YOKOGAWA

Co-innovating tomorrow™

Space & SDGs

Satoru Kurosu

Space Business Development Executive
Head of Space Business Development Office
Yokogawa Electric Corporation

2022.7.16

Agenda

- Introduction
- What is SDGs?
- Space for SDGs
- Yokogawa’s cases (examples)
- Closing

Satoru Kurosu (Cross)

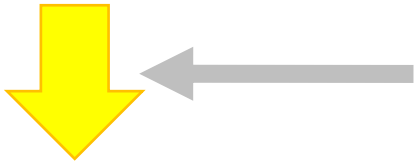
Satoru Kurosu is the founder of Space business of Yokogawa. After Mr. Kurosu had the role as Director, Executive Vice President, until March 2019, he entered the Executive Space Course of International Space University (ISU) in April 2019. Mr. Kurosu started Space business as Space Business Development Executive with the taskforce, in May. In 2020, Mr. Kurosu graduated Interactive Space Program (ISP20) of ISU. In July 2021, Mr. Kurosu established Space Business Development Office, the first Space dedicated organization of Yokogawa Electric Corporation. As he has the concurrent position of Chief Sustainability Officer, Mr. Kurosu is promoting Space enabled solutions which can contribute to SDGs on the Earth.

- **International Advisory Board Member, University Space Engineering Consortium (UNISEC)**
- Council Member, Lunar Industry Vision Council
- Executive Director, Japan Marketing Academy
- Director, Keio Engineering Foundation
- **Council Member, World Business Council for Sustainable Development (WBCSD)**
- Commissioner, Business Commission to Tackle Inequality (BCTI)

What is SDGs?

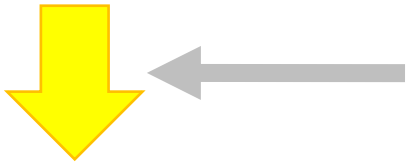
Summary

2000s : Save Developing Countries (MDGs)



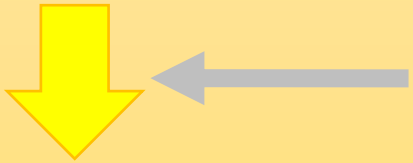
Climate Change Symptoms
Global Financial Crisis
Expanding inequality

2010s : Solve Global Problems



SDGs (2015)
“Leave no one behind”

2020s : SDGs as Business Chances



ESG

License to operate

What is SDGs?

SUSTAINABLE DEVELOPMENT GOALS

- The blueprint to achieve a better and more sustainable future for all. They address the global challenges we face, including those related to poverty, inequality, climate change, environmental degradation, peace and justice. The 17 Goals are all interconnected, and in order to **leave no one behind**, it is important that we achieve them all by 2030.
- Ratification: 25th Sept. 2015 at UN General Assembly

Main points

- Development that meets the needs of the present without compromising the ability of future generations to meet their own needs

- Harmonize three core elements:
  - Economic growth
  - Social inclusion
  - Environmental protection

- Another Way to Look at SDGs
  - The Five Ps

Source: "Transforming Our World:2030 Agenda for Sustainable Development"
Department of Public Information United Nations

Space for SDGs

SDGs related lectures at ISP20 of International Space University (ISU)

- International Space University (ISU)
  - Founded in 1987 by Peter Diamandis (Founder of X-Prize)、Todd Hawley and Robert D Richards. The main campus is in Strasbourg, France. The first chancellor was Mr. Arthur C. Clark.
  - ISU's motto is **"３Is" (Interdisciplinary, International, Intercultural).** They have unique programs which cover various disciplines necessary for Space developments, such as engineering, science, medicine, business, law and humanity.
  - About 5,000 parsons from more than 100 countries graduated. About 75% of them are working in Space industries.
- ISP（Interactive Space Program）20
  - Due to COVID-19, the Space Study Program planned in Strasbourg changed to online ISP20 from July 20,2021 for five weeks.
  - 86 persons form 30 countries attended. Professions are Space agencies, defense, Space company, non-Space companies, lawyer, venture, etc.
  - Because of COVID-19, ISP20 focused on how Space enables solutions can contribute to mitigate the pandemic.
  - Many lectures are related to solve issues on the Earth (SDGs), given by the professionals not only from Space agencies but also from UNOOSA and other organizations involved in SDGs.

Team Mars report

Examples of SDGs related lectures

- Policy Rational for Space Activity: John Logsdon, The George Washington University
- Electromagnetic Spectrum and the Space Environment: James Green, NASA Chief Scientist
- Telemedicine: Douglas Hamilton, Flight Surgeon, University of Calgary
- Space and Society: Kerrie Dougherty, Australian Space Agency
- Legal Underpinnings of Space Activities: Tanja Masson-Zwaan, Leiden University
- Introduction to Life Support Systems: Christophe Lasseur, ESA Life Support Coordinator
- Space and Disaster Management: Danling Tang, Chinese Academy of Sciences
- Introduction to Remote Sensing: Su-Yin Tan, University of Waterloo
- Ethics-A Necessary Horizon for Space Activities: Jacques Arnould, CNES
- Sustainable Development Goals and Space Governnce-The Case of Global Health: Niklas Hedman, UNOOSA
- International Law & Remote Sensing in the Context of a Pandemic Crisis: Alexander Soucek, ESA
- Space for Food Security: Joana Ruiter, Netherlands Space Office
- WMO Space Activities and Sustainable Development: Werner Balogh, WMO Space Program Office

Summary of ISP20

- **Synergy between the Earth and Space**
  - The power of satellite data
  - To address the environments on the Earth, we must at least talk about the solar system.
- **Space enabled solutions are already contributing to SDGs**
  - Disaster prevention, mitigation and recovery
  - Environment monitoring and improvement
  - Activity tracking and optimization
  - Developing country support
  - Various spin-off technologies
- **Potentials in the future**
  - Circular economy technologies developed in closed environments in Space
  - Environment management technologies by planetary sciences
  - Create “Starship Earth” by the overview effect to unify human being

SPACE4SDGS

出所：UNOOSA

MELISSA FOUNDATION

出所：MELISSA FOUNDATION

Yokogawa’s cases (examples)

Yokogawa Electric Corporation at a glance

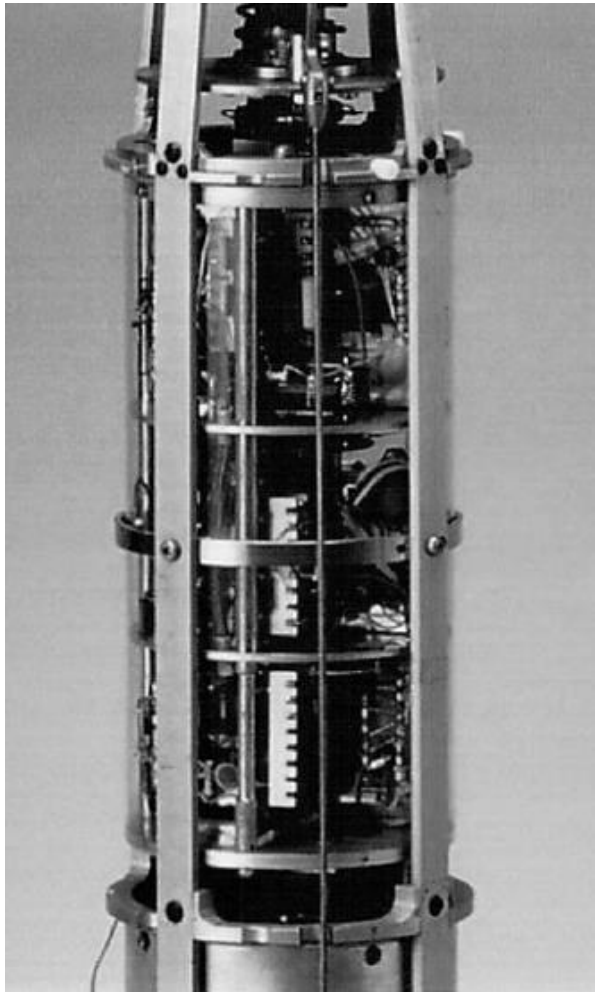
Founder: Dr. Tamisuke Yokogawa

Mitsukoshi Department Store
Building designed by Dr. Yokogawa in 1914

Founded	**September 1, 1915**
Paid-in Capital	**43.4 billion yen**
Business domain	**Measurement, Control & information** (No.1 process automation company in Japan and top five in the world)
Sales	**389.9 billion yen** (Approx.70% is from outside Japan)
Net income	**21.3 billion yen**
R&D Investment	**7.3% of sales**
No. of Employees	**17,258**
Capital Ratio	**60.0%**

(Results of FY2021)

Yokogawa's Space history started in 1961



Yokogawa Ionosphere Sensor
delivered to Kappa 8 rocket in 1961

NASA's Nike Cajun rocket
launched from Wallops Island in 1962

Yokogawa's Space History

Track record in Space

- Delivered the ionosphere sensors to Tokyo Univ. in 1961 and NASA in 1962.
- Supplied various measurement instruments to Space agencies and companies.
- Supplied equipment to N-II, H-I, H-II, H-II A/B rockets.

Attend ISU

In 2019, attend International Space University's Executive Space Course to search for business opportunities.

Leverage the experiences for mission-critical applications on the Earth

- Delivered a large number of control systems and sensors that operate 24/7 and 365 days/year to more than 100 countries around the world.
- They continue working even under extreme environments such as Deep Sea and the Arctic due to their quality and reliability.
- We aim to expand our horizon to Space.

Yokogawa Space Business Development History

2019

- **Launched Space Business Task Force “StarShot”**
- Participated in Frontier Business Study Group for Lunar developments and New Space Global Strategy Lab

2020

- **Delivered confocal scanner to "Kibo" on the ISS via Chiyoda Corporation**
- Participated in Moon Village Study Group and SPACE FOODSPHERE
- Attended International Space University Interactive Space Program
- Started monthly meetings to exchange Space information across business units

2021

- Participated in the Lunar Industry Vision Council
- Positioned “Space" as the area or exploration of the new medium-term business plan
- **Established Space Business Development Office**
- Started the first joint research and development with JAXA Exploration Hub
- Gave the first paper presentation at the 65th conference of the Japan Society for Aeronautical and Space Sciences
- Joined the study for energy related technologies on the Moon by Ministry of Economy, Trade and Industry

©JAXA/NASA

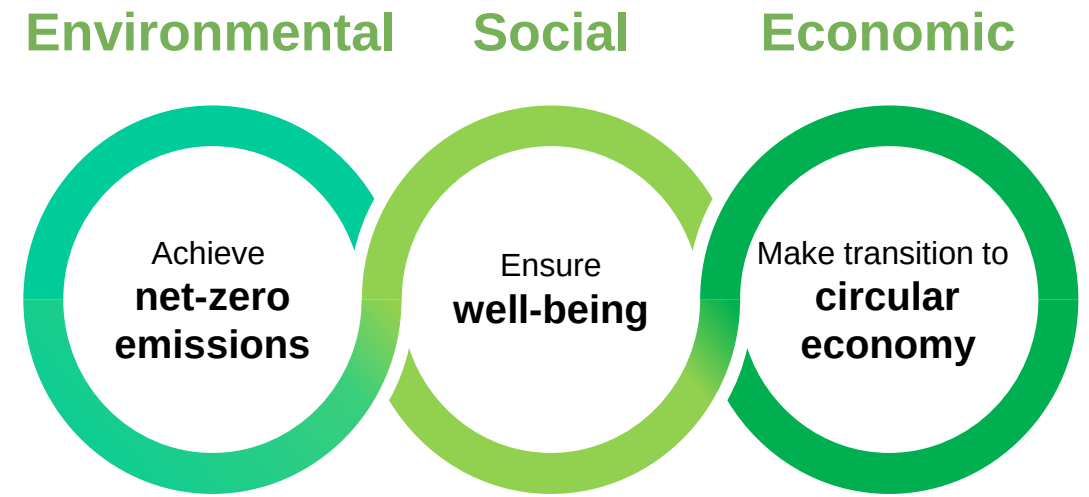
©JAXA

Vision for Society in 2050

Three goals for sustainability

Yokogawa has set three sustainability goals for 2050.

To achieve these goals, we have identified key issues related to sustainability and have set specific targets for the short, medium, and long term.



Yokogawa will work to achieve net-zero emissions, ensure well-being, and make a transition to a circular economy by 2050, thus making the world a better place for future generations.

Examples of sustainability activities

Three Goals

Net-zero Emissions

Well-being

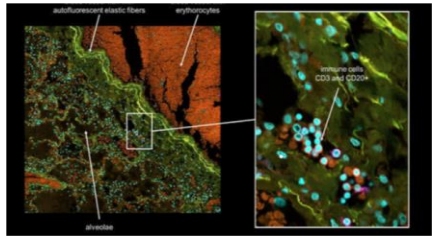
Circular Economy

Earth

Biomass geothermal supply system

Ichinohashi Bio Village
©2021 SHIMOKAWA Town

Contribution to measures against the new coronavirus



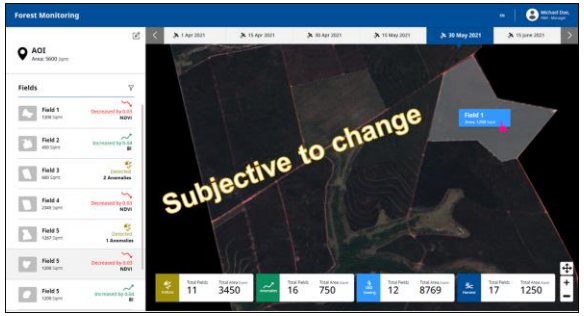
Source：CENIBRA and Charité Berlin
(https://www.yokogawa.com/eu/blog/life-innovation/covid-19-research-charite/)

Business collaboration with JEPLAN, INC. utilizing the latest recycling process

© JEPLAN, INC.

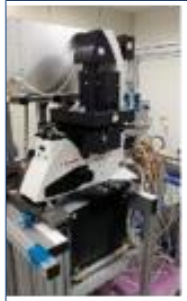
Space

Artificial satellite forest monitoring solution



© Yokogawa Electric Corporation

COSMIC(Confocal Space Microscope) for developing 3D cell culture technology such as ips cells under microgravity delivered to ISS



©JAXA ©JAXA/NASA

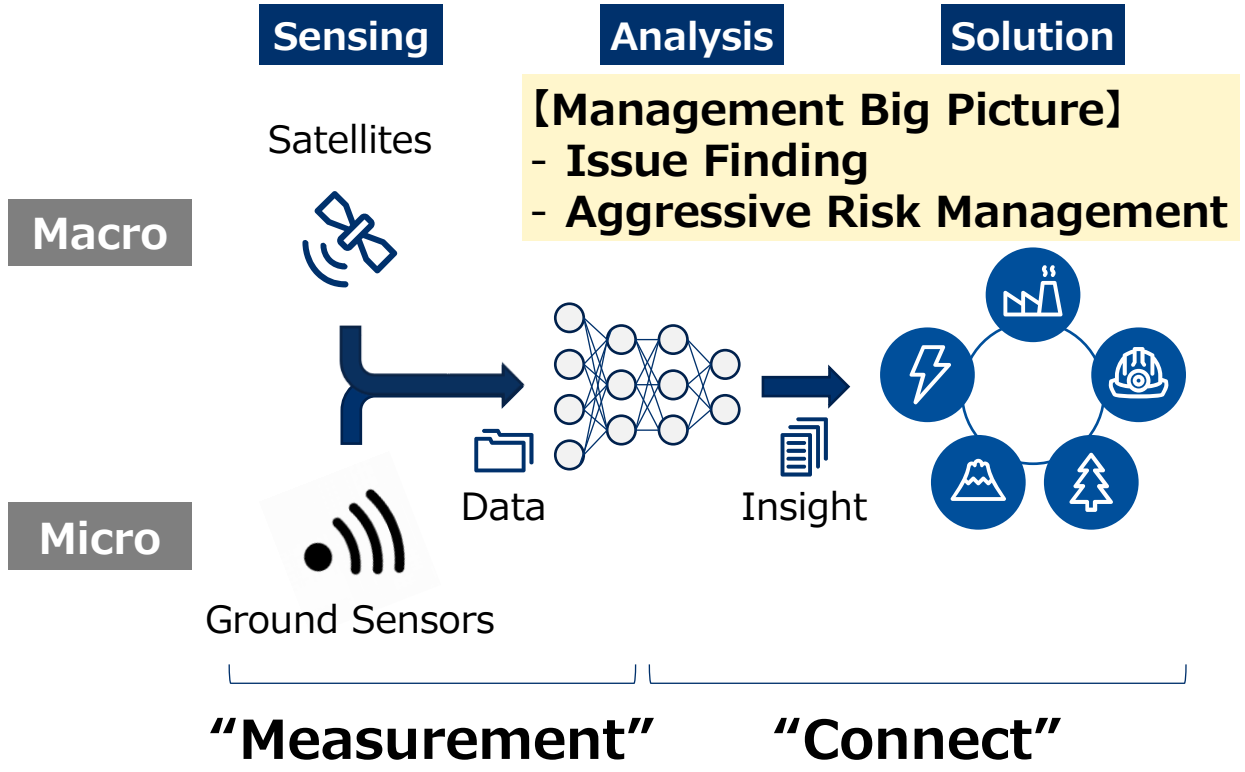
Circular economy from space

©2020 SPACE FOODSPHERE.

DX design by remote sensing
(From the 65th Japan Society for Aeronautical and Space Sciences Conference)

Digital Transformation Design with Remote Sensing by Yokogawa

◆Assist management decision making with insight extracted from combined macro and micro information as expanding our business based on “Connect” and “Measurement”



Development of “Ruler” to measure industrial activities with remote sensing data

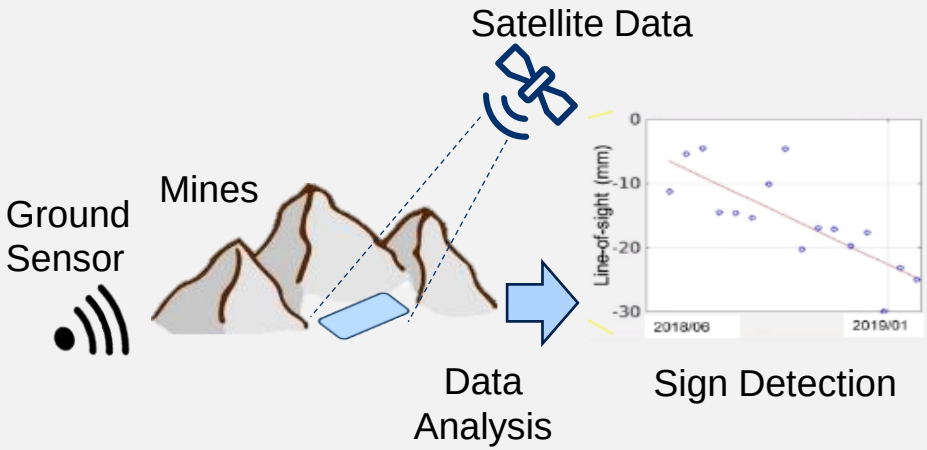
-What is “Ruler” ?-

- To catch activities at macro level, which is difficult to see on the ground
- To set up visualized and quantitative data usable for operation transformation

Cases for Proof of Concept (PoC)

Case1 : Land Displacement Decision Manager

- Mining industry requires operators surveillance-focused risk management system as ESG strategy
- Expand to operation and maintenance with accurate detection of tailing dam displacement enabled by advanced measurement



Case2 : Forest Optimizer

- Support the relief from labor-intensive work and efficient situational judgment
- Lead to efficient situational judgment such as early detection of damage due to pests and identification of abnormal areas, and supports on-site decision making

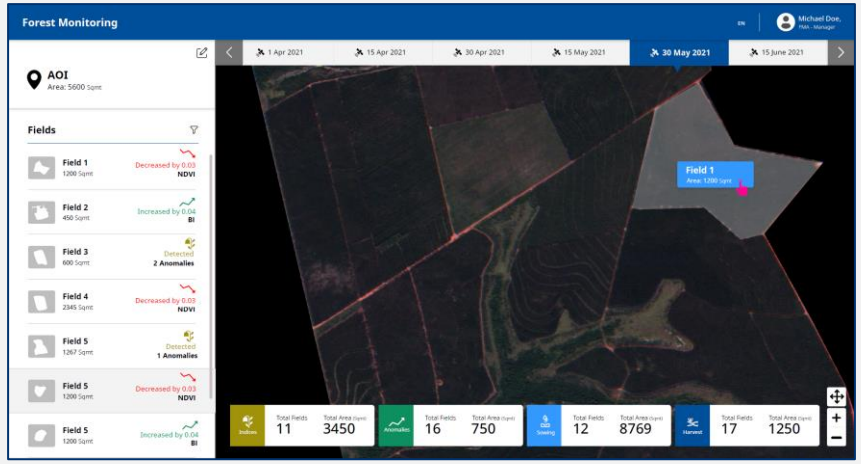
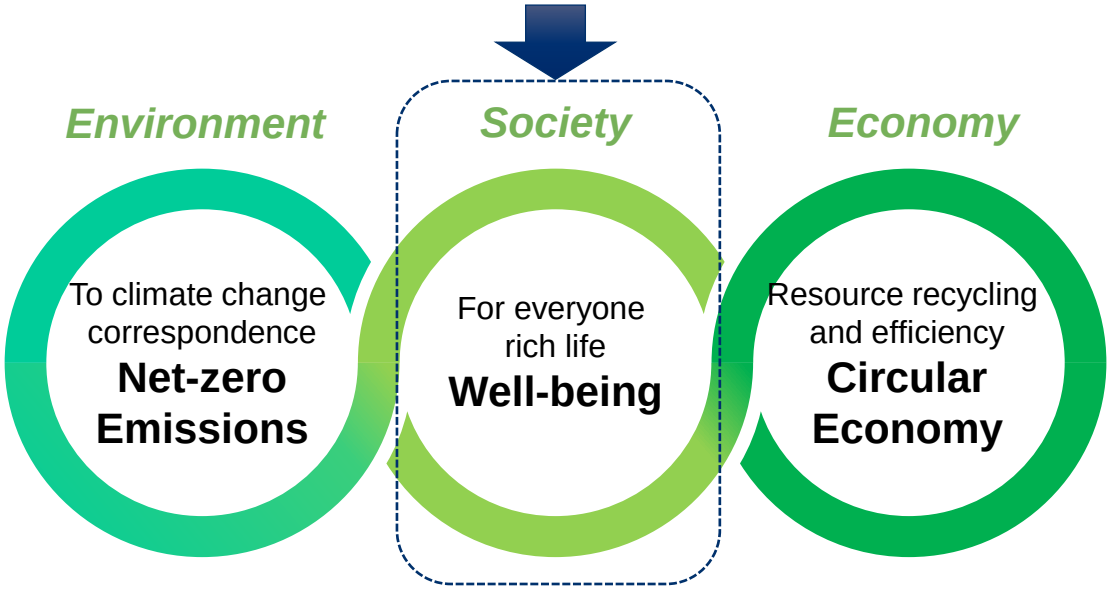


Illustration of Forest Monitoring Application

Life science research and development utilizing the space environment at ISS
(From the 65th Japan Society for Aeronautical and Space Sciences Conference)

Significance of life science research and development utilizing the Space environment

- Elucidate the influence of gravity on basic life phenomena such as development and evolution, and **deepen the essential understanding of life.**
- By elucidating the effects of gravity on physiological phenomena such as growth and aging, and diseases such as osteoporosis, **it will lead to the development of preventive and therapeutic methods for healthy longevity.**
- **Overcoming the health risks of staying in space** as the era of full-scale manned space activities approaches.



It will lead to the realization of "Well-being" which is one of the sustainability goals.

Yokogawa's contribution to life science research and development in Space

Life science research and development in "Kibo"

- Various life science research and development using the micro-gravity environment, such as culture experiments of three-dimensional tissues for cell medicine, are being carried out.
- **Three-dimensional observation of cell tissue is indispensable "in-situ" in orbit** in order to evaluate minute effects on cell-cell interactions.

In 2020, the live imaging system COSMIC was installed in "Kibo".

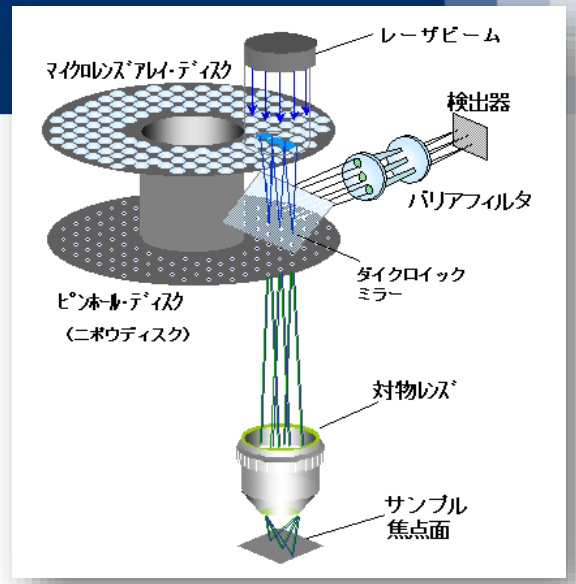
- COSMIC is a microscope system for space experiments developed by Chiyoda Corporation.
- It has the function of a confocal microscope widely used for stereoscopic observation of cell tissues.
- Yokogawa's CSU-W1 is used for the confocal scanner, which is the core of the confocal microscope.
- **We have been involved in the development of COSMIC for installation in Kibo.**

Live imaging system COSMIC ©JAXA

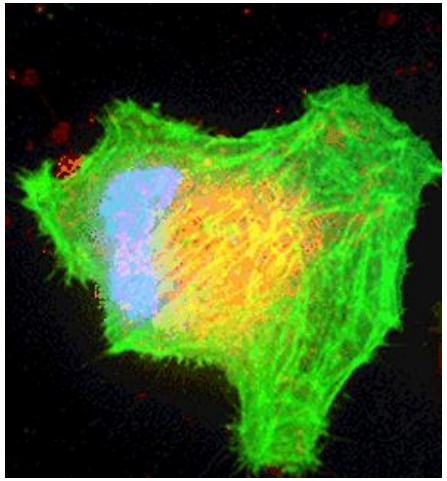
Confocal scanner CSU-W1

Features of Yokogawa's confocal scanner technology

- A confocal microscope is a special microscope that can observe a tomographic image of a sample.
- Yokogawa's confocal scanner CSU-W1 has **high-speed, low bleaching** characteristics due to its unique technology that scans 1000 laser beams at the same time.
- The Split View function, which measures two wavelengths simultaneously with one camera, enables highly accurate measurement using the fluorescence resonance energy transfer (FRET) phenomenon.
- These features of CSU-W1 **allow COSMIC to observe the dynamic life phenomena of living cells in orbit for long periods of time.**

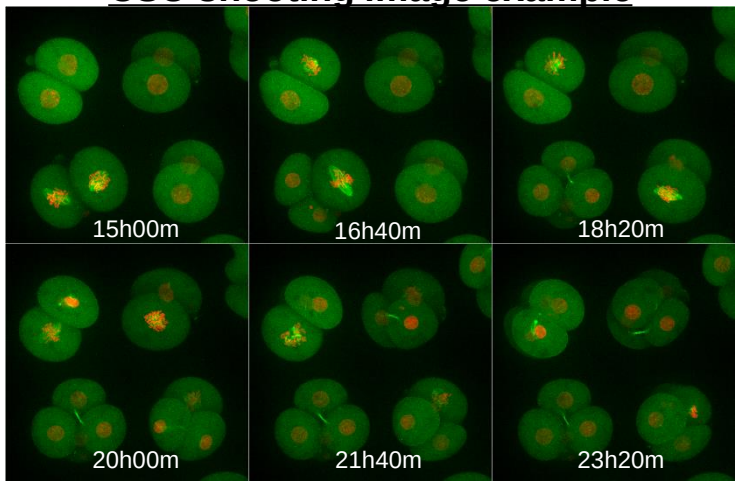


Principle diagram of confocal scanner

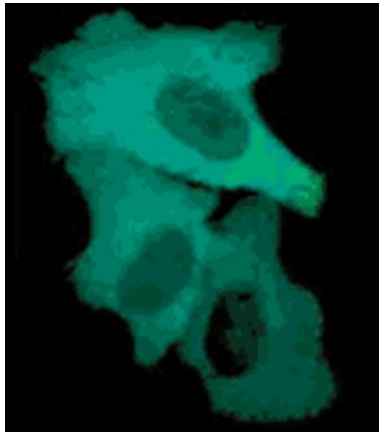


Escape of intracellular vesicles due to mechanical stress (Image courtesy of Professor Seiryo Sugiura, University of Tokyo)

CSU shooting image example



Long-term imaging of early mouse embryos(Image courtesy of Professor Kazuo Yamagata, Kindai University)



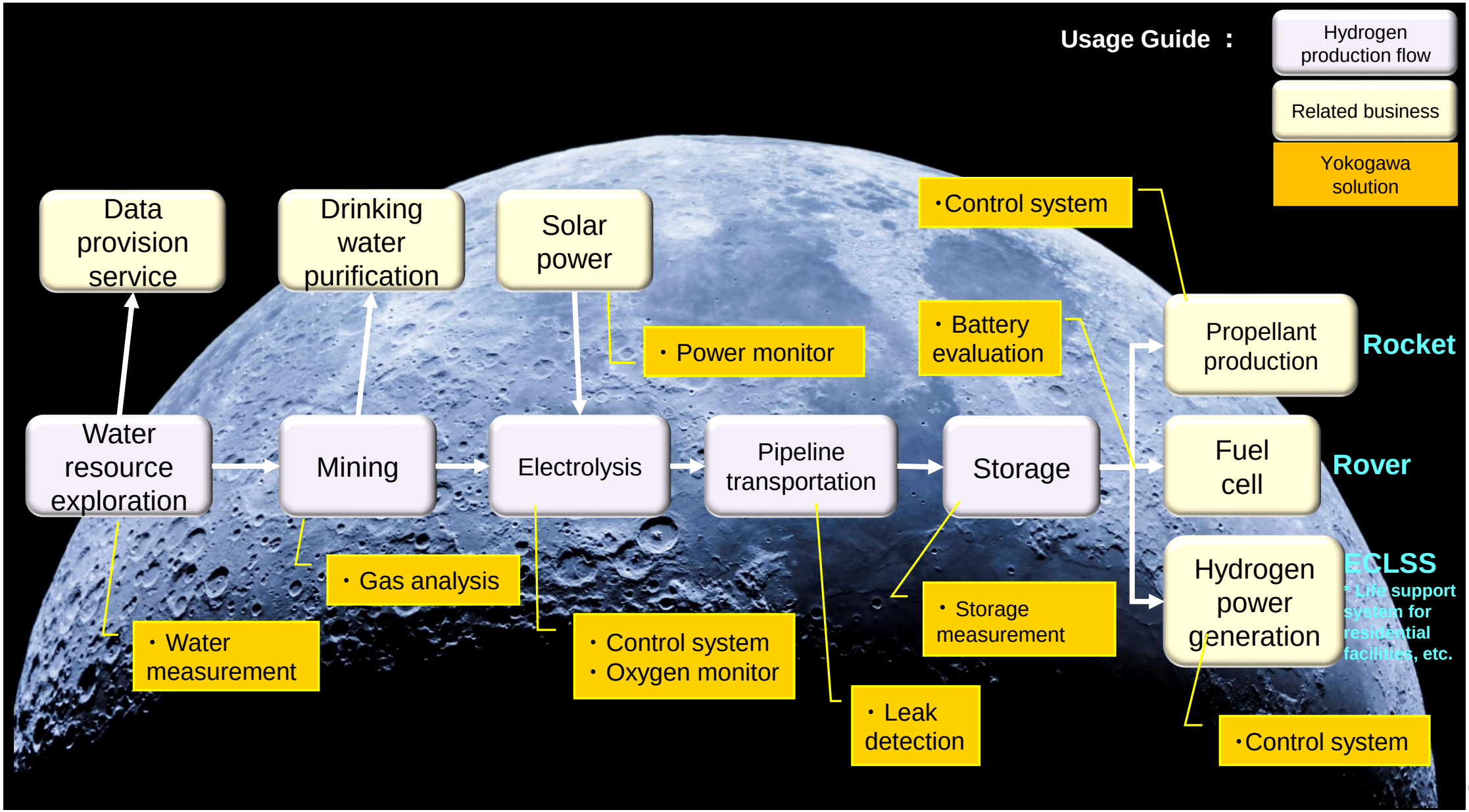
Ca2 + imaging using FRET phenomenon (Image courtesy of Atsushi Miyawaki, Ph.D., Institute of Physical and Chemical Research and Professor Kenji Nagai, Osaka University)

Experimental themes using COSMIC

- Space Organogenesis experiment （Representative Researcher: Professor Hideki Taniguchi, University of Tokyo, Yokohama City University）
  - Confocal observation of hepatocyte tissue cultured in space will be carried out with the aim of developing a technology for creating three-dimensional organs using iPS cells.
- Cell Gravisensing experiment（Representative Researcher: Professor Emeritus Masahiro Sokabe, Nagoya University）
  - He aims to clarify the mechanism by which cells are sensitive to gravity and lead to muscular atrophy and bone loss, and uses COSMIC's confocal observation function and FRET measurement function to image and analyze intracellular signals.

In the future, we believe that Yokogawa's technology can contribute to various basic research and technological development through various space experiments using COSMIC. Taking this as an impetus, we will focus on developing products and solutions that are useful for people's affluent lives on the ground and in space, and aim to realize "Well-being," which is one of our sustainability goals.

Yokogawa's contribution to the lunar hydrogen supply chain (examples)



Press release on June 17

Yokogawa to Join HAKUTO-R Commercial Lunar Exploration Program as a Supporting Company

- Targeting the development of equipment to explore lunar water resources for industrial use -

develop measurement technology that can be effective in searching for lunar water resources for industrial use, as well as control and other technologies necessary for the hydrogen value chain, and thereby help to realize the infrastructure necessary for lunar economic activities

y Agreement with ispace, inc. (ispace) to join HAKUTO-

anned to launch in 2022(Current plan as of June 2022),
une 2022). Through these missions, the HAKUTO-R
kogawa Electric has agreed with ispace to participate in

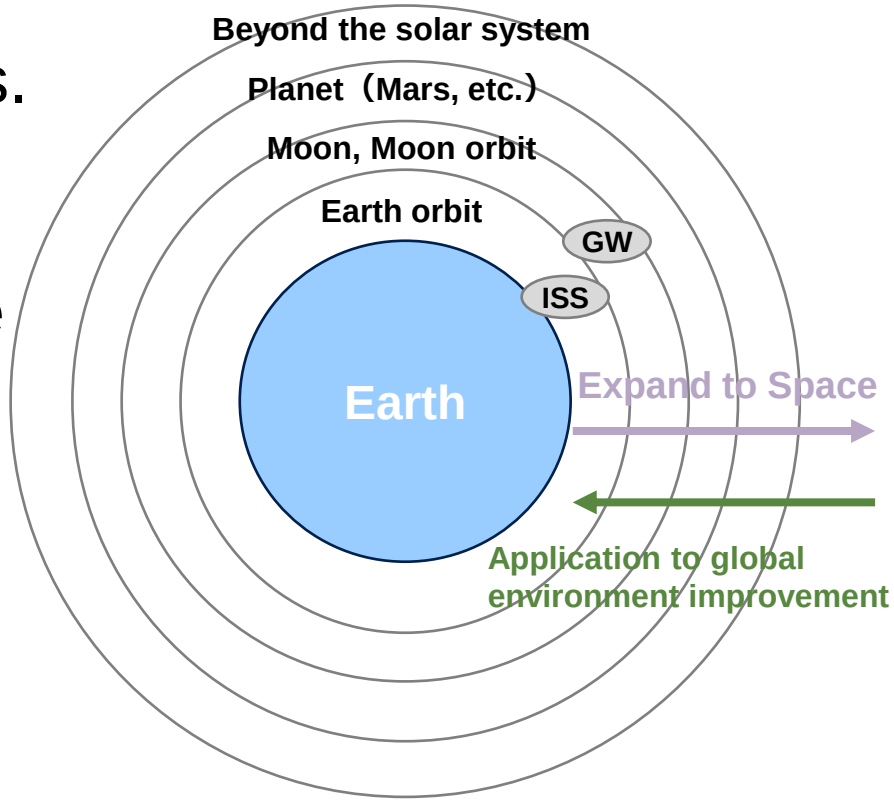
g

ted that
eded for
fuel and to support life. With this agreement, Yokogawa will leverage knowledge gained through the HAKUTO-R program and its own proven industrial technologies to **develop measurement technology that can be effective in searching for lunar water resources for industrial use, as well as control and other technologies necessary for the hydrogen value chain, and thereby help to realize the infrastructure necessary for lunar economic activities**.

Satoru Kurosu, general manager of Yokogawa Electric's Space Business Development Office, said, "Amid rising interest in the space business and commercial lunar use, we have positioned space as one of the areas for exploration in our long-term management framework. As co-members of the Lunar Industry Vision Council*3, Yokogawa and ispace have a common goal of building an internationally competitive foundation for the industry. And I am confident that the technology necessary for developing a supply chain for locally produced and consumed hydrogen in the extreme environment of the moon will also contribute toward a sustainable society on Earth."

Yokogawa's approach to Space

- Yokogawa continue to create **Net-zero emissions and Well-being solutions** from the Low Earth Orbits.
- On the Moon and beyond where all habitable (living, economic) resources such as air, water, food and electricity are extremely limited, Yokogawa contribute to create **ultimate Circular Economy solutions** in these extreme environments, including in-situ production, recycle / reuse and resource management.
- And make sure to use these solutions to **achieve Sustainable Development Goals (SDGs) of Humankinds.**

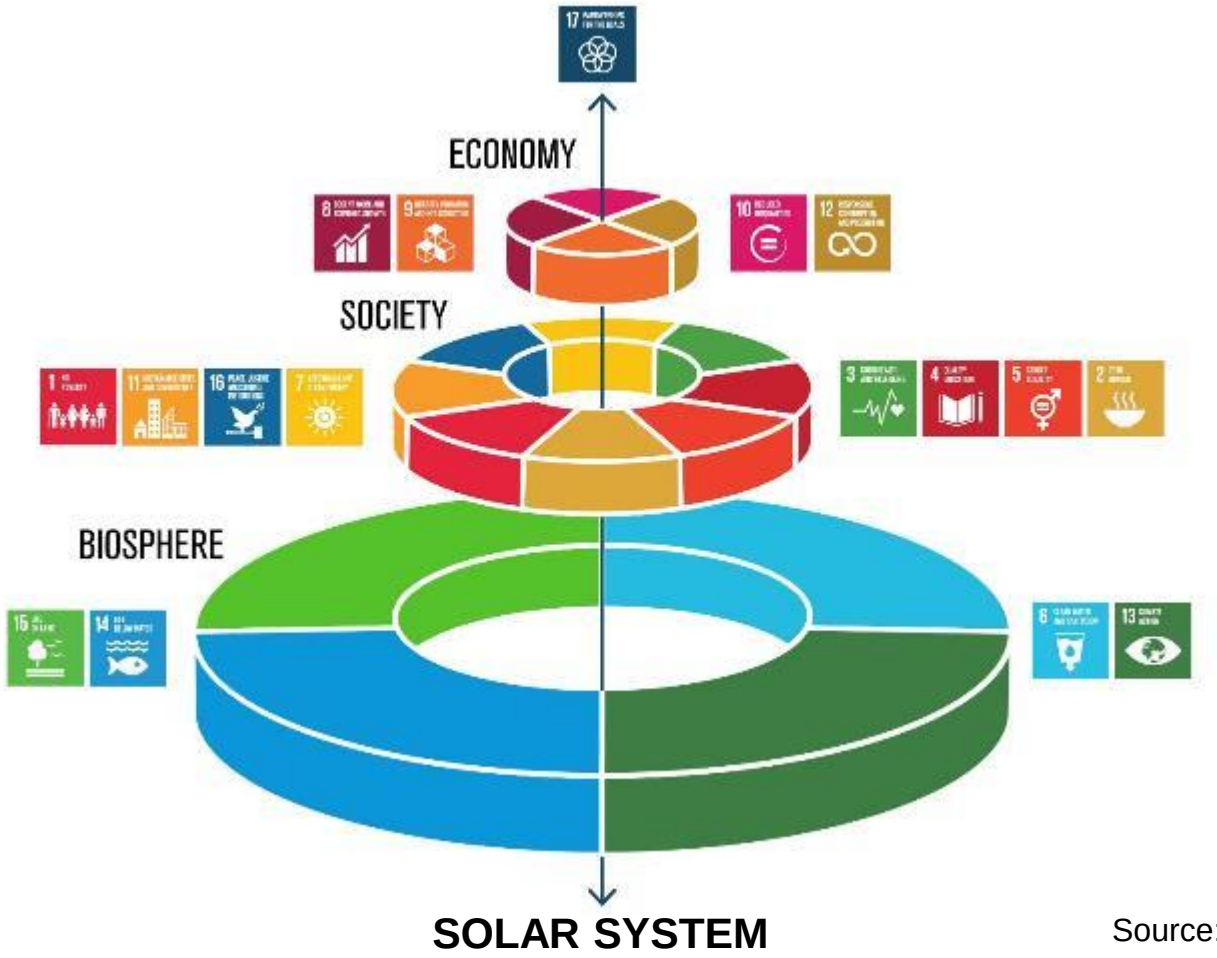


ISS：International Space Station
GW：Gate Way

"Think of Space" means "think of the Earth"

Closing

It is time to work closely together for our future



Source: Stockholm Resilience Centre

To protect the irreplaceable Earth

YOKOGAWA

Co-innovating tomorrow™