Geophysical Research Abstracts
Vol. 13, EGU2011-11662, 2011
EGU General Assembly 2011

First Design Concept for a Combined Thermal and Mechanical Penetration Device for Investigations of Icy Planetary Bodies – The 'Cryo-Mole'

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The search for traces of life on other planets has been one of the perspectives of science ever since. The water ice in the polar regions on Mars and the icy Jovian moon Europa or the subglacial lakes in the Antarctica are places of interest for astrobiological research.

Considering the astrobiological potential of these sites, the best way to explore their mysteries is to send a vehicle for the in-situ investigation of the chemical and biological properties of the ice layers. In the past, several concepts of melting probes, so called 'Cryobots', have been proposed for this purpose.
These melting probes are an effective way to bring research instruments to an operational depth, where it is guaranteed that the overburden soil or ice protects the traces of life from galactic rays. However, these probes might get stuck if soil accumulates in front of the probe.

At the German Aerospace Center DLR, a hammering drill ('mole'), called PLanetary Underground TOol (PLUTO) has been developed for the BEAGLE 2 lander, to represent a new and promising direction for subsurface sampling and in-situ measurements. This innovative lightweight and low power solution should be combined with heaters to melt the ice.

This paper shall present the results of a simulation and a parameter study and propose first design concepts based on these results.

The parameter study includes a discussion of the length to diameter ratio, the cone angle of the tip, the surface roughness of the housing, the mass of the housing and the ice temperature. The results of the parameter studies, for example, confirm an optimal performance for a cone angle of 60° and suggest to increase the length of the Mole rather than the diameter to enlarge the volume.

The first design concepts propose possible payloads and specify the total volume needed to shelter the heaters and the payload. Moreover ways to integrated the heaters in the tip and the structure of the original mole are described.

Due to the increase in mass the hammering mechanism has to be redesigned. This new more powerful hammering mechanism is presented in this paper as well.