

## Acoustic Aspects of Stage and Orchestra Pit in Opera Houses

Margriet Lautenbach<sup>1</sup>, Martijn Vercammen<sup>2</sup>, Klaus-H Lorenz-K<sup>3</sup>

<sup>1</sup> Peutz BV, Zoetermeer, the Netherlands, E-Mail: mla@peutz.de

<sup>2</sup> Peutz BV, Mook, the Netherlands, E-Mail: mv@peutz.de

<sup>3</sup> Peutz Consult, Düsseldorf, E-Mail: khl@peutz.de

### Introduction

Musicians and Singers in opera houses work under acoustic difficult circumstances. Due to acoustic and scenic reasons, mainly with respect to sound development and balance between orchestra and singers, the orchestra pit is a traditional and logical part of an opera house. The “underground” working place in the orchestra pit is especially beneficial for the balance between the singers and the orchestra. Especially for the grand opera’s the orchestra pit enables the sound and timbre of a full orchestra (about 100 musicians) without acoustically losing the singers completely. This can mainly achieved by an orchestra pit which is just partly open to the hall, with Bayreuth as an extreme example.

For musicians it is a challenge to work and to work together under these conditions: the musicians and the singer do usually not see the other, in the orchestra pit it is often quite to very loud and the singers are often surrounded by absorptive scenery and curtains. What transmission paths are still available for the musicians and how they can be evaluated acoustically?

### Measurements in Three Halls

To investigate the transmission paths for the musicians and singers room acoustic measurements are performed in three halls. The for this investigation highlighted and compared transmission paths are:

- Between a source and receivers on stage;
- Between a source and receivers in the orchestra pit;
- Between a source on stage and receivers in the orchestra pit and vice versa.

Besides the transmission paths the resulting balance in the public area between a source on stage and a source in the orchestra pit is compared.

The measurements are performed according to ISO 3382 and in the unoccupied halls with orchestra furniture in the pit. The scenery was depending on the opera playing. The acoustic relevant aspects of the scenery are described in the next paragraphs, combined with some data of the halls itself.

Figure 1 gives an overview of the measurement positions, in this case the opera house of Cologne, but the positions are systematically equal for the other two opera houses.

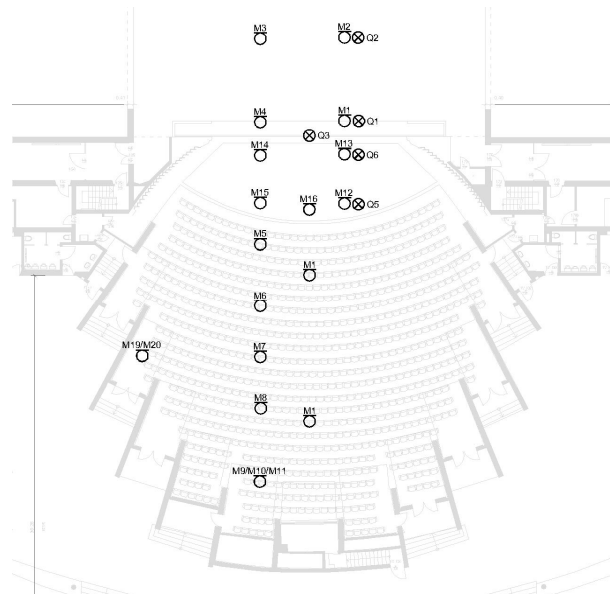


Figure 1. Measurement positions in the opera house of Cologne. Q1 to Qx are source positions, M1 to Mxx are microphone positions.

### Opera House Bühnen Köln

The opera house of the Bühnen Köln (“Cologne Stages”) has a public capacity of 1346 within a room volume of 10,000m<sup>3</sup> (hall without fly tower). The reverberation time of the unseated situation is 1.4 s, with audience the reverberation time is 1.2 s, both without the influence of the fly tower. In both cases with the stage opening is closed with a (metal) fire curtain. The scenery consisted of a reflective rear wall, on the sides curtains were present.

### Deutsche Staatsoper “Unter den Linden” Berlin

The Deutsche Staatsoper “Unter den Linden” in Berlin has a public capacity of 1350 within a room volume of 6,500m<sup>3</sup> (hall without fly tower). The reverberation time of the unseated situation is 1.3 s, with audience the reverberation time is 1.1 s, both without the influence of the fly tower. In both cases with the stage opening is closed with a (metal) fire curtain. The scenery was completely absorptive, all around stage was some kind of carpet with a layer of foam.

### Festspielhaus Bayreuth

The Festspielhaus in Bayreuth has a public capacity of 1800 within a room volume of 10,800m<sup>3</sup> (hall without fly tower). The reverberation time of the unseated situation is 2.4 s, with audience the reverberation time is 1.6\* s, both without the influence of the fly tower. In both cases with the stage opening is closed with a (metal) fire curtain. (\*The situation with audience is from literature [1], not from own measurements). The (famous) orchestra pit in Bayreuth is

quite large, therefore the number of measurements is larger, see figure 2 for an overview of the source and receiver positions in the pit. There was no scenery present, there was a curtain hanging in front of the rear wall, the side walls have reflecting panels under an angle of about 45 degrees, aimed at the hall.

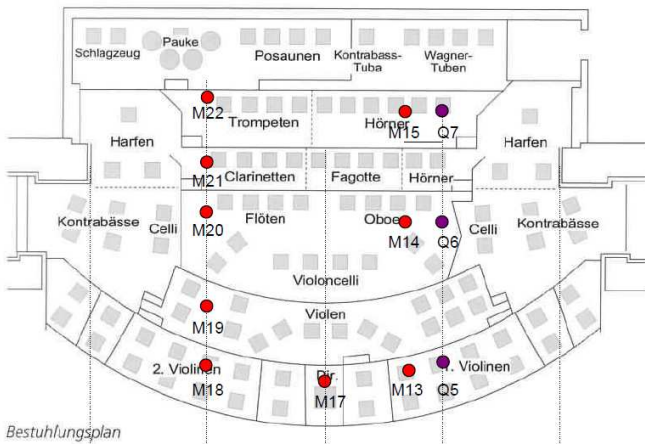


Figure 2. Measurement positions in the orchestra pit of the Festspielhaus. Q5 to Q7 are source positions, M13 to M22 are microphone positions.

### Comparisons between the Opera Houses

Figures 3 to 7 give an overview of a comparison of the three halls.

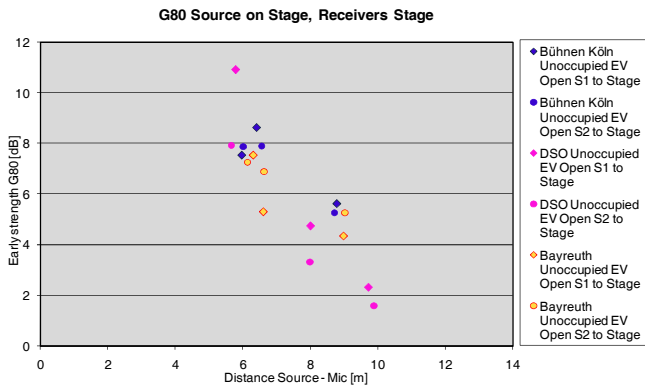


Figure 3. Measured Early Strength ( $G_{80}$ ) from the sources on stages to the receivers on stage. The absorptive surroundings in Berlin account for a large decrease of strength with distance.

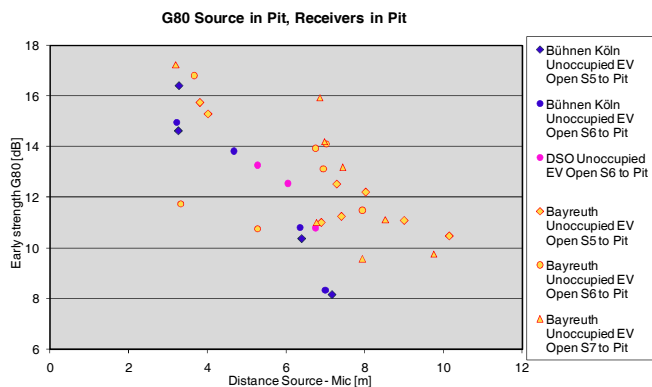


Figure 4. Measured Early Strength ( $G_{80}$ ) from the sources in the orchestra pit to the receivers in the orchestra pit.

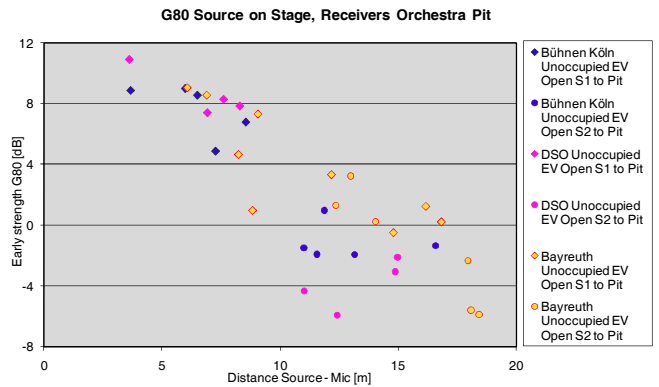


Figure 5. Measured Early Strength ( $G_{80}$ ) from the sources on stage to the receivers in the orchestra pit.

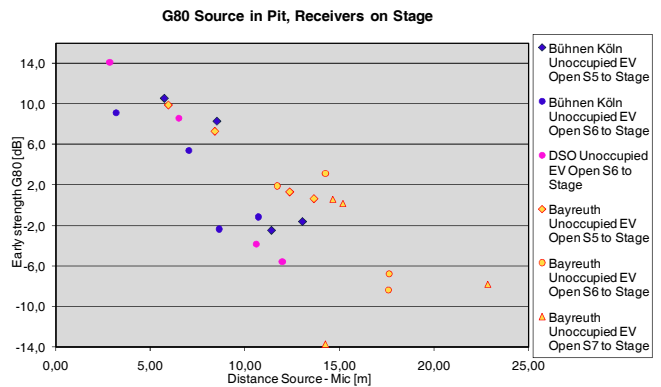


Figure 6. Measured Early Strength ( $G_{80}$ ) from the sources in the orchestra pit to the receivers on stage.

As for the balance in the public area, the measurements of the strength ( $G$ ) show:

- Cologne: A significant decrease with distance from stage, and less distance influence from the pit.
- Berlin: a large difference between the front of the stage and the back of the stage, sound from orchestra pit is relative loud.
- The sound from the stage gains much more natural strength than the sound from the orchestra pit. The balance is significantly different compared to the other two halls

### Impressions of the measurement results

Although there are not many reflective transmission paths between the musicians and the singers, the differences between the here presented opera houses are significant with respect to feed back, transmission and balance. Maximum use of reflections of proscenium walls and ceiling and orchestra pit walls improves the sound transmission between musicians and singers. The influence of the scenery is large, as is to be expected. A partly closed orchestra pit is very profitable in balance for the singers, but at the expense on the musicians underneath.

### Literatur

[1] Beranek, L.L.: Concert Halls and Opera Houses: Music, Acoustics, and Architecture. Springer, 2nd edition, 2004