Virtual Simulation Lab: Comparing VIRGO with an Experimental Measurement

In this post, we compare a VIRGO simulation of the diffusion coefficient of a hemicylinder with an experimental measurement from the 2D boundary plane goniometer.

In Figure 1, we show a schematic illustration of the 2D VIRGO goniometer. In order to create high-resolution polar responses, we are using a larger number of virtual microphones than are used experimentally.

In Figure 2, we compare the normal incidence normalized diffusion coefficient (top left) between the VIRGO simulation and the experimental measurement, according to ISO 17497-2. The excellent agreement is a testament to the validity of the boundary element simulation. In Figure 2 (top right), we compare the random incidence normalized diffusion coefficients, which also show an excellent agreement. In Figure 2 (bottom), we compare the normal incidence polar responses at three frequencies. Since VIRGO uses 180 microphones versus 37 for the experimental measurement, the simulation shows a higher resolution at 4,000 Hz.

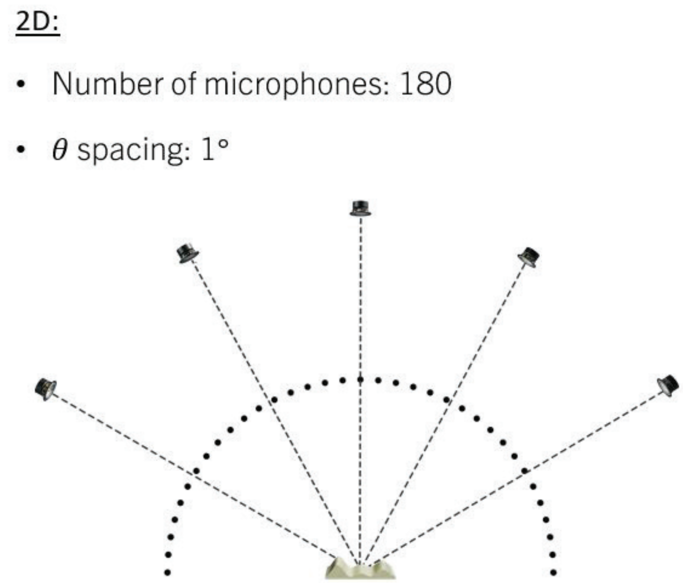


Figure 1. 2D Virtual Goniometer

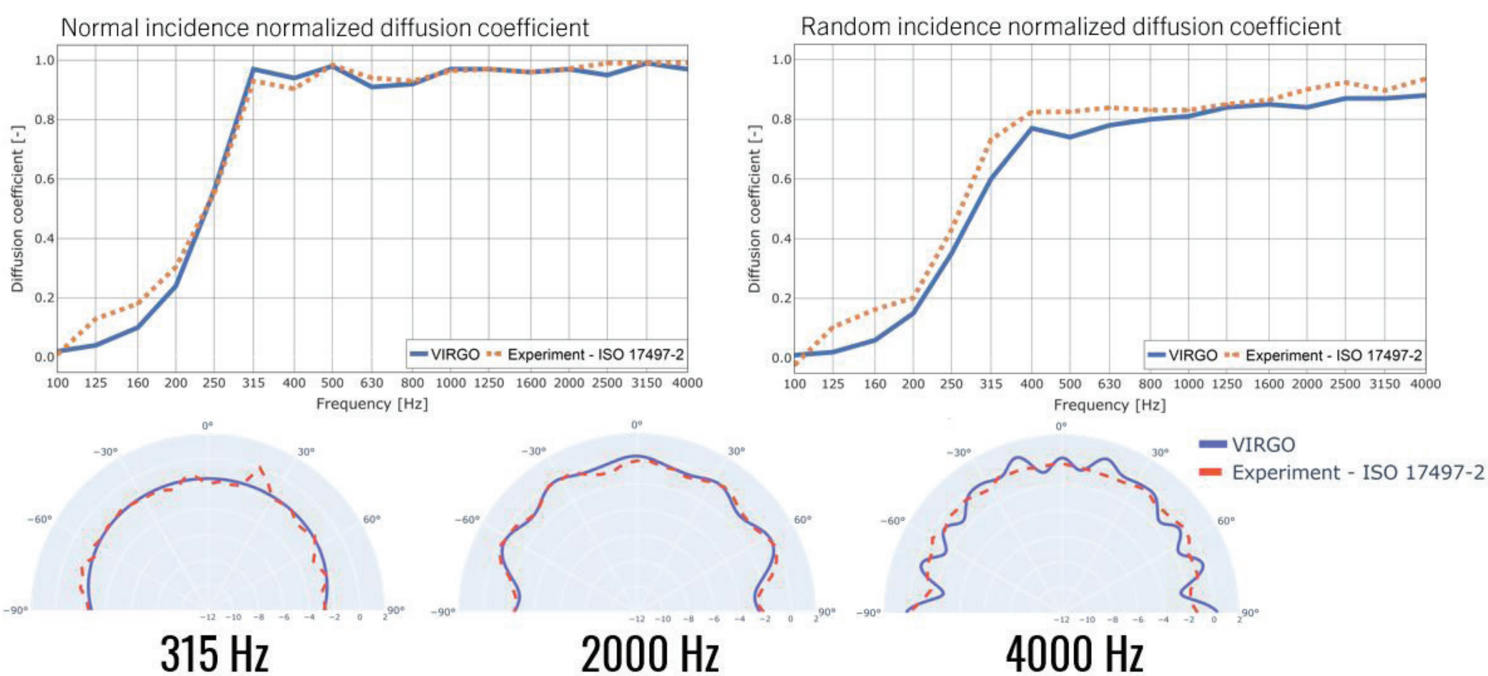


Figure 2. Top: Hemicylinder simulation versus experimental measurement for normal incidence (left) and random incidence (right); Bottom: Polar response comparison for normal incidence at three frequencies.

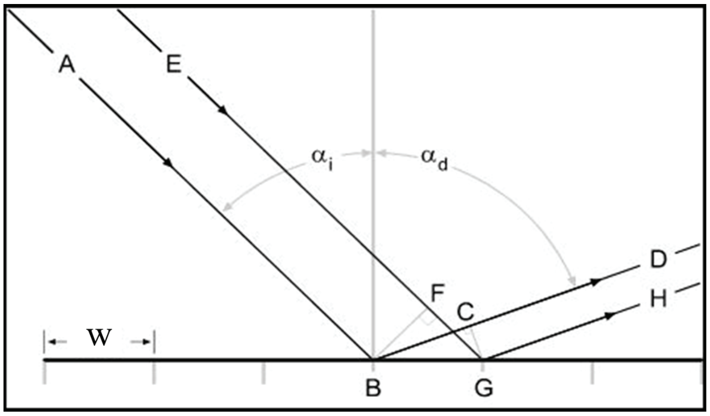


Figure 3. Constructive interference schematic.

The results in Figure 2 are for 1 hemicylinder. When a periodic array is measured the constructive interference generates grating lobes. Figure 3 shows the constructive interference schematic. For a given wavelength, l, angle of incidence, α_i, and sample width, w, when BC-FG=ml, i.e., an integral number of wavelengths, constructive interference occurs in m orders until sinα_d exceeds 1. The constructive interference equation relating those variables is shown in Figure 3.

$$\sin\alpha_d = \frac{m\lambda}{w} - \sin\alpha_i$$

Figure 4. Constructive interference equation.

In Figure 5, we illustrate the normal incidence polar response at 2 kHz, for a linear, periodic array of (4) 120 mm diameter hemicylinders. For normal incidence α_i is zero. It can be seen that the 7 diffraction orders, m=0 ±1, ±2, ±3, agree with the theoretical prediction.

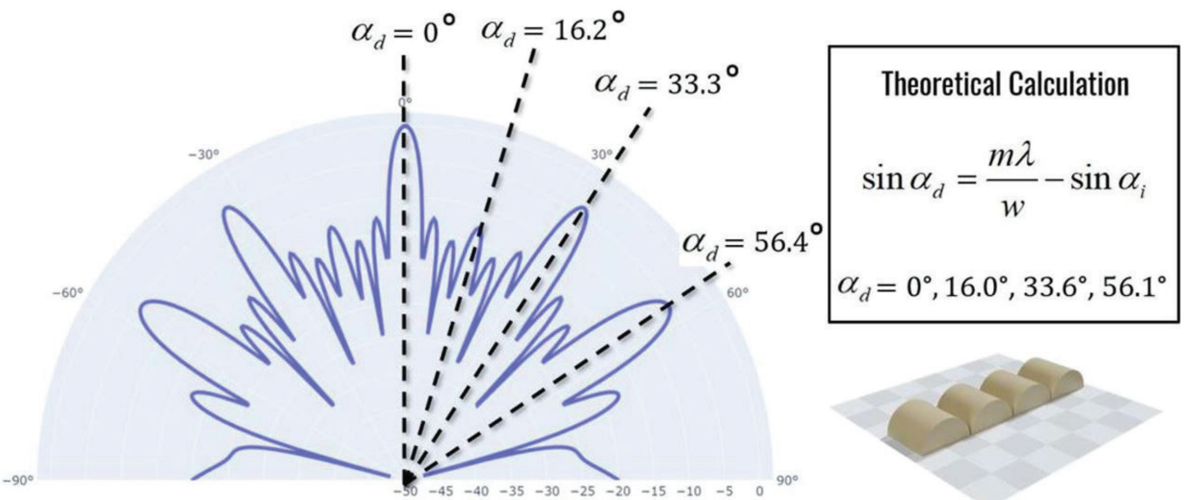
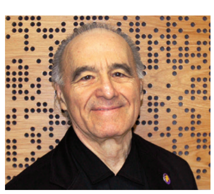


Figure 5. The position for 4 of the 7 diffraction grating lobes, m=0, m=0 ±1, ±2, ±3, are indicated to agree with the theoretical calculation

In the next post, we will simulate the scattering from a single hemisphere and a periodic linear and two-dimensional array of hemispheres.



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