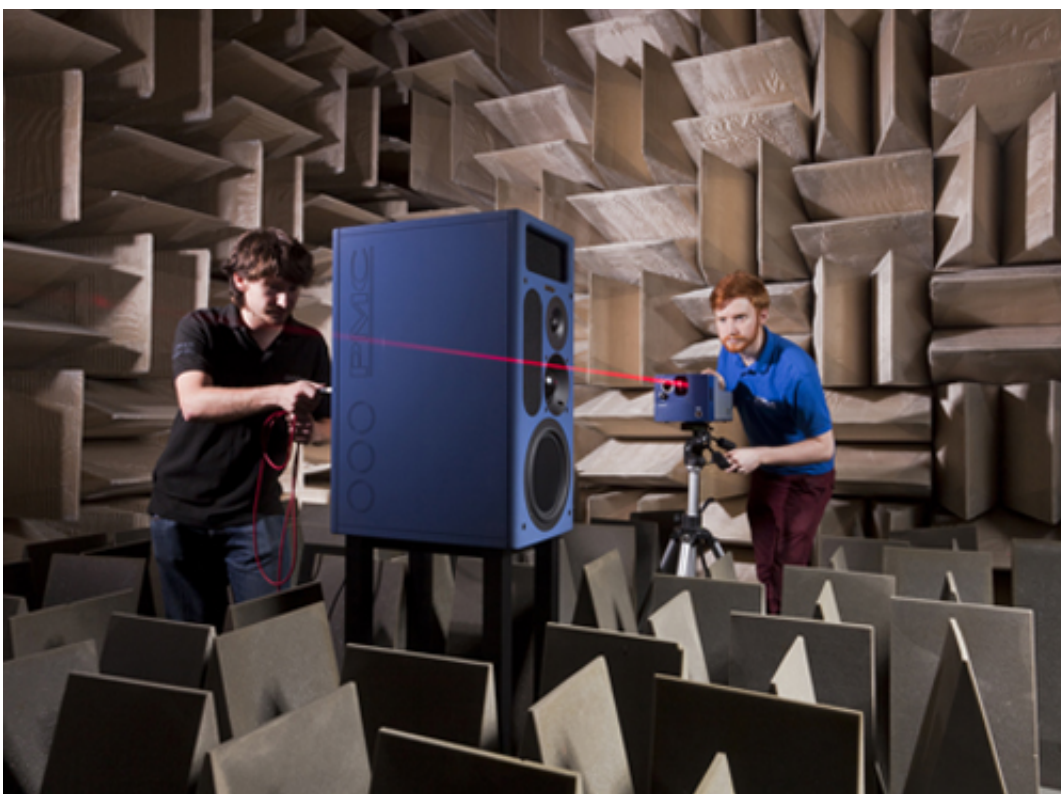


Laser-based acousto-optic mapping: Next-generation design tool for loudspeaker designers

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NPL's collaboration with PMC has provided vital industrial input on the design and development processes of high-end loudspeakers, honing the experimental technique into a valuable industrial tool.

NPL has developed a laser-based acoustic mapping technique, collaborating with PMC loudspeakers to adapt the technique into a

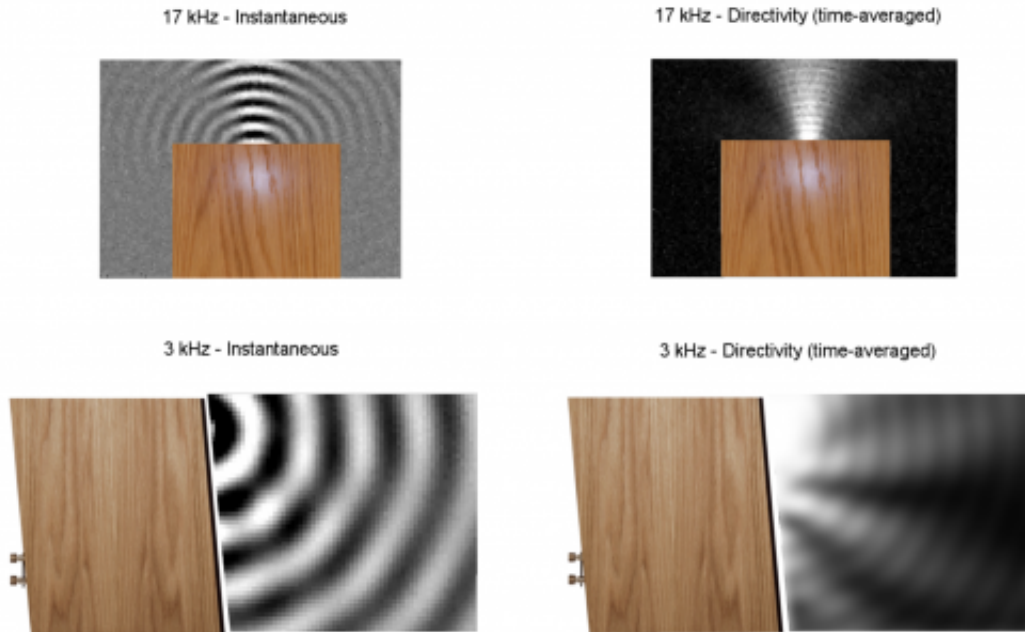
valuable design tool.

NPL scientists have furthered their development of a novel acousto-optic laser-based [measurement technique](#) for mapping how sound radiates from [acoustic](#) sources.

Through collaboration with PMC Ltd, a manufacturer of high-end loudspeakers, the [experimental technique](#) has been honed into an industrially relevant and valuable tool for the design and testing of acoustic products, namely loudspeakers.

The challenge

Measuring how sound propagates is classically an arduous task as it was necessary to use manual microphone scans to build up a spatial map of the acoustic field. For instance, looking at how sound radiates from a [loudspeaker](#) (a property termed the 'directivity' of the speaker) would require a large number of positions to be measured, demanding moving the microphone to each of these.



The NPL-developed acousto-optic measurement techniques have enabled spatial mapping of acoustic fields radiating from loudspeakers and other acoustic devices.

Computer-aided modelling can be used to provide an insight into the various performance characteristics of the speaker, but the validity is often limited.

As a result, high-resolution directivity studies are rarely conducted yet could be highly valuable in the design and manufacturing process.

The solution

NPL's new technique uses lasers instead of microphones or computer modelling, and can rapidly map acoustic fields non-invasively. It provides a way of studying acoustic properties, such as a speaker's directivity, in high-resolution and ultra-slow motion.

How it works

NPL's technique, which is called 'Rapid Acousto-Optic Scanning' (RAOS), uses the acousto-optic effect, which describes how light bends as it passes through an acoustic field.

When sound travels through air it causes the air's refractive index to change. This change can be detected by passing [laser light](#) through the air. The changes in [refractive index](#) bends the laser light slightly as it passes through, so by monitoring the light's speed you can measure the bending effect.

NPL has shown that the subtle speed change due to typical sound pressure levels in air can be detected using a laser-interferometer, a device which monitors laser light phase changes. In this case, laser light is reflected off a stiff optically retro-reflective board on the far side of the acoustic field, isolating the detectable effect on the speed of the laser light to the acoustic field.

Using a laser scanning vibrometer (a scanning version of the laser-interferometer described above), high resolution rapid scans of the sound field are possible. These provide a detailed insight into acoustic characteristics such as the directivity of loudspeakers and ultrasonic transducers, and the reflection characteristics of structural acoustic treatments such as diffusers and absorbers.

In this collaboration, PMC loudspeakers were evaluated using RAOS for various key acoustic characteristics, and a 3D tomographic reconstruction technique was explored for resolving greater detail in the acoustic field. PMC provided guidance on the validity and efficacy of these studies.

The impact

This collaboration with PMC has enabled NPL to develop, trial, and improve the technique guided by the requirements of an industrial partner, developing a service for customers which provides valuable information and is cost-effective.

Peter Thomas (founder of PMC) commented: "NPL's laser-based acousto-optic measurement technique provides a rapid, reliable method of viewing every aspect of loudspeaker dispersion. We are delighted to have collaborated with NPL to pioneer this highly innovative technique and we will apply this ground-breaking knowledge to further the development of all our products."

More information: Find out more about [NPL's acousto-optic scanning service](#).

Provided by National Physical Laboratory

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