ABSTRACT

Title of Dissertation: THE ELECTRONIC WORKS OF GYÖRGY LIGETI AND THEIR INFLUENCE ON HIS LATER STYLE.

Benjamin Robert Levy, Doctor of Philosophy, 2006.

Directed By: Professor Thomas DeLio, School of Music

This dissertation, entitled *The Electronic Works of György Ligeti and Their Influence on his Later Style* investigates the connections between the composer's pieces for electronic tape written in the late 1950s and the instrumental music he composed thereafter. There are numerous reasons to suspect such a chain of influence, including suggestive comments Ligeti has made in interviews. Moreover, these works, *Glissandi* (1957), *Artikulation* (1958), and the uncompleted *Pièce électronique no. 3* (1957-58), were written at a critical point in the composer's career, falling between two major stylistic periods. Before he fled Hungary in December 1956 his compositions were influenced by Bartók, but his orchestral pieces *Apparitions* (1958-59) and *Atmosphères* (1961) were much celebrated for their strikingly original textures and timbres.

While these orchestral pieces secured Ligeti's reputation as an important avant-garde figure, the first works he composed in the West were the electronic pieces, which have suffered relative neglect. There are difficulties inherent in analyzing electronic music, and thus the first chapter of this dissertation focuses on theoretical literature in this

growing field, including discussion of musical timbre, different means of notation, and in particular, the work of theorist Robert Cogan.

Chapters 2 and 3 are analytical studies of Ligeti's finished tape piece, using spectrographs and information from Ligeti's sketches to focus on the use of sonic material in the construction of form. Additionally each study is put in the context of Ligeti's contemporaries, composers such as Karlheinz Stockhausen and Gottfried Michael Koenig, as well as figures such as the philosopher T.W. Adorno. The fourth and final chapter focuses on the historical chain of influence and examines some of Ligeti's instrumental music, particularly *Apparitions*, in light of the their electronic precedents. These examples illuminate connections between the electronic and instrumental, ranging from the slightest nuances in individual gestures–many of which are translated directly from one medium to the other–to methods of constructing entire forms, which continue to appear throughout Ligeti's oeuvre; thus, the final aim of this dissertation is to provide groundwork for further studies which will deepen the understanding of other works by this innovative composer.

THE ELECTRONIC WORKS OF GYÖRGY LIGETI AND THEIR INFLUENCE ON HIS LATER STYLE

by

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Dissertation submitted to the Faculty of the Graduate School of the
University of Maryland, College Park, in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
2006

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ACKNOWLEDGMENTS

I would like to acknowledge the Paul Sacher Foundation for their generous support of this research through a stipend in June of 2004, and also for their knowledgeable and helpful staff. I would also like to acknowledge Universal Edition for their kind permission to reprint parts of the score to *Apparitions*. This project would not have been possible without the support of the faculty and staff of the University of Maryland, and in particular the committee. Likewise, I would like to thank my friends and family for their support and encouragement through this process.

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Chapter 1: Introduction

Historical Background and Reasons for this Study:

After fleeing Hungary in December 1956, György Ligeti composed two works for tape in the electronic music studios of the West Deutscher Rundfunk in Cologne: *Glissandi* (1957) and *Artikulation* (1958); he had drafted a third piece, but left it unfinished. Instead he turned his attention to a new orchestral piece, and after the premiere of *Apparitions* in 1959, he never returned to complete this work, or indeed, to work in the electronic medium ever again. His two finished works were composed under the guidance of Karlheinz Stockhausen and Gottfried Michael Koenig, and in many regards, these works reflect his introduction to the experimental music of this influential circle of avant-garde composers. Along with the unfinished *Pièce électronique No. 3*,[1] which he drafted between the other pieces from November 1957 through January 1958, these compositions occupy a fascinating position in the composer's oeuvre, as they are the first pieces composed entirely outside the repressive artistic climate of communist Hungary and immediately precede his orchestral masterpieces, *Apparitions* in 1958-59 and *Atmospheres* in 1961, which were celebrated at their premieres, brought him international recognition, and which are often considered the first works of his "mature" style. Yet these electronic pieces remain relatively neglected, when compared to the rest of his output.

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[1]This piece has since been realized by Kees Tazelaar along with Johann van Kreij and Paul Berg at the Institute for Sonology in the Hague. This version, completed in 1996, has been released on *His Master's Noise*, BVHAAST CD 06/0701.

There are many reasons to suspect that these orchestral pieces follow the electronic works in more than just chronology. There is a significant break in style between Ligeti's Hungarian works, which follow in the style of Béla Bartók and Zoltán Kodály, and the pieces from *Apparitions* on which were recognized for their original textures and timbres. Richard Steinitz describes the significance of this later style, saying, "In *Apparitions* and *Atmosphères* Ligeti created his trademark, the unmistakable 'Ligeti sound' that would define his music for the net two decades."[2] How Ligeti arrived at this radically new style is a matter deserving investigation, and as these electronic works are the only compositions bridging the timespan between the Hungarian and textural styles, and written during a period of "apprenticeship" while learning about post-war compositional developments, it seems quite reasonable, that these intervening electronic works may be a kind of link between these two bodies of music, containing many ideas which are transitional and provide the seeds of a new musical style which is more fully developed in his later works.

Before his flight from Hungary, it is clear that Ligeti had only limited experience with modern music. Much of this exposure to music banned by the Hungarian authorities would have come through smuggled scores and records. He was able to come by some of Theodor Wiesengrund Adorno's writings on new music, as well as a copy of Hanns Jelinek's *Anleitung zur Zwölftonkomposition*,[3] which contains examples from Schoenberg and Webern, but no information on later serial practice. He also reports having seen the

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[2]Richard Steinitz, *György Ligeti: Music of the Imagination* (Boston: Northeastern University Press, 2003), 98.

[3]Hanns Jelinek, *Anleitung zur Zwölftonkomposition* (Vienna: Universal Edition, 1952-58, 2nd ed., 1967).

score to Alban Berg's *Lyric Suite*, and to Bartók's third and fourth quartets, but performances of these pieces were banned in Hungary. It was possible that towards the end of 1955 or early in 1956 he could have heard some of these pieces on smuggled phonograph recordings, and it is also clear that he had heard some electronic music on radio broadcast, although these were often jammed. Most famously, Ligeti reports having stayed above ground during Soviet tank patrols and shelling in Budapest on November 7, 1956 to listen to a broadcast of Stockhausen's *Gesang der Jünglinge*. Ligeti had begun corresponding with Stockhausen in the summer of that year, and had subsequently received scores from him, although they arrived only shortly before the October uprising, and it is doubtful that Ligeti had examined them before he fled. Thus, Ligeti's experience with modern music before leaving Hungary was nothing more than a tantalizing glimpse of a few examples, and his real introduction to the avant-garde came in the following year, with his arrival in Cologne and his exposure to the electronic studio.

Comments that the composer has made in numerous interviews also suggest that his work in the electronic studio had a definite influence on his later compositions, yet these comments in themselves are often elliptical and vague, lacking in concrete details or tangible connections. For example Ligeti gave a short lecture on "The Effects of Electronic Music on my Compositional Work,"[4] in which he responds to the comment that *Apparitions* and *Atmosphères* are "electronic music, but 'set' for orchestra," denying that this is the case, but nonetheless conceding that, "the experiences with electronic music

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[4]György Ligeti, "Auswirkungen der elektronischen Musik auf mein kompositorisches Schaffen" in *Experimentelle Musik: Raum Musik, Visuelle Musik, Wort Musik, Elektronik Musik, Computer Musik*, International Week for Experimental Music, 1968 (Berlin: Mann, 1970) 73-80.

were influential in the musical thinking and compositional techniques which were relevant for these pieces. Therefore I believe that the work in the studio was particularly fruitful for my later work."[5] Ligeti mentions only two details, which I will discuss in depth in the last chapter of this dissertation, the first being a rhythmic experiment conducted by Gottfried Michael Koenig, and second, the division of the orchestra's string section into individual voices, and at no point does Ligeti discuss details of his own completed tape pieces.

Another intriguing detail connecting the electronic and orchestral pieces was the working title of *Pièce électronique No. 3*. This unfinished work was originally entitled *Atmosphères*, but was renamed when the orchestral piece of 1961 took over that title. While Ligeti has denied any direct connection between the two works, the shared title suggests at the very least a shared aesthetic goal, and, moreover, as the last chapter will reveal, shared compositional techniques.

Before the present study can truly propose answers to any of these questions of influence, or even evaluate what Ligeti and his critics might have meant by "electronic music 'set' for orchestra," we must undertake a detailed study of these electronic works in and of themselves. Thus, the second and third chapters of this dissertation will establish a solid understanding of the finished electronic pieces, *Glissandi* and *Artikulation*, though detailed analysis before the final chapter presents ways in which discoveries from these analyses can inform discussion of the orchestral works. The remainder of this present chapter focuses on the work already undertaken on these pieces and some of the

[5]Ligeti, "Auswirkungen," 74, 77.

challenges–particularly that of analyzing electroacoustic music–that may have prevented more widespread scholarly attention.

Review of Critical Literature

With these compelling reasons to suspect connections between the electronic and orchestral pieces of Ligeti's post-Hungarian period, it is curious that there are not more studies on the electronic works; while many authors comment briefly on these works, there are almost no serious analytical studies of *Glissandi* and *Artikulation*. Most biographies or general works on Ligeti devote a paragraph, or at most a few scant pages to these works, and most often these sources focus on the associations evoked by the musical surface rather than any underlying techniques or methods of construction. Constantin Floros and Wolfgang Burde[6] acknowledge that this period was highly influential in his acquisition of knowledge of serialism and psychoacoustics. However, neither author mentions details of the pieces themselves or how this knowledge might manifest itself in Ligeti's compositional work.

Richard Steinitz comments that, "characteristically, Ligeti focused on the communicative potential of synthesized sound as a quasi-language–evoking associations, images and implications... These extra-musical inferences are apparent in his first electronic work, *Glissandi* composed in 1957."[7] Steinitz goes on to characterize Artikulation as "a compendium of quasi-vocal mannerisms compressed into less than four

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[6]Constantin Floros, *György Ligeti: Jenseits von Avantgarde und Postmoderne* (Vienna: Verlag Lafite, 1996) and Wolfgang Burde, *György Ligeti: eine Monographie* (Zurich: Atlantis Musikbuch, 1993).
[7]Steinitz, *Music of the Imagination*, 79.

minutes."[8] Steinitz points to only two technical features of these works as relevant to Ligeti's later composition–freedom from traditional meter and the abandonment of "motivic and tonal organisation."[9] I do not wish to unjustly criticize what is an excellent biography, for failing to be more analytical–that is not its goal–but merely to point out that both of these comments focus on what traditional elements are now significantly removed from Ligeti's compositional language, rather than what elements Ligeti has employed to replace these.

Similarly, Richard Toop points to *Glissandi*'s "liveliness, and its good humour"[10] as the most striking features. Toop does greater justice to *Artikulation*, recounting its construction (largely according to Rainer Wehinger,[11] whose study is one of the exceptions to the general lack of analytical scholarship and will be discussed below) and moreover, the significance of Ligeti's working method in the context of the Cologne circle. Both of these studies, while excellent biographies, tend towards one vein of interpretation of these pieces, and while the identification of moments in the piece that resemble spoken language, or scatological sounds helps characterize the sound world of the piece for an audience that may not have reference to a recording, more attention to the details of musical coherence is needed to lay claim to any significant influence on Ligeti's later work.

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[8]Ibid, 81.
[9]Ibid, 82
[10]Richard Toop, *György Ligeti* (London: Phaidon Press, 1999), 56.
[11]Rainer Wehinger, *Ligeti – Artikulation: Elektronische Musik, eine Hörpartitur* (Mainz: Schott, 1970); Ulrich Dibelius also recounts this information in his *Moderne Musik* (Munich: Piper, 1966), and with brief commentary on all three electronic pieces in his "Die zweite Sprachfindung" in *György Ligeti: eine Monographie in Essays* (Mainz: Schott, 1994), 9-30, esp. 12, 15-17.

In the more analytical vein of interpretation, only one serious study of *Glissandi* exists, and even this is a very short article, written by Roberto Doati, the English version of which appeared in the journal *Interface*. Doati claims an analytical method derived from the psychologist and acoustician, Stephen McAdams, which consists of five areas of inquiry:

1. Reading the acoustic surface;
2. Organization of acoustic information into coherent auditory 'images';
3. Segmentation and extraction of the musical lexicon;
4. Building structural relations;
5. Following a musical discourse.[12]

According to McAdams, this organizational process is directed primarily at intrinsic musical structures, although it should "provide the structural and procedural grounds for eventually investigating aesthetic and emotional aspects of musical experience,"[13] yet Doati often jumps not only between these areas of intrinsic concern, but even outside this system, characterizing the sounds without reference to specific dimensions of sound or their relationships to each other. While Doati identifies many features salient for differentiating types of glissandi (range, direction, harmonic spectra versus filtered noise) these criteria are never explicitly stated, and are applied ad hoc, often associated with other undefined terms pointing to outside associations; throughout the article, Doati identifies different types of glissandi as, "bartokian," "ironic," or "personal,"[14] without explaining these associations either in terms of their constituent material or their

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[12]Roberto Doati, "György Ligeti's *Glissandi*: An Analysis," *Interface* 20 (1991), 80; originally in Stephen McAdams, "Music: A Science of the Mind?" in *Music and Psychology: A Mutual Regard*, *Contemporary Music Review* 2 no. 1(1987), 34-35.
[13]McAdams, "Music: A Science of the Mind?," 36.
[14]Doati, "Glissandi," 82, 83, and 85.

employment as part of the musical discourse. Consequently, while Doati's descriptions of the sounds of the piece are vivid, and his division of the piece into three main parts seems quite plausible (although in Chapter 2, I will argue for a different conception of the piece's structure), these two elements are disconnected from one another; the relationship of the former in determining the latter is unclear, as the criteria for determining divisions, let alone the relative strengths of these divisions are often unstated.

Moreover Doati is relying solely on audition and his lack of reference to a score, or other visual representation of the piece (only a crude diagram is given) leaves the analysis unrefined, as shown by his statement that in his Part III, "the formal elements built in the two previous parts, and sometimes real fragments of these parts, are composed in a kind of bas-relief by means of jagged amplitude envelopes."[15] In fact, as the composer himself has stated, and as a more precise representation of the piece would bear out, not just some of the elements of this section of the piece, but *all* of the sounds of the second half of the piece are derived quite strictly from the first.[16]

One major study of *Artikulation* addresses both the issue of visual representation and that of reliance on the composer's writings in a much different manner. Rainer Wehinger's graphic "listening score" for *Artikulation* was published in 1970 as an introduction to the piece and its method of construction, and as a transcription of the piece itself. Wehinger's goal is to provide a listening guide, and thus the analysis he undertakes is primarily devoted to explaining the development and layout of his score and the

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[15]Ibid, 85.
[16]In a discussion reprinted in Gottfried Michael Koenig, "Ligeti und die elektronische Musik" in *György Ligeti: Personalstil, Avantgardismus, Popularität* (Vienna: Universal Edition, 1987), 19.

description and definition of basic sound types, geared towards an audience unfamiliar with basic concepts of filtered noise, impulses, and sine tones, either singly or in harmonic or sub-harmonic combination.

While certainly an important achievement, the technology available to Wehinger at the time was rather primitive by today's standards, and while one can easily use the resulting score to follow along with the music and parse the surface into basic categories of sound types, it lacks sufficient detail to truly elucidate connections between events across the piece or to focus one's hearing on details which might otherwise go unnoticed. Due to its colorful presentation, it has also been used as cover art for the Wergo disc containing the piece,[17] has been compared to the work of Miro, whom Ligeti also cites as an influence from the visual arts, and has been referred to in less complimentary terms as a "funny graphical score" or as "the first symptoms, perhaps, of a new urban-technological species of ethnomusicology."[18] Costin Miereanu undertakes a more serious examination of Wehinger's work,[19] ending with a discussion of the types of scores produced for electronic music–prescriptive "realization scores" and more descriptive scores such as the "listening score"–as well as the types of analytic decisions this involves–issues I will return to in the discussion of spectrographs, below.

Wehinger also provides a list of sections, labeled A-G, taken from parts of Ligeti's sketches, and which he maintains reflect the form of the piece. While these do coordinate

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[17]György Ligeti, *Continuum, Zehn Stück für Bläserquintet, Artikulation*, Wergo 60161-50.
[18]Konrad Boehmer, "Koenig, Sound Composition, *Essay*" in *Electroacoustic Music: Analytical Perspectives*, ed. Thomas Licata (Westport, CT: Greenwood Press, 2002), 62; and Richard Toop, "Stockhausen's Electronic Works: Sketches and Work-Sheets from 1952-1967," *Interface* 10 (1981), 149.
[19]Costin Miereanu, "Une musique électronique et sa 'partiton': *Artikulation*," *Musique en jeu* 15 (1973), 99-109.

with pages of Ligeti's sketches, and are accompanied by the composer's description of these sections as "dialogues," "monologues," and so forth, there are problems with taking these divisions as having equal structural weight in the form of the piece. More likely they were of use in executing steps towards the pieces creation. Section A, for example, has 12 subsections and makes up nearly 70% of the piece, while sections B-G have no subsections and all combined are less than half of the duration of A. Thus while Doati proceeds without any reference to the composer's comments, Wehinger, in my view, follows Ligeti's sections too literally and falls into a common mistake which T.W. Adorno, among others warns against, saying that, "one should not overvalue the genesis of the music... and should not, above all, confuse it with the inner dynamics of the composition."[20] My accounts of both pieces will attempt to balance the composer's descriptions of the pieces' construction with a more perceptually informed discussion of how the piece unfolds.

Analytical Methodology

Achieving a level of detailed analysis while balancing different representations of musical structure will require a methodology for the analysis of electroacoustic music, a field in which there is, as of yet, no commonly agreed-upon theory. While McAdams's five areas of inquiry, mentioned briefly above in relation to Doati's analysis, are a good starting point for a theory of listening, including the type of "structural listening"[21] that

[20]T.W. Adorno, "On the Problem of Musical Analysis," trans. Max Paddison, *Music Analysis* 1, no. 2 (Jul. 1982), 183-84.
[21]Ibid, 173.

Adorno identifies as the ultimate concern of analysis, I wish to recast his points in a light less dependent on strict hierarchies; as we shall see later in the study, Ligeti's works, and *Artikulation* in particular, present challenges to strictly hierarchical organizational principles. Nevertheless, my methodology will need to address the need for identifying pertinent sonic information with consistent terminology, especially in the description of timbre; a means of parsing the surface of the music into meaningful units and logical segmentations; and finally, a means of identifying types of motion, transformation, or other degrees of relatedness between these sounds and events. Moreover, and especially in light of the scholarship examined above, the relationship of a score, or other visual representation of the music, to analytical practice.

In an early investigation of the analysis of electroacoustic music, Marco Stroppa identifies many of the problems which arise in the absence of a score.[22] Representations of electronic music fall into two categories, which can be generalized as prescriptive or descriptive–a list of instructions on how to realize the piece, or a representation of the resulting sounds. At the time of his essay, Stroppa finds fault with both, the former being geared towards specialists and often specific to the given technology, incomprehensible to even educated musicians without this technical background; and the latter being insufficiently exact. The problem of having no satisfactory score then compounds the matter of acoustical or perception based analysis, since there is nothing against which to check ones perceptions, resulting in the lack of detail that was evident in Doati's analysis

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[22]Marco Stroppa, "The Analysis of Electronic Music," *Musical Thought at IRCAM, Contemporary Music Review* 1, no. 1 (Oct. 1984), 175-80.

of *Glissandi*. Since Stroppa's first essay, however, advances in technology have made a number of options for creating visual representations of the music more feasible.

One such option is the use of spectrographs; the use of these computer-generated images was pioneered by Robert Cogan in his book, *New Images of Musical Sound*, and has since been adopted by many other analysts.[23] These images are quite intuitively constructed, and figures such as Figure 1.1 bear some resemblance to existing notational practice. Time proceeds along the horizontal axis, from left to right; pitch is displayed on the vertical axis, and in the example below and those which follow, is logarithmically scaled so that octaves appear equally spaced. Intensity corresponds to the darkness of a given image. Thus in the example above, taken from *Glissandi*, the initial material is the softest and is split between the highest and lowest register. The middle material consists of two thin sine-tone strands, and the material at the end is louder and noisier, filling out more of the spectrum at once and with the greatest energy not concentrated within one narrow frequency but spread out across a broad band.

Martha Brech[24] appraises the advantages and caveats of the use of spectrographs in electroacoustic analysis–some of which are clear even from this simple example. First of all, they are quite readable and their depictions are extremely precise. Moreover, spectrographs have a degree of universality which is uncommon in the field of electroacoustic music, and unlike many other representations which are generated for a

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[23]Robert Cogan, *New Images of Musical Sound* (Boston: Harvard Univ. Press, 1984); other analysts include Stephen McAdams, Philippe Depalle, and Eric Clarke, "Analyzing Musical Sound" in *Empirical Musicology: Aims Methods, Prospects* (Oxford: Oxford Univ. Press, 2004), 157-196; Agostino DiScipio and Martha Brech in articles cited below.

[24]Martha Brech, "Sonagraphische Analysen elektroakustischer Musik," in *Electroakustische Musik*, ed. Elena Ungeheuer (Laaber: Laaber-Verlag, 2002), 232-42.

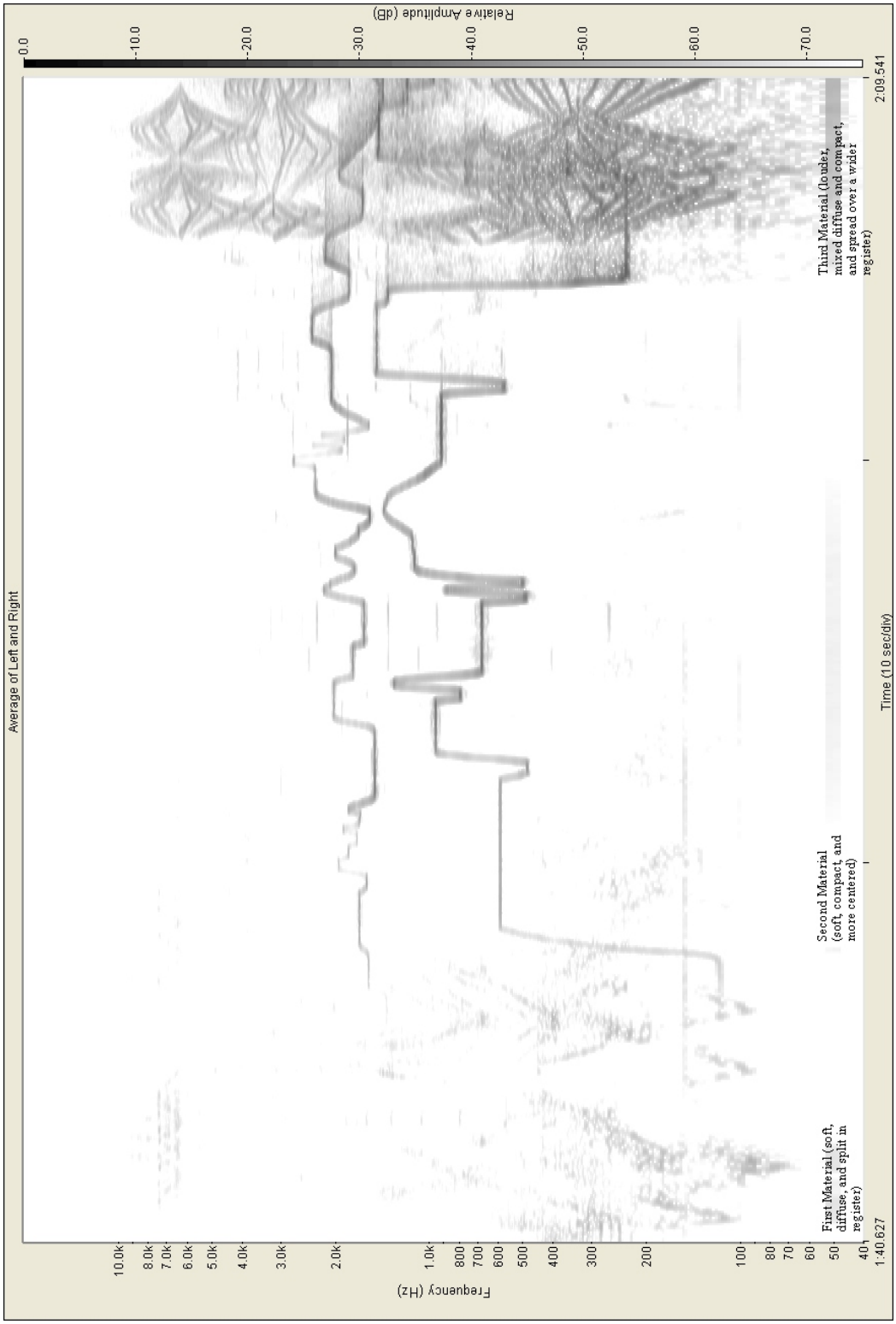

Figure 1.1. Sample Spectrograph from *Glissandi*: Three Types of Material

specific piece or to address a specific analytical problem, they are not as susceptible to subjective bias that may result from the analysts attempt to gear the notation towards making a specific point. This is not to say that spectrographs are completely neutral, for like any chart or graph, they can be manipulated or distorted as well, but there is at the very least, a blind starting point that will ideally help curtail the unconscious bias of the analyst and sharpen his or her audition, exposing details of the piece that a first hearing might not uncover or that a first interpretation might initially suppress.

The types of distortions that can arise from spectrographic analysis of a work are based on the misconception that the spectrograph is, in itself, the analysis, and these, so called distortions can be made transparent by a few words on cognitive considerations and through the simple realization that a spectrograph is a type of descriptive notation and will not substitute for hearing the piece–and usually with electroacoustic music, for multiple hearings.

One category of distortion can arise through the relative scales of various parameters. For example, the maximum number of decibels can be set to any level of sensitivity to get images which are correspondingly darker or lighter. Moreover, to take one of Brech's examples, when an event has all of its energy concentrated in one partial (as the sine tone strands in the middle of the example above), it may appear darker, and thus louder, than a single event where the same amount of energy is split among different

partials. There are also physiological factors such as masking, where a sound, such as a faint upper partial, is present but covered by a louder tone and not heard.[25]

A second main category of distortion arises from the overlapping of events, which are perceived as separate, but appear together in the spectrograph. This can happen either through collapsing multi-channel works into reductions (this is the case with *Artikulation* which was originally a quadrophonic piece but is presented in stereo) or simply through simultaneously occurring events, which for any number of reasons are perceived not as a single simultaneity, but rather as two separate events overlapping. Such events will appear fused in the spectrograph, and must be described by other cognitive criteria, and thus we must now turn to ways of defining the dimensions of timbre and thereafter to how these categories can be used to parse a musical surface into either consecutive events or concurrent streams of the type which would explain this type of distortion.

If one is aware of these potential distortions, and mindful of the ways in which discrepancies between the spectrograph and actual audition may arise, then the benefits of spectrographs are manifold. As Brech notes,

> Specific alterations over a long space of time, that are hardly ear-catching but concern multiple sounds, temporal augmentation or diminution, inversion of sounds and so forth, all of which squarely belong in the repertoire of electroacoustic compositional techniques and are more quickly and easily recognized when one looks at the sonogram and the sound of a piece together." (235)

These advantages outweigh any of the potential distortions, which can be cleared up quite easily, and thus I will adopt the use of spectrographs in this dissertation; in particular I will

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[25]This phenomenon is discussed in Charles Dodge and Thomas Jerse, *Computer Music: Synthesis, Composition, and Performance*, 2nd ed. (New York: Schirmer, 1997), 42-43.

generate spectrographs using the SpectraPLUS FFT Spectral Analysis System (Campbell, CA: Sound Technology, 1998), and will use a maximum dB rating of 75 unless otherwise stated.

While the concepts of pitch and loudness are described by the simple acoustic properties of a sound wave's frequency and amplitude, timbre is more complicated. Although timbre is commonly referred to as a single characteristic of sound, and often casually described as tone-color, since Helmholtz's acoustic investigations in the mid-nineteenth century[26] timbre has been dissected into its constituent elements, often relating to the relative strength of its partials, for vowel like qualities, or the aperiodic properties of its wave form, for noises. As these constituents have become better understood, composers have taken greater control over these in structuring contemporary music, and nowhere is this more true than in electroacoustic music, where the available technology makes this sort of control precisely reliable. J.K. Randall states the challenge this presents for music theory, using vibrato as a characteristic often grouped into the complex network of timbre:

> In electronic music, where spectra, envelopes, vibratos, and tremolos may be structured over a whole composition with the degree of subtlety and efficacy to which we have become accustomed in the domain of pitch, we must learn to stop hearing vibrato, for example, as a vaguely subliminal way of lushing-up a tone; that is, we must learn to stop mixing together a set of potentially independent musical dimensions into a monolithic dimension within which we can continue to get off easy by discriminating among 'mellow timbres,' 'nasal timbres,' and other similar bushel-basket catches. In the presence of music so structured, the perception of

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[26]Hermann von Helmholtz, *On the Sensations of Tone as a Physiological Basis for the Theory of Music*, 2nd English Ed., rev. and conformed to the 4th German ed. of 1877 (New York: Dover Publications, 1954).

> 'timbre' must be viewed not as a difficult psycho-acoustical problem, but as a sloppy habit.[27]

A number of music theorists have taken up this project and applied it differently to musical analysis and composition.

Randall's own discussion of the individual elements of timbre divides them into the following dimensions:

1. Registral position (regardless of "fundamentals")
2. Intervallic spread
3. Density
4. Total number of elements in a set
5. Distribution of relative amplitude over any set
6. Physical place or places from which any set, or any element of a set, seems to emanate.[28]

Elsewhere, he lists vibrato, tremolo, and envelope as elements that fall under the auspice of timbre, and here he states that, "this list could obviously be extended; but it is already sufficiently detailed to provide a basis for defining some musical operations on sets of partials–operations many of which may be viewed as attempts to capitalize upon the capacities of electronic media in order to subject to elaborate and continuous musical structuring aspects of sound...."[29] This list will need some expansion to be of analytical use for Ligeti's music. Particularly problematic is the fact that this list was developed primarily for the presentation of a compositional design involving operations on sets of sine-tone partials, and does not have categories which describe the noise content of a particular sound.

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[27]J.K. Randall, "Theories of Musical Structure as a Source for Problems in Psycho-acoustical Research," reprinted in *Being About Music*, vol. 1 (Red Hook, NY: Open Space Publications, 2003), 149.
[28]J.K. Randall, "Operations on Waveforms," reprinted in *Being About Music* vol. 1, 157.
[29]Randall, "Operations on Waveforms," 157.

Robert Morris's *Composition with Pitch-Classes* contains a similar list of elements which can be arranged into linear continua analogous to his c-space (an "undifferentiated" space modeling register where the size of specific intervals is indeterminate, but the position of elements relative to one another can be ordered, for example, as high, low, and middle).

1. c-space (low to high)
2. sequential time (early to late)
3. loudness (soft to loud)
4. timbre-color (dull to bright)
5. envelope (short to long)
6. internal agitation (slow to fast)
7. noise content (pure to noisy)
8. physical stereo-space-direction (left to right)
9. distance (far to near)
10. change in location (slow to fast)[30]

Morris's list contains many items analogous to Randall's, and of particular salience for the following study will be c-space (i.e. registral position), loudness, internal agitation, noise content, and spatial separation. Morris's categories for "timbre-color" and for "envelope" are too general, already incorporating several dimensions of timbre; for "dull to bright" Morris deals with the relative amplitude between specific harmonic partials,[31] and his category for envelope seems to deal exclusively with the onset time for attacks, whereas I will want to differentiate between attack, sustain, and decay properties.

Robert Cogan, mentioned above for his pioneering use of spectrographs, has also compiled a particularly thorough list of timbral dimensions. Unlike the other authors,

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[30]Robert Morris, *Composition with Pitch-Classes* (New Haven: Yale Univ. Press, 1987), 282.
[31]Morris is most likely influenced in this regard by Wayne Slawson who has developed a similar theory of sound color; see Wayne Slawson, *Sound Color* (Berkeley: Univ. of California Press, 1985) and "The Color of Sound: a Theoretical Study in Musical Timbre" *Music Theory Spectrum* 3 (1981), 132-41.

Cogan has applied his system not to one of his own compositions, or to a theoretical model of a how a composer might think, but rather to a number of compositions by a variety of composers and from differing time periods. His list derives from the work of linguist Ramon Jakobson, whose extensive research into the "ultimate invariants" of language were foundational to the field of phonology, as set forth in *The Sound Shape of Language*.[32] Following up on the work of Ferdinand de Saussure, this important book sought to define the phoneme and determine the minimal unit of sound which could have an effect on meaning, that is to say the minimum unit that, when changed, can also change one recognizable word into another. To isolate such a unit, Jakobson classifies elements of sounds into various oppositional groups; Cogan uses many of the same categories shown below to render similar service to musical analysis by considering sounds as being identifiable along axes in these thirteen dimensions.

1. grave/acute
2. centered/extreme
3. narrow/wide
4. compact/diffuse
5. non-spaced/spaced
6. sparse/rich
7. soft/loud
8. level/oblique
9. steady/wavering
10. no-attack/attack
11. sustained/clipped
12. beatless/beating
13. slow beats/fast beats[33]

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[32]Roman Jakobson and Linda R. Waugh, *The Sound Shape of Language*, 3rd ed. (Berlin: Walter de Gruyter, 2002).
[33]Cogan, *New Images*, 133 ff.

Each of these oppositional pairs describes one facet of sound, and they can also be considered as groups–the first three deal with the registral position of the sound as a whole. The first, easily enough, has to do with the frequency of a particular sound and is analogous to the first items on both Randall and Morris's lists; Cogan recommends that the total range used in a piece be divided into three parts: acute, neutral, and grave. While related to the first opposition, the centered/extreme category indicates whether or not a sound contains elements in one of the outermost regions of the active spectrum of a passage–Cogan suggests using the highest and lowest sixths as a guideline). Narrow/wide considers the total distance between outer elements of a sound, equivalent to Randall's intervallic spread.

Other oppositions have to do with the characteristics of the individual formant strands within a sound. The compact/diffuse opposition has to do with the individual elements of a sound, whether they are more compact formant strands such as sine tones, or diffuse bands of noise–a very useful distinction when dealing with sounds other than the collections of sine tones that Randall proposes. Spaced/non-spaced indicates how much distance is between individual strands, and sparse/rich refers to the total number of elements present, compared to the maximum for any element in the piece or passage–these correspond to Randall's categories of density and total number of elements.

Many of the remaining categories have to do with the envelope of a given sound. Attack/no-attack deals with the difference between the onset of a given sound and its "steady" state. As most steady states contain a great deal of internal fluctuation, other categories describe potential changes found in this part of the envelope, and in doing so,

flush out Morris's general category for "internal agitation." The oppositions of level/oblique and steady/wavering deserve special clarification. The first of these refers to whether the pitch of a note is fixed or noticeably moving; thus a glissando would be oblique. Steady/wavering refers to the more internal aspects of a sound, so that the use of vibrato, which Randall earlier cited as an area of timbre in need of refinement, could be cited here as an example of wavering. The final oppositions also deal with internal agitation; sustained/clipped deals with the internal disruption of a sound–whether it is intermittent, like a tremolo, or continuous. Beatless/beating describes the presence of acoustical beats caused by minor disturbances such as conflicting sound waves that differ by a small number of Hertz; this opposition and the final which describes the speed of these beats, should they be present, are of use in a limited number of cases.

Both Cogan and Jakobson emphasize the importance of taking these categories in the proper context. In a linguistic setting, not every oppositional category will have the power to change one phoneme to another; in some languages a shift from a back vowel to a front vowel may be perceived as an invariant–a matter of accent with no effect on meaning–while in others languages such as shift may correspond to a change verb tense or mood, and thus a significant alteration of meaning. To help ensure an appropriate context, I have, at times, made a few changes in the table of oppositions. First, I have added categories for channel mixture (in the analysis of *Artikulation*) and reverberation. While not strictly an aspect of timbre, the use of the spatial orientation of sound sources is included in both Randall and Morris's lists, and has a very significant effect on what we perceive as musically coherent. This will be particularly evident in *Artikulation*–originally

composed for four channels of electronic sound–where the spatial distribution was part of the compositional design and interacts quite clearly with these other oppositional categories. The use of reverberation is also quite important to electronic music and was a common technique for altering the timbre of a given sound. Particularly, reverb lengthens the decay of a given sound and thus affects part of the attack-sustain-decay model of envelope that is not addressed by other oppositions.

Furthermore, I have eliminated some of Cogan's original categories that seem less relevant to these compositions, such as those categories having to do with beating, which would require more sustained sounds to operate. These categories could certainly be of use to other pieces–perhaps even of primary importance in analyzing pieces such as those by Alvin Lucier which consciously address this acoustic phenomenon (his *Crossings*, for example). Moreover categories such as Randall's "distribution of relative intensity" or Morris's "timbre-color (dull-bright)" and which corresponds to the relative amplitude of certain harmonic partials, could be of great use in describing a piece where subtleties in the vowel-like qualities of harmonic arrangements of partials are contrasted meaningfully with each other. In Ligeti's work, however, the main contrast is not between brighter and duller arrangements of harmonic partials, but rather between harmonic arrangements and non-harmonic arrangements, or even between arrangements of sine-tone partials and arrangements of filtered noise. These more subtle matters of distribution of intensity are most likely perceived as a matter of accent or inflection rather than a difference in meaning.

Determining which of these dimensions of timbre plays an active role in the piece is an analytical activity closely related to the process of segmenting the surface of the piece and determining points of difference, change, or contrast. If an oppositional category is inactive, constant, or even absent (as is often the case for beating) for the entire course of a piece, it is extremely unlikely that it will be heard as a meaningful part of the piece's morphology. On the other hand if a number of changes occur at once, this is likely to effect a greater degree of difference, which may be perceived as a significant change, and a single opposition which participates consistently in a number of such changes may acquire the status of a primary parameter for the piece.

Returning to the spectrograph presented above (Figure 1.1), one can see that the change from diffuse noise bands to compact sine tones, along with the move from material in both registral extremes to more centered material helps strengthen the first change at around 1'48"; while the individual sine tones move in register throughout the next seventeen seconds, these changes, not paired with any other oppositional changes, are unlikely to be perceived as more salient than the initial change in multiple oppositions. Thus the first change is likely to be perceived as one of sectional importance while the changes of individual sine tones are likely to be heard as subdivisions within this new section.[34]

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[34]This method of tabulating the number of differences in various domains is used by a number of authors including Cogan in *New Images*, and also, notably, Christopher Hasty, "Segmentation and Process in Post-Tonal Music," *Music Theory Spectrum* 3 (Spring 1981), 54-73. Hasty's list of domains, however, does not include aspects of timbre other than differentiating arco from pizzicato, separate instrumental voices, and dynamic levels.

This method of calculating the strength of divisions is not, however, a mechanical algorithm; other weighting concerns can be presented by the process of an individual piece. If an inactive element is suddenly changed, this may seem more significant; for example if a piece were to use only sine tones for a long stretch of time, a move to more diffuse material might seem radically different even if this material occurs in the same registral height, extremity, and width; at the same dynamic level; and with the same attack and sustain characteristics as the preceding material. Moreover, depending on the perceived strength of these dimensions, this system has the flexibility either to support hierarchical structures, such as the ones insisted upon by many other linguistically oriented theories,[35] or to point out various rationales for competing segmentations, which may conflict with each other, while leaving the analytical decision of boundary lines open to varying interpretations. The number of oppositions changing at once gives a good prediction of sectional divisions, but not a strict calculus for them, and deviations from what is predicted, when they occur, provide valuable information about the way an individual piece goes.

A musical system will often create connections between events based on similarity as well as difference, and thus we will need to identify types of change, transformation, morphology, or motion between degrees of relatedness. Although he backs off of this claim in his later publications, in *New Images of Musical Sound*, Cogan suggests that the each of the oppositions has a positive and negative end to the spectrum and that rating

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[35]In particular Fred Lerdahl, in articles such as his "Timbral Hierarchies" in *Music and Psychology: A Mutual Regard*, *Contemporary Music Review* 2 no. 1(1987), 135-60. His theories have also greatly influenced McAdams who insists on hierarchical structures.

each sound by reckoning the total number of positives minus the number negatives will describe an aspect of the sound as a whole. While in many cases this turns out to be true, it is not necessarily the case, as sounds could contrast in every single opposition and still reckon to identical sums–take for example the trivial case where 12 oppositional categories are active and a sound occurs that is negative for all the even categories and positive for all the odd; a corresponding sound that is positive for all the even categories and negative for all the odd would be maximally contrasting, yet receive an identical rating. I will follow Cogan in his later work, which discusses specific oppositions or combinations of oppositions as more distinct without this kind of attempt to normalize individual sounds.

While similarity in one oppositional category is often enough to create some degree of similarity between two sounds, the consistent grouping of specific oppositions consistently will provide for the creation of larger categories of sound-types which can undergo more refined transformations. Typical instrumental timbres, which are often taken as being related, and used to perceive different polyphonic strands can be described by groups of oppositions. Pizzicato, for example, has a specific attack characteristic and noise content which allows a listener to follow a line–even between families of string instruments, over different registers, and so forth. Moreover various configurations of sine tones can all share the properties of being compact, containing a similar number of partials with similar spacing; if these configurations are consistently a part of the piece, nuances of the spacing, such as the division into harmonic, sub-harmonic and non-

harmonic categories that was common for composers working in the studio of the WDR in Cologne, can be discussed in greater depth.

David Lewin has spent much time and effort defining musical transformations, and discusses at least one model of timbre in his *Generalized Musical Intervals and Transformations*, and in doing so calls attention to another problem of analytical discourse on timbre–that of defining units. His system addresses timbre as a non-commutative generalized interval system (GIS) that is, a system in which there is no commonly held minimum unit of distance, such as the semitone for pitch or a beat for strictly metric music (although music such as Elliott Carter's, in which there are competing beats, is held as another example of non-commutative GIS). The lack of a standard unit of difference means that certain combinations of transformations, will yield different results depending on order. Lewin's model of timbre, however, applies only to very simple harmonic spectra, and governs only the difference in amplitude between the first three odd partials. Thus, in scope, Lewin's model is limited and moreover, Lewin himself admits that the formal intervals and transformations he is able to define, "match our sonic intuitions only to a certain extent... The models suffer here by comparison with the constructs of Wayne Slawson, who has developed an elegant model for an 'intuitive' timbral space."[36] Only a very specifically and limited musical context would support the results of Lewin's experiment, and even this would require the listener to learn how to hear these relationships which do not model common experiences. An extension of Lewin's model to

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[36]David Lewin, *Generalized Musical Intervals and Transformations* (New Haven: Yale Univ. Press, 1987), 85. See footnote 29 above for Wayne Slawson's theoretical writings.

include more complicated aperiodic wave-forms would, then, at best be a massively complex undertaking and at worst, a Procrustean bed which would stretch our musical intuitions in ways that may or may not have analytical rewards.

Robert Morris has developed another approach to defining transformations in conceptual spaces which do not have well defined and measurable units; in fact, his list of parameters, which we examined above, was in relation to a "contour-space" used for precisely such musical situation. Morris identifies a number of musical situations where one cannot or might choose not to perceive intervallic distance. His definition of c-space, "implies that the only perceptual skill necessary for the adequate perception of musical events in c-space is the ability to hear whether an element is higher than, lower than, or equal to another," and also describes this as the "most musically immediate pitch-space"[37] which will translate into a system with broad implications for analysis, since the types of motions and transformations it describes do not require a substantial realteration of the ways in which we commonly listen.

Dynamic levels provide a clear example of this concept. While there is a clear difference between mezzo-piano and forte, in practice, this might not be perceived as equivalent to the difference between pianissimo and mezzo-piano, although each of these distances is commonly held as an increase of two dynamic levels–indeed, it is even questionable whether two instances of a given dynamic level in different contexts or parts of the piece are perceived as the same. The vector described by each of these moves (soft to louder) is, however, clear, as are more complex dynamic shapes. The similarity

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[37]Morris, *Composition with Pitch-Classes*, 26.

between three-object sets; a move from *ff* to *pp* to *mp* can be understood as very similar to a forte-piano accent, followed by a crescendo to *mf*. While the former might be understood as an exaggeration of the later, and the later a compression (perhaps both in time and in range) they have a similarity in their shape from loudest, to softest, to mid-range.

Morris numbers each element of a set from lowest to highest using numbers from 0 to n-1, so that the three levels involved in this shape could be described as <2 0 1>, and then goes on to describe operations one can perform to transform recognizable contours. Morris's list includes the standard twelve-tone operators of inversion, retrograde, and retrograde-inversion, so that a low-high-middle contour, describable as <0 2 1>, could be inverted to <2 0 1>. This formality simplifies calculations for longer sets, but is often unnecessary for shorter elements; moreover this outlook often presents the temptation to over emphasize these connections even when they are not musically presented as related, or to ignore other relations or transformations which do not fall into these prototypes. While I will maintain Morris's rigorous outlook, the three and four element sets that we will find later in this study can often be described in either simple prose or graphical notation.

Morris's theories have been expanded substantially since the publication of *Composition with Pitch-Classes* to include a number of similarity relations and to be applied to a number of differing parameters.[38] While none of these analyses have applied

[38]Elizabeth West Marvin and Paul A. Laprade, "Relating Musical Contours: Extensions of a Theory for Contour," *Journal of Music Theory* 31, no. 2 (Autumn 1987), 225-67; Elizabeth West Marvin, "The Perception of Rhythm in Non-Tonal Music: Rhythmic Contours in the Music of Edgard Varèse," *Music*

contour theory to the elements of timbre, specifically, they have expanded the domain of contour theory past registral space and into duration spaces, and into dynamics. Since elements can be compared one against another in all of the dimensions of timbre that Cogan identifies, even if the exact distances are unmeasurable, Morris's system of contours has implications for the potential relationships involved in these dimensions, even if the following analyses differ details of their notation.

Two noteworthy analyses of electroacoustic pieces will serve as precedent for the broader goals of the analytical method I am using. First Robert Cogan's analysis of Edgard Varèse's masterpiece *Poème Électronique*[39] will demonstrate the use of these oppositional categories, in combination with spectrographs to elucidate the structure of a piece. Second, Agostino Di Scipio's analysis of Jean-Claude Risset's *Contours*[40] will demonstrate an admirable balance between information derived from the composer's comments and sketches and that derived from perceptual means.

Cogan's brief article proceeds from the large scale form of the piece to the minute details of surface contrasts–a method I will also use, as I believe this helps direct the analysis clearly by providing and then reinforcing a conception of the piece as a whole. Moreover, at each level Cogan elucidates his divisions through reference to the audible

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Theory Spectrum 13, no. 1 (Spring 1991), 61-78; Robert Morris, "New Directions in the Theory and Analysis of Musical Contour," *Music Theory Spectrum* 15, no. 2 (Autumn, 1993), 205-228; and Elizabeth West Marvin, "Generalization of Contour Theory to Diverse Musical Spaces: Analytical Applications to the Music of Dallapiccola and Stockhausen," in *Concert Music, Rock, and Jazz Since 1945: Essays and Analytical Studies* (Rochester: University of Rochester Press, 1995), 135-71.

[39]Robert Cogan, "Varèse: An Oppositional Sonic Poetics" *Sonus* 11, no. 2 (1991), 26-35.

[40]Agostino Di Scipio, "A Story of Emergence and Dissolution: Analytical Sketches of Jean-Claude Risset's *Contours*" in *Electroacoustic Music: Analytical Perspectives*, ed. Thomas Licata (Westport, CT: Greenwood Press, 2002), 151-186.

qualities described by his system of oppositional categories, which bear a special significance with the aesthetic of Varèse, whose piece is wrought with conflicting material. The largest division into two parts is based on the predominance of "complex spectral noise bands" in the first part, and "simpler *harmonic* (or *quasi-harmonic*) spectra"[41] in the second. This equates to a distinction between diffuse material in the first half and compact material in the second, further refined by characterizing the compact material according to more subtle partial distributions into harmonic (or similar) configurations. Within each section Cogan then discusses the nuances of more local progressions through other oppositions–grave to acute registral contrasts, sounds which are clipped following those that were sustained, and oblique glissandi answering level materials. Cogan then puts the piece, and in particular the points he has made about the role of contrast and opposition in Varèse's aesthetic, into a wider historical context, something I will also strive to do in both the conclusions to the individual analyses and the concluding chapter as a whole.

While Cogan uses some of the composer's quotations to ground his analysis and his analytical method, Agostino Di Scipio's analysis of Jean-Claude Risset's *Contours* makes use of more detailed information from the composer and, in contrast to the Doati and Wehinger analyses which began this discussion, it is notable for its balance between information on compositional construction and that pertaining to received structure. Di Scipio had access to Risset's sketches and programming code and reproduces these in the appendix, but he also explains several of these computer generated instruments in layman's terms. He posits two oppositions as fundamental to the course of the piece,

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[41]Cogan, "Varèse," 27.

namely, "harmonic versus inharmonic spectrum" and "synchronous versus asynchronous timing of partials."[42] He then discusses the roles of the instruments in these oppositions, and indeed, the process of the piece, clarifying the discussion through the use of spectrographs taken from the composition itself. While his analytical method is "bottom-up," proceeding from the local details to the larger form, I find that Di Scipio's comments on both how Risset's instruments were developed, and how they are used in the piece, to be particularly informative, and I will emulate this in my analyses which also rely on sketch material from the composer, which is held by the in the György Ligeti Collection of the Paul Sacher Foundation in Basel.

Thus the analyses that follow in Chapters 2 and 3 will work towards a better understanding of Ligeti's electronic works, using sketch material to represent the composer's vision of each piece's structure, and using Cogan's system of oppositions to connect these to audible categories which form the basis of a listener's perception structure. In most cases these overlap substantially–a fact that points towards Ligeti's awareness of the potential disparity between compositional design and perception and his concern with both. Ligeti refined his understanding of perception in the electronic music studios, and after a thorough investigation of the ways Ligeti applies this understanding to the construction of *Glissandi* and *Artikulation*, the final chapter will illustrate how many of the same concerns emerge in the compositional techniques and resulting musical textures and gestures used in *Apparitions* and in the works which followed.

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[42]Di Scipio, "Emergence and Dissolution," 173.

Chapter 2: Analysis of *Glissandi*

Ligeti began working at the WDR studio in Cologne in February 1957, absorbing the technical operation of the studio by assisting Gottfried Michael Koenig and also immersing himself in the works of Anton Webern and composers who followed him, most notably Karlheinz Stockhausen. The following analysis of *Glissandi* will show that his first electronic piece, completed later in that year, bears the influence of both exposure to new technology and new music, as well as nascent ideas which pervade his later music.

Ligeti had a stipend for the first four months of his apprenticeship in the studio, which he describes as his "second schooling,"[1] and he reports that he spent the first weeks of this period listening to "hundreds of pieces" of both acoustic and electronic new music on tape at the WDR and took weeks thereafter just to master the technical apparatus of the studio. Thus *Glissandi*, which was finished in August of that same year, was in part a student work, exploring the machinery and equipment available in the studio. Ligeti and Koenig later described the piece as a "finger exercise," and Ligeti had a very low opinion of the work, when compared to the rest of his output, withholding its premier until 1976, when it appeared on a Wergo recording. In a conversation after a lecture by Koenig, Ligeti confessed that,

> I don't really want to interfere with the discussion, and I believe that Mr. Koenig can say more about this, because, when I made *Glissandi*, above all, I learned from him. When he spoke of a "Finger Exercise," then that applies not to aspects of form and of musical language, but simply to the quality of the work. *Glissandi* is a weak piece, concerning both the sound and form. It has a primitive, almost

[1]György Ligeti, "Mein Kölner Jahr," originally "Meine Kölner Zeit" in *Erinnerungen: Neue Musik in Köln 1945-1971*, (Cologne, Materials from the exhibition *MusikTriennale 30. Köln* : 1994), 16-19. Reprinted in Ligeti's collected writings, Matthais Kassel, ed. (forthcoming).

> schematic, form. There is a succession of sections up to a middle point and from there out, the material of the piece is doubled–there is, then, so to speak, a way of thinking in row-manipulation, "a la mode". Here there aren't really any rows, but from the middle to the end the piece goes once backwards in retrograde, and simultaneously the original shape repeats once again, in which, however, most of it is filtered out so that only traces of it are there, actually appearing on the tape. As I finished and listened to it more often, I found that the compositional standard [niveau] which I set for myself was not reached. Insofar is it a lacking piece and on account of this I wished that it not be publicly performed. *Artikulation* was then to a large extent built up from the experience of that which I made badly in *Glissandi*.[2]

Ligeti's criteria for self criticism here point to a problem both with the technical quality of the sounds produced (and there are noticeable imperfections in the montage work, for example, abrupt level changes as material overlaps between large sections of the work), but also–as one can glean from the description *a la mode*–with the relationship between the form of the work, which is quasi-serial, and the more local material, in which sections are quite independently conceived. Stockhausen, on the other hand, used the series in a more thoroughgoing fashion to derive both the large scale formal divisions, the distribution of material within each division, as well the surface details of the piece.

Yet as mentioned above, Ligeti did eventually relent and allowed the piece to be premiered and released on record. While Ligeti does not elaborate on the reasons for this change of heart, this analysis will at least endeavor to demonstrate ways in which his short description is, indeed, oversimplified. While *Glissandi* is not strictly serial, especially in comparison to the works of Stockhausen or Koenig, and while it does sound very

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[2]Koenig, Gottfried Michael. "Ligeti und die Elektronische Musik" in *György Ligeti: Personalstil – Avantgardismus – Popularität*, Otto Kolleritsch, ed. Vienna: Universial Edition, 1987, 19. This quote came from Ligeti, himself, from the transcription of a discussion that followed Koenig's paper. This, and all other translations, are the author's unless otherwise stated.

sectional, this work is also organic in that many of the details, despite Ligeti's criticism, are clearly designed with the shape of the whole in mind. Furthermore the simplicity of the quasi-serial structure belies the conceptual complexity of the second half which combines the original form with its retrograde. Many of the details which recur in this second half must be reinterpreted in their new context as the filtering out of material dramatically alters the resulting texture.

Ligeti's description of the form of *Glissandi* suggests a piece with two distinct parts, and the following analysis will treat it as such, initially presenting the subsections that lead up to the midpoint, and then discussing their recombination in both prime and retrograde forms in the second half. The two part conception of form which Ligeti identifies in terms of large scale serial techniques is also applicable to studio technique, the first being a study in additive synthesis, using all types of generators available in the studio, the second half being a study in subtractive synthesis, using all types of filters to remove sounds from the texture.

About the Equipment

Since *Glissandi* has been described as a "finger-exercise" created as Ligeti learned to use the studio equipment, and since the two-part form of the piece can also be described in terms of studio techniques, it will be useful to take a moment to become familiar with the tools available for sound synthesis in the Cologne studio. In many of Ligeti's sketches, the source of the sound being used is also a way of classifying and

organizing the material, and thus the technical equipment and the analytical terminology are closely related.

The Cologne studio was designed with the ideology of *Elektronische Musik* in mind. In contrast to the *musique concrète* produced by the Paris studios, which used prerecorded sounds, the Cologne composers favored using sounds generated from sine-tones and filtered noise. The generators in the studio included a "Messgenerator" capable of producing exact sine-tone frequencies in whole number values from 30 to 11,000 Hz and another generator with an analog selection dial, capable of producing glissandi, but less accurate than the Messgenerator, and finally a low-tone generator capable of producing tones well below the audible range, and which was generally used in combination with a beat-frequency oscillator [Schwebungssummer] for amplitude modulation.[3]

The filters at the Cologne studio also came in several types: high-pass, low-pass, band-pass, and band-stop. A high-pass filter would allow audio signal above a given frequency to pass unchanged while muting the signal below that frequency, and a low-pass filter would do the reverse. Similarly, a band-pass filter would allow a certain frequency range to pass, muting all the signals outside this range while a band-stop filter will do the opposite. All of these filters have varying attenuation rates, such that these boundary

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[3]This information comes from the prefatory material in Karlheinz Stockhausen, *Nr. 12 Kontakte: Electronische Musik, Relisations Paritur*. London: Universal Edition, 1968. n.b. that this realization score has the plate number UE 13678 LW, and is different from the performance score of *Kontakte,* UE 14246 LW.

frequencies will not be exact, but rather sounds will begin to taper off at this frequency, and the rate of this attenuation will vary from filter to filter.[4]

Different types of band-pass filters were particularly important for Ligeti's compositions, and he often organizes material according to different widths of filtered noise. Three of the most common levels of filtering are octave-filtered, third-filtered, and 20-Hz-filtered noise. Octave and third-filtered noise would produce bands of noise approximately an octave or a third of an octave wide; these types of noise would be generated with specialized filter banks, and were thus used as ways of generating more or less diffuse bands of noise, rather than for sculpting already generated material. 20-Hz-filtered noise suggests that a constant number of Hertz was used as a bandwidth rather than an interval scaled to the octave. Thus bands of 20-Hz noise will seem more compact in higher registers and more diffuse in the lower registers.

Other studio equipment was also important in the composition of *Glissandi*, as it presented Ligeti with a number of ready-made compositional devices. The studio was equipped with a variable speed tape recorder, with which material could sped up or slowed down–both transposing the result and lengthening or shortening the segment by the corresponding interval. Thus an octave (the ratio 2:1) transposition up would result in a segment half as long as the original. The studio also had devices for generating impulses, and for techniques such as ring-modulation and reverberation, all of which will be discussed as they arise in *Glissandi* and later, in *Artikulation*.

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[4]Extensive information on attenuation rates and other aspects of filtering can be found in Peter Manning, *Electronic and Computer Music*, 2nd ed. (Oxford: Clarendon Press, 1995), esp. 56-61.

About the Form

In the following analysis, I will introduce Ligeti's large-scale design for the piece, define sectional boundaries within the first half, based on distinct changes in texture, density, and type of material, including the levels of compact to diffuse sounds introduced above. Yet a number of connections between individual sections within these parts make other conceptions of form possible. In particular, the prime plus retrograde construction forms a coherent, arching middle section set apart by sparser material on either side; this lends itself to a division into three parts rather than two, and as the analysis continues, I will pay specific attention to these competing conceptions of form. Scholars such as Herman Sabbe and Diane Luchese have identified similar polyvalent forms in other of Ligeti's pieces. Luchese refers to "several underlying structural principles"[5] in *Volumina* (1961-62), and Sabbe discusses the importance of competing, asynchronized layers in what he terms the "the Polyrhythm of Form"[6] in Ligeti's later music. Thus identifying *Glissandi* as an early example of this trend is significant for the later portion of this study, and is a point I will return to in the final chapter.

Glissandi runs to 7'33" and is a mono piece, realized in only one channel[7]; as Ligeti describes in the quote above, the piece proceeds to a midpoint (3'46.5"), and then the original material repeats in combination with its retrograde–a feat achieved quite simply by copying and reversing the magnetic tape. While this doubling of material should result in

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[5]Luchese, Diane. "Levels of Infrastructure in Ligeti's *Volumina*.," *Sonus*, vol. 9, 38.
[6]Sabbe, Herman. *György Ligeti*. Musik-Konzepte 53, Heinz-Klaus Metzger and Rainer Riehn, eds. Munich, 1987, 28 and 57 ff.
[7]Ligeti's sketches make reference to his planning a multi-channel version, but there is no evidence that this was ever realized.

much denser textures, the filtering of material ensures that only traces of the resultant come through, and the texture is often sparser than in the first half. I will define the first half as having six sections, labeled A through F. The timings of the first half's sections were carefully planned and result in an arrangement where most of Section D, which is one quarter of the way through the piece, maps onto itself in the second half; Section E combines with Section C, and bridges into Section B, and Section F overlaps with the rest of Section B as well as Section A. This arrangement is shown below, schematically, in Figure 2.1., a schematic diagram of the form.

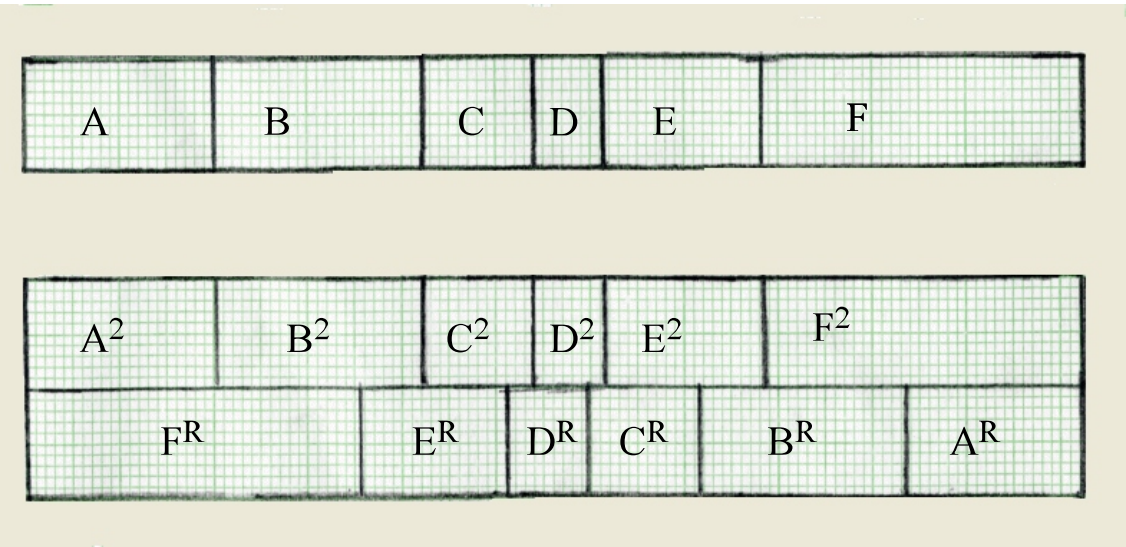


Figure 2.1. *Glissandi*: Schematic Diagram of the Form

Additionally, a spectrograph of the entire piece provides an overview of these sections and shows the clear changes in texture and material which define the sectional boundaries of the first half. Section A uses parallel bands of narrowly filtered noise; Section B uses various combinations of spectra and noise. Sections C and D use sparser

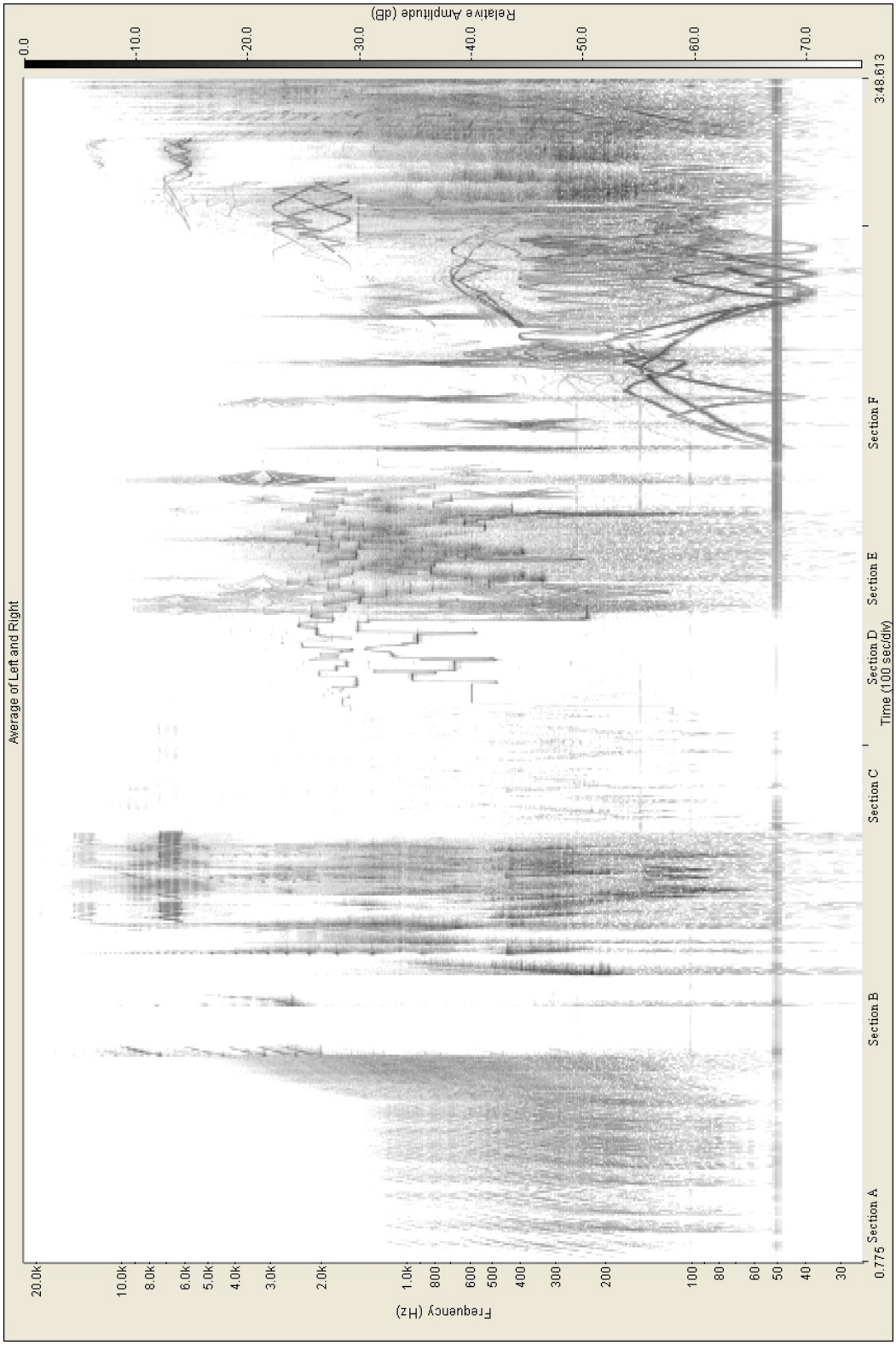


Figure 2.2a. *Glissandi*, Spectrograph of Entire Piece (1st Half)

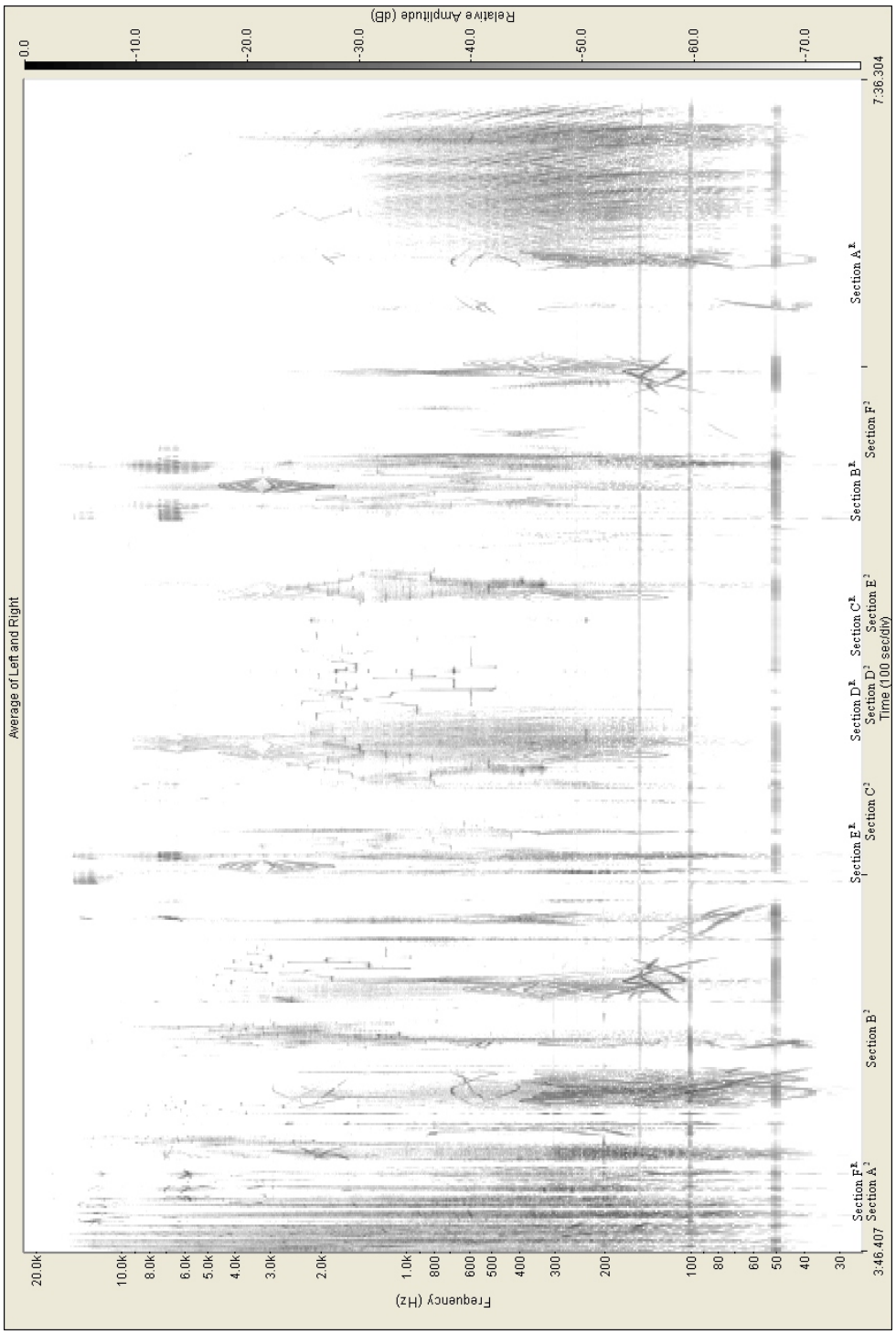


Figure 2.2b. *Glissandi*, Spectrograph of Entire Piece (2nd Half)

material, C filtering out material from B and D introducing a counterpoint of two individual sine tones. Section E reintroduces noise and reverberation to this texture, and Section F continues to build up combinations of varying materials to the midpoint, which is the densest point of the piece.

Analysis of Sections

The following analysis proceeds through the first sections–up to the midpoint–in detail, focusing on how material is used within each section, and what divides one section from another, so that their characteristic materials and shapes are clear and recognizable when encountered in their filtered and/or retrograded forms later in the piece. This will also draw out certain sections which share material and the connections which exist between them. From the midpoint on, I will focus on areas that are changed from the original form and how the concurrence of material from previously disparate sections mandates a recontextualization of the whole.

The first half of the piece builds up material in three stages. The first stage of accretion corresponds to Section A, the second to Section B, and the third, a more gradual and segmented accretion, corresponds to Sections C-F. These are arranged according to a series of durations which creates an exponential feeling of growth through these sections. In Ligeti's sketches,[8] these are described with roman numerals; I have

[8]All of the original sketches, which are the basis for many of the examples transcribed below, are held in the György Ligeti Collection of the Paul Sacher Foundation in Basel.

added my section labels and timings underneath, as one can see, the timings correspond quite closely.

seconds	I 40-50	II 40-45	IIIa 24	IIIb 20	IIIc 17 sum=	IIId 15 32
section	A 40	B 44	C 30	D 17	E	 33

IIIe	IIIf	IIIg	IIIh	IIIi	IIIj	IIIk	III l	IIIm	IIIn	IIIo
13	11	9.5	8	7	6	5	4	3	2	1
								sum=	69.5	
F										
									69	

Furthermore, one can discern a logic–influenced by the use of Fibonacci numbers, in this arrangement of durations. Beginning with roman numeral III, the subdivisions steadily decrease in length, and the rate at which they do so is determined by a Fibonacci-like series. Examining the differences in duration between sections yields the following arrangement.

grouping			1	1			3		2
difference		4	3	2	2	2	1.5	1.5	
duration	24	20	17	15	13	11	9.5	8	

								8
1	1	1	1	1	1	1	1	
7	6	5	4	3	2	1	0	

The interval by which durations decrease becomes steadily smaller; IIIa is 4 seconds longer than IIIb, which is 3 seconds longer than IIIc, subsequent sections differ by 2, then 1.5, then 1 second in length. Moreover, the rate at which the interval decreases is based groups of subsections which are bundled into Fibonacci numbered units; while the straightforward arrangement would yield groups of 1, 1, 2, 3, 5, 8, there are some

discrepancies here. There is 1 step where the difference between units is 4, 1 step where the difference is 3. The next two groups are then reversed–there are 3 units where the difference is 2, and 2 units where the difference is 1.5. Then Ligeti skips the number 5, and proceeds with 8 units where the difference is 1. This kind of modified additive series also occurs in later sections, such as Section B, as well, and helps create a feeling of growth in the short and long range rhythmic design of the piece.

Section A.

Section A (0-40") presents a clear trajectory in which material steadily increases, first in density and then in register. The material for this section is entirely 20 Hz filtered noise, and thus recognizable points within Section A are achieved by changes in density and register, and also by the direction of glissandi. I will divide this section into three events, the first from 0" to 12", the second from 12" to 30", and the final event from 30 to 40". These are shown below in Figure 2.3.

Event 1 employs upward-moving glissandi and establishes regular pacing. Bands of 20 Hz noise are grouped in spectra with approximately 9 bands, which extend from around 50 Hz upwards to around 1200 Hz, where they are filtered out with a low-pass filter. These bands enter at 0, 6 and 9 seconds and again at 12" with the beginning of Event 2, establishing units with a common base of 3 seconds.

This pacing also creates the impression of certain bands in the second group being the continuation of lower bands in the first, an effect Ligeti describes as a “permanent wave” in his sketches. In fact it is likely that some of these glissandi may have been

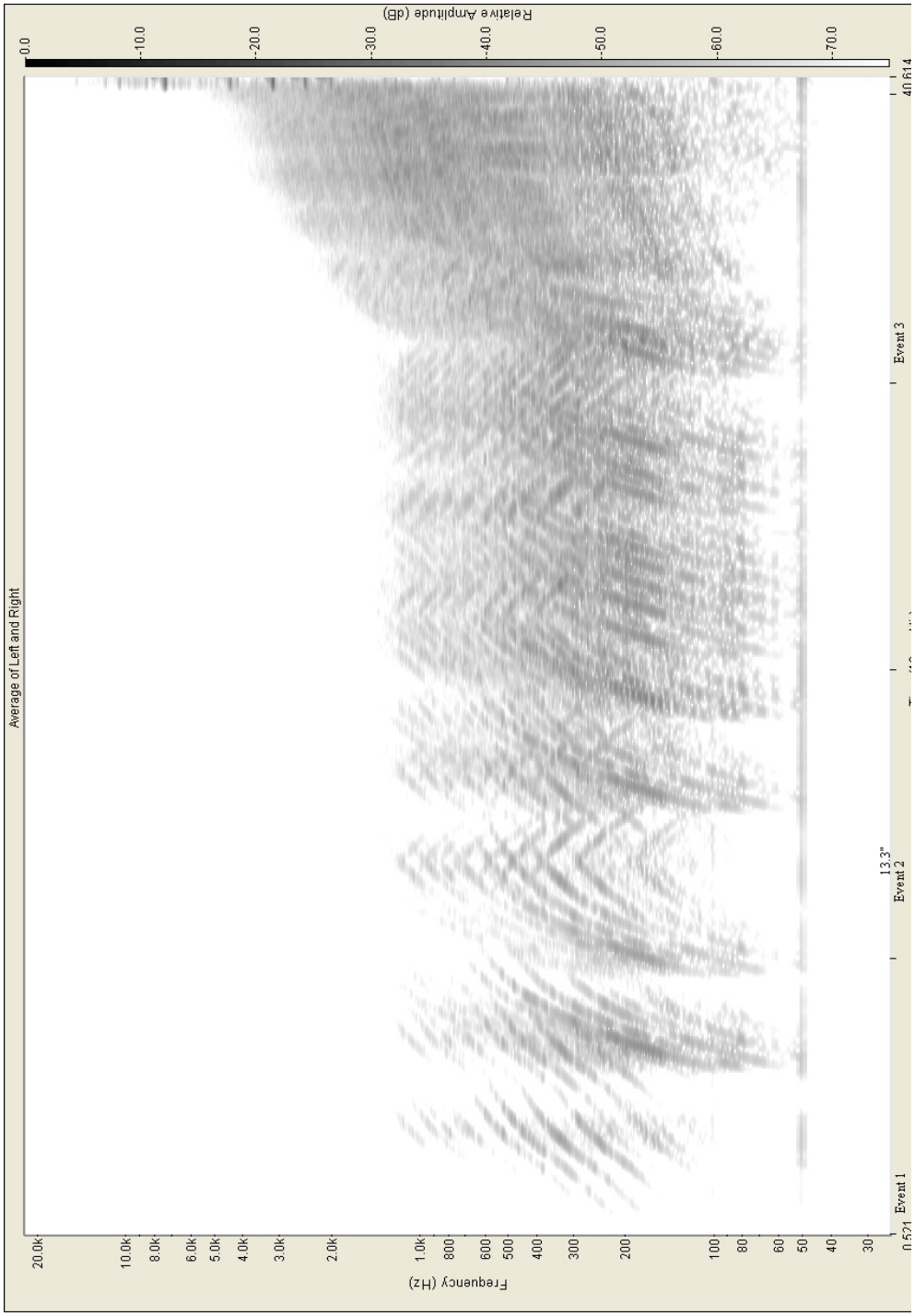


Figure 2.3. Spectrograph of Section A

produced as one continuous glissando, interrupted by additional filtering. This creates the impression of one glissando fading out and back in, rather than one glissando ending and a second beginning.[9]

The entrance of Event 2 at 12" marks the first downward glissando, an event which creates an axis of symmetry around 13.3", and which begins an acceleration in the accumulation of density. While the material is the same–20 Hz noise grouped into similar numbers of bands–and the pacing is initially in units of 3 seconds, with entrances at 12, 15, and 18 seconds, Event 2 begins to accelerate from the precedent set by Event 1. After the 3 second interval separating the first 3 entrances, the fourth group begins at 20", after only 2 seconds, and subsequent entrances gain speed steadily.

Although the second event's material consists of the same bands of 20 Hz noise as in the first event, Ligeti substantially increases the overall density, aligning not merely the continuations of various strands, but also the peaks and troughs of the ascending and descending glissandi to fill out more of the spectrum at once. This alignment results in the characteristic cross-hatching pattern seen in the spectrograph above (Figure 2.3). The axis of symmetry at 13.3" is one clear example of this, which will be invariant when retrograded, and will sound the same when it occurs in that form towards the end of the piece; moreover, the steadily increasing density of the cross-hatching pattern through the

[9]This technique, while more crudely constructed, resembles Shepards Tones (described by Roger N. Shepard "Circularity in Judgements of Relative Pitch" *Journal of the Acoustical Society of America*, vol. 36 no. 12 (1964), 2346-2353) in which tones are carefully arranged to produce the illusion of a continually rising (or falling) sound.

course of Event 2 is the effect of the accelerating entrances discussed in the paragraph above.

The third event is a large glissando rising to over 4300 Hz, which breaks from the register of the previous events; this is however the resultant texture, made of the previous material. While the direction of the whole is clearly upwards, elements of the downward glissandi introduced in event two are still audible, especially in the first half of this event, up to 34.6 seconds, where the cross-hatching in the spectrograph is still clearly evident. An increase in reverberation and the density of the texture obscures any individual entrances, and the whole is perceived as a single entity, one rising aggregate of noise bands.

Section B.

Section B begins immediately at 40" at the end of Section A and lasts until 1'24". While Section A was made of homogeneous material–20 Hz. noise–Section B uses a variety of different materials; and while Section A expanded upwards in register, Section B begins in this higher register, from approximately 2000-12,000 Hz, and then begins filling in the lower register with diverse materials growing in density. This accretion of material and density is defined by a duration scheme which determines the entrances of individual events. A quasi-serial matrix then assigns a type of material and register to each event–the spectrograph in Figure 2.4 labels these events according to Ligeti's matrix, which will be explained below.

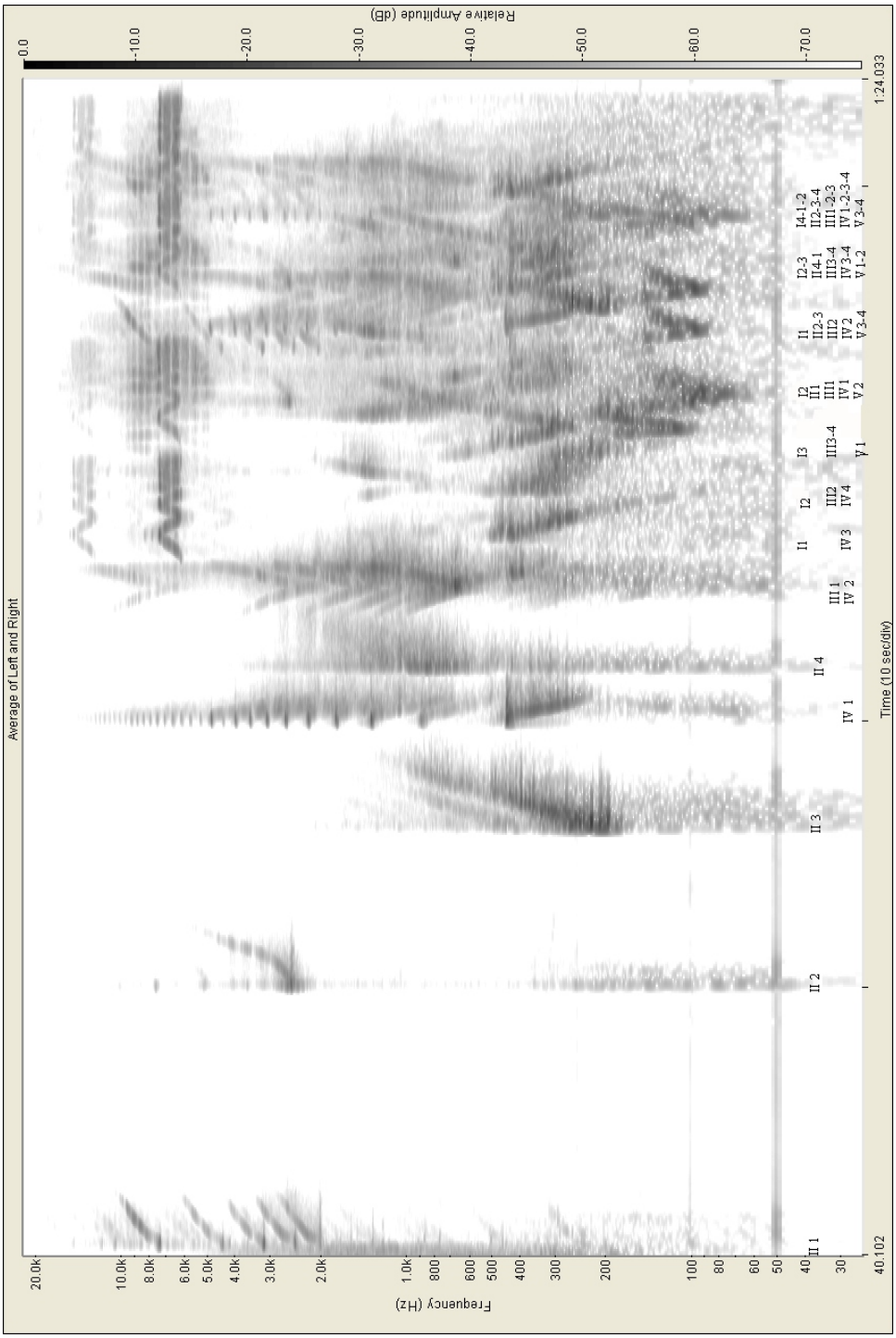


Figure 2.4. Spectrograph of Section B

The duration scheme of Section B is built from an additive series of numbers, similar to the plan for the large-scale form of the first half in that it achieves an exponential rate of growth. In Ligeti's sketches, the following diagram is found where numbers on the top line list the seconds in order and the bottom line gives the number of events which occur in that second.

Seconds																				
x2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	1					1			1		1	1	2	2	3	4	5	7	10	15

The pacing of these events in seconds relies on the Fibonacci series at first to determine the spacing of entries. The first event begins at 1", the second at 6", and the following at 9" and 11" so that they are spaced 5, 3, and 2 seconds apart, corresponding to the descending Fibonacci series.

After achieving the rate of one event per second, Ligeti piles up multiple events per second using a similar distribution. The events in 11" and 12" occur at 1 per second, those in 13" and 14" double this rate, and the following events return to Fibonacci distribution, this time with the number series determining the rate at which the number of events per second increases. The events from 15" on begin with 3 per second, and continue by adding 1, 1, 2, 3, and 5 events as shown below.

second	15	16	17	18	19	20
events	3	4	5	7	10	15
difference		1	1	2	3	5

The net result of this rhythmic design is an exponential acceleration, as shown in the graph below, and while all of these durations are doubled in the finished work (as shown in the spectrograph above) this exponential curve shown in Figure 2.5 remains the same.

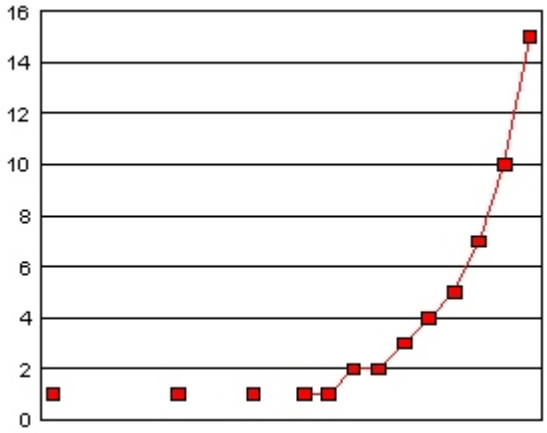
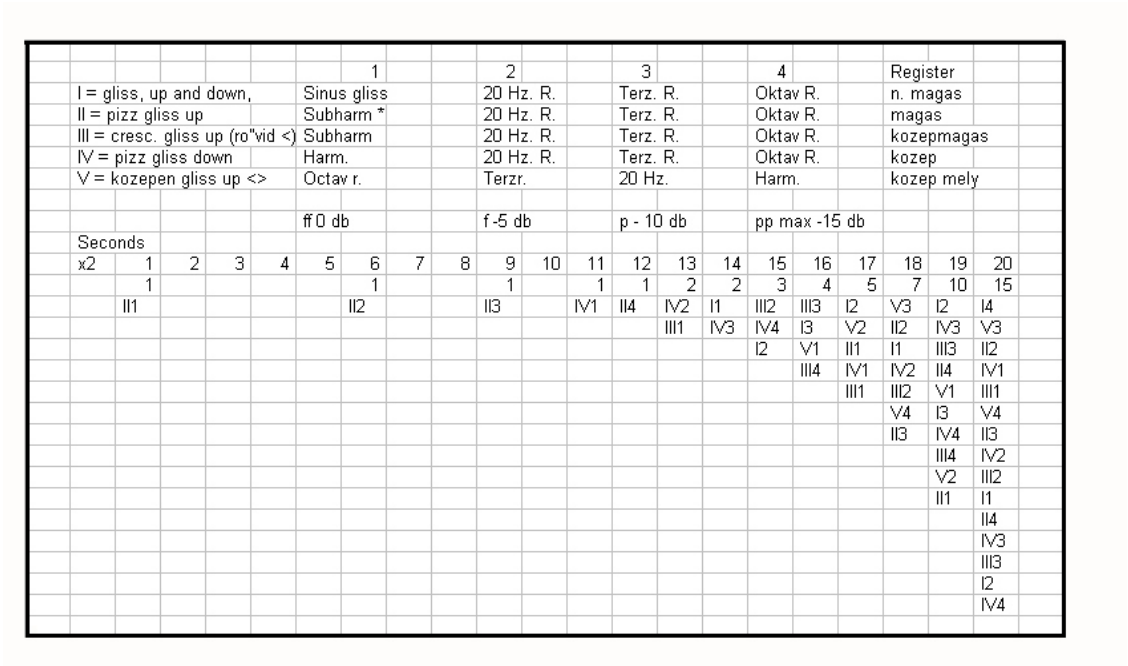


Figure 2.5. Exponential Acceleration in Section B (Events / Sec.)

Ligeti uses a quasi-serial matrix, transcribed in Figure 2.6, to define materials into categories and assign them to the events in this rhythmic design. The roman numerals on the vertical axis of this matrix refer to the type of attack, direction of the glissando, listed on the left-hand side, and on the right-hand side, the register. This will produce a stratified texture, where different types of events are consistently associated with a particular register; the continual up and down glissing will occur in the highest register, and the pizzicato glissando upwards (an upwards gliss with a sharp attack and quick decay) will always be in next register down. These registers do seem to overlap, and are treated with some flexibility in the finalized piece.



						1			2			3			4			Register		
I = gliss, up and down,						Sinus gliss			20 Hz. R.			Terz. R.			Oktav R.			n. magas		
II = pizz gliss up						Subharm *			20 Hz. R.			Terz. R.			Oktav R.			magas		
III = cresc. gliss up (ro"vid <)						Subharm			20 Hz. R.			Terz. R.			Oktav R.			kozepmagas		
IV = pizz gliss down						Harm.			20 Hz. R.			Terz. R.			Oktav R.			kozep		
V = kozepen gliss up <>						Octav r.			Terzr.			20 Hz.			Harm.			kozep mely		
						ff 0 db			f -5 db			p - 10 db			pp max -15 db					
Seconds																					
x2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
	1					1			1		1	1	2	2	3	4	5	7	10	15	
	II1					II2			II3		IV1	II4	IV2	I1	III2	III3	I2	V3	I2	I4	
													III1	IV3	IV4	I3	V2	II2	IV3	V3	
															I2	V1	II1	I1	III3	II2	
																III4	IV1	IV2	II4	IV1	
																	III1	III2	V1	III1	
																		V4	I3	V4	
																		II3	IV4	II3	
																			III4	IV2	
																			V2	III2	
																			II1	I1	
																				II4	
																				IV3	
																				III3	
																				I2	
																				IV4	

Figure 2.6. Quasi-Serial Matrix for Section B

Each roman numeral will rotate through four categories of material, listed horizontally on the matrix. These range from compact to diffuse and indicated by arabic numerals. Each roman numeral can occur with sine tones (often arranged in harmonic or sub-harmonic spectra), 20 Hz filtered noise, third-filtered noise, or octave filtered noise. While the sounds in the four upper registers proceed from the most compact to the most diffuse, the lowest register proceeds in the opposite direction.

The rate of the introduction of these different roman numerals also shares a sense of exponential expansion, beginning with restatements of the same material, before accelerating towards diverse materials. The first three events, are not only the most widely separated but are also all “pizzicato glissandi” (Type II) moving upwards; this makes the progression from compact to diffuse very clear across the beginning of Section

B–an aspect of the opening which adumbrates the trend of the section towards greater density. After this point, the Type II pizzicato glisses alternate with their descending counterparts, Type IV. After 2 Type IV events, Type III, (a single gesture glissing downward then back up) is introduced, and after only one Type III event, Type I enters. The low register events of Type V (which have characteristics similar to Type III) do not share the compact to diffuse direction with the other types and also enter substantially later in the series. The order of the introduction of events is given below.

			3		2	1	1
II1	II2	II3	IV1	II4	IV2	III1	I1

While the arrangement of materials in a matrix such as the one found in Section B suggests the influence of serial thought on Ligeti, there are also elements of more traditional composition in this section of *Glissandi*. The calculation of time in seconds, rather than in centimeters as one finds in the later tape pieces suggests a connection with traditional time measurement, and in particular with that of Bartók who often timed the sections of his pieces in seconds as well as measures–the use of Fibonacci numbers also recalls Bartók. Ligeti's reference to traditional instruments in defining his sounds, and in particular the label "pizzicato glissando" found in categories II and IV also suggests a thinking in terms of orchestral instruments. Finally, the choice of actual frequencies includes many traditional pitches, most strikingly A 440 at 1'00" (event IV-1).

Section C.

Section C lasts from 1'24" to 1'48" and consists of the same materials as in Section B; heavy filtering, however, differentiates Section C from the previous section. In fact,

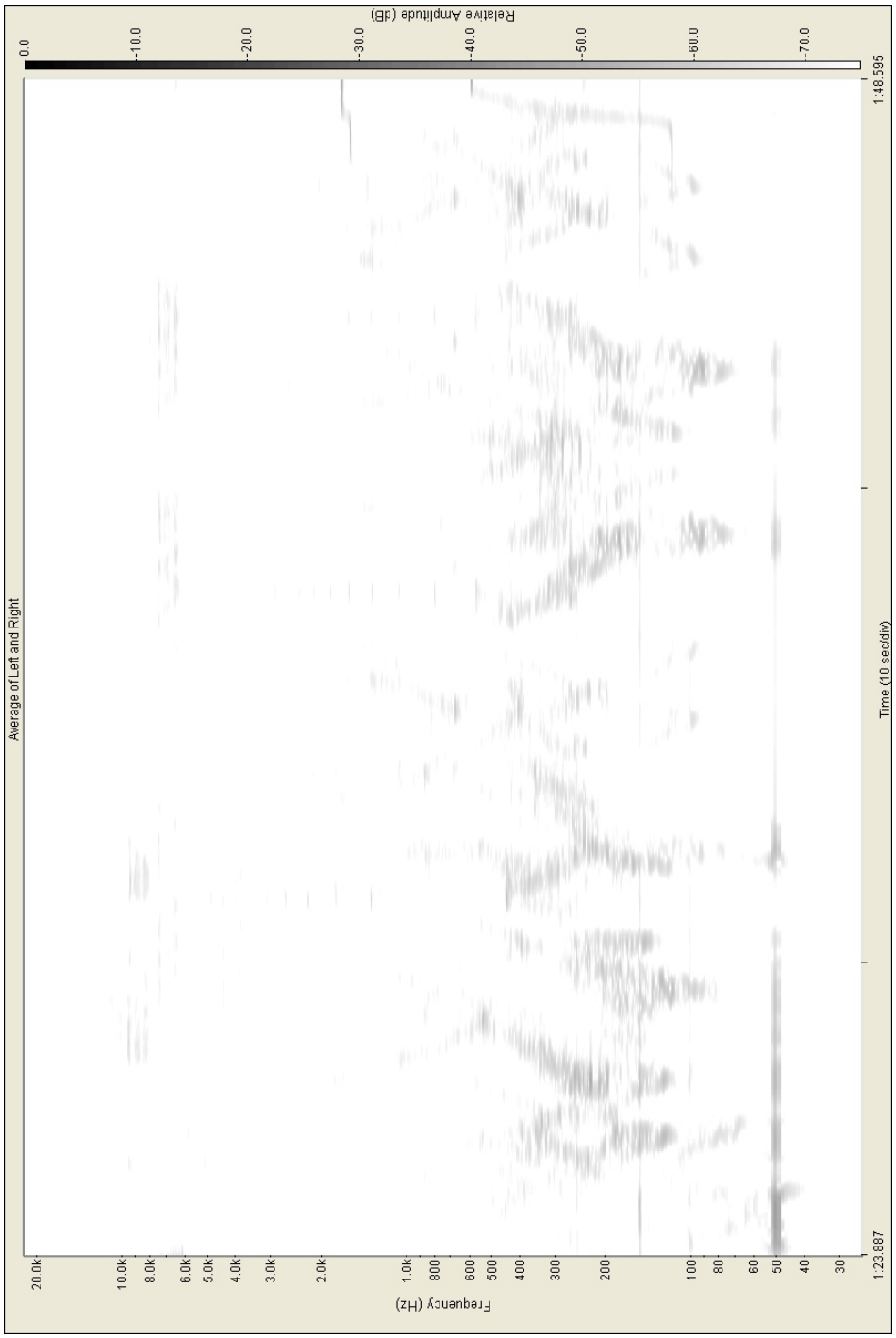


Figure 2.7. Spectrograph of Section C

Section C, which sounds like a faint echo of elements of Section B, is a first glimpse at techniques that Ligeti will use in the second half of the piece, using both retrograded material and filtering in a combination where the later obscures the presence of the former.

The use of such an "echo" section may be inspired by Karlheinz Stockhausen's *Studie I*, which made use of similar echo sections. Stockhausen first used serial operations to create collections of sine-tones. A series determined a number of pitches occurring simultaneously, their relative amplitudes, and elements of their synchronization and envelope. Stockhausen then presented these "structures," following each presentation with an echo-like repetition of the entire structure, transposed to a different speed (also serially determined) and with the addition of reverberation.[10] In the spectrograph (Figure 2.7) one can see the lowest and highest strata (events of Type V and I) of the layered texture of Section B. It appears that, rather than changing the speed or adding reverberation, Ligeti created this echo section by using a band-stop filter to remove materials between approximately 600 and 6,000 Hz.

Other particulars of how Ligeti alters his material in this echo section are revealed in another spectrograph in which the scale of intensity has been altered to a maximum higher decibel level, thus increasing the sensitivity to softer sounds and visually restoring the intensity of material that the filtering softened, but not completely removed; this image (Figure 2.8) presents both Sections B and C together.

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[10]This process is described in more depth by Richard Toop, "Stockhausen's Electronic Works: Sketches and Work-Sheets from 1952-1967, *Interface* 10 (1981), 149-97, as well as in the composer's extensive program notes to the compact disc, Karlheinz Stockhausen, *Elektronische Musik 1952-60*. Stockhausen Complete Edition, Vol. 3, 1991. Compact Disc.

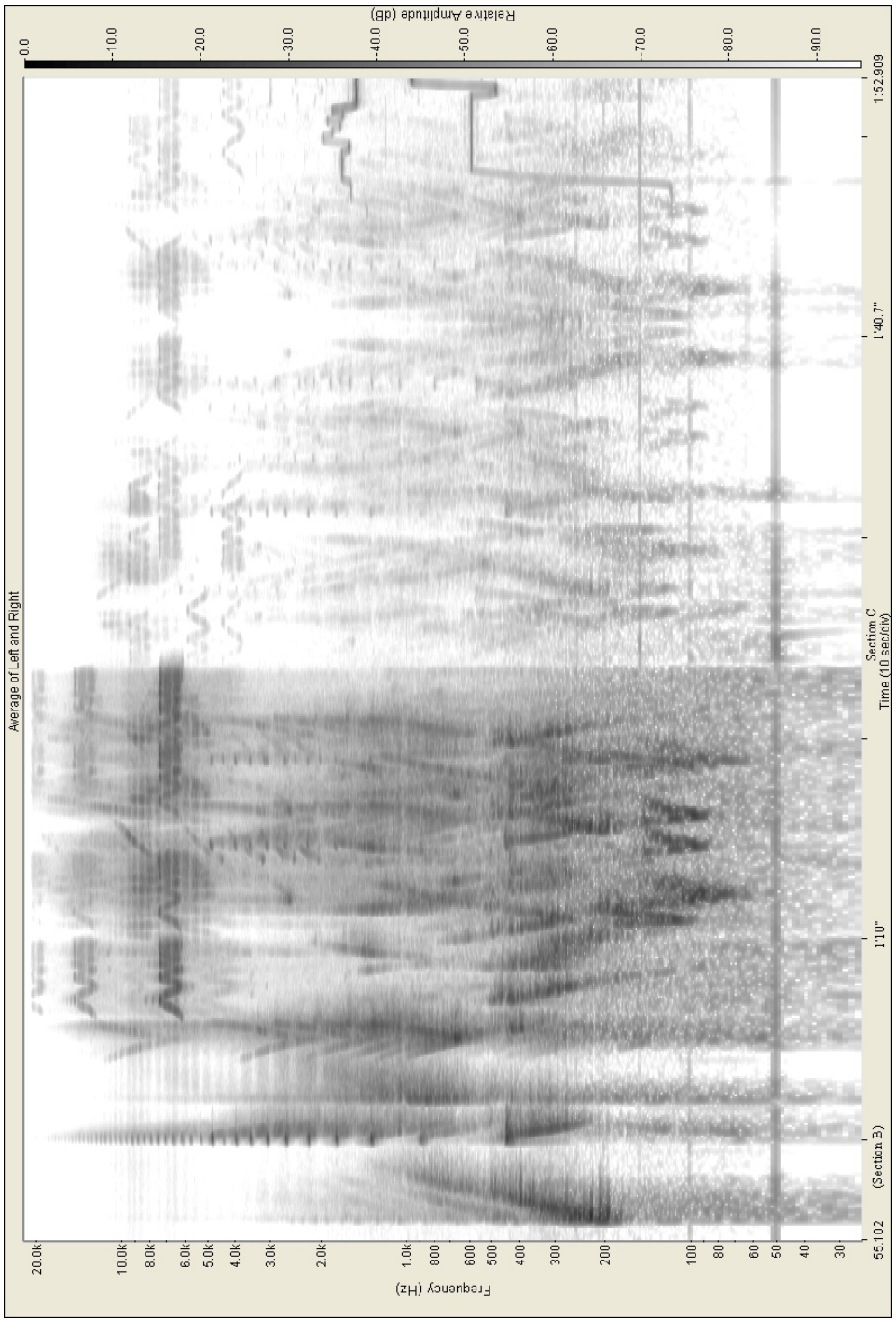

Figure 2.8. Spectrograph of Sections B and C at Increased dB Level

Here it becomes evident that there is an axis of symmetry around 1'40.7", and furthermore, the material which surrounds this axis derives from that which first occurred in Section B at 1'10". Ligeti retrogrades the material from 1'10" to approximately 1'23" (the end of Section B), and uses this to approach the axis of symmetry, saving the original form for the other side of this axis. Thus the retrograde statement begins at 1'27.7" and continues to 1'40.7" while the prime form begins at 1'40.7" and continues to the end of the section.

The intervening material between 1'23" and 1'27.7" consists of similar material, but transposed; this is most noticeable in the Type I material, which can now be seen in the register between 3614 Hz and 5886 Hz, significantly lower than anywhere in the B section, where 6022 Hz was the lower boundary for this type of material. This additional material resembles the original form of the Type I material, accelerating the pace of glissandi; moreover, it continues, and thus appears with the retrograded form of the original excerpt leading into the axis at 1'40". This additional material also appears in the continuation after this axis, now in its retrograde form, but along with the prime form of the larger excerpt.

This combination of retrograde and prime forms resembles the stated form of the entire piece, and is one of the first connections between the mid-level and large-scale structure of the composition. Here, however, the prime and retrograde are successive, and will thus make an invariant shape when reversed in the second half of the piece (i.e. the ideal shape of this passage as a whole will look and, moreover, sound the same when it is retrograded). The uneven filtering on each side of the axis of symmetry will, however,

mask this invariance, and perhaps most challenging to our perception of the underlying form is the extremely low dynamic level of Section C–the softest of the piece. This soft section is the starting point for the third phase of accretion, the longer, more sectional period of growth which will carry the piece to its midpoint.

Section D.

The individual sine tones which characterize Section D emerge from Section C beginning as early as 1'46", and by 1'48" Ligeti establishes a counterpoint of two glissing sine-tone lines as the predominant texture. These continue through 2'02"-2'04", where a substantial increase in reverberation alters their sonic character, and the section ends shortly thereafter at 2'05" with the introduction of the noisier sounds of Section E. Since most of Section D will overlap with its retrograde in the second half of the piece, the sparsity of this section is well planned, as the counterpoint will appear doubled in the second half. See Figure 2.9, a spectrograph of Section D.

This sine tone counterpoint is made of two lines; each line is a single sine tone with no overtones, each is a-metric but rhythmically distinct, and has a characteristic range. The upper tone moves the most frequently, making close to 30 changes in direction in the 19 seconds of this section; the upper tone, however, moves in a more constricted range of less than an octave, from 1482 to 2705 Hz. The lower tone, on the other hand, moves less frequently but in large leaps. The lower tone moves only 16 times, close to half the rate of the upper. The lower tone also occupies a much greater range, beginning and ending in the extremely low register, at about 114 Hz and 231 Hz, respectively, and

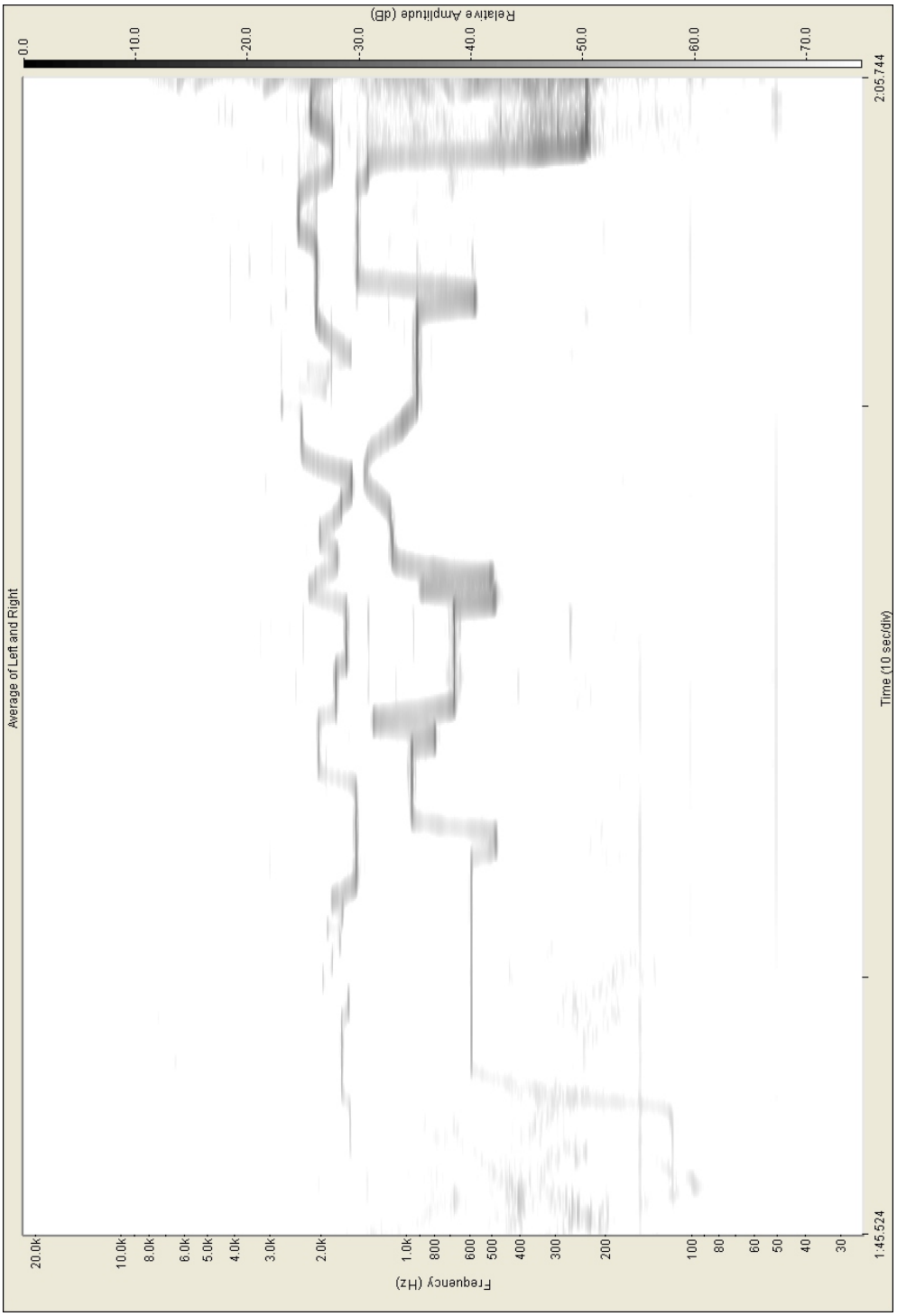

Figure 2.9. Spectrograph of Section D

peaking at 1460 Hz. While this peak is close to the lowest point of the upper line, these points are far removed in time, and at no point does either of these tones cross into the ambit of the other.

While Section C was the softest section, and thus represented a minimum point in intensity, Section D is the sparsest in attack strength and in spectral density. Thus while Section C shared material with Section B, and Section D's material will continue into Section E–and it would seem that this would create a strong division between Sections C and D–however, these intervening sections share common features in reduced attack strength, intensity, and spectral density, and have a certain cohesion of their own, thus smoothing out the change in material and helping the form unfold more organically. In fact the gradual build up of volume from Section C to Section D is the beginning of the third stage of growth which will carry the piece to its midpoint, and here, as elsewhere, the beginning of this accretion is slowly paced, before giving way to rapid acceleration.

Section E.

Section E, which runs from 2'05" to 2'38", takes the homogeneous sine tones of Section D, treats them with reverberation, and adds a mixture of other materials, including symmetrical, invariant gestures made of filtered noise, and also the addition of white noise. I will define Event 1 as 2'05"-2'12", in which these invariant gestures are predominant; In Event 2 (2'12"-2'26.5") the sine tones reemerge as the predominant material, although now with heavy reverberation and white noise in the lower register. Event 3 (2'26.5" -

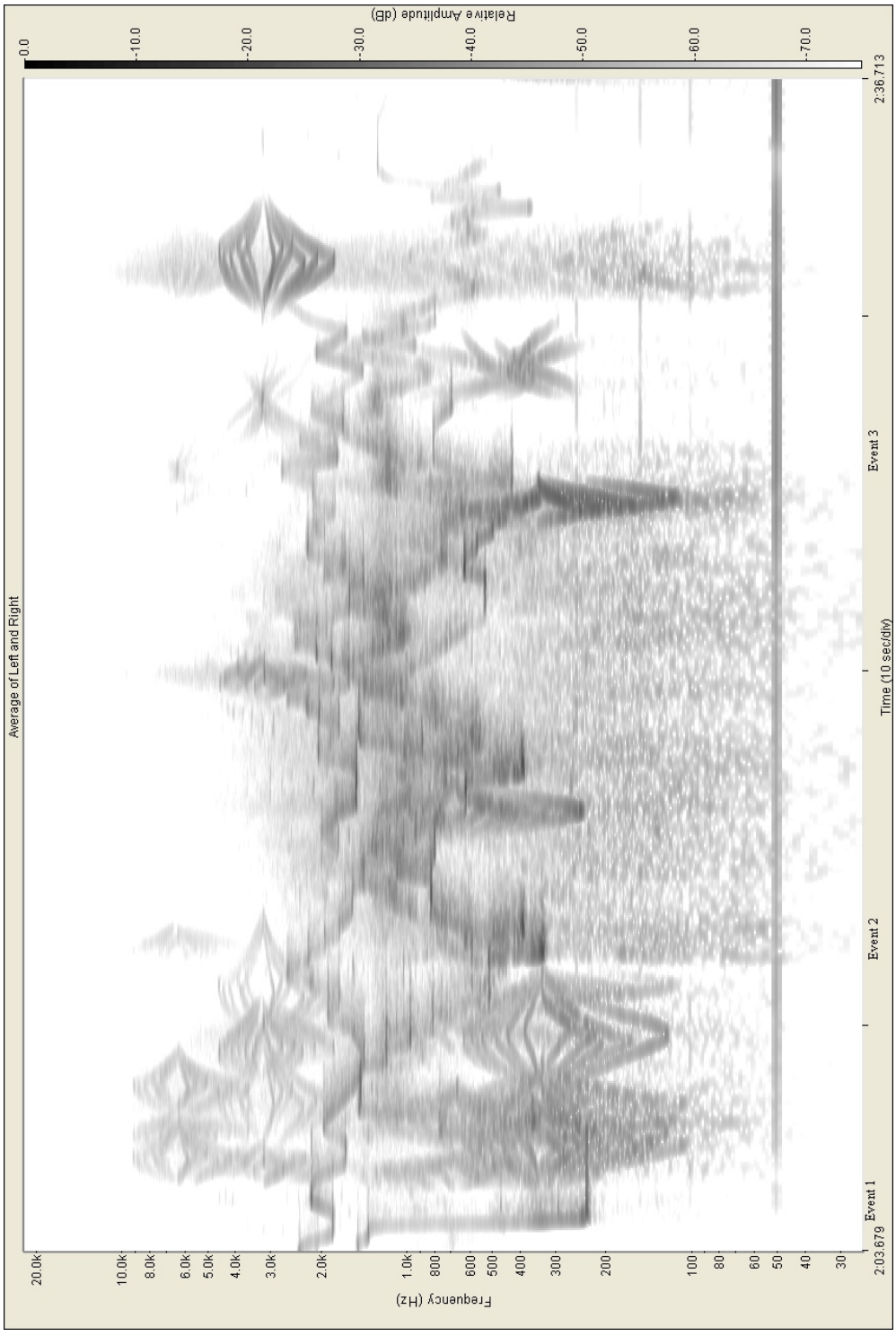

Figure 2.10. Spectrograph of Section E

2'38") dramatically reduces the reverberation while the sine tones trail away, leaving the invariant gestures, in both whole and fragmentary form.

The invariant gestures found in Event 1 are symmetrical around both horizontal and vertical axes, and thus would be invariant under both inversion and retrograde. The gesture can be idealized as a diamond shape, and was most likely created by the use of ring-modulation of a band of 20 Hz noise with a low frequency glissando which would produce bands symmetrically around the center frequency.[11]

These gestures are also arranged in specific registers, their center frequencies are arranged in octaves at 3200 and 6400 Hz. and in the lower register at 335 and 670 Hz. This suggests that this type of material was created all at once in the studio and then later distributed through the piece. Due to the noisy character of these gestures, the specific frequencies will not be heard; the most prominent feature of these gestures is a characteristic envelope, crescendoing to the peak of the divergence and then decrescendoing again–yet another invariant feature when retrograded. This combination of registral and dynamic expansion and contraction creates a Doppler-like effect, and even in a mono presentation creates an illusion of objects approaching and fading away, moreover, the gestures' presentation in rapid succession, or overlapping with one another makes this new type of material all the more prominent.

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[11]Given two input frequencies, ring modulation will yield the sum and difference of these frequencies, so that if the center frequency of 3200 was ring modulated with a glissando from 50-100 Herz, one would get mirror-image glissandi from 3250 Hz up to 3300 and from 3150 down to 3100 Hz. A thorough discussion of ring-modulation can be found in Charles Dodge and Thomas Jerse, *Computer Music: Synthesis, Composition, and Performance*, 2nd ed. (New York: Schirmer Books, 1997), 92-94.

These invariant gestures divert one's attention from the sine tone strands, which begin to multiply towards the beginning of Event 2. The lower strand is obscured by the invariant gestures centered on 335 Hz, which occupy the same range. When this strand leaps up again, it collides with the upper strand at 2'08.5" and at 1448 Hz–near the previous boundary between their ambits. From this point of intersection, the sine tones diverge again, almost symmetrically, and at the height of this divergence, Event 2 begins. While the onset of white noise clearly marks a new event, these sine tones continue, turning back towards convergence, and creating a nearly symmetrical diamond over the border of Events 1 and 2, which will be significant in the second half of the piece.

Event 2 begins with the introduction of white noise in the low and middle registers; the noise extends from about 2600 Hz downward. Within this noisy range the sine tone strands continue and even multiply, although the dense texture makes it difficult to point out exactly where the new strands enter. This heterogeneous texture also includes invariant gestures at 2'15" (670 Hz), and 2'19"(3200 Hz) and a final gesture at 2'24" (335 Hz). With this final gesture the white noise abates, and Event 3 begins.

As the texture thins, eliminating the white noise and dramatically reducing the reverberation, the sine tones reemerge along with occasional invariant gestures. These two types of material begin to separate in register as well, with the sine tones occupying the span from 370 to 2056 Hz, and the invariant gestures occurring largely on either side of this range–a trend which also contributes to the clarity of the texture. The final invariant gesture, however, occurs squarely within this range, centered again at 670 Hz, and with it materials which will characterize Section F begin to enter.

Some of the invariant gestures which occur towards the end of Section E and beginning of Section F occur in fragmentary form. Some of these appear to be made from a combination of two ring-modulated invariant gestures where the end of one gesture connects to the beginning of another. While the ring-modulated gestures shown earlier expanded and then contracted forming a diamond-like shape in the spectrograph, these fragmentary gestures contract and then expand again, forming more of an "X" shape than a diamond. Examples of these at 2'25.5" and 2'27.5" are centered on 6400 and 3200 Hz respectively, and thus have the same center frequencies as the gestures already heard. Others similar gestures have differing center frequencies, and might have been formed through separate ring modulation of a center frequency with a low-frequency glissando in the other direction–down and then back up. The instance at 2'28.5" is one example of this new shape, which occurs on a new center frequency of approximately 400 Hz, and subsequent entries in Section F, such as the have 2'42", share this 400 Hz range, or establish an octave transposition of this, as do the entries at 2'47", 2'54", and 3'03".

Section F.

An extremely low sine-tone glissando begins Section F (2'38"-3'46.5"), which continues as a massive crescendo and build in register from the lowest to the highest extremes heard in the piece. This culminates at the midpoint of the piece, where Ligeti begins to overlap the prime and retrograde forms of the entire first half, and subject these to filtering. The material of Section F is familiar from before, including invariant gestures, glissandi of sine tones and filtered noise, and unfiltered noise–the most diverse materials

since Section B, yet here Ligeti's plan calls for the sharing of materials across different registers to produce a less stratified and more completely intermingled texture.

This intermingling, however, occurs in stages; one can find the entrance points of similar materials marking each register, ascending from the lowest to the highest. As the previous materials continue underneath these new entrances, however, the texture becomes more and more opaque, entrances of new materials are obscured, and the sounding mass approaches white noise. As the section begins with low sine tone glissandi, and as these are readily perceived when they enter in other registers, I will define events in Section F based on these entrances. Event 1 begins around 50 Hz, at 2'37; Event 2 begins with the entrance at 400 Hz at 3'01"; Event 3 enters at 1551 Hz at 3'12"; Event 4 begins at 3'20" and 5709 Hz; and Event 5, the final entrance of this type of material, comes in at 11,249 Hz, at 3'30". An abrupt cut off at 3'37.3" provides an additional point of reference which I will designate as Event 6, which entails a change in material which lasts until the midpoint of the piece, 3'46.5". These are shown in Figure 2.11, a spectrograph of Section F.

This arrangement of events corresponds closely, though not exactly, to the rhythmic design of the first half of the piece, articulating many of the points Ligeti designates as subdivisions of roman numeral III, which are provided on the spectrograph above. Event F1 corresponds exactly to the span of IIIe and IIIf, although there is no clear internal division within this span. Events F2, F3, and F4 respectively correspond to IIIg, IIIh, and IIIi. From this point on, the correspondence is less straightforward. The beginning of IIIj occurs approximately at the spot where a set of very fast mid-range

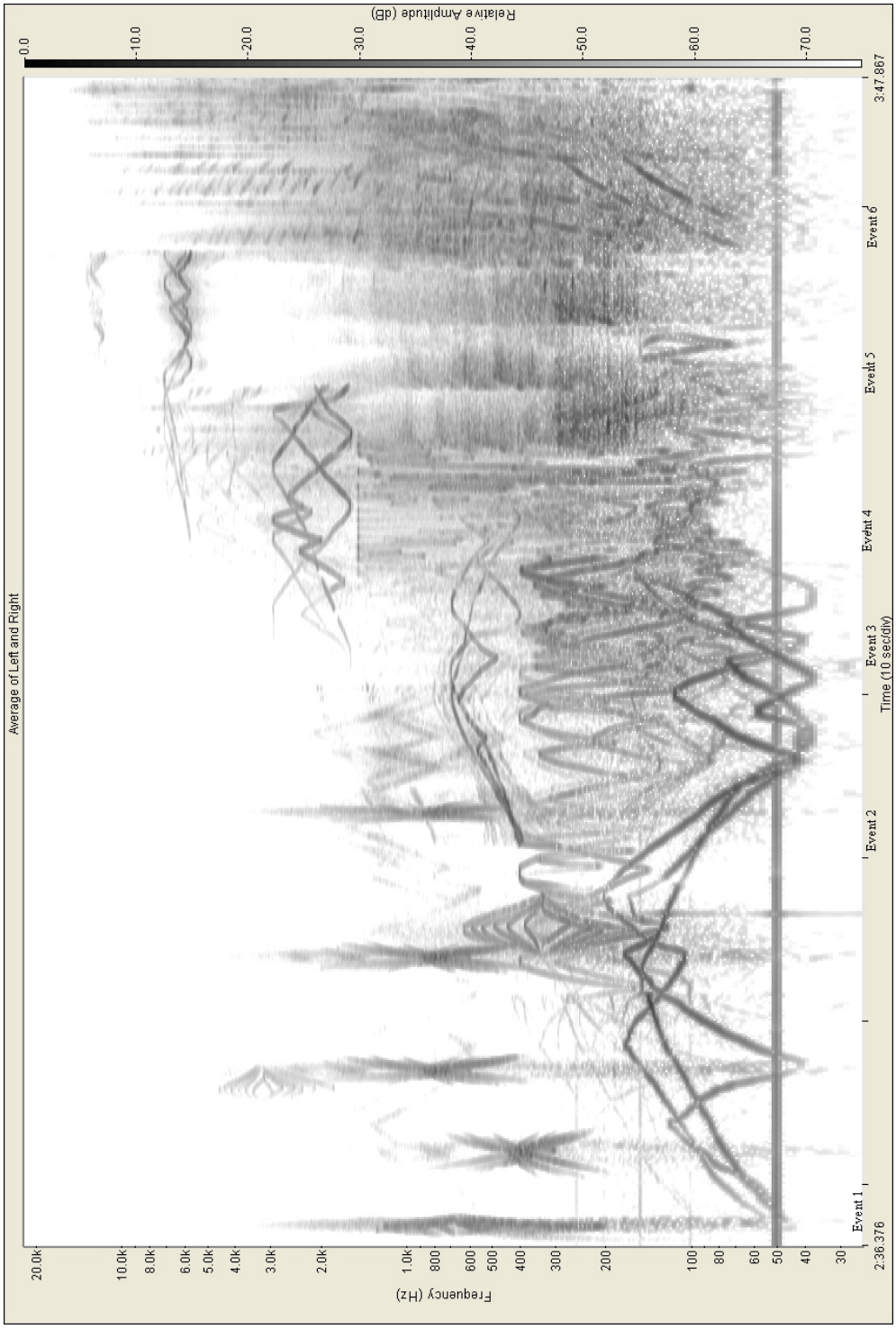

Figure 2.11. Spectrograph of Section F

glissandi end, and an area of low white noise begins. IIIk occurs one second away from a large reiteration of this noise, yet these spots fall on either side of the large cut-off of the upper-middle register and introduction of the highest register which define Event 5. Event 6 corresponds to III-l, and the following divisions, IIIm-IIIo may correspond to some of the clipping within Event 6, which clearly displays the same acceleration towards the midpoint.

Ligeti articulates these points of his rhythmic design largely by the introduction of new materials or new registers; as in Section B, the introduction of materials proceeds slowly at first, and then accelerates towards increased density. Events 1 and 2 prepare this process, as they are the longest events and introduce only slow moving material, while Events 3-6 bring it to its culmination, compressing the number of events per second and also accelerating the previous material to bring this third stage of accretion to its peak.

Event 1 contains only the invariant gestures introduced in Section E and a slow sine tone glissandi, and thus provides a smooth transition from the previous section. The invariant gestures share the same center frequencies as those in Section E, and as they gradually merge with other material in Event 2, they disappear when this transition is complete. The only new material in Event 1 are the low sine glissandi which occupy the register between 50 and 170 Hz. Event 2 transfers these slow glissandi to the area between 400 and 680 Hz, introducing faster glissandi in the area below 400 Hz. Event two also presents more angular glissandi of filtered noise in the range from 735 to 1459 Hz, the range above the newly introduced glissandi, and that previously occupied by the invariant gestures.

These angular glissandi fade in slowly, and doing so, help prepare the entrance of Event 3 at 1551 Hz. At 3'17", shortly after the entrance of these slow glissandi, extremely rapid glissandi begin fluctuating in the register below 1470. These continue the trend set by Event 2 of having the speed of glissandi increase in the register occupied by the slow glissandi of the previous event. This acceleration helps the texture build towards noise, and as Event 4 continues these fast glissandi, it also introduces wider bands of noise focused in the lower register (particularly strong in the octave between 150 and 300 Hz).

Event 5 continues these bands of noise and introduces material at 11250 Hz, the highest register yet heard. Underneath this new material, however, Event 5 cuts off the range from 1300 to 4735 Hz–the intervening register which Event 3's material first occupied. This cut-off breaks with the previous trend of accelerating the glissandi in the range below the newly introduced material, but simultaneously highlights the low noise bands which can be seen as the culmination of this process of acceleration. The momentary respite is quickly filled by Event 6 which introduces the combination of low glissandi moving primarily upwards, high glissandi moving downwards, and white noise across all registers. While this noise can be seen as the end result of chaotic patterns of accelerating glissandi, the glissandi themselves are now more ordered than the previous. The glissandi of Event 6 are arranged by register and often appear in harmonic combinations (at 3'38", for example, the frequencies, 766, 1514, 2278, and 3078 Hz appear, very close to the ideal 766, 1532, 2298, 3064 Hz) which suggest a higher degree of coordination than characterized previous material. This is undercut by the clipping of material, which continues to articulates the acceleration of subdivisions towards the

center, and also prepares the more dramatic filtering of material after the midpoint of the piece.

Section F introduces a mixture of materials similar to Section B, yet there are many differences in the ways these two sections unfold. In Section B, the individual events were short, and the feeling of a continuous stratified texture was built up through the increasing rate of repetition, as the roman numerals cycled together more and more quickly; in Section F, however, (and especially F1-F4) once a material is introduced, it usually continues throughout, materials are often available in all registers, and all materials are introduced in a unified build up from low to high. This pertains through the end of Event 4; the pause in Event 5, highlights the registral extremes–low noises and high sine tones–before Event 6, a recombination of tones and noise, but one from which any of the previous materials has the potential to emerge.

Second Half

Ligeti's schematic plan describes the second half of the piece as having doubled material, but also calls for the filtering of this material–a process so prevalent that often the second half is sparser than the original. The resulting texture has twice the potential material available, but one only hears small snippets present in the surface of the music–often just enough to be recognizable. As these recognizable excerpts engage the listener's memory and imagination, the filtering greatly effects one's perception of the form of the piece. Although all the material heard from here to the end is a literal restatement or transformation of previous material, a listener's expectations, based on how

material was previously used, have the potential to be fulfilled in the same way as in the first half, fulfilled in retrograde, or answered with contrasting material. This is particularly complex, since many of the individual gestures remain unchanged when retrograded. Moreover, Ligeti works anomalies into his stated plan, so that material from different sections appears "out-of-place" furthering the potential recombination of materials.

I will divide the second half of the piece into two phases, the first where these anomalies occur, and the second, which is more straightforward in form, but in which all of the gestures now draw on multiple referents. The first stage (3'46.5"-5'32") corresponds to the retrograded F and E Sections (henceforth F^R and E^R), along with the second statements of A, B, and most of C (A^2, B^2, and C^2). The second stage begins at 5'32" with the coincidence of D^2 and its own retrograde, D^R and continues to the end of the piece. Figure 2.12 is a spectrograph of the Second Half.

Stage 1

Ligeti's prime-plus-retrograde form will necessarily establish conflicting section boundaries; since the original sections are all of different lengths, there will be continually overlapping sections and the criteria for determining divisions will not necessarily coincide with all of the sectional boundaries of the initial half of the piece. Which sectional boundary is stronger will depend on the exigencies of their presentation in this new context, which in many cases includes the filtering out of many of the striking initial gestures of the beginning. The stages of the second half are much more fluid divisions than the sections of the first. Since the A section's reprise is largely overwhelmed by the

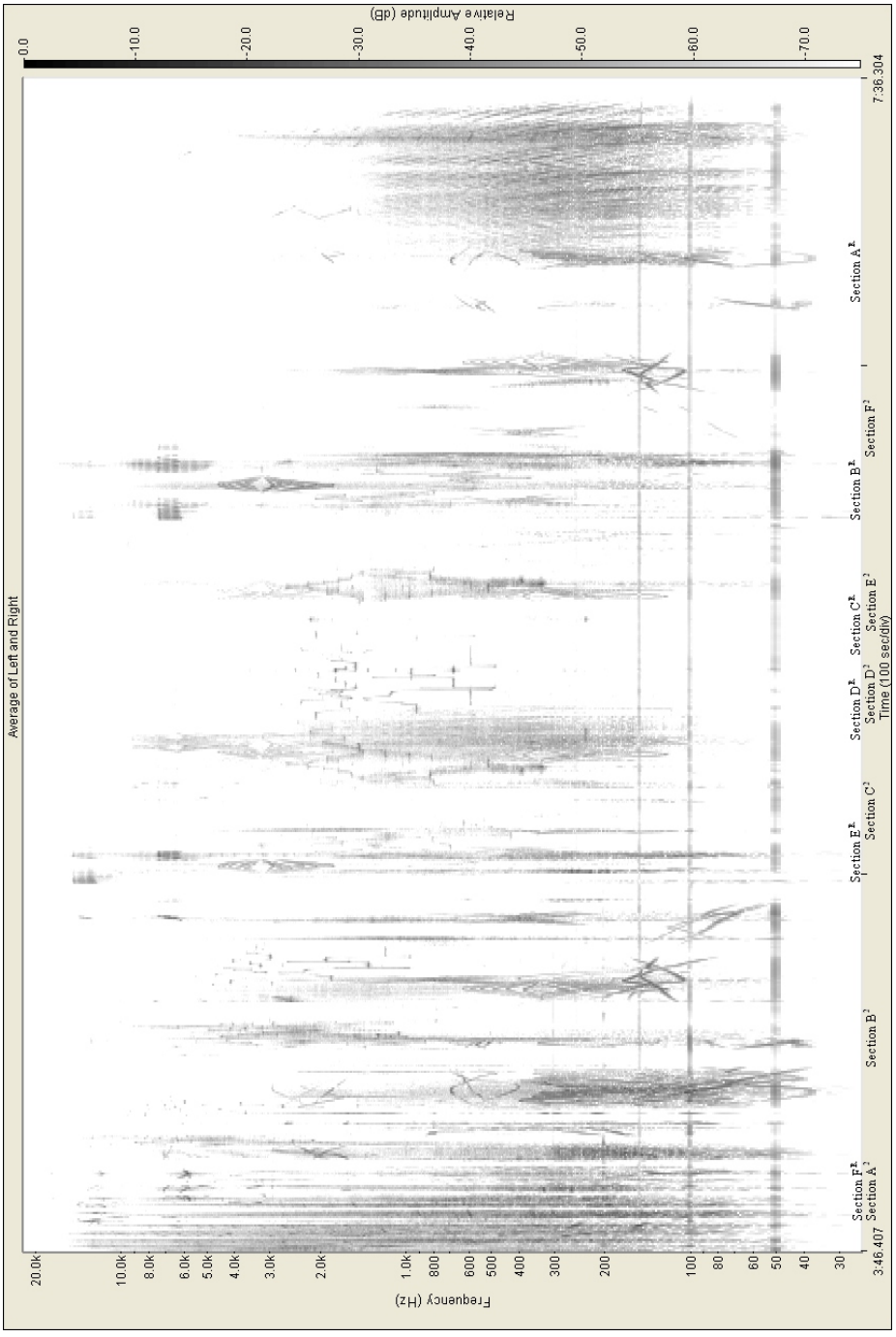

Figure 2.12. Spectrograph of the Second Half

retrograde of the louder, denser, and more wide ranging F Section, I will mark one such divisions at 4'54.5", the end of Section F^R. This span also contains anomalous material, not generated by the schematic form, in two separate areas.

The striking pizzicato glissando which began the initial B Section is filtered out in the reprise, and the end of Section E^R (which contains the third and final anomaly) transfers clearly to Section D^R, which, coinciding with the reprise of the D Section, constitutes a substantial change in material. Thus I will define the span of Section E^R as the second major division of Stage 1. These divisions are shown below in a spectrograph (Figure 2.13).

Retrograde of Section F

The retrograde of Section F is largely audible as such, and while fragmented, it creates a coherent arch around the midpoint of the piece. Two factors facilitate this perception, first, the decelerating rhythm of the filtered material which mirrors the acceleration towards the midpoint, and second the registral shape of Section F^R. The material of Section F was so diverse and spread through such a wide range, that its retrograde overwhelms the shape of Section A^2 with which it runs concurrently; moreover, since Section A is shorter than Section F, A's rise in register is swallowed within the shape of Section F^R's arching descent.

The clipping of material which accelerated through Event 6 of Section F, prepares the abrupt and interruptive filtering which begins the second half of the piece, and conversely, the slowly lengthening segments of unfiltered material reverse the accretion

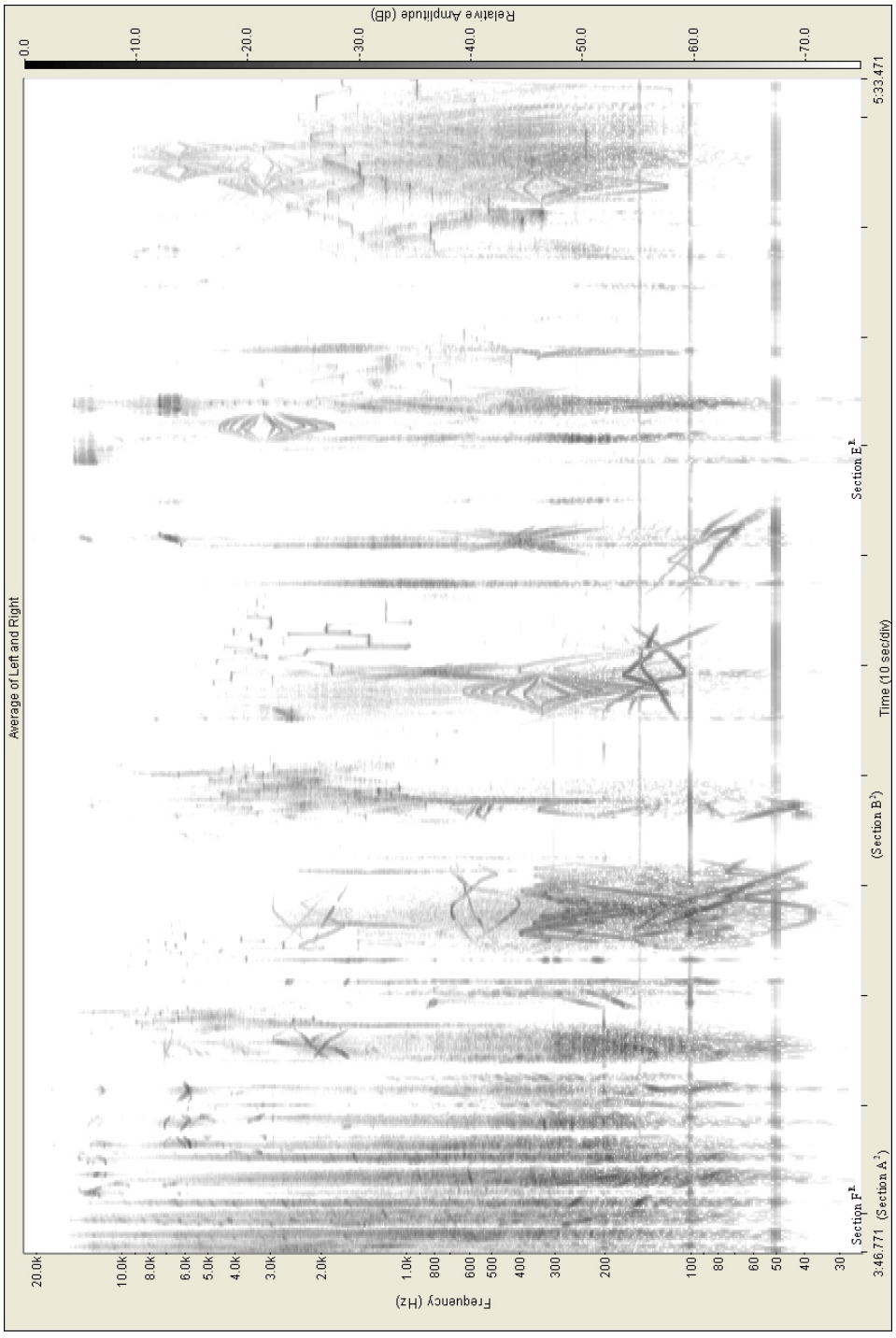

Figure 2.13. Spectrograph of the Second Half, Stage 1

that brought the piece to its midpoint. The durations of unfiltered material do not lengthen as regularly as the durations of Section F, which used an additive series to govern the third stage of accretion, but the trend is clearly towards longer segments. In the first 16.5 seconds (3'46.5"-4'03") of this division, there are no individual segments longer than one second; from 4'04" on segments as long as 8 seconds are heard. Figure 2.14, A spectrograph of Section F^R displays this trend.

Also visible in the spectrograph is one of the distinct types of filtering used in this stage. At first, segments are filtered across all registers–perhaps even by replacing segments of recorded tape with blank leader tape. Later in the piece, however, the filtering begins to affect only certain registers, passing only the high or low part of the previous material.

A previous use of filtering leads us to the first anomaly in Section F^R; the space from 3'29-3'36.5" involved an abrupt cut-off in the upper-middle register from 1300 to 4735 Hz. One would expect to find a corresponding window in this register during a span from 3'56.5-4'04", which is equally spaced 10 seconds from the center. This window, however, does not occur. As shown in the spectrograph below, Figure 2.15.

Since the material from Section A is, at this point, entirely below 1200 Hz, it will not impinge on this window, yet there are clearly bands of noise that stretch from the low register well into this area; these are most likely extensions of the low noises of Event 5. In the first half, Ligeti achieved a cut-off and the resulting window by abruptly using a band-stop filter to remove signals in this range, but this must have been done at a late stage of the composition, since, in the second half (and amongst all of the other filtering)

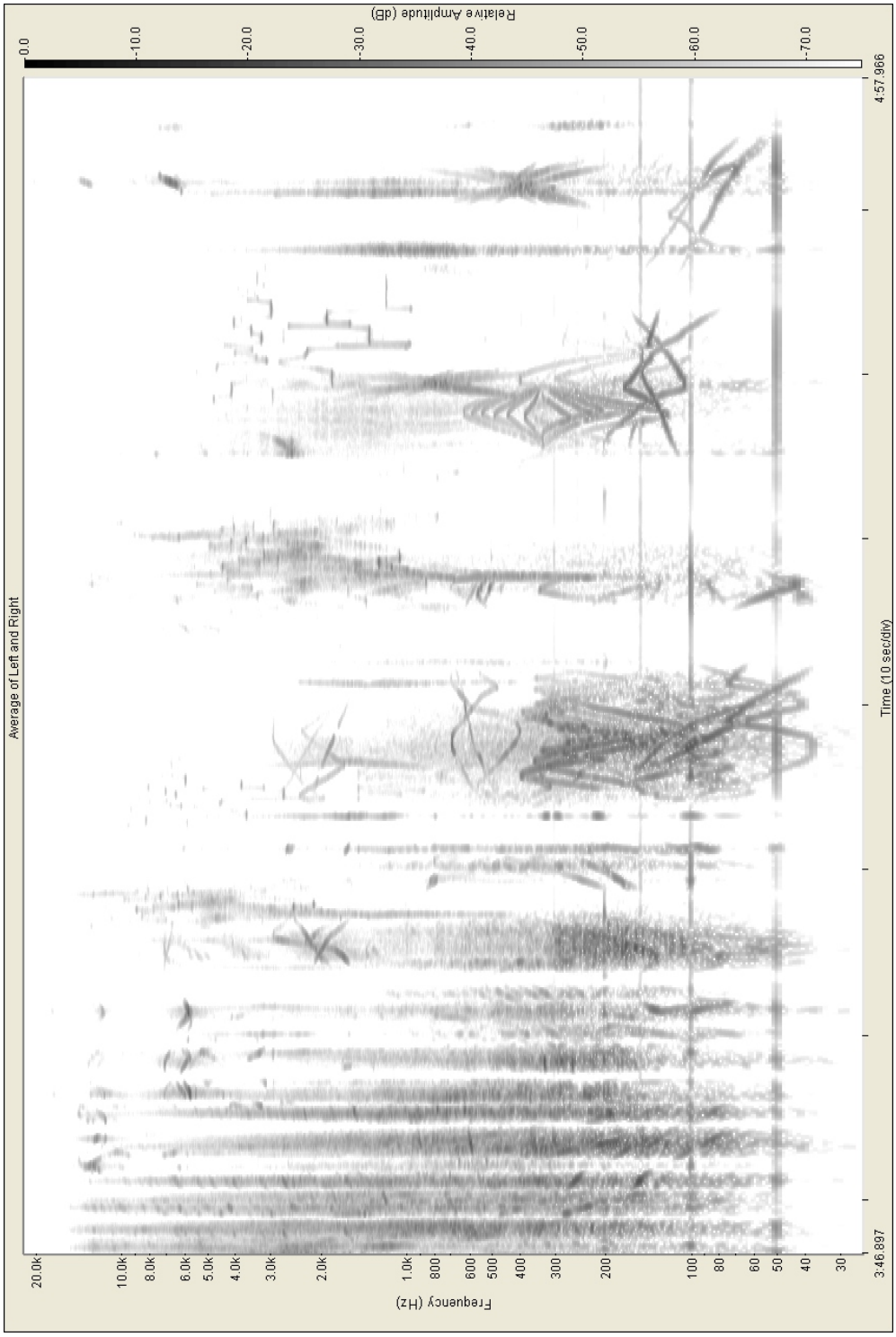

Figure 2.14. Spectrograph of Retrograde F

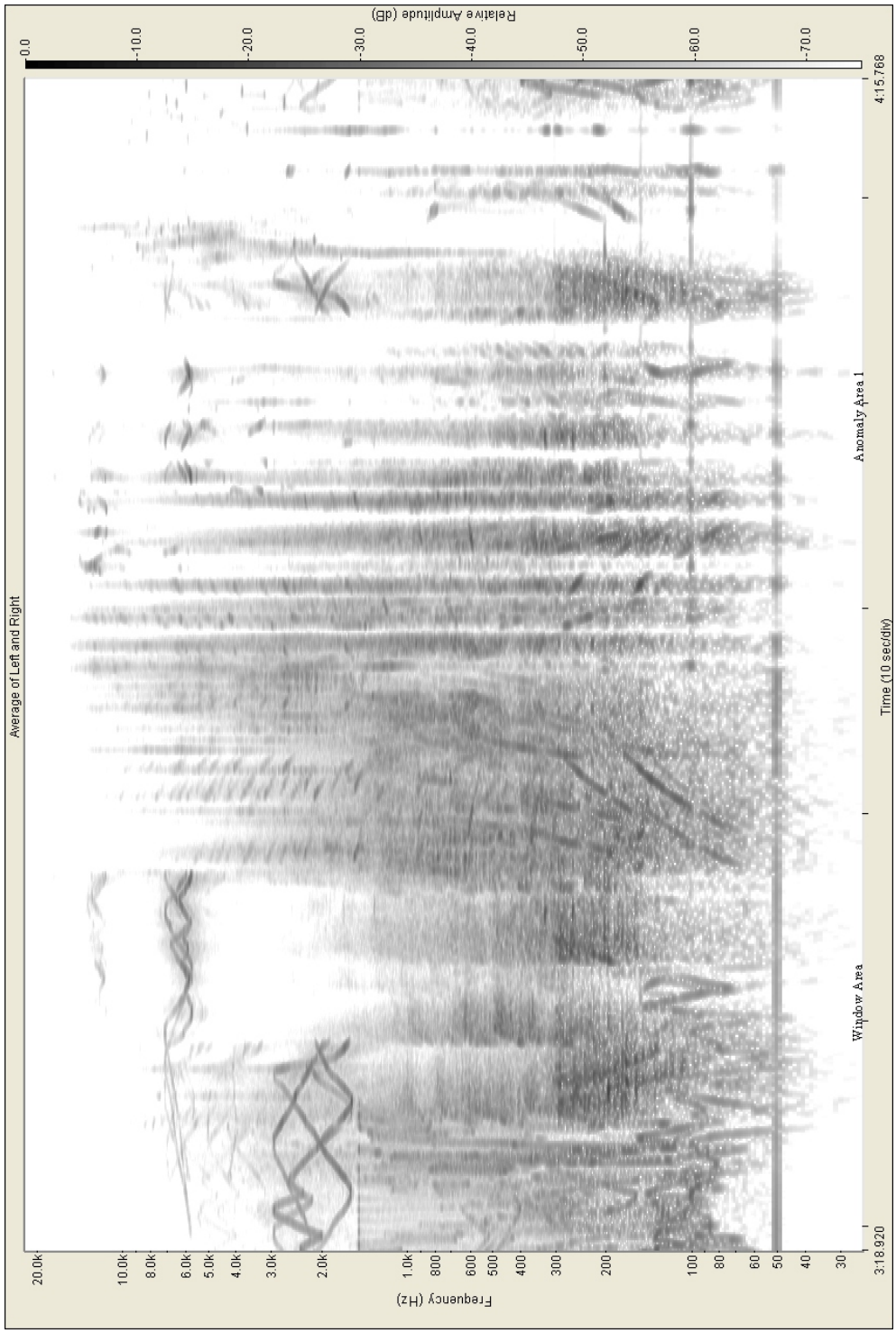

Figure 2.15. Spectrograph of Anomaly Area 1, the Midpoint of the Piece

Ligeti uses a version of these low noises that has not been treated with the band-stop filter. It is also in this area, during a more extensively filtered section between 4'00" and 4'03", that Section A's material is most clearly heard, and thus this point in the piece gives us two clues into the complexity of relationships between the two halves of the piece.

The second set of anomalies involve a different and more dramatic situation–rather than having an unfiltered version of the previous material occur, these anomalies involve transplanting material from different sections of the piece–sections not included in the schematic representation of the form. In particular, the span from 4'06" to 4'47" involves material from Sections D and E, occurring in a part of the piece where only material from Sections A^2, B^2, and Section F^R should be found. Figure 2.16 shows this span is in a spectrograph.

These anomalies are labeled a-d in the Figure 2.16, (and are shown at the same decibel scale used in Example 8 to bring out softer elements). Anomaly 2a, exists from 4'06" to 4'09.5" and is a retrograde of Section E, Event 2, transposed up two octaves and correspondingly shortened to a mere 3.5 seconds from its original 14.5. Anomaly 2b (4'12-4'17") is a version of the retrograde of Section D, similarly transposed two octaves higher than the original. This pair of anomalies is answered by a second pair: anomalies 2c (4'24-4'31.5") and 2d (4'38-4'47.5") are octave transpositions of the retrogrades of E and D, respectively.

Just as material in the initial F Section transferred like materials from one register up to the next, so Section F^R treats this anomalous material in the same way. These anomalies descend in register, and in doing so slightly expand the descent of Section F^R.

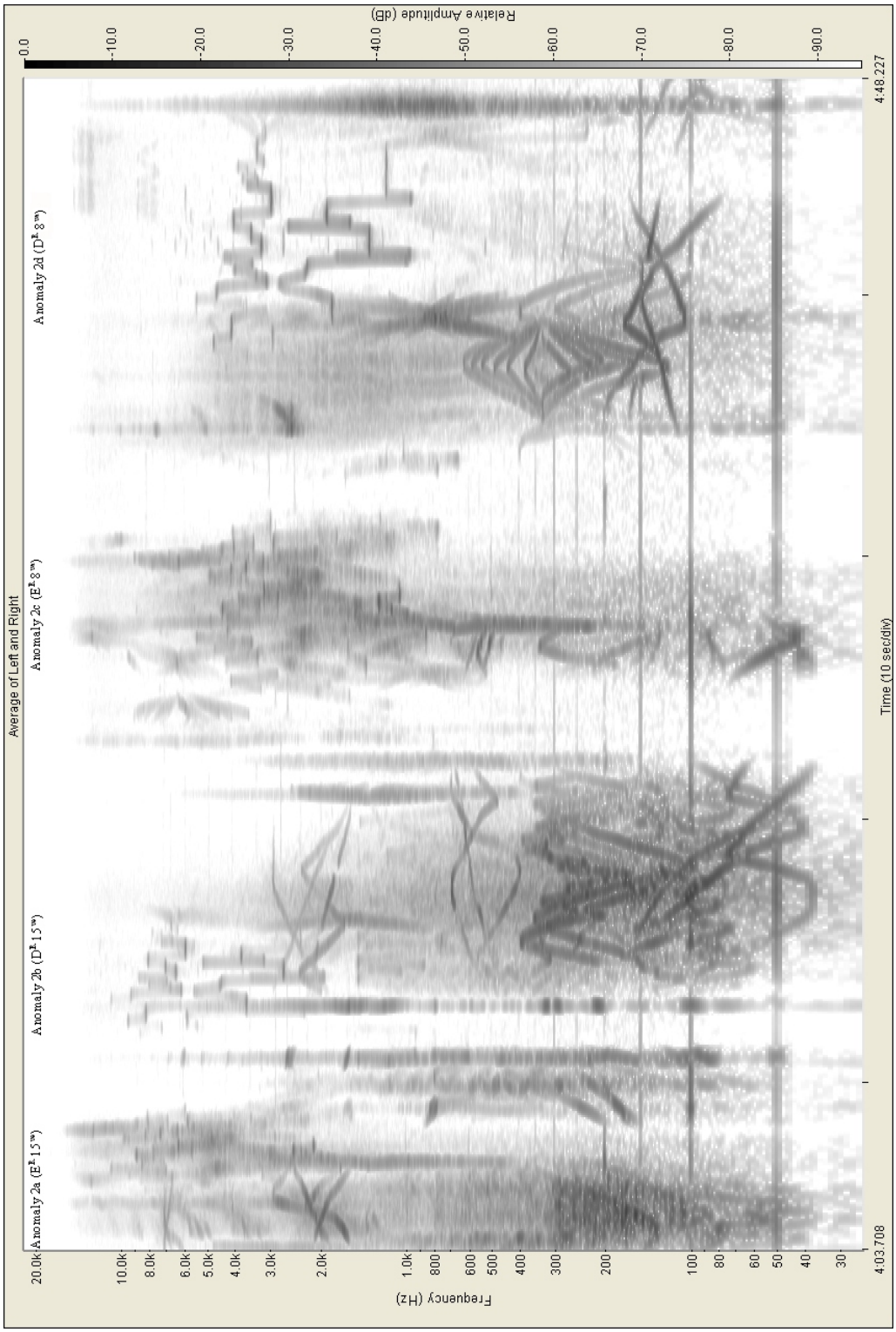

Figure 2.16. Anomaly Area 2, Material from Sections D and E

The first pair of anomalies, which coincides with the denser part of Section F^R, fits into the arch shape quite readily, but the second pair begins to stand out more prominently, and thus helps prepare the following sections. Sections E^R and D^R occur in the place allotted by the schematic form and outside the arch shape of Sections F and F^R, but prepared as they are by the anomalies in descending registers, these sections can also be seen as extending this descent past Section F^R, and smoothing out the transitional area between the two stages of the second half of the piece.

The reprise of Section B overlaps with the end of Section F^R and beginning of E^R, but Section B is largely filtered and stands out from these sections in only a few places. The first pizzicato glissando of Section B is filtered out, and the second instance (20 Hz noise) occurs at 4'35" just before material from both Section F^R and the second instance of Section D material. As such the beginning of Section B is not as well marked and does not readily define a division of this stage of the piece. Material from B is nonetheless notable at 4'51" in the highest register, and again from 4'58-5'07", although in both of these instances it occurs along with material from Sections F^R and E^R.

Retrograde of Section E

The retrograde of Section E is more intact than the reprise of either Section B or C, with which it overlaps. Furthermore, the second anomalous area prepares Section E by using transpositions of its material. Section E^R as shown in the spectrograph below, is intact except for the second event–the very event which is used in the previous anomalies.

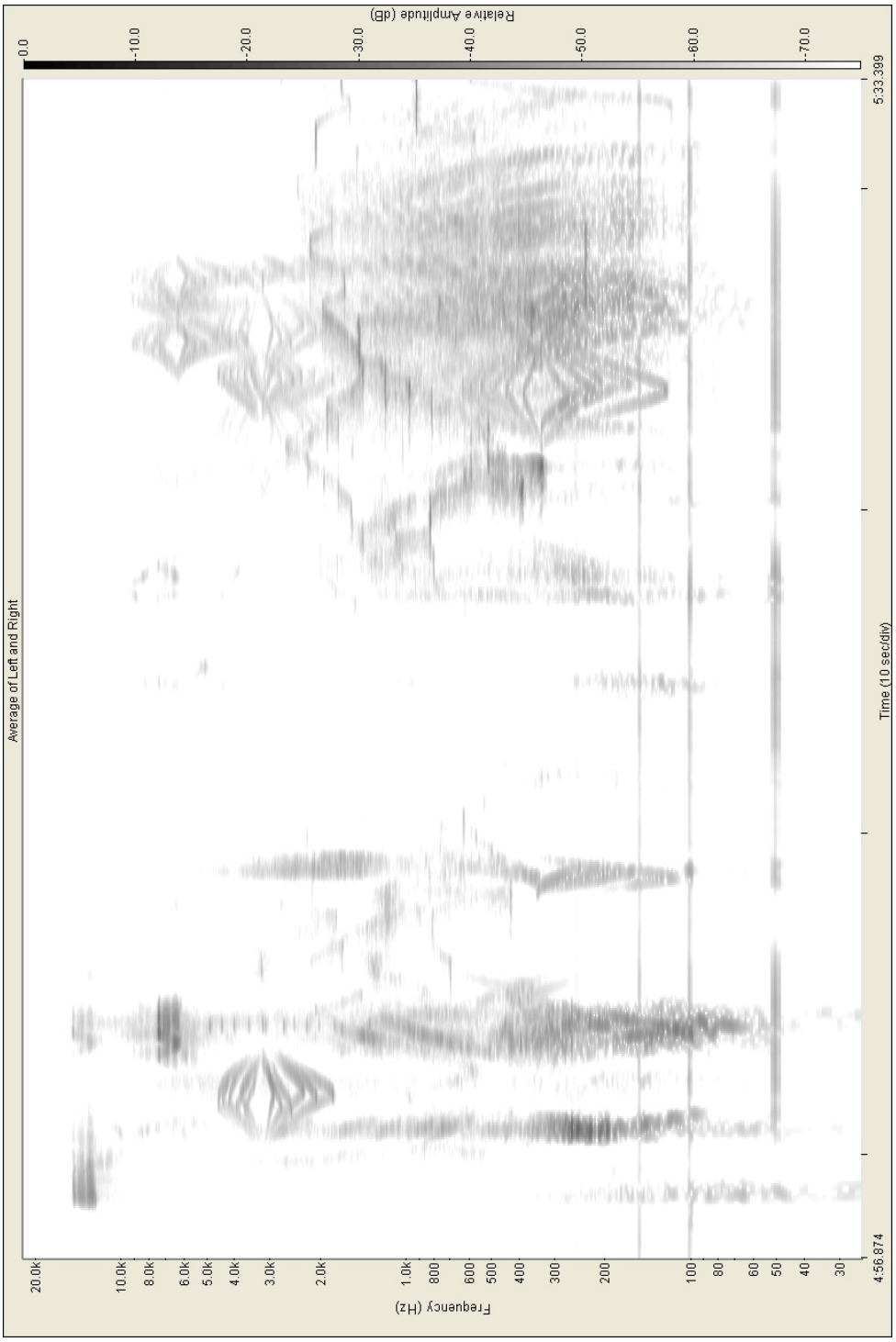

Figure 2.17. Spectrograph of Retrograde E

While Event 2 of Section E used sine tones in combination with white noise; the outer events of Section E used predominantly invariant gestures. Thus the material from Section E which was used earlier was the more directionally distinct material, while the material used here is symmetrical, including the nearly-symmetrical gesture which originally spanned the border between Events 1 and 2. In this way the previous, directional material helps reinforce the shape of Section F^R while the symmetrical material appears here in a more ambiguous state.

The first stage of the second half of the piece comes to an end with the third anomaly area, from 5'24" to 5'33", coinciding with the end of Section E^R. This final anomaly uses material from the retrograde of Section A–bands of 20 Hz noise aligned into downward glissandi, the invariant axis is now at 5'29.5" and the downward direction of the subsequent glissandi indicate the retrograde form, brings this section to an end and overlaps with the beginning of Section D^R. This anomaly is also transposed up an octave to the range between 100 and 2400 Hz., as shown in Figure 2.18.

The fact that the A based anomaly occurs at this point of intersection illustrates another feature of all of these anomalies. In the schematic form of the piece, Section A will coincide only with Section F, and share a border with only Section B. The Section A Anomaly coincides with Sections E^R and D^R as well as the overlapping Section C^2, and thus all of the sections with which A would not normally overlap or share a border. Similarly the area of paired anomalies earlier in the piece provides another opportunity for material from Sections E and D to be combined with material from Sections A^2 and B^2 as

Figure 2.18. Anomaly Area 3, Material from Section A

well as Section F^R. The chart below summarizes the pairings of material from all sections:

A&B	bordering		B&C	bordering
A&C	anomalous		B&D	anomalous
A&D	anomalous	(twice)	B&E	schematic
A&E	anomalous	(twice)	B&F	schematic
A&F	schematic			
C&D	schematic	bordering	D&E	bordering
C&E	schematic		D&F	anomalous
C&F	does not occur			

The fact that materials from Section C and Section F never coincide is of little consequence since Section C does not introduce any new types of material. Section C is the echo of Section B, and all its material derives originally from this section. Moreover, while Section C introduced filtered and retrograded segments of Section B and helped presage these effects which pervade the second half of the piece, Section C^2 is largely overwhelmed by the surrounding material, audible only briefly around 5'14".

Whereas the first half used C and D, which both consist of soft material yet share other characteristics with Sections B and E, as a transition, the second half uses Sections D and E are used a transition between its two stages. These sections bridge the space from the end of the arching Sections F and F^R to the space of the rest of the piece, which often omits clear beginnings and ends and breaks free from the direction set for it by the previous material. This is illustrated by the roles of the anomalous material, first to reinforce the shape of Section F^R, then to extend this shape, and finally to present the most diverse combination of different materials in the piece, as material from Section A combines with material from other sections it would not encounter if the form were strictly

schematic. Three-quarters of the way through the piece, the schematic form has the potential to present all the material of the piece twice, once in the first half and once more, considering the combination of retrograde and prime forms; these combinations are substantially enriched by the anomalies, and together present an extremely rich network of associations on which the last quarter of the piece will draw.

Stage 2

Stage 2 contains no anomalies; all of the material heard in this stage is allotted according to the schematic description of the piece's form. In this regard it is simpler than the first stage, but the degree to which Stage 2 is fragmented, and thus obscures the direction of either the retrograde or prime forms, makes it conceptually quite complex. I will treat Stage 2 in three divisions: the first, a transitional region comprising D and Section D^R, (5'33-5'53"), the second, a span of largely invariant gestures taken, most notably from the reprises of Sections E and F (5'53"-6'51"), and finally the stretch corresponding to Section A^R, which carries the piece to its close. These are shown below in a spectrograph, Figure 2.19.

Sections D and Retrograde D

The combination of Section D with its retrograde (5'33-5'53") is a transitional area, surrounding the point exactly three-quarters of the way through the piece (5'40.5") where the prime and retrograde strands both reach their midpoints. In one regard, prepared by the anomalies which used transpositions of D Material, this section is the lowest register in

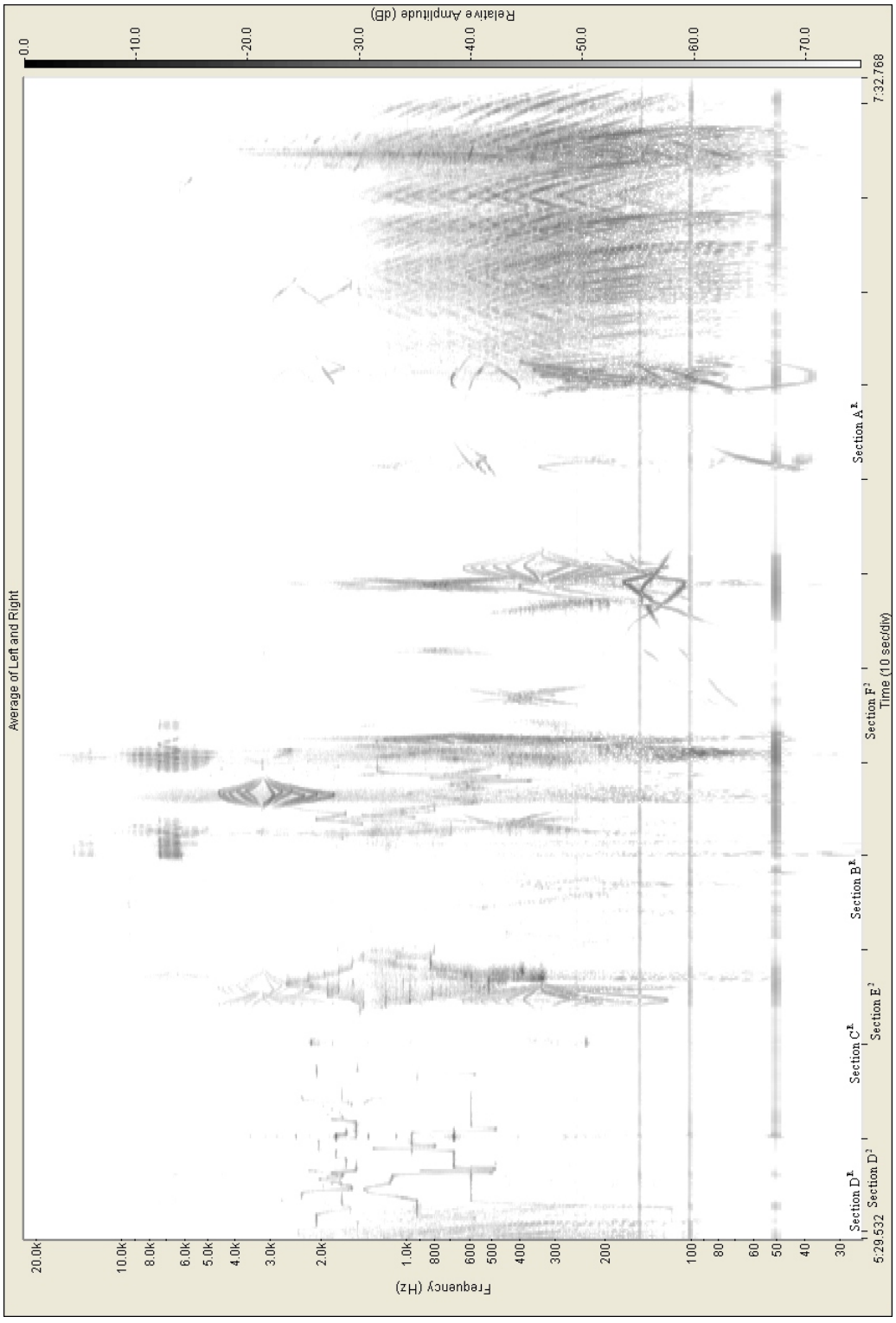

Figure 2.19. Spectrograph of the Second Half, Stage 2

the descent of this material, which follows, and, indeed, extends the descent heard through Section F^R. On the other, the sine-tone counterpoint is now symmetrical, and this ambiguous direction is a hallmark of this second stage. This transitional area is shown below in Figure 2.20.

In the spectrograph, one can clearly see the axis of symmetry around, 5'39", but a number of factors obscure the symmetry of these four sine-tone strands. One such factor is the fact that the two-part counterpoint of the original Section D did not contain any voice crossing, but when the lines are doubled with their retrogrades, both pairs cross freely, making individual voices hard to follow. The symmetry of this area is also disturbed by the use of filtering, which eliminates progressively more material as the section goes on, and in particular from 5'45" onwards where only traces of the original remain.

Invariant Passage (Reprise of Sections E and F)

The passage from 5'53" to 6'51" contains material from a variety of sections, filtered into four separate events. Event 1, which runs from 5'53" to 6'01", contains material from Section E; Event 2 (6'01-6'09") reveals material from Section C; Event 3 (6'09-6'26") uses excerpts from Sections B and E; and the final event (6'26-6'43") contains material from Section F, and is followed by a long rest, as shown below in Figure 2.21.

While these events come from different sections, they all share a common trait, emphasizing invariance. Event 1 consists of several of the invariant gestures found in Section E. The familiar ring-modulated invariant gestures centered on 335, 3200 and

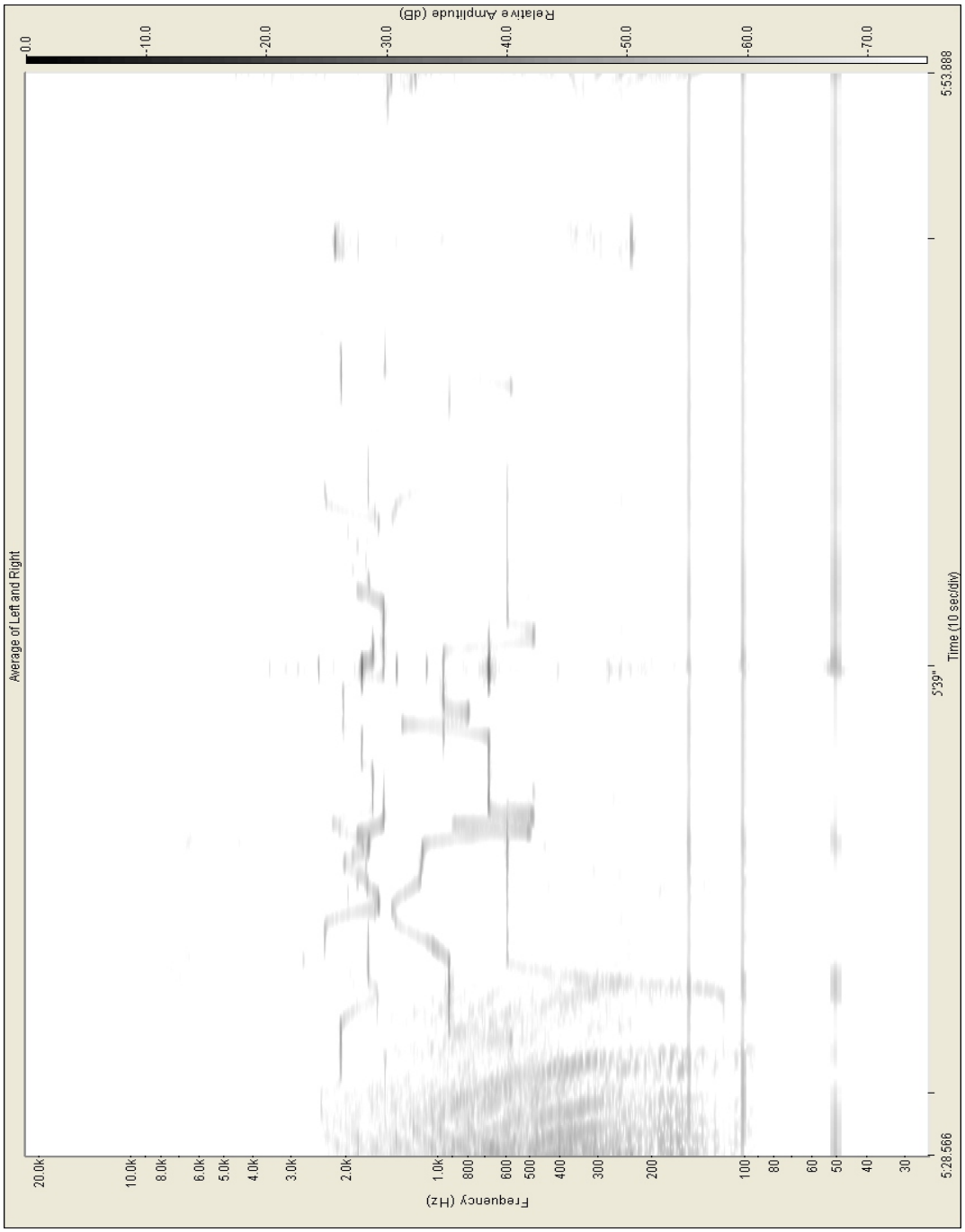

Figure 2.20. Spectrograph of Sections D and Retrograde D

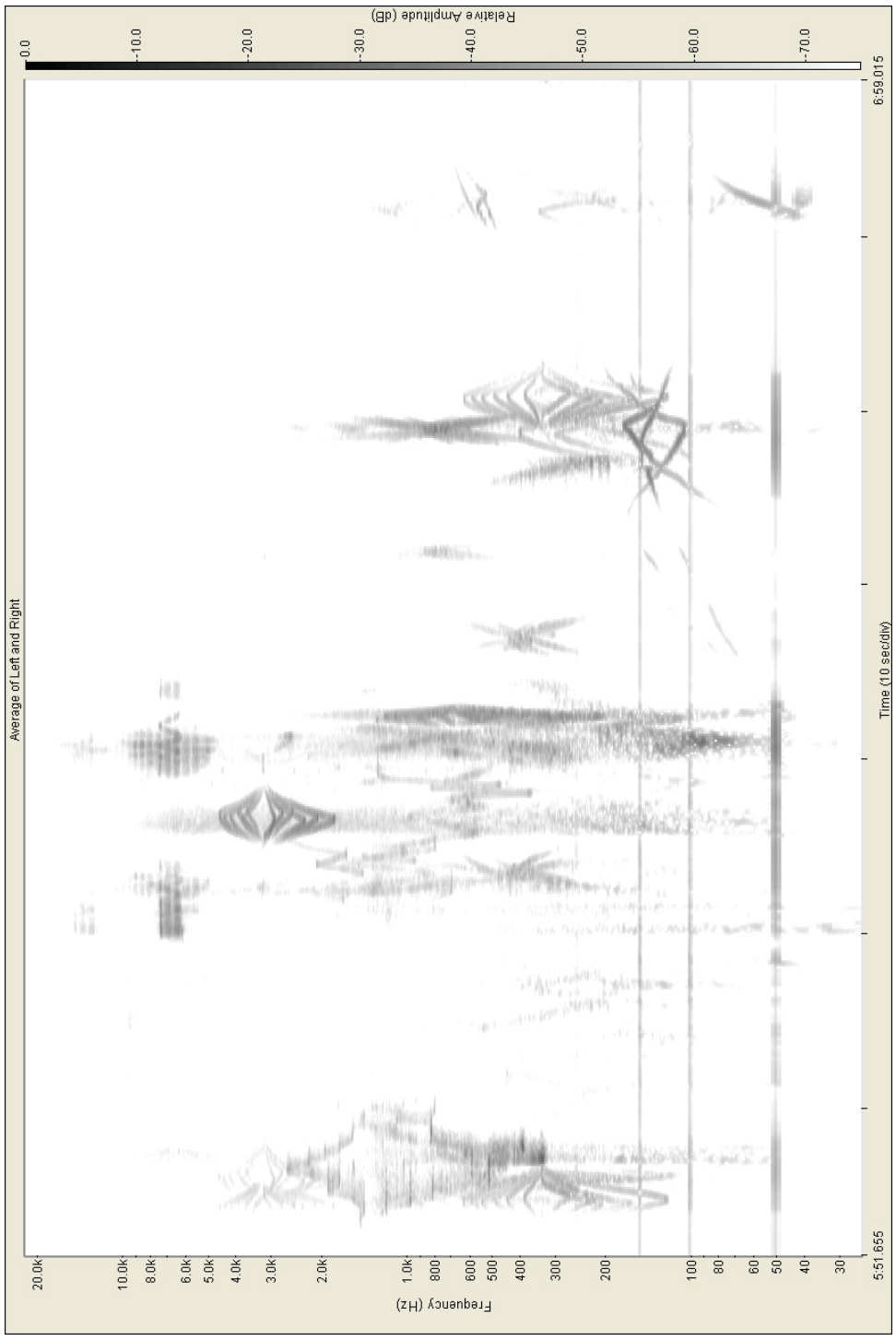

Figure 2.21. Spectrograph of the Invariant Passage

6400 Hz appear, and the nearly-symmetrical gesture which ran across the boundary of Section E, Events 1-2 is intact. This boundary gesture appears even more integral as a unit, since much of the noise which marked the division of the initial section's events has been filtered out from 5'57" onwards. Ligeti uses a high-pass filter here to remove most of the noise, which was a continuous and significant feature in the original Section E; without the presence of this diffuse material, however, the symmetry of these sine tone strands has nothing to interrupt it, and the result here is a reinterpretation is a reconceptualization of the boundaries of these events.

Event 2 consists of material from Section C–a section which already incorporates retrogrades of material from Section B, and Event 3 incorporates many of the same gestures, in less filtered form, taken from Section B^R. The particular surface of these two events features the most invariant of the gestures–the up and down motion of the highest register and the v-shaped glissandi of Types III and V in the middle and low registers. It is here in the piece that the associations between diverse segments of the piece are most complex. Material that originated in Section B, has been filtered and reversed two different stages, first by Section C as an echo, and then later by Section B^2. The final statement of this material in Section B^R draws on both of these precedents. This statement has a strong similarity to the statement in Section B^2, since the segmentation of this event is almost identical to that in Section B^2–preserving Section E's 3200 Hz invariant gesture between the Type I material in the highest register. Yet here the statement is *preceded* by its echo, and thus the more immediate association might be heard in relation to this

material, that in itself contains both repetitions and retrogrades of all the previous instances of B and C Section material.

Event 4 comes from Section F^2, and like Event 3, it preserves (in retrograde) a segment from Section F^R, earlier in the second half. While it contains many of the invariant gestures, what is more remarkable is that the highly directional material which began the climactic arch of Section F, is now clipped short, and has a very different effect. Here the clipped version of these low register sine glissandi emphasizes only the intersections of individual strands–in themselves quite similar to the invariant gestures–and not the global direction. Ligeti further downplays the global rising of the original F Section by following this event with an extensive rest, which also prepares the beginning of Section A^R and the conclusion of the piece.

Retrograde of Section A

Section A^R, shown in Figure 2.22, returns to a sense of directionality, where the retrograde becomes clear again, and thus brings the piece to its close. This sense of directionality, however, recurs only at the very end of the passage. The range-expanding glissando which was the last event of Section A is filtered out in the retrograde, so the first one hears of this material is the cross-hatched pattern of intersecting glissandi–an invariant gesture. At 7'20.5" the final invariant axis occurs in this material and is emphasized by the fact that this coincides with the window in Section F^2 material. This final section is quite different from the previous coincidence of material from Sections A and F; here Section F^2's material is largely filtered out to allow Section A^R to guide the piece to a close,

Figure 2.22. Spectrograph of Retrograde A

whereas before Section F^2 dominated the shape of the piece. There is one brief harmonic glissando from the reprise of Event F6 before the last glissando abruptly dies away.

Conclusions

While Ligeti himself was originally quite critical of *Glissandi*, and in particular the sectional nature of the piece, this analysis has shown a number of ways which details of the construction of individual gestures help unite the material across sections and help the piece unfold in an organic manner. The most important of these details involve the creation of invariant gestures which have ramifications on the perception of the form of the piece and also on the conceptual complexity of the second half–a feature to which Ligeti's schematic description does not do justice.

While some of these invariant gestures, notably the ring-modulated gestures first encountered in Section E, are already invariant in their first presentations, Ligeti often creates other invariant gestures through the combination of elements first presented separately. The invariance that occurs in Section A around the axis at 13.3" is one early example of this; others occur on a larger scale when elements from Section B are recombined in Section C. Yet other types of invariance are created by taking away parts of existing events. The ring-modulated invariant gestures in Section E are split at their midpoints and put end to end to change their typical shape from one resembling a diamond to one resembling an X. In the second half of the piece Ligeti filters out the noise that was previously a boundary between two events, and in doing so emphasizes the nearly-symmetrical boundary gesture between Events E1 and E2. In Section F^R Ligeti again

filters out material which was more directionally distinct to emphasize the intersections of strands of sine tones and create other nearly-symmetrical gestures.

These symmetries enrich the network of connections in the latter part of the piece, as some individual gestures can be heard quite literally as a repetition or as the retrograde of a retrograde, other literal retrogrades will be heard as repetitions, and thus, these invariant gestures contribute to a sense of direction has a significant role in interpreting the form of the piece. On the largest scale, the piece itself is one such structure, and this is most clearly evident in the central span of Sections F and Section F^R. This arching form is highly directional and, as such, particularly coherent, and thus lends itself to interpretation as a unified section with contrasting material on either side. This conception of the form is reinforced by a number of features in both the first and second halves. The first two periods of accretion (Sections A and B) are easily taken together as a kind of exposition–first showing an increase in registral span, then an increase in density and diversity of material. This exposition is then followed by the softer C and D Sections, which work as a transitional area to the third period of accretion, culminating in Section F. Section F^R reverses this accretion, quite clearly directed downward in register. Moreover, it is also followed by a transitional area, Sections E^R and the span of Sections D and D^R, which begin to lose this sense of direction. While the anomalies reinforce the shape of F^R, the invariant gestures which follow pervade the rest of the material until the final seconds of the piece, and thus unify this final segment of the piece.

While *Glissandi* shows many traditional influences, it is also an important work establishing elements of Ligeti's later style. It is true that *Glissandi* includes references to

traditional pitch systems, such as the prevalence of A 440 in Section B, and that parts of it are periodic, or semi-periodic. Other influences are nebulous: the calculation of durations in seconds is typical of Bartók, as is the emphasis on symmetry, though these could also have come respectively through Ligeti's instruction in the studio and his recent exposure to Webern. The ambiguity of the piece's form, however, is something quite novel, and as Sabbe and Luchese argue, multivalent forms are present in Ligeti's later works as well. When *Glissandi* is viewed as such, one realizes the degree to which Ligeti's initial description belies the subtleties of the work and denies much of its nuance and importance.

Chapter 3: Analysis of *Artikulation*

I. Background of *Artikulation*

The best known of Ligeti's works in the electronic medium, and, by the composer's own account, the most thoroughly worked out of his three tape pieces, *Artikulation* is a critical work in his stylistic development. It is this piece in which his divergence from the prevalent serial practices of the studio of the WDR is most pronounced, and in which he begins to develop his own language more fully. Because of its early success in concerts and radio broadcasts,[1] *Artikulation* is more widely recognized and has received more analytical attention than the other tape pieces, most notably from Rainer Wehinger, whose "listening score" provides valuable information on the composition of this piece as well as a rudimentary introduction to its form.[2]

The piece was composed in the first months of 1958, shortly after completing *Glissandi*, however, *Artikulation* was actually the third piece which Ligeti started; he began work on the composition now called *Piece electronique no. 3* before starting on *Artikulation*, but left this piece unfinished. By this point Ligeti had already picked up valuable information on current developments in serialism from Stockhausen, Koenig, and others, knowledge he demonstrated later in the same year when he published his analysis of Boulez's *Structures Ia* in *Die Reihe*. In this article as well as in his music, Ligeti

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[1] *Artikulation* was premiered later in March of 1958, shortly after it was completed, and was used as an example in many of Stockhausen's lectures on electronic music through the 1960s. By comparison, *Glissandi* was not heard publicly until much later, and has been described by the composer himself as an initial 'finger exercise' (see the previous chapter).

[2] Rainer Wehinger, *Ligeti – Artikulation: Electronische Musik, eine Hörpartitur* (Mainz: Schott, 1970).

demonstrates a thorough understanding of serial techniques and the rigors of this type of musical construction, but a more distanced attitude towards some of the extremes to which the avant-garde had come to rely upon the row.

Although ostensibly under the tutelage of Stockhausen, Ligeti worked more closely with Gottfried Michael Koenig and Cornelius Cardew, in the realization of *Artikulation*, and he cites Koenig as his principal mentor in the medium. Nonetheless, Ligeti developed a unique solution to the problem of working with this new medium, and does not merely adopt the techniques of these more established composers. While Stockhausen built his electronic compositions from the minutia up, seeking in his words, "to bring all the spheres of electronic music under a unified musical time, and to find one general set of laws to govern every sphere of musical time itself,"[3] Ligeti takes a dramatically different approach to the composition of electronic music in *Artikulation*. Most notably, he uses aleatory operations at the smallest levels of sonic construction, while still retaining full control over the shape of the piece as a whole.

II. Compositional Method

In addition to its divergence from Stockhausen's serial techniques, Ligeti's method of composing *Artikulation* involves procedures which more directly and organically embrace the technology involved in composing with magnetic tape. Most notable is Ligeti's use of serially inspired methods as a rational way of generating potential sonic

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[3]Stockhausen, Karlheinz. "The Concept of Unity in Electronic Music" trans. Elaine Barkin, *Perspectives of New Music* 1, no. 1 (1962), 48.

material, rather than as a principle of construction which mandated the manipulation of this material in predetermined ways or in a fixed order. Ultimately in *Artikulation*, Ligeti strikes a balance between serial and aleatory thinking through types of statistical distribution which, while formalized in regards to the generation of material, was more flexible its deployment.

The following examination which will proceed "bottom-up" from the smallest generated units to the largest formal elements. At the time of the composition of this piece, Ligeti had apparently studied aspects of phonetics and in particular, "analyses of acoustic spectrum and proportion of noise in sounds; the transient process and fade-out process in plosives; and the time-proportions of consonants and vowels in spoken languages."[4] He started the composition of *Artikulation* by generating a large number of source sounds which imitated phonemes–various consonants, vowels, and their combinations.

The study of phonetics at the WDR can be traced through Stockhausen to Werner Meyer-Eppler, a professor at the University of Bonn. Meyer-Eppler was trained as a physicist, but was currently working at the Institute for Phonetics in Bonn and was at the forefront of developing communications theory; Stockhausen who took courses from Meyer-Eppler described as "the best teacher I ever had."[5] Stockhausen describes some of the inspiration that he took from these classes, and directed into statistical composition.

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[4]Wehinger, op. cit.,11.
[5]Quoted in several sources including Richard Toop, *György Ligeti* London: Phaidon Press, 1999, 59; and Richard Steinitz *György Ligeti: Music of the Imagination*. Boston: Northeaster University Press, 2003, 80.

> In phonetics he [Meyer-Eppler] was analyzing the different sounds of language, in communications science he was engaged in studying statistics, because he wanted to know more precisely what all the different noises were, and analyzing the wave structure of noises and consonants in language led him to use statistical methods of description and analysis.[6]

Stockhausen continues with a description of an exercise which may have, in turn, inspired Ligeti's compositional method in *Artikulation*.

> He would give us exercises demonstrating the principles of the Markoff series; in one we were given cut-outs of individual letters from newspaper articles, and we had to put them in sequence by a chance operation and see what sort of a text came out. The we would repeat the operation with individual syllables, and then with combinations of two syllables, and so forth, each time trying to discover the degree of redundancy, as we called it, of the resulting texts.[7]

Ligeti categorized the phonetically inspired sounds of *Artikulation* into 42 types of basic materials with names describing either their means of construction (e.g. "subharmonic spectra") or more subjective associations (e.g. "barking" [*Ugató*]).[8] The lengths of individual sounds were determined by a basic unit of 10 mm and a scale proceeding by the interval 11/10, so that the next unit would be this ratio times the previous unit. For example:

10 x (11/10) = 11
11 x (11/10) = 12.1
12.1 x (11/10) = 13.31
13.31 x (11/10) = 14.641
14.641 x (11/10) = 16.1051
16.1051 x (11/10) = 17.71561
17.71561 x (11/10) = 19.487171

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[6]Karlheinz Stockhausen, *Stockhausen on Music*, Robin Maconie, ed. (London: Marion Boyars Publishers, Ltd., 1989), 50.
[7]Stockhausen, *Stockhausen on Music*, 50; other information on Meyer-Eppler's role in the WDR Studio is chronicled in Elena Ungeheur, *Wie die elektronishce Musik 'erfunden' wurde...: Quellensudie zu Werner Meyer-Epplers musikalischem Entwurf zwischen 1949 und 1953*. Kölner Schriften zur Neuen Musik vol. 2, Johannes Fritsch and Dietrich Kämper, eds. (Mainz: Schott, 1992).
[8]Wehinger, *Ligeti – Artikulation*, 11-12.

... ...
728.904824 x (11/10) = 801.795306
801.795306 x (11/10) = 881.974837
881.974837 x (11/10) = 970.172321
970.172321 x (11/10) = 1067.189553

He continues this process until 1067.189553, the 50th value reached in such a scale, and equal to about 14 seconds. These numbers were then rounded to the nearest whole millimeter (10, 11, 12, 13, 15, 16, 18, 19... 802, 882, 970, 1067), although in many of the sketches, Ligeti is inconsistent in the number of decimal places used, resulting in slight variance in the values returned.

Significantly, Ligeti divided the materials into individual sounds with specific durations by a means that he would later use for his orchestral work *Apparitions*[9]. His goal was to balance short and long durations within a given material, but not by giving all durations an equal number of occurrences, as a serial duration row would do. Ligeti explains that this would favor the longer durations, which, given an equal number of occurrences, would make up a more substantial portion of the piece than the shorter ones. Rather than this Ligeti chose a method by which the value of each duration, multiplied by the number of occurrences of that duration, would equal a constant, and thus the sum of each of the types of duration would make up an equal portion of the piece. As an example of this Wehinger cites a simple case where, "there were, for one material, 150 bits of tape 1 cm in length, and one bit of tape 150 cm in length."[10] Figuring a tape speed of 76

[9]See Ligeti's comments in "Metamorphosis of Musical Form," trans. Cornelius Cardew, *Die Reihe*, Vol. 7 (1960) 14, n 28.
[10]Wehinger, *Ligeti – Artikulation*, 17

cm/sec. which was standard at the WDR, this type of material had sounds ranging between .013 and 1.974 seconds.

In another type of material, Ligeti's sketches[11] indicate that a similar procedure was used. In the sketches for what is labeled, "Material 3," the series of durations appears (shown below in Table 3.1), and the second column shows the number of times each duration (in cm) occurs. Instead of filling in circles, Ligeti writes out the numbers and writes "R", "S", or "U" over them as they are used. These most likely stand for "Rausch" [noise], "Sinus" [sine tones], and "Ugato." [barking][12]. The third column is the product of the first two, and is my own calculation, not appearing in the original sketch. This column shows that the product of the duration in centimeters and number of instances was, in this case, equal to approximately 30.

Table 3.1. *Artikulation*, Material 3: Durations and Number of Instances

Length	Instances	Index	Unrounded	
1	30	30		
1.1	28	30.8	1.1	rounds to one decimal place
1.2	26	31.2	1.21	
1.3	24	31.2	1.32	
1.4	22	30.8	1.43	
1.5	20	30	1.54	
1.7	18	30.6	1.65	
1.9	16	30.4	1.87	
2.1	14	29.4	2.09	
2.3	12	27.6	2.31	
2.5	12	30	2.53	
2.8	10	28	2.75	
3.1	10	31	3.08	
3.4	8	27.2	3.41	
3.7	8	29.6	3.74	
4.1	7	28.7	4.07	
4.5	7	31.5	4.51	

[11]This and all subsequent sketches transcribed as the basis for examples in this chapter are held at in the György Ligeti Collection of the Paul Sacher Foundation, Basel.

[12]It is not uncommon for Ligeti to use a mixture of German (especially for technical terms, ones he might have learned recently for use in electronic music) and Hungarian for more descriptive terms.

5	6	30		4.95	
5.5	6	33		5.5	
6.1	5	30.5		6.05	
6.7	5	33.5		6.71	
7.4	4	29.6		7.37	
8.2	3	24.6		8.14	
9.1	3	27.3		9.02	
10	3	30		10.01	
11	3	33		11	
12	3	36		12.1	rounds to whole numbers
13	2	26		13.2	
14	2	28		14.3	
15	2	30	sin obiekt, ugató	15.4	
17	2	34	sin obiekt, ugató	16.5	
19	2	38	sin obiekt, sin	18.7	
21	1	21	20 hz obiekt	20.9	
23	1	23	ugató	23.1	
25	1	25	sin obiekt	25.3	
28	1	28	sin obiekt	27.5	
31	1	31	ugató	30.8	
34	1	34	sin obiekt	34.1	uses a quasi-additive series
41	1	41	20 hz obiekt	37.4	+7
50	1	50	20 hz obiekt	45.1	+9
61	1	61	sin obiekt	55	+11
74	1	74	ugató	67.1	+13
91	1	91	20 hz obiekt	81.4	+15
130	1	130	ugató	100.1	+39

This duration series shows similar characteristics to the 11/10 scale used in the previous example, but also shows some inconsistencies. I have added an additional column to this chart showing the unrounded series generated by multiplying the previous number by 11/10. First of all, after reaching the duration of 10 cm, rounding applies to whole numbers rather than tenths. Furthermore after the number 31 (significant because of the index of 30), Ligeti appears to begin using an additive series of odd numbers, 7 through 15, followed by 39, whose appearance cannot be explained by either system, although given the use of additive series here and elsewhere in Ligeti's work, one could speculate that it is equal to sum of the previous three additions (11+13+15). The reason for this

change is unclear–perhaps Ligeti had to reconcile a predetermined total duration with his system of subdividing, or perhaps he had more specific ideas for these longer durations, that could not otherwise be accommodated. It is, after all, these longer durations that are labeled as "objects" in the sketch. Either way this example shows both Ligeti's meticulous planning and attention to detail, as well has his willingness to make modifications to the details of his plan to keep it in line with more global considerations.

Ligeti then grouped the tape recordings these short sounds together according to similarities of sonic quality and character including, "combination of materials, pitch distribution, duration relationships, and intensity relationships,"[13] and he placed the similar sounds into bins. After this he began the aleatory process of blindly selecting strips of tape containing individual sounds from these bins and splicing them together into longer segments, which, in his sketches, he calls "texts." These ten texts were differentiated by virtue of contrasting material as follows:

1. 'coughing';
2. coughing and types of noise with explosion-like envelope;
3. sine tones and 20 Hz noise bands–linear and glissing;
4. dry impulses;
5. wet impulses;
6. 'sandpaper'
7. mixture of 'sandpaper', filtered and unfiltered impulses, and other materials
8. 'completely heterogeneous materials.'
9. 'sandpaper' reverberated noise, and 'glissando explosions'
10. harmonic and subharmonic spectra, linear and glissing.[14]

The duration of each text runs between 11 and 43 seconds. Some of these were then subjected to further treatment, being combined, transposed, or retrograded.

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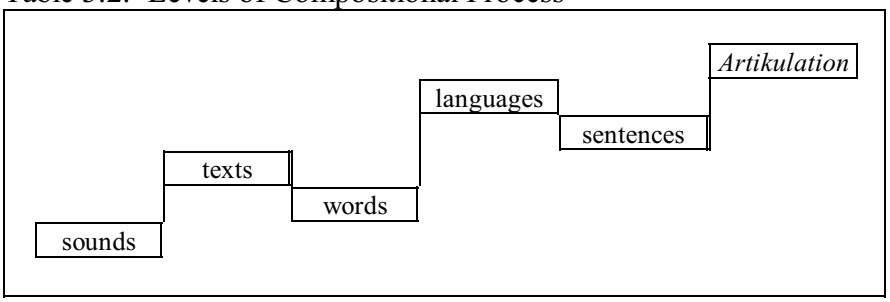
[13]Wehinger, *Ligeti – Artikulation*, 17.
[14]Wehinger, *Ligeti – Artikulation*, 18.

He then cut both the altered and unaltered texts back into mid-length segments, termed "words." Some words were further transformed with techniques such as reverberation and ring modulation, in addition to the techniques already used to alter the texts. Ligeti then treated the words as he did the sounds. He grouped them according to their sonic characteristics, again putting similar sounds in bins. By repeating the process of splicing bits of tape together and cutting them back into smaller segments, the stages of which are shown in Table 3.2, Ligeti completed the piece.

Table 3.2. Levels of Compositional Process



In moving from words to languages, Ligeti used categories such as type of text, duration and word-density, average register, average intensity, and presence of ring-modulation[15] to separate his recorded sounds into bins. Furthermore, Ligeti transformed these sounds at each level, just as he had done with the words and texts; Wehinger, cites instances where the sentences were interrupted, ring-modulated in their entirety or even synchronized with other sentences before being combined into the final piece. Thus at each step of the process, the sonic contents underwent substantial changes, not according to any serial predetermination, but rather to Ligeti's vision of the large-scale form of the

[15]Wehinger, *Ligeti – Artikulation*, 19.

piece, which he describes as, "a gradual, irreversible progress from the heterogeneous disposition at the beginning to the complete mixture and interpenetration of the contrasted characters at the end."[16]

While Ligeti himself identified several sections of the composition, it is my belief that these are not the most accurate way of reflecting the process of the piece as described above. In his sketches he labels sections A through G. These he first developed from a number series, and then modified, in a manner much like the one described above. However, after their substantial modification (see below), I feel these labels are slightly misleading. The sketches show an original arrangement calling for section A to be the longest section, having 12 subsections. Sections C, E, and F were then to have 3, 3, and 2 subsections, respectively. This was, however, changed and sections C and F were later reduced to one subsection each; sections B, D, and G also have one subsection each. In the end, Ligeti ended up with a plan calling for 20 total subsections, which were assigned lengths as follows:

Table 3.3a. *Artikulation*: Durations of Subsections

	cm	difference*	unrounded*	ratio*	
1	450				
2	500	50	500.00	10/9	
3	550	50	550.00	11/10	
4	610	60	610.00		12.2/11
5	670	60	671.00		12.1/11
6	740	70	737.00		12.1/11
7	820	80	820.73		12.2/11
8	910	90	909.45		12.2/11
9	1000	90	1000	10/9	
10	1100	100	1100	11/10	
11	1200	100	1200	12/11	
12	1300	100	1300	13/12	
13	1400	100	1400	14/13	

[16]Ligeti, "Metamorphosis," 15.

14	1500	100	1500	15/14	
15	1700	200	1704.55		12.5/11
16	1900	200	1900.91		12.3/11
17	2100	200	2098.64		12.15/11
18	2300	200	2300.45		12.05/11
19	2500	200	2509.09		12/11
20	2800	300	2795.45		12.3/11
total:	26050	(+410)			
total+ 410:		26460			

*the columns do not appear in the original sketch

These were then reordered to give the following (sub)sections the following values:

Table 3.3b. *Artikulation*: Reordered Durations of Subsections

A1	1300	B	1700
A2	910	C	2500
A3	670	D	1500
A4	740	E1	2100
A5	610	E2	500
A6	1100	E3	1000
A7	2300	F	2800
A8	1200	G	1400
A9	1900		
A10	450		
A11	820		
A12	550		

As such, this configuration would have produced a piece nearly 6 minutes long; and there were, indeed, further modifications of this scheme. Rainer Wehinger's listening score reproduces these section divisions, listing the final timings of the sections in seconds. I have converted them to centimeters below, using 76.2 cm/sec in the first column, and then 76 cm in the second.[17]

Table 3.3c. *Artikulation*: Comparison of Subsection Durations

	sec.	cm	cm	from sketches	in sec.
A1	17	1295.4	1292	1300	17.06
A2	11	838.2	836	910	11.94

[17]76.2 cm/sec was the standard tape speed, although for ease of calculation, composers at the WDR often made their calculations based on 76 cm/sec.

A3	7	533.4	532	670	8.79
A4	9	685.8	684	740	9.71
A5	7	533.4	532	610	8.01
A6	14	1066.8	1064	1100	14.44
A7	29	2209.8	2204	2300	30.18
A8	14	1066.8	1064	1200	15.75
A9	24	1828.8	1824	1900	24.93
A10	2	152.4	152	450	5.91
A11	9	685.8	684	820	10.76
A12	3	228.6	228	550	7.22
B	5	381	380	1700	22.31
C	6	457.2	456	2500	32.81
D	7	533.4	532	1500	19.69
E	18	1371.6	1368	2100, 500, 1000*	27.56, 6.56, 13.12
F	14	1066.8	1064	2800	36.75
G	14	1066.8	1064	1400	18.37

*3 values appear in the sketches for Section E

While some of the modifications are substantial, it is significant to notice that these fall predominantly in the second half of the piece. Nowhere before A10 is there more than 2 seconds (152.4 cm) of difference between the original and modified values. Also most of these alterations involve shortening the original durations of the second half of the piece. Since the piece, in Ligeti's own words, involves a progression towards states of mixture, and as we shall see in the analysis, this is often carried out by increasing the density of the textures, it could be that prolonging the later stages of the piece worked against this goal, although this is speculative. Since these later sections (B-G in particular) are so drastically shortened, I find it misleading to consider them as equal partners to Section A, especially since the subsections of A are often use the most contrasting material, and are, therefore, the easiest to distinguish aurally, while the later regions are the more interpenetrated and mixed together. I believe the "Regions" I identify below are more representative of how one experiences the piece. In most cases, these Regions coincide with the subsections of

A and the other sections, and in those cases where they do not, I will explain in the analysis below.

While Ligeti's flexible method and use of chance as a determinant, may seem strikingly original and even free in comparison to the strict serialism associated with the Cologne composers, it entails numerous constraints not unlike those imposed by serial practice. While the aleatoric method of drawing tape pieces out of a box may at first seem to undermine any idea of a preplanned or organized form, at each step the pieces were organized by their common characteristics thus limiting any randomness or chance operations to the smallest scale and to the most surface level of the piece. Secondly, the use of procedures termed "statistical" and approaching the use of chance operations was not unprecedented at the WDR; in fact here we see some of the influence of Koenig. While aiding Stockhausen with the realization of *Gesang der Jünglinge*, Koenig had a novel solution to the creation of very dense and complicated clouds of very short sounds. According to his student, Konrad Boehmer,

> Koenig was convinced that it would not be at all sensible to record thousands of centimeter-long particles of sinus tones and then to measure, cut, and finally glue them together. For this reason, he proposed a quasi-aleatoric production process in which he began with tapes of short magnetic and white-taped sections and then recorded a sinus-glissando that would be automatically divided into distinct, small particles. If several such tapes are synchronized... one hears a "cloud" of tiny sound particles with an all-embracing global direction. Although the composer might not have absolute control over every detail, he or she can control the audible result. Consequently in *Essay*, Koenig wanted to understand the entire process more accurately.[18]

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[18]Boehmer, Konrad. "Koenig–Sound Composition–*Essay*." in *Electroacoustic Music: Analytical Perspectives*, Thomas Licata, ed. (Westport: Greenwood Press, 2002), 62-63.

In fact, the instructions in the score to his composition, *Essay*,[19] Koenig describes a similar process of generating material, aspects of which were left to chance (although these aleatoric elements are largely confined to details of frequency curves which are only schematically indicated in the score), then transforming this material through techniques (usually serially determined) such as ring-modulation, transposition, filtering, and reverberation, and finally dividing up the resulting material and recombining it into sections of the finished piece.

There are, however, a few main differences in Ligeti's methods in defining source sounds, distributing these sounds into larger sections, and using these transformational techniques. First of all, Koenig's original materials consist of the many possible combinations of elemental timbres: sine tones, filtered noise, filtered impulses[20], and permutations of these (single elements, their combinations, and the transference from one element to another). This limited definition of starting material will ensure some basic similarity between the sounds both within and across sections. The definition of categories strictly related to these types of materials, and the serial organization of these categories, guides Koenig's organization of the larger scale elements of the piece. Ligeti's sounds on the other hand are not entirely divided by means of technical production, but, in some cases by more general categories (e.g. "coughing") which are less systematically used. Thus, even at this starting point, Ligeti's sounds could have been organized by the

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[19]Koenig, Gottfried Michael. *Essay: Komposition fur elektronische Klänge, 1957. Partitur zugleich technische Arbeitsanweisung*. (Vienna: Universal Edition, 1960).

[20]Noises are defined as a bandwidth 5% from a given frequency, impulses as a 1% bandwidth and usually refer to events with shorter durations, see Koenig, *Essay*, 12.

attack characteristics present, and entail a more complicated mixture of different materials through the body of the sound; in short his materials had the potential to deviate more widely within a given category.

Secondly, while Koenig's sections consist of serially distributed material, aiming, as Boehmer put it, for a more accurate understanding of the process, Ligeti's are balanced through more statistical operations. Koenig distributes his basic material serially within each of the piece's larger sections so that all of what he terms Material A ends up inhabiting Section A, and so forth; from Ligeti's sketches it appears that "words" taken from the same "text" could easily end up in different "languages," and subsequently in vastly different parts of the piece. Furthermore, Koenig uses a different combination of transformational techniques for each section; thus while they are structurally important within a given section, the transformations of one section's material have little bearing on the others. Since Ligeti's sounds go through more stages of alteration, (e.g. ring-modulation at the "sentence" level) the end result will be much farther removed from the original material, and the characteristics of effects like reverberation will have an effect across the whole of the piece, rather than section by section.

The relatively simple trajectory of *Artikulation*, moving from separate sound types to intermingled conglomerations, stands in contrast to the serial conception of a work such as Koenig's *Essay* or one of Stockhausen's *Studien*. Since these serial works are to a large extent attempting to articulate a structure that is inherent in the row and materials, the most basic, and recognizable, materials are chosen and their combinations attempt a serial exposition of all the possible interactions of these sound types. *Artikulation*, on the

other hand, while balanced in what Ligeti calls "conditions of aggregation"[21] progresses in a more globally straightforward path, but locally presents a collection sounds whose basic elements are more complex, and are not given immediately at the beginning of the piece or section, but come to be recognized as significant as they are articulated through continual recombination along this basic trajectory. Ligeti describes this as "an investigation of the degree of opposition and permeability of these characters... which could be mixed and which resisted mixture."[22] Identifying different steps along this process will be a major concern of the analysis that follows.

III. Analytical Caveats

A few other words of warning are in order before embarking upon an analysis of *Artikulation*. These considerations will involve issues which are not addressed by Ligeti in his other compositions for tape, including the use of different spatial locations, the limits of perception, increased sensitivity to the categorization of sound types, and finally to the play with language that this piece suggests, finally posing the question of how this effects our perception of larger scale form.

Artikulation uses spatial distribution in a more dynamic manner than either *Glissandi* which was created as a monophonic composition or *Pièce électronique no. 3*, for that matter, which although quad, involves only a few slight motions or as an enveloping effect. The spatial location of sounds, while included along with the

[21]Ligeti, "Metamorphosis," 15.
[22]Ibid.

parameters of timbre in this study, truly stands outside the strict definition of timbre, and can be a very powerful way of making formal divisions easily perceptible. From the outset of *Artikulation*, spatial location has a primary role in determining what I will label the "regions" of the piece, although changes in location are usually reinforced by changes in the sonic properties of the material. As the piece progresses, however, we see Ligeti move towards more active use of spatial location and with it, more gestures that depend on tracing a single sound or type of material across space.

Another important issue to consider is that the available recordings of *Artikulation* are of a stereo mix-down of the four-channel original, which consisted of front, right, back, and left channels. While the mix-down was done with Ligeti's approval, and is as accurate a reflection of the quad version as can be hoped for, there are still certain differences especially between a front/back and left/right arrangements. Given our usual concert-going habits of facing the sound source, the unfamiliar situation of sounds coming from the back of the hall could potentially assume a different significance, which can only be imagined in the stereo version.[23]

Because of its layered method of composition, Ligeti's *Artikulation* poses problems to a more detailed analysis which were not as readily apparent in the previous works. These problems often revolve around defining minimum units of structure, and, when assigning moderate or mixed values in certain oppositions. While in a work using only sine tones (such as *Pièce électronique no. 3* or one of Stockhausen's studies, which

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[23]See Roger Reynolds, "Thoughts on Sound Movement and Meaning," *Perspectives of New Music* 16, no. 2 (Spring-Summer, 1978), 181-90 for general discussion of spatialization.

will be discussed in the last chapter) each formant strand can be defined by its pitch (in Herz) and duration (in centimeters of tape, or fractions of seconds), the variety of materials in *Artikulation* are blended to a much higher degree through techniques of synchronization, ring-modulation, and so forth, distancing the final output from clearly its perceptible parts. This is particularly true when Ligeti uses small durations in combination with each other. The smallest unit of tape which Ligeti used was 1 cm., equivalent to 0.013 sec., a duration which would not allow the clear perception of values in pitch, let alone other basic parameters. To select a meaningful segment, one must often take a composite of tape pieces which could differ widely in any number of dimensions. Thus it will be necessary, at times, to acknowledge that the minimum perceptible unit is already contains contradictory values in certain oppositions. An example of such a state is given by the right channel at 2'34", towards the end of Region K, shown below by the amplitude graph in Figure 3.1a. This example, magnified greatly, shows six individual wave forms representing six different kinds of impulses, varying in register, attack-strength and so forth. But this moment is quite brief and it occurs in the midst of other sounds in the left channel. When heard in the context of the piece, as shown in Figure 3.1b it is perceived as a single object because of its differing spatial location, but upon further investigation is found to contain a variety of individual units.

Unfortunately, the specific categories which Ligeti used are impossible to reconstruct–his sketches are incomplete, and sometimes inconsistently labeled. So rather than using these categories (which included rather vague, descriptions like “barking” or “coughing”), I will follow Robert Cogan’s system of sonic oppositions, described in depth

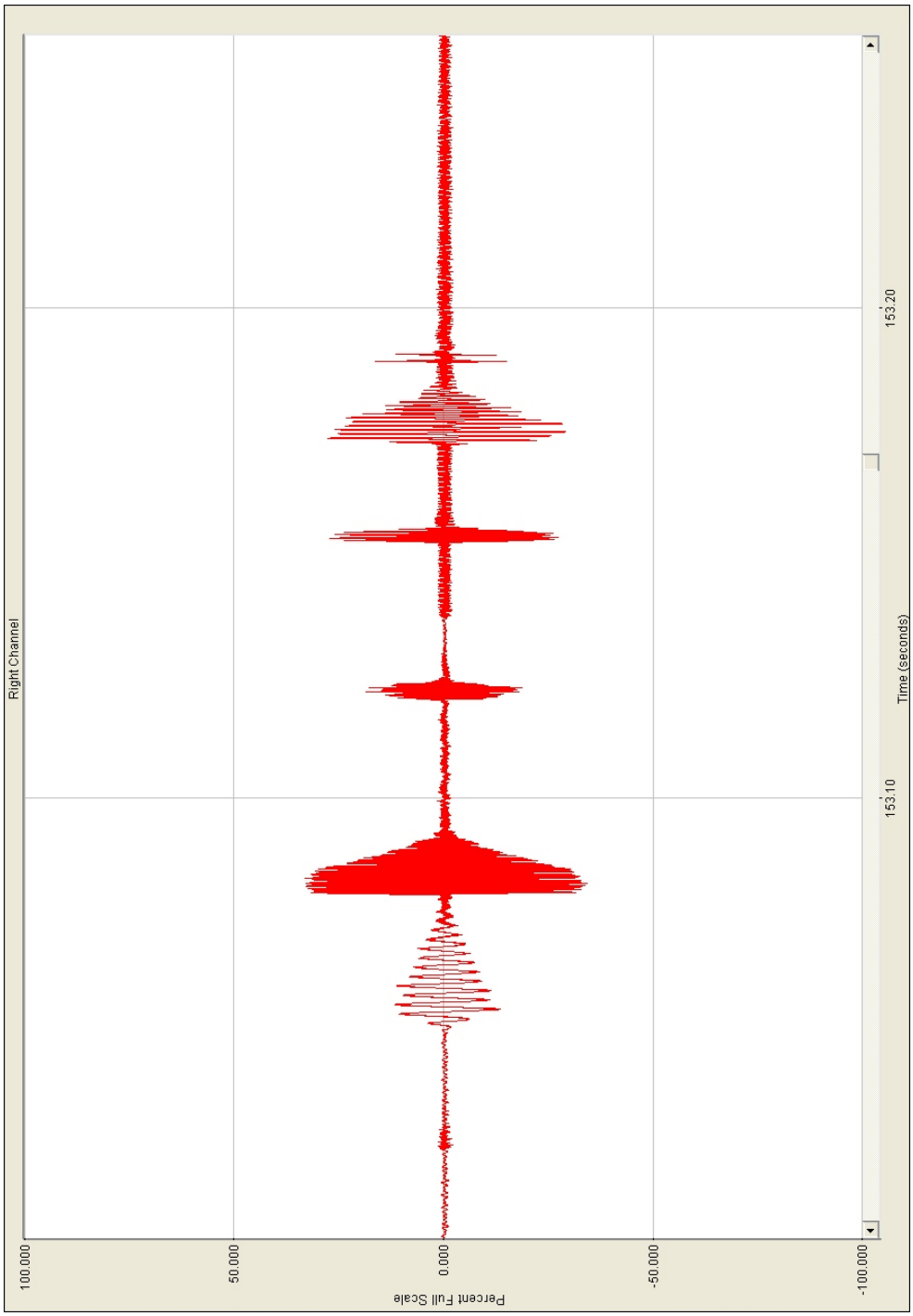

Figure 3.1a. *Artikulation*, 2'34", Amplitude Graph

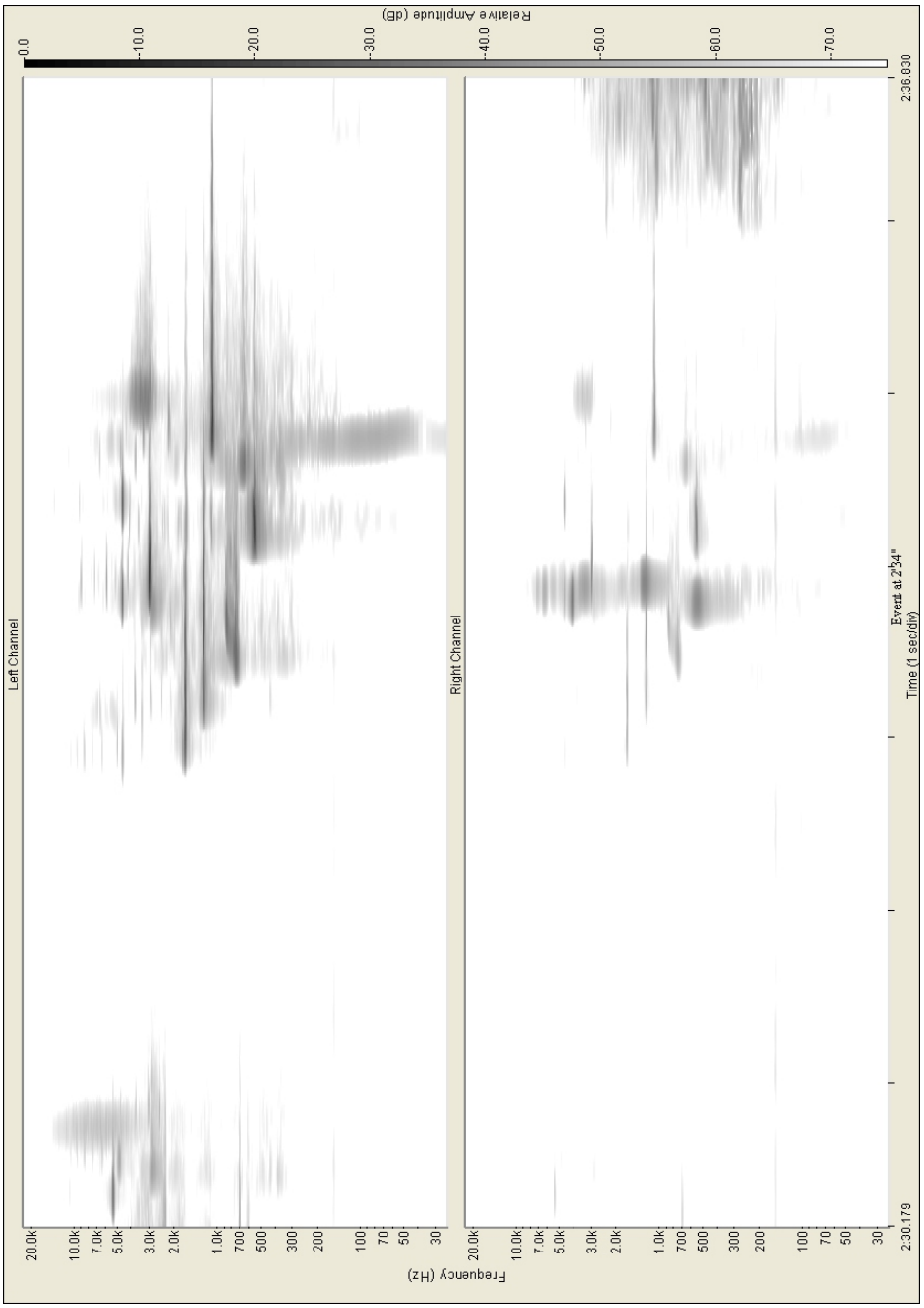

Figure 3.1b. *Artikulation*, 2'34", Spectrograph of Wider Context

in the introduction. Moreover, translations between the language used by the Cologne composers and that used by Cogan will prove useful. In terms of spectrum and more specifically, pitch versus noise, Ligeti, and subsequently, Wehinger usually define three basic categories: sine tones, impulses, and noise. This division resembles Koenig (see above footnote 20), who defines impulses as 1% deviation from a given bandwidth, and thus, for our purposes can be considered a mid-range category between compact (sine-tones) and diffuse (noise) materials. Herbert Eimert, in his essay "What is Electronic Music" defines the "*Impulse* or *pulsation*" as a basic element of electronic music, "also known as *Beats* or *Clicks* (regular or statistic); at high dynamic levels corresponds to 'detonation'."[24] Later in the same volume of *Die Reihe*, Stockhausen mentions the use of "'Periodic' or... 'Statistic' sequences of filtered 'beats' (*Knacke*–clicks)."[25] This use of impulses shows that impulses often implied shorter durations and were often connected (as they are in Koenig's *Essay*) to less "serial" and more "statistic" methods of composition.

Ligeti also used harmonic and subharmonic spectra in his categorizations. Cogan's oppositions can help describe spectra in several ways. Narrow vs. wide might describe the total spread of a given spectrum, non-spaced or spaced might describe the distance between individual formants within a spectrum, and sparse vs. rich could characterize the total number of strands present. Furthermore, Ligeti distinguishes between structures (spectra, noises, sine-tones, etc.) which are glissing up or down and those which are fixed. This corresponds to Cogan's level vs. oblique category.

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[24]Herbert Eimert, "What is Electronic Music," trans. uncredited, *Die Reihe* 1 (1955, English ed. 1957), 4.
[25]Karlheinz Stockhausen, "Actualia," trans. uncredited, *Die Reihe* 1 (1955, English ed. 1957), 46.

Using this terminology in place of the vague but colorful descriptive terms which Ligeti himself used, the following analysis will attempt to specify what the composer may have meant by his description of *Artikulation* in *Die Reihe*, which I will now quote in full:

> In my electronic piece 'Articulation' the aspect that occupied me most was the composition of the mutual effects exercised by these 'aggregate-conditions' on one another. First I chose types with various group-characteristics and various types of internal organization, as: grainy, friable, fibrous, slimy, sticky and compact materials. An investigation of the relative permeability of these characters indicated which could be mixed and which resisted mixture. The serial ordering of such behaviour-characteristics served as a basis for the erection of the form. In the detail-work I attempted to obtain contrast between the types of material and between the modes of amalgamation, whereas the over-all plan was a gradual, irreversible progress from the heterogeneous disposition at the beginning to the complete mixture and inter-penetration of the contrasted characters at the end.[26]

As the terms grainy, friable, etc. are somewhat nebulous, we shall do better to use Cogan's terminology to indicate points of contrast and similarity between types of material. Ligeti's use of "permeability" is clarified earlier in his article's discussion of Stockhausen's *Gruppen*:

> it is vitally important to pay attention to the available degrees of permeability. The two extreme types enjoy exceptionally good mutual permeability: a dense, gelatinous soft and sensitive material can be penetrated *ad libitum* by sharp, hacked splinters... 'Soft' materials are less permeable when combined with each other, and there are places in Stockhausen's 'Gruppen' of an opaque complexity beyond compare.[27]

Here it seems that Ligeti's definition of permeability has to do with materials' ability to stand out from each other when occurring simultaneously. Thus highly contrasting materials are mutually permeable–one will 'penetrate' or stand out from the other. Inter-penetration, on the other hand, must be regarded as a state of complete and *mutual*

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[26]Ligeti, "Metamorphosis," 15.
[27]Ligeti, "Metamorphosis," 14-15.

penetration–which amounts to an opaque, impermeable texture–a state of complete mixture.

While Ligeti's wording distances the final output from any specific serial techniques (we have already seen the modifications to the original formal plan above), the idea of a global process of a heterogeneous texture moving towards a less permeable, more opaque texture remains salient. This will be seen in the piece, by an incremental build-up of increasing volume, and internal complexity. This kind of teleological goal is akin to a normative direction for the piece,[28] but one which is greatly nuanced by the surface of the piece.

Ligeti states another of his goals as seeking contrast in the materials and modes of amalgamation–as materials are well defined above, I will now posit possible meanings of the latter. Much of the piece is concerned not only with simple states of sonic oppositions–one extreme, the other, or a neutral state in between–but is also concerned with ways that this material might transform itself from one state to another. Especially after the first stage of the piece is

over, materials will focus on one oppositional state, keeping it constant, often emphasizing it, while gradually changing others, and thus transforming the material. It is also in the later stages of the piece where Ligeti plays with the difference between neutral states and states of mixture. This interplay brings about interesting, almost paradoxical, situations where one opposition seems to blend into another.

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[28]In fact, Ligeti describes a similar global direction in *Apparitions* as an "imaginary musical syntax" in "States, Events, Transformations" (trans. Jonathan Bernard) in *Perspectives of New Music*, Vol. 31. no. 1(Winter 1993), 171.

IV. Analysis:

Overview:

With these considerations in mind, I will first present an overview of the design of *Artikulation* to provide a context for the more detailed analysis which follows. A spectrograph of the entire piece provides an ideal view of the form of the entire work, which runs to 3'47".

The spectrograph in Figure 3.2 is useful in examining the composition's macro-structure and to locate where other more detailed pictures will fall within the whole. I maintain that the form consists of three basic stages. The first stage lasts until 1'10"; the second, transitional stage picks up from there, lasting until 2'18", one second off of the golden section of the piece, 2'19". Stage III, which includes the climax of the piece, lasts from 2'18" to 3'20", and the Coda 3'20" through 3'47". Stage I, including Regions A-F, is largely expository introducing basic sound types in specific registers and in various combinations, often in what Ligeti terms "dialogs." These lead to progressively more complicated structures within each region, yet the basic sound types remain clearly distinguishable. The transitional Stage II begins to obscure these divisions as each side of a given dialogue becomes more internally differentiated, and Ligeti explores different connections and transformations between sonic characters. In Stage III, the move towards density and "inter-penetration" that Ligeti describes is most evident as the events of the piece begin to pile up into dense masses. After this dense section, the final 30 seconds of the piece seem like a coda or epilogue in which the sounds become very dry and clipped, and once again separate from one another as they fade away.

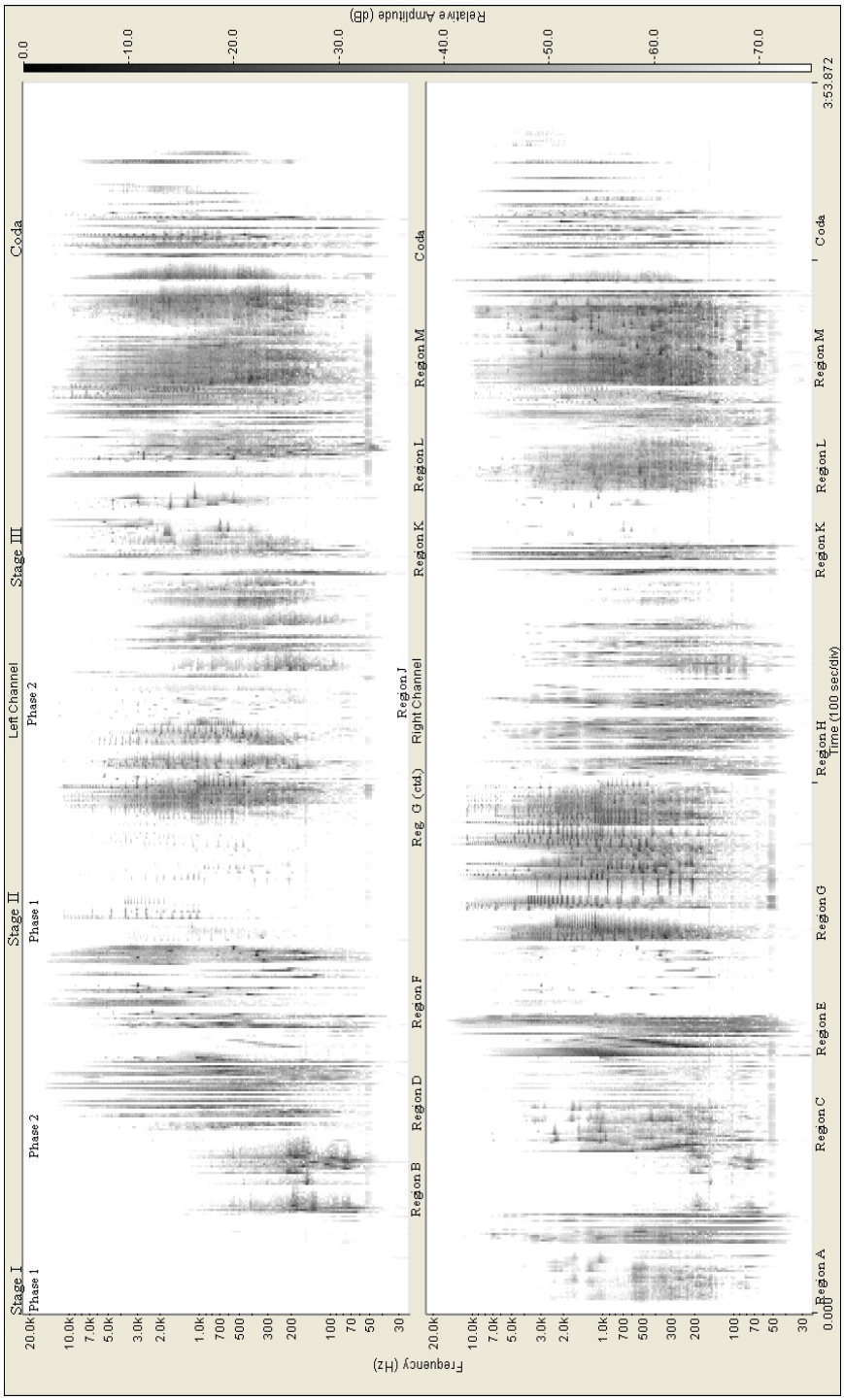

Figure 3.2. *Artikulation*, Spectrograph of the Entire Composition

The following table summarizes the sections of *Artikulation* in the terminology I will use for the remainder of this analysis.

Table 3.4. *Artikulation*: Formal Diagram

Artikulation					
Stage I		Stage II		Stage III	Coda
Phase 1	Phase 2	Phase 1	Phase 2	One Phase	
Regions A-B	Regions C-F	Regions G-H	Regions H-J	Regions K-M	

Stage I: Phases 1 and 2

Stage I has two major phases, the first of which is introductory; Regions A and B set precedents by coordinating the tendencies towards wider register, greater intensity, and more prominent and frequent attacks–clearly perceivable types of motion which support the large scale move towards denser textures (see Figure 3.3). The regions of the second phase elaborate and even contrast with these patterns while introducing more types of sound, which dramatically complicate the prevailing textures and forms of the regions. The use of channel separation and sonic character remains closely coordinated and is the primary criterion for defining regions. Moreover, the use of channels in creating the sense of overlapping regions is extremely important to the progress of Phase 2, as is the internal development of each region. Internally, Regions D and E begin to bifurcate into two consecutive subsections eventually resulting in the concurrent streams of sound characteristic of Region F. These large scale motions of overlapping and internal diversification work in parallel to reinforce the basic trend towards more complex states.

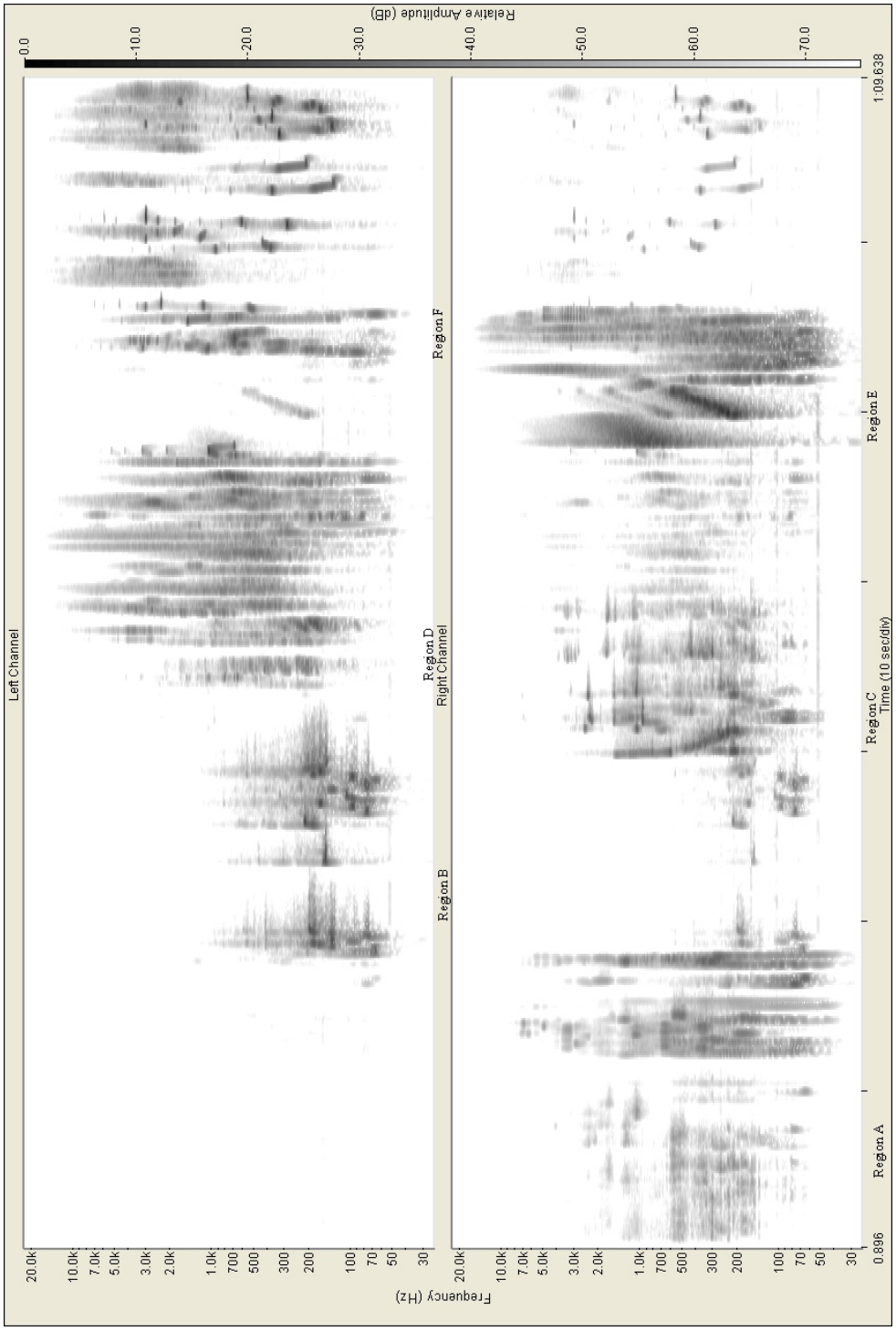

Figure 3.3. Spectrograph of Stage I

Stage II

In the transitional second stage, shown below in Figure 3.4, the use of overlapping material occurs on a much larger scale, and within these larger overlapping regions, Ligeti expands the type of internal transformations used in shaping gestures. Whereas the regions of Stage I, and particularly those of Phase 2, underwent change from one sonic character to another using discrete steps, the regions of the Stage II, and particularly Region G, begin to use not only discrete, but also gradually continuous transformations, which often take the form of glissandi and crescendo or diminuendo gestures. A very important development here involves a smooth transition where sound moves from one channel to another, which helps introduce Region H concurrently with the continuation of G, dramatically increasing the density of the whole texture. I will consider the extent of Region G, including this channel shift and the beginning of Region H, as the first phase of the transition, and the continuation of Region H, overlapping extensively with Region J[29] as the second. While this division is not as abrupt as that between phases of the first stage, it reflects an increase in the degree of change present in the second phase. This second phase focuses on preserving the smooth, glissando and crescendo gestures of Region G, while transforming the consistent pitched sound of harmonic and sub-harmonic spectra, typical of the earlier region, into more noise-based events, thus creating new kinds of connections between noise-based and pitch-based events.

[29]I do not identify a Region I to avoid confusion with the roman numerals used elsewhere.

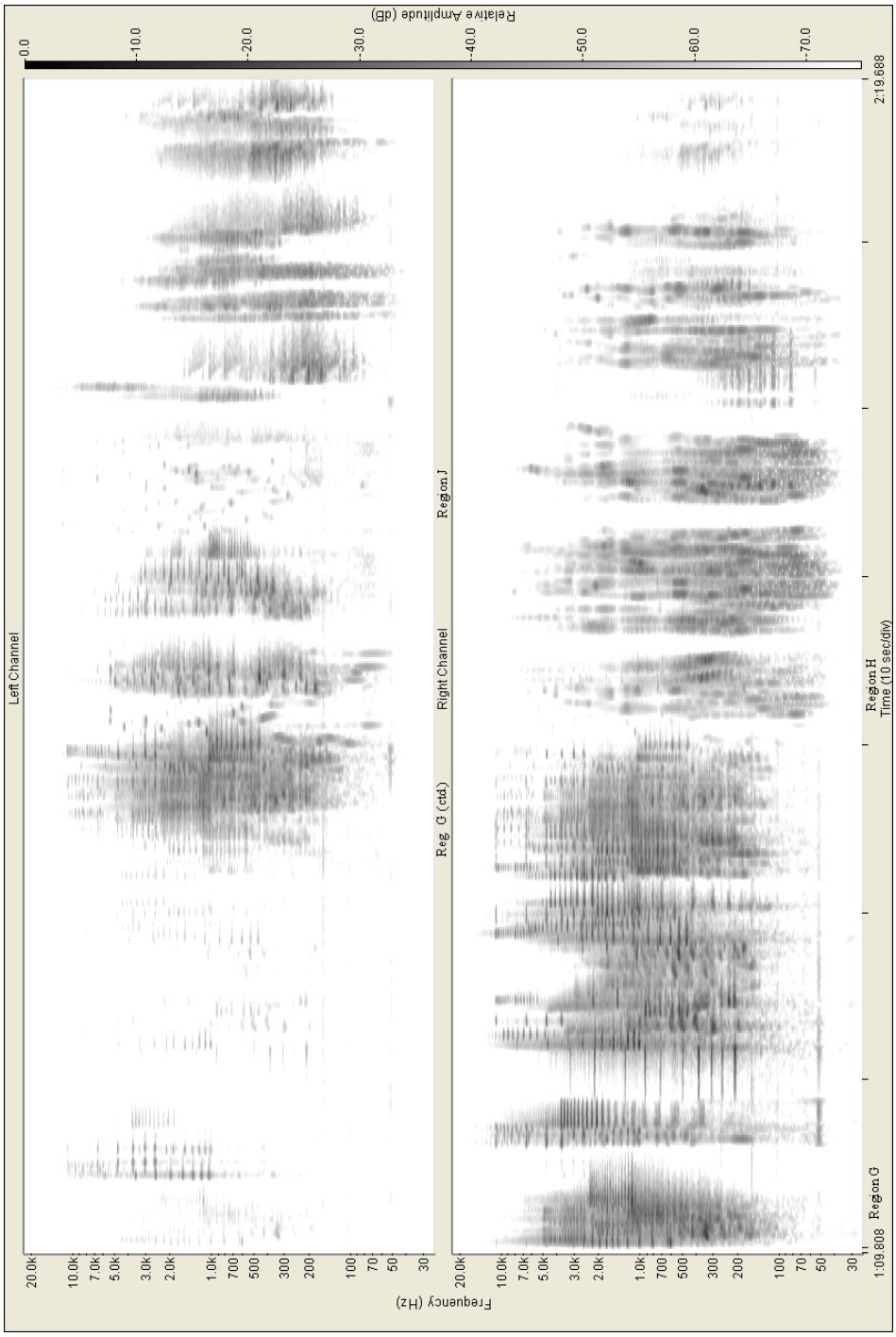

Figure 3.4. Spectrograph of Stage II

Stage III

After this point the cohesive unity of materials that characterized regions of Stage I has dissolved into regions which are either of a more mixed sonic character or which freely morph from one sonic pole to another; the events have become almost completely overlapping, and this represents the most dramatic accumulation of density, and eventual climax of the piece. The segmentation of Stage III into phases, regions, and events is a more difficult process, and the presence of diverse materials within smaller subdivisions leaves room for some ambiguity. I will divide Stage III into three regions of one large phase, since they are different steps in the same process. Region K lasts from 2'20" to 2'36" and is characterized by shorter events; Region L runs from 2'36" until the violent attack in both channels at 2'57" which begins Region M. It is difficult to separate the regions by channel in Stage III, and particularly by the onset of Region L, which has interesting relationships between events in different channels, so to bring those out more clearly, the regions will now include events in both channels.

Coda

The Coda is a series of 31 short events which alternate between the channels, and begin to fade out and incorporate longer rests between events. This process clearly stands outside the dense accumulation that characterized most of the piece–a feature which helps set it aside as a coda. The short, disconnected events allow reflection on individual elements rather than the connections made from one event to the next, and thus constitute a final reworking of the material used in the body of the piece.

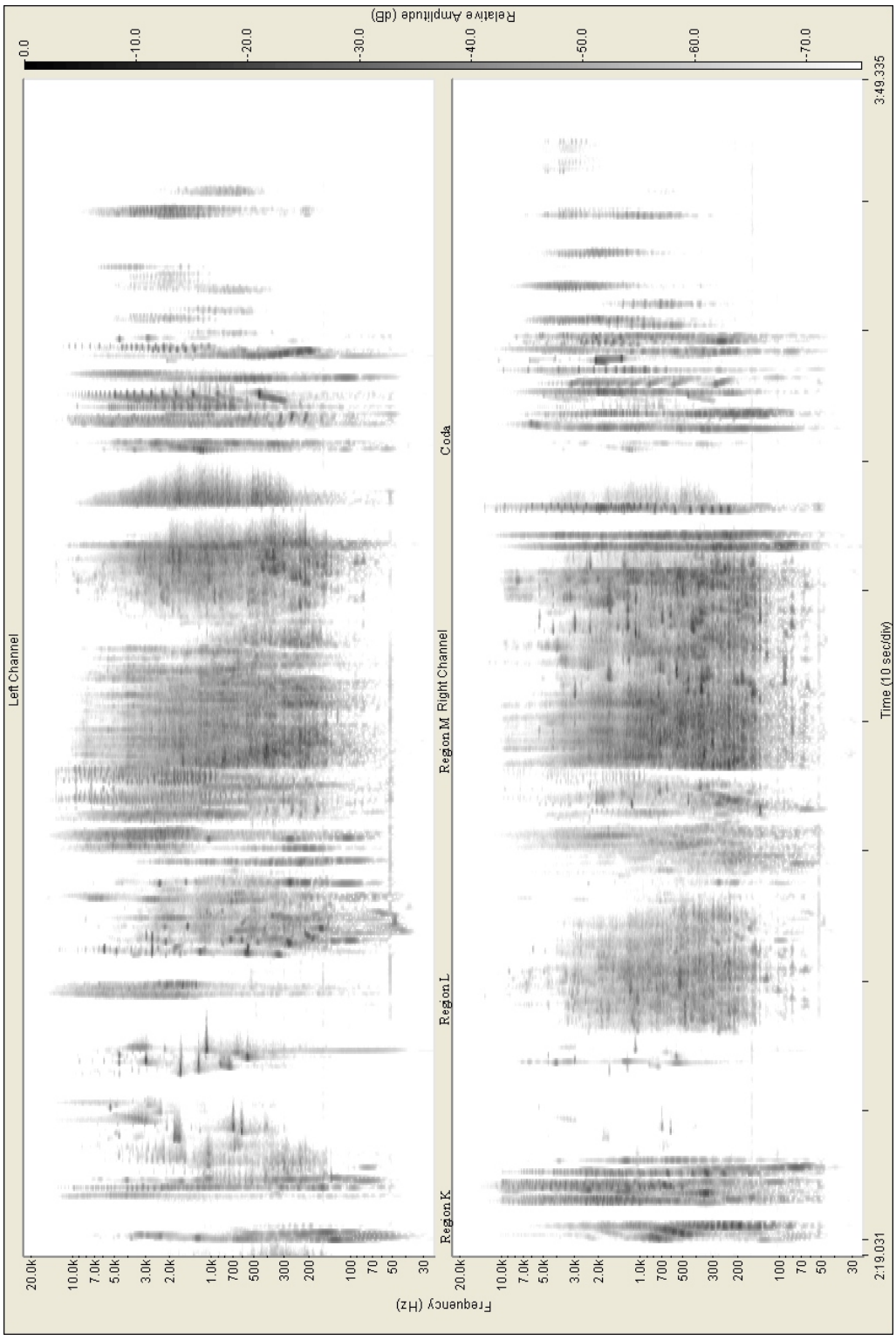

Figure 3.5. Spectrograph of Stage III and Coda

Detailed Analysis of Regions

Region A

Region A, (0"-18") shown below in Figure 3.6, exists entirely in the right channel and is divided into three events based on rests and changes in sonic materials, although the region is largely consistent in its use of impulses–occupying an intermediate state between pitch and noise. The first event is the longest, slowly fading in and ending at 11"; there is slightly over a second's rest before the entrance of Event 2. This event has the widest range of Region A stretching from approximately 40-6676 Hz. A smaller pause (17.3"-17.5") separates the third event which is also distinguished by being the loudest and having the most prominent attacks. These events create a strong impression of expansion and acceleration through their coordinated use of patterns in register, and in dynamics and attack strength. See Figure 3.6, a spectrograph of Region A.

Register

In terms of register, Region A begins with most of its activity centered between 134 and 586 Hz, however, within the course of the first event, the register quickly expands in both directions. The rise in register is made apparent by the rate at which the material above 600 Hz. enters in the first event. The material above 600 Hz begins quietly, but steadily gains in intensity in pushing upwards through areas of approximately 1200, 1600, and to a peak of 2287 Hz just before 8". A strong element at 1034 Hz continues in the 9th second while the centered material between 134 and 586 is silent, clearly emphasizing the higher register.

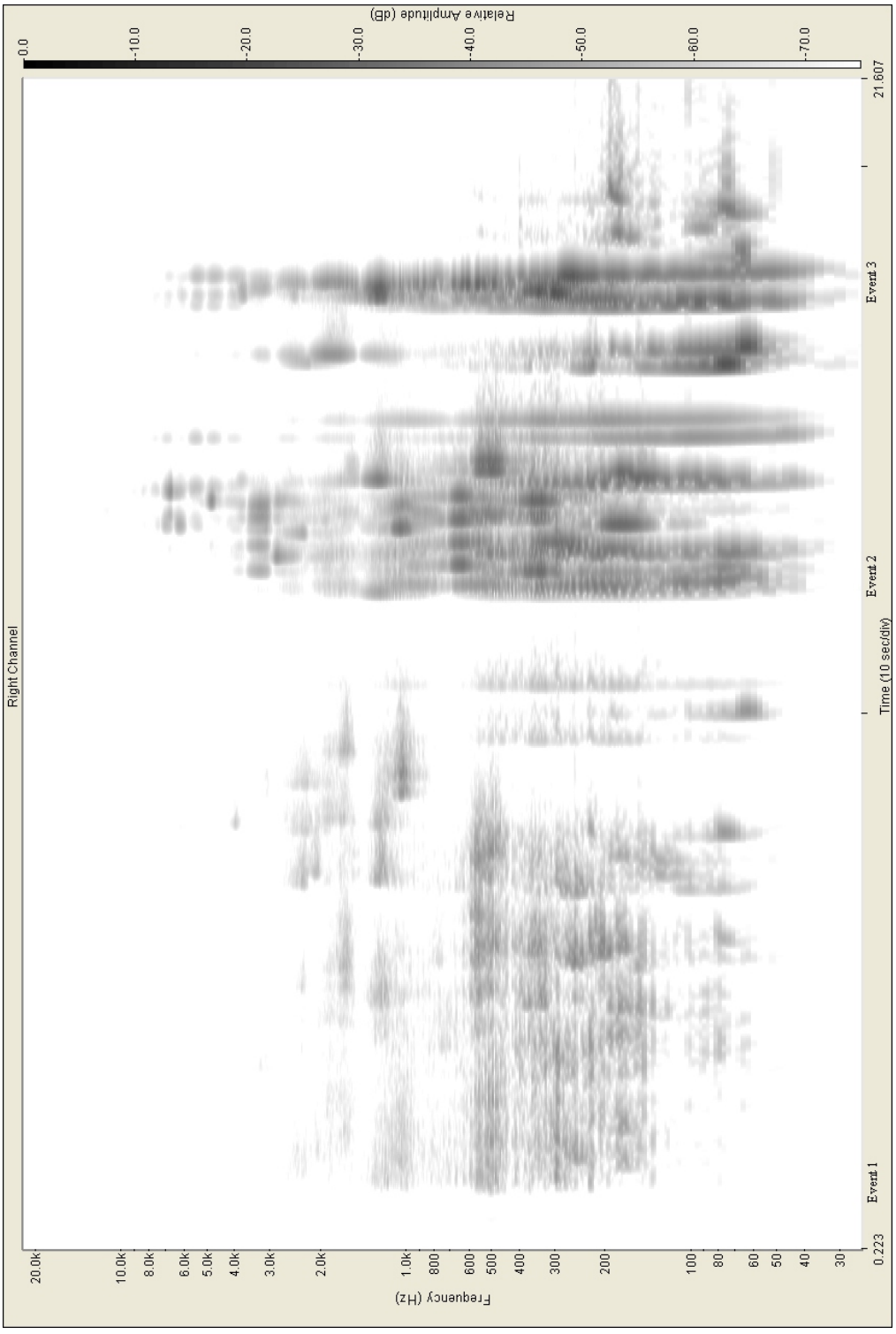

Figure 3.6. Spectrograph of Region A

The expansion into the lower register is also emphasized at the end of Event One when the original material centered between 134-586 Hz drops out. Material at around 80 Hz. quietly enters at around 3.8", growing in intensity until a prominent impulse at around 76 Hz is heard just before 8". This coincides with the exit of the centered material. The first event is then punctuated with another low impulse at 63 Hz, along with a faint reinstatement of the centered material at around 10". Taken together these low impulses at the end of Event One, along with the higher material at and above 1034 Hz, emphasize the low and high registers and thus the expansion of register from the original centered material.

The second event expands this motion even further, suggesting upwards motion within its own span and also continuing to push upwards into an even higher register than the first. At its peak Event 2 reaches 6676 Hz, and also extends as low as 40 Hz. Like Event One, this event ends with low impulses; these occur in two pairs, the first, being on the diffuse end of the spectrum, and the second more compact and at the same pitch levels–76 and 63 Hz. It is, in fact, because of the precedent set by the low impulses ending Event One that I hear these compact impulses (which are separated by brief rests on either side) as the end of Event 2 rather than the beginning of Event 3. The short, third event plateaus in this register, filling out the entire spectrum more densely and rapidly than the other two, punctuating the passage as a whole.

Dynamics and Attack Strength

The levels of intensity (dynamics) and attack characteristics also suggest a consistent trend, accelerating and growing louder across the events of Region A. First of

all this is accomplished by the progressively shorter lengths of the individual events (respectively 10, 4, and 1 seconds), and secondly by the intensities within each event. Event One begins with very soft reverberated impulses, as if fading in from a distance; these steadily increase in intensity through the course of the event, as can clearly be seen by the darkening images in the spectrograph shown in Figure 3.6, above. In conjunction with the spectrograph, we can see that it is not only the material above 600 Hz increasing in intensity, but also the impulses underneath this level also gain strength. As a result of this individual attacks become more perceptible, culminating in the low, dry, final impulse. These are seen in the spectrograph as images whose lefthand edges take less time to fade in. These spectral features are evident in the second event, clearly darker and more well defined anything occurring in Event One; the second event sounds much like a condensation of the first, expanding the register covered while contracting the amount of time, and again aided by the low final impulses. The third event, though short, has very prominent attacks and is at least as loud as Event 2, thus continuing the trend towards heavier attacks and louder overall dynamic levels.

Reverberation

Across all three events there is also a steady decrease in the use of reverberation, causing the ends of events to taper off more quickly. In the first two events this is highlighted by the dry, punctuating impulses. The third event itself is entirely unreverberated, and, since this event is also relatively loud, and the shortest of the three, it completes the overall motion of the region toward louder more accelerated material. The following table of oppositions (Table 3.5) represents many of the coordinated sonic

Region A

		1	2	3
grave	accute	0	0	0
centered	extreme	-1	1	1
narrow	wide	-1	1	1
compact	diffuse	0	0	0
soft	loud	-1	0	1
level	oblique	-1	-1	-1
no-attack	attack	-1	1	1
sustained	clipped	0	1	1
reverb	dry	-1	1	1
			d6	d1

	start	end	duration
A1	1.5	11	9.5
A2	12.3	17.3	5
A3	17.3	18.7	1.4

Table 3.5. Table of Oppositions for Region A

dimensions throughout Region A, showing a change in 6 oppositional categories between the first two events–moves from centered to extreme material, narrow to wide, soft to moderate dynamics, little or no attack to the presence of significant attacks, sustained to clipped elements, and reverberated to dry.

The profile established by the coordination of these characteristics is significant though other regions of the piece. One prominent feature is the rhythmic contour of long-short-short present across the three events, as well as within events 1 and 2, where the low ending impulses define shorter durations after the longer body of the event. The registral contour of middle-high-low, which is suggested subtly by Event A-1, is also significant, and becomes better articulated later in the piece. While the rhythmic contour, occurring on the scale of event and region, may suggest hierarchic construction, whether such a structure plays out is a complicated issue that will be addressed later on in this chapter.

Region B

Region B (18-31") is coupled with A in the first phase, because it echoes the trends of registral expansion, increase in volume, and acceleration of attacks. Region B contrasts from A as it occurs in the left channel and with a lower overall register–largely below 1000 Hz–and uses more compact impulses, closer to sine-tones, where pitches are readily discernable. Like A, however, it is partitioned into three events (18-23", 23-26", and 26-31") as shown in Figure 3.7. A long rest creates a clear break between the first two events. The use of longer oblique pitches makes the two elements of Event 2 cohere, and implies a weaker border with the third and final event. The first event begins close on

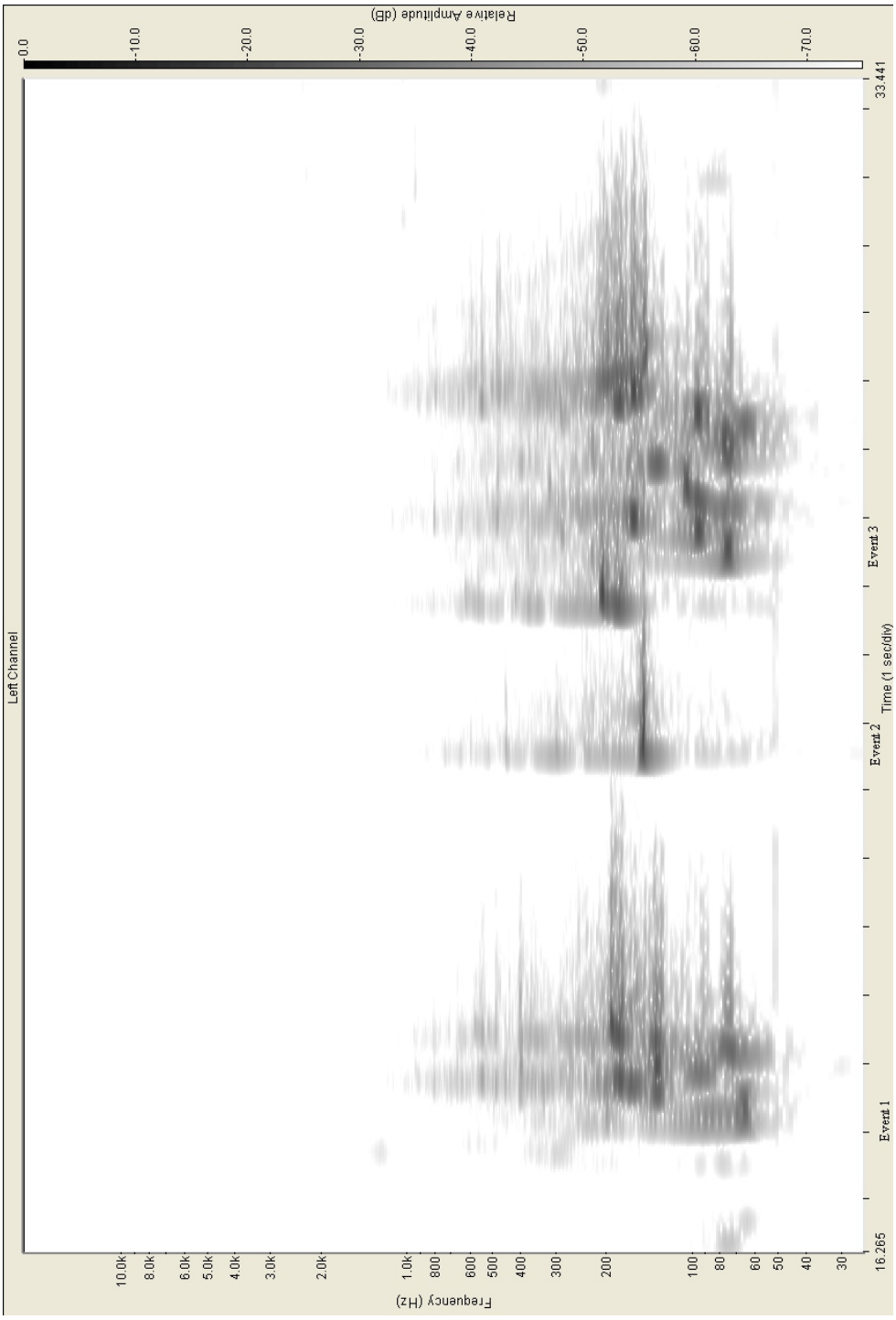

Figure 3.7. Spectrograph of Region B

the heels of Region A, and has an introductory quality–emphasizing the differences in spatial location and in sonic material (sine tones rather than impulses, and a return to low register, and heavy reverberation) between Regions A and B. After these faster initial elements, there is a long decay and rest taking up the last half of the first event, and it is from this point that the parallelisms between the two regions become more clear.

Register

The fundamentals of Region B's more compact events are solidly rooted between 65 and 209 Hz., and are more understated when compared to Region A's registral motion, nevertheless, the region itself does expand, and furthermore, each of the subsections shows an upward tendency. Event 1 has a number of distinct attacks beginning at 65 Hz and ending at closer to 194 Hz. The fact that these events are all more compact than those of Region A makes even a slight variation in pitch height more notable and this rising contour here is clear. The two pitches of Event 2 begin at 149 Hz and 204 Hz; moreover, both gliss slightly upwards, so that Event 2 contains an upwards direction both across the two notes and within each note. The rapid attacks of Event 3 also end higher than they begin, moving from 75 Hz, to leave the last pitches of 184 and 161 Hz reverberating near the peak of the passage. In general, this region does not use register as dramatically as Region A–the more precisely defined, compact nature of the pitches it employs make it possible to suggest a predominantly upward expansion more subtly, and the parallelism with Region A is carried out more fully in other dimensions.

Dynamics and Attack Strength/Density

If this registral movement is less dramatic than in Region A, Region B's trends towards more prevalent and pronounced attacks more than make up for this. Event 1 begins with around 9 clear attacks, but is followed by a long pause, which mitigates the overall density of the passage; in fact, if one considers the first 2 seconds as introductory, and less essential to the shape of the passage as a whole, the bulk (3 seconds) of the first event is one slow decay. Event 2 is quite sparse, consisting of only two oblique sine tones over 3 seconds. Consequently, the nearly 14 distinct attacks of Event 3 make the final event stand out as the densest of the region. The increase in volume is, again, subtle, but, still coupled with this increase in attack density the net result is a sense of growth and acceleration parallel to that of Region A.

Connections between Regions A and B

A nice connection between Regions A and B is the way in which pitches emerge in the low registers. The two low impulses at the end of Event A-1, to which I have referred above, are, noteworthy, in their context, for emphasizing the lower part of the wedge-like registral expansion. Nevertheless, in a larger context they are still faint, and intervening material, emphasizing the upper part of this wedge, complicates their perception as a gesture. The end of Event A-2, then introduces pairs of impulses as a gesture–first the diffuse pair, and then the compact pair, which harkens back to the end of A-1, suggesting a kind of "ending gesture" consisting of two low impulses. Furthermore, across these two events, the low impulses move from being faint and imbedded within a larger motion to being clearly presented in pairs–each time more distinct. This prepares the entrance of

Region B

		1	2	3
grave	accute	-1	-1	-1
centered	extreme	1	0	0
narrow	wide	-1	-1	-1
compact	diffuse	-1	-1	-1
soft	loud	-1	-1	0
level	oblique	-1	1	0
no-attack	attack	0	-1	1
sustained	clipped	0	1	0
reverb	dry	-1	-1	-1
			d4	d4

	start	end	duration
B1	18.2	23.6	5.4
B2	23.6	26.6	3
B3	26.6	29.9	3.3

reverb continues until 31.2
but is cut off by Region C

Table 3.6. Table of Oppositions for Region B

Region B, which begins, rather than ends, with low impulses–centered even more compactly around 65 Hz–and immediately uses these to fashion new gestures, introducing glissandi, and other registral motions within this grave register. The higher pitched impulses (i.e. the upper end of the wedge which ended Event A-1) have, in a way, been left hanging through Region B, but will be picked up again by aspects of Region C, discussed below. Connections such as these are numerous and serve to emphasize the point that while the Regions I have defined are meaningful units, the flow of the piece is much smoother than would be implied by simple succession of contrasting sections.

Stage I, Phase 2 (Regions C-F):

The second phase of Stage I begins to enrich the possibilities presented in the opening phase; this occurs both through the introduction of noisier sonic characters and through regions which contrast with the trends presented by A and B. Having established both impulses and more compact sine-tones in the 30 seconds of the opening phase, the next few regions of the piece continue to introduce several different sound types, largely playing with the distinction between noise and pitch and introducing more diffuse elements. These eventually intermingle within a single region. Region F completes this process and involves a more complicated sort of dialogue pitting noise and pitch against one another in a new, more polyphonic, way. In addition the continuing interaction of spatial positions further enhances this burgeoning sense of parametric polyphony.

The individual regions of Phase 2 also contrast with the direction laid out by the opening regions, although the trend across these regions is still clearly toward denser

activity. The introduction of differing sonic types in the same region leads to more complex forms than the simple accelerating patterns of Regions A and B. The subsequent regions begin to develop two-part structures, first based on parallelisms, and then having more dramatic differences between the first and second halves. Again, this process culminates in Region F which develops a polyphony of simultaneous, rather than successive parts. The use of channels in creating the sense of overlapping regions is also extremely important to the progress of Phase 2; these regions are noted in Figure 3.8.

Region C

Region C (29.8"-39.6") differs from the previous regions in that it uses a mix of compact and diffuse sounds, rather than moderate impulses, or either of these sonic poles exclusively. Furthermore, this region begins to vary and elaborate the types of motion established by the opening phase; these contrasts are what set it apart as the first Region of Phase 2. I will divide Region C into 3 events; the first is introductory, and the second and third create specific patterns within each pair. The first event lasts from 29.8" to 31.7", at which point the beginning of Event 2 marks a move from noise to pitch, and lasts until approximately 34.6", although reverberation carries through a bit later. I will also subdivide Event 2, into 2a and 2b, the latter marked by a prominent attack at 33.6". Event 3 is also subdivided with 3a beginning at 35.7" and Event 3b at 38.2. This division will help illustrate more specific ways in which Region C contrasts with A and B, as well as relationships between Region C's events.

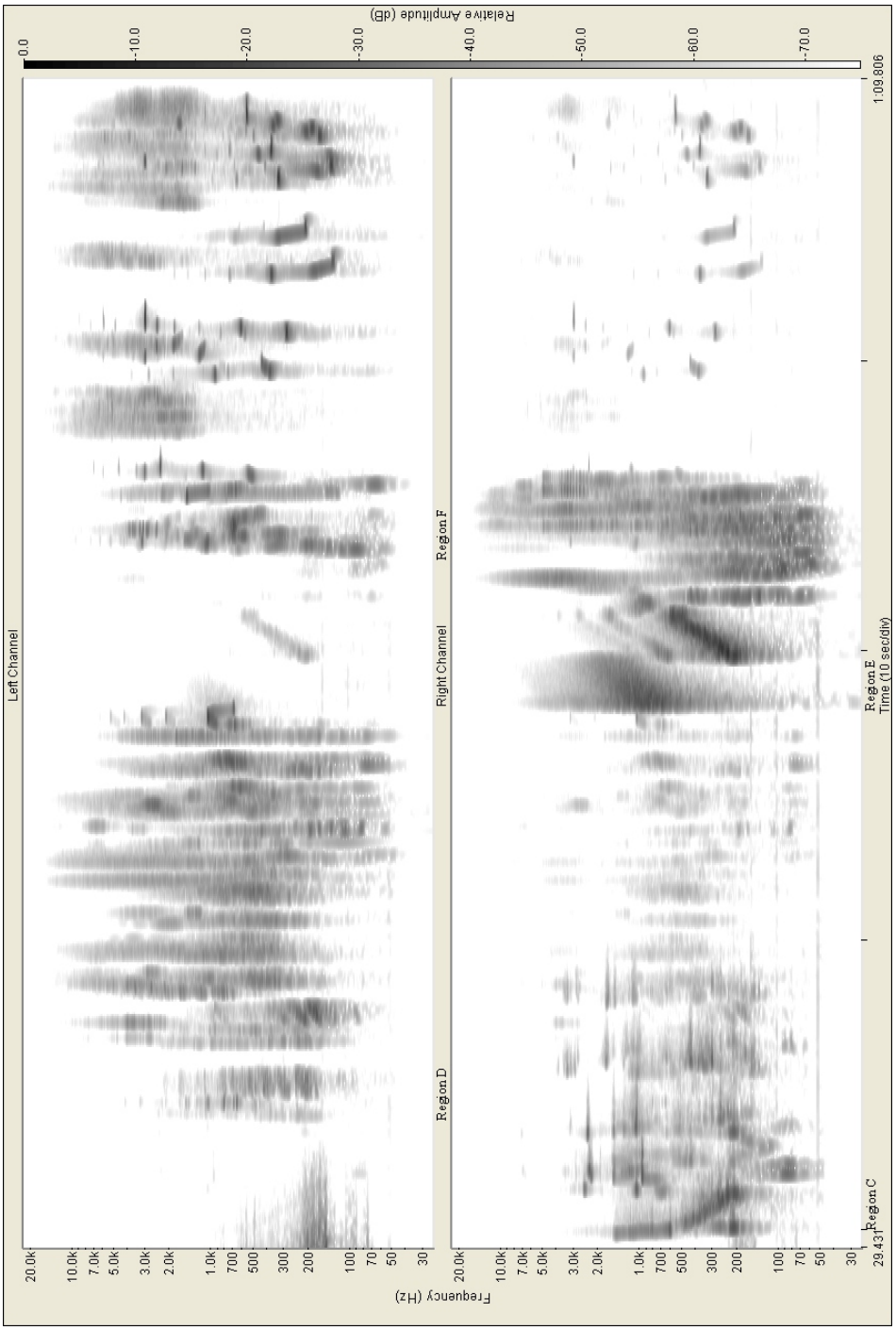

Figure 3.8. Spectrograph of Stage I, Phase 2

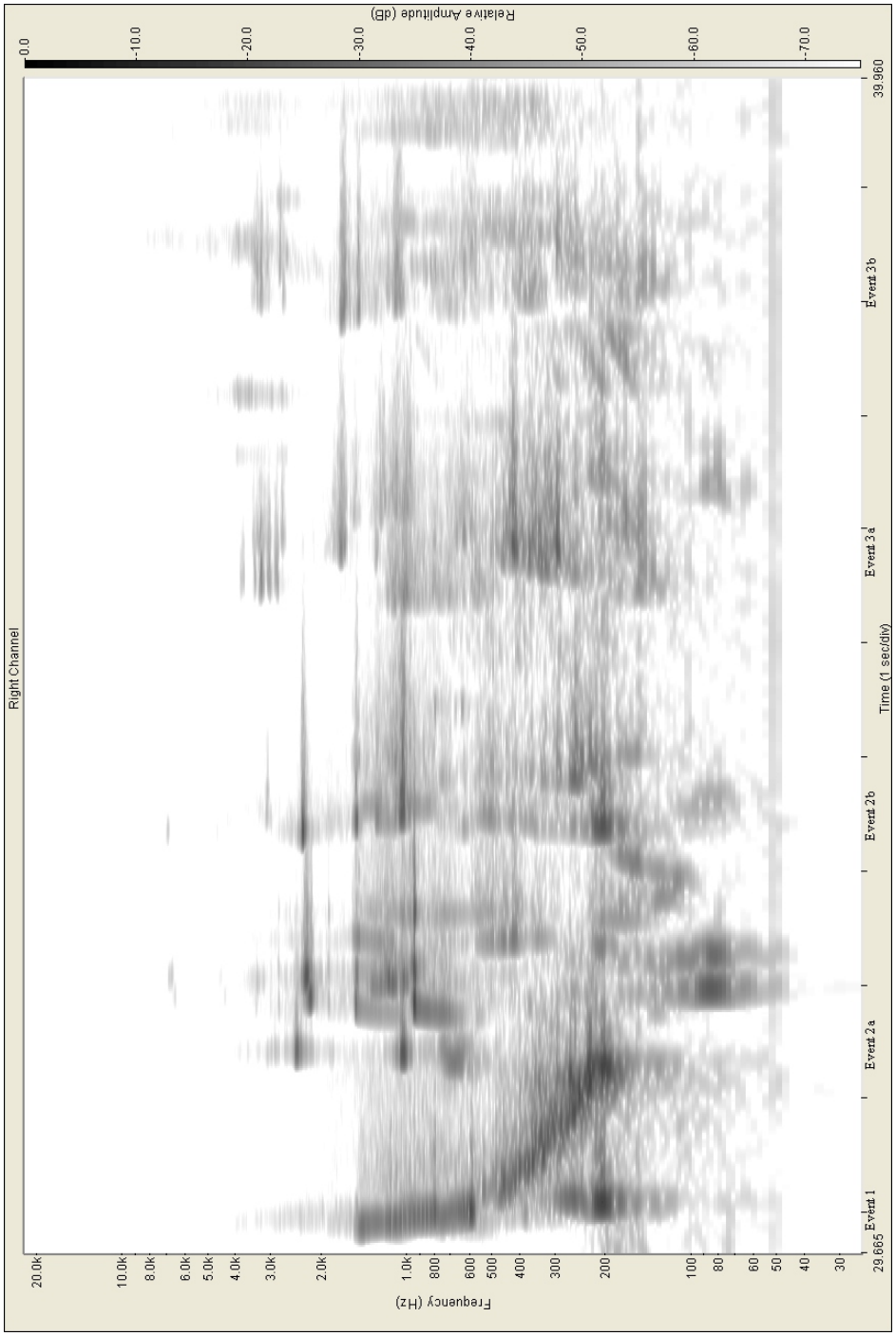

Figure 3.9. Spectrograph of Region C

Sonic Material (compact and diffuse)

A change in the use of diffuse materials helps divide Event 1 from Events 2 and 3. Region C begins with a striking initial gesture–a band of filtered noise that sweeps downward in a glissando of well over an octave from c. 480 - 180 Hz; noises up to this point have only been in the background, as Region A fades in. Or they have occurred as shorter, moderately compact/diffuse impulses and have not been this purely diffuse, been sustained, or had such clear motion and prominence as a gesture. The continuation of Region C, however, is largely mixed in character–using more compact tones prominently in the upper register, while diffuse impulses are softer and lower, taking a background role.

Register

The initial downward glissando of Region C is striking not only for its contrast with Region B's impulses and tones, but also in terms of register; the downward direction of this glissando contrasts with the generally ascending motion of the previous region. The contrast of this noise gliss is brought to the fore when compared to the prominent glissandi of Region B, which were very compact pitches, more subtle in their oblique motion, and were directed upwards. All of these registral and sonic characteristics set Region C apart as something new.

The contrast in registral direction is, however, only momentary, as the continuation of Region C is largely higher pitched, and this region presents a wide register throughout, with elements from 70 to 3700 Hz. The continuation contains many prominent compact tones as high as 3214 Hz–much higher than any definite pitched event in either of the first

two regions. At the beginning of the region these are punctuated with low impulses, such as the prominent one at 32", occupying a very diffuse position between 73-91 Hz. By the end of the region, this more diffuse material has largely moved into the middle register above 150 Hz, with a strong region at about 294 Hz at the end of Event 2b. This type of material remains in this region during the second pair of events. Thus while Region C uses a mixture of noise and pitch, moving towards a greater diversity of elements, rather than occupying a consistent mid-level value, as in Region A.

Mixture versus Moderation and the Presage of Polyphony

The use of material which mixes sonic opposites rather than exists as an intermediate state, is in one way a precedent to polyphony–especially as the material above 900 Hz operates differently from the material below it. At this point, however there are criteria that mitigate the perception of a true polyphony. First of all, the upper register's material is louder and more prominent, and is also organized into coherent gestures. This relegates the softer material below 900 Hz into a background role. The use of heavy reverberation also tends to blend the materials together making the perception of separate, more or less equal, strands difficult at this point. This is nonetheless, an important precedent to Region F, which will achieve this polyphonic effect quite clearly.

Dynamics and Attack Strength

The initial noise glissando creates a very prominent attack, and the subsequent decreases in dynamics, and corresponding decrease in attack strength directly contradict the trends of the opening. The sense of growth and acceleration in Regions A and B is reversed, and the motion of Region C, gradually becomes softer and slower. The heavily

pronounced attack of the beginning is the dynamic peak of the region, and the entry point of each subsequent event is softer, as shown clearly in the amplitude graph of Region C, presented with the spectrograph above.

Patterning within Registral Motion and Durations

Within the general framework, the body of the region consists of two events, each subdivided into twos, as shown above in Figure 3.9. This will show more specific ways in which Region C stands apart from its predecessors and coheres as its own region. While the use of register has been discussed above, certain nuances which help shape the region deserve further analysis. Events 2 and 3 present a parallelism in durations and in pitch contours in their compact material. Events 2a and 3a present longer durations of 2" and 2.4" while Events 2b and 3b are 1.7" each. Within each of these four units there is a simple downward contour, but the longer events repeat and draw out the second, lower note.

Here we might recall the closing gesture of Region A's first two events; while these events are much higher in register, this parallel occurs both in relative pitch-contour and in durations. Although they are more compact and higher in pitch than the originals, their position and function relative to events in Region C is the same.

This simple direction is, however, not without nuance. A decrease in the rate of attacks can be found between Events 2a and 2b, and again between Events 3 and 4, emphasizing this trend, and reinforcing the status of the final tones as echoes of the closing gesture of Region A. Through the pairing of these events and the transformation of earlier gestures, Region C has a distinct shape which provides local contrast within the greater

scheme of the piece. While locally contrasting, the clear direction of Region C allows for more extensive overlap with Region D, without compromising the identity of either region. Thus the decreasing attack rate within Region C allows Region D to enter, and, in the larger scheme of the piece, keep the trend towards greater density constant.

The table of oppositions clearly shows the profile of this region. The first, introductory, event differs from the continuation in seven sonic parameters. These include the significant moves described above, namely from the noisy, diffuse material to the mixed, but predominantly compact material of Events 2 and 3; loud to moderate dynamic levels; and oblique to level as the opening glissando gives way to more fixed sine tones. The less dramatic change between Events 2 and 3 is reflected in only one parameter–the dynamic level which drops between the two events. This difference is, however, enhanced by a slight rest (35.1"-35.5") between the two events. The subtler changes within Events 2 and 3 (from 2a to 2b, and 3a to 3b) are brought about by slight changes in pitch contour and are not reflected in the table of oppositions.

Overlap and Contrast Between Regions C and D

The contrast between the end of Region C, featuring reverberated pitches, dying away in the right channel, and the drier, noisier sounds of Region D, emanating from the left allow each to retain its individual identity while their events alternate in time. This is an important step towards the development of more complicated types of dialogue. While there was some slight overlap between previous regions, this has been mostly brief, and occurs when one region is clearly on its way out, the other clearly on its way in, for

Region C

		1	2a	2b	3a	3b
grave	accute	0	0	0	0	0
centered	extreme	-1	0	0	0	0
narrow	wide	0	0	0	0	0
compact	diffuse	1	0	0	0	0
soft	loud	1	0	0	-1	-1
level	oblique	1	-1	-1	-1	-1
no-attack	attack	1	0	0	0	0
sustained	clipped	1	0	0	0	0
reverb	dry	0	0	0	0	0
			d7	d0	d1	d0

	start	end	duration
C1	29.9	31.4	1.5
C2a	31.4	33.4	2
C2b	33.4	35.1	1.7
C3a	35.5	37.9	2.4
C3b	37.9	39.6	1.7

Table 3.7. Table of Oppositions for Region C

example, the reverberation of the final gesture of Region B lingers over into the beginning of Region C. Region C, however initiates two events after the beginning of Region D–events drifting downward in pitch and decreasing in volume which fall in spaces between events of Region D. While this is not a dramatic difference from what has gone before, it is the first step in a gradual but important process through the course of the piece.

Region D

Region D (34"-48") is defined by much noisier and drier sounds which occupy a very wide range, expanding upwards to 6744 Hz, with fainter partials even active around 13,000 Hz–a range that we will find is more typical for the rest of the piece. Region D is divided into two parts, the first of which shows certain patterns in contour and duration, and the second of which is more scattered in register, and consists of mainly shorter durations not participating in discernable patterns. Thus Region D creates a kind of two-part form, although one based on discontinuity rather than on parallelism, as was the case in Region C.[30]

[30]What I identify as the two parts of Region D appear as separate subsections of Part A (A3 and A4) in Ligeti's sketches. I choose to group them together in one region because of their strong connections, particularly consistency in channel and the use of diffuse sounds. Regarding Region D as a two-part construction is also creates a clear trend from Region C to Region E, which I will discuss below.

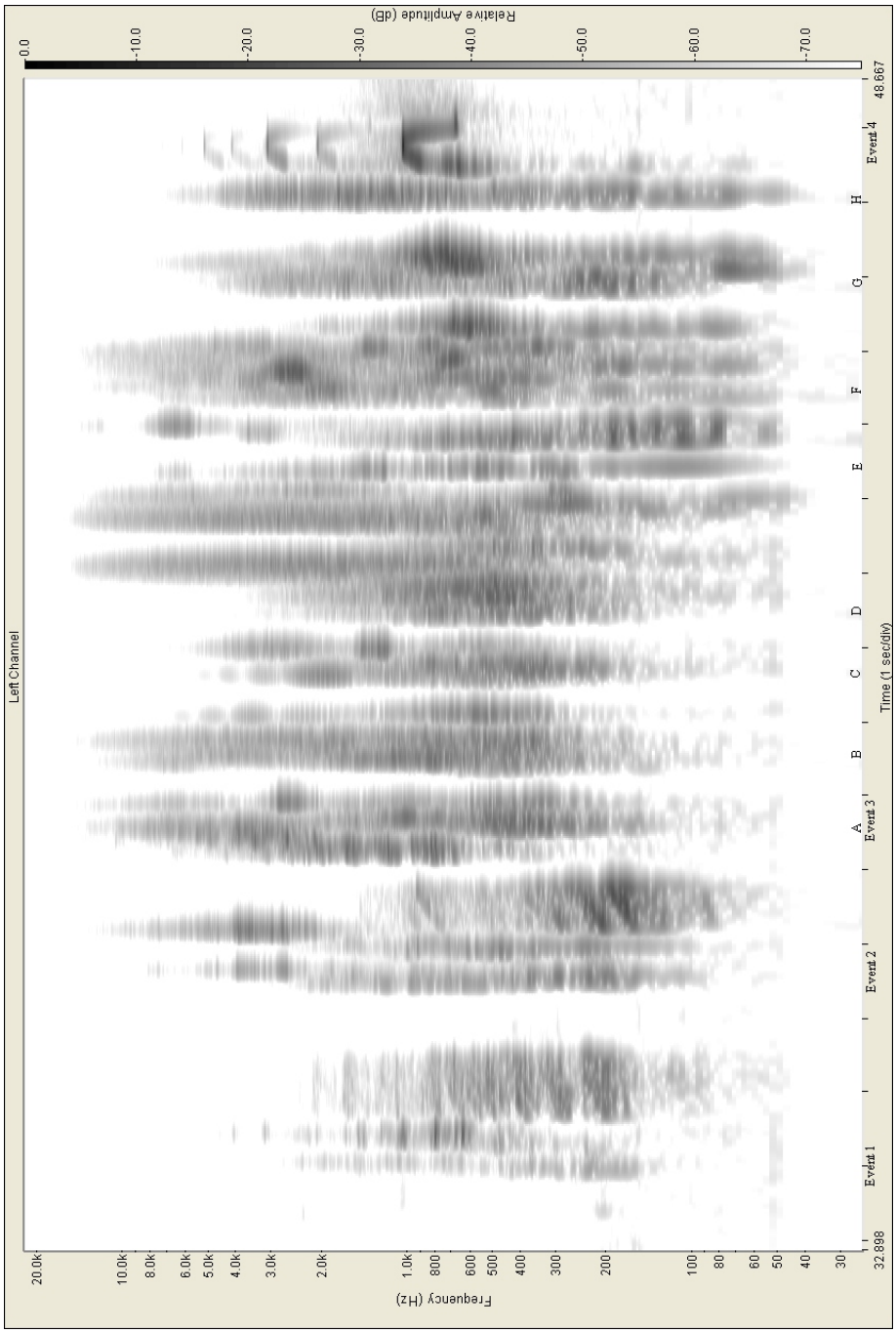

Figure 3.10. Spectrograph of Region D

Region D

		1	2	3	4
grave	accute	0	1	0	1
centered	extreme	-1	0	0	0
narrow	wide	0	0	1	-1
compact	diffuse	0	0	1	-1
soft	loud	0	0	1	1
level	oblique	0	0	0	1
no-attack	attack	1	1	1	1
sustained	clipped	0	0	1	0
reverb	dry	1	1	1	1
			d2	d5	d5

	start	end	duration	
D1	34	36.1	2.1	
D2	36.7	38.4	1.7	
D3	38.3	47.8	9.5	
D4	47.8	48.4	0.6	
	D3 Elements			
	38.3	1.3		
	39.6	1		
	40.6	0.1		
	40.7	0.3		
	41	0.5		
	41.5	0.6		
	42.1	0.7		
	42.8	0.7		
	43.5	0.5		
	44	0.5		
	44.5	0.3		
	44.8	0.4		
	45.2	0.8		
	46	1.1		
	47.1	0.7		
	47.8			
		9.5	0.633333	avg dur.

Table 3.8. Table of Oppositions for Region D

Events 1 and 2, durations

These initial events (labeled above in Figure 3.10) clearly relate to one another. In durations, they both present subdivisions which proceed short-short-long. Event 1 begins at 34.0", peaks with an attack at 34.4", and has a final element at 34.9-36.1", yielding durations of .4, .5, and 1.2". Event 2 begins at 36.4", has its highest attack at 36.8", and has its final glissing element from 37.4-38.4", yielding subdivisions of .4, .6, and 1.0"–durations closely parallel to the first event's.

Events 1 and 2, Register and Sonic Material (level/oblique)

This parallel is made stronger by the use of register. These events have identical registral contours, their subdivisions being ordered middle, high, low in each case. The long, low, final element of each contour also displays oblique motion–slight motion in the first event echoed by a more distinct upwards gliss in the second–an observation which aids their perception as parallel. Furthermore, this contour (in register) matches the paradigm of the first two events within A, which rise but are then punctuated with low impulses, although this happens in a greatly diminished time frame. The contour in duration, however, ends with the longest element and is thus a reversal of Region A. These initial two events then contrast with the continuation of the region, in which no such trends are found.

Continuation of Region D

At the point when Region C has ends, a change occurs in Region D. It is at this point that the register becomes more scattered. The continuation of D abruptly increases the region's attack density, as well, since it lacks the longer durations of the opening two

events. The absence of longer durations and of rests, such as the one dividing Events 1 and 2, make this second half of Region D difficult to parse into smaller units, other than pointing out a few anomalous individual elements which contract in register (D3, Element C) or use more pitch based material (Event D3, Element E and Event D4). Thus the morphology of Region D seems markedly different from the earlier regions, although the generally noisy sounds and consistent spatial location make the region cohere. The contrast between the opening and continuation is itself part of a trend in the piece; it prepares the next two regions which move towards more internal diversity, another way of approaching a state of complete mixture.

Region E

Region E (right channel, 48-57") resembles aspects of the previous two regions; transforming and resynthesizing familiar characteristics of the Regions C and D. The Region's form (a pair of introductory events followed by a contrasting continuation) and use of a wide register (with elements from c. 50-7000 Hz.) resembles that of D, while individual gestures recall events from Region C. Specifically, Region E's first two events recall the opening of Region C with diffuse glissandi, although this time they are ascending, rather than descending. The exceptionally wide glissing noise band of Event 1 (48.2") is echoed by a less diffuse gliss in Event 2 (49.8"). There are fewer glissandi in the continuation of Region E (Events 3a and 3b), and in this regard, too, it resembles Region C, which began with an oblique gesture before settling on a more level continuation.

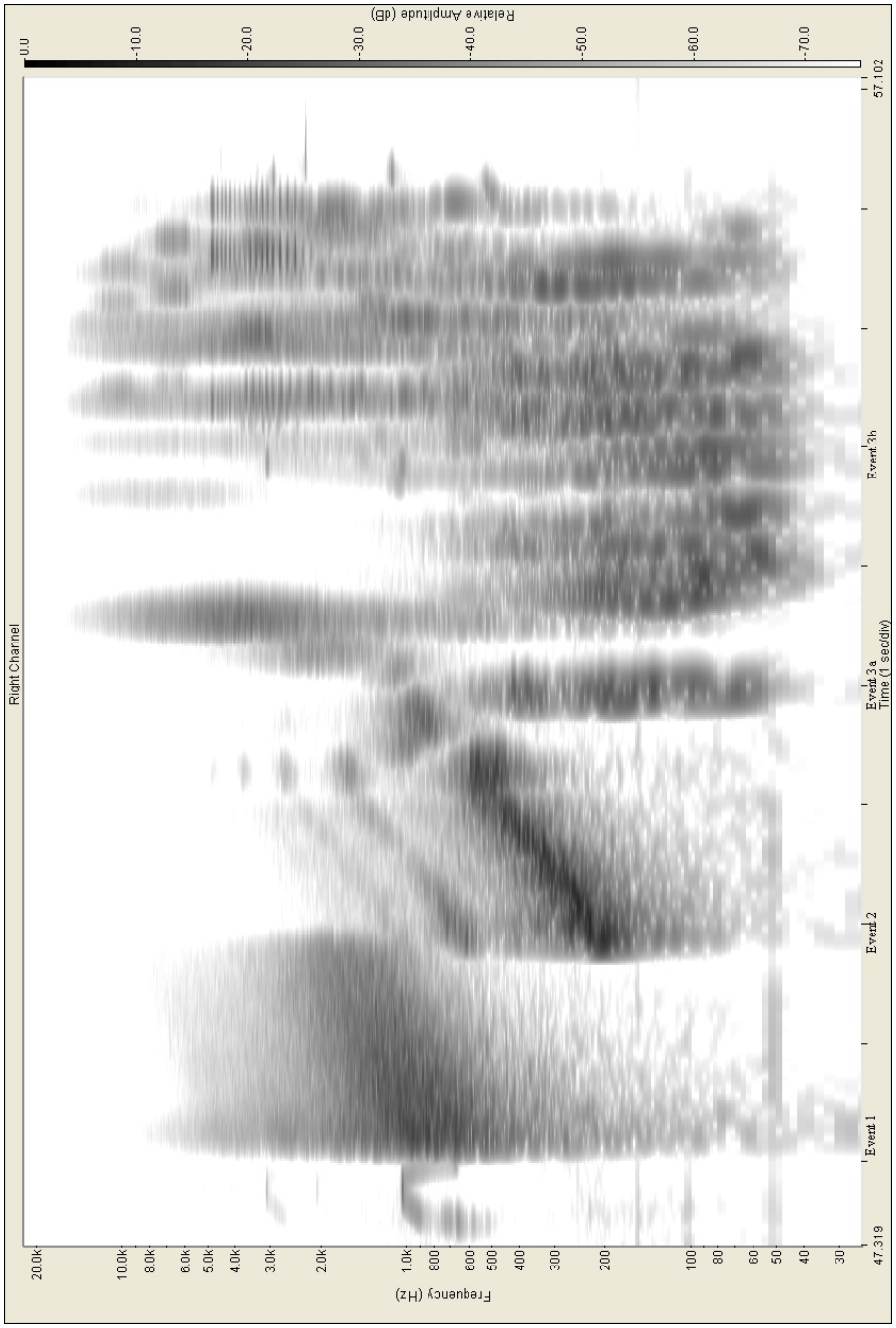

Figure 3.11. Spectrograph of Region E

Region E

		1	2	3a	3b
grave	accute	0	0	0	0
centered	extreme	-1	-1	1	1
narrow	wide	0	-1	0	1
compact	diffuse	1	1	0	0
soft	loud	1	1	1	1
level	oblique	-1	-1	1	1
no-attack	attack	1	1	0	0
sustained	clipped	-1	-1	1	1
reverb	dry	1	1	1	1
			d1	d6	d1

	start	end	duration
E1	48.2	49.8	1.6
E2	49.8	51.9	2.1
E3a	51.9	53.9	2
E3b	53.9	56.7	2.8

Table 3.9. Table of Oppositions for Region E

Register

Apart from the aforementioned level/oblique opposition, the two-part division of this region is emphasized by the continuation of Region E, which becomes more scattered in register. Event 3a (51.9"-53.9") has a low-high-low contour, achieved by the switch to level and narrower bands of noise. When taken together Event 3a fills the full spectrum of the region, although its attacks call attention to different parts of the spectrum at different points. Event 3b (53.9-56.7") accelerates the process, filling out the same spectrum almost continually throughout the last 2.5 seconds of the Region. There are scattered, clipped attacks throughout Event 3b which consist of diffuse noises of various widths mixed with extremely rich compact spectra, which, are actually very similar to the noises. After the low-high-low contour of 3a, the scattered attacks of 3b do not create as clear an image as the previously mentioned contours, and in this regard, the second part of Region E resembles the second part of Region D.

Rhythm and Durations

Region E's rhythm also helps partition it into two subsections, resembling those of Region D. The two glissandi (approximately 2 seconds each) are far longer than any of the elements of Event 3. This can be seen in the spectrograph above (Figure 3.11). The three elements of Event 3a last less than two seconds, Event 3b lasts for 2.8 seconds, and consists of multiple, uncoordinated elements. This pattern is familiar from Event D, where the longer elements of the beginning were essential to the recognition of the related contours of Events 1 and 2, and the continuation lacked both the longer durations and the clear contour relationships.

Sonic Materials (compact vs. diffuse)

Only along the axis from diffuse to compact does the piece move with any sort of moderation, that is to say, this is the only dimension which mitigates the abrupt two part division of this region. The exceptionally wide glissing noise band of Event 1 is echoed by a less diffuse gliss (a narrower band of noise with a significant "overtone" occurring a perfect 12th above) in Event 2, followed in turn by a mixture noises some of which are narrow and others of which are wide. All other categories change immediately with the onset of Event 3; the sustained single glisses give way to a multitude of shorter, level, events.

Region F

Region F is in many ways the culmination of the developments of dialogues and the use of channels seen in the second phase of the exposition. Instead of presenting one type of material, which may undergo some transformations through the course of the region, the degree of internal mixture is such that there are now two distinct types of material coexisting within Region F. A clear dialogue emerges between compact, pitch based events and noisier, diffuse, and mostly higher pitched sounds resembling scratches and whispers. Previously, changes in type of material–including changes in pitch versus noise based material–worked together with channel separation to define regions here the two types coexist. Due to the frequency of their alternation, they cannot be considered separate regions; the average length of each segment of a given material is comparable to

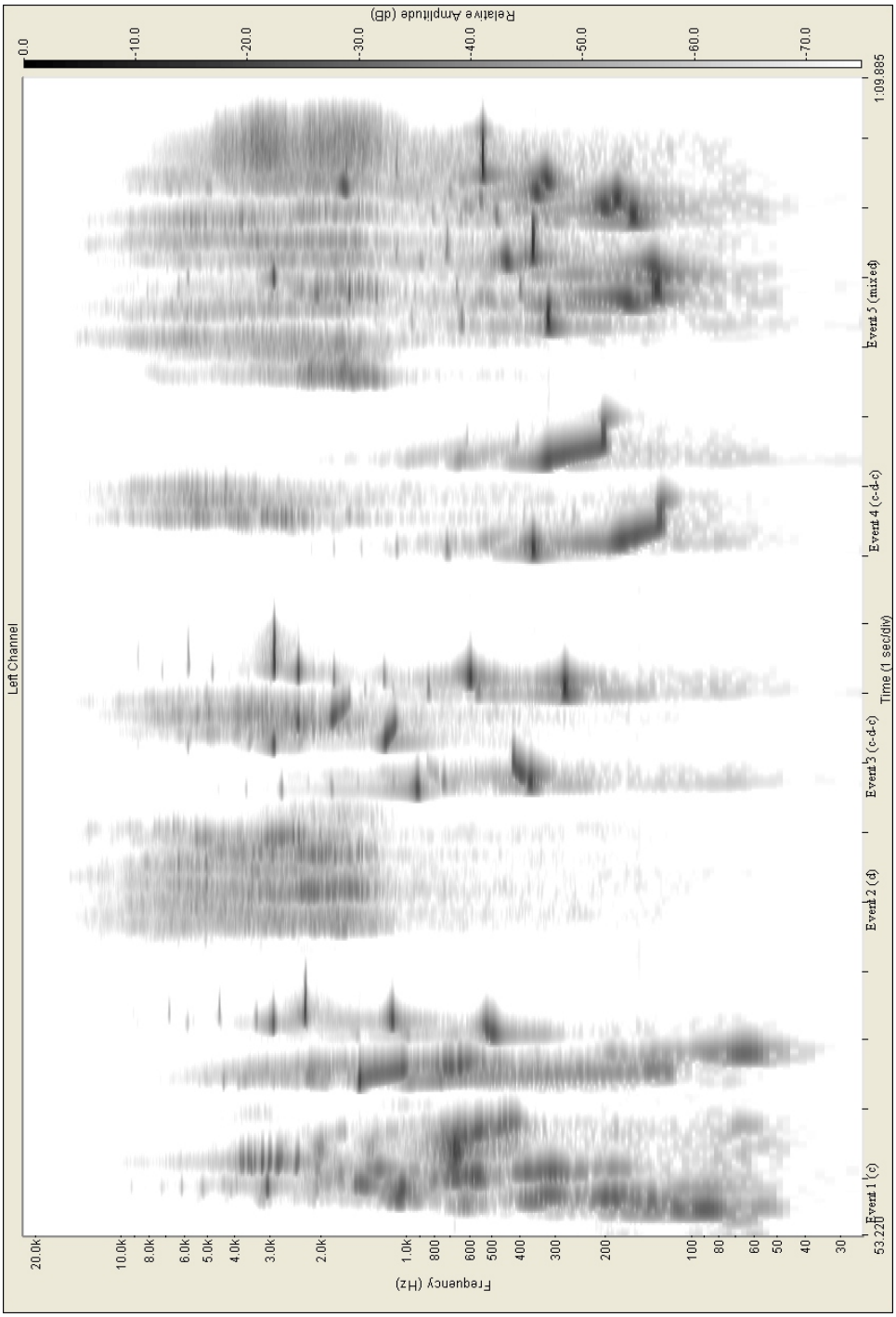

Figure 3.12. Spectrograph of Region F

Region F														
			1	2	3	4	5			start	end	duration
									F1	53.6	57.1	3.5
	grave	accute	0	1	0	0	0		F2	57.7	59.6	1.9
	centered	extreme	1	1	1	1	1		F3	59.6	62.6	3
	narrow	wide	1	-1	1	1	1		F4	63.1	65.6	2.5
	compact	diffuse	-1	1	0	0	0		F5	65.6	70	4.4
	soft	loud	0	0	0	0	0					
	level	oblique	-1	-1	-1	-1	-1					
	no-attack	attack	0	0	0	0	0					
	sustained	clipped	0	-1	0	0	1					
	reverb	dry	0	0	0	0	0					
				d4	d4	d0	d0					

Table 3.10. Table of Oppositions for Region F

the average length of previous events, and the time span of the entirety of the materials' interaction corresponds to the length of a typical region.

Spatial Location

As shown in Figure 3.12, the stereo version of the piece realizes all of these events in the left channel, in the quad version, however, the noises were in the left channel and the pitches in the back. Considering the quad version and the problems of reducing this to stereo, one should note that this is the first time that an extended dialogue has taken place in channels that are not diametrically opposed to one another. Since this region itself is a dialogue (rather than the dialogue between entire regions, as found between A and B), it also has the most frequent change between the channels yet heard, and represents a considerable development towards more active spatial motion. While this spatial activity is not rendered as such in the stereo version, the new development of having two sides of a dialogue in one channel conveys a similarly profound shift in the use of channel separation.

Coordination of Sonic Materials (compact vs. diffuse)

A number of factors aid the streaming of compact and diffuse materials into polyphonic streams; these factors include rhythmic coordination of streams and the internal consistency within each stream. Despite the more frequent exchanges between sides of the dialogue, it remains fairly well ordered and balanced between the two types of material. After the first event, a clear alternation can be seen, where most of the events of one type (labeled c for compact, d for diffuse in Figure 3.12) fall in the rests of the other, thus aiding their perception as separate elements.

Based on the precedent of Regions D and E, we might expect a region which, after an initial event or two, is abruptly transformed into something new, but Region F is novel in that it changes back and forth multiple times between two types of material, and that these types of material are, in themselves, relatively consistent–showing only slight changes in register and rhythm, but never compromising the extremes of the compact/diffuse dimension. This also aids the division of these materials into concurrent streams as the two types overlap more extensively towards the end of the region. While the discrete pitches in this region show a downward trend (Events 1 and 3 being mostly in the middle to high register, and those of the last two events being middle to low) the noises settle in the upper register.

Global Trend of Region F

Region F shows an acceleration in attack density, and in the speed at which the sides of the dialogue alternate, and thus continues the trend toward greater density present in previous regions. The first pitch based event lasts from 53.6" to 57.0", followed by a noise event from 57.7" to 59.6". The next two events take about the same duration (Event 3, 59.6"-1'02.7", Event 4, 1'03.1"-1'05.4") but each changes from pitch to noise, and back within its span. Event 5 (1'05.5-1'10.0") after beginning with a high noise element, contains both noise and pitched elements throughout its span alternating attacks very quickly. This, combined with the cognitive perception of two materials coexisting with different registral trends, creates a substantially more complex texture, and one which is an important precedent to what happens through the rest of the piece.

Conclusions (Stage I)

Thus, at the end of the first stage of the piece, two things have been accomplished, corresponding to the two phases of Stage I. First, the opening regions establish trends towards higher, denser, and louder sounds; these regions also establish the primacy of channel separation as a factor in determining the boundaries of regions. The regions of Phase 2 begin to elaborate and even to break down these trends. These regions do not always have the clear registral motions that the first did, and the other oppositions which were initially coordinated begin to divest themselves from this established progression towards accelerated activity and begin to present material which is varied or transforms itself in other ways through the course of a region. Furthermore, while the overlapping of Regions C and D, and later between E and F, does not present any conceptual obstacle to hearing the differences between these regions, it does set a precedent which will be taken up in the transition. Finally, Region F presents two distinct types of material which alternate, building on the idea of increased internal differentiation between sonic materials, and presenting the possibility of a dialogue within a single region.

Stage II

The transitional Stage II can also be considered in two phases, although here the change from Phase 1 to Phase 2 is a smoother process than in Stage I. The first phase of the Transition accomplishes two objectives. It first focuses on a number of gestures which change continuously, rather than discretely. These pave the way for a significant departure from previous use of spatial distribution by having Region G move continuously

between channels, most evident at 1'33" (see Figure 3.13) where material fades out of the right channel and into the left. This aides the second objective of Phase 1, the establishment of a polyphony between overlapping regions. Region H enters in this newly opened space at 1'42", and continues the motion towards increasing density that Ligeti establishes in Stage I.

The second phase begins as Region J replaces Region G in the left channel and continues this polyphony, working, as Phase 2 of Stage I did, to introduce more diverse materials. The materials of Region J transform very quickly from compact to diffuse as well as in other dimensions, and thus accelerate the trend towards internal diversification within one strand of this polyphony. Meanwhile the other strand (the continuation of Region H) is cast in a new light as the number of associations between these originally distinct regions increases–a process which can be viewed as an example of what Ligeti terms "amalgamation" in the description of the piece quoted at the beginning of this analysis.

Region G, Phase 1, general features

The continuous streaming of concurrent regions into this polyphony requires that the sound types within each strand remain fairly homogenous, this is also true if the listener is to perceive the transfer of one region's material from one channel to another, especially with the precedents set by Stage I, where regions alternated regularly between the right and left. By examining the spectrograph of the entire region (Figure 3.14); we can see that Region G is very consistent in its use of compact materials and oblique,

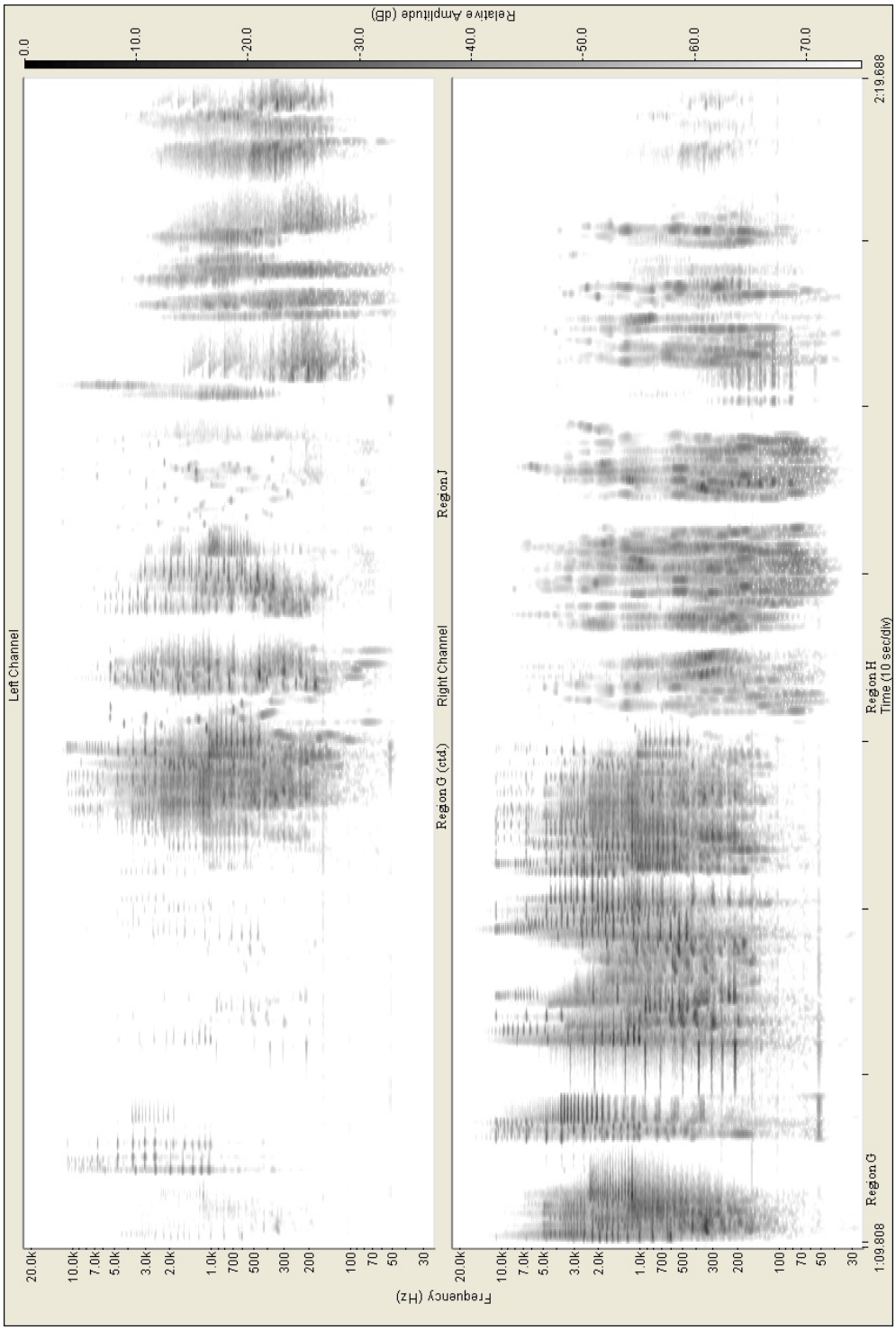

Figure 3.13. Spectrograph of Phase II

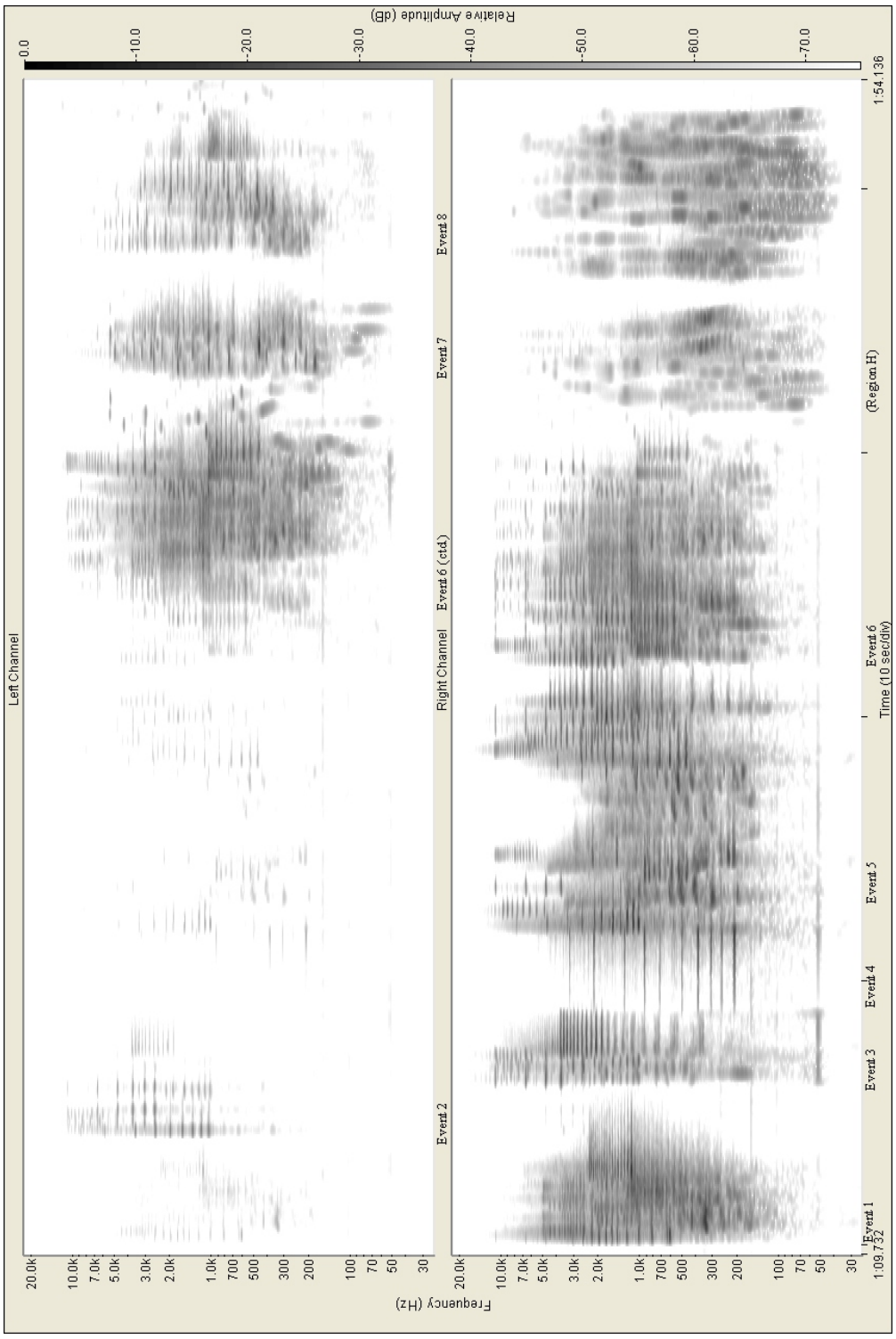

Figure 3.14. Spectrograph of Region G, All Events

Region G										
			1	2	3	4	5	6	7	8
	grave	accute	0	1	0	0	0	0	0	0
	centered	extreme	1	1	1	-1	1	1	-1	-1
	narrow	wide	1	-1	1	-1	1	1	1	0
	compact	diffuse	-1	-1	-1	-1	-1	-1	-1	-1
	nonspaced	spaced	-1	1	-1	1	-1	-1	-1	-1
	sparse	rich	1	-1	1	-1	1	1	1	1
	soft	loud	1	-1	0	1	1	1	1	1
	level	oblique	-1	-1	-1	-1	0	0	0	0
	no-attack	attack	1	0	0	-1	1	1	1	1
	sustained	clipped	1	-1	1	-1	0	0	0	0
	reverb	dry	0	0	0	0	0	0	0	0
				d7	d6	d7	d7	d0	d1	d1

	start	end	duration		
G1	70.4	74.5	4.1		
G2	74.5	76.3	1.8		
G3	76.3	79.4	3.1		
G4	79.4	82.1	2.7	11.7	total G1-4
G5	82.1	92.2	10.1		
G6	92.2	103	10.8		
G7	103.3	106.8	3.5		
G8	107.9	113.3	5.4		

Table 3.11. Table of Oppositions for Region G

gestures filled with glissandi. These range over a very wide range from 60 - 15,000 Hz, though in various densities, and occasionally retreating to a more centered range. Furthermore, these remain consistent for nearly 43 seconds, making Region G one of the longest regions in the piece. In its employment of consistent materials for a long period of time while Stage I moved towards more evenly interspersed dialogues, Region G certainly breaks the trends which Stage I established, and leaves the continuation of the piece open to further development along those lines. These relatively consistent features are summarized in Figure 3.14 and Table 3.11, above.

The initial spectra (events 1-4) are the most diverse, existing in a sparser texture than the events which follow; I will address these events first, as they create an interesting set. I will also group together events 5 and 6, which are much denser and begin to expand from their spatial positions, and finally I will address events 7 and 8, which begin to prepare Phase 2 of the Transition. After this I will go back to the beginning of Region H, a region that is internally consistent, yet contrasting from Region G, and which can, on account of this contrast, overlaps with the final events (7 and 8) of Region G.

While consistent in their basic sonic material, the events of Region G are far from static, in fact they begin to highlight the differences between discrete and continuous types of internal transformation. As mentioned, one of the consistent features of Region G is its use of compact formant strands which are–at least initially–often held for long durations. These narrow formants define their registers more precisely than noises, which are somewhat more nebulous, and these pitch-based events, being easier to identify with precision, facilitate a number of significant gestures, including glissandi in both directions

and very clear dynamic gestures–crescendi and diminuendi, as well as two types of spatial motion. Beginning with a sharp attack and rich, closely-spaced partials, G's first event makes a striking entrance; this sharp attack also allows focus on a dynamic gesture--the diminuendo of the partials dying out. Event 4, which enters at 1'19", stands out for a number of reasons and makes a similar distinction in dynamic quality. While the two intervening events have come in at discretely different dynamic levels, Event 4 answers the decay of Event 1's attack with a dramatic crescendo. The wide spacing of its formant strands and relatively uncluttered texture allow the clear perception of this single event's crescendo, as opposed to a crescendo brought about by the accumulation of many different events. These two events seem particularly designed to call attention to smooth changes in dynamics, an analogous situation to the more familiar distinction between a glissing pitch and two steady pitches.

The intervening events (Events 2 and 3) are clearly identifiable as events of Region G; like Event 1, both have "bell-tone" sounds with clear attacks and non-harmonic partials. These events use this clearly consistent character traits to ensure a sense of continuity, despite the idiosyncratic spatial location of Event 2, which occurs in the left channel (see Figure 3.15). This change in location foreshadows a more significant move later in the region, and highlights a distinction in types of motion–while the level spectra of Events 1 and 2 move discretely back and forth between channels, later events will move in a more smooth, continuous way.

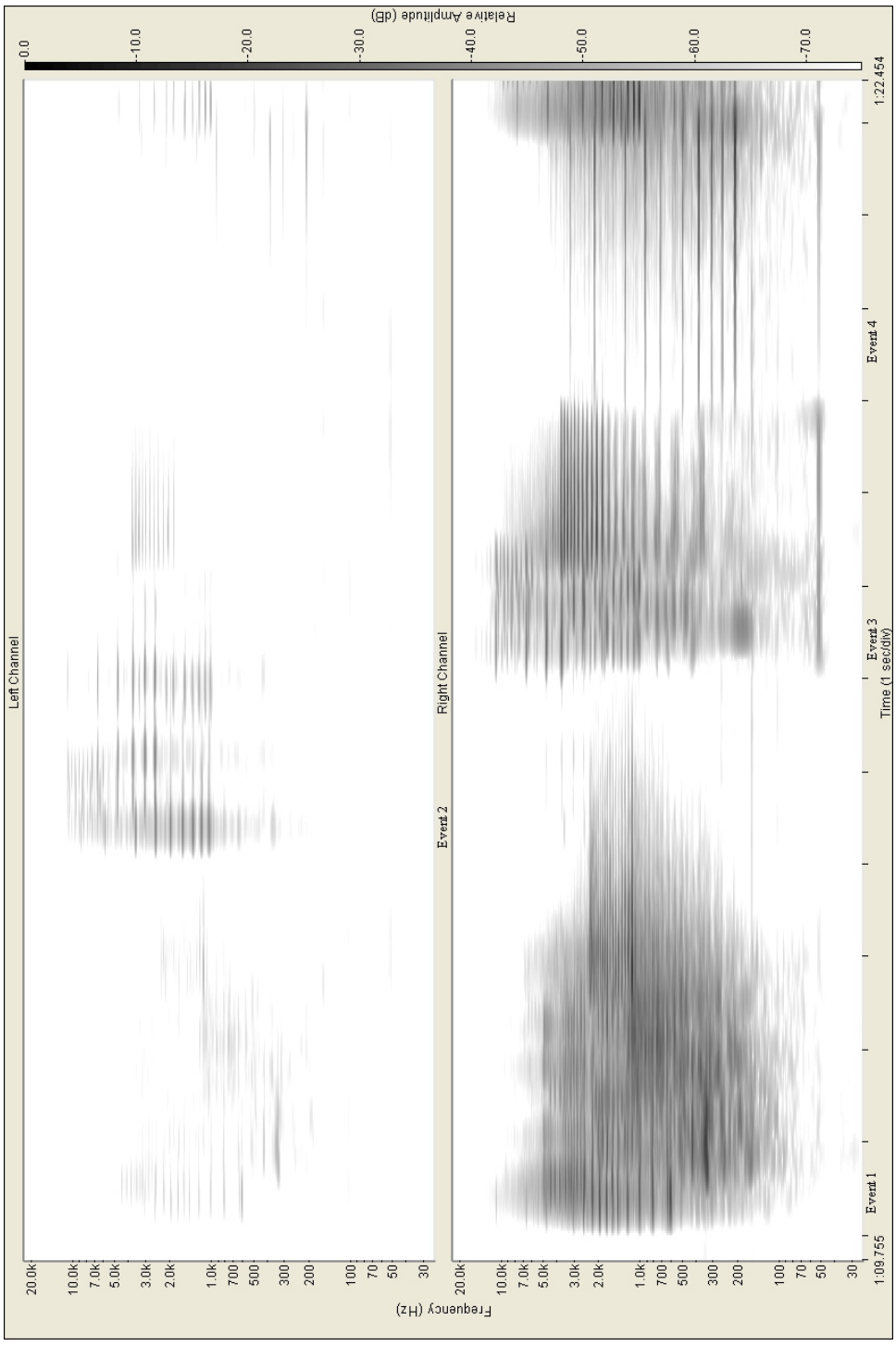

Figure 3.15. Spectrograph of Region G, Events 1-4

The remainder of Region G is largely devoted to the completion of this motion. Event 5 (shown below in Figure 3.16) begins another crescendo, now amplified by an acceleration of attack points building a much denser texture of more mixed level-oblique events (and it is worth noting the distinction here between a crescendo internal to an event, and one made by the accumulation of events). While the stereo rendition of the piece does not adjust the channel, in the original quad version this motion traveled from the right channel to the back, and then swept back through the right. The increase in reverberation through this event, and the distancing effect that reverb can have may be an attempt to emulate a change in channel here. The move is also paired with a temporary retreat from the highest register, linking, perhaps the lower register with the back channel.

Then at about 1'33", the beginning of Event 6, Ligeti begins to shift the sounds smoothly from the right channel to the left, by carefully fading out one channel while the same material fades into the other channel creating a kind of glissando in space, and also analagous to the role of the dynamic gestures discussed above. This is a new development, and a very significant one. Previously spatial distribution was a primary category for separating regions and events, and no regions existed in more than one channel; here, however, the similarities in sound material assert a single identity across all available channels.

While the initial events of Region G required coordinated attacks to create gestures, in the final events of the region, this coordination begins to break these spectra down into more isolated pitches, and in doing so prepares the way for more dramatic changes in Region J. This last part of Region G and the transition to Region J are shown

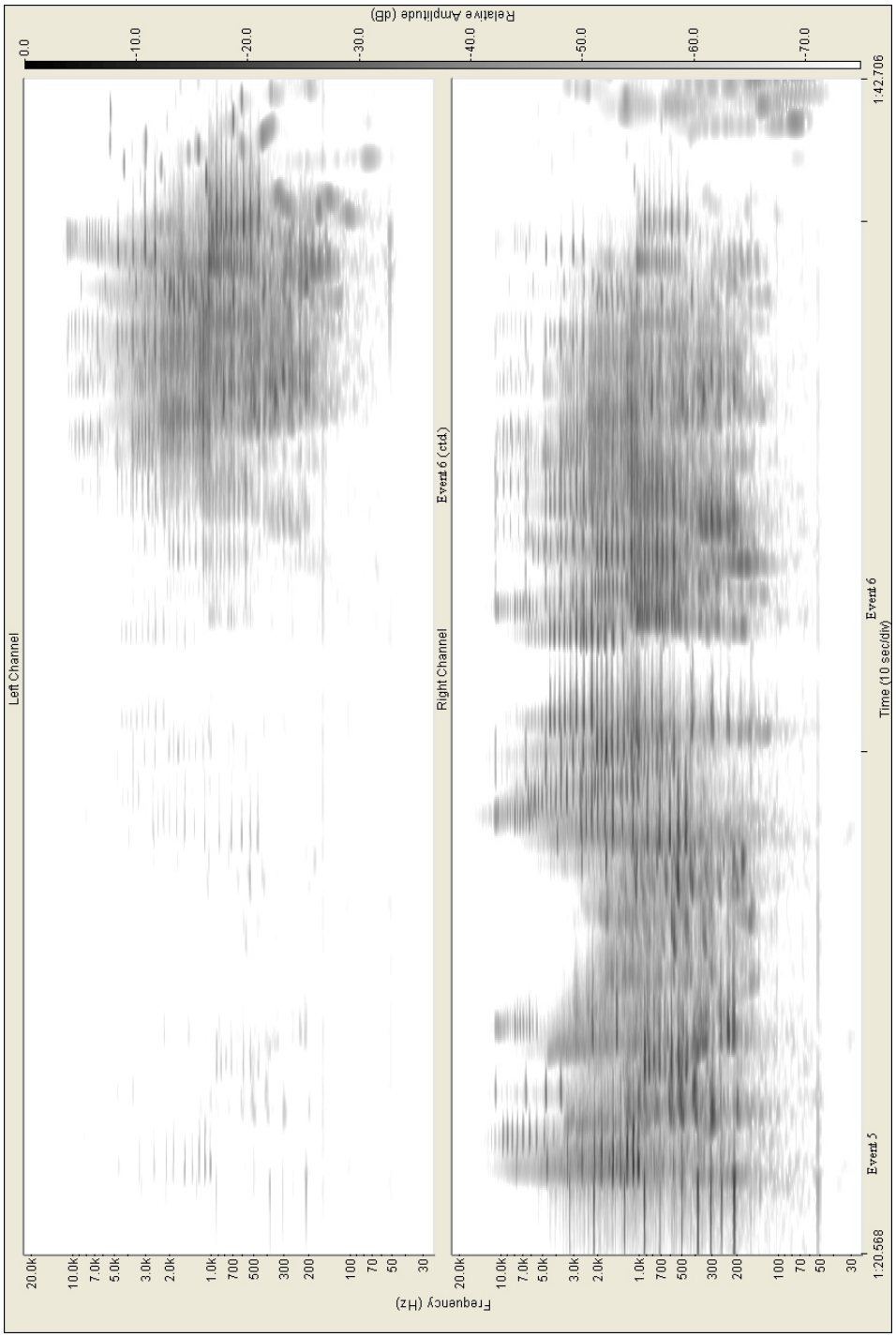

Figure 3.16. Spectrograph of Region G, Events 5, 6

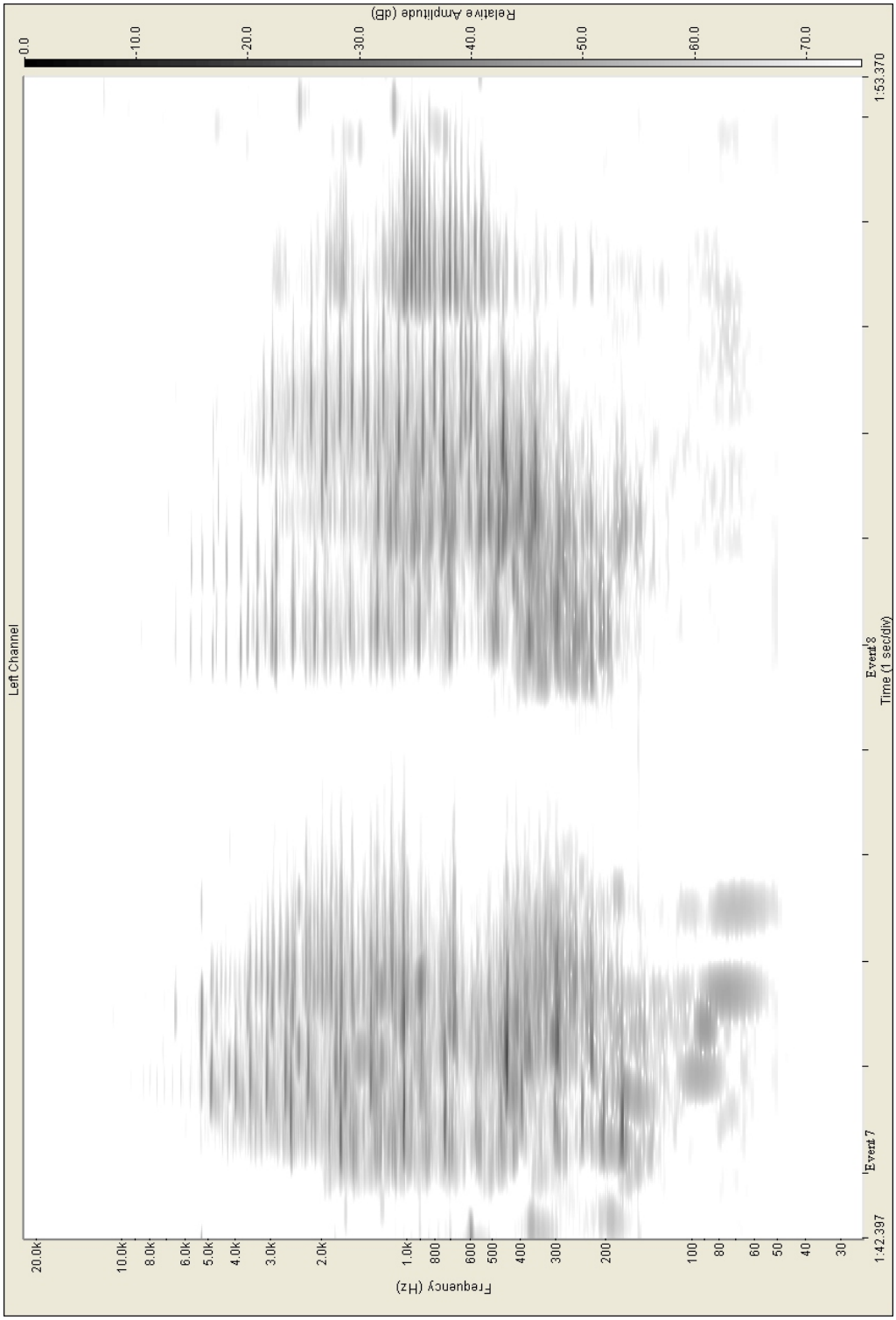

Figure 3.17. Spectrograph of Region G, Events 7, 8

in detail in Figure 3.18. At the end of Event 6, there are lingering pitches which are not part of any coordinated spectra. It is as if the individual formant strands have become separated from the group, now with individual attacks. While these descend by over an octave in register, from 10,642 to 5,188 Hz, the individual strands still occupy a wide range with similar material, nevertheless, the "bell-tone" effects, as well as the dramatic crescendi and decrescendi heard earlier in the region require more coordinated attacks, and thus the lack of coordination heard here is quite noticeable.

Event 7 occupies the same range as the end of Event 6, but returns to the familiar, more coordinated, attacks and thus highlights the contrast between it at the first event of Region H (discussed below). This contrast continues through Event 8 which is longer and has three separate coordinated attacks from 1'47" to 1'53" before trailing off into softer uncoordinated attacks for the last 7 seconds of the region. This dissolution happens, then, in stages first the end of Event 6 trails off, with a few lingering pitches, an adumbration, but hardly extraordinary on their own, especially following the dramatic channel transfer with which the bulk of Event 6 is occupied. Event 7 then returns to the more characteristic attacks, as does the beginning of Event 8. Event 8's continuation, however, is much more extended than the lingering pitches ending Event 6, and begins to push apart as the beginning of something new–preparation of Region J and Phase 2 of the Transition.

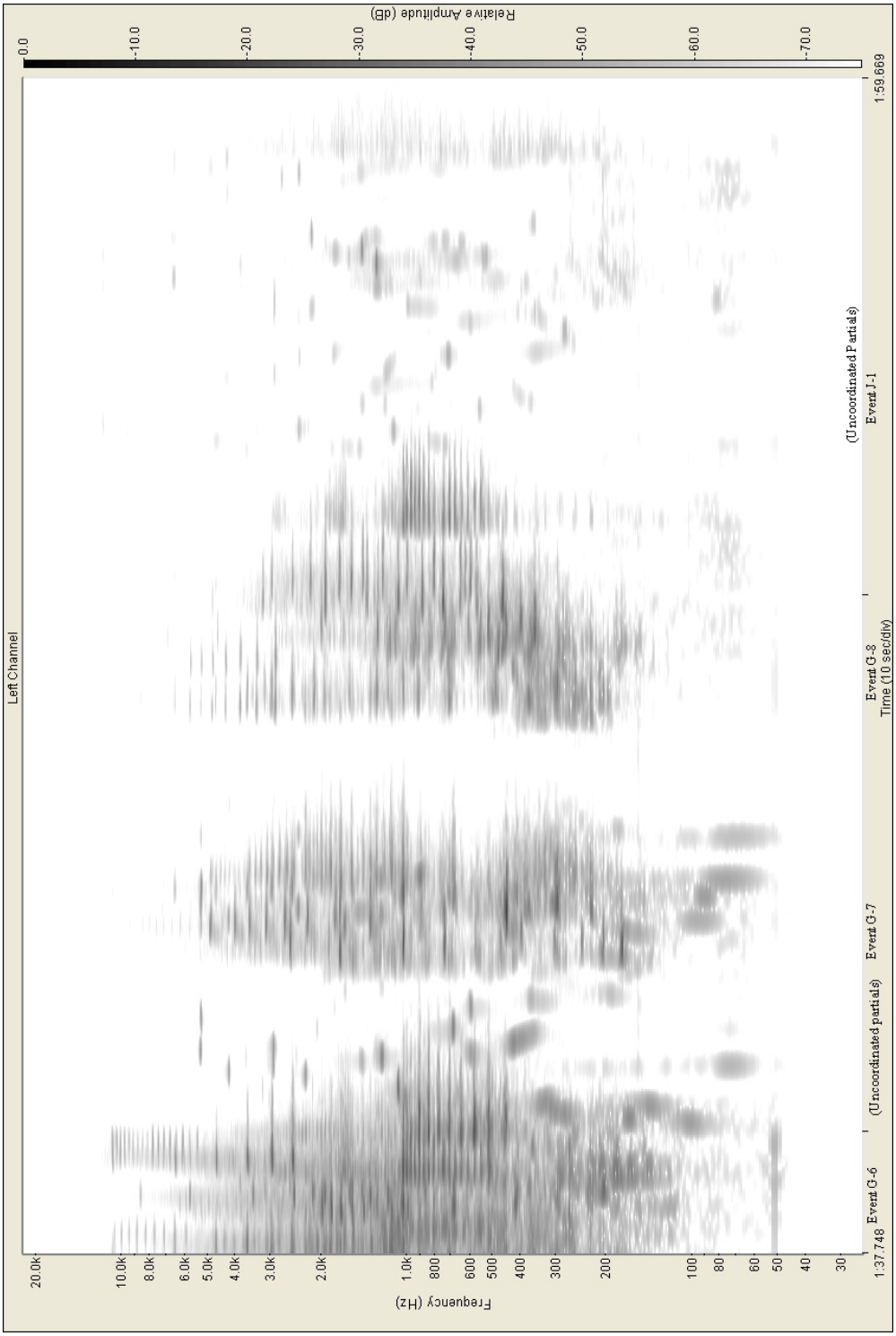

Figure 3.18. Spectrograph of Transition from Region G to Region J

Region H

Region H, General Features

As the piece continues to increase the amount of overlapping between regions, it does so on a larger scale. The events of Region H enter in the right channel at about 1'42", taking immediate advantage of the space left by the channel transfer of Region G. Region H is another long (30 second) stretch of relatively consistent sonic character, and includes two large events which overlap with Region G for a span of over 10 seconds from 1'42"-1'53"; this length and consistency is really required to balance the weight of Region G and is necessary for Region H to operate as an equal partner in the newly emerging polyphony. After the weakening of the power of channel separation to define regions, Region H's events must be consistent to each other and maximally contrasting with continuation of Region G to establish a new region rather than a return of Region G's material to its original channel. These events are largely impulses, containing a mixture of pitch and noise and moving in clouds of rapid succession over a wide register from 65 to 4810 Hz, though the loudest impulses seldom occur above 3,000 Hz. Region G's spectra concurrently range up to 6,000 Hz, with much stronger elements situated higher in the spectrum. They are, also, in contrast to Region G, generally soft and without reverberation. Furthermore while the sustained sounds of Region G allow for dynamic gestures and glissandi, the elements of Region H are short, never longer than about .6 seconds and clipped.

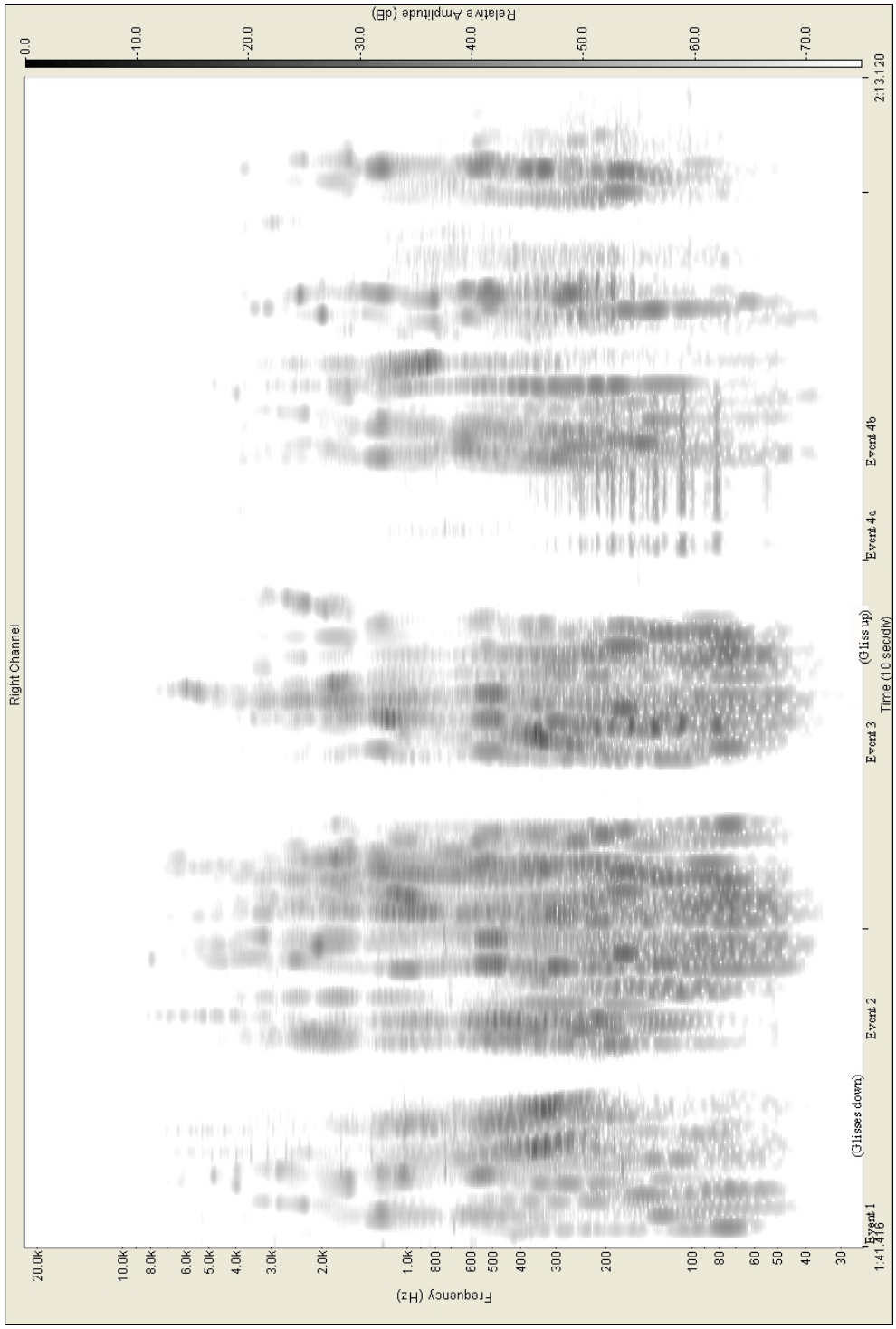

Figure 3.19. Spectrograph of Region H

Region H

		1	2	3	4a	4b
grave	accute	0	0	0	-1	0
centered	extreme	-1	-1	-1	1	-1
narrow	wide	1	1	1	-1	1
compact	diffuse	0	0	0	-1	0
soft	loud	-1	-1	-1	-1	-1
level	oblique	-1	-1	-1	-1	-1
no-attack	attack	0	0	0	0	0
sustained	clipped	1	1	1	0	1
reverb	dry	1	1	1	1	1
		d0	d0	d5	d5	

	start	end	duration
H1	102	105.9	3.9
H2	106.9	113.5	6.6
H3	114.8	119.7	4.9
H4a	120.5	122.8	2.3
H4b	122.8	132.2	9.4

Table 3.12. Table of Oppositions for Region H

Patterning within Region H

Globally, the characteristic clouds of impulses set Region H apart from Region G–but individual elements do suggest some interaction between the two contrasting regions. While G clearly presented both level and oblique elements, some of the gestures in Region H contain impulses that are registrally arranged to suggest a definite motion. This is particularly evident in the first and third events. The elements labeled "gliss." in Figure 3.19 consist of a number of compact and diffuse impulses arranged in ascending or descending order and proceeding so quickly that they come to sound almost like a dissevered glissando. The first event ends with a pair of downward gestures with a strong presence from 358-268 Hz; the third event ends with a glissando trailing upwards to around 2627 Hz. This kind of a glissando suggests not only that are there states of mixture between the oppositional sound characteristics, which can be set against each other in stark contrast only to meld back and forth from one to another, but that even the categories of discrete and continuous internal transformation, which Region G presented in clear contrast, are themselves subject to the same sort of dialectical questioning and deconstruction into resulting states of mixture.

Stage II, Phase 2, Regions H and J:

Region J

While the sounds of Region H continue in the right channel, the left channel's sounds segue from Region G directly into Region J. Much of Region J can be understood as preserving the glissando-like gestures of Region G while transforming the typical

pitched sound of harmonic and sub-harmonic spectra into more noise-based events. The general dynamic level and density of Region J, however, is much less than that which occurred in the bulk of Region G–resembling more closely the initial events of the previous region. See Figure 3.20 and Table 3.13, below.

Transition from Region G to Region J

The transition from Region G to J is well prepared, and a number of factors make this change quite smooth; at the most basic level, the absence of a dividing rest and the continually decreasing dynamic level suggests this. Once the channel transfer of Region G, Event 6 is complete, the final events (7 and 8) of Region G form a large decrescendo, and the new region sneaks in quietly at the low point of this diminuendo. Event G-6 also ends with a number of elements–single sine tones, no longer grouped into spectra–which linger on after the bulk of the sounds abate. When the final event of Region G ends, more of these single pitched sounds occur, but now they enter after a slight pause, and thus in a different role, not as the end of an event, but as independent of the spectra and marking the start of the new region.

Region J–overview

As Region J continues, it goes through a number of different types of sound material, itself, though Ligeti generally keeps at least one sonic characteristic in common between events to ensure some continuity. In particular the rate at which compact and diffuse sounds exchange positions surpasses anything in the piece so far, yet in doing so calls forth a number of associations to other regions. I will divide this region into three events based on rests as well as long durations with significant diminuendi, and I will

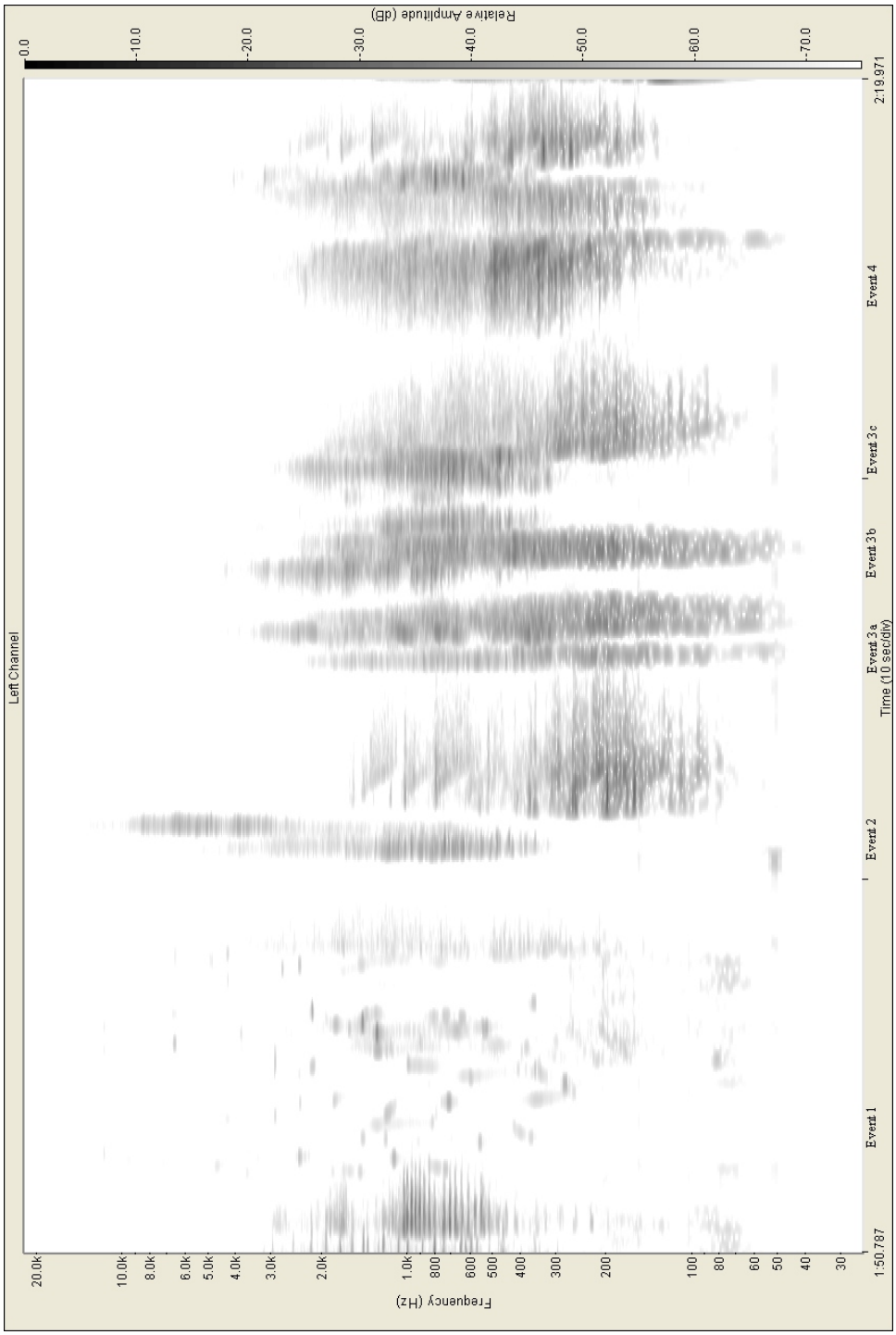

Figure 3.20. Spectrograph of Region J

Region J													
		1a	1b	2	3a	3b	3c	4			start	end	duration
grave	accute	0	0	1	0	0	0	0		J1a	113.3	118.4	5.1
centered	extreme	-1	-1	1	-1	-1	-1	-1		J1b	118.4	120.9	2.5
narrow	wide	0	0	1	0	0	0	0		J2	120.9	125.6	4.7
compact	diffuse	-1	1	0	1	1	1	0		J3a	125.6	127.5	1.9
soft	loud	-1	-1	0	0	0	0	0		J3b	127.5	129.8	2.3
level	oblique	-1	-1	0	-1	-1	1	0		J3c	129.8	133.5	3.7
no-attack	attack	-1	1	1	1	0	0	1		J4	134.3	140.2	5.9
sustained	clipped	1	0	0	0	0	-1	0					
reverb	dry	0	0	-1	1	1	-1	0					
			d3	d7	d6	d1	d3	d5					

Table 3.13. Table of Oppositions for Region J

further subdivide Event 3 into 3 parts, labeled a, b, and c in the spectrograph above. Since the sound characteristics of Region J are quite different from event to event, I will first describe the events in order and then provide a chart summarizing their sonic oppositions and interactions.

Event 1

The first event is somewhat unique in its use of pure sine tones and noise in clear contrast–the later events will begin to break down this opposition. The soft pitches of these initial events, which resembled Region G, are cut off by a noisy sound, similarly soft and contiguously sounding, but clearly much more diffuse. There are, in this noise, a few prominent partials (those at 746 and 1649 Hz) visible in the spectrograph, but for a short sound with such closely spaced partials, and in such immediate contrast to the previous sine tones, this event moves abruptly from pitch to noise.

Event 2

The events which follow begin a series of curious transformations from compact to diffuse. Event 2 enters at 2'01" with two short noises, followed immediately by a low pitch based glissando. This event returns to the mid-high-low contour familiar from earlier–its rhythmic contour, short-short-long, and the presence of a final glissing element are particularly reminiscent of the first two events of Region D. Simultaneously this event has more immediate resonances in as it reverses the compact/diffuse profile of Event 1 moving from noise back to pitch; while Event 1's pitches trailed upwards, Event 2 trails downwards providing registral contrast as well. The final oblique element of Event 2 does mediate some of the difference between noise and pitch; it has clear partials at

approximately 157, 196, and 253 Hz, using a difference of about 50 Hz, making it reminiscent of the harmonic spectra used in Region G. There are also fainter partials at 287, 354, 402, and 544, extending the harmonic series upwards. The slightly detuned nature of these partials adds a harsh quality to the compact materials, and helps bridge some of the gap between pure noises and tones, and does so in a way different from the impulses used previously.

The remainder of Region J is made of noises which gliss and use prominent crescendos and decrescendos; as pitch based events, these were hallmarks of Region G, but now they are used with noises. This creates a similarity between the two passages, based on gestures moving only in terms of registral space and dynamics, and in Event 3, these come in various combinations, creating a variety of associations and points of contrast with each other.

Event 3

Event 3a has no clear registral profile, although the middle is clearly higher and has more pitch components than the diffuse beginning and ending. Event 3b has a profile of high-low-middle, and event 3c trends downwards in two parts, much like Event 2 did.

While Event 3a's middle is compact, Event's 3b and 3c begin with diffuse elements and end more compact. It is worth noting that the initial element of Event 3b is only moderately diffuse with some more compact formants especially around 808 and 1604 Hz, though these are not exact sine tones and gives this element more of a hollow sound than that of any specific pitch.

Dynamic gestures form similarly complex interconnections. Event 3a crescendos to its compact element, while 3b and 3c crescendo with their initial diffuse elements and decrescendo at the compact conclusions. This relationship also holds for the direction of compact glissandi–3a's initial crescendo is paired with a rising gliss, while the compact glissandi that end 3b and 3c trail downwards. These relationships are summarized above in the Table of Oppositions (Table 3.13) and on the annotations to the spectrograph in Figure 3.20.

Event 4

There are a number of connections between Event 4 and Event 3c, though a relatively long rest gives a clear indication of a new event. Event 4 also runs from diffuse to compact, crescendoing through the diffuse areas and introducing the compact, downward glissing elements with an attack-and-decrescendo pattern. It is significant that Ligeti returns to the use of pitch-based glissandi to end this Region, and the Transition, at 2'18" (the golden mean of the piece); this reverses the relationship of the sounds which began Region J, where pitch based material was cut off by noises and suggests an increased flexibility in the handling of compact and diffuse materials.

Coordination of Regions H and J

As mentioned above, Regions H and J form a polyphony, yet one quite different from that between Regions G and H. While the initial regions merely maintained their contrasting states, Regions H and J interact more dynamically, playing off of each others' gestures while still retaining their independence.

One such point of interaction occurs as Region G dissolves into the uncoordinated attacks of Event J-1. The sustained spectra of the early events of Region G transform into dense, continuous, clouds of spectra, which in turn give way to the scattered, clipped pitches of J-1. With this change, one of the major distinctions between the sustained or moderately sustained events of Region G and clipped events of Region H is removed. Thus the starting point of Region J is already significantly closer to that of Region H in this dimension. A notable pause in Region H occurs at the onset of this new development, calling attention to the soft, scattered, sine tones in the nascent Region J. Since these attacks are more similar to Region H's they could be lost–overpowered by the louder events of the right channel–if Ligeti did not allow for this initial space. Furthermore, when Region H reenters, we hear the similarity in the clipped, level elements and must reinterpret the same material in a new context.

There is a similar point of interaction at the noisy ending of Event J-1, the point where noise and pitch exchange in Region J is most abrupt. The dissevered glissando at the end of H-3 follows immediately. This seemingly oblique point in Region H is made of level impulses, which help moderate the forthcoming exchanges between pitch and noise, and also help prepare the glissandi which persist in the other channel.

Event H4 also contains points of interaction with Region J. The anomalous low pitched sound (H4a) plays off of event J2. It surrounds the first, diffuse, element of J2, highlighting this sound as a noise when heard against the harmonic spectrum. There is also a clear contrast in registers as H4a occupies the space between 80 and 240 Hz. and J2's first element has its lowest partial at 353 Hz. These contrasts are then seemingly

synthesized by Event J2's final element, which, while consistent with the channel of Region J, and completing the mid-high-low contour mentioned above, also dips down into the range of previously occupied by Event H4a, and uses pitch-based spectra closer to those of H4a than to the noisier J2a.

Finally, the end of Event H4 contains a glissando, whose impulses are relatively diffuse and move quickly downward. This is followed immediately by Event J3, where the most dramatic exchanges of pitch and noise take place, and where the crescendoing and decrescendoing gestures are most frequent and most thoroughly mixed with glissandi. Once again the moderate state of Region H's event can be heard as mediating the contrasts in Region J. Furthermore, the glissando again brings together elements of the different regions. In particular the downward glissando which ends J3 can now be heard as recalling not only the downward gliss ending J2 (mentioned above in association with H4a), but also, more immediately, with the downward gliss of H4b which it follows directly.

Conclusions, Stage II

In Stage I, the first phase corresponded to the exposition of trends towards registral expansion, increase in volume, and acceleration and the second phase to an increase in internal diversification of regions. Stage II first presents clear changes in individual parameters–the glissing and crescendoing sounds of Region G, but quickly combines these in more complicated interactions. Stage I and Stage II, then, show global similarities, first focusing on motions within individual parameters, and then undercutting

the individual identities by incorporating these into denser textures which are also more internally diverse. Region G's move from the right to the left channel is particularly important in this regard as it diminishes the importance of channel separation in defining regions. While Region G asserts a single sonic character transferring across the channels and polyphonically paired with Region H, the segue to Region J further undercuts the distinct sides of this polyphony. The more dramatic exchanges between level and oblique, compact and diffuse, and dynamic gestures characteristic of Region J begin to resemble points in Region H, and thus, at points, another type of amalgamation seems to takes place–one which begins to unite distinct strands of polyphony into something which blends their two identities. By the end of the second phase, having both weakened the power of channel separation to define regions and blurred the line between changes internal and external to a region, the piece is set for the culmination of Ligeti's process of mixture, where the elements that were so clear at the beginning will almost completely lose their identities in an impenetrable mass of sound.

Stage III

After this point the cohesive unity of materials that characterized regions of Stage I has dissolved into regions which are either of a more mixed sonic character or which freely morph from one sonic pole to another; through the course of Stage III there is an increase in overlapping, which results in a clear accumulation of density. The segmentation of Stage III into phases, regions, and events is a more difficult process, and the presence of diverse materials within smaller subdivisions leaves room for some ambiguity. I divide

Stage III into three regions of one large phase, since they are different steps in the same process: a gradual accumulation of density, which is the culmination of the body of the piece (see Figure 3.21). Region K lasts from 2'20" to 2'36" and is characterized by shorter events often with intervening rests. Region L, characterized by longer, overlapping events, runs from 2'36" until the violent attack in both channels at 2'57" which begins Region M–a long span of dense activity, uninterrupted by rests. It is difficult to separate the regions by channel in Stage III, and particularly in Region L, there are interesting relationships between events in different channels, so to bring those out more clearly, the regions will now include events in both channels.

Region K

Region K has three events, divided by rests; I further divide these events into parts, where appropriate. In the first and third event, the parts indicate spatial distribution, and the second event is divided into three parts, the first initiated in the right channel, the second in the left, and the third being the continuation in the left channel, which entails a substantial shift in sonic character. As in Region J, discussion will proceed from event to event, with a summary chart towards the end.

Event 1: compact vs. diffuse. level vs. oblique, and register

Region K starts with a short event beginning with almost simultaneous attacks in each channel; this brevity and coordination unifies this as an event despite the differences in channel separation and also type of material. The left channel (Event 1a) uses rapid impulses spread through a wide register from around 40 to 3798 Hz, and with no definite

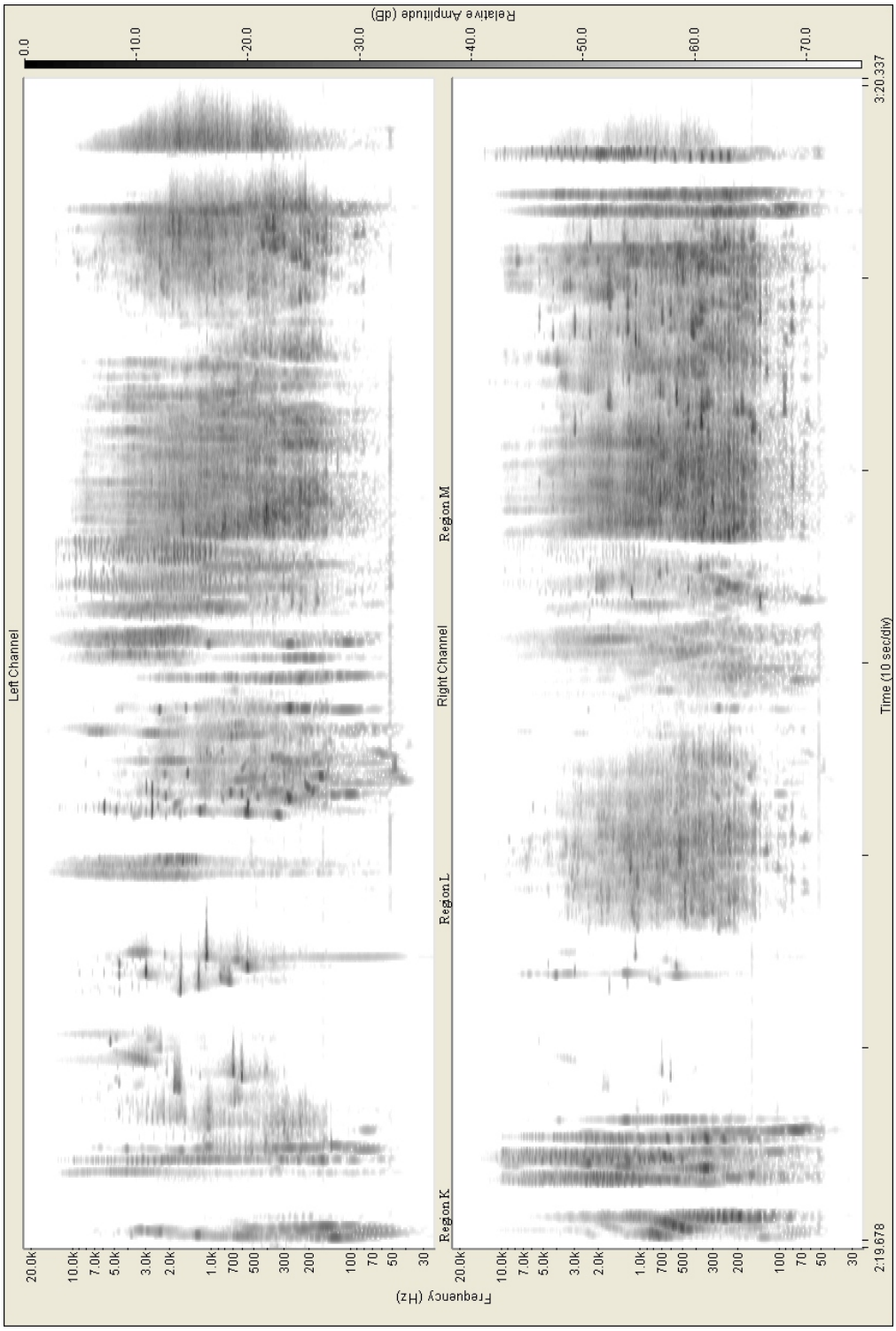

Figure 3.21. Spectrograph of Stage III

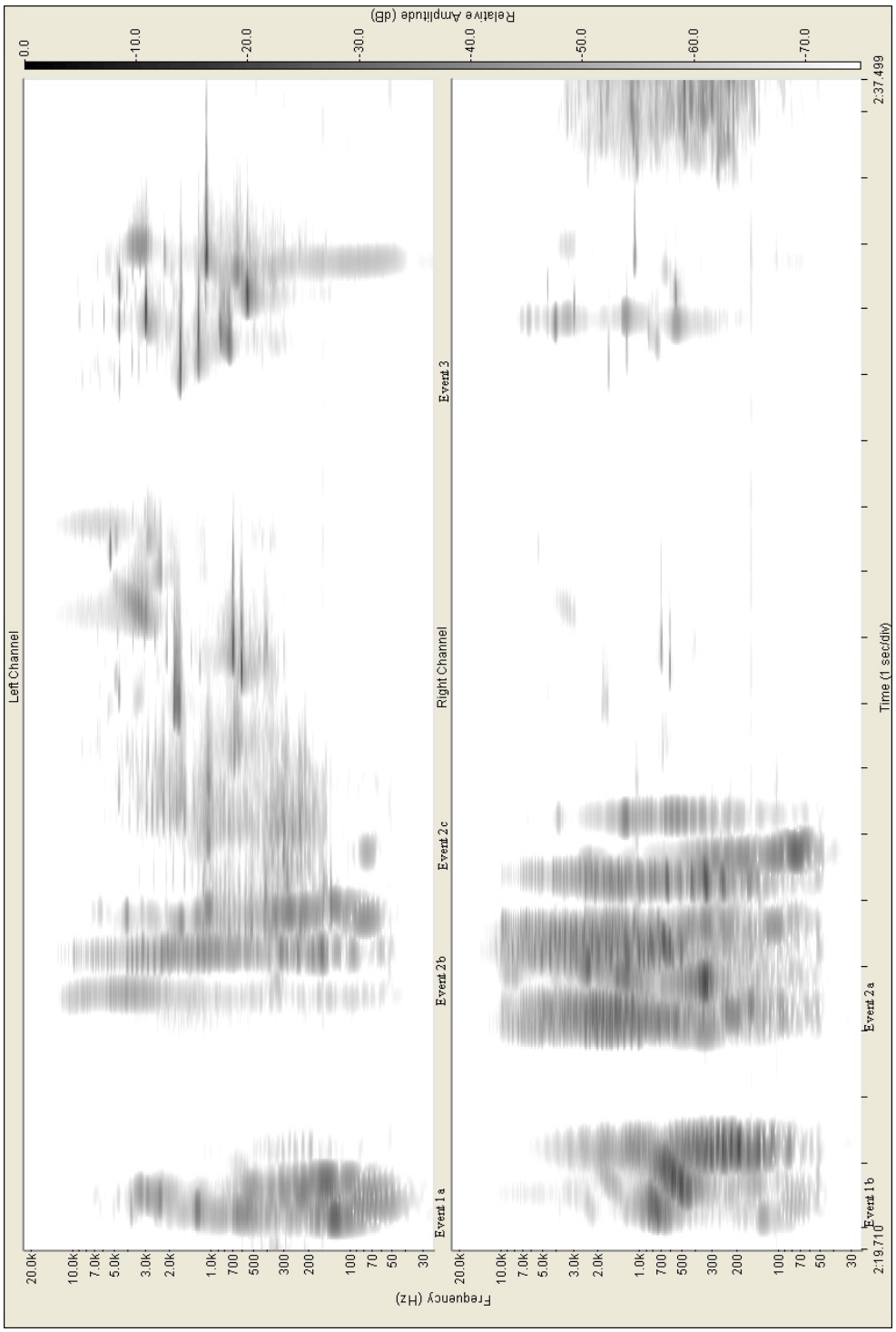

Figure 3.22. Spectrograph of Region K

Region K

		1a	1b	2a	2b	2c	3a	3b		start	end	duration	
		0	0	0	0	1	1	1	K1a	140.2	141.5	1.3	
grave	accute								K1b	140.3	142.1	1.8	
centered	extreme	-1	-1	-1	1	-1	-1	-1	K2a	143.1	147	3.9	
narrow	wide	1	1	1	1	0	0	0	K2b	143.6	146.3	2.7	
compact	diffuse	0	1	-1	1	-1	-1	0	K2c	146.3	151.3	5	
soft	loud	1	1	1	0	0	-1	-1	K3a	153.2	156.3	3.1	reverb longer but cut off by L
level	oblique	-1	1	-1	-1	0	0	0	K3b	153.8	154.7	0.9	
no-attack	attack	1	0	1	1	0	0	0					
sustained	clipped	1	1	1	0	-1	-1	1					
reverb	dry	1	1	1	0	-1	-1	1					
			d3	d3	d5	d8	d1	d3					

Table 3.14. Table of Oppositions for Region K

direction within this span. The right channel (originally the front channel) consists of three noises in a clear descent. The first two elements are downward glissandi of filtered noise and are accompanied by harmonic upper partials–a characteristic very similar to the beginning of Region E; the first element has a fundamental around 733 and upper partial resembling the third partial at 2195 Hz, and the second at 443 with a partial at 1445.

The last of these three right channel gestures is somewhat different in material, lower, with no harmonic partials, and level rather than oblique. It does, however seem naturally assimilated into the succession since it continues two trends. The first of these three gestures is the highest and glisses upwards the most quickly, the second, begins lower and glisses at a slower rate, and the third is the lowest, and, while actually not glissing, seems like a continuation of the flattening out of the two previous glissandi. Thus in the very short span of two seconds, we hear the transformation of oblique into level quite clearly–again sounding like a very compressed version of ideas in Region E. Region E began with two noise-based glissandi and continued with level but scattered material; here the descending noise glissandi and the scattered level impulses are presented together, but in opposite channels.

Event 2

The following events (Events 2 and 3) continue this trend towards mixture and transformation. Event 2 is quite diversely constructed; it begins with very richly constructed spectra, mixed with impulses to achieve a noisy sound, but moves to more widely spaced spectra and impulses at the end. Thus appearing to move along the spectrum from noise to pitch but doing this by altering richness and spacing of partials.

The overlapping sound in the left channel (labeled Event 2b-c) poses even more difficulties to clear segmentation. While it is a temporally connected unit it undergoes a dramatic shift from the beginning to the end, and its beginning and end states have vastly different sonic associations. The two beginning gestures of Event 2b (2'23"-2'24") are very dry and clipped, the first quite noisy and the second showing indications of more compact formant strands. This suggests a move from diffuse to compact, similar to what is happening concurrently in 2a. The emergence of compact formants continues in the gestures that follow. The pitch based gestures of 2c, however, suddenly switch from dry to reverberated, and from being coordinated spectra to being more free standing tones. Thus while the first two gestures are easily assimilated into Event 2a, concurrent in the right channel, 2c uses reverberation and channel separation to distinguish itself from the right channel's events. This reverberated sound looks forward to Event 3, which is, in fact, an almost identical sound to the final gestures of Event 2c.

Event 3

Event 3 stretches out from 2'33" to 2'37", and consists of heavily reverberated pitches, similar to those of Event 2c and also reminiscent of earlier reverberated pitches such as those of Region B. The longer, sustained pitches make a smooth transition into the events of Region L, which are, by and large, longer and begin to increase in density, continuing to build up material approaching Region M, which is the densest of the piece. The shorter events which interrupt these longer spans (Event K-3b and L-1b) create a similar rhythm which also helps connect the end of Region K to the beginning of L.

Region L

The sounds of Region L are no longer separated by rests as was the case in Region K, but rather, overlap extensively; therefore, delineation of events is based on other criteria such as entry of noise or pitch-based materials in different channels. I will divide Region L into 3 events, with subdivisions, again, to specify channel or to point to certain developments within the course of the event's span. Event 1 lasts until 2'47" in the right channel, overlapping with the onset of Event 2, which begins at 2'42" in the left. Event 3 is roughly coordinated between the channels beginning close to 2'49" in the right channel, and with the left channel following about a half second behind. Another important subdivision occurs at about 2'52.5" in the left channel and 2'53" in the right, when both channels begin to reintroduce distinctly pitched sounds into the texture. These divisions are shown in Figure 3.23

The first event of Region L lasting from 2'36"-2'47" in the right channel, is a large cloud of wet (i.e. reverberated) noise from which some pitches stand out, especially in the higher register. Other than these, the inner content of this is so dense and mixed, aided here by the heavy reverberation, that few individual features stand out from the mass; furthermore, the shape of the mass as a whole has a very distinct envelope, slowly fading in and then back out favoring its perception as a large gesture rather than a collection of smaller ones.

In this context, Event 1b stands out quite noticeably as being removed to the opposite channel (in the quad version, this was in the back channel, opposed to the front and right, containing Event 1a), more purely nosie, more heavily accented, dry, and also

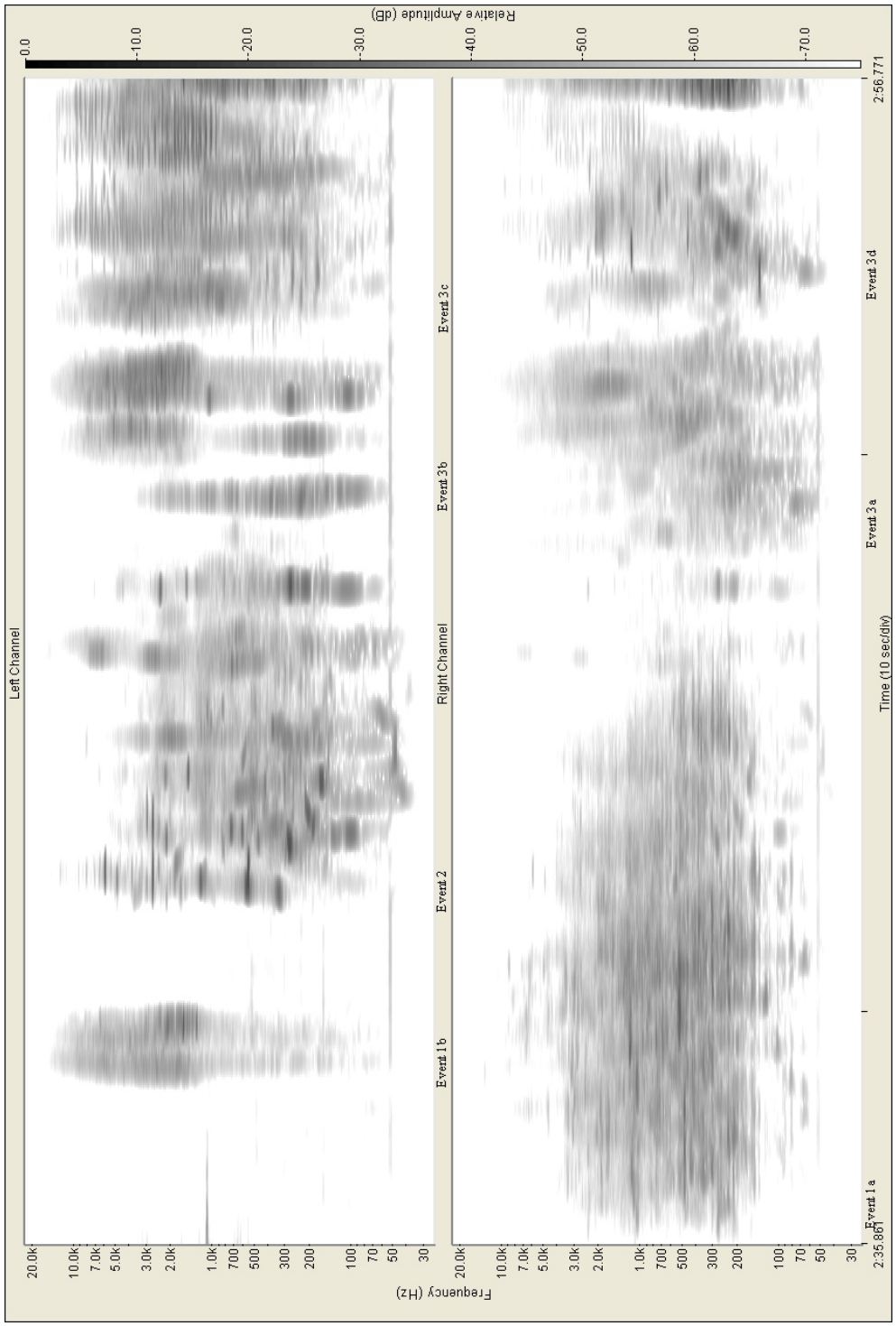

Figure 3.23. Spectrograph of Region L

Region L

		1a	1b		2	3a	3b	3c	3d			start	end	duration
		0		1	0	0	0	0	1		L1a	156.3	166.6	10.3
grave	accute										L1b	159	160.6	1.6
centered	extreme	0	0		0	0	0	0	0		L2	162.1	168.4	6.3
narrow	wide	0	0		0	0	0	0	1		L3a	166.6	172.4	5.8
compact	diffuse	0	1		0	1	1	0	0		L3b	169.3	172.7	3.4
soft	loud	0	1		1	0	0	0	0		L3c	172.7	176.8	4.1
level	oblique	-1	-1		-1	-1	-1	-1	0		L3d	172.4	176.7	4.3
no-attack	attack	-1	1		1	0	0	0	0					
sustained	clipped	0	0		0	0	0	0	0					
reverb	dry	-1	1		-1	1	1	-1	-1					
			d5		d3	d4	d0	d2	d3					

Table 3.15. Table of Oppositions for Region L

higher in register, extending up to nearly 12000 Hz, whereas the bulk of 1a is between 145 and 3333 Hz, with only occasional pitches reaching 8530 Hz. This is one of the last clear moments of such complete contrast.

When Event 2 enters, it has a very different effect from Event 1b, although it initially overlaps and contrasts with the continuation of 1a. Event 2 contains a mixture of spectra, sine tones, and impulses, covering a range closer to that of Event 1a, centered from 46 Hz, to around 2923 Hz, but with isolated elements occurring as high as 5767 Hz and later, 7442 Hz. Event 2 also begins wet–another connection with Event 1a. These initial connections are counteracted by more pronounced attacks than anything in Event 1a–attacks being a feature more associated with 1b. By 2'47", the contrasts increase as Event 2 has transformed into much drier noisier sounds. However at this point Event 1 has completely vanished and these contrasts are no longer contrapuntal, but could be interpreted as a transformation across channel and sound type.

In the left channel, this move from pitch to noisier sounds, and from wet to dry, is reversed in the third event. Event 3b begins as very dry noise, and 3c reintroduces pitches and reverberation. The level of attacks is held fairly constant throughout, however. Meanwhile in the right channel's 3a and 3d, the more gradual dynamic envelope (crescendo, decrescendo) still pervades, despite some more perceptible attacks, yet the same relationship between dry noise in 3a and wet pitch in 3d exists.

Thus there are several connections through Region L which preserve channel distinctions and several which encourage the perception of coordinated events between the channels. Most prominently dividing the channels is the use of gradual crescendo-

decrescendo gesture in the right and the use of more indiviuated attacks in the left. This is stated most clearly in Event 1, and then in more mixed and complicated versions in the later events. Adding to these complications are the features which encourage coordination, particularly the use of reverb and pitch, globally moving from reverberated pitches at the beginning of 2 along with the continuation of 1a to the almost completely dry and noisy beginning of 3a and 3b, and the return of reverberated pitch in 3c and 3d. These trends can be seen by comparing events in the following table of oppositions.

Region M

Just before 2'57", there is an explosive noise as both channels filling out as full a portion of the available spectrum as anything before–from nearly 67 to 8820 Hz in the right channel, and slightly higher–70 to 9334 Hz–in the left. The masses of noises in each channel are nearly continuous, almost indistinguishable from each other for the first 2 seconds, and indeed this is the densest moment of the piece, but the individual channels do begin to regain separate identities.

At about 2'59" a few pitches can be heard in the right channel, still heavily reverberated. When the left channel grows softer, at 3'02" these pitches emerge even more clearly. This point is labeled as Event 2 in Figure 3.24. Emerging as such, these pitches emphasize the composite nature of the right channel's texture–it is not just noise, but noise created by the complete mixture of materials. This episode reinforces the distance that the piece has come, reminding us of the reverberated impulses of the beginning of the piece, in the transition, and at the beginning of Phase 2, revealing that

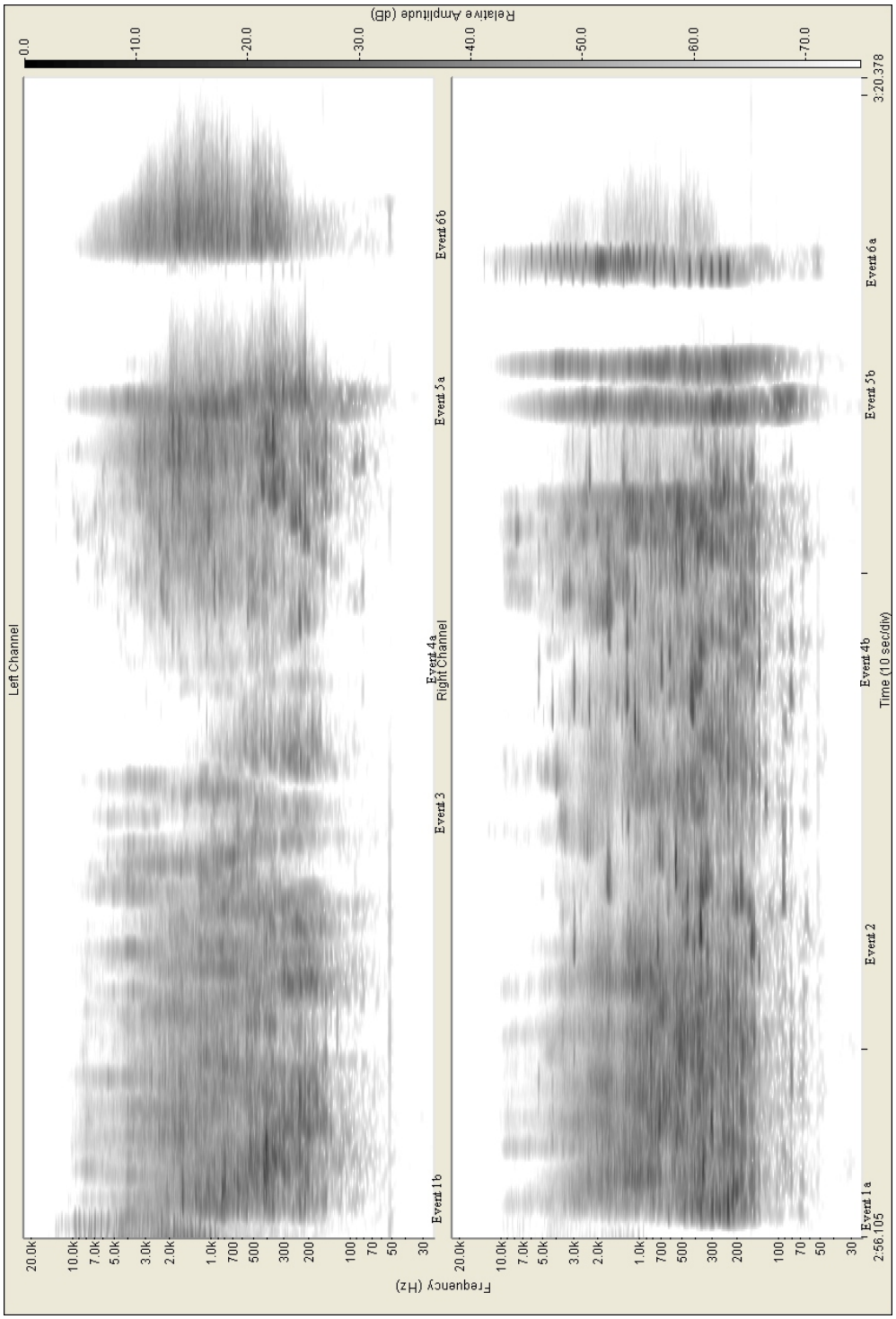

Figure 3.24. Spectrograph of Region M

Region M												
			1a	1b	2	3	4a	4b	5a	5b	6a	6b
	grave	accute	0	0	0	-1	0	0	0	0	0	0
	centered	extreme	0	0	0	0	0	0	0	0	0	0
	narrow	wide	1	1	1	1	1	1	1	1	1	1
	compact	diffuse	1	1	0	1	0	0	1	0	1	0
	soft	loud	1	1	0	0	0	0	1	1	1	1
	level	oblique	0	0	-1	-1	-1	0	-1	-1	-1	-1
	no-attack	attack	1	1	0	0	0	0	1	1	1	1
	sustained	clipped	0	0	0	0	0	0	0	0	0	0
	reverb	dry	1	-1	-1	1	0	0	1	1	0	0
				d1	d4	d3	d3	d1	d5	d1	d2	d1

	start	end	duration	
M1a	176.6	182.2	5.6	R
M1b	176.7	186	9.3	L
M2	182.2	189.7	7.5	
M3	186	189.5	3.5	
M4a	189.5	193.7	4.2	
M4b	189.7	193.7	4	
M5a	193.7	196.1	2.4	L
M5b	193.7	195.1	1.4	R
M6a	196.5	197.3	0.8	
M6b	196.8	199.9	3.1	

Table 3.16. Table of Oppositions for Region M

behind this impenetrable mass of sound there are all of these individual characteristics which we have come to know in various combinations throughout the piece so far.

The remaining events serve to provide this contrast, and then work towards a resynthesis of characteristics in events 2-3 and 4, respectively. Event 3, as labeled above, 3'06", is the point at which the left channel drops down to a peak of about 1054 Hz, and drops significantly in dynamic level as well. At this point the left channel is at its driest as well. As the right channel has remained relatively loud and wet and features prominent pitches, this is the point of highest contrast between the channels.

Event 4, coordinated between the channels, then builds back up into impenetrable density. Helping this coordination is the use of reverberation in the left channel, making it merge with the right, and the receding prominence of pitched material in the right. Just at the point where the channels are once again merging (3'12.8") the right drops out, abruptly calling attention to the crescendo in the left and reasserting the identity of the separate channels. In the original four-channel version the spatial distribution would have been more intricate, using all of the channels in various combination, which could have heightened the effect of the processes of synthesis and individuation.

Region M and ends with a series of booming attacks, Events 5 and 6. These first occur in the left, moderately reverberated, followed by two in the right, completely dry; the channels have switched the characteristics that were originally so important to their individuality. Event 6 preserves this wet/dry distinction with the paired attack of dry spectral materials in the right followed by reverberated noise in the left, trailing away into the coda.

Coda:

This silence prepares the final stage of the piece which is marked by the lack of concurrent or polyphonic events. While there is slight overlap initially, the coda soon returns to a clear-cut alternation between the channels and between sound types, though this now occurs at the level of events, rather than regions. The most notable difference between this and the previous material is that what came before was characterized by the alternation of longer monologues and simple dialogues, the coda is much more fragmented – single events lasting, on average, less than a second. The coda can be divided into two parts, the first from 3'21" to 3'33" and the final from 3'33.3" to the end. This division follows Ligeti's sketches which identified these as sections F and G, and corresponds, perceptually to an increase in the amount of rest between events, and the exit of compact material.

This change in material is less dramatic than the changes that divided previous regions, as the coda is fundamentally different from the body of the piece; the regions here reflect starting and ending states of similar collections of material. Here the individual events are short and separated and do not form consistent patters within each region. The first region presents a great variety of oppositional states, as can be seen in the table below. This initial region is predominantly clipped and dry–features which help isolate the events, and presents material that is a mixture of level and oblique, and compact and diffuse. The second region moves towards more consistently diffuse and level events, and across both regions the texture becomes sparser, softer, and slightly higher in register.

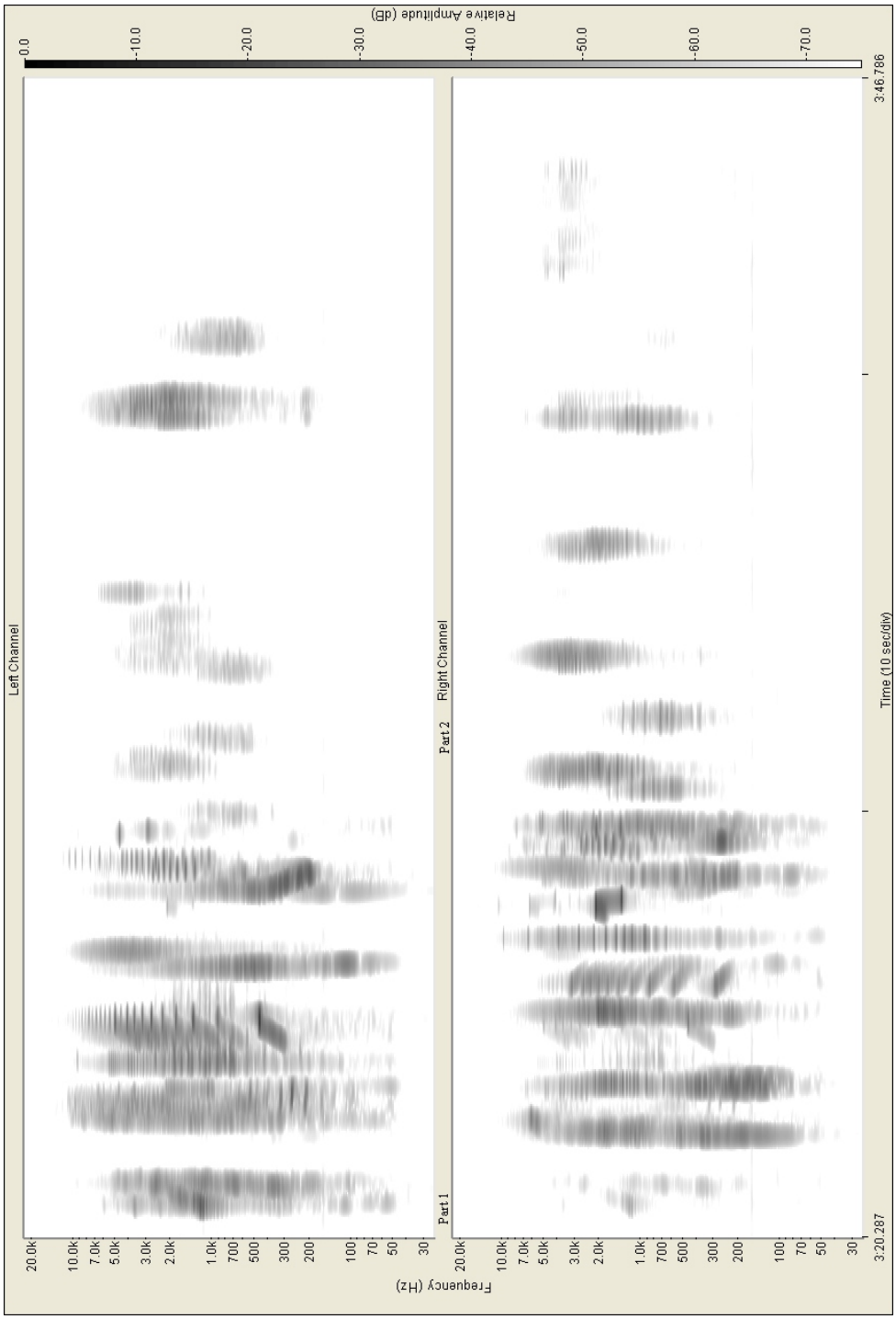

Figure 3.25. Spectrograph of the Coda

CODA						
			1	2		
	grave	accute	0	1	mod - accute	
	centered	extreme	0	0	centered	
	narrow	wide	1	-1	wide - narrow	
	compact	diffuse	0	1	mixed - diffuse	
	soft	loud	0	-1	mod - soft	
	level	oblique	0	-1	mixed - level	
	no-attack	attack	0	0	moderate	
	sustained	clipped	1	1	clipped	
	reverb	dry	1	1	dry	
			d5			

Table 3.17. Table of Oppositions for the Coda

This separation is clearly distinct from the body of the piece and separate from what Ligeti described as the "gradual, irreversible progress from the heterogeneous… to the complete mixture,"[31] and yet it is still a new reworking of the material, almost all of the oppositional states are present in the coda, yet none of them in a consistent enough way to dominate the texture. The events of the coda do not really develop in the way that previous regions did, but rather present a series of contrasting snippets. While some of these isolated moments do have surface connections to other material–for example, the compact-oblique gestures in Events 6 and 8 seem to recall states characteristic of Region G or the end of J–these are moments without the same kind of context and cannot be seen to relate to these previous sections in anything more than a surface association. The oppositional states in the coda are not so much worked upon, as in previous regions which strove towards new states of mixture and moderation, but presented simply, reminding us that after this grand amalgamation and move towards opacity, there remain individually dialectic states that cannot be fully resolved.

Conclusions

Artikulation is a complex piece, which balances an organically unfolding process with subtle challenges to any thoroughgoing hierarchy. The beginning of the piece presents very clear delineations of material based on channel separation and type of material. The compact/diffuse opposition is particularly important early on, as Region A is made of moderate impulses, Region B of more compact sine tones, and Regions C and D

[31] Ligeti, "Metamorphosis," 11.

introduce noisier, diffuse sounds. Within these regions oppositions such as level/oblique and sustained/clipped help bring about internal divisions between events or groups of events. Having defined these roles, Ligeti, however, does not use these consistently through the piece, as one might expect from a truly hierarchical structure.

By the end of the first stage, Ligeti begins to loosen these cagtegories' roles by mixing the sound types (particularly compact and diffuse) more and more extensively within each region; in the second stage, he begins to undercut the previous means of distinction more radically. First Ligeti undercuts the use of spatial distribution as the primary means of dividing regions. This occurs in Region G where a consistent sonic character (predominantly oblique and compact harmonic spectra) makes the region cohere more strongly than does the spatial location, which moves from the right channel to the left. Following this transfer, Ligeti begins to undercut the very oppositions which made Region G cohere. Region J is consistent in its use of dynamic crescendos and decrescendos, but switches freely between the compact and diffuse and pairing these inconsistently with the level and oblique. The gap between these extremes is filled, in part, by Region H, whose impulses occupy moderate room between compact and diffuse and create a special type of gesture which mediates between the level and oblique, thus suggesting more flexible connections across both channel and sonic character.

This deconstruction of the beginning of the piece occurs in a much denser environment than before, one which Ligeti has carefully built from the beginning. While Stage I contained minimal overlapping–only the clear ends of regions with the beginnings of others–Stage II builds quickly towards completely overlapping regions. Within this

polyphonic texture of two simultaneous but contrasting sound masses, that Ligeti begins to reintroduce smaller connections such as the ones between Regions H and J. One of the truly special moments of the piece occurs as the long regions of Stage II begin to yield these small scale interconnections which continue through to the end of the piece.

While the piece works towards this dense texture, Ligeti primes ones attention to these smaller connections through equally careful means; the registral contour of mid-high-low provides an illustrative example. This contour is first introduced abstractly by Region A as part of the expanding direction of the piece. In Regions C and D it appears again helping to associate certain events and subdivide each region; in D particularly, this contour is clearly presented in each of the first two events, with an oblique motion in the final element. In the context of Region D, this contour binds the first two events together, and creates a small scale division between these introductory events and the rest of the region, which is less clearly patterned. This exact configuration, including the final oblique element, is repeated in Region J, Event 2, but has a very different function. In Region J this event associates quite differently with the surrounding materials, through connections in sonic character and dynamic envelope and less through register. When it occurs in Region J, this contour itself recalls earlier material but does not have any immediate relevance to the region beyond delimiting one event, and thus one element which seemed so salient to the clear divisions of the beginning dissolves into just one of many coexisting elements by the end of Stage II.

Another recognizable gesture, the noise glissandi which first appear in Region C's introductory gesture, provide a similar example. A single noise gliss appears as Region

C's first event, which remains distinct from the rest of the region. This is followed by a pair noise glissandi in Region E which serve a similar function. When this pair recurs at the onset of Region K, it is again only significant as one event in a diverse heterogeneous mixture. In each case the distinctive gestures are presented clearly at first, often at the beginning of a region in the exposition, and in a way is significant to regional subdivisions, and suggests that they may have importance beyond even this. In actuality, these gestures are much more slippery and diminish in the scope of their influence from helping define regions to defining only events, yet they are a convenient point of entrance for understanding certain oppositions and arrangements of material, which leads to a greater appreciation of the immense richness of the chaotic tapestry which follows.

In many ways, the workings of this piece resemble the ideas of T. W. Adorno, one of Ligeti's contemporaries, whom he had met at Darmstadt during the previous year, and whose influential writings Ligeti had read while still in Hungary. Adorno's idea of negative dialectics has deep resonances with the structure of this piece; in explaining his grounding in Hegel, Adorno states that,

> As early as the Introduction to *Phenomenology of Mind*, Hegel comes close to a sense of the negativity of the dialectical logic he is expounding. That Introduction bids us purely observe each concept until it starts moving, until it becomes unidentical with itself by virtue of its own meaning—in other words, of its identity. This is a commandment to analyze, not to synthesize.[32]

Similarly, *Artikulation* presents a process where there are numerous of oppositions, that is to say theses and antitheses, and sides of various dialogues, but while these are initially

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[32] T.W. Adorno, *Negative Dialectics*, trans. E.B. Ashton, (New York: Seabury Press, 1971), 156.

presented as separate, their distinctions quickly break down. Ultimately there is no permanent or lasting synthesis, and no resolution of these disparate elements. The materials at the end are recognizable, but transformed from their initial appearances, as Ligeti does not force any sort of contrived formal recapitulation, nor does he end at the extreme goal of a simple process, instead he prefers this epilogue, which advances the piece while stepping back from the climax. Observing these sound types engage in yet another sort of interaction, now broken back down into shorter segments, but with each segment still a bundle of constituent elements, we come to a better awareness and understanding of the dynamic facets of these complex sounds and their underlying basis in opposition. And it is through the dialectic processes of combination and juxtaposition which make up the piece itself that these individual elements are better articulated, thus giving us a clue to the very title of the composition.

Chapter 4: Later Works and Concluding Thoughts

While he was composing the electronic works examined in the last two chapters, Ligeti was also working on the orchestral piece that would become *Apparitions*. This piece went through a number of different drafts under different titles, including *Víziók* (Visions) and *Sötét és Világos* (Dark and Light). Ligeti began the final version of *Apparitions* in 1958, just after *Artikulation*, and completed it early in 1959. It is this final version of *Apparitions* where the knowledge Ligeti has acquired in the studio is first put into practice in instrumental composition in recognizable ways.

The previous chapters have uncovered many new techniques and strategies for compositional design in the electronic idiom. In particular the analyses have included discussions of Ligeti's methods for determining durations, generating and categorizing musical material, as well as some of the factors he considered when arranging this material into the final piece. This chapter will continue to address these same concerns but rather than going through *Apparitions* as it unfolds, this chapter will be organized to address these issues in turn: first rhythmic practice, then approaches to pitch and resulting musical gestures, and finally form. This will allow the opportunity to make specific comparisons to the electronic precedents, pointing out specific chains of influence. It will also allow a preliminary extension of these findings to later pieces, and thus bringing this study to its stated goal.

Rhythmic Practice:

When Ligeti escaped Hungary during the revolution of 1956, he describes himself as largely ignorant of the practices of the Western-European avant-garde.

> Invited by Dr. Herbert Eimert, I came to Cologne in 1957 as a 'virgo intacta,' so to speak, having, no idea, then, not only about electronic music, but also even more generally about what had happened compositionally in the post-war years in Western Europe.[1]

This was particularly true for Ligeti in the domain of rhythm; he describes having the inspiration to compose a type of "static" music while still in Hungary, yet before his experiences in Cologne, he was without the technical means to realize this. In fact, one can glean from other comments that the rhythmic practice of the Cologne composers were quite striking–even liberating–to him, and he states that, "Up till then [arrival in Cologne] I had not got beyond the concept of notation based on metre."[2] Ligeti goes on to recall this struggle as, "both a notational and a compositional difficulty," and admits that even two of his more innovative pieces from this period, *Métamorphosis nocturnes* (1953-54) and *Musica Ricercata* (1951-53) "are conceived within the framework of conventional time measurement and periodic structure."[3] It is in his pieces *Artikulation* and *Apparitions* that Ligeti confronts this difficulty and finds his solution to the problem of organizing rhythm without meter.

Rhythmic Practice of *Apparitions*: An Alternative to the Duration Row

One of the technical means that enabled Ligeti to develop his characteristic static textures came through his alternative to serial duration rows. Ligeti did not merely adopt the duration rows in use by serial composers working at the time. In fact, he criticizes the

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[1]György Ligeti, "Auswirkungen der elektronischen Musik auf mein kompositorisches Schaffen," in *Experimentelle Musik*, ed. Fritz Winckel (Berlin: Mann, 1970), 73. Translations are the author's, unless otherwise noted.
[2]György Ligeti, *Ligeti in Conversation*, trans. Gabor J. Schabert (London: Ernst Eulenburg, Ltd.), 33.
[3]*Ligeti in Conversation*, 34.

adherence to duration rows in pieces like Boulez's *Structures Ia* in an analytical essay for the journal *Die Reihe*,[4] and also in a more theoretical article entitled, "Metamorphosis of Musical Form" which appeared in the same journal. Specifically, he objects to the fact that in such a system, the longer durations inevitably make up more of the piece than the shorter ones, and favors the following solution:

> in the first part of my orchestral piece 'Apparitions' I used a repertoire of durations (intervals of entry) with values attached to each element such that the product of each duration-value and the number of times that it occurred in the whole structure was a constant. By this means an equilibrium of intervals of entry was achieved: the shorter a particular duration-interval, the more frequently it appeared in the context, and so many short durations were used for every long one that the sum of the short ones equalled [sic] that of the long.[5]

He further notes that,

> In my electronic piece 'Articulation' I used a similar principle of distribution with the following difference however: here, the product of the individual duration values and their frequency of occurrence was not a constant, but changed according to the different kinds of texture that are used in the piece. The result is that the specific average density varies from texture to texture. Obviously one can set up numerous other statistics of distribution, depending on the specific ideas one has about the work one is composing.[6]

If Ligeti arrived in Cologne without the technical means to organize music without reference to meter, his experience with the electronic composition *Artikulation* must certainly have pushed him to develop new ways of thinking of rhythm in precisely this way, since in *Artikulation* these durations are *literally* segments of magnetic tape calculated in centimeters and cut to different lengths. In the previous chapters, we have

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[4]György Ligeti, "Pierre Boulez: Decision and Automatism in Structure 1a," trans. Leo Black in *Young Composers*, Vol. 4 of *Die Reihe* (Bryn Mawr: T. Presser; London: Universal Edition, 1960, German edition 1958) 36-62.
[5]György Ligeti, "Metamorphosis of Musical Form," trans. Cornelius Cardew *Form – Space,Die Reihe* 7 (1965, German edition 1960), 14.
[6]Ligeti, "Metamorphosis," 14, n. 28.

seen the progression from *Glissandi* where Ligeti calculates first and foremost in seconds, to *Artikulation* where the calculations are primarily in centimeters; his continued rhythmic practice in the first movement of *Apparitions* is similar, in that it involves calculations using almost-inaudibly minute units, in this case 32nd notes.

Returning to the earlier analysis of *Artikulation* in light of Ligeti's quote above, we can now tell that the determination of the material in "Material 3" (see the previous chapter, pp 98-100) followed the same procedures as Ligeti details in his quote above. Moreover, while the individual tape segments were further altered, rearranged, and impossible to trace back to the surface of the piece, this same process is found in *Apparitions* where it can be traced from the composition's abstract plan, directly to the score. In sketches for that piece the diagram in Table 4.1 is found.[7]

Table 4.1. Durations and Number of Instances for *Apparitions*, mvt. 1

I	2	80	160
II	3	53	159
III	4	40	160
IV	6	27	162
V	10	16	160
VI	14	11	154
VII	20	8	160
VIII	32	5	160
IX	48	3	144
X	80	2	160
XI	112	1	112
XII	160	1	160
(XIII)	256	1	256

Here, in an example quite similar to Table 3.1, showing "Material 3" from *Artikulation*, there are twelve base values, which, in the second column are calculated in thirty-second notes, and thus range from a sixteenth note to five whole notes, with a thirteenth value

[7]Tables 4.1-4.4 are all transcribed from sketches in the György Ligeti Collection of the Paul Sacher Foundation in Basel.

equal to 256 thirty-second notes given in parentheses. The number of occurrences is given in the next column, and in this case, the product is written out and is equal to approximately 160.

These values are then split up into four groups which will represent the four divisions of the movement of *Apparitions*. In other pages of the sketches, transcribed in Table 4.2, he outlines the duration scheme for each of these four groups.

Table 4.2. Division of Individual Durations into Sections of *Apparitions*, mvt. 1

A	160	80	48	32	20	14	10	6	4	3	2	
				32	20	14	10	6	4	3	2	
					20	14	10	6	4	3	2	
						14	10	6	4	3	2	
								6	4	3	2	
											2	

B	32	20	14	10	6	6	4	4	4	4	3	3	3	3	2	2	2	2
		20	14	10	6	6	4	4	4	4	3	3	3	3	2	2	2	
				10	6	6	4	4	4	4	3	3	3	3	2	2	2	
				10	6	6	4	4	4	4	3	3	3	3	2	2	2	
					6	6	4	4	4	4	3	3	3	3	2	2	2	
					6	6									2	2	2	
															2	2	2	

C	20	14	10	6	4	3	3	2	2	2	2
		14	10	6	4	3	3	2	2	2	2
			10	6	4	3	3	2	2	2	
				6	4	3		2	2	2	
					4	3		2	2	2	
						3		2	2	2	
								2	2	2	

V	256	112	80	48	32	20	14	10	6	4	4	3	3	3	2	2
				48	32	20	14	10	6	4	4	3	3	3	2	2
							14	10	6	4		3	3	3	2	2
								10	6	4		3	3	3	2	2
									6	4		3	3	3	2	2
										4					2	2
															2	2
															2	2
															2	2
															2	2

Here the letter names correspond to the rehearsal letter which ends that section, thus "A" designates from the beginning to Letter A, "B" from Letter A to B, and so forth, with "V" standing for the Hungarian "vége" meaning "end."

A careful examination of these numbers reveals that Ligeti has modified the distribution slightly, leaving out nine instances of the number 2, four 3s, two 4s, and one 10. The rationale for this division and modification of the numerical scheme, may be related to the proportions between the lengths of these larger sections; in interviews Ligeti states that,

> In the first movement of *Apparitions*, I applied Bartók's golden section as interpreted by Lendvai. Its first part is in a low register and the second in a high register; the relative duration of the two parts corresponds to the golden section. Subsequent shorter parts of the movement are also divided in the same proportion. The golden section is in fact the dominant formal principle of the work. Looking back on it, I must say that I could have applied any other principle of proportions just as well.[8]

This last sentence is particularly telling, since it turns out that the actual division reflects the proportion of 2:3 (or approximately 0.667) rather than the golden section (approximately 0.618). The sums of the individual values for each of the four sections are shown in Table 4.3.

Table 4.3a. Proportions Between Sections of *Apparitions*, mvt. 1

A	B	C	V
585	390	195	877

V:A = 877:585 = 3:2
A:B = 585:390 = 3:2
B:C = 390:195 = 2:1

[8]Ligeti, *Ligeti in Conversation*, 43. Toop (*Ligeti*, 68) also reports this as the golden section. See also Ernö Lendvai, *Béla Bartók: An Analysis of His Music* 2nd ed. (London: Kahn & Averill, 1979), especially 17-26 which deal with the golden section in determining proportions of large forms.

Table 4.3b.

A	B	C	V
585	390	195	585

A:(B+C):V = 585:585:586 = 1:1:1
(A+B+C):V = 1170:585 = 2:1
B:C = 390:195 = 2:1
A:B = 585:390 = 3:2
A or V:(A+B+C+V) = 1:3
A+B+C:(A+B+C+V) = 2:3

This final duration of 877 32nd notes does not actually occur in the piece, and there is some ambiguity as to exactly how long this final section lasts. In the completed score, the duration from Letter C (which begins with the violin cluster at the end of bar 73) to the final bar line is 637 32nd notes. The last two measures, however, are filled with rest, and if they are not counted, one finds a duration of 573. Within this range of 573 to 637, one finds two significant values. If one considers the original scheme of durations, subtracting the parenthetical duration of 256 from the original total of 877 yields the result of 621, close to the upper limit of this range. The value of 585, which is the length of Section A, lies closer to the beginning of this range. If the value 585 is taken as the ideal length of the last section, then Ligeti is dividing the piece into thirds, opting to have the 2:3 relationship between the entire movement and the initial sections (A-C) which occur in the low register, before the final section shifts abruptly higher. This proportion is also reflected in the relationship between the first two sections, leading to a situation closely resembling the one described by Ligeti in the previous quotation. This ambiguous span of silence may be a compromise between the previously determined durations and these idealized proportions.

Having divided the individual durations into groups whose sums reflected the above proportions, Ligeti went about arranging these into an order which would produce the musical surface of *Apparitions*. Here Ligeti proceeds statistically, and probably somewhat intuitively, rather than by any serial ordering. Table 4.4 shows that is some modification of the numbers at this point–the upper row of numbers comes directly from the numbers shown in Table 4.2-A, the lower row shows the values Ligeti will actually employ in the piece. The modifications are most likely to avoid repetition which could lead to some sort of periodicity or even a brief feeling of meter, and also to increase the variety of rhythmic units, including numbers like 1 and 7 which were not part of the original scheme. Where Ligeti subtracts from one value, however, he adds this amount to another, so that the sums and their underlying proportions remain unchanged.

Table 4.4. Rhythmic Scheme for *Apparitions*, mvt. 1, Section A

A

160	48	20	80	32	14	20	32	10	20	14	6	10	14	14
160	56	16	80	28	12	20	32	12	16	14	6	10	16	12

10	6	4	10	4	6	3	2	3	4	6	3	4	6	2	2	4	3	2	3	2	2
10	6	4	12	5	7	3	1	4	5	6	2	3	7	2	1	5	4	1	2	1	4

This numerical scheme corresponds to the reduced score example given found in Figure 4.1.[9] This reduced score gives only the type of instrument or instruments playing and the total duration as both a note value and a number of 32nd notes. In this reduction the rhythmic design of this section of the piece becomes quite clear. However some of the decisions Ligeti made in devising these details, and the aesthetic concerns they entail

[9]cf. György Ligeti, *Apparitions* (Vienna: Universal Edition, UE 18326, 1964), 1-2.

demand further reflection. For instance, as you can see in Figure 4.1, his design corresponds to the initial attacks of each cluster; some of the attacks do not fill up the entire span, while others carry over past the next attack point.

In each stage of the realization of this portion of *Apparitions*, the composer allows himself certain liberties. First, in the large scale distribution, Ligeti altered the strict balance of his initial distribution to create large sections in certain proportions, as shown in Table 4.3. Within these proportions, by leaving the specifics of ordering open, he allows himself the flexibility to achieve a specific aesthetic goal. The composer noted that the piece begins with a carefully balanced state, which is then disturbed by the more impulsive events until, "the network is irrevocably changed; the stationary sounds heretofore only weakly stirred by internal vibrations, are now crumpled. Trills and tremolos animate the sounding masses, and a continually irregular fluctuation of the dynamics hinders the retrieval of any equilibrium."[10] The outer sections contain a mixture of longer and shorter durations, while the inner sections contain mostly shorter ones; these are arranged in the piece, first to effect a gradual acceleration through part A, then to create a more turbulent area through parts B and C, and finally to bring about fierce juxtapositions in the final section, where long sustained clusters are interrupted by chaotic passages, labeled "wild" in the score.

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[10]György Ligeti, "States, Events, Transformations," trans. Jonathan Bernard, *Perspectives of New Music*, Vol. 31, No. 1, 167.

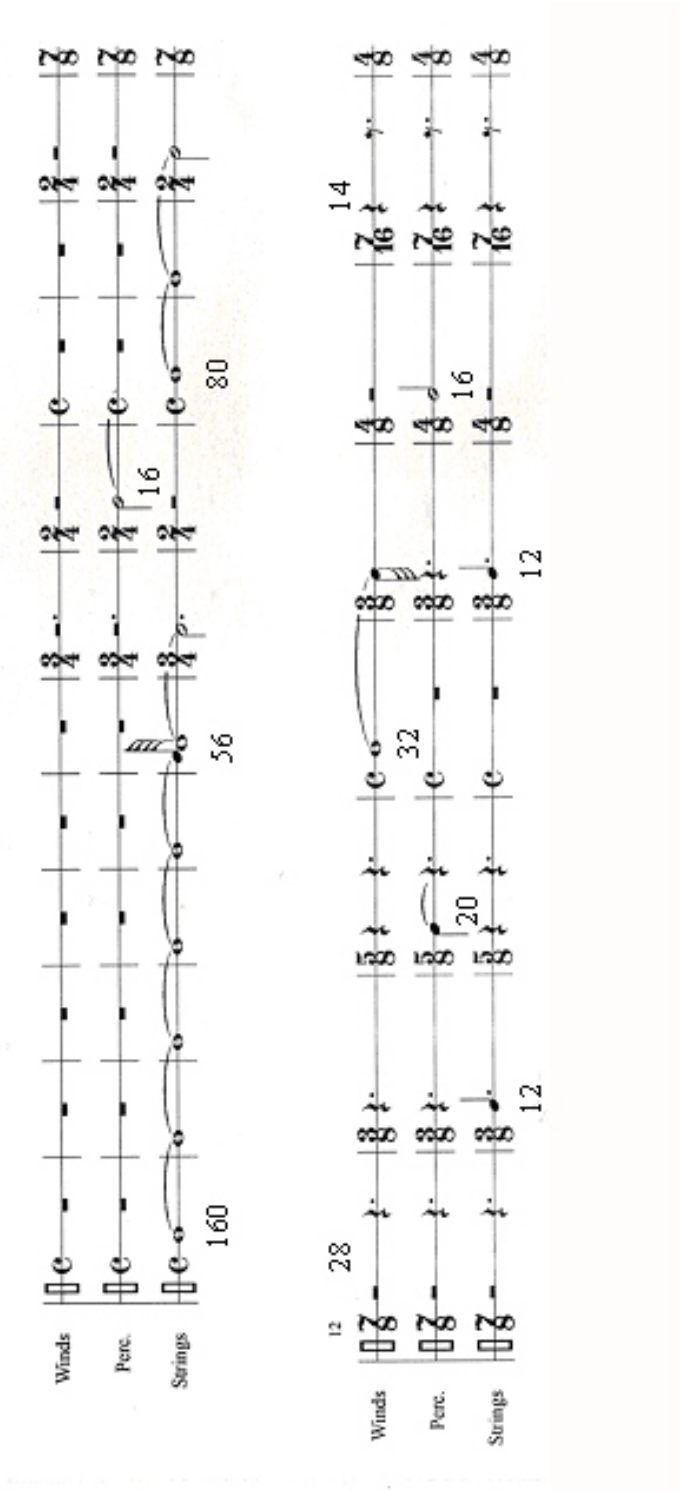

Figure 4.1. Duration Scheme for *Apparitions*, mvt. 1, Section A

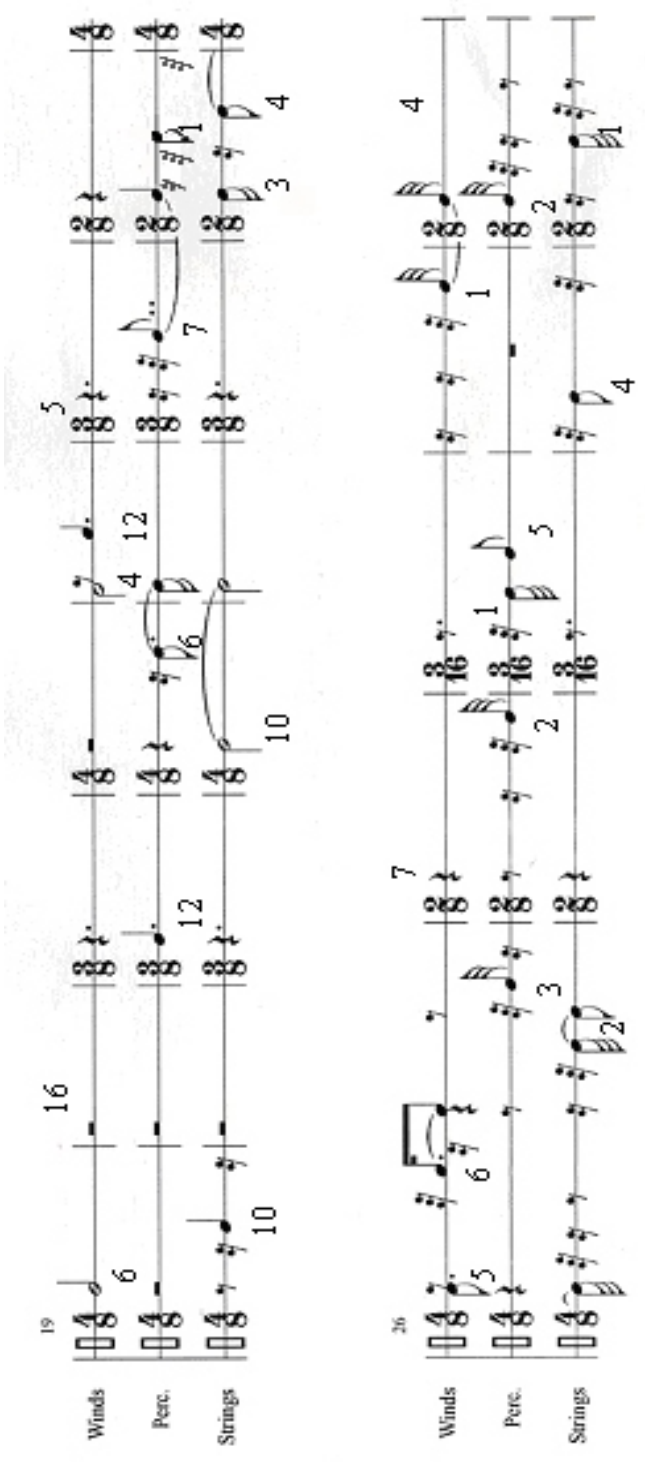

Figure 4.1. Duration Scheme for *Apparitions*, mvt. 1, Section A

Another way in which this compositional method allows Ligeti his desired flexibility its specification of only points of entry, rather than fixed durations. It is important to realize that Ligeti viewed this design as an underlying grid rather than a strict ordering of a set of note-values; this entails a significant difference from *Artikulation* where these numbers *did* correspond to durations (i.e. lengths of tape). Here however, Ligeti has replaced the periodic, metrical grid which frustrated him in his earlier compositions with an aperiodic one, and the composer retains the freedom to compose a musical surface which articulates this grid in any number of ways. Thus, some points are marked by the entrance of a new cluster, others by the change from sound to rest. This allows Ligeti to carry certain clusters past the duration suggested by the initial scheme, and to create some ambiguity by leaving other suggested durations only partially filled.

In the A section, given above, he does this sparingly, beginning in measure 22, where the string cluster, designated as 10 32^{nd} notes is held longer, while the cembalo and brass articulate other points on the grid. As the piece goes on, however, it diverges more and more from the balance of the opening, Ligeti takes ample opportunity of this freedom. The final "wild" passages commonly use borrowed divisions which the scheme itself is incapable of deriving, over the top of extremely long sustained clusters.

Rhythmic Practice 2: Koenig's Experiment

Aspects of the sonic material in *Apparitions*, including these borrowed divisions, as well as the tremolos and trills of the more turbulent B section, also stem from one of

Ligeti's experiences in the electronic music studio, which influenced his awareness of the intersections of rhythm and pitch. In his lecture on the "Effects of Electronic Music on my Compositional Work," Ligeti recounts an experiment carried out by Gottfried Michael Koenig involving a succession of single events played at different speeds.

> In Koenig's work there were successions of sine tones in which one could recognize the individual elements. The speed of succession lay over the limit of blurring of about 50 msec. The succession could be perceived as such. However, these same tone-successions were contracted in time. That could easily be accomplished through simple technical manipulation in the studio. Through this, the single tones submerged into the area underneath the limit of differentiation... and the progressions, which were originally successive, turned into a simultaneity.[11]

He goes on to express his opinion that, rather than either of these extremes,

> it is most interesting when the whole occurrence is not so far contracted... that it all coincides in our hearing, but rather when it contains some transitional room in which to play–when one finds some elements over the limit of blurring of about 50 msec, and others below, so that a durational emergence and submergence takes place, then one time rhythm changes over into tone color, and another time tone color changes to rhythm.[12]

Ligeti terms this phenomenon "Bewegungsfarbe," or "moving color," and in his electronic works, he commonly uses values below this threshold. At a tape speed of 76.2 cm/sec, 50 msec would equal 3.81 cm of tape. Thus, the example from the duration schemes for *Artikulation* shown earlier contain several elements which will not sound as individual events, but rather as this type of "moving color." Furthermore, in *Pièce électronique no. 3*, the minimum unit of duration is one centimeter.

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[11]Ligeti, "Auswirkungen," 75. Ligeti also begins his"Musik und Technik: Eigene Erfahrungn und subjective Betrachtungen" in *Computermusik; Theoretische Grundlagen, Kompositionsgeschichtliche Zusammenhänge Musiklernprogramme* (Laaber: Laaber Verlag, 1987) 9-35. with a longer discussion of Koenig's experiment.
[12]Ibid.

While such speeds are easily achieved in the electronic music studio, the limitations of acoustic instruments make this impractical, to say the least. Ligeti has acknowledged this fact: "Since you cannot play an instrument fast enough to produce a succession of notes at a rate of twenty per second, I built the rhythmic shifts into the music."[13] And while he goes on to mention *Atmosphères* as a specific example of these rhythmic shifts, one need look no farther than *Apparitions*.

In the second movement of *Apparitions*, one finds rhythmic shifts of the type that Ligeti identifies. For instance, in measure 17 of this movement (see Figure 4.2) the cross rhythm of 10 against 9 occurs in the violins. The second violins, playing 10 subdivisions at a metronome marking of half-note = 40 (or quarter-note = 80) produce, 13.33 attacks per second. The first violins, playing 9 subdivisions will reproduce only the first attack, since there is no common factor between 10 and 9, and these two patterns will coincide only at this point. The total number of independent attacks comes to 18 per quarter-note, or an average of 24 per second, truly exceeding the limit of blurring. The different groupings of violins also share part of the same range, in which it will be impossible to perceive the individual instruments playing the notes, let alone discern any lines moving within this cluster. All of these calculations are based on strictly accurate renditions, but Ligeti seems to be inspired by instrumental mistakes, even counting on their occurrence. He cites a precedent, which he realized retrospectively in Wagner, of all composers, saying, "the string parts at the end of *Walküre* (Feuerzauber) are such that no violonist

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[13]Ligeti, *Ligeti in Coversation*, 40.

[sic] can play them, all of them make mistakes, different mistakes all the time. These mistakes add up and create a floating, fluctuating pattern, i.e. *Bewegungsfarbe*. Technically, *Atmosphères* is based on the same principle."[14] See Figure 4.2[15]

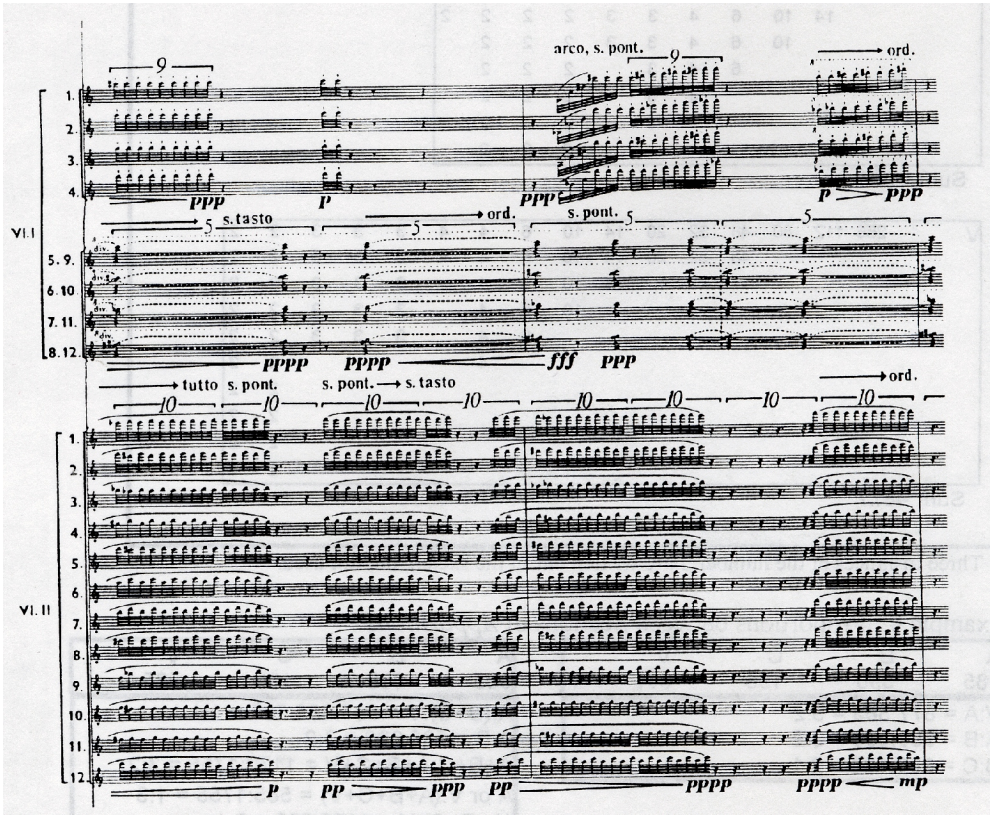

Figure 4.2. Score of *Apparitions*, mvt. 2, mm. 17-18

[14]Ligeti, *Ligeti in Conversation*, 40.
[15]György Ligeti, *Apparitions* (Vienna: Universal Edition, UE 18326, 1964), 12. Reproduced with permission.

This is an extreme example and a rhythmic climax of this section of the piece, which contains precisely measured tremolos to achieve an ebb and flow of internal speed, without any melodic direction. Returning to the first movement, however, the tremolos in Section B, which are to be played as quickly as possible contain a potential for internal motion that is a starting point for the exploration of other gestures, which exploit the effects of rhythm and dynamics on our perceptions of pitch.

New Approaches to Pitch

Before discussing the novel use of pitch in specific gestures which Ligeti transfers from electronic medium to the acoustic, I will address the use of clusters more generally, for it is this maximally dense articulation of an equal-tempered pitch-space which enables many of these gestures to take form. The idea of using chromatic clusters–simultaneously sounding stacks of semitones–was an idea simultaneously and independently developed by Ligeti, Krzysztof Penderecki, and Iannis Xenakis. Penderecki's *Anaklasis* was premiered in October of 1960, a mere four months after Ligeti's *Apparitions*, and while Xenakis's *Metastasis* dates from earlier (1954), it is clear that Ligeti did not know the piece until the summer courses at Darmstadt in 1960.

Apparitions uses chromatic clusters as its basic material, employing these as most of the harmonically sounding entities of the first movement. These clusters make up the network of the piece, which the duration scheme above helps articulate and which Ligeti describes as undergoing a gradual and irrevocable development from stasis and balance to animated motion. While these clusters have roots dating back before Ligeti's flight from

Hungary, their particular employment from *Apparitions* on was significantly effected by Ligeti's experience in the studio.

In early versions of *Apparitions* including the remaining fragments of *Viziók* and *Sötét és Világos* contain clusters, but in a very primitive form, lacking the sophisticated internal motion of *Apparitions* in its final form. The extant sketches of these early orchestral works are scant,[16] and the final form that *Apparitions* would have taken, had Ligeti's life gone differently, must ultimately remain a matter of speculation, yet in the example of *Sötét és Világos*, dating from 1956, we find clusters, moving to tremolos and even a few clusters near the end where all the instruments play glissandi together. All of these moves happen, however in discrete steps, and none of the nuances found in the final version of *Apparitions* exist.

Ligeti's early choral work, *Észjaka* (Night) uses a simple canon to create diatonic clusters. Here the technique is expressive–coloring the text of "endless thorns" (*rengeteg tövis*). Moreover, the relatively slow tempo, the text, and the small number of voices make the individual lines more perceptible than in the dense massed clusters of the orchestral pieces. The use of clusters here is a bit of an anomaly, and still used for contrast, giving way to pentatonic material later in the movement, and to a very melodic, folk-influenced style in the second movement, *Reggel* (Morning). Figure 4.3 presents transcriptions from the diatonic and pentatonic sections of this piece.

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[16]There are four pages of a draft, held by the Paul Sacher Foundation in Basel Switzerland, furthermore these are reprinted in Ove Nordwall, *György Ligeti: Sketches and Unpublished Scores 1938-1958* (Stockholm: Royal Sweedish Academy of Music, 1976); they are also described in depth by Steinitz, *Music of the Imagination*, 69.

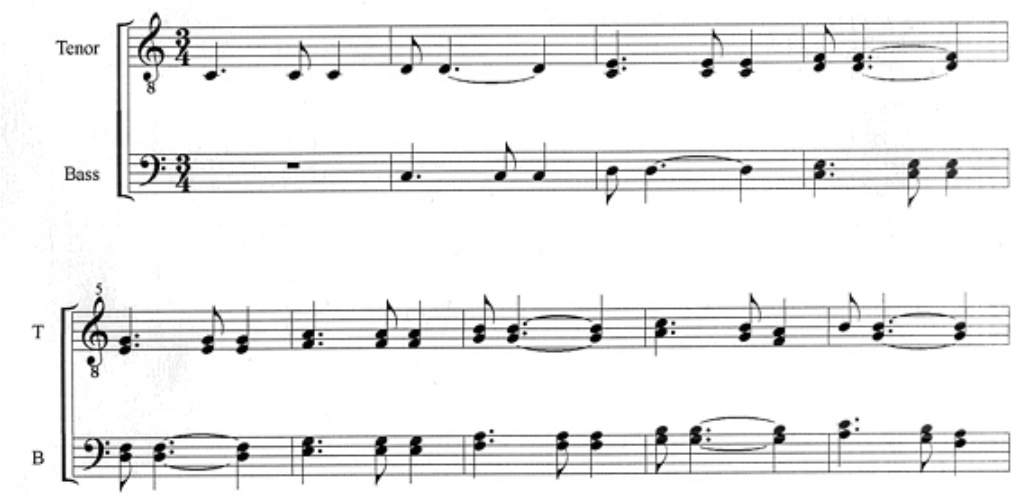

Figure 4.3a. Score to *Éjszaka*, mm. 1-9

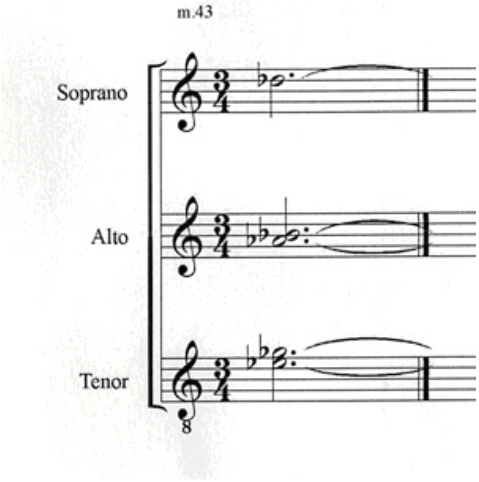

Figure 4.3b. Score to *Éjszaka*, m. 43

One may note the similarity in these early works' titles, "Dark and Light" and the choral pair, "Night" and "Morning;" moreover, each piece uses cluster-like material in stark contrast to express the first part of this opposition. The emphasis in these pieces is on binary contrast, not on a sense of developing internal motion within these clusters, yet considering the role of micro-polyphony to create clusters in Ligeti's later music–and particularly in *Atmosphères*–one cannot ignore this humble precedent.

Some aspects of Ligeti's use of clusters is undoubtably influenced by Karlheinz Stockhausen–particularly the techniques he used when composing his two electronic studies (1953-54). These were the pieces in which Stockhausen made his first attempts to use exclusively sine tones as his pitch material, and many similarities can be seen between the way he handles these sine-tones and the way Ligeti handles the individual pitches of his tone-clusters.

In his *Studie II*, Stockhausen defines a scale where each note is $\sqrt[25]{5}$, or approximately 1.066495 times the previous; a standard semitone is slightly smaller than this, approximately 1.059 in equal temperament. From this field of available pitches chose 5 different types of note-mixtures: sounds which are made of 5 consecutive notes from this scale, sounds which use every other note in the scale, every third note, and so forth. Each note-mixture uses 5 sine-tones in one of these combinations. Since the number of pitches is constant, the width of the chords will correspond inversely to their density, but the individual tones will always be evenly spaced within the whole, and thus there will be five discrete types of note-mixture defined by spacing and width.

Koenig uses a similar approach to pitch in his electronic work, *Essay*–the piece Ligeti helped realize as part of his apprenticeship learning how to use the equipment at the WDR studio. In *Essay*, Koenig uses several different pitch scales; for example his Section A uses intervals defined by a variable scale with steps ranging from between $\sqrt[8]{1}$ and $\sqrt[8]{2}$, and in his Section B he uses a constant step-size of $\sqrt[24]{16}$. All of these decisions (including the number of scales used per section) are serially determined. Both Stockhausen's and Koenig's pieces are largely driven by the presentation of this pitch material as an expression of the underlying series, and serial permutations determine the ordering of this material as well as other aspects of this presentation.

One of these other serialized aspects governs the synchronization of the available tones as well as the shaping of dynamic curves and levels of intensity. Within each of his cluster-like sounds, Stockhausen synchronizes the individual strands differently, based on different schematic forms elsewhere referred to as "modus."[17] These were a way of varying the actual presentation of these note-mixtures through different rhythmic presentation; his modes included synchronizing the beginnings of tones, but having them filter away at different points; synchronizing the ends, but having the beginnings staggered, and so forth. Koenig also used schematic diagrams to order the presentation of his frequency-fields. These included both "directionally undefined" (i.e. highly permuted so as to sound random) and "directionally defined" (i.e. perceptible as ascending, descending, converging, diverging, etc.).

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[17]Richard Toop, "Stockhausen's Electronic Works: Sketches and Work-Sheets from 1952-1967" *Interface* 10 (1981), 149-197.

Stockhausen also permutes dynamic levels serially, and in elaborate detail, especially in his *Studie I*. *Studie I* differs from *Studie II* in that it varies the number of sine tones per tone-mixture. Each tone-mixture has its maximum amplitude determined serially, and furthermore, each element of a tone-mixture will differ in amplitude. In fact, the length of his *Studie I* is partially due to Stockhausen's decision to repeat the succession of structures, rotating through each note of the tone-mixture as the dynamically strongest element. In both *Studie I* and *Studie II*, Stockhausen also uses different dynamic envelopes (crescendo, decrescendo, steady) to vary the presentation of these tone-mixtures.

Ligeti's *Pièce électronique no. 3* uses many of the same principles as Koenig's *Essay* and Stockhausen's studies, although Ligeti's practice differs in certain regards. First of all, rather than using complicated calculations for his choice of pitches, Ligeti selects only harmonic and sub-harmonic arrangements of sine tones. Secondly, while Ligeti does use many of the modes similar to Stockhausen, he does not arrange them serially. Thus in a spectrograph of the realization of what Ligeti terms "Structure 2" of that piece, we find a pitch-space divided into two octaves from 500 to 1000 Hz, and from 1000 to 2000; each octave has 16 sine tones (counting 1000 Hz in both octaves), which are arranged harmonically from 1000 up to 1937, and sub-harmonically from 1000 down to 517 Hz (see Figure 4.4). These filter towards frequencies of 667, 1000, and 1500, the center frequency of the whole, and the center frequencies of each of the octaves. This rate of decay resembles Stockhausen's use of "modus" which would sometimes define tone-mixtures with a single coordinated attack, but different ending points, which often

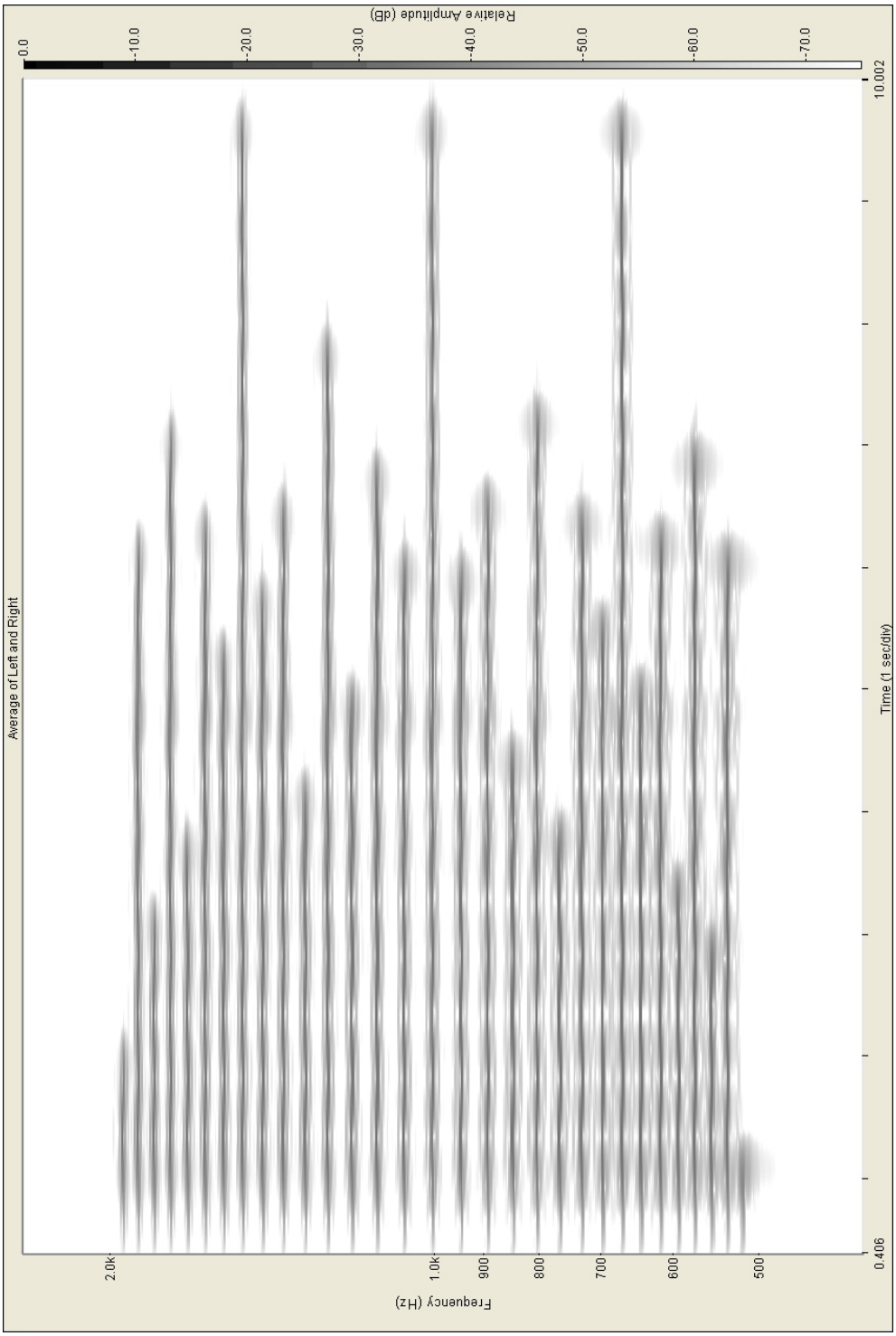

Figure 4.4. Spectrograph of *Pièce électronique no. 3*, Structure 2

proceeded from lowest to highest, highest to lowest, or towards a center point. Unfortunately for this unfinished piece, very little information on the distribution of intensities exists,[18] yet we know from the other electronic pieces that Ligeti was acutely aware of the importance of dynamics in the presentation of his music, and, as the continuation of this study will show, this concern is carried over fully into the orchestral pieces.

Gestures in Pitch and other Parameters: Cross-Fading Gestures

Ligeti's recognition of the importance of intensity, and in particular its importance on our perception of pitch and other parameters, is quite clear from one family of gestures which arises in *Apparitions*. As mentioned above, Ligeti does not serially order his parameters such as dynamic levels and synchronization of individual strands within the clusters of *Apparitions*, but rather, arranges them to support the global conception of form, and to gradually develop types of internal motion.

Section B is pivotal in this development, as introduces a number of different dynamic changes, resulting in the final tremolo cluster in measure 49–shown in Figure 4.5,[19] along with a spectrograph–which contains a truly unique effect. A chromatic cluster from E3 to B4 in violins and violas diminuendo while an adjacent cluster from E*b*3 to D1 in the cellos and basses crescendos. This coordination of duration, pitch, and dynamics

[18]Ligeti's score has only rough dynamic markings for entire structures, and none for individual tones, other than decrescendo markings where these tones fade out separately. Because of this, Tazelaar and Van Kreij realized their version of the piece at a constant dynamic level.
[19]György Ligeti, *Apparitions* (Vienna: Universal Edition, UE 18326, 1964), 4-5. Reproduced with permission.

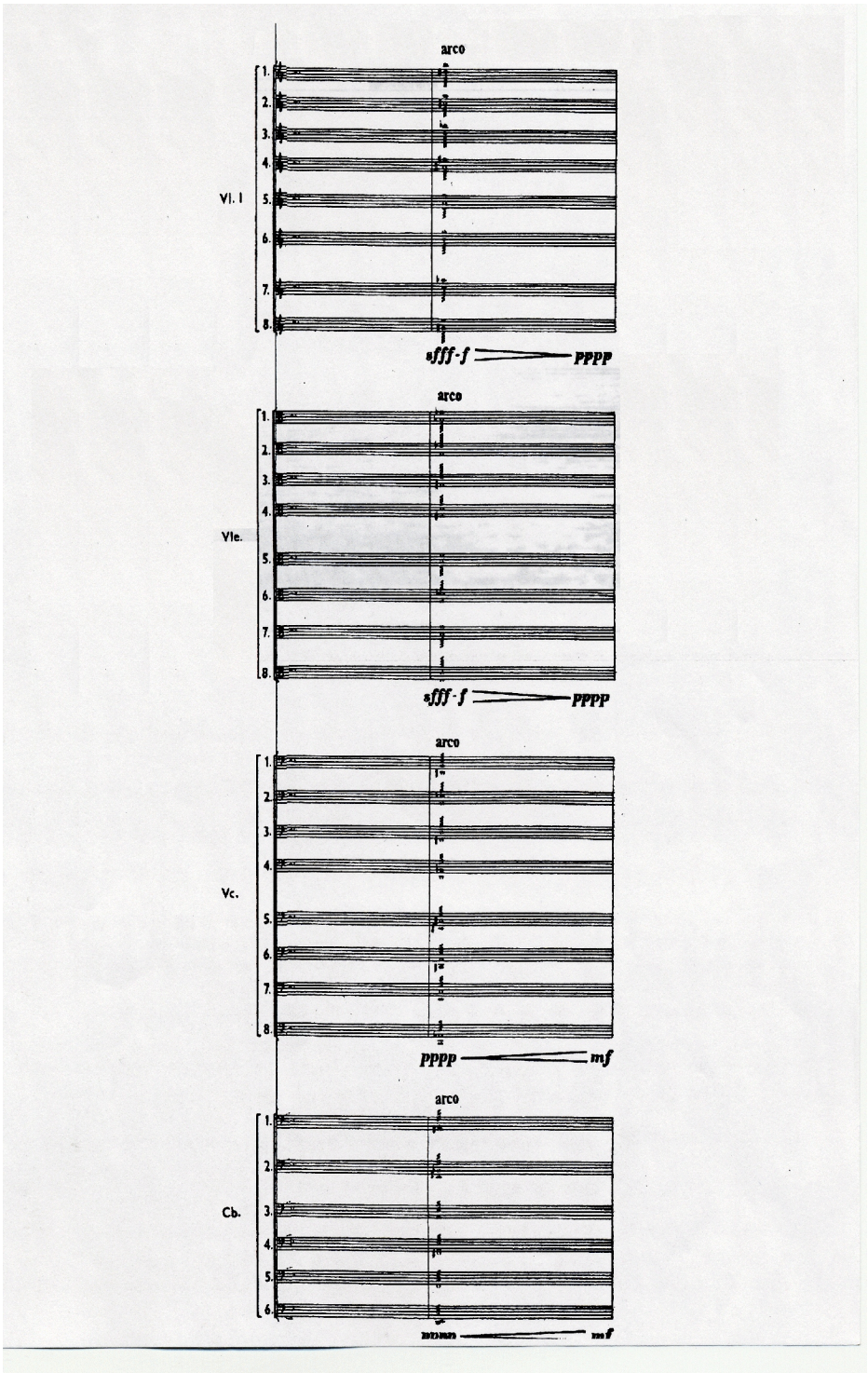

Figure 4.5a. Score of *Apparitions*, mvt. 1, m. 49

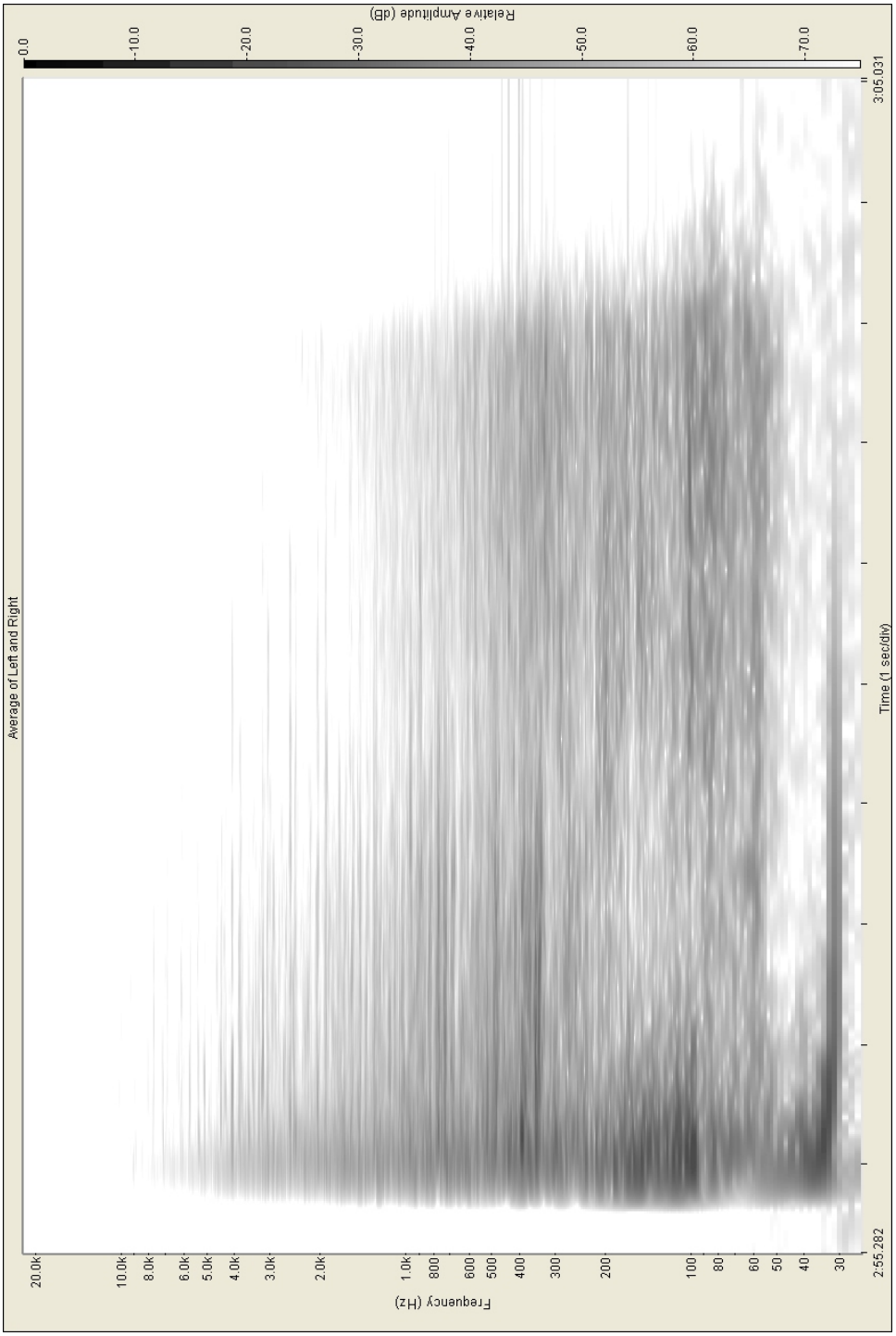

Figure 4.5b. Spectrograph of *Apparitions*, mvt. 1, m. 49

clearly suggests that these are not two separate events, but rather one event, gradually shiftng the focus of its register from high to low. Due to its barely audible (pppp) dynamic marking, this example occupies a critical spot in the movement's development from stasis, to vibration, to actual motion. While all of the individual pitches are constant in every regard other than dynamics, the effect of the whole is one of distinct registral and even spatial motion moving from one side of the orchestra to the other.

This unique gesture, while unusual for orchestral writing, is indebted to a common electronic studio technique–that of cross-fading. This technique would have been used whenever composers needed smooth transitions between two events or different channels, or even to move smoothly from between two different timbres, and could have been accomplished in a number of ways, either by manually fading out the input to one microphone while fading in another, or for a small segment, by splicing pieces of tape at an angle rather than perpendicularly. When spatializing parts of his *Gesang der Junglinge*, Karlheinz Stockhausen played a completed segment of the piece through a highly directional speaker on a rotating table, and physically turned it around while recording it back into four different microphones in the corners of the room.[20]

Artikulation, Ligeti's most sophisticated electronic piece, and the piece which immediately proceeded *Apparitions*, makes frequent use of this technique. To intensify the feeling that the beginning of the piece is fading in from a distance, Ligeti uses reverberation in a similar manner. In his sketch he indicates that the basic material consists

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[20]Recounted in Joel Chadabe, *Electric Sound: The Past and Promise of Electronic Music* (Upper Saddle River, New Jersey: Prentice Hall, 1997), 40.

of "dry [i.e. unreverberated] impulses" (szaraz imp). Below this are two parallel lines, much like staves in a score; one is labeled "dynamics" (Dinamika) crescendoing to the maximum value of 0 dB, while another labeled "reverberation" (Hall) fades out about halfway through (see Figure 4.6). This type of cross-fading was facilitated by the studio equipment, as the reverberation unit would most likely have had two outputs, one dry and the other reverberated, and a dial that would allow simple fading from one version to the other, allowing for a smooth transition in timbre and the effect the sketch describes as coming near (közel jön).[21]

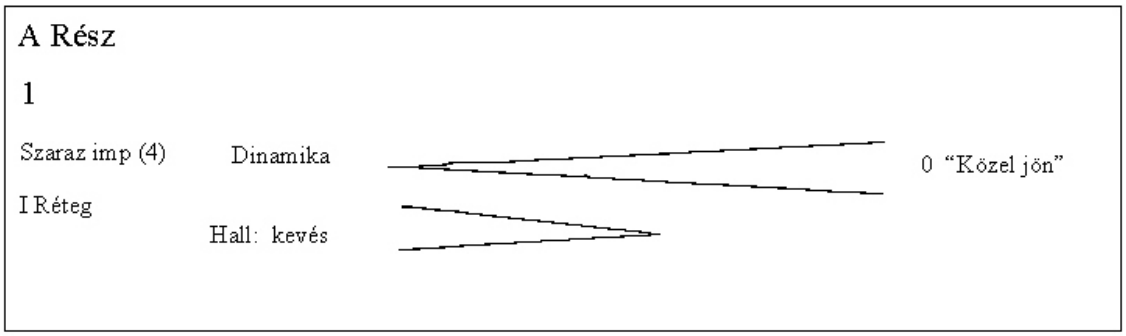

Figure 4.6. Reverberation Levels for *Artikulation*, Region A

In Region G of *Artikulation*, material fades from one channel into another, and here the sketches are similar. The Roman numerals here represent the different channels of the quadrophonic original, I being the front, II, the right, III the back, and IV the left; thus the spectra of this example, from about 1'10" into the piece, move smoothly from right to front and then from front to left, as shown in Figure 4.7.

[21]Figures 4.6 and 4.7 are transcriptions of sketches held in the György Ligeti Collection of the Paul Sacher Foundation, Basel, they are also reproduced in Wehinger, *Artikulation*, as Figures 13 and 16.

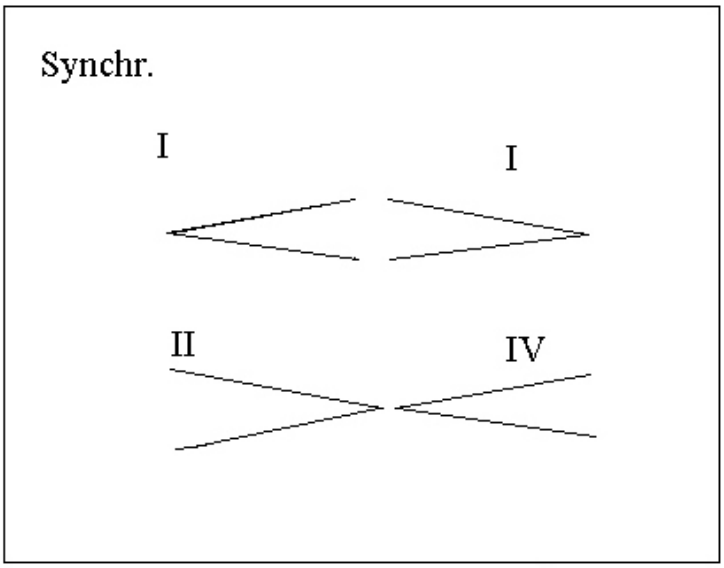

Figure 4.7. Synchronization of Channels for *Artikulation*, Region G

The use of cross-fading in the electronic studio was common enough for changes in timbre and spatial location, but using this kind of technique to fashion a type of glissando would not have been standard–it is a credit to Ligeti's imagination that he adapted it as such for orchestra.

Another unique use of cross-fading within the orchestra demonstrates quite clearly the difference in Ligeti's early use of cluster-like sounds and his mature practice; the celebrated texture of *Atmosphères* contains an illuminating example at rehearsal letter B. Up to this point, the piece has consisted of fully saturated chromatic clusters, yet here this cluster begins to divide. As shown in the reduced score, Figure 4.8, the strings playing the white-key diatonic collection crescendo to *ff* at the end of measure 17 while the strings playing the black-key pentatonic collection decrescendo to *pppp*; this kind of division is echoed by the winds where the oboes, bassoons, trumpets, and trombones, all playing

diatonic material, crescendo to a peak at measure 18, while the flutes, clarinets, and horns, all playing pentatonic material, peak in the following measure where the diatonic material has now subsided. Thus there are conflicting layers within the orchestra; dynamic shape draws out divisions based on pitch content and also on instrumental type, as the diatonic winds peak at a different point than the diatonic strings; this internally fluctuating clusters have an essentially different function from the clusters in *Észjaka* in which diatonic and pentatonic clusters were used consecutively in a stark contrast.

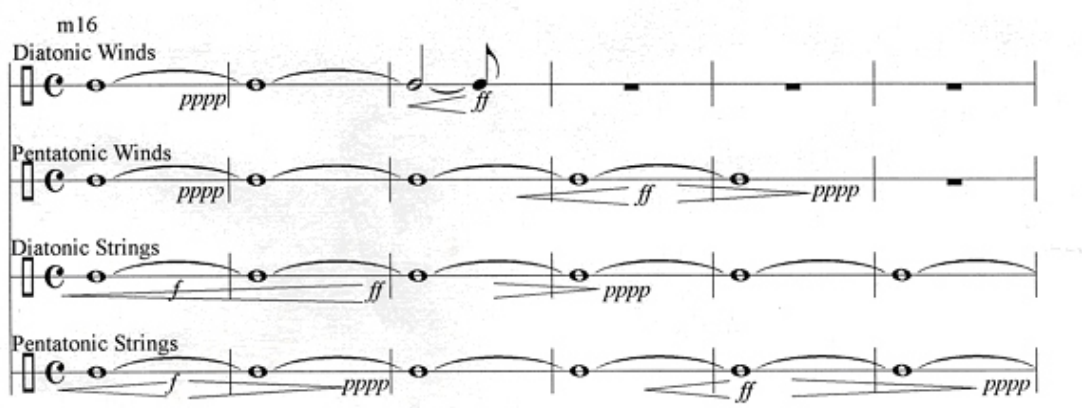

Figure 4.8. Reduced Score of *Atmosphères*, mm. 16-21

Gestures in Pitch and Other Parameters 2

Section B of *Apparitions* provides an example of another important family of gestures derived from electronic music; a unique glissando occurs in measures 62-63 the cellos and basses, which has a clear precedent in *Pièce électronique No. 3*. The lowest note of the chromatic cluster jumps upwards to become the highest, and as this process replicates itself, the entire cluster seems to crawl gradually upwards. The notes are represented in a line graph as shown along with the score in Figure 4.9. Coming just a

few measures after the cross-fading example, this gesture can be understood as a more advanced stage in the progression from stasis to motion. Here the individual parts each move once by a large leap, yet the whole sound creeps along continually, slowly, and with difficulty.[22]

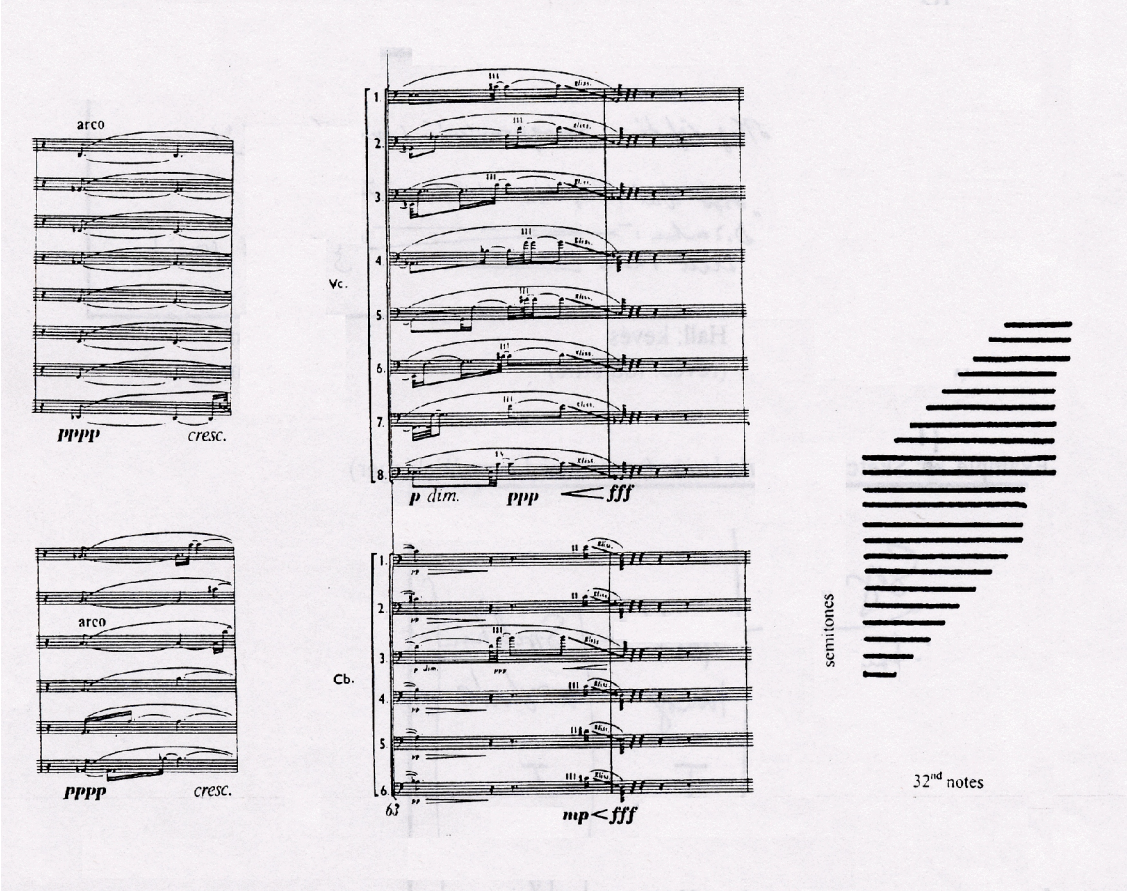

Figure 4.9. Score of *Apparitions*, mm. 62-64, with line graph

This type of glissing sound was originally attempted in Ligeti's unfinished, *Pièce électronique no. 3*, where, in fact, it constituted the predominant type of motion. A

[22]György Ligeti, *Apparitions* (Vienna: Universal Edition, UE 18326, 1964), 4-5. Reproduced with permission.

spectrograph of a passage from near the end of that piece (Figure 4.10) demonstrates these glissandi both ascending and descending. Furthermore, this same technique can be found in later works such as *Atmosphères*.

Ligeti produced a score for this piece which resembles this spectrograph in a remarkable number of ways. In his sketches, he also listed the succession of individual frequencies that could proceed directly from one to the next with no intervening rests. This would ensure optimum efficiency in recording these tones onto tape, and it also grouped these pitches and durations into individual lines and assigned them to a single production source–that is to a single "voice"–in a way directly analogous to the lines that each individual instrument plays in passages such as that shown above in Figure 4.9. This treatment of instruments in the manner of sine-tone generators is by no means incidental.

With other, slower, glissandi in *Pièce électronique no. 3*, the desired effect is slightly different, despite the similarity in construction. The sine tones used in *Pièce électronique no. 3* were most likely the result of Stockhausen's influence, and the pervading ideology of the Cologne Studio that the additive synthesis of sine tones (along with filtered white noise) should be able to produce any conceivable sound. In conversation with Peter Varnai, Ligeti explains that,

> my idea was that a sufficient number of overtones without the fundamental would, as a result of their combined acoustic effect, sound the fundamental... I planned to make music out of pure sine-waves with harmonic and subharmonic combinations, by introducing [these sounds] gradually, not all at once. I imagined that slowly, different composite sounds would emerge and slowly fade away again like shadows... When I tried to do all that in the studio, it turned out to be a quite

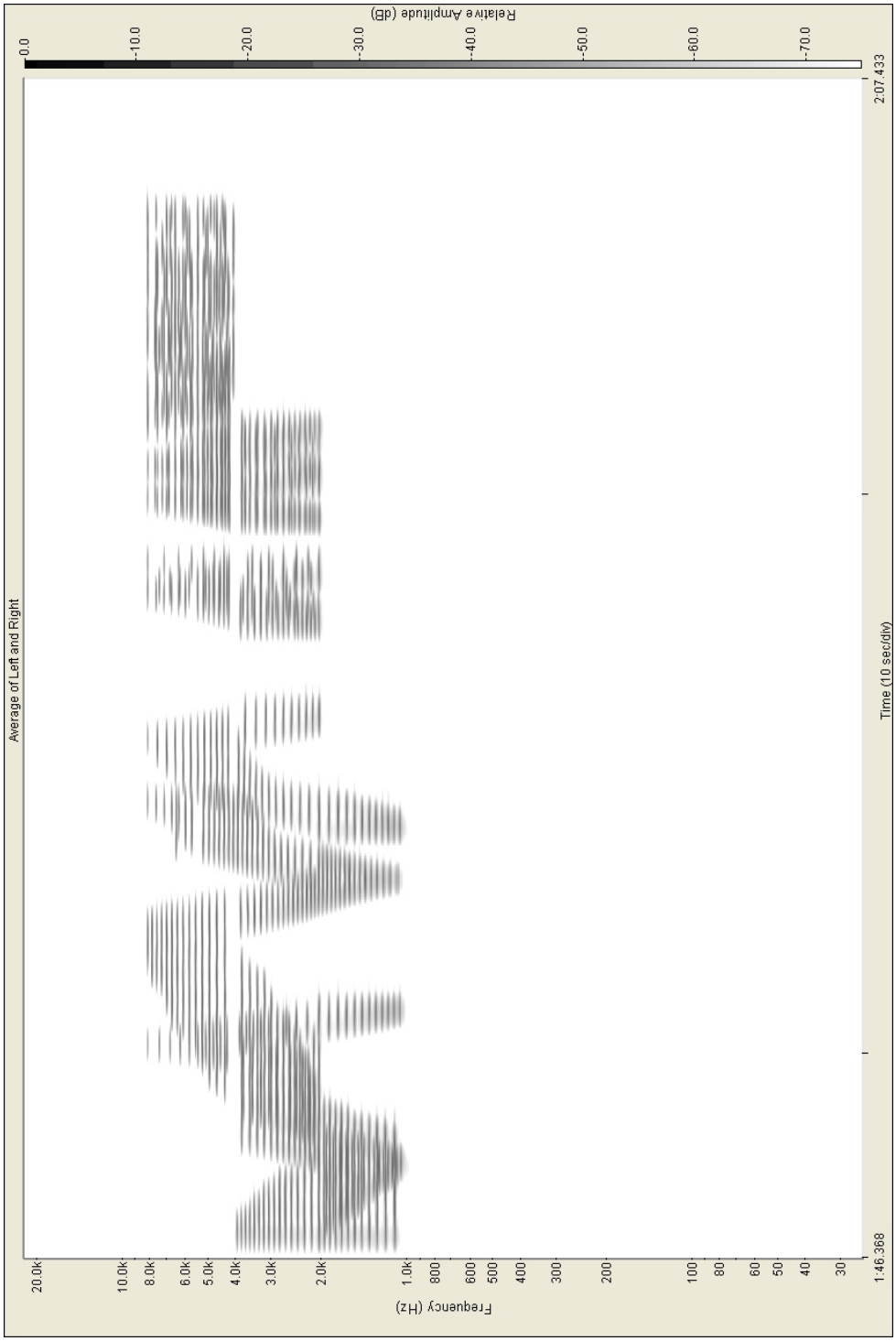

Figure 4.10. Spectrograph of *Pièce électronique no. 3*, end

> illusory idea, unfeasible. It dawned on me that the sound I wanted could be realized much more easily with an orchestra.[23]

Thus, one of Ligeti's goals was to excite audible frequencies which were not actually generated through the use of the studio's oscillators. The staggered entrances and exits of individual strands may have actually been his attempt to make these emerge gradually–when enough of the partials were sounding the fundamental would vibrate weakly, when more were present it would grow in strength. Although this experiment was not entirely successful, it demonstrates Ligeti's concern not with the purity of these sine tones for their own sake, as Stockhausen has implied was the case for his *Studie I*, but rather a concern with creating a gradually changing effect from discretely changing objects, which is quite similar to the effects already observed above.

Ligeti has remarked that, "to label instrumental music as 'natural' and electronic on the other hand as 'technical' or 'artificial' is misguided –there aren't really violin sounds, in 'nature' either, this is also quite artificial. The violin was built by man just as much as the electronic generator."[24] While this quote is somewhat glibly put, this study shows that there are indeed many similarities in the way that Ligeti treats traditional and electronic instruments in these compositions–not only in notational practice, or in their physical implementation, but also in his concern for the irregular or unpredictable elements in each. There is a similarity in the difference tones to be generated by *Pièce électronique no. 3* and the blurring to created by the piling up of instrumentalists' mistakes–in each

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[23] György Ligeti, *Ligeti in Conversation*, 37.
[24] Ligeti, "Auswirkungen," 77.

situation Ligeti is attempting to turn an irregularity of the system into a compositional tool. Moreover, Ligeti seems to treat the audience in the same way, relying on the limits of human perception for the success of other effects. This study has shown examples of gestures which rely on challenging the minimum units of perception of both duration, in the *Bewegungsfarbe* effects, and in intensity, with the cross-fading events. Each instance leads to a distinct and new aural construct, blurring the perception of pitch, and helping to undercut the independence of these "separate" parameters.

Strategies of Formal Design

Along with Ligeti's change in the treatment of material came a change in his treatment of musical form. The greater control of different parameters made available in the electronic studio led to thinking of form in terms of different layers. This much is clear from Herman Sabbe's study of Ligeti, in which he states,

> In summary, one might say that Ligeti's music is composed of different simultaneous layers, the course of which is, for the most part, not synchronized. From this asynchronous complexity the formal categories of *Continuity* and *Phase Displacement* arise.
> The form can only be described as polyrhythmic, as the intertwining of dimensions and variables, each of which demonstrates its own tempo: one tempo for register change, another tempo for timbre change, another for the change of interval-contours, etc.[25]

[25]Sabbe, Herman. *György Ligeti*. Musik-Konzepte 53, Heinz-Klaus Metzger and Rainer Riehn, eds. Munich, 1987, 28.

The degree of alignment of the design of various parameters is, indeed, a very significant tool in Ligeti's attempt to shape the form and its rate of change by controlling degrees of similarity and difference.

While other composers working in Cologne treated these different dimensions as separate parameters subject to predetermined serial ordering, Ligeti reacted against this idea, perhaps more strongly than any other aspect of serialism. In his lecture on form at the Darmstadt summer courses in 1965, Ligeti spoke of the results of such an extreme separation of stages of the compositional process into "perfectly self-contained" phases, concluding that, "in the various phases, compositional work was done in which the character of the hoped-for music was either only summarily anticipated or even not at all."[26] By contrast, in Ligeti's own music these phases tend to be organized with different global shapes and types of motion in mind. We already have seen one example of this in the explanation of Ligeti's alternative to the duration row and the rhythmic practice of *Apparitions*, where the composer allowed himself certain freedoms to shape the music with the global form in mind. Often in Ligeti's music these different layers–even when asynchronized–work together either to effect either gradual shifting textures, when only a few parameters change at once leading to weak formal divisions, or to bring about more abrupt changes, when multiple parameters change at once. These two divisions often correspond, respectively, to internal and external changes.

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[26]György Ligeti, "Form" in *Contemplating Music*, Carl Dahlhaus and Ruth Katz, eds. (translation uncredited) New York: Pendragon Press, 1992, 791. This was the text of a lecture given by Ligeti at the Darmstädter Interntionale Ferienkurse für Neue Musik in 1965.

Ligeti has described the difference between composed structure and received structure as, "the difference between music as such and musical form: 'music' would thus be the purely temporal process, 'musical form,' conversely, the abstraction of the same temporal process, in which the relations within the process are no longer temporal but present themselves as spatial."[27] While it is evident from the discussion above that Ligeti was deeply concerned with crafting connections perceived, in the temporal process, as internal or external changes, he was equally concerned with the conception of form as spatial, and indeed with the interaction between the spatial conception of form and the temporal process. With *Glissandi* and *Artikulation* we have seen two types of global shape to which Ligeti returns often in his later music. The large-scale form of *Glissandi* is an example of a skewed symmetry, achieved by the reversal of the tape with the addition of filtering; the form of *Artikulation* is a trajectory towards increased density and ending with the impenetrable mass of sound. These types of form are related in that they are often intuitive, readily perceptible, and easily described as processes (the global trends in both these examples are actually described by Ligeti in a matter of a few sentences). The main difference between the two is a matter of either ending where it began, or ending at a different point, usually at the other end of a sonic continuum from where the piece began.

Glissandi represents a type form that is easily conceptualized as symmetrical, although with this piece, and others of the same type, Ligeti goes to great lengths to disrupt or obfuscate this symmetry. In *Glissandi* the symmetry was emphasized by the

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[27]Ligeti, "Form," 783.

fact that the arching middle section (Section F and its retrograde) was coherent, and that the final F Section was filtered, letting the retrograde of Section A come through clearly. The symmetry was blurred, however by the disruptive filtering of the second half, the anomaly areas, and the presence of both prime, retrograde, and invariant figures in the second half.

One finds a later example of this symmetrical form in Ligeti's organ piece, *Harmonies* (1967). The pitch structure of *Harmonies* is highly symmetrical, and, as can be seen in Figure 4.11, the expanding, then contracting shape is highly reminiscent of the ring-modulated gestures in *Glissandi* itself. This piece is analyzed by Pozzi Escot,[28] who points out a number of other symmetrical parings such as finger pairings for the organist's hands through striking visual representations.

What Escot does not mention in her article is that this symmetry is also distorted. Ligeti provides a full page of instructions on how the organ is to be prepared, including any number of ways to reduce wind pressure to the pipes. One section of this score, labeled, "fluctuation of intonation and dynamics," states that,

> Half-drawn stops, half-depressed keys, and pipes (especially reeds) that do not speak properly due to too little wind pressure all cause fluctuations of dynamics and intonation (micro-intervals, glissandos, etc.). 'Impurities' of this kind are welcome in realizing the piece; they contribute further to the denaturing the tone colours. The notated pitches in the musical text, then, refer only to the keys to be depressed or held; the succession of pitches that actually results can fluctuate freely; the 'harmonies' are 'tainted' and more or less diverge from the written text.[29]

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[28]Pozzi Escot, "'Charm'd Magic Casements,' Mathematical Models in Ligeti" *Sonus* 9, no. 1, 17-37.
[29]György Ligeti, *Zwei Etüden für Orgel* (Mainz: B. Schotts Söhne, 1969), 4.

Thus the symmetry described by Escot reflects only the background structure of the music, much like the schematic description of *Glissandi* as the prime form, followed by the simultaneously running prime and retrograde forms, and in each case there, this symmetrical spatial structure is presented through another compositional layer altering the way this schematic form unfolds in time, and enriching its complexities and nuance.

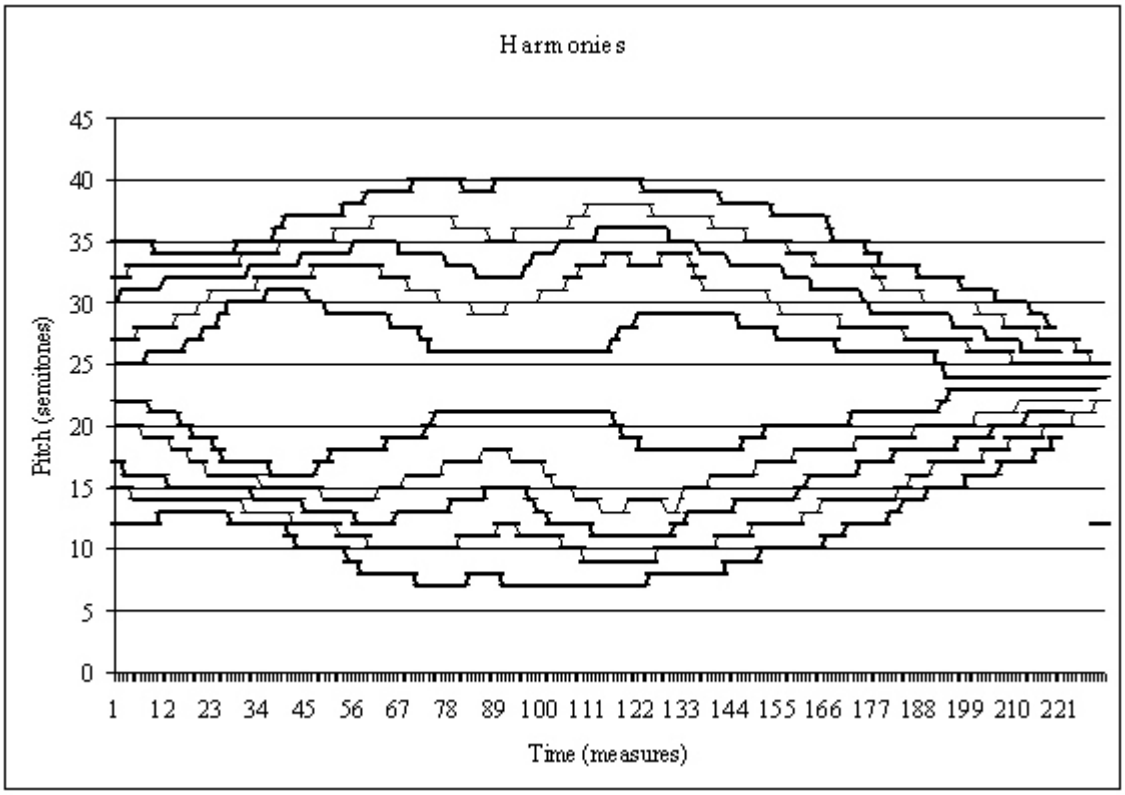

Figure 4.11. Symmetrical Pitch Structure of *Harmonies*

The schematic description of *Artikulation* involved a progression from contrasted material to dense conglomerations of sound, and was a particularly complex progression involving the recombination of multiple parameters of sound. While oppositions such as

compact and diffuse material and spatial location established contrasts at first, these are eventually undercut to help achieve this goal of complete mixture.

Other compositions by Ligeti define trajectories in other parameters as a global direction for their forms. *Pièce électronique no. 3* and the first movement of *Apparitions* share a common trajectory in terms of register; both pieces begin in the lower part of their range, and end in the extremely high register. Moreover, both pieces play with the distinction of external and internal as part of their schematic forms. In Ligeti's description of *Apparitions* he maintains that the impulsive events, such as the sharp staccato notes and the "wild" passages, mentioned above have an effect on the more sustained clusters (what Ligeti terms "states"), "because the degree of state alteration is approximately proportional to the attack strength of events, the impression is created of a causal relationship between event and state alteration. This causal relationship is of course only apparent: it is an element of a merely imaginary musical syntax."[30] Thus the internal agitation of the sustained clusters is effected by their bombardment with external impulses. At the climax of the movement, this relationship, significantly, coincides with the registral plan for the movement. As Ligeti describes it,

> a particularly penetrating *pizzicato* [m. 73]... is the strongest attack that has occurred in the movement and thus must have (in conformance to the compositional principles in use) the furthest-reaching consequences. Actually the entire form is tipped over at this point. This is accomplished through a sudden alteration of register: up to now the deepest registers have dominated... from now on the high registers are in command, the lower remaining only here and there as traces. This register reversal (inversion) represents the most striking development

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[30]György Ligeti, "States, Events, Transformations" (trans. Jonathan Bernard) in *Perspectives of New Music*, vol. 31, no. 1 (Winter 1993), 170.

> in the whole extent of the movement, whose entire architecture is illuminated by this sudden flare.[31]

Thus the movement's "architecture" must be understood as consisting of shapes determined by two main strands, one relating to register and the other relating to this distinction of states versus events (a distinction which involves oppositions such as attack strength, and sustained-clipped), and it is the point at which both these strands move at once that Ligeti identifies as the climactic and illuminating moment of the piece.

While Ligeti has denied any explicit connection between *Pièce électronique no. 3* and the orchestral work *Atmosphères* (which took over the working title of the unfinished electronic piece), nevertheless, a significant connection exists between the first movement of *Apparitions* and the third electronic piece–namely that they have the same approach to form based on the combination of registral shift and the interaction of internal states and external events. The sketches for this piece include a "Structure 7" occurring 6,000 cm (approximately 79 seconds) into the piece. Ligeti's sketches identify the material simply as impulses, and without further indication, this structure was left out of the Sonology Institute's realization. Significantly, however, this is also at this point in the piece where one finds both a shift from lower to highest register, and also a shift from sine tones to filtered noise as the main type of material–this much is shown in a spectrograph of the version of this piece completed at the Sonology Institute (Figure 4.12). Thus, the event-like impulses can be viewed as external to the cluster like states which precede it, and can also be heard as having the same type of imaginary syntax, breaking the sine-tone clusters

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[31]Ligeti, "States, Events, Transformations," 167.

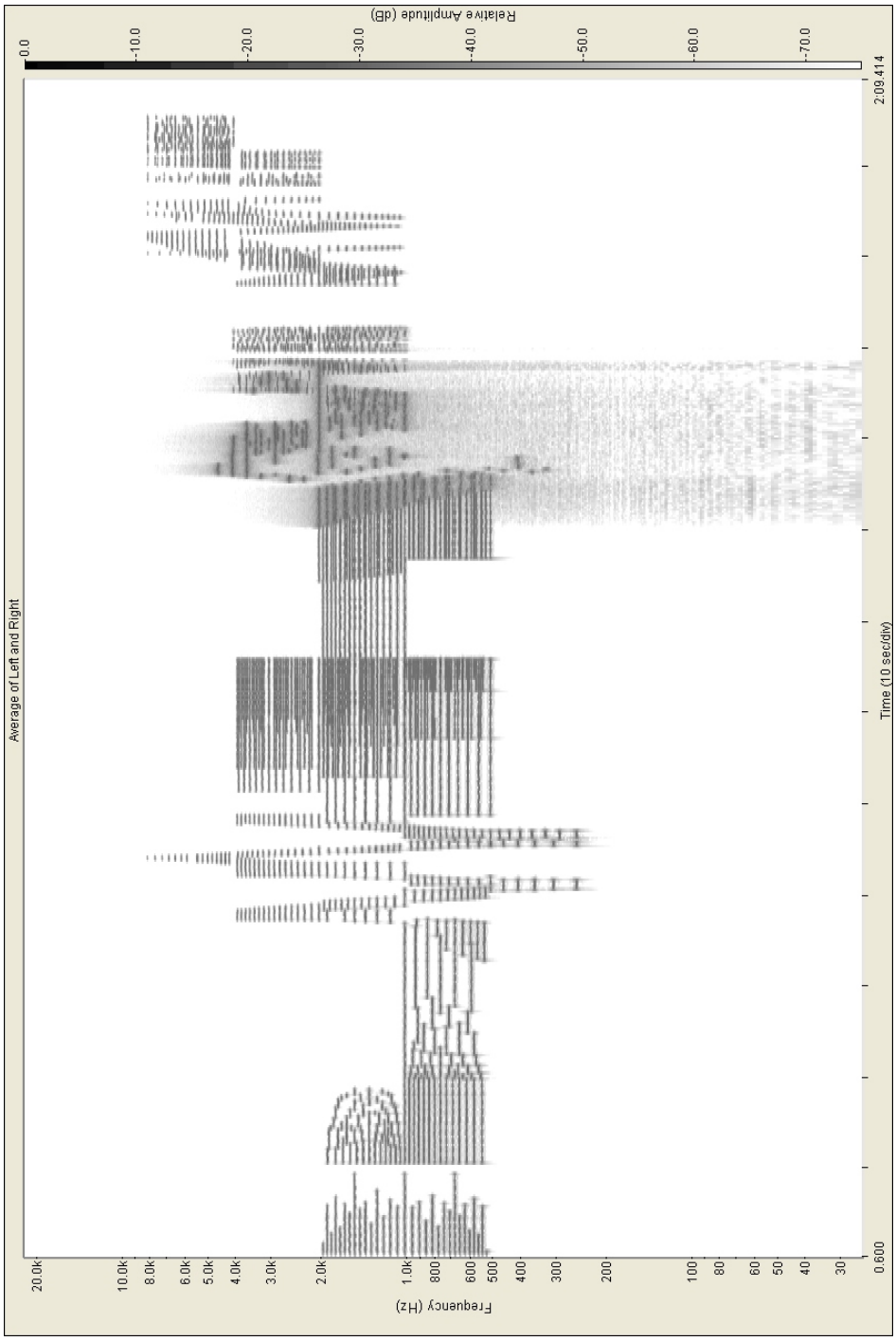

Figure 4.12. Spectrograph of *Pièce électronique no. 3*, Entire Piece

into filtered noise and shifting the register higher. In *Apparitions*, this process is extremely gradual, taking the length of the entire movement, a duration of eight minutes; in *Pièce électronique no. 3*, however, this happens very quickly, in a matter of seconds.

Thinking about form in terms of different layers defined by different dimensions also elucidates one of the principle differences between *Apparitions* and *Atmosphères*. After finishing the pieces where internal changes were contrasted with external ones, Ligeti set out to compose a piece where the external influence was minimal. He describes *Atmosphères* as, "just a floating, fluctuating sound, although it is polyphonic."[32] The emphasis here is on the singular–*one* sound, with the polyphonic elements relegated to fluctuating internal dynamics. This is achieved in *Atmosphères* through a number of means. The feeling of continual fluctuation occurs through instrumentation, most notably the absence of percussion which played such an important role in the external events of *Apparitions*. The musical surface of *Atmosphères* is also designed for continuity. Unlike *Apparitions*, where some points on the ametrical grid were filled by silence, the surface of *Atmosphères* is notably more continuous–rests are almost completely absent.

This continuity helps smooth over other divisions in the piece, such as the notable shift in register which occurs at rehearsal letter G (3'51"), where the extremely high cluster of the piccolos and violins is suddenly taken over by the *ffff* entrance of the contrabasses. Even this division, which is clearly seen on the spectrograph (Figure 4.13), can be heard as a type of transformation, as if the pitch-continuum were circular and the natural extension

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[32]*Ligeti in Conversation*, 14.

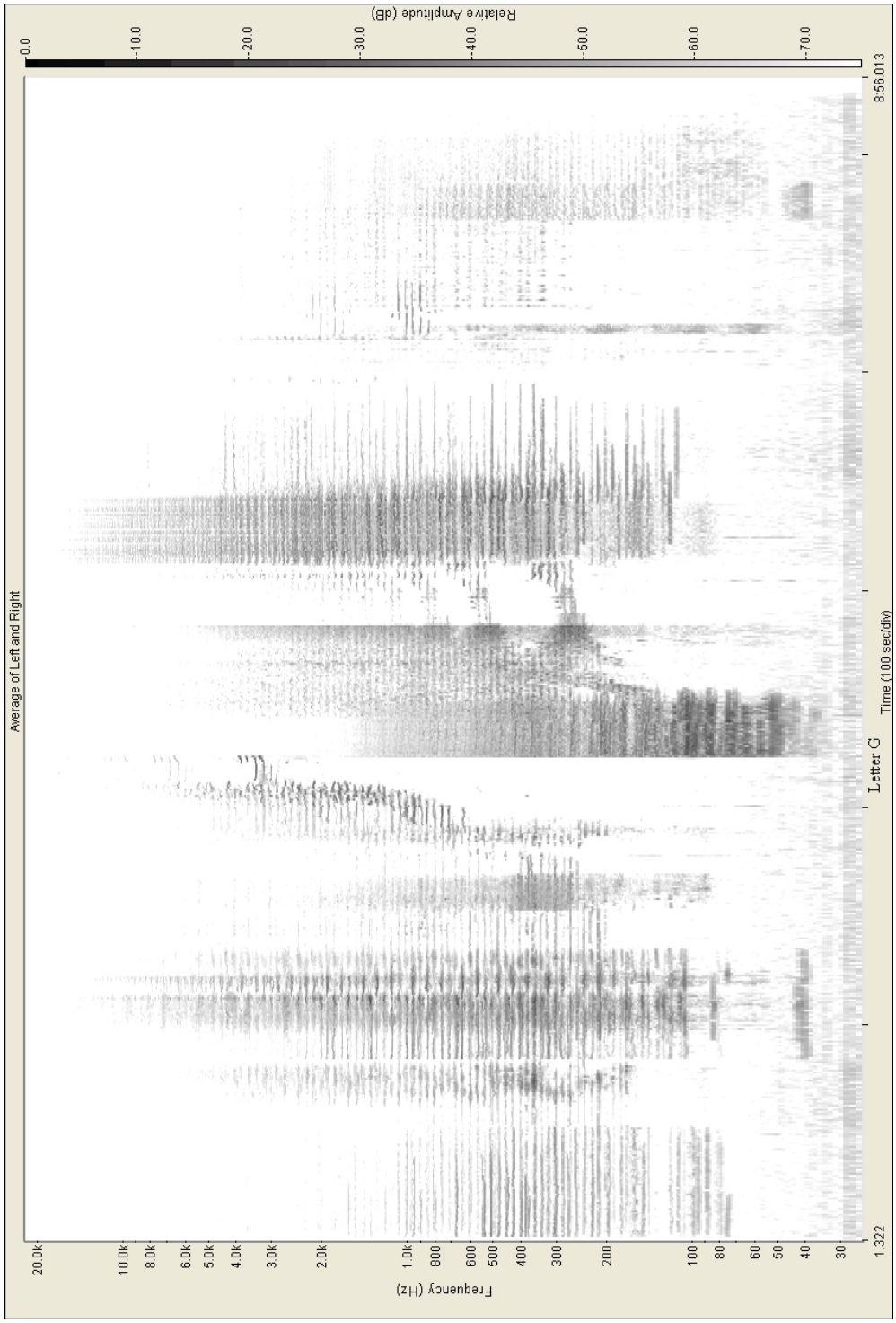

Figure 4.13. Spectrograph of *Atmosphères*, Entire Piece

of this upper register arrived back at the lower as a matter of course. Unlike the register change in *Apparitions*, several oppositions support an interpretation of *continuity*, in spite of the fact that this is the largest registral shift in the piece. First of all, there is a continuity in dynamics; the piccolos crescendo into this change, arriving very swiftly at the same *ffff* marking with which the basses continue. There is also a continuity in that both clusters use extreme (as opposed to centered) material; if the piccolo cluster suddenly moved back to the middle-register which began their ascent, we would most likely hear this repetition as a new beginning, and thus a more distinct division than a continuing development.

The duration scheme for *Atmosphères* is also calculated to avoid repetitions of segment lengths, and thus support the continuity of the piece. Ligeti gives the following series of durations (in seconds) for the rehearsal letters of this piece–as before, the letter given is the rehearsal letter which ends each section.

Table 4.5a. Section Durations for *Atmosphères*

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
48	29	55	37	6	23	33	14	21	18	5	8	10	26	43	16	9	12	4	7	73

The final duration is altered in the score to 71 seconds and is followed by a prescribed 19 seconds of rest (again a unique value). When arranged in order, one can see that the proportions between sections are calculated in a manner similar to the scales used in determining durations for *Artikulation*; here the proportion between sections ranges from 1.06 to 1.33, when calculated to two decimal places, furthermore, as shown in the right-

hand column of the chart below, the change from 73 to 71 seconds for the final section, and the addition of 19 seconds of rest does not change this fact.

Table 4.5b. Scale of Section Durations for *Atmosphères*

4	
5	1.25
6	1.20
7	1.17
8	1.14
9	1.13
10	1.11
12	1.20
14	1.17
16	1.14
18	1.13
21	1.17
23	1.10
26	1.13
29	1.12
33	1.14
37	1.12
43	1.16
48	1.12
55	1.15
73	1.33

4	
5	1.25
6	1.20
7	1.17
8	1.14
9	1.13
10	1.11
12	1.20
14	1.17
16	1.14
18	1.13
19	1.06
21	1.11
23	1.10
26	1.13
29	1.12
33	1.14
37	1.12
43	1.16
48	1.12
55	1.15
71	1.29

Moreover, when these are arranged in order in the piece, Ligeti reorders these segments, avoiding any clear trajectory and also never placing two sections with the same proportion next to one another. Thus while the duration scheme in *Apparitions* was used to emphasize the relationship between internal and external changes, in *Atmosphères*, the composer fastidiously avoids any proportional similarities that could create a sense of equivalence or parallelism. Thus the duration scheme here supports the continuous and gradually changing surface in creating a sense of continual development and reinvention.

While the form of *Atmosphères* is clearly indebted to the interplay between different dimensions of timbre–an aspect of formal construction we have previously associated with *Artikulation*–another feature of the rhythmic practice combines this with the skewing of schematic form mentioned in connection with *Glissandi*. Ligeti discusses his tempo markings saying that, "It was typical of me that I gave the exact duration of each formal section in seconds and then wrote on the first page of the score that both duration and metronome markings are simply approximate indications."[33] Thus while the proportions of the piece are geared towards this perception of continual fluctuation, they may not be strictly observed. This is unlikely to dramatically effect the way the piece unfolds, yet Ligeti's acceptance of this kind of "impurity" is a significant aspect of his later composition.

Conclusions:

The final chapter of this study has focused on *Apparitions* for a number of reasons. As it is the first piece which Ligeti composed after the electronic works, it is here that many of the compositional devices are most clearly transferred from the electronic to the acoustic medium, and thus a thorough understanding of *Apparitions* is foundational to any investigation of Ligeti's later acoustic works, as the brief discussions of *Harmonies* and *Atmosphères* have shown. Ligeti's concern with internal versus external change and the

[33]Ligeti in Conversation, 43.

rhythmic design of stasis as well as his use of the gestures and formal strategies developed here continue throughout his oeuvre, and are essential to his characteristic style.

In this study of the origins of this style, we have seen Ligeti persistently strive for a balance between the type of formalism associated with serial and his perceptually-oriented instincts; this balance which lies at the essence of his experiences in the Cologne studio. Many of the composers working at the WDR Studio saw the pairing of serial and electronic music as the union of the most advanced compositional techniques of the day with the most advanced technology, and strove to use the newfound control afforded by this technology to drive the serialization of all separate parameters.[34] Ligeti's approach is radically different from this and in all the aspects of this study we have seen him use serial techniques to investigate materials, but has left out strict ordering procedures in favor of those which will support the perception of a global form. In rhythmic design Ligeti's alternative to using serial duration row first appears in *Artikulation* and then in *Apparitions*, where each step of the process of construction is undertaken with the resulting whole in mind. Ligeti's concern is not with form as the unveiling of its compositional process, or as the articulation of the underlying series, but as the listener's perception of the finalized piece. Within this rhythmic framework, the pitch-designs and gestures Ligeti develops can also be seen as putting perceptual considerations over existing formalisms. While many of these gestures relate to the "modus" idea of

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[34]See for example, Herbert Eimert,"What is Electronic Music?" trans. Cornelius Cardew, in *Electronic Music*, Vol. I of *Die Reihe* (Bryn Mawr, Pennsylvania: T. Presser; London: Universal Edition, 1958, German edition 1955).

Stockhausen's electronic studies, in Ligeti's music they are not used to reinforce the identity of elements of a series, but rather to blur the distinction between motion and stasis, and while many serial composers sought to develop other parameters in the model of equal-tempered pitch, by subjecting them to the same types of serial transformations, Ligeti brought about other sorts of transformations which undercut the primacy of pitch by showing its dependence on rhythm and dynamics.

Ligeti has always resisted being placed into any single musical camp or being associated with any single ideology; perhaps then, it should not be surprising that the parallel influences of serialism and electronic music are used so uniquely in *Apparitions* and Ligeti's later compositions. In the early years of the Cologne studio, Stockhausen, Eimert, and most of the other composers working there saw electronic music as a means to produce perfectly proportioned, and somehow, "pure" compositions, which could be rendered with clinical precision. Ligeti often focused on the irregular aspects of both electronic and acoustic media, and how they intersect with the imperfect nature of human perception; while on one hand this study has shown how Ligeti is indebted to serial thought and electronic music, it must also show how these intense perceptual concerns, also developed through work in the studio, set him apart from his contemporaries, and at least in part, how he developed his truly distinctive voice.

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Sketch Materials

All of Ligeti's papers, sketches, and fair copies of scores are held by the Paul Sacher Foundation in Basel, Switzerland; those discussed in this dissertation came from the Foundation's György Ligeti Collection, and were examined by the author in June, 2004.