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Author: Mr. Konstantinos Konstantinidis
Universität der Bundeswehr München, Germany

Dr. Julia Kowalski
FH Aachen University of Applied Sciences, Germany
Mr. Claudio Flores Martinez
Heidelberg University, Germany
Prof. Bernd Dachwald
FH Aachen University of Applied Sciences, Germany
Prof.Dr. Roger Förstner
Universität der Bundeswehr München, Germany
Mr. Dirk Ewerhart
Germany

SOME NECESSARY TECHNOLOGIES FOR IN-SITU ASTROBIOLOGY ON ENCELADUS

Abstract

The plumes discovered by the Cassini mission emanating from the south pole of Saturn's moon Enceladus and the unique chemistry found in them have fueled speculations that Enceladus may harbor life. The presumed water-filled cracks from which the plumes emanate would make a prime target in the search for extraterrestrial life and would be more easily accessible than the moon's subglacial ocean. A lander mission that is equipped with a subsurface maneuverable ice melting probe will be most suitable to assess the existence of life on Enceladus. A lander would have to land at a safe distance away from a plume source and use a melting probe to melt to the inner wall of the crack to analyze the plume subsurface liquids before potential biosignatures are degraded or destroyed by exposure to the vacuum of space.

A concept study for such a lander mission was performed as part of the "Enceladus Explorer" (EnEx) project funded by the German Space Administration (DLR). During this study some key technologies for such a mission were identified, and will be discussed in this paper:

1. The mission includes two critical operational phases: a descent and landing phase with pinpoint accuracy, and a subglacial melting phase where the melting probe must navigate and maneuver to the side of the target water filled crack at a certain depth to sample the water there. Guidance, Navigation and Control systems are presented for both the lander and the melting probe, as well as autonomy concepts for their operation.

2. Due to the high power demand for melting the cold ice on an icy moon, high density power sources are necessary. At the same time, future planetary protection regulations will likely restrict or prohibit landing nuclear power sources near astrobiologically interesting areas for fear of contamination. Here, both small nuclear reactors and high density hydrogen fuels cells are discussed as candidate power sources, their technological maturity is assessed and future development steps are proposed.

3. Several instruments can be conceivably used to detect biosignatures in-situ: antibody microarrays, nanopore-based devices, microscopes, flow cytometers, fatty acid markers, and mass spectrometers. However technological maturity and capability for miniaturization vary between each instrument type. Here we propose a way forward for the development of such suitable miniaturized instruments for in-situ icy moon astrobiology.