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the RDX relatedness index was consistently high. In other tests, a limit of detection less than 100 ng/cm^2 was demonstrated at a standoff distance of 1 meter using a 38 mm diameter collection aperture. Using a modestly larger aperture or at higher concentration amounts, the instrument can detect and identify explosives at longer standoff distances.

The developed sensor has an excitation wavelength of 248 nm from a transversely excited hollow cathode (TEHC) laser. An alternate excitation wavelength of interest is 224 nm, also from the TEHC laser. Although the optimum excitation wavelength is less than 250 nm at present, there is also an expectation that longer wavelengths up to about 400 nm may also be relevant for some applications.

This work was done by William Hug and Ray Reid of Photon Systems, Inc., and Rohit Bhartia and Arthur Lane of Caltech for NASA's Jet Propulsion Laboratory under an Army Phase I STTR contract (No. W81XWH-06-C-0395 CM: Dr. Gary Gilbert) with Photon Systems.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Refer to NPO-45166, volume and number of this NASA Tech Briefs *issue, and the page number.*

Using Fluorescent Viruses for Detecting Bacteria in Water

Lyndon B. Johnson Space Center, Houston, Texas

A method of detecting water-borne pathogenic bacteria is based partly on established molecular-recognition and fluorescent-labeling concepts, according to which bacteria of a species of interest are labeled with fluorescent reporter molecules and the bacteria can then be detected by fluorescence spectroscopy. The novelty of the present method lies in the use of bacteriophages (viruses that infect bacteria) to deliver the fluorescent reporter molecules to the bacteria of the species of interest. Bacteriophages that selectively infect that species are selected, and fluorescently labeled virus probes (FLVPs) are prepared by staining these bacteriophages with a fluorescent dye. The FLVPs are immobilized on an optical substrate, which could be a window or a waveguide.

Bacteria/bacteriophage complexes are formed when the substrate is exposed to water containing the bacteria of interest. These complexes exhibit a characteristic fluorescence spectrum, which can be measured to determine the concentration of the complexes and, thus, of the bacteria of interest. Biosensors based on this method could, potentially, enable rapid, selective, and potentially very sensitive detection of bacteria in water. Such biosensors could be used alternatively or complementarily to immunodiagnostic or nucleic acid-based biosensors.

This work was done by Mary Beth Tabacco, Xiaohua Qian, and Jaimie A. Russo of Echo Technologies, Inc., for Johnson Space Center.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Refer to MSC-23371-1, volume and number of this NASA Tech Briefs *issue, and the page number.*

Gradiometer Using Middle Loops as Sensing Elements in a Low-Field SQUID MRI System

Device could lead to an MRI diagnostic device for human diagnosis.

NASA's Jet Propulsion Laboratory, Pasadena, California

A new gradiometer scheme uses middle loops as sensing elements in low-field superconducting quantum interference device (SQUID) magnetic resonance imaging (MRI). This design of a second order gradiometer increases its sensitivity and makes it more uniform, compared to the conventional side loop sensing scheme with a comparable matching SQUID. The space between the two middle loops becomes the imaging volume with the enclosing cryostat built accordingly.

For optimal coupling to SQUID, the inductance of the gradiometer must be matched to that of the SQUID input coil. Previously, a second-order gradiometer was designed with optimized wire shape and split middle loops to increase the turn number for increased sensitivity, and/or the size for a larger field of view while keeping the inductance matched. This design was described in "Optimized Geometry for Superconducting Sensing Coils" (NPO-44629), *NASA Tech Briefs*, Vol. 32, No. 1 (January 2008), p. 26.

In a typical configuration of a SQUID MRI, the sensitivity of a gradiometer is a rapidly decreasing function of the distance from the sensing loops. This results in severe non-uniformity of sensitivity and signal-to-noise ratio (SNR) in the image. This problem can be solved by using two second-order gradiometers positioned at the opposite sides of the imaging volume, with two SQUIDs, one per gradiometer. This is not cost-effective since SNR improves only by a square root of two at the center of the imaging volume.

The new design, depicted in the figure, uses a single second-order gradiometer where the middle loops are used for sensing. Both the SNR and the uniformity of the gradiometer are greatly improved. In this scheme, the space between the middle loops be-