# Stage acoustics for symphony orchestras

Research on orchestra acoustics – acoustic conditions for orchestral musicians

## Improving the acoustics for orchestras under a low ceiling

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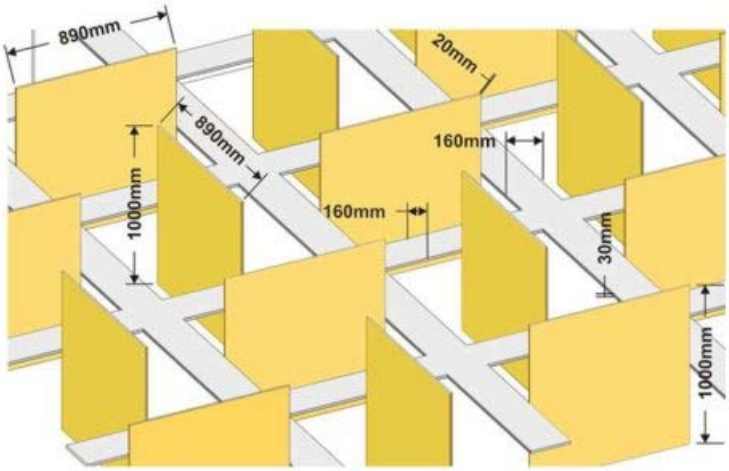
One of the major findings from the research project documented on this website was that low ceiling can be very problematic for a symphony orchestra. Recently a paper by Higini Arau-Puchades (Arau Acustica) has been published in Acta Acustica united with Acustica; *Increasing the Acoustic Volume of Performance Spaces without Altering the Internal Dimensions*. The cases covered in this paper suggest that a low ceiling is the major reason for difficult acoustic conditions experienced by the orchestras playing in their specific venues. The paper also includes a design of a grid of vertically oriented solid panels suspended above the orchestra, called an *acoustic labyrinth*. The picture below is taken from the mentioned paper.




The apparent effect of this construction is to block the direct reflection from the ceiling particularly above 500 Hz. Blocking the direct path results in the sound travel a longer path from the orchestra via the ceiling back down towards the orchestra, resulting in lower level and larger delay on the ceiling reflection. The grid also contributes to scatterthe ceiling reflection into different directions. The ceiling of the actual venues had curved ceiling that focused the reflected sound down towards the orchestra. Blocking the direct reflection by the grid will in such cases have a very significant effect on the level of reflection sound from the ceiling.The orchestras reported on a significantly improved acoustic conditions with the grid installed. This is very encouraging since it suggests that there can be a cost-effective alternative to improve conditions for orchestras under a low ceiling. Raising the ceiling physically will in most cases be too expensive to be feasible.There are only given a few suggestions in the paper to why the grid improves the perceived conditions. Apparently the experienced improvement can largely be explained by the findings from **my PhD thesis;** a high ceiling was here found beneficial for avoiding loud instruments becoming too loud and contributing to make the string section and the acoustic response from the main auditorium audible to the whole orchestra. This conclusion was based on comparing acoustic conditions with the orchestra present on stage, related to the psycho-acoustic effects masking, precedence effect and the cocktail-party effect. The real stages studied in the PhD also supported this conclusion.

It will be interesting to hear more about the players' experiences with Arau-Puchade's grid in the future. To further understand the effect of the grid it would be very interesting to see measured acoustic responses in detail and results for $G_{late}$ and $C_{80}$, both on stage and in the main auditorium for these venues – not only Schroeder curves, $T_{30}$, $G$ and $ST_{early}$ on stage.

**Dammerud, J. J. (2009).** *Stage Acoustics for Symphony Orchestras in Concert Halls,* PhD thesis, University of Bath, England.