National Standards and Research Activities at NMIJ

Short report to 5th Meeting of the CCAUV

1. Acoustics

NMIJ has developed calibration systems for the national standard of sound pressure in air.

- Primary calibration of pressure sensitivity level of laboratory standard microphones (LS1P & LS2P) by using the reciprocity technique. (CMC for LS1P already published)
- Primary calibration of free-field sensitivity level of laboratory standard microphones (LS1P & LS2P) by using the reciprocity technique. (CMC not published yet)
- Comparative calibration of working standard microphones in an anechoic chamber. (CMC not published yet)

Now, NMIJ has been developing new acoustic standards, and they will be established within one or two years.

- Microphone calibration system for low frequency range (infrasound) between 1 Hz to 100 Hz, by using "laser pistonphone". The purpose of this standard is the low frequency noise evaluation.
- Microphone calibration system for high frequency range (airborne ultrasound, 20 kHz to 100 kHz) by the reciprocity technique in a small anechoic chamber. The purposes of this standard are for human safety or for testing high definition audio systems.

Recent publications:

[1] T. Fujimori, R. Horiuchi, and S. Sato, "Free-field correction for laboratory standard microphones of type LS2aP", Acoust. Sci. & Tech., 23, 6, pp.350-352, 2002.

[2] R. Horiuchi, T. Fujimori, and S. Sato, "Uncertainty analysis for pressure sensitivities of laboratory standard microphones", Acoust. Sci. & Tech., 25, 5, pp. 354-363, 2004.

[3] R. Horiuchi, T. Fujimori, S. Sato, V. Plangsangmas, P. Rattanangkui, and S. Pattarachindanuwong, "Bilateral comparison of pressure sensitivities of laboratory standard microphones between NMIJ and NIMT", AIST Bulletin of Metrology, 3, 4, pp.489-493, 2005.

2. Ultrasound

Calibration services both hydrophone sensitivity and ultrasonic power have started at the beginning of 2006.

Calibration of hydrophone sensitivity

- The primary calibration system for standard membrane hydrophones uses the laser interferometry.
- The secondary calibration system uses the comparison method.
- The frequency range of the calibration is 0.5 MHz to 20 MHz. Within one or two years, NMIJ has plan to expand frequency range between 0.1 MHz to 40 MHz.
- Typical values of expanded uncertainties (k=2) for primary system are 3.6 % (1 MHz), 2.6 % (5 MHz), 2.9 % (10 MHz), 3 % (15 MHz) and 3.3 % (20 MHz).
- Typical values of expanded uncertainties (k=2) for secondary system are 7.6 % (1 MHz), 5.8 % (5 MHz), 6.4 % (10 MHz), 6.9 % (15 MHz) and 8.1 % (20 MHz).

Calibration of ultrasonic power

- The primary standard for ultrasonic power uses the radiation force balance method.
- The frequency range is between 0.5 MHz to 20 MHz, and power range is between 1 mW to 500 mW. The power range will be expanded to 20 W (up to 5 MHz) by the end of March 2008.
- The measurement uncertainties depend on both frequency and power. Typical values of expanded uncertainties (k=2) for 100 mW are 4.2 % (0.5 MHz), 2.4 % (10 MHz) and 10.4 % (20 MHz). For 10 mW, 5.0 % (0.5 MHz), 3.9 % (10 MHz) and 10.7 % (20 MHz).

Future work for ultrasonic measurements

NMIJ is going to start some projects for developing new method concerned to HIFU (High Intensity Focused Ultrasound) measurements and human safety.

- Ultrasonic power measurement for HIFU.
- Quantitative measurements for cavitation generation.
- New concept hydrophones used in HIFU.
- Phantoms for demonstrating temperature rise in human body.

Recent publications:

[1] M. Yoshioka, J. Ohoto, T. Kikuchi, and S. Sato, “Hydrophone Calibration System

Using Laser Interferometry at NMIJ/AIST", 18th International Congress on Acoustics (ICA2004), 2004.

[2] T. Kikuchi, M. Yoshioka, and S. Sato, “Ultrasonic Power Measurement System Using a Radiation Force Balance Method at AIST", 18th International Congress on Acoustics (ICA2004), 2004.

[3] T. Kikuchi, S. Sato, and M. Yoshioka, “Quantitative estimation of streaming effects on radiation force balance method", IEEE International UFFC 50th Anniversary Joint Conference, 2004.

[4] M. Yoshioka, S. Sato, and T. Kikuchi, “A Method for Measuring the Frequency Response of Photodetectors Using Twice-modulated Light", IEEE Journal of Lightwave Technology, 23, 6, pp.2112-2117, 2005.

3. Vibration

NMIJ has developed four calibration systems for the national standard of vibration acceleration [1]-[4]. All of the systems are in compliance with ISO 16063-11 (Methods for the calibration of vibration and shock pick-ups. Part 11: Primary vibration calibration by laser interferometry) [5]. They are classified for their calibration frequency range as follows.

System 1; Very low frequency range: 0.1 Hz – 2 Hz. (CMC not published yet)

System 2; Low frequency range: 1 Hz – 200 Hz. (CMC already published)

System 3; Middle frequency range: 20 Hz – 5 kHz. (CMC already published)

System 4; High frequency range: 5 kHz – 10 kHz. . (CMC not published yet)

System 1 is realized by a combination of Michelson laser interferometer for fringe-counting method in compliance with ISO-16063-11 and an electro dynamic vibrator with airborne slider which maximum stroke is 36 cm. The motion of vibrator is horizontal direction. Applicable acceleration range lies from 0.03 m/s^2 to 10 m/s^2 [3].

System 4 is realized by a combination of modified homodyne Michelson laser interferometer and an electro dynamic vibrator with airborne slider. The motion of vibrator is vertical direction. To obtain high resolution laser interferometer for displacement measurement in vibration, we developed the modified Michelson type laser interferometer with a multifold optical path which can be applied for Sine-approximation method [4].

The system 1 and 4 have been developed recently and the calibration service will be started in the year 2006. NMIJ is also developing shock acceleration calibration facility.

References:

[1] T. Usuda and T. Kurosawa, "Calibration methods for vibration transducers and their uncertainties", Metrologia, 36, pp. 375-383, 1999.

[2] T. Usuda, E. Furuta, A. Ohta and H. Nakano, "Development of laser interferometer for a Sine-approximation method", Proc. SPIE 4827, (Proc. of the 5th International Conference on Vibration Measurements by Laser Techniques: Advances and Applications) pp. 29-36, 2002.

[3] T. Usuda, A. Ohta, T. Ishigami, O. Fuchiwaki, D. Misaki, H. Aoyama, and S. Sato, "The current progress of measurement standards for vibration in NMIJ/AIST", Proc. SPIE 5503, (Proc. of the 6th International Conference on Vibration Measurements by Laser Techniques: Advances and Applications) pp. 30-38, 2004.

[4] Akihiro Ohta, Takashi Usuda, Tamio Ishigami, Hisayuki Aoyama, and Sojun Sato, DEVELOPMENT OF PRIMARY CALIBRATION SYSTEM FOR VIBRATION ACCELERATION STANDARD EXTENDING TO HIGHER FREQUENCY RANGE, Proc. of 12th International Congress on Sound and Vibration, 11-14th July, Lisbon Portugal, 2005.

[5] ISO16063-11: Methods for the calibration of vibration and shock pick-ups. Part 11: Primary vibration calibration by laser interferometry, International Organization for Standardization, 1999.