

The seat includes a thigh-support structure and a lower-leg support structure that can be adjusted for various heel-to-back-of-knee lengths. The occupant's heels are supported by a heel support pan and could be affixed to the pan by clips similar to those of mountain biking shoes and pedals or by straps over the tops of the feet. At the pivot between the thigh and lower-leg support structures there is a flat panel that provides for strength in adjustment and provides lateral support of the knees. The combination of lateral support of the knees and support and restraint of the feet is intended to prevent flailing or other movement of the legs while the occupant is seated.

The seat includes lateral supports at the hips that serve the dual purpose of

restraining the occupant from shifting laterally and providing structural support to the rest of the seat by acting as a gusset. To accommodate all hip sizes, the seat pan is designed to fit the largest hip breadth allowable. For a smaller occupant, spacer pads can be installed to fill the voids. Shoulder supports, which cover the shoulder joints and extend short distances down the arms, are also sized for occupants having shoulders of maximum breadth and to be fitted to smaller occupants by use of spacer pads. The seat supports bony protrusions of the torso at the shoulders and hips only, leaving the mid-torso area free of supports to enable the occupant to leave the seat by rolling through the clear space.

The seat includes a head support. However, head support on the prototype differs from the envisioned Orion head support: In Orion, the occupant would wear a space helmet and the head support would extend along the right and left sides of the helmet to prevent lateral motion of the head.

Another prominent design feature is a load-distributing seven-point harness similar to harnesses worn in off-road automobile racing. The seven-point harness includes straps over the tops of the shoulders that act, in effect, as wrap-around extensions of the lateral shoulder supports.

*This work was done by Dustin Gohmert of Johnson Space Center. Further information is contained in a TSP (see page 1). MSC-24485-1*

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## Open-Access, Low-Magnetic-Field MRI System for Lung Research

*Lyndon B. Johnson Space Center, Houston, Texas*

An open-access magnetic resonance imaging (MRI) system is being developed for use in research on orientational/gravitational effects on lung physiology and function. The open-access geometry enables study of human subjects in diverse orientations. This system operates at a magnetic flux density, considerably smaller than the flux densities of typical other MRI systems, that can be generated by resistive electromagnet coils (instead of the more-expensive superconducting coils of the other systems).

The human subject inhales air containing  $^3\text{He}$  or  $^{129}\text{Xe}$  atoms, the nuclear spins of which have been polarized by use of a laser beam to obtain a mag-

netic resonance that enables high-resolution gas space imaging at the low applied magnetic field. The system includes a bi-planar, constant-current, four-coil electromagnet assembly and associated electronic circuitry to apply a static magnetic field of 6.5 mT throughout the lung volume; planar coils and associated circuitry to apply a pulsed magnetic-field-gradient for each spatial dimension; a single, detachable radio-frequency coil and associated circuitry for inducing and detecting MRI signals; a table for supporting a horizontal subject; and electromagnetic shielding surrounding the electromagnet coils.

*This work was done by Ross W. Mair, Matthew S. Rosen, Leo L. Tsai, and Ronald L. Walsworth of the Harvard-Smithsonian Center for Astrophysics; Mirko I. Hrovat of Mirtech, Inc.; Samuel Patz of Brigham and Women's Hospital; and Iullian C. Ruset and F. William Hersman of the University of New Hampshire 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:*

*Harvard-Smithsonian Center for Astrophysics  
Cambridge, MA 02138*

*Refer to MSC-24182-1/3-1, volume and number of this NASA Tech Briefs issue, and the page number.*

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## Microfluidic Mixing Technology for a Universal Health Sensor

*John H. Glenn Research Center, Cleveland, Ohio*

A highly efficient means of microfluidic mixing has been created for use with the rHEALTH sensor — an elliptical mixer and passive curvilinear mixing patterns. The rHEALTH sensor provides rapid, handheld, complete blood count, cell differential counts, electrolyte measurements, and other lab tests based on a reusable, flow-based microfluidic platform.

These geometries allow for cleaning in a reusable manner, and also allow for

complete mixing of fluid streams. The microfluidic mixing is performed by flowing two streams of fluid into an elliptical or curvilinear design that allows the combination of the flows into one channel. The mixing is accomplished by either chaotic advection around microfluidic loops.

All components of the microfluidic chip are flow-through, meaning that cleaning solution can be introduced into the chip to flush out cells, plasma

proteins, and dye. Tests were performed on multiple chip geometries to show that cleaning is efficient in any flow-through design. The conclusion from these experiments is that the chip can indeed be flushed out with microliter volumes of solution and biological samples are cleaned readily from the chip with minimal effort.

The technology can be applied in real-time health monitoring at patient's bedside or in a doctor's office, and real-

time clinical intervention in acute situations. It also can be used for daily measurement of hematocrit for patients on anticoagulant drugs, or to detect acute myocardial damage outside a hospital.

*This work was done by Eugene Y Chan and Candice Bae of DNA Medicine Institute for Glenn Research Center.*

*Inquiries concerning rights for the commercial use of this invention should be ad-*

*ressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18391-1.*

## Microfluidic Extraction of Biomarkers Using Water as Solvent

### Terahertz modulation of permittivity of water would enable solvation of molecules of interest.

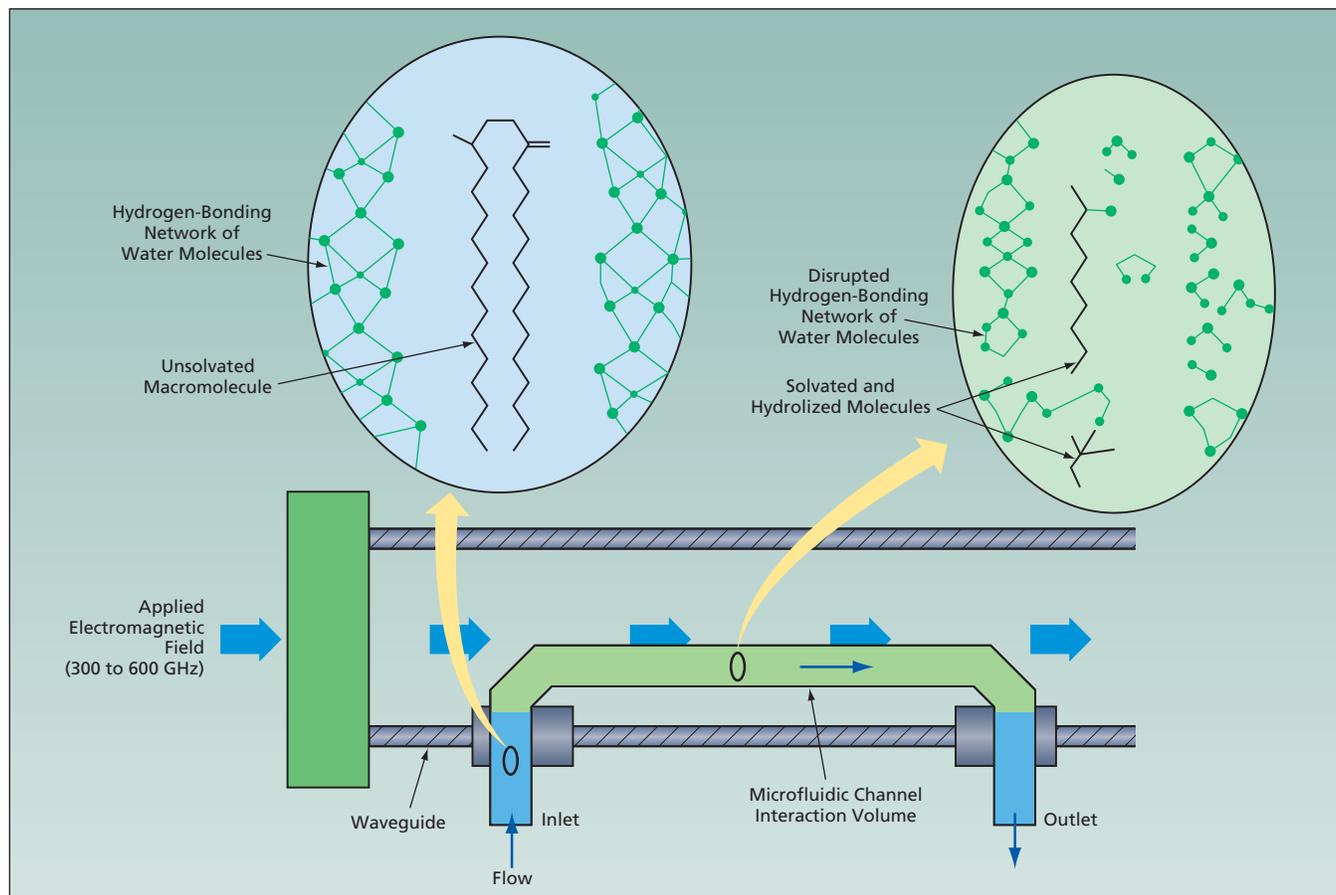
NASA's Jet Propulsion Laboratory, Pasadena, California

A proposed device, denoted a miniature microfluidic biomarker extractor ( $\mu$ -EX), would extract trace amounts of chemicals of interest from samples, such as soils and rocks. Traditionally, such extractions are performed on a large scale with hazardous organic solvents; each solvent capable of dissolving only those molecules lying within narrow ranges of specific chemical and physical characteristics that notably include volatility, electric charge, and polarity. In contrast, in the  $\mu$ -EX, extractions could be performed by use of small amounts (typically between 0.1 and 100  $\mu$ L) of water as a universal solvent.

As a rule of thumb, in order to enable solvation and extraction of molecules, it is necessary to use solvents that have polarity sufficiently close to the polarity of the target molecules. The  $\mu$ -EX would make selection of specific organic solvents unnecessary, because  $\mu$ -EX would exploit a unique property of liquid water: the possibility of tuning its polarity to match the polarity of organic solvents appropriate for extraction of molecules of interest. The change of the permittivity of water would be achieved by exploiting interactions between the translational states of water molecules and an imposed electromagnetic field in the frequency range of

300 to 600 GHz. On a molecular level, these interactions would result in disruption of the three-dimensional hydrogen-bonding network among liquid-water molecules and subsequent solvation and hydrolysis of target molecules. The  $\mu$ -EX is expected to be an efficient means of hydrolyzing chemical bonds in complex macromolecules as well and, thus, enabling analysis of the building blocks of these complex chemical systems.

The  $\mu$ -EX device would include a microfluidic channel, part of which would lie within a waveguide coupled to an electronically tuned source of broadband electromagnetic radiation in the fre-



**Water Flowing in a Microfluidic Channel** would be exposed to electromagnetic radiation, causing the solvation of biomarker macromolecules that would otherwise be insufficiently soluble in water.