Short report on INRiM activities in Acoustics, Ultrasound and Vibration.

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1. Presentation of INRiM

INRiM is one of the National Metrology Institutes of Italy, together with ENEA-INMRI that is in charge of the ionising radiation standards. INRiM is the results of the 2006 merging of IMGC, that was the NMI for mechanical and temperature quantities, and IEN that dealt with electrical quantities, time, photometry and acoustics. INRiM is controlled by Ministry of "Istruzione, Università e Ricerca".

From the second half of 2007 INRiM is organised in four Divisions, acoustic and ultrasound being part of "Termodinamica" Division and vibrations of "Meccanica" Division.

Among the activities of INRiM in the AUV field are the development and maintenance of national standards, a service of traceability to calibration laboratories, research in the field of materials for acoustical and vibration mitigation, type approval of instrumentation and devices for noise measurement, testing of properties of materials.

In the "Termodinamica" Division, an acoustical programme is active in the determination of the speed of sound in gases and in liquids, for the characterisation of their thermodynamic properties, and in sonochemistry. The precision measurement of the speed of sound in spherical resonators is part of the INRiM contribution to iMERA+ research project TP1 - JRP "Determination of the Boltzmann Constant".

2. Standards in AUV

INRiM is in charge to operate the Italian national standards of acoustical pressure, sound power, ultrasonic power and acceleration. The measurement capabilities in these field are listed in the CMCs database on BIPM website.

The standard for acoustical pressure is realised by primary calibration of laboratory standard microphones in the range 20 Hz to 25 kHz, according to the pressure reciprocity method described in IEC 61094 part 2 norm. A free field reciprocity standard is under development.

The sound power standard consists of the calibration of reference sound sources in a hemi anechoic room following ISO 6926 norm.

The ultrasonic power from 0.01 W to 15 W in the frequency range 1.8 MHz to 11 MHz is measured by means of a radiation force balance with both absorbing and reflective targets.

Vibrations standards follow ISO 16063 part 11 and part 21 standards and cover the frequency range from .5 Hz to 10 kHz.

In the framework of SIT Italian calibration accreditation service, 15 laboratories in the field of Acoustics, 7 in Vibration and one in Ultrasound obtain the traceability of their transfer standards from INRiM.

3. Other activities related to AUV

A considerable work is done on the characterisation of the acoustical and vibration properties of materials. Testing is routinely performed according to ISO standards on sound transmission loss, absorption coefficient, flow resistance and dynamic stiffness.

A research activity on the development of advanced methods for the determination of the physical properties of materials is going on. Some of these methods are based on the measurement of the speed of sound of longitudinal and transversal waves in solids. The data obtained is then used by mathematical models of the material.

The measurement of the viscous creep and compressibility of viscous-elastic materials used for vibration mitigation gives data for models for the forecast of long term loss of damping properties.

In the ultrasound field, materials for making phantoms mimicking the characteristics of organic tissues have been constructed and their properties characterised. The next step is to embed temperature sensors that are suitable for measuring the local temperature increase due to highly focalised ultrasound fields.

The standard for ultrasonic power needs to be extended to the high levels generated by HITU devices; a new force balance, whose response is much faster than that of the force balance based on a commercial mass balance, has been constructed and is now under test. The device can measure short pulses (the bandwidth is approximately 700 Hz) and thus the heating of the absorbing target is reduced, prolonging its life. Given its mechanical construction, the targets are directly connected with the force sensor and thus the reflecting target is less susceptible to unwanted lateral movement under the force generated by the ultrasonic beam.

In fig.1 the comparison of the new measurement apparatus (red curve) with the radiation balance used for calibrations is shown. A reflecting target was used in both cases, and ultrasonic power vs. driving voltage to transducer is plotted. The duration of the driving signal for the measurements with the new apparatus was 300 ms.

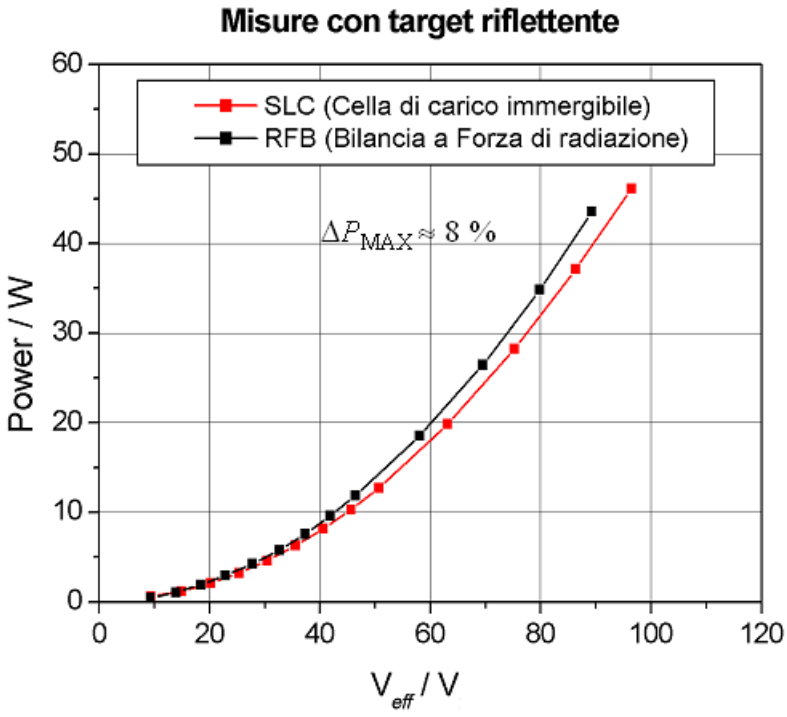

Fig. 1. Comparison of ultrasonic power measurements with two measurement apparatuses.

4. Cooperation in metrology and standardisation organisations

Some of the work in ultrasound is part of iMERA project TP2 JRP7 “External Beam Cancer Therapy”, in cooperation with other european NMIs..

INRiM participates in EURAMET TCAUV, and at present is pilot laboratory for project 1056, that addresses the measurement of pressure to free field response corrections of Sound Level Meters. The results of this project will be used by WG17 of IEC T29 to validate the uncertainties of a standard under development.

INRiM participates in other WGs of IEC TC 29 and in ISO and IEC national TC for acoustics and ultrasound.