ICSV13 - Vienna
The Thirteenth International Congress on Sound and Vibration
Vienna, Austria, July 2-6, 2006

THE ACOUSTIC SITUATION AT THE ST. STEPHEN`S CATHEDRAL IN VIENNA

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Abstract

During history the acoustic itself as well as the music played at the St. Stephen's cathedral in Vienna has changed a lot. In the presented project extensive acoustic measurements were made and a model for room acoustic simulations was built. This is the basis for a better scientific understanding of the present acoustic situation and will help to develop a proposal for optimization of the musician's situation.

HISTORY AND PRESENT SITUATION

The St. Stephen's cathedral in Vienna (see figure 1) was built during the Romanesque and the Gothic period. At this time the music and its performance was completely different to now (see [3] and [4]). Additionally there were some architectural changes which had an impact on room acoustics, too.
Table 1 shows a list of typical positions for music performance. Figure 2 shows these positions within the ground plan of the cathedral.
The aim of the presented work was to get a better scientific understanding of the acoustic situation in this large room because there have no detailed measurements done before. On basis of these measurements and additional room acoustic simulations proposals for an optimization of the musician's situation should be made.

Eds.: J. Eberhardsteiner, H.A. Mang, H. Waubke

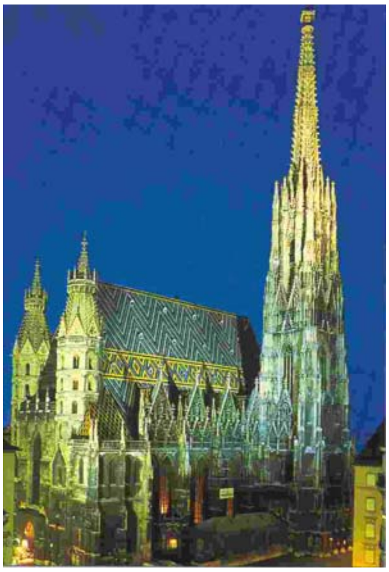

Figure 1 – St. Stephen’s cathedral in Vienna

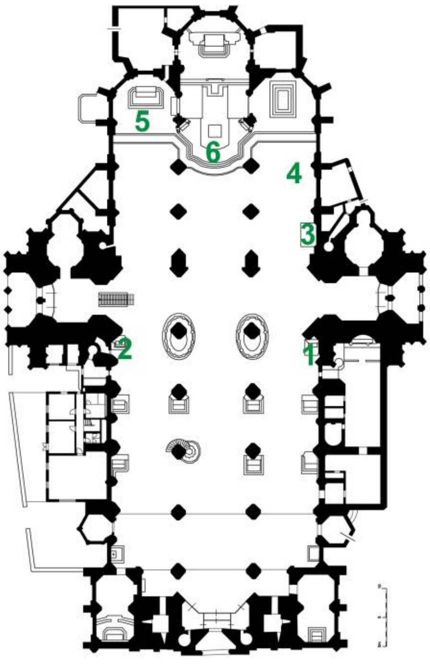

Figure 2 – Ground plan of the St. Stephen’s cathedral in Vienna with typical positions for music performance (1-6)

Table 1 - Typical positions for music performance at the St. Stephen's cathedral in Vienna

Position Number	Position Name
1	Füchselbaldachin
2	Orgelfuß
3	Neue Orgel
4	Friedrichsschiff
5	Altar Wr. Neustädter Schiff
6	Volksaltar

MEASUREMENTS

The measurements were done with a Norsonic dodecaeder and AKG studio microphones, a PC, an 8-channel professional soundcard and the software WinMLS2000, which works with maximum length sequences.
Source positions of the dodecaeder were at position 3, 4, 5 and 6 (see fig. 2). There were in total 213 microphone positions all over the room. Figure 3 gives an impression of the measurements at the cathedral.

Figure 3 - Measurements at the cathedral: the source was located at the Volksaltar and the microphones are in the Hauptschiff

For the analysis of this huge amount of measurement and simulation data a special tool for visualization was programmed. With the aid of this tool a 2-dimensional display of different user-defined parameters was possible (which is not possible within the software WinMLS).
Results of the measurements for the reverberation time T30 are shown in figure 4.
Concerning the height of the source position the measurements show a significant better acoustic situation for a height of 3 meters in comparison with 1.5 meters (see figure 5).
An analysis of the hall radius has shown that there are no musical relevant so-called coupled rooms at the cathedral.

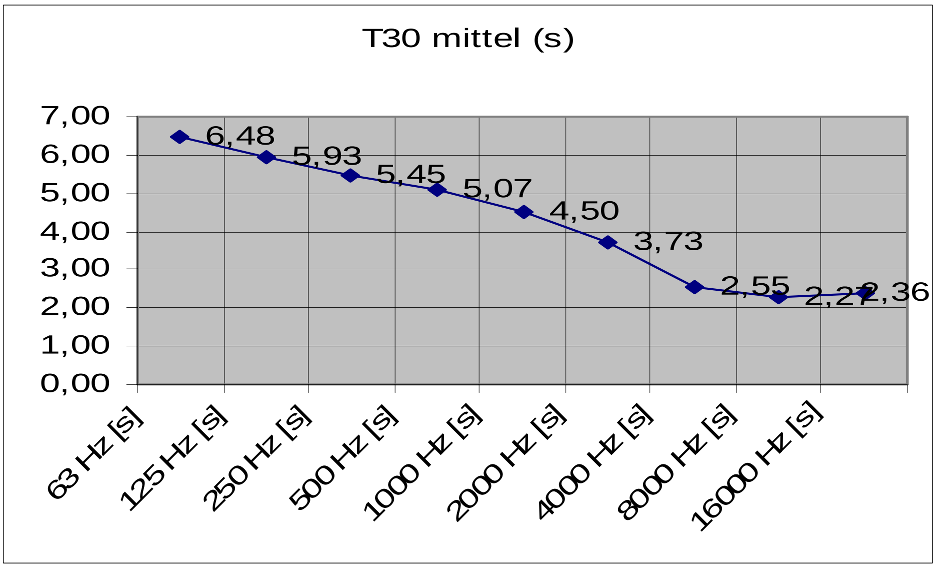

Figure 4 - Results for the reverberation time T30 at source position 4 at a height of 3.0 m

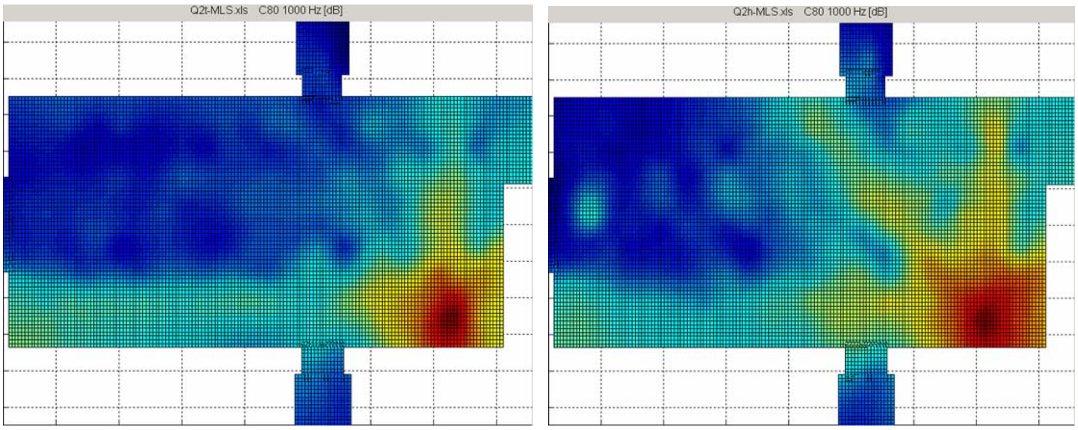

Figure 5 - Measurement results for the clarity C80 at source position 4 at 1 kHz at a height of 1.5 m (left) and 3.0 m (right)

SIMULATIONS

The room acoustic simulations were done with the software CATT Acoustic. The model has about 4700 planes, which reaches the limits of the software. Figure 6 shows the model of the cathedral, figure 7 a view from the west balcony into the room.

The optimization of the model showed that the parameter for the air dissipation has an important effect on the calculation results.

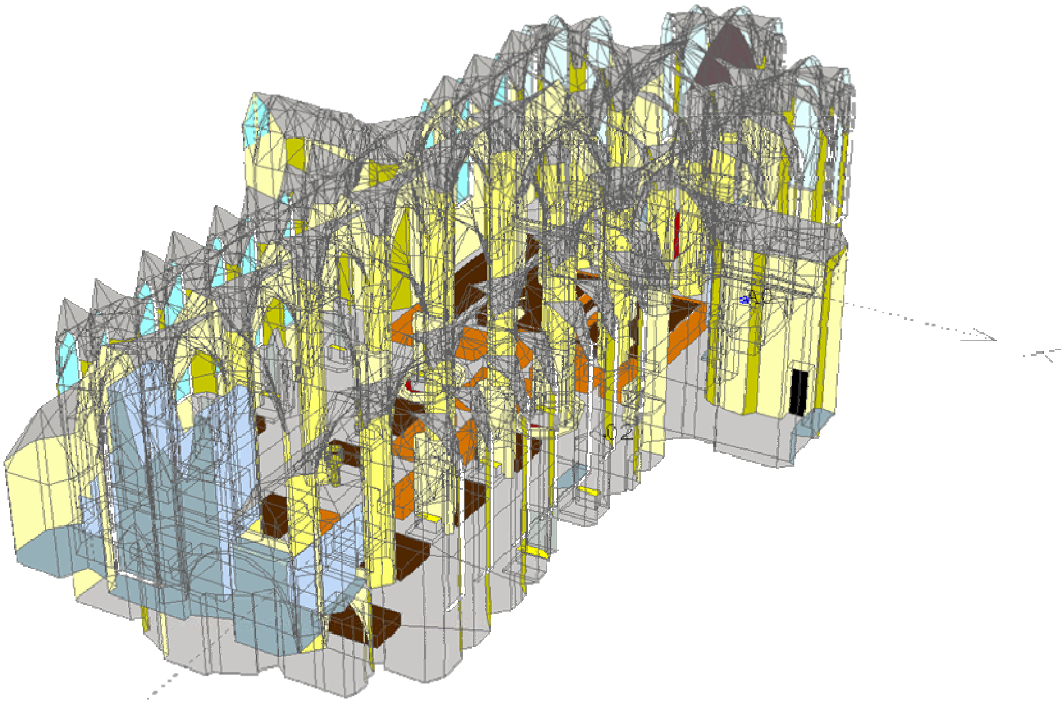

Figure 6 - Room acoustic model of the cathedral

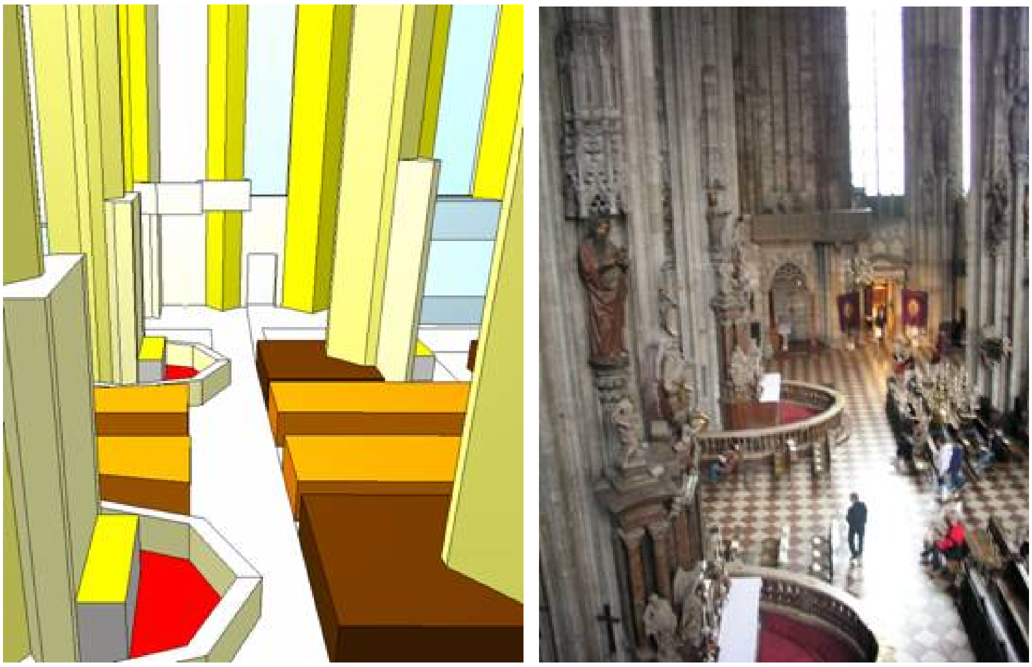

Figure 7 - View from the west balcony into the room at the modell (left) and in reality (right)

POSSIBILITIES FOR OPTIMIZATION

Several variations and combinations of walls, reflectors and podiums were simulated for source position 4. These simulations showed that an optimization of the musician's and listeners's situation could be achieved by a higher podium and special walls for the musicians as well as reflectors in the Friedrichsschiff and the Hauptschiff for a better sound distribution (see figure 8). The impact of the directivity of musical instruments as analyzed in [1] was studied, too.

Figure 10 shows a comparison of the results of the simulation without any wall or reflectors (top) and with walls and reflectors as shown in fig. 8 left (middle and bottom).

Figure 9 shows the simulation results of reflectors as shown in figure 8 right. The use of an additional reflector results in better values of C80 in the Hauptschiff.

Limitations for realizing possible actions are liturgical aspects and the protection of monuments.

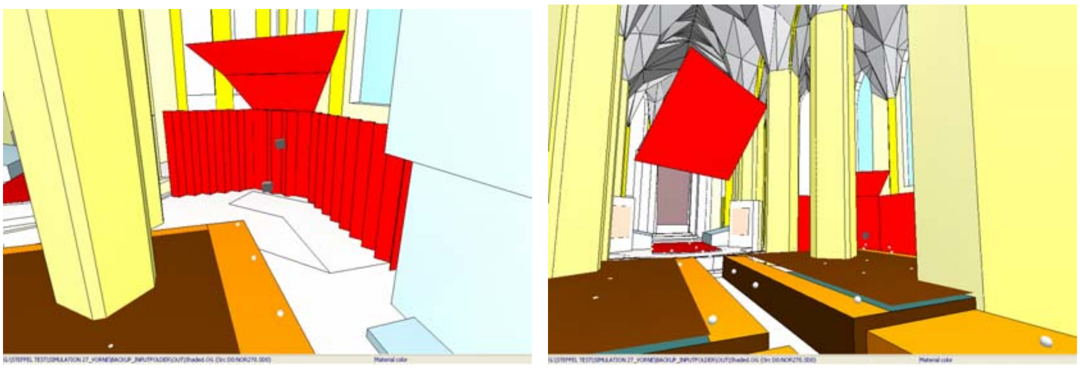

Figure 8 - Example of a wall and reflectors for an optimization of the musician's and listener's situation (left) and an additional reflector in the Hauptschiff (right)

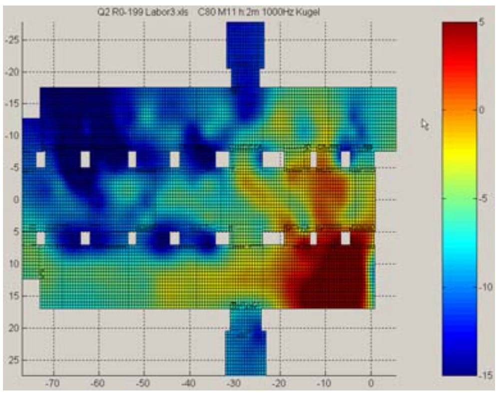

Figure 9 - Simulation results of clarity C80 with wall and reflectors as shown in figure 8 (right) at 1 kHz and 2.0 m

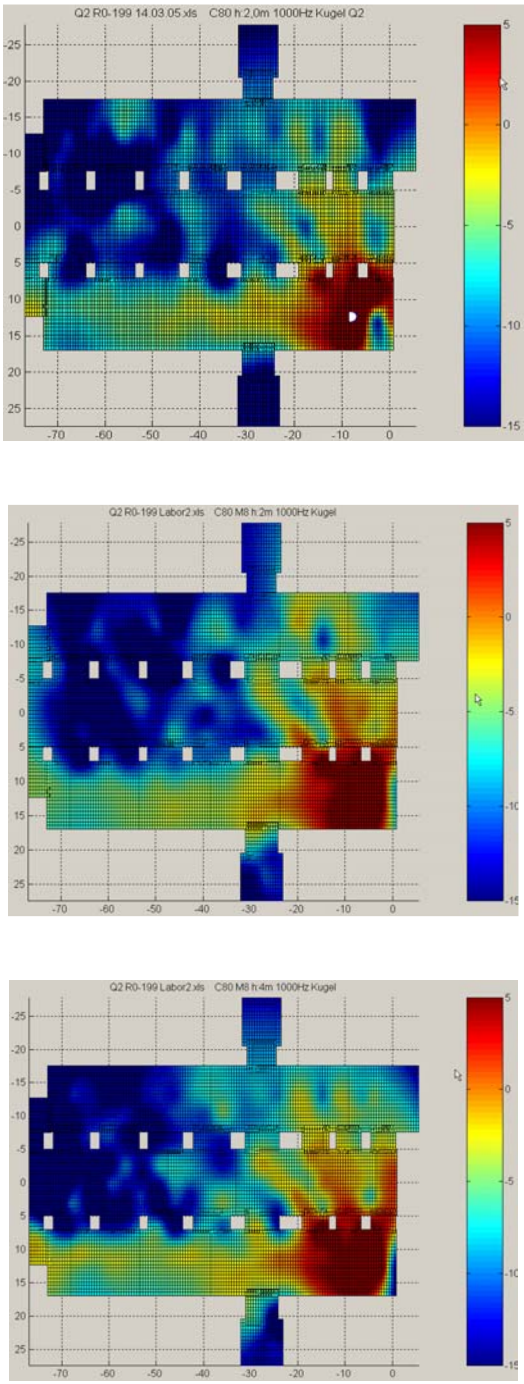

Figure 10 - Comparison of the simulation results of clarity C80 without any optimization (top) and with walls and reflectors shown in figure 8 left (middle and bottom) at the frequency of 1 kHz. The height of the source is 2.0 m (top and middle) respectively 4.0 m (bottom)

CONCLUSIONS

In this project the fine structure of the acoustic situation in a Gothic cathedral was investigated. Measurements as well as simulations have shown that there are no so-called coupled rooms at the St. Stephen´s cathedral in Vienna. The position for music performance in the Friedrichsschiff (position 4) is the best one regarding the given liturgical and musical circumstances.

An optimization of the musician's and listeners's situation could be achieved by a higher podium and special walls for the musicians as well as reflectors in the Friedrichsschiff and the Hauptschiff for a better sound distribution. Limitations for realizing these actions are liturgical aspects and the protection of monuments.

The authors would like to thank the Oesterreichische Nationalbank for providing grants for this project, Dombaumeister Wolfgang Zehetner, Domkapellmeister Johannes Ebenbauer and Franz Zehetner for their cooperation and support as well as the following people for their assistance (in alphabetical order): Stefan Behr, Ferdinand Fuhrmann, Lukas Leitner, David Ludwig, Nils Peters, Harald Rainer, Bernhard Rettenbacher and Gerd Weber.

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