12-13 December 2013

Tech Briefs

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

INTRODUCTION

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Innovative Partnerships Offices are located at NASA field centers to provide technology-transfer access to industrial users. Inquiries can be made by contacting NASA field centers listed below.

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Tech Briefs

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Technology Focus: Electronic Components

Microwave Kinetic Inductance Detector With Selective Polarization Coupling

Low-noise detector and readout functionality are combined into one device.

Goddard Space Flight Center, Greenbelt, Maryland

A conventional low-noise detector requires a technique to both absorb incident power and convert it to an electrical signal at cryogenic temperatures. This innovation combines low-noise detector and readout functionality into one device while maintaining high absorption, controlled polarization sensitivity, and broadband detection capability. The resulting far-infrared detectors can be read out with a simple approach, which is compact and minimizes thermal loading.

The proposed microwave kinetic inductance detector (MKID) consists of three basic elements. The first is the absorptive section in which the incident power is coupled to a superconducting resonator at far-infrared frequency above its superconducting critical frequency (where superconductor becomes normal conductor). This absorber's shape effectively absorbs signals in the desired polarization state and is resonant at the radio frequency (RF) used for readout of the device. Control over the metal film used in the absorber allows realization of structures with either a 50% broadband or 100% resonance absorptance over a 30% fractional bandwidth.

The second element is a microwave resonator — which is realized from the thin metal films used to make the absorber as transmission lines — whose resonance frequency changes due to a variation in its kinetic inductance. The resonator's kinetic inductance is a function of the power absorbed by the device. A low-loss dielectric (mono-crystalline silicon) is used in a parallel-plate transmission line structure to realize the desired superconducting resonators. There is negligible coupling among the adjacent elements used to define the polarization sensitivity of each detector. The final component of the device is a microwave transmission line, which is coupled to the resonator, and allows detection of changes in resonance frequency for each detector in the focal plane array.

The spiral shape of the detector's absorber allows incident power with two polarizations to couple to the detector equally. A stepped impedance resonator was used that allows the incident power absorbed in the detecting membrane area to be uniformly distributed in the detector's transmission line at the RF readout frequency. This maximizes the sensitivity of the detector. The signal is read out via a frequency multiplexing technique that requires a minimum number of interface transmission lines for readout. This reduces the packaging complexity and coupling to the device's thermal environment.

This work was done by Edward Wollack, Kongpop U-yen, Thomas Stevenson, Ari Brown, Samuel Moseley, and Wen-Ting Hsieh of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-16342-1

Flexible Microstrip Circuits for Superconducting Electronics

Improved wiring geometry should further reduce the size of the wiring while also reducing the crosstalk among wire pairs.

Goddard Space Flight Center, Greenbelt, Maryland

Flexible circuits with superconducting wiring atop polyimide thin films are being studied to connect large numbers of wires between stages in cryogenic apparatus with low heat load. The feasibility of a full microstrip process, consisting of two layers of superconducting material separated by a thin dielectric layer on 5 mil (≈0.13 mm) Kapton sheets, where manageable residual stress remains in the polyimide film after processing, has been demonstrated. The goal is a 2-mil (≈0.051-mm) process using spin-on polyimide to take advantage of the smoother polyimide surface for achieving high-quality metal films. Integration of microstrip wiring with this polyimide film may require high-temperature bakes to relax the stress in the polyimide film between metallization steps.

Focal planes of cryogenic detectors typically have detectors at the lowest temperature stage with bias and readout located at higher temperature stages to reduce the cooling power requirement on the refrigerator stage that achieves the base temperature for the detectors. Large numbers of wires between cryogenic stages are often necessary and need to be designed to maintain a manageable heat load to each stage. A microstripline wiring configuration is also desired to suppress thermal crosstalk into the detectors due to amplifier switching and bias changes. With the size of focal planes increasing into the range of thousands of biased elements, and a further need for compactness of the focal plane architecture, a technology is needed that can accommodate thousands of superconducting wires between cryogenic components.

Flexible niobium wiring has been demonstrated on Kapton pieces where the impedance of the line was set by the distance between the Nb wires and the dielectric properties of the Kapton. This work proposes to fabricate microstrip Nb wiring consisting of a narrow Nb trace atop a wider trace separated by a thin dielectric layer. This wiring geometry, in comparison to the coplanar designs, should further reduce the size of the wiring while also reducing the crosstalk among wire pairs. Further, the use of a thin polyimide layer will enable lower heat loads between stages for a similar length of flexible wiring.

It was shown that 5-mil (≈0.13-mm) sheets could be readily mounted smoothly onto the substrate. The substrates were taken through all process steps, including Nb deposition and etch, oxide deposition, and aluminum deposition and etch. In all cases, the heat-release tape held the Kapton onto the substrate, indicating that the processes could be run serially to complete a full microstrip process. A Kapton film with a patterned Nb layer on it was released, and showed that the film was superconducting at a temperature close to the expected critical temperature of Nb. Polyimide layers that were free of roughness and pitting were generated through a spin-on process that used successive spins and bakes, with gradual heat lip and cooldown cycles, to build up the film to a full thickness of 2 mils (»0.051 mm). The full thickness film is baked at elevated temperatures to relieve residual stress in the film.

This work was done by James Chervenak of Goddard Space Flight Center, and Jennette Mateo of SB Microsystems. Further information is contained in a TSP (see page 1).GSC-16718-1

Software

CFD Extraction Tool for TecPlot From DPLR Solutions

This invention is a TecPlot macro of a computer program in the TecPlot programming language that processes data from DPLR solutions in TecPlot format. DPLR (Data-Parallel Line Relaxation) is a NASA computational fluid dynamics (CFD) code, and TecPlot is a commercial CFD post-processing tool. The TecPlot data is in SI units (same as DPLR output). The invention converts the SI units into British units. The macro modifies the TecPlot data with unit conversions, and adds some extra calculations. After unit conversions, the macro cuts a slice, and adds vectors on the current plot for output format. The macro can also process surface solutions.

Existing solutions use manual conversion and superposition. The conversion is complicated because it must be applied to a range of inter-related scalars and vectors to describe a 2D or 3D flow field. It processes the CFD solution to create superposition/comparison of scalars and vectors.

The existing manual solution is cumbersome, open to errors, slow, and cannot be inserted into an automated process. This invention is quick and easy to use, and can be inserted into an automated data-processing algorithm.

This work was done by David Norman, Jr. of The Boeing Company for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809. MSC-24982-1

RECOVIR Software for Identifying Viruses

Most single-stranded RNA (ssRNA) viruses mutate rapidly to generate a large number of strains with highly divergent capsid sequences. Determining the capsid residues or nucleotides that uniquely characterize these strains is critical in understanding the strain diversity of these viruses. RECOVIR (an acronym for "recognize viruses") software predicts the strains of some ssRNA viruses from their limited sequence data. Novel phylogenetic-tree-based databases of protein or nucleic acid residues that uniquely characterize these virus strains are created. Strains of input virus sequences (partial or complete) are predicted through residue-wise comparisons with the databases.

RECOVIR uses unique characterizing residues to identify automatically strains of partial or complete capsid sequences of picorna and caliciviruses, two of the most highly diverse ssRNA virus families. Partition-wise comparisons of the database residues with the corresponding residues of more than 300 complete and partial sequences of these viruses resulted in correct strain identification for all of these sequences.

This study shows the feasibility of creating databases of hitherto unknown residues uniquely characterizing the capsid sequences of two of the most highly divergent ssRNA virus families. These databases enable automated strain identification from partial or complete capsid sequences of these human and animal pathogens.

This work was done by Sugoto Chakravarty, George E. Fox, and Dianhui Zhu of the University of Houston for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809. MSC-24358-1

Enhanced Contact Graph Routing (ECGR) MACHETE Simulation Model

Contact Graph Routing (CGR) for Delay/Disruption Tolerant Networking (DTN) space-based networks makes use of the predictable nature of node contacts to make real-time routing decisions given unpredictable traffic patterns. The contact graph will have been disseminated to all nodes before the start of route computation. CGR was designed for space-based networking environments where future contact plans are known or are independently computable (e.g., using known orbital dynamics). For each data item (known as a bundle in DTN), a node independently performs route selection by examining possible paths to the destination. Route computation could conceivably run thousands of times a second, so computational load is important.

This work refers to the simulation software model of Enhanced Contact Graph Routing (ECGR) for DTN Bundle Protocol in JPL's MACHETE simulation tool. The simulation model was used for performance analysis of CGR and led to several performance enhancements. The simulation model was used to demonstrate the improvements of ECGR over CGR as well as other routing methods in space network scenarios. ECGR moved to using earliest arrival time because it is a global monotonically increasing metric that guarantees the safety properties needed for the solution's correctness since route re-computation occurs at each node to accommodate unpredicted changes (e.g., traffic pattern, link quality). Furthermore, using earliest arrival time enabled the use of the standard Dijkstra algorithm for path selection. The Dijkstra algorithm for path selection has a well-known inexpensive computational cost. These enhancements have been integrated into the open source CGR implementation. The ECGR model is also useful for route metric experimentation and comparisons with other DTN routing protocols particularly when combined with MACHETE's space networking models and Delay Tolerant Link State Routing (DTLSR) model.

This work was done by John S. Segui, Esther H. Jennings, and Loren P. Clare of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

The software used in this innovation is available for commercial licensing. Please contact Dan Broderick at Daniel.F.Broderick@jpl.nasa.gov. Refer to NPO-47650.

Orbital Debris Engineering Model (ORDEM) v.3

A model of the manmade orbital debris environment is required by spacecraft designers, mission planners, and others in order to understand and mitigate the effects of the environment on their spacecraft or systems. A manmade environment is dynamic, and can be altered significantly by intent (e.g., the Chinese anti-satellite weapon test of January 2007) or accident (e.g., the collision of Iridium 33 and Cosmos 2251 spacecraft in February 2009).

Engineering models are used to portray the manmade debris environment in Earth orbit. The availability of new sensor and in situ data, the re-analysis of older data, and the development of new analytical and statistical techniques has enabled the construction of this more comprehensive and sophisticated model. The primary output of this model is the flux [#debris/area/time] as a function of debris size and year. ORDEM may be operated in spacecraft mode or telescope mode. In the former case, an analyst defines an orbit for a spacecraft and "flies" the spacecraft through the orbital debris environment. In the latter case, an analyst defines a ground-based sensor (telescope or radar) in terms of latitude, azimuth, and elevation, and the model provides the number of orbital debris traversing the sensor's field of view.

An upgraded graphical user interface (GUI) is integrated with the software. This upgraded GUI uses project-oriented organization and provides the user with graphical representations of numerous output data products. These range from the conventional flux as a function of debris size for chosen analysis orbits (or views), for example, to the more complex color-contoured two-dimensional (2D) directional flux diagrams in local spacecraft elevation and azimuth.

This work was done by Mark Matney of Johnson Space Center; Paula Krisko and Yu-Lin Xu of Jacobs Technology; and Matthew Horstman of ERC. Further information is contained in a TSP (see page 1). MSC-25457-1

Scatter-Reducing Sounding Filtration Using a Genetic Algorithm and Mean Monthly Standard Deviation

Retrieval algorithms like that used by the Orbiting Carbon Observatory (OCO)-2 mission generate massive quantities of data of varying quality and reliability. A computationally efficient, simple method of labeling problematic datapoints or predicting soundings that will fail is required for basic operation, given that only 6% of the retrieved data may be operationally processed. This method automatically obtains a filter designed to reduce scatter based on a small number of input features.

Most machine-learning filter construction algorithms attempt to predict error in the CO_2 value. By using a surrogate goal of Mean Monthly STDEV, the goal is to reduce the retrieved CO_2 scatter rather than solving the harder problem of reducing CO_2 error. This lends itself to improved interpretability and performance.

This software reduces the scatter of retrieved CO_2 values globally based on a minimum number of input features. It can be used as a prefilter to reduce the number of soundings requested, or as a post-filter to label data quality. The use of the MMS (Mean Monthly Standard deviation) provides a much cleaner, clearer filter than the standard ABS(CO_2-truth) metrics previously employed by competitor methods.

The software's main strength lies in a clearer (i.e., fewer features required) filter that more efficiently reduces scatter in retrieved CO_2 rather than focusing on the more complex (and easily removed) bias issues.

This work was done by Lukas Mandrake of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

This software is available for commercial licensing. Please contact Dan Broderick at Daniel.F.Broderick@jpl.nasa.gov. Refer to NPO-48255.

Manufacturing & Prototyping

Thermo-Mechanical Methodology for Stabilizing Shape Memory Alloy Response

This innovation is directly applicable to actuator applications employing shape memory alloys.

John H. Glenn Research Center, Cleveland, Ohio

This innovation is capable of significantly reducing the amount of time required to stabilize the strain-temperature response of a shape memory alloy (SMA). Unlike traditional stabilization processes that take days to weeks to achieve stabilized response, this innovation accomplishes stabilization in a matter of minutes, thus making it highly useful for the successful and practical implementation of SMA-based technologies in real-world applications. The innovation can also be applied to complex geometry components, not just simple geometries like wires or rods.

SMAs are being developed for use as actuators, switches, and other devices in aerospace, automotive, and many other industries. An important aspect of developing a useful SMA technology is the ability to achieve a stabilized material response. Most SMAs exhibit dimensional instability when thermally cycled in the presence of applied stress. In order to mitigate the need for the design to deal with such issues, "training" or stabilization of the materials response must be achieved prior to utilizing the material under service conditions.

The process of stabilizing an SMA for actuator response is generally thought of as a stabilization of the strain during thermal cycling under conditions of fixed stress (the so-called isobaric response). Although this formulation is entirely appropriate, the underlying reason for the strain stabilization is governed by the internal states that the combination of stress and temperature produce (in this case, one of the drivers being transient and one being fixed). Hence, any combination of stress and temperature that would produce the same strain state could also stabilize the material for the intended service condition. In general, thermal cycling under fixed stress is commonly used to achieve stabilized behavior, but this process is not only time-consuming but costly.

The current innovation replaces this process with an alternate method utilizing mechanical cycles under conditions of fixed temperature (the so-called isothermal response), since mechanical cycling takes far less time than thermal cycling. The current innovation describes a process for determining this link, followed by achieving stabilization by a rapid and efficient mechanical cycling treatment. To begin, the stabilization point for the material (the absolute strain levels achieved after stabilization) is established by performing an isobaric experiment under conditions identical to those that will be used during service. Once known, a set of isothermal mechanical cycling experiments is performed using different levels of applied stress. Each of these mechanical cycling experiments is left to run until the strain response has stabilized. Once the stress levels required to achieve stabilization under isothermal conditions are known, they can be utilized to train the material in a fraction of the time that would be required to train the material isobarically. Once the strain state is achieved isothermally, the material can be switched back under isobaric conditions, and will remain stabilized for the service conditions.

The advantage of approaching the problem via this technique is that it is now possible to reduce the amount of time required to achieve a stabilized material response from days to weeks, down to a matter of minutes. The significant reduction in time translates into a more cost-effective solution for SMA-based technologies that in turn improves the viability of SMA device utilization.

This work was done by Santo Padula of Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18594-1.

Hermetic Seal Designs for Sample Return Sample Tubes

Prototype sample tube seals prevent material loss and maintain sample integrity.

NASA's Jet Propulsion Laboratory, Pasadena, California

Prototypes have been developed of potential hermetic sample sealing techniques for encapsulating samples in a ≈1-cm-diameter thin-walled sample tube that are compatible with IMSAH (Integrated Mars Sample Acquisition and Handling) architecture. Techniques include a heat-activated, finned, shape memory alloy plug; a contracting shape memory alloy activated cap; an expanding shape memory alloy plug; and an expanding torque plug.

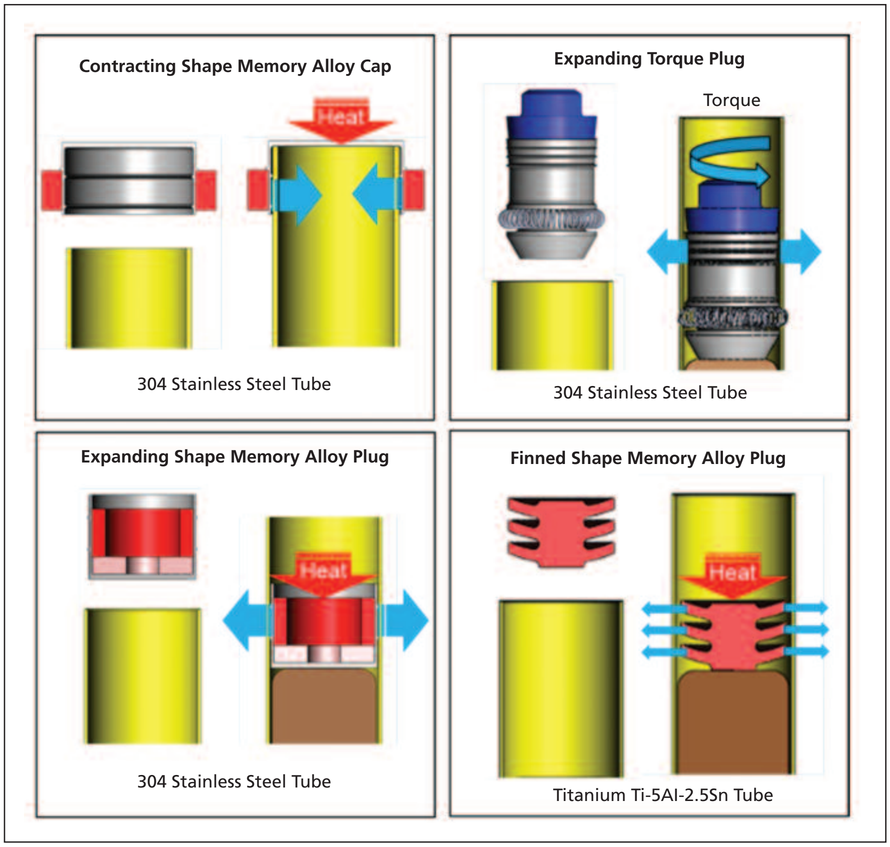
Initial helium leak testing of the shape memory alloy cap and finned shape memory alloy plug seals showed hermetic-seal capability compared against an industry standard of $<1\times10^{-8}$ atm-cc/s He. These tests were run on both clean tubes and dirty tubes dipped in MMS (Mojave Mars Simulant). The leak tests were also performed after thermal cycling between –135 and +55 ºC to ensure seal integrity after Martian diurnal cycles. Developmental testing is currently being done on the expanding torque plug, and expanding shape memory alloy plug seal designs.

The finned shape memory alloy (SMA) plug currently shows hermetic sealing capability based on preliminary tests. The finned SMA plug sealing technique requires a heater to actuate the plug. Materials have been selected to comply with current sample compatibility, contamination control, and planetary protection concerns. Various Nitinol SMA chemistries are currently being investigated that allow the seal to start activating at temperatures as low as 45 °C (if low-temperature sealing is required for sample integrity), and as high as 135 °C (if planetary protection dry heat microbial reduction is required).

The contracting shape memory alloy cap requires a heater to actuate an SMA ring that swages the toothed cap onto the outside of the tube. The expanding SMA plug also requires a heater to actuate a ring that swages the toothed cap into the inside of the tube.

The benefit to the expanding torque plug is that no heat is required to create a seal. All that is needed is a rotating actuator to actuate the plug.

This work was done by Paulo J. Younse of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-48927



Potential hermetic **Sample Sealing Techniques** include a contracting shape memory alloy cap, expanding torque plug, expanding shape memory alloy plug, and a finned shape memory alloy plug.

Silicon Alignment Pins: An Easy Way To Realize a Wafer-to-Wafer Alignment

Etched pockets and silicon pins are used to align two wafers together.

NASA's Jet Propulsion Laboratory, Pasadena, California

Submillimeter heterodyne instruments play a critical role in addressing fundamental questions regarding the evolution of galaxies as well as being a crucial tool in planetary science. To make these instruments compatible with small platforms, especially for the study of the outer planets, or to enable the development of multi-pixel arrays, it is essential to reduce the mass, power, and volume of the existing single-pixel heterodyne receivers.

Silicon micromachining technology is naturally suited for making these submillimeter and terahertz components, where precision and accuracy are essential. Waveguide and channel cavities are etched in a silicon bulk material using deep reactive ion etching (DRIE) techniques. Power amplifiers, multiplier and mixer chips are then integrated and the silicon pieces are stacked together to form a supercompact receiver front end. By using silicon micromachined packages for these components, instrument mass can be reduced and higher levels of integration can be achieved.

A method is needed to assemble accurately these silicon pieces together, and a technique was developed here using etched pockets and silicon pins to align two wafers together. Each silicon piece is patterned with the pockets on both sides of the wafer, front and back, which are then etched down to ≈130 µm.

Meanwhile, the silicon pins are etched in a 200-µm thick wafer. By etching a C-shaped pin, the pin can be compressed to fit into the alignment pocket by an appropriate choice of the pin wall thickness. When released, the pin expands to fill the pocket. A tight fit is ensured by choosing the relaxed pin diameter to be greater than the pocket diameter. This approach reduces the misalignment tolerance to the positional variation between the photolithographically defined pockets, which is typically under 3 µm.

During assembly, the silicon compression pins are placed on the etched pockets of the first wafer, and the wafer to be aligned will find the right location using its own "back" etched pockets. The two wafers are therefore quickly and easily aligned. If more wafers need to be stacked, one can place additional layers, each time using the pins and the etched pockets as alignment features.

Using this method, one can align several wafers, if needed, by only handling and aligning two wafers at a time. Also, for accurate and tight alignments, the tolerances can be chosen down to only 1 μm by using more accurate lithography.

This work was done by Cecile Jung-Kubiak, Theodore J. Reck, Robert H. Lin, Alejandro Peralta, John J. Gill, Choonsup Lee, Jose Siles, Risaku Toda, Goutam Chattopadhyay, Ken B. Cooper, and Imran Mehdi of Caltech; and Bertrand Thomas of RPG Radiometer Physics GmbH for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov.

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-48079/608, volume and number of this NASA Tech Briefs *issue, and the page number.*

Mechanics/Machinery

Positive-Buoyancy Rover for Under Ice Mobility

This floating rover operates at the ice/water interface in lakes and seas.

NASA's Jet Propulsion Laboratory, Pasadena, California

A buoyant rover has been developed to traverse the underside of ice-covered lakes and seas. The rover operates at the ice/water interface and permits direct observation and measurement of processes affecting freeze-over and thaw events in lake and marine environments. Operating along the 2-D ice-water interface simplifies many aspects of underwater exploration, especially when compared to submersibles, which have difficulty in station-keeping and precision mobility.

The buoyant rover consists of an all aluminum body with two aluminum sawtooth wheels. The two independent body segments are sandwiched between four actuators that permit isolation of wheel movement from movement of the central tether spool. For normal operations, the wheels move while the tether spool feeds out line and the cameras on each segment maintain a user-controlled fixed position. Typically one camera targets the ice/water interface and one camera looks down to the lake floor to identify seep sources. Each wheel can be operated independently for precision turning and adjustments. The rover is controlled by a touch- tablet interface and wireless goggles enable real-time viewing of video streamed from the rover cameras.

The buoyant rover was successfully deployed and tested during an October 2012 field campaign to investigate methane trapped in ice in lakes along the North Slope of Alaska.

This work was done by John M. Leichty, Andrew T. Klesh, Daniel F. Berisford, Jaret B. Matthews, and Kevin P. Hand of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-48863

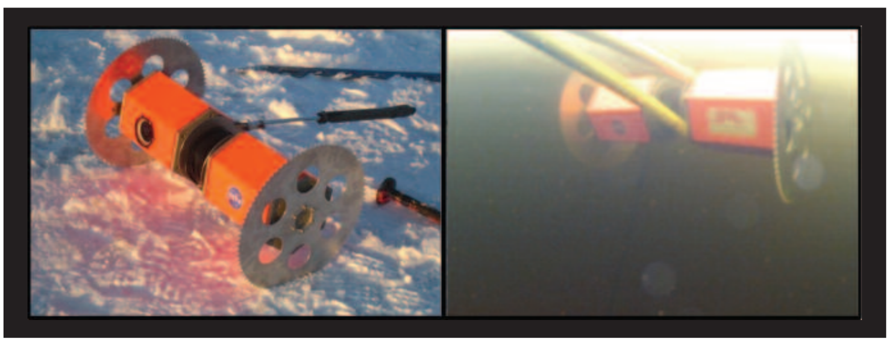

Figure 1. The **JPL Buoyant Under-Ice Rover** shown on the ice (left) and crawling on the underside of the ice (right) during a 2012 field campaign in Alaska. For scale, the rover is 0.54 m wide.

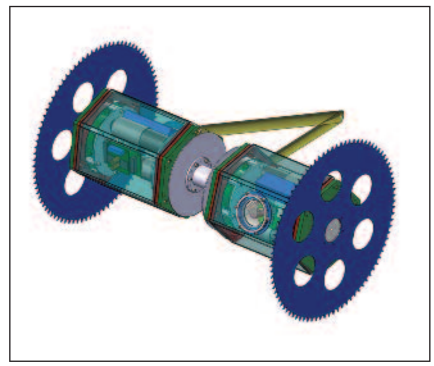

Figure 2. Computer aided design (CAD) model of the **JPL Buoyant Under Ice Rover** showing the two independent chassis regions each with wheel, camera, and instrument capability. The central tether spool can also operate independent of the side chassis.

Electric Machine With Boosted Inductance to Stabilize Current Control

Lyndon B. Johnson Space Center, Houston, Texas

High-powered motors typically have very low resistance and inductance (R and L) in their windings. This makes the pulse-width modulated (PWM) control of the current very difficult, especially when the bus voltage (V) is high. These R and L values are dictated by the motor size, torque (K_t), and back-emf (K_b) constants. These constants are in turn set by the voltage and the actuation torque-speed requirements. This problem is often addressed by placing inductive chokes within the controller. This approach is undesirable in that space is taken and heat is added to the controller.

By keeping the same motor frame, reducing the wire size, and placing a correspondingly larger number of turns in each slot, the resistance, inductance, torque constant, and back-emf constant are all increased. The increased inductance aids the current control but ruins the K_t and K_b selections. If, however, a fraction of the turns is moved from their "correct slot" to an "incorrect slot," the increased R and L values are retained, but the K_t and K_b values are restored to the desired values. This approach assumes that increased resistance is acceptable to a degree. In effect, the heat allocated to the added inductance has been moved from the controller to the motor body, which in some cases is preferred.

The slew-rate of the current is calculated as V/L and can easily be 250,000 A/s. With a pulse width resolution of 10 μs, for example, the current could slew 2.5 A, which in some cases may exceed the resolution needed for the current control loop. If L is increased, the problem is proportionately improved. Consider a certain motor size and gear train selection where the back-emf constant has been selected to meet a required output speed. The corresponding K_t and L, however, produce an uncontrollable current regulator. If the wire size is decreased by three gauges, for example, and the slots arc filled with twice as many turns (the slots will be full in this example), then the R and L will increase by a factor of four, while the K_t and K_b will increase by a factor of two. If the slots are only filled 67 percent in the correct fashion and the other 33 percent of the windings are placed in incorrect slots, then the K_t and K_b are reduced to their original levels.

The fourfold benefit of the inductance increase assists the current control. The resistance increase will cause more heating since the current level is unchanged in this example. If this is a problem, the motor thermal mass can be increased as a solution.

This work was done by Steve Abel of Honeywell Aerospace for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809. MSC-24906-1

International Space Station-Based Electromagnetic Launcher for Space Science Payloads

NASA's Jet Propulsion Laboratory, Pasadena, California

A method was developed of lowering the cost of planetary exploration missions by using an electromagnetic propulsion/launcher, rather than a chemical-fueled rocket for propulsion. An electromagnetic launcher (EML) based at the International Space Station (ISS) would be used to launch small science payloads to the Moon and near Earth asteroids (NEAs) for the science and exploration missions. An ISS-based electromagnetic launcher could also inject science payloads into orbits around the Earth and perhaps to Mars.

The EML would replace rocket technology for certain missions. The EML is a high-energy system that uses electricity rather than propellant to accelerate payloads to high velocities. The most common type of EML is the rail gun. Other types are possible, e.g., a coil gun, also known as a Gauss gun or mass driver. The EML could also "drop" science payloads into the Earth's upper atmosphere for science investigations.

This work was done by Ross M. Jones of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-48920

Books & Reports

Advanced Hybrid Spacesuit Concept Featuring Integrated Open Loop and Closed Loop Ventilation Systems

A document discusses the design and prototype of an advanced spacesuit concept that integrates the capability to function seamlessly with multiple ventilation system approaches. Traditionally, spacesuits are designed to operate both dependently and independently of a host vehicle environment control and life support system (ECLSS). Spacesuits that operate independent of vehicle-provided ECLSS services must do so with equipment self-contained within or on the spacesuit. Suits that are dependent on vehicle-provided consumables must remain physically connected to and integrated with the vehicle to operate properly.

This innovation is the design and prototype of a hybrid spacesuit approach that configures the spacesuit to seamlessly interface and integrate with either type of vehicular systems, while still maintaining the ability to function completely independent of the vehicle. An existing Advanced Crew Escape Suit (ACES) was utilized as the platform from which to develop the innovation. The ACES was retrofitted with selected components and one-off items to achieve the objective.

The ventilation system concept was developed and prototyped/retrofitted to an existing ACES. Components were selected to provide suit connectors, hoses/umbilicals, internal breathing system ducting/conduits, etc. The concept utilizes a low-pressure-drop, high-flow ventilation system that serves as a conduit from the vehicle supply into the suit, up through a neck seal, into the breathing helmet cavity, back down through the neck seal, out of the suit, and returned to the vehicle. The concept also utilizes a modified demand-based breathing system configured to function seamlessly with the low-pressure-drop closed-loop ventilation system.

This work was done by Brian A. Daniel, Garret R. Fitzpatrick, Dustin M. Gohmert, Rick M. Ybarra, and Mark O. Dub of Johnson Space Center. Further information is contained in a TSP (see page 1). MSC-24804-1

Data Quality Screening Service

A report describes the Data Quality Screening Service (DQSS), which is designed to help automate the filtering of remote sensing data on behalf of science users. Whereas this process often involves much research through quality documents followed by laborious coding, the DQSS is a Web Service that provides data users with data pre-filtered to their particular criteria, while at the same time guiding the user with filtering recommendations of the cognizant data experts.

The DQSS design is based on a formal semantic Web ontology that describes data fields and the quality fields for applying quality control within a data product. The accompanying code base handles several remote sensing datasets and quality control schemes for data products stored in Hierarchical Data Format (HDF), a common format for NASA remote sensing data. Together, the ontology and code support a variety of quality control schemes through the implementation of the Boolean expression with simple, reusable conditional expressions as operands.

Additional datasets are added to the DQSS simply by registering instances in the ontology if they follow a quality scheme that is already modeled in the ontology. New quality schemes are added by extending the ontology and adding code for each new scheme.

This work was done by Richard Strub, Christopher Lynnes, Thomas Hearty, and Young-In Won of Goddard Space Flight Center; and Peter Fox and Stephan Zednik of Rensselaer Polytechnic Institute. Further information is contained in a TSP (see page 1). GSC-16227-1

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Space Administration