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Research areas
Acoustics and Ultrasonics
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Acoustic output of a harmonic scalpel: Airborne ultrasound and derived acoustic power in water
Ultrasonic surgery systems are widely used in open and endoscopic surgery. While hollow tubes were employed in the beginning, for example in neurosurgery or opthalmology, recently developed scalpel-type devices are increasingly used in many fields when bleeding control or minimal injury are desired. A titanium knife blade driven by a transducer oscillates longitudinally and ensures cutting as well as coagulation. Although the blades are available in several shapes and configurations, all of them are bulk devices with outer dimensions in the mm-range, and significant sound emission is to be expected. During open surgery, the blade is a source of airborne ultrasound which reaches the operator’s and the patient’s ears. During the close contact between blade and tissue, ultrasound is coupled into patient’s body and transmitted into many parts of the body.
A quantification of the blade’s performance and an assessment of the risk of harmful bioeffects on both, the operator and the patient, require that the acoustic output of the harmonic scalpel be determined. The standard IEC 61847 in fact specifies the measurement of the derived output power in water and of the blade amplitude, however it does not take into account the airborne ultrasound and different blade geometries. The research work deals with the measurement of the sound pressure level of the airborne ultrasound generated by different blades. Measurements are carried out with both, a microphone and an artificial head, so that the free-field value and the sound level at the entrance at the bottom of the cavum conchae of the ear could be determined.
The measurement procedure for the determination of derived output power in water described in IEC 61847 is applied to the harmonic scalpel. The results are strongly influenced by cavitation effects. The power values with and without cavitation differ by more than a factor of 5. The measurement of acoustic output parameters forms the basis for describing the performance of the devices and for an assessment of the risk of harmful bioeffects on both the operator and the patient.

Reconstruction of ultrasonic fields by deconvolving the hydrophone aperture effects
In the field of sonography, in particular if applied to the eye and to organs close to the body surface, transducer arrays with frequencies of up to 60 MHz are increasingly used to improve the resolution in time and space. The development of commercial hydrophones suitable for the investigation of such high-frequency ultrasound fields has not kept up with the progress made in instruments design. The piezoelectric hydrophones at present available do not meet the requirements for a “point detector”; as a result of their finite detector area they rather furnish sound pressure values averaged in space. It has been the aim of a research work, starting from the averaged measurement values, to reconstruct the structure of complex ultrasound

fields by deconvolving the aperture effect to achieve in this way an improvement of the lateral resolution.
This task has been treated as an inverse problem. It has been proved by numerical simulation that suitable reconstruction methods can be applied in both the spatial range and the spatial frequency range. The Wiener method has proved to be especially advantageous and can be easily implemented in the spatial frequency range.
The results of the simulations were checked at 2.25 MHz. The factor decisive for the choice of this working frequency was that hydrophones were available at this frequency, which could be used for reference measurements. PVDF membrane hydrophones of different geometry and dimensions were manufactured. The choice of the hydrophone parameters, in particular of the hydrophone geometry/wavelength ratio, and of the measurement conditions has ensured that the results can to a large extent be applied to the high frequency range.

Inter-laboratory test of sound insulation measurements on heavy solid walls
The intention of sound reduction index (SRI) measurements in transmission suites is to obtain reliable values of the sound insulation properties of the specific test element. Unfortunately, these values are influenced by the mounting of the test element itself and the construction design of the test facility. Both can affect the damping of the test specimen and thus the sound reduction index. The requirements for the construction of test facilities according to ISO 140 allow a large variety of boundary conditions such as separating the test object by structural breaks from the flanking walls of the laboratory, resulting in a corresponding scattering of the sound reduction index of the 'same' building elements with the 'same' mounting conditions. From previous studies it was expected that for heavy solid building elements it should be possible to obtain a laboratory independent sound reduction index value, if the loss factor of the specimen was measured and used for correction of the sound reduction index. To check this, an inter-laboratory test with a calcium silicate solid wall (400 kg/m^2) was organised with 12 participating institutes. It could be shown, that the loss factor correction reduces the standard deviation of the SRI in different laboratories considerably at frequencies higher than the coincidence frequency (about 200 Hz), which covers the main part of the frequency range of interest. At frequencies lower than 200 Hz, other influences like the modal structure of the sound field cause the main uncertainties of the SRI measurement.