Technology for a Thermo-chemical Ice Penetrator for Icy Moons Jonathan Arenberg[1], George Harpole[1], James Zamel[1], Bashwar Sen[1], Greg Lee[1], Floyd Ross[1] and Kurt Retherford[2]
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Introduction: The ability to place sensors or to take samples below the ice surface enables a wide variety of potential scientific investigations. Penetrating an ice cap can be accomplished via a mechanical drill, laser drill, kinetic impactor, or heated penetrator. This poster reports on the development of technology for the latter most option, namely a self-heated probe driven by an exo-thermic chemical reaction: a Thermo-chemical ice penetrator (T-ChIP). Our penetrator design employs a eutectic mix of alkali metals that produce an exothermic reaction upon contact with an icy surface. This reaction increases once the ice starts melting, so no external power is required. This technology is inspired by a classified Cold-War era program developed at Northrop Grumman for the US Navy.

Terrestrial demonstration of this technology took place in the Arctic during the 1980's; however, this device cannot be considered high TRL for application at the icy moons of the solar system due to the environmental differences between Earth's Arctic and the icy moons. These differences demand a T-ChIP design specific to these cold, low mass, airless worlds. It is expected that this model of T-ChIP performance will be a complex model incorporating the forces on the penetrator, the thermo-chemistry at the interface between penetrator and ice, and multi-phase heat and mass transport, and hydrodynamics. Our initial efforts are aimed at the development of a validated set of tools to predict the performance of the penetrator for both the environment found on these icy moons and for a terrestrial environment. The inclusion of the terrestrial environment is expected to aid in model validation. Once developed and validated, our model tools will allow us to design penetrators for a specific scientific application on a specific body.

This poster discusses the range of scientific investigations that can be enabled by T-ChIP. We also introduce the development plan to advance T-ChIP to the point where it can be considered for infusion into a program.