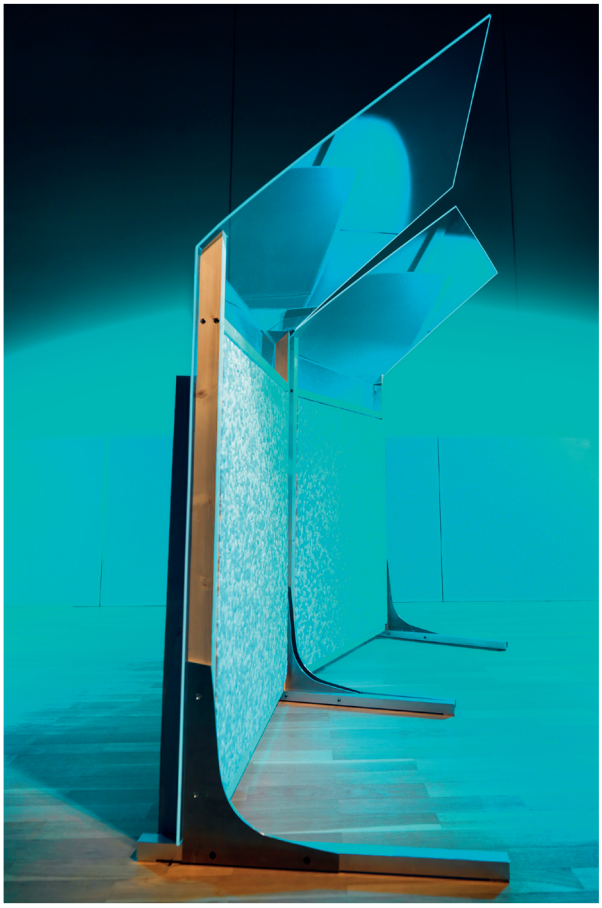
Division 1
Mechanics und Acoustics



1. Mechanics and Acoustics

Division 1 deals with the following three topics: *Mass and Related Quantities*, *Flow*, as well as *Acoustics, Ultrasound, Acceleration*. In the following, important activities and focal points as well as significant developments in these fields will be presented.

1.1 Mass and Related Quantities

In the subject area *Mass and Related Quantities*, the activities in the Departments 1.1, 1.2, 1.3, and 1.7 are focused on the realization and dissemination of the mechanical units of mass, force (static and dynamic), torque and dynamic pressure – based on the Units Act, the Verification Act and the Act on the Proof Testing of Arms and Ammunition, as well as on the Ordinance on Units and on the Verification Ordinance.

One of the main tasks of Department 1.1 *Mass* is to realize and disseminate the SI base unit *kilogram* in the range from 1 mg to 5000 kg – carried out by the Working Group *Realization of Mass*. The Working Groups *Weighing Instruments*, *Dynamic Weighing* and *IT Weighing Technology* are dedicated to the testing of non-automatic and automatic weighing instruments and modules.

The activities of the Working Group *Realization of Mass* mainly focus on the discussion about the new definition of the kilogram, which includes all the related research and institutional activities. A new recommendation (CCM Recommendation G 1 (2013) "On a new definition of the kilogram") was adopted at this year's session of the *Consultative Committee for Mass and Related Quantities* (CCM); this recommendation has meanwhile been confirmed by the *International Committee for Weights and Measures* (CIPM) and serves as a basis for a roadmap for the possible re-definition of the kilogram in 2018. In addition, the Working Group *Realization of Mass* was significantly involved in designing the current proposal with regard to a *mise en pratique* for the re-defined kilogram as well as in research activities within the scope of the EMRP projects SIB03 "kNOW" and SIB05 "NewKILO" and in the international comparison measurements CCM.M-K7 and COOMET.M.M K8. At the national level, the German accreditation body (DAkkS) and the Technical Committee *Mass* of the *Deutscher Kalibrierdienst* (DKD – German Calibration Service) are supported in the technical inspection of calibration laboratories and in the realization of comparison measurements.

The Working Group *Weighing Instruments* organized, together with METAS (Switzerland), the first peer assessments of manufacturers' testing laboratories within the scope of the OIML Mutual Acceptance Arrangements (MAA) in September 2013. The auditors from France and South Africa paid particular attention to the assessment of the independence and impartiality of these testing laboratories as well as to the interaction with the responsible OIML issuing participants, PTB and METAS. The reports of the auditors give reason to expect that the three manufacturers' testing laboratories involved will be accepted at the next session of the CPR (Committee on Participation Review) and will be officially integrated in the *Declaration of Mutual Confidence* (DoMC) for non-automatic weighing instruments (OIML R 76).

After the WELMEC Guide 8.8 on a voluntary modular evaluation system for the conformity assessment of non-automatic weighing instruments and measuring instruments according to the MID had been ratified in 2012, sub-working groups of the WELMEC Working Group 2 are currently working on corresponding adjustments of the WELMEC Guides 2.2 "POS" and 2.4 "Load Cells". The discussions, in which also representatives of VDMA as well as manufacturers of weighing instruments and of load cells are involved, are not completed yet.

The *Solid Mechanics* Department realizes forces from 0.5 N to 16.5 MN by means of force standard machines, as well as torques from 1 mN·m to 1.1 MN·m by means of torque standard machines.

In connection with the establishment of renewable energy sources, especially wind power, the Department is experiencing a considerable increase in the demand for traceable calibrations for very large forces and torques. The Working Group *Realization of Force* therefore reacted by acquiring a 30-MN build-up system last year; it has now been possible to extend it to 50 MN (Fig. 1). After its validation, the force measuring range of the system can now be extended from previously 16.5 MN to 50 MN. The EMRP project SIB63 "Force Metrology" – which was

Cover picture:
Newly developed sound protection screen to reduce the sound-induced stress of orchestral musicians

Figure 1: 50-MN build-up system for the traceable measurement of very large forces

launched in July 2013 and is coordinated by Department 1.2 *Solid Mechanics*, and in which 10 leading European metrology institutes as well as the BAM Federal Institute for Materials Research and Testing, Berlin, and various European manufacturers and users from industry are involved – is connected with this topic. Within the scope of this project, the relevant influence quantities on built-up systems for large forces are to be scientifically investigated and models are to be developed to be able to take these into account in the measurement uncertainty budget.

Figure 2: 1.1-MN×m torque calibration facility after the relocation

The Working Group *Realization of Torque* covers the range from 1 mN×m to 1.1 MN×m; the 1.1-MN×m torque calibration facility is the largest in the world – and also the only facility of its kind worldwide (Figure 2). This facility – which has been in operation for approx. 10 years and has been used to capacity – was, for various reasons, moved into a neighbouring room of the same building in 2013. Since it had to be taken apart for this purpose, this opportunity was used to carry out several constructional improvements and to re-determine the lever length by means of a mobile coordinate measuring machine.

Between the smallest measuring facility (1 N×m) and the next larger one (1 kN×m), the overlapping range has, to date, been rather small, so that torque transducers having a measuring range between 2 N×m and 10 N×m could not be calibrated with sufficient accuracy. This gap should soon be closed thanks to the new acquisition of a 20 N×m torque standard machine which will allow automatic, effective calibration operation.

The cross-divisional activities within the scope of the EMRP research project IND09 „Dynamic Measurement of Mechanical Quantities“, which are coordinated by Working Group 1.73 *Impact Dynamics*, were continued in 2013. In this regard, the Working Group *Periodic Forces*, together with the Spanish partner institute CEM, carried out bilateral comparison measurements on a piezoelectric force transducer in the frequency range up to 2000 Hz for the first time. The first set of results obtained have shown good agreement between the dynamic sensitivities of the piezoelectric transducer measured by PTB and those measured by CEM (Fig. 3). The results have also confirmed the uncertainties stated by PTB in the list of services contained in the Quality Management Manual for the dynamic calibration of force transducers.

In Working Group 1.73 *Impact Dynamics*, measurement series were carried out on the modernized 20-kN impact force standard machine (Fig. 4) with diverse transducers within the scope of the same EMRP project (IND09); with these measurements, a new methodology of parameter identification is to be developed. Measurements which had started the previous year on various force transducers have been continued; these will allow the influence of different installation conditions on the dynamic behaviour during shock calibration to be investigated.

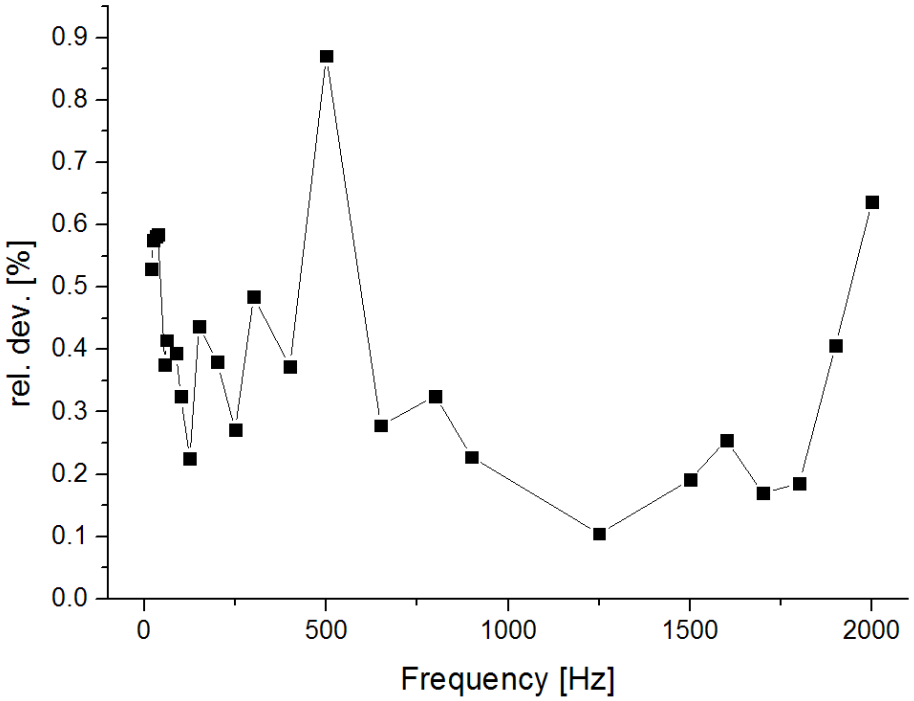


Figure 3: Relative deviation of the sensitivities of a piezoelectric force transducer determined by PTB and CEM in the frequency range up to approx. 2000 Hz

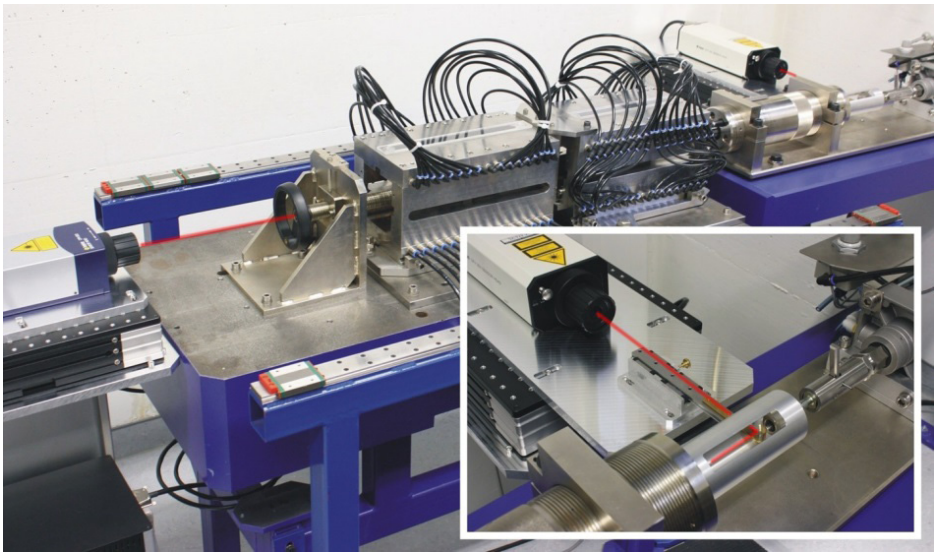


Figure 4: Modernized 20-kN impact force standard machine with coaxial interferometric acceleration measurement

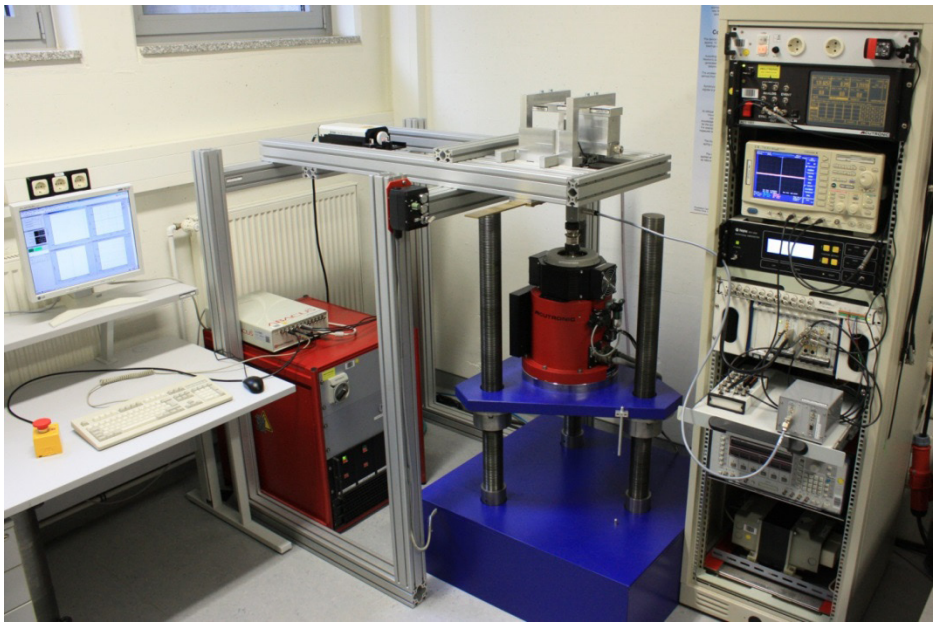


Figure 5: PTB's new dynamic torque standard machine up to 20 N×m and 1 kHz

Further progress has been achieved also in dynamic torque calibration. A measuring facility for small, sinusoidal torques of up to max. 20 N×m in the frequency range up to 1 kHz has been completed and first sets of test measurements have been carried out (Figure 5). The project partners involved in these activities were PTB Working Group 8.42 *Data Analysis and Measurement Uncertainty* as well as the French partner institute LNE.

Last but not least, a new procedure for the dynamic calibration of pressure sensors has been developed in Working Group 1.33 *Dynamic Pressure Measurement*. The first step, consisting in demonstrating that the procedure of interferometric pressure measurement is suitable for static pressures of up to 500 MPa, was successfully completed. This is the foundation for further investigations with a new test facility which is to be used to show that the interferometric procedure is also suitable for the link-up of short-term, half sinusoidal gas pressure impulses or hydraulic pressure impulses of up to 800 MPa, as they occur, e.g., in fuel injection pumps.

1.2. Flow

On the basis of the Units Act, the Departments 1.4 *Gas Flow* and 1.5 *Liquid Flow* deal with the realisation and dissemination of the units for the flow quantities *volume*, *flowrate* and *flow velocity* of gases and liquids.

In the Working Group *Fluid Flow Measuring Techniques* of Department 1.4 *Gas Flow*, advanced investigations of different procedures for the link-up of laser-doppler anemometers with a view to their utilization as reference standards have been carried out. All in all, it turned out that comparability of the calibration results is ensured, independent of the approaches considered for the determination of the LDA calibration constant in the range of $U = 0.2$ %. LDA calibrations with expanded uncertainties of $U < 0.1$ % are conceivable, but they require the uniformization of procedures which still have to be specified more precisely.

The CCM Key Comparison KC3 «Air Speed» was prepared by PTB and LNE-Cetiat (France) as pilot laboratories with the support of INRiM (Italy); a total of 10 participants from 4 regional metrology organizations (APMP, COOMET, EURAMET, SIM) took part in the comparison which started in summer 2013 using, for the first time, a laser-doppler anemometer as a transfer standard. The major part of the measurements carried out by the European participants have already been completed.

In the past year, further tests on newly developed partial components were carried out successfully within the scope of the «Transfer Wind LIDAR» project, and essential requirements from the various application fields were defined. The use of the system for the measurement of wind velocities will first take place in flat environments according to the relevant standard IEC 61400-12-1 and will later be extended to more complex environments. Comparison measurements for the verification of the system were discussed with partners from the wind power sector and have been incorporated both into a recently launched MSTQ project and into an EMRP project which has been applied for with leading European wind farm operators.

In the Working Group *Gas Meters*, a test rig for the investigation of gas meters at gas temperatures up to 600 °C has been commissioned and presented to PTB's "Kuratorium" (Advisory Board) (Fig. 6). Within the scope of the test rig's validation, the target uncertainty of $U = 0.2$ % for gas flowrate has been achieved with the meter under test. Current investigations are focussing, in particular, on optimum temperature acquisition in the gas flow.

The mobile measuring unit, which was conceived and built within the scope of the joint project "MONA" for the investigation of the methane escape in biogas facilities that are connected to the natural gas grid, was used for the first time at several biogas facilities. The ultrasonic measuring device for the determination of the volume rate, which was manufactured according to PTB's constructional specifications, exhibited the required metrological quality and the necessary flexibility to be able to take the

Figure 6: The new high-temperature gas flowrate test rig was presented to the participants within the scope of the 2013 "Kuratorium" meeting.

different conditions on site into account. Transmitting the measurement data via the mobile telecommunications network allows a permanent remote monitoring of the facilities, so that the major part of the measurement campaigns can be carried out automatically.

The venturi nozzles used in sonic operation according to the step-by-step method in the air test rig for the calibration of gas meters up to 5600 m^3/h were recalibrated after five years within the scope of the regular procedure. The results obtained confirmed the very good agreement with the calibration values obtained during the prior calibration round and the good reproducibility of the sonic venturi nozzles. For flowrates below Q = 0.6 L/h, a new standard – based on an actively driven double piston – was conceived, acquired and tested for the first time. The constructional characteristics of this standard ensure a minimization of the dead volume and, thus, also allow smaller values to be achieved with regard to the measurement uncertainty.

An increasing number of conformity assessments and approval tests for gas meters were carried out, mainly for national customers. In this way, the conformity of a gas meter, among other things, which is used in the industrial and light industrial field in a gas temperature range from -40 °C to 70 °C – and, thus, over the full temperature range defined in the European Measuring Instruments Directive (MID) – was assessed for the first time. The tests were carried out at the Working Group's test rig which is unique in Europe for this kind of measurement.

The Working Group *High-pressure Gas* was considerably involved in turning a page in the realization and dissemination of the unit of the volume of high-pressure gas. On 23 September 2013, the representatives of the metrological institutes from Germany, France, the Netherlands and Denmark signed a memorandum of understanding (MoU) on cooperation, named "**Eu**ropean **Re**ference for **Ga**s metering" (EUREGA). This MoU replaces the prior agreement on the harmonization of the cubic metre for high-pressure gas from 1999/2004. Essential components of the agreement's contents were updated and adapted to the technical and organizational framework conditions (which have meanwhile changed considerably) of the partners involved. It must be pointed out that new partners – such as FORCE from Denmark – can join the MoU by virtue of explicitly stated framework conditions.

Pursuing harmonization within the new EUREGA group, which now consists of four partners, ensures that the metrological basis for a uniform reference value in the field of international trade with natural gas – which is an economically highly important area – is guaranteed at the highest metrological level. In this way, proof was furnished – and presented at FLOMEKO 2013 – that this reference value could be disseminated with an excellent reproducibility of 0.11 % from 2005 to 2011.

The next determination of the harmonized cubic metre on the basis of an extensive round robin within the EUREGA group is on the agenda for 2014. For this purpose, the technical preconditions have already been created and recalibrations were carried out in the relevant national traceability chains in 2013.

Department 1.5 *Liquid Flow* deals with a wide range of activities in the fields of volume and flowrate measurement of liquids – both flowing and at rest.

Last year, the activities of the Working Group *Traceability of Liquid Flow Measurement* focussed on extensive work for the preparation and organization of international comparison measurements. In this way, the COOMET comparison of the primary standard test rigs for water in the range from 0.5 m^3/h to 100 m^3/h were ultimately completed with the elaboration of the corresponding Draft B Report. The comparison standards of the BIPM Key Comparison CCM.FF-K1, for which PTB will act as the pilot laboratory, could, within the scope of a bilateral preliminary comparison with the primary standard test rig of NEL in Glasgow, be extensively investigated at flowrates between 30 m^3/h and 220 m^3/h and be qualified for the key comparison.

The activities of the Working Group *Liquid Test Facilities* focussed on further improving the measurement uncertainty of the standard measuring facilities for liquids other than water. One of the most meaningful results of these extensive investigations was that the expanded measurement uncertainties of U = 0.05 % for the white-spirit-operated mineral oil test rig (0.6 m^3/h to 250 m^3/h) could also be proved in dynamic operation with the so-called «flying start/stop» and U = 0.1 % for the test rig for the smallest quantities (0.1 L/h to 300 L/h).

The field of activities of the Working Group *Liquid Meters* focusses on the approval and certification of liquid meters within the scope of the Verification

Act and on active cooperation in the relevant national and international standardization and regulation committees. Urgently needed improvements in the existing regulations of legal metrology are hereby supported also by corresponding joint research activities carried out in collaboration with the verification authorities and with industry. In this way, the cooperation project "Temperature distribution in large storage tanks" made it possible to obtain, for the first time, new, scientifically validated findings, for example, for the elaboration of realistic procedures for the conversion of a volume of liquid located in a tank to the corresponding reference or conversion temperature.

1.3 Acoustics, Ultrasound and Acceleration

In the working field of *Acoustics*, *Ultrasound* and *Acceleration*, the Departments 1.6 *Sound*, 1.7 *Acoustics and Dynamics* as well as 1.3 *Velocity* work on metrological issues regarding the realization and dissemination of acoustic and dynamic mechanical units. Pursuant to the requirements laid down in the Units Act, the Verification Act and the Medical Devices Act, various scientific studies are being conducted and numerous services that are necessary for society and the economy are carried out with the highest accuracy and reliability.

Department 1.6 *Sound* deals with a large variety of issues concerning acoustic metrology, the approval of sound level meters and calibrators, hearing and ultrasound.

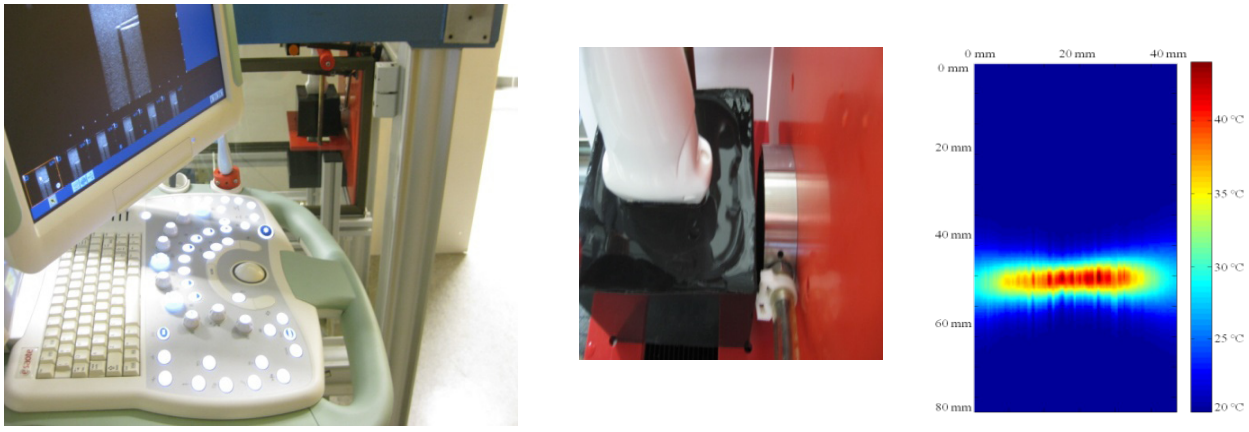
The *Sound in Air* Working Group supplies the unit of sound pressure, the pascal, as a basis for the traceability of acoustic measurements; hereby, the Working Group supports DAkkS by means of expertise activities for the accreditation of the calibration laboratories which are in charge of disseminating the unit. Within the scope of the EMRP project "EARS", measurements on brain activation by means of infrasonic signals are being prepared in collaboration with the *Biosignals* Department. For this purpose, special, calibratable, MRI-suitable infrasound generators were developed, tested and have already been used in the Working Group for investigations of the perceptibility threshold of infrasound.

In order to improve the intelligibility of loudspeaker announcements and their accessibility for hearing-impaired persons, the connection between the technical transmission quality of public address systems and the actual speech intelligibility is being determined within the scope of a project realized by the "Zentrales Innovationsprogramm Mittelstand" (ZIM – Central Innovation Programme for SMEs).

A reference sound source system has been set up as basis for HITU (high-intensity therapeutic ultrasound) metrology in the *Ultrasound* Working Group; it is already being used in clinical practice, e.g., for tumour ablation. A back-coupling adjustment allows long-term-stable, particularly accurately defined therapeutic ultrasonic fields of different power to be generated for calibration purposes.

Within the scope of the EMRP project "DUTy", the Working Group realized a non-invasive method of temperature measurement in tissue phantoms under irradiation by means of therapeutic ultrasound. A modified diagnostic ultrasonic device (Fig. 7) provides raw echo data from which temperature distributions inside the tissue phantom can be calculated by means of specially developed cross-correlation calculations. This technique is to be used in future

Figure 7: Ultrasonic diagnostic device (left), used for non-invasive temperature measurement in a tissue phantom into which therapeutic ultrasound is introduced from the right (centre), and measured temperature distribution in the focal zone in the direction of sound propagation (right)



to determine the dose, e.g., to plan a therapy, and for the regular checking of clinical therapeutic devices.

In a project supported by the Deutsche Forschungsgemeinschaft (DFG – German Research Foundation), possible risks of phacoemulsification were investigated. The influence of thermal effects was clearly ruled out, which provides surgeons with different clues with regard to operation strategies.

The Working Group *Noise Measuring Technology* has, within the scope of the EMRP project "EARS", set up new measuring arrangements which are used to characterize airborne ultrasound and have, to date, not been available in any other metrological laboratory. In order to acquire the spatial acoustic field distribution of sound sources metrologically, a system has been set up with which 3D frequency-selective directional characteristics can be determined for sources up to 100 kHz. In addition, the first measuring set-up for the calibration of microphones in the ultrasonic frequency range up to 100 kHz has been set up. This made it possible to carry out traceable measurements of the output quantities of airborne ultrasonic sources.

The Working Groups *Realization of Acceleration*, *Applied Acoustics* and *Impact Dynamics* are part of the *Acoustics and Dynamics Department* (1.7).

The focus of the *Realization of Acceleration* Working Group is the calibration of reference acceleration transducers for accredited laboratories in Germany, but also for international clients and foreign metrology institutes.

To realize primary calibrations of accelerometers at very low frequencies, the Working Group *Realization of Acceleration* has set up a new calibration facility (Fig. 8). The air-borne linear drive used as a shaker for this purpose allows a total displacement of 1500 mm (previously: 1000 mm).

This facility is to be used to carry out calibrations down to 0.1 Hz with similarly low measurement uncertainties as for higher ranges of frequency. Such low-frequency vibrations are playing an increasing role in building monitoring and the design and monitoring of wind power plants.

The new standard facility uses a new procedure to measure the acceleration by means of a laser-doppler vibrometer; this procedure allows the instantaneous Doppler shift of the laser measuring beam to

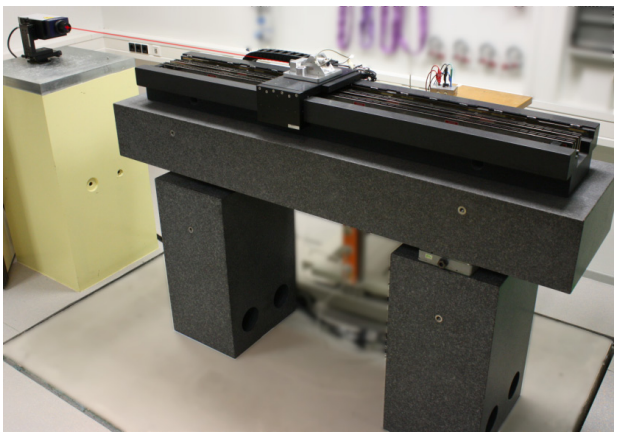


Figure 8: New lowest-frequency standard accelerometer of PTB with a displacement of 1500 mm

be determined by means of a frequency counter at sampling rates of up to 50 kS/s.

Last year, part of the activities of the *Applied Acoustics* Working Group focused on the quality assurance of test centres for building acoustics. For this purpose, a new concept was developed for the approx. 90 VMPA-approved test centres within the scope of a collaboration with the *Verband der Materialprüfungsanstalten* (VMPA – German association of materials test centres) and the *Materialprüfanstalt für das Bauwesen* of the TU Braunschweig (MPA – Civil engineering materials testing institute of the Technical University of Braunschweig). Quality assurance is essentially based on a comparison measurement taking place at MPA in Braunschweig in which all test centres must participate within 3 years. The measurements to be performed are: airborne sound reduction and impact sound reduction measurements as well as measurements of the noise emitted by technical facilities in buildings. When selecting the measurement tasks, attention was paid to providing realistic situations in buildings and including new measurement procedures. This gives this comparison measurement the simultaneous function of a training measure. The admissible tolerance ranges within which the results of the test centres should lie were determined by means of 6 independent measurements carried out by PTB. The first 13 test centres have already performed the measurements, and it turned out that the new quality assurance system has been well accepted on the part of the test centres. Another advantage lies in the fact that PTB has access to the measured data which provide valuable information on the uncertainties occurring in real measurements on buildings.

Another achievement in 2013 was the beginning of a European project for the realization, dissemi-

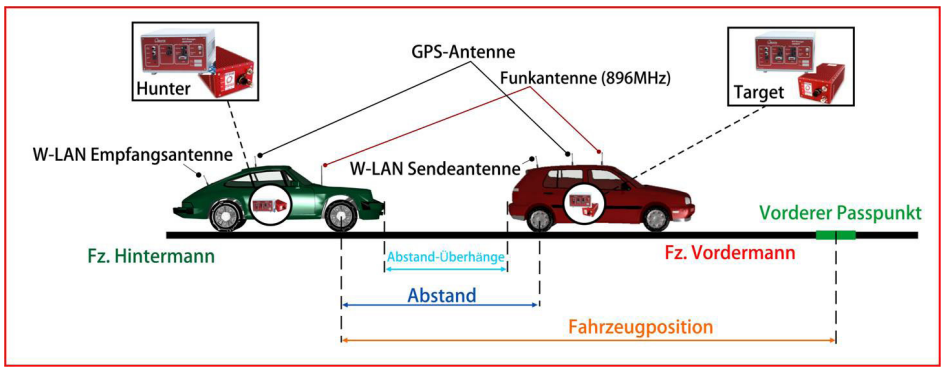


Figure 9a: Set-up of the reference system with two DGPS inertial systems for the accurate determination of the distance between two test vehicles driving in flowing traffic.

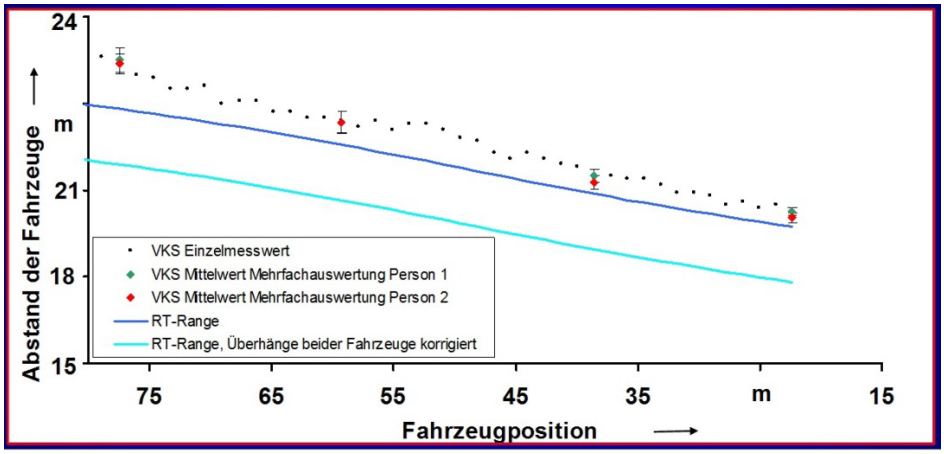


Figure 9b: Results of the comparison between the distance values measured with an approved traffic-monitoring system (TMS) (top, dotted line) and the reference values supplied by means of the DGPS inertial system (centre, continuous line); the bottom line shows the distance values corrected by the overhang that are relevant within the scope of road traffic legislation.

nation and application of the unit watt in airborne sound. This project, which was initiated and coordinated by PTB, will have a considerable impact on global metrology in applied acoustics, since the central quantity "sound power" becomes traceable for the first time.

In the Working Group *Speed Measuring Instruments* of Department 1.3 *Velocity*, the existing type approval of a traffic-monitoring system (TMS) that has already been in operation for numerous years has been extended, so that now, video-based speed and distance measurements are possible even on challenging road sections, e.g. on winding or hilly road sections. In addition, further investigations were carried out within the scope of a joint cooperation project with two partners from industry in order to confirm the correctness of official distance measurements under real conditions, using modern measurement procedures. For this purpose, extensive measurement series were carried out with specially equipped test vehicles in normal traffic, and the time-dependent positions – and, thus, the distance between two vehicles – were recorded and analyzed with high resolution by means of two high-end DGPS inertial systems (Fig. 9). The reference distances between two vehicles were varied by targeted braking and accelerating manoeuvres and could thus be determined with a measurement uncertainty of 3 cm. As a result, it turned out that throughout the measuring range, the TMS always determines the distance between two vehicles that is relevant within the scope of road traffic legislation (= distance overhangs in Fig. 9a) largely in favour of the motorist (Fig. 9b).

The Working Group *Dynamic Pressure Measurement* issues, upon request, the so-called "F in a pentagon" for civil firearms which are operated, e.g., with cold gases or by means of spring pressure. The main criterion for the attribution of this mark is the kinetic energy output transmitted to the projectiles which may not exceed 7.5 J in order to prevent significant injuries to third parties. If these – and further – criteria are met, a „notification certificate" is issued according to the German Act on the Proof Testing of Arms and Ammunition, Section 9, para. 2, No. 1, and the weapons may be used freely. These tests are carried out each time with well-defined standard projectiles; besides the shape of the projectile, also its mass and its velocity are decisive (Fig. 10, bottom). An investigation of the Working Group *Dynamic Pressure Measurement*, carried out in close cooperation with *"Universitätsmedizin Greifswald"*, has shown that some special – but commercially available – plastic-jacket bullets for compressed-air weapons with kinetic energy at the upper limit (Fig. 10, top) can reach clearly higher kinetic energies than the above-mentioned 7.5 joules, which, of

course, entails the risk of serious injuries to humans and animals alike. Consequently, it is being checked whether the currently valid technical and legal provisions applying to weapons for civil use are still state of the art.

Apart from this, the Working Group *Dynamic Pressure Measurement* is also in charge of, among other things, serial tests of powder-actuated captive bolt pistols according to the Machinery Directive 2006/42/EC, whose scope of application exclusively serves the protection of labour for persons stunning animals in slaughterhouses. Due to high rates of failures of such captive-bolt pistols for stunning cattle, which have come into the focus of media reports, animal welfare is now also being considered, in particular by the new ordinance 1099/2009 which came into force in Germany as of 1 January 2013. In this context, PTB is supporting current scientific research projects that are aimed at improving animal welfare further by means of measurements of the kinetic impact energy of the bolt of certain captive-bolt pistols. The conclusion of these investigations is that it is a tightrope walk to comply simultaneously with the requirements of safety at work for the personnel and with animal welfare requirements and that this can only be achieved if all essential parameters – such as the contact point, the impact direction and velocity, the exit length and diameter of the bolt – are optimally defined as a function of the type and size of animal and are complied with in daily practice.

For reasons pursuant to occupational safety, the refurbishing of all shooting ranges and testing rooms of the Working Group has started in 2013, so that considerable limitations of the testing operations are to be expected until the repair work has been completed – which is planned for August 2014.

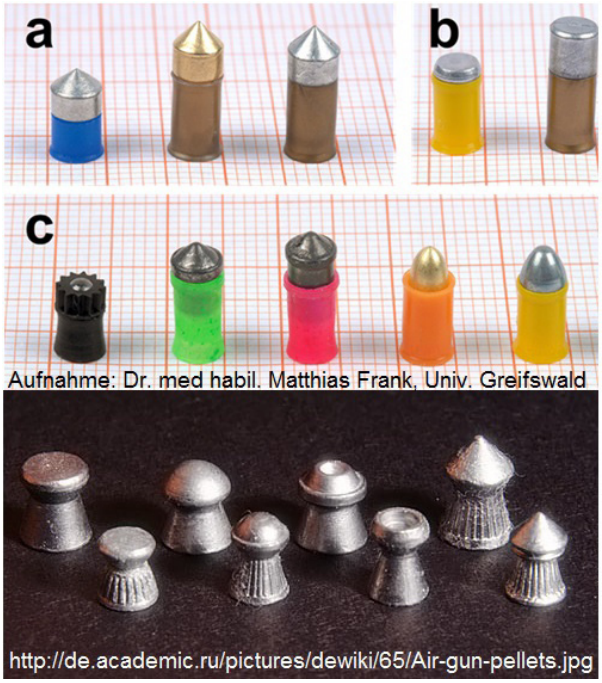


Figure 10: Commercially available plastic-jacket bullets for compressed-air weapons (a, b, c, top), compared to standard projectiles as are used for measuring the kinetic energy (bottom)

Headlines: News from the Division

Fundamentals of Metrology

Metrological assessment of the 1 N·m torque standard force measuring machine completed
(D. Röske, FB 1.2, dirk.roeske@ptb.de)

Gravimetric measurements on the influence of oxide formation on the mass stability of silicon spheres
(M. Borys, FB 1.1, michael.borys@ptb.de)

Quantification of the dynamic behaviour of flowmeters
(R. Engel, FB 1.5, rainer.engel@ptb.de)

Calibration facility for forward-scattering LDA systems
(V. Strunck, FB 1.4, volker.strunck@ptb.de)

Small sources, loud noise
(C. Kling, FB 1.6, christoph.kling@ptb.de)

Research project for the traceability of the measurand "sound power" launched
(V. Wittstock, FB 1.7, volker.wittstock@ptb.de)

Reciprocity calibrations of measuring microphones in a diffuse field
(V. Wittstock, FB 1.7, volker.wittstock@ptb.de)

Investigation of the dynamic behaviour of the 250 kN impact force standard machine
(M. Kobusch, FB 1.7, michael.kobusch@ptb.de)

Testing of exponential sweep signals with the aid of Hilbert transform
(I. Bork, FB 1.6, ingolf.bork@ptb.de)

Heat transmission in fluid-filled micropores
(U. Hammerschmidt, Abt. 1, ulf.hammerschmidt@ptb.de)

Monte Carlo simulations of the susceptometer method to determine the magnetic properties of weights
(F. Scholz, FB1.1, frank.scholz@ptb.de)

Metrology for the Economy

Newly developed mobile measurement facility for methane leaks in biogas plants successfully commissioned
(H.-B. Böckler, FB 1.4, hans-benjamin.boeckler@ptb.de)

High-temperature gas flowrate test rig successfully commissioned
(R. Kramer, FB 1.4, rainer.kramer@ptb.de)

A sensor to determine the effectiveness of ultrasonic cleaning devices
(M. Jüschke, FB 1.6, matthias.jueschke@ptb.de)

Heat transmission of fluid-saturated sandur freestone
(U. Hammerschmidt, Abt. 1, ulf.hammerschmidt@ptb.de)

Proposals for a revision of the standard for the calibration of torque tools
(D. Röske, FB 1.2, dirk.roeske@ptb.de)

Component catalogue "Frame Construction" of DIN 4109 "Sound insulation in buildings" revised
(H. Bietz, FB 1.7, heinrich.bietz@ptb.de)

Metrology for Society

Investigations of the effectiveness of powder-actuated captive-bolt pistols under the aspects of animal welfare and safety at work
(H. C. Schönekeß, FB 1.3, holger.schoenekess@ptb.de)

Revision of the WELMEC Guide 2.4 for load cells
(O. Mack, FB 1.1, oliver.mack@ptb.de)

Recognition of manufacturer test results in OIML MAA certificates
(D. Knopf, FB 1.1, dorothea.knopf@ptb.de)

Quantitative error analysis in video-based distance measurements with traffic-monitoring systems by means of a precise GPS inertial system clearly confirms that the system operates correctly
(F. Märtens, FB 1.3, frank.maertens@ptb.de)

Recent results of the investigation of the temperature distribution in large storage tanks
(R. Jost, FB 1.6, ruediger.jost @ptb.de)

Damping of acoustic room modes by tunable Helmholtz resonators
(I. Bork, FB 1.6, ingolf.bork@ptb.de)

International Affairs

European cooperation for the measurement of very large forces up to 50 MN
(R. Kumme, FB 1.2, rolf.kumme@ptb.de)

COOMET comparison of the flowrate primary standards for water successfully completed
(G. Wendt, FB 1.5, gudrun.wendt @ptb.de)