structured cell

for 10 musicians, live electronics in a 22.2 speaker array,
recorded in a 22.2 3D audio recording session

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A thesis submitted to McGill University in partial fulfillment of the requirements of the degree of Doctor of Music

Abstract

Spatialization as a compositional parameter in multi-speaker environments opens many new opportunities in music research while simultaneously highlighting several important questions. How can space be used as an effective compositional tool? On a technical level, in which manner will the spatialization be implemented in a space? How would one capture an acoustic space in a recording that would emulate an environment accurately? How can we reimagine a performance space to enhance the experience of contemporary music? These were the questions driving the composition 'structured cell'. The piece was written for 10 performers, a 22.2 speaker dome surrounding the musicians performed with MaxMSP and live electronics, in collaboration with sound engineer and 3D audio specialist Will Howie captured in a 22.2 3D private audio recording session.

Résumé

La spatialisation en tant que paramètre de composition dans des environnements à haut-parleurs multiples ouvre de nouvelles opportunités en recherche musicale, tout en accentuant plusieurs questions importantes. Comment l'espace peut-il être utilisé en tant qu'outil de composition efficace? Au niveau technique, de quelle manière peut-on implémenter la spatialisation dans un espace ? Comment ré-imaginer une salle de spectacle afin d'améliorer l'expérience de la musique contemporaine? Ce sont ces questions qui poussaient la composition «structured cell (cellule à structure)». La pièce a été écrite pour dix interprètes et un dôme de haut-parleurs ambiophonique en format 22.2 entourant les musiciens, pour être interprétée en utilisant MaxMSP et des sons électroniques en live, en collaboration avec Will Howie, ingénieur du son et spécialiste en audio 3D, qui en a fait la capture de son lors d'une séance d'enregistrement d'audio 3D en format 22.2.

Acknowledgements

I would like to thank Professor Brian Cherney for his incredible patience as an advisor and support to navigate the complexities of the academic process from start to finish. I would also like to thank my colleague in video production Professor George Massenburg for his patience and time for the constant questions and technical challenges dealing with the complexities of working with technology in high pressure production environments. Also, providing the jobs and crazy opportunities over the years that helped fund my degree.

I would like to thank the Composition Area for the teaching positions that allowed me to work in the Digital Composition Studio (hopefully similar opportunities are available to future graduate students!) and the DCS technician Richard Mackenzie who has worked through many technical issues throughout the years and helped with the setup of this project. Also, Professor Peter Schubert for conducting the project and introducing me to the right people at McGill. Lastly, Brice Gatinet and Jack Kelly who both were excellent co-instructors willing to take a creative approach to teaching.

Also, CIRMMT for funding this thesis and providing the equipment to complete this project.
I would like to thank my colleagues in the DMus program that gave challenging and thoughtful perspectives in music and work.

Furthermore, the stage managers and all of the other members of the Schulich School of Music who provided me with the means to work freely and creatively in the spaces provided.

Lastly, I would like to thank my partner on the opposite side of the planet JiHye Kim, who supported me on this long journey and has had the patience to let me explore my musical ideas.

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Chapter 1: Origins

1.1 Introduction

structured cell was designed to exploit the performance spaces and compositional/technical resources at my disposal at the Schulich School of Music. The composition resulted from the nature of my work environment during my studies at McGill University. The challenge was how to process various influences, use the technological resources in a configuration that maximized their potential, but aligned with an aesthetic concept that explored new possibilities. The design of *structured cell* reflects my combined experiences with work — technical production activities — and composition.

structured cell is scored for flute, clarinet and bass clarinet, percussion, harp, prepared piano, 2 violins, viola, cello, double bass, and live electronics. The performers are positioned in a circle facing each other, and a dome of speakers surrounds them as illustrated in Figure 1.1. The purpose of this analysis is to describe the compositional thinking and technological procedures used to construct the thesis.

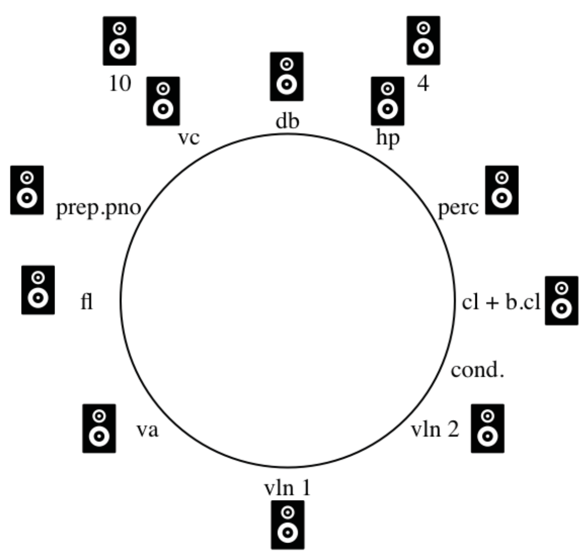

Figure 1.1. The layout of performance space viewed from above (excluding the 10 height channel speakers).

1.2 Historical Background

Music has often been influenced by particular technological developments. In the mid-twentieth century composers such as Varèse, Stockhausen, Xenakis and Boulez found interesting ways to involve technology in their work. Furthermore, the introduction of the personal computer has contributed immensely to compositional possibilities.

One of the parameters that composers from the post-war period questioned was the listeners' relationship to music in acoustic spaces. One reason to explore this parameter was that the performance space traditionally confines the performers to the stage, presenting the music from one location, and the audience engages in the musical dialogue opposite the performers. There is no question that this stage format, a left-over from traditional European performance practice, provided a space into which the music was projected. However, from the point of view of certain post-Second World War composers, the concert hall setting was extremely limited as a compositional performance space. After 1945 composers such as Varèse, Stockhausen, Xenakis, and Boulez began to investigate new spatial relationships between performances and audiences[1]. Despite the blurring of musical boundaries, in many respects, over the past sixty years, the traditional concert format remains intact. In *structured cell*, by contrast, I have attempted to explore anew the spatial parameter of contemporary concert music and capture the sounds of this multidimensional musical environment in a 3D recording. The composition demonstrates the innovative potential of the technological resources available to communicate musical ideas.

1.3 Technological Influences

Historically, in the 20th century, technology and spatial parameters have stimulated composers and sound engineers to explore new methods of expression, capture and distribution.

Two early pieces that explore spatialization combined with electronics are *Gesang der Jünglinge* (1955-56) by Karlheinz Stockhausen and *Poème électronique* (1958) by Edgard Varèse. Both

[1] Maria Anna Harley analyses in her dissertation *Space and Spatialization in Contemporary Music* the various perspectives of the Post-Second World War composers contemplating music and space. In particular chapter II, III and V of her dissertation discusses music and space and is listed in the bibliography at the end of this document.

compositions were major works which incorporated space and electronics as an inherent part of the compositional process.

Gesang der Jünglinge, using 1950s analogue equipment, explored integral serial structures in composition. Through a difficult process of capturing a child's singing voice and manipulating the vocal sounds by applying analogue processes in the signal chain, Stockhausen constructed a piece of singular complexity. However, given the equipment he was using and the timbral structures that he was generating with the aid of serial procedures, Stockhausen demonstrated the compositional potential of employing technology in musical practice. Furthermore, Stockhausen played these recorded, serially structured processes back through a five loudspeaker setup. Beyond the timbral explorations, Stockhausen was concerned with the spatial parameter as well. What we see in Stockhausen's setup is a sound reinforcement speaker system surrounding an audience; this plays back five discrete channels in the auditorium. Stockhausen was clearly aware of the compositional value of the spatial parameter. The significance of this piece was the combination of the electronics, processing of the recorded tape, and a playback system in space.

Poème électronique by Varèse was a piece which had speakers built into the structural layout of the Philips Pavilion at the Brussels World Fair in 1958. The piece was performed with a series of black and white abstract projected images. The composition was a series of sound sources including bells, complex sine-tone structures, and rhythmic pulses. These were recorded on three separate, but synchronized playback channels. Subsequently, these sound images were controlled by operators who projected the sound 'images' by turning a collection of approximately 150 speakers on and off in arrays of five speakers. The implementation of a project this ambitious would have been difficult, partly due to the weight of old analogue equipment. However, the project made an effort to consolidate multiple systems, and was an early experiment in multimedia work heavily incorporating technology.

1.4 Historical Relations

It was only after completing *'structured cell'*, that I began to explore the origins of ideas which had historical parallels. What I found interesting about these early pieces is the composers' awareness of what technologies were at their disposal and how the tools available could be manipulated to inform a compositional process. I find that my composition method shares a similar workflow to the compositions outlined above and is reflected in the design of '*structured cell*'.

These early works of Varèse and Stockhausen are unique primarily because they seek to break new ground in terms of material, technology and spatialization. The overall process of constructing such pieces, in a spatial dimension, requires the mindset of both an architect and a composer. The mental and physical demands to complete projects like *Poème électronique* and *Gesang Der Jünglinge* exemplify how challenging it can be to innovate with contemporary technologies. However, it is this challenge that I find deeply interesting because the composition requires so much effort in order for it to be executed properly. I find when a composition becomes almost like an 'entity' to be actualized, when I am 'called' to physically engage in the process, to be under strain, the compositional method becomes deeply engaging and rewarding.

Chapter 2: Developing the Concept from Outside to Inside

2.1 Background

'*structured cell*' was conceived from years of work in production. Prior to studying at McGill University I lived in South Korea and my spare time was spent composing, working on small productions and capturing media. These formative years provided many useful experiences and a foundation of technical questions that I had and wanted to answer.

During my years at McGill I gravitated towards the Digital Composition Studio (DCS) and Video Production because of my interest in resolving these early technical questions. Furthermore, I viewed composition not as a vehicle of musical expression, but as a solution to a problem. How do I compose music in the twenty-first century, given the exponential and overwhelming growth of technology? Where is composition going? How is composition relevant given technologies' uncompromising involvement with almost every facet of human productivity? How is it possible to capture media in a broader sense? While at McGill, my response to these questions was to engage with technology, wrestle with it, and conceive of a piece that exploited technologies' strengths in a compositional domain.

2.2 Work as Inspiration

Work is generally my driving force for inspiring creative ideas. This work is that which does not directly relate to my area of study, but operates on the periphery of composition; for example, working in video production, sound recording, and interdisciplinary art forms. I believe that this extra-compositional work informs my compositional process, and *structured cell* is a clear result of this process. So, the framework of the project resulted from the production activities that I had been doing while studying at McGill.

2.3 A Composition Designed to Develop Skills

The compositional process of *structured cell* was intended to be demanding. The primary reason was to ensure that the time I invested in it would be commensurate with the outcome. I reflected on my work experiences at McGill, analyzed how these were interrelated, and then conceived of a system that grew out of these experiences and required significant thought as to how to tailor this in an individual manner. Therefore, I designed a system that demanded intense programming with MaxMSP and required a complex system setup. This would produce an original composition involving acoustic instruments, electronic processing and a spatially imagined sound environment.

2.4 Limitations Defining Structure

The first challenge was the fact that the Centre for Interdisciplinary Research in Music Media and Technology (CIRMMT) Multimedia Room (MMR), an ideal research space for this project, was under construction. Therefore, Pollack Hall was the only remaining venue at McGill that would provide both the space requirements and technical infrastructure to execute the project. Fortunately, I was able to book the facility for a period of four days, since the complexity of the setup necessitated an extended time for installation.

2.5 Spatialization: A Compositional Parameter

structured cell's design was a result of a previous piece I had written for the Contemporary Music Ensemble called *Dots, Lines, and Trajectories*. The dilemma, when writing this piece, was where to place the speakers in order to 'spatialize' the music. When speakers are placed around the audience, does this mean that the sound is now 'spatialized'? To further complicate the issue, *Dots, Lines, and Trajectories* was also intended to be a live webcast. The problem, therefore, was how to place the speakers in order to accurately recreate the music in the live webcast?

To resolve this dilemma, I simply put four speakers on stage with the performers. Now the speakers took on the role of performers, and became embedded in the musical fabric. The 'captured' video and audio recording was an accurate representation of the performance. *Dots,* *Lines, and Trajectories* left me puzzled, however. The way that the speakers coalesced with the performance space posed a question; how can the electronics and performers merge into a larger immersive[2] experience?

2.6 Developing the Composition

The Digital Composition Studio has acquired a 'dome' of Genelec 8020 speakers. There are 22 speakers and 2 subwoofers. The configuration of the speakers in the DCS is modelled on the Hamasaki 22.2 system[3]. This speaker array in the DCS provided a working environment to create an abstract model of the composition with the electronics. Furthermore, this 22.2 model would eventually define the speaker layout in the Pollack Hall performance space.

2.7 The Technical Infrastructure

As stated in section 2.1, both the physicality and the technical challenges of my production work at McGill created the concepts which formulated this composition. As a result of this, I became well informed about the underlying multimode fiberoptic infrastructure within the building. Furthermore, CIRMMT has the RME 32AD->32DA high end MADI (Multichannel Audio Digital Interface) convertors allow transmission of 32 audio channels at a sample rate of 96,000 kHz of MADI over fiberoptic lines. Also, the old Strathcona and new Elizabeth Wirth buildings have fiberoptical connectivity to interface with the immersive recording lab in the basement of the Elizabeth Wirth Building.

Due to my close affiliation with the Sound Recording Area, I was aware that Dr. Will Howie, a graduate of the McGill sound recording program, was working with this system, recording in Pollack Hall in a 3D audio format.

[2] 'Immersive' refers to using technology to construct virtual landscapes for the listener through speaker arrays or headphone technology.

[3] A Hamasaki 22.2 Multichannel Sound System (i.e. 22 speaker array and 2 subwoofers) surrounding the listener(s) developed by Kimio Hamasaki at NHK Science and Technology Research Laboratories. See bibliography.

Because of my production work in the facilities, I was aware of the fact that the infrastructure was not only available, but that it was also being used to capture audio in 3D.

The problem of how to combine all of these different areas into one composition became clear. By using the DCS model, knowing the infrastructure of the building, and interacting with the other departments through my work production, I was able to design the composition *structured cell*.

2.8 Connecting the Signal Paths

The completed design of the project was as follows:

1) Create a 3D model using the 22.2 dome in the Digital Composition Studio. This allowed me to develop a working model of the concept and evaluate the technical challenges faced when programming with spatialization using the MaxMSP IRCAM forumnet Spat objects. Additionally, by creating this model I would be able to assess the most practical procedures to implement the technology and its relationship to the musical instruments and scored material.
2) Next take the research areas - composition, real time processing with spatialization, and 3D sound recording methods - unify them into one working model. This would require working through the technical issues regarding the interactive components combined with the musicians. Furthermore, I would need to determine all of the technical apparatuses that were required to achieve the vision of the composition and prepare for the sound recording sessions.
3) The session was designed to implement the working model from the Digital Composition Studio and scale the model up 3:1 in Pollack Hall with the Meyer UPJ-1P speakers. The space would have four days broken up as follows:
    - Day 1 - install the speakers in Pollack Hall on the stage grid above the performers, prepare the electronics and have the first rehearsal
    - Day 2 - first half of the rehearsal, no electronics, thirty minutes test with the electronics

- Day 3 - rehearsal with the electronics and recording session setup
- Day 4 - final recording session

4) The post-production phase of the project would be a meeting with Will Howie in the immersive recording lab to work out the sections for the final mix.

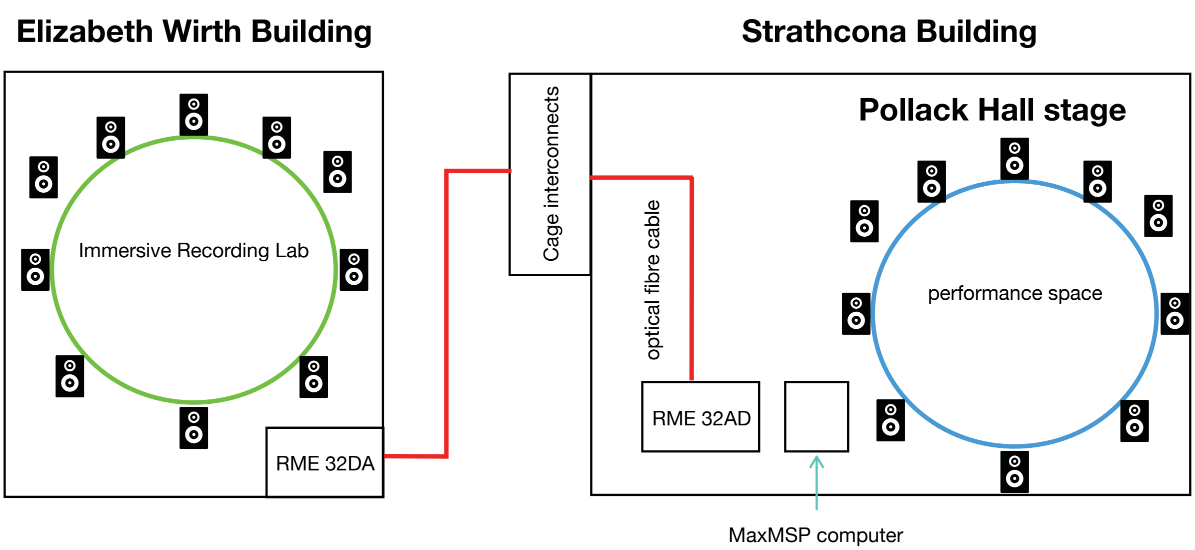

Figure 2.1. System illustration of the technical layout and how the optical fibre cables were connecting the two buildings.

Chapter 3: The MaxMSP Environment

3.1 Real Time Processing

Using the Max programming environment was always intended to be an integral part of the compositional process for this piece. This programming environment allows for complex computer interaction. The programming design of *structured cell* was derived from my exposure to MaxMSP patches that I had worked on in the Contemporary Music Ensemble concerts from IRCAM. These patches were designed from a general model of programming of applications referred to as Model View Controller (MVC) programming design.

3.2 Model, View, Controller (MVC)

The nature of this design makes the program execute efficiently when a user is interacting with technology. "The Model-View-Controller metaphor is a way to design and implement interactive application software that takes advantage of modularity, both to help the conceptual development of the applications, and to allow pieces already developed for one application to be reused in a new application"[4]. The breakdown of the three components, Model, View and Controller is as follows: The Model is where all of the Digital Signal Processing (DSP) takes place; the View is both visual feedback to the user and the user interactive component of the program; lastly, the Controller is the interaction of the 'call'[5] functionality with the Model in order to respond to any changes of the controls and implement DSP processes.

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[4] E. Krasner, Glenn & T. Pope, Stephen. (2000). A Description of the Model-View-Controller User Interface Paradigm in the Smalltalk-80 System. JOOP- Journal of Object-Oriented Programming. Prog. page 32.

[5] A 'call' refers to code that sends data to another area in the program structure that receives and performs a specific computational task.

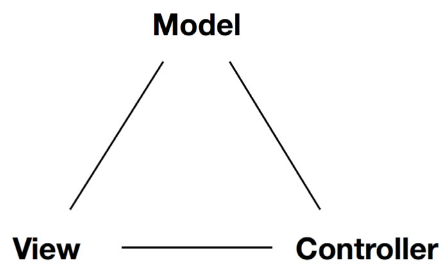

Figure 3.1. The triangular figure is an illustration of a graphical view of the MVC programming style.

3.3 The MaxMSP Patch

Constructing the MVC design-based MaxMSP patch was a carefully developed period of focused work during the summer of 2017. Building on the MVC model, the Max patch was broken up into seven main modules (referred to as abstractions) as illustrated in figure 3.2: 1) the audio input, 2) digital signal processing modules, 3) the scheduled events corresponding to the score, 4) the matrix signal distribution, 5) the output, 6) the keyboard shortcuts 7) user window viewer. Categorically these fall under the following roles in the MVC design: Model - 1,2,3,4,5; View - 6; Control - 3, 7;

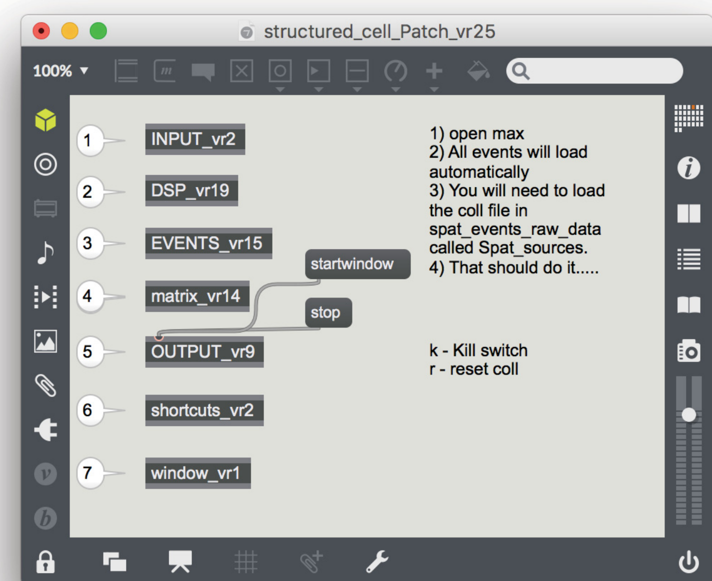

Figure 3.2. Description of the top level of the Max patch with all of the modules, referred to as abstractions[6] which comprised the framework that allowed the data or signal flow to be executed

[6] 'Abstractions' refers to a Max object that uses another Max patches logic and functionality as a Max object. The object is labelled according to the file name saved in the file directory. In figure 3.2 [INPUT_vr2] is an example of an abstraction.

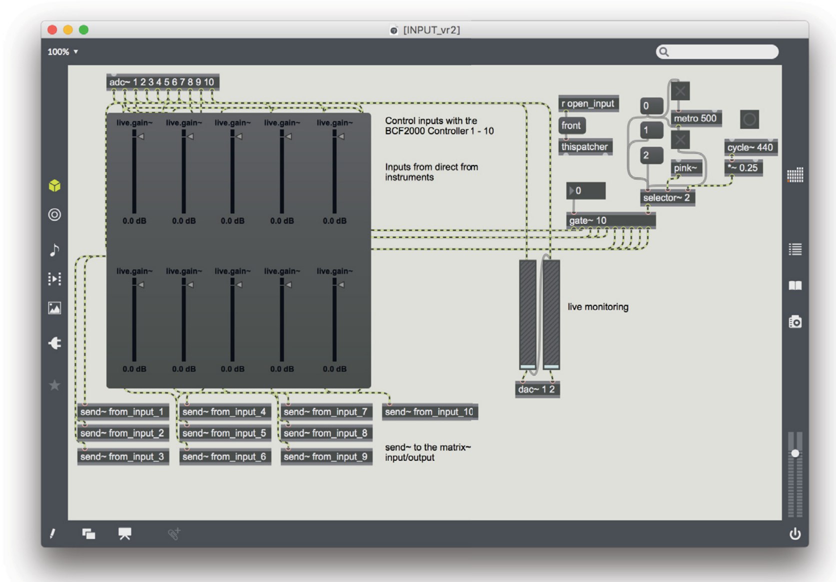

Figure 3.3. Illustration of the Input module that monitors the ten microphone signal inputs processing each instrument in the ensemble. This signal is then distributed through the send~ object to the matrix module.

Figure 3.4 is a portion of the [events] module. Each event was an encapsulation[7] that was triggered by the [counter] object counting through the data contained in the [coll] object[8]. As the values incremented they would trigger the events in the patch.

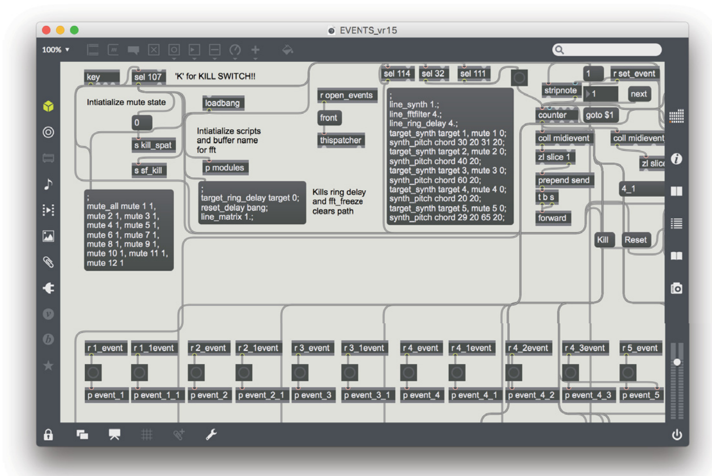

Figure 3.4. Illustration of the Event module intended to control the patching environment with messages. The messages were responsible for the CPU management, matrix signal distribution, spatialization algorithms, and automation control.

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[7] Encapsulation is collection of objects (usually with a specific function) grouped into a sub-patch.

[8] The [coll] object is an object that can store messages that can be used to send elsewhere in the patch.

Within each encapsulated event there was a series of messages that distributed instructions to the DSP ‘model' of the patch. These instructions governed the channels in the matrix which were turned on or off, the processes which were being used, and the sources’ positions or movements. The events essentially were the communication bridge between the controller and the DSP model, illustrated in figure 3.5:

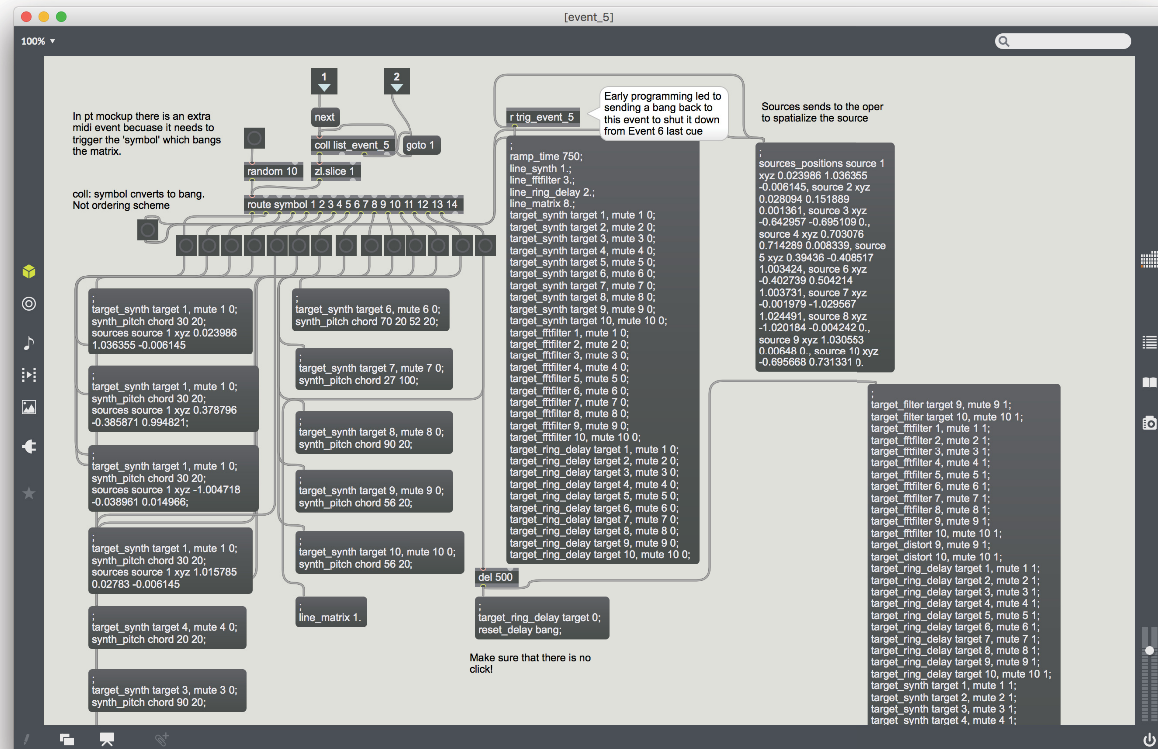

Figure 3.5. Illustration of an event with a series of messages that instruct the Max patch to execute operations when the event is triggered.

3.4 Effects Processing

There were ten instruments, each programmed with its own effects channels, which could be dynamically turned on and off, and configured in any pattern within the matrix. The effects processing was modular in design, so if there were a need to change any modules during the development of the piece this could easily be accomplished. The modules that were used in the final instance of the Max patch for the composition were as follows:

1) Granular synthesis [sogs~] an IRCAM forum object
2) Phase Vocoder [supervp~] an IRCAM forum object
3) Wavetable lookup for distortion effects
4) A noisegate for rhythmic patterns
5) A filter object [cascade~] a combination of several biquad filters
6) A spectral filter [pfft~]
7) A ring delay (sample based delay effects unit)
8) A sound file play back unit
9) A ring modulator
10) A modular FM/AM synthesizer I had built to create synthesizer effects

The left-most box (red in colour images), in figure 3.6 on the following page, illustrates an encapsulated DSP module. To the right side of these modules is the [matrixctrl] object that gives visual feedback to the user, highlighting the specific process that is being used by which instruments.

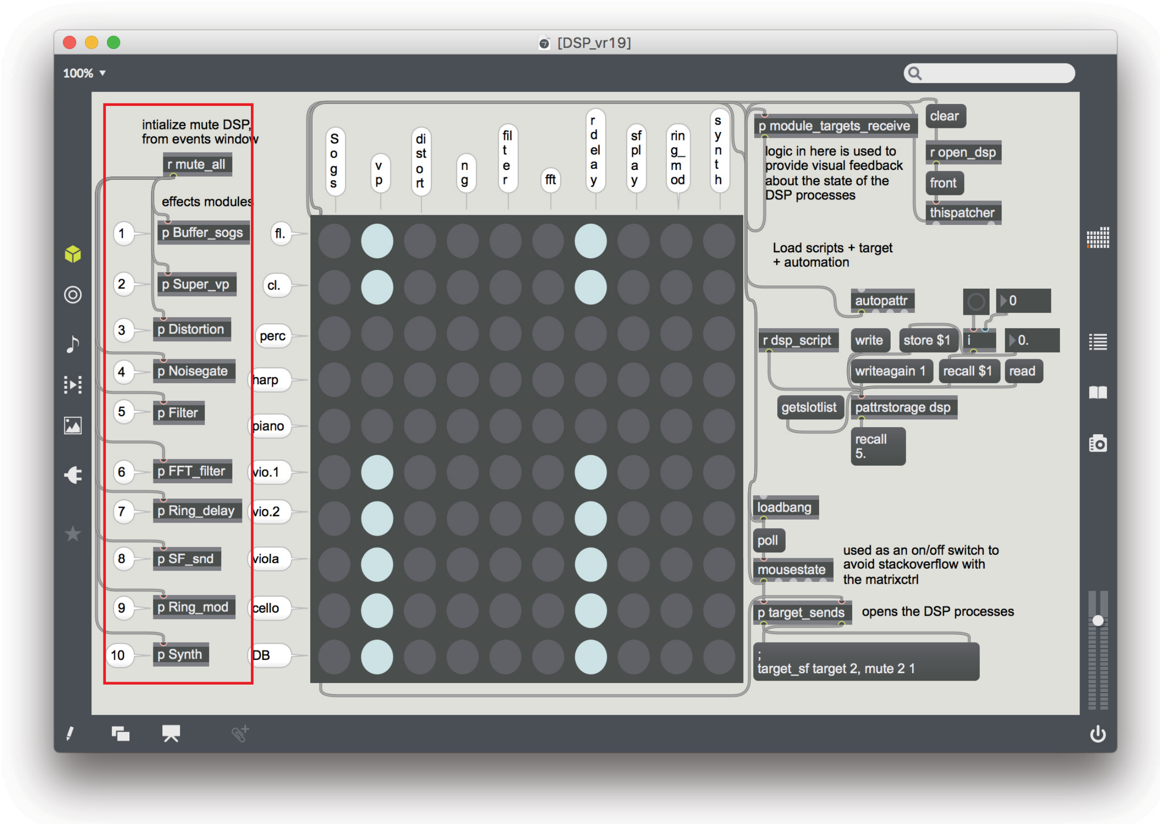

Figure 3.6. Illustration of the processing units in red on the left labelled according to the processing units function i.e. Noisegate. The [matrixctrl] informs the user what instrument is being processed by the program.

Figure 3.7 illustrates an example of a DSP module inside an encapsulation. On this level there are two important key programming elements. On the left side, in the red box, we have the [poly~] object that shows the number of internal processing units, in this case [poly~ Filter_vr1 10] indicates 10 instantiations. On the right side, in the blue box, there is a [pattrstorage] object for storing and recalling the data for each event for this process unit.

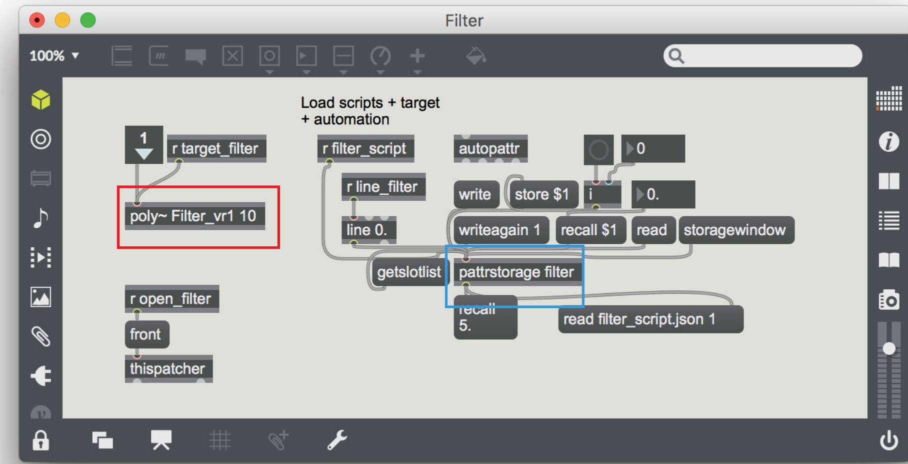

Figure 3.7. Illustration of a DSP module, in this case the [Filter] processing unit. To the right, in blue, is [pattrstorage][9] designed to load and read all of the scripts that are receiving messages from the Events module.

Figure 3.8 is an example of a DSP module inside the [poly~][10] object. Inside the [poly~] object we have ten processing units per each effect. The example below illustrates one virtual instance of the filter processor.

Figure 3.8. Illustration of the filter processing unit for the flute. Each DSP module is designed to target the specified module, along with [thispoly~] to manage the CPU. Furthermore, there is the DSP units processing logic, in this case the [cascade~][11] which has built-in biquad filter parameters.

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[9] A Max object designed to save and recall data from pattr object presets. In the composition it was used for automation control.

[10] [poly~] is a MaxMSP object designed to manage multiple (polyphony) DSP instances.

[11] [cascade~] is a biquad filter.

3.5 Central Processing Unit (CPU) Management

Ensuring that a piece operates at an optimal and efficient level requires careful programming. Since there were ten instruments with ten independent processes each, management of the CPU required dynamic control of these units. Each DSP processor uses the CPU and this can cause issues in functionality if the processor is not managed properly. Therefore, it was important to control the specific processor units to relieve the strain on the CPU. This meant that each event had to turn on the particular module that was processing a signal, and turn it off when it was completed.

In order to optimize this process I implemented the [poly~] object, as illustrated above in figure 3.7. The [poly~] object, based on the name given (i.e. [Filter_vr1 10]), targets the abstraction of a module, and duplicates the process according to the second argument value (in *structured cell* this value is ten, for ten instances of each module). The [poly~] object also provides the logic required to mute or unmute voices. Therefore, when I built this portion of the Max patch I set it up in such a way that a specific module could be activated. In doing so, only that particular instrument channel's processor would be instantiated. The result was a system that managed to control the CPU in order to maintain computational efficiency.

In Figure 3.9 each layer corresponds to a filter processor effect for each instrument. Each effect was targeted and activated from the events module by a message. For example {target_filter target 3, mute 3 1}: first, it highlights the processor, in this case, the filter, i.e. target_filter, this is followed by the instance, target 3 and followed by the CPU manager, mute 3 1, that turns on the third instance with the value 1. In this way, the core DSP processing was controlled and it was essential to manage the CPU.

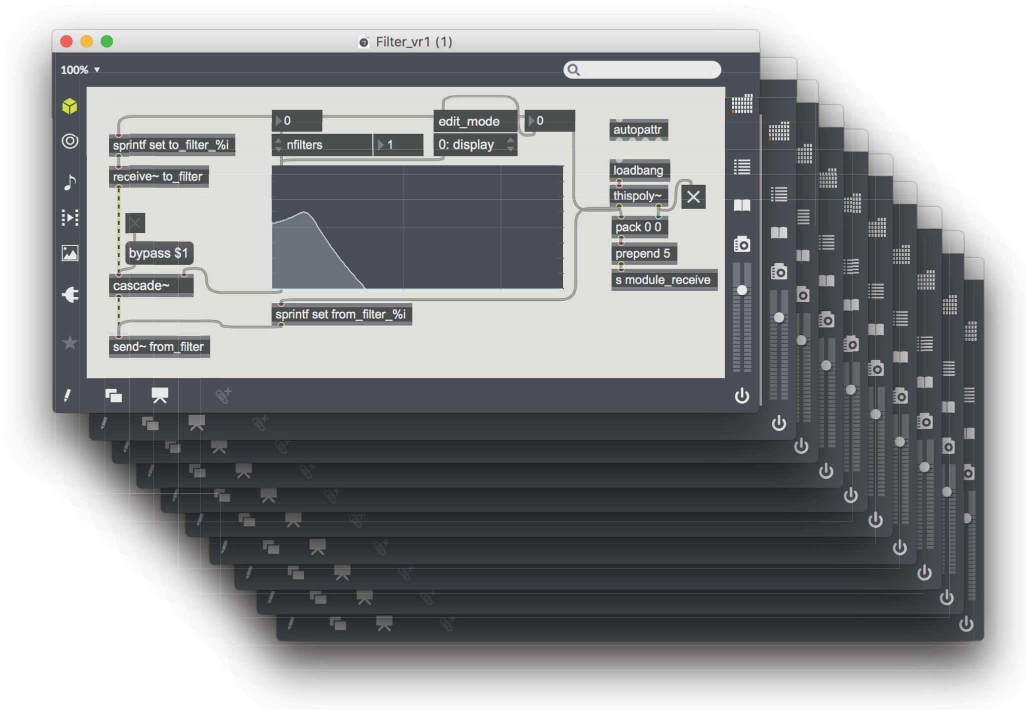

Figure 3.9. Illustration the [poly~] functionality where each instance is a represented by a numerical value that targets the specific processing unit.

3.6 Automation Control

Since each instance of each module was addressable using the [poly~] object, now the patch required an automation system. The implementation of the [pattr] family, a collection of objects designed for interpolation between stored data states, was the framework for the automation system. Each stored data state was saved in a .json[12] script file that was loaded automatically when the patch was opened. When a stored state was recalled from this .json file, based on a time value given, it automated the parameters.

[12] A .json file is a file that stores simple data structures and objects in JavaScript Object Notation (JSON) format, which is a standard data interchange format.

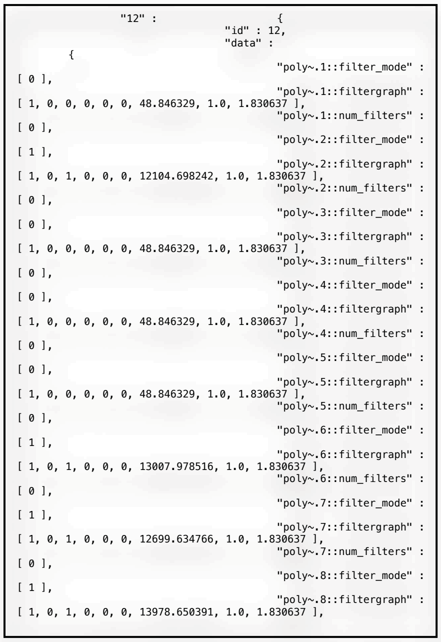


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Figure 3.10a

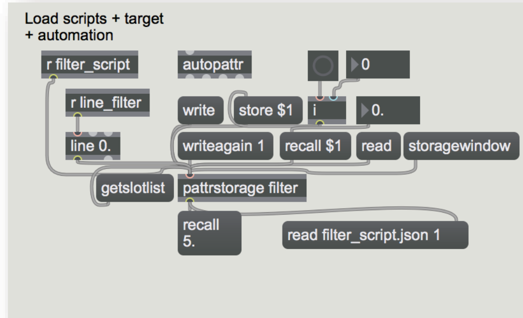

Figure 3.10b

Figure 3.10a. Illustration of a selection of data points that are stored and can be recalled by the [pattrstorage] object in Figure 3.10b.

For example, in section 7, illustrated in Figure 3.11 below, nine sixteenth-note values of a struck temple block are captured in a buffer to manipulate with a granular process. This motive is then processed by changing the grain values and transposition of the buffer. Lastly, this buffer is sent to a high pass filter which has a low pass frequency sweep from 20,000 Hz to around 80Hz.

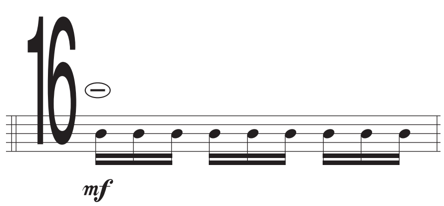

Figure 3.11. Illustration of the nine sixteenth-note values captured in the audio buffer and played back through the speaker array.

3.7 Programming Workflow

In order to optimize this process for a compositionally efficient workflow I utilized the {writeagain} message in [pattrstorage]. For example, if I had stored a section and had programmed it in the filter to change the bandwidth, and later wanted to make adjustments, I could easily overwrite the stored values in the script , and click {writeagain}, without affecting other stored values. Due to the complexity of the project, it was essential to be able to modify both the DSP process modules and automation data without affecting the other programmed parameters; this flexibility allowed for a smooth compositional process and production.

3.8 Spatialization

The final section of the Max patch is the output. In this part of the patch the audio signals are distributed to their source destination in the speaker array. The channels are passed through the [spat.oper~] IRCAM object[13]. This family of objects is a complex system designed to build spatial environments. The [spat.oper~] object is a higher order object that I implemented in order to make use of the built-in programmed structures within the Spat environment. It was at this point that I made the selections of the number of virtual speakers in the speaker array, and the way in which these sources were virtually programmed.

3.9 Virtual Space

The chosen format to use in digital signal processing was the IRCAM Spat Max environment. This provided an environment that allowed for creative flexibility and precision in the spatialization of the musical material. The format that defined the virtual spatialization parameter was 3D Vector Based Amplitude Panning (VBAP)[14]. This was chosen to reinforce the ability to localize the ten discrete sources in the spatial environment.

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[13] IRCAM SPAT is a software suite for spatialization of sound signals in real-time: http://forumnet.ircam.fr/product/spat-en/

[14] Ville Pulkki, "Generic panning tools for MAX/MSP." International Computer Music Conference Proceedings 2000. http://hdl.handle.net/2027/spo.bbp2372.2000.210

3.10 Programming for Efficiency

The important step in this programming process was to anticipate, during the more intense, time restricted compositional and production periods, that the system operated effectively. So, the Max program needed to be designed in a way that ensured this efficiency was structurally built into the program. Certainly in the case of *structured cell* this was crucial. Given the time allotted to complete the piece, and the complexity of the technical component, this inherent programming design was the difference between success and failure.

3.11 Conditions Designed for Efficiency in Production

In order to anticipate the problems I created very specific guidelines needed to be considered. These were as follows:

1) the Max environment could be easily modified during the compositional process.
2) the Max patch would be simple to set-up and operate during the production.
3) the CPU would be managed in such a way as to operate efficiently.
4) the patch was intended to be optimized for both performance and rehearsal workflows.
5) the real-time computer processes would not hinder the musicians' ability to perform, but would integrate with them seamlessly during the production.

The specific reason why these guidelines needed to be achieved during the development of the piece was to ensure that the production, during the short period that I had available, provided a space where everyone could do their job. Ultimately, I do not look at this form of composition from the standpoint of a composer with notes on the page. I view it through the lens of macro-level production[15]. That means the integrated parts (electronics, 3D recording process, Pollack Hall space and available time) are just as important as the score. This was not about composing a piece of music, it was about composing an experience.

[15] Macro-level production means looking at a composition that considers all aspects of the production process. This means time management, system implementation, error management, schedule organization etc. For me this is essential in my work and one of the key reasons I compose.

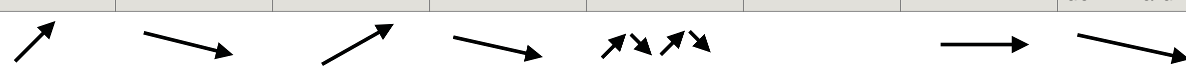
Chapter 4: Materials

4.1 Musical Material

structured cell arises from a complex dialogue between the macrostructure, spatial, and timbral elements. The large scale form consists of a series of developing gestures that are introduced at the beginning and find their resolution later on in the piece.

The overall form of the composition is created by constantly evolving thematic ideas, motivic gestures and rhythmic complexities. This material determines how the overarching timbral and spatial material is developed. In terms of the large structural form, the essential material is moving up in register against a contrasting tendency that keeps pushing the material downward. Throughout the piece this 'tendency' is intended to create a sense of tension as the rising and falling musical gestures recur throughout the composition.

1	2	3	4	5	6	7	8
mm. 1 - 22 Intro A	mm. 23 - 52 Synth + Sine	mm. 52 - 81 Harm+synth gliss.	mm. 82 - 104 Approximate	mm. 107 - 147 Upward gliss.	GP	mm. 148 - 168 quiet lull	mm. 169 - 196 Tutti hits, down ward kill



9	10	11	12	13	14	15	16
GP	mm. 197 - 228 Temple block hit	mm. 229 - 254 Additive sounds A1	GP	mm.. 256 - 259 transition repeat	mm.. 260 - Ring mod + multi	mm.. 260 - 291 Ring mod + multi	mm.. 291 - End One hit + gliss

Figure 4.1. Illustration of the overall form according to the rising and falling gestures. The arrow illustrates the sense of upward or downward motion or a period of stasis. Furthermore, there is a labelling scheme that identifies the particular musical 'characteristic' of these sections.

4.2 Gesture as Form

To illustrate this internal upward/downward tension within the musical composition we can look at the opening sections, nos. 1 and 2. In section 1 (mm. 1-22) there is a repeated block, operating like a large-scale sound envelope with an attack, decay, sustain and release. There is a slow attack that begins with an upward gesture in the string section accompanied almost immediately by the clarinet and flute. This slow attack peaks with a tutti attack, followed by the decay, sustain and release gesture. This recurrent block happens three times, each getting higher in pitch content. In the fourth occurrence of this block, there is a change in the material, there is a bowed tremolo in the strings, followed by quick downward glissandi, then processed by a noise gate processing unit.

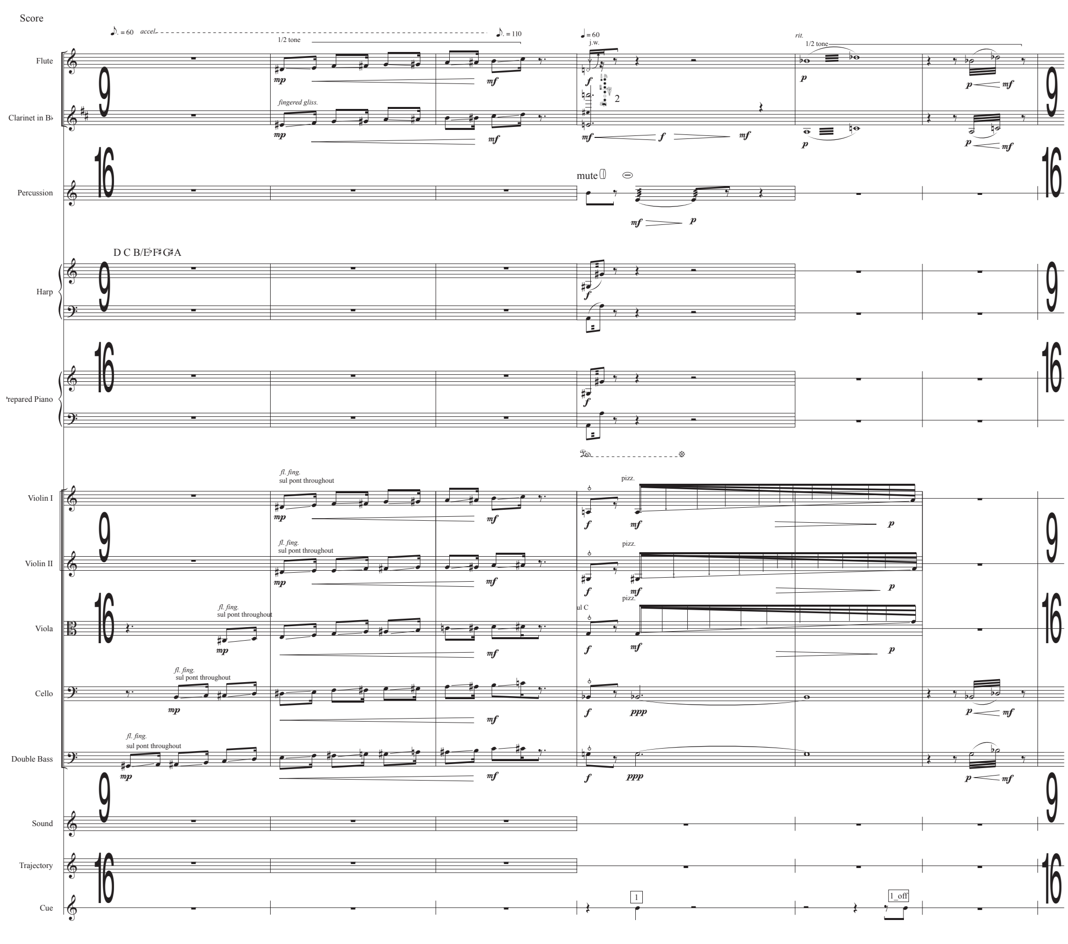


Figure 4.2. Illustration of the introduction (mm. 1-6) in the strings followed by the clarinet and flute building to a tutti attack. This introduction section was imagined as a large-scale sound envelope with an attack, decay sustain and release.

In contrast to the opening section, section 2 begins with considerably different material: a combination of thin two-part or three-part instrumental voices with a synthesizer as the electronic parameter. Each entry begins simultaneously with another voice and the conclusion of this section begins with a soundfile that moves downward in the space. This event is reinforced by the downward trajectories of the FM synth with sustained sine tones. The sine tone entries, accompanied by the other instruments, also move downward both spatially and in pitch content. There are two cycles of 10 sine tone entries. Each entry is accompanied by an instrument which, in most cases, reinforces this downward spatial and pitch trajectory.

Figure 4.3. Illustration of mm. 31-34 with lines indicating the simultaneous entry points' connecting with the 'cue' event structures below.

Another example is found at the climax of the piece, in section 11, illustrated in figure 4.4 below. This features the re-entry of the motivic gestures from section 1. All of the pitched instruments move upward in register content. At measure 239 there are upward glissandi in both the strings and the electronics. Appearing on the same downbeats with the rest of the musical content are twenty-seven events consisting of sharp, transient punctuations that are placed in the speaker array and are static. These events are broken up into units of 8, 6, 6, 9. The first 8 punctuations are from one source coming out of one speaker, the next 6 events increase to two sources from two separate speakers, the next 6 events turn into three sources from three separate speakers, and the last 9 events feature four sources from four speakers. So, the result is not only an upward gesture, but an accumulation in the density of the material. Both gestures and density emphasize the climax of the composition.

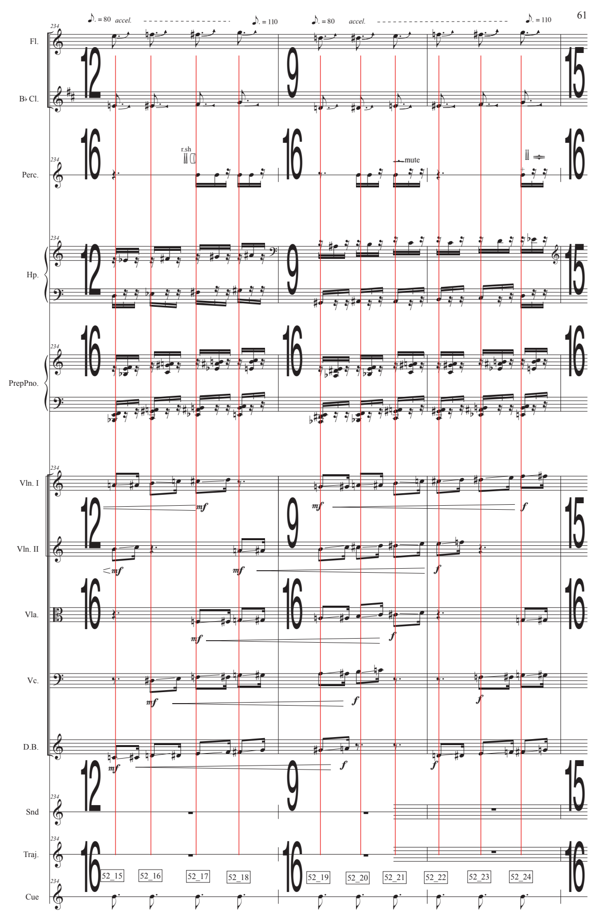


Figure 4.4. Illustration of section 11 (mm.234-236) where each downbeat is punctuated by electronic sources.

In response to this climax in sections 13-15 there is another downward gesture combining the static and dynamic layers. This extended section is the intended resolution resulting from the intensity of section 11 illustrated above. Throughout these last sections in the composition the emphasis is on a downward passage in piano and harp processed through a harmonizer. The descending notes of this passage are echoed in the electronics, with low and heavy sounds in the speaker array. There is a sense of weight as the composition is clearly coming to a close.

However, the very last gesture of the composition finishes on a glissando upward in the violin, followed by a freeze frame sound ascending upward in space. This process then goes to a noise gate and the final source moves to the top speaker where it dies out.

4.3 Composing for space

Compositionally there are two spatial layers, one layer that is static (the instruments), and another layer that is dynamic (electronics). The composition was designed to create an interactive 3D sound image in which at times these layers coalesce or are disconnected. With these two spatial categories (layers) in mind I composed the instrumental part and the electronics.

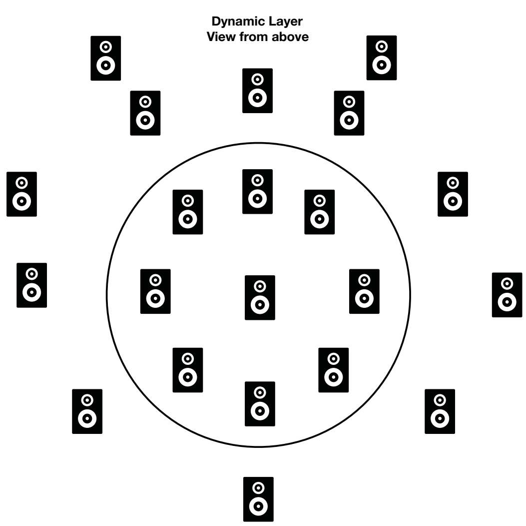


Figure 4.5a

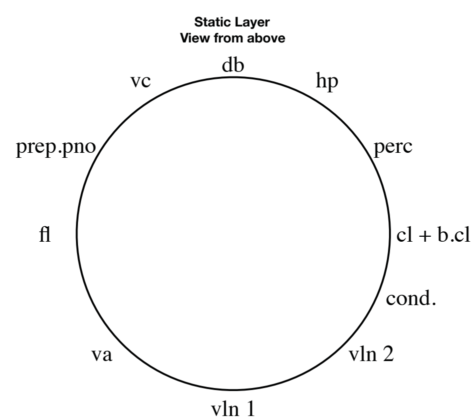


Figure 4.5b

Figure 4.5a. Illustration of the dynamic layer and figure 4.5b is an illustration the static layer.

The material chosen for the spatial layers was defined in two categories: sustained trajectories or transient sounds. The sustained trajectories generally travel in spherical fashion around the speaker array, moving from height speaker channels to the low speaker channels, or low channels to high channels depending on the particular trajectory of the sound, as illustrated in figure 4.6.

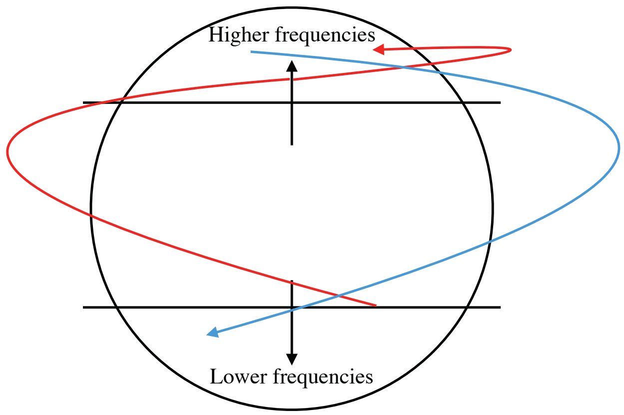


Figure 4.6. Illustration of the spherical movement of the sustained trajectories viewed from the side of the dome.

In contrast to this, the transient, percussive sounds were localized[16] sources in the speaker array. The transient sources were chosen specifically for the ability to localize the source in the space as illustrated in figure 4.7:

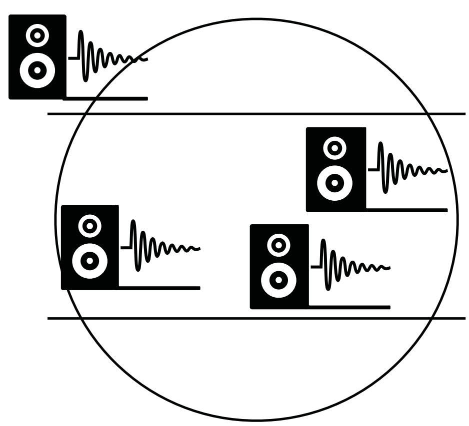


Figure 4.7. Illustration of the localized transient sources projected from speakers in the dome (viewed from the side).

[16] By localized I am referring to the mapping of sounds to a source without a trajectory.

The sustained sounds lack the clear localization of particular processed sources, and because of this act as a coalescing ‘spatial bridge’ between the dynamic and static layers in the music environment. In the composition, the role of these sustained sounds is to create a unified, ambient environment to shape specific sections in the piece.

The ‘spatial bridge’ is highlighted in the following two examples: first, the instruments, in section 2 (mm.23-52), perform a slow, downward glissando gesture over a duration of forty-eight seconds. The corresponding sound in the electronics is an FM synthesized sound where each source’s pitch content goes downward in conjunction with the entry of an instrument. The perceptual effect is a sense of the spatial layers merged together and moving downward in the space as one musical gesture. This is illustrated in the score figure 4.8a.

Figure 4.8a

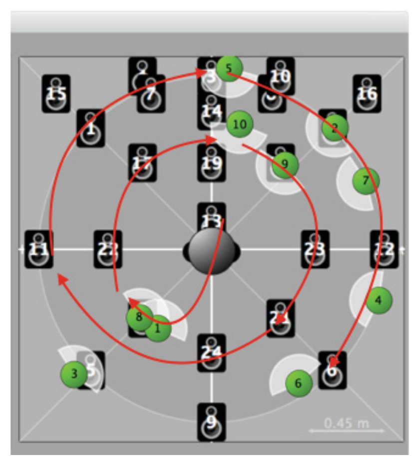


Figure 4.8b

Figure 4.8a. Demonstration of the downward glissando in the score (mm.45-48) referred to as the static spatial layer. Each entry point is synchronized with a downward trajectory of an FM synth corresponding to a signal source. Figure 4.8b. Illustration of the trajectory of the FM synthesized sounds moving downwards in the dynamic spatial layer viewed from above. The numbers on the speaker icon in 4.8b refer to the output channel.

In the second example, in sections 14-15 (figure 4.9, mm. 260-291), there is a dense combination of long sustained notes in the static instrumental layer, with the dynamic layer of electronically processed sources. The ambient space envelopes the listener in a dense texture of sounds, emphasized by multiphonics in the clarinet and reinforced with a toneless air sound in the flute. The strings, harp and piano are a fusion of long sustained pitch material and a slow downward motive (highlighted below in red). The strings, harp and piano parts are processed through a ring modulator[17] in order to create a concentrated immersive space. Again, as a result of the barrage of sounds, the static and dynamic layers coalesce and unite the spatial layers into one cell.

Figure 4.9. Demonstration of the pitch content that moves downward while the instruments are processed through a ring modulator. The static and dynamic layers coalesce, and a dense timbral texture envelopes the space.

[17] A ring modulator is a time domain signal processing unit where the carrier frequency is modulated by another frequency (i.e. multiplying their instantaneous amplitudes sample by sample) highlighting sidebands, and the frequencies that are not in the original frequency create a tremolo effect.

In contrast to the sustained trajectories, localized transient sound sources were used throughout the piece. These transient sources create thin, localized, accented points of attack or simultaneous dense punctuations and add an interesting contrast to the long sustained notes.

As an example, in the opening of section 2 (mm.23-25), using the oscillators, there is a motivic idea. The repeated opening pitch occupies a specific localized point output from channel 3, behind the double bass. Each subsequent pitch introduced is placed in the speaker array in different channels. This motive, in the dynamic spatial layer, is separate from the static instruments because sources 2, 5, 6, 7 are placed in the height channels[18], distancing them from the static instrument layer. The pitch content of this motive is heard again in section 8, but in this case the rhythmic parameter is separated from the original motive, and the pitches are rhythmically synchronized with the instrumental tutti strikes.

Figure 4.10. Illustration of the synthesizer motive heard (only rhythmically notated in the events on the bottom of the score in mm.23-25); in section 8 (mm.170-188) the same pitch content is heard again, but the rhythm has changed.

Again, there is a similar relationship in the climax in section 11 (mm.229-254), illustrated in figure 4.4, when the dynamic layers' rhythmic punctuations are synchronized with the instrumental downbeats. In this case, the short, sharp transients begin, in groups of one, two, three, then four, to create a dense musical texture. At first the transient points are identifiable in the speaker channels; however, as the punctuations begin to accumulate the spatial layers begin to merge as one unit, and the transient points become harder to localize in the space. The overall effect is a combination of the two spatial layers accumulating and enveloping the listener in a complex, agitated musical environment.

[18] Height channels refer to the speakers that occupy the upper level of the speaker dome.

The static and dynamic layers, i.e. the instrumental and electronic spatialized sound sources, carve out the overall form of the piece. Specifically, in the dynamic layer the sustained ambient sounds and punctuated transients defined the spatialized structure of the composition. Composing for the dynamic layer (sustained and transient sound sources), and having the static layer (instruments) interacting, as described above, resulted in a compositional design which would integrate the instruments and the electronic layers.

4.4 Composition Material

The composition material was broken up into several different structural categories: *imitative, contrast, tutti, polyrhythmic,* and *gestural trajectories.* These categories were used to exaggerate the static and dynamic spatial layers of the music.

Imitation was used in the composition to capture a musical moment and send it through a series of processes that correspond to the musical idea in the speaker array. An example of this was when the prepared piano and harp, in a series of recurrent formal repetitions, were sent through a harmonizer with a slight delay. In the speaker array this material clearly is the original source, but its inherent structural qualities have been distorted. Spatially the ideas are disconnecting, but perceptually maintaining their origin, therefore creating two distinct spatial layers.

We can see this process in the motive that is repeated in section 5, measures 106, 111, and 116. This recurrent downward motivic gesture is seen throughout the piece in many variations.

Contrast is used throughout the piece in a variety of ways. There are rhythmic contrasts (tutti strikes versus long sustained sections), thin musical layers (section 3, mm.52-81) versus intense rhythmic material (section 8, mm.169-196). Another example is when the dynamic layer of the electronics comes to the foreground (sections 13-15, mm.256-291) as opposed to the static layer of the instruments taking the lead (section 7, mm.148-168). Spatially, there are times when the music moves around the listener with long sustained notes, in contrast to sharp, clear transient punctuations that permeate the environment. There is also a constant use of intermittent silence in contrast to the generally constant sound in the piece.

In the case of one contrasting type of event there is actually one processed event - a sound is captured by the processing unit and then is fed through a noise gate. This happens three times in the piece. This processed sound is rhythmically cut off, alternating between the sound and silence. These occurrences may be found at measures 22, 147 and the very end of the piece and is, in fact, the last sound. This particular noise gate process defines a clear shift in the formal material. In measure 22 the silence indicates a transition away from the introductory material; at the end of measure 147 it indicates a shift to the quieter material. The last instance of this process is the end of the piece. These clearly defined structures illustrate three of the many examples in which silence plays a role in contrast to the musical material.

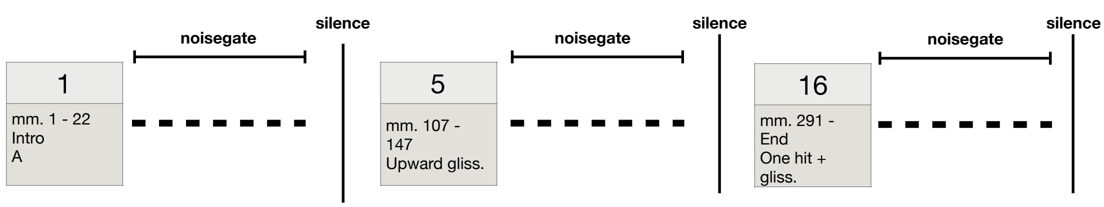


Figure 4.11. Description of the formal structure defined by the noise gate processing unit.

The most striking example of using contrast to accentuate a particular effect is the climax in section 11, measures 249 - 252 (refer to the score). Here there is a dense image[19] of sharp transients in the electronics and all of the instruments playing at *forte*; this is cut by very short intermittent silences. The sound material, a combination of instruments and electronics, in opposition to the brief moments of silence, amplifies the intensity of the sound material during this point in the composition.

Tutti strikes are a recurrent musical gesture I employ in my musical language. Given the dense timbral textures often associated with computer music, tutti strikes give a clear point of attack. Exploiting this compositional gesture in this piece I imagined a large-scale 'spatial sound

[19] 'image' refers to the sound projected from the speaker array.

envelope', in which the tutti strike is the attack in the envelope, and the processes that take place after are the decay, sustain and release, like an envelope.

Figure 4.12a

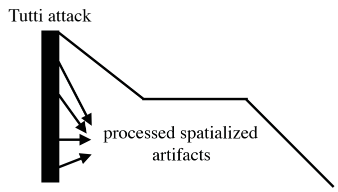


Figure 4.12b

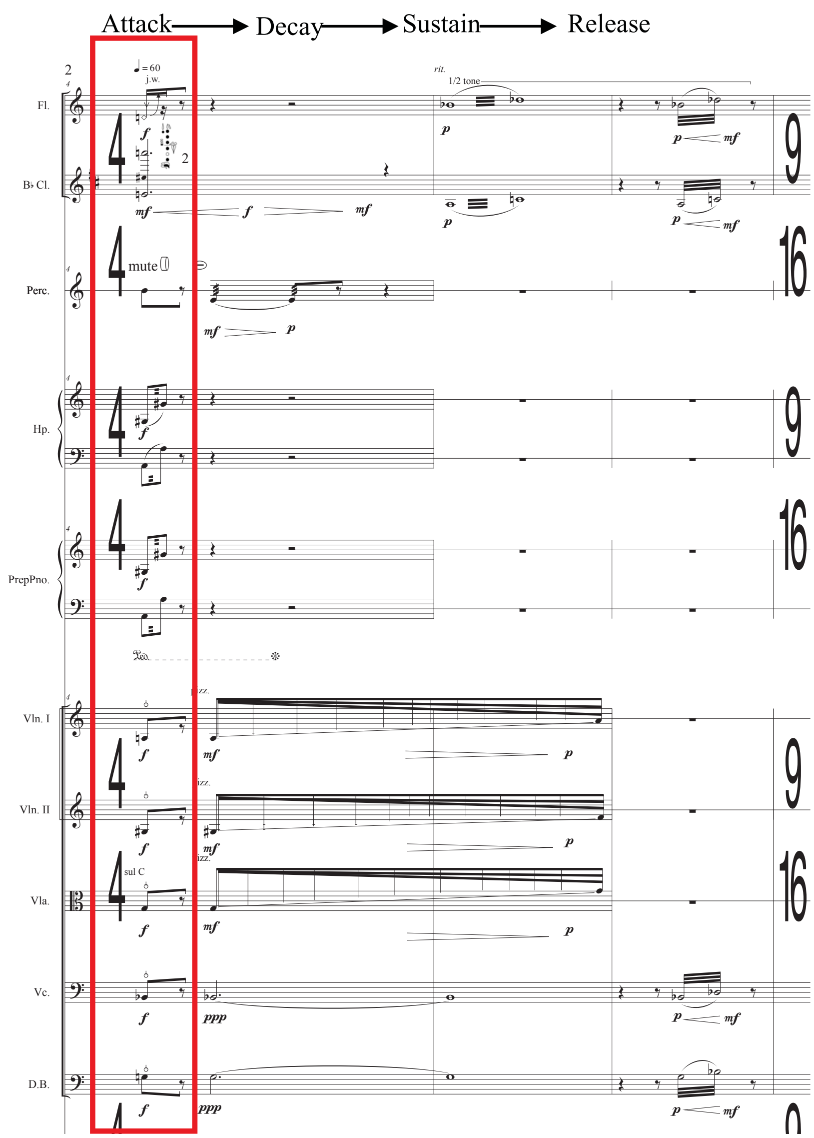


Figure 4.12a. Illustration of a sound envelope in mm.4-6.

figure 4.12b. Illustration of the imagined or realized result of the sound envelope concept is presented in the score.

In the introductory section of the piece there are several consecutive *tutti* strikes. These are performed by the static, instrumental layer. These instrumental *tutti* strikes are then captured and processed in a series of effects units from harmonizers, to ring delays, to granulation processes. The spatial transition from the inner static layer (instruments), outward to the dynamic spatial layer (speaker array), is conceived as the process of the decay, sustain and release, resulting from the envelopes' initial attack. This served compositionally as a way to introduce and make the interaction between the two spatial layers coalesce.

The more elaborate *poly-rhythmic* musical section near the end of the piece emphasizes a dense texture of sound between the static and dynamic spatial layers. The build-up toward this section is highlighted by an upward gesture in each of the instrumental parts. These are further emphasized by percussion hits, in combination with sharp, short, transient spikes in the electronics, articulating each beat. The electronics build in spatial complexity by adding additional sounds over time. As outlined in section 4.2 (illustrated in figure 4.4), the first eight transient sounds, are independent and clearly localized. However, the sounds accumulate, they become more difficult to localize, and the interaction between the spatial layers is hard to distinguish. The result is that the environment immerses the listener in one uniform space. This *poly-rhythmic* section, through an extreme amount of sharp transient information, coupled with the instruments, ends up merging the spatial layers due to the overwhelming amount of sound information.

As illustrated in the formal diagram above (fig. 4.1), *gestural trajectories* play a role in the compositional material which defines a large part of this formal structure in the composition. Frequently there are tutti strikes that are fast glissandi, emphasizing the upward or downward thrust of the musical material. These instances are captured and processed in real time in the harmonizer processor. The electronics capture a 'frame', a fast repeating loop, and then extend the glissandi, through real-time transposition processing, from the instrument layer into the spatial layer. The electronics reinforce the gestural trajectory and embellish the structural shape of this gesture as illustrated below in figure 4.13. This combined gestural trajectory of instruments and electronics is evident in section 3 (mm.52-81). The material is periodically ascending upwards in the strings. This occurs in five different places: mm.68, 72, 76, 79, and 81.

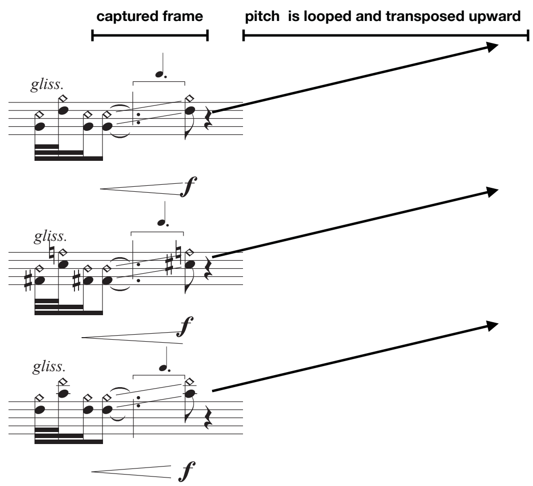


Figure 4.13. Illustration of the point the sound in m.68 was captured and the real-time transposition processing that results from the electronics.

Another example of *gestural trajectories* is the downward gesture in section 8 (mm.169-196). In this particular instance, there are tutti strikes that descend rapidly from m.183 to m.194. The pitch content is moving downwards throughout this section and it is evident that the general trajectory of this section is intended to end in a low register. Again, the emphasis on the *gestural trajectory* defines the immediate directionality of the material and also reinforces the overall structural form outlined in the formal layout of the piece.

Figure 4.14. Illustration (mm.183-196) of the overarching gestural trajectory that is intended to resolve on a low point and concludes section 8.

In the introduction, section 1 (also discussed in 4.1), there is an accelerating upward gesture, repeated three times. This upward gesture occurs again in section 11. In section 1, we referred to the introduction as the 'large spatial envelope' (figure 4.12a-b), in which the upward gesture peaks as an attack; however, in its recurrence in section 11 (mm.229-239), this shape operates as the build up to the culmination of the material in the composition. In section 11, coupled with the transient sounds in the electronics, the instrumental glissandi are repeated from section 1. From mm.238-245 the instruments are processed by transposition with the electronics into an upward glissandi. The climax of the piece between mm. 247 and 254 is the plateau of this upward gesture. It is quickly captured and processed with a lowpass filter. In response to this climax sections 13-15 reinforce the downward trend until the final section, again making use of *gestural trajectories* as a core device to structure the form of the composition.

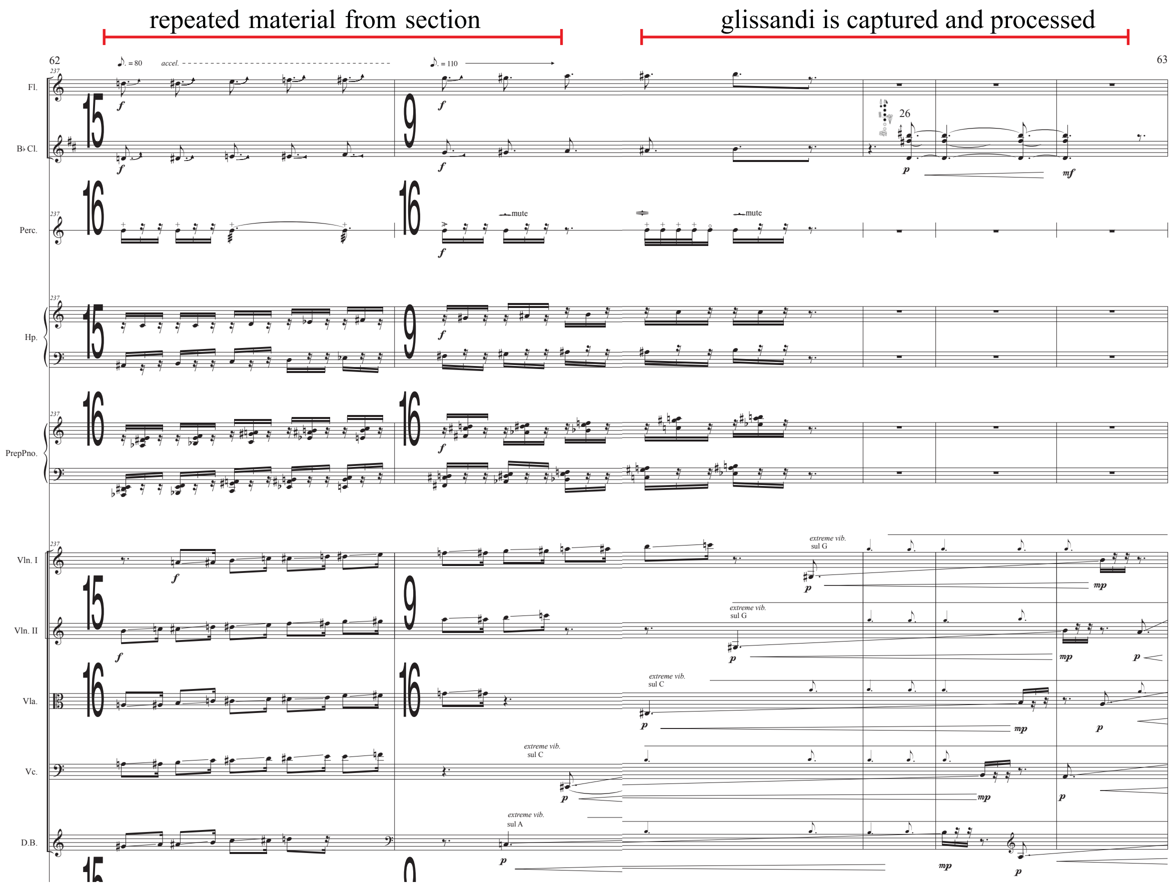


Figure 4.15. Illustration of section 11 (mm.237-238), the repeat of material taken from the opening of the piece (section 1). However, section 11 is coupled with the transient sounds in the electronics and from m. 238 on the instruments are processed by transposition with the electronics into an upward glissandi.

Gesture trajectories played a very important role in shaping the internal aspects of the material, but also defined the larger sections of the composition. These structural categories define the form of the piece both in the acoustic writing and within the space.

Chapter 5: Pitch Material and Rhythmic Organization

5.1 The Pitch Material

The harmonic and rhythmic organization of the instrumental material reinforced the interactive relationships between the electronics and instruments. However, it should be noted that the composition did not rely heavily on preconceived pitch structures and rhythmic patterns. The reason was that during the compositional process the intention was to establish a dialogue between the instrumental material and the computer processes and vice versa. Therefore the development of the composition depended on making judgments about these interactive relationships and working them out in the course of the subsequent writing and experimentation.

However, as in the case of most creative work, during this working-out process, pitch content and rhythmic tendencies started to reveal themselves in the thematic ideas, motivic gestures and rhythmic complexities outlined in the previous chapter.

Throughout the piece the pitch material is based on a statistically significant combination of intervals. These are mostly comprised of unisons and/or octaves, major and minor 2nds, and minor thirds. These intervals can be thought of as independent entities in which pitch classes can be doubled in another register and/or added, much like additive synthesis, thus altering the registral space as well as the basic intervals.

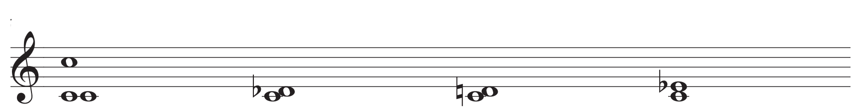


Figure 5.1. Illustration of the basic intervals that permeate the musical fabric of *structured cell.*

To illustrate the pitch material in context I will explore different structural aspects of the piece and demonstrate what role the pitch intervals play in the work's formal structure. At the opening of the composition a series of short glissandi in the strings illustrates the additive process, just described, of working with the intervals:

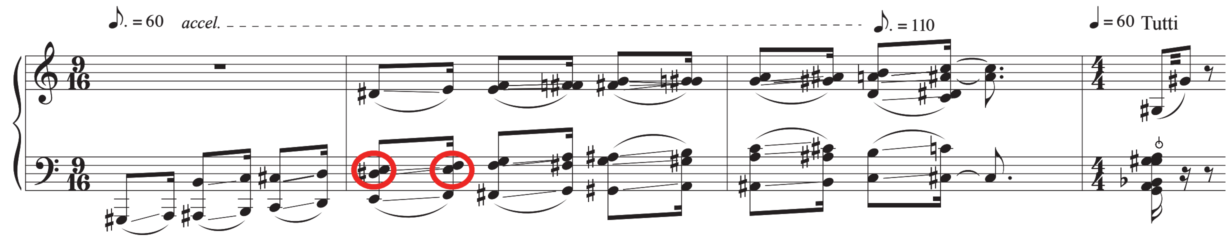


Figure 5.2. Description of a (mm.1-4) a piano reduction showing an accumulation of the pitched material building from a thin fabric to greater density. This pattern recurs at the opening four times, establishing this pitch-related procedure as a core part of the pitch organization of the composition.

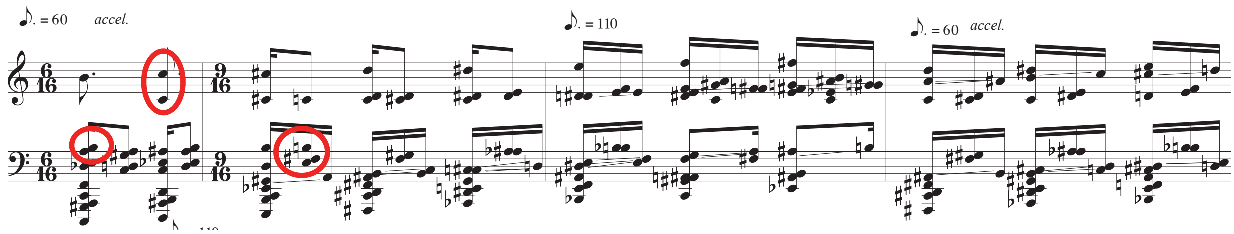


Figure 5.3. Illustration of a piano reduction of a combination of intervals ascending to the climax of the composition The red circles illustrate just a few of the many intervals that are used to construct these dense chords (mm. 229-232).

The piano reduction in figure 5.3 (section 11), shows the approach to the climax of the composition. Here, the entire ensemble performs a dense collection of ascending components of the intervals. In this case the material is further supported by transient sounds projected from the speakers into the space. The combination establishes a complex timbral fabric. The consistency of the pitch material contributes to this.

A recurring downward motive, which occurs frequently, further illustrates the use of intervals throughout the piece. In the examples below, taken from sections 4 and 15, the motivic idea can be heard in a thin fabric, based on dyads.

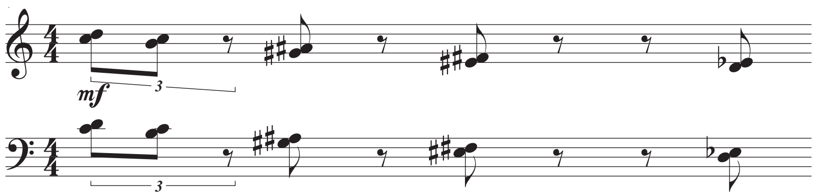


Figure 5.4. Description of a piano reduction of the harp and piano alone, in unison, in measure 106. The instrumentation is supported by the electronics which respond to the major and minor 2nd intervals by being processed through pitch shifters that dramatically alter and exaggerate the downward trajectory of the motivic material.

In figure 5.5, the harp material is followed by the piano, slowly moving downward. The gesture ends with all of the instruments being processed through a ring modulator, resulting in a dense fabric. The fragmented use of these intervals (as illustrated in this chapter) emphasizes the fact that certain characteristic tendencies were worked out during the compositional process. The intervals in this structural framework were used as the pitch material in *structured cell*.

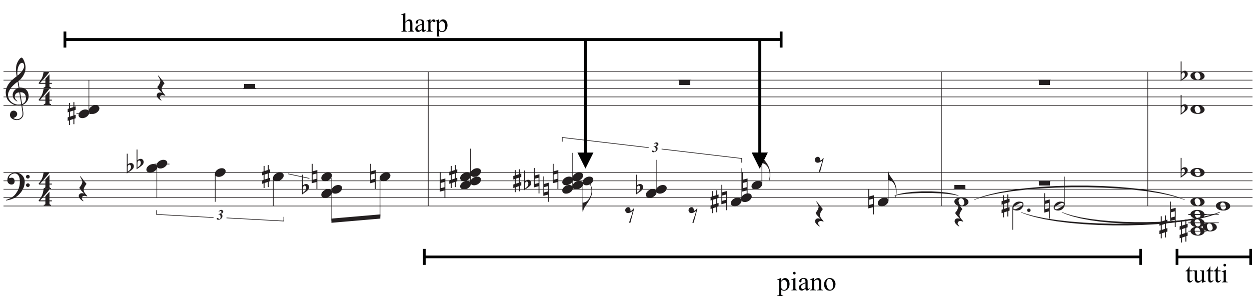


Figure. 5.5. Illustration of the harp material followed by the piano moving downwards in register in mm.288-291.

5.2 The Rhythmic Material

The rhythmic material operates within a wide spectrum. However, there are three general categories of rhythmic tendencies that define the characteristics of the musical material in each section: synchronistic events, unmeasured rhythms, and sustained rhythmic values. Each section, illustrated in the formal outline in chapter 4, relies on one of these rhythmic patterns or a combination of them.

5.3 Synchronized Events

Synchronized events occur frequently throughout the composition. The overall fabric of *structured cell*, including the added complexity of electronics, requires the use of synchronicity to organize dense timbral material. Synchronistic events emphasize the structural relationship between instruments and electronics. There are three categories that can be defined in the composition: the interrelationship of musical layers, tutti strikes and tempo alterations.

Firstly, synchronistic events highlight the interrelationship between pitch intervals and the dynamic and static spatial layers outlined in chapter 4. These synchronized points of entry define the layers as independent structures but the simultaneity of their entries reenforces their relationship as a greater whole. To illustrate, the beginning of section 2 (m.23) starts only with the synthesizer sound and accumulates voices which enter together, establishing the synchronicity of temporal events (also discussed in chapter 4).

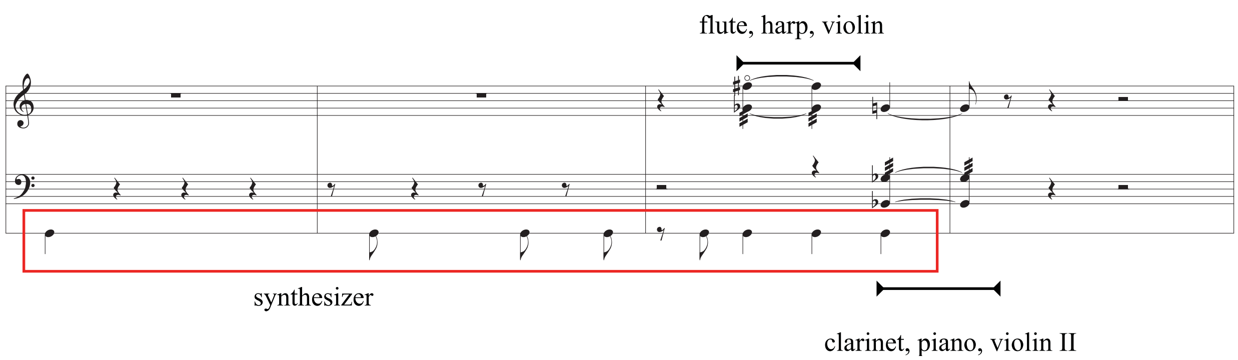


Figure. 5.6. Illustration of the synthesizer in the red box followed by the synchronistic temporal events (mm.23-26).

This synchronistic event early on in the composition, sets the stage for a forceful tutti device used throughout the composition. I will refer to this as a "tutti strike". Most of the compositional material in my music originates in vividly imagined ideas. The tutti strike finds its origins in this manner: I hear in my head a bang and the music is a composed response that reproduces this experience in a structured format. In the example below, taken from section 5 (mm.131-137), we can hear this tutti strike used again and again. The tutti strikes are unified, articulated rhythmic points within a fast triplet rhythmic texture. The pace of this music is interrupted by injections of fortissimo tutti strikes, punctuating the musical fabric and establishing these strikes as essential to the rhythmic material employed throughout the piece.

Figure 5.7. The red boxes illustrate the articulated tutti strikes interrupting the fast triplet rhythmic texture (mm. 131-137).

5.4 Tempo Alterations

This tutti strike also helps to emphasize another crucial aspect of *structured cell*: tempo. When tutti strikes are subjected to tempo changes - that is, when they speed up or slow down - they underline and even enhance the sense of *accelerando* and *ritardando* in a given section. This occurs in several sections of the composition and thus becomes an important part of the musical fabric. The pacing of synchronized events is the driving force of the musical fabric. They enhance the *accelerando* and *ritardando* tempo alterations used throughout several sections in the composition. For example, after a quiet period in section 7 (mm.148-168), the tempo regains momentum and in section 8 (over 27 measures) there are 18 tutti strikes. The first 9 tutti hits are intended to accentuate the rhythmic pulse and establish the tempo with the material in this section. The subsequent 9 tutti strikes follow a downward pitch trajectory and the *ritardando* is affirmed by the tutti strikes' increased rhythmic distance.

In figure 5.9, shown on the following page, we can see the first 9 tutti strikes that establish the rhythmic material in section 8. This is transformed in the latter half of the section with descending pitches, diminuendo, and the spreading out of the temporal distance with eighth rest values between each tutti hit. The eighth rest durations are grouped in the following way:

(3)𝄾𝄾𝄾, (1)𝄾, (1)𝄾, (2)𝄾𝄾, (3)𝄾𝄾𝄾, (4)𝄾𝄾𝄾𝄾, (5)𝄾𝄾𝄾𝄾𝄾, (4)𝄾𝄾𝄾𝄾

Figure 5.8. Illustration of the increased number of rests that separate each tutti strike beginning from m.182 until the end of the section. Numbers are printed below the rests in figure 5.9.

Figure 5.9. The red lines highlight the tutti strikes (mm.170-196). The brackets over the first 9 tutti strikes illustrate the establishment of the rhythmic material. The following highlighted tutti strikes with the numerical representations below that illustrate the spreading out of the temporal distance based on these eighth rest values outlined in figure 5.8.

This section is followed by a general pause in section 9 (m.196), the halfway point in the piece, then section 10 (m.197) enters with 9 temple block strikes metered in 9/8. This marks the beginning of the drive to the end of the piece. However, structurally, section 10 would not be as emphatic if the tutti strikes in the previous section did not the alter the tempo. Playing with these temporal events carves out internal sectional ideas and also helps establish the larger formal structure of the piece.

5.5 Unmeasured Rhythms

In *structured cell* unmeasured rhythms play an intermittent, but important structural role. Computer processing has endless ways to manipulate and process sounds that rhythmically would be impossible to accurately perform in strict notation. However, unmeasured notation contains structural principles that are similar to the computer processes. Exploiting this unmeasured notational practice in *structured cell* establishes a relationship between the instruments and the computer processed sounds. In the introduction of the piece, after each tutti strike (in the first section), the instruments are processed through a granulator that varies the pitch and duration of the grains. Simultaneously the strings are performing a pizzicato and speeding up their attacks (although this is only graphically notated). This is done deliberately to introduce the electronics early on in the piece and use the unmeasured rhythmic structure as a way of establishing a link between the instruments and the computer generated, randomized processed sounds.

Figure 5.10. The string section playing unmeasured pizzicato are being captured and processed in real-time in the speaker array.

Again, unmeasured notation is used at the climax of the piece in section 11 (mm.229-254), following the synchronized ascent in the instruments between measures 247 and 250. In this section fortissimo tutti blocks, each consisting of various kinds of fragments and linear figures, saturate the texture. There are four of these blocks, each interspersed with short silences. These blocks are reenforced in the sound space by the accumulative sharp transient sources (outlined in section 4.2, figure 4.4), that are projected through the speaker array, corresponding to the entry points of the blocks. The unmeasured rhythmic values in the percussion, harp and prepared piano, coupled with the electronics in the speaker array emphasize the "organized" chaos that is projected into the sound space.

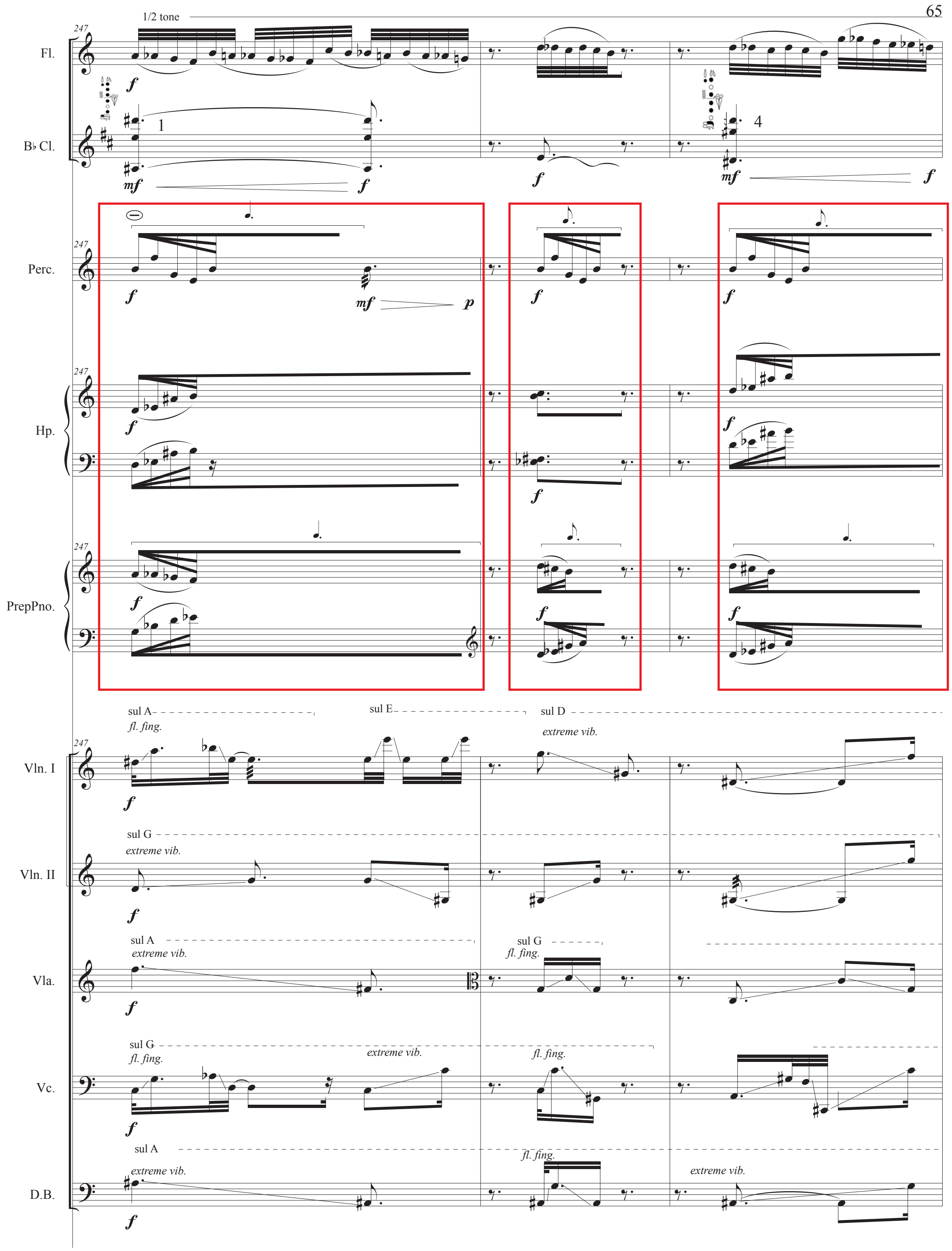


Figure 5.10. Illustration of three of the unmeasured blocks used by the piano, harp and percussion.

During the compositional process, the decision to use this rhythmic technique during this particular section of the piece faithfully reflects the experience of imagining an erratic mental state - anxious, agitated and energetic. Again this demonstrates that much of the material in the piece came from certain imagined states of being interpreted in sounds.

5.6 Sustained Durations

From a structural point of view, synchronized and unmeasured rhythmic ideas form some of the more complicated rhythmic sections in the piece. In contrast, long sustained durations also play an important role in shaping sections. These slower durations are used to build contrasting material that spreads out the material into a more diffuse state. These sections offer a repose from the rhythmically dense textures throughout the composition.

Sections 7 and 13 to 15 highlight two examples that demonstrate the kind of variety which also gives the composition its form. In section 7 (mm.148-168) there are three distinct rhythmic layers: sustained values in the flute and clarinet, rhythmically short chordal figures in the harp and piano articulated with percussion hits; these are responded to by the sustained harmonies in the strings. This section's mono-rhythmic character gives the overall sense of unifying these layers and calming the events in the previous section. The texture in this section is slow and reflective; the instrumentalists come to the foreground of the fabric and the processed layer is subtly present.

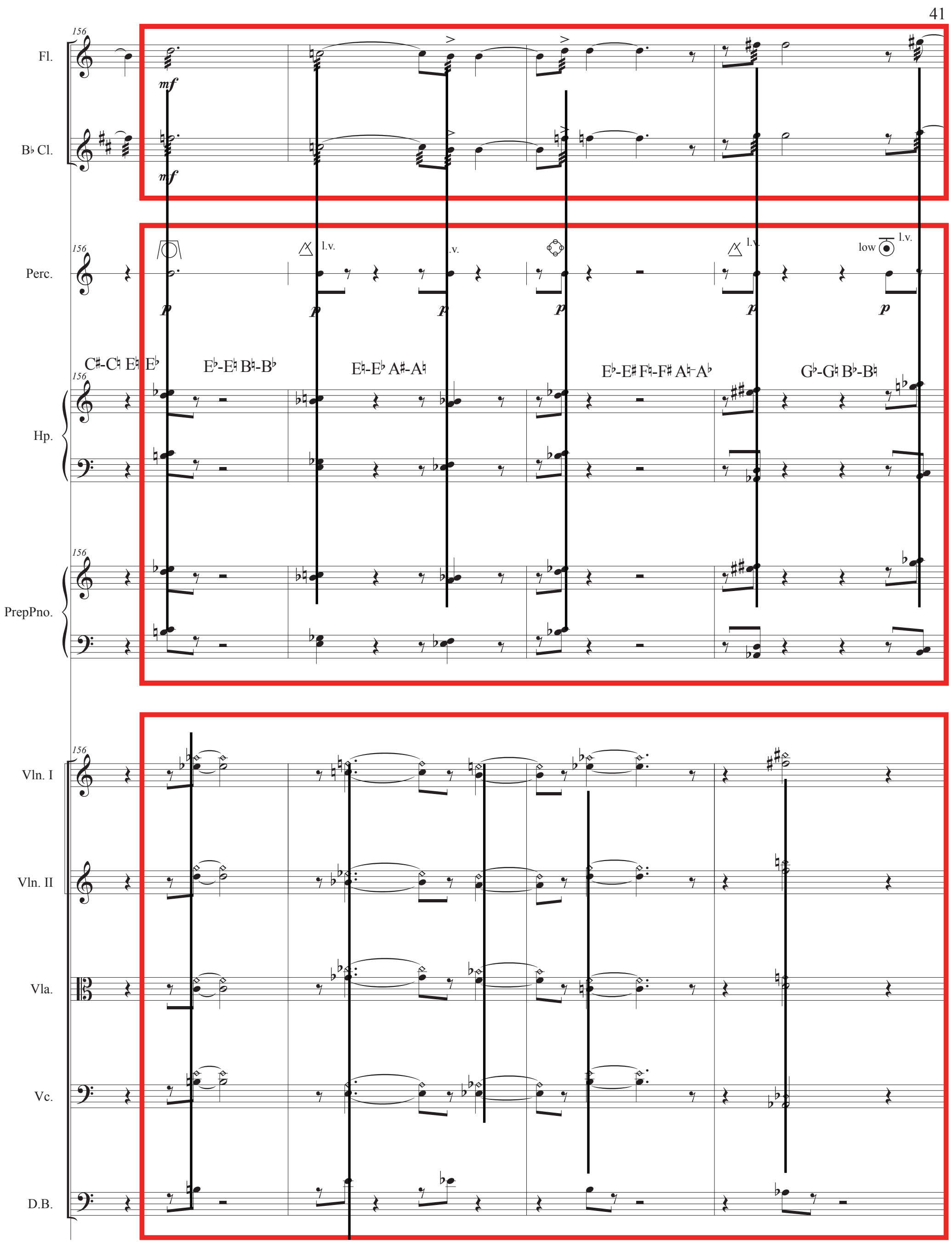


Figure 5.11. Illustration of the three layers outlined above (mm.156-159). Lines indicate the entry points of the instruments, the flute and clarinet articulated by the harp, piano and percussion (note the percussion offset with the gong hit, occasionally offsetting an element that has established a pattern is a tendency I have in my overall compositional work).

Also, in sections 13-15, these long sustained rhythmic values are the aftermath of the saturation resulting from the previous section's unmeasured material. This is the most ambient sound environment in the entire piece. This section is heavily processed with ring modulation and clarinet multiphonics, therefore identifying sources becomes difficult. Aside from the interspersed motive outlined in figure 5.5, the sounds envelope the listening space almost like a black storm cloud over a landscape. This dense texture is the intended result of using long sustained note values.

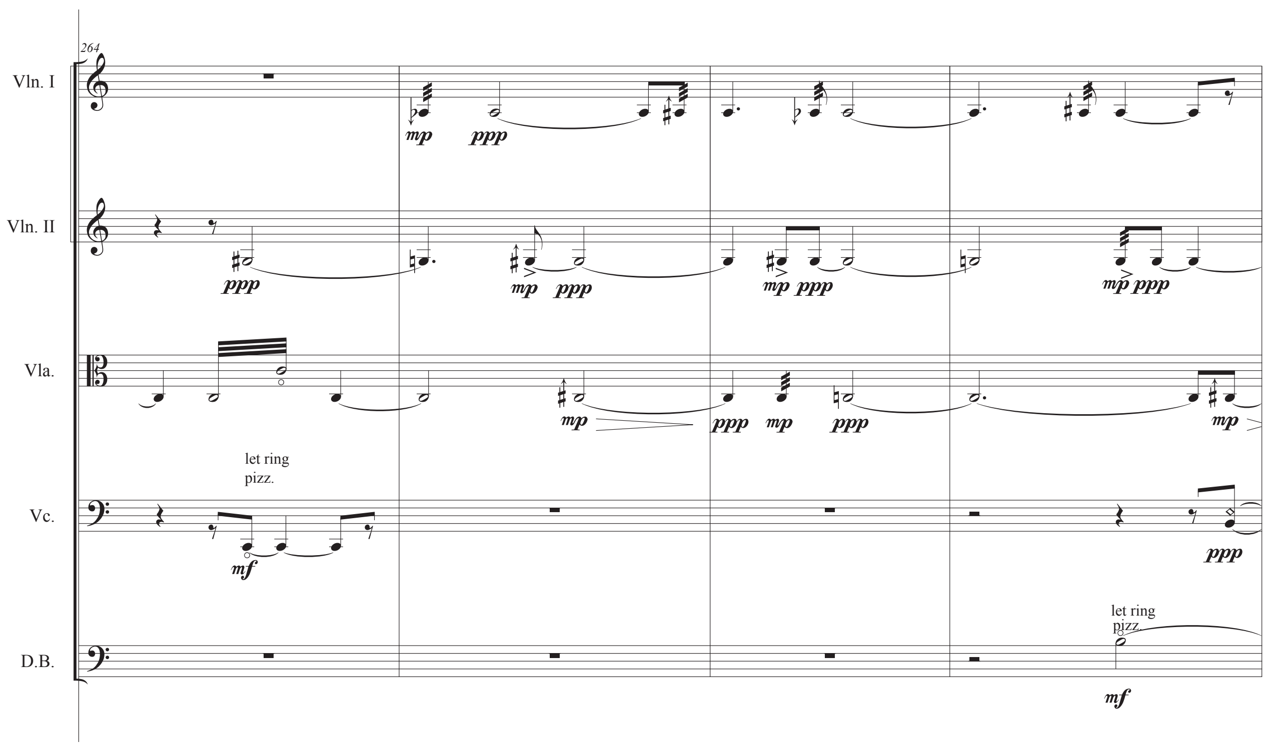


Figure 5.12. Illustration of the sustained values in the strings (mm.264-267).

The rhythmic structures employed throughout the piece are form-giving. Most of the rhythmic material was determined during the composition process. It was essential that the material used result in sections which had their own set of distinct ideas. Rhythmic ideas played a key role because they essentially defined the character of the section — the pitch material was secondary.

Chapter 6: 3D Audio Recording

6.1 Recording

Ever since I began to compose music I have been capturing performances of my music in either an audio or visual format. This eventually became an essential part of the composition process and in most cases I bypassed the traditional performance stage and was satisfied to simply record the music. This approach was driven by an interest in the broader dimensions of working with sound, but also by the traditional performance space (i.e. concert halls), which is always subject to reevaluation. I wanted to extend this personal aspect of my approach into *structured cell* and work with recording formats that are presently being explored.

Therefore, recording the environment in 3D was an essential part of the project, since the goal was to reimagine musical space and to capture an accurate representation of this performance. This portion of the project was in collaboration with Dr. Will Howie, a 3D sound recording researcher. One of the intriguing characteristics of Will Howie's recording method is the attention paid to capturing spatial and aural cues as accurately as possible. In his work this requires a significant number of microphones to record the complex, individual layers, and reconstruct them in the immersive recording lab. *structured cell* was recorded in the 22.2 standard created by NHK Japan[20].

What is unique about the recording process from a compositional point of view, is that each sound source in space represents an object in a perceptual field; this constructs the composition. The configuration of the speaker array and the positioning of the performers is intended to re-enforce this perceptual field. The recording is designed to capture these essential spatial sound structures that are written and performed. Therefore, *structured cell* is a complete unit in which each component (i.e. score, performers, electronics, speaker array, recording) is dependent on another to define the totality of the composition. Will Howie's 3D audio engineering techniques capture this essential quality of the piece and participate as a compositional parameter.

[20] NHK (Nippon Hōsō Kyōkai) is translated as Japan Broadcasting Corporation.

Chapter 7: Conclusion

7.1 Conclusion

structured cell is a reflection on my accumulated work over the years. Various explorations have intersected and are combined in this project. This composition is simultaneously a collaboration, a re-imagining of parameters, a challenging technical feat. The project is an exploration of space and sound, performance practice with electronics, and innovative 3D recording techniques. My particular blend of these techniques constitutes an original contribution to the incorporation of spatial recording techniques into contemporary acoustically-based compositional practice. I expect that this approach will occupy my compositional practices for years to come.

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STRUCTURED CELL

for 10 instruments and 22.2 spatialized live electronics
recorded in 22.2

David Rafferty

Schulich School of Music McGill University

A thesis submitted to McGill University in partial fulfillment of the requirements of the degree of Doctor of Music

Section 2: Score

Program Notes

structured cell is an exploration of space and sound, performance practice with electronics, and innovative 3D recording techniques. This composition is simultaneously a collaboration, a re-imagining of parameters, a challenging technical feat.

Ensemble Instrumentation

1 flute
1 clarinet in Bb (doubling Bass Clarinet)

percussion

- Hihat
- Claves
- Bass Drum
- low Low (22") Chinese Gong (not pitch specific)
- tamborine
- Tam Tam Large
- triangle
- Chinese Cymbal
- Temple Blocks

harp

prepared piano (only apply blu tack over the string to dampen the frequencies. Place approximately 10cm above each hammer)

strings

violin 1
violin 2
viola
cello
double bass

computer/electronics

Technical Requirements for live processing

32 RME DA/AD and 10 mic preamps.
MADIFace - USB2.0

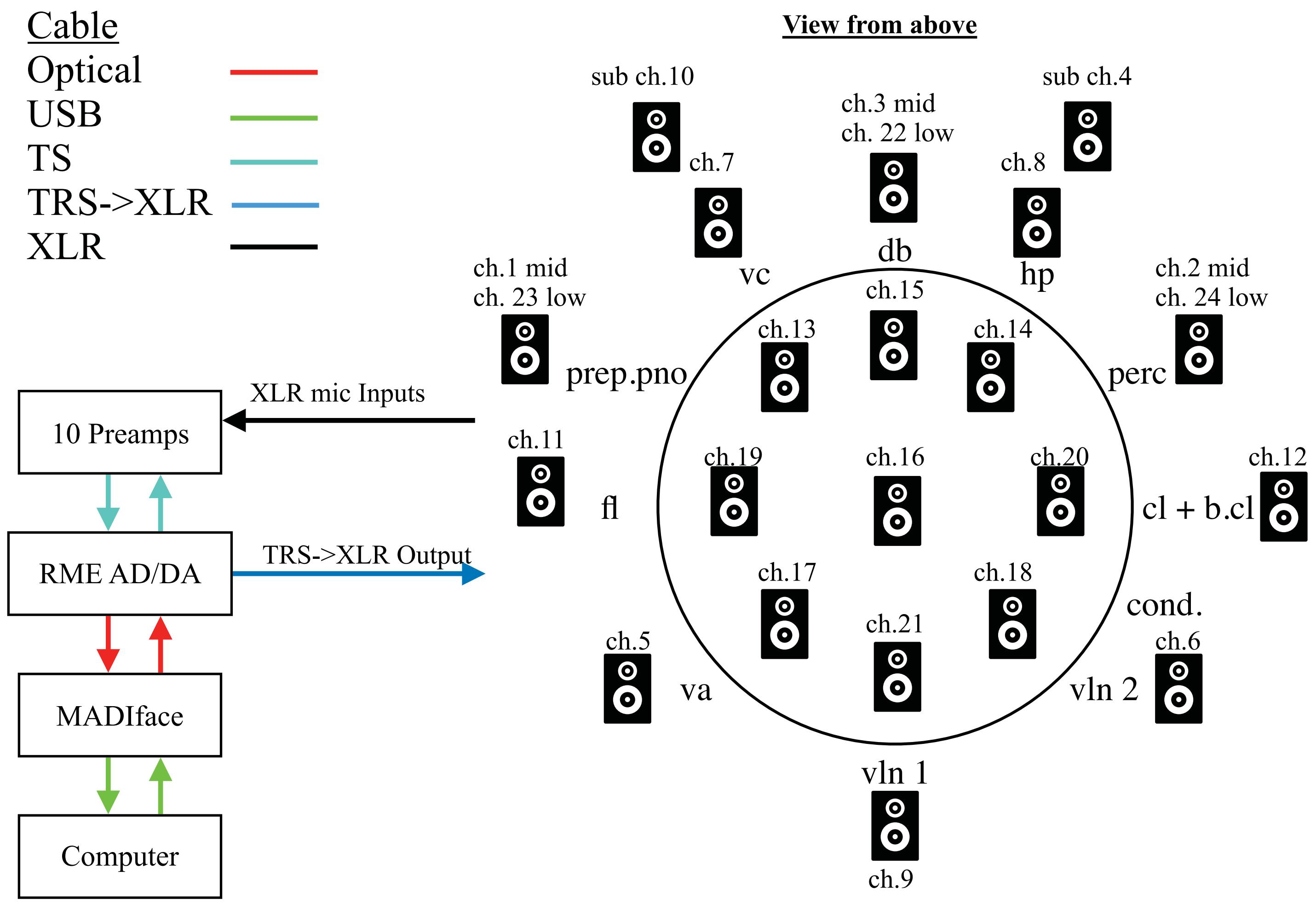
Microphones: 5 DPA 4099 (clip on strings), 5 Neumann KM185 (flute, clarinet, harp, percussion, prepared piano)

Macbook Pro 2013 (early) retina or higher

Maxmsp 7.3.5

IRCAM Forumnet Objects (SPAT 4.9.3, Super VP, SOGS)

Stage Setup



Input List

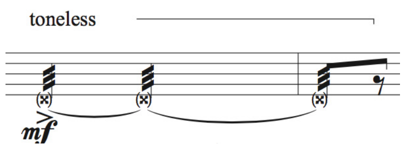
Input Number RME AD	Instrument	Mic	Stand Type	Max Input
1	Flute	KM185	Stand/Boom	**1**
2	Clarinet/ B.Clr	KM185	Stand/Boom	**2**
3	Percussion	KM185	Stand/Boom	**3**
4	Harp	KM185	Stand/Boom	**4**
5	Prepare piano	KM185	Stand/Boom	**5**
6	Violin 1	DPA4099	Clip	**6**
7	Violin 2	DPA4099	Clip	**7**
8	Viola	DPA4099	Clip	**8**
9	Cello	DPA4099	Clip	**9**
10	Double Bass	DPA4099	Clip	**10**

Output List

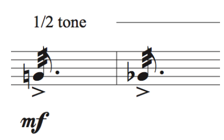
Speaker Channels RME DA	Label	Name
1	FL	Front Left
2	FR	Front Right
3	FC	Front Center
4	LFE1	LFE1
5	BL	Back Left
6	BR	Back Right
7	FLc	Front Left Center
8	FRc	Front Right Center
9	BC	Back Center
10	LFE2	LFE2
11	SiL	Side Left
12	SiR	Side Right
13	TpFL	Top Front Left
14	TpFR	Top Front Right
15	TpFC	Top Front Center
16	TpC	Top Center
17	TpBL	Top Back Left
18	TpBR	Top Back Right
19	TpSiL	Top Side Left
20	TpSiR	Top Side Right
21	TpBC	Top Back Center
22	BtFC	Bottom Front Center
23	BtFL	Bottom Front Left
24	BtFR	Bottom Front Right

Performance Techniques

Flute



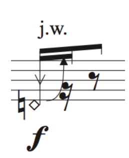
Toneless means air steam fluttering rapidly through the flute



1/2 tone means 50% pitch and 50% breath

Bend the pitch upward (both are the same technique)

pizz. indicates standard pizzicato technique. ‘norm’ indicates return to standard playing technique.

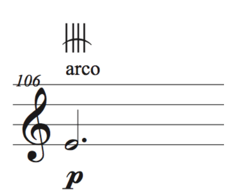


j.w. means Jet Whistle or fast blast of air through the instrument.

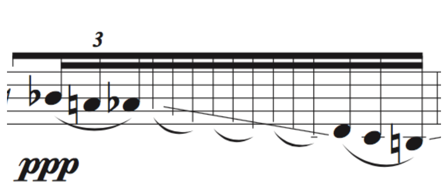
Strings

sul ponticello should be used throughout the piece.

floating fingers (fl.fing) - the performer glides the fingers over the string and does not press down on the fingerboard of the instrument.

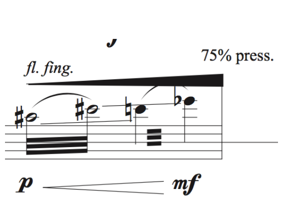


This symbol indicates over the bridge. The staff represents the four strings of the instrument. The lowest line on the staff indicates the lowest string. In the example, the violin string is playing over the bride on ‘G’.

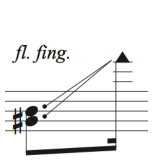


Between measures 164 and 168 this figure indicates floating fingers in a triplet fashion while freely glissando up or down the string.

Very aggressive vibrato creating extreme tension.

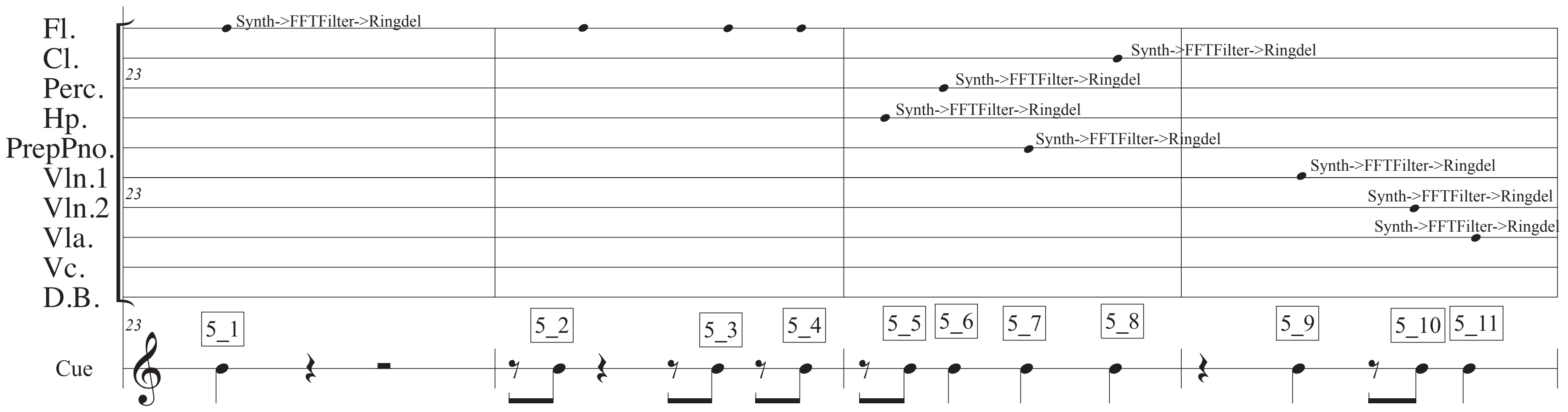


A line above the staff as in the image indicates the amount of pressure the bow requires. The more the pressure the more ‘scratchy’ the sound should be. ’75% press.’ indicates quite a bit of ‘scratch’.



A triangle notehead indicates the trajectory of the finger should aim for the highest point it can achieve in the duration of the time given.

Notes on the Score



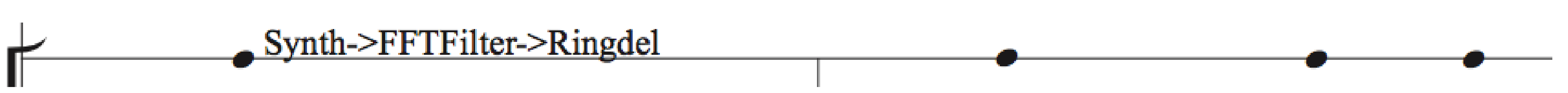
The lines indicate the ten instruments and their processes happening during each measure.

Cue refers to the event in the Max patch that triggers and determines the DSP processes applied to a signal.

A black notehead indicates an event trigger and its corresponding instrument is open to being processed. The abbreviated words indicate both the processing and the order in which the signal flows. The abbreviations mean the following:

sogs = Granular Synthesis
VP = Phase Vocoder
Distort = Distortion
NG = noisegate
Filter
FFTfilter = FFT filter
Ringdel = Ring delay
SF = Soundfile
Ringmod = Ring Modulator
Synth = Synthesizer

In the instance of a repetition in the processing signal in an event the abbreviated words are not repeated as in this example:



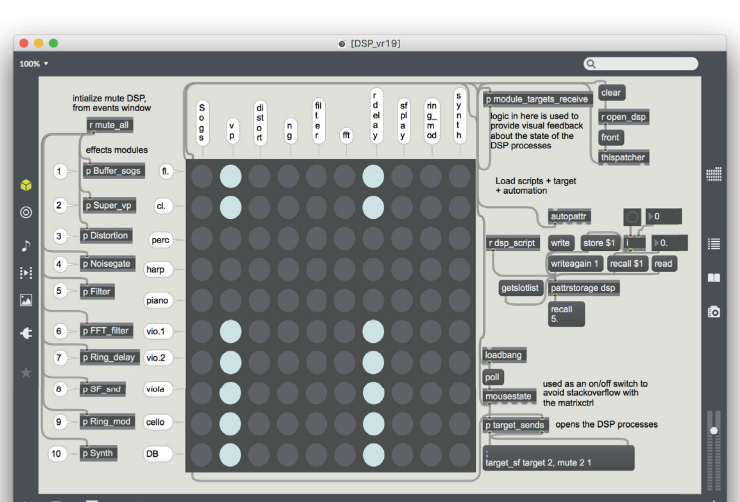
If there is a hyphen followed by an arrow this process is being sent down the processing chain to another processing unit:

ex. Synth->

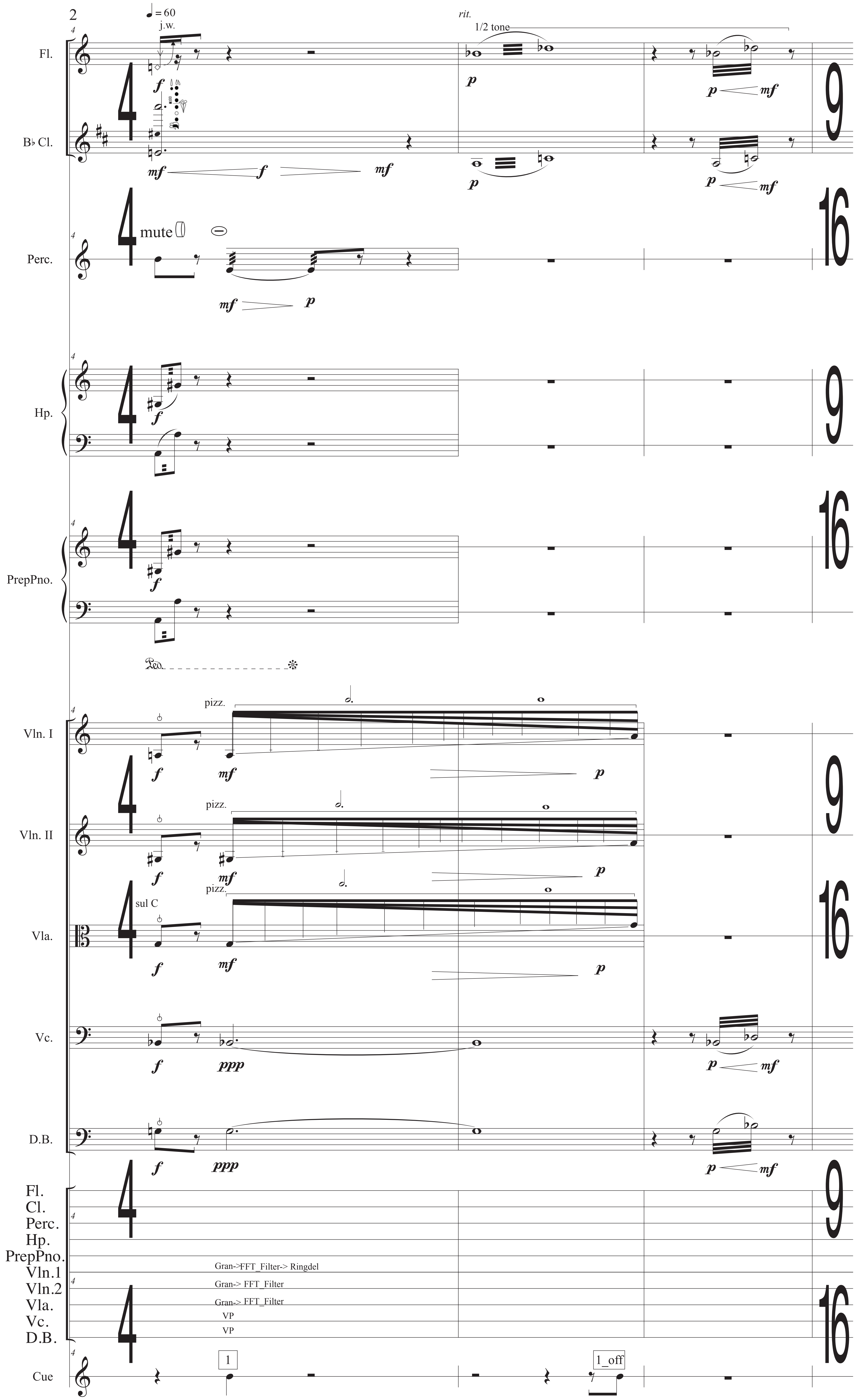
An abbreviation without an arrow indicates that the signal is the only or the final process in the signal chain:

ex. Ringdel

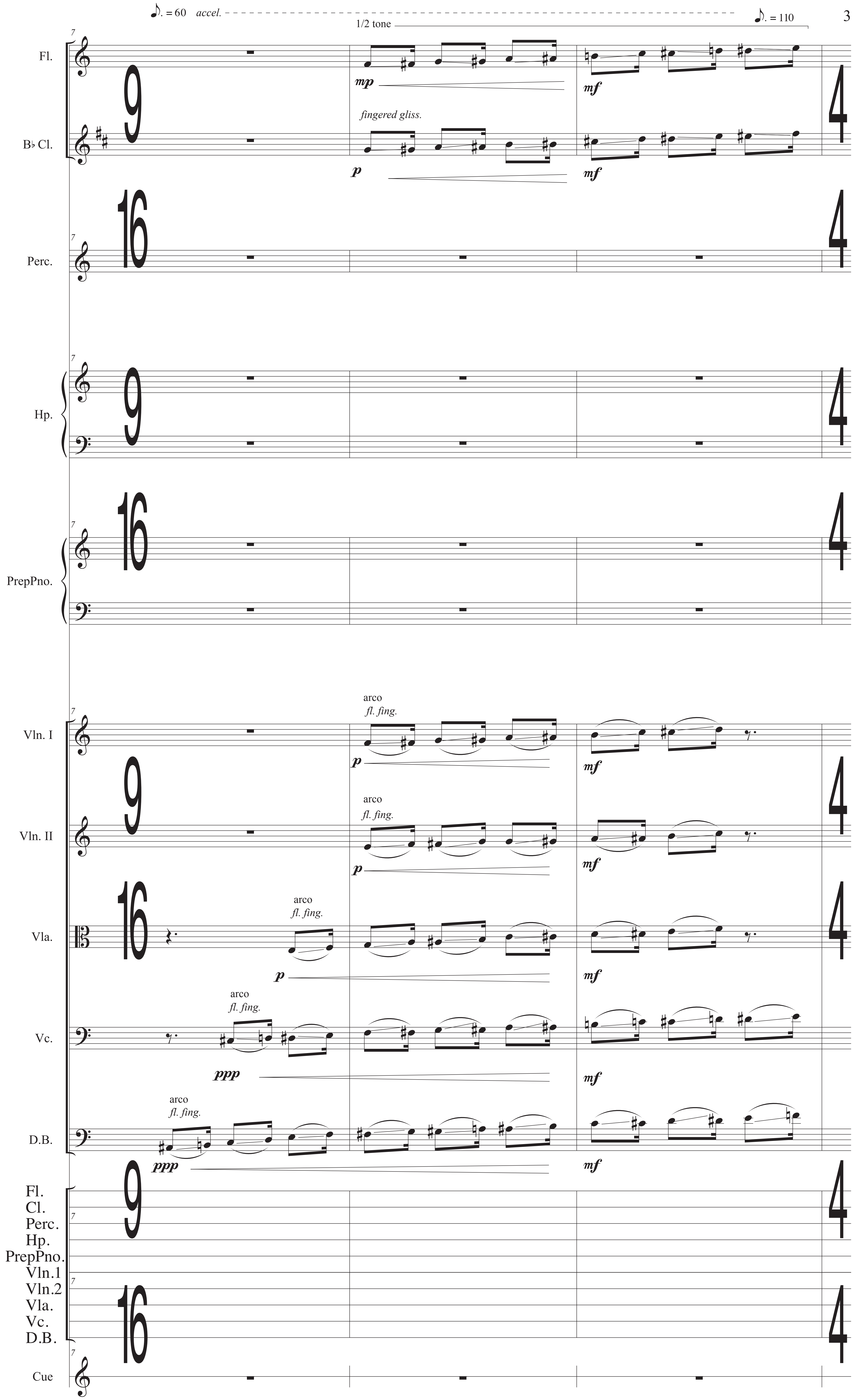
The score illustrates the same DSP visual feedback from the matrix control [mtrctrl] object in the DSP module in the Max patch:



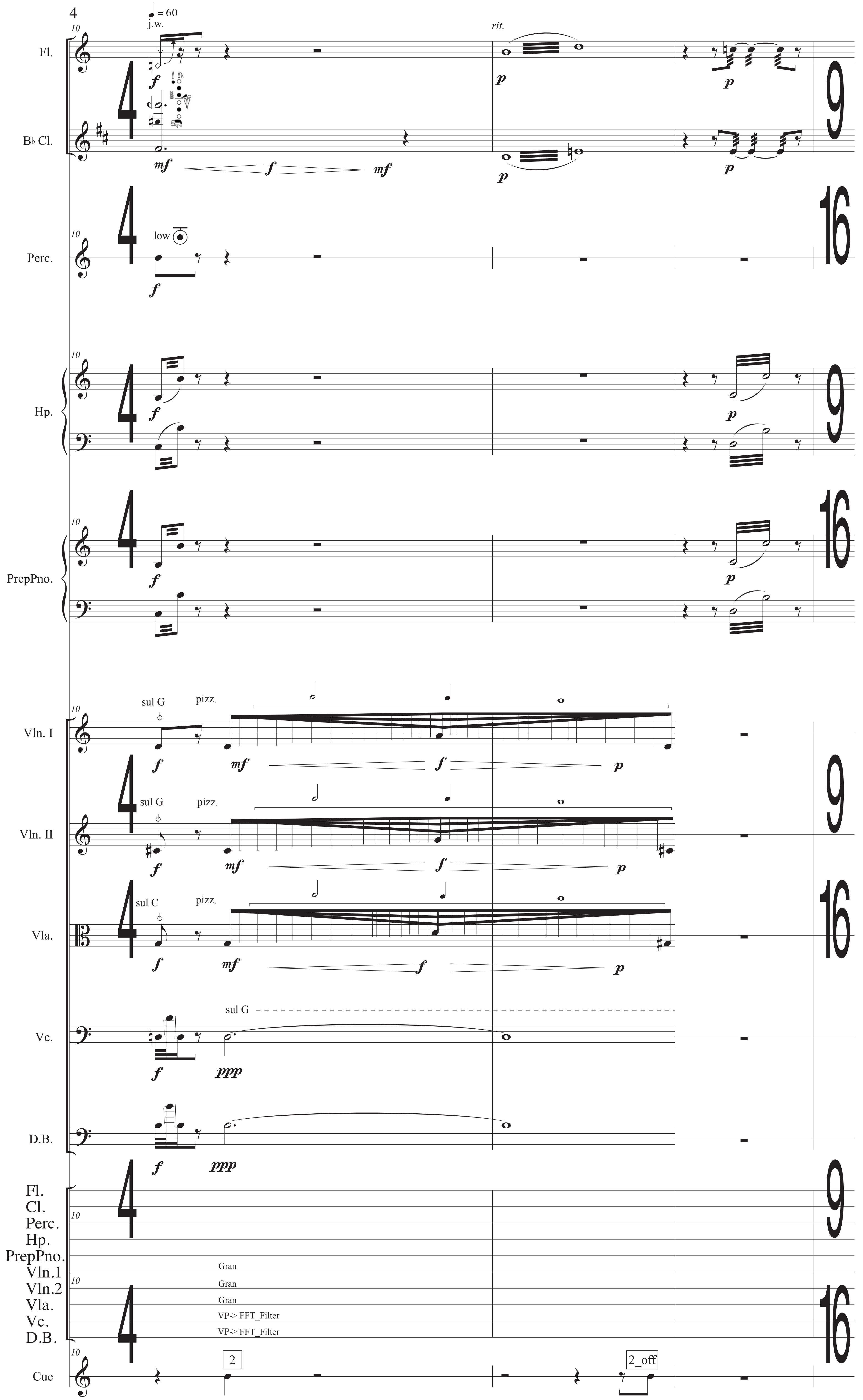
Transposed Score

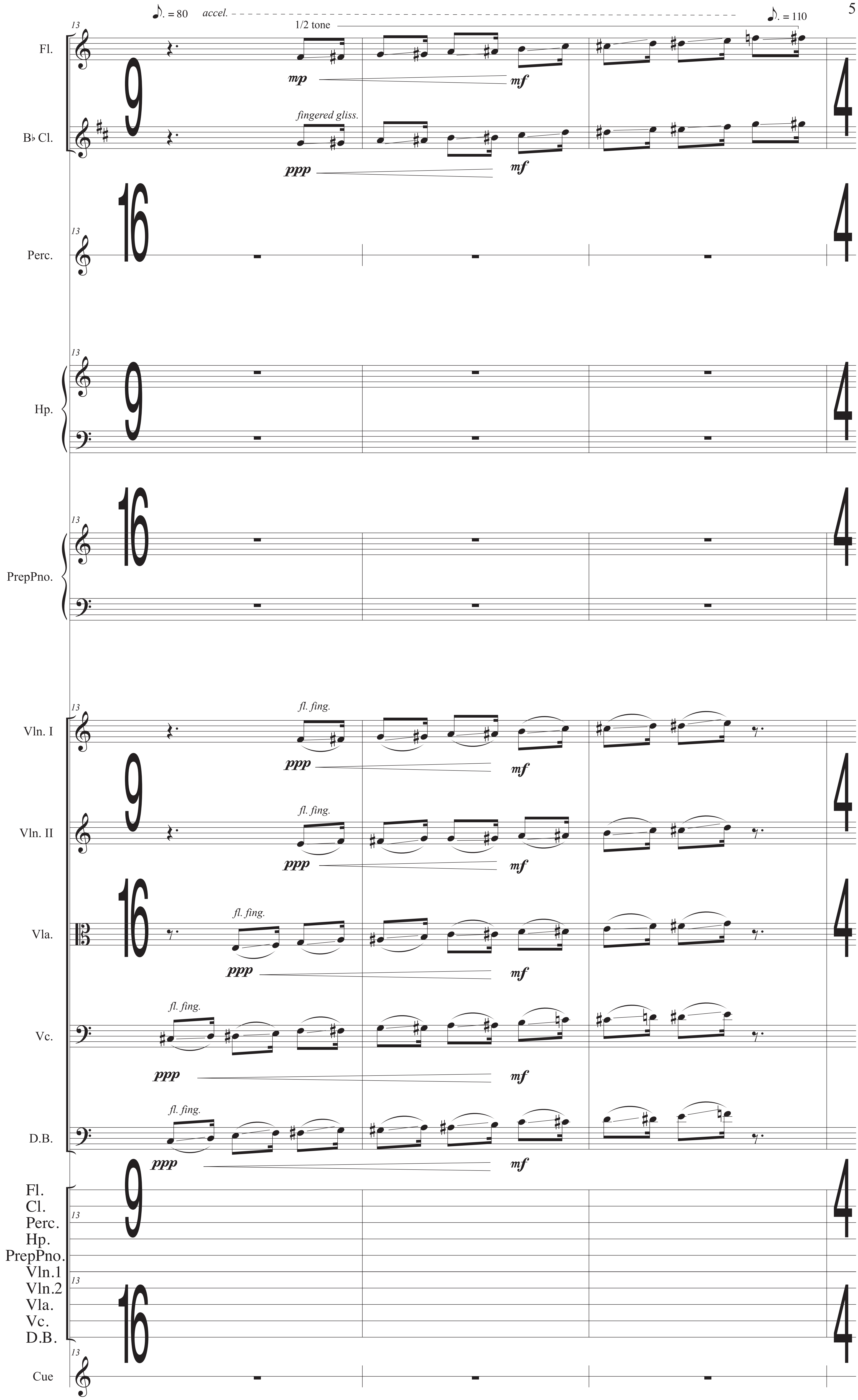


= 60
j.w.
rit.
1/2 tone
Fl.
B♭ Cl.
mute
Perc.
Hp.
PrepPno.
pizz.
Vln. I
Vln. II
sul C
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Gran-> FFT_Filter-> Ringdel
Gran-> FFT_Filter
Gran-> FFT_Filter
VP
VP
Cue
1
1_off

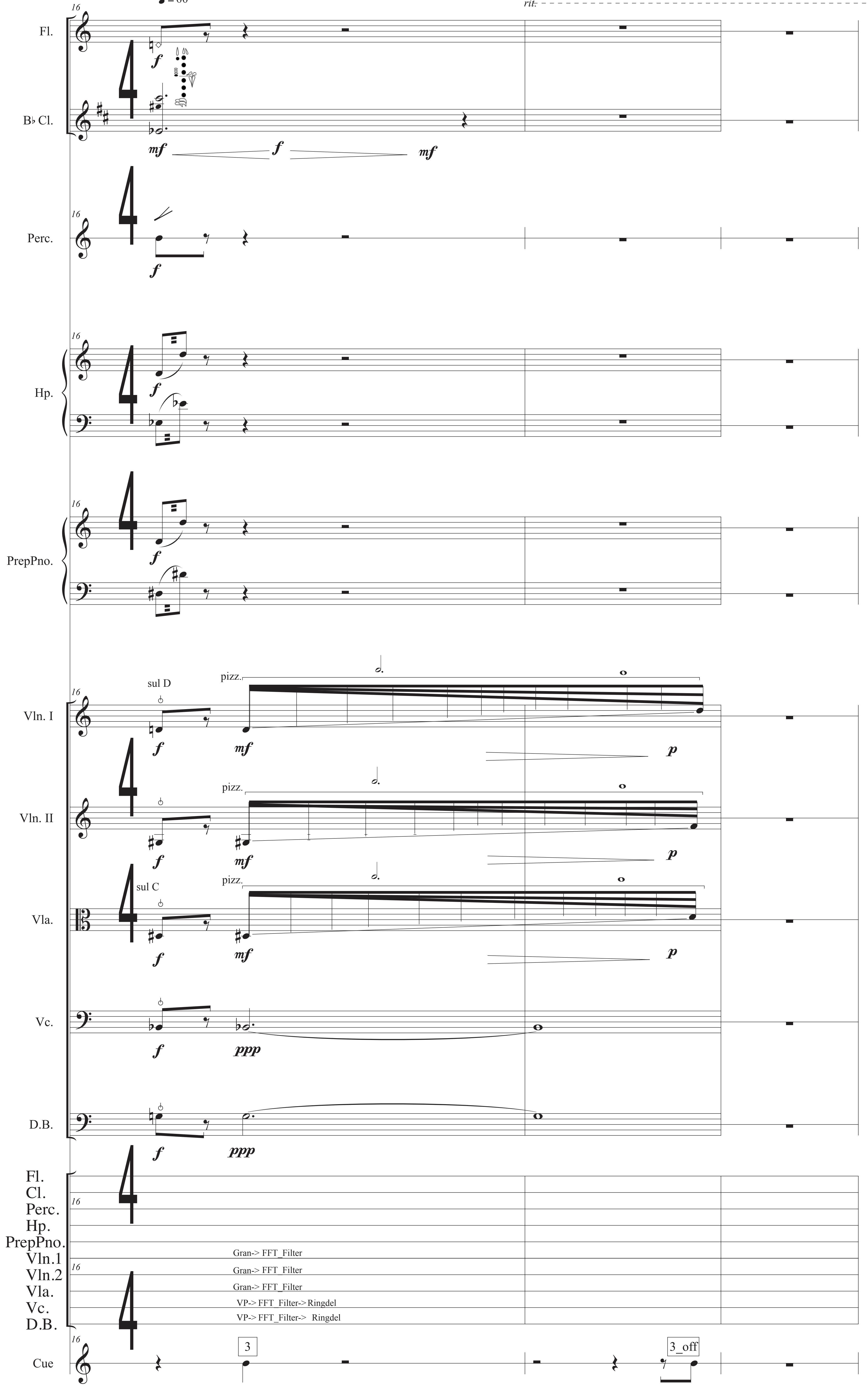


♪. = 60 accel.
1/2 tone
♪. = 110
Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
mp
mf
fingered gliss.
p
arco
fl. fing.
ppp
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Cue


= 60
j.w.
rit.
Fl.
B♭ Cl.
low
Perc.
Hp.
PrepPno.
sul G
pizz.
Vln. I
Vln. II
sul C
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Gran
Gran
Gran
VP-> FFT_Filter
VP-> FFT_Filter
2
2_off
Cue



♪. = 80 accel. ♪. = 110
1/2 tone
Fl.
mp mf
fingered gliss.
B♭ Cl.
ppp mf
Perc.
Hp.
PrepPno.
fl. fing.
Vln. I
Vln. II
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Cue


♩= 60
rit.
Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
sul D
pizz.
Vln. I
Vln. II
sul C
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Gran-> FFT_Filter
Gran-> FFT_Filter
Gran-> FFT_Filter
VP-> FFT_Filter->Ringdel
VP-> FFT_Filter-> Ringdel
Cue
3
3_off

a tempo
Fl.
B♭ Cl.
Perc.
E♭-E♮
Hp.
PrepPno.
arco
fl. fing.
sul D
Vln. I
Vln. II
sul C
Vla.
Vc.
D.B.
VP->
Ringdel->
Ngate
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Cue
4
4_1
4_2
4_off
5_trig

Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
col legno tratto w/ hair
col legno tratto w/ hair
col legno tratto w/ hair
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Synth->FFTFilter->Ringdel
Cue
5_1
5_2
5_3
5_4
5_5
5_6
5_7
5_8
5_9
5_10
5_11


toneless
pizz.
norm.
Fl.
B♭ Cl.
mute
Perc.
G♯-G♮ E♮-E♯
Hp.
PrepPno.
col legno tratto w/ hair
col legno tratto w/ hair
extreme vib.
Vln. I
col legno tratto w/ hair
col legno tratto w/ hair
extreme vib.
Vln. II
extreme vib.
fl. fing.
Vla.
fl. fing.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Synth->FFTFilter->Ringdel
Synth->FFTFilter->Ringdel
5_12
5_13
6_trig
6_1
6_2
6_3
Cue


Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
pizz.
norm.
F♯-F♮ E♯-E♮
D♮-D♯A♮-A♭
fl. fing.
L.H. pizz.
let ring
norm.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Cue
6_4
6_5
6_6
6_7
6_8
6_9
6_10


Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
pizz.
norm.
mute
fl. fing.
norm.
fl. fing.
norm.
Synth->FFTFilter->Ringdel
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Cue
6_off
5_11
5_12
5_13


Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
Cue
pizz.
pizz.
norm.
l.v.
D♭ C B/E♯F♯ G♮ A♮
arco
sul G
slowest possible gliss.
SF
Synth->FFTFilter->Ringdel
Synth->FFTFilter->Ringdel
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
5_off
7
8_trig
8_1
8_2


Fl.
B♭ Cl.
Perc.
l.v.
Hp.
F♯-F♮
PrepPno.
Vln. I
Vln. II
Vla.
arco
sul C
slowest possible gliss.
Vc.
arco
sul C
slowest possible gliss.
D.B.
arco
sul E
slowest possible gliss.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Synth->FFTFilter->Ringdel
Cue
8_3
8_4
8_5
8_6
8_7
8_8
8_9
8_10
8_11
8_12
8_13


Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Cue
8_14
8_15
8_16
8_17
8_18
8_19
8_20


toneless
Fl.
B♭ Cl.
To bass clarinet
Perc.
mute
Hp.
E♯-E♮
D♭-D♮
PrepPno.
Vln. I
fl. fing.
Vln. II
fl. fing.
Vla.
fl. fing.
Vc.
D.B.
pizz.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Synth
Cue
8_off
9_trig
9_1


Fl.
pizz.
mf
B♭ Cl.
ppp
mf
Perc.
f
p
mp
Hp.
f
mp
PrepPno.
f
mp
sul G
norm.
Vln. I
mf
p
ppp
mf
sul G
norm.
Vln. II
mf
p
ppp
mf
sul C
norm.
Vla.
mf
p
ppp
mf
norm.
Vc.
ppp
mf
fl. fing.
D.B.
ppp
mf
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Synth
Synth
Synth
Cue
9_2
9_3
9_4


toneless
pizz.
Fl.
B♭ Cl.
mute
l.v.
Perc.
Hp.
PrepPno.
sudden burst
fl. fing.
norm.
Vln. I
Vln. II
Vla.
Vc.
pizz.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Synth
Cue
9_5
9_6
9_7
9_8
9_9
9_10

Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
Cue
pizz.
F♮-F♯
F♯-F♮
sul D
gliss.
norm.
arco
fl. fing.
Synth
Gran
9_11
9_off
10_trig
10_1
10_2
10_3
10_4
10_5


69
Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
pizz.
toneless
embrochure bend
mute
sul D
extreme vib.
fl. fing.
arco
Synth
Gran
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
11_1
11_trig
10_off
11_2
11_3
11_4
11_5
11_6
11_7
11_8
11_9
11_10
11_11
Cue

73
Fl.
pizz.
B♭ Cl.
Perc.
Hp.
D♮-D♭ F♮-F♯
D♭-D♮ C♮-C♯ A♮-A♭
PrepPno.
Vln. I
fl. fing.
sul D
norm.
Vln. II
Vla.
Vc.
D.B.
pizz.
arco
Synth
Gran
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Cue
11_off
12_trig
12_1
12_2
12_3
12_4
12_5
12_6

77
Fl.
pizz.
B♭ Cl.
Perc.
Hp.
C♯-C♮ A♭-A♮
D♮C♯ B/E F G♭ A
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Synth
Synth
Synth
Gran
Gran
Gran
Gran
Gran
Cue
12_off
13_trig
13_1
13_2
13_3
13_4
13_off
14_trig


♩ = 100
pizz.
Fl.
B♭ Cl.
mute
low
Perc.
Hp.
PrepPno.
pizz.
arco
sul G
Vln. I
Vln. II
sul C
Vla.
Vc.
D.B.
Synth
Synth->Filter
Gran
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
15_1
15_trig
14_1
14_2
14_3
14_4
14_off
15_2
15_3
15_4
Cue


1/2 tone
Fl.
B♭ Cl.
Perc.
mute
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Synth->Filter
16_trig
15_5
15_6
15_7
15_8
15_9
15_10
15_off
16_1
16_2
16_3
16_4
16_5
16_6
16_off
Cue


86
Fl.
pizz.
1/2 tone
norm.
B♭ Cl.
To clarinet
Perc.
mute
Hp.
PrepPno.
Vln. I
sul G
col legno tratto w/ hair
Vln. II
sul G
col legno tratto w/ hair
Vla.
sul C
col legno tratto w/ hair
Vc.
sul C
col legno tratto w/ hair
D.B.
col legno tratto w/ hair
sul A
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Synth->Filter
Synth->Gran->Filter
Cue
17_trig
17_1
17_2
17_3
17_4
17_5
17_6


= 110
j.w.
1/2 tone
Fl.
B♭ Cl.
Perc.
D♯ C♯ B♯/E♯ F♯ G♮ A♭
Hp.
PrepPno.
sul G
pizz.
arco
fl. fing.
jete
Vln. I
Vln. II
arco
jete
Vla.
Vc.
sul D
D.B.
ppp
SF
VP-> Filter
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
17_off
18
19
19_off
Cue


93
Fl.
j.w.
1/2 tone
f
mf
mf
ppp
B♭ Cl.
embrochure bend
f
mf
p
Perc.
mute
low
mf
f
Hp.
PrepPno.
mf
Vln. I
p
f
mf
f
Vln. II
jete
p
f
f
Vla.
arco
fl. fing.
jete
fl. fing.
jete
p
f
mf
f
Vc.
pizz.
jete
jete
fl. fing.
jete
p
f
mf
f
D.B.
p
f
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
VP->FFT_Filter
VP->FFT_Filter
VP->FFT_Filter
VP->FFT_Filter
Cue
20


1/2 tone
Fl.
mf
ppp
embrochure bend
B♭ Cl.
Perc.
D♯-D♮
bisb.
Hp.
PrepPno.
pizz.
Vln. I
Vln. II
arco
jete
Vla.
sul D
Vc.
sul A
D.B.
VP->FFT_Filter
VP->Filter
Gran
Gran->automation
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
20_off
21
21_off
22
22_1
Cue


100
1/2 tone
Fl.
mf
embrochure bend
B♭ Cl.
mf
Perc.
B♯-B♮
B♮-B♭
Hp.
PrepPno.
Vln. I
ppp
Vln. II
ppp
Vla.
ppp
Vc.
ppp
sul E
D.B.
ppp
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Cue


= 60
Fl.
B♭ Cl.
Perc.
mute
Hp.
D♮C♮B♮/E♯F♯G♯A♯
E♯-E♭
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
arco
VP->Filter
VP->FFT_Filter
Cl.
Vln.1
Vln.2
Cue
22_off
23
23_off


♪. = 110
pizz.
107
Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
9
16
mf
p
f
4
pizz.
arco
fl. fing.
jete
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Ringdel->FFTfilter
Cue
24
24_off

Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Cue
♩= 60
♪. = 110
pizz.
D♮C♮B♮/E♭ F♮G♭ A♭
D♮-D♭
E♭-E♯ A♭-A♮
arco
jete
jete
VP->FFT_Filter
VP->FFT_Filter
Ringdel->FFTfilter
Ringdel->FFTfilter
Ringdel->FFTfilter
Ringdel->FFTfilter
Ringdel->FFTfilter
Ringdel->FFTfilter
25
25_off
26

♩= 60
Fl.
B♭ Cl.
Perc.
mute
Hp.
B♮-B♭
D♮-D♯A♮-A♭
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
VP-> Filter
VP->FFT_Filter
Cue
26_off
27


117
Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
pizz.
rit.
mute
arco
norm.
fl. fing.
sul G
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Gran->VP
VP
+ Gran
VP + Gran
Cue
27_off
28
28_off
29
29_1
29_2


toneless
a tempo
= 110
j.w.
Fl.
B♭ Cl.
Perc.
D♮C♮B♭/E♭ F♮G♭A♮
E♭-E♮
B♭-B♮ E♮-E♭
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Ring_mod->FFT_Filter
29_off
30
Cue


1/2 tone
j.w.
j.w.
pizz.
Fl.
B♭ Cl.
Perc.
l.v.
Hp.
E♭-E♮
PrepPno.
Vln. I
pizz.
Vln. II
fl. fing.
fl. fing.
jete
Vla.
jete
Vc.
arco
D.B.
fl. fing.
fl. fing.
pizz.
Synth->Filter
Synth->Filter
Ring_mod->FFT_Filter
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Cue
30_off
31_trig
31_1
31_2
31_off
32


131
j.w.
j.w.
pizz.
Fl.
B♭ Cl.
Perc.
D♮C♯B♯/E♭ F G♯ A
Hp.
PrepPno.
fl. fing.
Vln. I
jete
gliss.
Vln. II
Vla.
ad lib. gliss. fast repeated bowing based
on the hand position from the origin
Vc.
arco
D.B.
Synth->Filter
Gran->VP
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
33_trig
32_off
33_1
33_2
33_off
34
35_trig
35_1
Cue


♩= 100
rit.
pizz.
Fl.
B♭ Cl.
Perc.
Hp.
D♭C♮B♮/E♭ F G♯ A
PrepPno.
norm.
0% press.
75% press.
fl. fing.
Vln. I
Vln. II
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Synth->Filter
VP
Processes open until Event 38
VP + VP->Gran
35_2
35_off
36
37
38_trig
Cue


♪. = 110
pizz.
♩= 60
Fl.
B♭ Cl.
Perc.
Hp.
D♭-D♮
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
fl. fing.
norm.
75% press.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Synth->Filter
Cue
38_1
38_2
38_3
38_4

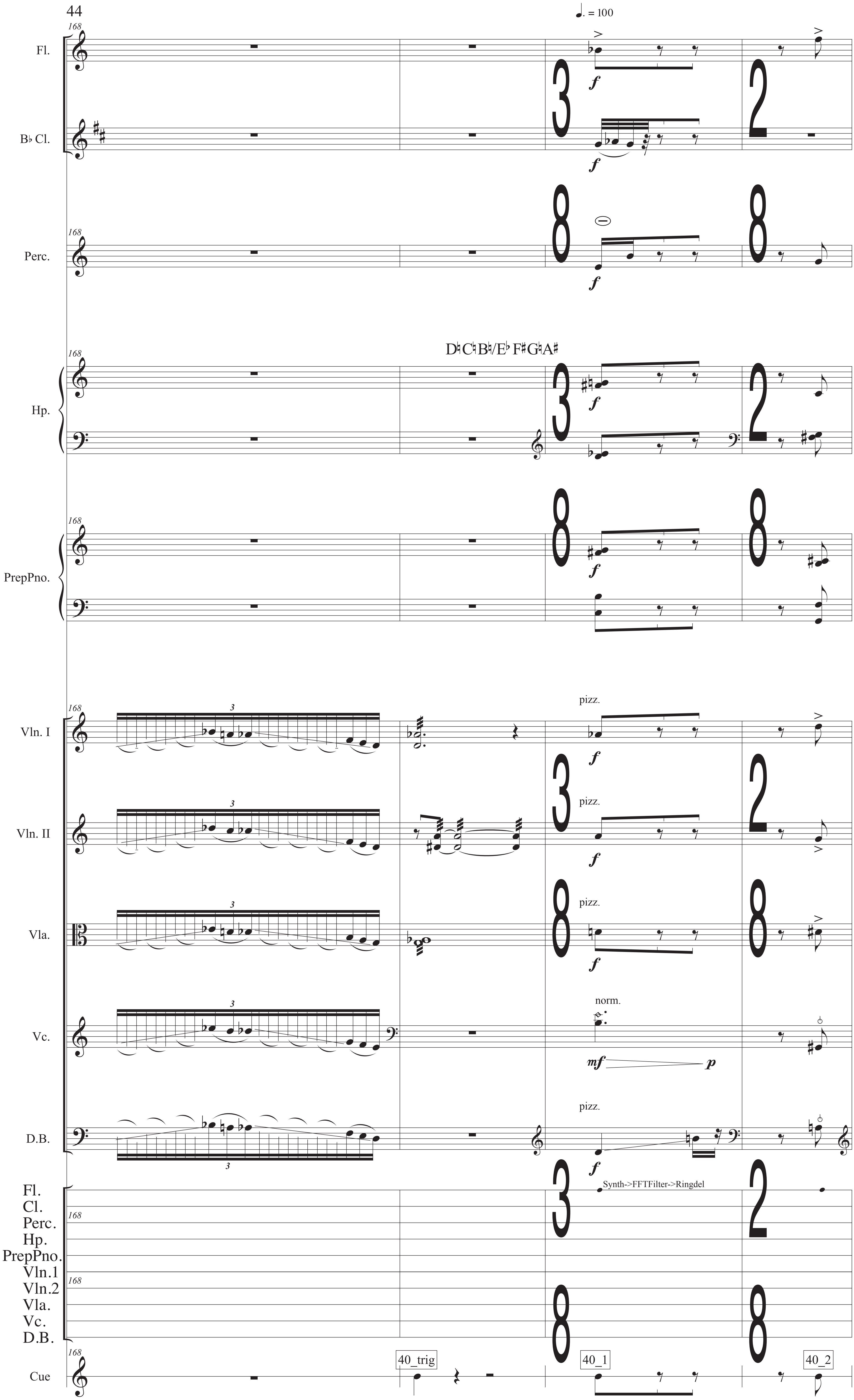

G.P
147
Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
toneless
norm.
mf
p
mp
ppp
mute
D♮C♮B♭/E♭ F♯G♮A♮
bisb.
fl. fing.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Ringdel->FFT_Filter
VP-Off
Gran->Ngate
Cue
38_5
38_off
39_trig_1
39_2


toneless
152
Fl.
B♭ Cl.
Perc.
low
Hp.
D♮C♯B♮/E♮F♮G♭A♯
PrepPno.
3
pizz.
arco
fl. fing.
norm.
Vln. I
Vln. II
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Cue
39_3
39_4

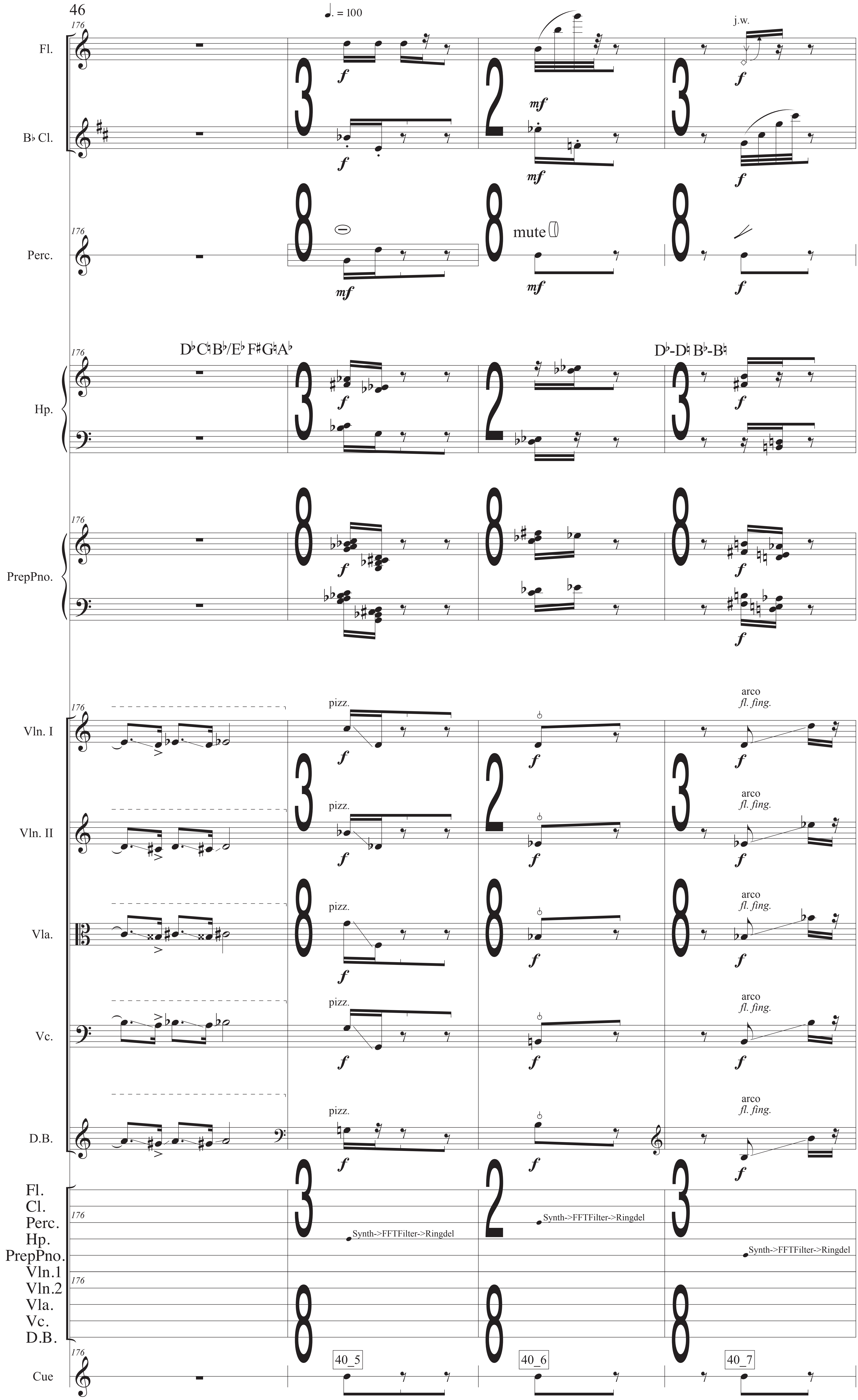

156
Fl.
mf
B♭ Cl.
mf
Perc.
l.v.
l.v.
l.v.
low
l.v.
p
p
p
p
p
p
C♯-C♮ E♮-E♭
E♭-E♮ B♮-B♭
E♮-E♭ A♯-A♮
E♭-E♯ F♮-F♯ A♮-A♭
G♭-G♮ B♭-B♮
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Cue
39_5
39_6
39_7
39_8
39_9


Fl.
B♭ Cl.
Perc.
l.v.
mute
low
Hp.
D♮C♮B♮/E♭ F♯G♯A♭
D♮-D♯ E♭-E♮ G♯-G♮
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Cue
39_10
39_11


164
Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
sul G
fl. fing.
Vln. I
ppp
sul G
fl. fing.
Vln. II
ppp
sul C
fl. fing.
Vla.
ppp
sul A
fl. fing.
Vc.
ppp
sul G
fl. fing.
D.B.
ppp
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
39_off
Cue


♩. = 100
168
Fl.
B♭ Cl.
Perc.
Hp.
D♮C♮B♮/E♭ F♯G♮A♯
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
pizz.
norm.
Synth->FFTFilter->Ringdel
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Cue
40_trig
40_1
40_2

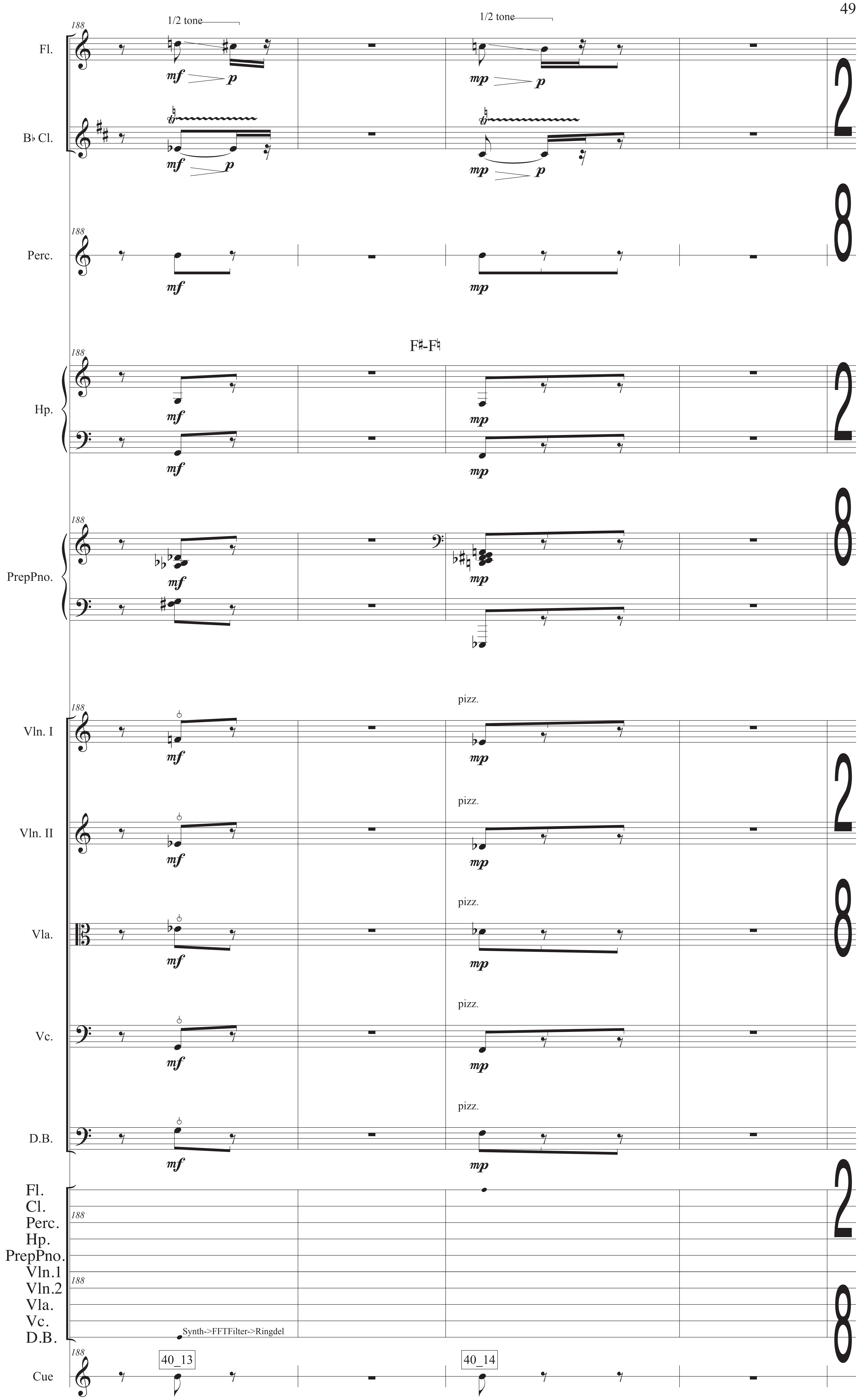

♩= 100
Fl.
B♭ Cl.
Perc.
f
C♮-C♯B♮-B♭A♯-A♮
Hp.
PrepPno.
arco
fl. fing.
gliss.
Vln. I
p
Vln. II
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
40_3
40_4
Cue

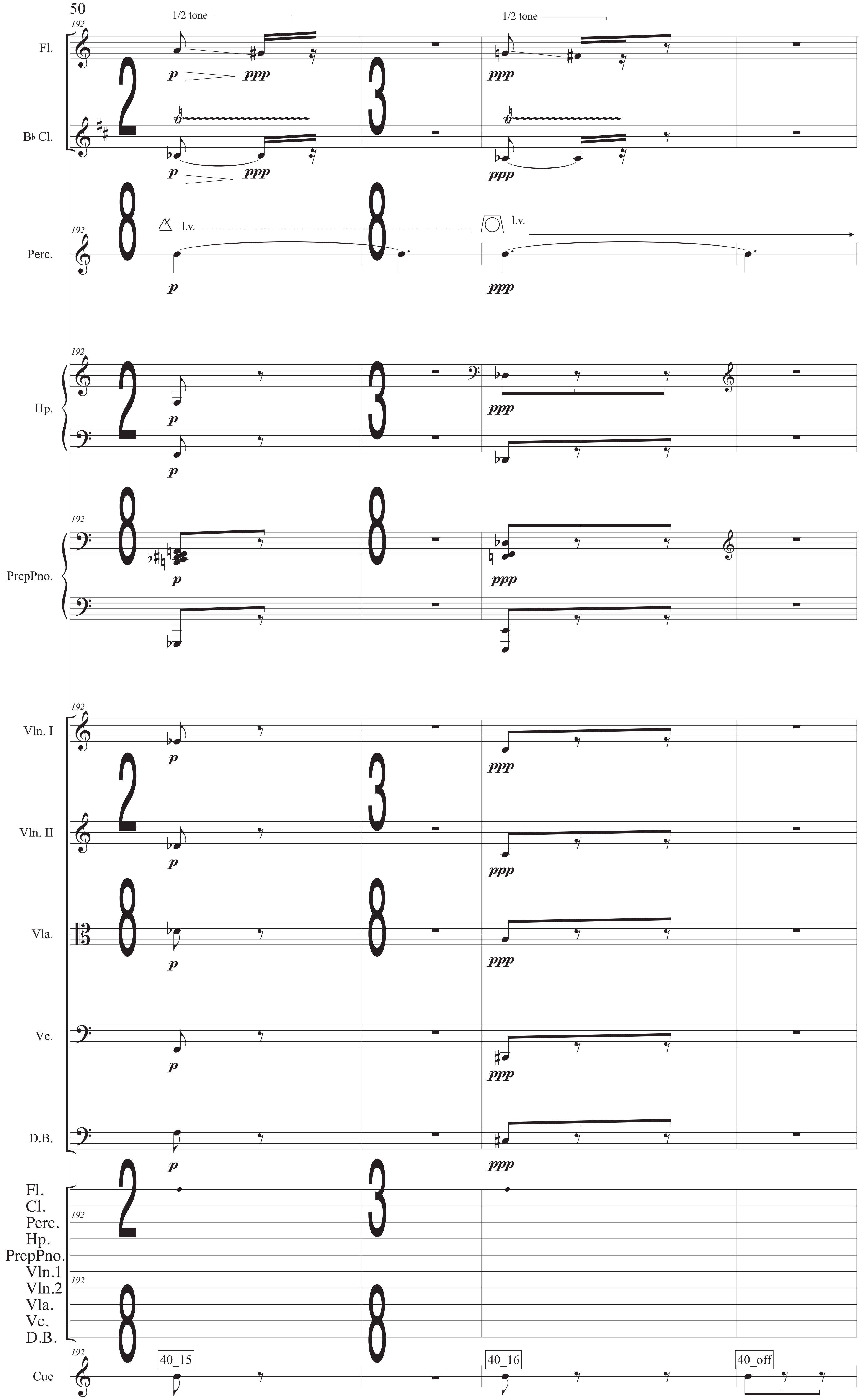


♩. = 100
Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
j.w.
mute
D♭C♮B♭/E♭ F♯G♮A♭
D♭-D♮ B♭-B♮
pizz.
arco
fl. fing.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Synth->FFTFilter->Ringdel
Synth->FFTFilter->Ringdel
Synth->FFTFilter->Ringdel
Cue
40_5
40_6
40_7


180
Fl.
B♭ Cl.
Perc.
mute
Hp.
D♮-D♭
PrepPno.
extreme vib.
Vln. I
Vln. II
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Synth->FFTFilter->Ringdel
40_8
Cue


Fl.
B♭ Cl.
Perc.
low
mute
Hp.
A♭-A♮
A♮-A♭
PrepPno.
15ma
Vln. I
Vln. II
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Synth->FFTFilter->Ringdel
Synth->FFTFilter->Ringdel
Synth->FFTFilter->Ringdel
Synth->FFTFilter->Ringdel
Cue
40_9
40_10
40_11
40_12


188
1/2 tone
1/2 tone
Fl.
Bb Cl.
mf
p
mp
Perc.
F♯-F♮
Hp.
PrepPno.
pizz.
Vln. I
Vln. II
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Synth->FFTFilter->Ringdel
40_13
40_14
Cue
2
8


1/2 tone
1/2 tone
Fl.
B♭ Cl.
Perc.
l.v.
l.v.
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Cue
40_15
40_16
40_off


G.P
♪. = 110 toneless
Fl.
B♭ Cl.
Perc.
Hp.
D♮C♮B♮/E♭ F♭G♯A♮
PrepPno.
Vln. I
pizz.
Vln. II
pizz.
Vla.
Vc.
D.B.
pizz.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Gran->Buffer_Capture trig->Gran+VP+Filter
Gran->2000ms ->off
Cue
41
42


200
Fl.
toneless
pizz.
toneless
pizz.
mf
mf
B♭ Cl.
p
mf
p
Perc.
D♮-D♭
D♭-D♮
Hp.
PrepPno.
f
p
p
arco
50% pressure
Vln. I
mf
p
f
arco
pizz.
Vln. II
mf
mf
f
50% pressure
arco
extreme vib.
50% pressure
Vla.
mf
mp
f
f
pizz.
arco
50% pressure
Vc.
mf
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Gran->2000ms ->off
Gran->2000ms ->off
Cue
43
44


toneless
1/2 tone
toneless
Fl.
B♭ Cl.
Perc.
F♭-F♮
Hp.
PrepPno.
fl. fing.
col legno
50% pressure
extreme vib.
Vln. I
arco
Vln. II
50% pressure
col legno
extreme vib.
Vla.
col legno
pizz.
Vc.
col legno
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Gran->2000ms ->off
Gran->2000ms ->off
45
46
Cue


Fl.
j.w.
toneless
1/2 tone
toneless
B♭ Cl.
embrochure bend
Perc.
Hp.
A♮-A♯
G♯-G♮
E♭-E♮ G♮-G♯ A♯-A♮
PrepPno.
Vln. I
Vln. II
extreme vib.
Vla.
col legno
col legno
extreme vib.
Vc.
col legno
extreme vib.
jete
D.B.
col legno
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Gran->2000ms ->off
Gran-> VP
Cue
47
48_morph

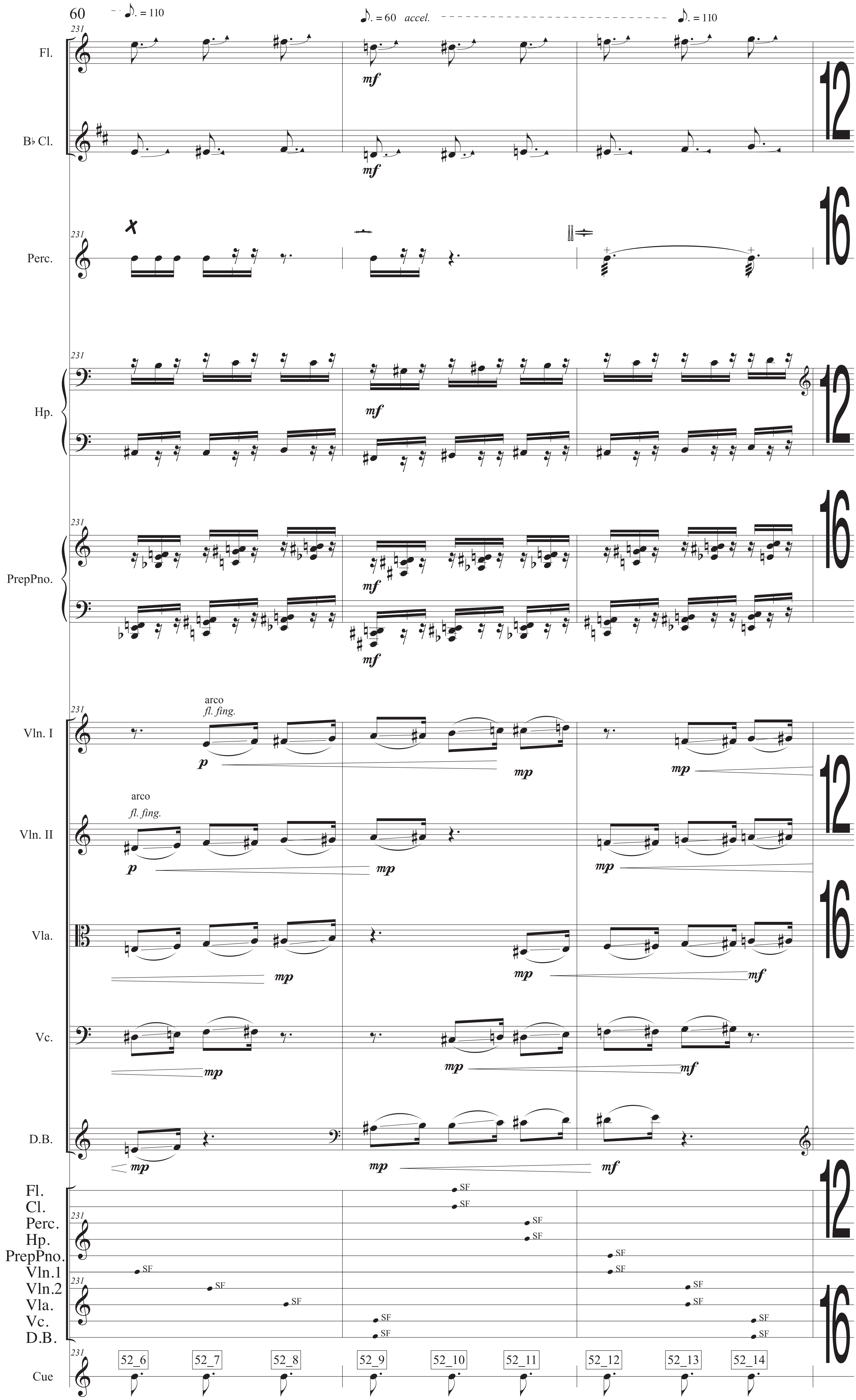

212
Fl.
j.w.
toneless
B♭ Cl.
Perc.
mute
Hp.
PrepPno.
extreme vib.
pizz.
Vln. I
Vln. II
Vla.
Vc.
col legno
D.B.
fl. fing.
arco
sul D
sul G
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Gran->VP
48_1morph
Cue


216
Fl.
1/2 tone
mf
p
j.w.
f
B♭ Cl.
p
mf
p
f
Perc.
mute
f
Hp.
A♮-A♯
f
PrepPno.
f
extreme vib.
Vln. I
f
Vln. II
f
Vla.
jete
extreme vib.
mf
f
jete
jete
f
fl. fing.
f
Vc.
jete
f
jete
col legno
f
fl. fing.
f
D.B.
sul D
f
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Gran->VP
Gran->VP
Cue
49_morph
49_1morph

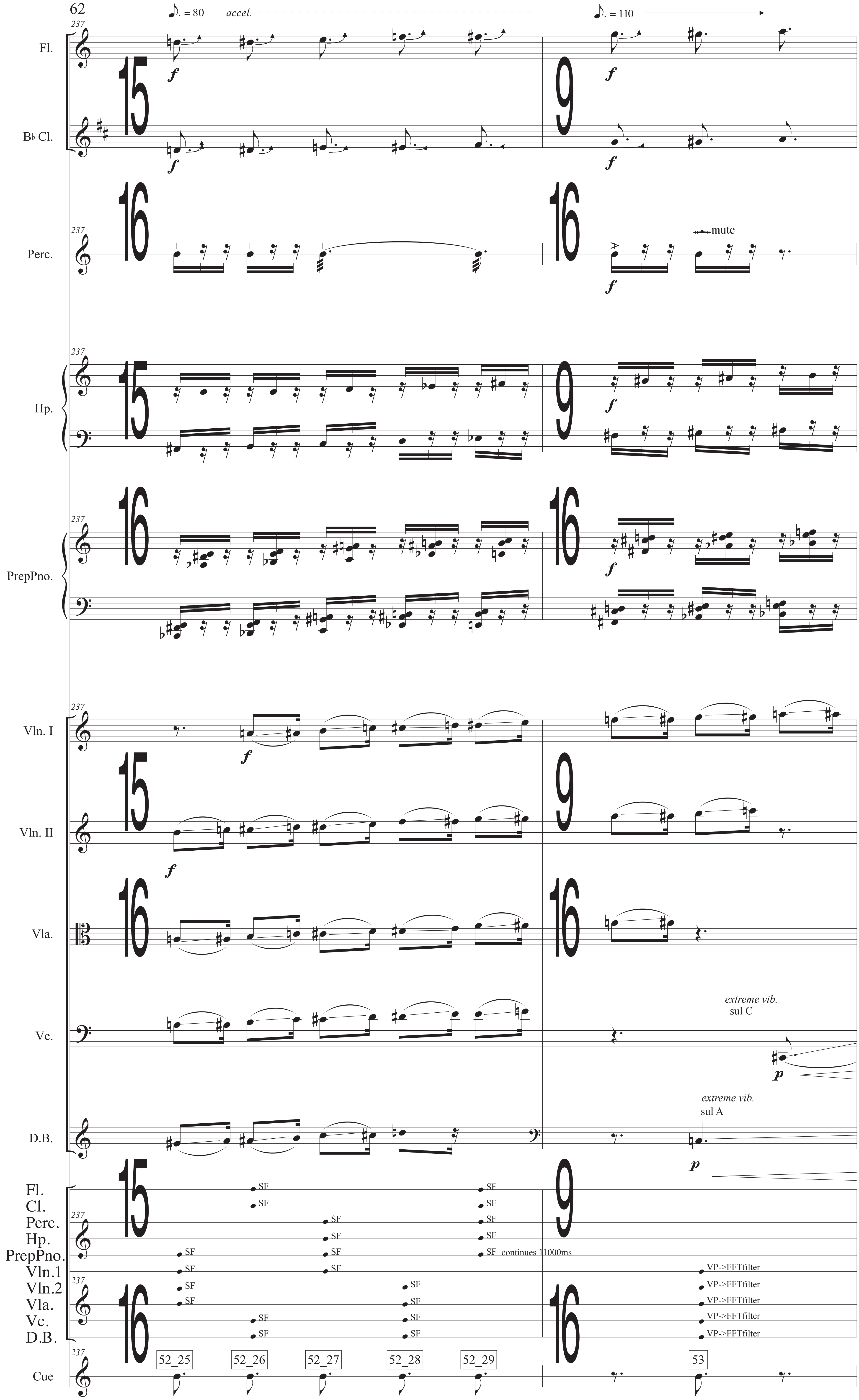

220
1/2 tone
j.w.
Fl.
B♭ Cl.
mf
p
f
mute
Perc.
G♯-G♮
F♮-F♯
D♮-D♭ E♮-E♭
Hp.
PrepPno.
Vln. I
Vln. II
pizz.
sul C
Vla.
Vc.
pizz.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Gran->VP
50_morph
50_1morph
Cue


224
Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
Cue
1/2 tone
j.w.
mute
D♮C♮B♮/E♭ F♯G♯A♯
pizz.
col legno
arco
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Gran->VP->Filter
51_morph
51_off


♪. = 60 accel.
lip gliss.
j.w.
fingered gliss.
mute
low
pizz.
arco
fl. fing.
Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
SF
Cue
52_trig
52_1
52_2
52_3
52_4
52_5

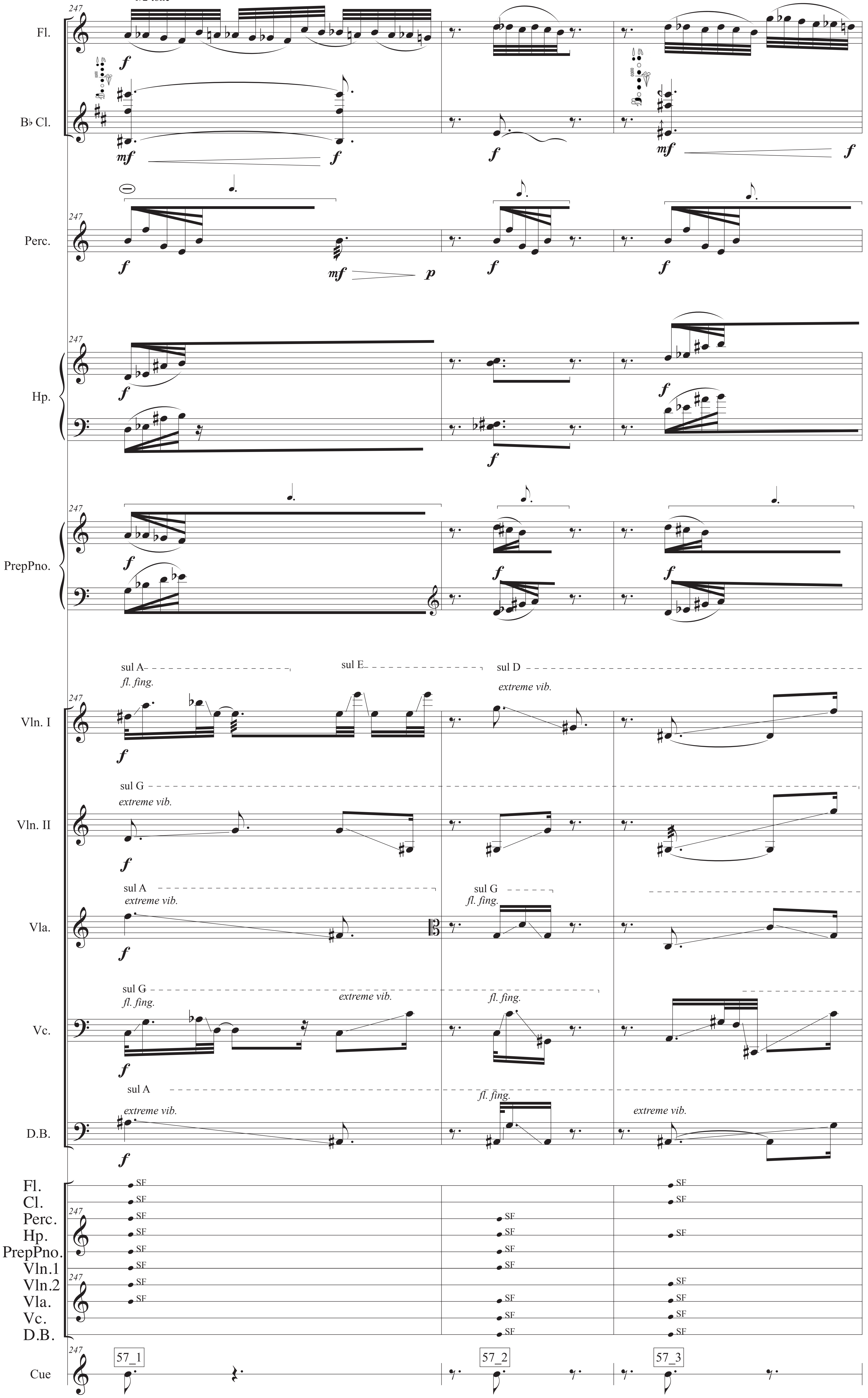

♪. = 110
♪. = 60 accel.
♪. = 110
231
Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
Cue
mf
mp
p
arco
fl. fing.
12
16
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
SF
52_6
52_7
52_8
52_9
52_10
52_11
52_12
52_13
52_14

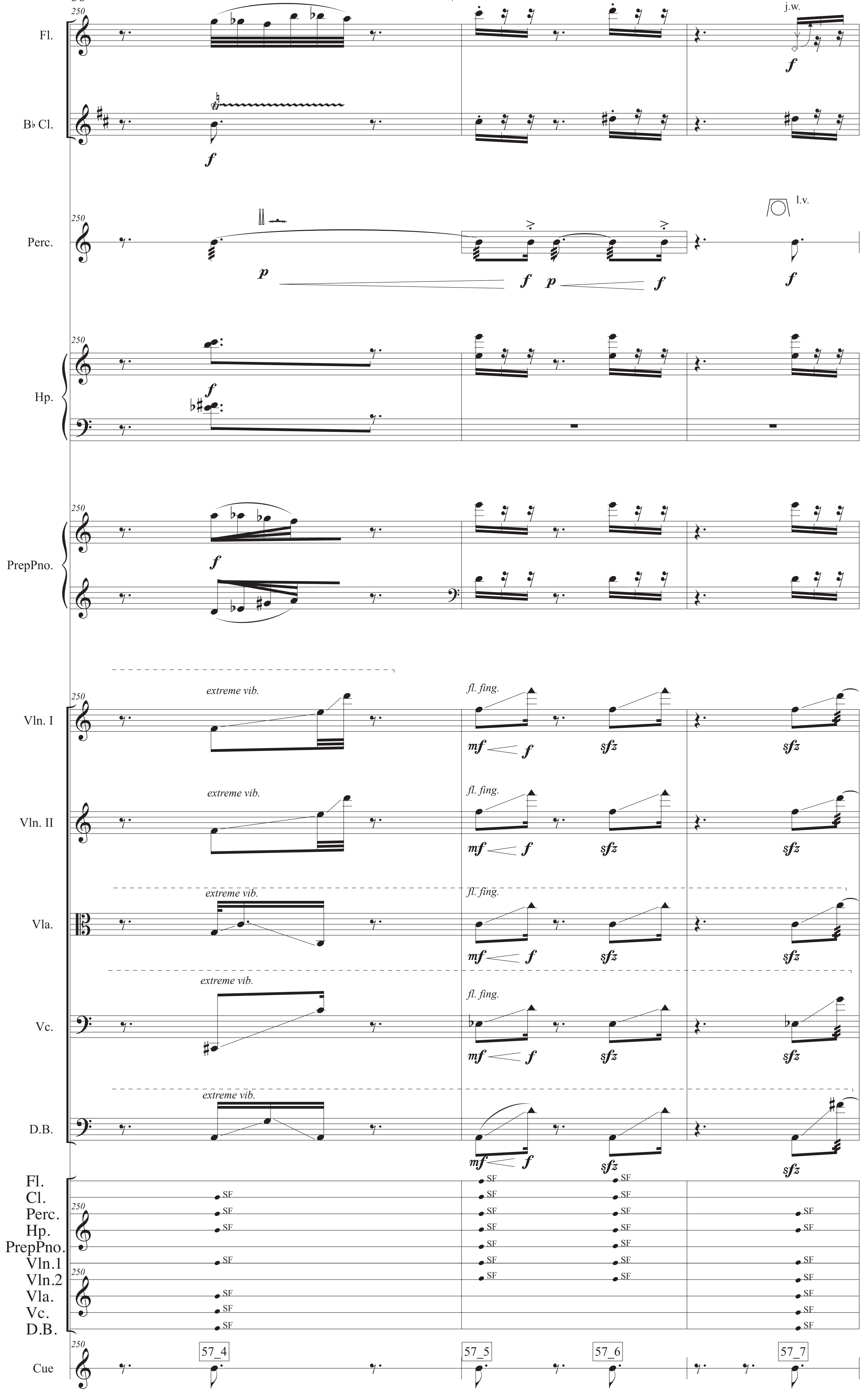

♪. = 80 accel.
♪. = 110
234
Fl.
B♭ Cl.
Perc.
r.sh
mute
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
mf
f
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
SF
Cue
52_15
52_16
52_17
52_18
52_19
52_20
52_21
52_22
52_23
52_24

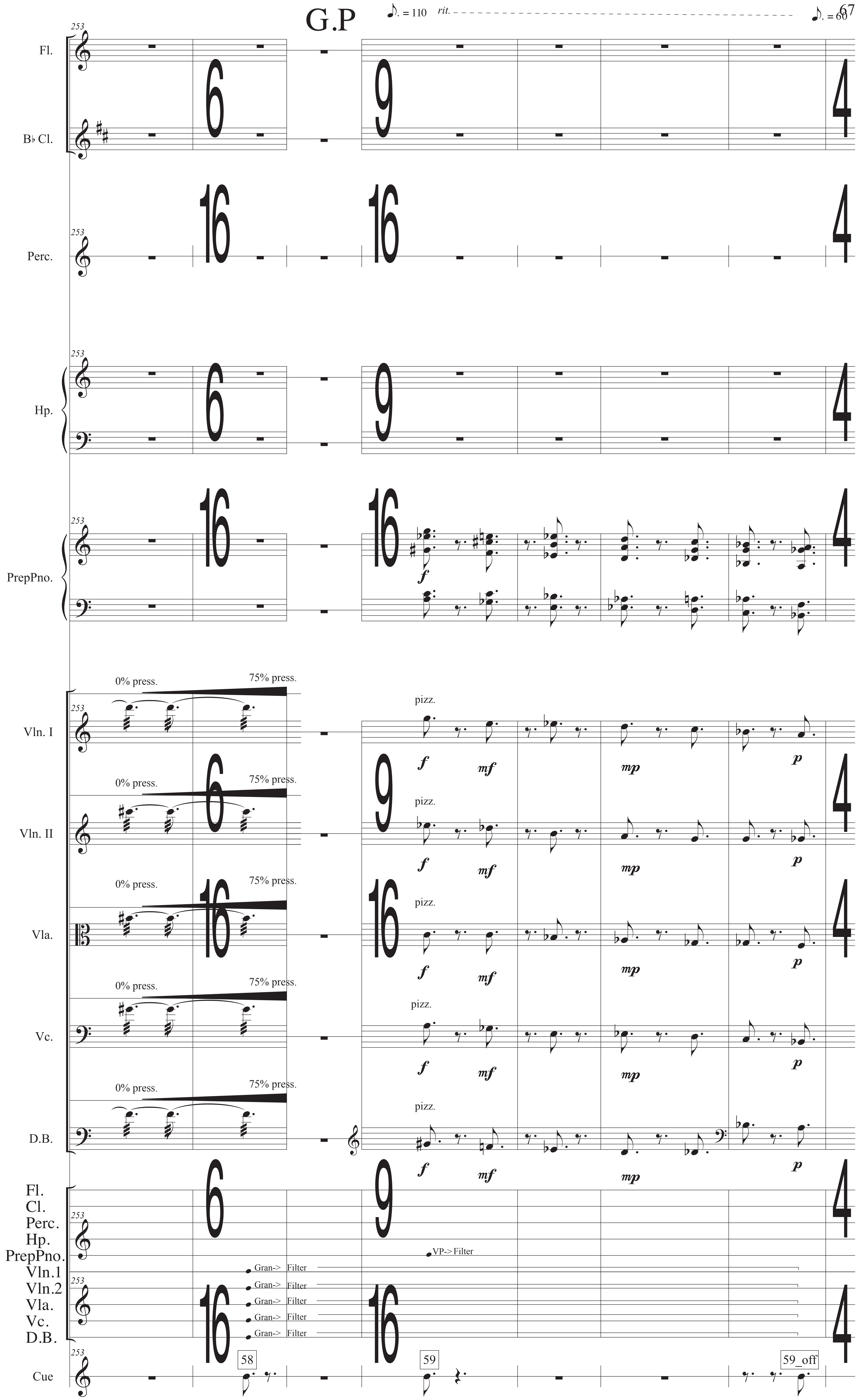

♪. = 80
accel.
♪. = 110
Fl.
B♭ Cl.
Perc.
mute
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
extreme vib.
sul C
D.B.
extreme vib.
sul A
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
SF
continues 11000ms
VP->FFTfilter
52_25
52_26
52_27
52_28
52_29
53
Cue

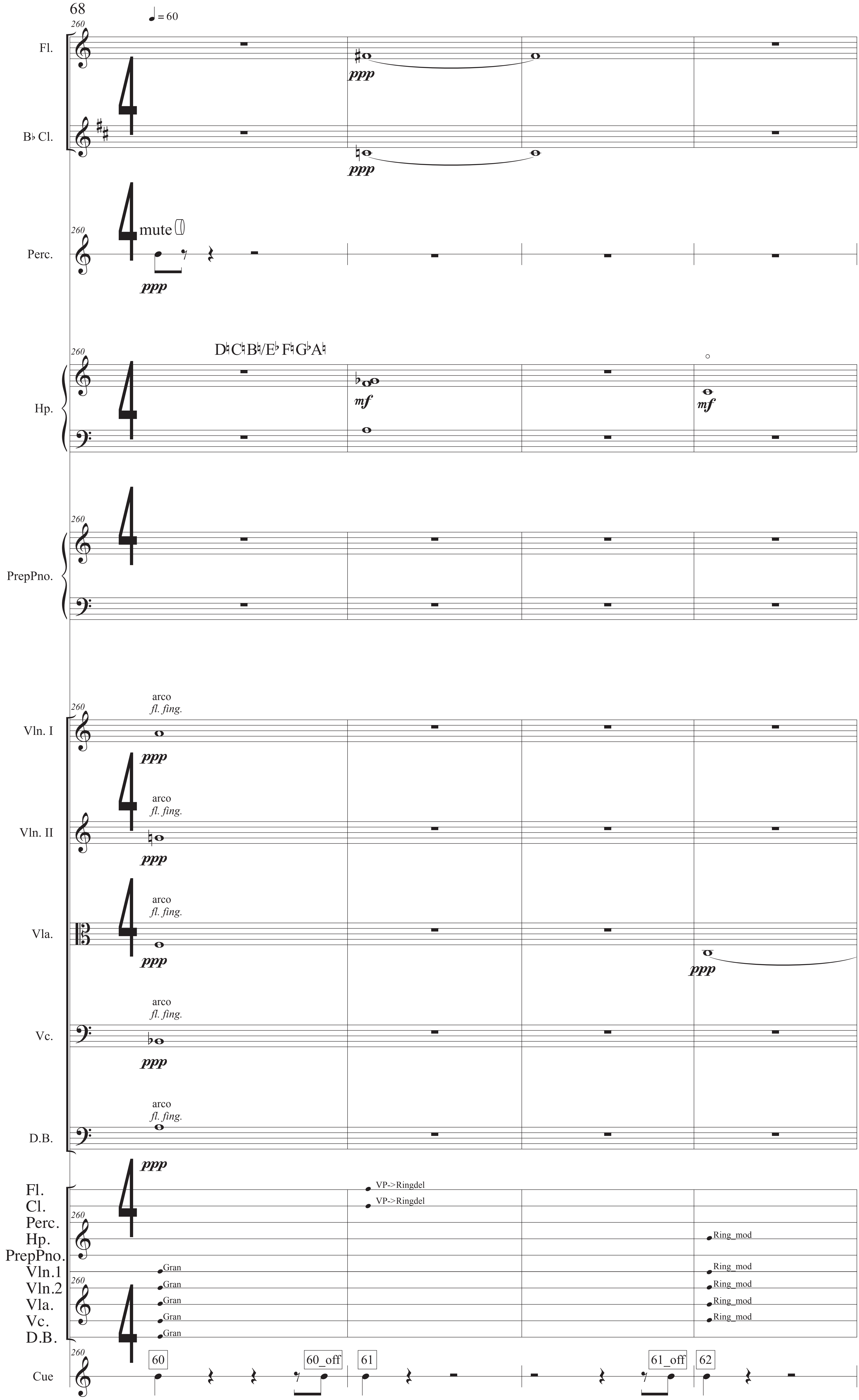

Fl.
B♭ Cl.
p
mf
Perc.
mute
Hp.
PrepPno.
Vln. I
extreme vib.
sul G
p
mp
Vln. II
extreme vib.
sul G
p
mp
p
Vla.
extreme vib.
sul C
p
mp
p
Vc.
mp
p
D.B.
mp
p
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
VP->FFTfilter
VP->FFTfilter
VP->FFTfilter
VP->FFTfilter
VP->FFTfilter
54
Cue


243
Fl.
B♭ Cl.
p
mf
Perc.
f
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
VP->FFTfilter
SF
Cue
55
56
57_trig


1/2 tone
247
Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
sul A
fl. fing.
sul E
sul D
extreme vib.
Vln. I
sul G
extreme vib.
Vln. II
sul A
extreme vib.
sul G
fl. fing.
Vla.
sul G
fl. fing.
extreme vib.
fl. fing.
Vc.
sul A
fl. fing.
extreme vib.
extreme vib.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
SF
57_1
57_2
57_3
Cue


250
Fl.
B♭ Cl.
f
j.w.
f
Perc.
p
f
p
f
l.v.
f
Hp.
f
PrepPno.
f
extreme vib.
fl. fing.
Vln. I
mf
f
sfz
sfz
Vln. II
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
SF
Cue
57_4
57_5
57_6
57_7


G.P
= 110 rit.
= 60
Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
0% press.
75% press.
pizz.
f
mf
mp
p
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
VP-> Filter
Gran-> Filter
Cue
58
59
59_off


♩ = 60
Fl.
B♭ Cl.
Perc.
mute
Hp.
D♮C♮B♮/E♭ F♮G♭A♮
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
arco
fl. fing.
ppp
mf
VP->Ringdel
Gran
Ring_mod
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Cue
60
60_off
61
61_off
62


toneless
toneless
Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
let ring
pizz.
let ring
pizz.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
VP
Ring_mod->automation
Ring_mod->automation
Ring_mod->automation
Ring_mod->automation
Ring_mod->automation
63
64
Cue


268
Fl.
toneless
toneless
B♭ Cl.
Perc.
low
Hp.
bisb.
C♮-C♯ E♭-E♮
bisb.
PrepPno.
Vln. I
Vln. II
sul G
Vla.
pizz.
arco
Vc.
D.B.
sul D
pizz.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Ring_mod->automation
Ring_mod->automation
Ring_mod->automation
Ring_mod->automation
Ring_mod->automation
Cue
65


toneless
Fl.
B♭ Cl.
Perc.
low
Hp.
PrepPno.
pizz.
arco
Vln. I
Vln. II
sul C
Vla.
Vc.
sul A
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Kill
Kill
Kill
Kill
Kill
Kill
Ring_mod->automation
Ring_mod->automation
Ring_mod->automation
Ring_mod->automation
Ring_mod->automation
Cue
66
67


276
Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
pizz.
toneless
mute
bisb.
sul D
fl. fing.
pizz.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Kill
Ring_mod->automation
Cue
68_mute
69


280
Fl.
toneless
B♭ Cl.
Perc.
low
Hp.
D♭C♮B♭/E♮ F♯G♯A♮
G♯-G♮
PrepPno.
Vln. I
Vln. II
arco
Vla.
Vc.
sul A
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Kill
VP
Ring_mod->automation
Kill
Ring_mod->automation
Ring_mod->automation
Ring_mod->automation
Ring_mod->automation
Cue
70
71


284
Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
Cue
j.w.
ppp
f
mf
p
D♮C♯B♭/E♮F♮G♯A♮
fl. fing.
norm.
sul D
pizz.
3
SF
Ring_mod->automation
Kill
VP
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
72
73
74
75


288
Fl.
B♭ Cl.
mf
mf
Perc.
C♮-C♭
G♯-G♮
Hp.
f
3
PrepPno.
f
p
15ma
Vln. I
ppp
Vln. II
mf
ppp
Vla.
mf
ppp
Vc.
p
mf
ppp
arco
D.B.
p
mf
ppp
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
VP
Ring_mod->automation
Cue
76
77


= 100
pizz.
bass clarinet
Fl.
B♭ Cl.
Perc.
D♮C♮B♮/E♮F♮G♮A♭
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
SF
Cue
77_off
78_trig
78_1
78_2
78_3


rit.
296
j.w.
Fl.
f
ppp
B♭ Cl.
ff
ppp
Perc.
mute
ff
ppp
Hp.
ff
ppp
ppp
PrepPno.
ff
p
Vln. I
ff
ppp
sul D
fl. fing.
Vln. II
ff
ppp
Vla.
ff
ppp
Vc.
ff
ppp
D.B.
ff
ppp
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
SF
Gran
Gran
Cue
78_4
79
80


300
Fl.
B♭ Cl.
Perc.
Hp.
PrepPno.
Vln. I
Vln. II
Vla.
Vc.
D.B.
Fl.
Cl.
Perc.
Hp.
PrepPno.
Vln.1
Vln.2
Vla.
Vc.
D.B.
Gran-> Ngate
Kill
Cue
81
82_Kill