

# (Inter)Section

Jiun-You OU

Written component of Master's Thesis

Submitted in partial fulfilment of the requirements for the degree of Master of Arts (MA)  
at the University of Applied Arts, Vienna, Institute of Fine Arts and Media

Jiun-You OU

REGISTRATION NUMBER: 12127103

VIENNA, SUMMER SEMESTER 2026

PROGRAMME NUMBER: S 066 776

STUDY PROGRAMME: ART & SCIENCE

SUPERVISOR: Univ-Prof. VIRGIL WIDRICH, Sen.Art. Dipl.-Ing. Dr. techn. NICOLAJ KIRISITS



For Ping-Quang OU

© 2026 Jiun-You OU. All rights reserved.

This thesis, including its text, photographs, images, diagrams, and artistic works, is protected by copyright. No part of this thesis may be reproduced, distributed, stored, transmitted, adapted, or otherwise used without the prior written permission of the author, except as permitted by applicable copyright law.

Unauthorized reproduction or use of this thesis may result in civil and/or criminal liability under applicable copyright laws.

# Abstract

*(Inter)Section* is a practice-led artistic research project investigating sectional epistemology as a condition of knowledge production. The research employs a sonic-spatial method combining a directional speaker, white noise, and spectrogram analysis as its methodological framework, conducted across eight experiments in varied indoor and outdoor environments between 2023 and 2025. Operating across a structural gap between room acoustics and signal processing, the method approaches the central question: if a spatial field is only accessible through an interface, what can be known?

Through the mathematical constitution of the spectrogram and its inherently sectional nature, the research develops a sectional epistemology situated within broader epistemological perspectives on sectioning, visibility, and mediated perception. The concept of *(Inter)Section* operates as a structural condition, topological configuration, and isomorphic expansion, proposing that conditionality itself is the basis upon which knowledge becomes possible.

Keywords: section, sectioning, sectional epistemology, spectrogram, sonic-spatial method, directional speaker, STFT, time–frequency uncertainty, topological space



# Table of Content

|    |                                                      |
|----|------------------------------------------------------|
| 5  | Abstract                                             |
| 9  | Introduction                                         |
| 11 | Chapter 1 Sonic-Spatial Methodology and Method       |
|    | 1.1 Research Background                              |
| 13 | 1.2 Methodological Framework                         |
|    | 1.2.1 Methodological Constitution and Interface      |
|    | 1.2.1.1 The Apparatus: Directional Speaker           |
| 15 | 1.2.1.2 The Signal: White Noise                      |
| 16 | 1.2.1.3 The Interface: Spectrogram                   |
| 17 | 1.2.2 Methodological Analogies                       |
| 19 | 1.2.3 Artistic References                            |
| 23 | 1.3 Methodological Iteration                         |
|    | 1.3.1 Variance vs. Constancy                         |
| 24 | 1.3.2 Sensorial Extension vs. Mechanical Control     |
|    | 1.3.2.1 Sensorial Extension                          |
| 26 | 1.3.2.2 Mechanical Controls                          |
| 29 | 1.3.3 Indoors vs. Outdoors                           |
| 33 | 1.4 Spectrogram as A Spatial Interface               |
| 34 | 1.4.1 Signal-Based Inference                         |
| 36 | 1.4.2 Situated Inference                             |
| 39 | 1.5 Methodological Conclusion and Research Questions |

|    |                                                            |
|----|------------------------------------------------------------|
| 41 | Chapter 2 Spectrogram and Sectional Epistemology           |
|    | 2.1 Spectrogram as Sectioning Operation                    |
|    | 2.1.1 From signal to spectrogram: FT and STFT              |
| 43 | 2.1.2 Uncertainty Principle                                |
| 45 | 2.2 Spectrogram as Conditioned Seeing                      |
|    | 2.2.1 Spectrogram in its Nature: Constructed Visibility    |
| 47 | 2.2.2 Spectrogram in the Method: Methodological Partiality |
| 49 | 2.3 Sectional Epistemology                                 |
|    | 2.3.1 Sectional Temporality and Spatiality                 |
|    | 2.3.2 Sectional Knowledge                                  |
| 51 | 2.3.3 Boscioli: toward (Inter)Section                      |
|    | 2.3.3.1 from Interface to Trace                            |
| 52 | 2.3.3.2 (Inter)Section                                     |
| 57 | 2.4 Conclusion                                             |
| 59 | Afterword: A Note Is a Note Is a Note                      |
| 63 | Bibliography                                               |
| 65 | Appendix I: Sectioned Boscioli                             |
| 73 | Appendix II: Installation View of the Artworks             |
| 81 | Biography                                                  |

# Introduction

If a spatial field is only accessible through an interface, what can be known?

This question did not arrive as a premise. It emerged gradually, through resistance, from a research process that began with a much simpler intention: to document a space using sound.

The method at the center of this research combines a directional speaker emitting white noise, a portable recorder, and a spectrogram as the analytical interface. The directional speaker produces a narrow, focused beam of audible sound through parametric array technology, functioning as an incising instrument cutting through space. White noise, with its flat frequency spectrum and equal energy distribution across frequencies, maximizes the observable range of acoustic interactions within any given environment. The spectrogram, a time-frequency domain representation generated through the Short-Time Fourier Transform (STFT), provides the visual interface through which the recorded signal becomes analytically accessible. Taken together, they constitute an unusual methodological framework: the directional speaker and white noise are situated in the field of room acoustics, while the spectrogram belongs to signal processing. This structural gap is generative rather than incidental. It is the condition from which the entire research unfolds.

The research was developed through eight experiments conducted between 2023 and 2025, across indoor environments of varying spatial scales and outdoor open environments. Each experiment produced iterations in the methodological design: from hand-held vertical scanning to motor-driven 360-degree rotation; from attempts at whole-space capture to a constrained belt-like scanning path at ear level; from indoor enclosures with legible acoustic responses to an unbounded outdoor environment where the conditions for spatial inference dissolved. These iterations are the record of how the research question became progressively refined, rather than a technical account of trial and error. The most significant of these shifts occurred at Boscioli, a braidplain of the Maggia River in Ticino, Switzerland, where the absence of enclosing boundaries dissolved the inferential relation between spectrogram and space. It is here that the method reaches its limit, and precisely at that limit, the relational configuration of the research becomes most legible.

Chapter 1 documents this development, establishing the methodological constitution alongside artistic analogies and references, examining how the inferential chain from spectrogram texture to signal behavior to acoustic phenomenon to spatial geometry becomes progressively underdetermined, and ultimately proposing the spectrogram as a spatial interface, one that reveals discernible differences across spaces while their causes remain underdetermined. The chapter treats this not as a working record of technical decisions, but as an explorative process through which understandings emerged, where the boundary of the method's applicability is precisely its epistemic productivity. The chapter concludes by questioning the visual-centric assumptions embedded in the methodological design, as well as the Euclidean conception of space that had been underlying the experiments, two conditions that the method itself eventually brought to the surface.

Chapter 2 takes the spectrogram as the point of departure for a broader epistemological argument. Beginning with the mathematical construction of the spectrogram through FT and STFT, and the time–frequency uncertainty principle that renders it inherently sectional, the chapter develops a sectional epistemology drawing on Matthias Bruhn's tomological vision, Foucault's visible/expressible distinction, and Don Ihde's hermeneutic relation. The final section, Boscioli: toward (Inter)Section, locates the experiment at the methodological limit, where the spectrogram shifts from inference to trace, and where the concept of (Inter)Section is fully articulated as a structural condition, topological configuration, and isomorphic expansion across heterogeneous material constitutions.

What this research arrives at is a method whose conditions of partiality are precisely where its epistemological productivity lies. The boundary of applicability is the site where the underlying question becomes most legible.



# Chapter 1 Sonic-Spatial Methodology and Method

## 1.1 Research Background

The whole research should be traced back to a pilot project, *a stone is a stone is a stone (I)* (2023). At the end of November 2023, I had a chance to do a short-term residency at the Wasserbehälter Raum of the former Semmelweislinik. At that moment, coincidentally, I also faced the problem that the storage space for my heavy and large-scale work was no longer available. I had no choice but to transport them to Vienna, and thus struggled with the availability and rent of the storage. Originally, the planned project there was totally different. However, after visiting the location, the remote location, narrow and steep stairs, compressive spatial structures, and even its former role of Semmelweislinik triggered a constellational thought among the site, life, and materiality, I thus decided to bring my 250 kg flesh-colored Untersberg Marble (limestone) sculpture to the room, and broke it into pieces. (see fig.1, and fig.2) The whole project is neither about self-sabotage nor a confrontation. It is just about that the stone sculpture is indeed a massive and precious artwork made by me, but it is also an intersection of deep time and personal time. While the time of stone is sealed, mine continues. Thus, breaking the stone sculpture is not just an artistic but also a practical decision, which can let my time move on.



Fig.1. (left) OU Jiun-You, (Bas)Relief, 2018. Untersberg Limestone, 120 x 90 x 25 cm. Photo by OU Jiun-You

Fig. 2. (right) OU Jiun-You, a stone is a stone is a stone (I), 2023. Broken pieces of the work (Bas)Relief, variable dimension. Photo by OU Jiun-You

Although I decided on the physical condition of the sculpture, I would still like to document the sculpture for memorial reasons and possible further application. Plenty of photography, 3D scanning, and even latex molding were made; they seemed

reasonable and thoughtful, but the interwoven resistance from the context and time-based characters from the objects were not really captured. Meanwhile, after working with raw materials in a massive manner for more than a decade, I was looking for a possible medium that could perform more agilely. Coincidentally, the intangibility of sound drew my attention and implied an interesting oscillation between the massiveness of my stone-based practices at that moment. Right before the project at Semmelweisklinik, to explore the possible transformation between intangible sound and visual-physical manifestations, I once developed a project that turned the tool path of a CNC-milled model into an audio-visual representation through a visual programming Max/MSP patch. However, the representation reflected more from the assigned parameters of Max objects but less regarding the physical properties of the model. To approach the intention that can be more related to the physical condition of the object, I started to think about whether I could use sound to depict and further reflect an object with its physicality or as an embodied process. Thus, based on the suggestions from several seminars and initial wanderings in various sonic visualizers and analysis software, I started to work with the directional speaker, white noise, and later on, an unexpected adoption of spectrogram as the components of the method.<sup>1</sup>

As a complete beginner of sound art, acoustics, and sound engineering at that moment, the experiment was just conducted by embracing what I only knew. The on-site employment of the method at Semmelweisklinik actually didn't really depict the stone sculpture, but recorded more about my moving paths of holding the device in the space. However, even though the experience still raised an intriguing question regarding how to capture those intersections derived between subjects and objects as well as tangibility and intangibility, where irreversibility is situated within the space, the moment, and the materials. I, as a subject who held the directional speaker and played the white noise, also developed my relations toward the object and the space, especially when the spectrogram gave intangible sound a tangible form in a scientifically precise but aesthetically poetic manner. A potential interface toward a still unrecognizable but undefined method, which suggested an unconventional perspective about how we can have access to an object, a space, or an environment.

---

<sup>1</sup> The working approach was first suggested and further consulted by Sen.Art. Dipl.-Ing. Dr. techn. Nicolaj Kirisits in the seminar together with Univ.-Lekt. Klaus Filip. Meanwhile, I also received valuable suggestions from Univ.-Lekt. Mag.art. Ulla Rauter, die Angewandte.

## 1.2 Methodological Framework

### 1.2.1 Methodological Constitution and Interface

The initial idea of the method aimed to experiment on whether sound could document or depict a space. Since various recording approaches and sound propagation in different spatial conditions could be discussed diversely, I will just focus on the most essential components from my on-site work: directional speaker, white noise, and later spectrogram.

#### 1.2.1.1 The Apparatus: Directional Speaker

The directional speaker I have employed for the whole research period, named Audio Spotlight (24 inch), was produced by the company Holosonics (US). It was refined and built by Frank Joseph Pompei in the early 2000s based on his research.<sup>2</sup> The genealogy of the specific technology of directional speakers could be traced back to the research about underwater sonar techniques in the 1960s by American physicist Peter. J. Westervelt.<sup>3</sup> After two decades, a prototype was finally built by Japanese researchers, but it failed due to its extremely high levels of total harmonic distortion (THD).<sup>4</sup> Which means the received sound came out recognizably, but it was no longer a precise reproduction of what was received. Thus, it can't be properly produced and employed until Pompei's refinement.

Unlike ordinary speakers,<sup>5</sup> the directional speaker is a type of loudspeaker built with ultrasonic transducers arranged in a parametric array. An audio signal is first encoded onto the ultrasonic waves through amplitude modulation. Ultrasound is an inaudible sound that has an extremely high frequency and thus has a correspondingly short wavelength. When the wavelength is much smaller than the size of the emitting array, it can propagate in a highly focused and narrow beam. Arrayed ultrasonic transducers produce a high sound pressure level (SPL) of the ultrasound beam, which makes the air behave nonlinearly. This nonlinearity in air

---

<sup>2</sup> F. J. Pompei, "Sound from Ultrasound: The Parametric Array as an Audible Sound Source," PhD dissertation, Massachusetts Institute of Technology, 2002.

<sup>3</sup> P. J. Westervelt, "Parametric Acoustic Array," *The Journal of the Acoustical Society of America* 35 (1963): 535–537.

<sup>4</sup> M. Yoneyama et al., "The Audio Spotlight: An Application of Nonlinear Interaction of Sound Waves to a New Type of Loudspeaker Design," *The Journal of the Acoustical Society of America* 73 (1983): 1532–1536.

<sup>5</sup> Ordinary speakers are usually omnidirectional, which means sound propagates in all directions.

causes the audio signal to self-demodulate as it travels and become audible sound. In other words, *“the ultrasonic beam becomes the loudspeaker”*.<sup>6</sup> The source of sound is no longer the physical device but the invisible beam of ultrasound. (see fig.3)

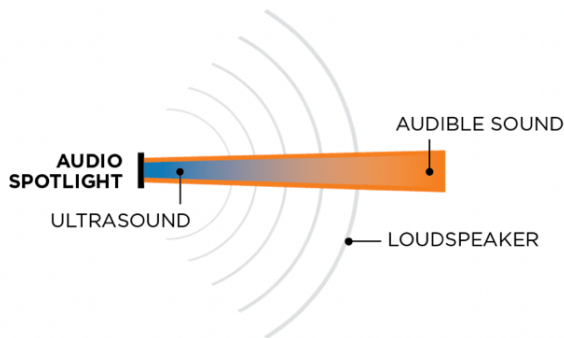


Fig. 3. “Ultrasound as a Sound Source!” Courtesy of Holosonics. Accessed March 25,2026,  
<https://www.holosonics.com/what-makes-a-sound-source-directional>

According to the initial experiment from F. J. Pompei, the propagation range of the directional speaker in length is “a teardrop-shaped lobe extends for approximately 3.5m”.<sup>7</sup> As for the propagation range in width, he didn’t give a clear number but only indicated *“the beam width narrows with distance, and appears to approach a constant width of about half the transducer diameter”*.<sup>8</sup> He also mentioned *“a lateral movement of 0.5m can cause a 15-20 dB drop in level”*,<sup>9</sup> which means that around one step outside the audible field of the directional speaker, the sound levels are reduced by 82% to 90%. Although the technical descriptions exactly show the strong directionality of the speaker, they should be regarded only as references, because they were all from experiments under specific conditions, such as experimenting with a specific frequency or within a specific environment.

Under these conditions, the strong but highly constrained sound could be almost imagined as an invisible but thin cutter that penetrates the space. Based on its obvious sound level drop, distinctive changes observed from one reflective surface to another, an extreme transient relation thus emerged and, in the end, accumulated as the specifically arranged sound field. This allows sound to be treated not simply

<sup>6</sup> F. J. Pompei, “Sound from Ultrasound,” 10

<sup>7</sup> Ibid., 53

<sup>8</sup> Ibid., 51, in my case, half of the diameter should be 12 inch (30.48 cm)

<sup>9</sup> Ibid., 53

as a temporal event, but potentially becomes an interpretation regarding spatiality through its variations. Here, the directional speaker doesn't only function as an apparatus but also as almost an incising instrument cutting through the space.

#### 1.2.1.2 The Signal: White Noise

To give it a definition: white noise is a *“random noise that has a flat frequency spectrum. It occurs when each sample in the time domain contains no information about the other samples”*.<sup>10</sup> In other words, white noise is a random signal with equal energy distributed across frequencies. It has been continually adopted across the experiments of my research. When it is adopted together with a directional speaker, which makes the previously mentioned sound-incising process more observable. Because white noise has much more opportunity to reveal the interactions between sound and space. For example, if a single-frequency tone (e.g., 800 Hz) is emitted into a space using a directional speaker, the resulting response reflects only the behavior of that specific frequency—800 Hz. Acoustic phenomena such as reflection, absorption, and resonance still occur, but they are confined to that frequency. In contrast, white noise, which contains a broad spectrum of frequencies, allows multiple frequency-dependent interactions to be observed, thereby offering a more comprehensive view of how sound interacts with the space.

Since I adopted white noise for its multiple frequency-dependent interactions, until I started to dive into the potential analyses between quantitative or qualitative approaches, I also realized that how the signal was emitted was also important. In my case, the emitted white noise across the experiments, which were all generated via the “noise~” object in the visual programming tool Max/MSP.<sup>11</sup> However, in a standard acoustic measurement, both the emitted signal and the received signal should be recorded, enabling the user or researcher to extract the spatial impulse response through deconvolution. Since the **noise~** object does not output the same signal twice, and the signal it generates is not stored. So, the way I generated white noise, which has already been decided, is that the research can only be further analyzed through qualitative comparison and inference.<sup>12</sup> Therefore, the way I employed white noise has its pros and cons - within the framework of my project, it

---

<sup>10</sup> Steven W. Smith, *The Scientist and Engineer's Guide to Digital Signal Processing* (San Diego, CA: California Technical Publishing, 1997), 642.

<sup>11</sup> The “noise~” object in MAX/MSP represents that the signal has a normalized amplitude between -1 and 1 and a uniform random distribution.

<sup>12</sup> The importance of how the signal was sent was pointed out during the “Infotalks” with the scientists from Das Institut für Schallforschung (ISF), Österreichischen Akademie der Wissenschaften (ÖAW).

leads to observable results in the spectrogram, while further analysis from a room acoustics perspective becomes less feasible.

Thus, the overview of the methodological constitution can be visualized as fig.4. A represents normally the position of the directional speaker; B represents the portable recorder. Gradient black part C refers to the white noise sound beam from the directional speaker. Concentric circles represent the sound propagation in rotation through time. For fig.5, shows the methodological constitution of the actual working scene.



Fig.4. (left), the working scene across the experiments, author's illustration

Fig.5. (right), the actual working scene of the experiment (E6), 2024. Photo by OU Jiun-You

### 1.2.1.3 The Interface: Spectrogram

When an audio signal is captured, it can be imported into different sonic software and thus be analyzed with various interfaces; the spectrogram is one of the interfaces. The most common format of spectrogram is a time–frequency domain representation, which is composed of the x–axis with time, the y–axis with frequency – pitch, in auditory experience, and its brightness shows the amplitude - loudness, in auditory experience.

Actually, juxtaposed to the methodological constitution, a spectrogram is an unusual choice. As for me, initially, the adoption of the spectrogram was just out of curiosity to see and explore the recordings through different audio software. I was drawn by the aesthetic quality of the spectrogram, which was produced from this specific methodological constitution – directional speaker and white noise. At that moment, I cannot specify and address a concrete reason; its trembling textures implied happenings in a subtle but expressive manner. During the discussion with Nicolaj and Klaus in their seminar, I surprisingly got to know that the texture of the

spectrogram from this method is pretty unique compared to ordinary spectrograms in most of the analyses. Thus, the adoption of the spectrogram was actually the convergence of multiple factors, coincidentally at that moment.

Only when I gradually learned more about sound and can position differentiations among the fields better, did I realize that the constitution of directional speakers and white noise is situated more in the field of room acoustics. Since a spectrogram is actually not a room acoustics tool for analyzing how sound propagates in the space, but it works as a representation of how an audio frequency spectrum changes over time. Thus, although the constitution of directional speaker and white noise, as well as the interface – spectrogram, are all related to sound and have some shared analytical base, they actually served for different research purposes. This interesting structural gap, or an intentional appropriation from different levels of analysis, was actually the starting point. Later, they might be continued, refined, or even abandoned. For me, this is exactly the most intriguing dynamics among practice, research, and artistic work.<sup>13</sup>

### 1.2.2 Methodological Analogies

From the experiences of the experiments in the early stage, I positioned the method within a broader field of unconventional sensing. Compared to the historically dominant visual-centric approaches, sound or other non-visual media are usually adopted when objects or intended targets cannot be observed directly or fully through ordinary visual observations. Through the operation of specific approaches, a relational field or interface was revealed. Subjects thus gain access to identify or recognize what they would like to know.

For example, echolocation and sonar operate through the emission and reception of sound. While echolocation functions actively but without a revealed visual representation, sonar translates the temporal delay of echoes into measurable and visualized data. In both of them, sound operates as a signal that orients or detects objects without ordinary visual access. Ultrasonography introduces a similar but different process: it operates based on physical contact and aims at a pre-defined target. As a real-time visualization, its resulting image is transient and partial, but with precision, which shows a seeing through into the body that unaided eyes cannot reach. Furthermore, it first looked irrelevant, but Clairvoyance also drew my attention

---

<sup>13</sup> In chapter 2.1, I will give more details regarding how the spectrogram is mathematically composed, because its sectional construction also plays a meaningful role throughout the research.

in an unconventional manner. Basically, clairvoyants depicted or made those so-called mental impressions from spatially or temporally inaccessible targets onto photographic plates or papers. Although Clairvoyance has been usually defined as para-psychology in history due to a lack of falsifiability, it demonstrates a speculative perspective toward how sensing could be imaginative.<sup>14</sup>

To focus more on the role of sound, some of the above methodological analogies can also be understood through what Peter McMurray describes as forms of soundmapping or sonic cartography.<sup>15</sup> McMurray systematically developed a taxonomy of the relationships between sound and mapping with four prepositions, which include: mapping about sound, mapping in sound, mapping of sound, and mapping by sound. Among the categories he proposes, my research is particularly related to mapping by sound. In this category, McMurray further discusses Friedrich Kittler's experimental revisiting of the Sirens episode from Homer's *Odyssey*, in which opera singers were positioned along coastal cliffs in order to reproduce and test the imagined geography of the Sirens' voices. Rather than pursuing factual verification, mapping by sound, as McMurray notes, *"opens up a space of imagined listenings – and re-listenings – as sonic geographies are reproduced and shared around the globe"*.<sup>16</sup> In this sense, sound functions not merely as an audible object, but as a cartographic tool for probing and constructing spatial knowledge. Here, soundmapping doesn't reconstruct an objective space or a conventional mapping system based on fixity and certainty. It constructs a partial relational and interpretative access through sound.

Taking these methodological analogies and McMurray's notion of mapping by sound together, they indicated several parameters and provided a point of analogy for situating the method I have developed. For the scope of the target or object, the para-psychological approach is the widest, as it could refer even to an unseen spatiality or temporality. Echolocation and sonar are adopted in a certain scope, but it is not certain what is within it. As to ultrasonography, it is applied to a specific organ based on anatomic knowledge. In this sense, it refers to the inverse relationship between reliability and interpretation. This inverse relationship is also influenced by how physical contact is employed and the visualized result is generated. When there

---

<sup>14</sup> During the early 20th century, Clairvoyance became a prominent trend, which is basically seeing what is unseen and imagining it (with thoughtphotography). The most iconic experiment was conducted by Fukurai Tomokichi (1869–1952) with Mifune Chizuko (1886–1911).

<sup>15</sup> Peter McMurray, "Ephemeral Cartography: On Mapping Sound," *Sound Studies* 4, no. 2 (2018): 110–142.

<sup>16</sup> *Ibid.*, 112



are more direct physical contacts or physical engagement, they can reach higher reliability. Meanwhile, when there are more verifiable visualizations that can be represented, they also represent themselves more convincingly. Thus, technical constitutions, employed scopes, and later resulting interfaces, shift the method on the spectrum between demonstration and speculation. These analogies became particularly relevant to the development of my own method, which has not previously existed, yet remains structurally comparable. Rather than positioning the method within a binary logic of success or failure, the results from the experiments gradually revealed different degrees of interpretative openness. Similar to McMurray's notion of mapping by sound, the resulting spectrograms therefore function less as stable representations and more as interpretative interfaces through which spatial conditions can only be partially inferred, interpreted, and imagined.

### 1.2.3 Artistic Reference

Besides the previously introduced methodological analogies, several artistic practices provide insightful perspectives for situating my methodological constitution. Rather than serving as direct influences, these works demonstrate different approaches toward how sound and space are inextricably connected and interlocked. Meanwhile, for the methodological interface – spectrogram, some similar approaches are also included here, they showed exactly how spectrogram is adopted specifically and differently in my research.

For the methodological constitution, Alvin Lucier's *Vespers* (1968) provides an important reference, particularly in its use of echolocation as a spatial sensing operation.<sup>17</sup> In the work, blindfolded performers navigate through space using a specific pulse-emitting device called Sondols, relying on returning reflections to orient themselves and avoid collision. (see fig.6) Inspired by echolocation, the work does not attempt to construct a stable representation of space, but instead reveals how spatial conditions can only be partially inferred through acoustic reflections, bodily movement, and continuous adjustment. From the description of the work, it is written: *“each echo reveals a little detail of the surrounding space. Thus, the whole piece is like a panoramic, acoustic photograph, made up of countless individual shots.”*<sup>18</sup> Sound therefore, functions less as a compositional material than as an operational signal for probing spatial relations.

---

<sup>17</sup> <https://www.youtube.com/watch?v=oUqEU87pLL0>, the re-enactment of *Vespers* (1968) in 2010

<sup>18</sup> <http://alvin-lucier-film.com/vespers.html>



Fig. 6. *Vespers*, Alvin Lucier, 1968; re-enactment, 2010. Courtesy of Alvin Lucier. Accessed Mar 15, 2026, <http://alvin-lucier-film.com/vespers.html>.

Another important reference is the artistic and research-based practice of Marcus Maeder, particularly projects such as *Sounding Soil* (2019–2023),<sup>19</sup> and *trees* (2012–2015).<sup>20</sup> Across these works, environmental processes are approached through recording systems, sensors, and computational analysis. Rather than treating sound as an aesthetic medium, Maeder employs technological systems as methodological interfaces for accessing environmental relations and processes that remain otherwise inaccessible through ordinary perception. Through these technical configurations, environmental interactions among atmosphere, material conditions, sound propagation, and site-specific variables become observable. This perspective became especially relevant to my research, especially in later outdoor experiments. Because the environmental condition is not treated as a fixed background but approached through an intentionally constructed technical setup, where the resulting observation emerges through the interaction between the sensing system and the environment.

On the other hand, for the methodological interface – spectrogram, after its invention in the mid twentieth century, it has long been adopted as an objective scientific data. Until the spectral composition (spectralism) emerging particularly in the 1970s and 1980s, this movement was defined by a specific circle of composers associated with IRCAM,<sup>21</sup> represented by figures such as Tristan Murail and Gérard Grisey.<sup>22</sup> In spectralism, existing sounds, resonances, and frequency structures were analyzed and translated into musical materials and orchestration. Here, the spectrogram no longer functions as a representation of sound but becomes a generative structure for

<sup>19</sup> <https://www.biovision.ch/soundingsoil/ueber-soundingsoil/>

<sup>20</sup> <https://www.researchcatalogue.net/view/215961/215962>

<sup>21</sup> IRCAM was founded in 1977 and is a French institute dedicated to the research of music and sound, especially in the fields of avant-garde and electro-acoustic art music.

<sup>22</sup> For example, Gérard Grisey's "Partiels" (1975), <https://www.youtube.com/watch?v=OrdCU7sjD0E>

composition. Spectralism can be historically defined as the first to treat the spectrogram not only as a tool for scientific analysis, but also as the essential grammar for composition.

Subsequently, moving into the late twentieth century, the spectrogram evolved from a specialized compositional method into a frequent fixture within electronic music, experimental sound art, and digital media practices. In many of these works, the spectrogram is not approached as an analytical tool or compositional grammar, but rather as a visual representation that can be aesthetically encoded, constructed, or further interpreted through sound. One common approach involves embedding hidden images or graphical forms into an audio signal. Through precise manipulation of frequencies and amplitudes, artists and musicians construct sounds that reveal recognizable figures, texts, or portraits when visualized as spectrograms in audio software. For example, one of the most iconic examples is the spectrogram from Aphex Twin's *Windowlicker* (1999).<sup>23</sup> Similar but different approaches can also be found in spectral image practices and image-to-sound synthesis systems, such as the software Photosounder, MetaSynth, or Coagula. They allow users to construct sound through graphical manipulation in the frequency domain, where image structures are translated into frequency, amplitude, and temporal distributions. In these cases, the spectrogram or spectrogram-like representation no longer serves as an analytical interface but becomes a compositional environment for generating sound.

Across these practices, spectrograms primarily operate as compositional structures, encoded visualizations, or translation systems. In contrast, the role of the spectrogram in my research fundamentally differs from these approaches. The spectrogram is not approached as a visual target to be intentionally produced, nor as a medium for translating images into sound. Instead, it emerges through the interaction among directional speaker, white noise, recording setup, and environmental conditions – the specific methodological operations partially capture the specific site. In this sense, the spectrogram in this research doesn't operate as a representation but a conditioned interface through which the field becomes partially accessible and inferred.

---

<sup>23</sup> the spectrogram of the track starts to show a specific image,

<https://www.youtube.com/watch?t=321&v=M9xMuPWAZW8&feature=youtu.be>



## 1.3 Methodological Iteration

The experiments in the following text are chronologically numbered. The adjustment of methodology and method-based development through incorporating feedback from previous results into subsequent configurations can be clearly observed across the chronological sequence of the experiments. However, the iteration I am going to elaborate on will not be merely based on the timeline, but rather related to the main parameters that I concluded in the methodological analogies previously or derived from the analyses across the experiments.

- Experiment 1 (E1), Semmelweis Klinik – Wasserbehälter Raum, Vienna, Austria, 2023
- E2, the Yard of ZFF (Zentrum Fokus Forschung), Vienna, Austria – open environment, 2024
- E 3, Art & Science Corridor (Österreichische Postsparkasse, EG), Vienna, Austria, 2024
- E 4, The base structure of the Large Refractor at the Vienna University Observatory (Der Große Refraktor der Wiener Universitätssternwarte), Vienna, Austria, 2024
- E 5, Postsparkasse – Kassenhalle, (Österreichische Postsparkasse, EG), Vienna, Austria, 2024
- E 6, Art and Science Seminar Room (Österreichische Postsparkasse, EG), Vienna, Austria, 2024
- E 7, Boscioli, Switzerland – open environment, 2024 - 2025
- E 8, Fukhaus Wien, Vienna, Austria, 2025

### 1.3.1 Variance vs. Constancy

The locations where experiments were executed were first during a site-specific project, and then at different locations during seminars and university locations. Then, different spatial conditions were taken into account, such as in E4, an extremely high and specially structured space. Besides E2, most of the experiments were conducted indoors. Only after finalizing the rotating mechanism of the speaker from E6, experiment E7 was started to be conducted in an unbounded outdoor condition.

Later, the experiment E8 was once again conducted indoors, but on a similar scale to the arrangement with E7. Although the spatial conditions have changed constantly from experiment to experiment, the technical constitution and interface have been similarly controlled through time. The adopted devices were composed of the following items:<sup>24</sup>

- 24-inch Audio Spotlight Directional Speaker
- Max/MSP generated white noise signal on a laptop
- Zoom H6 Recorder with XY microphone<sup>25</sup>

### 1.3.2 Sensorial Extension vs. Mechanical Control

What was most different in the initial phase and the later phase (before and after E6) was the moving mechanism of the directional speaker. It has its changes from being hand-held with irregular movements to regularly discrete motor-driven rotating movements. I defined the former as sensorial extension and the latter as mechanical controls.

#### 1.3.2.1 Sensorial Extension

From E1 to E5, all the experiments were conducted by hand-holding the directional speaker to move vertically in discrete steps along the surface of the sculpture (object) or interior structures. Taking vertical movements as a kind of scanning path which was based on pretty practical reasons: because the space could be long or structured as an end-to-end closed loop horizontally, thus the vertical dimension is relatively shorter and controllable. This vertical and active sonic sensing process performs more like an extension of sensorial experience. In this sense, the sensing process is less precise but subjectively bodily and sensorially engaged. Since the hand-holding process also creates uneven distance from the speaker to the interior surface, speed, and different discrete steps, the whole process thus reflects not only the space but also how it was sensed through the movements. More concretely, since the sound from the speaker was always playing, the vertical movements also brought the question of whether the sensed areas overlapped from step to step, and

---

<sup>24</sup> During the process, there were also different devices that were employed, such as an ambisonic microphone, a directional microphone, a condenser microphone with an ORTF setup, and so on. However, the analyzed data were all based on the stereo recordings from the Zoom H6 XY microphone, to avoid any further analytical conflicts and confusion.

<sup>25</sup> A recording technique and setup has two angled cardioid microphones and is arranged for stereo recording.

thus had additional information. (see fig.7) Furthermore, referring to the logic of the directional speaker mentioned in chapters 1.2, since the directional sound is a strongly formed beam, the reaction of the beam also reacted through drastic movements of moving up and down in the air. Thus, it turned out that the spectrogram shows the obvious tree-like patterns, but it was more likely derived from the movements rather than the depiction of the space. (see fig.8)



Fig.7. the working scene from E3, 2024. Photo by OU Jiun-You

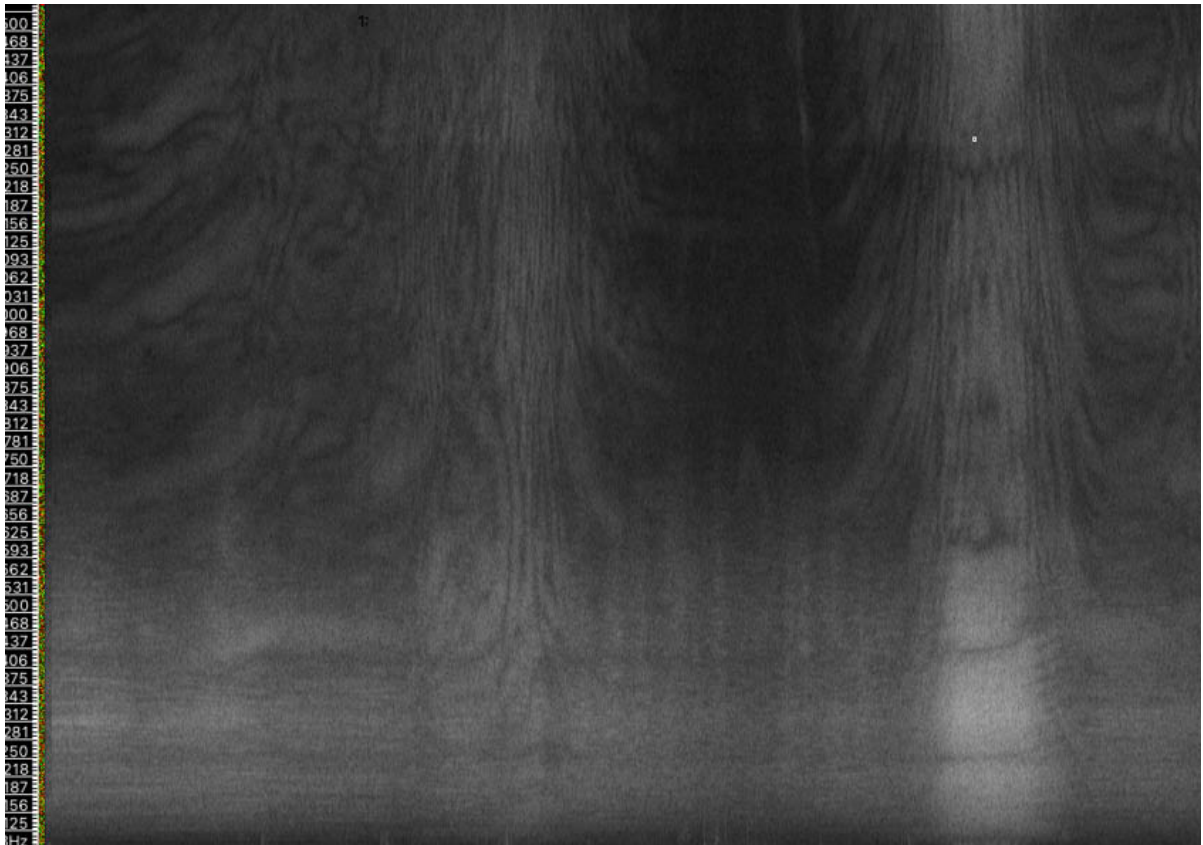


Fig.8. the spectrogram from E1 (detail), exported from Sonic Visualizer, 2023.

### 1.3.2.2 Mechanical Controls

After the experiments from E1 to E3, I had the chance to make E4, at the ring-shaped base structure under the large refractor at the Vienna University Observatory. At that moment, I started to associate this method with a way of seeing, because of the inspiration from a medical examination image of the eyes.<sup>26</sup> (see fig.9) This also made me wonder if I could work in a circular space and thus make the method respond to the connotations toward eyes or vision. At that stage, I held an overly direct and naive assumption that the sound propagation in a circular space could also lead to a circular representation. Of course, at the graphical or rendering level, it is possible anyway, but less so regarding the methodological and method-based development. Only when I look back, I realize that was just based on the visual association and interpretation between this medical image and spectrogram, regardless of where the level of analysis or methodology is situated. Even though this thought is still worthy to be mentioned because it also triggered the idea of starting the later experiment with the rotational mechanism.



Fig.9. the image of whole eye scan, digital scan from author's collection.

Conducting E4 was pretty complicated because it has a ring-shaped structure and has a height of around 8 to 10 meters, which brought problems to the relative position between the speaker and the recorder.<sup>27</sup> While the technical information of the directional speaker indicates that it can propagate as far as around four meters. Which made me wonder how the sound can actually propagate in the space. With

---

<sup>26</sup> The attached image is an Optical Coherence Tomography (OCT) scan, providing a cross-sectional view of the eye, often referred to as a "whole eye scan".

<sup>27</sup> Based on the known scale of the Great Refractor (10.5 m focal length) and the 14 m diameter of the main dome, the vertical dimension of the lower chamber is estimated to be around 8–10 meters.



the vertical scanning path by circumnavigating the center structure and positioning the recorder at a fixed spot, there are still observed frequencies across a wide range, although they have more high frequencies attenuated. The result suggests that the emitted signal shows a detectable presence even in a high and unusual spatial condition. (see fig.10)

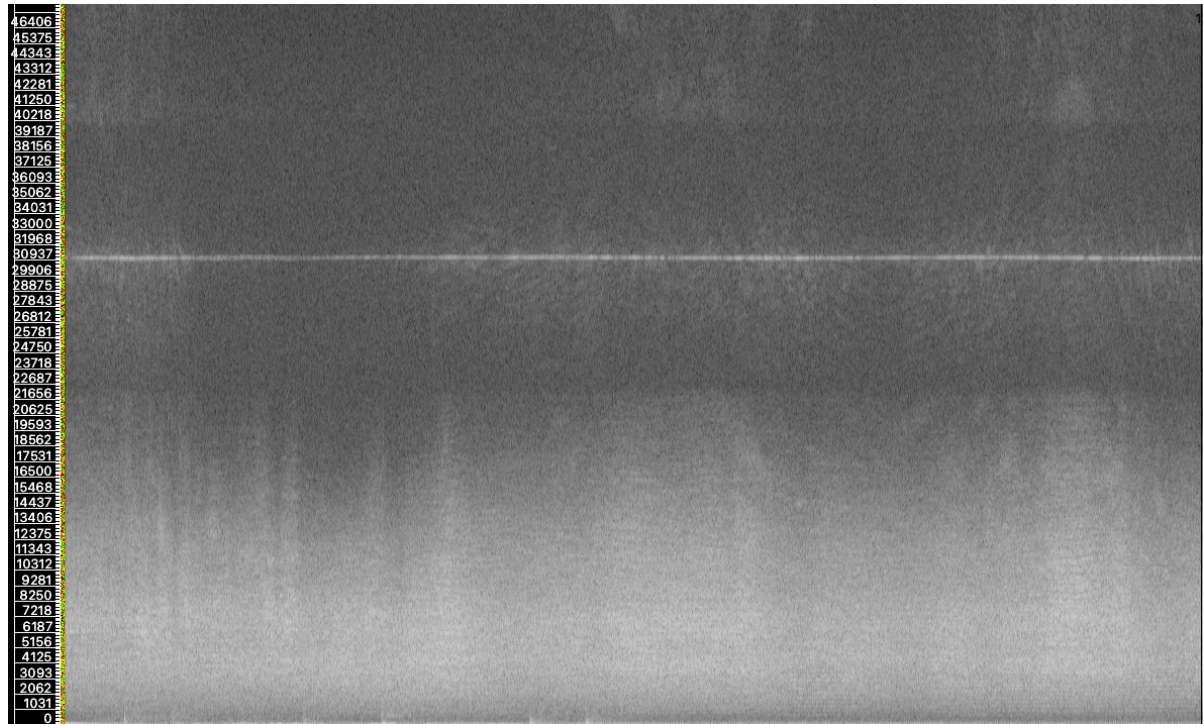


Fig.10. the spectrogram from E4 (detail), exported from Sonic Visualizer, 2024

Because of the results from E4, in E5, I started to hold the speaker and stand in the approximate center of the space. However, the scale of the space introduced new challenges. Since the height of Kassenhalle is actually as high as two stories, the choice for vertical movements also became less controllable and approachable. Although during the process I adopted both vertical and horizontal movements, and even divided the space into four zones, just in order to solve the scale of the space as an issue. In the end, I found that the single horizontal moving path already contains more than abundant information. (see fig.11)

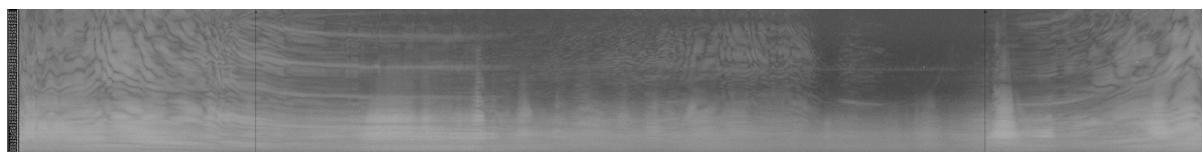


Fig.11. the spectrogram from horizontal moving path, E5, exported from Sonic Visualizer, 2024.

From E5, the scale of the space brought up crucial questions, which actually significantly narrowed down my methodological and method-based practices, as well as later sharpened my research questions:

- Should the method capture the whole space or just some parts of the space?
- If scanning the entire space is impractical, what kind of movement can be most precisely adopted?
- How can the method become more systematically applicable?
- How can the spectrogram be visually related to space?

So later, the directional speaker was modified with a step motor and microcontroller, as well as an adjustable tripod underneath for the motor-driven rotations.<sup>28</sup> (see fig.12) Thus, from E6 to E8, the experiments were conducted with a 360-degree rotation in 60 seconds. This motor-driven movement design reflected a relatively modular arrangement of the experiment. Since scanning the whole space is unrealistic and ineffective, for example, if I were to scan the whole space, how about the ceiling or the floor? In other words, to what extent does it mean the “whole” space? Therefore, after some tryouts, I decided to focus just on the most common human auditory experience – ear level, around 150 cm in height, to connect the experience between subjective sensation and mechanical sensing. Meanwhile, sending sound from the center of the space, whether hand-holding or motor-controlled, positioned the experiment with a centric propagation, which triggered the association among eyes, radar, and even vinyl. Thus, since E5, the centered position led me to render the resulting spectrogram with a specific graphical representation.<sup>29</sup> (see fig.13)

---

<sup>28</sup> The discussion of re-designing the method from space to space, as well as the modification of the directional speaker, was generously supported by Sen.Lect. Mag.art. Jakob Scheid and Sen.Sc. Mag. Liddy Scheffknecht, die Angewandte.

<sup>29</sup> It is necessary to clarify that this rendered representation is an artistic interpretation, not a scientific visualization, referring to the spectrogram-space relation.



Fig.12. (left), modified directional speaker, installation view of E6, 2024. Photo by OU Jiun-You

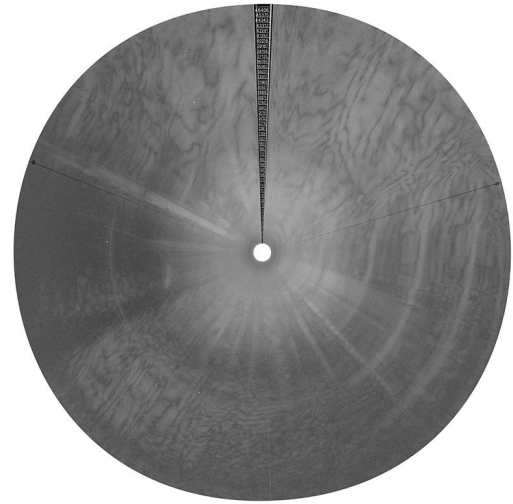


Fig.13. (right) OU Jiun-You, Atlas #3, 2024. Rendered spectrogram.

### 1.3.3 Indoors vs. Outdoors

The experiments indoors shape the main methodological design, because the environments are generally more controllable and stable. However, for the outdoor environment, the main difficulty is not merely sound attenuation through distance, but the lack of reflective boundaries as well as the high variability of environmental conditions such as wind or temperature. Thus, besides E2 and E7, all the experiments happened indoors and have relatively consistent and legible acoustic responses.

As for outdoors, the initial experiment was E2, at ZFF (Zentrum Fokus Forschung). During the discussion with Nicolaj Kirsits, I got to know that a group of trees might lead to different sound propagation and thus be played as acoustic agents, such as absorbers.<sup>30</sup> They might create a different sound field, which leads to different

<sup>30</sup> Mengmeng Li, Timothy Van Renterghem, Jian Kang, Kris Verheyen, and Dick Botteldooren, "Sound Absorption by Tree Bark," *Applied Acoustics* 165 (2020): 107328.

results in the spectrogram. The experiment day was unfortunately very windy; the atmospheric conditions created much more complexity and masked a lot of the sound field. Another problem is that, since at that moment, the center-propagation approach (derived from E5) had not yet appeared, it led to a seemingly simple but tricky question: where should I start in the whole area? It became crucial in an open or half-open space, because it referred to whether the area includes distinctive acoustic agents or not, and thus leads to a completely different sound field. Although the outdoor work in ZFF was not ideally experimented because of the very windy weather conditions, knowing that certain natural elements could perform as acoustic agents later led to a bigger scope of experiment - E7 in an open environment during my artist residency at Centro Internazionale di Scultura Peccia (CIS, International Sculpture Center), Switzerland. (see fig.14)

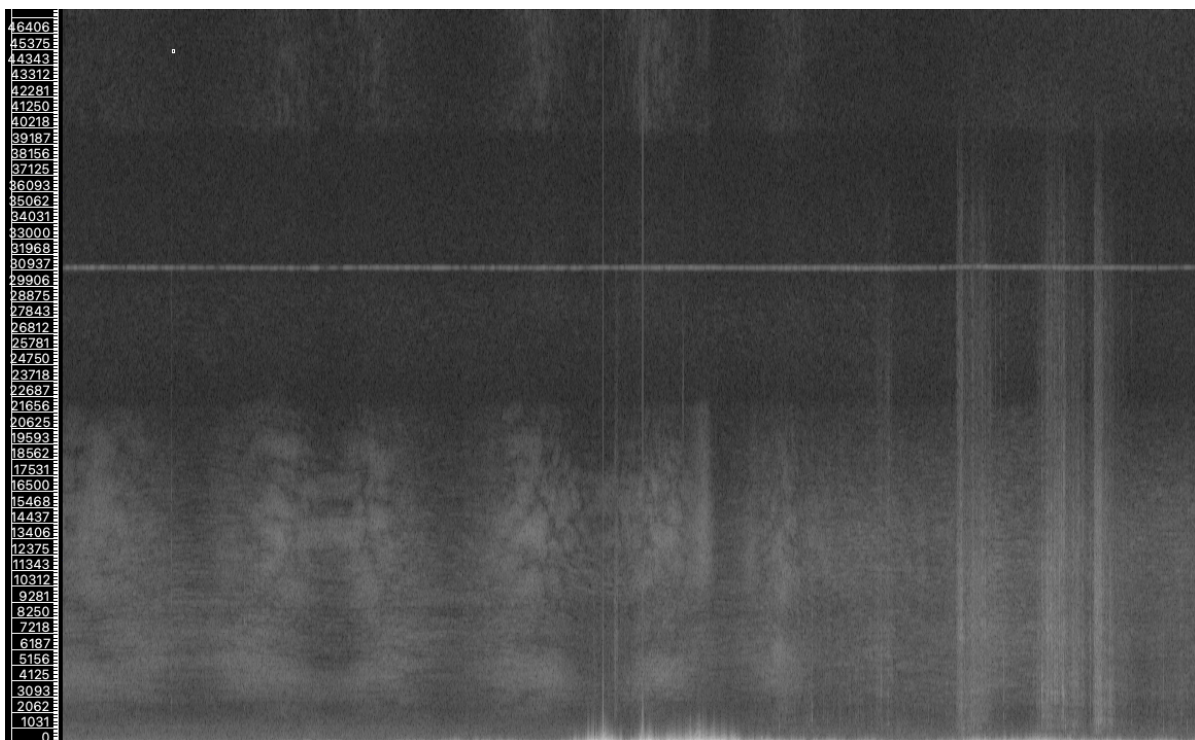


Fig.14. the spectrogram from E2 (detail), exported from Sonic Visualizer, 2024.

The experiment E7 was conducted at Boscioli (Cevio, Ticino, Switzerland), a braidplain of the Maggia River extending for more than 500 km.<sup>31</sup> A braidplain is not a stable landform, but a shifting configuration of water and sediment. When we arrived there, it was full of sand, exposed gravel, and boulders, woody debris,

<sup>31</sup> I marked six working spots along the Boscioli on google my maps:

<https://www.google.com/maps/d/u/0/edit?mid=19U1ik3NcBKpkIJ26V6v7o3bZUIAXs4k&usp=sharing>



because of the flood that happened at the end of June, 2024.<sup>32</sup> Some seemingly ancient monumental stone parts, woody debris, and metamorphic rocks spread over the area and created an unstable surface spreading miles, which made it strenuous to move around.<sup>33</sup> Since the first visit, during the time of my AiR, I visited there frequently and actually observed that the land was always changing, because of the local weather, such as sudden downpour, continued rain lasting for weeks, and also the strong wind. Unlike E2 (ZFF), which still has its boundaries because it is actually a yard with walls and gates, Boscioli only has rows of trees along the two sides of the braidplain and fragmentary elements spread over the landscape. (see fig.15) When the space is so huge, the execution of the method could only start from selected points with distinctive environmental elements. (see fig.16) Thus, I selected several spots that contain some large stone parts, a bigger group of trees, a nearly two-meter-high woody debris, and a deliberately chosen open area spot. Lacking common reflective boundaries like indoor space, as well as the attenuation of the sound and sparsely distributed objects in the scene, led to the subtle expressions in the spectrogram. Besides presenting the signals from the method, it also included distinctive ambient sound, the strong windy conditions, and even the specific characteristics of the directional speaker.<sup>34</sup> (see fig.17)




---

<sup>32</sup> Right before artists' arrival for the AiR, the end of June 2024 flash flood was among the most violent in the region for 200 years in the Valle Maggia. Buildings, roads, bridges, and valleys were heavily destroyed, and 7 people were killed. A detailed backtracking article on the flood in Val Maggia:

<https://www.theguardian.com/world/2025/aug/05/forest-gone-storm-that-moved-a-mountain-climate-crisis-environment>

<sup>33</sup> The Alpine landscape was mainly formed during the Alpine Orogeny, around the geological time Cenozoic (66 million years ago). Along the riverbed of the Maggia River, there were covered from thumb size to life size metamorphic rocks, such as gneiss, schist, and amphibolite

<sup>34</sup> Fig. 17. shows a comparison of all the locations 1 to 6, at E7. However, location 4 (the 4th spectrogram) is almost an area without any boundary, but still shares the cloud-like texture, which is most likely due to the specific beam texture of the directional speaker.

Fig. 15. (left) screenshot from the drone footage of Boscioli, where E7 was conducted, 2024. © Martin Binder

Fig. 16. (right) working scene from E7 in Boscioli, 2024. Photo by OU Jiun-You

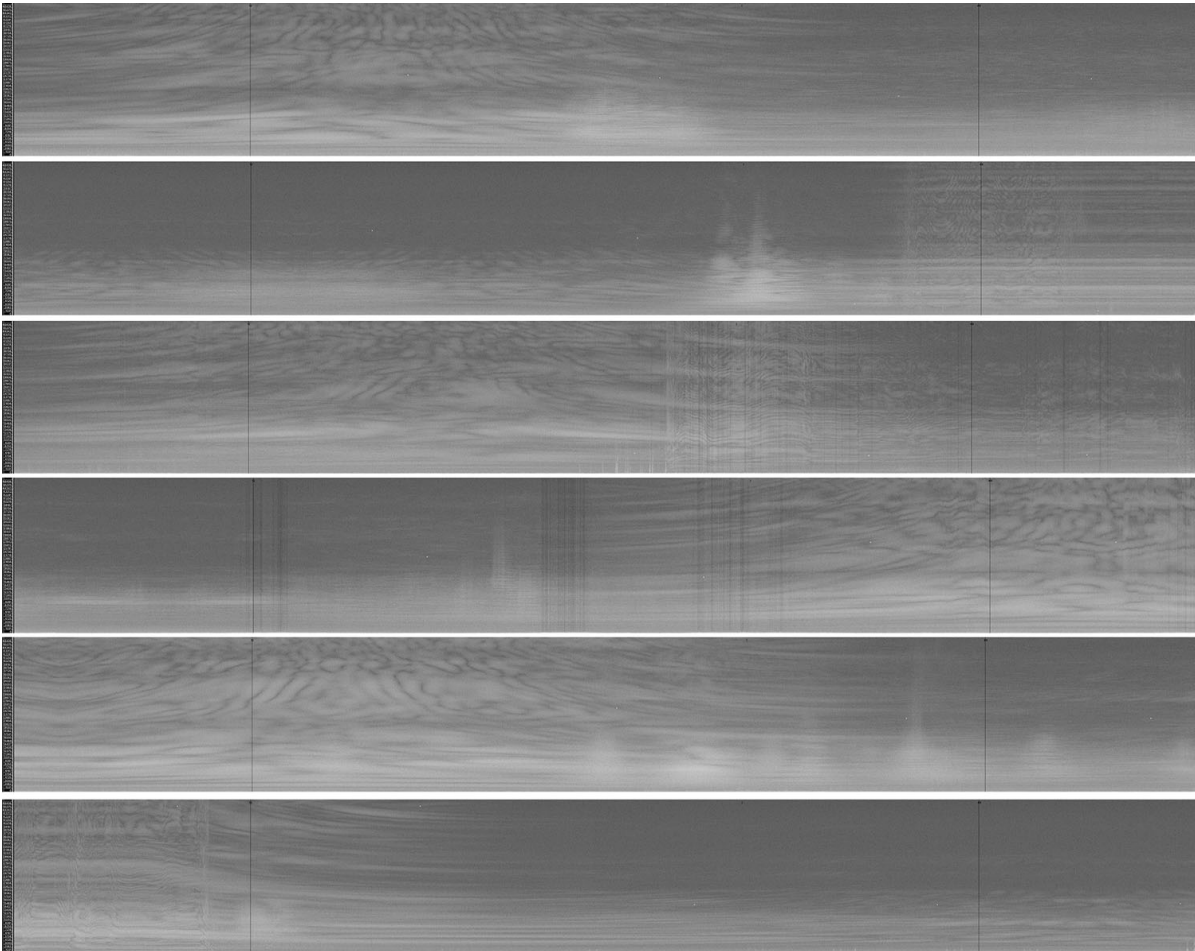


Fig. 17. the spectrograms from various locations at Boscioli, E7, exported from Sonic Visualizer, 2024.

Working in an outdoor environment like Boscioli is not about an ignorant intention to challenge the fundamental principles of acoustics, but rather to examine what happens when a method initially designed for controlled, enclosed spaces is applied to an environment that exceeds its assumptions. In an open environment, the sound field is no longer formed by structural surfaces but by dispersed and variable conditions, including natural elements such as trees, rocks, ambient sound, and even atmospheric fluctuations. Under such conditions, the spectrogram no longer provides inferential information to the spatial condition; it merges more as the trace of how sound, material, and environment act upon one another in a specific place and moment.<sup>35</sup>

---

<sup>35</sup> The experiments took place in Boscioli, which has a specific role in my research. Please also refer to chapters 2-3, and 2.4 for further details.

## 1.4 Spectrogram as the Spatial Inference

This research has an unusual methodological framework, which contains the methodological constitution - directional speaker and white noise, as well as the methodological interface – spectrogram. This intentional appropriation should not be taken as a defect but rather as a generative condition under which relational inference becomes possible. However, the pair of directional speakers and white noise situate more in the field of room acoustics, while the spectrogram is situated in the field of signal processing. This structural gap between the domains has thus brought challenges of analysis, because the ordinary analytical tools from each domain cannot be shared. In other words, a whole new analytical approach should also be invented for this specific methodological framework.

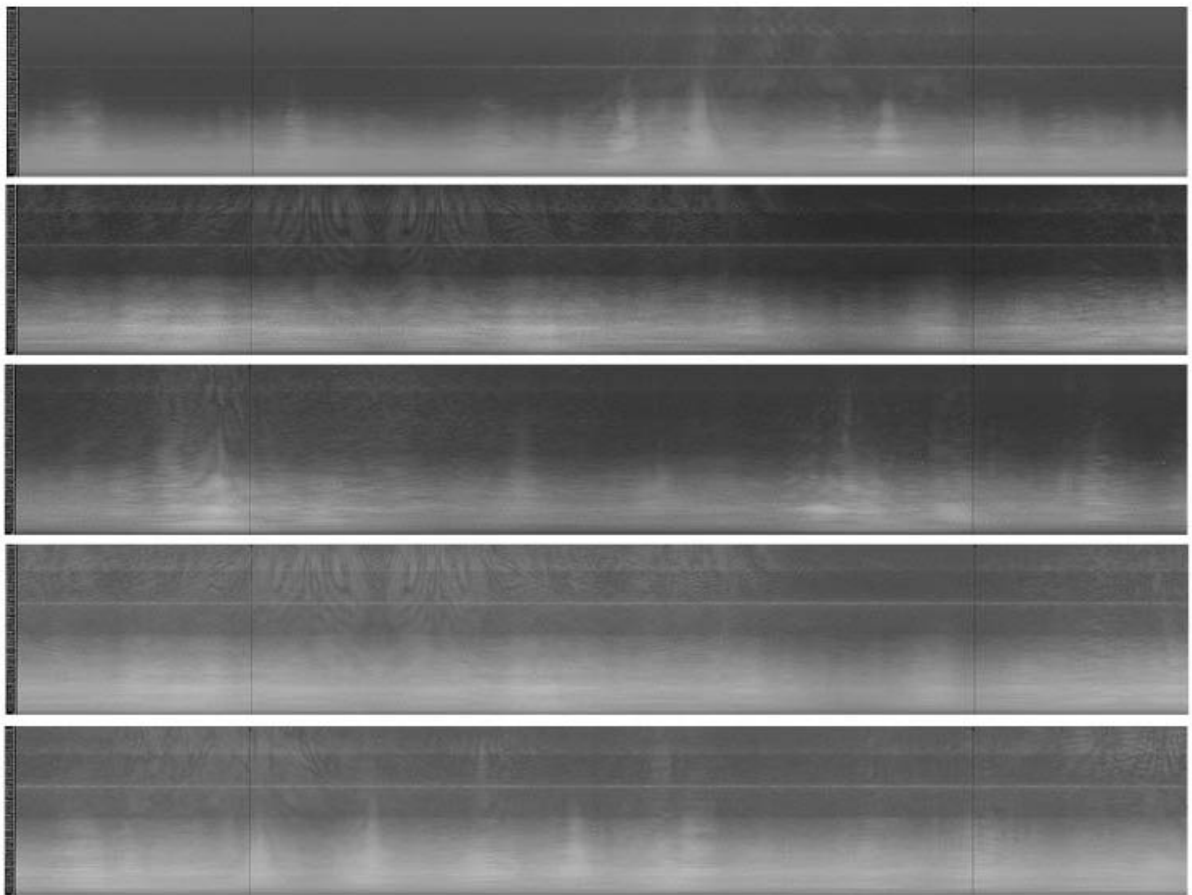


Fig.18. the spectrograms from various locations at Funkhaus Wien, E8, 2025, exported from Sonic Visualizer

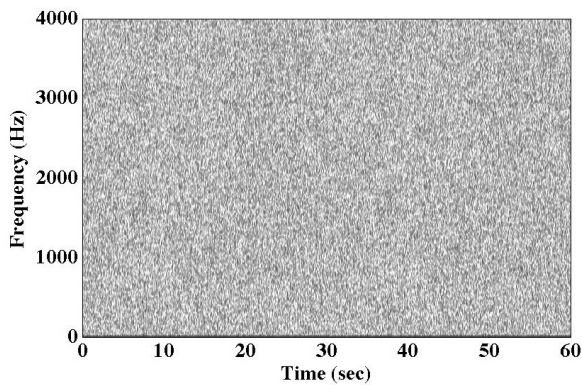


Fig.19. the spectrogram of white noise. accessed March 10, 2026,

[https://www.researchgate.net/figure/Frequency-spectrogram-of-white-noise\\_fig2\\_265250556](https://www.researchgate.net/figure/Frequency-spectrogram-of-white-noise_fig2_265250556)

To start with the analysis, we can read this comparative data from E8. These five spectrograms from different locations shared the same methodological constitutions - from directional speaker, white noise, and were all recorded with a Zoom H6 recorder XY microphone. From the spectrograms, we can see different distributions of frequency and amplitude (energy) from space to space. (see fig.18). Also, compared to the spectrogram of white noise in fig. 19, its even, granular texture has also changed in different spaces.

In this sense, we can infer that space might be one of the factors creating such differences. However, what do the textures in the spectrogram actually represent? Can they be referred to the space? Or what does the “space” actually mean here? All of these questions require a different analytical approach. Therefore, the following two approaches are proposed to examine the relation between the spectrogram and space.

#### 1.4.1 Signal-Based Inference

In the beginning, I found some research that is situated in the field of acoustic reconstruction or inverse problems in acoustics.<sup>36</sup> This is the point that led me to re-examine the design of the method as well as whether to adopt quantitative or qualitative analysis in my research. However, they reconstruct spatial geometry through precise acoustical measurements, which is what my method hasn't recorded since the beginning. Meanwhile, what concerns me most was far from the precise

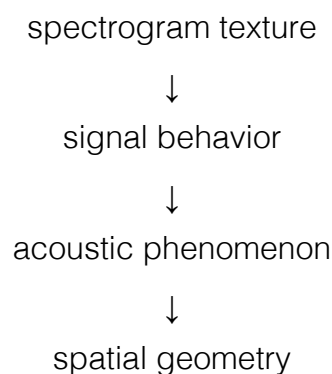
---

<sup>36</sup> Ivan Dokmanić, Reza Parhizkar, Andreas Walthner, Yue M. Lu, and Martin Vetterli, "Acoustic Echoes Reveal Room Shape," *Proceedings of the National Academy of Sciences* 110, no. 30 (2013): 12186–12191.



reconstruction of a space since the very beginning, but what can be inferred about a space from the spectrogram. In this sense, the typical room acoustics analytical tool is neither applicable nor necessary. Since conventional room acoustics analyses are not directly applicable to spectrogram interpretation, I decided to begin with the analysis of the spectrogram itself.

Before proceeding, it is necessary to clarify what spatial inference means in this research. Spatial inference here does not refer to the reconstruction, representation, or precise measurement of spatial geometry. Instead, it refers to the possibility that variations observed in the spectrogram may be related to differences in spatial conditions. The objective is therefore not to determine what a space objectively is, but to examine what aspects of space may become accessible through the methodological constitution and its resulting spectrogram. Under this understanding, the following analyses began with an assumption that there is an inferential chain as follows:



The textures visible in the spectrogram represent signal behaviors, namely, how the signal changes over time. These include variations in frequency distribution and amplitude, as well as temporal changes such as frequency decay, where a specific frequency gradually shifts from brighter to darker intensity. Therefore, the step of the inference from spectrogram texture to signal behavior is valid, as the observed textures refer to variations in frequency and amplitude over time.

So, the next question would be: could signal behavior be related to an acoustic phenomenon? The variations that are observed from the spectrogram could refer to the physical effects of how sound behaves in an environment, such as propagation, reflection, resonance, interference, absorption, and so on. However, it is actually a non-unique (one-to-many) inference. For example, when there is a frequency decay

observed from the spectrogram, it can be referred to either the presence of absorbers in the environment or a longer propagating distance.<sup>37</sup>

Thus, the inference between signal behavior and acoustic phenomena is actually underdetermined. In this sense, the inference from acoustic phenomena to spatial geometry is not necessarily pursued, since a non-unique inference at the previous stage would inevitably lead to subsequent stages of inference.

Furthermore, these are just the analyses situated within the inferential level; there are also other influential parameters within the executional level, such as the position or angles of the recorder, as well as the relative positions among the directional speaker, recorder, and the space. Meanwhile, missing information, such as distance or the specific absorption coefficients of materials, means that key parameters affecting acoustic interpretation remain undetermined. Therefore, any attempt to further infer spatial conditions from the observed acoustic phenomena becomes increasingly underdetermined.

Through the analyses above, a spectrogram only registers variations in the signal and cannot be uniquely inferred to a specific acoustic phenomenon, nor can it be further determined as spatial geometry due to the non-unique nature of the inference. Thus, the proposed inferential chain does not hold, and a confirmed relation between spectrogram and space cannot be established.

#### 1.4.2 Situated Inference

There could be another approach that aligns the spectrogram with the actual environment synchronously. If there is a video or (panoramic) photograph that documents the scene with a shared center point, with the same speed, and the same discrete steps, that the directional speaker rotates.<sup>38</sup> Ideally, the spectrogram and the environment could then be compared directly (see fig. 20). During my on-site work, I took some panoramic photographs and videos. However, they neither share the same center position nor rotate synchronously. Thus, the alignment between the documentation and the spectrogram is unfortunately impossible in my case. Meanwhile, spatial information should not be reduced just to object identification, but involves a multiplicity of indices arising from structural and material conditions. Thus, the situated approach ideally could be possible, but could also be pretty complex

---

<sup>37</sup> Heinrich Kuttruff, *Room Acoustics*, 6th ed. (Boca Raton, FL: CRC Press, 2016).

<sup>38</sup> The initial idea of this approach was also suggested during my presentation in the "Infotalks" with the scientists from Das Institut für Schallforschung (ISF), Österreichischen Akademie der Wissenschaften (ÖAW).

and large-scale in its data.<sup>39</sup>

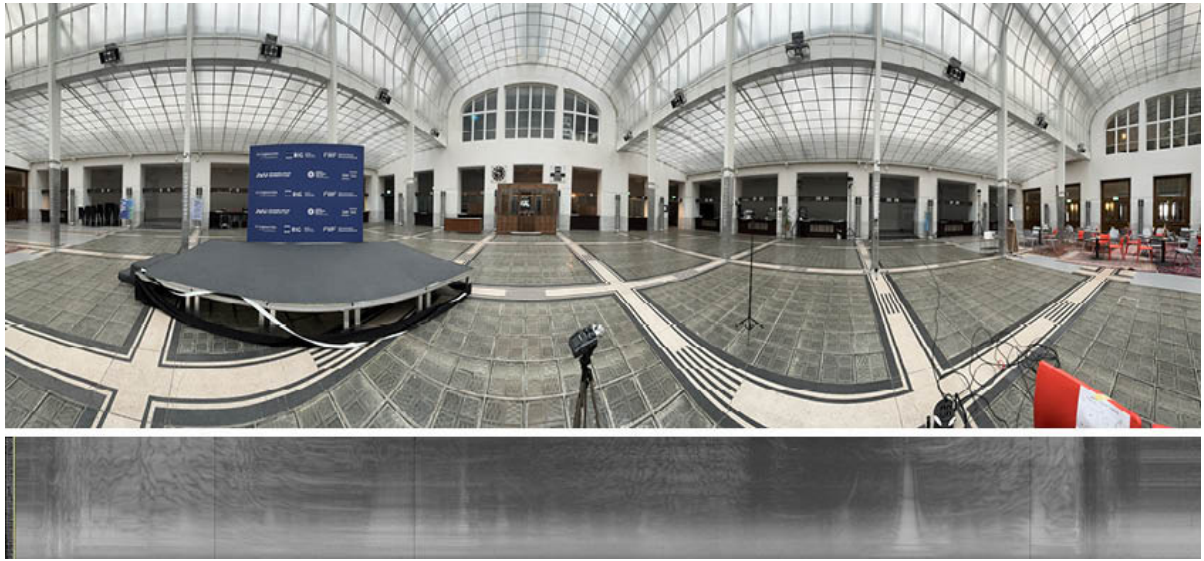


Fig.20. The image only presents a schematic and non-synchronized juxtaposition between the panorama (upper) and the spectrogram (lower), no direct spatial correspondence is implied, 2024. Photo by OU Jiun-You

To sum up this section, the fundamental difficulties in inferring the spectrogram to space are mainly derived from the structural gap between the analytical levels of signal processing and room acoustics. Thus, a spectrogram does not have a direct inference toward spatial conditions. Although the inference from spectrogram to spatial conditions cannot be uniquely determined because of its non-unique inferences from signal behaviors to acoustic phenomena, and to spatial geometries, the most crucial observation remains that spectrograms perform differently across spaces. In this sense, rather than validating the inference from spectrogram to space, the spectrogram reveals differences that are discernible while their causes remain undetermined. Thus, spectrogram, as the spatial inference in this research, does not refer to the reconstruction or determination of spatial geometry, but operates as an interface that reveals the specific spatiality and temporality within each experiment.

---

<sup>39</sup> During the discussion with Nicolaj, I got to know the AI tool – Essentia, which could be employed for this situated approach. <https://essentia.upf.edu> Essentia, an open-source library and tools for audio and music analysis, description and synthesis, built and developed by Universitat Pompeu Fabra – Barcelona.



## 1.5 Methodological Conclusion and Research Questions

In this chapter, I devote substantial attention to tracing the methodological and method-based development. It is not about giving just a meticulous working note or technical guidance, but about revealing an explorative process of how understandings emerged through iterative experimentation and subsequent analyses. The fundamental structural gap between the methodological constitution – directional speaker and white noise, as well as the methodological interface – spectrogram, led the whole research to be only analyzed through an emergent inferential approach. Although the inference from spectrogram to spatial conditions cannot be uniquely determined, the most crucial observation remains that spectrograms perform differently across spaces. This empirical observation from the methodological framework should not be seen as a failure but as an epistemic productivity. Only when the method is pushed to the boundary of its applicability does the underlying intention and question become more refined.

Thus, during the whole experimentation until the end of the analyses, the most intriguing but also unanswered question is, what does **space** actually mean in my research? In most of the experiments, space was actually understood in a Euclidean geometric sense. Thus, this understanding has largely influenced how the space was accessed in a visual-centric way, although the methodological constitution is a sonic constitution. The iteration of the methodological and method-based development, from vertical movements to horizontal movements; from hand-holding to motor-rotating of moving the directional speaker, was all developed visual-centrally. This Euclidean conception of space is undeniable and also operates as the base for the application of the method, until encountering the analytical limitations as well as the results from the outdoor experiments at Boscioli (E7), and, retrospectively, the pilot project at Semmelweisklinik (E1). Although the contexts in these two were not completely identical, they have a shared question regarding: if this method doesn't record the space or the object in a Euclidean geometric sense, what do they actually capture? And what do those spectrograms from these experiments refer to?

Here, the notion that I quoted in the section on methodological analogies, what Peter McMurray describes as mapping by sound, provides an insightful perspective. Which means, in my research, the methodological constitution actually functions as a cartographic tool for constructing spatial knowledge. Especially when the observed differences in the spectrograms cannot be uniquely inferred to specific spatial

parameters, the focus of this research shifts from spatial geometric construct to revealing the relations through which spatial differences become perceptible. Thus, space in this research is not considered as Euclidean geometry, but as a **relational configuration**. In this sense, the experimentation actually suggested a topological understanding of the space.

With this understanding, when I look back at the experiment in Boscioli (E7), which has already told more than the method itself and its analysis. The spectrogram no longer refers to the representation of the spatial condition as an Euclidean conception of space, but to the trace of multiple interacting factors at a specific moment within the scene. The seemingly failed application of the method actually recorded the specific temporality and spatiality of each moment, capturing the relations among material, environment, and the subject, as well as my presence. This understanding also partially addresses those raised interests during E1 at Semmelweislinik, when the method was even in its initial construction.

Thus, when a spectrogram operates as a spatial interface, where different systems interact and where relations are dynamically produced through transformation, it reveals an epistemological question:

***If a space or an environment is only accessible through an interface, what can be known? The answer is: the spatial field should not be understood as a stable geometric construct, but as a relational configuration that becomes partially accessible, interpreted, and even imagined through the method.***

## CH2 Spectrogram and Sectional Epistemology

In chapter 1, the practice-driven exploration has gradually shaped a methodological and method-based development. Through the iterative practices of the method, essential questions emerged and proposed an epistemological configuration that refers to an interface between sound and space. In this chapter, I will further examine the spectrogram as a methodological interface and elaborate on how it could serve as the point of departure for a sectional epistemology. Rather than just translating mathematical formulas and textbook explanations, this section attempts to reconnect concepts dispersed across signal processing, acoustics, and visual representation into a trajectory that supports the methodological and epistemological concerns of this research.

### 2.1 Spectrogram as Sectioning Operation

#### 2.1.1 From signal to spectrogram: FT and STFT<sup>40</sup>

A spectrogram is a time–frequency domain representation of an audio signal, which is generated through the Fourier Transform (FT) and Short Time Fourier Transform (STFT) from a waveform signal: a time-domain representation, where the x-axis represents time and the y-axis represents amplitude. FT did integration over time, which means it decomposes the entire signal into constituent frequency components. In other words, FT gives a global frequency distribution of the signal, meaning which frequencies are present, but can't show when a specific frequency appears. The time-domain information is not lost but collapsed into a single spectrum, which represents frequency on its x-axis and amplitude on its y-axis. To put it simply, what FT does is to reveal the overall frequency content within a specific signal.

So, FT provides a precise, stationary global frequency structure of the signal, but it can't show how the frequency changes over time. Since most of the sound is non-stationary, knowing when specific frequencies appear and how they change over time is essential for meaningful analysis. Especially in my experiment, the method aims to reflect the audio signals' changes over time, which could thus be referred to

---

<sup>40</sup> Julius O. Smith, *Spectral Audio Signal Processing* (W3K Publishing, 2011), <https://ccrma.stanford.edu/~jos/sasp/>.

the sonic-spatial relations as an interface. Thus, to reintroduce temporality, the Short-Time Fourier Transform (STFT) is employed.

The STFT contains several steps and corresponding parameters:

- window size: selecting a specific length of time
- window function: the shape that represents the weighting of the window
- hop size: the sliding over the lapped area

First of all, a window size is selected on the waveform of the signal, which will decide how frequency and time are traded off in this section. A bigger window means a longer time, and vice versa for the small window. Since frequency requires time to be measured,<sup>41</sup> the bigger window size can give more accurate information about frequency, whereas the smaller window can't. When the smaller window size is selected, the temporal resolution becomes higher because the smaller time window means less uncertainty within a selected time window, and thus leads to less resolution in frequency.

After the window size is decided, a specific window function is applied to each window.<sup>42</sup> The weighting is determined by the mathematical form of the window function (see fig.21), assigning a value to each sample based on its position within the window.<sup>43</sup> Different window functions refer to different weighting of the samples within the selected window, which aims to make the boundary of the window become smoother and avoid spectral leakage.<sup>44</sup> After weighting the signal with a window function, STFT applies the FT to the windowed segment to obtain its local frequency spectrum.<sup>45</sup>

---

<sup>41</sup> For a single sinusoidal wave, according to the equation of frequency:  $f=1/T$ ,  $f$  represents frequency – how many cycles per second;  $t$  represents the time taken to complete one cycle of an oscillation or rotation. So, when the time is shorter (smaller window size), there is not enough time to capture a full cycle of the waveform, and thus the frequency cannot be accurately determined.

<sup>42</sup> There are various window functions, such as Hann, Hamming, Gaussian, Rectangular, etc. Usually, the Hann window is most adopted, because it has more balanced or averaged spectral leakage and main lobe width (frequency resolution)

<sup>43</sup> A sample refers to a discrete data point in the time domain (waveform), representing the amplitude of the audio signal at a specific moment in time.

<sup>44</sup> Spectral leakage occurs when energy from a single frequency spreads into adjacent frequencies due to the abrupt truncation of the signal (by window size). It is not a loss of information, but a redistribution of energy across frequencies.

<sup>45</sup> The STFT conceptually applies the FT, but in practice, it is computed using the FFT (Fast Fourier Transform) algorithm- a



Then hop size determines how the window moves across the signal during STFT, and how much the window is overlapped as the window moves to another. In other words, when the window moves less, the previously selected and fixed window size has more overlaps from move to move (window to window). Meanwhile, the overlaps from the hop size can also compensate for the shape of the specific window function. In this sense, it enhances the continuity of the signal from the previously employed window size as well as the window function. STFT applies FT to a sequence of localized segments defined by a sliding window. Each window selects a finite temporal interval, within which the signal is assumed to be approximately stationary. FT is then computed for each segment, producing a series of spectra (pl.) distributed over time. When these local spectra are arranged sequentially, the result is a spectrogram: a two-dimensional matrix in which time is represented on the x-axis, and frequency on the y-axis, as well as amplitude encoded through intensity. (see fig.22)

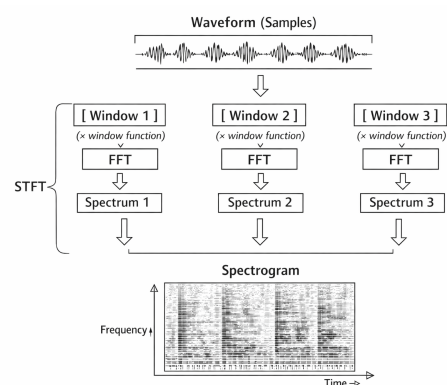
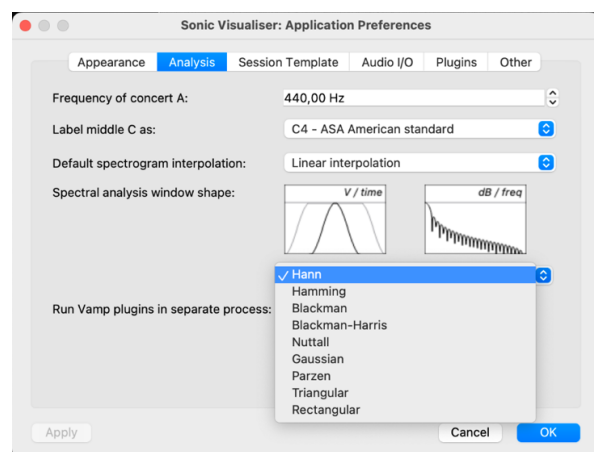


Fig.21. (left) for example, different window functions can be selected in the software, screenshot from sonic visualizer.

Fig.22. (right) Schematic diagram of the STFT process (FFT here refers to FT in above text), author's illustration with AI assistance.

## 2.1.2 Uncertainty Principle

Heisenberg's uncertainty principle in quantum mechanics and the time–frequency uncertainty in signal processing (e.g., spectrogram) share the same mathematical

---

faster way to compute the FT.

foundation in Fourier duality.<sup>46</sup> Duality refers to the relationship between two domains, such as time and frequency in FT. Where a signal can be represented in both, and the properties in one domain directly affect those in the other. In other words, the more accurately one property is measured, the less accurately the other property can be known. As I mentioned in 2-1-(1), in the process of formulating a spectrogram by STFT, the act of windowing (selected window size in STFT) introduces a fundamental constraint, which is the time–frequency uncertainty principle. Since frequency can only be measured over time, a smaller window captures time more precisely but lacks sufficient duration to resolve frequency, while a larger window resolves frequency more accurately but blurs temporal detail.<sup>47</sup>

This trade-off reveals a structural condition: the spectrogram cannot simultaneously achieve complete resolution in both time and frequency domains. In other words, a spectrogram can't fully preserve both temporal precision and spectral detail at the same time. In this sense, the spectrogram is inherently **sectional**. Thus, the uncertainty principle demonstrates that any sectional operation necessarily entails a limitation, making partiality not a defect but a condition where observation is produced under constraints.

To sum up the discussions above, the sectional nature of the spectrogram exists on two levels. First, each windowed segment is inherently partial, due to the time–frequency uncertainty principle. The spectrum yielded from a windowed segment is only precise in one domain, with the trade-off of imprecision in the other. Second, the spectrogram as a whole is an assemblage of these partial transformations. Its continuity is constructed from the alignment of discontinuous segments. These two levels together constitute the sectional essence of the spectrogram and thus lead the previously established methodological and method-based development toward a sectional understanding. In this sense, the spectrogram can be understood not merely as a representation of sound, but as the result of a sectional operation. It is not understood as an intact whole, but as a sequence of constructed segments, in which each segment produces a partial observation that accumulates into a conditioned understanding of the signal. Thus, sectioning should not be understood as a limitation, but as the basis upon which access is established under constraints.

---

46 Dennis Gabor, "Theory of Communication," *Journal of the Institution of Electrical Engineers*, vol. 93, 1946, pp. 429–457

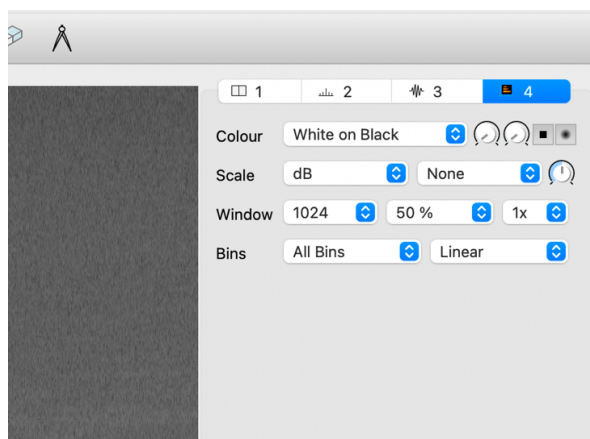
47 Smith, *Spectral Audio Signal Processing*, 2011

## 2.2 Spectrogram as Conditioned Seeing

### 2.2.1 Spectrogram in its Nature: A Constructed Visibility

While chapter 2.1 has demonstrated how the spectrogram is constructed through a series of mathematical operations as a constructed continuous data, now the raised question is, how can this sectional nature of the spectrogram become visible? With which practical media can we have access to such abstract operations?

In my context, Don Ihde's hermeneutic relation could be adopted to describe how a spectrogram could be read. From an audio signal, I have no access to the spectrogram directly, but can only reach it through specific software. Similarly, the understanding of a certain audio signal is mediated through the spectrogram with its sectional nature. What we can read is not neutral but mediated. This hermeneutic relation does not replicate the world, but only selectively reveals certain aspects of it.<sup>48</sup> To bring this observation back to the spectrogram, its constructed visibility becomes apparent through the various tools that render it.<sup>49</sup> Taking the software "Sonic Visualizer" as an example, besides what I mentioned in the last section for employing different window functions, the window size and hop size can also be adjusted. (see fig.23). These parameters exist as parts of the software user interface (UI), which operationalize the sectioning operation from how the spectrogram is mathematically constructed.



---

<sup>48</sup> Don Ihde, *Technology and the Lifeworld: From Garden to Earth*, Indiana University Press, 1990

<sup>49</sup> There are various software programs that can generate spectrograms. For example, I adopted Sonic Visualizer across the whole project. There are also musical software programs, such as Audacity, that can show a spectrogram, but in a very simplified way. Praat is a Phonetics software that can give more details with diverse parameter settings. There is also software such as REW, which tends more to room acoustic measurement and analysis.

Fig.23. parameters from the screenshot of the software Sonic Visualizer

Meanwhile, following the window size caused a trade-off between the resolution of time and frequency, which is another level of the spectrogram's sectional nature. The abstract explanations proposed above can actually be intuitively observed via software. From figures 24 and 25, we can see the tradeoff of time-frequency. In fig.24, when a longer window length is selected, the spectrogram shows high resolution of frequency, which means a clear texture of the spectrogram can be seen. Since the window includes more time, if there is a very short acoustic event, which might not be visualized as a pixel, it could be smaller than a pixel. On the contrary, in Fig. 25, when a short window length is selected, temporal detail becomes visible at this scale, and each pixel is observed referring to an acoustic event. However, the time is just too short to complete a full cycle where frequency is observable.

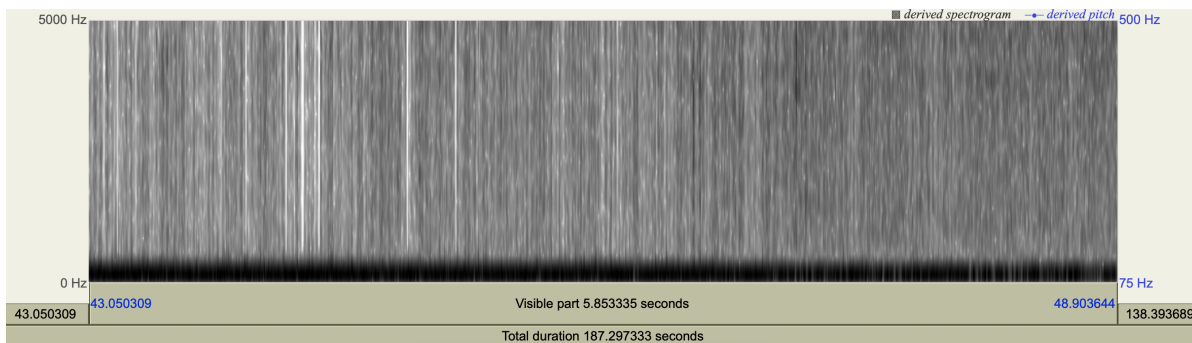


Fig.24. within a longer window length, the spectrogram shows higher resolution of frequency, screenshot from the software Praat.

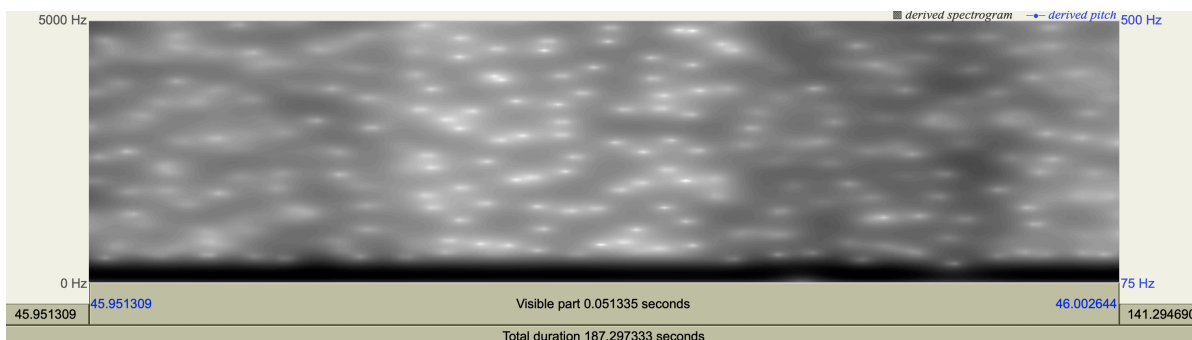


Fig.25. within a shorter window length, the spectrogram shows lower resolution of frequency, screenshot from the software Praat.

### 2.2.2 Spectrogram in the Method: A Methodological Partiality

Furthermore, besides the inherent nature of the spectrogram, I have to position how the spectrogram operates in this research project. In Chapters 1.3 Methodological Iterations and 1-4 Spectrogram as A Spatial Interface, I positioned the role of spectrogram in this research project as an interface of sensing the space, and I also elaborated on where the constraint of this spatial inference comes from. With these premises, the conditioned seeing derived from methodological and method-based development refers to two aspects.

One is from the methodological structural gap between room acoustics and signal processing. Which means, the recorded sound field, which was created by a directional speaker and white noise propagating in the space, is actually situated in the field of room acoustics. The proper analytical tools for spatial properties are typically inferred through quantifiable metrics, which could reveal how sound propagates in a space. However, the adoption of spectrogram, which is situated in the field of signal processing, is usually employed in phonetic analyses or just simply for how frequency and amplitude changed over time, thus the user or the researcher can form an inference of the sound. In other words, it reveals what kind of sound could be, but is not related to sound propagation in space. Thus, when the methodological constitution and interface are combined in this specific way, the spectrogram does not establish a determinate mapping to space. It can only sustain an inferential rather than a demonstrable relation to the spatial condition. Thus, this structural gap indeed reveals that the spectrogram does not function as a tool for reconstructing space or depicting space, but it performs as an interface where relations among signal, device, and environment become visible in an unconventional way, as an interpretative projection based on conditioned legibility.

Another form of partiality emerged from the methodological iteration itself. When the method was employed in large indoor spaces and later in outdoor environments, the question was no longer how to capture a space, but to what extent the method could operate within it. Initially, the directional speaker was handled vertically with an implicit assumption that broader coverage would lead to a more complete understanding of spatial conditions. However, different spatial scales and semi-open environments gradually revealed that expanding the scope did not necessarily produce more meaningful observations as well as further inferences. This led to a methodological and method-based shift from sensorial extension toward controlled mechanical operation. Since E6, the method no longer attempted to capture the so-called wholeness, but operated through a belt-like scanning area approximately

corresponding to ear level. Rather than representing the space as a whole, this adjustment established a consistent and constrained condition through which spatial relations became partially accessible and comparable.

From the inherent sectionality of the spectrogram, as well as two aspects of methodological partiality regarding the structural gap between fields and the physical limitation from experimental scope, they constitute a conditioned seeing. Thus, what becomes available through the spectrogram is neither sound nor space itself, but a mathematically sectioned and methodologically situated mode of access.

## 2.3 Sectional Epistemology

### 2.3.1 Sectional Temporality and Spatiality

As discussed in the previous sections, the spectrogram does not provide direct access to sound or space, but establishes a conditioned mode of seeing. Under this condition, sectionality in this research unfolds along two dimensions: temporality and spatiality.

Sectional temporality is inherent to the mathematical constitution of the spectrogram. Since the spectrogram is generated through windowing and constrained by the time–frequency trade-off, the signal becomes available only through sequential and accumulated sections rather than continuous presence. What is produced is therefore not an uninterrupted temporal field but a temporally sectional condition in which each observation remains partial. On the other hand, sectional spatiality does not originate from the spectrogram inherently but emerges through the methodological positioning and deployment of the method. Through selected positions and scanning scope across different spaces and environments, the method does not attempt to access space as a complete entity but establishes situated and constrained relations with spatial conditions. Spatial access is therefore not given but methodologically produced.

These two dimensions should not be understood independently. Temporal sectioning determines how the signal becomes available, while spatial sectioning determines how the method approaches and establishes relations with space. Together, they indicate that what the research constructs is not a complete observation, but a sectional mode of approaching its objects. What these two dimensions together reveal is that the spectrogram is a conditioned seeing through a sectioning operation. If what the spectrogram produces is neither a representation of sound nor a mapping of space, then the question is no longer about what it can successfully capture, depict, or document, but about how and what kind of knowledge it can produce.

### 2.3.2 Sectional Knowledge

Until now, as a practice-led research project, the notion of section that has been proposed above is based on the derivations from methodological and method-based

development. To position this observation within a broader epistemological context, I draw on two perspectives that have comparable notions.

Art historian Matthias Bruhn brought a historical perspective regarding how sectioning migrates from anatomical dissection to geological slicing, and later into technological imaging such as tomography.<sup>50</sup> In anatomical practices, the act of cutting destroys the original continuity of the body while translating its internal structures into a new visual form. The internal structure becomes visible and thus legible only through a specific act. In his context, the blade doesn't reveal what was already there, but through the destruction of the continuity of the body, it makes visibility become possible. Similarly, the spectrogram does not represent the sound or space in their continuity. It produces a new form of visibility through segmentation and transformation, and thus produces knowledge. Like the anatomical section, it destroys the original continuity of the signal in time to produce a different kind of visibility.

Furthermore, in Matthias Bruhn's context, he wrote, *"It is neither projected nor printed, woven or molded, but intersects with the body, virtually becomes the section itself. Ideally, the sharpness of the blade and the sharpness of vision intersect."*<sup>51</sup> Although Bruhn's observation is situated in the context of anatomical illustration, it also points to a broader principle that, in tomological vision,<sup>52</sup> the act of cutting and the act of seeing converge. They are not sequential but simultaneous: to see is to cut, and to cut is to make something visible. Thus, sectional knowledge is not only about the knowledge derived from specific conditions but also about the act that led to it. In this sense, the spectrogram in my research is essentially different from an ordinary spectrogram, which represents a specific audio signal. Because each spectrogram is produced from a specific cut, a particular configuration of directional speaker, and white noise. Since the methodological constitution itself has changed through iteration, each experiment produces its own sectional knowledge, not only due to spatial difference but also due to the shift in how the cut was made.

Like Bruhn, Foucault proposed that dissection creates the conditions for visibility. Moreover, his writing in *The Birth of the Clinic* introduces a further perspective

---

50 Matthias Bruhn, "Seeing as Cutting: A 'Tomological' Concept of Vision," in *Uncanny Interfaces*, ed. Konstantin Daniel Haensch, Lara Nelke, and Matthias Planitzer (Hamburg: Textem Verlag, 2013), 143–163.

51 Bruhn, "Seeing as Cutting," 150.

52 Tomological is a neologism that was coined by Bruhn, which includes practices as well as visualizations, Bruhn, "Seeing as Cutting," 153



regarding that visibility alone does not constitute knowledge.<sup>53</sup> In other words, visibility must be situated within a framework of knowledge in order to become legible. In Foucault's context, the previously established dissection knowledge and anatomical atlas brought the visibility of the disease within the body. Only when medical discourses and their taxonomic configuration make the diseases spatialized and localized can doctors gaze and traverse the body. What Foucault demonstrates here is the reciprocal dependency between what he calls the visible and the expressible, in his words, *"A hearing gaze and a speaking gaze: clinical experience represents a moment of balance between speech and spectacle. A precarious balance, for it rests on a formidable postulate: that all that is visible is expressible, and that it is wholly visible because it is wholly expressible."*<sup>54</sup> Thus, *"It was also necessary to open up language to a whole new domain: that of a perpetual and objectively based correlation of the visible and the expressible."*<sup>55</sup>

In the case of the spectrogram in my context, this reciprocity is essential, as the structural gap of this research is situated. According to chapters 1.4, a spectrogram operates as an interface that shows frequency changes, amplitude variations, and spectral textures. However, the signal-based analysis has its fundamental non-unique inference and thus makes the spectrogram cannot be uniquely determined as a definitive spatial interpretation. Following Foucault, that is, what is visible exceeds what is expressible in my methodological framework.

### 2.3.3 Boscioli: toward (Inter)Section

#### 2.3.3.1 from Interface to Trace

Throughout the experiments, the spectrogram cannot be definitively determined as spatial conditions due to the partial inference derived from the structural gap discussed in Chapters 1.3 and 1.4. The variations in frequency and amplitude in the spectrograms can only be read as potential indications of spatial conditions, but cannot be definitively determined. This is the role of the spectrogram across the experiments in this research – as a partially inferred interface.

Compared to indoor experiments, the experiment outdoors in Boscioli (E7) is especially different. The employed method remains the same: directional speaker,

---

<sup>53</sup> Foucault, Michel. *The Birth of the Clinic: An Archaeology of Medical Perception*. Translated by A. M. Sheridan Smith. London: Routledge, Taylor & Francis e-Library, 2003. Originally published 1973.

<sup>54</sup> Foucault, *The Birth of the Clinic*, 115

<sup>55</sup> Foucault, *The Birth of the Clinic*, 196

white noise, and spectrogram. However, due to a lack of enclosing boundaries and stable reflective structures, the same methodological constitution operates differently. In Foucault's framework, he wrote "*the relation between the visible and invisible — which is necessary to all concrete knowledge — changed its structure, revealing through gaze and language what had previously been below and beyond their domain.*"<sup>56</sup> This suggests that accessibility is not only determined by observation itself, but also by the conditions under which observation takes place. When the conditions change, what becomes accessible changes accordingly.

As a result, the spectrogram in Boscioli no longer sustains spatial inference and instead contains inseparable environmental conditions. The interface in Boscioli began to register distributed interactions that exceeded inferential determination. The resulting spectrogram, therefore, produced what was defined in Chapters 1.4 as trace, which remains perceptible but is no longer inferable. Once inference no longer operates in the same way, another condition appears: the section remains operative, yet what becomes accessible is no longer space itself but relations distributed across environmental conditions. Thus, the resulting spectrogram should not be understood as the collapse of the method, but rather reveals the boundary of the method. This shift reveals a relational configuration in which interactions remain registered without being inferred as spatial conditions. In this sense, trace does not depart from sectional epistemology but reveals a different epistemological status, that is, a different role in the process of knowing.

#### 2.3.3.2 (Inter)Section

From the previous discussion, the spectrogram inherently reveals how spectra are accumulated in temporal sequence as well as methodologically operates as a spatial interface and trace. No matter methodologically or mathematically, sectional knowledge is produced through intentional operations – the act of sectioning.

Regarding how sectioning operates, a structural perspective from French anthropologist Claude Lévi-Strauss provides a compelling notion: division, which is originally grounded in the operation of binary oppositions within mythological elements. The notion division here should not be solely understood as destruction but as the production of relation.<sup>57</sup> If a division is materialized as a split, splitting doesn't simply separate the entity, the space, or the environment; it also generates

---

<sup>56</sup> Foucault, *The Birth of the Clinic*, 196, xii

<sup>57</sup> Claude Lévi-Strauss, *The Savage Mind* (Chicago: University of Chicago Press, 1966).

new surfaces where relations can be perceived.<sup>58</sup> The seemingly sealed wholeness or completeness thus becomes legible through the revealed surfaces. In my research, these surfaces are situated inherently and methodologically within spectrograms. This understanding doesn't introduce a new operation, but makes explicit what is already implicit in sectional epistemology – the notion of **(Inter)Section**.

The symbol () – parentheses, etymologically, should be understood as that which puts what was derived next to the origin.<sup>59</sup> The parentheses here indicate a dual reference: each section is a partial, conditioned knowledge, and it is also an intersection, where relations emerge. Because whenever a section is produced, it simultaneously reveals a new surface and a relation. This surface is not a revelation of an interior truth, but the condition under which relations become perceptible only through the act that produces them. Thus, (Inter)Section is the necessary consequence of sectional epistemology when more than one section is produced. Each section remains partial, yet their juxtaposition opens what no single section could reveal alone. In this sense, when a single spectrogram is operated and observed, it refers to a partial understanding – the relation between what is seen and what is unseen; when multiple spectrograms are operated from different locations and moments, what emerges is not a complete picture of the whole space or environment, but a relation among partial sections. Especially when the experiments are conducted in a large and even open environment, their juxtaposition reveals what a single section, interface, or spectrogram cannot tell. This is what (Inter)Section refers to in a structural perspective – as a static relation: the condition under which relations emerge across sections, rather than within any single one of them.

Meanwhile, the relation here is not only static as previously described, but also a dynamic configuration derived from how the method is applied and analyzable. When the spectrogram shifts from inference to trace, as in the outdoor experiment at Boscioli, the method reaches its limit, and it is precisely at this limit that the topological dimension of becomes most legible. When the method can no longer sustain inference, it also disrupts the visual-centric assumption and Euclidean

---

<sup>58</sup> There is a particularly resonant mythological section in Claude Lévi-Strauss, "Harelips and Twins," in *Myth and Meaning* (New York: Schocken Books, 1979), 29–30. "...the elder sister starts to split the body of the [hare]; if this split were carried out to the end – if it did not stop at the nose but continued through the body and to the tail – she would turn an individual into twins."

<sup>59</sup> The word parenthesis is composed by: par- + en- + thesis. Etymologically its prefix "par~"(para~) means: beside, next to; "en~" means: in, into; "thesis" (these) means: position, arrangement. <https://en.wiktionary.org/wiki/parenthesis>

geometric sense of space. What is foregrounded is the role of sound – directionally propagated white noise as an agency that mapped multiple interacting factors at a specific moment within the scene. It doesn't capture the space with objective spatial parameters, but develops a structural continuity across material, environment, and the subject. (Inter)Section here operates through a topological reading of space, in which neighborhood does not necessarily refer to metric proximity, but to a set containing a point together with points sufficiently close to it.<sup>60</sup> Here, relations become locally accessible without requiring complete spatial determination, and thus trigger an unconventional imagination of space. In other words, ambient sound, atmospheric conditions, and other variables that were previously excluded from inference are no longer excluded but become continuous with the sections. Thus, what (Inter)Section here refers to is the dynamic knowledge of how space is topologically perceived.

Furthermore, (Inter)Section is not only what actually happens in the experiment within the method, but also denotes an isomorphic understanding. During the time of writing on this thesis, an ordinary day of working on the stone in the Atelier, another sectional structure unexpectedly appeared from the metamorphic rock that I collected from Boscioli (see fig.26). Actually, it has always been there, but only foregrounded when sectional epistemology is defined. The cut and faceted stone surface revealed formalized knowledge, whether understood as geological fabric or observed as microstructure. This conditioned entity is partially known but reveals abundant information regarding its specific temporality and spatiality. As Bruhn has shown, sectioning as a mode of knowing has migrated across media throughout the history of science and art—from anatomical dissection to geological slicing to technological imaging.<sup>61</sup> A slice of stone actually can be reconfigured as an isomorphic expansion. In this sense, the stone section and the spectrogram no longer appear as translations of one another, but reveal a transferable epistemological structure that conveys similar but different sectional knowledge. What became transferable was neither appearance nor medium itself, but the logic established through sectioning. In this sense, (Inter)Section refers to the intersections where section(s) can be isomorphically expanded across heterogeneous material constitutions.<sup>62</sup>

---

<sup>60</sup> James R. Munkres, *Topology*, 2nd ed. (Upper Saddle River, NJ: Prentice Hall, 2000).

<sup>61</sup> Bruhn, *Seeing as Cutting*, 153.

<sup>62</sup> The sectioned stone surface carries scientific and poetic dimensions; for example, geological thin sections and cross sections reveal crystalline structures under the microscope, while Roger Caillois's collection of sliced and polished stones, documented in Roger Caillois's *The Writing of Stones* (trans. Barbara Bray, Charlottesville: University Press of Virginia, 1985),

Thus, sectional epistemology is not only about what a single section reveals, but also about what emerges when sections are understood as operations that produce (inter)Sections. The (Inter)Section operates on three levels. As a structural condition, it names the relation that emerges across partial sections, which no single section could disclose alone. As a topological configuration, it describes how space becomes accessible through the method's limit, where relations are locally perceptible without requiring complete spatial determination. As an isomorphic expansion, it refers to the transferable epistemological logic through which sectioning migrates across heterogeneous material constitutions, from spectrogram to stone, from sound to geology, and more. In each case, what is produced is not totality, but the condition under which relations become legible.



Fig.26, a cut slice of the metamorphic rock from Boscioli, 8 x 4.5 x 0.1 cm, 2026. Photo by OU Jiun-You

---

demonstrates how the cut surface opens onto imaginative interpretation.



## 2.4 Conclusion

Returning to the research question: ***if a spatial field is only accessible through an interface, what can be known?*** The answer this research arrives at is that conditionality itself gives rise to knowledge. What can be known is not the space itself, but the sections of a space or environment under specific conditions, and those conditions are what the method, through its structural gap, its mathematical constitution, and its experimental iterations, has made legible. This understanding did not arrive as a premise but emerged through resistance during the development of the research.

Each resistance encountered across the experiments, the non-unique inference, the scale of the space, and the dissolution of boundaries at Boscioli did not obstruct the research but refined its question. The experiments did not converge toward a more complete picture of space but toward a more precise understanding of what partiality means as a condition of knowledge production. The boundary of the method's applicability is precisely where its underlying epistemological intention becomes most refined. In this sense, resistance is not external to the epistemological framework but constitutive of it.

The experiment at Boscioli holds a unique position in this research. Methodologically, it operates at the limit of the method's applicability. Epistemologically, it is where the topological dimension of the research becomes most legible. Across all experiments, the method does not reconstruct Euclidean spatial geometry but establishes structural continuities through the interaction of sound and space. In enclosed environments, this topological understanding remains implicit, sustained by the partial inferential relations the spectrogram produces. It is only in Boscioli, where the absence of enclosing boundaries dissolves the conditions for inference, that this understanding becomes explicit: what the spectrogram registers is no longer a partial spatial inference but an open relational field in which ambient sound, atmospheric conditions, and material interactions are no longer excluded but become continuous with the sections. The methodological obstacle of the open environment becomes the most adequate scene for a topological understanding of space.

What Boscioli makes explicit also points beyond itself. Sectional epistemology, as this research proposes, actually also designates a transferable logic of knowledge production under conditions. This logic is not confined to this method or to any single

medium, but carries a potential for isomorphic expansion across heterogeneous material constitutions: wherever a conditioned operation produces a section, relations become perceptible that no single section could disclose alone. The artistic work operates under this same logic, as one among other possible expansions of the epistemological structure this research has established.

The three levels on which (Inter)Section operates are thus also three forms of an answer to the research question. As a structural condition, it names the relation that emerges across partial sections, which no single section could disclose alone. As a topological configuration, it describes how space becomes accessible through the method's limit, where relations are locally perceptible without requiring complete spatial determination. As an isomorphic expansion, it designates the transferable epistemological logic through which sectioning migrates across heterogeneous material constitutions, and more. In each case, what is produced is not totality, but the condition under which relations become legible.

***Thus, this research makes four significant contributions:***

- ***developing an original sonic-spatial methodological constitution combining a directional speaker and white noise as a spatial sensing operation***
- ***appropriating the spectrogram as a spatial interface, opening its analytical and artistic potential beyond its conventional use***
- ***proposing a sectional epistemology through which space is approached as a topological configuration, questioning the Euclidean geometric assumptions that typically govern spatial knowledge***
- ***introducing the concept of (Inter)Section, whose isomorphic logic extends the epistemological structure of this research beyond its original methodological context.***



## Afterword: A Note Is A Note Is A Note

Reflecting on the development of the whole project, there has been just an on-and-on problem-solving process, which has exactly revealed various conditions encountered during an interdisciplinary project, from domain-specific knowledge, methods, and experimental design, to access to specific devices, and those almost Sisyphean struggles in Boscioli or other on-site workings - these are just methodological and executional aspects. What is more crucial for me is how to find a proper position between artistic and scientific languages, as well as positioning myself throughout the whole research and artistic work.

The research once got really stuck because it was difficult to arrange the borrowing of certain devices or just build one's own device (to the experimental standard), especially sonic practice and its research are always very device-demanding. Compounding the problem, to properly position the method and methodological interface – spectrogram, is also a tough task. I went through various possibilities of spectrogram, like what I mentioned in the section on artistic references. From graphical representations to artistic expressions, they are attractive in their way for sure, but those back-and-forth movements on the representational levels are not really convincing and thus gradually lose their sincerity for me.

However, these were the exact moments foregrounding the word section and sectional epistemology – I can only work under certain conditions and know the partiality; meanwhile, this condition view contains its unique abundance above its limitation. What really materialized this observation was an ordinary day that I was cutting a piece of metamorphic rock and doing one of my favorite preparations- faceting. Then I realized, they revealed a way of knowing, from the pattern as a formalized knowledge as geological fabric or micro structure, or as how Roger Caillois roamed in his faceted and polished stone collections. The isomorphic connotation and transferable capacity truly excite me. And a cut, of course, cannot be undone. Every section, whether a cut through stone or a spectrogram of a passing moment, marks a point of no return.

This materialized understanding also reminds me that there have been numerous resistances along the development, or allow me to say it dramatically: Odyssey. However, these resistances were actually neither touched nor included in the initial phase of developing the artistic works. The drastic development of AI in the first season of 2026 also unexpectedly reminds me to rethink what resistance means for

me – no matter in a passive or active sense. To embrace them in a proper way, in the end, how can this iterative conceptual development and artist works be systematically elaborated and developed under the findings regarding art, science, and even oneself, is the most challenging task.

I remember once, during a discussion with one of the supervisors, Nicolaj Kirisits, I was still confused by the role of the spectrogram in my whole research. Not only about how it can be analyzed and interpreted, but also regarding a more abstract question: is it enough? I mean, is a spectrogram enough for getting to know a space or environment? I've already forgotten the exact sentences, but I realized that if I can only understand a space or environment through a spectrogram, whether it is enough or not, is not the problem, because this is the only way. Once again, retrospectively, this thought echoes on the whole process of developing this project, the pilot project, and even my early working method - bricolage.

\* \* \*

This two-and-a-half-year research project has received numerous generous supports (in chronological order):

For the methodological and method-based development, I would like to thank Nicolaj Kirisits, Jakob Scheid, the Digital Art department, and the Art & Science department for supporting the equipment and devices generously. I am also grateful for the feedback from Klaus Filip, Ulla Rauter, Stefan Voglsinger, Sophie Luger, Robert Mathy, Robert Zimmermann, and the Institut für Schallforschung (ISF, ÖAW).

The experiments included in this research were conducted either independently or in conjunction with specific events. I would like to thank the team of Semmelweisklinik, Zentrum Fokus Forschung, Anna Buchner, Alexandra Graupner (Postsparkasse, AIL), the Centro Internazionale di Scultura, and the team of Never at Home and Funkhaus Wien.

For this writing component, I am grateful for the insightful feedback from Nicolaj Kirisits. I also would like to thank Virgil Widrich and Valerie Deifel for polishing the structures and words.





# Bibliography

Bruhn, Matthias. "Seeing as Cutting: A 'Tomological' Concept of Vision." In *Uncanny Interfaces*, edited by Konstantin Daniel Haensch, Lara Nelke, and Matthias Planitzer, 143–163. Hamburg: Textem Verlag, 2013.

Caillois, Roger. *The Writing of Stones*. Translated by Barbara Bray. Charlottesville: University Press of Virginia, 1985. Originally published 1966.

Dokmanić, Ivan, Reza Parhizkar, Andreas Walther, Yue M. Lu, and Martin Vetterli. "Acoustic Echoes Reveal Room Shape." *Proceedings of the National Academy of Sciences* 110, no. 30 (2013): 12186–12191.

Foucault, Michel. *The Birth of the Clinic: An Archaeology of Medical Perception*. Translated by A. M. Sheridan Smith. London: Routledge, 2003. Originally published 1973.

Gabor, Dennis. "Theory of Communication." *Journal of the Institution of Electrical Engineers* 93 (1946): 429–457.

Ihde, Don. *Technology and the Lifeworld: From Garden to Earth*. Bloomington: Indiana University Press, 1990.

Kuttruff, Heinrich. *Room Acoustics*. 6th ed. Boca Raton, FL: CRC Press, 2016.

Lévi-Strauss, Claude. *Myth and Meaning*. New York: Schocken Books, 1979.

Lévi-Strauss, Claude. *The Savage Mind*. Chicago: University of Chicago Press, 1966.

Li, Mengmeng, Timothy Van Renterghem, Jian Kang, Kris Verheyen, and Dick Botteldooren. "Sound Absorption by Tree Bark." *Applied Acoustics* 165 (2020): 107328.

McMurray, Peter. "Ephemeral Cartography: On Mapping Sound." *Sound Studies* 4, no. 2 (2018): 110–142.

Munkres, James R. *Topology*. 2nd ed. Upper Saddle River, NJ: Prentice Hall, 2000.

Pompei, F. Joseph. "Sound from Ultrasound: The Parametric Array as an Audible Sound Source." PhD diss., Massachusetts Institute of Technology, 2002.

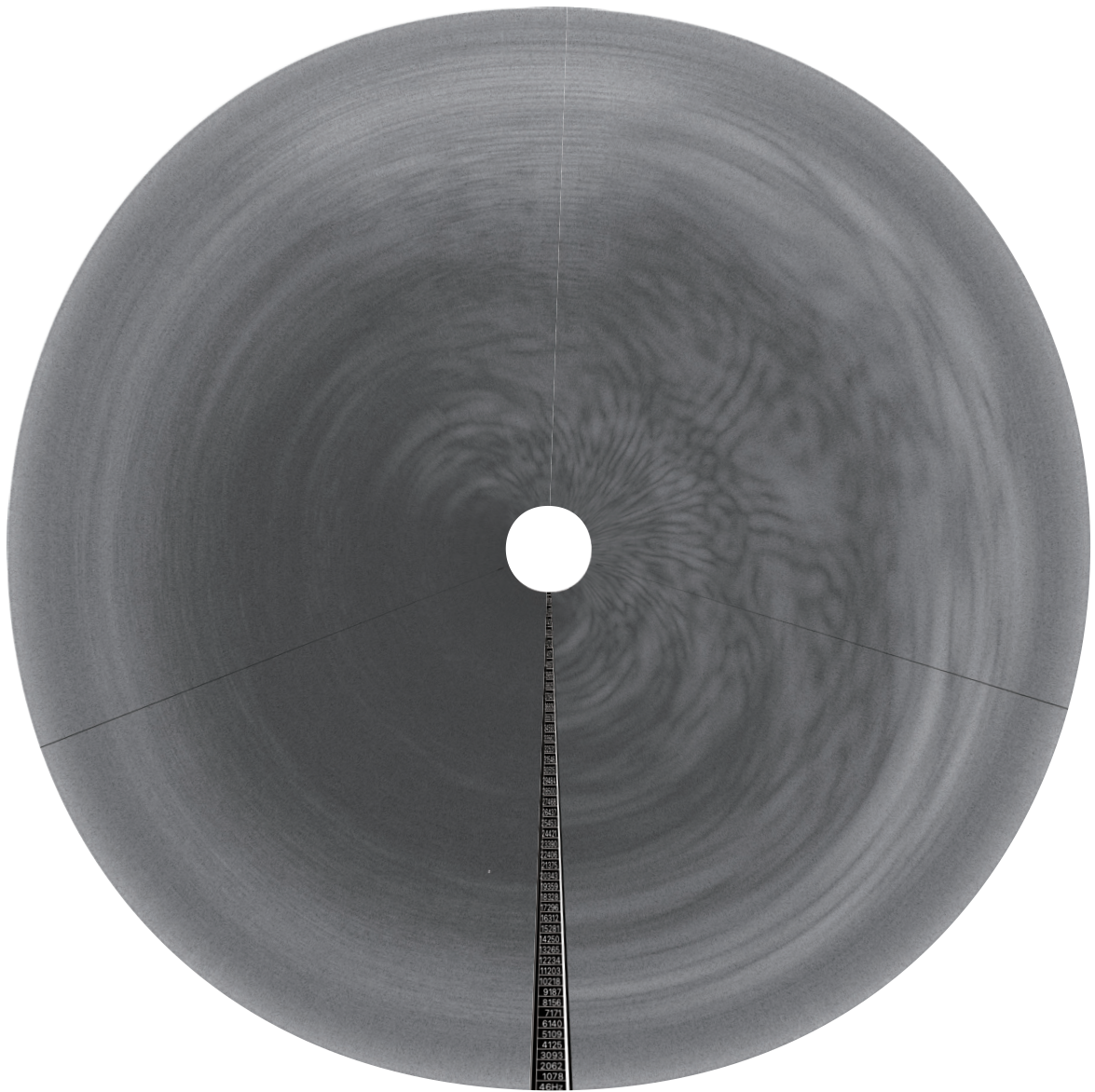
Smith, Julius O. *Spectral Audio Signal Processing*. W3K Publishing, 2011.  
<https://ccrma.stanford.edu/~jos/sasp/>

Smith, Steven W. *The Scientist and Engineer's Guide to Digital Signal Processing*. San Diego: California Technical Publishing, 1997.

Westervelt, P. J. "Parametric Acoustic Array." *The Journal of the Acoustical Society of America* 35 (1963): 535–537.

Yoneyama, M., J. Fujimoto, Y. Kawamo, and S. Sasabe. "The Audio Spotlight: An Application of Nonlinear Interaction of Sound Waves to a New Type of Loudspeaker Design." *The Journal of the Acoustical Society of America* 73 (1983): 1532–1536.

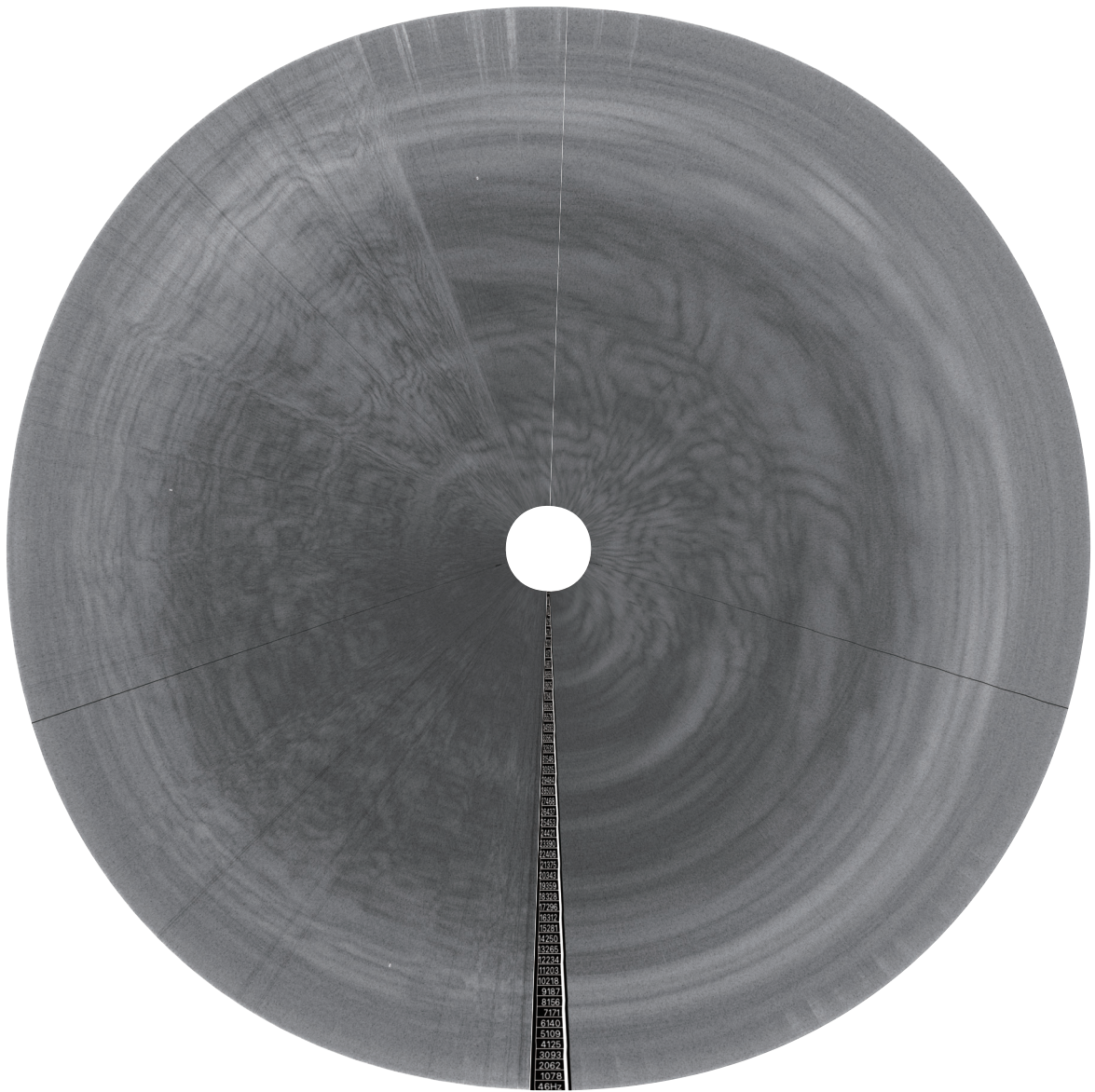
## Appendix I: Sectioned Boscioli



46.31237, 8.60816



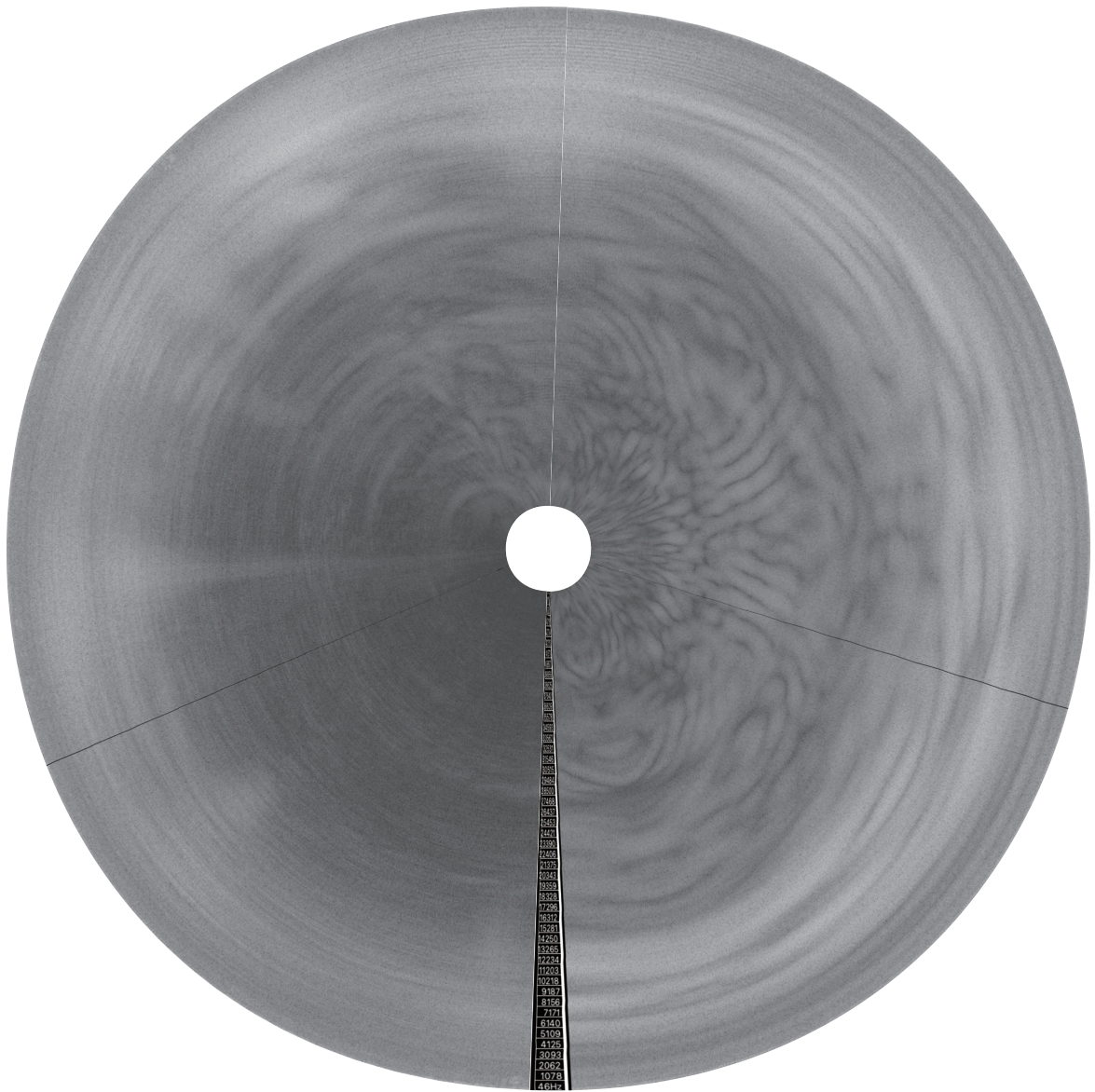








46.31297, 8.60858









## Appendix II: Installation View of the Artworks

### Work List

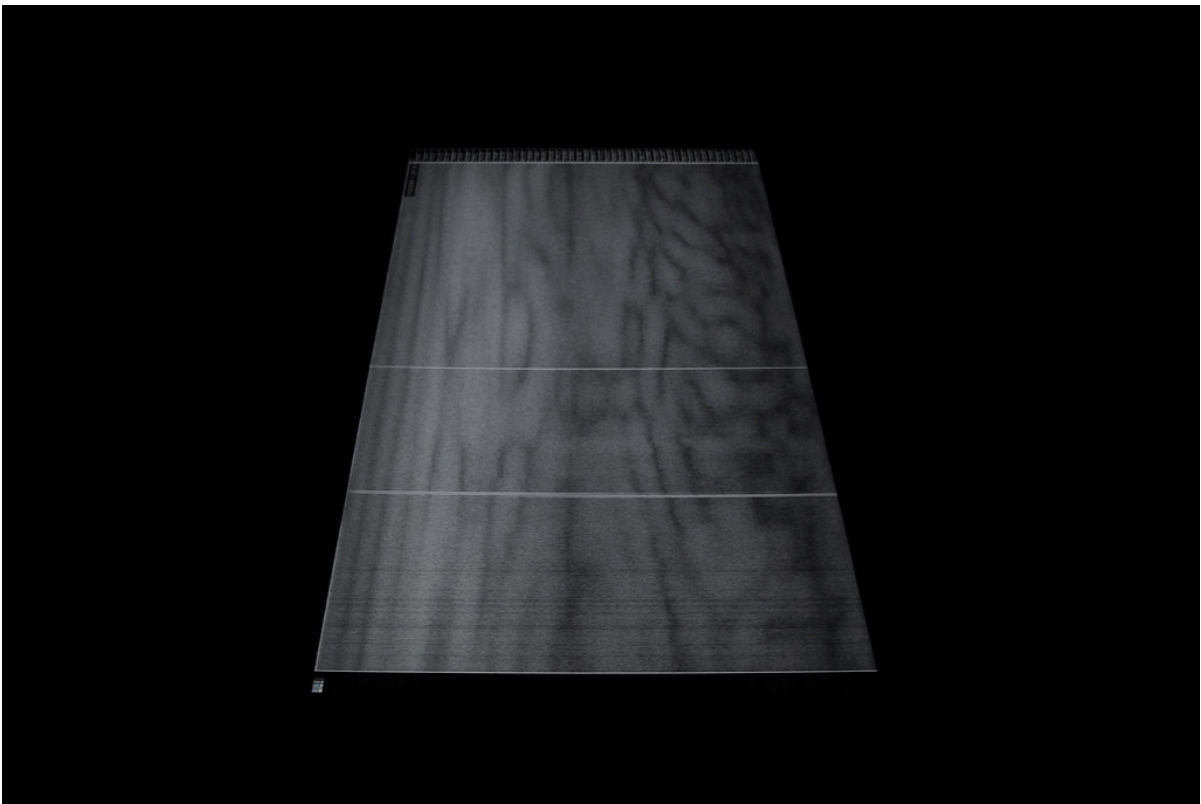
1. #00, Six Spectrograms displayed on monitor, 06'30", 2024-2026
2. #01, two-channel projection on the wall, 59'58", 2026
3. #02, thin metamorphic rock slices on the wooden platform, 50 x 50 x 0.1 cm (50 x 50 x 5cm), 2024-2026
4. #11, two sheets of vintage float glass (from Funkhaus Wien, A103 Kommunikation) with fabricated steel structures, 110x140x0.8 cm (glass); 116 x 115 x 145 cm (steel), 2026

Photo: all by Jiun-You OU



















**OU Jiun-You** is a Taiwanese artist and researcher, currently living and working in Vienna (AT). As an experienced lithic-based practitioner and a recent sound explorer, Ou's current research expands through material investigation, sonic–spatial methodologies, and mediational forms of working. She is particularly interested in how unconventional and even seemingly problematic working methods result in a personal or collective odyssey. Stone, space, and landscape operate as relational sites within her work, composing weighty objects, floating sound, and an atlas.

[oujiunyou.com](http://oujiunyou.com)

