National Aeronautics and Space Administration

The Next Generation, Fieldable Digital Holographic Microscope

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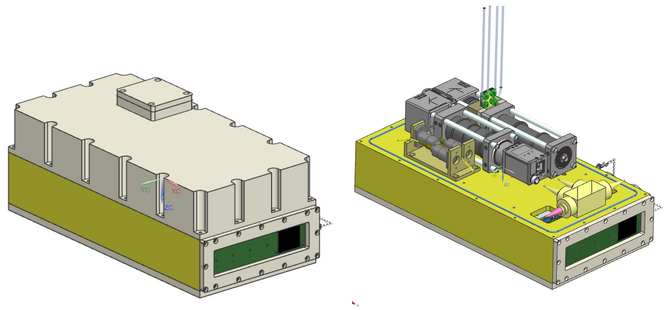
Program: FY21 R&TD Innovative Spontaneous Concepts

Objectives

Digital holographic microscopy (DHM) is a powerful technique capable of producing high-resolution, volumetric images from a single snapshot with no moving parts. When volumetric images are acquired at video rates, the resulting 'micro fish tank' allows scientist to track and characterize the motility of microorganisms in space and time. The previous instrument worked at a single wavelength, and had a limited computer interface. This revised instrument will work at multiple wavelengths, and it will have faster data transfers.

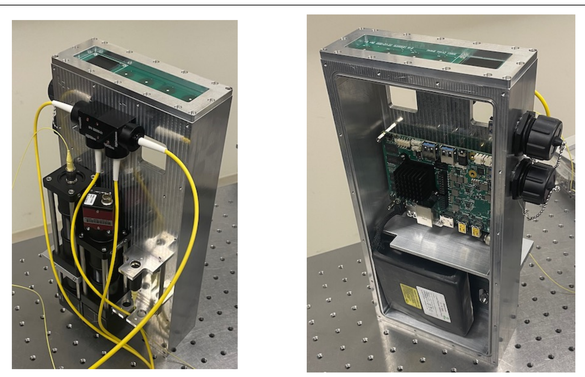
Our hardware objectives are to fabricate, assemble, test and deploy the next generation of DHM field instruments. This same team has fielded the previous generation of instruments and will provide science observations as well as engineering feedback for continued application and development of this technology. The science objectives are to use the next generation portable DHM on microbial communities of existing brines to understand the low biomass and potentially decreased cell motility in Permian-aged samples. Moreover, Raman analyses will be conducted in conjunction with DHM analysis to compare motile cells to geomicrobiological features that Raman can quantify and identify.



Renderings of the the digital holographic field instrument are shown above. The left image is with the cover on, the right is with the cover off. The right side shows the core of the optical instrument with holographic microscope assembly, the multi-wavelength combiner, and the laser diode bracket.

Results

- Instrument Designed
- Mechanical Hardware Fabricated
- Custom Daughter Card Fabricated
- Interface Card/Display Fabricated
- Components Integrated



Images of the assembled hardware are shown above. The left-hand side shows the instrument side, the right-hand image shows the electronics/power side. The touch interface can be seen on the top along with the micro display for providing instrument status and health.

Benefits to NASA/JPL

Motility is a hallmark of life, and the combination of volumetric image in an instrument with no moving parts make it well suited for the search for bacterial life on the planets and icy moons of our solar system. Indeed, since this approach was first formulated, we have been actively developing and deploying instruments for use in the field. In particular, in extreme environments such as acidic springs, arctic seas, briny desert pools, and deep mines. Instruments which are taken to the sample are important for detecting these species in situ, where there is minimal disruption to the native environment. At JPL, the DHM technique is now primarily focused on developing instrumentation for flight missions. However, the need for new field instruments and more field work remains. NASA and JPL have the goal of looking for life in the universe, and studying life should it be found. This instrument is well aligned with these ambitious goals.

Conclusions

- The next generation DHM field instrument has more capabilities and is more robust than previous instruments.
- This instrument has been designed, fabricated, and assembled.

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Clearance Number:
RPC/JPL Task Number: R21260