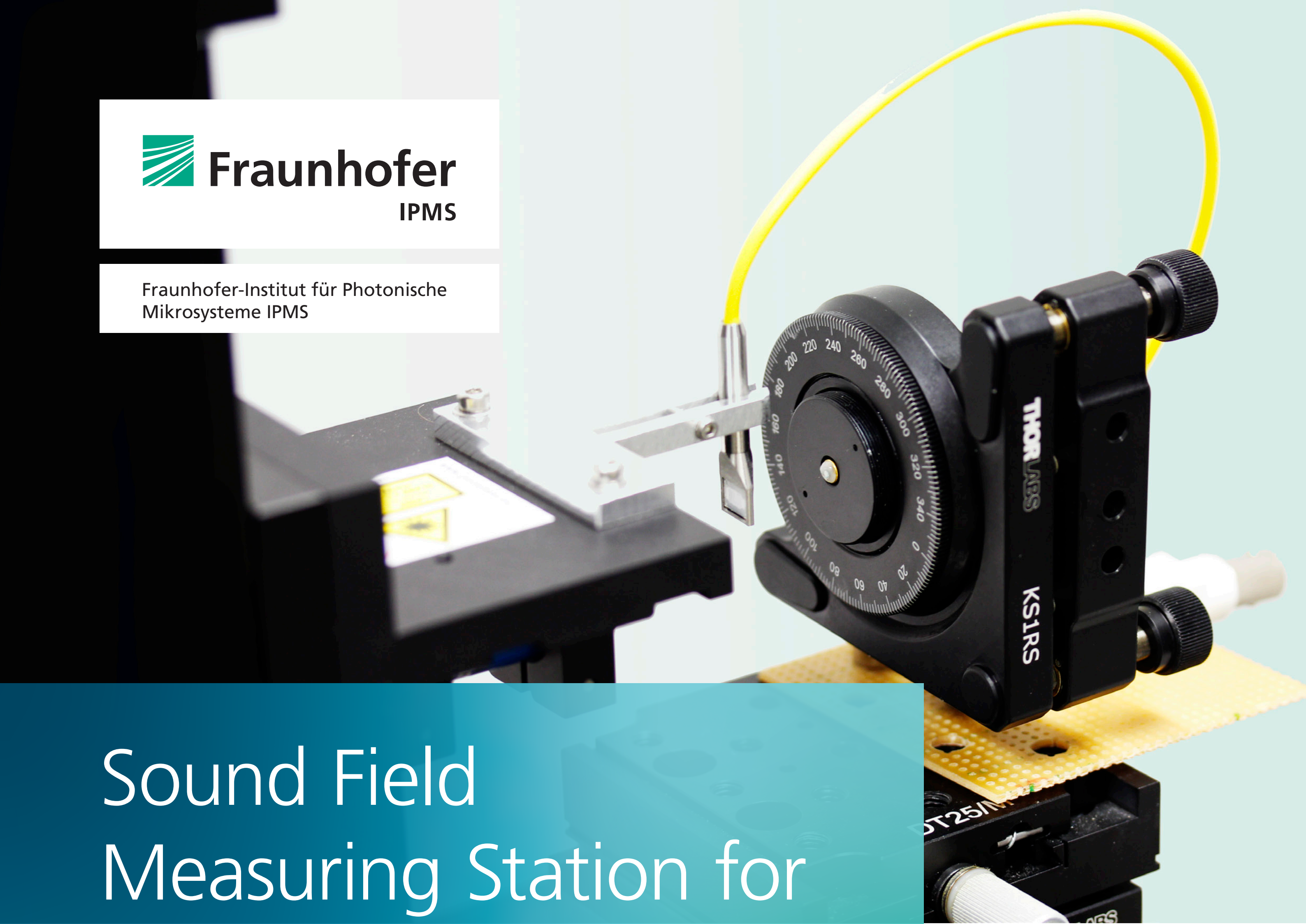
Fraunhofer IPMS

Fraunhofer-Institut für Photonische Mikrosysteme IPMS



Sound Field Measuring Station for Ultrasound in Air

1 Close-up of the membrane-free optical microphone and of the sample carrier. The sample carrier can be set in 6DOF.

Application Areas

Fraunhofer IPMS measures ultrasonic fields via an optical microphone to characterize and tests the sound behavior of ultrasonic transducers in air. In addition to the sound field, the microphone measures the time signal and the frequency distribution over the entire measurement range. The optical microphone can work with high sound levels and also analyzes undefined sound fields. At the same time, the measurement principle offers high linearity over the entire frequency range. The measuring station accommodates MEMS devices such as CMUTs, PMUTs or piezocomposites (Fig. 1). Customer-specific adaptations for further transmitters are possible.

Service

Fraunhofer IPMS offers the measurement of ultrasonic fields with high sensitivity in air. The measuring station measures transmitters in a range of 200 mm x 200 mm x 150 mm in 0.2 micrometer steps in the plane. The two-dimensional ultrasonic fields serve as a basis for the threedimensional evaluation of the sound field. The experts at Fraunhofer IPMS provide support on technical issues relating to the design and evaluation of ultrasonic transducers, drawing on many years of experience in ultrasound technology.

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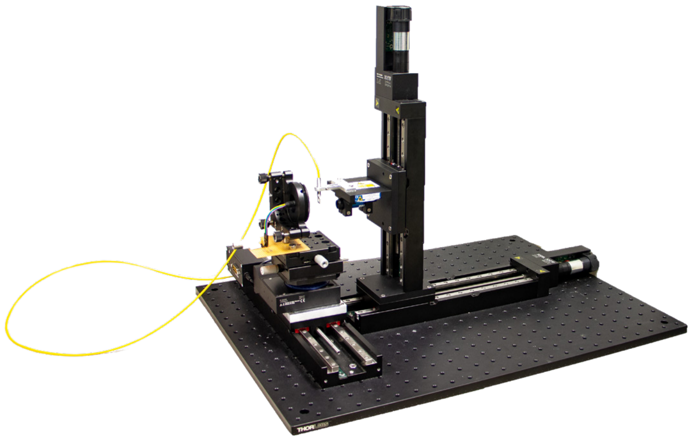
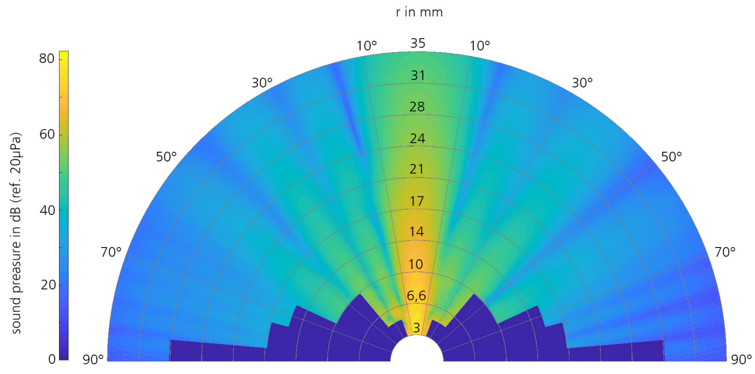


2 Close-up of the measuring system with positioning table and linear axes. The optical fiber for the optical microphone is shown in yellow.



2 Sound field of a micromechanical ultrasonic transducer for air applications (color scaling in dB)

Operation Principle

The measurement method is based on a commercial optical microphone: In a rigid Fabry-Perot laser interferometer, consisting of two miniaturized mirrors, the refractive index of the air changes due to sound-induced pressure fluctuations. The change in optical wavelength and the associated transmission behavior is evaluated in an electrical signal.

Key Facts

The measurement offers:

- high resolution and linearity
- a large measurement area
- determination of unknown sound fields
- accomodation of all common transmitters

Key Figures

The microphone detects small pressure changes in the measurement field with high resolution and also detects small side lobes in the sound field (Fig. 3).The measurement setup measures frequencies in the range from 300 kilohertz to 2 megahertz. The dynamic range is 100 decibels and has a resolution between 20 micro- and 10 millipascals. The drive allows DC voltages up to 100 volts and AC voltages with peak-to-valley values up to 100 volts. Square-wave pulses and sine-wave signals can be used as excitation signals. The measured time signals allow common evaluations (e.g. frequency spectra, intensity distribution).

In the standard version, the fixture is designed for a TO18 housing that can be positioned in six degrees of freedom.
The measurement setup measures all three dimensions in a range of 200 mm x 200 mm x 150 mm with a step size of 0.2 micrometers (Fig. 2). The result are two-dimensional pressure fields for which angular positioning of 6.3 microrads is achieved in a range of ± 90 degrees. According to the manufacturer, the optical resolution is 0.1 to 0.2 millimeters.

Parameter	**Value**	**Unit**
Detection distance	3 to 198	mm
Pressure resolution	> 20	µPa
Dynamic area	100	dB
Frequency range	0.3 to 2	MHz
Max. operation voltage AC/DC	100	V
Max. angle	± 90	°
Spatial resolution	0.1 to 0.2	mm
Angular resolution	> 6.3	µrad

Table 1: Overview of key figures of the measurement setup