Array sensor

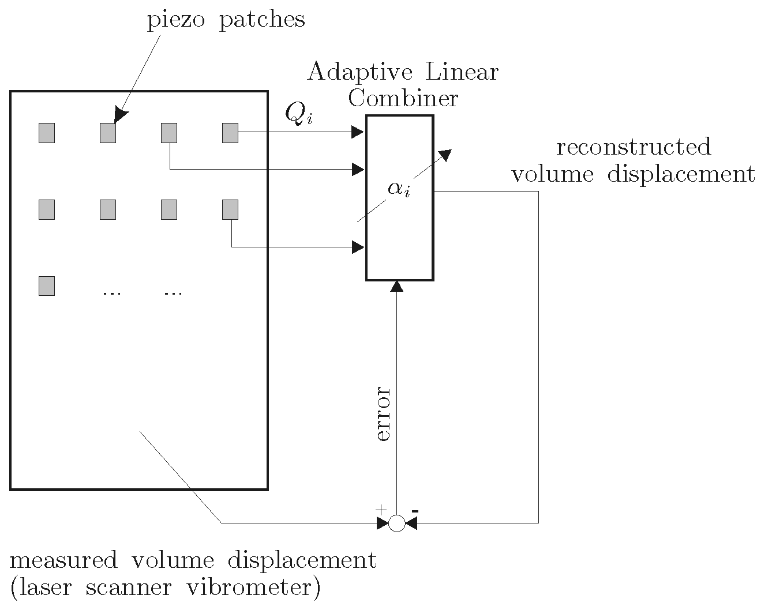

Figure 1: Principle of the volume displacement sensor

A noise radiation sensor consisting of an array of independent piezoelectric patches connected to an adaptive linear combiner was proposed (Preumont et al., 1999); the piezoelectric patches are located at the nodes of a rectangular mesh. The electric charges Q_i induced on the various patches by the plate vibration are the independent inputs of a multiple input adaptive linear combiner (Fig.1). The coefficients α_i of the linear combiner are adapted in such a way that the mean-square error between the reconstructed volume displacement (or velocity) and either numerical or experimental data is minimized. It must be noted that the same array sensor can also be used as modal filter by suitably adapting the coefficients α_i of the linear combiner.

This strategy can be used for reconstructing the volume displacement of a baffled plate with arbitrary boundary conditions. If the piezoelectric patches are connected to current amplifiers instead of charge amplifiers, the output signal becomes the volume velocity instead of the volume displacement.

The laboratory demonstration model (Fig.2) consists in a glass plate (54 cm$\times$124 cm, 4 mm thick) mounted in a standard window fitting and covered with an array of 4 by 8 piezoelectric patches (*PZT* piezoceramics - 13.75 mm$\times$25 mm, 0.25 mm thick). The materials properties are summarized in Table 1.

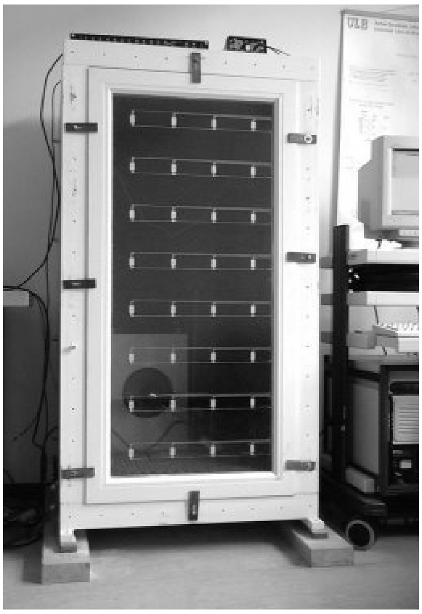

Figure 2: Array sensor: experimental setup

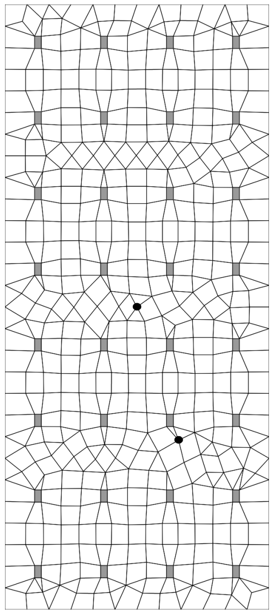

Figure 3: *FE* mesh

The finite element mesh used for the numerical analysis is shown on Fig.3. The first thirty eigenmodes were extracted from the dynamic analysis and taken into account for the state space representation. We used the opportunity given by the scanner laser vibrometer to measure the velocity of an array of points over the glass plate to deduce the volume velocity. The excitation used was provided by two shakers actuating the plate directly. Figure 4 shows the comparison between the frequency response functions between the excitation of Shaker #1 (in the center of the glass plate) and, respectively, sensors #7, #14 and the volume velocity obtained by finite element analysis and experimentally.

References

Preumont, A., François, A. & Dubru, S., 1999, 'Piezoelectric array sensing for real-time, broad-band sound radiation measurement', *Journal of Vibration and Acoustics*, 121.

Glass plate		
Y	72	(GPa)
ν	0.22	
ρ	2500	(kg/m^3)
PZT		
Y	69	(GPa)
ν	0.3	
ρ	7800	(kg/m^3)
d_{31}	205 10^{-12}	(Cb/N)
d_{32}	205 10^{-12}	(Cb/N)
ε_r	2600	

Table 1: Material properties

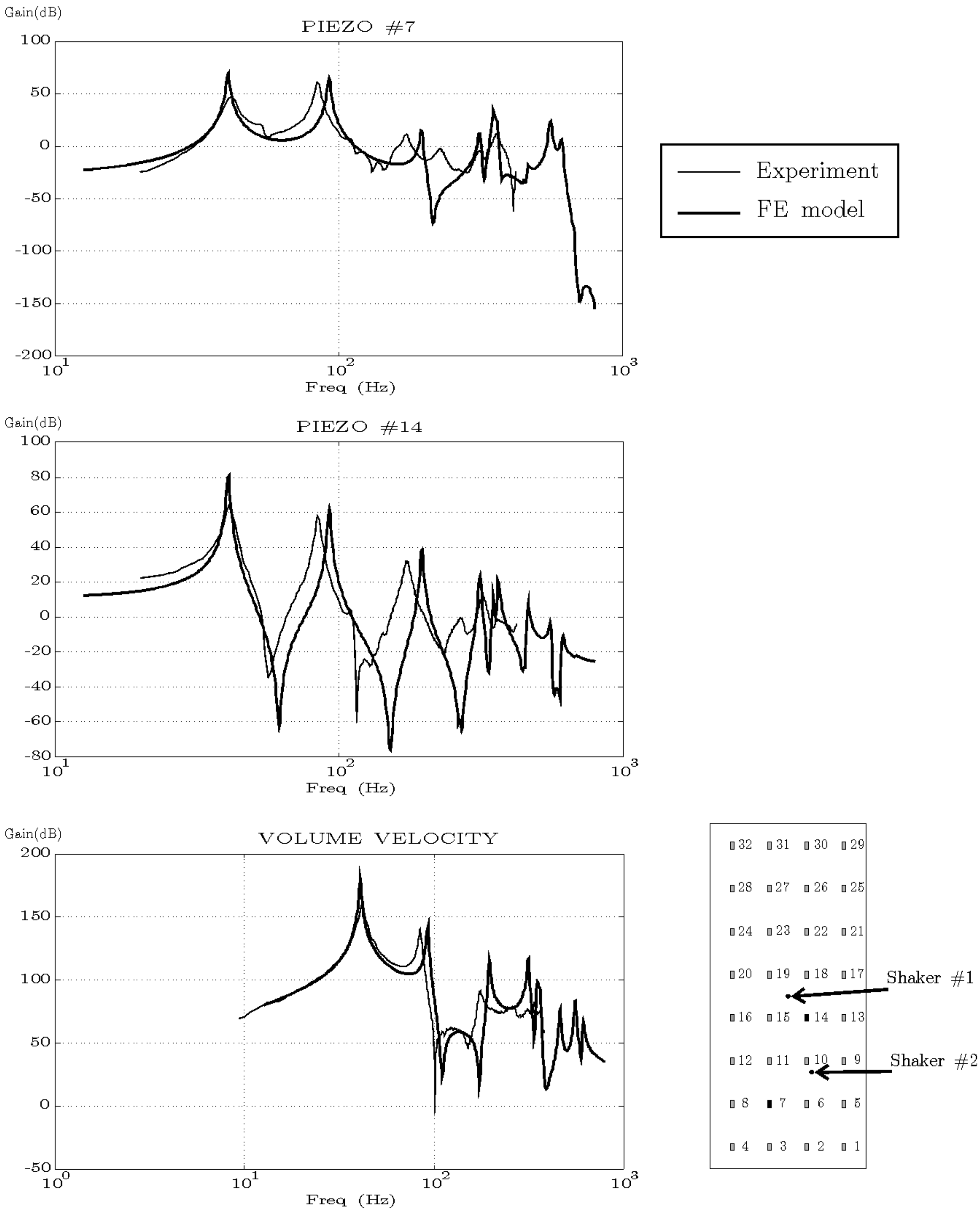

Figure 4: Frequency response functions /Shaker #1