



# Emerging Technology Developments at JPL

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**Jet Propulsion Laboratory**

**California Institute of Technology**

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# The Jet Propulsion Laboratory – At A Glance

- NASA-owned, Federally Funded Research and Development Center (FFRDC)
- Operated by California Institute of Technology
- Approximately 5000 employees
- Annual Budget ~\$1.5 B

## Robotic Exploration of Outer Space

- Planetary Rovers
- Satellites to other planets
- Probes to planetary bodies
- Earth-orbiting satellites

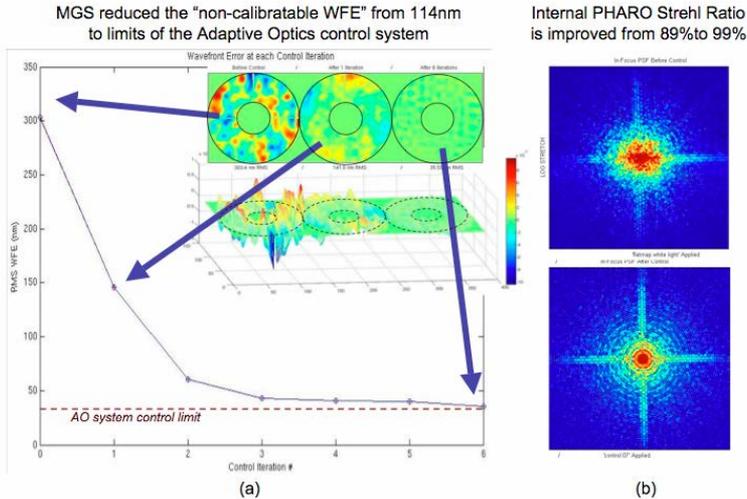


# Commercial Applications of JPL Technologies





# Adaptive MGS Phase Retrieval (Wavefront Sensing and Control)



## **Description:**

Software – determines the wavefront errors in an optical system and enables corrective action to improve the performance of the optical system.

## **Importance:**

### **NASA -**

- Enabling for the development of future space telescopes
- Implemented on the Palomar Telescope

### **Non-NASA -**

- Space-based military applications
- Other optical systems
- Laser eye surgery

## **Program Highlights:**

**Sponsor:** NASA, DoD

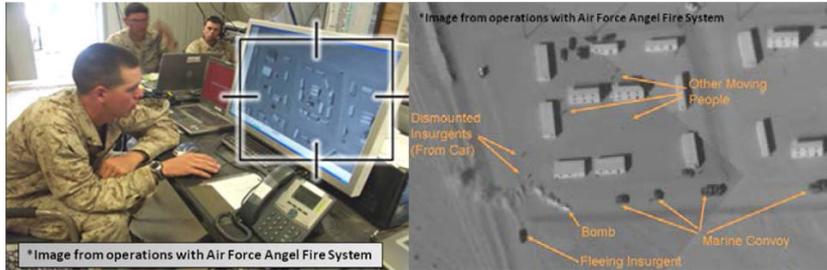
**Technical Staff:** David Redding, Joseph Green, Siddarayappa Bikkannavar, Scott Basinger, Catherine Ohara, Fang Shi, John Lou

**Funding:** Ongoing

**Status:** Operational



# Building a 2.5D Digital Elevation Model from 2D Imagery



## **Description:**

This technology generates a high-quality DEM (Digital Elevation Map) from a collection of 2D images taken from multiple viewpoints, plus pose data for each of the images and a camera model for the sensor

## **Importance:**

### **NASA –**

- Utilizes capabilities developed for image processing and analysis during planetary exploration

### **Non-NASA -**

- Aerial Surveillance (military and civilian)

## **Program Highlights:**

**Sponsor:** DoD (AngelFire)

**Technical Staff:** Curtis Padgett (PI)

**Funding:** Task completed

**Status:** Code delivered to customer for inclusion in AngelFire

# **JPL** HAMMERHEAD – A Vision-Based Obstacle Detection and Tracking System for Autonomous Surface Vessels



## ***Description:***

This technology is a vision-based system (HammerHead) for detecting and tracking both static and dynamic obstacles on the water surface. The HammerHead system consists of hardware and software components for detecting geometric hazards; i.e., objects that protrude above the waterline.

## ***Importance:***

### **NASA –**

- Autonomous robotic navigation

### **Non-NASA -**

- Navigation of autonomous or semiautonomous surface vessels.
- Defense and security applications (such as harbor patrol, asset/force protection and surveillance)
- Science applications (automated sampling)

## ***Program Highlights:***

**Sponsor:** DoD

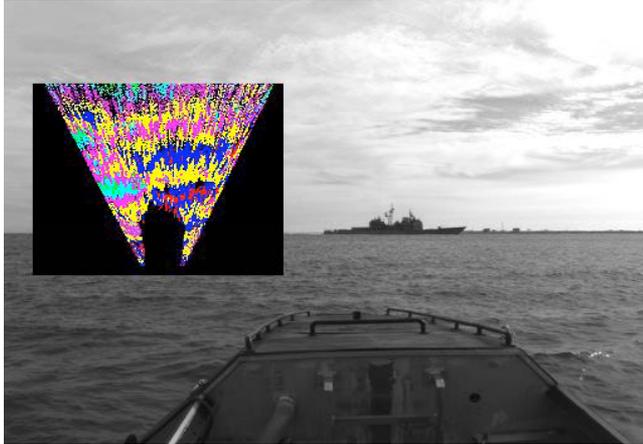
**Technical Staff:** Andrew Howard, David Trotz

**Funding:** Ongoing

**Status:** The system has been tested, fielded and is functionally complete for fair weather conditions and daylight illumination. There is ongoing development work to increase the operating envelope to include more difficult weather conditions and night-time operation (possibly using IR cameras).



# PSSEARCH: A System for Predictive Sea State Estimation for Automated Ride Control and Handling



## ***Description:***

This software uses sensory inputs including IMU, stereo, radar, etc. to determine the sea state and wave conditions (height, frequency, etc) in the vicinity of a rapidly moving boat. This information can then be used to plot a "safe" path through the oncoming waves

## ***Importance:***

### ***NASA –***

- Autonomous robotic navigation

### ***Non-NASA -***

- Navigation of autonomous or semiautonomous surface vessels.
- Defense and security applications (such as harbor patrol, asset/force protection and surveillance)

## ***Program Highlights:***

**Sponsor:** DoD (Navy)

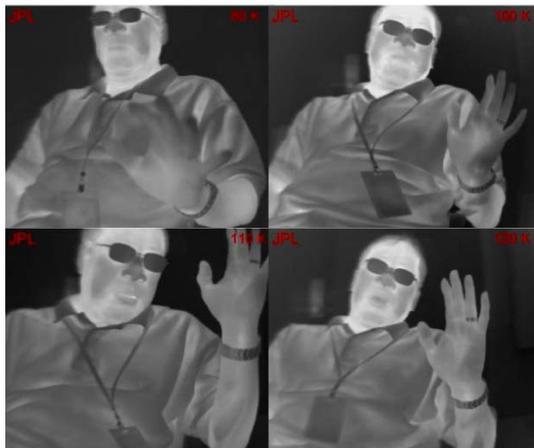
**Technical Staff:** Terrance Huntsberger, Andrew Howard, Hrand Aghazarian

**Funding:** Ongoing

**Status:** Tested in simulations; tested in sea environment FY 11



# Infrared Detector and Focal Plane Array Technology



## **Description:**

Goal: To demonstrate high performance, high operating temperature, and highly uniform large format IR focal planes based on III-V technology for space and defense applications.

## **Importance:**

### **NASA –**

- Astronomy, astrophysics and planetary missions due to their ability to obtain chemical information

### **Non-NASA -**

- Environmental monitoring
- Process monitoring (temperature)
- Medical imaging
- Surveillance – night vision, mid-course missile tracking

## **Program Highlights:**

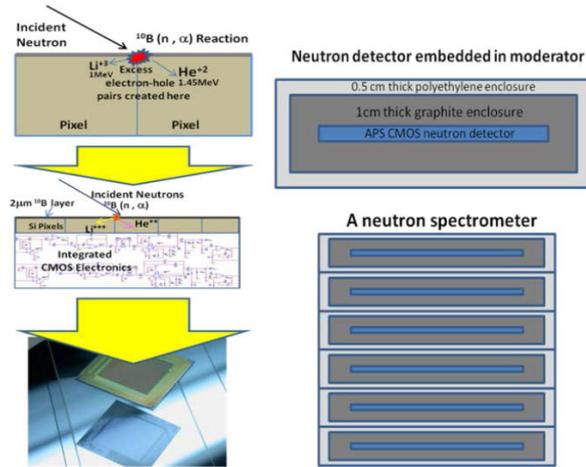
**Sponsor:** AFRL, Army, DARPA, Industry, JPL, MDA, NASA, OSD, NRO

**Technical Staff:** Sarath Gunapala, David Ting and others

**Funding:** Ongoing

**Status:** Technology proven and continuing to develop

# JPL Active Pixel Sensor Based Directional Neutron Detector/Spectrometer



## **Description:**

This technology represents the development of a neutron detector capable of detecting low fluxes of fission neutrons and can differentiate between fission neutrons and cosmic background neutrons.

## **Importance:**

### **NASA –**

- Allows monitoring of space radiation for the protection of astronauts

### **Non-NASA -**

- Homeland Security – Monitoring of cargo holds (ships, trucks, etc.) for radioactive materials

## **Program Highlights:**

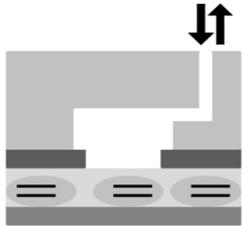
**Sponsor:** NASA (current); Homeland Security (potential future funding)

**Technical Staff:** Jagdish Patel, Thomas Cunningham

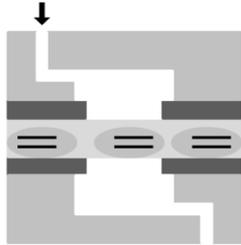
**Funding:** Ongoing; additional funding being sought for further development

**Status:** Proof of principle in the laboratory; additional development needed for working detectors

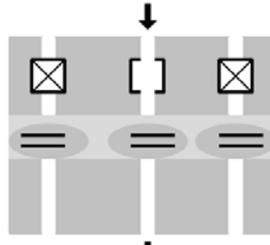
# Tissue Microfluidics



Tissue microfluidics – basic device.



Tissue microfluidics – 3D device.



Tissue microfluidics – maskless “through” chip.

## **Description:**

Integration of microfluidic techniques and tissue slice samples to separate and identify specific cancer cells in a tissue sample

## **Importance:**

### **NASA –**

- Life detection
- Astronaut health monitoring

### **Non-NASA -**

- Rapid identification of cancer cells for everyday medical diagnostics

## **Program Highlights:**

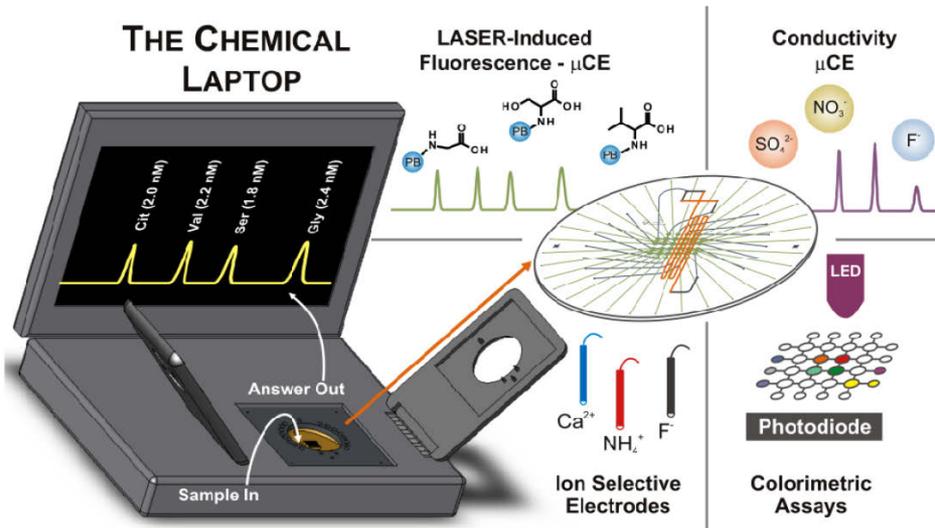
**Sponsor:** NIH/NSF (tentative/initial), NASA

**Technical Staff:** Lawrence Wade, (USC), (USC), (USC)

**Funding:** Anticipated funding in near future

**Status:** Initial proof-of concept demonstrated; seeking funding for further development

# The Chemical Laptop



## Description:

An automated, self-contained chemical analysis instrument based on advanced microfluidics “lab-on-a-chip” technology

## Importance:

### NASA –

- Astrobiology on other planets/moons
- Astronaut health/environmental monitoring

### Non-NASA -

- Environmental monitoring of lakes, oceans, water supply, etc.
- Field chemical analysis (military, law enforcement, homeland security)

## Program Highlights:

**Sponsor:** NASA/SBIR

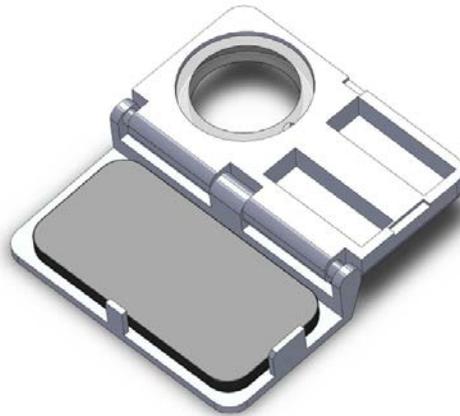
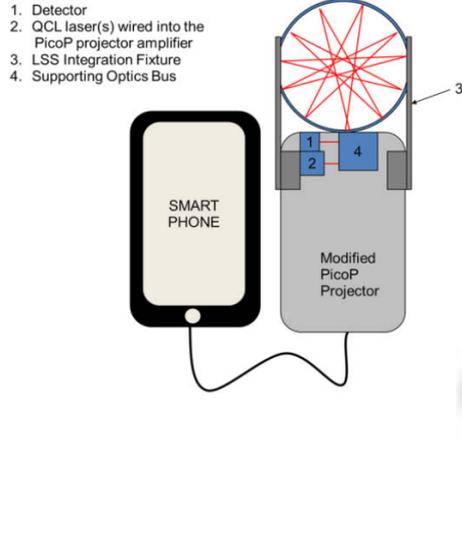
**Technical Staff:** Peter Willis, Amanda Stockton, Fernanda Mora, Morgan Cable

**Funding:** Current funding through prototype development

**Status:** Prototype under development; delivery expected late 2012



# Laser Spiderweb Sensor used with Portable Handheld Devices



## **Description:**

A handheld sensor for the chemical detection and analysis of gases that can be used in conjunction with an iPhone or other similar smart phone

## **Importance:**

### **NASA –**

- Gas analysis on other planets/moons
- Astronaut health/environmental monitoring

### **Non-NASA -**

- Environmental monitoring
- Field chemical analysis (military, law enforcement, homeland security)
- Medical – analysis of breath for potential disease screening

## **Program Highlights:**

**Sponsor:** NASA

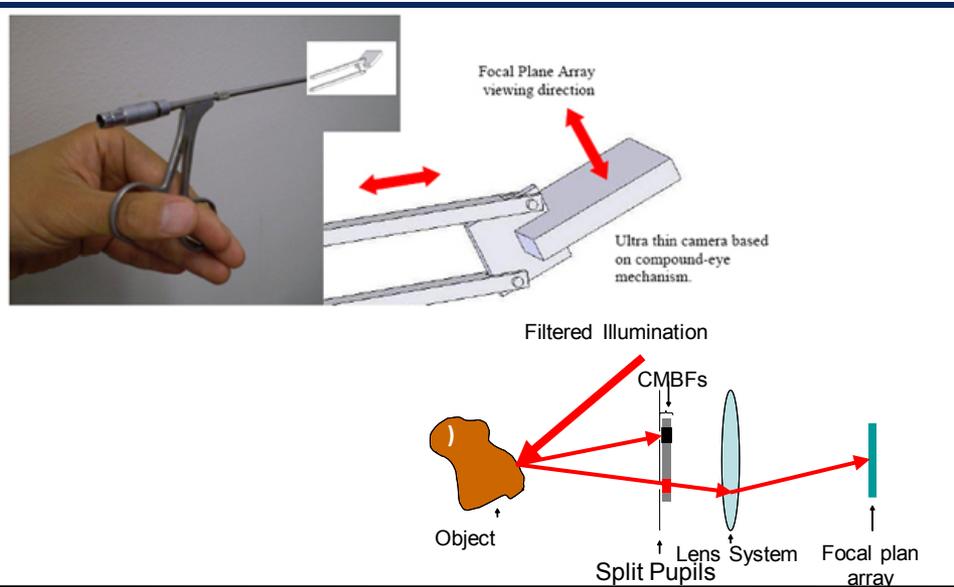
**Technical Staff:** Alexander Ksendzov, Warren P. George, Richard L. Baron, James A. Smith, Absullah S. Aljabri

**Funding:** Currently funded

**Status:** Prototype under development



# Multi-Angle and Rear Viewing Laparoscopic Endoscope (MARVEL) Tool/3-D Endoscopic Imaging



## **Description:**

This technology is two-fold; it allows for side and rear viewing from an auxiliary endoscope during surgical procedures develops stereoscopic images with a miniature endoscope using a single objective and a single chip. These 3-D stereoscopic images are created using a pair of conjugated multiple bandpass filters to separate stereo images. These time multiplexed images are then mixed and reconstructed to display as stereoimages.

## **Importance:**

### **NASA –**

- Miniature analytical/observation tools

### **Non-NASA -**

- Medicine (Minimally invasive surgeries)
- Geological industry (mining, exploration)

## **Program Highlights:**

**Sponsor:** Skull Base Institute

**Technical Staff:** Harish Manohara, Youngsam Bae, Victor White

**Funding:** Ongoing; \$1.2 MM for 2 yrs through Dec 2010

**Status:** Prototype developed and undergoing FDA approval process



# Non-Contacting Electrocardiograph Machine



## **Description:**

This technology represents a microwave *remote-sensing* technique which allows the pulse-rate, respiration-rate, bio-impedance variations, and even an electrocardiogram of a person to be obtained without any physical contact. This technique works over long distances (10's of meters) and allows human vital signs to be detected through barriers, such as walls or doors.

## **Importance:**

### **NASA -**

- Astronaut health monitoring

### **Non-NASA -**

- Search and Rescue
- Medical diagnostics
- Bio-identification
- Health monitoring of combat personnel

## **Program Highlights:**

**Sponsor:** Classified (Intelligence) – initial work;  
DoD (Army)

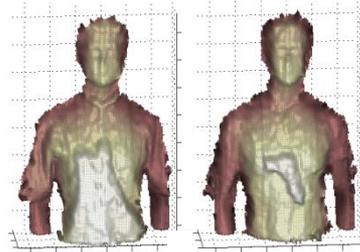
**Technical Staff:** William (Rob) McGrath; Ashit Talukdar

**Funding:** DoD (Army)

**Status:** Reduced to practice in laboratory;  
software algorithms developed; integrating into an advanced monitoring system for military



# Terahertz Imaging Radar System



## **Description:**

This technology represents a 670 GHz Imaging Radar System that can be used to scan a person for concealed weapons from a remote distance.

## **Importance:**

### **NASA –**

- Utilizes terahertz technologies and advanced antenna technologies under development for future astrophysics instruments

### **Non-NASA -**

- Homeland Security – airports, courtrooms
- Military

## **Program Highlights:**

**Sponsor:** DoD (Navy)

**Technical Staff:** Ken Cooper, Peter Siegel, Robert Dengler, Goutam Chattopadhyay, Erich Schlecht, Imran Mehdi, Anders Skalare

**Funding:** Ongoing; current - \$1 MM (Navy), \$ 500K (TSWG)

**Status:** Reduced to practice; signal processing time at 1-5 seconds; scan distance at 25 meters