

**Space Strategy Fund (Phase II)
Grant Awarded for “Elemental Technologies for Lunar
Surface Infrastructure”
—Pathfinder for In-situ Operations with Novel
Electron-beam Engineering and Robotics—**

- Under the Space Strategy Fund Program for Exploration (Phase II) technology development theme “Elemental Technologies for Lunar Surface Infrastructure,” a proposal led by Tohoku University has been selected, and the Lunar Pathfinder for In-situ Operations with Novel Electron-beam Engineering and Robotics (PIONEER) Project is now officially launched.
- The project will develop high-efficiency, high-strength regolith solidification technology using an electron beam in the lunar polar regions, along with a lunar mobile robot system to apply it.
- Five private companies are participating in the Lunar PIONEER Project as partner organizations. Building on past R&D results, the industry-academia collaboration aims to develop a demonstration model that charts a path toward establishing the fundamental technologies needed for future lunar outpost construction.

[Overview]

Specially Appointed Professor Kazuya Yoshida of the New Industry Creation Hatchery Center (NICHe) at Tohoku University leads the technology development project named “**Pathfinder for In-situ Operations with Novel Electron-beam Engineering and Robotics (PIONEER)**” (Note 1), which has been selected for the JAXA Space Strategy Fund Program (Phase II): Elemental Technologies for Lunar Surface Infrastructure. The grant decision was made on March 30, 2026, and with it, the Lunar PIONEER Project is now underway.

In recent years, exploration plans by national space agencies and private companies have advanced rapidly toward the construction of sustainable activity bases on the Moon. Future lunar activities will require infrastructure to support landing, mobility, and habitation, but one of the greatest challenges is

the extremely high cost of transporting materials from Earth. To address this challenge, it is essential to establish technologies that utilize lunar regolith (surface soil), which is widely available on the lunar surface, as an in-situ construction material for building structures.

This project aims to demonstrate the feasibility of producing construction materials directly on the Moon by melting and solidifying regolith using an electron beam. The ultimate goal is to establish the foundational technologies required to construct infrastructure such as landing pads and access roadways in situ. Furthermore, by developing a multifunctional lunar mobile robot system capable of performing these tasks, and by validating construction techniques under conditions that simulate the lunar environment, the project will advance the technological framework necessary for future lunar outpost construction.



Concept drawing of the lunar robot to be developed in this project.

A robot equipped with an electron-beam generator irradiates the lunar surface directly beneath it, conducting heating and melting experiments on lunar regolith (surface soil).

This initiative

To advance this project, technology development will be carried out by an industry-academia team including five private companies, led by Specially Appointed Professor Kazuya Yoshida at Tohoku University as principal investigator. Professor Yoshida previously provided technical leadership for Team HAKUTO in the Google Lunar XPRIZE (Note 2) and, more recently, served as project manager for Moonshot R&D Goal 3 (Note 3).

In addition, the project will pursue integration with the high-precision lunar landing system being developed by the organization selected under the Space Strategy Fund Program for Exploration (Phase II) technology development theme “High-Precision Landing Technologies in Lunar Polar Regions” (Note 4), and aims to develop a flight-ready model for actual operation on the lunar surface.

(Comment from the Principal Investigator)

We are deeply honored that our development project, under the Space Strategy Fund program for “Elemental Technologies for Lunar Surface Infrastructure,” has been selected.

We have long pursued the goal of connecting university research outcomes in space robotics technologies to actual flight missions and have continued to take on challenges through opportunities such as the Google Lunar XPRIZE. Being entrusted with this opportunity to undertake full-scale development as part of the Space Strategy Fund program, I am once again keenly aware of both the responsibility we bear and the significance of this endeavor.

To ensure the success of this project, we will fully leverage the strengths of industry-academia collaboration and devote our utmost efforts to establishing the foundational technologies required for lunar infrastructure construction.

Tohoku University, Professor Emeritus
New Industry Creation Hatchery Center,
Specially Appointed Professor
Kazuya Yoshida
<https://astro2.mech.tohoku.ac.jp/en/>

(Partner Organization: Comment from Space Quarters Inc.)

In this project, Space Quarters will be responsible for developing the electron-beam equipment used to heat and melt lunar regolith, as well as the electron-beam-based regolith melting and solidification technology itself.

We are deeply honored to be entrusted with developing the mission's core product and technology. Since our founding, we have advanced high-voltage electron-beam technology and, ahead of the rest of the world, independently developed and demonstrated electron-beam-based regolith melting and solidification technology. By further refining these technologies, our team is fully committed to making this mission a success as a touchstone for regolith construction technology and to contributing to humanity's expansion onto the Moon.

Space Quarters Inc., CEO

Shogo Onishi

<https://space-quarters.com>

(Partner Organization: Comment from Hakusan Corporation)

Our laboratory's strength lies in the development of robot and sensor technologies for extreme environments, and we have a track record of putting robots used in decommissioning work and other applications into practical use. In the Moonshot R&D program, we also participated in the development of the reconfigurable AI robots being advanced by Tohoku University. We are currently studying a robotic arm to be mounted on the crewed pressurized rover for which JAXA is responsible under the Artemis program.

Drawing on these technologies and experience, in this project, we will be responsible for developing the hardware for a deployable mobile robot system that can be transported by a small lander. We will also introduce globally unprecedented, innovative, lightweight, high-power mechanisms and sensor systems, thereby enhancing Japan's international competitiveness.

Hakusan Corporation

Hyper-Environmental Robots Laboratory, Director

Shigeo Hirose

https://www.hakusan.co.jp/english/research_and_development/hero_lab.htm

(Partner Organization: Comment from the Research Institute of Systems Planning, Inc.)

We are greatly honored to participate as a partner organization in the Space Strategy Fund project for “Elemental Technologies for Lunar Surface Infrastructure.” In this project, the Research Institute of Systems Planning (ISP) will be responsible for the communications technology domain that supports the operation of the lunar mobile robot system.

The lunar environment is expected to impose severe conditions, including communication delays, bandwidth constraints, and operational uncertainty. To enable safe and efficient robotic activity, it is essential to design the entire system with communication in view. Drawing on the knowledge we have cultivated in designing, analyzing, and verifying complex systems that include communications, supported by software technology, we will contribute to establishing a highly feasible technological foundation for lunar infrastructure construction within the industry-academia collaboration led by Tohoku University.

Research Institute of Systems Planning Inc., Representative Director

Hitoshi Kadowaki

<https://www.isp.co.jp/>

(Partner Organization: Comment from JAOPS Inc.)

JAOPS is greatly honored to support this groundbreaking project by developing and testing the ground segment infrastructure.

In addition to practical experience in operating mission-critical ground systems, JAOPS possesses deep expertise in mission control software with spaceflight heritage, including operating the first private rover on the lunar surface. Going forward, through smooth system integration as well as iterative testing, simulation, and rehearsals, we will contribute to reliable mission execution and support the next step in lunar infrastructure development.

JAOPS Inc., Co-founder and CEO

Alejandro Sela

<https://www.jaops.com>

(Partner Organization: Comment from Asteria ART LLC)

We are deeply honored to participate in this national Space Strategy Fund project as a member of the industry-academia team led by Tohoku University.

The continuous simulation platform “Artefacts” provided by Asteria ART will serve as the foundation for dramatically accelerating the development cycle in the lunar environment, where real-hardware verification is difficult. Through thorough verification in virtual space, including the development and mission operations of electron-beam regolith solidification technology and the lunar mobile robot system, we will support the success of this project.

We will also apply the space-mission simulation technologies cultivated through past projects with Professor Yoshida’s research team at Tohoku University to this project and contribute to the advancement of space robotics.

Asteria Artificial Recognition Technology LLC, CEO

Tomoya Sonoda

<https://artefacts.com/>

(Note 1) **PIONEER** means “trailblazer” and acronym from **Pathfinder for In-situ Operations with Novel Electron-beam Engineering and Robotics**.

(Note 2) **The Google Lunar XPRIZE (GLXP)** was a competition organized by the U.S.-based XPRIZE Foundation, with Google as title sponsor, to award the world’s first privately funded unmanned lunar exploration mission, and it ran from 2007 to 2018. Among 34 teams registered from around the world, **HAKUTO** was the only team from Japan, and Professor Kazuya Yoshida of Tohoku University served as its technical leader. HAKUTO received the Milestone Prize for the lunar mobility subsystem in January 2015.

<https://www.xprize.org/competitions/google-lunar>

<https://web.archive.org/web/20180802215003/http://team-hakuto.jp/>

(Note 3) Under **Moonshot R&D Program Goal 3**, “By 2050, realize robots that can learn autonomously, act autonomously, and coexist with humans through the co-evolution of AI and robots,” the Research and Development project “Self-Evolving AI Robot System for Lunar Exploration and Human Outpost Construction,” proposed by Professor Kazuya Yoshida at Tohoku University as Project Manager (PM), was selected in FY2022. Over the four years through FY2025, R&D was carried out on a reconfigurable modular AI robot system composed of multiple heterogeneous robot types. The developed robot system was named **MoonBot** and underwent ground demonstration testing at full-scale lunar environment simulation facilities, including the Space Exploration Field at the JAXA Sagami-hara Campus and the LUNA facility jointly operated by the European Space Agency (ESA) and the German Aerospace Center (DLR) in Cologne, Germany. In summer 2025, it was also exhibited for demonstration at the World Expo 2025 Osaka, Kansai, Japan.

<https://srl-moonshot.mech.tohoku.ac.jp/index.en.html>

https://www.jst.go.jp/moonshot/en/program/goal3/3B_yoshida.html

(Note 4) Under the Space Strategy Fund program for Exploration (Phase II) technology development theme “High-Precision Landing Technologies in Lunar Polar Regions,” the proposal by **ispace, inc.**, “Support for payload activities in the polar region through high-precision landing near the south pole and a communications relay satellite,” was announced as selected on January 16, 2026.

https://fund.jaxa.jp/content/uploads/kekka2_16.pdf (in Japanese)