



BIRTH Lab

SCARLESS Sample Return

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Research question: Can risk be mitigated from small-body sample return missions using modular swarm robotics?

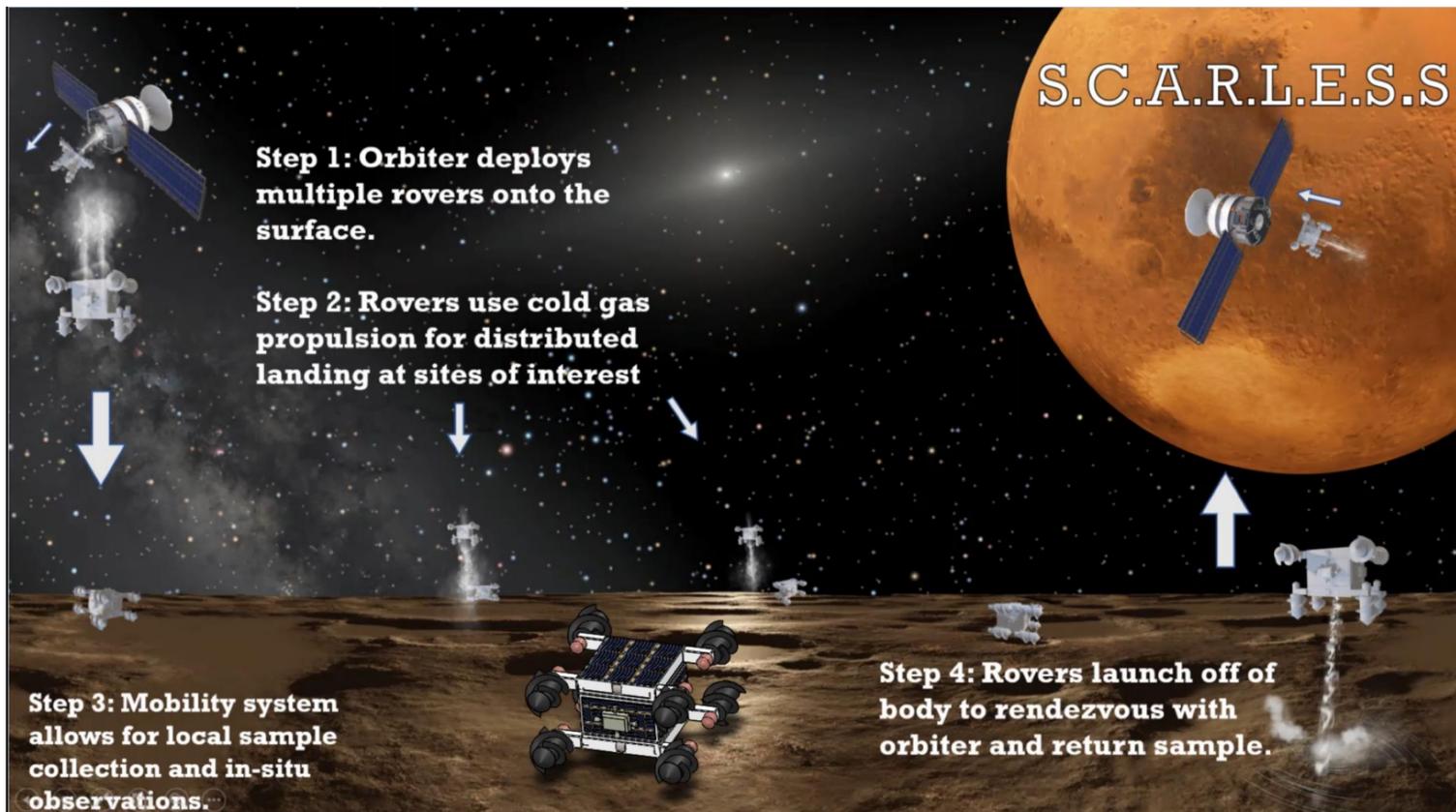


Figure 1. SCARLESS Mission Concept

Abstract

SCARLESS is a rover design that utilizes helically groused wheels to traverse the unknown terrain of small bodies in the solar system. In one direction of travel, these wheels act as screws and are effective in a powdery regolith environment. In the other direction, they act as normal wheels and are robust to rocky terrains. Equipped with cold gas thrusters, SCARLESS can descend onto small bodies where it can navigate and retrieve soil samples. Then, it can reuse the thrusters to return the sample to an orbiter.

Background

- Small-body sample return missions require an orbiter to physically contact the surface for sample collection
- This maneuver is a high mission risk
- This risk often outweighs the value of collecting multiple samples, as seen in the Hayabusa-2 mission
- If the sample collection mechanism and stage of operation is decoupled from the main spacecraft, this could result in more samples for less risk
- This decoupled mission architecture could use a swarm robot approach to increase number of samples, investigate additional surface characteristics, and lower risk as seen in figure 1, used for NASA's NIAC proposal

Design Decisions

- Helically groused wheels for traversability
 - Screw shape is robust in both powdery and rocky environments
- Cold gas thrusters enable SCARLESS descent
 - Craft can land itself on small-bodies the size of Phobos and smaller
- Orbiter releases multiple SCARLESS craft
 - Each craft can navigate planetary surface and take samples
- Cold gas thrusters return payload to orbiter
- SCARLESS craft remains on the body and pursues other mission goals.
- Main craft remains in safe orbit during mission

Conclusion and Future Work

The base mission concept and design work has been successfully completed for this project. The team has determined a craft like SCARLESS is feasible. Future work will require further specification of sample collection methods as well as other scientific instrumentation. Finally, SCARLESS will need to be fully prototyped and tested before further implementation.

Acknowledgements

Special thanks to Professor Marvi, Andrew Thoesen, Justin Martia, Teresa McBryan, Marko Greene, Dallas Wells, and the rest of BIRTH Lab.