

The acoustics of Renaissance theatres in Italy

Stefan Weinzierl ¹⁾, Paolo Sanvito ²⁾, Frank Schultz ¹⁾, Clemens Büttner ¹⁾

¹⁾ Technische Universität Berlin, Audio Communication Group

²⁾ University of Naples "Federico II", Department of Architecture

INTRODUCTION

The **Teatro Olimpico in Vicenza**, opened in 1585, is the oldest, fully preserved, modern theatre in Europe. Along with the theatres in Sabbioneta (1590) and Parma (1618), they are the only surviving examples of Renaissance theatre design. The earliest evidence of theatrical buildings in early modern Europe originates from the late 15th century, when temporary stages were built in several cultural centres of Italy. In the course of the 16th century a development towards permanent, roofed buildings can be observed, yielding a new building type and a new challenge for architects. The Teatro Olimpico was commissioned to the architect Andrea Palladio (1508–1580). After Palladio's death, the architect Vincenzo Scamozzi (1548–1616) was commissioned to supervise the project during the last months of construction. It was finally opened in 1585 with a performance of the Greek tragedy *Oedipus Rex* by Sophocles in a new Italian translation. The same Vincenzo Scamozzi designed the **Teatro all' Antica in Sabbioneta**. Built between 1588 and 1590, it is the first free-standing, modern theatre building. The

Teatro Farnese in Parma was built by Giovanni Battista Aleotti (1546–1636). It was completed in 1618 but opened only 10 years later with the opera *Mercury and Mars* and music by Claudio Monteverdi.

Whereas the room acoustical conditions of open and roofed ancient theaters as well as of baroque theaters and opera houses are quite well documented, theaters of the early modern period have attracted little attention of room acoustics so far in spite of their significance for European cultural history. The current study complements a series of acoustical measurements by a partial reconstruction of the historical state of the buildings along with acoustical simulations for the occupied condition, based on computer models of the rooms. By considering the room acoustical conditions in the light of their contemporary reception and the theatrical performance practice of their time we try to investigate, in how far later standards for the acoustical design are applicable to theatres of the Renaissance period.

METHOD

Impulse response **measurements** were performed in all rooms using a FFT-based measurement system with swept sine excitation, with a dodecahedron speaker as sound source, a diffuse field calibrated measurement microphone, a Neumann KU81i dummy head for BRIR acquisition, and a Fostex 6301B speaker with 4" broadband driver simulating a speaker directivity for STI measurements.

For the **simulation** of the occupied state, computer models (see Fig. 1) were created and transferred to a software for acoustical simulation using a hybrid mirror image/ray tracing algorithm. The absorption coefficients were defined according to observations in the actual theaters. Different absorption coefficients were assigned to the stage and backstage floor, the unoccupied tiers, and the audience, while all other surfaces were treated with a residual absorption coefficient, that was fitted so that the simulated reverberation times T_{20} would match the measured values within 0.1 s resolution.

RESULTS

With **reverberation times** (see Fig. 2) $T_{20,m}$ of 3.3 s (Vicenza), 2.4 s (Sabbioneta) and 2.9 s (Parma) for the unoccupied (U) room, the theatres of the Renaissance period are considerably more reverberant than typical baroque opera houses ($T_{20} = 1.2\text{--}1.6$ s). In the occupied condition, reverberation times are still relatively long and surprisingly similar, with values of 2.0 s (Vicenza), 1.7 s (Sabbioneta), and 2.0 s (Parma). From the **room acoustic parameters** (see Table 1) it gets obvious, that the acoustical conditions of all three theatres are far from modern standards for speech intelligibility and theatre design. Evidence for this are $D_{50,m}$ values < 0.5 , as well as STI values < 0.6 , even for the occupied (O) case.

Tab 1

	G_m (dB)		D_{-50_m}		STI	
	U	O	U	O	U	O
Vicenza	9.7	5.6	0.2	0.4	0.5	0.5
Sabbioneta	13.4	11.1	0.3	0.4	0.5	0.5
Parma	1.9	-1.5	0.3	0.5	0.5	0.6

Fig 1

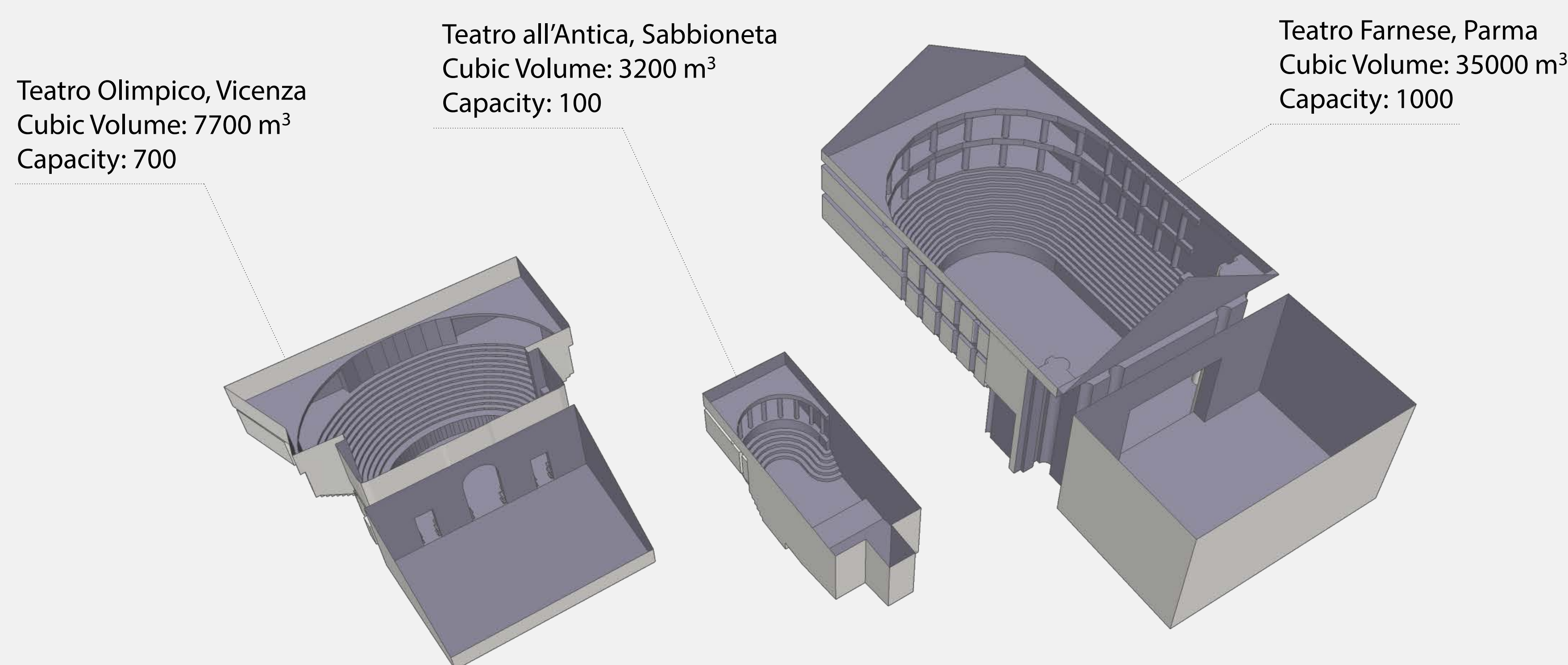
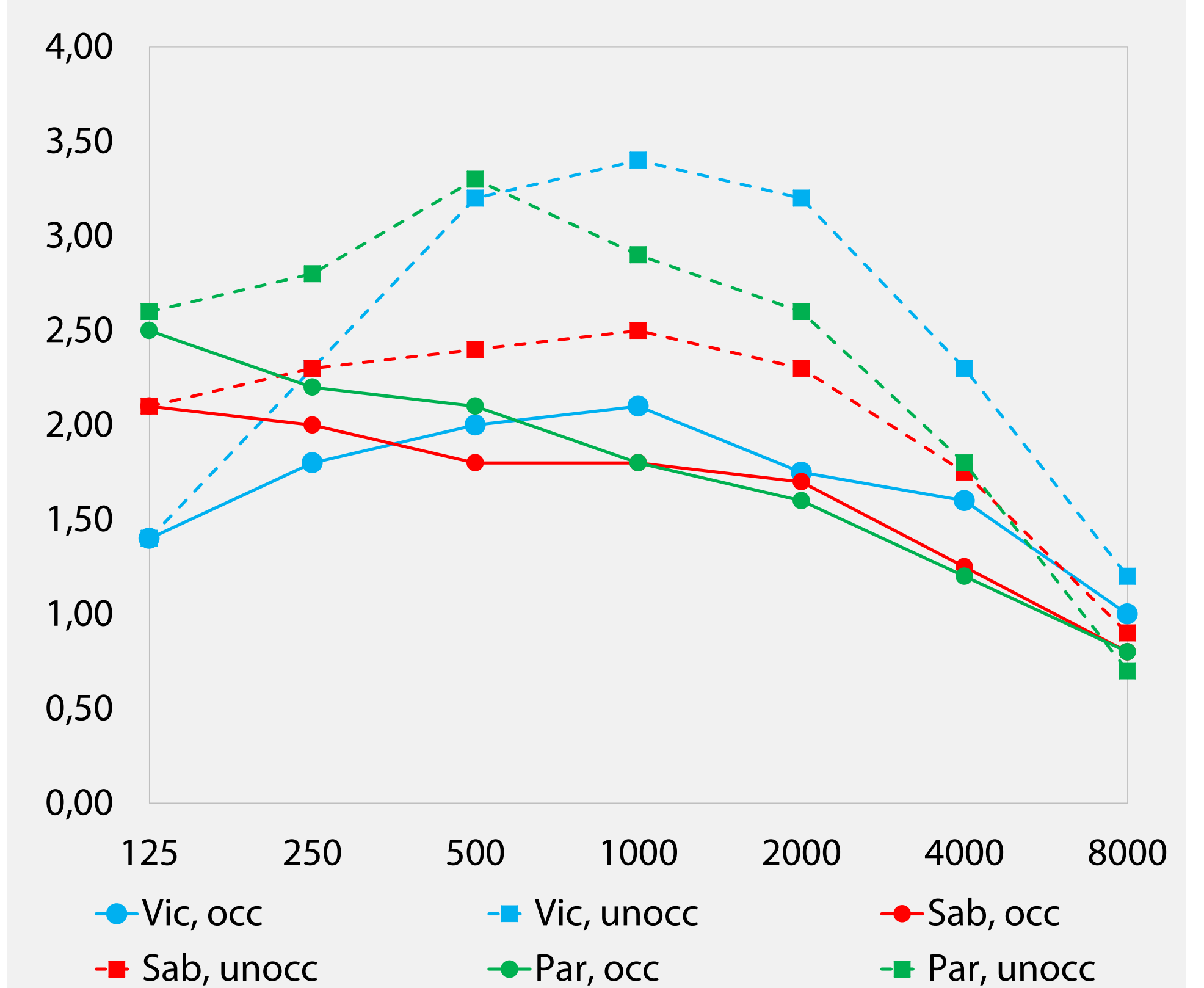


Fig 2



DISCUSSION

For modern standards, all venues from this period would seem acoustically largely inappropriate as a theatrical performance place. With reverberation times of 2.4–3.3 s for the unoccupied room and still 1.7–2.0 s with audience, they are far from modern recommendations for speech of 1.0 seconds or less. Hence, one could be tempted to consider the buildings as an acoustical failure. This conclusion would, however, not take account of the cultural context.

Considering the architect's experience with theatre design, the acoustics of the Teatro Olimpico could be no surprise, neither to the architect nor to the academy as his client. Moreover, none of the numerous preserved reactions to the opening performance in the theatre indicate that the contracting institution was unsatisfied with the building or with the production itself. All sources underlined the positive overall impression of the

performance as a result of the selected play, its staging and the performance space with its visual and acoustical properties. The play with its important musical parts as well as the venue have to be regarded as musical as much as spoken theatre, so the environment has to be judged at least as much according to its effect on music as on speech. The musical composition, with its predominant focus on text intelligibility and a subordination of

instrumental parts, anticipates elements of the opera, emerging as a new theatrical genre only a few years after the opening of the Teatro olimpico. That Renaissance theatres provided appropriate acoustical conditions for this new theatrical genre seems clearly confirmed both by contemporary reports and by the acoustical data of the current investigation.

OPEN ACCESS

All original data has been published using the **DepositOnce** repository for research data of TU Berlin. The dataset contains:

- Measured and simulated room impulse responses
- 3D models of the theatres (in DXF and SKP format)
- Anechoic recordings of the prologue of *Edipo Tiranno*
- Auralizations of the prologue, using measured impulse responses of the three theatres

<http://dx.doi.org/10.14279/depositonce-32>