

# Holistic Acoustic Architecture

CAR, 18 April 2018



# Agenda

- Who we are
- What do we mean by holistic acoustic architecture
- Acoustics: some theory
- A case study: San Lorenzo da Brindizi
- In brief: other examples
- Conclusions

# Introductions



## **Francesco Pellisari:**

- Lecturer in Applied Acoustics - 1996
- Awarded designer
- Founder of NacSound - 1997
- Specialising in the production of innovative acoustic technology (e.g. Omnidirectional speakers) - 12 patents holder
- Numerous exhibitions including Victoria & Albert, Centre Pompidou



## **Laura Montanini:**

- Chartered Architect with more than 20 years of professional experience in Italy and the UK
- Worked along world-leader designers and architects including Ingo Maurer
- Background in music education
- Works with Nacsound since 2005 on holistic acoustic projects

# Who we are

- New Acoustic Concept founded in Italy in 1997
- Based in Cambridge since 2013. Team of 5 specialists covering acoustic design & engineering, architecture, civil engineering and project management
- Provides acoustic consultancy services for specialised projects across the world on applied acoustics and design
- Clients include architects, interior designers, sound engineers, large property managers (e.g. theatres, churches) and luxury private home owners
- NacSound lab in Rome had developed innovative acoustic technology now used across the sound speaker industry

***seeking uniqueness is our main objective,  
every variation is an opportunity to create***



# Holistic Acoustic Architecture - *definition*

- Space/environment can be conceptualised in separate *parts*, yet it is one *system*
- *Relating to the total system* instead of just to its *parts* is what holistic refers to
- The impact of combining sound engineering and architecture disciplines is larger than the sum of the two



# Holistic Acoustic Architecture - *acoustic*

- Sonority or sound may appear immaterial, yet like light, or air determine the way we experience a space
- Holistic approach to sound architecture assumes that listening is not simply a result of the physical phenomenon.



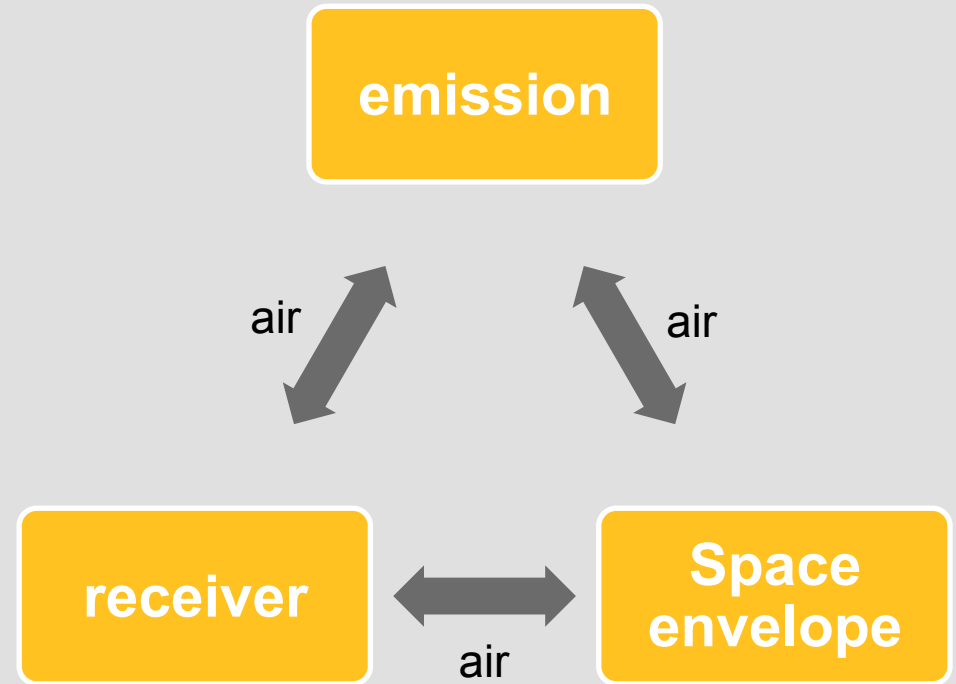
Epidauros theatre, Greece: 4c BC

Architectural design having its focus on sound is not something new

# Holistic Acoustic Architecture - *acoustic experience is not a model output*

- By simplifying acoustic experience to what we can physically measure (e.g. db), we fail to consider the complex relation of elements that interact

## The analytical approach



# Holistic Acoustic Architecture - *going beyond what is measurable*



Sound is principally an interactive emotional experience



Bruder Klaus Field Chapel - Peter Zumthor

Would a simple Lumen light measurement express the architectural value of this building?

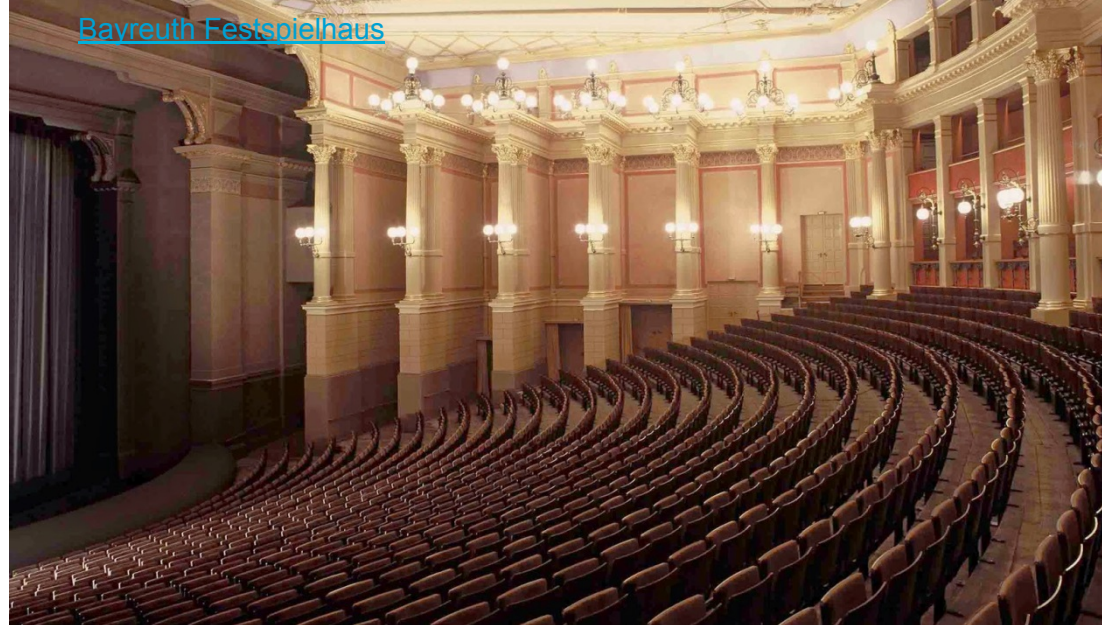


Can we evaluate this space without identifying light as the primary element?



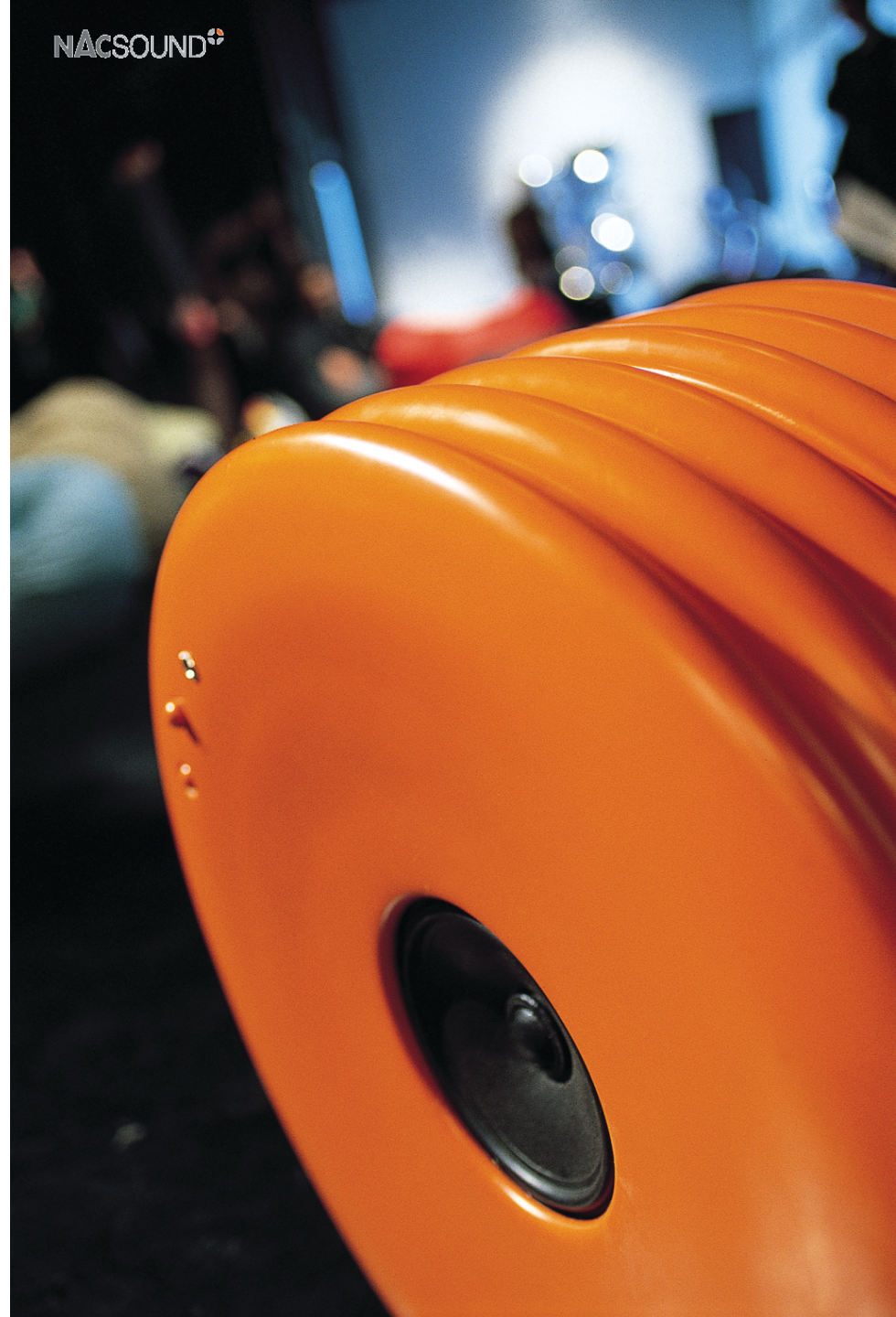
# Holistic Acoustic Architecture - *the aim*

- Finding the harmony between space in sound and sound in space
- Every space defines its sound and every sound can define its space
- Holistic acoustic architecture goes beyond soundscaping

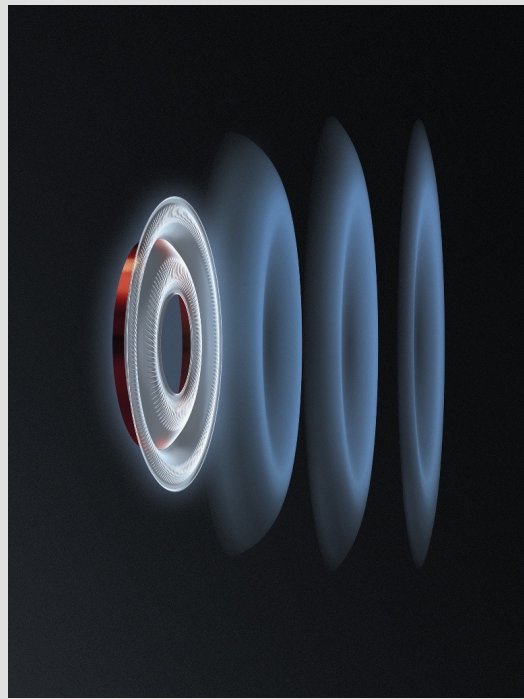




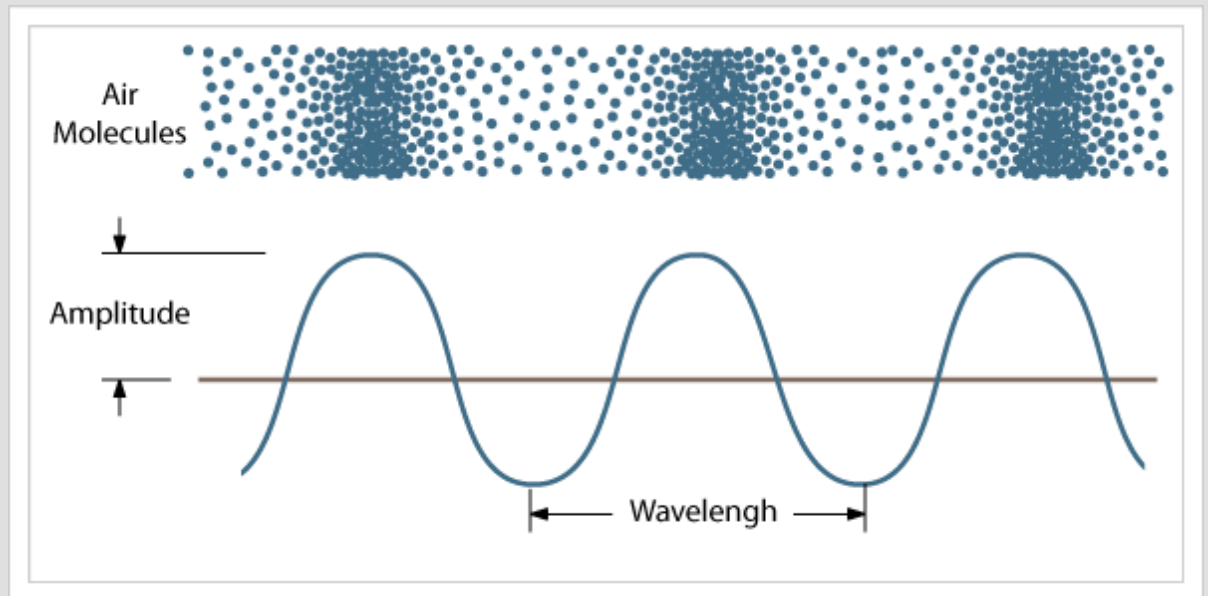
# Physics of acoustics - *What is sound?*



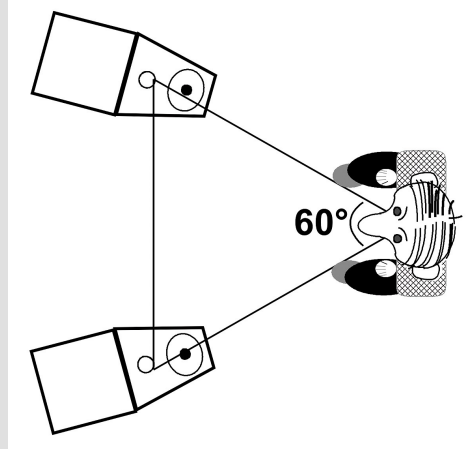
# What is sound



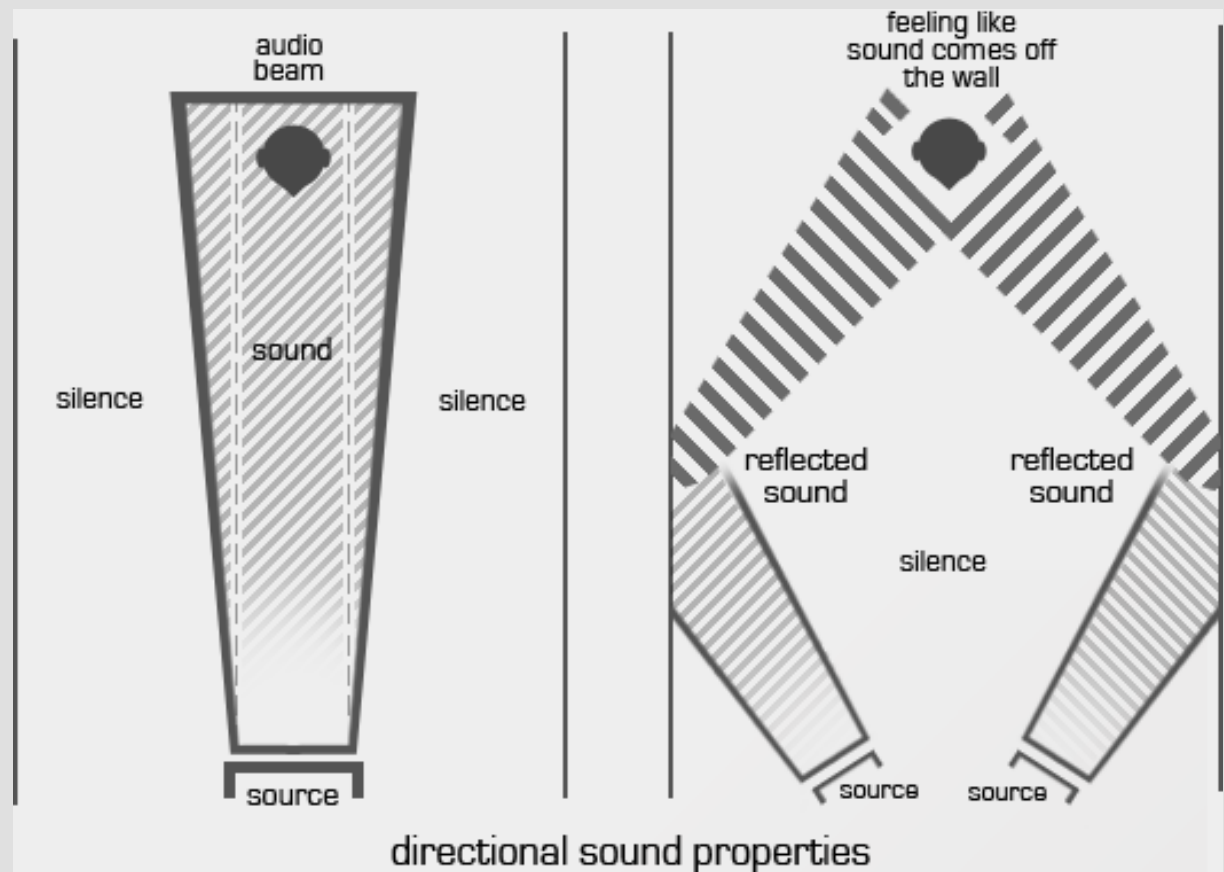
**The sound waves are formed by elastic energy and it is important to understand them both as corpuscles and waves example the light**



# Sound waves: some basics

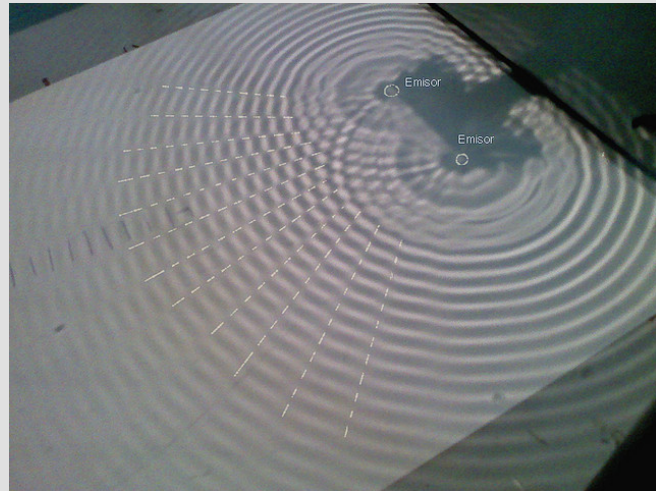
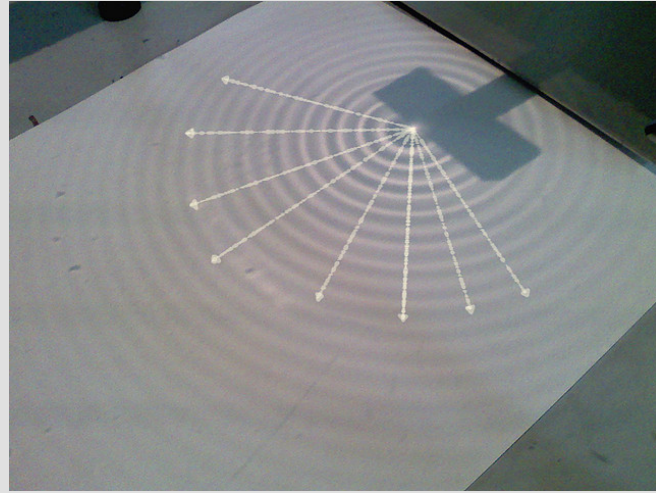


**Waves propagate and reflect on the walls same as light : is this true?**



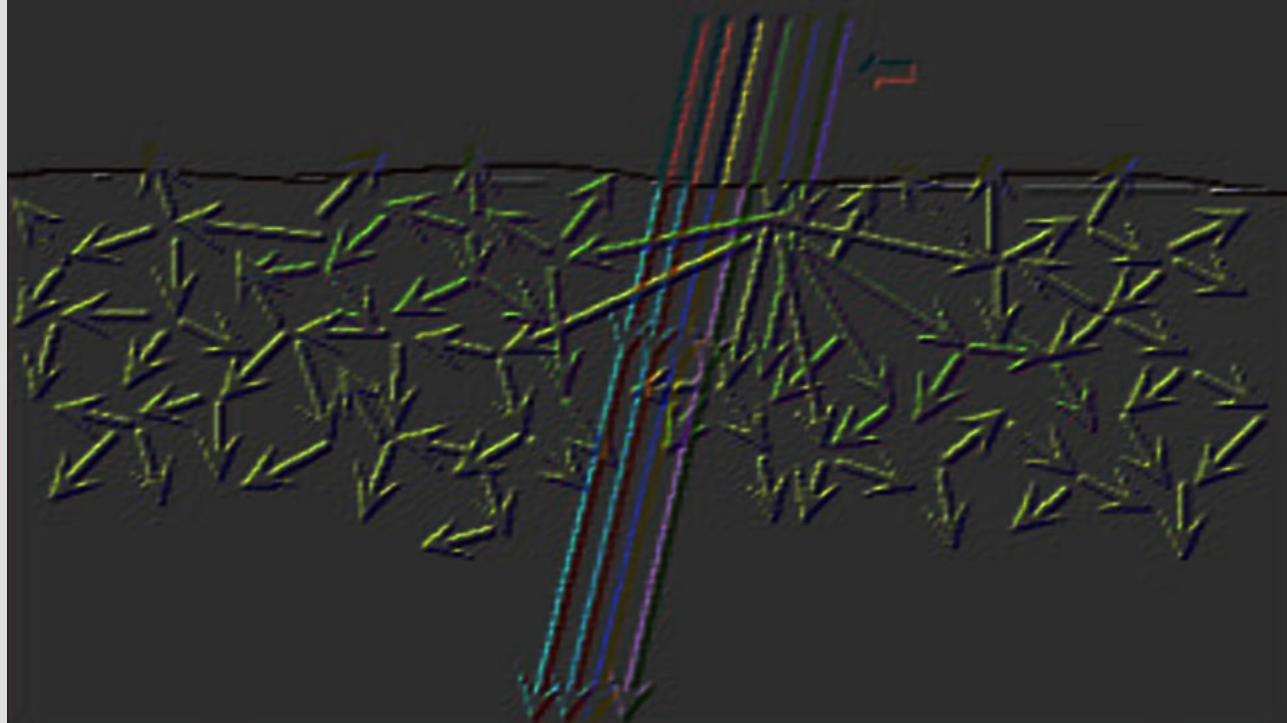


# Sound waves omni



**Waves do not have perfect geometry**

# Sound waves: scattering



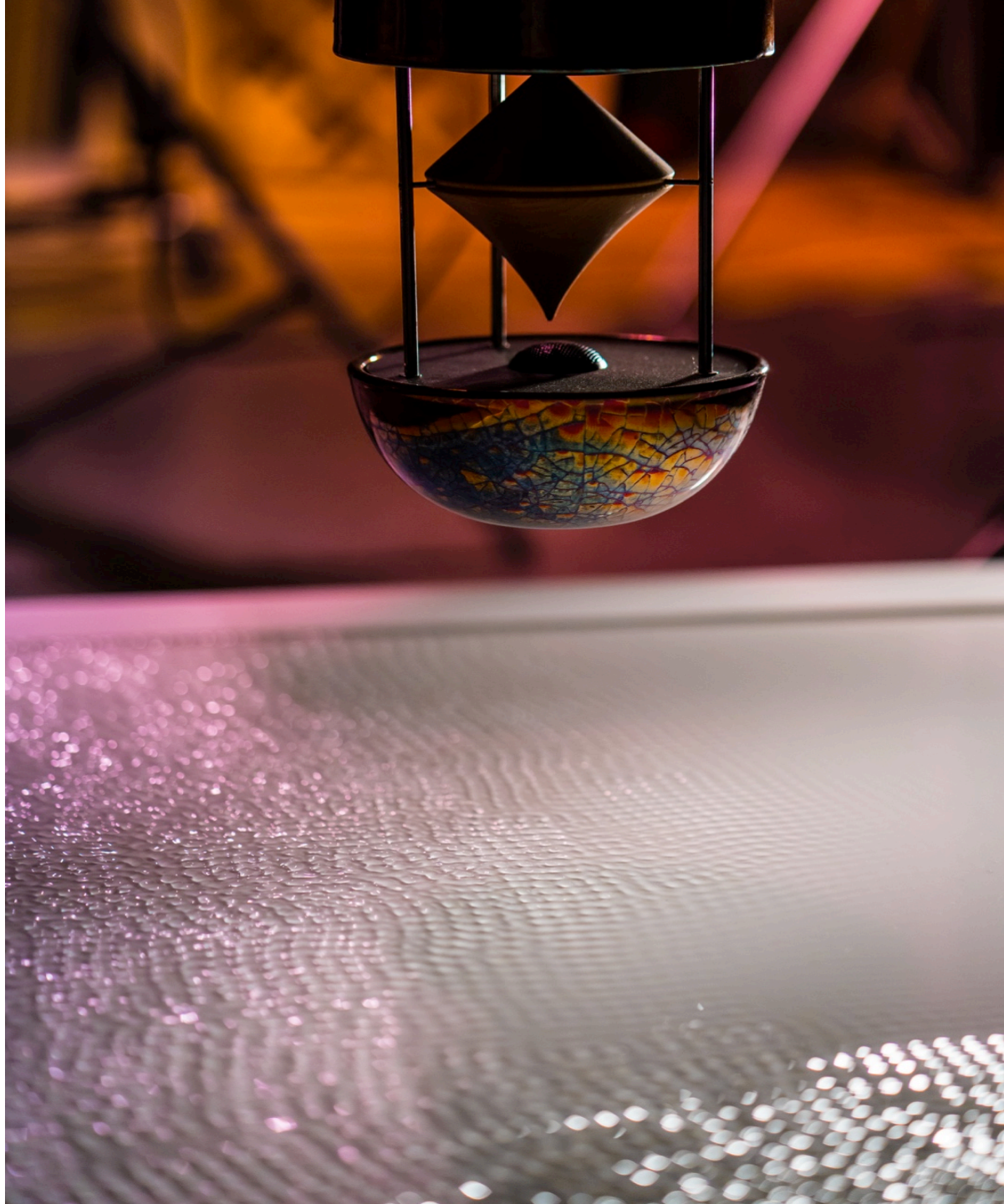
**Light's scattering effect also  
applies to sound “waves”**

# Non-coherent sound-waves



**From a physics perspective, to conceptualise non-coherent sound waves, one has to conceptualise the difference between the light emitted by a light bulb and a laser beam**

# Sound waves: reflection in the space





# Case study: San Lorenzo da Brindizi

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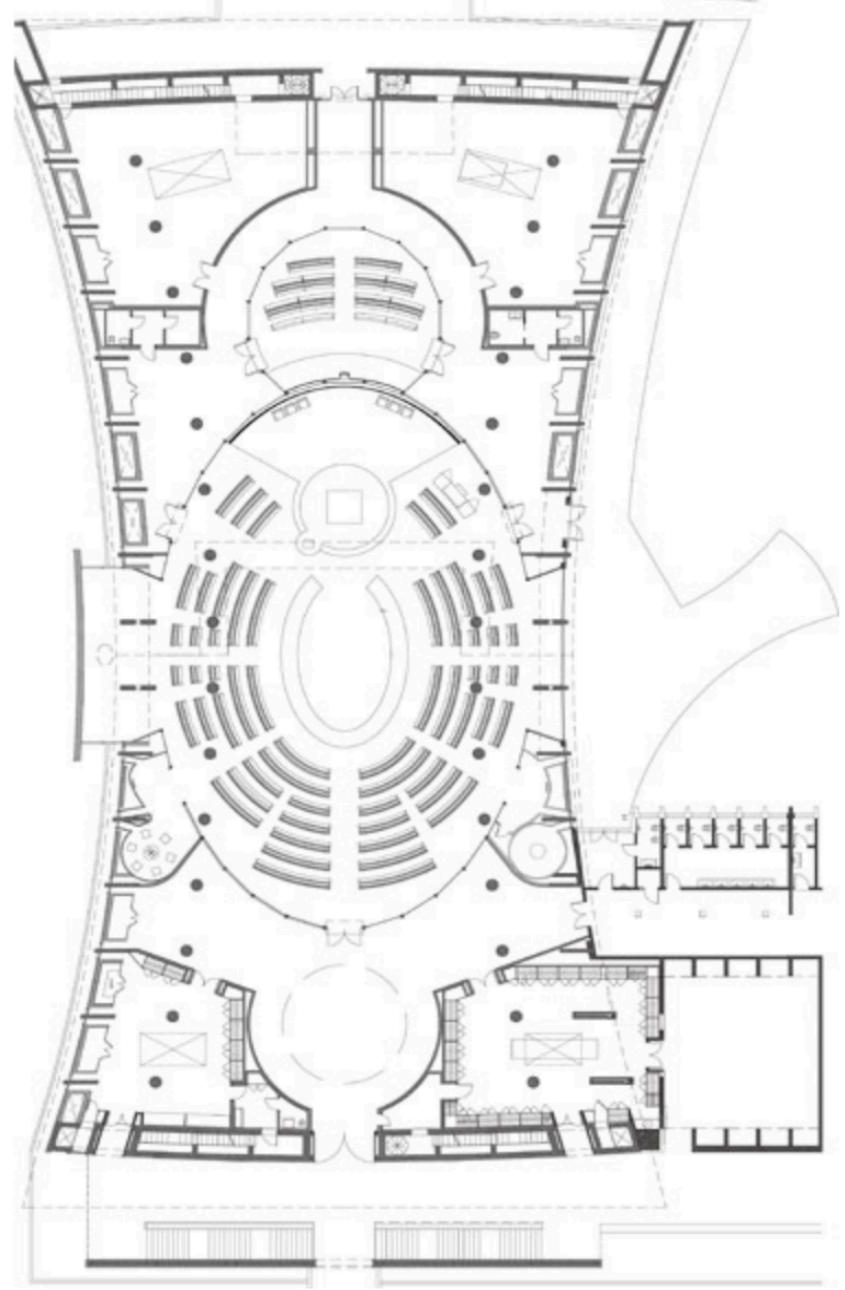
# Background to the project

- **Client:** San Lorenzo da Brindisi parish church
- **Location** – Rome,
- **Project lead:** Arch. Paolo Marciani
- **NacSound role:** designer acoustic consultant
- Built originally in 1960
- Project aim: total reconstruction of the interior of the Church



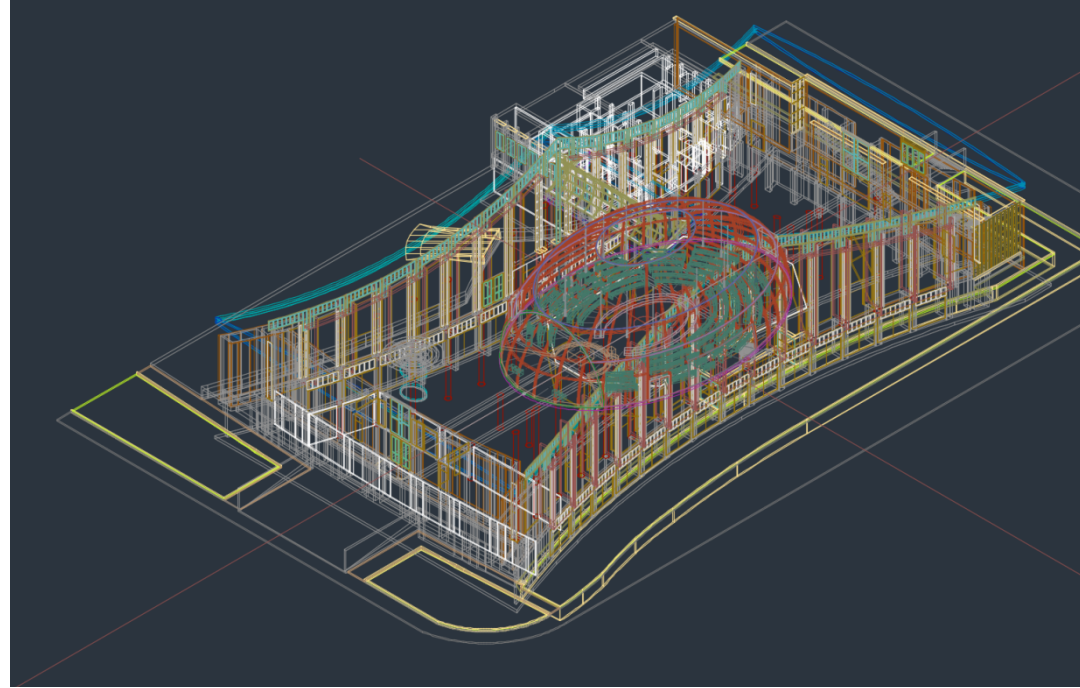
# The project [1/3]

- Plan of intended reconstruction

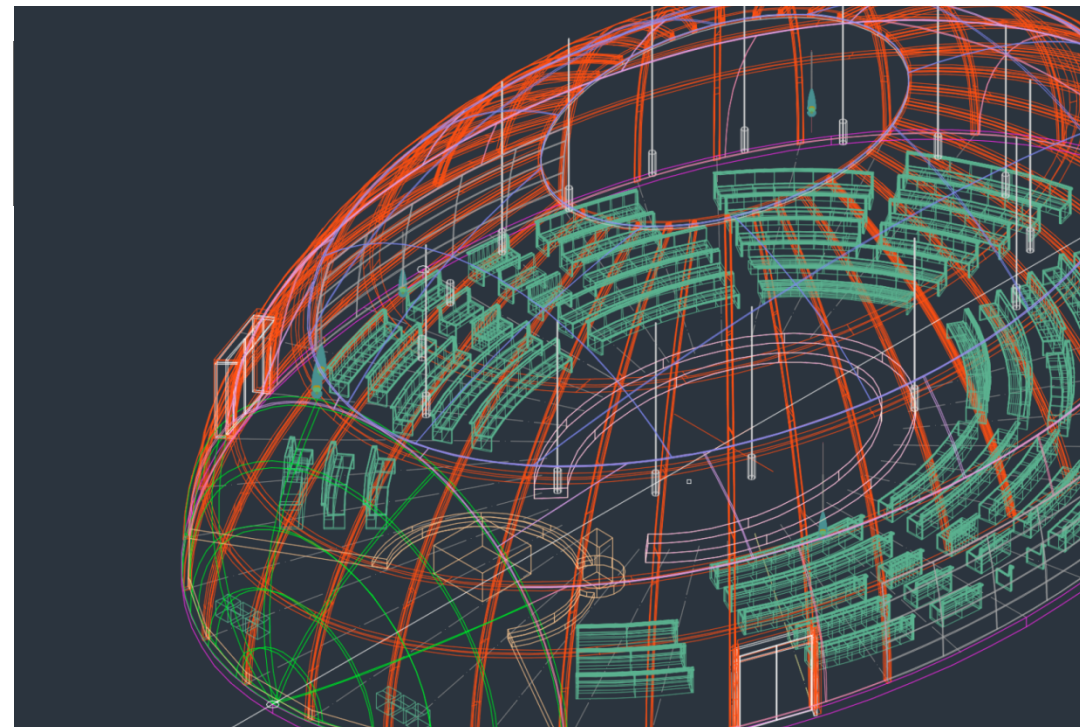




# The project [2/3]

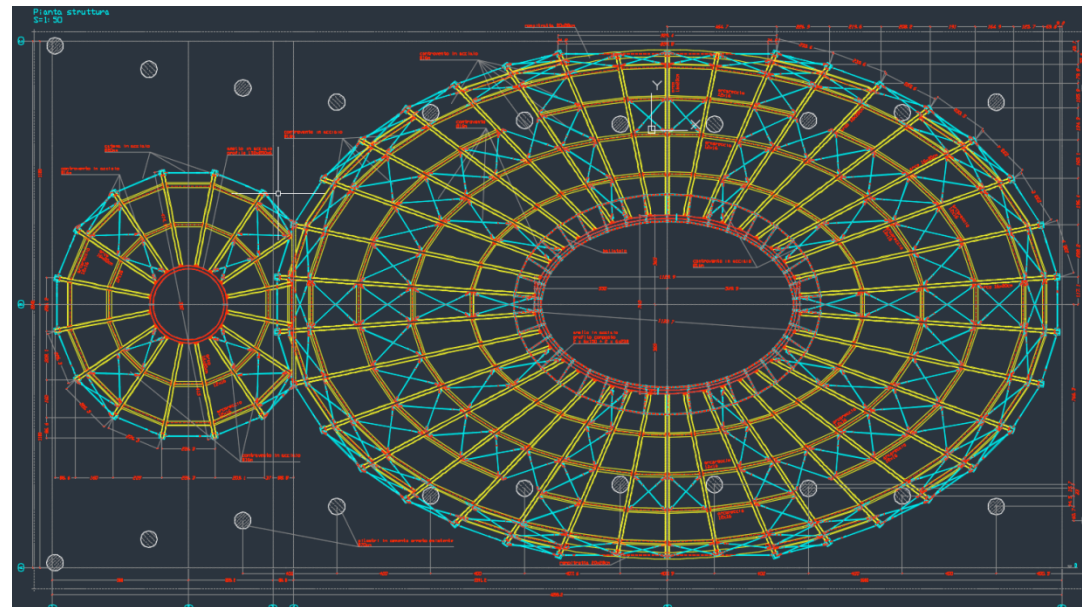


- 3D plans



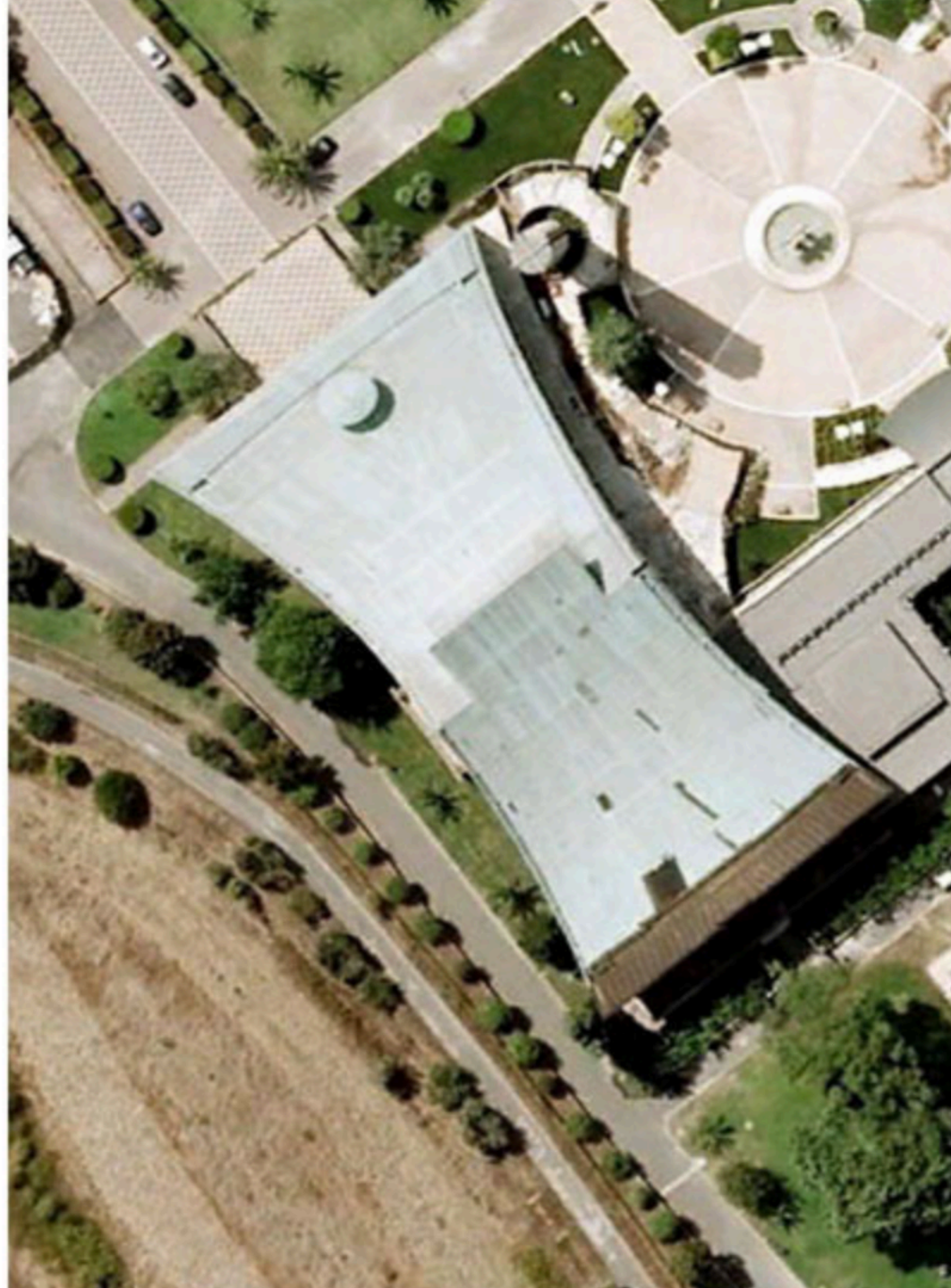


- **3D plans**



# The main challenges

- **Original building - problems: everything in reinforced concrete, very long reverberation times**
- **Amplification of low and high frequencies?**
- **Cancellation of the voice in many sessions**
- **Singing poor of harmonics and annoying**





# The HAA solution [1/6]

- **Challenges:** Project included: new interior space solution, a consistent restoration of existing build and external works
- **HAA solution #1:** use CrossLam wood in a bespoke design of spacing each element to deal with the scattering issue



# The HAA solution [2/6]

- **HAA solution #2:** Spacing between the variable beams in the centre of the dome where we will have the most fire a metal structure for the drum
- Custom-made, double layer drum, the perpendicular crosspieces





# The HAA solution [3/6]

- **HAA solution #3:**  
Custom-made speaker using omnidirectional, non-coherence wave diffusion
- The Acoustic arrangement is not symmetrical
- Thor 500w above organ
- 5 Omni in the lateral circumference spaced by ear for the voice



# The HAA solution [4/6]

- **HAA solution #4:** internal design layout of timber slates, placing of speakers and drum to consider both light and sound





# The HAA solution [5/6]

- **HAA solution #5:** Custom-design and make of resonator benches with internal absorption to cater for sound absorption both when the church is full or empty



# The HAA solution [6/6]

- **HAA solution #6:** The temple presented major challenge given there was no appetite to change any layout
- Innovative solution was the design and installation of the mosaic placed in specific pitch to improve acoustics





# Other examples of holistic architecture projects

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# Private property, Holland

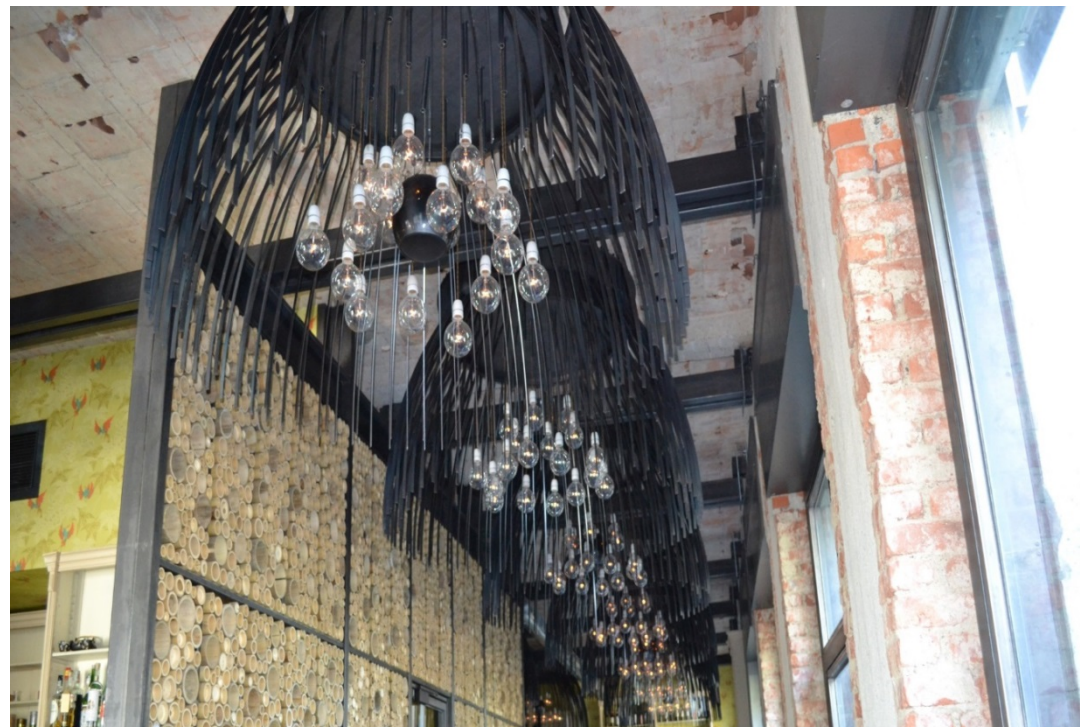
- **Client:** Dune Blue, Holland
- **Project:** Laura Montanini
- **NacSound role:** designer & constructor of solution
- **Realised:** 2011
- **Challenges:** concrete & glass cuboid space
- **HAA solutions:** Natural balance of interior design and engineering - Bespoke design of Schofner diffusor, Omnidirectional, custom-built speaker





# Qor fusion restaurant, Milan, Italy

- **Client:** Qor, Italy
- **Project:** Nisi Magnoni
- **NacSound role:** designer & constructor of solution
- **Realised:** 2009
- **Challenges:** high ceiling, glass and concrete walls
- **HAA solutions:** Work with both light and sound. Solutions included a bespoke timber diffusor, create lights that increase diffraction, as well as a custom-made diffraction wall





# Synagogue Shalom, Cambridge, UK

[1/3]

- **Client:** Beth Shalom
- **Project Lead:** Cowper Griffith Architects
- **NacSound role:** designer & constructor of HAA solution
- **Realised:** 2015
- **Challenges:** parallel walls with high sound wave reflectivity; very poor audibility



# Synagogue Shalom, Cambridge, UK

[2/3]

- **HAA solution #1:** without changing material pitch the side walls to change geometry.
- **HAA solution #2:** without changing the texture of the material, design custom perforation interval for ceiling to increase sound absorption





# Synagogue Shalom, Cambridge, UK

[3/3]

- **HAA solution #3:** custom-designed and made ribs, spaced out to best diffuse sound, whilst keeping the aesthetics similar to their intended scope
- **HAA solution #4:** Use of custom-made, omni-dimensional, non-coherency wave emitting Thor speaker made of terracotta (NacSound)

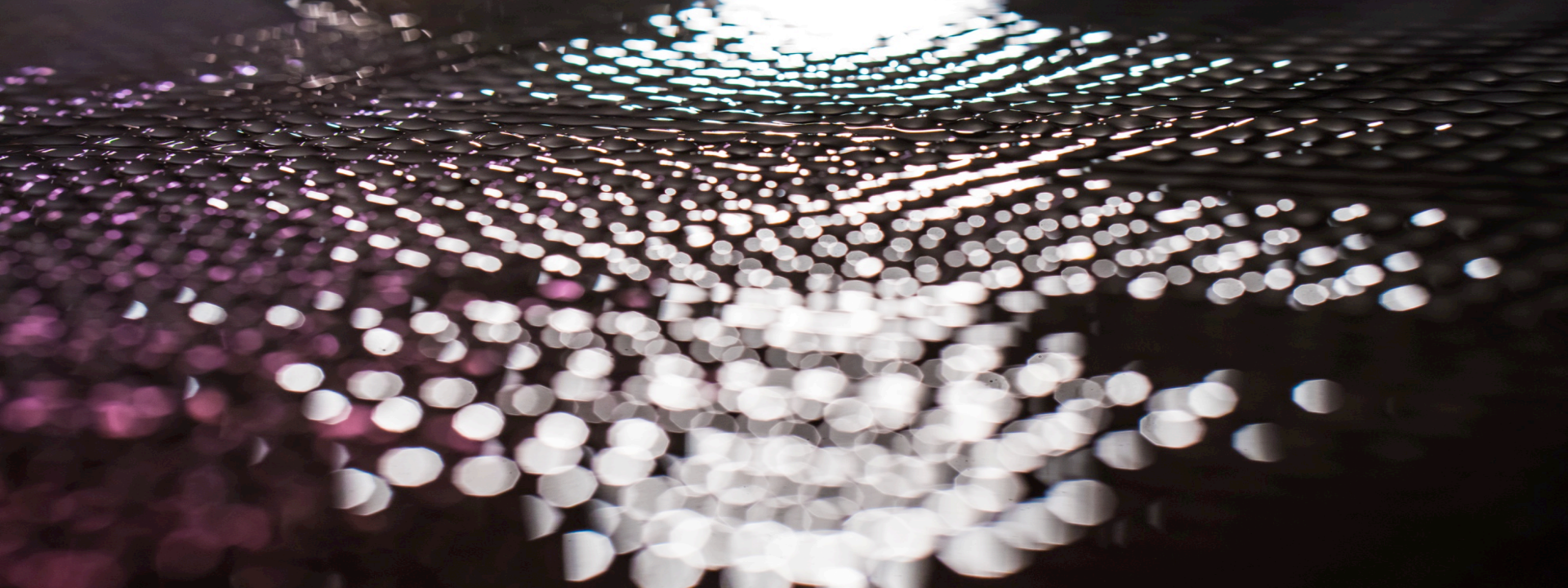




# Conclusions

## What are the key conclusions?

- Sound is more than what we can physically measure
- Holistic acoustic architecture can harvest the harmony between space in sound and sound in space
- Every space defines its sound and every sound can define its space
- The application of holistic acoustic architecture across different settings has proven its applicability being able to add value and produce savings



# Thank you

Seeking uniqueness is our main objective

Every variation is an opportunity to create

[www.nacsound.com](http://www.nacsound.com)