

tures for the Earth scan. These data are then input to a 1D variational retrieval algorithm to produce temperature, water vapor, and cloud liquid water profiles, as well as several derived products such as potential temperature and relative humidity.

The addition of a state-of-the-art LNA to the 183-GHz receiver front-end and the upgrade of the 118-GHz LNA provide excellent low-noise performance, which is critical for microwave sounding retrievals. The data system is upgraded to provide in-flight data access through the Global Hawk data link, making it

possible to relay data to the ground in real time. This is particularly relevant for hurricane observations where HAMSr can provide real-time information on tropical storm structure, intensity, and evolution.

This instrument is the first to demonstrate the value of the technology through atmospheric water vapor measurements. The receiver noise was reduced by an order of magnitude compared to the previous receiver. A ground-based measurement campaign demonstrated unprecedented measurements of small-scale water vapor vari-

ability, resolving atmospheric fluctuations on meter and second space and time scales. Subsequent airborne measurements on the Global Hawk UAV showed similar results over a 40-km swath. This is a critical step in space-qualifying these receivers.

*This work was done by Shannon T. Brown, Boon H. Lim, Alan B. Tanner, Jordan M. Tanabe, Pekka P. Kangaslahti, Todd C. Gaier, Mary M. Soria, Bjorn H. Lambriksen, Richard F. Denning, and Robert A. Stachnik of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact [iaoffice@jpl.nasa.gov](mailto:iaoffice@jpl.nasa.gov). NPO-48100*

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## PRTs and Their Bonding for Long-Duration, Extreme-Temperature Environments

*NASA's Jet Propulsion Laboratory, Pasadena, California*

Research was conducted on the qualification of Honeywell platinum resistance thermometer (PRT) bonding for use in the Mars Science Laboratory (MSL). This is the first time these sensors will be used for Mars-related projects. Different types of PRTs were employed for the Mars Exploration Rover (MER) project, and several reliability issues were experienced, even for a short-duration mission like MER compared to MSL. Therefore, the development of a qualification process for the Honeywell PRT bonding was needed for the MSL project. Reliability of the PRT sensors,

and their bonding processes, is a key element to understand the health of the hardware during all stages of the project, and particularly during surface operations on Mars. Three extreme temperature summer season cycles and three winter season cycles (total: 1983 thermal cycles) were completed, and no Honeywell PRT failures associated with the bonding process were found.

Seventy-eight PRTs were bonded onto six different substrate materials using four different adhesives during the thermal cycling, which included a planetary protection cycle to +125 °C

for two hours, three protoflight/qualification cycles (-135 to 70 °C), 1,384 summer cycles (-105 to 40 °C), and 599 winter cycles (-130 to 15 °C). There were no observed changes in PRT resistances, bonding characteristics, or damage identified from the package evaluation as a result of the qualification tests.

*This work was done by Rajeshuni Ramesham, Gordon C. Cucullu III, and Rebecca L. Mikhaylov of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact [iaoffice@jpl.nasa.gov](mailto:iaoffice@jpl.nasa.gov). NPO-47649*

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## Mid- and Long-IR Broadband Quantum Well Photodetector

*NASA's Jet Propulsion Laboratory, Pasadena, California*

A single-stack broadband quantum well infrared photodetector (QWIP) has been developed that consists of stacked layers of GaAs/AlGaAs quantum wells with absorption peaks centered at various wavelengths spanning across the 9- to 11- $\mu\text{m}$  spectral regions. The correct design of broadband QWIPs was a critical step in this task because the earlier implementation of broadband QWIPs suffered from a tuning of spectral response curve with an applied bias. Here, a new QWIP design has been developed to overcome the spectral tuning with voltage that results from non-uniformity and bias variation of the electrical field

across the detector stacks with different absorption wavelengths.

In this design, a special effort has been made to avoid non-uniformity and bias tuning by changing the doping levels in detector stacks to compensate for variation of dark current generation rate across the stacks with different absorption wavelengths. Single-pixel photodetectors were grown, fabricated, and tested using this new design.

The measured dark current is comparable with the dark measured current for single-color QWIP detectors with similar cutoff wavelength, thus indicating high material quality as well as absence of per-

formance degradation resulting from broadband design. The measured spectra clearly demonstrate that the developed detectors cover the desired spectral range of 8 to 12  $\mu\text{m}$ . Moreover, the shape of the spectral curves does not change with applied biases, thus overcoming the problem plaguing previous designs of broadband QWIPs.

*This work was done by Alexander Soibel, David Z. Ting, Arezou Khoshakhlagh, and Sarath D. Gunapala of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-48398*