NMIJ Newsletter
No.12, November 2020

Greetings from Deputy Director General of NMIJ

Dr. FUJIMOTO Toshiyuki
Deputy Director General, NMIJ

I hope that all readers have been having a healthy and happy life even under the COVID-19 pandemic. We, all NMIJ/AIST staff are continuing our work while preventing infection by introducing several counter measures such as telework as appropriate. Under this situation, I am very pleased to be able to deliver the NMIJ Newsletter No.12 as planned.

NMIJ/AIST are conducting researches related to the COVID-19, such as high-precision detection/quantification technologies and environmental control technologies, as well as sharing information that may contribute to a remote education. You can find some of these research topics in this issue.

The effects of the COVID-19 are having a significant impact on our lifestyle. Similarly, various measures and changes have been made in industry. At the production site, there is an expression that "it can be controlled to the point where it can be measured." This means that "the quality of the product is determined by the accuracy of the measurement." In order to realize a safe and secure life, it is necessary to accurately measure and evaluate various events. It may not be overstated that it is important to utilize our knowledge such as intrinsic standards, remote calibration, and reference materials, based on sufficient traceability studies.

While facing the COVID-19 crisis, our contribution as a group of measurement experts is paramount in order to realize a safe, secure and sustainable society.

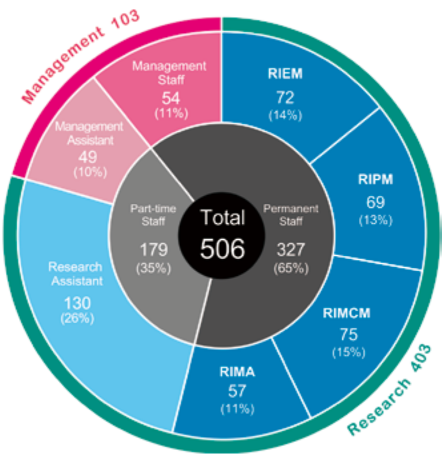
NMIJ organization chart and measurement activities

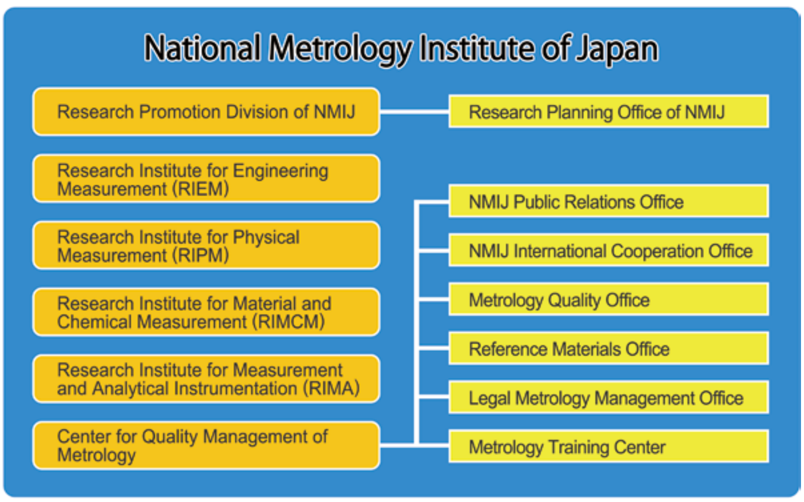
NMIJ is composed of four Research Institutes (Research Institute for Engineering Measurement, Physical Measurement, Material and Chemical Measurement, Measurement and Analytical Instrumentation), Center for Quality Management of Metrology and Research Promotion Division of NMIJ.

As of 1st April 2020, NMIJ has 273 researchers and in total, 506 personnel. Our missions and hot research topics organized by the institutes and the center are on the following two pages.

As of June 2020, NMIJ has participated in 448 Key Comparisons (KCs) and 85 Supplementary Comparisons (SCs), piloting 68 KCs and 26 SCs. Regarding the calibration and measurement capabilities (CMCs), NMIJ has registered 1126 CMCs.

Personnel



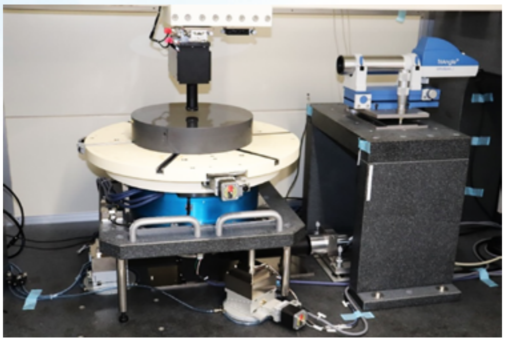


Research Institute for Engineering Measurement (RIEM)

Dr. OTA Akihiro
Director of RIEM

has a mission to contribute to manufacturing industries by establishing, maintaining and disseminating measurement standards in length, dimensions, angle, mass, density, viscosity, pressure, vacuum, force, torque, hardness, ultrasound, flow, and the other related quantities. Recently, new technology developments such as hydrogen gas flow measurement, micro force measurement and complicated shape measurement are strongly promoted in RIEM for the next generation society. In addition, RIEM is responsible for performing a wide range of important tasks in legal metrology in cooperation with the Ministry of Economy, Trade and Industry including type approval tests of specified measuring instruments and inspections of verification standards used in local verification offices. Optical surfaces with a few nanometer flatness used in extreme ultraviolet lithography, synchrotron radiation facilities and gravitational wave interferometer are recently being fabricated.

At NMIJ, flatness standards have been provided using a Fizeau interferometer with 10 nm uncertainty over a measurement range of Ø300 mm. To reduce the measurement uncertainty and increase the measurement range, we developed a three-dimensional scanning deflectometric profiler (3-D SDP). Unlike the Fizeau interferometer, the 3-D SDP does not require a reference surface and can directly measure a large-diameter surface profile. In the 3-D SDP, the distribution of local slope angle of a specimen is measured with several tens of nanoradian uncertainty, and the surface profile with sub-nanometer resolution is obtained by integrating the obtained distribution of local slope angle. The measurement range and measurement uncertainty of 3-D SDP are Ø600 mm and 5 nm. NMIJ will start a new surface profile measurement service in October 2020.



Three-dimensional scanning deflectometric profiler (3-D SDP)

Research Institute for Physical Measurement (RIPM)

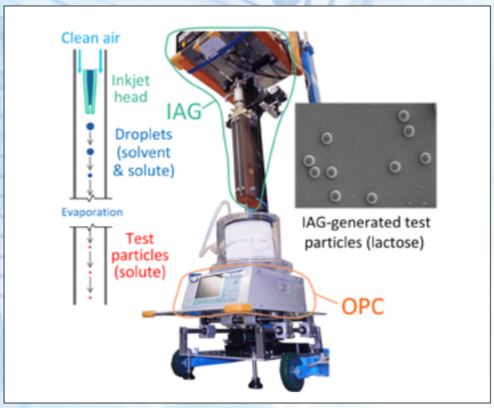
Dr. SHIMADA Yozo
Director of RIPM

develops and disseminates the national measurement standards for electricity, electromagnetic wave, time and frequency, temperature, optical radiation and the other physical quantities, and also provides the related measurement technologies to the industry. The electrical standards based on the quantum effects of current, voltage and resistance contribute to the improvement of credibility of electrical measurement. The temperature standards established over a wide temperature range are vital such as for accurate temperature measurement in semiconductor and materials processing. Photometry and spectroradiometry for light sources, responsivity measurement for photodetectors and spectrophotometric evaluation of materials are expected to be applied in various industrial fields. The RIPM promotes the development of next-generation national frequency standard based on optical lattice clocks toward a redefinition of the SI second, quantum imaging and information technologies based on single-photon detection, broadband electromagnetic sensing technologies, optical frequency comb generation and its application, as well as radiation thermometry required in this COVID era.

Research Institute for Material and Chemical Measurement (RIMCM)

Dr. GONDA Satoshi
Director of RIMCM

establishes the national metrology standards, such as high-purity elemental, biological-related, composition-based reference materials, which are indispensable to ensure safety of our life and foods, and advanced material-based reference materials to secure quality of high-tech industrial products. In addition, we are developing measurement and analysis technologies, providing and upgrading reliability-proven, making comprehensive databases useful in the field of materials, metrology, and evaluation technologies, and pursuing activities to improve user analysis skills, by promoting cooperation with external organizations and customers.



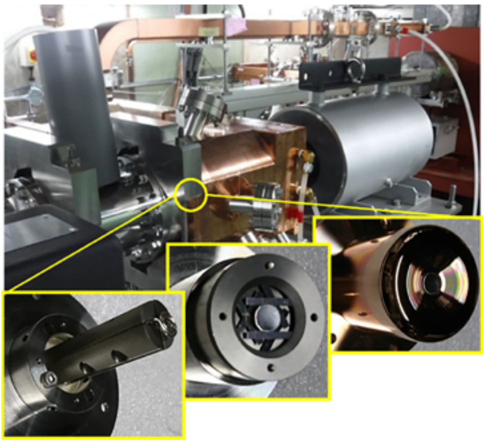
Calibration system for the number of micrometer-sized particles

Currently, NMIJ provides a calibration service for the counting efficiency (CE) of optical particle counters (OPCs) in the range of particle diameter from 0.5 µm to 10 µm. This calibration service takes advantage of the inkjet aerosol generator (IAG) developed by NMIJ, as a monodisperse particle number standard which can generate airborne particles in the above size range at a precisely controlled rate with the relative expanded uncertainty of 0.005. This service, for example, has been utilized for calibrating OPCs that are used in the pharmaceutical industry to monitor microbial contamination in cleanrooms.

Research Institute for Measurement and Analytical Instrumentation (RIMA)


Dr. ISHII Juntaro
Director of RIMA

aims to develop and disseminate the national measurement standards of ionizing radiation, acoustics and vibration which are supplied to users in a wide range of industries and healthcare such as X-ray standards for securing reliability of medical equipment. Based on the national standards and quantum beam technologies, RIMA also aims to research and develop advanced measurement methods and instruments, such as a positron annihilation lifetime technique for material science. In addition, non-destructive diagnostic techniques with X-ray imaging as well as optical phase-analysis are currently being intensively investigated to address industry needs. These research results are transferred to analytical and testing industries, and RIMA contributes to making society safer and more prosperous.


High-peak current electron gun with a backside electron beam heating system

Electron beam is widely used in advanced measurement and manufacturing technologies such as electron microscopes, metal 3D printers and electron accelerators. We work on the development of new electron source materials and electron gun systems for the next-generation electron beam applications. The developed materials, which are cerium iridium (Ce-Ir) compounds, have advantages in the high efficiency of electron emission, long lifetime, and robustness of the emission surface. A high-peak current electron gun (see figure) equipped with Ce-Ir emitter was successfully developed, which enabled us to provide more than twice as much beam current as a conventional one. To maximize the emission properties, we have established a surface cleaning technique by in-situ annealing in this electron gun, called a backside electron beam heating. The Ce-Ir emitter is expected to be used in novel electron microscopy, for example, and will enable us to acquire images at higher speed than before.

Center for Quality Management of Metrology (CQMM)


Dr. KOBATA Tokihiko
Director of CQMM

is responsible for administrative support tasks in NMIJ. CQMM plays a role of promoting the results of activities related to metrology and measurement to our society while ensuring dissemination of measurement standards. CQMM consists of six sections: i) NMIJ Public Relations Office, ii) NMIJ International Cooperation Office, iii) Metrology Quality Office, iv) Reference Materials Office, v) Legal Metrology Management Office and vi) Metrology Training Center. CQMM provides a wide variety of services and information relating to metrology and measurement directly to domestic and international customers, metrology experts, private companies and metrological institutes. Main activities of CQMM are public relations, collaboration with international organizations and national metrology institutes, calibration and testing services, certified reference material distribution, cooperation with central and local governments to ensure the national legal metrology system, and training for metrology experts. For more information, please visit our website: https://unit.aist.go.jp/nmij/english/info/center/

Research topics concerning COVID-19 supported by Japan Agency for Medical Research and Development

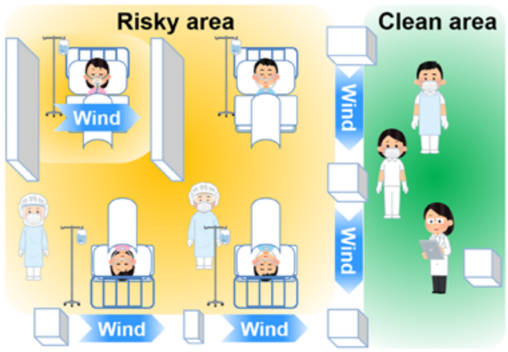
Verification of zoning effect on air flow control in higher-infection risk space

TAKATSUJI Toshiyuki

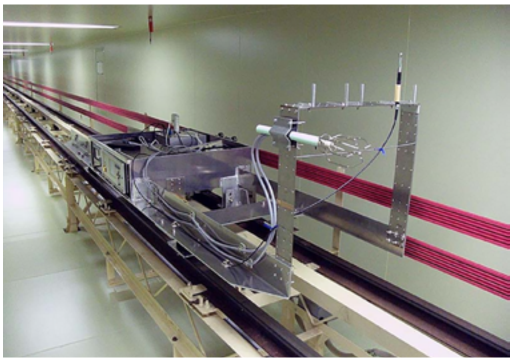
Air control devices which appropriately control the air flow are low cost, simple and can be set up flexibly, therefore, they can be used to help mitigate the spread of viruses. Whilst negative pressure chambers are often used in hospitals, alternative measures are demanded. For example, in a big gymnasium where a large number of patients with mild symptoms are accommodated, air control devices are suitable to separate the risky and safe zones in such environments.

Such devices have already been on the market, and the accurate measurement of the air speed and its visualization will facilitate their effective use. With the support of Japan Agency for Medical Research and Development (AMED), NMIJ launched a new project to develop relevant technologies for this task. The research topics are as follows:

1. Improvement of the accuracy and efficiency of the calibration for the primary standard on low air speed measurement which is installed in the underground tunnel in NMIJ
2. Development of a simple 3D air flow sensor, primarily for use at infection control sites
3. Establishment of a facility to calibrate the sensors developed in the above item 2 efficiently
4. Verification of the effect of the commercial air flow control devices by using the sensors developed in the above item 2



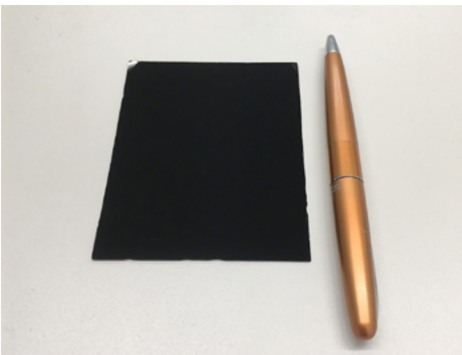
Zoning by air control device


Primary standard for low air speed

Reliability enhancement of non-contact fever screening technology including thermography for quarantine inspection

AMEMIYA Kuniaki

We have started a project to develop the basic technology for non-contact body temperature measurement of high accuracy and reliability, which contributes to strengthening the prevention of new infectious diseases, reducing the burden imposed on the medical site, and normalizing the economic activities. In this project, we are developing a highly accurate on-site temperature reference with a planar blackbody (reference infrared radiator) that can correct thermographic devices for fever screening. We have established a manufacturing technology for a planar blackbody material offering an unprecedentedly high emissivity of >0.998, which would not be affected by surroundings (background infrared radiation, etc.) when correcting and evaluating thermographic devices. The target temperature setting accuracy of the reference planar blackbody radiator is 0.1 °C (laboratory level). Thereby the error factors of fever-screening thermography in the field including performance of thermography devices (stability, response uniformity, temperature resolution, etc.), influence of measurement target (emissivity, distance) and influence of ambient environment (temperature, humidity) would be inspected in more detail. This project is supported by Japan Agency for Medical Research and Development (AMED).


A novel perfect blackbody sheet for an accurate radiation temperature reference

Three-dimensional radiometric temperature measurement by digital holography

IMBE Masatoshi

Thermography enables instant temperature mapping in a non-contact way. This feature provides numerous applications, such as monitoring for laser processing, non-destructive testing of buildings, and fever screening to prevent the spread of viral infection. When thermal images are captured by thermographic devices, they should be in focus by adjusting the lens since out-of-focus blurred images impair spatial resolution and accuracy of temperature measurement. When the object whose radiation temperature is to be measured moves along the focal depth direction, temperature measurement would be accurate only if the lens also moves along the depth direction to keep the thermal image in focus. When the object moves too fast to be kept focused, however, the measurement accuracy will be significantly reduced. To overcome this problem, we have been developing a three-dimensional radiometric temperature measurement system using digital holography. Thermal radiation emitted by an object is recorded as a hologram by utilizing a Michelson interferometer with an incoherent light source. The radiometric quantities and the object locations are encoded as the amplitude and the phase in the hologram. Applying the numerical propagation can reconstruct the thermal images at any depth in a computer. This “numerical focusing” method can adjust the focal point without moving any optical components once the hologram is obtained. We also have developed a calibration and measurement procedure to obtain the spatial distribution of radiation temperature from the reconstructed thermal images (see Figure). Spatial distribution of radiation temperature of the blackbody furnace moving along the focal depth direction is found to be successfully obtained by reconstructing the “numerically focused” thermal images from each acquired digital hologram.

Reference: M. Imbe, Appl. Opt. **58**, A82 (2019).

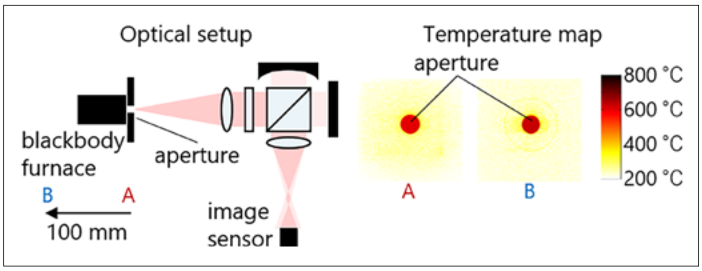


Figure: Optical setup for demonstrating three-dimensional radiometric temperature measurement. The setup was calibrated by a blackbody furnace with radiation temperature of 600 ℃ located at position A. Holograms are captured at initial (A) and backward (B) positions.

NMIJ operation examples with COVID-19 Situation

Learn about Metrology - at home — Establishment of website “Anyone from children to adults can learn” —

NMIJ Public Relations Office

“Anyone from children to adults can learn” (in Japanese)
https://unit.aist.go.jp/nmij/info/enjoy/

NMIJ is working on the service related to daily life of the citizens as social contribution activities to take measures against the COVID-19. Due to the COVID-19 outbreak, people were requested to stay inside and even schools were closed (Many universities still hold classes entirely online in October.). Given the situation, NMIJ has developed a site that provides information to help make the “Stay-at-home order” a bit more enjoyable. NMIJ selected contents produced to date, including some introductory videos that are related to the SI and technical developments of NMIJ. This website will also introduce some experiments and crafting relating measurement science and many other contents that will allow anyone to learn about “metrology” and “measure” in a fun, amusing way. Currently, this site is provided only in Japanese. NMIJ considers the development of the English site in the future.

Preventive measures against the COVID-19 for a safe and controlled restart of training courses

Metrology Training Center

The Metrology Training Center provides various training courses for public servants engaged in legal metrology services and applicants for a national qualification called a certified measurer. Unfortunately, due to the COVID-19 pandemic, we have been obliged to reschedule or cancel all the training courses since May this year. Although a speedy restart was necessary to keep delay to a minimum, it took a few months to recover social stability. We recently restarted a part of the training courses taking measures against the COVID-19 as follows:

Lecture scene from an environmental measurement training course

– Regular hand-washing or use of rubbing alcohol by all participants.
– Wearing a mask in classroom learning and an additional face shield in practical training.
– Reducing capacity by 50 % - 75 % to avoid the "Three Cs" (closed spaces, crowded places, and close-contact settings).
– Routine cleaning, sanitizing and disinfection of touched surfaces and objects.
– Ensuring proper ventilation with outside air (opening windows regularly, etc.)
– Effective use of online lectures.

We hope that the list will be of use to those involved in metrology services, and that it will further support a safe and controlled restart of your business.

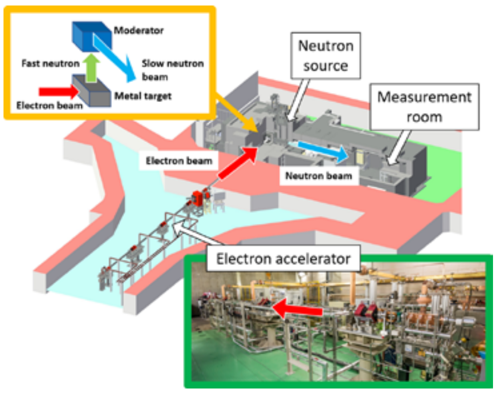
Featured Events

Analytical facility for Industrial Science and Technology using Accelerator-based Neutron Source

Photo of opening ceremony for AISTANS

On 25th February 2020, the National Institute of Advanced Industrial Science and Technology (AIST), together with the Innovative Structural Materials Association (ISMA) celebrated the inauguration of a novel neutron analysis facility, Analytical facility for Industrial Science and Technology using Accelerator-based Neutron Source (AISTANS) established at the AIST Tsukuba campus. Dr. OSHIMA Nagayasu of RIMA/NMIJ and his colleagues have developed the AISTANS facility and initiated operation of the neutron source in January 2020. A neutron beam generated using an electron accelerator will be used for the non-destructive analysis of structural materials.

At the ceremony, congratulatory messages, including from Mr. TOYAMA Takeshi, Director of the Research and Development Division, Ministry of Economy, Trade and Industry (METI), were received, with the invited guests expressing their expectations for industrial applications such as non-destructive analysis using AISTANS. Subsequently a facility tour and a workshop were organized. At the workshop, discussions were held among participants, in particular the invited industry representatives, on the needs for material analysis of structural materials such as steels and non-destructive analysis using neutron beam technologies.



Overview of the AISTANS. Neutrons generated by injection of high energy electrons into a metal target were moderated and extracted as a slow beam for analyzing structural materials.

NMIJ-KRISS Summit 2020 -online-

The NMIJ-KRISS Summit 2020 was held online on 22nd July 2020. This annual meeting has been hosted alternately between Japan and Korea since 2003, but this year, it was conducted through video-call for the first time due to the COVID-19 pandemic. The video call was attended by three representatives from each side: Dr. USUDA Takashi (Vice President of AIST cum Director General of NMIJ), Dr. KOBATA Tokihiko (Director of Center for Quality Management of Metrology) and Dr. SAITO Norio (Manager of NMIJ International Cooperation Office); Dr. Hyun-Min Park (President of KRISS), Dr. Jin Hwan Lee (Director, Division of Policy and Strategy) and Mr. In Yong Hwang (Head, Office of International Cooperation).

As this was the first meeting attended by the newly appointed President of KRISS, Dr. Park, he introduced the new philosophy in KRISS management such as emphasis on team performance and research collaboration among team units. On the other hand, Dr. USUDA, elaborated on the primary missions of NMIJ that was newly launched the 5-Year-midterm Plan of AIST starting from 2020 till 2024. Followed by their introductions, they exchanged ideas on other issues such as cyber-security, research related to COVID-19, etc.

In the end, both directors reiterated the importance of maintaining the long-standing close bilateral relationship between the two NMIs and hoped to meet each other in person in the next summit.

Attendees from KRISS (from left to right): Dr. Jin Hwan Lee, Dr. Hyun-Min Park and Mr. In Yong Hwang

Attendees from NMIJ (from left to right): Dr. SAITO Norio, Dr. USUDA Takashi and Dr. KOBATA Tokihiko

NMIJ-NIMT MoU Signing Ceremony & Directors Meeting 2020 -online-

The NMIJ-NIMT directors meeting was held online on 3rd August 2020 starting at 11:00 AM (JST) or 9:00 AM (THA). Dr. USUDA Takashi and Mrs. Ajchara Chareonsook, Director of NIMT delivered updates on the activities carried out in their respective institutions, and continued with discussions where one of the agreements was subject to the implementation of cooperation in developing measurement standards for medical devices and their traceability. The event was followed by a signing ceremony for renewal of the MoU virtually. With this renewal, the MoU has a validity period of five years, the appropriate timeframe for evaluation and improvement.

NMIJ and NIMT have forged a long-standing partnership, marked by the success of JICA-NIMT project from 2002 to 2008. On this occasion, both directors mutually reaffirmed to continue and further strengthen this well-established partnership and collaboration.

NMIJ-NIMT directors meeting -online-

Peer Review and International Comparisons

The NMIJ dispatches peer reviewers to other NMIs upon their requests (if available). In the period from April to September 2020, Dr. HATTORI Koichiro remotely assessed the Hardness Standards of NIM, China on 27th - 28th August. Also, NMIJ has participated in the following international comparisons

NMIJ Participant	KCDB Code	Field	Title	Pilot Lab	Start Date
Dr. HAYASHI Toshiyuki	CCM.F.K-23	Force	Force key comparison CCM.F.K-23 Measurand Force 200 N and 500 N	METAS	15 Dec. 2019
Dr. SHIBAYAMA Sachie, Dr. FUJII Shin-ichi	CCQM-P199.b	Mole, copy number concentration	SARS-CoV-2 RNA copy number quantification	LGC, NIBSC, NIST, NIM	6 July 2020
Dr. HIRAI Akiko	APMP. L-K1.2018	Length, Dimensional Metrology	Gauge blocks by interferometry	KRISS	31 July 2020
Dr. KAJIKAWA Hiroaki	APMP. M-H1.2020	Hydraulic pressure, 200 MPa	Hybrid comparison of pressure	MUSSD	7 Sep. 2020
Dr. KOJIMA Momoko	APMP. M-H2.2020	Gas pressure, 7000 kPa	Hybrid comparison of pressure	MUSSD	1 Sep. 2020

Selected Research Reports

1) Y. Tanaka, Y. Seino, K. Hattori, “Automated Vickers hardness measurement using convolutional neural networks”, The International Journal of Advanced Manufacturing Technology, **109**, 1345–1355, 2020, DOI: 10.1007/s00170-020-05746-4
2) N. Takegawa, M. Ishibashi, T. Morioka, “Experimental study on improving the critical back-pressure ratio using a step in a critical-flow Venturi nozzle”, Flow Measurement and Instrumentation, **71**, 101682, 2020, DOI: 10.1016/j.flowmeasinst.2019.101682
3) Y. Yamamoto, K. Fujita, K. Fujii, “Development of a new apparatus for SI traceable small mass measurements using the voltage balance method at NMIJ”, IEEE Transactions on Instrumentation and Measurement, **69**, 11, 9048-9055, 2020, DOI: 10.1109/TIM.2020.3001408
4) Y. Shimizu, H. Koshikawa, M. Imbe, T. Yamaki, K. Amemiya, “Large-area perfect blackbody sheets having aperiodic array of surface micro-cavities for high-precision thermal imager calibration”, Optics Express, **28**, 15, 22606-22616, 2020, DOI: 10.1364/OE.397136
5) Y. Okazaki, T. Oe, M. Kawamura, et al., “Precise resistance measurement of quantum anomalous Hall effect in magnetic heterostructure film of topological insulator”, Applied Physics Letters. **116**, 143101, 2020, DOI: 10.1063/1.5145172
6) S. Okubo, N. Kuramoto, H. Inaba, “40 GHz continuous, precise, and low power-loss laser frequency sweep using an electro-optic modulator”, Optics Express, **28**, 8, 11956-11964, 2020, DOI: 10.1364/OE.389297
7) Y. Amagai, T. Shimazaki, K. Okawa, et al., “High-accuracy compensation of radiative heat loss in Thomson coefficient measurement”, Applied Physics Letters, **117**, 063903, 2020, DOI: 10.1063/5.0018593
8) Y. Zhu, J. J. Gonzalez, X. Yang, et, al., “Calcium fluoride as a dominating matrix for quantitative analysis by laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS): A feasibility study”, Analytica Chimica Acta, **1129**, 24-30, 2020, DOI: 10.1016/j.aca.2020.07.002
9) N. Hanari, J. Falandysz, E. Yamazaki, N. Yamashita, “Photodegradation of polychlorinated naphthalene in mixtures“, Environmental Pollution, **263**, Part B, 114672, 2020, DOI: 10.1016/j.envpol.2020.114672
10) Y. Matsuura, A. Nakamura, H. Kato, “Novel approach for reliable determination of the refractive index of particles in the liquid phase using a hybrid flow particle tracking method”, Analytical Chemistry, **92**, 5994-6002, 2020, DOI: 10.1021/acs.analchem.0c00252
11) N. Sei, T. Takahashi, “First demonstration of coherent resonant backward diffraction radiation for a quasi-monochromatic terahertz-light source”, Scientific Reports, **10**, 7526, 2020, DOI: 10.1038/s41598-020-64426-1
12) K. Michishio, S. Kuma, Y. Nagata, et, al., “Threshold photodetachment spectroscopy of the positronium negative ion”, Physical Review Letters, **125**, 063001, 2020, DOI: 10.1103/PhysRevLett.125.063001
13) Q. Wang, S. Ri, P. Xia, Z. Liu, “Automatic detection of defect positions including interface dislocations and strain measurement in Ge/Si heterostructure from moiré phase processing of TEM image”, Optics and Lasers in Engineering, **129**, 106077, 2020, DOI: 10.1016/j.optlaseng.2020.106077
14) D. Asakawa, H. Mizuno, E. Sugiyama, and K. Todoroki, “In-Source Fragmentation of Phenethylamines by Electrospray Ionization Mass Spectrometry: Toward Highly Sensitive Quantitative Analysis of Monoamine Neurotransmitters”, Analytical Chemistry, **92**, 12033–12039, 2020, DOI: 10.1021/acs.analchem.0c02667

Upcoming Event

IMEKO XXIII World Congress Yokohama 2021

XXIII World Congress of the International Measurement Confederation (IMEKO 2021)

August 30 to September 3, 2021 in Yokohama, Japan

www.imeko2021.org

IMEKO

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