Brief report on primary standards for acoustics and vibration at GUM to the 7th Meeting of CCAUV

Reciprocity calibration of laboratory standard microphones

The first GUM experience with the reciprocity calibration of standard microphones had been related to B&K manually operated facilities. In 1998 GUM purchased the computer-operated facility developed at NPL for reciprocity calibration of LS2 microphones. Its capabilities were extended to the calibration of LS1 microphones in 2000 by GUM staff with the assistance of NPL specialists. Thereafter GUM capabilities in reciprocity calibration of microphones were confirmed in key comparisons: EUROMET.AUV.A-K1, CCAUV.A-K1, CCAUV.A-K3, COOMET.AUV.A-K1 and COOMET.AUV.A-K3.

This system enabled reciprocity calibration of microphones in the frequency range of 31,5 Hz to 10 kHz (LS1) or to 20 kHz (LS2) with third-octave frequency resolution. There were both calibrations of 17 GUM LS reference microphones and some WS microphones performed every six months to maintain sound pressure unit and also the calibrations of microphones for accredited calibration laboratories.

However computer hardware and measurement controlling and data processing software running under MS DOS as well as some analogue measuring instrumentation became obsolete after over ten years of use. The measurements performed using this system appeared to be very time consuming. It became the main reason for the decision of improving the capabilities of acoustical primary standard in Poland. Additional reasons are the changes in the requirements of IEC 61094-2 standard (second edition 2009) and the aim to achieve a chance for participation in ongoing key comparison in laboratory standard microphones calibration, significantly extended in scope compared to previous key comparisons.

In 2009 it was decided to enter into a contract with NPL to upgrade the existing GUM calibration facility to the latest specification in use at NPL. The core elements of the previous GUM setup (microphones with their histories, couplers and instrumentation providing traceability) remained unchanged. This enables existing CMCs to be retained without change. The upgrading included purchase of new DSP selective voltmeters, exchange of software to operating under MS Windows, and also significant extension of technical scope of the setup by including phase calibration capability, extending of low frequency operation range down to 2 Hz and multi-coupler calibration facility for microphone acoustical parameters determination.

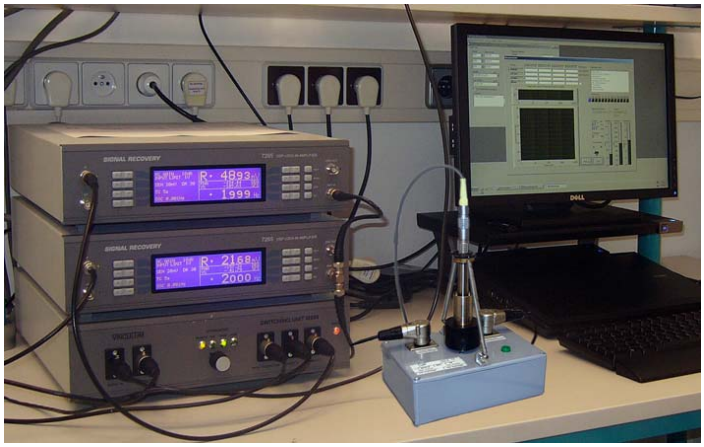

Fig. 1 The GUM reciprocity setup used currently for calibration of LS1 microphones

The most important advantages of the upgrading are:

- significant improvement of run-time, by virtue of new DSP selective voltmeters and new software running under MS Windows;
- lowering of system sensitivity to the changes of environmental conditions due to the reduced run-time of measurements;
- improved reliability thanks to the graphical user interface which alerts the user to run-time anomalies and let him to solve problems during measurements;
- background processing of data performed while the measurements are in progress;
- extended low frequency operation capability
- improved frequency resolution (calibration at 1/nth-octave steps and at exact frequencies)
- multi-coupler facility allowing to perform as well one-inch as half-inch microphone acoustical impedance determination;
- new capability for phase calibration;
- ensuring the conformance to recent edition of IEC 61094-2;
- chance to reduce measurement uncertainty, especially for LS2 microphones.

For traceability assuring the particularly valuable issue is however that the upgraded system enables existing historical performance data to remain valid and relevant into the future. The series of LS1 and LS2 microphones calibrations performed at GUM in 2010 show no significant changes between the present results and those achieved with old reciprocity setup.

Primary vibration calibration by laser interferometry

The measurement setup used in GUM for primary vibration calibration by laser interferometry is the CS 18 P system developed by SPEKTRA (Germany), installed in GUM in 2002. The system enables an absolute magnitude and phase calibration of accelerometers and acceleration measuring chains according ISO 16063:11 (method 3), in the frequency range from 1 Hz to 10 kHz. Two types of vibration exciter are involved: Endevco 2911 enabling vertical vibration excitation within frequency range from 10 Hz to 10 kHz and APS 500 producing horizontal vibration at frequencies from 1 Hz to 100 Hz.

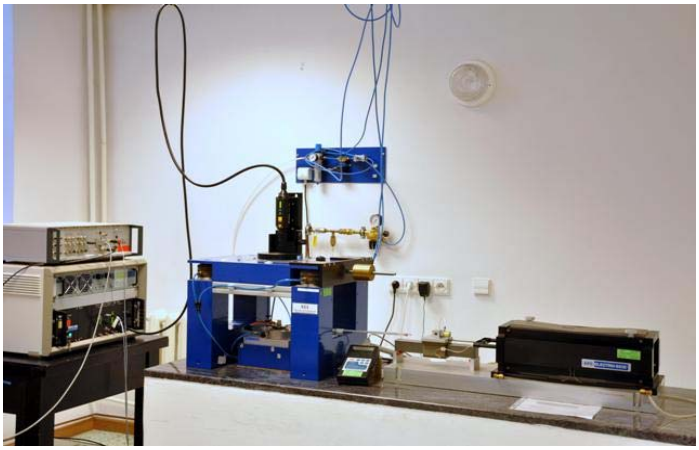

Fig. 2 The GUM measurement setup for primary vibration calibration

Expanded measurement uncertainties of magnitude calibration of accelerometers in frequency range from 10 Hz to 10 kHz have been estimated as:
0,6 % within frequency range from10 Hz to 16 Hz and for 5 kHz
0,5 % within frequency range from 20 Hz to 4 kHz,
1,1 % within frequency range from 6,3 kHz to 8 kHz,
1,4 % for 10 kHz

The above capabilities were confirmed in EUROMET AUV.V-K1 key comparison and enabled the CMCs to be approved. GUM participated also in COOMET AUV.V-K1 key comparison (the draft B of final report is under preparation) and in CCAUV.V-K2 key comparison (in progress).

In 2009, due to the requirements concerning the calibration of human vibration meters according to ISO 8041:2005, chapter 13, the frequency range of absolute calibration in vertical direction was extended down to 5 Hz. The expanded uncertainty of magnitude sensitivity measurement was estimated as 0,7 % in the frequency range of 5 Hz to 8 Hz. The uncertainty value was verified by comparison of calibration results obtained for the same transfer accelerometer type 8305 in GUM and in PTB (see Fig. 3). The maximum difference between the values of magnitude sensitivity obtained in GUM and PTB within frequency range from 5 Hz to 8 Hz was 0,3 %.

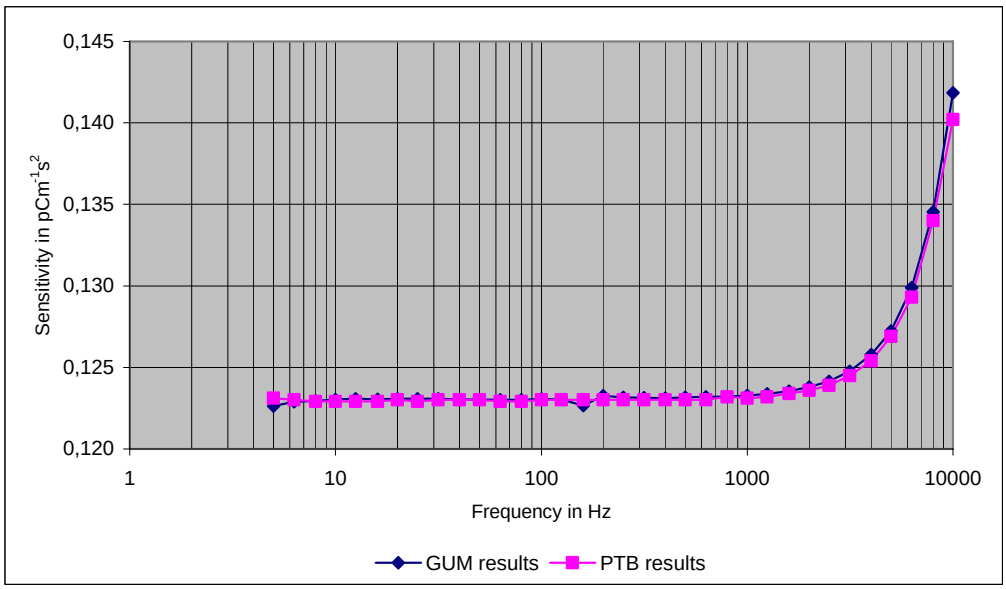

Fig. 3 Results of absolute magnitude calibration of B&K 8305 accelerometer performed by GUM and PTB

GUM activity in the primary vibration calibration was previously focused on magnitude calibration of accelerometers. In 2008, after upgrading the software, the range of calibration was extended to phase calibration. The expanded uncertainties of absolute phase calibration were estimated as:
1,1 ° within frequency range from 5 Hz to 8 Hz,
0,7 ° within frequency range from 10 Hz to 16 Hz,
0,6 ° within frequency range from 20 Hz to 4 kHz,
0,8 ° for 5 kHz,
1,0 ° within frequency range from 6,3 kHz to 10 kHz.

The verification of GUM capabilities in absolute phase calibration will be possible after the CCAUV.V-K2 key comparison completion.