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# HP3 on ExoMars – Cutting airbag cloths with the sharp tip of a mechanical mole

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The HP3 – Heat Flow and Physical Properties Package – is planned to be one of the Humboldt lander-based instruments on the ESA ExoMars mission. HP3 will allow the measurement of the subsurface temperature gradient and physical as well as thermophysical properties of the subsurface regolith of Mars down to a depth of 5 meters. From these measurements, the planetary heat flux can be inferred. The $HP^3$ instrument package consists of a mole trailing a package of thermal and electrical sensors into the regolith. Beside the payload elements Thermal Excitation and Measurement Suite and a Permittivity Probe the HP3 experiment includes sensors to detect the forward motion and the tilt of the HP3 payload compartment.

The HP3 experiment will be integrated into the lander platform of the ExoMars mission. The original accommodation featured a deployment device or a robotic arm to place HP3 onto the soil outside the deflated lander airbags.

To avoid adding such deployment devices, it was suggested that the HP3 mole should be capable of piercing the airbags under the lander. The ExoMars lander airbag is made of 4 Kevlar layers (2 abrasive and 2 bladders). A double fold of the airbag (a worst case) would represent a pile of 12 layers. An exploratory study has examined the possibility of piercing airbag cloths by adding sharp cutting blades on the tip of a penetrating mole.

In the experimental setup representative layers were laid over a Mars soil simulant. Initial tests used a hammer-driven cutting tip and had moderate to poor results.

More representative tests used a prototype of the HP3 mole and were fully successful: the default 4 layer configuration was pierced as well as the 12 layer configuration, the latter one within 3 hours and about 3000 mole strokes This improved behaviour is attributed to the use of representative test hardware where guidance and suppression of mole recoil were concerned.

The presentation will provide an explanation of the technical requirements on airbag cutting with a mole and the mentioned experimental setup and results.