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Shake Hands

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Feature Story

Fly

INNER VIEW

Kazuo Terakado Science journalist

Returning to the Original Intention
～Having a Dream about Space Again

RION CO., LTD.

Kazuo Terakado

Born in 1947, Kazuo Terakado graduated from Waseda University with a degree in telecommunications. He worked for the *Kyoikusha* publishing company as the managing editor of the science magazine Newton, the editor-in-chief of the business magazine Common Sense, the managing editor of Biotechnology Japan, and as the Publishing Manager. Today, he is a senior researcher at the Japan Space Forum, and a member of the editorial board of JAXA's, the magazine of the Japan Aerospace Exploration Agency. As a journalist, he specializes in space development, astronomy, planetary science, molecular biology, genome science, advanced medicine, global environmental issues, energy issues and technology in general. He is well-connected with scientists and research institutes both in Japan and internationally. His books include *Final Frontier*, *The Maruwakari Taiyo-kei Guidebook* (A Complete Guide to the Solar System), *A Field Book on Ginga Tetsudo no Yoru* (The Night of the Milky Way Train) and *Uchu kara Mita Ame* (Rain Viewed From Space).

Kazuo Terakado

Science journalist / Senior Researcher, Japan Space Forum

Returning to the Original Intention

~Having a Dream about Space Again

Text by Michinari Okazaki / Photo by Megumi Yoshitake

On October 4, 1957, the Soviet Union launched the world's first artificial satellite Sputnik 1. Kazuo Terakado, a boy living in Kokubunji in Tokyo, read about the satellite in a newspaper, which sparked his interest in outer space. Terakado became a science journalist and an evangelist to spread his fascination with space and science.
Last year he worked to locate where Japan's first rocket launch experiment was carried out. What did he realize when he found the starting point for Japan's space development ?

Rocket development solely for peaceful purposes

On a chilly day in February 2015, Terakado was conducting a survey using ground-penetrating radar on a tennis court at Waseda Jitsugyo High School in Kokubunji, Tokyo. He was trying to find where Japan's first rocket launch experiment was conducted. You may wonder why a rocket would be launched in a town. The rocket used for the first experiment was only 23 cm long. The small rocket, called "Pencil Rocket", was launched horizontally.

A series of rocket development attempts starting in 1955 was led by Professor Hideo Itokawa from the University of Tokyo, and he is considered the father of Japan's space and rocket development. The Hayabusa spacecraft was the first to successfully collect specimens from an asteroid. The asteroid visited was named after Professor Itokawa.

Terakado says, "In those days, there was no system to track a rocket going upwards. Professor Itokawa thought of launching a rocket horizontally. Last year, Kokubunji City planned an event to commemorate the 60th anniversary of the launch. While I was volunteering at the event, we, the event team, wondered about the exact site of that first Pencil Rocket experiment, and we decided to locate it. Sixty years ago, people wouldn't have expected a rocket to go into space."

Terakado compared the photographs of the experiment stored in the Japan Aerospace Exploration Agency (JAXA) with a detailed map at the Geospatial Information Authority of Japan and the aerial photographs taken by the US occupation army soon after World War II. He located the experiment site and finally found the concrete remains under a tennis court, using ground-penetrating radar. The place had been used as a munitions factory and the Japanese army was test-firing guns there.

"It has symbolic significance that Professor Itokawa conducted the experiment on the site of a former munitions factory. As Japan was restructuring the war-devastated land, space development was being conducted solely for peaceful purposes. Japan's rocket development has never had any exchange with military technology. The 23 centimeter tiny pencil rocket was the origin of the present huge rockets extending several tens of meters and weighing several tens of tons. The significance will be more and more important as Japan's space development advances. I want the site to be preserved."

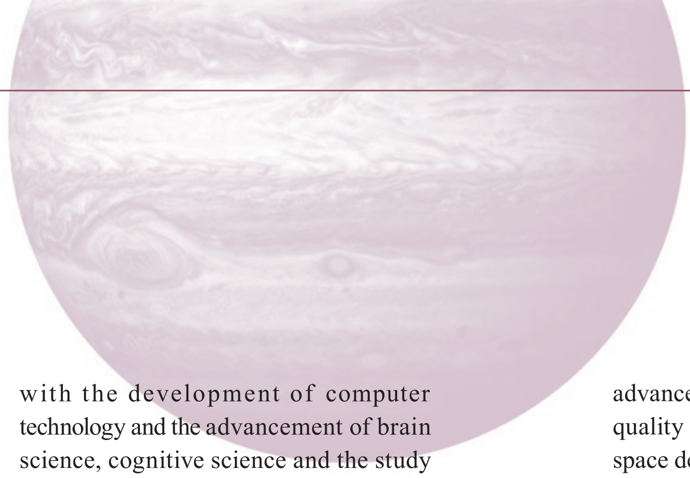
Fascinated by Sputnik

Terakado lived in Kokubunji for seven years, between the age of four to eleven. During that time there was an incident that sparked his interest in space.

"In 1957, I heard the news that the Soviet Union launched Sputnik 1. I was fascinated by the idea of an artificial satellite. I'd seen pictures of rockets and possible future space development in science magazines and books, but I was surprised that someone had actually launched a rocket. It gave me a sense of hope that the space age was coming. That was my starting point. My career in the field of science and space technology can be traced to my days in Kokubunji. I was living there for only a short time; but the space age began during that brief period."

Terakado learned electronics at the School of Science and Engineering of Waseda University. After graduating, he chose a journalistic career and engaged in the founding of Newton, a science magazine that is still being published.

"I chose a career as an editor, hoping to travel around the world. After I began my career, I realized that the world of science was moving much more rapidly than I'd expected. Science, including space, was becoming more and more important and related to everyday life. I



thought it was important to report accurately on the various movements. Science has both its good and bad sides. I decided I ought to cast light on both. Based on these ideas, I decided to try to broaden public awareness of such information as an independent science journalist, while working as a magazine editor."

Terakado has various achievements. He visited the space center of the former Soviet Union for the first time as a Japanese science journalist. He interviewed James Watson, a discoverer of the helical structure of DNA. What does he most want to tell people now?

"It is a dream. Nowadays, not many Japanese people dream about space. In my childhood, everything was a dream as few dreams in this field had come true. The Space Shuttle was planned, actually launched into space and finally retired. The futuristic things I saw in pictures have been realized, one by one. In such an advanced society, it is difficult to have a simple dream. I want to help create an environment in which children dream of going to the moon or Mars, or building a space colony."

Science and Technology are Merging

Terakado specializes in having a broad view of scientific and technological fields. He says that advanced science and technology are merging.

"Science and technology have different roles. Science is a study to find out the truth. It is fun to explore to identify the pathogen of a mysterious disease, the role of DNA, or the cause of the extinction of dinosaurs. Technology is a tool to help solve a problem. Today, state-of-the-art science and technology are connected. The latest genome technology that enables the editing of base sequence of DNA is closely connected with the latest scientific research to find out what gene each base sequence corresponds to. Similarly, artificial intelligence is closely connected with the development of computer technology and the advancement of brain science, cognitive science and the study of brain neurons."

It is now comparatively easy to go up to the orbit of the International Space Station (ISS). Scientific surveys of outer space are handled by unmanned machines. How will space development evolve in the future?

"Some things can be done by machines. Other things can be done by humans. It is time for humans to stop and rethink what future space development should be. If we want a new frontier, possible goals would be to go to the moon and to Mars. We will be able to use robots for scientific surveys of the moon, Mars or other planets, observing them with remote sensors. In fact, the US robotic rover, Curiosity, rather than geologists, is now exploring Mars. Although scientific surveys can be unmanned, considering the potential uses of the moon, Mars and other planets to solve problems on the earth in the future, humans will have to go to those places themselves. To that end, it is important to have technology that can create an environment that enables humans to live there. We need both science and the technology that will enable us to live for a long time in space."

The Day when People take Business Trips into Space ～The Role of Engineers

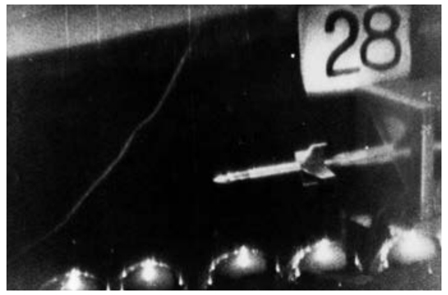
Private companies and individuals are participating in space development. The age of space industrialization is approaching. Because it involves huge costs, space development has been led by governmental organizations, like NASA and JAXA. But the technology established is used in the private sector. According to Terakado, things only indirectly connected to space, like industrial power, product reliability, advances in manufacturing systems, and quality improvements, will help enhance space development technology.

"In the past, the technologies needed for artificial satellites and rockets were limited to sensors, valves and the like. In ten or twenty years, it might be common for even ordinary people to go to the Space Station on business trips or to be assigned there to work, away from their families. Those people will need everything they have and use on Earth. It will be almost impossible to produce all those things specially for use in space. Instead, commercial off-the-shelf products will be used in space. On a space trip for exploration, the astronauts take only limited personal belongings. On future space trips, people will take just the things they need for daily life. Japanese industrial products are high in quality and they will be suitable for use in space. If a product is high in quality and free of problems, it will be widely used. There is a good market for Japanese products in space."

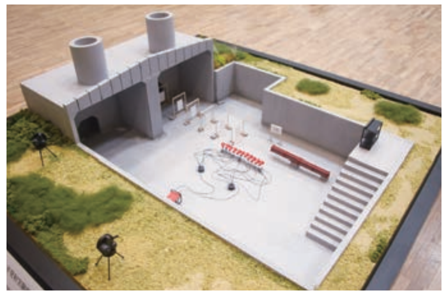
I've asked Terakado where he wants to go in outer space. His answer was "Mars." He has explained the reason, "Mars is interesting. It has mountains and valleys. There may be life there." "Ganymede's Garden"[1], Terakado's blog, illustrates that he is curious about a wide variety of things. What is he most interested in ?

Launch of M-V5 carrying Hayabusa ©JAXA

"Whether extraterrestrial life exists. That's a big question in today's astronomy. Observations using the Kepler telescope in orbit are underway on earth-like planets. On the earth, similar attempts are being made with the Subaru telescope. TMT[2], planned to be used for observations next to Subaru, is designed to examine the atmosphere of discovered planets to look for indirect signs of life, such as the existence of oxygen and carbon dioxide. The SETI[3] project started in the 1960s is aimed at receiving messages from extraterrestrial life using radio waves. The biggest theme for human civilization is whether there is any other life in the vast universe and whether we are alone in space. That used to be only a subject of science fiction. Now it is a subject for researchers. That mostly comes from progress in technology. I hope space will bring dreams in your business."



Horizontal launch experiment of Pencil Rocket ©JAXA



A diorama of the pencil rocket launch experiment site (Built and the photo Kokubunji City)

[1] "Ganymede's Garden" http://blog.scienceweb.jp/

[2] TMT (Thirty Meter Telescope): next-generation supersize telescope with a diameter of 30 m planned to be built on top of Mauna Kea in Hawaii by Japan, the US, Canada, China and India

[3] SETI (Search for Extra-Terrestrial Intelligence): A project to search for extraterrestrial intelligence

Feature Story

Fly

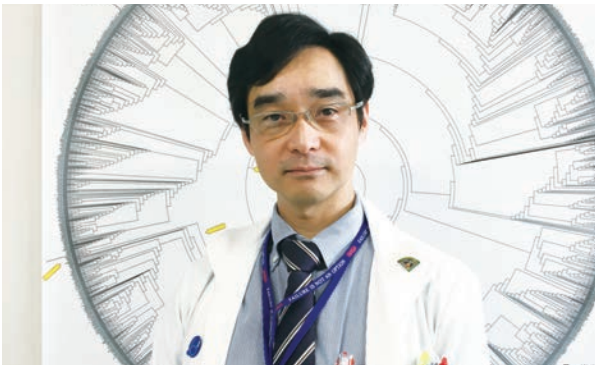
No one knows who first made and launched a paper plane.
Did that person imagine the day would come when humans would fly ?
To fly farther, faster, and higher, we've accumulated knowledge for generations and achieved impressive technological progress in technology.
All this is driven by a yearning for the sky, the spirit of adventure, and dreams.
Flight technology continues to fascinate people. Let's take a glimpse at it.

01 Case
Measuring the environment in the International Space Station

Everywhere humans live, microbes live. The International Space Station (ISS) orbiting in space is no exception. There is concern that those microbes may affect the condition of the equipment and the crew's health. In 2009, the Japan Aerospace Exploration Agency (JAXA) started a project to examine the microbes in the ISS over an extended period of time. This project is called Microbial Dynamics in the International Space Station (Microbe-I to -III). We asked principal investigator Professor Koichi Makimura (Teikyo University Institute of Medical Mycology) about the study.

Space and Mold

The International Space Station (ISS) is a habitable artificial satellite. A total of 15 countries, including the US, Japan, Canada, Russia and many EU countries, initially participated in the ISS program. The ISS is fitted together from components launched by those countries and assembled in space. Including its solar panels, it is now as large as a football ground. The crew, which includes a Japanese astronaut, live and do experiments in the habitat and experiment modules. As they stay in the ISS over long periods, their healthcare is an issue.
According to a report [1] compiled by US flight surgeons (primary-care physicians for astronauts) Barratt et al., diseases developed in space include space motion sickness, traumatic injuries, nasal inflammation and infections. The Infections include fungus infections. Fungi are a relative of mold, mushrooms and yeasts. Mold is considered to not only harm astronauts' health but also to cause trouble with devices and machines in the ISS.
Professor Makimura talks about the significance of examining microbes in the ISS. "One of the most common health problems caused by fungi is an infection, such as athlete's foot, candida infection or aspergillosis. Others include allergies, such as asthma and chronic (persistent) coughing caused by fungi remaining in the respiratory tract. So, we had to find the airborne fungi in the ISS."
How do the environments on earth and in the ISS differ ? " The greatest differences are microgravity, the enclosed environment, and cosmic radiation in the ISS. What types of microbes exist in such an environment ? By examining the dynamics of microbes in the Japanese Experiment Module Kibo, we can find out how microbes adapt to the space environment and utilize that information to maintain the crew's health and protect the machines."
Kibo was suitable for examining how microbes grow due to the astronauts' activities. The air in the module had been sampled to make sure that the air was clean in terms of the microbial environment before it was launched.
Microbe projects to continually examine microbes in Kibo have been headed by Professor Makimura and Professor Masao Nasu at the Graduate School and School of Pharmaceutical Sciences, Osaka University. In 2009, the Microbe-I project was undertaken. To date, three sampling sessions have been performed in total. At present, Microbe-IV, the monitoring stage, is underway. It is monitoring microbes in Kibo to ensure the safety of space habitation (Table 1).



Professor Koichi Makimura standing in front of a phylogenetic tree of life
M.D., Ph.D., COH (Certified Occupational Health Consultant),
Teikyo University Institute of Medical Mycology,
General Medical Education Center of Teikyo University

International Space Station in orbit : Japanese Experiment Module "Kibo" is encircled.
©JAXA / NASA

Kibo is clean

"The gravity inside the ISS is extremely low. Fungi that will fall on the earth are flying in the air, which increases the risk of inhaling them. In this way, the effects of fungi are different on the earth and in space. Fungi, harmless on the earth, can cause unprecedented symptoms," says Professor Makimura.
"In the Microbe projects, microbes were sampled before and after the launch of Kibo. In Microbe-I, samples were taken from the machine surfaces using sterile swabs to evaluate microbes staying, fixing or growing on those surfaces. As a result, fungus DNA considered to derive from human skin was detected. In Microbe-II, molds were cultured on various machines and observed. They were continuously cultured after being brought back to the earth. They were molds commonly seen on the earth, including penicillium and aspergillus. Those molds spread a large quantity of small spores and they may become allergens. They may also cause infections or produce mycotoxins. In addition to those examinations, in Microbe-III, air samples were taken

Table 1 : Outline of Microbe projects (Kibo was launched and its operation started in March 2008.)

Project	Period	Purpose	Result
Microbe-I	Aug. to Sep. 2009	Development and analysis of sampling methods for fungi in the bacteria in Kibo	Sampling of surfaces, including the walls of machines, gave the following results. * A microscopic examination revealed the dust from fibers, but no living tissue, including microbes. * Samples were cultured but no microbes grew. * Fungus DNA considered to derive from human skin was detected by a molecular biological analysis.
Microbe-II	Feb. to Mar. 2011	Monitoring of microbes in Kibo after Microbe-I	Samples, almost the same as those taken by surface sampling in Microbe-I, were cultured and fungi grew in Kibo.
Microbe-III	Sep. to Oct. 2012	Ditto	The air and water in the humidifier were analyzed in addition to Microbe-II sampling. * Culturing of the surface samples showed that fungi were increasing both in species and count. * No airborne fungi were detected.
Microbe-IV	From Feb. 2015 onwards	Monitoring of microbes in Kibo to ensure space habitation safety	Monitoring is underway.

with an air sampler to detect airborne microbes. No microbes grew and no DNA was detected. Kibo is as clean as a bio-clean room.”

What does it mean for our knowledge of space ?

The results were more or less as Professor Makimura had expected. “In a microgravity environment, where air currents do not occur by natural convection, air is forced to circulate so that a person will not be suffocated by the carbon dioxide he or she exhales. The air is passed through the HEPA filter. That is why I expected the air would be clean. Unlike on earth, there is little black mold and there are a lot of penicillium and aspergillus in space. Flora peculiar to space are formed. The microbes have an uneven distribution. Among 100,000 species of microbes, only 300 species have been found in manned space environments. In the space environment, microbial dynamics unknown to humans are being created. “The day may come when people build moon bases and live there or when people travel to Mars. It takes years simply to get there and back. In such a special environment, the crew must maintain their health by themselves. To help with that, it is necessary to accumulate basic data and we should begin to do that now. But, that is not the only purpose of this research,” says Professor Makimura.

“Molds are also problems on earth. For instance, mold growth is accelerated by condensation in a sick building and the molds harm people’s health. We need a system to accurately assess environments and take appropriate measures. To that end, we need standard particle counts to be used for a control. To identify the contamination level by microbes or their species, we usually culture a sample and examine the CFU (colony-forming units). If the contamination level correlates with the measurement on a particle counter, the contamination level can be discovered more simply, without culturing. Culturing takes a lot of time and labor, but also poses the risk of increasing harmful microbes.”

To know about space is to know about the earth. That is one of the important purposes of space science research.

Particle Counter

The handheld airborne particle counter KR-12A[2] was used in and after Microbe-III. The KR-12A was developed specially for the projects by Rion Co., Ltd. and Chiyoda Advanced Solutions Corporation (now Chiyoda Corporation) specifically for use in space. The particle counter was modified for space use as below.

- The particle size of 10 μm was added to count dust containing spores.
- The power supply was changed from AC to battery.
- Fire retardant cables are used.
- The LCD is covered with a mesh for electromagnetic protection.
- Velcro is used to prevent the counter floating away.
- Modifications were made in the software, including changes in the defaults, to make it easier to operate.

Table 2 shows the specifications (after modifications) and Figure 1 shows the appearance of the particle counter.

Reported by Nobuhisa Okamoto, Development Department

Table 2 : Specifications of the particle counter (summary)

Item	Specifications
Optical system	Side scattering
Light source	Semiconductor laser (Class 1)
Light receiving element	Photodiode
Flow rate rating	2.83 L/min
Measuring particle sizes	Six sizes: 0.5 μm or more, 1.0 μm or more, 2.0 μm or more, 3.0 μm or more, 5.0 μm or more and 10.0 μm or more
Maximum rated particle count concentration	70,000 particles / L
Sample exhaust	Filter (0.1 μm)
External data recording	Connected to a PC with a USB cable. Saved in CSV format.
Temperature/humidity measurable range	10 to 40℃, 20 to 90% (approx.)
Operating conditions	10 to 40℃, 20 to 90%
Power supply	Continuous operation for 24 hours or more with four D cells
Dimensions	115 mm width, 104 mm depth and 334 mm height (main body)
Weight	2.01 kg (including the cable and dry cells)

Figure 1 ©JAXA
: Modified particle counter. The box at the bottom is a dry cell box attached as a modification.

[1] “Principles of Clinical Medicine for Space Flight” Barratt, Pool NASA / Johnson Space Center
[2] At present, a handheld airborne particle counter, KC-51/52, the successor to the KR-12A, is available for sale. (See page 19 or the website below.)

Joint research

02

Working towards a quiet supersonic transport ～Aiming at a low sonic boom

One of the key challenges with development of a next-generation supersonic transport (SST) is reduction in noise called a sonic boom. A sonic boom can be reduced by changing the shape of the plane. To confirm the effect, sound measurement technology is also explored.
In July 2015, Japan Aerospace Exploration Agency (JAXA) performed D-SEND#2, the phase 2 varidation test of the low sonic boom design concept, in Sweden. During testing, JAXA achieved in the world’s first supersonic flight of an aircraft whose entire frame was designed for low sonic booms.
Rion Co.,Ltd. undertook joint research with JAXA aimed at improving the measurement technology for sonic booms.

【Supersonic passenger jet】
A passenger jet flying faster than the speed of sound. The speed of sound is about 340 m/s at 15ºC or about 1,225 km/h. This speed is Mach 1. The well-known supersonic passenger jet Concorde flew at Mach 2. It was retired in 2003 because of several problems, including the high operation cost and the loud sonic boom.

【Sonic boom】
Noise associated with the shock waves created by rapidly compressed air around an airplane when it travels at supersonic speed. The shock waves gather at the front and the tail of the plane and make a thunder-like sound.

Significance of joint research

As of June 2016, there is no established measurement method or assessment index for sonic booms. International Civil Aviation Organization (ICAO), an agency that establishes international aircraft standards, is now discussing them. While JAXA has measured sonic booms,the effects of the measurement system cannot be evaluated when they are obtained by the same measurement system. In our joint research, we measured sonic booms using different measurement systems under the same conditions and compared the results to varidate the validity.

Flight test in D-SEND project

The D-SEND project is aimed at verifying JAXA’s low sonic boom design technology by flying a test airplane designed with the technology and establishing a sonic boom measurement method. The test airplane is 7.9 m long with a wing width of 3.5 m, weighing 1,000 kg. It is an unmanned airplane with no engine. The rudder and the stabilator are used for flight control. Figure 1 shows the shape of the airplane and the sonic boom waveform. The nose, the wing and the tailplane are given the low boom design, which retards the integration of shockwaves at the front and the tail and reduces the sound

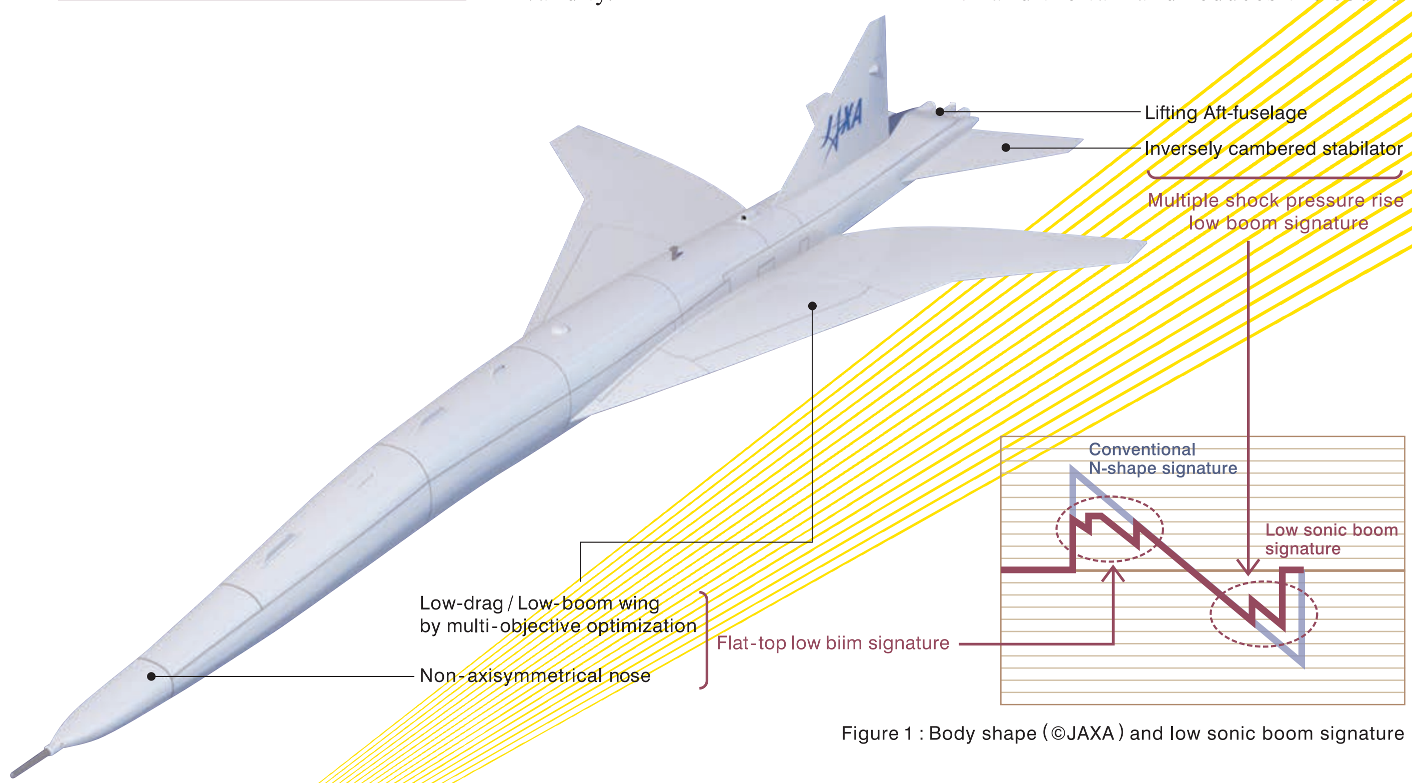


Figure 1 : Body shape (©JAXA) and low sonic boom signature

D-SEND#2 Flight model ©JAXA

pressure at the peak.
The test was conducted at the Esrange Space Center in northern Sweden. The center had a vast test area of 100 km from north to south and 70 km from east to west. As shown in Figure 2, the test airplane was suspended from a balloon, carried to an altitude of 30 km and dropped from the blimp. After it was dropped, the airplane flew, by controlling itself, towards the measurement point and generated a low sonic boom above the boom measurement systems. Four sets of microphones and measurement systems were moored with a tether connected to a blimp. They were placed at different altitudes. In addition, another set was placed on the ground. These measurement systems were placed at three positions within the test area. Depending on where the test airplane was separated from the blimp, the best position was chosen.

Comparison between JAXA's and Rion's instruments

Three measurement systems were used for the test and the results were compared. One of them was the existing system configured by JAXA. Two were new systems using Rion's instruments. Figure 3 shows how the microphones were installed. On a 1-m square metal panel laid on the ground, microphones are horizontally placed with regular spaces of 110 mm. To protect from wind noise, they were covered with a hemispherical wind screen with a diameter of 90 mm. Cables from the microphones (preamplifier) were extended to place the measurement system inside the measurement facility.
We report the measurement result, focusing on the waveforms obtained by the new system (1) (multifunctional measurement system RIONOTE). The waveforms have been obtained by the JAXA's microphone (Ch1) and Rion's microphone UC-59L (Ch.2) using the two channels of the RIONOTE. When a comparison is made between those two microphones, the properties of the measurement system can be ignored.
Figure 4 shows the sonic boom waveforms obtained with the two microphones of the new system (1) (RIONOTE). The two waveforms are almost the same. They are also more or less the same as the waveform obtained by the existing system with the microphone installed on the same metal plate. As it is the verification test of the low sonic boom design concept, the pressures rise gently and the peaks are low compared with an N-shaped waveform. Figure 5 shows a magnified view of the area encircled by a dotted line in Figure 4. The peaks of the two waveforms are slightly different. Figure 6 shows the FFT analysis result of the waveforms in Figure 5. The principal components range 20 Hz to 30 Hz.
The waveforms obtained by JAXA's existing system and Rion's systems are almost the same. That is considered to be because the two microphones meet the specification for sonic boom measurement that JAXA has been using, and because the measured sonic booms have the principal components in a band in which the characteristics of the microphones differ little. But, the waveforms are slightly different in amplitude at the peak, which is considered to result from the difference in measurement environment (due to the distance of 110 mm) as well as the difference in characteristics of the systems.
In this test, Rion has succeeded in measuring sonic booms using domestic measurement systems and contributed to improvement in Japan's measurement technology. This achievement, coupled with the achievement of JAXA's flight test, is expected to contribute to establishment of standards by ICAO.

The stay in Sweden
(Interview with Hiromitsu Umayahara)

I stayed in Sweden for two months as a member of the measurement team. The country, located in the Arctic Circle, was in the season of nightless nights. The highest temperatures were a little above 10ºC. During the first month, we carefully installed the systems and conducted training. We had to complete the preparations and operation of the systems within a specified period of time. There were some difficulties. We had a swarm of mosquitos, and it was hard to walk on the ground covered with short grass. After we moved to the test stage, we had to wait for three weeks until we had optimum weather conditions. Finally, the test, which lasted 24 hours, began. The measurement of sonic booms was a success at all the measurement points. I felt a sense of accomplishment with a pleasant sensation of fatigue.

(Reference)
JAXA D-SEND Project Site
http://www.aero.jaxa.jp/eng/research/frontier/sst/d-send.html

Left : Hiromitsu Umayahara, Measuring instrument technical service section (temporarily transferred to JAXA in 2015)
Right : Dai Adachi, Development Department

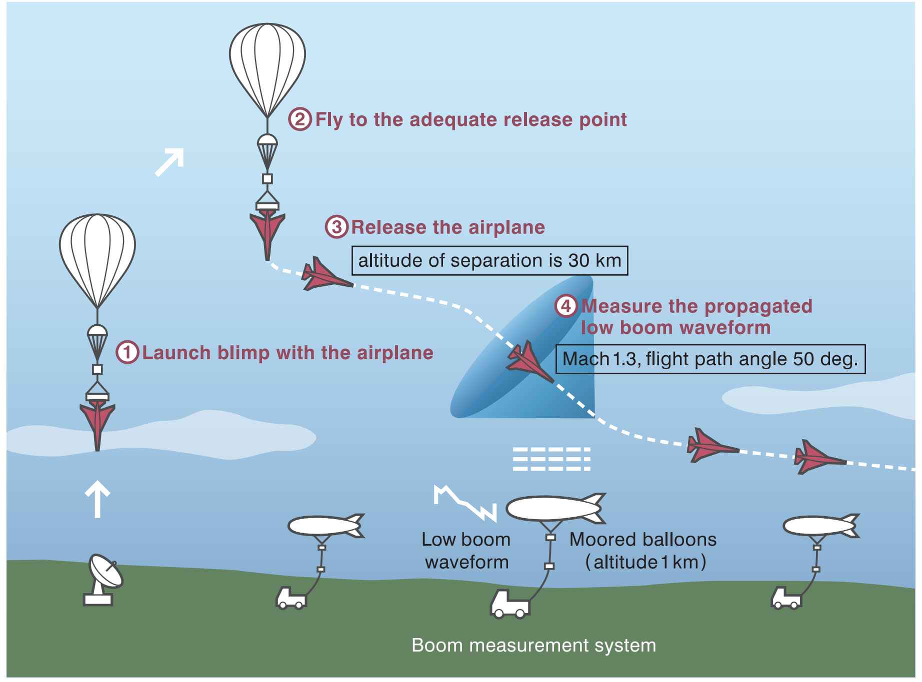
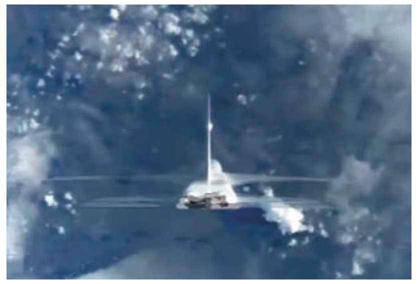


Figure 2 : Conceptual image of the flight test
(Rion 4-channel data recorder DA-21 was set on the mooring lines)

Scene of launch ©JAXA



Scene of release ©SSC

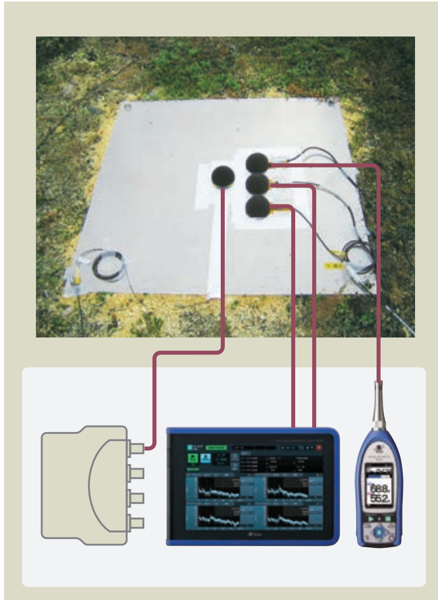


Figure 3 : Installation (The top photo ©JAXA)
Starting from the left, JAXA's existing system (schematic diagram), new system (1) (Rion RIONOTE) and new system (2) (Rion NL-62)

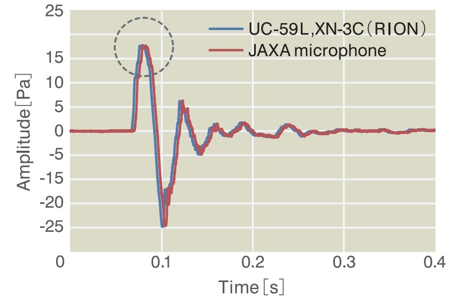


Figure 4 : Waveforms for sonic boom

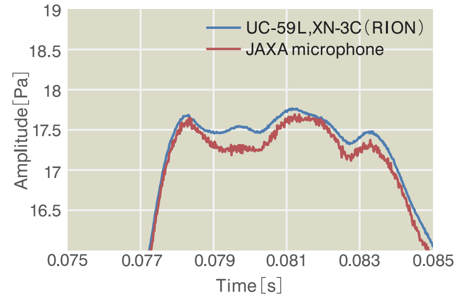


Figure 5 : Magnified waveforms of sonic boom

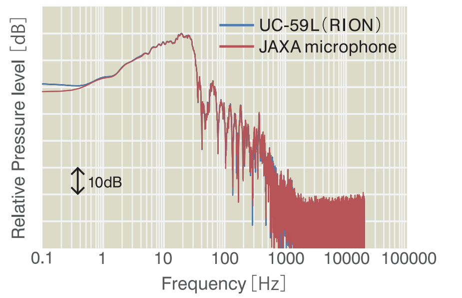


Figure 6 : Power spectrum of sonic boom

D-SEND#2 mission logo ©JAXA

03

Our technology

Automatic monitoring of aircraft noise

Rion's aircraft noise monitoring system identifies the areas in which noise is generated based on changes in measured noise levels to automatically determine whether the noise is produced by aircraft or something else. The following article describes the mechanism that detects the direction from which the sound arrives to identify aircraft noise and examples of system applications.

Measuring and assessing aircraft noise

Since aircraft noise can affect everyday life, noise is monitored near airports as part of noise management efforts. Aircraft noise measurements are performed for hours for extended periods. In many cases, a sound level meter is installed permanently for monitoring. The conventions used to assess aircraft noise vary from country to country; for example, Japan uses the Lden unit. Lden is the mean energy level of various noise events, weighted by time of day. A noise event is a change in noise levels generated by incoming or outgoing aircraft. ISO 20906:2009[1] is the international standard applied to the constant monitoring of aircraft noise.

Rion's aircraft noise monitoring system automatically identifies the areas in which a noise event is generated based on changes in noise levels. The system also has a mechanism that detects the direction from which the sound arrives to identify whether the noise event is caused by aircraft or another source. If the event is determined to be aircraft noise, the system identifies whether the aircraft is taking off or landing.

Detecting the direction from which sound arrives

The direction from which sound arrives can be identified based on the time lag between the sound pressure waveforms obtained with two microphones. Assuming sufficient distance from the sound source, time lag τ_z has the relationship indicated by equation (1) below with elevation angle θ of the direction of arrival. The symbols h and c, respectively, represent the space between the microphones and the speed of sound.

$$\tau_z = \frac{h}{c} \times \sin(\theta) \quad \text{Equation (1)}$$

Since τ_z is estimated from sound pressure signals obtained by two microphones, elevation angle θ can be obtained from equation (1). When the process is repeated for three axes, we can locate the sound source in three-dimensional space. Rion's system uses four microphones configured about the common origin along the X-, Y- and Z-axis directions, creating a three-axis structure (Figure 1).

The direction from which sound arrives is expressed by the angle between the aircraft and the X axis in the horizontal plane (azimuth angle φ) and the angle between the aircraft and horizontal plane in the vertical plane (elevation angle θ). Angles φ and θ have the relationships indicated by equations (2) and (3) below based on the time lags in the arrival of sound pressure waveforms between microphones, τ_z (Z axis), τ_x (X axis) and τ_y (Y axis).

$$\tan\phi = \tau_x / \tau_y \quad \text{Equation (2)}$$

$$\tan\theta = \tau_z / (\tau_y^2 + \tau_x^2)^{1/2} \quad \text{Equation (3)}$$

Creating a three-axis structure by using a three-axis microphone system, the approach angles in three dimensions of the sound source, φ and θ, are obtained from equations (2) and (3).

Microphone system for automatic monitoring

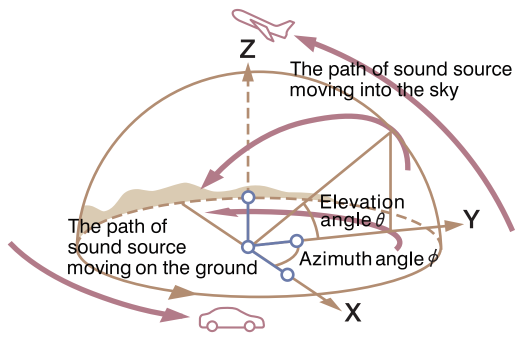


Figure 1 : Microphone setting for detecting arriving sound direction

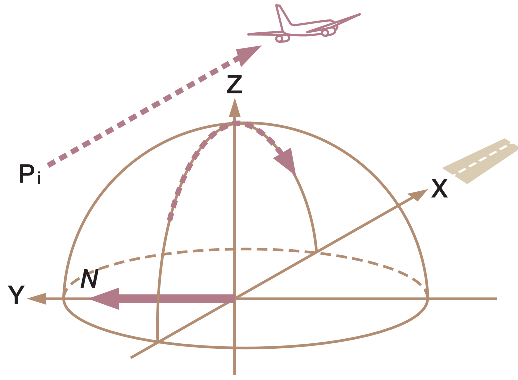


Figure 2 : Mean normal vector representing the path of arriving sound direction

Automatically identifying the course of an aircraft

This section explains how to determine the direction in which the sound source is moving—i.e. the course of the aircraft. With the reference microphone set as the origin, the X-, Y- and Z-axis orthogonal coordinate system is established near an airport. The X-axis is positioned to point toward the runway (Figure 2).

If we assume that the vector for the direction from which a sound arrives at some time of the day i is $s_i=(x_i, y_i, z_i)^T$, the temporal sequence of m-sets of noise event section data is expressed as s = $(s_1, s_2, s_3 \cdots, s_m)$. The mean normal vector N is defined as the index representing the path of the arriving sound, as shown by equation (4) below.

$$N = \frac{1}{m-p}\sum_{1}^{m-p}(s_i \times s_{i+p}) \quad \text{Equation (4)}$$

where p represents calculated interval between normal vectors.

The mean normal vector N is an average of many normal vectors over a short period of time. When aircraft is flying toward a runway (i.e., landing), the vector points in the positive direction along the Y-axis. When an aircraft is flying in the opposite direction (taking off), the vector points in the negative direction along the Y-axis. By focusing on the Y-axis component of the mean normal vector, we can automatically determine the course of the aircraft, whether taking off or landing.

Applications of the aircraft noise monitoring system

Aircraft noise is generally monitored by national governments, the company responsible for operating the airport, or the municipality near the airport, which regularly publish reports on monitoring. In addition, some systems involve several noise monitoring systems installed around the airport, which acquire measurements constantly by network and disclose this information by Internet. Rion offers software for acquiring and tabulating data from multiple noise monitoring systems. Rion also offers information disclosure systems tailor-made for individual customers (Figure 3).

We will continue to pursue more accurate and reliable aircraft noise monitoring systems and continue to develop methods to distinguish and assess multiple sound sources, as well as methods to identify this information based on the radio waves emitted by an aircraft. ✍

Figure 3 : Example of aircraft noise information disclosure system
Narita Airport Environmental Community
(Narita International Airport Corporation)
http://airport-community.naa.jp/noise/

[1] ISO 20906 : 2009 Acoustics - Unattended monitoring of aircraft sound in the vicinity of airports

Keishi Sakoda,
Development Department

Rion's History of Technology

LEARNING from our Past Products

The sound level meter compliant with international standards, the ancestor of our present sound level meters

NA-20 series

When the NA-20 series handheld sound level meter was launched in 1978, sound level meters varied in shape. After the launch, the shape of the NA-20 became the mainstream. The NA-20 was full of new technologies. The model won high market confidence for its performance and quality.It sold more than 22,000 units globally in 20 years. The NA-20 series opened a new frontier of Rion's sound level meters. Kyoji Yoshikawa*, who was engaged in its development, told us stories about the model.

*A former board member. He was in the group 1 of the S&V Development Department when the NA-20 was developed.

——Please describe the general background of sound level meters before the NA-20 series was launched.

After World War II, noise pollution was an issue in Japan. In 1967, the Basic Act for Environmental Pollution Control was established. Since the launch of its first sound level meter N-1101 in 1955, Rion had been developing and manufacturing sound level meters. The new law triggered a major shift from a sound level meter used simply for measurement to grasp the situation to a sound level meter also used for an analysis of measurement data.

——What was the development concept of the NA-20 series?

In 1961, the international standards IEC Pub.123 "Recommendations for sound level meters" were established. In 1973, IEC Pub.179 "Precision sound level meters" was established. To comply with them, the JIS was revised and the JIS C 1502-1977 "Sound level meters" and the JIS C 1505:1977 "Precision sound level meters" were established. The NA-20 was launched in 1978, the year after the JIS was revised. The development concept was "a sound level meter fully compliant with the IEC standards and suited for global marketing." We tried to build it into a system designed to do both measurement and analysis in order to enhance its competitiveness. We were also aiming at reorganizing and

Mr. Kyoji Yoshikawa

integrating our various models of sound level meters.

——You were trying to reorganize and integrate sound level meters?

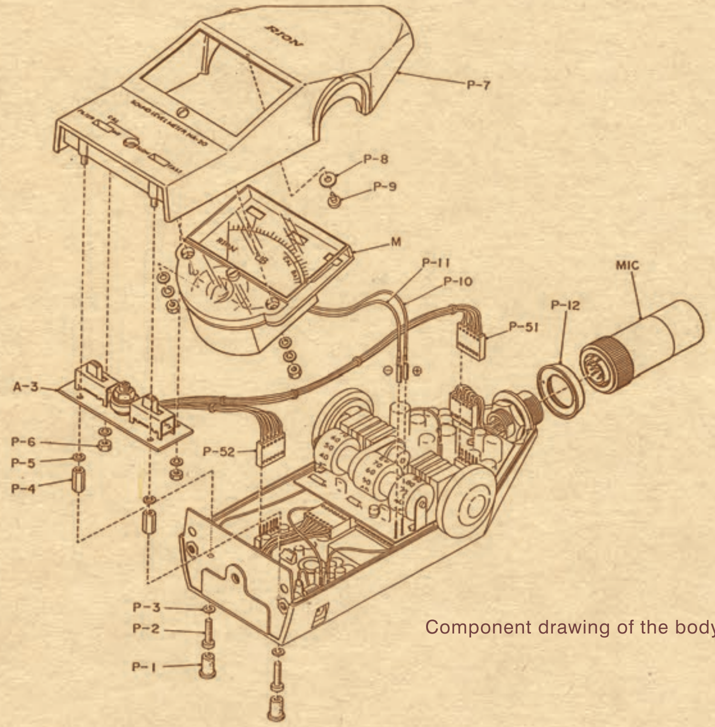
Yes. In the decade from 1967 to 1976 we developed about 14 different models of sound level meter, as a matter of fact there were more, if derived models were included. We had developed different products for different uses to meet the soaring demand for noise measurement. Our development capacity was close to its limit and we needed to sort out those sound level meters considering the basic performance of acoustic measuring instruments and the applicability to various measurement conditions.

——What is a sound level meter that meets the IEC performance standards like?

In circuit design, for instance, we designed A-weighting and C-weighting to meet the standard levels. The microphone was designed to have as flat a response as possible. And, we used many new technologies. We developed a standards, a high-damping indication mechanism with small overshoot and undershoot with an equally spaced scale, precision capacitor and precision array resistor (module IC) for achieving octave or 1/3 octave band filter with low power consumption.

——I heard you also introduced a new production system.

Yes. We introduced, to enhance product quality, a production system including the management of microphone sensitivity characteristics, performance design standards for sound level meters, standards for numerical data management of the overall characteristics, performance standards for microphone extension cables and acceptance inspection standards for



Component drawing of the body

IC components. The introduction of the system made it possible to design the theories behind the overall characteristics of a sound level meter.

——The chassis design has been drastically changed, too.

In IEC standards, the characteristics include reflection of sound wave by the chassis to determine the performance of a sound level meter. The standards also stipulate the influence by the angle of incidence of sound wave. That is based on the concept that the influence on the measurement by sound wave, the chassis of the meter reflects should be as small as possible. We made several models of the NA-20 varied in shape and conducted testing and measurement to choose a shape. The knob of the level range dial is shaped like an umbrella. That is a result of the experiment.

——What are other ideas?

As the most required feature of a handheld sound level meter is mobility. We have offered many optional extras, such as the digital indication unit, the Leq calculation unit, and the frequency analysis unit. Those units are interlocked with the level range dial of a sound level meter. The frequency analysis unit has a mechanism for synchronized analysis with the level recorder to differentiate our products from competitors'.

——Looking back on those days, how do you feel?

The development of the NA-20 lasted about two years. But, it took several years more to reorganize and integrate the sound level meters and establish us as an acoustic measuring instrument manufacturer. We were able to put our ideas into practice and complete the new product thanks to the sheer determination of the development team. Today, 38 years after we developed the model, all of the members who engaged in the development have retired, and some of the companies we worked with no longer exist.

——Will you give a pep talk to the young engineers?

People engaged in product development must always try to develop the state-of-the-art technology for new products. Engineers must know well about the product they are in charge of and have the analytical ability that enables detached observation. As far as a sound level meter goes, you will always find help in the standards. If a new mechanism is to replace the current sound level meters, it will be one combined with IoT (the Internet of Things, which involves connecting up physical devices to the Internet). It would require a stable and reliable sensor and a calibration mechanism. Otherwise, it will be nothing more than a smartphone microphone. I want young engineers to develop something that reshapes or goes ahead of the standards.

Interviewer: Kazuhiko Nakamura, Sound and vibration measuring instrument sales department

Hello From the Office

Solution partner of customers
Rion Service Center Co.,Ltd.

ilac-MRA IAJapan JCSS 0217 JCSS

Maintenance of functions and accuracy is critical to a measuring instrument. We provide various services to customers using Rion Group's sound and vibration measuring instruments, particle counters and medical equipment. We provide inspection, calibration and maintenance services based on the ISO 9001 certified quality control, and control by measurement and making the most of our accumulated expertise. We even receive such questions from customers as how to use the instruments.

Our quality control department is accredited for JCSS as an MRA (Mutual Recognition Arrangement) compliant operator in the category of acoustics & ultrasound, acceleration measuring instruments. We can issue calibration certificates bearing the ILAC MRA compliant JCSS logo for JCSS-calibrated acoustics & acceleration measuring instruments (sound calibrators and pistonphones) in the accredited range.

We also offer services such as rental of instruments, measurement, installation and adjustment, and data organization. We are making efforts to serve customers as a solution partner on measurement based on expertise and trust.


Calibrating a pistonphone

Rion Service Center Co.,Ltd.
TEL+81-42-632-1131
Headquarters : 2-22-2 Hyoe Hachioji, Tokyo 192-0918, Japan
http://www.rion-service.co.jp/rsc/ (Japanese)

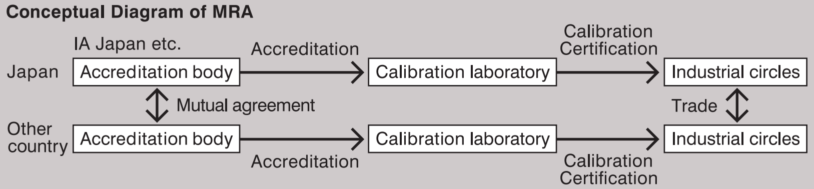
Tell Me Dr. Sojun

Q. What is the MRA for measuring instruments?

Smooth trade can become troubled if standards and certification systems for products and service quality are different between countries. Therefore, agreements were made that were aimed towards the globalization of conformity assessment systems such as testing, calibration and service certifications. These agreements form the international MRA (Mutual Recognition Arrangement) that guarantees the equivalency of testing reports and calibration certificates.

An authoritative body evaluates whether a calibration laboratory satisfies certain requirements, and has the performance to calibrate appropriately; it then issues accreditation for that laboratory. The JCSS (Japan Calibration Service System) is one such accreditation system, managed by IAJapan (International Accreditation Japan), a part of NITE (the National Institute of Technology and Evaluation). Naturally, because it is necessary for the accreditation body itself to work within consistent international guidelines, IAJapan joins ILAC (International Laboratory Accreditation Conference) and APLAC (Asia Pacific Laboratory Accreditation Cooperation), in having mutual agreements (ILAC MRA and APLAC MRA) to keep the equivalence between each accreditation body and to recognize the calibration certificates of accredited calibration laboratories. In this way a calibration certificate published by an accredited calibration laboratory, based on MRA, is acceptable internationally.

Conceptual Diagram of MRA



Reference note : In the case of conformity assessment for quality management systems and environmental management systems, the term MLA (Multilateral Recognition Arrangement) is used.

Dr. Sojun Sato, Senior Adviser, former Head of Acoustics and Vibration Metrology Division, NMIJ, National Institute of Advanced Industrial Science and Technology

SCIENCE COLUMN

Q. Is there a correlation between the height of fireworks and the level of applause?

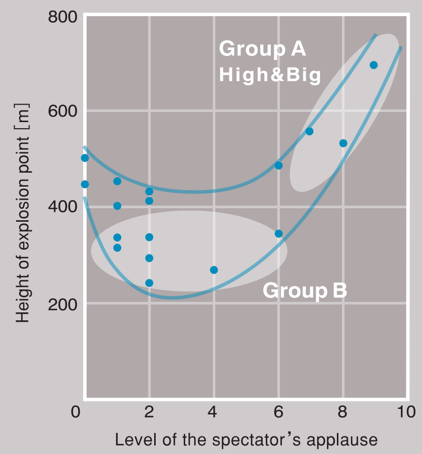
My friend recently invited me to her place to watch a fireworks show in a nearby park. Her room is on 10th floor of the apartment in front of the park and only about 500 m away from the discharge point. The conditions were great for watching the fireworks show: it was clear sky, with a cool breeze, and no mosquitos. We drank some beer and chatted while we were watching the fireworks and waiting for the sunset.

The show started around 7:30pm. Almost immediately, I noticed that the higher the explosion of the fireworks, the louder and more robust the spectator's applause. I was left with the idea that the real pleasure of a fireworks show is in its big, splendid size and powerful sound.

It occurred to me to measure the time difference between the light and sound with a stopwatch. Sound propagates at the speed of 340 m/s, so if the time difference is 2 sec, the slant distance between the firework explosion point and the observation point is 680 m. This is the hypotenuse, and using a base distance of 500 m and a room height of 35 m, then the height of the explosion point would be 451 m, according to the Pythagorean theorem. At the same time, I graded the level of the spectator's applause on a scale of one to ten, and I plotted them on a graph.

The results of these admittedly rough measurements basically showed that higher explosion points resulted in bigger spectator applause. However, I also found that there were two distinct groups of explosions: group A had high explosion points and very large scales, while group B had lower explosion points but a wider variety of unique colors or shapes. That was when I noticed that the visual experience of each firework also had an impact. Of course, my beer was getting warm and flat.

Toshiya Ohshima, Development Department



Japanese scenery


Photographed on August 2, 2014 : Masahiro Sunohara, R&D Center

On summer nights, firework shows are held across the country. People go out, wearing *yukata*, a casual summer *kimono*, and holding *uchiwa*, a rigid fan, to watch spectacular fireworks and forget the summer heat. The photograph shows a Japanese traditional firework called *Warimono*, which spreads out into a circle and looks like chrysanthemum petals, at the Edogawa River. The photo also shows a houseboat for firework viewers.

ShineView!

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

I will talk about
my love of amateur radio
since my high school.

Kenichi Shimizu (President & CEO)

Amateur radio is an ancestor of SNS ?

What is amateur radio?
You take a national exam to become a radio operator. After you pass the test, you are granted a license a call sign is issued, and you can open an amateur radio station. The license is valid for life. You can communicate with radio hams across the world and exchange QSL cards, certificates of the radio communication with them. It is fun to design your QSL cards, compete on the size of your collection of the cards, or on the rarity of the countries.

——What was your childhood like ?
When I was in elementary school, I already liked working with miniature bulbs or building crystal radios. In middle school, I built a small transmitter using vacuum tube, consulting a technical magazine. I played Rolling Stones songs and did a DJ. To find out how far the broadcast could reach, I held the radio and walked around the neighborhood. I also drew out wires from the speaker terminals of a tape recorder, placed them in a loop on the floor, connected a bar antenna to earphones in the loop and checked if I could hear a sound.

——How did you encounter amateur radio ?
In those days, late-night radio programs were popular among young people. I wanted to broadcast myself. I repeated experiments to find out how far the broadcast was heard and how I could broadcast farther. When I was a high school student, I happened to see the activity of the Ham Radio Club on the rooftop. I joined the club. Soon later, I passed the national test and began to devote myself to the world of amateur radio. On radios transistorized and downsized, we communicated between a high school building and a lodge far from it. We even took the radios to Kyoto on a school trip. At college, as the ham radio club did not have a radio, we opened a disco at the school festival to make money for a radio. (The radio cost 1.5 times the initial monthly salary of a college graduate!)

——What is amateur radio used for ?
It is very useful as a means of telecommunication. It is similar to SNS. Many people can talk together and you don't need to pay telephone charges (laughing). On a summer weekend, if someone says "It's hot," then someone else says, "Let's go to the seaside" or "Let's go skiing" if it is winter. Conversations instantly lead to action. If you leave the radio on, it is as if you have friends in the room. I feel as if I live with them.

——Do you still communicate on radio frequently after you have become president ?
Yes, I do so every day. When I connected to an overseas station the other day, before I introduced myself, the person said " Hi! Ken!!." It was the first time to communicate with that person. He must have checked my call sign on the Internet. I was surprised and I was pleased.
There is one sad story. This January, a spider web antenna I had been using for ten years at home was broken under the weight of snow. I want to repair it. But, the cost will go over my allowance (crying).

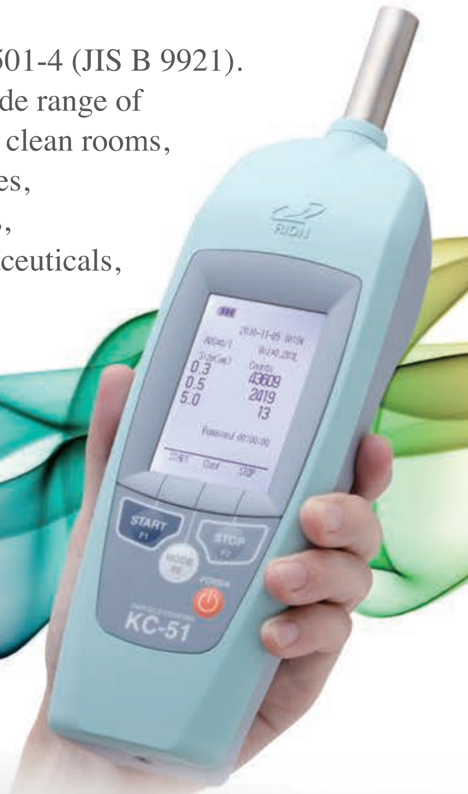

Class-2 amateur radio operator license


Miserably broken large antenna
(It was a double X-shaped antenna.)

(Ham licenses)
December 1969 : Obtained a telephone-class amateur radio operator license.
August 1976 : Obtained a class-2 amateur radio operator license.
December 1989 : Obtained a class-1 amateur radio operator license.

Interviewer : Yasuo Nojima, Development Department

The KC-52 and KC-51 are compliant with ISO 21501-4 (JIS B 9921).
These particle counters are suitable for a wide range of clean air management applications, such as in clean rooms, hospitals and other medical facilities, at semiconductor fabrication sites, and at manufacturing facilities for pharmaceuticals, beverages, and food products.



Hand Held Particle Counter
KC-52
- Particle size range: 0.3, 0.5, 1.0, 2.0, and 5.0 µm
- Equipped with a USB terminal and SD card slot
- Able to connect to the multi-point monitoring system

Hand Held Particle Counter
KC-51
- Particle size range: 0.3, 0.5, and 5.0 µm
- 3.2-inch monochrome LCD panel
- Equipped with a USB terminal

The RIONOTE lets you create an optimal measurement environment for a myriad of uses in the field.
Even at sites where cabling is difficult, the wireless capability makes setup problem-free.

Portable Multi-function Measuring System
RIONOTE
- Color LCD touch screen allows intuitive operation.
- B5 size ideal for measurements in the field. Light weight: only 1.2 kg including amplifier and battery.
- Powered by a rechargeable Li-Ion battery which can be easily swapped in the field.
- IPX54 waterproof rating for main unit.
- Support for wireless measurements eliminates the need for cumbersome cabling on site.

Main Control Unit and Amplifier
SA-A1B2 (2 channel)
SA-A1B4 (4 channel)
Supports direct connection of microphone or piezoelectric accelerometer (integrated CCLD)

Wireless Dock
SA-A1WD
Choice of amplifier supports 2 or 4 channel configurations.

Wireless Sensor Amplifier
SA-A1WL1 Coming Soon
Integrated type wireless dock and amplifier (single-channel configuration)

Use of wireless dock and amplifier or single-channel wireless amplifier for wireless connection of platform and amplifier allows measurements at a distance.

*The sale of the wireless dock (SA-A1WD) and wireless sensor (SA-A1WL1) differs in each country.
Please contact us with further questions.

TOPICS

◎ Exhibitions

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

S Inter-Noise 2016

Period : August 21 to 24, 2016　Venue : Hamburg (Germany)
http://www.internoise2016.org/

P SEMICON Taiwan

Period : September 7 to 9, 2016　Venue : Taipei (Taiwan)
http://www.semicontaiwan.org/en/

P Regenerative Medicine Japan 2016

Period : October 12 to 14, 2016　Venue : Pacifico Yokohama
http://saiseiexpo.jp/index.html

S Measurement and Control Show 2016 Osaka

Period : November 9 to 11, 2016　Venue : Grand Cube Osaka
http://jemima.osaka/en/

S 5th Joint Meeting of Acoustical Society of America and Acoustical Society of Japan

Period : November 28 to December 2, 2016
Venue : Honolulu (Hawaii)
http://www.acousticalsociety.org/content/5th-joint-meeting

P SEMICON Japan

Period : December 14 to 16, 2016　Venue : Tokyo Big Sight
http://www.semiconjapan.org/en/?vlang=en

P SEMICON Korea

Period : February 8 to 10, 2017　Venue : Seoul (Korea)
http://www.semiconkorea.org/en/

P Interphex Osaka

Period : February 15 to 17, 2017　Venue : Intex Osaka
http://www.medical-jpn.jp/en/About/About/IPJ-K/

P SEMICON China

Period : March 14 to 16, 2017　Venue : Shanghai (China)
http://www.semiconchina.org/

◎ Seminars

We conduct seminars on sound and vibration across the country. Please visit the web site (http://svmeas.rion.co.jp/event/all) for dates, venues, programs and other details.

* For inquiries, contact the planning section at +81-42-359-7860.

About the Front Cover

Does extraterrestrial life exist ? What is life ? To look for answers to the questions humans have been asking for centuries, humans are continuing to progress with curiosity about the unknown, just like a plant flies seeds for preservation of the species. (Mayumi)

Editorial Postscript

We choose the design for the front cover from several samples at an editorial meeting. We were split on the front cover design for the inaugural issue. For this issue, we decided on the design almost unanimously. The puffs, flying far up into the sky, somehow remind of the space station, representing human's dream. "Shake Hands" Vol.2 dealt a topic on space and aviation fields and connection with Rion's products with them in the feature story "Fly." We will report more of Rion's products used for research in various fields to help realize people's dreams and happiness. (Hajime Watanabe, Development Department)

This magazine can be downloaded from our website. http://rion-sv.com/shakehands/

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