Picture this SELFI: A Technology Maturation Project for a Submillimeter Enceladus Life Fundamentals Instrument (SELFI)

Paul Racette[(1)], Carrie Anderson[(1)], Damon Bradley[(1)], Gordon Chin[(1)], Negar Ehsan[(1)], Terry Hurford[(1)], Tilak Hewagama1[(1.2)], Tracee Jamison[(1)], Tim Livengood[(1,2)]

(1) NASA Goddard Space Flight Center (GSFC), Greenbelt, MD 20771, www.nasa.gov
(2) University of Maryland, College Park, MD, USA

The Submillimeter Enceladus Life Fundamentals Instrument (SELFI) is a passive remote sensing submillimeter heterodyne spectrometer being developed at NASA GSFC under NASA's Maturation of Instruments for Solar System Exploration (MatISSE) program. SELFI will advance submillimeter receiver technology by 1) investigating the chemical and isotopic compositions and corresponding densities of Enceladus' plume material, their vertical thermal structures, and the transport mechanisms within the plumes, and 2) characterizing the source regions from which the plumes emerge.

The Enceladus plumes are important in the context of life and habitability of its subsurface ocean environment. SELFI remote sensing measurements will 1) measure the spatial and temporal variabilities in the plume chemical compositions, 2) provide insight in to Enceladus' subsurface ocean environment by monitoring H_2O, HDO, $d^{18}O$, and $d^{17}O$, 3) constrain the oxidation state of the subsurface ocean using H_2O_2 and O_3, and 4) utilize the SO_2 and H_2S spectral signatures to constrain the impact arising from both the sea-floor volcanoes and pre-biotic molecules. Moreover, the detection of the remaining molecular species (14 in total) is vital to improving the current state of knowledge of Enceladus' subsurface ocean habitability – this also permits us to explore the chemical alteration processes arising from primordial volatiles that have been observed in comets. Lastly, SELFI's continuum observations enable the correlation between observed variations in plume activity with surface temperatures.

SELFI is currently being developed under a technology maturation program that will advance the RF-to-digital electronics of a submillimeter-wave heterodyne spectrometer to simultaneously observe fourteen molecular species with resonances between 530 GHz and 600 GHz. SELFI will have fine radiometric resolution, high spectral resolution (resolving power $R > 10^6$), multiple continuum channels and a high dynamical range, necessary to map Enceladus across its 30 K to 250 K temperature range. Under the MatISSE program, SELFI will advance – from TRL 4 to 6 – four key technologies of the RF-to-digital subsystem, which are: 1) the RF low noise amplifier design; 2) the single-sideband (SSB) mixer and local oscillator; 3) the IF assembly down-converter that maps the fourteen species to 2 x 500 MHz bandwidth; and 4) the digital spectrometer electronics.