**LUMINESCENCE SPECTROSCOPY FOR LONG-DURATION MISSIONS ON ICY BODIES.** N. E. Bramall[1], T. K. Nielsen[2], W. C. Stone[3], B. P. Hogan[3], S. LeLievre[3], B. E. Schmidt[4], [1]Leiden Measurement Technology — 751 Laurel Street #344, San Carlos, CA 94070 (N.Bramall@LeidenTechnology.com); [2]Univ. of Southern California – Ming Hsieh Dept. of Electrical Engineering, Los Angeles, CA 90089 (TKNeilse@usc.com); [3]Stone Aerospace – 3511 Caldwell Lane, Del Valle, TX 78617; [4]Georgia Tech (britneys@eas.gatech.edu)

**Introduction:** For long-duration in-situ missions, it is important to have triage instrumentation to identify potentially interesting samples before using dedicated or high-fidelity instruments which can only process a limited number of samples. Luminescence spectroscopy is an ideal approach because it requires no sample handling/acquisition, sample modification (e.g., heating), is very rapid, requires no consumables and is remarkably sensitive to many organic molecules.

Luminescence detection instruments may take many forms, including borehole logging instruments (possibly integrated into drill strings), surface scanning instruments, flow-through analyzers, and even remote detection instruments.

We present two luminescence instruments developed for the detection and discrimination of proteins and minerals specialized for the in-situ exploration of icy worlds: The Sub-glacial Under-water Reconnaissance Flow-through Fluorescence Spectrometer (SURFFS) and the Protein Fluorescence Spectrometer (PFS).

Both instruments use deep-ultraviolet (DUV) excitation from LEDs to excite fluorescence in the targets which is analyzed for the presence of proteins, minerals, and other biomarkers. We will present the designs and preliminary data from these instruments as well as possible future directions for them.

**Supporting ASTEP Projects:** SURFFS and the PFS have been built to support two ongoing NASA ASTEP-funded Europa-analog projects. SURFFS is being deployed as part of the payload for the Very-deep Autonomous Laser-powered Kilowatt-class Yoyoing Robotic Ice Explorer (VALKYRIE, Dr. William Stone, PI). VALKRYIE is a highly-capable autonomous cryobot (Stone Aerospace) capable of penetrating very deep ices and characterizing the ice and melt water produced.

The Protein Fluorescence Spectrometer (PFS) has been custom-designed for the Sub-Ice Marine and Planetary analog Ecosystems (SIMPLE, Dr. Britney Schmidt, PI) project. It is part of the scientific instrument payload on the ARTEMIS vehicle (Stone Aerospace) — a long-range, hover-capable hybrid autonomous under-water robotic vehicle designed to explore the sub-ice environment below the McMurdo Ice Shelf (MIS).

**SURFFS:** SURFFS is a flow-through instrument that analyzes glacial melt water produced by the VALKYRIE cryobot. SURFFS continuously monitors the water using highly-sensitive photon counting photomultiplier tubes (PMTS). LEDs were chosen for the excitation to conserve power and space while providing continuous excitation. SURFFS' primary function is to act as a robust triage instrument for other water-filtering and –sampling subsystems to ensure that only scientifically-interesting samples are collected.

At the heart of SURFFS is a custom-designed high-pressure, high-volume flow cell. A large-volume flow cell was chosen for two reasons: (1) to ensure that a statistically-relevant number of bacteria are measured each second in the low-bacterial-concentration melt water and (2) to help prevent clogging of the flow cell in the event that a mineral layer is encountered.

SURFFS was tested in the field during the June, 2014 VALKYRIE testing at Matanuska Glacier, AK, where it was able to detect protein signatures in the glacial ice. It will be deployed on VALKYRIE during the final field deployment in June, 2015.

**PFS:** The PFS is a fluorimeter designed to detect proteins and minerals in-situ within the sub-glacial ice of the MIS at the ice-water boundary. The primary goal of the PFS is to map out the density of life in the ice at the ice-water boundary in order to determine what physical and chemical properties of the ice and surrounding sea water make for a habitable environment.

To avoid interference with the surrounding sea water, the PFS has been designed to be pushed into contact with the ice during autonomous deployment on the ARTEMIS vehicle. ARTEMIS will drag the PFS along the underside of the MIS at select locations in order to understand the variability of life over a range of 20 kilometers or more.

To excite fluorescence, a high-power nine-element array of DUV LEDs is used. LEDs were chosen to enable high data rates, important for obtaining statistically-significant sample densities in minimal time. A bank of photon-counting PMTs is used for detection to enable a large sample volume, important for measuring low cell concentration ($10^3$ cells/cc), in a relatively small package.