LENSLESS DIGITAL HOLOGRAPHIC MICROSCOPY FOR LIFE DETECTION. E. Serabyn[1], K. Liewer[1], J.K. Wallace[1], S. Rider[1], C. Lindensmith[1] and J. Nadeau[2], [1]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, [2]California Institute of Technology, Pasadena, CA 91125.

Introduction: Microscopy capable of volume imaging can be used to search for microbial life on ocean worlds. Here we discuss our digital holographic microscope (DHM) systems, which provide high resolution, compactness and stability. Our most recent lensless DHM provides micron-scale resolution in a very compact package.

Background: Microbial motions can deviate noticeably from the average flow, so one way of identifying microbial life in aqueous or icy environments is the use of microscopic techniques that are sensitive to full 3-dimensional volumes, wherein the motions of any particulates or microbes present can be tracked. We have thus been developing a series of deployable digital holographic microscopes.

Digital holographic microscopy [1] has many advantages, including instantaneous 3-d volume imaging, high lateral resolution (micron scale), a large depth of field (mm-range), a large field of view, and compressed data sampling. Our initial submersible DHM for (terrestrial) field science [2] has been deployed to Greenland once, but its lens-based optics left this instrument larger than desirable for space missions. We thus have also been investigating "lensless" approaches [1] to digital holographic microscopy.

Lensless DHM: Our lensless DHM configurations rely on fiber-injection of the object and reference beams, and a small (few cm) free-space path from the sample plane to the detector plane. Our initial lensless system still relied on a lens-based optical relay to provide the desired focal ratio for both beams (in order to fully illuminate the detector array), but the imaging part of the optical system is lensless (i.e., from the final source focal plane just prior to the sample to the detector array). This system demonstrated micron-scale resolution over a large field of view, once aberrations were corrected by viewing a clear glass region.

As miniaturization for space-flight applications is a priority, we eliminated the initial relay by incorporating gradient-index lenses into the source assembly, leaving a free-space propagation distance of only a few cm. Such a compact system has many immediate applications, both terrestrial and space-based, including the search for microbial life on ocean worlds.

References: [1] M.K. Kim (2011) *Digital Holographic Microscopy* (Springer). [2] J.K. Wallace, S. Rider, E. Serabyn, J. Kühn, K. Liewer, J. Deming, G. Showalter, C. Lindensmith and J. Nadeau (2015), Opt. Exp. **23**, 17367.