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Technical Presentation
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Vienna

Expanding partnerships in space exploration

--- Developing technology for space habitation and its applications to the earth society ---

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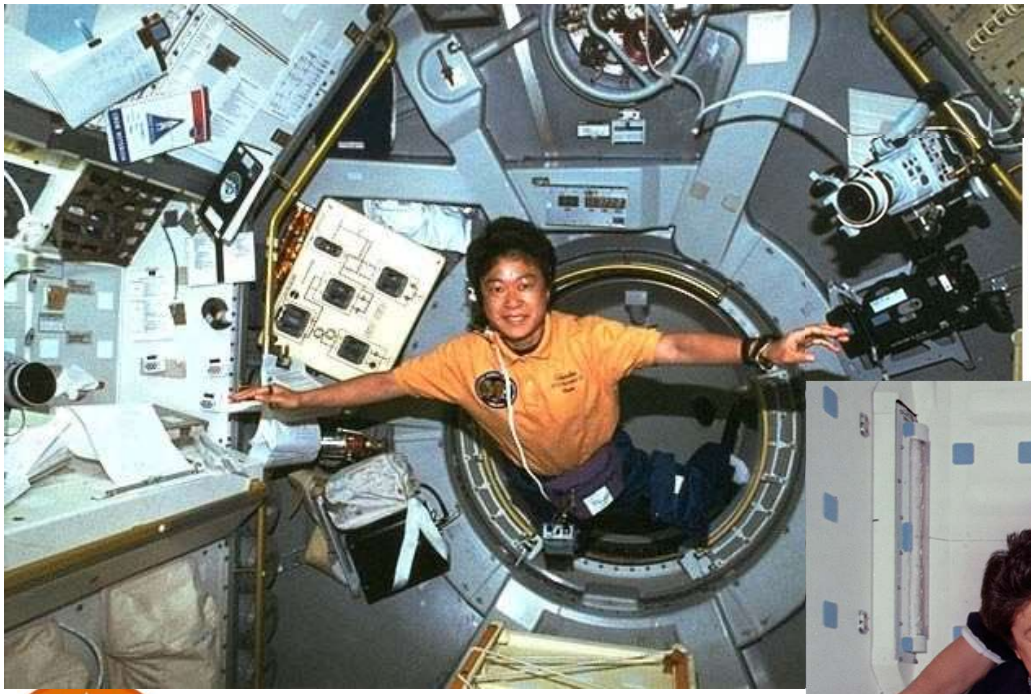
Senior Advisor: JAXA Japan Aerospace Exploration Agency (JAXA)

Living and working in space is wonderful, and requiring many challenges in technology

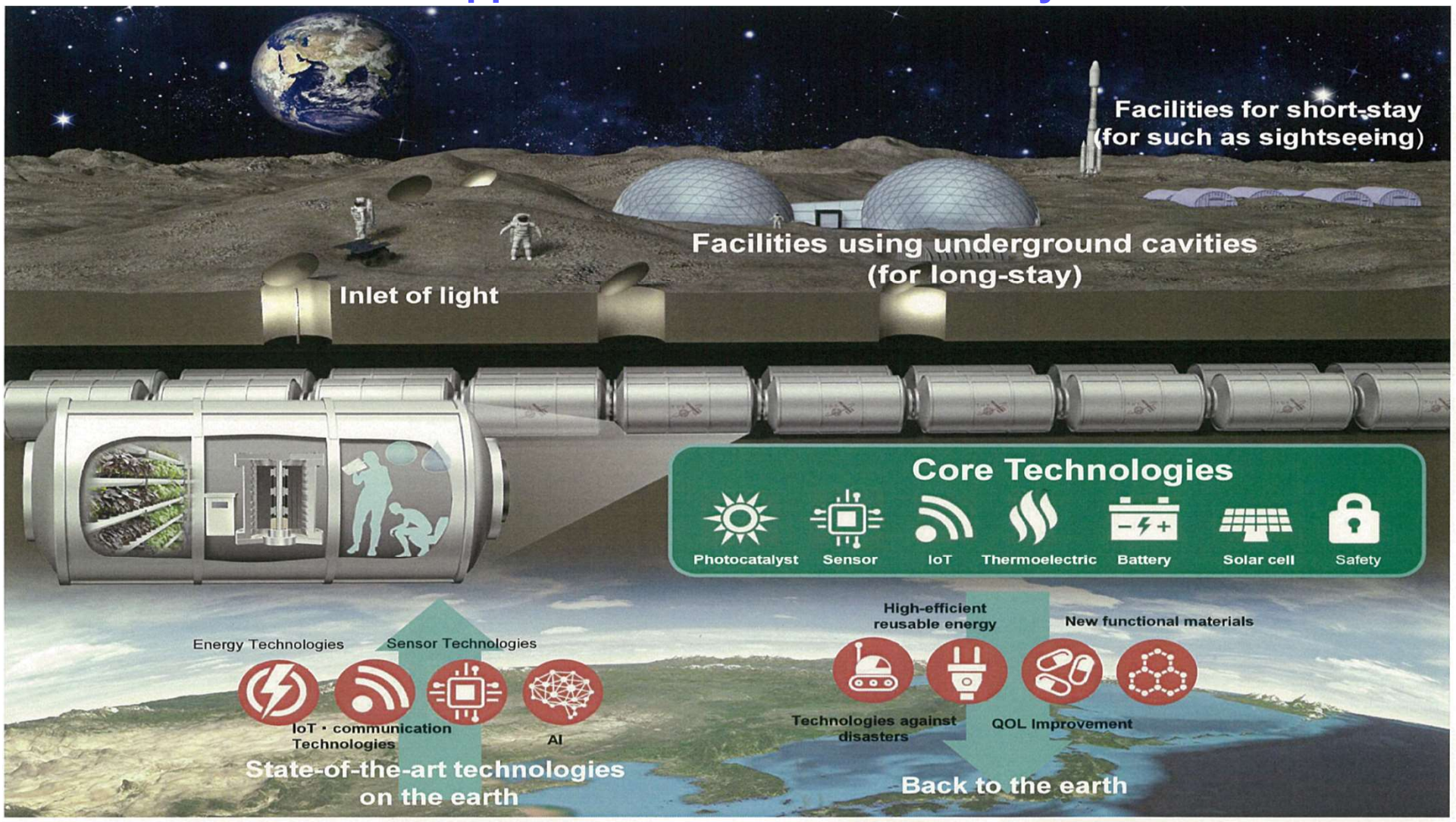


International Microgravity Laboratory 2 (IML-2/STS-65) in 1994

STS-95 in 1998

TUS Research Center for Space Colony

Developing technology for moon-base habitation and its applications to the earth society



History and overview of Tokyo University of Science

東京理科大学 TOKYO UNIVERSITY OF SCIENCE

No space department exists

The 21 founders of Tokyo University of Science

Building a better future with science

Prof. Kotaro HONDA
First President of TUS

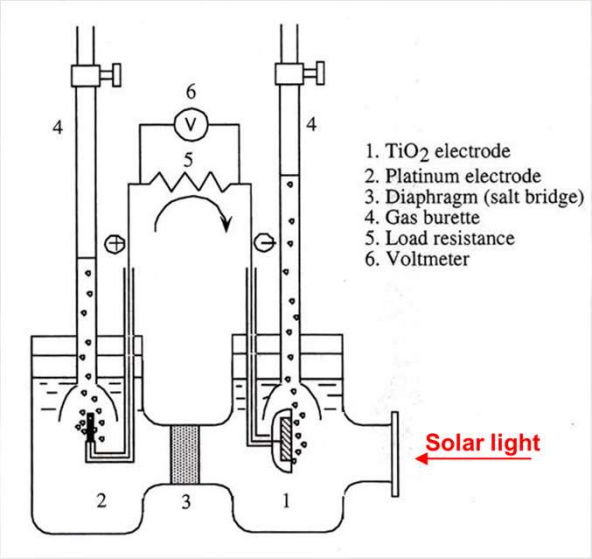
1881	The establishment of the Tokyo Butsurigaku Koshujo (Tokyo Academy of Physics) is advertised.
1883	The Academy is renamed the Tokyo Butsuri Gakko (Tokyo College of Science).
1949	The Tokyo College of Science is renamed the Tokyo Butsuri Gakuen (Tokyo Academy of Physics) Faculty of Science Division I and II is established
1960	Faculty of Pharmaceutical is established
1962	Faculty of Engineering is established.
1967	Faculty of Science and Technology is established.
1981	Research Institute for Science and Technology is established.
1987	Faculty of Industrial Science and Technology is established.
1989	Research Institute for Biomedical Sciences is established.
1993	School of Management is established.

As of May 2016

Faculties		Admin. Stuffs		Students	
Prof.	346	Clerical	428	Undergrad	16,528
Ass. Prof.	143	Professional	96	MA	2,640
Jr Ass. Prof.	114	Medical	7	PhD	298
Assist. Prof.	222	Part-Time	117	Professional	209
Total	825	Total	648	Total	19,675

Photocatalysis

Akira Fujishima, Ph.D.
Former President
Professor Honor
Director in Photocatalysis International Research Center



A. Fujishima, K. Honda, *Nature* (1972)

Opened in April 2013

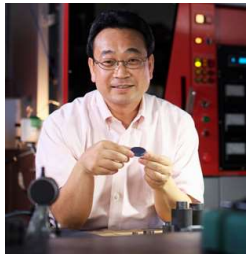
Application Fields

Battery (Energy Creation & Energy Storage)

The Yai dry-battery

The world's first dry-battery was invented in Japan in 1887 during the Meiji Era.

The inventor was Sakizou Yai who attended Tokyo Physics School, the predecessor of the university



Prof. Tsutomu IIDA

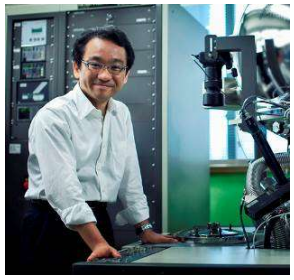
Development of heat recycling system by thermoelectric materials

Prof. Mutsumi SUGIYAMA

Growth and Characterization of CIGS and fabrication of CIGS solar cell

Assoc. Prof. Jun KOYANAGI

Composite materials
Experimental Mechanics
Computational Mechanics
Flywheel-battery



Prof. Shinichi KOMABA

Lithium Ion Battery
Sodium Ion Battery
Potassium Ion Battery

Approach in RIST (Research Institute for Science and Technology)

東京理科大学 TOKYO UNIVERSITY OF SCIENCE

Corroborate professors with different expertise beyond departments
Promote interdisciplinary studies

7 centers, 20 research divisions (as of March, 2018)

Functional Materials

○Water Frontier Science & Technology Research Center
○Photocatalysis International Research Center
○Division of Colloid and Interface Science
○Photovoltaic Science and Technology Division
○Division of Thermoelectrics for Waste Heat Recovery
○Division of Synergetic Supermolecular Coordination System in Multiphase
○Advanced EC Device Research Division
○Advanced Agricultural Energy Science and Technology Research Division

Fundamentals

○IR FEL Research Center
○Imaging Frontier Center
○Division of Mathematical Modeling and its Mathematical Analysis
○Division of Modern Algebra and Cooperation with Engineering

Interdisciplinary

Research Center for Space Colony (RCSC)

Bio and Pharmacy

○Translational Research Center
○Academic Detailing Database Division
○Division of Medical-Science-Engineering Cooperation
○Fusion of Regenerative Medicine and DDS
○Division of Agri-biotechnology
○Brain Interdisciplinary Research Division

Structural Materials

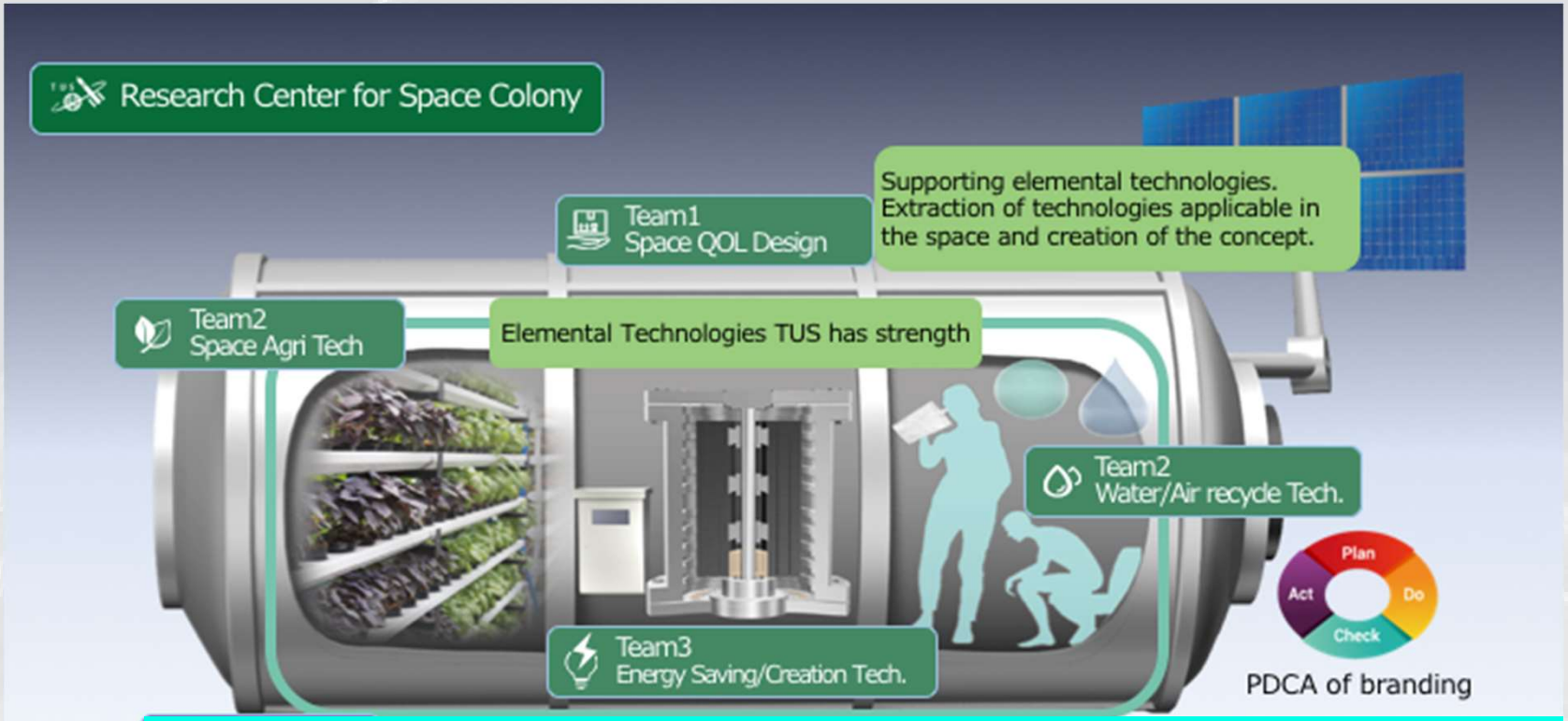
○Research Division of Multiscale Interfacial Thermofluid Dynamics

Information and Societal

○Center for Fire Science and Technology
○Division of Intelligent System Engineering
○Division of Advanced Urbanism and Architecture
○Division of Things and Systems
○Atmospheric Science Research Division
○Division of Super Distributed Intelligent Systems

Research Center for Space Colony

Developing technology for moon-base habitation and its applications to the earth society



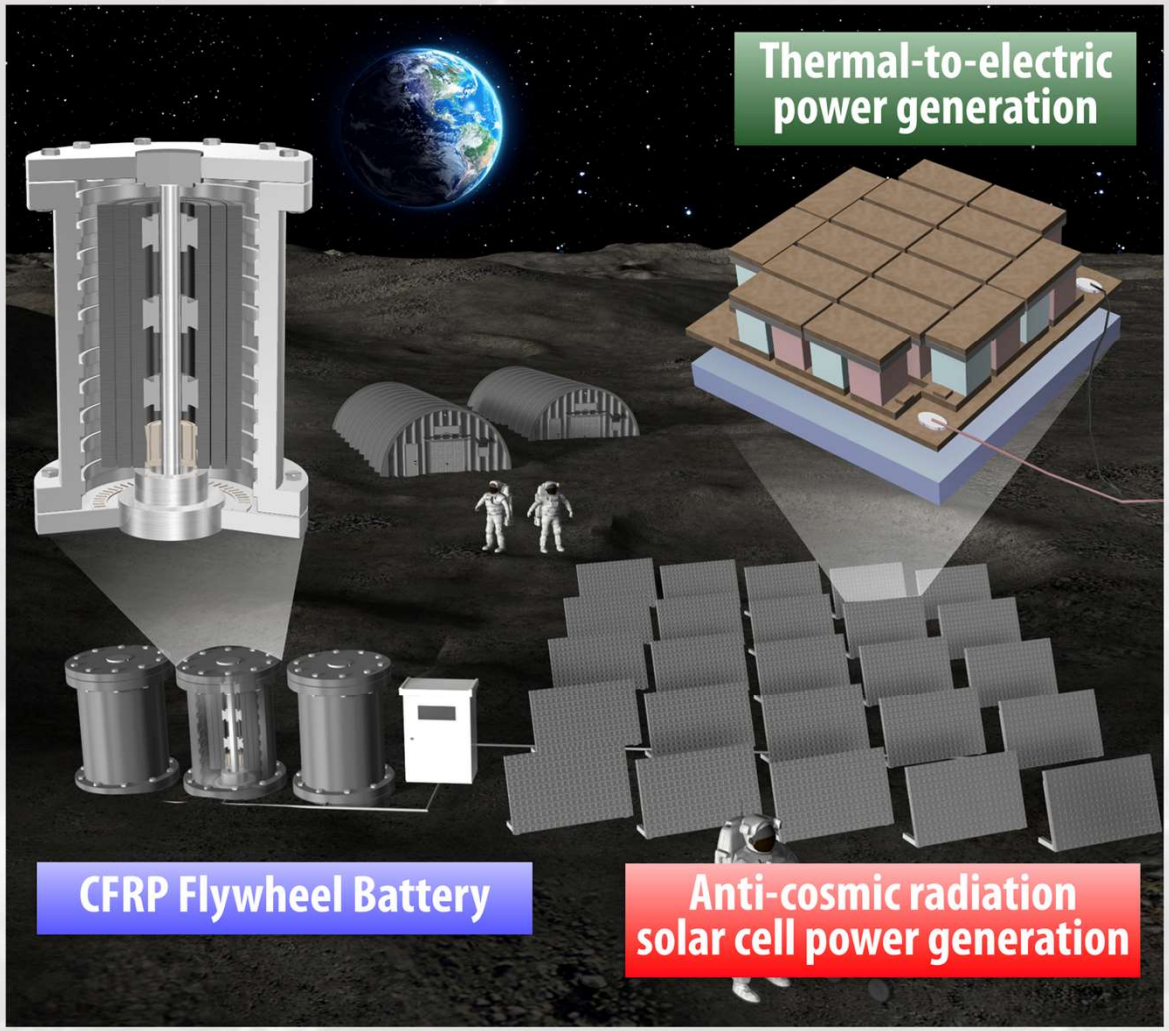
Living in space needs:

Energy supply

Recycle of water and air

Food production for self -support

Energy Generation and Storage



- Power generation and storage at space colony
- Anti-cosmic ray solar cell for daylight power generation
- Thermal-to-electric power generation from temperature difference
- Power storage and conditioning using flywheel battery

Water and air recycle technology

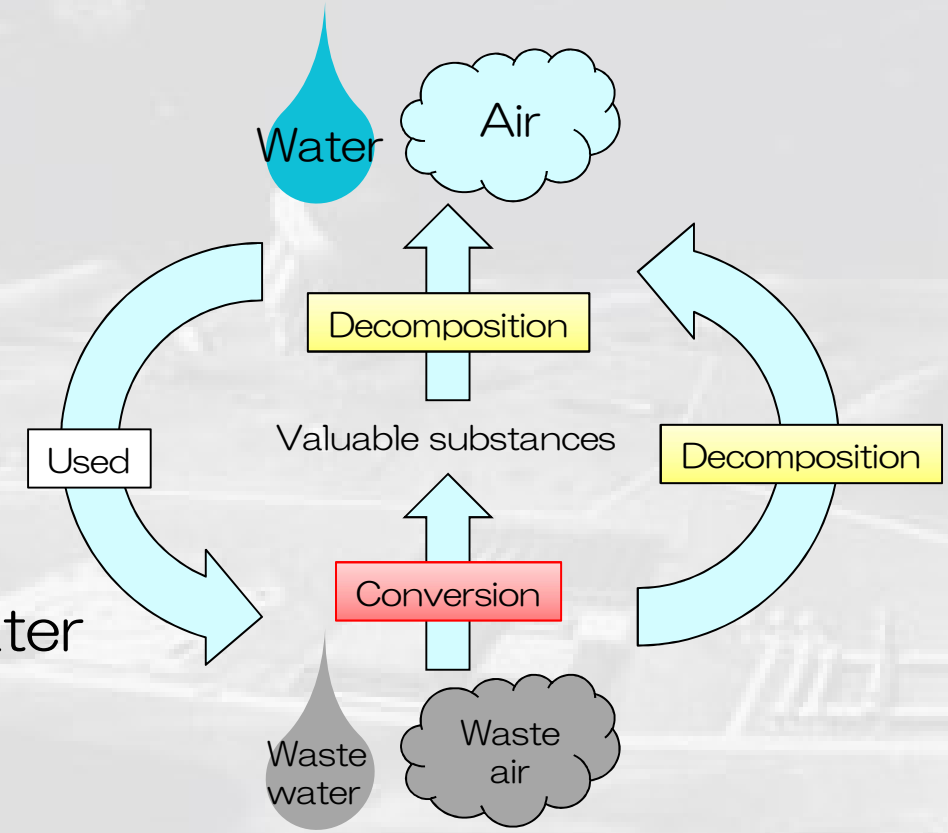
Environmental remediation for better stay

Goal 1

Improvement of water and air recycle technology
- more efficient
- more compact

Goal 2

Expansion of concept for water and air recycle technology
- Create useful compounds from waste



Application of in-liquid plasma technology and diseases & insects-free cultivation system

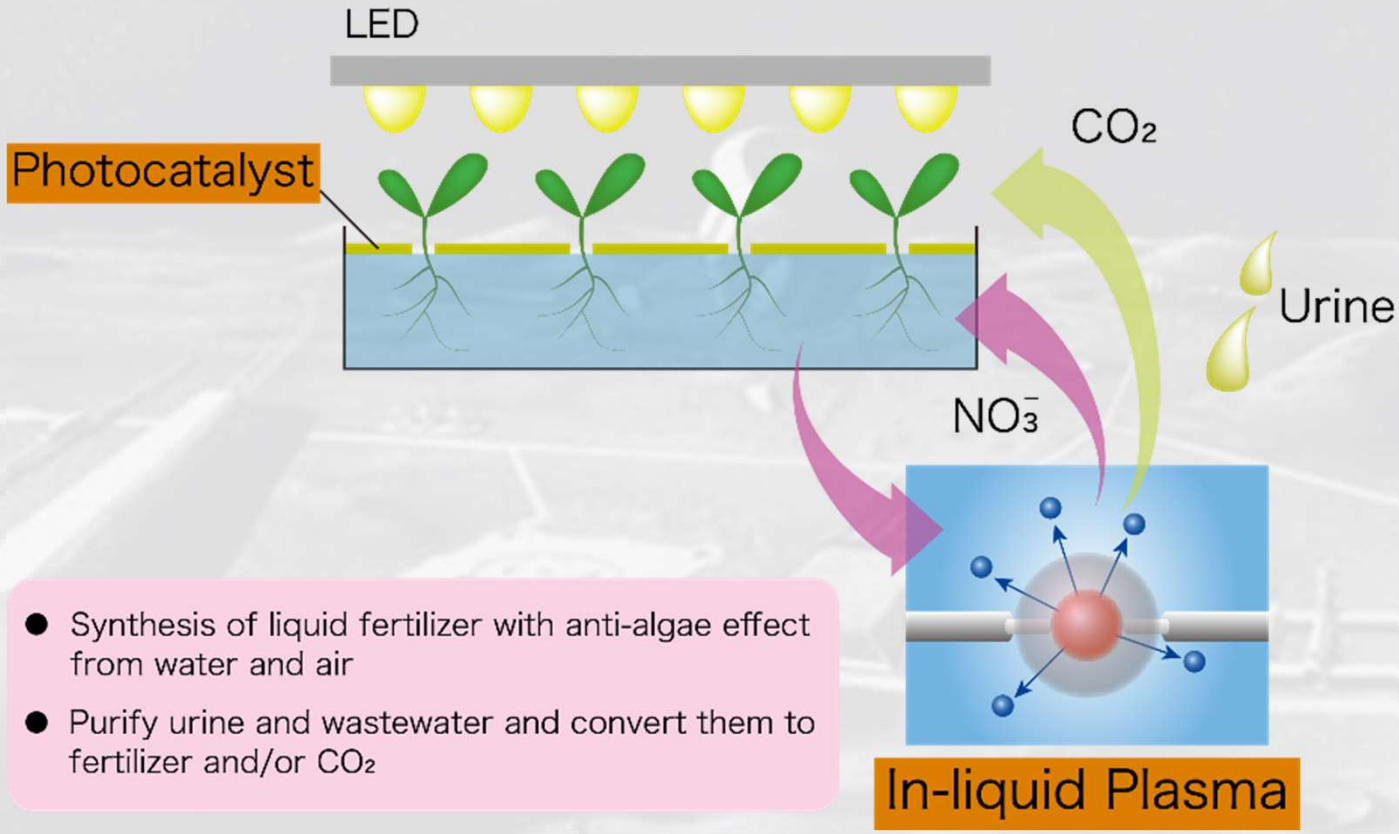
Closed system

Virus-free seedling supply utilizing bag-type culture vessel technology

Tansa

TAKENAKA
KIRIN
CHIBA UNIV
TUS

Open system for growing plants



- Synthesis of liquid fertilizer with anti-algae effect from water and air
- Purify urine and wastewater and convert them to fertilizer and/or CO_2

In-liquid plasma technology

Cloud = Water + Air

These are ionized and/or recombined by natural plasma. Then, **nitrogen compounds as natural nutrient are produced**.

Mimic of Thunder

Resource

H_2O, N_2, O_2

$$N_2 + O_2 \rightarrow 2NO \xrightarrow{O_2} 2NO_2 \xrightarrow{H_2O} 2HNO_3$$

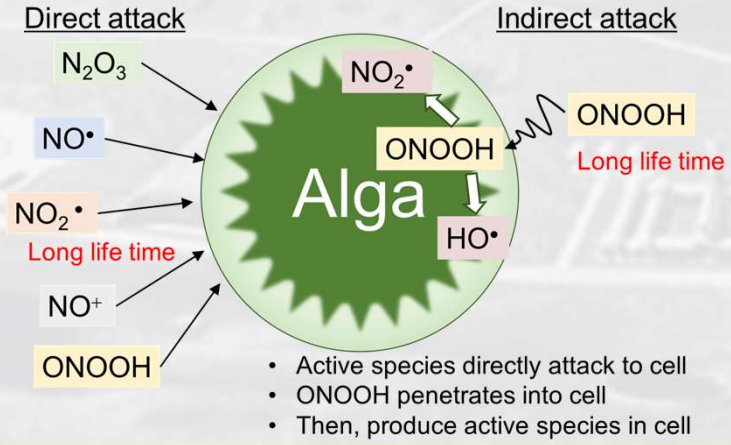
$$3H_2 + N_2 \rightarrow 2NH_3$$

Ammonia

$$1/2N_2 + 3/2H_2O \rightarrow NH_3 + 3/4O_2$$

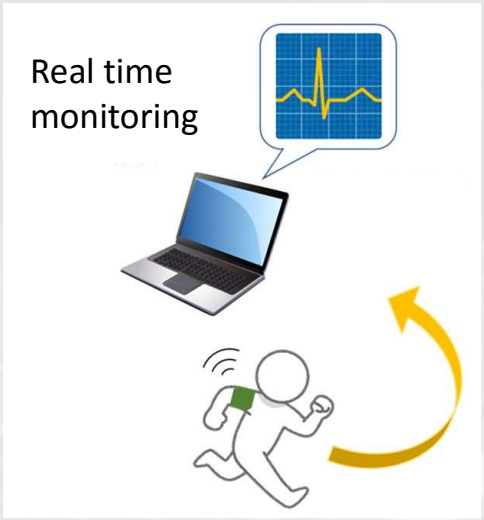
Nitric acid

Sanitary

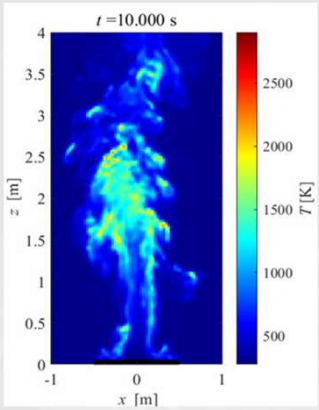


Space QOL design

Improvement of QOL in longtime space flight



Biosensing for stress and healthcare monitoring with wireless system



Fire behavior prediction in low-gravity environment

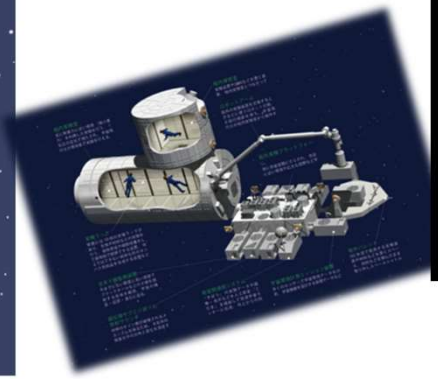
Image acquiring with high resolution in low Light intensity environment

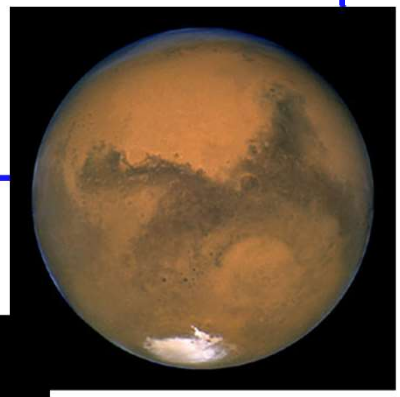
Next-generation Internet in space and amusement contents fit for each astronaut

Dual development approach: Space & Ground

Resource(water, energy, food etc.) dependency:

- **ISS** depends on earth resources almost 100%
- **Moon** needs to use in situ resources to live
- **Mars** should be totally independent (self-sufficient)





The exploration/habitation research is analogous to the countries with less-natural resources becoming more independent from the out side (foreign) resources

Developing technology for space habitation will greatly contribute to involve everyone for achieving sustainable development through space