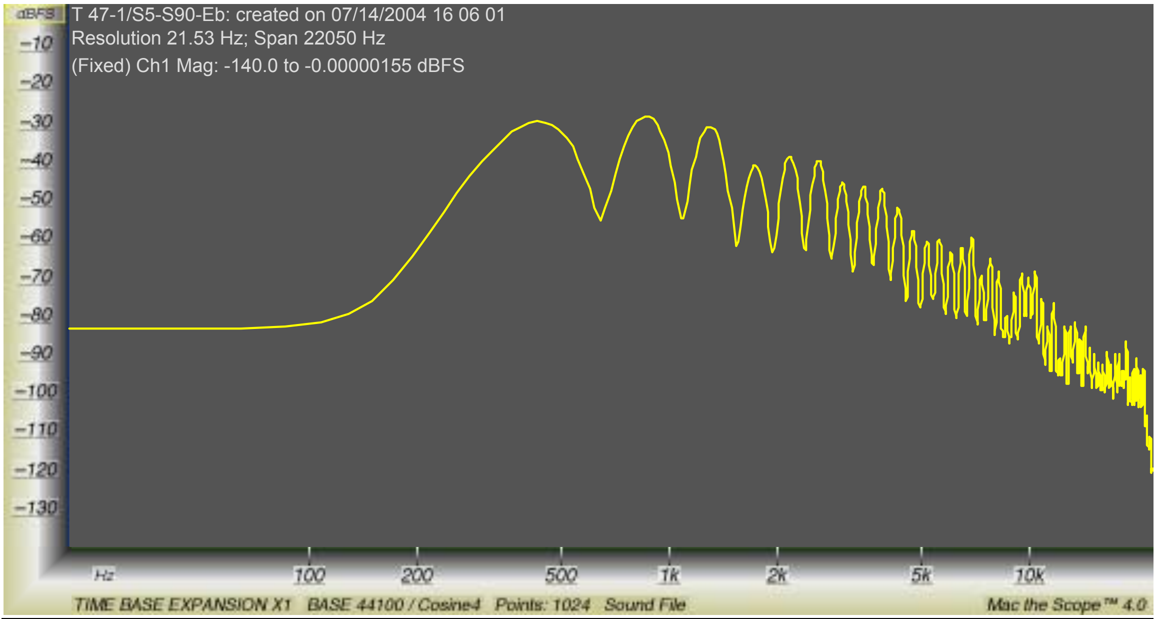
Subject 4, S90-Eb, Take 38, Blow 1:



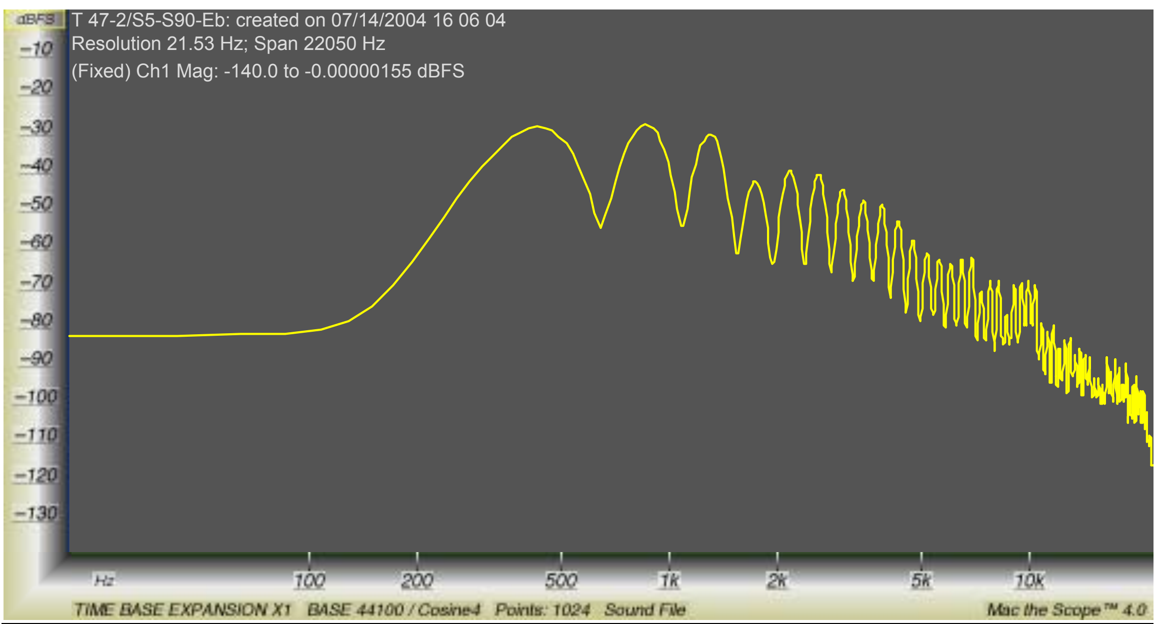
Subject 4, S90-Eb, Take 38, Blow 2:



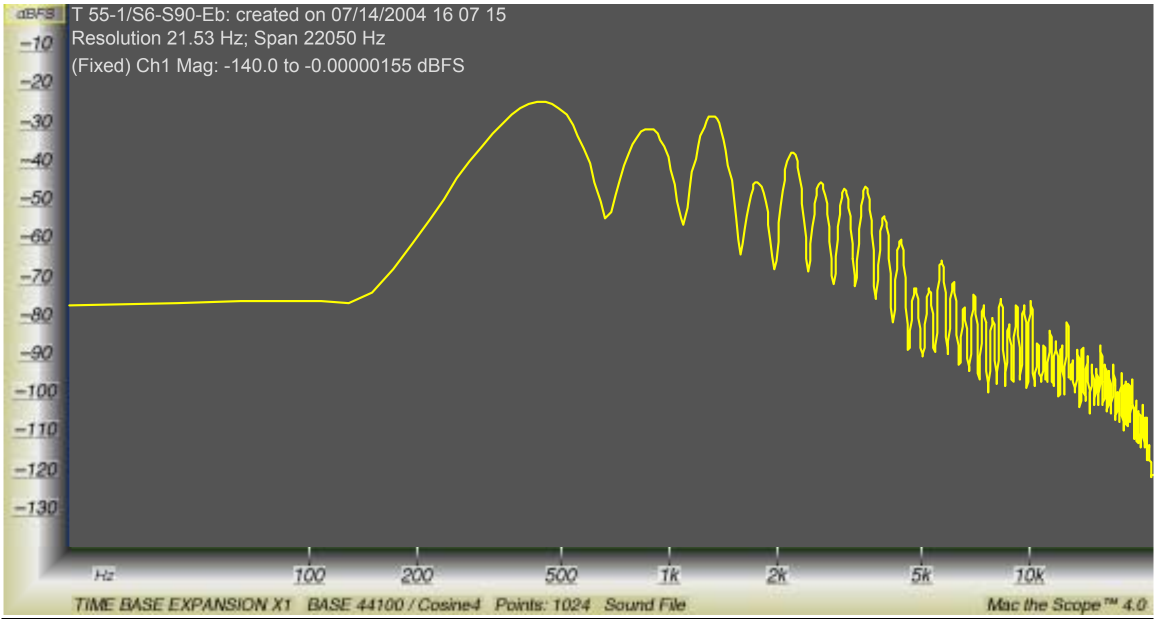
Subject 5, S90-Eb, Take 47, Blow 1:



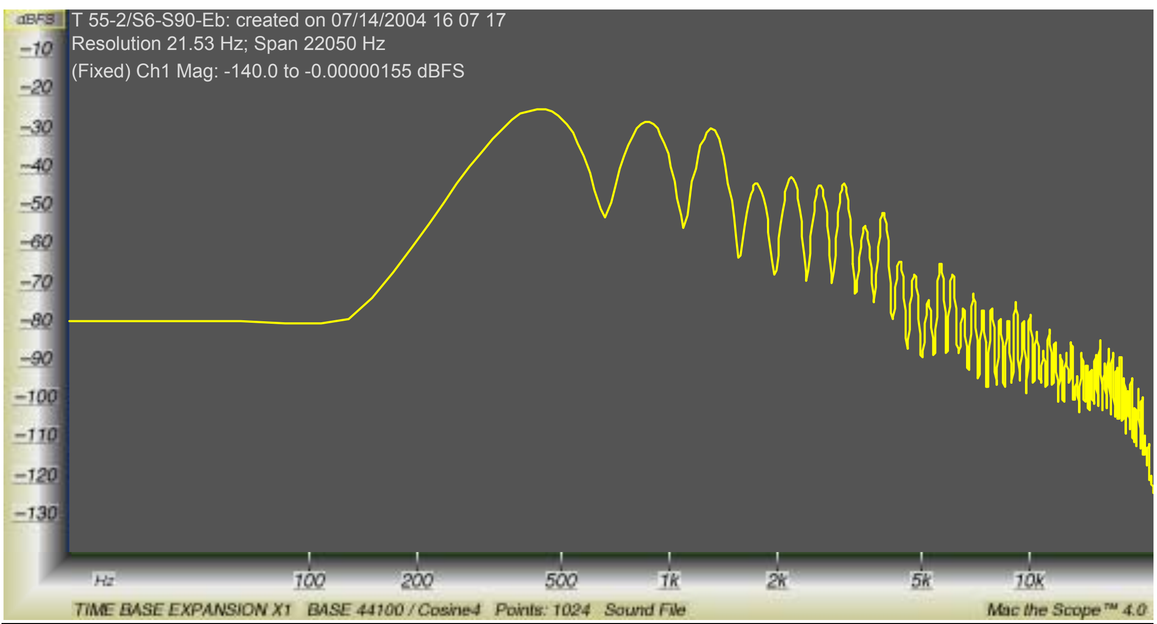
Subject 5, S90-Eb, Take 47, Blow 2:



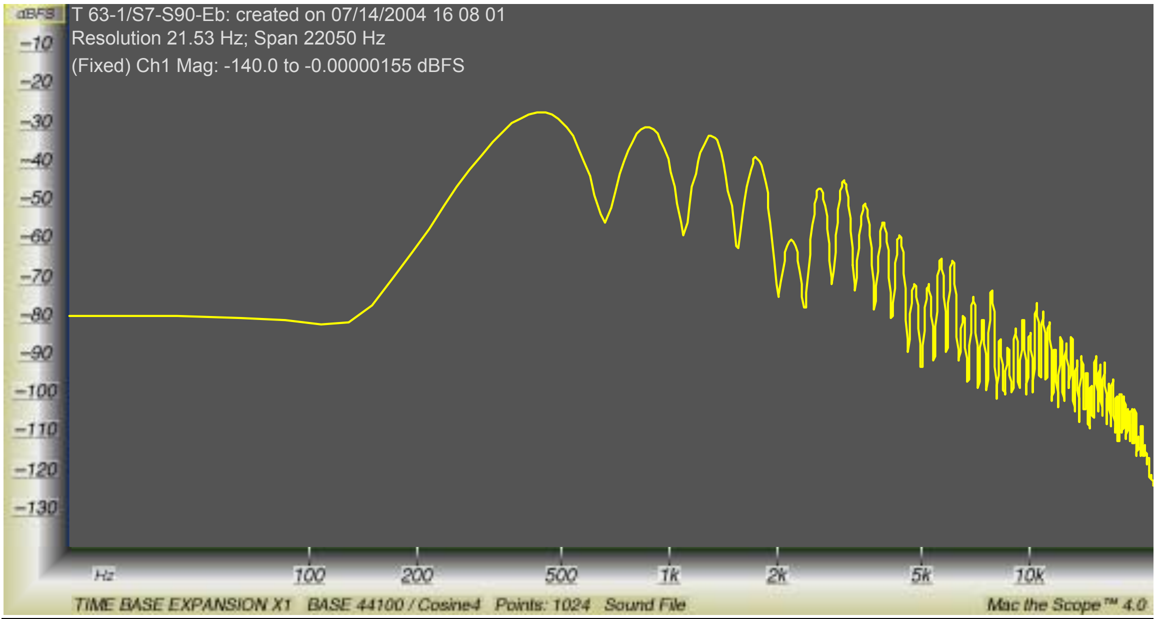
Subject 6, S90-Eb, Take 55, Blow 1:



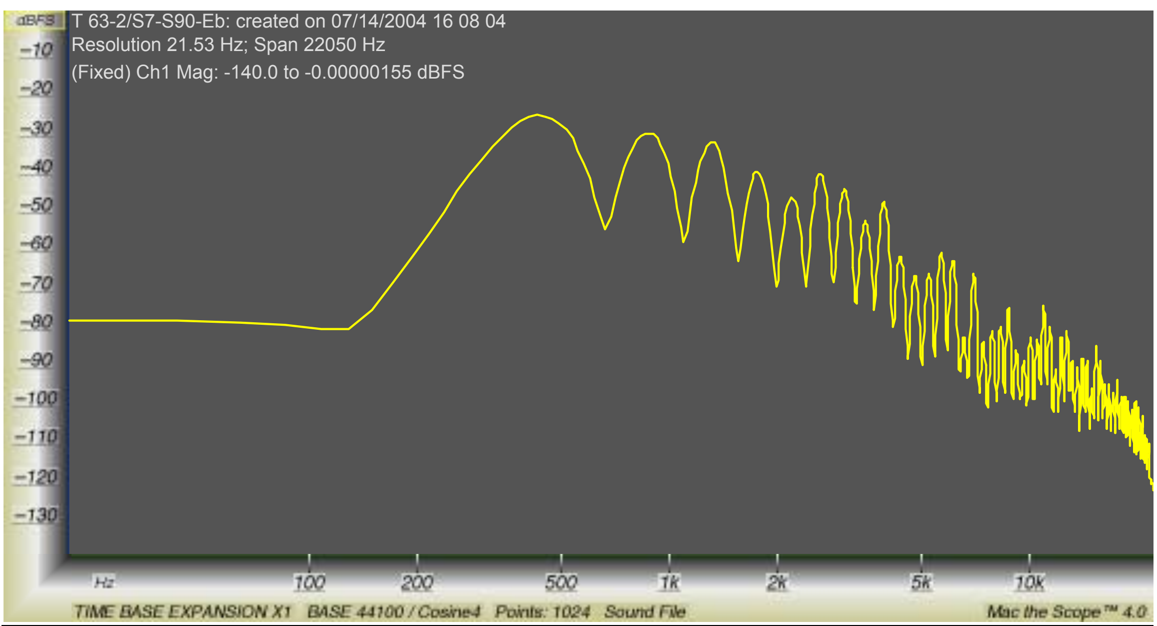
Subject 6, S90-Eb, Take 55, Blow 2:



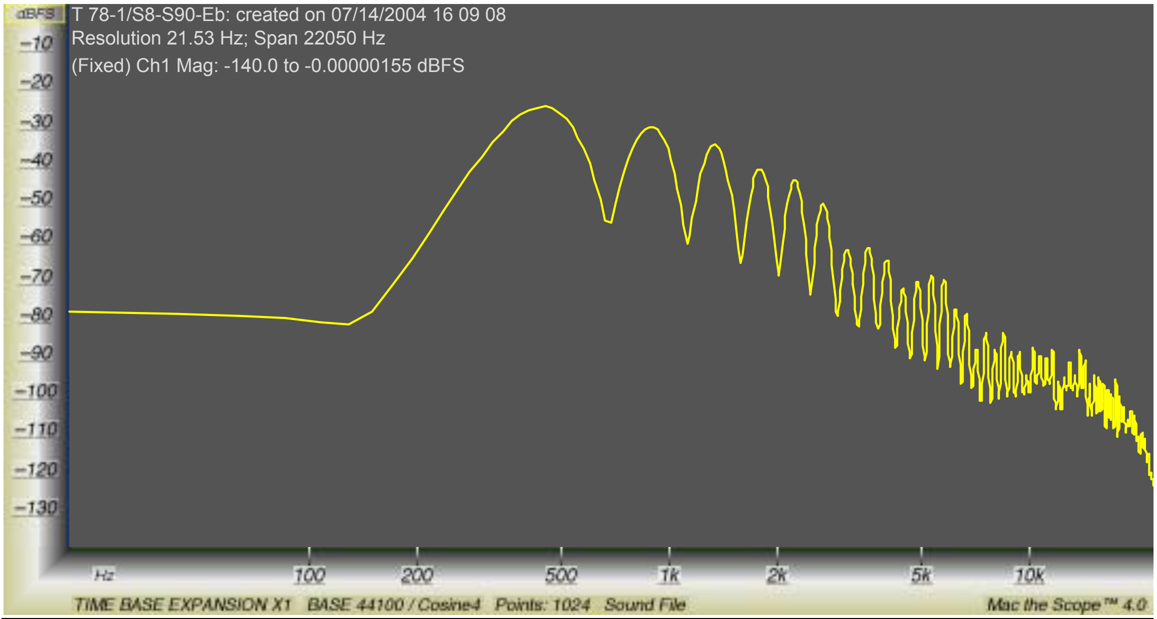
Subject 7, S90-Eb, Take 63, Blow 1:



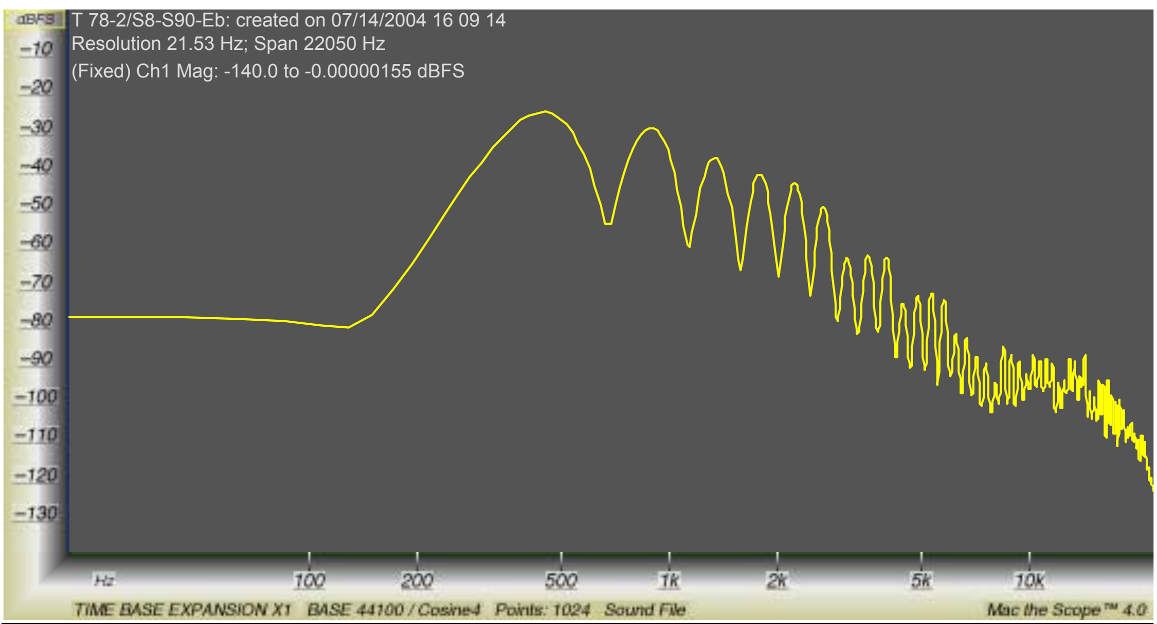
Subject 7, S90-Eb, Take 63, Blow 2:



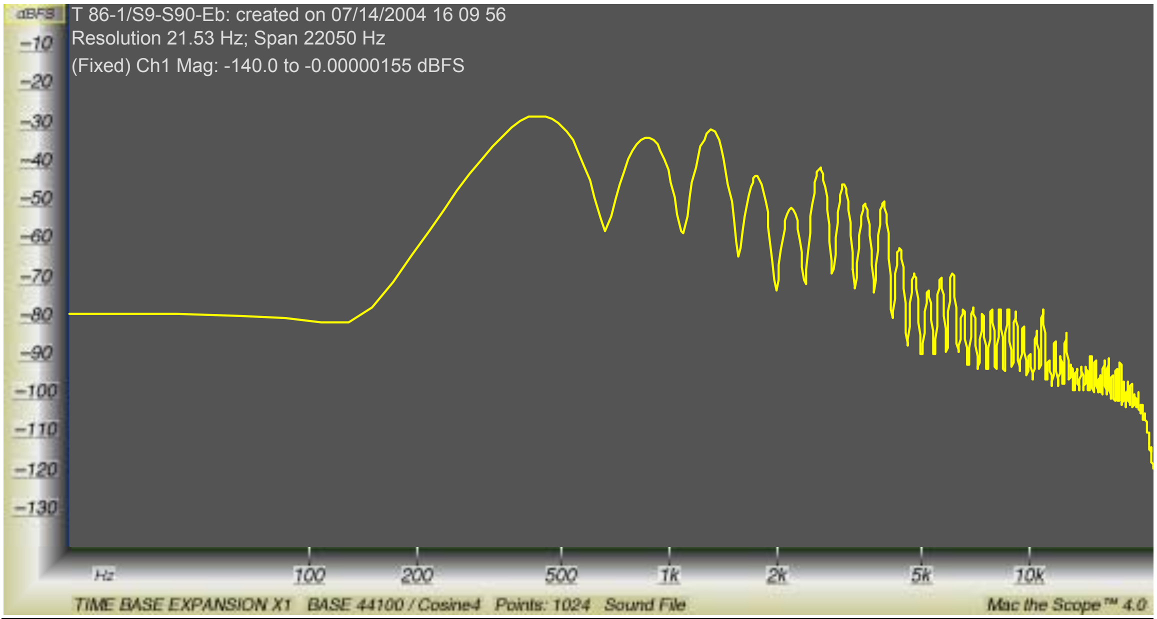
Subject 8, S90-Eb, Take 78, Blow 1:



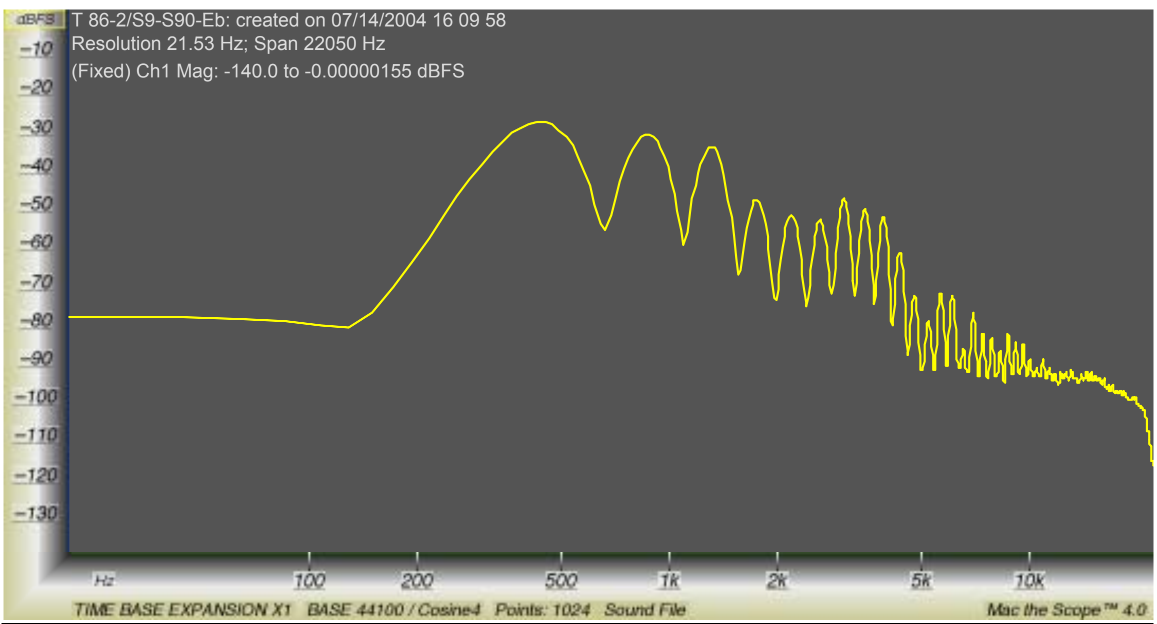
Subject 8, S90-Eb, Take 78, Blow 2:



Subject 9, S90-Eb, Take 86, Blow 1:

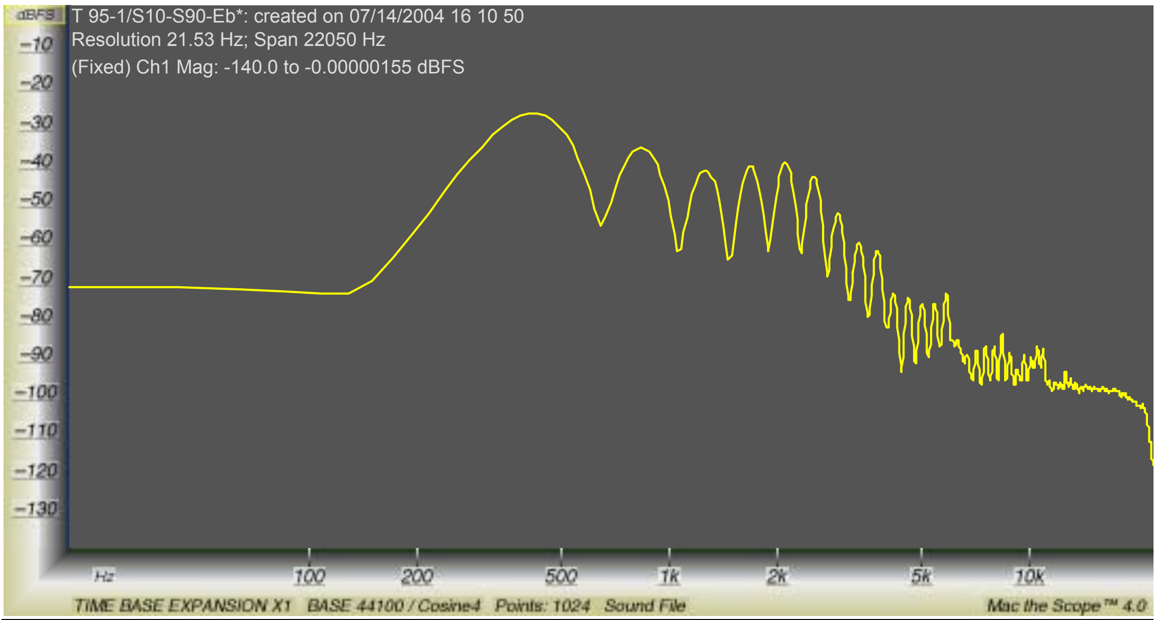


Subject 9, S90-Eb, Take 86, Blow 2:

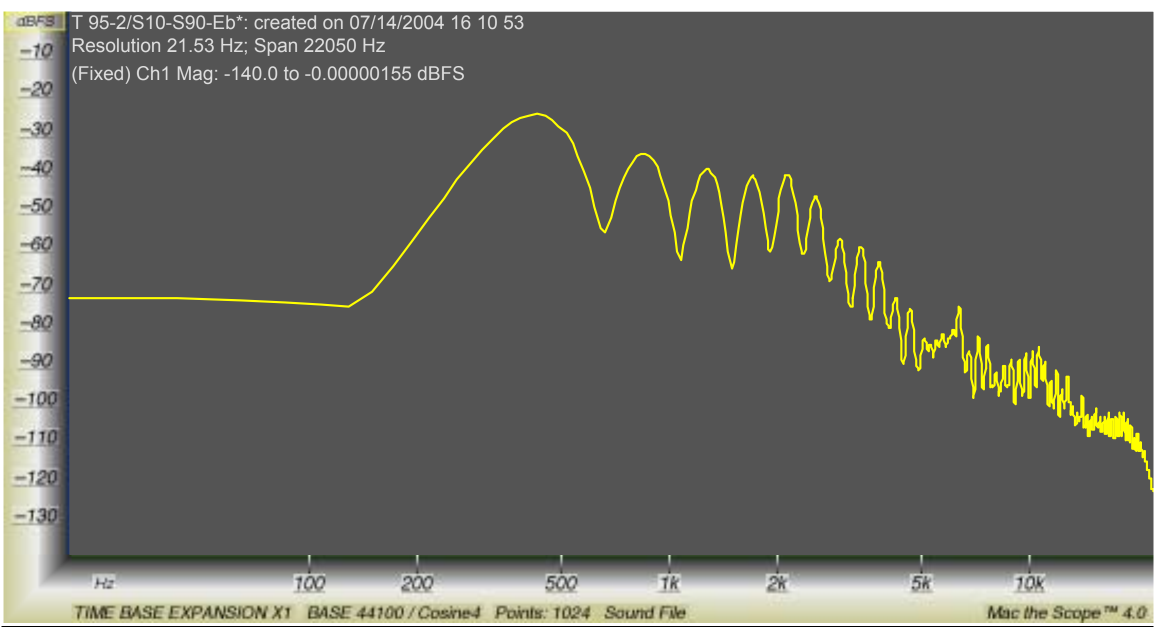


Subject 10 was not able to produce any pitches below an Eb on the mouthpiece. The '*' denotes that the Eb was a stretch.

Subject 10, S90-Eb*, Take 95, Blow 1:

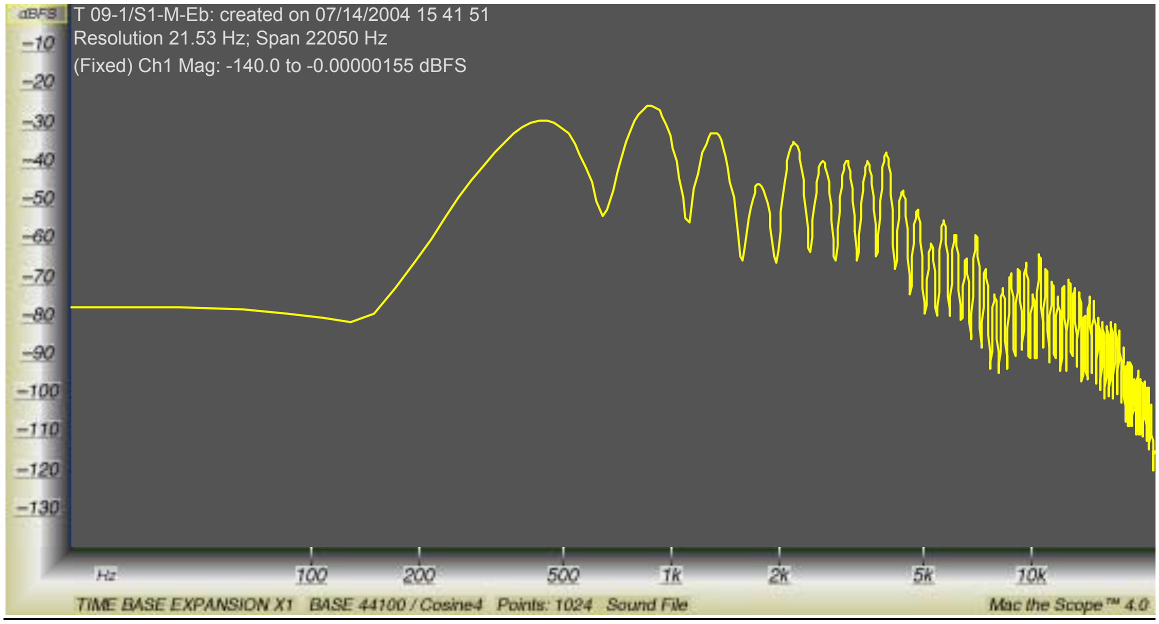


Subject 10, S90-Eb*, Take 95, Blow 2:

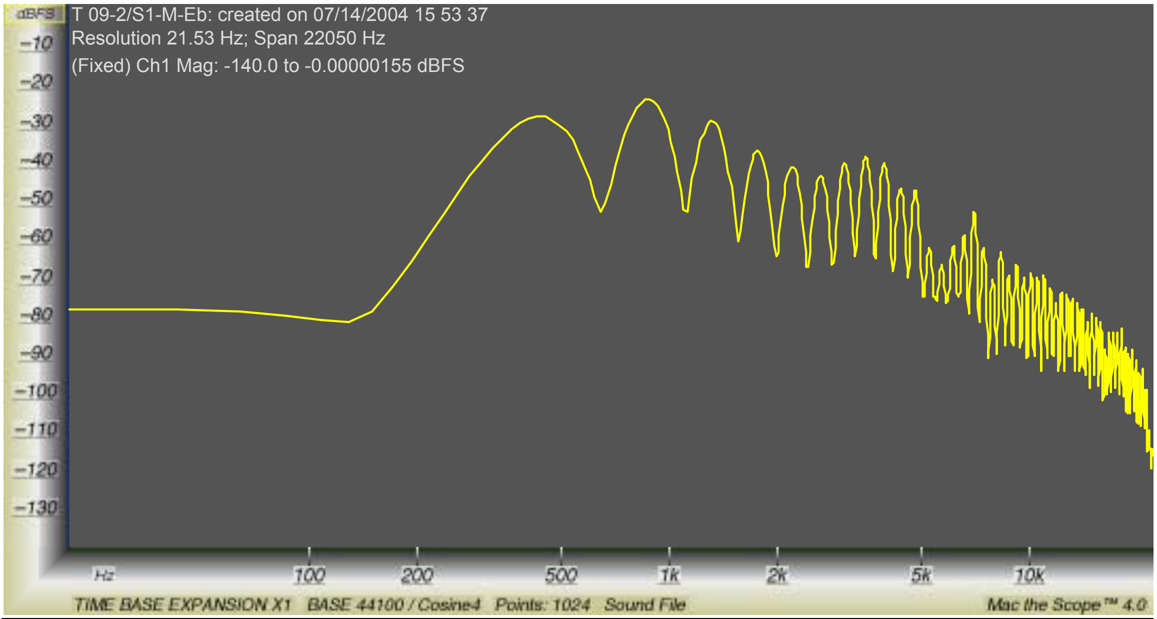


APPENDIX H: SPECTRAL ANALYSIS OF SAXOPHONE TONE QUALITY USING MEYER 6M MOUTHPIECE AT MOUTHPIECE PITCH LEVEL OF Eb5

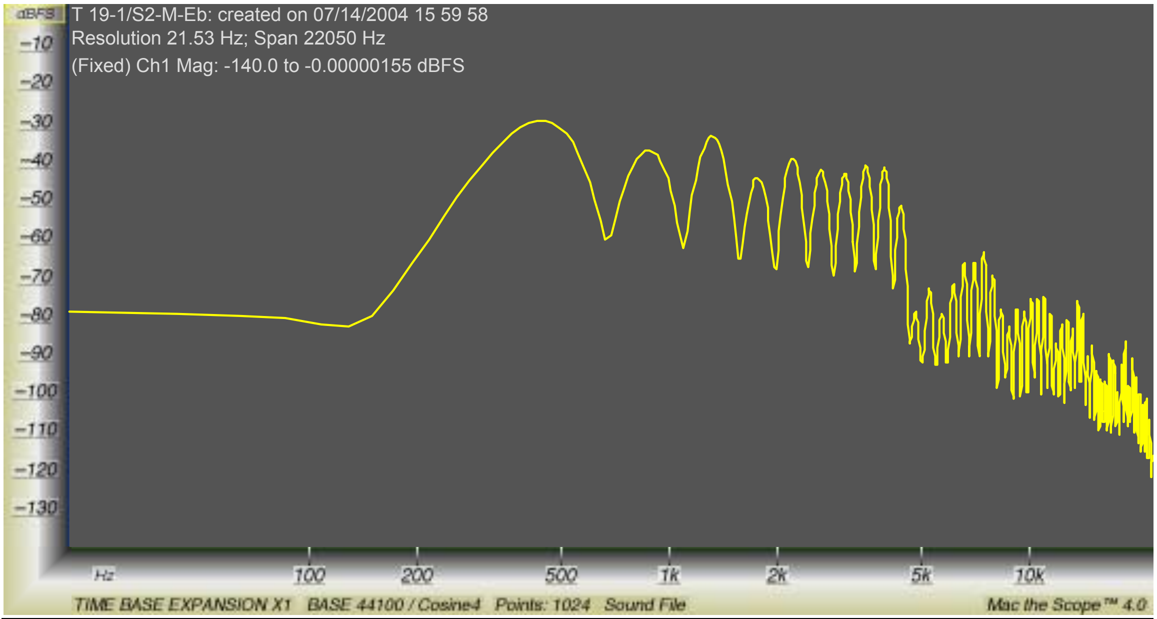
Subject 1, Meyer-Eb, Take 9, Blow 1:



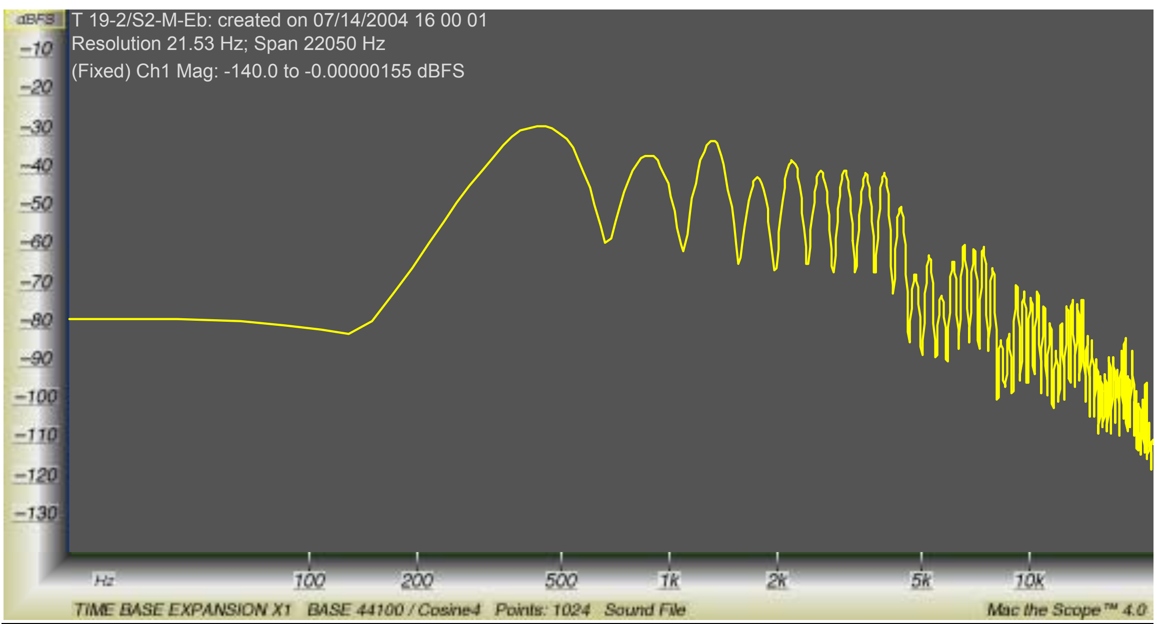
Subject 1, Meyer-Eb, Take 9, Blow 2:



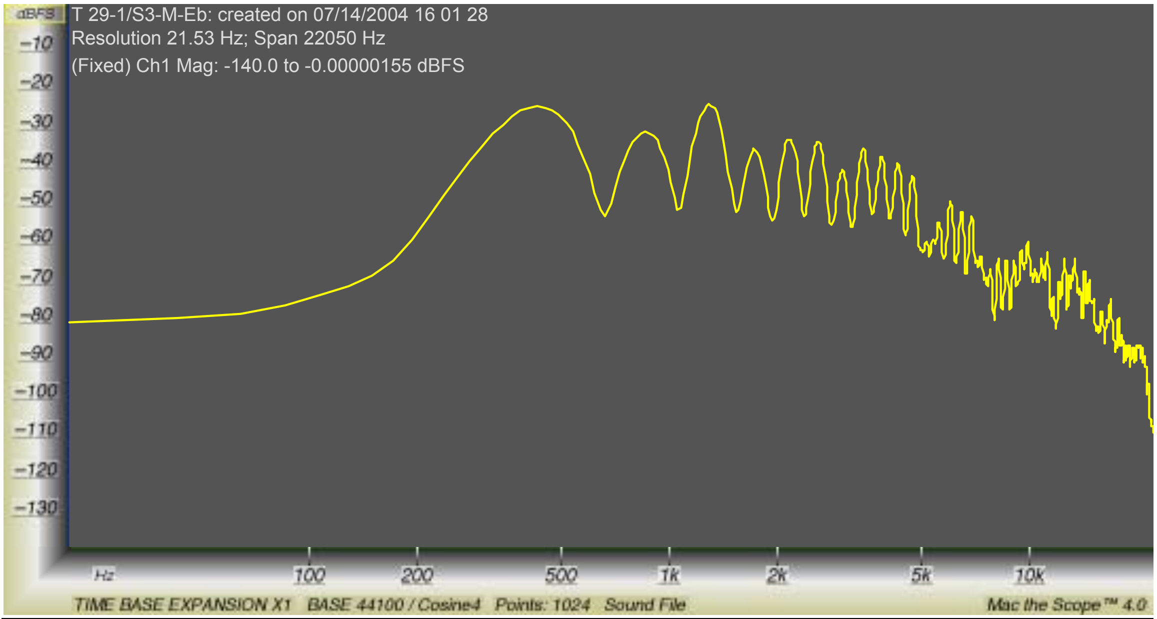
Subject 2, Meyer-Eb, Take 19, Blow 1;



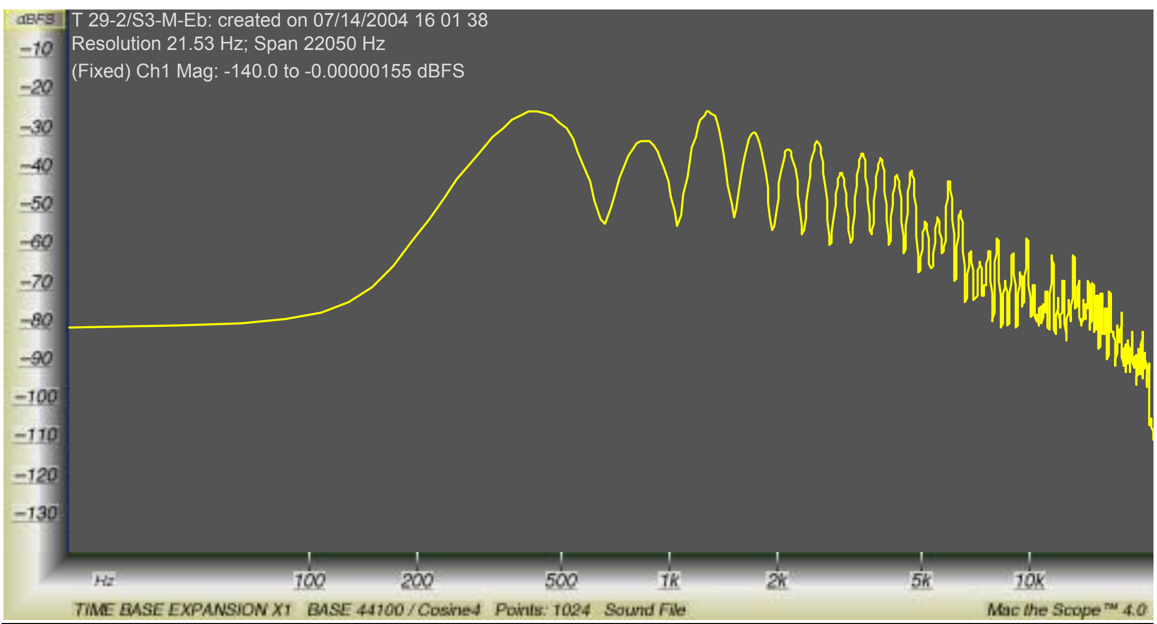
Subject 2, Meyer Eb, Take 19, Blow 2:



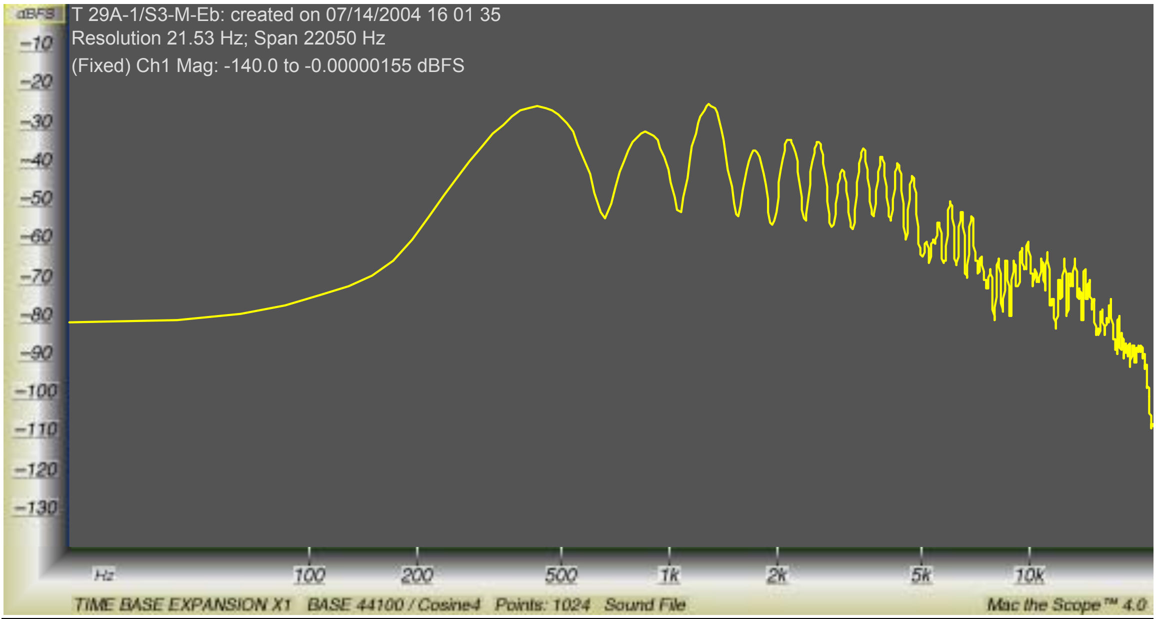
Subject 3, Meyer-Eb, Take 29, Blow 1;



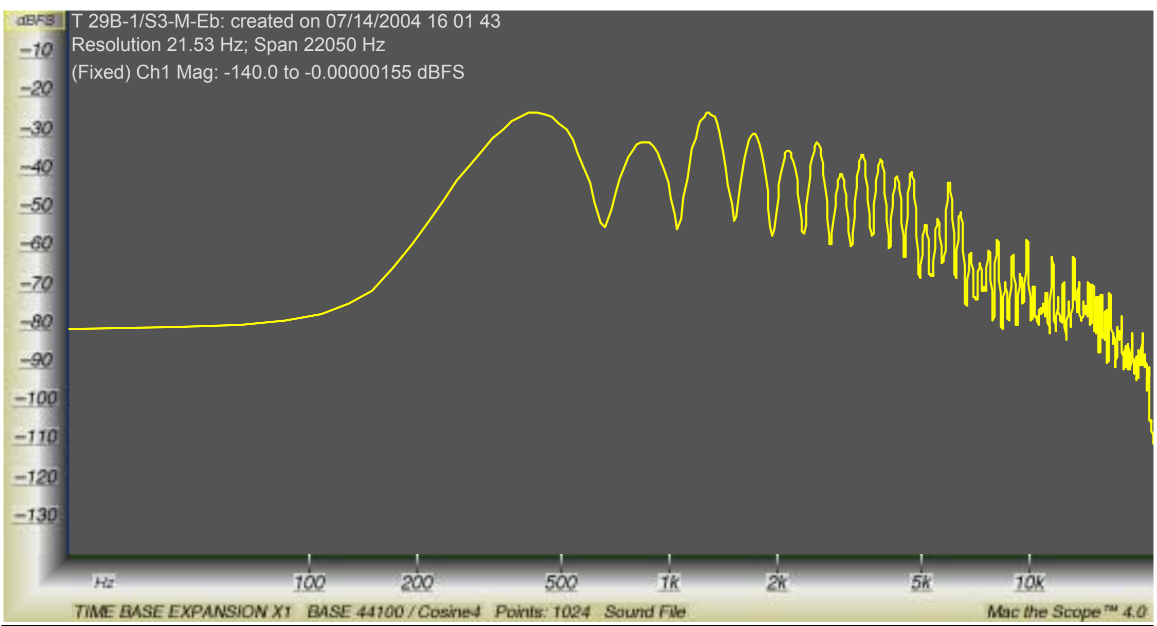
Subject 3, Meyer-Eb, Take 29, Blow 2:



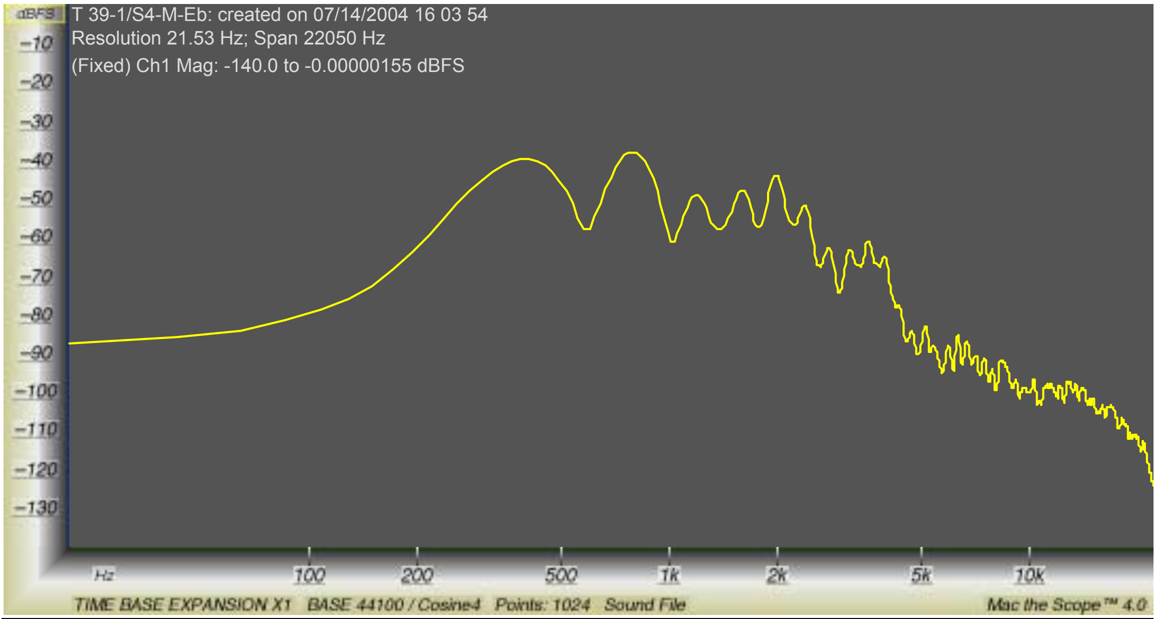
Subject 3, Meyer-Eb, Take 29A, Blow 1:



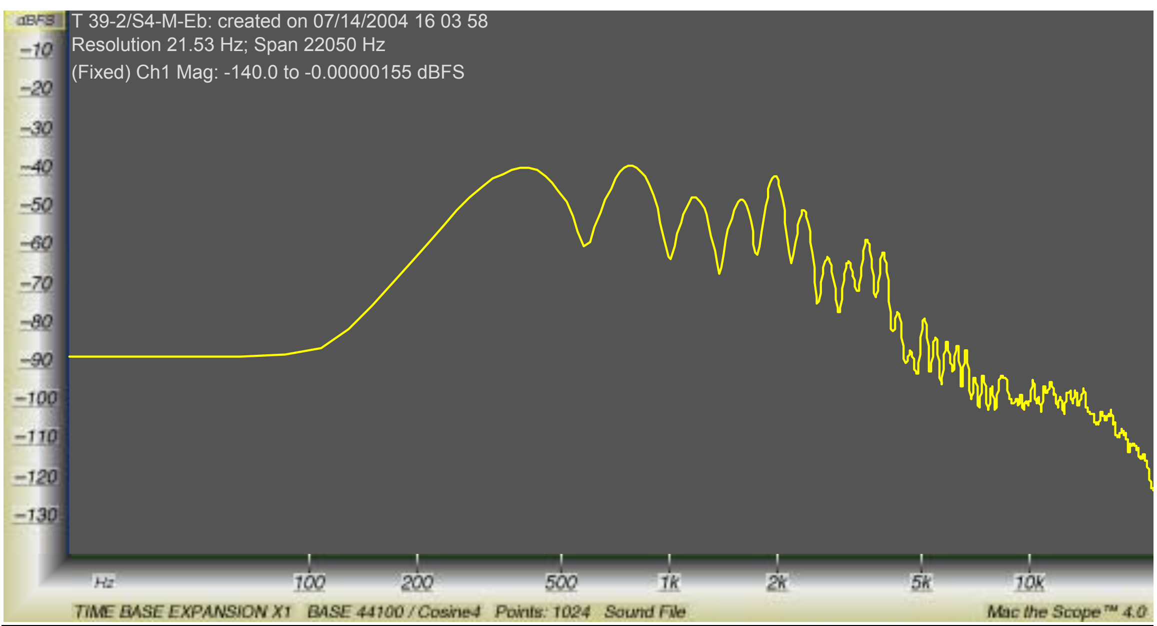
Subject 3, Meyer-Eb, Take 29B, Blow 1:



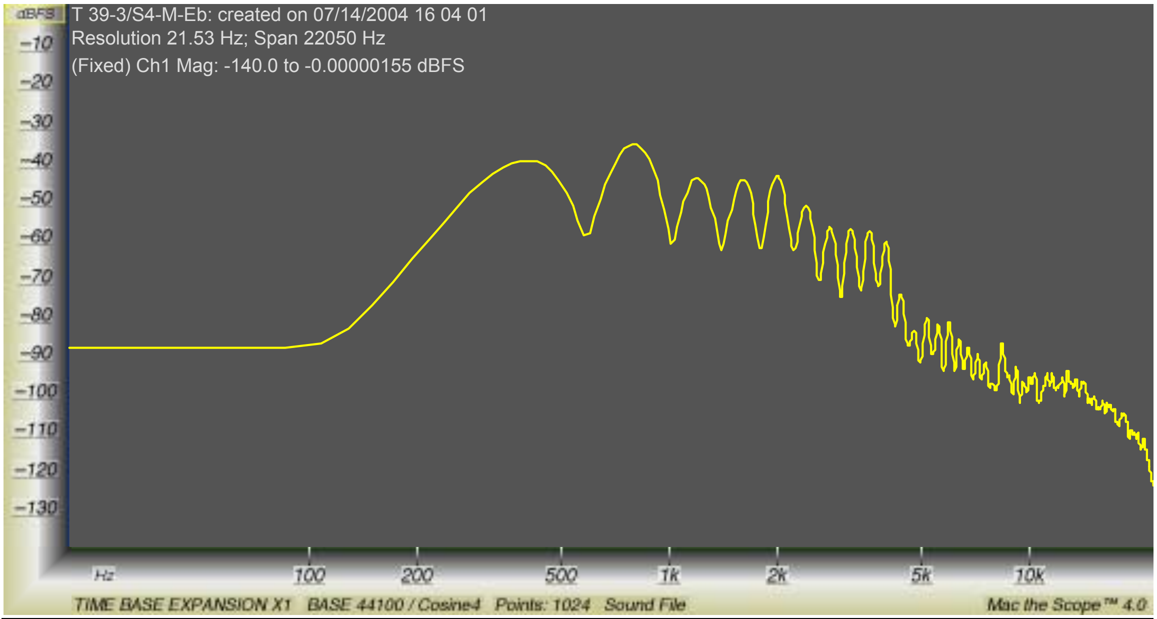
Subject 4, Meyer-Eb, Take 39, Blow 1:



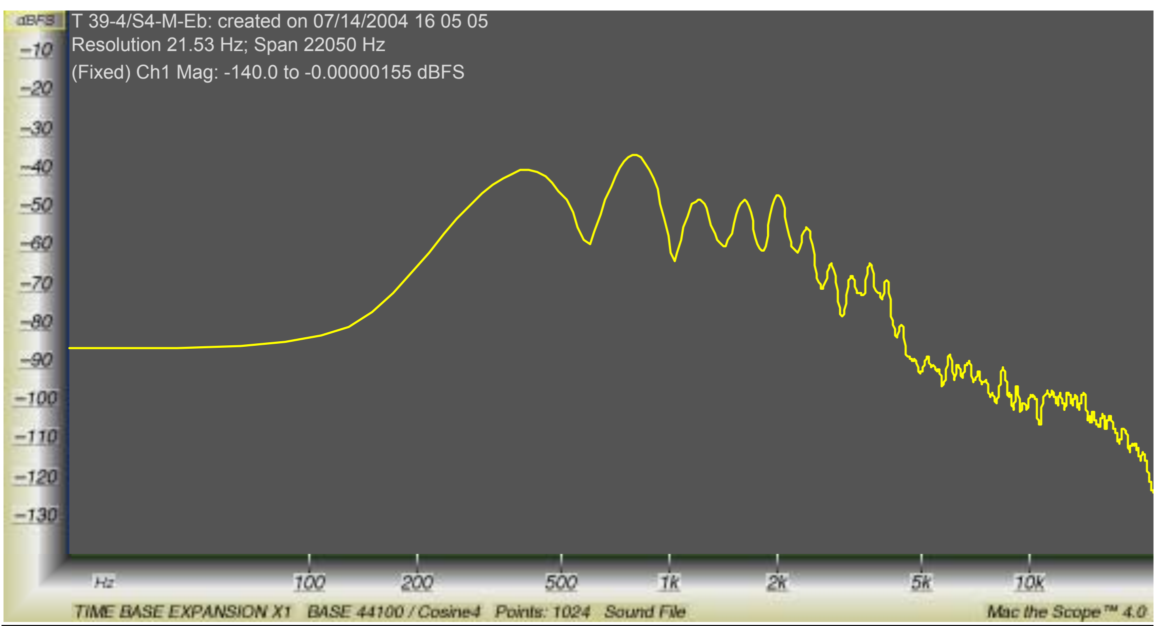
Subject 4, Meyer-Eb, Take 39, Blow 2:



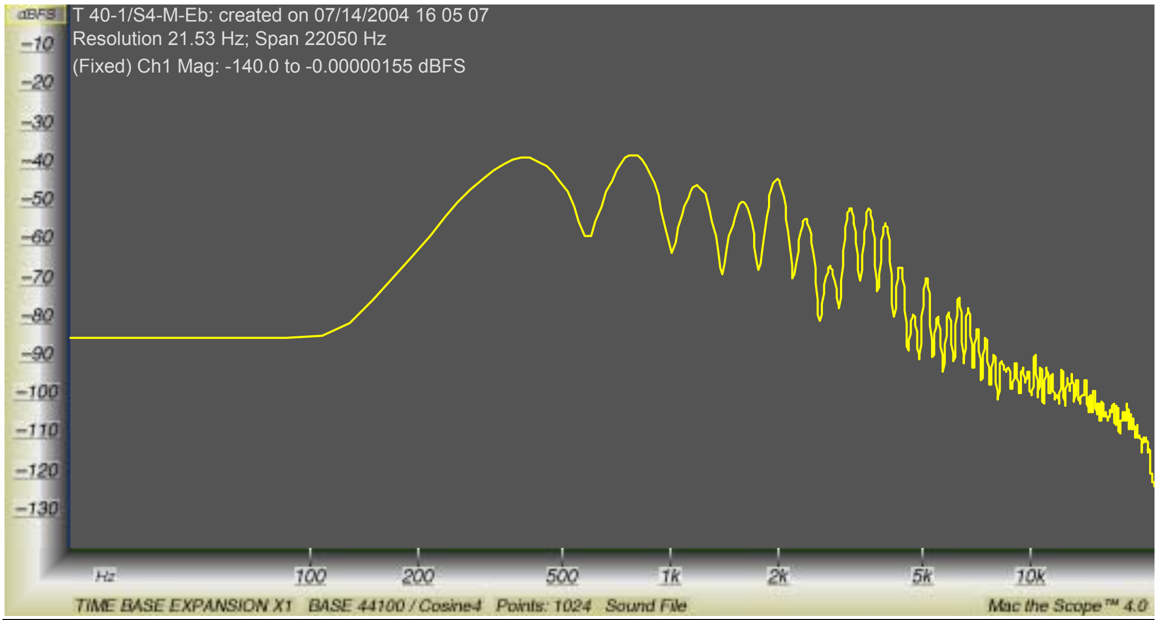
Subject 4, Meyer-Eb, Take 39, Blow 3:



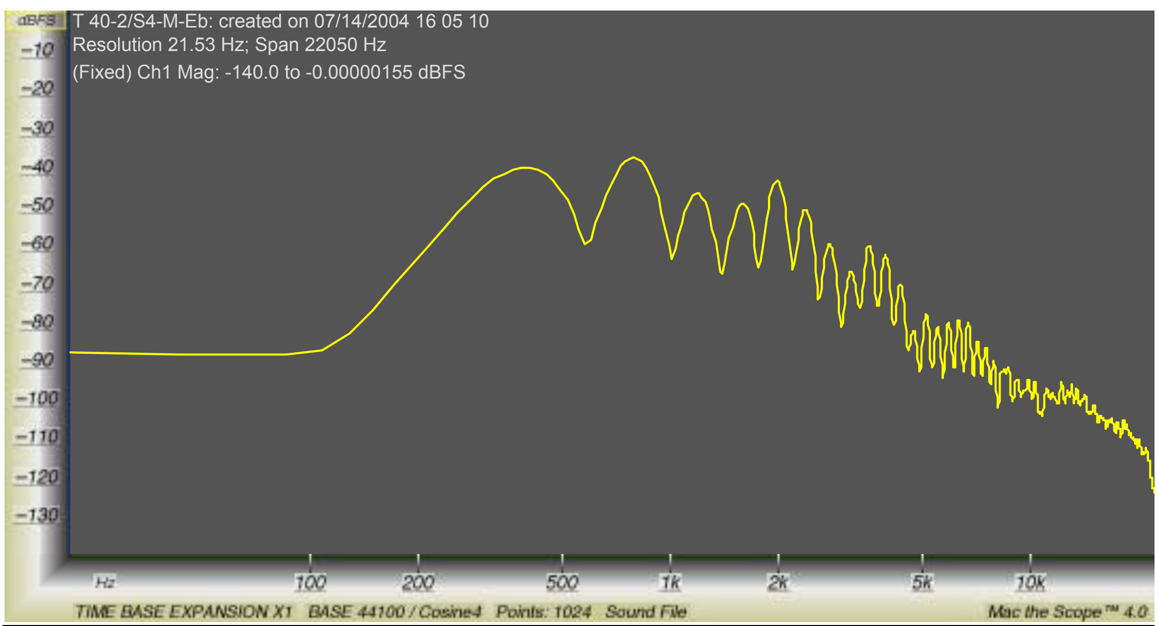
Subject 4, Meyer-Eb, Take 39, Blow 4:



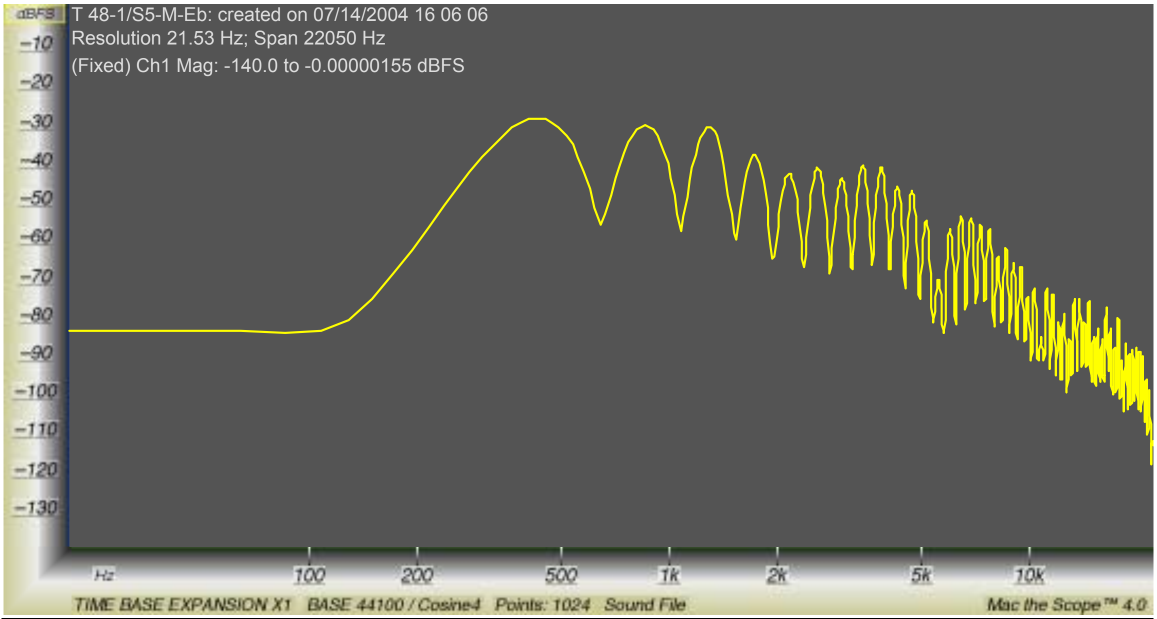
Subject 4, Meyer-Eb, Take 40, Blow 1:



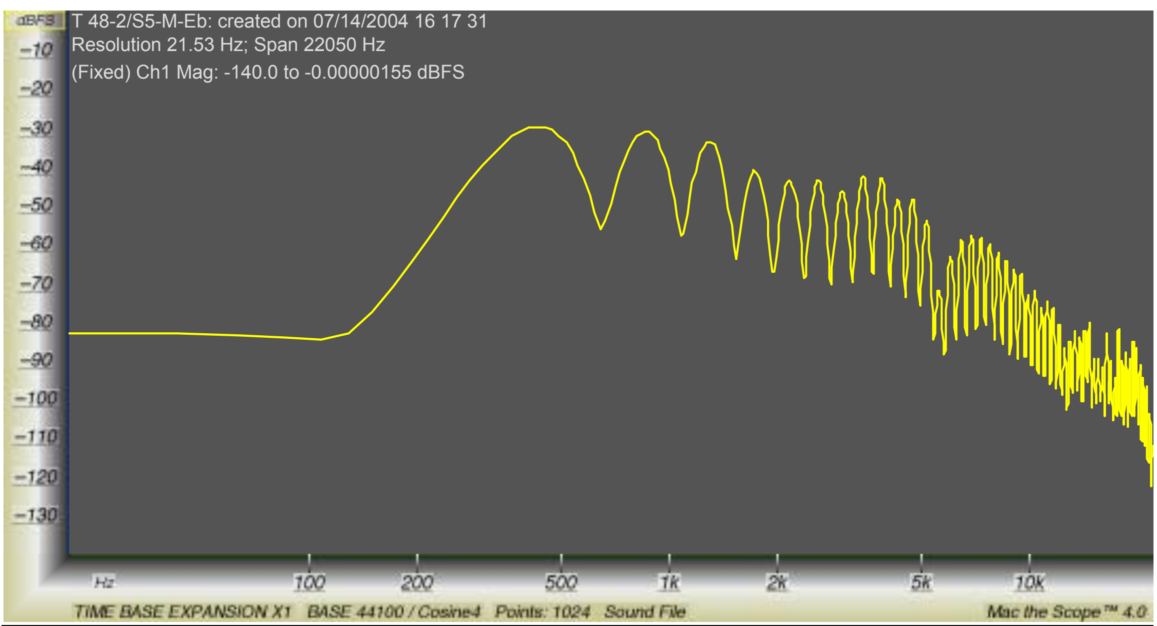
Subject 4, Meyer Eb, Take 40, Blow 2:



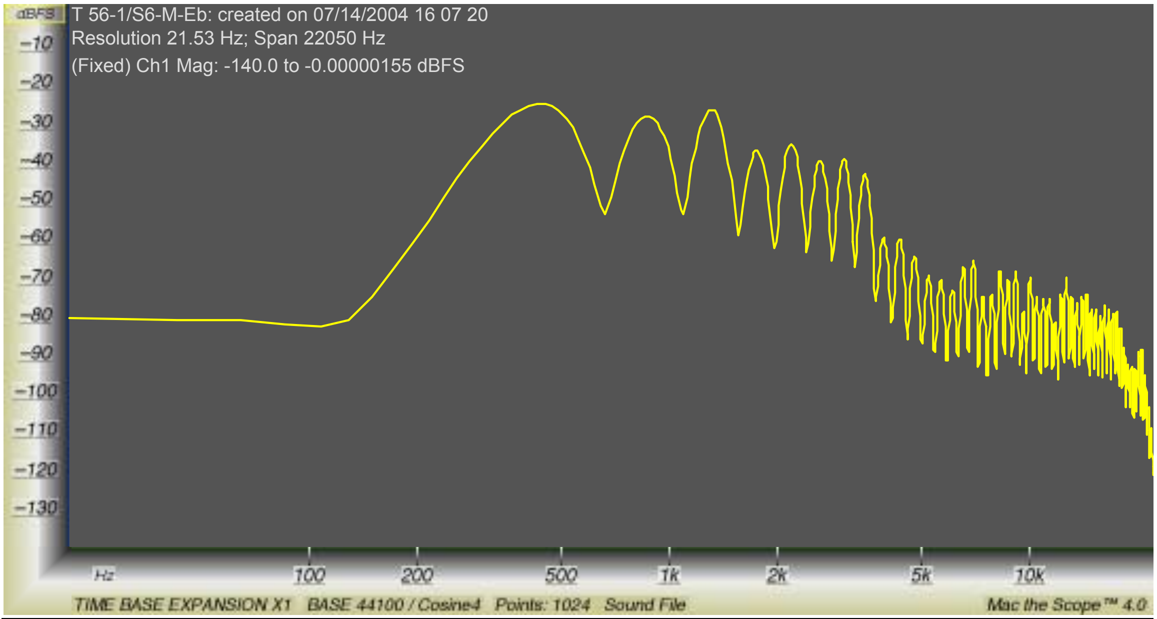
Subject 5, Meyer-Eb, Take 48, Blow 1:



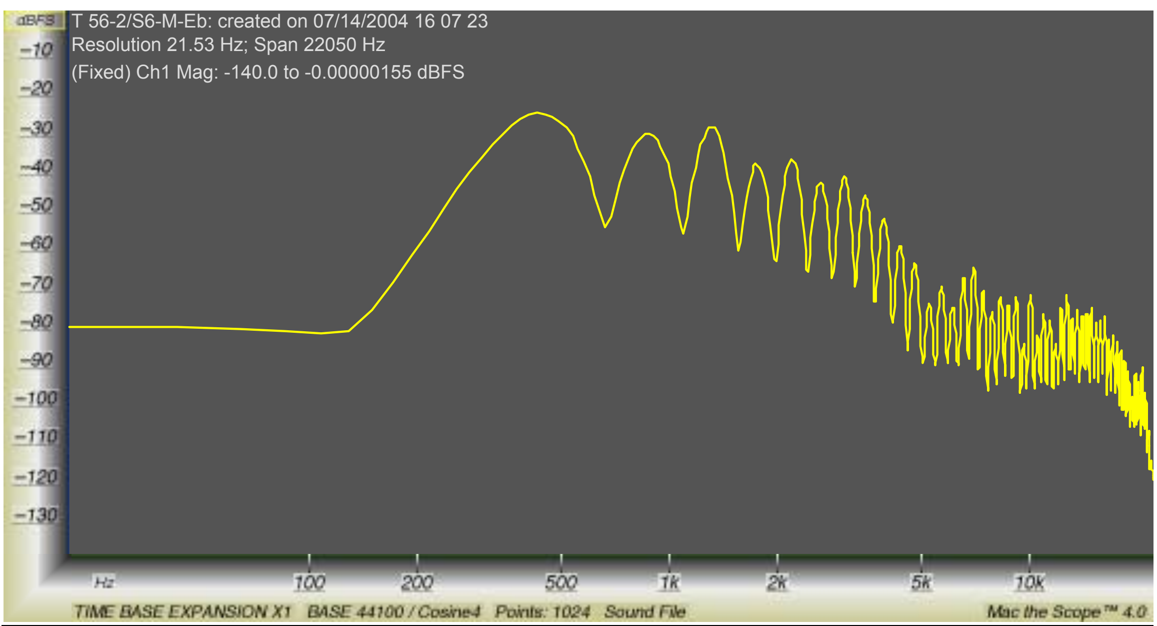
Subject 5, Meyer-Eb, Take 48, Blow 2:



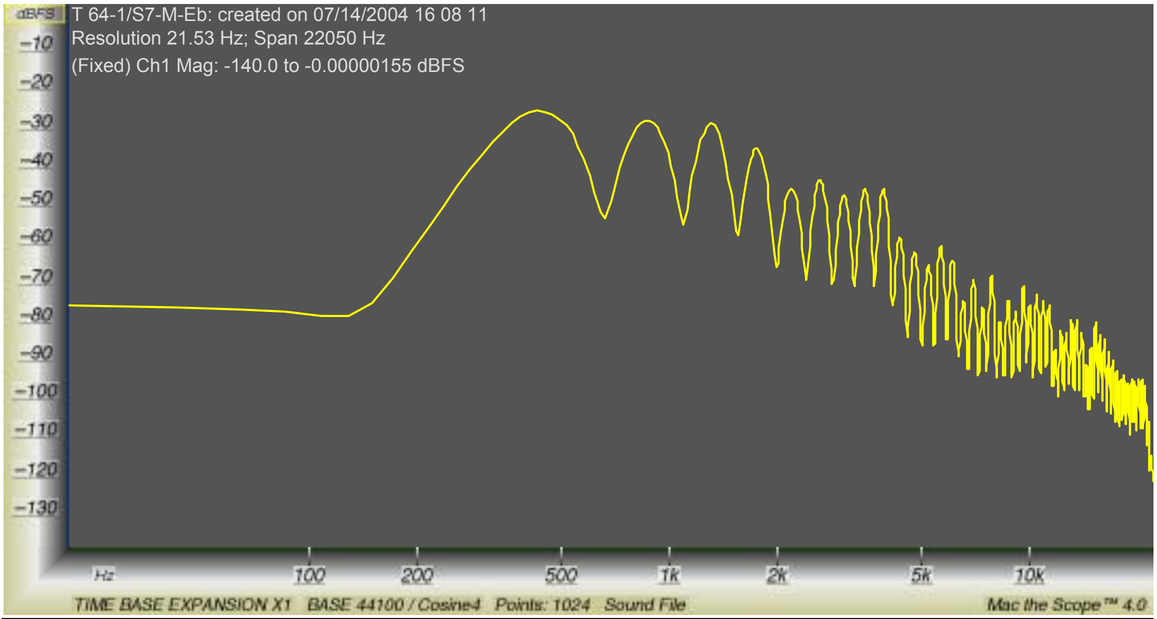
Subject 6, Meyer-Eb, Take 56, Blow 1:



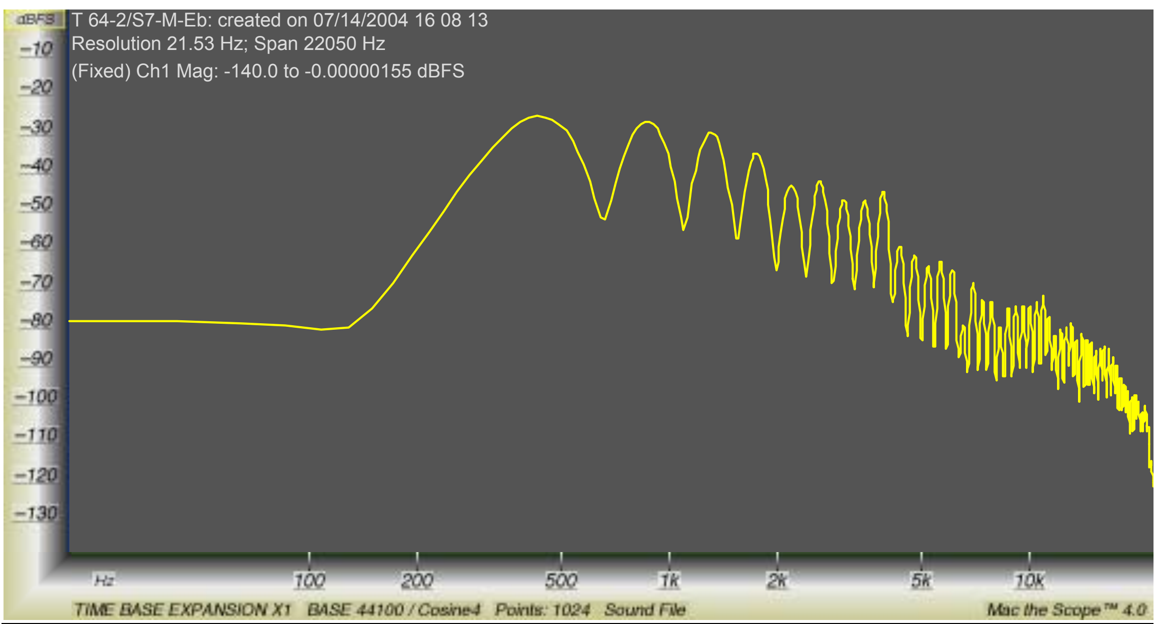
Subject 6, Meyer-Eb, Take 56, Blow 2:



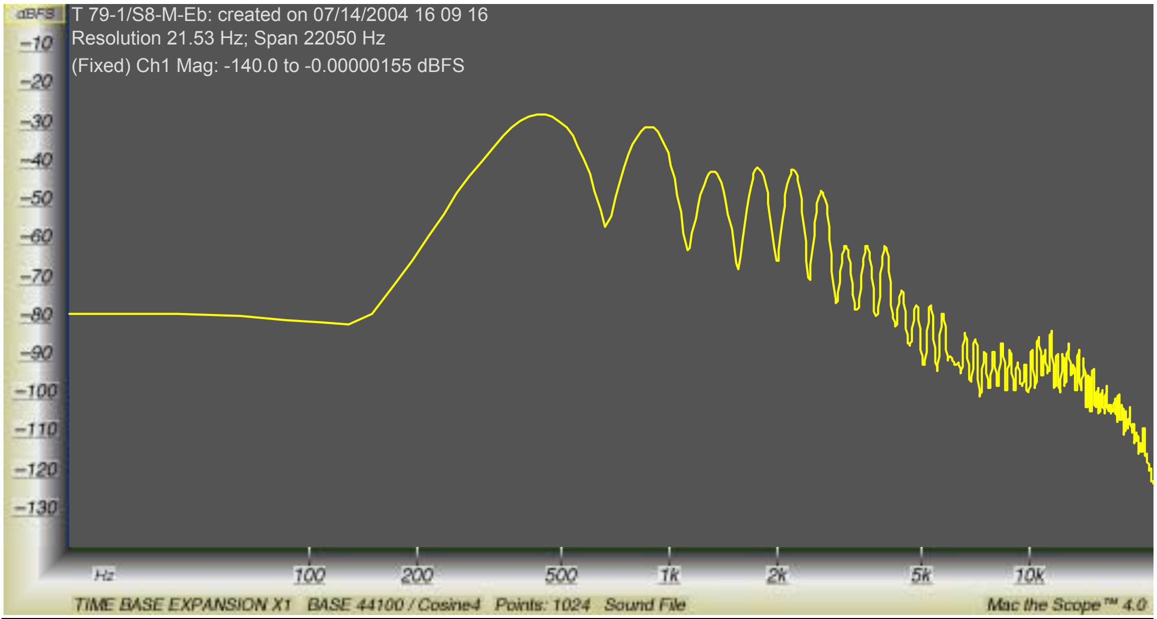
Subject 7, Meyer-Eb, Take 64, Blow 1:



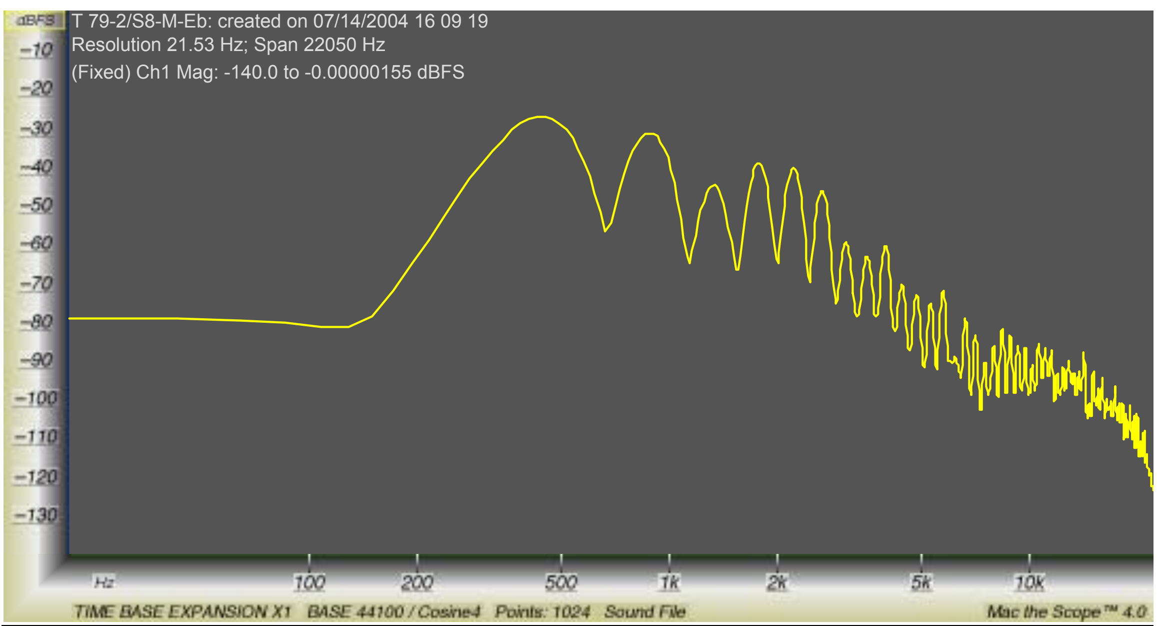
Subject 7, Meyer-Eb, Take 64, Blow 2:



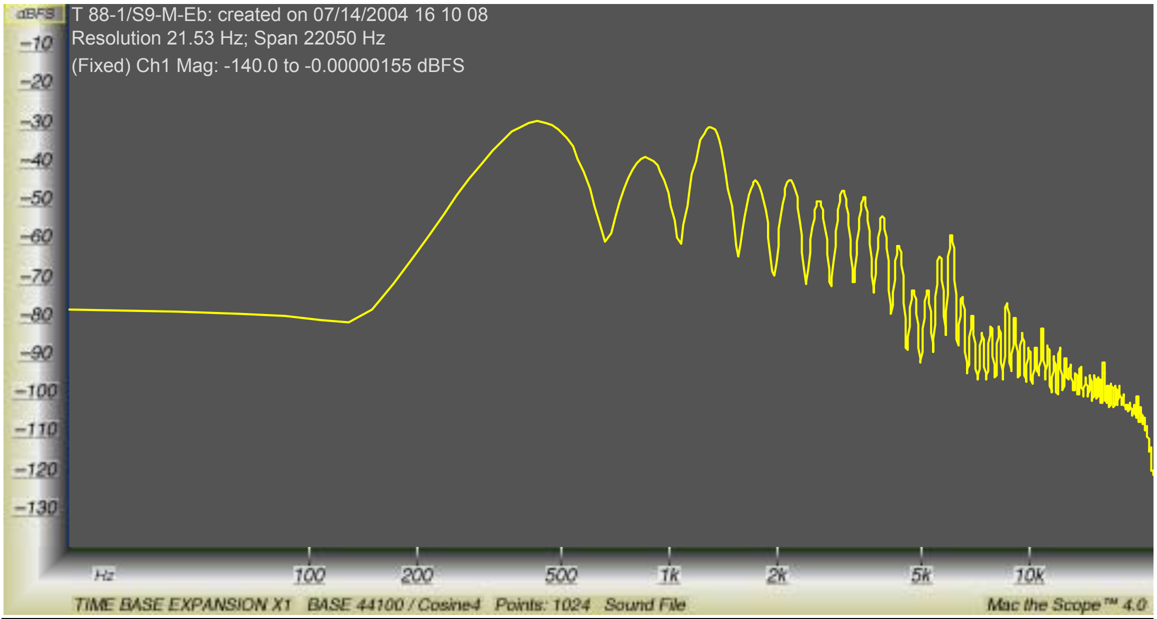
Subject 8, Meyer-Eb, Take 79, Blow 1:



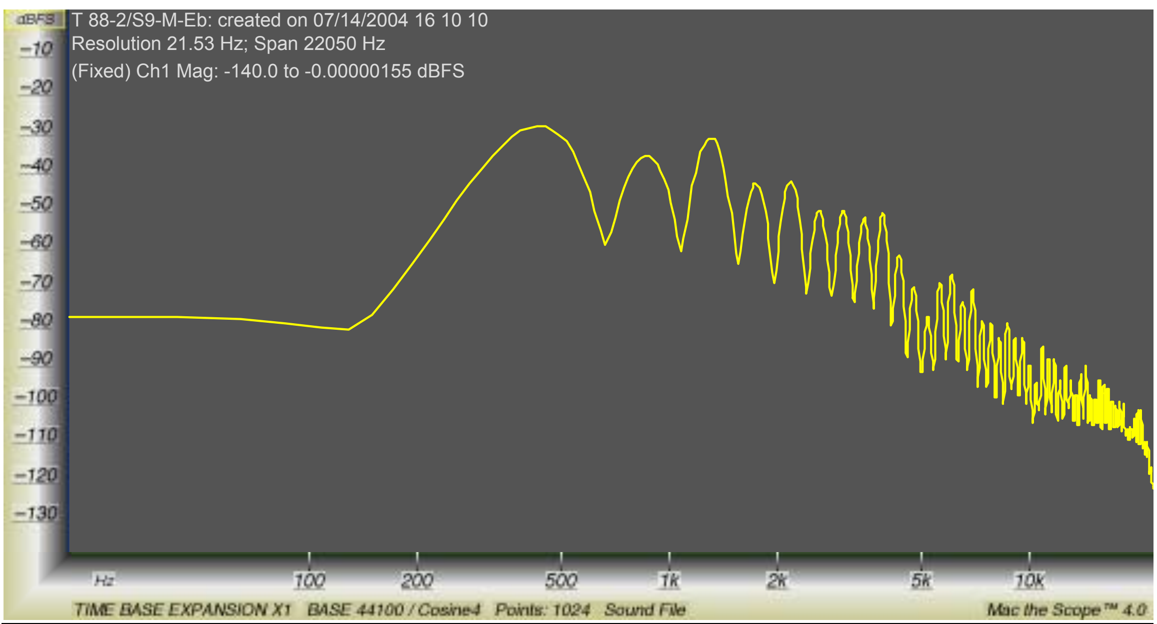
Subject 8, Meyer-Eb, Take 79, Blow 2:



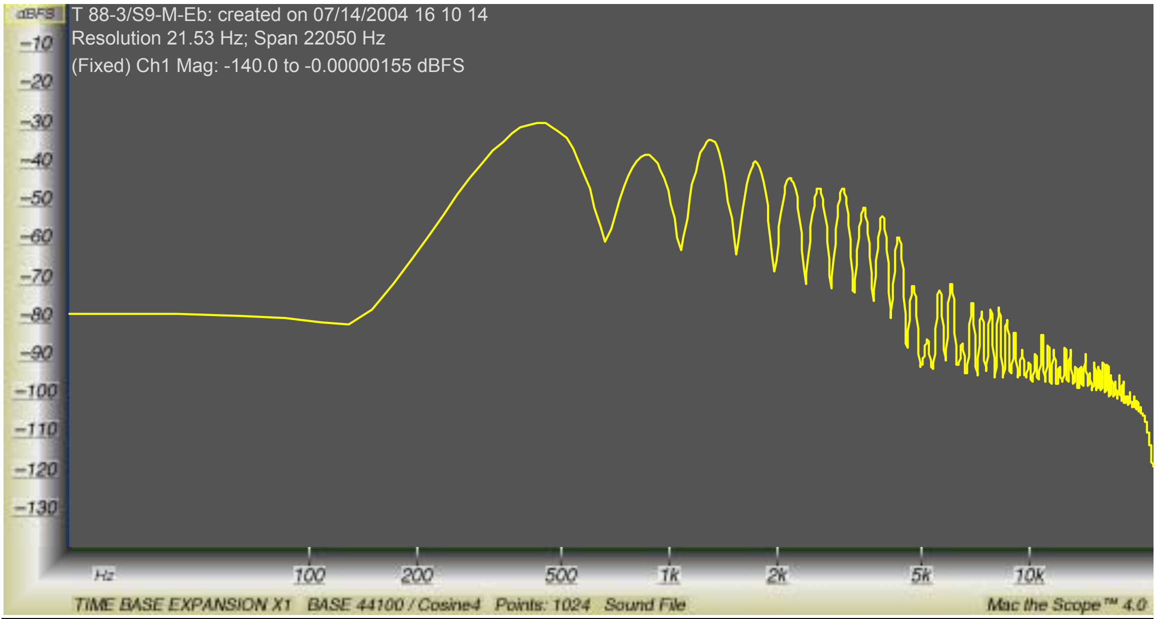
Subject 9, Meyer-Eb, Take 88, Blow 1:



Subject 9, Meyer-Eb, Take 88, Blow 2:

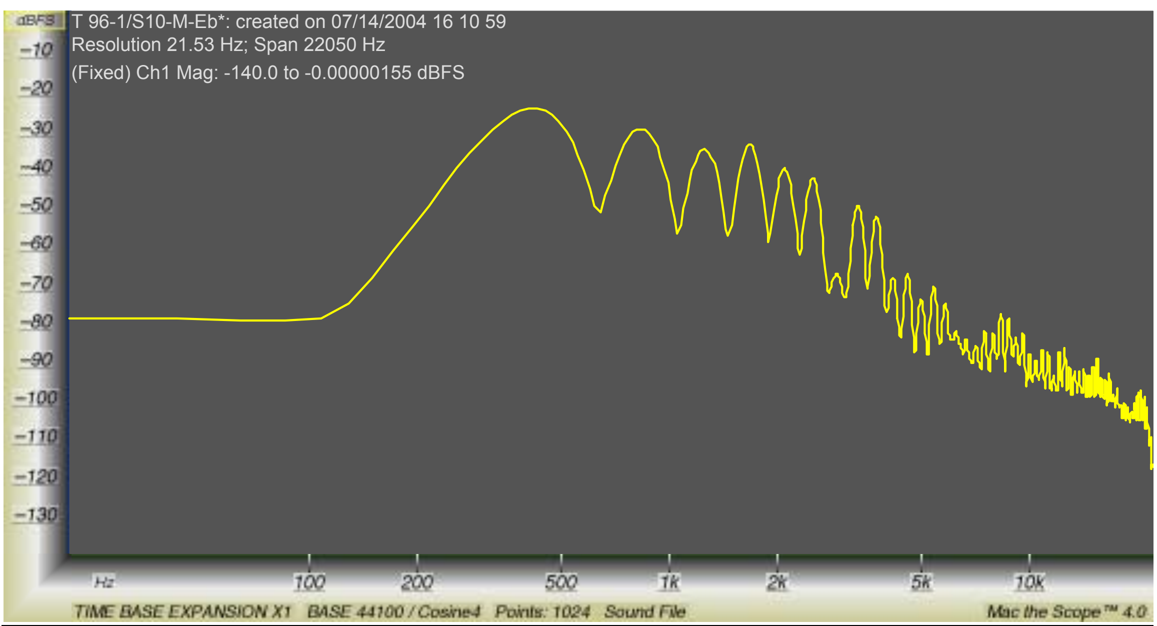


Subject 9, Meyer-Eb, Take 88, Blow 3:

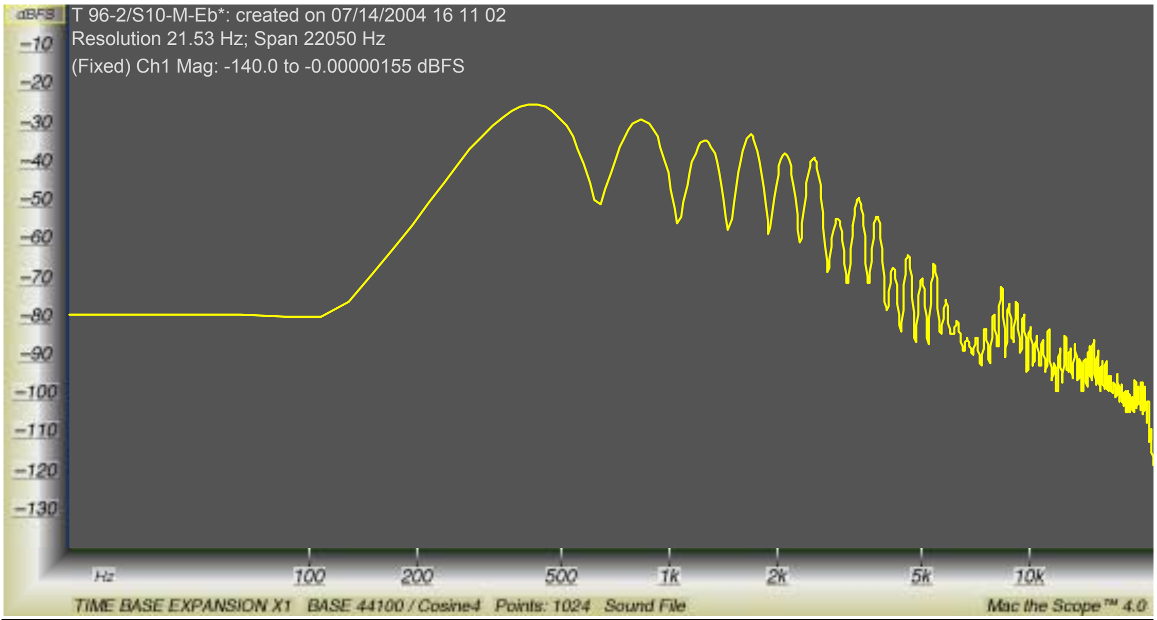


Subject 10 was not able to produce any pitches below an Eb on the mouthpiece. The '*' denotes that the Eb was a stretch.

Subject 10, Meyer Eb*, Take 96, Blow 1:

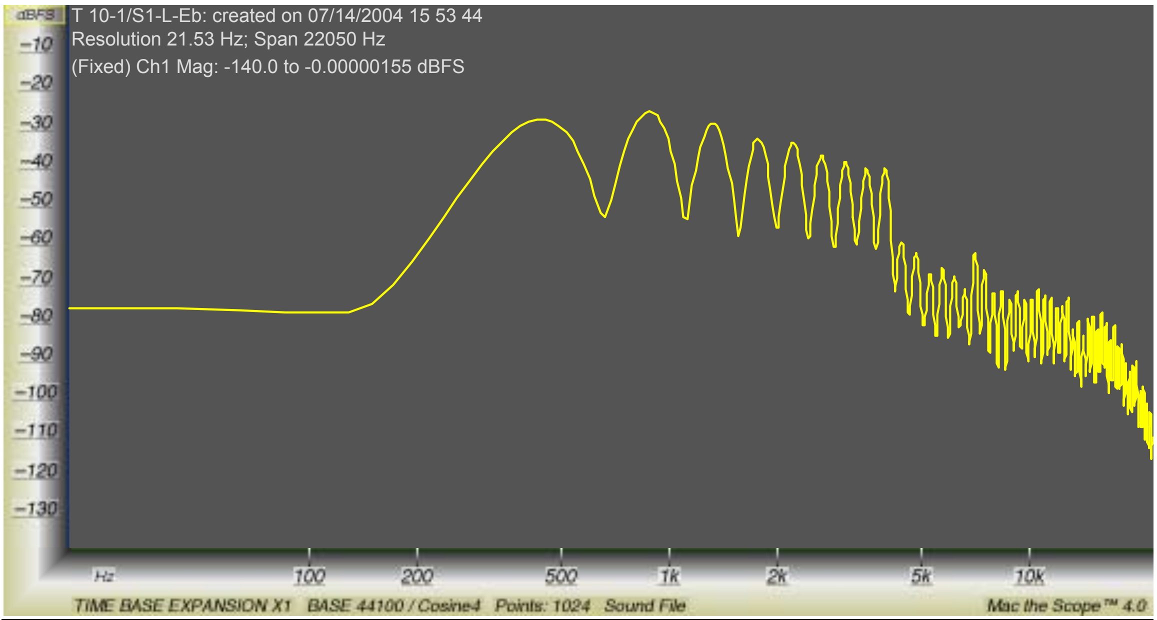


Subject 10, Meyer-Eb*, Take 96, Blow 2:

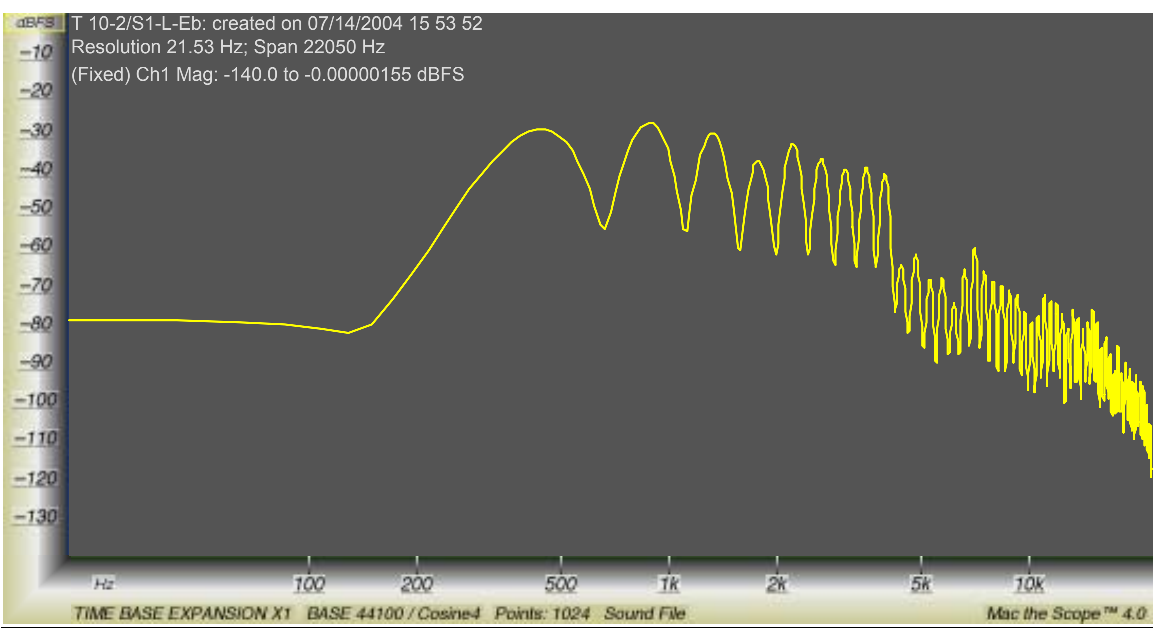


APPENDIX I: SPECTRAL ANALYSIS OF SAXOPHONE TONE QUALITY USING CLAUDE LAKEY 4*4 MOUTHPIECE AT MOUTHPIECE PITCH LEVEL OF Eb5

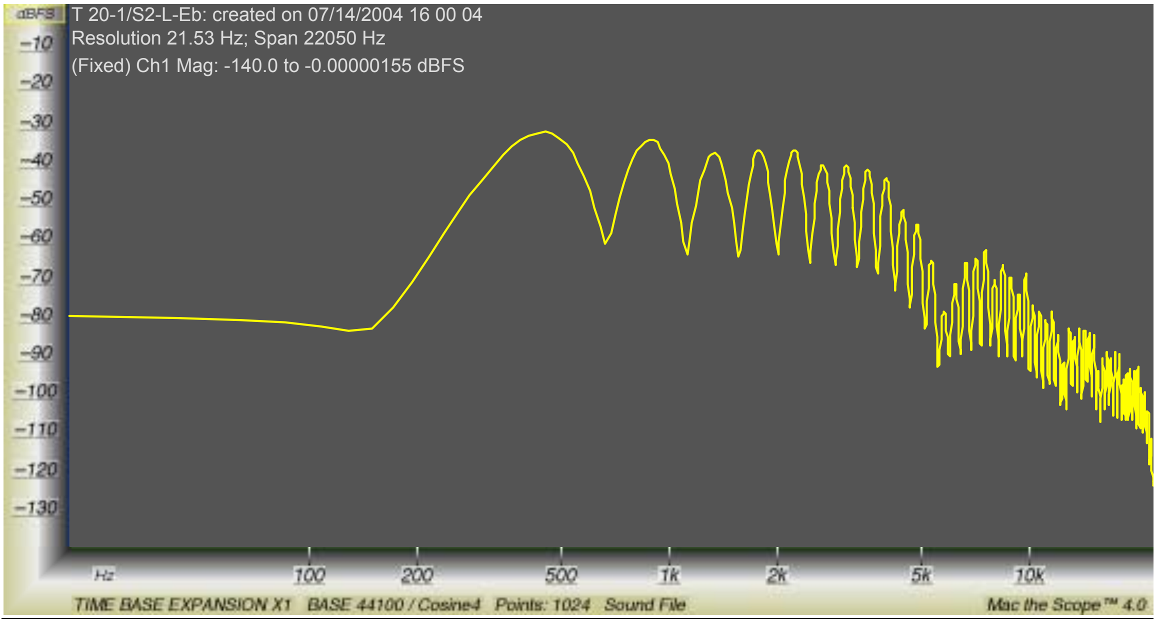
Subject 1, Lakey-Eb, Take 10, Blow 1:



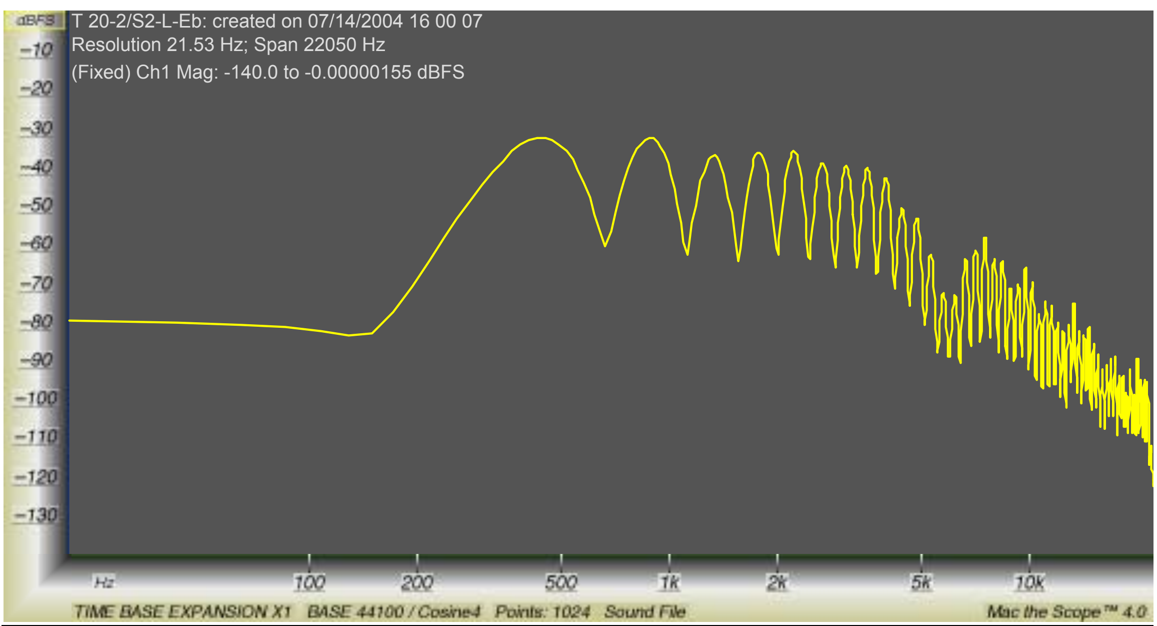
Subject 1, Lakey-Eb, Take 10, Blow 2:



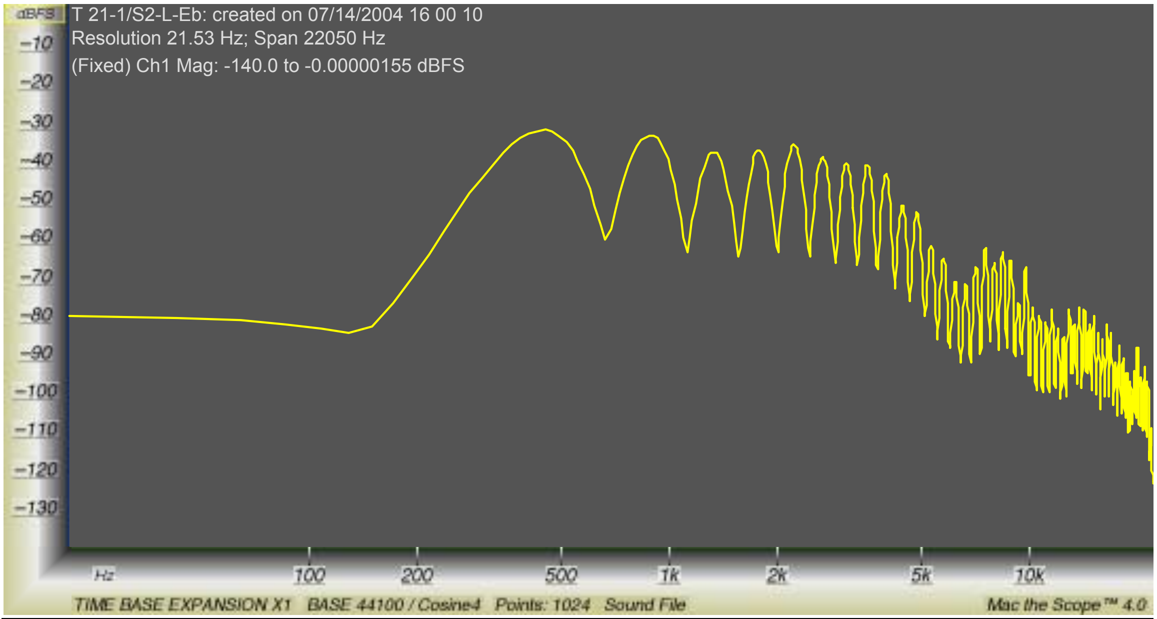
Subject 2, Lakey-Eb, Take 20, Blow 1:



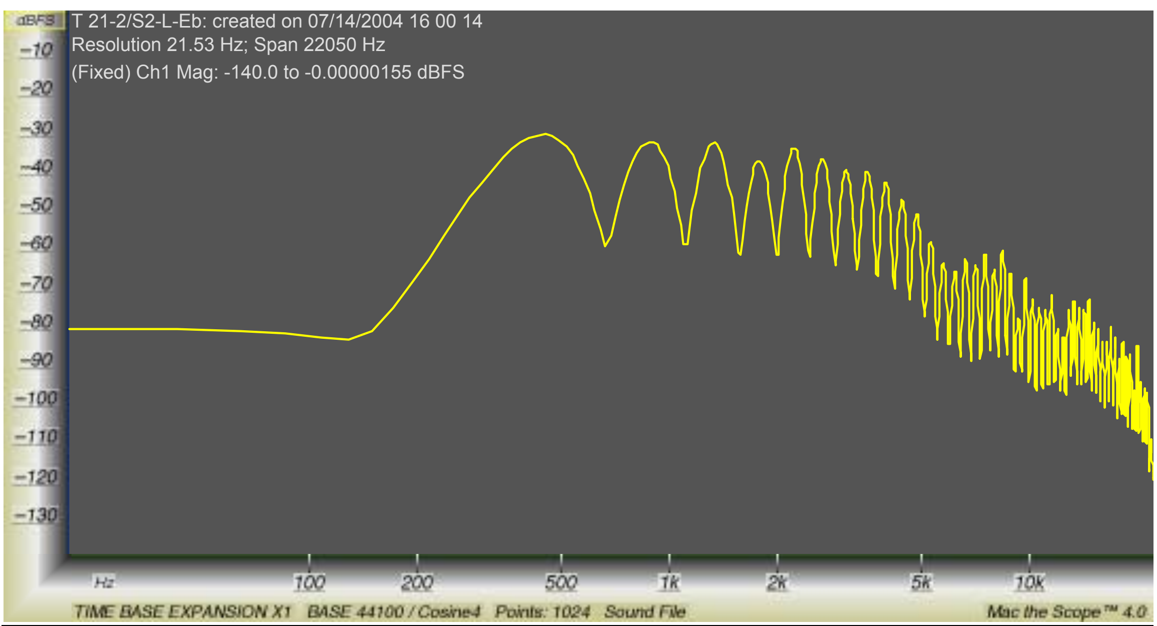
Subject 2, Lakey-Eb, Take 20, Blow 2:



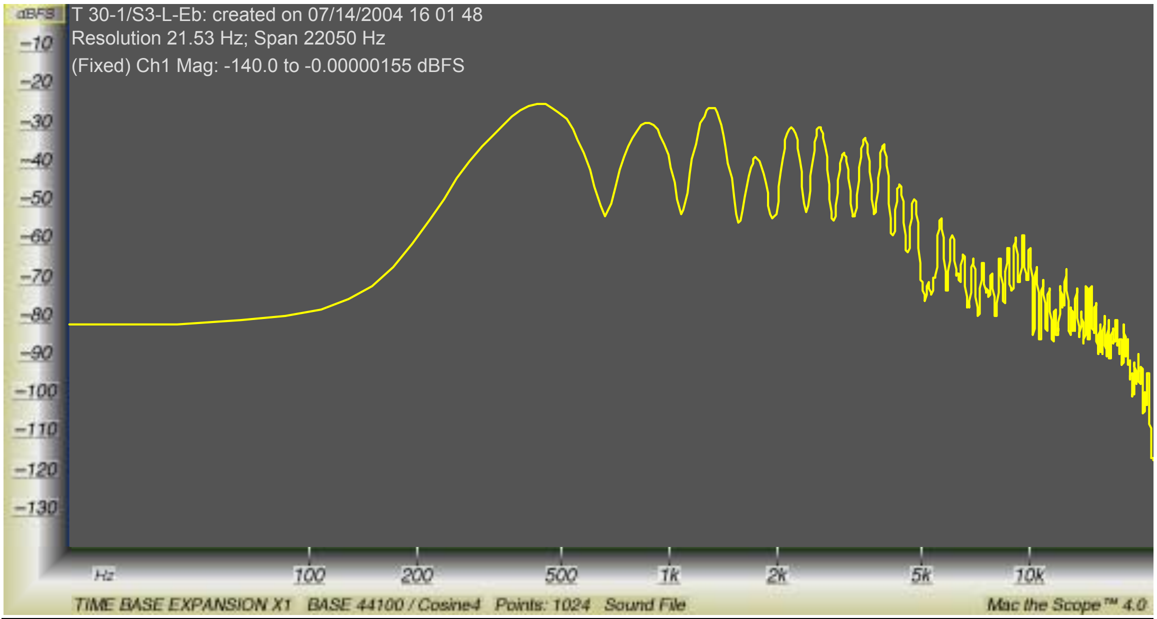
Subject 2, Lakey-Eb, Take 21, Blow 1:



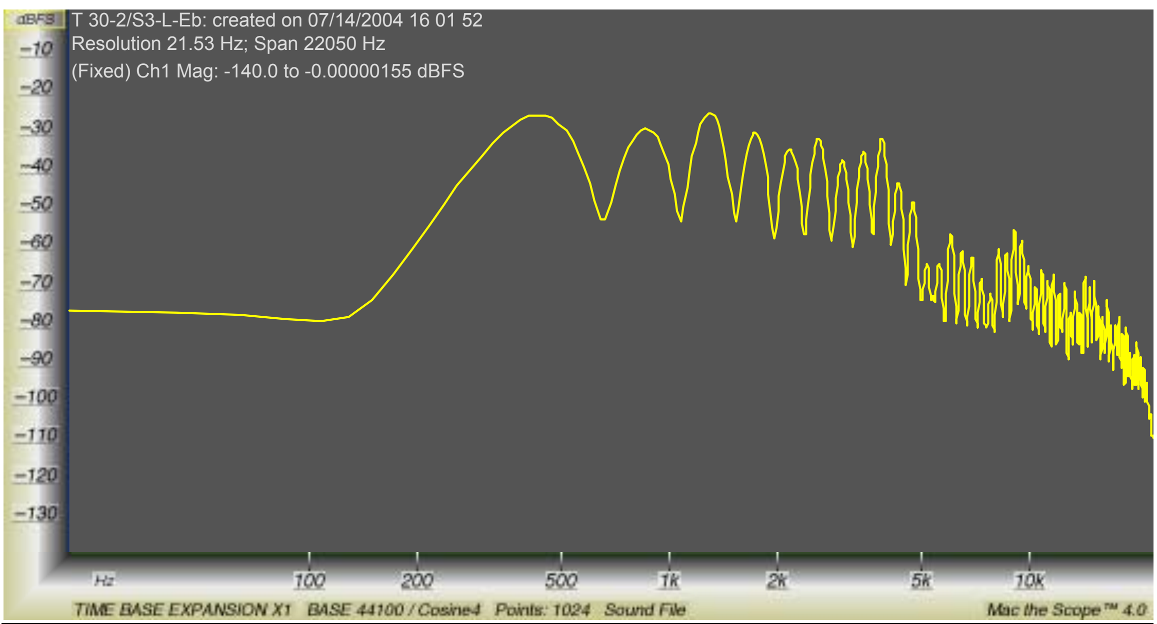
Subject 2, Lakey-Eb, Take 21, Blow 2:



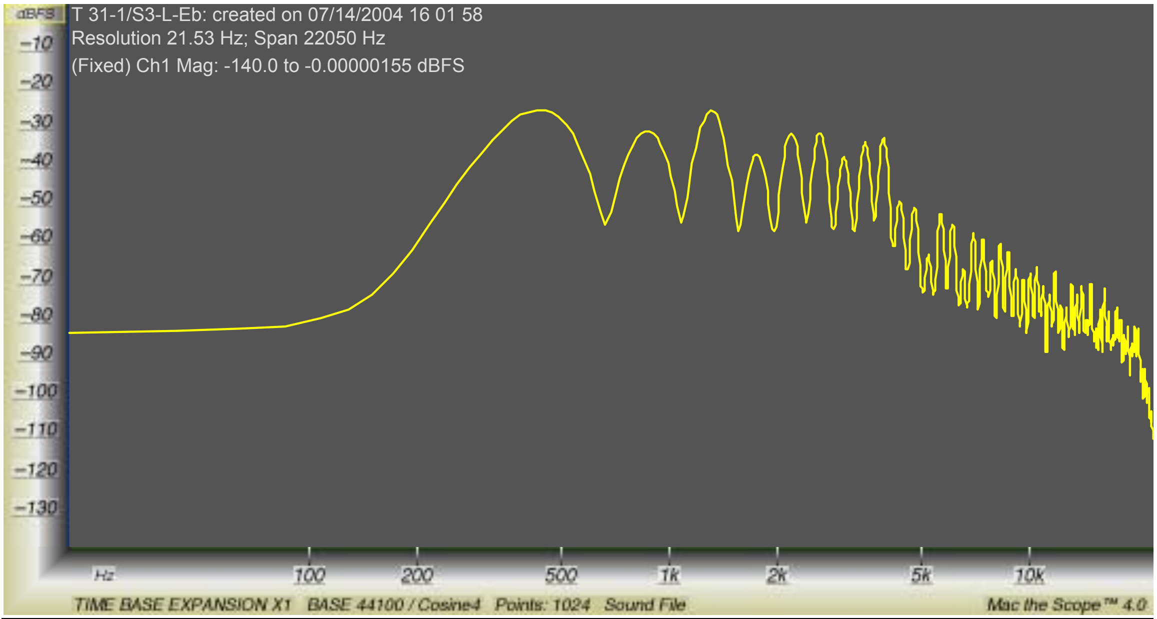
Subject 3, Lakey-Eb, Take 30, Blow 1:



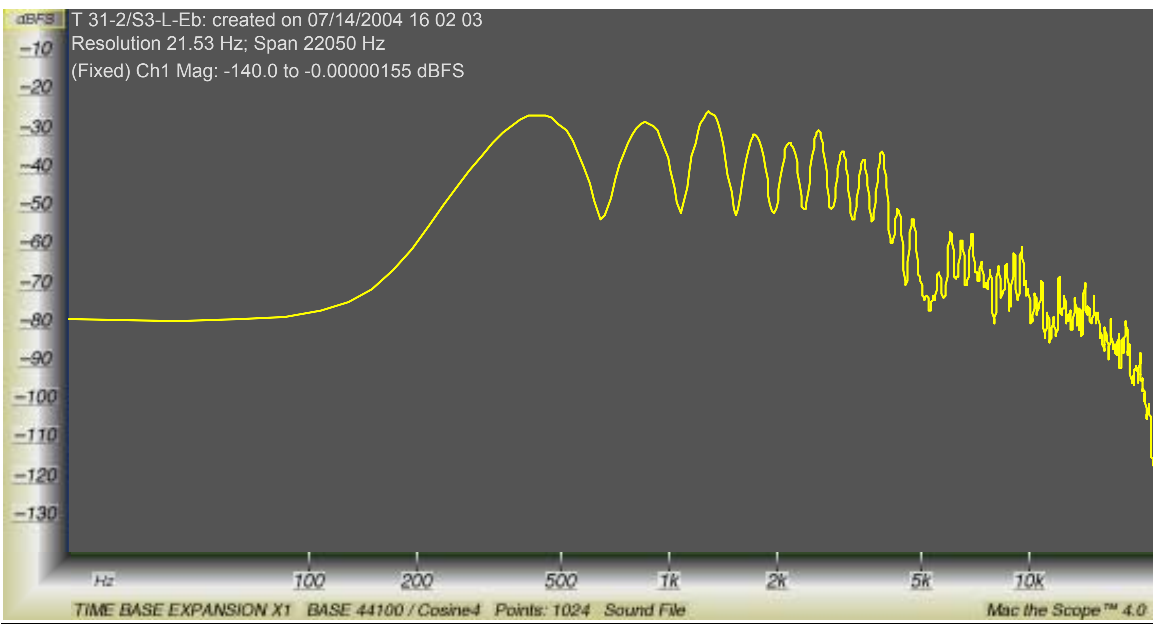
Subject 3, Lakey-Eb, Take 30, Blow 2:



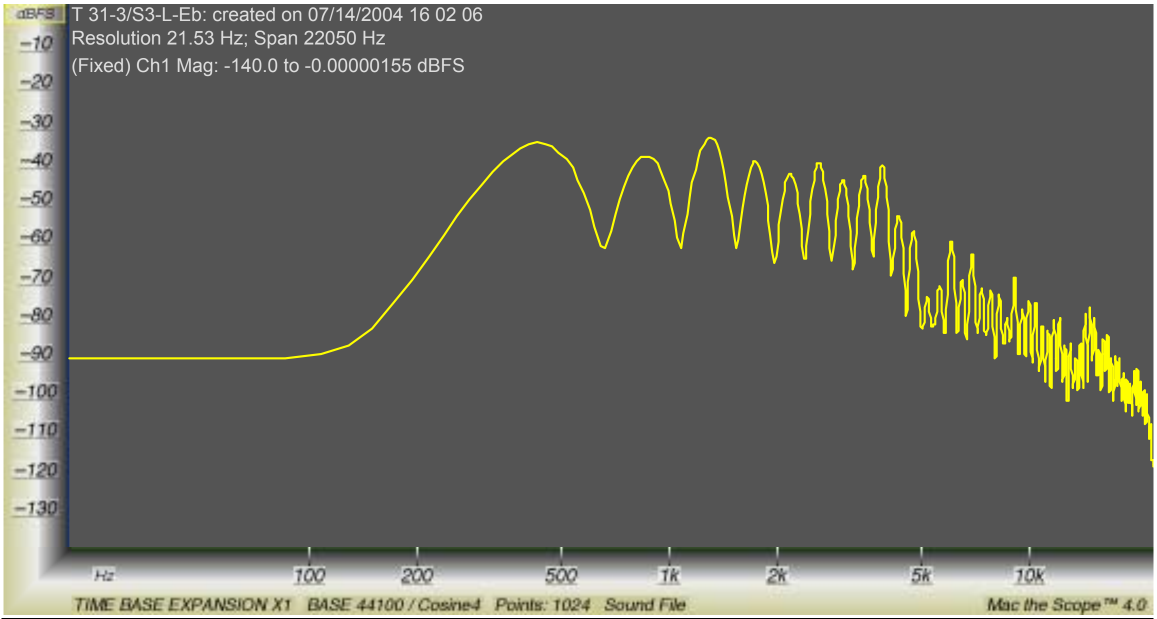
Subject 3, Lakey-Eb, Take 31, Blow 1:



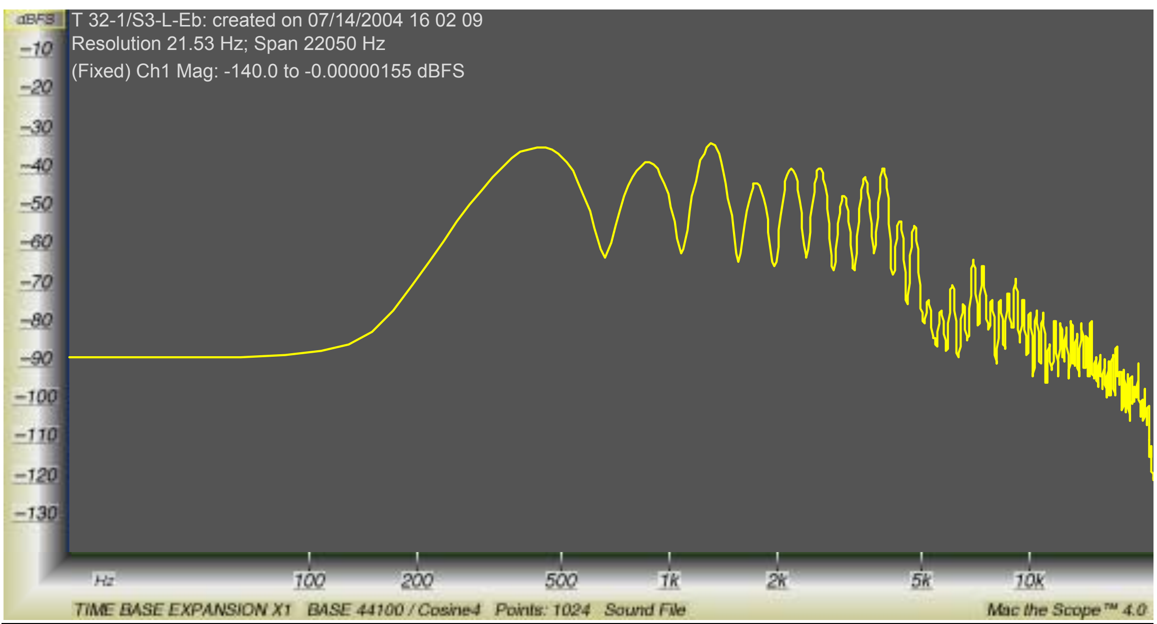
Subject 3, Lakey-Eb, Take 31, Blow 2:



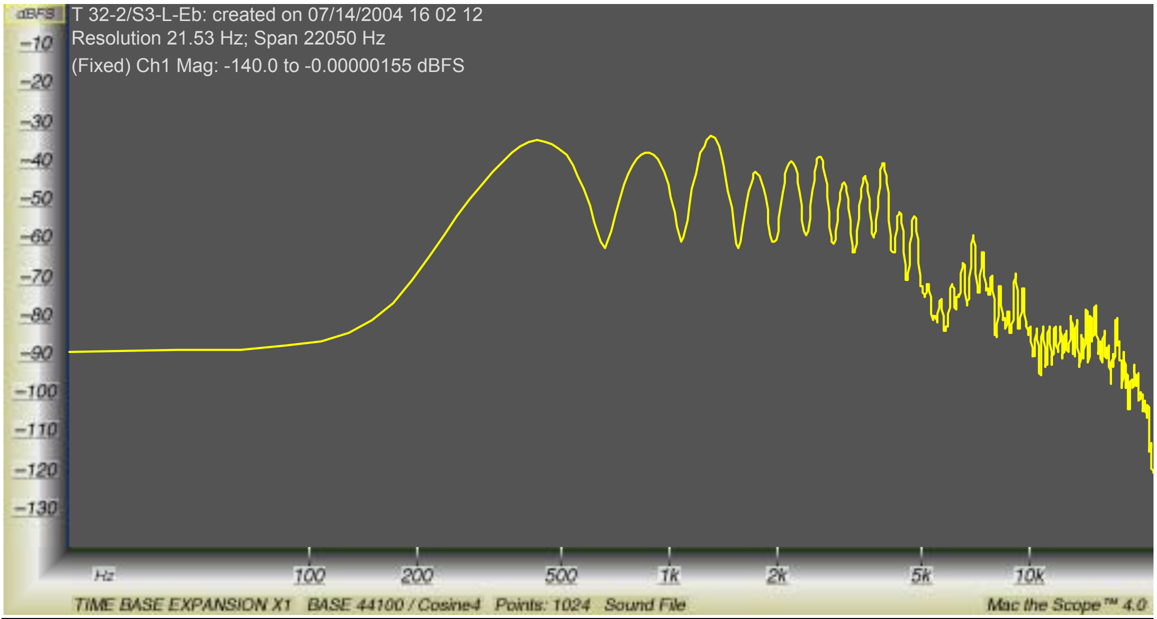
Subject 3, Lakey-Eb, Take 31, Blow 3:



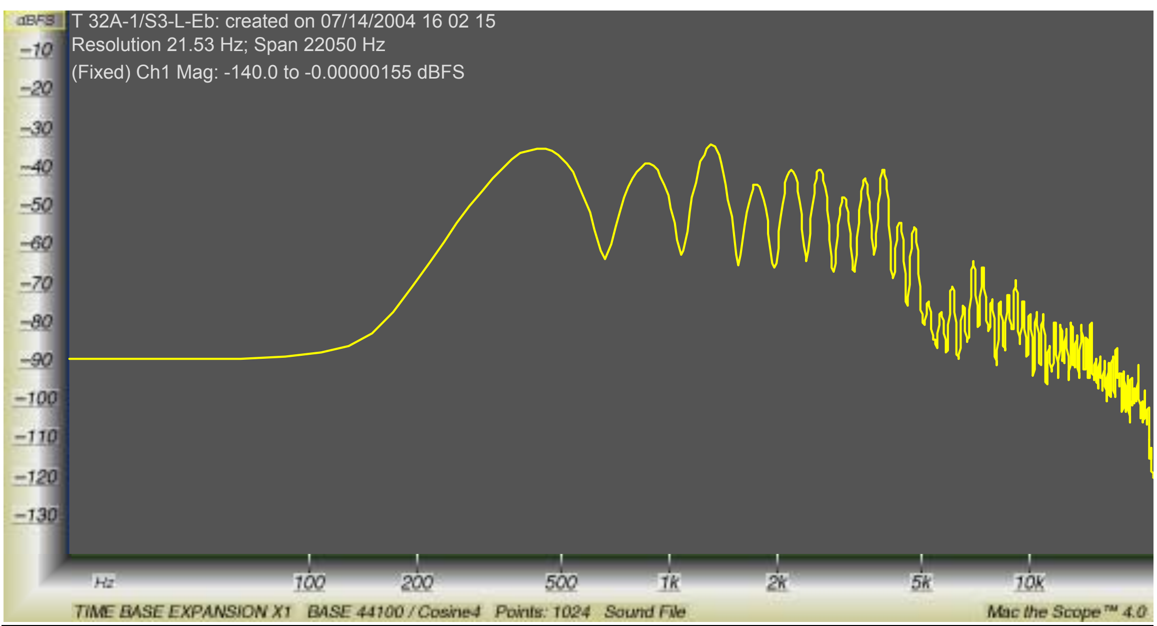
Subject 3, Lakey-Eb, Take 32, Blow 1:



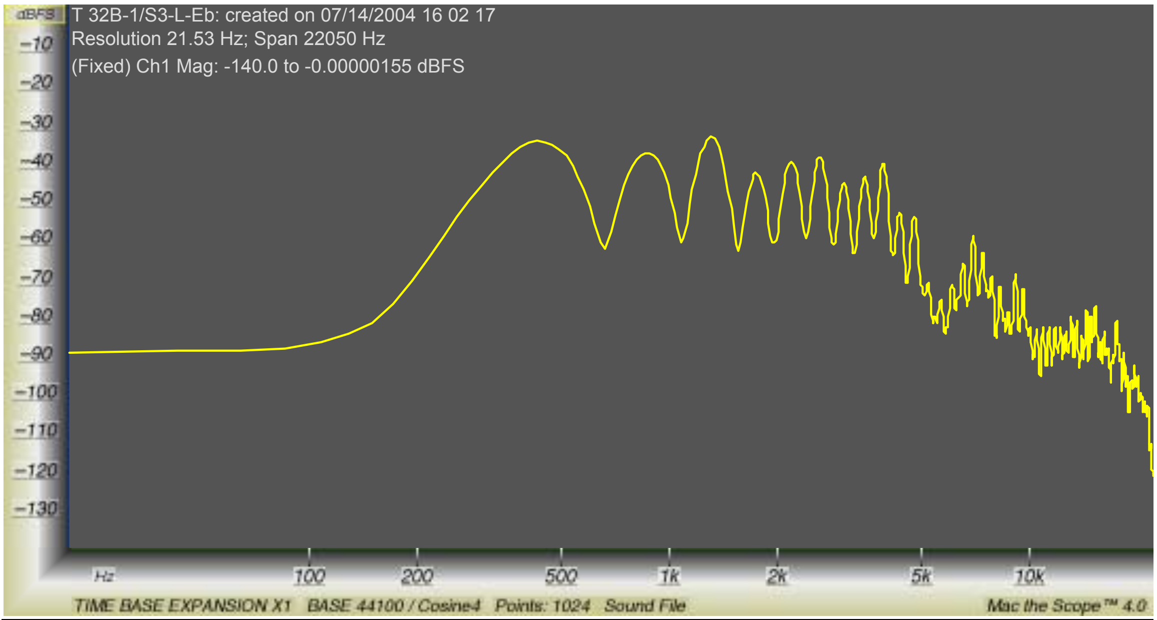
Subject 3, Lakey Eb, Take 32, Blow 2:



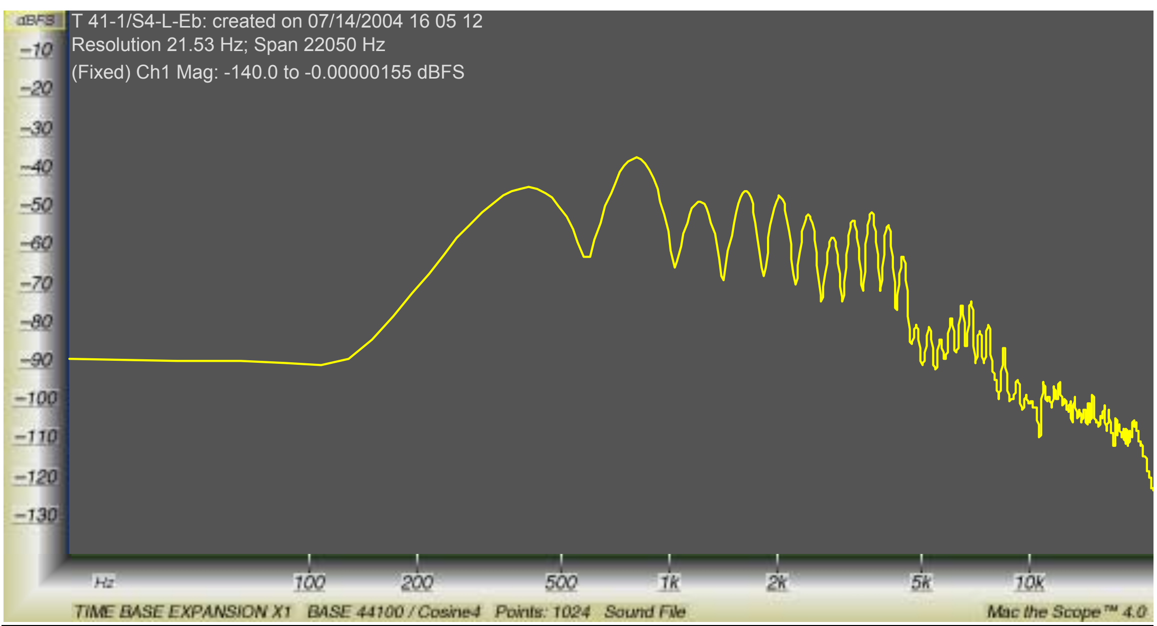
Subject 3, Lakey-Eb, Take 32A, Blow 1:



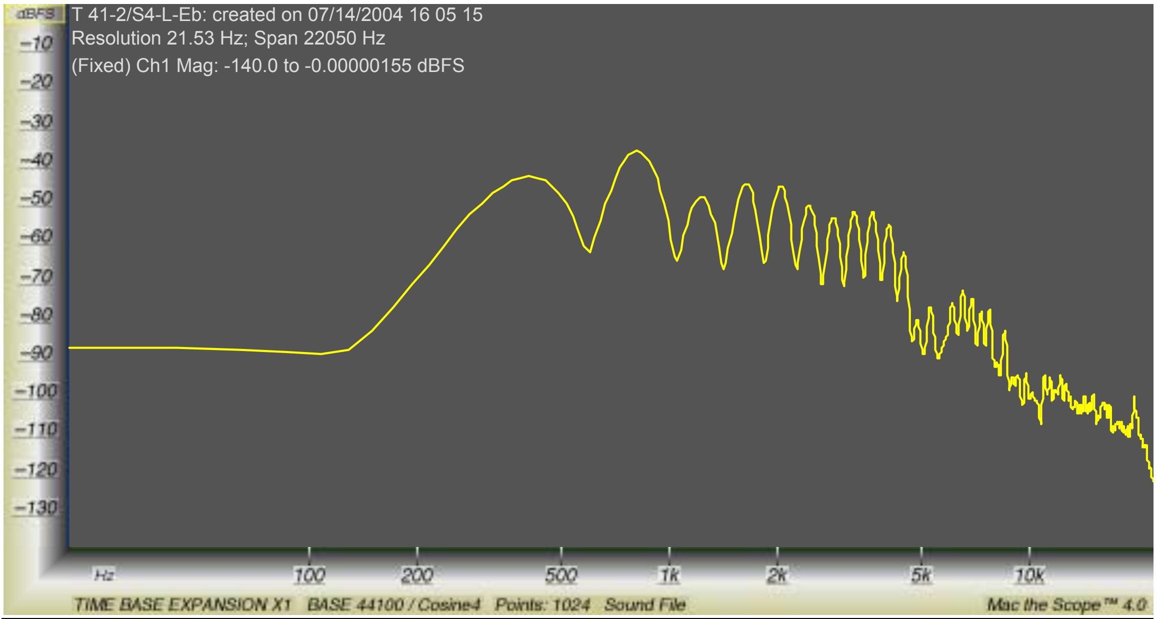
Subject 3, Lakey-Eb, Take 32B, Blow 1:



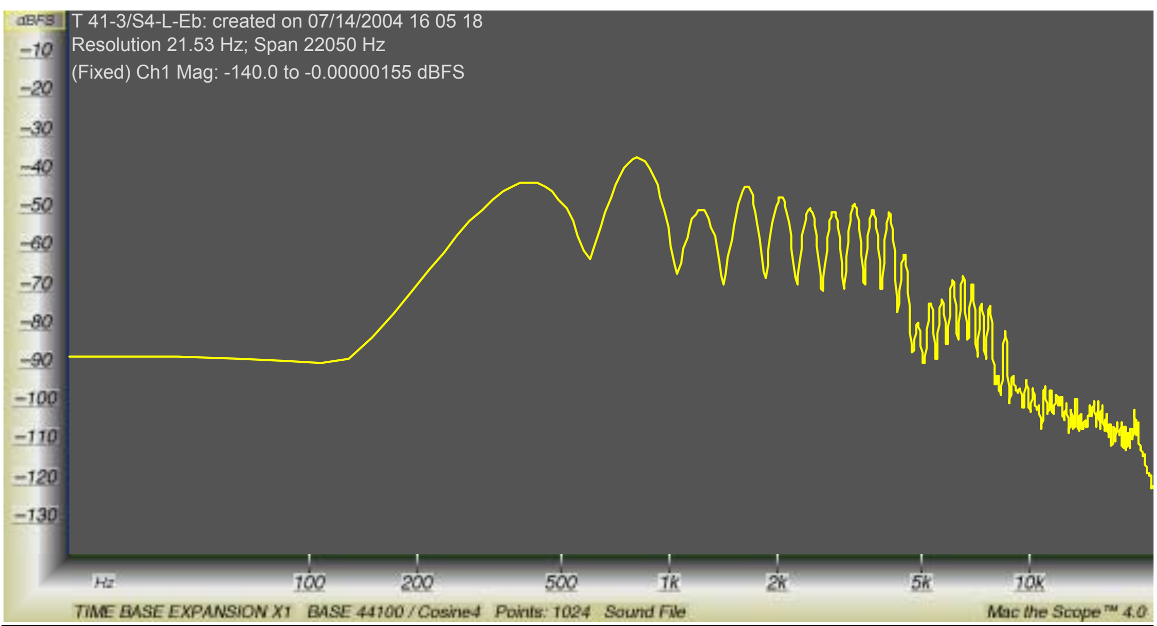
Subject 4, Lakey-Eb, Take 41, Blow 1:



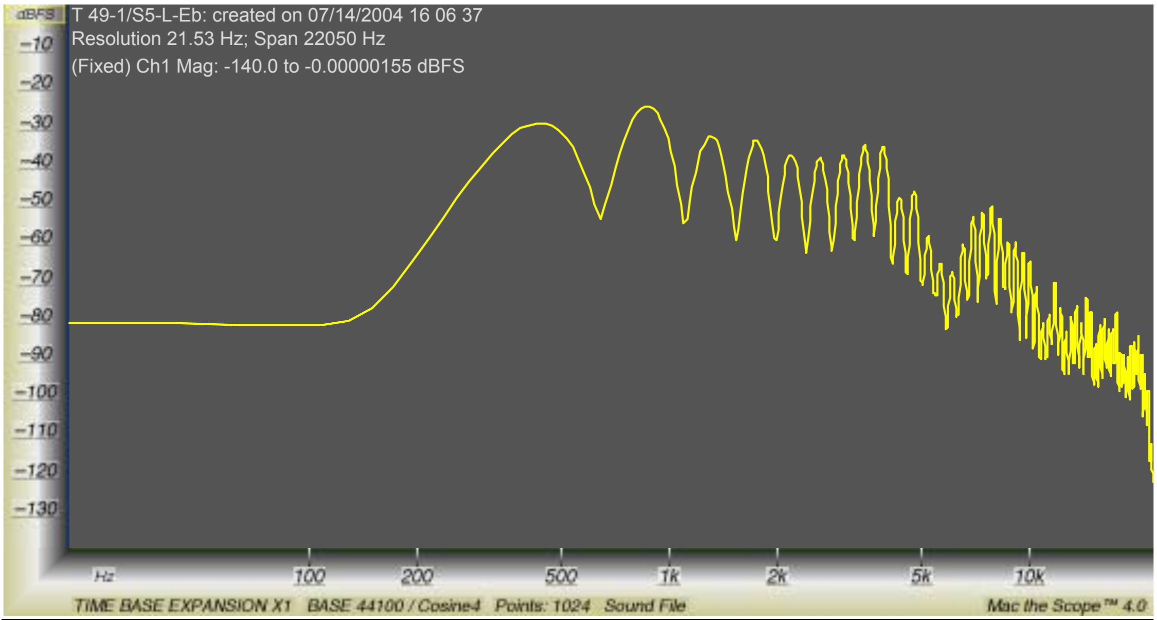
Subject 4, Lakey-Eb, Take 41, Blow 2:



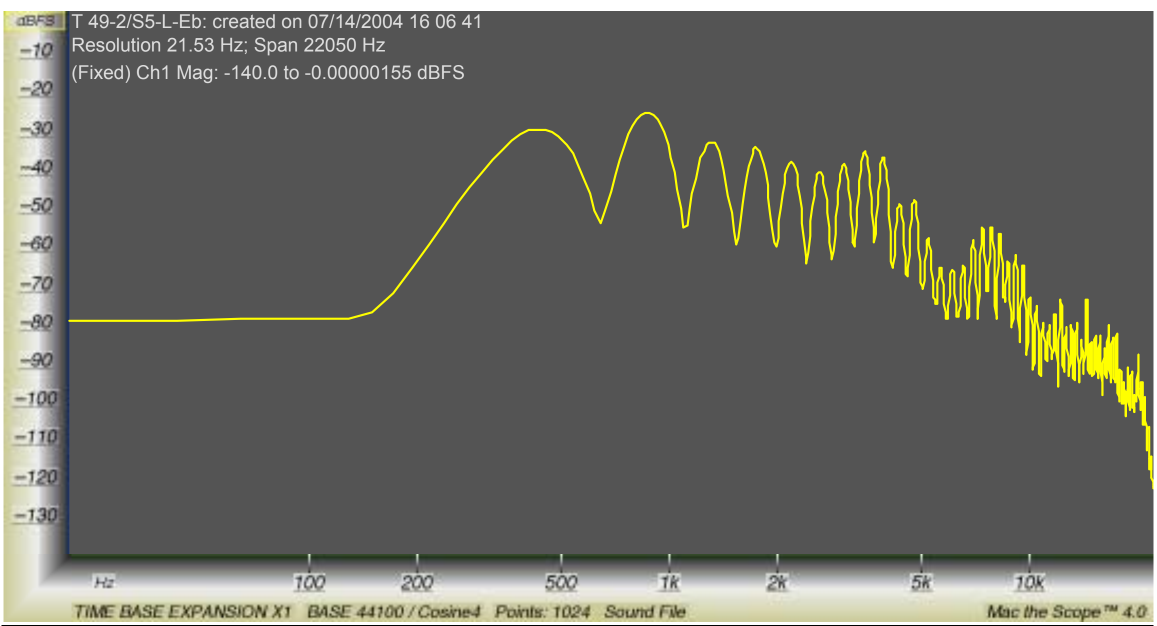
Subject 4, Lakey-Eb, Take 41, Blow 3:



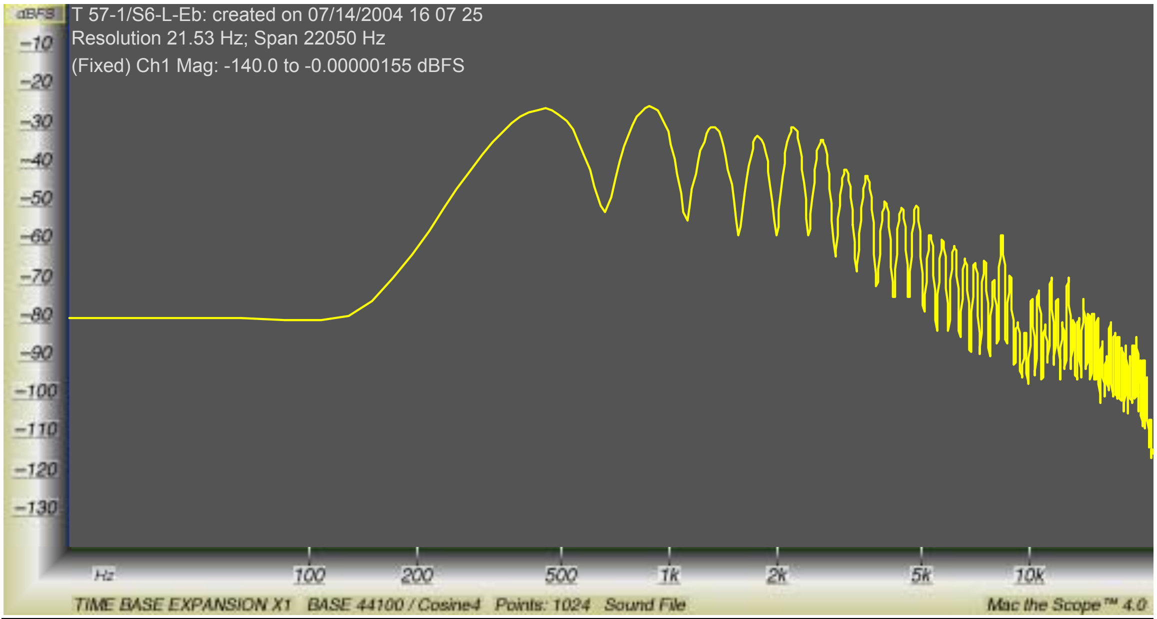
Subject 5, Lakey-Eb, Take 49, Blow 1:



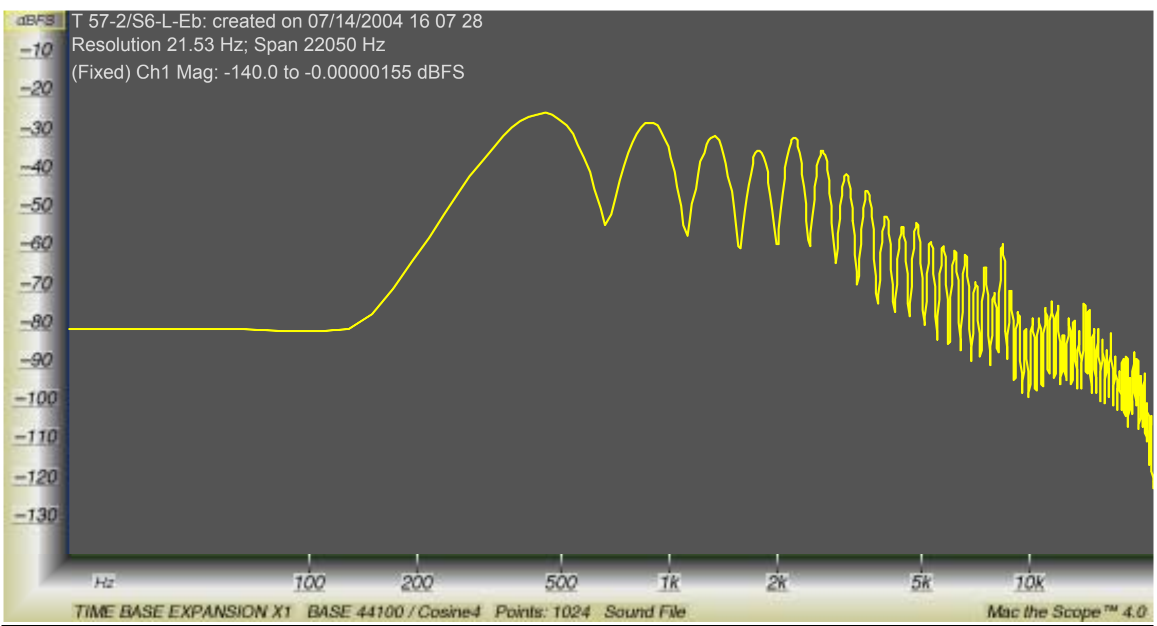
Subject 5, Lakey-Eb, Take 49, Blow 2:



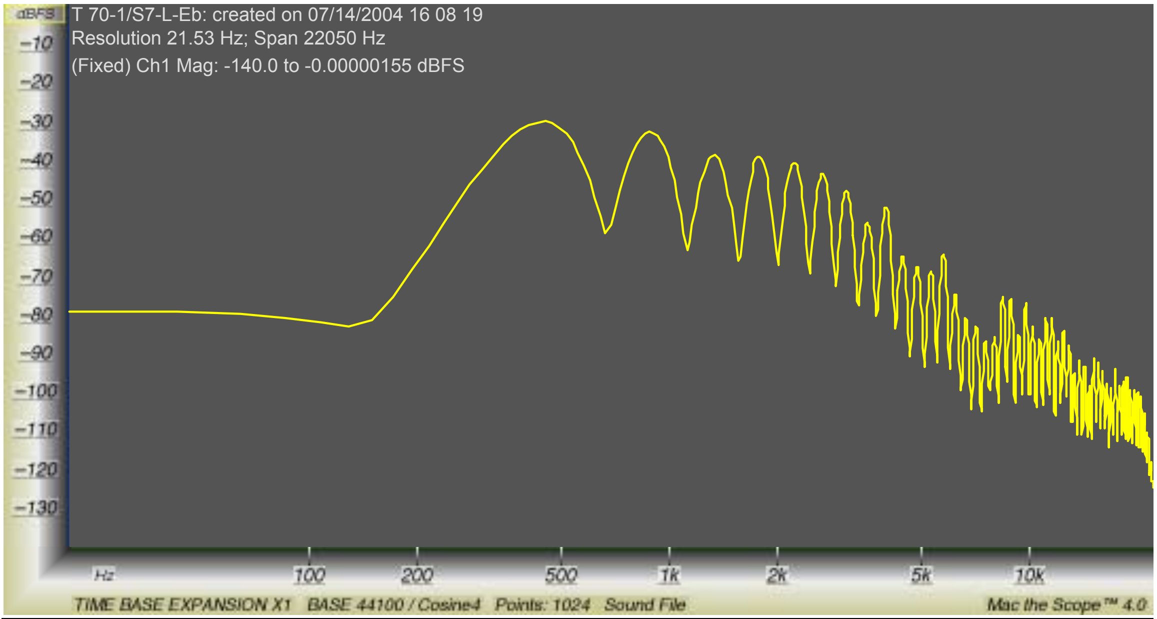
Subject 6, Lakey-Eb, Take 57, Blow 1:



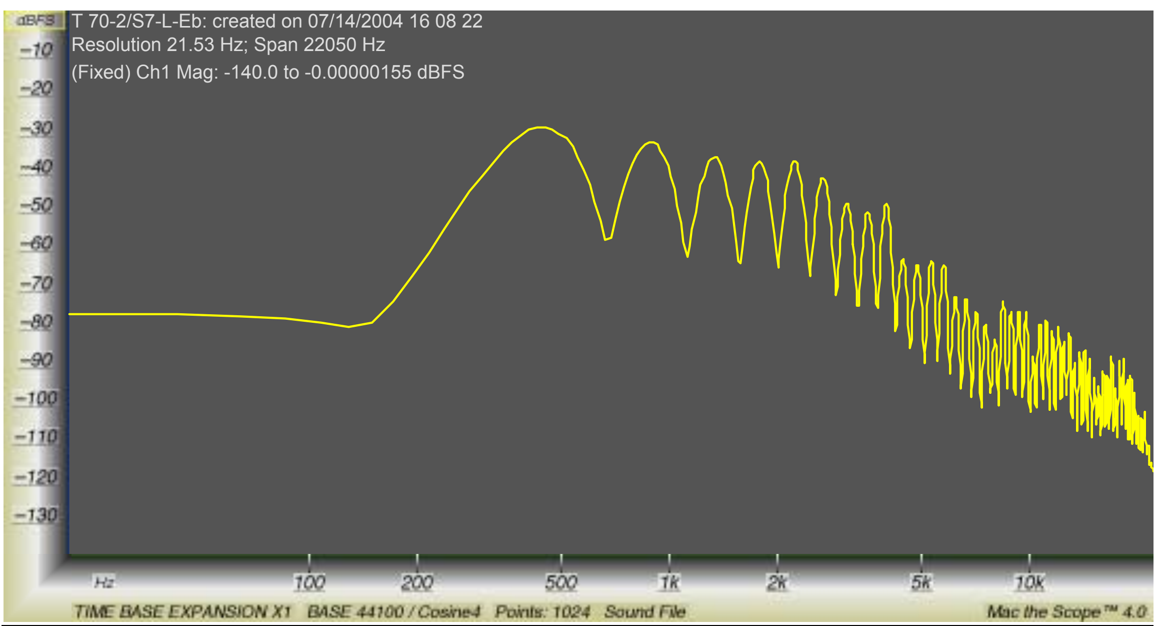
Subject 6, Lakey-Eb, Take 57, Blow 2:



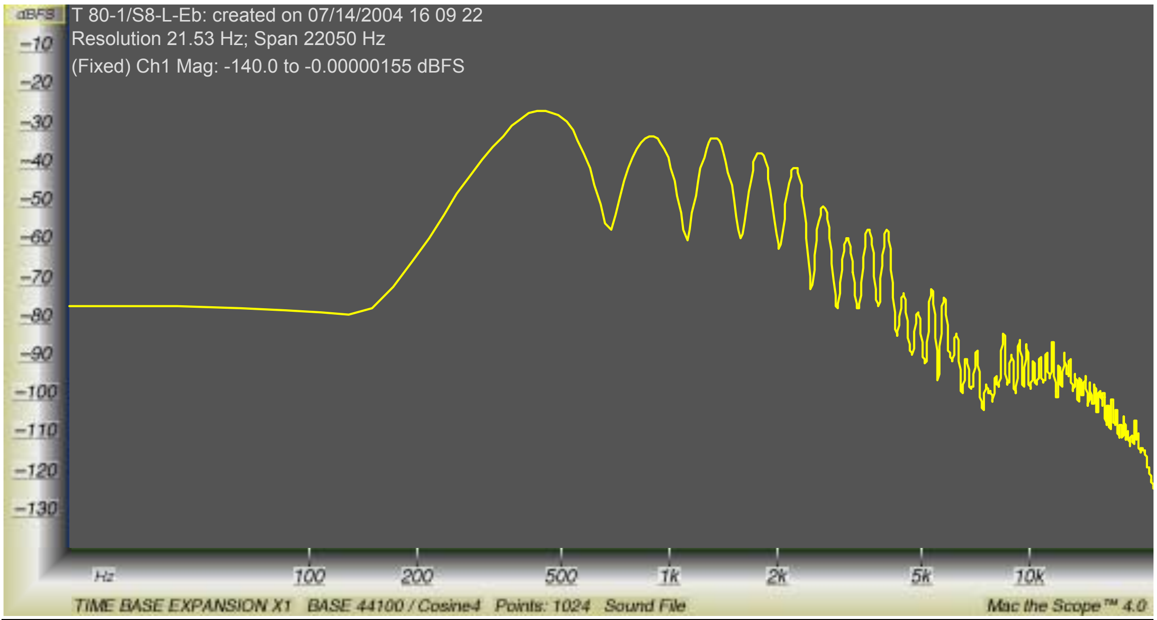
Subject 7, Lakey-Eb, Take 70, Blow 1:



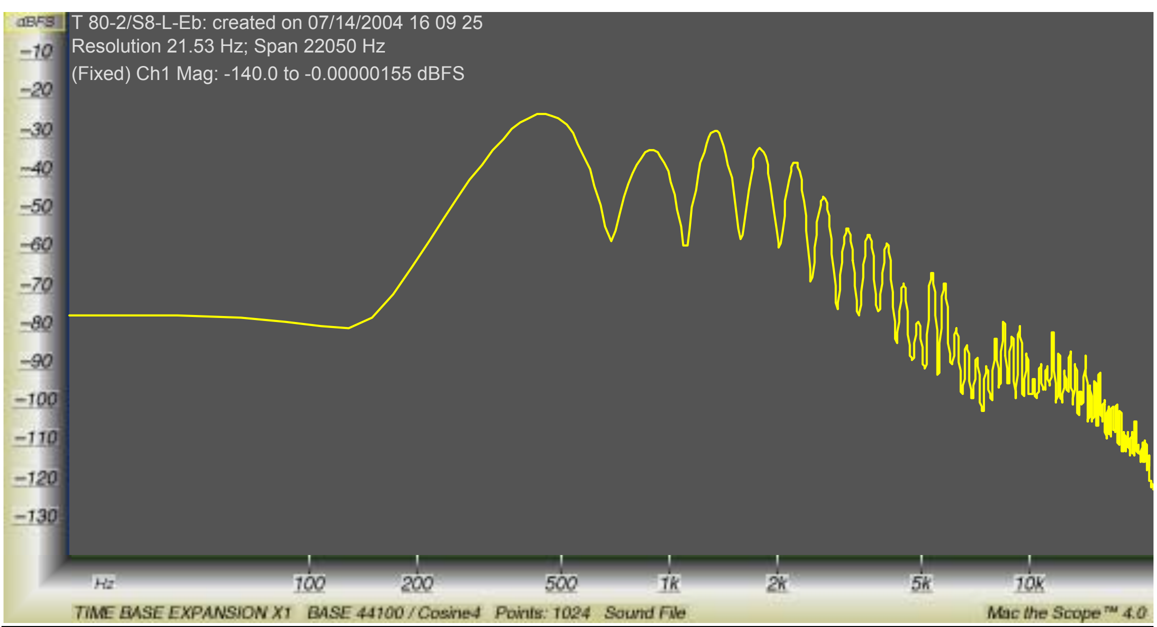
Subject 7, Lakey-Eb, Take 70, Blow 2:



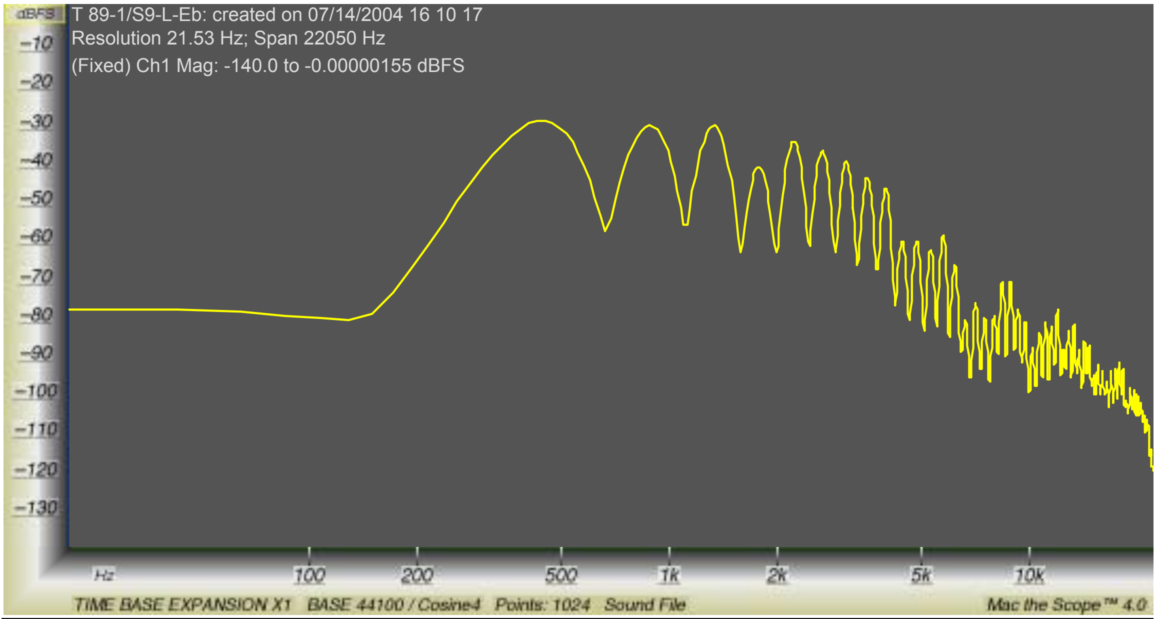
Subject 8, Lakey-Eb, Take 80, Blow 1:



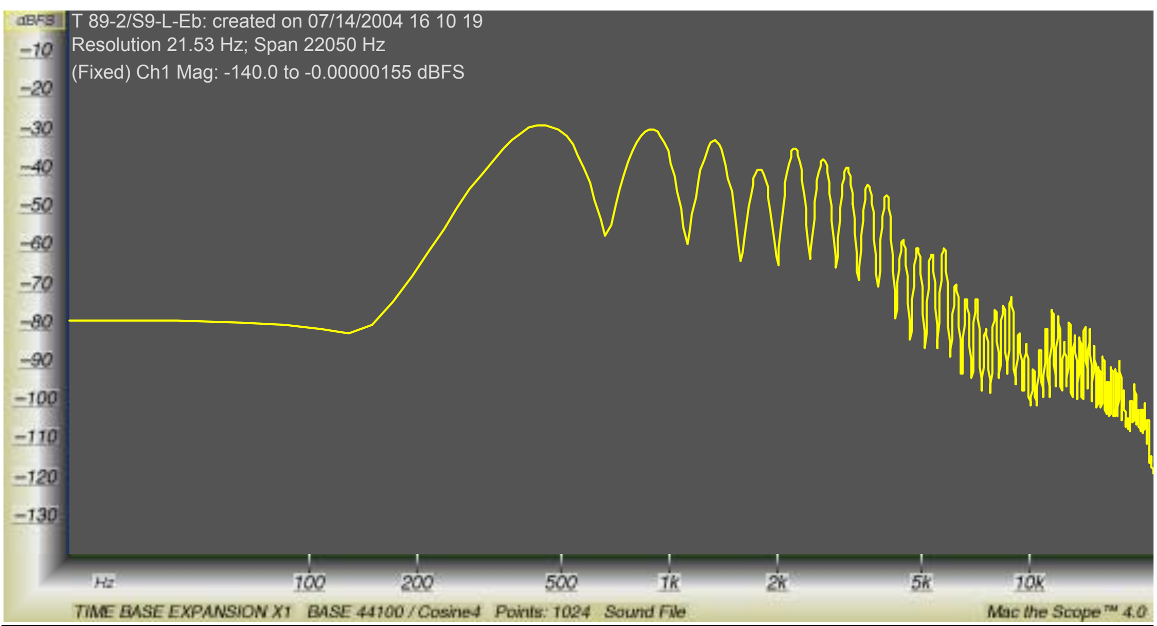
Subject 8, Lakey-Eb, Take 80, Blow 2:



Subject 9, Lakey-Eb, Take 89, Blow 1:

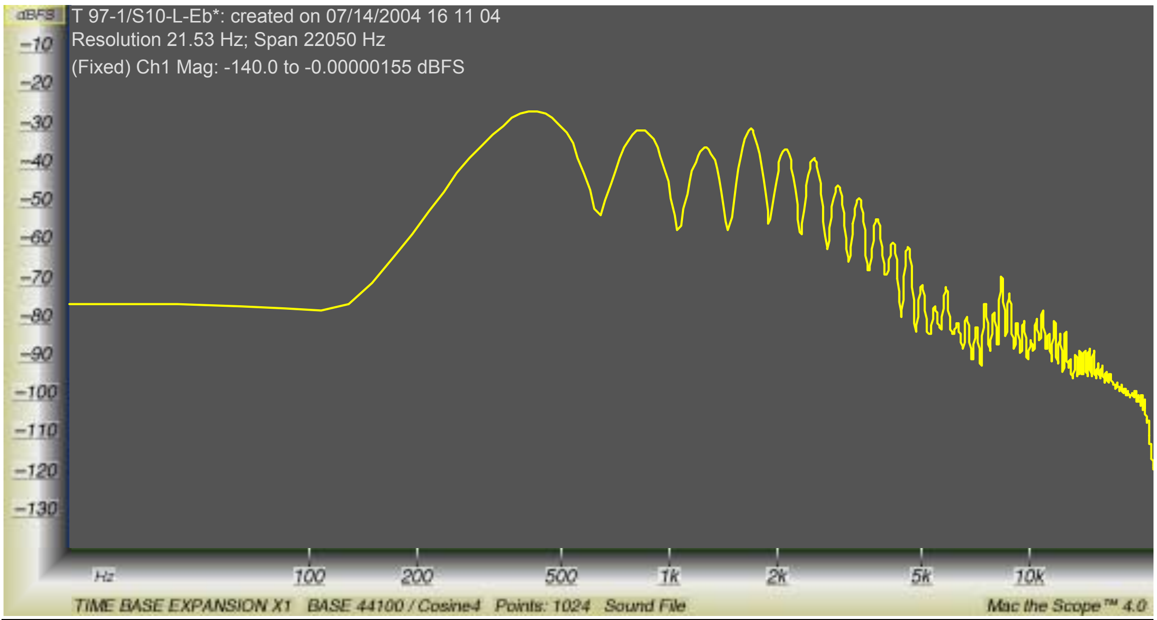


Subject 9, Lakey-Eb, Take 89, Blow 2:

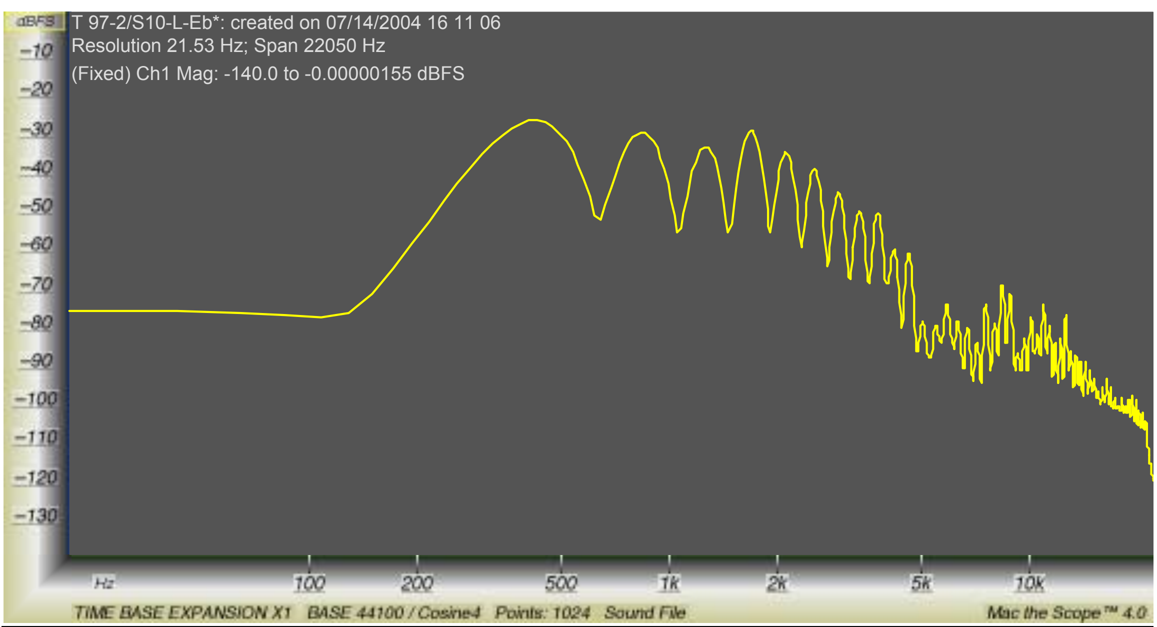


Subject 10 was not able to produce any pitches below an Eb on the mouthpiece. The ‘*’ denotes that the Eb was a stretch.

Subject 10, Lakey-Eb*, Take 97, Blow 1:



Subject 10, Lakey-Eb*, Take 97, Blow 2:



APPENDIX J: ITAKURA-SAITO DISTANCES OF SAXOPHONE TONE QUALITIES AT MOUTHPIECE PITCH LEVEL OF A5

S = Subject
T = Take
# = Blow

80 = S80 Mouthpiece
90 = S90 Mouthpiece
M = Meyer Mouthpiece
L = Claude Lakey Mouthpiece

JR = Jazz Reference
CR = Classical Reference

O = OK, tone was a classical match
E = Error, tone was a jazz match
Match = smallest number in row

		JR1, 1	JR1, 2	JR2, 1	JR2, 2	JR3, 1	JR3, 2	CR1, 1	CR1, 2	CR1, 3	CR2, 1	CR2, 2	CR3, 1	CR3, 2	O/E
S1-T3, 1	**80**	720.73	594.02	787.52	1145.88	1291.28	1574.27	3963.77	3634.02	4029.46	475.83	565.87	234.76	1279.76	O
S1-T3, 2	**80**	588.55	589.53	832.43	1301.61	1287.88	1373.16	4587.97	4591.19	4648.91	735.4	890.21	180.78	759.43	O
S1-T4, 1	**90**	1237.39	829.44	825.12	1030.88	1588.66	2734.69	722.14	1352.25	789.19	304.22	306.67	484.06	1722.24	O
S1-T4, 2	**90**	1096.53	731.74	785.18	1011.52	1569.28	2349.19	977.06	1786.19	1058.23	288.79	299.64	363.67	1184.98	O
S1-T5, 1	**M**	728.63	1695.26	393.62	2093.76	1179.84	5000.06	52106.33	40769.23	63159.15	3970.45	5027.06	2413.16	5915.45	E
S1-T5, 2	**M**	826.53	1501.24	426.15	2850.56	1499.38	9041.04	71434.81	61282.62	88951.81	5017.54	6677.74	4095.6	13138.86	E
S1-T6, 1	**L**	3977.45	1656.01	1469.95	1419.68	3567.38	10467.78	27696.61	28773.21	31722.07	2754.12	3683.18	7319.12	20624.72	E
S1-T6, 2	**L**	492.53	1035.99	679.76	2334.56	1588.88	6013.79	39131.08	34573.13	41584.32	4536.31	6224.38	4339.88	10039.74	E
S2-T12, 1	**80**	1613.58	733.95	860.67	1040.99	1628.76	3943.33	3208.43	3467.88	3975.86	289.96	299.61	1171.39	5472.34	O
S2-T12, 2	**80**	760.31	687.24	760.25	1223.79	1309.93	2878.59	6771.18	5272.94	8455.85	578.53	742.47	825.93	4523.58	O
S2-T13, 1	**90**	824.75	699.26	732.78	1009.75	1289.08	1606.36	1806.44	1870.97	2121.56	347.33	431.95	254.51	1381.75	O
S2-T13, 2	**90**	1853.61	1118.11	717.21	851.19	1478.04	2425.28	1780.44	2205.14	2063.77	199.05	270.78	908.24	3147.5	O
S2-T14, 1	**M**	22497.77	24452.98	18298.92	6485.02	15854.36	41487.95	4833.05	4054.93	8839.28	16344.94	15223.04	53409.9	96519.18	O
S2-T14, 2	**M**	24539.75	24314	14878.72	6157.5	11267.51	288893.12	18915.64	10654.3	27419.36	18774.91	19505.1	47159.24	81730.64	E
S2-T14, 3	**M**	28032.21	26328.58	13278.33	2992.67	13594.62	39667.39	6089.32	5118.64	5724.53	7681.77	6791.13	39003.99	86939.79	E
S2-T15, 1	**L**	8074.2	11618.12	6859.27	4034.64	7869.56	12000.26	4392.39	3065.63	5251.04	6965.21	7027.26	15491.77	22740.3	O
S2-T15, 2	**L**	5450.24	6018.88	4625.18	2825.7	5279.28	10140.1	1703.73	1672.51	2466.49	3712.76	3926.82	9181.95	18710.38	O
S2-T15, 3	**L**	61997.54	73138.93	67973.43	37329.8	49056.24	117641.04	38522.9	24931.74	59709.23	88893.13	83775.29	223519.1	332619.59	O
S2-T15, 4	**L**	70587.44	85331.84	81085.9	44426.08	58737.15	132597.83	49691.42	30741.17	80189.61	115074.18	110210.41	266460.92	396077.77	O
S2-T16, 1	**L**	71416.87	83960.34	81763.37	43726.99	56113.51	132690.8	49175.69	29687.75	75539.92	112483.79	105527.41	267154.35	384256.79	O
S2-T16, 2	**L**	65614.52	74442.33	68647.47	33454.31	52947.72	126635.15	28413.46	20610.15	52727.32	90990.07	83134.69	231232.7	356598.37	O
S3-T23, 1	**80**	1244.79	3532.19	974.26	2109.72	1169.14	1478.62	26612.65	20407.99	25965.18	3186.92	3996.85	2270	2967.11	E
S3-T23, 2	**80**	1196.89	4941.3	1766.25	3247.88	1058.93	911.88	42400.37	27813.85	40339.59	5977.91	6605.31	3556.73	3282.59	E
S3-T24, 1	**90**	602.71	1644.76	578.35	2741.86	937.05	2391.74	26329.74	22533.14	29670.02	2924.85	3856.37	1447.99	4333.57	E
S3-T24, 2	**90**	808.57	1866.3	618.41	2598.99	1018.91	1856.28	25419.8	18726.16	26345.69	2682.74	3569.89	1256.19	3546.99	E
S3-T25, 1	**M**	93701.76	55845.69	22844.17	6137.29	27524.05	99272.37	56477.68	56551.15	62112.33	10835.89	8994.18	86744.21	226962.09	E
S3-T25, 2	**M**	114828.94	59193.71	21205.85	4791.61	25269.13	88232.74	36286.56	46072.19	41119.72	6400.57	4207.6	86556.25	218728.06	O
S3-T26, 1	**L**	25528.18	76600.71	26512.26	39061.15	4017.89	1271.9	392912.75	220506.21	456001.71	169573.62	172574.16	102740.36	85345.42	E
S3-T26, 2	**L**	11486.24	59232.58	15448.12	30276.51	1411.96	1188.51	307500.04	189284.66	366825.09	105219.91	111298.23	62487.81	51166.37	E
S3-T26a	**L**	25565.18	76628.31	26502.56	39042.09	4017.12	1271.6	392920.22	220519.31	456010.7	169549.68	172557.4	102726.93	85340.78	E

		JR1, 1	JR1, 2	JR2, 1	JR2, 2	JR3, 1	JR3, 2	CR1, 1	CR1, 2	CR1, 3	CR2, 1	CR2, 2	CR3, 1	CR3, 2	O/E
S3-T26b	**L**	11533.38	59299.82	15453.74	30272.36	1415.52	1203.92	307520.41	189319.95	366852.71	105228.18	111318.68	62526.86	51228.03	E
S4-T33, 1	**80**	935.06	706.9	1416.9	1699.39	1883.29	1709.8	600.88	997.19	521.99	925.81	903.43	477.27	580.09	O
S4-T33, 2	**80**	752.26	636.54	1094.68	1292.29	1549.28	1420.77	292.25	563.66	258.5	636.4	646.91	362.39	525.27	O
S4-T34, 1	**90**	557.72	599.2	821.45	1153.77	1318.44	1520.5	3132.9	4255.95	3387.58	714.26	894.97	363.22	751.34	O
S4-T34, 2	**90**	642.71	501.05	967.63	1281.46	1534.44	1607.63	2188.63	3060.51	2374.03	673.31	732.27	330.29	594.81	O
S4-T35, 1	**M**	458.3	999.87	927.6	1633.69	1066.95	1226.78	9089.25	8176.41	10079.68	1943.59	2145.89	882.69	1596.76	E
S4-T35, 2	**M**	559.99	1494.57	1008.67	2291.58	1055.4	1014.45	7905.77	6931.41	8511.8	2593.91	3049.19	1291.28	1737.17	E
S4-T36, 1	**L**	15007.92	8981.04	4131.32	1456.88	6046.61	25453.84	2071.72	3450.91	2253.3	1383.51	976.98	16128.72	48413.62	O
S4-T36, 2	**L**	8927.49	6510.05	4108.68	1876.93	6361.47	22813.41	463.91	862.17	278.03	1799.43	1305.12	14331.33	40342.65	O
S5-T42, 1	**80**	2321.62	1082.2	386.61	841.14	2220.07	5090.39	11680.34	13619.29	11729.81	1200.12	1925.3	2721.94	6007.77	E
S5-T42, 2	**80**	1532.06	756.13	419.78	1439.88	2649.18	7224.99	18134.99	19532.9	19521.67	2109.59	3215.86	3760.98	8156.48	E
S5-T43, 1	**90**	809.88	945.8	429.24	1385.65	1570.96	4067.56	17264.85	17440.26	16795.57	1761.61	2524.2	1750.69	4096.16	E
S5-T43, 2	**90**	1670.86	959.42	373.54	1156.96	2180.35	5887.8	17578.99	18925.42	17278.5	1656.56	2589.69	2677.2	6954.44	E
S5-T44, 1	**M**	968.72	7144.91	1566.98	5081.95	797.37	2098.35	93555.42	59253.73	110502.11	15813.22	17666.9	7161.26	8309.02	E
S5-T44, 2	**M**	1093.49	8248.88	2102.4	5990.32	818.02	1443.91	83722.88	51366.77	99161.7	17080.97	19062.01	7851.97	8046.73	E
S5-T45, 1	**L**	1861.01	1345.4	478.27	2863.27	1449.37	10509.34	72851.91	61791.67	78275.64	5135.52	6884.31	3974.83	15998.05	E
S5-T45, 2	**L**	1359.38	1377.52	475.21	3508.36	1356.53	8094.3	71703.55	60551.92	78821.69	5931.59	7827.73	3325.31	12329.67	E
S6-T50, 1	**80**	820.14	613.88	955.83	1221.8	1511.03	1604.6	888.27	1364.52	920.88	454.76	451.11	191.58	626.85	O
S6-T50, 2	**80**	566.04	557.54	855.38	1202.58	1305.97	1429.64	3585.31	3634.04	3304.03	638.16	755.49	288.47	620.88	O
S6-T51, 1	**90**	806.42	532.55	1016.77	1287.36	1571.36	1694.24	833.03	1264.34	818.38	527.71	523.82	243.06	681.15	O
S6-T51, 2	**90**	917.72	585.51	938.43	1107.13	1460.93	1796.51	422.79	755.58	476.21	454.99	472.43	486.85	1214.08	O
S6-T52, 1	**M**	1594.76	608.44	515.73	1280.07	1800.78	5073.86	15208.1	14117.51	17116.07	946.16	1376.58	1859.32	7629.85	E
S6-T52, 2	**M**	3340.02	852.32	574.76	1869.12	2820.23	10625.02	29874.02	24347.65	34769.57	1549.85	2192.46	3685.47	18011.06	E
S6-T53, 1	**L**	6300.41	5343.84	2498.09	1153.52	5532.31	12631.98	1907.23	2911.75	1477.7	1317.34	1045.21	8309.18	25530.18	O
S6-T53, 2	**L**	5278.13	5447.76	2855.65	1519.64	5223.35	11553.41	1138.16	1448.31	647.29	1877.75	1591.15	8029.69	22000.56	O
S7-T58, 1	**80**	1484.96	712.47	745.49	859.63	1410.7	2294.51	1486.15	1893.96	1774.73	298.92	347.96	924.68	2657.45	O
S7-T58, 2	**80**	1115.62	558.47	901.81	1220.64	1568.26	2224.43	2471.29	3013.61	2817.87	487	528.68	527.19	2110.35	O
S7-T59, 1	**90**	845.78	581.7	964.95	1252.04	1513.42	1930.62	2099.65	2701.29	2064.91	490.02	491.7	244.71	1045.6	O
S7-T59, 2	**90**	694.84	592.87	913.9	1238.74	1426.38	1632.58	2426.11	2836.5	2452.44	546.23	601.47	185.27	719.2	O
S7-T60, 1	**M**	3472.61	2443.21	1311.11	939.86	2653.42	5827.95	1019.96	1633.95	956.61	542.55	476.81	2812.57	8014.48	O
S7-T60, 2	**M**	1470.91	658.42	560.84	872.47	1557.11	3268.55	6091.97	6709.76	6635.14	363.27	538.52	849.68	3344.07	O
S7-T61, 1	**L**	2195.26	979.7	655.51	905.29	2030.19	7190.77	15140.22	15600.75	15836.74	822.26	1159.89	2516.73	9254.4	E
S7-T61, 2	**L**	2865.3	892.37	675.11	808.82	2565.93	7952.15	8026.34	10091.37	8644.5	236	263.66	2137.39	8908.99	O
S8-T73, 1	**80**	2495.98	2307.58	1910.56	1506.77	3628.09	6089.06	296.69	573.96	352.31	1274.49	1168.44	3441.05	8355.31	O
S8-T73, 2	**80**	2243.67	2029.7	1741.86	1530.62	2985.95	5278.96	292.02	635.76	251.04	1097.32	990.82	2679.3	6553.51	O

		JR1, 1	JR1, 2	JR2, 1	JR2, 2	JR3, 1	JR3, 2	CR1, 1	CR1, 2	CR1, 3	CR2, 1	CR2, 2	CR3, 1	CR3, 2	O/E
S8-T74, 1	**90**	1287.88	1121.21	1208.53	1344.47	2041.81	2990.64	260.14	597.7	168.85	643.66	602.9	920.2	2255.02	O
S8-T74, 2	**90**	1218.62	1085.85	1136.64	1260.97	1966.61	2963.22	263.5	558.92	197.37	595.14	566.34	883.99	2369.37	O
S8-T75, 1	**M**	1423.46	757.28	686.2	919.14	1582.34	2721.25	3365.24	4563.33	3574.14	288.93	351.8	594.99	2155.36	O
S8-T75, 2	**M**	1005.09	582.11	688.09	1061.45	1494.99	2499.09	4739.86	6637.32	5037.84	445.75	553.31	483.37	1738.8	O
S8-T76, 1	**L**	9105.27	15143.63	4995.98	2728.5	10934.22	18294.96	1544.62	1383.26	2090.81	5185.98	4209.16	16651.12	30661.78	O
S8-T76, 2	**L**	7144.21	11243.84	4342.02	2404.47	9441.28	16822.07	1110.06	1206.68	1565.75	4406.09	3590.02	14306.6	29759.4	O
S9-T82, 1	**80**	984.86	1408.1	699.58	939.66	1201.74	1154.06	5915.61	5651.93	7021.59	938.01	1119.62	437.96	473.15	O
S9-T82, 2	**80**	760.47	937.35	813.26	1048.25	1198.89	1060.03	3168.48	3473.46	3577.85	722.88	807.56	322.83	382.18	O
S9-T83, 1	**90**	1383.83	1096	668.55	839.25	1371.71	2793.16	2310.44	2681.7	2440.9	239.21	335.3	475.05	2175.66	O
S9-T83, 2	**90**	1718.87	1658.96	755.48	871.07	1491.41	2009.91	1620.37	1958.05	1703.79	322.91	510.33	654.89	1497.34	O
S9-T84, 1	**M**	887.7	746.43	540.78	818.53	1249.72	3059.29	9225.36	7656.71	9614.06	379.04	538.7	518.12	3044.32	O
S9-T84, 2	**M**	2055.12	1033.49	504.06	784.43	1852.33	8061.33	22302.28	18444.07	24999.52	484.3	751.16	1516.62	8709.72	O
S9-T85, 1	**L**	21495.2	14115.02	8240.46	1837.71	15927.27	56082.17	1598.83	2172.81	1280.45	3931.52	2766.13	34623.57	95703.72	O
S9-T85, 2	**L**	37379.09	27227.85	20468.98	5191.86	30117.03	97490.11	2396.28	2359.05	3561.14	14341.36	10317.81	90081.21	191991.14	O
S10-T90, 1	**80**	824.95	801.86	980.72	1200.45	1436.88	1242.64	345.47	668.93	321.2	484.35	503.68	176.46	176.64	O
S10-T90, 2	**80**	808.34	761.18	1006.67	1242.08	1453.88	1267.37	342.56	659.91	298.76	510.4	515.32	182.95	191.16	O
S10-T91, 1	**90**	707.15	678.63	854.4	1070.15	1273.27	1175.46	590.19	914.3	611.57	413.23	440.05	162.14	332.93	O
S10-T91, 2	**90**	748.49	697.89	910.16	1127.97	1345.22	1267.39	430.09	813.93	456.49	439.15	453.72	189.89	341.39	O
S10-T92, 1	**M**	2214.58	1500.98	1235.32	1001.6	2133.47	5377.68	2534.4	3261.05	2433.23	524.26	500.16	2678.02	8246.6	O
S10-T92, 2	**M**	1458.02	1154.4	1142.71	1157.87	1955.08	3940.23	1451.18	2184.75	1112.76	521.87	465.58	1450.98	4810.92	O
S10-T93, 1	**L**	16915.74	17309.94	7426.72	2575.49	9627.9	24774.37	4556.84	3878.21	5821.43	6782.37	5792.74	26349.26	58894.55	E
S10-T93, 2	**L**	10529.76	10677.47	4995.86	1889.87	7421.17	22261.55	1683.98	1469.99	1771.53	3888.64	3200.63	17825.98	46380.32	O

APPENDIX K: ITAKURA-SAITO DISTANCES OF SAXOPHONE TONE QUALITIES AT MOUTHPIECE PITCH LEVEL OF Eb5

S = Subject
T = Take
# = Blow

80 = S80 Mouthpiece
90 = S90 Mouthpiece
M = Meyer Mouthpiece
L = Lakey Mouthpiece

JR = Jazz Reference
CR = Classical Reference

O = OK, tone was a jazz match
E = Error, tone was a classical match
Match = smallest number in row

		JR1, 1	JR1, 2	JR2, 1	JR2, 2	JR3, 1	JR3, 2	CR1, 1	CR1, 2	CR1, 3	CR2, 1	CR2, 2	CR3, 1	CR3, 2	O/E
S1-T7, 1	**80**	1701.53	1169.6	896.93	956.94	1735.33	3054.91	636.2	1127.37	608.49	326.75	325.9	960.68	2804.54	E
S1-T7, 2	**80**	1077.62	808.31	686.55	881.2	1380.71	1883.85	1429.43	1799.35	1481.73	230.13	281.98	331.28	1192.75	E
S1-T8, 1	**90**	735.39	699.79	807.45	1038.94	1306.83	1216.73	792.62	1107.48	793.66	361.91	411.67	119.74	353.35	E
S1-T8, 2	**90**	838.12	737.82	796.93	1008.45	1324.5	1477.06	552.51	947.36	565.19	326.21	366.49	180.1	571.37	E
S1-T9, 1	**M**	1280.71	6920.24	773.5	7706.65	2395.58	19144.41	133206.99	88266.23	164098.55	18498.27	24793.51	13420.14	33160.68	O
S1-T9, 2	**M**	1058.67	3873.15	864.73	10380.55	1555.61	13950.68	103900.29	57844.95	133243.67	14702.83	19655.86	10535.08	38154.78	O
S1-T10, 1	**L**	11682.92	4822.04	3218.68	1145.34	5927.15	19112.3	15547.26	16604.33	20331.68	3586.82	4679.04	16562.39	37790.51	O
S1-T10, 2	**L**	16764.79	6327	2800.57	1056.39	7757.99	25295.89	19369.19	21544.32	23745.87	1800.66	1461.03	15788.18	46491.25	O
S2-T17, 1	**80**	796.2	1409.32	745.8	1907.05	1077.61	4681.71	19910.06	13356.74	24669.4	2506.3	3499.69	3156.79	10982.64	O
S2-T17, 2	**80**	590.7	2538.14	982.52	3767.56	1050.11	3700.07	24208.9	14739.01	30203.57	4455.78	5797.01	3876.54	11228.73	O
S2-T18, 1	**90**	589.05	817.57	688.06	1369.01	1137.92	1581.03	4039.98	4260.68	4647.66	973.12	1288.77	396.76	1286.27	E
S2-T18, 2	**90**	606.79	659.02	666.95	1277.02	1238.1	1762.87	3496.24	3839.7	3861	828.66	1116.09	387.22	1166.74	E
S2-T19, 1	**M**	1500.93	904.14	383.73	3778.26	2001.87	13660.54	70404.87	54358.78	93084.53	4871.27	6858.18	5245.95	23544.18	O
S2-T19, 2	**M**	1863.43	6672.95	878.17	12105.64	2489.66	18151.54	121892.43	85244.95	158098.33	16978.45	22539.65	12511.49	38517.52	O
S2-T20, 1	**L**	86502.23	80860.14	53575.08	21789.49	37901.7	119746.03	13442.27	10732.5	21584.61	45045.88	38535.86	175116.3	341664.31	E
S2-T20, 2	**L**	112718.65	86656.1	43775.97	15036.07	31304.77	113476.37	13083.69	14440.21	12234.86	22330.98	16695.49	134656.05	306964.2	E
S2-T21, 1	**L**	88940.43	80967.92	47649.22	17781.59	37717.55	124023.47	10989.47	8804.65	13287.87	35728.41	28710.5	159432.96	338187.23	E
S2-T21, 2	**L**	87749.72	76686.04	39242.77	11980.64	33245.22	114660.09	13545.22	14177.21	13504.61	25461.53	20526.43	136261.62	310151.26	O
S3-T27, 1	**80**	90002.84	137599.33	82998.39	63886.72	20224.46	15567.86	313264.99	140834.82	361446.25	234918.31	236625.65	277504.52	288990.64	O
S3-T27, 2	**80**	85348.84	129600.38	77235.8	57985.38	18681.37	15312.23	288065.25	139892.55	330410.85	212811.75	213121.75	249429.03	261507.02	O
S3-T27a	**80**	90028.03	137632.23	82988.55	63879.47	20224.58	15569.01	313269.77	140843.45	361455.21	234904.37	236620.51	277501.2	288991.32	O
S3-T27b	**80**	85319.5	129550.83	77244.38	57995.97	18686.74	15302.27	288026.45	139864.48	330370.07	212811.96	213112.77	249417.1	261469.11	O
S3-T28, 1	**90**	10692.62	58321.43	14580.15	30805.82	1214.51	3256.61	133439.07	89766.56	156894.61	53452.94	63470.55	46637.54	47471	O
S3-T28, 2	**90**	13318.6	51739.64	14176.3	23877.01	1283.41	1283.39	109266.84	75259.9	131312.59	48022.54	55610.64	40176.41	39257.63	O
S3-T28a	**90**	10778.53	58515.65	14603.5	30850.9	1206.89	3256.3	133651.94	89875.36	157112.71	53572.96	63611.03	46757.98	47623.01	O
S3-T28b	**90**	13400.84	51864.38	14192.91	23889.85	1288.16	1296.87	109390.98	75323.12	131445.4	48063.82	55663.01	40250.42	39352.77	O
S3-T29, 1	**M**	120347.64	188191.47	125301.83	95680.3	48177.57	47071.15	406578.74	178992.75	507349.05	335903.52	352062.62	481534.6	550556.07	O
S3-T29, 2	**M**	171743.01	242366.38	200842.76	114884.5	62280.71	53203.75	472760.59	227156.7	625871.17	452514.79	477611.34	689720.91	846710.04	O
S3-T29a	**M**	121283	189460.24	125688.23	95949.51	48570.88	47604.45	407680.34	179974.51	508570.63	336424.02	352732.86	482429.42	551680.71	O
S3-T29b	**M**	171899.93	242557.44	200886.9	114904.64	62321.16	53258.91	472878.58	227287.33	626037.13	452570.01	477701.53	689848.24	846897.13	O

		JR1, 1	JR1, 2	JR2, 1	JR2, 2	JR3, 1	JR3, 2	CR1, 1	CR1, 2	CR1, 3	CR2, 1	CR2, 2	CR3, 1	CR3, 2	O/E
S3-T30, 1	**L**	18801.43	58546.46	18320.39	26546.91	2349.27	2896.62	309201.36	157593.59	360500.96	139206.54	148692.76	83237.48	70321.87	O
S3-T30, 2	**L**	72736.17	128654.27	77033.14	60467.96	18969.08	15159.61	425354.97	189958.6	520246.99	344507.89	353316.35	457999.89	429733.01	O
S3-T31, 1	**L**	16193.16	56026.86	16543.46	32409.79	2350.32	5701.12	304623.01	158303.23	376738.88	130708.7	143489.97	76745.44	62490.42	O
S3-T31, 2	**L**	53141.14	95047.15	54103.23	39357.23	12837.17	12258.84	372340.57	170806.48	408464.8	261090.85	255046.76	271851.19	245748.49	O
S3-T31, 3	**L**	53722.33	102747.07	61778.53	59839.28	13791.71	8402.08	397678.92	169506.19	496705.22	330878.82	339555.38	375458.59	328156.86	O
S3-T32, 1	**L**	22230.4	60172.43	17361.29	37797.45	2409.95	5585.86	333403.5	159097.28	426417.48	167268.85	183715.46	97431.52	82934.11	O
S3-T32, 2	**L**	36720.11	90109.81	30770.26	58953.47	4566.75	6232.63	352442.93	171827.96	445616.36	188508.22	209093.76	129616.31	115496.52	O
S3-T32a	**L**	22515.29	60557.72	17554.88	37882.37	2455.68	5603.97	333937.64	159302.97	427151.21	167766.06	184244.36	98252.74	83908.49	O
S3-T32b	**L**	36725.5	90223.05	30801.45	58975.26	4566.23	6233.69	352547.37	171876.83	445710.18	188561.09	209150.72	129717.09	115569.18	O
S4-T37, 1	**80**	68657.37	100871.66	111347.89	101240.98	10356.88	14815.51	204253.65	115742.54	223209.99	189587.13	196576.91	187728.8	225747.97	O
S4-T37, 2	**80**	32441.79	51546.84	53361.54	53192.5	5327.61	5458.92	139287.52	100142.14	144414.74	141996.13	144404.6	103465.54	120870.7	O
S4-T38, 1	**90**	26178.97	41849	40439.27	41801.66	4551.82	4066.22	120068.88	89895.15	126185.09	131352.26	131977.58	89903.47	106993.19	O
S4-T38, 2	**90**	16891.98	28436.57	27428.74	29922.76	3520.67	2487.47	94166.38	77097.98	93800.94	100073.75	100595.23	60717.26	69973.62	O
S4-T39, 1	**M**	169187.36	275919.32	180930.01	152644.57	43336.92	132212.34	287073.19	182630.63	346109.34	250495.88	269587.48	327074.34	373496.04	O
S4-T39, 2	**M**	187121.67	286381.39	168218.38	130210.59	50327.47	152523.28	455907.72	224191.48	473774.25	280909.27	311455.8	395157.2	462785.13	O
S4-T39, 3	**M**	182055.75	314887.34	216940.85	187825.31	41181.66	145106.69	207837.49	156140.16	267282.64	243823.05	257236.65	328041.05	362646.97	O
S4-T39, 4	**M**	156363.64	269008.93	210411.38	191620.89	37690.76	112952.49	181229.26	148750.88	216858.67	222025.4	231085.28	259172.4	275982.23	O
S4-T40, 1	**M**	179581.61	276902.78	178984.06	148129.87	42799.24	150120.96	287052.07	201733.83	352800.27	251260.44	268786.12	333054.99	381963.32	O
S4-T40, 2	**M**	166113.62	271860.82	188446.94	161621.85	45232.29	143342.75	293522.55	185639.14	352783.88	259625.84	279115.49	333225.65	382001.84	O
S4-T41, 1	**L**	218503.17	357917.2	286843.43	230364.67	44361.93	136946.13	270959.45	156267.85	372306.16	352282.49	354918.96	509360.38	594758.03	O
S4-T41, 2	**L**	359498.49	532236.02	324330.91	266627.22	117245.21	206540.3	454111.42	315925.92	562246.38	403377.6	432138.62	591922.16	690324.99	O
S4-T41, 3	**L**	234887.31	384388.13	293305.91	222710.74	40149.65	112858.36	383063.46	165912.02	536976.72	427601.75	444065.94	655060.98	778357.32	O
S5-T46, 1	**80**	52048.62	86671.14	55135.02	35038.49	16582.01	15890.92	204090.88	106964.74	226939.48	142785.87	145033.34	180075.09	192593.12	O
S5-T46, 2	**80**	43768.82	59564.87	30846.22	18193.77	11200.75	10491.02	160651.61	83216.02	167355.54	99255.2	100764.06	107524.79	105793.53	O
S5-T47, 1	**90**	40128.8	62198.52	38763.21	30520.28	9270.65	7500.34	173175.06	83386.37	184966.28	111497.26	111788.12	128648.05	130670.49	O
S5-T47, 2	**90**	27590.87	44260.23	27758.39	20574.34	7228.41	5905.8	129699.69	67284.36	138430.77	85678.5	85018.98	96978.11	98155.98	O
S5-T48, 1	**M**	159493.99	215165.55	146281.88	116264.53	29284.9	28027.4	302206.35	129887.1	430315.42	300757.47	318316.53	437601.42	524311.95	O
S5-T48, 2	**M**	131367.76	184340.02	115935.09	99589.29	23277.61	20680.07	275451.86	100361.94	383829.11	265095.1	278033.47	378541.69	433262.9	O
S5-T49, 1	**L**	77097.22	201392.2	63904.44	102939.15	2328.22	1701.54	395268	184691.9	506442.89	230429.91	266393.12	195586.14	181321.01	O
S5-T49, 2	**L**	28106.06	103047.12	29558.3	57614.75	1016.05	930.95	298857.66	132419.45	379587.69	153854.61	173992.99	108653.14	90735.9	O
S6-T54, 1	**80**	634.67	2074.28	886.17	1542.83	1021.05	1031.23	15096.6	11542.65	15343.92	3021.83	3225.93	1368.22	1179.03	O
S6-T54, 2	**80**	553.65	1584.42	730.15	1450.98	1067.57	1354.91	11117.25	8907.04	11446.08	1969.31	2280.84	787.49	891.75	O
S6-T55, 1	**90**	521.21	829.8	656.35	1314.44	1179.91	1859.86	14240.25	10895.17	14362.79	1415.7	1747.99	560.38	1470	O
S6-T55, 2	**90**	997.32	3670.49	1367.08	2337.29	971.87	882.7	22498.62	16673.07	25379.48	6397.09	6862.5	3447.94	2670.18	O
S6-T56, 1	**M**	4789.83	15681.07	4284.85	5605.94	1331.53	2267.48	66709.21	46971.32	68546.03	16410.79	18043.97	11078.91	10595.14	O
S6-T56, 2	**M**	2079.62	11277.97	2483.33	4737.46	1332.54	4089.67	43180.44	31699.03	45290.09	8684.38	10716.32	7659.27	8803.18	O
S6-T57, 1	**L**	22475.27	12065.18	4351.48	1299.42	9417.84	28027.96	15272.63	17532.1	17572.06	2453.53	1762.71	22340.74	61462.3	O
S6-T57, 2	**L**	31518.86	28773.3	13513.1	4082.52	14990	43772.57	4671.24	5665.67	4532.89	84890.81	6193.61	41955.42	91205.4	O

		JR1, 1	JR1, 2	JR2, 1	JR2, 2	JR3, 1	JR3, 2	CR1, 1	CR1, 2	CR1, 3	CR2, 1	CR2, 2	CR3, 1	CR3, 2	O/E
S7-T62, 1	**80**	4009.02	2401.02	1353.35	1172.92	2556.71	7411.19	19948.16	16335.58	23810.62	1852.83	2303.51	5955.32	15375.5	O
S7-T62, 2	**80**	2114.51	7957.67	2275.75	5866.25	1015.94	921.49	63342	43873.43	76471.39	25665.04	27212.59	11134.91	7112.82	O
S7-T63, 1	**90**	1242.92	5189.41	1770.26	3132.6	1047.5	981.81	30098.56	22956.84	34940.42	11541.61	11952.59	6039.55	4808.5	O
S7-T63, 2	**90**	533.05	3103.41	1017.28	3088.77	1033.75	1964.24	26922.08	23513.05	32370.15	6682.05	7443.61	2819.22	2848.15	O
S7-T64, 1	**M**	3052.23	10519.07	2916.91	4876.81	1139.66	944.19	47041.31	34795.07	51163.38	18440.8	19914.35	10954.77	9275.18	O
S7-T64, 2	**M**	4105.45	13406.88	3375.45	4671.22	1580.75	1668.47	56394.12	41787.94	58327.66	23614.04	24742.05	18291.29	16658.04	O
S7-T70, 1	**L**	12403.05	13103.99	7098.72	2400.54	11158	27917.6	1687	1770.2	1787.15	5837.62	4476.57	24475.22	55338.05	E
S7-T70, 2	**L**	18658.4	21238.74	12336.01	4126.13	16204.77	40503.77	3024.1	2461.53	4590.01	12382.29	9885.46	47169.57	100670.82	E
S8-T77, 1	**80**	17193.6	33437.45	13246.39	6622.53	20842.34	26683.48	6094.98	4190.44	8459.8	15511.83	13680.82	40377.71	61635.53	E
S8-T77, 2	**80**	21512.68	41097.02	16844.18	7783.3	28035.86	38919.97	7546.07	6030.38	10549.27	19678.19	17557.27	55725.58	93071.36	E
S8-T78, 1	**90**	3722.89	4946.29	2862.03	1761.78	4935.69	8702.48	488.18	746.91	688.02	2417.68	2127.57	6682.58	13247.07	E
S8-T78, 2	**90**	3275.33	4574.6	2539.83	1619.03	4753.35	8125.97	486.41	749.22	635.62	2092.14	1804.39	6020.49	12706.8	E
S8-T79, 1	**M**	1595.29	1326.96	868.85	825.82	2041.99	3661.73	1284.13	1944.89	1169.05	386.34	397.85	1419.46	4119.72	E
S8-T79, 2	**M**	1778.39	1540.47	998.58	905.86	2194.53	4966.29	793.43	1388.52	668.93	450.48	428.69	1827.64	6112.17	E
S8-T80, 1	**L**	10726.57	18566.85	5980.76	2748.96	13159.68	22281.4	1806.27	1496.24	2470.96	6669.64	5242.57	22434.2	42624.88	E
S8-T80, 2	**L**	18137.9	32274.3	9975.25	4291.94	22739.48	36967.7	2725.21	2171.78	3846.56	11142.45	8734.25	37508.01	69922.45	E
S9-T87, 1	**80**	1842.73	6597.25	2116.95	4209.03	888.68	866.31	32074.75	23992.56	36302.82	11802.42	12527.76	5740.49	4715.21	O
S9-T87, 2	**80**	679.54	1183.4	608.57	1408.14	1070.51	1313.98	9769.75	8384.49	11200.17	1388.5	1760.99	360.95	904.35	E
S9-T86, 1	**90**	1601.49	5461.38	1815.75	3255.36	915.96	702.43	44988.36	33911.79	51923.99	19123.51	18861.77	7793.11	5475.99	O
S9-T86, 2	**90**	1125.22	2686.13	931.04	1786.96	1026.55	927.19	20439.2	13508.89	25213.47	7026.18	7422.73	2949.59	2171.15	O
S9-T88, 1	**M**	6579.09	16473.3	12592.13	10205.86	5428.8	2466.85	84659.29	53846.99	90003.22	45088.59	45547.21	44358.67	40136.92	O
S9-T88, 2	**M**	3467.74	8004.22	4487.06	5589.7	1553.24	886.16	59388.73	39696.84	58162.37	23037.35	23700.7	17762.72	14025.06	O
S9-T88, 3	**M**	5797.65	14860.85	6753.15	5837.51	2165.99	1392.86	102634.81	66841.51	99132.26	50276.25	47474.34	37565.98	30137.64	O
S9-T89, 1	**L**	18864.7	13406.32	8849.01	2669.6	15330.16	49747.33	6373.35	6002.37	7552.94	7220.53	5672.27	38877.75	94166.77	O
S9-T89, 2	**L**	32437.56	31367.34	28000.18	10541	31208.14	80518.45	7278.34	5053.41	12075.16	28538.63	23575.19	101148.75	186490.39	E
***S10-T94, 1**	**80**	5546.25	11352.29	8771.11	4528.69	1564.48	1075.47	55712.7	24764.96	50753.12	35128.24	32638.49	38587.18	34164.36	O
***S10-T94, 2**	**80**	1614.42	3764.03	3003.29	2329.47	1225.48	984.36	35441.48	17236	31665.41	17480.47	16149.81	13290.55	9956.78	O
S10-T95, 1	**90**	39170.82	69908.14	30152.5	19730.04	3595.01	2447.24	141314.61	49885.62	140053.26	68759.35	74012.98	114960.19	139812.75	O
S10-T95, 2	**90**	16486.07	34150.67	11823.8	6235.13	2620.79	1779.96	74627.2	36521.14	68543.71	36018.16	37181.05	59413.36	70427.88	O
S10-T96, 1	**M**	60450.4	131203.47	41264.88	34550.12	4420.52	5008.63	166303.69	81908.74	150974.84	89321.42	95053.89	136774.97	167425.95	O
S10-T96, 2	**M**	69919.62	148417.97	46608.02	36495.08	4749.94	4336.56	219420.15	98844.49	205315.53	117561.65	125034.84	180755.92	223147.8	O
S10-T97, 1	**L**	101268.71	226652.1	63936.83	42147.76	5851.41	4872.35	361155.85	146912.54	338966.65	166825.69	177588.68	294074.11	365538.74	O
S10-T97, 2	**L**	105167.24	258873.32	56353.88	32778.3	5612.98	3502	415214.6	190128.13	371475.91	181799.7	191289.92	336345.94	406933.57	O

* Subject was only capable of producing an E5 on mouthpiece, no lower.

APPENDIX L: CLOSEST ITAKURA-SAITO DISTANCE OF SAXOPHONE TONE QUALITIES AT MOUTHPIECE PITCH LEVEL OF A5

S = Subject
T = Take
# = Blow

80 = S80 Mouthpiece
90 = S90 Mouthpiece
M = Meyer Mouthpiece
L = Claude Lakey Mouthpiece

JR = Jazz Reference
CR = Classical Reference
O = OK, tone was a classical match
E = Error, tone was a jazz match

		Distance	**Reference**	**O/E**
S1-T3, 1	**80**	234.5	CR3	O
S1-T3, 2	**80**	180.78	CR3	O
S1-T4, 1	**90**	304.22	CR2	O
S1-T4, 2	**90**	288.79	CR2	O
S1-T5, 1	**M**	393.62	JR2	E
S1-T5, 2	**M**	426.15	JR2	E
S1-T6, 1	**L**	1419.68	JR2	E
S1-T6, 2	**L**	492.53	JR1	E
S2-T12, 1	**80**	289.96	CR2	O
S2-T12, 2	**80**	578.53	CR2	O
S2-T13, 1	**90**	254.1	CR3	O
S2-T13, 2	**90**	199.05	CR2	O
S2-T14, 1	**M**	4054.93	CR1	O
S2-T14, 2	**M**	6157.5	JR2	E
S2-T14, 3	**M**	2992.67	JR2	E
S2-T15, 1	**L**	3065.63	CR1	O
S2-T15, 2	**L**	1672.51	CR1	O
S2-T15, 3	**L**	24931.74	CR1	O
S2-T15, 4	**L**	30741.17	CR1	O
S2-T16, 1	**L**	29687.75	CR1	O
S2-T16, 2	**L**	20610.15	CR1	O
S3-T23, 1	**80**	974.26	JR2	E
S3-T23, 2	**80**	911.88	JR3	E
S3-T24, 1	**90**	578.35	JR2	E
S3-T24, 2	**90**	618.41	JR2	E
S3-T25, 1	**M**	6137.29	JR2	E
S3-T25, 2	**M**	4207.6	CR2	O
S3-T26, 1	**L**	1271.9	JR3	E
S3-T26, 2	**L**	1188.51	JR3	E
S3-T26a	**L**	1271.6	JR3	E
S3-T26b	**L**	1203.92	JR3	E
S4-T33, 1	**80**	477.27	CR3	O

S4-T33, 2	**80**	258.5	CR1	O
S4-T34, 1	**90**	363.22	CR3	O
S4-T34, 2	**90**	330.29	CR3	O
S4-T35, 1	**M**	458.3	JR1	E
S4-T35, 2	**M**	559.99	JR1	E
S4-T36, 1	**L**	976.98	CR2	O
S4-T36, 2	**L**	278.03	CR1	O
S5-T42, 1	**80**	386.61	JR2	E
S5-T42, 2	**80**	419.78	JR2	E
S5-T43, 1	**90**	429.24	JR2	E
S5-T43, 2	**90**	373.54	JR2	E
S5-T44, 1	**M**	797.37	JR3	E
S5-T44, 2	**M**	818.02	JR3	E
S5-T45, 1	**L**	478.27	JR2	E
S5-T45, 2	**L**	475.21	JR2	E
S6-T50, 1	**80**	191.58	CR3	O
S6-T50, 2	**80**	288.47	CR3	O
S6-T51, 1	**90**	243.06	CR3	O
S6-T51, 2	**90**	422.79	CR1	O
S6-T52, 1	**M**	515.73	JR2	E
S6-T52, 2	**M**	574.76	JR2	E
S6-T53, 1	**L**	1045.21	CR2	O
S6-T53, 2	**L**	647.29	CR1	O
S7-T58, 1	**80**	298.92	CR2	O
S7-T58, 2	**80**	487	CR2	O
S7-T59, 1	**90**	244.71	CR3	O
S7-T59, 2	**90**	185.27	CR3	O
S7-T60, 1	**M**	476.81	CR2	O
S7-T60, 2	**M**	363.27	CR2	O
S7-T61, 1	**L**	655.51	JR2	E
S7-T61, 2	**L**	236	CR2	O
S8-T73, 1	**80**	296.69	CR1	O
S8-T73, 2	**80**	251.04	CR1	O
S8-T74, 1	**90**	168.85	CR1	O
S8-T74, 2	**90**	197.37	CR1	O
S8-T75, 1	**M**	288.93	CR2	O
S8-T75, 2	**M**	445.75	CR2	O
S8-T76, 1	**L**	1383.26	CR1	O
S8-T76, 2	**L**	1110.06	CR1	O
S9-T82, 1	**80**	437.96	CR3	O
S9-T82, 2	**80**	322.83	CR3	O
S9-T83, 1	**90**	239.21	CR2	O
S9-T83, 2	**90**	322.91	CR2	O
S9-T84, 1	**M**	379.04	CR2	O
S9-T84, 2	**M**	484.3	CR2	O

S9-T84, 1	**L**	1280.45	CR1	O
S9-T84, 2	**L**	2359.05	CR1	O
S10-T90, 1	**80**	176.46	CR3	O
S10-T90, 2	**80**	182.95	CR3	O
S10-T91, 1	**90**	162.14	CR3	O
S10-T91, 2	**90**	189.89	CR3	O
S10-T92, 1	**M**	500.16	CR2	O
S10-T92, 2	**M**	465.58	CR2	O
S10-T92, 1	**L**	2575.49	JR2	E
S10-T92, 2	**L**	1469.99	CR1	O

APPENDIX M: CLOSEST ITAKURA-SAITO DISTANCE OF SAXOPHONE TONE QUALITIES AT MOUTHPIECE PITCH LEVEL OF Eb5

S = Subject	80 = S80 Mouthpiece	JR = Jazz Reference
T = Take	90 = S90 Mouthpiece	CR = Classical Reference
# = Blow	M = Meyer Mouthpiece	O = OK, tone was a jazz match
	L = Claude Lakey Mouthpiece	E = Error, tone was a classical match

		Distance	**Reference**	**O/E**
SI-T7, 1	**80**	325.9	CR2	E
S1-T7, 2	**80**	230.13	CR2	E
S1-T8, 1	**90**	119.74	CR3	E
S1-T8, 2	**90**	180.1	CR3	E
S1-T9, 1	**M**	773.5	JR2	O
S1-T9, 2	**M**	864.73	JR2	O
S1-T10, 1	**L**	1145.34	JR2	O
S1-T10, 2	**L**	1056.39	JR2	O
S2-T17, 1	**80**	745.8	JR2	O
S2-T17, 2	**80**	590.7	JR1	O
S2-T18, 1	**90**	396.76	CR3	E
S2-T18, 2	**90**	387.22	CR3	E
S2-T19, 1	**M**	383.73	JR2	O
S2-T19, 2	**M**	878.17	JR2	O
S2-T20, 1	**L**	10732.5	CR1	E
S2-T20, 2	**L**	12234.86	CR1	E
S2-T21, 1	**L**	8804.65	CR1	E
S2-T21, 2	**L**	11980.64	JR2	O
S3-T27, 1	**80**	15567.86	JR3	O
S3-T27, 2	**80**	15312.23	JR3	O
S3-T27a	**80**	15569.01	JR3	O
S3-T27b	**80**	15302.27	JR3	O
S3-T28, 1	**90**	1214.51	JR3	O
S3-T28, 2	**90**	1283.39	JR3	O
S3-T28a	**90**	1206.89	JR3	O
S3-T28b	**90**	1288.16	JR3	O
S3-T29, 1	**M**	47071.15	JR3	O
S3-T29, 2	**M**	53203.75	JR3	O
S3-T29a	**M**	47604.45	JR3	O
S3-T29b	**M**	53258.91	JR3	O
S3-T30, 1	**L**	2349.27	JR3	O
S3-T30, 2	**L**	15159.61	JR3	O

S3-T31, 1	**L**	2350.32	JR3	O
S3-T31, 2	**L**	12258.84	JR3	O
S3-T31, 3	**L**	8402.08	JR3	O
S3-T32, 1	**L**	2409.95	JR3	O
S3-T32, 2	**L**	4566.75	JR3	O
S3-T32a	**L**	2455.68	JR3	O
S3-T32b	**L**	4566.23	JR3	O
S4-T37, 1	**80**	10356.88	JR3	O
S4-T37, 2	**80**	5327.61	JR3	O
S4-T38, 1	**90**	4066.22	JR3	O
S4-T38, 2	**90**	2487.47	JR3	O
S4-T39, 1	**M**	43336.92	JR3	O
S4-T39, 2	**M**	50327	JR3	O
S4-T39, 3	**M**	41181.6	JR3	O
S4-T39, 4	**M**	37690.76	JR3	O
S4-T40, 1	**M**	42799.24	JR3	O
S4-T40, 2	**M**	45232.29	JR3	O
S4-T41, 1	**L**	44361.93	JR3	O
S4-T41, 2	**L**	117245.21	JR3	O
S4-T41, 3	**L**	40149.65	JR3	O
S5-T46, 1	**80**	15890.92	JR3	O
S5-T46, 2	**80**	10491.02	JR3	O
S5-T47, 1	**90**	7500.34	JR3	O
S5-T47, 2	**90**	5905.8	JR3	O
S5-T48, 1	**M**	28027.4	JR3	O
S5-T48, 2	**M**	20680.07	JR3	O
S5-T49, 1	**L**	1701.54	JR3	O
S5-T49, 2	**L**	930.95	JR3	O
S6-T54, 1	**80**	634.67	JR1	O
S6-T54, 2	**80**	553.65	JR1	O
S6-T55, 1	**90**	521.21	JR1	O
S6-T55, 2	**90**	882.7	JR3	O
S6-T56, 1	**M**	1331.53	JR3	O
S6-T56, 2	**M**	1332.54	JR3	O
S6-T57, 1	**L**	1299.42	JR2	O
S6-T57, 2	**L**	40822.52	JR2	O
S7-T62, 1	**80**	1172.92	JR2	O
S7-T62, 2	**80**	921.49	JR3	O
S7-T63, 1	**90**	981.81	JR3	O
S7-T63, 2	**90**	533.05	JR1	O
S7-T64, 1	**M**	944.19	JR3	O
S7-T64, 2	**M**	1580.75	JR3	O
S7-T70, 1	**L**	1687	CR1	E
S7-T70, 2	**L**	2461.53	CR1	E
S8-T77, 1	**80**	4190.44	CR1	E

S8-T77, 2	**80**	6030.38	CR1	E
S8-T78, 1	**90**	488.18	CR1	E
S8-T78, 2	**90**	486.41	CR1	E
S8-T79, 1	**M**	386.34	CR2	E
S8-T79, 2	**M**	428.69	CR2	E
S8-T80, 1	**L**	1496.24	CR1	E
S8-T80, 2	**L**	2171.78	CR1	E
S9-T87, 1	**80**	866.31	JR3	O
S9-T87, 2	**80**	360.95	CR3	E
S9-T86, 1	**90**	702.43	JR3	O
S9-T86, 2	**90**	927.19	JR3	O
S9-T88, 1	**M**	2466.85	JR3	O
S9-T88, 2	**M**	886.16	JR3	O
S9-T88, 3	**M**	1392.86	JR3	O
S9-T89, 1	**L**	2669.6	JR2	O
S9-T89, 2	**L**	5053.41	CR1	E
***S10-T94, 1**	**80**	1075.47	JR3	O
***S10-T94, 2**	**80**	984.36	JR3	O
S10-T95, 1	**90**	2447.24	JR3	O
S10-T95, 2	**90**	1779.96	JR3	O
S10-T96, 1	**M**	4420.52	JR3	O
S10-T96, 2	**M**	4336.56	JR3	O
S10-T97, 1	**L**	4872.35	JR3	O
S10-T97, 2	**L**	3502.95	JR3	O

VITA

Vanessa Rae Hasbrook was born in Vancouver, Washington on March 19, 1974. In 1996, she earned a Bachelor of Music in saxophone performance and music education from the University of Idaho, where she studied with Dr. Robert Miller. In 1998, she completed a Master of Music in saxophone performance at Baylor University, studying with Dr. Michael Jacobson. While attending the University of Illinois at Urbana-Champaign, she studied with Professor Debra Richtmeyer. Vanessa has served on the faculties of Southern Illinois University, Seattle Pacific University, Saint Martins College and Pacific Lutheran University. She currently teaches instrumental music at Lakeridge Junior High School in Sumner, Washington, and will begin teaching instrumental music at Bonney Lake High School in Bonney Lake, Washington in fall, 2005.