

the RDX relatedness index was consistently high. In other tests, a limit of detection less than 100 ng/cm² 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.

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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.

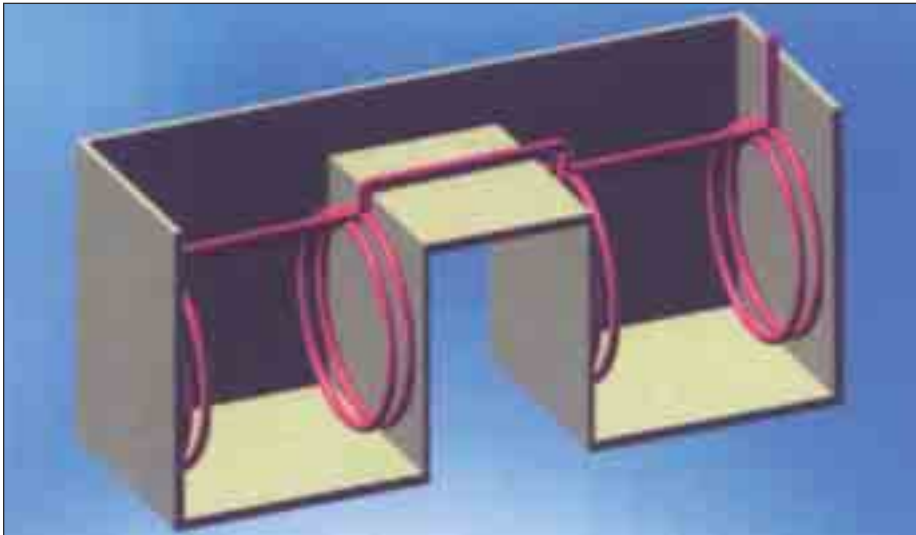
For optimal coupling to SQUID, the inductance of the gradiometer must be matched to that of the SQUID input

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 sensi-

tivity 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-



The **Middle-Loop Sensing Gradiometer** concept shows a schematic illustration of cryostat wall geometry (cut-off view). The imaging volume is in between two middle loops, outside the cryostat at room temperature.

comes the imaging volume with the enclosing cryostat built accordingly.

Because of the sensing middle loops at both ends of the imaging volume, the sensitivity at the center of the im-

aging volume is twice that of conventional geometry with the same SQUID noise. Only about half of the induced energy is lost in the non-sensing loops in the new scheme. The symmetric

placement of the sensing loops gives more uniform sensitivity. There is no inductance matching penalty associated with the new configuration, because the geometry and the inductance remain to be that of a single second-order gradiometer.

This work was done by Konstantin Penanen, Inseob Hahn, and Byeong Ho Eom of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

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-45720, volume and number of this NASA Tech Briefs issue, and the page number.

🌀 **Volcano Monitor: Autonomous Triggering of *In-Situ* Sensors**

NASA's Jet Propulsion Laboratory, Pasadena, California

In-situ sensors near volcanoes would be alerted by the Earth Observing-1 (EO-1) craft to take more frequent data readings. This project involves developing a sulfur-dioxide-sensing volcano monitor that will be able to transmit its readings through an Iridium modem. The monitor, when integrated into the Sensor Web network, will demonstrate the autonomous capabilities of the Sensor Web, as well as the speed and accuracy of the network. A potential scenario might involve an Earth-based sensor near the volcano, such as a tilt meter or a seismometer, encountering a critical

reading. This particular sensor could alert EO-1, which could then look for other sensors in the area. It would then send an alert message down to the Volcano Monitoring Box, which would increase the frequency of its readings from once an hour to once a minute. All these data would then be collected on a Web site that is accessible by volcanologists and other scientists. A typical data reading will include a date, time, temperature reading, humidity reading, and sulfur dioxide reading.

By using the speed and ease with which EO-1 transmits data, information

about volcanic activity can be collected quickly and autonomously. In better understanding the volcanoes of Earth, this technology will enable better study and understanding of volcanoes on other moons and planets as NASA sends unmanned vehicles to farther regions of space.

This work was done by Kate Boudreau of University of Idaho, Johanna Cecava of New Mexico State University, and Alberto Behar, Ashley Davies, and Daniel Q. Tran of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-45445

🌀 **Wireless Fluid-Level Sensors for Harsh Environments**

Sensors can be encased for protection, and are interrogated without wire connections.

Langley Research Center, Hampton, Virginia

Magnetic-field-response sensors have been developed for use in measuring levels of fluids under extreme conditions. The sensors work without wire

connections or direct physical contact with power sources, microprocessors, data-acquisition equipment, or electrical circuitry. For fuel-level sensors, the ab-

sence of wire connections offers an important safety advantage in elimination of potential ignition sources.

The sensors can be designed for