Noneto: A Collaborative Sonic Interaction Between the Real and the Virtual

By

Nicolás Alejandro Mariano Arnáez

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Abstract

Noneto is an electroacoustic composition for string quartet and a quintet of loudspeakers. Each one of these sound sources perform written music: instrumentalists play their lines following a visual clock while a Max patch performs the voice of the loudspeakers. The overall timbre of the piece is generated by a sound synthesis module specifically coded for *Noneto* which features two digital wave modulation processes: 1) a resynthesized live sound amplitude modulation entitled *RESA modulation,* and 2) a process called *double modulation* which utilizes four oscillators consisting of one carrier and three modulators.

Noneto re-contextualizes and blends different methods of music composition—the dodecaphonic series, modes of limited transposition, Karlheinz Stockhausen's idea of formula (mantra), musical interactivity, and others—which are merged together to create a piece of music that challenges the senses, driving the ears through a virtuosic aural journey of three musical movements which are based on the same musical seed, while exploring an innovative human-machine music correlation.

In memory of my beloved father.

… el sol acarició mi faz.

Acknowledgments

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Introduction

This document describes the historical context, groundwork, and technical aspects of a new musical work of my authorship called *Noneto*. This piece embodies knowledge I attained during several years of studying at the University of Alberta. *Noneto* also represents my appreciation of music created in the twenty-first century, representing a personal aesthetic combining acoustic performance, music technology, modern Western music theory, and the historical aspects of varying styles and aspects of composition.

As an artist, one of my goals has been to devise a comprehensive methodology of music composition. My personal approach to music making expands the tradition of Western classical music writing by incorporating contemporary social phenomena, current cultural principles, newer empirical aural expressions, and technology. Hence, my doctoral thesis project is an electroacoustic musical piece involving the following elements:

1. A strong theoretical framework from which the musical elements are derived;
2. An acoustic component, performed by musicians;
3. A digital sound component, performed by computer software;
4. A synchronization principle between acoustic and digital elements;
5. An interactive setting that allows the performative aspects of one source to influence the musical performance of the other.

Motivation

Noneto is motivated by diverse investigations, realizations, and collaborations. Over the years, I have been exposed to new music works where the use of technology has been a key element.[1] In these works, the composer's approach to music making immediately caught my attention and triggered an unstoppable desire of implementing similar processes to my own work.

Since 2014, I have worked closely with composers and performers while acting as the production manager at *The Society for New Music Edmonton*. Some of the pieces we presented involved the use of a significant amount of electronic equipment. One of my primary duties in this society was to produce concerts, many of which had extensive technological requirements, such as multichannel works, live-processing algorithms, and diffusing electronic pieces.[2] Furthermore, I have composed works that implement live interaction and multichannel systems, as well as sound installations and maker culture practices. I have also participated in collaborations with musicians, dancers, and spoken word artists.

Noneto's treatment of musical elements has been inspired by diverse historic compositional methods. For example, harmony and pitch collections are borrowed from Oliver Messiean's musical language and Josef Hauer and Arnold Schonberg's twelve-tone technique. Melodically, my work repurposes linear processes from serialist composers like Anton Webern and Alban Berg. Rhythmic phrases are influenced by the work of Oliver Messiaen, György Ligeti, and Pierre Boulez, and traditional baroque counterpoint. The musical form of the three movements of *Noneto* has been inspired by organizational methods such as John Cage's micro-macrocosmic structure, György Ligeti and Krzysztof Penderecki's sound mass, and classical Western music structures such as theme and variation. The timbral quality of *Noneto* can be associated with the electroacoustic pieces created of Pierre Boulez, Karlheinz Stockhausen, Kaija Saariaho, and Karlheinz Essl. Furthermore, the collaborative computer-human interaction has been strongly inspired by the work of composers such as Alvin Lucier, Keith Hamel, Karlheinz Essl, Michael Beil, and Lara Morciano.

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[1] Examples include late-20th century composers such as Luc Ferrari, Alvin Lucier, John Chowning, Kaija Saariaho, Karlheinz Essl, and Michael Beil (amongst others). Ancillary influences include Claude Debussy, Arnold Schonberg and Igor Stravinsky to Pierre Schaeffer, Oliver Messiaen, Pierre Boulez, and Karlheinz Stockhausen.

[2] Some of these works include Chiyoko Szlavnics' *Constellations I-III* (2011) for piano and sinetones; Nicole Lizée's *White Label Experiment* (2012) for turntables, percussion quartet and live electronics; Keith Hamel's *Heroes in the Seaweed* (2015) for flute, cello, piano and interactive electronics; Mauricio Pauly's *Patrulla Reliquia* (2015) for amplified piano, live electronics and recordings of dry leaves dragged and crushed over ceramic slabs; Darren Copeland's *While Working and Walking* (2016) for live octophonic spatialization system; and Alissa Aska's *The Woman and the Lyre: Sapphic Cycle* (2017) for flute, cello, piano, soprano and octophonic sound system.

Scope of the Composition

In fourth edition of his book *Electronic and Computer Music* (2013), Peter Manning provides a comprehensive view of the dualism and partnership between composers and technology. Manning provides a profound reflection about the future of music in regards to technology and where this dynamic will take us in the future. In his conclusion, Manning notes that during the 1970s the limitations of existing human-machine communication techniques such as graphic user interphases (GUI), and WIMPs toolkit (windows, icons, menus, pointer) influenced the creation and performance of computer music in the following decades. The reason for this influence was due primarily to the communication techniques' evident limitations, such as the dependency on human tactile input regarding the computer interface, lack of immediate reaction, and preestablished and unchangeable physical ranges. This acted as a ". . . catalyst for the development of alternative means of communications that in turn have made significant contributions to the ongoing discourse about future directions" (490). These directions kept developing throughout the 90's and 2000's, several of which were based in a real-time correlation between performers and software.

In the year 2020, there have been hundreds of successful approaches to developing new devices for human-machine interaction based on electronic sensors, MIDI, Open Sound Control (OSC) and similar digital protocols. Nowadays, we can say the challenge has shifted directions from those that Manning discusses. As I see it, the incorporation of these interfaces in chamber music settings, i.e. the ability to play note-focused material (as opposed to pure electronic sounds or sonic augmentation) has been sparsely explored. The biggest challenge for these interfaces is to acquire a similar playability, sensibility, musicality, and expression level to that of traditional acoustic instruments. Nevertheless, there are some examples of this dynamic being successful in pieces like *Ripples Never Come Back* by Italian composer Michele Tadini for violin, violoncello, karlax and electronics (Tadini 2012) where string instruments interact with the karlax, a MIDI controller with multiple sensors that allows the player to perform digital sounds with a high level of expressivity. Another example is *Après Presque Rien* (2004) by Luc Ferrari for 14 instruments and 2 samplers, where the musical discourse of the acoustic instruments finds an interruption by samplers for interacting together as an ensemble of 16 voices.

There is still a large area to explore when combining acoustic and electronic instruments; thus giving rise to the following questions: Can we find newer methods for connecting the acoustic world of a performer with the digital interpretation of sound? Can we compose musical pieces that integrate organically human musicianship with computational processes? Is there a chance for computers to interact actively with humans and somehow help define the development of a fully written musical discourse? Could human performers' interpretations of notated passages influence the sounding material of the computerized sound, and vice versa? Can we further elaborate upon the concept of live sound processing with the goal of acquiring sonic results based on something other than modifying and enhancing timbre? Can electronically produced sounds and string players work cooperatively as an ensemble of multiple voices?

The use of spatialization and the application of an interactive component are two principles I have used in many of my compositions over the last nine years. These concepts have often been introduced through the use of technological resources like loudspeakers, computers, sensors, and software. When there has been a score to perform, I often use a mix of graphic, text and traditional notation. Furthermore, the sound processing has typically been a consequence of the interaction between humans and computers, i.e. the digital sound processing of an acoustic instrument, which may also be understood as a timbral augmentation of the natural source.

It was my purpose to approach *Noneto* from a different angle: a syncretism of music notation and sound processing which may be understood as the creation of a digital musician/performer capable of playing human-like sounds via live-produced synthesis, and furthermore where the sound is triggered by some score-following inspired techniques. Hence, the goals of the new work are as follows:

- To create a traditionally Western notated score which addresses both acoustic and electronic instrumentation;
- To strictly control all musical elements (minimizing improvisation);
- To avoid the use of notation techniques like graphic or text scores;
- To approach the new work as a nonet, where four of the performers are human string players and the other five are a quintet of loudspeakers (five individual channels);
- To treat each one of the loudspeakers as an individual musician which is able to perform a traditionally notated score and change their timbre according to interpretative shifts in the ensemble;
- To have all nine sources coexist harmonically and rhythmically, similar to a traditional human musical ensemble.

Innovations

With these goals in mind, I foresaw some innovative approaches to music making while simultaneously answering some of the questions inspired by Manning's book.

To begin, I wanted to have a strong theoretical framework for *Noneto*. I discovered the best approach was to acquire a personal and well-grounded structural model by combining practices and theories of composers I admire, but which also included my own voice. Secondly, I wanted to avoid using the traditional approach to multichannel electroacoustic works by designing a collaborative setting between all nine sound sources; the computer would first act as a performer on its own and then use the five loudspeakers as five extra performers (instead of using them as a spatialization multichannel set up). This led me to the final and most remarkable feature of *Noneto*: these electronic performers would need a special and carefully crafted timbre that would blend with the human-produced tones. Inspired by sampling techniques, I imagined that this digital voice would resonate with the human-produced music. The best approach that occurred to me was to imitate, extend, and augment the harmonic spectrum of the present acoustic sources. The result of this reasoning led me to what I call *RESA Modulation*. At the same time, a complementary approach based in pure digital sound synthesis emerged: *double modulation*. Using a powerful and versatile computer software program capable of executing all of these conditions without significant problems eventually became something unique in itself.

Structure

The present document consists of five chapters. Firstly, I present a deconstruction of the diverse musical elements where the theoretical framework is discussed in detail. Chapter two focuses on exemplifying the application of the theoretical framework in the three movements of *Noneto.* Chapter three describes the construction and implementation of the complementary software. Chapter four examines the future applications of the results achieved during this research. Chapter five consists of the score of the piece.

CHAPTER 1 – The Elements of Music: Theories, Predecessors and Blending.

The theoretical base of *Noneto* consists of a conglomeration of music theories and compositional techniques developed by specific composers at various times in the history of Western music. In this chapter, I will describe my compositional procedures and their utilization in *Noneto*. The first section describes the blending of three musical elements (harmony, pitch sequence, and rhythm) used to generate *Noneto*'s central element: the formula*.* The second section concerns the usage of ancillary complementary music parameters.

Three Core Elements, One Formula

Initially, the combination of harmony, pitch sequence and rhythm become a gestalt, a pre-compositional set of materials (which we will call formula) that the three movements of *Noneto* are based upon. Later we will discuss the impact of this formula on *Noneto*'s form, texture and timbre.

Harmony

The first core element is the use of a specific pitch collection. I have always been fascinated by Oliver Messiaen's approach to harmony and rhythm, concepts clearly explained in his book *The Technique of my Musical Language* (Messiaen 1956). In it, Messiaen describes his famous *modes of limited transposition*. These modes have been used for more than sixty years and they offer an interesting pitch-collection oriented configuration. As explained by Messiaen, symmetry is the origin of these modes—their balanced proportion is the result of intervallic groupings which produce a collection of pitches resembling many tonalities simultaneously without being polytonal, consequently maintaining melodic and harmonic structure (Messiaen 1956, 1:58–59). I adopted Messiaen's theory and employed it in *Noneto* after listening and analyzing the distinctive tones achieved in the works where these modes were used. Some of these pieces are Messiaen's compositions, such as the organ work *La Nativité du Seigneur* (1935) (Messiaen 1956, 1:61-62), and the *Quartet for the End of Time* (1941) (Bellusci 2009). Messiaen's theory has influenced other composers who have incorporated his modes into their own music.[3]

In *Noneto*, I felt particularly attracted to use Messiaen's third mode, which is constructed by three groups of four notes (Messiaen 1956, 1:60):

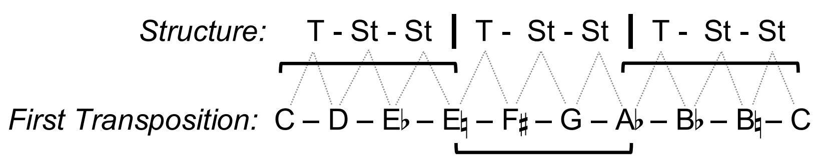


Fig.1 Third mode, structure of T (Tone) and St (semitones), example in C.

This mode is made out of nine pitches, and its intervallic structure can be transposed four times. The fifth transposition repeats the intervals and note content starting from different degrees of the scale (Messiaen 1956, 1:60-61). The most attractive aspect of this particular pitch collection is the fact that nine pitches are featured, a condition which ideally aligns with the nine sound sources of *Noneto* (four string instruments and five loudspeakers).

I then decided to use three of the four possible transpositions. Each of the three movements is based mostly on one transposition, shown below:

[3] One example of this is Tōru Takemitsu's *Requiem for Strings* (1957), where the solemn sound captivated my imagination. Furthermore, Peter Burt's analysis of Takemitsu's work (Burt 2001, 55-60) confirmed my beliefs about the profundity and complexity of Messiaen's modes.

Movement I - 2nd transposition:

Movement II - 1st transposition.

Movement III - 3rd transposition.

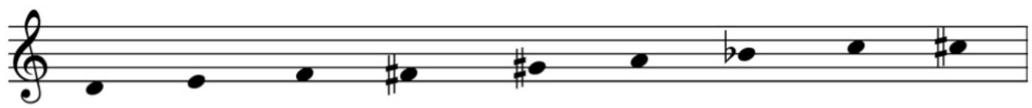


Fig.2 Messiaen third mode, transpositions used in *Noneto*.

With this pitch collection, I harmonized each one of the nine notes of each series utilizing Messiaen's ideas of chord construction as a starting point. The first movement (2nd transposition) superimposes perfect or augmented fourths (Messiaen 1956, 1:50-51) instead of piling notes on the interval of a third (as done in the tonal era). It then takes each of the nine pitches as a root and adds notes on top by repeating the interval of a fourth three times. This interval changes its type (augmented or diminished) according to the accidental notes that belong to the mode. As shown below, the augmented fourth interval of the note A reads as a diminished fifth (E♭ instead of D♯) just to keep consistency on the explanation of the theory (marked with a * below).

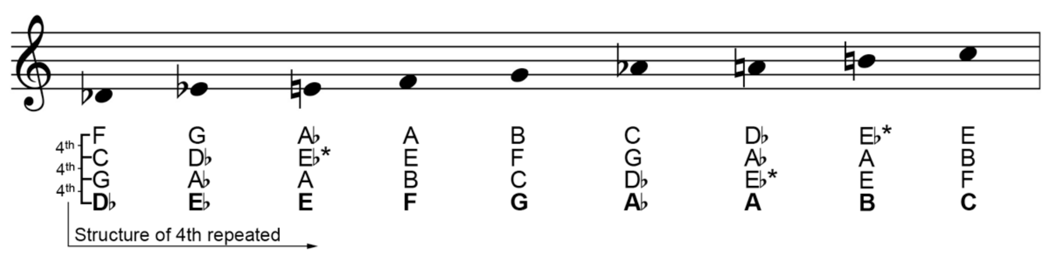


Fig.3 Harmonization of the second transposition.

In the second movement (first transposition), the intention is to elicit a cloud-like harmonic motion, i.e. the sensation of a mass of sound similar to György Ligeti's *Lux Aeterna* (1966). The first transposition of the mode is found vertically, creating a large chord of nine notes spread throughout the register:

Fig.4 Harmonization of the first transposition.

The third movement (3rd transposition) constructs its harmony by following a harmonic procedure also suggested by Messiaen (Messiaen 1956, 1:61). Over the first note of the mode (D) I define the structure of a chord — a minor third, semitone, tone, tone — and subsequently continuing from each one of the resultant pitches (D, F, F♯, G♯, B♭) the scale upwards. Hence, this process creates nine chords (one per note), as shown below:

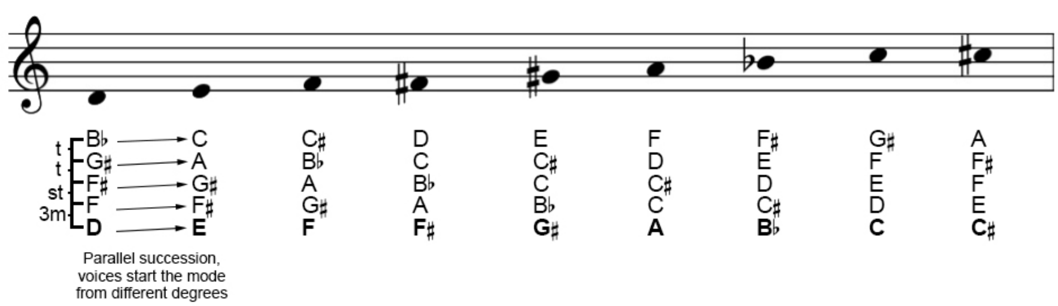


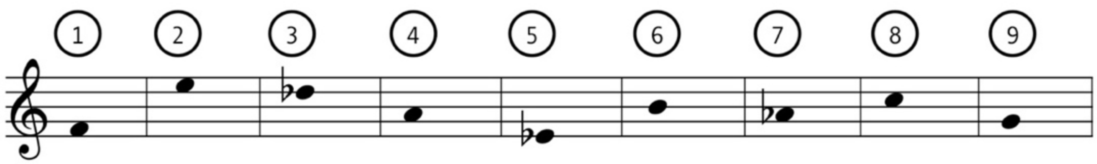
Fig.5 Harmonization of the third transposition.

The harmonic plan of the entire piece is then defined by these *designated chords*, a term that I adopt in this document to refer to these pitch structures.

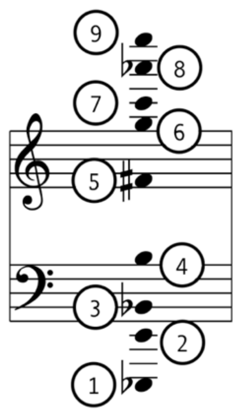
Pitch Sequence

The second core element concerns the linear treatment over time of these nine pitches which are organized differently in each of the three movements. The sequence of pitches is a horizontal single musical line that defines intervallic content, which is processed by diverse contrapuntal approaches. The first step is to place these nine pitches in a row, a procedure inspired by Josef Hauer's *Law of Twelve Tones* (Harvey 1980, 47-48) and Arnold Schonberg's *Composition with Twelve Tones* (Schonberg 1950, 102-143). In constructing my nine-value row, I employed Hauer and Schonberg's principles of non-pitch repetition, but I also differed from their theories in two distinct ways. First, I don't use all twelve notes of the chromatic scale but rather the nine obtained from Messiaen's third mode. Second, I welcome tonal intervals between subsequent degrees of the row, and do not mind having tonal reminiscences within the row.[4] As a result, I obtain three series of nine pitches each, two of which are set vertically and one which is set horizontally:

a. *Movement I:*



b. *Movement II:*



c. *Movement III:*

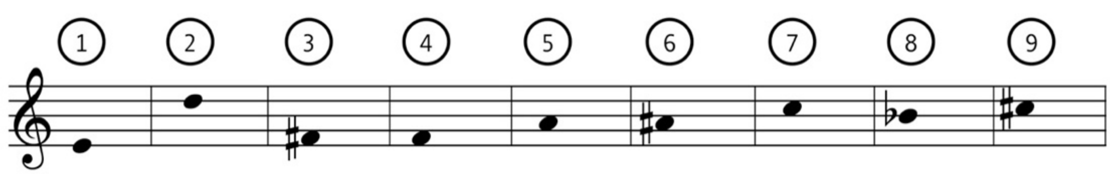


Fig.6 Nine pitch series used on *Noneto*'s three movements.

[4] i.e. 2^{nd}, 3^{rd} and 4^{th} notes on the row of the first movement form an A mayor chord.

Rhythm

The principle of symmetry underlying Messiaen's modes is also applicable to the third core element of *Noneto*: rhythmic organization. In the preface for the chamber piece *Quartet for the End of Time*, Messiaen describes his system of rhythmic organization, which he classifies as *rhythms with added values*, *augmented or diminished rhythms*, *non-retrogradable rhythms*, and *polyrhythms and rhythmic pedals* (Messiaen 1942, II-IV). Many of these rhythmic theories are models extracted from techniques used in musical systems such as Ragavardhana Hindu Rhythms, rhythmic patterns of ancient Greece, and the augmentation and diminution proportions used by Johan Sebastian Bach (Messiaen 1956, 1:14-26), these systems are modified by him to fit in his own theoretical approach, leaving behind any track of cultural practices attached to them in their original environment. The effect of this rhythmic conceptualization on other composers of the 20th century is well-documented, such as Canadian musicologist Jonathan Goldman's studies concerning the use of rhythmic canons and added rhythmic values in Pierre Boulez' work *Mémoriale* (1985/1993) (Goldman 2011, 156-157); and the presence of non-retrogradable rhythms and rhythmic canons in Boulez' *Athèmes* (1991) (Goldman 2011, 164-169).

For the construction of *Noneto*'s rhythmic material, I decided to use Messiaen's idea of non-retrogradable rhythms (Messiaen 1942, II): a rhythmic palindrome with a central value (or axis). If one plays the full rhythmic phrase from end to beginning, they obtain the same phrase from beginning to end (Fig. 7). Therefore, you cannot retrograde the phrase because you obtain the same result. Despite the fact the ear hardly recognizes this symmetric feature just by listening, in my point of view it offers intrinsic coherency, unity and balance. I also use the rhythms with added values technique which is featured at the beginning and end of *Noneto*'s base rhythmic phrase (marked with a + sign).

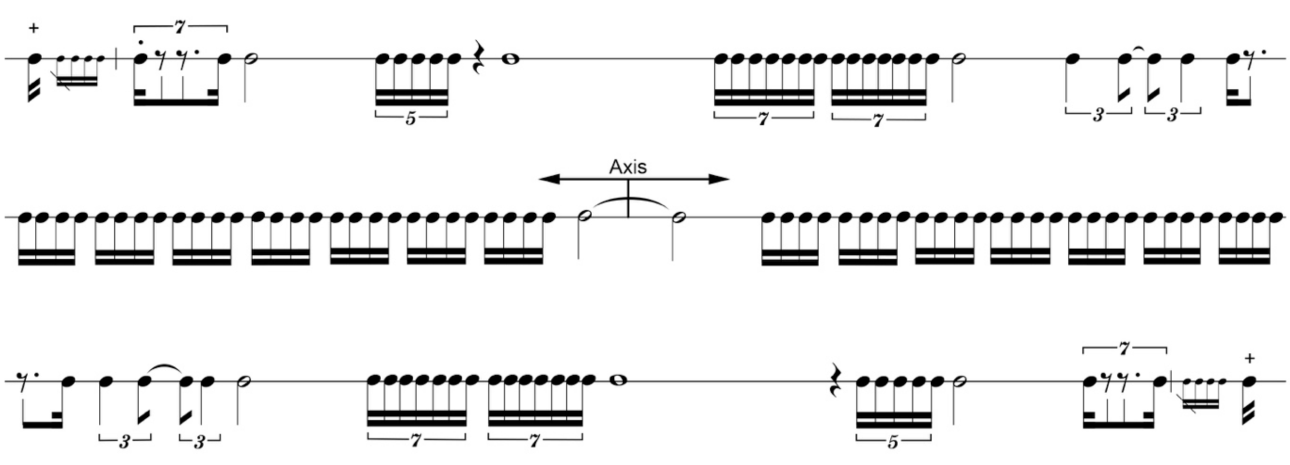


Fig.7 Non-retrogradable rhythmic phrase.

Other procedures inspired by Messiaen's' rhythmic theory are used to further develop the formula inside each movement, which will be explained in later chapters.

Formula

The formula is the most important constructive element of *Noneto*. Karlheinz Stockhausen defines formula as "a series of tones or syllables that are constantly repeated—in different tempi, with varying dynamics—in a way that is both acoustically audible and inwardly meditated. Through concentration on such a series of tones, the listener enters a higher state of receptiveness and consciousness." [5] (Paul 2015, 7:27). Thus, *formula* is a collection of recognizable short musical gestures carefully put together which generates a musical catalog, this catalog contains the aural identity of a full-sized sound work. The composer will focus on this formula's musical cells by expanding freely and irregularly their individual characteristics (pitch content, rhythmic gestures, articulations, dynamics, etc) with the goal of creating a fully composed musical piece.

In *Noneto*, the blending of the harmonic, melodic, and rhythmic procedures described above ultimately results in nineteen individual cells, each of which contains specific motivic gestures with specifically designated harmonic chords, this is *Noneto*'s formula (Fig. 8). In attempting to make each one of these cells even more identifiable (and following on Stockhausen's procedures), I dress each one of them with different ornaments, dynamics and articulations. On a large scale, these particularities become identifiable key components of sections as each cell is developed freely and based on their construction to longer musical parts (Stockhausen 1973, 16:15).

Noneto's score (chapter five) displays the term *imprints* instead of *movements*. As mentioned before, these three parts are three different expansions of the formula—they can be considered three different stamps of the same conceptual object. In this case, the term *imprint* appears more accurate: an analogy of the action of stamping with the same mould an image in different surfaces, utilizing different ink colors, etc. However, in the rest of this document I will continue using the term *movement* to avoid confusions.

[5] Stockhausen used the terms *mantra* and *formula* interchangeably to avoid confusions with his piece for two pianos, also entitled *Mantra* (piece where this technique was first used in 1970). Hence, the use of the term *formula* becomes more appropriated.

Fig.8 *Noneto*'s formula.

Form & Texture, Timbral Innovation, and the Interactive Component

Concerning *Noneto*'s structural characteristics, I appealed to the implementation of recognizable music forms adapted to the language of the piece. *Noneto* features three movements with different tempi, which thereby offered enough diversity to explore and extract musical material out of the overarching formula. These three movements are based on a lenient use of the traditional tempo/mood markings Allegro, Lento, and Presto. Throughout *Noneto*, I don't use a constant beat stream or tonal harmony, hence the use of these mood markings is not applied conventionally. Instead, I retain the impression of something moving at distinctive speeds: Moderate – Slow – Fast. Within each one of the three movements there are recognizable structures and textures used in Western music.

Each one of these three movements focus on elaborating distinctively different sections of the formula. The first movement takes the first 10 cells and expands them by elaborating their motivic features. The second movement focuses solely on one cell (number 10) and stretches its characteristics for more than four minutes. The last movement expands each cells' motivic gestures of cells between 11 and 19, this time in shorter episodes (since the elaboration is shorter, the third movement repeats this process four times one right after the other, thereby creating new material every time).

Form & Texture

In writing for an ensemble of nine instruments, I was compelled to explore different textures in each movement. Subsequently, I decided to revert to some previously known forms that would guarantee diverse textures.

The first movement maintains a fractured texture: each one of its sections corresponds to an expansion of each one of the cells of the formula assigned to it (its form then becomes the formula's form but enlarged in time). The texture of the first movement changes gradually over time which invariably changes each cell's stylistic and timbral characteristics: homophony (rehearsal letters A, B, E, F), a cloud of sound (C, N, H, I), contrapuntal (D, M), minimalist (G), parallel and unison (J, K), pointillistic (L), and hybrids of these conditions (O, P, Q, R).

Throughout the first movement, the nine sources are combined in diverse groupings which assemble specific rhythmic and harmonic material (the grouping depends on the type of desired texture at the given time). For example, you can find two groups assembling two different musical materials at the same time (particularly at letters E, M, P and R, all of which feature electronic and acoustic elements); nine sources working as a whole where everyone shares the material, as seen in letters C, G, H, I, J and K; individualism, where each source has its own voice as seen in D and L; and one or more sources which play against each other, such as the unbalanced groupings in B, F, N, O and Q.

The second movement uses cell 10 of the formula, which is simply a large chord of nine pitches. Throughout the movement this chord is featured in nine different voicings (with the "original" chord close to the golden ratio of the movement at letter J). In each of the nine stanzas of the chord, the individual voices are held for several seconds which neutralizes any possible melodic content. Thus, I am able to create a dense texture which has no elaboration; it is always the same chord explored in different states, dynamics, speeds, and points of entry. Furthermore, not all voices articulate their notes at the same time aside from a few exceptions. The cloud-like sonority (at rehearsals C, N, H, I) can be associated with works that focus on timbral elaboration, such as Arnold Schonberg's idea of *klangfarbenmelodie*, a term coined by Schoenberg and translated in English as *tone-color melodies* (Schonberg [1911] 1983, 421-422). Schonberg does not fully clarify this concept, but it is possible to understand it as linear movement driven by the combination and development of the timbre of the notes played as the opposite of their pitch, intervals, and rhythm (as was typically done during the tonal period of music composition). Schoenberg's most influential work for me has been *Farben* (1909) for orchestra, where a C-G♯-B-E-A chord is explored by the orchestra utilizing the tone-color melody concept. Another influence for this kind of sonority was György Ligeti's micropolyphony technique, where a sonorous mass is created by dense canons (Ligeti [1978] 1983, 14-15), a technique used in several of his pieces for large ensembles such as *Apparitions* (1958-1959), *Atmosphères* (1961), and *String Quartet No 2* (1968), where according to Miguel Roig-Francolí "net-structures" come into account to produce the mass effect (Roig-Francolí 1955, 243). The sonority of my second movement is similar to that achieved by Ligeti in *Lux Aeterna* (1966), particularly in regards to the use of long notes. In movement two, all sources work as one to obtain one final timbre.

The third and final movement takes the most traditional approach in regards to musical structure. It adopts a form of theme and variations: cells 11 through 19 formulate the "theme" which subsequently evolves into four different elaborations (beginning at rehearsal letters A, I, Q and V). These four elaborations of the formula are inspired by many of Beethoven's works. In many of Beethoven's theme and variation pieces the theme is freely elaborated without strict adherence to its structure. In some cases, Beethoven re-writes a completely new piece by liberally expanding the theme. Some examples of this are the variations between measure 185 and 388 of his *Fantasy for Piano, Orchestra and Choir* (1808) Opus 80 (Lemoine, n.d.), and the Fugue (variation 32) of the historically renowned *33 Variations on a Waltz by Anton Diabelli* (1819-1823)

Op. 120. *Noneto* expands its nine cells by stretching their features in four variations, sometimes overlapping the development of two or three cells simultaneously in different instruments (chapter two takes a closer look at these procedures). This third movement also presents changing textures and shifting instrumental groupings between its nine sources (i.e. A, B), acoustic vs electronics elements (H, T), and three trios (I, K, L, R etc).

Timbral Innovation

Composers have maintained a variety of approaches when mixing electronic sounds with live acoustic sources. One common technique is to embellish the timbre of the live source by applying electronic enhancements via microphone and hardware or software sound processors. Hence, the original source is sonically augmented by the electronics which reproduces the result through loudspeakers. This approach has changed dramatically over the last sixty years. Three pieces that *Noneto* takes its influence from in regards to electronics is first the iconic *Répons* (1981) for large chamber orchestra with six percussions and live electronics by Pierre Boulez. In *Repons,* an audio processor records material performed by the orchestra and reformulates it timbrally and dynamically through loudspeakers strategically positioned throughout the concert hall (Henahan 1986). *Aer*, the seventh part of the ballet *Maa* (1991) by Kaija Saariaho, utilizes a computer which affects the acoustic instruments and triggers electronic textures (Saariaho, 1991). Austrian composer Karlheinz Essl's *juncTions* (2011-2012), composed for grand piano (two players) and live-electronics, produces delicate sounds which are layered and processed by a Max patch and subsequently amplified via a quadraphonic loudspeaker arrangement (Essl, 2019). In these works, the efficacy of the electronic material depends on the acoustic instruments, i.e. the electronics enhance the timbral nature of the acoustic instruments in real time.

Noneto employs the use of electronics in a unique way. Firstly, it uses five loudspeakers, which are treated as five extra musicians participating in the ensemble. As demonstrated in the score, the loudspeakers elicit their own musical material which consistently interacts with the string quartet. Secondly, their timbre depends on the timbre of the acoustic instruments. In other words, the loudspeakers' sonic identities are germinated by the string players. This is achieved by using what I refer to as *RESA modulation* (Resynthesized Sound Amplitude Modulation). *RESA modulation* is an electronic process where a live sound is first resynthesized via FFT (Fast Fourier Transformation) and then modulated in amplitude by an oscillator. In *Noneto* this resynthesized sound is a specific note of a string instrument captured live via a microphone as the string player performs their score. The sound obtained after this process is later mapped throughout the entirety of the tonal register of a MIDI keyboard. Finally, intensity envelopes amplitude modulations with different ratios and noises are added with the goal of creating a fully playable synthesizer.

There is a second additional voice design method used to build the loudspeakers' timbre, an element I refer to *double modulation*. Here, timbre is built electronically via four oscillators (three modulators and one carrier). The main characteristic of this technique is that the user can choose the three oscillators to simultaneously modulate the carrier's frequency and amplitude at the same time as desired. With this much control, it becomes easy to achieve string-like sounds with minimal effort. The same Max module, which I call *ReDo Synth* (Fig. 9) provides a switch to change the type of modulations used. During the composition of *Noneto*, I had the option of choosing either RESA or double modulation depending on the musical impact I wanted to achieve.[6]

Fig.9 ReDo synthesizer graphic user interface.

Summary

The following table attempts to summarize what has been discuss thus far:

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[6] Detailed diagrams of RESA modulation, double modulation, and alternate elements of the ReDo synth can be found in chapter 3.

	1st movement	2nd movement	3rd movement
Tempo	Moderate	Slow	Fast
Duration	c.a. 8:04 minutes.	c.a. 4:45 minutes.	c.a. 6:27 minutes.
Form	Fragmented	Sound mass	Theme and variations
Harmony	Messiaen's mode 3. Second transposition. First transposition.	Messiaen's mode 3. First transposition.	Messiaen's mode 3. Third transposition.
Series	Horizontal. F E D♭ A E♭ B A♭ C G	Vertical. E♭ D B♭ B F♯ G C A♭ E	Horizontal. E D F♯ F A A♯ C B♭ C♯
Formula	Cells 1 to 10 and a half.	Cell 10.	Cells 11 to 19.
Rhythmic procedures	Formula dependent.	Long notes.	Pulse stream.
Texture	Homophonic. Cloud of sound. Counterpoint. Minimalist. Parallel and unison. Pointillistic.	Cloud of sound.	Homophonic. Minimalist. Parallel movement.
Timbre	Strings. RESA modulation. Double modulation.	Strings. RESA modulation. Double modulation.	Strings. Double modulation.
Sources Grouping	Acoustic - Electronics. Nine sources working as a whole. Individualism. One or more sources against the rest.	Nine sources working as a whole.	Nine sources working as a whole. Acoustic – Electronics Three trios.

Table 1 *Noneto* music elements summary.

CHAPTER 2 – *Noneto*

In this chapter I analyze all three of *Noneto*'s movements in an attempt to demonstrate how formula expansion is utilized. This chapter primarily elucidates how the inherent harmonic, rhythmic, timbral and ornamental aspects of the formula's cells are enlarged throughout the piece.

Estampa Uno [Imprint One]

Subformula

The first movement focuses on cells one to ten and a half. This movement's essential characteristic is defined as both direct and retrograde representations of these 10.5 cells, catalyzed by a pivot point. This procedure has been implemented with the goal of reflecting the same process applied to the rhythm of the full formula (see chapter 1, Fig. 7). From a rhythmic perspective, the full formula may be used as a substitute for the retrograde motion (rhythmically, 10.5 to 1 is the same than 10.5 until 19) but I wanted to keep the motivic material (in retrograde motion) of cells 1 to 10.5 as well as this sequence's harmonic essences, articulations, and dynamics. One key point here is that during the second part of movement one (measure 57 until the end) the cells are retrograded from where this section expands from, not their elaboration (the second half has its own elaboration based on the retrograded cells). In other words, I create a variation of the main formula, a subformula which starts from cell one and moves left to right until cell number ten. At cell ten's halfway point, I move in reverse from right to left until I reach cell one again, as shown in Fig 10.

Fig.10 Movement one's subformula.

The next step was to determine a proportion between the subformula and the first movement. Originally, my decision was to make each time unit last a total of 9600ms, with the resultant proportion being 1 to 9.6. This proportion is used as a guide rather than as a rigid value—it is rounded several times to even values depending on the musical passage. Also, not all of the voices use the resultant time collectively as the elaboration of the cells is ultimately carried by all nine instruments (not necessarily at the same time). Some of the instruments start before and others finish later, thereby assuring a smooth transition from one cell to another when needed. In many instances the full proportion is applied to one of the voices, while the others are freer, interrupting a process half-way or using material not coming from the cell. In the score, some rehearsal letters do not match the beginning and end of a cell elaboration while other cells do, thereby making it easier to identify cells by the beat time number.

Sixth Cell Elaboration

Concerning the expansion work applied to the subformula, the same concept has been applied to all 20 cells in this movement. In this section I will illustrate how the elements of music of length, rhythm, melody, harmony and dynamics are extended.

In looking the original sixth cell of the subformula, one notices its distinctive characteristics:

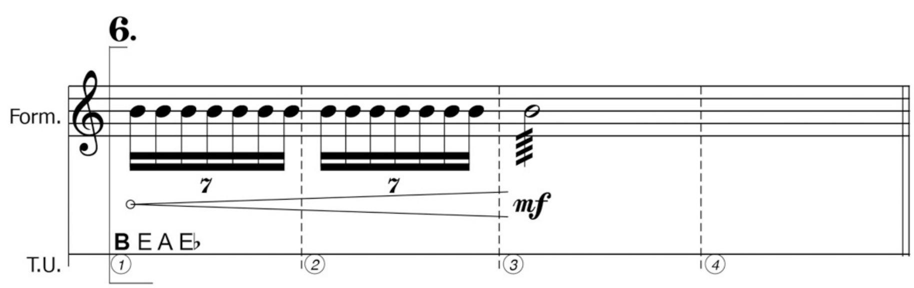

Fig.11 Formula cell six.

- Length: Four time units.
- Rhythm: During the first two time units there are 14 equal rhythmic values at a rapid pace. The second half also repeats but with an unmeasured rhythmic value.[7]
- Melody: There are no melodic gestures, there is just one pitch throughout.
- Harmony: The designated chord is made out of four notes: B - E - A - E♭.

[7] Tremolo in *Noneto* is understood as “as fast as possible” and not as an even subdivision of the displayed rhythmic value.

- Dynamics: The overall cell grows from complete silence to *mf* and remains throughout the rest of the cell.

In examining these conditions the compositional structure is clear: the elaboration of this cell on the first movement of *Noneto* begins at beat number 1:30 in channel four and finishes at the end of beat 2:08 in all nine instruments. In observing the length between these beats, we can see the 1:9.6 proportion mentioned above: cell six has 4 time units, times 9.6 gives a result of 38,4 therefore the elaboration of cell six lasts 38 beats (38,000ms, rounded value of 38,400ms).

Rhythmically, each one of the computer channels maintains different rhythmic augmentations of the original rhythm of cell six (Messiaen 1956, 18-19):

Fig.12 Augmentation of rhythms applied to cell six (electronic voices).

These rhythms also formulate a rhythmic pedal as each phrase repeats four times in each channel during this expansion (with the exception of channel four that repeats three times). The string players' rhythms are freer from proportions in that they perform a written accelerando at the beginning which concludes on a tremolo. Players perform these phrases as rhythmic pedals as well since they reappear four times in each voice.

Melodically, an intervallic gesture structure is defined for each channel (Fig. 13):

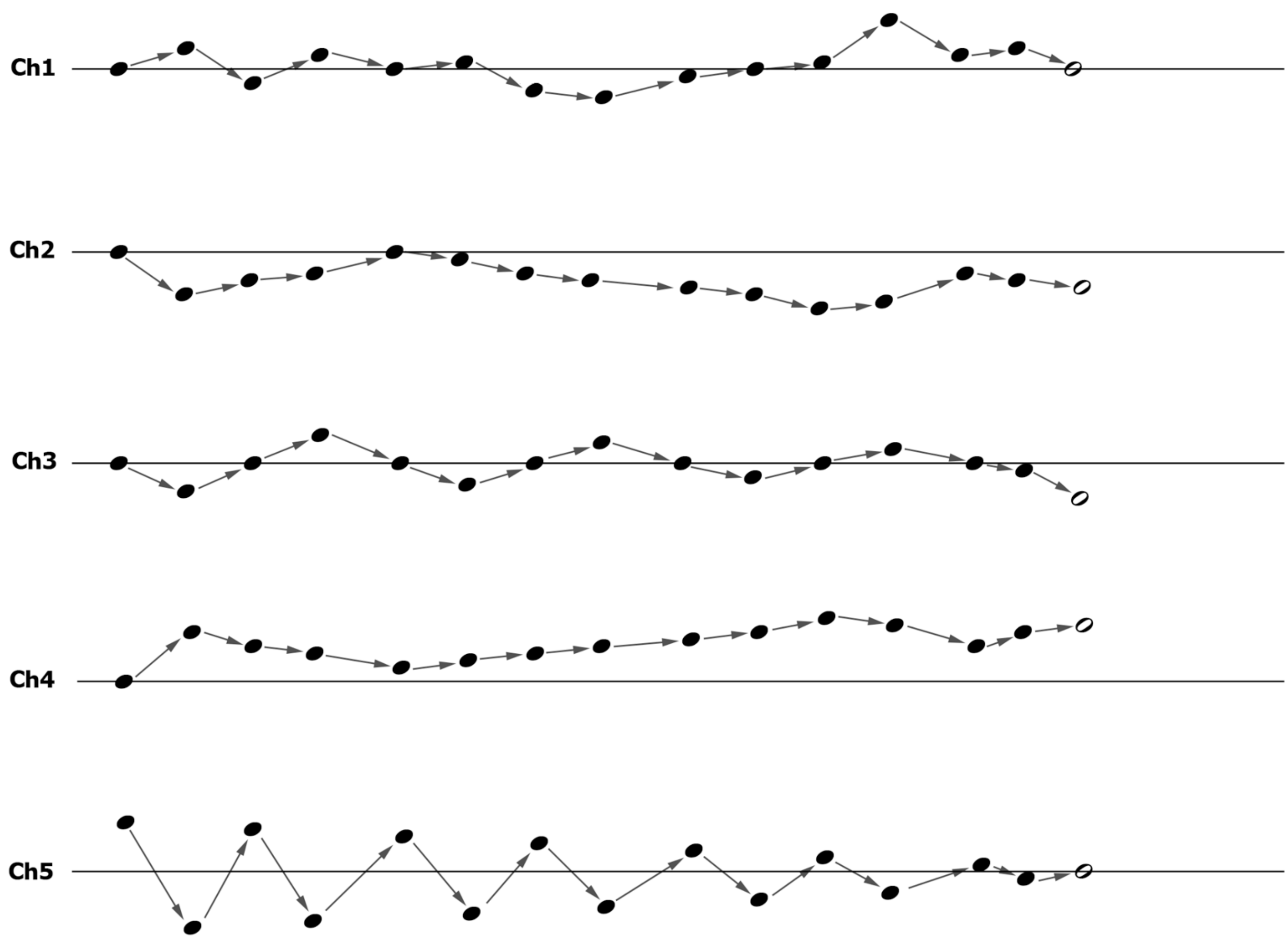

Fig.13 Intervallic gestures used in the elaboration of cell six (electronic voices).

This structure is repeated throughout the section but with two particularities based on harmony first, the starting point of the melody is a pitch of the designated chord and applies the gesture structure following notes of the mode. Secondly, each voice starts on a different note of that chord and continues with the next value for the following three repetitions, a process which is also followed by the string instruments (Fig. 14):

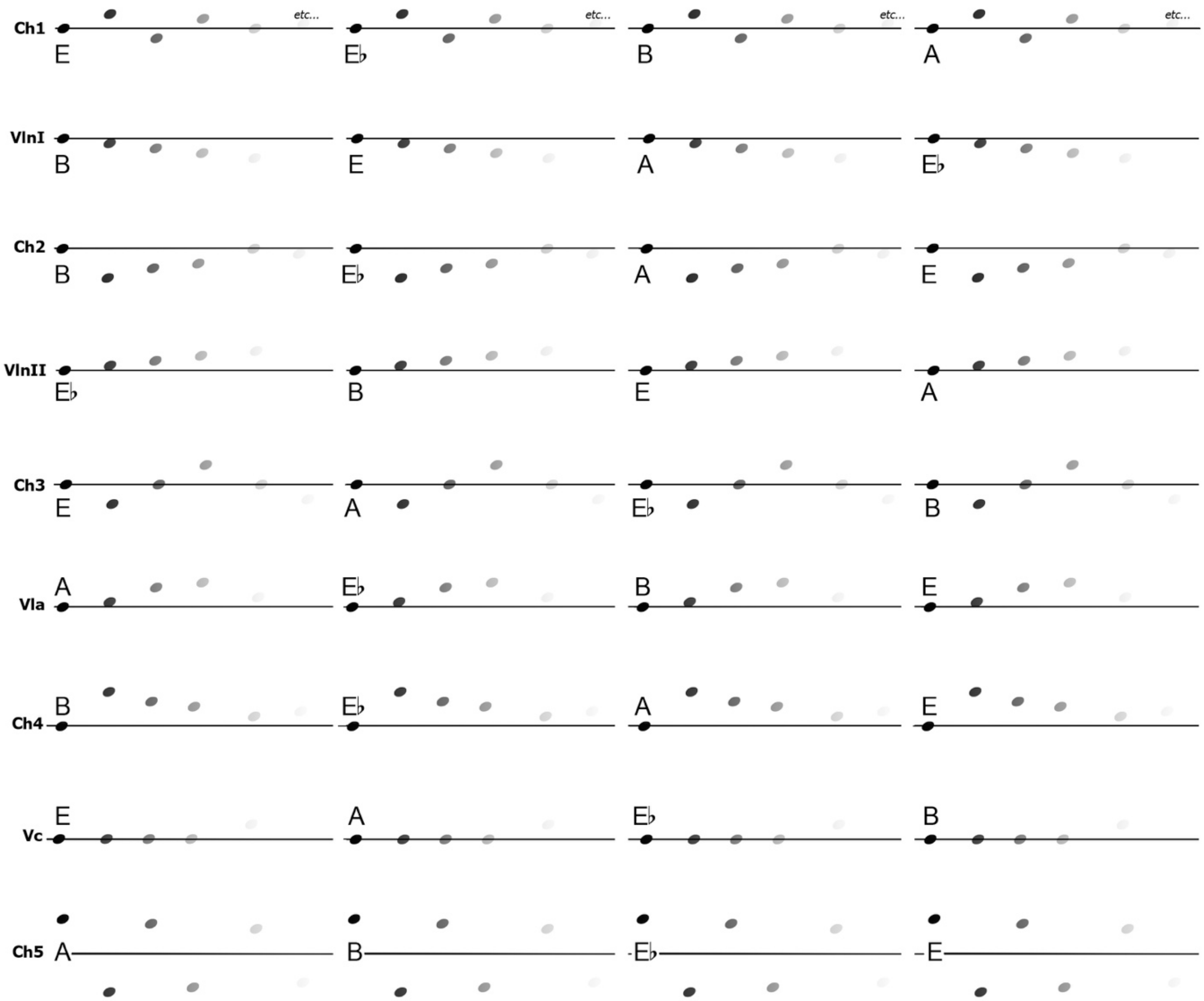

Fig.14 Designated chord in each repetition.

Dynamically, electronic voices follow closely to the original dynamic levels of the cell (quiet to medium loud), while the string voices play the original dynamics in retrograde motion, adding an accent half way between each phrase.

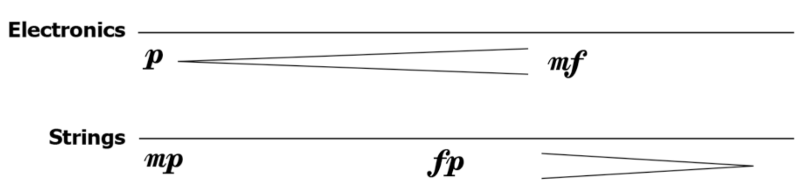

Fig.15 Dynamic structures.

Once these procedures were applied to each of the nine voices they were placed on the score. I was particularly interested in rhythmic activity which started simple and subsequently built to a substantial climax, something that would create tension towards the end of the part and conclude in the following section (rehearsal letter E). I then overlapped the last repetition of all nine voices to achieve a more chaotic ending in which all melodic lines are played simultaneously (measure 25), therefore creating the desired buildup which started automatically in the previous measures. Additional changes were added with the goal of achieving something more appealing to the ears, such as inserting crescendo dynamics in the concluding measure and the addition of rests to some voices to ensure textural control (such as channel four's rests between melodies).

Cell Expansion Scheme

A table with a summary of the processes applied to the twenty cells of movement one is presented below to illuminate the extensive detail of the expansions of the subformula. This table includes the cell number, the time units of each cell (T.U.), proportions used (T.U. to ms), real used lengths (rounded proportion in seconds), the voices to which the proportion is applied, and the start and end points (beat time) of each cell. This table may be examined in correspondence with the written score:

Cell No.	T. U.	Proportion Used (T.U. to ms)	Real length- Voice	From-To (beat no.)	Processes used
1	+	Free	7"- all	0:01-0:07	▪ Grace notes extended by repetition ▪ Rhythmically similar (long-fast) ▪ Articulation maintained as original ▪ Electronic voices focus on first value ▪ Designated chord displayed vertically, fundamental is triplicated, others duplicated
2	1	1:9.6 = 9600	10"- Vln1	0:08-0:18	▪ Strings play the septuplet motif by rhythmic augmentation. Original in Vln1 ▪ Articulations and dynamics are maintained as original ▪ Each voice starts on a different note and continues while melodically following the designated chord (E, E♭, A, A♭) ▪ Electronic voices fill string rests ▪ Channel 3 plays a free melody

3	2	1:9.6 = 19200	16”- Vln1	0:19-0:35	▪ Cell three is rhythmically and dynamically untouched and repeats through the section ▪ Horizontal notes are notes of the designated chord ▪ Channel 3 never plays the cell, rather it continues with the previous process (melody)
4	2	1:9.6 = 19200	19”- Vln1	0:36-0:54	▪ Electronic voices repeat the original rhythmic cell in the first half of the section, then strings play the cell with different levels of rallentando at the end ▪ Electronics display cells’ designated chord, fundamental is duplicated ▪ Vln1 plays free melody, adopting the cells’ slurs and “molto expressivo” indication ▪ In beat 0:45 strings play the cell’s rhythm while climbing through the chord on each beat ▪ New variations of articulations and dynamics are present
5	4	1:9.6 = 38400	40”- Ch4	0:50-1:29	▪ Vibrato is elaborated in each voice ▪ Rhythms throughout each section are non-retrogradable ▪ All voices use the notes from the designated chord in different sequences
6	4	1:9.6 = 38400	38”- Ch4	1:30-2:08	▪ Electronics have different degrees of rhythmic augmentations of the cell ▪ String voices progress from slow to fast ▪ All rhythmic phrases are used as rhythmic pedals ▪ All voices have their own intervallic gestures which repeat in each rhythmic iteration, starting from different degrees of the designated chord ▪ Electronics follow the original dynamics of the cell (quiet to medium loud) ▪ Strings play the cell’s dynamics in retrograde and add an accent in the middle

7	2	1:9.6 = 19200	19"- all	2:09-2:27	▪ Electronics play a melody based on a triplet, slower rhythmic values reflect notes of the designated chord notes, faster ones are free ▪ Strings ornament the melody using varied articulations ▪ Dynamics reinforce melodic gestures
8	1	1:9.6 = 9600	10"- all	2:28-2:37	▪ Vc plays a free melody, which is reinforced by Channel 5 ▪ Electronics perform ***sffz*** and play the designated chord ▪ Vln1, Vln2 and Vla perform the pizzicato indication together in key moments of the melody, completing the designated chord at every iteration
9	7	1:9.6 = 67200	68"- all	2:38-3:44	▪ Electronics perform the rhythm of the cell and repeat it with different tempo variations ▪ Electronics perform the fundamental of the chord (G), while the repeat is transposed ▪ Dynamics of the electronics align with the dynamics of the cell ▪ Strings create parallel movements and intertwine the patterns of four voices, furthermore exploring chromatic values that move inwards similar to the original cell ▪ New variations of articulations and dynamics are present
10	8	1:2.4 = 19200	19"- Vln1	3:45-4:03	▪ The cell's designated chord is explored in different dynamics, articulations and motions ▪ A steady rhythm occurs as in the original cell ▪ The dynamics ***cresc.*** and ***decres.*** are used as in the original cell
	8	1:2.4 = 19200	18"- all	4:05-4:22	▪ Same as above in addition to added trills and tremolos

11	7	1:9.6 = 67200	66”- all	4:23-5:29	▪ Rhythmic unison throughout the cell; ▪ Melodic unison (or octave) throughout the cell; in each repetition one or two voices jump to another note of the designated chord ▪ Two intertwined rhythmic processes occur which feature substantial augmentation and diminution; in each repetition one phrase adds a quarter note as the other rests for one beat: *7* 6 *8* 5 *9* 4 *10* 3 *11* 2 ▪ The melodic contour of the cell is developed ▪ New variations of articulations and dynamics are present
12	1	1:9.6 = 9600	10”- Vln1	5:30-5:39	▪ The cell’s rhythm is augmented in different voices ▪ All voices play ten equal notes and ten equal rests ▪ The notes played are part of the designated chord with the addition of a previously stated tone or semitone: F*E* A*B* E*F* D♭*C* E♭*E* ▪ The string instruments read this series from right to left, electronics from right to left ▪ Channel 3 is free of these processes; ▪ Strings retain the original pizzicato indication
13	2	1:9.6 = 19200	19”- ch4	5:36-5:55	▪ From here until beat 6, 28 cellular elaborations overlap ▪ The rhythmic characteristic of Cell 14 is augmented in all voices ▪ Dynamics are consistent as in the original cell ▪ Channel 3 does not elaborate cell 14
14	4	1:9.6 = 38400	34”- Vln1	5:50-6:27	▪ Some voices replace the tremolo with a trill ▪ Harmony deviates from the neighbor notes of the designated chord ▪ The rest of the voices play a melody over the trill/tremolo harmony ▪ The fourteen repeated notes of the cell are extended with a melodic contour in the electronic channels ▪ Strings play a descending scale with the notes of the mode in the same rhythm than that of the cell (at 6:26)

15	4	1:9.6 = 38400	38" - Electro	6:28-7:05	▪ Channel 2 freely plays a melody ▪ The rest of the voices perform sustained notes ▪ The strings' harmony represents the designated chord ▪ Strings maintain the original molto vibrato indication ▪ Over time, the voices that harmonize the melody duplicate and hold a note from Channel 2 while this continues
16	2	1:9.6 = 19200	19"- all	7:06-7:24	▪ Quarter note and quintuple rests are expressed melodically in the strings and chordally in the electronics ▪ Melodies retain the gestures of the original cell ▪ Chords are built from last note of the quintuple and a 5th following the movements' mode
17	2	1:9.6 = 19200	20"- all	7:25-7:44	▪ Strings play long trills (long values, similar to the cell's rhythm) ▪ The notes of the melody are extracted from the designated chord ▪ Dynamics are the opposite of the cell's dynamics ▪ Electronics reinforce the notes of the designated chord and maintain the original dynamics scheme
18	1	1:9.6 = 9600	10"- all	7:45-7:54	▪ Maintains an identical rhythm than the cell which is repeated in Vln2 ▪ The rest of the voices unexpectedly reinforce some notes by unisons and octaves ▪ Each voice uses a new note of the designated chord ▪ Staccato articulation is mapped to all notes in the section ▪ Dynamics are new
19	+	Free	7"- all	7:55-8:02	▪ Grace notes are extended by repetition ▪ Articulations are maintained as in the original cell ▪ Electronic voices focus on the first value ▪ The designated chord's fundamental is triplicated while other notes are duplicated

Table 2 Summary of first movement cell expansions.

Armonía de Una Estampa Inmóvil [Harmony of a Motionless Imprint]

The most elementally constructed section of *Noneto* is the second movement. The only assigned cell from the formula (number 10) lacks rhythmic changes, a characteristic that is easily recognizable in the movement. Furthermore, there is no melodic contour, which accounts for why there are no individual voices heard throughout the movement. Rather, this section is heard as a progressive cloud of sound. Finally, there are no chord changes in the formula as the entire movement uses the same nine-note pitch collection throughout. Hence, in this section there is a calculated evolution of the elements of music. Chord voicings are closely controlled in addition to texture, timbre and dynamics.

Voicing Plan

It is impossible to talk about a harmonic plan when the second movement features just one chord. What ultimately becomes important (and what creates compelling aural sensations) is the voicing of that chord, the use of different octaves, and the specific notes played by each instrument. There is a plan on how the movement's overarching chord is revealed. The movement's most salient characteristic is that each one of its nine voices never repeats a pitch. Therefore, all nine inversions always have a new instrument for each one of their notes, as shown below in Table 3:

	Voicing1	*Voic2*	*Voic3*	*Voic4*	***Original***	*Voic5*	*Voic6*	*Voic7*	*Voic8*
Ch1	F♯	C	B♭	G	**E**	E♭	B	D	A♭
Vln1	E♭	B♭	F♯	C	**A♭**	D	E	G	B
Ch2	D	G	E	A♭	**C**	B♭	E♭	B	F#
Vln2	C	E♭	A♭	B	**G**	E	F♯	B♭	D
Ch3	B	D	C	E	**F♯**	G	Ab	E♭	B♭
Vla	B♭	A♭	G	E♭	**B**	C	D	F♯	E
Ch4	A♭	F♯	E♭	D	**B♭**	B	C	E	G
Vc	G	E	B	F♯	**D**	A♭	B♭	C	E♭
Ch5	E	B	D	B♭	**E♭**	F♯	G	A♭	C

Table 3 Movement two, voicing plan.

Similar to *Noneto*'s previous movements, this voicing plan is not a rigid scheme. There are moments where the same note is heard twice—some voices exist in the previous voicing while others move on to the next voicing stage. At the beginning of the movement, the electronic voices produce the notes of the strings. In this case, priority is given to the improvisatory boxes, which are explained in detail below.

Improvisatory Boxes

In the improvisatory boxes, string players encounter a set of rhythms, pitch-collections and other indications to choose from. The main purpose of these boxes is to produce a controlled level of sonic variety.[8] Though the material given to the musicians strictly belongs to the harmonic and rhythmic movement of the area in which they are placed, they become new agents in the musical discourse. Their spontaneity allows them to rise above the thick texture in distinctive moments. Furthermore, they become thematic since the Max patch records these boxes and saves them for reproduction in future moments of the movement. Simultaneously, when they are played back on the loudspeakers, pure string timbres are revealed in all nine sources which consequently impact the overall timbre. After the original chord is played (3:01) the boxes recur individually at an accelerated pace. Additionally, while one electronic voice plays the three boxes in tandem (overlapped and in a louder dynamic), the accompanying voices' dynamics descend without a change in pitch. If the performer chooses to be active and expressive during improvisatory boxes in the first half of the movement, the second section retains a homophonic character. However, if the improvisation retained a more tranquil sensibility, this section will be heard as another cloud of sound.

There are three boxes per string player, each of which offers the same amount of rhythms and pitches to play. The first box features very slow rhythms and three notes, subsequently increasing the amount of material gradually until the last box which features faster rhythms and a maximum of five pitches. All boxes will last either 10, 15, 17 or 21 seconds.

Texture, Timbre and Dynamics

In a musical work with no traditional elaboration[9] secondary elements become crucial. Texture refers to the character of sound over time and is closely related to timbre. A key characteristic of texture concerns the makeup of a sound's timbral essence. The second

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[8] In a world of no evolution, steadiness, and repetition, the performance of live improvisation brings about a compelling performance as well as surprising elements.

[9] E.g. melodic development, chord and transposition progressions, rhythmic elaborations, etc.

movement balances texture (hence the resultant timbre) by initially controlling the articulation of voices overtime. With the exception of specific points where a drastic shift in timbre and texture is desired, movement two avoids articulating note changes at the same time on more than one voice. Therefore, the ear has a hard time identifying changes as they occur gradually. Secondly, timbre and texture are combined due to the types of sounds each voice uses. RESA modulation is used quite frequently here, which results in a natural and holistic sonic temperament.

Intensity is also an essential consideration in regards to texture. If dynamics are not controlled and efficiently arranged, the timbral blending between electronics and acoustic instruments can be compromised. Movement two maintains a dynamic plan which allows volume changes to occur in all nine voices simultaneously. The original chord materializes out of a slow crescendo from nunca to ***ff***, and then a decrescendo towards the end appears (Table 4).

Time	Dynamic
0:01 - 1:00	***pp***
1:01 - 2:00	***p***
2:01 - 2:30	***mp***
2:31 - 3:00	***mf***
3:01 - 3:14	***ff***
3:15 - 3:34	***mf***
3:35 - 3:41	***f***
3:42 - 3:49	***mf***
3:50 - 4:07	***mp***
4:08 - 4:15	***mf***
4:16 - 4:33	***p***
5:35 - 4:43	***pp***

Table 4 Movement two dynamic plan.

These may be considered “arrival dynamics,” as all transitions between such dynamics occur via sustained crescendos and diminuendos.

Estampa de un Volar Complejo [Imprint of a Flying Complex]

As most of the procedures concerning the aforementioned movements are similar in terms of harmonic plans, the usage of the designated chords, and melodic and textural elaborations, I will now focus on describing some ancillary extension procedures applied to the formula in this last movement (procedures are also used on the other two movements).

The final movement has two important conditions concerning the construction of its formula. First, it uses the second half of the main formula — cells 11 until 19. Second, the overarching musical form may be interpreted as the classically oriented theme and variation; the formula receives four different extensions (variations) throughout the movement which always begin from cell eleven and end at cell nineteen.[10]

Slurring as Numeric Code

Shown below is the elaboration of the first cell in all four variations:

Fig.16 First cell of movement three (eleventh cell in the main formula).

The above cell shows a rhythmic pulse stream with no variation. This pulse stream is a clear characteristic of all of variation four's openings (found in rehearsal letters A, I, Q, and V). Additionally, the cell features slurred groupings of the 28 sixteenth notes present in seven uneven groups that display 7, 6, 5, 4, 3, 2, and 1 notes per unit, with each grouping containing a soft accent on the first note.

These groupings and accents become key elements in all four elaborations of this cell throughout the movement. Ultimately, the slurring presents a numeric code (7, 6, 5, 4, 3, 2, 1) which is explored differently in all four variations as follows:

[10] Although some cells in the last two variations are not elaborated, they gradually become free from all processes mentioned on this document.

Variation No	Between beats	Processes used

1	0:01-0:45	- The pulse stream of 16th notes is set throughout the section.
		- Accents on the pulse stream follows the numeric code which repeats nine times throughout the section.
		- In every repetition the last group is eliminated, and some groups repeats, as follows:
		    o 7, 6, 5, 4, 3, 2, 1
		    o 7, 6, 5, 4, 3, 2 (repeated twice)
		    o 7, 6, 5, 4, 3
		    o 7, 6, 5, 4
		    o 7, 6, 5
		    o 7, 6 (repeated twice)
		    o 7
		- Voices enter one at the time on a new accent after the aforementioned process (which started on Vln1). Once begun, the new voices join to the process described above.
		- The pitches used are from the designated chord.

2	2:59-3:19	- The pulse stream of 16th notes is set throughout the section on six voices, while the other three voices play in designated accents.
		- Accents on the pulse stream follow the inversion of the numeric code which repeats seven times through the section.
		- In every repetition the last group is eliminated, as follows:
		    o 1, 2, 3, 4, 5, 6, 7
		    o 1, 2, 3, 4, 5, 6
		    o 1, 2, 3, 4, 5
		    o 1, 2, 3, 4
		    o 1, 2, 3
		    o 1, 2
		    o 1
		- Melodically, all six voices use exact same sequence of pitches shown in the cell in each of the repetitions. However, they begin from different points and move from left to right or right to left. In a new repetition they obtain a new starting pitch.
		- Harmonically, the three middle voices play notes from the designated chord, from two notes at the beginning (in different combinations of the five) up to the full five at the end.

3	5:13-5:32	- Contains a texture of three voices (Vln1, Vln2, Vla) against six. - Each of the three voices take a section of the cell (Vln1 first, Vln2 second, Vla last) in tandem. - The length of this section (the amount of notes which are played) is shortened following the numeric code including a tail of three repetitions of the last note: o 7, 6, 5, 4, 3, 2+1 o 6, 5, 4, 3, 2+1 o 5, 4, 3, 2+1 o 4, 3, 2+1 o 3, 2+1 o 2+1 - The starting points of these melodies shift in each new repetition. Eventually each starting point transposes and inverts the direction of the melodies. - The other six voices reinforce beginning and ending points by playing chords with a similar process than the one mentioned above in cell 2.
4	6:44-7:17	- A pulse stream of 16th notes is set throughout the section. - Accents on the pulse stream follow the numeric code which repeats nine times throughout the section. This pulse stream is the mirrored version of variation 1. - In every repetition a new value is added: o 7 o 7, 6 o 7, 6, 5 o 7, 6, 5, 4 o 7, 6, 5, 4, 3, o 7, 6, 5, 4, 3, 2 o 7, 6, 5, 4, 3, 2, 1 - All of the voices play this process together, and in some of the accents one or two randomly selected instruments play an ornament consisting of four 32nd notes. In other accents a scale is played in the following repetitions with the goal of finding new stationary pitches. - Some pitches are related to the designated chord in every accented pitch change, whether by octaves or by changing to other notes. When a scale is played the new stationary pitch may or may not belong to the designated chord.

Table 5 Cell 11th numeric code application.

Rests and Notes as Sequences

Another notable process in *Noneto* is counting rhythmic values and extracting sequences. At distinct points, beats are grouped according to where their values were extracted from, either rhythmic values or rests. In this movement, beat counting has been applied clearly to cell number twelve. This cell is quite simple as it displays a dotted 8th rest and a 16th note:

Fig.17 Second cell of movement three (twelfth cell in the main formula).

The extracted sequence is quite simple: 3-1, three rests, one note. This sequence is further expanded as follows:

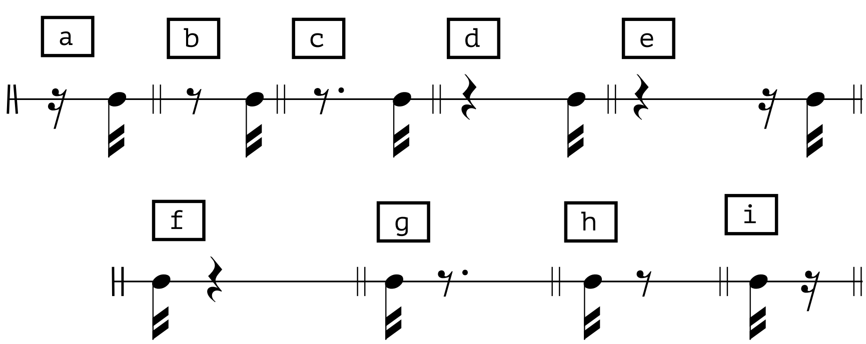


Fig.18 Rhythmic extension of cell 12 used on the third movement.

Hence, a new sequence is formulated: a:1-1, b:2-1, c:3-1, d:4-1, e:5-1, f:1-4, g:1-3, h:1-2, i:1-1. This sequence is subsequently used with diverse approaches to all four elaborations of cell twelve in the rhythmic realm of the variations, including ancillary harmonic, melodic, and articulation processes:

Variation No	Between beats	Processes used
1	0:46-0:56	- The extended sequence is played as shown in Fig. 18 from left to right by all the instruments starting from different letters: Vla starts at *a*, Ch3 in *b*, VlnII in *c*, Ch4 in *d*, Ch2 in *e*, Vc in *f*, VlnI in *g*, Ch5 in *h*, Ch1 in *i.* - The melody follows the same procedure with a symmetric series of notes which are extracted from the designated chord: D-F-F♯-G♯-B♭-G♯-F♯-F-D, where B♭ is the pivot central pitch. - All instruments begin this series from a different note and follow it from left to right. - Consequently, a series of articulations are notated in this series. Each voice begins this series from a different articulation and follows the series left to right: ***sfz*** > · *pizz* *normal* or *arco* – ***sffz*** >̣ ***p***
2	3:19-3:29	- Rests shown on the extended sequence become audible by the correspondent subdivision of the values in 16th notes (played staccato). - The audible 16th note value in the extended sequence acquires an accent during the variation. - The extended rhythmic sequence is played individually by each voice, following a specific order shown below — (r) is the retrograde motion of the letter: b, c, d, e, e(r), d(r), c(r), c(r), b - The melodic process is the same as variation one.
3	5:34-5:43	- The rhythmic sequence is the same as variation two, with occasional elaboration (a value of 7 is added, hence the order of the patterns is shortened). - All individual staccato marks in variation two became a legato phrase, while the accent on the first beat is left untouched. - Melodies are built in an ascending movement following the mode, beginning each time on a different degree of the designated chord. - The top three voices play a new passage in counterpoint (no relation with the cell or its extension). - The bottom three voices play the rhythm and chords of variation one with the same accented staccato articulations.
4	7:18-7:28	- Consistency is the dominant element of variation three, keeping the idea of descending melodies on the strings as they simultaneously duplicate rhythmic values. - There is no track of sequences, but the material is inspired on the sonority provided by sequences. - Electronics maintain the 16th note pattern with individual ascending and descending movements. Every starting point of an ascending or descending melody contains a note of the designated chord. All subsequent notes are the notes of the mode.

Table 6 Cell 12 rhythmic extension usage.

Other Transformations

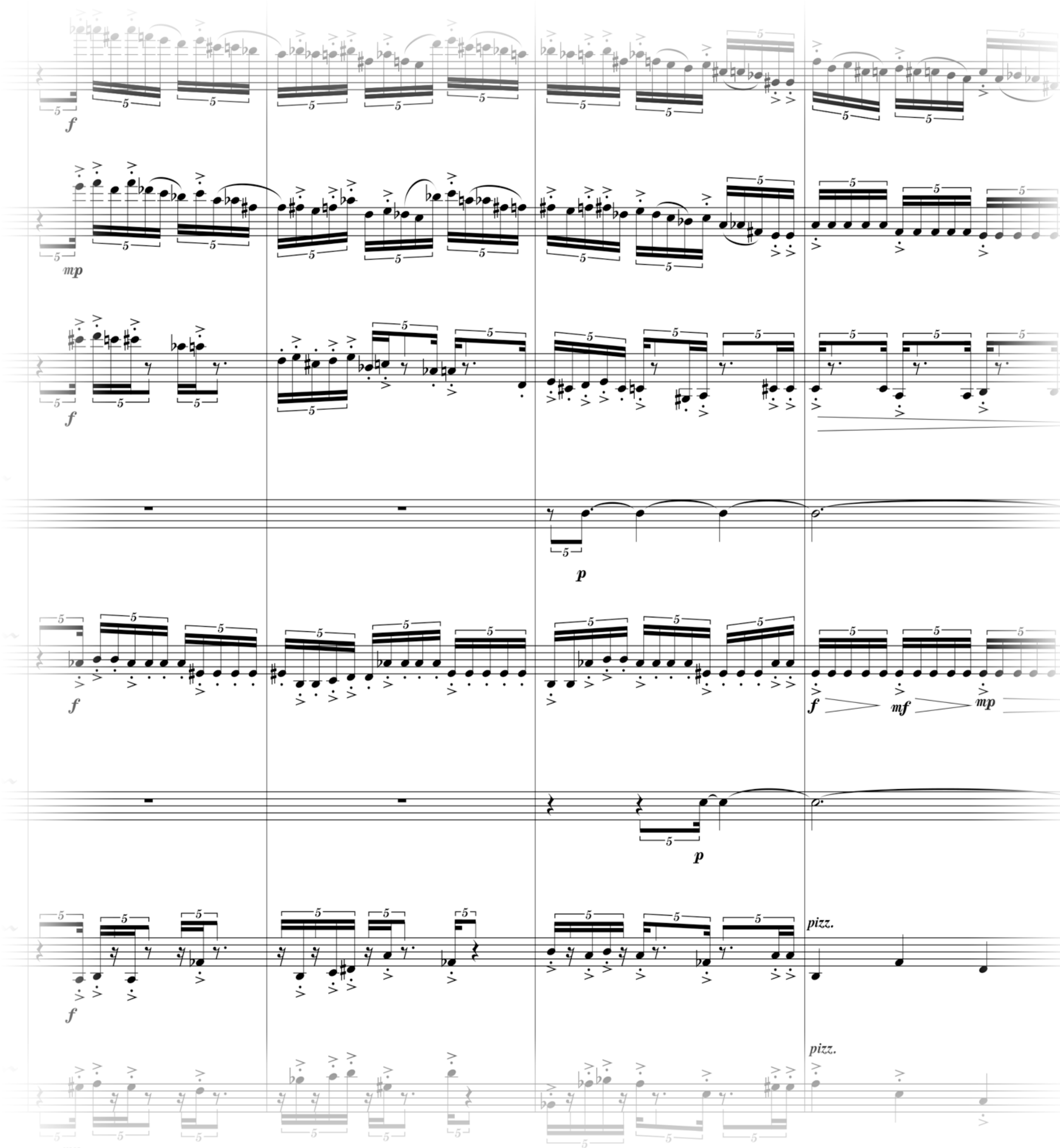
Cell elaboration is based on several processes. As heard from the beginning, this movement is based on a perceivable, fluctuating beat with a distinctive metric organization. *Noneto*'s procedures encapsulate a beat stream-based musical methodology which shifts over time. The accents shown in the cells function as a base to build new rhythmic patterns in the elaborations, thereby reinforcing *Noneto*'s underlying beat-stream methodology. An ideal example of this process is found on the second half of cell fourteen (14 notes accented in every 1, 2, 4, 5 and 2 notes), here the accented notes in the formula define an irrational time signature in the piece (beat 1:29):

Fig.19 Accents series transformed in time signature, explorations.

The third movement features unexpected metronomic shifts which are ultimately formulated from analyzing the cells' metric tendencies and exploring their embedded metric subdivisions. While some cells display binary rhythms, others demonstrate a ternary subdivision. Furthermore, many cells exhibit irregular rhythms with uneven accents, while others have varying degrees of speed:

a. Binary to ternary shift.

b. Irregular rhythms with uneven accents.



Measure 78

Measure 81

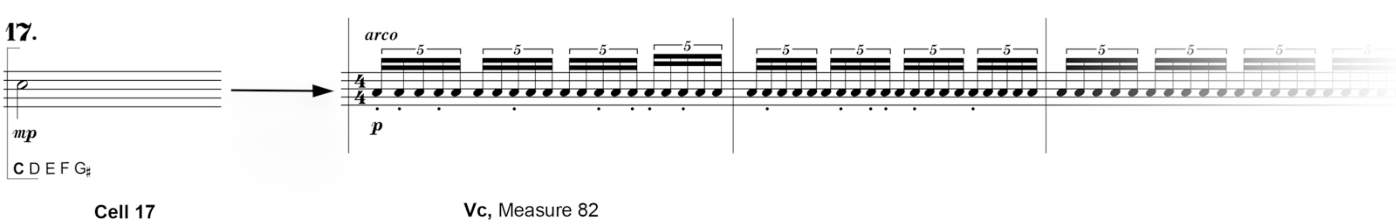
c. Written rallentando.

Fig.20 Examples of metronomic and rhythmic variations.

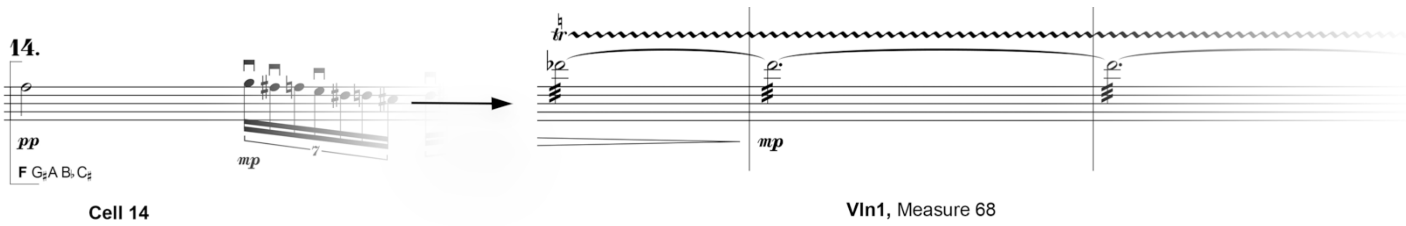
At various points in this last movement this feature is mixed together, thereby creating polyrhythms within the same cell, as shown at rehearsal letter H (beats 2:31 - 2:54).

To maintain the character of the movement, several sustained pitches in the cell become repeated notes, tremolos, unisons, or alternately notated rhythms, hence relating to the "motion of the static" approach:

a. From held note to rhythmicized repetition.



b. From held note to trilled and tremoled figures.



c. From trilled held note to written and accented values.

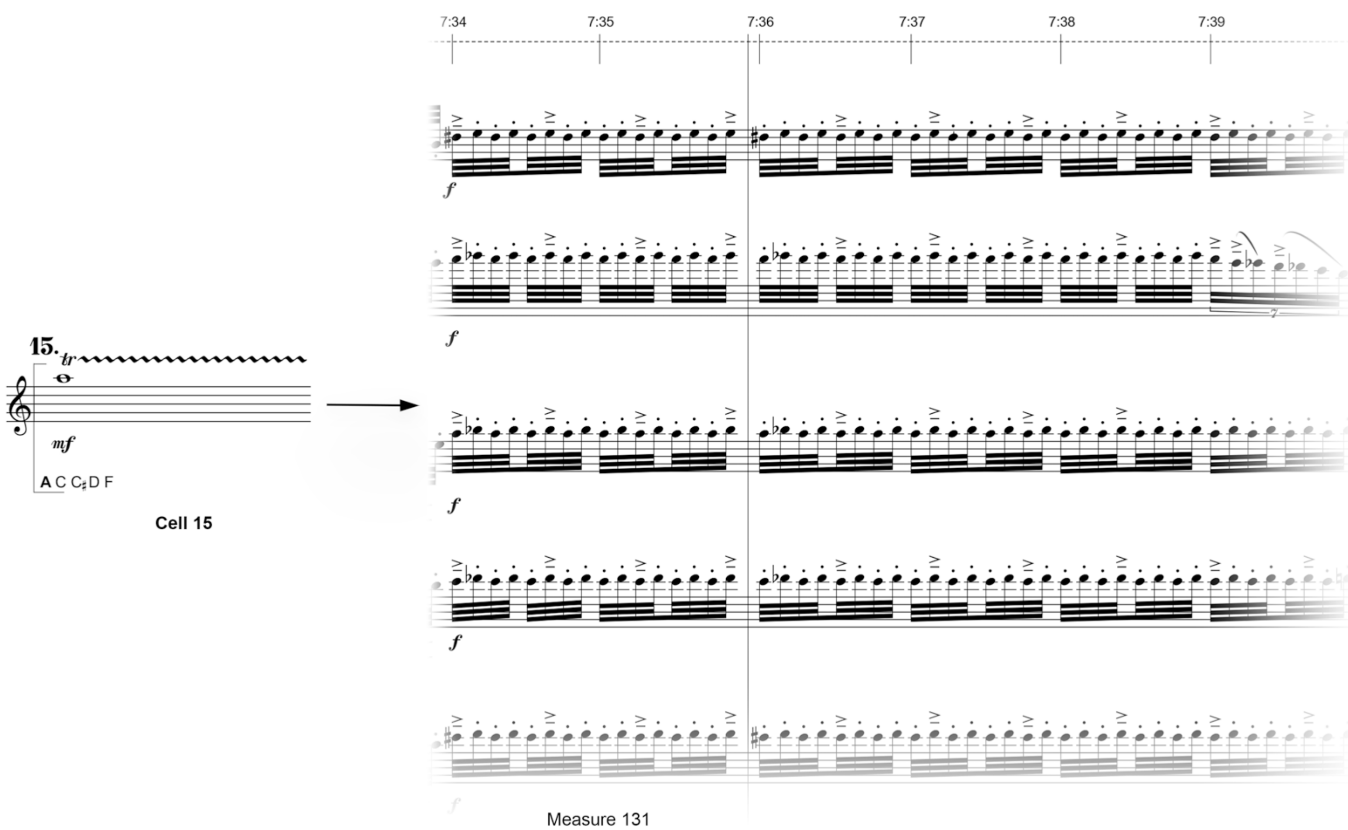


Fig.21 Examples of "motion of the static."

The last movement maintains a distinctive elaborative freedom. Movement one is based solely on the subformula, and movement two follows a strict voicing plan. Movement three instead ignores some cells and elaborates material resultant of a previous elaboration, furthermore adding free material that coexists and complements its rigid process. This is explicitly shown in the ending of the third variation and throughout the entirety of the fourth variation.

CHAPTER 3 – Software

Noneto's performance relies on music software which controls functions like score playing, buffering, synchronization, sound synthesis, etc. This software was developed in the hopes that I might integrate it into future compositions. The software was fully coded in the programming environment Max 8 (Cycling 74, 2020) and may be divided in two main parts. First, there is a section in charge of creating the timbre, voices, and sound processing of the five channels present on-stage. Secondly, there is a portion of the software that carries the performative tasks which align with *Noneto*'s musical score (e.g. notes to be played, sections to be buffered, etc.) and human-machine synchronization (e.g. global tempo, clock display, intensity control, etc).

Computer Voices

In this first section, I focus on the computational processes involved in *Noneto*'s sound design in relation to the computer's five channels. *Noneto* carefully develops a coherent global sound—the quality of the timbre of the piece is built by combining acoustic instruments and electronic sounds. In designing the electronic voices, I have created organic sounding notes by building harmonic content on top of fundamental tones similar to the ones produced by acoustic instruments. This is achieved by using a software program I designed entitled *ReDo synth* (Arnáez 2020). *ReDo synth* offers its users the option to switch between two modulation methods: RESA modulation and double modulation. ReDo synth also features traditional synth parameters like a flexible ADSR amplitude curve, a noise generator, and variable vibrato and tremolo effects.

RESA (Resynthesized Sound Amplitude) Modulation

This particular amplitude modulation technique has the characteristic of using a simplified sample of a sound as a carrier which is initially captured in live performance. The sound spectrum of this carrier becomes remarkably rich, and the amplitude modulated result keeps the original sound's timbral characteristics while it augments its sonority electronically.

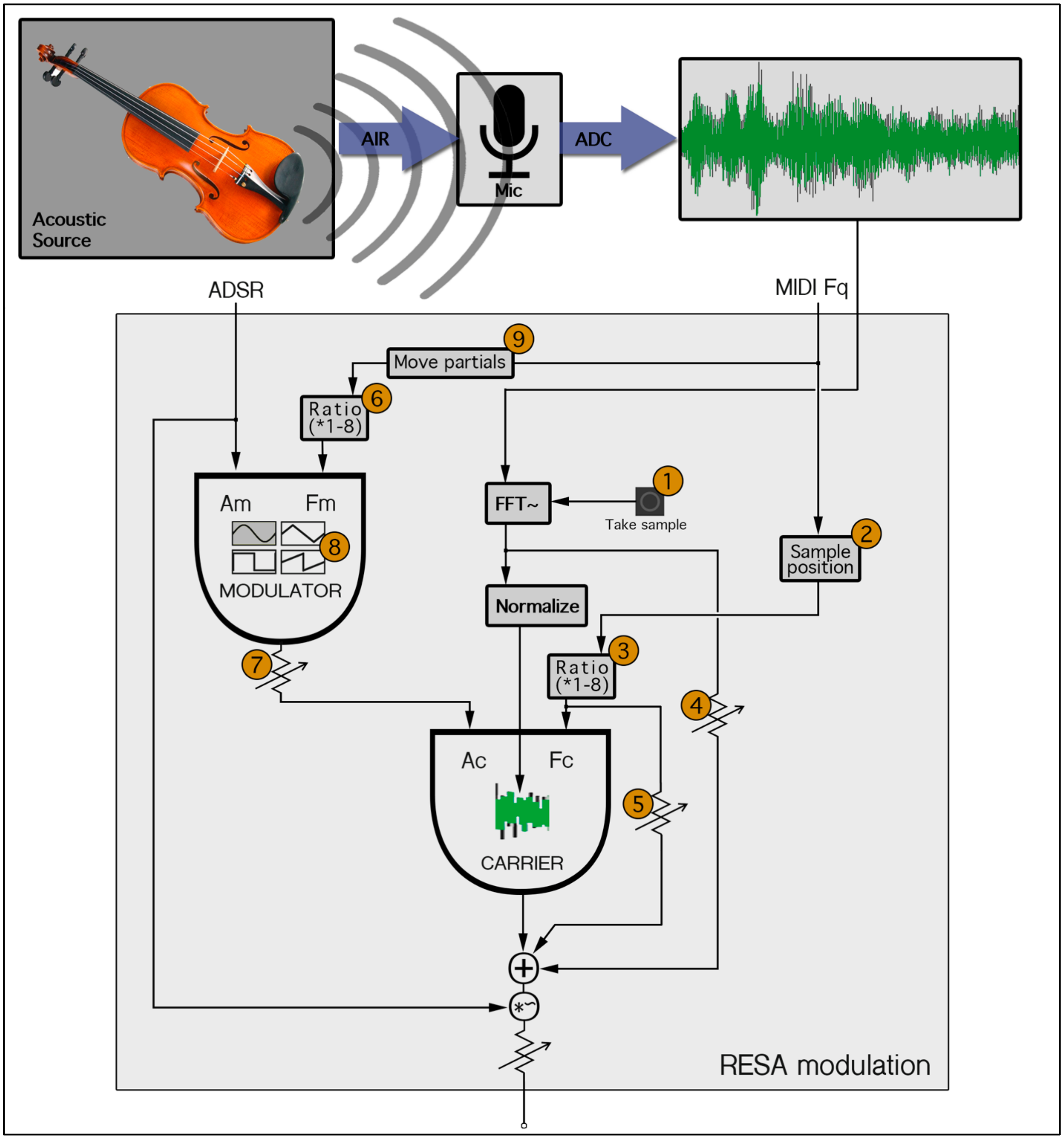


Fig.22 RESA modulation structure.

The functioning of RESA modulation is simple and effective. As shown in Fig. 22, a sample of the live input is captured live via a microphone, and the simplified reconstruction of the acoustic sound is carried by an external abstraction based on an FFT re-synthesis technique developed by French composer Jean-François Charles, as explained on his article *A Tutorial on Spectral Sound Processing Using Max/MSP and Jitter*. The Max abstraction in Charles' piece resynthesizes one spectral frame of live sound constantly (100). This resynthesized sound is treated as an oscillator which becomes the carrier of a malleable synthesis process. The carrier's amplitude is modulated by a second oscillator. As with all AM, two (or more) sidebands are added to each harmonic of the original sound. Furthermore, the position, intensity and frequency of these sidebands are controllable by the user. RESA modulation's GUI offers diverse controls for changing different sound parameters within the synthesis processes in order to mold the sound to the user's sonic taste (Fig. 23).

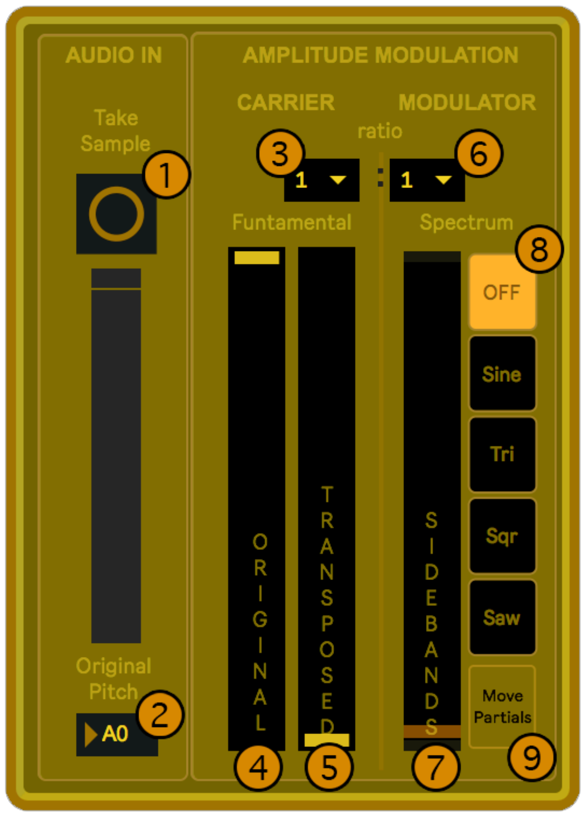


Fig.23 ReDo's RESA modulation graphic user interface.

As shown in figures 22 and 23, the numbers in orange circles represent the controls the user can manipulate:

AUDIO IN section:

1. *Take Sample* (bang): Click to take the sample of the incoming audio signal (carrier)
2. *Original Pitch* (MIDI box number): Once the sample has been taken it may be placed in the correct note and register, then it is mapped to the full MIDI keyboard (the patch will automatically transpose the sample to the proper frequencies)

AMPLITUDE MODULATION section

CARRIER:

3. *Ratio* (pop-up menu): Defines the pitch of the original sample (carrier) following the harmonic series: 1 is the original pitch, 2 is the second harmonic (octave), 3 is the third harmonic (octave plus a fifth), etc
4. *Fundamental – Original* (slider): Controls the audible level of the original grain in the resultant sound
5. *Fundamental – Transposed* (slider): Controls the audible level in the resultant sound of the grain after being transposed by the Ratio control

MODULATOR:

6. *Ratio* (pop-up menu): Defines the pitch of the modulator following the harmonic series: 1 matches the pitch of the carrier, 2 duplicates the pitch of the carrier, 3 is an octave plus a fifth, etc
7. *Spectrum – Sidebands* (slider): Defines the intensity of the sidebands
8. *Spectrum – wave selector* (tab): Allows the user to choose the waveform of the modulator: e.g. sine, triangle, square or sawtooth wave
9. *Spectrum – Move Partials* (button): When turned on, this button activates a randomizer in charge of creating frequency sidebands' slight shifts. This parameter should be active when a more natural-like sound is desired

In *Music for Solo Performer* (1965) by Alvin Lucier, a musician wears a brainwave sensor that reads in real-time the alpha waves produced by the performer's brain, and the subsequent signals are sent to loudspeakers which are placed over percussion instruments. The percussion instruments vibrate either by being hit by the loudspeakers or by the movement of air particles (Rusche 2012). In the case of this piece, I understand the interaction to be somewhat involuntary since the performer does not have complete control of their brainwaves. With *Music for Solo Performer*, I find a correlation to my RESA modulation procedures in that the string players do not know precisely when a sample of their sound is resynthesized by the computer. I understand this as a music performance variation of the computer voice since the different musical interpretations of the string players also become different interpretations of the loudspeakers. The live sampling aspect of *Noneto* guarantees that no two performances of the work will sound exactly the same.

Double Modulation

The second modulation method seen in ReDo synth is called *double modulation*. In this case there is no live input other than four oscillators, which ultimately results in a purely digital synthesis. One of these oscillators act as a carrier and the other three act as modulators of that carrier. This method is unique in that the user can set each one of the three modulators to modulate the carrier's amplitude, frequency, or both of these parameters simultaneously. As shown in Fig. 24, the outputs of the modulators are summed together before arriving at the carrier.

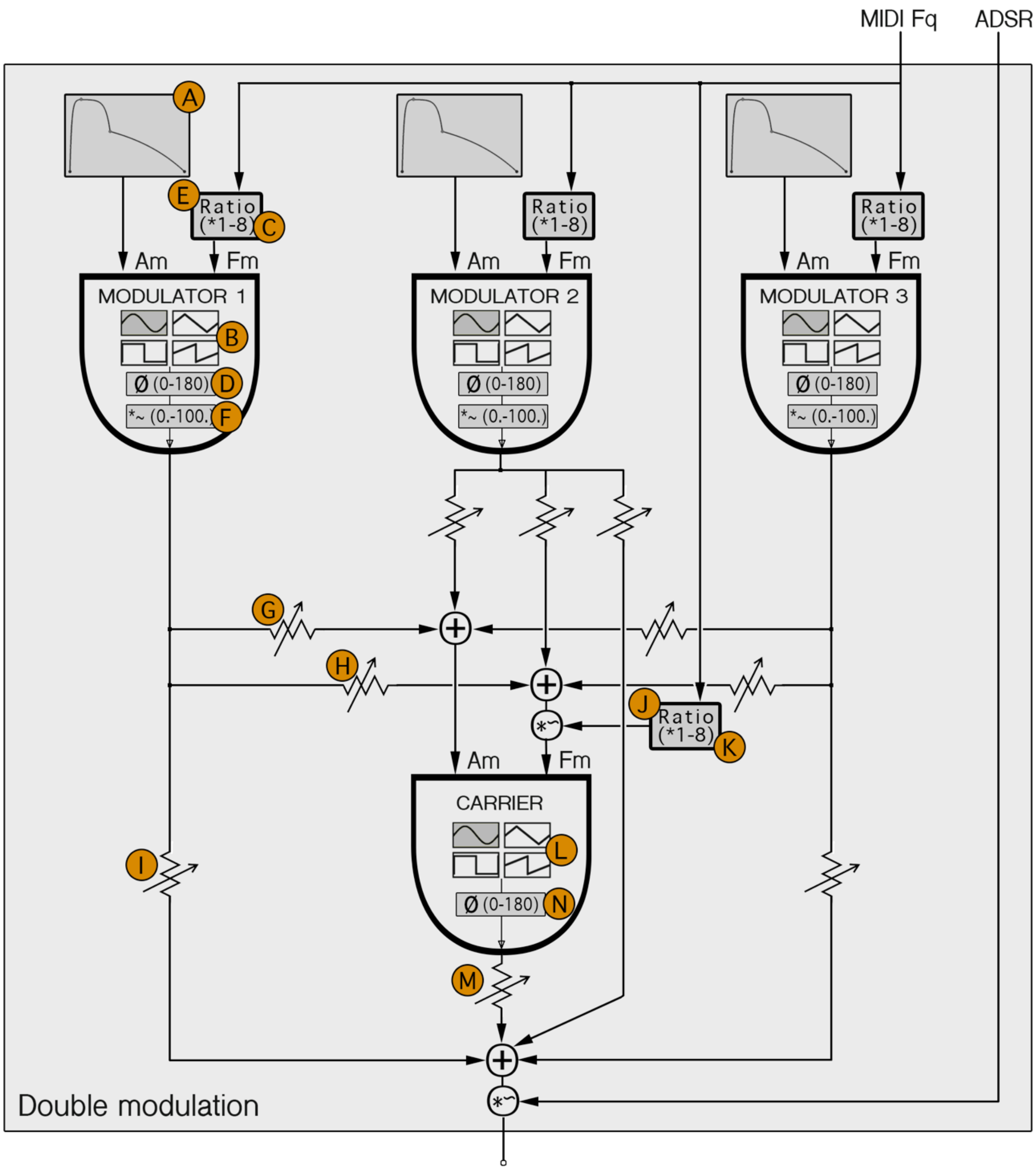


Fig.24 Double modulation structure.

The GUI of this second type of modulation displays several control knobs and sliders which are able to produce a large variety of harmonic and inharmonic sounds. Figures 24 and 25 lists the controls of only one modulator (letters A until I), with the remaining modulators retaining identical parameters.

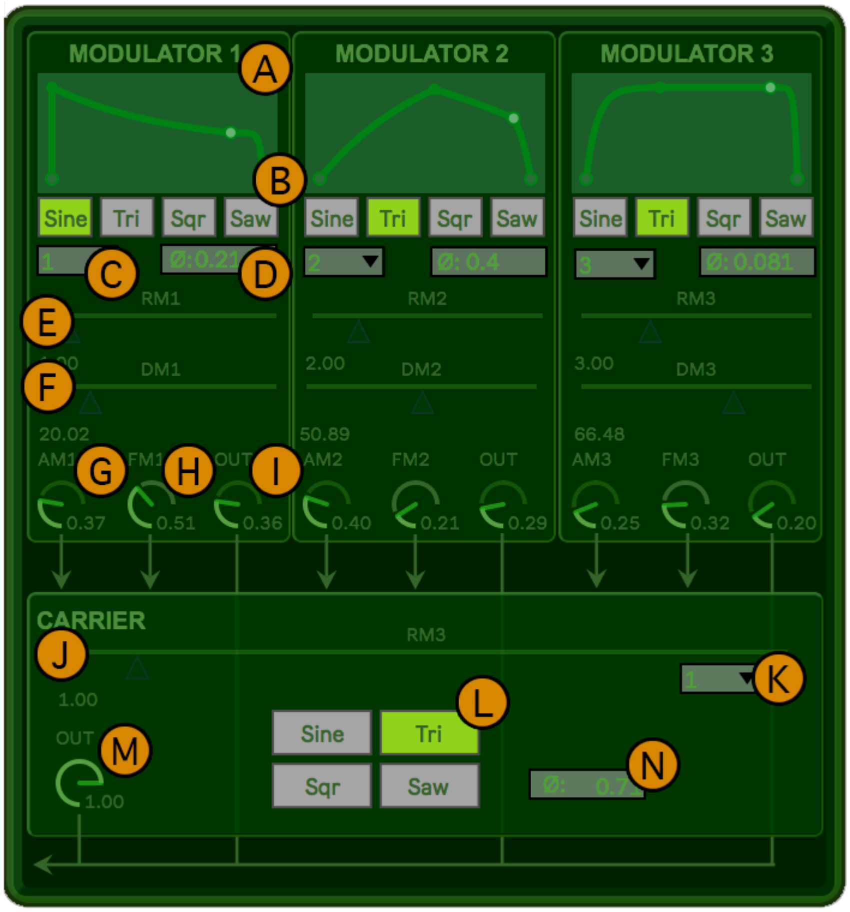


Fig. 25 ReDo's double modulation, graphic user interface.

- MODULATOR:

A. *ADSR* (function): Defines attack, decay, sustain and release of the modulator. The total time length preassigned in the X axis is 3000ms. To create curved lines the user can hold the "option" key ("ctrl" in Windows computers) before clicking the line, and then drag the mouse up or down

B. *Spectrum – wave selector* (tab): Allows the user to choose the waveform of the modulator which may be a sine, triangle, square or sawtooth wave

C. *Ratio* (pop-up menu): Defines the pitch of the modulator following the harmonic series: 1 matches the pitch of the carrier, 2 duplicates the carrier, 3 is an octave plus a fifth, etc
D. *Phase* (float number): Defines the starting point of the selected waveform
E. *Free Ratio* (slider): Allows the user to choose non-integer ratios for the modulator
F. *Deviation* (slider): When using frequency modulation this slider allows the user to control the amplitude deviation of the modulator (which is capable of amplifying up to 100 times the amplitude)
G. *Amplitude Modulator* (knob): Controls how much amplitude modulation is applied to the carrier
H. *Frequency Modulator* (knob): Controls how much frequency modulation is applied to the carrier
I. *Out* (knob): Controls how much of the modulator (selected waveform in B) is heard in the resultant sound

- CARRIER:

J. *Free Ratio* (slider): Allows the user to choose non-integer ratios for the carrier
K. *Ratio* (pop-up menu): Defines the pitch of the carrier based on the program's established harmonic series: 1 is the original pitch, 2 is the second harmonic (octave), 3 is the third harmonic (octave plus a fifth), etc
L. *Spectrum – wave selector* (tab): Allows the user to choose the waveform of the carrier, which may be a sine, triangle, square, or sawtooth wave
M. *Out* (knob): Controls how much of the carriers' modulation is heard in the resultant sound. (this knob does not change the intensity of the modulators' output levels (letter I)
N. *Phase* (float number): Defines the starting point of the selected waveform

Expressive Controls

After the synthesis modules, ReDo synth sends the processed audio to three units in charge of shaping, tinting, and humanizing the resultant sound. This is achieved by adding sonic details to the designed voice. It is important to mention that these modules are shared by both RESA and double modulation (Fig. 26).

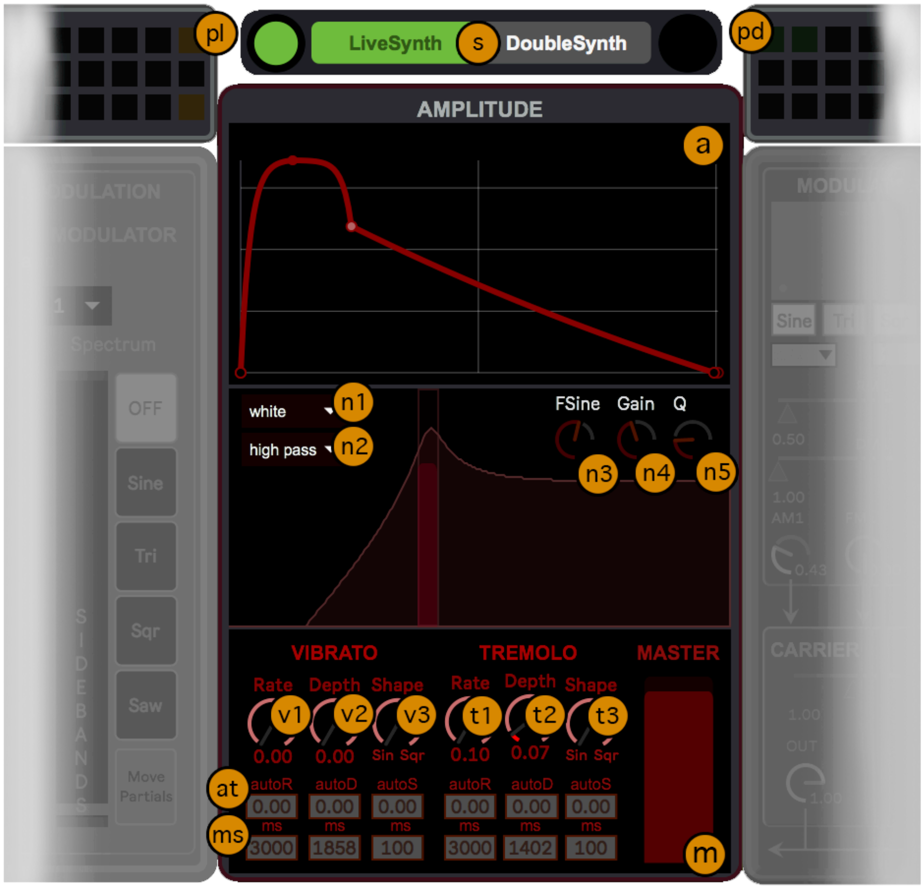


Fig.26 ReDo's expressive controls graphic user interface.

The first module is an ADSR amplitude control (Fig 26, a). Here, the user can shape the attack, decay, sustain, and release of the synthesised sound by clicking and dragging two interactive dots left to right and top to bottom. By default, the lines created between dots are straight lines, yet they may also be curved by clicking and holding the "option" key ("ctrl" in Windows computers) and moving the mouse up (for concaved curves) and down (for convex curves).

Once the sound has achieved its amplitude feature over time, a noise generator appears. This module attempts to mimic the non-pitched component of a musical instrument.[11] The noise generator presents the user with four types of *Noises* (Fig 26, n1) to add to the sound: "White," adds computer generated white noise; "Bow" adds an acoustic sample of a bow sliding over a string (non-pitched); "Blow," which adds an acoustic sample of an airflow recorded in the tube of a saxophone (also non-pitched); and "Pizz," which changes the ADSR to a pizzicato shape and

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[11] Such as the hissing of a bow over a string, the airflow travelling through the tube of a wind instrument, the hitting of a hammer on a piano string, etc.

triggers the a sample of an inharmonic pizzicato contour sampled from a cello. There are several recordings of each one of the acoustic noises, each of which are randomly chosen for every note created in ReDo synth. The need for multiple recordings is to avoid sample repetition, thereby achieving an unnatural sound. Next to the noise generator is a parametric equalizer which may (optionally) filter the chosen noise via four different *Filter Types* (Fig. 26, n2): low pass, high pass, bandpass, and resonant[12] filters. There are two controls for these curves, one for the *Gain* of the selected filter (n4), and another for the filter's *Q* ratio (n5). The cut off frequency of each filter is always the fundamental frequency of the pressed key. A special knob shows up when the RESA modulation is being used, known as *FSine* (n3). This knob controls the level of a sinewave that ReDo places on top of the selected pitch (the frequency of the pressed key), which ultimately reinforces the sound of the fundamental harmonic.[13]

The last module adds controllable frequencies and amplitude cyclic variations which emulate vibrato and tremolo. On the frequency realm the user may alter the following:

v1. *Rate* – adjusts the speed of the vibrato (from non-vibrato to 10 times per second)
v2. *Depth* - controls the amount of frequency deviation (form 0. until +-0.125 Hz)
v3. *Shape* - adjusts the vibrato's oscillation type (from a sine wave to a square wave and steps between these)

The three following knobs control amplitude cycling changes, which allow the user to change:

t1. *Rate*, intensity change times per second (from 0 until 20 hz)
t2. *Depth,* from where these variations start (0 is no variation and 1 is from no intensity to full intensity)
t3. *Shape,* adjusts the tremolo's oscillation type (from a sine wave to a square wave and steps between these)

Vibrato and tremolo may be manipulated in two ways: 1) by simply moving the correspondent knobs to the desired position thus immediately triggering frequency and amplitude variations every time a key is pressed; and 2) the user can set them to slide automatically from

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[12] In Max 8, a resonant filter is a bandpass filter with constant skirtwidth.
[13] Depending on the sound source, its intensity and mic positioning sometimes the resynthesized sample does not plays the fundamental pitch of the sound with enough loudness, then this feature helps boosting it, if needed.

zero until a desired point, in a certain amount of time, and every time a new key is pressed. If the second option is chosen, the user must first define how far the knob will be set at the end of the slide by clicking and dragging the correspondent number box (marked as “autoX”. Fig 26, at) and then selecting how much time it will take the knob to reach the determined value (in the box marked as “ms”). Every time a new key is pressed these knobs will move automatically to the selected point in the selected amount of time.[14] The last control presented here is the master volume (m).

The top of ReDo’s interface features a switch to change between RESA modulation and double modulation (Fig.26, s). There are also preset slots on both sides for saving RESA modulation presets (left side orange, pl), and double modulation presets (right side green, pd). In a normal work flow, users will first design their sounds by interacting with knobs, sliders, box numbers, and curves. Once they achieve a satisfying result, they can save these settings in the preset area by holding the “shift” key and clicking on any of the designated slots. To recall a saved sound the user may simply click on it or send the correspondent MIDI message via an inlet (see the Communication Protocol, Inlets & Outlets section below). In order to delete a saved slot, the user must click and hold “option” and “shift” before clicking the saved slot. There are up to 60 slots for each RESA and double modulation presets.

Modulators, synthesis techniques, intensity envelope controls, and ratios can be freely defined according to the timbral needs of the musical passage. As with every synthesizer, sounds are mapped to all notes in all registers (typically with the extension of an 88 key piano layout) where polyphony, sensitivity, and post-synthesis effects are added after the initial sound is designed.

Fluctuations

Computers are very efficient when it comes to live performance. Compared to humans, computers can create a precise pattern of rhythms where the rigidity of time is easily identified by human ears. Hence, the accuracy and perfection demonstrated by computers in a musical performance is often seen as something negative, fake, devalued, and even unmusical. (Hennig et al. 2012). Musical appreciation and the scientific analysis of human performances helped us understand that for listeners to adopt positively music it must contain time incurrences and pitch deviations (Keil 275, 1987). This in fact also applies to note lengths, dynamics, phrasing, etc.

[14] This feature is inspired by human performance, as performers often begin a vibrato and tremolo from non-fluctuation and gradually add the corresponding variations.

In *Noneto*, I have added several pieces of code which are in charge of perpetually randomizing numbers, thereby imitating humanistic nuances in musical performance, such as slight variations in pitch, rhythmic inaccuracies, and dynamic fluctuations. These randomizers are ongoing trigonometric functions running in different speeds and depths amongst them, every time a new note is played, the function will shift slightly a precise given action. I.e. when a frequency of 440Hz is requested to be played by an oscillator, the code will modify that number slightly (i.e. 441, 439.7, 440.2, and such), since the code runs freely, every new request of the same value will be different. These minor variations have been applied in every part of the code which results in something audible by the human ear, e.g. the oscillators' frequencies (modulators, carriers, ratios, equalizers' cut-off frequencies, etc.), the oscillators' intensities (ADSRs, amplitudes, velocities), etc. Ultimately, these pieces of code are extremely important for achieving a decent, realistic musical timbre as well as a compelling performance from the computer.

Communication Protocol, Inlets & Outlets

ReDo is a MIDI based synthesizer — it receives specific MIDI messages for specific functions following the standardized MIDI message format (MIDI Manufactures Association, 2020). As shown below in Table 7, it understands note messages (note on, note off, velocity) and some Control Change Messages:

Control Change Nro	ReDo action	Values
CC7	Volume change	Single value: Volume level (0-127)
CC14	RESA modulation - Take Sample	Single value (127): Take sample Other values ignored
CC15	Recall saved preset	Single value: Go to preset No (1-64 RESA modulation presets / 65-127 double modulation)
CC20	Vibrato rate level	Single value: Vibrato rate level (0-127)
CC21	Vibrato depth level	Single value: Vibrato depth level (0-127)
CC22	Vibrato shape level	Single value: Vibrato shape (0-127)
CC23	Tremolo rate level	Single value: Tremolo rate level (0-127)
CC24	Tremolo depth level	Single value: Tremolo depth level (0-127)
CC25	Tremolo shape level	Single value: Tremolo shape (0-127)

Table 7 ReDo's list of MIDI control changes.

The data required to make RESA and double modulation work is input through ReDo's GUI interface which features five inlets, as shown in table 8:

Inlet Nro	ReDo action	Values
1	Synth On/Off	Single value: 0 off - 1: on, other values ignored
2	Note, velocity	Two value list: Pitch (0-127) - Velocity (0-127)
3	Changes on Expressive control	Two value list: CC number (0-127) - CC level (0-127)
4	Audio to sample	Live audio from a microphone
5	Take sample	Bang to take sample

Table 8 ReDo's inlets description.

Noneto features five parallel copies of ReDo. For a more controlled, organized and efficient performance I reverted to a lower level MIDI codification which necessitated using a MIDI implementation chart and five different channels for the resultant .mid file (three files, one per each movement). The full list of controls is shown in Appendix B.

ReDo synth uses MIDI note messages to perform, and these messages can arrive from several sources. One source (used in the performance of *Noneto*) is MIDI messages saved in a .mid file. The MIDI files used in *Noneto* were generated in the main program used to create the score, NoteAbility Pro (Hamel 2020). Once these files were created, they were modified and refined using two programs: 1) Logic Pro X (Apple Inc., 2020), in which all the automation data for CC MIDI messages were added following the music sheet's specific changes; and 2) Reaper, a popular digital audio workstation (Cockos Inc., 2020) in which all note velocities were adjusted and humanized.[15] Notes which have a specific articulation indication such as sforzato, staccato, marcatto, and legato were individually treated to represent a human performance as accurately as possible (e.g. shortening note lengths, changing velocities, overlapping the end of a note with the beginning of another note). Finally, concerning sustained pitches, the volume value (CC7)

[15] The beginning (note on) and end (note off) points of all MIDI messages were slightly modified by hand.

was humanized by drawing a slight up and down variation by the hand and by keeping NoteAbility's MIDI values for velocity as the average value:

ppp: 40	***pp***: 50	***p***: 60	***mp***: 70
mf : 80	***f*** : 95	***ff*** : 110	***fff*** : 125

Fig.27 NoteAbility Pro's MIDI velocities, used as such in *Noneto.*

Lastly, all unnecessary MIDI messages—such as program changes and text messages—initially created by NoteAbility and Logic Pro were eliminated in Reaper.

The second option to enter MIDI messages in ReDo synth is by connecting a MIDI keyboard to the proper input.[16] In *Noneto*, this method was used when designing the voice of each channel in each passage. I first connected a MIDI keyboard and began moving knobs and sliders until I found the desired sound, and subsequently saved the settings as a preset. These presets are recalled in *Noneto*'s performance automatically as they are embedded in the MIDI files of each movement (CC15).

In *Noneto*, ReDo synth is used in a special manner. Since there are five copies of ReDo synth running at the same time, the computer resources are used intensively. In order to mute unnecessary processes and control CPU consumption I separated ReDo's control area (GUI) and audio processing into two sections: a bpatcher (for control) and two poly~ objects (for audio processing). Therefore, ReDo's GUI in *Noneto* features a total of sixteen outlets which are connected to two poly~ objects, one which carries RESA modulation processing (outlets 1 to 6), and the other which processes double modulation algorithms (outlets 7 to 16). The public version of ReDo will feature just one outlet which will be the resulting audio (both poly~ objects will be built into the GUI's bpatcher).

Score & Control

Outside ReDo synth there is still a fair amount of code that helps *Noneto* become a musical piece. Interactions between human and computer elements becomes a key factor, which is explained in this second half of this chapter. There are two extra software modules in charge of

[16] This approach is also convenient for live performances and recording sessions.

performance, synchronization, and playability. These two modules carry specifics tasks, which are further explained below.

Interactivity

Human-machine interactivity has been a major element of my oeuvre since 2011. In *Noneto* the level of interaction between performer and machine is relatively low, yet the result of that interaction is unique and remarkable because of the entire ensemble's timbral result. In *Noneto*, the computer does not adapt to human performance as it does in pieces such as *Raggi di Stringhe* (2011) for violin and live electronics by the Italian composer Lara Morciano. In Morciano's work, the triggering of electronic processes is controlled by software Antescofo (IRCAM).[17]

Nevertheless, *Noneto*'s software is not simply a playback track. Rather, it is built over a MIDI score that processes sounds in real time (thereby allowing for easily achievable tempo changes). Playback tempo, dynamics, and other electronic processes are produced by the five loudspeakers which follow an internal clock. The resultant synchronicity is one-way (performers adapt to the computer's clock). In a performance this synchronicity is controlled by a Max patch operator which purposely manipulates tempo and intensity as needed; the operator listens to the live musicians. The presence of this Max patch operator has proven to deliver similar results to automatic processes of score following techniques. A significant example of this method of synchronization is demonstrated in *Heroes in the Seaweed* (2015) for Flute, Cello and piano by the Canadian composer Keith Hamel. *Heroes* is performed with a Max patch which receives data to start and stop electronic processes from the music notation software NoteAbility Pro while musicians play their traditional paper scores. Though the main synchronization happens between the two software programs, there is an operator monitoring timing between the performers and NoteAbility. The operator can alter the tempo of the sections as needed via a MIDI controller, thus ensuring synchronicity between the humanistic and virtual elements of the piece. This is the exact model that *Noneto* uses to maintain synchronicity between both of its sound sources, with the exceptions that it uses only one piece of software, which is in charge of all computer processes.

The rhythmic correlation between musicians and the electronics occurs specifically inside Max. To achieve this correlation, two pieces of code work together, which are the Transport and the BEAT control.

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[17] This software automatically distinguishes variables such as score position and tempo variations based on the musician's performance.

The Transport

Appearing as a bpatcher, the Transport is in charge of two main tasks. First, it displays the traditional controls found in all transports: start, pause, stop, and BPM changes. Secondly, it loads and sends five channels of MIDI information (notes and CCs messages) to the correct copy of the five ReDo synths in *Noneto*. In regards to its controls, Transport features the following layout and functions (Fig. 28):

Fig.28 Transport graphic user interface.

- **a.** *Transport,* "PLAY" for starting and pausing sequences, "STOP" for stopping and rewinding sequences to the beginning
- **b.** *START at…,* sets the performance at the beginning of any rehearsal letter shown in the score
- **c.** *Clock,* sets the score to begin from any beat in the score (the user can type in minutes and seconds using the computer keyboard)
- **d.** *GO,* sets the starting point (either chosen as a rehearsal letter or beat position). The Transport will load the requested data while the legend "WAIT" appears (no other

command can be entered while this legend is shown). Once it finishes loading it will display “READY.” For starting from that specific point, PLAY must be triggered

e. *BPM* will automatically set the movement’s tempo, which may be adjusted faster and slower by clicking and dragging up and down at any point before or during a performance
f. *reset*, if for any reason the Transport freezes, this button will reset all Transport controls back to normal

Once the user selects the movement to be performed (which occurs outside the Transport controls), the corresponding MIDI file is loaded into the Transport. Consequently, all rehearsal letters’ number values shown in the score are automatically loaded into the “START at…” area.

BEAT control

The BEAT control’s main purpose is to create the visual information necessary for ensemble synchronization. This is achieved using jitter in Max: the BEAT control creates a flying window that displays the current beat position of the transport. This window is then dragged to a larger screen which is placed in front of the ensemble (see chapter 5). BEAT control (Fig. 29) features the following controls:

a. *Timer:* currently displays the location of the Transport in the score. The timer ultimately mirrors what is shown in the flying windows; when numbers are red no music is to be performed (pre-count, or loading data), yellow numbers indicate the patch is ready to start, and white numbers appear when the performance is running
b. *Blink ON/OFF:* If Blink is on, the flying window’s background will blink white on specific beats to create a visual signal for the performers. If Blink is off, numbers will run with a permanent black background
c. *Blink option:* The user may choose if the blinking happens on every beat or at the first beat of each measure
d. *Blink length*: Controls how long the background holds white on the selected beats (the range is from 70ms until 600ms)
e. *Flying window:* Makes the flying windows appear or disappear
f. *Full screen:* When dragged to the attached monitor, the user can change the appearance of the timer to occupy the full screen by clicking this option (or by using the shortcut, which is pressing the key “ ` ”)

g. *Metronome:* Activates a built-in click sound which adjusts intensity. The sounding click is heard in channels 1 and 2.

Fig.29 BEAT control graphic user interface.

The sixth channel in *Noneto*'s MIDI files is in charge of controlling the running numbers shown on the screen (and consequently the entire synchronicity of the piece). Channel 12 has a note on/off MIDI message (value of a sixteenth note) per each individual beat of every movement. There are three different notes in Channel 12 (midievent 155) that the Transport sends to the BEAT control for regulating the timer:

- MIDI note 72: Counter reverse count (negative numbers counting before each movement).
- MIDI note 73: Counter measure on the first beat.
- MIDI note 74: Counter measures on following beats.

Click Tracking and Synchronization

Click-tracking has been an effective technique for synchronicity in works that combine electronic sounds with acoustic instruments. A great example of this is German composer Michael Beil's *Key Jack* (2017) for a pianist without piano, live video, and tape. The synchronicity needed for *Key Jack* is extreme as the piece features video buffering and processing that must be precisely coordinated with the live source in addition to an audio playback. Beil invites the pianist to use headphones with a click track for ensuring synchronicity throughout the performance (Beil 2017). My synchronization system may be understood as an expansion of click-tracking practices. In *Noneto*, a screen is positioned at the front of the stage and the Max patch automatically displays a timer (see below BEAT control). Together, all electronic processes (e.g. loudspeaker performances, timbre changes, buffering) and the functioning of this clock are embedded the aforementioned MIDI track 12 (Fig. 30).

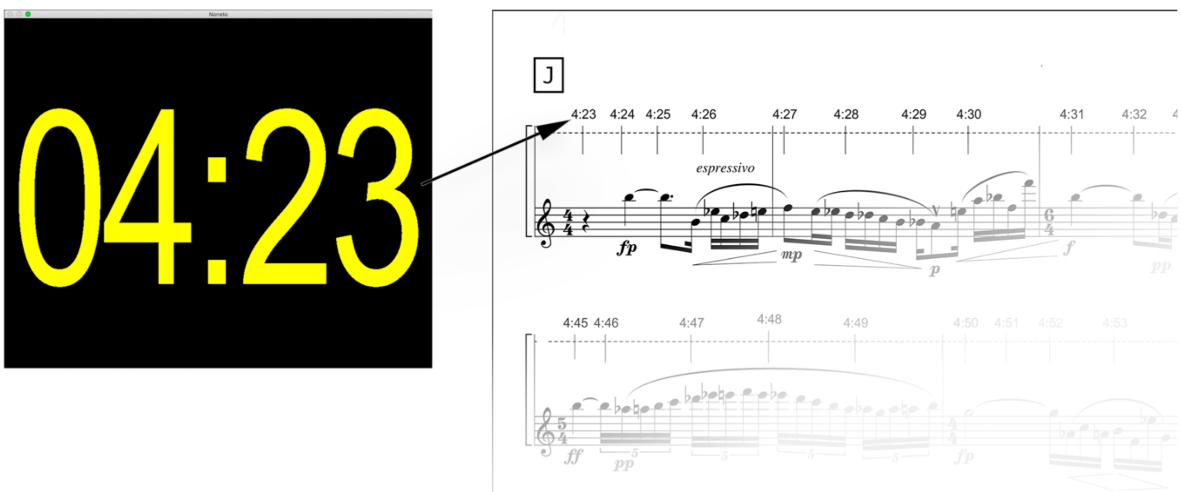


Fig.30 *Noneto*'s software timer and score time display.

The musicians' written parts contain a special staff line depicting the seconds of the timer (the performer must read their score while monitoring the clock on-screen). Simultaneously, the Max patch operator fixes timing shifts between the string performers and the electronic processes. I have had excellent results using this technique in my first string quartet *Sobre Cómo Pintar en el Tiempo* (2013), which featured an octophonic ambisonics system and a string quartet. Another successful integration of this procedure is found in *Emergiendo* (2016), my septet for violin, trumpet, clarinet, bassoon, trombone, double bass, percussion, female dancer and 5.1 sound system. In *Noneto* I have added some adjustable features to the timing clock that are further explained below. An audible click track can be routed to performers via headphones if needed.

Electronic Voices Usage

Throughout *Noneto*'s three movements, the five voices are meticulously controlled by this complex piece of software. I designed *Noneto*'s software over many months, and I believe I have constructed a reliable and effective system for controlling and manipulating distinctive musical nuances capable of replicating the performances of human musicians. The following table shows a detailed list of the computer voices used in *Noneto* (first movement - channel 1, for a full-length table please visit Appendix B):

Channel No.	Preset recalled at BEAT No	Preset number recalled	Synthesis used	Take sample at	To play between beats
1	-7	65 (1)	Double	-	0:01 - 0:07
	0:36	66 (2)	Double	-	0:37 - 0:49
	0:50	1	Live	0:32	0:51 - 1:30
	1:33	67 (3)	Double	-	1:34 - 2:28
	3:46	2	Live	3:44	3:47 - 4:20
	4:23	68 (4)	Double	-	4:24 - 5:28
	5:31	69 (5)	Double	-	5:32 - 5:53
	5:55	70 (6)	Double	-	5:56 - 7:07
	7:08	71 (7)	Double	-	7:08 - 7:16
	7:18	72(8)	Double	-	7:19 - 7:25
	7:26	73 (9)	Double	-	7:26 - 7:52
	7:53	74 (10)	Double	-	7:54 - 7:59
	8:02	71 (7)	Double	-	8:02

Table 9 *Noneto* usage of ReDo synth (first movement, channel 1).

CHAPTER 4 – Future Views

Noneto has revealed compelling compositional procedures which could lead to new research topics and creative projects in various musical fields. In this short chapter, I will discuss how the most innovative aspects exhibited in *Noneto* may function as the groundwork for future academic and artistic creations.

The software created for *Noneto* is one of the work's most compelling elements. Ultimately, it becomes a tool which may be further developed and subsequently re-used for future projects. Thus, I foresee two aspects that will bring about a substantial amount of creative and researched-based work: 1) the computer voice and 2) the correlation and synchronicity between human and computer essences (such as interpretation, listening, influence etc).

When referring to the computer voice, two concepts are worth mentioning. First, as an expressive tool the ReDo synth has proven to be a powerful and malleable virtual instrument. The sonic results of this first version can be improved with the addition of new features, such as the addition of post-synthesis effects[18] and waveform modulation methods such as frequency and phase modulation. Furthermore, granular synthesis may be integrated as well—the timbral qualities of the granulized sound can be based on the existing FFT resynthesis process used in RESA modulation. The flexibility offered by the controls of ReDo synth provide the effectiveness of a music software normally used in mainstream pop music (its features have aroused interest in some personal associates who work in this music industry). The aforementioned additions

[18] Similar to what various types of commercial software employ nowadays, such as reverbs, delays, phasers, chorus, etc.

would create a robust synthesizer capable of being utilized as a live instrument in, for example, contemporary jazz and free improvisation performances.

Secondly, because ReDo is coded in Max, its functionality can be extended easily to a more interactive piece of software,[19] thereby signifying it as a powerful tool when utilized in collaborative and interdisciplinary art making situations. Ultimately, my research has brought about an ideal resource for building interactive sound installations, particularly where it concerns live input response. From my own experience, public participation and engagement in interactive works is augmented when the audience has the option of including their physical voice. In interdisciplinary art, a movement sensor for staged and visual pieces including actor, dancers and musicians tends to guarantee a fantastic multidisciplinary coalition.

Finally, the correlation and synchronicity between human and computer essences in *Noneto* made possible by the Transport and BEAT controls has the potential to be further developed by investing more time on new features. The most promising addition would be the incorporation of a score-following algorithm. For the BEAT control, an improvisatory aspect based on MIDI input presents intriguing possibilities. Such a concept could potentially work in specific types of music based on listening and improvisation (e.g. jazz, free improvisation, installation art, etc.).

As an example of the abovementioned concepts, the results of the research demonstrated in *Noneto* have already been used in a rescued project of mine. The results are becoming key elements in a series of compositions for solo instruments I have been working on for more than five years. In 2014, I started conceiving the idea a series of compositions for solo instruments and computer (Arnáez, 2015) inspired by Luciano Berio's *Sequenzas*. My works feature the word *Duo* as standard nomenclature (i.e. *Duo I, for violin and speaker)*. *Duo* works are conceptualised to serve as compact and low-maintenance electroacoustic pieces. The project was shelved in 2016, thereby providing time for me to formulate a technological methodology in addition to an overall theoretical concept for *Duo*. After two years of working on *Noneto,* I believe I have developed the essential tools to re-start the *Duo* series. With the formula and theoretical blending approach — in addition to the ReDo synth, the BEAT control, and the Transport — I have everything I need to begin composing these pieces for one human and one loudspeaker using a minimal number of electronic devices (one computer, one loudspeaker, one microphone). With the knowledge I have acquired composing *Noneto*, I am confident to begin formulating full-scale works for my *Duo* project.

[19] This extension can refer to diverse type of electronic sensors input, extended MIDI or Arduino based controllers, etc.

Theoretically, *Noneto* demonstrates a unique yet traditional approach to musical composition. For one, *Noneto* addresses traditional and widely-used sound organization techniques which are employed using a significant amount of novelty. This novelty is based on a coalition of techniques and theories that are not often combined (Messiaen modes and dodecaphonism, Stockhausen's formula used in a theme and variations form, etc.) as well as rethinking basic approaches to music making, from simple counterpoint to sound design and sound synthesis. This opens the door to stylistic blending—composers may combine compositional styles to create new and unique creative processes inspired by musicians throughout history. Furthermore, the composer's ingenuity may be seen not only in the art of combining creative methodologies but also in their own compositional choices: e.g. adapting historic techniques to the specific needs of specific pieces, conjoining theoretical concepts, and breaking rigid processes. In this aspect, stylistic blending can reach profound heights of expressiveness. There are composers and performers who are currently working with dodecaphonic melodies in rock (Durão and Fenerick 2009, 61), utilizing Messiaen modes in jazz music (Djuric 2009, 2), and creating minimalist ambient music (Sherburne 2017). *Noneto* expands the notion of stylistic blending by combining modes, dodecaphonism, and formula. New research questions have emerged from here: Is popular music ready for using unconventional approaches to music making? What kinds of alternative music theories can be combined and how? What would be the sonic characteristics of works which employ numerous stylistic blending? It is my hope that future research will be able to answer these stimulating inquiries.

CHAPTER 5 – Music Score

noneto

Nicolás Arnáez

noneto

For string quartet and five speakers.
Duration: c. 20 mins

I.	Estampa Uno	[Imprint One]
II.	Armonía de una Estampa Inmóvil	[Harmony of a Motionless Imprint]
III.	Estampa de un Volar Complejo	[Imprint of a Flying Complex]

Para mi padre, fuente de paz.
....el sol acarició mi faz.

Composed between January 2018 and February 2020 as part of the final thesis for the Doctorate of Music in Composition degree at the University of Alberta in Edmonton, Canada under the supervision of Dr. Scott Smallwood. Additional committee members included Dr. Howard Bashaw, Dr. Michael Frishkopf and Dr. Mark Hannesson.

PROGRAM NOTES

Una semilla musical (mantra) percibida desde tres ángulos.
Dos fuentes sonoras colaborando para ser una.
Tres estampas.

One musical seed (mantra) perceived from three angles.
Two sound sources interacting to become one.
Three imprints.

noneto
Nicolás Arnáez

INTRODUCTION

Noneto is a piece of music were speakers and performers play sheets of music which are traditionally notated. The synchronization between them is achieved by a synch counter clock shown to all musicians, with clock number marks (representing beats) added to each musician's score. There is a Max patch that creates a flying window with the synch counter clock displayed on a large monitor which must be connected to the computer. (the ensemble may decide on the particular appearance of the synch counter clock). Performers are in charge of following the counter clock as they read their music while making sure each pulse in the score is played on the correct numbered beat.

While the musicians perform their parts, the attached Max patch also feeds its audio processing from an audio interface, this interface contains (at least) four inputs and five outputs. Each string instrument will have a microphone (close mic-ing technique is strongly recommended). An ideal microphone for this piece is the DPA 4099. The five outputs will be connected to five high quality studio monitors (Focal and Genelec brands are preferred), and four of these should have a speaker with a diameter of at least 5" (like the Focal CMS 50). The fifth monitor must be a matching subwoofer monitor (like the Focal CMS Sub 11"). The basic computer specifications for Noneto are, for Mac, a Processor of 2.2 GHz Inter core i7, 16GB 1600 MHz DD3, and macOS High Sierra (10.13.6).

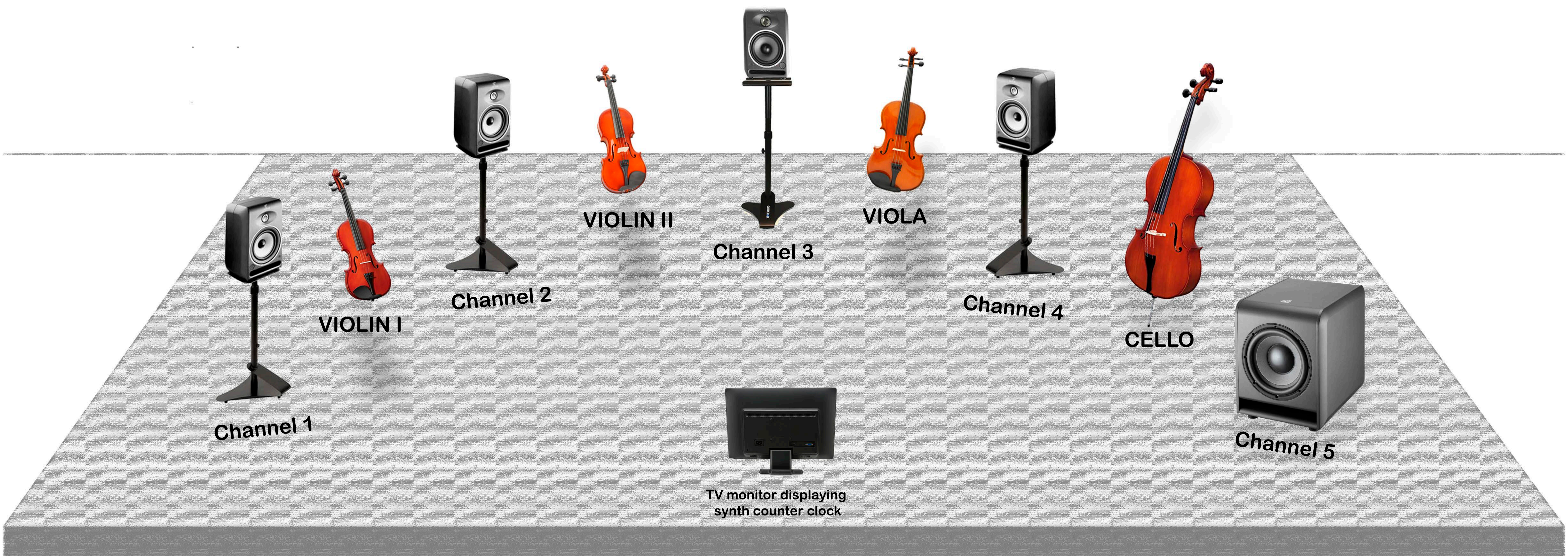
A Max patch operator is required for Noneto. The operator is responsible for setting up the clock, changing movements accordingly, and controlling levels (inputs and outputs). The Max patch operator should have a copy of the score and follow the performance, making slight tempo corrections as needed (more information on next page).

As shown below, speakers are positioned between each string performer. It is crucial to keep the loudness of the speakers at equal intensity to the human players. Monitors 1 to 4 should be placed on stands at the same height as the violins and viola (around 1.20 mts). Channel 5 can be placed directly on the floor.

NOTATION

Noneto has been primarily notated using a traditional Western style. The following considerations should be observed:

- Accidentals last for the length of a measure (applies just to the note shown, not octaves), any new measure needs new accidentals (played natural if there is nothing written).
- Tremolo indications are to be played as fast as possible (instead of subdividing the written value in equal shorter rhythms).
- l.v. means "Let vibrate" (do not mute the string after the articulation)
- The second movement has improvisatory "boxes." The string player is required to perform what is described in each box for the length shown.



MAX PATCH

This is the graphic user interface the Max patch operator will utilize for Noneto's performance, please note:

In rehearsals:

1. Plug in an extra computer monitor and drag the sync counter clock flying windows into the monitor, choose full screen mode on the BEAT control menu (Key`).
2. Set up the clock, discuss with the ensemble the best setting for everyone (e.g. blink on the first beat, in all beats, no blink, how long the blink is, etc.).
3. The Transport menu offers the option of starting the piece at any point in the score by entering the exact time or choosing the rehearsal letter. The latter is highly recommended to ensure synchronicity.
4. First enter the time/letter, then hit "GO" and wait until the clock shows it's ready (yellow numbers). Once it is ready you can hit PLAY to resume from that point.
5. If needed, the BPM of the piece can be changed in this window as well. All electronic processes will be automatically adapted to the new tempo.
6. If the transport window freezes, it can be reset by clicking the reset button.
7. Although the individual channels' synthesizers look interactive, the operator has no access to its controls. The synthesizers are shown only as a reference and set internally.

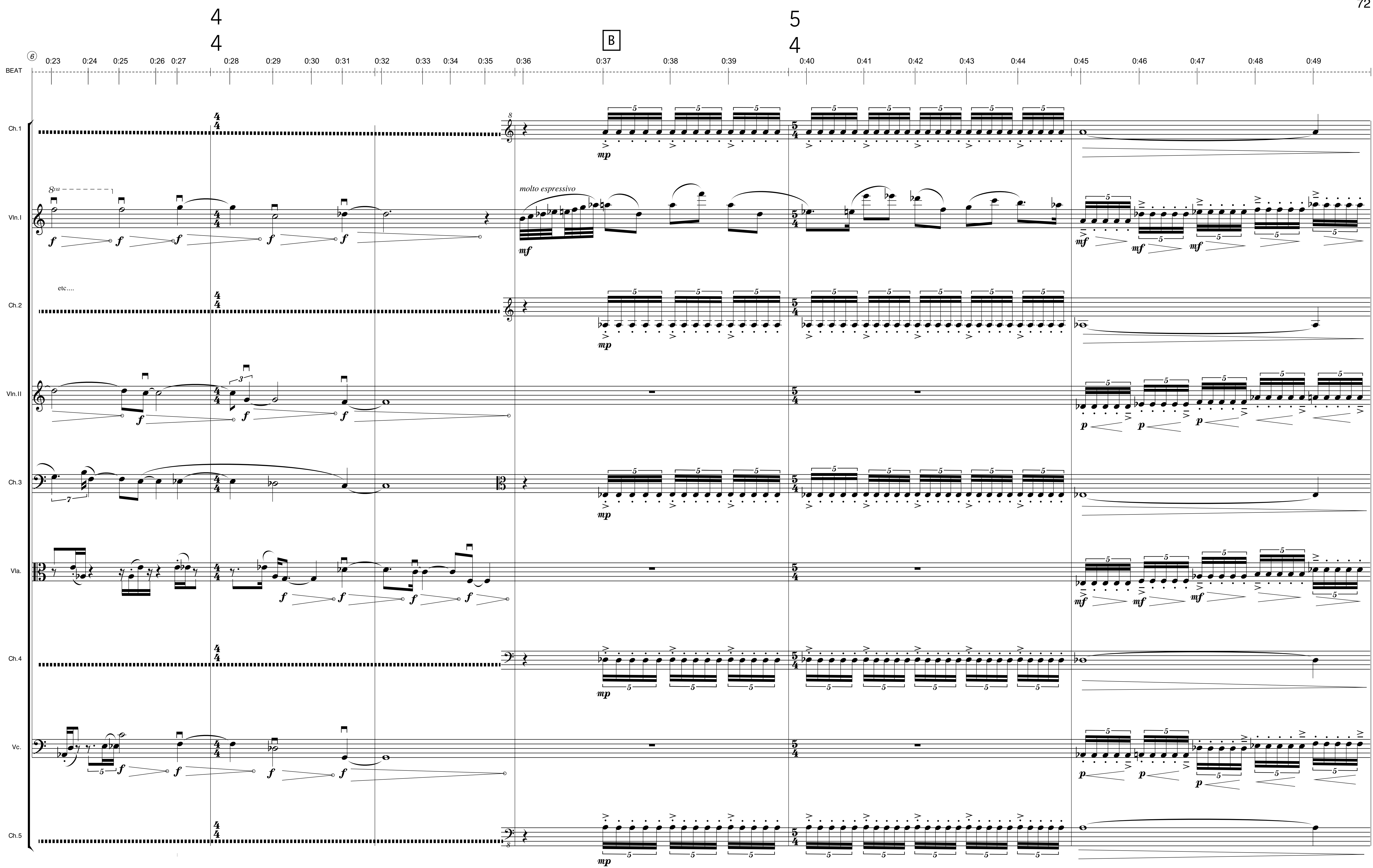
In performance, the operator simply has to choose the movement by clicking with the mouse at the top left, then pressing "PLAY" on the Transport menu. Once the movement has finished, the patch stops performing automatically and goes to stand-by mode for the operator to choose another movement. If agreed collectively upon in rehearsal, a new BPM can be entered before starting (all electronic components will automatically adapt to it). It is highly recommended to check the input levels and the output levels to avoid clipping and retain balance with the string players. A KORG nanoKONTROL2 MIDI controller can be used to manipulate on-screen faders (first five faders form left to right as five channels outputs; first four rotary knobs as level inputs; play to start; stop to stop).

Tempo corrections

The Max patch operator is also in charge of following the string players performances in correlation with the score. As needed, the BPM of each movement can be varied by interacting with the patch via the computer keyboard or the nanoKONTROL2 input, as follows:

- Arrow up/REW button
  (one BPM value down each push)
- Arrow down/FF button
  (one BPM value up each push)
- Arrow right/PLAY button
  (jump back to original BPM)

Estampa Uno [Imprint One]


B
BEAT
0:23 0:24 0:25 0:26 0:27 0:28 0:29 0:30 0:31 0:32 0:33 0:34 0:35 0:36 0:37 0:38 0:39 0:40 0:41 0:42 0:43 0:44 0:45 0:46 0:47 0:48 0:49
Ch.1
Vln.I
molto espressivo
etc....
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5

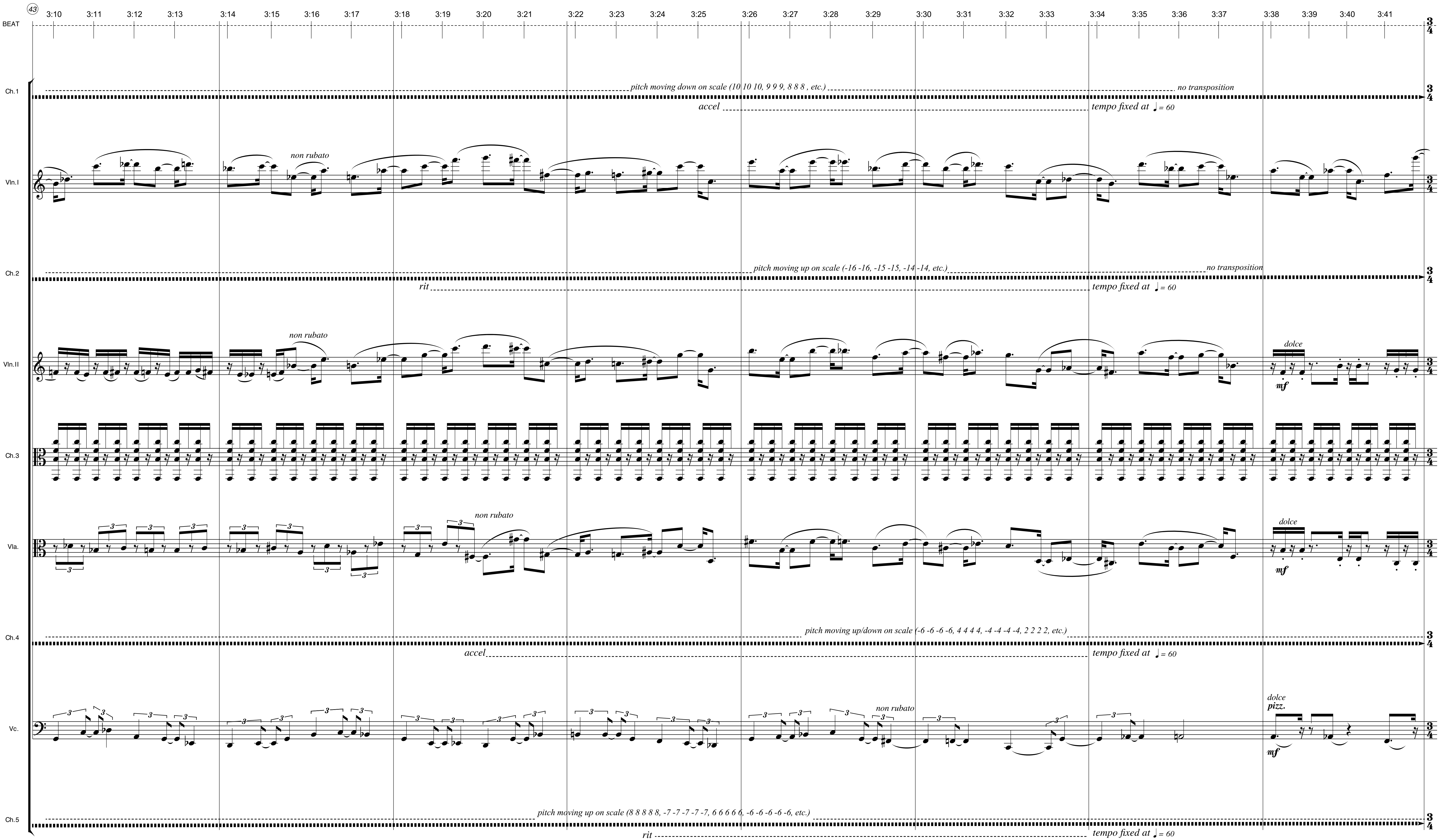

C
12
0:50 0:51 0:52 0:53 0:54 0:55 0:56 0:57 0:58 0:59 1:00 1:01 1:02 1:03 1:04 1:05 1:06 1:07 1:08 1:09 1:10 1:11 1:12 1:13 1:14 1:15 1:16 1:17 1:18 1:19 1:20 1:21 1:22 1:23 1:24
BEAT
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
vib.
molto espressivo
8va
mp

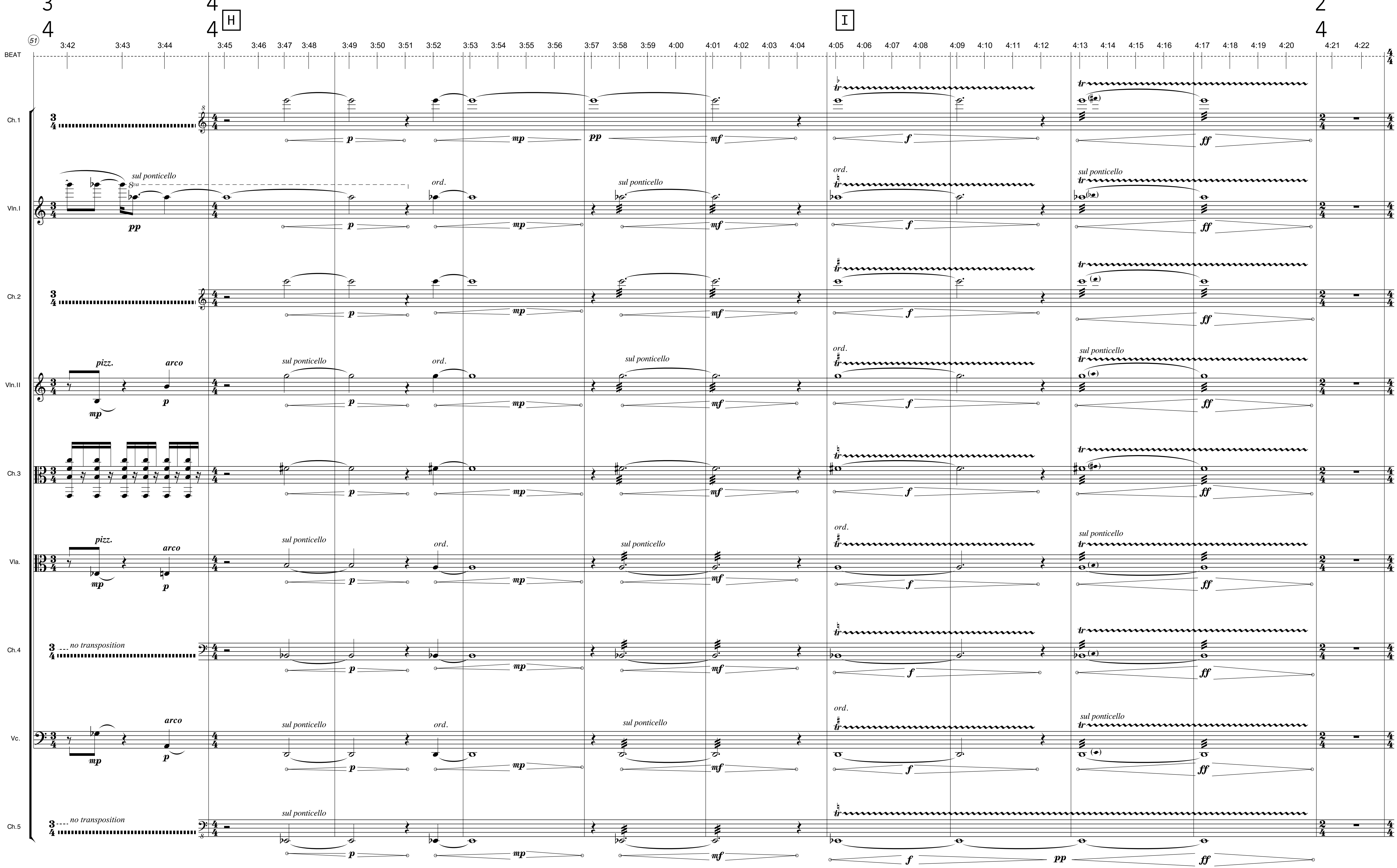
D
19
BEAT
1:25 1:26 1:27 1:28 1:29 1:30 1:31 1:32 1:33 1:34 1:35 1:36 1:37 1:38 1:39 1:40 1:41 1:42 1:43 1:44 1:45 1:46 1:47 1:48 1:49 1:50
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5

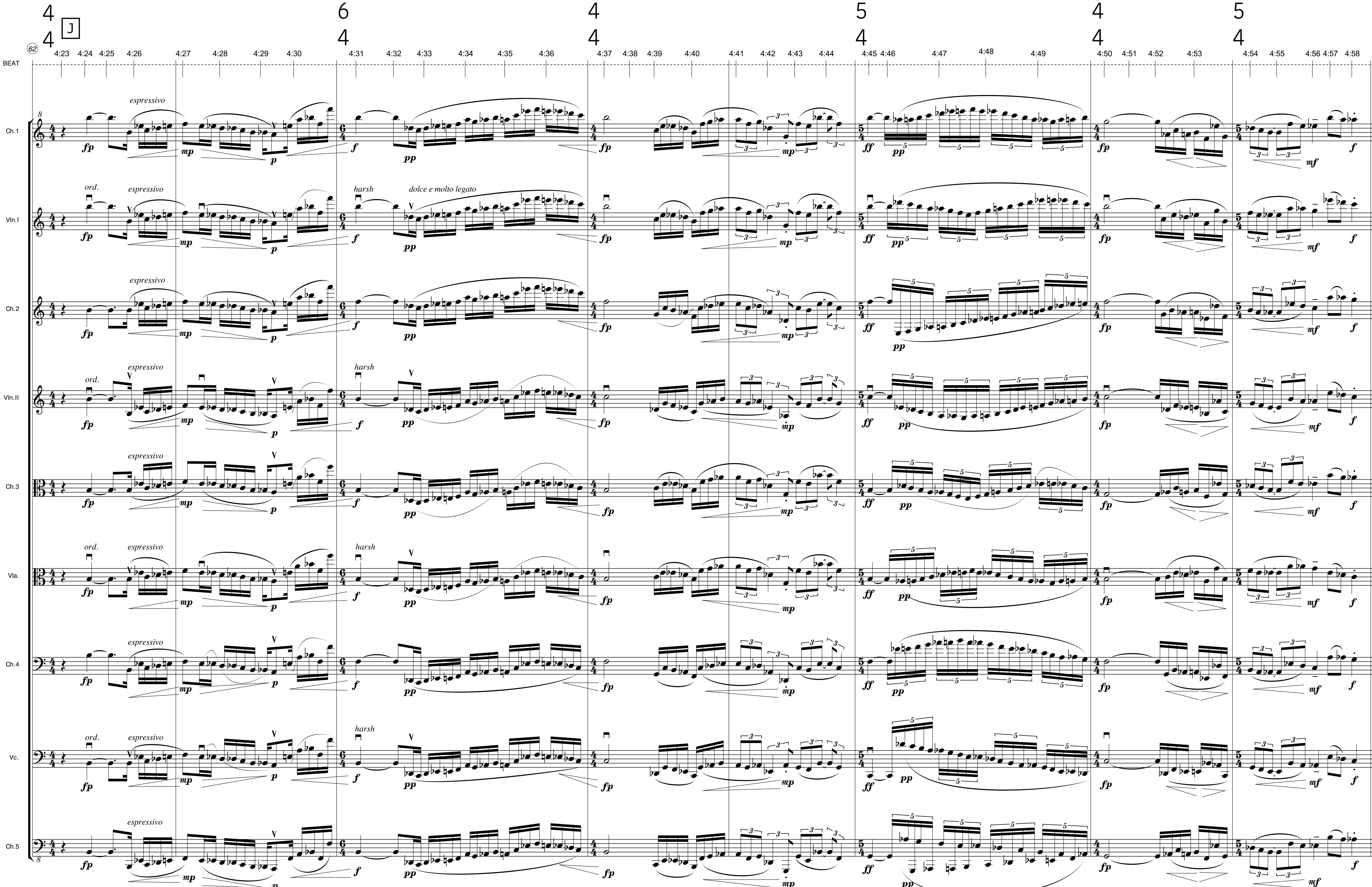

23
BEAT
1:51
1:52
1:53
1:54
1:55
1:56
1:57
1:58
1:59
2:00
2:01
2:02
2:03
2:04
2:05
2:06
2:07
2:08
2:09
2:10
2:11
2:12
2:13
2:14
2:15
E
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
8va
col legno
pizz.
arco
l.v.
p
mp
mf
fp

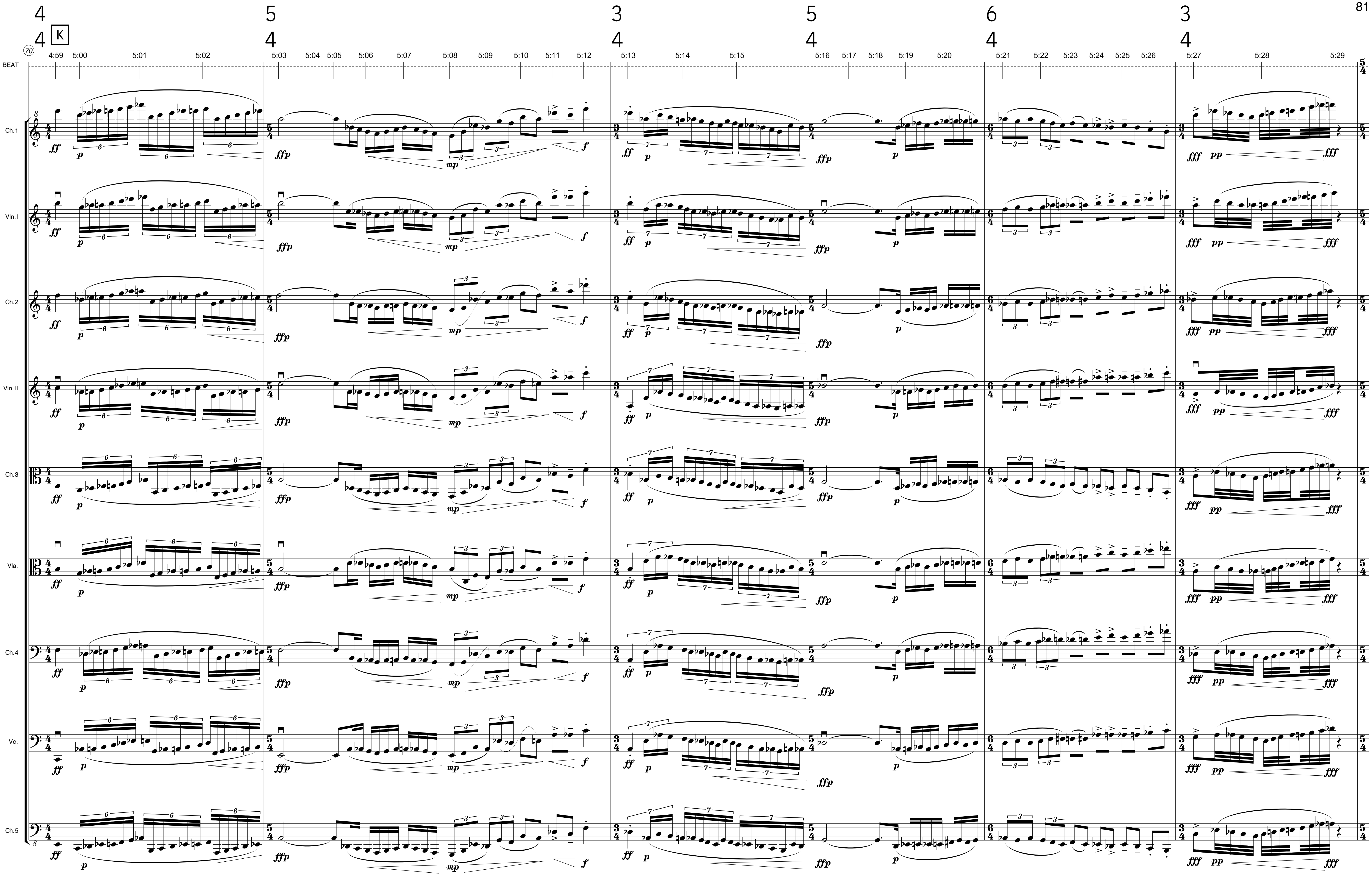

F
BEAT
2:16
2:17
2:18
2:19
2:20
2:21
2:22
2:23
2:24
2:25
2:26
2:27
2:28
2:29
2:30
2:31
2:32
2:33
2:34
2:35
2:36
2:37
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
col legno
vibrato e molto expressivo
arco
pizz.
r.h. thumb
vib.
senza vib.
mp
mf
f
sfz
sffz


G
35
BEAT
2:38 2:39 2:40 2:41 2:42 2:43 2:44 2:45 2:46 2:47 2:48 2:49 2:50 2:51 2:52 2:53 2:54 2:55 2:56 2:57 2:58 2:59 3:00 3:01 3:02 3:03 3:04 3:05 3:06 3:07 3:08 3:09
Ch.1
Vln.I delay
etc....
pitch moving up on scale (1, 2 2, 3 3 3, 4 4 4, etc.)
rit
tempo fixed at ♩= 41
Vln.I
arco
rubato
Ch.2
Vln.II delay
etc....
pitch moving down on scale (-2 x11, -3 x10, -4 x9, etc.)
accel
tempo fixed at ♩= 92
Vln.II
arco
rubato
Ch.3
Vla.
arco
rubato
l.v.
Ch.4
Vla. delay
etc....
pitch moving down/up on scale
(-2, 2 2, -3 -3 -3, 2 2 2 2, etc.)
rit
tempo fixed at ♩= 53
Vc.
arco
rubato
Ch.5
Vc. delay
etc....
pitch moving down on scale (1 x11, -2 x10, 2 x9, -3 x8, etc.)
accel
tempo fixed at ♩= 117


43
3:10 3:11 3:12 3:13 3:14 3:15 3:16 3:17 3:18 3:19 3:20 3:21 3:22 3:23 3:24 3:25 3:26 3:27 3:28 3:29 3:30 3:31 3:32 3:33 3:34 3:35 3:36 3:37 3:38 3:39 3:40 3:41
BEAT
Ch.1
pitch moving down on scale (10 10 10, 9 9 9, 8 8 8 , etc.)
no transposition
accel
tempo fixed at ♩= 60
Vln.I
non rubato
Ch.2
pitch moving up on scale (-16 -16, -15 -15, -14 -14, etc.)
no transposition
rit
tempo fixed at ♩= 60
Vln.II
non rubato
dolce
mf
Ch.3
Vla.
non rubato
dolce
mf
Ch.4
pitch moving up/down on scale (-6 -6 -6 -6, 4 4 4 4, -4 -4 -4 -4, 2 2 2 2, etc.)
accel
tempo fixed at ♩= 60
Vc.
non rubato
dolce
pizz.
mf
Ch.5
pitch moving up on scale (8 8 8 8 8, -7 -7 -7 -7 -7, 6 6 6 6 6, -6 -6 -6 -6 -6, etc.)
rit
tempo fixed at ♩= 60


H
I
3:42
3:43
3:44
3:45
3:46
3:47
3:48
3:49
3:50
3:51
3:52
3:53
3:54
3:55
3:56
3:57
3:58
3:59
4:00
4:01
4:02
4:03
4:04
4:05
4:06
4:07
4:08
4:09
4:10
4:11
4:12
4:13
4:14
4:15
4:16
4:17
4:18
4:19
4:20
4:21
4:22
BEAT
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
sul ponticello
ord.
pizz.
arco
no transposition


J
62
BEAT
4:23 4:24 4:25 4:26 4:27 4:28 4:29 4:30 4:31 4:32 4:33 4:34 4:35 4:36 4:37 4:38 4:39 4:40 4:41 4:42 4:43 4:44 4:45 4:46 4:47 4:48 4:49 4:50 4:51 4:52 4:53 4:54 4:55 4:56 4:57 4:58
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
espressivo
ord.
harsh
dolce e molto legato
fp
mp
p
f
pp
ff
mf

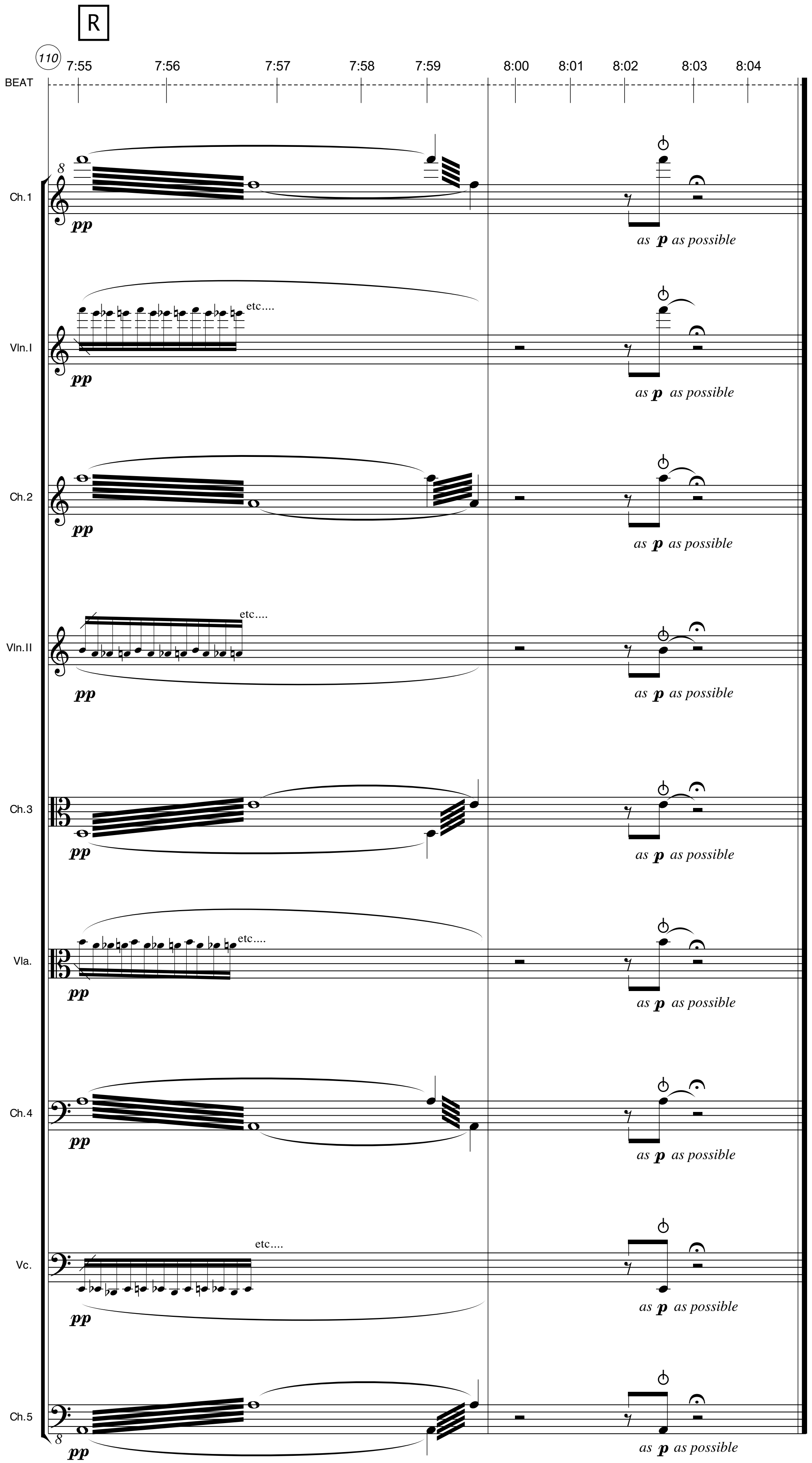

K
70
4:59 5:00 5:01 5:02 5:03 5:04 5:05 5:06 5:07 5:08 5:09 5:10 5:11 5:12 5:13 5:14 5:15 5:16 5:17 5:18 5:19 5:20 5:21 5:22 5:23 5:24 5:25 5:26 5:27 5:28 5:29
BEAT
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5


5
4
L
77
BEAT
5:30 5:31 5:32 5:33 5:34 5:35 5:36 5:37 5:38 5:39 5:40 5:41 5:42 5:43 5:44 5:45 5:46 5:47 5:48 5:49 5:50 5:51 5:52 5:53 5:54 5:55 5:56 5:57 5:58 5:59 6:00 6:01 6:02 6:03 6:04 6:05 6:06 6:07 6:08 6:09
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
sempre pizz.
arco
tremolo as fast as possible
tr
mp
mf
f
p
pp
ppp

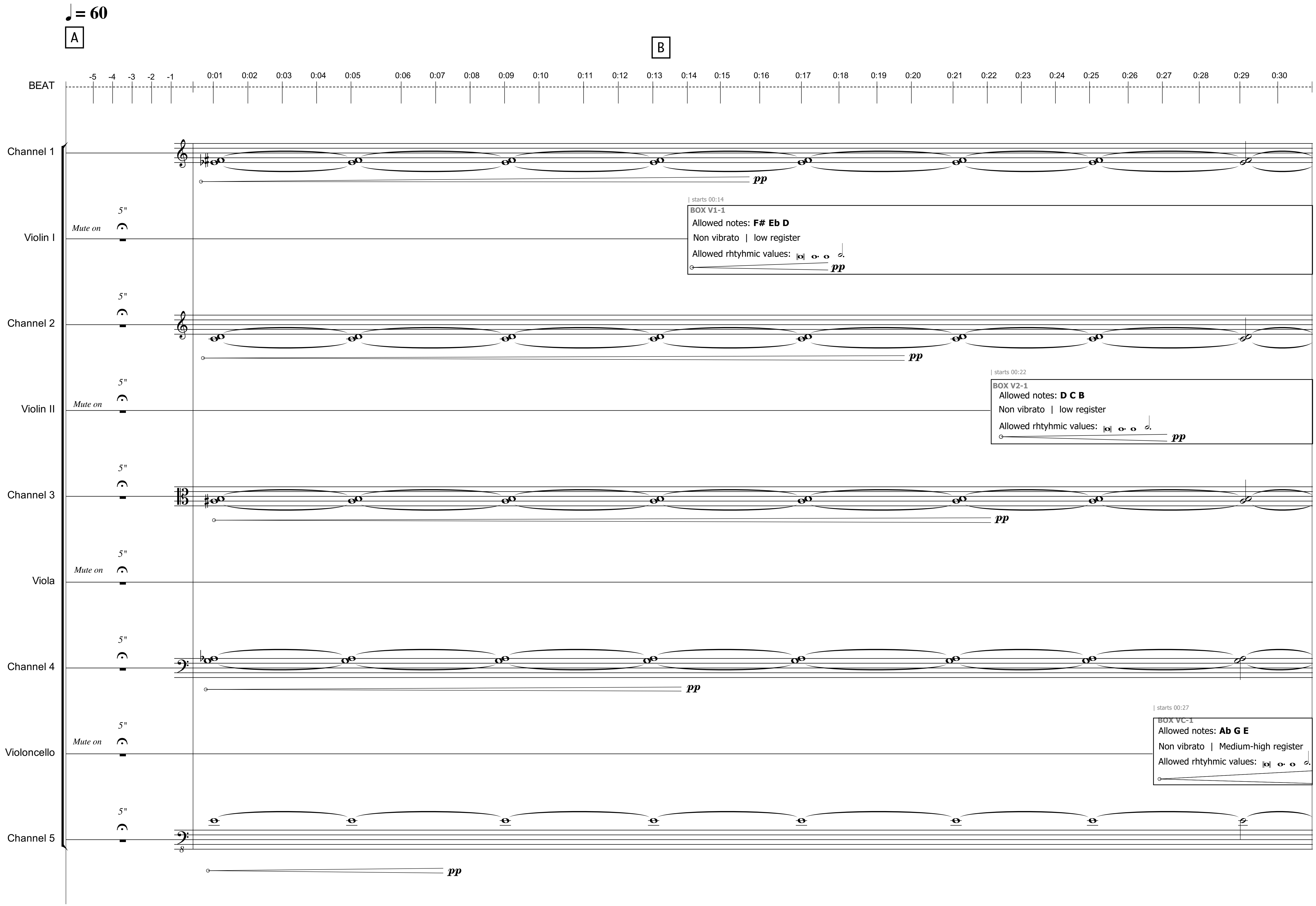

M
N
BEAT
6:10
6:11
6:12
6:13
6:14
6:15
6:16
6:17
6:18
6:19
6:20
6:21
6:22
6:23
6:24
6:25
6:26
6:27
6:28
6:29
6:30
6:31
6:32
6:33
6:34
6:35
6:36
6:37
6:38
6:39
6:40
6:41
6:42
6:43
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
molto vib. sempre
short vib. sempre

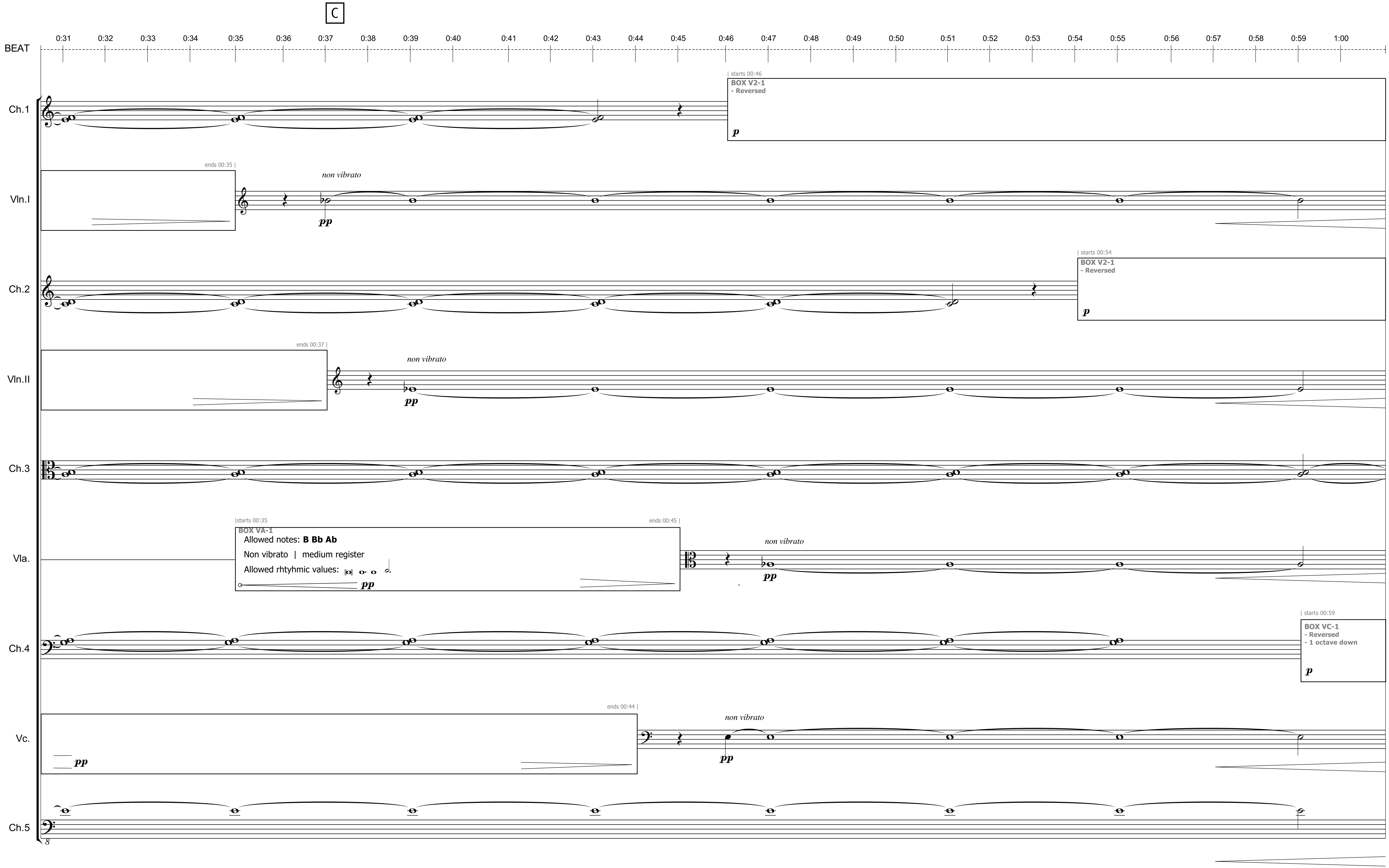

93
BEAT
6:44 6:45 6:46 6:47 6:48 6:49 6:50 6:51 6:52 6:53 6:54 6:55 6:56 6:57 6:58 6:59 7:00 7:01 7:02 7:03 7:04 7:05 7:06 7:07 7:08 7:09 7:10 7:11 7:12 7:13 7:14 7:15 7:16 7:17 7:18 7:19 7:20 7:21 7:22 7:23 7:24
0
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
ppp
mp
mf

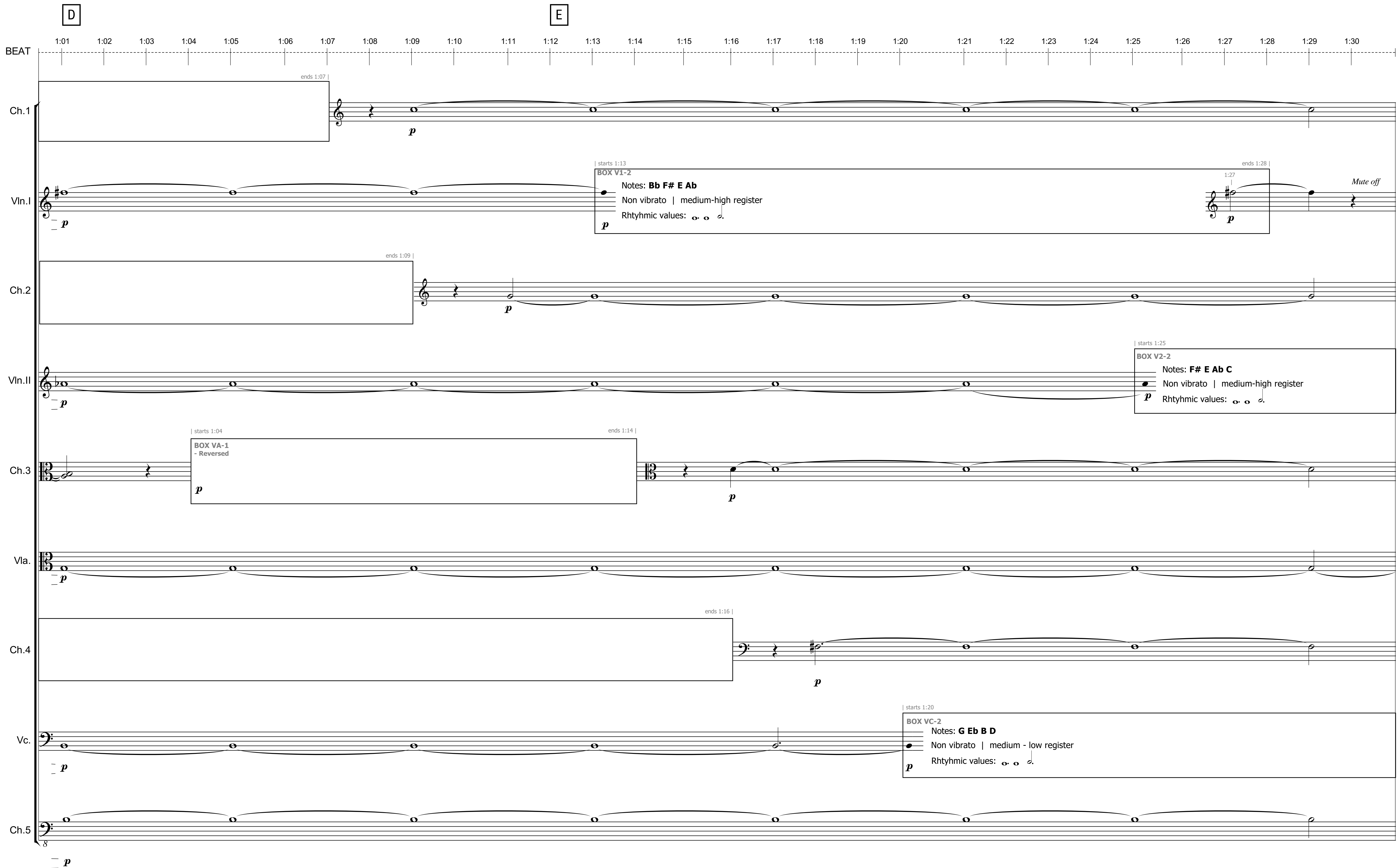

P
Q
103
BEAT
7:25 7:26 7:27 7:28 7:29 7:30 7:31 7:32 7:33 7:34 7:35 7:36 7:37 7:38 7:39 7:40 7:41 7:42 7:43 7:44 7:45 7:46 7:47 7:48 7:49 7:50 7:51 7:52 7:53 7:54
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
pizz.
arco
tr

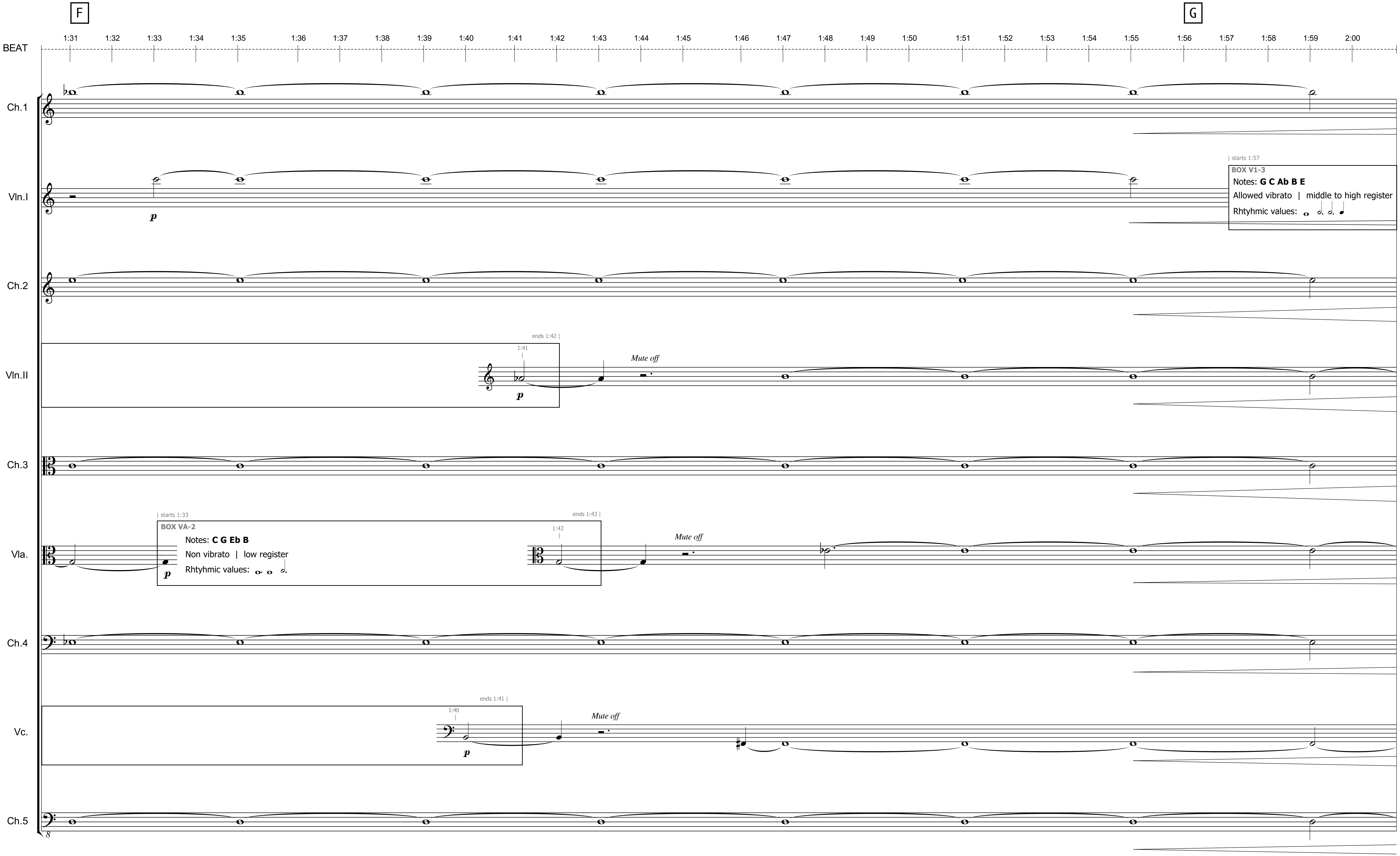

R
110
7:55
7:56
7:57
7:58
7:59
8:00
8:01
8:02
8:03
8:04
BEAT
Ch.1
pp
as p as possible
Vln.I
etc....
pp
as p as possible
Ch.2
pp
as p as possible
Vln.II
etc....
pp
as p as possible
Ch.3
pp
as p as possible
Vla.
etc....
pp
as p as possible
Ch.4
pp
as p as possible
Vc.
etc....
pp
as p as possible
Ch.5
pp
as p as possible

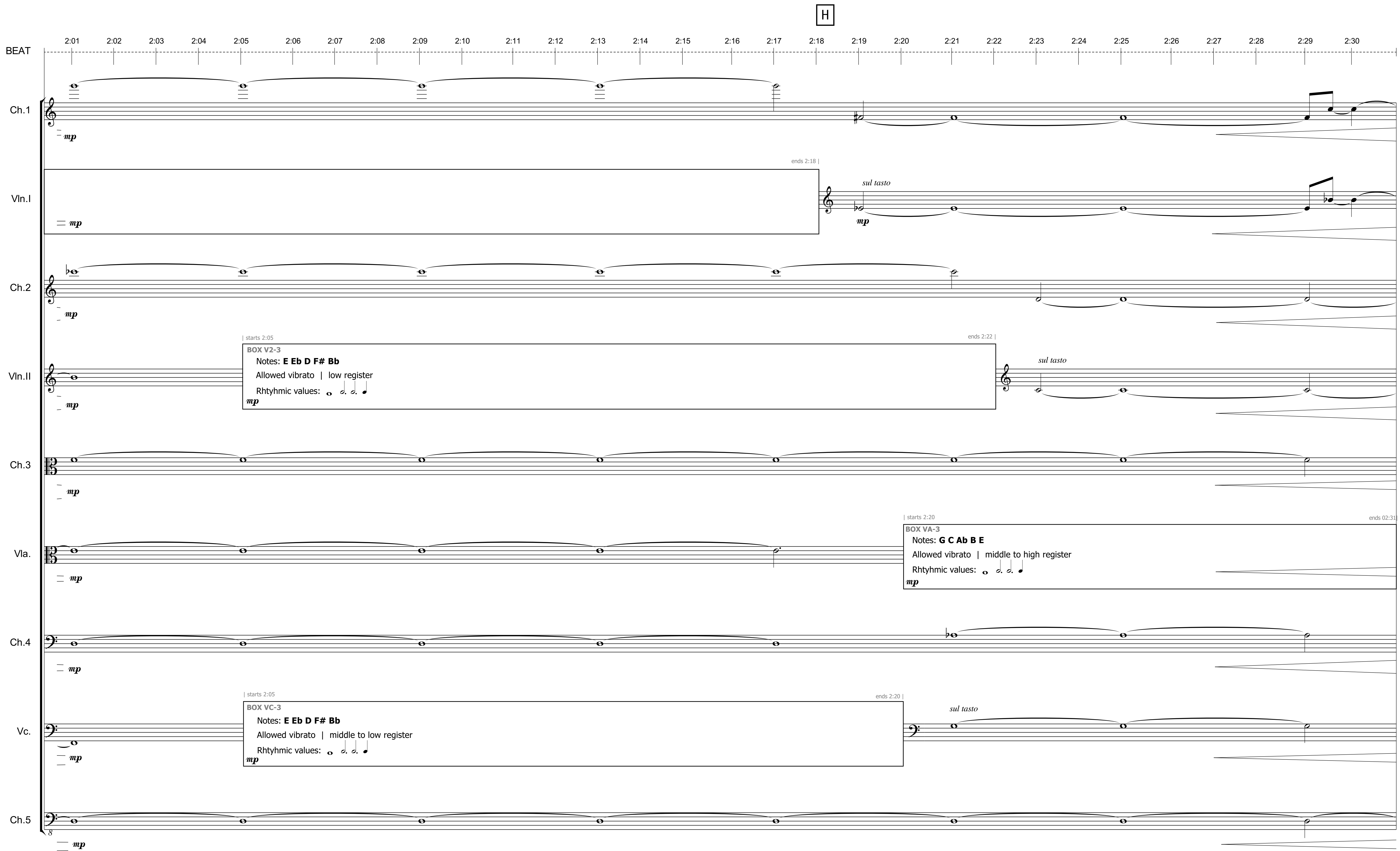
Armonía de una Estampa Inmóvil [Harmony of a Motionless Imprint]

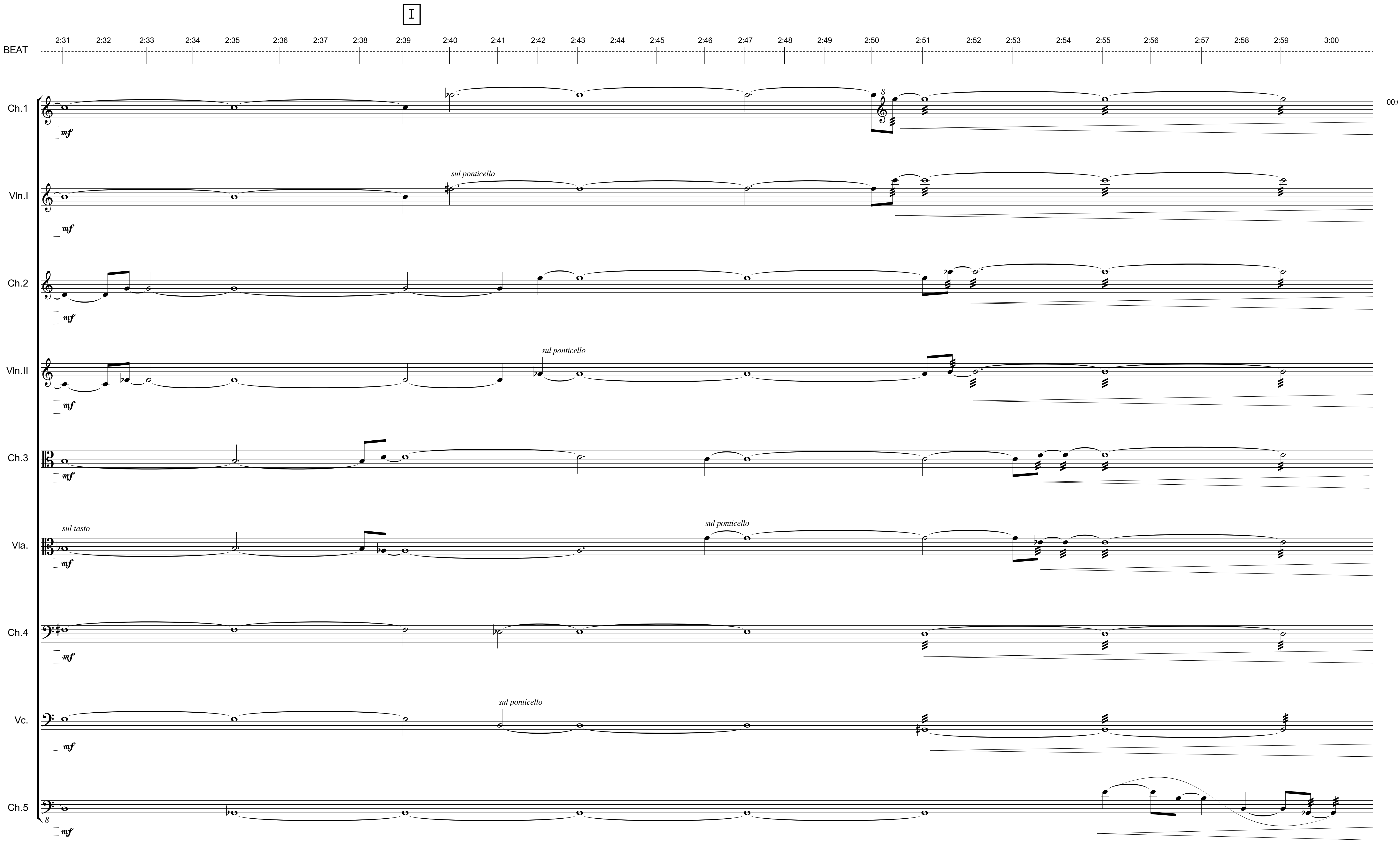


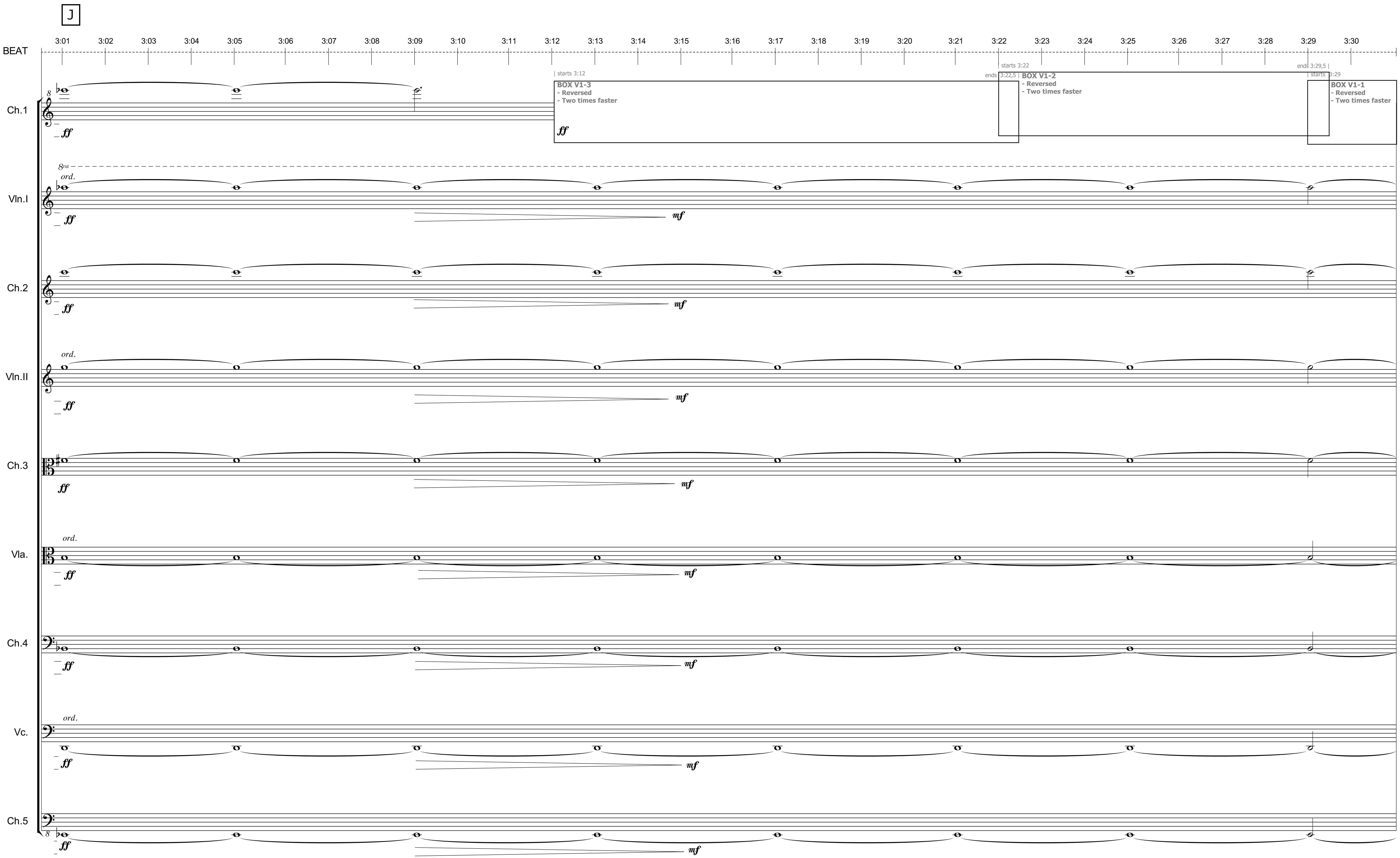

C
BEAT
0:31
0:32
0:33
0:34
0:35
0:36
0:37
0:38
0:39
0:40
0:41
0:42
0:43
0:44
0:45
0:46
0:47
0:48
0:49
0:50
0:51
0:52
0:53
0:54
0:55
0:56
0:57
0:58
0:59
1:00
Ch.1
| starts 00:46
BOX V2-1
- Reversed
p
Vln.I
ends 00:35 |
non vibrato
pp
Ch.2
| starts 00:54
BOX V2-1
- Reversed
p
Vln.II
ends 00:37 |
non vibrato
pp
Ch.3
Vla.
|starts 00:35
BOX VA-1
Allowed notes: B Bb Ab
Non vibrato | medium register
Allowed rhtyhmic values:
pp
ends 00:45 |
non vibrato
pp
Ch.4
| starts 00:59
BOX VC-1
- Reversed
- 1 octave down
p
Vc.
ends 00:44 |
pp
non vibrato
pp
Ch.5

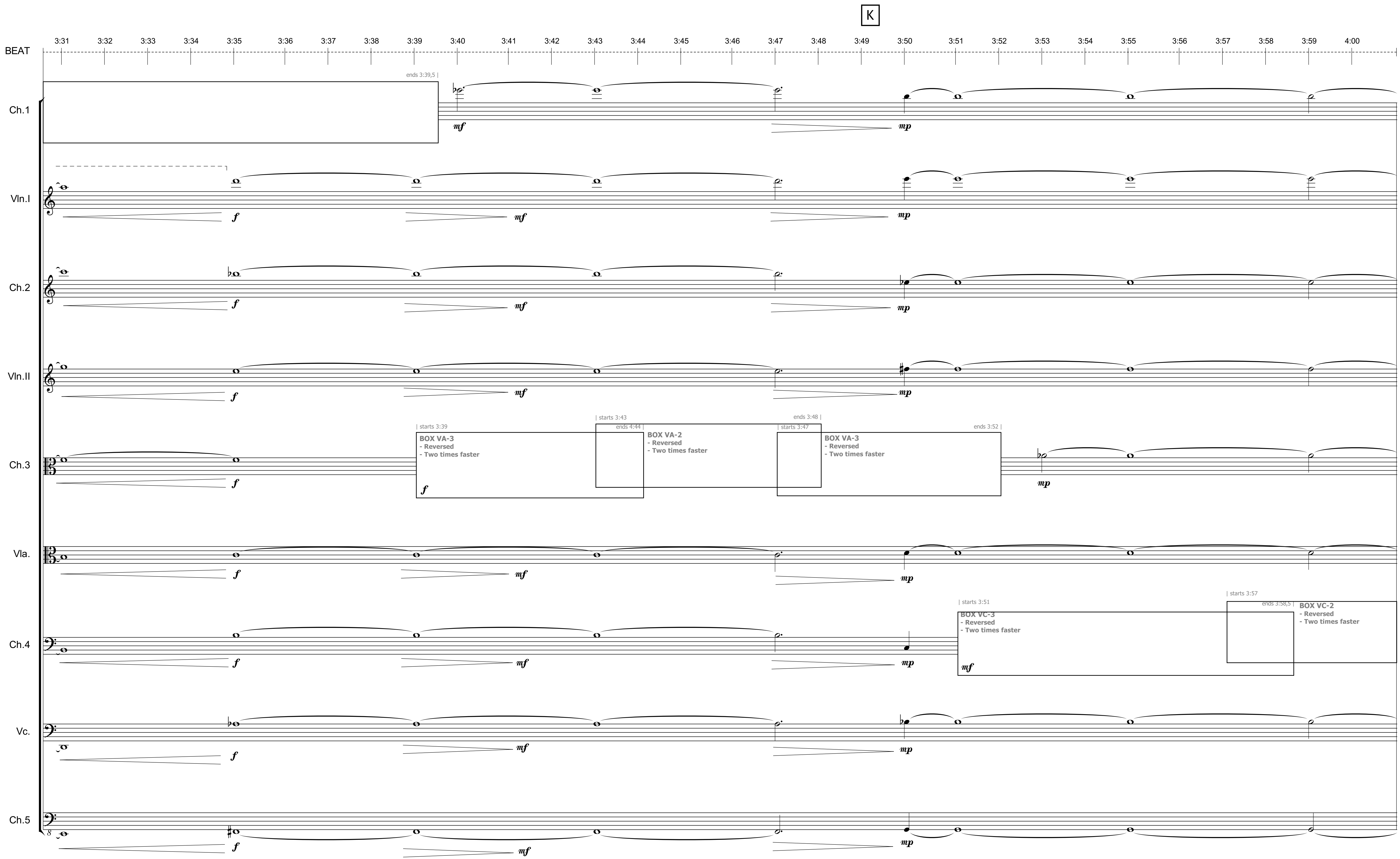

D
E
BEAT
1:01 1:02 1:03 1:04 1:05 1:06 1:07 1:08 1:09 1:10 1:11 1:12 1:13 1:14 1:15 1:16 1:17 1:18 1:19 1:20 1:21 1:22 1:23 1:24 1:25 1:26 1:27 1:28 1:29 1:30
Ch.1
ends 1:07 |
Vln.I
| starts 1:13
BOX V1-2
Notes: Bb F# E Ab
Non vibrato | medium-high register
Rhtyhmic values:
ends 1:28 |
1:27
Mute off
Ch.2
ends 1:09 |
Vln.II
| starts 1:25
BOX V2-2
Notes: F# E Ab C
Non vibrato | medium-high register
Rhtyhmic values:
Ch.3
| starts 1:04
BOX VA-1
- Reversed
ends 1:14 |
Vla.
Ch.4
ends 1:16 |
Vc.
| starts 1:20
BOX VC-2
Notes: G Eb B D
Non vibrato | medium - low register
Rhtyhmic values:
Ch.5

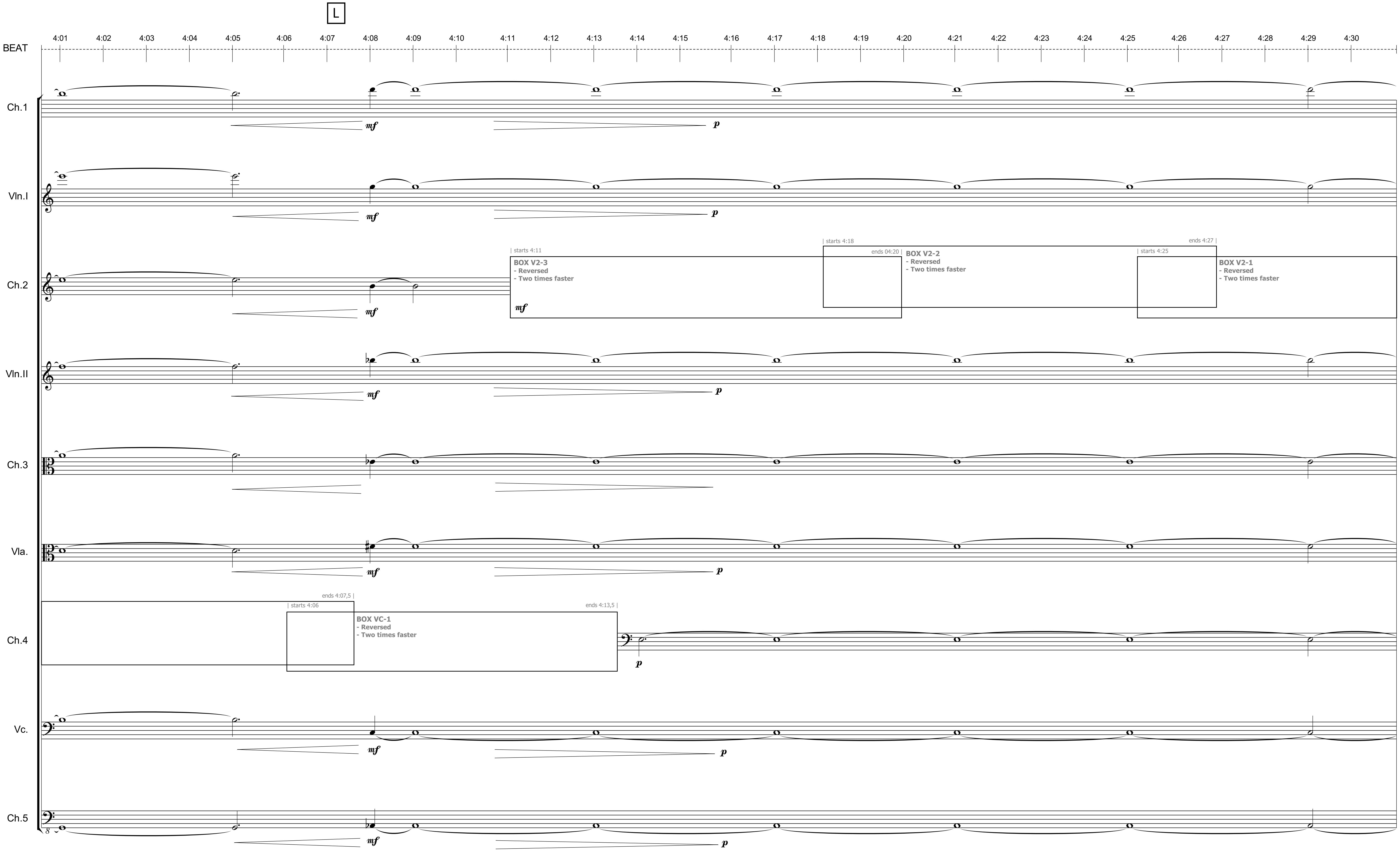

F
G
BEAT
1:31
1:32
1:33
1:34
1:35
1:36
1:37
1:38
1:39
1:40
1:41
1:42
1:43
1:44
1:45
1:46
1:47
1:48
1:49
1:50
1:51
1:52
1:53
1:54
1:55
1:56
1:57
1:58
1:59
2:00
Ch.1
Vln.I
p
| starts 1:57
BOX V1-3
Notes: G C Ab B E
Allowed vibrato | middle to high register
Rhtyhmic values:
Ch.2
Vln.II
ends 1:42 |
1:41
p
Mute off
Ch.3
Vla.
| starts 1:33
BOX VA-2
Notes: C G Eb B
Non vibrato | low register
Rhtyhmic values:
p
ends 1:43 |
1:42
Mute off
Ch.4
Vc.
ends 1:41 |
1:40
p
Mute off
Ch.5
8

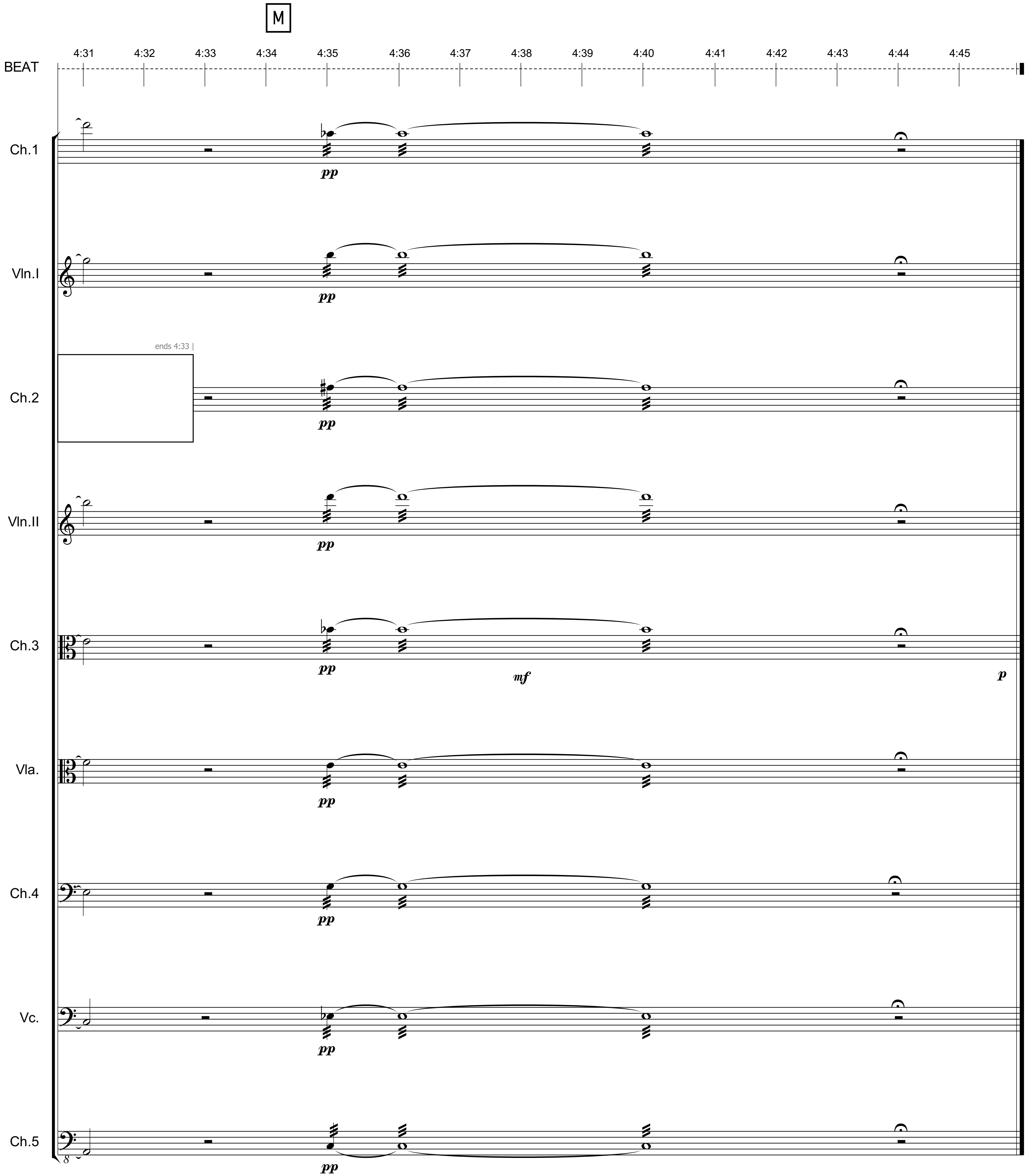

H
BEAT
2:01 2:02 2:03 2:04 2:05 2:06 2:07 2:08 2:09 2:10 2:11 2:12 2:13 2:14 2:15 2:16 2:17 2:18 2:19 2:20 2:21 2:22 2:23 2:24 2:25 2:26 2:27 2:28 2:29 2:30
Ch.1
Vln.I
ends 2:18 |
sul tasto
Ch.2
Vln.II
| starts 2:05
BOX V2-3
Notes: E Eb D F# Bb
Allowed vibrato | low register
Rhtyhmic values:
ends 2:22 |
sul tasto
Ch.3
Vla.
| starts 2:20
BOX VA-3
Notes: G C Ab B E
Allowed vibrato | middle to high register
Rhtyhmic values:
ends 02:31|
Ch.4
Vc.
| starts 2:05
BOX VC-3
Notes: E Eb D F# Bb
Allowed vibrato | middle to low register
Rhtyhmic values:
ends 2:20 |
sul tasto
Ch.5
mp


I
BEAT
2:31
2:32
2:33
2:34
2:35
2:36
2:37
2:38
2:39
2:40
2:41
2:42
2:43
2:44
2:45
2:46
2:47
2:48
2:49
2:50
2:51
2:52
2:53
2:54
2:55
2:56
2:57
2:58
2:59
3:00
00:0
Ch.1
mf
Vln.I
sul ponticello
mf
Ch.2
mf
Vln.II
sul ponticello
mf
Ch.3
mf
Vla.
sul tasto
sul ponticello
mf
Ch.4
mf
Vc.
sul ponticello
mf
Ch.5
mf


J
BEAT
3:01 3:02 3:03 3:04 3:05 3:06 3:07 3:08 3:09 3:10 3:11 3:12 3:13 3:14 3:15 3:16 3:17 3:18 3:19 3:20 3:21 3:22 3:23 3:24 3:25 3:26 3:27 3:28 3:29 3:30
Ch.1
| starts 3:12
BOX V1-3
- Reversed
- Two times faster
| starts 3:22
ends 3:22,5 |
BOX V1-2
- Reversed
- Two times faster
ends 3:29,5 |
| starts 3:29
BOX V1-1
- Reversed
- Two times faster
Vln.I
8va
ord.
Ch.2
Vln.II
ord.
Ch.3
Vla.
ord.
Ch.4
Vc.
ord.
Ch.5
ff
mf


K
BEAT
3:31 3:32 3:33 3:34 3:35 3:36 3:37 3:38 3:39 3:40 3:41 3:42 3:43 3:44 3:45 3:46 3:47 3:48 3:49 3:50 3:51 3:52 3:53 3:54 3:55 3:56 3:57 3:58 3:59 4:00
Ch.1
ends 3:39,5 |
Vln.I
Ch.2
Vln.II
Ch.3
| starts 3:39
BOX VA-3
- Reversed
- Two times faster
| starts 3:43
ends 4:44 |
BOX VA-2
- Reversed
- Two times faster
ends 3:48 |
| starts 3:47
BOX VA-3
- Reversed
- Two times faster
ends 3:52 |
Vla.
Ch.4
| starts 3:51
BOX VC-3
- Reversed
- Two times faster
| starts 3:57
ends 3:58,5 |
BOX VC-2
- Reversed
- Two times faster
Vc.
Ch.5


L
BEAT
4:01 4:02 4:03 4:04 4:05 4:06 4:07 4:08 4:09 4:10 4:11 4:12 4:13 4:14 4:15 4:16 4:17 4:18 4:19 4:20 4:21 4:22 4:23 4:24 4:25 4:26 4:27 4:28 4:29 4:30
Ch.1
Vln.I
Ch.2
| starts 4:11
BOX V2-3
- Reversed
- Two times faster
| starts 4:18
ends 04:20 |
BOX V2-2
- Reversed
- Two times faster
| starts 4:25
ends 4:27 |
BOX V2-1
- Reversed
- Two times faster
Vln.II
Ch.3
Vla.
Ch.4
ends 4:07,5 |
| starts 4:06
BOX VC-1
- Reversed
- Two times faster
ends 4:13,5 |
Vc.
Ch.5

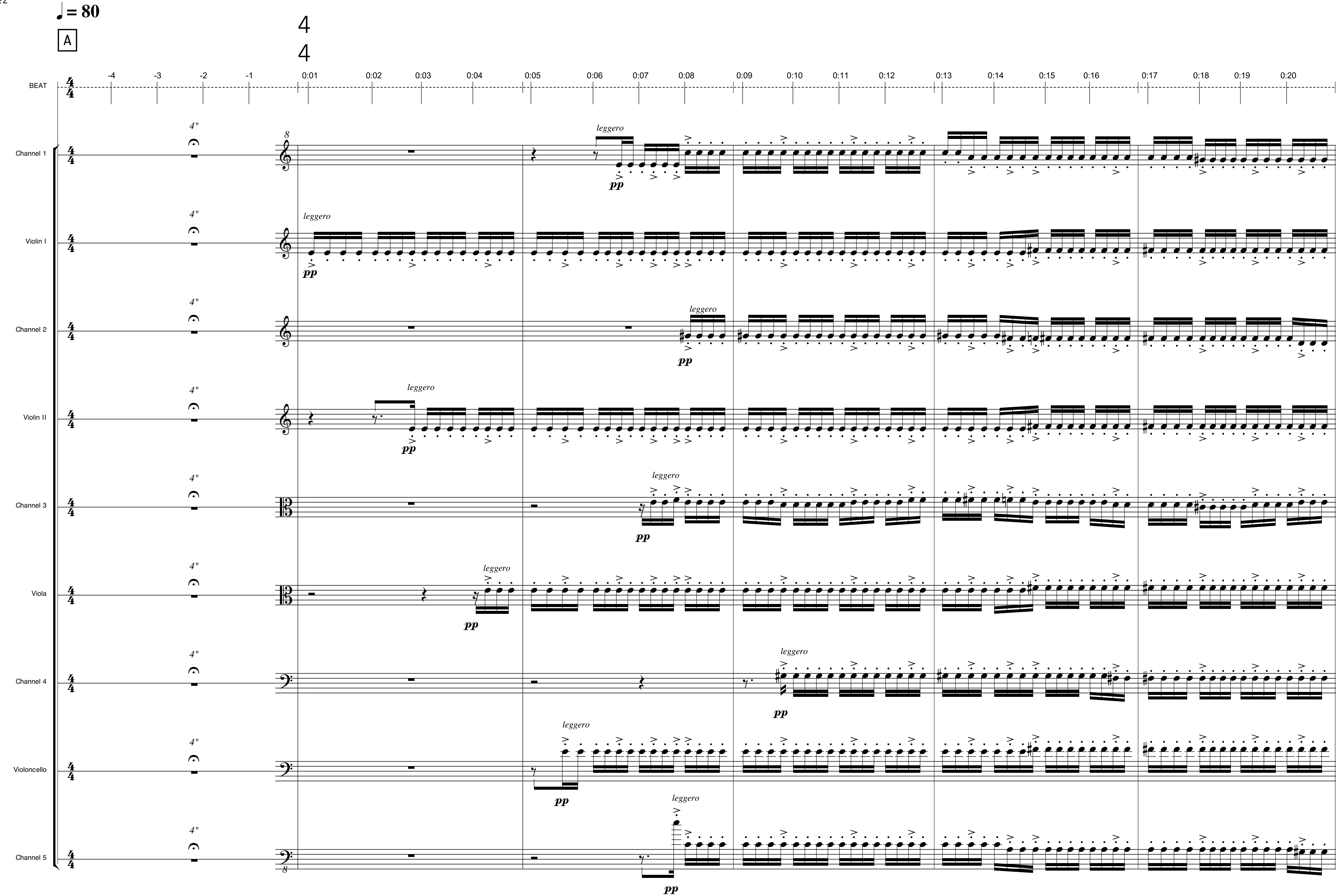

M
BEAT
4:31 4:32 4:33 4:34 4:35 4:36 4:37 4:38 4:39 4:40 4:41 4:42 4:43 4:44 4:45
Ch.1
Vln.I
ends 4:33
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
pp
mf
p

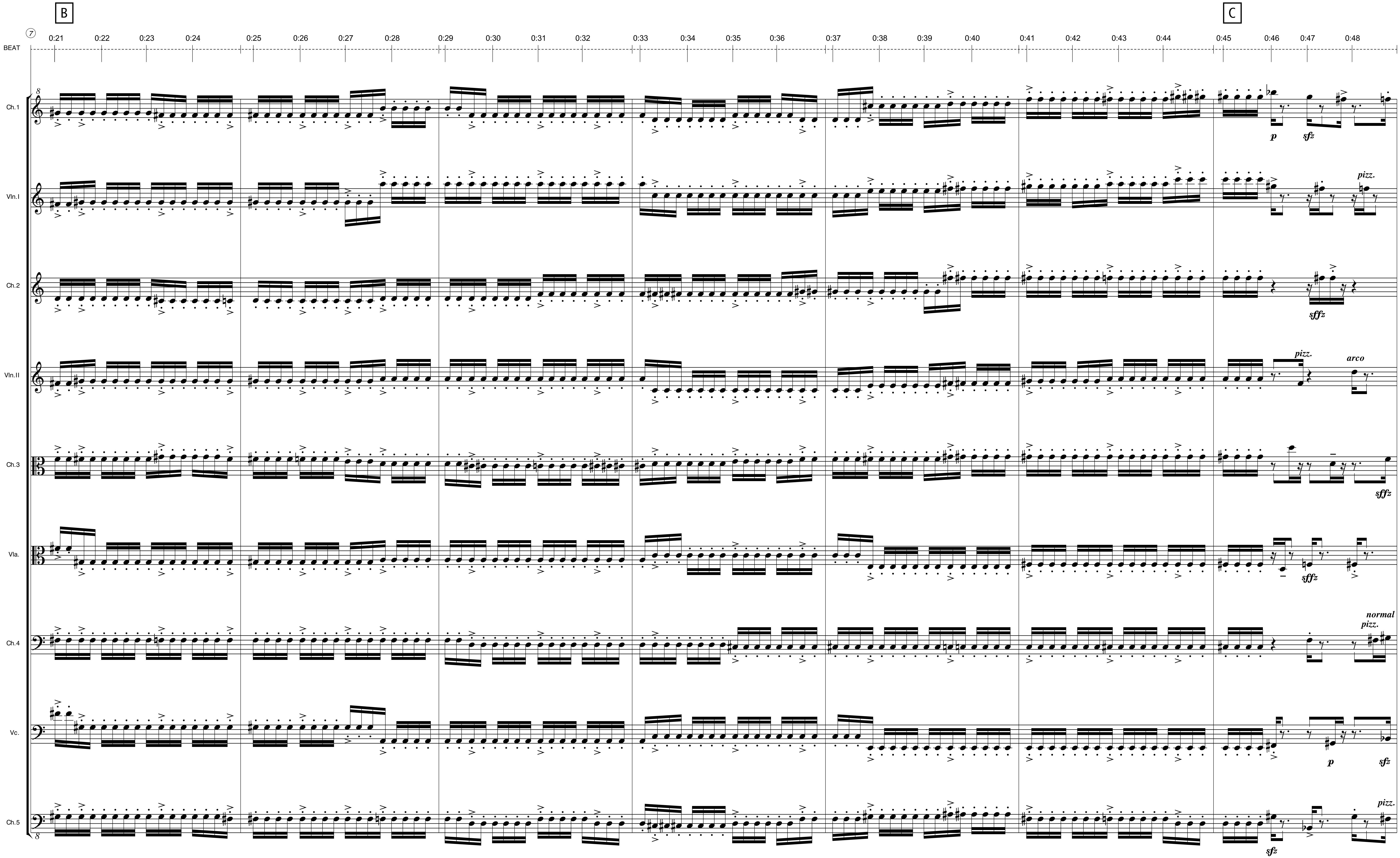
noneto

Nicolás Arnáez

3

Estampa de un Volar Complejo [Imprint of a Flying Complex]

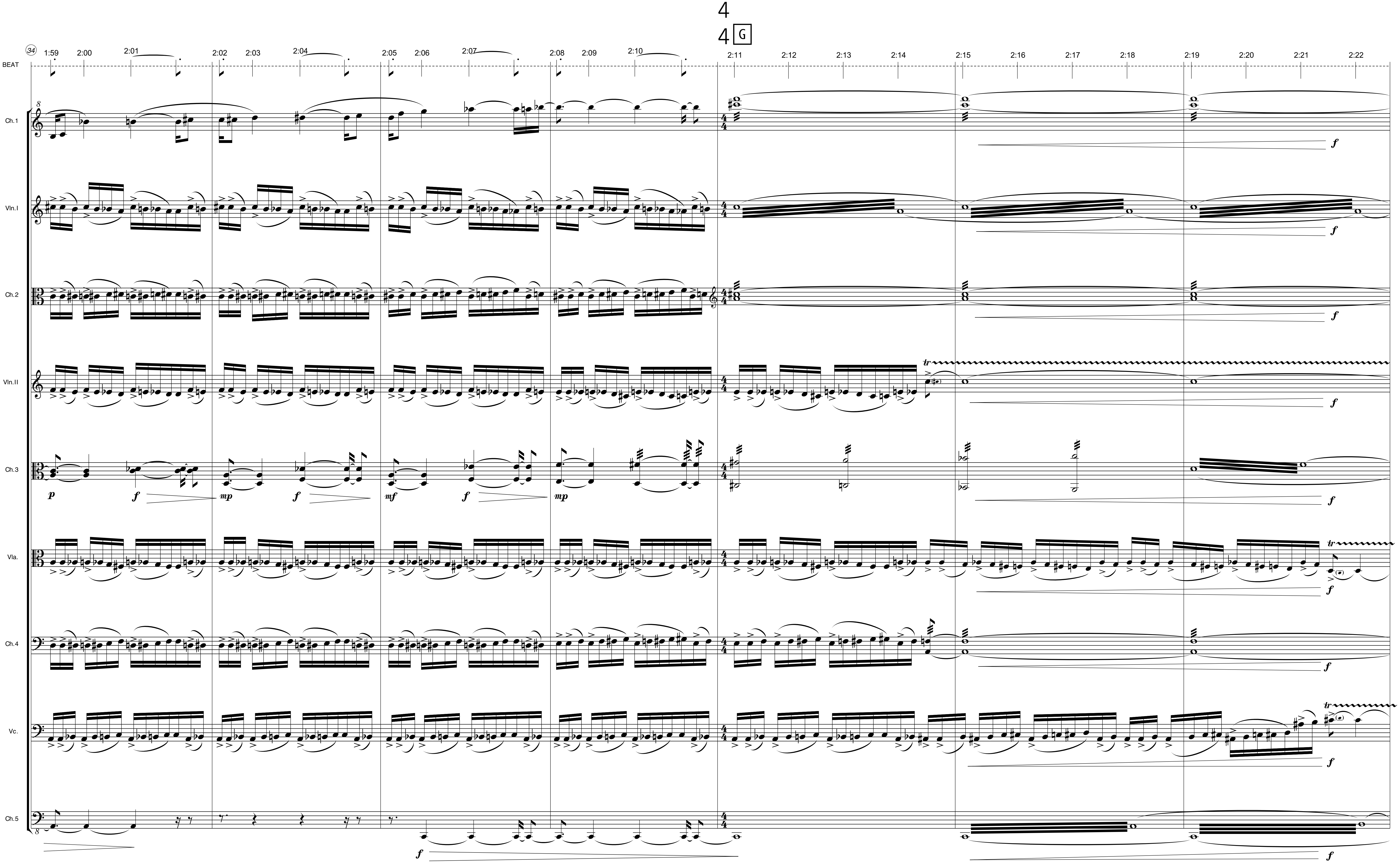



B
C
7
0:21 0:22 0:23 0:24 0:25 0:26 0:27 0:28 0:29 0:30 0:31 0:32 0:33 0:34 0:35 0:36 0:37 0:38 0:39 0:40 0:41 0:42 0:43 0:44 0:45 0:46 0:47 0:48
BEAT
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
p
sfz
pizz.
sffz
pizz.
arco
sffz
sffz
normal
pizz.
p
sfz
pizz.
sfz

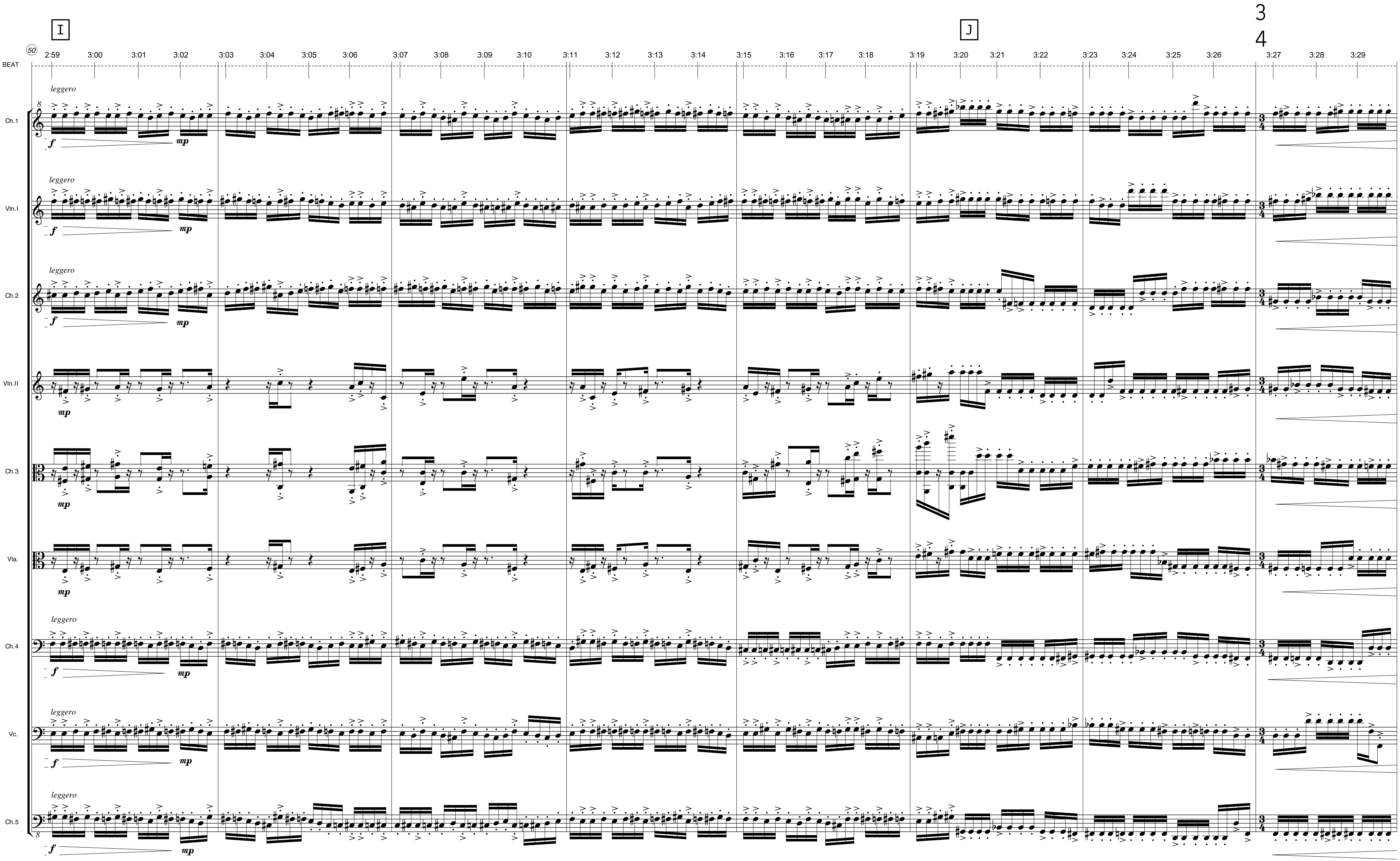

D
E
14
0:49 0:50 0:51 0:52 0:53 0:54 0:55 0:56 0:57 0:58 0:59 1:00 1:01 1:02 1:03 1:04 1:05 1:06 1:07 1:08 1:09 1:10 1:11 1:12 1:13 1:14 1:15 1:16
BEAT
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
pizz.
normal
arco
sul. pont.
leggero
espressivo
sffz
sfz
fp
f
p
pp

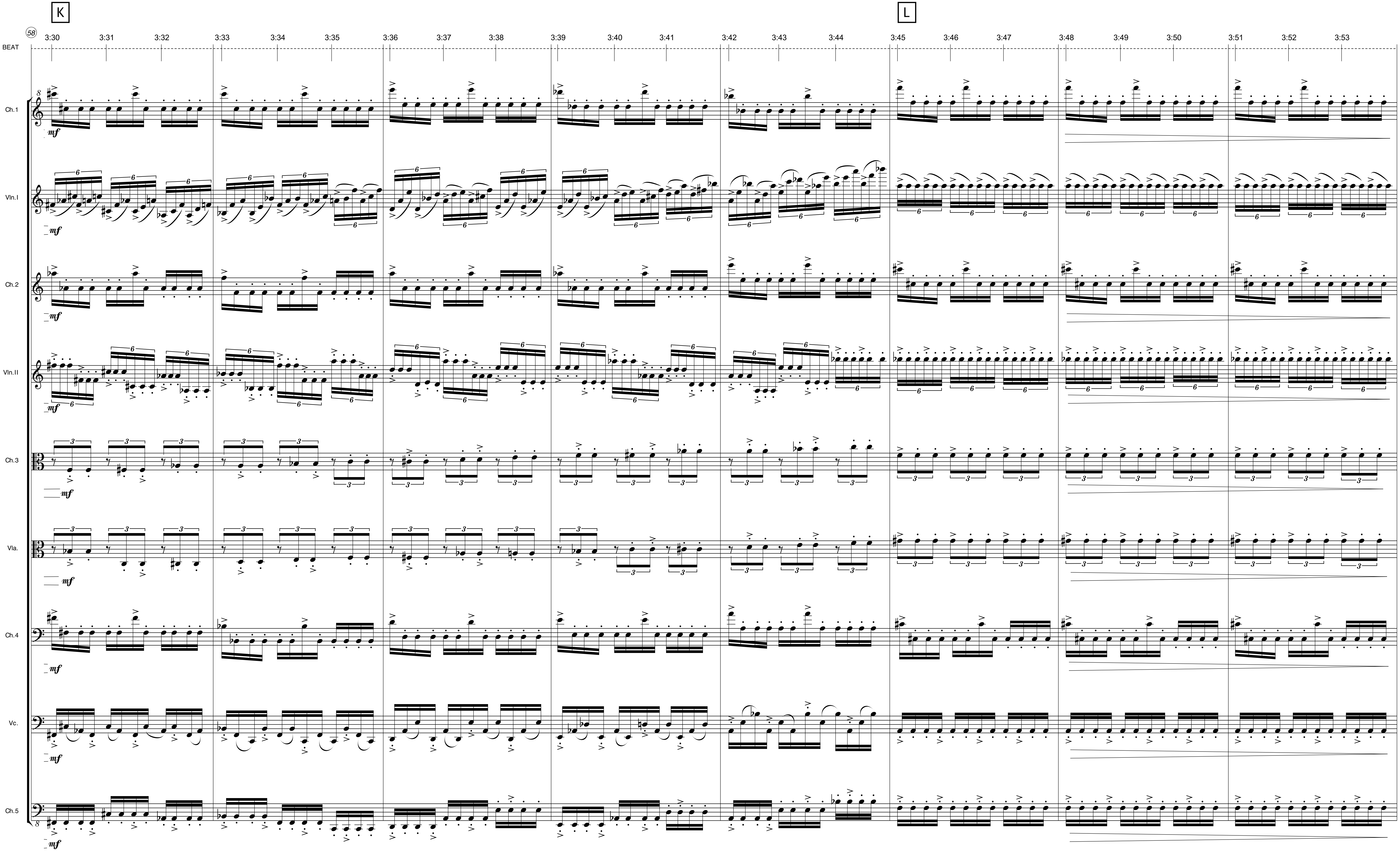

3/16 + 1/4 + 7/16
F
21
BEAT
1:17
1:18
1:19
1:20
1:21
1:22
1:23
1:24
1:25
1:26
1:27
1:28
1:29
1:30
1:31
1:32
1:33
1:34
1:35
1:36
1:37
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
pp
p
mf
mf
mf
f
p
f
p
f
mf
pp
f

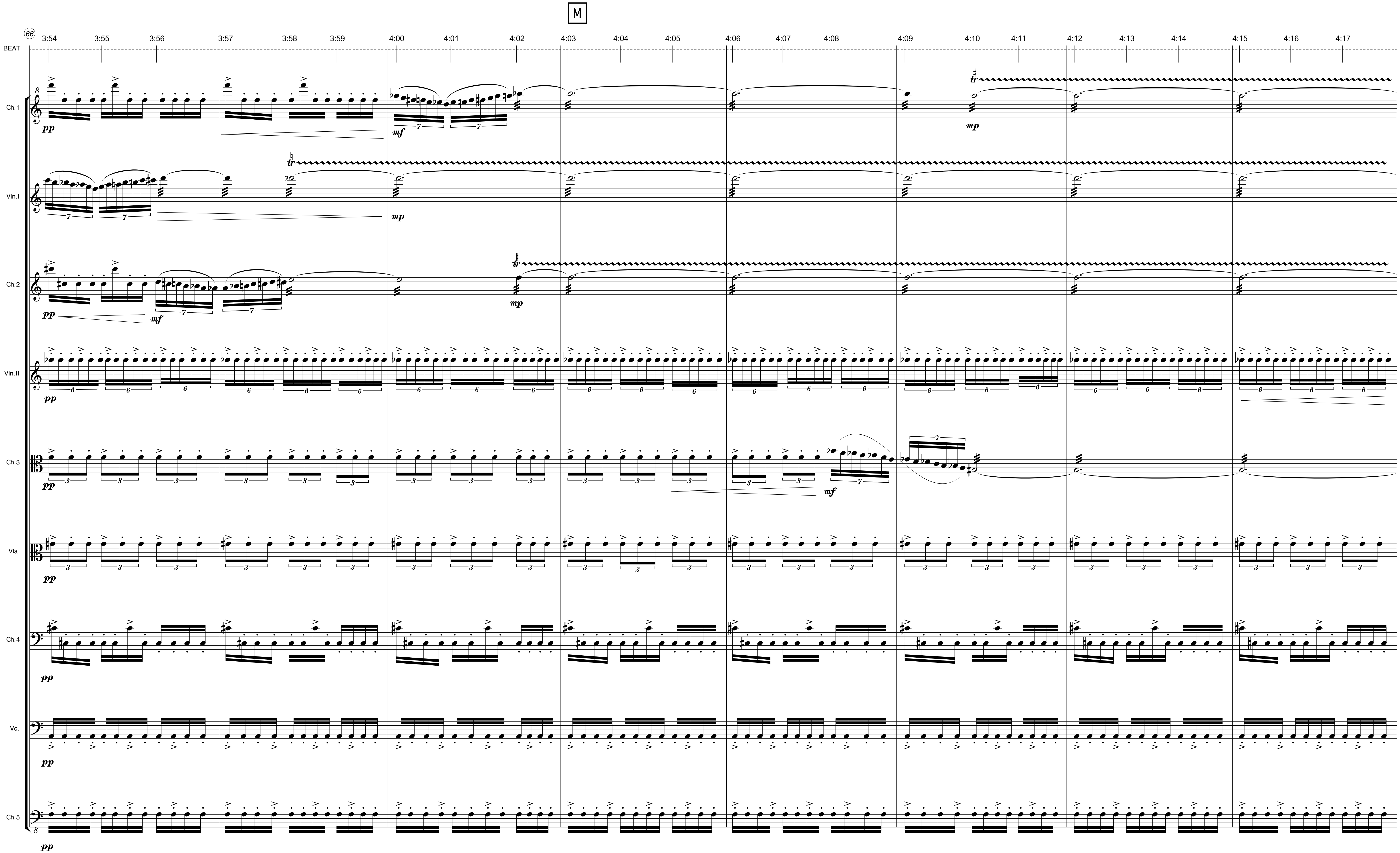

27
1:38 1:39 1:40 1:41 1:42 1:43 1:44 1:45 1:46 1:47 1:48 1:49 1:50 1:51 1:52 1:53 1:54 1:55 1:56 1:57 1:58
BEAT
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
p f
mf
f


4
4 G
34
1:59 2:00 2:01 2:02 2:03 2:04 2:05 2:06 2:07 2:08 2:09 2:10 2:11 2:12 2:13 2:14 2:15 2:16 2:17 2:18 2:19 2:20 2:21 2:22
BEAT
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
p f mp f mf f mp
tr
f

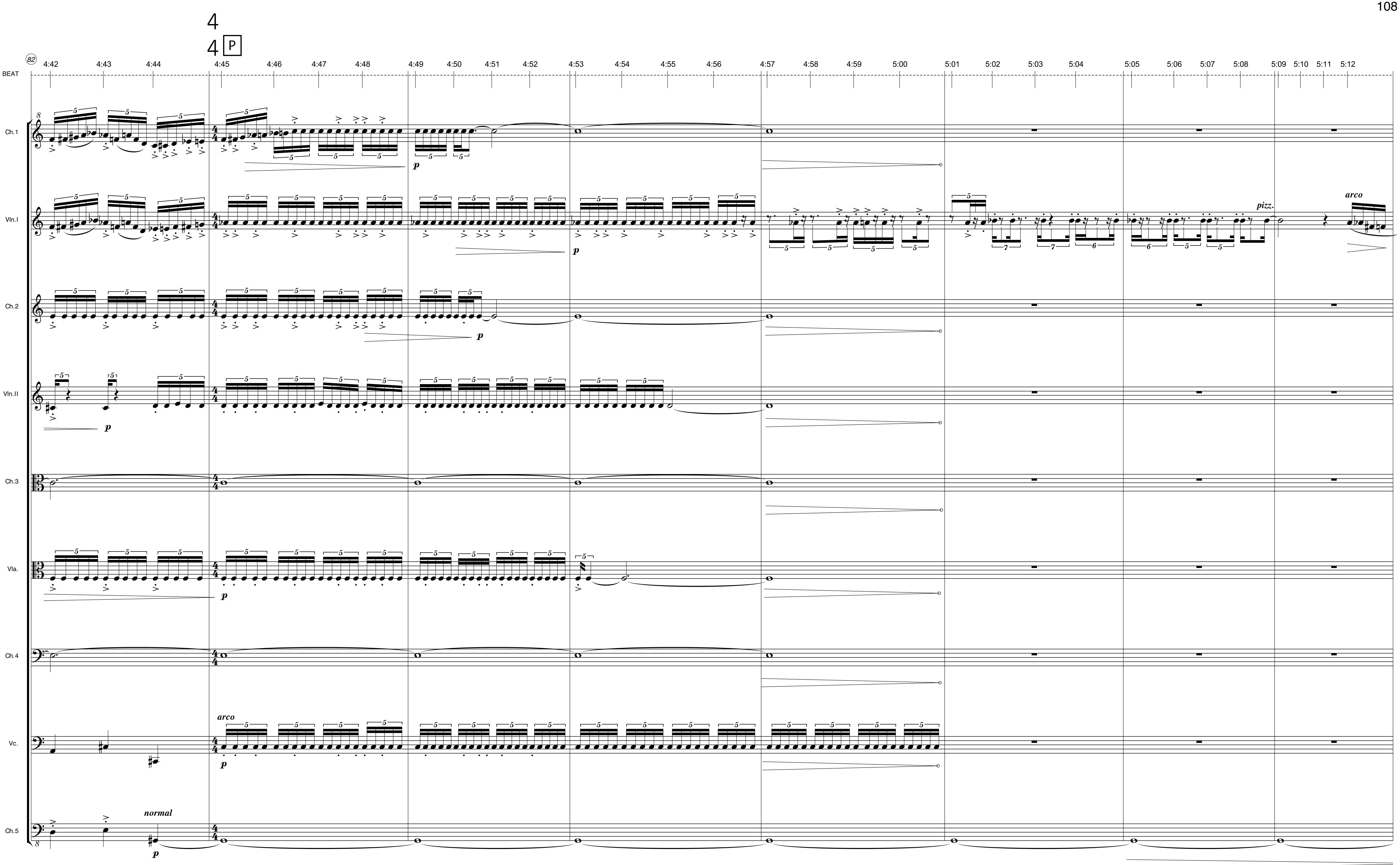

H
41
2:23 2:24 2:25 2:26 2:27 2:28 2:29 2:30 2:31 2:32 2:33 2:34 2:35 2:36 2:37 2:38 2:39 2:40 2:41 2:42 2:43 2:44 2:45 2:46 2:47 2:48 2:49 2:50 2:51 2:52 2:53 2:54 2:55 2:56 2:57 2:58
BEAT
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
leggero
etc....


I
J
3
4
50
2:59
3:00
3:01
3:02
3:03
3:04
3:05
3:06
3:07
3:08
3:09
3:10
3:11
3:12
3:13
3:14
3:15
3:16
3:17
3:18
3:19
3:20
3:21
3:22
3:23
3:24
3:25
3:26
3:27
3:28
3:29
BEAT
leggero
Ch.1
f
mp
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5

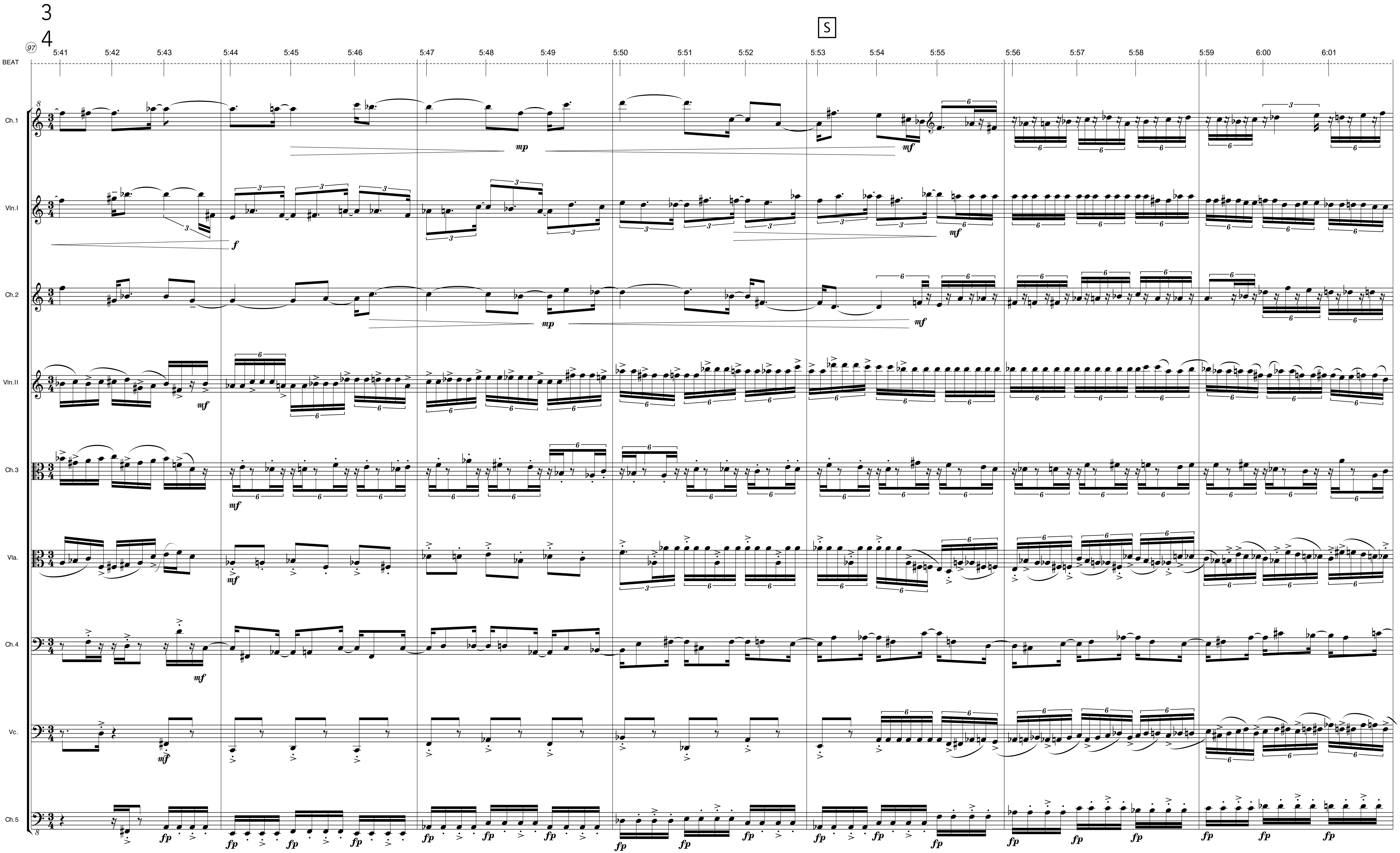

K
L
58
3:30
3:31
3:32
3:33
3:34
3:35
3:36
3:37
3:38
3:39
3:40
3:41
3:42
3:43
3:44
3:45
3:46
3:47
3:48
3:49
3:50
3:51
3:52
3:53
BEAT
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
mf


M
66
3:54
3:55
3:56
3:57
3:58
3:59
4:00
4:01
4:02
4:03
4:04
4:05
4:06
4:07
4:08
4:09
4:10
4:11
4:12
4:13
4:14
4:15
4:16
4:17
BEAT
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
pp
mf
mp

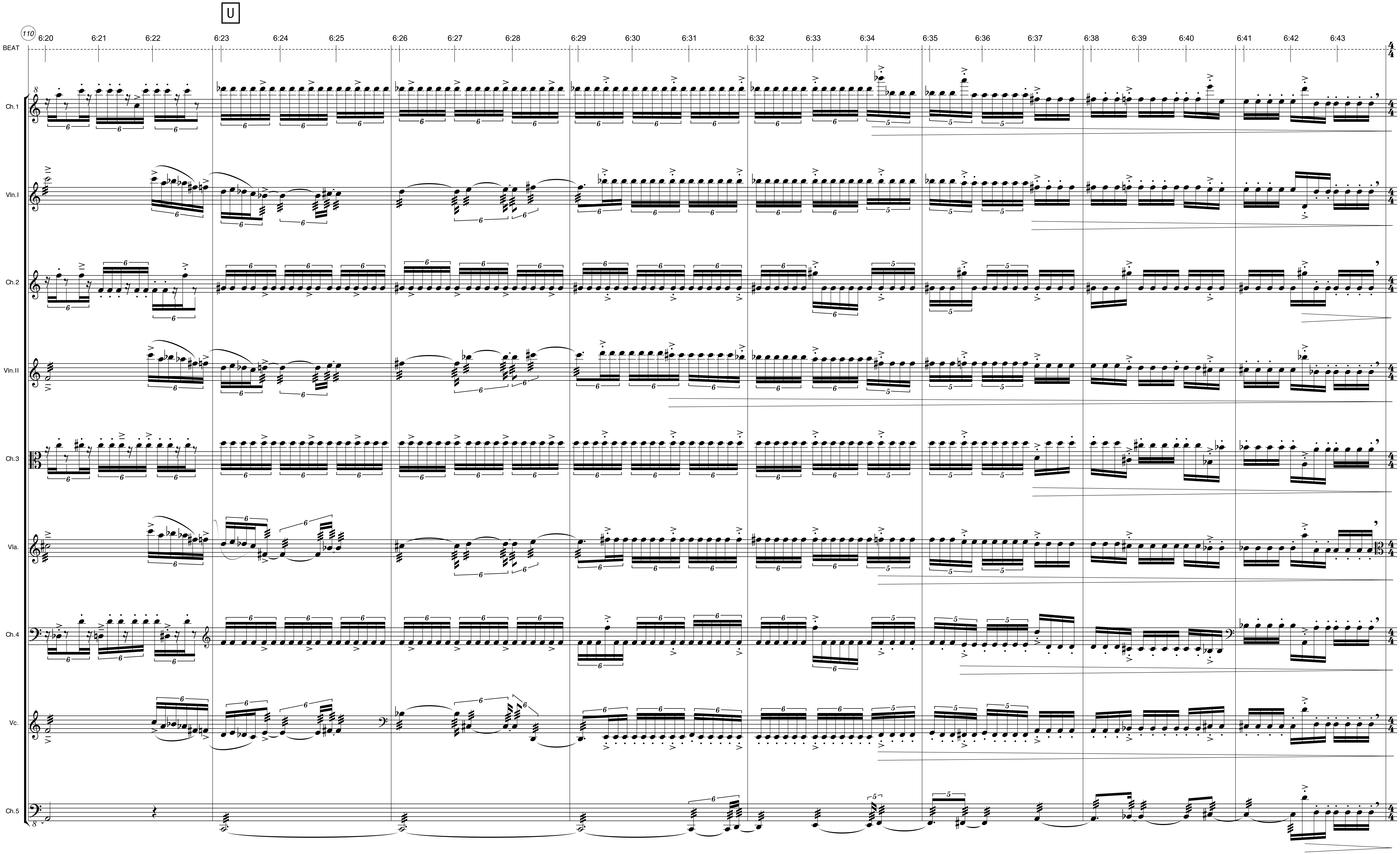

N
O
74
BEAT
4:18
4:19
4:20
4:21
4:22
4:23
4:24
4:25
4:26
4:27
4:28
4:29
4:30
4:31
4:32
4:33
4:34
4:35
4:36
4:37
4:38
4:39
4:40
4:41
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
pizz.
pizz.

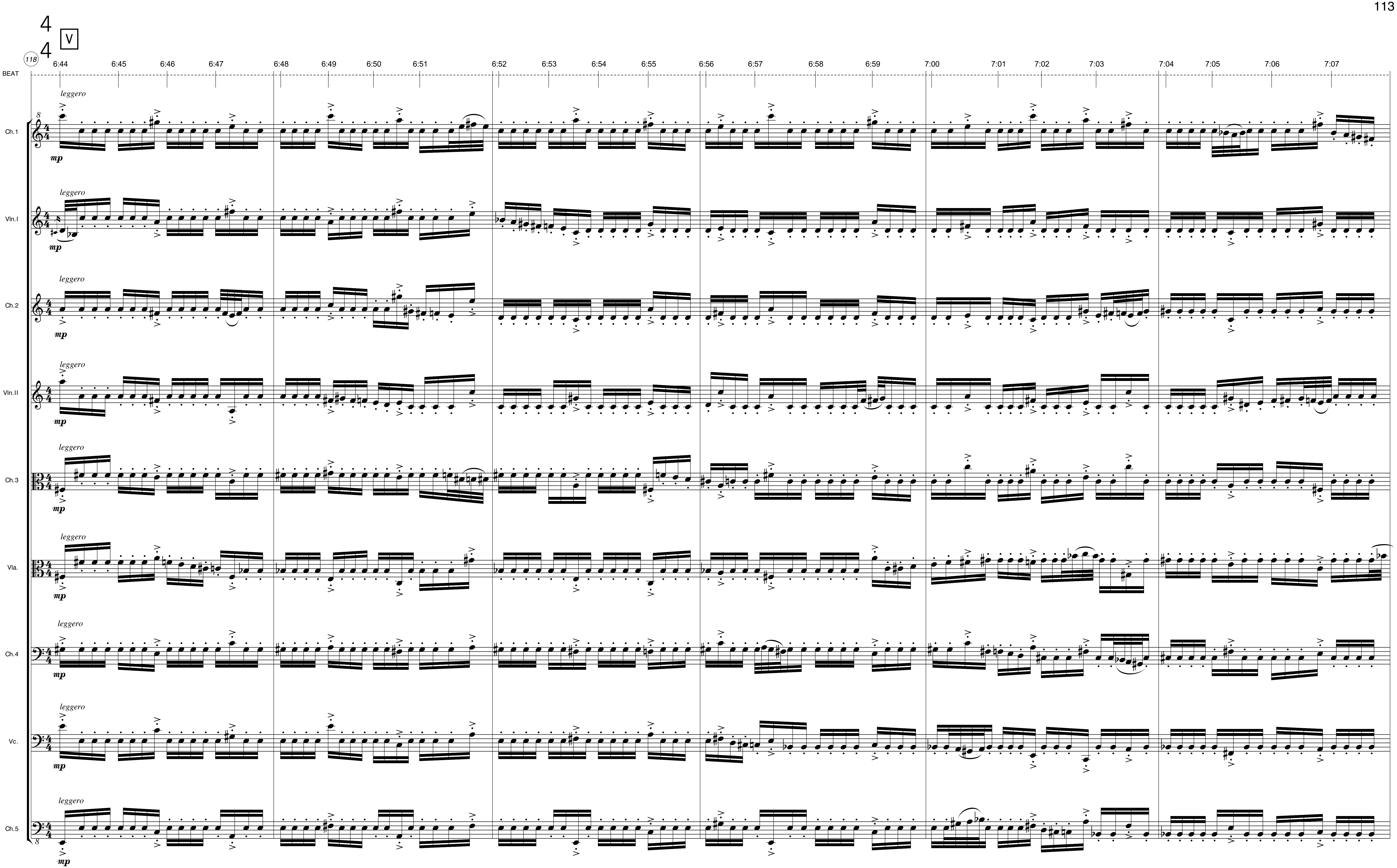

P
82
4:42 4:43 4:44 4:45 4:46 4:47 4:48 4:49 4:50 4:51 4:52 4:53 4:54 4:55 4:56 4:57 4:58 4:59 5:00 5:01 5:02 5:03 5:04 5:05 5:06 5:07 5:08 5:09 5:10 5:11 5:12
BEAT
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
pizz.
arco
arco
normal

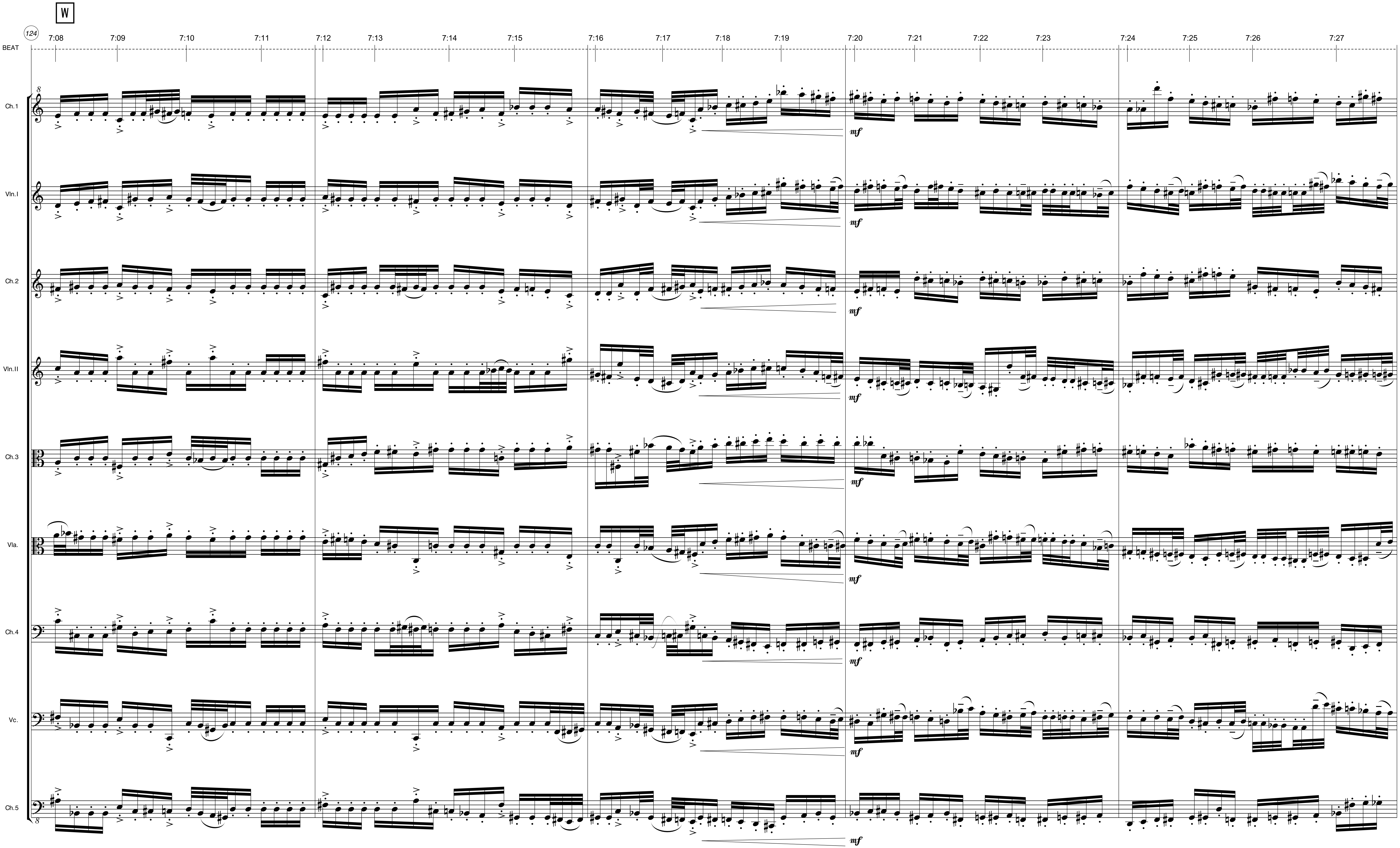

Q
R
90
BEAT
5:13
5:14
5:15
5:16
5:17
5:18
5:19
5:20
5:21
5:22
5:23
5:24
5:25
5:26
5:27
5:28
5:29
5:30
5:31
5:32
5:33
5:34
5:35
5:36
5:37
5:38
5:39
5:40
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
leggero
leggero
leggero
leggero
leggero
leggero

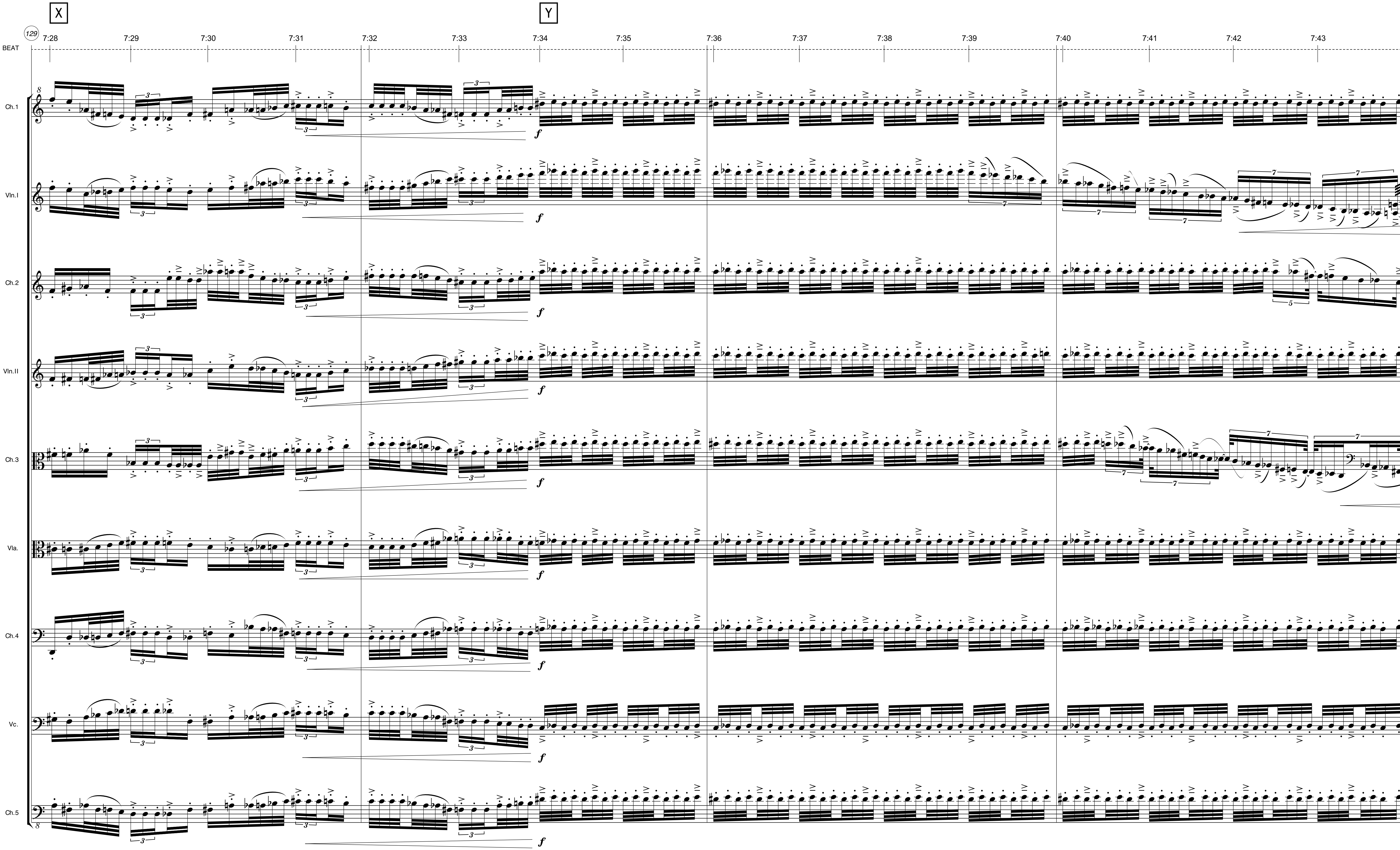

S
97
5:41
5:42
5:43
5:44
5:45
5:46
5:47
5:48
5:49
5:50
5:51
5:52
5:53
5:54
5:55
5:56
5:57
5:58
5:59
6:00
6:01
BEAT
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
mp
mf
f
fp

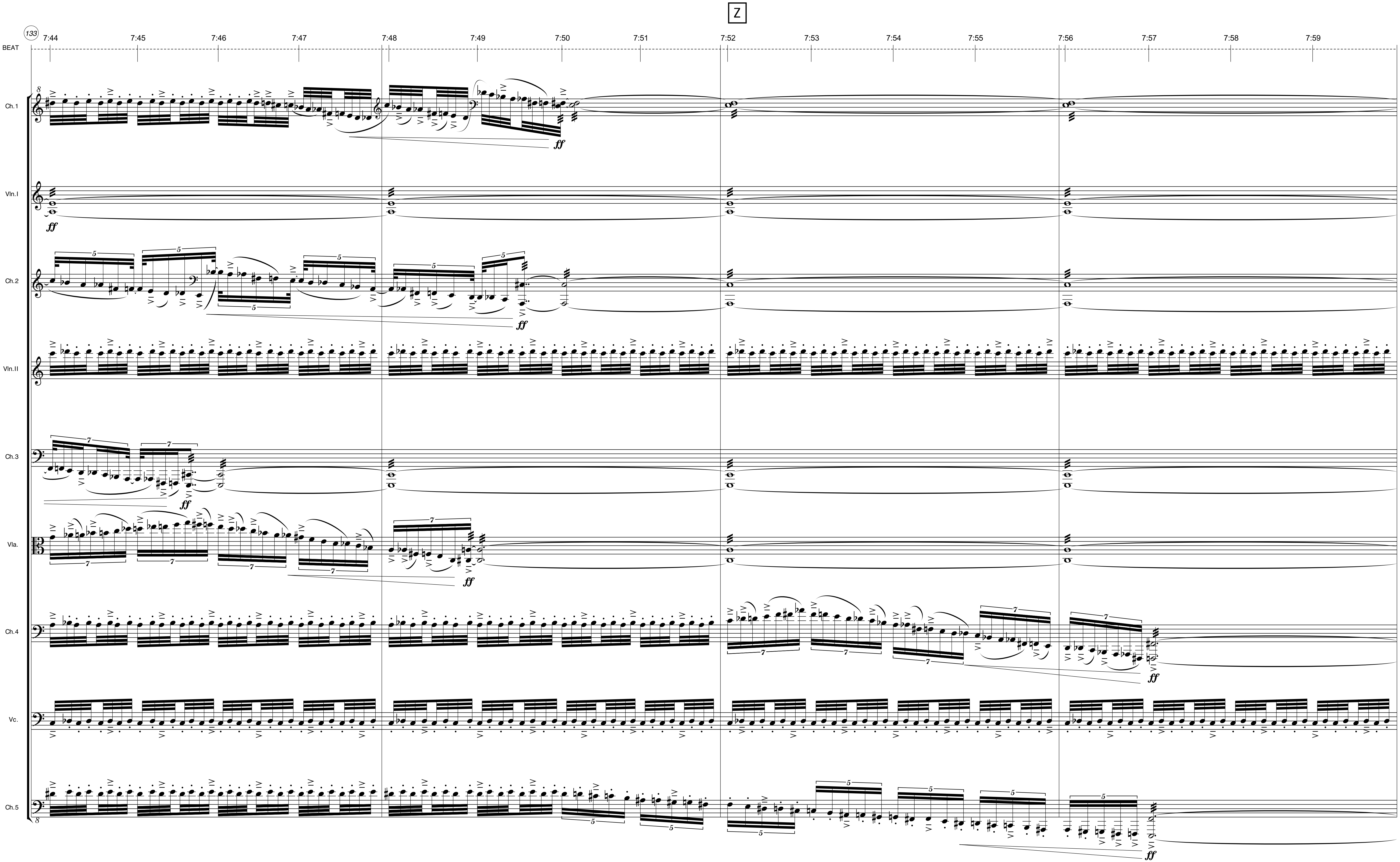

T
104
6:02
6:03
6:04
6:05
6:06
6:07
6:08
6:09
6:10
6:11
6:12
6:13
6:14
6:15
6:16
6:17
6:18
6:19
BEAT
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5


U
110
BEAT
6:20
6:21
6:22
6:23
6:24
6:25
6:26
6:27
6:28
6:29
6:30
6:31
6:32
6:33
6:34
6:35
6:36
6:37
6:38
6:39
6:40
6:41
6:42
6:43
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5


4/4
V
118
6:44
6:45
6:46
6:47
6:48
6:49
6:50
6:51
6:52
6:53
6:54
6:55
6:56
6:57
6:58
6:59
7:00
7:01
7:02
7:03
7:04
7:05
7:06
7:07
BEAT
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
leggero
mp


W
124
7:08
7:09
7:10
7:11
7:12
7:13
7:14
7:15
7:16
7:17
7:18
7:19
7:20
7:21
7:22
7:23
7:24
7:25
7:26
7:27
BEAT
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
mf


X
Y
129
7:28
7:29
7:30
7:31
7:32
7:33
7:34
7:35
7:36
7:37
7:38
7:39
7:40
7:41
7:42
7:43
BEAT
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5


Z
133
7:44
7:45
7:46
7:47
7:48
7:49
7:50
7:51
7:52
7:53
7:54
7:55
7:56
7:57
7:58
7:59
BEAT
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
ff


137
BEAT
8:00
8:01
8:02
8:03
8:04
8:05
8:06
8:07
8:08
8:09
8:10
8:11
8:12
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8:16
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8:18
8:19
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8:21
8:22
8:23
8:24
8:25
8:26
8:27
8:28
8:29
Ch.1
Vln.I
Ch.2
Vln.II
Ch.3
Vla.
Ch.4
Vc.
Ch.5
ff
fff
f
l.v.

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APPENDIX A - Listing of Associated Files.

File 1 - Name: NonetoMAX.zip

This zip file contains all the needed software to perform *Noneto* live. To have the patch running follow these steps (just on Mac computers).

1. Download Max from https://cycling74.com (trial version will run the patch, no need to purchase any license).
2. Install Max in a Mac computer (you must use Max version 8.0.6, or later).
3. Unzip the folder on the computer's desktop.
4. Open Max, and set up *Noneto* folder, as follow:
   Options > File Preferences > + > choose > (find *Noneto* on your desktop).
5. Reboot Max.
6. Open *Noneto* folder from your desktop, to run the piece with live musicians double click on "*Noneto (performance patch).maxpat*" to listen a live rendering of the piece, done with MIDI sampled string instruments double click on "*Noneto (listening patch).maxpat*"

If this file is not available for some reason, a copy of it can be downloaded from my webpage www.nicolas-arnaez.com

File 2 - Name: NonetoWAV.zip

This zip file contains three full quality audio files, they are listening files to use as a reference.

File 3 - NonetoSCORE.zip

This zip file contains a PDF of the sole score, in case it is needed separately form this thesis document.

APPENDIX B - Noneto MIDI Implementation Chart (ReDo Synth MIDI Management).

midievent	MIDI info	MIDI Ch	ReDo action	Values
144	Note on/off	1	Note on/off Ch1	Two value list: Pitch (0-127) – Velocity (0-127)
145	Note on/off	2	Note on/off Ch2	"
146	Note on/off	3	Note on/off Ch3	"
147	Note on/off	4	Note on/off Ch4	"
148	Note on/off	5	Note on/off Ch5	"
176 - 7	Volume value	1	Volume change Ch1	Single value: Volume level (0-127)
177 - 7	Volume value	2	Volume change Ch2	"
178 - 7	Volume value	3	Volume change Ch3	"
179 - 7	Volume value	4	Volume change Ch4	"
180 - 7	Volume value	5	Volume change Ch5	"
176 - 14	CC14	1	Take sample Ch1	Single value (127): Take sample. Other values ignored
177 - 14	CC14	2	Take sample Ch2	"
178 - 14	CC14	3	Take sample Ch3	"
179 - 14	CC14	4	Take sample Ch4	"
180 - 14	CC14	5	Take sample Ch5	"
176 - 15	CC15	1	Call preset Ch 1	Single value: Go to preset No (1-64 RESA modulation presets / 65-127 double modulation)
177 - 15	CC15	2	Call preset Ch 2	"
178 - 15	CC15	3	Call preset Ch 3	"
179 - 15	CC15	4	Call preset Ch 4	"
180 - 15	CC15	5	Call preset Ch 5	"
176 - 20	CC20	1	Vibrato rate Ch1	Single value: Vibrato rate level (0-127)
177 - 20	CC20	2	Vibrato rate Ch2	"
178 - 20	CC20	3	Vibrato rate Ch3	"
179 - 20	CC20	4	Vibrato rate Ch4	"
180 - 20	CC20	5	Vibrato rate Ch5	"
176 - 21	CC21	1	Vibrato depth Ch1	Single value: Vibrato depth level (0-127)
177 - 21	CC21	2	Vibrato depth Ch2	"
178 - 21	CC21	3	Vibrato depth Ch3	"
179 - 21	CC21	4	Vibrato depth Ch4	"
180 - 21	CC21	5	Vibrato depth Ch5	"

176 - 22	CC22	1	Vibrato Shape Ch1	Single value: Vibrato Shape (0-127)
177 - 22	CC22	2	Vibrato Shape Ch2	"
178 - 22	CC22	3	Vibrato Shape Ch3	"
179 - 22	CC22	4	Vibrato Shape Ch4	"
180 - 22	CC22	5	Vibrato Shape Ch5	"
176 - 23	CC23	1	Tremolo rate Ch1	Single value: Tremolo rate level (0-127)
177 - 23	CC23	2	Tremolo rate Ch2	"
178 - 23	CC23	3	Tremolo rate Ch3	"
179 - 23	CC23	4	Tremolo rate Ch4	"
180 - 23	CC23	5	Tremolo rate Ch5	"
176 - 24	CC24	1	Tremolo depth Ch1	Single value: Tremolo depth level (0-127)
177 - 24	CC24	2	Tremolo depth Ch2	"
178 - 24	CC24	3	Tremolo depth Ch3	"
179 - 24	CC24	4	Tremolo depth Ch4	"
180 - 24	CC24	5	Tremolo depth Ch5	"
176 - 25	CC25	1	Tremolo shape Ch1	Single value: Tremolo shape (0-127)
177 - 25	CC25	2	Tremolo shape Ch2	"
178 - 25	CC25	3	Tremolo shape Ch3	"
179 - 25	CC25	4	Tremolo shape Ch4	"
180 - 25	CC25	5	Tremolo shape Ch5	"

APPENDIX C - Usage of ReDo synth in Noneto, Full Chart.

First Movement

Channel No.	Preset recalled at BEAT No	Preset number recalled	Synthesis used	Take sample at	To play between beats
1	-7	65 (1)	Double	-	0:01 - 0:07
	0:36	66 (2)	Double	-	0:37 - 0:49
	0:50	1	Live	0:32	0:51 - 1:30
	1:33	67 (3)	Double	-	1:34 - 2:28
	3:46	2	Live	3:44	3:47 - 4:20
	4:23	68 (4)	Double	-	4:24 - 5:28
	5:31	69 (5)	Double	-	5:32 - 5:53
	5:55	70 (6)	Double	-	5:56 - 7:07
	7:08	71 (7)	Double	-	7:08 - 7:16
	7:18	72(8)	Double	-	7:19 - 7:25
	7:26	73 (9)	Double	-	7:26 - 7:52
	7:53	74 (10)	Double	-	7:54 - 7:59
	8:02	71 (7)	Double	-	8:02
2	-7	65 (1)	Double	-	0:01 - 0:07
	0:36	66 (2)	Double	-	0:37 - 0:49
	0:52	1	Live	0:32	0:53 - 1:32
	1:37	67 (3)	Double	-	1:38 - 2:28
	3:46	2	Live	3:44,5	3:47 - 4:20
	4:23	68 (4)	Double	-	4:24 - 5:28
	5:30	69 (5)	Double	-	5:31 - 5:46
	5:46	70 (6)	Double	-	5:47 - 6:27
	6:31	3	Live	6:12	6:32 - 7:07
	7:08	71 (7)	Double	-	7:08 - 7:16
	7:18	72(8)	Double	-	7:19 - 7:25
	7:26	73 (9)	Double	-	7:26 - 7:52
	7:53	74 (10)	Double	-	7:54 - 7:59
	8:02	71 (7)	Double	-	8:02
3	-7	65 (1)	Double	-	0:01 - 0:35
	0:36	66 (2)	Double	-	0:37 - 0:49
	0:53	1	Live	0:35,5	0:54 - 1:32
	1:39	67 (3)	Double	-	1:40 - 2:28
	3:46	2	Live	3:44,5	3:47 - 4:20
	4:23	68 (4)	Double	-	4:24 - 5:28
	5:29	69 (5)	Double	-	5:30 - 6:11
	6:15	70 (6)	Double	-	6:15 - 7:07
	7:08	71 (7)	Double	-	7:08 - 7:16
	7:18	72(8)	Double	-	7:19 - 7:25
	7:26	73 (9)	Double	-	7:26 - 7:52

	7:53	74 (10)	Double	-	7:54 - 7:59
	8:02	71 (7)	Double	-	8:02
4	-7	65 (1)	Double	-	0:01 - 0:07
	0:36	66 (2)	Double	-	0:37 - 0:49
	0:49,5	1	Live	0:32	0:50 - 1:32
	1:37	67 (3)	Double	-	1:38 - 2:28
	3:46	2	Live	3:44	3:47 - 4:20
	4:23	68 (4)	Double	-	4:24 - 5:28
	5:30	69 (5)	Double	-	5:30 - 5:35
	5:36	70 (6)	Double	-	5:36 - 7:07
	7:08	71 (7)	Double	-	7:08 - 7:16
	7:18	72(8)	Double	-	7:19 - 7:25
	7:26	73 (9)	Double	-	7:26 - 7:53
	7:53	74 (10)	Double	-	7:54 - 7:59
	8:02	71 (7)	Double	-	8:02
5	-7	65 (1)	Double	-	0:01 - 0:07
	0:36	66 (2)	Double	-	0:37 - 0:49
	0:51	1	Live	0:31,5	0:52 - 1:32
	1:35	67 (3)	Double	-	1:36 - 2:37
	3:46	2	Live	3:44	3:47 - 4:20
	4:23	68 (4)	Double	-	4:24 - 5:28
	5:32	69 (5)	Double	-	5:33 - 5:57
	6:00	70 (6)	Double	-	6:01 - 7:07
	7:08	71 (7)	Double	-	7:08 - 7:16
	7:18	72(8)	Double	-	7:19 - 7:25
	7:26	73 (9)	Double	-	7:26 - 7:52
	7:53	74 (10)	Double	-	7:54 - 7:59
	8:02	71 (7)	Double	-	8:02

Second movement

Channel No.	Preset recalled at BEAT No	Preset number recalled	Synthesis used	Take sample at	To play between beats
1	-5	85 (21)	Double	-	0:01 - 0:44
	1:08	21	Live	1:02	1:09 - 2:18
	2:19	86 (22)	Double	-	2:19 - 3:00
	3:01	87 (23)	Double	-	3:01 - 3:11
	3:40	23	Live	3:31	3:40 - 4:43
2	-5	85 (21)	Double	-	0:01 – 1:30
	1:31	21	Live	1:21	1:31 - 2:22
	2:23	86 (22)	Double	-	2:23 - 3:00
	3:01	87 (23)	Double	-	3:01 - 3:34
	3:35	23	Live	3:31	3:35 - 4:43

3	-5	85 (21)	Double	-	0:01 – 1:02
	1:16	21	Live	1:09	1:16 - 2:30
	2:31	86 (22)	Double	-	2:31 - 3:00
	3:01	87 (23)	Double	-	3:01 - 3:38
	3:35	23	Live	3:31	3:53 - 4:43
4	-5	85 (21)	Double	-	0:01 - 0:58
	1:18	21	Live	1:09	1:18 - 2:20
	2:21	86 (22)	Double	-	2:21 - 3:00
	3:01	87 (23)	Double	-	3:01 - 3:34
	3:35	23	Live	3:31	3:35 - 4:43
5	-5	85 (21)	Double	-	0:01 - 1:30

Third movement

Channel No.	Preset recalled at BEAT No	Preset number recalled	Synthesis used	Take sample at	To play between beats
1	0:06	105 (41)	Double	-	0:06 -0:45
	0:46	106 (42)	Double	-	0:46 -0:48
	0:50	113 (49)	Double (pizz)	-	0:50
	0:51	106 (42)	Double	-	0:51 - 0:54
	0:56	107 (43)	Double	-	0:56 - 1:03
	1:05	108 (44)	Double	-	1:05 - 2:10
	2:11	109 (45)	Double	-	2:11 - 2:26
	2:31	110 (46)	Double	-	2:31
	2:32	111 (47)	Double	-	2:32 - 2:34
	2:34	112 (48)	Double	-	2:34 - 2:48
	2:49	105 (41)	Double	-	2:49 - 3:19
	3:20	106 (42)	Double	-	3:20 - 3:29
	3:30	107 (43)	Double	-	3:30 - 3:44
	3:45	108 (44)	Double	-	3:45 - 4:09
	4:10	109 (45)	Double	-	4:10 - 4:29
	4:30	110 (46)	Double	-	4:30 - 4:50
	4:50	111 (47)	Double	-	4:50 - 5:00
	5:13	105 (41)	Double	-	5:13 - 5:32
	5:33	106 (42)	Double	-	5:33 - 5:44
	5:44	107 (43)	Double	-	5:44 - 5:54
	5:55	108 (44)	Double	-	5:55 - 6:10
	6:11	109 (45)	Double	-	6:11 - 6:22
	6:23	110 (46)	Double	-	6:23 - 6:29
	6:29	111 (47)	Double	-	6:29 - 6:34
	6:34	112 (48)	Double	-	6:34 - 6:41
	6:42	105 (41)	Double	-	6:42 - 7:17
	7:17	106 (42)	Double	-	7:17 - 7:27

	7:28	107 (43)	Double	-	7:28 - 7:33
	7:34	108 (44)	Double	-	7:34 - 7:49
	7:50	109 (45)	Double	-	7:50 - 8:01
	8:04	110 (46)	Double	-	8:04 - 8:08
	8:10	111 (47)	Double	-	8:10 - 8:14
	8:14	112 (48)	Double	-	8:17 - 8:25
2	0:08	105 (41)	Double	-	0:08 - 0:45
	0:47	106 (42)	Double	-	0:47 - 0:52
	0:53	113 (49)	Double (pizz)	-	0:53
	0:54	106 (42)	Double	-	0:54 - 0:55
	0:56	107 (43)	Double	-	0:56 - 1:03
	1:05	108 (44)	Double	-	1:05 - 2:10
	2:11	109 (45)	Double	-	2:11 - 2:26
	2:31	110 (46)	Double	-	2:31
	2:32	111 (47)	Double	-	2:32 - 2:34
	2:34	112 (48)	Double	-	2:34 - 2:48
	2:49	105 (41)	Double	-	2:49 - 3:19
	3:20	106 (42)	Double	-	3:20 - 3:29
	3:30	107 (43)	Double	-	3:30 - 3:44
	3:45	108 (44)	Double	-	3:45 - 4:01
	4:02	109 (45)	Double	-	4:02 - 4:29
	4:30	110 (46)	Double	-	4:30 - 5:00
	5:14	105 (41)	Double	-	5:14 - 5:32
	5:33	106 (42)	Double	-	5:33 - 5:42
	5:43	107 (43)	Double	-	5:43 - 5:54
	5:54	108 (44)	Double	-	5:55 - 6:08
	6:09	109 (45)	Double	-	6:09 - 6:22
	6:23	110 (46)	Double	-	6:23 - 6:29
	6:29	111 (47)	Double	-	6:29 - 6:32
	6:33	112 (48)	Double	-	6:34 - 6:41
	6:42	105 (41)	Double	-	6:42 - 7:17
	7:17	106 (42)	Double	-	7:17 - 7:27
	7:28	107 (43)	Double	-	7:28 - 7:33
	7:34	108 (44)	Double	-	7:34 - 7:49
	7:49	109 (45)	Double	-	7:50 - 8:01
	8:04	110 (46)	Double	-	8:04 - 8:08
	8:10	111 (47)	Double	-	8:10 - 8:14
	8:14	112 (48)	Double	-	8:17 - 8:25
3	0:06	105 (41)	Double	-	0:07 - 0:45
	0:46	106 (42)	Double	-	0:46 - 0:54
	0:55	113 (49)	Double (pizz)	-	0:55
	0:56	107 (43)	Double	-	0:56 - 1:03
	1:05	108 (44)	Double	-	1:05 - 2:18
	2:19	109 (45)	Double	-	2:19 - 2:26
	2:31	110 (46)	Double	-	2:31

	2:32	111 (47)	Double	-	2:32 - 2:34
	2:34	112 (48)	Double	-	2:34 - 2:48
	2:50	105 (41)	Double	-	2:50 - 3:19
	3:20	106 (42)	Double	-	3:20 - 3:29
	3:30	107 (43)	Double	-	3:30 - 3:44
	3:45	108 (44)	Double	-	3:45 - 4:19
	4:20	109 (45)	Double	-	4:20 - 4:29
	4:36	110 (56)	Double	-	4:36 - 5:00
	5:14	105 (41)	Double	-	5:14 - 5:32
	5:33	106 (42)	Double	-	5:33 - 5:43
	5:44	107 (43)	Double	-	5:44 - 6:13
	6:14	108 (44)	Double	-	6:14 - 6:22
	6:23	110 (46)	Double	-	6:23 - 6:29
	6:29	111 (47)	Double	-	6:29 - 6:36
	6:37	112 (48)	Double	-	6:37 - 6:41
	6:42	105 (41)	Double	-	6:42 - 7:17
	7:17	106 (42)	Double	-	7:17 - 7:27
	7:28	107 (43)	Double	-	7:28 - 7:33
	7:34	108 (44)	Double	-	7:34 - 7:45
	7:45	109 (45)	Double	-	7:45 - 8:01
	8:04	110 (46)	Double	-	8:04 - 8:08
	8:10	111 (47)	Double	-	8:10 - 8:14
	8:14	112 (48)	Double	-	8:17 - 8:25
	0:09	105 (41)	Double	-	0:09 - 0:45
	0:46	106 (42)	Double	-	0:47
	0:47	113 (49)	Double (pizz)	-	0:48
	0:50	106 (42)	Double	-	0:50 - 0:55
	0:56	107 (43)	Double	-	0:56 - 1:03
	1:05	108 (44)	Double	-	1:05 - 2:14
	2:14	109 (45)	Double	-	2:14 - 2:26
	2:31	110 (46)	Double	-	2:31
	2:32	111 (47)	Double	-	2:32 - 2:34
	2:34	112 (48)	Double	-	2:34 - 2:46
4	2:47	105 (41)	Double	-	2:47 - 3:19
	3:20	106 (42)	Double	-	3:20 - 3:29
	3:30	107 (43)	Double	-	3:30 - 3:44
	3:45	108 (44)	Double	-	3:45 - 4:27
	4:28	109 (45)	Double	-	4:28 - 4:29
	4:37	110 (46)	Double	-	4:37 - 5:00
	5:16	105 (41)	Double	-	5:16 - 5:32
	5:33	106 (42)	Double	-	5:33 - 5:42
	5:43	107 (43)	Double	-	5:43 - 6:05
	6:05	108 (44)	Double	-	6:05 - 6:10
	6:10	109 (45)	Double	-	6:11 - 6:22
	6:23	110 (46)	Double	-	6:23 - 6:29

	6:29	111 (47)	Double	-	6:29 - 6:32
	6:33	112 (48)	Double	-	6:33 - 6:41
	6:42	105 (41)	Double	-	6:42 - 7:17
	7:17	106 (42)	Double	-	7:17 - 7:27
	7:28	107 (43)	Double	-	7:28 - 7:33
	7:34	108 (44)	Double	-	7:34 - 7:56
	7:57	109 (45)	Double	-	7:57 - 8:01
	8:04	110 (46)	Double	-	8:04 - 8:08
	8:10	111 (47)	Double	-	8:10 - 8:14
	8:14	112 (48)	Double	-	8:17 - 8:25
5	0:06	105 (41)	Double	-	0:07 - 0:45
	0:46	106 (42)	Double	-	0:46 0:48
	0:48	113 (49)	Double (pizz)	-	0:48
	0:49	106 (42)	Double	-	0:49 - 0:55
	0:55	107 (43)	Double	-	0:56 - 1:03
	1:05	108 (44)	Double	-	1:05 - 2:14
	2:15	109 (45)	Double	-	2:15 - 2:26
	2:31	110 (46)	Double	-	2:31
	2:32	111 (47)	Double	-	2:32 - 2:34
	2:34	112 (48)	Double	-	2:34 - 2:46
	2:47	105 (41)	Double	-	2:47 - 3:19
	3:20	106 (42)	Double	-	3:20 - 3:29
	3:30	107 (43)	Double	-	3:30 - 3:44
	3:45	108 (44)	Double	-	3:45 - 4:27
	4:28	109 (45)	Double	-	4:28 - 4:29
	4:30	110 (46)	Double	-	4:30 - 4:43
	4:44	111 (47)	Double	-	4:44 - 5:14
	5:29	105 (41)	Double	-	5:29 - 5:32
	5:33	106 (42)	Double	-	5:33 - 5:42
	5:43	107 (43)	Double	-	4:43 - 6:05
	6:05	108 (44)	Double	-	6:06 - 6:21
	6:23	110 (45)	Double	-	6:23 - 6:41
	6:42	105 (41)	Double	-	6:42 - 7:17
	7:17	106 (42)	Double	-	7:17 - 7:27
	7:28	107 (43)	Double	-	7:28 - 7:33
	7:34	108 (44)	Double	-	7:34 - 7:56
	7:57	109 (45)	Double	-	7:57 - 8:01
	8:04	110 (46)	Double	-	8:04 - 8:08
	8:10	111 (47)	Double	-	8:10 - 8:14
	8:14	112 (48)	Double	-	8:17 - 8:25