THE ACOUSTICS OF THE NEW CHAMBER MUSIC HALL IN BERLIN (WEST)
(Experiences during planning a central concert hall and the results)

Thomas Fütterer

Berlin (West), Germany

THE BASIC CONCEPT OF THE CHAMBER MUSIC HALL

The new Chamber Music Hall in Berlin is a fully concentric room in which the podium, the music, occupies the focal position. It was officially opened in October 1987.

In the case of the Berlin Philharmonic Hall, inaugurated in 1963, the architect, H. Scharoun, had initially also intended to create a completely central space. During planning, however, L. Cremer managed to persuade the architect to move the podium to a favourably situated decentralized position.

Notwithstanding this experience, H. Scharoun bequeathed the sketch for a completely central space for a chamber music hall, already intended to build at that time, in the immediate vicinity of the Philharmonic Hall (see Figure 1).

The architect, E. W i s n i e w s k i, the former colleague and, today, the administrator of the inheritance of H. Scharoun, felt that he was not in a position to deviate from this concept sketch and adopt a decentralized position for the podium as desired by the acoustic consultants and substantiated by them.

As the acoustical consultants, L. Cremer and the author of this report were aware of the difficulties involved in a concept of this type, the question arose as to whether or not they ought to undertake the advisory work. Initially, in such cases, one always anticipates a particularly interesting and challenging task. Had we already foreseen at that time the great extend to which we would be forced to make compromises as regards all of the acoustically necessary measures, we might possibly have declined to act as advisers.

Figure 2 shows the ground-plan and sectional view of the new Chamber Music Hall.

The fundamental acoustic planning principles are the same in both the Chamber Music Hall and the Philharmonic Hall. These principles involve, in the present case, however, a completely central tentlike ceiling with the reflectors suspended above the podium and a corresponding circular arrangement of the audience areas in sub-areas ascending in a terraced manner (vineyard-steps). This dividing up the audience represents a harmonization of a design concept conditioned by socio-political factors with favourable acoustic conditions - the unfavourable absorption effect arising through glancing incidence of sound over audience areas is interrupted, and supplementary reflection areas are created where the step heights are adequate.)

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MEASURES FOR THE ACOUSTIC PLANNING OF THE CENTRAL HALL

In the case of a central hall, the acoustic advisory work which is always required for concert halls additionally necessitates the solution of particular problems in view of the directional characteristics of the instruments and of the lot of surfaces which may cause focussing, echo-forming reflections.

Let us begin with the main problem, i.e. with the measures for the required balancing of the directional effects of the instruments. As it was expected that the preferred arrangement of the musicians would be such as to radiate the sound especially in one direction, as in all concert halls (here to Block A), it was necessary at this point to create hight surfaces with the greatest possible effectiveness in order to supply the seats located behind the instrumentalists with sufficiently strong early reflections.

Figure 3 shows the situation on this side of the hall. The dotted lines represent various possibilities for the attempts at realizing a very hight and effective step. The acoustically effective height, however, is greatly reduced owing to the aisle which is present for architectonic reasons between the upper and lower audience circles (main access area). It becomes clear, furthermore, that the aisle causes an unnecessary enlargement of the distance between the sound source and the outer audience area. Also, the suggestion of creating the required step height by means of reducing the inclination of the seat rows in front of the aisle could not be realized.

We were obliged to agree to the compromise of having this important reflection area in the parapet behind the aisle. The height thus effected represents the absolute minimum. It could have been still increased by lowering the parapet located directly in front. Now two areas of approximately equal height are present behind one another. (It should point out that one step of a given continous height is considerably more effective than two separated ones each of only half the height since the cutoff frequency increases in its geometrical effect in indirect proportion to the square of the step height.)

To allow also the audience sitting behind, to enjoy a good view also over standing singers, it had to be arranged for a parapet of the corresponding height at that point. For the same reasons, surfaces, but somewhat lower, are also present at each side of the podium.

Thus, inspite of the basic concept - music at the central point - which the architect had intended to achieve for this hall, a frontal and one-sided alignment has resulted, also in the optical sense.

It was thus possible, for the area of the podium, to create favourable acoustic conditions through synchronization with the required favourable visibility conditions.

The already mentioned reflectors (clouds) which are suspended freely above the podium were reduced to a half of the total effective area and their position altered more to the centre of the hall during the construction planning, contrary to our original concept with which the architect had been familiar.

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The provision to the podium and the lower audience areas of the individual reflections coming from the total of the 10 clouds is just about guaranteed. This, however, makes it no longer possible to obtain the originally desired overlapping distribution of reflections which would thus also have been projected more from the side (lateral).

The planned flank reflectors must also be mentioned here in connection with the lateral reflections which are generally regarded as important and which are necessarily generated by the side walls in a classical rectangular space. In a central hall, lateral reflections can only be produced by means of special measures. In the lower audience area they could be realized more or less successfully by parapet surfaces. This proved no longer possible in this form in the upper area. It was therefore proposed that large-area flank reflectors be provided on both the sides of the upper blocks in order thus to guarantee lateral reflections. The architect, however, preferred to split these up into three-sub-sections which provided hardly more effective acoustically. In this form they can no longer be regarded as reflectors but merely as architectonic design elements (see Figure 4).

The solution to the second geometrical problem concerning a central hall, the echo-forming reflections from all the "rear walls" or from all the angles between the edges of the ceiling and the rear walls, was provided in this case only by creating an oblique or acute angle between both contact surfaces. This causes the reflections coming from there to be spread out and the intensity to be sufficiently weakened to prevent any further concentrations (see Figure 3).

SUBJECTIVE ASSESSMENTS

The above explanations will, to some extent, have evoked the impression that they are intended as justifications for a lack of good acoustic conditions. This, however, is not the case.

Figure 4 shows a photograph of the hall taken from the last row of the upper circle, the front side, Block G, and looking in the direction to the "back end", the music tribune situated behind the podium.

Notwithstanding all of the above-mentioned concessions, the hall was assessed very positively, especially by the musicians with regard to the good contact and the good "spatial effect", but also by sound mixers and listeners.

The hall has reverberation times of adequate length and a hight distinctness which is just right for chamber music. Echo-forming reflections cannot be ascertained in the podium and audience areas. This, however, should not be allowed to conceal the fact that some listeners have assessed the hall unfavourably when they were sitting behind instruments which have an extremely distinct directional characteristic (eg. guitars).

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To what extent, then, it has been achieved in compensating the directivities of the instruments? Here the presence of maxima, eg. in the funnel direction of horns, is of less importance than the presence of minima which arise chiefly from the musician himself, eg. a cellist shading off the instrument with his whole body. Loudness and brilliance become weaker on the shaded side and this may even lead to a complete masking of the instrument in question, if others play equivalent loud at the same time.

Owing to the aisle between the upper and lower audience circles, which is not interrupted at any point, the hall offers the unique opportunity of directly comparing the differences from various directions. A difference is basically noticeable in all instruments to a greater or lesser degree, i.e. loudness and brilliance become weaker on the shaded side of the instruments.

These disadvantages become less apparent with increasing distance from the podium and, accordingly, with increasing height above the podium. This is especially true in case of the greatly elevated music tribunes. It would, therefore, actually have been possible to set the whole upper audience circle within the plane of the tribunes, without changing the distance to the sound source. This would also have necessarily resulted in a much higher step for useful reflections between the lower and upper circles. Without further alterations, however, this would have caused a reduction in the spatial volume and thus also led to shorter reverberation times.

Figure 5 shows a photograph of the hall taken from the music tribune behind the podium and looking in the direction of the "front end".

During one of the first concerts, an "open" concert where the audience were free to enter and leave the hall during the performance, it could be observed that the "latecomers" tended above to group themselves on the aisle behind Block A, the front side, until the whole of that reflecting parapet became shaded off completely. With regard to the seats on the opposite side, it became increasingly obvious here that the loudness and brilliance had fallen off to a degree which was no longer acceptable.

As a subjective inverse conclusion, it is successfully proved that the planned reflection surfaces for compensation of the directional characteristics of the instruments are practical and effective. It is therefore possible to a certain extent to compensate the directional differences in the sound radiation of the instruments. The use of higher reflecting surfaces would definitely have corroborated the above to an even greater extent. Nevertheless, until now, we do have the impression that this also would not be capable of completely eliminating the directivities.

RESULTS OF MEASUREMENTS

Figure 6 shows the measured reverberation times, T -5 to -35 dB, for a corresponding continued drop to a level of -60 dB for the condition without and with listeners. Also summarized here are the essential dimensions and the seating capacity of the hall.

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Pink noise was used as the transmission signal, this being directed from a spherical loadspeaker positioned near the centre of the podium. The selected reception points were a seat in the lower audience circle (Block A, right-hand side, centre) and a seat in the upper audience circle (Block G, row 2, right-hand side). These measurements had been done by the BeSB GmbH, Berlin, with a Nortronic 830.

The attempted magnification was at 125 Hz, and the magnification at 1000 Hz came as a surprise. We were less happy, however, with the decline at 250 Hz, this presumably being connected with the kind of the seating arrangement.

In view of the fact that no-one has as yet even mentioned, an unbalanced timbre, we have indeed informed our client of possible improvements but also suggested that it would be best to leave a final decision on effecting these to a later point in time when adequate experience will have been collected.

In order to make a more precise and objective assessment of the hall though solely as regards the empty room, recordings were also made of impuls noise at various points and these were then evaluated digitally by Müller BBM, Planegg, i.e. reverberation times were again determined and the clearness, the clarity and the time of centre of gravity evaluated, along with printing of echograms.

As transmission signal here were used pistol shots with 9 mm blank cartridges and the recording was effected by means of a NAGRA IV SJ. The results from 3 transmisson/reception point combinations are presented below.

Figure 7 shows the results for the transmission point at the front end of the lower circle (Block A, Row 6, in the hall axis) and for a reception point in the centre of the podium.

The echogram still displays a favourable path. The somewhat heavier drop after 65 ms is noticeable, but not to any detriment. We have tried to find out the surfaces which effect the main reflection peaks. The peak designated with 1) is caused by the reflectors. The convex surfaces required for a uniform distribution of reflections means that the intensity will become correspondingly smaller. The strong one designated with 2) comes from the hight parapet behind the podium. So the effectiveness of that surface is very well demonstrated. The reflection peaks designated with 3) and 4) come from different parts of the tentlike ceiling. These reflections are rather strong, eventhough the clouds are hanging rather compact. The peaks designated with 5) mark the reflections from the outer walls.

The also in this figure nominated values for the measured and calculated (expected) clearness of the hall verify the subjective impression.

Figure 8 shows the results for a transmission point directly behind the podium (Block C, Row 1, in the hall axis) and for a reception point, once again, in the centre of the podium.

Here the initial drop is heavier. A real effective reflection surface is lacking on the front side (behind Block A) whereas in the case of the first echogram such a surface was provided by the step behind the podium.

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The peak designated with 1) is caused by the floor of the Podium, the relative weak one designated with 2) by the reflectors. The ones designated with 3) and 5) come from different parts of the tentlike ceiling. They are weaker as at the first echogram as here the shading effect by the reflectors is stronger. The very small peaks designated with 4) come from the parapets behind Block A, the ones designated with 6) from the different parts of the outer walls.

The measured values for the clearness here are also higher as the expected ones.

Figure 9 shows the results for a transmission point on the music tribune, i.e. also behind the podium (Tribune L, Row 1, in the hall axis) and for a reception point in the centre of the podium.

Here, the initial drop is even heavier than for a seat directly behind the podium. As, in the case of a centric hall there are no hight side walls which lie relatively close to the sound source, stronger reflections within the range from 30 to 70 ms are lacking here. The reflections, still very strong, within the range from 150 to 200 ms, are generated by the outer walls. Here it is not necessary to discuss the different reflection peaks. The surfaces which cause the reflections between the ones designated with 3) und 4) could not be find clearly out.

In spite of the above mentioned intitial heavy drop in the level of the reflections, the music tribunes, which as a rule are occupied by listeners show themselves to be very good places owing to the early ceiling reflections and the merely small drop in level which has a total duration of up to around 200 ms.

RÉSUMÉ

The idea of the architect, H. Scharoun, of arranging the audience in a circular manner is correct and practical as regards an active communication which engages the circle itself. For activities of a one-way nature, on the other hand, aimed in the direction of a necessarily passive audience, this idea is definitely not practical owing to the present directivities of most of the sound sources.

On recognizing that the directional characteristics of the instruments, particularly where their numbers are low, and recognizing that the proportion of direct sound with its special frequency response play a wholly decisive role for the acoustics in a concert hall, the following essential question must be asked: Is a concentric concert hall at all necessary? Cannot the concept of "music at the central point", "sitting in a circle" and "experiencing in togetherness" be achieved just as well through a decentralized, in fact even a very much decentralized, position of the podium?

Hans Scharoun has already supplied a definite answer to this question with the large Berlin Philharmonic Hall. The concentric hall with the podium in the central position is not necessary for the realization of this concept.

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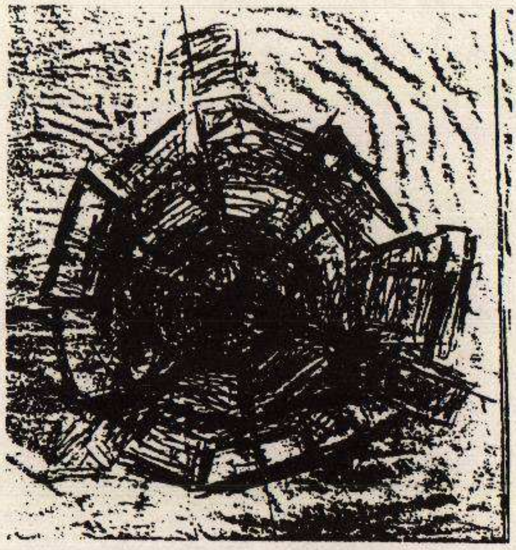

Fig. 1 Sketch from the architect H. Scharoun (the onlyone he had drawn), the idea for the new Chamber Music Hall in Berlin (West)

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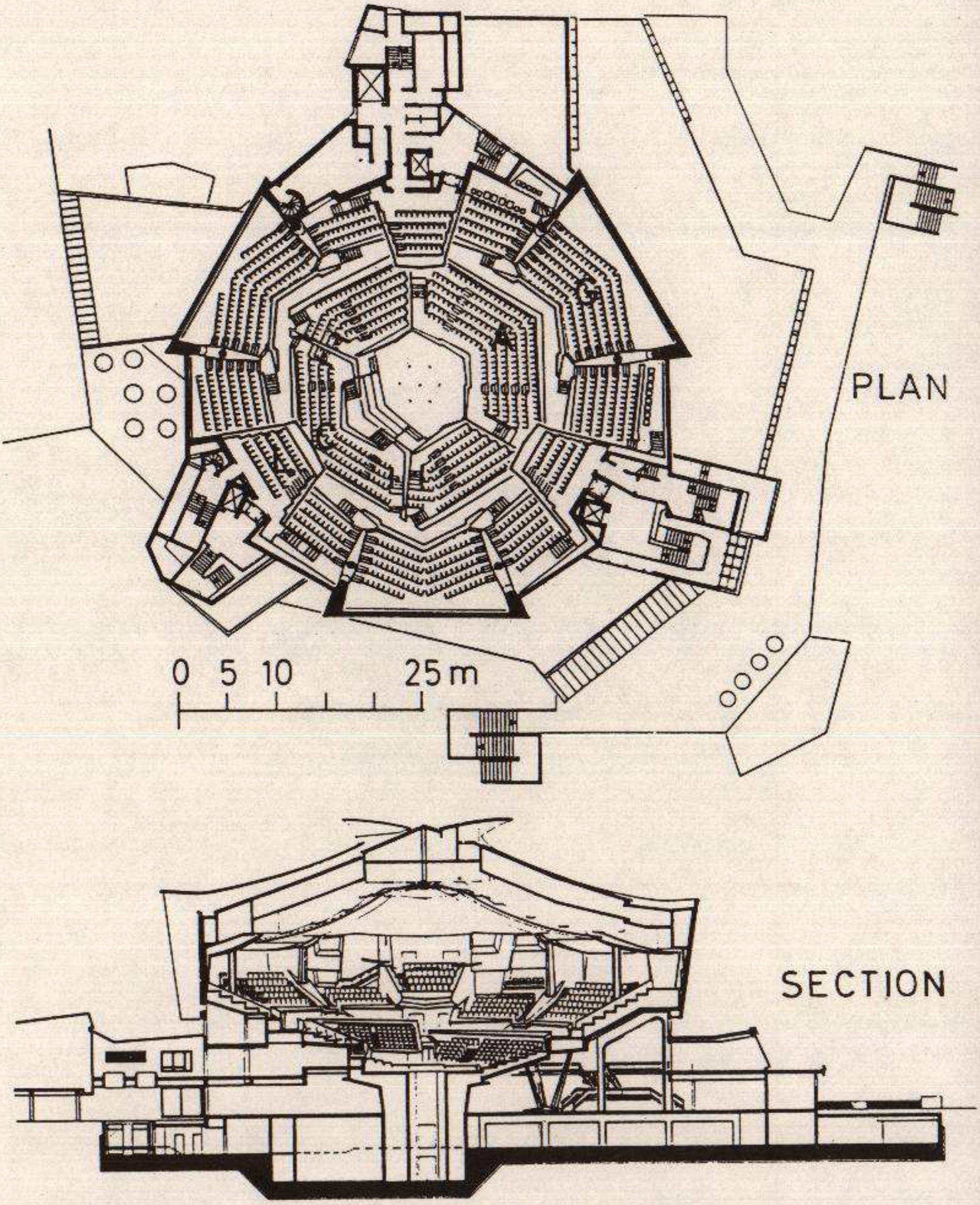

Fig. 2 Plan and section of the new Chamber Music Hall in Berlin (West)

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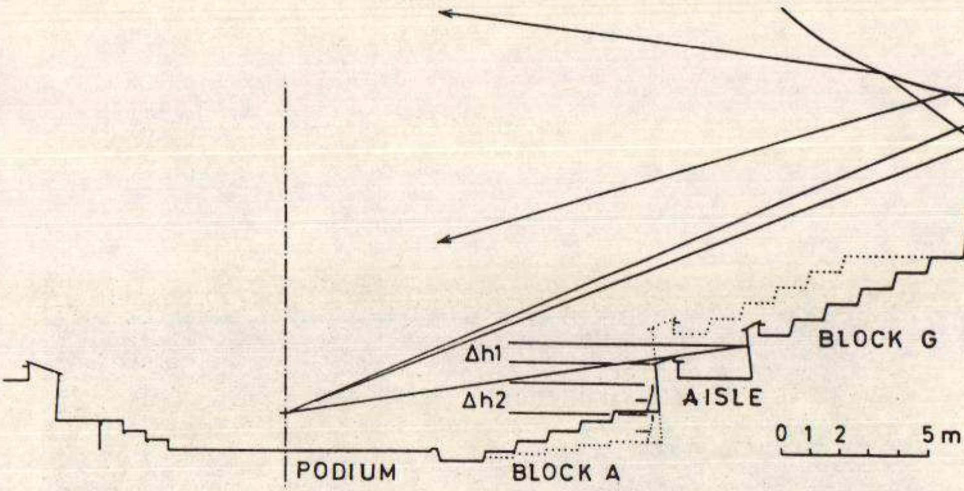

Fig. 3 Section of the frontpart of the hall to demonstrate possibilities to get hight surfaces for reflections.

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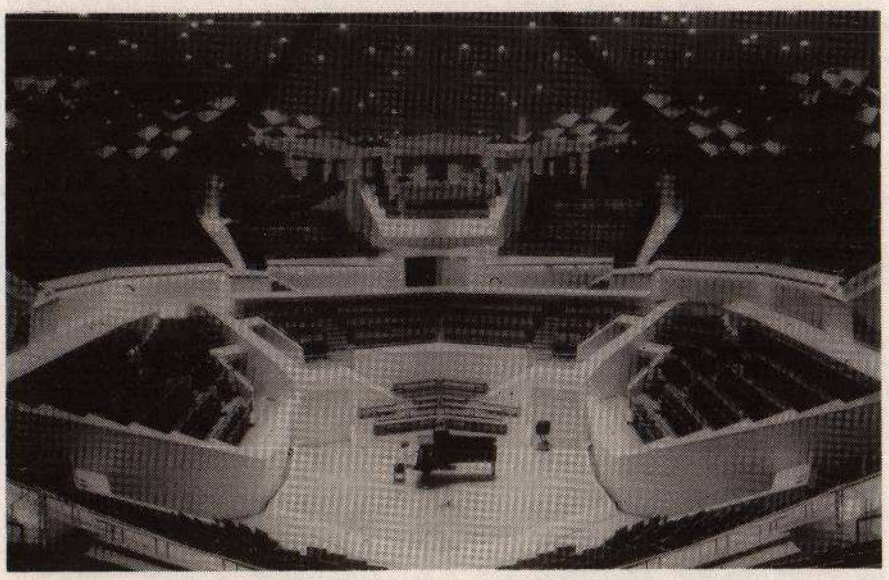

Fig. 4 Picture from the hall looking from the last row of the front part (Block G) to the rear part.

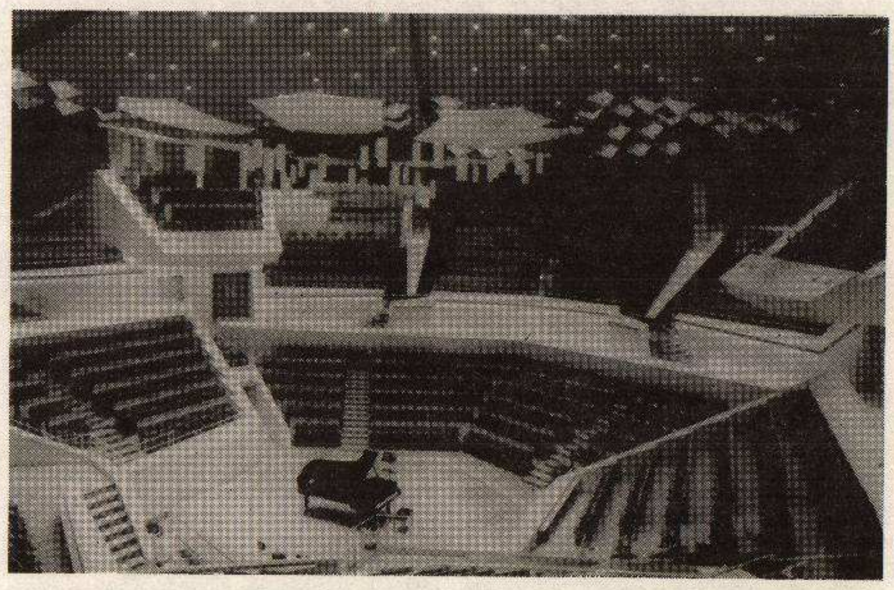

Fig. 5 Picture from the hall looking from the rear part (close to the Music Tribune L) to the front part.

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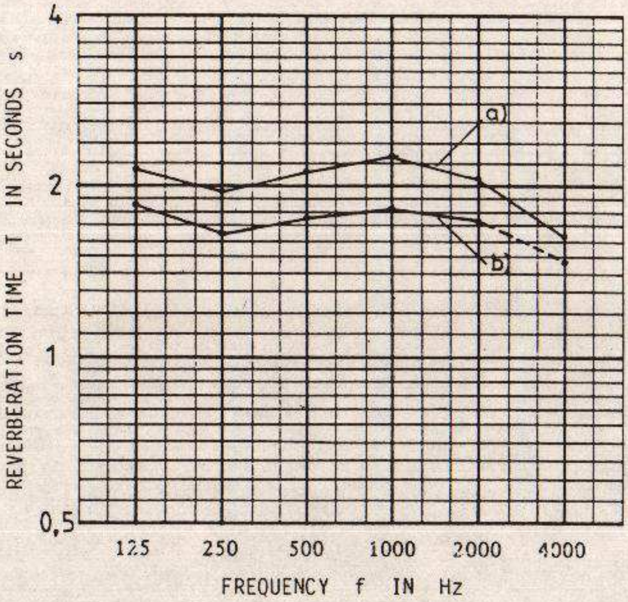

a) T = 2.17 1.97 2.14 2.28 2.07 1.62 s
b) T = 1.85 1.65 1.77 1.81 1.72 (1.48)* s

( )* ONLY TWO THIRD OCTAVES HAD BEEN EVALUATED

a) MEASURED REVERBERATION TIMES IN THE EMPTY HALL
b) MEASURED REVERBERATION TIMES IN THE OCCUPIED HALL BUT WITHOUT MUSICIANS

MEASURES OF THE CHAMBER MUSIC HALL (ALL VALUES ARE ROUNDED UP):

MEDIUM DIAMETER BETWEEN THE OUTER WALLS	D	=	48	m
MAXIMUM HIGHT OF THE CEILING OVER THE PODIUM	h	=	18	m
STAGE SURFACE INCLUDING THE PART FOR THE CHOIR	S	=	125	m^2
HIGHT OF THE CLOUDS OVER THE PODIUM	h	=	9.8 TO 10.75	m
EFFECTIVE SURFACE OF ALL THE 10 CLOUDS	S	=	59	m^2
TOTAL ACOUSTIC VOLUME	V	=	12500	m^3
CAPACITY WITHOUT THE THREE MUSIC TRIBUNES		=	1064	SEATS
CAPACITY INCLUDING THE THREE MUSIC TRIBUNES		=	1165	SEATS

Fig. 6 Measured reverberation times of the empty and full occupied hall and the main measures.

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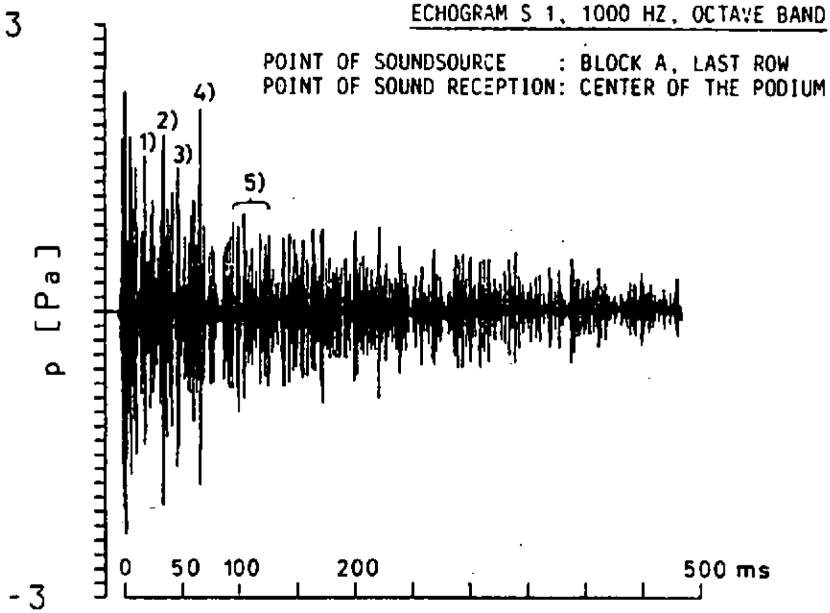

1) REFLECTION FROM THE CLOUDS
2) REFLECTION FROM THE PARAPET BEHIND THE PODIUM
3) REFLECTION FROM THE CEILING OVER BLOCK A
4) REFLECTION FROM THE CEILING OVER BLOCK C
5) REFLECTIONS FROM THE REARWALLS

SPECIAL CRITERIONS:

	1000 HZ OCTAVE BAND		500 HZ OCTAVE BAND	
	MEASURED	EXPECTED	MEASURED	EXPECTED
CLEARNESS	40,1%	26,3 %	39,5 %	28,6 %
CLARITY	- 1,3 dB	- 2,0 dB	- 1,3 dB	- 1,5 dB
CENTER OF GR.TIME	128 ms	164 ms	117 ms	149 ms

Fig. 7 Echogram at the seat S 1 and special acoustic criterions.

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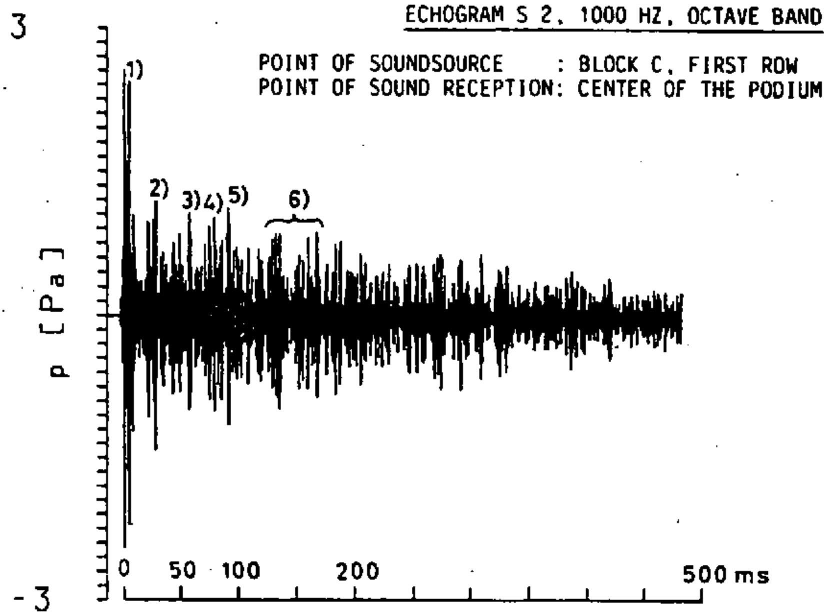

1) REFLECTION FROM THE FLOOR OF THE PODIUM
2) REFLECTION FROM THE CLOUDS
3) REFLECTION FROM THE CEILING OVER BLOCK C
4) REFLECTION FROM THE CEILING OVER BLOCK A
5) REFLECTIONS FROM THE PARAPET BEHIND BLOCK A AND IN FRONT OF BLOCK G
6) REFLECTIONS FROM THE REARWALLS

SPECIAL CRITERIONS:

	1000 HZ OCTAVE BAND		500 HZ OCTAVE BAND	
	MEASURED	EXPECTED	MEASURED	EXPECTED
CLEARNESS	34,2%	27,2 %	44,4 %	27,8 %
CLARITY	- 2,4 dB	- 1,8 dB	- 0,8 dB	- 1,7 dB
CENTER OF GR.TIME	151 ms	157 ms	116 ms	154 ms

Fig. 8 Echogram at the seat S 2 and special acoustic criterions.

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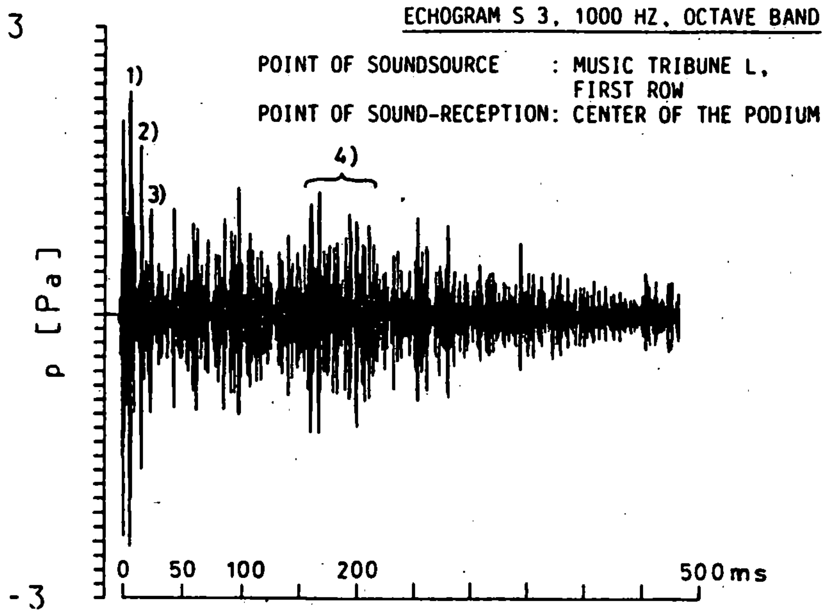

1) REFLECTION FROM THE FLOOR OF THE PODIUM
2) REFLECTION FROM THE CLOUDS
3) REFLECTION FROM THE CEILING OVER BLOCK C
4) REFLECTIONS FROM THE REARWALLS

SPECIAL CRITERIONS:

	1000 HZ OCTAVE BAND		500 HZ OCTAVE BAND	
	MEASURED	EXPECTED	MEASURED	EXPECTED
CLEARNESS	32,2%	27,1 %	38,0 %	28,3 %
CLARITY	- 2,9 dB	- 1,8 dB	- 1,8 dB	- 1,5 dB
CENTER OF GR.TIME	162 ms	159 ms	147 ms	158 ms

Fig. 9 Echogram at the seat S 3 and special acoustic criterions.