Earth Science Technology Office (ESTO) Investments in support of the

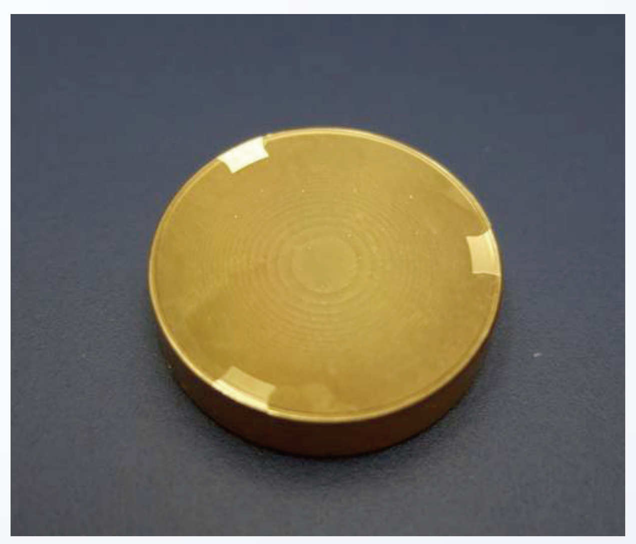
Hyperspectral Infrared Imager (HyspIRI) Mission

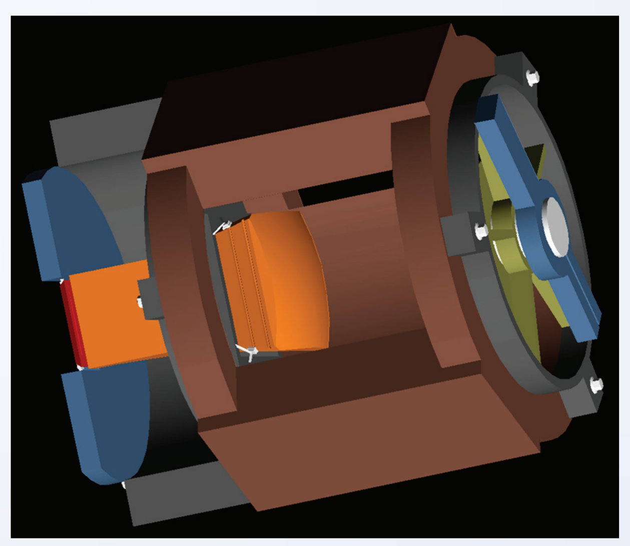
ESTO
Earth Science Technology Office

For over 10 years, the Earth Science Technology Office (ESTO) has been actively funding and developing a broad range of technologies that enable scientific measurements of Earth, mission operational requirements, and other related applications. A substantial subset of these technologies are directed broadly toward the study of ecosystems and natural hazards and several relate directly to the goals and requirements for the Hyperspectral Infrared Imager (HyspIRI) Decadal Survey Mission. Below are a few examples of current and completed ESTO technology development efforts that may aid the formulation of the HyspIRI mission.

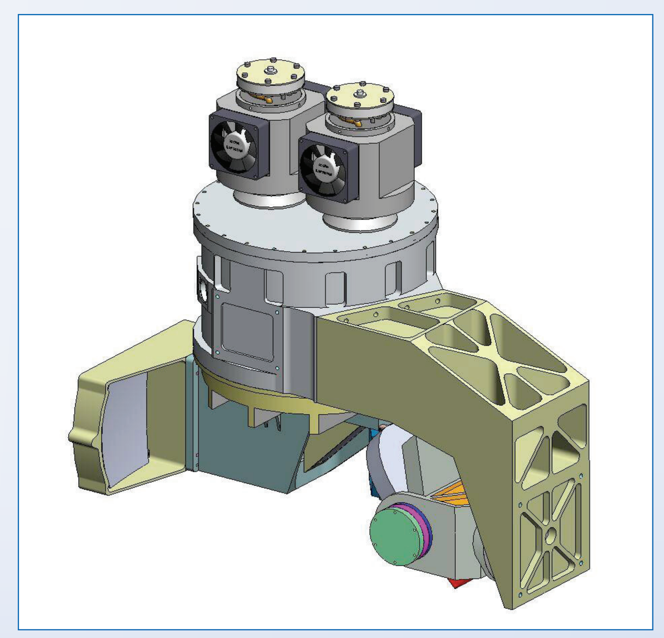
Instrument Technologies

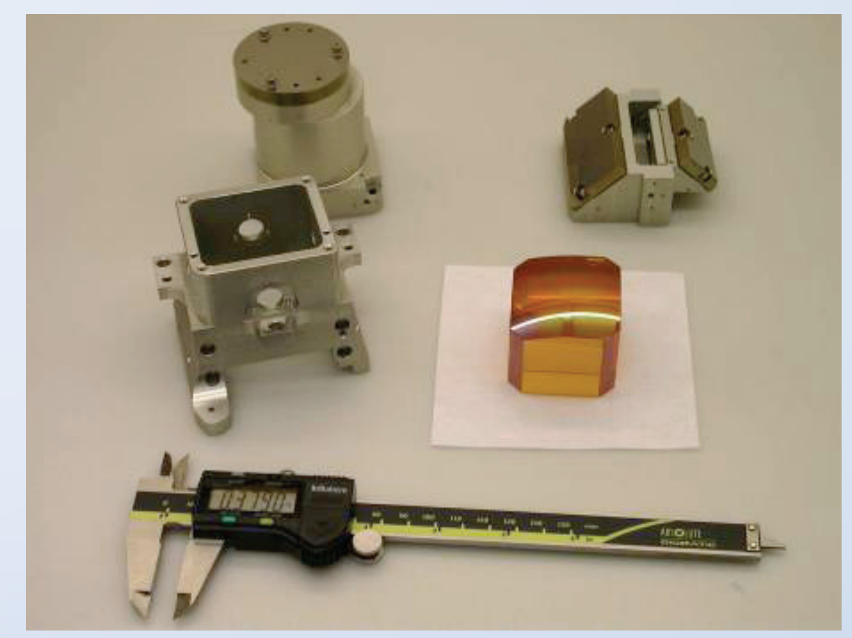
Direct Application to HyspIRI





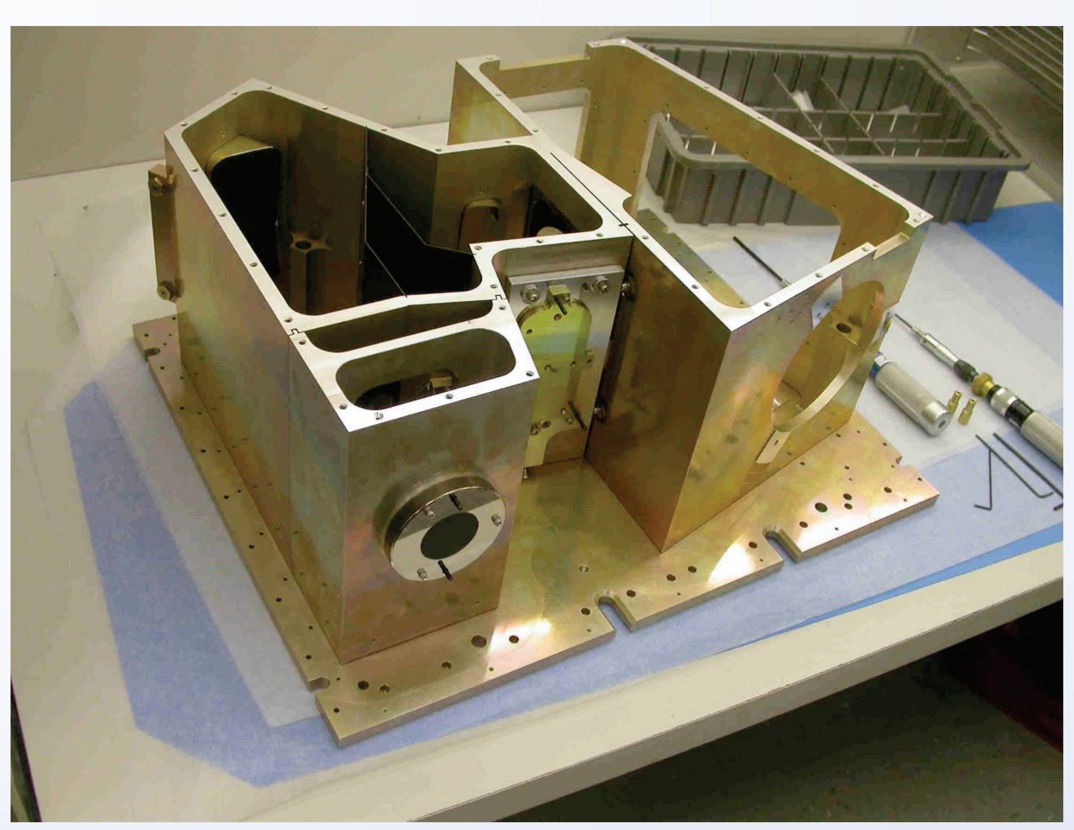
The above left photo shows a concave diffraction grating that is one component of the Hyperspectral Thermal Emission Spectrometer (HyTES), a thermal infrared imaging spectrometer that will have high spatial and spectral resolution. The HyTES project team at the Jet Propulsion Lab seeks to build and deploy an airborne version of HyTES as a precursor to the HyspIRI mission and for use in Earth science studies. This airborne instrument will have 512 pixels across track with pixel sizes in the range of 5 to 50 m depending on aircraft flying height and 256 spectral channels between 7.5 and 12 µm. Above right is a mechanical drawing of the HyTES structure.
[Simon Hook, Jet Propulsion Lab]



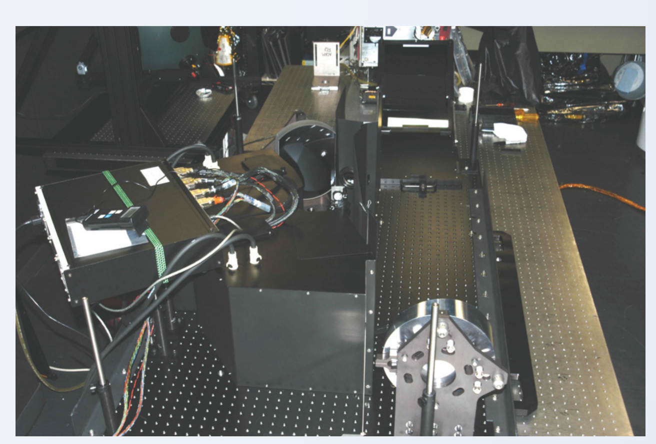


Above left is a concept drawing for an airborne sensor consisting of a high-performance thermal imager for HyspIRI-type measurement applications. The central cylindrical cryostat houses a small, cooled, optically fast Dyson spectrometer that disperses light from an input slit into 28 spectral bands between 7 and 12 microns. The telescope that is external to the cryostat is configured to give the desired pixel field-of-view, and a gimbal mirror assembly scans the slit image across the scene in a whiskbroom fashion. Above right are components for the Dyson spectrometer – clockwise from the upper right are: the slit assembly, a Dyson lens, a caliper for scale, the Dyson housing, and the grating assembly.
[Jeff Hall, The Aerospace Corp.]

Indirect Application to HyspIRI



Above is the optical bench assembly for SIRAS-G, the Spaceborne Infrared Atmospheric Sounder for GEO. The SIRAS-G project, which graduated from ESTO funding in 2006, had two major components: 1) to develop and demonstrate an infrared imaging spectrometer at cryogenic temperatures in a laboratory environment, and 2) to develop infrared spectrometer concepts suitable for future Earth science missions.
[Thomas Kampe, Ball Aerospace]

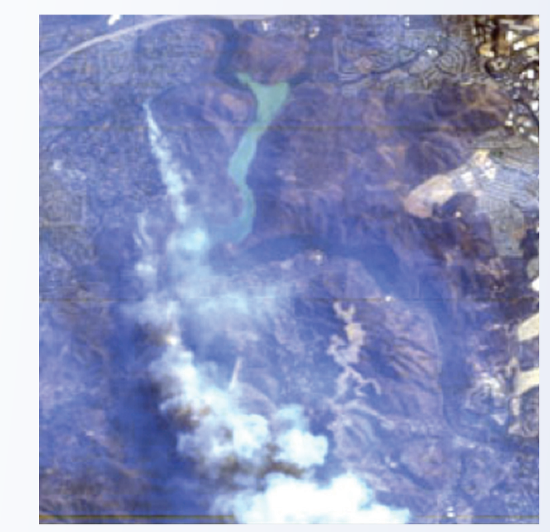


The Geostationary Spectorgraph (GeoSpec) project sought to demonstrate the feasibility of future GEO missions using hyperspectral UV/VIS/NIR instrumentation. By 2007, the project team had completed testing of a fully aligned breadboard system (shown above) as well as studies for a flight instrument concept. Below are final hybrid detector packages. *[Scott Janz, Goddard Space Flight Center]*

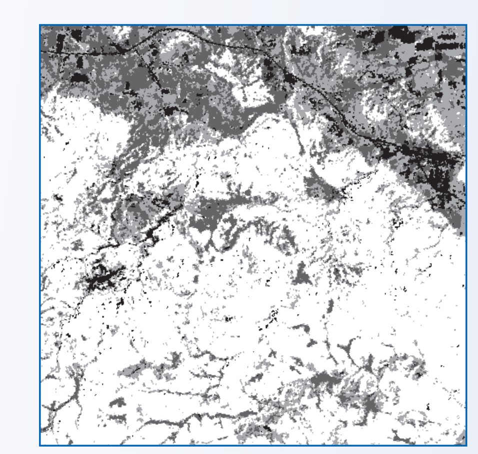
Detector Component Technologies

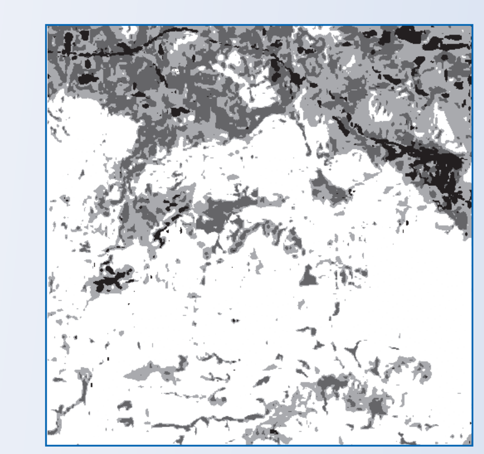
Above is a false color, far infrared image taken by the Quantum Well Infrared Photodetector (QWIP) imaging array. The QWIP project was first funded by ESTO in 1999 and was awarded additional funding in 2002. By 2006, a one-megapixel version of QWIP was the world's largest infrared detector array sensitive to the 8-14 µm infrared spectral region.
[Murzy Jhabvala, Goddard Space Flight Center]

Information Systems Technologies



The two images above are from the Hyperion hyperspectral instrument on-board the EO-1 satellite. The left image used visible bands so smoke and other features are seen as they would appear with the naked eye. The right image used the short wave infrared bands. These bands can see through the smoke to view the active fire shown in yellow on the northern shore of the reservoir. Selected SWIR bands were assigned false colors to highlight the burn scar severity shown in brown. The EO-1 sensor web project acquired these images based on a fire event detected by the MODIS instrument. These images appeared on CNN and other news outlets at the time of the Southern California wildfires in October 2007. *[Dan Mandl, NASA/GSFC]*





The left image above is a raw data image taken by the Landsat 2 multispectral scanner. The right image is a highly compressed version produced by an ESTO-funded project at the University of Washington. The "Reconfigurable Computing Based Compression for Hyperspectral Images" project enabled a fast, efficient compression of NASA hyperspectral data and achieved a compression ratio of 3.11 to 1 for lossless data compression.
[Scott Hauck, University of Washington]

Additional Information Systems Projects:

- MATLAB-Based Adaptive Computing for Image Processing Applications, Scott Hauck, University of Washington
- Region-of-Interest Data Compression with Prioritized Buffer Management, Sam Dolinar, Jet Propulsion Lab
- Coupling High-Resolution Earth System Models Using Advanced Computational Technologies, Christa Peters-Lidard, Goddard Space Flight Center
- Land Information Sensor Web, Hongbo Su, Institute of Global Environment and Society, Inc.
- Data Mining for Understanding the Dynamic Evolution of Land-Surface Variables: Technology Demonstration using the D2K Platform, Praveen Kumar, University of Illinois
- Science Model Driven Autonomous Sensor Web, Ashley Davies, Jet Propulsion Lab
- A Reconfigurable Computing Environment for On-Board Data Reduction and Cloud Detection, Jacqueline Le Moigne, Goddard Space Flight Center
- Expanded Interoperable Sensor Architecture to Facilitate Sensor Webs in Pursuit of GEOSS, Dan Mandl, Goddard Space Flight Center
- Anomaly Detection and Analysis Framework for Terrestrial Observation and Prediction System (TOPS), Ramakrishna Nemani, Ames Research Center
- Advanced Hybrid On-Board Data Processor, Space Cube 2.0, Tom Flatley, Goddard Space Flight Center
- Autonomous, On-board Processing for Sensor Systems, Matthew French, University of Southern California