FURTHERING THE UNDERSTANDING AND EXPLORATION READINESS OF TERRESTRIAL AND PLANETARY UNDERWATER VENT SYSTEMS. P. Sobron[1,2], L. M. Barge[3], the InVADER Team. [1]SETI Institute, Mountain View, CA, [2]Impossible Sensing, St. Louis, MO, [3]Jet Propulsion Laboratory, Pasadena, CA. psobron@seti.org

Science and Technology Motivations: It has been theorized that vents driven by serpentinization might exist on Europa and/or Enceladus and may be able to drive the emergence of life on ocean worlds. Whether other types of vents, which are mostly associated with plate tectonics, could exist on ocean worlds is unknown. Regardless, simply detecting vents on an ocean world would not be enough to make inferences about the type(s) of life that might be possible there, because the metabolic strategies utilized in a particular system depend on the available geochemical free energy generated by the mixing of a vent fluid with overlying fluids. For example, Lost City – a rare type of vent formed by water/rock interaction – emits hydrogen and methane that fuels microbial communities. However, these vents stand in stark contrast to the black smokers, where life would most likely utilize reduced S and Fe. Distinctions between types of vents facilitate inferences about their energy sources and energetic environments. Because vent type is a function of its particular geochemical/geological source, identification of specific vent characteristics is key for an effective exploration of habitable environments on ocean worlds.

We have developed a new concept for a robotic payload (Fig 1) and a science operations strategy (Fig 2) aimed at determining how best to distinguish between diverse possible vent types, to prepare for situations where we lack knowledge of environmental specifics. Our payload utilizes high-resolution 3D mapping and laser Raman, laser-induced breakdown spectroscopy, and laser-induced native fluorescence (LRS+LIBS+LINF) to perform integrated, context preserving, stand-off, *in-situ* characterizations of vent fluids and mineral precipitates.

Our concept puts forward transformative innovations for the *in-situ* exploration of vents. First, we integrate a science payload containing a stereo imaging sensor and three spectroscopic sensors – Raman, LIBS, and LINF – into a cost-effective underwater platform. Second, we advance adaptive multisensor data product acquisition for real-time integrated data management and extraction of scientific information to the user(s). While Raman and LIBS technologies have been deployed at seafloor vents, our concept features the first combined imaging *and* spectroscopy payload for underwater sensing. Moreover, unlike existing underwater Raman and LIBS applications, our concept does not require an ROV and ROV-support; it leverages cost-effective, high-heritage technologies and platforms to reduce program cost, risk, and time-to-field.

Our concept paves the way for future autonomous ocean/vent exploration, with applications to future targeted exploration of ocean worlds.

Our concept is designed around moderate-cost, high-heritage technologies to reduce program cost, risk, and time-to-flight. At the meeting we will describe our concept and an early-stage prototype, and discuss a proof-of-concept demonstration.

Significance: Our concept can provide valuable scientific, technological, and operational returns for the robotic exploration of hydrothermal vents. Our work lowers the risks of planetary vent exploration through tech/science operations demonstrations.

Figure 1. Instruments and platform. From left: stereo cameras, COTS housing and early stage LRS/LIBS/LINF instrument.

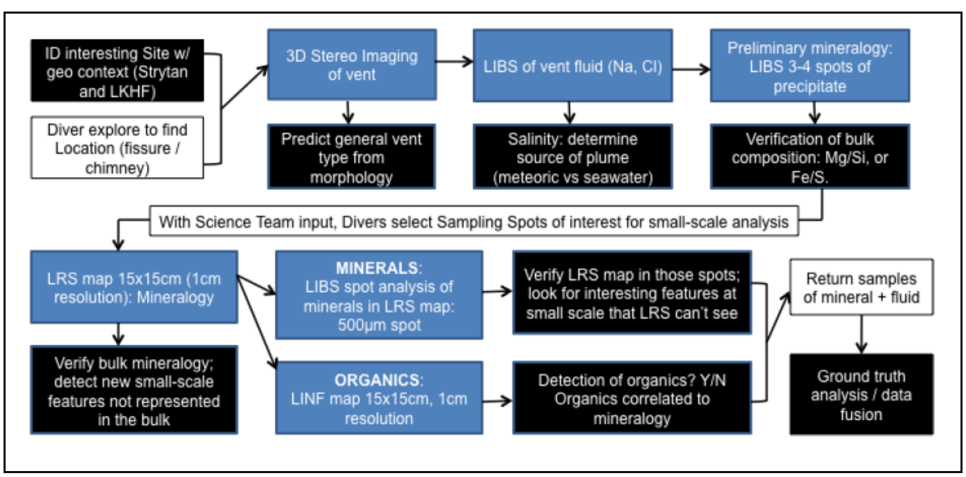

Figure 2. Science operations strategy for each Location. The lower procedure can be repeated for 2-3 Sample Spots in each Location, and we will sample at several Locations per Site,