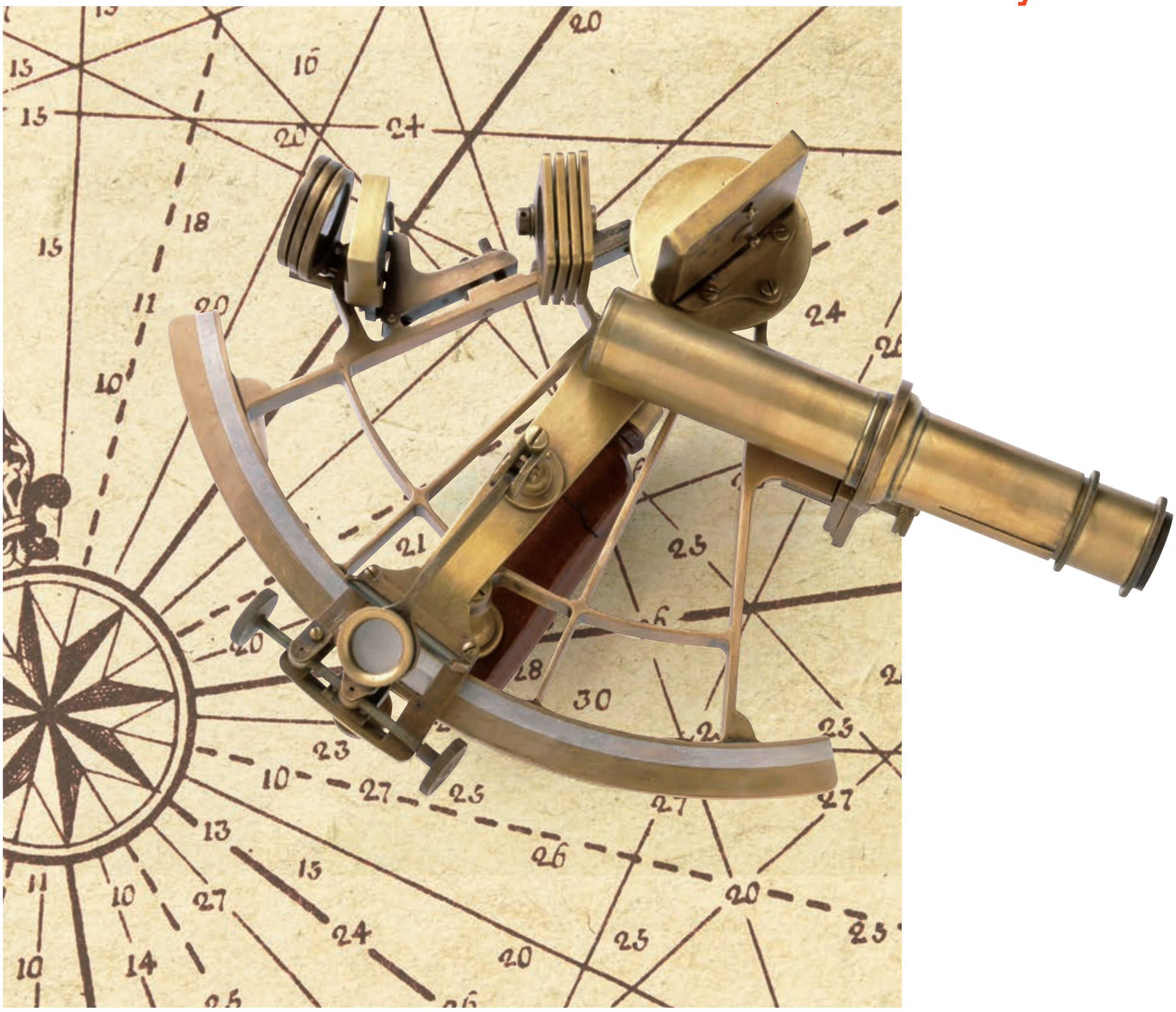
Unite the World with Technology. Technical journal of Rion, JAPAN

# ShakeHands

Vol.1
May 2016



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On the Publication of the Inaugural Issue

RION CO., LTD.

# Dr. Kohei Yamamoto

Institute Head, Kobayasi Institute of Physical Research

# Hear What Cannot Be Heard

## ～A Source of Power to Change Lives～

Text by Michinari Okazaki / Photo by Megumi Yoshitake

Kobayasi Institute of Physical Research stands midway on a long and massive Kokubunji cliff line, commonly called *Hake*,which goes across Tokyo.The institute, founder of Rion Co., Ltd., is a leader in the field of acoustics in Japan, and is active in various areas from basic studies related to noise and vibration, to research and development on piezoelectric materials.
How did its institute head, Kohei Yamamoto, open his eyes to the world of sound?
What made him choose a career in research? What part of acoustics is he interested in today?

### Dr. Kohei Yamamoto

Institute Head, Kobayasi Institute of Physical Research

Kohei Yamamoto was born in 1950, in Kohama-mura, Kawabe-gun, Hyogo-ken*[1]. In 1974, he graduated from Kyushu Institute of Design with a degree in Acoustic Design*[2], and became the assistant researcher at Kobayasi Institute of Physical Research, located in Kokubunji-shi, Tokyo. In 1989, he became the chief researcher for the institute, and has been institute head since 1999. From 2004-2006 he was the president of the Institute of Noise Control Engineering of Japan, and from 2009-2011 the President of the Acoustical Society of Japan. He has been a board member of the International Commission for Acoustics since 2013, and a Board member of the International Institute of Noise Control Engineering since 2015. Yamamoto is specialized in applied acoustics, and holds a doctorate for research on a prediction method for road noise propagation. He enjoys reading, listening to music, bird watching, city walks, and strolling for food.

*[1] Takarazuka-shi, Hyogo-ken, currently
*[2] School of Design, Kyushu University, currently

### Kobayasi Institute of Physical Research

Kokubunji-shi,Tokyo. Founded in 1940 primarily through the efforts of Dr. Koji Sato and Dr.Takuzo Sakai using funds for the public good, donated by industrialist Uneo Kobayasi. The Kobayasi Institute of Physical Research started out as an institute focused on basic and applied research in physics, but since the postwar period, its research has concentrated on acoustics. In 1944, in the wake of development of artificial cultures/processing methods for Rochelle salt, the Institute established Kobayasi-riken Co.,Ltd.(now Rion Co.,Ltd.) to commercialize and sell Rochelle salt products.
http://www.kobayasi-riken.or.jp/english/english_frame_top.htm

"I was the only student in a spacious lecture hall with my professor. "
Not many students were enrolled in philosophy, and during the semester students dropped out and the class size kept getting smaller. And eventually Yamamoto was the only student left in the class, resulting in one-on-one lectures. He became fascinated by the French philosopher René Descartes, who defined the idea of the self with the words, "I think, therefore I am."
Japan achieved sensational technology accomplishments during the period of high economic growth from the mid 1950s to the mid 1970s. However, as a consequence, new problems emerged such as environmental contamination and pollution. The Kyushu Institute of Design was founded in 1968 under these challenging conditions with the purpose of "nurturing designers grounded in artistic sensibility, as well as a range of knowledge covering culture, society and nature, to allow the application of technology to people's lives" (summary from Article 1 of the school code). Yamamoto was a second-grader in high school at this time. " There's nowhere else," he thought, and took the entrance exam without considering to apply to any other universities. But he failed. This was the first big defeat in his life, but he remained undaunted. After spending one year as an entrance exam rejectee, he was finally accepted into the university. The university offered many appealing classes that were not defined by the traditional categories of humanities or science.
" Philosophy was the most interesting of all classes. I thought 'It's not that interesting that the thinking self exists. What's so great about spending his whole life only to discover such a common thought?' But when I thought about what we can be sure about, I noticed the thinking self is the only one thing that is left after all. And things evolve from there. It's interesting."

### Music Experience That Made the Heart Dance

Yamamoto was born in Kohama-mura, Kawabe-gun, Hyogo-ken (Takarazuka-shi today) in 1950.
"I was an unruly child. I played outside until I was very tired. When I got home, I forgot about homework. I didn' t care about being yelled at."
He said he was indulged. In his primary school days, he often skipped classes to play at the riverside, and was often kicked out of the of the classroom, as a punishment for neglecting his homework. One day, during his fifth year in primary school, he woke up to a sound when his uncle turned on his stereo. It was Liszt's " Hungarian Rhapsody No. 2."
"I exclaimed, 'What is that music?' I was excited by the sound of the music. It made my heart dance. I've been hooked since then."
Attracted to classical music, Yamamoto began to frequently listen to the radio and records by Tchaikovsky, Beethoven, Brahms, Bruckner, and Mahler.
"Music gave me peace of mind. I did gymnastics when I was in a junior high school, and no matter how physically exhausted I was, my body was able to relax when I listened to music."
When he was in high school, he enjoyed the wonderful sound of the stereo, which he had built himself.
"I didn't have to attend concerts to affect my emotions. My feelings changed just by listening to my favorite music on the stereo. I started to think it would be nice to have a job that made other people feel the same way."
Around this time, his mother showed him a newspaper article about a university with an acoustic design department that would open in Fukuoka.

### The Joy of Research Discovered in the Middle of Defeat

While he was studying at university, he joined the school orchestra where he got

to play the timpani. His aspiration, of getting involved in music production, changed as he experienced and realized the requirements of the industry.
"I had hoped to get a job as a producer or mixing engineer, however, I realized that the job was more requiring than I had expected. Not only did it involve recording of the music, but also the ability to change it into something new."
He listened to a recording of his own live performance, which was a completely different experience compared to what he heard during the performance. He realized that the requirements for this job such as the ability to read music, have knowledge about songs, and being able to make a new piece of art by turning the material from a music performance into the form of a phonograph record, required great use of creativity, and was beyond his ability. This was the second defeat in his life. In his senior year of college, he chose "Two-channel Stereophony Recording and Playback Using a Dummy Head" as the subject of his senior thesis.
"I thought if the best recording could be made using a dummy head, then everyone could enjoy the best music. However, since everyone has a different head shape, no one hears exactly the same sound. I did multiple experiments about acoustics throughout my senior thesis, and found it interesting to immerse myself into a specific topic. When I made a discovery after experimenting it gave me joy."
He told his instructor, who was in charge of job placement, that he wanted a research job, and that he was not concerned about making money. Soon after, his instructor introduced him to the Kobayasi Institute of Physical Research. Without even knowing what a sound level meter was, Yamamoto visited to see the institute and got a job there in 1974.
At the institute, while he repeated many experiments under the guidance of the senior staff, he was presented to a phenomenon that was unknown to him and could not be explained by the theories he knew. It was the boundary surface problem,which involved acoustic propagation on a finite impedance face.
"I did dozens and dozens of experiments, and while I plotted data manually on graph paper, I began to see a certain pattern. I tried modeling to make it usable, and realized I needed a theory for calculation, which confirmed my theory, as the tendency was almost the same as my hypothesis."
It formed the base of Yamamoto's research article about study on prediction of road noise propagation, which gave him a doctorate.

The forest on *Hake*, the Kokubunji cliff line, and the cityscape of Fuchu can be seen from the windows of the institute head's office.(Photo by Yasutaka Nakajima / Development Department)

## The Relationship between Measurement and Identity

When he was asked what kind of people he respected, he thought for a moment before he said: "I think Dante is a genius." Dante is the greatest writer of medieval Italy, the poet who wrote the magnificent epic "The Divine Comedy."
"He had a good knowledge of European history, mythology and theology, and made a vision of the world in 'The Divine Comedy.' The hell he describes is similar to how the Japanese conceive hell. Dante's way of thinking reminds me of Indian Buddhism in some ways, and there is a similar story in the 'Kojiki' (records of Japanese ancient matters). Dante's knowledge was unbelievable! He inspired my intellectual interest in many different topics. Dante was the cue."
In "The Divine Comedy (Inferno)," the main character (Dante) sees people suffering various tortures in Hell, and asks one after another, "Who are you?"
"That person answers 'I am so-and-so.' If the person is recorded in a historical book, it means his/her existence is verified by a third person. That is identity verification."
Yamamoto says he couldn't help wondering why he needed to carry a passport with him when he was overseas on a business trip. It inspired him to think about what it meant to be himself.
"It's written in a family register that I am Japanese, and my passport verifies the person on the family register is me. Any verification of identity between me and that person is made by third parties. It's one aspect of identity. But if the family register didn't exist, who could verify that I am Japanese? This is a subject of social identity. There's one more thing; the idea of biological identity. The immune mechanism of a living object measures and analyzes a cell in some way to determine if the cell belongs to the living object's own body and whether to take in the cell or eliminate it. We can verify our identity of ourselves through measurements and evaluations without the eyes of a third party. This is how measurement and identity are related."

## Intellectual Interest ——Another Approach to Acoustics

Yamamoto says his identity lies primarily in being Japanese. His way of thinking and acting is that of the Kansai people. He values people with humor and self-mockery, and for example loves *Yoshimoto Shin-kigeki* (Kansai Comedy) because he makes no effort to hide his Kansai dialect. Why is a person with such characteristics so important to Yamamoto?
"I prioritize people with intellectual interest. People who question *how is the world made up ? What is the origin and history of language ? What keeps historical continuity common to the whole world ? Where did human beings come from ?* I want to discover all these things."
Acoustics is a science that provides safety and comfort to life. This is what Koji Satoh, the second chairman of the institute, said. Another mission of acoustics is to "satisfy intellectual interest," as Yamamoto believes now.
"Acoustics has an impact on the quality of a person's life. It's a broad cross-sectoral science that embraces science and engineering, medical science, and even the humanities. Descartes said that his own thinking was the one thing he couldn't doubt. But *Hannya Shingyo* (Heart Sutra, one of the Buddhist scriptures) has a mantra, sacred utterance or sound, which means the completion of prajna. It's said, when a prajna is completed, even the thinking self does not actually exist. This is beyond Descartes. What meaning does something like this that can't be sensed with any of the five senses have? Who on earth can understand this? I think this is interesting, although it may be not lead anywhere. I myself may change. But I want to find out someday what my forerunners looked for."

## Science and Engineering Begin with Measurement

According to Yamamoto, it is the importance of measurement that encourages Rion.
"After all, phenomena must be measured to be understood. Measurement converts physical phenomena into figures and symbols, and through the following analysis researchers try to find patterns. The basis of science is to observe natural phenomena, test hypothesis, and make laws based on the conclusion. Measurement is vital to observation. Moreover, from an engineering aspect, if an observational result is quantified, it can be used for predictions and design, which leads to solutions for various problems. Just as philosophy starts with thinking, science and engineering begin with measurement, and advances in measuring technologies has changed the world of academic research. The transition from optical telescopes to radio telescopes changed the world of astronomy. Similarly, if we can see what cannot be seen or hear what cannot be heard, we can easily understand phenomena that we didn't understand before. Progress in measuring technology has the power to make significant changes in the world of academic research, as well as ordinary lives."
Philosophy, acoustics, people's life. Yamamoto's quest for interesting topics shows no signs of ending yet.

Feature Story

# Measure

*Shaku* is a unit of length, originating from China, based upon the length of a forearm.
As a result of the developing economy, the demand for common units
that could be used for trading arose. Eventually, nations established units applied nationwide
to show the power, and nowadays, criteria of units are standardized internationally.
Reviewing the act of measuring reveals the dynamism of human activities.

01

## *Sokutei* and *Keisoku*

### What is the Difference between *Sokutei* and *Keisoku*?

In Japanese the term *Sokutei* is different from the term *Keisoku*, but both are translated to “measurement” in English. If particularly asked “what is the difference between the two?,” we face the necessity to think about what measuring is.
For researchers and engineers engaged in product development, manufacturing, or inspections, measuring is an everyday act. Correct measurement is essential to fair trading and product compatibility /safety. We rely on values shown on commercial products when we purchase them, as we assume that they are measured correctly. However, if we are asked, “How reliable is the measurement result?”—is it enough to answer, “The data was measured with a regularly calibrated measuring instrument” ; “… it was measured by experienced staff” ; or “… there can’t be any mistakes because the result obtained is similar to those from the past” ? When measurements are done due to necessity, both values and a demonstration of reliability are often required.
According to JIS Z 8103 “Glossary of Terms Used in Measurement” by Japanese Industrial Standards, *Sokutei* is described as “a comparison of certain quantity to another quantity, used as a criterion, to represent the result by numerical values or symbols.” On the other hand, *Keisoku* involves “investigating and implementing a method/means to grasp matters quantitatively from a specific purpose and using the result to achieve the desired goal.” This includes a series of operations to be done after considering why the measurements should be done.

### How to Represent the Reliability of Measurement Results

When you perform measurements, you may often experience inconsistency and fluctuations in data indicated by a measuring instrument. Data that fluctuates less, tends to be regarded as more accurate and reproducible. However, being accurate does not necessarily equals being close to the true value. The difference between a measured value and the true value is called “error”; data with fewer errors is regarded as more exact. Although this suggests that you could use accuracy and exactness to represent the reliability of a measurement result, “the true value” is generally unknown. You cannot calculate errors associated with the data. Moreover, there is another problem in that these terms are used differently in different technological fields and nations.
International organizations involved in instrumentation tried to establish a unified method to evaluate/represent the reliability of instrumentation data. This led to a proposal to use “uncertainty” as a new criterion to replace “error” and “accuracy.” Uncertainty is a rational estimate of fuzziness accompanied by measurement results.
Simply put, uncertainty is obtained as follows. First, enumerate all factors that potentially can influence the measurement value. Next, calculate the standard deviation from actually obtained measurement data for statistically workable quantities; or, as for other quantities, use information from calibration data, experience, and knowledge to estimate the dispersion of the measurement data and calculate as a quantity equivalent to the standard deviation. Lastly, set an uncertainty for each factor. In this series of processes, it is important to be able to list every uncertain factor and to be able to estimate individual uncertainty without excess and deficiency. This is why evaluations of uncertainty depend on knowledge of the measurement quantity or nature of the measurement.
“Intervals” and “confidence levels” are used to quantify uncertainty. “Interval” means a range within which the true value is expected to fall; “confidence level” indicates the probability of the true value being within this interval. Half the value of the interval corresponding to the confidence level is called “expanded uncertainty.” In many cases, a confidence level used is 95 percent.
For example, a measurement result is indicated as “5.04 mm in length, with an extended uncertainty of 0.05 mm (confidence level at 95 percent).” This means “the length is estimated within a range of 5.04 mm ±0.05 mm with a probability of 95 percent,” or “we are 95 percent confident to say that the length falls within a range of 4.99 mm to 5.09 mm.”

### System for Ensuring the Reliability of Measuring Instruments ——Traceability of Calibration

When a measuring instrument is calibrated, it receives a certificate of calibration issued by a calibration/inspection organization. The certificate indicates the calibration value and its uncertainty. Standards used by such calibration/inspection organizations are calibrated by upper-level calibration/inspection organizations. In this way, a chain of calibration goes all the way up to the national standard. All calibration /inspection organizations that are part of this calibration traceability system are accredited by laboratory accreditation bodies. Furthermore, laboratory accreditation bodies have international mutual recognition agreements with other laboratory accreditation bodies nationally and internationally. The national metrology institute that is responsible for the national standard also has international mutual recognition agreements with national metrology institutes of other nations. This means a calibration certificate issued by an accredited calibration/inspection organization that meets requirements is valid internationally. Our country uses the JCSS, or Japan Calibration Service System, a traceability system based on the Measurement Act.
This laboratory accreditation mechanism is an authentication system similar to quality management systems (ISO 9001) or environmental management systems (ISO 14001).
In order for a calibration/inspection organization to be accredited, the management of calibration work and technical competence are required, based on the international standard ISO/IEC 17025 “General requirements for the competence of testing and calibration laboratories”. As seen above, a traceability system that shows the reliability of a measurement in terms of uncertainty is internationally accepted. But whether to use it or not is left as an option.
On the other hand, some measuring instruments are governed by law because they are closely related to our lives. They are called specified measuring instruments and are covered by the Measurement Act. This law covers scales, water meters, electricity meters and others used for transactions, as well as sound level meters and vibration level meters used to prove conformity to a given environment standard. They are subject to the official verification system established in the Measurement Act. The official approval system focuses on determining whether or not to approve measuring instruments. Thus, it is treated differently from traceability systems based on uncertainty for the purpose of ensuring reliability.
The reliability of measurement is indicated by an internationally established way of expressing uncertainty. However, knowledge of uncertainty analysis is required not just among people in charge of measuring, but also among users who demand reliable measurement results. Because uncertain factors vary widely, they are not just the measuring instruments used, but also the measurement environment, measurement conditions, measurement procedures, and the skills of those performing the measurements. Ultimately: “The measurement result that is obtained as the best estimate value may not be the true value, but a range of dispersion is guaranteed by an expanded uncertainty value with confidence level added.”
( Dr. Sojun Sato / adviser, former Head of Acoustics and Vibration Metrology Division, NMIJ, National Institute of Advanced Industrial Science and Technology )

- We are a calibration service supplier accredited by JCSS (Japan Calibration Service System: traceability system covered by the Measurement Act). We can issue internationally acceptable calibration certificates for sound level meters, measurement microphones, sound calibrators and standard piezoelectric acceleration pickups.
- We are a designated sound level meter/vibration level meter manufacturer established under the Measurement Act. We can carry out, official verification of individual measuring instruments on behalf of public verification organizations.

## 02

# Revision of the Verification and Inspection Standards for Sound Level Meters / Vibration Level Meters under the Measurement Act of Japan

JIS (Japanese Industrial Standards) for sound level meters include the JIS C 1509 series, which was established in alignment with the IEC 61672 series, and the JIS C 1516:2014 "Sound Level Meters – Measuring Instruments Used in Transaction or Certification", which was established for use as a direct reference in the Verification and Inspection Standards for specified measuring instruments ("Verification and Inspection Standards" hereafter). For vibration level meters, we also have JIS C 1510:1995 and JIS C 1517 :2014 "Vibration Level Meters – Measuring Instruments Used in Transaction or Certification", established for use as a direct reference in the Verification and Inspection Standards. In 2015, to comply with JIS, the Verification and Inspection Standards for Sound Level Meters/ Vibration Level Meters under the Measurement Act and related laws, were revised. This was the first major revision of the standards for sound level meters, as the specified measuring instruments, since 1993, when the SI unit system was introduced to replace the unit "phon"* with decibel.

For sound level meters, the most significant change between the previous Verification and Inspection Standards and the revised version is the calibration method. Conventionally, calibration by using the internal electrical signals of sound level meters was deemed valid. But the revision only recognizes calibration by sound calibrators as valid. Additionally, new requirements have been added, including the requirement for resistance to environmental factors such as electromagnetic fields and static pressure. Other requirements have been made more rigorous. For example, the acceptable margin of linearity errors for scale marks, and testing procedures for time-weightings have become more stringent.

Sound calibrators must comply with JIS C 1515 and must be adequately maintained and managed. Noise measurement and evaluation manuals issued by the Ministry of the Environment require sound calibrators to be calibrated periodically at intervals not exceeding three years; additionally, sound calibrators must be calibrated by JCSS (Japan Calibration Service System : a traceability system based on the Measurement Act) accredited calibration laboratories or equivalent agencies, or by manufacturers possessing a standard traceable to a national measurement standard.

No major changes were made for vibration level meters. Vibration level meters that comply with JIS C 1510:1995 may undergo verification testing for instrumental errors based on the new criteria. They can thus be regarded as practically having no expiration date for use as long as they are properly calibrated.

As a transitional measure, old-type sound level meters will remain acceptable for instrumental error verification testing until October 2027 based on the earlier criteria, and may be used until October 2032. The old-type sound level meters that comply with JIS C 1509-1 and are approved by the manufacturers may undergo instrumental error verification testing based on the new criteria. In this case, no expiration date for use is set for those sound level meters.

Many of the vibration level meters currently available comply with JIS C 1510:1995 and may undergo instrumental error verification testing based on the new criteria. They may also undergo instrumental error verification testing based on the old criteria until October 2022, and those that are tested based on the old criteria may be used until October 2028.

This major revision of the Verification and Inspection Standards, the first in 22 years, brings the performance requirements for sound level meters stipulated under the Measurement Act in alignment with international standards. It resolves the calibration double standard imposed by the Measurement Act, which allows calibration by internal electrical signals, and the international standard, which recognizes only calibration by acoustic calibrators as valid, and consolidates those calibration methods into calibration by acoustic calibrators incorporating microphones.

(Masaharu Ohya / Business Planning Department)

*Although the unit "phon" is known to denote loudness level, it had been used differently in Japan.

## 03

# Revision of the International Standard for Cleanrooms

Cleanrooms, which used to be considered advanced technologies for specific industries like electronics, have now become very common in the industry as well. Standardization of performance indication or evaluation techniques was implemented separately by few advanced nations. Later, cleanrooms entered use in many fields of manufacturing environments, such as precision equipment/chemical products and drug/food, along with health and safety. As globalization and international specialization advanced into more and more industries, the demand for international sharing of evaluations of controlled clean environment arose. In 1999, the ISO 14644 series "Cleanrooms and associated controlled environments" was issued.

Before 1999, the US Federal Standard FED-209 was widely used internationally. However, partly because it uses a US-specific unit system, this ISO series was designed based on the Japanese standard (JIS B 9920). Although FED -209 was abolished in 2001, its practical influence remained because it was used for a long time and expressed in easily understood ways. One typical example can be seen with the present specification of airborne particle counters. For many, its flow rate is set at a value of 2.83 L/min (= 0.1 cubic feet) or 28.3 L/min ( = 1 cubic foot) is adopted as a sample flow rate.

As shown in **Table 1**, ISO 14644 is currently composed of nine parts and is being revised in ISO/TC 209. There is also discussion on standardizing new targets, including contamination emission amounts of installed equipment and measurement evaluations of suspended nanoparticles. Under the old edition, the classification that indicates the performance of cleanrooms was stipulated in Part 1, and the method to examine proper evaluation for classification in Part 3. The latest revision has brought them together in Part 1. Part 3 describes the testing methods for evaluating the operating condition of clean rooms. As for the revision of Part 1, it was aimed to show that 90 percent or more of a clean room meets the classification with a reliability not lower than 95 percent. Major items in the standard were reviewed, including a study of how to decide measurement values and evaluation techniques, and many discussions were held on compromises between scientific basis of prescribed value and efficiency during actual operations. Since cleanrooms have many uses across a wide range of fields, many experts of different backgrounds were involved in the revision of the standard. It was not easy to reach an agreement; it took nine years to release a revision, and sixteen years had passed since the last revision. **Table 2** shows the revised edition of the classification that forms the framework of Part 1. Although the basic concept has not changed, some values were deleted because they could not be reliably evaluated with current particle measurement technologies.

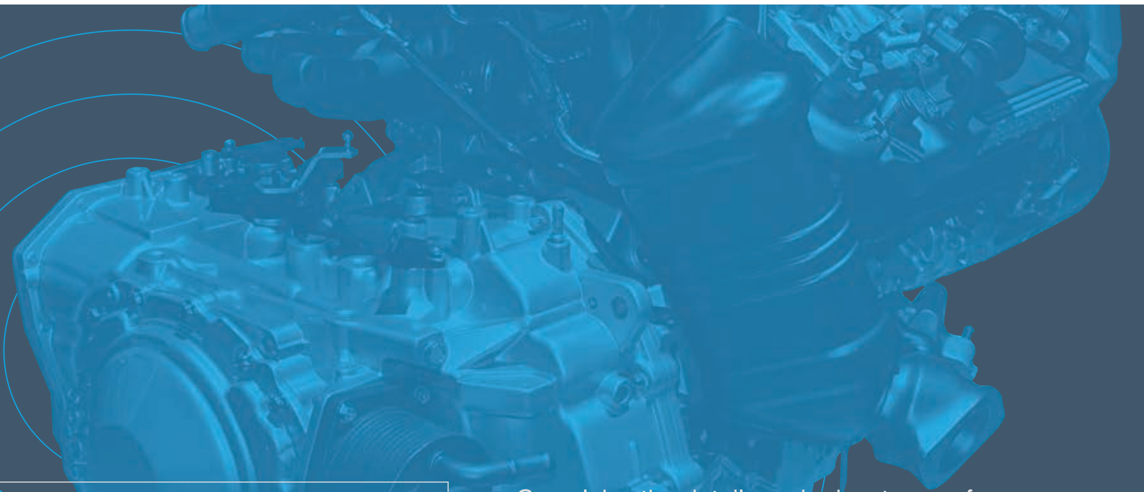
The market for industrial low-cleanliness cleanrooms, related to food and living environment, is expanding in many countries. On the other hand, with thanks to localized cleaning technologies, semiconductor industry which traditionary cleanrooms with ultra-high cleanliness, is now said to be enough with that of cleanrooms such as drug or precision equipment industries for production of next generation semiconductor products. Although the pursuit of ultra-high cleanliness of cleanrooms is no longer a major industrial concern, with globalization advancing in many industries, it is becoming more important to share universal evaluation criteria for cleanliness control internationally. I would like to mention the efforts by the people who achieved a revision of this standard through cooperation and many discussions. I expect the standard to enter wide use.

Table 1 : Composition of ISO 14644

| | |
|---|---|
| Part1 | Classification of air cleanliness by particle concentration |
| Part2 | Monitoring to provide evidence of cleanroom performance related to air cleanliness by particle concentration |
| Part3 | Test methods |
| Part4 | Design, construction and start-up |
| Part5 | Operation |
| Part6 | Separative devices (clean air hoods, glove boxes, isolators and mini-environments) |
| Part7 | Classification of air cleanliness by chemical concentration(ACC) |
| Part8 | Classification of surface cleanliness by particle concentration |
| Part9 | Classification of surface cleanliness by chemical concentration |

Table 2 : Classification of Cleanrooms
( Slant lines indicate the values deleted in the revision this time. )

| ISO Class (N) | Maximum allowable density (particles/m³) for each particle size | | | | | |
|---|---|---|---|---|---|---|
| | 0.1μm | 0.2μm | 0.3μm | 0.5μm | 1μm | 5μm |
| 1 | 10 | ~~2~~ | | | | |
| 2 | 100 | 24 | 10 | ~~4~~ | | |
| 3 | 1 000 | 237 | 102 | 35 | ~~8~~ | |
| 4 | 10 000 | 2 370 | 1 020 | 352 | 83 | |
| 5 | 100 000 | 23 700 | 10 200 | 3520 | 832 | ~~29~~ |
| 6 | 1 000 000 | 237 000 | 102 000 | 35200 | 8 320 | 293 |
| 7 | | | | 352000 | 83 200 | 2 930 |
| 8 | | | | 3520000 | 832 000 | 29 300 |
| 9 | | | | 35 200 000 | 8 320 000 | 293 000 |



# Acoustical Capacity Meter / Volume Meter

Archimedes' Principle is the most used measurement technique when it comes to the cubic volume of objects. However, its requirement for liquid has consequences for the measurement, which is why Rion uses the Acoustic Method[1] that contains several advantages compared to Archimedes' Principle.

## Benefits of Acoustic Method

From ancient times until today, the volume of an object has, in most cases, been measured with a method based on Archimedes' principle that states: "objects weigh less in fluid, by the weight corresponding to the fluid displaced." For measurement of capacity, the burette method is generally used, in which "oil or other fluid is poured into the void, and its quantity is then measured." However, both methods are disadvantageous in workability, due to its need of liquid:

- The target object gets wet and needs to be dried after measurement.
- Take a long time.
- Require skill.

The Acoustical Capacity Meter has advantages to resolve such weaknesses:

1) No need to wet the target object. Measurement can be done in the dry state.
2) Requires very little time.
3) Easy to operate. Does not need skill.

Above all, 1) is the biggest advantage because a process to dry the target object is unnecessary after measurement, and a target object that is not wettable can be measured.

For 2), a shorter time of measurement is achieved for general industrial instrumentation. The capacity/volume can be measured immediately after calibration. It only takes about 2 seconds after setting the meter to the target object to obtain a measurement value.

For 3), this measurement method does not depend on the skill of the worker. As long as the proper procedure is followed, a beginner measurer will get measurement results identical to those of an engineer working for the manufacturer of this meter.

In addition, this measurement method has another advantage:

4) High repetitive accuracy.

It achieves high repetitive accuracy within ±0.1 percent of the capacity/volume of the target object. It is employed by several manufacturers in the automobile-related industry who need very high accuracy.

## Measuring Changes in Pressure in Reference Chamber and Measurement Chamber

This meter has a two-tiered structure as shown in **Fig. 1**. By driving a speaker between a reference chamber and a measurement chamber with a sine wave, the two chambers show very small volume changes of the same absolute value but with the opposite sign. If the air inside the reference chamber changed adiabatically by $\Delta V$, very small pressure changes $\Delta P_1$ and $\Delta P_2$ occur in the reference and the measurement chambers. The relation is described by the following expression:

$(\text{Pressure})\times(\text{Volume})^{\gamma} = \text{constant}.$

More approximately, the following expressions hold.

$\Delta P_1 / P_0 = \gamma \cdot \Delta V / V_1$

$\Delta P_2 / P_0 = \gamma \cdot \Delta V / V_2$

$P_0$ : Static pressure inside the chamber
$\Delta P_1$ : Very small pressure change in the reference chamber
$\Delta P_2$ : Very small pressure change in the space combining the inside of the adapter and the target object
$V_0, V_1, V_2$ : Refer to Fig.1.
$\gamma$ : Ratio of specific heat of air

From the above, $V_2$ is described by the following expression:

$V_2 = V_1 \cdot \Delta P_1 / \Delta P_2$

Therefore, volume of the target object V can be calculated by the following expression:

$V = V_2 - V_0 = V_1 \cdot \Delta P_1 / \Delta P_2 - V_0$

$V_1$ and $V_0$ are calculated during calibration, and are constant. $\Delta P_1$ / $\Delta P_2$ is a ratio of change of pressure in the reference and the measurement chambers. By using a microphone in the reference chamber to detect individual pressure change, capacity/volume of the target object can be measured.

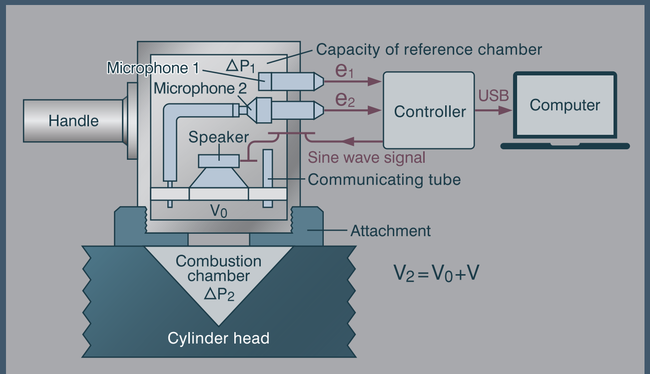


Fig.1. Cross-sectional View of Acoustical Capacity Meter

## Examples of Measurement

**Measurement of Capacity of a Cylinder Head and a Piston**

This meter is mostly used to measure the capacity of cylinder head combustion chambers in engines of automobiles. The capacity of the combustion chamber can be measured just by putting a reference chamber on the cavity of the combustion chamber. The automobile industry has the technology to improve the performance of engines by varying the shape of hollows in the top parts of pistons. This meter is also introduced for measuring their capacity.

**Measurement of the Combustion Chamber of an Engine Already Assembled**

Mainly used to measure the capacity of a combustion chamber with a piston at the top dead center. Since this meter allows the target object to be measured in the dry state without being wet, capacity measurement is possible without disassembling the engine in each process, including in engine production and tune-up.

**Measuring the Volume of Industrial Components**

These measurements apply to industrial components whose volumes must be confirmed to fall within a specified range, including mating components that must be shaped precisely to fit a matching hollow area. This is technically difficult to confirm. If such a component is measured using this meter and the volume is found to be out of the specified range, the component can be rejected immediately, since a component that is out of range volume-wise is very likely out of specification shape-wise.

**Measuring the Volume of Weights**

To ensure accuracy and to meet the International Organization of Legal Metrology (OIML) standards, weights must have their density measured. JIS B 7609:2008 "Weights" - Appendix B, Measurement Method G explains the details and advantages of a measurement method involving an acoustical volume meter. This method has the advantage that it is free of contamination of weights and the influence on stability of mass associated with the use of liquids. It is also possible to use a reference weight which volume is calibrated by the hydrostatic weighing method as a calibrator to implement volume measurements with extremely small relative uncertainty.

## Future Prospects

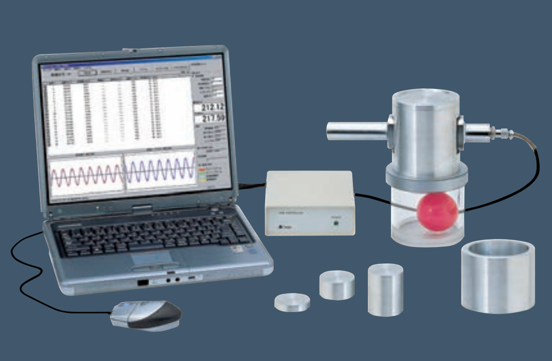
Over the past several years, the demand for the Acoustical Capacity Meter has increased internationally as well as domestically. Due to the meter's significant advantages in workability and repetitive accuracy,the demand is expected to increase further. More devices based on the same principle are currently under study to achieve practical use. One of these devices regards the calculation of the surface area of an object based on measurement of acoustic impedance[2]; another device detects pinholes on receptacles[3].

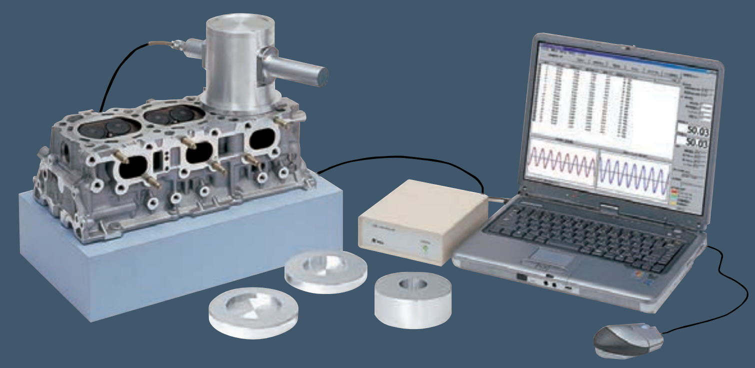
(Yukihito Iseki / Measurement Instrument Technical Support Section)

References

[1] ISEKI : Acoustic Volumeter, Journal of INCE/J vol.38, pp.46-49 (2014)
[2] TORIGOE : Measurements Using Sound, Journal of INCE/J vol. 38, pp.6 (2014)
[3] HIRAO, ISEKI, IWAHASHI, TORIGOE: Development of pinhole tester utilizing acoustic impedance, collection of papers presented at a meeting of The Acoustical Society of Japan on September 2012, pp.717-718 (2012)

**Please visit the Products page on Rion "Support Room" website for more information on the Acoustical Capacity Meter/ Volume Meter.**
**http://rion-sv.com/**





Rion's History of Technology

## DISCOVERY from the Past Products

# The First Domestic Airborne Particle Counter
# KC-01


Rion's first work with particle counters, which measure the number and the size of particles in air or liquid, began with the import and sale of US-made products in 1972. Jun Seki* told stories about how these products were sold in early days, as well as how the company later began developing the KC-01 in 1975.

*Development Department; assigned to the Measurement Instrument Developing Section 1 at that time of developing the KC-01

**——Please tell us how you got involved with particle counters.**

I joined the company in 1972. I worked on maintenance for the US-made particle counters that came on the market that year. Later I got involved in developing the KC-01.

**——What were some of the difficulties when sales first started?**

At the time the products were launched, there were only a few cleanrooms in Japan, and there were almost no cleanliness controls. Therefore, our customers did not have great interest or knowledge about particle counters.

However, our sales staff made great efforts and often helped customers until late at night. Thanks to our determined sales staff, pharmaceutical companies and other cleanroom-related companies, gradually began purchasing our products.

**——How was Rion's technical staff doing in those days?**

We faced a great challenge because we had no previous experience with handling particle counters, which made it difficult for us to repair and maintain the products. Therefore, we studied the products thoroughly, and used the trial and error method to understand and solve the problems. I clearly remember when the section chief, at the time, told me: "It's a time of groundbreaking. Everything starts with groundbreaking. We' ll dig our way through this."

**——How did the US products you sold perform?**

We had a popular low-price model that collects forward scattered light (i.e.,at an angle close to the illuminating ray) and a more expensive model that collects sideway scattered light (i.e.,at sideway angles away from the illuminating ray). The expensive model was uniquely constructed to use a rotary oval mirror to realize full 360-degree gathering of the lateral scattered light and offers reliable performance.

**——What prompted Rion to begin developing its own particle counter?**

Since we had sold US products for three years, our sales staff began to feel, if the quality was good, this product category met a customer need. Expectations for particle counters gradually rose within the company, so we decided to enhance our particle division. We began developing our own product based on the concept of a small, light product offering high performance and high reliability.

**——How did the development of the KC-01 proceed?**

Akira Yokochi, professor at Tokai University, who studied particles in air, told us about the light scattering theory, which was the underlying principle for detecting particles and particle behavior. The mathematical expressions of light scattering are complicated. However, around 1973, by using a computer that read punched paper tape, we managed to calculate light scattering under several conditions. Our design background and experience with maintenance helped a lot in redirecting our policy from US products to our own products.

Around 1975, the development of KC-01 started with a section chief and six young staff members. Since this was our first development we experienced some difficulties, but the efforts of each staff member culminated and led to the completion of the KC-01 in 1977.

**——What technologies were used?**

The product incorporated many of our own technologies, including the 70-degree side scatter method and the sheath air method.

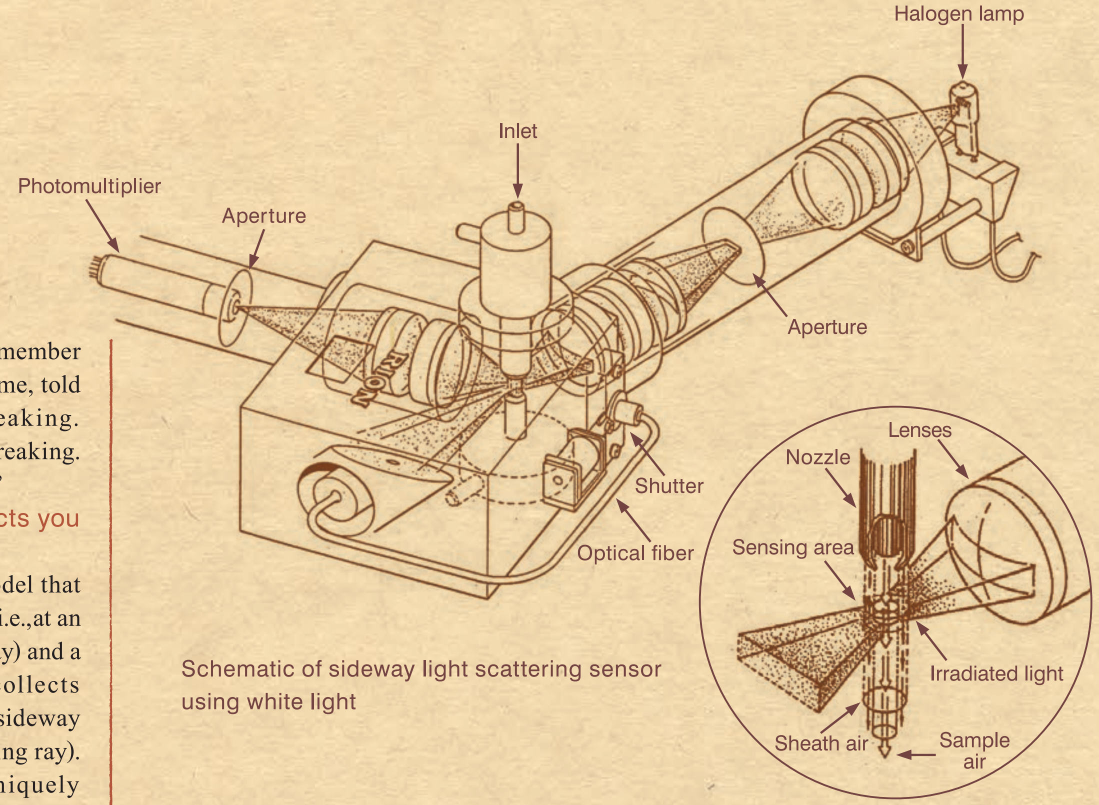
With the 70-degree side scatter method, sensors gather light scattered at 70 degrees from the illuminating ray. This method offers excellent linearity and sensitivity. It couldn' t have been achieved without numerical calculations of light scattering. With the sheath air method, sheath-form purified air is directed around the sample air. The sample air flows in a laminar fashion and is free of turbulence in the detection area, allowing precise detection of particles in the sample air.

**——How was the product evaluated?**

KC-01 had top-level capabilities for the time, with a minimum measurable particle diameter of 0.3 micrometers. It was also compact, priced under 1 million yen, and earned a great reputation. It drew the attention of the semiconductor industry as a device for use in cleanliness control and other applications, and sales gradually began to rise. Developing the KC-01 gave us a huge confidence boost for subsequent development efforts.

**——What message do you want to pass on as a developer?**

The KC-01 could not have been completed just by those directly engaged in its development. It required assistance from Professor Yokochi and many other experts. The KC-01 was the fruit of the efforts of all those people who were interested in particle counters during those days. I expect young engineers to try to come up with new ideas for everything, and continue pursuing a challenge until they are satisfied, without fear of failure.




Schematic of sideway light scattering sensor using white light

# ShineView!

Introduction of *SHAIN* ( means worker ) Who Are Shining on and off Duty

## Won a Victory at Guam Ko'Ko' Half Marathon and Ekiden Relay !

### Rion Track and Field Club

Ekiden is a sport of Japanese origin in which multiple runners run a long-distance relay. In recent years, ekiden has become popular and meetings have been held in other countries as well. In the Guam Ko'Ko' Half Marathon and Ekiden Relay, held in Guam on November 8th, 2015, a total of 1,064 runners, from 266 teams, participated. From the Rion track and field club, 12 runners of three teams participated. The climate in Guam is hot and humid, with temperatures up to 27° C and humidity around 80 percent. The start time was 5 o'clock in the morning, before sunrise. Despite these harsh conditions, the three teams from Rion had significant success, winning the first, second, and fourth place in the corporate team division. Even at such early hours, a lot of supporters stood by the roadside, cheering loudly for the members of the Rion track and field club, who kept running towards the finish line without giving up.

## Accomplishing a Long-Cherished Desire to Win, with a High Spirited Performance !

### Rion Self-defense Firefighting Team

The Fire Service Act requires business establishments, with 50 or more employees, to organize self-defense firefighting teams. The Rion firefighting team is composed of a few selected members ( four new employees in recent years ) recommended from each workplace. In September 2015, the Kokubunji-shi fire station hosted a juried show of self-defense firefighting training. Here, the Rion firefighting team accomplished a long-cherished ambition to become champions- the first to do so in 17 years. The eight participants included Rion, companies, schools in Kokubunji-shi, and the city office. All were strong competitors having record of victory. The mission of self-defense firefighting teams is to minimize or reduce damage in emergencies, such as fire, earthquake, or other disasters. After the juried show finished, the firefighting team continues to protect the safety of Rion.



# PRODUCT INFO

## Multi-functional Measuring System RIONOTE

You can build a wireless system by using an optional wireless dock, without annoying on-site cabling, for easy measurement. With dust-/water-proof performance at IP54, there's no need to worry about sudden rainfall. Optional programs allow enhanced functionality, and customization is possible to meet user requirements.

http://rion-sv.com/rionote/

## Vibration Level Meter VM-55

Allows simultaneous measurement of vibration level (Lv) and vibration acceleration level (Lva). Measurement results can be stored in internal memory or to a high-capacity (up to 32 GB) SD card and exported in CSV format for importing into Excel or other software. Conforms to the requirements of the standard vibration measurement manual (by Environmental Vibration Evaluation Subcommittee of The Institute of Noise Control Engineering/Japan).

http://rion-sv.com/products/10008/VM550009

## Precision Sound Level Meter NL-62

A sound level meter provided with a low frequency sound measurement function. One unit of this product lets you measure a broad range from low frequency to noise (1 Hz to 20,000 Hz) simultaneously. The product is designed to be easy to operate, just by following instructions on the screen, reducing the need to look into a manual for instructions. If you have a NL-62, a free trial version of the optional program is available at our website. We hope you will try it.

http://rion-sv.com/products/NL-62-E.html

## Particle Sensor for Multi-point Monitoring KA-05

In addition to being light and compact, it achieves high flow rates of 28.3 L/min (10 times better than our conventional products) for more precise measurements in less time. Ideal for monitoring in sterile pharmaceutical manufacturing areas that require high-level control of air cleanliness. Supports multi-point monitoring. The chassis is made of stainless steel for chemical resistance.

http://www.rion.co.jp/english/product/particle/airborne/multi_point_monitoring/ka-05_1.html

## Liquid-borne Particle Counter KL-30B

Monitors particle contamination in ultrapure water, with a minimum measurable particle diameter of 0.05 µm. Designed as an all-in-one model combining a sensor, controller, flow meter, and data storage, it can be directly installed on an ultrapure water line for process control. Equipped with a purge air unit, D/A converter (4 to 20mA), and alarm output contacts as standard features.

http://www.rion.co.jp/english/product/particle/liquid_borne/inline/kl-30b.html

Seeking to provide products free of toxic chemicals, Rion is working on parts procurement and product development. All the products introduced in this page are Rion Green products that meet our own criteria "Rion Green Supply Guidelines" established to provide environment-friendly products.

ECO GREEN

Rion Green Products Logo mark

## TOPICS

### Participation in Automotive Engineering Exposition

A specialized exhibition for engineers and researchers working on the front lines of the automotive industry. One of the largest automotive technology exhibitions in Japan, where the latest technologies and products are introduced from all over the world.
[ May 25 - 27, 2016 at Pacifico Yokohama ]
http://expo.jsae.or.jp/english/

### Participation in INTERPHEX JAPAN

One of the largest specialized technology exhibitions in Japan, where devices/systems/technologies for manufacturing and R&D related to medicine/cosmetics/detergents are exhibited.
[ June 29 - July 1, 2016 at Tokyo Big Sight ]
http://www.interphex.jp/en/Home/

### Presentation at a meeting of the Acoustical Society of Japan

We gave a joint presentation with the Japan Aerospace Exploration Agency (JAXA) titled "The difference of the sonic boom waveform between different measurement systems."
[ March 9 - 11, 2016 Spring Meeting of the Acoustical Society of Japan at Toin University of Yokohama ]
http://www.asj.gr.jp/eng/index.html

### Do You Know? We Also Manufacture Hearing Instruments

Since 1948, when we launched Japan's first mass-production hearing instrument, we've contributed to society, with the world's first technology for waterproof, digital signal processing, and so forth. We are familiarly known as " Rionet hearing instruments." Our TV commercial has received favorable response.

## On the Publication of the Inaugural Issue

Rion Co., Ltd. will turn 72 years old this year. Around 70 years ago, we launched sales of hearing instruments for the first time in Japan ; 60 years ago we began selling sound level meters, followed by particle counters 40 years ago. I myself will be 60 this year. I happened to be born in the year in which Rion launched its sound level meters, which, in some ways, makes me feel linked to the company by fate. The age of 60 is called *Kanreki* in Japan . It refers to the point at which the first cycle of calendar of life ends and the second cycle begins. I decided to draw on my experience from the first cycle to publish "Shake Hands," in the year when I begin walking into the second cycle. In pace with the rapid economic development facing the world, including emerging nations, there is a growing list of challenges related to quality control for products and the environment affecting people's lives. For those reasons, I believe that Rion's environmental instruments business can contribute to the world through its accomplishments up to this point and with the innovations still to come. "Shake Hands" is an informational magazine intended to actively deliver this potential to the world.

Kiyokatsu Iwahashi
Director,
Environmental
Instrument Division

## About the Front Cover

In the past, sea travel was limited to the range of water within sight of land. The photograph shows a sextant, an instrument used to measure the altitude of astral bodies. This use of a sextant made it possible for ships to determine where they were in the vast ocean spaces. Progress in measurement technologies created the Age of Exploration, and greatly influenced people's lives.

## Editorial Postscript

In this year, gravitational waves were observed for the first time in the world, and Hitomi, a Japanese X-ray astronomy satellite, was launched. As these, measurement technologies are in the spotlight. Just as Dr. Yamamoto noted, advancing technology is opening up new worlds, making visible what can't be seen. Rion continues to improve its measurement technologies to advance the safety and comfort of human beings. The title, "Shake Hands," refers to our wish to connect us to the users of our products. We encourage you to look forward to the coming editions of "Shake Hands."

( Michinari Okazaki / Development Department )

**You can see this magazine and annex from banner on the top page of our website.**


Publisher
Kenichi Shimizu

Planning & Production
Shake Hands Editorial Committee
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English Version Editor : Thomas Kønigsfeldt

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Caroline Kønigsfeldt

Designer
Mayumi Oana (macmicron)

Special Thanks to
Shinichi Kuramasu
Hidetoshi Ishikawa
Rie Nakata
Shuhei Kaneko

Published on May 1, 2016



SH-00010E This publication uses environmentally-friendly UV ink and recycled paper.



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