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Beyond the Symphony or Museum Experience: The Design of the Tippet Rise Art Center, Montana

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ABSTRACT

Western classical music and arts are traditionally experienced in the concert halls and museums of cosmopolitan areas, or during festivals. New trends are emerging however, with diverse audiences being drawn to installations or concerts taking place in unusual or alternative environments including found spaces, "pop-up" venues, or curated "destinations". In this vein, the Tippet Rise Art Center, located in the foothills of Montana's Beartooth Mountains, and recognized today as a new destination for art and music in America, juxtaposes music, architecture and large-scale sculptures with dramatic natural landscapes. The paper describes the planning and design process of the art center and how it was conceived, at the outset, from sound principles, to create a diverse palette of indoor and outdoor environments for art and music, including a new music barn, an outdoor concert shell, large-scale outdoor concrete sculptures and a natural amphitheater. The paper presents acoustical measurements conducted in the finished projects. The authors contrast the results with traditional acoustic metrics, highlighting the relevance of context and multisensory performance set-ups on audience engagement, and proposes, as conclusions, new models for considerations in the planning of new arts and culture facilities.

Keywords: Recital Hall, Outdoor Music, Acoustic Shell

1. INTRODUCTION

The Tippet Rise Art Center is a 4,900-hectare property located in Southern Montana, dedicated to the exhibition of large-scale sculptures and the performance of classical music events. Located 170 km North of Yellowstone Park, it sits in a bucolic rural grassland area used for farming, ranching, and outdoor vacationing, bordered by the cities of Billings (105 km), Bozeman (205 km) and Red Lodge (90 km). The nearest town of Fishtail counts 478 habitants.

The property operates as a fully functioning ranch with grazing sheep and cattle to promote healthy grounds and lush vegetation, while fostering natural habitats, plants and trees. Wild animals often spotted on the property include elk herds, deer, coyotes, rapacious birds, and bears and wolves on rare occasions.

The art center's mission is to juxtapose and engage dialogues between art, music and the vast natural landscapes of the American West. Sculptures from world-renowned artists, their placement on the land, and performances from leading composers and musicians are curated to create space for meditation, thinking and relaxation, away from the conditions of urban life and generate transformative connections between music, art and nature.

Large scale sculptures, concert halls, exhibition spaces, habitations, parking, and infrastructure are concealed within the multiple canyons and rolling hills of the site, with elevation ranging from 1,350 to 2,000 meters. Coupled with exemplary music program of world-renowned performers, spanning acoustic music repertoire from the classic to the contemporary, the center won the 2016 Leading Cultural Destination Award and was named as "One the 100th World's Greatest Places to Visit in 2018" by Time Magazine.

2. PLANNING AND DESIGN PROCESS

The vision for the Tippet Rise Art Center was developed over multiple decades of travels, passion for the outdoors, concert experiences, artistic projects and philanthropic endeavors by the founders Cathy and Peter Halstead. Arup was commissioned to provide multi-disciplinary services to masterplan the site and develop designs for indoor and outdoor concert venues, following initial benchmarks by the founders, which included the Snape Maltings Concert Hall, home of the Aldeburgh Festival in England, completed in 1968 by Arup Associates for Benjamin Britten (1), and Storm King Art Center in New York.

The land, composed almost exclusively of un-touched grassland, required all new infrastructure, roads and constructions to be built from scratch. Sustainable approaches to planning, design and future operation was fundamentally integral to the project from the outset.

Whilst the land is very large, the ambitions for the project were more about the quality of the experience than the size of the facilities. Design goals included a desire for connectivity and proximity with the artworks and musicians, stirring and rich acoustics, and connections with the natural wild.

Before architecture was discussed, the team worked to define a set of desirable indoor and outdoor acoustical spaces for music, with their sizes and geometries, which then served to define the complete space list requirements, the locations of buildings, how to supply power and water, and create the necessary infrastructure and access.

Performance space designs were progressed over 2 years and included visits to existing spaces, auralizations in the ArupSoundLab and the development of design prototypes, as documented by the authors in (2, 3, 4). The work led to several venue spaces and a palette of contrasting acoustical experiences, which included:

- The 150-seat recital hall *Olivier* Music Barn, conceived as an intimate space, with the goal that every audience member would feel connected to each other and to the musicians, with a powerful and immersive acoustics, and in a controlled environment (protected from weather)
- The 100-seat outdoor acoustical shell *Tiara*, conceived as a sound-reflecting structure that surrounds both the audience and the performers, while maintaining views to the surrounding landscape; a structure also used in conjunction with the *Olivier* Music Barn
- The 900-seat concert hall *Glacier* (un-built), conceived as a raw and large acoustical space with a long natural reverberation and equipped with a reconfigurable interior acoustical shell, for natural or amplified music
- A large outdoor amphitheater, which uses the natural contours and formation of the site, of similar scale and geometry as Epidaurus in Greece.

To preserve the purity of the natural wild and free-up the land for artwork, building facilities were placed on the periphery of the site. Newly commissioned or acquired sculptures were placed away from each other so that each piece could engage and entertain its own dialogue with nature, un-obstructed from other artwork or building structures, with mile-long visibility onto four surrounding mountain ranges. Newly commissioned sculptures included the three *Structures of Landscape* by Ensamble Studio. These pieces were curated to develop a narrative for the exploration of the land, serve as markers in the vast landscape, and to possess some natural acoustic qualities so they could also be used for occasional music performances.

The building facilities were then conceived to blend in with the environment and the local ranching community, using a familiar rustic architecture and vernacular from the region, and were made by local timber framers Gunnstock Timber Frames, located in Wyoming.

The authors worked closely with the founders to lead the envisioning, planning, design, and construction, with a total contiguous project duration of four years opening in 2016. New constructions included 25 kilometers of new roads, 3-phase and fiber connections, LEED-Gold certified infrastructure (rain collection systems, photovoltaic power, geothermal heat and cooling, drain fields), six residential buildings, two music venues, and nine large scale sculptures.

Figure 1 – *Olivier* Music Barn ©1

Figure 2 – *Tiara* Acoustical Shell ©2

Figure 3 – *Domo, Structures of Landscape* ©2

Figure 4 – *Domo, Structures of Landscape* ©2

3. THE OLIVIER MUSIC BARN

3.1 Design

Arup successfully used a pitched wooden ceiling at Snape Maltings Concert Hall, and has since utilized it in the design of a number of performance spaces including Sevenoaks School (Kent, UK), Emmanuel College (Cambridge, UK), and Colyer Gerguson Music Building (Cantebury, UK), among others. The room design of the recital hall at Tippet Rise developed by listening to these benchmarks, in the Arup SoundLab, (as well as visits in some halls in persons), and with music rooms of different sizes, such as the Wigmore Hall and the Music Room at the Schloß Esterházy (Fertöd, Hungary). The project owners favored the acoustics of smaller rooms such as the Esterházy space for its spaciousness and loudness qualities. Instead of constructing a larger hall with varying acoustical qualities over the audience area, it was decided to build a smaller one with concentrated acoustical attributes.

During the listening tests a proprietary real-time auralization interface was used to listen to created acoustical signatures by setting up in 3D 20 early reflections with control over their timing, incidence, intensity, and spectrum, and controlling the reverberation times of the diffuse sound field(s), (the diffuse sound field is divided into different segments of spaces to simulate late reverberation effects from coupled chambers). The tests allowed the team to identify an ideal acoustical signature which was then used to create the shape and geometries of the performance spaces (this technique was also applied to *Glacier*, the larger hall). The design quickly converged towards a smaller rectangular room, with a pitched ceiling. The final design of the room emerged after listening tests and optimization algorithms applied to 42 variations of the ceiling shape to match the desired acoustical effect, Figure 5 and 6.

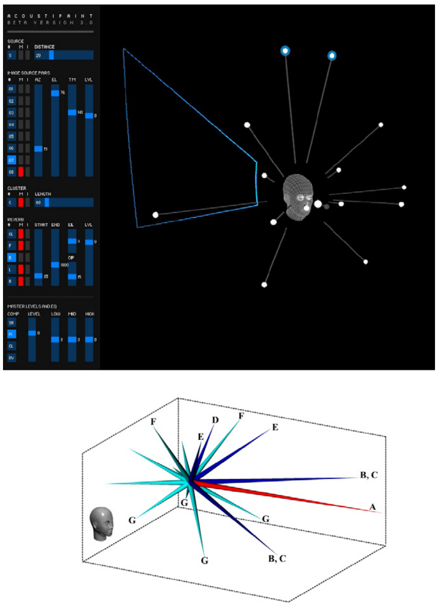

Figure 5: Real-time auralization interface and target acoustical signature deduced from the listening tests

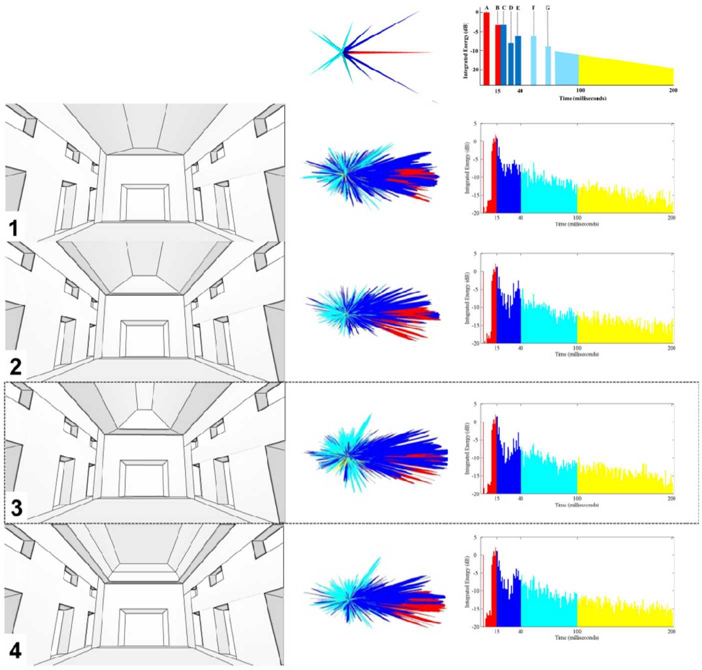

Figure 6: Target acoustic signature on top, samples of the ceiling design variations, along with computer simulation of their acoustical response (Catt-Acoustic)

3.2 Measurements

Acoustical measurements were conducted in the facility in June 2019, using the SoundField ST450 microphone, Sound Devices 788T digital hard-drive recorder, Brüel & Kjaer 2250 sound level meter with Type 4189 microphone, Brüel & Kjaer dodecahedron loudspeaker and QSC subwoofer. Theatrical drapes were used in the *Olivier* Music Barn to cover the seats to simulate the effect of an audience.

Acoustic parameters are summarized in Table 1 with comparisons to the project benchmarks. The reverberation time is similar than other chamber music rooms such as the Wigmore Hall, and the Esterházy Music Room. Both the loudness and clarity indexes are greater than Snape and Wigmore, outlining the desire for a louder and clearer acoustics than larger halls. Index of spaciousness is high across all seats, but lower on average than Snape, which could be due to the greater on-axis contribution from the rear wall at Tippet, compared to larger halls, where the on-axis rear wall reflection would be more attenuated due to distance and to the seat dip effect.

The authors also present the FR (Front-Rear lateral ratio) and LH (Low-High lateral ratio) spaciousness parameters (5), which provide an indication of how the lateral sound responsible for the impression of envelopment is distributed in space, (when FR equals 1, the lateral energy is equally distributed between the front and rear; when LH equals 1, the lateral energy is equally distributed between the bottom and top). Values of FR in Table 1 indicate that the Tippet recital hall has greater sense of envelopment coming from the rear than Wigmore and Snape, because the room is shorter and rectangular, creating stronger rear corner reflections. Similar than Esterháza, values of FR and LH show that the lateral energy is evenly distributed between the front, rear, bottom and top, indicating a highly immersive space and which match the desired effect deduced from the listening tests conducted during the design phase. The 3D impulse responses in Figure 12 clearly show the 3-dimensional distribution of sound reflections, reminiscent of the Esterházy Room (5).

Figure 11 shows how the envelopment indexes at Tippet fit between Snape and Esterháza and remain concentrated in the same region, unlike in Snape or a longer hall where seats at the front would experience a more frontal sense of envelopment, while most seats at Tippet get an even sense of envelopment (envelopment in Wigmore is mostly frontal and lifted, due to its famous vaulted ceiling).

Reactions from audience members and musicians after the opening confirmed those results, with an overall impression of feeling as being “inside the music”, and “floating sound”.

The main surface supporting low-frequency sound is the thick concrete floor. The walls are constructed with structural insulated panels (SIP), reinforced with bonded gypcrete and plywood, and finished with tongue and grove larch timber. The all-wood smooth finishes create a slightly bright reverberation as seen in Figure 8 at 2,000Hz. A bass index of +3dB (G_{125}-G_{mid}) is measured in the space, fitting within the preferred range for concert halls according to (6), creating a warm sound. The room is also equipped with portable rolls of 6mm thick felt which can be hung along the walls to reduce loudness.

The room uses lightweight “director’s chairs” made of timber legs and arm rests, and cloth for the seat back and seat bottom, chosen to lessen the impact of the chairs on acoustics, similar to the wood and woven straw chairs used at Snape, Figure 7. Measurements conducted in the empty room, then with chairs in place, provide an estimation of the chair’s acoustic absorption, Figure 9. Audio recording engineers also tend to use the chairs and to hang felt on the walls to adjust the spectral balance of the hall during recording sessions.

Figure 7 – Left: Chairs at Snape Concert Hall, Right: “Director’s Chairs” at the *Olivier* Music Barn

The recital hall is almost a single room building with fewer buffer zones or structural layers protecting against exterior noises than typical concert halls. The Doors, walls and the roof did not have to be strengthened or made heavier because the natural ambient noise on site is very low, 19dB LAeq, which approaches the noise floor of the sound level meter used for the measurements. The site is far from human transportation systems, and the relative silence experienced on site is one of the main characteristics of the art center, supporting the artwork experience, and conveying an excellent clarity for outdoor musical sounds, or natural sound of birds and animals.

During thunder, rain or hail events, some noise filters inside the concert hall which contributes to the overall mission of the art center to mix music with nature, Figure 10. The Hall is also often used for high-end recordings, which tend to occur during the winter season, when rain events are less frequent. The art center produces its own music recordings and videos, with contributions to Medivi.tv, helping to broadcast its music program internationally to a larger audience. The Music Barn is equipped with a 9.1 and ambisonic recording studio operating at 384kHz / 32BIT, and with a multi-channel audio reproduction system in the performance space for film, and surround sound installation.

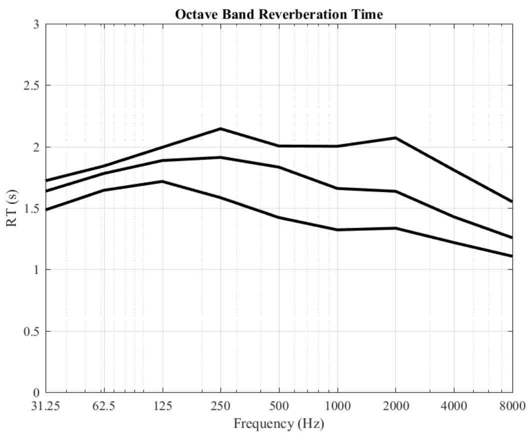

Figure 8 – Reverberation times: no chairs(top), empty chairs (middle), occupied chairs (bottom)

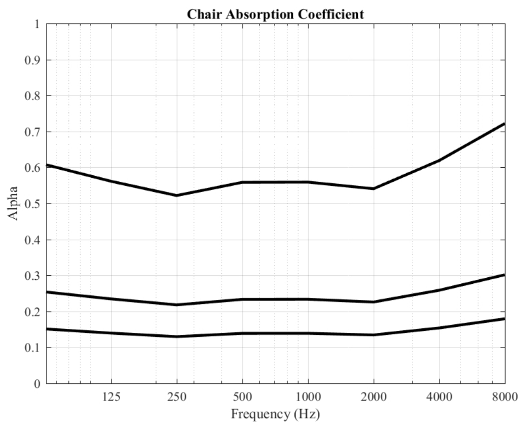

Figure 9 – Occupied chairs (top), chairs only (middle), residual (bottom)

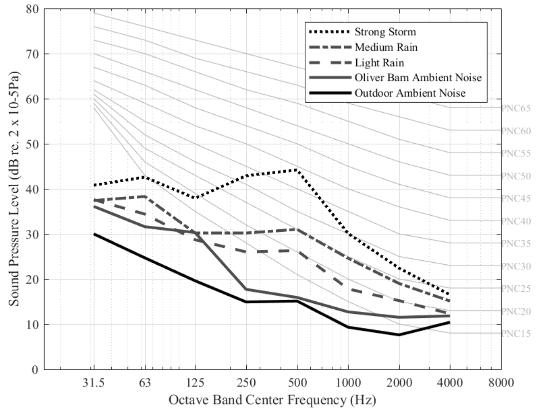

Figure 10 – Noise level measurements (LA90)

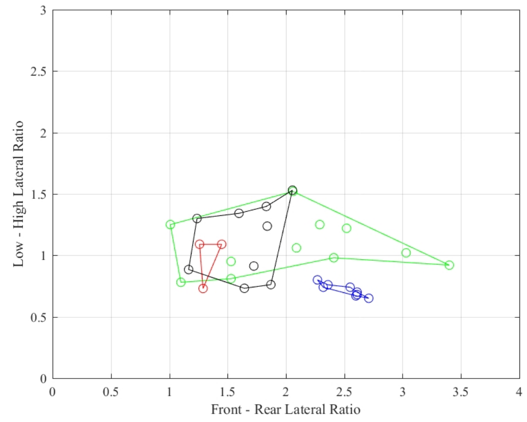

Figure 11 – Lateral energy ratios, Snape (green), Wigmore (blue), Esterháza (red), Tippet (black)

Table 1 – Summary of the acoustical parameters in the *Olivier* Music Barn (500-1,000-2,000Hz averages). † IACC values were calculated after B-format to binaural conversion.

	Oliver Music Barn Stage $_{S1}$	*Schloß Esterházy*[1] *Music Room*	*Wigmore Hall*[1]	*Snape Maltings Concert Hall*[1]
RT_{empty}	2.00s			
$RT_{unoccupied}$	1.71s	*2.5s*		
$RT_{occupied}$	1.40s	*1.2mid – 2.3low*[2]	*1.40s*	*1.80s*
G_{mid_empty}	13.0dB			
$G_{mid\_unoccupied}$	12.1dB			
$G_{mid\_occupied}$	9.8dB	*11.0dB*	*8.5dB*	*6.0dB*
$BI_{occupied}$	2.9dB			
$D50_{occupied}$	40.0% ±9%			
$C80_{occupied}$	1.1dB ±1.2dB	*-1.0dB*	*0.0dB*	*-1.0dB*
$ST1_{early\_occupied}$	-6.5dB			
$ST1_{late\_occupied}$	-8.6dB			
$1\text{-}IACC^{\dagger}_{early}$	0.64 ±0.05	*0.60*	*0.65*	*0.70*
$1\text{-}IACC_{late}$	0.62 ±0.03			
$FR_{occupied}$	1.6 ±0.3	*1.3*	*2.5*	*2.1*
$LH_{occupied}$	1.0 ±0.3	*1.0*	*0.7*	*1.1*

[1]Acoustic measurements conducted by the Authors as part of the Constellation Center acoustic survey in 2005
[2]According to Jürgen Meyer (7)

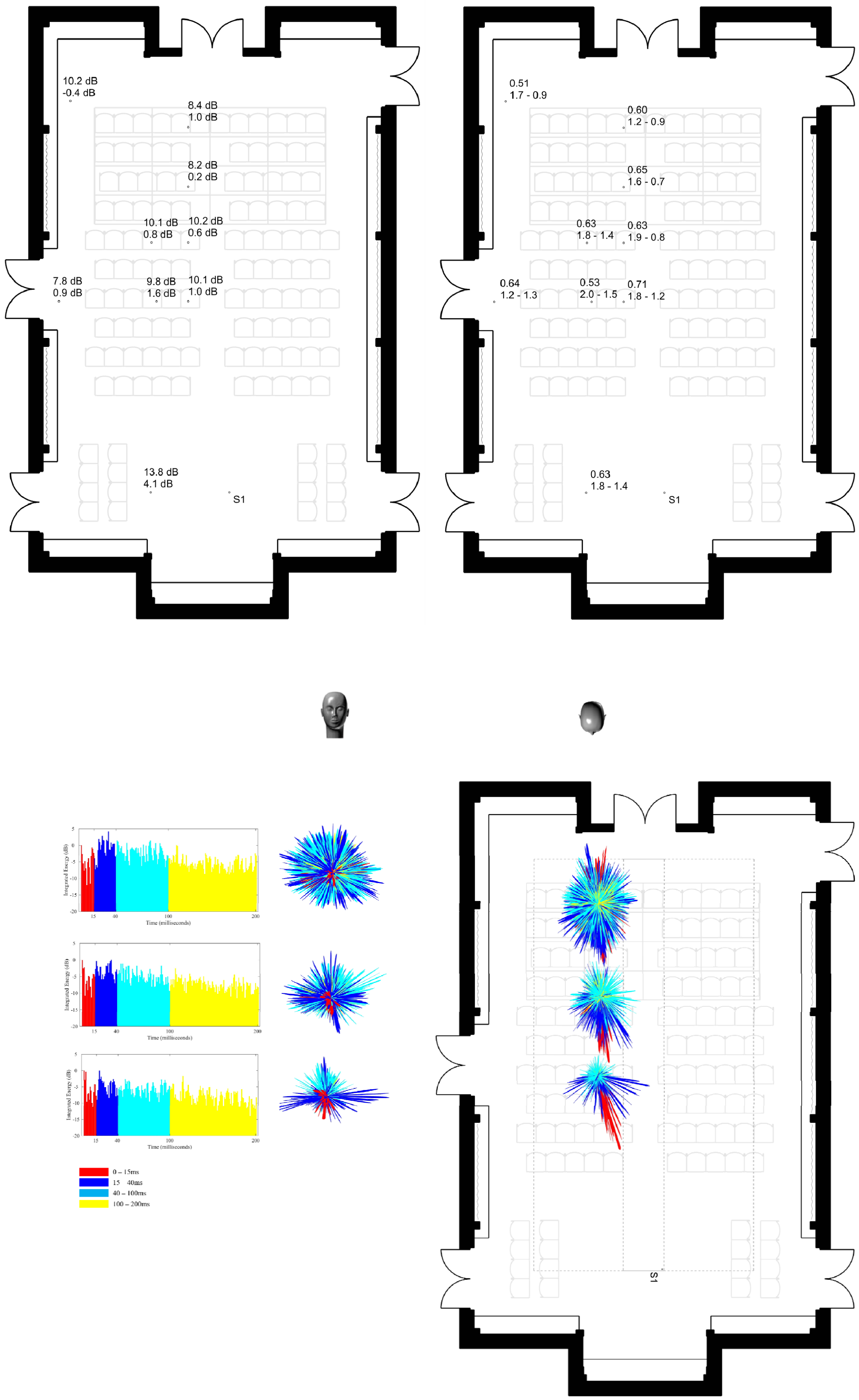

Figure 12 – Top Left: Measured G and C80 parameters under occupied conditions; Top Right: Measured ASW and FR – LH parameters under occupied conditions; Bottom: Measured 3D impulse responses

4. THE TIARA ACOUSTICAL SHELL

4.1 Design

While most acoustic shells use walls around an orchestra to project sound, we created a shell for Tippet where upper walls and perimeter ceiling supported from timber posts, create “corners” that surround both the audience and the performers. Like the skeleton of a room but without a central overhead roof, or lower walls, the shell opens the views to the surrounding landscape while listening to a music performance, matching with the mission of the art center. The corners act as cue-ball reflectors, concentrating sound energy towards the audience and the performers, augmenting the impression of loudness, clarity and intimacy. Without a canopy or a rear stage wall which tend to reinforce the front axial sound energy, most of the sound reflections are lateral, and therefore participate to a greater sense of envelopment. The shape is a simplified version of the Music Barn design, only keeping its upper corners, to continue the envelopment quality of the Barn in but an outdoor environment.

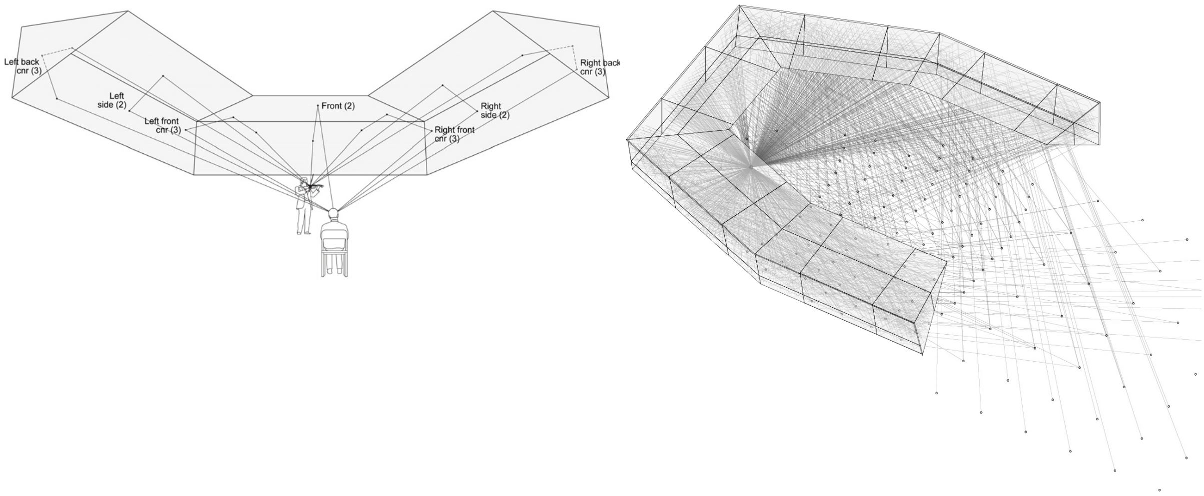

Figure 13 – Left: Angles used for sound coverage optimization, Right: Sound coverage after optimization of reflection angles

Optimization algorithms in Grasshopper were applied to increase the sound coverage of the shell’s corners for every seat inside the area of coverage, as documented in (3). The elongated shape of the shell also contributes to extend the area of coverage beyond the structure using sound focusing, compensating in part for distance attenuation, and extending the audience area at the rear onto a natural hill.

4.2 Measurements

Validation measurements were conducted and documented in (3). We add here ambisonic measurements and measurements of sound coverage area. These were conducted by holding a sound level meter microphone while walking at a regular speed and measuring pink noise levels from a dodecahedron loudspeaker along 6 lines, running from stage right to stage left, over a 35-meter long by 15-meter wide area. Results were then interpolated in MATLAB for area plotting. The displayed data in Figure 15 represents the RMS sound level difference between the sound pressure that the dodecahedron would have produced without the shell at each measurement location, with the measured data including the shell.

SPL mapping clearly shows the coverage area of the shell, with a concentration along the center axis and edges, that extends beyond the structure. Audience members located 15 meters away can sit or lay down on the hill and still enjoy the acoustic projection of the shell at further distances.

In the center of the shell we find similar loudness values to the Music Barn, with similar timing for the first early reflections between 15 to 20 milliseconds helping with a sense of proximity to the performers. The 3D impulse responses clearly show the contributions from the upper corners of the shell coming from the sides, and spaciousness index (ASW) rising to 0.80 in the center.

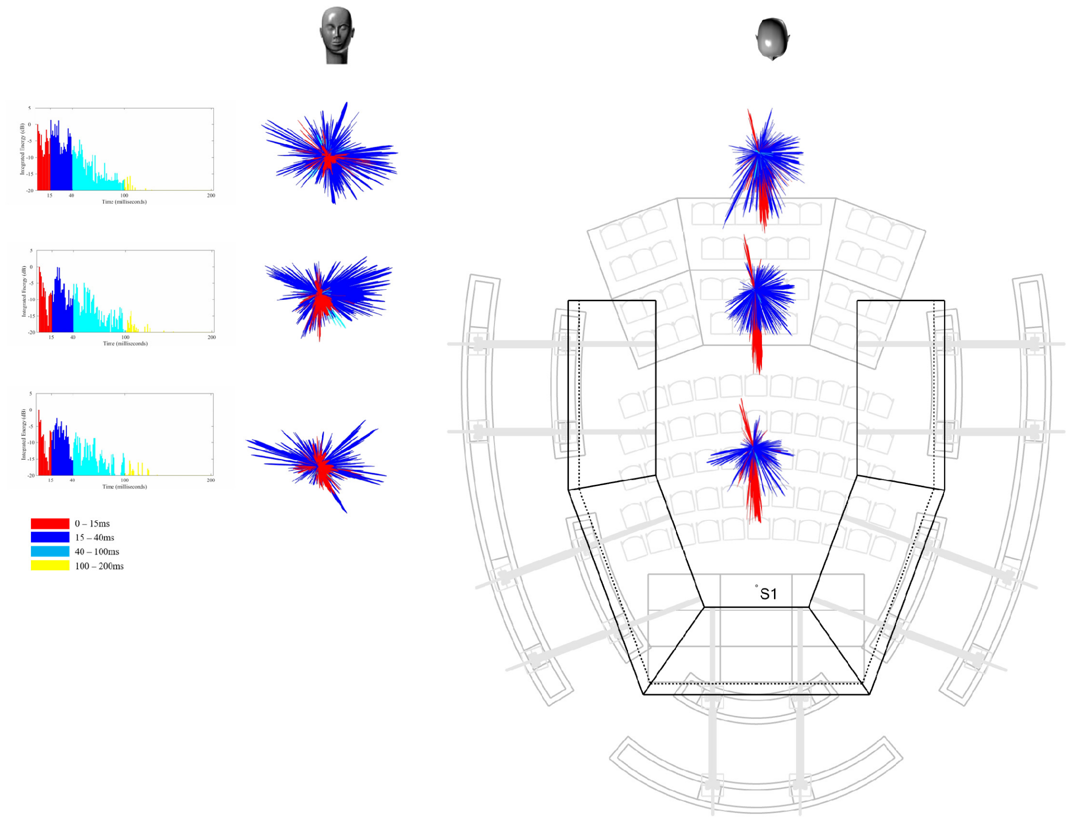

Figure 14 – Measured 3D impulse response diagrams

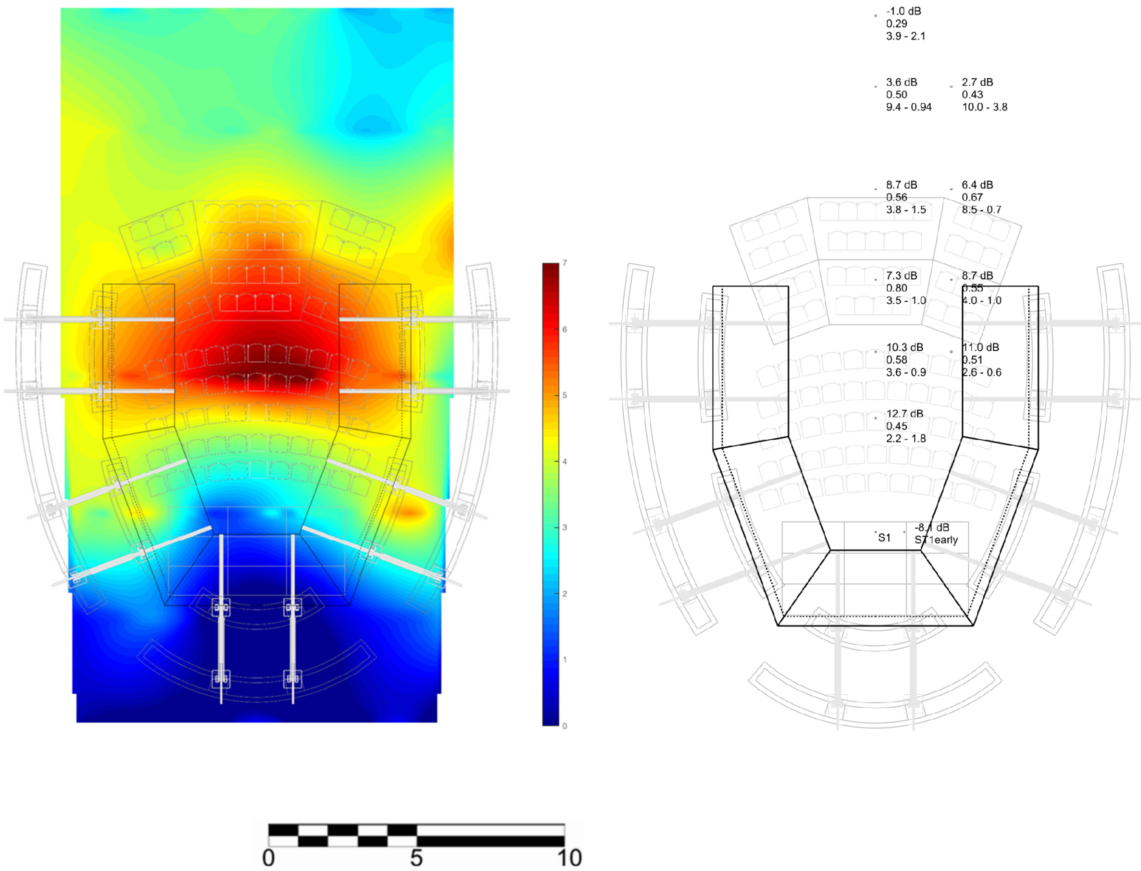

Figure 15 – Left: Measured RMS SPL area, Right: G, ASW and FR – LH parameters at each measured position

Table 1 – Summary of the acoustical parameters for the *Tiara* acoustic shell and *Domo, Structures of Landscape*, †inside the structure, †† outside the structure, * both inside and outside

	Tiara Stage $_{S1}$	Domo Stage $_{S1}$
$RT_{unoccupied}$	0.3s	0.3s†
$G_{mid\_unoccupied}$	8.1dB† ±3dB	10.4dB† ±5dB
	7.0dB* ±4dB	5.5dB†† ±5dB
$BI_{occupied}$	-1.2dB†	-1.2dB†
$D50_{occupied}$	94% ±2%	97%† ±1%
$ST1_{early\_unoccupied}$	-7.8dB	
$1\text{-}IACC_{early}$	0.60† ±0.10	0.40† ±0.15
	0.54* ±0.14	0.31†† ±0.10
$FR_{unoccupied}$	5.1 ±3.0	
$LH_{unoccupied}$	1.4[1] ±1.0	

5. DOMO, STRUCTURES OF LANDSCAPE

5.1 Design

As part of the newly commissioned sculptures, the *Structures of Landscape*, created by Ensamble Studio were born of a desire by the founders and the team for a visceral and radical connection with the natural environment, beyond traditional architecture, with structures that would be detached from current times and echo the magic of ancient civilization's architecture. Planned as a series of pieces distributed on the landscape, they help guide visitors through the land, develop a narrative of exploration, serve as shelters from the elements, and can be used as performance stages for music events. Acoustics was built in the structure to increase their mystic, echoing ancient monuments such as the Mayan pyramids, or Neolilthic structures sush as Stonehenge in England (Salisbury, England).

Following previous work in Spain, Ensamble Studio developed a construction method of excavating and shaping the ground at the site into the desired form, pouring concrete directly into the ground at their location, which impregnates a print of the land into the final shape and texture of the structures, which after the concrete has cured, are tilted up into position. The larger piece, *Domo*, measuring 15 meters wide by 30 meters long was poured into an artificial gravel hill, and was unearthed by removing the gravel. For the ground-facing sides of the pieces, the Ensamble team used plastic sheathing, folded into an artistic fashion, that would create a very smooth concrete texture and make shapes and ripples on the final structure, resembling the folding of clothing of roman marble sculptures. The upside face of the concrete facing the sky was covered with rocks and dirt creating a very rough and porous texture. The artistic process by Ensamble Studio resulted in two very distinct acoustic effects, one face with a highly reflective side, and the other face with a very absorbing one, Figure 16. *Beartooth Portal* and *Inverted Portal* both play with the alternating of the rough/absorbing and the smooth/reflecting sides.

[1]LH will decrease closer to 1.0 with an audience, occluding the sound reflections from the footings

Figure 16 – *Structures of Landscape*, Left: Porous concrete surface finish, Right: Smooth concrete surface finish

The legs supporting *Domo* are 5 meters tall solid concrete elements. The smooth interior surface finish is highly reflecting to sound and projects well to the surrounding hills and provides good support for musicians inside the structure.

During design, Ensamble made scaled versions of the structures which were scanned with Lidar and studied digitally for structural and acoustical analyses. The team did an evaluation of the acoustic properties of the shapes of the structures and proposed refinements to the shapes for sound projection, and ideal locations of performers, Figure 17.

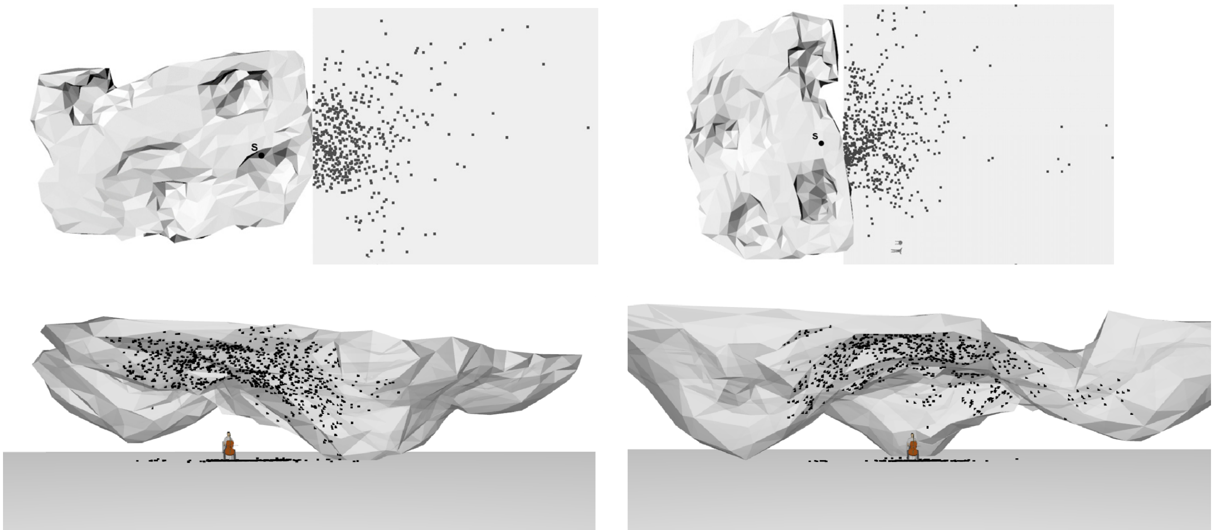

Figure 17 – Acoustic raytracing for shaping studies of *Domo, Structures of Landscape*

5.2 Measurements

Measurements of sound coverage were conducted across 2 areas with 2 different positions of the dodecahedron loudspeaker, as shown in Figure 18. Measurements of pink noise levels were collected by walking at a regular speed along perpendicular lines to the source location. A greater sound projection is achieved for a sound source located in the middle of the 3 legs of the structure, which is the primary orientation of performers inside the structure for concerts. The sound coverage pattern is not exactly uniform due to the organic and artistic shaping of the structure; however, at 10 to 15 meters, the structure can still provide up to 10dB of sound amplification relative to free-field conditions, highlighting the sound reflecting effect of the smooth and thick concrete surface and its curved and sound focusing shape. Sound coverage at S2 is not as strong but can still provide up to 5 dB of gain at almost 40 meters. It is a position used on occasion for concerts as it faces a rising hill, and provides good views to the stage, and to the mountains in the background. Under low wind conditions, a single instrument can be heard distinctly at greater distances from the structure because the site is very quiet. Assuming a level of 80dB at 1 meter produced by a single musical instrument, it will be perceived 55 to 60dB at 40 meters with the amplification from the structure. With an ambient background noise of 19dB LAeq, this still provides between 35 to 40dB of audible dynamic range.

The structure provides good loudness under its canopy, (Table 2), which are fun places to experience a concert, and where there is also good support for performers. There is not a significant amplification of the low frequency sound as shown by the Bass Index, as most of the low frequencies escape through the open structure.

Unlike *Tiara* where the sound projection is lateral, at *Domo* the sound projection is realized by the canopy which reinforces the axial sound, and therefore is mostly perceived frontally, with little improvement to the sensation of envelopment. However, the perception of envelopment is improved when listening under the canopy itself, which distributes sound more laterally.

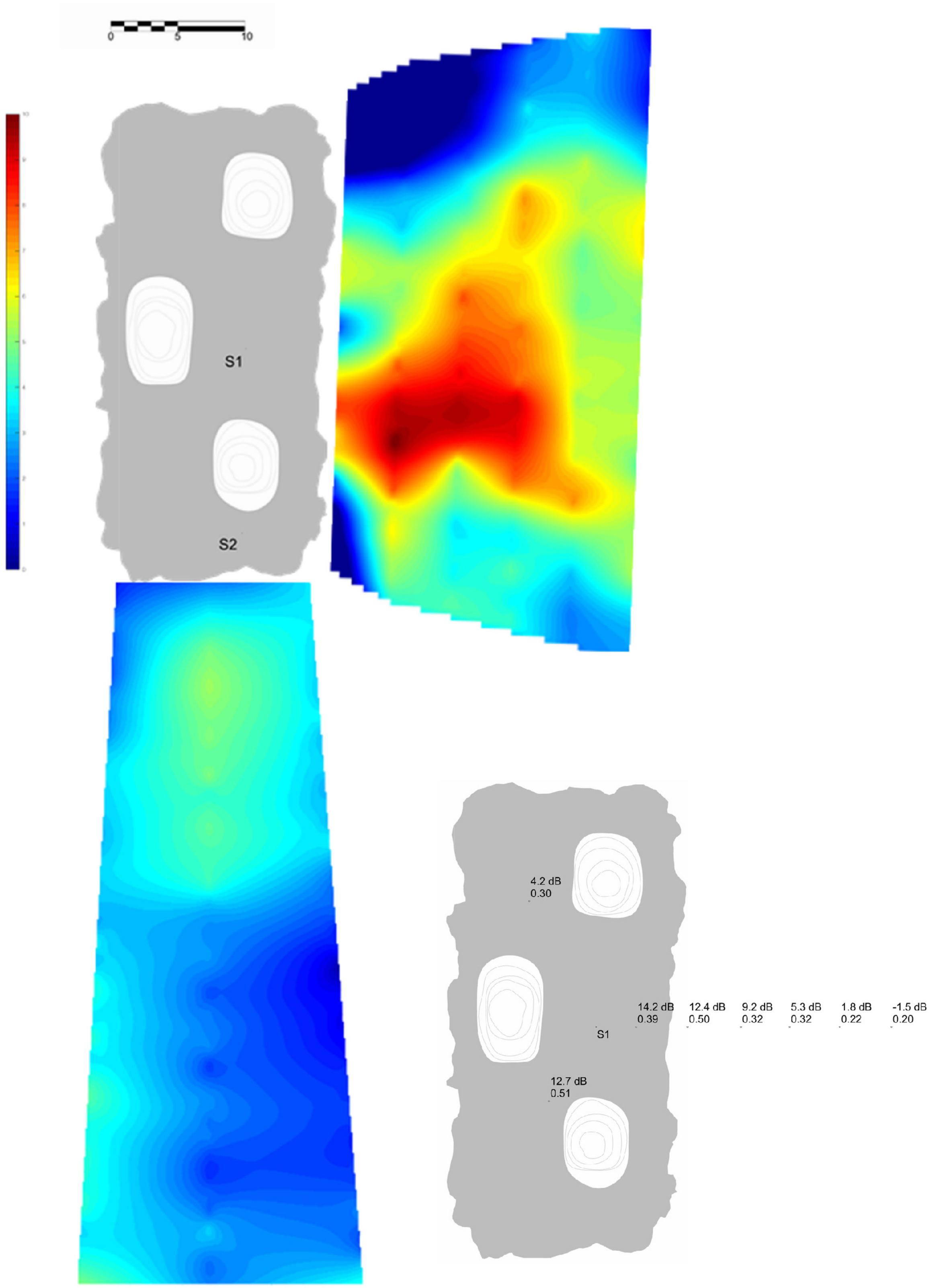

Figure 18 – Left: Measured sound coverage area; Right: Measured G and ASW parameters

6. CONCLUSION

This study aims to highlight some the un-usual qualities of the performance environments at the Tippet Rise Art Center. The *Olivier* Music Barn is a concentrated concert hall experience with powerful, immersive, clear and intimate sound at every seat. The *Tiara* delivers an ethereal immersive sound in outdoor conditions, and *Domo* projects sound onto an area surrounded by four mountain ranges and pristine silence.

While the spaces are small compared to other larger concert halls, the center proposes a range of experiences that are designed to feel intimate but within vast landscapes, and with special acoustical qualities. The curating of artwork, their careful placement on the land, and the tailored music programming produce multisensory experiences and meanings, connecting people and performers together and to the elements – described by many who have visited the site as “life changing”.

One of the most interesting aspect of the success of the Tippet Rise Art Center is how the project captures people’s imagination and creates a real draw of audiences and visitors to travel hundreds or thousands of miles to experience it. The excitement expressed by the audience going to attend a classical music performance in the mountains of Montana is not commonly experienced in the hallways of our major concert halls in metropolitan areas. For planners and designers, it demonstrates how creating an original, connective and transformative experience can be successful, even in the most remote location of the world. In fact, Tippet Rise fits within other established or emerging destinations such as Marfa Texas, Naoshima in Japan, The Sound of the Dolomites in Italy, or the Chapel of Sound in China. Embedded in the local culture, the center has also developed an extensive education program that extends locally, regionally and globally, to bring young people of all backgrounds, to learn about arts, music, and sustainable design and farming.

The success of the center also shows how the totality of the experience shapes the impressions of music and art (8); a model which can be transposed to other new facilities when thinking about the approach and the environment around performances, as much as the acoustic properties of performance spaces. Similar attributes can also be found in contemporary performance and installation spaces which challenges our traditional concert formats, such as informality, the ability for the audience to move through art and music, the proximity with art and performers, and immersivity, in spaces like the Park Avenue Armory and the Shed in New York City, The RuhrTriennal in Germany, or Les Ateliers Lumières in Paris.

With the growing quality of delivery of on-demand online concerts and entertainment, it becomes harder to mobilize individuals to go to concerts, and the Tippet Rise Art Center demonstrates how a transformative experience can motivate individuals to travel long distances to be part of a communal music event. Those are maybe the signals of a shift in the paradigm of how newer audiences look to enjoy art and music and of the emergence of new music rituals.

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