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The acoustics of the concert hall Auditorio Juan Victoria from San Juan, Argentina

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The Auditorio Juan Victoria is a concert hall inside the cultural center of the same name, opened in 1970 in San Juan province, Argentina. The audience area is rectangular with a seating capacity of 976 people. The stage is fan shaped in which 80 musicians seated with their instruments and a choir of 90 singers standing can be accommodated. The hall is 22 m wide, 40 m long and 10 m high. The hall is equipped with a pipe organ with 44 ranks and 3565 pipes. In this article, the acoustic quality of the hall is assessed by a questionnaire and acoustic parameters are measured using the state of the art methods, including ISO 3382-1 parameters and subjective evaluation. Results are compared with subjective and objective data from other similar halls and recommended values from literature.

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1. INTRODUCTION

The Auditorio Juan Victoria is a concert hall inside the cultural center of the same name, opened in 1970 in San Juan province, Argentina. The building contains an outdoor theater, several practice rooms, classrooms, rehearsal rooms, foyers and dressing rooms. Figure 1 shows a general view of the building.

Figure 1: Auditorio Juan Victoria, Cultural Center building

Figure 2 shows a photograph of the concert hall from the audience area to the stage. The stage is fan shaped in which 80 musicians seated with their instruments and a choir of 90 singers standing can be accommodated. Hall dimensions are about 22 m wide, 40 m long and 3.50 m to 11 m high. The hall is equipped with a pipe organ with 44 ranks and 3565 pipes.

The ceiling is coffered and constructed from wood beams. The coffers are 150 cm wide, 150 cm long and 50 cm deep. Some of these coffers contain luminaires.

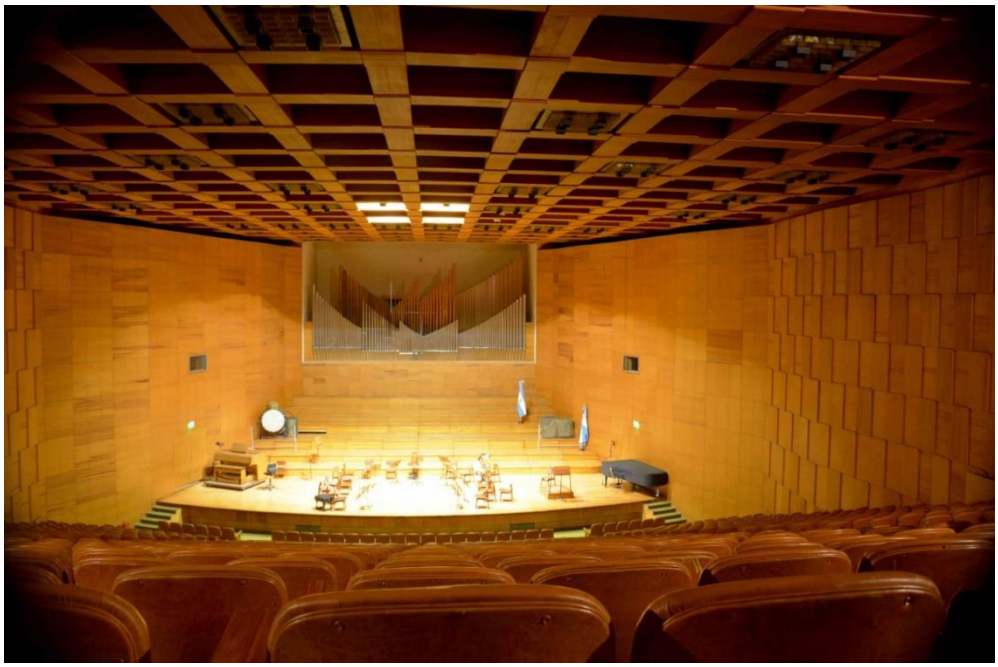

Figure 2: Concert Hall: Auditorio Juan Victoria. Stage view from audience area.

The photograph in Figure 3 shows the concert hall from the stage to the audience. The hall can accommodate 976 people on an audience area of rectangular plan. Sidewalls are made of wood with irregular rectangular shapes of about 5 cm deep. A carpet covers the floor and the seats are upholstered in leather.

Figure 3: Concert Hall: Auditorio Juan Victoria. Audience area view from the stage.

The hall is small in volume (9000 m^3) and capacity (976 people), compared to the concert halls reported in the literature as the halls with the better acoustic quality [1]. Auditorio Juan Victoria

concert hall is well-known at the regional level due to its excellent acoustic quality. It is the first of the concert halls especially created only for symphonic music in Argentina. The engineer and acoustical consultant was Federico Malvarez.

Figure 4 shows a section scheme of the hall. The slope of the audience is 18º.

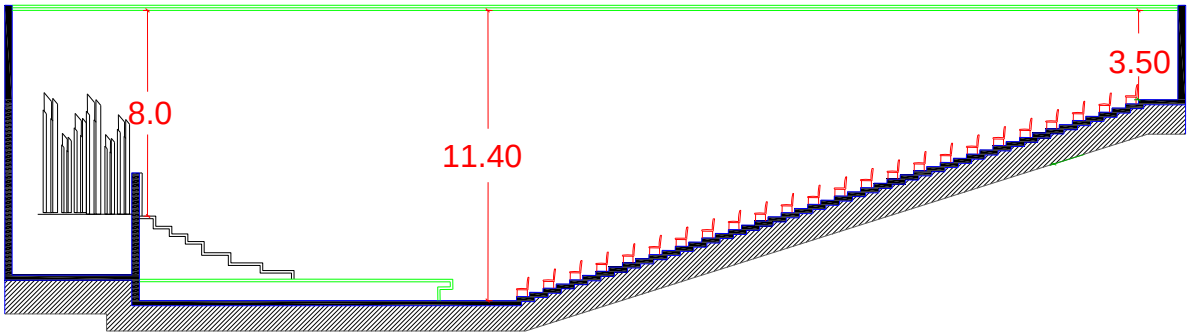

Figure 4: Concert Hall: Auditorio Juan Victoria. Section scheme (dimensions in meters).

2. MEASUREMENTS

A. MONAURAL MEASUREMENTS

We measured the impulse responses with the microphone of a sound level meter and a sound recorder validated for acoustic measurements [2].We used the method of the integrated impulse response of IRAM 4109-1 [3], corresponding to ISO 3382-1 [4]. Figure 5 shows the plan scheme and the positions of source and microphone.

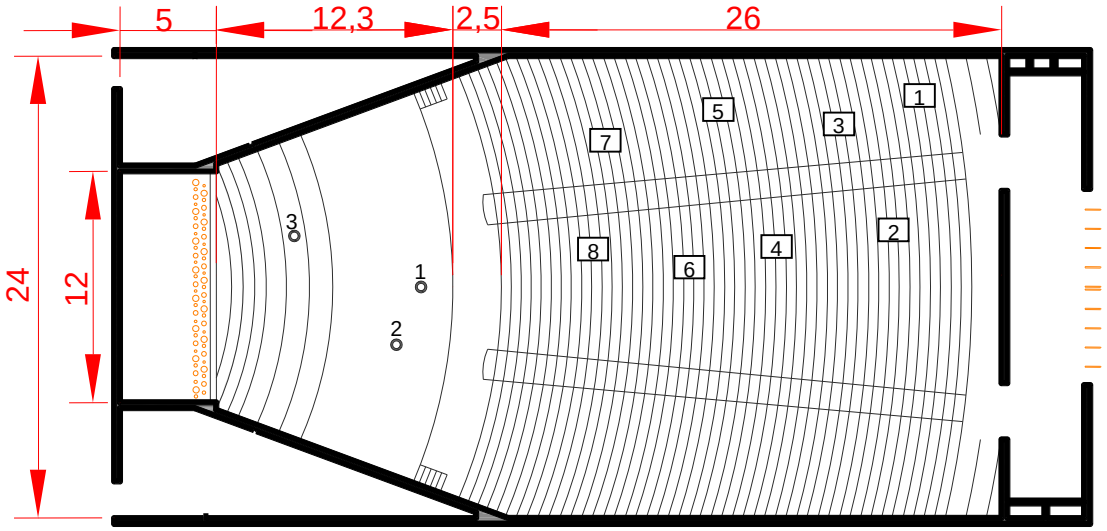

Figure 5: Concert Hall: Auditorio Juan Victoria. Plan scheme (dimensions in meters). Circles: source positions. Squares: Microphone positions.

We used balloons as impulsive sources (see Figure 3) positioned at the three points marked with circles in Figure 5. We decided to use balloons because it is a simple technique even though they do not conform the omnidirectional criteria [5] of the standards IRAM 4109-1 [3] and ISO 3382-1 [4] for low frequencies. We estimated reverberation time, early decay time, and other parameters from ISO 3382-1, from measurements.

We estimated the reverberation time (T) and early decay time (EDT_{MID}) using T_{30} and EDT at 500 Hz and 1000 Hz octave bands with a correlation coefficient of 0.99 (See [3] and [4]). We also estimated the bass ratio from the relation of T at 125 Hz and 250 Hz to T at 500 Hz and 1000 Hz.

B. SOUND DIFFUSIVITY INDEX AND INITIAL TIME DELAY GAP

We estimated the sound diffusivity index using the visual method of weighted average proposed by Haan and Fricke as reported in [1]. We calculated the initial-time-delay gap t_i at the 24 combinations of source and microphone positions.

Figure 6 shows one of the time series of the absolute value of pressure obtained using numerical computing software. We used this kind of plots to check that t_i < 20 ms for each combination source-microphone.

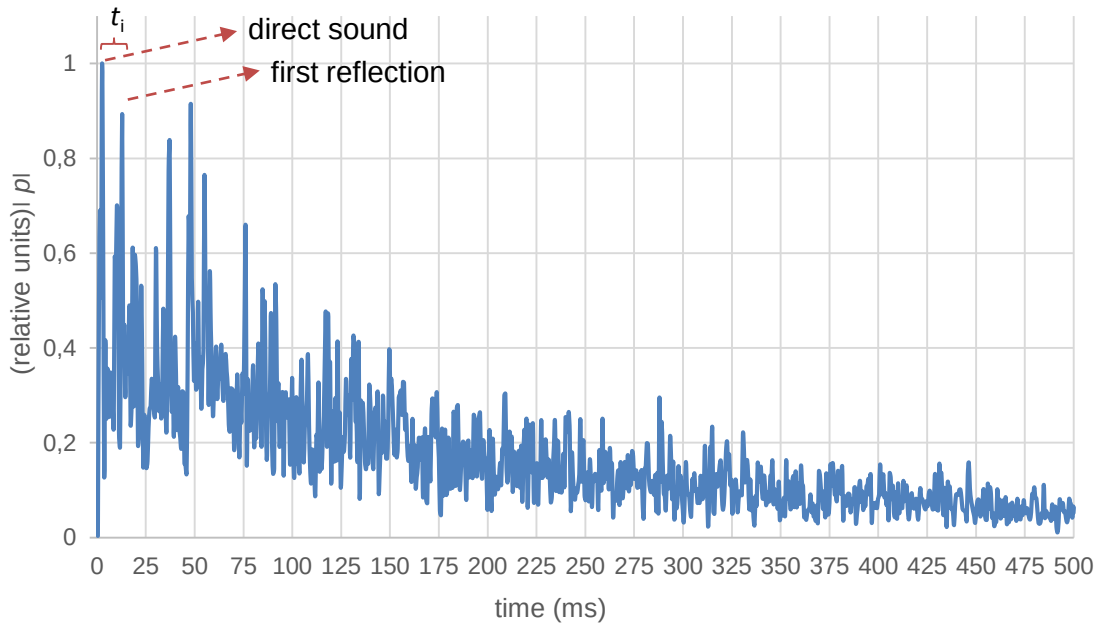

Figure 6: Absolute value of impulse response at microphone position 7 for source position 1.

C. SOUND STRENGTH

The sound strength should be measured following recommendations in [3] and [4]. An omnidirectional sound source with known sound power is required. In order to estimate sound strength at mid frequencies G_{MID}, in accordance with relations of several concert halls shown in [1], we used

$$G_{\mathrm{MID}} \approx 37 - 10\log_{10}\frac{0.161T}{V}$$

where V is the room volume (m^3).

D. OBJECTIVE PARAMETERS

Table 1 shows a summary of the measured parameters. The early interaural cross correlation for mid frequencies ($IACC_{E3}$) is available from a previous work [6].

Table 1: Summary of measured parameters

Parameter	Value
1-IACC$_{E3}$	0,66
t_i(ms)	<20
G_{MID}(dB)	6,8
EDT$_{MID}$(s)	1,7
BR	0,9
SDI	0,7
TR (s)	1,8

3. QUESTIONNAIRE

We conducted a questionnaire, inspired in the ones introduced by Barron and used by Beranek [1]. We used a 5-point Likert scale for each question. The first and last points of the scale were labelled. We asked about Clarity, Reverberance, Spatial impression, Intimacy, Sound strength, Balance for: treble, bass, soloist-orchestra and Background Noise. Finally, we asked for the global impression using a 7-point scale with the following labels for each point: very poor, poor, almost acceptable, acceptable, good, very good, and excellent.

The following list shows the translation of the subjective parameters (and labels used in each scale).

1.Claridad musical: Confuso – Claro

2.Viveza de la sala:Apagada – Viva

3.Impresión espacial: Amplia – Reducida

4.Intimidad acústica:Elevada – Pobre

5.Sonoridad: Elevada – Deficiente

6.Balance

a. *Agudos – Medios: Débiles – Altos*
b. *Graves– Medios: Débiles – Altos*
c. *Solistas – Orquesta: Débiles – Altos*

7.Ruido de fondo: Inaudible –Aceptable – Tolerable – Intolerable

8.Impresión Global: Muy mala – Mala – Aceptable – Buena – Muy buena – Excelente

The sample is composed of 25 persons including 2 directors, 12 musicians and 11 aficionados. Figure 7 shows average responses and the standard deviation. The result for the overall acoustic quality is 92 % with 2 % of standard deviation.

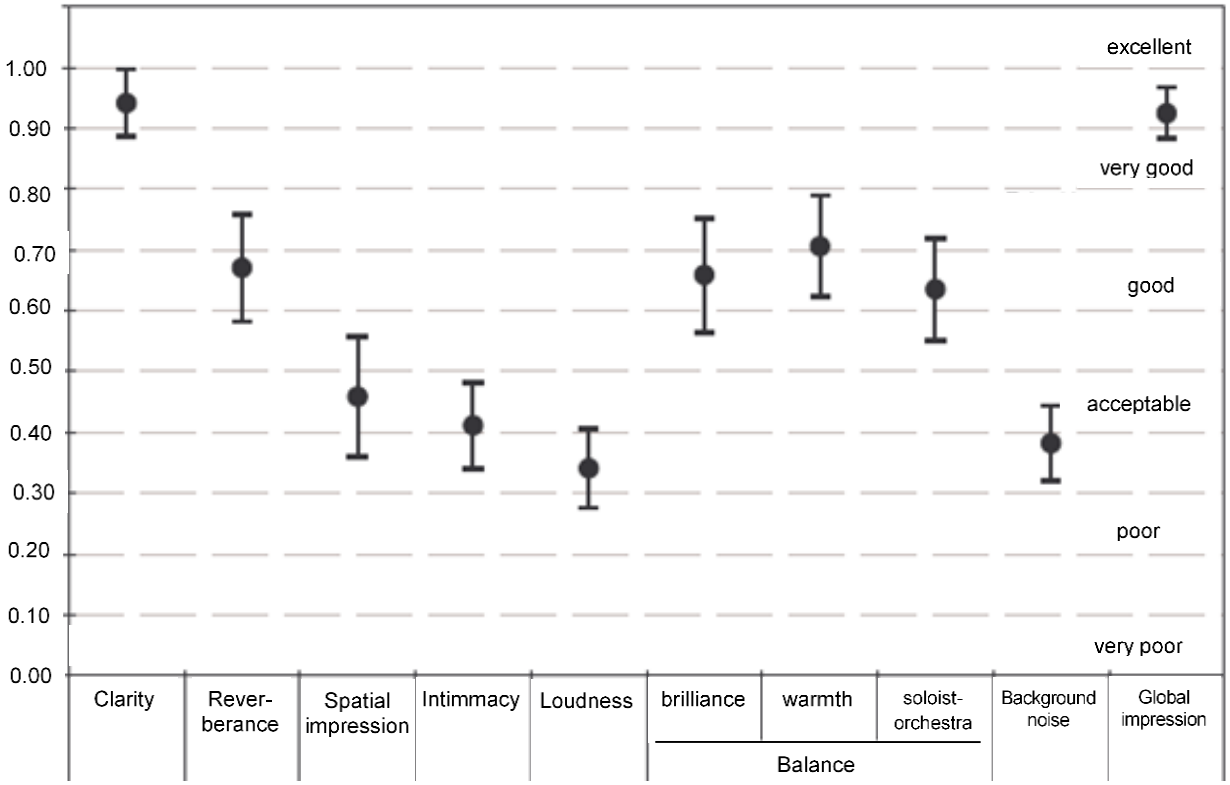

Figure 7: Questionnaire responses. Circles: average value considering scale between 0 and 1. Whistles: standard deviation

Subjective responses are similar to results reported in the literature for halls with similar acoustic quality. The acoustic quality of the hall is concluded to be between very good and excellent, a difficult condition to reach for such small concert halls used for symphonic music.

4. CONCLUSIONS

We analyzed the acoustics of the oldest concert hall designed only for symphonic music in Argentina. There are several older opera houses and theatres in Argentina used for symphonic concerts. A remarkable and well-known example is Teatro Colón, which Beranek [1] identifies as one of the best houses not only for opera but also when used for symphonic music.

We measured several objective parameters and conducted a questionnaire collecting subjective responses related to these objective parameters and to the acoustic global impression. The subjective response for global impression is very good to excellent. The global impression relates well with subjective and objective parameters of other rooms with similar global impression.

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