Nanokhod Micro-Rover Environmental Compatibility Requirements and Design

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Nanokhod is a micro-rover conceived for scientific exploration of celestial bodies such as planets or moons. With a net rover mass of 1450 g, it can accommodate 1100 g of payload instruments, transport them to sites of scientific interest in the vicinity of a lander, and carry out in-situ measurements. Locomotion is assured by tracks, giving the vehicle outstanding capabilities for overcoming obstacles or recovering from difficult situations such as tip-over. A central payload cab suspended between two track bodies accommodates the payload instruments. This allows to orient all payload instruments to the same sample without the need to displace the rover.

During the last years, the Nanokhod technical and operational concept made significant progress. Early conceptual ideas and laboratory models were developed at the Max-Planck-Institute for Chemistry in Mainz. The Nanokhod idea then was developed in a detailed flight model conceptual design including an advanced laboratory model for locomotion demonstration within an ESA Technology Research and Development (TRP) activity called "Micro-Robots for Scientific Applications" (Micro-RoSA). Further ESA TRP activities focussed on an end-to-end control system for a Nanokhod-type rover ("Payload Support for Planetary Exploration", PSPE), as well as on tools for deep drilling using a larger version of the Nanokhod rover ("Micro-RoSA 2").

On a flight mission, Nanokhod has to cope with the harsh environment of the planetary surface. For example on Mars, the outside ambient temperatures are expected to be between -120°C and +50°C. Other celestial bodies such as Mercury impose an even more challenging environment with respect to upper temperature limits and temperature variations. Dust with particles of sub-micron-size and low pressure atmospheres are other environmental factors that need to be considered.

Within Micro-RoSA, proof-of-concept tests had been carried out in order to verify the feasibility of the flight model conceptual design, especially with respect to low temperature and dust resistance. These tests gave strong evidence for the feasibility of a completely passive thermal control system as well as for different critical technical solutions for dust sealing, mechanical actuators and lubrication. In order to complete the preparative technology development prior to the flight model development, another TRP activity called "Robotic Technology for Planetary Exploration" (RTPE) has been initiated. It is focussed on all relevant subsystem and overall system technological issues associated with the environmental compatibility needs of a future Mars flight mission, leading to a detailed and verified technical concept of the Nanokhod micro-rover.

This paper describes the preliminary results originating from the RTPE activity. It will focus on the requirements baseline applicable to the Nanokhod rover, as well as on detailed design concepts for critical subsystems and components retained for the Nanokhod.