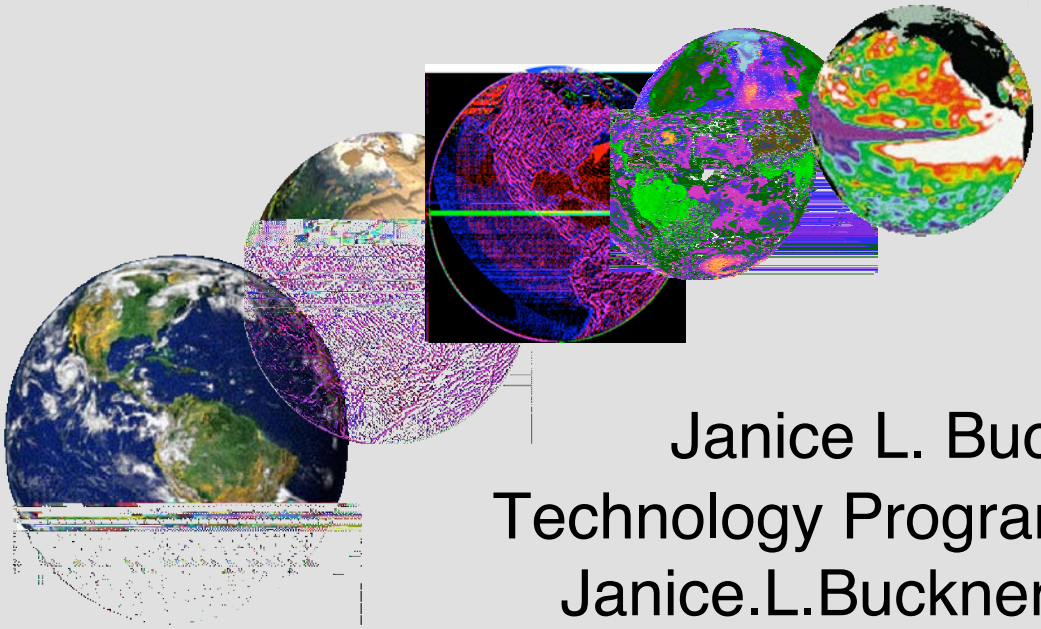
IGARSS 2003

NASA/ Advanced Component Technology Program Investments in Remote Sensing Technologies



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Outline

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- ACT Program
- Technology Readiness
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- Earth Science Questions
- Remote Sensing Instruments
- Active Remote Sensing Technologies
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Introduction

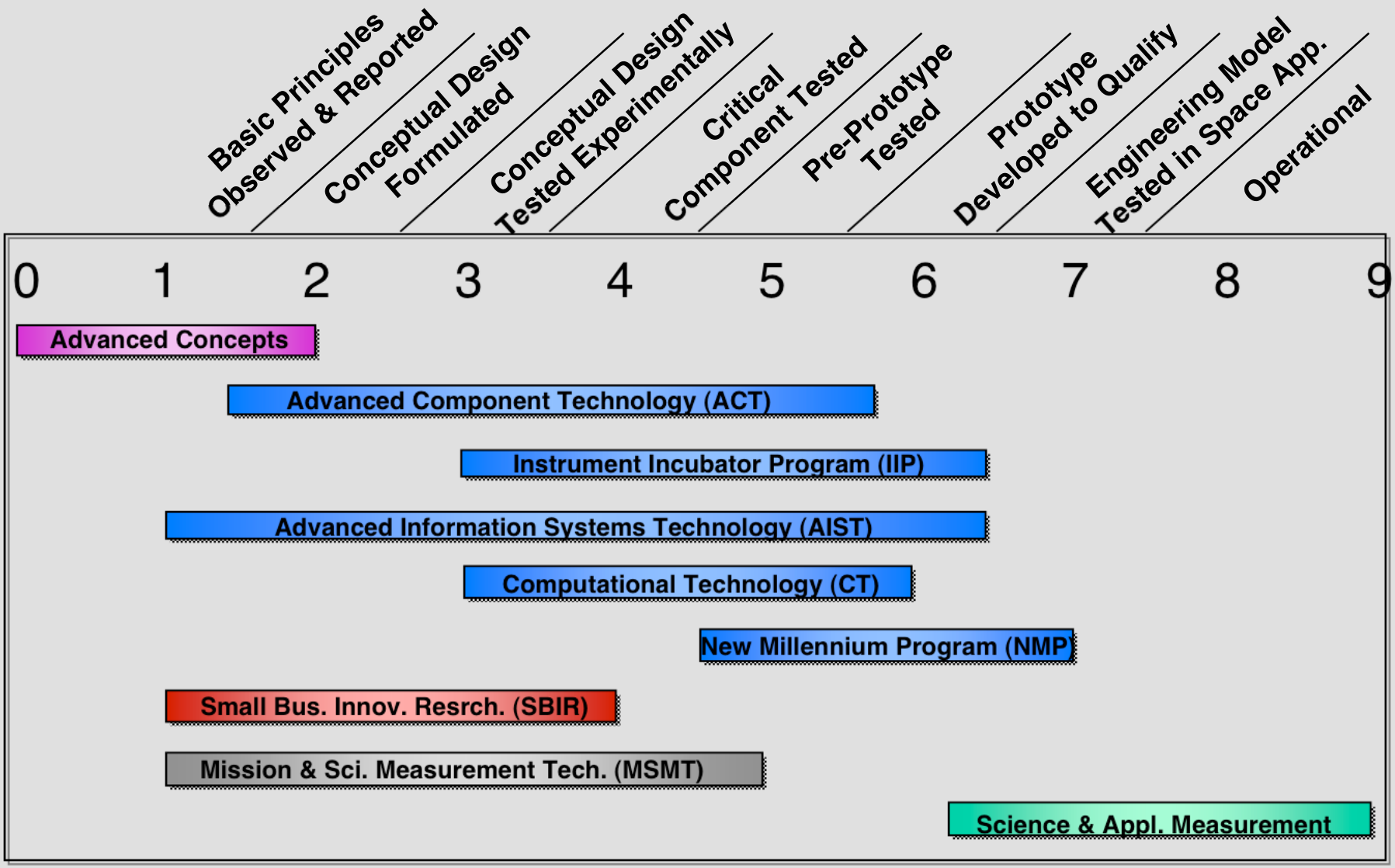
- Investments in remote sensing technologies have become increasingly important as Earth Scientist strive to better understand changes in the earth system.
- This presentation will describe investments in active and passive remote sensing technologies that provide new measurements capabilities for advanced observing satellite systems
- Such measurement will enable more reliable predictions of weather, climate, and other globally important elements in the Earth's system

Advanced Component Technology Program

- The objectives of the ACT program are to identify, develop and demonstrate component and subsystem technologies which:
  - Reduce the risk, cost, size, and development time for Earth observing instruments, platforms and information systems and,
  - Enable new Earth observation measurements.
- More than 85% of the investments consist of new technology components for active and passive remote sensing instruments.

Technology Program Readiness Levels

How



Earth Science Questions

- How is the global Earth System changing?
- What are the primary forcing of the Earth System?
- How does the Earth system respond to natural and human-induced changes?
- What are the consequences of change in the Earth system for human civilization?
- How well can we predict future changes in the Earth system?

Value of Technology Investments

The component technologies describe herein will aid scientists in providing solutions to the unanswered earth science questions.

- **Enables NASA's ability to fully achieve critical Earth Science measurements**
  - Atmospheric Carbon
  - Global Warming
  - Soil Moisture
  - Ocean Winds and Surface salinity
  - Ice Sheets
- **Provides data continuity in the study of**
  - Aerosols and Greenhouse gasses
  - Sea Surface height and temperature
  - Lands and Coastal Interactions
  - Natural Hazard Detection

Remote Sensing Instrumentation

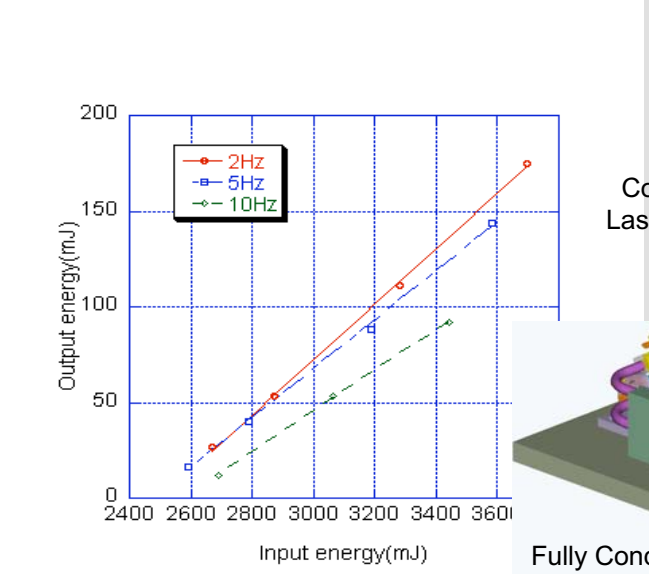
As the Earth Science Enterprise forges into the future, a variety of sensing techniques that afford new and unique capabilities are needed

- **Active remote sensing instruments**
  - Advanced imaging spectrometers
  - Advanced microwave sounders
  - Space-based lidars
  - Advanced hyperspectral radiometers
- **Passive remote sensing instruments**
  - Large aperture antennas
  - Synthetic aperture radars
  - Light weight, flexible transmitters and receivers
  - Detector arrays and coolers

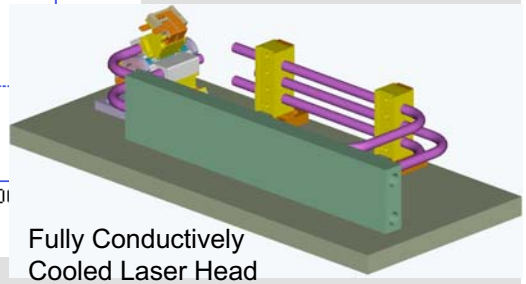
Active Remote Sensing Technologies

2-Micron Laser Transmitter

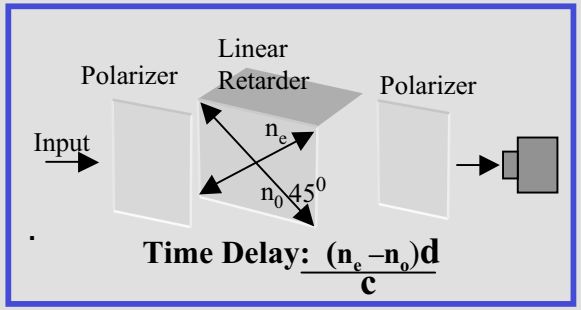
Developing an Efficient, Conductively-Cooled, Double-Pulsed 2-Micron Laser capable of generating 500 mJ at 10 Hz with an overall efficiency of 5%. Successfully demonstrated a laser system with 1050mJ Q-switched output energy. This is the first time a Q-switched 2 micron laser exceed the 1 J level. This technology will enable the measurement of global CO2 and have the capability of measuring winds speeds up to 11km.

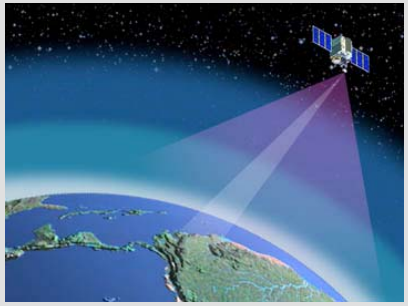


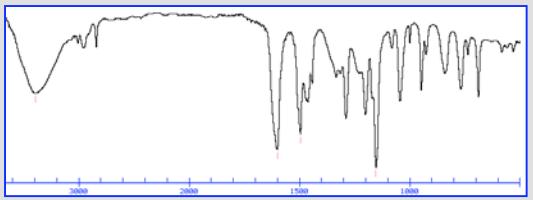
Conductively Cooled diode Laser pumped 2-micron LuLiF laser performance



Fully Conductively Cooled Laser Head Design





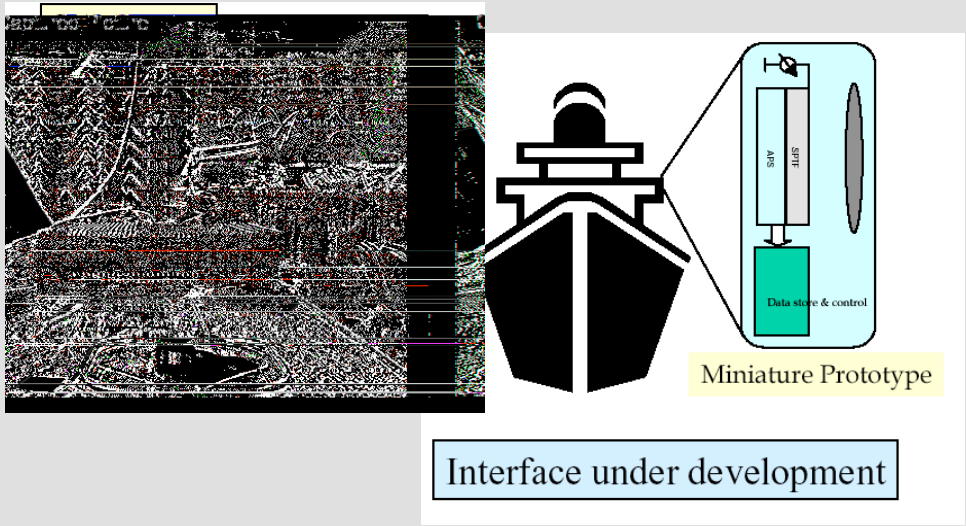


Electro-Optic Imaging Fourier Transform Spectrometer

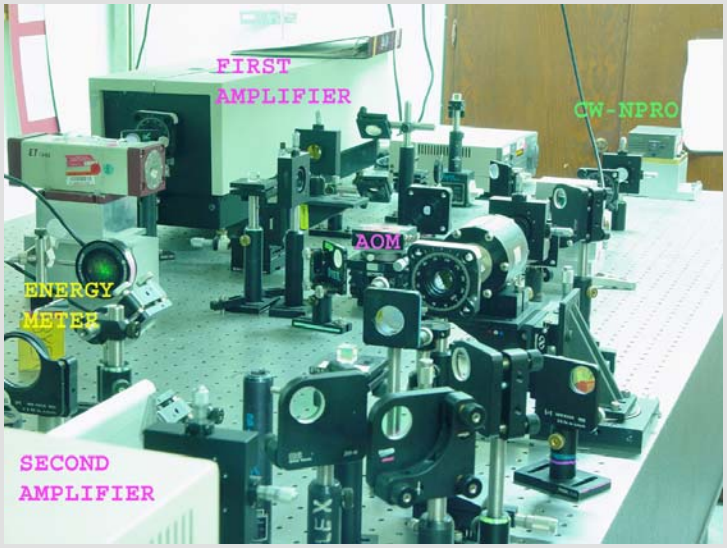
Developing and an innovative compact, low mass, Electro-Optic Imaging Fourier Transform Spectrometer (E-O IFTS) with no moving parts. The spectral region of this spectrometer will be 1 – 2.5 mm (1000 – 4000 cm^{-1}) to allow high-resolution, high-speed measurement of a large number of different atmospheric gases simultaneously in the same airmass.

Active Remote Sensing Technologies

Multi-Spectral Staring CMOS Focal-Plane Array (FPA) for Oceanographic Imaging Applications ▼



Developing an advanced, low-cost, compact, high-resolution, Vis/NIR staring multi-spectral digital (FPA) based on demonstrated CMOS Active Pixel Sensor (APS) and Surface-Plasmon-Tunable-Filter (SPTF) technologies. This technology is a light weight, low power, non scanning spectrometer, with a tunable spectral band (400-100nm), enables clear visible oceanographic images.



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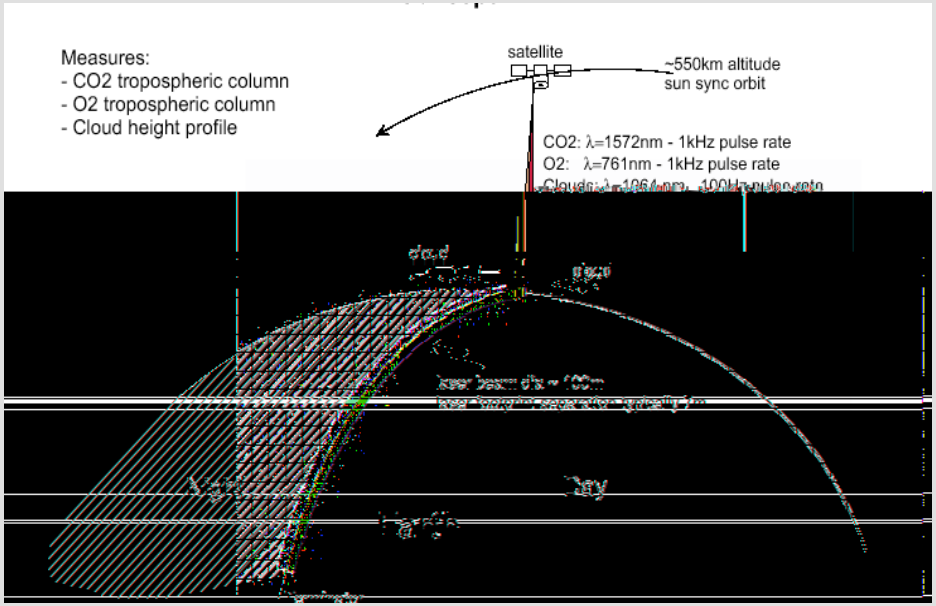
High Beam Quality Nd Laser for Global Ozone

Efficient energy storage and extraction from a solid state laser is important for pulsed laser applications such as laser remote sensing of stratospheric ozone concentrations or tropospheric wind velocities. The goal of this technology development is to extend the edge-pumped ND:YAG slab “laser engine” design to Yb:YAG MOPA for increased energy storage. (305-320nm)

Active Remote Sensing Technologies

Laser Sounder for Atmospheric CO2

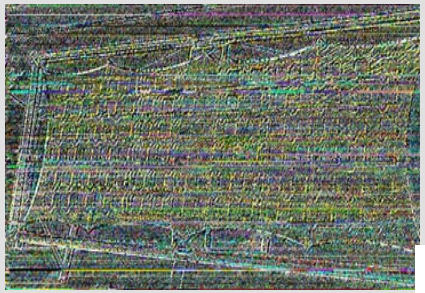
A critical laser technology which will enable atmosphere CO2 measurements in orbit. Developing two key component technologies that will enable the measurement; (1) 1572 nm (for CO2) and 761 nm (for O2) laser transmitters and optical receiver and 2) a high sensitivity direct detection 1572 optical receiver.



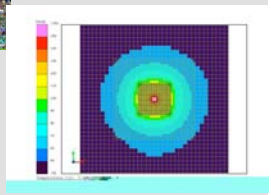
T/R Membranes for Large Aperture Scanning Antennas

This technology will dramatically reduce the weight, volume and associated cost of space-based radars by replacing conventional rigid manifold antenna
architecture with a flexible thin-film membrane. The objective is to develop membrane compatible T/R modules for active membrane SAR antennas.

Flex-Compatible Electronics

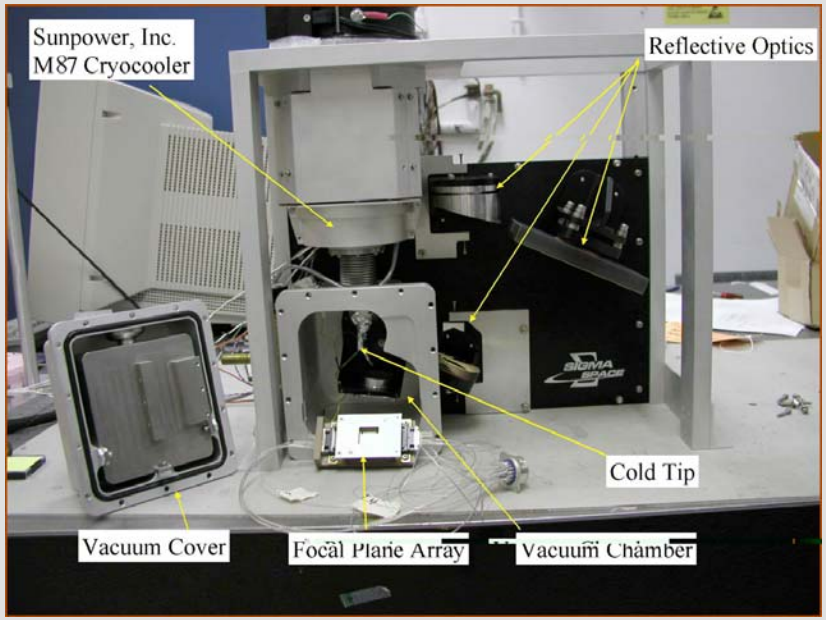


Membrane Antenna



Temperature Profile

Passive Remote Sensing Technologies



GaAs QWIP Imaging Array

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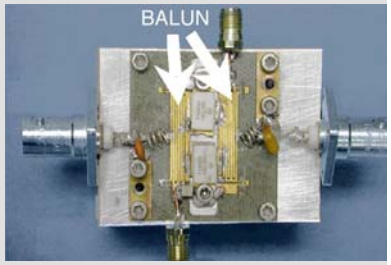
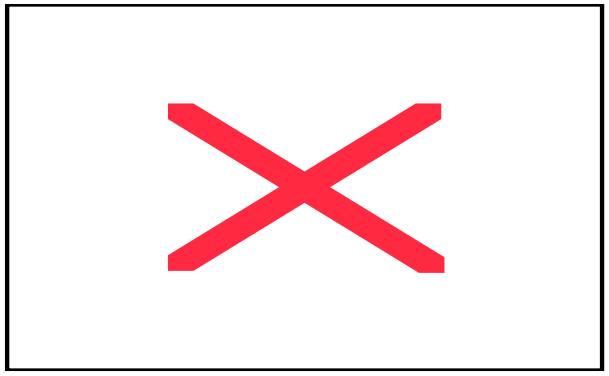
Monolithic four band, 512x640, GaAs Quantum Well Infrared Photodetector (QWIP) imaging array. Enables hyper-spectral measurements, in the 3 to 15 micron region, will allow remote sounding of numerous geophysical quantities such as cloud, surface, and atmospheric parameters.

L- Band T/R Module





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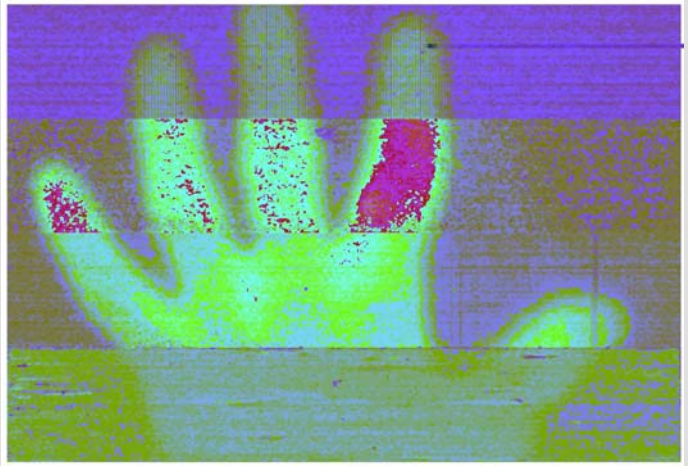
Lightweight, high-power, high-efficiency L-band T/R module for use in SAR antennas. The goal is to achieve an overall module efficiency of 70% with a minimum of 30-Watts output power at L-band frequencies.

Band 1

Band 2

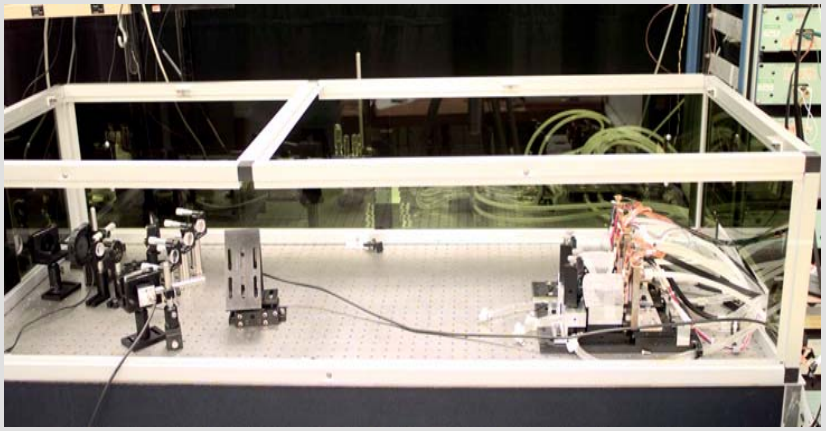
Band 3

Band 4



Passive Remote Sensing Technologies

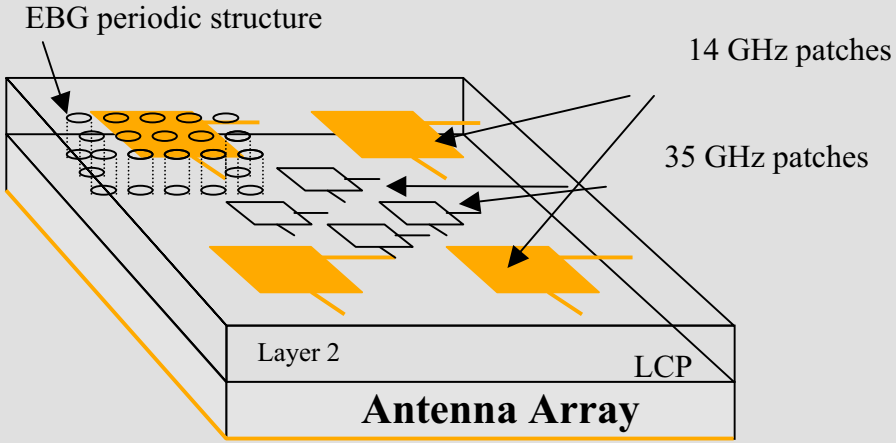
▼ 0.94 um Water Vapor DIAL Transmitter



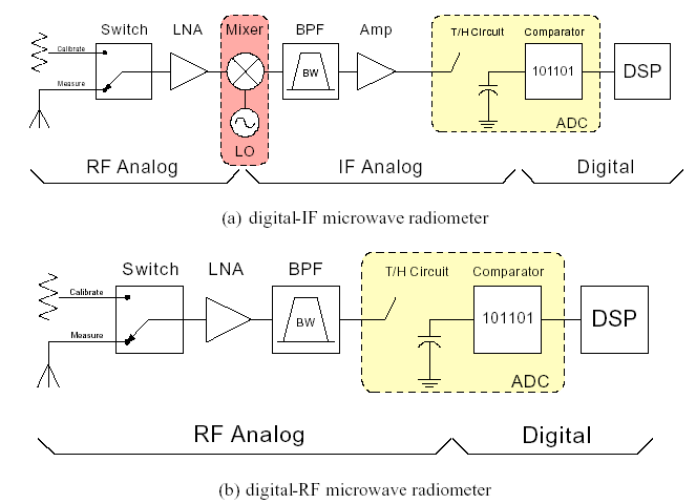
A breadboard demonstration of the major components of a DIAL transmitter including a seed laser, power oscillator, preamplifier and power amplifier. Water vapor absorption lines are much stronger around 0.94 µm than the currently used 0.82 µm lines, allowing more accurate measurements in the upper troposphere and lower stratosphere. This laser is well suited to search for water on other planets.

Lightweight, Deployable, Dual-Frequency/Polarization Microstrip Antenna Array for Remote Sensing of Precipitation ▼

Developing a dual-frequency, dual-polarized antenna on a flexible organic substrate that has low-loss and light weight, as well as multi-layer and low-cost fabrications capability. This technology will help earth scientist with a the accurate measurement of global precipitation, evaporation, and cycling of water.



Passive Remote Sensing Technologies



Radio-frequency analog-to-digital converter for digital microwave radiometry

This technology will target synthetic thinned array radiometry (STAR) for 10-km soil moisture remote sensing. The RF-ADC will operate at 500 MSps with 1.5-GHz input bandwidth and have at least a 2 bit output. Target power dissipation is less than 330W.

Conclusion

- As NASA strives to better understand the Earth system, the ACT Program continues to invest in innovative active and passive remote sensing component technologies that will help scientist overcome limitations and deploy a new series of advanced observation satellites.
- ACT technology investments provide new capabilities that are crucial to the advancement of future generations of remote sensing instrumentation.
- Potential end users of these technologies include NASA, NOAA, the USGS and other government agencies, as well as academia, private industry, and international Earth Science partners.

For More Information on the
Advanced Component Technology Program
in the
Earth Science Technology Office
Go to
http://esto.nasa.gov