

# TRIPLE-ICECRAFT: A PLATFORM FOR SCIENTIFIC ACCESS TO DEEP ICE –ANTARCTIC RESULTS AND FUTURE OPPORTUNITIES

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Subglacial lakes and unexplored water reservoirs in the polar regions of Earth represent some of the most isolated and pristine environments known to science. Exploring these hidden ecosystems is of great significance not only for understanding our own planet, but also in the context of astrobiology and the search for life beyond Earth. Several celestial bodies in our solar system—such as Jupiter’s moon Europa, Saturn’s Enceladus, and the polar subsurface regions of Mars—are believed to host liquid water beneath thick layers of ice. Autonomous melting probes offer a promising technological pathway to access and investigate these environments in a minimally invasive and contamination-free manner.

The TRIPLE-IceCraft is a modular melting probe platform designed to enable in-situ scientific investigation of water-bearing layers within and beneath glacial ice. During descent, the probe can transport sensors and scientific payloads through the ice and into subglacial water bodies, enabling continuous data collection along the melt path and in the water column. One of the key features of the TRIPLE-IceCraft is the ability to re-freeze its access channel, ensuring environmental protection and preserving the integrity of potential subglacial ecosystems. This characteristic is particularly crucial for future astrobiological missions where planetary protection standards are essential.

This contribution presents and discusses the results of two successful technical demonstration campaigns conducted at the Neumayer Station III in Antarctica. The tests focused on validating the operational functionality, system reliability, and integrated sensor performance of the TRIPLE-IceCraft platform under realistic environmental conditions. During these deployments, housekeeping data were collected to monitor and optimize system behavior. A camera was included as a demonstration payload to verify data transmission capabilities. The primary objective was to demonstrate the probe’s capability for controlled thermal descent and reliable operation in deep ice, rather than conducting scientific measurements. Based on these findings, we outline future opportunities for TRIPLE-IceCraft in both terrestrial and planetary exploration missions, and evaluate the integration potential of scientific payloads tailored for hydrological, chemical, and biological investigations in extreme cryoenvironments.

## References

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**Primary author:** ESPE, Clemens (GSI GmbH)

**Co-authors:** AUDEHM, Jan (Physics Institute III B, RWTH Aachen University, Aachen, Germany); DO, Mia Giang (Physics Institute III B, RWTH Aachen University, Aachen, Germany); FELDMANN, Marco (GSI GmbH, Aachen, Germany); FRANCKE, Gero (GSI GmbH, Aachen, Germany); GÜNTHER, Christoph (Physics Institute III B, RWTH Aachen University, Aachen, Germany); HEINEN, Dirk (Physics Institute III B, RWTH Aachen University, Aachen, Germany); HEUTELBECK, Dirk (HAW Hamburg, Hamburg, Germany); MICHELS, Lukas (Physics Institute III B, RWTH Aachen University, Aachen, Germany); SCHÖTTLER, Fabian (GSI GmbH, Aachen, Germany); SCHORBACH, Vera (HAW Hamburg, Hamburg, Germany); WIEBUSCH, Christopher (Physics Institute III B, RWTH Aachen University, Aachen, Germany); ZIERKE, Simon (Physics Institute III B, RWTH Aachen University, Aachen, Germany)

**Presenter:** ESPE, Clemens (GSI GmbH)

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