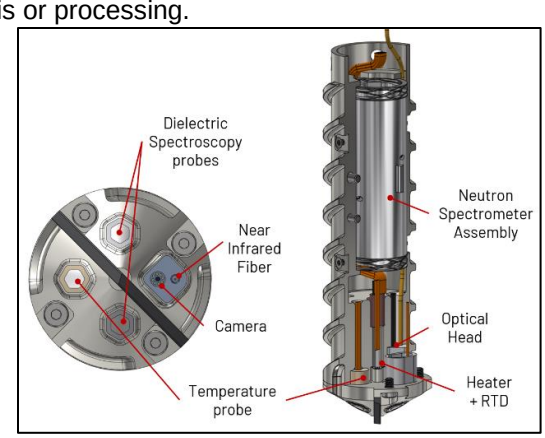
SMART: Instrumented Drill for ISRU Investigations on the Moon. Leo Stolov[1], Kris Zacny[1], Jennifer Heldmann[2], Kathryn Bywaters[1], Carter Fortuin[1], Sofia Kwok[1], Anthony Colaprete[2], Arwen Dave[2], Richard Elphic[2], Dayne Kemp[2], Keith B. Chin[3], [1]Honeybee Robotics, 2408 Lincoln Ave, Altadena, CA 91001, [2]NASA Ames Research Center, Moffett Field, CA 94035, [3]Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA 91109 (Contact: lastolov@honeybeerobotics.com)

Introduction: SMART (Sensing, Measurement, Analysis, and Reconnaissance Tool) is a next generation drilling system for lunar ISRU applications. SMART is a rotary percussive drill mounted on a linear stage, similar to The Regolith and Ice Drill for Exploration of New Terrains (TRIDENT) that is flying to the Moon in 2022 and 2023 [1]. Unlike TRIDENT, which uses the auger to move drill cuttings up to the surface for analysis, the SMART auger and bit assembly is integrated with instruments that can perform analysis in situ. By instrumenting the auger, we are changing the paradigm of exploration – we are bringing an instrument to the sample as opposed to bringing the sample to an instrument.

Instruments: SMART is instrumented with five sensors in a 2 inch (5.08 cm) diameter auger and bit assembly: (1) neutron spectrometer for hydrogen detection, (2) near infrared spectrometer for volatiles and mineralogical information, (3) dielectric spectroscopy probe for electrical properties, (4) temperature sensor and heater for thermal gradient and thermal conductivity measurements, and (5) camera for visible light images and surface texture. The drill is also an instrument, as drilling power and penetration can be used to determine regolith strength. The chosen sensors are used to "sniff" for water ice and determine volatile composition thus allowing for high-grading lunar sample. SMART allows missions to make to make educated and expeditious decisions as to whether the downhole soil sample should be delivered to any rover mounted ISRU instruments for further analysis or processing.



System design: SMART consists of several major subsystems: a rotary-percussive drill head for providing percussion and rotation to the drill string, a linear stage for advancing the drill string into the subsurface, an instrumented drill string, a slip ring section to feed the electrical signals to a data acquisition box, and a fiber optic rotary joint section to feed the optical signal out to the near-infrared spectrometer. A prototype has been developed with the goal of demonstrating instrument functionality and testing in a relevant lunar environment. SMART can be mounted to a lander, rover, or even be adapted as a handheld system for high grading on the lunar surface as part of the Artemis program.

References:

[1] K. Zacny, et al., (2021) LPSC 52, Abstract #2400.