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Engineering Challenges of the Heat Flow and Physical Properties Package (HP^3) on ExoMars

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The Heat flow and Physical Properties Package (HP^3) is part of the Humboldt payload for ESA's upcoming ExoMars mission and consists of an instrumented mole system,

a self-penetrating probe designed to penetrate up to 5 m into the Martian regolith. This experiment will for the first time access the martian subsurface to a significant extent and allow for a depth resolved measurement of the physical, thermal, and electrical soil properties. The combination of these measurements will allow for a determination of the planetary heat flow, a key quantity delineating the thermal state of the planet. This presentation will give an overview of the development status of HP^3 which is based on several precursor developments in the ESA technology programme as well as on the flight-developed PLUTO sampling mole system flown on the Beagle 2 lander of Mars Express. Whereas the mechanical design concept of HP^3, involving a two-body mole system including a trailed instrument and electronics compartment as well as an instrumented tether leading back to the surface, has been well progressed (including environmental testing) through the precursor studies, the principal design challenge lies in the miniaturized yet still space qualifyable front end electronics required in the 26 mm diameter instrument compartment trailed by the electro-mechanical mole. These electronics are needed to service the mole mechanism and provide control for and pre-amplification and digitization of signals from a permittivity sensing subsystem as part of HP3 while being able to survive the rigors of the shock environment induced

by hammering of the mole during the soil intrusion phase and offering a sound comprise between use of rad hard components and dedicated qualification of commercial components combined with radiation shielding.