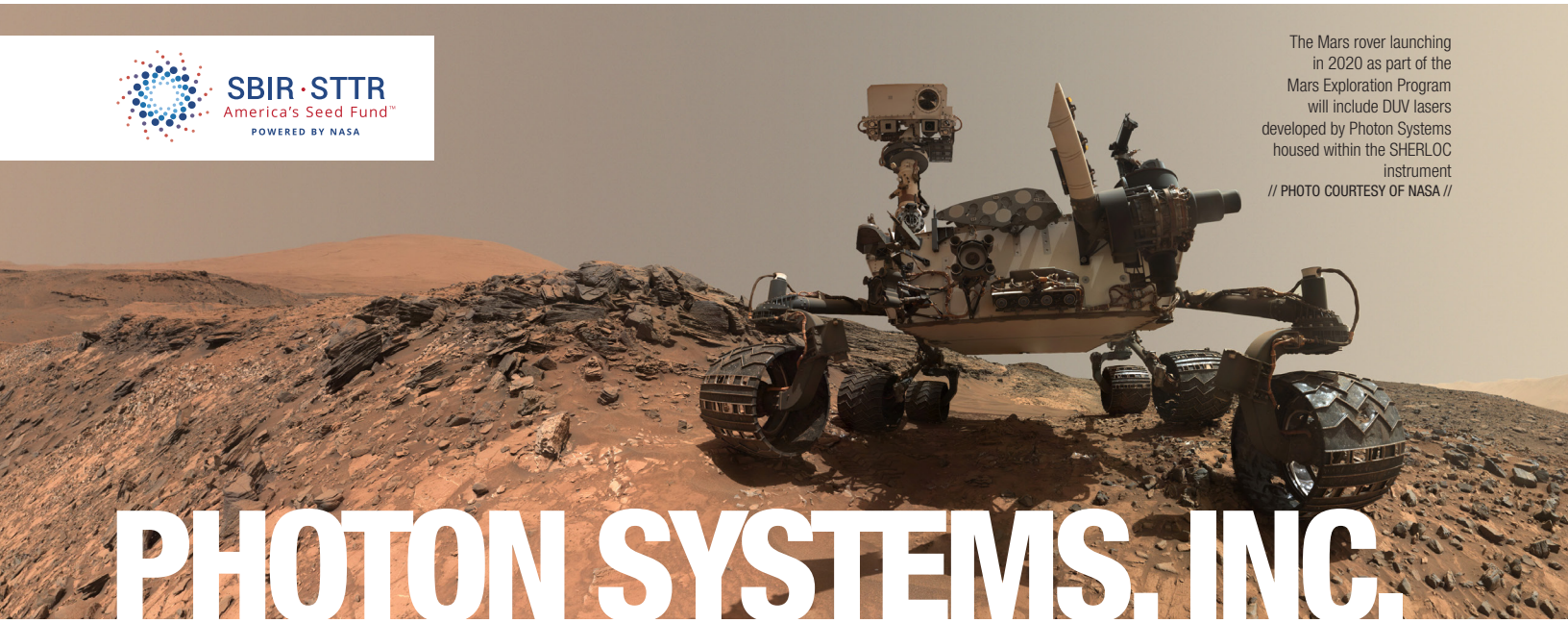

The Mars rover launching in 2020 as part of the Mars Exploration Program will include DUV lasers developed by Photon Systems housed within the SHERLOC instrument
// PHOTO COURTESY OF NASA //

PHOTON SYSTEMS, INC.

The 2020 Mars Rover is already one of the most highly anticipated robotic missions in NASA's history. As part of the Mars Exploration Program, this rover is designed to address key questions about the potential for life on the Red Planet and to gauge the challenges of future human exploration. One way to accomplish this is by using specialized ultraviolet (UV) lasers developed by Photon Systems to trace miniscule amounts of organics, such as amino acids; the building blocks of life.

PROJECT
Deep Ultraviolet (UV) Laser for Mars 2020 SHERLOC Instrument

MISSION DIRECTORATE
Science

PHASE III SUCCESS
Contracts with NASA worth $3 million; additional contracts with the DOD worth $4 million and commercial contracts worth $8 million

SNAPSHOT
The 11-person team at Photon Systems has been working with NASA since the late 90s to develop a DUV laser and the related resonance Raman and fluorescence spectrometer that will be instrumental in exploring Mars in 2020.

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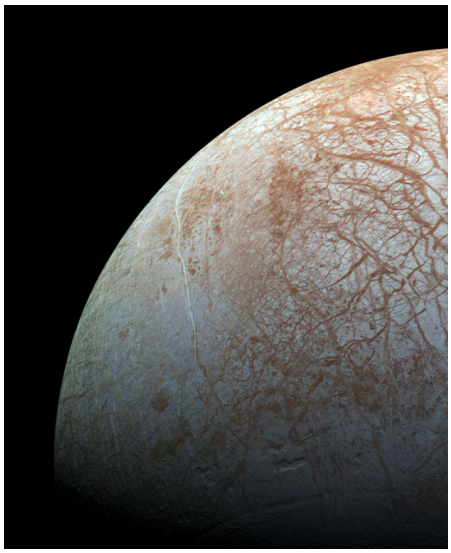
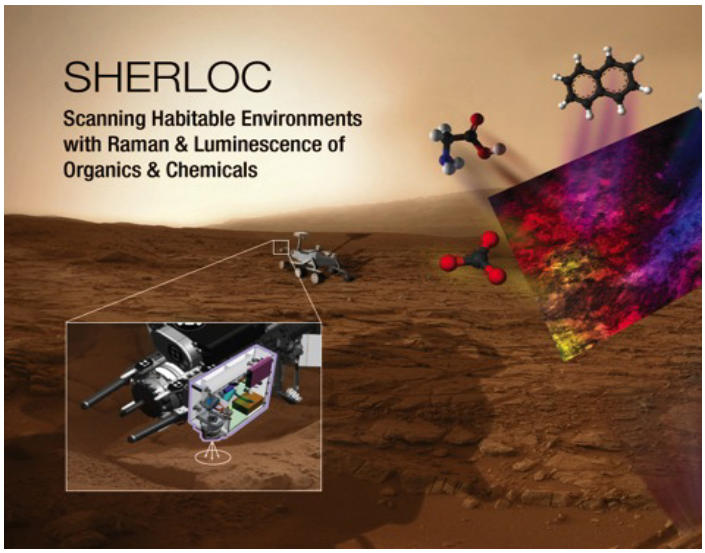
These Deep Ultraviolet (DUV) lasers are housed within one of the key pieces of equipment on the rover – SHERLOC – Scanning Habitable Environments with Raman & Luminescence for Organics and Chemicals. Through a contract with NASA's Jet Propulsion Laboratory (JPL), and several Small Business Innovation Research (SBIR) awards, Photon Systems is perfecting its laser and the ability to utilize deep UV methods for detecting organics.

Since anything designed for Mars has to go through decades of development, Photon Systems has been working closely with NASA since 1997 on all of the facets required for the highly ambitious task of planetary exploration. This evolved into using deep UV laser based technology to analyze trace amounts of other organic and inorganic materials as well as minerals. NASA hopes to create a detailed chemical/spatial map of portions of the Martian surface that will identify potential signs of ancient Martian conditions and perhaps even potential biosignatures within a rock.

"We had an idea for a small laser that was lightweight, with a low power consumption that could detect and characterize trace small amount of organics," recalls Dr. Bill Hug, Chairman and CEO of Photon Systems, Inc. "Through additional SBIRs focused on detecting amino acids and other prebiotic materials, this led to our current work on SHERLOC on developing a mini laser that enables mini-deep UV spectroscopic methods."

Photon's ultraviolet light lasers – which weigh about 1 pound – will be stationed on the robotic arm of the Mars rover and will use two types of ultraviolet-light spectroscopy to help search for signs of potential life on Mars. Interesting samples will be collected for possible return to Earth on a future mission. SHERLOC aims the UV laser light at a specific target and looks at the spectral signature





LEFT Europa, Jupiter's smallest moon, could be home to various life forms due to its many oceans. NASA has plans to use Photon Systems' patented UV laser technology to eventually explore the surface of Europa
// PHOTOS COURTESY OF NASA //

coming back. In the first type of spectroscopy, a distinct fluorescence spectral signature is emitted from molecules that contain rings of carbon atoms; clues that shine light on the potential for past life. The SHERLOC instrument hovers about 5 cm above the ground and ensures anything it measures remains sterile, which is important for planetary protection.

The second type of spectroscopy is called Raman scattering, which identifies certain minerals borne from salty water as well as other organic and inorganic compounds. This dual-use instrument is the first of its kind, and allows for the powerful analysis of many different compounds that were never before achievable. With an input power less than 10 W and emission wavelength at 248 nm, these lasers are smaller, lighter, and use less power than other lasers emitting in the deep UV, which are needed for the type of spectroscopy being employed in SHERLOC. These lasers have demonstrated the ability to operate at the extremes of temperature, from minus 130 Celsius to plus 70 Celsius; a necessity for operation on the rover arm of the Mars 2020 lander. This was previously unattainable.

> "The NASA SBIR program has enabled a very complicated technology to be developed that if it were left to private enterprise, never would have been built."
>
> PHOTON SYSTEMS, INC.
> CHAIRMAN AND CEO
> **DR. BILL HUG**

The beauty of such a laser is that it is capable of generating strong signals from organic materials that enables ultrahigh sensitivities. Just as the technology can pick up the detection of trace organic species on a planetary surface, that same principle can be applied to other sorts of detection, including chemical, biological and explosive weapons, as well as crime scene investigations. Photon Systems has contracts in place with the Department of Defense worth $4 million that utilize the same technology originally developed under the NASA SBIR project.

"The NASA SBIR program has enabled a very complicated technology to be developed that if it were left to private enterprise, never would have been built," adds Hug. "We believe we are at the forefront of a large number of commercial and government applications, both with the DOD, NASA, EPA, NIOSH, etc. but it has taken 17 years. No venture capitalist would have waited that long."

In the commercial sector, Photon Systems is working with both Pfizer and DuPont on contracts that involve the validation for manufacturing equipment and looking for trace amounts of containments in manufactured pills and food products. Additional applications in the pharmaceutical and food safety industry are also being explored. Commercial revenue stemming from the SBIR-funded technology has exceeded $8 million.

As for NASA, the agency has plans beyond the Mars 2020 mission to explore Titan, the largest of Saturn's moons; Enceladus, the active moon of Saturn; and Europa, a moon of Jupiter. All of these celestial bodies are high priority targets. Titan, because of the wealth of organic species present on the surface; Enceladus, because of liquid water in the subsurface that is being flung into space; and Europa, due to its under ice ocean that contains twice as much water as there is on Earth. These reasons make all three of them the best possible candidates for future exploration beyond Mars.

With just eleven employees and missions extending into the outer realms of our solar system, Photon Systems is just beginning to break ground in the buzzed-about deep UV territory. With concurrent projects right here on Earth utilizing the same futuristic technology, Photon Systems may be one of the few companies that can honestly say it has cornered the universal market.

NASA

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