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HOTROD: Prototype melt-tip for rapid ice-sheet drilling

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HOTROD is a prototype melt-tip drill for rapid sampling of ice-sheet temperatures. The relatively low-cost melt-tip, which has thermistors embedded along its integrated tether cable, is intended for single-use deployment. This means the melt-tip is not recovered following insertion of the temperature sensors. The main shaft of HOTROD is 120 cm in length and 5 cm in diameter. Forward heating elements, embedded in a 60° copper cone forming the melt-tip nose, draw 5 KW of power. Analogous 5 KW aft heating elements, embedded in a copper flange, protrude 0.75 mm from the main shaft. This aft flange yields a minimum borehole diameter of 6.5 cm. Lateral heating, via a lower wattage (< 1 KW) coiled heating braid, prevents freeze-in of the main shaft. Real-time monitoring of embedded thermocouples allows the forward and aft primary heating elements to be alternatively powered, by a single 5 KW power source. This offers the potential to avoid both freeze-in and overheating. Assuming a heat-transfer efficiency of 40 % between the melt-tip and the surrounding ice, we anticipate penetration rates of between 5 and 10 m/hr in pure ice, depending on effective borehole diameter and heating element performance. For relatively easy deployment, the entire HOTROD apparatus, including a 6.4 KW generator with 21-day gasoline supply, weighs < 600 kg. Initial ice-sheet testing of HOTROD will take place in May 2020 in West Greenland. Our minimum goal is to re-measure the 125 m deep temperature profile initially measured at Camp VI (69.70°N, 48.27°W, 1595 m) in 1950. Our maximum goal is to achieve a drill depth of 500 m. Open-design development of the HOTROD melt-tip by the Geological Survey of Denmark and Greenland is funded by the Villum Foundation.

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