



**KAIREI / KAIKO “Cruise Report”**  
**KR18-09**

**The Sea Trial for Deep Sea Element Technology Using  
ROV / AUV to Pioneer the Ocean Frontier**  
Evaluation test of deep sea floor image acquisition technology using deep  
sea super high definition camera (U8K-SHV) by ROV "KAIKO" (The First  
cruise)

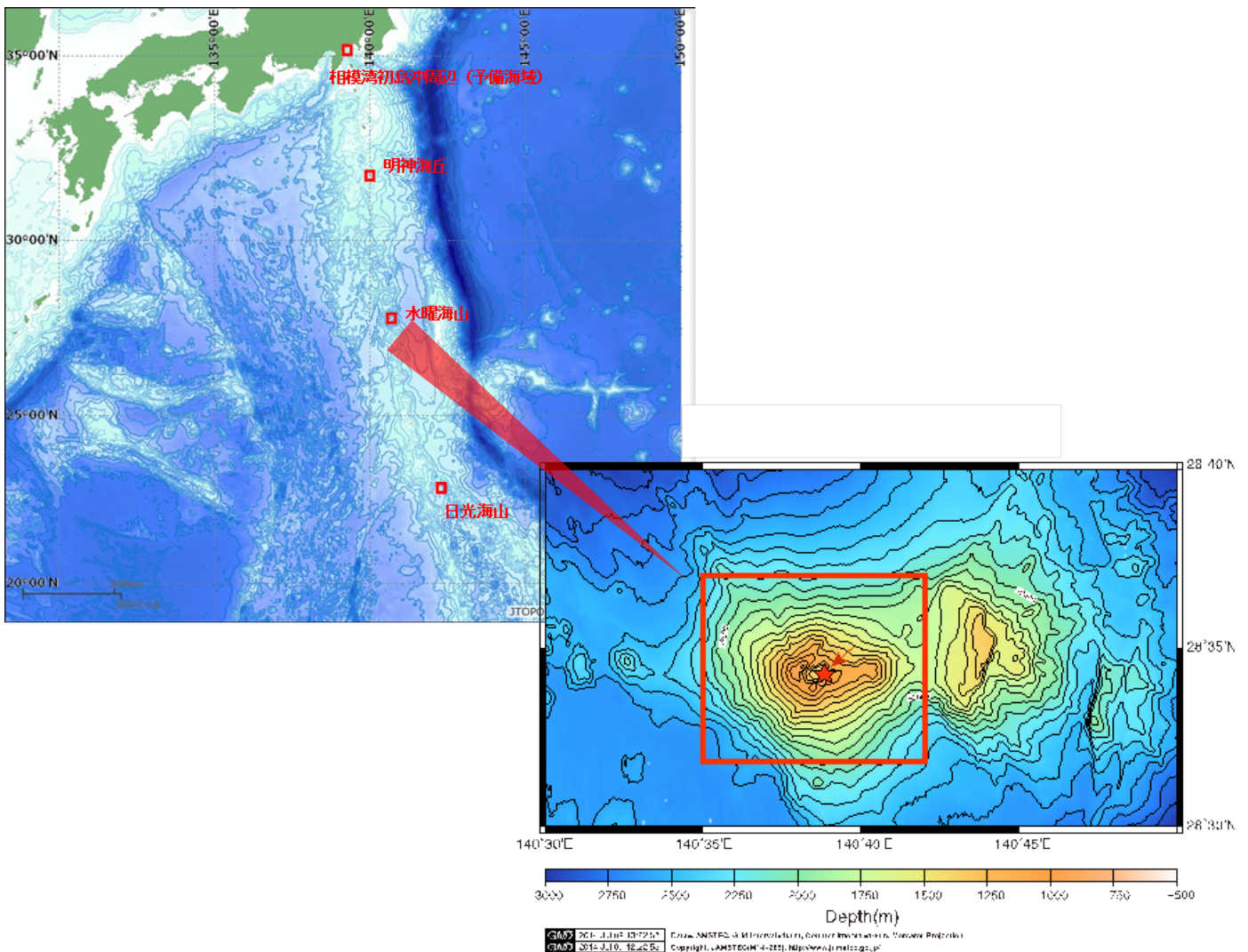
**Suiyo-Seamount / Izu-Ogasawara**

**July.23,2018-July.30,2018**

**Japan Agency for Marine-Earth Science and Technology  
(JAMSTEC)**

## 1. Cruise Information

- Cruise ID : KR18-09 「KAIREI」 / 「KAIKO」
- Name of vessel : KAIREI
- Title of cruise :  
The Sea Trial for Deep Sea Element Technology Using ROV / AUV to Pioneer the Ocean Frontier  
(Evaluation test of deep sea floor image acquisition technology using deep sea super high definition camera (U8K-SHV) by ROV "KAIKO" (The First cruise))
- Chief Scientist [Affiliation] : Shojiro Ishibashi [MARITECH / JAMSTEC]
- Cruise period : 7/23/2018 – 7/30/2018
- Ports of departure / call / arrival : Yokohama Bay – Shimizu Bay
- Research area : Suiyo-Seamount / Izu-Ogasawara
- Research map :



## 2. Research Proposal and Science Party

- Title of proposal :  
The Sea Trial for Deep Sea Element Technology Using ROV / AUV to Pioneer the Ocean Frontier | JS1802  
(Evaluation test of deep sea floor image acquisition technology using deep sea super high definition camera (U8K-SHV) by ROV "KAIKO" (The First cruise))
- Representative of Science Party [Affiliation] : [Hiroyuki Osawa\(JAMSTEC\)](#)
- Science Party (List) [Affiliation, assignment etc.] : [Shojiro Ishibashi, JAMSTEC](#)  
[Tetsuya Miwa, JAMSTEC](#)  
[Makoto Tanaka, JAMSTEC](#)  
[Hidehiko Nakajo, JAMSTEC](#)  
Takao Yoshida, JAMSTEC  
Tetsuro Ikuta, JAMSTEC  
Masatsugu Mitsuhashi, NHK  
Taiki Furusawa, NHK  
Tomoyuki Matsumoto, NHK  
Yoshinori Iimura, NHK  
Tamotsu Ogawa, NHK Media Tech.  
Takayuki Ogura, NHK Medea Tech.  
Managu Hirose, NHK Enterprise  
Katsuhiko Utugi, Shoki-Nichibun  
Shin Kamijo, Shibatech  
Hideo Otani, Shibatech  
Katsutoshi Ishikawa, Air-Camera  
Kenta Kuroki, Furane

## 3. Research/Development Activities

- Evaluation test of high-definition optical visualization technology by U8K-SHV camera for deep sea

### - Responsible personnel. - Purpose. background

For the following issues approved by the In-house Use Issues Examination Committee in 2018, evaluation tests will be conducted with the marine research vessel "Kairei" and the unmanned spacecraft "Kaiko".

This project is the next-generation research and development project described in "I-1- (5) (3) Construction of a research infrastructure that opens up the ocean frontier, (a) Research and development of advanced ocean infrastructure technology" The purpose of this project is to evaluate ultra-high-definition video technology in actual seas in the research and development of platform element technologies. At the same time, the task was to build a Super Hi-Vision camera developed by the Japan Broadcasting Corporation (NHK), which is scheduled to become a general broadcaster in 2020, as a deep-sea specification, and to evaluate each element item related to ultra-high-definition video on the deep sea floor. To be implemented.

This item has already been implemented as joint research with NHK, "Basic Research on Deep Sea Super Hi-Vision Camera System" from FY2015 (this year is the last year). We will work on optical transmission technology (large-capacity transmission technology) when installed on board and compression / storage technology for onboard systems. In addition, the objective is to quantitatively evaluate an illumination method for evaluating and guaranteeing deep-sea optical characteristics for an ultra-high-resolution image sensor. Against this background, the cruise will evaluate and verify the practicality of each of the above elemental technologies by applying "Kaiyo" in the actual sea area.

Aiming to commercialize the "Super Hi-Vision camera (8K camera)" as a deep sea specification, we will manufacture a prototype (U8K-SHV camera) and evaluate each technical item in the

actual sea area. The "Kaiko" will be equipped with a USHV, and each evaluation test (optical transmission evaluation, performance evaluation, function (control) evaluation, etc.) will be conducted on the deep sea floor. At the same time, USHV underwater optical properties will be evaluated using a deep-sea LED lighting system, and 8K video will be acquired (recorded) in each evaluation test.

#### - Activities

##### (1) Work by "Kairei"

Seafloor topographical surveys using a multi-beam sounding sounder, geological surveys using a sub-bottom profiler, etc. were conducted according to the situation.

##### (2) Work by "Kaiko"

###### 1) Evaluation test on 8K video transmission / recording and optical system control

(1) : The USHV will be mounted on the "Kaiko" (mounted on the sample basket) and will dive. The USHV video (8K video) is received on the 8K monitor installed in the "Kaiko" operation room. The video is recorded by the 8K video recording device installed in the "Kaiko" operation room.

(2) : Check and verify the received video for "out of frame" or "video noise".

(Optical transmission technology evaluation)

(3) : Verify and evaluate the quality (noise / distortion / color) of 8K video underwater and in hydraulic environment with NHK technical staff.

(4) : A camera control unit (CCU) for USHV will be installed in the "KAIKO" operation room, and this will be used for "iris control and adjustment" of the optical system.

(5) : Perform "zoom control / adjustment" using the zoom demand attached to the CCU.

(6) : Perform "focus control" using the focus demand attached to the CCU.

(7) : In USHV iris, zoom-in / out, and focus optical system controls, verify the control functions (reproducibility of indicated values) on a monitor from 8K video. (Evaluation of optical system controller)

(8) : Record the results of each evaluation test on the recording device.

###### 2) USHV optical characteristics evaluation test using LED lighting equipment for deep sea

(1) : Install the "ITE standard resolution chart and color bar chart" panel on the sea floor.

(2) : Hold the "Deep Sea LED Lighting Device" with a manipulator or install it on the seabed, and irradiate the "ITE standard resolution chart and color bar chart". At this time, the lighting of each LED (white light / red light) is controlled by a timer using the "LED lighting device for deep sea", and the behavior is confirmed.

(3) : Record 8K video of the "ITE standard resolution chart and color bar chart" panel under each lighting condition using the LED lighting equipped with "KAIKO" and the "LED lighting device for deep sea". At this time, the effects of optical system aberrations are verified and evaluated on an 8K monitor.

(4) : Evaluate and record each color level change using the RGB level monitor device from the video of the "ITE standard resolution chart and color bar chart" panel taken by USHV.

###### 3) High-resolution wide-area photography test (seabed landscape photography test)

(1) : Use the USHV to take wide-area photography of the deep sea floor (seafloor landscape photography).

(2) : Install the timer-set "Deep Sea LED Lighting" near the shooting target such as a chimney (about 1 to 2 m from the shooting target). Use up to three "LED lighting devices for deep sea". It is mounted on a sample basket of "KAIKO", transported to the sea floor, and installed at an arbitrary point on the sea floor using a "KAIKO" manipulator.

(3) : Use up to two "Edokko 1" units and use the lighting equipped with "Edokko 1" as ambient light. Before the "Kaiko" dive, "Edokko 1" is put on the seabed, moved

using the "Kaiko" manipulator, and installed at an arbitrary point on the seabed.

(4) : The seabed near USHV is photographed using the LED lights installed on the "KAIKO". Taking into account the distance, attitude, and light directivity with the "Deep Sea LED Lighting" and "Edokko 1" lighting, each light is turned on and off as appropriate at the site.

(5) : Record the acquired 8K video on the recording device, and verify and evaluate the distortion, resolution, color, etc. of the wide area video with the NHK technical staff on the 8K monitor.

#### 4) Deep-sea organism collection

(1) : Using the USHV, take high-precision images of biological communities in deep-sea hydrothermal fields, and collect the captured organisms as appropriate. (Conduct as appropriate according to the environment and test conditions)

(2) : Biological sampling will be carried out using a slurp gun (underwater suction capture device) mounted on the "KAIKO".

(3) : Compare the collected creatures with 8K images from USHV, and examine the utility of USHV images in the field of biological research such as species identification using the images.

#### (3) Work by NHK (\*All recording equipment of this item is brought in by NHK)

##### 1) Photographing activities on board

(1) : Photograph each work on board the "Kairei" and "Kaiko" using 8K camera and broadcast camera. It is carried out using a plurality of mobile shooting cameras, fixed installation cameras, and the like.

##### 2) Shooting during landing, infiltration, and dive

(1) : A high-quality underwater camera (underwater 4K camera) that operates electrically independently will be mounted on the "Kaiko" vehicle, and the main image of the "Kaiko" vehicle will be photographed when it lands. Attach an underwater 4K camera to the rear of the vehicle and start recording in advance (before the aircraft is lifted), and continue recording until the landing is completed.

(2) : The underwater 4K camera, which operates electrically independently, is mounted on the "Kaikou" launcher to capture the situation where the vehicle leaves the launcher. It also shoots the situation where the vehicle joins the launcher. Attach it to the rear of the launcher and start recording in advance (before lifting the aircraft), and continue recording until the landing is completed.

(3) : Select one of the above ① and ② in advance.

(4) : Before landing at Kaiko, launch a small camera \* into the sea from the stern of Kairei and land at Kaiko ⇒ photograph the situation during the dive from underwater. Attach a small camera to a rod (bamboo rod or fishing rod) so that it does not interfere with the "Kairei" hull and the "Kaiko" body + cable.

##### 3) Shooting work scenery using a drone

(1) : Use a flying drone \* to shoot "Kairei" and "Kaiko" from above. It will be implemented at the site with the permission and instruction of the ship, such as the shooting location, shooting time, and shooting timing.

##### 4) Recording of on-site acoustic data by underwater recording equipment

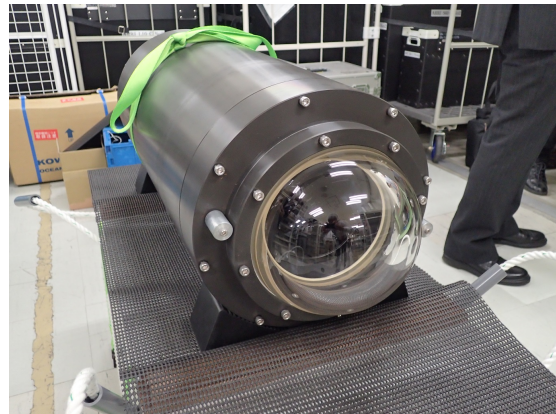
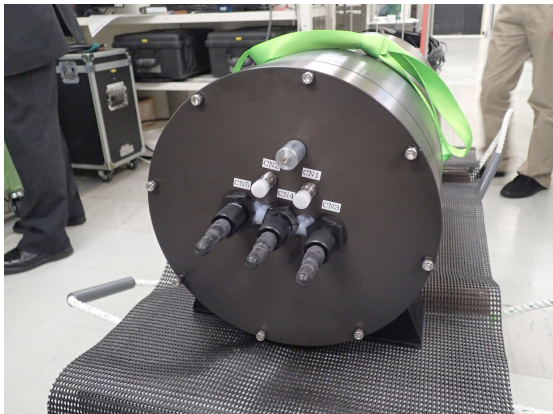
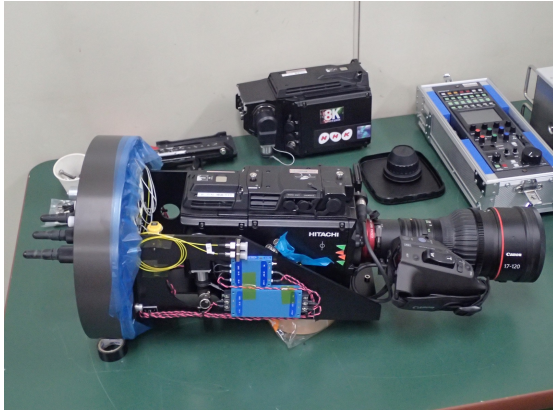
(1) : A submersible recording device \* that operates electrically independently will be installed on "Edokko 1" and will be dropped and installed on the sea floor near the sea area where the USHV evaluation test will be conducted.

(2) : The underwater recording device starts recording before dropping into the sea, and continuously records acoustic data until the ascent / discharge is completed. (The underwater recording device can record continuously for more than 72 hours.)

(3) : This item is performed simultaneously with "3) High-resolution wide-area photography test (seabed landscape photography test)".

- Instruments

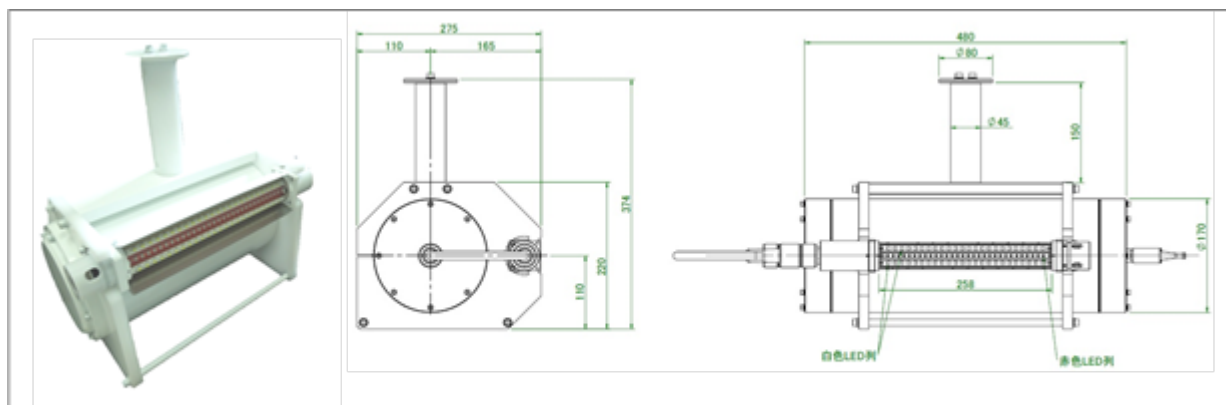
【U8K-SHV Camera】



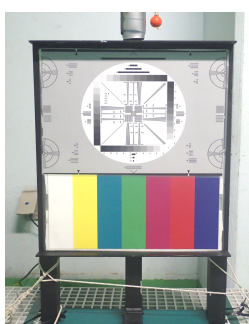
*Specifications*

Size	: $\phi$ 305 x 751 mm
Weight (air)	: 68kg
Weight (water)	: 20kg
Working Depth	: 3,000m
Power	: 24VDC
Camera	: SK-UHD8060B
Sensor	: C-MOS Single-Plate (Super-35mm)
Resolution	: 33 million pixels
Frequency	: 59.94Hz(progressive)
Sensitivity	: 2,000lx @F8.0
Telemetry	: Optical Fiber comm.   CWDM   Uplink x1, Downlink x1 Serial x2

【1.Deep-Sea LED Lighting System】



1	Device	Deep-Sea LED Lighting System		Number	3	Owner	JAMSTEC
	Method	It has a battery and a control device inside the lighting device, and turns on / off the LED with the deep sea LED lighting device alone. The LED has two rows of white and one row of red, and each LED can be turned on and off at a predetermined time by setting a timer offline. Transportation and gripping to the sea floor will be carried out at Kaiko.					
	Size	480×275×374mm	Weight (air)	19.9kg	Weight (water)	9.85kg	
	Comments	This device was subjected to a water pressure test during production.					



【2. ITE Standard Resolution Chart and Color Bar Chart】

2	Device	ITE Standard Resolution Chart and Color Bar Chart		Number	1	Owner	JAMSTAEC
	Method	A board that displays the evaluation pattern of the U8K-SHV Camera. Transport, installation and recovery to the sea floor will be carried out at "KAIKO". The work image during installation and recovery is shown in Outline of installation and recovery of submarine equipment.					
	Size	500mm×300mm×1000mm	Weight (air)	5kg	Weight (water)	3kg	

【3. Underwater 4K Camera】



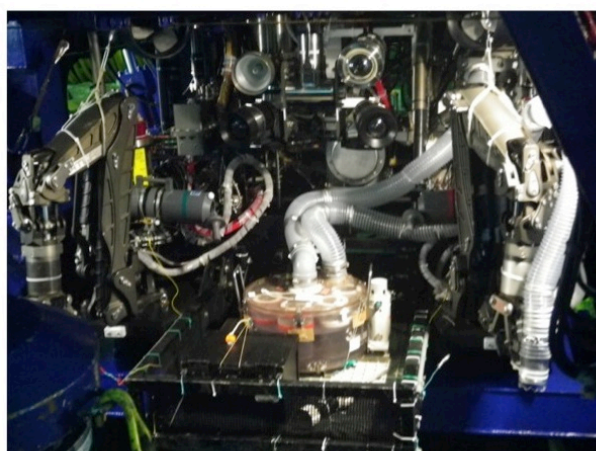
【4. Underwater Sound Recorder】



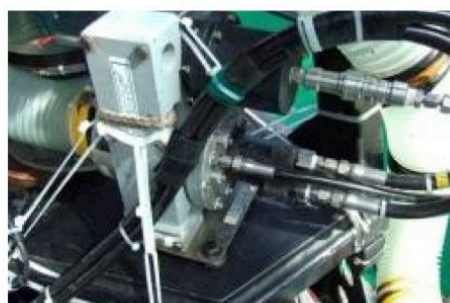
3	Device	Underwater 4K Camera		Number	1	Owner	NHK
	Method	Mounted on the vehicle or launcher section of "KAIKO" to capture the landing status of the landing and the detachment / coupling of the vehicle. Model: Goto Aquatics underwater camera Water resistance: 2,000m Shooting time: 6 hours					
	Size	150×150×332 mm	Weight (air)	11kg	Weight (water)	8kg	
	Comment	This device was subjected to a water pressure test during production.					

4	Deivce	Underwater Sound Recorder		Number	1	Owner	NHK
	Mehod	A recorder that operates electrically independently. Record the site (seabed) environment by installing it on "Edokko 1". Continuous recording for more than 72 hours is possible with battery operation. Water resistance 3,000m Shooting time 72 hours					
	Size	φ180mm×586mm	Weight (air)	12.5kg	Weight (water)	4.0kg	
Comment	当該装置は制作時に耐水圧試験を実施している。						

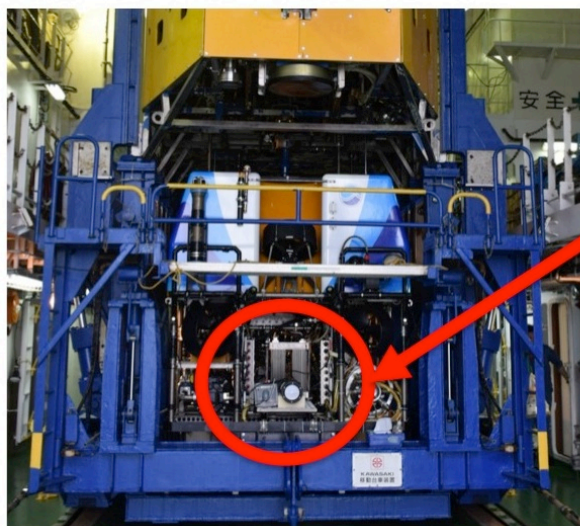
【Slurp-Gun & Multiple-Canister】



●スラップガン ホース部分の配置例  
(写真は、多連キャニスターを使用)



●スラップガン ポンプ部分  
かいこうのバスケット以外の搭載できる場所に設置予定



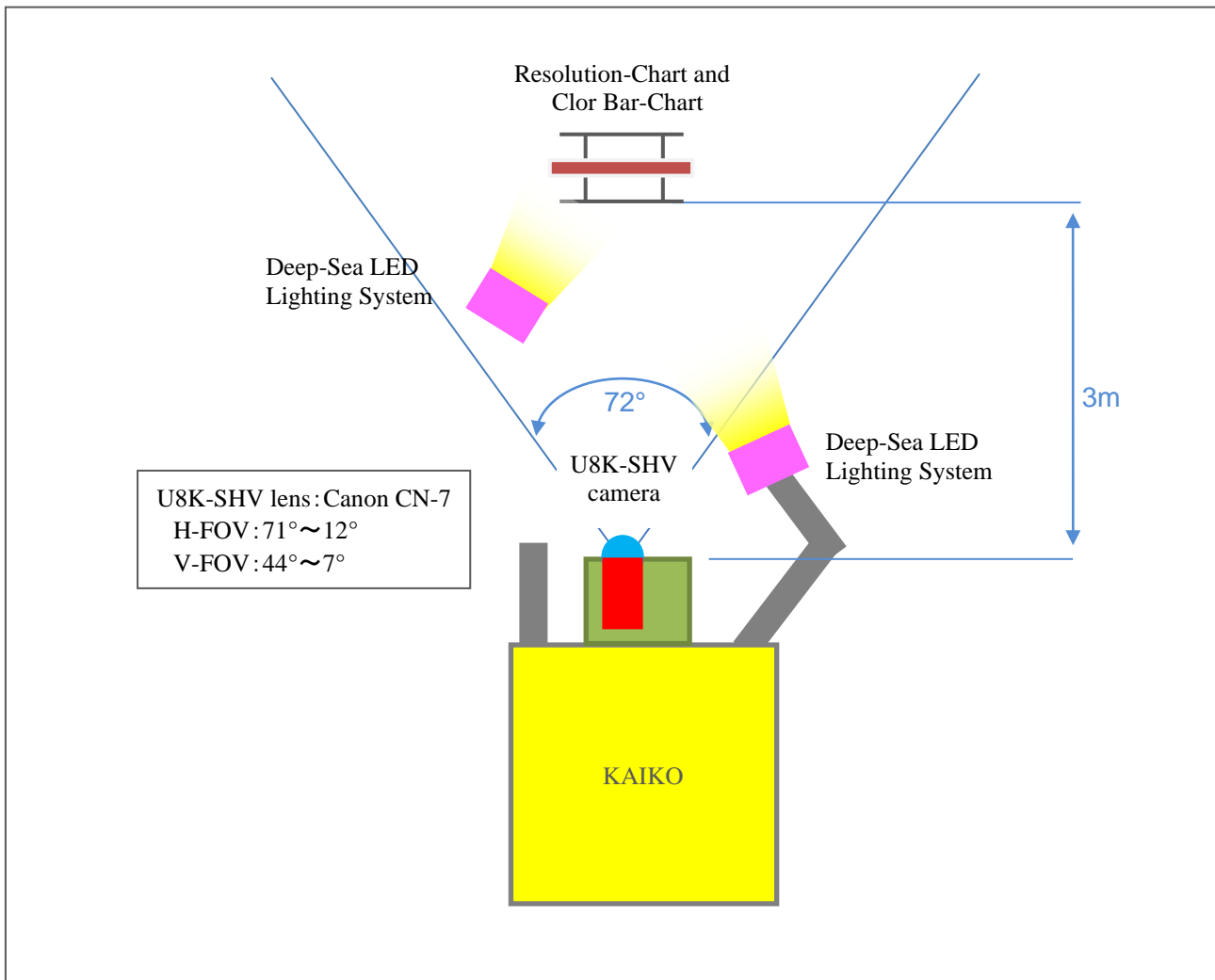
●保存容器(単式キャニスター)部分  
かいこうの後部の赤丸部分に設置予定

5	Device	Slurp-Gun and Multiple-Canister		Number	1	Owner	JAMSTEC
	Method	It consists of a hose for aspirating organisms, a storage container and a pump. Use fixed on a submarine. Operate the hose with a manipulator and collect a sample.					
	Size	595X490X275 mm	Weight (air)	35kg	Weight (water)	14.5kg	

- Methods

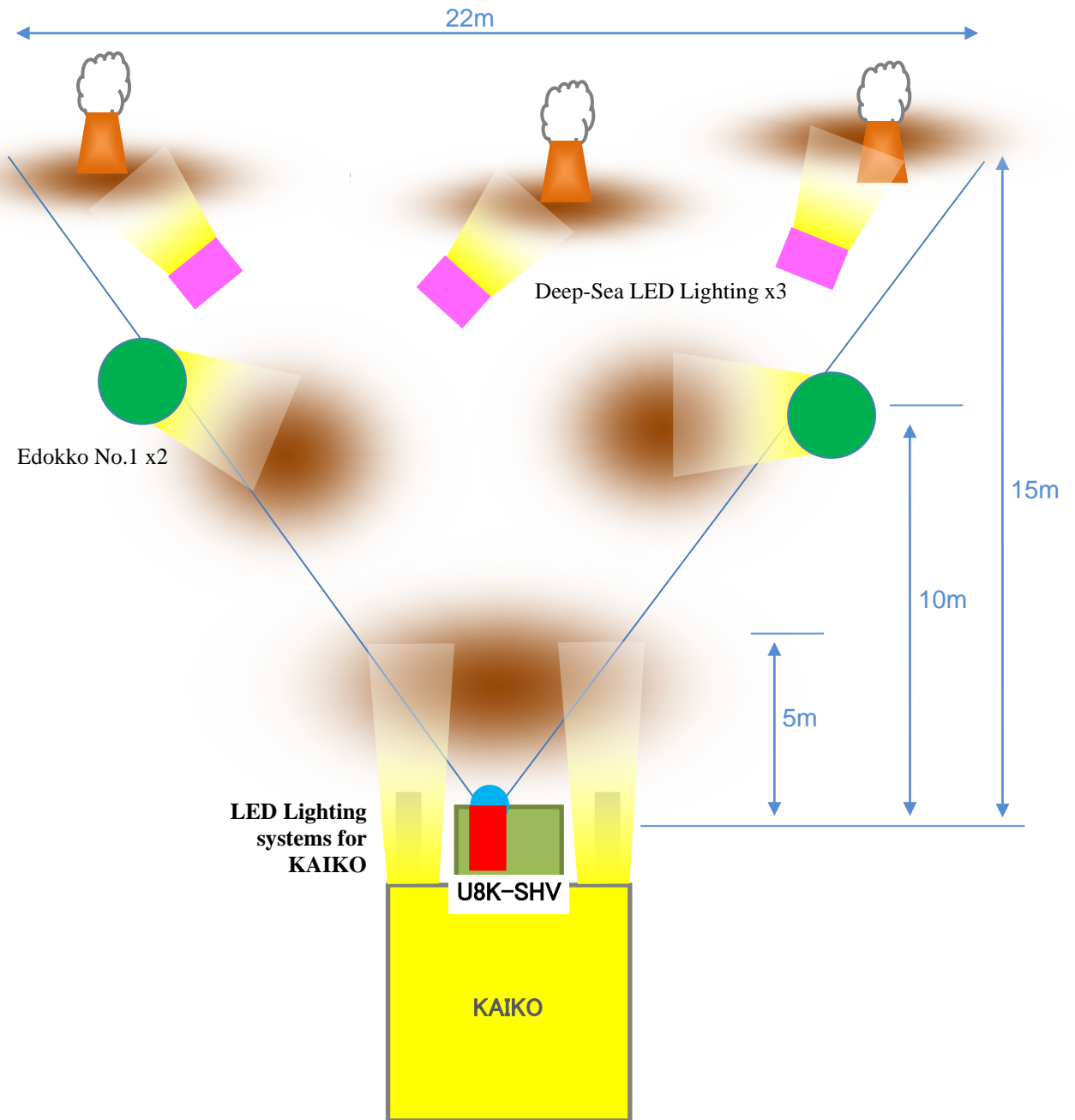
<TEST OUTLINE for U8K-SHV Camera Optical Characteristic>

The evaluation test on U8K-SHV optical characteristics (resolution and color sensitivity) using deep-sea LED lighting system described in this report. The LED lighting device for deep sea is one unit, and the evaluation test is performed by holding it with a manipulator or installing it on the sea floor.



<TEST OUTLINE for High-Resolution & Wide-Area Imaging>

The High-resolution wide-area imaging test described in this report. Two deep-sea LED lighting system and two “Edokko No. 1” units are installed on the sea floor, and combined with multiple LED lighting units equipped with “KAIKO” to provide a step-by-step approach to a 15 m deep seabed environment. The lighting environment is adjusted to (3 steps) and wide area photography (20m or more) using USHV is implemented.

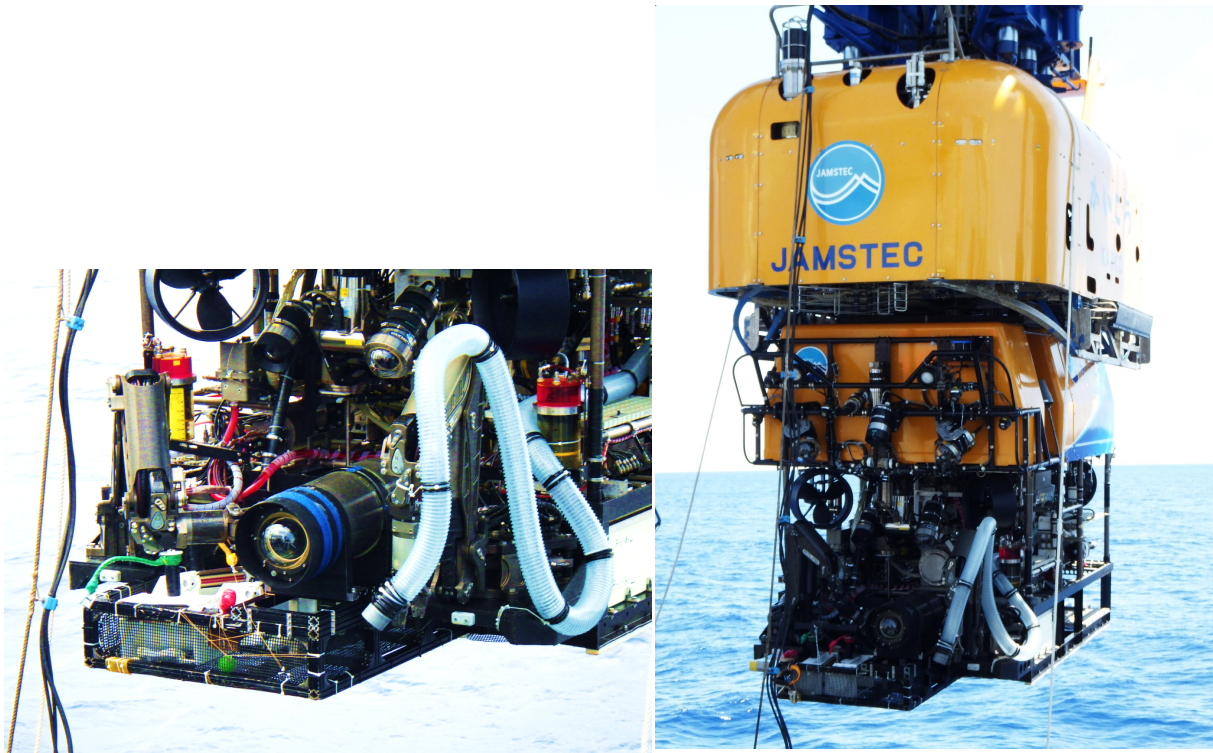


- Procedure

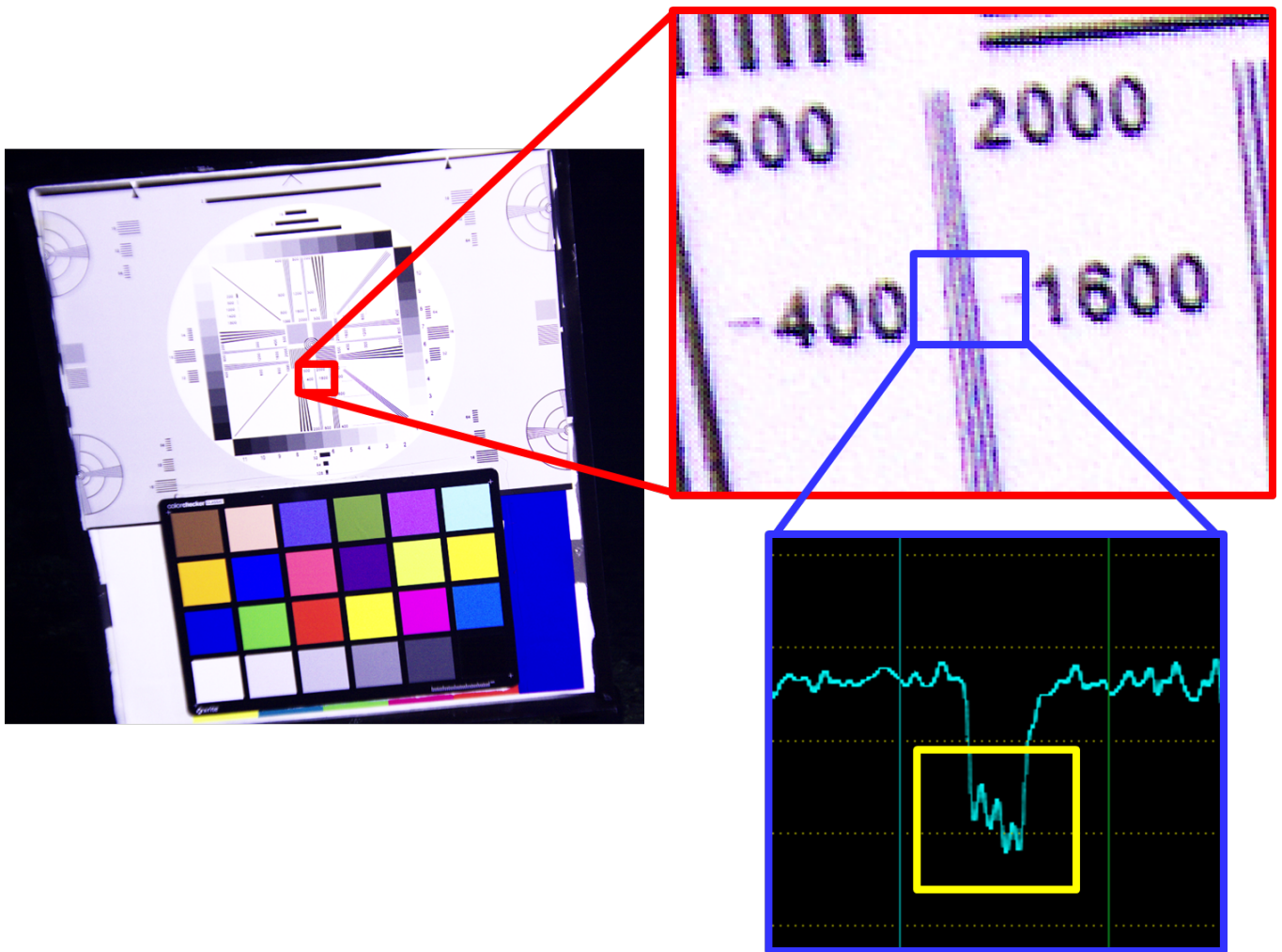
1. Two Edokko 1 units will be put on the day before the shooting test, and will be installed at any seabed (the shooting test site) using "KAIKO". The lighting and camera photography of each "Edokko 1" is set in advance with a timer, and operates according to each test time from the next day.
2. Acoustic positioning of the two Edokko No. 1 installation locations from the ship and identifying each location.
3. On the day of the photography test, three "Deep Sea LED Lights" will be stored in the "Kaiko" basket and will dive. Landed around the seabed where two "Edokko 1" units were installed on the previous day, and installed three deep-sea LED lighting units at any seabed while considering the positional relationship with "Edokko 1". To place.
4. In this case, if the location of "Edokko 1" is inconvenient for arranging "LED lighting for deep sea", or if it is expected that it will hinder the behavior of "Kaiko", After shifting the position of the first child and securing the operating range of "Kaiko" for the next movement, the "Deep Sea LED Lighting" will be placed. Each "LED for deep sea" is preset with a timer and operates (lights up) according to the test time of the day.
5. After arranging the three deep-sea LED lighting units, install the two Edokko 1 units again at appropriate locations. If it is difficult to move and set up in a plane motion, appropriate placement position and posture are ensured by three-dimensional motion including a climbing motion as appropriate.
6. After installing three "Deepwater LED Lighting Units" and two "Edokko No. 1" units at the desired locations, land the "Kaikou" at any point that has an appropriate positional relationship with those devices.
7. The shooting test will be conducted in accordance with the lighting of each of the two Edokko 1 and 3 deep-sea LED lights controlled by the timer. At this time, the lighting effect on the shooting subject in the short range is verified by appropriately turning on and off the LED lighting equipped with "KAIKO".
8. After the lights of the two Edokko No. 1 units and the three deep-sea LED lighting units have been turned off, the photography test will be continued using the appropriate LED light units equipped with the "KAIKO".
9. After the test is completed, the "Kaiko" will be moved, and the "3 Deep Sea LED Lights" will be collected in the "Kaiko" basket, separated from the site, and surfaced. At this time, "Edokko No. 1" will remain at the site until the shooting test the next day. The lighting and camera photography of "Edokko No. 1" will be turned on and off according to the schedule set in advance in the shooting test on the following day and after.
10. In the shooting test on the following day, perform "3" → "9".
11. After the completion of the photographic test on this cruise, the "Edokko 1" will be notified of the "Leaving Order" from the ship, and will leave / float, and will be collected on board as appropriate.

- Results

On July 24-26, 2018 (3 days), the U8K-SHV camera was used to perform a deep seafloor dive using the deep sea unmanned spacecraft "KAIKO" and dive into the Ogasawara waters at a depth of 1,300m-1400m. Undersea photographing test was conducted. As a result, it was confirmed that the ultra-high resolution performance that the 8K camera should have in the deep sea environment was fully demonstrated, and quantitative evaluation was possible. At the same time, we succeeded in acquiring ultra-high-definition deep-sea images (from macro to micro). This means that large-capacity, high-quality, high-speed optical communication has been established over a long-distance optical transmission line over a distance of about 10 km via the Kaiko, which links the U8K-SHV camera to the ship. Acquisition of 8K video using a platform in a deep sea environment is the world's first attempt, and at the same time, we succeeded in wide-angle shooting in the seabed hot water area, full-size shooting of ultra-large chimney, shooting of benthic colony etc. Quantitative evaluation of the realization of ultra-high resolution performance for each image on the deep sea floor (actual shooting environment) is the only achievement in the world that has a very significant meaning in each field of deep sea technology and imaging technology. It becomes. As the use of 8K camera technology in the deep sea has not yet been realized internationally, the combination of the world's leading imaging technology and deep sea technology will bring great progress in future seafloor visualization technology, and at the same time, deep sea research field Also showed new possibilities in the research method of.

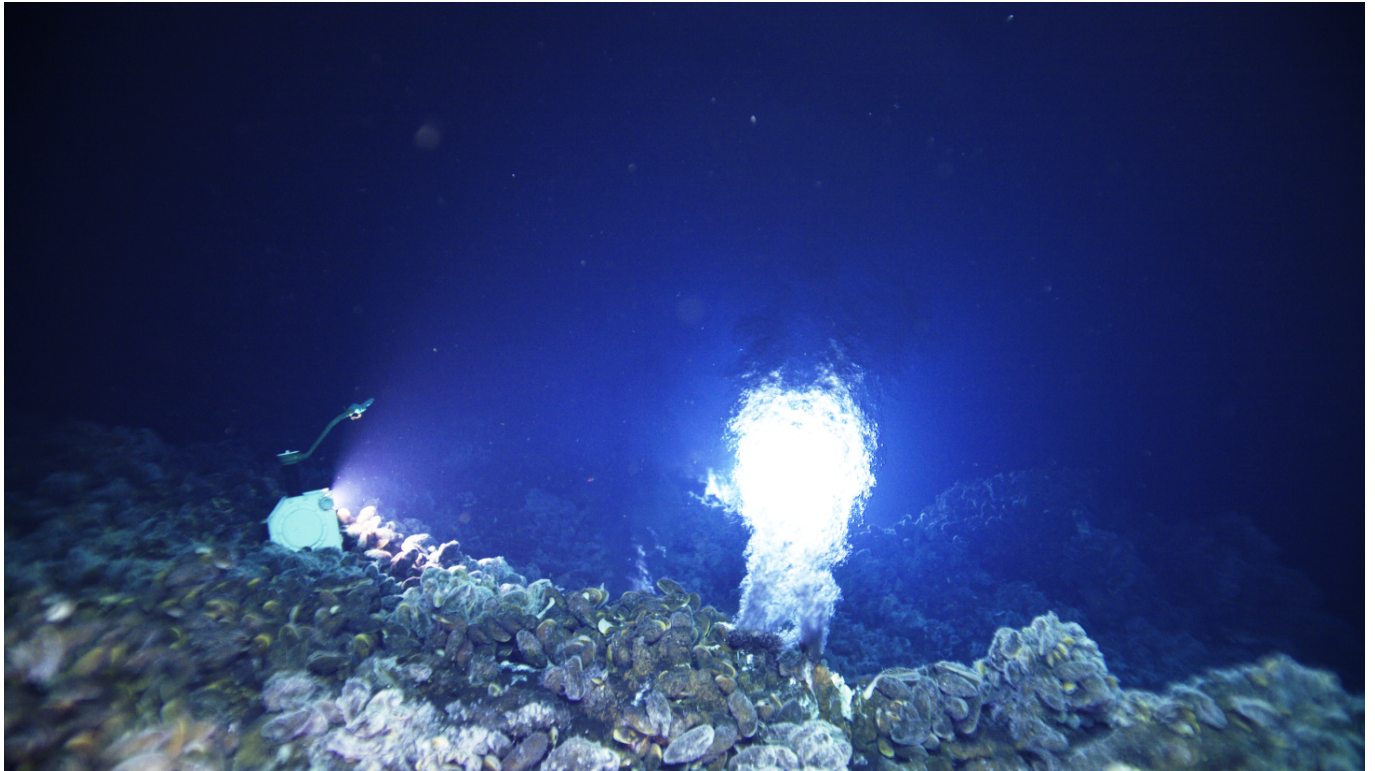


【U8K-SHV camera mounted on KAIKO at field tests】



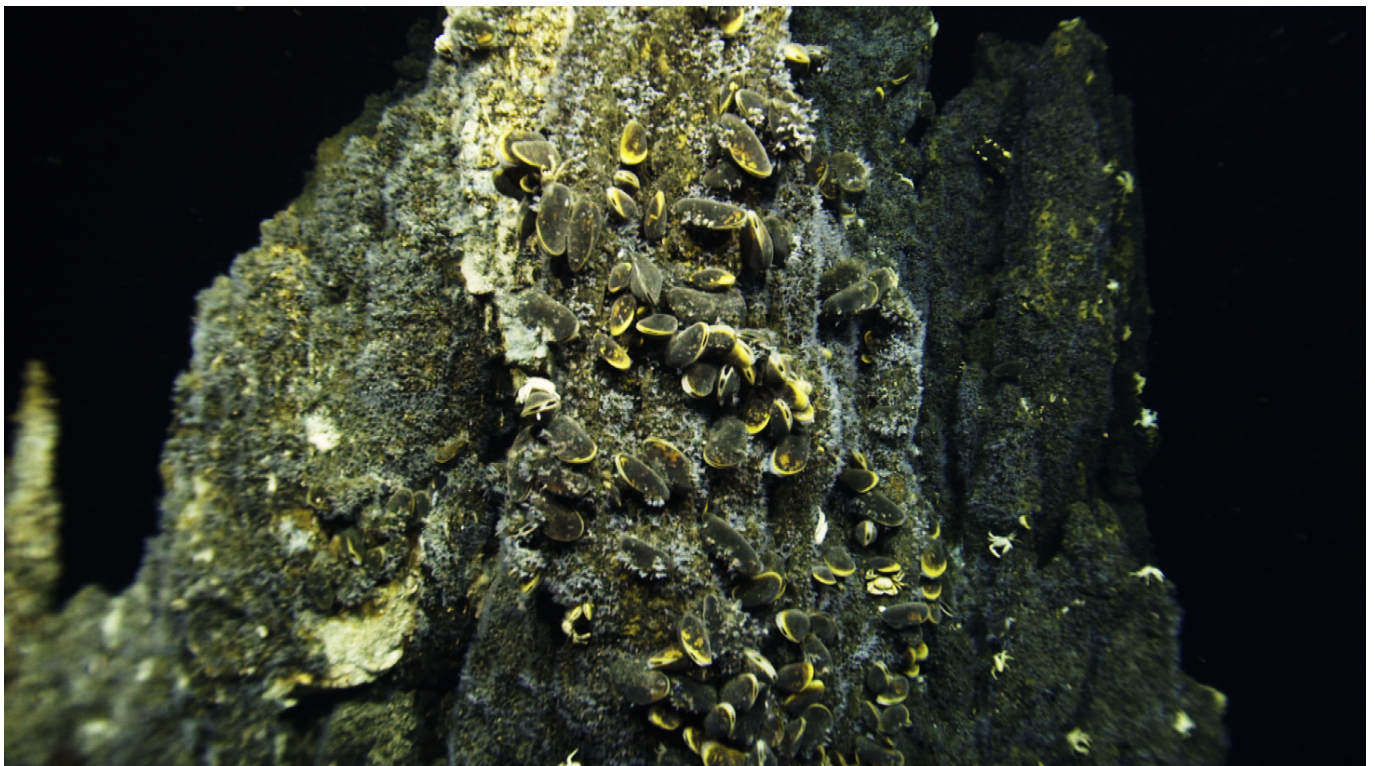
【Image of Resolution-Chart taken by U8K-SHV camera】

Since the quality of the image is deteriorated (compressed) when the image is pasted on the paper, the resolution evaluation chart (including the enlarged view) is a coarse image. In this performance evaluation test, since the chart is photographed in a size of about 1/2 of the regular size, the value of twice the number of TVs of the observed resolution is the true resolution. In the test results, more than 1600 TV lines could be disassembled on the deep sea floor, confirming the ultra-high resolution performance unique to an 8K camera with a true resolution of 3200 TV lines or more.



【Image “1” taken by U8K-SHV camera】

Hot water blown out from the hot water vent at the seabed at a depth of 1,400m. You can clearly see the fluctuation caused by the hot water and the diffusion into the seawater.



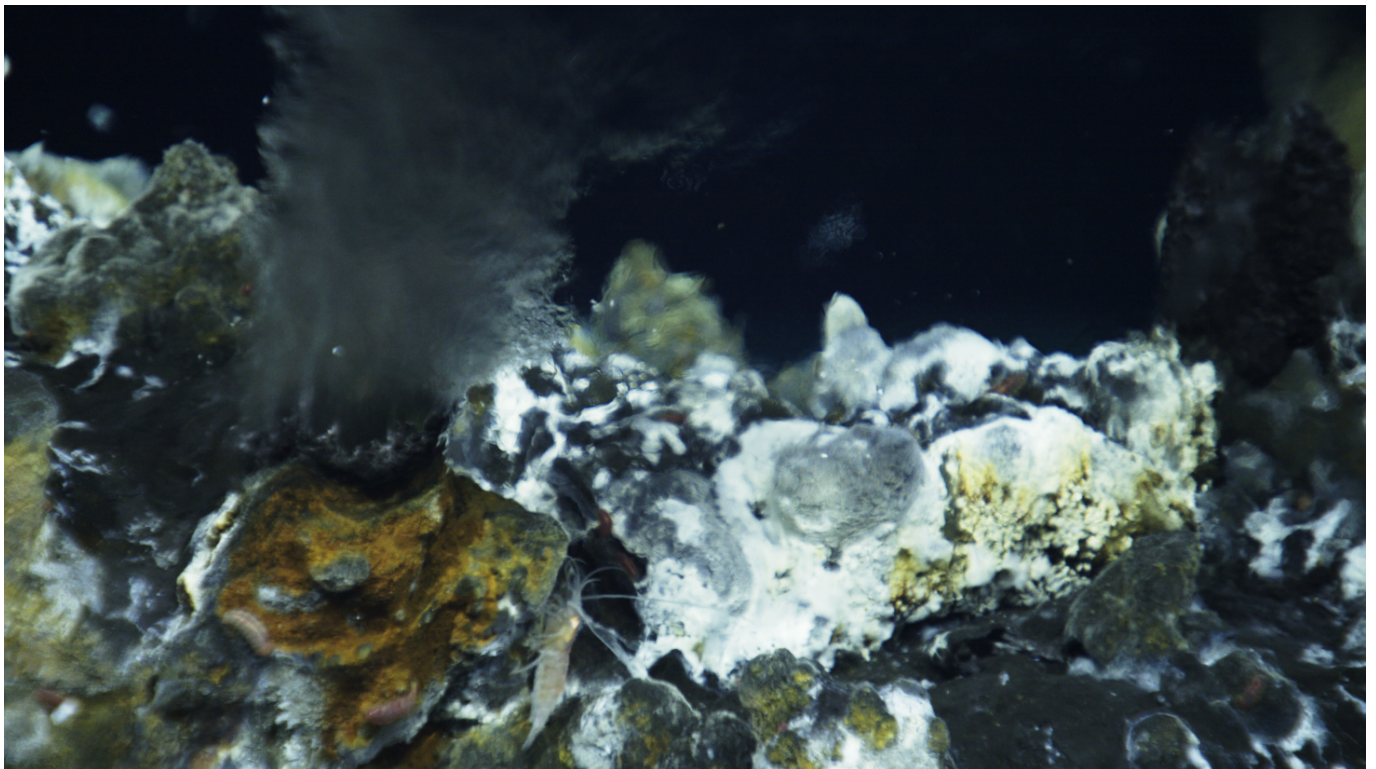
【Image “2” taken by U8K-SHV camera】

The middle part of a large 20m-class chimney that exists in the hydrothermal vent area. The distribution of living organisms (bivalves and barnacles) attached to the surface can be understood in detail.



【Image “3” taken by U8K-SHV camera】

A worm that is a friend of earthworms that lives in the spring waters. The texture of the gill thread can be observed in detail.



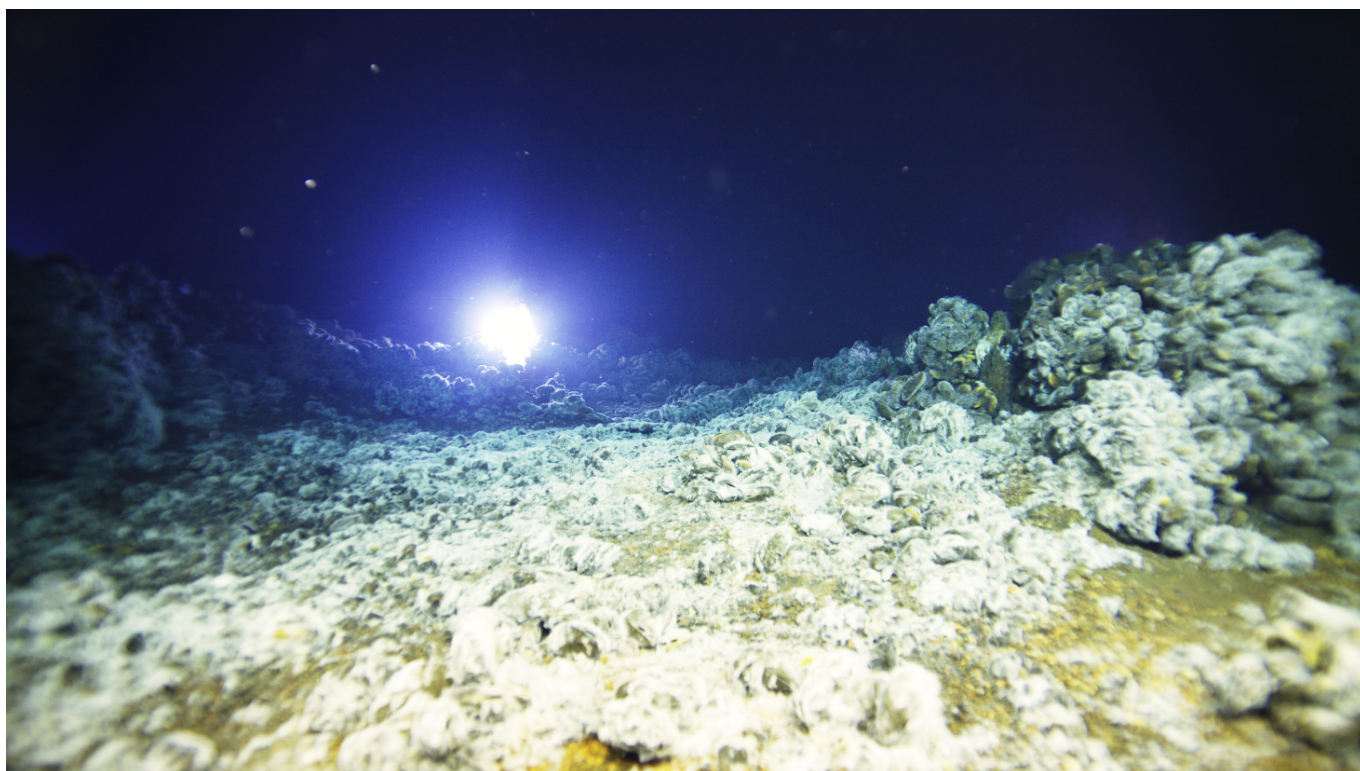
【Image “4” taken by U8K-SHV camera】

Small creatures that inhabit the hydrothermal vent and its surroundings.



【Image “5” taken by U8K-SHV camera】

A fish that swims around the bivalves and worm colonies in the spring area (a friend of the rockfish).



【Image “6” taken by U8K-SHV camera】

Bivalves in the hydrothermal vent area and bacterial mats attached to them. By using a deep-sea lighting device, the distribution of bacterial mats in bivalves can be understood in detail.



Image taken by a HD-TV camera



Image taken by U8K-SHV camera

**【Comparison image between U8K-SHV camera and high-definition camera】**

Compared to high-definition video, U8K-SHV video clearly shows up to one gill thread of the worm.

- **5. Notice on Using**

This cruise report is a preliminary documentation as of the end of cruise.  
This report is not necessarily corrected even if there is any inaccurate description (i.e. taxonomic classifications). This report is subject to be revised without notice. Some data on this report may be raw or unprocessed. If you are going to use or refer the data on this report, it is recommended to ask the Chief Scientist for latest status.  
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