Physikalisch-Technische Bundesanstalt

Braunschweig und Berlin

Prüfbericht

Test Report

Gegenstand: *Object:*	Hydrophone for the detection of ultrasound
Hersteller: *Manufacturer:*	Müller Instruments Hasengarten 35 61440 Oberursel Deutschland
Typ: *Type:*	Needle-type Hydrophone
Gerätenummer: *Serial No.:*	300/25/658
Auftraggeber: *Applicant:*	Müller Instruments Hasengarten 35 61440 Oberursel Deutschland
Anzahl der Seiten: *Number of pages:*	4
Geschäftszeichen: *Reference No.:*	1.62-4068553
Prüfzeichen: *Test mark:*	1.62/16003 PTB 14
Datum der Prüfung: *Date of test:*	2014-03-10

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Im Auftrag
On behalf of PTB

Braunschweig, 2014-03-18

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Dr. Volker Wilkens

Im Auftrag
On behalf of PTB

Dr. Volker Wilkens

Determination of the effective radius

On customers demand, the effective radius of the hydrophone was determined by measurements of the directional response in two directions. The measurements were performed in the far field of a plane source transducer at frequencies 5 MHz, 10 MHz, 15 MHz, and 20 MHz. The middle section (5 – 12 cycles) of single-frequency tonebursts comprising 30 cycles were measured after the hydrophone had been positioned at the lateral sound field maximum and perpendicular to the sound beam axis. By means of two additional perpendicularly mounted manual translation stages, the sensitive element of the hydrophone was adjusted in such a way that it was centered at the rotational axis of a steppermotor-driven rotation stage to ensure the same portion of the sound field being measured during rotation. This adjustment was controlled and optimized by measurements of short test pulses from the source transducer driven by voltage spikes, and observation and minimization of the angle-dependent phase shifts of the received pressure waveform for symmetric rotation angles of $\alpha = \pm 15°$. The directional responses were then obtained by measurement of the angle-dependent voltage amplitudes $U(\alpha)$ related to the amplitudes at normal incidence $U(\alpha = 0°)$. For each frequency setting f, the effective radius a was determined by least-squares fitting of a function of the form:

$$\frac{U(\alpha)}{U(0°)} = \left| \frac{2 J_1(ka \sin(\alpha))}{ka \sin(\alpha)} \right|$$

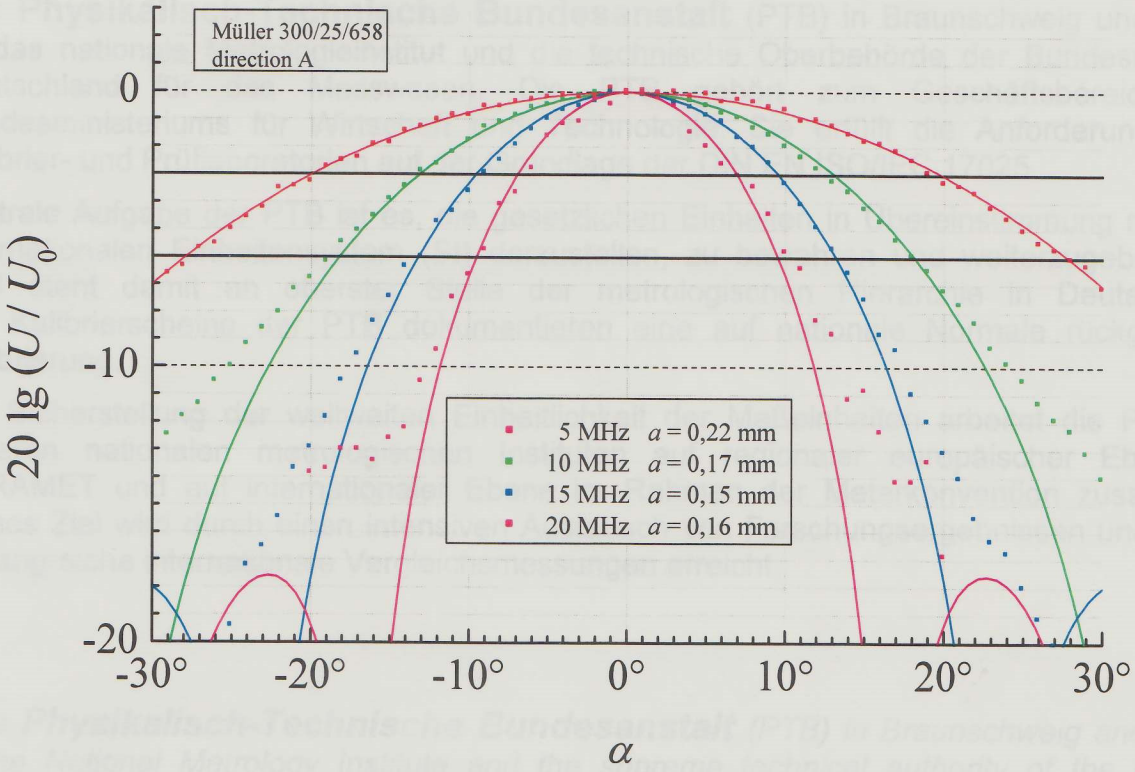
to the measured data, where J_1 denotes the Bessel function of the first kind and first order, $k = 2\pi f / v$ the wavenumber, and $v = 1480$ m/s the speed of sound in water at the water temperature of $T = (19{,}1 \pm 0{,}3)$ °C, respectively. The measurements were performed for two different rotational axis leading to radius data in directions A and B (see figures below). Direction A is perpendicular to the direction indicated by a green dot and direction B is perpendicular to direction A. The range of data used for the fit depended on the frequency:

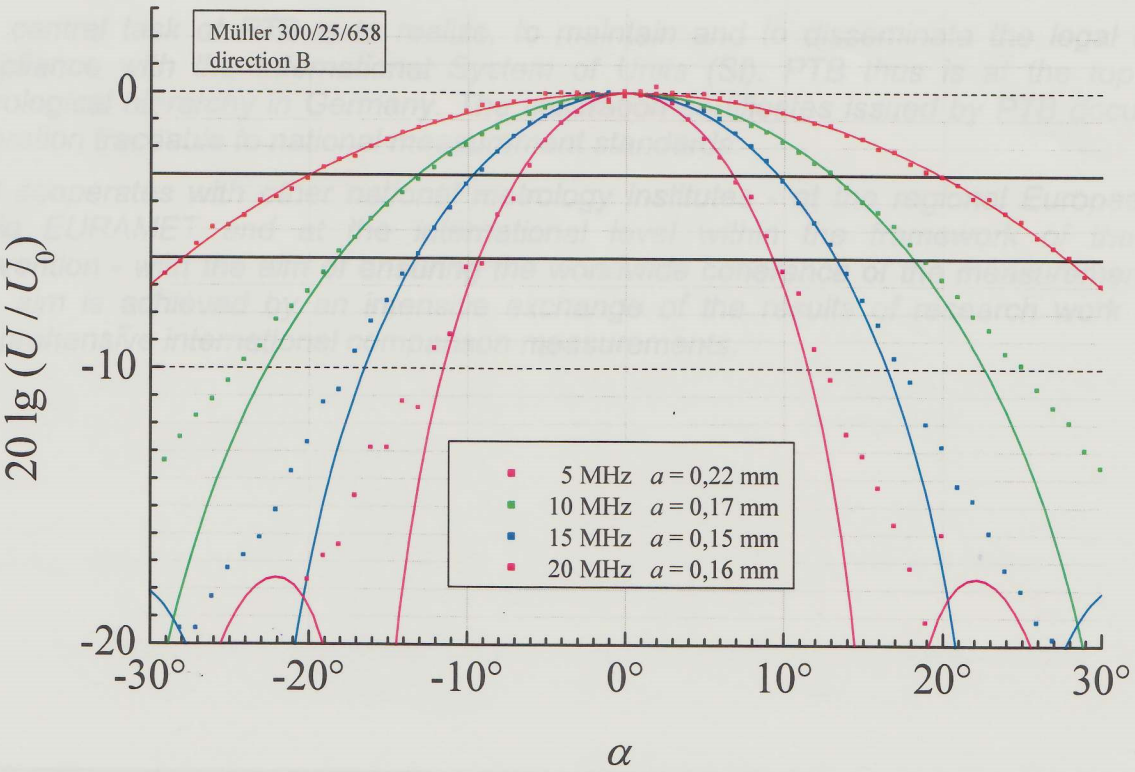
- Both directions:
  α from -10° to 10° for $f = 20$ MHz, from -15° to 15° for $f = 15$ MHz, from -20° to 20° for $f = 10$ MHz, and from -40° to 40° for $f = 5$ MHz.

The results are given in the following figures. The high frequency (20 MHz) effective radius is:

$a = (0.16 \pm 0.03)$ mm in direction A,

$a = (0.16 \pm 0.03)$ mm in direction B.


Müller 300/25/658
direction A
0
-10
-20
20 lg (U / U0)
5 MHz a = 0,22 mm
10 MHz a = 0,17 mm
15 MHz a = 0,15 mm
20 MHz a = 0,16 mm
-30°
-20°
-10°
0°
10°
20°
30°
α


Müller 300/25/658
direction B
0
-10
-20
20 lg (U / U0)
5 MHz a = 0,22 mm
10 MHz a = 0,17 mm
15 MHz a = 0,15 mm
20 MHz a = 0,16 mm
-30°
-20°
-10°
0°
10°
20°
30°
α

Die Physikalisch-Technische Bundesanstalt (PTB) in Braunschweig und Berlin ist das nationale Metrologieinstitut und die technische Oberbehörde der Bundesrepublik Deutschland für das Messwesen. Die PTB gehört zum Geschäftsbereich des Bundesministeriums für Wirtschaft und Technologie. Sie erfüllt die Anforderungen an Kalibrier- und Prüflaboratorien auf der Grundlage der DIN EN ISO/IEC 17025.

Zentrale Aufgabe der PTB ist es, die gesetzlichen Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI) darzustellen, zu bewahren und weiterzugeben. Die PTB steht damit an oberster Stelle der metrologischen Hierarchie in Deutschland. Die Kalibrierscheine der PTB dokumentieren eine auf nationale Normale rückgeführte Kalibrierung.

Zur Sicherstellung der weltweiten Einheitlichkeit der Maßeinheiten arbeitet die PTB mit anderen nationalen metrologischen Instituten auf regionaler europäischer Ebene in EURAMET und auf internationaler Ebene im Rahmen der Meterkonvention zusammen. Dieses Ziel wird durch einen intensiven Austausch von Forschungsergebnissen und durch umfangreiche internationale Vergleichsmessungen erreicht.

The Physikalisch-Technische Bundesanstalt *(PTB) in Braunschweig and Berlin is the National Metrology Institute and the supreme technical authority of the Federal Republic of Germany for metrology. The PTB comes under the auspices of the Federal Ministry of Economics and Technology. It meets the requirements for calibration and testing laboratories as defined in DIN EN ISO/IEC 17025.*

The central task of PTB is to realize, to maintain and to disseminate the legal units in compliance with the International System of Units (SI). PTB thus is at the top of the metrological hierarchy in Germany. The calibration certificates issued by PTB document a calibration traceable to national measurement standards.

PTB cooperates with other national metrology institutes - at the regional European level within EURAMET and at the international level within the framework of the Metre Convention - with the aim of ensuring the worldwide coherence of the measurement units. This aim is achieved by an intensive exchange of the results of research work and by comprehensive international comparison measurements.