MULTI-MICE: A NETWORK OF INTERACTIVE NUCLEAR CRYOPROBES TO EXPLORE ICE SHEETS ON MARS AND EUROPA

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A new concept for an interactive network of high-power, high-mobility cryoprobes to explore ice sheets on Mars and Europa is described. Each MICE (Mars Ice Cap Explorer) cryoprobe carries a very small, ultra-lightweight nuclear reactor that generates thermal power to melt descent/ascent channels, plus electric power for instruments and RF data transmission. The water cooled and moderated MICE reactor uses the same Zirconium/UO_2 cermet fuel that presently operates in hundreds of reactors around the world with excellent reliability, zero release of fission products, and core lifetimes of many years. Each MICE cryoprobe consists of a reactor unit and an instrument unit separated by a tether, with the intervening water providing a shielding factor of greater than 10^7 against neutrons and gamma radiation. Nominally, the MICE probe can descend or ascend vertically 320 meters per day in a 60 cm melt channel. With high RF power and relatively low transmission frequency, e.g. 300 MHz, MICE probes would be able to transmit data at high rates over distances of several kilometers through the ice sheets. Using several mobile MICE probes in a multi-probe network, a lander could explore an ice sheet in detail over a wide area, e.g. on the order of 20 km in diameter, to a depth of 10 km or more. Deploying multiple MICE probes also offers a built-in mission redundancy. Each MICE probe would have a standard instrument package which would include a microfluidic (“lab-on-a-chip”) biosignature detection instrument, a suite of electrochemical sensors, an optical imager (including microscopic imagery), a seismometer, and an integrated RF communications / Ice Penetrating Radar instrument. Non-standard instruments could include among others: life detection growth chambers, mass-spectrometers, Laser Induced Breakdown Spectrometers (LIBS), and high power acoustic or seismic sources for ice sheet and crustal mapping.