COMMERCIAL EXPLORATION OF LUNAR RESOURCES WITH ISPACE AND THE POLAR ICE EXPLORER MISSION. J.-A. Lamamy[1], A. Calzada-Diaz[1],[1]ispace Europe, 5 rue de l'Industrie, 1811 Luxembourg, Luxembourg (j-lamamy@ispace-inc.com).

Introduction: ispace Europe is currently developing the Polar Ice Explorer mission, scheduled to be the first water-prospecting rover mission on the Moon funded by a public-private partnership with the support of Luxembourg and other European and international partners. This mission will leverage ispace's existing SORATO rover, which was developed and flight qualified for the Google Lunar XPRIZE, and ispace's lunar lander, whose on-going development is funded by a >$90M Series A raised in December 2017. The Polar Ice Explorer passed its Mission Concept Review in October 2017 and the launch is planned in 2022.

ispace, a lunar resource company: ispace Europe S.A. is the Luxembourg subsidiary of ispace inc., a space resource utilization company headquartered in Japan with a third office at the NASA Ames Research Park in California. The company's vision is to expand and sustain humanity's presence in space by utilizing resources available on the Moon. To that end, ispace is proposing a new paradigm of commercial exploration with microrovers and microlanders to advance the scientific investigation of the Moon and the exploitation of its resources .

Sorato Rover and the XPRIZE. ispace inc. was created in 2010 when the company entered the Google Lunar XPRIZE competition under the name Team Hakuto [1]. The company developed, flight-qualified, and delivered on schedule its Sorato rover to Team Indus, the lander partner. ispace was one the remaining five finalists when the prize was terminated in early 2018. At 4 kilograms, the Sorato rover remains the lightest flight-qualified planetary rover whose development was privately funded.

Figure 1: Sorato Flight Model

ispace lander, a new era. ispace inc. raised $94.5M in Series A funding. These funds are being invested in the development of ispace's first two lander missions. The ispace lander is designed to deliver 30 kg of payload anywhere on the near side and provide communication-relay service for 14 day surface missions.

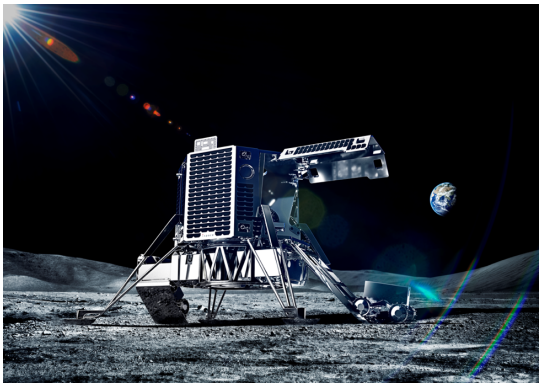

Figure 1: ispace lunar lander concept

ispace Europe, lunar R&D center in Europe: ispace Europe was formed in March of 2017 with the official signing of a Memorandum of Understanding between ispace and the Government of Luxembourg. ispace Europe currently has 10 employees and plans to grow to 25 employees by 2020. ispace Europe performs R&D in partnership with European research institutions and coordinates the development of lunar missions for European customers. Through the Hague International Space Resources Working Group and the Moon Village Association, ispace Europe is also actively engaged in promoting the space resources economy and advising the development of future policy.

ispace Europe R&D. ispace Europe has two on-going advanced technology projects and several proposals under evaluation for maturing new lunar instruments. The company is partnered with the Luxembourg Institute of Science and Technology (LIST) to develop new detectors for a magnetic sector mass spectrometer. The aim is to mature the instrument and develop a flight version in order to operate it on a subsequent ispace mission to characterize volatiles. In addition, ispace Europe is collaborating with the University of Luxembourg to develop new surface localisation solutions using a solid-state lidar system for ispace's next generation lunar rovers.

Polar Ice Explorer: this mission is the first being developed by ispace Europe with support from the Government of Luxembourg.

Project Goals. The goals of the mission are listed below:

- Overall goal: to advance the economic, scientific, and technological readiness for the harvest and utilization of lunar resources
- Science goal: to gain knowledge about the lunar environment that is necessary for the harvest and utilization of lunar resouces
- Enginering goal: to develop and test technologies that are necessary for the harvest and utilization of lunar resources
- Management goal: to conduct projects that are affordable, schedule-efficient, and minimize programmatic risks
- Business goal: to establish the foundation of a profitable business

In order to achieve these goals, ispace Europe is balancing engineering and programmatic constraints to design a mission with sharpely-focused science objectives [2]. The chief science objective of the mission is to determine the local distribution and abundance of hydrogen in the subsurface. This mission could be the first to provide a map of hydrogen deposits with meter-scale spatial resolution at a lunar pole. The core instrument is a passive neutron spectrometer; however, an ion mass spectrometer and sampling tool are also being considered to augment the instrument suite and characterize the hydrogen-bearing molecules present in the subsurface regolith.

The overall rover system with the enhanced payload is designed to be less than 15 kg so that it can be transported on the ispace lander along with another mission of opportunity.

The Polar Ice Explorer is an agile, affordable, and technologically mature mission that targets key Strategic Knowledge Gaps [3]. As such, the mission is a critical component in the Lunar Exploration Program of past and future flagship orbiter and landed missions. The mission's high-resolution map will be an important calibration point for broader but lower-resolution orbiter maps [4]. The emphasis on mobility and mapping complements the PROSPECT/Luna27 lander mission's emphasis on sophisticated sampling and analysis payloads developed by ESA and Roscosmos [5]. With a targeted launch year of 2022, the mission could possibly serve as a precursor to NASA's Resource Prospector mission [6]. The characterization of the distribution of hydrogen deposits by the Polar Ice Explorer could greatly inform the Resource Prospector's overall mission planning and operations.

Conclusions: the campaign of future lunar exploration missions that has been proposed [7] will benefit from a broadened scope that fully leverages the value and cost-effectiveness of small-scale missions like the Polar Ice Explorer. Private exploration companies like ispace are best positioned to develop and operate the small robotic explorers that are needed to perform the wide survey of volatile resources at both lunar poles.

References:

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