

# Pulse Shape 22: Audiovisual Performance and Data Transmutation

Mark Cetilia

Mark Cetilia  
Brown University  
mark\_cetilia@brown.edu

See <[www.mitpressjournals.org/toc/leon/49/4](http://www.mitpressjournals.org/toc/leon/49/4)>  
for supplemental files associated with this issue.

## ABSTRACT

*Pulse Shape 22* is an improvisational audiovisual performance featuring shortwave radio transmissions as the sole source material for real-time audio processing alongside video of the sun projected through cast-glass lenses designed specifically for this piece. The structure of the piece is derived from metrics on energy accumulation over a period of 2.2 nanoseconds resulting from the targeting of 60 laser beams on a single tetrahedral hohlraum in weapons testing experiments as carried out by the Los Alamos Inertial Confinement Fusion unit, at the Omega Laser Facility at the University of Rochester. *Pulse Shape 22* is an exploration of architectural space through the use of site- and time-specific information found in regions of the electromagnetic spectrum outside the reaches of the human sensory apparatus. It is an attempt to alter the audience's perceptions of their surroundings and create a moment of rupture from hidden worlds found in our local environment.

## Experimental Data as Formal Structure

The formal structure for *Pulse Shape 22* is based on energy accumulation in tetrahedral hohlraum experiments undertaken at the University of Rochester's Omega Laser Facility. The OMEGA laser "stands 10 meters tall and is approximately 100 meters in length" and is used to "[deliver] pulses of laser energy to targets in order to measure the resulting nuclear and fluid dynamic events" [1].

A hohlraum is the closest physical approximation of an "ideal radiator" that "absorbs all incident radiation and reflects none" and is found in nuclear weapons and reactors [2]. In these experiments, the hohlraum is targeted by a number of laser beams simultaneously and, rather than simply absorbing all radiation without reflection, evenly redistributes the energy in all directions in the form of X-rays, triggering an implosion that starts a nuclear reaction [3].

In *Pulse Shape 22*, data derived from a burst of energy lasting 2.2 nanoseconds is stretched out to the length of a performance. This data is mapped to the rate at which a single frame of video held in a Frame Buffer Object is replaced within custom video processing software, and is used as a visual aid for the performer, who is able to follow the progressing accumulation of energy by watching a "playback head" advance. Higher values are taken to represent a greater sonic "intensity," produced through an increase in spectral density (especially at frequencies within the range of the human voice) and overall amplitude, as well as through the use of more chaotic and tumultuous transmissions as raw material for manipulation, and by decreasing the number of bits used to represent a given signal.

In addition to the energy accumulation data, *Pulse Shape 22* also utilizes pointing parameters for the laser beams to drive the spatialization engine throughout the piece. These pointing parameters are used to determine location in quadraphonic sound space for each of 12 possible buffer playback engines within the SuperCollider scripting language, which exchange positions 60 times throughout the duration of a performance. Thus, in a half-hour



performance, the position of each buffer playback engine in quadraphonic space shifts every 30 seconds with a cold, mechanical accuracy.

The piece begins almost imperceptibly, with gentle visual pulsations and a dull roar far in the distance. Stretched out nearly a trillion times the duration of the original experiment, *Pulse Shape 22* creeps into the consciousness of its audience, slowly filling every space with blinding light and full-frequency noise. When the implosion finally occurs, all that is left is a sharp ringing in the ears and blurred vision, fading into darkness—and silence.

#### **Data Transmutation**

While the foundation of *Pulse Shape 22* is data derived from scientific experiments, this work does not seek to reveal patterns in complex data, as in most data visualization/sonification projects. Instead, it is a phenomenological response to the data that situates the viewer/listener inside a *new* experiment. The data itself is transformed and mutated into an artistic work through a personal process that does not seek decoding or quantification.

#### **Electromagnetic Transmissions as Source Material**

Throughout the history of electronic music-making practice, numerous artists have worked with radio transmissions as source material for compositions and performances. John Cage mentioned “the sound of... static between the stations” as one of a number of potential sonic materials to “capture and control... not as sound effects but as musical instruments,” as far back as 1937 in “The Future of Music: Credo” [4]. Radio transmissions were equally important for writer William Burroughs, who would “leave ‘three off-tuned radios blaring static’ in his room in Tangier,” and carry out “experiments using tape recorders, many of which incorporated radio sound and static” from which “words would emerge” [5]. This act of listening to radio transmissions for voices hidden within the static dates back to the early days of radio. In 1920, Thomas Edison claimed that he had “been thinking for some time of a machine or apparatus” that would be “so delicate that if there are personalities in another existence or sphere who wish to get in touch with us in this existence or sphere, the apparatus will... give them a better opportunity to express themselves than... the other crude methods now purported to be the only means of communication” [6].

Mining recordings of radio static for voices of the dead is a technique commonly used within the Electronic Voice Phenomena (EVP) community. In 1960, Friedrich Jürgenson, namesake of the Jürgenson Frequency (1485.0 kHz), was instructed to “use the radio” as a means of communicating with the dead; he “connected a microphone and a radio receiver to the tape recorder” in order to have “real-time [conversations] with his ‘friends’” by asking questions and listening to responses on frequencies between 1445 and 1500 kHz [7].

Belief in EVP has become widespread since Jürgenson’s time, and with the advent of the internet, numerous groups and forums have appeared wherein users trade tips on how best to capture these recordings. Joe Banks, perhaps best known for his recordings of radio anomalies released under the moniker “Disinformation” (1995–present), has, in *Rorschach Audio*, framed EVP as sound recordings whose existence is “as relevant to the emergent field of sound art as studies of optical illusions have been to the study of visual art” [8].

Though I am not looking to communicate with the dead, the concerns of my artistic practice are somewhat analogous to the concerns of the EVP community. I not only carefully scrutinize the radio noise I use as raw sonic material in my performances, I also look for ways to make meaning from this material—both for myself and for my audience.

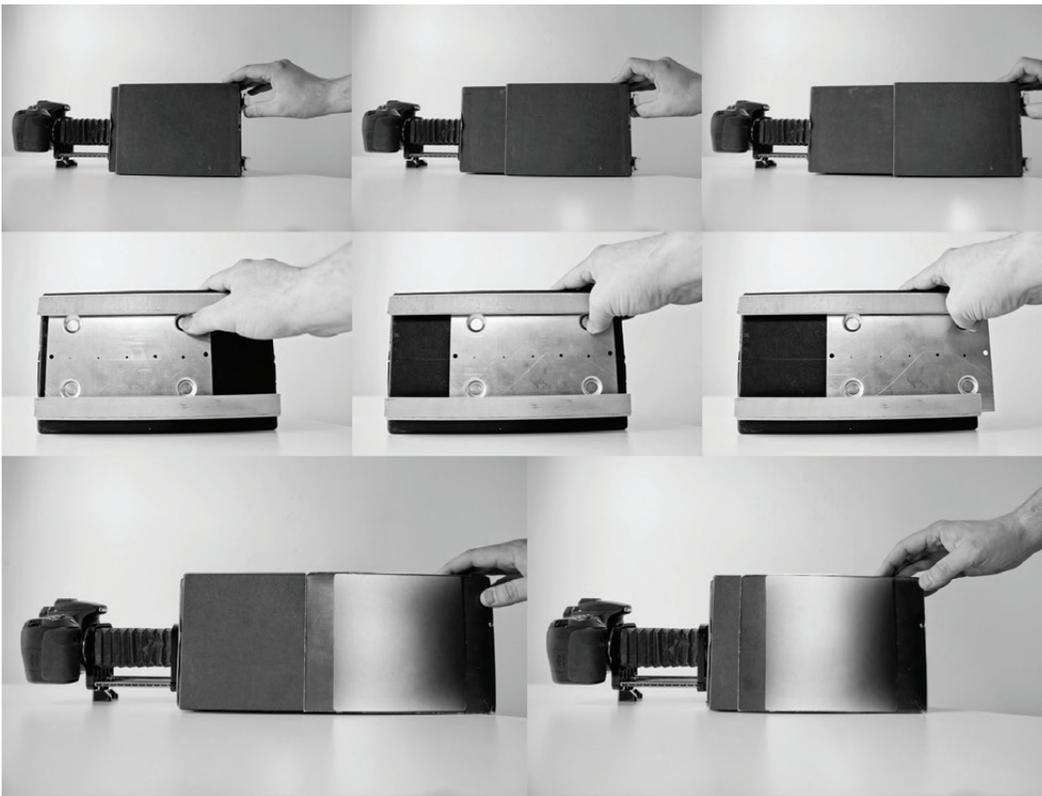


Figure 1. Demonstration of custom pinhole camera's focal length, aperture, and positive meniscus lens. (© 2012 Mark Cetilia)

This meaning-making is impacted by the very presence of radio transmissions in the performance space itself. John Cage once remarked to Morton Feldman that radio “[makes] available to your ears what was already in the air and available to your ears but you couldn’t hear it. ... [All] it is, is making audible something which you’re already in” [9]. *Pulse Shape 22* allows audience members to consider their relationship to their local environment: the raw sonic materials used in the performance are in fact transmutations of changes in the electromagnetic fields in which the audience is subsumed.

#### Visual Material and Historical Precedents

The visual material used in *Pulse Shape 22* is comprised entirely of images of the sun shot through a custom cast-glass lens designed for this purpose, via custom hardware used in conjunction with a Digital Single-Lens Reflex (DSLR) camera (Figure 1).

The hardware used to collect images for *Pulse Shape 22* is comprised of a pinhole camera with an adjustable aperture (a sliding metal plate with holes of different sizes), adjustable focal length (obtained by adjusting how far the lid of the box slides into its base), and support for multiple lenses, including a positive meniscus lens affixed to the outer shell of the box, and “external” lenses in the form of cast-glass blocks with various inclusions. This hardware is utilized in conjunction with a DSLR via a commercially available bellows attachment (Figure 2).

The sun was used as the sole source for visual material due to its linkages both to nuclear activity and its properties as a generator of electromagnetic energy received our bodies themselves (Figure 3).

Plants are already dialled into higher regions of the electromagnetic spectrum through photosynthesis. They are patched through a transductive mechanism called a light-

harvesting complex that takes sunlight and feeds it into a system of proteins and pigments that feeds the plant. We harvest plants and they harvest light. We feed on them feeding on light. The term “light-harvesting complex” cropped up in the 1930s when biophysicists were historically closer to agrarian culture than in the Cold War years of the 1950s, when the same mechanism began to be called a “light-harvesting antenna.” ...For the artist James Turrell, plants were not the only ones. “As human beings, we drink light in the form of vitamin D through the skin, so we are literally light eaters.” [10]

Though *Pulse Shape 22* uses projected imagery rather than fields of pure color, it is nonetheless an investigation into the physicality of light as medium and is closely tied to the history of the “flicker effect,” as demonstrated by Brion Gysin and Ian Sommerville’s *Dream Machine*, as well as in films by Tony Conrad, Peter Kubelka, and others.

The *Dream Machine* is “a simple flicker machine” consisting of “a slotted cardboard cylinder which turns on a gramophone at 78 rpm with a light bulb inside” [11]. Users of the *Dream Machine* face the flickering light with their eyes closed, so that kaleidoscopic patterns of color will wash over them at the same rhythm as alpha waves, electrical waves that occur in the brain during periods of deep relaxation.

Tony Conrad’s *The Flicker* (1965) is a 30-minute film comprised solely of alternating bits of white and black film leader. Over the course of the piece, the alternation of these frames “progresses from twenty-four frames per second down to four then back up to twenty-four” [12].

In conjunction with the “crescendo/ diminuendo” structure of the stroboscopic light, *The Flicker* features a “tonal pitch in the ‘lower ranges of audibility’ and rapid rhythms” meant to “[give] unexpected birth to a sense of aural vastness and spaciousness” analogous to the “harmonic structures of light” [13]. The same year, John Cavanaugh created a work known alternately as *Flicker* or *Blink* [14]. The intent of Cavanaugh’s film was to assault the viewer’s eye to the point of fatigue, creating “temporary blindness characterized by slowly moving, pulsating colorless blobs that hover over the continuous flash of the film” [15].

In addition to Conrad and Cavanaugh, a number of filmmakers—notably Peter Kubelka and Paul Sharits—incorporated this effect into their work around this time (Kubelka’s *Arnulf Rainer*, widely considered the first “flicker film,” actually dates back to 1960). The flicker effect is listed as one of the four characteristics of “structural film,” as defined by P. Adams Sitney:

The structural film insists on its shape, and what content it has is minimal and subsidiary to the outline. Four characteristics of the structural film are a fixed camera position (fixed

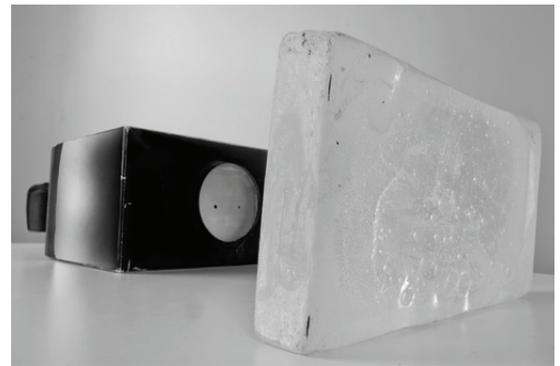


Figure 2. Custom pinhole camera positioned to shoot through an “external” lens. (© 2012 Mark Cetilia)



Figure 3. Video still from a *Pulse Shape 22* performance, 2012. (© 2012 Mark Cetilia)

*frame* from the viewer’s perspective), the flicker effect, loop printing (the immediate repetition of shots, exactly and without variation), and rephotography off of a screen. [16]

Though Sitney quickly qualifies this definition by stating that one will seldom find “all four characteristics in a single film, and there are structural films that avoid these usual elements” [17], this definition nonetheless created a conceptual framework for understanding a new type of filmmaking: one concerned primarily with the structure of a film, rather than plot, character development, or any of the characteristic qualities typically associated with film.

*Pulse Shape 22* follows in the tradition of this filmmaking practice, and despite the fact that the images change throughout the piece, the visual aspect of the piece is primarily propelled by the intensity of the light and the pacing of the strobe, which in turn acts as a means of relating the underlying data structure to the audience.

The flicker effect is, in fact, an essential element common to all motion pictures, and was even employed in many pre-cinematic devices such as the zoetrope. Filmmaker Ken Jacobs’s work, including his “Nervous System” (1975–2000) [18] and “Nervous Magic Lantern” (1990–present) [19], has employed overtly stroboscopic projections for decades. Jacobs calls these performances “paracinematic” [20], a term he coined in the 1970s to allow for discussion of works “equivalent [to] cinema... created by other than filmic means or by using film in other than standard ways” [21]. His influence may still be felt throughout this burgeoning field today, in the work of artists such as Sandra Gibson and Luis Recoder, Bruce McClure, and Alex MacKenzie, whose performances feature stroboscopic light and various forms of physical intervention with the projection apparatus by the artists themselves. The “Nervous Magic Lantern” performances were also incredibly influential in the development of the visual element of *Pulse Shape 22*: they led me to consider the utilization of “gentle” strobing during the opening and closing sequences, which slowly ramp up and down in luminosity, as well as strategies for projection extending beyond the confines of a traditional projection screen. I ultimately accomplished this through the use of “water lenses”—glass vessels filled with water, placed in front of a projector.

### **Sinesthesia**

It is important to note that *Pulse Shape 22* is not built on a foundation of sound-to-image data transmutation, but instead finds both sound and image driven from a common source of data. This allows the sonic and visual elements to function within their own native languages.

Contemporary discourse regarding audiovisual works often includes discussion of *synaesthesia*, a neurological condition in which “regions of the brain which do not usually communicate, such as the visual and auditory cortexes, show signs of what is known as ‘crosstalk’” [22]. While a handful of composers—notably Scriabin, Messiaen, and Ligeti—were truly “synaesthetic” [23], most artists (and their audiences) do not experience the world in this manner, and simply mapping sound to vision does not take into account the complexities of visual language. Christoph Cox summed up the problem with such mappings in 2005:

Sound is real... something too quickly forgotten by the fantasy of a “union of the senses,” which remains a visual fantasy. Genuine sound art today is fostered not by... consensus, but by a dis-sensus that gives sound and hearing their due. [24]

The necessity of working with media in ways that take into account the intricacies of sonic and visual languages has long been understood by experimental (or “structural”) filmmakers such as Paul Sharits, who, in 1978, said:

I do not wish to suggest that I was or am captivated by the notion of “synesthesia”... I am not proposing that there exist any direct correspondences between, say, a specific color and a specific sound, but that operational analogues can be constructed between ways of seeing and ways of hearing (and sometimes, when such structural analogues are composed, one can thereby experience those levels of ultimate difference between the two systems)... Can there exist a visual analogy of that quality found in a complex aural tone, the mixture of a fundamental tone with its overtones?... But how can one film frame of one solid color possess such a quality? It cannot. Yet, a series of single frames of different colors, which creates “flicker,” can, depending upon the order and frequency of the tones, suggest such a quality; but, it can only *suggest*. [25]

In works such as *Ray Gun Virus* (1966), Sharits explored the use of stroboscopic color fields in a way that *suggests* simultaneity, which he purports to be a visual analogue to the use of complex overtones in a piece of music. In this process, Sharits breaks down sonic and visual elements to their essential components, then recombines them, but he does not expect the viewer/listener to perceive these newly combined elements as a single “linked” synaesthetic experience—rather, he states that this pairing may in fact be used to reveal the differences between these modes of perception.

In a recent interview, contemporary sound and visual artist Steve Roden (born 1964, active 1985–present) discusses his strategy for considering sonic and visual elements of audiovisual works separately:

I’m very firm about something until I kind of “know” it and then I contradict myself to open new territory. And so, I decided to try something where a sound and visual work could converse in a single space. What I like about this situation... is that it is a somewhat unresolved relationship. Rather than each enhancing each other,... the two things tend to pull apart from each other.... I can explore my ideas in various languages without worrying about how much they relate on the surface—I’m striving for connections that are much deeper. [26]

*Pulse Shape 22* is the result of such a separation of thought and labor. My initial investigations into this piece were solely concerned with its sonic component and the development of the necessary tools and technologies for this performance. Throughout this developmental phase, I spent time learning how to play the instrument I was creating; this allowed for a degree of flexibility in designing the performance system, ultimately arriving at a design that was best suited to the needs of the piece and my desires as a performer. Upon completion of this phase, I put together a sound-only performance of the piece, before ever considering the visual component—and when I began work on the visual component of the piece, I set aside the sound entirely. I feel that this process was incredibly important for the success of the piece, as it allowed me to focus on the data transmutations that would be most appropriate for its sound and visual elements.

#### **Observations and Future Directions**

I am interested in continuing the evolution of my working process to include the development of systems for data transmutation that do not always need to provide answers to the audience, or demonstrate features of the data itself. By defining and refining ways to draw inspiration from primary sources without constantly seeking justification of my artistic intent or disallowing self-questioning, I hope to engage more deeply with source material and learn directly through the process of artistic production.

## Acknowledgments

Thanks to Joseph Rován, Todd Winkler, Shawn Greenlee, Ed Osborn, and Jocelyne Prince for their feedback and encouragement. This work is dedicated, as ever, to Laura Cetilia.

## References and Notes

1. OMEGA, <[http://www.lle.rochester.edu/omega\\_facility/omega/](http://www.lle.rochester.edu/omega_facility/omega/)>, accessed March 2016.
2. S.P. Parker, ed., *McGraw-Hill Dictionary of Physics*, 2nd ed. (New York: McGraw-Hill, 1997), 42.
3. Los Alamos National Laboratory, *Tetrahedral Hohlraum High-Convergence Implosion Experiments on Omega ID4-FY98* (Los Alamos, NM: Los Alamos National Laboratory, 1998), 2.
4. J. Cage, *Silence* (Hanover, NH: Wesleyan University Press, 1961), 3.
5. D. Kahn, "Three Receivers," *Experimental Sound and Radio*, ed. Allen S. Weiss (Cambridge, MA: MIT Press, 2001), 73.
6. T. Edison, "Edison's Views on Life and Death," *Scientific American*, 446 (October 1920).
7. C.M. von Hauswolff, "1485.0 kHz," *Cabinet Magazine*, Issue 1, 60 (Winter 2000/01).
8. J. Banks, "Rorschach Audio: Ghost Voices and Perceptual Creativity," *Leonardo Music Journal* Volume 11, 77 (2001).
9. J. Cage, and M. Feldman, *Radio Happenings: Conversations / Gespräche* (Cologne: MusikTexte, 1993), 19.
10. D. Kahn, "Electrical Atmospheres," *Invisible Fields: Geographies of Radio Waves*, eds. José Luis de Vicente, Honor Harger, and Josep Perelló (Barcelona: Arts Santa Mònica, 2012), 26.
11. B. Gysin, "Dreamachine," *Flickers of the Dreamachine*, ed. Paul Cecil (Hove, UK: Codex, 1996), 5.
12. A. Powell, *Deleuze, Altered States and Film* (Edinburgh: Edinburgh University Press, 2007), 107.
13. *Ibid.*
14. Cavanaugh later withdrew all of his films from the Anthology Film Archives "at a time in his life when, due to extreme LSD experiences, he sank into a period of insanity during which he was institutionalized for several years," cf. *Fluxfilm Anthology*, <[http://home.utah.edu/~klm6/3905/ff5\\_Blink.html](http://home.utah.edu/~klm6/3905/ff5_Blink.html)>, accessed March 2016.
15. H. Higgins, *Fluxus Experience* (Berkeley: University of California Press, 2002), 17.
16. P. Adams Sitney, "Structural Film," *Film Culture Reader*, ed. P. Adams Sitney (New York: Cooper Square Press, 2000), 327.
17. *Ibid.*
18. W. Rose, "Annotated Filmography and Performance History," *Optic Antics: The Cinema of Ken Jacobs*, eds. M. Pierson, D. E. James, and P. Arthur (New York: Oxford University Press, 2011), 270.
19. *Ibid.*, 272.
20. J. Walley, "The Material of Film and the Idea of Cinema: Contrasting Practices in Sixties and Seventies Avant-Garde Film," *October* Volume 103, 17 (Winter 2003).
21. M. Pierson, "Introduction: Ken Jacobs—A Half-Century of Cinema," *Optic Antics: The Cinema of Ken Jacobs*, eds. M. Pierson, D. E. James, and P. Arthur (New York: Oxford University Press, 2011), 16.
22. C. van Campen, *The Hidden Sense: Synaesthesia in Art and Science* (Cambridge, MA: MIT Press, 2008), 45.
23. *Ibid.*, 20–23, 50–53.
24. C. Cox, "Lost in Translation: Sound in the Discourse of Synaesthesia," *ArtForum*, 241 (October 2005).
25. P. Sharits, "Hearing: Seeing," *The Avant-Garde Film: A Reader of Theory and Criticism*, ed. P. Adams Sitney (New York: Anthology Film Archives, 1978), 256–7.
26. Y. Novak, "Interview with Steve Roden," <<http://www.tokafi.com/15questions/interview-steve-roden/>>, accessed March 2016.