Die „gläsernen“ Studios von Schweizer Radio DRS1 – Ein Entwicklungs- und Erfahrungsbericht

(The Glass-Studios of Swiss Radio DRS1 - Development and Long-Term Review)

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Abstract

Back in the year 2002 the management of the Swiss national broadcast organization (SRG) decided to build a new studio complex for "DRS1" their principal program in German language. The design brief for the architects required the new studios to be built with glass walls to integrate into an overall design/CI concept which strongly emphasized the attribute of "transparency". Several floors of the existing main building at the Zurich site of Swiss national radio (DRS) were converted to house the new studio complex.

Quite obviously the development of the glass-studios presented a challenge to the acousticians involved. This paper describes the (room-) acoustic design process of the new glass-rooms which lasted for about one and a half years. The development of the required acoustic treatment (in form of free-standing, three-dimensional objects) will be outlined and results from computer simulations and laboratory measurements will be presented. The predicted data will be compared with the actual measurement results acquired during final commissioning of the rooms. In addition to this technical information there will be a summary of statements from the actual users of the rooms and from the facility management – looking back at seven years of operation of the studio complex.

1. Introduction

In parallel with a significant restructuring of the studio infrastructure of Radio DRS[1] in 2002 the then relatively new concept of "*Integrierte Programmherstellung - IPH*" ("integral program production") was introduced. In terms of room layouts the "IPH" concept means that the on-air studios are now located within the office areas where the journalists do their work – no longer does the geographical separation exists between offices and studios.

To enhance the new possibilities of a close interaction between journalists and presenters the management of Swiss Radio put forward the wish that the studios shall have glass walls to enable to visual contact between all who are working on the program. The glass studios

[1] Known today as „SRF – Schweizer Radio und Fernsehen“

were also regarded as a strikingly new and unusual feature for the guests coming to be interviewed and the visitors touring the facilities of the Zurich studio of Radio DRS.

2. Layout

The studios - 13 rooms in total - were to be incorporated on three floors of an existing multi storey building that belongs to the Zurich site of Radio DRS. This is actually one of the very few buildings designed by famous Swiss designer and architect Max Bill and is today a listed building

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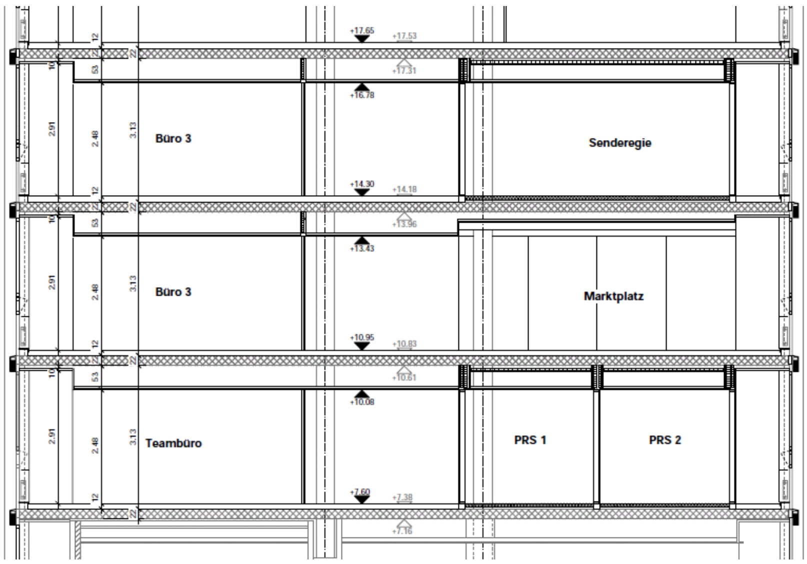


Abb. 1: Section through floors housing the glass studios [1]

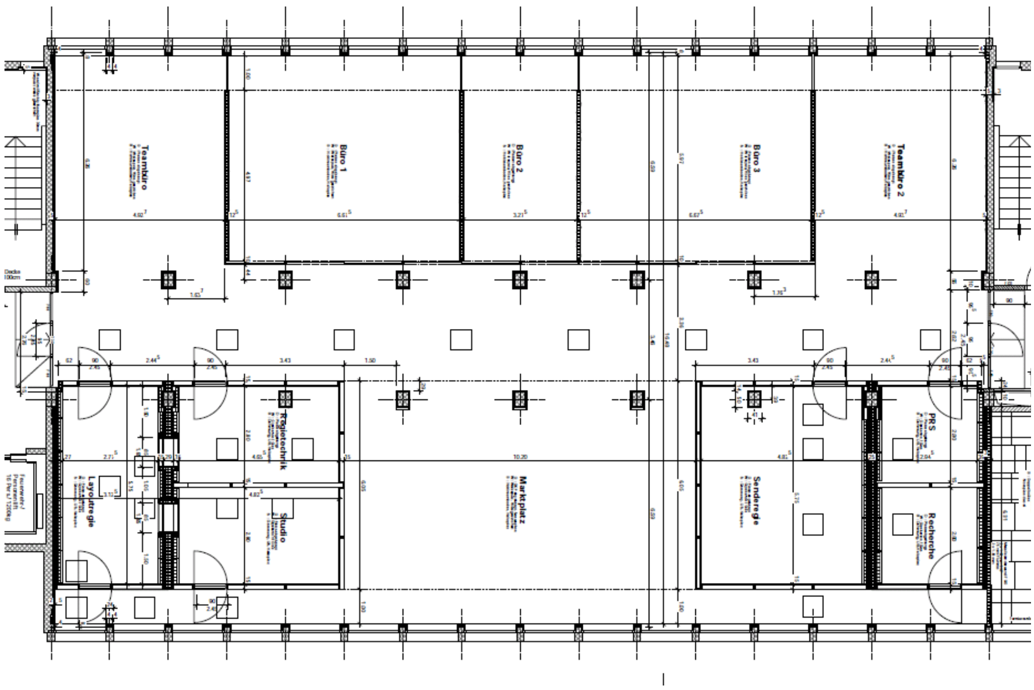


Abb. 2: Layout of middle floor (Main On-Air Studio/ two Pre-Production Studios / “Layout”- Control room / Voice Studio / “Marketplace”) [1]

3. Early Concepts

3.1. General

A strategy paper describing the requirements for the new studios was issued by the management by February 2003 and the design work process was officially launched. The contracted acousticians set to work in close collaboration with a working group of Radio DRS consisting of six members from technical and operational departments, including the head of the presenters.

Although members of the working group and many other involved people were initially quite skeptical and concerned about the outcome of the project, the design process of the studios was very fruitful and in the final report the working group basically accepted the proposed concept of glass studios with “organic shaped cylindrical absorbers” – outlined in the following text.

It may be mentioned here that many a decision the group made was based on subjective evaluation of auralisations prepared by the acousticians and not on written reports containing acoustical data. Nevertheless a set of acoustical specifications regarding room acoustics, sound insulation and background noise was prepared for the project. These specifications seemed to have led to satisfactory results and are now universally in use throughout Radio DRS for new studio projects.

3.2. Building Acoustics

Being not the main topic of this paper some general information regarding sound proofing shall suffice. Many of the new studios have glass walls on three sides, each constructed as a double-wall system with the necessary set of double glass-doors. The remaining fourth wall is not transparent and constructed as a standard dry wall system with metal studding and multi-layered planking from gypsum-board with additional layers of heavy “sound deadening”-foil to provide additional mass and damping for increased LF-sound insulation.
The ceiling consists of elastically suspended gypsum board layers similarly reinforced as the wall. The floors in the studios are standard floating floors (concrete on layers of mineral-fibre) but with increased thickness of the concrete slab and the elastic layer to lower the resonance frequency of the system.

Airborne sound insulation values around 55 dB ($D_{nT,w}$) from studios to adjoining areas (offices) were specified by the operational department. The target curve for background noise in the on-air control rooms was “GK15” (according to specifications issued by the “Institut für Rundfunktechnik – IRT”) a curve which leads to an “equivalent” A-weighted SPL of around 26dB(A). Impact noise in the on-air studios was to be <= 45dB ($L'_{nT,w}$) – lower values apply for the voice studios etc.

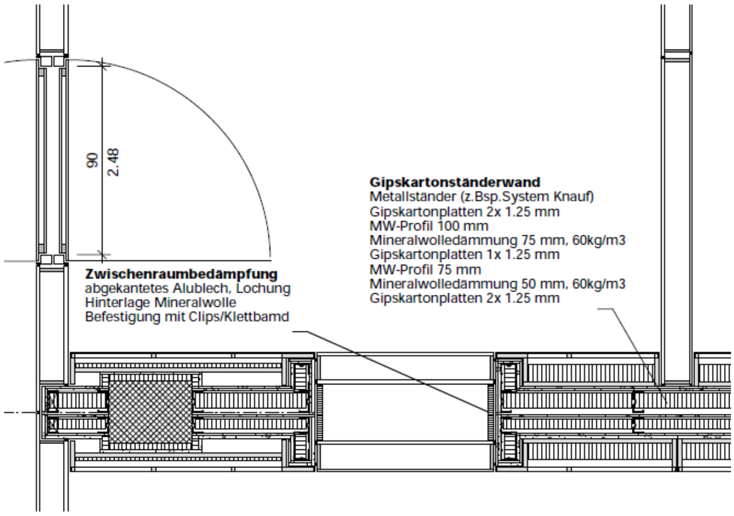


Abb. 3: Horizontal section through typical intersection between glass- and gypsum-board walls. [1]

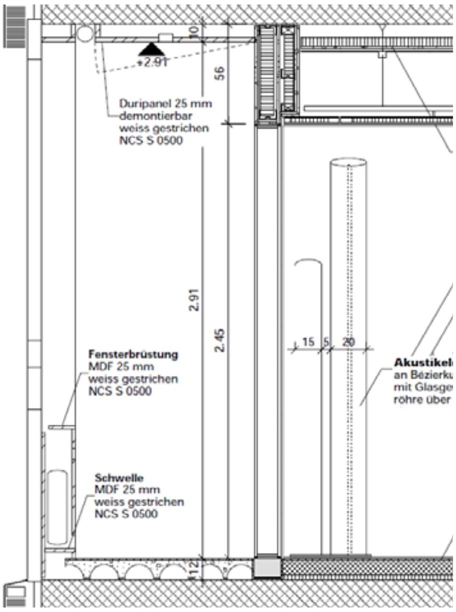


Abb. 4: Vertical section through typical glass-wall construction (corridor along façade to the left, studio to the right) [1]

3.3. Room Acoustics

The architects „Di Gallo Architects" of Zurich, together with the acousticians, very soon began with conceptual studies how to create room acoustical treatment for glass studios. The conflict between transparent glass walls and ordinary room acoustical surfaces is probably obvious to anyone - it doesn't make much sense to build studios with glass walls only to cover them later with opaque acoustic materials. Commercially available, visually transparent, sound absorbers such as micro perforated glass panels or foils were refused for aesthetical reason and also for operational issues such as durability and cleaning.

In a multi-staged process solutions were developed which gradually eliminated the flat continuous absorbing surfaces. In a first stage flat absorbing structures with a high percentage of openings were considered. Such structures would allow a degree of visual transparency (because of the open areas) while still providing a significant area of absorption also helped by the boundary effects around the many edges.

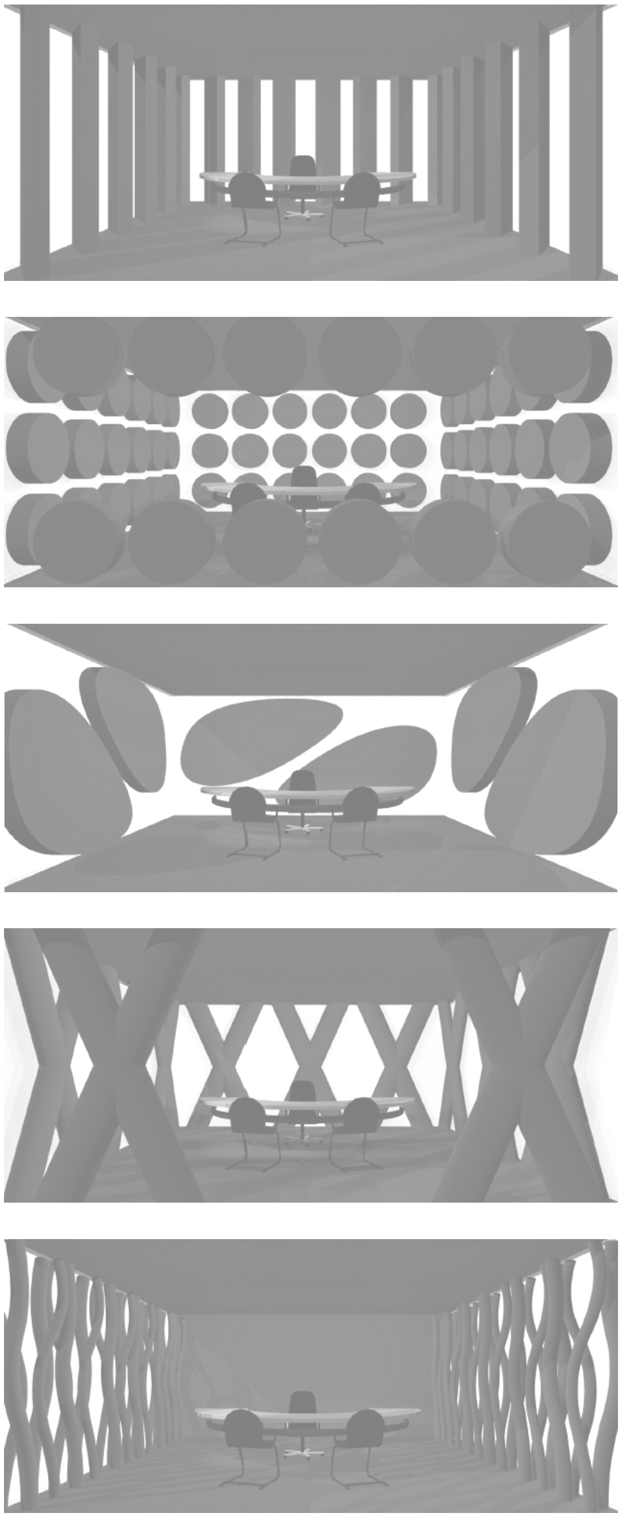


Abb.5: Stages of development of absorbing structures [1]

Further stages of development led to a transformation of the flat absorbing surfaces into free standing 3D-objects. Early on a cylindrical cross-section and a “naturally-curved”-shape was favored for aesthetical reason (quite quickly the absorbers gained the infamous nickname “Spaghetti-Absorbers”…). The final design consisted of clusters of four cylindrical absorbers of different height and with two different diameters mounted on a common base plate.

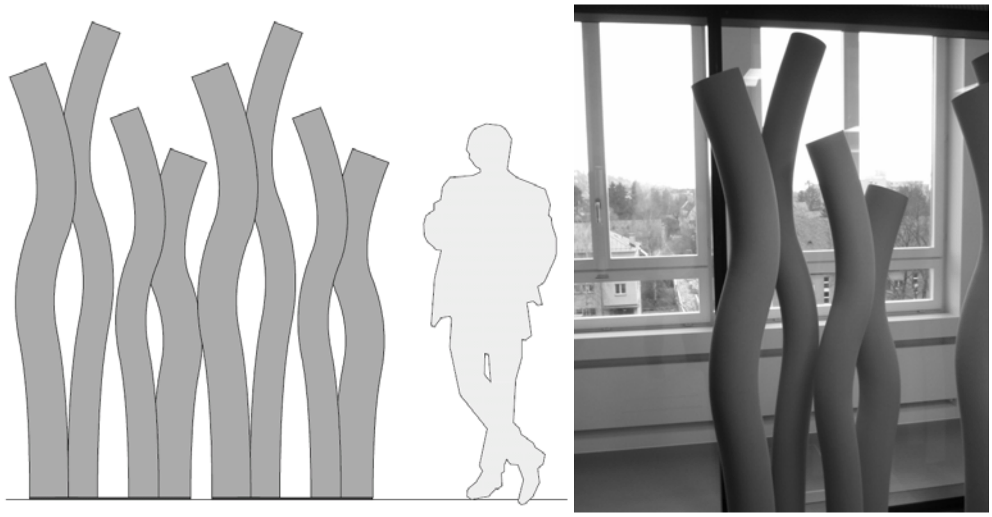


Abb.6: Plan view of two clusters of absorbers (left) and a cluster of absorbers positioned in one of the studios during commissioning (right) [1] / [2]

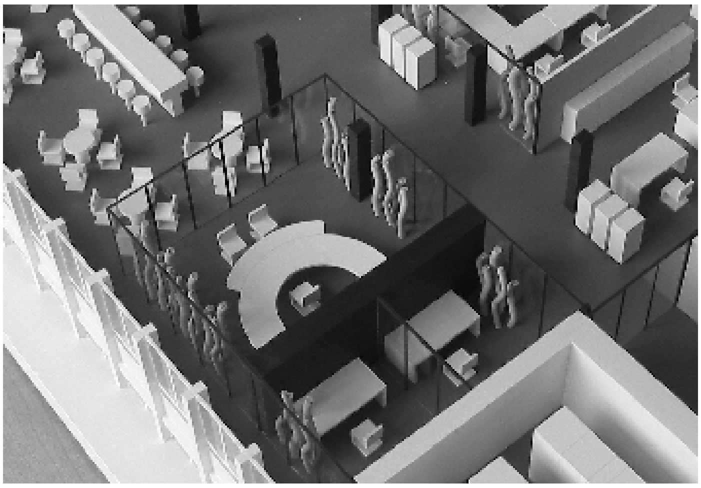


Abb. 7: Architects impression of the glass studios (main on-air studio with two pre-production studios "back to back") [1]

Due to the relatively large surface area of the cylindrical absorbers, their “random” distribution and their staggered placement in two rows along the glass walls, quite a large acoustically active area is generated. In the actual studios the absorbers are only placed in strategic locations and therefore do not cover the whole surface of the walls. Indeed one glass-wall of the studios is usually bare of any absorbers to give an unobstructed view along the main visual-axis. The glass on this wall is then angled in the vertical plane to avoid direct reflections from the talkers back to the microphone(s). All in all a quite high degree of visual transparency can be achieved while maintaining the necessary amount of absorption and reflection management.

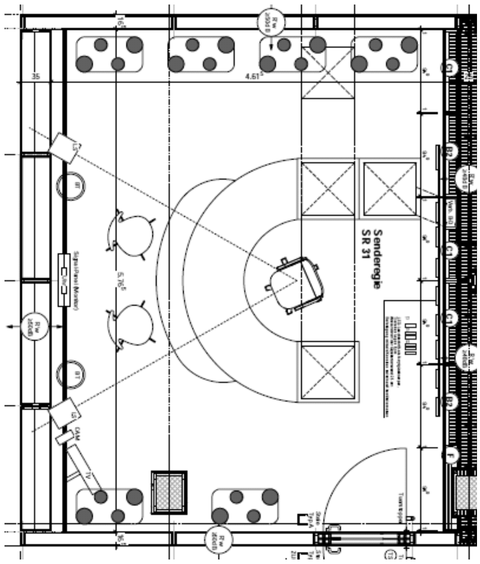


Abb.8: Proposal for placement of cylindrical absorbers (solid dots) in an on-air studio [1]

Abb. 9: Angled front glass-wall and cluster of absorbers in an on-air studio according to above floor plan. [2]

4. Development of Custom-Made Absorbers

4.1. Development of the "Spaghetti"-Absorbers

Once a basic shape of the "naturally curved cylindrical absorbers" had been established, work begun for the acousticians to design the absorbers in detail. Early calculations did show that it would be desirable for these absorbers to contribute more to the absorption of low-mid frequencies than could be expected purely from their shape and size if they were to be fabricated from material acting as a porous absorber. Because a rigid core was anyway needed to give the absorbers their shape, the idea was born to make use of this core for additional absorption purpose. This led to the development of a hollow core which acts as a "Helmholtz"-type absorber for low-mid frequencies. This perforated core is fabricated from wood and is surrounded by melamine foam which provides the bulk of high-frequency absorption and also acts as an acoustical resistance to broaden absorption-peak of the core. The foam is finally enclosed by a layer of acoustically very transparent fabric which was especially "knitted" (like socks are made) for the project.

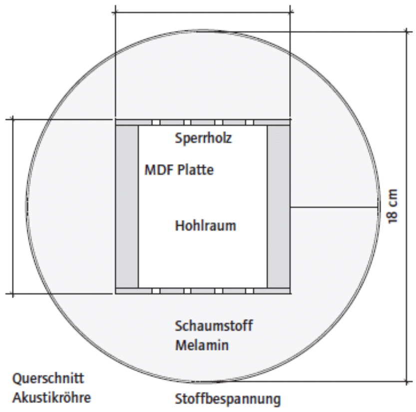


Abb. 10: Cross section through "Spaghetti" absorber [2]

Once the theoretical design was finished prototypes were built and tested in the reverberation chamber of the Swiss National Institute of Material Science (EMPA) in Dübendorf near Zurich. The measurements showed a quite even distribution of absorption over frequency with a good extension into the low-mid range.

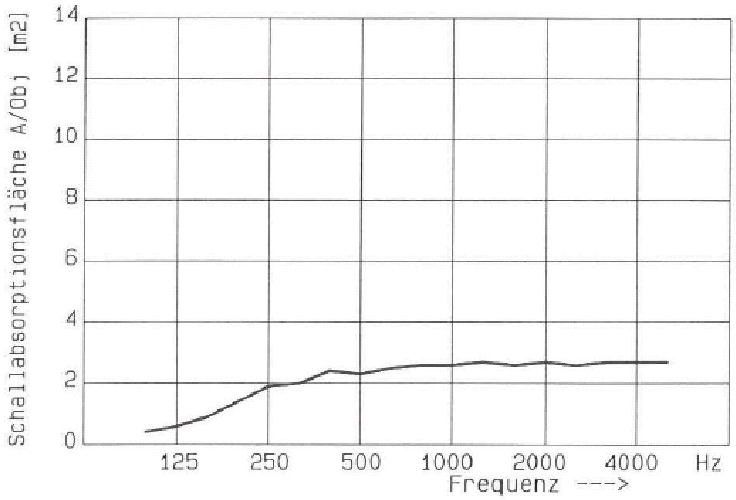


Abb.11: Equivalent absorption area per group of "Spaghetti"-absorbers

Abb. 12: "Spaghetti"-absorbers in the reverberation chamber at EMPA [2]

4.2.Development of other absorbing surfaces

4.2.1. Ceiling Panels

Because the architects were not happy with the visual appearance of the acoustic ceiling panels on the market by then, they set out to develop their own design. The result was a sheet-metal panel with pressed-out sections which was called "Schlitzbrückenblech". Again samples were tested in the reverberation chamber at EMPA. A surprisingly high absorption was measured although there are no visible openings if the panel is viewed directly perpendicular. The values were carefully decreased for the acoustical calculations because in real life one cannot expect a diffuse sound incident in a small studio as is the case in a reverberation chamber. It is more appropriate to assume a strongly angled sound incidence from the talkers or the loudspeakers in the studio.

Abb. 13: Sample of the "Schlitzbrückenblech" during the design phase [1]

4.2.2. Low Frequency Absorption

The bulk of the necessary low-frequency absorption was incorporated into the one wall in each studio which was not made from glass with some additional LF-absorbers mounted behind the ceiling panels to provide LF control also in the Z-axis.

All the low frequency absorbers were designed as membrane absorbers based on the well known principles.

5. Acoustical Simulations and Calculations

5.1. General

Throughout the design phase of the glass-studios extensive use was made of acoustical simulations and auralisations as it became clear quite early on that the way to communicate between the staff of Radio DRS and the acousticians had to be on a “subjective level” via sound samples generated by auralisation. Even with people working in radio production - despite their high affinity to sound and acoustics – it’s not appropriate to discuss acoustical matters via abstract data and graphs.

The main goal of using computer simulation was to study the effects of various layouts and “density” of the “Spaghetti”-absorbers. The author was fully aware about the limited validity of the results which standard room acoustic simulation software available ten years ago could generate when applied to small rooms (i.e. no valid results in the low frequency range). Nevertheless after some initial tests the quality of the auralisation-files and the data regarding reverb times and reflection behavior in the mid- and high-frequencies were seen as sufficient for *qualitative* comparison of different versions of acoustic treatment within the same room.

During the design process various sets of auralisations representing different layouts of absorbers were prepared for the working group of Radio DRS. For these auralisations anechoic recordings of various actual presenters (male and female) were used. A sound source with a frequency dependant directional characteristic resembling a human head was placed in the computer model as a “virtual presenter”. The presenter’s microphone was represented as a possible receiver point within the computer model.

The members of the working group then held listening sessions and returned their feedback to the acousticians. Simultaneously the acousticians used various output data from the simulation software to study reflection behavior etc. and to augment and validate data from “manual” calculations regarding reverb time, modal behavior etc.

5.2. Main On-Air Studio

Out of the selection of the studios that were included in the computer simulations we will focus for this paper on the main on-air studio which has a volume of approx. $65m^3$.

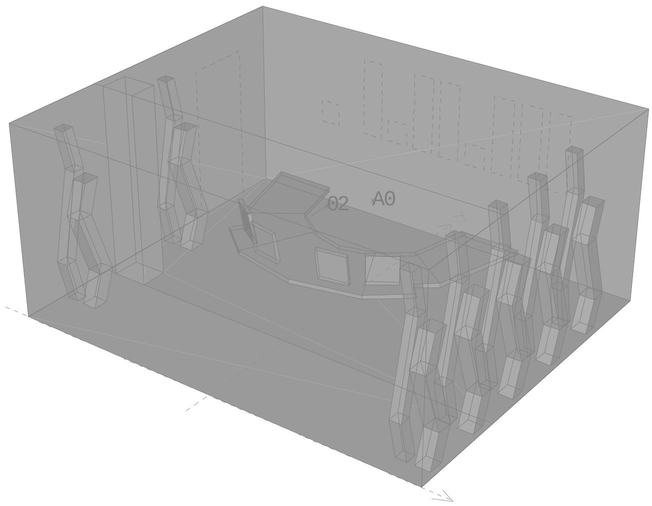


Abb. 14: Computer model of main on-air studio with an “absorber density” of 50% [2]

5.2.1. Reverb Time

It became obvious that the target reverb time curve could be achieved relatively easy with a quite low “density” of the “Spaghetti”-absorbers. In the final design about 50% of the available length along the glass-walls was treated with such absorbing structures.

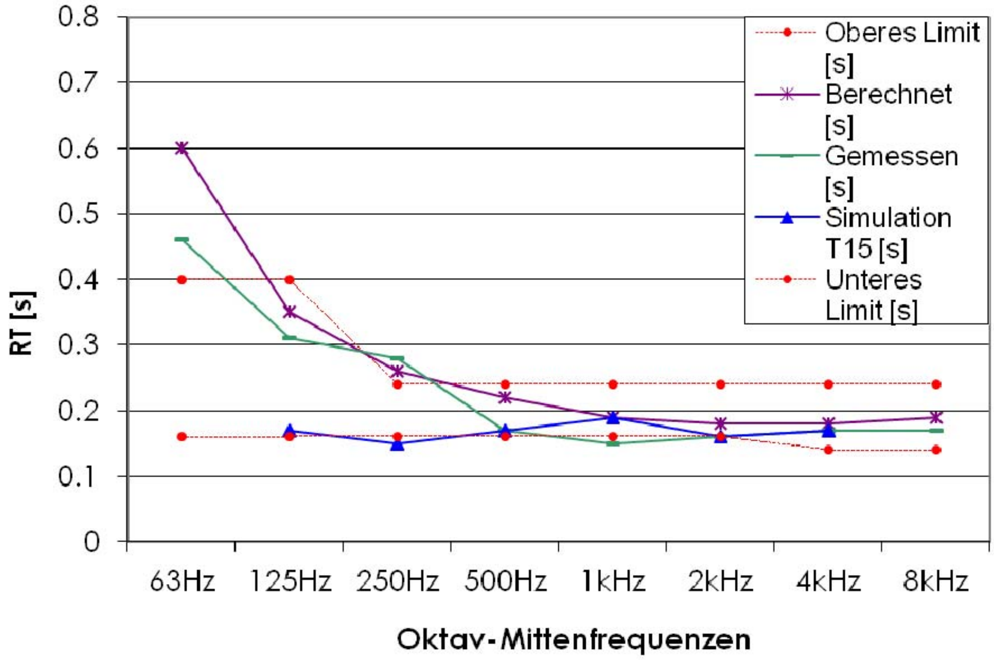


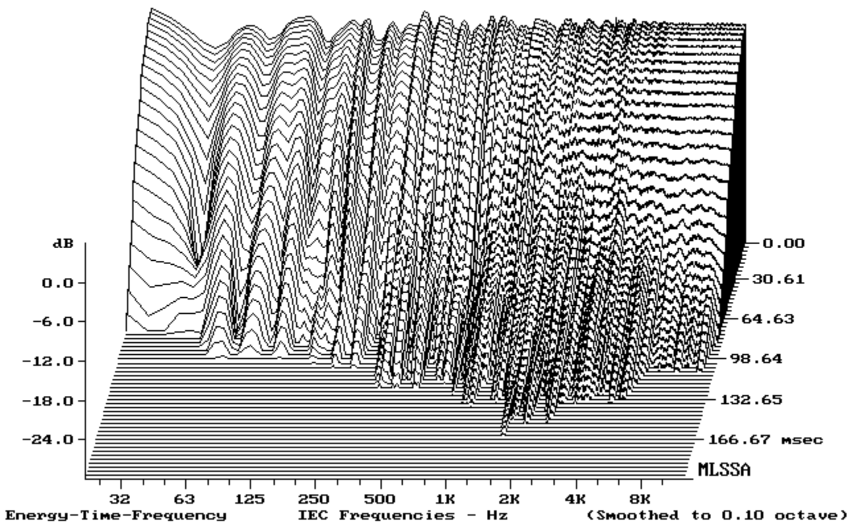
Abb. 15: Main On-Air Studio; final design – calculated, simulated and measured reverb times vs. upper and lower limits

- ● Upper limit of reverb time
- * Calculated reverb time (according to Eyring)
- \- Measured T15 reverb time
- ▲ Simulated T15 reverb time
- ● Lower limit of reverb time

Calculated, computer simulated and measured reverb times shown in Abb. 15 for the main on-air studio exhibit a fairly good agreement in the mid- and high frequencies. Not surprisingly the values start to fluctuate in the low frequencies due to the limitations of the simulation and the non-diffuse sound field in small rooms at these frequencies.

5.2.2. Reflection Behavior

Creating an acoustical environment free from disturbing reflections which are causing "comb-filtering" at the presenter's microphone or flutter-echoes within the room was as important as achieving the target reverb time curve. Besides studying the ETC's derived from the computer simulation, the impulse responses were exported to a MLS analysis software and processed to appear as ETF ("Waterfall") diagrams. The resulting diagrams often helped with finding unwanted clusters of reflections.



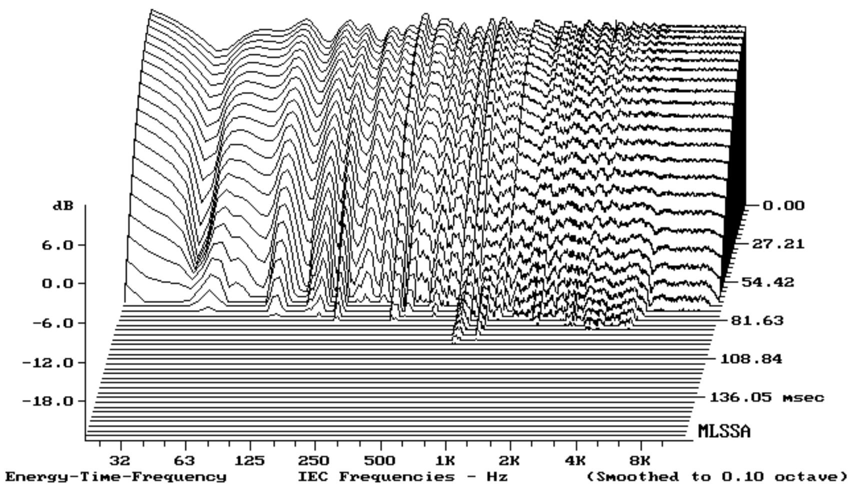


Abb. 16: Comparison of "Waterfall"-diagrams generated from simulated impulse responses; top: on-air studio with limited amount of absorbers placed along glass side walls; bottom: on-air studio treated with absorbers along side walls [2]

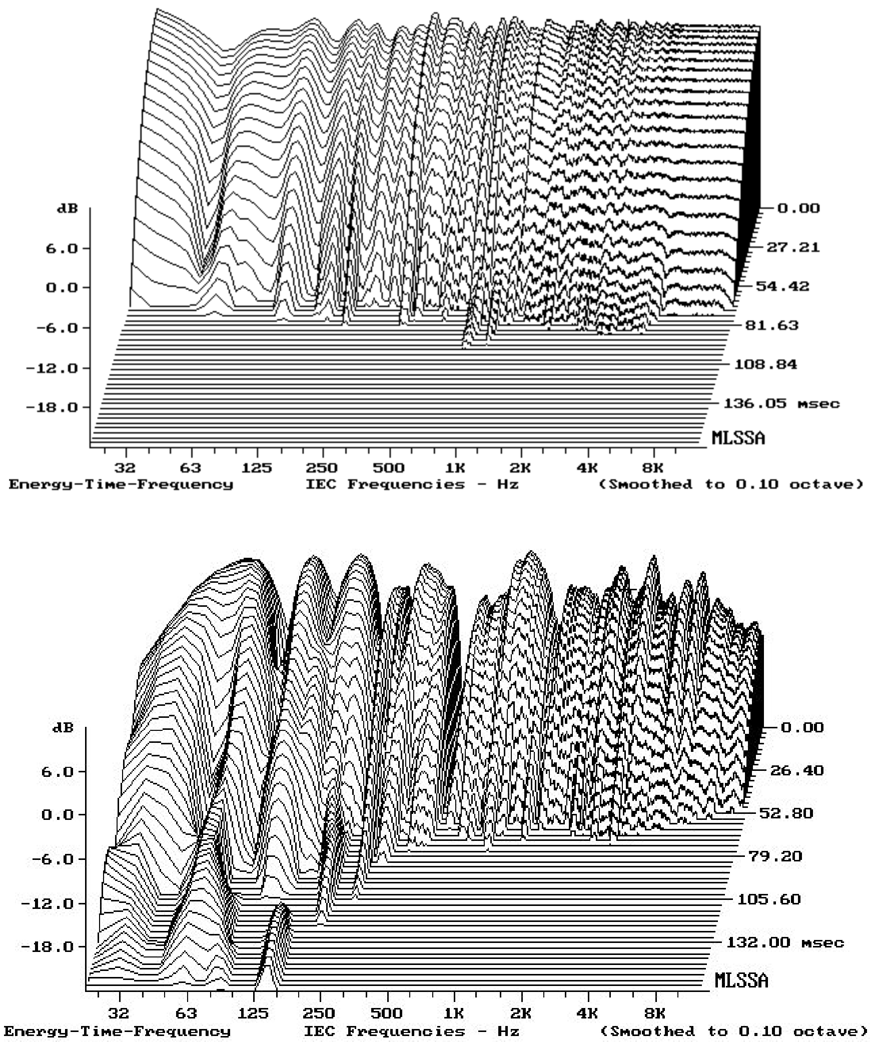


Abb. 17: Comparison between simulated and actually measured “Waterfall” diagrams in main on-air studio (not valid below 200Hz). [2]

It may be a well known fact but it seems appropriate here to mention again that any reflecting surfaces close to the microphone(s) can cause strong reflections which lead to very unpleasant colorations of the recorded signal. Contemporary broadcast studios contain a large amount of flat-screen displays etc. often arranged in a semi-circular fashion around the presenter. This often leads to serious problems with reflections from these surfaces. Careful consideration should therefore be given to the positioning and angling of such reflecting surfaces close to the presenter’s microphone. Even the best room acoustical treatment on the surfaces of the room will not help if the recorded sound is degraded by reflections from surfaces close to the microphone.

6. User Feedback

6.1. General

At the time of writing this paper the main channel of Radio DRS is broadcasted from the glass studios since more than 7 years. The author was interested to learn what the users had to say after such a relatively long time of continuous operation. Interviews were therefore held with the head of presenters and the head of technical operations responsible for the Zürich studio of Radio DRS. Some of the questions and respective answers are reproduced below in condensed form.

6.2. Feedback from the Presenters

Q:
How do the presenters feel working in the glass-studios and being visually "exposed" to their colleagues and to guests and visitors?

A:
The presenters like to work in the glass-studios. The fact that they are "connected" to their surroundings and also to the outside world (i.e. seeing daylight, the weather etc.) is much appreciated. They don't feel visually "exposed" due to the glass walls of the studios – they are already much more exposed to the public by the continuous presence of webcams in the studios.

Q:
How do guests and visitors like the glass-studios?

A:
There haven't been any negative reactions from guests or visitors. In general they don't feel visually exposed – again the presence of webcams is what usually concerns people. The "Spaghetti"-absorbers are quite frequently a talking-point between presenters and guests coming to be interviewed and such conversations often helps to "break the ice" ahead of the actual interview.

Q:
Were there any comments from the listeners after broadcasting of DRS1 had switched from the conventional to the new glass-studios?

A:
No, there haven't been any know comments from the audience after switching to the glass-studios.

Q:
Would you consider building similar studios in the future? If yes, do you have any suggestions for improvements?

A:
Yes we would consider building similar studios in the future. Reverting back to "traditional" studios would be regarded as a step backwards.

New studios should be larger to be able to accommodate the additional people involved in modern radio production. In the future the studios might become even more “transparent” up to the point that the presenter is part of a “Newsroom” where no studio walls do exist anymore.

Abb. 18: View from outside into the main on-air studio [2]

6.3. Feedback from the Technical Department

Q:
Have the glass-studio proved suitable for the demanding on-air broadcasting and pre-production work?

A:
Yes. The on-air studios have never been the cause of any problems. The pre-productions studios within the complex are suitable for day to day voice recordings. For more demanding applications such as radio-drama, talking books etc. they are only recommended with some reservations.

Q:
Have the acoustic treatment in the studios been changed in any way during the last years?

A:
Yes, there has been some experimenting with the placement of the “Spaghetti”-absorbers as they can easily be moved around.

Q:
Has it been necessary to use any special audio equipment (i.e. microphones) in the glass studios?

A:
No. There have been tests with alternative microphones over the time but by demand of the presenters traditional large-diagram condenser microphones are still used.

Q:
Would you consider building similar studios in the future? If yes, do you have any suggestions for improvements?

A:
Regarding the on-air studios the concept is sound and the studios do work without problems. For (pre-) production studios a more conventional approach (i.e. less visually transparent with more conventional room acoustical treatment) would be preferred.

Abb. 19: View from presenter's desk - "traditional" large capsule condenser microphones are used. [2]

7. Conclusion

Based on the technical facts and the feedback from users it seems permissible to say that the project of building the glass-studios has been successful. Despite initial concerns the sound quality of the on-air studios is rated by the responsible people as equally good as studios

with conventional construction and room acoustical treatment. The pre-production studios are suitable for the daily needs of radio production. For more specialized recording applications studios of more conventional construction would be preferred.
From the observation that no comments at all have been received from the audience it might be said that the changeover between the old conventionally built and the new glass-studios has been quite unnoticeable for the listeners.

The new environment has been well received by the people working in the studios. The visual transparency has been rated positive and helps the presenters and guests to feel “connected” to the outside world.

8. Bildquellen

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