Sonic Mysticism and Composition
by

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This dissertation by Kristina M. Wolfe is accepted in its present form by the Department of Music as satisfying the dissertation requirement for the degree of Doctor of Philosophy.

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Vitae

Kristina Wolfe is a composer, electronic musician, thing-maker, and multi-instrumentalist. Born in Tampa, Florida on March 3, 1984, Wolfe is of Danish and American heritage, and spent many of her formative years wandering through the forests of Mols Bjerge (near the city of Århus) in Denmark, listening to the sounds of space and place. This environment, rich with mysterious stone markers, history, and ancient roadways, cultivated her imagination and creative focus on the spirits of the past, and has inspired her work and listening practices up to the present day.

Wolfe has always composed music, but became interested in electronic music as an undergraduate at Florida International University in Miami under the direction of Dr. Kristine Burns, and graduated in 2007 with a B.A. In Music Technology. As an undergraduate, her work for Viola da Gamba and Electronics was presented at the International Computer Music Conference, the International Alliance for Women in Music Conference, and the Third Practice Electro-Acoustic Music Festival, in 2006. In 2007, she was the Greg Altman Media Intern at the Deep Listening Institute at Rensselaer Polytechnic Institute (RPI), under Pauline Oliveros.

Wolfe then went on to study at Dartmouth College under Jon Appleton, Michael Casey, Charles Dodge, Larry Polansky, Christian Wolff, and Kui Dong, where she graduated in 2009 with an M.A. In Digital Musics. While at Dartmouth, Wolfe was awarded an International Computer Music Association Scholarship, and was chosen for a 2008 residency at Visiones Sonoras in Morelia, Michoacan, Mexico under Dennis

Smalley, as well as several university and other fellowships and awards. Other notable teachers include Paul Lansky, Robert Hasegawa, Dennis Bathory-Kitsz, and Dan Trueman.

More recently, while at Brown University, while studying with Butch Rovan and Todd Winkler, Wolfe was awarded residencies at the 2013 Ostrava New Music Festival in Ostrava, Czech Republic; the 2013 Composit Festival and Institute in Rieti, Italy (under Philippe Leroux, Josh Fineberg, and Davide Ianni); and the Centre D'Art Contemporani I Sostenibilitat El Forn de la Calc in Calders, Catalonia, Spain. Her work has been featured at the Darmstadt International New Music Festival (2012), the International Computer Music Conference (2012), the Electro-acoustic Music Studies Conference (2013) and many others. Her article, *Sonification and the Mysticism of Negation* was published in Organised Sound in 2014.

In the next year, she will be a resident at Bang-On-A-Can Summer Festival at MASS MoCA in Western Massachusetts, an ISCM VICC Composer-In-Residence, and training in the Deep Listening certificate program at Rensselaer Polytechnic Institute. She was also a finalist for the 2016 Viol Composition Competition (Viola da Gamba Society) and the 2014 Pauline Oliveros Prize (IAWM Search for New Music). She was semi-finalist in the Villiers 2016 New Works Composition Competition.

She currently lives in Florida with her husband.

Acknowledgments

There are a number of people I would like to thank: First, my husband, Doug and my parents, grandparents, aunts, uncles, cousins, and in-laws. I would like to thank my very first music teachers: Brian Donahue, Brett Dawson, Jackie De Los Santos, and Luis Gomez-Imbert. Then, I would like to thank my teachers, mentors, helpers, and advisors from college, grad school, and beyond (not in any order): Kristine Burns, David Dolata, Orlando Jacinto Garcia, Joel Galand, Thomas Owen, Michael Casey, Jon Appleton, Kui Dong, Charles Dodge, Larry Polansky, Christian Wolff, Newton Armstrong, Paul Lansky, Dan Trueman, Daniel Heller-Roazen, Robert Hasegawa, Petr Kotik, G.F. Haas, Horst Kloss, Leigh Landy, Lu Wang, Butch Rovan, Todd Winkler, Josh Fineberg, Davide Ianni, Paul De Marinis, Ed Osborn, Lucky Leone, Paul Badger, Margaret Schedel, Pauline Oliveros, Carol Ione, John Ferguson, Jim Moses, Carlos Dominguez, Eric Lyon, Kim Cascone, Kraig Grady, Joel Chadabe, Georg Hajdu, David Toop, Paula Matthusen, Kersten Lehmann, Soomi Lunau, and Dennis Bathory-Kitsz.

I would like to thank my friends and classmates in the meme program (Akiko Hatekeyama, Jacob Richman, Peter Bussigel, Frieda Abtan, Kevin Patton, Robbie Byron, Caroline Park, Stephan Moore, Mark Cetilia, Jinku Kim, Asha Tamarisa, Jordan Bartee, Bevin Kelly, Luke Moldof, and Brian House) and my friends who have supported me along the way (you know who you are). Thank you.

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Project Description and Intention

My dissertation project consists of an album of three pieces based on mystical processes and shimmering intonation systems, a series of scores, and a Codex of imaginary illuminated works. I was driven to create these systems to break out of my creative habits and discover new ways of working. This direction was inspired by research on holy numbers and their relationship to temperament and knowledge, Deep Listening, EVP (Electronic Voice Phenomenon), Infrasound, medieval traditions, and my readings in archaeoacoustics and aural architecture. These studies led to meditations and reflection on sound, the perceptual characteristics of space and objects, and the creative use of these characteristics.

Specifically, my research on holy numbers and temperament led to explorations of the *quadrivium*, and ancient notions of the limits of 'knowing' through *quanta* (quantity/ Number/mundane/measure) and *qualia* (quality/experience/divine/immeasurable). I was fascinated by this world view—especially the historical notions of the immeasurable and methods devised to comprehend that which, by definition, can never be fully understood. According to these ancient doctrines, hidden aspects of the world can be 'transcribed' and reproduced through numerical sound (q*ualia* can be accessed through the use of *quanta,* but *qualia* cannot be understood using *quanta).* The aesthetic profundity of the experience was proof that the listener had discovered and learned to conjure something immeasurable (divine). Patterns of the world could be comprehended through sound, but

the mechanism by which this knowledge was attained was mysterious and interpreted as sacred. This ancient perspective returned in the Victorian era due to the incorporeal quality of recorded sound. Recordings, because they reproduced the ephemeral, seemed to prove the shrouded existence of the Unseen by documenting its movement in the air (vibration). Sentiments resembling these can be found in philosophies on recording, sonification, and microtonality, but this level of speculation on the origin of disembodied sound has become uncommon in contemporary listening.

Specialized listening practices such as *Deep Listening* can train the ear to hear these presences in the world in a holistic, mystical, and imaginative way. This is similar to medieval eremitic traditions that listen to the songs of the world and can hear the voice of nature. These kinds of listening practices train the ear to hear subtlety and meaning. For listeners, training in sonic attention, imagination, and non-judgement can foster empathy and a deeper appreciation for the sound world.

The presumption of meaning in sound has a profound effect on its reception and I explore this at length in this dissertation. Scholars such as Jean-Luc Nancy and Don Idhe have studied how sounds are perceived differently when they are assumed to be meaningful, and in Archaeoacoustics, Aural Architecture, audio analysis, and paranormal studies, this recognition of presence can be defined in relatively quantitative terms. This *quanta* permits the composer to investigate (or gives the composer the impression of being able to investigate) the *qualia* of presence.

The *quanta* (recordings or transcriptions of the mystical sonic experience), can be used creatively, and in electronic music and spectral techniques (such as instrumental synthesis), an appreciation of these phenomena may add dimension to musical works. In this project, the resulting music, dissertation, scores and mode of listening are intended to 1) promote curiosity and attentiveness to the present, 2) inspire exploration of listening habits and knowledge, and 3) serve as historical background and inspiration for listeners to reflect on the role of attention and imagination in appreciating their experience of the world.

The mystical systems I built reveal presence and give rise to curiosity in the world in the following ways:

1. as mediators of experience
2. as conjurers of experience
3. as documentation of notable experiences
4. as perceptual experience-seeking systems
5. as exploratory tools

Process music and generative systems are well-suited to bring out the mystical in sound and to bend the compositional intuition. As conjuring or divination tools, the

system can be set to generate work based on rules or spells. These rules/incantations are expressed in the experiential-ephemeral domain and become mystical through the mediation of the invisible.

Sound is a mediation of the invisible. The systems and tools that I have made mediate between my perception and the experience. As a mediator, the systems permit me to go beyond my compositional and imaginative predilections to look for things that I may not have been able to imagine, and allows me to explore my listening without having to remember every detail of the process. Automating small-scale decisions in my compositions allows room for prototyping imaginary forms and compositions embedded within the generated material. This process transforms the composer into a listener, experiencer, or audience member and changes the emphasis of a work from personal expression to something similar to storytelling. These works are generative—not through-composed; they are based on experiences I have had and wanted to share.

Musical systems are also a way to explore knowing and epistemology because emergent, sonified, and generative systems are never objective. The rules and preconceptions of a system are determined by the designer. Designing a system brings this process of rule creation into the foreground of a work and is a form of contemplation for me. When implementing historical or magical systems, the process of learning and researching historical context for a system is academically rewarding. I learn about the

world from a new perspective and use these perspectives to reflect upon my work.

The compositions I have created mark three points in this process: 1) *Kyrie*: the first point where I composed work using a glowing pitch system[1] 2) *Agnus Dei:* the point when I composed a work based on a structured historical ephemera-driven process, and 3) *Ebbinge*: exploring the relationship to magic and conjuring in emergent processes. The recordings are records of my intentions and are examples of the phenomena and micro-events in my work. With the Codex and scores, I try to find a notation system that materially represents my process and illustrates some of these concepts.

My Listening Inspiration

> *I believe when I am in the mood that all nature is full of people whom we cannot see, and that some of these are ugly or grotesque, and some wicked or foolish, but very many beautiful beyond any one we have ever seen, and that these are not far away when we are walking in pleasant and quiet places. Even when I was a boy I could never walk in a wood without feeling that at any moment I might find before me somebody or something I had long looked for without knowing what I looked for. And now I will at times explore every little nook of some poor coppice with almost anxious footsteps, so deep a hold has this imagination upon me. You too meet with a like imagination, doubtless, somewhere, wherever your ruling stars will have it, Saturn driving you to the woods, or the Moon, it may be, to the edges of the sea. I will not of a certainty believe that there is nothing in the sunset, where our forefathers imagined the dead following their shepherd the sun, or nothing but some vague presence as little moving as nothing. (Yeats, 2004, p. 45)*

When I was a child, I spent many summers wandering in the woods with my brother and cousins in one of the oldest areas of Denmark called *Mols Bjerge*. People

[1] see the chapter titled: *Presence in Sound: Glowing and Shimmering*

have settled near this natural harbor since the Neolithic Era, and many remnants of the past remain, such as roads, barrows, and dolmens. The adults in my family used to like to tell us about the history and purpose of these monuments and numerous “legends” about the various incorporeal beings that inhabited the area. As children with children’s imaginations, we took these stories as practical advice on what to look out for while alone in the woods.

One legend told of malevolent trees that would intentionally re-position themselves so they could confuse travelers and trap them in the forest forever. Another mentioned a spirit who walked to the sea at sunset and would turn anyone who saw her into stone. Other ideas would seemingly just invent themselves, especially when alone and left to come up with explanations for evocative situations.

These supernatural risks meant that we needed to pay attention to our surroundings, for even if spirits were not interested in us, they were still all around us; they assumed the form of imagined observers and watchful eyes. While we could not see them, they were aware of us and chose not to act upon our presence. My working assumption was that I could learn to recognize them by listening to the changes of space in place. Most have had the experience of having a bad ‘feeling’ about a place or sensing something under the bed (or in the dark) as a child. This heightened, primed attention is a highly creative, curious and imaginative state. I realized,years later when

reading accounts of archaeoacoustical sound scholars, that my technique for sensing fantastical creatures was centered around listening for subtle differences in the soundscape and could be used to expand my listening practice. Once the imagination is primed for the recognition of the uncanny, even the most common sounds are rendered strange, meaningful, and engrossing. The unusual reflection of a rock or tree can sound as though there is something lingering just out of sight. The eye can see that there is nothing, but the mind cannot shake the distrust, curiosity, or unease that results from sensing an unknown—or the Unknown.

An Imagination Turned Towards Listening

From the perspective of the composer or sound artist, this raises a few technical questions. Mysterious presences can be interpreted from many angles. A composer can prime the listener with stories and descriptions or even attempt to recreate work reminiscent of this space in hopes that the effect will reproduce itself. Were there unique timbral characteristics to the sound that imbued it with an uneasy sense of presence? It is difficult if not impossible to determine whether a sound is inherently strange or if the 'thinking' made it so.

Sounds without visually-apparent sources (or sources of manipulation) have always been a source of aesthetic interest in electronic music, and inspired some of the

first electronic modes of listening such as *musique concrète* and acousmatic music. These modes of listening typically characterize invisible sound sources from a formalized aesthetic perspective—with emphasis on their form and shape. They trade in image but not visions. The implicit perspective in these methodologies is that people are not visited by spirits during a work; the veil of reality remains firmly in place. When listening while seated in a closed space, it is not customary to believe that the body has moved. The perception of motion is believed to rest solely inside the imagination, and the impression of the experience is considered less real than an experience that can be seen, felt, or recorded scientifically. Stockhausen criticizes this in his *Four Criteria of Electronic Music:*

> *Our conception of truth of perception is entirely built on the visual. It has led to the incredible situation where nobody believes somebody else if he can't see what it is. In every field of social life you find this need to establish everything in visual terms, because what you cannot see people do not believe . . . when they hear the layers revealed, one behind the other, in this new music, most listeners cannot even perceive it because they say, well, the walls have not moved, so it is an illusion. I say to them, the fact that you say the walls have not moved is an illusion, because you have clearly heard that the sounds went away, very far, and that is the truth. (Stockhausen, 1972, pp. 107-108)*

In my work, these mysterious sounds and spaces strike me as similarly (and singularly) inspiring, and very much like the magical wall that Stockhausen heard. I use many of the same techniques as in the formalized listening modes mentioned above, such as attention to timbre, gesture, and space. The primary difference is that I believe perceptual

incongruities, such as Diana Deutsch's album *Phantom Melodies* (Deutsch, 2003) or any optical illusion, should not be treated as a daydream. Like Stockhausen's wall, the world has moved, and ghosts have appeared. The mind has learned to see it.

In my practice, I seek out and discover sounds in their own realms, record their "pathetic triggers" (Voegelin, 2006, p. 13) in material forms, and attempt to capture and record their experiences in my memory. The sounds of interest to me are heard to come from other worlds or represent the voice of the world. Instead of choosing to believe these particular sounds are projections, I hear them as real meetings with "sonic strangers", and use the tools of electronic music to transcribe and reflect upon the experience. "Transcription" and "reflection" are both terms reminiscent of measure, but my recordings are personal markers of fantastical occurrences that were experienced once and perhaps never again. "Transcriptions" and "recordings", in this case, are more like travel journals or bestiaries than atlases. They are reminders of compositions I have not written.

Mystical Listening

> *"The laws of logic which ultimately govern the world of the mind are, by their nature, essentially invariable; they are common not only to all periods and places but to all subjects of whatever kind, without any distinction even between those that we call the real and the chimerical; they are to be seen even in dreams."—Comte, Cours de Philosophie (Patterson, 2011, p. 244)*

This paper combines three approaches to sound mysticism: practice-based approaches (such as Deep Listening), mystico-theoretical/structural approaches (like Stockhausen or Radulescu), and poetic inspirational research-based narratives (like Jonathan Sterne, Barry Blesser, or David Toop). The aim of this dissertation is to give theoretical context, creative motivation, and process-based guidance on understanding and creating the mystical work. It is also a guide to understanding my work and the reasoning behind the dissertation project. I hope to expand and collect the research on this kind of sound divination as a way in for those who might not fully grasp the reasoning and influence of mystical sounds. I hope this dissertation helps clarify not only how phantom and apparitions might be found in sound, but why.

There is a scientific and academic bias towards quantitative data and logic to prove something, rather than qualitative, intuitive, phenomenological understanding. This tradition, when applied to art and contemporary composition, tends to prioritize the musico-theoretical underpinnings and rational justification of a work over the irrational and mystical aspects of the same work.[2] This is problematic in the mystical work, where there is a natural tension that exists between "capturing the metaphysical/spiritual/ amorphous" and the physical media used to try to capture it: "the 'spirit' seeking embodiment in art clashes with the 'material' character of art itself" (Sontag 1969). A composer's mysticism, superstitions, or religion (in short, their intentions) are often

[2] This practice is rooted in the Western media "acculturation" that prioritizes the concrete and discourages any "experience which linked the natural environment with mystical rapture" (Sorrel 1988, 83).

treated with great sensitivity and then passed over in favor of more easily answered questions.

This avoidance is well-illustrated in Horatiu Radulescu's *Brain and Sound Resonance: The World of Self-Generative Functions as a Basis of the Spectral Language of Music.* Radulescu dives into deep mathematical and technical detail on how to conjure a phantom viola da gamba and other "timbre-psyche processes" (Radulescu, 2003, p. 331) using "preferential phenomenology." (Radulescu, 2003, p. 322) This is similar to Kyle Gann's *Outer Edge of Consonance*, where Gann devotes pages to describing the precision of La Monte Young's intervallic structures. Given each of these composers' deep interest in phenomenological precision, it is justifiable that these texts would express these efforts, but it might have, perhaps, been just as helpful to attempt to aid others in learning how to recognize a phantom viola da gamba when it enters a room.

To be fair, there are many reasons to favor the theoretical over the mystical in a textual setting. For one, it is much, much easier to discuss mathematical or theoretical frameworks than it is to speak about the mystical or experiential in art. The mystical must be experienced to be understood. While I fully acknowledge with the importance of theory, so, too, is intention, and even more important than intention is the explanation of how listeners, like archaeologists, can discover and reproduce experiences in their own imaginations.

The spiritual imagination is crucial to understanding and appreciating the mystical spectral or electronic music work. Composers conjure, using illusion and metaphors of light, beautiful timbres, and construct ghostly images of phantom objects (using techniques like ring modulation and instrumental synthesis). For example, composer Tristan Murail "compares the effect of [his] overtone chord with the condition that occurs when the sun is at its zenith: it casts no shadows" (Haas, 2007, p. 3). In these "outer edges" of consonance, composers describe works using words dripping of séances, storytelling, and Plutonian shores, but generally avoid speaking of the mystical in the music. Conjuring and magic within ring modulation and phantom instruments is set aside in favor of the mathematic proportions that are used to conjure it. The imagery and inspiration is missing, replaced only with the tools used to channel these effects. When the imagery and background is neglected, listening becomes disorganized. Echoes disintegrate and become dissonance. The spirits leave.

I am not suggesting that listeners drive themselves mad trying to understand how Harvey might have felt comprehending a "long day's journey on the Saturday" (Harvey, 1999, p. 47) any more than I would suggest that a listener physically suffer as Hildegard von Bingen might have during her *Passion* (Holsinger, 2001, p. 191). I am suggesting, however, that listeners develop an imaginative mysticism, and learn to turn their ears to an inner mystic. Mysticism and superstition are universal habits of mind and the only way to truly appreciate a work based on mysticism is to allow oneself to let go of a pre-

formed perspective in favor of the possibility of finding something new (or something very old).[3]

Important Note

It is not dangerous to momentarily don a shamanic imagination, nor is it imperialistic to try on views without actually harboring them yourself. Like an optical illusion, the shamanic imagination is a sign of a shared tendency to frame the world in certain ways. Kim Cascone says that "our sensory/intellectual process of perception often is the very thing that prevents us from truly 'hearing' the inner spirit of the sound" (Cascone, 2015). By prioritizing the rational faculties, there is a risk of gradually losing the ability to hear a work as it might have meant to be heard. This imagined superstitious empathy might help us see, if only for a minute, what was meant to be seen. It does not matter if it was appealing. Art is a way of seeing. This medium can be both a form of communication and a being in itself.

The Medieval and the Other

Medieval mysticism and Medievalism play an important role in the creation and framing of this dissertation and in the contemplative art practices that will be discussed in the next section. In short, the Medieval era is strange in comparison to modern

[3] This voluntary liberation can be regarded as a kind of "intellectual acculturation"— a term coined by by Katz which states that "the forms of consciousness which the mystic brings to experience set structured and limiting parameters on what the experience will be"(Katz, 2013, p. 5).

sensibilities. In composition, this strangeness is a way of reflecting upon the aesthetic apparatus, or the intuition.

> *A composer seriously concerned with 'expressing himself' is at once fascinated, by, and highly suspicious of, this aesthetic apparatus. In no circumstances will he simply make use of it; rather must he master it, technically and spiritually. Whether he recognizes it or not, he cannot wrestle with the rules of the games implicit in the aesthetic apparatus without being dragged into the conflict that determines the consciousness of our society. This conflict-fear of freedom and simultaneous longing for it-is his own as well, and consequently he cannot evade the crucial decision. Either he must face up to the conflict and bring it to a head, or he must close his eyes and trust in his 'naive artistry'. If he chooses the latter course he must try to salve his conscience by pretending that the current rules of the aesthetic apparatus are harmless 'laws of nature', which can be ingeniously exploited, once one has adapted oneself to them. But he should recognize that the material he uses, however arcane or however familiar, is always and from the outset in direct connexion with the aesthetic apparatus, and under its sway. (Lachenmann, 1980, p. 23)*

The Middle Ages was, in many ways, the last holdout of a very different mindset, and is thus in essence a stranger or an Other. The Medieval aesthetic is also a luxurious, enigmatic, impressive, imaginative, and extraordinarily beautiful one. From a creative perspective, the Medieval work that has survived shows extraordinary amounts of effort put into articulating the beautiful. The narrative of modern philosophy and aesthetics frames itself as being born from Renaissance and Classical thinking, with the ‘dark’ or Medieval era being generally cast off as the time before Western society found Reason. In spite of this, the Renaissance was born from the Medieval.

> *The literary history of the Middle Ages told the story of how we came to be what we are, in strange disguises. It is a story we (do not) recognize; some sense of its import glances across our reading, but only peripherially, insofar as its meaning escapes from… the canon is an allegory whose code has been misplaced, or more precisely, repressed. (Haidu, 2004, p. 5)*

What is known of the Middle Ages and its underlying aesthetics alludes to a philosophical framework that is culturally similar to the Renaissance and Enlightenment, yet is still wholly separate from it.[4] These views reflect the materials that have survived from the era, notably in bestiaries, cosmological texts, puzzle scores, architecture, and illuminated manuscripts.

The Medieval era, in my practice, is both a source of inspiration and a reminder that the world is not as fixed and structured as it is represented in modern society. In my studies, the aim of this contemplation was to question my contemporary process and aesthetics by comparing them with the Medieval. Just as an experiment may raise more questions than answers, the aim in my practice was to displace comfortable certitude in any preconceived ideologies that might frame the world as a small and solved place. Medieval art, while sharing history and an interest in Greek philosophy, produces work

[4] This can be viewed sociologically as a stranger relationship, as outlined by Georg Simmel as a combination of proximity and novelty, in which proximity is defined as "he, who is close by, is far," and strangeness is defined as that in which "he, who also is far, is actually near" (Simmel, 1950, p. 1). The Medieval era satisfies both criteria in that it shares language and location with the Renaissance and yet has very little in common with it. This condition of strangeness within nearness is a form of cultural objectivity and a way to reflect upon preconceived notions. Objectivity from the perspective of history allows the viewer to survey "conditions with less prejudice; his criteria for them are more general and more objective ideals; he is not tied down in his action by habit, piety, and precedent" (Simmel, 1950, p. 2). This objectivity is not detachment, but a "particular structure composed of distance and nearness, indifference and involvement" (Simmel, 1950, p. 2). Strangeness, then, "is less … of substance than of perspective … The outsider threatens and transforms less by virtue of what he does than what he highlights" (Sussman, 2007, p. 18).

that is completely different.[5] Some examples of these differences can be found in the process and philosophy of timekeeping, mysticism of the historical event, and nature mysticism, which I will discuss in further detail.

The Medieval sensation of time is similar to the spectral definition of time in music, in which "Real musical time is only a place of exchange and coincidence between an infinite number of different times" (Grisey, 1987, p. 274). Medieval time, like spectral time, is defined only through events. It is defined as such in *Time in the Medieval World*: "time itself, especially past time, was not measured. It could be counted, but only for very specific purposes," and that time was "not intended to situate events on a continuous time-line" (Humphrey & Ormrod, 2001, p. 5). In early Christian communities, there was a feeling that Mankind existed in a boundless, formless, middle era between the birth of Christ and the Resurrection. This eschatological perspective framed the world, as a time without form. This present era, "between the Incarnation and the Second Coming" (Humphrey & Ormrod, 2001, p. 27) was imagined to be "entirely homogeneous" (Ibid.).

> *"This is the sixth and final age of the world… there are no divisions, no landmarks which have any significance" (Ibid.).*

[5] This process is also a study in material culture, where "objects made or modified by man reflect, consciously or unconsciously… the beliefs of the larger society to which they belonged" (Prown, 2001, p. 70). Although strange, the stranger is "close to us, insofar as we feel between him and ourselves common features of a national, social, occupational, or generally human, nature" (Simmel, 1950, p. 2).

This is an important perspective to remember in the sections on *Time*, *Process Eschatology* and *Computer Time*. Time was not necessarily conceived as progressing on time lines, but rather on time circles, where the end of one cycle became the beginning of the next.

There was also a mystical logic of *permeability* in the reality of the natural world, particularly from mystical and eremitic traditions. In this context, permeability meant there were, as Jean Clottes said, "no barriers, so to speak, between the world where we are and the world of spirits" (Savigny, 2014, p. 59). Sound was often interpreted as the song of the spirit of place. The idea that listening to the voice of dramatic, beautiful, and solitary places in order to reflect upon the world has had a major impact on my thinking reminiscent of Schaeffer's *World Soundscape Project*. For example, the *Life of St. Anthony* is filled with intensely imaginative accounts of the voices of demons inhabiting in tombs[6], caves, ruins and mountains[7], and the desert. In one example, St. Anthony hears evil and temptation in the soundscape of the Egyptian desert. He tells the other hermits: "Great is their [the demons] number in the air [invisible, in sound] around us , and they are not far from us…. the inroad and the display of the evil spirits is fraught with confusion, with din, with sounds and crying" (Life of St. Anthony). In the *Life of Aelred of Rievaulx,* the sound of place is heard with less suspicion, but just as imaginatively. St. Aelred speaks of the spirit of place singing peacefully "when the

[6] see *His life in the tombs, and combats with demons there*

[7] *How Antony took up his abode in a ruined fort across the Nile, and how he defeated the demons. His twenty years' sojourn there*

branches of lovely trees rustle and sing together and the leaves flutter gently to the earth, the happy listener is filled increasingly with a glad jubilee of harmonious sound" (Dutton, 98). This appreciation of the benevolent sound of place is also reflected in medieval Irish ascetics where the listeners revel in the song of the world: "I hear the soughing of the pine-trees and pay no money; I am richer far through Christ, my Lord, than ever you were." (Bieler, *Ireland*, *Harbinger of the Middle Ages*). The medieval soundscape was steeped with intentionality and imagination, and I try to use this in my work.

There was also a form of mysticism that reveres the experience of the imagined past— or a part of the world that has left. This mystical account of an imagined past event is linked in my practice with sounds that seem old, such as old recordings or historical music. This particular "mysticism of the historical event" is a practice in which "one recalls a significant event in the past, enters into its drama and draws from it spiritual energy" and "eventually mov[es] beyond the event towards union with God" (Sorrell, 1988, p. 84). When working within memory and the "textualized traces" (Hutcheon, 2003, p. 89) of a past event, there is a liminal space in which pieces of the event "remains in our memory as a whole, in the form of a central idea or emotion… as a disconnected series of images, of peaks, of visionary icebergs" (Eco, 1985, p. 4). The past and the events within reside in a realm distinct from the present, but moments of the past can be accessed through mystical effort and reflection on these icebergs. For example, the three dissertation project pieces are derived from a past sonic experience

driven by a process that was recorded and re-transcribed. The codex is derived from recorded sounds and symbols. The realizations of each piece are based on whole number ratios, ancient tonal systems, and temperaments. While not being explicitly 'old' sounding (yet), these recordings are the apotheosis of a moment.

There is also a great deal of inspiration lurking within the idea of the past and the mysticism of the Medieval era as an historical event. Many composers, writers, and artists are almost mystically inspired by the past, Umberto Eco being one of the most well known among them:

> *There are magic moments, involving great physical fatigue and intense motor excitement, that produce visions of people known in the past. As I learned later from the delightful little book of the Abbé de Bucquoy, there are also visions of books as yet unwritten. (Eco, 1998, p. 9)*

Ancient Gaps

Many composers and artists feel a kindred spirit to the Middle Ages and their philosophies, and it must be stressed that these philosophies are distinct from the classical notions on the role of art. J. M. Martel bases his manifesto on the ascetic seriousness in Medieval art philosophies of Medieval art. According to Martel, his work is "derived from the philosophy of Thomas Aquinas and the Medieval Scholastics… the most fundamental power of art is to reveal the *quidditas* or 'suchness' of things" (Martel, 2015,

p. 27). The conjuring or imagination of spirits, the mystical in sound and sound practice, Medieval timelessness and strangeness—these are the threads that come together in my work.

I wish to acknowledge the philosophical and inspirational gaps that might give some readers pause. For example, some readers will notice that discussion centered on the unknowable in art includes no mention of Immanuel Kant. Others may notice that my analysis of mystical number emphasizes the doctrine of harmonics without discussing composers like Scriabin. These are intentional omissions, as the history and prehistory that motivated this project are based on philosophies that lie outside many concepts of philosophy developed in the past 600 years. One reason for this is that:

> *For Kant and modern rationalism, beauty really is in the eye of the beholder. For Aquinas, Joyce, and Wilde, it is the other way around: beauty exists as a fundamental reality that we, as beholders, can come to witness as something larger than us… There is a beauty that rests on conditioned judgment, and one that opens onto truth. (Martel, 2015, p. 42)*

This perspective on history in art is reminiscent of Harry Partch's decision to view "the whole trend of music since Gregorian chant as a tangent to the main historic stream" (Partch & McGeary, 2000, p. 163). I do not consider the past with such disregard, but Enlightenment philosophies do not play a large role in my work. Some of the only philosophical concepts of the classical compositional tradition that I am aligned with are

1) I consider my practice a matter of choice rather than tradition, 2) I create and define musical systems, 3) I call myself a composer.

Conjuring, Magic, and Divination: Definitions and Context

> *…[P]hysical matter of the cosmos' is filled with meaning, nothing follows more naturally than the belief that '[g]estures and rituals might somehow or other lead to physical effects of material transformation' (Adams et al., 2013, p. 2)*

Conjuring and Divination come up often in discussions on the mystical in music and contemporary music. In this short section, the concepts of conjuring, presence, magic, liminality, occult, and divination will be defined and I will attempt to contextualize them in contemporary work. In my own work, these concepts are of significant importance. I often think of my process (and my uses of process) as similar to conjuring or divination. After meeting (and sometimes recording) a sonic stranger, I try to recapture and "conjure" the meeting or environment through sonic imagery, systems or processes. My systems, in a way, can be understood as tools for conjuring the mystical experience of a meeting or locale that made an impression on me. The reasons as to why this require some introduction to basic concepts of magic and mysticism.

Composition using systems, controllers, or any performance system where the exact physical mechanism of sound generation is hidden can be seen as an *occult*

practice. The *occult* is generally defined to refer to any process thought to lie beyond the range of ordinary knowledge or experience (Krinsky, 2012, p. 30). The word is also used to refer to information whose true source is interpreted as somehow concealed or hidden, or to refer to a practice where the mechanism of it efficacy is secret to the uninitiated.

Liminality is the state of being 'in-between' two distinct states, such as being between a dream and reality, as in lucid dreaming, or between dead and alive as a ghost. In ritual, liminality "refers to an ambiguity arising from everyday tasks being reinterpreted as symbolic activities." (Burtner, 2005, p. 5). Similar to the human search for meaning in the natural world, liminality describes the attribution of supernatural import to human action. When repeated, these symbolic tasks become rituals.

Rituals are "the collectively patterned performance forms through which processes of cultural or sacred signification are integrated into consciousness and social practices" (Tomaselli, 1996, p. 81). The link between performance and ritual is direct, as the ritual of musical performance can conjure magic.

Magic is defined as "the attempt to bring about tangible effects by means of actions invoking occult powers whose efficacy is thought to depend upon their form" (Dawes, 2013, p. 36). The belief in magic in some form is almost universal throughout human history and across cultures, and it arises from the human mind trying

to understand an ambiguous situation. Anthropologist T.M. Luhrmann has conducted extensive research on magical culture, and he has identified its basis as the following fundamental beliefs and habits of mind:

1) The subjective and the objective are conflated (Luhrmann, 1991, p. 165)
2) The world is patterned and meaningful. Chance is replaced with meaningful occurrence (Luhrmann, 1991, p. 168)
3) The belief that Analogy has inferential validity. Metaphor as a way of conceptualizing the unknowable (Luhrmann, 1991, p. 171)

Through this use of metaphor, and the concept of fluidity which implies that "the categories that we have… can shift. A tree may speak" (Savigny, 2014, p. 59), aspects of the world can change into other things. This transformative process is called "interpretive drift" (Luhrmann, 1991, p. 307) and Luhrmann explains two kinds of additional "intellectual habits" that deepen this interpretation of the mystical. There is a change in what is considered acceptable evidence this permits the perceiver to see connections where one previously saw coincidence (Luhrmann, 1991, p. 316). The second is that the perceiver is given the proper mode of occult practice (practice where the exact means of development remain hidden or do not exist). This provides the perceiver with a template to contextualize what is happening around her.

Fluidity also lends a voice and personality to spaces and objects. This personality is the audible soul of the space or acoustic 'presence'. Objects communicate by the sounds that they make (or are made to make), but spaces communicate using the reverberant. Reverb, using the logic of fluidity, "can be understood as listening to the voice of the spirit of a thing or space. The reverberating sound of a cavern then becomes the voice of the cave spirit. Voice becomes the means by which a spirit, whether near or far, talks to us" (Blesser & Salter, 2009, p. 87). Presences are intangible and "felt" or heard (through the ears and skin) as disturbance in the vibrations of space. Sound and music are perceived and interpreted using similar mechanisms.

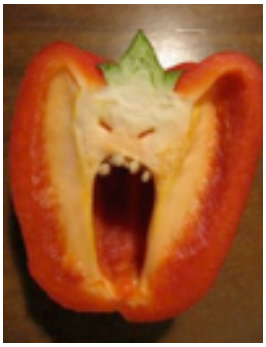
Divination is a type of ritual practice that involves the use of certain kinds of objects and materials to gain mystical insight. Some examples of this are "Geomancy, taking pricks in the sand, Hydromance, in water; Piromance, in fire… and Nigromance" (Heather, 1954, p. 19). *Nigromance* is another word for black magic, or the conjuring of demons for mystical purposes.

Conjuring is the practice of calling "upon a spirit or ghost using a magical ritual," but can also mean to "make (something) appear unexpectedly or seemingly from nowhere" (Stevenson, 2010, p. 369). This spirit is often felt as a presence, or presence itself. It is similar to summoning. In the imagination, conjuring is the act of making things appear from the use of an obscure, occult, or hidden source. An evocative musical

example of this conjuring is the tone produced from perfect intervals during Sardinian chanting. This 5th 'voice' is interpreted as the Virgin Mary.

Presence refers to an impression of sentience emanating from within an object or place. This will be discussed in the section focused on *shimmer*. Often this presence is felt as having the potential for communication, but other times a presence can seem to loom over an area, or to spectate. Generally, presence is sensed by a discrepancy between what is expected to be present and what is felt to be present. An example of this is an empty room that seems occupied. This notion is thought to be fueled by the human mind's "innate capacities for social intelligence" (M. Winkelman & Baker, 2015, p. 174) and the human desire and social need to communicate and ascertain the inner emotional states of other creatures: "The universality of spiritual beliefs reflects this adaptive tendency … populating nature with spirit beings who operated with the same features as humans" (Michael Winkelman, 2015, *Imitation of Animals in Shamanism*). An example of this is the "angry" red pepper in Illustration 1:

Illustration 1: Angry Red Pepper



Magic In Contemporary Art

> *The people who first stretched a gut over two bridges, or found tones in wood suspended at the nodes, discovered magic, just as certainly as the people who found tones in electronic tubes. Then, through art, they plunged intuitively toward an insight into the greater universe. (Partch & McGeary, 2000, p. 184)*

The *ritual* of mathematically dividing a string produces, as if by *magic*, harmonic sound. As will be discussed in the next section, the religious belief that the world was created by the *division* of larger objects has the effect of priming the listener (through specialist knowledge) to hear this real effect of string harmonics as evidence of the mystical within the world. The metaphor of division, through inferential validity, shows that just as numbers can be divided, so can objects in the world (using fluidity/ interpretive drift). The *liminal* act of performing division, or counting, transforms the division of the string into ritual, and the fact that the results of this experiment are incorporeal, renders the cause *occult* and therefore supernatural. Expectation plays a large part in the appreciation of art magic, and leads to the impression of special meaning in the result.

In composition and performance, the source or mechanism of the sound is considered to be hidden if it is not directly mapped or visible. This definition of occult is important for the discussion of sonification and emergence. Sound—especially recorded sound with no source—is inherently occult in many ways and has been treated as such. An example of this is Radulescu's phantom instrument séance:

> *This music sets out to create a state of trance close to that of a spiritual séance, through which one can evoke the presence of one's "alter ego" or "higher self". The very descent into the subconscious register facilitates the arrival of this psycho-acoustic phantom (Gilmore, 2003, p. 113).*

This will be explored in the section on *ineffability* and *emergence*. The mechanism of the effect of music (its 'spell') is also somewhat obtuse to the perceiver, and is also hidden.

Divination and ritual are complex concepts in modern art, with popular examples of its use in art implementing the *I-Ching*, as is the case with works by John Cage. The role of practice, performance, symbolic gesture and communication all figure significantly in contemporary electronic, cybernetic, and telematic art practice. Roy Ascott labels this kind of art *Behaviorist Art*:

> *Process culture and behaviourist art need not mean the end of the object, as long as it means the beginning of new values for art. Maybe the behaviourist art object will come to be read like the palm of your hand. Instead of figuration—prefiguration: the delineation of futuribles. Pictomancy—the palmistry of paintings—divination of possible futures by structural analysis. Art as apparition? Parapsychology as a Courtauld credit? (Ascott & Shanken, 2003, p. 158)*

In his essay, *Errormancy*: *Glitch as Divination*, Kim Cascone suggests that the supernatural may be attempting to communicate through small glitches in technology and digital error such as a flickering screen. This flickering, a Morse Code or semaphore language, hints at communication from another world. The "cluster of glitches" form "an outline," define an "area," and trace "a route through uncharted space." This space is

virtual, invisible, an "n-dimensional 'potential space,'" and this error can be used to "navigate this space," with the intent of seeking "unexpected patterns, chance juxtapositions," and "subliminal content" (Cascone, 2011). The glitches and flicker are like the shimmering signals of the ancestral beings that will be discussed later.

In modern times, technology is used for magic. One famous example of this is Luigi Galvani's "re-animation" of the dead through electric shock and EVP, among other means. In modern electronic art, the role of technology is also the role of the magician. Like Pepper's Ghost, audio effects, spatial effects, special effects, or any complex process that seems to go beyond the frame of reality fuel this historical mindset that believes in magic. Performance, practice, and process are all rituals in their own right, and performers are notoriously superstitious in regard to their creative setup and perform many rituals to guarantee a good show.

Conjuring is an important topic in electronic sound, telematic, virtual, and immersive art. Sounds and visions are divorced from their sources and are reproduced using hidden means. The immersive work is often viewed as "conjuring up a sense of surrounding atmosphere" (Morton, 2007, p. 22) that will furtively vanish as soon as the work is over. This performative action can be found in Susan Kozel's *Dreaming the Telematic Body*, where touch and presence are conjured in participants. She discusses her experiences in *Spacemaking: Experiences of a Virtual Bod*y:

> *The famous claim associated with virtual technology is that the body is futile, replaced by an infinitely enhanced electronic construct. If this is so, then why did nastiness or violence enacted upon my image hurt? How could the body be futile yet still exert a basic visceral control over my movement? (Kozel, 1994)*

The compositional process bears resemblance to divination. Sonification can be divination, which will be discussed in the mystical sonification chapter. Composing a work can *feel* like divination (especially in a process piece if the process is working smoothly). Inspiration from these concepts and their modern counterparts such as glitch divination, conjuring, and mystical communication through recording and sound can be found throughout my work.

In the following chapter I will review in more detail the relevant historical, philosophical, and musical background that has impacted my work, and in the chapter thereafter I will analyze the works that specifically comprise the Dissertation Project itself.

Chapter I: Relevant Background

It is a challenging task to build a coherent philosophical framework or history that accurately describes the state of mystical contemporary music. It is a task in itself to construct any narratives around contemporary music considering the sheer number of possible aesthetics. That being said, there are a number of crucial pieces of background information that will aid in contextualizing the work in this dissertation.

In this project, the ancient and contemporary are placed within the same frame and are used interchangeably. Some historical influences include Harmonics, Techne, number philosophy and mysticism, Medievalism, Victorian media superstition, time, divination, and illumination. In the contemporary realm, there are spectral techniques, new media philosophies, sonification, microtonality, aurality, art/science, emergence, time, and graphical notation. Each of these concepts will be briefly explained using examples of ways in which they complement one another.

In this chapter, I will first cover a brief history of sonic mysticism and ineffability, followed by modern uses of sound to reveal knowledge, the measured numerical (microtonal and spectral) systems in sonic mysticism, sonification, and, finally, the use of audio illusions as a mediator of the mystical. I will argue for the mystical imagination,

and explain the rationale behind trying to learn to hear sounds and the voices of spaces as meetings with beings from other worlds.

Section 1: A Brief History of Sonic Mysticism

Sound and Ineffability [8]

Sound can be measured, yet the experience of sound is ineffable. The ear is an unreliable witness, and the mind creates or uncovers links between the sonic event and the listener. The experience of sound is demonstrably subjective; psychoacoustic studies have found nonlinear and complicated relationships between external sound stimuli and metrics of perceptual experience (Loy, 2011, p. 155). Sound itself is logarithmic, but is not perceived as such. What is abstractly a curve is heard as a line. This has imaginative analogies in time and sound, with both linear time and the monochord. Moreover, the perception of certain frequencies depends on gender, age, and ear shape. Perry R. Cook's psychoacoustics anthology, *Music, Cognition, and Computerized Sound*, and Gareth Loy's chapter in *Musimathics* on the "Psychophysical Basis of Sound" plumb the depths of this topic.

We also know that there is a huge difference between hearing and listening; scholars such as Michel Chion, Pierre Schaeffer, and Dennis Smalley have explored and

[8] This section was edited and excerpted in part from my previously published article, *Sonification and the Mysticsm of Negation*, in *Organized Sound*

articulated this distinction in great detail. Hearing is "a physiological process, a kind of receptivity and capacity based on physics, biology, and mechanics" (Sterne, 2003, p. 2). The act of listening is quite different, and involves subjective engagement. In the most basic sense, the difference between hearing and listening is intent. What is heard depends upon the mode of listening. Listening is a complicated process that "involves will, both conscious and unconscious—perhaps a better word than will would be disposition or even feel" (Sterne, 2003, p. 93).

Culture and training also play pivotal roles in the perception of sound, adding even more nuance to the concepts of hearing and listening. When listening in a contemporary world and with contemporary ears it is customary to trust a recorded sound. Sterne argues that the modern conception of listening has been intentionally paired with "notions of science, reason, and rationality" (Sterne, 2003, p. 93), which has been reinforced by the advent of modern recording technology.[9] Blesser suggests this might have been an intentional marketing effort by early recording engineers to rebrand necessarily-dry recordings as being more desirable to a futuristic or sophisticated listener because they were more "precise" or "objective" (Blesser & Salter, 2009, p. 128). Whatever the reason, technical listening is a prevalent and important mode of listening in electronic music, and one cultivated specifically by training.

9 An interesting perspective on this can be found in Andrew Durkin's "Decomposition" in which he discusses multiple alternatives and listener engagement.

Despite associated notions of objectivity, the words used to describe the experience of sound can be imprecise and subjective. They are "based in and described through a language of mediation" (Sterne, 2003, p. 94). This can be problematic in the search for an objective description of a sonic experience. For example, sounds are described using words that reference imaginary physical characteristics of the sounding objects, and "the qualities of the visual object are transferred to a sounding object-structure" (Smalley, 1996, p. 89). There is a paucity of specific terms with which to describe both sound and sound-based experiences because listening, like sound, is ineffable. This view, while far from indisputable, is echoed in the works of Barry Blesser, R. Murray Shafer, Robin Maconie, Susan Douglas, and John Mowitt, among others.

The perceptual effects of sonic mediation have been studied with provocative results in fields such as Acoustic Ecology and Ecological Psychology. A representative example of this research comes from William Gaver's article, "How Do We Hear In The World?". Gaver studies the perception of sound in various contexts, focusing on the "internal processes that mediate between the … sound … and the experience of its source" (Gaver, 1993, p. 288). He finds that if there is ambiguity in the sound event or input, the mind will fill in the gaps: "If the input for perception is inadequate to specify events, then the processing mechanisms must be complex to compensate" (Gaver, 1993, p. 288). Even within the realm of hearing and listening, the way the mind processes sound adds an additional layer of abstraction.

Ineffable Sound is Mystical

This ambiguity (ineffability) is also an inherent characteristic of mysticism. Gaver notes perceptual compromises between the way the mind processes the world and the way the world may exist objectively. The imagination fills voids that exist within vague pieces of information, which can have a notable effect on the level of objective 'truth' that can be gleaned from sound. Apophatic techniques make direct use of this experiential-rational tension, deriving mystical information directly from trying to understand an ambiguous experience. The failure of this objective truth is also evidenced in composers performing or directing their own work. The vivid compositional imagination fueled by the sonic experience can be so strong that it interferes with the objectivity necessary to successfully perform a work.

Mystical ineffability is not limited to the liminal spaces between the rational and irrational experience. Many scholars consider ineffability to be a fundamental, albeit challenging, characteristic of music. Jonathan Harvey writes extensively on the subject in "The Role of Ambiguity," a chapter from his book, *In Quest of Spirit*:

> *Music has to do with... ambiguity… it must be full of contradictions... We are both objective and subjective, observing and creating… we recognize… that the struggle in time is "truth" (J. Harvey, 1999, pp. 28-29)*

Vladimir Jankélévitch echoes these sentiments in *Music and the Ineffable*, arguing that the perception of music "takes place on the margins of truth" (Jankelevich & Abbate, 2003, p. 1) He rejects the modern objective notions of listening, asserting that listening "borders more on magic than on empirical science" (Jankelevich & Abbate, 2003, p. 2). This link to magic, illusionary presence, and the imagination has been expanded upon by artists like Sally Jane Norman and Joel Ryan, who suggest that musical material, "like the sets and props on which circus and magician's arts are hinged, draw us into realms … free of utilitarian goals, allowing us to revel in creative, symbolic … encounters which play out our grasp of the world? or lack of" (S. J. Norman, Ryan J, 2013). This ineffability is often seen as a source of creative influence and as a method of connecting with the mystical.

Ineffability can also be considered a major component of electronic music. Francis Dhomont defines acousmatic music as "the art of mental representations triggered by sound" (Network, 1993, p. 8). He asserts that the ineffable ambiguity of the source is a key aspect of electronic music, and that the "imagination gives wings to intangible sound" (Ibid.).

Some refer to this additional layer of experiential information as "imagination," but I join the scholars who contend that ineffability in music—especially electronic music—permits the mind to receive information along a wholly different dimension. According to Pauline Oliveros, "sounds can be the gateway into a heightened awareness of the

moment" (Oliveros, 2005, p. 80) or a key to a higher level of mystical consciousness. In an interview in 2002, La Monte Young stated that listening to certain frequency relationships, specifically whole number ratios, "leads to a state of high [sic] god-consciousness, [and an] in tune-ness with [a] universal structure" (Young, 2002). Harvey considers the role of electronics in music akin to "the desperate peace-broker on the battlefield where the rational self and the suppressed experiencer of a forbidden or other reality fight it out"(Jonathan Harvey, 1999, p. 57). The suppressed experiencer, in this case, is an individual who has managed to escape the rational world and grasp at the deeper meaning hiding within the experience of sound itself.

Ineffability is not the only element worth considering; other characteristics of the mystical and apophatic way are also implicit in many electronic music forms and have significantly informed the scholarship surrounding it. Deconstruction and the discursive limits of the music, which are part of what Simon Emmerson calls the "Acousmatic Condition," draw directly from the ineffable (Emmerson, 2007, p. 3). Indeed, it is through the deconstruction of the source that electronic music gains its power. The mystery of electronic musical sound, "in depriving us of what we have been told is the dominant sense perception of the late twentieth century media, has engaged and encouraged that most essential faculty, the imagination" (Emmerson, 2007, p. 34). The admission of the limits of the "knowable" and "sayable" are also crucial components of the experience, through which "we shift from the feelings associated with these sounds to a description of them … if we are to discuss them at all" (Ibid., 17). Dennis Smalley even

posits that the field of electronic music itself is utterly bound by the listener's experience and cannot be understood in an objective manner because it exists entirely "within the perceptual experience of the listener" (Smalley, 1996, p. 83).

As scholars such as Oliveros, Harvey, and Emmerson have proposed, electronic music has strong mystical potential. In these practices, sound is believed to be the mediator of mystical experiences, and mediation is integral to the way sound experiences are described. Most methods of sonic mediation involve listening to real and imagined sound worlds, ratios, and repetition. These processes deconstruct the original sonic sources of information, and shift focus and attention to information beyond the more easily identifiable information.

My work follows in this tradition. Sound has always been mystical for me, a window into the unknown, a meeting with a stranger, and this relationship with the mystical utterly permeates my work.

Apophatic Mysticism Defined

Mysticism is a multi-faceted term that, generally, deals with uncovering knowledge of hidden or secret aspects of the world. The philosopher Jerome Gellman defines the mystical experience in the Stanford Encyclopedia of Philosophy as a "super sense-perceptual or sub sense-perceptual unitive experience granting acquaintance of

realities or states of affairs that are of a kind not accessible by way of sense-perception, somatosensory modalities, or standard introspection" (Gellman, 2001, p. 140). There are many mystical traditions, but the most relevant to this dissertation is Apophatic Mysticism—or the Mysticism of Negation. Apophatic methods are common in Buddhism, Mystical Christianity, and Hinduism.

In the 5th or 6th century, the philosopher Pseudo-Dionysius wrote extensively on the Apophatic Way, describing it as a method of comprehending that which is beyond or above knowledge (Dionysius, 1987, p. 192). He described a meditative practice that granted access to the 'unknowable' using theurgy, or ritual. Pseudo-Dionysius' ritual practice was a "complex and necessarily deceptive or subversive" practice which utilized the rational and intuitive minds to grasp "the encoded insight (or contemplation) in created things" (Corrigan, 2015). The influence of Pseudo-Dionysius' writings on Negative Theology was so far-reaching that the practice became synonymous with mysticism itself, and at least in the Western world, "the original meaning of 'mystical' as hidden or secret became associated with the spiritual technique of the negation of language" (Katz, 1992, p. 237).

Apophatic is the opposite of Kataphatic which means the "way of affirmation, from phasis (speech) and kata (according to)" (Katz, 1992, p. 236). These two mystical processes differ in whether aspects of the world are considered to be ultimately comprehensible by man using reason alone. Kataphatic methods suggest experiences are

ultimately describable, while Apophatic methods claim that the information is ineffable and can only be experienced. Another perspective points to the difference between the two methods existing not within the belief in the ultimate comprehensibility of the world, but rather in the process by which mystical information is retrieved. Kataphatic techniques exercise the "rational faculties" (Keating, 2002, p. 146), whereas the Apophatic method "involves a practice of 'emptying' out of other conscious content in order to 'make room' for the apprehension of God, who is beyond our discursive, sensual natures" (Gellman, 2001, p. 2). Bertrand Russell emphasizes the role of the Apophatic in retrieving mystical information: "only direct acquaintance can give knowledge of what is unique and new ... It is neither intellect nor intuition, but sensation, that supplies new data" (Russell, 2013, p. 17). This "data" is viewed as impossible to describe because "the conceptual system ... is limited in the sense that not everything that is knowable is 'sayable' within it" (Matilal, Katz, 1992, p. 149). This is also an issue with the necessary verbal transmission of philosophy. The "data" in mysticism, as Russell says, is ineffable. Some examples of negation techniques are the koan and the mantra, with a few examples in early Christian mysticism such as *Anagoge* or the *Spiritual Sense* of scripture. These techniques take a source of information, deconstruct it by repetition, meditation, or over-thinking, and use the resulting state to glimpse into fragments of a higher truth embedded in the source.

The Apophatic Way maintains that mystical information comes to the recipient only through sensation and experience. Information must be converted into a form that

can be received as experience if one is to grasp the mystical information. As will be discussed later, there are numerous parallels to be drawn between the ways scholars discuss music and the ways mystics discuss the spiritual experience. Musical information is often treated in a similar fashion to mystical deconstructions. Sound is often imagined as a tool to allow the practitioner to transcend—as with a mystical negation—"the regulative categories of knowing" and become "opened up to new forms of awareness" (Katz 1992: 6). For more information on Apophatic Mysticism, I would recommend *Apophatic Bodies: Negative Theology, Incarnation, and Relationality* by Catherine Keller, *The Navya-Nyaya Doctrine of Negation* by Bimal Krishna Matilal, and *Mystical Theology* by Pseudo-Dionysius.

Mysticism Through Number

Number, or the belief that the mind of God was represented in the certainty of mathematics, was a key tool used to decode and understand the world. To the Greeks, there were four mathematical disciplines: Arithmetic, Geometry, Astronomy, and Harmonics (Musica). The goal of each discipline was to uncover truth using the faculties. Just as modern philosophers tend to frame their task as "scientific because science is, for the modern world, the model for certitude; mathematics held a similar position for the ancients" (Surles, 1993, p. 4). Numbers have always had a certain occult power partially

because they are assumed to be objective (this will be discussed in further detail in subsequent sections).

The four mathematical disciplines comprised the bedrock of the quadrivium: indeed, it was considered the key to the pattern of the world and was "the method by which the divine intellect became intelligible… for human comprehension" (Hopper, 1938, p. 99). Number was also considered a form of inalienable certainty and could measure the quality of anything from art to inventory in a way that was considered objectively (and divinely) correct. In this belief system, if the maker "keeps his eye on the eternally unchanging and uses it as his pattern for the form and function of his product, the result must be good" (Plato, 360 B.C.E.-b). Nichomachus of Gerasa famously said:

> *All that has by nature with systematic method been arranged the universe seems both in part and as a whole to have been determined and ordered in accordance with number, by the forethought and the mind of Him that created of things; for the pattern was fixed, like a preliminary sketch, a domination of number pre-existed in the mind of the world-creating God, Number conceptual only and immaterial in every way, but at the same time the truth and the eternal essence, so that with reference to it, as to an artistic plan should be created all of these things, time, motion, the heavens, the stars, all sorts of revolutions. (Nasr, 1993, p. 49)*

Music, because it is invisible and because of the aural appeal of "mathematicizable" harmonic phenomena such as the overtone series, was considered

especially mathematical and divine. Medieval scholars such as Jacobus Leodiensis believed that music was "an apprehensible reflection of the transcendent numerical order" (Surles, 1993, p. 15), and an analysis of the perfection of a *musicus*' (knowledgable musician) implementation of harmonics (composition) was both an objective way to judge quality in art and imitate the divine.

Music, at least in the Greek definition, was the science of measured sound—the aural manifestation of Number. It was also considered the self-evident communication of an object or being's present/audible essence or way of being. Harmonic sound was geometrical (based on circles and proportion) and musical time was a manifestation of arithmetical time.

Further reading on the subject of Number, Numerology, and Music can be found in Lawrence Schrenk's article titled: *God as Monad: The Philosophical Basis of Medieval Theological Numerology*, or Daniel Heller-Roazen's *The Fifth Hammer: Pythagoras and the Disharmony of the World*, Jacob Kline's *Greek Mathematical Thought and the Origin of Algebra,* Walter Burkert's *Lore and Science in Ancient Pythagoreanism* or Robin Maconie's chapter on Number in *The Science of Music.*

Harmonics: Ancient Number

Harmonics (Musica), or musical numbers, was the ancient study of Nature (sound) according to immutable (geometric) laws. It was a way to transcribe the relationship of the physical and spiritual worlds into the language of "reason" or mathematics. Harmonics was the sister discipline to Astronomy,[10] and as a field somewhat like modern Astrology, this form of Astronomy was the study of celestial motion for the purpose of making predictions about the future, or divination. Music was one of the means through which human beings could reliably reproduce, or conjure, spirits. Harmonious sound was heard as the revelation of supernatural objects in motion. As with a cosmic event, frequency is also cyclical. These cycles, not unlike planetary motion, were important to those who sought to understand the symmetrical patterns in the universe.

Part of this Pythagorean belief system involved the notion of spheres. The spheres were circular areas of influence that surrounded the world. They surrounded the more "mundane" objects of the universe. In Peter Apianus' astrological text *Cosmographia*, he explains in a straightforward manner this geocentric world view. According to this text, the world is composed of elemental and æthereal regions, or tangible and intangible regions.[11] The elemental, or worldly region (Earth), is located in the center of this universe and is subject to physical change over time. This realm was constructed by the

[10] This link between music and astronomy is especially important to remember for *Agnus Dei*

[11] "Each of these spheres, however, contains but one star: and these stars, in passing through the zodiac, always struggle against the primum mobile, or the motion of the tenth sphere; they are also entirely luminous. In the next place follows the firmament, which is the eighth or starry sphere, and which trembles or vibrates (trepidat) in two small circles at the beginning of Aries and Libra (as placed in the ninth sphere); this motion is called by astronomers the motion of the access and recess of the fixed stars."(Apianus 1574 p. 2)

Gods using the four “Elements” of earth, water, air, and fire. The physical world was surrounded by the unchanging heavens, or the æthereal region. Each region was governed by a celestial object.

The most powerful spheres, those of God, lay beyond the geocentric solar system and held sway over the universe. They were constant, holy, and perfect. To the modern eye, these spheres are made up of the stars and constellations in the night sky. The planets, or wandering stars seemed to fight against the fixed state of the universe. As the stars and the planets (“moving stars”) moved in predictable ways against the highest sphere, this was presumed to be the fundamental cycle of the universe.[12]

Harmonics and the cosmos are related in their ephemerality. Sounds are beings that cannot be seen or touched. Sound, specifically harmonious sound, was found to be mathematically and proportionally related in a reliable way to the motions of other objects, such as the stars. Through the mystical concept of permeability, music was therefore a revelation or earthly metaphor of cosmic Truth, and a mediated path to the spirit realm.

Humans were thought to need this sort of mediation: man has an an ephemeral soul which is trapped during life in his elemental body. The body is considered to be the

[12] “Now that which is created is of necessity corporeal, and also visible and tangible. And nothing is visible where there is no fire, or tangible which has no solidity, and nothing is solid without earth. Wherefore also God in the beginning of creation made the body of the universe to consist of fire and earth.” (Plato, 360 B.C.E.-b)

earthly representative of the soul and, like the lyre, can be attuned to the divine.[13] The relationship between the immortal soul and the mortal body is analogous to the relationship between harmony and the lyre. While the lyre is said to be composed of earthly, mortal, or "elemental" parts, proper construction and attention (attunement, tuning) illustrate how it can be used to access the properties of the immortal region (the aether). If the lyre is taken apart, only the earthly representative of the spirit realm is permanently destroyed, but the harmony is not. These ethereal beings wait for the physical world to access them through harmony.[14]

Pythagoreans, The Creation Story, and Plato's Timaeus

Specific relationships of these ephemeral objects play a decisive role in accessing the divine. The proper harmonious relationship to the universe is one that has rediscovered its whole self through harmonious relationships, or "proportion." The exact nature of these ratios and their religious implications are described in another dialogue by Plato, titled *Timaeus*. It is one of the most famous dialogues dealing with the nature of the world through the harmonious relationships of objects, known as the *Doctrine of Means*. This concept is referenced in sources as diverse as Nicomachus' *Manual of Harmonics,*

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[13] "Out of the indivisible and unchangeable, and also out of that which is divisible and has to do with material bodies, he compounded a third and intermediate kind of essence, partaking of the nature of the same and of the other, and this compound he placed accordingly in a mean between the indivisible, and the divisible and material... When he had mingled them with the essence and out of three made one, he again divided this whole into as many portions as was fitting, each portion being a compound of the same, the other, and the essence."(Plato, 360 B.C.E.-b)

[14] "But two things cannot be rightly put together without a third; there must be some bond of union between them." (Plato, 360 B.C.E.-b)

Iannis Xenakis' *Stochastic Music,* and Hans Zender's *Gegenstrebige Harmonik*. In *Timaeus*, four speakers debate the relationship of the soul to the harmonic properties of the universe and how these relationships are made audible through Harmonics. This is also supported in Nicomachus' text.

According to this doctrine, God created the first essence or Monad, and then halved it. He took the half of the first object and divided it in half again. He then divided each resulting piece in half until he ran out of material.[15] God assembled the rest of the world out of the one, the unison or the monad.[16] The resulting proportions and their musical equivalents were seen as the fundamental ratios of the God-created universe.[17]

The Monochord as Monad, Harmony as Recording

The monochord is a physical and musical metaphor for the creation of the universe mentioned above. This particular monochord is called the Celestial Monochord. It is an open string which represents the monad, the one, or the only. When a single string

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15 "The lowest pitched note in the octave was called hypate, for hypaton means highest up. On the other hand, from the fact that the course of the moon is the lowest of all and is situated nearer to earth, the name neate was derived, for neaton signifies the lowest. The term parhypate was derived from the position of Zeus, being below Kronos one one side, while at the other side, the position of Aphrodite, being above the Moon, occasioned the name, paraneate. The term mese was derived from the Sun's most central position, this being the fourth from either end, since the mese in fact stood at a distance of a fourth in the ancient heptachord. The term hypermese, also called lichanos, was derived from one of the positions on either side of the sun, that or Ares, which was assigned the sphere between Zeus and the Sun. On the other side of the Sun between Aphrodite and the Sun, the position occupied by Hermes provided the name paramese".(Nicomachus, 1994, p. 45)

16 "The fairest bond is that which makes the most complete fusion of itself and the things which it combines; and proportion is best adapted to effect such a union" (Plato, 360 B.C.E.-b)

17 "If any one affirms that in which these two are found to be other than the soul, he will say the very opposite of the truth. " (Plato, 360 B.C.E.-b)

is divided at a node, it creates harmonics that are derived from the fundamental—just as the Creator had done with the universe. The musical analog is transparent. A sound and the relationship between this sound and another, through the careful use of number and proportion, reveals another being, a 'third' essence: the harmony or soul. This third essence is a phenomenon only accessed through mediation.

Similar to the lyre[18], the metaphor for the corporeal, ephemeral sound is a product of the instrument but not a tangible part of the instrument itself. It is seen as the soul, or an apparition that is conjured through the proper incantation. The monochord can be used to reliably produce and reproduce a sound by tuning the instrument to a specific proportion, or attunement. When an instrument is destroyed, the sound that it produces is not destroyed, but can be brought back with the aid of another lyre tuned the same way. This makes the monochord a cult object, an instrument, a tool for conjuring, and a playback system where mathematics plays the dual role of the spell and record.

The Recording Device as Monochord

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[18] "Might not a person use the same argument about harmony and the lyre-might he not say that harmony is a thing invisible, incorporeal, fair, divine, abiding in the lyre which is harmonized, but that the lyre and the strings are matter and material, composite, earthly, and akin to mortality? And when someone breaks the lyre, or cuts and rends the strings, then he who takes this view would argue as you do, and on the same analogy, that the harmony survives and has not perished; for you cannot imagine, as we would say, that the lyre without the strings, and the broken strings themselves, remain, and yet that the harmony, which is of heavenly and immortal nature and kindred, has perished-and perished too before the mortal. The harmony, he would say, certainly exists somewhere, and the wood and strings will decay before that decays. For I suspect, Socrates, that the notion of the soul which we are all of us inclined to entertain, would also be yours, and that you too would conceive the body to be strung up, and held together, by the elements of hot and cold, wet and dry, and the like, and that the soul is the harmony or due proportionate admixture of them." (Plato, 360 B.C.E.-a)

> *Sound is void, fear and wonder. Listening, as if to the dead, like a medium who deals only in history and what is lost, the ear attunes itself to distant signals, eavesdropping on ghosts and their chatter. (Toop, 2010, p. vii)*

Sounds in electronic or recorded sound can be considered in conversation with the function of the lyre, as both have the potential to become mystical objects. These devices conjure both ephemera and the unknowable past. This is similar to the concept of death in Roland Barthe's *Camera Lucida* and St. Francis' *Mysticism of the Historical Event*. In Barthes' view, every photograph has the ability to bring about "the return of the dead" (Barthes, 1981, p. 9). The recording device captures, like mathematics does with harmonics, the essence of a sound or being at a particular point in time. It captures what was previously ephemeral and renders the unrepeatable repeatable and available for reflection (as can be seen with the celestial harmony on the lyre). Robin Maconie describes these traits in the context of early perceptions of the gramophone:

> *...the gramophone was a medium in the mystical as well as actual sense of storing and retrieving at will voices from the dead. To hear a voice speaking from a disc was construed in the terms of a séance or rite of communion with the eternal, since the sound of a person's voice was understood to be a mirror of the soul. (Maconie, 2012, p. 12)*

The recording device, like a photograph, is imagined as something that "mechanically repeats what could be repeated existentially … the event is never transcended for the sake of something else … it is the absolute Particular, the sovereign Contingency … the This …the Occasion, the Encounter, the Real, in its indefatigable expression" (Barthes, 1981, p. 4). This aura of credibility within the impermeable past

gives the viewer/listener a near-mystical impression of conjuring a past, which, as with music, " … was an event that was perceived in a particular situation, and that disappeared when it was finished … The effect of recording is that it takes music out of the time dimension and puts it in the space dimension" (Eno, 1983, p. 1). Barry Blesser argues that because of the assumed objective credibility of technology and the notion of scientific and technological progress, the "mystical experience of sound without a visible source reappeared" (Blesser & Salter, 2009, p. 121), and its reappearance marked a turning point in the human experience. Recording devices capture sounds from both natural and supernatural sources, just as monochords conjured and replayed the audible perfection of the divine plan.

Recorded sounds are simultaneously icons and relics, though this comparison is not satisfactory in either case. Relics provide corporeal proof of the once-real while icons represent the immaterial, but this proof is indirect and ephemeral in a recording. The experience of listening to a recording is to listen to the vibrations of another time. In this vein of reality, "[s]ound haunts their silence as a spectre of history that can never be heard in full, yet its presence is buried within their creation" (Toop, 2010, p. xiii).

A recording serves as tangible representation of a past vibration, yet it is not the embodiment of this vibration. It is assembled from bits and pieces of this past experience, but the relationship to this sensation of past dies with those who had shared

the experience. The original "body" that was the source of the recorded experience is forever lost to time and is only alluded to. At one time it existed as a representation, but it becomes a death mask or map over time, hinting at an unknowable past. Like spirits, these recorded sounds no longer have sources and give credence to the notion that the sounds being heard are "of mysterious provenance" (Jonathan Harvey, 1999, p. 57). Just as the harmony of the monochord conjures the ephemeral, the phonograph replays vibrations to recreate, or conjure, the past.[19]

Section 2: Contemporary Sound Mysticism

Composition and art practice are often considered important methodologies for reflecting upon the habits of the composer. Composers like James Tenney describe new music as "sound for the sake of perceptual insight" (Hasegawa, 2008, p. 3). Statements like this remind us of the ancient philosophies that considered sound as uncovering truth. Furthermore, composer Lou Harrison shows us that in many cases, these references are deliberate. In his writings, Lou Harrison said that he and Partch "used to joke with one another that, whereas we were both publicly considered radical modernists, we were actually dealing with, and much more concerned with Greek and Hellenistic music" (Dunn, 2013, p. 134). This section discusses some of the ways that these ancient notions have been brought back to contemporary musical conversations.

[19] Future work will involve more research on how the recording is differently embodied when created by analogy and represented as image (analog sound) or created by measurement and represented by numbers (digital sound).

Listening and Awareness

Modes of listening have developed to emphasize the role of the preconception and attention in the reception work. Modes of listening prime the listener on ways to perceive the audible world. Some modes re-focus the listener away from classical aesthetics, such as the works of composers and theorists like Iannis Xenakis or Dennis Smalley. Others modes bring the listener into the present such as Pauline Oliveros' *Deep Listening*, and still more question the nature of noise in the world like John Cage's *Silence* or R. Murray Shafer's *World Soundscape Project*. Of course, even the act of developing a mode of listening questions the culturally-imposed notion of an aesthetic appreciation of sound. Most argue that meaningful sound is is a phenomenon that brings the listener back into the world or fosters curiosity by encouraging "active sensorial engagement on the part of the listener" (Lane & Parry, 2006, p. 1).

> *… when the sonic materials seem to evoke what we imagine to be the experience of the world outside the music… In listening to acousmatic music, rather than suffering some kind of sensory deprivation, I am led spontaneously to contemplate the, possibly unique or unfamiliar, virtual transmodal richness afforded by the aesthetic configurations of the music. (Smalley, 2007, p. 5)*

Just as Greek philosophers would tune themselves to the 'properties of the world,' and thereby align themselves with those properties, so too would these modern soundscapes advocate a state of being that aligns the listener with her world.

Sound as a Way to Reflect on the Nature of Time

> *The things are not in the time but the time occurs in the things… moving away from astronomical time to the biological organic concept of time (Stockhausen & Maconie, 1989, p. 96).*

Another notable way that contemporary musical thought has become similar to older philosophies can be found in the reconsideration of time and, particularly, the notion of multiple times. The idea that time is malleable, linked to events rather than chronology, and the acceptance of alternate realities of time (affected by individual perception) are all notions that directly derive from Greek/Medieval thought. It is also an obvious continuation of the ancient notion of spheres and cosmology, because that sound was thought to come from the spiritual realm. This region of the universe was notable because it existed in a separate form of time than one found in the physical world.

This relativistic temporal perspective in both contemporary music and ancient discussions of time is crucial. This idea of time as divided into cycles of events is one that is different from a chronological view of time that exists in many other facets of the

modern world, but at the same time, it is not meant to diminish the importance of events occurring in chronological time. The key difference is that in chronological time, an event is measured, accounted for, and referenced in relation to a fixed time. A modern chronological view of time does not admit the possibility of other times and therefore ignores the sacred aspects of time. Modern musical time reconsiders the notion of cyclical and relative time, and hints at other temporal and perceptual realms.

There are many examples of contemporary composers and theorists choosing to consider the perception of time as relative to the gesture of a musical event. In some cases, this relativity in time is referred to by discussing gesture or by analyzing the continuity of form. For example, composer Dennis Smalley describes his own taxonomy, *Spectromorphology*, as a way of hearing that "is an aid to describing sound events and their relationships as they exist within a piece of music" (Smalley, 2007, p. 1). The perception of time is altered by the behaviors of musical objects James Tenney calls these behaviors gestures, or *Gestalts*, in his book *Meta-hodos*. In *The Concept of Time*, Brian Ferneyhough echoes this notion of a nonlinear perception of time when he says that "musical experience articulates not one, but many 'times'" (Ferneyhough, 1993, p. 1). Steve Reich refers to the innate temporal qualities of a gesture and suggests that the inherent time of a work is determined by the nature of the material being used: "material may suggest what sort of processes it should be run through (content suggests

form)" (Reich, 1968, p. 305). Time has once again become a subject of perceptual discussion.

In these contexts, time is not considered in terms of chronology or linear duration. Iannis Xenakis mentions the relationship between these two modes—what he calls "time structures"—in *Formalized Music*. Spectralism is described by Jonathan Harvey as "subject-in-process time," and he even goes so far as to claim that it "is in essence outside the world of linear time" (Fineberg, 2000b, p. 12) and (Harvey, 2000, p. 39). The importance of these modern considerations has more to do with composers' conscious manipulation and reflections of pure time with music as a mediator and less to do with the fact that musical time exists. The reasons behind time being associated with both the spectral qualities of sound and the philosophical concerns of absolute time become apparent when considering three types of time: sacred, measured, and eschatological.

The notion of *sacred time* is associated with *qualia*, incommensurability, experience, the divine, proportion (Just Intonation), geometry, and ineffability. There is also *worldly time*, clock time— a modern temporality associated with Reason, the world of Man, *quanta*, temperament, division, measurability, and comprehensibility. The modern notion of time "begins with the replacement … of the cyclical, recurrent, and sacred time … with a form of linear, progressive, and secular time centered … on the state" (Connor, 1999, p. 16). Just as in other aspects of value in technology and media,

that which is measured in time is prioritized because of its certainty (refer to the appendix titled *Ends and Means: Result vs. Process/Technique*). This, in turn, has perceptual ramifications on the conception of time and history. This perspective is argued by philosopher Sylviane Agacinski in *Time Passing: Modernity and Nostalgia*:

> *Through the techniques by which time is measured and through its assimilation as a market value, we can witness the Western hour's hold over the entire world. Enfolded in our time, distinct and distant societies are now inscribed into our own history. The technical hegemony of the West expresses itself all over the world through the extension of production methods and the establishment of its temporal architecture. But it is not only the measure of time that has been unified; it is also its value, reduced to the market value of work time. (Agacinski, 2003, p. 6)*

Within the virtual landscape there is a third time: *Media Time/Computer Time.* This is a time that is unique to the digital or technological era based exclusively on measured times and clocks used in mechanization. This form of time is seen as a more problematic version of the modern view of time; while clock time can be ignored, computer time and media time are built into the materials and virtual landscape. This is true of the material and how it is utilized, but it is not necessarily how it is perceived. From a technical perspective, Computer Time is not permanent, but flexible (and fallible). Desynchronized multiprocessor clocks and technical-timing issues needing hardware or software-level adjustments (like Y2K) can transform computer time into cyclical time. Media can conjure the past and transcend linear time.

In spite of this, the virtual is still a realm derived from measure with corresponding number-based limitations on the user experience. Paul Virilio considers this constantly measured and logical state of the digital space to be deeply suspect because it constructs "a permanent present, an unbounded, timeless intensity" (Virilio, Violeau, & Moshenberg, 2012, p. 15). "Unbounded" expanse, in this case, is similar to the Medieval eschatological time mentioned earlier (which is oddly dissimilar to sacred time):

> *"The crisis of the physical dimension in the age of telecommunications is apparently a crisis of substantive, continuous, homogenous space … Unlike analog representation, which is continuous, digital technology is inherently discontinuous (Vernallis, Herzog, & Richardson, 2013, p. 577).*

Further reading on these ideas can be found in Sylviane Agacinski's *Time Passing: Modernity and Nostalgia* and Steve Dixon's *Digital Performance*.

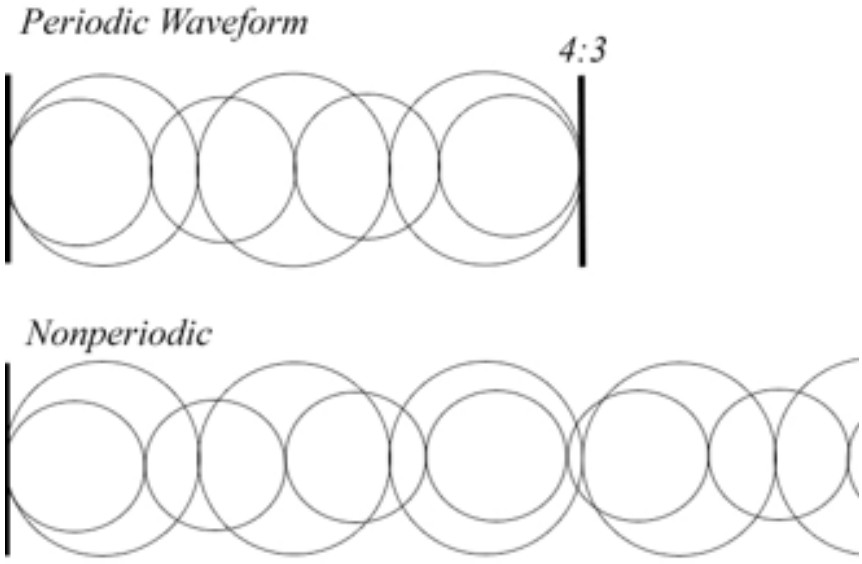
Many composers physically conjure sacred time using intonation. Just Intonation, for example, is seen as best suited to reflect the qualitative (immeasurable) state of sound or the "Drone-state-of-mind" (Duckworth and Fleming 1996, p. 161), while tempered intervals may represent worldliness. We can see this perspective plainly in Hans Zender's consideration of the mediation of intervals:

> *In principle, no mediation is possible between these two manifestations of the interval; hearing pure (perfect) intervals is an experience of quality, while hearing tempered intervals represents the experience of a quantity-governed tone-order generated by culture. (Zender transl. Hasegawa 2011)*

Perspectives similar to this are implicit (and explicit) in the work of many modern composers. For example, La Monte Young, Hans Zender, and Terry Riley believe that the quantitative (measurable) time and temperament of traditional Western music renders the ear unable to reflect upon time and the world.

Kyle Gann refers to this otherworldly atemporal object as an "Outside Time Structure"— a phrase derived from Xenakis' criticism of post-medieval Western musical traditions in *Formalized Music*. Young asserts this "may be one reason that only a few examples of pitches of long duration such as organum, pedal point, and the drone are to be found in music" (Young and Zazeela 1969 p. 7). Objects that are felt to have no explicit beginning or end are called *Outside Time Structures.* These objects in music express pure time, or the "musical expression of suspension in space" (Harvey 1999, p. 71). Xenakis argues that the Western musical tradition is not comfortable with these musical objects since they are not easily manipulated to bring out the inner time of a work.

Composer La Monte Young believes that learned periodic intervals can be used to access mystical, subconscious thoughts and memories. To him, Non-periodic waveforms are an *auditory eternity*, and represent an impenetrable sensation of time—that is to say, inexpressible through sound. Young's understanding of just-intuned sonorities as the



physical manifestation of number in relationship to time actually draws from ancient belief, while simultaneously stemming from the Medieval notion that "all music should be founded upon reason and speculation, the real *musicus* was that man who possessed the ability to judge intervals, modes, rhythms, and melodies according to a true understanding of the numerical properties of music" (Shrenk 1993, p. 17). Radulescu's perspective on harmony builds upon this definition: "If the music is very good and well done, it reflects very profound harmonic laws, in the true sense of harmony, universal harmony laws" (Gilmore, 2003, p. 113). Tempered intonations are not periodic (they don't repeat regularly), and example of this can be seen in **Illustration 2**:

Because of this lack of reliable repetition, it is thought that the true state of the interval cannot be ascertained and therefore believed to be unsuitable for reproducing the mystical.

Illustration 2: Periodic Harmony

> *… Chords in which any pair of frequency components must be represented by some irrational fraction… produce composite sound waveforms that are infinitely non-repeating, only an infinite number of lifetimes of listening could possibly yield the precise analysis of the intervallic relationship.*
>
> *Astronomers have known for some time that if a measurement or comparison is to be made of two orbits which involve many years of time, the degree of precision of the measurement will be proportional to the duration for which the measurement is made.* (Young and Zazeela 1969 p. 7)*

Electronics, Spectral Techniques, and Microtonality

Electronic and Recorded sound has permitted musicians and acousticians to study the experience of sound in a relatively systematic way. This has led to stimulating

discoveries on timbre and pitch, but has also led to the discovery of auditory illusions and other fascinating aspects of the auditory experience which were "heretofore were not accessible to compositional reflection" (Haas, 2007, p. 138).

For example, timbre has been traditionally considered as a quality "divorced conceptually from pitch and loudness" (Wessel 1979), but studies of timbre and pitch spaces, such as the work of Jean-Claude Risset and others, have found surprising perceptual borderlands in music where pitch and timbre become perceptually inseparable. In these musical situations, "where all sounds are complex, where many pitches and many timbres are involved, and where attention is integral to the musical experience, … we hear sounds and read pitch and timbre, but frequency does not always equal pitch" (Erickson 1975).

This notion of pitch being inseparable from timbre is an integral concept to many harmonic structures in modern tuning systems, especially in microtonal and spectral techniques. Studies by scientists such as J.C. Risset, J.M. Grey, and others show that blended harmonic structures are heard as single entities with a fundamental frequency. This is similar to the *third essence* in Plato's *Timaeus*. According to Grey, this fundamental is not necessarily the lowest pitch in the chord, but rather the loudest. The notion of the relative strength of a pitch as a determinant (or deterrent) of a perceptual fundamental is used in the harmonic structures featured in this dissertation.

Frequency Modulation (FM) Synthesis is a process where the timbre of a simple waveform is made more complex by modulating it with another frequency. It is generally used as a method to create dynamically changing timbres, but has been integral to the composition of new pitch systems by permitting composers to systematically construct complex electroacoustic timbres with relatively few sources. In the past, spectral composers have used these techniques "to integrate electronic FM sounds with instrumental timbres to create a new category of spectral models for use in all types of pieces" (Fineberg, 2000a, p. 96). Composers use these techniques to systematically derive timbres, and because timbre and pitch are somewhat inseparable, these timbres can be itemized and cataloged in pitch-space as a kind of musical scale. This is much like the derivation of the monochord as well as the Greek mediation of opposites.[20] Through the careful mediation of two objects (with the use of sacred forces or modulation frequencies), a *third essence* can be derived. These concepts have expanded the notion of intonation, pitch, and timbre, and have additionally helped composers reflect on the systems they have been "brought up with." I argue that these notions have had the effect of piquing the acoustic imagination with dreams of instrumental phantoms derived from two acoustic instrumentalists. In my work, the concepts of FM synthesis and instrumental synthesis are explored in relation to *isoluminance* and the conjuring of sound spirits which I will discuss in the section on shimmer.

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[20] "But two things cannot be rightly put together without a third; there must be some bond of union between them." (Plato, 360 B.C.E.-b)

Spectralism/Spectral Techniques

Spectralist composers[21], despite being called such, only sometimes use spectral analysis to transcribe objects in the physical world into their basic harmonic properties. This is a technique called *instrumental synthesis* and is based on the idea that complex sounds can be reconstructed or synthesized from a specific combination of sine tones and attack transients (Risset & Mathews, 2009). This technique divides a sound into its acoustical spectrum—the collection of partials or overtones at different frequencies that lends each sound its distinct timbre. These partials are then assigned to the instruments, which together produce an rough imitation of the original sound in a process "akin to additive synthesis" (Hasegawa, 2012, p. 1). The discussion of Instrumental Synthesis is only one aspect of spectral concerns, and while informative is incomplete and "takes into account only one limited aspect of the group's aesthetic" (Hasegawa, 2012, p. 1).

Composer Horatiu Radulescu has created an entire harmonic philosophy on conjuring sound spirits through spectra and has termed it "Preferential Phenomenology." Virtual functions are audible illusions like ring modulation and difference tones, and

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[21] Spectralism is somewhat of a blanket term for a disparate group of individuals that "invoke Fourier spectral analysis as a conceptual point-of-reference" (Wannamaker, 2008, p. 91). This is not necessarily the best definition, as many spectral composers base their work off of sound illusions not explicitly based from a Fourier analysis. When many refer to spectralism, they mean the *école spectrale*, which is heavily linked to the work of the l'Itinéraire composers Gérard Grisey and Tristan Murail. There are also composers such as Georg Friedrich Haas who, while explicitly denying any association with spectralist schools, use similar techniques but instead draw their lineage from Major 7th based sonorities of Webern and Wyschnegradsky (Hasegawa, 2015, p. 1). There are other composers who work idiosyncratically or have less specific lineages such as Akira Nishimura, Bernhard Lang, La Monte Young, Horatio Radulescu, Wolfgang von Schweinitz, and Peter Ablinger (see Haas's *Mikrotonalität und spektrale Musik seit 1980*).

“rings of resonance” and are the aesthetic discernment of a presence within a sound or space. The mathematical operations, or rituals, used to conjure these presences are: 1) specific harmonic operations are spectral dilation, 2) spectral multiplication, differential harmonics produced at high intensity, 3) ring modulations arpeggios, 4) chords built from the spectra of extremely low instruments (see Radulescu, 2003, pp. 343-359).

These phantoms require not only specific mathematical functions to be summoned, but they also require specific spaces and conditions. These phenomena are generally outlined as spells using mathematics. Radulescu is explicit in the mathematics of his magic in conjuring presence, but these kinds of ideas are common in many spectral works. In the next section, I hope to describe the sensation and the mechanism of the conjured presence and its use in contemporary microtonal composition.

This project encompasses microtonal and spectral techniques that utilize spatial resonances and perceptual illusions. Many composers are implicit in their use of these illusions, with one such example being Olga Neuwirth’s microtonal “shadow” piano in her *Piano Concerto.* This shadow piano was created by detuning one piano a quarter-tone down from the first piano. Exactly why a piano detuned slightly would be a shadow instrument can be seen in the following deconstruction of a bell's echo off of a stone building in **Illustration 3** (and in this video[22]).

[22] https://www.youtube.com/watch?v=0Ps4-czlaxo&index=7&list=PLmHRIo_H-52_6jDcSAC7BlK-sNmiK00f-

In this harmonic breakdown of the echo, it becomes evident that the echo is slightly detuned by around a quarter tone with changes in register around the edges. The specific frequencies required to produce the echo are plainly audible and are exactly why Neuwirth has chosen this intonation system.

Illustration 3: Harmonic Makeup of a Bell Echo Off Stones

Original	*Echo*	*Activity*
563.123413		*vanishes*
684.985779		*vanishes*
968.570007	967.911377	c. unison
1507.750122	1507.072144	c. unison
1620.832031	1628.470947	c. schisma (3 to the 8th/2 to the 12th x 5/8)
1675.994751	1678.743408	c. schisma (3 to the 8th/2 to the 12th x 5/8)
1780.736572	1764.759155	c. schisma (3 to the 8th/2 to the 12th x 5/8)
1928.702148	1780.033325	c. schisma (3 to the 8th/2 to the 12th x 5/8)
1971.590210	1928.047974, 1970.836182	c. inferior quarter-tone (Ptolemy), *schisma*
2122.761719	2123.075684	c. schisma
2188.805420	2186.690918	c. schisma
2564.916992	2568.250244,	c. schisma
2675.296387	2667.402832, 2815.296875	c. quarter tone, half step
3033.362305	3029.518555	c. schisma
3121.087891	3117.801758	c. median half step
	3444.387939	*arrives*
	3576.608154	*arrives*
	3688.365479	*arrives*
	4408.717773	*arrives*

Isoluminance: Sounds of Mysterious Provenance

> *That sense of unreality was all the more wonderful because the next day I heard sounds as unaccountable as were those lights, and without any emotion of unreality, and I remember them with perfect distinctness and confidence. (Yeats, 2004, p. 139).*

Sound presence, or the sensation of a potential "other" in sound, is compelling to many composers. Sound spirits can be conjured in many highly-varied ways. There are sounds that present a quality of otherness or an illusory, almost paranormal quality. This can either be an atmosphere of liveliness, unreliability, presence, or perhaps a location that is perceived to be improbable. A practical example of this is a sound that has no discernible source and yet exists. The listener can sense a presence but cannot place it—much like a ghost. The ambiguity of the situation, as discussed in the previous section on magic, leads to interesting perceptual results.

Many artists, especially sound artists and spectral composers, seem very interested in these phenomena. Haas' *Mikrotonalität und spektrale Musik seit 1980* describes a number of common microtonal processes, but two of them are of particular interest because they have mystical connotations and are often described using terms typically associated with light: uncontrolled microtonality and blurred unisons. The blurred unison is often described in reference to light and "shining" objects and in

comparison to the unison. I would compare uncontrolled microtonality to “shimmer,” which I will discuss shortly. Recall that Tristan Murail “compares the effect of [his] overtone chord with the condition that occurs when the sun is at its zenith: it casts no shadows” (Haas, 2007, p. 3). With some imagination, the invisible glowing object that Murail is describing could be imagined as a ghost. In actuality sounds cannot be seen nor do they cast shadows, but the habit of describing them in these evocative visually-oriented terms reveals something about how they are imagined. At the very least, Murail’s overtone chord is no mere chord but a presence, which is one of the key aspects of sound spiritualism and mysticism.

Sonorities such as the blurred unison have inspired many composers to work with phantoms, visions of reality, and shadow instruments. Jonathan Harvey describes sound presence as halos in his Passion and Resurrection: “I supplied all the characters with a spectrum that moved above their lines in parallel, composed of from one to twelve partials according to the dullness or brilliance of the halo I imagined them to have” (J. Harvey, 1999, p. 53). Morton Feldman uses a similar set of descriptions when defining his work based on the aesthetics and philosophy of the “Single Sound." To him, single sounds take on characteristics reminiscent of glowing: “It's frozen, at the same time it's vibrating" (Feldman, 2000, p. 84).

Heinz Holliger describes his *Siebengesang* as ‘shimmering torrents, full of purple stars’ (Griffiths, 2011, pp. 214-215). Hans Abrahamsen’s *Schnee Canon 1B and 5B (inversus)* are enchanting examples of shimmer using similar techniques, and are even described as shimmering by Paul Griffiths, as “adding shimmer to what is already shimmering” through the use of “their microtonal displacements” (Griffiths, 2011, p. 424). Composer James Tenney generates shimmer from a single tone in his Spectral CANON for CONLON Nancarrow (1974):

> *The intricacy of the accumulating and accelerating polyrhythms eventually defeats the perception of relationships between individual voices, producing an audibly chaotic maelstrom of rhythmic and melodic fragments that obscures the commencement of rhythmic retrogressions in the lower voices. As these retrogressions gradually invade higher voices, an unexpected textural transformation unfolds. Harmonic glissandi begin to sweep progressively higher in pitch, ultimately supplanting the preceding disarray with a new, multifaceted rhythmic and melodic order. As this happens, the instrument seems to begin to “ring" as though it were sustaining a single shimmering complex tone. (Wannamaker 2008)*

Spiritual spectral composers and sound artists have used techniques like ring modulation to “summon” phantom sounds and divine presences. Composers may refer to these phenomena abstractly and conjure “new sum and difference tones” (Gilmore, 2007, p. 5), as experienced in Claude Vivier’s *Lonely Child*, or may indicate the presence of unseen sound spirits, as in the “virtual B fundamental in the cello, or a virtual F-sharp fundamental in the piano” (Hirs, Gilmore, & voor de Kunsten, 2009, p. 141) in Murail’s *Winter Fragments*. Horatiu Radulescu’s phantom sounds, instruments, and shimmers are

explicitly conjured for spiritual purposes. In his *Inner and Outer Time Series* or *Incandescent Serene* (note the light reference), Radulescu works with shimmering tones and phantom instruments; his enormous phantom Viola da Gamba from his Opus 33 entitled *Infinite to be cannot be infinite, infinite anti-be could be infinite* is one such example.

> *...It's creating spectra, revealing spectra from nothing, because if you compose like that – with frequency components of spectra and emancipating them up to nearly actual instruments ... You excite your brain with these in order to listen to other functions which are not present, but which respond to the rule of ring modulation. You see? It's nature. (Radulescu interviewed by Gilmore, 2003, p. 107)*

Claude Vivier calls his shimmering ring modulation tones 'les couleurs' (Gilmore, 2007, p. 2), and Hans Zender describes the effect of a just-untuned interval as "luminous": "for many music lovers it is a revelation to discover that intervals like the just major third … have a luminosity, which compared to the color of a tempered interval is like a radiant red compared to a muddy red-brown" (Hasegawa, 2011, p. 2).

Light, phantoms, and shimmering are important topics in the modern mystical work, but there is a lot of background needed to appreciate the ways that these phenomena can be heard to the 'uninitiated'. In the next section, I will explain the experience of presence and shimmering in philosophical, phenomenological, and harmonic terms so that these effects can be utilized and appreciated.

On Presence

In *Phenomenology of Spirit*, Hegel says that individuals become conscious of themselves only through noticing other perceived autonomous beings— or presences. Shimmering and glowing, in both sound and light, are important to the experience of consciousness because of the way they appear to reveal information about the shape, motion, and environment of a being from an impossible location. I will begin with a discussion on the multimodal uses of 'presence' in sound and then delve into shimmer and isoluminance.

Shimmering and glowing, in both sound and light, are important determinants of presence because of the way they appear to reveal information about the shape, motion, and environment of an object. In this next section, I will discuss some theories concerning why shimmer and glow reveal presence in a markedly mystifying way.

Phenomenologies of presence, mutuality, and recognition are complex philosophical subjects and will not be discussed here. Instead, I am going to focus on the various forms of presence in art and explain how visual impressions of presence exist in the experience of sound.

> *…we are able, depending on context and motivation, to attend to particular sounds and establish an auditory aura: a penetrating, invading presence that is more than the sounds, more than the space and more than the sounding thing(s) within it. By physically penetrating the body and the spaces it occupies, sounds can command and encourage us to obey. We can become*

> *dramatically engaged in listening, participating with our whole bodies (Mills, 2014, p. 43).*

Presence can be a technical term, a noun, an adjective, or a verb, and thusly takes on different connotations depending on the context. In many ways, all uses of the term combine in the musical work. In art, presence and its variety of possible meanings is used creatively and somewhat interchangeably to create networks of meaning and possibility in a work. I will focus on four primary uses of the term presence in music and investigate how they function in the context of shimmering, revealing, and attention.

Presence, as a technical term, is a setting on an amplifier. It is also a term used to describe an audio process that "boosts the upper mid-range frequencies to make the sounds of voices and instruments with similar tonal ranges seem more 'present'" (Jackson, 2008, p. 75). In film and television, the term is used to describe the characteristic sound of silence in a particular room. Philosophical concerns of realness in media aside, recorded sound is being altered to make a sound seem more lively.

> *In… these seascapes, the same essential features find a place—the calm expanse without any defined boundary—the silence—the play of delicate colour—the suggestions of rest after toil, of peace after storm—and chiefest of all, the strangely moving contrast of power and gentleness, the suggestion of hidden strength (Mercer, 1913, p. 181).*

Along with indicating the existence of something, presence also carries social, religious, paranormal, and mystical connotations. Presence, in a Buddhist tradition, is a state of attention.

> *First there is dissolution; then the dharmakaya, emptiness; then the samboghakaya, clarity; then the nirmanakaya, manifestation. The principle is always to remain in non-dual presence. The division of processes… is simply to make it easier to bring our awareness into the passing moments, to give us something to look toward, to train us to use inevitable experiences as a support for the practice of pure presence.(Rinpoche & Dahlby, 2004, p. 181)*

A presence can also refer to any unknown that has been noticed and has the potential for communication. Presence is an admission of inherent human sociability and attention to others, as in "the presence of an Other comparable to us, to whom we are subjected, enjoined to pay a kind of exclusive attention" (Connor, 2012, p. 1). The term is often used to refer to ghosts, or to the somewhat perplexing feeling of "not being alone" while alone. Walt Whitman uses presence to refer to the spirit of nature: "How it is I know not, but I often realise a presence—in clear moods I am certain of it, and neither chemistry nor reasoning, nor aesthetics will give the least explanation" (Whitman, 1891, p. 105).

In its verb form, presence appears almost exclusively in mysticism and divination. To "presence" something or bring something "into presence" is to conjure or summon

something using a ritual or spell. J. L. Nancy describes painting as if he were conjuring ghosts:

> *Painting presents presence and always, saying nothing, says: here is this thing, and here is its presence, and here is presence, absolute, never general always singular. Presence which comes, the coming into presence, the coming-and-going, ceaselessly coming and going from its own discreteness to the discreteness of every time that is "proper" to it. (Nancy, 1993, p. 348)*

Liza Lim uses the verb in her essay*, Staging the Aesthetics of Presence,* regarding the Aboriginal practice of *Dreamtime*: "'[Dreamtime] is an originary force of creation that underlies all things and can be presenced in all times, mythical, historical, and contemporary" (Lim, 2009b, p. 2).

In sound, presence can take on all of these connotations because presence in sound is an indicator of both physical and metaphysical presence.

> *Sound is a present absence; silence is an absent present. Or perhaps the reverse is better: sound is an absent presence; silence is a present absence? In this sense, sound is a sinister resonance — an association with irrationality and inexplicability, that which we both desire and dread. Listening, then, is a specimen of mediumship, a question of discerning and engaging with what lies beyond the world of forms. (Toop, 2010, p. vii)*

This can be a disturbance in an environment of sound, a presence within or indicated by the existence of sound within the environment. Or it can be the individual characteristics of the sound environment that are unique to that environment—like a *genus loci* or spirit

of place. This is a personal and imaginative understanding of the world, where the listener "'lends an ear' to resonate with, and become immersed in, the mobile, vibrating, modulating, sonorous presence that results in the setting in motion of place" (Scarre et al., 2006, p. 42).

Within both music and mysticism, presence can take on all the aforementioned meanings simultaneously. Presence demands attention because, as mentioned before, it suggests communication or even danger. In some philosophies on the role of art and music, the perception of presence implies an other's intent to communicate. George Steiner, in his *Real Presences*, argues that art itself gains its semblance of presence from the potential of communication:

> *the potential of insight and response when one human voice addresses another… when we encounter the other in its condition of freedom, is a wager on transcendence. This wager… predicates the presence of a realness, of a 'substantiation'… within language and form. It supposes a passage, beyond the fictive or the purely pragmatic, from meaning to meaningfulness. (G. Steiner, 2013, pp. 1-2)*

In composition and art practice, there is always a multiplicity of communicative threads within a work—separate from any actual speakers in a hall or space. The composer can interpret the presence in a shamanic way, and in this case she is spoken to and is then re-iterating a message to the audience. In another way, the work and the practice itself engage in a dialogue with the creator, who can then use the perspectives

drawn from the work to reflect upon other aspects of her life. Within that progression, the work is not transmitting, but speaking in private. The sublime aspects of the work—those which galvanize the creator to 'speak' and tell others—demand the transmission of their words. The composer represents herself to an audience, speaking with them using the work, and the audience, by their presence, is responding.

Presence and the Unison

Ritual or process-based spiritual composers often create systems that derive from the manipulation of the *monad*. This manipulation is often the source of presence, and fuels the sense that there is an otherworldly vitality to a sound. The unison can be seen as a presence, a sound object, or a religious icon, but the gradual modulation of this unity reveals the spirit, just as an object lightly glowing or shimmering reveals the veil of reality.

> *In… these seascapes, the same essential features find a place—the calm expanse without any defined boundary—the silence—the play of delicate colour—the suggestions of rest after toil, of peace after storm—and chiefest of all, the strangely moving contrast of power and gentleness, the suggestion of hidden strength (Mercer, 1913, p. 181).*

Most are familiar with the cliché form of the spirit dislodging itself from the background, as illustrated in a Liu Bolin photograph (Bolin, 2011).

Illustration 4: Liu Bolin's 'Plasticizer'

The idea that spirits reveal themselves by coming out of the static (the world) and into focus is common in popular culture and movies. They are, as in Harvey's static sonority, "where the Many and the One are pointed up separately… [they] turn to modality, where the One permeates the Many without being separated from it" (J. Harvey, 1999, p. 70).

Unisons can also be seen as "mediums" to be manipulated by spirits. A present, unchanging sound object like the drone, unison, or monad has always been a feature of religious art. For example, in many Buddhist chanting traditions it is customary to chant in unison and as together with the group as possible.

> *The Daimoku that we chant must be performed attentively and diligently. When chanting, we should not have trivial thoughts in our minds. The speed should not be too fast and our pronunciation should not be slurred. We must maintain a medium pitch and chant calmly, resolutely and steadily. (Nichiren Shoshu Basics of Practice, pages 18-19)*

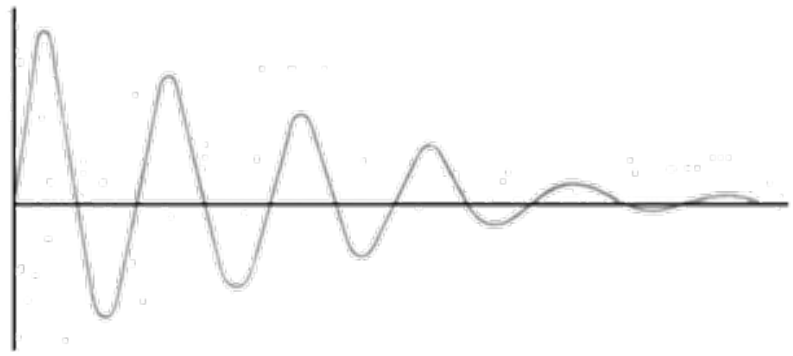
The aura of peace and stillness evoked by a singular presence like the unison exists for whole number ratios as well. Jonathan Harvey considers equal divisions of the octave as meditations on a specific point of stasis and says the unison "becomes a musical expression of suspension in space … it is itself a form of prayer, a means for experiencing unity. It is not a code for pointing to something" (J. Harvey, 1999, p. 71). Morton Feldman uses a similar set of descriptions when defining his work based on the aesthetics and philosophy of the "Single Sound." To him, single sounds take on characteristics reminiscent of glowing. Recall his earlier statement that a single sound is "frozen, at the same time it's vibrating" (Feldman, 2000, p. 84).

In sound, unisons, like the pure tones discussed in the Time section, are "frozen" and seem meditative because they exude pure time. As "sound beings," they have an indisputable impression of spirit, as Musicologist Daniel Thompson quotes Harvey (quoting Takemitsu): "the single sound is complete enough to stand alone-if we are prepared to listen in the manner most appropriate to apprehend its "spiritual" qualities" (Jonathan Harvey, 1999, p. 78) and (Thompson, 1999, p. 494).

Shimmer and Glow: Definitions

Objects that shimmer and glow have always captured the human imagination. Shimmering objects shine with a “soft tremulous light” (Merriam-Webster, n.d.-b) and glowing objects emit “steady light without flame” (Merriam-Webster, n.d.-a). Shimmering and glowing are two sides of an imaginative continuum that describe the relative speed and texture of undulating luminance in time as illustrated in **Illustration 5**:

Illustration 5: Shimmer and glow



Shimmering describes quick and fragmented beams of light, while glowing refers to slow motion of light that seems to come from a single source.

In some religious traditions, shimmering is understood as the “scintillating light of nature that is the spirit of place” (Morphy, 2013, p. 2). In the *Yolngu* art of Australia, it is called the *bir’yun*, and reveals where the barrier between reality and the supernatural is

weakest. Howard Morphy describes the *bir'yun* as "the flash of light, the sensation of light one gets and carries away in one's mind's eye, from a glance at *likanpuy miny'tj*" (the ancestral beings). From a physical perspective it is the "sensation of light … They see in it a likeness to the *wangarr* (Ancestral past) … the shimmering effect … which project[s] a brightness that is seen as emanating from the *wangarr* (Ancestral) beings … this brightness is one of the things that endows the painting with Ancestral power" (Morphy, 1989, p. 28). Christian mystics such as Saint Hippolytus have also seriously considered the transmutative properties of mystical shimmer:

> *Wherefore it is constrained, by all its reflection and understanding, to collect into itself the lustre and scintillation of light with the fragrance of the spirit. And it is possible to behold an image of the nature of these in the human countenance; for instance, the pupil of the eye, dark from the subjacent humours, (but) illuminated with spirit. As, then, the darkness seeks after the splendour, that it may keep in bondage the spark, and may have perceptive power, so the light and spirit seek after the power that belongs to themselves, and strive to uprear, and towards each other to carry up their intermingled powers into the dark and formidable water lying underneath.(Hippolytus, 1868, p. 172)*

Shimmer is also "akin to the structure of natural forces like weather … A surface is not a static plane but part of a shifting system that registers ripple effects, shimmering, and turbulence patterns from the movement of forces below" (Lim, 2009b, p. 3). Just as a glowing object emits a steady light without a discernible origin (and thus alludes to unseen forces at work), a shimmering or glowing sound is created by or gives the impression of an underlying force or combination of forces.

Sounds created by the careful manipulation of bowing and string vibration can be thought of as shimmering.

> *Striated, shimmer effects are created in the interaction between the competing planes of tension held in the retuned strings as they are affected by fingers and the varied playing surfaces of the two bows traveling at changing speeds, pressure and position. (Lim, 2009a, p. 2)*

The surface of the supernatural realm is represented by the fundamental tone produced by the bow and the physical plane of the string. Vibrating strings shimmer as they vibrate, and the manipulation of the periodic "surface" of the bowed tone and string conjures new, ringing tones. In electronics, composers conjure sum and difference tones, glowing tones, and inharmonic ringing spectra creatively treated as phantom tones, or ghosts.

An Explanation of Isoluminance

In colorimetry and the visual, the shape and location of an object are thought to be determined by the variations in the chromaticity (or color-matching) and luminance of an object. In basic terms, chromaticity is the specific color (hue and saturation) of an object. Luminance is the brightness, or merely "a statistic designed to express the fact that lights of equal power but different wavelengths do not all appear equally bright" (Arend, 2015).

Information regarding objects in space is processed using a combination of two "streams" of information—the ventral stream and the dorsal stream. The ventral stream "plays a critical role in the identification and recognition of objects" while the dorsal stream "mediates the localization of those same objects" (Wilson & Keil, 2001, p. 873) and (Mishkin & Ungerleider, 1982).[23] The dorsal stream is considered the "where" pathway, deals with "location and movement for action," and is largely unconscious (Van de Gaer, 2015). The ventral stream is the "what" pathway, focuses on object recognition and form analysis, and is considered a conscious process. According to Margaret Livingstone in *Vision and Art - The Biology of Seeing*, luminance is associated with the dorsal stream and is thought to aid in the determination of motion and the location of an object while the ventral stream focuses on form (Livingstone, 2002, p. 194).

An isoluminant object is perceived "when the spatiotemporal pattern of visual stimulation is made up only of variations in chromaticity, without accompanying variations in luminance" (Lindsey & Teller, 1990, p. 1751). Some scholars, such as Conway and Livingstone, argue that this is due to "perspective and reflections chang[ing] second to second as we move our eyes across a scene… there would have been little biological benefit to incorporate the rules for… illumination into our visual computations" (Conway & Livingstone, 2007, p. 479). Studies in vision and neuroaesthetics such as Turano and Pentle's *On the mechanism that encodes the*

[23] Reality is more complex. For more information, see: http://ai.ato.ms/MITECS/Entry/goodale

movement of contrast variations: velocity discrimination and Teller and Lindsey's *Motion at isoluminance: discrimination/detection ratios for moving isoluminant gratings* have shown that when objects are processed using only one "stream," a "wide variety of visual functions are compromised" (Lindsey & Teller, 1990, p. 1751).

This ambiguity has great creative potential, and Anjan Chatterjee, a scholar in neuroaesthetics, more explicitly discusses the perceptual and creative experience of shimmer:

> *...the shimmering quality of water or the sun's glow on the horizon seen in some impressionist paintings ... is produced by isoluminant objects distinguishable only by color. This strategy plays on the distinction between the dorsal (where) and ventral (what) processing distinction ... The dorsal stream is sensitive to differences in luminance, motion, and spatial location, whereas the ventral stream is sensitive to simple form and color. Isoluminant forms are processed by the ventral stream but are not fixed with respect to motion or spatial location, as the dorsal stream does not process this information. Thus, isoluminant forms are experienced as unstable or shimmering. (Chatterjee, 2011, p. 53)*

The conflation of location and identification can lead to interesting and somewhat supernatural impressions of objects in space, because the eye can easily identify the presence of an object but cannot easily determine where the object is. Sometimes, when the object is not located in the visual field, the object is interpreted to be from another, possibly spiritual, realm.

Isoluminance can be identified in many religious art traditions, where the divine body is represented as glowing or shimmering. Examples of this can be seen in medieval paintings of holy people, in Hindu and Buddhist art, and in the Yolngu art practice. The divine is represented by light with a shimmer or a glow to represent the spirit. Examples of this can be seen in **Illustration 6**:

Illustration 6: Shimmering and glowing in medieval, buddhist, and Yolngu art

Anunciation by Simone Martini and Lippo Memmi

Dambulla rock temple caves Sri Lanka

Djambawa Marawili Garrangali 2010 etching and screenprint

Isoluminant Sound

Though *isoluminance* is a term used specifically to refer to light, there are analogous experiences when processing non-localizable sounds. Obviously, there are differences between an "object" in vision and an "object" in sound as well as differences in how location information is processed by the two faculties. I argue though that the ephemerality and time-variable nature of isoluminant phenomena brings this particular visual experience closer to sound and the mystical-ephemeral than to the normal visual sphere. As a creative trope, isoluminance works well within the context of sound and

sparks the imagination with dreams of sounds that have as Harvey said, ‘mysterious provenance’.

Like there are two ‘information streams’ that help the viewer identify objects visually, there is evidence that there are somewhat-equivalent ‘streams’ that aid the listener in the identification of sounds. Jennifer Bizley and Yale Cohen have discussed this at length in their article *The what, where, and how of auditory-object perception*, in which they assert that “substantive auditory-object processing has been identified in the dorsal pathway, and substantial information about auditory space has been found in the ventral pathway” (Bizley & Cohen, 2013, p. 4).

I define “audio-luminance” as the spatial and locational information gathered from a sound and “audio-chromaticity” as the perception of ‘thingness’ (i.e. violin-ness). An isoluminant sound would be easily identifiable as a sound object but impossible to locate in space (“Where is that sound coming from?”), or a sound that seems to have spatial qualities separate from the known listening space (“Why is there reverb in my anechoic chamber?”). Within this context, isoluminant objects exist almost outside of the realm of space, time, and form. This conflation of the *where* within the space of *what* can conjure new objects identified as beings communicating from another realm.

> *In their illumination and their obscurity, the transparent colors are without limits, just as fire and water can be regarded as their zenith and nadir …The relation of light to transparent color is, when you come to look into it deeply,*

> *infinitely fascinating, and when the colors flare up, merge into one another, arise anew, and vanish, it is like taking breath in great pauses from one eternity to the next … It is these, however, that are able ... to produce such pleasing variations and such natural effects that ... ultimately the transparent colors end up as no more than spirits playing above them and serve only to enhance them. (Goethe, 1926) quoted in (Benjamin, Jennings, Doherty, Levin, & Jephcott, 2008, p. 234)*

These kinds of effects are not difficult to find and it is possible to trick the ear into hearing sounds that come from strange or unusual places. This effect can be created through changes in instrumental timbre (like instrumental synthesis). A sound object can be altered to seem to exist in a liminal space where the recognition of the object itself becomes difficult. These kinds of effects can be created using many sound techniques (like ring modulation) and not necessarily through any particular manipulation of cognitive processes. That being said, the ubiquity of light and shimmer metaphors in music underscores the importance of the underlying visual, perceptual and experiential specifics of isoluminance. In my view, this feeling of a spirit that can be perceived yet remain out of reach gives new meaning to David Toop's account of a sound that "came from nowhere, belonged nowhere, so had no place in the world except through my description" (Toop, 2010, p. vii).

Conjuring Shimmering Tones

The modulation of the static in music can be used to create an air of presence, shimmer, or otherness in sound. In my work, I often work with presence within pitch, specifically with divergences from a unison, whole tone ratios, drones, textures, and 'noise.'

Through listening and experimentation I found that complex and noise-rich sounds are useful when conjuring glowing effects. These types of phenomena such as ring tone modulation, difference tones, sampling rate resultant tones, shepherd tones, and timbre-specific harmonic effects can only be brought about in specialized circumstances and environments, but there are a few general rules that can be applied to begin searching for them. It is important to begin by learning to hear subtle qualities of sound and space, and so I have included a sonic meditation entitled *Sound Vision* in the Appendix. In this section, links to a few videos are provided to show examples of conjuring shimmer and glow. I use glowing unisons in my compositions, and they play key roles that allow me to bring out senses of space and presence. This can be done both electronically (like ring modulation) and instrumentally.

In my work, I use glowing tones and they play key roles in my pieces. These are specific pitch groups that are similar to "chorusing tones" (Leedy, 1991, p. 204) such as the "wolf" Fifth. Glowing pitches, called chorusing tones according to Carlos, are "[o]scillations of about 0-6 Hz" and oscillations "around 6-16" are categorized as

"roughness" (Carlos, 1987, p. 33). Shimmering tones begin to arise out of timbres that Carlos calls "roughness" but in my experience this is extremely timbre dependent. These tones can arise from temperaments like meantone, with their "noticeable but not unpleasant beats" (Leedy, 1991, p. 204).

In the pitch domain, I have found that Glowing tones begin to be produced when perfect intervals are altered between the range of a *schisma*[24] (+/-1.954 cents or 32805/32768) in simple waveforms to slightly[25] less than a quarter tone (around +/-35 cents or slightly less than a 49/48 ratio) against an unaltered complex tone. Adding additional altered overtone pitches (doubled in respective unevenness) will amplify the effect and produce a better result. In the following examples and in the analysis section, the glowing or shimmering sonorities are marked with an * at each end, such as **schisma**. Here are a few examples of tones altered using these particular ratios in **Illustrations 7** and **8**:

Illustration 7: Example of a Glow Tone

	1.02155	**1**
1.02155	1/1 (tonic)	* 46/45 (inferior quarter-tone (Ptolemy)) *
1		* 1/1 (tonic)

Octaves are altered in a similar fashion:

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[24] 1.00112915039062 in decimal

[25] 1.02155

Illustration 8: Glowing Octaves and Perfect Fifths

	1.962052	**1.51223**	**1**
1.962052	1/1 (tonic)	83/64 (83rd harmonic)	* 51/26 *
1.51223		1/1 (tonic)	* 121/80 *
1			1/1 (tonic)

Like reverberation, the conception of space surrounding the overtone sonority is altered by de-tuning the pitch of the sonority. In Video Example 1[26], the change in the impression of space is brought about through slight alterations in pitch around this limit of a schisma (**Illustrations 9** and **10**).

Illustration 9: **Screen Shot from** ***Video Example 1***

Illustration 10: Glowing Overtone Chord

662.108276	**550.333008**	**440.88965**	**331.02399**	**220.149078**	**110**

[26] https://www.youtube.com/watch?v=ZRARCvF1Dq8&list=PLmHRIo_H-52_6jDcSAC7BlK-sNmiK00f-&index=2

662.10827 6	1/1 (tonic)	77/64 (77th harmonic)	3/2 (perfect fifth)	1/1 (tonic)	3/2 (perfect fifth)	2/1 (octave)
550.33008		1/1 (tonic)	* 8192/6561 (Pythagorean "schismatic" third) *	* 128/77 *	5/4 (5-limit major third)	2/1 (octave)
440.88965			1/1 (tonic)	4/3 (perfect fourth)	* 32805/32768 (schisma (3 to the 8th/2 to the 12th x 5/8)) *	2/1 (octave)
331.02399				1/1 (tonic)	3/2 (perfect fifth)	3/2 (perfect fifth)
220.14907 8					1/1 (tonic)	* 32805/32768 (schisma (3 to the 8th/2 to the 12th x 5/8)) *
110						1/1 (tonic)

Nothing about the way the sound was produced changes over the course of the video, but the change in pitch mimics a change in space. This specific change in intonation in instrumental music creates place within place, and alters the experience. In electronic sounds, it is very difficult to appreciate these kinds of effects because the ear and mind are quite used to electronic sound masquerading as both space and image. That being said, it is important to avoid thinking of the resulting sound as a 'sound effect' because it reduces the imaginative power of the experience. As Stockhausen said earlier: "most listeners… say, well, the walls have not moved, so it is an illusion… the fact that you say the walls have not moved is an illusion, because you have clearly heard that the sounds went away… and that is the truth. (Stockhausen, 1972, pp. 107-108).

Overtone chords built using specific intervals conjure spatial effects using difference tones. When combined with other forms of aliasing from sampling rates and speaker bodies, these effects produce sounds that have an air of space to them that is not reducible to the parts alone. This can be heard as conjuring phantom sonorities. An example of this can be seen **Illustration 11** and in Video Example 2[27].

Illustration 11: Screen Shot from Video Example 2

These overtone sonorities produce additional invisible singers, like the phantom voice of the Virgin Mary in Sardinian Chant. These voices, because they only exist in the mind, create an imaginary space based on sounds that are present yet have no source (**Illustration 12**).

[27] https://www.youtube.com/watch?v=DIviriImkUM&index=1&list=PLmHRIo_H-52_6jDcSAC7BlK-sNmiK00f-

Illustration 12: Unaltered Overtone Glows from Difference Tones

	3000	**2500**	**2400**	**2250**	**2000**	**1800**
3000	1/1 (tonic)	6/5 (5-limit minor third)	5/4 (5-limit major third)	4/3 (perfect fourth)	3/2 (perfect fifth)	* 5/3 (5-limit major sixth) *
2500		1/1 (tonic)	25/24 (minor 5-limit half-step)	* 10/9 (minor whole-tone) *	5/4 (5-limit major third)	25/18 (augmented fourth (4/3 x 25/24))
2400			1/1 (tonic)	16/15 (major 5-limit half-step)	6/5 (5-limit minor third)	4/3 (perfect fourth)
2250				1/1 (tonic)	* 9/8 (major whole-tone) *	5/4 (5-limit major third)
2000					1/1 (tonic)	* 10/9 (minor whole-tone) *
1800						1/1 (tonic)

Ring modulation can also produce phantom spaces and voices, like the different ring modulated spaces in **Illustrations 13-14** and Video Example 3[28]. In this example, the same ratios are applied to oscillators in a ring modulation process and scaled to resonate with the particularities of the example waveform.

[28] https://www.youtube.com/watch?v=XIaGwhzGuzM&list=PLmHRIo_H-52_6jDcSAC7BlK-sNmiK00f-&index=3

Illustration 13: Screen Shot from Video Example 3

Illustration14: Relationship of Tones in Shimmering Ring Modulation

	660	**464.8**	**460**	**455**	**330**
660	1/1 (tonic)	125/88	33/23	29/20	2/1 (octave)
464.8		1/1 (tonic)	* 99/98 *	* 46/45 (inferior quarter-tone (Ptolemy)) *	31/22
460			1/1 (tonic)	* 99/98 *	46/33
455				1/1 (tonic)	40/29
330					1/1 (tonic)

The purpose of these examples was to:

1) Prepare the ear by example for the kind of listening necessary for the analysis and appreciation of my pieces

2) Present the structural elements and phenomena used in the dissertation pieces

3) Show, concretely, how these kinds of sounds are created using specific tonal relationships
4) Complement the previous sections on why these kinds of phenomena were used and how they were heard

The first example should have shown how small alterations in the pitch structure changes the feeling of presence and motion in a sound. This small change can be described or experienced as glow and liveliness. The second example is based on the first but instead of detuning the overtone chord to create phantoms, a similar type of presence is conjured using specific ratios.

Section 3: Art Magic and Technological Divination

Magic and science, due to their relationship to practice, have been joined together historically with *Natural Magic* (medicine/science) and the supernatural. The scientific method is, in part, a ritual. So is the exact order in which a performer sets up a stage. The reason that science is often mistaken for magic (and the other way around) can be best summarized by Arthur C. Clarke: “Any sufficiently advanced technology is indistinguishable from magic” (Prucher, 2007, p. 22). From the perspective of the “uninitiated" or superstitious, science and medicine (like magic) invoke processes and “powers that remain occult,” or hidden “even when they can be demonstrated experimentally and described in precise, mathematical terms” (Dawes, 2013, p. 36). The

fissure between the scientist and magician, of course, is the belief in the comprehensibility of the process, where science "rejects the idea that an occult power can be invoked by actions or objects merely by virtue of their form" (Ibid.). This link between technology and sorcery is a key component in the creation of electronic mystical art.

Sonification and Apophatic Mysticism [29]

Sonification, as the name would suggest, is the practice and process of converting information into sound for either creative or scientific purposes. Taking this definition a step further, sonification is a tool for converting information into the experience of sound. I am not referring to audification in the sense of an *Earcon* or assistive display where listeners can avoid backing their vehicles into trees; rather, I am going to discuss sonification, like harmonics and the monochord, as the process by which one listens to data for the purpose of revealing knowledge. In the next section I will discuss scientific and creative sonification in light of sound as a revelation of knowledge regarding the invisible and unknowable, magic, mysticism, harmonics, experience, apophatic mysticism, and number. I will focus on the scientific frame of sonification and how this provenance serves as a listening mode by which listeners are trained to hear the Unknown and possibly the Unknowable through apophatic processes.

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[29] this section also contains excerpts from *Sonification and the Mysticism of Negation*

Composer Barry Truax considers the process of sonification to be a tool that aids a listener's comprehension and reflection. He believes that sonifying data, or "forces or data from the real world," might "direct the listener's attention back to an understanding of some facet of that world" (Truax, 2012, p. 195). Others define the practice as a method of deduction:

> *Data sonification is a form of "auditory display" wherein data is converted to sound to aid in scientific understanding. Time-tested examples of data sonification include the Geiger counter and electrocardiogram (ECG) machines. However, this field has begun to expand rapidly in recent years, and the use of data sonification may be found throughout scientific study, and is potentially useful wherever patterns in complex data might need to be revealed. (Cetilia, 2014)*

The notion of data being 'revealed' through sound is very entrancing to me. Sonification is framed as an objective activity and because of this, an ambiance of certitude permeates the act of listening to data. Like mystical listening, certitude primes the imagination to focus, trust, and apprehend knowledge through experience. Due to the faith in the communicative and revelatory potential of numbers, the data becomes imbued with presence. Moreover, sound is a mediator, and the act of translating objective information into experience to gain insight is a mystical technique common in many religions. Sonification and audification, specifically when framed objectively are trusted and accepted as pathways to knowledge and secure some of their musical and mystical power from this faith.

Historically, sonification has been deeply rooted within a contemporary mode of listening which tends to frame listening as an objective activity that one can be trained in and use for objective aims. In *The Sonification Handbook*, sonification is defined by Bruce Walker and Michael Nees as a "display that uses sound to communicate information" (Nees & Walker, 2009, p. 9). This is a version of the definition found in the 2010 *Sonification Report*, referring to sonification as the "transformation of data relations into perceived relations in an acoustic signal for the purposes of facilitating communication or interpretation" (Kramer et al., 2010, p. 6). Scholars such as Hermann and Hunt expand on these definitions and suggest that sonification is "the use of sound within a tightly closed human computer interface where the auditory signal provides information about data under analysis, or about the interaction itself, which is useful for refining the activity" (Hermann & Hunt, 2005, p. 1). As a practice, sonification is intended as a tool to guide the listener's navigation of the world, as the "auditory equivalent of scientific visualization" (Hermann, 2011). This is similar to the practice of the medieval *musicus* or the diviner of the celestial monochord. Sound is the mediator of knowledge regarding the unknown and unseen aspects of the world.

By providing the perceiver with another method of interpreting data, sonification is promoted in some scientific settings as a method to enhance or accentuate existing scientific knowledge, to "disclose or make emerge aspects of the data that might not have been discovered before" (Dombois & Eckel, 2011, p. 301). Carefully trained listeners,

"by engaging with the data in a process of analytic listening," can learn to decipher patterns which were "otherwise undetectable" (Ibid., 307). The authors are careful to mention the need for specific listening training and guidance in how to listen and their implications are straightforward: sonification is viewed as an objective and discrete method of interpreting and analyzing data. Information from these sound sources is being sought through the lens of modern science, which assumes a certain level of objectivity and an intention to use the information to further a scientific or intellectual goal.

Despite this aim, sonification has a number of peculiarly subjective qualities that detract from objective tasks but are perfect for mystical activities. Unlike other forms of information, sonified data is "delegated almost completely to the human auditory sense" (Ibid.). Traditionally, visual information has been treated as more objectively trustworthy than auditory information. R. Murray Schafer says that listeners are "trustworthy" only when discussing "sounds directly experienced and intimately known" (Schafer, 1993, p. 8). Sonification is also an unusual tool for data analysis because the data is presented in a form that "intrudes into reality for a moment, but escapes it in the next ... a form, which is expressed over time, but cannot be touched" (Dombois & Eckel, 2011, p. 301). Dombois argues that repetition and careful guidance will lead to an improved understanding of data, but I propose instead that repetition is more likely to deconstruct the data in an Apophatic sense. The listening training that is suggested is similar to the second stage of initiation where the novice is

given the proper techniques of occult practice, specifically where the the exact means of development remain hidden. Repeated listenings to data can become liminal, like a ritual, and free the mind to received mystical information.

Mapping, or the way that data has been represented in sound, is the backbone of this practice and is not objective. The importance of this part of the process is sometimes overlooked. A convincing mapping can mediate and transform data into powerful sound that can be heard (or embellished to make it seem) to reveal hidden dimensions of information in the data. This can be seen as biasing the data and removing the objectivity, but sonified data without an imaginative or compelling mapping can discourage attention to the experience while still not being objective. Unless the data is sound, mapping information into sound is always a process of mediation. From a creative standpoint, a successful mapping is an power akin to alchemy that can both divine and conjure presence in sound.

To add to this alchemy, sonifying data is not seen merely as a way of communicating information about data, but to communicate knowledge regarding the invisible—like the monochord. The meaning of this duality is revealed in Paul Vickers' research on Process Monitoring, in which he states that the goal of a sonified system is to "communicate knowledge and awareness" of remote activities, or the invisible or inaudible (Vickers, 2011, p. 473). Some examples of this kind of information include

remote or internal computer processes, ultrasound, data mining, glitch art, and visual data. This perspective has also proven to be fertile ground for artists who have found creative inspiration in "Unheard Sound Cosmos," in which the data "displayed another world beside ours… making the inaudible audible" (Dombois & Eckel, 2011, p. 307). It is worth noticing the almost *koan*-like tantalizing promise of hearing the inaudible. If a sound can be heard it is not inaudible; any inaudible sound that can be heard is not the sound it claims to be. Hints of other realms translated into perceptible versions of themselves retain the power of their hidden origins in the imagination.

To retain the semblance of objectivity (or possible actual objectivity), the listener must be carefully trained (or initiated) on how to focus and interpret previously unknown and possibly "unknowable" patterns manifested in the data. This is similar to the process of learning magic, and in this understanding sonification resembles that of the listener seeking mystical knowledge through an Apophatic analysis and contemplation of sound. In the latter practice, the listener:

> *… must concentrate his whole attention on the fact that the sound tells him of something that lies outside his own soul. He must immerse himself in this foreign thing. He must closely unite his own feeling with the pleasure or pain of which the sound tells him. He must get beyond the point of caring whether, for him, the sound is pleasant or unpleasant, agreeable or disagreeable, and his soul must be filled with whatever is occurring in the being from which the sound proceeds. Through such exercises, if systematically and deliberately performed, the student will develop within himself the faculty of intermingling, as it were, with the being from which the sound proceeds … Through her resounding tones, the whole of nature begins to whisper her secrets … What*

> *was hitherto merely incomprehensible noise to his soul becomes by this means a coherent language of nature. And whereas hitherto he only heard sound from the so-called inanimate objects, he now is aware of a new language of the soul. (R. Steiner, 2007, p. 33)*

Other methods of analysis (like, data analysis) lean towards language, replicability, and objectivity. They lend themselves to description and observation—thereby encompassing Kataphatic characteristics—while sonification does not. By transforming the data into the mediated experience, the data is negated. This negation of the descriptive effect of language renders this process Apophatic. To the mystic, the information is not being created, but conjured.

5th century theologian and philosopher Pseudo-Dionysus maintained that in order to reach the divine, or "that which is beyond all abstraction", the mystic must apply "negations to things which are most remote from It" (Dionysius, 1987, p. 208). In order to reach the mystical, one must negate the objective. In a textual frame, this means that in order to grasp the mystical in a word, the meaning must be removed and then the perceiver should seek what is left. Consequently, in order to uncover the mystical in data, the descriptive and objective qualities of the data must be removed. Data must become *nondata*, it must be felt, and this is exactly what sonification achieves. Before being mapped into sound, the data is objective and had the potential to be analyzed. The resulting insights could be described, tested, and replicated. When the data is transformed into experience and its objectivity is implied yet cleverly disguised, it is negated. It moves into the Apophatic domain, and becomes a *mantra* or a vision.

This deconstruction of the state of the information leads to the revelation of a different kind of knowledge: mystical information gained through the process of being in "direct acquaintance" with the data. As Harvey attests, sound or music "undoes the 'word' and returns to pure awareness—or at least gives a glimpse of it" (J. Harvey, 1999, p. 38). In some sense, the data is being used in a manner similar to that of a Buddhist who uses language to negate its objective trappings in his or her *koan* practice:

> *... through the obverse of words, is its obverse dialectically—words, in their destructive function, lead to the transcendence of words but only through using words. (Katz, 1992, p. 13)*

Afterwards, the information gathered has been conjured in the mind through the experience. It is transformed "into perceptual cues, which we then use to synthesize an experience of the external world" (Blesser & Salter, 2009, p. 2), but the process by which this knowledge was gained remains occult. The result is ineffable, mystical, and will remain so. The source may remain behind the veil, strongly lit, though for a connotative-minded or imaginative listener it will appear as shadow play.

Despite the objective and scientific goals of many practitioners of sonification, it may be an unpredictable tool for ascertaining truly objective information— but the belief that it can is absolutely necessary. The impression of the Real within the data is crucial to its creative and evocative power, and the listening methodologies and techniques used in

both creative and scientific sonification are fascinating. Sonification, as a form of data analysis (or divination tool in my opinion), "discloses or makes emerge aspects of the data that might not have been discovered before" (Dombois & Eckel, 2011, p. 301), and it will also, as a mystical practice, "so dispose" or arrange things so "that they are [*sic*] a figure of something else" (Martin, 2006, p. 13). The sonification of data reveals shadows, not facts.

Sonified information is compositionally and spiritually provocative, and serves as an invaluable structure through which artists can investigate facets of the world and our places within them. The mystical information that is uncovered and the deep connections made can enable us to "return to real life disturbed, excited and challenged on a spiritual and social plane by music with hands on relevance to both our inner and outer lives" (Norman 2005). Sonified information understood as mystical experience plays an important role as compositional inspiration in my work, and the information. Creatively speaking, this impress of objectivity and the scientific provenance of data is precisely what allows this negation to take place. It is also why sonification is so uniquely suited for the task. The experience of sensing something deep and lurking within a series of numbers, derived from some aspect of the world, is one that I find to be irresistible and influential.

Process Music and Emergence

Emergence Defined

Process music is related in effect and purpose to emergence and complexity science of the early twentieth century. Emergence is the appearance in a system of properties which are not predicted from the system's constituent components; emergent properties are "novel, qualitatively different features … in comparison to the … system's parts" (Krohs & Kroes, 2009, p. 280). In science, it is used to study subjects such as evolution, psychology, traffic, and movement, but for the purpose of this dissertation, it is of greater importance and relevance to grasp the metaphysical aspects and the imaginative potential of emergence.

Rule-driven, process and system-based music can be viewed as an emergent property of the system used to generate it. This emergence can be viewed at three levels: nominally, the microstructures of the system map to what is heard (often in a novel way); weakly, the microstructures assemble together to produce a piece that is greater than the sum of the parts; and strongly, the musical system can take on a life of its own, transcending itself and even the composer's will. Such emergence is omnipresent in my work and is often how I view my systems and their results.

Emergence, as a process, is the mediation of both reductionist and holistic viewpoints, where phenomena are both reducible to and more than the sum of their parts.

The process is contingent upon its parts in a highly nontrivial way, and any removal of parts of the process will change the result. Irreducibility is both a mathematical and philosophical concept, and is a common topic in consciousness studies, divination, and religion. Many theologians take advantage of the irreducibility of the parts from the whole (as in consciousness) and use this gray area of causality to insert the divine. This is often used as a politically expedient metaphor to muddy the waters in arguments over evolution. In harmonics, irreducibility is one of the fundamental properties of the essences, where the harmony is the third essence and can only arise from the completion of the parts. The other two parts exist, but the third must be conjured and the process that is used is hidden, or occult.

Emergence and the Observer

Considering the epistemological reasons I outlined, the observer plays a fundamental yet heavily suspicious role in the perception of emergence. There is no such thing as an unbiased observer, and in composition both the composer and audience play this role. The human mind looks for patterns and will find them everywhere. This is ideal for experiencing music and art, but problematic for engaging objectivity:

> *Defining structure and detecting the emergence of complexity in nature are inherently subjective, though essential, scientific activities. Despite the difficulties, these problems can be analyzed in terms of how model-building observers infer from measurements the computational capabilities embedded in nonlinear processes. An observer's notion of what is ordered, what is*

> *random, and what is complex in its environment depends directly on its computational resources: the amount of raw measurement data, of memory, and of time available for estimation and inference. (Crutchfield, 1994, p. 1)*

Types of Emergence

In order to combat this magical thinking in psychology, an emergent process is labeled and analyzed with regard to the method by which it was identified. Scholar Mark Bedau divides emergent processes into three basic groups (M. Bedau, 2002, pp. 8-11):

1) intuition based
2) observer centric pattern formation based
3) intrinsic to the process

Intuitive emergence is akin to the observation of novelty in a process, pattern formation is when an observer identifies a pattern with the emergent process, and an intrinsic process is found when "the system itself capitalized on patterns that appear" (Crutchfield, 1994, p. 4). Within each of these modes of perception, there are three kinds of emergent processes: strong, weak, and nominal. There are also two kinds of possible emergent properties within this: resultant (expected) effects and emergent (novel) effects. These divisions represent the relative strength of the ephemera that has emerged, or in the metaphysical usage of the term, conjured. These degrees of observance are similar to the

kinds of processes used in process music, divination, and this will be discussed in the next section.

Bedau defines *nominal emergence* to be a process where the whole is entirely dependent on the parts. A macrostructure is defined by its dependence on the microstructure. An example of this is the circle. A circle is constructed of points that, when seen together, form the shape. If the circle is generated intentionally rather than observed, it becomes "a resultant process" (M. Bedau, 2002, p. 4).

Strong emergence is a striking case philosophically, where the emergent process becomes supervenient and is regarded as having irreducible and new "causal powers" (O'Connor & Wong, 2005, p. 670). This is, in essence, a system where the macrostructural process is modeled as becoming autonomous from the microstructure processes. This is usually referred to as downward causation and these "irreducible causal powers give emergent properties the dramatic form of ontological novelty that many people associate with the most puzzling kinds of emergent phenomena, such as qualia and consciousness" (M. Bedau, 2002, p. 5):

> *Although strong emergence is logically possible, it is uncomfortably like magic. How does a reducible but supervenient downward causal power arise, since by definition it cannot be due to the aggregation of the micro-level potentialities? Such causal powers would be quite unlike anything within our scientific ken (M. A. Bedau, 1997, p. 3).*

Weak emergence lies somewhere between these two extremes. Emergence, especially notions of strong emergence and the resulting self-controlled/conjured ephemera, give the impression of the supernatural or Artificially Intelligent/Omniscient.

More information on the history of complexity science and emergence can be found in Peter Corning's *The Re-emergence of "Emergence:" A Venerable Concept in Search of a Theory*, Mark Bedau's *Downward causation and the autonomy of weak emergence*, David Blitz's *Emergent Evolution: Qualitative Novelty and the Levels of Reality*, David Chalmer's *Strong and Weak Emergence*, or James Crutchfield's *The Calculi of Emergence: Computation, Dynamics, and Induction*.

Emergence in Music

While the magical and divine aspects of strong emergence and complexity have no place in science, there is plenty of room for these concepts in music.

In many ways, ontology of emergence plays into the narrative of the muse in composition, or the grouping of gesture, meaning, and mapping. Interactive and telematic art, "controllers and sound synthesis facilitates a fusion between the embodiment of a performer … and a disembodied counterpoint of forms in the virtual" (Burtner, 2005, p. 5). During the compositional process, the discovery of the motions or mappings that produce the intended (or novel) result can be a mystical occasion. The gesture, as the

musical work, becomes musical because the artist "must create something as through the outside inspiration. And afterwards one scarcely understands how it happened" (J. Harvey, 1999, p. 29). As in mathematics, this mystical "charm … comes from the fact that the human mind forgets its own way of proceeding and loses sight of its own preconceptions" (Burkert, 1972, p. 2). Once the mind forgets that patterns are reflective of a mind destined to search for patterns, the presence of the pattern reveals meaning through design.

Magic and mysticism have always been at least a small part of chance procedures and emergent systems in music. The I Ching is a practice of divination and fortune telling. In some veins of emergence theory, such as a self-organizing system, it is, according to the common phrase, "not magic...but feels like magic" (Corning, 2010, p. 123). "Chance" or indeterminacy lays open the possibility of something magical in a work, and emergence can be seen as the incantation that sets the spell in motion.

Process Music

> *... pulling back a swing, releasing it, and observing it gradually come to rest; turning over an hour glass and watching the sand slowly run through to the bottom;*
> *placing your feet in the sand by the ocean's edge and watching, feeling, and listening to the waves gradually bury them. (Reich, 1968, p. 34)*

Process music is any music that arises from a process. Musical processes play a large role in my work and I use them to conjure compositions.

Apart from magic and emergence, process is a musical concept utilized in minimalism, serialism, sonification, stochastic systems and many others. Some examples of processes have been outlined by a number of scholars such as Erik Christiansen, Galen Brown, and Michael Nyman:

1. Chance determination processes (Nyman, 1999, pp. 6-10)
2. People processes (Ibid.)
3. Contextual processes (Ibid.)
4. Repetition processes (Ibid.)
5. Electronic processes (Ibid.)
6. Mathematical Processes (Brown, 2010, p. 2)

Erik Christiansen divides these processes into transformative or generative systems in which the transformative system sets rules for the manipulation (“unfolding") of predetermined material, and the generative system is used to form the material itself. In his system, rule-determined processes abide by strict limitations, goal-directed processes

are based on rules that are to be loosely followed, and indeterminate processes are, as the word suggests, unspecified. The six categories are:

1. Rule-determined transformation processes (Christensen, 2004)
2. Goal-directed transformation processes (Ibid.)
3. Indeterminate transformation processes (Ibid.)
4. Rule-determined generative processes (Ibid.)
5. Goal-directed, and generative processes (Ibid.)
6. Indeterminate generative processes (Ibid.)

These terms are more often used as boundaries than definitions. In a way, the act of bringing people together to create any work removes at least one layer of indeterminacy. A fully indeterminate process composition would be indistinguishable from life, as in some of the work of John Cage:

> *... Now, whenever I hear radios – even a single one, not just twelve at a time, as you must have heard on the beach, at least – I think, "Well, they're just playing my piece. (John Cage, Radio Happenings)*

Compositional material is determined by the implementation of a system comprised of chance determination processes and indeterminate generative processes, while "people processes" either generate or transform material using the inevitable variability of individual human performance. Contextual processes and goal-directed transformation processes are akin to choose-your-own-adventure novels, where the material is determined by preceding events within the work. Repetition processes or rule-determined transformation processes take advantage of perceptual changes in material that can only

emerge from simultaneous changes in attention during repetition.[30] Electronic processes are works where some or all of the material is determined by a mechanical or automatic system, which is similar to a mathematical process. These are all emergent processes since the work that results is non-trivially and often surprisingly related to the microstructures and microrules:

> *Now that we see that the world is all process, constant change, we are less surprised to discover that our art is all about process too. We recognise process at the human level as behaviour, and we are beginning to understand art now as being essentially behaviourist ... (Ascott & Shanken, 2003, p. 158)*

Michael Nyman, in *Experimental Music: Cage and Beyond* argues that process is more of a reflection of contemporary musical predilections rather than a reflection on motion or a method of generating compositional inspiration. He says that process music is the result of modern composers being less interested in controlling the exact time and structure of the "unfolding" or development of a work, "but are more excited by the prospect of outlining a situation in which sounds may occur, a process of generating action (sounding or otherwise), a field delineated by certain compositional rules" (Nyman, 1999, p. 5). I am more inclined to view process as a way to control the exact time and structure of a piece, but within a slightly different definition of "time" and "structure."

Process Eschatology

[30] Repetition processes are not new. For example, canons have been around since the Medieval era

The process itself, especially in works that involve real-world or mathematical inputs, can be seen to continue long before and after the final moment in any performance of a work. The work itself is the singular moment of attention in an otherwise vast expanse of silence. Stockhausen considered a work of art the "result of a creative act" to be the presentation of a single "instant in the process" and one "particular manifestation of what is happening in general" (Stockhausen, 1971). This notion of a work as a fleeting glimpse into an eternal process has theological and even eschatological undertones. Within a work of process, often the purpose of the work is to focus not simply on the process but on the long timescales it represents, of the immeasurable within a human lifetime. The artist with a philosophical temperament will find appeal in this metaphor of the glimpse of the momentary eternal within the confines of human time.

> *"The universe repeats itself endlessly and runs in place. Eternity plays imperturbably in the infinity of its representations." — Blanqui (quoted in Wolin, 1994, p. 2)*

Some examples of this kind of eschatology can be seen in La Monte Young's *Dreamhouse*, John Cage's *Organ²/ASLSP*, or Jem Finer's *Longplayer*. Danny Hillis' massively expensive, massively egotistical, and massively eschatological *Clock of the Long Now* is an example of the almost Medieval eschatology inherent in extremely long process work. The Clock of the Long Now is a large device being built into a mountain to ring the passage of centuries. The designer, Danny Hillis, defends the creation of this work with a philosophy very reminiscent of early Christian eschatology that views the

present time “between the Incarnation and the Second Coming" as “entirely homogenous … there are no divisions, no landmarks which have any significance.” (Humphrey & Ormrod, 2001, p. 27). Danny Hillis’ justification for his creation is that:

> *I am a part of a story that starts long before I can remember and continues long beyond when anyone will remember me. I sense that I am alive at a time of important change, and I feel a responsibility to make sure that the change comes out well. I plant my acorns knowing that I will never live to harvest the oaks. (Kelly, 2015)*

There are philosophical resemblances between process music and process-seeking composition, between the sonification of real-world systems and compositions created from large collections of recorded data. The composer might pore through large swaths of information in hopes of finding something fascinating. There is always the possibility, a gambler’s fallacy perhaps, that the next time the system runs, the results will be fruitful. Or perhaps the moment has already passed and no one was there to hear it.

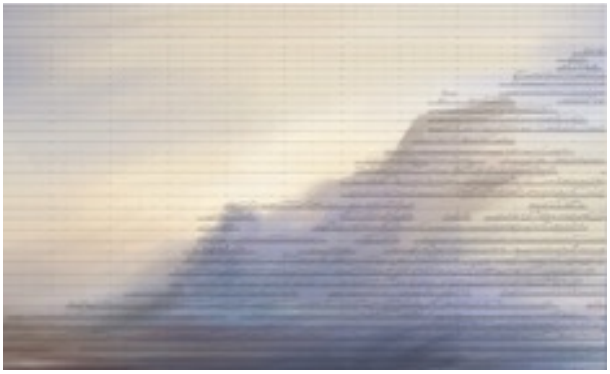
Concluding Remarks

Technology is associated with reason and its use can give the impression of confidence in an *a priori* “rational" world. The belief that the world is so-called “solved" promotes social stability and discourages actions and beliefs that deviate from this philosophy.

These ideas are illustrated in the confidence and authority attributed to data— like the recording device and the monochord. The role of precision and replicability in the concept of a rational reality cements this notion of a solved world. If it can be repeated, then it is solved and can be locked away into the vault of things that are no longer necessary to think about. If the question is not answerable using reason, then it might as well not be asked. If the activity has no use, then it might as well not be done. The central problem is that the assumed precision and gravitas embedded in the quantifiable is not inherently rational. Precision and mathematics are also qualities of magic.

My dissertation is based on all of these concepts and is a perversion of these concepts. Reason, data, technology, sonification, and precision are used to explore the perceptual world and conjure the spirits of experience rather than solve anything. Technology is used as Techne (a manner of revealing). The rendering of Ebbinge revealed a mountain (**Illustration 15**).

Illustration 15: Ebbinge



The codex can be reverse engineered to uncover the sounds of the past. The scores and recordings are proofs—both numerically, spiritually, and textually— of these past experiences. They can be replicated. The scores and recordings outline a system of reasoning that can be used to both find the meaning in these works and outline the path towards finding more compelling individual works.

Technology, magic, and numbers mediate. Like optics, they are the *means* one uses to see, and can be used to learn *how* to see and to navigate the world. What is seen may have no express purpose except perceptual exploration. Perception is the foundation of experience, and is clouded by beliefs, biases, imaginations, and preconceptions. The truly rational mind is an abstract concept, and a solved world is dull. Perhaps it is better to become accustomed to the reality that some aspects of the world are shrouded in mystery and that we should be reminded of this regularly.

Harmonic concerns in each piece are complex and irrational. Sonorities are notated very precisely and not arbitrarily. Precision is a requirement in harmony. Imperfect “perfect" intervals (octave, unison, 3:2, 4:3 etc.) are immediately noticeable to both modern and ancient listeners and must be calculated exactly. The sonorities are notated with extreme precision because the recreation/replication of the sounds must be equally extreme in precise and specific in timbre. An example of this is shimmer: in spite of being mystical, the concept refers to a specific and very real phenomena. Isoluminance

—like ring modulation, harmonic sound, an optical illusion, or a difference tone—is located at a borderlands of perception. This is the same borderland where the spirits live. Spectralism inhabits these borderlands, as in *Preferential Phenomenology*.

These pieces exist in specific borderlands. *Agnus Dei* is based on a chimeric harmonic structure that implies different harmonic roles. The *Kyrie* was created from slightly and specifically detuned overtone structures that, unlike Murail's overtone chord, cast shadows onto the surrounding harmony. The tonic sonorities of *Ebbinge* prominently feature unisons that swell and an atmosphere of unstable foreboding. Glowing tones, or tones that express spaces outside of their actual space, are also used in each piece. These sounds have a cabalistic presence to them, and are aesthetically appealing to me.

When composing these works, I dreamed of hearing sounds that alluded to wandering stillness, slow change, and presence. In *Agnus Dei*, I wanted to grasp some aspect of the ever-changing yet ever-present stars in the sky. Historically, I wanted to hear the celestial overtone chord that was believed to be the sound of the heavens for centuries. Their mathematics were my recording. When I derived it, I was struck with the revelation of stillness and immutability within the sound. It was still, but wandered almost imperceptibly. I derive my own harmonic structure using a combination of the immutable chord and the wandering sonority. I retained the still, multiplicative quality of the ancient sound but I sentenced it to a life of constant change. In *Ebbinge*, I wanted to

embody a sorcerer, gesture to the invisible, and set up a spell/process to conjure. The result of this spell was a meandering unison that sounded like it might leap out of the speaker. In *Kyrie*, my aim was to hear the difference between blurred, glowing sonorities and clarity.

In Archaeology, past objects of value tend to be decorated, and scholars who discover strange ornate objects will generally conclude that while they do not know what they were, they were certainly valuable. These scores, recordings, and codex are all valuable artifacts of my experiences. While the logic or reasoning may be obtuse, my goal is that the implicit value, decoration, and dedication that went into their creation is obvious. The codex lauds and decorates error—something that should have been thrown away under the utilitarian mindset. This is because, in my view, there should always be time to make objects beautiful, and it is often the case that the errors can be the most beautiful and unique aspects of a work.

Of course, it is not necessary to create complex specific structures in order to seek out spirits and perceptual incongruities. I chose to build these systems in order to discover new and old things and to attempt viewing the world in a different way. In reflecting upon my own preconceptions, my own world view, and my own listening imagination, I sought to follow, through action and practice, the logic of magic. The logic is similar to the logic behind dreaming in Buddhism: " . . the rigidities of mind, the

limitations of wrong views that obscure wisdom and constrict experience, keep us ensnared in illusory identities and prevent us from finding freedom." (Rinpoche, 1998, p. 120).

Chapter 2: Intentions and Analysis

Kyrie

Kyrie is a piece that was originally composed for imaginary reed organ but is also arranged for accordion and electronics to make an imaginary pipe organ. It was the first piece I composed based on specifically detuning ratios in order to bring out presences I found in other sounds. The motivation was based on these activities during the pre-composition process:

4) I worked on an analysis/re-synthesis experiment where I pored through recordings of Sardinian chant, greek orthodox modal chanting, Albanian Iso-Polyphony, UNESCO music recordings, and historical recordings looking for glimpses of overtones, alterations, timbres, and 'moments' that contained aspects of the presence in sounds I found interesting.
5) I made and kept records of the pitch and timbral characteristics of these moments
6) I analyzed my chosen sounds for commonalities

7) I modulated and Pitch-shifted other sounds using these sonorities and structures to see if the qualities I found could be used to synthesize my intuition.
8) Made binaural field recordings of environmental changes of space that interested me
9) Worked on *Sound Vision* meditation(see Appendix)

Generally, the sound that I was interested in had a strange feeling of space to it (as though it only came from a corner, for example) or a sound seemed to glow from within. Analysis of some of these patterns found that slight intonation alterations of whole-tone ratios was a common aspect of my chosen sonorities.

The timbre was chosen to imitate a large, old, surly imaginary organ— like the 18th century organ of *Saint Nicolas de Champs* in Paris (you can listen here). The accordion, pitch shifted both up and down, with all the bellows resonating, suits this purpose well. In the imaginary reed organ, the amplitude of the pitches is waved to form dissonance.

The *Kyrie,* formally speaking, is primarily about the changes in focus that occur between glowing, altered overtone sonorities, and the powerful focus of pure overtone sonorities. Glowing has a beautiful effect, but it smears the shape of the sound object in a halo of sound and reduces the impression of focus and power in a sound. These changes in focus were curious to me and are used to bring out the form of the piece. For example,

the first few sonorities pair pure and altered intervals together to emphasize the contrast of the perfect octave and fifth at the very end of the first section. In the accordion realization, each sonority is doubled at the octave (above and below) with an added Perfect fifth.

The second section features large changes in register and emphasizes shrill pitches on each end of the *tessitura* and a delayed playback of earlier recorded material to make the sound even larger. This has the effect of also causing glowing and shimmering pitches caused by small changes in phase and pitch from the the bellows in the accordion. In the imaginary reed organ version, the shimmering pitches are created through warbling the lower register.

In hindsight, my impression of Kyrie has changed with my listening and I would change a number of things about the imaginary pipe organ version. I would extend the *Christe* section to give the listener time to hear the large changes in harmony.

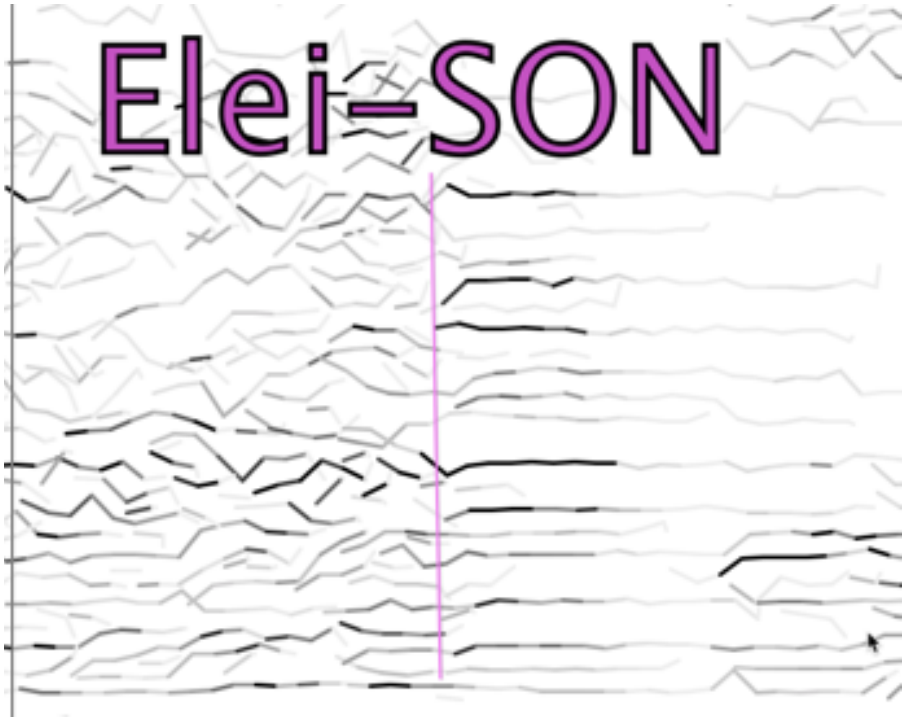
Form for Kyrie

There are two possible forms for the *Kyrie*: an interactive open-ended rounded binary form centered around the text, harmonic focus, and glow or a strict text-driven, liturgical form. There are common harmonic tendencies in Medieval and Renaissance melismatic and polyphonic settings that informed my use of timbre in *Kyrie*. I reference

1) the use of pauses between words and the rhythmic qualities of the text 2) the relative open and closed qualities of the syllables 3) the historical use of the powerful unified harmonic cadence at the end of each phrase followed by a pause.

One of the most pronounced characteristics of the Kyrie is how the end of each phrase is cadenced with a large open, focused, overtone chord. This can be seen in Guillaume de Machaut's *Messe de Notre Dame* (**Illustration 16**) and also in my piece. An example can be heard here[31]:

Illustration 16: An example of a large timbral and harmonic shift in syllables in Machaut



[31] https://www.youtube.com/watch?v=xPh5RjPtpek&index=9&list=PLmHRIo_H-52_6jDcSAC7BlK-sNmiK00f-

In Kyrie, this change is articulated by using a shimmering sonority right before an overtone sonority as outlined in **Illustration 17**:

Illustration 17: Eleison Sonorities

	663.476	**523.6**	**330**		**660**	**440**	**220**
663.476	1/1 (tonic)	* 19/15 *	* 126/125 *	660	1.0, 1/1 (tonic)	1.5, 3/2 (perfect fifth)	1.5, 3/2 (perfect fifth)
523.6		1/1 (tonic)	46/29	440		1.0, 1/1 (tonic)	2.0, 2/1 (octave)
330			1/1 (tonic)	220			1.0, 1/1 (tonic)

This dichotomy of the shimmering, undulating, unfocused harmonic structure is similar in effect to the complex, melismatic harmonic motion of historical polyphonic Kyries that suddenly simplify at the end of each phrase.

The rhythmic proportions in Kyrie are often derived from the text and harmonic textures closely follow the vowels. Historically, the Kyrie is a melismatic form that has a relatively simple message and this freedom led to compositional flourishes and melismas based on the text. In the following example (**Illustration 18**), I will show some basic rhythms that are common in settings of the traditional Kyrie:

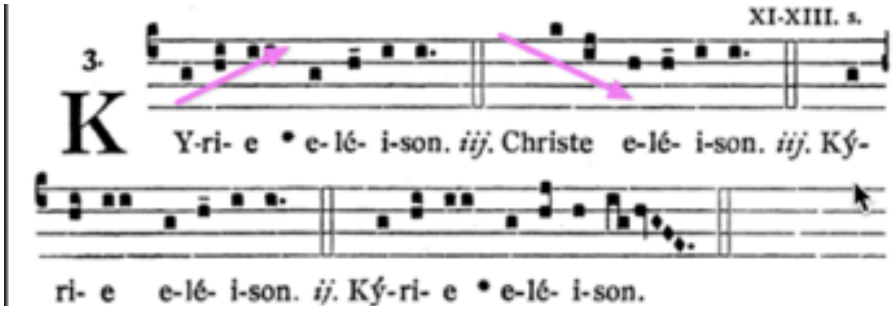
Illustration 18: Rhythmic Proportions in Kyries

	Ky*-ri-e/* ***Chri-*** *ste*	***E****-le-is-****on***
Ky*-ri-e' E-le-is-****on****.*	𝅗𝅥 (𝅗𝅥 /𝅘𝅥) 𝅗𝅥 *Pause (or elision)*	(𝅘𝅥)* 𝅗𝅥𝅘𝅥𝅘𝅥𝅝
Chri-*ste' E-le-is-****on****.*	𝅗𝅥𝅗𝅥 *Pause (or elision)*	(𝅘𝅥)* 𝅗𝅥𝅘𝅥𝅘𝅥𝅝
Ky*-ri-****e' E****-le-is-****on****.*	𝅗𝅥 (𝅗𝅥 /𝅘𝅥) 𝅗𝅥 *Pause (or elision)*	(𝅘𝅥)* 𝅗𝅥𝅘𝅥𝅘𝅥𝅝

bold *letters represent open sounds*
**Depending on the context, this vowel may be enunciated or heard as an extension of the previous word*

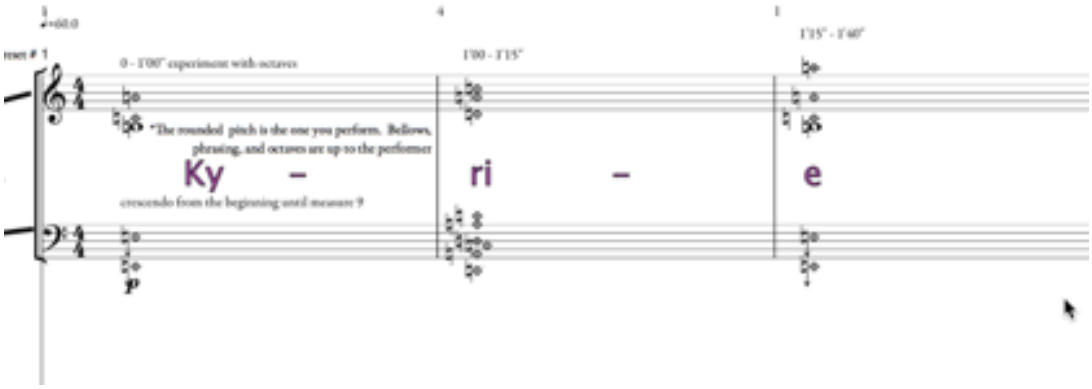
In my work, this rhythmic structure is also utilized and can be seen in the beginning of the *Kyrie* section and in the *Christe.* This example is also illustrative of a common pattern in *Kyries* that harmonic motion in the *Kyrie* section trends one way, and the *Christe* section trends the other. The *Kyrie*, in this case, trends upwards in motion and the *Christe* trends downward **Illustration 19**:

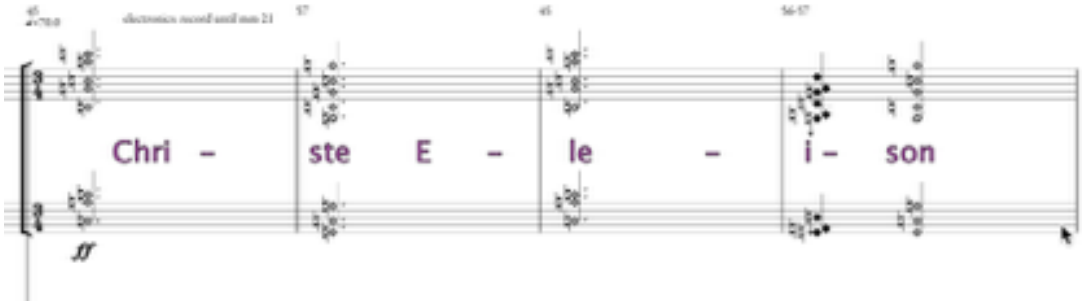
Illustration 19: Contrary melodic motion between sections in the Kyrie from Missa XVI



The harmonic texture also follows these contrasts, where the Kyrie begins in a relatively closed sonority and expands into an open sonority, while the Christe begins from an open sound and moves towards a more dissonant sonority. The rhythms and the changes in texture can be found in **Illustration 20** and heard in my work here.

Illustration 20: An example of rhythmic proportional and harmonic motion in Kyrie





The form of the piece follows the text, but then branches out into melismas of both *Kyrie* and *Christe* shimmering sounds before returning to the original *Kyrie* texture. When listening to this piece, it is important to pay attention to the lilt of the text from the rhythms and the cadential patterns. These textures are combined to make sounds that glow.

Agnus Dei

Agnus Dei is built from slowly repeating cycles of celestial and musical events in process through inhuman time. This piece was based on my explorations in *Kyrie* where I found small changes that imbued sounds with presence. My initial intent when building this process was to create an audible system that would allow me to hear the sound of planetary motion as I imagined it. I dreamed of hearing a sound that spoke of wandering stillness and wanted to comprehend some aspect of its ever-changing presence in the sky. I also wanted to hear the celestial overtone chord that was believed to be the sound of the heavens for centuries. When I derived it, I was struck that such a still sound might

represent objects specifically referred to as “moving stars.” I then set out to create a structure that retained the multiplicative structure of the historical immutable sonority but would be destined to a life of constant change.

Cyclical repetition and permutations of overtones expose small changes over time through intonation. Imperfect “perfect” intervals have been immediately noticeable to listeners throughout history. In this piece, sonorities were derived from the combination of “immutable” Just-intuned families and wandering "irrationally derived” families to create harmonic structures that meander in and out of pure consonance.

As a work, this piece began as a system for reflective listening, but was then re-built to be a compositional tool. There was a version of the work for large choir and interactive live-generated score, and a version was created where performers would listen to a pre-recorded sine wave and interpret it on their instrument. I made a recording of it for 9 cellos. It was awarded Honorable Mention in the International Alliance for Women in Music’s Pauline Oliveros Prize.

Analysis of Agnus Dei

On the Derivation of the Sonorities

Within the harmonic system, there is a default sonority in which every instance of the piece will begin. There are 9 initial voices, each representing a celestial body. In this

piece, there are two types of celestial bodies and three distinct sets of harmonic structures based upon them:

The Celestial Bodies:
Historical:
The Sun, Moon, Mercury, Venus, Mars, Jupiter, Saturn, and the Stars.[32]

Modern:
Sun, Moon, Mercury, Venus, Mars, Jupiter, Saturn, Uranus, Neptune, and (Pluto[33]*)*

The Harmonic Families
Historical/Doctrine of Harmonics
Data derived
Historically-informed Sonified Data

The first pitches were derived using the combination of theorist Franchino Gafori's 1496 *Practica Musica (Strunk & Treitler, 1998, p. 390)* and Boethius' *De Musica (Boethius, 1100).* When looking at these two manuscripts closely, there are a few discrepancies that can be sources for harmonic systems. In Boethius' manuscript in **Illustration 21-22**, the relationship of the cosmos to the overtone scale and the horizon is made direct:

[32] Uranus, Neptune, and Pluto had not yet been discovered

[33] Pluto is not a planet. That's ok.

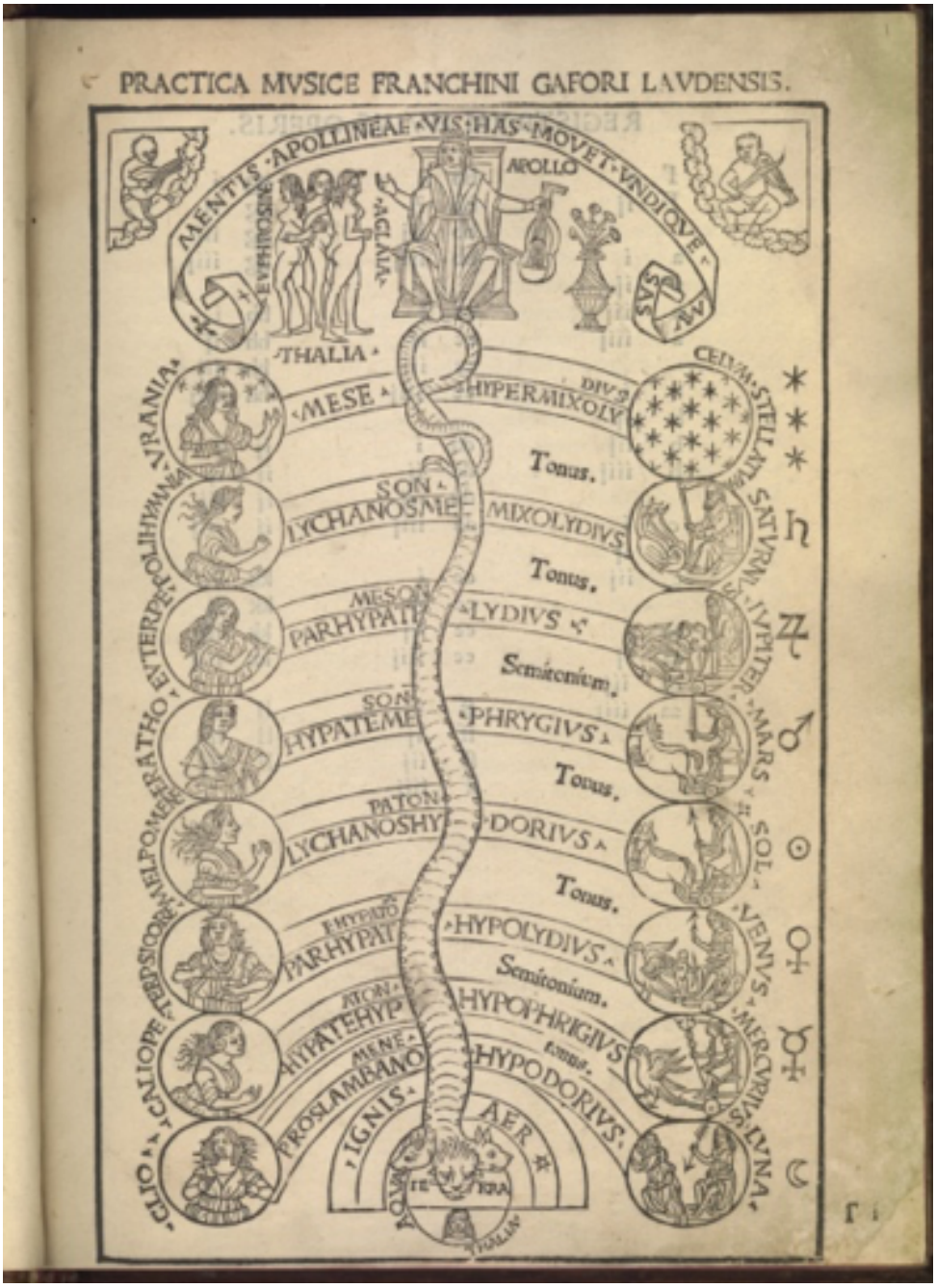
Illustration 21: Celestial Harmonics from De Musica

Highest	1:1
Zeus	
Either side of the Sun	4:3
Noon	3:2
Between Aphrodite and the Sun; the other center (also Paramese)	2:1
Aphrodite	
The Moon	

Illustration 22: Modes, Symbols, and Note Names

Boethius defines the moon to be an octave (2:1) and shows us, through the use of pitch and ratio, what he means by the words used to describe the celestial monochord. Compare this with the Gafori text in **Illustration 23**:

Illustration 23: **Gafori's *Practica Musica***



As with much of history, translations and mistranslations can be sources of insight. For example, the moon is an octave. The chord is structured based on the calculation of tones and semitones. This chord would be a scale very much like an overtone scale and possibly not particularly engaging. We can alter the timbre by interpreting it using the Greek overtone terminology (i.e. Parhypate, Lychanosme) to multiply the planetary information against the holy unison, the monad, or the Hypate (the world of god, the lowest pitch, the stars, or the hypermixolydius). If that pitch is not useful or results in an uninteresting octave, it can be changed to a pitch derived from various modes and hypermodes listed on the manuscript (hypermodes are regular modes started on the fourth note). Octaves and intervals calculated using the doctrine of means are considered equivalents.

For example, Saturn is labeled Son, Lychanosme, Mixolodius, and a tone above the Mese. This Mese is also considered the realm of God (Dius) and the heavens. I chose based on context whether I was going to define Saturn to be a tonus (whole tone) above, a 4:3/3:2 ratio, or a 6:5 (Boethius' Lichanos). When deriving the divine sound of the remaining three "undiscovered" celestial bodies, I instantiated them by continuing the Gafori manuscript between Saturn and "the stars" with 10:9 whole tones to produce the following overtone sonority [34] (see **Illustration 24**):

[34] the deviations from Just Intonation come from the multiplication of floats rather than ratios

Illustration 24: Breakdown of Initial Sonority

	1138	**771**	**660**	**548**	**440**	**330**
1138	1/1 (tonic)	31/21	50/29	27/26	128/99	50/29
771		1/1 (tonic)	90/77	38/27	7/4 (septimal minor seventh)	90/77
660			1/1 (tonic)	77/64 (77th harmonic)	3/2 (perfect fifth)	2/1 (octave)
548				1/1 (tonic)	56/45	128/77
440					1/1 (tonic)	4/3 (perfect fourth)
330						1/1 (tonic)

The rest of the sonorities are not discussed in such detail. I deemed it important to provide an overview of the derivation of the first chord in order to bring up some key background aesthetic and philosophical notions that inform the next harmonic scheme. This first chord, like the heavens from the ancient perspective, is unchanging and immutable. Derivations using this system always begin with this chord. After this chord is presented, the cycle of permanent change represented by the second family is set into motion.

"Concerning the" Derivation of the Second Harmonic Family

The function of the second harmonic family is to create a perceptible impression of the movement of the heavens/celestial bodies over time from a geocentric perspective.

Qui extendit aquilonem super vacuum
et adpendit terram super nihili

He stretcheth out the north over the empty place,
and hangeth the earth upon nothing. (Job 26:7)

This sonority group is based off of the literal mapping of the celestial bodies' distance to Earth in Astronomical Units35 (0–40 AU, equivalent to the distance from the sun to slightly beyond Pluto) to sounds across almost the full range of human hearing (0–22,050 hertz). Astronomical Units of distance can be used in combination with the Azimuth36 to focus on the small rates of visible change in the sky using human-readable numbers. I did not intend for these differences to be immediately obvious; my goal was that listeners or composers should have to record, reflect upon, and explore the qualities of differences throughout days and years. This is the same goal that the Medieval astronomers who sought to derive and reflect upon the celestial/divine harmonic structures embedded in the motion of the heavens.

This extreme pitch range also serves two primary functions:

35 *Astronomical Unit: the mean distance between the Earth and the Sun*

36 Azimuth: the direction of a celestial object from the observer, expressed as the angular distance from the north or south point of the horizon to the point at which a vertical circle passing through the object intersects the horizon

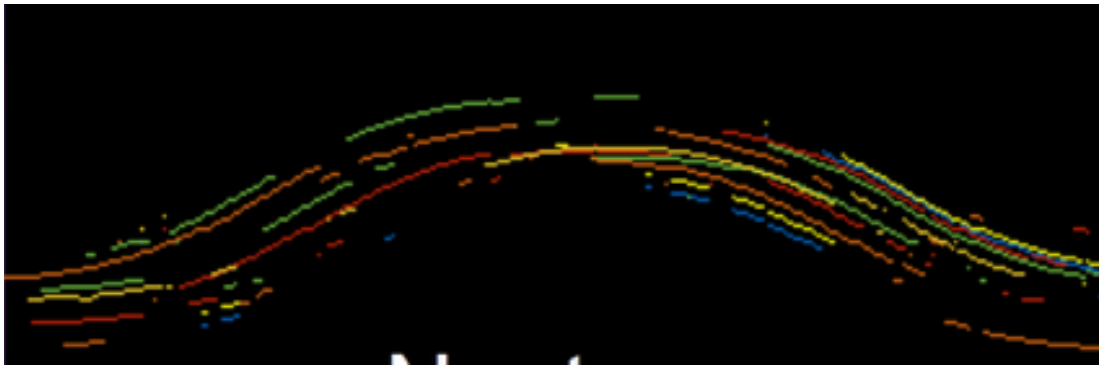
1. to make the subtle distance changes of the outer planets more obvious
2. to limit the influence of problematic pitches

There are many differences between the results derived using the historical overtone formula and the modern "data" mapping. There is a strong presentiment of distance in "actual" space that is not represented in the space of an octave nor represented in a scale or harmonic series. As I mentioned earlier, I wanted the sonority to give the impression of a vast slowly-evolving quasi-stillness. In this context, this means that the pitches derived from the system should be distinct enough from each other to sound like individual voices, but close enough in register to form harmonic structures. The sun and the moon are somewhat evocative in their historical overtone structure, but the sonority derived from distance mapping (based on a single Astronomical Unit of the sun combined with the historical 2:1 ratio of the moon on the horizon) overpowers the rest of the planets. To counter this, they were mixed into the sonority rather than mapped.

The celestial bodies that are farther than 1 AU from Earth are treated with additional parameters. The dynamics, reverb, and spatialization are determined by the placement of the celestial body on the horizon combined with the distance to the planet. This adds to the perception of individuality within the sonorities and allows individual sounds to rise (enter the sound field) and set (leave the sound field).

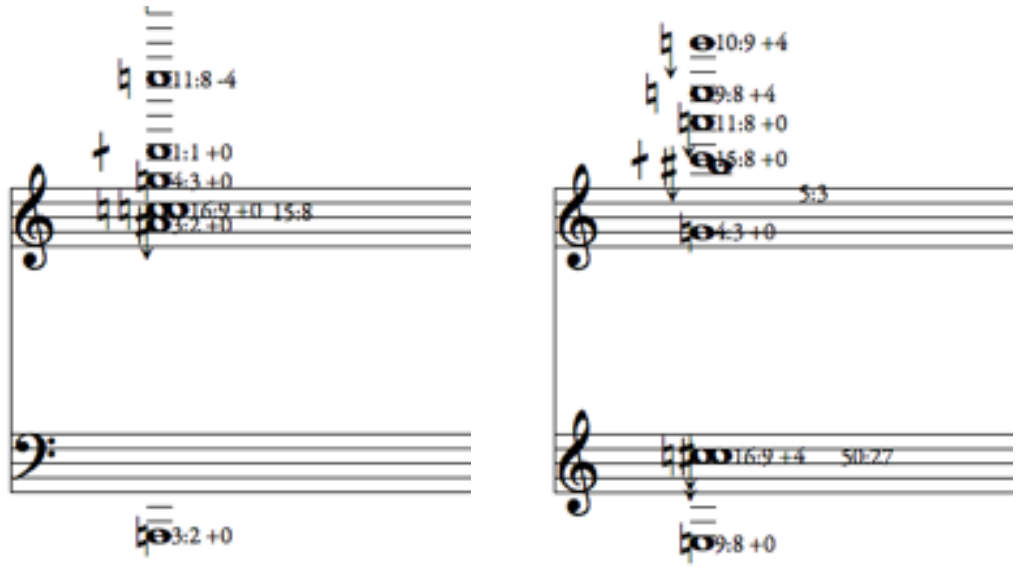
In the figure below, the relative positions of the celestial bodies on the horizon over a 24-hour cycle can be seen in **Illustration 25**. We can see that the position of each planet on the horizon changes and overlaps with the other planets. The motion is never fixed.

Illustration 25: Movement of all the bodies over a long period sampled randomly throughout the year



In these graphics, the horizon is located on each end, and the proximity to the horizon at the time of composition determines the dynamic of the celestial body's pitch. The following examples in **Illustration 26** of pitches come from 14:00 on November 10, 2015 and 21:00 on November 9, 2015. There are a few pitches not pictured because of their extreme pitch range. We can see that the sonority changes drastically throughout the day.

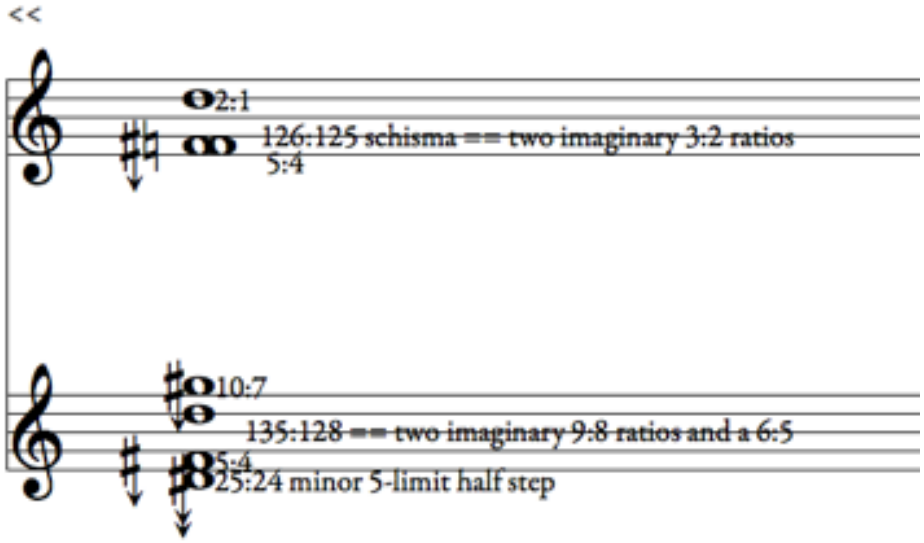
Illustration 26: The chord at different times of day



"Concerning the" Third Harmonic Family

There is a third set of tones that combines ideas from the two previous families. In this group, the pitches of the second "irrational" family are multiplied using the logic of the "cosmic" first family. There are a number of pitches that are outside the audible range for most people. The mapped pitches based off of Astronomical Units have been multiplied by both the proportions mentioned by Boethius and by the scale of tones and semitones (tonus, semitonium) outlined in the Gafori manuscript. If the regular pitch has left the realm of human hearing, it is derived from a Hypate of 300 hertz. This brings out the schisma, comma, and limma, that are derived from the differences of untempered scales and their octaves. An example has been provided in **Illustration 27**:

Illustration 27: Sonorities based on the multiplication of intervals



Throughout the piece, these three harmonic classes are shuffled and rearranged to form new sonorities and to modulate through to the next harmonic family. An example of a kind of harmonic transition between the second and third harmonic family is shown in **Illustration 28**. The lower notes (i.e. the Sun and Moon) cycle out of range and the sonority is eventually replaced with an overtone chord derived from the Hypate of the second family.

Inherent motions of the System

There are default settings in the generating system that infuse the results with a distinctive sound. These are the system update time, download time, the time delay

between individual chord changes, the updates that continue even if the pitches are not in use, and the ability to halt changes by going into another mode.

The system updates information on planetary motion every 30 seconds. The data is output at one planet per 3 second period regardless of mode. Modes can be disabled and settings can be sustained as long as desired. It is also possible to set a cycle in motion and then continue the same cycle using another harmonic family. When modes are not being cycled, dynamics can be adjusted to suit compositional preferences, but will be returned to their "mapped" state when cycling is resumed.

Form of Agnus Dei

In the realization of *Agnus Dei*, the second and third harmonic family are presented and re-presented, cycling until they reach a momentary harmonic stasis point which occurred by chance when the composition was drafted. Voices will change by a maximum of 15.3 hertz in a 1-minute period. Depending on the perspective of the listener, the voices may only budge and some may not move at all (like the North Star). The point of the piece is to express small alterations of motion in time by reviewing a progression at different points in the time and listening to how harmonic motion becomes stretched and altered by small changes in intonation. The original recording of the sine tones was recorded. I then returned to add relative dynamics, distribute octaves, and other harmonic devices needed to emphasize the structure I intended to compose.

Contrasts in a work of small changes can be expressed in changes in harmony though time and register. Listeners need time to learn to hear small alterations in pitch. Octave doubling brings out changes that happen to exist in registers that the ears are not as adept at hearing. I consider these changes to be in light of my theoretical intentions, because, as I mentioned before, I have chosen to consider octaves and intervals derived through the doctrine of means to be equivalent structures. Another way to express the temporal motion is by building a chord from two versions of the same sonority recorded at different times. The following sonority is an example of a chord generated by superimposing the same set sampled twice over a 10-15 minute period. A video of the harmonic reduction can be found here[37].

The top pitches have hardly changed, but the bottom has been altered by 130 cents, respectively. I found that these structures had a subtle glow to them, and so I used them. From a theoretical perspective, I found sonorities like these to have presence because they can be interpreted to be literal representations of the passage of time.

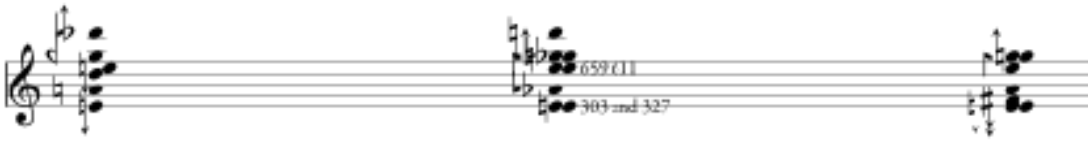
Agnus Dei can be divided into six sections. These are not discrete sections, but more significant qualities of the overall state of motion in time. The sections are described as:

[37] https://www.youtube.com/watch?v=Nd-tDz_WmC4&list=PLmHRIo_H-52_6jDcSAC7BlK-sNmiK00f-&index=4

I. Hypate ascending into the cosmos
II. Cosmos transforming into multiplicative consonance, returning altered
III. Cosmos wander out of hearing into an altered consonance
IV. Slower cycle into unstable updated consonant system
V. Unstable system transforms into a true harmonic sonority
VI. Harmonic system doubled at the 3:2 ratio.

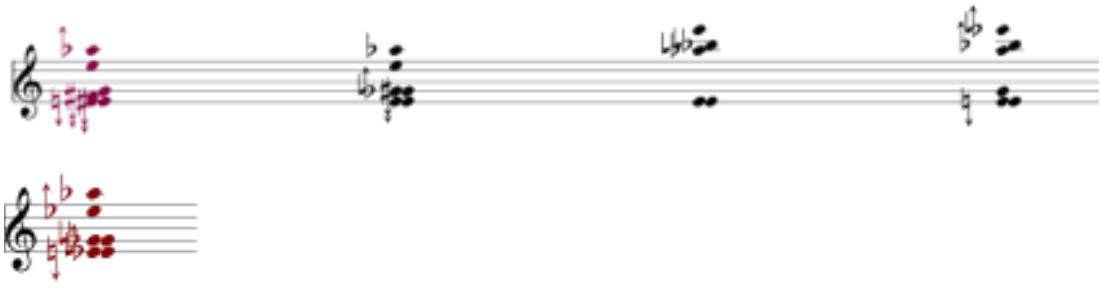
I. Hypate ascending into the cosmos (**Illustration 28**)

Illustration 28: Harmonic transition between the pitches



II. Cosmos into multiplicative consonance and returning, altered (**Illustration 29**).

Illustration 29: Altered harmonic transition, returns

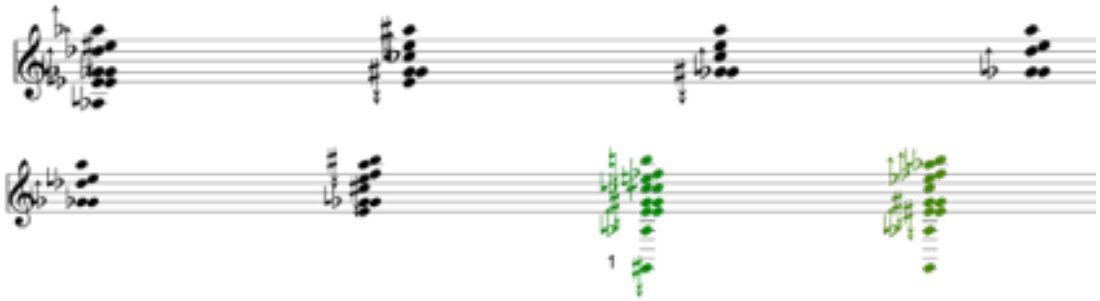


III. Cycle out of hearing into altered consonance. Returning Altered (**Illustration 30**).

Illustration 30: Altered harmonic transition expands

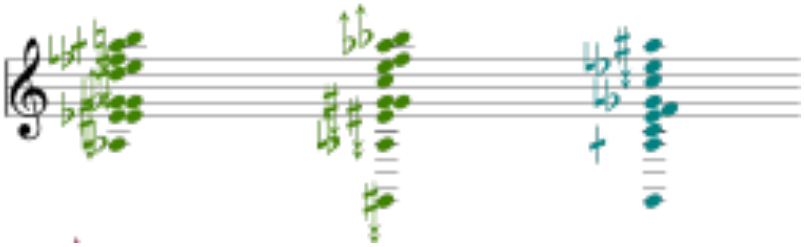
Slower cycle into unstable updated consonant system combined with sonority from 10 minutes ago, transformed (**Illustration 31**).

Illustration 31: Altered harmonic transition



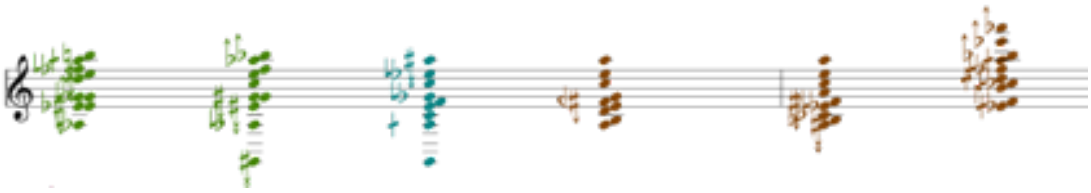
IV. Unstable system updates into a true harmonic sonority (**Illustration 32**)

Illustration 32: Instability to Harmonicicm



The harmonic system updates out of stability, and then doubled and multiplied at the 3:2 ratio (**Illustration 33**).

Illustration 33: Final Structures



Ebbinge

Intentions

This piece is continuation of a series of process-based magical emergence studies I did between *Agnus Dei* and *Ebbinge*—most notably my *Stone Ritual.* In *Stone Ritual*, I conjure the sound of a howling wind by filtering the 'white' noise of trees and background noise by changing the shape of my hands as a Theremin player might. This white noise was made volatile by layering, doubling, and pitch shifting this noise to make even the smallest gestures (like the tapping of a fingernail) meaningful and audible. The feeling of performing this piece was reminiscent of magic because I could control, conjure, and manipulate music by positioning my hands upon a 'seeing stone' (thereby adjusting the 'Q' of the background noise). The source was not controllable directly, but with proper concentration to movement and detail (and luck) I could create work.

In *Ebbinge*, I sought to work in a similar mode. Instead of conjuring music by filtering white noise with my hands, I wanted to conjure harmony and create sounds that seemed to edge up against their harmonic tendencies. This flocking algorithm had properties about it that I found compelling and similar to the *Stone Ritual* in behavior and mechanism of control. Like *Stone Ritual*, I mirrored the gestural control to be like that of a sorcerer. The automata, or visions, can be conjured and loosely controlled by hand. With the proper tools, gestures, attention, and settings, the work can be conjured in real-

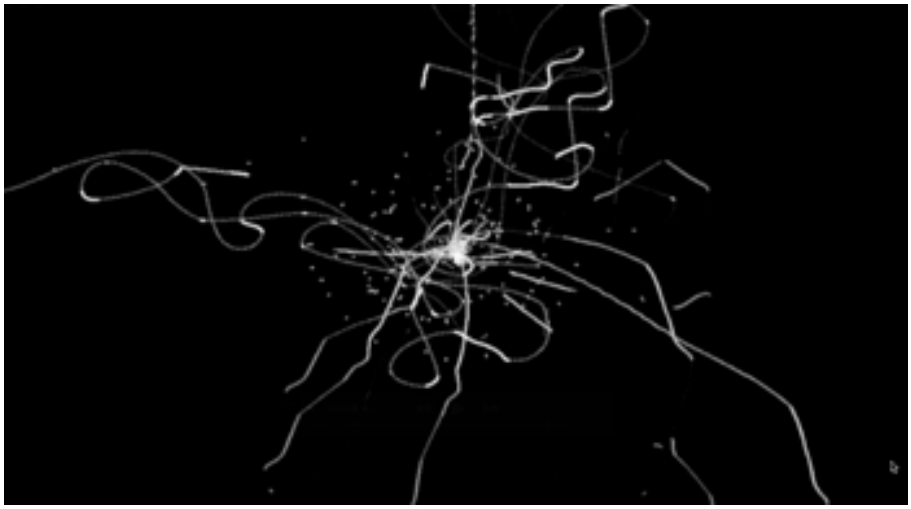
time and exist on the edge of being controlled without descending into chaos

(**Illustration 34**).

Illustration 34: An Illustration of Conjuring. The Magic Circle. by John William Waterhouse

I wanted the harmonic and timbral results to breathe and glow with a sense of intention, rebelliousness, and fey, and mapped the pitches within glowing range. The patch I created to realize the work permits motion outside the limits and so the piece will sometimes get out of control. I recorded a successful incantation in real-time and then translated the results on the double bass. When creating a version of this piece, I control it gesturally using my hands. I can see the automata and track their movements. This helps me set the parameters and notice patterns. An example of their wandering musical pathways can be seen in **Illustration 35**:

Illustration 35: Wandering motion



Analysis of Ebbinge

Ebbinge can be divided into two distinct parts. The first part lasts around 8 minutes, and the second lasts about 7 minutes. These forms are realized with the following gestures (combinations of general behaviors):

Section I:

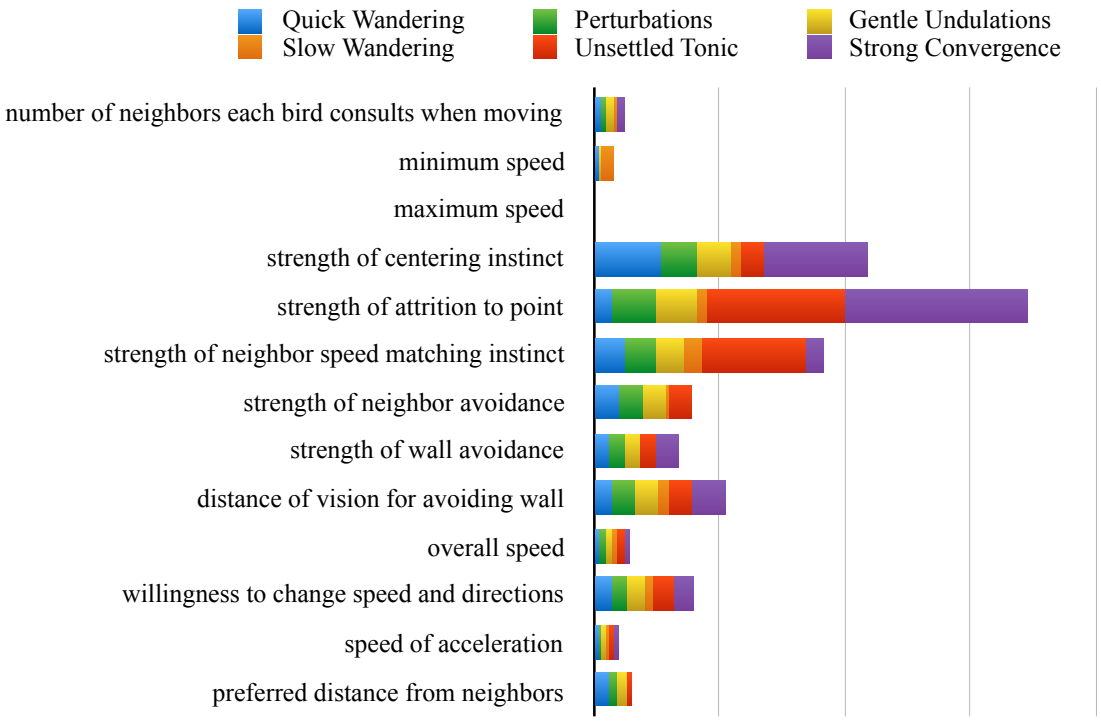
VI. Small Perturbations to Gentle Undulations
VII. Large, slow waves from Gentle Undulations to slow wandering
VIII. Perturbations, returning, then wandering again

Section II:

IX. Branching out, voices following spectral neighbors.
X. Uneasy calm (unsettled tonic into slow wandering)
XI. Convergence upon an unstable tonic
XII. Simultaneous Unsettling and Convergence
XIII. Calm (Strong convergence)

These behaviors are made present with the live manipulation of the following parameter sets in time (**Illustration 36**):

Illustration 36: Parameter settings and their characteristics



These parameters are mapped into pitch and stereo space. Voices grow louder and more pronounced as they close in on the attractor point, and they become soft and reverberant as they leave the field. Pitches can wander arbitrarily far away, but while in the "walls," the behavior around the pitch field is mapped to a maximum of an 11:10 ratio (165 cents, 1/2 way between a unidecimal half-step and a minor whole tone) in lower bound and a 22:21 (80.5 cents ptolemaic "hard" half-step) as an upper bound. Usually, the bounds are much smaller to encourage beating and phasing behavior. Generally, I try to limit the range as much as I can to avoid theremin-like effects. The attractor pitch is set in the

middle with the *x* coordinate driving the pitch, but it is often repositioned during performance to draw the voices into a particular region.

The form (**Illustration 37**) is executed automatically by a timer, but other changes are used mid-performance to interrupt or to emphasize intended gestural motion. For example, if the voices are in danger of wandering out of the intended space or the composer needs to prepare the sound field for an upcoming change in behavior, then momentarily adjusting the system to a more or less aggressive state can repair the gesture. Changing from "slow wandering" to "convergence" for a few seconds and then returning to wandering will often be enough of a disturbance to redirect any undesired motion. For a more dramatic change, "unsettled tonic" will radically alter the trajectory away from "walls." This is useful when conjuring and successfully manipulating gestures during the compositional process.

The character of the musical result will change dramatically depending on the choice of these other initial settings:

I. Base pitch
II. Drone pitch (optional)
III. Upper and lower bounds
IV. Location of attractor point
V. Levels of voices
VI. Mapping of sound field

In this realization, the base pitch was set to 110 hertz, the drone was adjusted in real-time to suit the harmonic content of the emergent motion, the bounds were loosely set to around 100 cents, and the attractor point was replaced many times. Before composing this realization, I had practiced performing the system many times and had attempted multiple realizations of the piece before succeeding.

In the following analysis I have rendered linear visualizations of the gestures and accompany the visualizations with a harmonic results of these gestures. The sonorities that I have chosen to represent in the reduction are some important harmonic moments in the work. The form is fairly general and takes the shape of am incoming tide or a swell. The voices are all perturbed by the same general forces, but each individual voice responds differently.

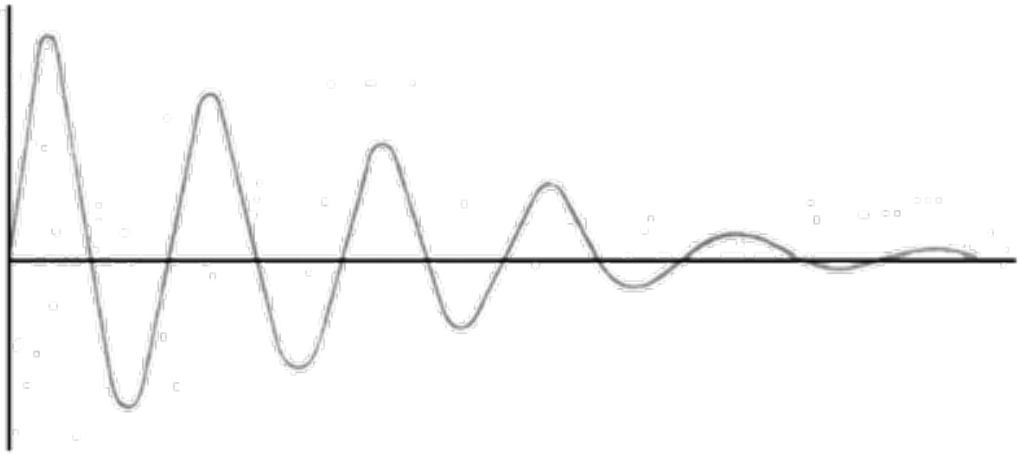
Illustration 37: Overall form of Ebbinge

The First Section

The initial gesture is a simple one based off of seven voices converging upon the attractor point as well as rhythms derived from voices wandering towards and away from one another. There is a very small additive effect that creates beating, which is ultimately realized as rhythm (**Illustration 38**). The harmonic reduction can be heard here[38].

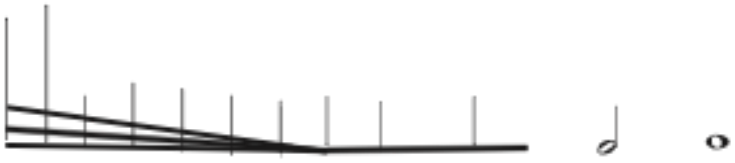
Illustration 38: Tone rhythms

[38] https://www.youtube.com/watch?v=rVwdfsvrHyQ&list=PLmHRIo_H-52_6jDcSAC7BlK-sNmiK00f-&index=5

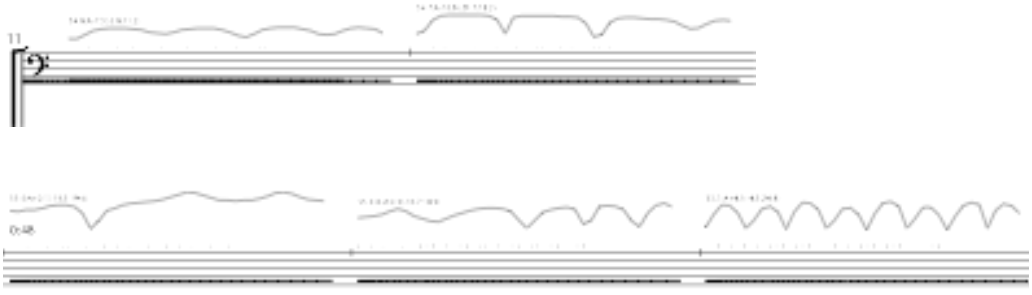


(photo credit: Mannell, 2015)

becomes:



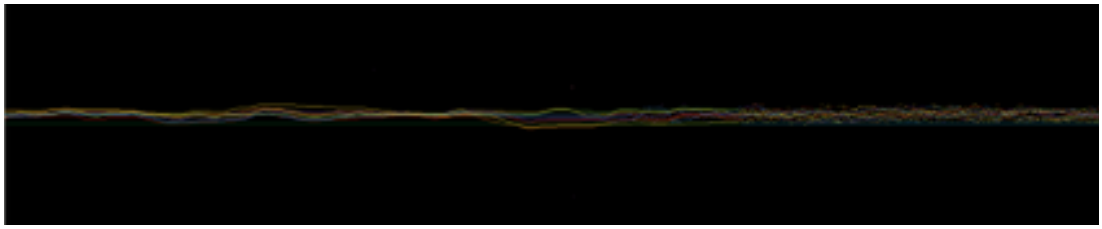
in notation (reversed):



Throughout the first section, the strength of the attractor point is gradually reduced while all of the other parameters are maintained. The effect results in voices following each other, gradually spiraling away from the tonic, and wandering back again.

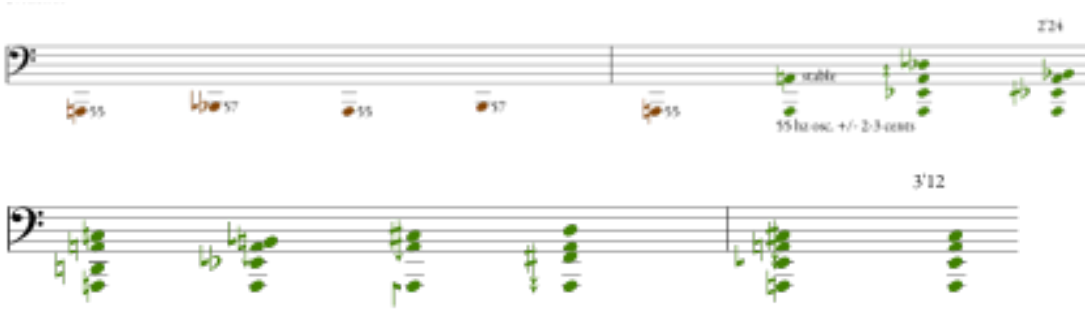
When the voices spread out slightly more, the first gesture begins to appear. This gesture is characterized by slow swaying of pitch stability and gradual expansion of the emergent motion into more voices. This behavior can be seen in **Illustration 39**.

Illustration 39: Undulation timbre shifting into unstable waves

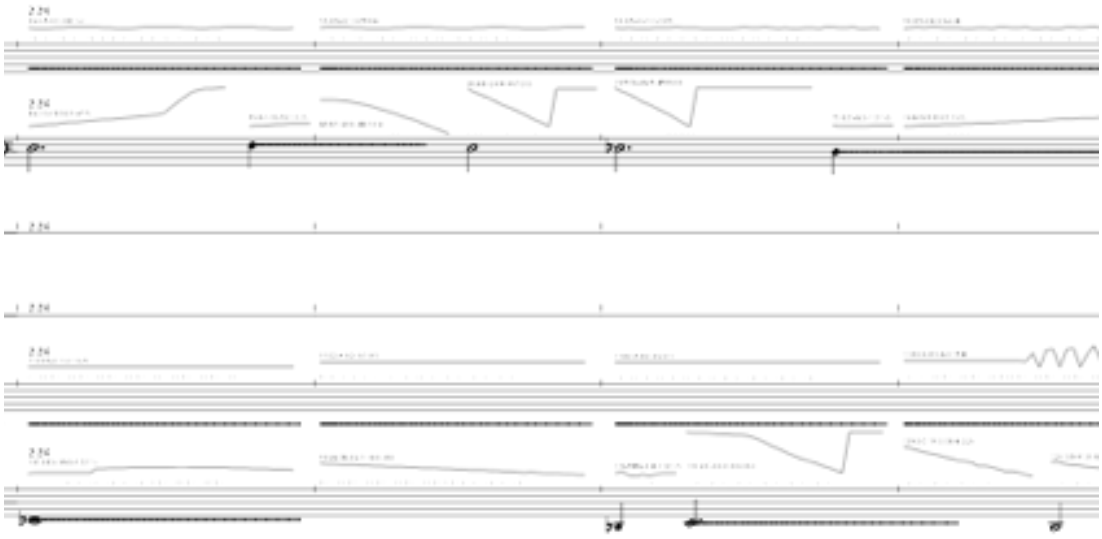


The branching and meandering motion results in a sonority that wanders in and out of harmonic stability. The results from the meandering stepwise motion can be seen in **Illustration 40**. It is useful to note that octaves are equals, and the movement of singular voices can wander subtly in and out of octaves on the double bass through circular bowing.

Illustration 40: Initial Pitch and secondary pitch stepwise structures



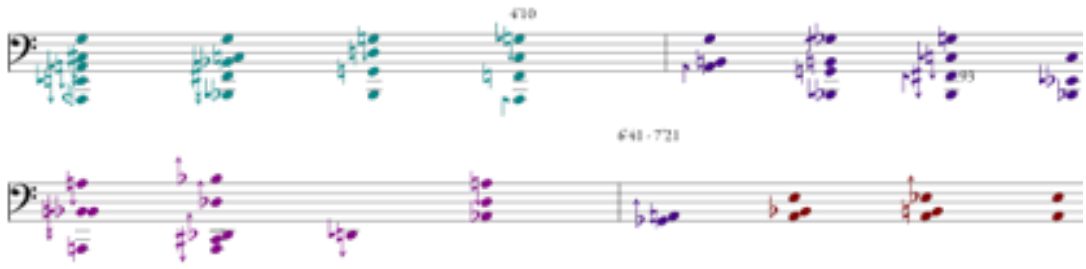
we can see the wandering and returning motions in the lines:



These gestures are expanded as the hold of the attractor point is weakened, and the voices wander farther apart. New voices are added as they branch far enough away from the neighbors to be distinguished as something other than a rhythmic structure; they are then gradually pulled back towards the attractor to begin the next section. Throughout this

section, I adjusted the strength of the attractor frequently and intuitively to encourage the motions that I found stirring (**Illustration 41**).

Illustration 41: Suspended structures returning to stasis



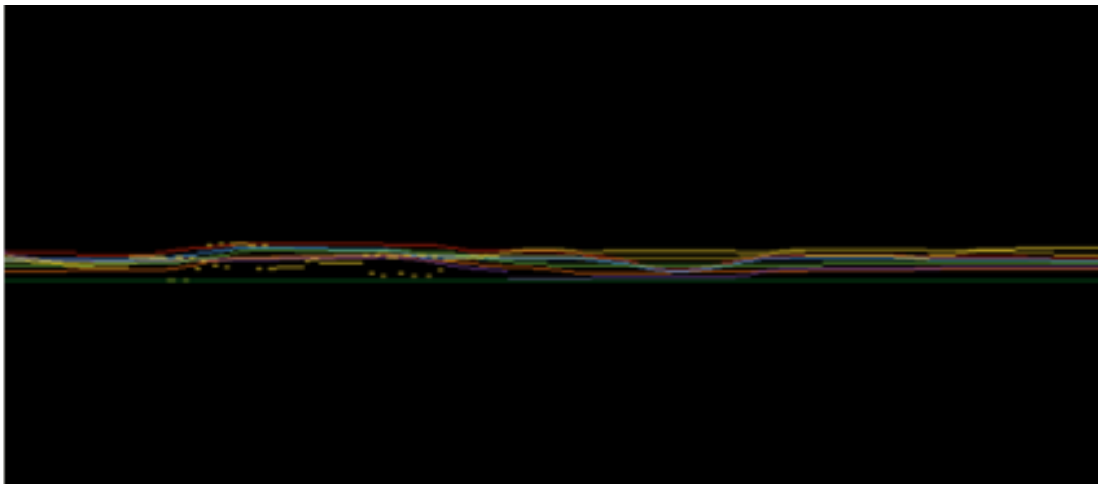
The first section ends with an uneasy tonic using the strong convergence setting. It resolves only momentarily before the next gesture begins. The initial stepwise wandering has expanded and contracted into a larger space and has cleared a path for the harmonic motion in the second section.

The Second Section

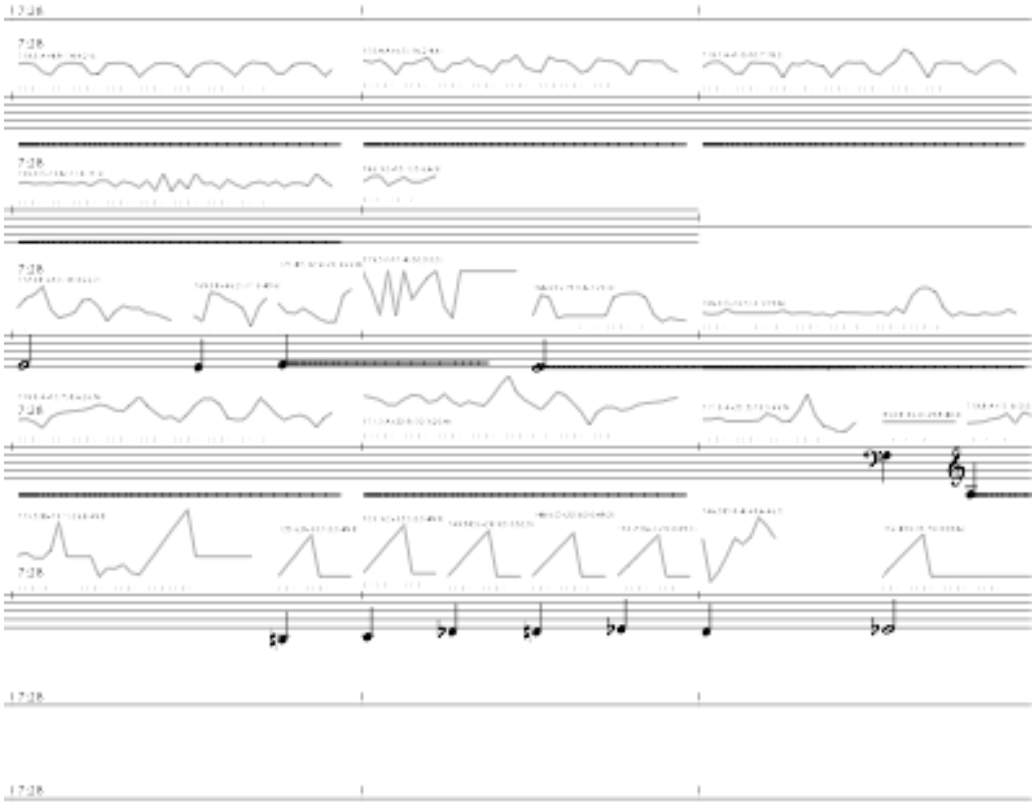
The second section is characterized by a storm of long gestures that grow dramatically with each swell. The first swell is similar to the introduction, but the voices are not particularly drawn to the tonic and the settings dictate that the voices meander in

orbit around the point. I adjust the level of avoidance of neighbors in real-time to bring out a different type of static motion that derives its cadence from converging on mutual points without immediately being repelled from these points. The first gesture is a slow and perturbed orbit around a center with rhythmic motion generated from voices converging upon one another (**Illustration 42**).

Illustration 42: Gesture IV/Perturbed undulations



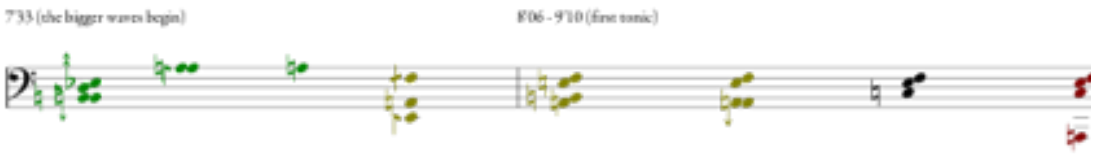
perturbed gestures



The voices converging upon one another and not upon the attractor build sonorities that swell in and out of tune. In this case, intonation is defined as chordal structures that do

not generate rhythm using an additive process like the one in the first section (**Illustration 43**).

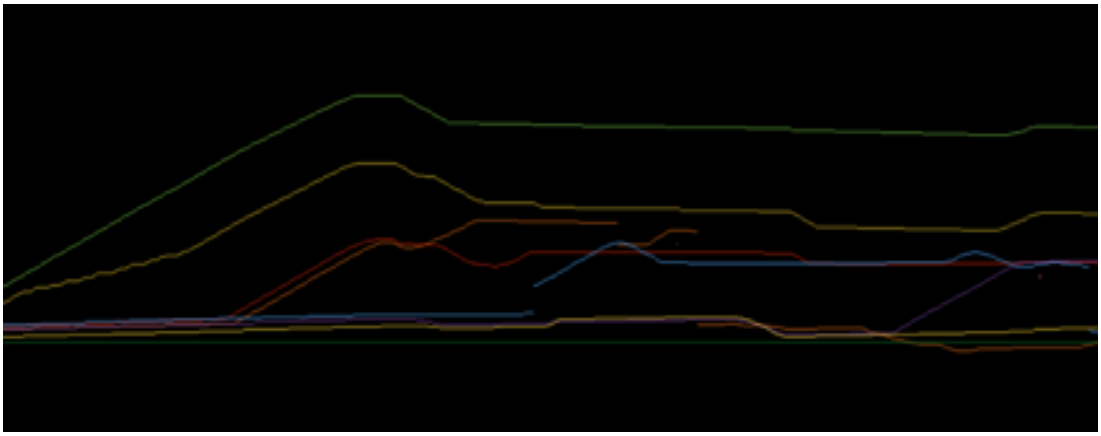
Illustration 43: Perturbed undulations returning to relative stasis



These harmonic structures cadence through rhythmic gesture and the lack of continuous motion in a sonority. The voices are drawn to each other but are not uncomfortable being away. The next gesture begins with the final sonority.

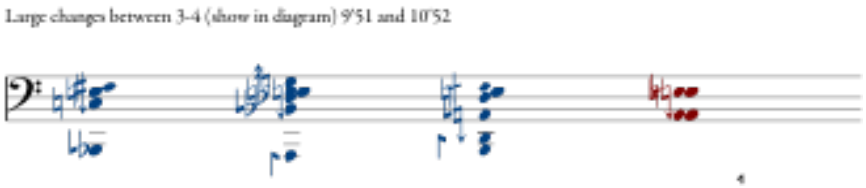
The next swell is based on a different parameter than the previous one, but has a similar set of behaviors that emerge on a larger scale. Voices are not as "uncomfortable" being "alone" and so they wander further away from their neighbors. The voices are also not uncomfortable being next to one another, either, so if they "stumble" into range of neighbors, they will follow. This creates spectral motion akin to that found in an overtone series (**Illustration 44**).

Illustration 44: Branching out, voices following spectral neighbors.

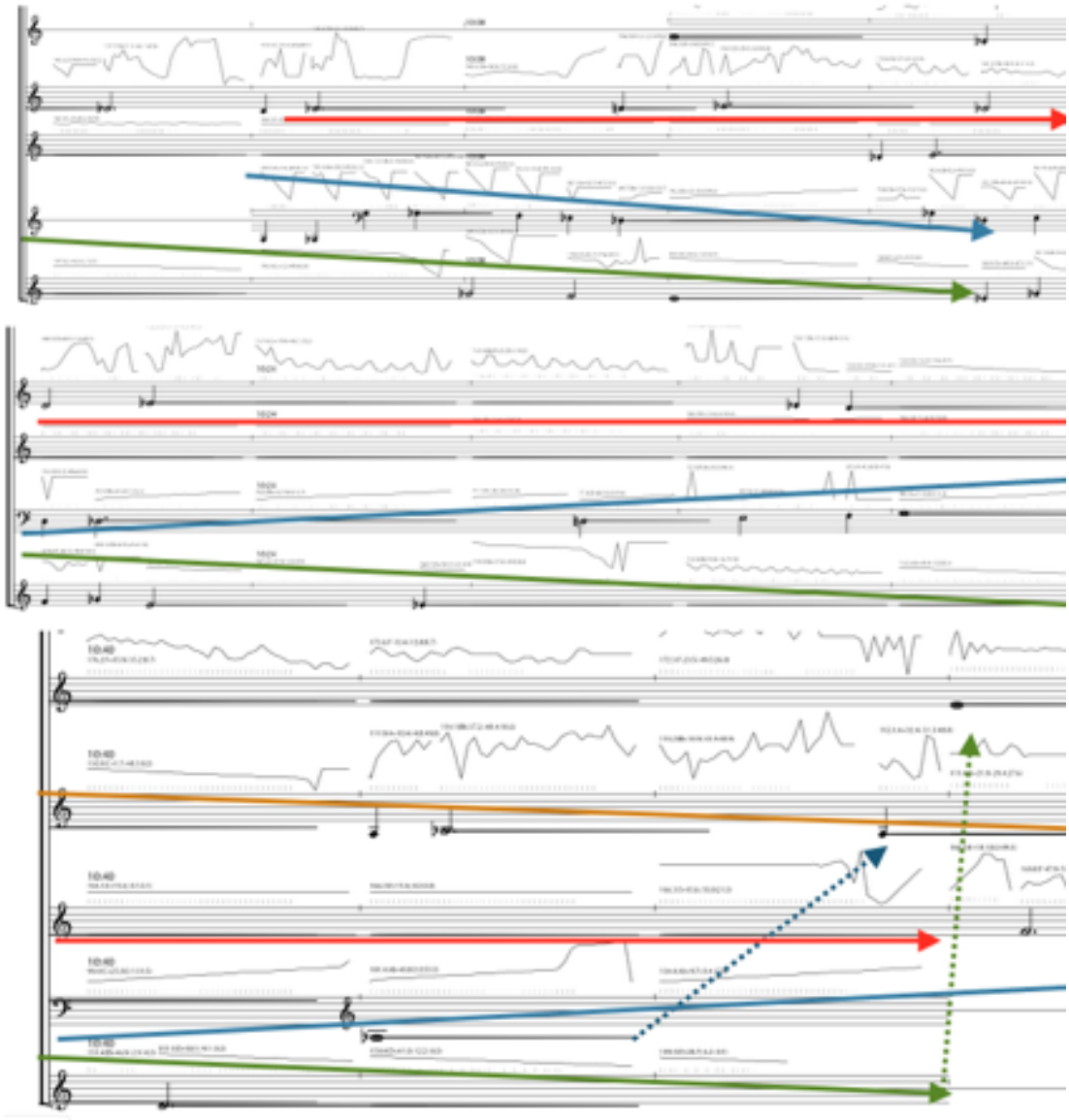


The initial positions were determined by the final chord of the previous section, and the voices wander rather quickly in close, unstable pitch space. We can see the harmonic reduction of the branching behavior in **Illustration 45**.

Illustration 45: Gesture V/Harmonic branching, returning

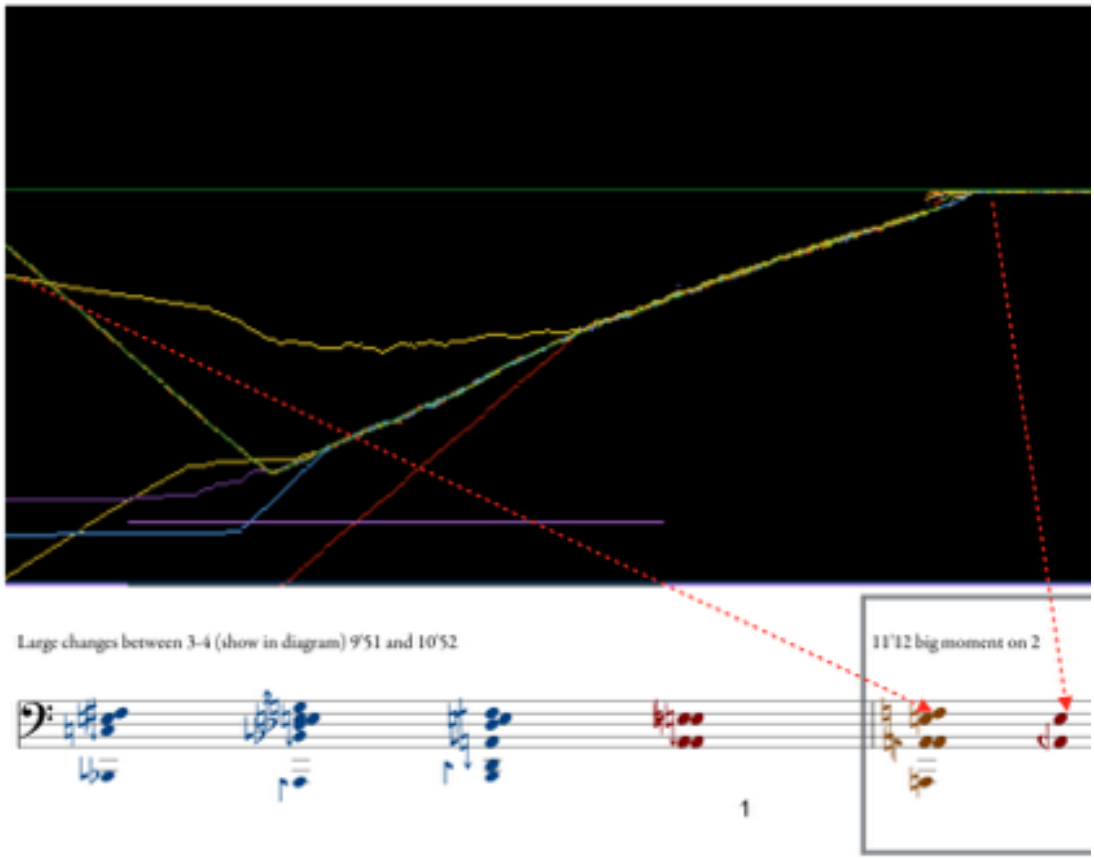


Large motions in the 4 lower voices heading towards a stasis.



The section resolves with a strong convergence upon a tonic (**Illustration 46**). This motion is a large and dramatic gesture.

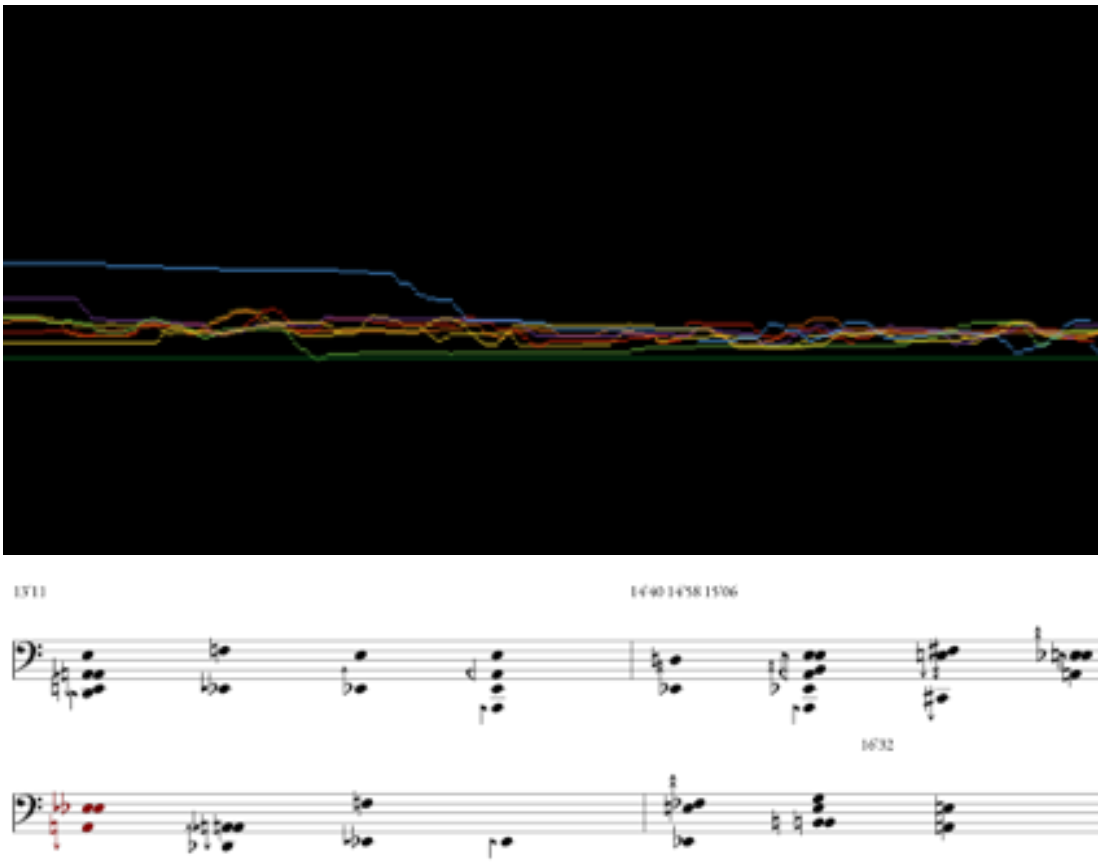
Illustration 46: Convergence upon an unstable tonic



This is one of the largest moments in the piece: it is the largest wave, and the rest of the work declines in an uneasy drama similar to a dwindling storm. This process is generated through simultaneous avoidance and convergence in slow gestures. Voices will try to converge upon a tonic. They cannot stay, because every time another voice comes nearby,

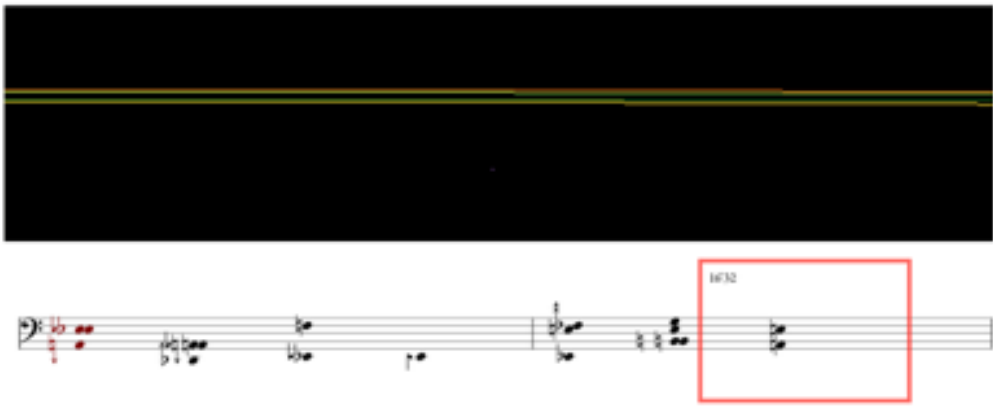
the two are repelled. This creates an expanding and contracting gesture. In this section, the level of avoidance to neighbors is intuitively decreased to gradually permit the voices to converge upon the tonic. This motion is shown in **Illustration 47**.

Illustration 47: Simultaneous Avoidance and Convergence



The piece ends in the same way that it began—as an uneasy static point that glows (**Illustration 48**).

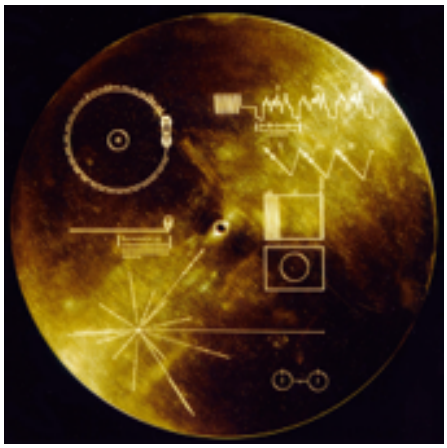
Illustration 48: Stasis



Codex and Notation System

A reader once said, “I received your score. I have no idea how to read it.”

Illustration 49: The Golden Record



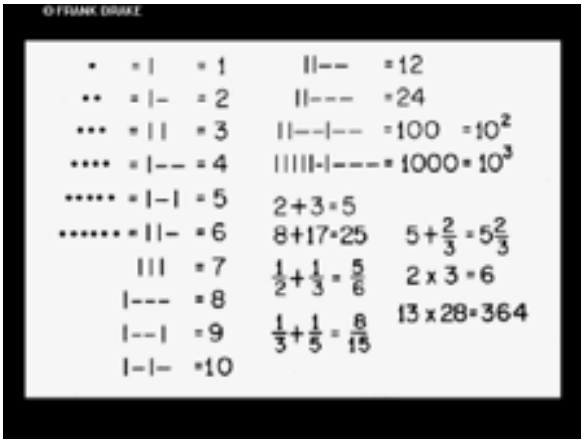
Illuminations Codex: Error and Artifact

In 1977, NASA sent the famous *Golden Record* (**Illustration 49**) into space with a collection of sounds and material cultural items. The intent of this work was to send the record to an alien civilization 40,000 years into the future (a species with eyes and ears presumably). The instructions were written “in symbolic language” and intended to “explain the origin of the spacecraft and indicate how the record is to be played” (Chen, 2013, p. 1). Jimmy Carter said the record was "a present from a small, distant world … This record represents our hope and our determination, and our good will in a vast and awesome universe" (Torricelli, Carroll, & Goodwin, 2000, p. 324).

The form of this “present" or interstellar presentation was a phonograph, and a series of electronic images encoded in gold. Etched upon it was symbolic instructions on how to build a phonograph. Once this device was created, the phonograph would play series of messages in almost every language to provide future civilizations or alien civilizations with the codes necessary to begin to understand past human culture. On the phonograph is an inscription: “To the makers of music—all worlds, all times” (Harper, 2011, p. 1).

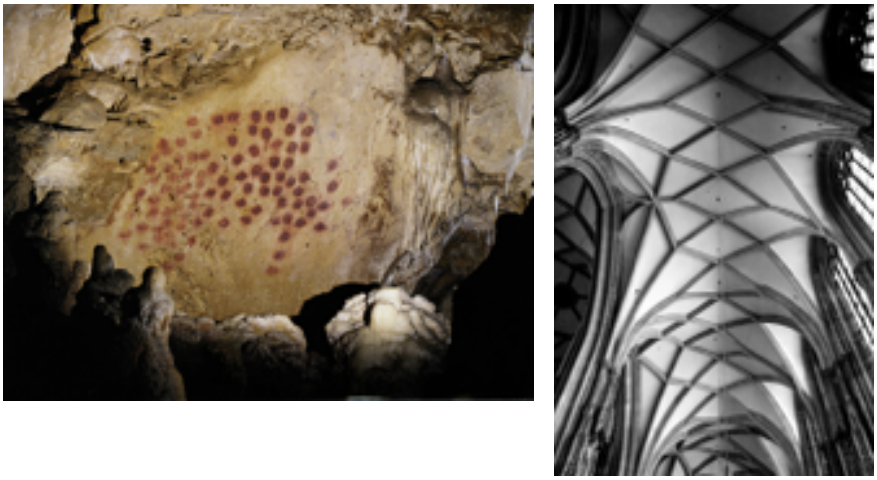
The reason that the golden record was framed in this way is due to the idea that central to any alien civilization is the concept of deduction from basic principles, mathematics, and an intuitive faith in the universality of intentions based on reason (**Illustration 50**).

Illustration 50: Principles of Mathematics, from the Golden Record. Photo credit: (Drake, 1977).



It is common to associate intention with symmetry, but I would argue that symmetry is not a tool of humanity. Symmetry is a tool of nature and humanity is shown in the imperfect imitation of nature. Humanity is found in error and the adjustment of the overall structure to cover up the error. Furthermore, humanity is found in the evidence of hands that created and fixed it as they went along, and the micro-fixes and kludges that the creator employed to fix little errors in the execution. Examples of these can be seen in the paleolithic paintings in the *Chauvet* caves of France as well as Gothic vaults of churches (**Illustration 51**).

Illustration 51: The Human Touch



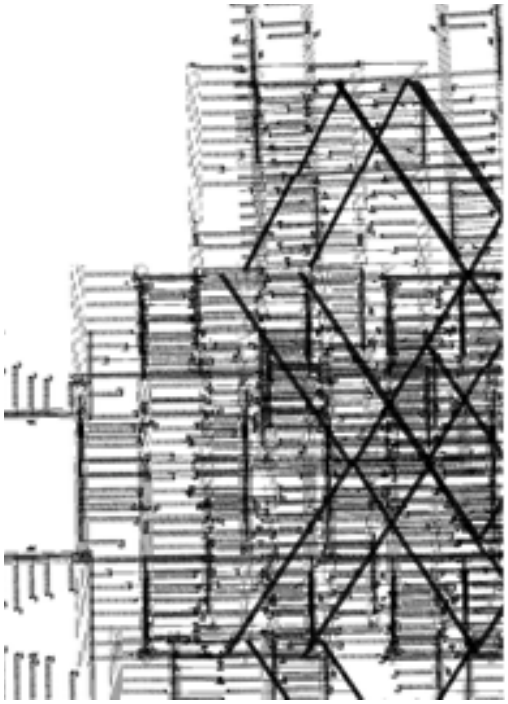
It its obvious that a human has placed these symbols on this rock at least in part because of the imperfection of the arrangement. The Gothic vaults gain their appeal from the small adjustments to the structure that were made to diminish problems with measurement along the way. These works show the human imitation of nature and the representation of nature according to human aesthetic concepts.

The *Illuminations Codex* is a book of error. The Codex is not meant to be played literally. The piece hints at works and leaps playfully around the page. In realizations of these works, this unwritten potential should be prioritized, but in the archaeology of the codex, the system is more important. The codex is considered a conceptual and visual form that references notation and a speculative music that may be produced using the imagination. I think I make this clear in the forward:

This is a book of imaginary scores based on my favorite typesetting catastrophes that occurred while creating a score-writing and graphical notation program. These errors contained evocative glimpses of my intended score while also flying off the page in interesting ways. They hinted at marquetry, movement, wild melodies, and architecture. They were pieces in themselves and so I illuminated them.

The codex is a work based on the coded errors of other works. This is because developing a system to automatically engrave music in a readable way involves a lot of trial and error. There were many mistakes, but the mistakes that seemed to leap from the page with hints of imperfect symmetry caught my eye. Some of these were layered in exceedingly complex (yet very imprecise) tessellations that work themselves out. An example of this can be seen in **Illustration 52**.

Illustration 52: Extremely detailed Imprecision



They were all arranged by hand and then illuminated out of their black-and-white shells, because, as the famed schematic in *A Canticle for Leibowitz* proposes: " . . . The meaning of the diagram itself was obscure, he dared not alter its shape or plan by a hair; but since its color scheme was unimportant, it might as well be beautiful" (Miller, 1960, p. 15).

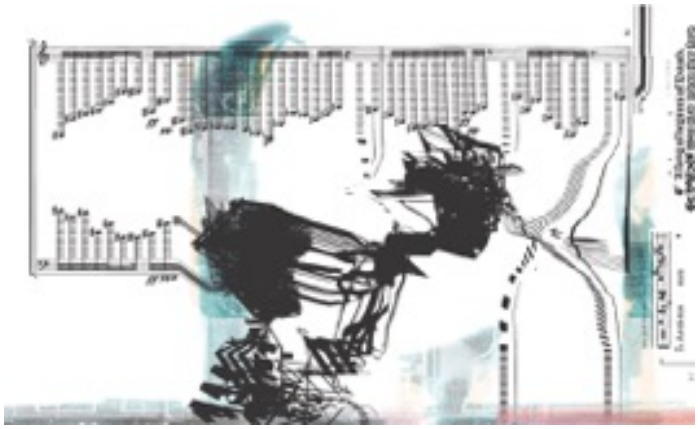
Aesthetics

From an inspirational standpoint, there is nothing more disheartening than the disparity between the sound inspiration and the traditional representation of it in notation (**Illustration 53**).

Illustration 53: Notation and Expectation

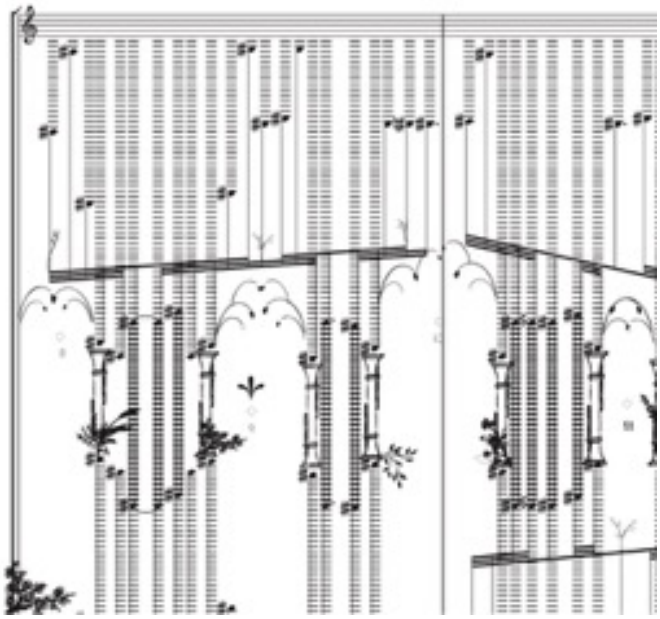
Middle C

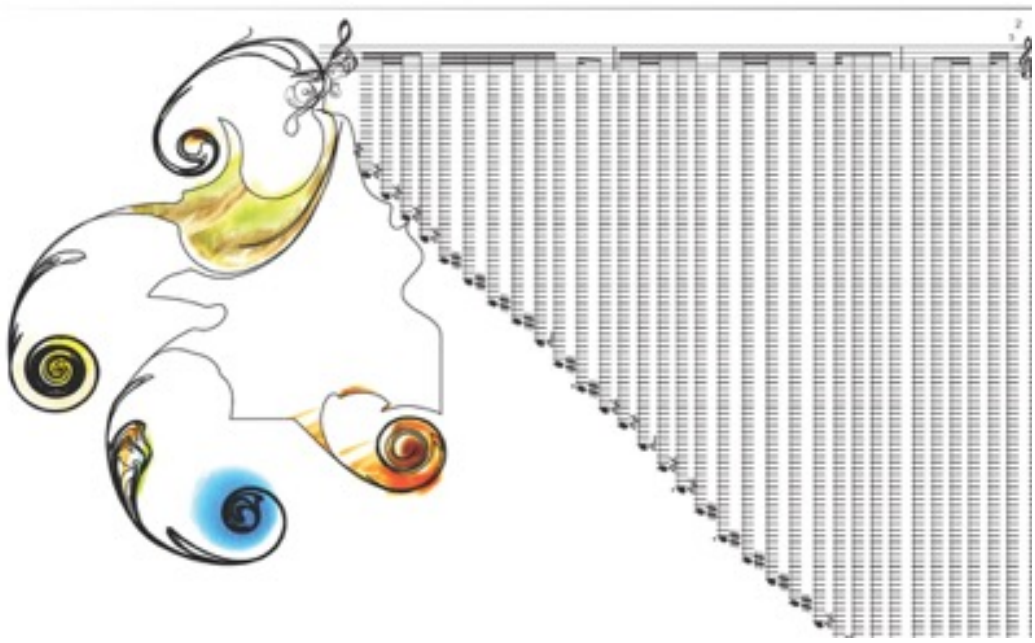
It seemed more like this!



To my mind, it feels like it should not have been so plain. It felt grander. In real terms it was not merely a note, but rather a complex waveform with presence and meaning. The system does not communicate what is needed. The situation improves with the addition of ledger lines because the height communicates drama and precariousness from its location among the treetops.

Illustration 54: **Ledger Lines In *Illuminations Codex***





Ledger lines play a pivotal role in the *Illuminations Codex* (**Illustration 54**). The lines and large leaps symbolize a work that cannot be constrained to its symbols. The pitches seem to either exist in a place where they are lower than they are, or more difficult to reach than they are. This conception of register is significant because it can imbue the work with a spirit of risk and peripherality.

I painted the codex digitally and by hand because I firmly believe that my scores should always be ornate and that time should be taken to embellish them. As a rite or ritual, adorning the codex symbolized the value that I placed on a series of scores that under most circumstances would be discarded. For me, the decoration process distanced

the work from a utilitarian formal engraving and re-placed these errors into the realm of purpose.

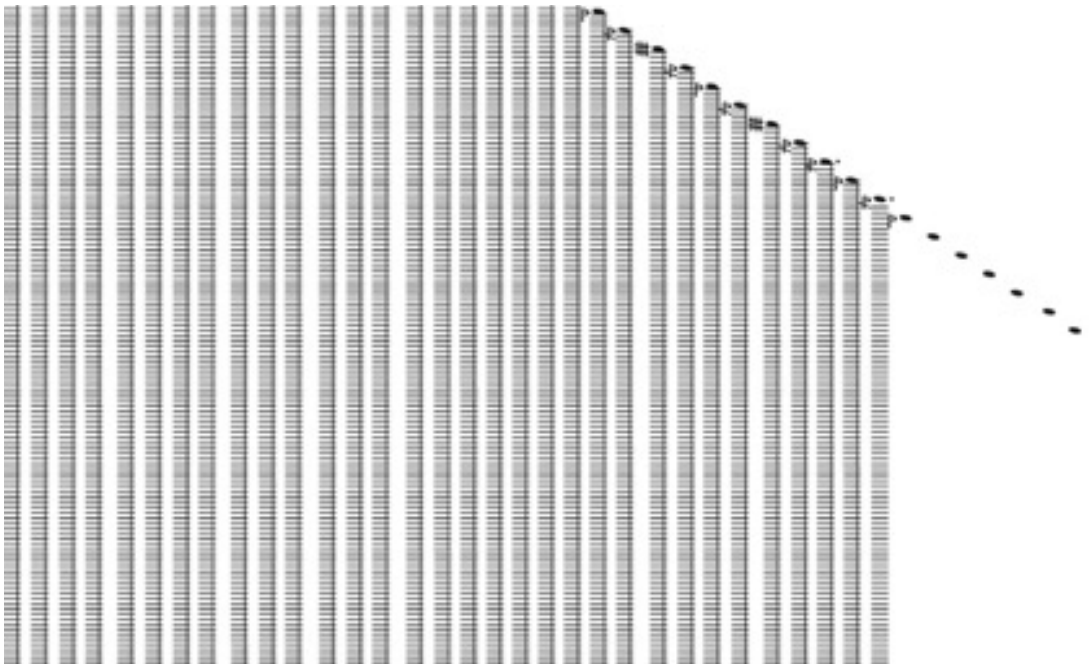
The modern score inhabits a somewhat postmodern world, and so it is almost impossible for me to view the score as purely a means of transmitting performance information. I wanted to be conscious of the decisions I was making about the way the work would be understood by the enigmatic, amorphous future and to play with these ideas. The score is subject to the same textual archaeology, temporality, degradation and interpretation as a book. I have always been interested in ephemera and wanted my work to reflect this.

Comprehensibility

My Illuminations Codex is a riddle of legibility within a musical context. Scores, as cultural documents that represent a past or future body of knowledge, are a form of communication. Scores or other ephemera can be readily understood or they may take ongoing review to decipher. Some may be completely opaque. Within this branch, there are works that can be decoded, and there are works where the code has been lost through time or destroyed. The codex has aspects of both. Scores with hundreds of ledger lines *can* be deciphered with a bit of counting, but music that was unintentionally rendered

outside of the page might be lost forever or hidden in another version of the engraving script that has to be found (**Illustration 55**).

Illustration 55: **Falling of the Page In *Illuminations Codex***



A third category of inscrutable writings come from the human attempt at cementing a mystical or ephemeral object. Examples of this include *asemic* texts (Jacobson & Gaze, 2013), mystical writings, or a Rorschach test (Banks, 2012). The meaning of these documents comes from the habits of mind and universally human intention the work expresses. As Italo Calvino asserted about the *Seraphini Codex*, "[i]f the Other Universe communicates anguish to us, it's less because it differs from ours than because it resembles it" (Calvino, 1983, p. i). Human documents, at the very basic level, communicate humanity. Beauty within error and imitation is one of the most basic

examples of art. These were all ideas that informed my aesthetic decisions when creating the codex and notation system. The pieces I sought to engrave are mystical works, and sound is ephemeral.

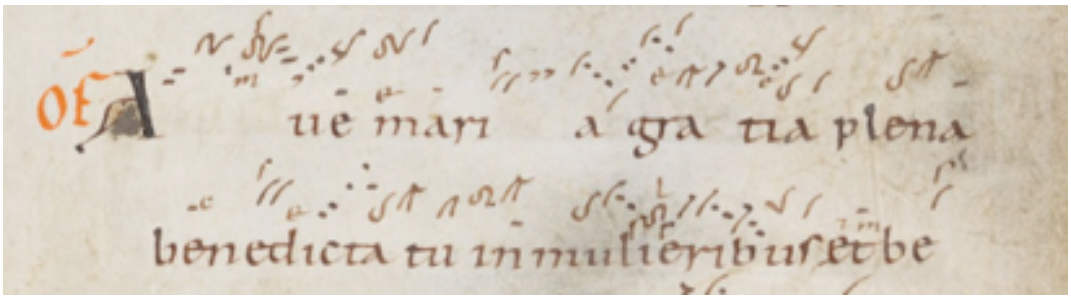
The *Illuminations Codex* is, despite the occasional difficulty one encounters in deciphering it, a reliably coded system. The initial sounds and sources that are visually represented in the codex can be reverse engineered, which means a real and tangible potential for communication exists. The scores can be read, and, given the time and interest, they could even be simulated. Further, the original sounds could even be estimated, and I hope that this palpable potential for communication is appreciated.

The Notation System as Future Artifact

The physical manifestations of the codex and notation systems are artifacts, and I see these artifacts as providing temporal context and precedent for interpreting my work. A score is the material form of sound and "when belonging to history, forms a document from a previous age" (Tarasti 1994). Composers, when notating a work, try to clarify their intentions and render the work comprehensible and relatively repeatable (in process or result) in the foreseeable future. They do this using various temporal and culturally imposed signs, graphics, and symbols which are then sent into the world.

My notation system was devised in a similar way as the *Golden Record*. Like the phonograph schematic, I intended it to convey aspects of the sound that are not always apparent in the work. My goal was to make a textual "recording" of the system that has the potential to be reverse engineered. In effect, it is a textual record of alteration in the music. Melodies are expressed as lines and wobbles, like Medieval notation (**Illustration 56**).

Illustration 56: 9th Century Notation (photo credit: Anonymous 2015)



Instrumentation is left to the reader, as is common in "early" polyphonic music. The *tessitura* is presented in the front, and the performer chooses the appropriate instrument for the part. In some modes, the timbre of the work is analyzed and a phoneme is added below the score information to provide the reader with a tablature of timbre. These scores are very difficult to read, to play, and to understand on their own, but they are not really meant to be used for performance. When a listener chooses to hear the recording and follow along with either the graphical score or the typset score, the primary goal was that they might find the experience to be a visually rewarding one.

Chapter 3: Implementation and Public Presentation

Setting and Participants

The result of this project was the recordings and scores of three works. The dissertation compositions were presented in abstractions: a book of scores, realizations, puzzles, and an album of non real-time performances of the works within a Listening Room Exhibition space. The recordings and book cataloged various captured ephemera and the tools for others to easily do the same. A bestiary, a codex, and an album resulted from this work.

Past Projects

In 2013 I submitted my first dissertation proposal to compose a mass for voices and electronics. My first drafts came from tape delaying, shifting, and microtonally altering and layering chants to build pieces that were highly impractical to perform but, nevertheless, represented my aesthetic interests and investigations. I first started to tune and retune the pieces live and interactively until I found an order that suited my distorted vision of the original. Over time, I remapped them in the time domain to create incidental and timbral harmonies. I created many pieces, but they were not practical to perform due

to their specific time and timbral qualities. This process was very labor intensive, but it provided me with valuable listening awareness practice and ear training. I started to work with other sources of mapping information to discover new qualities of the pieces using stochastic systems, among them glitch harmonicism, topographies, and optical distortion. I also began searching for methods through which I could easily notate and represent pieces that contain highly specific and complex timbres.

My first presentable example of work in this direction was the patch that influenced my piece, *Agnus Dei* (part of my original proposed mass). In this patch I combined the current position of the celestial bodies in pitch space with the idealized pitch space from earlier associations of harmony and the planets. (It changes every day.) I made a series of pieces every month for a year to reflect on the small changes. I began to build a notation encoding program to write down the extremely specific and slow-moving harmonies that were integral to the work. For example, it is painstakingly difficult to notate a 12–minute glissando that moves up 10 cents, but these are essential motions in this work due to the time scales involved. It was fascinating to hear and reflect on the extremely slow harmonic motion over a period of years, much like Young's *Dreamhouse*. On smaller time scales, small glissandi references the electronic music of Eliane Radigue.

This process emboldened me to search for other sounds I could find in spaces that I found compelling. I started making systems to search for the "ghosts" that were

somewhat "in the machine" but also "of the world," yet fundamentally dependent upon the machine. I created systems to listen to or interact with the spirits of place and space.

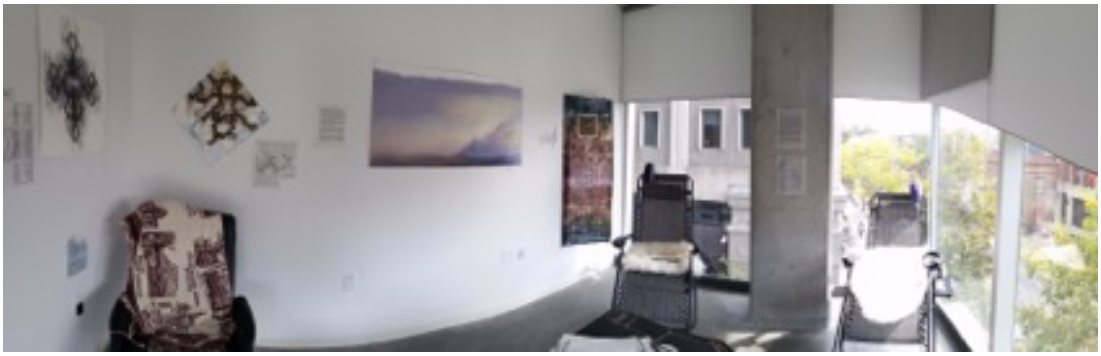
Description and Details of the Listening Room

This project was presented to the public in the form of an exhibition that took place in Granoff 3S on October 8-15, 2015. The space was chosen because it was an open, sunny, and pleasant sun room for reading and relaxing. It was meant to exude the atmosphere reading nook in one's home, and participants were supposed to engage with the work on their own terms. The room was not intended to be visited at a specific time and not by many people at once because it would put pressure on the participant to engage socially. The room was kept open for a few days and by appointment. The listening and gallery session was expected to take a participant anywhere from 12–60 minutes to experience. Within the space, there was 1) seating for reading and listening (three to four people at a time) in a relaxing atmosphere with tea, headphones, reading lamps, and media players, and hand sanitizer, 2) a small gallery space to view illuminated score experiments, 3) three to five copies of the codex placed upon a coffee table, and 4) tea for visitors to enjoy.

Media players and headphones were provided in the space for the participants to listen to pieces while reading the codex and scores. Alternatively, if the participant preferred to

use his or her phone/computer and personal headphones to listen there was a SoundCloud playlist that could be accessed via any mobile device. The Gallery area was decorated with large-format illuminated scores (**Illustration 57**).

Illustration 57: Layout of Listening Room



The Listening Room was presented to the public in the following wall text:

> *To the Greeks, there were four mathematical disciplines: Arithmetic, Geometry, Astronomy, and Harmonics (Musica). According to Medieval scholars, Musica was the study of truth using the "witness of the ears." Sound was seen as a mediator between the seen and unseen world. It was considered to be a unique window into human nature and the inner invisible workings of Nature itself. Nature was governed by logic, logic is described by Number, and the application of number granted legitimacy to even the most incredulous beliefs with almost an occult power.*
>
> *The successful aural reproduction ("intonation") of these invisible truths was a mathematical proof of Man's comprehension and mastery of the world—like divination. Intonation, like the proper recitation of a spell, was a mystical representation of an unseen logic. Through music, Man understood the cosmos. The invisibles of nature could be transcribed using proportion (and musical notation).*

These views have been translated, misunderstood, and translated again to find meaning and reason through sound in almost every era. There are echoes of these beliefs of logic and inherent reason of numbers in legitimized fields such "Big Data" and less legitimate areas of inquiry such as pseudo-science and "fuzzy math." A popular example of misuse of "reason" is the common application of the Fibonacci Nautilus Proportions to argue the perfection of a work of art.

The composition of music, then and now, can be a bit like this. My work explores electronic music composition and representation using the logic of Medieval mathematics. I use these ideas (and many more) in the systems and data sets that I have based my works. Information from mystical sources such as planetary motion, flocking algorithms, or whole number ratios is mediated, recorded, translated, performed, re-translated, beautified, re-imagined, and embellished with gold leaf.

The participants were provided with program notes and I was available to answer any and all questions.

Kyrie *(9 minutes, realized as a work for accordion and electronics) : This piece is about the aliasing that comes from shifting and layering timbres and whole number ratios. The inspirations came from an analysis and re-synthesis of digital and harmonic artifacts in recordings of of Eastern Orthodox and Sardinian chants.*

Agnus Dei *(12 Minutes, realized as a work for 9 instruments) : This is a work inspired by the interesting historical relationship of music, religion, and astronomy. In this work, I use the placement of the celestial bodies on the modern horizon to create chordal structures. I also work in harmonic rules from a 1489 text which specifies the proportional relationships of music and the cosmos. I alternate and combine these pitch sets to modulate between the cosmic (divine) and human worlds. The electronics place the performers in the space and adjust levels based on the planets' positions on the horizon (spatialization), as well as reverb (a representation of distance and time) based on the planets' distance (in Astronomical Units). Pitch is derived from the distance and is modulated very, very slowly by the oscillation of the orbits. All of this depends on the position of the listener and the time of year.*

Ebbinge *(17 Minutes, realized as a work for 8 double basses) : This piece is intended to capture the motion of drains/galaxies/flocking in timbre space. I have always been*

fascinated with the wandering motion and tonal parallelism of objects all trying to converge upon a point (the tonic). At slow speeds, this blind following-and-imitating can sound ritualistic—like hundreds of people walking slowly in a procession. Motions are intricately linked to the sensation of pitch, much like physical motion of carrying 'boomboxes' in Phil Kline's Unsilent Night. In the Draining and Flocking algorithm, there are points at which the flock is drawn to or repelled from with varying speeds and within other parameters. It "flocks" in pitch and dynamic spaces. The pitch is variable and relative to the initial number of members and distance scaling settings at the time of onset. Generally, the further away from the drain, the lower the dynamics. Objects can travel arbitrarily far away into silence. Rhythmic material is derived from two or more members being so near in frequency that they beat against one another.

Codex and Scores

A good recording can often be the best record of a work, but historical and contemporary efforts to create written records of sound (notation or other) are fascinating. Like an ancient scroll or the *Golden Record* sent into outer space to try to speak to other worlds, it is hoped that the chosen codes will be decipherable, inviting, and thought-provoking.

The codex was intended to be an object of interest, mystery, and curiosity. It was printed on fine paper, bound, and then hand illuminated with gold ink (**Illustration 58**). The reason for this was tactile. Simply put, it feels good to thumb through something while sitting by a window. A comfortable audience is more likely to be receptive to the experience. The codex was made available for online reading and for download.

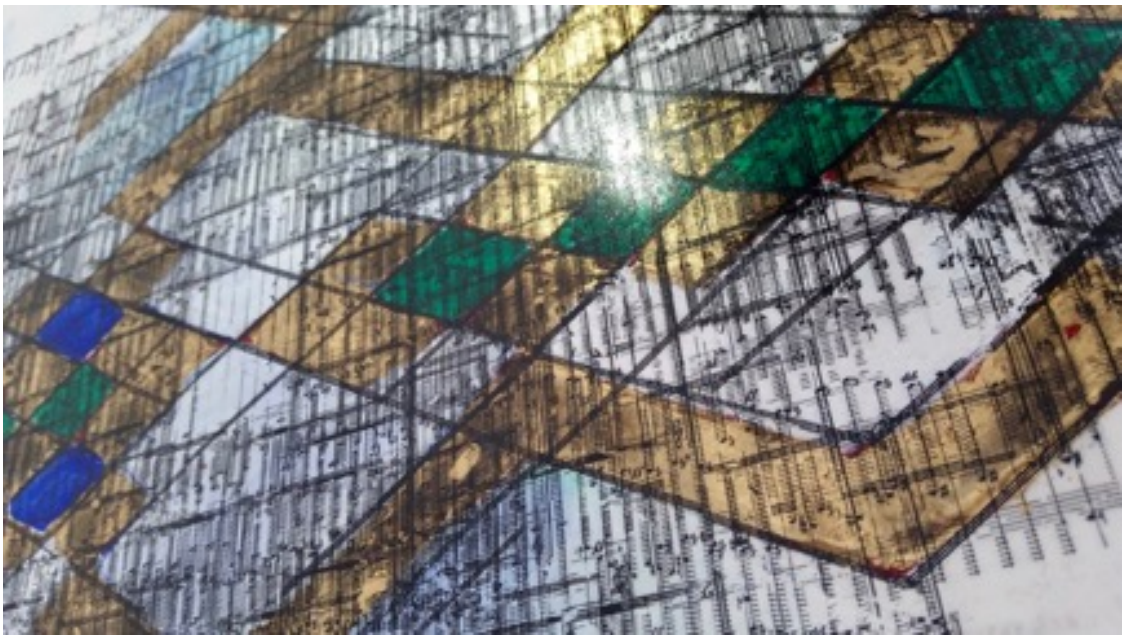
Illuminated Manuscripts

There were four selected illuminated manuscripts that contained enough detail to warrant being printed and hand illuminated onto large format paper and vellum. These were the score for Ebbinge (60 x 30 inches) (**Illustration 58**), an error that looked like purfling (32 x 24 inches) (**Illustration 59**), an error that looked like marquetry (20 x 20 inches) (**Illustration 60**), and a swirling melodic line that was tessellated (72 x 11 inches) (**Illustration 61**). These pieces were made in the following ways: 1) acetone transfer and hand leaf and painting 2) color print transfer, hand inking, and sealing, and 3) large-format printing.

Reception and Goals

The reception was positive and visitors tended to stay for at least 30 minutes. There were a few repeat visitors.

Illustration 59: Purfling (32x24):



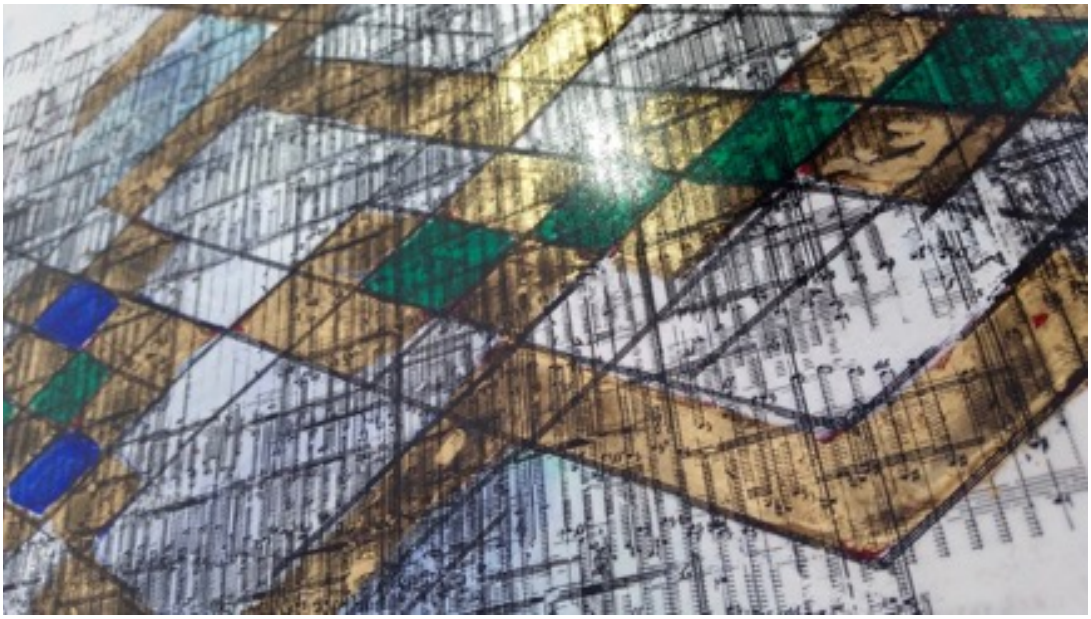


Illustration 58: A Few Pages from the Illuminations Codex

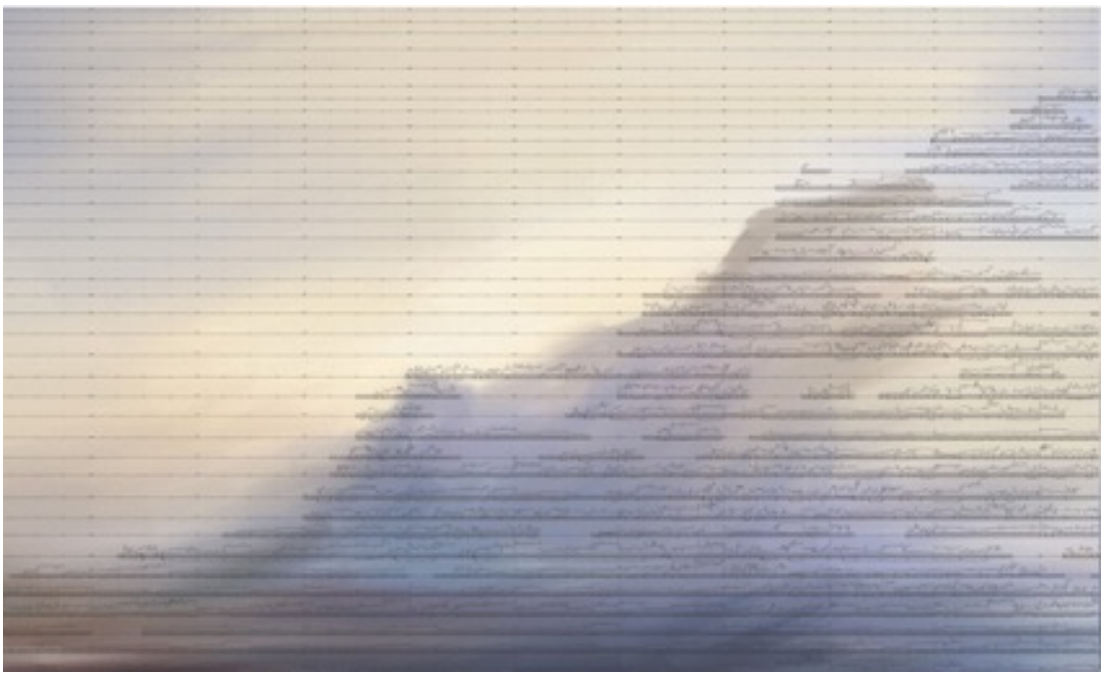


Illustration 60: Marquetry (24x24)

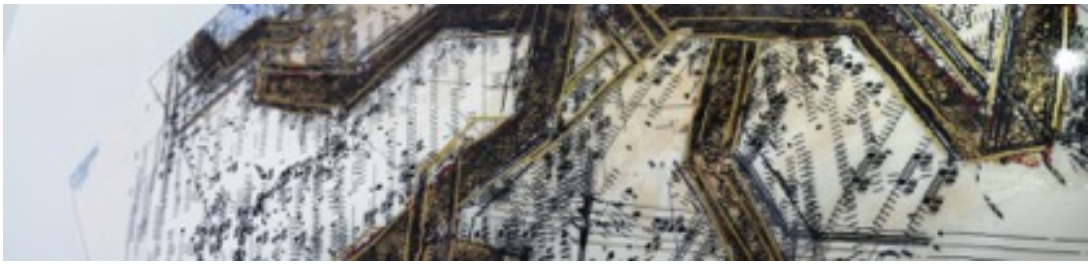


Illustration 61: Tessellation Stained Glass (72x11)

About the Scores

The scores were the creation of a custom script intended to create visual records of the audible in a way that might one day also include timbre. During the process of creating this system, many brilliantly disastrous typesetting errors were made and these were the material used in the creation of the codex.

The Need for Microtonal Resolution

These projects are all composed using irrational microtonal systems that are painstakingly specific. The task of writing any of the work by hand would be a frustrating one, and most systems make it highly difficult to notate works with “irrational" precision.

Why Lilypond as Output

Lilypond is a compiled text-based open-source engraving program based on LaTeX and originally developed by Han-Wen Nienhuys and Jan Nieuwenhuizen. This easily (and almost arbitrarily) extendible markup code was deemed the most ideal candidate for this project (though far from ideal in many aspects) because of the relative ease of use and relative compatibility among systems and notation. There are a number of fonts and libraries for microtonal notation as well as graphical elements like curves. Lilypond scores are automatically generated from Sinusoidal Partial Editing Analysis and Resynthesis (SPEAR) data, written by Michael Klingbeil (see Klingbeil and University 2009). A program was written in the Python programming language to translate SPEAR data files into Lilypond source files.

Why SPEAR as Input?

SPEAR exports a large text file of data consisting of plain text, one line per hundredth of a second, with each line specifying a set of one or more voices (frequencies and amplitudes) sounding at the given time. The composer can add, delete, and otherwise orchestrate a work visually and spectrally.

It is also fairly easy to convert other kinds of data or sound sources to fit the format, and the orchestration can be easily specified by voice number. Within this file, as

is the logic with SPEAR, the frequency and dynamic information is bound in time and can be easily re-synthesized. When enough frequency “bands" are represented, the file begins to resemble an FFT and represents timbre.

Timbre can be calculated within an orchestration by searching for the F1 and F2 frequency pairs of a voice and then output as a phoneme or “lyric."

How The System Works:

The system was built in 2015 in collaboration with Doug Swanson. The Python program reads the SPEAR data file, parses it, groups lines together into notes (the number of lines per quarter or eighth note is a configurable parameter, and is equivalent to choosing the overall tempo), and adds those notes to Score and Staff objects in memory. Once the SPEAR file is parsed, the program runs back through the data, consolidating consecutive notes, adding ties, dynamics, and other notational elements, and generally creating “sane” and malleable notation.

There were two problems in creating the system:

4. The method by which individual notes should be assigned to individual Staffs in the Score

5. The method by which irrational microtonal frequencies in 12-tone notation could be notated

It is considered conventional to notate irrational microtonal pitches using a quarter tone estimation and then add the alteration in cents above the note. This is insufficient for the notation of microtonal gestures and often makes music look more difficult than necessary.

Implementation

First, in order to assign individual notes from SPEAR to individual Staffs in the Score, two different strategies were implemented, one termed "register continuity" and the other termed "voice continuity." In "register continuity" mode, the lowest-pitch note is always placed on the bottommost staff, the second lowest note on the second lowest staff, and so on. This technique enables staffs to "own" particular registers, but at the expense of sometimes requiring voice crossing. For example, if a new lowest voice appears, it "takes over" a lower staff, moving all other voices up one staff. Conversely, in "voice continuity" mode, the SPEAR-derived "voice numbers" are used to guess which notes "go with" which other notes, and those notes are assigned to the same staff (or to a staff in a similar register) wherever possible. In other words, SPEAR's voice indexing is "trusted" to map notes to staffs. The composer or designer can link voices together in pre-processing to assist in this orchestration. This technique minimizes voice crossing, but

sometimes mixes multiple registers together in the same staff. The continuity mode is an adjustable parameter in the program configuration file. These modes can be paired with an audio file that will give an estimate of the phoneme that might represent the sound. The desired outcome is for this system to be able to represent timbre.

Second, in order to notate frequencies that fall between conventional 12-tone ledger positions, the notation system uses "wobbles." A wobble is a note in 12-tone Equal Tempered-notation with a base frequency and a sequence of frequency deviations. The wobble is notated by showing the closest 12-tone representation to the desired frequency as well as the frequency alterations (in cents) that must be sounded in order to capture the original material. For example, in order to notate a SPEAR voice which begins at 445 Hz and sounds for 1 second (one quarter-note at 60 bpm), climbing from 445 Hz to 450 Hz over the course of the second, the notation system would create a wobble with a base frequency of 445 Hz, a base notation of A 440 Hz (the closest 12-tone note to 445 Hz), and would additionally mark up this A with a line (using Lilypond's textual markup feature) showing rising motion from 445 Hz (A440 + 19.5 cents) to 450 Hz (A440 + 38.9 cents).

Cents were used rather than proportion because it is easier to conceptualize a microtonal pitch by imagining the deviation as a number between 1–100, where 1 is the written pitch and 100 is the next possible unaltered pitch. The frequency is also notated in

Hertz so that it can be plugged into an oscillator or tuner. This system also functions seamlessly with Just Intonation and notates the absolute frequency above the pitch. Just Intonation notation is not used.

Procedure

The program uses a configuration file enabling the user to customize notational style, font, rhythmic resolution, and input/output parameters. These parameters should be considered with considerable care to determine the appropriate output of a score. After the program is run, the output can be passed directly to Lilypond to render a final score. This score can be opened in *Lilypond*, *Frescobaldi*, or exported to *Music XML* and edited if desired.

Conclusion

My intentions when building this project were to 1) learn to hear the world in a different way 2) learn to conjure voids and sound spirits 3) reflect upon my intuition 4) to develop a patient practice. The processes, systems, pieces, and codex have all been results in an ongoing project to create new and intriguing works based on space, the awareness of place, and presence in sound. This conception of space and the timbre of presences relies upon a very subtle type of listening and has much in common with many contemplative practices and the phenomenology of sound. There has also been a lot of research into presence in sound, space, apparitions, and sonic illusions. This research into

presence has outlined commonalities in my own thinking (such as the *Genus Loci* or spirit of place, medievalism, glowing, and shimmer) with other studies such as infrasound, archaeoacoustics, and preferential phenomenology. I have been able to broaden the scope of my research and experiments to connect aspects of my work that I had formerly not found a relationship between.

The systems I have made can be used to conjure original sound experiences and provide me with creative distance to evaluate a work. When recording the conjured material, the fact that the experience is recorded, repeatable (and fully deletable), adds freedom to take creative risks and work beyond my comfort zone and intuition. The fact that the material is generated based on a system makes the creative process less about personal ability and creativity (and ego) and more about working with what is presented and knowing good material when it appears. If a system is not working, it is easy for me to move on without feeling like I have wasted time or material. The recordings I have made serve as evidence of an experience and of my intentions.

Within these systems and practices I have devised for this dissertation project, I have also found that recording the experience can give me the opportunity to reflect upon the material I have recorded and to spend time contemplating why I found the sounds compelling. This contemplation is best done in a low-stress and low-risk setting. Recording the experience is important because it makes me feel that if something really

magical happens I can go back and find out exactly what it was. Sometimes I find the sound was not as compelling in hindsight, but I am glad that I had the chance to decide for myself rather than allowing the arrow of time or memory to choose what I build my work upon. Sounds can have meaning for many different reasons and it is important to try to figure out why. Tools of recording and audio analysis allow me to try to pick apart compelling sounds , to try them out in different situations, and to see if I can bring out the part of the experience that I was driven to re-examine.

In a contemplative sense, my goals have been met in this dissertation project for the most part. I compose and listen in a very different way than I did before, and I think my work reflects this. My reasoning and interests have been laid out, and the aesthetic, contemplative and theoretical goals of my future work seem obvious to me for the time being. Future work will involve composition and the development of systems based on echoes, voids, shadows, and spaces that I find during explorations of the world. My practice, as a listening practice, will involve composing less and listening more. Like the eremitic philosophers, I plan to make it my practice to go alone and listen in dramatic, quiet, and ancient places (or conjure old systems based on ancient branches of knowledge) in hopes that I can hear, explore, and record the qualities of other worlds and beings that I may have the good fortune to stumble upon.

The End.

Appendix

Appendix 1: Sonic Mediations on Place

Introduction

Every object in the environment both emits and reflects sound. Every material, as we know, reflects or resonates sound in a particular way. That is why we make walls from stone and use wood to build an organ and not the other way around. In our normal lives, things resonate and echo their presence like beams of sound that you can hear if only you pay attention to the qualities of the ambient silences.

For example:

1) the low absorbent void of a tree or telephone pole
2) the high reflective shimmer of a rock face
3) the high-pitched-patchy glow of a holly bush
4) the spotty aliasing of a wooden fence
5) the absorbent shadow of the person in front of you
6) the openness of a mountainside looking down upon a valley
7) The enormous shadows of large objects like cliffs.
8) The crisp hiss of tree leaves

In 'silence' we can hear space. I was convinced to try to learn to *see* with my ears after reading the following section of Barry Blesser's Book *Spaces Speak, Are You Listening?*

> *The native ability of human beings to sense space by listening is rarely recognized; indeed, some people think of such an ability in unique to bats and dolphins. But sensing spatial attributes does not require special skills—all*

human beings do it: a rudimentary spacial ability is genetic hardwired part of our genetic inheritance….

Notice how the clear sounds of your shoes on uncarpeted stairs provide navigational confidence, especially when your eyes are focused elsewhere. When crawling through underground caves, spelunkers can gauge the depth of a dark passageway by its resonances. But even nonspelunkers have acoustic awareness. It is available to all of us….

As a simple illustration of how we hear an object that itself does not produce any sound, consider a flat wall located at some distance. When the sound wave from a hand clap is reflected from that distant wall, we hear the reflection as a discernible echo. The distance to the wall determines the delay for the arrival of the echo, the area of the wall determines the intensity, and the material of the wall's surface determines the frequency content. These physical facts relate only indirectly to perception. Our auditory cortex converts these physical attributes into perceptual cues, which we then use to synthesize an experience of the external world. On the one hand, we can simply hear the echo as an additional sound (sonic perception) in the same way that we hear the original hand clap (sonic event). On the other hand, we can interpret the echo as a wall (passive acoustic object). The echo is the aural means by which we become aware of the wall and its properties, such as size, location, and surface materials. The wall becomes audible, or rather, the wall has an audible manifestation even though it is not itself the original source of sound energy. When our ability to decode spatial attributes is sufficiently developed using a wide range of acoustic cues, we can readily visualize objects and spatial geometry: we can "see" with our ears.

After reading this, I spent the next three years in frequent practice whenever the conditions were favorable. The following meditations are a description of the process that I have come up with to learn to 'see' with my ears. I have also included some observations I have made along the way in hopes they will aid the interested listener in his/her quest. Even though I write this, I am still in practice and have a long way to go

before I would consider myself proficient in this task. That being said, the process in itself has proven to be invaluable and extremely rewarding.

This meditation takes both time and practice. We are not used to being able to 'see' behind our head, but we can hear in all directions. This change from our visually oriented conception of the world means we need to acclimate to the logic of this added sensation of space before we can fully utilize our ears. For example, when we see a landscape we can see it both as a single image and as a collection of many three dimensional things. If we had just learned to see only a few moments ago, we might not make this distinction immediately. This is often the case in people who have trouble with depth perception. We need to *learn* to distinguish objects in our new multi-dimensional space and must start by coming up with little rules and space-specific generalizations. We have to focus on *small things first* and will therefore start by dichotomizing and categorizing sounds in any way that we can. The categories you come up with should be personal and do not need to be systematic. As with sight, we hope to be able to listen holistically one day— but it may not be today. These meditations are an effort to break up this great task into smaller more manageable pieces.

Things to Keep In Mind

★ Practice is most effective when the air is dry, cool, and moderately still. If it is too windy, you will not be able to hear beyond the wind blowing in your ears. If it is too

still, then there will be no sound movement. It is hardly ever too still, but it has happened to me before.

★ Generally, you can tell when it is an ideal climate to practice by listening to the air. If you can hear a light hissing sound (not tinnitus) from the air around you, then is is probably a good time to go on an adventure. You may not yet know the sound to which I am referring.

★ It is important to avoid inattentive practices such as listening for a minute, noticing, and then considering the whole process understood and moving on. This is a time and repetition-based skill and must be honed gradually.

★It is also important to view this practice as a start on a road of understanding and seeing through hearing. It is a process and a choice.

★ You should always make sure to *spend time in the space* and *marvel* at how you are seeing with your ears. Retaining appreciation and wonder is crucial to your practice. You should reflect (and reflect often) on the fact that you are seeing the world in a new way. Remind yourself that with practice you can hear the image of the world.

★ Lastly, this meditation is intended to be enjoyed. If you don't want to practice, don't.

Meditation I: Home resonance

Audience: Only you

Duration: 3 weeks or more (5-10 minutes daily) until proficient

Location: your home

This piece is intended for individuals and is not meant to be done at any particular time. The purpose of this meditation is to learn the way the material composition of objects manifests itself in the ambient sound around you. This is the first part of the Sound Vision meditations and serves as the foundation for the later meditations.

It best to start in a place you know well-- like your house. Hence this home meditation. Your comfort and familiarity with the objects around you will make it easier to begin to hear their specific qualities in the silence. It also means you can practice without regard to the weather or concern for your safety.

As stated before, the purpose of this meditation is to learn the way the material composition of objects in your home manifest themselves in ambient sound in the world. In the comfort of the white noise in our homes, we can begin to hear the warmth of wood, the cool hiss of stone, the hiss of glass, the echo of tile, or the dampening thud of drywall. Every house is different and so each listener will start with what he or she has.

Through this meditation, you will develop some basic rules for categorizing the aural qualities of space that you will hopefully find meaningful in your later practice. Through repetition, you should start to form associations that you can use in meditations on the rest of the house and the world beyond.

To Begin:

1) Find an object, space, or surface to focus your attention upon
9) Face one ear towards the subject to be analyzed and one ear away.
10) Watch the object closely with your eyes and ears. Listen closely, and allow your eyes to help you get a sense of the shape and material of the object. Tap on it. Knock on it. Make it ring somehow. For example, due to their composition and shape glass vases often ring quietly in the air even when they are not touched. Tapping the glass will reveal this tone and you can use this information to identify it. Listen to the object and focus on the spectral qualities of its sound.
11) Close your eyes
12) Focus your mind on the object in relation to the space. Listen and try to memorize the quality of this particular space.
13) Turn your attention to the other ear. Listen not only to the space in itself but focus on the spectral nature of the space. In my case, I would ask myself: Does it absorb high

frequencies like wood? Does it reflect high frequencies like concrete? Is it a combination of the two? Twist your head to compare the spaces around you. Try to learn them but don't stress about it.

14) repeat steps 4 and 5 until you can feel the presence of your subject in space.

15) Now, focus on your impression of size in space. Are you closed in? Are you in an open room? How would you know?

In the beginning, it can feel like we are relying too much on vision and are only imagining that we hear the spaces. It is important to have something to compare and rely upon visually in the beginning. We need to develop listening patterns. After we have managed to hear the subtleties of material in a binary way (i.e. this is a hard flat surface combined with a warm absorbent surface) we can generalize our rules to other spaces.

Test your rules so you can gain confidence. You don't have to be able to tell that a room has 70% drywall with cherry moulding and a marble floor! Just that there is a hard surface below and an absorbent surface on your side. If you know the exact composition of your room, use your knowledge to get to know the sound signature of the space and really concentrate on these familiar yet unfamiliar spaces.

Meditation II: Contrasts

Audience: you again

Duration: until proficient

Location: anywhere

As the title suggests, this is a meditation on comparing contrasts and similarities of surfaces and objects around you. Sometimes these contrasts can be meditated upon side-by-side, and others can be experienced only as a transition from one to the other.

There are many kinds of contrasts. Arguably, every object has a distinct quality and could therefore be reflected upon in relation to another. With practice, you might even learn to track the changes in a sound world through time and memory.

Some examples of contrasts in the sound world are (but not limited to):

1) Open and Closed

Example(s): walking through a doorway into the outside, walking to the mouth of a cave, coming in and out of the water, standing in the doorway with one ear in and the other out etc.

2) Hard and Porous

Example(s): Standing in the bathroom with one ear trained to the bathroom tile and the other to the drywall, in a corner with one ear trained to a cement wall and the other to a

bulletin board, next to a large wooden altar in a cathedral with another ear facing the stone, a wall and a fence, a window screen and an open window etc.

3) Smooth and rough

4) Solid and Liquid

etc.

You should repeat the process of the original home meditation, altering the process to fit your intended points of focus. I will give a few examples.

If you were going to meditate on the mouth of a cave, you would first walk to the mouth and back again many times with your eyes open. The purpose is to listen to the contrasts while also learning the terrain and making notes of possible dangers as well as characteristics or phenomena you can use to guide your ears. Do not perform this meditation if there is any chance of injury or falling off of a cliff or into a hole! Try to find the place in the space where your experience of the contrast is most pronounced. Once you have found this 'borderland' between the spaces, you can walk back and forth in the area. Reflect upon this pronounced change until you are comfortable with it. Then, close your eyes and walk through this border zone and open your eyes when you feel the transition to see if you are correct. Repeat until you are confident in your experience.

Advanced listeners can attempt to learn a contrasts in space over time. If you chose to meditate on a time/transition-based contrast and have never tried to memorize a space before, bring a notebook. To start, try to find a space that has a consistent state change (like the temperature shifts in the desert) and try to memorize at least two states (more if you want). You might even want to record the space to help your memory (or make you feel better about the unreliability of memory). A state is memorized when you can feel the state of space viscerally. Learn the second state and compare. Learn to appreciate the states as they change. Then move on.

Meditation III: Totems/Static Objects in Space

Audience: still you

Duration: until proficient

Location: near a telephone pole, column, tree, or totem pole

This meditation is to be done only after you have practiced in your home. It is better to do this practice after mastering *Contrasts* because it is a meditation in even more subtle contrasts. Keep in mind that you are outside. Be careful!

A round wood pole is a good subject for this meditation because it common in public spaces, it tends to be on the sidewalk at regular intervals, and causes a long, thin,

consistent disturbance in the acoustic space. Wood absorbs high frequencies in the ambient noise to make a riveting void and the round shape gives you a chance to observe a void gradient. A metal or cement pole will reflect the white noise of the outside world. It is not unsuitable, but it is more difficult in my experience.

The size of the object is important. In my practices I have found that objects much smaller than a telephone pole have such a small windows of perception that they are easily missed with a lapse of attention. Either that, or you have to be impractically close to them. Being ridiculously close to an object inhibits listening practice because it is difficult to get an accurate impression of the space without also feeling it tactically by crashing into it by accident. Smaller objects are more advanced and require a lot of training to discern the smaller disturbances they cause.

As mentioned before, it is most effective when the air is dry, cool, and moderately still. Listen to the air. If you can hear a light hissing sound from the air around you, then is is probably a good time to practice.

1) Find telephone pole, tree, or other tall, thin, round object. Trees will be more difficult because their shadow is more complex.

16) Face one ear towards the pole. Keep one ear away. Train your attention to the pole/ tree/totem. Look around you for possible dangers like pot holes, cliffs, cars, other people, etc.

17) Close your eyes.

18) Focus your mind on the spectral hole in the soundscape that is created by the presence of the pole. Imagine it is a ghost and the presence is important.

19) Turn your attention to the other ear. Listen to both the space and the spectral nature of the space. Repeat the process on the other ear. Try to really feel the change caused by the void. You should be able to feel it in your ears. You might not be able to feel it at first, but with practice it will come.

20) Continue steps 4 and 5 until you can viscerally feel the presence in space

21) Now, disorient yourself a little, and walk towards the pole with your eyes closed. Try to feel the passing of the pole. If you have a sidewalk to yourself, try to walk towards another pole and sense that one. Is there anything else you hear? It should sound like a ghost passing through the air. Repeat until the space feels like an interruption of presence and disturbs your sensibility within the silence.

Meditation IV: A Long Walk Home

Audience: you and anyone walking near you

Duration: until proficient

Location: your way home

When the weather is good, walk home! With your eyes and ears, memorize the terrain and focus on the objects around you. Learn to use what you practiced and hear the different qualities of space. Concentrate on specific areas to get a detailed mental image of each area. When you are confident, try to navigate your way through your sound world using only your ears. Tread lightly and carefully. You are bound to forget something.

You might think that this memorization would hinder your listening because you would just be able to 'count your steps' and walk home. In my practice, I have not found this to be true. The world is always changing. Your steps are of variable length. Sometimes your stride will vary and send you in a slightly different direction than you think. Memorization can only guide you. Even if you count your steps, you might still run into a telephone pole so listen carefully!

I used to perform this practice on College Hill in Providence, Rhode Island. Starting on Angell Street, I would walk northward on Prospect street on the left side of the road. Then, I would turn left on Lloyd Ave, take a right on Congdon street and then walk to Terrace Park. This small walk had many inherent qualities that made it an ideal place to practice. First, it is on a large, steep hill overlooking the downtown area. The hill is so steep between Prospect Street and Congdon that you can hear the hill and compare it to the open air. It is also a quiet area and there are not many cars or other pedestrians to disturb your concentration. This was good for safety reasons as well. There are beautiful old houses with fences, gardens, walls, wood, brick, stone, cement, trees, and plenty of telephone poles. The rich contrasts make this little stretch an ideal location for this practice. At the end, I could sit in terrace park and listen to the open air.

Appendix 2: Kyle Gann's Anatomy of an Octave with added decimal reference

Name (if any)	Cents	Proportion		Decimal Reference
tonic	0	1	1	1
schisma (3 to the 8th/2 to the 12th x 5/8)	1.954	32805	32768	1.00112915039062
	13.795	126	125	1.008
	14.367	121	120	1.00833333333333

Name (if any)	Cents	Proportion		Decimal Reference
	17.399	100	99	1.010101010101 01
	17.576	99	98	1.010204081632 65
syntonic comma	21.506	81	80	1.0125
Pythagorean comma (3 to the 12th/ 2 to the 19th)	23.46	531441	524288	1.013643264770 51
65th harmonic	26.841	65	64	1.015625
	27.264	64	63	1.015873015873 02
	27.7	63	62	1.016129032258 06
	30.109	58	57	1.017543859649 12
	30.642	57	56	1.017857142857 14
Ptolemy's enharmonic	31.194	56	55	1.018181818181 82
	31.767	55	54	1.018518518518 52
	33.617	52	51	1.019607843137 25
	34.283	51	50	1.02
	34.976	50	49	1.020408163265 31
	35.697	49	48	1.020833333333 33
inferior quarter-tone (Ptolemy)	38.051	46	45	1.022222222222 22

Name (if any)	Cents	Proportion		Decimal Reference
	38.906	45	44	1.022727272727 27
diminished second (16/15 x 24/25)	41.059	128	125	1.024
enharmonic diesis (Avicenna)	43.408	525	512	1.025390625
	43.831	40	39	1.025641025641 03
superior quarter-tone (Eratosthenes)	44.97	39	38	1.026315789473 68
	45.561	77	75	1.026666666666 67
superior quarter-tone (Archytas)	48.77	36	35	1.028571428571 43
	49.166	250	243	1.028806584362 14
E.T. 1/4-tone approximation	50.184	35	34	1.029411764705 88
	51.682	34	33	1.030303030303 03
33rd harmonic	53.273	33	32	1.03125
inferior quarter-tone (Didymus)	54.964	32	31	1.032258064516 13
	56.305	125	121	1.033057851239 67
superior quarter-tone (Didymus)	56.767	31	30	1.033333333333 33
	58.692	30	29	1.034482758620 69
	60.751	29	28	1.035714285714 29

Name (if any)	Cents	Proportion		Decimal Reference
	61.836	57	55	1.036363636363636
inferior quarter-tone (Archytas)	62.961	28	27	1.037037037037037
	66.17	80	77	1.038961038961039
	65.337	27	26	1.038461538461538
1/3-tone (Avicenna)	67.9	26	25	1.04
	69.259	51	49	1.040816326530612
	70.1	126	121	1.041322314049587
minor 5-limit half-step	70.672	25	24	1.041666666666667
	73.681	24	23	1.043478260869567
	75.612	117	112	1.044642857142857
	76.956	23	22	1.045454545454545
67th harmonic	79.307	67	64	1.046875
hard 1/2-step (Ptolemy, Avicenna, Safiud)	80.537	22	21	1.047619047619047
	84.467	21	20	1.05
	87.676	81	77	1.051948051948052
	88.801	20	19	1.052631578947368

Name (if any)	Cents	Proportion		Decimal Reference
Pythagorean half-step	90.225	256	243	1.05349794238683
	91.946	58	55	1.05454545454545
limma ascendant	92.179	135	128	1.0546875
	92.601	96	91	1.05494505494506
	93.603	19	18	1.05555555555556
	97.104	55	52	1.05769230769231
	97.364	128	121	1.05785123966942
E.T. half-step approximation	98.955	18	17	1.05882352941176
equal-tempered half-step	100	2 to the 1	12th	1.05946309435929
ET half-step approximation	100.099	89	84	1.05952380952381
	101.867	35	33	1.06060606060606
	102.876	52	49	1.06122448979592
	103.698	86	81	1.06172839506173
overtone half-step	104.955	17	16	1.0625
	108.237	33	31	1.06451612903226
	109.377	49	46	1.06521739130435

Name (if any)	Cents	Proportion		Decimal Reference
major 5-limit half-step	111.731	16	15	1.06666666666667
	115.458	31	29	1.06896551724138
	116.234	77	72	1.06944444444444
Cowell just half-step	119.443	15	14	1.07142857142857
	123.712	29	27	1.07407407407407
	128.298	14	13	1.07692307692308
69th harmonic	130.229	69	64	1.078125
	130.721	55	51	1.07843137254902
alternate Renaissance half-step	133.238	27	25	1.08
	133.81	121	112	1.08035714285714
3/4-tone (Avicenna)	138.573	13	12	1.08333333333333
	140.828	64	59	1.08474576271186
	142.373	38	35	1.08571428571429
	143.159	63	58	1.08620689655172
	143.498	88	81	1.08641975308642
	144.353	25	23	1.08695652173913

Name (if any)	Cents	Proportion		Decimal Reference
	145.568	62	57	1.08771929824561
	147.143	135	124	1.08870967741935
	147.428	49	45	1.08888888888889
undecimal "median" 1/2-step	150.637	12	11	1.09090909090909
	153.307	59	54	1.09259259259259
35th harmonic	155.14	35	32	1.09375
	157.493	23	21	1.095238095238 1
	158.94	57	52	1.09615384615385
	159.92	34	31	1.09677419354839
	160.897	800	729	1.09739368998628
	161.915	56	51	1.09803921568627
	165.004	11	10	1.1
	168.213	54	49	1.10204081632653
	170.423	32	29	1.10344827586207
	173.268	21	19	1.10526315789474
	176.21	31	28	1.10714285714286

Name (if any)	Cents	Proportion		Decimal Reference
	176.646	567	512	1.107421875
	178.636	51	46	1.10869565217391
71st harmonic	179.697	71	64	1.109375
minor whole-tone	182.404	10	9	1.1111111111111
	186.334	49	44	1.11363636363636
	187.343	39	35	1.11428571428571
	189.05	29	26	1.11538461538462
	190.115	125	112	1.11607142857143
	190.437	48	43	1.11627906976744
	192.558	19	17	1.11764705882353
	194.468	160	143	1.11888111888112
	196.198	28	25	1.12
	196.771	121	108	1.12037037037037
	199.98	55	49	1.12244897959184
equal-tempered whole-tone	200	2 to the 1	6th	1.12246204830938
	200.532	64	57	1.12280701754386

Name (if any)	Cents	Proportion		Decimal Reference
major whole-tone	203.91	9	8	1.125
	207.404	62	55	1.127272727272 73
	208.835	44	39	1.128205128205 13
	210.104	35	31	1.129032258064 52
	212.253	26	23	1.130434782608 7
	213.598	112	99	1.131313131313 13
	216.687	17	15	1.133333333333 33
	221.309	25	22	1.136363636363 64
	222.667	58	51	1.137254901960 78
	223.463	256	225	1.137777777777 78
	223.696	33	29	1.137931034482 76
	225.416	729	640	1.1390625
	226.841	57	50	1.14
73rd harmonic	227.789	73	64	1.140625
septimal whole-tone	231.174	8	7	1.142857142857 14
	235.104	63	55	1.145454545454 55

Name (if any)	Cents	Proportion		Decimal Reference
	235.677	55	48	1.14583333333333
	237.527	39	34	1.14705882352941
	238.886	225	196	1.14795918367347
	239.171	31	27	1.14814814814815
	239.607	147	128	1.1484375
	241.449	169	147	1.14965986394558
	241.961	23	20	1.15
	243.545	2187	1900	1.15105263157895
	244.24	38	33	1.15151515151515
diminished third (6/5 x 24/25)	244.969	144	125	1.152
	245.541	121	105	1.15238095238095
	247.741	15	13	1.15384615384615
	250.304	52	45	1.15555555555556
37th harmonic	251.344	37	32	1.15625
	252.68	81	70	1.15714285714286
	253.076	125	108	1.15740740740741

Name (if any)	Cents	Proportion		Decimal Reference
	253.805	22	19	1.15789473684211
	255.592	51	44	1.15909090909091
consonant interval (Avicenna)	256.596	196	169	1.15976331360947
	256.95	29	25	1.16
	258.874	36	31	1.16129032258065
	260.677	93	80	1.1625
	261.816	57	49	1.16326530612245
	262.368	64	55	1.16363636363636
septimal minor third	266.871	7	6	1.16666666666667
	270.08	90	77	1.16883116883117
augmented second (9/8 x 25/24)	274.582	75	64	1.171875
	275.378	34	29	1.17241379310345
	276.736	88	75	1.17333333333333
	277.591	27	23	1.17391304347826
	281.358	20	17	1.17647058823529
	284.447	33	28	1.17857142857143

Name (if any)	Cents	Proportion		Decimal Reference
	285.792	46	39	1.17948717948718
	289.21	13	11	1.18181818181818
	291.925	58	49	1.18367346938776
	292.711	45	38	1.18421052631579
Pythagorean minor third	294.135	32	27	1.18518518518519
overtone minor third	297.513	19	16	1.1875
equal-tempered minor third	300	2 to the 1	4th	1.18920711500272
	301.847	25	21	1.19047619047619
	304.508	31	26	1.19230769230769
	305.777	105	88	1.19318181818182
	309.357	55	46	1.19565217391304
5-limit minor third	315.641	6	5	1.2
77th harmonic	320.144	77	64	1.203125
	325.562	35	29	1.20689655172414
	327.622	29	24	1.20833333333333
	329.547	75	62	1.20967741935484

Name (if any)	Cents	Proportion		Decimal Reference
	329.832	98	81	1.20987654320988
	330.008	121	100	1.21
	330.761	23	19	1.21052631578947
	332.208	63	52	1.21153846153846
	333.041	40	33	1.21212121212121
	336.13	17	14	1.21428571428571
	337.148	243	200	1.215
	338.125	62	51	1.215686274509 8
	340.552	28	23	1.21739130434783
39th harmonic	342.483	39	32	1.21875
	342.905	128	105	1.21904761904762
	343.301	8000	6561	1.21932632220698
undecimal "median" third	347.408	11	9	1.22222222222222
	350.617	60	49	1.22448979591837
	351.338	49	40	1.225
	352.477	38	31	1.22580645161 29

Name (if any)	Cents	Proportion		Decimal Reference
	354.547	27	22	1.22727272727273
	359.472	16	13	1.23076923076923
79th harmonic	364.537	79	64	1.234375
	364.807	100	81	1.23456790123457
	364.984	121	98	1.23469387755102
	365.825	21	17	1.23529411764706
	368.914	99	80	1.2375
	369.747	26	21	1.23809523809524
	371.194	57	46	1.23913043478261
	372.408	31	25	1.24
	374.333	36	29	1.24137931034483
	378.602	56	45	1.24444444444444
	381.811	96	77	1.24675324675325
Pythagorean "schismatic" third	384.36	8192	6561	1.24859015393995
5-limit major third	386.314	5	4	1.25
	393.09	64	51	1.25490196078431

Name (if any)	Cents	Proportion		Decimal Reference
	395.169	49	39	1.25641025641026
	396.178	44	35	1.25714285714286
	397.447	39	31	1.25806451612903
	399.09	34	27	1.25925925925926
equal-tempered major third	400	2 to the 1	3rd	1.25992104989487
	400.108	63	50	1.26
	400.681	121	96	1.26041666666667
	401.303	29	23	1.26086956521739
	403.713	125	99	1.26262626262626
	404.442	24	19	1.26315789473684
	405.866	512	405	1.26419753086420
	407.384	62	49	1.26530612244898
Pythagorean major third	407.82	81	64	1.265625
	409.244	19	15	1.26666666666667
	412.745	33	26	1.26923076923077
	413.578	80	63	1.26984126984127

Name (if any)	Cents	Proportion		Decimal Reference
	417.508	14	11	1.272727272727 27
	420.597	51	40	1.275
	421.289	125	98	1.275510204081 63
	424.364	23	18	1.277777777777 78
diminished fourth	427.373	32	25	1.28
41st harmonic	429.062	41	32	1.28125
	430.145	50	39	1.282051282051 28
	431.875	77	60	1.283333333333 33
septimal major third	435.084	9	7	1.285714285714 29
	439.353	58	45	1.288888888888 89
	440.139	49	38	1.289473684210 53
	441.278	40	31	1.290322580645 16
	443.081	31	24	1.291666666666 67
	443.517	1323	1024	1.2919921875
	444.772	128	99	1.292929292929 29
	446.363	22	17	1.294117647058 82

Name (if any)	Cents	Proportion		Decimal Reference
	448.15	57	44	1.29545454545455
	448.879	162	125	1.296
	449.275	35	27	1.2962962962963
83rd harmonic	450.047	83	64	1.296875
	452.484	100	77	1.2987012987013
	454.214	13	10	1.3
augmented third (5/4 x 25/24)	456.986	125	96	1.30208333333333
	459.994	30	23	1.30434782608696
	462.348	64	49	1.30612244897959
	463.069	98	75	1.30666666666667
	464.428	17	13	1.30769230769231
	466.278	72	55	1.30909090909091
	466.851	55	42	1.30952380952381
	467.936	38	29	1.31034482758621
septimal fourth	470.781	21	16	1.3125
	473.135	46	35	1.31428571428571

Name (if any)	Cents	Proportion		Decimal Reference
	475.114	25	19	1.31578947368421
	476.539	320	243	1.31687242798354
	478.259	29	22	1.31818181818182
	478.492	675	512	1.318359375
	480.646	33	25	1.32
	485.286	45	34	1.32352941176471
85th harmonic	491.269	85	64	1.328125
perfect fourth	498.045	4	3	1.33333333333333
equal-tempered perfect fourth	500	2 to the 5	12ths	1.33483985417004
	505.757	75	56	1.33928571428571
	509.397	51	38	1.34210526315789
43rd harmonic	511.518	43	32	1.34375
	512.412	121	90	1.34444444444444
	512.905	39	29	1.34482758620689
	514.612	35	26	1.34615384615385
	515.621	66	49	1.34693877551020

Name (if any)	Cents	Proportion		Decimal Reference
	516.761	31	23	1.34782608695652
	519.551	27	20	1.35
	523.319	23	17	1.35294117647059
	525.745	42	31	1.35483870967742
	528.687	19	14	1.35714285714286
	529.812	110	81	1.35802469135802
87th harmonic	531.532	87	64	1.359375
	532.328	34	25	1.36
	533.742	49	36	1.36111111111111
	536.951	15	11	1.36363636363636
	539.104	512	375	1.36533333333333
	543.015	26	19	1.36842105263158
	544.462	63	46	1.36956521739133
	546.815	48	35	1.37142857142857
	547.211	1000	729	1.37174211248285
undecimal tritone (11th harmonic)	551.318	11	8	1.375

Name (if any)	Cents	Proportion		Decimal Reference
	554.812	62	45	1.37777777777778
	556.737	40	29	1.37931034482759
	558.796	29	21	1.38095238095238
	561.006	112	81	1.38271604938272
	563.382	18	13	1.38461538461538
augmented fourth (4/3 x 25/24)	568.717	25	18	1.38888888888889
89th harmonic	570.88	89	64	1.390625
	571.726	32	23	1.39130434782609
	573.657	39	28	1.39285714285714
	575.001	46	33	1.39393939393939
	578.582	88	63	1.3968253968254
septimal tritone	582.512	7	5	1.4
	585.721	108	77	1.4025974025974
low Pythagorean tritone	588.27	1024	729	1.40466392318244
high 5-limit tritone	590.224	45	32	1.40625
	591.648	38	27	1.40740740740741

Name (if any)	Cents	Proportion		Decimal Reference
	593.718	31	22	1.40909090909091
	595.149	55	39	1.41025641025641
	597	24	17	1.41176470588235
equal-tempered tritone	600	Square root of 2		1.414213562373 1
	600.088	99	70	1.41428571428571
	603	17	12	1.41666666666667
	606.282	44	31	1.41935483870968
	607.623	125	88	1.42045454545455
	608.352	27	19	1.42105263157895
91st harmonic	609.354	91	64	1.421875
low 5-limit tritone	609.776	64	45	1.42222222222222
high Pythagorean tritone	611.73	729	512	1.423828125
	613.154	57	40	1.425
	614.279	77	54	1.42592592592593
septimal tritone	617.488	10	7	1.42857142857143
	621.418	63	44	1.43181818181818

Name (if any)	Cents	Proportion		Decimal Reference
	624.999	33	23	1.43478260869565
	626.343	56	39	1.43589743589744
23rd harmonic	628.274	23	16	1.4375
diminished fifth (3/2 x 24/25)	631.283	36	25	1.44
	631.855	121	84	1.44047619047619
	632.696	49	34	1.44117647058824
	636.618	13	9	1.44444444444444
	638.994	81	56	1.44642857142857
	640.119	55	38	1.44736842105263
	641.204	42	29	1.44827586206897
	643.263	29	20	1.45
	645.188	45	31	1.45161290322581
93rd harmonic	646.991	93	64	1.453125
	648.682	16	11	1.45454545454545
	651.771	51	35	1.45714285714286
	652.789	729	500	1.458
	653.185	35	24	1.45833333333333

Name (if any)	Cents	Proportion		Decimal Reference
	656.985	19	13	1.46153846153846
	660.896	375	256	1.46484375
	663.049	22	15	1.46666666666667
47th harmonic	665.507	47	32	1.46875
	666.258	72	49	1.46938775510204
	667.672	25	17	1.47058823529412
	670.188	81	55	1.47272727272727
	671.313	28	19	1.47368421052632
	674.255	31	21	1.47619047619048
	674.691	189	128	1.4765625
	676.681	34	23	1.47826086956522
dissonant "wolf" 5-limit fifth	680.449	40	27	1.48148148148148
	683.239	46	31	1.48387096774194
95th harmonic	683.827	95	64	1.484375
	684.379	49	33	1.48484848484848
	685.388	52	35	1.48571428571429

Name (if any)	Cents	Proportion		Decimal Reference
	687.095	58	39	1.48717948717949
	688.16	125	84	1.48809523809524
	694.243	112	75	1.49333333333333
	694.816	121	81	1.49382716049383
equal-tempered perfect fifth	700	2 to the 7	12ths	1.49830707687668
perfect fifth	701.955	3	2	1.5
	716.322	121	80	1.5125
	719.354	50	33	1.51515151515152
97th harmonic	719.895	97	64	1.515625
	721.508	1024	675	1.51703703703704
	721.741	44	29	1.51724137931034
	723.461	243	160	1.51875
	724.886	38	25	1.52
	726.865	35	23	1.52173913043478
	729.219	32	21	1.52380952380952
	732.064	29	19	1.52631578947368
	733.149	84	55	1.52727272727273

Name (if any)	Cents	Proportion		Decimal Reference
	733.722	55	36	1.527777777777778
	735.572	26	17	1.52941176470588
	736.931	75	49	1.53061224489796
49th harmonic	737.652	49	32	1.53125
	740.006	23	15	1.53333333333333
diminished sixth (8/5 x 24/25)	743.014	192	125	1.536
	745.786	20	13	1.53846153846154
	747.516	77	50	1.54
	750.725	54	35	1.54285714285714
	751.121	125	81	1.54320987654321
	753.637	17	11	1.54545454545455
99th harmonic	755.228	99	64	1.546875
	756.919	48	31	1.54838709677419
	758.722	31	20	1.55
	760.674	45	29	1.55172413793103
septimal minor sixth	764.916	14	9	1.55555555555556
	768.125	120	77	1.55844155844156

Name (if any)	Cents	Proportion		Decimal Reference
	769.855	39	25	1.56
augmented fifth	772.627	25	16	1.5625
	775.636	36	23	1.56521739130435
undecimal minor sixth	782.492	11	7	1.57142857142857
	786.422	63	40	1.575
	787.255	52	33	1.57575757575758
101st harmonic	789.854	101	64	1.578125
	790.756	30	19	1.57894736842105
Pythagorean minor sixth	792.18	128	81	1.58024691358025
	792.616	49	31	1.58064516129032
	794.134	405	256	1.58203125
	795.558	19	12	1.58333333333333
	798.697	46	29	1.58620689655172
	799.892	100	63	1.58730158730159
equal-tempered minor sixth	800	2 to the 2	3rds	1.587401051968 2
	800.91	27	17	1.58823529411765
	802.553	62	39	1.58974358974359

Name (if any)	Cents	Proportion		Decimal Reference
	803.822	35	22	1.59090909090909
51st harmonic	806.91	51	32	1.59375
5-limit minor sixth	813.686	8	5	1.6
Pythagorean "schismatic" sixth	815.64	6561	4096	1.601806640625
	818.189	77	48	1.60416666666667
	821.398	45	28	1.60714285714286
103rd harmonic	823.801	103	64	1.609375
	825.667	29	18	1.61111111111111
	827.592	50	31	1.61290322580645
	828.053	121	75	1.61333333333333
	830.253	21	13	1.61538461538462
	832.676	55	34	1.61764705882353
	834.175	34	21	1.61904761904762
	835.193	81	50	1.62
	838.797	125	77	1.62337662337662
overtone sixth	840.528	13	8	1.625
	844.328	57	35	1.62857142857143

Name (if any)	Cents	Proportion		Decimal Reference
	845.453	44	27	1.62962962962963
	847.523	31	19	1.63157894736842
	848.662	80	49	1.63265306122449
	849.383	49	30	1.63333333333333
undecimal "median" sixth	852.592	18	11	1.63636363636364
105th harmonic	857.095	105	64	1.640625
	857.517	64	39	1.64102564102564
	859.448	23	14	1.64285714285714
	861.875	51	31	1.64516129032258
	862.852	400	243	1.64609053497942
	863.87	28	17	1.64705882352941
	866.959	33	20	1.65
	869.239	38	23	1.65217391304348
	870.168	81	49	1.65306122448978
	872.378	48	29	1.65517241379311
53rd harmonic	873.505	53	32	1.65625

Name (if any)	Cents	Proportion		Decimal Reference
	874.438	58	35	1.65714285714286
	875.223	63	38	1.65789473684211
	879.856	128	77	1.66233766233766
107th harmonic	889.76	107	64	1.671875
5-limit major sixth	884.359	5	3	1.66666666666667
	894.513	57	34	1.67647058823529
	895.492	52	31	1.67741935483871
	898.153	42	25	1.68
	898.726	121	72	1.68055555555556
equal-tempered major sixth	900	2 to the 3	4ths	1.68179283050743
	902.487	32	19	1.68421052631579
Pythagorean major sixth	905.865	27	16	1.6875
	908.075	49	29	1.68965517241379
	910.79	22	13	1.69230769230769
	914.208	39	23	1.69565217391304
	915.553	56	33	1.696969696969 7

Name (if any)	Cents	Proportion		Decimal Reference
	918.642	17	10	1.7
109th harmonic	921.821	109	64	1.703125
	922.409	46	27	1.703703703703 7
	923.264	75	44	1.704545454545 45
	924.622	29	17	1.705882352941 18
diminished seventh (16/9 x 24/25)	925.418	128	75	1.706666666666 67
	929.92	77	45	1.7111111111111 1
septimal major sixth	933.129	12	7	1.714285714285 71
55th harmonic	937.632	55	32	1.71875
	941.126	31	18	1.722222222222 22
	941.562	441	256	1.72265625
	943.05	50	29	1.724137931034 48
	946.195	19	11	1.727272727272 73
	946.924	216	125	1.728
	947.496	121	70	1.728571428571 43
	949.696	45	26	1.730769230769 23
	952.259	26	15	1.733333333333 33

Name (if any)	Cents	Proportion		Decimal Reference
111th harmonic	953.299	111	64	1.734375
augmented sixth (5/3 x 25/24)	955.031	125	72	1.736111111111111
	955.76	33	19	1.73684210526316
	958.039	40	23	1.73913043478261
	960.829	54	31	1.74193548387097
	964.323	96	55	1.74545454545455
	964.896	110	63	1.74603174603175
septimal minor seventh	968.826	7	4	1.75
	976.304	58	33	1.75757575757576
	976.537	225	128	1.7578125
	977.333	51	29	1.75862068965517
	978.691	44	25	1.76
	983.313	30	17	1.76470588235294
113th harmonic	984.215	113	64	1.765625
	986.402	99	56	1.76785714285714
	987.747	23	13	1.76923076923077
	989.896	62	35	1.77142857142857

Name (if any)	Cents	Proportion		Decimal Reference
	991.165	39	22	1.772727272727 27
	992.596	55	31	1.774193548387 1
Pythagorean small min. seventh	996.09	16	9	1.777777777777 78
57th harmonic	999.468	57	32	1.78125
equal-tempered minor seventh	1000	2 to the 5	6ths	1.781797436280 68
	1000.02	98	55	1.781818181818 18
	1003.80 2	25	14	1.785714285714 29
	1007.44 2	34	19	1.789473684210 53
	1010.95	52	29	1.793103448275 86
	1013.66 6	88	49	1.795918367346 94
115th harmonic	1014.58 8	115	64	1.796875
5-limit large minor seventh	1017.59 6	9	5	1.8
	1023.79	56	31	1.806451612903 23
	1026.73 2	38	21	1.809523809523 81
29th harmonic	1029.57 7	29	16	1.8125

Name (if any)	Cents	Proportion		Decimal Reference
	1031.787	49	27	1.81481481481482
	1034.996	20	11	1.81818181818182
	1038.085	51	28	1.82142857142857
	1039.103	729	400	1.8225
	1040.08	31	17	1.82352941176471
	1042.507	42	23	1.82608695652174
117th harmonic	1044.438	117	64	1.828125
	1044.86	64	35	1.82857142857143
	1045.256	4000	2187	1.82898948331047
undecimal "median" seventh	1049.363	11	6	1.83333333333333
	1052.572	90	49	1.83673469387755
	1054.432	57	31	1.83870967741935
	1055.647	46	25	1.84
	1056.502	81	44	1.84090909090909
	1057.627	35	19	1.84210526315789

Name (if any)	Cents	Proportion		Decimal Reference
59th harmonic	1059.172	59	32	1.84375
	1061.427	24	13	1.84615384615385
	1066.762	50	27	1.85185185185185
	1067.78	63	34	1.85294117647059
	1071.702	13	7	1.85714285714286
119th harmonic	1073.781	119	64	1.859375
	1076.288	54	29	1.86206896551724
	1080.557	28	15	1.86666666666667
	1084.542	58	31	1.87096774193548
5-limit major seventh	1088.269	15	8	1.875
	1091.763	62	33	1.87878787878788
	1095.045	32	17	1.88235294117647
	1097.124	49	26	1.88461538461538
	1098.133	66	35	1.88571428571429
equal-tempered major seventh	1100	2 to the 11	12ths	1.88774862536339

Name (if any)	Cents	Proportion		Decimal Reference
	1101.045	17	9	1.88888888888889
121st harmonic	1102.636	121	64	1.890625
	1105.668	125	66	1.89393939393939
	1106.397	36	19	1.89473684210526
	1107.821	256	135	1.896296296296 3
	1108.054	55	29	1.89655172413793
Pythagorean major seventh	1109.775	243	128	1.8984375
	1111.199	19	10	1.9
	1115.533	40	21	1.904761904761 9
61st harmonic	1116.885	61	32	1.90625
	1119.463	21	11	1.90909090909091
	1123.044	44	23	1.91304347826087
	1126.319	23	12	1.91666666666667
	1129.328	48	25	1.92
	1129.9	121	63	1.92063492063492
123rd harmonic	1131.017	123	64	1.921875
	1132.1	25	13	1.92307692307692

Name (if any)	Cents	Proportion		Decimal Reference
	1133.83	77	40	1.925
	1134.663	52	27	1.92592592592593
septimal major seventh	1137.039	27	14	1.92857142857143
	1139.249	56	29	1.93103448275862
	1141.308	29	15	1.93333333333333
	1143.233	60	31	1.93548387096774
31st harmonic	1145.036	31	16	1.9375
	1146.727	64	33	1.93939393939394
	1148.318	33	17	1.94117647058824
	1150.834	243	125	1.944
	1151.23	35	18	1.94444444444444
	1156.169	39	20	1.95
augmented seventh (15/8 x 25/24)	1158.941	125	64	1.953125
	1161.094	88	45	1.95555555555556
	1161.949	45	23	1.95652173913043
	1164.303	96	49	1.95918367346939
	1165.024	49	25	1.96

Name (if any)	Cents	Proportion		Decimal Reference
	1166.383	51	26	1.96153846153846
	1168.233	108	55	1.96363636363636
	1168.806	55	28	1.96428571428571
	1169.891	57	29	1.96551724137931
63rd harmonic	1172.736	63	32	1.96875
	1178.494	160	81	1.97530864197531
	1182.601	99	50	1.98
	1186.205	125	63	1.98412698412698
127th harmonic	1186.422	127	64	1.984375
octave	1200	2	1	2

Appendix 3: Thoughts on Ends and Means: Result vs. Process/Technique

The idealized dichotomy between theory and practice exists in many aspects of modern (not modernist) philosophy and has affected the treatment of art. Romantic tropes of the irrational artist or craftsman contrast that of the scientist.

There are also implications for practicality and use, where art is generally seen as unreliable and impractical. To the opposite effect, modernist artist-scientism and the

complex taxonomies and theory that are used to justify a work both play within and elude it this dichotomy. Technology, science, and rationalism are generally placed in opposition to art. These trends are changing, but when given the choice of funding or cultural trust, technological advancement isconsidered useful *a priori* and routinely favored.

There are also implications for the treatment of the notion of truth, where truth in art (Episteme) and the work (Techne) is considered relative and subjective, while truth in mathematics (Episteme), science, and technology (Techne) is treated as immutable.

The Role of Art and Technology

Within both modern and ancient philosophies of art and human creativity, the role of Episteme and Techne within art is an indispensable concept that must be understood. It is possibly one of the most important parallels between the modern *musicus* (or composer) and the ancient "geometer" or diviner of truth (see Bucchianeri, 2008, p. 17). In modern philosophy these concepts are generally considered to be opposed to one another, but this has not always been the case and is not necessarily the case in art.

First, there are historical differences between the meaning of Episteme and Techne, as well as between the modern reinvention and technological interest in this subject. According to the ancient defintion, τέχνη means craft, cunning, agency, means, art, skill, trade, sorcery, or art practice (Liddell, 2015). Episteme is usually translated as

pure scientific knowledge, like in the case of Geometry. Techne is knowledge that is changing, and Episteme is immutable. According to the Stoic philosophers' defintiion, Techne is the intuition and learned knowledge of pure truth.

A fantastic summary of the complex relationship of the two concepts was written by Richard Parry in the Stanford Encyclopedia of Philosophy. Parry says that the modern definitions of the two "may inappropriately harbor some of our contemporary assumptions about the relation between theory (the domain of 'knowledge') and practice (the concern of 'craft' or 'art')" (Parry, 2014):

> *Outside of modern science, there is sometimes skepticism about the relevance of theory to practice because it is thought that theory is conducted at so great a remove from the facts, the province of practice, that it can lose touch with them. Indeed, at the level of practice, concrete experience might be all we need. And within science, theory strives for a value-free view of reality. As a consequence, scientific theory cannot tell us how things should be — the realm of 'art' or 'craft.' So we must turn elsewhere for answers to the profound, but still practical, questions about how we should live our lives. However, some of the features of this contemporary distinction between theory and practice are not found in the relation between Episteme and Techne (Ibid.).*

A dichotomy between Episteme and Techne is not identified until the writings of Aristotle, which means that theory and practice have not always been separate. In the works of Plato, Techne and Episteme are somewhat interchangeable. In short, Socratic/ Platonic Techne has two goals: 1) to investigate the nature of a thing and to be able to give an account of it, and 2) to pursue the welfare of the thing investigated. Episteme is is

the ability to know the real. In another context, Plato considers Techne the knowledge of pure form and Episteme to be pure theory, while also considering Episteme to work with forms (Ibid.). In some sense, Techne is form over time and Episteme is the immutable knowledge of form:

> *Knowledge, in the sense of Episteme, will be deductive and logical, like mathematics; unlike mathematics, its deductions will be based on foundations that need no further justification. In part it will be something like mathematical deduction based in fundamental reality. Two aspects of this development are significant. First, using a mathematical model as the root of this conception of knowledge makes it purely theoretical; it is theoretical because … it has no separate product. Second, in using mathematical thinking as an analogue for dialectic, Socrates is still relying on the notion of Techne since both geometry and calculation are technai. So even though Plato distinguishes between Techne and Episteme, their relation is more of a tension than a divorce. (Ibid.)*

Aristotle considers the two to be separate, but then the two concepts are mixed again in Stoicism. In some Stoic philosophy, the practice of virtue and the abstract knowledge of virtue are not entirely separate concepts because the abstract knowledge of truth arouses action or reflection, which is the realm of craftsmanship (Techne), as in Cicero's *Ends and Means*. A craftsman proves his knowledge through the correct imitation, or proof, of pure truth. Further reading on ancient Techne can be found in the full article in the *Stanford Encyclopedia of Philosophy*, Anne Balansard's *Techne dans les dialogues de Platon*, and Laertius Diogenes' *Lives of Eminent Philosophers*.

The Question Concerning Technology

> *Transgressing disciplinary boundaries ... [is] a subversive undertaking since it is likely to violate the sanctuaries of accepted ways of perceiving. Among the most fortified boundaries have been those between the natural sciences and the humanities. (Greenberg, 1990, p. 1)*

The link between Techne and electronic music and new media art is firmly established, but the philosophical importance of the task of electronic music in contemporary life is somewhat less obvious. Heidegger, in his essay *The Question Concerning Technology*, considers the human and cultural ramifications of this modern belief of immutability in technological advancement, where "we hear more frequently, to the effect that technology is the fate of our age, where 'fate' means the inevitableness of an unalterable course" (Heidegger, 1982, p. 25). He argues that the catalyst is the return of the link between Episteme and Techne, but through the definition of means rather than craft. In some sense, there is a sleight of hand in the enframing of means and pure truth, and this forms a destructive feedback loop:

> *Because physics, indeed already as pure theory, sets nature up to exhibit itself as a coherence of forces calculable in advance, it therefore orders its experiments precisely for the purpose of asking whether and how nature reports itself when set up in this way. (Heidegger, 1982, p. 21)*

According to Heidegger, there is a grave danger in this general belief of technological progress as an immutable force. The means by which Mankind has constructed truth have become synonymous with truth and, as a result, Mankind has become the means by

which this truth manifests itself. Mankind itself becomes the standing reserve, or the means by which ends are achieved.

The answer to this problem of “destining" is to redefine the immutability of technological means to include truth from art, and this art should be built using the means, or technological advancement. New media can be considered such an art, and Heidegger views it as the answer to this problem of destining. This perspective is supported by composer Augustino Di Scipio:

> *The artist's work becomes a metaphor for a cultural view in which technology is less a powerful instrument to actualize dreamed-of visions than something to excite new, autonomous visions. (Di Scipio, 1995, p. 8)*

Here, technological art is both an ancient misinterpretation and a revolution in the fact that this “questioning,” or the use of the means as means rather than ends in themselves, breaks the bound of the barrier that prevents Mankind from continuing the search for Truth (Heidegger, 1982, p. 27):

> *Advancements in science and shortcomings in humanity continued to erode traditional belief systems of the West. More existential philosophies were advanced in the postwar years in an effort to accommodate this; technology too began to be viewed in a more critical, cautionary manner. Nonetheless, advancements in electronics helped to firmly establish and enrich the practice now known as electroacoustic music, opening entirely new areas to sonic discovery. (Bocast, 2012, p. 243)*

Humanity spends a large bulk of time negotiating the unknown and unseen world of the virtual and engaging in relationships in ways that were previously nonexistent. It is not surprising, then, to see that Art, especially technological art, has taken a turn away from the confident and sure-footed realism and become more of a paleolithic, symbolic, alchemistic art.

Techne in Electronic Music

Both Stoic and Platonic notions of Techne are relevant to the practice and craft of electronic music, and this is well documented by many composers and theorists.

To the Stoics, the role of the practice of craft as result/truth is obvious in many electronic art practices. For example, in Process composition the result is often not as important as the consideration of the impetus itself. It is generally accepted that in some contexts, a work may not be able to speak for itself. The lack of the concrete form and the theoretical nature of the compositional tools can be seen as Techne insofar as the craft itself is embedded in the theory and practice of its production. The tools cannot be separated from the theory:

> *In electroacoustic music the making of the work is, to some extent, captured and documented in the technical tools adopted or specially designed by the composer. The composer's relationship to the materials and the forms of his/her art (which, to me, is the very object of any analytic view) are mediated by those design tools - tools of work and thought. They cannot be considered foreign to an aesthetic approach, for they do reflect, to some extent to be studied, the artist's knowledge and his/her conception of sound and music.*

> *The technological tools embody the theory of music behind a composer's attitude and work (knowledge of the field) and objectify the cognitive strategies involved in using the theory (action-knowledge) (Di Scipio, 1995, p. 6).*

Platonic Techne can also exist implicitly in electronic musical practices such as sonification, field recording, interactive art, and spectral techniques. Recording and Analysis investigate the nature of a thing and the reproduction serves as the “account" or explanation of truth. The reproduction of the real, as in recording or synthesis, is simultaneously practice, truth, and theory. As Techne can also be the study of pure form over time, composition using these techniques serves as the proof of this knowledge:

> *The meaning of the Greek word Techne from which both “technique" and “technology" are derived offers an indication of the unity of this concept with art. If art is the external representation of something internal, the concept of technique embraces everything which pertains to the realisation of that interior substance. In the case of music, not only the realisation of spiritual substance in the score is involved, but the transformation which makes this score accessible to sensory perception as well. In short, both production and reproduction are involved. Musical technique embraces the totality of all musical means: the organisation of the substance itself and its transformation into a physical phenomenon (Adorno, 1976, p. 79).*

Further reading on this subject can be found in Simon Emmerson’s *The language of electroacoustic music*, Peter Manning’s *The significance of Techne in understanding the art and practice of electroacoustic composition*, Adorno’s *Musik und Technik*, and A. Di Scipio’s *Centrality of Techne for an Aesthetic Approach on Electroacoustic Music*.

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Illuminations

a codex

by Kristina Wdfe

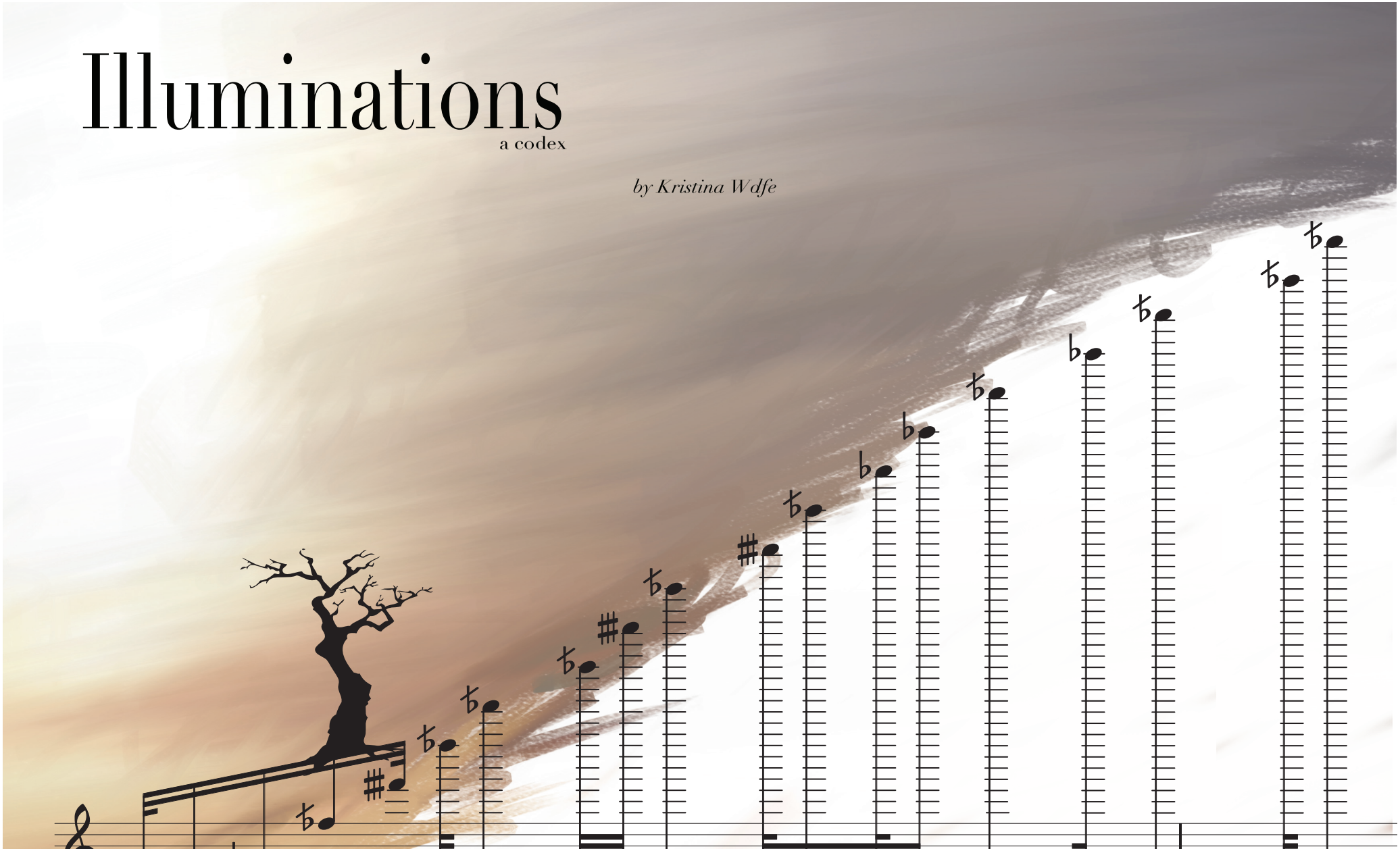


Table of Contents

About this Book

I. General Spirals

II. Places of Residence

III. Neumes and Knots

IV. Three Landscapes

About This Book

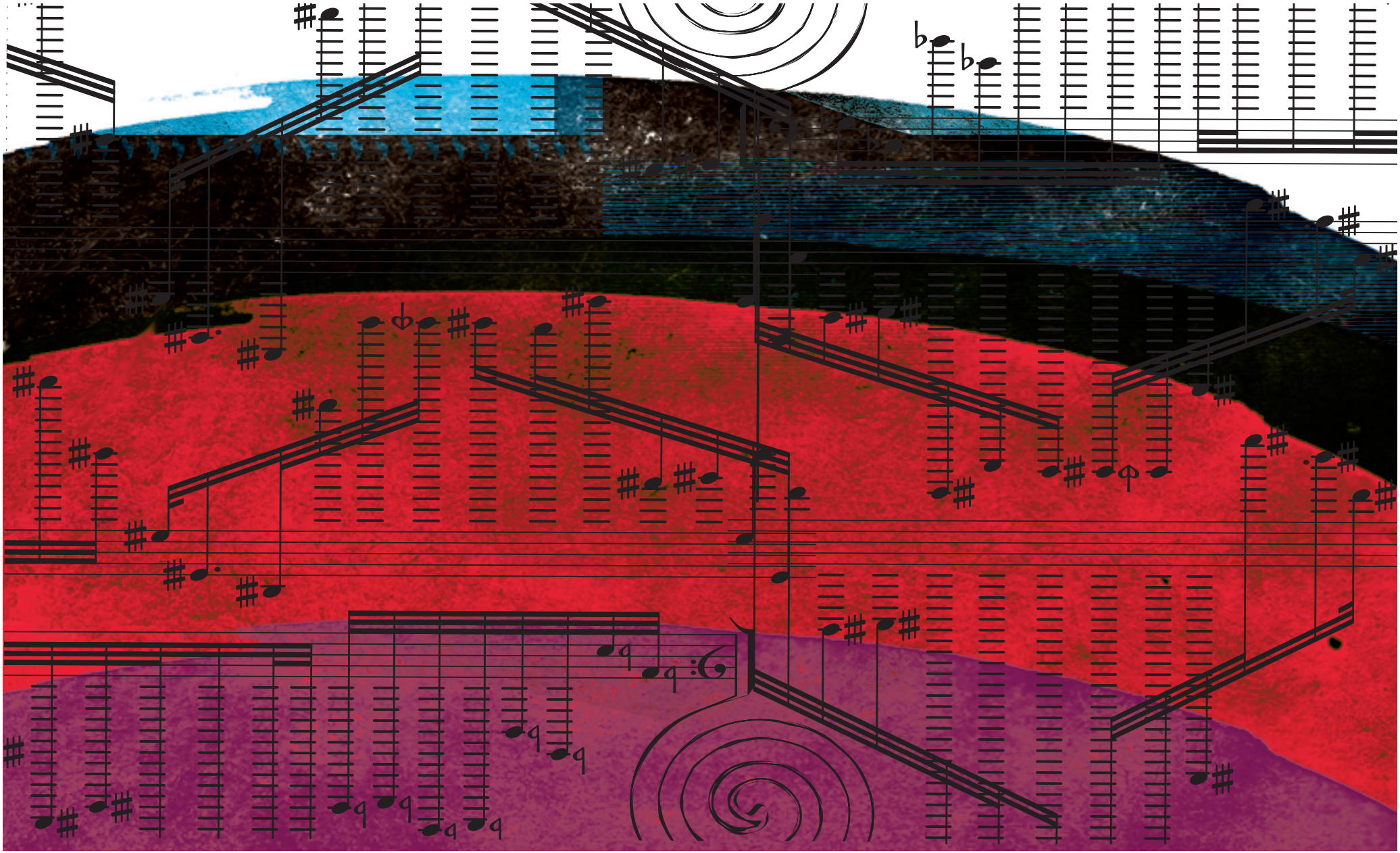
This is a book of imaginary scores
based on my favorite
typesetting catastrophes
that occurred while creating a
score-writing and graphical notation program.

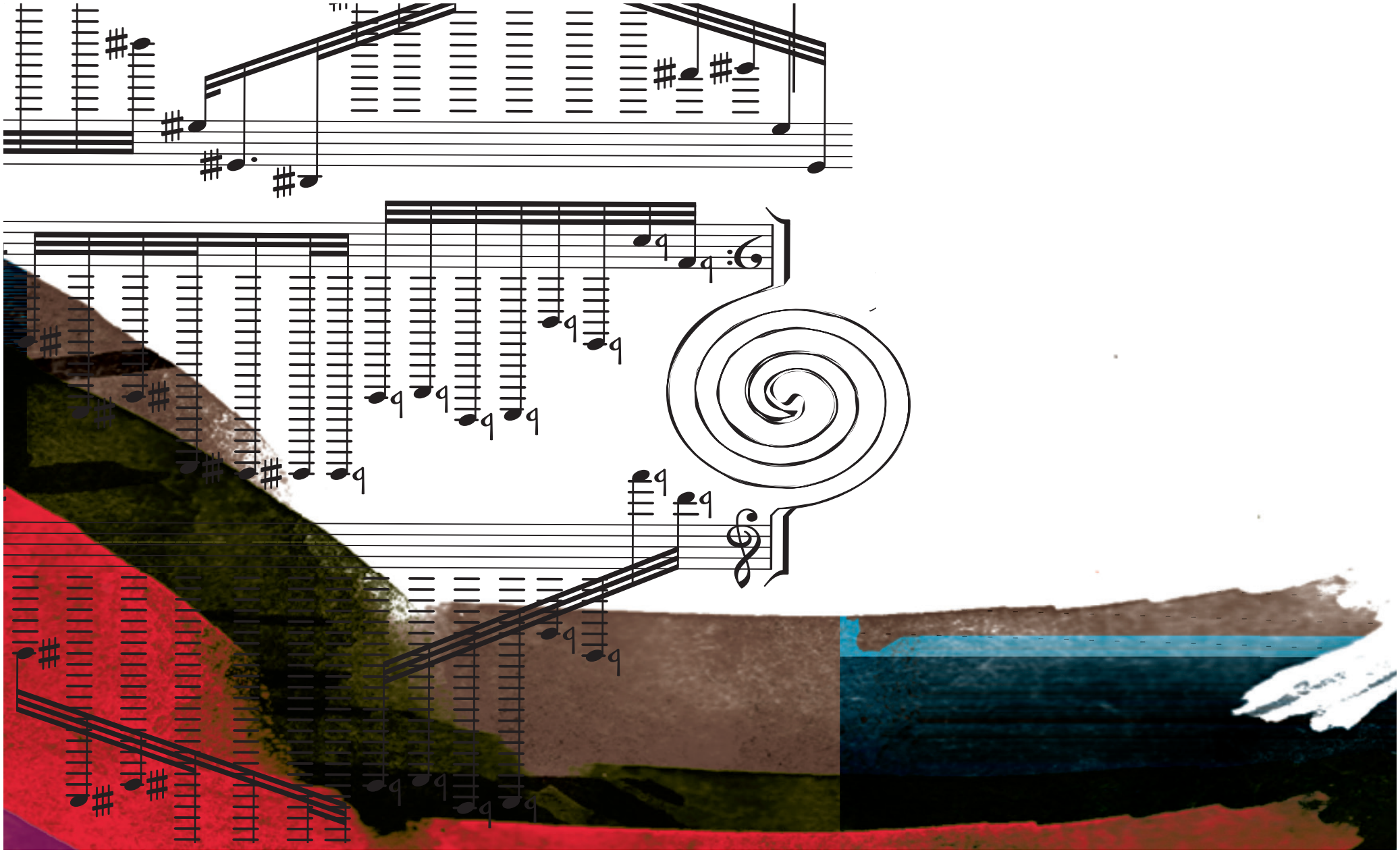
These errors contained evocative glimpses of my
intended score while also flying off the page in interesting ways.
They hinted at marquetry, movement, wild melodies, and architecture.
They were pieces in themselves
and so I illuminated them.

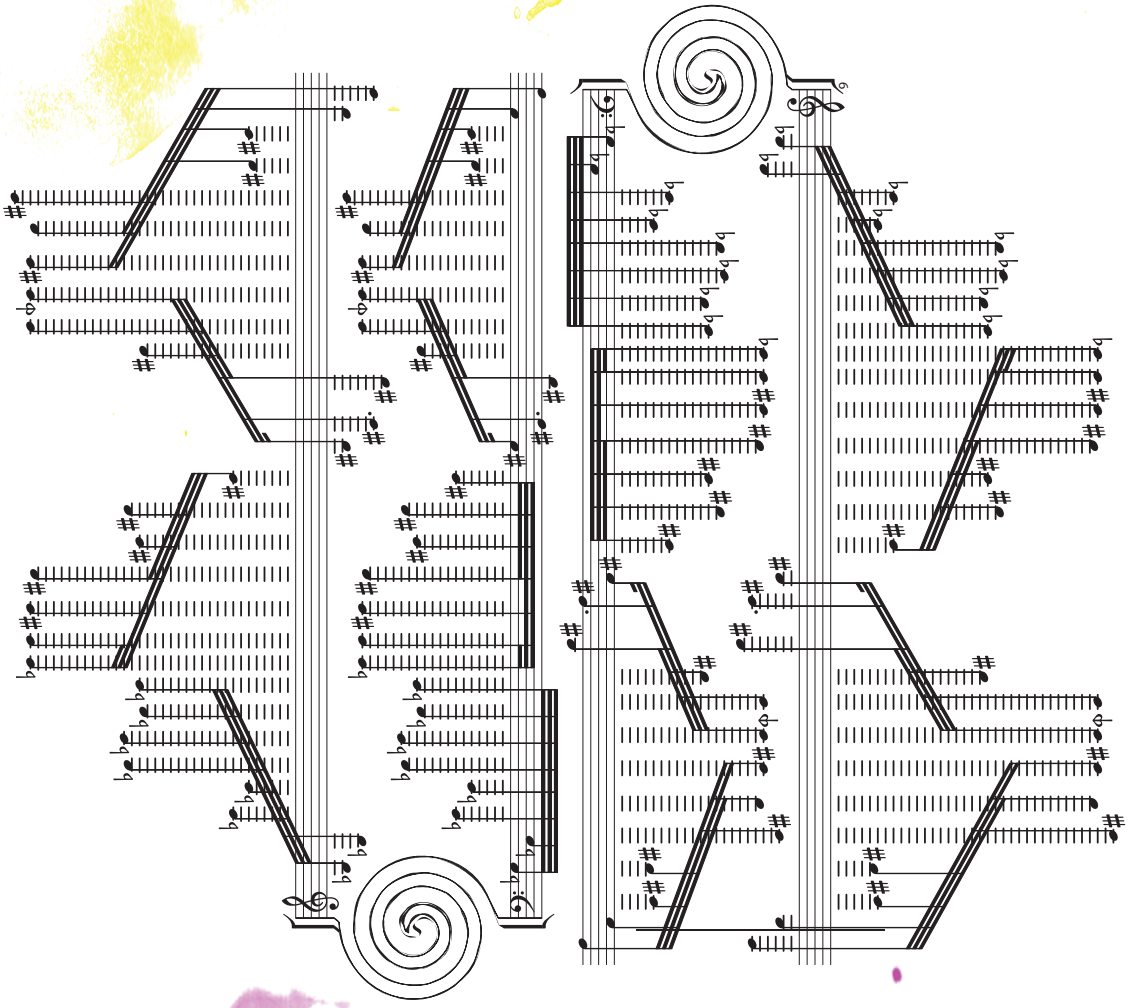
These pieces can be realized
like Cages's Fontana Mix.

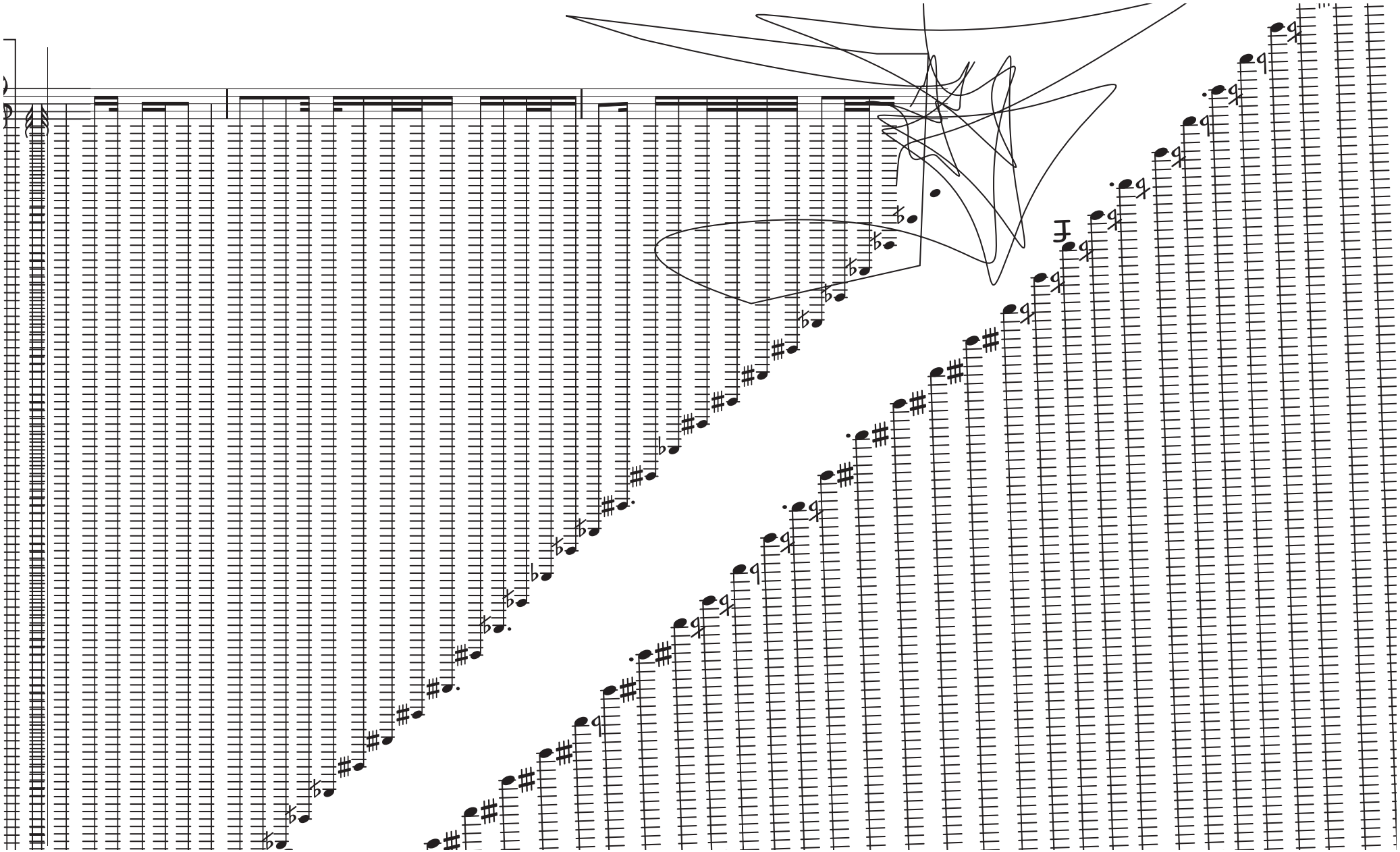
They can also be read in
silence and imagined.

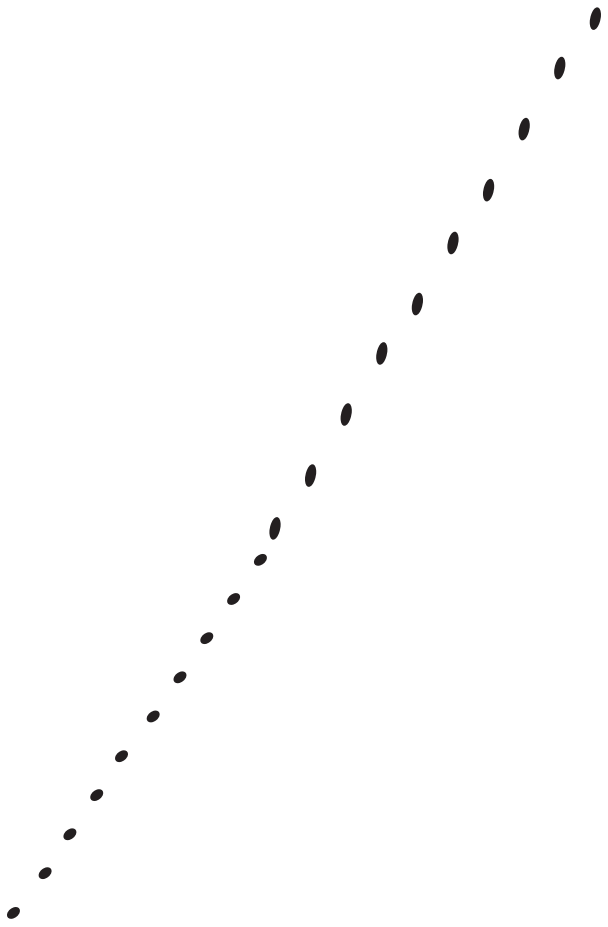
Part I: General Swirls



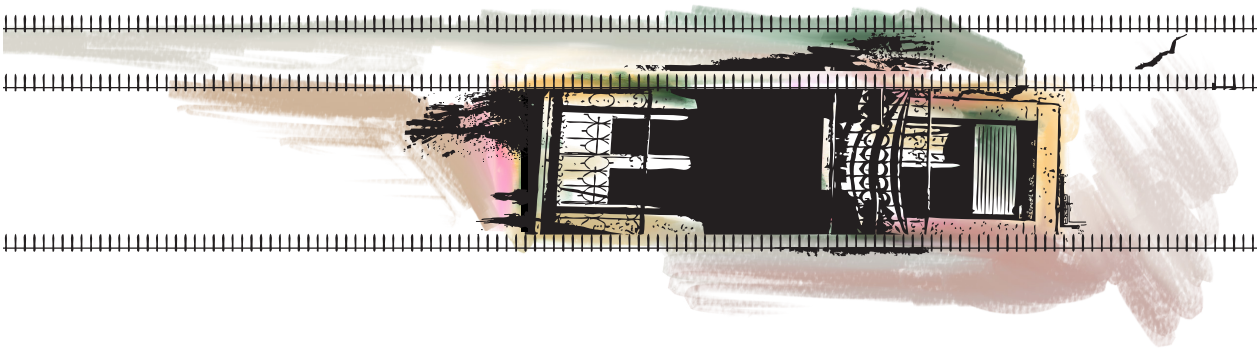


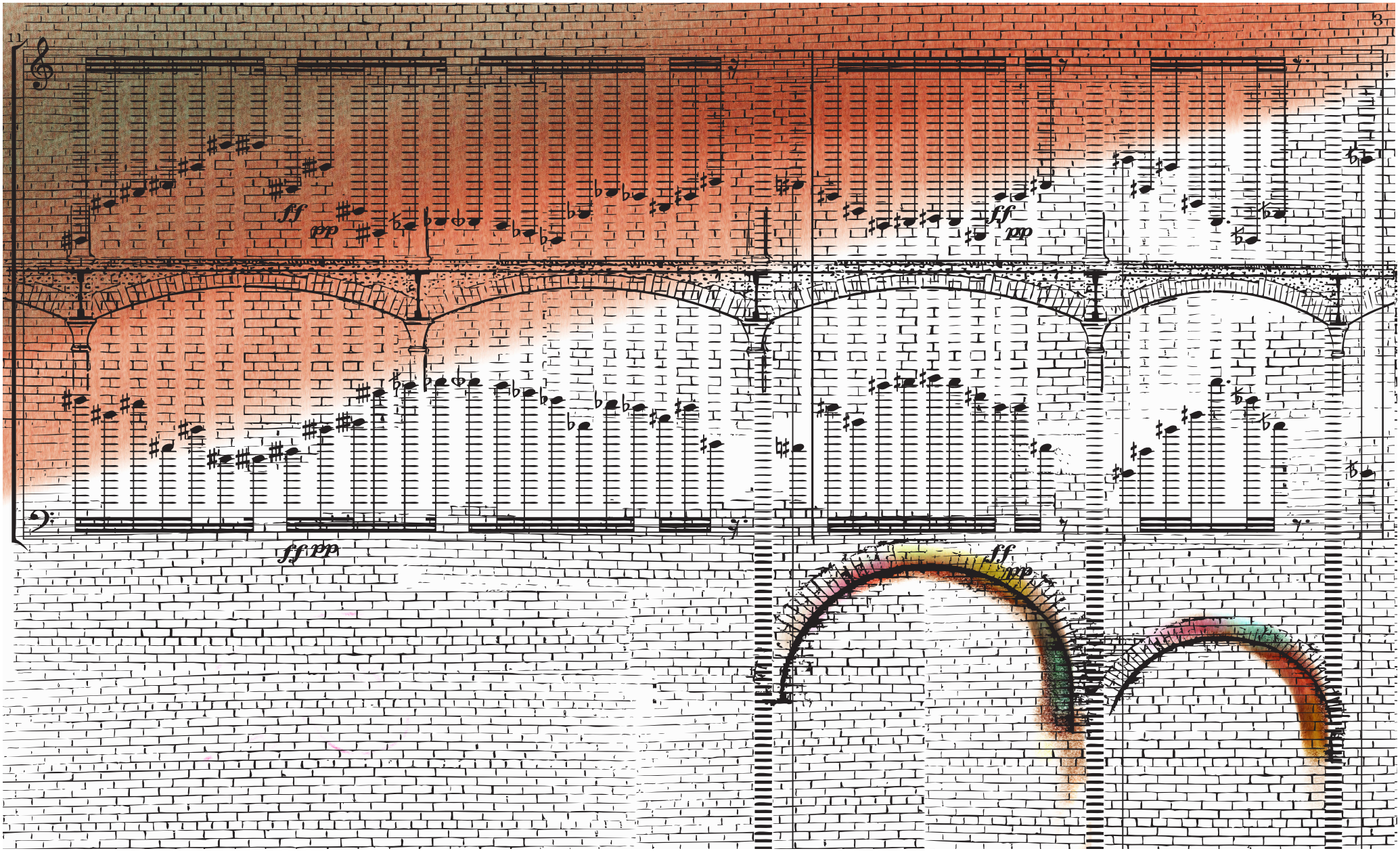






II. Places of Residence

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3
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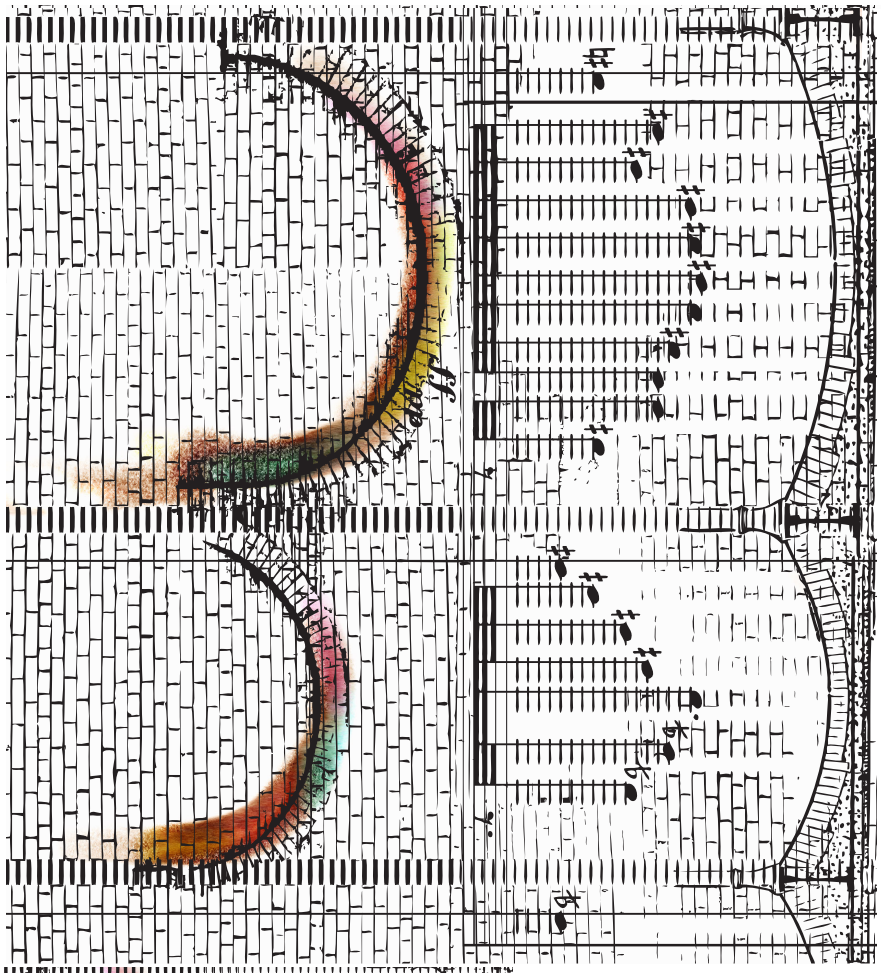
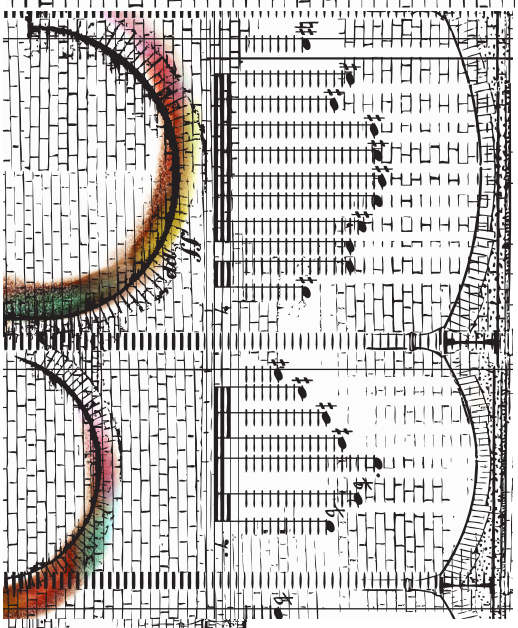
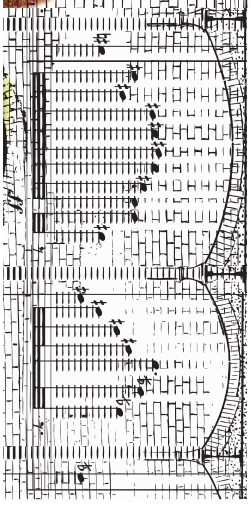
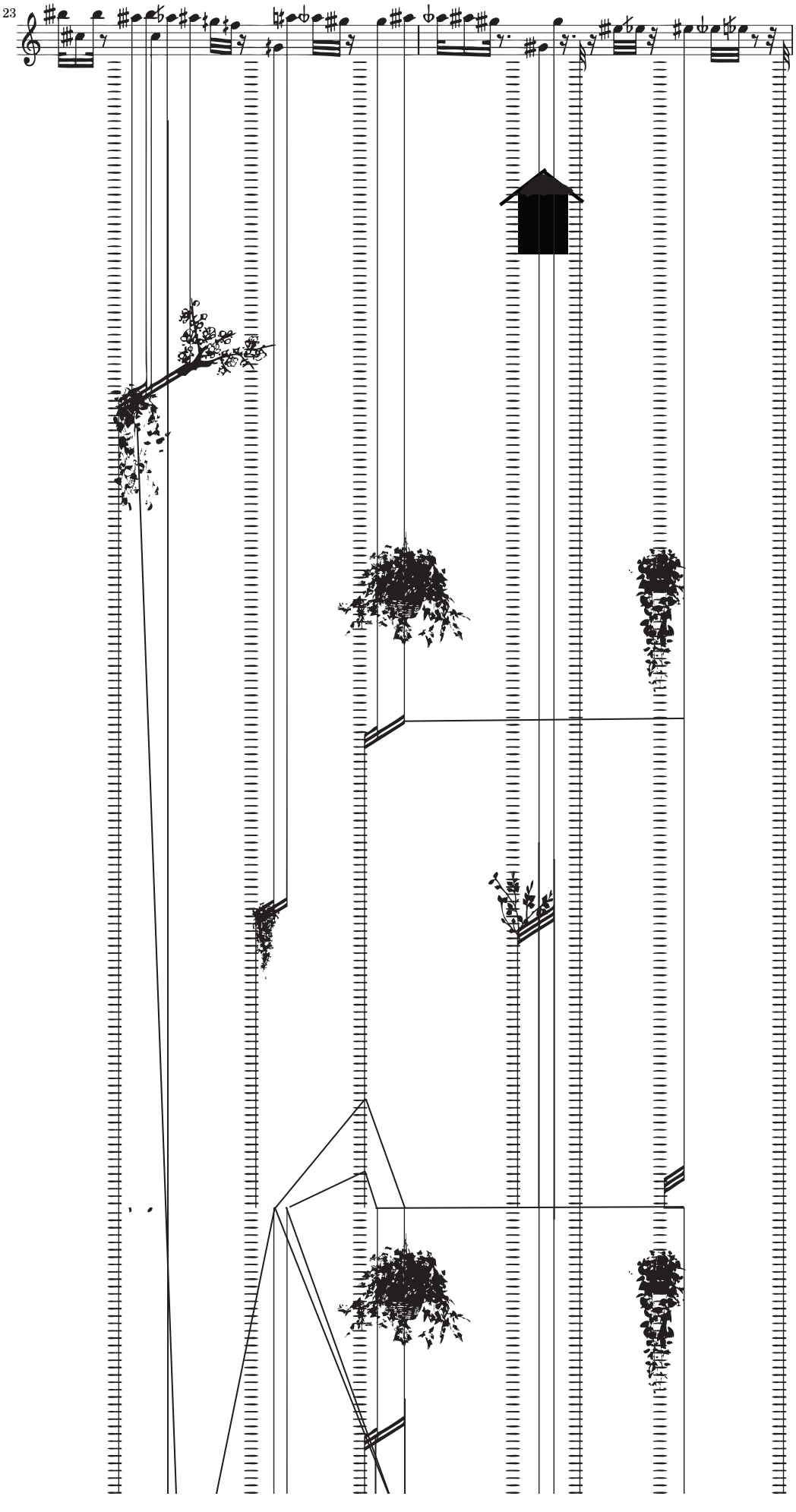
pp
ff
pp
ff
pp
ff
pp





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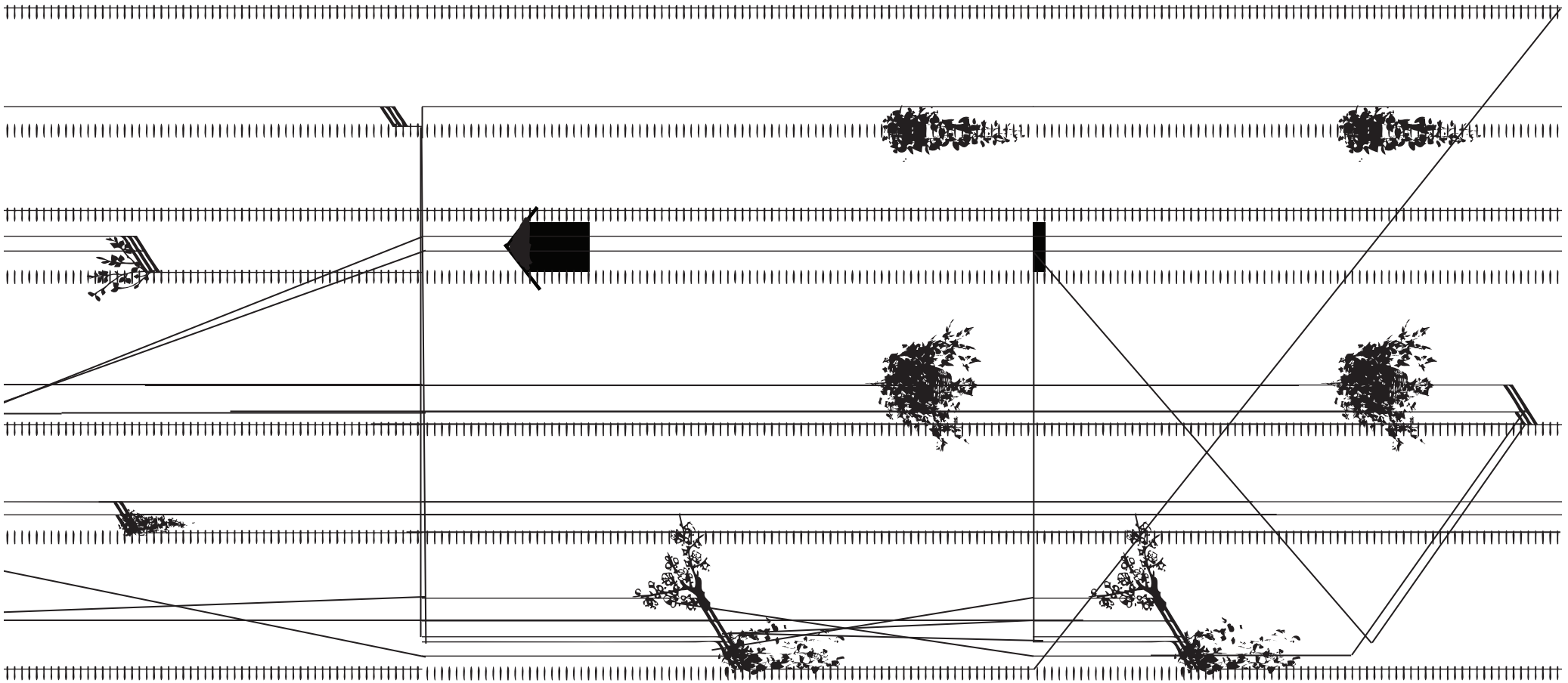

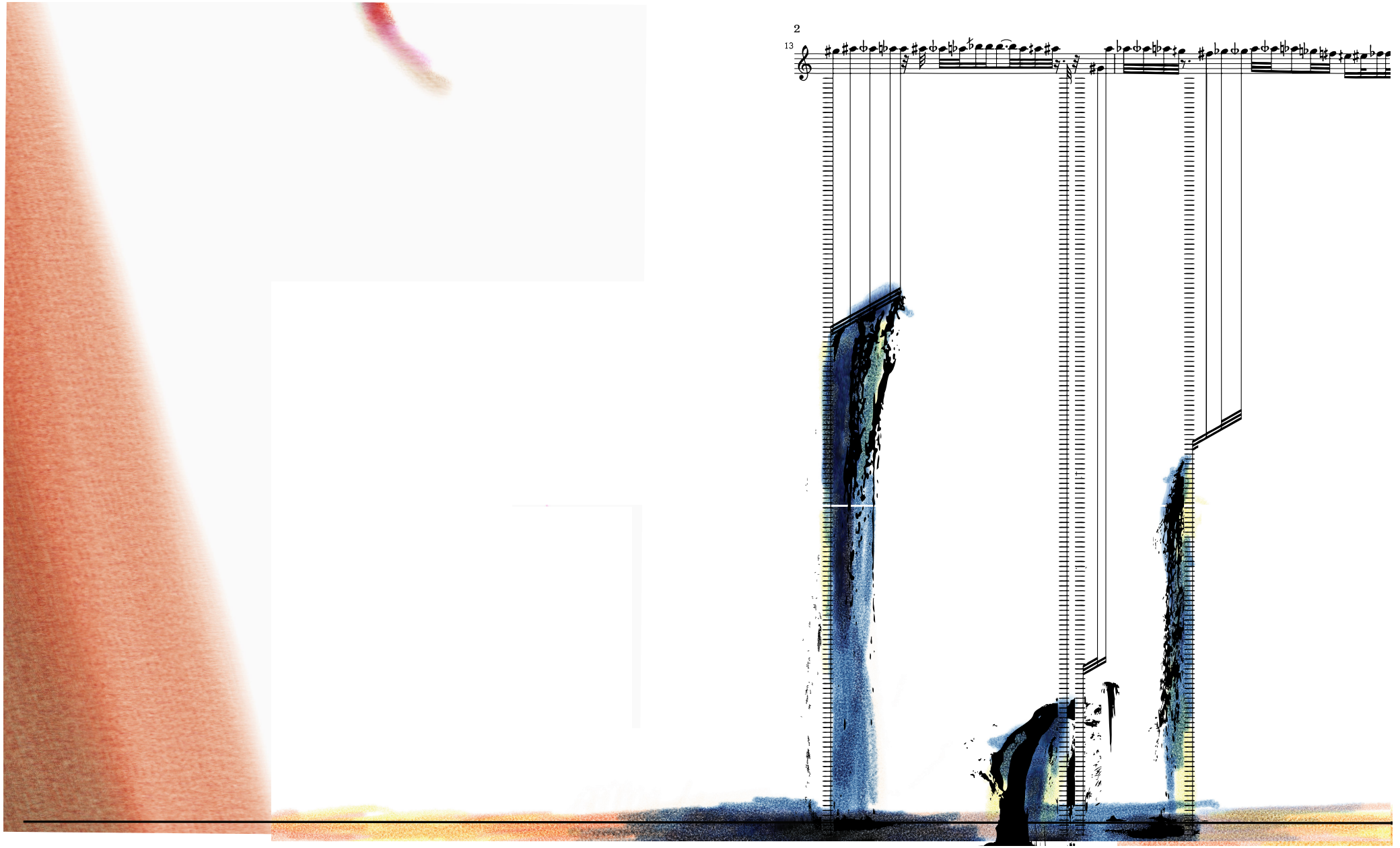
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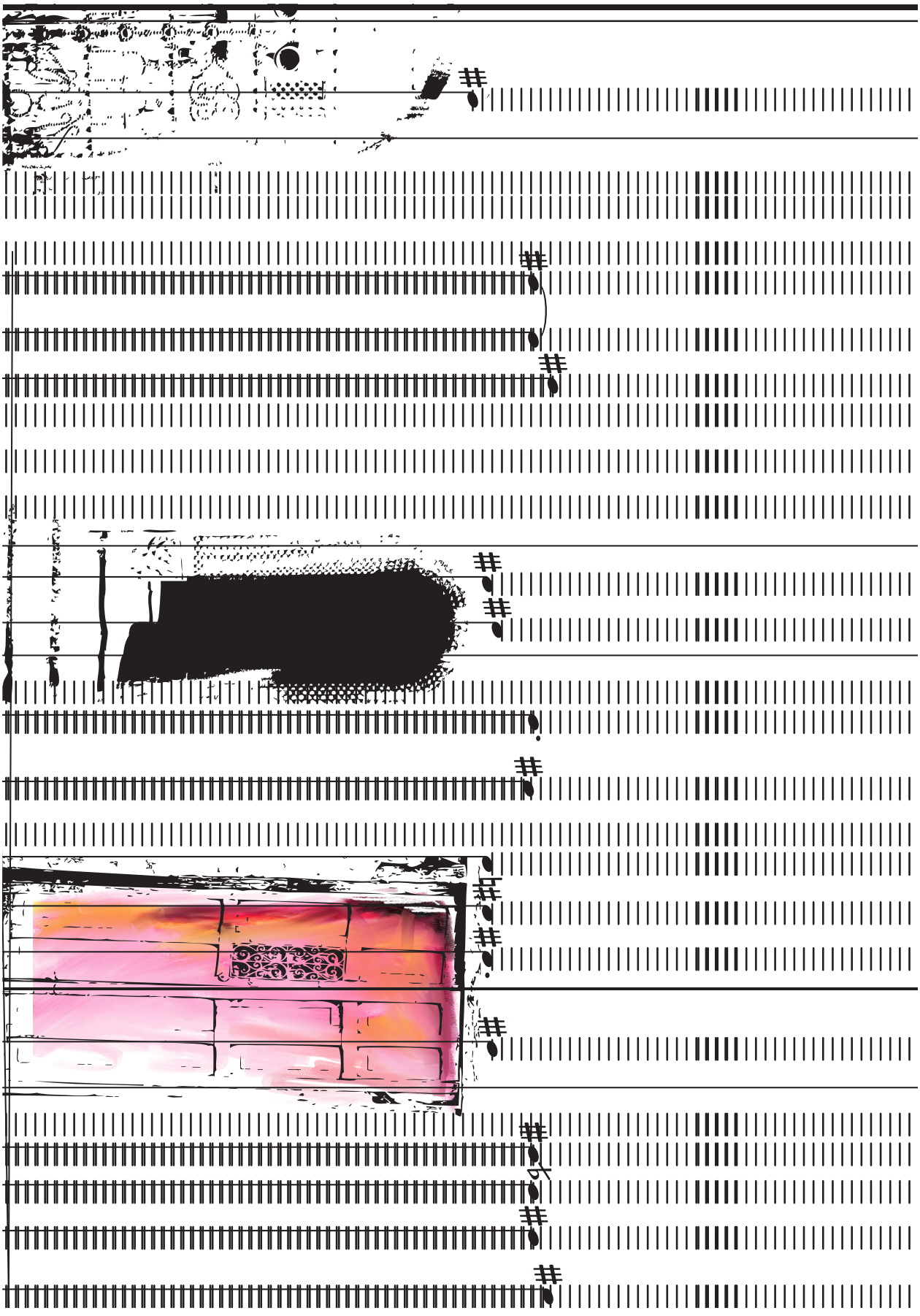
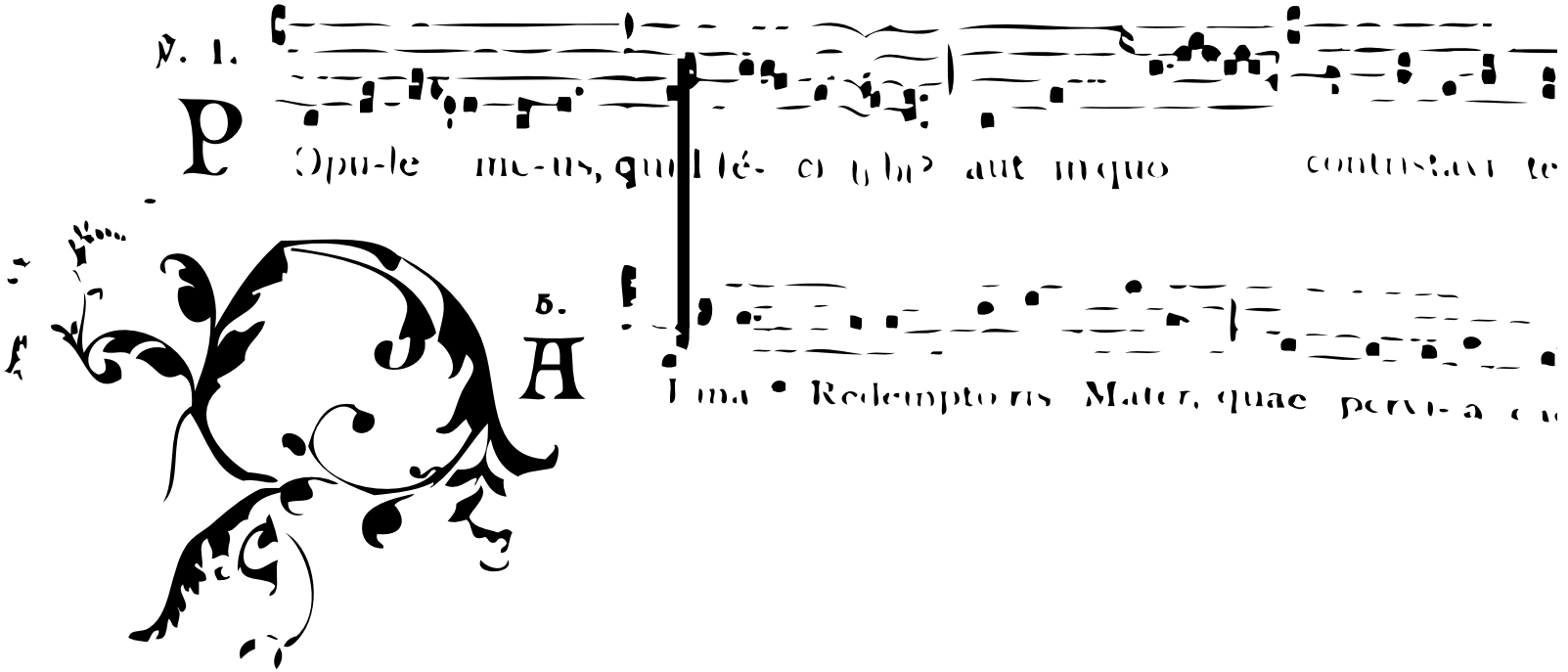
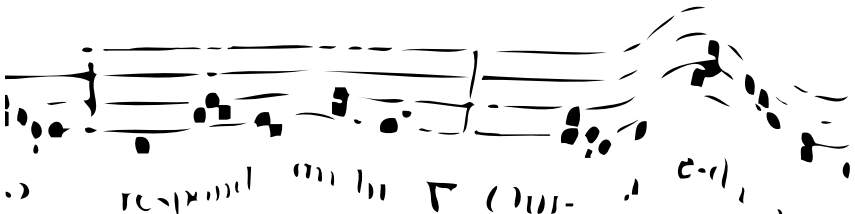
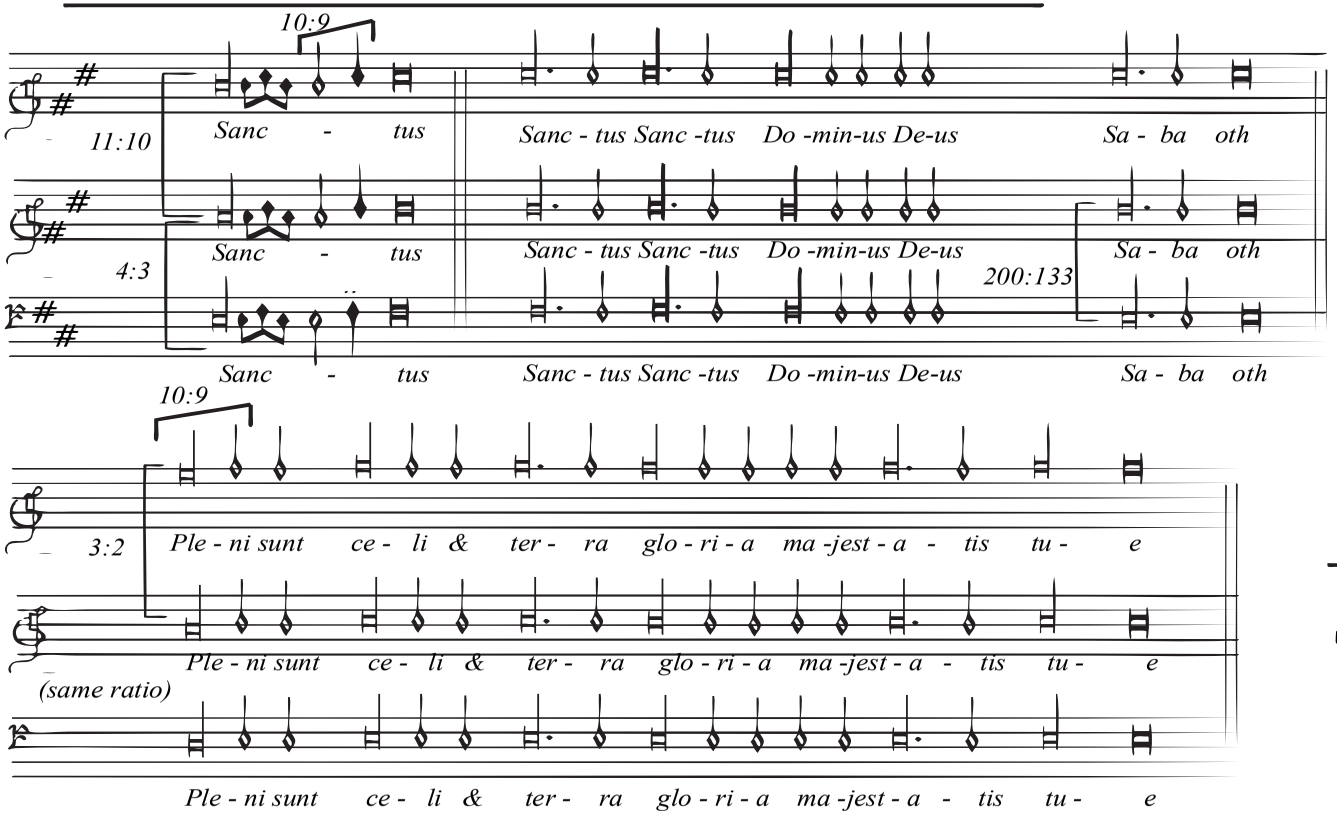



V. 1.
P
Opu-le me-us, qui l'é- ci-bi? aut in quo contristavi te
5.
A
Ima Redemptoris Mater, quae pervi-a



Section III: Neumes and Knots

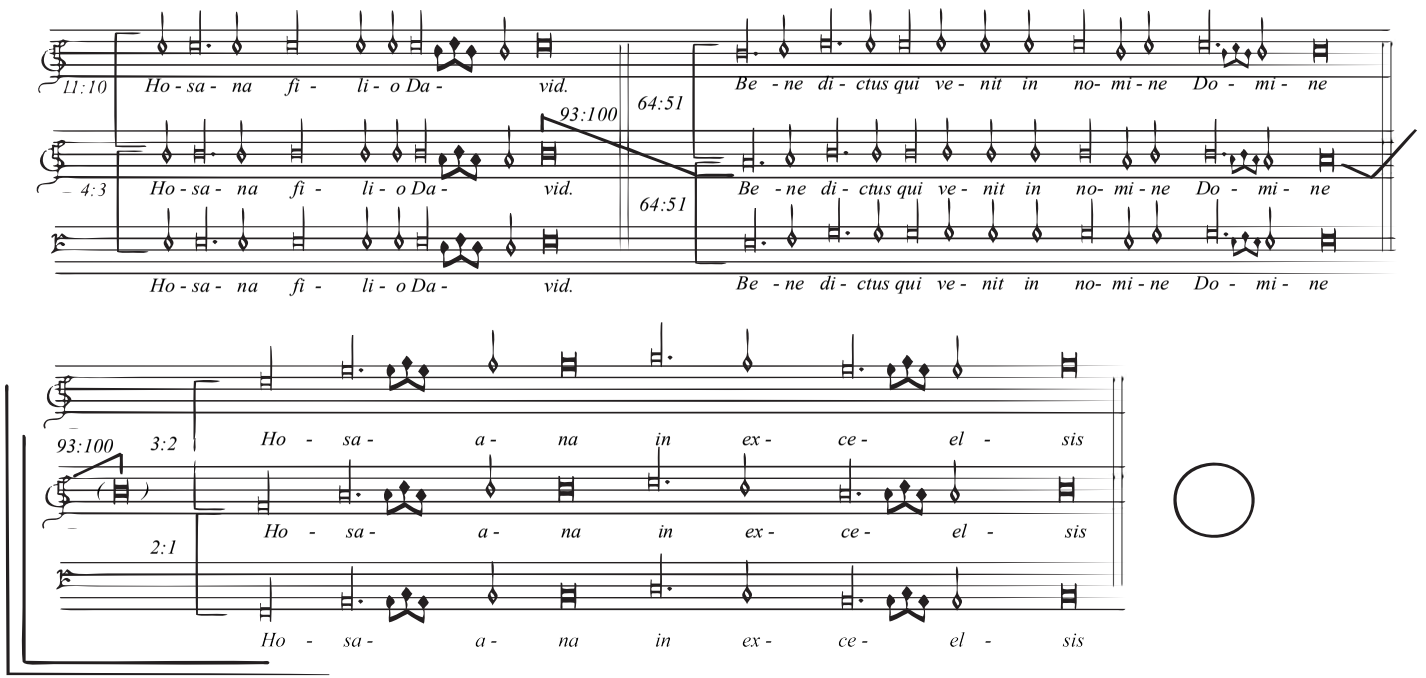


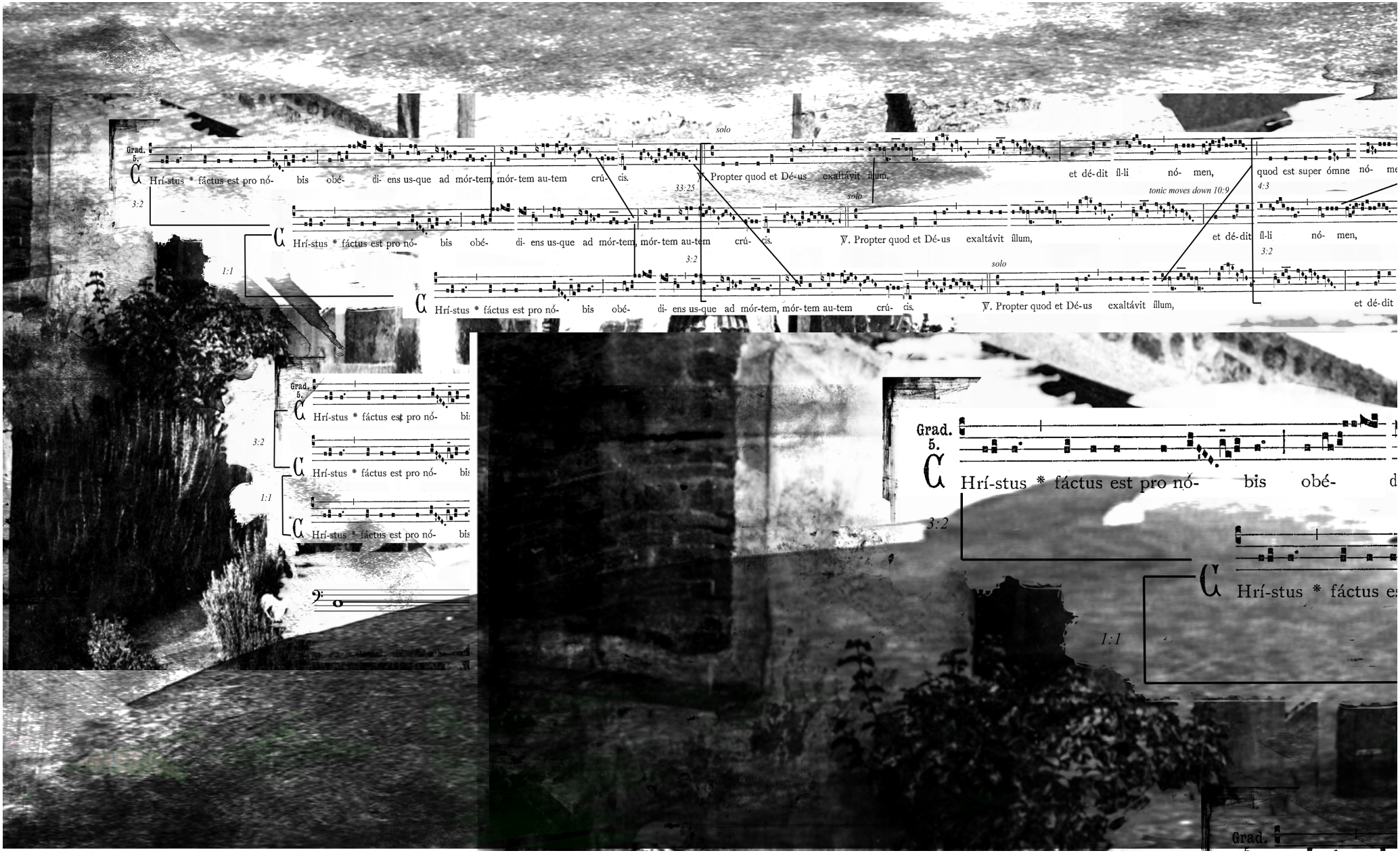
Respondeat Chorus. Sanctus. Sanctus. Sanctus. Dominus Deus Sabbaoth: Pleni sunt celi & terra gloria majestatis tue. Osanna filio David. Benedictus qui venit in nomine Domini. Osanna in excelsis. Agyos. Agyos. Agyos. Kyrie. Otheos.

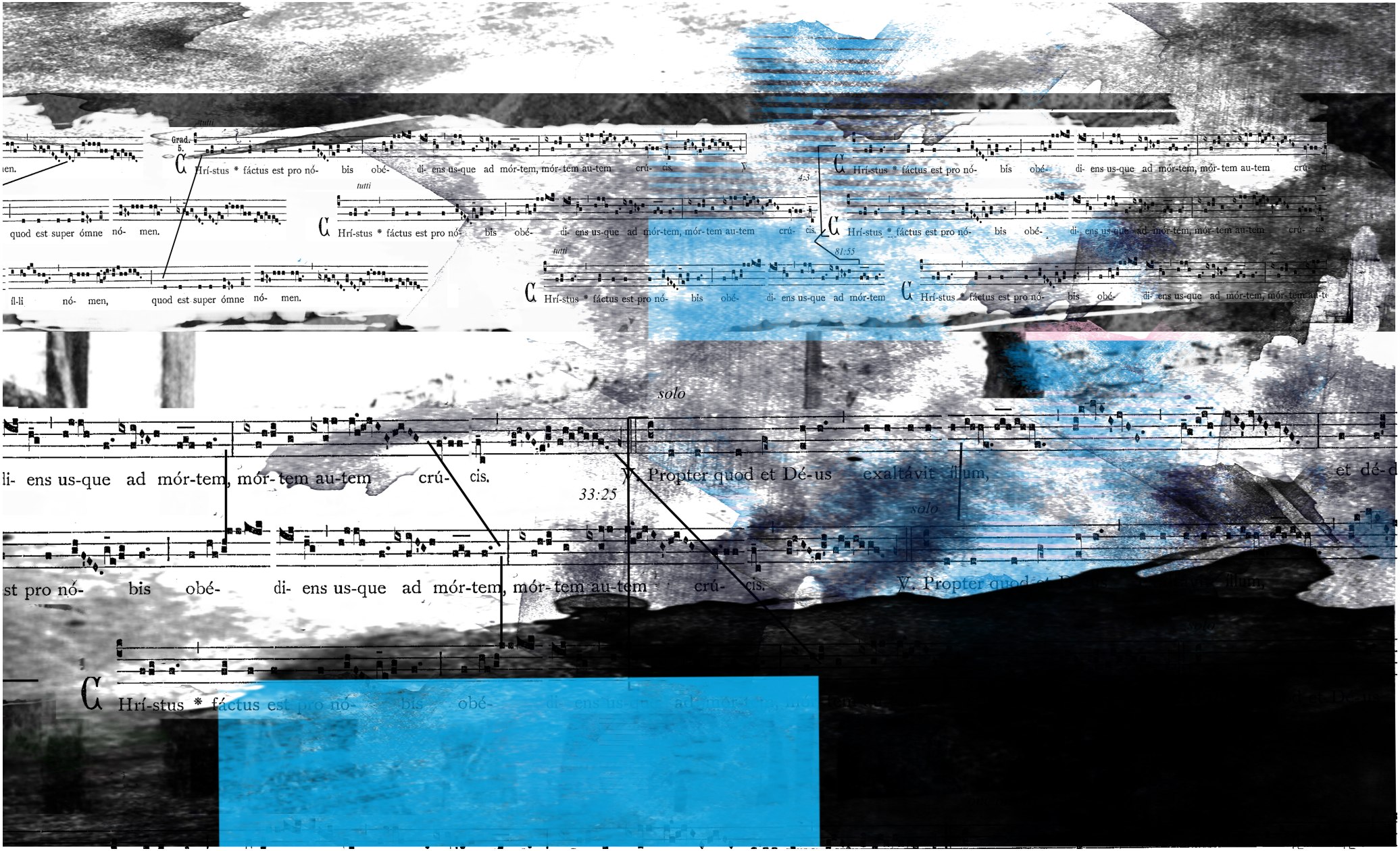
Postea dicat Presbyter.

SANCTUS

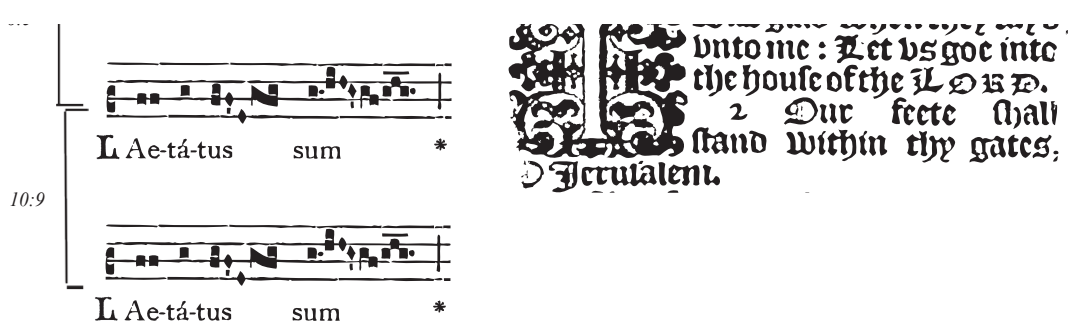
K. Wolfe

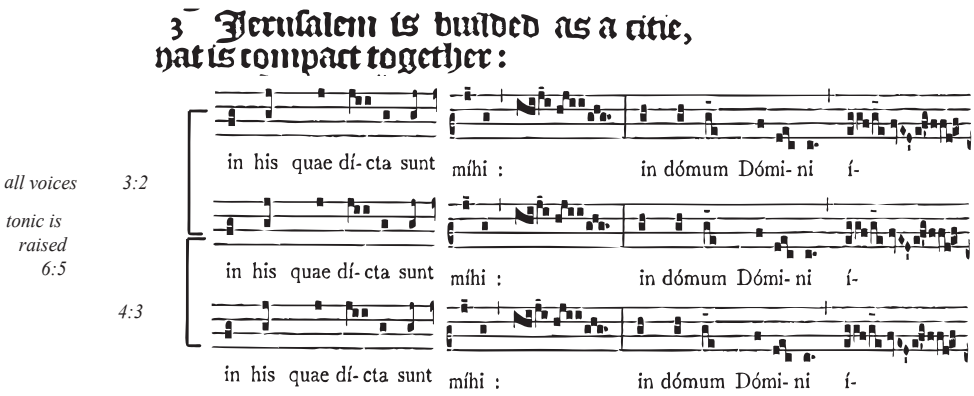

11:10
Ho - sa - na fi - li - o Da - vid.
93:100
64:51
Be - ne di - ctus qui ve - nit in no- mi - ne Do - mi - ne
4:3
Ho - sa - na fi - li - o Da - vid.
64:51
Be - ne di - ctus qui ve - nit in no- mi - ne Do - mi - ne
Ho - sa - na fi - li - o Da - vid.
Be - ne di - ctus qui ve - nit in no- mi - ne Do - mi - ne
93:100
3:2
Ho - sa - a - na in ex - ce - el - sis
2:1
Ho - sa - a - na in ex - ce - el - sis
Ho - sa - a - na in ex - ce - el - sis

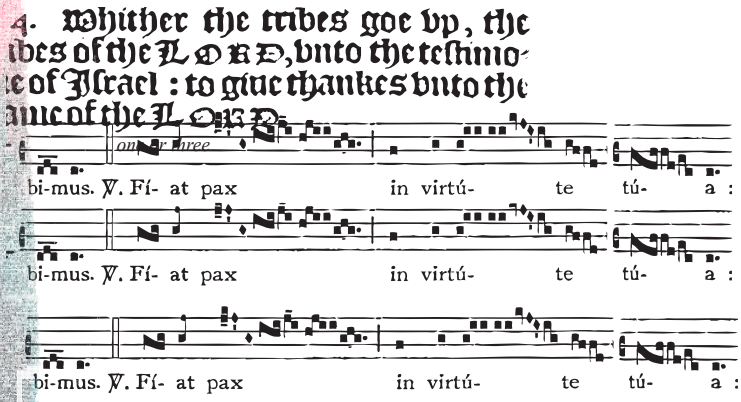

Grad. 5.
Hrí-stus * fáctus est pro nó- bis obé- di- ens us-que ad mór-tem, mór-tem au-tem crú- cis.
℣. Propter quod et Dé-us exaltávit illum,
et dé-dit fl-li nó- men,
quod est super ómne nó-
solo
33:25
tonic moves down 10:9
4:3
3:2
1:1

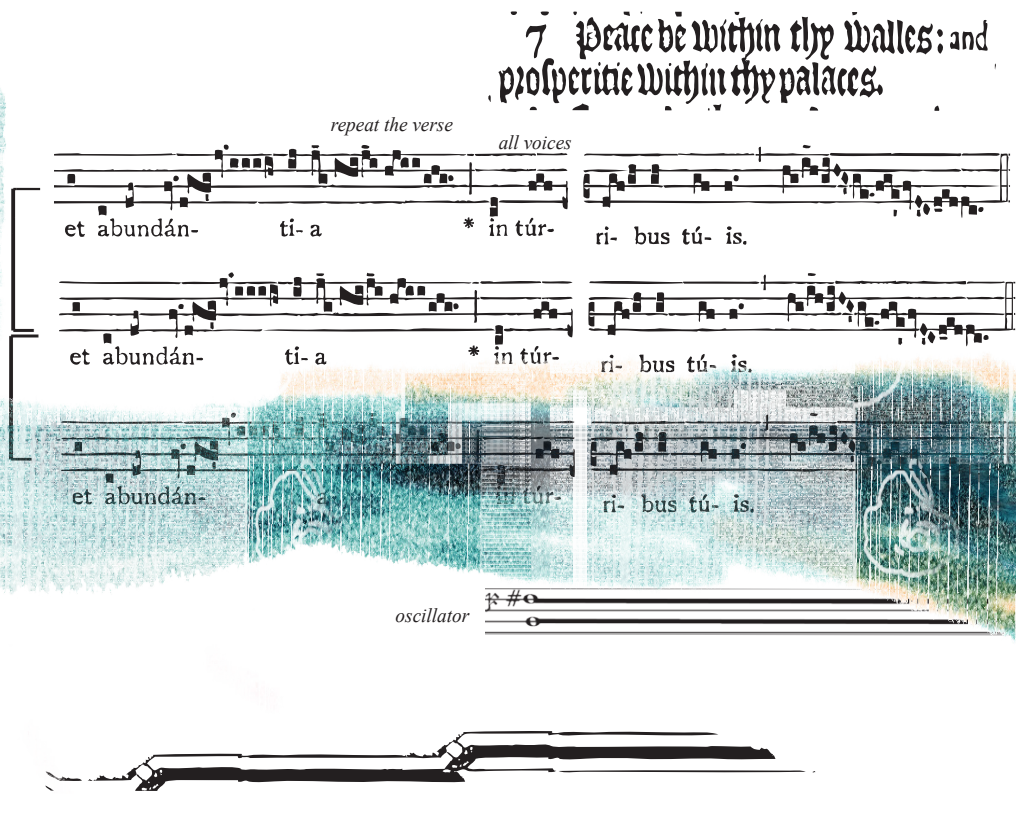

tutti
Grad.
℣.
℟. Hrí-stus * fáctus est pro nó- bis obé- di- ens us-que ad mór-tem, mór-tem au-tem crú- cis.
quod est super ómne nó- men.
fl-li nó- men, quod est super ómne nó- men.
4:3
81:55
solo
℣. Propter quod et Dé-us exaltávit illum,
et dé-
33:25

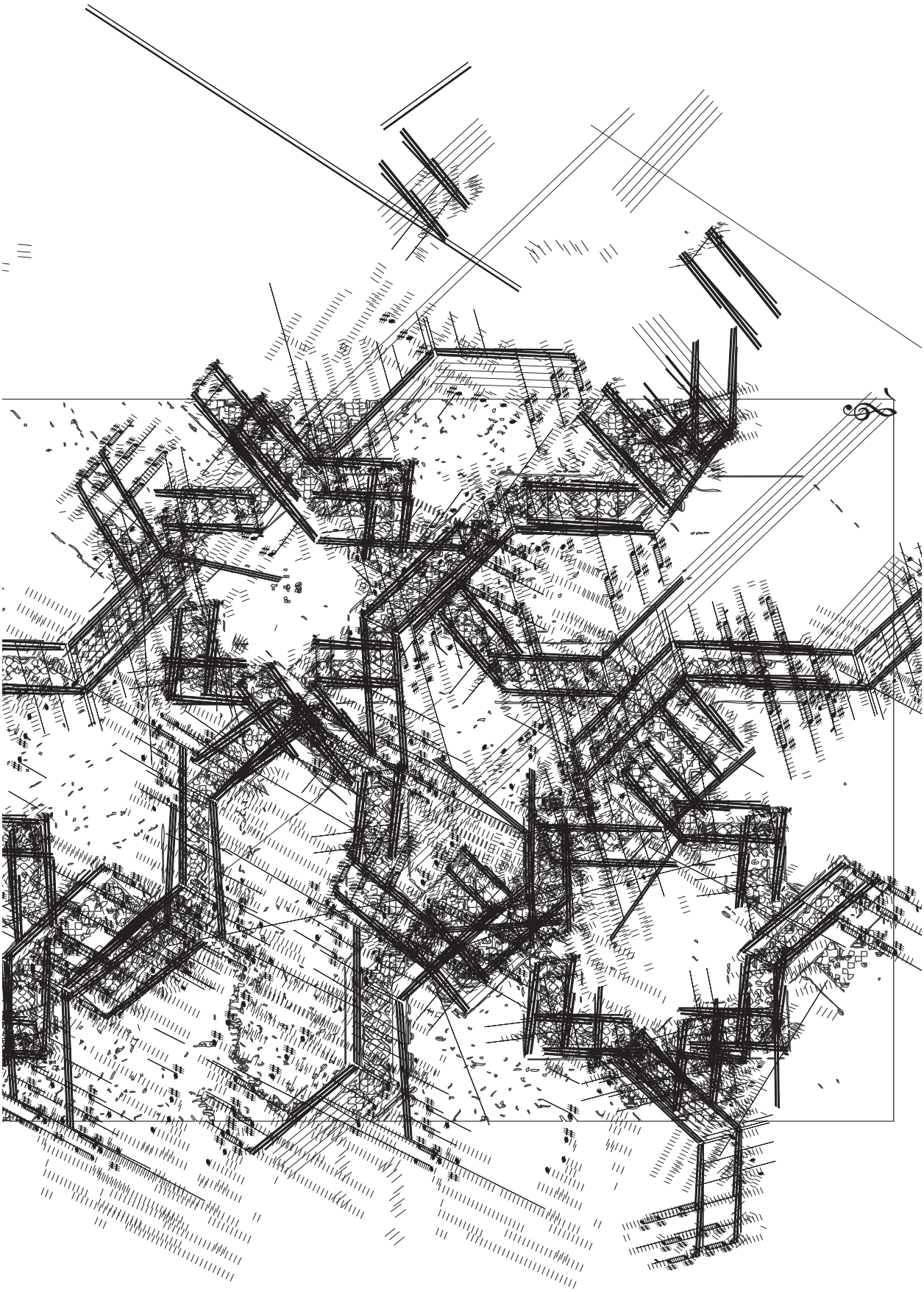
11
3
one (with live electronics) or three
L Ae-tá-tus sum *
¶ A long of degrees of Dauid.
was glad When they sayd
6:5

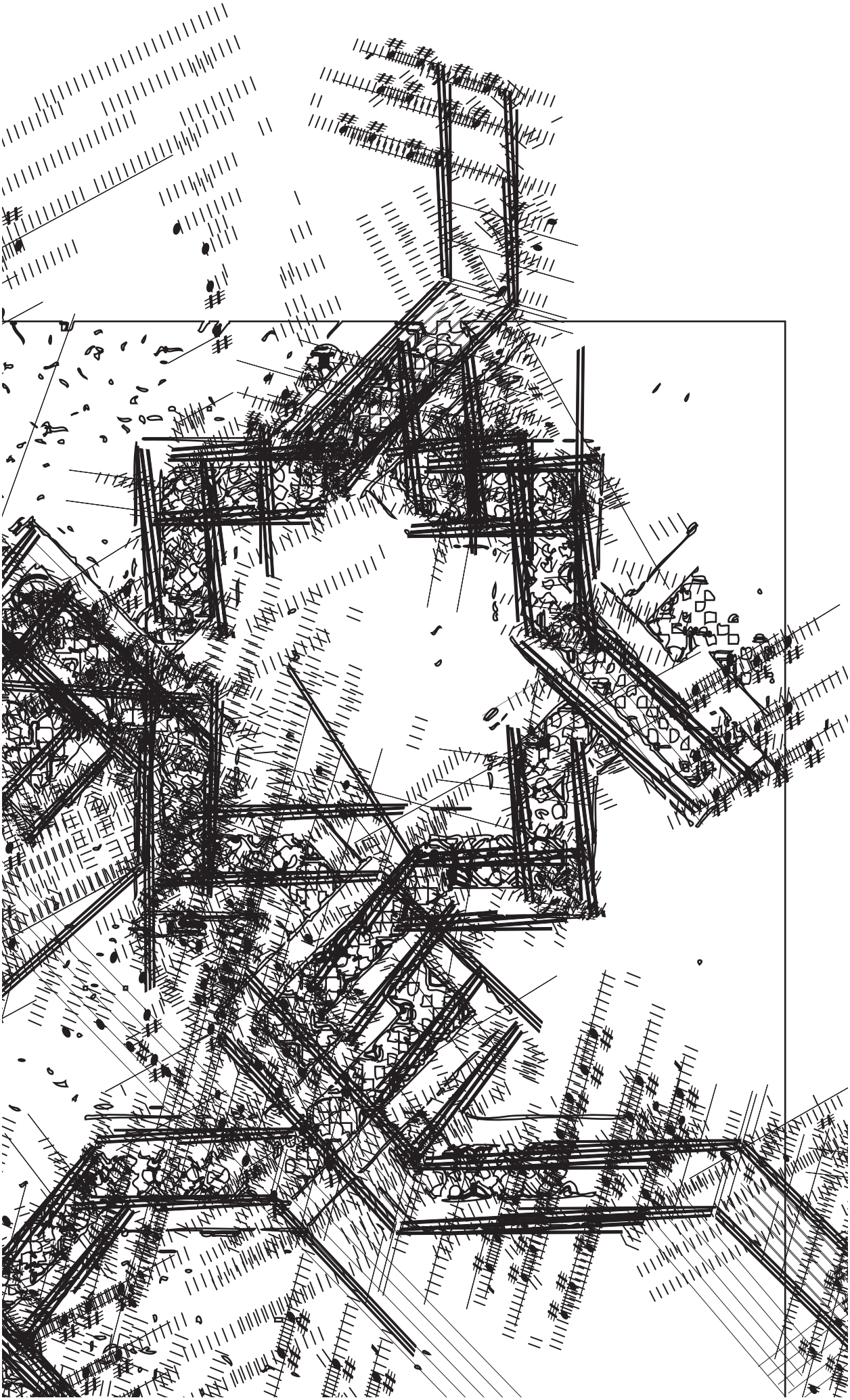

L Ae-tá-tus sum *
10:9
L Ae-tá-tus sum *
bnto me : Let vs goe into
the house of the LORD.
2 Our feete shall
stand within thy gates,
O Jerusalem.

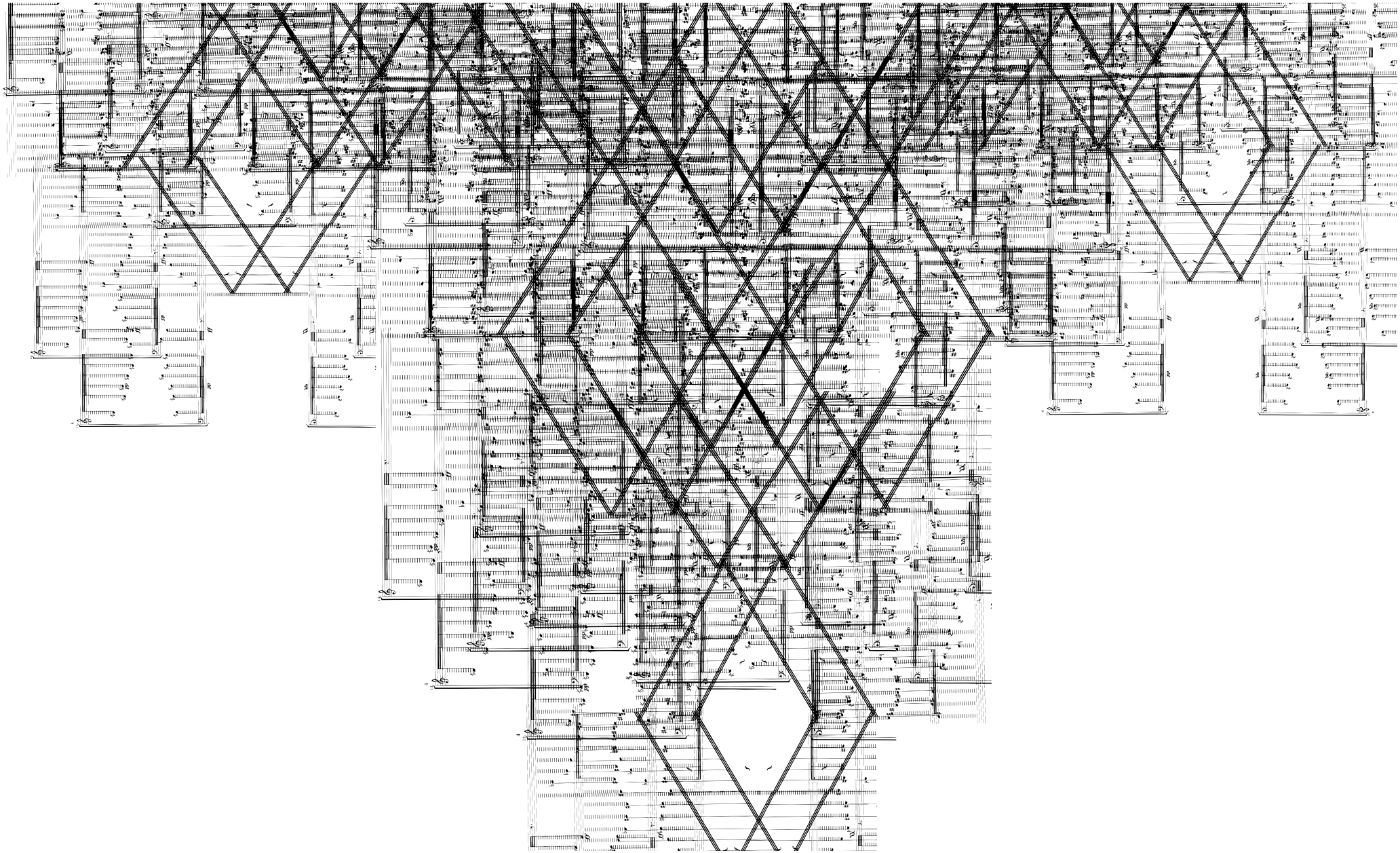

3 Jerusalem is builded as a citie,
hat is compact together :
all voices
3:2
tonic is
raised
6:5
4:3
in his quae dí- cta sunt
míhi :
in dómum Dómi- ni
í-

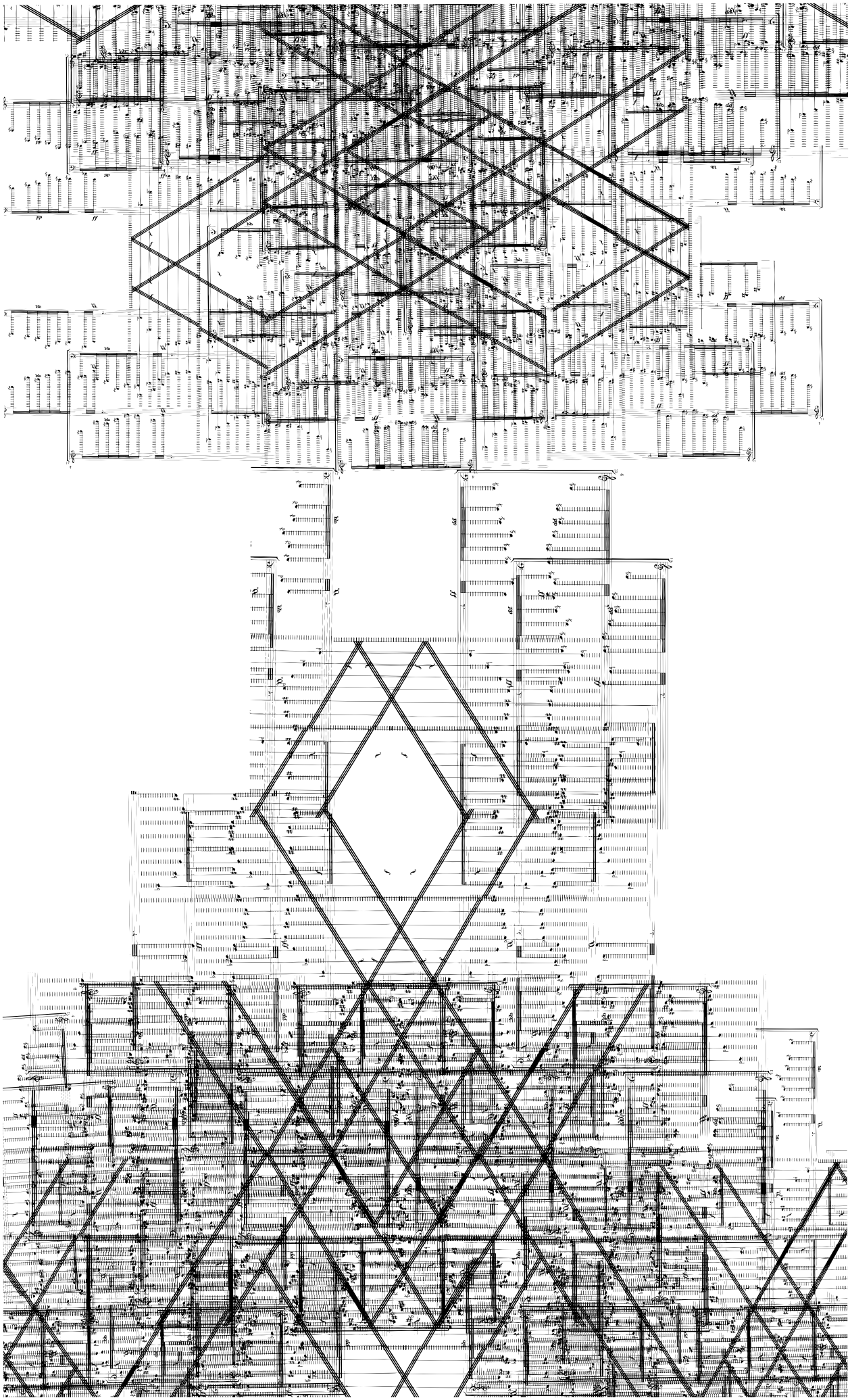

4. Whither the tribes goe vp, the
ibes of the LORD, vnto the testimo-
e of Israel : to giue thankes vnto the
ame of the LORD.
bi-mus. ℣. Fí- at pax
in virtú-
te
tú-
a :

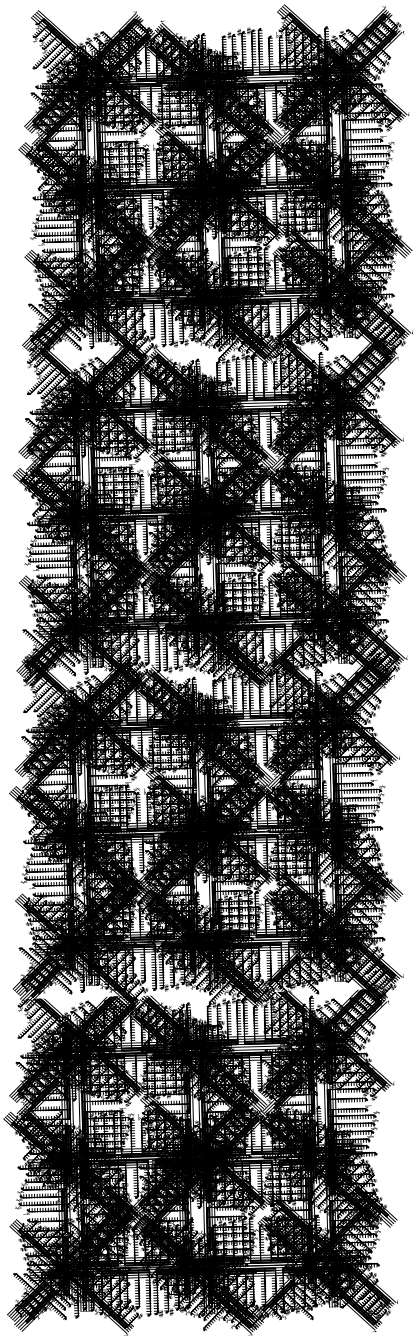

7 Peace be within thy walles : and
prosperitie within thy palaces.
repeat the verse
all voices
et abundán-
ti- a
* in túr-
ri- bus tú- is.
3:2
1:133
oscillator

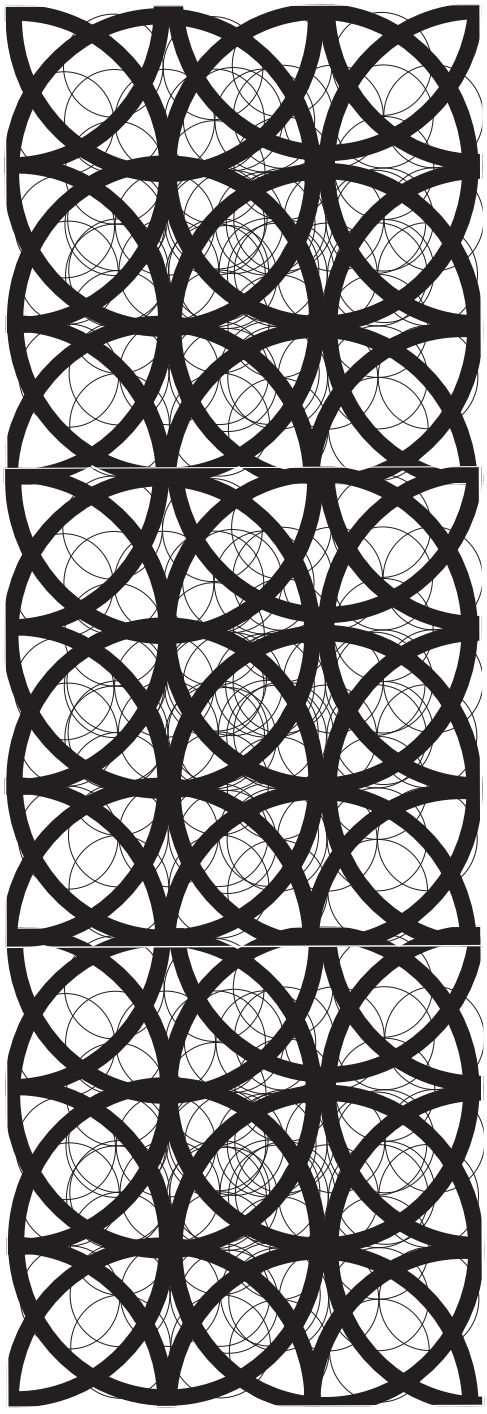


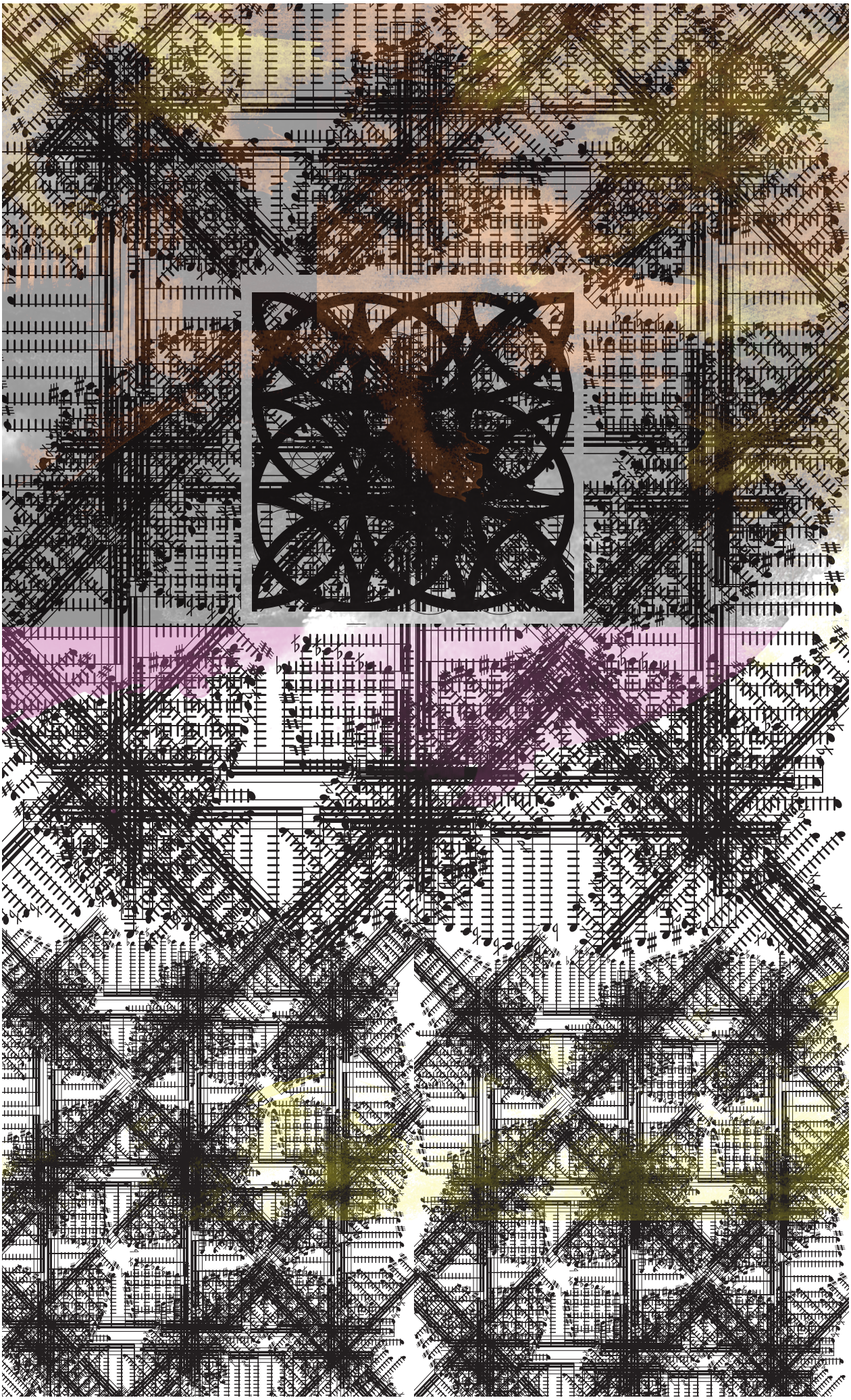












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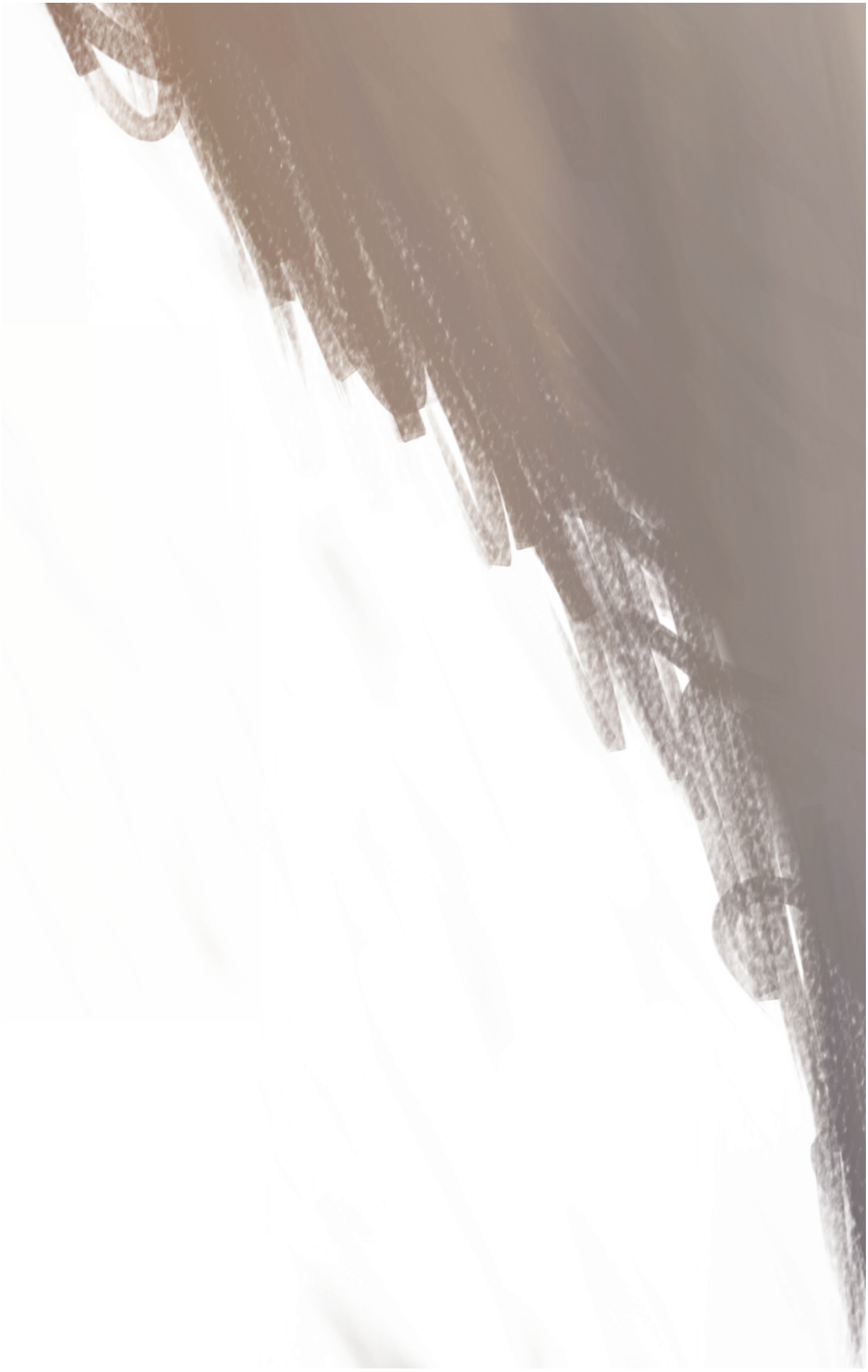

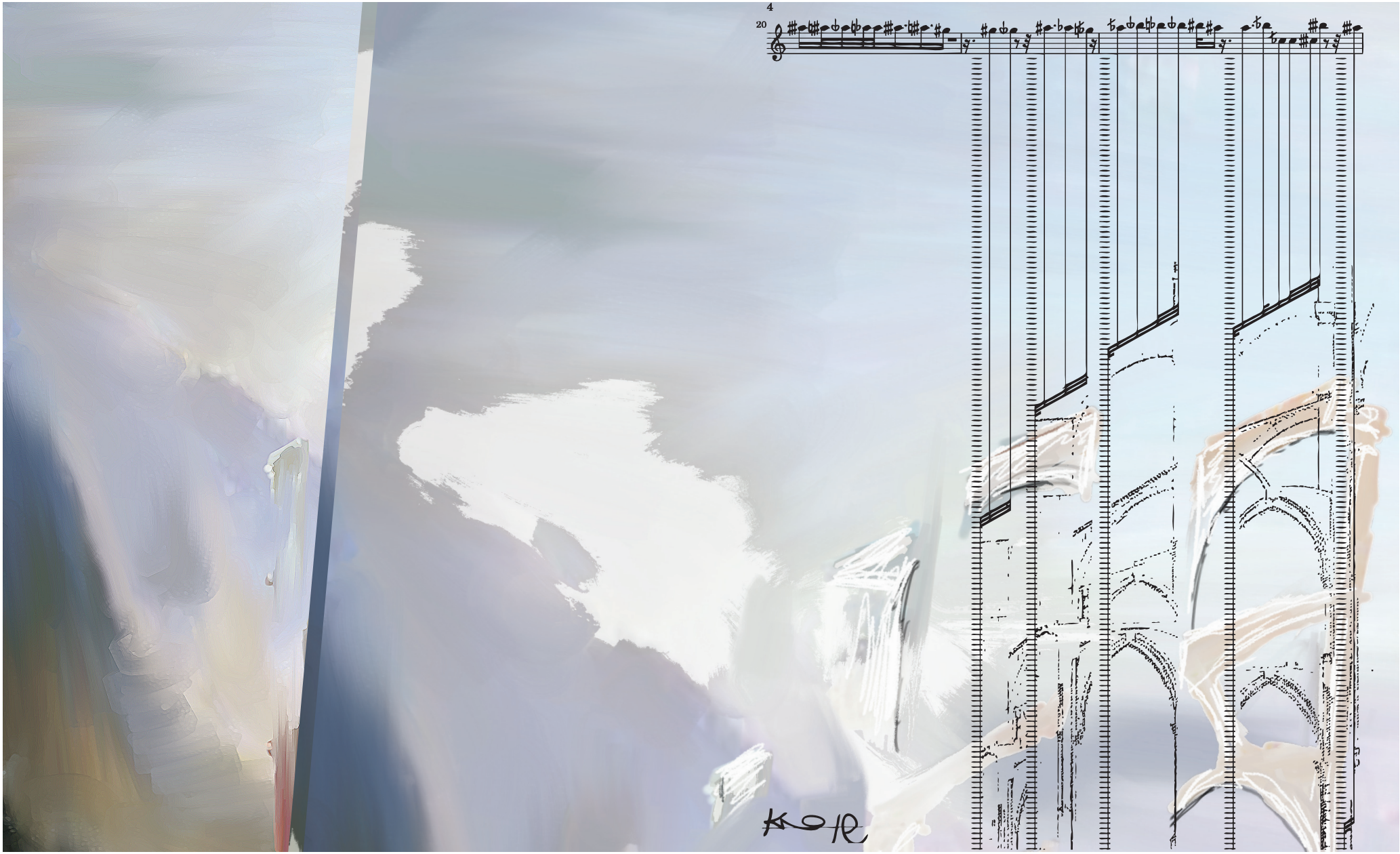
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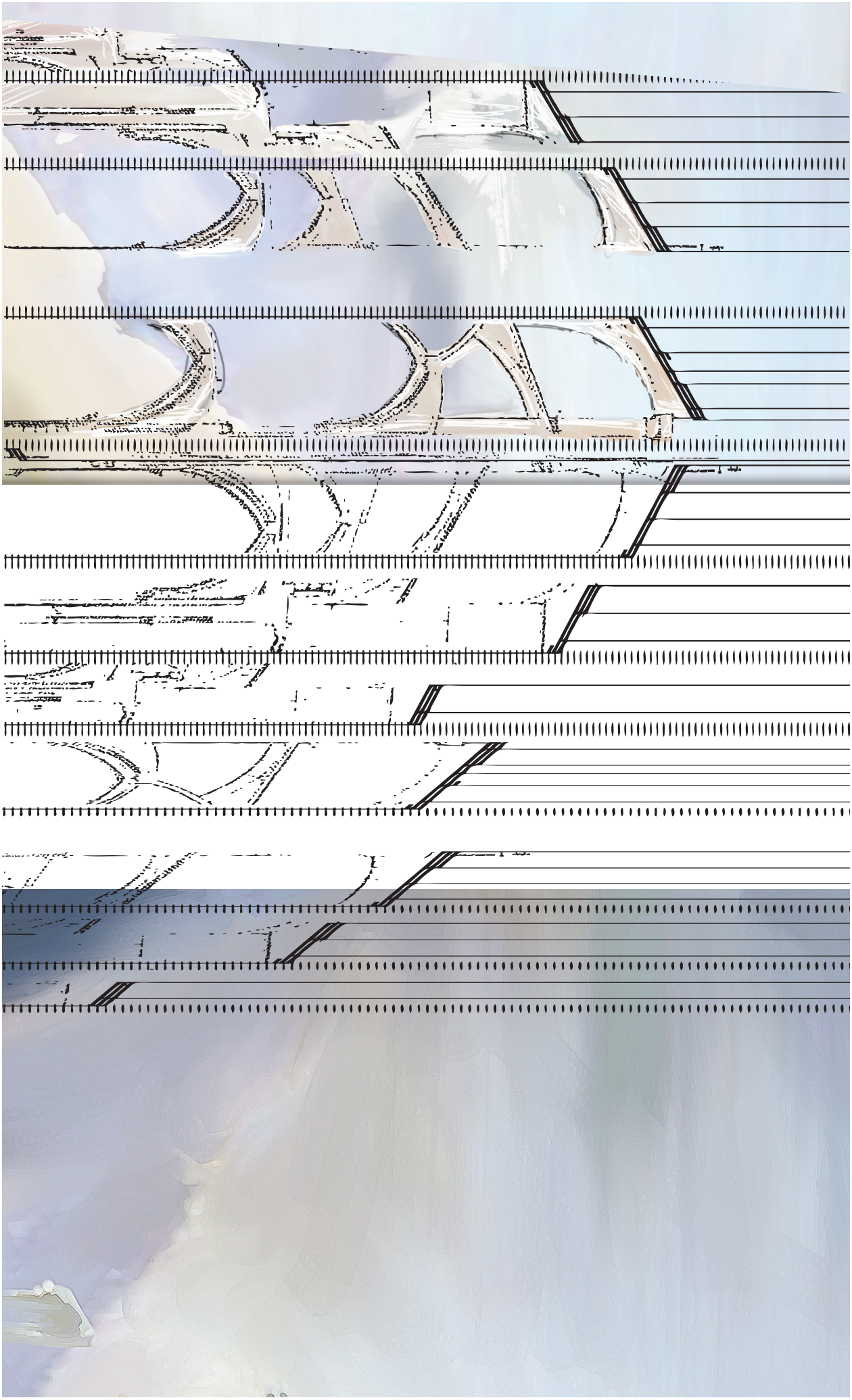
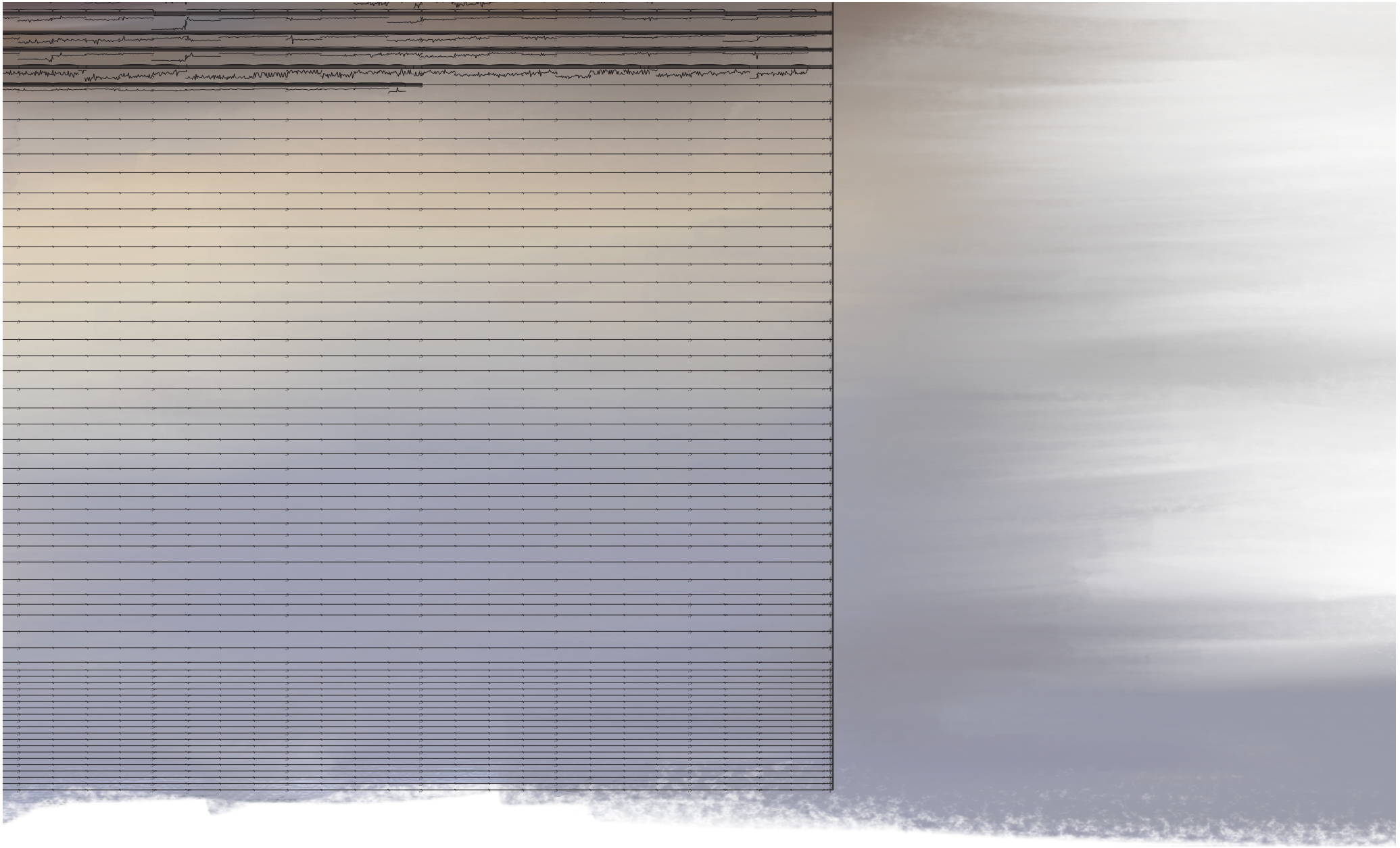
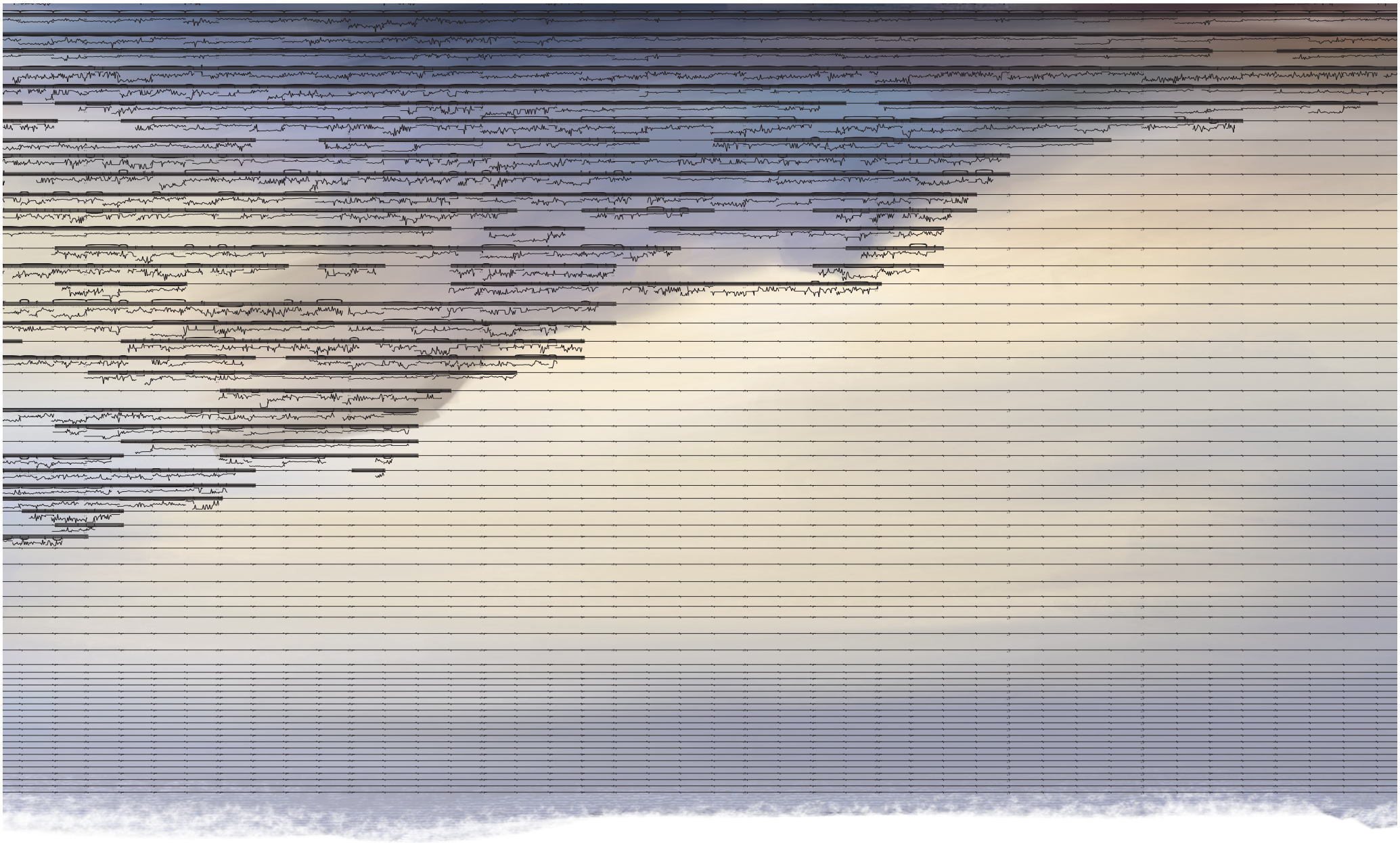
20







Kyrie

for accordion and electronics

2015

by
Kristina Wolfe

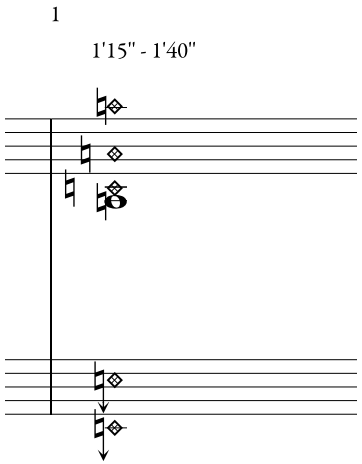
This is a piece for Accordion and live electronics.

There are two performers:
1) Accordionist (on stage)
2) Electronics Accompanist (offstage)

The accordion performs single notes, bellows, and octaves which are compounded and pitch shifted by the electronics.

These alterations were chosen because of the way they compound the timbre of the accordion.

Notation Key:

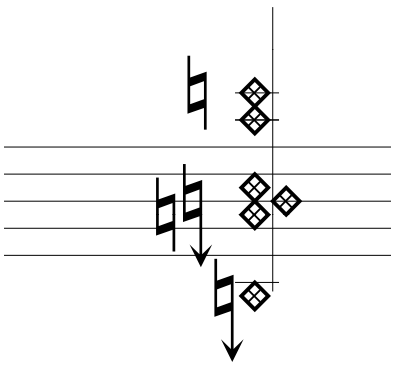


The diamonds are the pitches that result from the electronics processing

The round notes are the notes you key. You can choose how to phrase them and how much octave doubling, bellows, registers, etc.

Timing is very free here, but to get you started I have included timing guidelines (in minutes and seconds) and tempi. When you get a feel of the piece you are free to make it your own. It should last anywhere between 9 - 13 minutes.

45

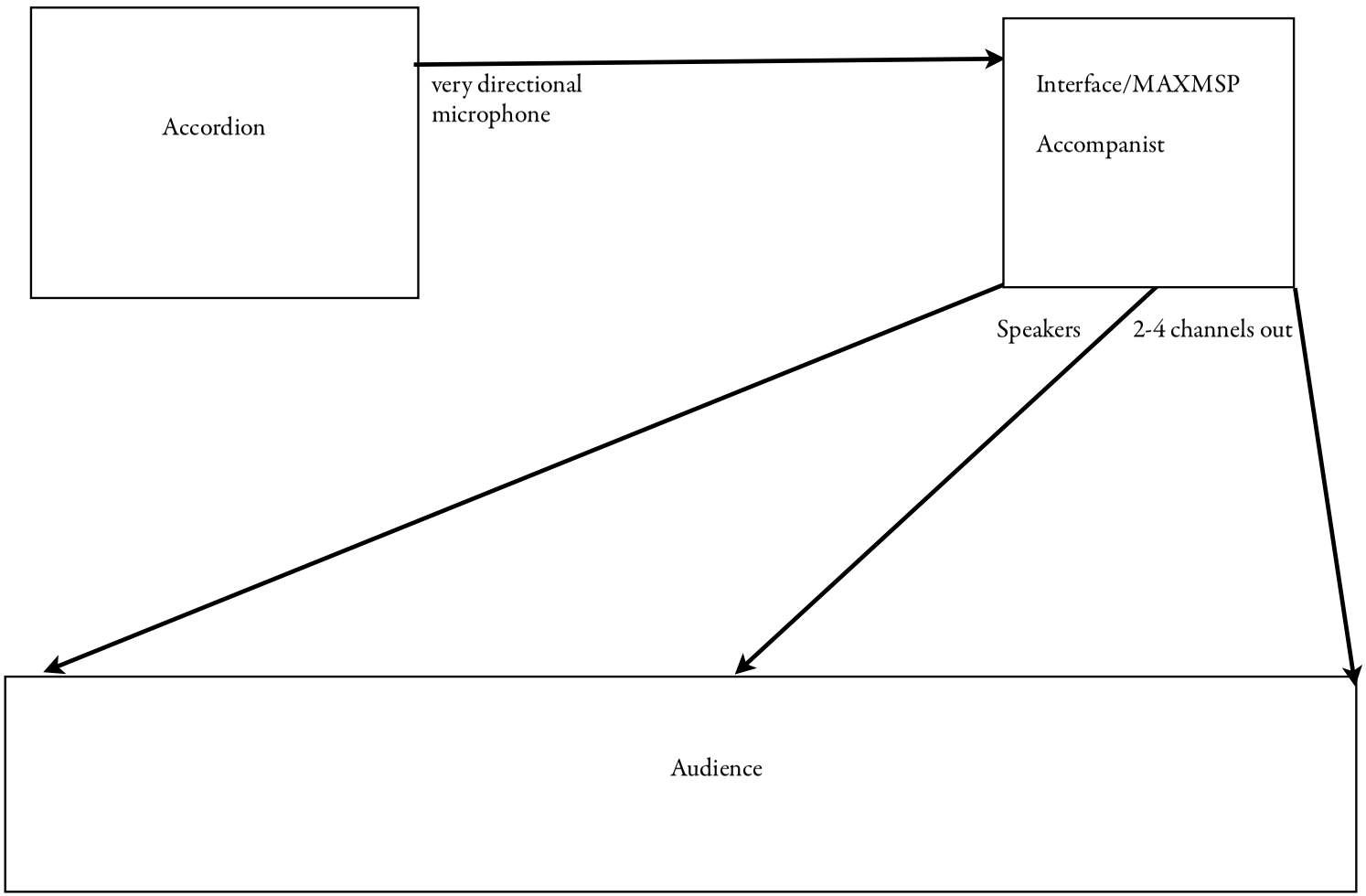


There are some rendering errors in the noteshape.

If you see an example where there is no rounded note, play the A in the chord.

The number above the chord is the preset. The accompanist should follow you and set the presets when you want them.

Helmholtz-Ellis Notation is used for accuracy.


Accordion
very directional
microphone
Interface/MAXMSP
Accompanist
Speakers
2-4 channels out
Audience

The Extended Helmholtz-Ellis JI Pitch Notation

microtonal accidentals designed by Marc Sabat and Wolfgang von Schweinitz, 2004

3-LIMIT (PYTHAGOREAN) INTERVALS

FUNCTION OF THE ACCIDENTALS

notate 35 pitches from the series of untempered perfect fifths
(3/2) ≈ ± 702.0 cents;
perfect fifth (3/2); perfect fourth (4/3); major wholetone (9/8)

5-LIMIT (PTOLEMAIC) INTERVALS

notate an alteration by one syntonic comma (81/80) ≈ ± 21.5 cents;
major third (5/4); minor third (6/5); major sixth (5/3); minor sixth (8/5); minor wholetone (10/9)

notate an alteration by two syntonic commas
(81/80)·(81/80) ≈ ± 43.0 cents;
augmented fifth (25/16); diminished fourth (32/25)

notate an alteration by three syntonic commas
(81/80)·(81/80)·(81/80) ≈ ± 64.5 cents;
minor diesis (128/125)

7-LIMIT (SEPTIMAL) INTERVALS

notate an alteration by one septimal comma (64/63) ≈ ± 27.3 cents;
natural seventh (7/4); septimal wholetone (8/7);
septimal diminished fifth (7/5); septimal tritone (10/7);
septimal minor third (7/6); septimal quartertone (36/35)

notate an alteration by two septimal commas
(64/63)·(64/63) ≈ ± 54.5 cents;
septimal sixthtone (49/48)

11-LIMIT (UNDECIMAL) INTERVALS

notate an alteration by one undecimal quartertone
(33/32) ≈ ± 53.3 cents;
undecimal augmented fourth (11/8); undecimal diminished fifth (16/11)

13-LIMIT (TRIDECIMAL) INTERVALS

notate an alteration by one tridecimal thirdtone (27/26) ≈ ± 65.3 cents;
tridecimal neutral sixth (13/8); tridecimal neutral third (16/13)

PRIMES IN THE HARMONIC SERIES OCTAVE 16 - 32 *(5-limit signs are given here relative to "A")*

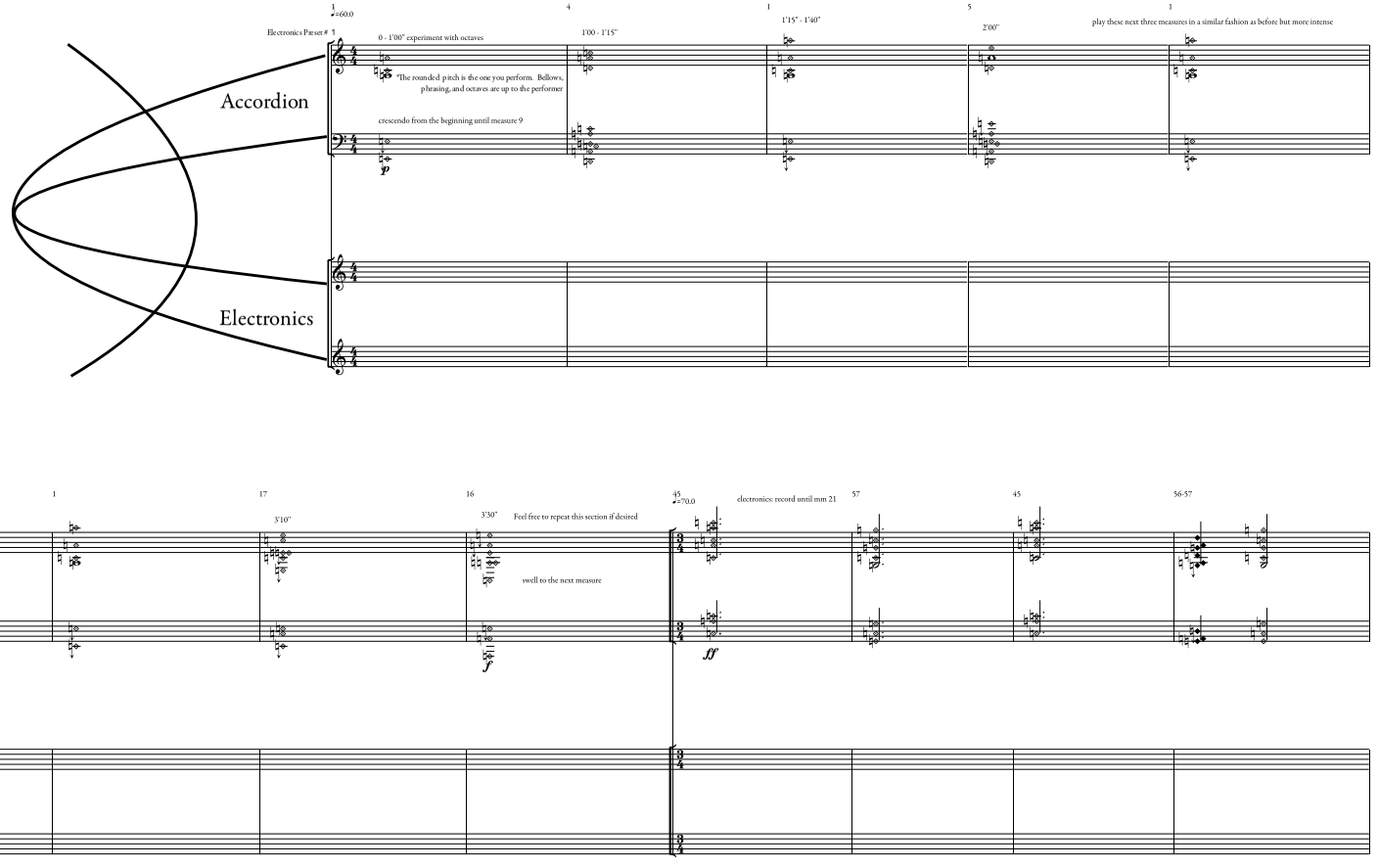
notate an alteration of the 5-limit accidental by one 17-limit schisma
(16/17)·(16/15) = (256/255) ≈ ± 6.8 cents;
Galileo's "equal-tempered" semitone (18/17);
17-limit diminshed seventh chord 10:12:14:17

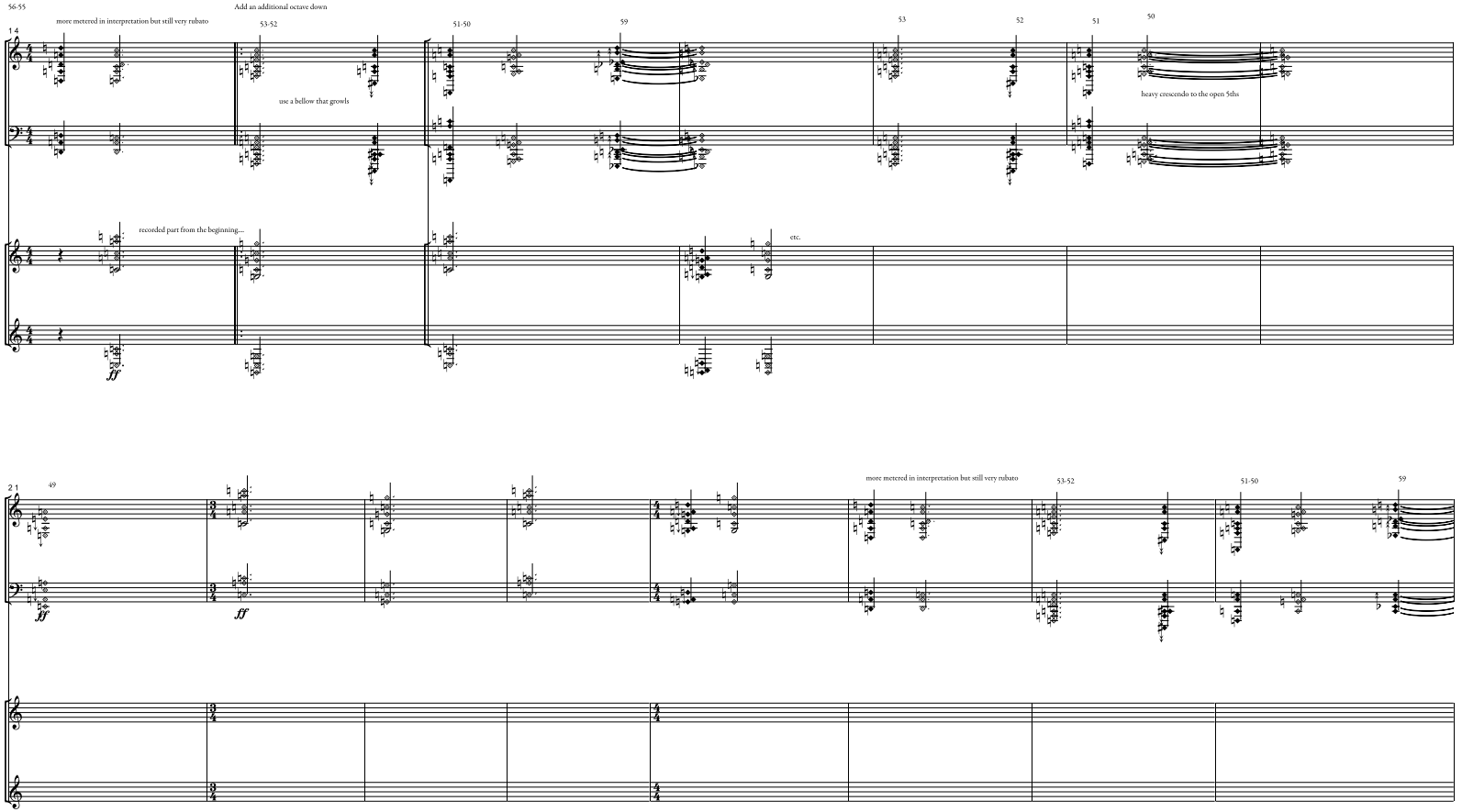
notate an alteration by one 19-limit schisma
(19/16)·(27/32) = (513/512) ≈ ± 3.4 cents;
19-limit minor third (19/16); 19-limit minor triad 16:19:24

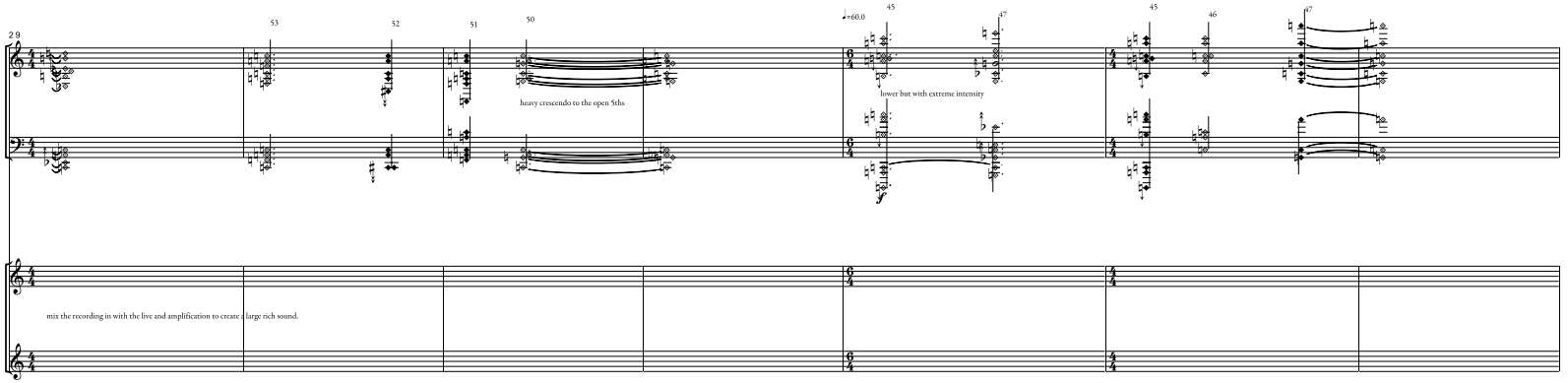
notate an alteration by one 23-limit comma
(23/16)·(8/9)·(8/9)·(8/9) ≈ ± 16.5 cents;
raised leading tone (23/12)

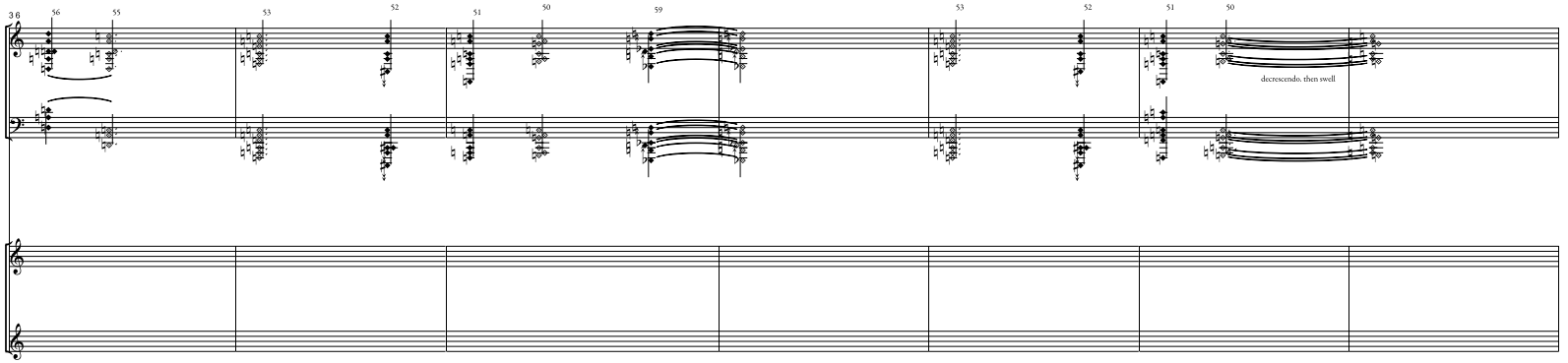
Kristina Wolfe

Kyrie

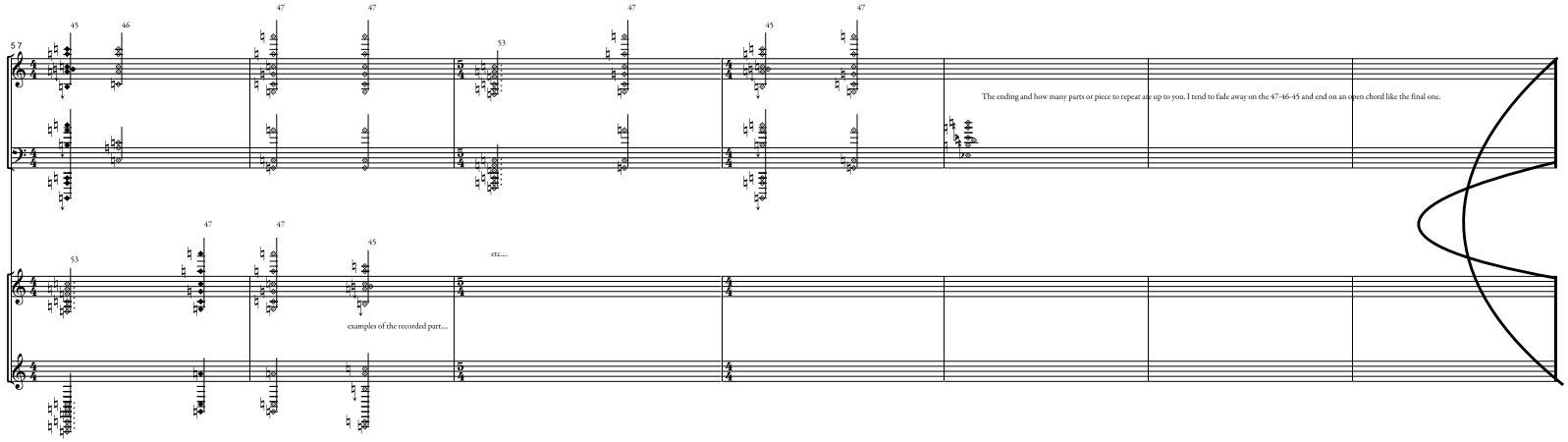



56-55
more metered in interpretation but still very rubato
Add an additional octave down
53-52
use a bellow that growls
51-50
59
53
52
51
50
heavy crescendo to the open 5ths
recorded part from the beginning...
etc.
ff
49
more metered in interpretation but still very rubato
53-52
51-50
59


29
53
52
51
50
heavy crescendo to the open 5ths
♩=60.0
45
47
lower but with extreme intensity
45
46
47
mix the recording in with the live and amplification to create a large rich sound.


38
56
55
53
52
51
50
59
53
52
51
50
decrescendo. then swell

decrescendo, then swell
decrescendo, then swell


5 7
45
46
47
47
53
47
45
47
The ending and how many parts or piece to repeat are up to you. I tend to fade away on the 47-46-45 and end on an open chord like the final one.
53
47
47
45
etc....
examples of the recorded part...

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(954) 830-6184

Ebbinge

flocking motion for 8 double basses

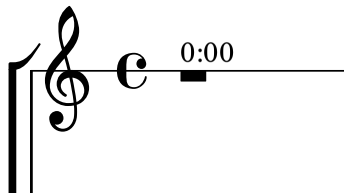
2015

by
Kristina Wolfe

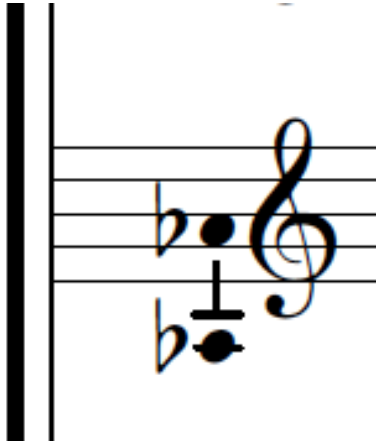
This piece is a stochastic work intended to capture the motion of drains/galaxies/flocking in timbre space. I have always been fascinated with the wandering, ebbing, and tonal parallelism of voices trying to converge upon a point.

Symbol

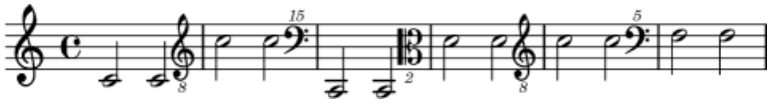
Meaning



Clef and time signatures are self-explanatory and tempo is assumed to be *60 bpm*.



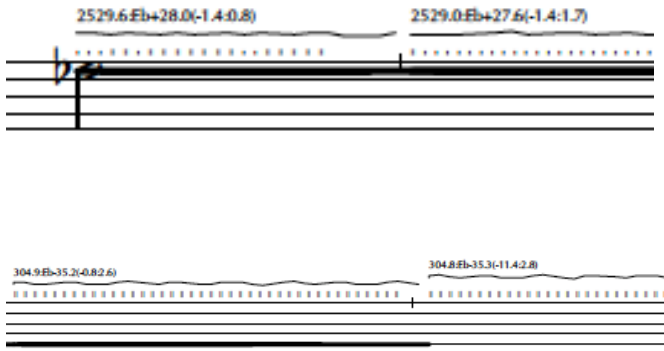
The tessitura of each staff is indicated at the beginning of the piece. Instrumentalists should choose a staff that is playable. Of course, if they like a challenge they can attempt the impossible.



Efforts have been made to minimize *ledger lines* and various treble and bass clefs are used instead. Each pitch is notated in *concert pitch* and is not transposed in register either.

Symbol	Meaning
	The *notches* in staves are the equivalent of *barlines* and are meant as a rough estimate of the beginning and end of a 4-second period.
	Time in the work is shown in *seconds*. For ease of reading, there is a notch every 4 seconds and will work well even if interpreted in 'common' time.
	Whole rests have the staff lines and rests omitted. This is done to make it clearer where entrances begin and end.

Symbol



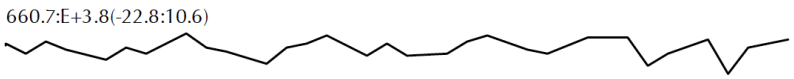
Meaning

The lines attached to longer notes indicate a prolonged sustain of a pitch. Bowing and timbre are up to the performer. Vibrato is not. Do not use vibrato.

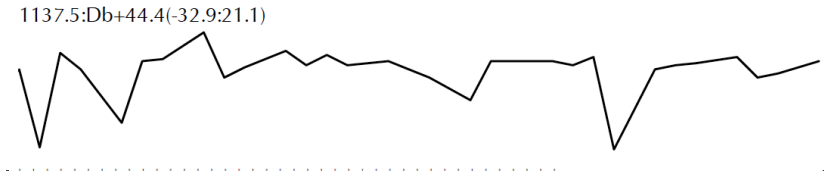
Longer sustains can be 'embellished' using bowing techniques such as circular bowing, playing overtones/harmonics, or doubling at the octave. Open strings and harmonics should be used whenever possible.

Occasionally, the sustain lines stop before the dynamic markings stop -- especially at the end of a long sustained pitch. In this case, hold the previous note until the end of the dynamic markings and pitch graph. Then, fade out.

Symbol



Other examples:



An example of a stable pitch:

Meaning

Every effort has been made to make this music easy as possible to read and to give each performer as much information in as little space as possible.

The gestalt of the pitch alteration is approximated using a line below the figure.

This does not need to be completely accurate in performance. Instead, use these markings as a guide.

That being said, perfection should be attempted in the beginning stages of private practice to get an idea of the melodic and timbral content in the line.

660.7:E+3.8(-22.8:10.6)

This symbol means:

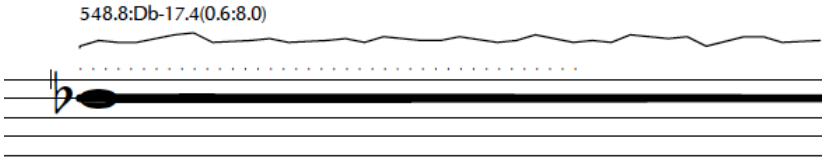
Pitch in Hertz **:** Equal Tempered Approximation of initial pitch with Alteration in cents **:** (lower bound **:** upper bound in cents **)**

It is important that <u>considerable</u> attention be paid to the alterations of the pitch.

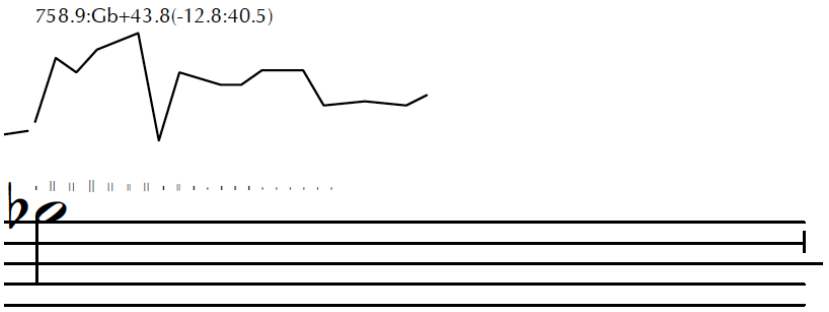
That being said, these numbers are intended as guides for human readers and are not meant to be intimidating or esoteric. They are as specific as they are because they are intended as a reference for performers who may use oscillators or pitch shifting software to practice.

Symbol **Meaning**

Note: the crest and troughs of the line are the upper and lower limits of the alterations. The 'center' of the gesture should be interpreted as your base note with the ET approximation. Some effort has been made to make the size of the waves reflective of the alterations overall. It is hoped that this will make it easier to read.



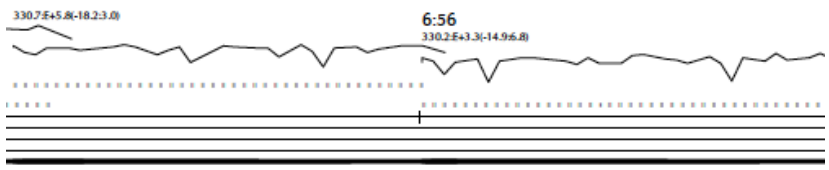
When combined with the line, you can see the subtle alterations of the pitch in time space



The ||||||||||| symbols above the staff are *dynamic markings*. The largest, most bold line is roughly equivalent of a *fortissimo* marking and the line continues smaller and smaller to *niente*. If you have a very, very, small line, play as quietly as possible. If there is ambiguity on what dynamic to perform, consult the score and play in relative loudness or softness to the others.

Using these lines, we can interpret the overall dynamic gesture of the pitch. Each dynamic marking is intended to last as long as the pitch. Combined with the pitch alterations, we can get a clearer picture of the harmonic and timbral gesture.

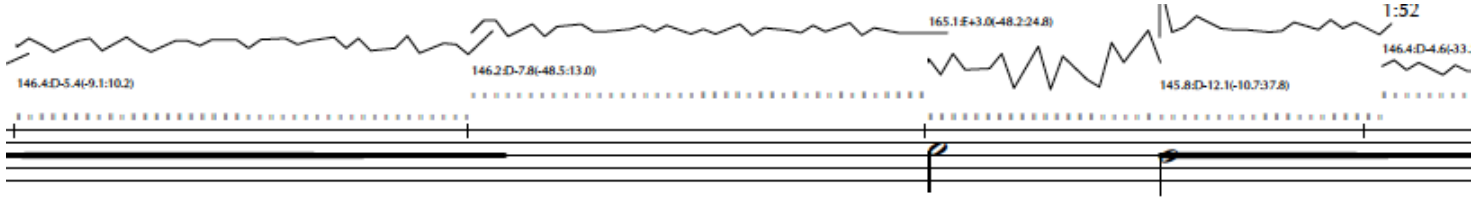
Symbol



Meaning

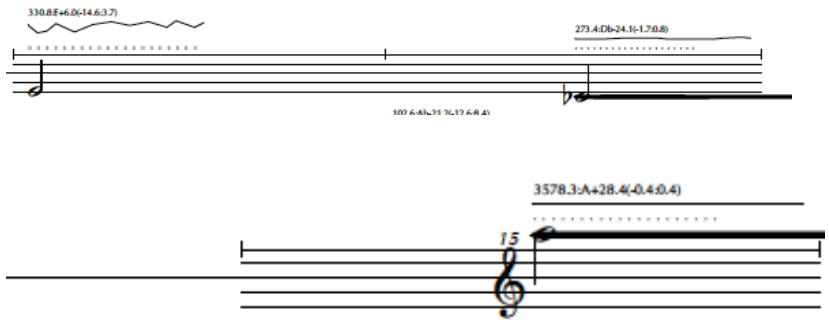
Considerable effort was put into the typesetting of the work. That being said, *sometimes the dynamic lines overlap with one another.* Most of the time these dots do not conflict substantially, but in cases where the notation overlaps and conflicts, it is useful to know that *the dynamics for the note <u>always</u> begin above the pitch* and last for the exact length of the pitch

Here is an example:



Even though there is a break between the lines, we should not interpret this as a break in pitch or gesture because we can see that there is a full line of pitch alteration and dynamic information. Unless indicated in the dynamics, phrase, or space (see below), lines should be considered to be continuous.

Symbol



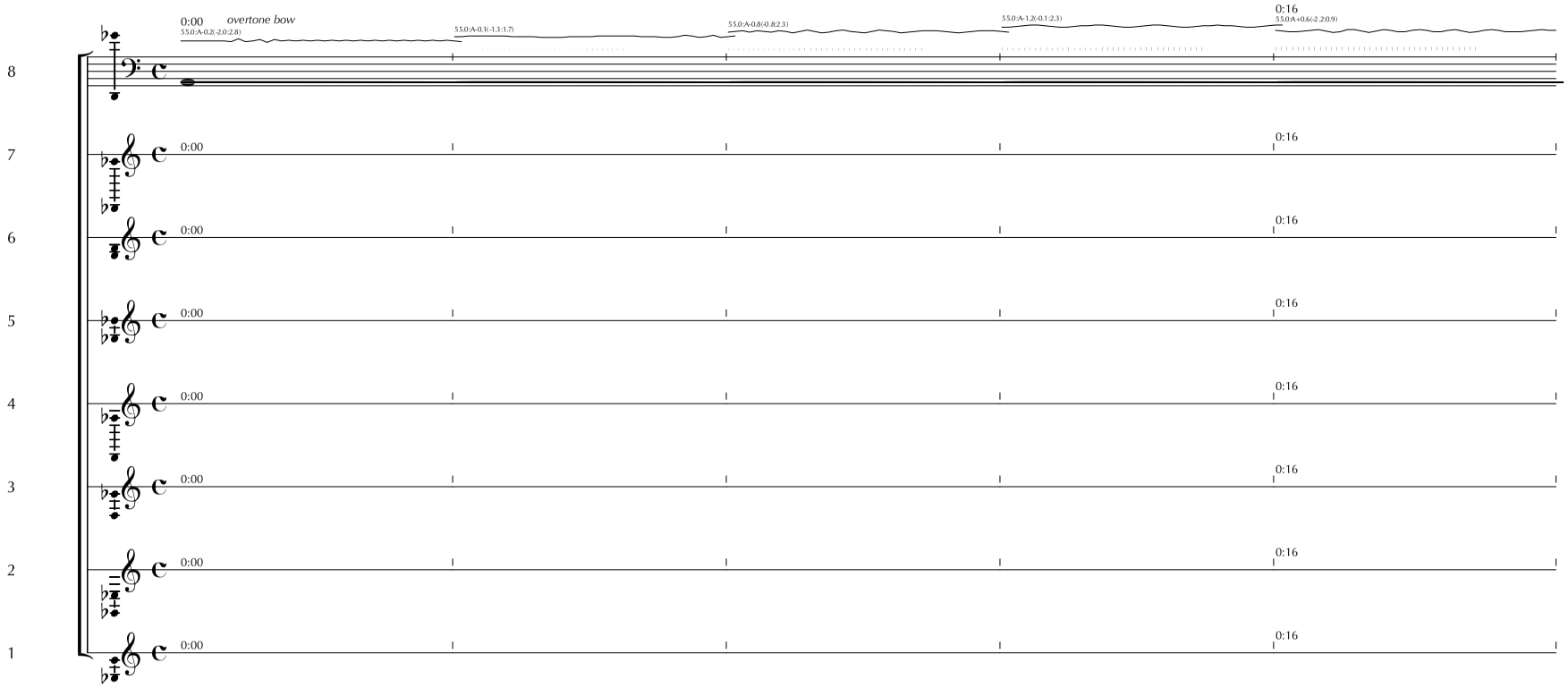
Meaning

Rests are indicated by space. Blank lines indicate silences as well.

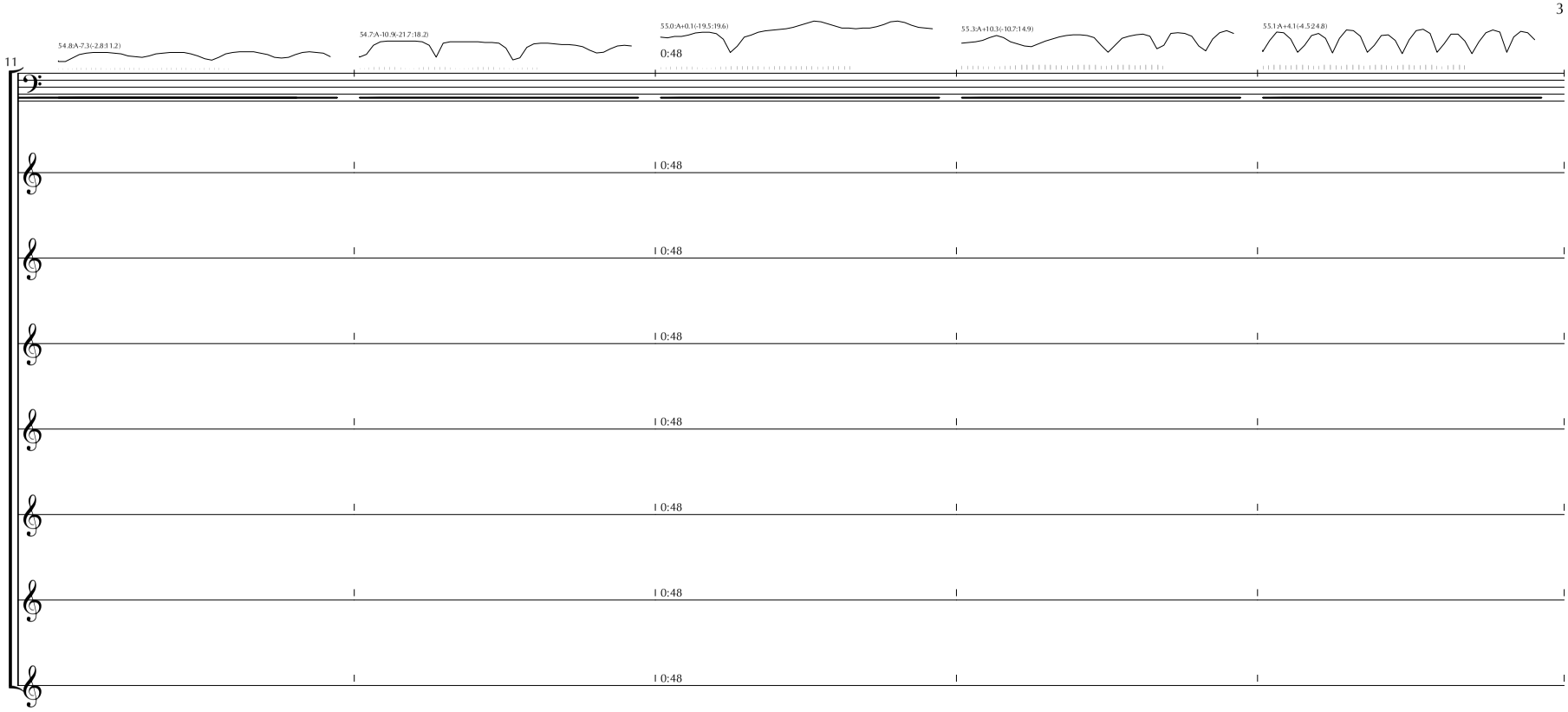
Areas without pitch or dynamic information should be interpreted as silence.

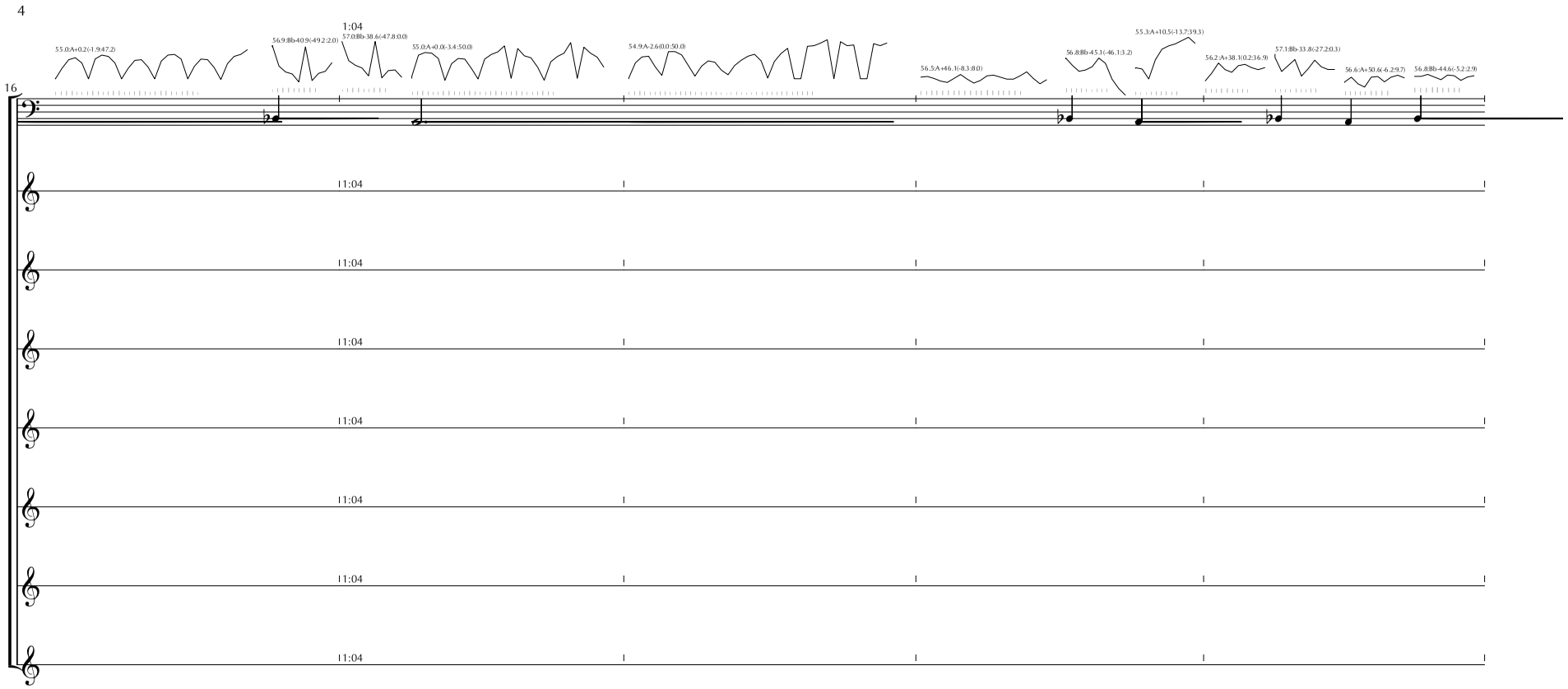
Ebbinge

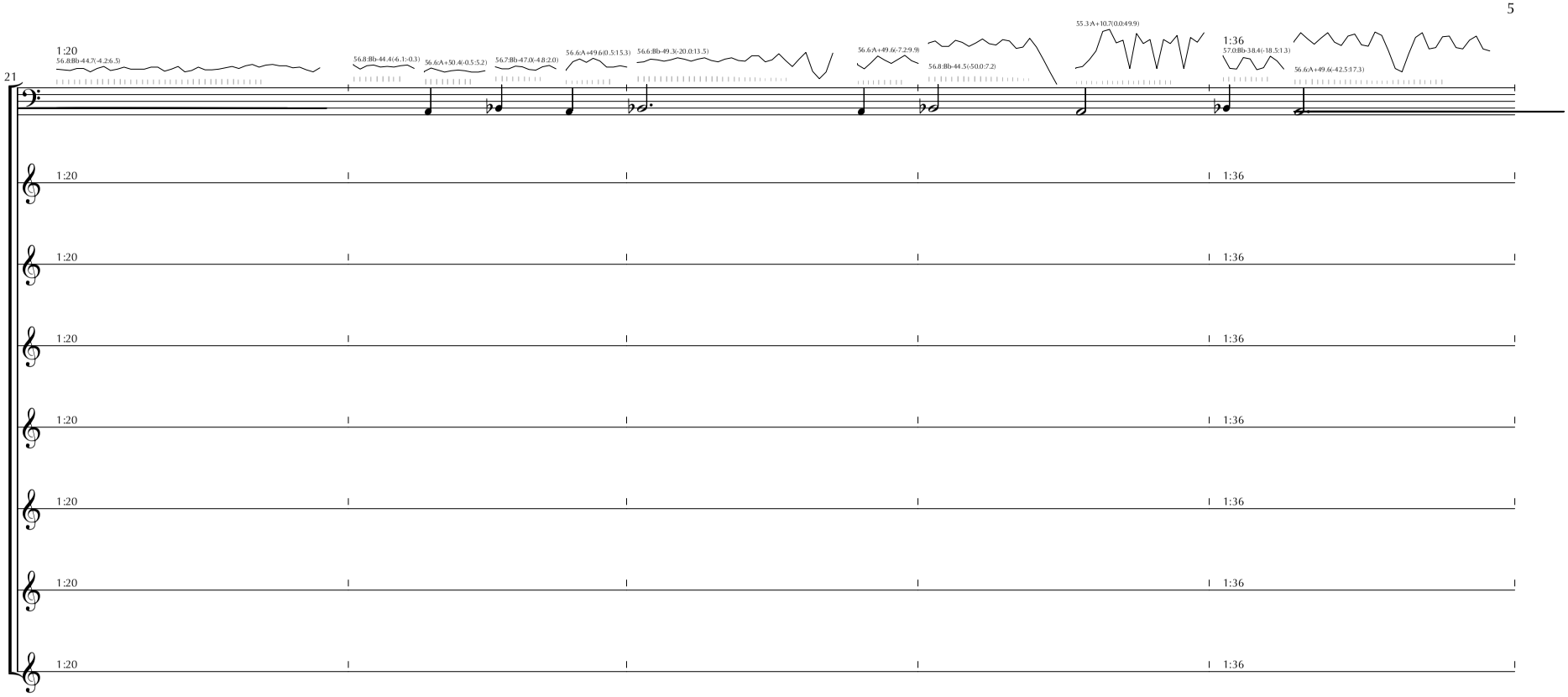
for 8 Double Basses

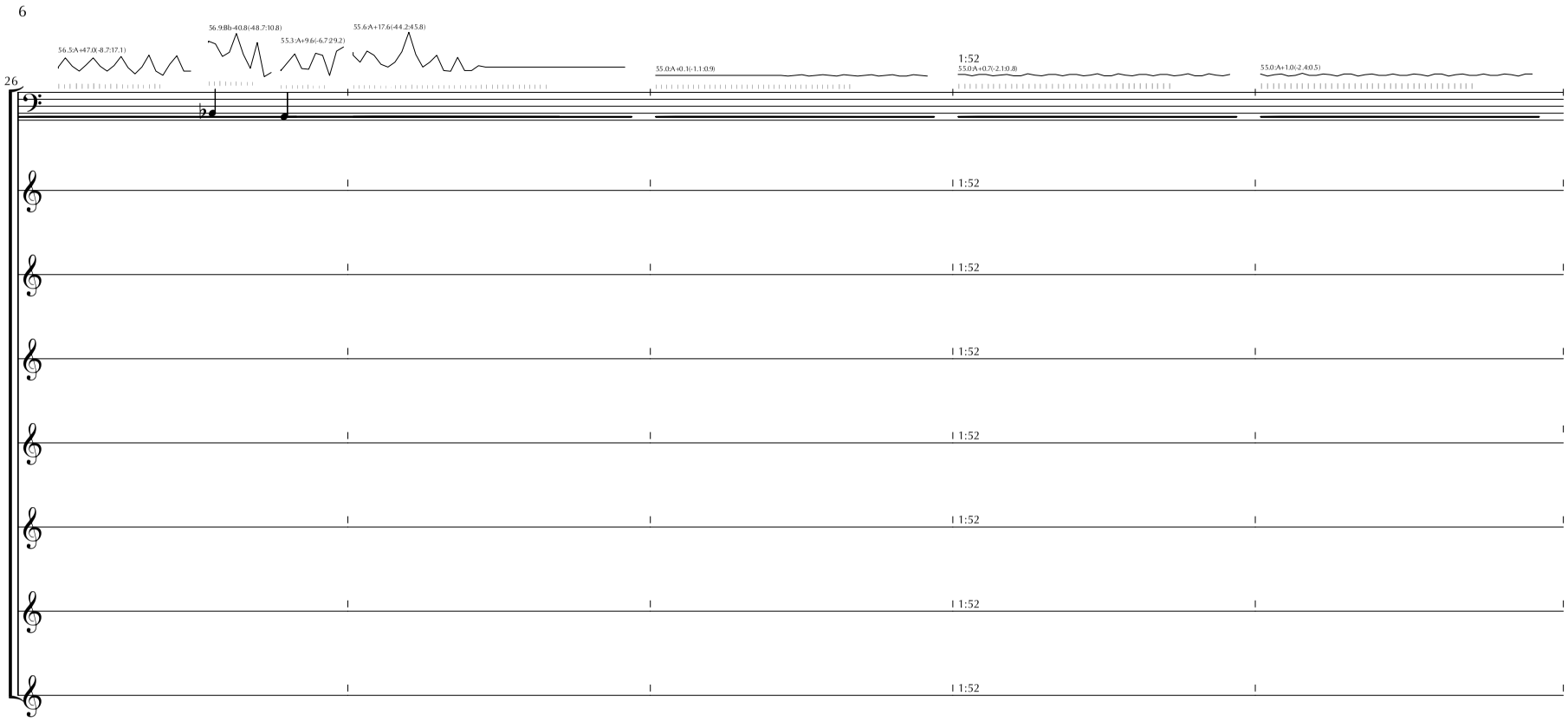


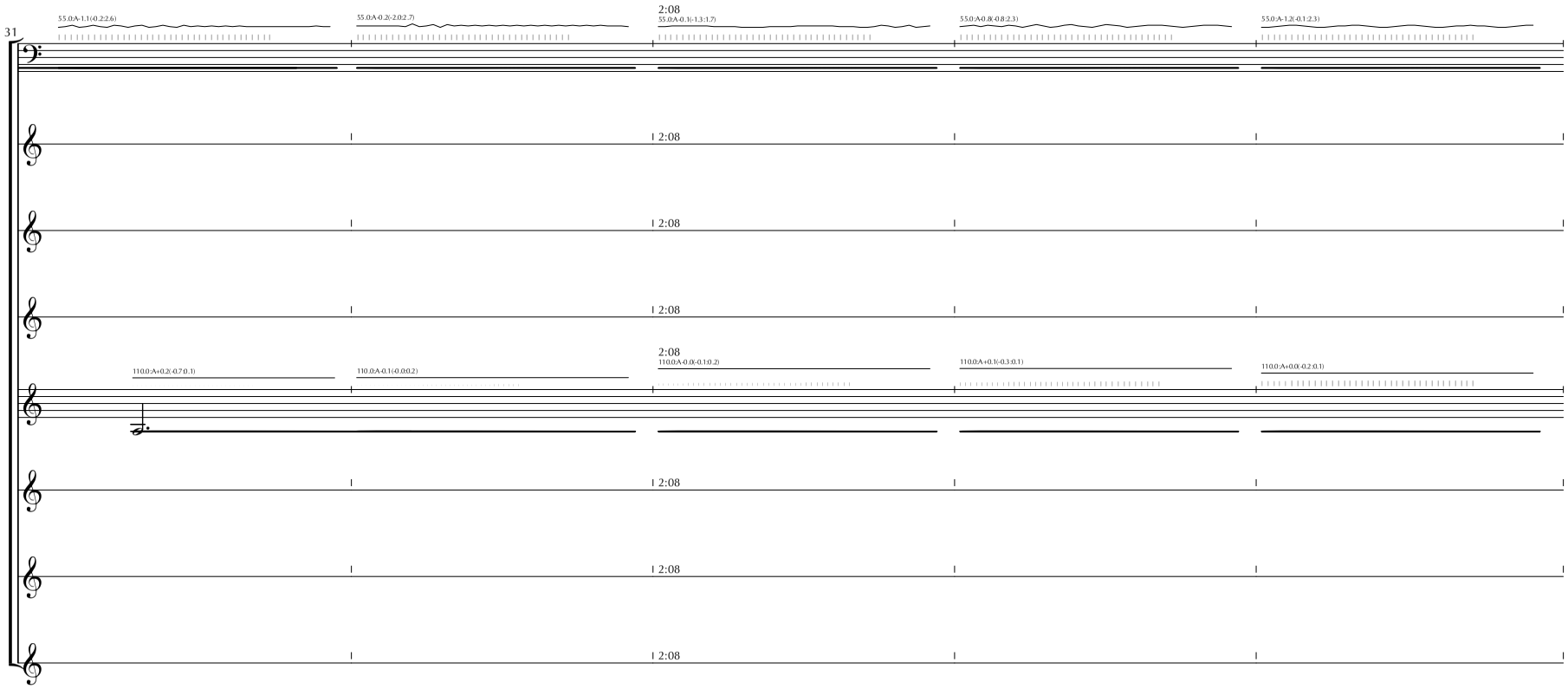
2
6
55.0:A-0.2:(-0.8:1.2)
55.0:A+0.1:(-1.2:0.8)
55.0:A+0.1:(-1.3:0.9)
0:32
55.0:A-0.3:(-1.1:1.7)
55.0:A+0.5:(-34.9:8.2)
0:32
0:32
0:32
0:32
0:32
0:32
0:32

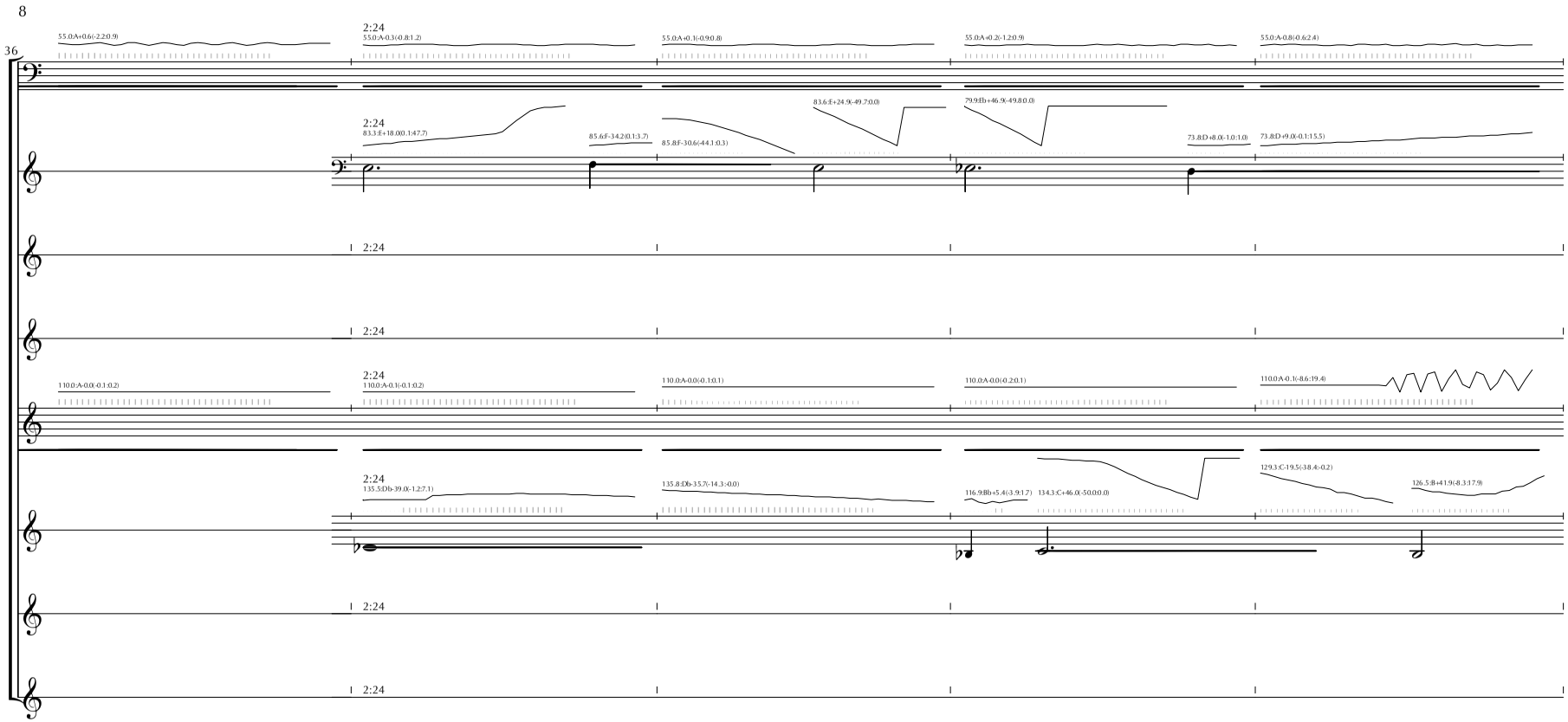

11
54.8(A-7.3(-2.8:11.2)
54.7(A-10.9(-21.7:18.2)
55.0(A+0.1(-19.5:19.6)
0:48
55.3(A+10.3(-10.7:14.9)
55.1(A+4.1(-4.5:24.8)
0:48
0:48
0:48
0:48
0:48
0:48
0:48

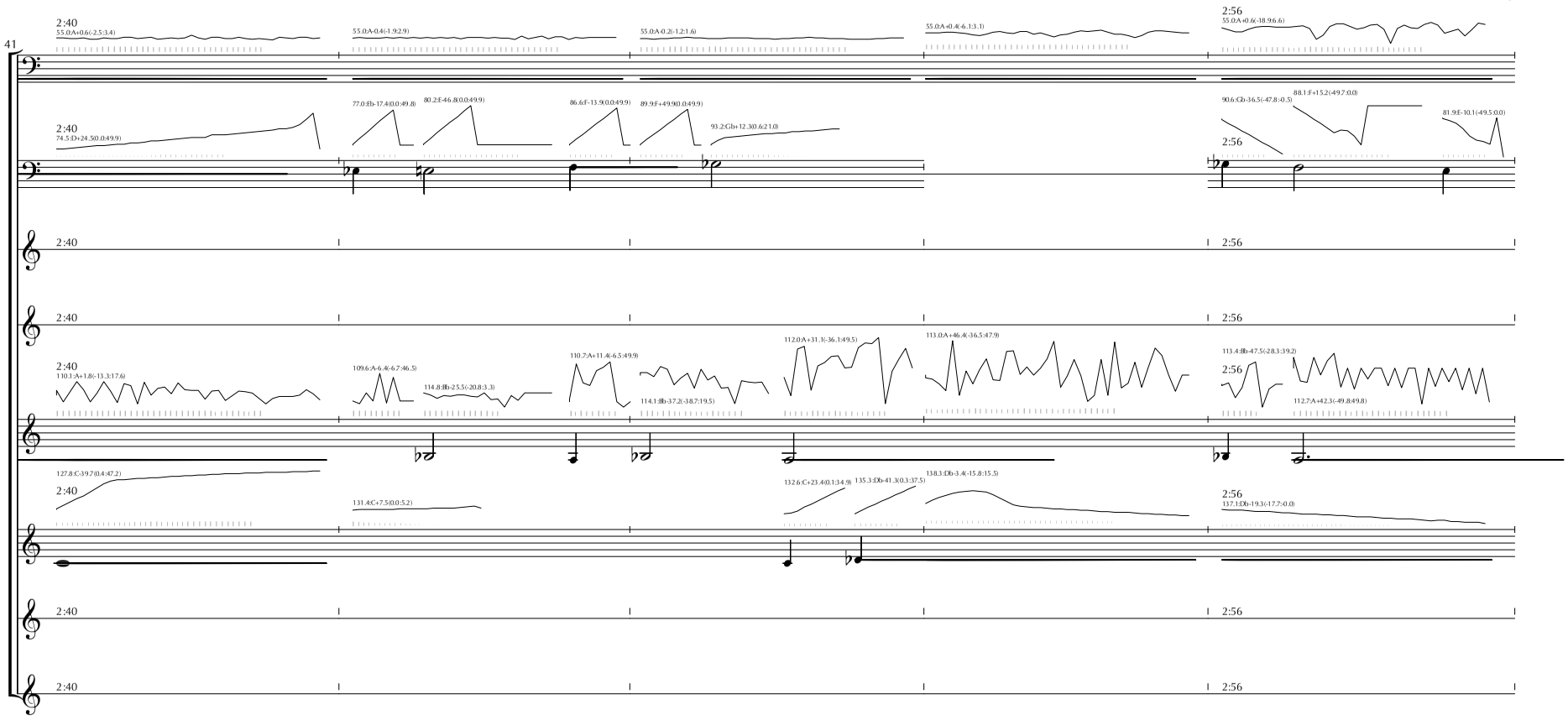

4
16
1:04
55.0:A+0.2(-1.9:47.2)
56.9:Bb-40.9(-49.2:2.0)
57.0:Bb-38.6(-47.8:0.0)
55.0:A+0.0(-3.4:50.0)
54.9:A-2.6(0.0:50.0)
56.5:A+46.1(-8.3:8.0)
56.8:Bb-45.1(-46.1:3.2)
55.3:A+10.5(-13.7:39.3)
56.2:A+38.1(0.2:36.9)
57.1:Bb-33.8(-27.2:0.3)
56.6:A+50.6(-6.2:9.7)
56.8:Bb-44.6(-5.2:2.9)
11:04
11:04
11:04
11:04
11:04
11:04
11:04

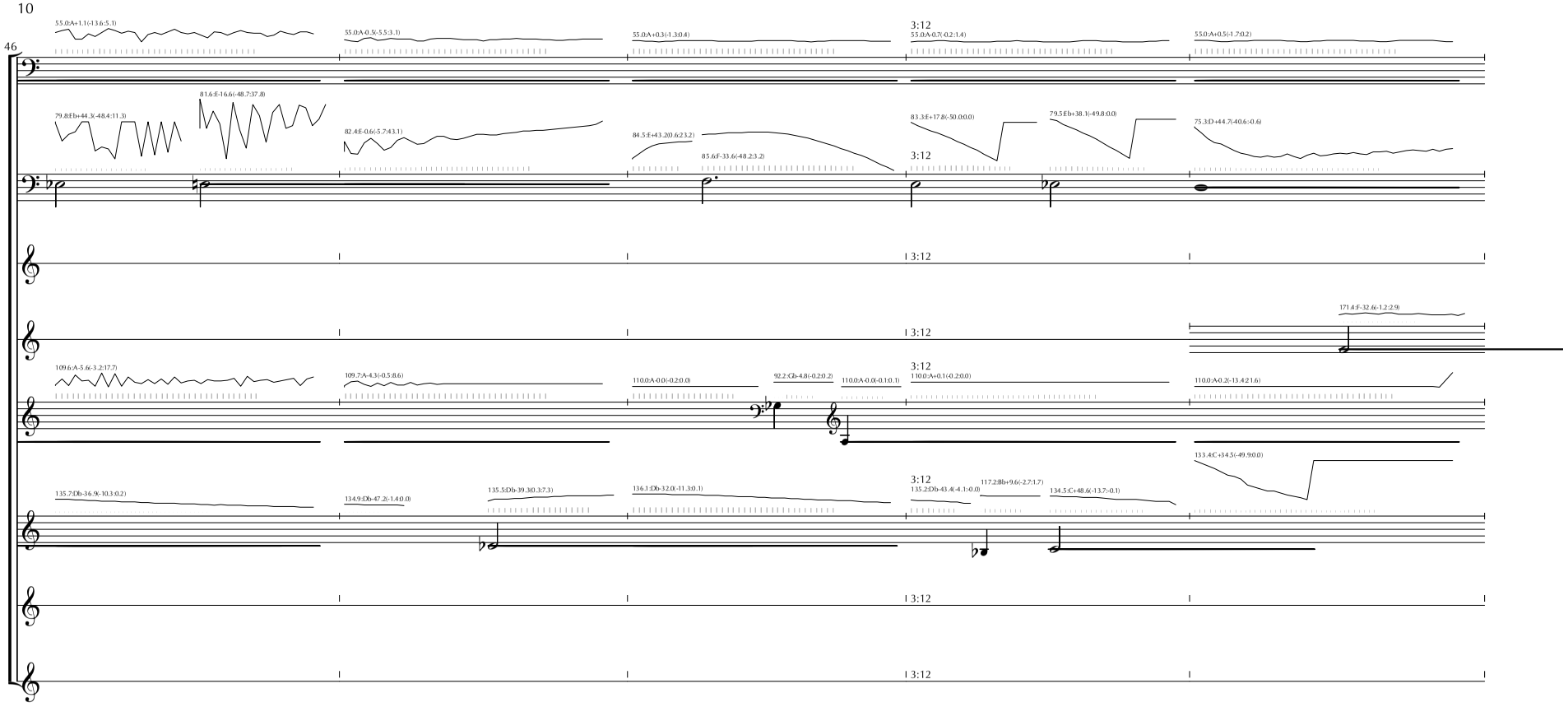

21
1:20
56.8:Bb-44.7(-4.2:6.5)
56.8:Bb-44.4(-6.1:-0.3)
56.6:A+50.4(-0.5:5.2)
56.7:Bb-47.0(-4.8:2.0)
56.6:A+49.6(0.5:15.3)
56.6:Bb-49.3(-20.0:13.5)
56.6:A+49.6(-7.2:9.9)
56.8:Bb-44.5(-50.0:7.2)
55.3:A+10.7(0.0:49.9)
1:36
57.0:Bb-38.4(-18.5:1.3)
56.6:A+49.6(-42.5:17.3)
1:20
1:36

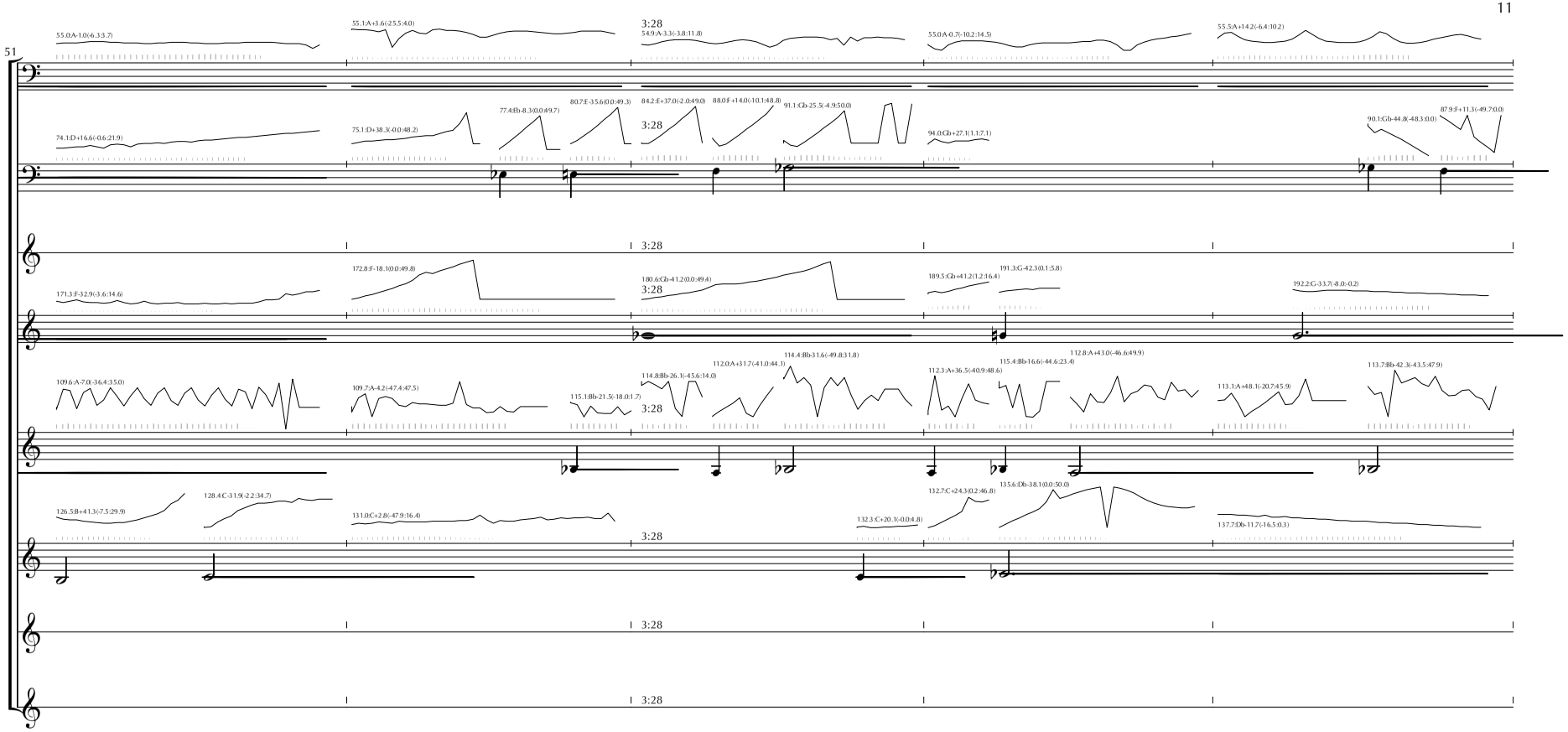

6
26
56.5:A+47.0(-8.7:17.1)
56.9:Bb-40.8(-48.7:10.8)
55.3:A+9.6(-6.7:29.2)
55.6:A+17.6(-44.2:45.8)
55.0:A+0.1(-1.1:0.9)
1:52
55.0:A+0.7(-2.1:0.8)
55.0:A+1.0(-2.4:0.5)
1:52
1:52
1:52
1:52
1:52
1:52
1:52

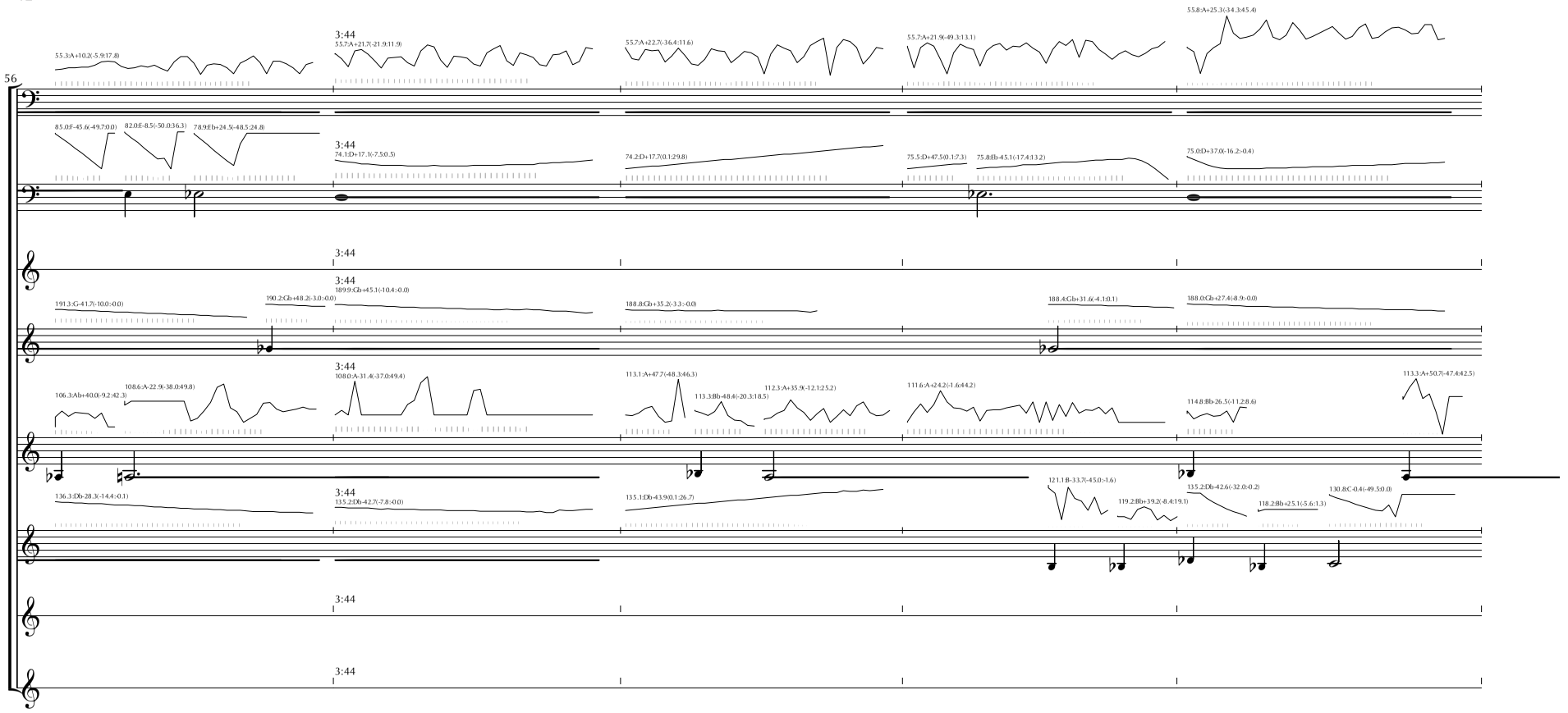

31
55.0:A-1.1:(-0.2:2.6)
55.0:A-0.2:(-2.0:2.7)
2:08
55.0:A-0.1:(-1.3:1.7)
55.0:A-0.8:(-0.8:2.3)
55.0:A-1.2:(-0.1:2.3)
110.0:A+0.2:(-0.7 0.1)
110.0:A-0.1:(-0.0:0.2)
110.0:A-0.0:(-0.1:0.2)
110.0:A+0.1:(-0.3:0.1)
110.0:A+0.0:(-0.2:0.1)

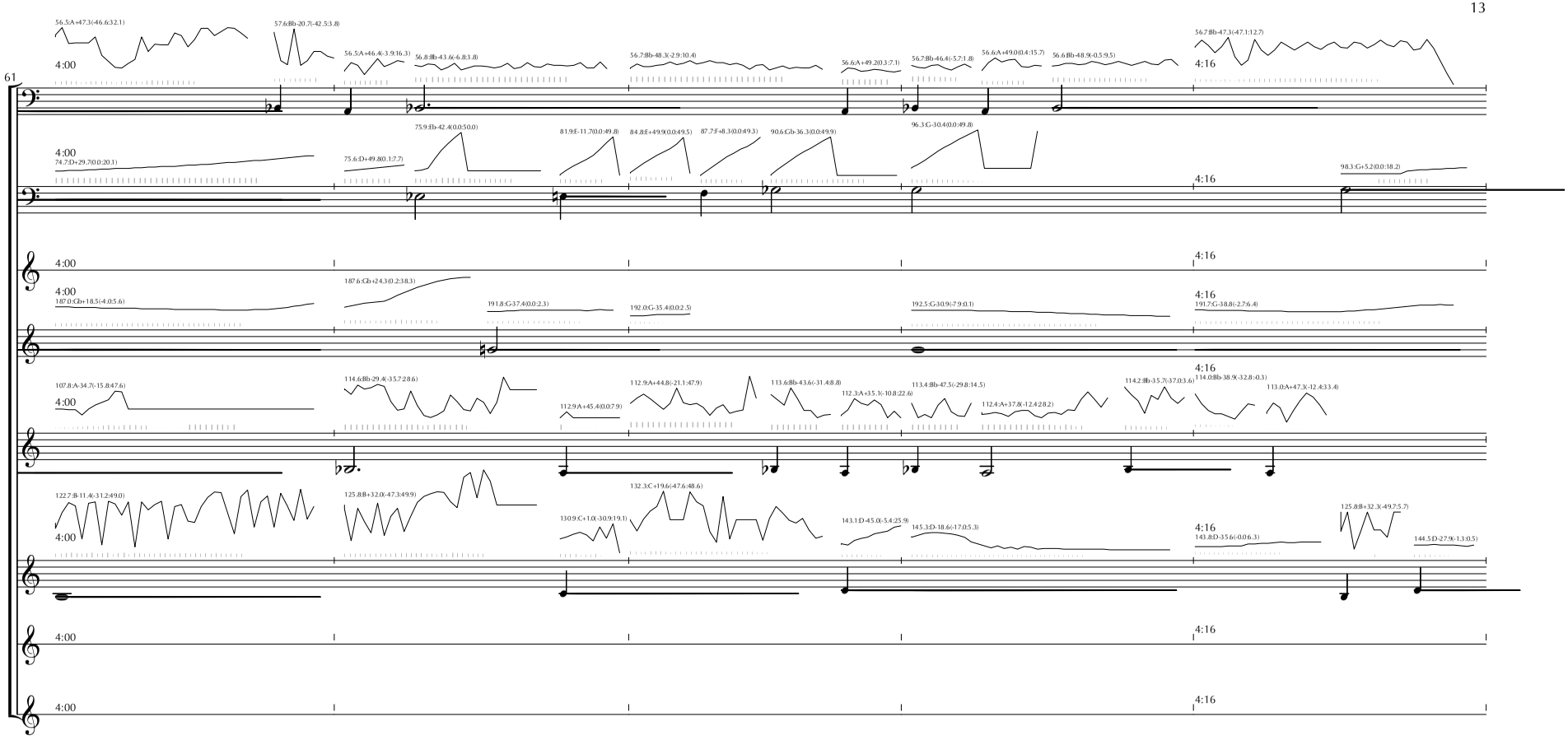

36
55.0:A+0.6(-2.2:0.9)
2:24
55.0:A-0.3(-0.8:1.2)
55.0:A+0.1(-0.9:0.8)
55.0:A+0.2(-1.2:0.9)
55.0:A-0.8(-0.6:2.4)
2:24
83.3:E+18.0(0.1:47.7)
85.6:F-34.2(0.1:3.7)
85.8:F-30.6(-44.1:0.3)
83.6:E+24.9(-49.7:0.0)
79.9:Eb+46.9(-49.8:0.0)
73.8:D+8.0(-1.0:1.0)
73.8:D+9.0(-0.1:15.5)
2:24
2:24
110.0:A-0.0(-0.1:0.2)
2:24
110.0:A-0.1(-0.1:0.2)
110.0:A-0.0(-0.1:0.1)
110.0:A-0.0(-0.2:0.1)
110.0:A-0.1(-8.6:19.4)
2:24
135.5:Db-39.0(-1.2:7.1)
135.8:Db-35.7(-14.3:-0.0)
116.9:Bb+5.4(-3.9:1.7)
134.3:C+46.0(-50.0:0.0)
129.3:C-19.5(-38.4:-0.2)
126.5:B+41.9(-8.3:17.9)
2:24
2:24

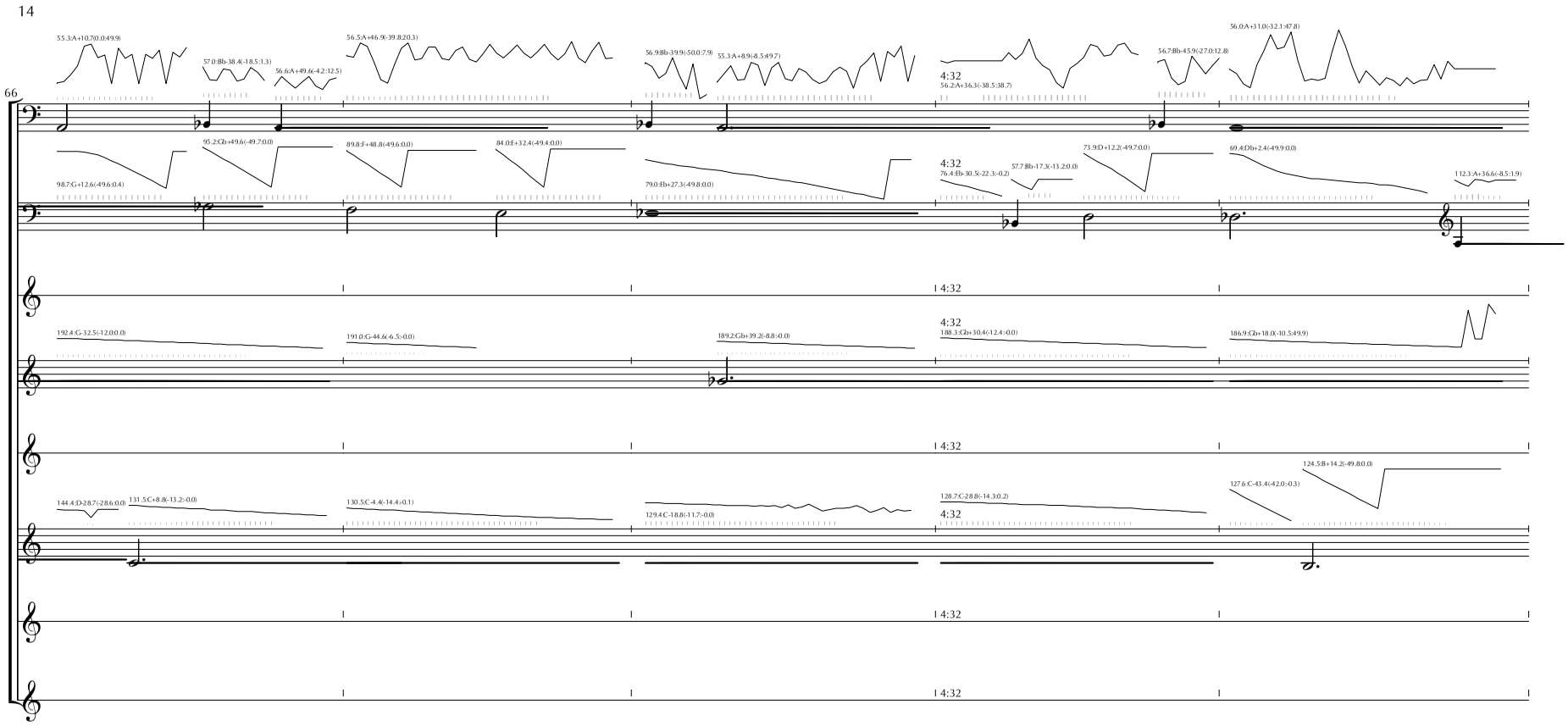

41
2:40
55.0:A+0.6(-2.5:3.4)
55.0:A-0.4(-1.9:2.9)
55.0:A-0.2(-1.2:1.6)
55.0:A+0.4(-6.1:3.1)
2:56
55.0:A+0.6(-18.9:6.6)
2:40
74.5:D+24.5(0.0:49.9)
77.0:Eb-17.4(0.0:49.8)
80.2:E-46.8(0.0:49.9)
86.6:F-13.9(0.0:49.9)
89.9:F+49.9(0.0:49.9)
93.2:Gb+12.3(0.6:21.0)
2:56
90.6:Gb-36.5(-47.8:-0.5)
88.1:F+15.2(-49.7:0.0)
81.9:E-10.1(-49.5:0.0)
2:40
2:56
2:40
2:56
2:40
110.1:A+1.8(-13.3:17.6)
109.6:A-6.4(-6.7:46.5)
114.8:Bb-25.5(-20.8:3.3)
110.7:A+11.4(-6.5:49.9)
114.1:Bb-37.2(-38.7:19.5)
112.0:A+31.1(-36.1:49.5)
113.0:A+46.4(-36.5:47.9)
2:56
113.4:Bb-47.5(-28.3:39.2)
112.7:A+42.3(-49.8:49.8)
127.8:C-39.7(0.4:47.2)
2:40
131.4:C+7.5(0.0:5.2)
132.6:C+23.4(0.1:34.9)
135.3:Db-41.3(0.3:37.5)
138.3:Db-3.4(-15.8:15.5)
2:56
137.1:Db-19.3(-17.7:-0.0)
2:40
2:56
2:40
2:56

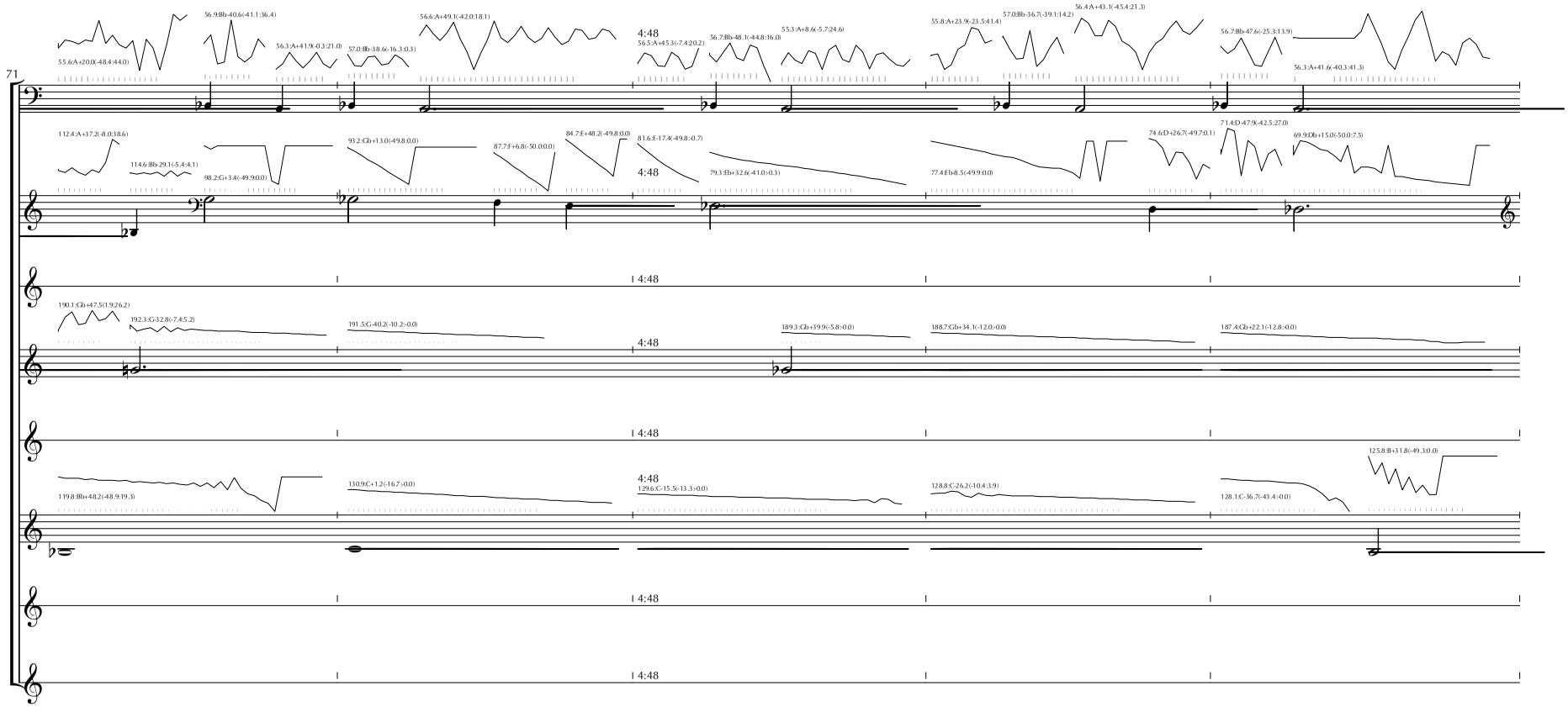

10
46
55.0:A+1.1(-13.6:-5.1)
55.0:A-0.5(-5.5:-3.1)
55.0:A+0.3(-1.3:0.4)
3:12
55.0:A-0.7(-0.2:-1.4)
55.0:A+0.5(-1.7:0.2)
79.8:Eb+44.3(-48.4:11.3)
81.6:E-16.6(-48.7:37.8)
82.4:E-0.6(-5.7:43.1)
84.5:E+43.2(0.6:23.2)
85.6:F-33.6(-48.2:3.2)
83.3:E+17.8(-50.0:0.0)
79.5:Eb+38.1(-49.8:0.0)
75.3:D+44.7(-40.6:-0.6)
171.4:F-32.6(-1.2:2.9)
109.6:A-5.6(-3.2:17.7)
109.7:A-4.3(-0.5:8.6)
110.0:A-0.0(-0.2:0.0)
92.2:Gb-4.8(-0.2:0.2)
110.0:A-0.0(-0.1:0.1)
110.0:A+0.1(-0.2:0.0)
110.0:A-0.2(-13.4:21.6)
133.4:C+34.5(-49.9:0.0)
135.7:Db-36.9(-10.3:0.2)
134.9:Db-47.2(-1.4:0.0)
135.5:Db-39.3(0.3:7.3)
136.1:Db-32.0(-11.3:0.1)
135.2:Db-43.4(-4.1:-0.0)
117.2:Bb+9.6(-2.7:1.7)
134.5:C+48.6(-13.7:-0.1)

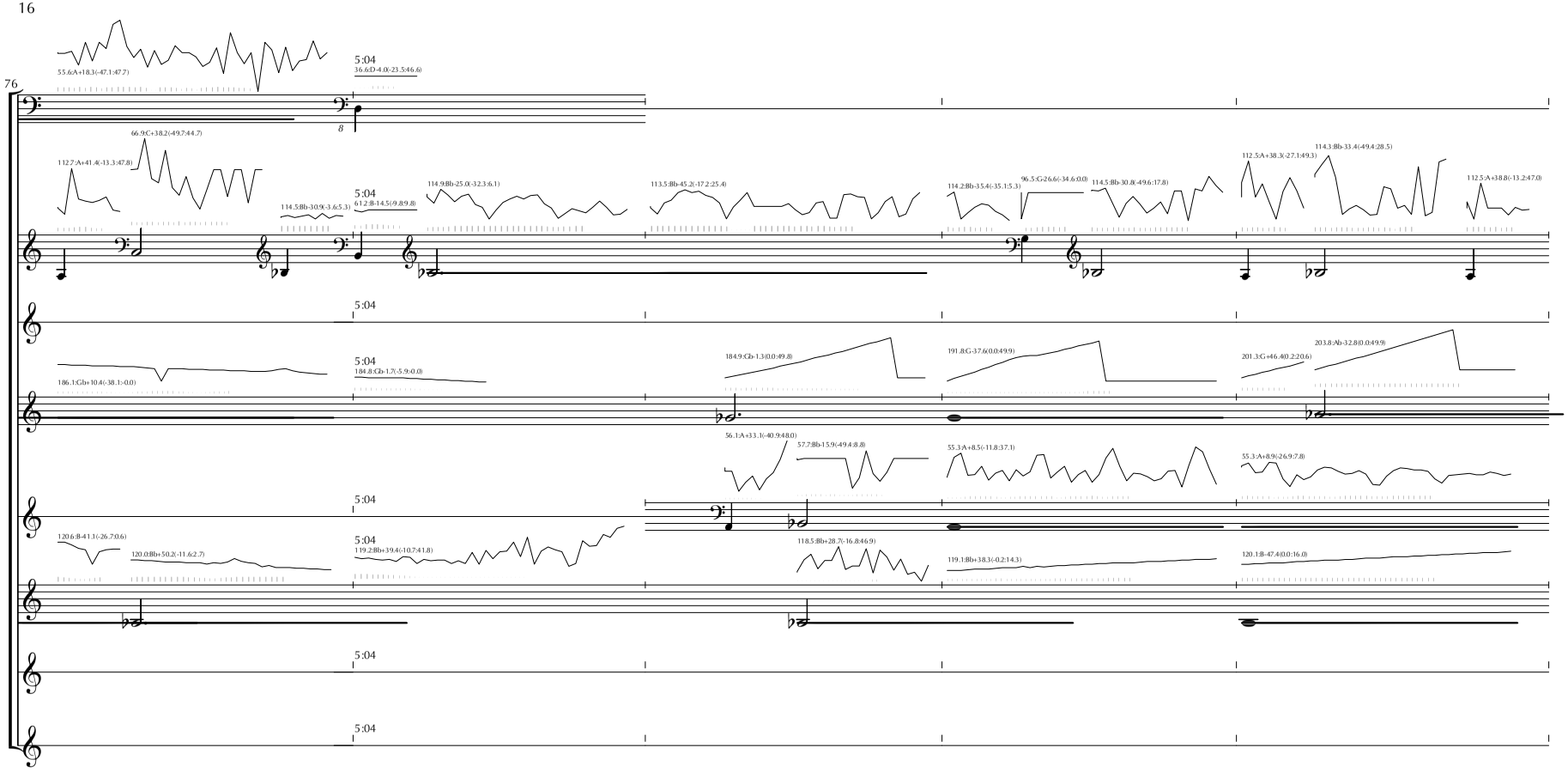

51
55.0:A-1.0(-6.3:3.7)
55.1:A+3.6(-2.5:5.4:0)
3:28
54.9:A-3.3(-3.8:11.8)
55.0:A-0.7(-10.2:14.5)
55.5:A+14.2(-6.4:10.2)
74.1:D+16.6(-0.6:21.9)
75.1:D+38.3(-0.0:48.2)
77.4:Eb-8.3(0.0:49.7)
80.7:E-35.6(0.0:49.3)
84.2:E+37.0(-2.0:49.0)
88.0:F+14.0(-10.1:48.8)
91.1:Gb-25.5(-4.9:50.0)
94.0:Gb+27.1(1.1:7.1)
90.1:Gb-44.8(-48.3:0.0)
87.9:F+11.3(-49.7:0.0)
171.3:F-32.9(-3.6:14.6)
172.8:F-18.1(0.0:49.8)
180.6:Gb-41.2(0.0:49.4)
189.5:Gb+41.2(1.2:16.4)
191.3:G-42.3(0.1:5.8)
192.2:G-33.7(-8.0:-0.2)
109.6:A-7.0(-36.4:35.0)
109.7:A-4.2(-47.4:47.5)
115.1:Bb-21.5(-18.0:1.7)
114.8:Bb-26.1(-45.6:14.0)
112.0:A+31.7(-41.0:44.1)
114.4:Bb-31.6(-49.8:31.8)
112.3:A+36.5(-40.9:48.6)
115.4:Bb+16.6(-44.6:23.4)
112.8:A+43.0(-46.6:49.9)
113.1:A+48.1(-20.7:45.9)
113.7:Bb-42.3(-43.5:47.9)
126.5:B+41.3(-7.5:29.9)
128.4:C-31.9(-2.2:34.7)
131.0:C+2.8(-47.9:16.4)
132.3:C+20.1(-0.0:4.8)
132.7:C+24.3(0.2:46.8)
135.6:Db-38.1(0.0:50.0)
137.7:Db-11.7(-16.5:0.3)

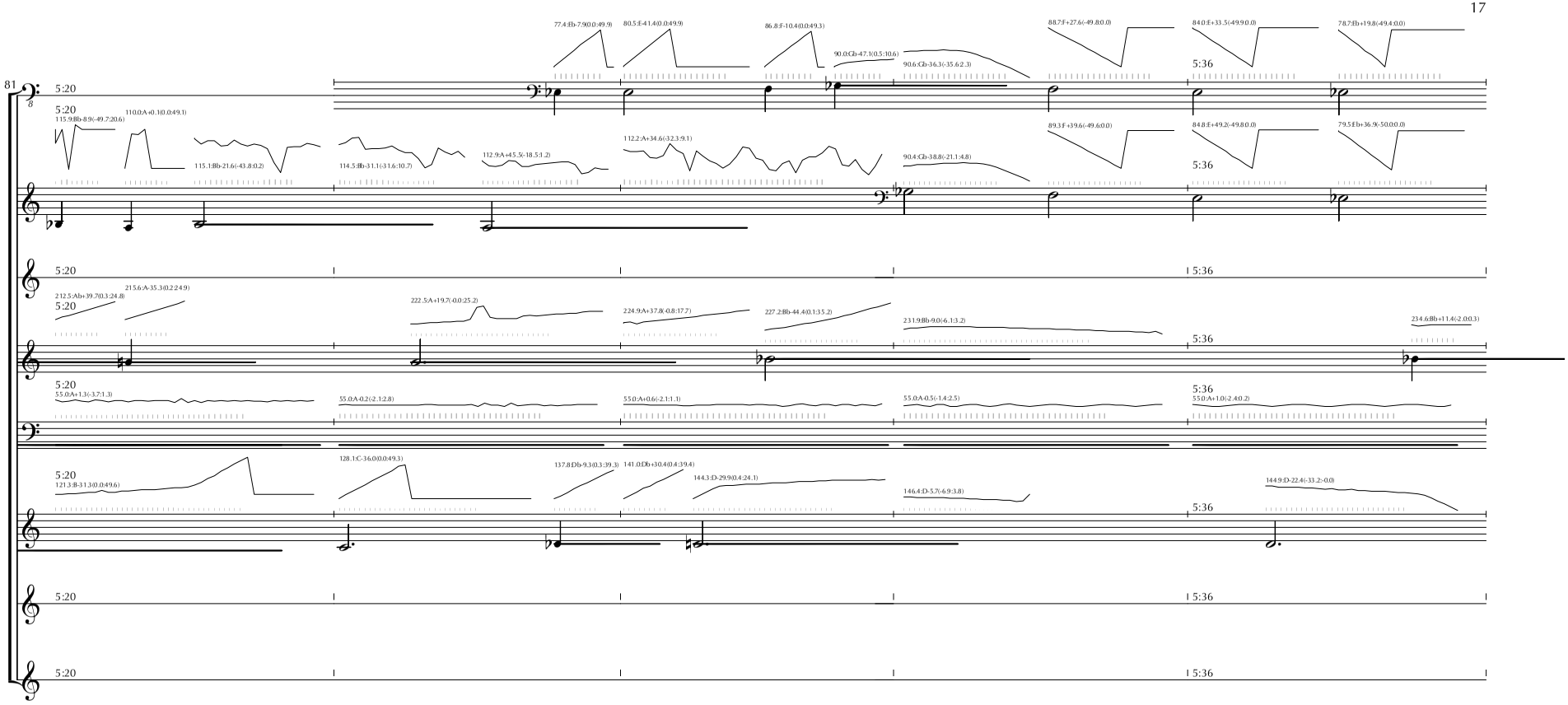

56
55.3:A+10.2(-5.9:17.8)
3:44
55.7:A+21.7(-21.9:11.9)
55.7:A+22.7(-36.4:11.6)
55.7:A+21.9(-49.3:13.1)
55.8:A+25.3(-34.3:45.4)
85.0:F-45.6(-49.7:0.0)
82.0:E-8.5(-50.0:36.3)
78.9:Eb+24.5(-48.5:24.8)
3:44
74.1:D+17.1(-7.5:0.5)
74.2:D+17.7(0.1:29.8)
75.5:D+47.5(0.1:7.3)
75.8:Eb-4.5.1(-17.4:13.2)
75.0:D+37.0(-16.2:-0.4)
3:44
3:44
191.3:G-41.7(-10.0:-0.0)
190.2:Gb+48.2(-3.0:-0.0)
189.9:Gb+45.1(-10.4:-0.0)
188.8:Gb+35.2(-3.3:-0.0)
188.4:Gb+31.6(-4.1:0.1)
188.0:Gb+27.4(-8.9:-0.0)
3:44
106.3:Ab+40.0(-9.2:42.3)
108.6:A-22.9(-38.0:49.8)
108.0:A-31.4(-37.0:49.4)
113.1:A+47.7(-4.8.3:46.3)
113.3:Bb-48.4(-20.3:18.5)
112.3:A+35.9(-12.1:25.2)
111.6:A+24.2(-1.6:44.2)
114.8:Bb-26..5(-11.2:8.6)
113.3:A+50.7(-47.4:42.5)
3:44
136.3:Db-28.3(-14.4:-0.1)
135.2:Db-42.7(-7.8:-0.0)
135.1:Db-43.9(0.1:26.7)
121.1:B-33.7(-45.0:-1.6)
119.2:Bb+39.2(-8.4:19.1)
135.2:Db-42.6(-32.0:-0.2)
118.2:Bb+25.1(-5.6:1.3)
130.8:C-0.4(-49.5:0.0)
3:44
3:44

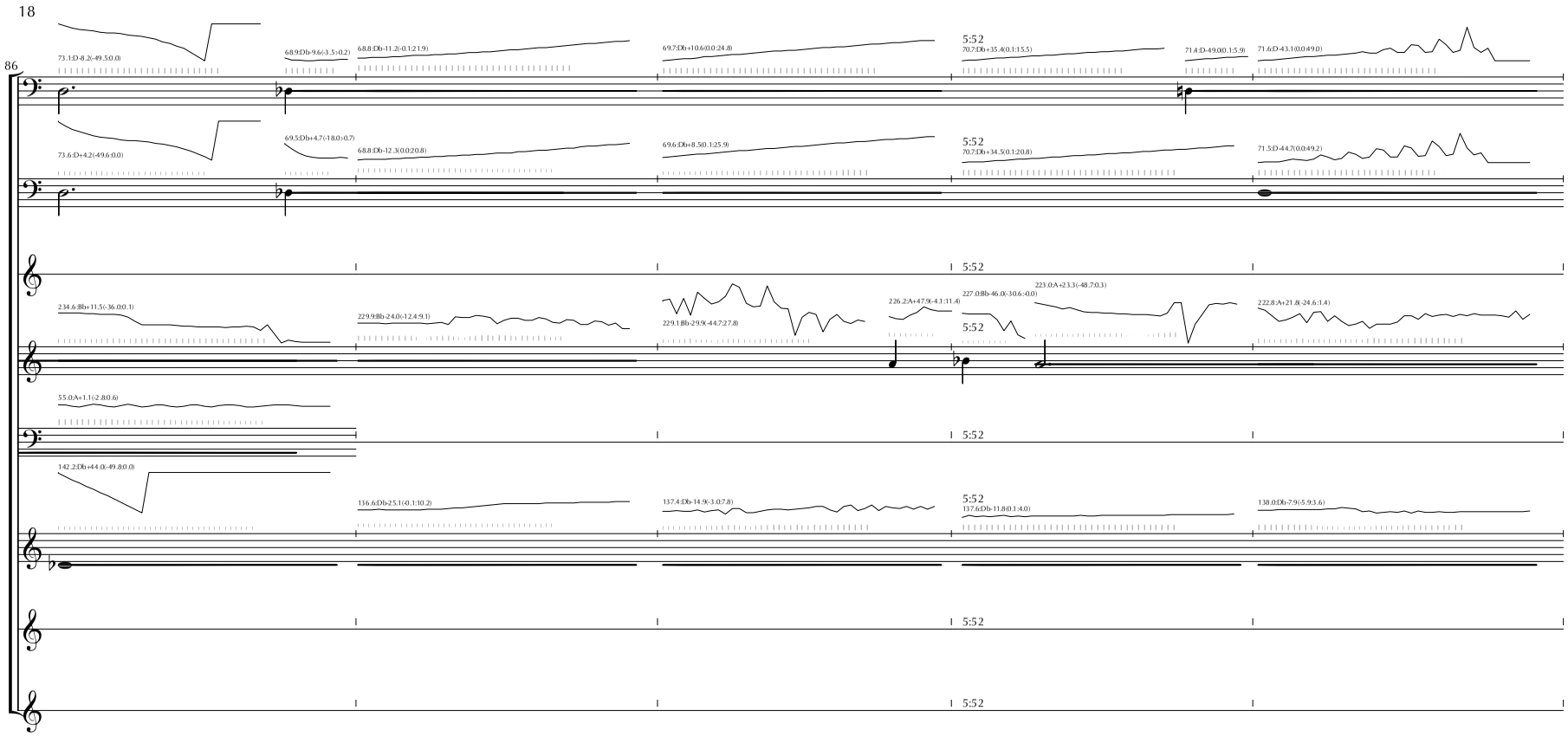

61
4:00
4:16
56.5:A+47.3(-46.6:32.1)
57.6:Bb-20.7(-42.5:3.8)
56.5:A+46.4(-3.9:16.3)
56.8:Bb+43.6(-6.8:3.8)
56.7:Bb-48.3(-2.9:10.4)
56.6:A+49.2(0.3:7.1)
56.7:Bb-46.4(-5.7:1.8)
56.6:A+49.0(0.4:15.7)
56.6:Bb-48.9(-0.5:9.5)
56.7:Bb-47.3(-47.1:12.7)
74.7:D+29.7(0.0:20.1)
75.6:D+49.8(0.1:7.7)
75.9:Eb-42.4(0.0:50.0)
81.9:E-11.7(0.0:49.8)
84.8:E+49.9(0.0:49.5)
87.7:F+8.3(0.0:49.3)
90.6:Gb-36.3(0.0:49.9)
96.3:G-30.4(0.0:49.8)
98.3:G+5.2(0.0:18.2)
187.0:Gb+18.5(-4.0:5.6)
187.6:Gb+24.3(0.2:38.3)
191.8:G-37.4(0.0:2.3)
192.0:G-35.4(0.0:2.5)
192.5:G-30.9(-7.9:0.1)
191.7:G-38.8(-2.7:6.4)
107.8:A-34.7(-15.8:47.6)
114.6:Bb-29.4(-35.7:28.6)
112.9:A+45.4(0.0:7.9)
112.9:A+44.8(-21.1:47.9)
113.6:Bb-43.6(-31.4:8.8)
112.3:A+35.1(-10.8:22.6)
113.4:Bb-47.5(-29.8:14.5)
112.4:A+37.8(-12.4:28.2)
114.2:Bb-35.7(-37.0:3.6)
114.0:Bb-38.9(-32.8:-0.3)
113.0:A+47.3(-12.4:33.4)
122.7:B-11.4(-31.2:49.0)
125.8:B+32.0(-47.3:49.9)
130.9:C+1.0(-30.9:19.1)
132.3:C+19.6(-47.6:48.6)
143.1:D-45.0(-5.4:25.9)
145.3:D-18.6(-17.0:5.3)
143.8:D-35.6(-0.0:6.3)
125.8:B+32.3(-49.7:5.7)
144.5:D-27.9(-1.3:0.5)

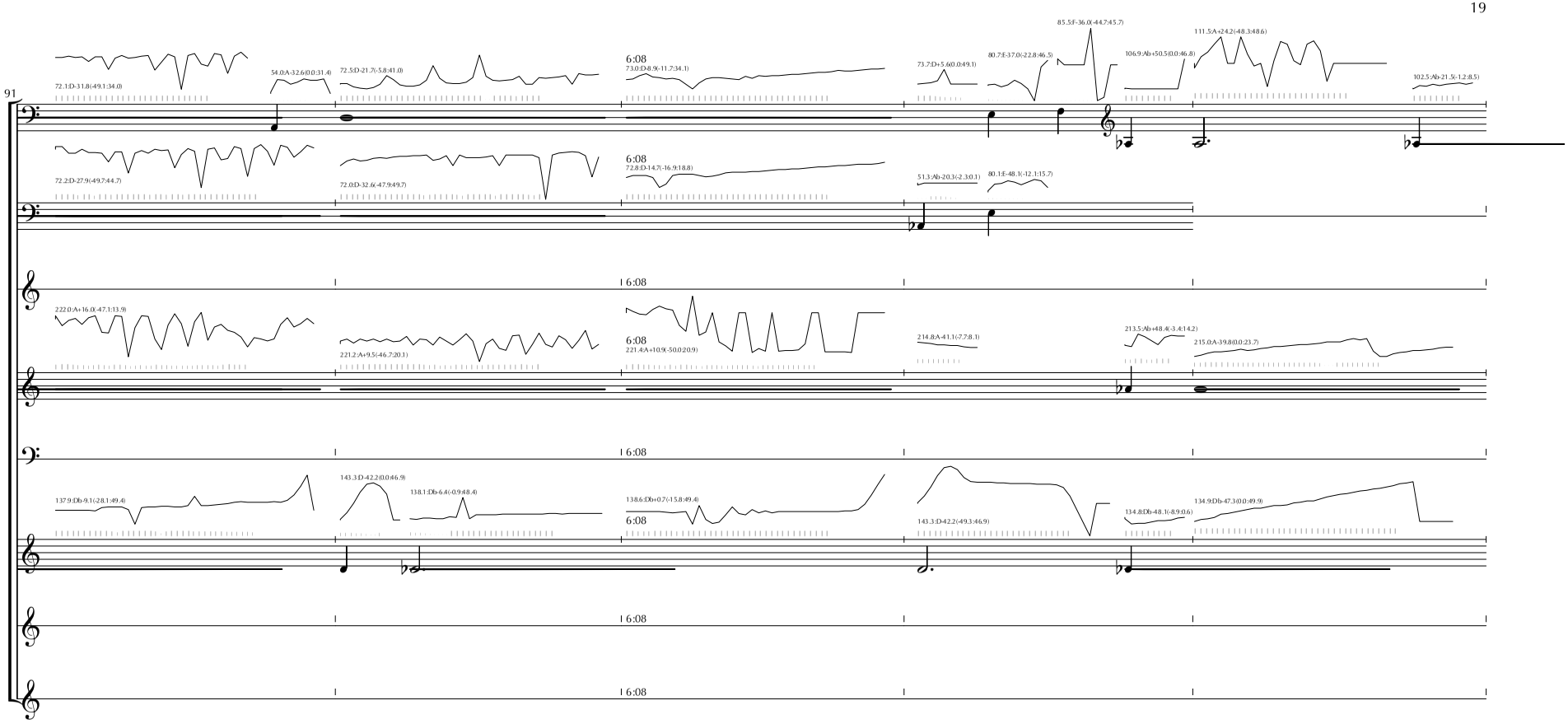

66
55.3:A+10.7(0.0:49.9)
57.0:Bb-38.4(-18.5:1.3)
56.6:A+49.6(-4.2:12.5)
56.5:A+46.9(-39.8:20.3)
56.9:Bb-39.9(-50.0:7.9)
55.3:A+8.9(-8.5:49.7)
4:32
56.2:A+36.3(-38.5:38.7)
56.7:Bb-45.9(-27.0:12.8)
56.0:A+31.0(-32.1:47.8)
98.7:G+12.6(-49.6:0.4)
95.2:Cb+49.6(-49.7:0.0)
89.8:F+48.8(-49.6:0.0)
84.0:E+32.4(-49.4:0.0)
79.0:Eb+27.3(-49.8:0.0)
4:32
76.4:Eb-30.5(-22.3:-0.2)
57.7:Bb-17.3(-13.2:0.0)
73.9:D+12.2(-49.7:0.0)
69.4:Db+2.4(-49.9:0.0)
112.3:A+36.6(-8.5:1.9)
4:32
192.4:G-32.5(-12.0:0.0)
191.0:G-44.6(-6.5:-0.0)
189.2:Gb+39.2(-8.8:-0.0)
4:32
188.3:Gb+30.4(-12.4:-0.0)
186.9:Cb+18.0(-10.5:49.9)
4:32
144.4:D-28.7(-28.6:0.0)
131.5:C+8.8(-13.2:-0.0)
130.5:C-4.4(-14.4:-0.1)
129.4:C-18.8(-11.7:-0.0)
128.7:C-28.8(-14.3:0.2)
4:32
127.6:C-43.4(-42.0:-0.3)
124.5:B+14.2(-49.8:0.0)
4:32
4:32

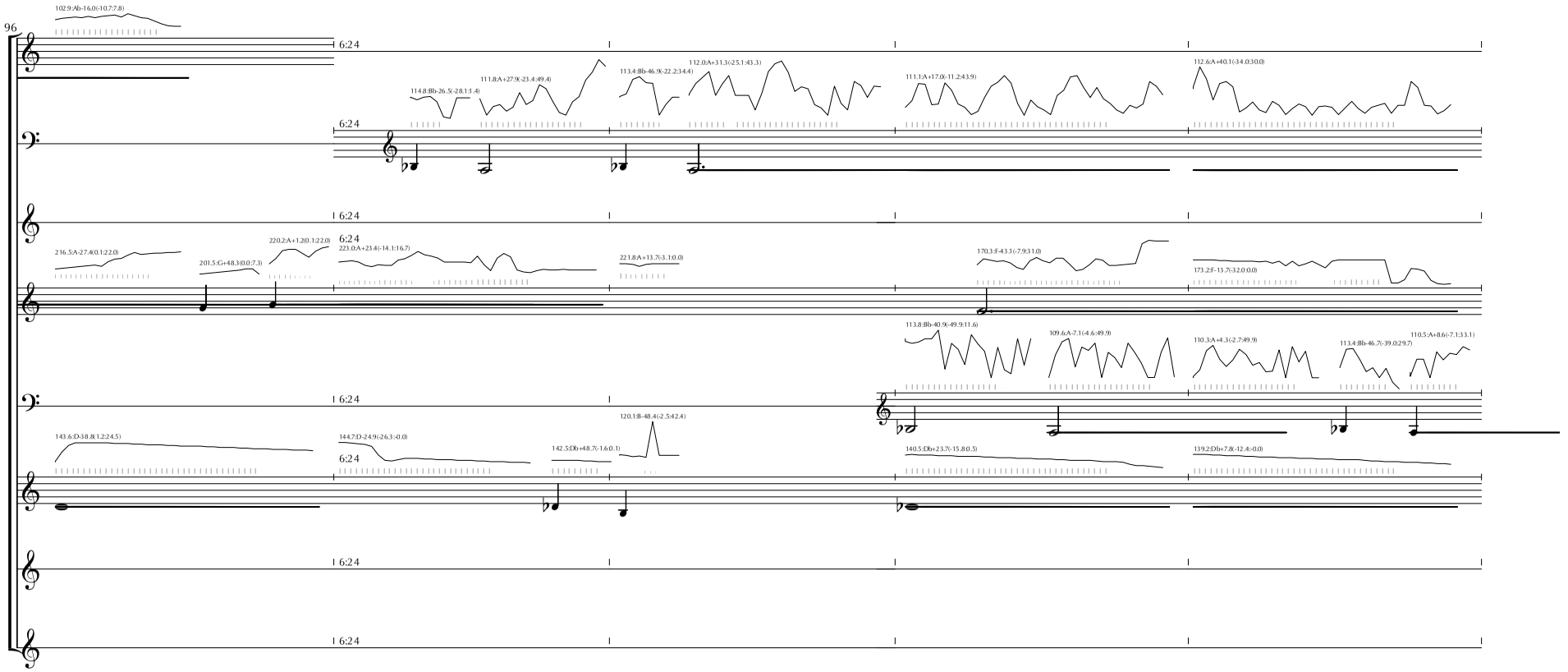

71
55.6:A+20.0(-48.4:44.0)
56.9:Bb-40.6(-41.1:36.4)
56.3:A+41.9(-0.3:21.0)
57.0:Bb-3.8(-16.3:0.3)
56.6:A+49.1(-42.0:18.1)
4:48
56.5:A+45.3(-7.4:20.2)
56.7:Bb-48.1(-44.8:16.0)
55.3:A+8.6(-5.7:24.6)
55.8:A+23.9(-23.5:41.4)
57.0:Bb-36.7(-39.1:14.2)
56.4:A+43.1(-45.4:21.3)
56.7:Bb-47.6(-25.3:13.9)
56.3:A+41.6(-40.3:41.3)
112.4:A+37.2(-8.0:38.6)
114.6:Bb-29.1(-5.4:4.1)
98.2:G+3.4(-49.9:0.0)
93.2:Gb+13.0(-49.8:0.0)
87.7:F+6.8(-50.0:0.0)
84.7:E+48.2(-49.8:0.0)
81.6:E-17.4(-49.8:-0.7)
79.3:Eb+32.6(-41.0:-0.3)
77.4:Eb-8.5(-49.9:0.0)
74.6:D+26.7(-49.7:0.1)
71.4:D-47.9(-42.5:27.0)
69.9:D0+15.0(-50.0:7.5)
190.1:Gb+47.5(1.9:26.2)
192.3:G-32.8(-7.4:5.2)
191.5:G-40.2(-10.2:-0.0)
189.3:Gb+39.9(-5.8:-0.0)
188.7:Gb+34.1(-12.0:-0.0)
187.4:Gb+22.1(-12.8:-0.0)
119.8:Bb+48.2(-48.9:19.3)
130.9:C+1.2(-16.7:-0.0)
129.6:C-15.5(-13.3:0.0)
128.8:C-26.2(-10.4:3.9)
128.1:C-36.7(-43.4:-0.0)
125.8:B+31.8(-49.3:0.0)

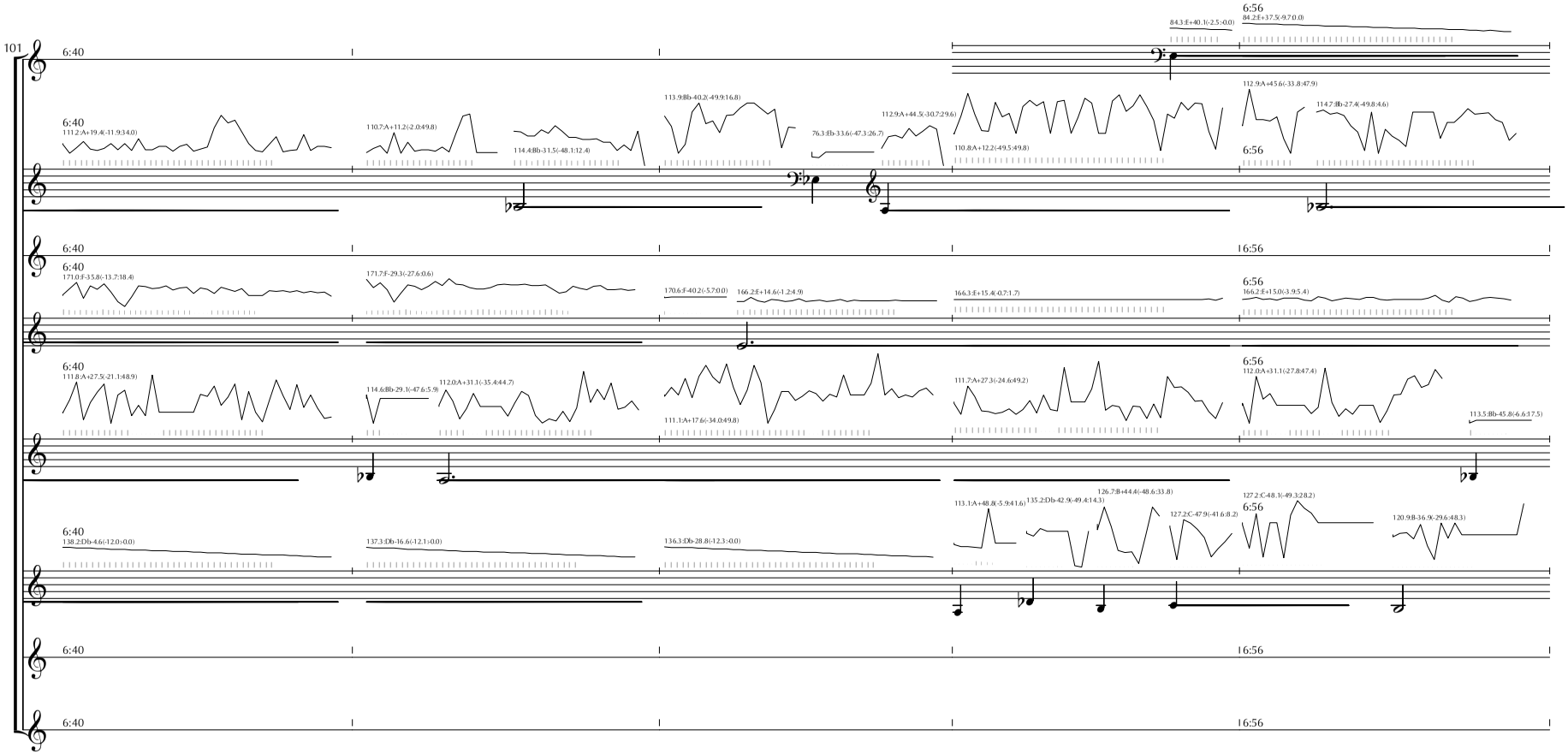

76
55.6:A+18.3:(-47.1:47.7)
5:04
36.6:D-4.0:(-23.5:46.6)
66.9:C+38.2:(-49.7:44.7)
112.7:A+41.4:(-13.3:47.8)
114.5:Bb-30.9:(-3.6:5.3)
5:04
61.2:B-14.5:(-9.8:9.8)
114.9:Bb-25.0:(-32.3:6.1)
113.5:Bb-45.2:(-17.2:25.4)
114.2:Bb-35.4:(-35.1:5.3)
96.5:G+26.6:(-34.6:43.0)
114.5:Bb-30.8:(-49.6:17.8)
112.5:A+38.3:(-27.1:49.3)
114.3:Bb-33.4:(-49.4:28.5)
112.5:A+3.8:(-13.2:47.0)
5:04
186.1:Gb+10.4:(-38.1:-0.0)
5:04
184.8:Gb-1.7:(-5.9:-0.0)
184.9:Gb-1.3:(0.0:49.8)
191.8:G-37.6:(0.0:49.9)
201.3:G+46.4:(0.2:20.6)
203.8:Ab-32.8:(0.0:49.9)
56.1:A+33.1:(-40.9:48.0)
57.7:Bb-15.9:(-49.4:8.8)
55.3:A+8.5:(-11.8:37.1)
55.3:A+8.9:(-26.9:7.8)
5:04
120.6:B-41.1:(-26.7:0.6)
120.0:Bb+50.2:(-11.6:2.7)
5:04
119.2:Bb+39.4:(-1.0:7.4:1.8)
118.5:Bb+28.7:(-16.8:46.9)
119.1:Bb+38.3:(-0.2:14.3)
120.1:B-47.4:(0.0:16.0)
5:04
5:04

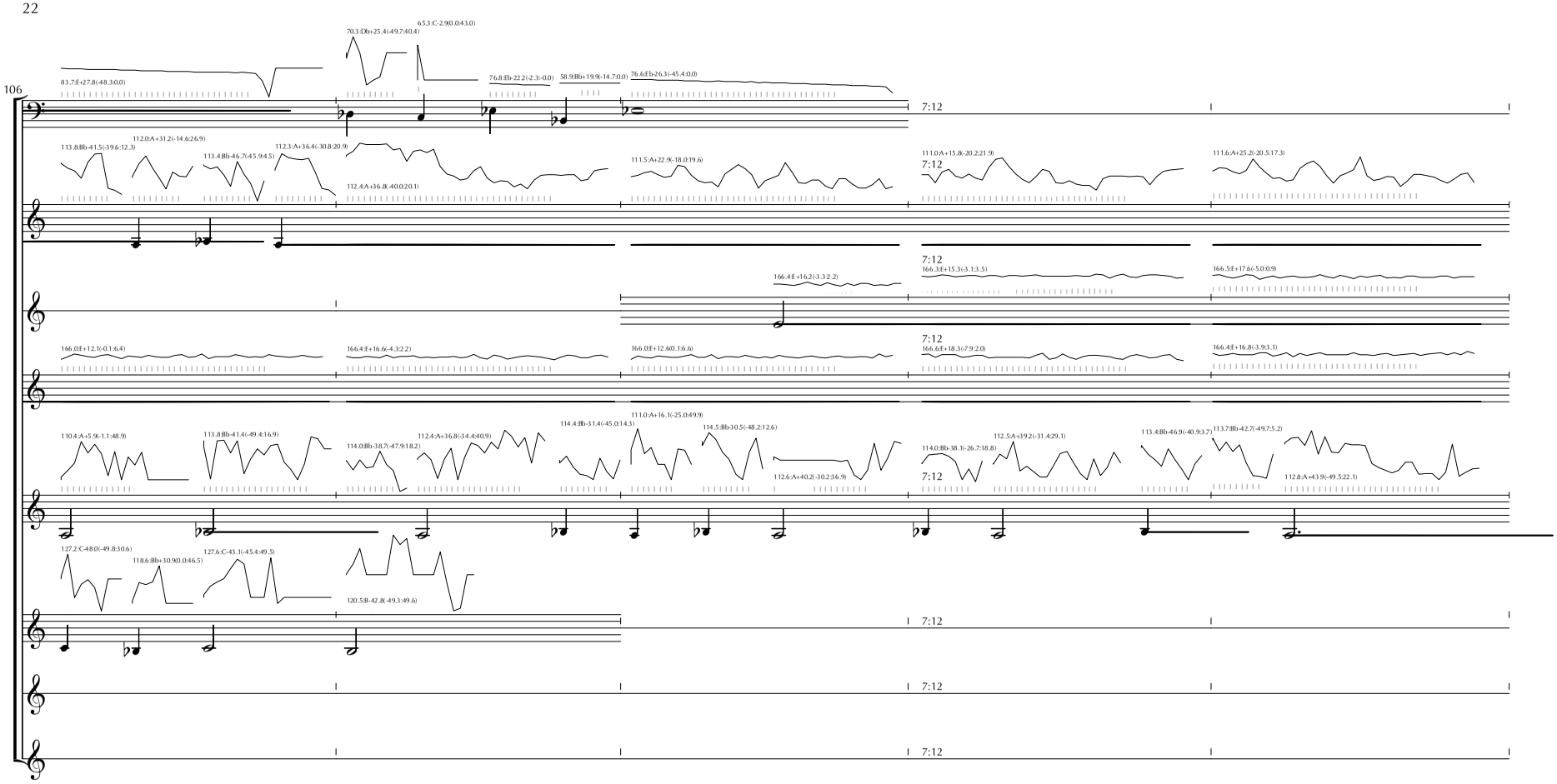

81
5:20
5:36
77.4:Eb-7.9(0.0:49.9)
80.5:E-41.4(0.0:49.9)
86.8:F-10.4(0.0:49.3)
90.0:Cb-47.1(0.5:10.6)
90.6:Cb-36.3(-35.6:2.3)
88.7:F+27.6(-49.8:0.0)
84.0:E+33.5(-49.9:0.0)
78.7:Eb+19.8(-49.4:0.0)
115.9:Bb-8.9(-49.7:20.6)
110.0:A+0.1(0.0:49.1)
115.1:Bb-21.6(-43.8:0.2)
114.5:Bb-31.1(-31.6:10.7)
112.9:A+45.5(-18.5:1.2)
112.2:A+34.6(-32.3:9.1)
90.4:Cb-38.8(-21.1:4.8)
89.3:F+39.6(-49.6:0.0)
84.8:E+49.2(-49.8:0.0)
79.5:Eb+36.9(-50.0:0.0)
212.5:Ab+39.7(0.3:24.8)
215.6:A-35.3(0.2:24.9)
222.5:A+19.7(-0.0:25.2)
224.9:A+37.8(-0.8:17.7)
227.2:Bb-44.4(0.1:35.2)
231.9:Bb-9.0(-6.1:3.2)
234.6:Bb+11.4(-2.0:0.3)
55.0:A+1.3(-3.7:1.3)
55.0:A-0.2(-2.1:2.8)
55.0:A+0.6(-2.1:1.1)
55.0:A-0.5(-1.4:2.5)
55.0:A+1.0(-2.4:0.2)
121.3:B-31.3(0.0:49.6)
128.1:C-36.0(0.0:49.3)
137.8:Db-9.3(0.3:39.3)
141.0:Db+30.4(0.4:39.4)
144.3:D-29.9(0.4:24.1)
146.4:D-5.7(-6.9:3.8)
144.9:D-22.4(-33.2:-0.0)

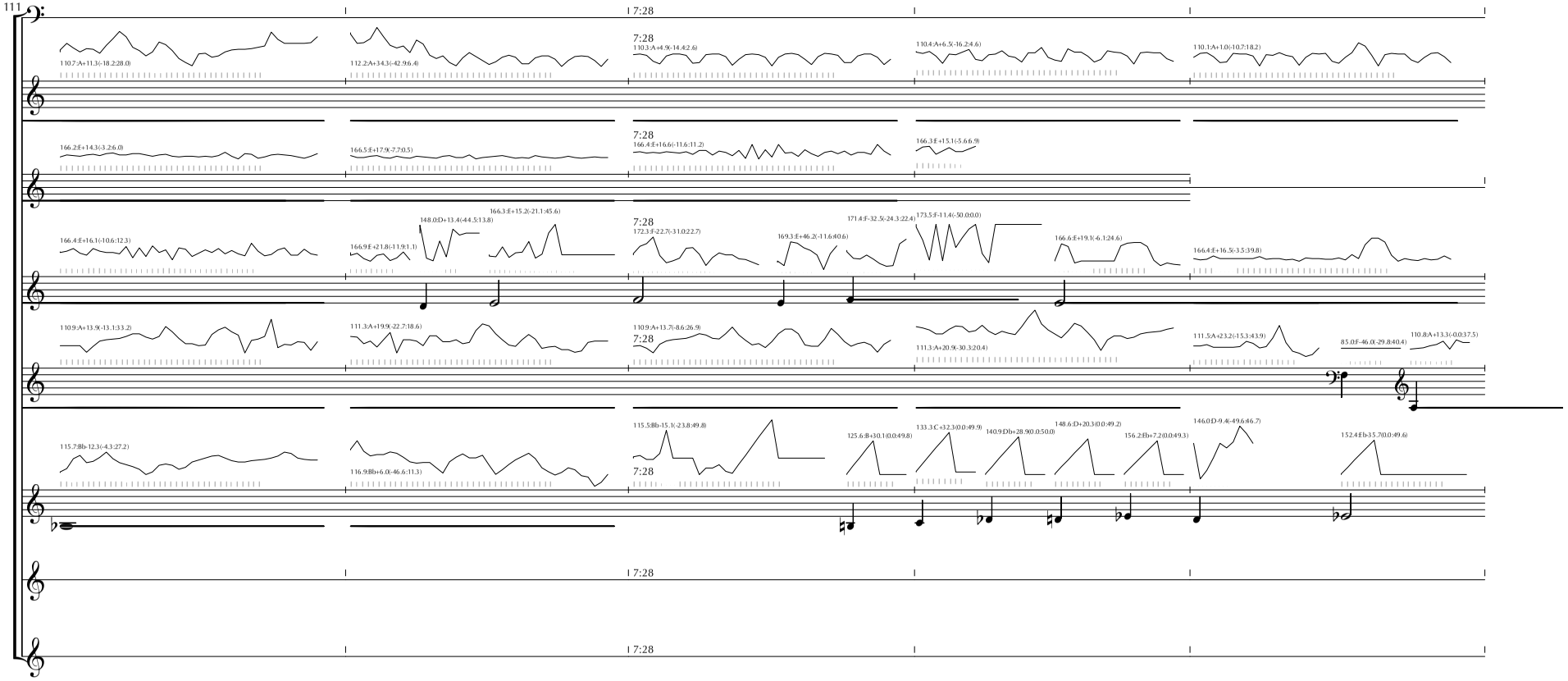

18
86
73.1:D-8.2(-49.5:0.0)
68.8:Db-9.6(-3.5:0.2)
68.8:Db-11.2(-0.1:2.1.9)
69.7:Db+10.6(0.0:24.8)
5:52
70.7:Db+35.4(0.1:15.5)
71.4:D-49.0(0.1:5.9)
71.6:D-43.1(0.0:49.0)
73.6:D+4.2(-49.6:0.0)
69.5:Db+4.7(-18.0:0.7)
68.8:Db-12.3(0.0:2.0.8)
69.6:Db+8.5(0.1:25.9)
70.7:Db+34.5(0.1:2.0.8)
71.5:D-44.7(0.0:49.2)
234.6:Bb+11.5(-36.0:0.1)
229.9:Bb-24.0(-12.4:9.1)
229.1:Bb-29.9(-44.7:27.8)
226.2:A+47.9(-4.1:11.4)
227.0:Bb-46.0(-30.6:-0.0)
223.0:A+23.3(-48.7:0.3)
222.8:A+21.8(-24.6:1.4)
55.0:A+1.1(-2.8:0.6)
142.2:Db+44.0(-49.8:0.0)
136.6:Db-25.1(-0.1:10.2)
137.4:Db-14.9(-3.0:7.8)
137.6:Db-11.8(0.1:4.0)
138.0:Db-7.9(-5.9:3.6)

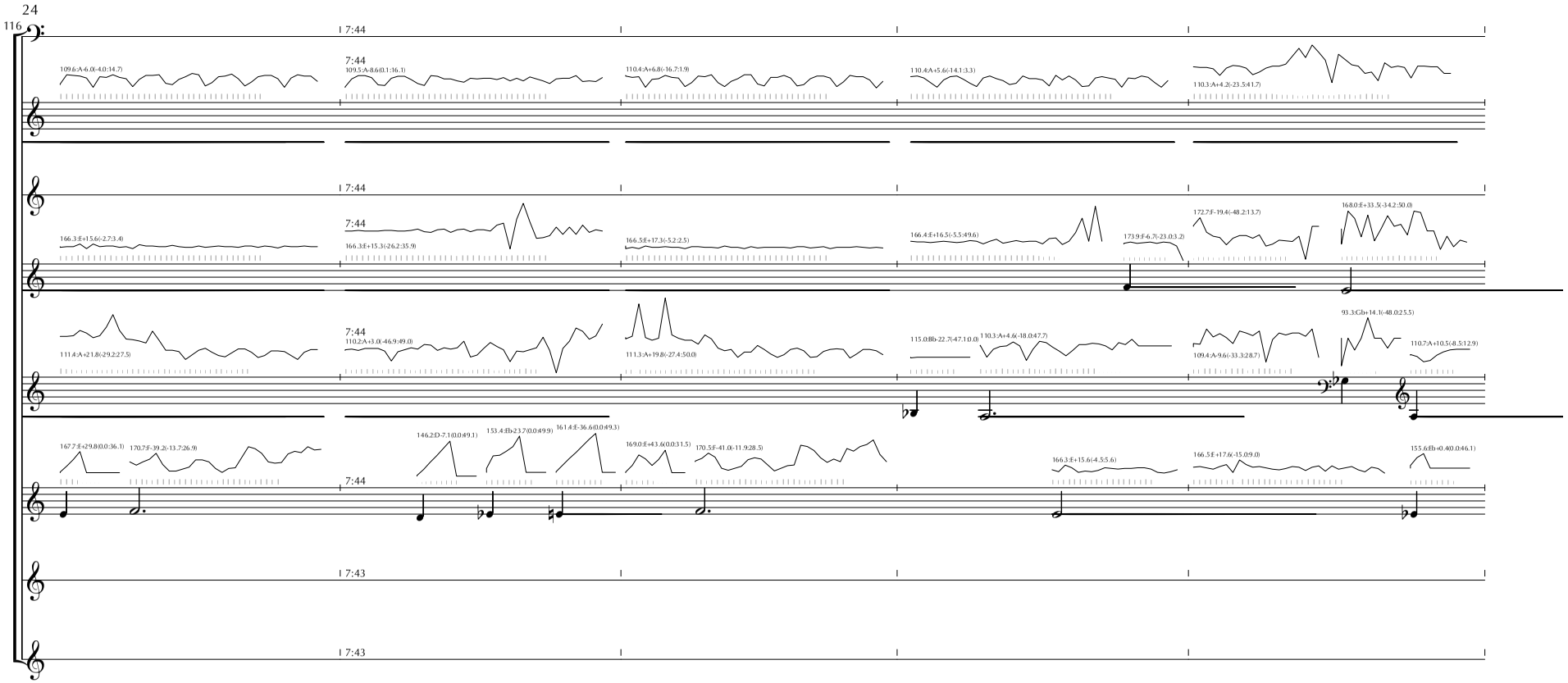

91
72.1:D-31.8(-49.1:34.0)
54.0:A-32.6(0.0:31.4)
72.5:D-21.7(-5.8:41.0)
6:08
73.0:D-8.9(-11.7:34.1)
73.7:D+5.6(0.0:49.1)
80.7:E-37.0(-22.8:46.5)
85.5:F-36.0(-44.7:45.7)
106.9:Ab+50.5(0.0:46.8)
111.5:A+24.2(-48.3:48.6)
102.5:Ab-21.5(-1.2:8.5)
72.2:D-27.9(-49.7:44.7)
72.0:D-32.6(-47.9:49.7)
6:08
72.8:D-14.7(-16.9:18.8)
51.3:Ab-20.3(-2.3:0.1)
80.1:E-48.1(-12.1:15.7)
6:08
222.0:A+16.0(-47.1:13.9)
221.2:A+9.5(-46.7:20.1)
6:08
221.4:A+10.9(-50.0:20.9)
214.8:A-41.1(-7.7:8.1)
213.5:Ab+48.4(-3.4:14.2)
215.0:A-39.8(0.0:23.7)
6:08
137.9:Db-9.1(-2.8:1.49.4)
143.3:D-42.2(0.0:46.9)
138.1:Db-6.4(-0.9:48.4)
138.6:Db+0.7(-15.8:49.4)
6:08
143.3:D-42.2(-49.3:46.9)
134.8:Db-4.8.1(-8.9:0.6)
134.9:Db-47.3(0.0:49.9)
6:08
6:08

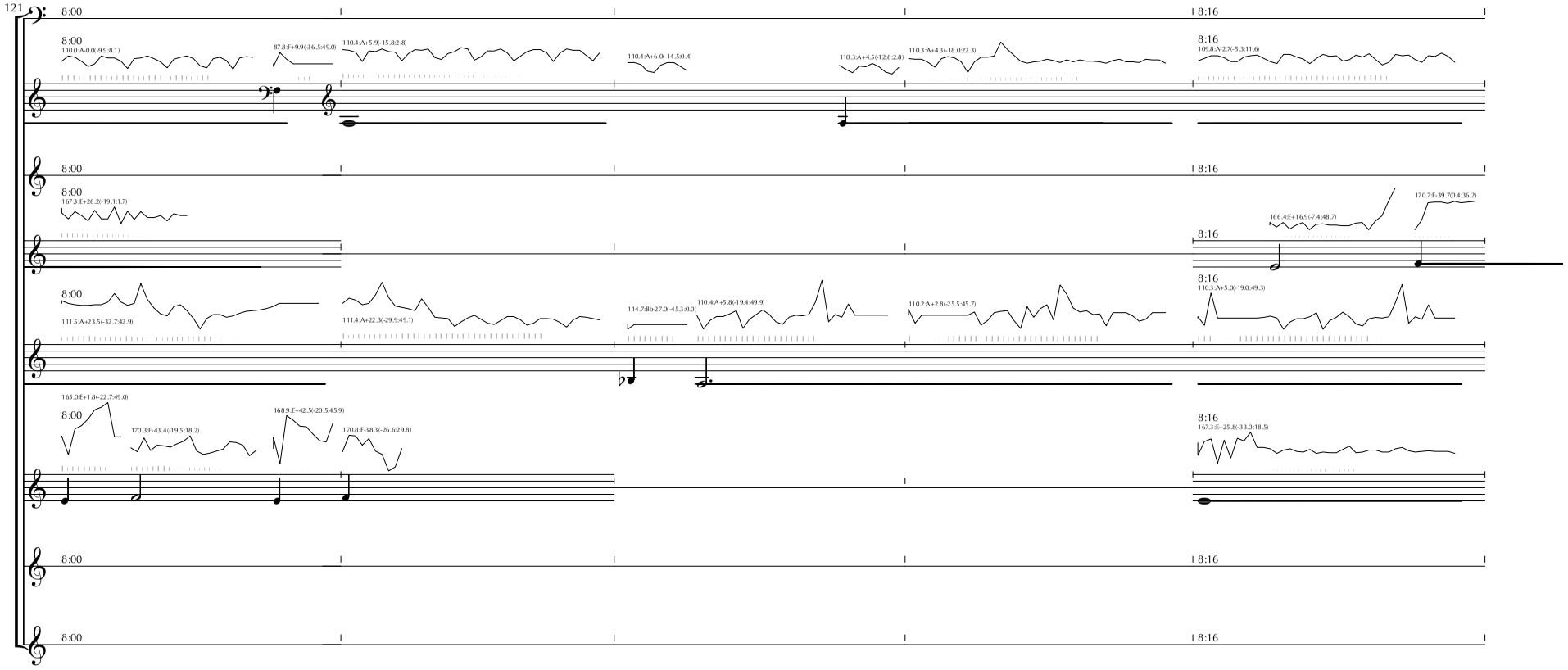

96
102.9:Ab-16.0(-10.7:7.8)
6:2 4
114.8:Bb-26.5(-28.1:3.4)
111.8:A+27.9(-23.4:49.4)
113.4:Bb-46.9(-22.2:3.4.4)
112.0:A+31.3(-25.1:43.3)
111.1:A+17.0(-11.2:43.9)
112.6:A+40.1(-34.0:30.0)
216.5:A-27.4(0.1:22.0)
201.5:G+48.3(0.0:7.3)
220.2:A+1.2(0.1:22.0)
223.0:A+23.4(-14.1:16.7)
221.8:A+13.7(-3.1:0.0)
170.3:F-43.1(-7.9:3.1.0)
173.2:F-13.7(-32.0:0.0)
113.8:Bb-40.9(-49.9:11.6)
109.6:A-7.1(-4.6:49.9)
110.3:A+4.3(-2.7:49.9)
113.4:Bb-46.7(-39.0:29.7)
110.5:A+8.6(-7.1:33.1)
143.6:D-38.8(1.2:24.5)
144.7:D-24.9(-26.3:-0.0)
142.5:Db+48.7(-1.6:0.1)
120.1:B-48.4(-2.5:42.4)
140.5:Db+23.7(-15.8:0.5)
139.2:Db+7.8(-12.4:-0.0)

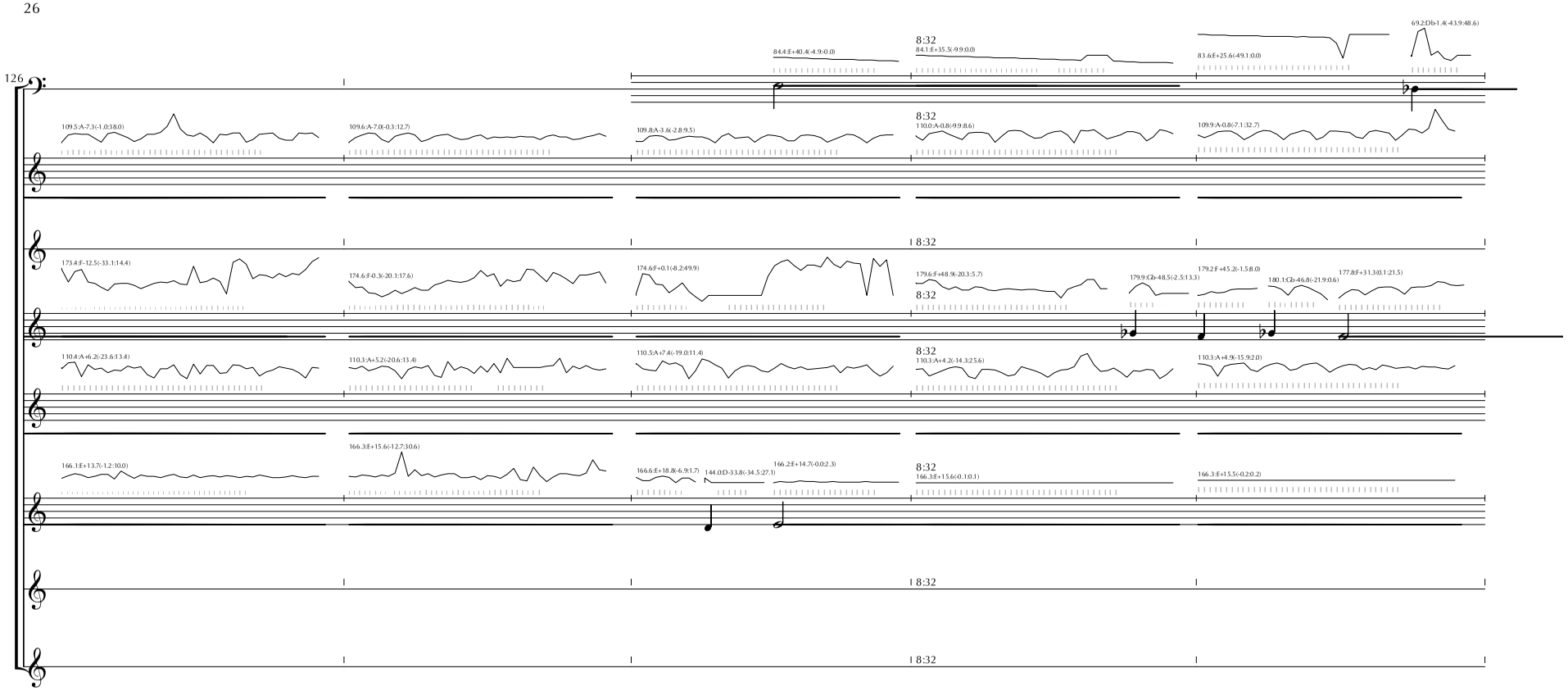

101
6:40
111.2:A+19.4(-11.9:34.0)
110.7:A+11.2(-2.0:49.8)
114.4:Bb-31.5(-48.1:12.4)
113.9:Bb-40.2(-49.9:16.8)
76.3:Eb-33.6(-47.3:26.7)
112.9:A+44.5(-30.7:29.6)
84.3:E+40.1(-2.5:-0.0)
6:56
84.2:E+37.5(-9.7:0.0)
110.8:A+12.2(-49.5:49.8)
112.9:A+45.6(-33.8:47.9)
114.7:Bb-27.4(-49.8:4.6)
16:56
171.0:F-35.8(-13.7:18.4)
171.7:F-29.3(-27.6:0.6)
170.6:F-40.2(-5.7:0.0)
166.2:E+14.6(-1.2:4.9)
166.3:E+15.4(-0.7:1.7)
166.2:E+15.0(-3.9:5.4)
111.8:A+27.5(-21.1:48.9)
114.6:Bb-29.1(-47.6:5.9)
112.0:A+31.1(-35.4:44.7)
111.1:A+17.6(-34.0:49.8)
111.7:A+27.3(-24.6:49.2)
112.0:A+31.1(-27.8:47.4)
113.5:Bb-45.8(-6.6:17.5)
138.2:Db-4.6(-12.0:-0.0)
137.3:Db-16.6(-12.1:-0.0)
136.3:Db-28.8(-12.3:-0.0)
113.1:A+48.8(-5.9:41.6)
135.2:Db-42.9(-49.4:14.3)
126.7:B+44.4(-48.6:33.8)
127.2:C-47.9(-41.6:8.2)
127.2:C-48.1(-49.3:28.2)
120.9:B-36.9(-29.6:48.3)

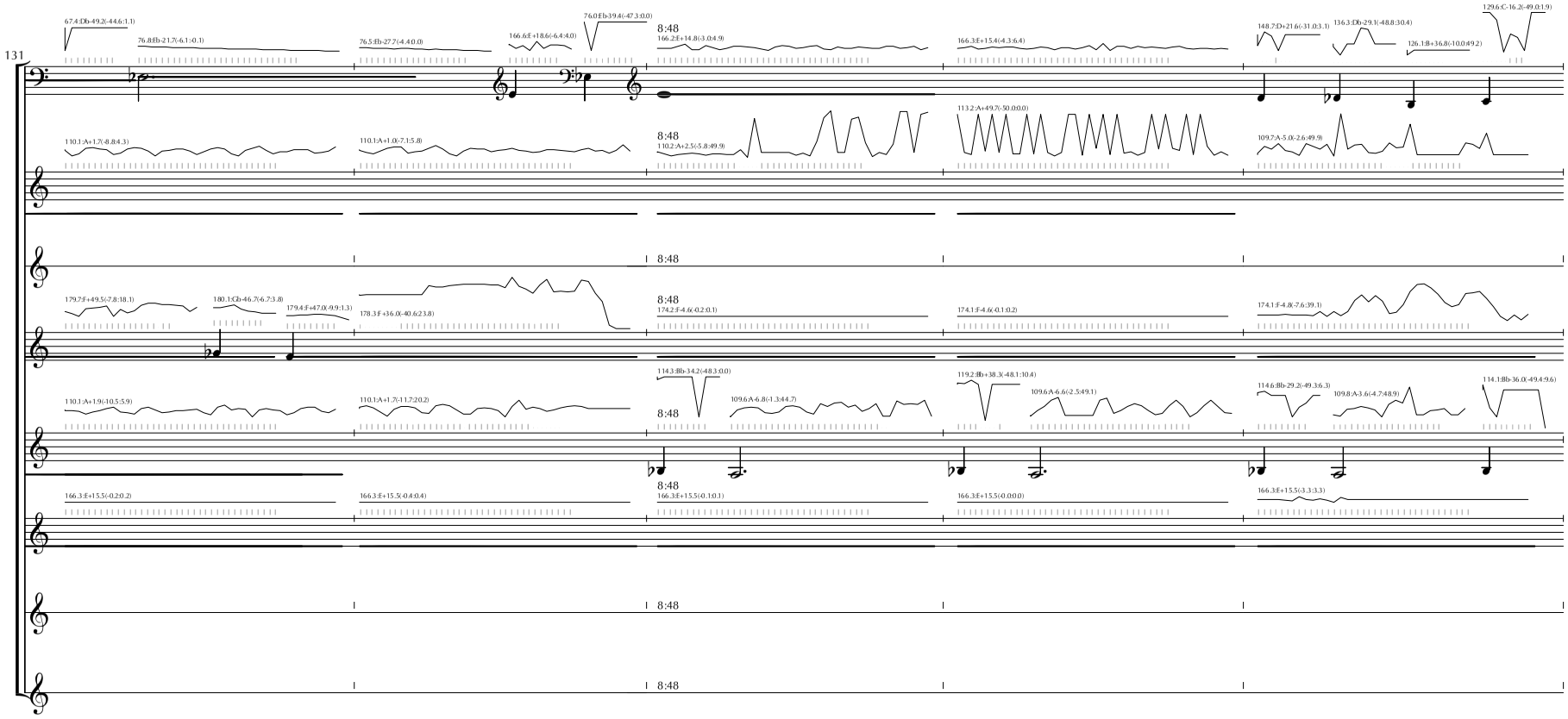

106
83.7:E+27.8(-48.3:0.0)
70.3:Db+25.4(-49.7:40.4)
6.5.3:C-2.9(0.0:43.0)
76.8:Eb-22.2(-2.3:-0.0)
58.9:Bb+19.9(-14.7:0.0)
76.6:Eb-26.3(-45.4:0.0)
7:12
113.8:Bb-41.5(-39.6:12.3)
112.0:A+31.2(-14.6:26.9)
113.4:Bb-46.7(-45.9:4.5)
112.3:-A+36.4(-30.8:20.9)
112.4:A+36.8(-40.0:20.1)
111.5:A+22.9(-18.0:19.6)
111.0:A+15.8(-20.2:21.9)
111.6:A+25.2(-20.5:17.3)
166.3:E+15.3(-3.1:3.5)
166.4:E+16.2(-3.3:2.2)
166.5:E+17.6(-5.0:0.9)
166.0:E+12.1(-0.1:6.4)
166.4:E+16.6(-4.3:2.2)
166.0:E+12.6(0.1:6.6)
166.6:E+18.3(-7.9:2.0)
166.4:E+16.8(-3.9:3.1)
110.4:A+5.9(-1.1:48.9)
113.8:Bb-41.4(-49.4:16.9)
114.0:Bb-3.8(7.4:7.9:18.2)
112.4:A+36.8(-34.4:40.9)
114.4:Bb-31.4(-45.0:14.3)
111.0:A+16.1(-25.0:49.9)
114.5:Bb+30.5(-48.2:12.6)
112.6:A+40.2(-30.2:36.9)
114.0:Bb-38.1(-26.7:18.8)
112.5:A+39.2(-31.4:29.1)
113.4:Bb-46.9(-40.9:3.7)
113.7:Bb-42.7(-49.7:5.2)
112.8:A+43.9(-49.5:22.1)
127.2:C-48.0(-49.8:30.6)
118.6:Bb+30.9(0.0:46.5)
127.6:C-43.1(-45.4:49.5)
120.5:B-42.8(-49.3:49.6)

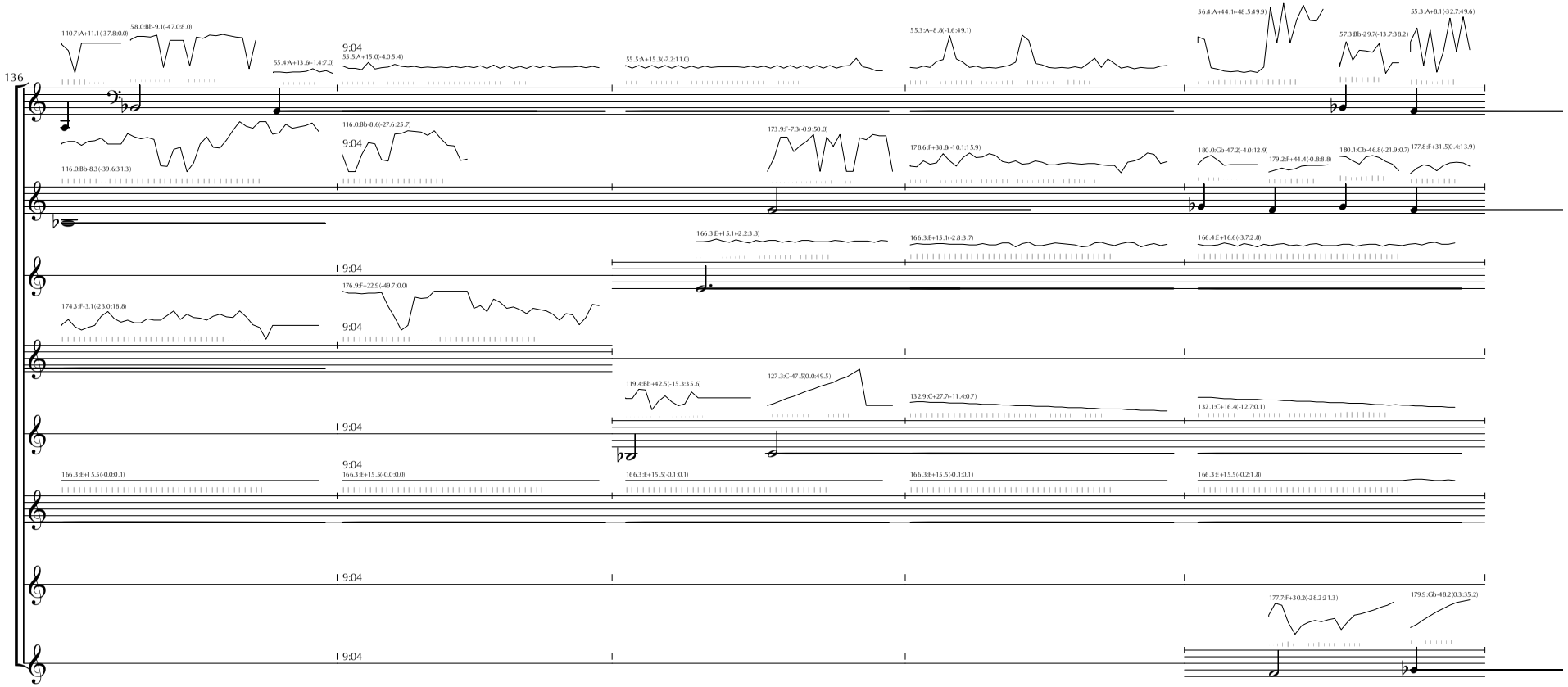

111
7:28
110.7:A+11.3(-18.2:28.0)
112.2:A+34.3(-42.9:6.4)
7:28
110.3:A+4.9(-14.4:2.6)
110.4:A+6.5(-16.2:4.6)
110.1:A+1.0(-10.7:18.2)
166.2:E+14.3(-3.2:6.0)
166.5:E+17.9(-7.7:0.5)
7:28
166.4:E+16.6(-11.6:11.2)
166.3:E+15.1(-5.6:6.9)
166.4:E+16.1(-10.6:12.3)
166.9:E+21.8(-11.9:1.1)
148.0:D+13.4(-44.5:13.8)
166.3:E+15.2(-21.1:45.6)
7:28
172.3:F-22.7(-31.0:22.7)
169.3:E+46.2(-11.6:40.6)
171.4:F-32.5(-24.3:22.4)
173.5:F-11.4(-50.0:0.0)
166.6:E+19.1(-6.1:24.6)
166.4:E+16.5(-3.5:39.8)
110.9:A+13.9(-13.1:33.2)
111.3:A+19.9(-22.7:18.6)
110.9:A+13.7(-8.6:26.9)
7:28
111.3:A+20.9(-30.3:20.4)
111.5:A+23.2(-15.3:43.9)
85.0:F-46.0(-29.8:40.4)
110.8:A+13.3(-0.0:37.5)
115.7:Bb-12.3(-4.3:27.2)
116.9:Bb+6.0(-46.6:11.3)
115.5:Bb-15.1(-23.8:49.8)
7:28
125.6:B+30.1(0.0:49.8)
133.3:C+32.3(0.0:49.9)
140.9:Db+28.9(0.0:50.0)
148.6:D+20.3(0.0:49.2)
156.2:Eb+7.2(0.0:49.3)
146.0:D-9.4(-49.6:46.7)
152.4:Eb-35.7(0.0:49.6)
7:28
7:28

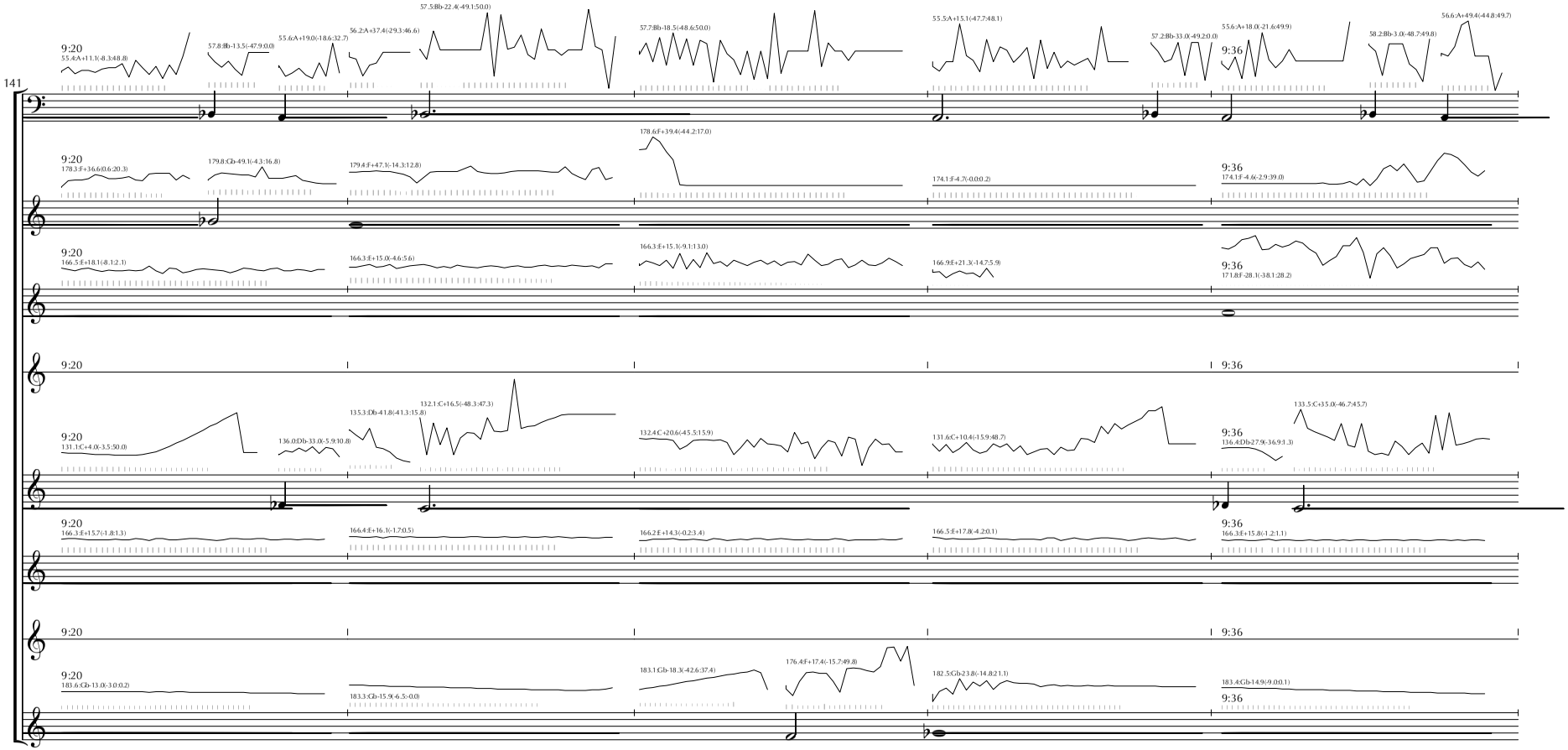

24
116
7:44
109.6:A-6.0(-4.0:14.7)
109.5:A-8.6(0.1:16.1)
110.4:A+6.8(-16.7:1.9)
110.4:A+5.6(-14.1:3.3)
110.3:A+4.2(-23.5:41.7)
166.3:E+15.6(-2.7:3.4)
166.3:E+15.3(-26.2:35.9)
166.5:E+17.3(-5.2:2.5)
166.4:E+16.5(-5.5:49.6)
173.9:F-6.7(-23.0:3.2)
172.7:F-19.4(-48.2:13.7)
168.0:E+33.5(-34.2:50.0)
111.4:A+21.8(-29.2:27.5)
110.2:A+3.0(-46.9:49.0)
111.3:A+19.8(-27.4:50.0)
115.0:Bb-22.7(-47.1:0.0)
110.3:A+4.6(-18.0:47.7)
109.4:A-9.6(-33.3:28.7)
93.3:Gb+14.1(-48.0:25.5)
110.7:A+10.5(-8.5:12.9)
167.7:E+29.8(0.0:36.1)
170.7:F-39.2(-13.7:26.9)
146.2:D-7.1(0.0:49.1)
153.4:Eb+23.7(0.0:49.9)
161.4:E-36.6(0.0:49.3)
169.0:E+43.6(0.0:31.5)
170.5:F-41.0(-11.9:28.5)
166.3:E+15.6(-4.5:5.6)
166.5:E+17.6(-15.0:9.0)
155.6:Eb+0.4(0.0:46.1)
7:43

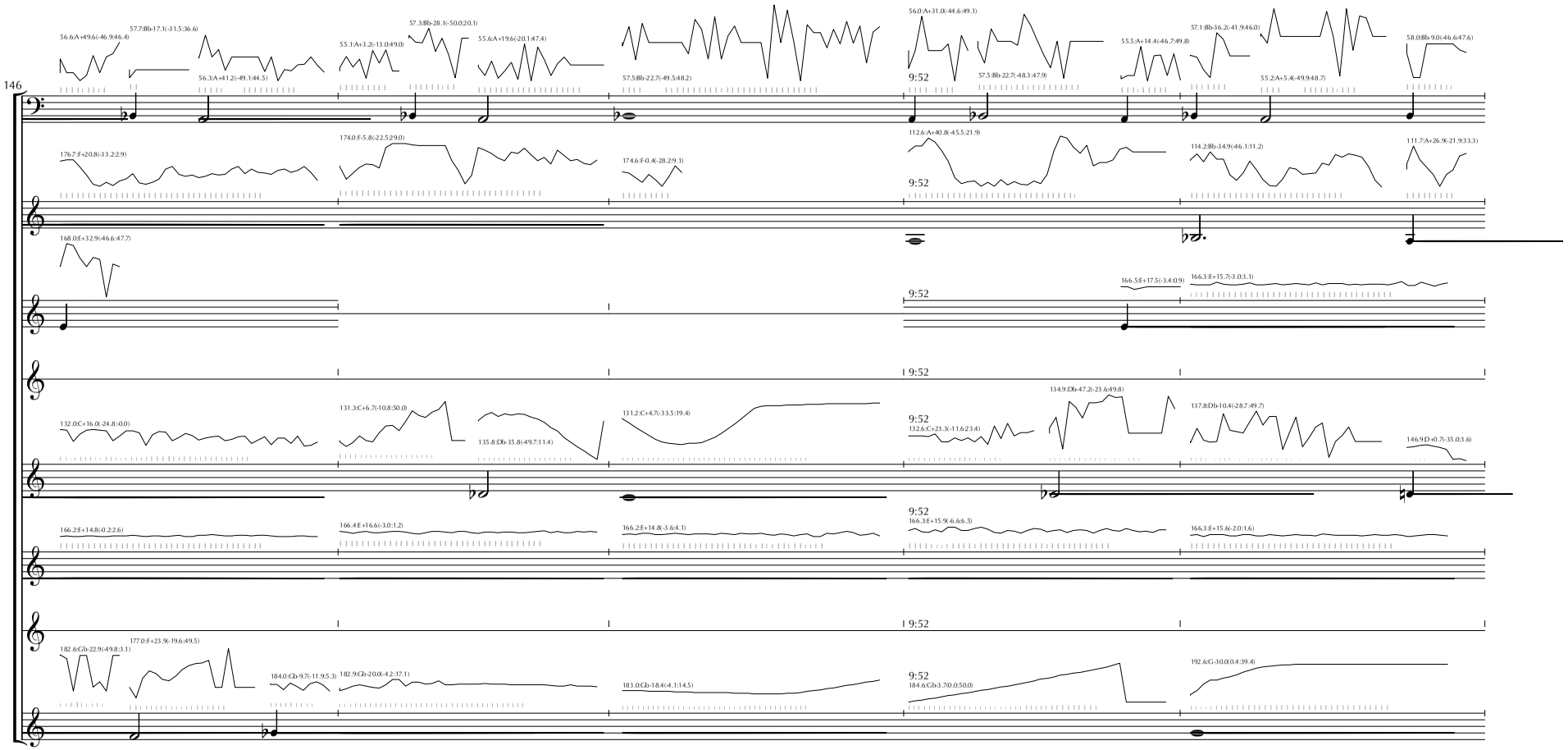

121
8:00
8:16
110.0:A-0.0(-9.9:8.1)
87.8:F+9.9(-36.5:49.0)
110.4:A+5.9(-15.8:2.8)
110.4:A+6.0(-14.5:0.4)
110.3:A+4.5(-12.6:2.8)
110.3:A+4.3(-18.0:22.3)
109.8:A-2.7(-5.3:11.6)
167.3:E+26.2(-19.1:1.7)
166.4:E+16.9(-7.4:48.7)
170.7:F-39.7(0.4:36.2)
111.5:A+23.5(-32.7:42.9)
111.4:A+22.3(-29.9:49.1)
114.7:Bb+27.0(-45.3:0.0)
110.4:A+5.8(-19.4:49.9)
110.2:A+2.8(-25.5:45.7)
110.3:A+5.0(-19.0:49.3)
165.0:E+1.8(-22.7:49.0)
170.3:F-43.4(-19.5:18.2)
168.9:E+42.5(-20.5:45.9)
170.8:F-38.3(-26.6:29.8)
167.3:E+25.8(-33.0:18.5)

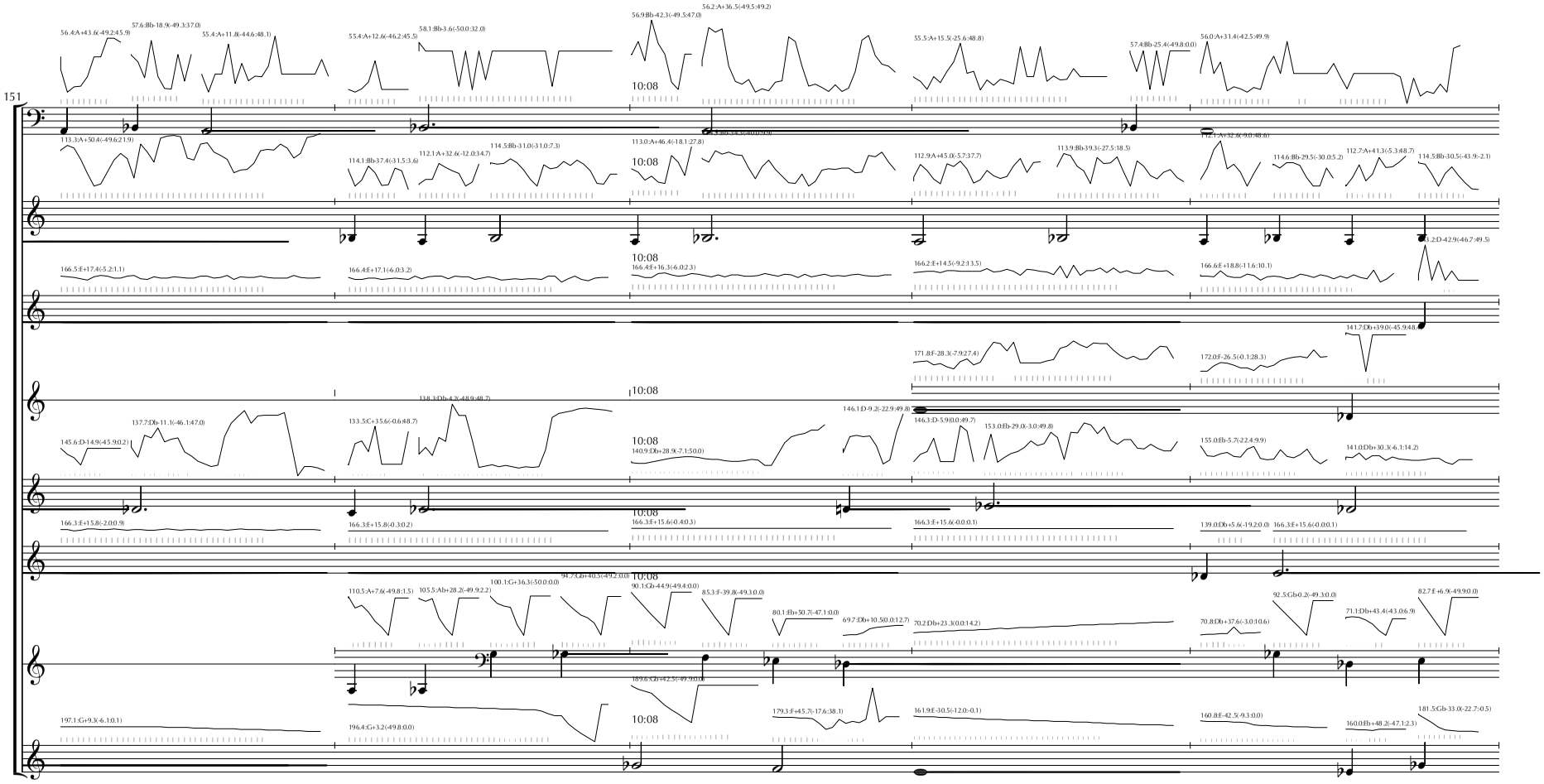

126
8:32
84.4:E+40.4(-4.9:-0.0)
84.1:E+35.5(-9.9:0.0)
83.6:E+25.6(-49.1:0.0)
69.2:Db+1.4(-43.9:48.6)
109.5:A-7.3(-1.0:18.0)
109.6:A-7.0(-0.3:12.7)
109.8:A-3.4(-2.8:9.5)
110.0:A-0.8(-9.9:8.6)
109.9:A-0.8(-7.1:32.7)
173.4:F-12.5(-33.1:14.4)
174.6:F-0.3(-20.1:17.6)
174.6:F+0.1(-8.2:49.9)
179.6:F+48.9(-20.3:5.7)
179.9:Cb-48.5(-2.5:13.3)
179.2:F+45.2(-1.5:8.0)
180.1:Cb-46.8(-21.9:0.6)
177.8:F+31.3(0.1:21.5)
110.4:A+6.2(-23.6:13.4)
110.3:A+5.2(-20.6:13.4)
110.5:A+7.4(-19.0:11.4)
110.3:A+4.2(-14.3:25.6)
110.3:A+4.9(-15.9:2.0)
166.1:E+13.7(-1.2:10.0)
166.3:E+15.6(-12.7:30.6)
166.6:E+18.8(-6.9:1.7)
144.0:D-33.8(-34.5:27.1)
166.2:E+14.7(-0.0:2.3)
166.3:E+15.6(-0.1:0.1)
166.3:E+15.5(-0.2:0.2)

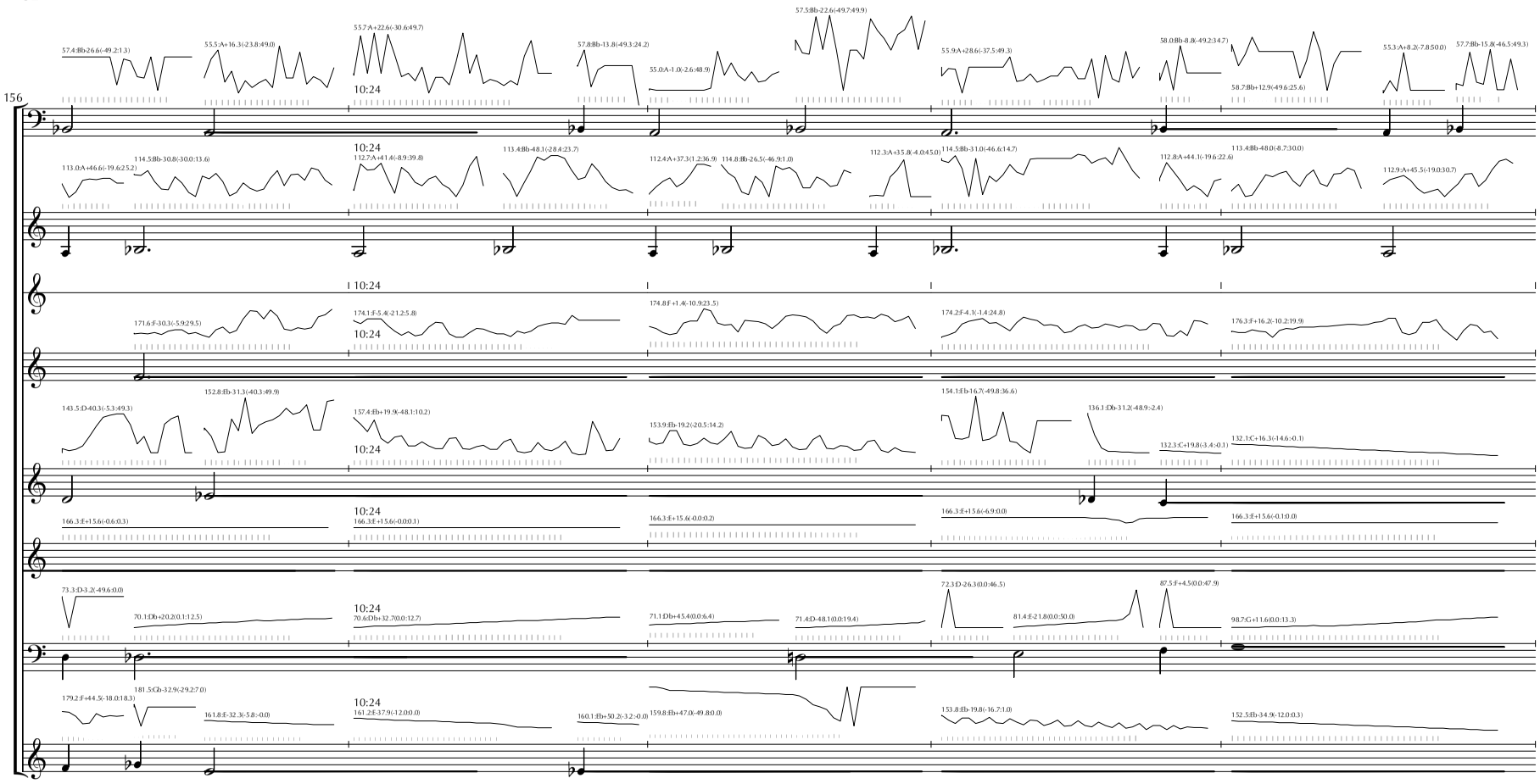

131
67.4:Db-49.2(-4.4:6.1:1.1)
76.8:Eb-21.7(-6.1:-0.1)
76.5:Eb-27.7(-4.4:0.0)
166.6:E+18.6(-6.4:4.0)
76.0:Eb-39.4(-47.3:0.0)
8:48
166.2:E+14.8(-3.0:4.9)
166.3:E+15.4(-4.3:6.4)
148.7:D+21.6(-31.0:3.1)
136.3:Db-29.1(-48.8:3.0.4)
126.1:B+36.8(-10.0:49.2)
129.6:C-16.2(-49.0:1.9)
110.1:A+1.7(-8.8:4.3)
110.1:A+1.0(-7.1:5.8)
8:48
110.2:A+2.5(-5.8:49.9)
113.2:A+49.7(-50.0:0.0)
109.7:A-5.0(-2.6:49.9)
8:48
179.7:F+49.5(-7.8:18.1)
180.1:Gb+46.7(-6.7:3.8)
179.4:F+47.0(-9.9:1.3)
178.3:F+36.0(-40.6:23.8)
8:48
174.2:F-4.6(-0.2:0.1)
174.1:F-4.6(-0.1:0.2)
174.1:F-4.8(-7.6:39.1)
110.1:A+1.9(-10.5:5.9)
110.1:A+1.7(-11.7:20.2)
114.3:Bb-34.2(-48.3:0.0)
8:48
109.6:A-6.8(-1.3:44.7)
119.2:Bb+38.3(-48.1:10.4)
109.6:A-6.6(-2.5:49.1)
114.6:Bb-29.2(-49.3:6.3)
109.8:A-3.6(-4.7:48.9)
114.1:Bb-36.0(-49.4:9.6)
166.3:E+15.5(-0.2:0.2)
166.3:E+15.5(-0.4:0.4)
8:48
166.3:E+15.5(-0.1:0.1)
166.3:E+15.5(0.0:0.0)
166.3:E+15.5(-3.3:3.3)
8:48
8:48

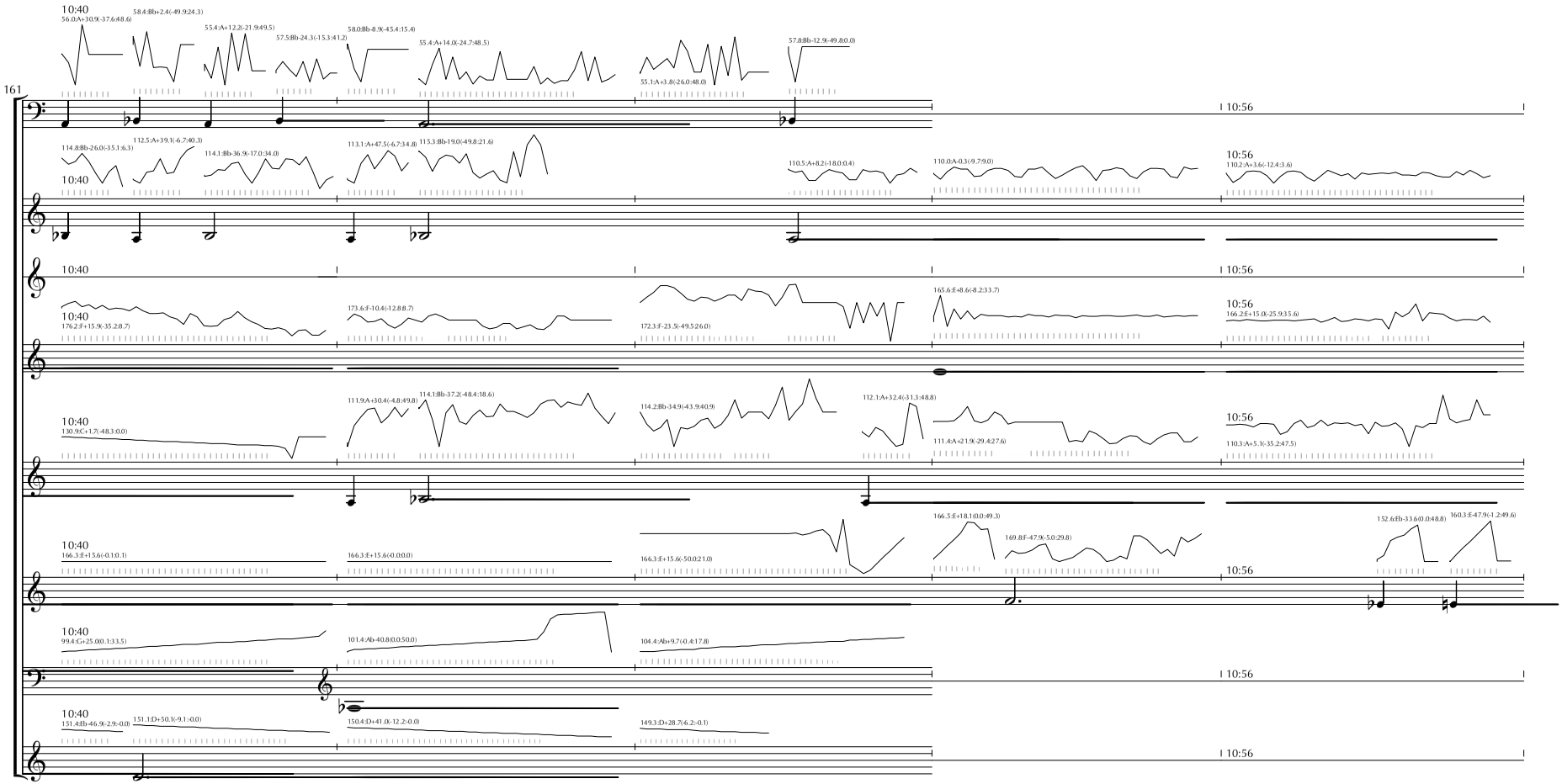

136
9:04
110.7:A+11.1(-37.8:0.0)
58.0:Bb-9.1(-47.0:8.0)
55.4:A+13.6(-1.4:7.0)
55.5:A+15.0(-4.0:5.4)
55.5:A+15.3(-7.2:11.0)
55.3:A+8.8(-1.6:49.1)
56.4:A+44.1(-48.5:49.9)
57.3:Bb-29.7(-13.7:38.2)
55.3:A+8.1(-32.7:49.6)
116.0:Bb-8.3(-39.6:31.3)
116.0:Bb-8.6(-27.6:25.7)
173.9:F-7.3(-0.9:50.0)
178.6:F+38.8(-10.1:15.9)
180.0:Cb-47.2(-4.0:12.9)
179.2:F+44.4(-0.8:8.8)
180.1:Cb-46.8(-21.9:0.7)
177.8:F+31.5(0.4:13.9)
166.3:E+15.1(-2.2:3.3)
166.3:E+15.1(-2.8:3.7)
166.4:E+16.6(-3.7:2.8)
174.3:F-3.1(-23.0:18.8)
176.9:F+22.9(-49.7:0.0)
119.4:Bb+42.5(-15.3:35.6)
127.3:C-47.5(0.0:49.5)
132.9:C+27.7(-11.4:0.7)
132.1:C+16.4(-12.7:0.1)
166.3:E+15.5(-0.0:0.1)
166.3:E+15.5(-0.0:0.0)
166.3:E+15.5(-0.1:0.1)
166.3:E+15.5(-0.1:0.1)
166.3:E+15.5(-0.2:1.8)
177.7:F+30.2(-28.2:21.3)
179.9:Cb-48.2(0.3:35.2)

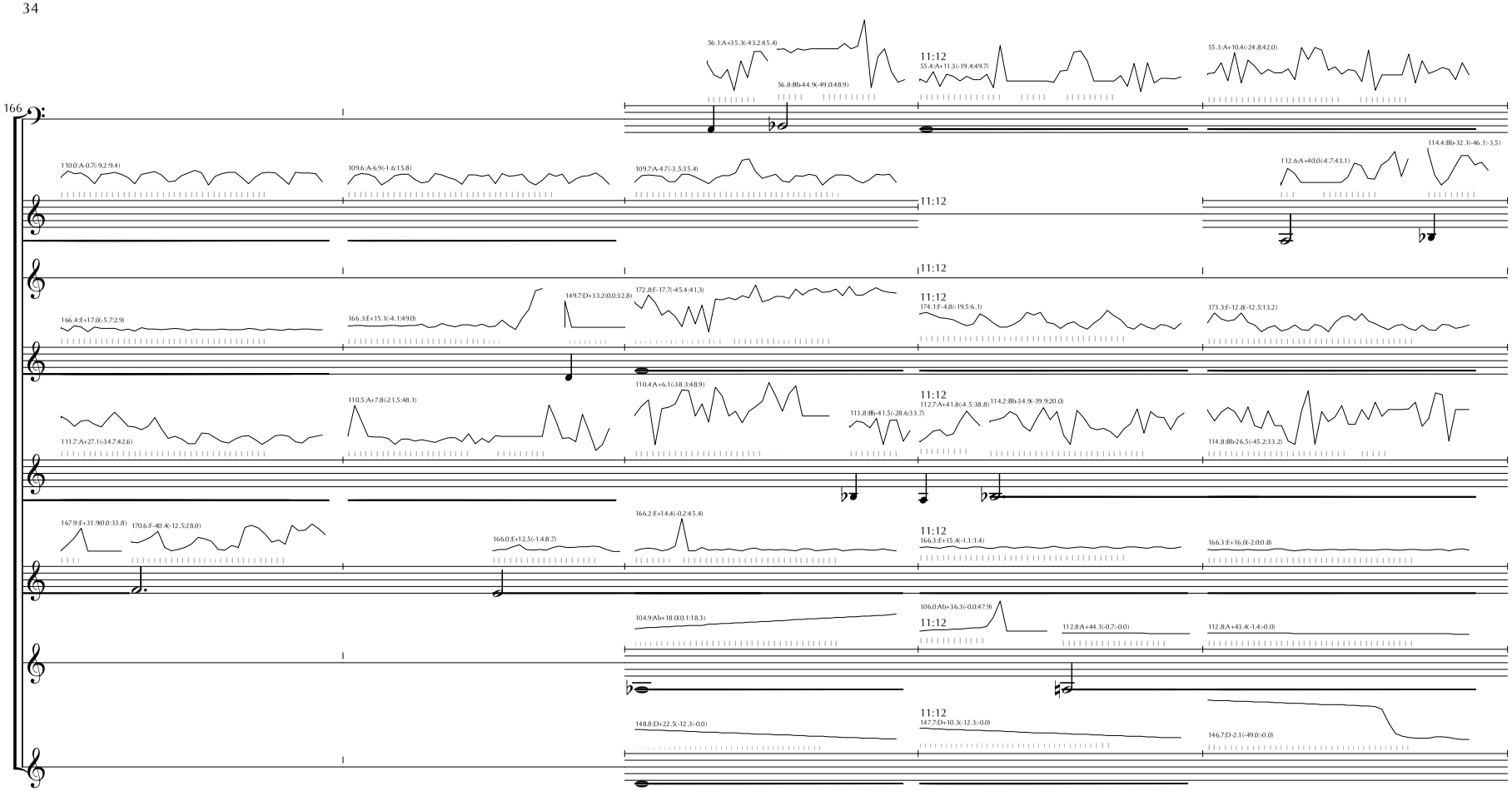

141
9:20
55.4:A+11.1:(-8.3:48.8)
57.8:Bb-13.5:(-47.9:0.0)
55.6:A+19.0:(-18.6:32.7)
56.2:A+37.4:(-29.3:46.6)
57.5:Bb-22.4:(-49.1:50.0)
57.7:Bb-18.5:(-48.6:50.0)
55.5:A+15.1:(-47.7:48.1)
57.2:Bb-33.0:(-49.2:0.0)
9:36
55.6:A+18.0:(-21.6:49.9)
58.2:Bb-3.0:(-48.7:49.8)
56.6:A+49.4:(-44.8:49.7)
9:20
178.3:F+36.6:(0.6:20.3)
179.8:Cb-49.1:(-4.3:16.8)
179.4:F+47.1:(-14.3:12.8)
178.6:F+39.4:(-44.2:17.0)
174.1:F-4.7:(-0.0:0.2)
9:36
174.1:F-4.6:(-2.9:39.0)
9:20
166.5:E+18.1:(-8.1:2.1)
166.3:E+15.0:(-4.6:5.6)
166.3:E+15.1:(-9.1:13.0)
166.9:E+21.3:(-14.7:5.9)
9:36
171.8:F-28.1:(-38.1:28.2)
9:20
9:36
9:20
131.1:C+4.0:(-3.5:50.0)
136.0:Db-33.0:(-5.9:10.8)
135.3:Db-41.8:(-41.3:15.8)
132.1:C+16.5:(-48.3:47.3)
132.4:C+20.6:(-45.5:15.9)
131.6:C+10.4:(-15.9:48.7)
9:36
136.4:Db-27.9:(-36.9:1.3)
133.5:C+3.5:(0.-46.7:45.7)
9:20
166.3:E+1.5.7:(-1.8:1.3)
166.4:E+16.1:(-1.7:0.5)
166.2:E+14.3:(-0.2:3.4)
166.5:E+17.8:(-4.2:0.1)
9:36
166.3:E+15.8:(-1.2:1.1)
9:20
9:36
9:20
183.6:Cb-13.0:(-3.0:0.2)
183.3:Cb-15.9:(-6.5:-0.0)
183.1:Gb-18.3:(-42.6:37.4)
176.4:F+17.4:(-15.7:49.8)
182.5:Gb-23.8:(-14.8:21.1)
183.4:Gb-14.9:(-9.0:0.1)
9:36

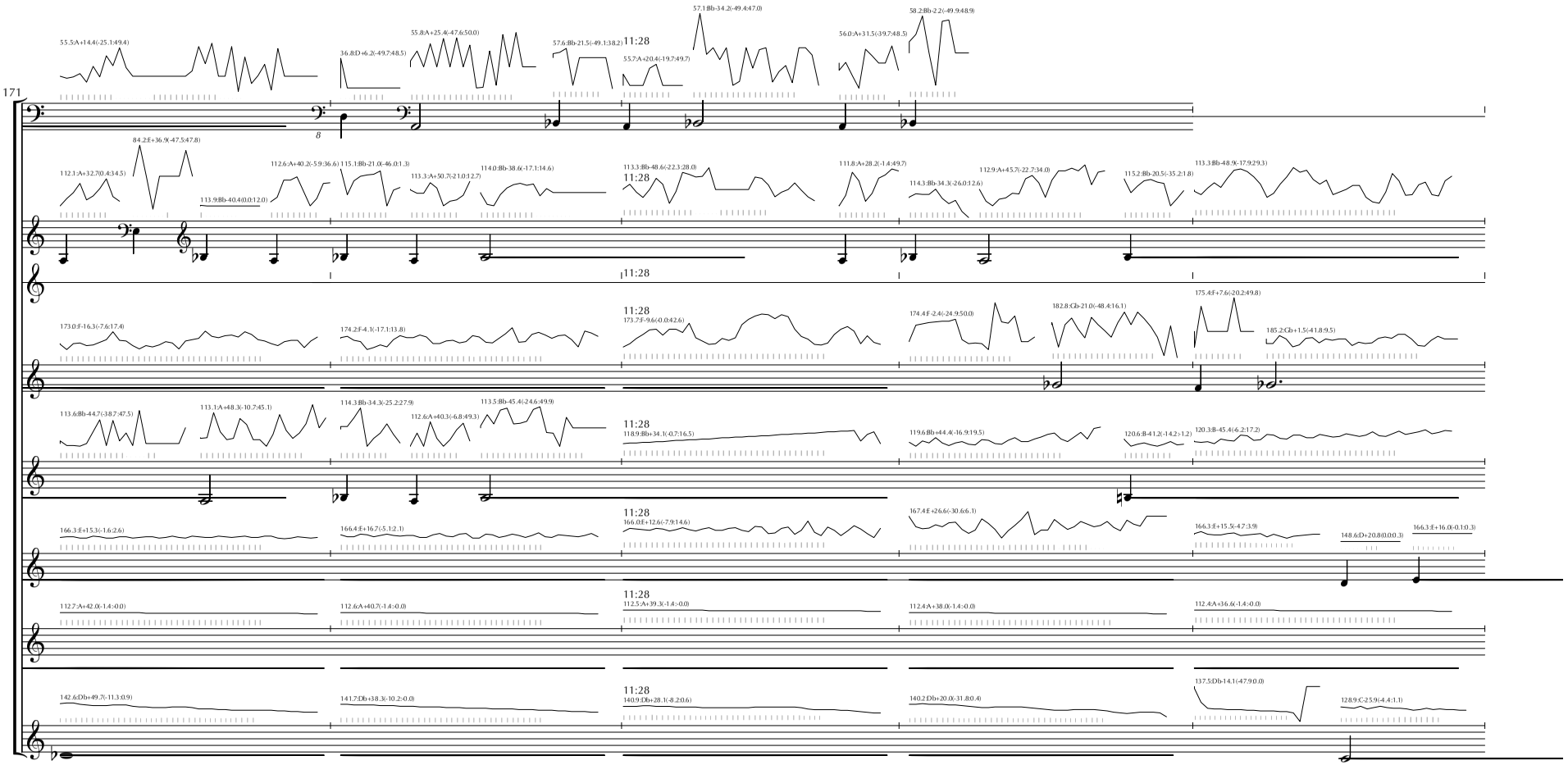

146
56.6:A+49.6:(-46.9:46.4)
57.7:Bb-17.1:(-31.5:36.6)
56.3:A+41.2:(-49.1:44.5)
55.1:A+3.2:(-13.0:49.0)
57.3:Bb-28.1:(-50.0:20.1)
55.6:A+19.6:(-20.1:47.4)
57.5:Bb-22.7:(-49.5:48.2)
56.0:A+31.0:(-44.6:49.1)
9:52
57.5:Bb-22.7:(-48.3:47.9)
55.5:A+14.4:(46.7:49.8)
57.1:Bb-36.2:(-41.9:46.0)
55.2:A+5.4:(-49.9:48.7)
58.0:Bb-9.0:(-46.6:47.6)
176.7:F+20.8:(-33.2:2.9)
174.0:F-5.8:(-22.5:29.0)
174.6:F-0.4:(-28.2:9.1)
112.6:A+40.8:(-4.5.5:21.9)
9:52
114.2:Bb-34.9:(-46.1:11.2)
111.7:A+26.9:(-21.9:33.3)
168.0:E+32.9:(-46.6:47.7)
166.5:E+17.5:(-3.4:0.9)
166.3:E+15.7:(-3.0:3.1)
9:52
132.0:C+16.0:(-24.8:-0.0)
131.3:C+6.7:(-10.8:50.0)
135.8:Db-35.8:(-49.7:11.4)
131.2:C+4.7:(-33.5:19.4)
134.9:Db-47.2:(-23.6:49.8)
9:52
132.6:C+23.3:(-11.6:23.4)
137.8:Db-10.4:(-28.7:49.7)
146.9:D+0.7:(-35.0:3.6)
166.2:E+14.8:(-0.2:2.6)
166.4:E+16.6:(-3.0:1.2)
166.2:E+14.8:(-3.6:4.1)
9:52
166.3:E+15.9:(-6.6:6.5)
166.3:E+15.6:(-2.0:1.6)
182.6:Gb-22.9:(-49.8:3.1)
177.0:F+23.9:(-19.6:49.5)
184.0:Gb-9.7:(-11.9:5.3)
182.9:Gb-20.0:(-4.2:17.1)
183.0:Gb-18.4:(-4.1:14.5)
9:52
184.6:Gb-3.7:(0.0:50.0)
192.6:G-30.0:(0.4:39.4)

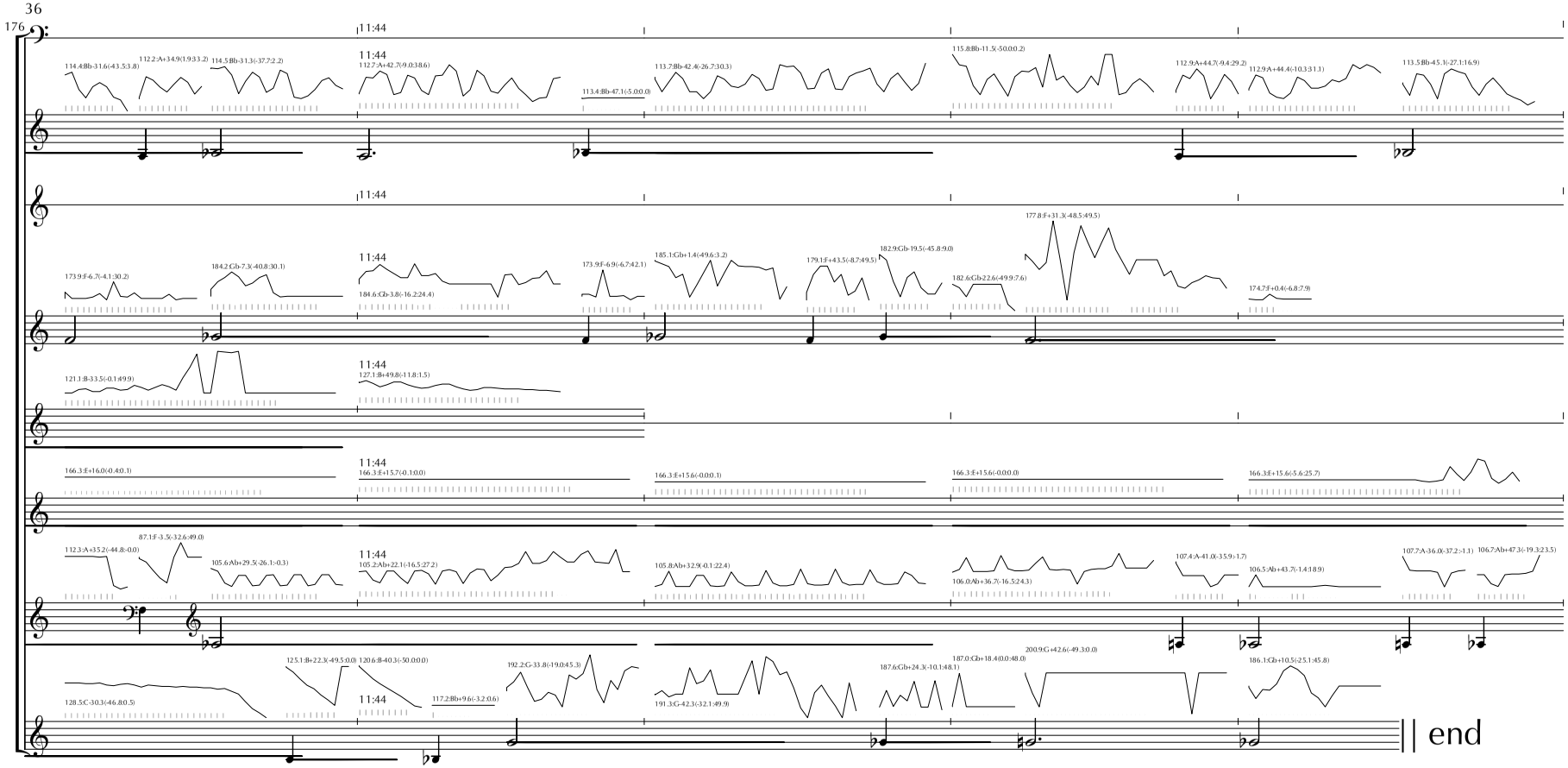

151
10:08
10:08
10:08
10:08
10:08
10:08
10:08

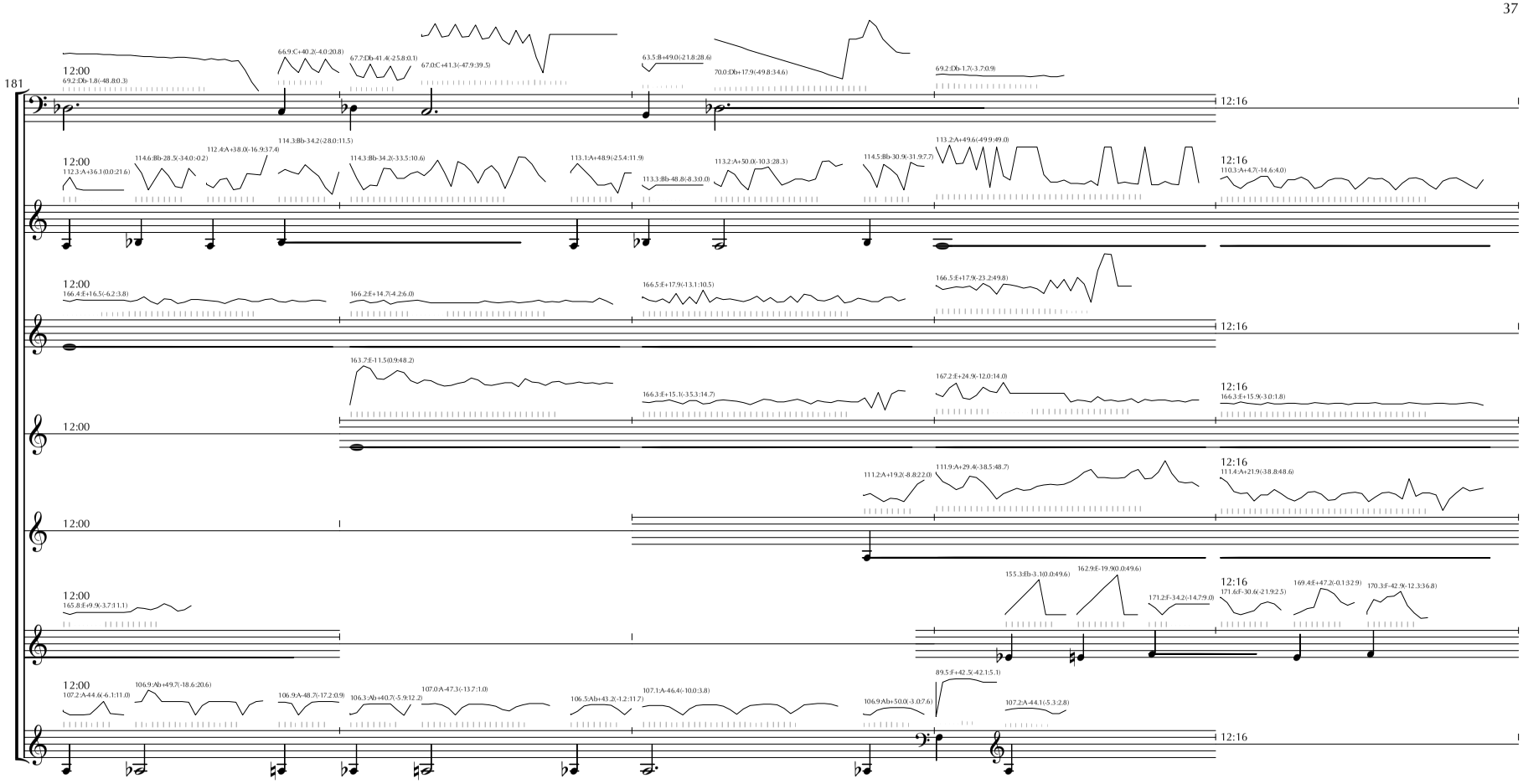

156
10:24

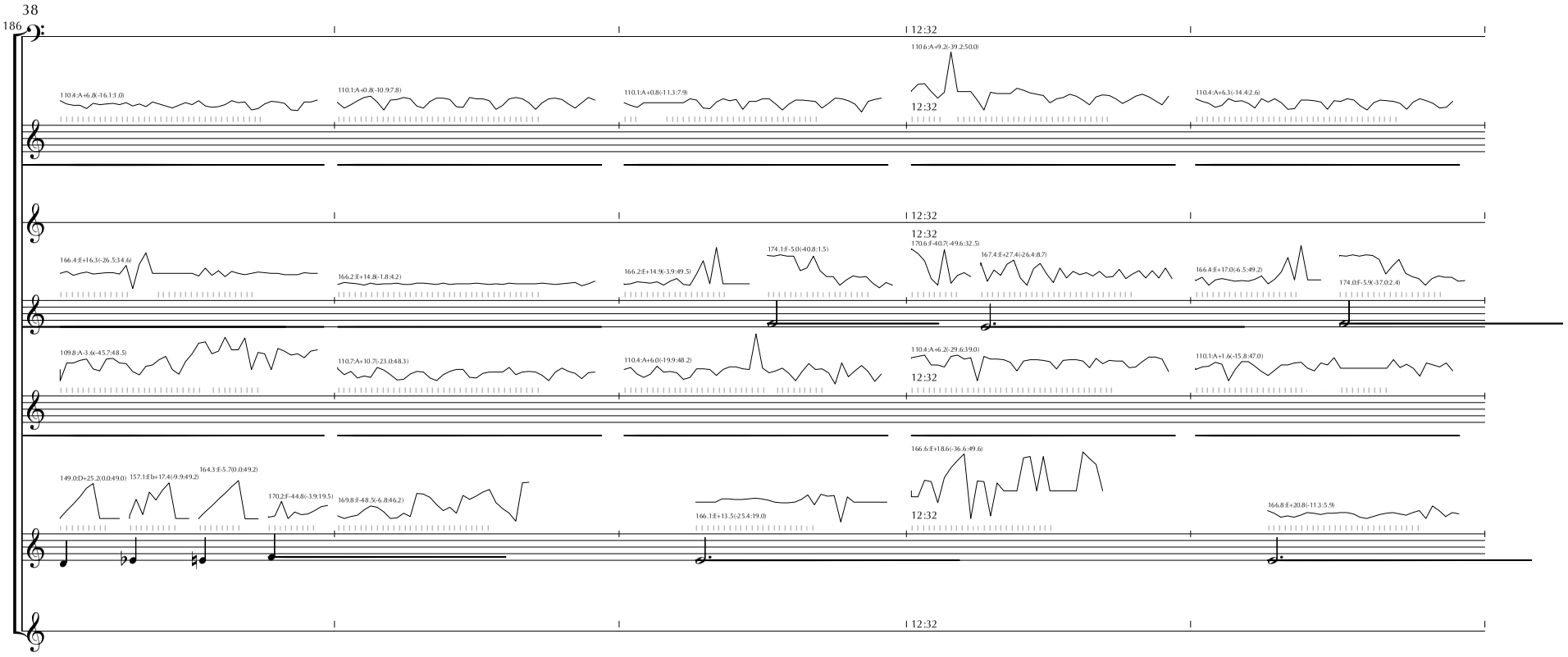

161
10:40
56.0:A+30.9(-37.6:48.6)
58.4:Bb+2.4(-49.9:24.3)
55.4:A+12.2(-21.9:49.5)
57.5:Bb-24.3(-15.3:41.2)
58.0:Bb-8.9(-45.4:15.4)
55.4:A+14.0(-24.7:48.5)
55.1:A+3.8(-26.0:48.0)
57.8:Bb-12.9(-49.8:0.0)
10:56
114.8:Bb-26.0(-35.1:6.3)
112.5:A+39.1(-6.7:40.3)
114.1:Bb-36.9(-17.0:34.0)
113.1:A+47.5(-6.7:34.8)
115.3:Bb-19.0(-49.8:21.6)
110.5:A+8.2(-18.0:0.4)
110.0:A-0.3(-9.7:9.0)
110.2:A+3.6(-12.4:3.6)
176.2:F+15.9(-35.2:8.7)
173.6:F-10.4(-12.8:8.7)
172.3:F-23.5(-49.5:26.0)
165.6:E+8.6(-8.2:33.7)
166.2:E+15.0(-25.9:35.6)
130.9:C+1.7(-48.3:0.0)
111.9:A+30.4(-4.8:49.8)
114.1:Bb-37.2(-48.4:18.6)
114.2:Bb-34.9(-43.9:40.9)
112.1:A+32.4(-31.3:48.8)
111.4:A+21.9(-29.4:27.6)
110.3:A+5.1(-35.2:47.5)
166.3:E+1.5.6(-0.1:0.1)
166.3:E+15.6(-0.0:0.0)
166.3:E+15.6(-50.0:21.0)
166.5:E+1.8.1(0.0:49.3)
169.8:F-47.9(-5.0:29.8)
152.6:Eb-33.6(0.0:48.8)
160.3:E-47.9(-1.2:49.6)
99.4:G+25.0(0.1:33.5)
101.4:Ab-40.8(0.0:50.0)
104.4:Ab+9.7(-0.4:17.8)
151.4:Eb-46.9(-2.9:-0.0)
151.1:D+50.1(-9.1:-0.0)
150.4:D+41.0(-12.2:-0.0)
149.3:D+28.7(-6.2:-0.1)

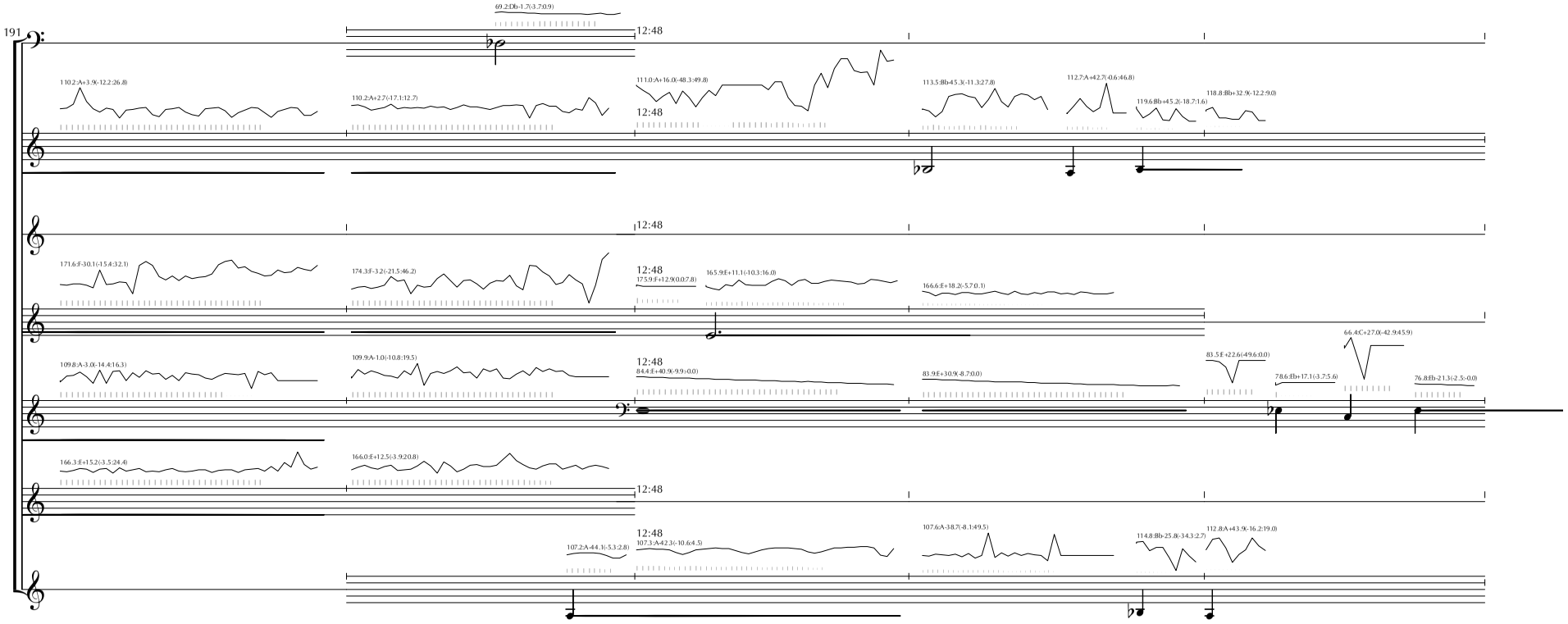

166
56.1:A+35.3(-43.2:45.4)
56.8:Bb+44.9(-89.0:48.9)
11:12
55.4:A+11.3(-19.4:49.7)
55.3:A+10.4(-24.8:42.0)
110.0:A-0.7(-9.2:9.4)
109.6:A-6.9(-1.6:15.8)
109.7:A-4.7(-3.5:35.4)
11:12
112.6:A+40.0(-4.7:43.1)
114.4:Bb-32.1(-46.1:-3.5)
166.4:E+17.0(-5.7:2.9)
166.3:E+15.1(-4.1:49.0)
149.7:D+33.2(0.0:32.8)
172.8:F-17.7(-45.4:41.3)
11:12
174.1:F-4.8(-19.5:6.1)
173.3:F-12.8(-12.5:13.2)
111.7:A+27.1(-34.7:42.6)
110.5:A+7.8(-21.5:48.1)
110.4:A+6.1(-38.3:48.9)
113.8:Bb-41.5(-28.6:33.7)
11:12
112.7:A+41.8(-4.5:38.8)
114.2:Bb-34.9(-39.9:20.0)
114.8:Bb+26.5(-45.2:33.2)
167.9:E+31.9(0.0:33.8)
170.6:F-40.4(-12.5:28.0)
166.0:E+12.5(-1.4:8.7)
166.2:E+14.4(-0.2:45.4)
11:12
166.3:E+15.4(-1.1:1.4)
166.3:E+16.0(-2.0:0.8)
104.9:Ab+18.0(0.1:18.3)
106.0:Ab+36.3(-0.0:47.9)
11:12
112.8:A+44.1(-0.7:-0.0)
112.8:A+43.4(-1.4:-0.0)
148.8:D+22.5(-12.3:-0.0)
11:12
147.7:D+10.3(-12.3:-0.0)
146.7:D-2.1(-49.0:-0.0)

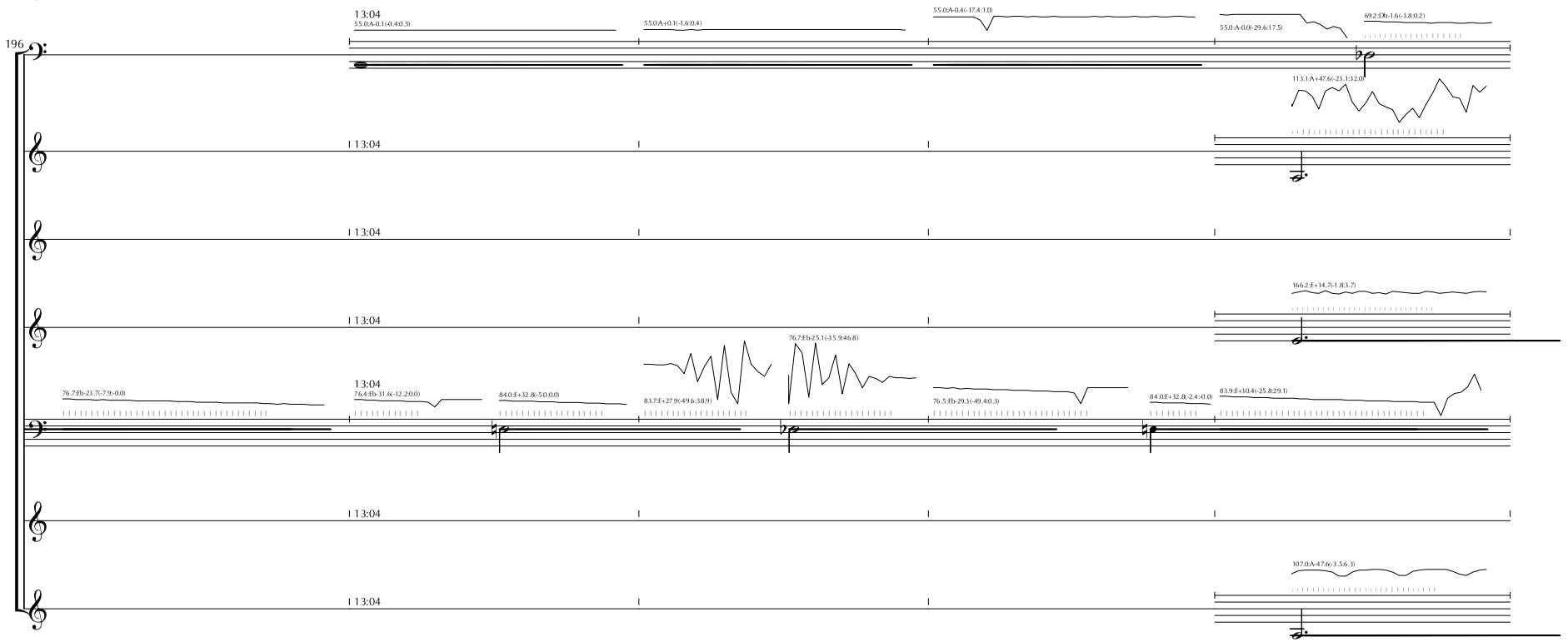

171
55.5:A+14.4:(-25.1:49.4)
36.8:D+6.2:(-49.7:48.5)
55.8:A+25.4:(-47.6:50.0)
57.6:Bb-21.5:(-49.1:38.2)
11:28
55.7:A+20.4:(-19.7:49.7)
57.1:Bb-34.2:(-49.4:47.0)
56.0:A+31.5:(-39.7:48.5)
58.2:Bb-2.2:(-49.9:48.9)
112.1:A+32.7:(0.4:34.5)
84.2:E+36.9:(-47.5:47.8)
113.9:Bb-40.4:(0.0:12.0)
112.6:A+40.2:(-5.9:36.6)
115.1:Bb-21.0:(-46.0:1.3)
113.3:A+50.7:(-21.0:12.7)
114.0:Bb-38.6:(-17.1:14.6)
113.3:Bb-48.6:(-22.3:28.0)
111.8:A+28.2:(-1.4:49.7)
114.3:Bb-34.3:(-26.0:12.6)
112.9:A+45.7:(-22.7:34.0)
115.2:Bb-20.5:(-35.2:1.8)
113.3:Bb-48.9:(-17.9:29.3)
173.0:F-16.3:(-7.6:17.4)
174.2:F-4.1:(-17.1:13.8)
173.7:F-9.6:(-0.0:42.6)
174.4:F-2.4:(-24.9:50.0)
182.8:Cb-21.0:(-48.4:16.1)
175.4:F+7.6:(-20.2:49.8)
185.2:Cb+1.5:(-41.8:9.5)
113.6:Bb-44.7:(-38.7:47.5)
113.1:A+48.3:(-10.7:45.1)
114.3:Bb-34.3:(-25.2:27.9)
112.6:A+40.3:(-6.8:49.3)
113.5:Bb-45.4:(-24.6:49.9)
118.9:Bb+34.1:(-0.7:16.5)
119.6:Bb+44.4:(-16.9:19.5)
120.6:B-41.2:(-14.2:>1.2)
120.3:B-45.4:(-6.2:17.2)
166.3:E+1.5:(-1.6:2.6)
166.4:E+16.7:(-5.1:2.1)
166.0:E+12.6:(-7.9:14.6)
167.4:E+26.6:(-30.6:6.1)
166.3:E+15.5:(-4.7:3.9)
148.6:D+20.8:(0.0:0.3)
166.3:E+16.0:(-0.1:0.3)
112.7:A+42.0:(-1.4:<0.0)
112.6:A+40.7:(-1.4:<0.0)
112.5:A+39.3:(-1.4:<0.0)
112.4:A+38.0:(-1.4:<0.0)
112.4:A+36.6:(-1.4:<0.0)
142.6:Db+49.7:(-11.3:0.9)
141.7:Db+38.3:(-10.2:<0.0)
140.9:Db+28.1:(-8.2:0.6)
140.2:Db+20.0:(-31.8:0.4)
137.5:Db+14.1:(-47.9:0.0)
128.9:C-2.5:9:(-4.4:1.1)

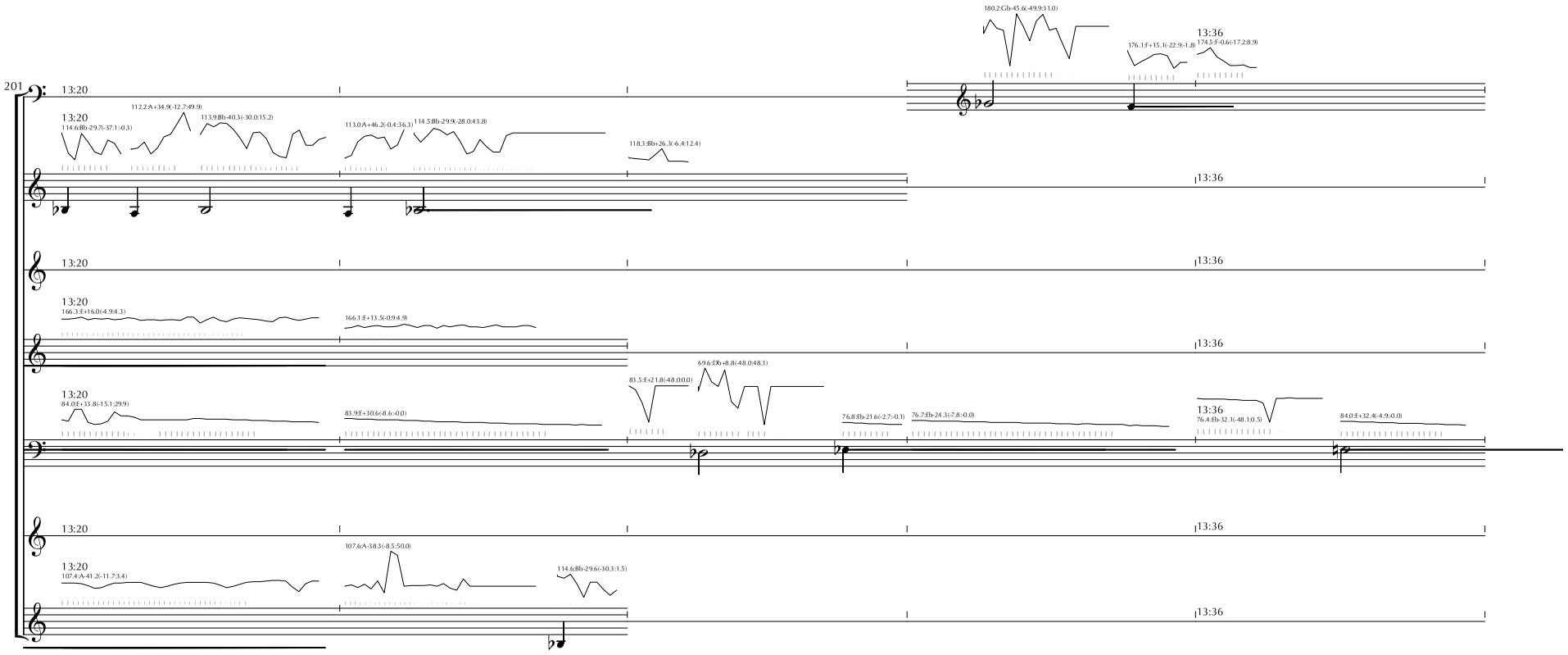

176
11:44
114.4:Bb-31.6(-43.5:3.8)
112.2:A+34.9(1.9:33.2)
114.5:Bb-31.3(-37.7:2.2)
11:44
112.7:A+42.7(-9.0:38.6)
113.4:Bb-47.1(-5.0:0.0)
113.7:Bb-42.4(-26.7:30.3)
115.8:Bb-11.5(-50.0:0.2)
112.9:A+44.7(-9.4:29.2)
112.9:A+44.4(-10.3:31.1)
113.5:Bb-45.1(-27.1:16.9)
11:44
173.9:F-6.7(-4.1:30.2)
184.2:Gb-7.3(-40.8:30.1)
11:44
184.6:Gb-3.8(-16.2:24.4)
173.9:F-6.9(-6.7:42.1)
185.1:Gb+1.4(-49.6:3.2)
179.1:F+43.5(-8.7:49.5)
182.9:Gb-19.5(-45.8:9.0)
182.6:Gb+22.6(-49.9:7.6)
177.8:F+31.3(-48.5:49.5)
174.7:F+0.4(-6.8:7.9)
121.1:B-33.5(-0.1:49.9)
11:44
127.1:B+49.8(-11.8:1.5)
166.3:E+16.0(-0.4:0.1)
11:44
166.3:E+15.7(-0.1:0.0)
166.3:E+15.6(-0.0:0.1)
166.3:E+15.6(-0.0:0.0)
166.3:E+15.6(-5.6:25.7)
112.3:A+3.5.2(-44.8:-0.0)
87.1:F-3..5(-32.6:49.0)
105.6:Ab+29.5(-26.1:-0.3)
11:44
105.2:Ab+22.1(-16.5:27.2)
105.8:Ab+32.9(-0.1:22.4)
106.0:Ab+36.7(-16.5:24.3)
107.4:A-41.0(-35.9:-1.7)
106.5:Ab+43.7(-1.4:38.9)
107.7:A-36.0(-37.2:-1.1)
106.7:Ab+47.3(-19.3:23.5)
128.5:C-30.3(-46.8:0.5)
125.1:B+22.3(-49.5:0.0)
120.6:B-40.3(-50.0:0.0)
11:44
117.2:Bb+9.6(-3.2:0.6)
192.2:G-33.8(-19.0:45.3)
191.3:G-42.3(-32.1:49.9)
187.6:Gb+24.3(-10.1:48.1)
187.0:Gb+18.4(0.0:48.0)
200.9:G+42.6(-49..3:0.0)
186.1:Gb+10.5(-25.1:45.8)
|| end

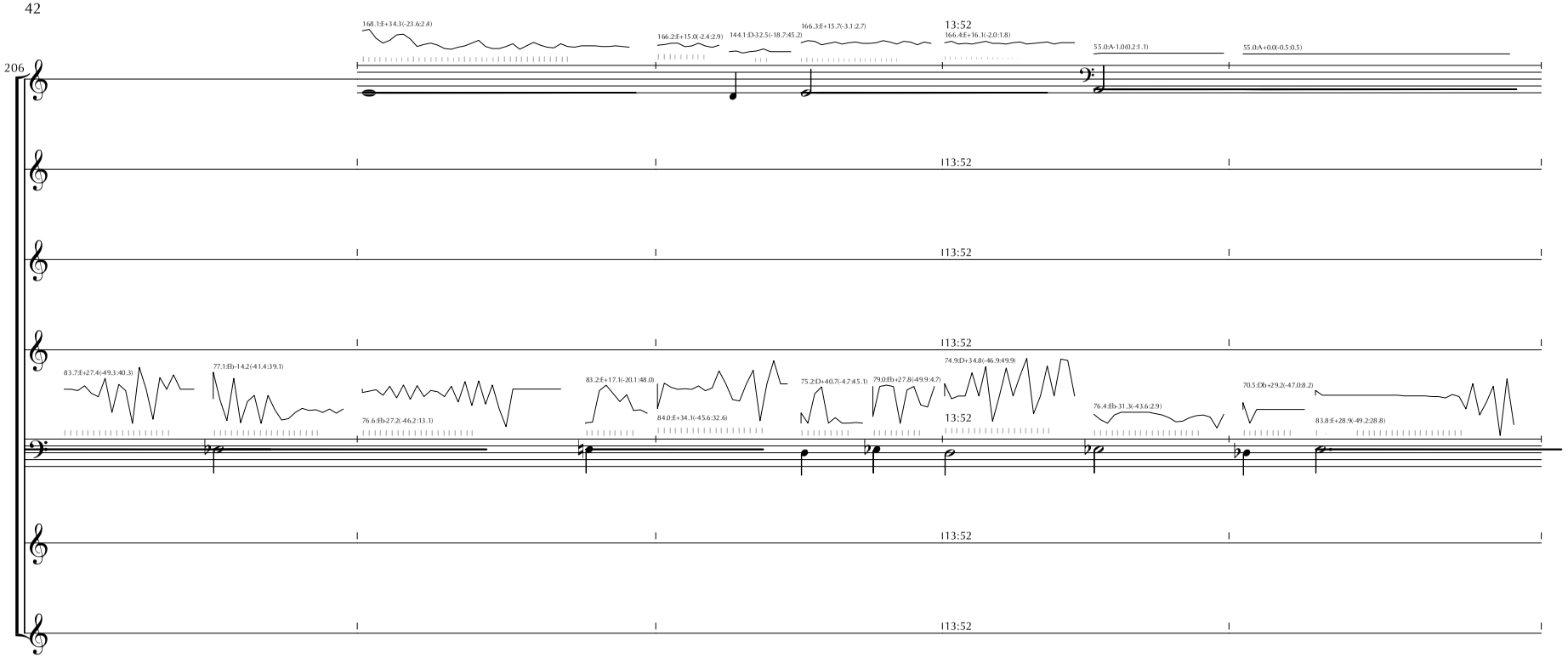

181
12:00
69.2:Db-1.8(-48.8:0.3)
66.9:C+40.2(-4.0:20.8)
67.7:Db-41.4(-25.8:0.1)
67.0:C+41.3(-47.9:39.5)
63.5:B+49.0(-21.8:28.6)
70.0:Db+17.9(-49.8:34.6)
69.2:Db-1.7(-3.7:0.9)
12:16
12:00
112.3:A+36.1(0.0:21.6)
114.6:Bb-28.5(-34.0:-0.2)
112.4:A+38.0(-16.9:37.4)
114.3:Bb-34.2(-28.0:11.5)
114.3:Bb-34.2(-33.5:10.6)
113.1:A+48.9(-25.4:11.9)
113.3:Bb-48.8(-8.3:0.0)
113.2:A+50.0(-10.3:28.3)
114.5:Bb-30.9(-31.9:7.7)
113.2:A+49.6(-49.9:49.0)
12:16
110.3:A+4.7(-14.6:4.0)
12:00
166.4:E+16.5(-6.2:3.8)
166.2:E+14.7(-4.2:6.0)
166.5:E+17.9(-13.1:10.5)
166.5:E+17.9(-23.2:49.8)
12:16
163.7:E-11.5(0.9:48.2)
166.3:E+15.1(-35.3:14.7)
167.2:E+24.9(-12.0:14.0)
12:16
166.3:E+15.9(-3.0:1.8)
12:00
111.2:A+19.2(-8.8:22.0)
111.9:A+29.4(-38.5:48.7)
12:16
111.4:A+21.9(-38.8:48.6)
12:00
165.8:E+9.9(-3.7:11.1)
155.3:Eb-3.1(0.0:49.6)
162.9:E-19.9(0.0:49.6)
171.2:F-34.2(-14.7:9.0)
12:16
171.6:F-30.6(-21.9:2.5)
169.4:E+47.2(-0.1:32.9)
170.3:F-42.9(-12.3:36.8)
12:00
107.2:A-44.6(-6.1:11.0)
106.9:Ab+49.7(-18.6:20.6)
106.9:A-48.7(-17.2:0.9)
106.3:Ab+40.7(-5.9:12.2)
107.0:A-47.3(-13.7:1.0)
106.5:Ab+43.2(-1.2:11.7)
107.1:A-46.4(-10.0:3.8)
106.9:Ab+50.0(-3.0:7.6)
89.5:F+42.5(-42.1:5.1)
107.2:A-44.1(-5.3:2.8)
12:16

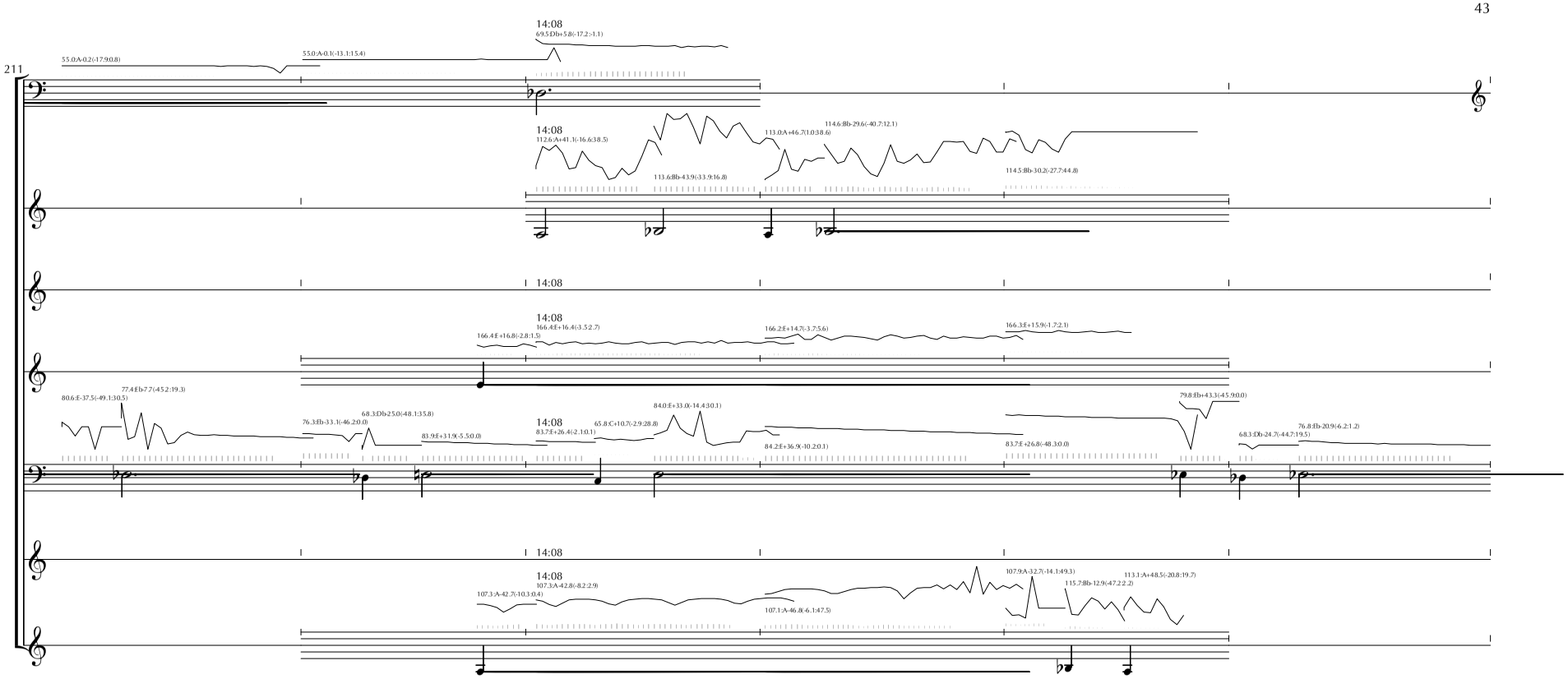

38
186
12:32
110.4:A+6.8(-16.1:3.0)
110.1:A+0.8(-10.9:7.8)
110.1:A+0.8(-11.3:7.9)
110.6:A+9.2(-39.2:50.0)
12:32
110.4:A+6.3(-14.4:2.6)
166.4:E+16.3(-26.5:34.6)
166.2:E+14.8(-1.8:4.2)
166.2:E+14.9(-3.9:49.5)
174.1:F-5.0(-40.8:1.5)
170.6:F+40.7(-49.6:32.5)
167.4:E+27.4(-26.4:8.7)
166.4:E+17.0(-6.5:49.2)
174.0:F-5.9(-37.0:2.4)
109.8:A-3.6(-45.7:48.5)
110.7:A+10.7(-23.0:48.3)
110.4:A+6.0(-19.9:48.2)
110.4:A+6.2(-29.6:39.0)
12:32
110.1:A+1.6(-15.8:47.0)
149.0:D+25.2(0.0:49.0)
157.1:Eb+17.4(-9.9:49.2)
164.3:E-5.7(0.0:49.2)
170.2:F-44.8(-3.9:19.5)
169.8:F-48.5(-6.8:46.2)
166.1:E+13.5(-25.4:19.0)
166.6:E+18.6(-36.6:49.6)
12:32
166.8:E+20.8(-11.3:5.9)

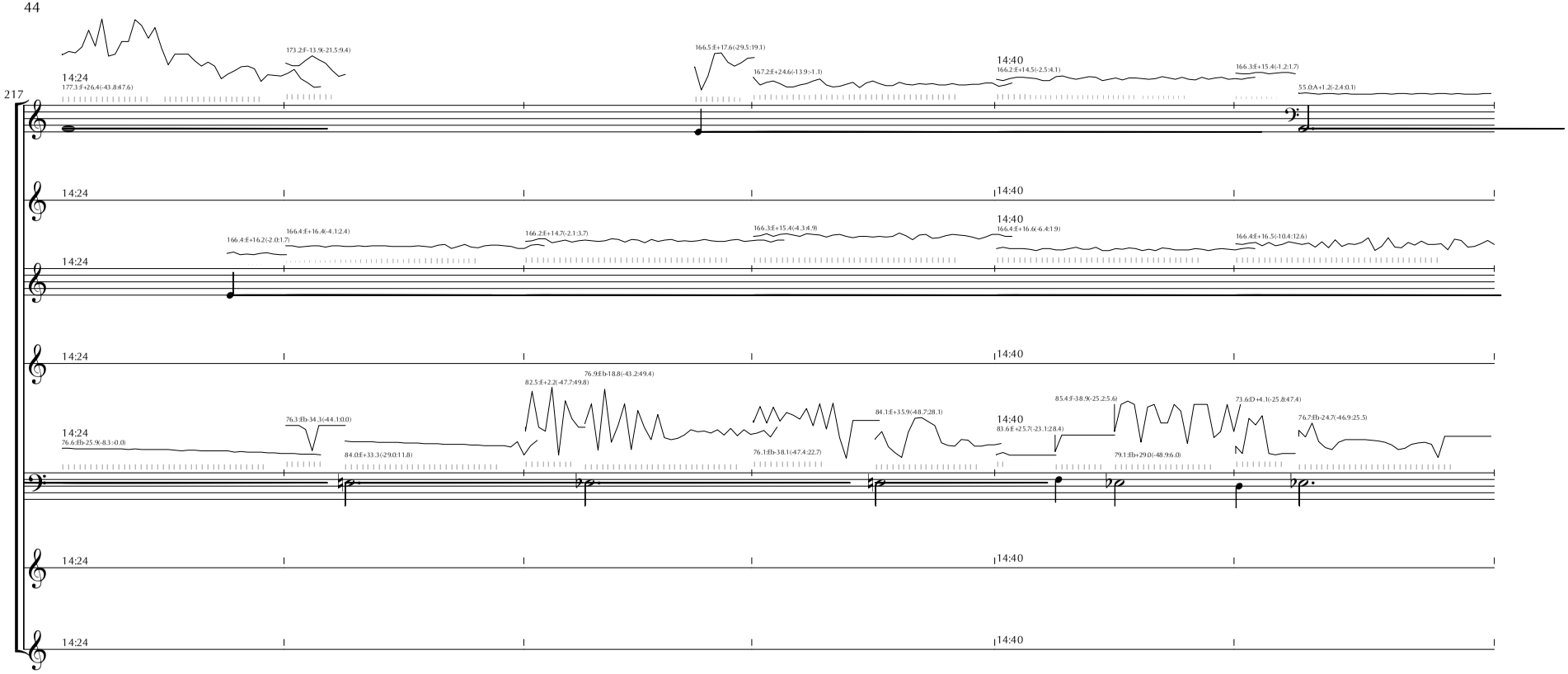

191
69.2:Db-1.7(-3.7:0.9)
12:48
110.2:A+3.9(-12.2:26.8)
110.2:A+2.7(-17.1:12.7)
111.0:A+16.0(-48.3:49.8)
113.5:Bb-45.3(-11.3:27.8)
11.2.7:A+42.7(-0.6:46.8)
119.6:Bb+45.2(-18.7:1.6)
118.8:Bb+32.9(-12.2:9.0)
171.6:F-30.1(-15.4:32.1)
174.3:F-3.2(-21.5:46.2)
175.9:F+12.9(0.0:7.8)
165.9:E+11.1(-10.3:16.0)
166.6:E+18.2(-5.7:0.1)
109.8:A-3.0(-14.4:16.3)
109.9:A-1.0(-10.8:19.5)
84.4:E+40.9(-9.9:-0.0)
83.9:E+30.9(-8.7:0.0)
83.5:E+22.6(-49.6:0.0)
78.6:Eb+17.1(-3.7:5.6)
66.4:C+27.0(-42.9:45.9)
76.8:Eb-21.3(-2.5:-0.0)
166.3:E+15.2(-3.5:24.4)
166.0:E+12.5(-3.9:2.0.8)
107.2:A-44.1(-5.3:2.8)
107.3:A-42.3(-10.6:4.5)
107.6:A-38.7(-8.1:49.5)
114.8:Bb-25.8(-34.3:2.7)
112.8:A+43.9(-16.2:19.0)

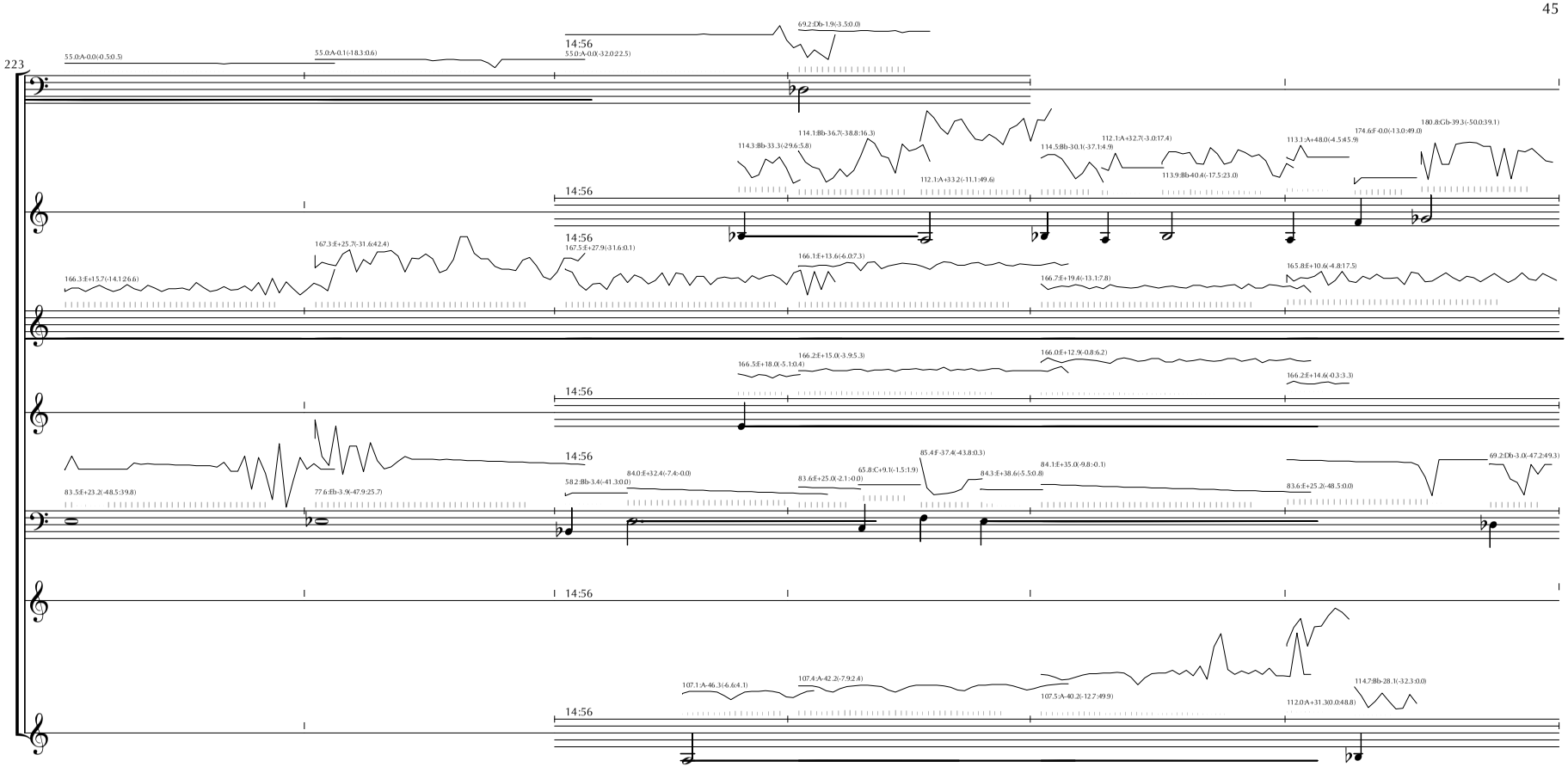

196
13:04
55.0:A-0.1(-0.4:0.5)
55.0:A+0.1(-1.6:0.4)
55.0:A-0.4(-17.4:1.0)
55.0:A-0.0(-29.6:17.5)
69.2:Eb-1.6(-3.8:0.2)
113.1:A+47.6(-23.1:32.0)
166.2:E+14.7(-1.8:3.7)
76.7:Eb-23.7(-7.9:-0.0)
76.4:Eb-31.6(-12.2:0.0)
84.0:E+32.8(-5.0:0.0)
83.7:E+27.9(-49.6:38.9)
76.7:Eb-25.1(-35.9:46.8)
76.5:Eb-29.3(-49.4:0.3)
84.0:E+32.8(-2.4:-0.0)
83.9:E+30.4(-25.8:29.1)
107.0:A-47.6(-3.5:6.3)

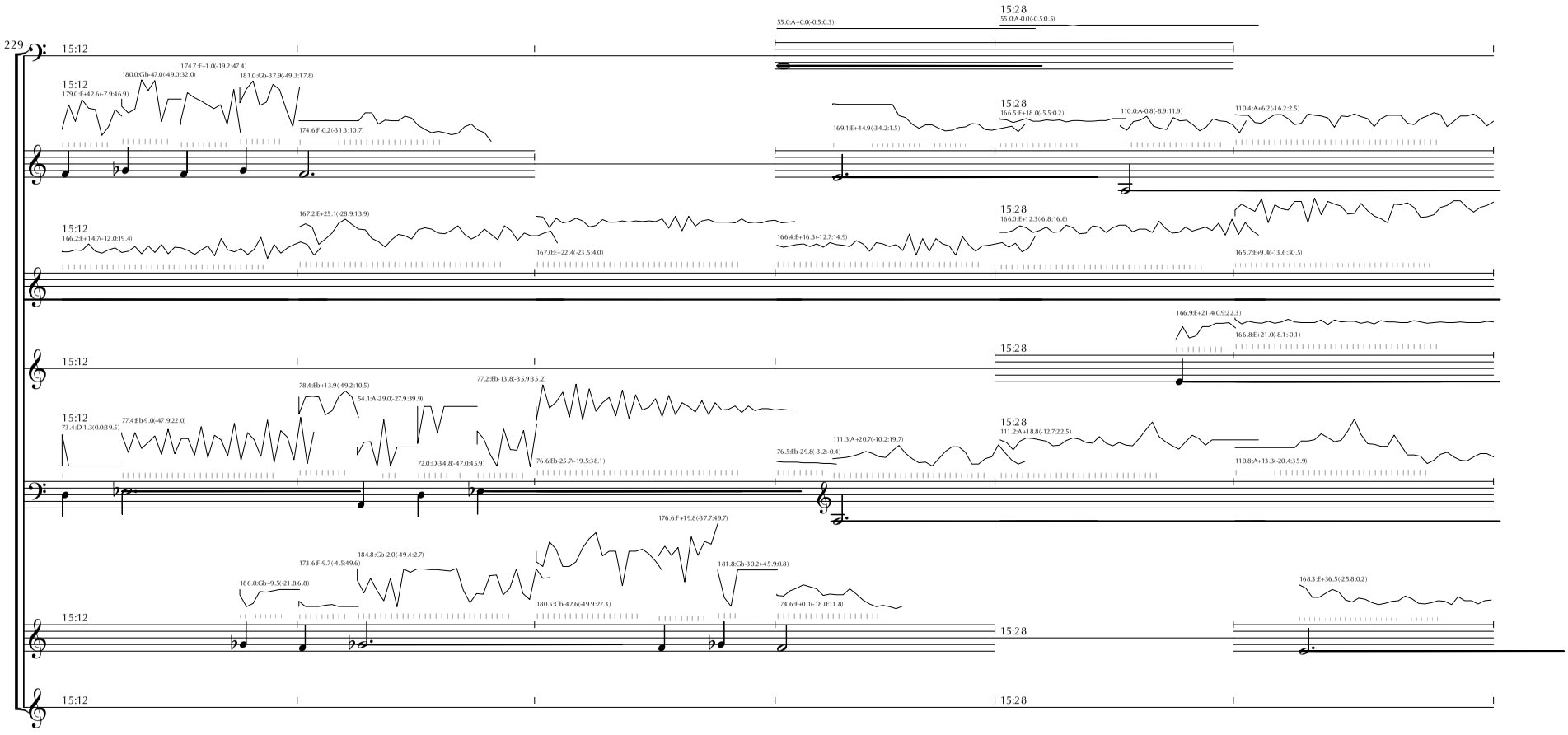

201
13:20
13:20
114.6;Bb-29.7(-37.1:-0.3)
112.2;A+34.9(-12.7:49.9)
113.9;Bb-40.3(-30.0:15.2)
113.0;A+46.2(-0.4:36.3)
114.5;Bb-29.9(-28.0:43.8)
118.3;Bb+26.3(-6.4:12.4)
180.2;Gb-45.6(-49.9:31.0)
176..1;F+15.1(-22.9:-1.8)
13:36
174.5;F-0.6(-17.2:8.9)
13:36
13:20
13:20
166.3;E+16.0(-4.9:4.3)
166.1;E+13.3(-0.9:4.9)
13:36
13:20
84.0;E+33.8(-15.1:29.9)
83.9;E+30.6(-8.6:-0.0)
83.5;E+21.8(-48.0:0.0)
69.6;Db+8.8(-48.0:48.3)
76.8;Eb-21.6(-2.7:-0.1)
76.7;Eb-24.3(-7.8:-0.0)
13:36
76.4;Eb-32.1(-48.1:0.5)
84.0;E+32.4(-4.9:-0.0)
13:36
13:20
13:20
107.4;A-41.2(-11.7:3.4)
107.6;A-38.3(-8.5:5.0.0)
114.6;Bb-29.6(-30.3:1.5)
13:36

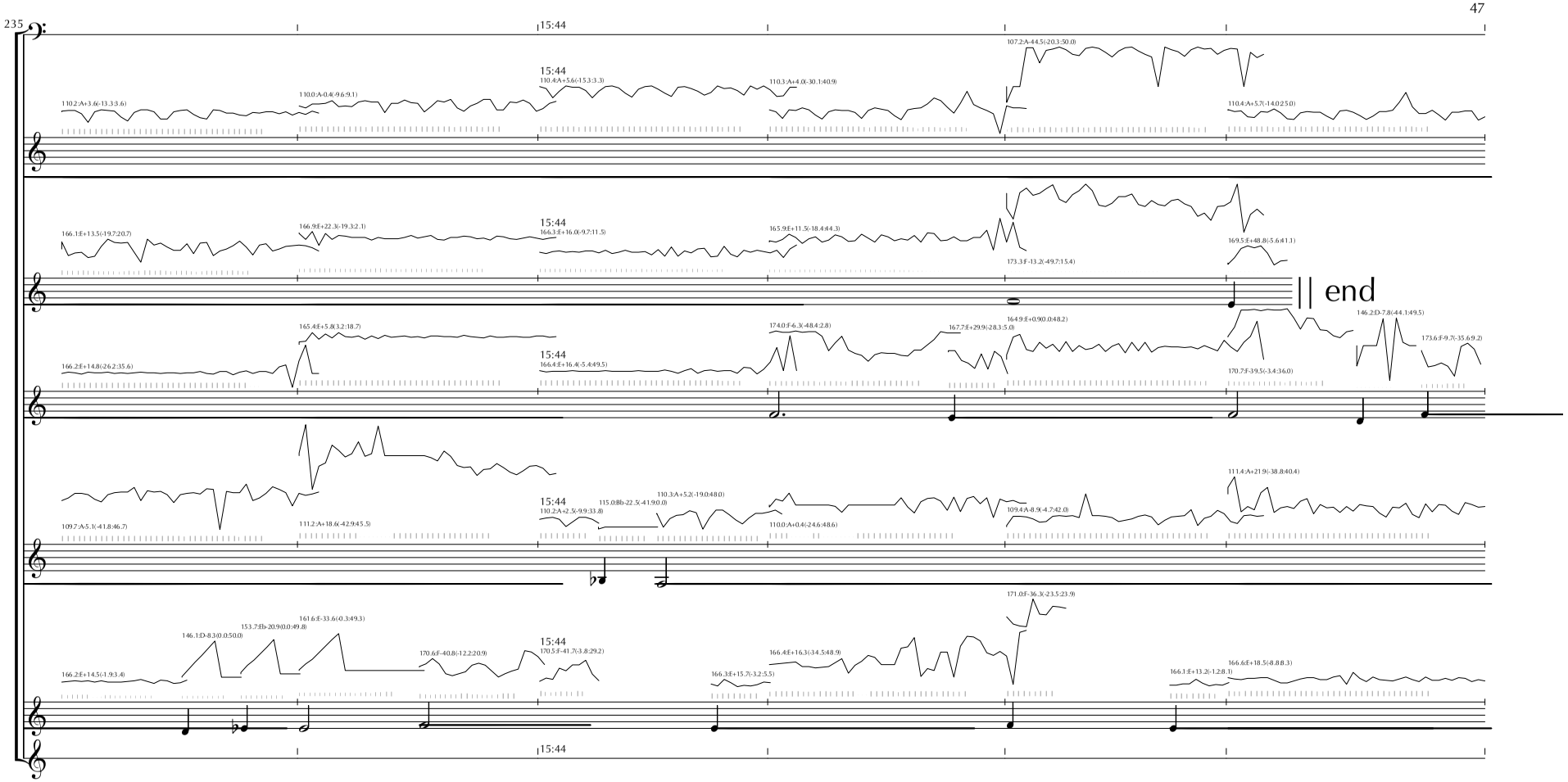

206
168.1:E+34.3(-23.6:2.4)
166.2:E+15.0(-2.4:2.9)
144.1:D-32.5(-18.7:45.2)
166.3:E+15.7(-3.1:2.7)
13:52
166.4:E+16.1(-2.0:1.8)
55.0:A-1.0(0.2:1.1)
55.0:A+0.0(-0.5:0.5)
13:52
13:52
13:52
83.7:E+27.4(-49.3:40.3)
77.1:Eb-14.2(-41.4:39.1)
76.6:Eb-27.2(-46.2:13.1)
83.2:E+17.1(-20.1:48.0)
84.0:E+34.1(-45.6:32.6)
75.2:D+40.7(-4.7:45.1)
79.0:Eb+27.8(49.9:4.7)
74.9:D+34.8(-46.9:49.9)
13:52
76.4:Eb-31.3(-43.6:2.9)
70.5:Db+29.2(-47.0:8.2)
83.8:E+28.9(-49.2:28.8)
13:52
13:52

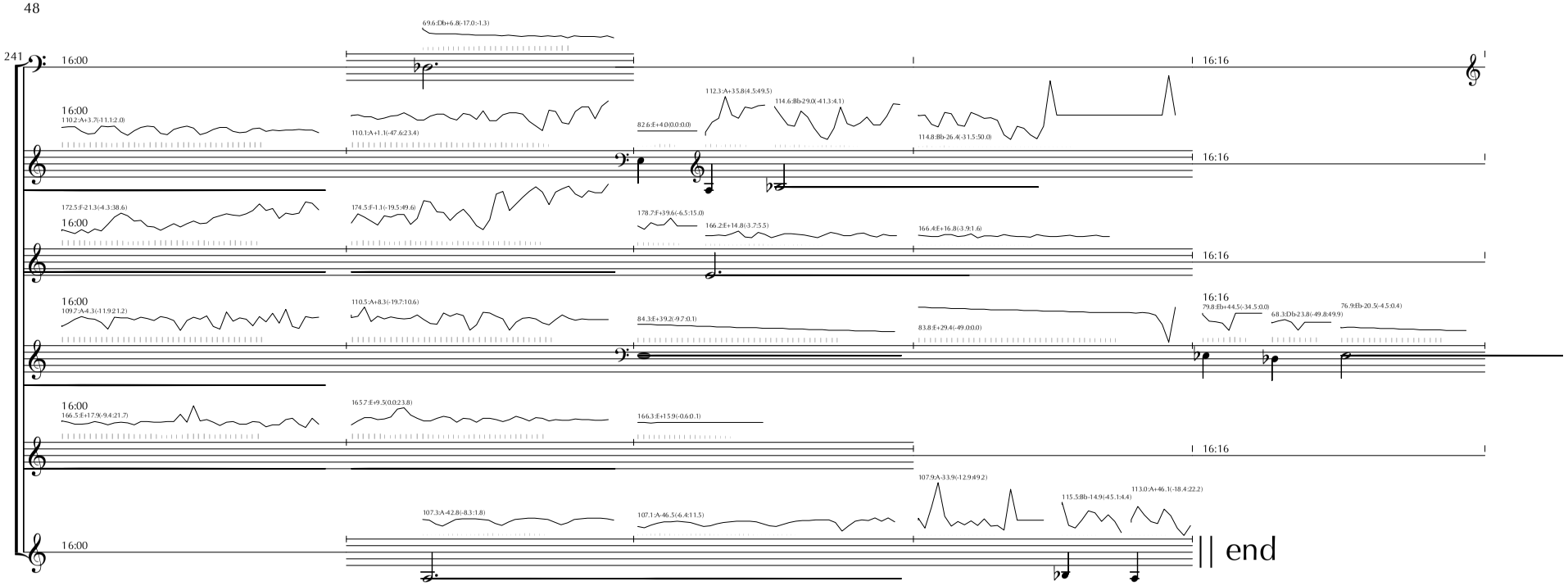

211
55.0:A-0.2(-17.9:0.8)
55.0:A-0.1(-13.1:15.4)
14:08
69.5:Db+5.8(-17.2:-1.1)
14:08
112.6:A+41.1(-16.6:38.5)
113.6:Bb-43.9(-33.9:16.8)
113.0:A+46.7(1.0:38.6)
114.6:Bb-29.6(-40.7:12.1)
114.5:Bb-30.2(-27.7:44.8)
14:08
14:08
166.4:E+16.8(-2.8:1.5)
166.4:E+16.4(-3.5:2.7)
166.2:E+14.7(-3.7:5.6)
166.3:E+15.9(-1.7:2.1)
80.6:E-37.5(-49.1:3.0.5)
77.4:Eb-7.7(-45.2:19.3)
76.3:Eb-33.1(-46.2:0.0)
68.3:Db+25.0(-48.1:3.5.8)
83.9:E+31.9(-5.5:0.0)
14:08
83.7:E+26.4(-2.1:0.1)
65.8:C+10.7(-2.9:28.8)
84.0:E+33.0(-14.4:3.0.1)
84.2:E+36.9(-10.2:0.1)
83.7:E+26.8(-48.3:0.0)
79.8:Eb+43.3(-45.9:0.0)
68.3:Db-24.7(-44.7:19.5)
76.8:Eb-20.9(-6.2:1.2)
14:08
14:08
107.3:A-42.7(-10.3:0.4)
107.3:A-42.8(-8.2:2.9)
107.1:A-46.8(-6.1:47.5)
107.9:A-32.7(-14.1:49.3)
115.7:Bb-12.9(-47.2:2.2)
113.1:A+48.5(-20.8:19.7)

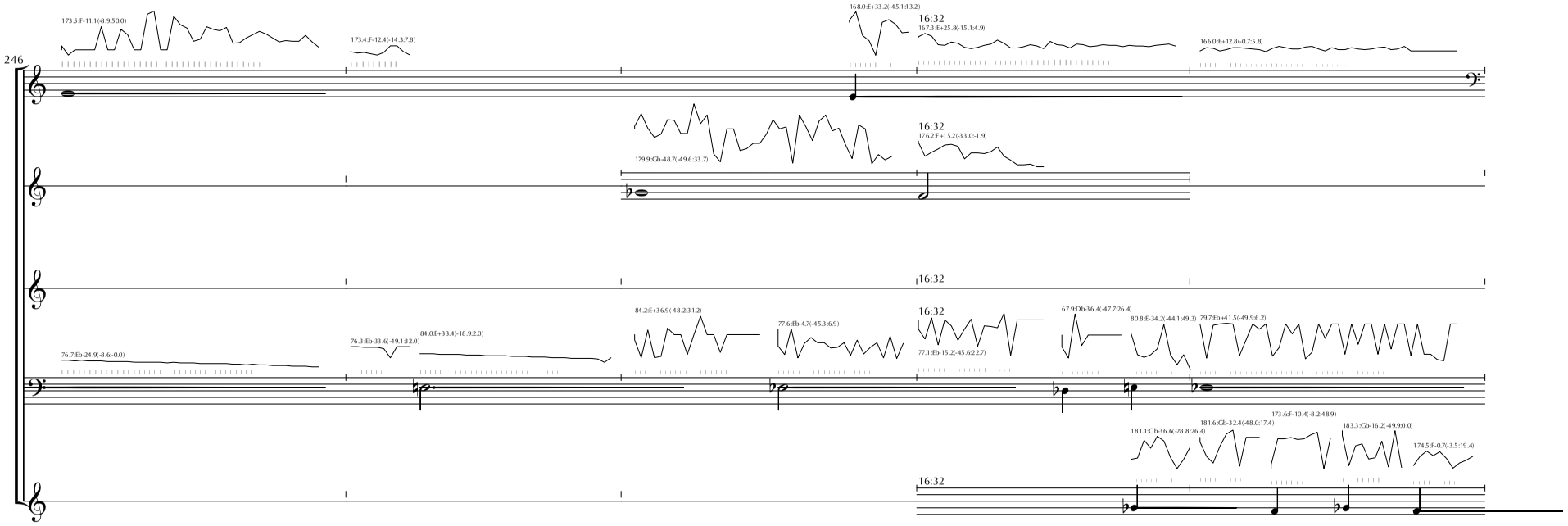

217
14:24
177.3:F+26.4(-43.8:47.6)
173.2:F-13.9(-21.5:9.4)
166.5:E+17.6(-29.5:19.1)
167.2:E+24.6(-13.9:-1.1)
14:40
166.2:E+14.5(-2.5:4.1)
166.3:E+15.4(-1.2:1.7)
55.0:A+1.2(-2.4:0.1)
14:24
14:40
14:24
166.4:E+16.2(-2.0:1.7)
166.4:E+16.4(-4.1:2.4)
166.2:E+14.7(-2.1:3.7)
166.3:E+15.4(-4.3:4.9)
14:40
166.4:E+16.6(-6.4:1.9)
166.4:E+16.5(-10.4:12.6)
14:24
14:40
14:24
76.6:Eb-25.9(-8.3:-0.0)
76.3:Eb-34.3(-44.1:0.0)
84.0:E+33.3(-29.0:11.8)
82.5:E+2.2(-47.7:49.8)
76.9:Eb+18.8(-43.2:49.4)
76.1:Eb-38.1(-47.4:22.7)
84.1:E+35.9(-48.7:28.1)
14:40
83.6:E+2.5.7(-23.1:28.4)
85.4:F-38.9(-25.2:5.6)
79.1:Eb+29.0(-48.9:6.0)
73.6:D+4.1(-25.8:47.4)
76.7:Eb-24.7(-46.9:25.5)
14:24
14:40
14:24
14:40

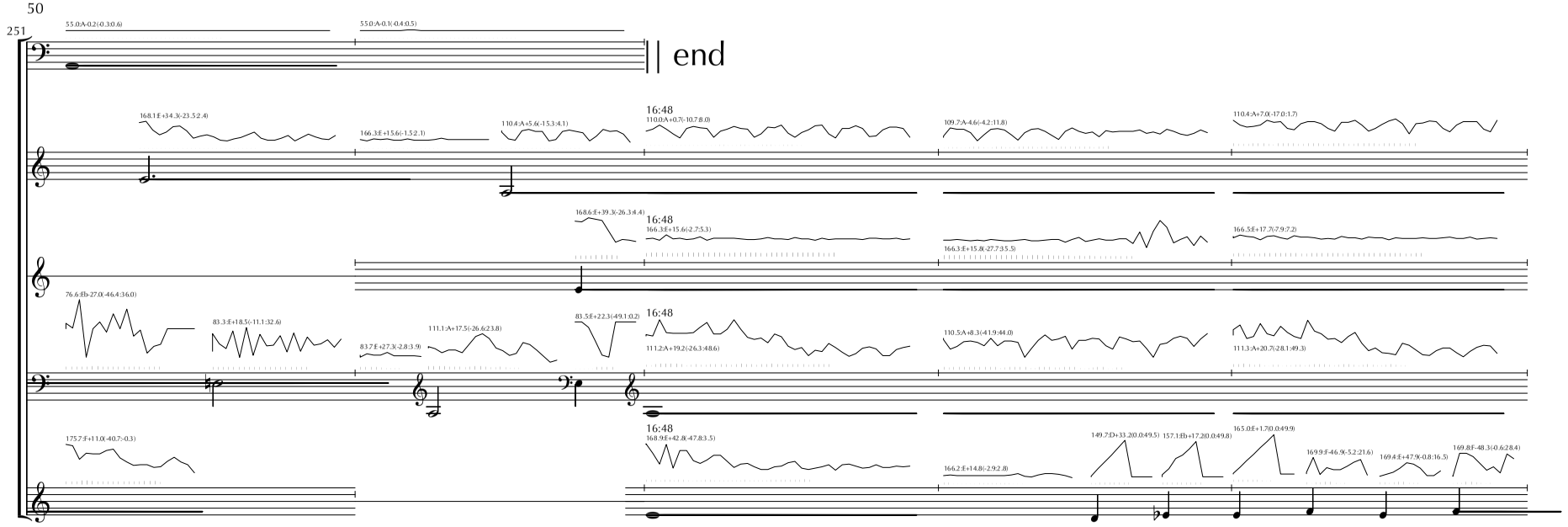

223
55.0:A-0.0(-0.5:0.5)
55.0:A-0.1(-18.3:0.6)
14:56
55.0:A-0.0(-32.0:22.5)
69.2:Db-1.9(-3.5:0.0)
114.3:Bb-33.3(-29.6:5.8)
114.1:Bb-36.7(-38.8:16.3)
112.1:A+33.2(-11.1:49.6)
114.5:Bb-30.1(-37.1:4.9)
112.1:A+32.7(-3.0:17.4)
113.9:Bb-40.4(-17.5:23.0)
113.1:A+48.0(-4.5:45.9)
174.6:F-0.0(-13.0:49.0)
180.8:Gb-39.3(-50.0:39.1)
166.3:E+15.7(-14.1:26.6)
167.3:E+25.7(-31.6:42.4)
167.5:E+27.9(-31.6:0.1)
166.1:E+13.6(-6.0:7.3)
166.7:E+19.4(-13.1:7.8)
165.8:E+10.6(-4.8:17.5)
166.5:E+18.0(-5.1:0.4)
166.2:E+15.0(-3.9:5.3)
166.0:E+12.9(-0.8:6.2)
166.2:E+14.6(-0.3:3.3)
83.5:E+23.2(-48.5:39.8)
77.6:Eb-3.9(-47.9:25.7)
58.2:Bb-3.4(-41.3:0.0)
84.0:E+32.4(-7.4:-0.0)
83.6:E+25.0(-2.1:-0.0)
65.8:C+9.1(-1.5:1.9)
85.4:F-37.4(-43.8:0.3)
84.3:E+38.6(-5.5:0.8)
84.1:E+35.0(-9.8:-0.1)
83.6:E+25.2(-48.5:0.0)
69.2:Db-3.0(-47.2:49.3)
107.1:A-46.3(-6.6:4.1)
107.4:A-42.2(-7.9:2.4)
107.5:A-40.2(-12.7:49.9)
112.0:A+31.3(0.0:48.8)
114.7:Bb-28.1(-32.3:0.0)

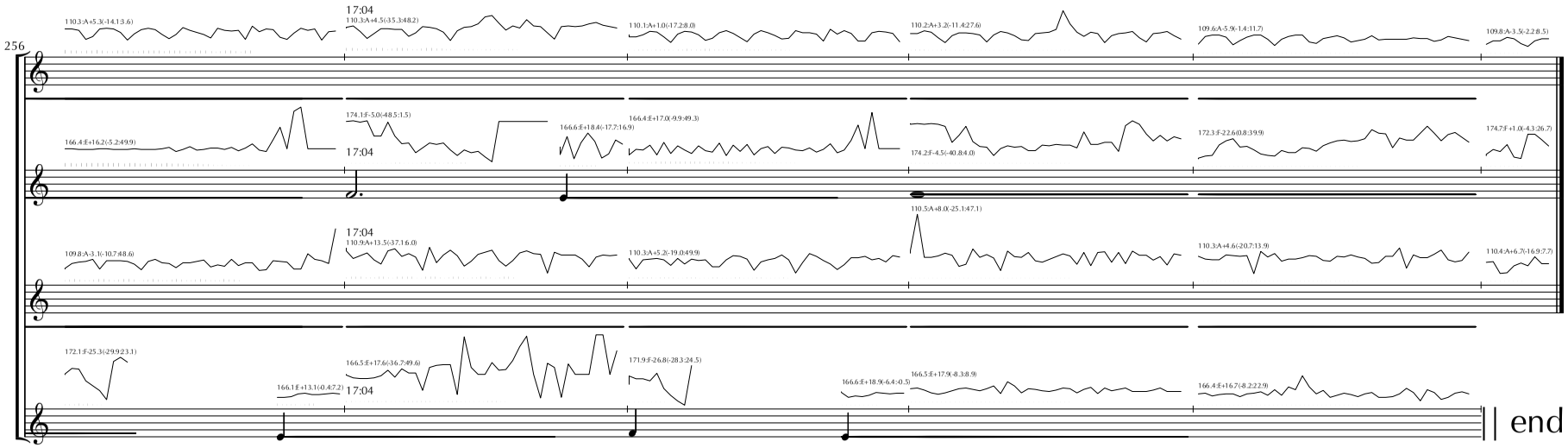

229
15:12
15:28
55.0:A+0.0(-0.5:0.3)
55.0:A-0.0(-0.5:0.5)
174.7:F+1.0(-19.2:47.4)
180.0:Gb-47.0(-49.0:32.0)
181.0:Gb-37.9(-49.3:17.8)
179.0:F+42.6(-7.9:46.9)
174.6:F-0.2(-31.3:10.7)
169.1:E+44.9(-34.2:1.5)
166.5:E+18.0(-5.5:0.2)
110.0:A-0.8(-8.9:11.9)
110.4:A+6.2(-16.2:2.5)
167.2:E+25.1(-28.9:13.9)
166.2:E+14.7(-12.0:19.4)
167.0:E+22.4(-23.5:4.0)
166.4:E+16.3(-12.7:14.9)
166.0:E+12.3(-6.8:16.6)
165.7:E+9.4(-13.6:30.5)
166.9:E+21.4(0.9:22.3)
166.8:E+21.0(-8.1:0.1)
78.4:Eb+13.9(-49.2:10.5)
77.2:Eb-13.8(-35.9:35.2)
54.1:A-29.0(-27.9:39.9)
77.4:Eb-9.0(-47.9:22.0)
73.4:D-1.3(0.0:39.5)
72.0:D-34.8(-47.0:45.9)
76.6:Eb-25.7(-19.5:38.1)
111.3:A+20.7(-10.2:19.7)
76.5:Eb-29.8(-3.2:-0.4)
111.2:A+18.8(-12.7:22.5)
110.8:A+13.3(-20.4:35.9)
176.6:F+19.8(-37.7:49.7)
184.8:Gb-2.0(-49.4:2.7)
173.6:F-9.7(-4.5:49.6)
181.8:Gb-30.2(-45.9:0.8)
186.0:Gb+9.5(-21.8:6.8)
180.5:Gb-42.6(-49.9:27.3)
174.6:F+0.1(-18.0:11.8)
168.3:E+36.5(-2.5:8.0.2)


235
15:44
110.2:A+3.6(-13.3:3.6)
110.0:A-0.4(-9.6:9.1)
15:44
110.4:A+5.6(-15.3:3.3)
110.3:A+4.0(-30.1:40.9)
107.2:A-44.5(-20.3:50.0)
110.4:A+5.7(-14.0:25.0)
166.1:E+13.5(-19.7:20.7)
166.9:E+22.3(-19.3:2.1)
15:44
166.3:E+16.0(-9.7:11.5)
165.9:E+11.5(-18.4:44.3)
173.3:F-13.2(-49.7:15.4)
169.5:E+48.8(-5.6:41.1)
|| end
166.2:E+14.8(-26.2:35.6)
165.4:E+5.8(3.2:18.7)
15:44
166.4:E+16.4(-5.4:49.5)
174.0:F-6.3(-48.4:2.8)
167.7:E+29.9(-28.3:5.0)
164.9:E+0.9(0.0:48.2)
170.7:F-39.5(-3.4:36.0)
146.2:D-7.8(-44.1:49.5)
173.6:F-9.7(-35.6:9.2)
109.7:A-5.1(-41.8:46.7)
111.2:A+18.6(-42.9:45.5)
15:44
110.2:A+2.5(-9.9:33.8)
115.0:Bb-22.5(-41.9:0.0)
110.3:A+5.2(-19.0:48.0)
110.0:A+0.4(-24.6:48.6)
109.4:A-8.9(-4.7:42.0)
111.4:A+21.9(-38.8:40.4)
166.2:E+14.5(-1.9:3.4)
146.1:D-8.3(0.0:50.0)
153.7:Eb-20.9(0.0:49.8)
161.6:E-33.6(-0.3:49.3)
170.6:F-40.8(-12.2:20.9)
15:44
170.5:F-41.7(-3.8:29.2)
166.3:E+15.7(-3.2:5.5)
166.4:E+16.3(-34.5:48.9)
171.0:F-36.3(-23.5:23.9)
166.1:E+13.2(-1.2:8.1)
166.6:E+18.5(-8.8:8.3)
15:44


241
16:00
16:16
69.6:D0+6.8(-17.0;-1.3)
110.2:A+3.7(-11.1;2.0)
110.1:A+1.1(-47.6;23.4)
82.6:E+4.0(0.0;0.0)
112.3:A+35.8(4.5;49.5)
114.6:Bb-29.0(-41.3;4.1)
114.8:Bb-26.4(-31.5;50.0)
172.5:F-21.3(-4.3;38.6)
174.5:F-1.1(-19.5;49.6)
178.7:F+39.6(-6.5;15.0)
166.2:E+14.8(-3.7;5.5)
166.4:E+16.8(-3.9;1.6)
109.7:A-4.3(-11.9;21.2)
110.5:A+8.3(-19.7;10.6)
84.3:E+39.2(-9.7;0.1)
83.8:E+29.4(-49.0;0.0)
79.8:Eb+44.5(-34.5;0.0)
68.3:Db+23.8(-49.8;49.9)
76.9:Eb-20.5(-4.5;0.4)
166.5:E+17.9(-9.4;21.7)
165.7:E+9.5(0.0;23.8)
166.3:E+15.9(-0.6;0.1)
107.9:A-33.9(-12.9;49.2)
113.0:A+46.1(-18.4;22.2)
115.5:Bb-14.9(-45.1;4.4)
107.3:A-42.8(-8.3;-1.8)
107.1:A-46.5(-6.4;11.5)
|| end


246
173.5:F-11.1:(-8.9:5.0.0)
173.4:F-12.4:(-14.3:7.8)
168.0:E+33.2:(-45.1:13.2)
16:32
167.3:E+25.8:(-15.1:4.9)
166.0:E+12.8:(-0.7:5.8)
16:32
176.2:F+15.2:(-13.3.0:-1.9)
179.9:Cb-48.7:(-49.6:33.7)
16:32
84.2:E+36.9:(-48.2:31.2)
77.6:Eb-4.7:(-45.3:6.9)
16:32
67.9:Db-36.4:(-47.7:26.4)
80.8:E-34.2:(-44.1:49.3)
79.7:Eb+41.5:(-49.9:6.2)
77.1:Eb-15.2:(-45.6:22.7)
76.7:Eb-24.9:(-8.6:-0.0)
76.3:Eb-33.6:(-49.1:32.0)
84.0:E+33.4:(-18.9:2.0)
173.6:F-10.4:(-8.2:48.9)
181.6:Cb-32.4:(-48.0:17.4)
181.1:Gb+36.6:(-28.8:26.4)
183.3:Cb-16.2:(-49.9:0.0)
174.5:F-0.7:(-3.5:19.4)
16:32


50
251
55.0:A-0.2:(-0.3:0.6)
55.0:A-0.1:(-0.4:0.5)
end
168.1:E+34.3:(-23.5:2.4)
166.3:E+15.6:(-1.5:2.1)
110.4:A+5.6:(-15.3:4.1)
16:48
110.0:A+0.7:(-10.7:8.0)
109.7:A-4.6:(-4.2:11.8)
110.4:A+7.0:(-17.0:1.7)
168.6:E+39.3:(-26.3:4.4)
16:48
166.3:E+15.6:(-2.7:5.3)
166.3:E+15.8:(-27.7:3.5.5)
166.5:E+17.7:(7.9:7.2)
76.6:Eb-27.0:(-46.4:36.0)
83.3:E+18.5:(-11.1:32.6)
83.7:E+27.3:(-2.8:3.9)
111.1:A+17.5:(-26.6:23.8)
83.5:E+22.3:(-49.1:0.2)
16:48
111.2:A+19.2:(-26.3:48.6)
110.5:A+8.3:(-41.9:44.0)
111.3:A+20.7:(-28.1:89.3)
175.7:F+11.0:(-40.7:-0.3)
16:48
168.9:E+42.8:(-47.8:3.5)
166.2:E+14.8:(-2.9:2.8)
149.7:D+33.2:(0.0:49.5)
157.1:Eb+17.2:(0.0:49.8)
165.0:E+1.7:(0.0:49.9)
169.9:F-46.9:(-5.2:21.6)
169.4:E+47.9:(-0.8:16.5)
169.8:F-48.3:(-0.6:28.4)

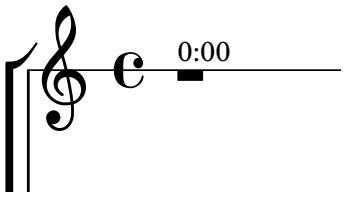
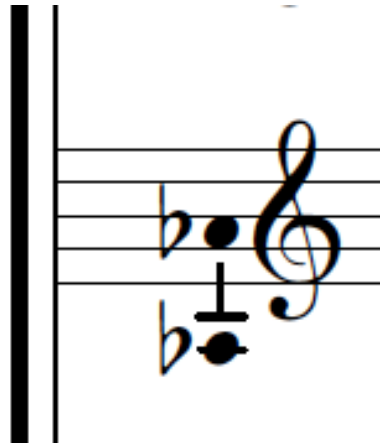
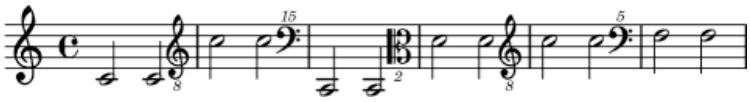

256
110.3:A+5.3(-14.1:3.6)
17:04
110.3:A+4.5(-3.5:3:48.2)
110.1:A+1.0(-17.2:8.0)
110.2:A+3.2(-11.4:27.6)
109.6:A-5.9(-1.4:11.7)
109.8:A-3.5(-2.2:8.5)
166.4:E+16.2(-5.2:49.9)
174.1:F-5.0(-48.5:1.5)
17:04
166.6:E+18.4(-17.7:16.9)
166.4:E+17.0(-9.9:49.3)
174.2:F-4.5(-40.8:4.0)
172.3:F-2.2.6(0.8:39.9)
174.7:F+1.0(-4.3:26.7)
109.8:A-3.1(-10.7:48.6)
17:04
110.9:A+13.5(-37.1 6.0)
110.3:A+5.2(-19.0:49.9)
110.5:A+8.0(-25.1:47.1)
110.3:A+4.6(-20.7:13.9)
110.4:A+6.7(-16.9:7.7)
172.1:F-25.3(-29.9:23.1)
166.1:E+13.1(0.4:7.2)
166.5:E+17.6(-36.7:89.6)
17:04
171.9:F-26.8(-28.3:24.5)
166.6:E+18.9(-6.4:-0.5)
166.5:E+17.9(-8.3:8.9)
166.4:E+16.7(-8.2:2.2.9)
end

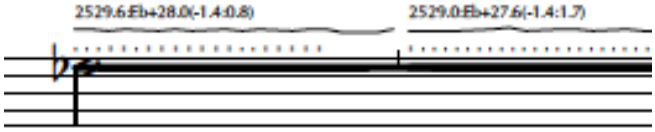
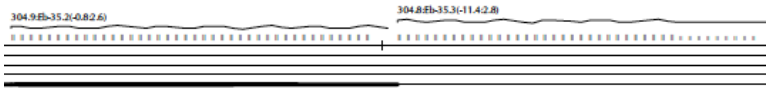
Agnus Dei

for Unspecified Orchestra

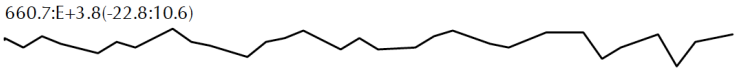
2015

by
Kristina Wolfe

Symbol	Meaning
	Clef and time signatures are self-explanatory and tempo is assumed to be *60 bpm*.
	*The tessitura of each staff is indicated at the beginning of the piece. Instrumentalists should choose a staff that is playable. Of course, if they like a challenge they can attempt the impossible.*
	Efforts have been made to minimize *ledger lines* and various treble and bass clefs are used instead. Each pitch is notated in *concert pitch* and is not transposed in register either.
	The *notches* in staves are the equivalent of *barlines* and are meant as a rough estimate of the beginning and end of a 4-second period.

Symbol	Meaning
	Time in the work is shown in *seconds*. For ease of reading, there is a notch every 4 seconds and will work well even if interpreted in 'common' time.
	Whole rests have the staff lines and rests omitted. This is done to make it clearer where entrances begin and end.
	The lines attached to longer notes indicate a prolonged sustain of a pitch.
	Occasionally, the sustain lines stop before the dynamic markings stop -- especially at the end of a long sustained pitch. In this case, hold the previous note until the end of the dynamic markings and pitch graph. Then, fade out.

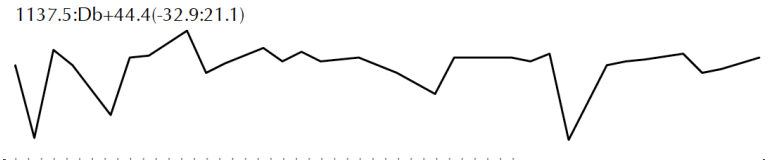
Symbol



Meaning

Every effort has been made to make this music easy as possible to read and to give each performer as much information in as little space as possible. .

Other examples:



The gestalt of the pitch alteration is approximated using a line below the figure.

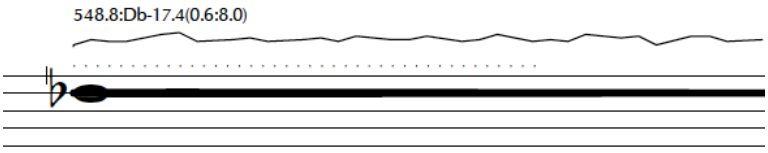
An example of a stable pitch:

660.7:E+3.8(-22.8:10.6)

This symbol means:

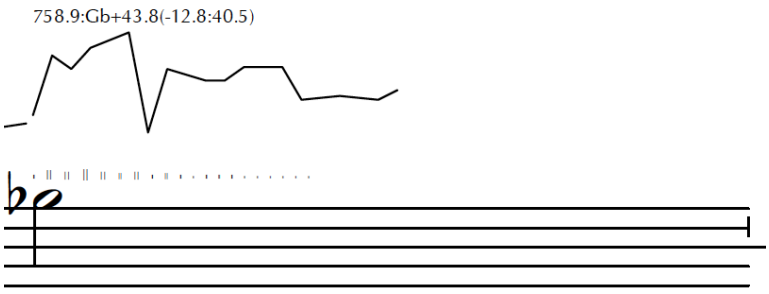
Pitch in Hertz **:** Equal Tempered Approximation of initial pitch with Alteration in cents **: (** lower bound **:** upper bound **)**

Note: the crest and troughs of the line are the upper and lower limits of the alterations. The 'center' of the gesture should be interpreted as your base note with the ET approximation. Some effort has been made to make the size of the waves reflective of the alterations overall. It is hoped that this will make it easier to read.



When combined with the line, you can see the subtle alterations of the pitch in time space

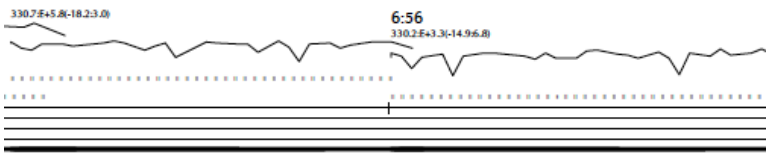
Symbol



Meaning

The ||||||||||| symbols above the staff are *dynamic markings*. The largest, most bold line is roughly equivalent of a *fortissimo* marking and the line continues smaller and smaller to *niente*. If you have a very, very, small line, play as quietly as possible. If there is ambiguity on what dynamic to perform, consult the score and play in relative loudness or softness to the others.

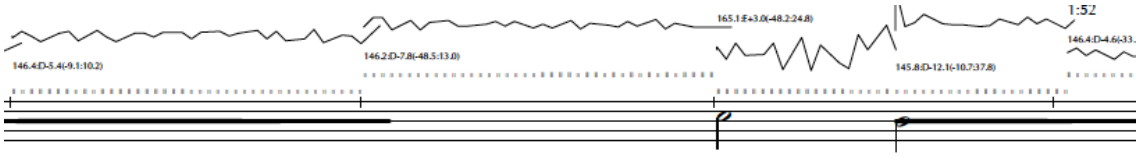
Using these lines, we can interpret the overall dynamic gesture of the pitch. Each dynamic marking is intended to last as long as the pitch. Combined with the pitch alterations, we can get a clearer picture of the harmonic and timbral gesture.



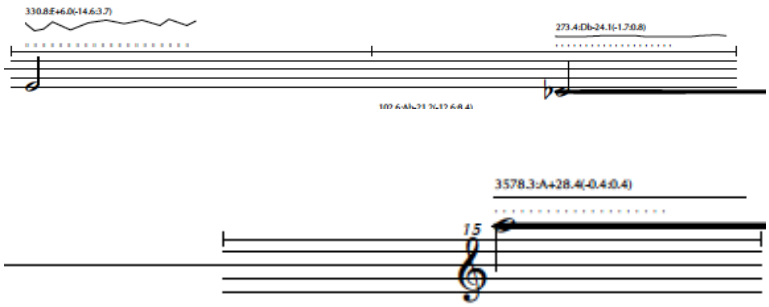
Considerable effort was put into the typesetting of the work. That being said, *sometimes the dynamic lines overlap with one another.* Most of the time these dots do not conflict substantially, but in cases where the notation overlaps and conflicts, it is useful to know that *the dynamics for the note <u>always</u> begin above the pitch* and last for the exact length of the pitch

Symbol **Meaning**

Here is an example:



Even though there is a break between the lines, we should not interpret this as a break in pitch or gesture because we can see that there is a full line of pitch alteration and dynamic information. Unless indicated in the dynamics, phrase, or space (see below), lines should be considered to be continuous.

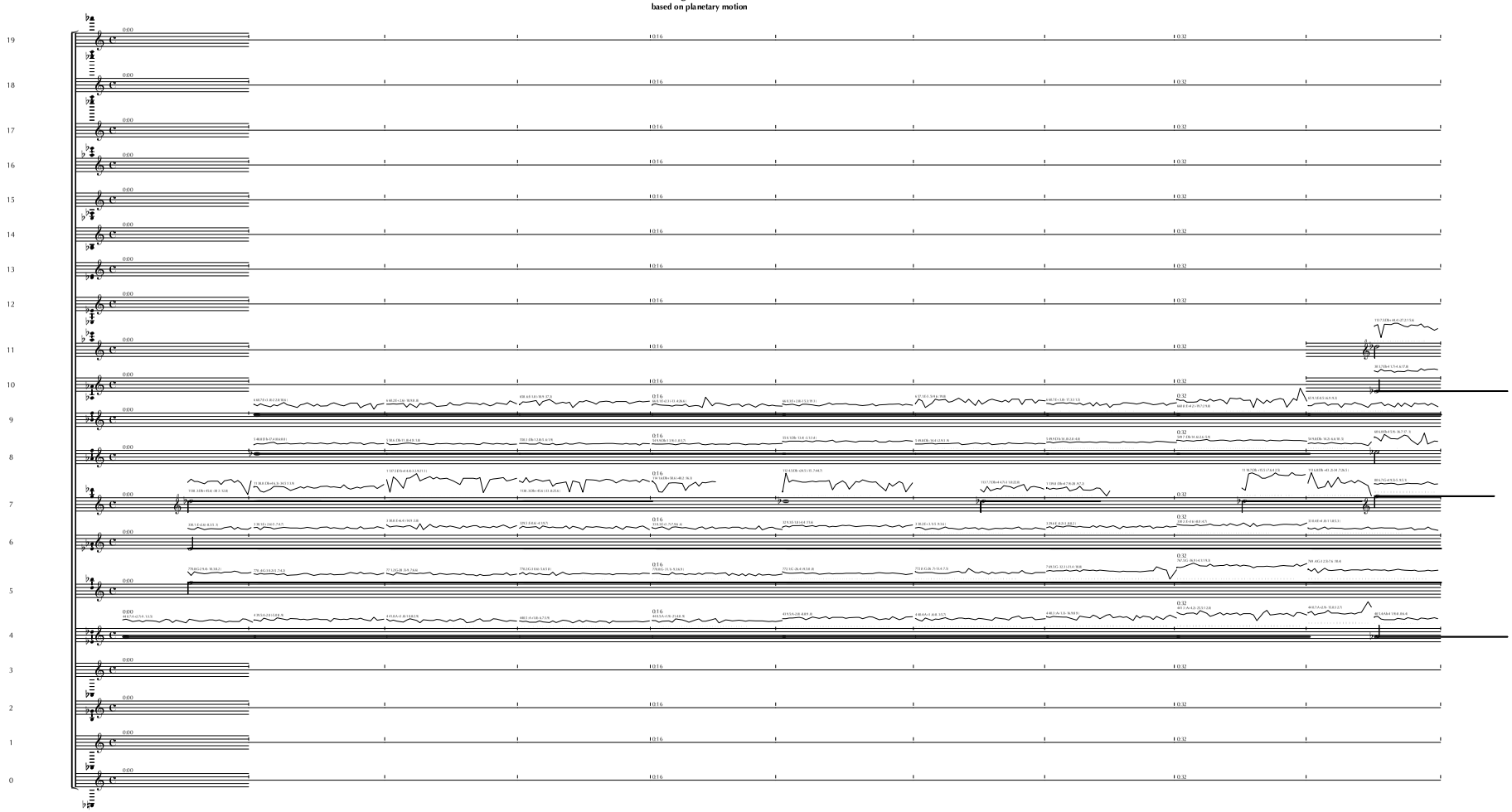


Rests are indicated by space. Blank lines indicate silences as well.

Areas without pitch or dynamic information should be interpreted as silence.

Agnus Dei

based on planetary motion



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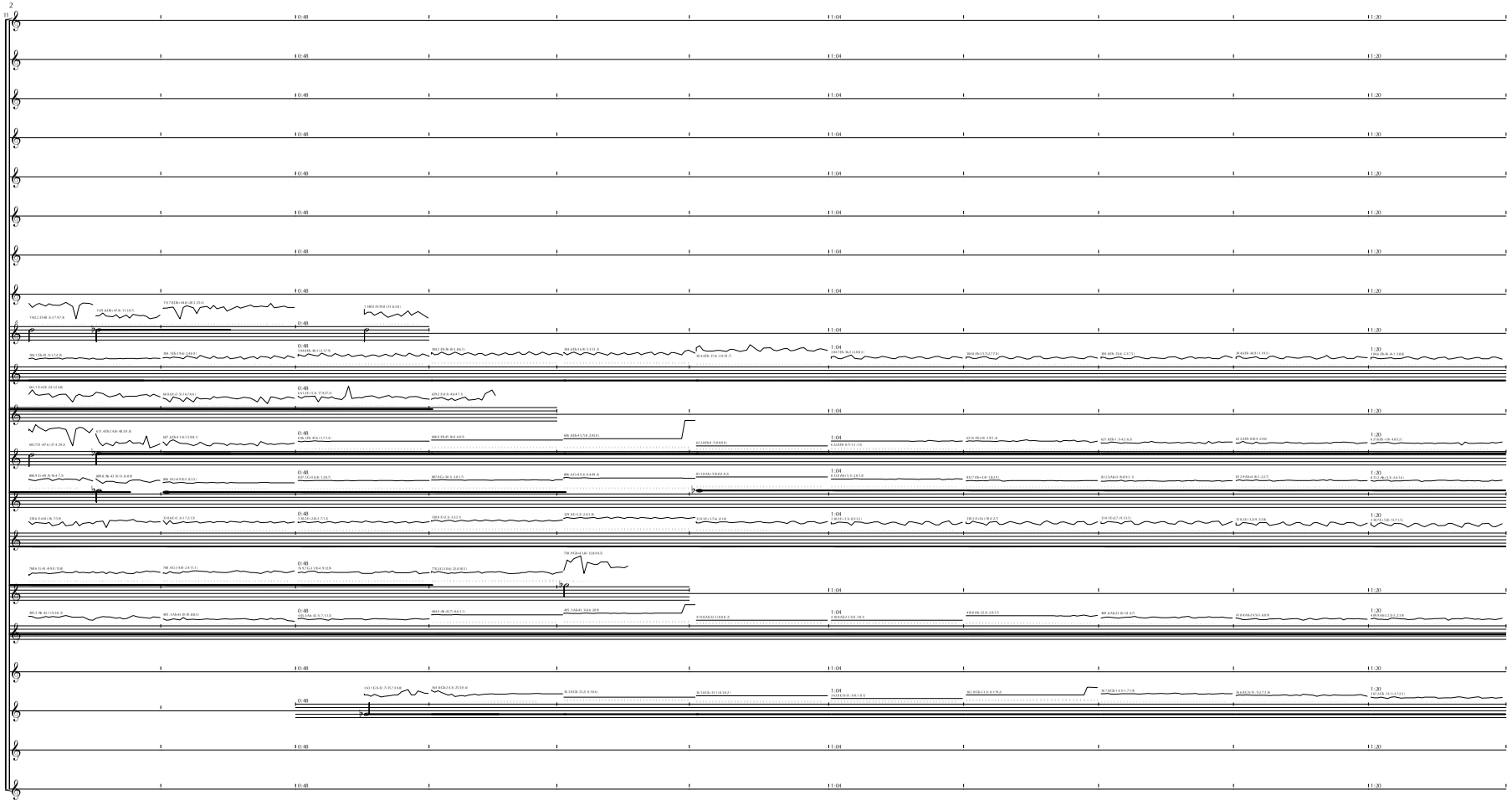

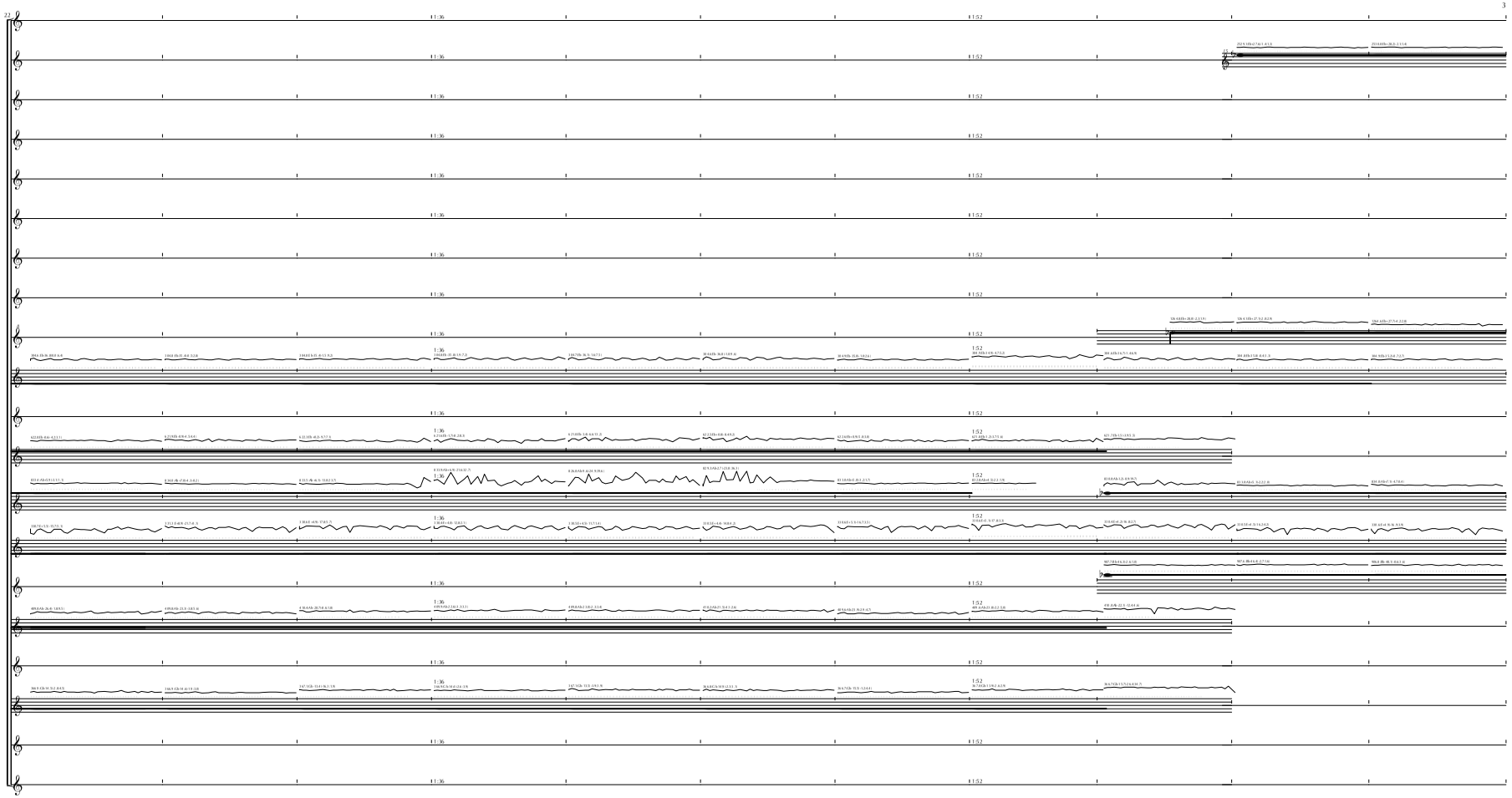

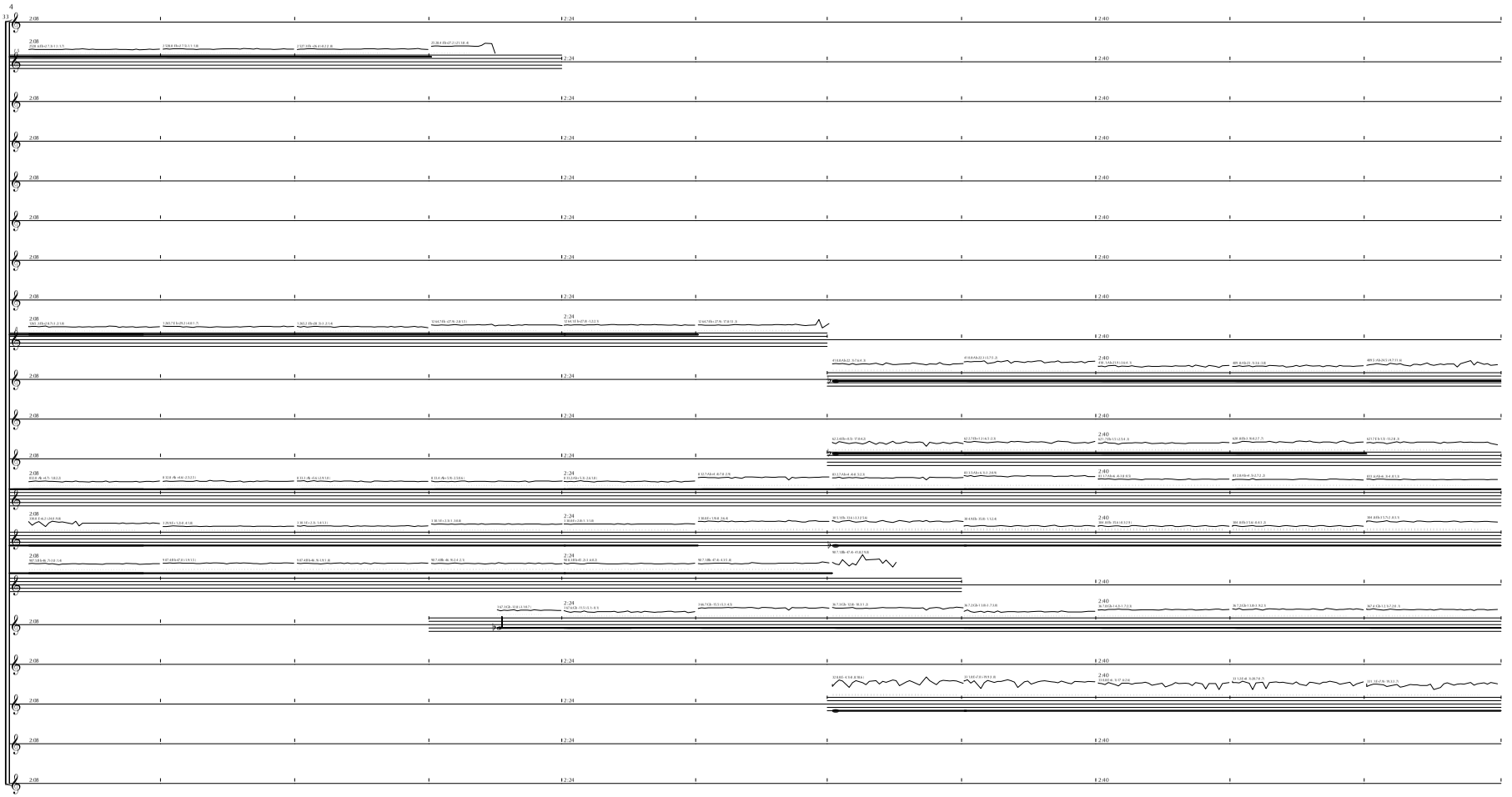

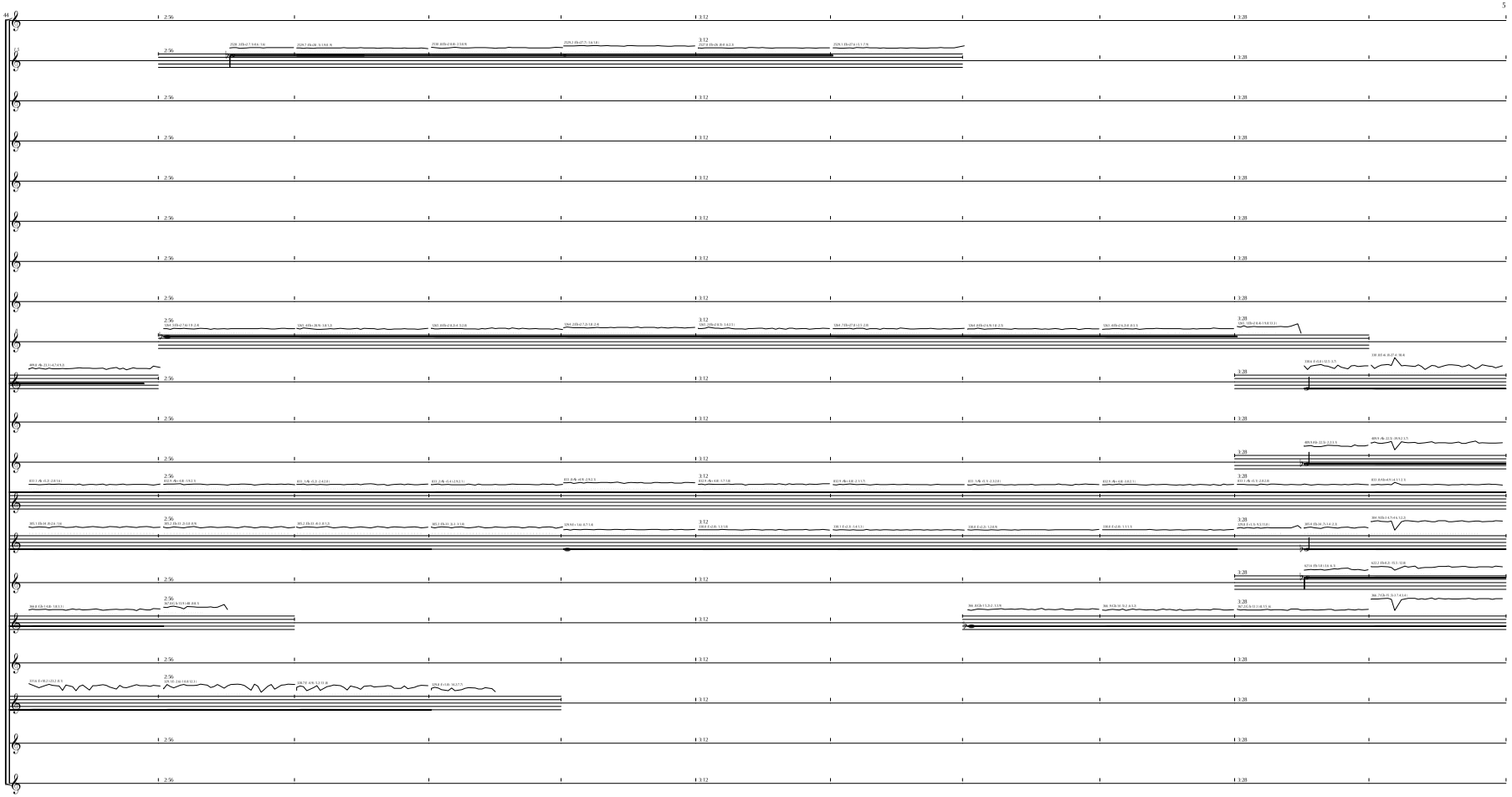

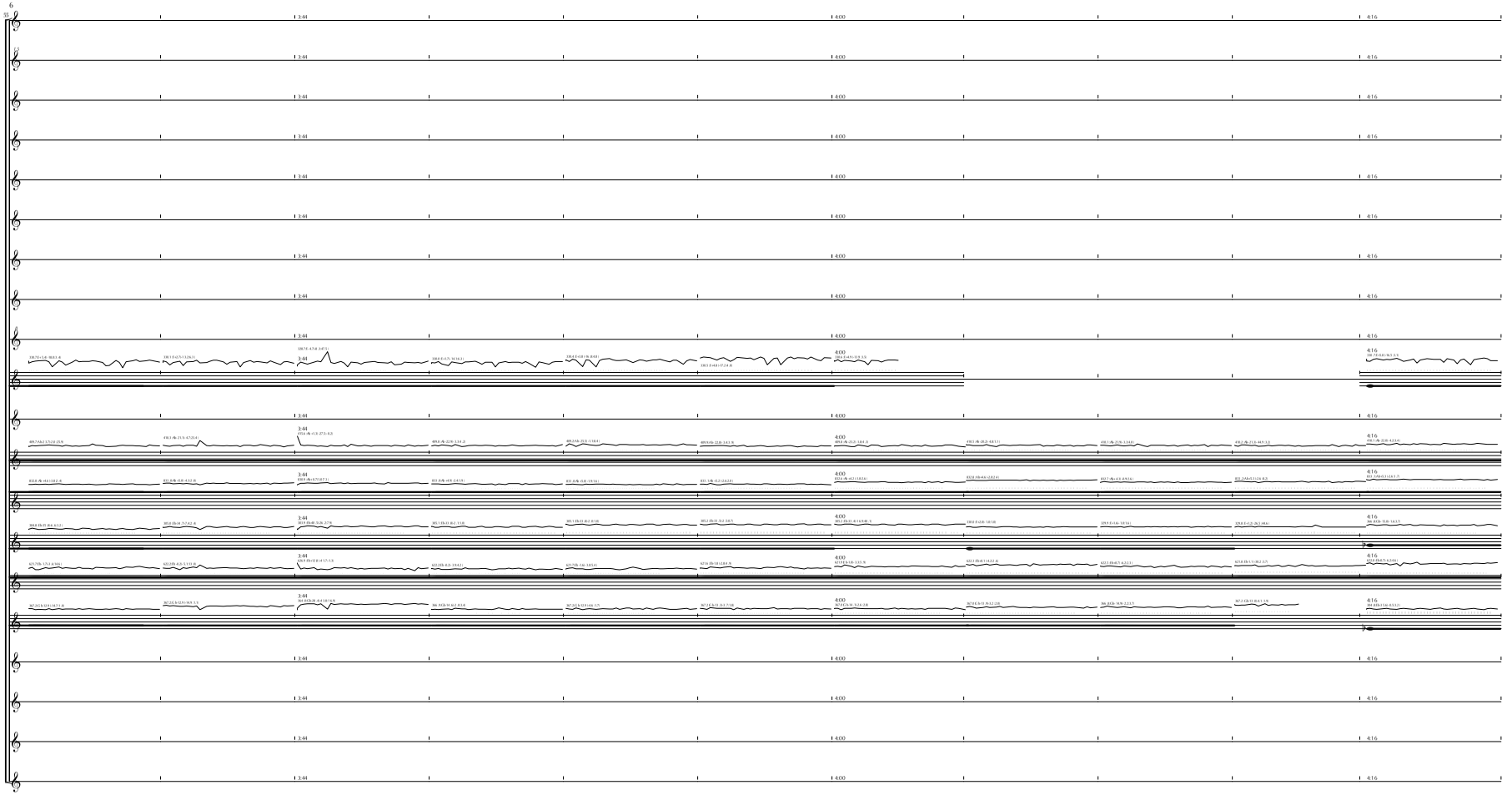

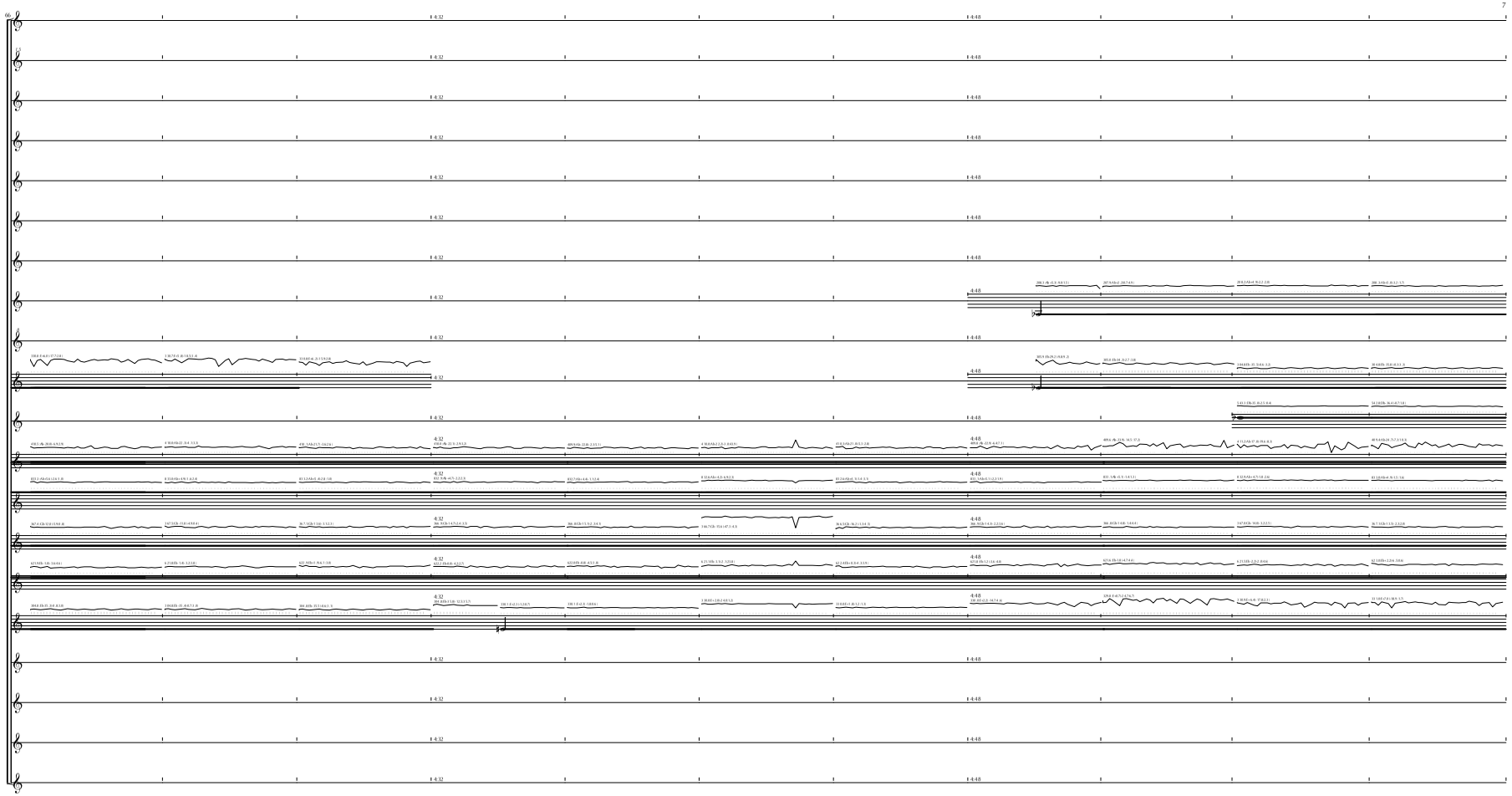

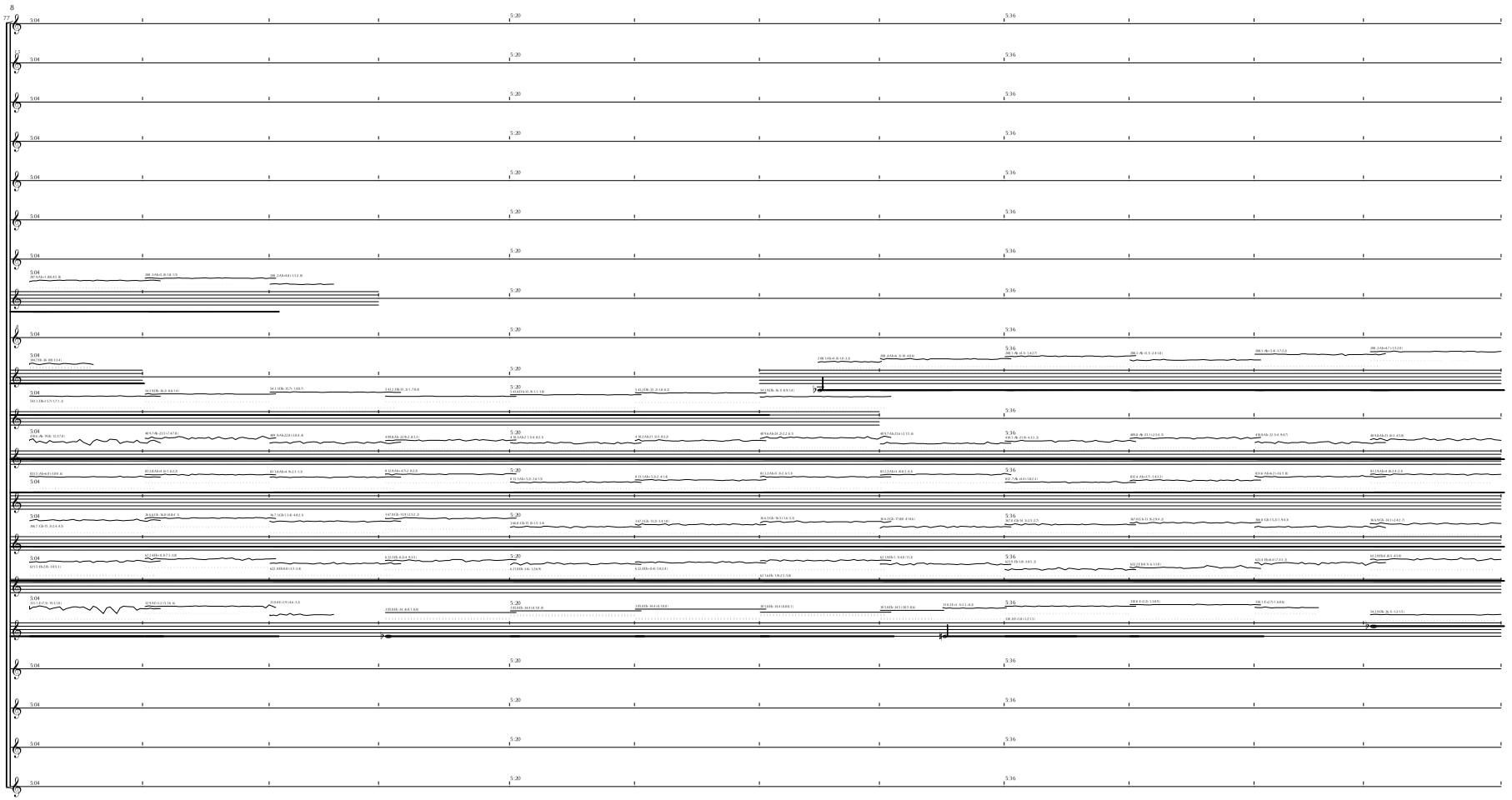

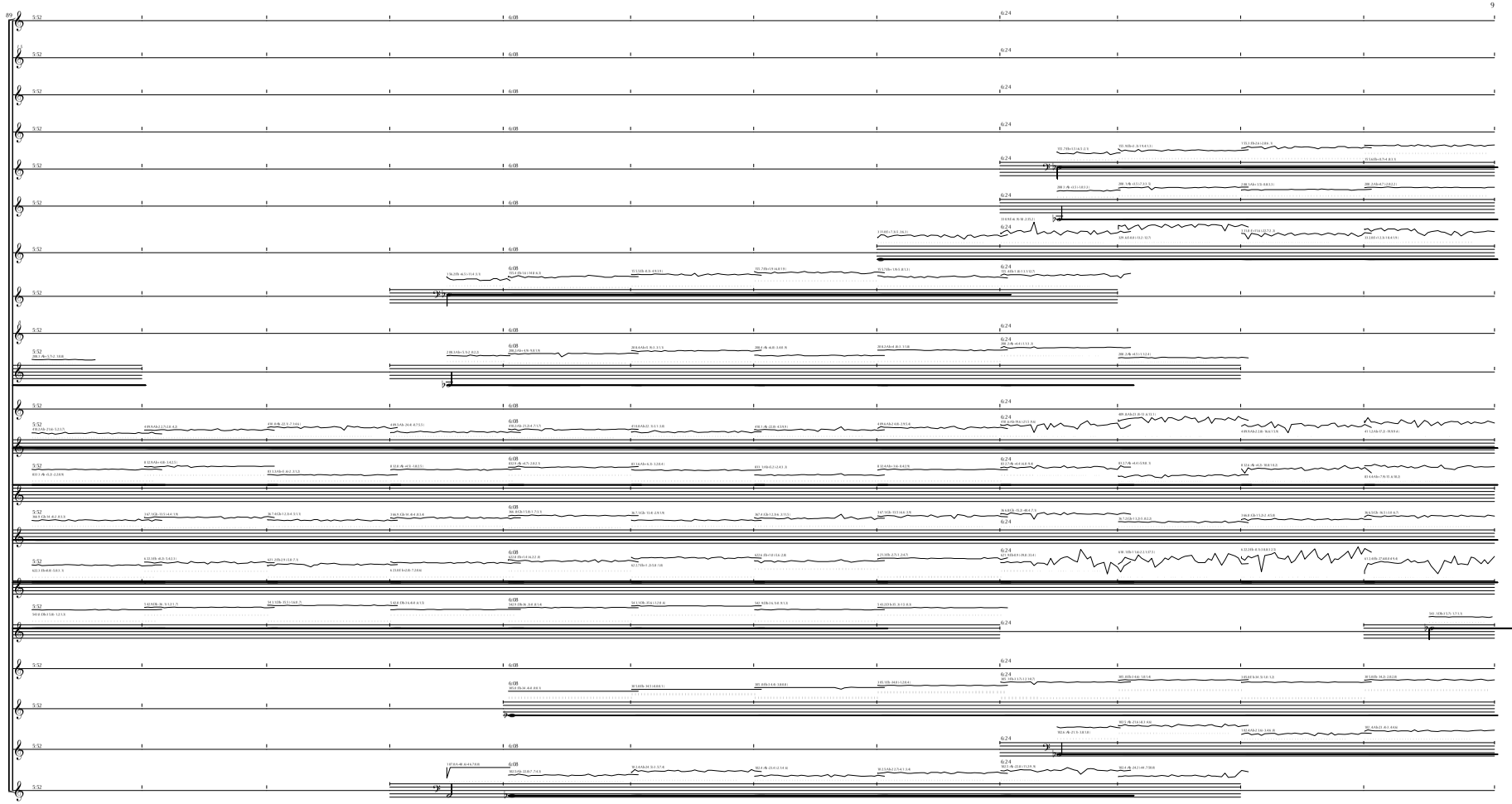

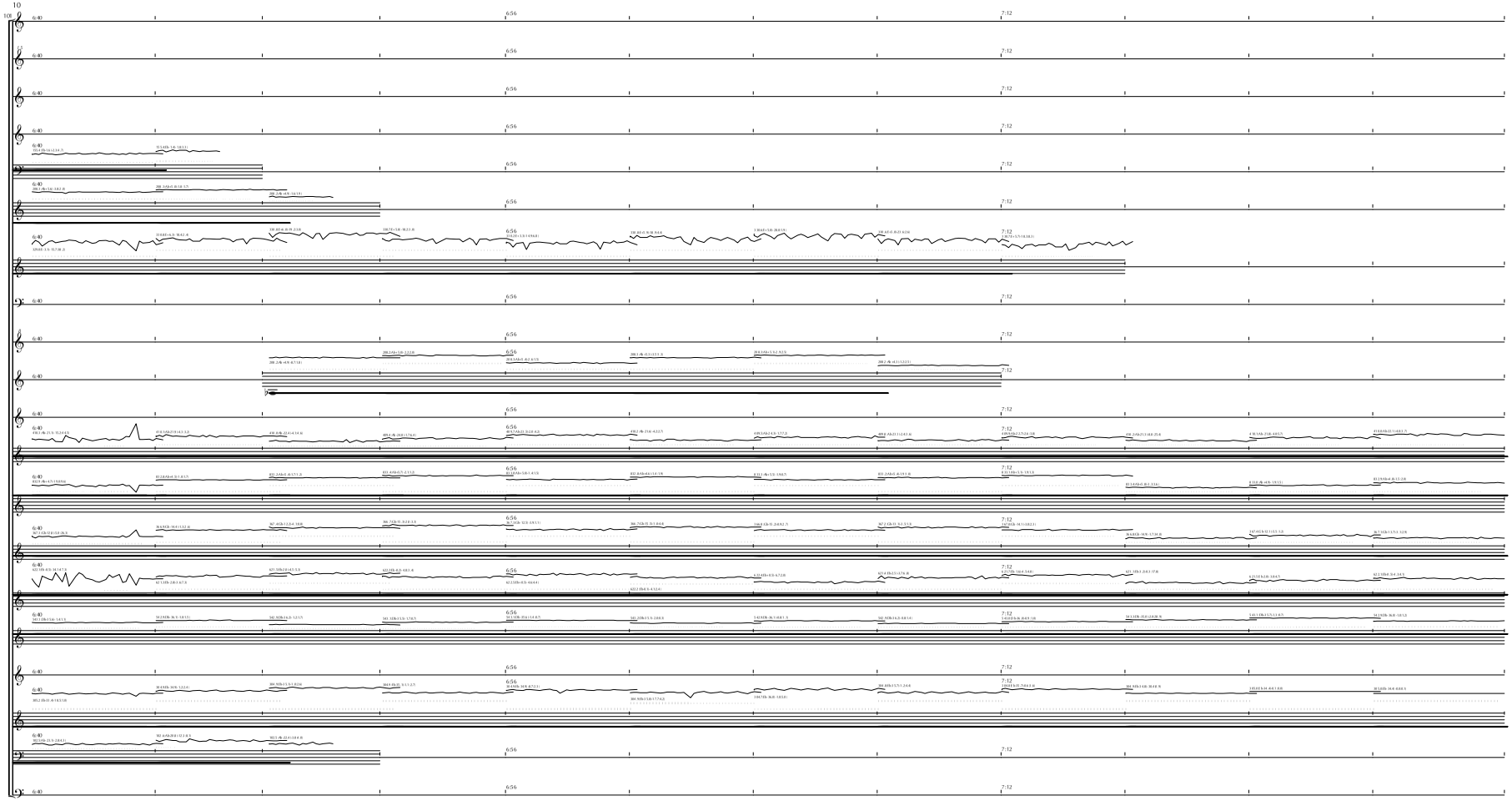

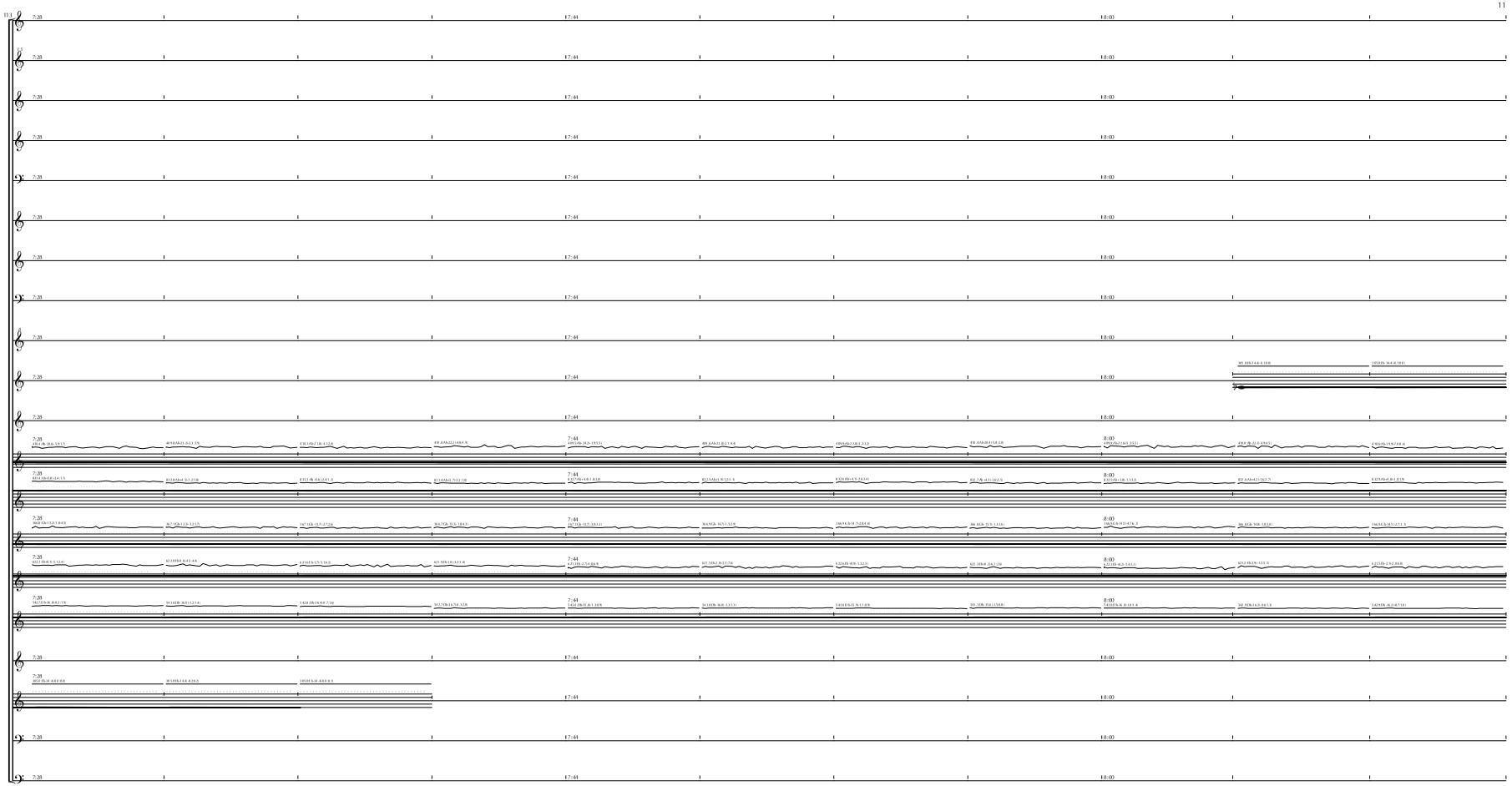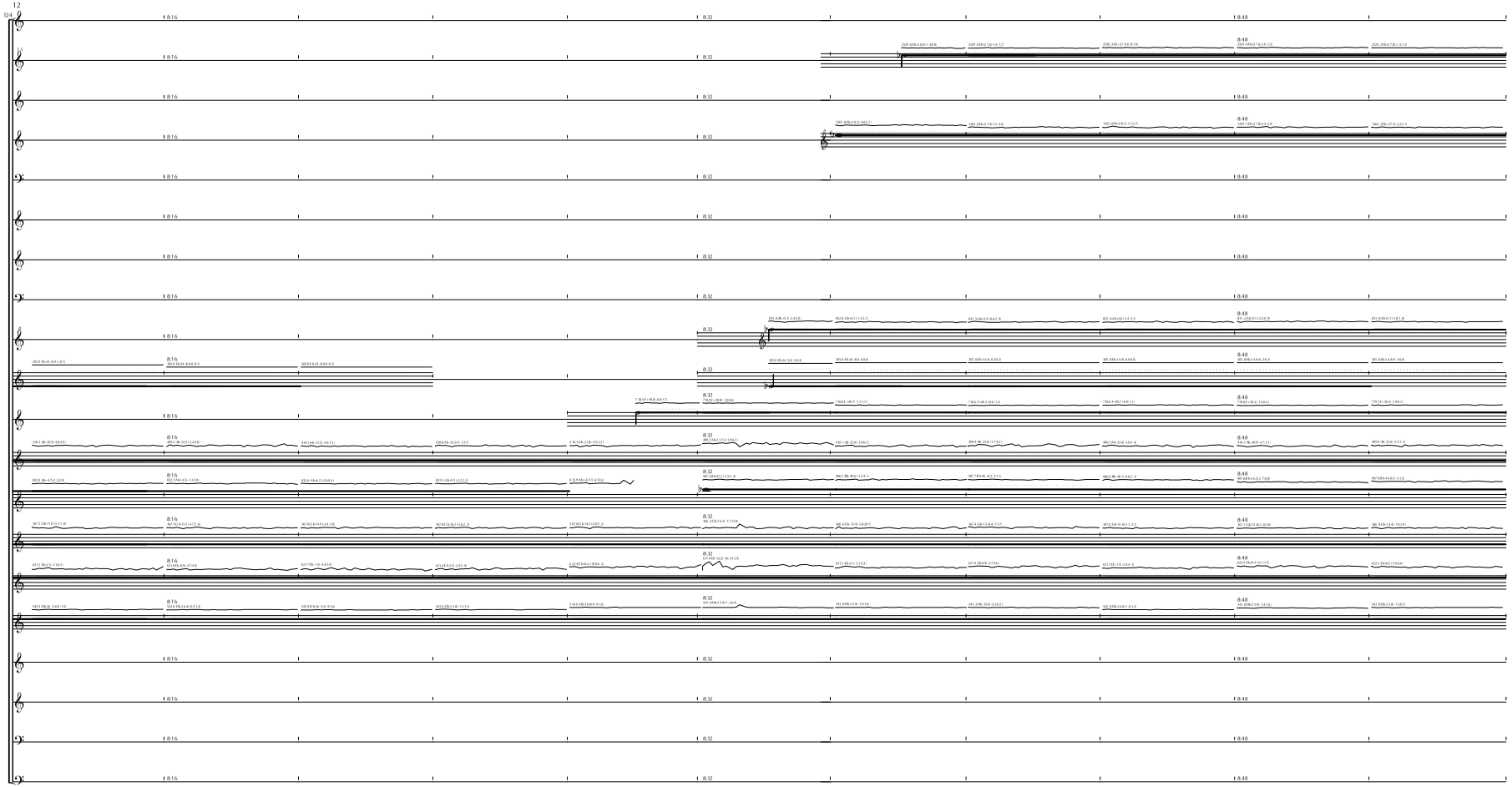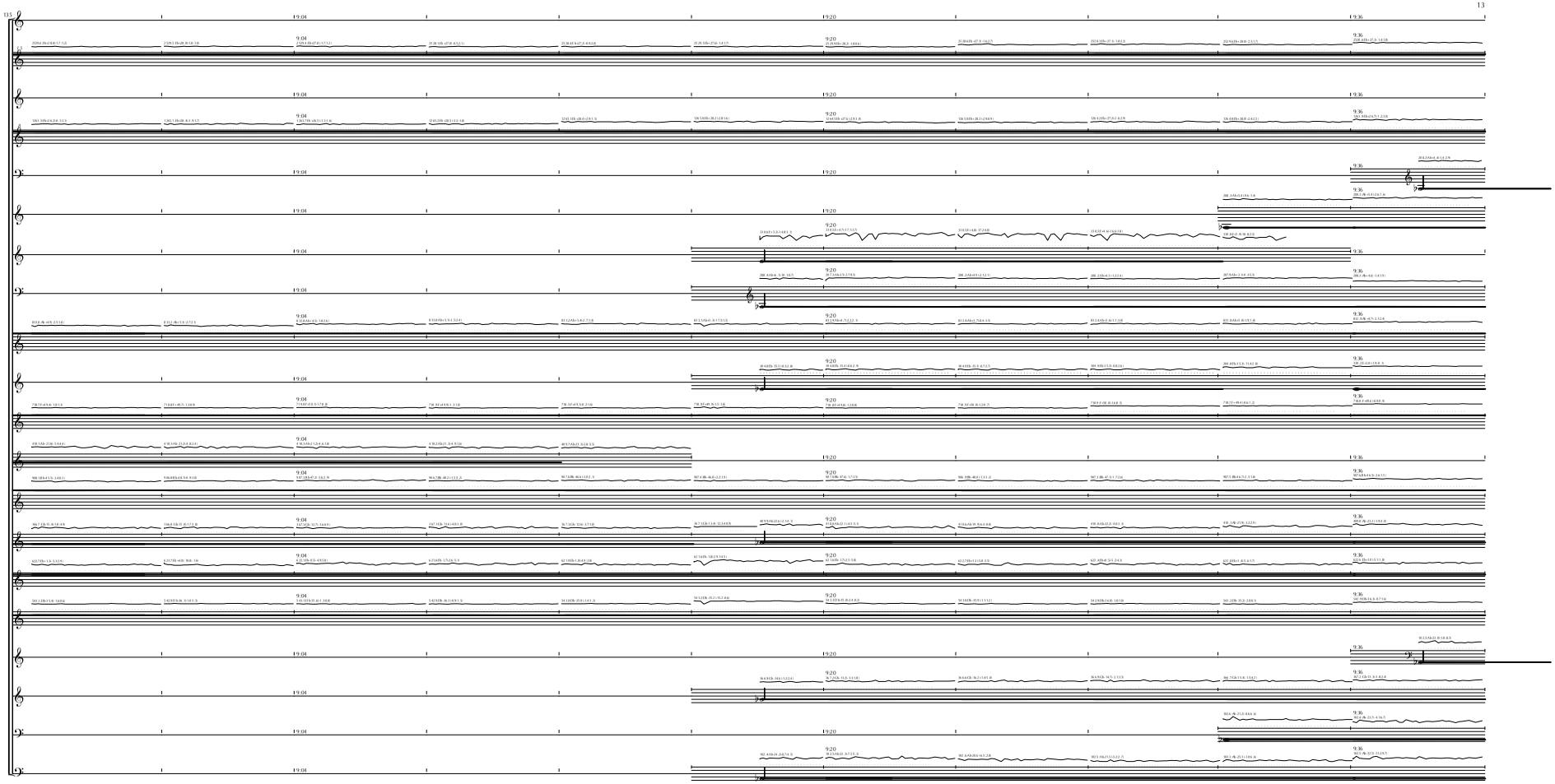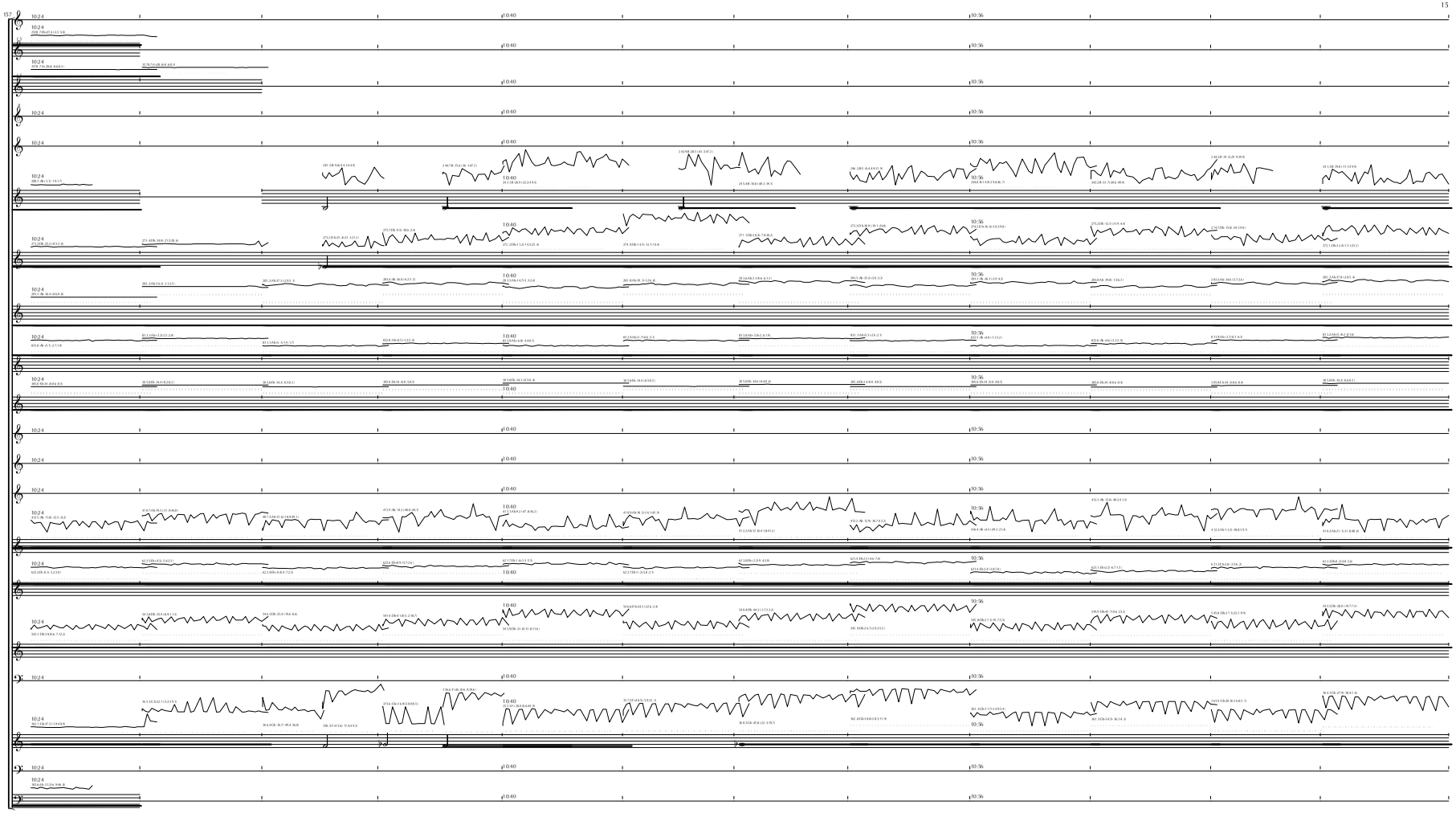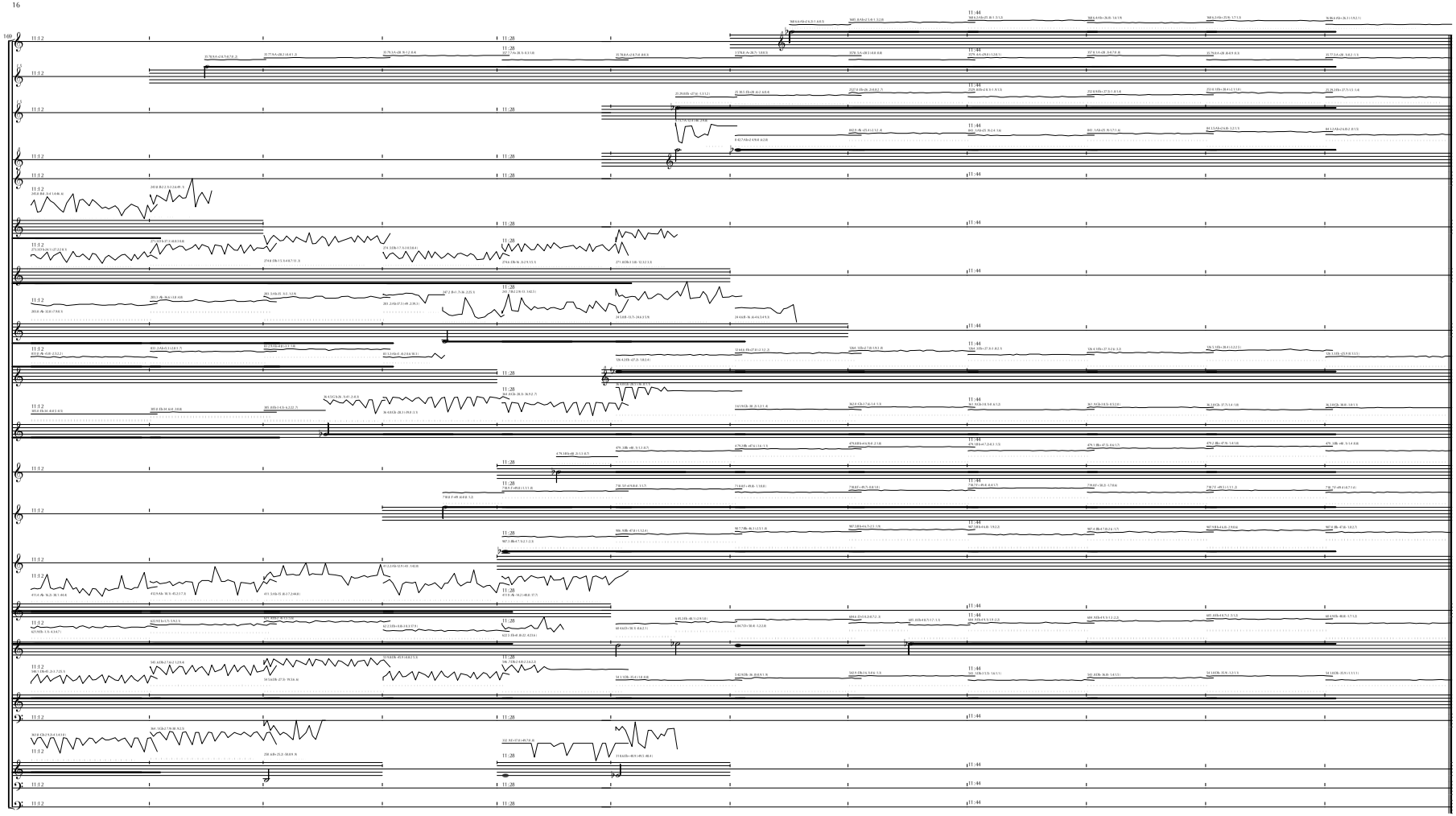
7:28
7:44
8:00