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Feature Story

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INNER VIEW

Kenichi Fujii

National Metrology Institute of Japan (NMIJ)/
National Institute of Advanced Industrial Science and Technology (AIST)
Research Institute for Engineering Measurement
Prime Senior Researcher

Lunch Breaks are for Meeting People and Generating New Ideas

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RION CO., LTD.

Kenichi Fujii

Ph.D. in engineering. Born in Tokyo in 1959, Dr.Kenichi Fujii completed the master's program of the Graduate School of Engineering, Keio University, in 1984. In the same year, he joined the National Metrology Research Laboratory of the Agency of Industrial Science and Technology (now the National Metrology Institute of Japan, AIST). In 2001, he received a commendation from the Minister of Education, Culture, Sports, Science and Technology. He assumed his current position in 2015. He specializes in the precision measurement of thermal properties and density and is a coordinator in the International Avogadro Coordination (IAC) Project and a member of the Committee on Data of the International Council for Science (CODATA). He enjoys listening to jazz and classical music.

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Dr. Kenichi Fujii

National Metrology Institute of Japan (NMIJ) /
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Lunch Breaks are for Meeting People and Generating New Ideas

~The Life of a Researcher Tackling the Challenge of Redefining Mass

Photo by Megumi Yoshitake

Pursuing a line of research with no finish line in his working life——A fortuitous meeting during a job interview sets him on the course of a major challenge that comes to define his academic career.

The Night His Dream Came True

On November 16, 2018, Dr. Fujii was watching an online broadcast of a meeting of the General Conference on Weights and Measures held in France.

"The people involved and the press were assembled in a lecture hall at AIST to watch the broadcast. The resolution to revise the definitions passed at 9 p.m., Japan Standard Time. The moment was greeted with applause by everyone in the hall. I stayed until the end of the press conference and didn't get home until past midnight. My family was already asleep, but they left a cake on the dinner table with a decoration that read, 'Congratulations, kg' [laughs]." (**Fig.1**)

The definitions that had been revised, of course, were those of four of the base units of the International System of Units (SI).* The talks centered on the kilogram, the unit for mass, whose definition was to be freed, after 130 years, from the artificial object known as the International Prototype of the Kilogram (IPK). Japan contributed significantly to this redefinition. The revision marked the fruition of a long, arduous research journey to establish a precise determination of the Avogadro constant, among the fundamental physical constants.

"This redefinition was the long-awaited dream for all those involved in metrology. The realization of the effort made everyone incredibly happy."

Fig.1 The cake with the decoration reading "Congratulations, kg" (courtesy of Kenichi Fujii)

*The International System of Units (SI) was first established under the Metre Convention, a treaty signed in the 19th century. At the 2018 General Conference on Weights and Measures, the decision was made that of the seven base units in use, four—the kilogram, ampere, kelvin, and mole—would be redefined at the same time. The revised definitions entered effect on May 20, 2019.

A Lunch Break Meeting

In the summer of 1983, the then 24-year-old Dr. Fujii was visiting the National Research Laboratory of Metrology of the Agency of Industrial Science and Technology, the predecessor of NMIJ, for a job interview.

"During my days as a university student, I'd been doing research on energy conservation based on precise measurements of the thermal properties of materials. The National Research Laboratory of Metrology had measuring instruments of the highest precision. So I assumed if I was accepted here, I'd be in position to measure thermal properties with the ultimate precision."

During lunch that day, he chanced upon a researcher who did precision measurements with the goal of redefining the kilogram.

"He told me he'd been working for more than 10 years but still couldn't quite achieve the required precision and was having difficulties. His story caught my interest. I was surprised to hear no one had succeeded (at the time) in redefining mass for nearly 100 years. What's more, I thought maybe I could apply my skills in *monozukuri* manufacturing to good use in the field of materials and precision measurement."

As a child, Dr. Fujii had always enjoyed crafts and making things. Assigned a crafts project at school, he was never satisfied working on it only during class. He brought his project home. He also liked to design things and made model planes and cars based on the blueprints he drew up himself. These experiences would eventually lead to his research on redefining the kilogram, something he heard about for the first time that day.

"When you're trying to achieve the highest measurement precision, you end up having to make your own instruments, because no commercial models are available. Since you have to make new instruments, skills in *monozukuri* are

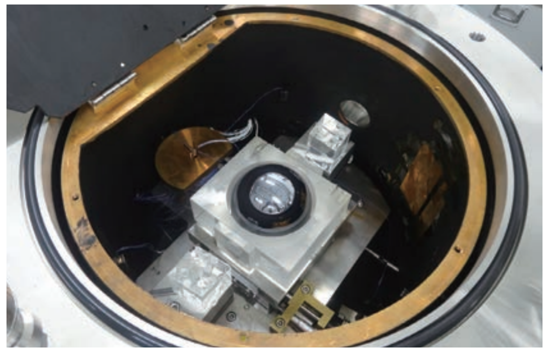


Fig.2 Instrument used to measure the diameter of a silicon sphere

essential. That's why I say that what ultimately led me into this field was my love of making crafts."

Counting Atoms

The Avogadro constant is equivalent to the number of atoms in 12 grams of carbon (^{12}C), a tremendously large number: some 6×10^{23}. But the exact number of atoms had yet to be determined. Since mass had been defined based on the International Prototype of the Kilogram, the number of atoms in the material was simply a measured value. The value was subject to uncertainty. Dr. Fujii's efforts targeted precise measurements of this value whose stability would exceed that of the International Prototype of the Kilogram and which could be used, as a defined value free of uncertainty, to express mass. To determine this value, one merely divides the volume of a crystal whose mass is known by the volume of a single atom. The optimal material for such measurements is the silicon crystal, since its atoms are arranged regularly and the optimal shape of the crystal is a sphere. The major challenge lies in measuring the mass, volume, and size an atom with the required precision.

In 1988, five years after Dr. Fujii joined the National Research Laboratory of Metrology, it became possible to polish a spherical crystal of silicon. Based on this development, he created an Avogadro Team—five volunteers drawn from laboratory coworkers—to begin measurements. But numerous obstacles had to be overcome to improve the measurement precision.

"For example, in the case of the instrument that measured the size of an atom using X-rays, the precision required for the orientation of the specimen stage was 1 nanoradian (10^{-9} radian). To put this into perspective, this angle is equivalent to the one needed to identify, from Earth, a footprint made on the surface of the moon by an astronaut. And since the volume of a material depends on temperature, the temperature of the sphere in a vacuum has to be controlled to within 3/10,000 of a degree."

All of this sounds quite daunting. In their discussions, the team members had mentioned the task was unlikely to be completed in their lifetime. Where, then, did the motivation come to continue the research?

"The research posed enormous difficulties. But we knew even if we didn't succeed in revising the definition, we could still contribute to physics by enhancing the precision of a fundamental physical constant, the Avogadro constant, and that our endeavors would further technological applications. That was enough for us. I think we were rather optimistic about it all. [laughs]"

The Spherical Gift of Peace and International Cooperation

According to the new definition, mass is defined using the Planck constant, which is related to the energy of a photon. Since the Planck constant and the Avogadro constant can be converted into one another, determining one means determining the other. Researchers in countries such as the United States, the UK, and Canada had been pursuing research to determine the Planck constant with high precision. Researchers in countries like Germany, Italy, Japan, and Australia had been pursuing research to determine the Avogadro constant with high precision.

"The major turning point in the determination of the Avogadro constant came when it became possible to enrich silicon isotopes."

In nature, three types of silicon isotopes (forms of an element having the same atomic number but different numbers of neutrons) coexist. The uncertainty in the abundance ratio of these isotopes in a crystal is a major obstacle to enhancing precision. At this point, the team received an offer from a German team: Would Japan be interested in taking part in isotope enrichment? Since the isotopes have different mass, they can be separated using a centrifuge. But producing highly-enriched silicon in great volumes requires advanced facilities like those used to make nuclear weapons, not to mention significant funding.

"They told us it would be impossible for one country to do it alone—so, let's work together. That's how the International Avogadro Coordination (IAC) Project got started. Looking back, I think the ability to do isotope enrichment was one of our major breaks. We'd been invited by the Germans because we'd engaged in technological exchange with Germans as part of international efforts in the past."

The isotope enrichment was carried out at a nuclear fuel facility in Russia that had fallen into disuse after the fall of the Soviet Union.

"What we were doing was for peaceful purposes. Russia didn't charge us much to use the facility, since the work would allow them to maintain the facility and their engineers. In 2007, I watched as the first isotopically enriched silicon crystal weighing 5 kg was pulled out. That was one of the high points of my long life as a researcher. I knew then that everything would turn out fine."

In the years that followed, Australia developed the polishing technology required for silicon spheres; Italy developed an X-ray interferometer for atomic-scale measurements; and Japan and Germany developed an instrument to make high-precision measurements of the diameter of silicon spheres (**Fig.2**) and surface analysis technologies. All the countries contributed to enhancing measurement precision in the area of their special expertise. Ultimately, Japan, Germany, and Italy reported the Avogadro constant to the precision required for the redefinition. Based on this and the Planck constant reported by countries like United States and Canada, a decision was reached on the constant required for the new definition of mass.

This marked the first time a non-Western country had contributed directly to the redefinition of an SI unit. As a coordinator for the IAC Project, Dr. Fujii worked tirelessly to coordinate the efforts of the countries involved. Rather than sitting confined to a laboratory making measurements, he preferred talking to people.

"It's stimulating to talk and interact with users outside our laboratory in my everyday life—'We might be able to measure density with higher precision if we do this …' 'We might be able to apply mass measurement in this manner…' or 'We might be able to apply the results of precise measurements to develop pharmaceuticals or novel semiconductor devices.' I also love interacting with others and exchanging information at workshops and seminars. Researchers need to speak to people regularly to generate new ideas. In research groups, too, I think it's really important for members to sit together at lunch and talk about their research in idle conversation."

A Redefinition to Lay the Path to Our Future

An obvious merit of the redefinition of mass is the freedom from the object known as the International Prototype of the Kilogram. The redefinition will allow anyone with the necessary technology to produce a mass standard. But Dr. Fujii stresses another significant point.

"Until now, there was only one point acting as a standard for mass, which was one kilogram. To obtain standards for smaller masses, you had to keep dividing larger weight pieces into smaller weight pieces. As the number of such divisions increase, the uncertainty in the mass of the weights grows. This approach imposes a limit on the mass you can measure accurately using a balance using subdivided weight pieces. The limit is 0.1 microgram (10^{-6} grams). It was essentially impossible to measure ultra-small masses on the scale of nanograms (10^{-9} grams) or picograms (10^{-12} grams)."

For example, the mass of a PM2.5 particle (microparticle of diameter less than 2.5 micrometers) is about 20 picograms. But according to the conventional definition, this mass can't be measured with any traceability, because no reliable standard had previously existed for masses in this range.

"The revised definition not only means rules will change. It means we can measure things we couldn't measure before, using the Planck constant as the standard and with traceability. This has great significance because we can expect it to generate new technological advancements."

In fact, the unit of length was revised in 1983 to base it on the speed of light. What followed was a surge of new technologies, which eventually led to a Nobel Prize. Redefinition isn't an end in itself; it opens doors to new measurement technologies. We asked Dr. Fujii, the person who opened this door, on his current feelings.

Dr. Fujii spoke cheerfully about his future project in monozukuri: "It took so long to achieve it doesn't seem real to me yet [laughs]. I think I'm happiest to see that Japan's contributions played a major role. We reached this goal by clearing one hurdle after another. The next generation of researchers will create new standards for mass based on the Planck constant and provide them for the world to use. I'm currently the project leader for research on ultra-small mass measurements. Many issues need to be resolved, like vibration and temperature fluctuations, but developing a new measuring instrument is exciting." ✍

Definition of mass

Prior	1 kilogram is equal to the mass of the International Prototype of the Kilogram.
New	The kilogram is defined by taking the fixed numerical value of the Plank constant h to be 6.626 070 15×10^{-34}J s.

The act of measuring involves comparing something against a standard.
That's why the reliability of the standard is directly
linked to the reliability of the measurement.
Let's look back on efforts that have been made to maintain such standards.

Feature Story

Compare

01 Introduction

Fulfilling Our Responsibility to Future Societies ~Thoughts on the Redefinition

In May 2019, redifinition of four base units in the International System of Units (SI) took effect. Japan contributed significantly to these revisions, many efforts related to which took place at the National Metrology Institute of Japan (NMIJ), AIST. We interviewed Dr. Takashi Usuda, Director General of the NMIJ and a member of the International Committee for Weights and Measures (CIPM).

A Globally-Shared Set of Values

In one painting from ancient Egypt, a divine representative compares the weight of a dead person's heart to that of a feather. It was believed evil deeds made the heart grow heavier. The statues of Lady Justice found in front of courthouses hold a balance and a sword, representing justice and judgment. That such images are shared among people of different ages and cultures signify our trust in measurements lies at the root of social order.

In practice, measurement standards are what make the act of measuring specifically reliable. In the 19th century, the National Prototype of the Meter and the National Prototype of the Kilogram (**Fig.1**) given to Japan upon its accession to the Metre Convention became Japan's first international measurement standards. These were placed at that time in the Central Inspection Institute of Measuring Instrument in Ginza,formar NMIJ.

Visiting the facility at the first time after I joined the institute, I asked, "How were the standards maintained during the Pacific War? " I was told they were evacuated to a rural area, the Kakioka Magnetic Observatory, located some 30 km from the current AIST. Since the observatory measured geomagnetic fields, nothing was located around the facility, eliminating the risk posed by air raids. When I visited the observatory later years guestbook, I saw the signatures of researchers who had worked at our center at the time and several public officials who visited in April 1944. On the next page, I found the horizontal signatures of several GHQ officers (**Fig.2**). The Occupation Forces had sent officials to make sure the Japanese were properly maintaining the standards. Even in the destructive wartime atmosphere, Japan had maintained its commitment to the globally-shared sense of the importance of reliable measurements. Following in their footsteps, we've maintained the standards as a set of articles that help preserve the order of the world.


Dr.Takashi Usuda holding a model of the silicon crystal structure

The Comprehensive Strengths of NMIJ

Progress in science and technology and industrial growth expanded the number of units in use. In the past, standards in Japan were produced and managed independently by different fields: those associated with electricity by the Electrotechnical Laboratory; those associated with chemistry by the National Chemical Laboratory for Industry; and so forth. All these units are minutely related to each other. By the end of the 20th century, awareness began to grow that an institute was required to unify the management of standards. In response, in 2001, the offices managing the measurement standards scattered across Japan were brought together into one department under AIST, becoming, true to its name, the NMI (National Metrology Institute). This is now known as the NMIJ.

Researchers handle various parameters in the process of redefining mass: for example, when measuring the diameter of a silicon sphere. They need to control temperature and to measure length (which is equivalent to measuring wave length). This, in turn, requires a precise clock. The NMIJ holds all the peripheral measurement standards within its facility. For each scientific field, the NMIJ offered an environment for minimizing the factors that generate uncertainty when measuring targets. If the standards had been managed separately by various institutes, creating such an environment would have been significantly more challenging.

The Significance of the Redefinition

The current redefinition was a response to the question of how we could maintain reliable standards when the reliability of the International Prototype of the Kilogram as an object appeared to be approaching its limits — of how we could fulfill our responsibilities to future societies.

"What you cannot measure, you cannot make," goes the saying. The new definition will allow us to measure things we previously could not and allow us to make things we previously could not. There are many ways to contribute to the global community, but I believe it's especially significant that Japan was able to play a role in an extremely fundamental area for both science and industry.

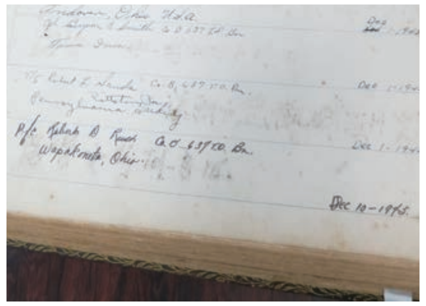


Fig.2 The signatures of GHQ officers in the guestbook (courtesy of Dr.Takashi Usuda)


Fig.1 The Japanese copy of the International Prototype of the Kilogram
©AIST

A Verification Facility on the Move
~There Goes the Verification Vehicle

Verification vehicles make the rounds, performing tests on sound level meters and vibration level meters. The vehicles are operated by the Measurement and Calibration Center of the Japan Quality Assurance Organization (hereafter referred to as JQA). We interviewed Mr. Toshio Kubota, the head of the Measuring Instruments Verification Section, and Mr. Hiroshi Taira, the chief inspector.

Returned on the Same Day

All cars that are driven on public roads must pass safety inspections. Similarly, under the Measurement Act, the specified measuring instruments used for trade and certification must also undergo verification.
Since 1973, the JQA has been the only designated verification organization in Japan that verifies sound level meters and environmental measuring instruments. Environmental measuring instruments are verified at four branch offices of JQA (Tokyo, Aichi, Osaka, and Fukuoka). While most users bring their instruments for verification, some users are located a fair distance away. That makes it inconvenient for them to come, or the number of days required for verification affects their operations. Thus, JQA makes annual trips in their verification vehicles to offer their services in various regions of Japan.
"The mobile verification service lets users complete verification of their instruments and take them back with them on the same day as the application. That's the key benefit for our customers." (Mr. Kubota)
JQA owns two verification vehicles. One operates in eastern Japan and one in western Japan.

One-Week Shift for Inspectors

The venues of the mobile verification service are usually the measurement verification offices in the respective prefectures for measurement certification business operators and on the premises of the regional Automobile Service Promotion Association for automobile maintenance factories. Once on the road, a verification vehicle spends a month making the rounds of the venues in the region—connecting

From left, Mr. Hiroshi Taira and Mr. Toshio Kubota

the dots, as it were. There are normally three to four inspectors for each vehicle, with up to six, in certain cases. Since the vehicles aren't fitted with sleeping facilities, the inspectors sleep at local hotels and "commute" every morning to the verification vehicle to get a punctual start on their verification duties at each venue.
"We're borrowing the space of other organizations, so we can't work overtime. We have a limited amount of time to make decisions on whether or not an instrument passes verification. That's why we've adopted various strategies to ensure the efficient execution of the verification process." (Mr. Taira)
The inspectors are on one-week shifts. Depending on the place and itinerary, they can get permission to leave the verification vehicle at the venue over the weekend or to park it at an airport or some other place.

Verification Environment Equivalent to the Indoor Facilities

Since the verification process occurs outdoors, the greatest care is taken to maintain the environment required for the verification. For example, the anechoic box used to test sound level meters is covered with a sturdy metal frame so that it remains unaffected by external noise or vibration and doesn't become deformed during transport. The chamber weighs 600 kg. Rather than a box, it can be considered a small anechoic room.
"Even though the verification is provided as a mobile service, the performance requirements for the test environment are the same as at our indoor facilities. We take special care in maintaining and inspecting the equipment to ensure nothing happens." (Mr. Kubota)
To verify sound level meters, Rion's NA-42 is used as the sound pressure level measuring amplifier to display the output from the reference standard electrostatic microphone. Sound, at frequencies of 125 Hz, 1,000 Hz, 4,000 Hz, and 8,000 Hz, is output from the speaker. The values measured by the user's sound level meter are compared to the values displayed on the NA-42 connected to the reference standard to confirm that instrumental error remain within verification tolerances.
"Depending on the power source at the site, we may have to shut off the air conditioning in the vehicle to eliminate the effects of noise on instruments like signal generators. Sometimes we're forced to stay in the vehicle with only a single, small electric fan in mid-summer or tolerate near freezing temperatures huddled in heavy winter clothing. What's amazing is that, even under these extreme conditions, our test equipment functions reliably." (Mr. Taira)
The 2019 fiscal year, a new model of the verification vehicles entered service. Serving as mobile test facilities, the verification vehicles are out on the road somewhere in Japan today, working to support the reliability of measuring instruments.

New model of verification vehicle ©JQA


The Anechoic Box located at the rear of the car


NA-42 sound pressure level measuring amplifier used in the vehicle

Interview made with the cooperation of the Japan Quality Assurance Organization https://www.jqa.jp/english/

03 Case Study

Supporting a First for Thailand Private-Sector Business
～A Sound Calibration System

Rion and the Rion Service Center (RSC) helped a Thai company acquire accreditation as the first private-sector acoustics testing laboratory in Thailand. We introduce these efforts below.

The Backdrop for Measurement Control in Thailand

The Kingdom of Thailand has the second highest nominal GDP among ASEAN nations. The nation's per capita GDP is also the second highest among ASEAN nations with a population exceeding 10 million. Thailand has a relatively large economy and high living standards. These circumstances have generated strong demand for reliable measurements and traceability.
As the nation's most prestigious metrology institute, the National Institute of Metrology (Thailand) (NIMT), pursues research on acoustic and vibration measurements, maintains national standards, supplies measurement standards, and offers routine calibration and testing services. Countless numbers of sound level meters and sound calibration instruments are submitted to NIMT for routine testing and calibration. While several other public institutes besides NIMT offer such calibration and testing services, growing industrial demand for traceability accompanying Thailand's economic growth has outpaced the capacity of the existing institutes. To meet this demand, Thailand has actively supported private-sector companies in their efforts to acquire ISO/IEC 17025.*

* ISO/IEC 17025: An international standard that sets forth requirements for accrediting properly operated testing and calibration laboratories. Test results and calibration certificates issued by such accredited organizations are recognized as internationally reliable.

Efforts by Sithiporn

In light of these developments, Sithiporn Associates, a precision measuring instrument distributor in Thailand, moved to acquire ISO/IEC accreditation. This private company operates a wide-ranging marketing network for chemical analysis instruments and acoustic and vibration instruments and already offered calibration services for chemical analysis instruments at the ISO/IEC 17025 accredited testing laboratory. To launch a new testing and calibration service, the company hoped to take advantage of this experience to acquire accreditation for a testing laboratory for sound level meters and sound calibration instruments.
There are several options for the routine testing of sound level meters. In Thailand, sound level meters made by various manufacturers are submitted for testing. Sithiporn decided to adopt a testing method performed in a free sound field, which doesn't require correction of individual sound fields, and asked NIMT to design an anechoic chamber to use as their free sound field facility, in addition to guidance from NIMT on the concept of uncertainty and an overview on the calculation method. Rion and RSC delivered a calibration system to Sithiporn, which would serve as their testing instrument, and also provided practical advice on the elements associated with uncertainty. To facilitate the accreditation acquisition process, NIMT, Rion, and RSC joined forces in supporting Sithiporn. As a result, Sithiporn became the first private company in Thailand to operate the ISO/IEC 17025 accredited laboratory for testing sound level meters and sound calibration instruments.
The opening ceremony of the testing laboratory was held in December 2018. Dr. Percha, the Managing Director of Sithiporn, expressed her ambitions as follows: "We're grateful to NIMT and Rion for their assistance in establishing this laboratory. We would like to take this opportunity to contribute to the dissemination of competent measurement in Thailand and to expand our business."

Promoting Competent Measurement in Asia

Rion develops and manufactures a comprehensive lineup of acoustic and vibration measuring instruments, from sensors to hardware and software. In recent years, the Rion Group has also sought to develop and market instruments for testing measuring instruments, as well as offering services related to measurement control. This includes helping companies provide calibration services using our testing instruments. The Sithiporn testing laboratory is a prime example of these efforts.
Since the 2013 revise to the IEC 61672 series, which defines international standards for sound level meters, testing and calibration activities have become more and more common at research institutes and at ISO/IEC 17025-accredited institutions in Asian nations. Through a wide range of technical activities that go well beyond the development of measuring instruments, Rion hopes to contribute to the dissemination of competent measurement, thereby supporting metrology institutes not just in Thailand, but in all countries currently pursuing the development of measurement control.

Masaharu Ohya
(Business Planning Department)

Downtown Bangkok, Thailand

A scene from the opening ceremony of the laboratory
From left : Dr. Percha (Managing Director, Sithiporn),
Ms. Surat (Metrologist, Senior Professional, NIMT),
Mr. Surasith (President, Sithiporn), and Mr. Iwahashi (Director, Rion)
©Sithiporn

The sound calibration system delivered

SITHIPORN associates
http://www.sithiphorn.com

Rion's History of Technology

LEARNING from our Past Products

A Particle Counter Hailed by the Semiconductor Industry for Its Hydrofluoric Acid Resistance

KL-21

This particle counter is widely used in the semiconductor industry.
Introduced in 1987, the KL-21 was Rion's first venture into this field. Here we interview Takayuki Kosaka.[*1]

*1 Current Head of the Particle Counter Division

——Can you introduce the features of the KL-21 for us?

The KL-21 was a liquid-borne particle counter marketed in 1987 that could measure fine particles in hydrofluoric acid.[*2] A sapphire cell was used in the detector unit.

*2 Hydrofluoric acid: An acidic solution prepared by diluting hydrogen fluoride in water. It is highly corrosive and toxic to the human body.

——What prompted the development of this counter?

Nishiyama Corporation, a distributor we'd been doing business with, was also involved in proposing self-developed technologies. They'd been showing us custom-made optical parts. Among these was a sapphire cell. I asked who the customer was and was told it was a company in the semiconductor industry. Hydrofluoric acid is a reagent used in the rinsing process at semiconductor plants. The semiconductor industry was a fast-growing industry in Japan at the time, and we anticipated significant demand.

——So the other products available at the time weren't capable of measuring solutions containing hydrofluoric acid?

Conventional detector units used synthetic quartz for the cell, which would dissolve when rinsed with highly corrosive hydrofluoric acid. But sapphire doesn't dissolve when exposed to hydrofluoric acid. Natural sapphire has a blue tint. Synthetic industrial-purpose sapphire is colorless and transparent. We cut the sapphire into square pipes for use as cells. At the time, Rion was the first to acquire the technology needed to measure particle sizes to a minimum of 0.3 µm in diameter. But the particle counter system, which was a combination of the counter unit and the sampler, was quite large and not easy to use. The KL-21 overcame these shortcomings.

——How did you solve the problem of user-friendliness?

We adopted a unit called a syringe sampler for sample aspiration. With a conventional sampler, you put the sample solution in a bottle, which is then set inside the main unit (chamber), and apply pressure to feed the solution into the cell. That meant bottle measurement was required. With the aspiration unit, you could take the sample solution directly from either the rinse tank or the bottle. So the KL-21 could be placed on a trolley to be carried to wherever the rinse tank was. All the user had to do was insert the tube into the tank. That made it an unusually user-friendly system.

——So you were involved in sales?

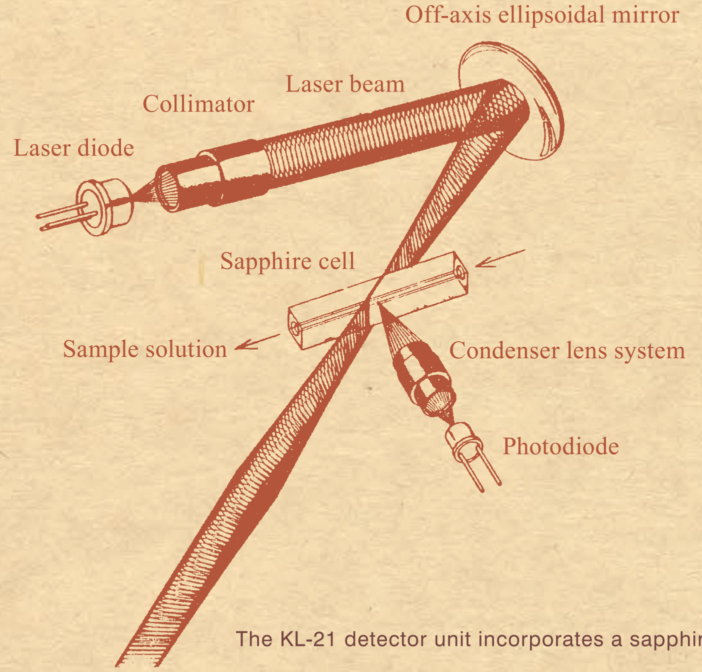
I joined Rion mid-career in 1984 and was assigned to the sales department. Until then, I knew hardly anything about particle counters. But around that time, Rion produced its first liquid-borne particle counter, and I was in charge of its sales. I think the introduction of the KL-21 happened during my fourth year at Rion.

——How were sales of the KL-21?

When we completed developing the KL-21 in 1987, we signed a contract with Nishiyama Corporation, which granted Nishiyama Corporation exclusive sales rights. We delivered 45 units, worth over 300 million yen. I had to transfer temporarily to Nishiyama Corporation, where I managed to sell all 45 units in one year and even received orders for additional units. The KL-21 sold incredibly well.

——How did you cultivate the sales channel to the semiconductor industry?

I didn't even know how many semiconductor plants existed. But when I went to give a demonstration at the first plant, they understood the potential. I then asked them to let me to see their storage area for reagents. There were well over 10 different reagents, each purchased from multiple manufacturers. That's when I realized semiconductor plants weren't the only facilities that needed to control the quality of their solutions. I proceeded to visit the reagent manufacturers and told them, "I've just given a demonstration at that semiconductor plant, which was well-received. Would you be interested in quality control for particle sizes on the order of 0.3 µm?" Their response was: "Go ahead, we'd like to see a demo, too." That company would introduce me to another affiliated company, and so on and so forth. That's how I cultivated my personal connections and expanded the sales channels. I established the basic style for the sales of particle counters currently in use.



The KL-21 detector unit incorporates a sapphire cell.

——So you made an assessment of the industry structure?

At the very beginning, I asked the people at the semiconductor plant: "What problems do you experience when manufacturing semiconductors?" And they instantly replied, "The wafers, of course." So I asked them from whom they were purchasing the wafers, and they gave me information on the company and the person in charge. At other times, I looked at the pipeline material and saw it was Teflon. I then found out the name of the manufacturer of the joints. When I examined the semiconductor manufacturing process step by step, I learned about the manufacturers of the materials needed to make the semiconductors. I thought the semiconductor industry was interesting and noticed how they were structured to generate profits.

Takayuki Kosaka

——What's the best part of working in sales?

Talking to and becoming friends with my customers. Really, when I'm making measurements with my customers as part of our sales activities, we can always come up with new ideas for improving our instruments. As I make my daily rounds and interact with customers, I learn more about semiconductors. This helps me grasp the problems they're facing or plan my next steps. That's what I learned in my experiences with sales of the KL-21.

Hello From the Office

Activities that Expand Our Social Circles
Environmental Activities Committee

To keep the local environment healthy, Rion has participated in environmental activities since 2018. Nine people on the Environmental Activities Committee oversee these activities. They've designed a uniform for these activities and currently oversee three activities: Park Volunteering, the Give & Get Market, and the Recycled Books Library.

Park Volunteering

We do volunteer work at Musashi Kokubunji Park, a municipal park located near our company site. Six workers from our company participate for one hour every Tuesday. The park staff gives instructions on what to do, which vary from day to day: cleaning the park, making items to use at events, or replanting the flower garden. Tulips we planted as bulbs last November were in full bloom this April.

Give & Get Market

The Give & Get market encourages the reuse and recycling ("give and get") of old or unwanted items. To host a flea market event at our company, we discussed what types of items we should collect and decided to ask for clothes and stuffed toys. The response was surprisingly strong. We collected a fair number of items. The turnout at the event was also strong. Everyone seemed quite content with their new acquisitions. The remaining items were donated to support groups and recycling businesses.

Recycled Books Library

We collected books found lying around at homes and installed a bookshelf in the common space in front of the cafeteria. Workers are free to take any book home. The books cover any number of genres—cooking, education, language skills, paperbacks, comic books, and so on. The bookshelf was made from an old shelf found on the company site. The library appears to be experiencing robust use now. We're considering donating books to a used books donation program in the future.

Advertising Our Activities

We're presenting our activities online on SNS media. We've worked to make our reports more attractive and, with increased support, the number of likes is gradually rising. We invite you to check out our account!

Kazuko Sasaki (Chairperson)

Members on the committee; the 2nd person from the left in the front row is the author.

Volunteering at the park

Trading things at the Give&Get Market

Twitter @rion_kankyokatu
Instagram #rion_kankyokatudou

Twitter Instagram

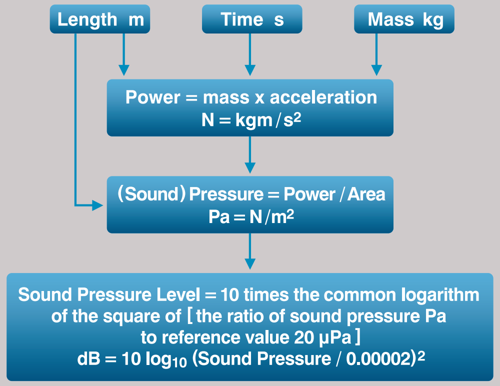
SCIENCE COLUMN

The Decibel (dB) Is Among the Non-SI Units!

In 1875, the Metre Convention was established to coordinate methods and units for measuring size and quantity. The definitions of the International System of Units (SI, abbreviated from the French Système international (d'unités)) have since been compiled in an international document, the SI Brochure. The SI units have been revised over time and have been in the news lately due to the redefinition of the kilogram. Units play a fundamental role in our society and life. While the system of SI units is simple and elegant in theory, it's not necessarily ideal for representing certain quantities. How is the decibel (dB), a unit used in acoustics, treated within the framework of SI?

According to the most newly 9th edition of the SI Brochure, the dB is (unfortunately) listed under "Non-SI units." Included on this list are the bel (B), the basis for dB, and the neper (Np), a logarithmic scale based on natural logarithms. Before the compilation of the previous 8th edition, there was actually a movement to include the Np among the SI units. But there was strong opposition from acoustic specialists, who normally use dB. Currently, dB, like Np and B, is regarded as a non-SI unit used only in specific fields but accepted for use with SI units. However, when dB is used as a unit for representing the nature of the magnitude of a quantity (i.e., the level), both the quantity and the reference value must be specified. For sound pressure levels, the reference value adopted is 20 micropascals (μPa); for sound power levels, 10^{-12} W is used. The unit dB is used without any suffixes.

Dr.Sojun Sato(Advisor, Former Head of Acoustics and Vibration Metrology Division, NMIJ of the National Institute of Advanced Industrial Science and Technology)



The unit of mass is also related to the sound pressure level !

Japanese scenery

At Hayama (Kanagawa Pref.)
Photo by: Nobuhiko Hiruma
(Technical Development Center)

The hydrangea is a flower associated with Japan's rainy season.
The flowers differ in color not because of cultivars, but of the acidity of the soil they grow in.

The three-part series to know about our measuring instruments

MANGA Understanding Measuring Instruments

Sound Level Meter Part 1

Manga by Hisako Takagi

*1 H 132 mm × W 74 mm × D 65 mm　*2 The phon was a unit of sound level at the time.

Shine View!

Introducing one of Rion's shine workers, someone who shines, on and off duty.

Takuya Tabuchi

Technical Development Center

Multitasking Against Time ——An Automobile Mechanic

A rally is a motorsport event that takes place on public roads. The driver is the major player, but it's also a team sport. The mechanic who handles the maintenance work is one of the key players.

——What motivated you to become a mechanic?

I loved cars. I joined my university automobile club. But I enjoyed tinkering with a car more than driving it, so I also got a part-time job at a motorsports shop. I went to car races as a mechanic and supported my team in the maintenance area.

—— What exactly do you do?

Rallies take place on public roads. So there's maintenance work that has to be completed before the race, like automobile safety inspections. Preparations for a race begin several months before the actual race, including getting the car, spare parts, and tools ready for the race. During the race, in addition to the routine maintenance work of changing tires, fixing the brakes, and changing the oil, broken parts have to be repaired. Most rallies in Japan are held in Hokkaido, but I've also participated in a world championship rally in New Zealand. Of course, being an amateur, I don't get paid, but they do cover my travel and hotel expenses.

—— Would you like to share an episode with us?

Several times, we had to pull an all-nighter to fix a car our driver had damaged so that it could race the next morning.

—— Do you think it's had a positive effect on your real life?

Servicing a racing car is a multitask process where you have to perform various tasks simultaneously. I can train myself to consider what's required for each task to perform the service more efficiently. We have limited time to complete pit work during a race. So, whenever something unexpected comes up, it creates the challenge of quickly calculating how I can complete all the necessary work in time.

——What's the appeal of being a mechanic?

It's a hobby for me, through and through. It lets me experience a world away from real life. It gives me an opportunity to cultivate the spirit of ambition, the will to overcome challenges. The joy I experience when I've achieved my goals after giving everything I have is wonderful. There's a great feeling of accomplishment on seeing the car sent safely out of the pit. I'm focused on that moment, the here and now, free of worries about my everyday work. I think that's the greatest appeal.

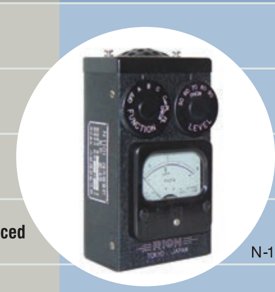
Work tools

At the 2014 Rally Hokkaido; Mr. Tabuchi is on the right.
(Photo by Toshiyuki Taniguchi)

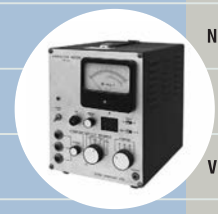
Thanks to your support, Rion is celebrating the 75th anniversary of our founding.

Based on our corporate philosophy —contributing to people, society, and the world through all our activities —we've promoted social welfare, provided safe environments for life, and created technological innovations over many years by constantly tackling the challenge of developing new technologies while accumulating technological expertise. We will continue to strive to accomplish these social missions.

Year	Rion	Medical Instruments	S&V Measuring Instruments	Particle Counter
1944	Founded under the name of Kobayasi-riken Co., Ltd. (currently, Rion Co., Ltd.)			
1948		H-501 mass-produced hearing instrument introduced (First in Japan)		
1952		A-1002 audiometer introduced		
1955			N-1101 sound level meter introduced	
1960	Company renamed Rion Co.,Ltd.			
1965			VM-01 vibration meter introduced	
1970			NA-10 digital sound level meter introduced (First in the world)	
1977				KC-01 airborne particle counter introduced (First in Japan)
1980			SM-10 seismometer introduced	
1983		Development of middle ear implant (First in the world)		
1984				KL-01 liquid-borne particle counter introduced (First in Japan)
1986		Waterproof behind-the-ear hearing instrument introduced (First in the world)	SA-26 1/N octave band real-time analyzer introduced	
1991		Digital hearing instrument introduced (First in the world)		KS-90 airborne particle counter for gas introduced
2000	Shares listed on the Tokyo Stock Exchange 2nd Section			
2010				KC-52/51 handheld airborne particle counters introduced
2011	Shares listed on the Tokyo Stock Exchange 1st Section		NL-42/52 water-resistant sound level meters introduced	Development of microbial particle detection technology (First in the world)
2013				KS-41B liquid-borne particle counter for resist introduced
2014			RIONOTE tablet-type analyzer compatible with wireless measurement introduced	KS-19F liquid-borne particle counter introduced
2017		Cartilage conduction hearing instrument introduced (First in the world)		
2019	75th anniversary of company founding			

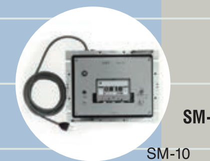


N-1101

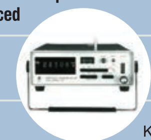


VM-01

NA-10



SM-10



KC-01

KL-01

SA-26

KS-90

NL-52

KC-52

Bioparticle Counter

SA-A1

KS-41B

KS-19F

TOPICS Research presentations, articles, etc.

【Related to sound and vibration measuring instruments】

◎Architectural Acoustics and Noise Control No.184 (vol.47 no.4) 2018/12

- Propagation of Noises to High-rise Buildings and Influence of Weather Conditions / T.Ohshima (in Japanese)

◎Acoustical Society of Japan 2019 Spring Meeting (March 5-6, The University of Electro-Communications, Japan)

- System construction of structural health monitoring utilizing environmental noise. / Y.Takahashi[*1], N.Sato, Y.Nakajima (in Japanese)
- Study on methods for localization of the infrasound / T.Doi, K.Iwanaga[*2], T.Kobayashi[*2], T.Nakayama[*3], Y.Nakajima (in Japanese)

*1 TMCIT *2 Kobayasi Institute of Physical Research *3 Gakushuin Univ.

【Related to particle counters】

◎ INTERPHEX OSAKA 2019 (February 20-22, INTEX Osaka, Japan)

- The concrete measurement report / T.Minakami (in Japanese)

◎EIDEC Symposium (March 11, KFC Hall & Rooms, Japan)

- Development of the New Particle Measurement Instrument using Flow Particle Tracking Method. / K.Kondo (in Japanese)

Award winner

◎ISSM 2018 Best Paper Award
Real Time Measurement of Exact Size and Refractive Index of Particles in Liquid by Flow Particle Tracking Method / T.Tabuchi

◎The Association of Powder Process Industry and Engineering
Subcommittee Achievement Award / Y.Matsuda

◎Japan Electric Measuring Instruments Manufacturers' Association (JEMIMA)
Product Safety / EMC Committee
Outstanding performance award

◎Society of Automotive Engineers of Japan, Inc.Kanto branch
Letter of thanks

Exhibitions

[S] Related to sound and vibration measuring instruments
[P] Related to particle counters

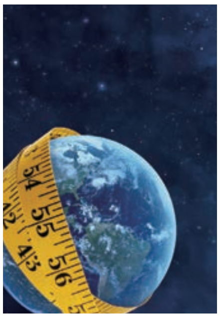
[S] INTER-NOISE 2019 (June 16-19, Madrid, Spain)
[S] ICSV26 (July 7-11, Montreal, Canada)
[S] AUTOMOTIVE ENGINEERING EXPOSITION 2019 NAGOYA (July 17-19, Port Messe Nagoya, Japan)
[S] Plant Maintenance Show (July 24-26, Tokyo Big Site, Japan)
[S] Noise-Con (August 25-28, California, U.S.A.)
[S] ICA (September 9-13, Aachen, Germany)
[S] Automotive Testing Expo China 2019 (September 24-26, Shanghai, China)
[P] ULTRAPURE MICRO (UPM) 2019 (June 5-7, Arizona, U.S.A.)
[P] INTERPHEX JAPAN (July 3-5, Tokyo Big Sight, Japan)
[P] SEMICON West 2019 (July 9-11, San Francisco, U.S.A.)
[P] SEMICON Taiwan 2019 (September 18-20, Taipei, Taiwan)

Editorial Postscript

The National Metrology Institute of Japan (NMIJ) of the National Institute of Advanced Industrial Science and Technology (AIST) was founded by bringing together the National Research Laboratory of Metrology ,Electrotechnical Laboratory, and the National Institute of Materials and Chemical Research to perform duties associated with measurement standards. To undertake future technological development, Rion has also founded a Technical Development Center. In addition, the Particle Counter Division has been spun off from the Environmental Instrument Division. While our organization may be undergoing some changes, Shake Hands will continue to disseminate technical information. (Okamoto)

About the Front Cover

A meter was once defined based on the length of the meridian of Earth. This definition has been superseded by a definition based on the distance traveled by light. It's fascinating how the quest for the definition of units for length and mass has proceeded based on technological cooperation across borders. (Oana)



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https://rion-sv.com/shakehands/

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