able for geophysical interpretation, the relative position between the platform positions at the time a point is imaged for a pair of repeat-pass observations, i.e. the interferometric baseline, needs to be known to the millimeter level. Bridging the gap from the 2–10 cm position accuracy of the metrology system to the desired millimeter relative position accuracy uses information contained within the SAR imagery. Image-based residual motion recovery algorithms using radar imagery have been developed for airborne (and spaceborne) platforms previously; however, these algorithms have not been employed for systems using electronically scanned arrays.

The UAVSAR repeat-pass processing software called JPRP, has been specifically designed to permit the generation of radar repeat-pass interferograms of surface deformation suitable for geophysical

interpretation. This software automatically processes and co-registers data from multiple flight lines. JPRP has been modified from previous codes to do motion compensation and image formation for airborne systems employing electronically scanned antennas. Since UAVSAR employs an onboard Block Floating Point Quantization (BFPQ) scheme whereby 12 bit recorded radar echoes can be compressed to M bits where M ranges from 2–10 and is a radar commandable parameter, the JPRP includes appropriate BFPQ decoding algorithms. JPRP also includes code and algorithms for computing the repeat-pass interferometric baselines for airborne data using *a priori* GPS and INU data and for estimating refined residual baselines from the radar imagery needed for resolving dynamic residual baselines at the subcentimeter level. These algorithms have been adapted to work for systems

employing electronically scanned antennas. The program includes advanced repeat-pass motion compensation algorithms that include subaperture, terrain-dependent motion compensation for range/Doppler, or wave domain processing. Also, a new algorithm that is computationally efficient was developed for topographic fringe removal and geolocation.

This work was done by Scott Hensley, Thierry R. Michel, Cathleen E. Jones, Ronald J. Muellerschoen, Bruce D. Chapman, Alexander Fore, and Marc Simard of Caltech and Howard A. Zebker of Stanford University for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov.

The software used in this innovation is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-46093.

⟩ Plug-and-Play Environmental Monitoring Spacecraft Subsystem

New architecture provides real-time information to validating spacecraft health in harsh environments.

NASA's Jet Propulsion Laboratory, Pasadena, California

A Space Environment Monitor (SEM) subsystem architecture has been developed and demonstrated that can benefit future spacecraft by providing (1) real-time knowledge of the spacecraft state in terms of exposure to the environment; (2) critical, instantaneous information for anomaly resolution; and (3) invaluable environmental data for designing future missions. The SEM architecture consists of a network of plug-and-play (PnP) Sensor Interface Units (SIUs), each servicing one or more environmental sensors. The SEM architecture is influenced by the IEEE Smart Transducer Interface Bus standard (IEEE Std 1451) for its PnP functionality. A network of PnP Spacecraft SIUs is enabling technology for gathering continuous real-time information critical to validating spacecraft health in harsh space environments.

The demonstrated system that provided a proof-of-concept of the SEM architecture consisted of three SIUs for measurement of total ionizing dose (TID) and single event upset (SEU) radiation effects, electromagnetic interference (EMI), and deep dielectric charging through use of a prototype Internal Electro-Static Discharge Monitor (IESDM). Each SIU consists of two
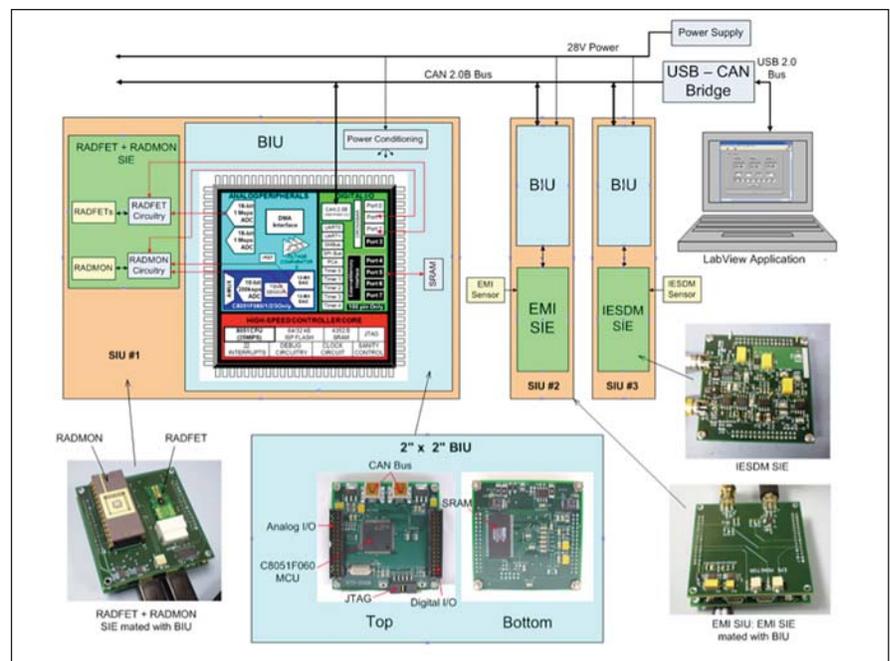
Space Environment Monitor Demonstration System.

stacked 2×2 in. (≈5×5 cm) circuit boards: a Bus Interface Unit (BIU) board that provides data conversion, processing and connection to the SEM power-and-data bus, and a Sensor Interface Electronics (SIE) board that provides sensor

interface needs and data path connection to the BIU. The figure illustrates the demonstration system components and connectivity where SIU #1 functions as a radiation monitor, servicing a RADiation Field Effect Transistor (RADFET)

TID sensor and a RADiation MONitor (RADMON) SEU sensor, SIU #2 monitors EMI through use of two RF antenna, and SIU #3 monitors spacecraft charging conditions by interfacing to an IESDM sensor. The heart of the BIU is a Silicon Laboratories C8051F060, a mixed-signal in-circuit-programmable (ISP) flash micro controller unit (MCU) with controller-area network (CAN) bus interface.

At the time of this reporting, follow-on work is needed to develop designs that use space-qualified parts, in developing a standard fault-tolerant spacecraft interface, which would spawn a multidrop backbone SIU bus (i.e. CAN), and in developing the PnP software that leverages off IEEE Std 1451.

Power-Combined GaN Amplifier With 2.28-W Output Power at 87 GHz

Applications include radar and remote sensing spectrometers, and W-band communications.

NASA's Jet Propulsion Laboratory, Pasadena, California

Future remote sensing instruments will require focal plane spectrometer arrays with higher resolution at high frequencies. One of the major components of spectrometers are the local oscillator (LO) signal sources that are used to drive mixers to down-convert received radio-frequency (RF) signals to intermediate frequencies (IFs) for analysis. By advancing LO technology through increasing output power and efficiency, and reducing component size, these advances will improve performance and simplify architecture of spectrometer array systems. W-band power amplifiers (PAs) are an essential element of current frequency-multiplied submillimeter-wave LO signal sources. Substantial W-band (75–110 GHz) power is required due to the lossy passive frequency multipliers used to generate higher frequency signals in nonlinear Schottky diode based LO sources. By advancing PA technology, the LO system performance can be increased with possible cost reductions compared to current gallium arsenide (GaAs) PA technology.

This work utilizes GaN monolithic millimeter-wave integrated circuit (MMIC) PAs developed from a new HRL Laboratories LLC 0.15-μm gate length GaN semiconductor transistor. By additionally waveguide power combining PA MMIC modules, the researchers here target the highest output power performance and efficiency in the smallest volume achievable for W-band. GaN has higher voltage breakdown capability than other currently available W-band semiconductor technology such as GaAs. GaN PAs have shown significant improvements compared to state-of-the-art GaAs PAs in W-band for output power density and efficiency.

High-power, high-efficiency GaN PAs are cross-cutting and can enable more efficient LO distribution systems for new astrophysics and planetary receivers and heterodyne array instruments. They can also allow for a new electronically scannable solid-state array technology for future Earth science radar instruments and communication platforms.