Steering Committee for the
Decadal Survey on Biological and Physical Sciences in Space
14 October, 2009
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Washington, DC 20418

JEM Utilization Overview

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Human Space Systems and Utilization Mission Directorate,
Japan Aerospace Exploration Agency (JAXA)
ISS Program Status

The first element (Logistic Module) of JEM “Kibo” attached in March 14, 2008 and Pressurized Module (JEM PM) of Kibo attached on June 3, 2008.

Exposed Facility of the Kibo attached on July 19, 2009 and Kibo on-orbit assembly was completed.

The demonstration flight of H-II Transfer Vehicle (HTV-1) successfully launched on September 11 and birthed to the ISS on September 19, 2009.

Science Experiments on Kibo

Microgravity science on Ryutai Rack (Marangoni, Ice crystal, etc.)
Life science experiments on Saibo Rack (Dome Gene, etc.)
Exposed Payloads (SEDA, MAXI and SMILES) was launched and now in operation (SEDA) or in commissioning (MAXI, SMILES)

JAXA has started preparation of the 2nd phase of Kibo utilization for 2010 -2012 timeframe.
## Long term perspective of JEM utilization

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<tbody>
<tr>
<td>2008</td>
<td>Develop Kibo’s potential for space env. utilization</td>
<td>- Implement leading scientific researches</td>
<td>- Improve quality of life</td>
<td>To be discussed</td>
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<td>2009</td>
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<td>- Foster practical utilization contributing to social needs</td>
<td>- Expand leading science &amp; technology</td>
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<td>2020</td>
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### Return outcomes to society
- (e.g. Welfare of aging society & Safe, relieved medical care, Innovation in cooperation with industries, Environment, energy and food related issues)

### Scientific researches utilizing space environment
- (life science, material science, Earth observation, space science)

### Demonstrate technologies for future space activities
- (e.g. space solar power system, robotic technology, etc.)

### Commercial, cultural & educational use and cooperation with Asian countries

- Life science
- Space Medicine
- Physics, Material Science
- Technology development
- Applied R&D activities
- Encouraging public participation
Technology development for human exploration to Moon and beyond

- New space suit, Life support systems
- Space Robotics
- Space Medicine and Manned Space Technology

New frontier of science
- Understand adaptability of Human
- Astronomy, Earth Science

Contribution to activities on the Earth
- Improvement of material processing on the ground
- Improvement of medication
- Earth environment monitoring

Outcomes of JEM utilization contribute to improve the quality of life

Diversify JEM utilization

1st Phase (2008～Mid 2010)
Develop potential of JEM

2nd Phase (Mid 2010～2012)
Outcomes of JEM utilization contribute to improve the quality of life

3rd / 4th Phase ~
Diversify JEM utilization

Life science
- Explore adaptability of life using cell
- Collaborate space life science and space medical research
- Understand elementary step of physical phenomena
- Develop potential of JEM-EF

Space medicine
- Explore adaptability of life using individual
- Establish high reliability space medical technology

Physics, Material science
- Make Integrated model of physical phenomena
- Challenge to top science and technology

Technology development / JEM-EF

Long term perspective of JEM utilization (Science)
Perspective of Life science in JEM

Mechanism of muscular atrophy (Analysis of the protein related to muscle degradations)

- Understanding of the role of gravity in evolution of life
- Understanding of the adaptability of life to space environment
- Establish countermeasures for ensuring the safety of human activities beyond low earth orbit

Future (2013-)

Understand adaptability of Human

- Candidates selected

Explore adaptability of life using individual

1st Phase (-2010): In progress

Explore adaptability of life using cell

- the role of gravity in evolution of life and complexity and diversity of life

- mechanisms of gravity perception in cell (signaling events, receptor)
- Cell differentiation, histogenesis
- Evaluation of effects by space radiation
- mechanisms of amyotrophy
**Perspective of Physics and Material science in JEM**

- **1st phase (~2010): In progress**
  - Understanding of the fluid behavior under microgravity (Understanding the Marangoni convection, and finding a clue of the controlling method of Marangoni convection)
  - In-situ observation of crystal growth mechanism
  - Production method of large diameter single crystal (homogeneous composite semiconductor)

- **2nd phase (~2012): Candidates selected**
  - Making of Integrated model for improvement of material processing on the ground

- **Future (2013-)**
  - Material Science under low gravity
  - In-Situ material processing technology
  - Thermal management technology for large scale space systems
  - Thermal-photovoltaic device
  - Application to gas sensor

- **Understanding of elementary step of physical phenomena for material processing**
  - Crystal Growth Mechanism
  - Unstable flux and of the Marangoni-convection pattern formation
  - High-quality actual -use material (such as composite semiconductor)

- **In-situ observation of the Ice Cell growth**

- **Thermal management technology for large scale space systems**

- **Modeling of complex Marangoni-convection (Unstable flux and of the Marangoni-convection pattern formation)**
  - Modeling of crystal growth mechanism
  - Boiling, Two-phase flow
  - Modeling of the spray combustion
  - New functional materials using containerless processing
  - Phenomena near the critical point
Science and Technology development on JEM-EF

- Technology development for human exploration to Moon and beyond
- New frontier of space science
- Contribution to the ground activities (Global change, Space weather, Solar power utilization)

Future (2013 ~)

2nd Phase (~2013): Candidates selected

Challenge to top science and technology

Develop JEM-EF’s potential

- Demonstration of large structure technology in space (EVA support Robot, Inflatable technology)
- Global change related research (Extreme high energy cosmic ray, atmospheric optical phenomenon)
- Search of interplanetary matter on ISS orbit
- Demonstration of the state of art technology (Long term operation of cryogenic apparatus)

1st Phase (~2010): In progress (11 missions)

- Observation and notification report of the X-ray objects (over 1000)
- Long term space environment measurement
- Recovery monitoring of the stratospheric ozone lamina
- Technology demonstrations (mechanical space-use 4K refrigerating equipment (world first) and X-ray camera which has the largest field of view and highest sensitivity in the world)
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<tr>
<td>March, 2008</td>
<td>June, 2008</td>
<td>July 2009</td>
<td>HTV#1 launch</td>
<td>HTV#2 launch</td>
<td>HTV#3 launch</td>
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<td>JEM ELM-PS</td>
<td>JEM-PM</td>
<td>JEM-EF &amp; ELM-EF</td>
<td>HTV#2 launch</td>
<td>HTV#3 launch</td>
<td>HTV#4 launch</td>
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<td>Saibo Rack</td>
<td>On the ELM-EF</td>
<td>On the ELM-EF</td>
<td>On the ELM-EF</td>
<td>On the ELM-EF</td>
<td>On the ULC of HTV</td>
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<tr>
<td>Ryutai Rack</td>
<td>SEDA-AP</td>
<td>SMILES</td>
<td>Multi-Purpose Small payload Rack</td>
<td>Electrostatic Levitation Furnace Rack</td>
<td>Port Occupied Type Exposed Payload</td>
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<td>In operation</td>
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<td>Now in on-orbit checkout phase</td>
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<td>2 candidates</td>
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The 1\textsuperscript{st} phase JEM utilization

- Utilization began in August 2008 with fluid physics experiment.
- More than 100 experiments will been conducted until 2010.

<table>
<thead>
<tr>
<th>JEM Pressurized Module</th>
<th>29 themes (100 experiments)</th>
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<tr>
<td></td>
<td>Life science and Material science</td>
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<td>(16 themes / 73 experiments)</td>
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<td>Space medicine and Manned space technology</td>
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<td>(5 themes)</td>
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<td>Applied research (3 themes / 8 experiments)</td>
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<td>Education and Culture (2 themes / 11 experiments)</td>
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<td>Commercial (3 themes)</td>
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<tr>
<th>JEM Exposed Facility</th>
<th>3 themes (11 experiments)</th>
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<tr>
<td></td>
<td>X ray monitor (MAXI), Earth observation (SMILES), Space environmental data acquisition (SEDA-AP / 9 experiments)</td>
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</table>
Ryutai Rack contains four payloads
- Marangoni Experiment series is performing in the FPEF
- FACET and Ice Crystal experiment have done in the SCOF
- High Quality Protein Crystal is under performing in the PCRF
- Image Processing Unit (IPU) support all experiment

Key point:
Microgravity environment is useful to find out physical phenomena those are hidden on the earth by Gravity, and can be used for processing new things.
Life Science on the Saibo Rack

Cell Biology Experiment Facility (CBEF)

Clean Bench (CB)

Special culture bag designed for space experiment. Rad Gene and LOH:
Those experiments are investigate space radiation effect to cultured cell through gene expression.

Rad Silk is biodosimetry experiment using silk work eggs, eggs are in refrigerator in JEM to expose space environment until return.

Space Seed (©JAXA/Toyama Univ.)
Investigate seed to seed plant culture
On-going from Sept to Nov. 2009

Dome Gene (©JAXA/Tokyo Univ.)
Special gene expression under microgravity using amphibian cell.
Performed in March 2009

Key point:
How the space environment affects to life forms those evolving on the earth? The knowledge will be dedicate to fundamental biology as well as human space flight.
Radiation monitoring by passive dosimeter (PADLES)

Holter Electric Cardiogram to monitor crew Biorhythm in the ISS.

Microbe sampling
JEM Exposed Facility Payloads

Space Environment Data Acquisition equipment-Attached Payload (SEDA-AP)

- Monitor Neutron, Plasma, Atomic Oxygen, Heavy Ion Capture Micro-Particles Expose Numerous Materials in Space Environment

SDOM (Standard dose monitor is mapping electron density (0.28-0.79 MeV)
South Atlantic anomaly can be seen.
Monitor of All-sky X-ray Image (MAXI)

- Observe X-ray burst by Gas Slit Camera and X-ray CCD Slit Camera
- Real-time Data Acquisition and Archiving
- Now in commissioning phase and interesting data is observed.

The First light image from MAXI gas slit camera observed
August 15th 2009 15:00 to 16:30 (90min)
Superconducting Sub millimeter-wave Limb-Emission Sounder (SMILES)

SMILES will monitor substance/molecules in the atmosphere those effect to Earth environment such as ozone layer destruction, Global heating.

- Demonstrate Sub-millimeter Sensor Technology based on Superconductive Mixer and 4-Kelvin Mechanical Cooler
- Sub-millimeter Limb-emission Sounding of the Atmosphere
- Global Observation of Trace Gases in the Stratosphere

Now in commissioning

SMILES was attached to the JEM EF on 9/24

The lowest temperature of JEM/SMILES mechanical cooler reached to ~4.1 Kelvin. This is key component of signal processor using super conducting technology.
Perspective of Life science in JEM

- Understanding of the role of gravity in evolution of life
- Understanding of the adaptability of life to space environment
- Establish countermeasures for ensuring the safety of human activities beyond low earth orbit

Future(2013-)

Understand adaptability of Human

Fundamental research of the plant cultivation
- mechanisms of amyotrophy
- the reception of cardiovascular system by mechanical stress
- Evaluation of effects by space radiation in long flight
- Microbiology research in spacecraft

Explore adaptability of life using cell
- the role of gravity in evolution of life and complexity and diversity of life

1st Phase(-2010): In progress
- mechanisms of gravity perception (signaling events, receptor)
- Cell differentiation, histogenesis
- Evaluation of effects by space radiation
- mechanisms of amyotrophy

2nd Phase(-2012):
- Candidates selected

Explore adaptability of life using individual

- Model organism

※Feature of Medaka Fish
- genomic analysis has completed
- alternation of generations will complete within 45 days

Radiation

If on this line, it shows that no difference between ground and microgravity.

Mechanism of muscular atrophy (Analysis of the protein related to muscle degradations)
Perspective of Physics and Material science in JEM

- Material Science under low gravity
- In-Situ material processing technology
- Thermal management technology for large scale space systems
  
  Future (2013~)

- Understanding of the fluid behavior under microgravity (Understanding the Marangoni convection, and finding a clue of the controlling method of Marangoni convection)
- In-situ observation of crystal growth mechanism
- Production method of large diameter single crystal (homogeneous composite semiconductor)
  
  1st phase (~2010): In progress
  
  2nd phase (~2012): Candidates selected

- Understanding of elementary step of physical phenomena for material processing

- High-quality actual-use material (such as composite semiconductor)

- Modeling of complex Marangoni-convection (Unstable flux and of the Marangoni-convection pattern formation)
- Modeling of crystal growth mechanism
- Boiling, Two-phase flow
- Modeling of the spray combustion
- New functional materials using containerless processing
- Phenomena near the critical point

- In-Situ observation of the Ice Cell growth

- Unstable flux and of the Marangoni-convection pattern formation

- Modeling of spray combustion → Efficiency improvement of internal-combustion

- Huge permittivity material using containerless processing (electrostatic) (Application to the electric device such as micro-condenser)
- High-refractive index glass (for Blue-ray laser)

- Making of integrated model for improvement of material processing on the ground
Science and Technology development on JEM-EF

- Technology development for human exploration to Moon and beyond
- New frontier of space science
- Contribution to the ground activities (Global change, Space weather, Solar power utilization)

Future (2013～)

- Observation and notification report of the X-ray objects (over 1000)
- Long term space environment measurement
- Recovery monitoring of the stratospheric ozone lamina
- Technology demonstrations (mechanical space-use 4K refrigerating equipment (world first) and X-ray camera which has the largest field of view and highest sensitivity in the world)

1st Phase (~2010): In progress (11 missions)

2nd Phase (~2013): Candidates selected

Challenge to top science and technology

Develop JEM-EF’s potential
Overview of 2nd phase utilization

• Time Frame
  - About 3 years from mid 2010 to 2012

• Utilization Policy
  - Return the results of ISS research to our society.
    • Fundamental science research and new knowledge from space experiments.
    • Innovations from manned space activity and space environment.
  - Establish Key technology for future exploration mission.
  - Astronomical science contribution & technology development utilize the JEM Exposed Facility.

• New Payloads in preparation
  - 2 racks in JEM-PM and 2 payloads on JEM-EF will be added.
• Preparation for the next phase of JEM utilization (2010-2012) has started.
  – Fourteen candidates had selected and now in preparation.
  – Announcement of opportunity for 2012 had released and more than sixty proposals are collected.

• JEM Pressurized Module Utilization
  – JAXA is developing Next Generation Experiment Facility
    ➢ Multi-purpose Small Payload Rack for small experiment users
    ➢ Aquatic Habitat (AQH) for small fishes (Medaka, Zebra fish)

• JEM Exposed Facility Utilization
  – JAXA and mission team are conducting design study.
    ➢ Port Shared Type: 5 phase B/C
    ➢ Port Occupy Type: 2 Phase A
Microgravity Science on the Kobairo Rack

- Kobairo Rack contains a single payload, Gradient Heating Furnace (GHF).
- Kobairo Rack will be launched by HTV-2 in 2011.
- The Gradient Heating Furnace (GHF) is a high-temperature electrical furnace with automatic sample exchange mechanism.
- Three Heater-Units can generate high temperature gradient to produce large scale pure crystals.
Multi-Purpose Small payload Rack (MPSR)

- **Purpose**
  - Provide experiment space, working table and resources such as electric power and communications for small experiment equipment.
  - The development cost of the user equipment should be low and the development schedule should be short.

- **Status**
  - Phase D/E design and Flight Model manufacturing

- **Overview & Specification**
  - Free work space
  - Work bench
  - User friendly interface
    - Power: 28, 16, 12VDC
    - Communication: Ethernet, USB
    - Video: Standard and High Definition NTSC
    - Cooling: cold plate, avionics air cooling
    - Vacuum bent / Gas supply
  - Experiment control by laptop PC
  - Safety
    - Temperature anomaly detection and power shutdown
    - Fire detection
    - Over-current protection

- **Conceptual Image**
  - Aquatic Habitat
  - Combustion Chamber
  - Work Volume
  - Small experiment area
  - Work Bench
  - Educational experiment
  - 3D photonic crystal
Aquatic Habitat (AQH)

- **Purpose**
  AQH will be utilized for biomedical researches and fundamental biology in space.
  - Biomedical researches
  - Fundamental researches
  - Educational researches, International cooperation

- **Research Area**
  - Alternation in gene expression
  - Mechanism of Bone loss and muscle atrophy
  - Effects of cosmic radiation

- **Status**
  - Phase D design and Engineering Model testing

- **Overview and Specification**
  - Breed small fish (Medaka, Zebra fish) across 3 generation in 90 days
  - Artificial pulmonary ventilation
  - Ammonia and Nitrous acid decomposition by bio-process
  - Automatic feeding system
  - Sampling, Chemical fixing, freezing of specimen by crew operation
  - Observation by CCD
• **Purpose**
  – Measure the thermo-physical properties concerning the high-temperature melt and the super cooled liquid
  – Establish a theory concerning metastable material processing from super cooled condition
  – Levitate metal and ceramic materials by an electro-static force and melt samples without container

• **Status**
  – Phase B study is going on.
Candidate JEM-EF missions of the 2nd Phase

Port Shared Type Payload

- On-Orbit Demonstration of Space Inflatable Structure (SIMPLE)
- ISS Ionosphere, Mesosphere, upper Atmosphere, and Plasmasphere mapper (ISS-IMAP)
- JEM-GLISM (Global Lightning and Sprite Measurement)
- REXJ: Robot Experiment on JEM

Port Occupy Type Payload

- EUSO (Extreme Universe Space Observatory)
  To determine energy and direction of extreme high energy cosmic ray, and reveal it’s generation source
- CALET (Calorimetric Electron Telescope)
  To search origin of cosmic ray and dark matter by observing electron and gamma-ray in high energy cosmic ray

Four payloads are in phase B/C  Two payloads are in phase A
perspective of life science in JEM

- Understanding of the role of gravity in evolution of life
- Understanding of the adaptability of life to space environment
- Establish countermeasures for ensuring the safety of human activities beyond low earth orbit

Future(2013-)

Understand adaptability of Human

- Mechanism of muscular atrophy (Analysis of the protein related to muscle degradations)

2nd Phase(-2012): Candidates selected

- Fundamental research of the plant cultivation
- Mechanism of amyotrophy
- The reception of cardiovascular system by mechanical stress
- Evaluation of effects by space radiation in long flight

Explore adaptability of life using individual

※Feature of Medaka Fish
- Genomic analysis has completed
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1st Phase(-2010): In progress

- Mechanisms of gravity perception in cell (signaling events, receptor)
- Cell differentiation, histogenesis
- Evaluation of effects by space radiation
- Mechanisms of amyotrophy

Explore adaptability of life using cell
the role of gravity in evolution of life and complexity and diversity of life

Model organism
(Source: Prof. Kudo, Tokyo Institute of Technology)
Understanding of elementary step of physical phenomena for material processing

1st phase (2010): In progress

- In-situ observation of crystal growth mechanism
- Production method of large diameter single crystal (homogeneous composite semiconductor)

2nd phase (2012): Candidates selected

- Modeling of complex Marangoni-convection
  (Unstable flux and of the Marangoni-convection pattern formation)
- Modeling of crystal growth mechanism
- Boiling, Two-phase flow
- Modeling of the spray combustion
- New functional materials using containerless processing
- Phenomena near the critical point

Making of Integrated model for improvement of material processing on the ground

- Material Science under low gravity
- In-Situ material processing technology
- Thermal management technology for large scale space systems

Future (2013~)

- Huge permittivity material using containerless processing (electrostatic) (Application to the electric device such as micro-condenser)
- High-refractive index glass (for Blue-ray laser)

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Modeling of spray combustion → Efficiency improvement of internal-combustion
Science and Technology development on JEM-EF

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1st Phase (~2010): In progress (11 missions)

2nd Phase (~2013): Candidates selected

Challenge to top science and technology

Develop JEM-EF’s potential

- Technology development for human exploration to Moon and beyond
- New frontier of space science
- Contribution to the ground activities (Global change, Space weather, Solar power utilization)

- Demonstration of large structure technology in space (EVA support Robot, Inflatable technology)
- Global change related research (Extreme high energy cosmic ray, atmospheric optical phenomenon)
- Search of interplanetary matter on ISS orbit
- Demonstration of the state of art technology (Long term operation of cryogenic apparatus)

Future (2013 ~ )
Summary

◆ Life Science/Space medicine
  • Understanding of vital phenomenon and evolution
    – Started from the research that uses the cell, and will progress in stages; bion (e.g. “Medaka”, ”Zebrafish”), to study biological influence across generations and coaction
    – Understanding mechanisms of lives on the Earth :"Diversity", "Complexity", "Homeostasis", and "Robustness"
  • Finding new scientific knowledge for Exploration in future
    – To develop the method to various problems in Space medicine
    – To construct a variety of ecosystems (e.g. ECLSS, food production)
Physics, Material science

- JEM would be mainly used for the research on the condensed system, the fluid physics and the creation of new materials.
  - Modeling of macroscopic phenomena observing the microscopic movement of atoms and molecules
  - Study on nonequilibrium phenomena which would become evident under microgravity
  - Understanding of the complex phenomena caused by the interaction between the fast chemical reaction and the flow
  - Creation of new materials using the world’s most advanced technology such as electrostatic furnace
  - Study of macro and mesoscopic interfacial thermal-hydraulic system

JEM-EF mission

- Further promotion of international corporation
  - It is indispensable to cooperate and to allot within ISS Partners for realization of large-scale utilization mission (CALET, JEM-EUSO).
- Continuation of ISS program
  - Kibo-EF utilization is expected to continue after 2016 for new utilization missions.
• JAXA will use JEM fully as an only human outpost/laboratory in space, conduct various utilization to contribute our society and develop new world for human in future.
Thank you!
Back up
The 1\textsuperscript{st} phase JEM Utilization Experiments
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<tr>
<th>Experiment Title</th>
<th>Principal Investigator</th>
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<tbody>
<tr>
<td>Control of cell differentiation and morphogenesis of amphibian culture cells</td>
<td>Makoto Asashima, Tokyo University</td>
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<tr>
<td>(Dome Gene)</td>
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<tr>
<td>Cbl-Mediated Protein Ubiquitination Downregulates the Response of Skeletal</td>
<td>Takeshi Nikawa, University of Tokushima</td>
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<td>Muscle Cells to Growth Factors in Space (Myo Lab)</td>
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<td>RNA interference and protein phosphorylation in space environment using the</td>
<td>Atsushi Higashitani, Tohoku University</td>
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<td>nematode Caenorhabditis elegans (CERISE)</td>
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<tr>
<td>Biological effects of space radiation and microgravity on mammalian cells</td>
<td>Hideyuki Majima, Kagoshima University</td>
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<td>(Neuro Rad)</td>
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<td>Gene expression of p53-regulated Genes in Mammalian Cultured Cells after Exposure</td>
<td>Takesh Ohnishi, Nara Medical University</td>
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<td>to Space Environment (Rad Gene)</td>
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<td>Detection of Changes in LOH Profile of TK mutants of Human Cultured Cells (LOH)</td>
<td>Fumio Yatagai, RIKEN</td>
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<td>Integrated assessment of long-term cosmic radiation through biological responses</td>
<td>Toshiharu Furusawa, Kyoto Institute of Technology</td>
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<td>of the silkworm, Bombyx mori, in space (Rad Silk)</td>
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<td>Life Cycle of Higher Plants under Microgravity Conditions (Space Seed)</td>
<td>Seiichiro Kamisaka, Toyama University</td>
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<tr>
<td>Regulation by Gravity of Ferulate Formation in Cell Walls of Wheat Seedlings</td>
<td>Kazuyuki Wakabayashi, Osaka City University</td>
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<td>(Ferulate)</td>
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<td>Hydrotopism and auxin-inducible gene expression in roots grown in microgravity</td>
<td>Hideyuki Takahashi, Tohoku University</td>
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<td>conditions (Hydro Tropi)</td>
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<td>Science, Medicine &amp; Technology</td>
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<tr>
<td><strong>Experiment Title</strong></td>
<td><strong>Principal Investigator</strong></td>
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<tr>
<td><strong>Fluid physics</strong></td>
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<tr>
<td>Chaos, Turbulence and its Transition Process in Marangoni Convection (MEIS)</td>
<td>Hiroshi Kawamura, Science University of Tokyo</td>
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<tr>
<td>Spatio-temporal Flow Structure in Marangoni Convection(Marangoni UVP)</td>
<td>Yasushi Takeda, Hokkaido University</td>
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<tr>
<td>Experimental Assessment of Dynamic Surface Deformation Effects in Transition to Oscillatory Thermo capillary Flow in Liquid Bridge of High Prandtl Number Fluid</td>
<td>Satoshi Matsumoto, JAXA</td>
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<tr>
<td><strong>Crystalline growth</strong></td>
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<tr>
<td>Investigation on Mechanism of Faceted Cellular Array Growth (Facet)</td>
<td>Yuko Inatomi, JAXA</td>
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<tr>
<td>Study on micro-gravity effect for pattern formation of dendritic crystal by a method of in-situ observation (Ice Crystal)</td>
<td>Yoshinori Furukawa, Hokkaido University</td>
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<td><strong>GHF</strong></td>
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<tr>
<td>Growth of Homogeneous In0.3Ga0.7As Single Crystals in Microgravity* (Hicari)</td>
<td>Kyoichi Kinoshita, JAXA</td>
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<td><strong>ESA plant</strong></td>
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<td>Role of Microtubule-Membrane-Cell Wall Continuum in Gravity Resistance in (Resist-Wall)</td>
<td>Takayuki Hoson, Osaka City University Plants</td>
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<tr>
<td>Reverse genetic approach to exploring genes responsible for cell-wall dynamics in supporting tissues of Arabidopsis under gravity conditions. (Cell-Wall)</td>
<td>Kazuhiko Nishitani, Tohoku University</td>
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<td><strong>Space Technology</strong></td>
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<tr>
<td>Preflight zoledronate infusion as an effective countermeasure for spaceflight-induced bone loss and renal stone formation (Bisphosphonates)</td>
<td>Toshio Matsumoto, University of Tokushima</td>
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<tr>
<td>Digital Holter ECG (Holter)</td>
<td>JAXA Chiaki Mukai</td>
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<tr>
<td>Study on the Fluctuation of Biorhythms in space (Biorhythms)</td>
<td>JAXA Chiaki Mukai</td>
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<td>Myco</td>
<td>JAXA Chiaki Mukai</td>
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<tr>
<td>Space radiation area dosimetry by using PADLES in fixed JEM locations (Area Padres)</td>
<td>JAXA Ailko Nagamatsu</td>
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<tr>
<td>Medicine &amp; Technology</td>
<td>Experiment Title</td>
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<td>Medicine</td>
<td>Transport environment monitoring package at HTV cargo transfer bag</td>
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<td>Activation and Test Downlink of HDTV System</td>
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<td>Application</td>
<td>Hige Quality Protein Crystallization Experiment (HQPC)</td>
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<td>Nanoskeleton</td>
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<td>Exposed Facility</td>
<td>Research on Long-and Short-Term Variations of ALL Sky X-ray Sources (MAXI)</td>
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<td>Experimental Observation of Atmosphere Using “SMILES” (SMILES)</td>
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<td>Monitoring the Space Environment and Research on Its Effects on Parts &amp; Materials (SEDA)</td>
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The 2\textsuperscript{nd} phase JEM Utilization Experiment Candidates
## Experiment Candidates for the 2nd phase JEM Utilization

### Life sciences

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<th>Experiment Title</th>
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<th>Experiment Facility</th>
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<tr>
<td>Regulation of bone metabolism in space: analysis by an in vitro assay system using goldfish scale as a model of bone</td>
<td>Nobuo Suzuki (Kanazawa University)</td>
<td>Cell Biology Experiment Facility (CBEF)</td>
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<tr>
<td>Hypothesis testing of osteopontin function</td>
<td>Masaki Noda (Tokyo Medical and Dental University)</td>
<td>Cell Biology Experiment Facility (CBEF)</td>
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<tr>
<td>Detection of male germ cell mutagenesis in space environment using Medaka as vertebrate model</td>
<td>Hiroshi Mitani (University of Tokyo)</td>
<td>Aquatic Habitat (AQH)</td>
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<tr>
<td>Analysis of blood circulation in the space</td>
<td>Shunichi Takeda (Kyoto University)</td>
<td>Aquatic Habitat (AQH)</td>
</tr>
<tr>
<td>Studies on microbiota on board international space station and their relationship to health problem*</td>
<td>Koichi Makimura (Teikyo University)</td>
<td>Sampling kits</td>
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<tr>
<td>Studies on the role of auxin efflux facilitators in the gravity-influenced growth and development of plants</td>
<td>Hideyuki Takahashi (Tohoku University)</td>
<td>Cell Biology Experiment Facility (CBEF)</td>
</tr>
<tr>
<td>Mechanisms of gravity resistance in plants – from signal transformation and transduction to response</td>
<td>Takayuki Hoson (Osaka city university)</td>
<td>Cell Biology Experiment Facility (CBEF)</td>
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<tr>
<td>Structure and function relationship of erythrocyte band 3</td>
<td>Naotaka Hamasaki (Nagasaki international university)</td>
<td>Protein Crystallization Research Facility (PCRF)</td>
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*: This will be conducted merged with ”Microbial Monitoring on the ISS” (PI: Masao Nasu, Osaka University)
## Experiment Candidates for the 2\textsuperscript{nd} phase JEM Utilization

### Material sciences

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<tr>
<th>Experiment Title</th>
<th>Principal Investigator</th>
<th>Experiment Facility</th>
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<tr>
<td>Growth mechanisms and integrity of protein crystal from solution under microgravity using in-situ observation</td>
<td>Tsukamoto Katsuo Tohoku University</td>
<td>Solution Crystallization Observation Facility (SCOF)</td>
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<tr>
<td>Crystal growth mechanisms associated with the macromolecules adsorbed at a growing interface – Microgravity effect for self-oscillatory g</td>
<td>Yoshinori Furukawa Hokkaido University</td>
<td>Solution Crystallization Observation Facility (SCOF)</td>
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<tr>
<td>Interface Susceptibility and Control of Instability in Thermocapillary Convection</td>
<td>Satoshi Matsumoto JAXA</td>
<td>Fluid Physics Experiment Facility (FPEF)</td>
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<tr>
<td>Crystal growth of homogeneous alloy semiconductors under microgravity</td>
<td>Yuko Inatomi JAXA</td>
<td>Gradient Heating Furnace (GHF)</td>
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<tr>
<td>Elucidation of Flame Spread and Group Combustion Excitation Mechanism of Randomly-distributed Droplet Clouds</td>
<td>Masatoikami Yamaguchi University</td>
<td>Multi-Purpose Small payload Rack (MPSR)</td>
</tr>
<tr>
<td>Establishment of database in microgravity boiling and two-phase flow for the design of high-performance thermal management systems in the next generation of space development</td>
<td>Haruhiko Ohta Kyushu University</td>
<td>Multi-Purpose Small payload Rack (MPSR)</td>
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## The 2nd phase JEM EF mission candidates

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<tr>
<th>Payload Type</th>
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<th>Principal Investigator</th>
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<td>Full Payload</td>
<td>Extreme Universe Space Observatory onboard JEM/EF (JEM-EUSO)</td>
<td>Toshikazu Ebiszaki, RIKEN</td>
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<td>High energy electron and gamma rays observation device (CALET: CALorimetric Electron Telescope)</td>
<td>Shoji Torii, Waseda University</td>
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<tr>
<td>Mixed Small Payload</td>
<td>Space Inflatable technology experiment on JEM-EF</td>
<td>Takahira Aoki, The University of Tokyo</td>
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<td>ISS Ionosphere, Mesosphere, upper Atmosphere, and Plasmasphere mapper (ISS-IMAP)</td>
<td>Akinori Saito, Kyoto University</td>
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<td>JEM-GLISM (Global Lightning and Sprite Measurement)</td>
<td>Tomoo Ushio, Osaka University</td>
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<td></td>
<td>REXJ: Robot Experiment on JEM</td>
<td>Mitsushige Oda, JAXA</td>
</tr>
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