ICEFIN:A NEW SMALL MODULAR AUV FOR POLAR AND PLANETARY EXPLORATION. B. E. Schmidt[1], M. E. West[1], M. M. Meister[1], A. Spears[1], C. C. Walker[1], J. J. Buffo[1], [1]Georgia Institute of Technology, (britneys@eas.gatech.edu).

Introduction: Icefin is a modular, field-portable hybrid autonomous underwater/ remote operated vehicle designed as a long-range, and deep water under-ice robotic oceanographer that can survey cavity geometry, ice properties and ocean conditions beneath floating ice that are not resolvable in remotely-sensed observations or using localized mooring data. was designed and built at Georgia Tech, under Schmidt's startup funds with effort contributed from GTRI. Icefin's unique design provides greater capability and improved operational simplicity relative to large vehicles. Icefin is optimized by modularity: the vehicle consists of detachable sections containing the thrusters, power and electronics, and a sensor bay that can be oriented up or down depending upon the mission. Here, vehicle control and data systems can be stably developed and power modules added or subtracted for mission flexibility, while multiple sensor bays can be developed to serve multiple science objectives. As opposed to the larger vehicles which require much greater logistics with much larger costs, the relatively small modular Icefin can be deployed through small holes drilled in the ice. Thus, Icefin will satisfy the demands of sub-ice missions while maintaining a small form factor and easy deployment necessary for repeated, low-logistical impact field programs.

The current Icefin prototype is 12 inches in diameter, 10 feet long, and weighs 220 pounds. Rather than a single vehicle that must be completely taken apart to address any failures or in order to change instrumentation, Icefin consists of five modules including a nose cone, two vertical/horizontal thruster modules, a sensor bay, an electronics module and a rear propulsion module. Because of its small size and modularity, the vehicle can be broken down by module, transported in Pelican boxes and deployed easily by the field staff, rather than requiring cranes or oceanographic vessels to transport and launch. This modular design is robust to failures, allows easy switching out of science modules that increases available sensors without increasing vehicle size, reduces the assembly time of the vehicle, provides a simpler mode for disassembling while in the deep field, and allows the vehicle to be customized for each mission, with imagers, sonar, and sensors pointing up or down depending on whether the ice or the silicate interface is under study.

Icefin is currently fitted with sensors for scientific analysis of the ice-ocean system including, a sensor bay with Side Scan Sonar (SSS), Dopplar Velocity Log (DVL) with current profiler, altimeter, and imaging sonar. This sensor bay may be pointed in the down position for ocean bottom mapping or in the upward position for topographical ice mapping. The forward module includes a forward looking blazed array sonar,, a CTD senso and obstacle avoidance camera. The current guidance navigation and control of the Icefin will allow for efficient collection of scientific data through the fusion of an advance fiber optic gyro (FOG) inertial measurement unit (IMU), compass, DVL, altimeter and pressure sensor for low-level motion control and high-level localization. Icefin also includes moisture sensors for leak detection. The vehicle is rated to 1500 m depth and has a 3.5 km Kevlar-reinforced fiber optic tether rated to 600lb for communication, data retrieval, and emergency vehicle recovery. Additional batteries can be added in the form of a separate module to provide the vehicle greater duration and range capabilities. The vehicle's novel thruster design provides control for full holonomic six degrees of freedom for vehicle movement with no protruding surfaces. This allows the vehicle to easily control pitch, yaw, heave (up and down) and sway (side-to-side). The thruster configuration provide the stabilization that is necessary to hover in the water for data and image collection missions, and eventually for sampling.

The first Icefin prototype has been developed and successfully operated in Antarctica in Austral summer 2014. Icefin was deployed through a borehole in the McMurdo Ice shelf and successfully collected sonar, imaging, video and water column data.

Fig. 1: An Icefin CAD drawing, showing Icefin disassembled into its individual modules and foam.