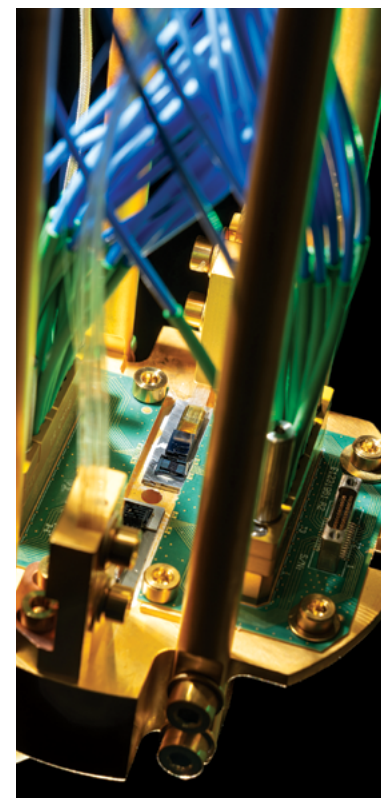
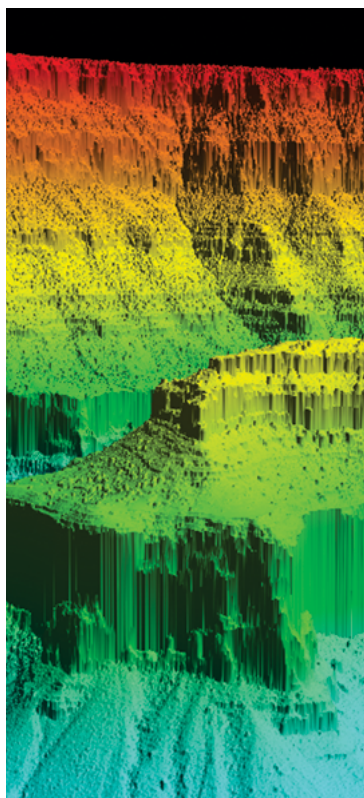


R&D 100 Awards

101
MIT LINCOLN LABORATORY
technologies recognized as among the
best innovations of each year, 2010–2024





Technology in Support of National Security

MIT Lincoln Laboratory researches and develops a broad array of advanced technologies to meet critical national security needs. What sets us apart from many national R&D laboratories is our focus on building operational prototypes of the unique systems we design.

Our ability to turn concepts into field-worthy systems is supported by state-of-the-art facilities, such as a world-class semiconductor research and fabrication laboratory, a flight facility with aircraft customized for field-testing airborne systems, and New England's fastest, most powerful supercomputing center.

Behind our innovative R&D are people with exceptional technical abilities and creativity, working in cross-disciplinary teams to develop advanced technologies for diverse needs—for example, defending against missile threats, providing secure communications, monitoring activity in space, and even inventing biomedical devices.

Quick Facts

MIT Lincoln Laboratory is a Department of Defense federally funded research and development center

Established

1951

Location

Lexington, Massachusetts

Research areas

- Sensor systems
- Communications
- Advanced imaging
- Cybersecurity
- Artificial Intelligence
- Data analytics
- Microelectronics
- Bioengineering
- Air and missile defense
- Space systems

WWW.LL.MIT.EDU

Letter from the Director

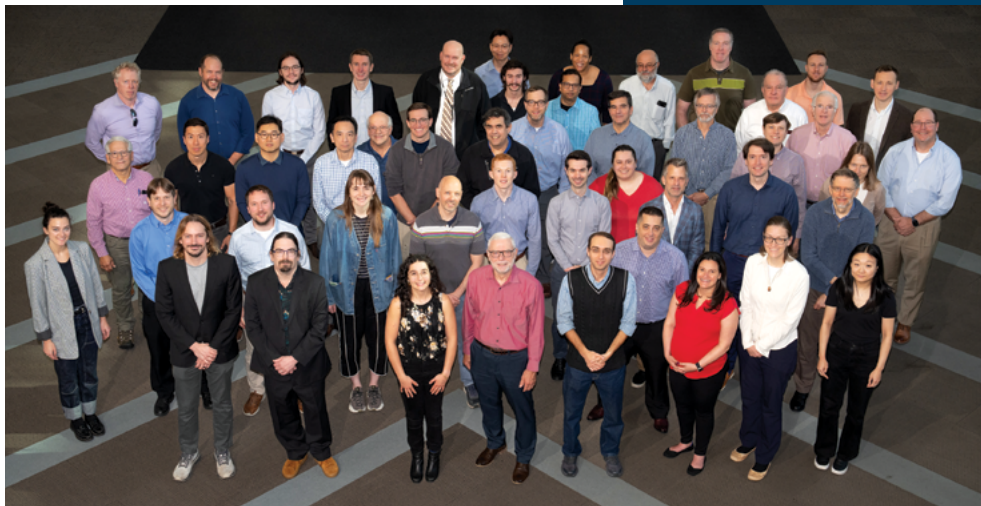
Each year, R&D 100 Awards are awarded to the 100 most innovative technologies transitioned during the year for use in real systems or applications. The awards are selected by a panel of technical editors and subject-matter experts, and they represent a cross section of work from across the research and development community. MIT Lincoln Laboratory is honored to have been selected for 101 of these awards—including two R&D Editor's Choice Awards and one Special Recognition Silver Medal—over the past 15 years.

Our recognized technologies reflect the wide range of research and development in which Lincoln Laboratory is engaged across our mission areas. Some of the winners come from our long-standing work on radar technology and air traffic control systems, while others come from newer fields, such as wearable biosensing and quantum networking. Many of the technologies began as projects supported by funding from the Under Secretary of Defense for Research and Engineering for investigations into new technology that supports important, new defense capabilities.

This booklet was produced not only to recognize our award-winning technologies but also to applaud the work of the teams behind each of these awardees. Some of the teams collaborated with sponsoring agencies, academic partners, and industry. Many of these teams worked with dozens of contributors for several years to mature their technologies for transition to real systems. These projects represent the commitment of the entire Lincoln Laboratory to technical excellence in support of national security.



Melissa G. Choi
Director



Principal investigators
and team members of
Lincoln Laboratory's
2024 R&D 100 Award
winning technologies.

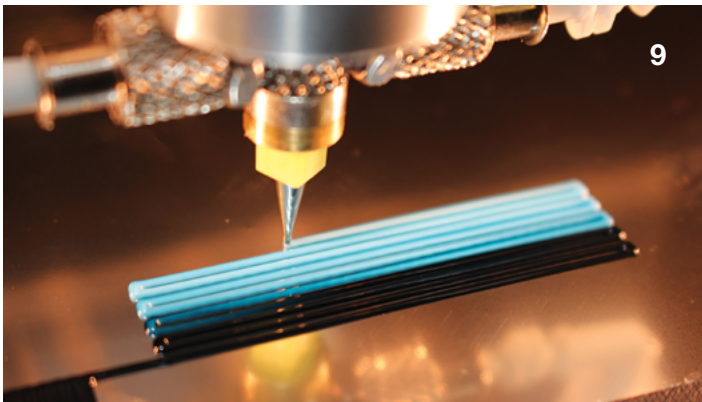
CONTENTS BY YEAR

R&D 100 AWARD WINNERS

2024

- Autonomous Sparse-Aperture Multibeam Echo Sounder 6
- Electrooculography and Balance Blast Overpressure Monitoring System 6
- Engineered Substrates for Rapid Advanced Imaging Sensor Development 7
- FocusNet 7
- Heat Injury Prevention System 7
- In-Band Full-Duplex Wireless System with Advanced Interference Mitigation 8
- Low-Temperature Additive Manufacturing of Glass Composites 8
- Megachip 8

- Mixture Deconvolution Pipeline for Forensic Investigative Genetic Genealogy 9
- Nanocomposite Inks for 3D Printing Radio-Frequency (RF) Devices and Radiation Shielding 9
- Neuron Tracing and Active Learning Environment 10
- Portable Aircraft Derived Weather Observation System 10
- Precision Photon Synchronization System for Quantum Networking 10
- Superconductive Many-State Memory and Comparison Logic 11
- Tunable Knitted Stem Cell Scaffolds 11



2023

- Joint Communication Architecture for Unmanned Systems Security/Cyber Module End Cryptographic Unit 12
- Noncontact Laser Ultrasound for Medical Imaging 12
- Puckboard 13
- Scalable Photonic Quantum Memory Module 13



2022

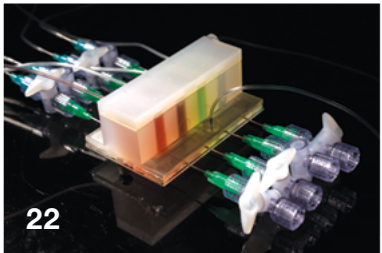
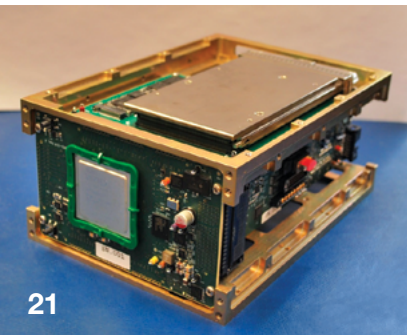
- Airborne Collision Avoidance System sXu 14
- Constrained Communications and Radar Dual-Use 14
- Embedded Microjet Cooling for High-Power Electronics 14
- Timely Address Space Randomization 15
- Toroidal Propeller 15
- TROPICS Pathfinder Satellite 15

CONTENTS BY YEAR

R&D 100 AWARD WINNERS

2020

- Cyber Sensing for Power Outage Detection 19
- Defensive Wire Routing for Untrusted Integrated Circuit Fabrication 19
- Forensic Video Exploitation and Analysis 20
- Keylime 20
- Large-Scale Vulnerability Addition 20
- Reconnaissance of Influence Operations 21
- TeraByte InfraRed Delivery 21
- Timely Randomization Applied to Commodity Executables at Runtime 21



2019

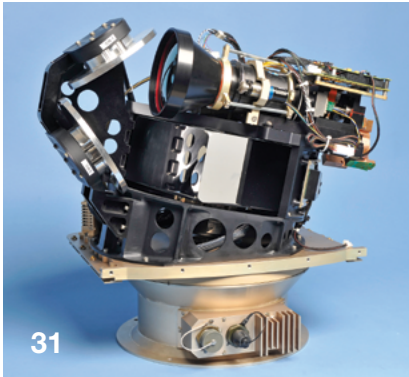
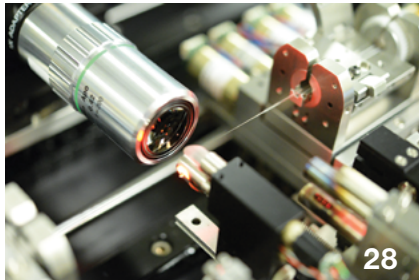
- Aperture-Level Simultaneous Transmit and Receive Phased Array 22
- Dual-Mode Imaging Receiver 22
- ArtGut 22
- Gas Mapping LiDAR™ 23
- Lightweight Deployable Array Panels for Space 23
- Mobility and Biomechanics Insert for Load Evaluation 24
- Rapid Convective Growth Detector 24
- Tactical Microgrid Standard Open Architecture 25
- Targeted Acoustic Laser Communication 25
- Visibility Estimation through Image Analytics 25

CONTENTS BY YEAR

R&D 100 AWARD WINNERS

2018

- Dynamic Flow Isolation 26
- Human-Machine Collaborative Optimization via Apprenticeship Scheduling 26
- Immersive Imaging System 27
- Intelligent Power Distribution 27
- Multirate Differential Phase Shift Keying Optical Communications 27
- Peregrine: Network Navigation 28
- Photonic Lantern Adaptive Spatial Mode Control 28
- Ultrafast Computational Methods for Searching DNA Databases 28
- Very Large-Scale Integration Process for Superconducting Electronics 29
- Web-Based HURREVAC 29



2017

- CO₂/O₂ Breath and Respiration Analyzer 30
- Ground-Based Sense-and-Avoid System for Unmanned Aircraft Systems 30
- Polarimetric Co-location Layering 30
- Presymptomatic Agent Exposure Detection 31
- Pulse-to-Pulse Phase Diversity Processing for Interference Suppression and Range Disambiguation 31
- Wide-Area Infrared System for Persistent Surveillance 31

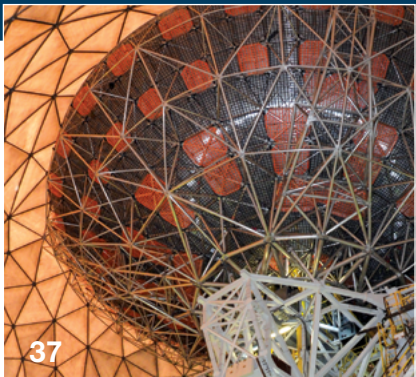
2016

- Airborne Collision Avoidance System for Unmanned Aircraft 32
- Broadband Magnetometry and Temperature Sensing with a Light-Trapping Diamond Waveguide 32
- EnteroPhone™ 33
- Laserscope 33
- Offshore Precipitation Capability 34
- Small Airport Surveillance Sensor 34



2015

- Platform for Architecture-Neutral Dynamic Analysis 35
- Self-Defense Distributed Engagement Coordinator 35
- Video Content Summarization Tool 35



2014

- Airborne Sense-and-Avoid Radar Panel 36
- Curled Microelectromechanical Switch 36
- Haystack Ultrawideband Satellite Imaging Radar 37
- Localizing Ground-Penetrating Radar 37
- Lunar Laser Communication System 38
- Wide-Area Chemical Sensor 38

2013

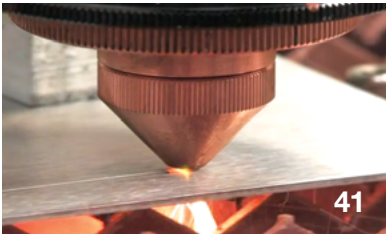
- Structured Knowledge Space 39
- Photoacoustic Sensing of Explosives 39

CONTENTS BY YEAR

R&D 100 AWARD WINNERS

2012

- Lincoln Open Cryptographic Key Management Architecture 40
- Route Availability Planning Tool 40
- Wide Field-of-View Curved Focal Plane Array 41
- Wavelength Beam-Combining Fiber-Coupled Diode Laser 41

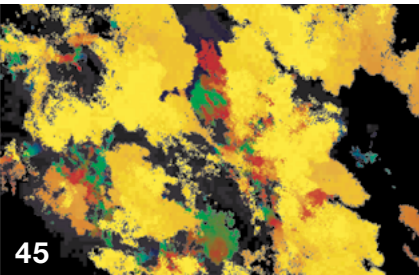


2011

- Airborne Ladar Imaging Research Testbed 42
- Multifunction Phased Array Radar Panel 42
- Parallel Vector Tile Optimizing Library 43
- Pathogen Analyzer for Threatening Environmental Releases 43

2010

- Digital-Pixel Focal Plane Array 44
- Miniaturized Radio-Frequency Four-Channel Receiver 44
- Geiger-Mode Avalanche Photodiode Detector Focal Plane Array 45
- Runway Status Lights 45
- Subwavelength-Separated Superconducting Nanowire Single-Photon Detector Array 45



Index 47

2024

R&D 100 AWARD WINNERS

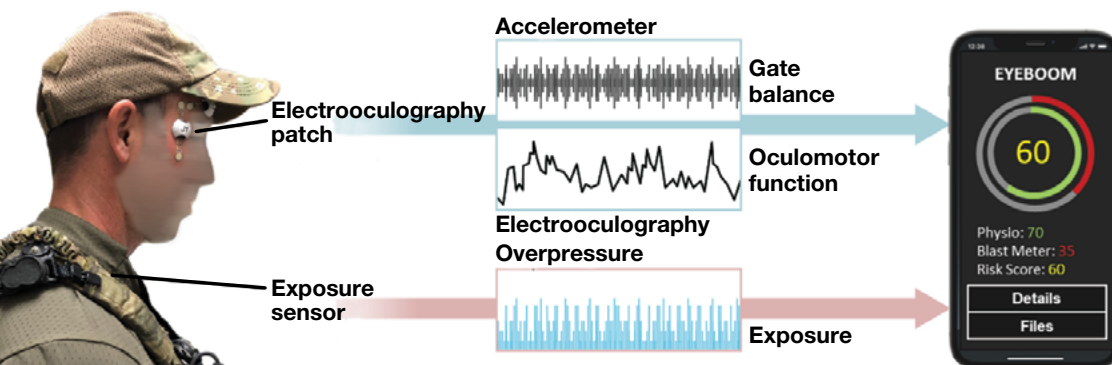
Autonomous Sparse-Aperture Multibeam Echo Sounder

A large sonar array, comprising a swarm of autonomous surface vessels, that uses estimation algorithms and acoustic signal processing techniques to rapidly generate high-resolution seabed maps

CODEVELOPERS: RESEARCHERS IN THE MIT DEPARTMENT OF MECHANICAL ENGINEERING



Electrooculography and Balance Blast Overpressure Monitoring System



A wearable blast- and cognitive-monitoring system that provides early warning of blast-exposure risk for cognitive injury

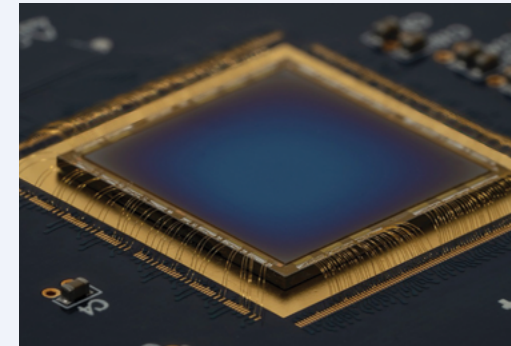
CODEVELOPERS: STAFF FROM CREARE LLC AND LIFELENS LLC

2024

R&D 100 AWARD WINNERS

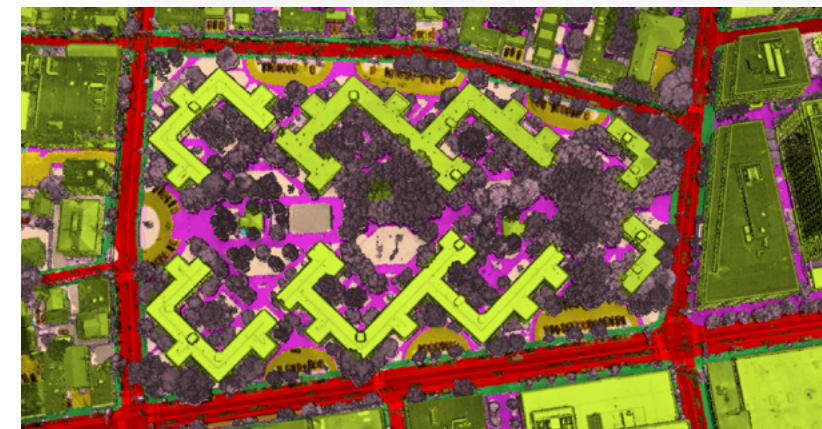
Engineered Substrates for Rapid Advanced Imaging Sensor Development

A fabrication process that reduces the development time and cost of advanced silicon imaging sensors by enabling a straightforward back-illumination process and uniform thinning on small batches of detectors



FocusNet

A machine learning architecture that performs context-driven automatic feature recognition and semantic segmentation of airborne ground-mapping lidar data



Heat Injury Prevention System



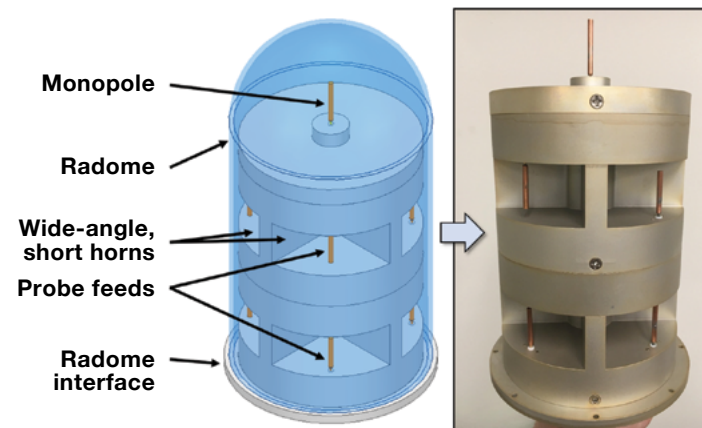
A rugged, easy-to-use wearable sensor system that monitors for heat-injury risk, employing algorithms for estimating body temperature, gait instability, and adaptive physiological strain index

2024

R&D 100 AWARD WINNERS

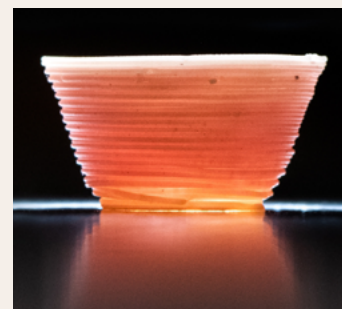
In-Band Full-Duplex Wireless System with Advanced Interference Mitigation

A wireless system that enables the mitigation of multiple interference sources, increasing the number of devices supported, their data rate, and their communications range



Low-Temperature Additive Manufacturing of Glass Composites

An approach that uses a direct-ink-writing technique to extrude multimaterial glass ink into a desired form at room temperature

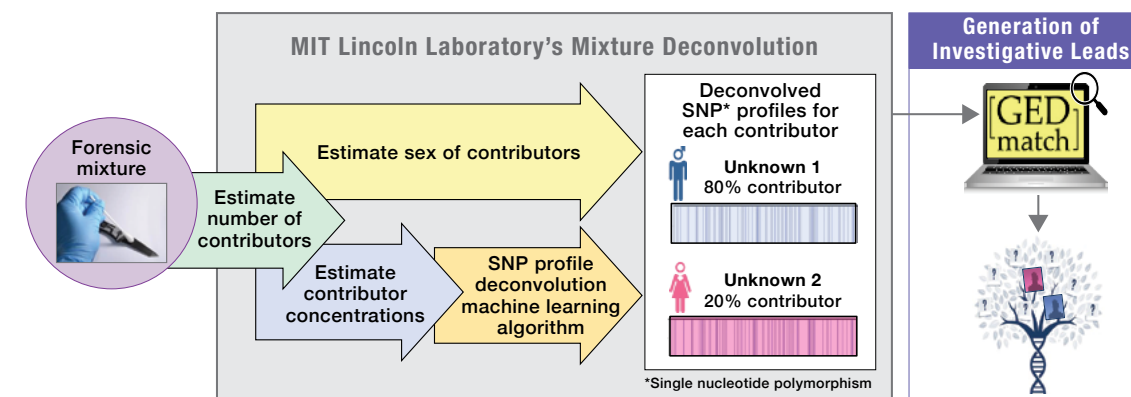


2024

R&D 100 AWARD WINNERS

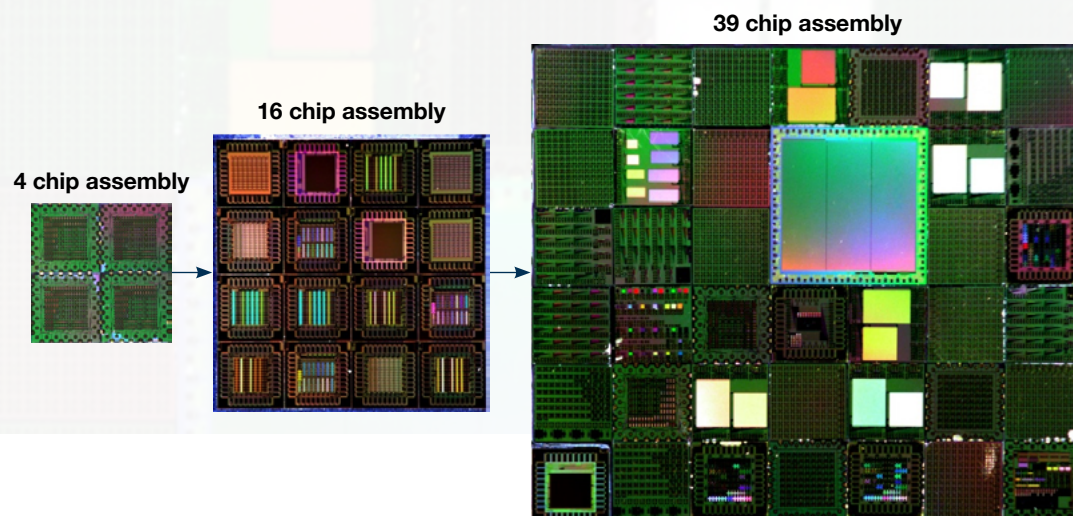
Mixture Deconvolution Pipeline for Forensic Investigative Genetic Genealogy

Software that allows analysts to decipher forensic samples containing DNA from two contributors without matching to reference profiles, enabling search in commercial genealogical databases



Megachip

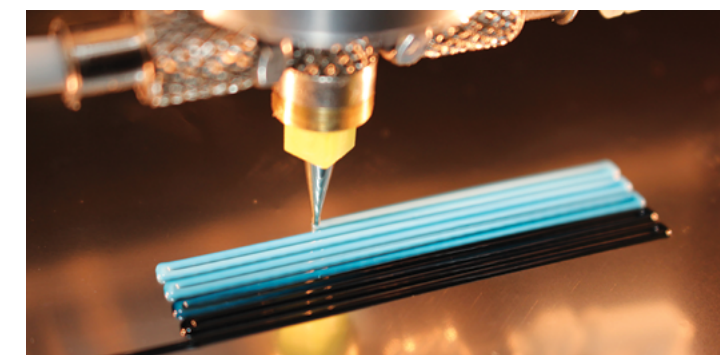
A chip-tiling approach that interconnects small specialized chips into a monolithic integrated circuit, capable of containing billions of transistors and reducing latency and energy costs for processing artificial intelligence data



Nanocomposite Inks for 3D Printing Radio-Frequency (RF) Devices and Radiation Shielding

A materials system and process that use specially tailored nanocomposite inks to additively manufacture RF devices with graded dielectric properties

CODEVELOPERS: RESEARCHERS AT HARVARD UNIVERSITY

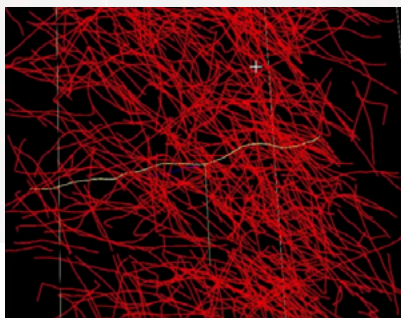


2024 winners continue on page 10 »

Neuron Tracing and Active Learning Environment

An end-to-end software pipeline that generates segmentations of neurons from large brain imaging datasets and allows expert validation from a web browser to enable semi-automated brain mapping

**CODEVELOPERS:
RESEARCHERS
FROM THE MIT
CHUNG LAB**



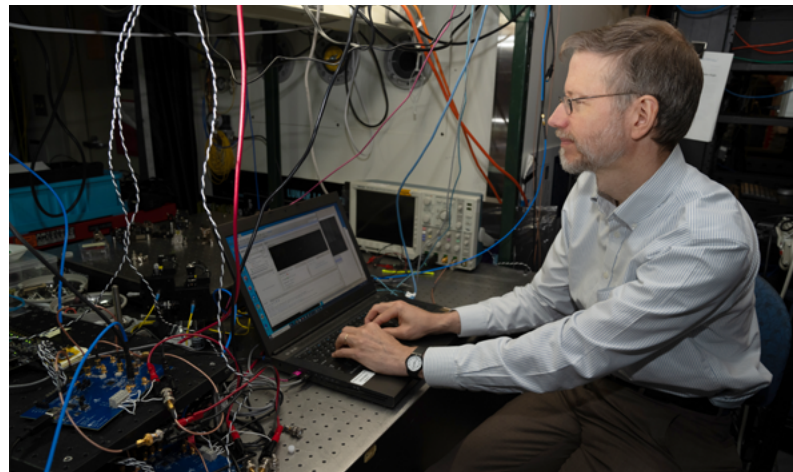
Portable Aircraft Derived Weather Observation System

A system that significantly increases the number and quality of real-time wind and temperature observations from aircraft, enabling improved weather forecasts and climate monitoring



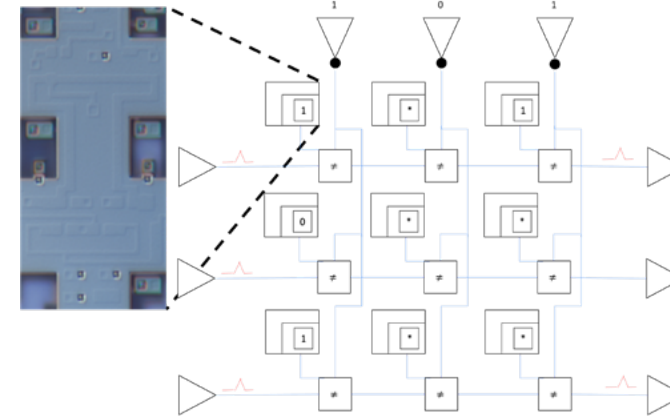
Precision Photon Synchronization System for Quantum Networking

A system that precisely synchronizes photons for long-distance free-space quantum entanglement distribution between different ground sites via an intermediary satellite



Superconductive Many-State Memory and Comparison Logic

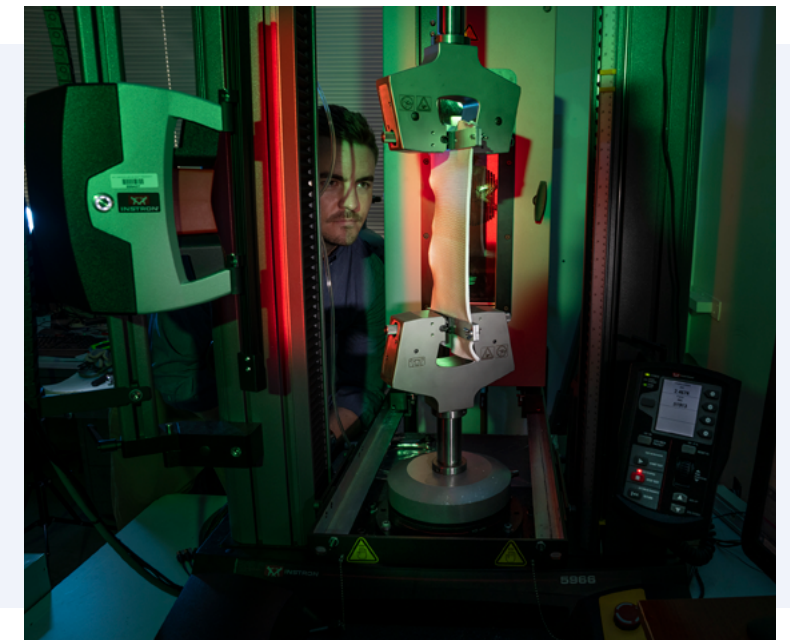
Superconductive circuits that natively store and compare greater than two discrete states, without significantly increasing the number of devices or surface area of the circuits



Tunable Knitted Stem Cell Scaffolds

Biocompatible knitted material (scaffold) that advances cell regeneration by mimicking the mechanics of soft tissue to allow more successful stem cell therapy with fewer complications than achieved with current stiff scaffolds

**CODEVELOPERS: RESEARCHERS IN
THE MIT DEPARTMENT OF MECHANICAL
ENGINEERING**



2023

R&D 100 AWARD WINNERS

Joint Communication Architecture for Unmanned Systems Security/Cyber Module End Cryptographic Unit

A compact, National Security Agency-certified device that secures tactical datalinks of unmanned systems processing sensitive information

CODEVELOPERS: STAFF FROM NAVAL INFORMATION WARFARE CENTER PACIFIC



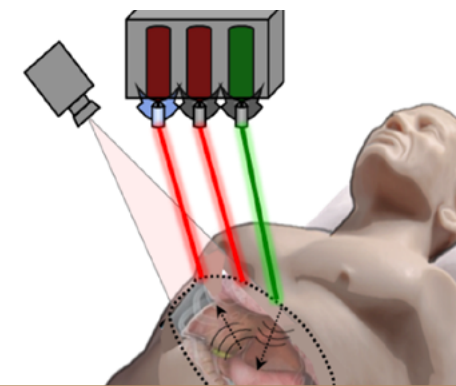
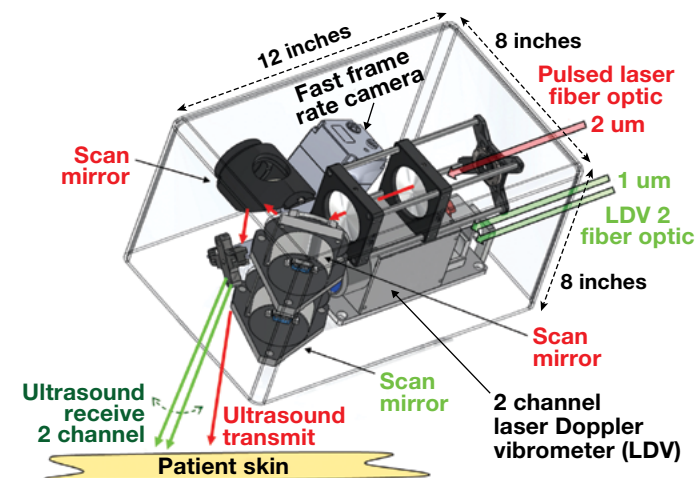
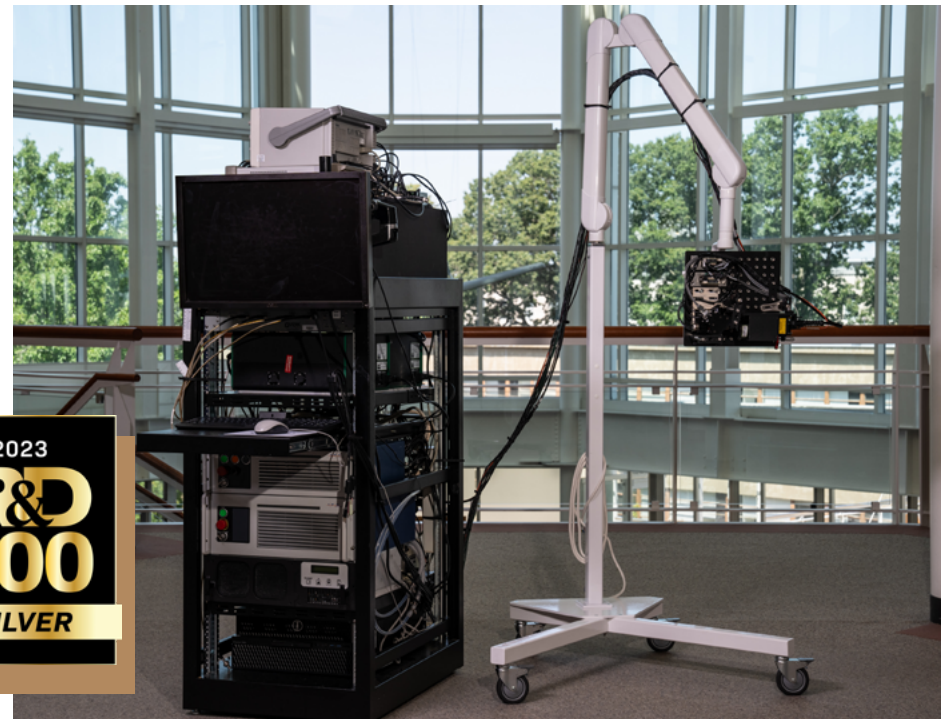
Noncontact Laser Ultrasound for Medical Imaging

A portable system that uses an eye- and skin-safe laser to acquire interior images of human tissue without touching the patient

CODEVELOPERS: STAFF FROM MASSACHUSETTS GENERAL HOSPITAL CENTER FOR ULTRASOUND RESEARCH TRANSLATION AND SOUND & BRIGHT, LLC

Silver Medal for Special Recognition, Market Disruptor—Products

This technology was also the winner of an R&D 100 Silver Medal in the Market Disruptor category recognizing industry-changing products



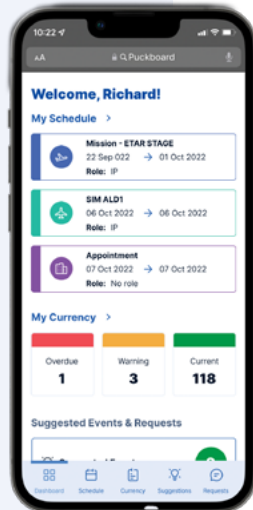
2023

R&D 100 AWARD WINNERS

Puckboard

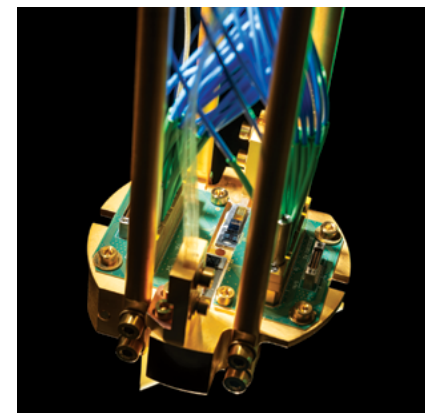
A web-based software application that uses artificial intelligence to optimize scheduling U.S. Air Force aircrews to mission and training flights

CODEVELOPERS: RESEARCHERS FROM REVACOMM, DEPARTMENT OF THE AIR FORCE—MIT AI ACCELERATOR, MIT, 15TH WING, 60TH AIR MOBILITY WING, 437TH AIRLIFT WING, HEADQUARTERS AIR MOBILITY COMMAND, AIR FORCE RESEARCH LABORATORY, ASSISTANT SECRETARY OF THE AIR FORCE (INSTALLATIONS, ENVIRONMENT, AND ENERGY), RAYTHEON-BBN



Scalable Photonic Quantum Memory Module

A single unit that combines a photonic interface, loss-error correction, and an architecture accommodating multiple memory modules to enable high-rate, high-efficiency quantum networking for computing and distributed sensing



Airborne Collision Avoidance System sXu

A system that allows small uncrewed aircraft systems to detect nearby aircraft and maneuver away to avoid a potential midair collision

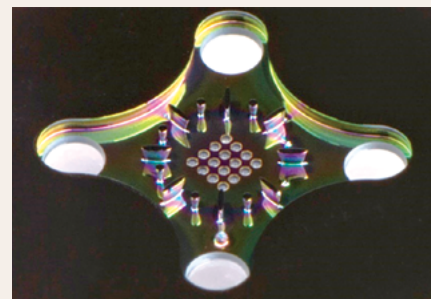
CODEVELOPERS: RESEARCHERS FROM THE FEDERAL AVIATION ADMINISTRATION, MITRE, AND JOHNS HOPKINS UNIVERSITY APPLIED PHYSICS LABORATORY



Constrained Communications and Radar Dual-Use



A method of designing waveforms that can perform both radar and communications tasks simultaneously, using the same transmitter and receiver



Embedded Microjet Cooling for High-Power Electronics

A device that uses arrays of micron-scale fluid jets, embedded directly into the device at the chip level, to drastically improve heat transfer in electronics

Timely Address Space Randomization

Software that prevents memory corruption by automatically shuffling, or rerandomizing, the location of code in memory every time the software observes an output from an application

Unprotected server or application



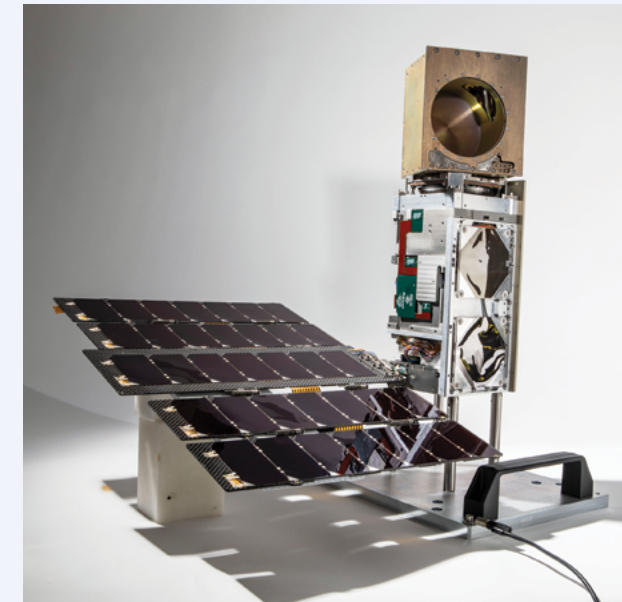
TASR frequently randomizes the memory of a server or application after every possible leakage point



Toroidal Propeller



A propeller designed for commercial drones that is significantly quieter than common multirotor propellers



TROPICS Pathfinder Satellite

A small satellite, or CubeSat, that uses a novel, miniaturized microwave sounder to provide high-resolution weather data over the Earth's tropical belt

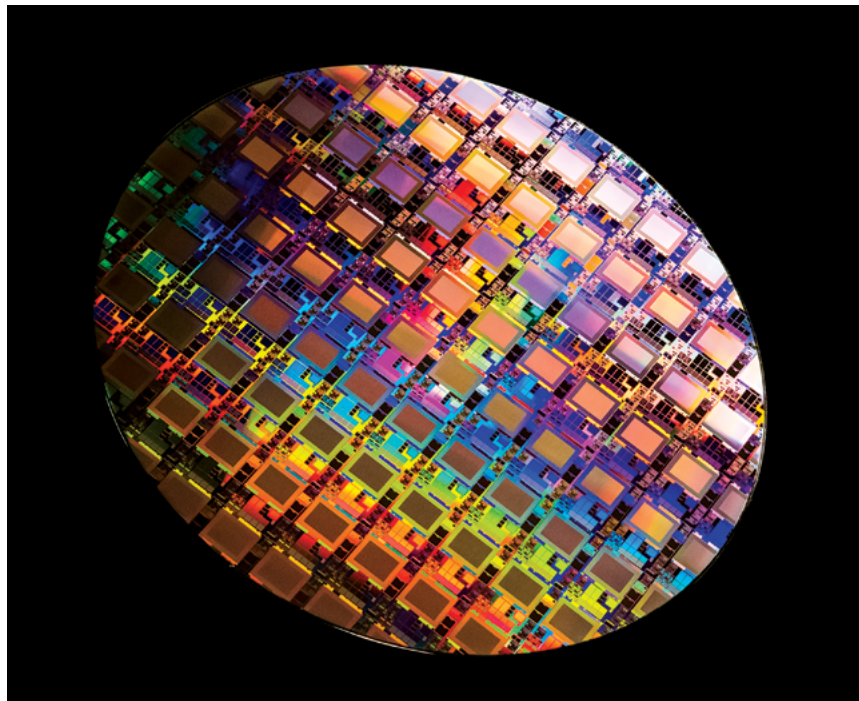
CODEVELOPERS: RESEARCHERS FROM NASA AND BLUE CANYON TECHNOLOGIES

2021

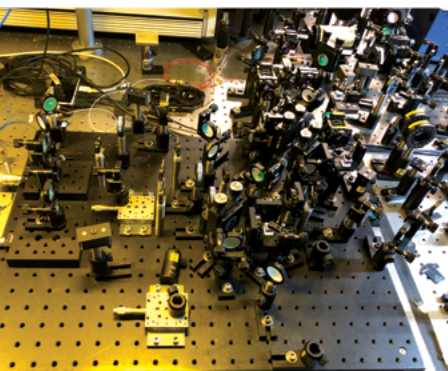
R&D 100 AWARD WINNERS

Field-Programmable Imaging Array

A universal digital back end for camera systems that, when hybridized to an image detector array, results in a flexible and powerful digital processing system-in-package



Free-Space Quantum Network Link Architecture



A system that enables the generation, distribution, and remote interaction of entangled photons across free-space links

Global Synthetic Weather Radar

A technology that provides radar-like weather imagery and radar-forward forecasts in global regions where actual weather radar are not deployed or available

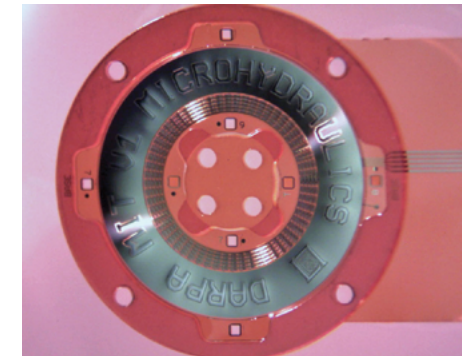


2021

R&D 100 AWARD WINNERS

Microhydraulic Motors

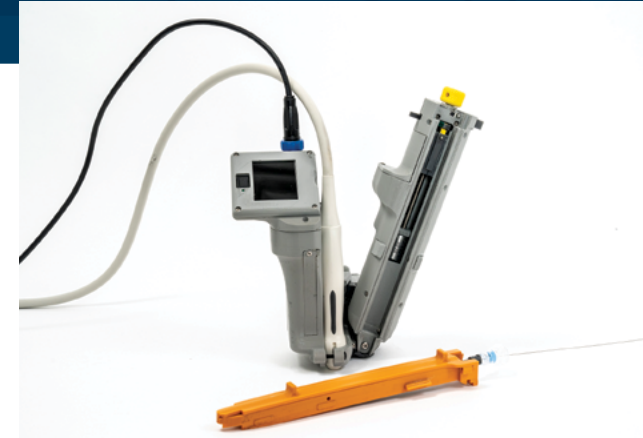
A scalable, electrowetting-based actuation platform that has a torque density two orders of magnitude higher than that of electric motors



Guided Ultrasound Intervention Device

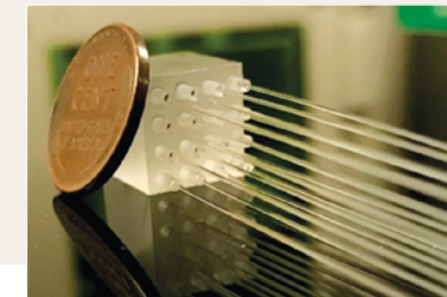
A handheld tool, utilizing real-time artificial intelligence software, that enables a medic to rapidly and accurately catheterize a central vein or artery in a prehospital environment

CODEVELOPERS: RESEARCHERS AT MASSACHUSETTS GENERAL HOSPITAL



Monolithic Fiber Array Launcher

An all-glass, monolithic fiber array launcher that is smaller and more robust than standard arrays



2021 winners continue on page 18 »

2021

R&D 100 AWARD WINNERS

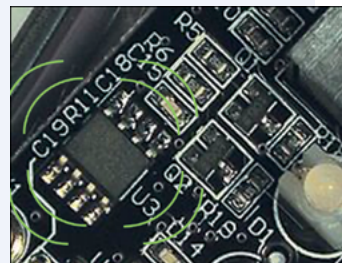
Motion Under Rubble Measured Using Radar

A lightweight, portable life-detection radar that rapidly senses, ranges, and characterizes survivors trapped beneath rubble



Spectrally Efficient Digital Logic

A set of digital logic families that operate with intrinsically low electromagnetic interference emissions



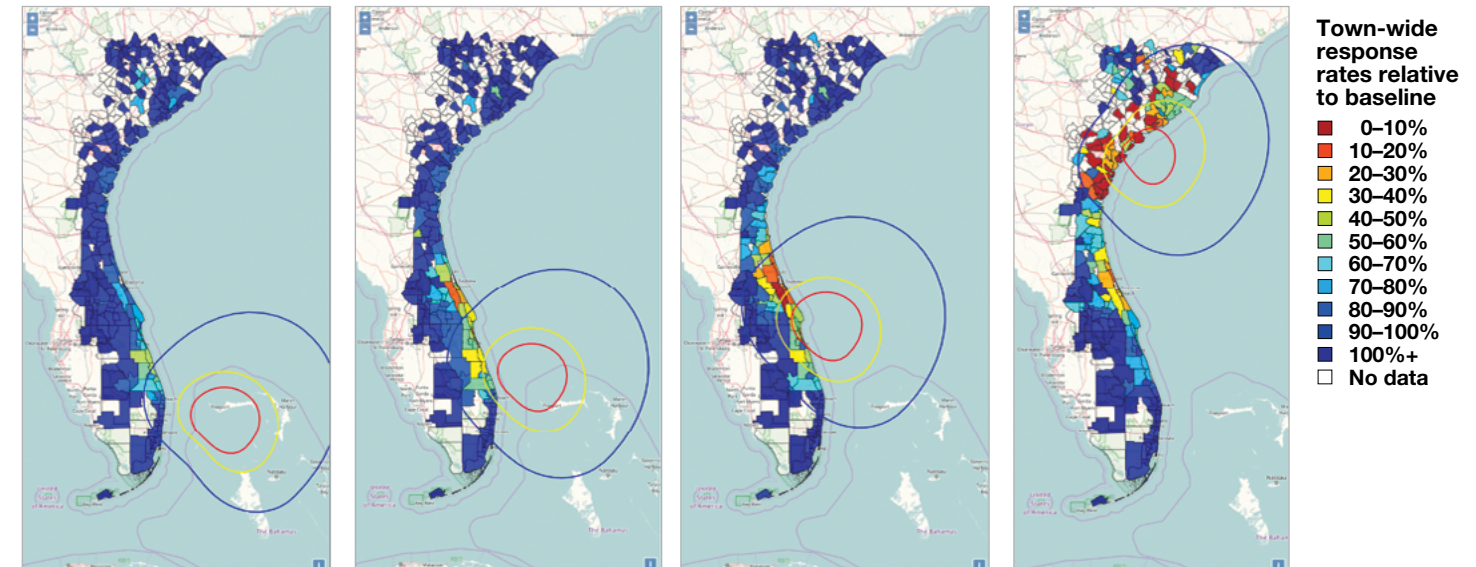
Traffic Flow Impact Tool

A tool for air traffic control managers that predicts and displays impacts to airspace capacities and traffic flow rates during convective weather



2020

R&D 100 AWARD WINNERS

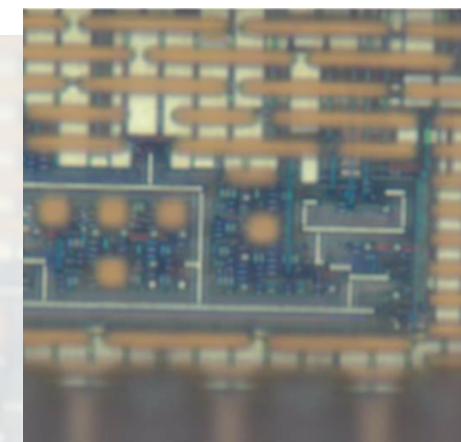


Cyber Sensing for Power Outage Detection

A system that uses data on internet traffic to rapidly estimate and map the extent and location of power outages across geographic boundaries

Defensive Wire Routing for Untrusted Integrated Circuit Fabrication

Techniques that deter an outsourced foundry from maliciously tampering with or modifying the security-critical components of a digital circuit design



2020 winners continue on page 20 »

2020

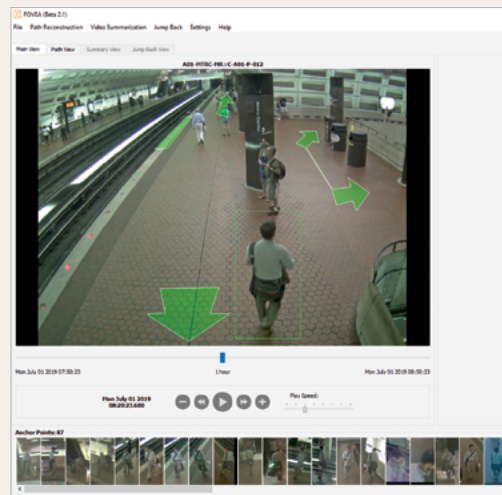
R&D 100 AWARD WINNERS

2020

R&D 100 AWARD WINNERS

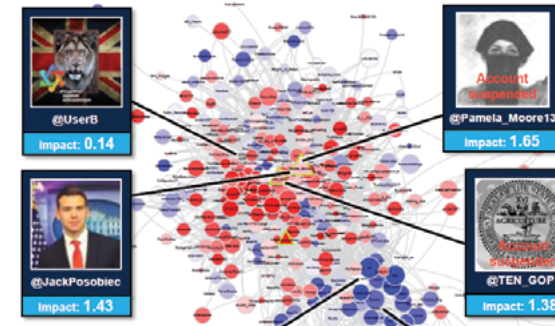
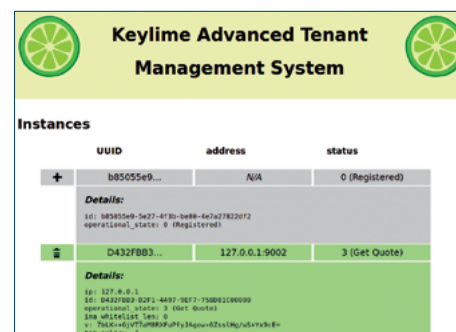
Forensic Video Exploitation and Analysis

A suite of tools that enables users to efficiently analyze video captured by existing large-scale closed-circuit television systems



Keylime

An open-source key bootstrapping and integrity management software architecture that is designed to increase the security and privacy of edge, cloud, and Internet of Things (IoT) devices



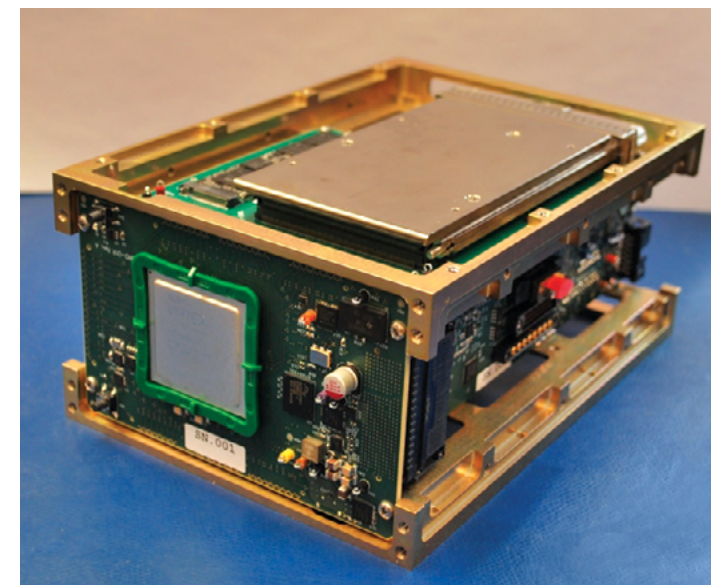
Reconnaissance of Influence Operations

A software system that automates the detection of disinformation narratives, networks, and influential actors to address the growing threat posed by adversaries using social media for political objectives

CODEVELOPERS: RESEARCHERS FROM HARVARD UNIVERSITY

TeraByte InfraRed Delivery

An optical communications technology that enables error-free transmission of data from low Earth-orbiting satellites at a rate of 200 gigabits per second



Timely Randomization Applied to Commodity Executables at Runtime

A technique that protects Windows applications against cyberattacks by automatically and transparently re-randomizing the applications' sensitive internal data and layout every time an output is generated

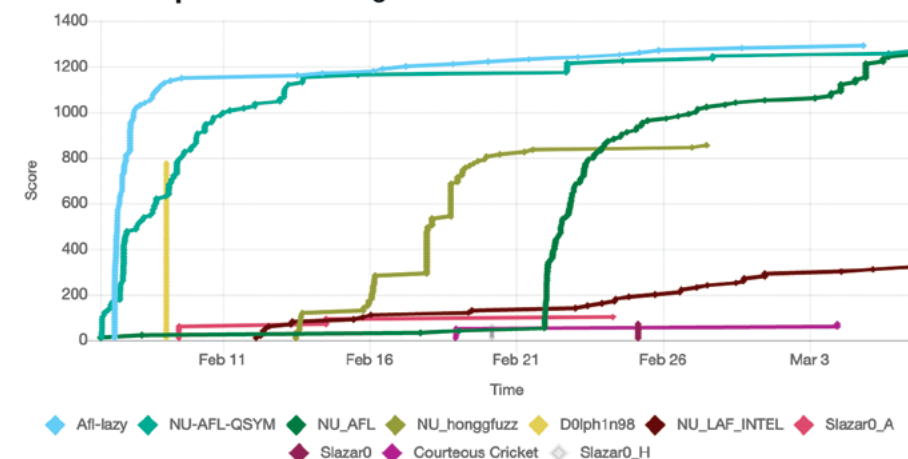


Large-Scale Vulnerability Addition

A technique that injects numerous bugs into a program at known locations and constructs triggering inputs for each to create ground truth for evaluating bug-finding systems

CODEVELOPERS: STAFF FROM NEW YORK UNIVERSITY, NORTHEASTERN UNIVERSITY, AND U.S. ARMY

Score Graph - All challenges

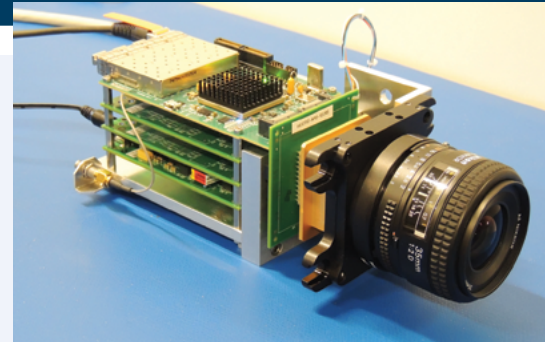
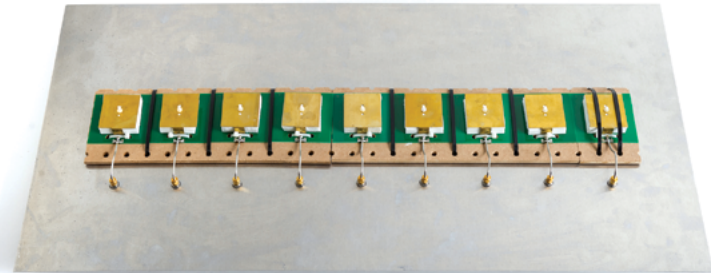


2019

R&D 100 AWARD WINNERS

Aperture-Level Simultaneous Transmit and Receive Phased Array

The first-ever demonstration of a phased array antenna system that has sufficient isolation to enable practical multibeam full-duplex communication



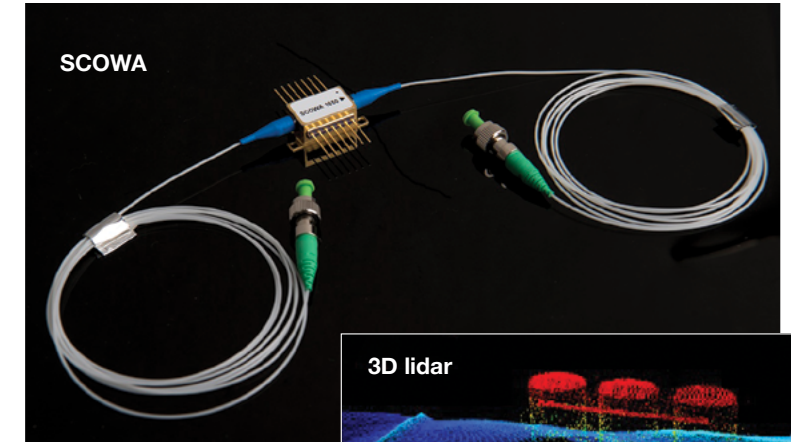
Dual-Mode Imaging Receiver

A camera that integrates the previously disparate functions of high-frame-rate photon-counting imaging and single-photon-sensitive communications into a single optical receiver

Gas Mapping LiDAR™

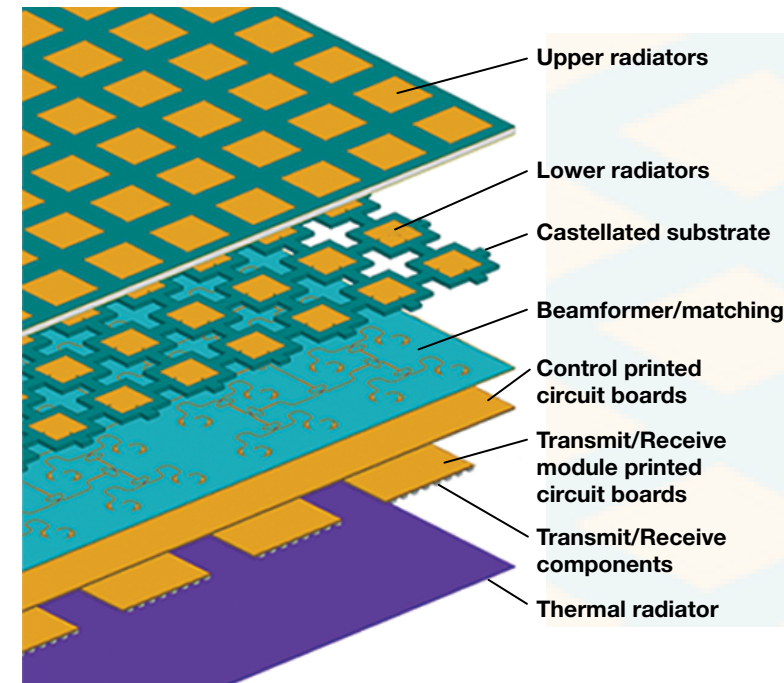
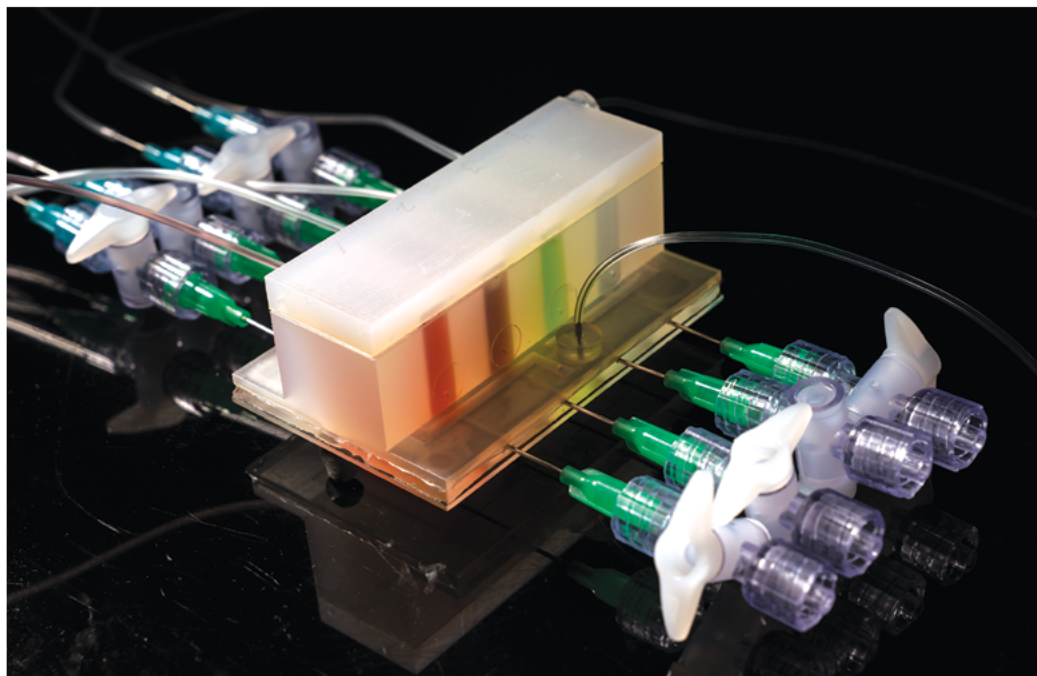
A sensor, built by Bridger Photonics and enabled by Lincoln Laboratory's slab-coupled optical waveguide amplifier (SCOWA), that remotely detects, locates, and quantifies methane leaks and oil and gas infrastructure status

CODEVELOPERS: STAFF FROM BRIDGER PHOTONICS



ArtGut

The first in vitro platform that enables researchers to perform high-resolution, physiologically relevant gut microbiome studies



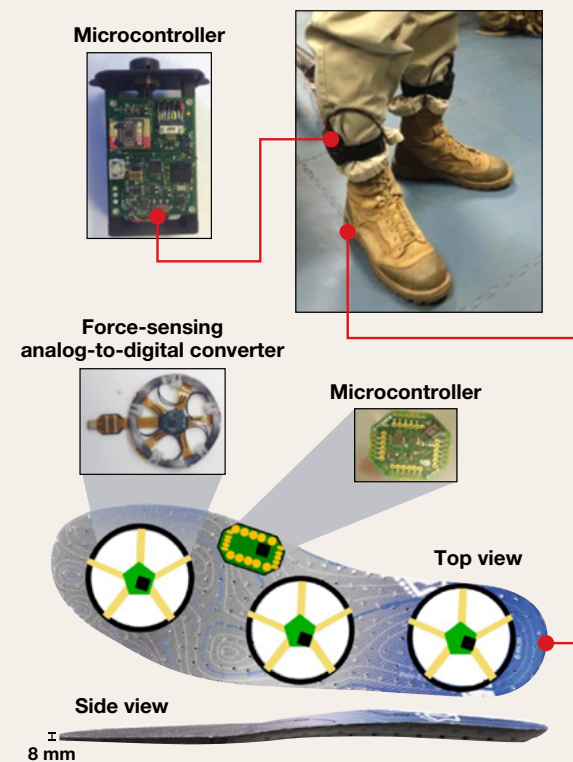
Lightweight Deployable Array Panels for Space

Panels for space-based communications and remote-sensing systems that have minimized weight and size to lower launch costs by reducing fuel needs and increasing capacity to accommodate more systems per launch

2019 winners continue on page 24 »

Mobility and Biomechanics Insert for Load Evaluation

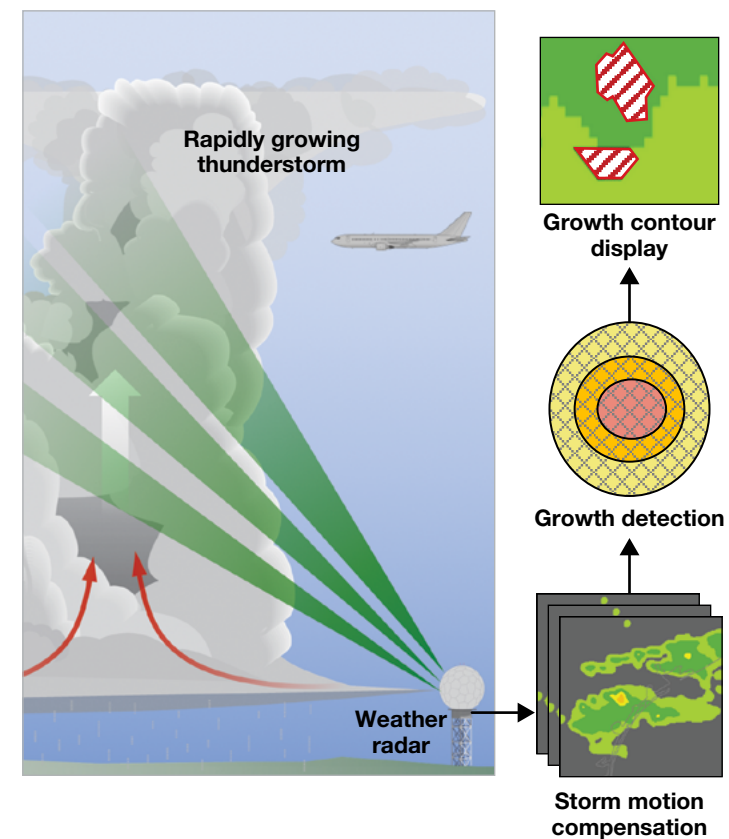
Biomechanical sensors that are built into a shoe insert and small ankle package to measure a user's weight and lower leg movements to help guide decisions about load-bearing and gait



Rapid Convective Growth Detector

A system that uses tilt-by-tilt processing of weather radar data to identify and display regions of hazardous storm growth 10 times faster than other weather sensors

CODEVELOPERS: STAFF FROM THE FEDERAL AVIATION ADMINISTRATION



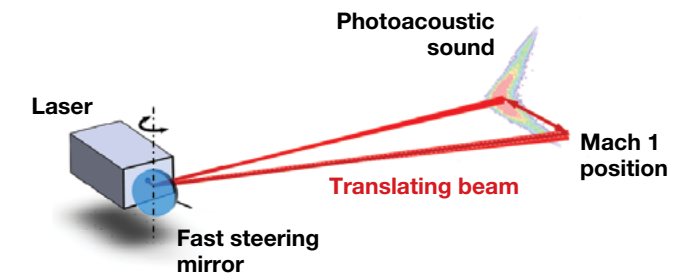
Tactical Microgrid Standard Open Architecture

An architecture that was developed by a Department of Defense-led consortium of government, industry, and academic partners to provide an interoperability standard for highly modular, resilient, scalable, and mission-specific microgrid solutions

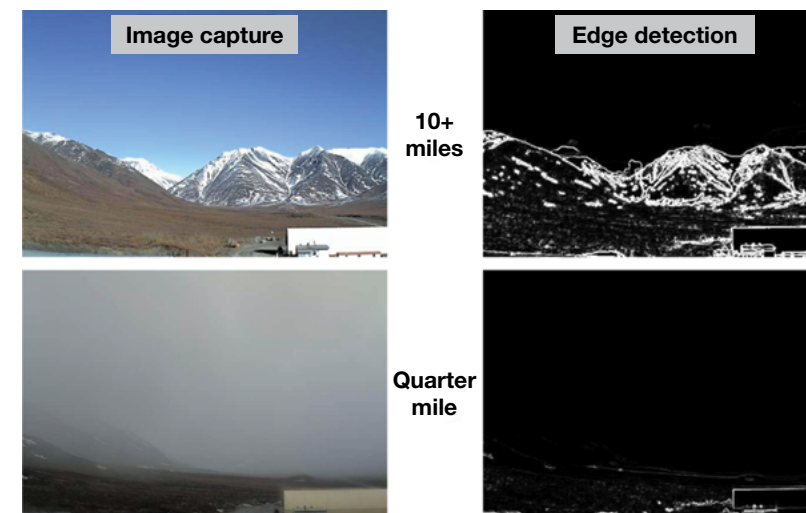
CODEVELOPERS: STAFF FROM HG ENGINEERS, PARSONS, SCHWEITZER ENGINEERING LABS, U.S. ARMY, AND U.S. MARINE CORPS

Targeted Acoustic Laser Communication

A system that uses laser photoacoustics to create audible messages in a person's ear, enabling secure and remote communications with the individual of interest and no one else



Visibility Estimation through Image Analytics



A software system that provides air traffic managers and pilots with an inexpensive, yet effective, way to automatically extract from camera images vital data about meteorological visibility

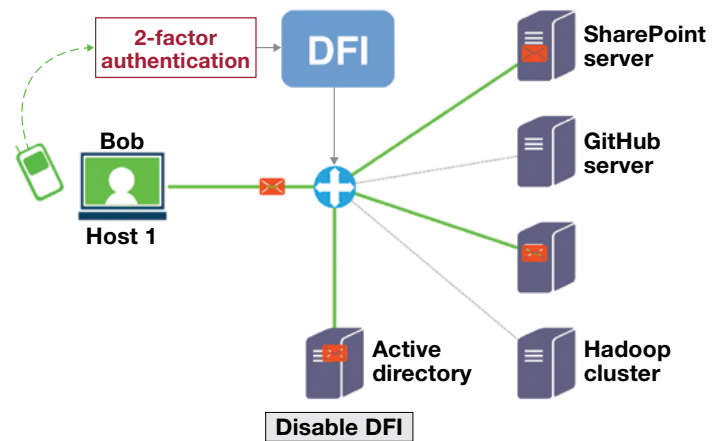
CODEVELOPERS: STAFF FROM THE FEDERAL AVIATION ADMINISTRATION

2018

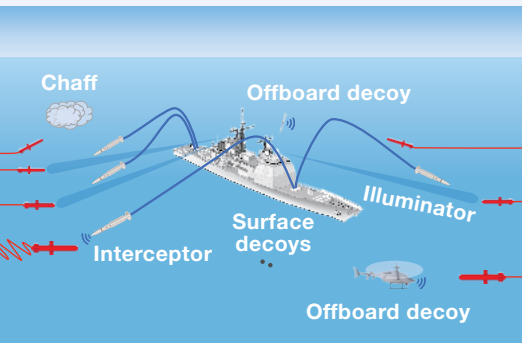
R&D 100 AWARD WINNERS

Dynamic Flow Isolation

A technique that reduces unauthorized access to networks by restricting user privileges to only the computer resources users need



Human-Machine Collaborative Optimization via Apprenticeship Scheduling



A machine learning algorithm that provides real-time decision support by applying heuristics learned from the observed behavior of human experts



Immersive Imaging System

A wide-area video surveillance system that provides very high-resolution images and 360-degree coverage from a single vantage point

2018

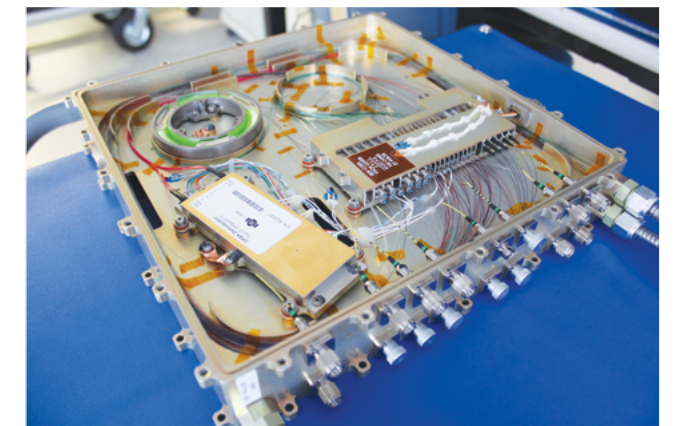
R&D 100 AWARD WINNERS

Intelligent Power Distribution

An electrical box that improves the efficiency and resiliency of a microgrid operating in austere conditions by coordinating the microgrid's energy resources and loads



Multirate Differential Phase Shift Keying Optical Communications



A format that enables efficient free-space laser communications over a wide range of data rates by using a single easy-to-implement transmitter and receiver design

2018 winners continue on page 28 »

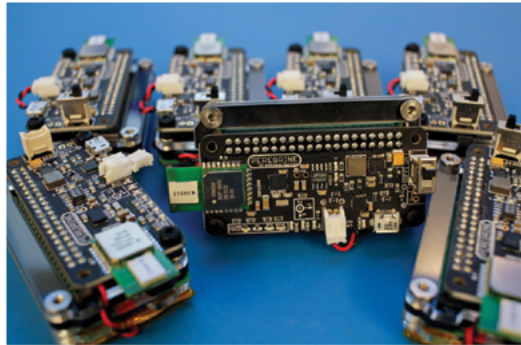
2018

R&D 100 AWARD WINNERS

2018

R&D 100 AWARD WINNERS

Peregrine: Network Navigation

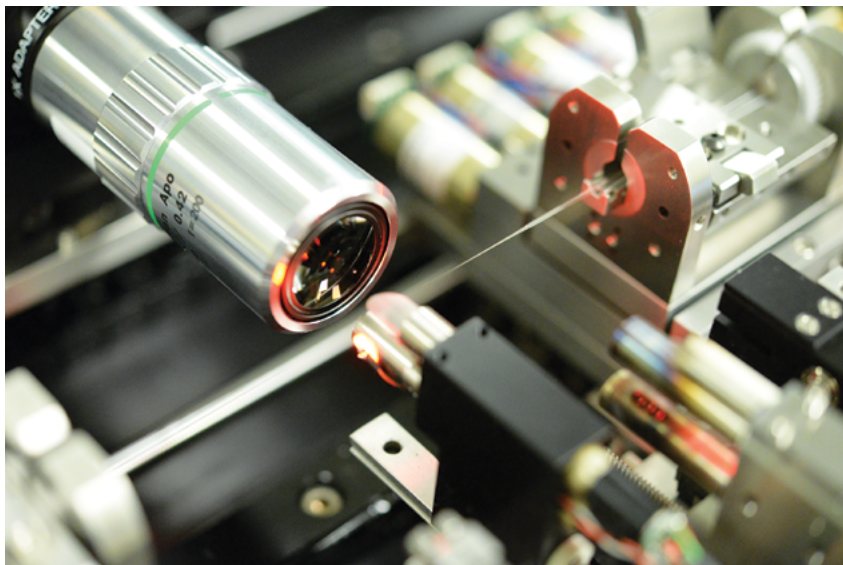


A system of networked deployable devices, powered by cooperative algorithms, that enables highly accurate navigation in environments where GPS is not available, reliable, or precise

CODEVELOPERS: RESEARCHERS FROM MIT

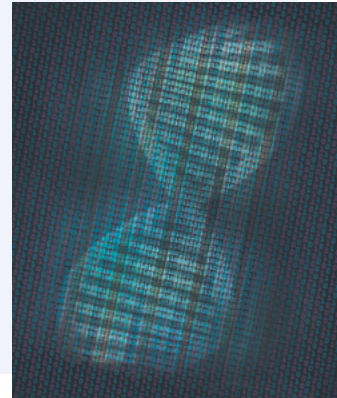
Photonic Lantern Adaptive Spatial Mode Control

A technology that provides the ability to steer and shape a laser beam, as well as scale its power, in the presence of optical disturbances and turbulence



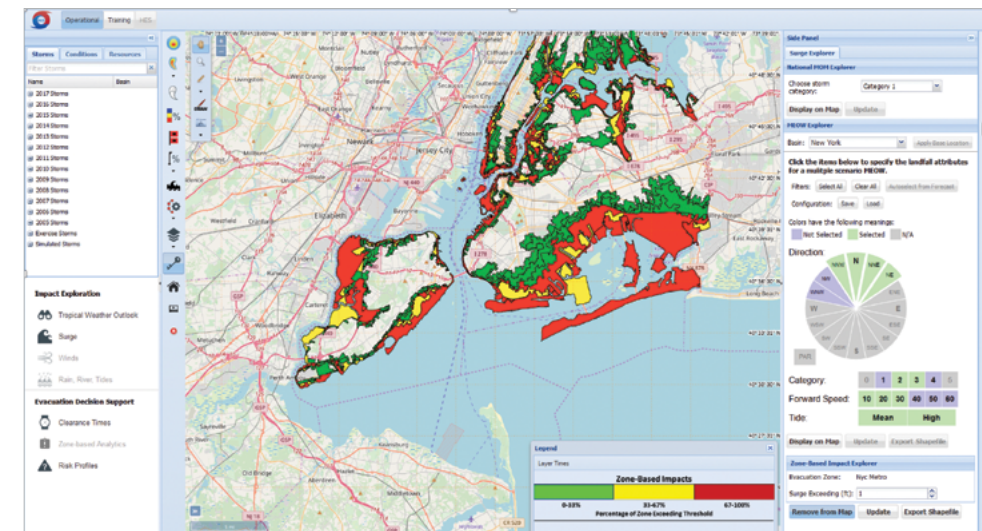
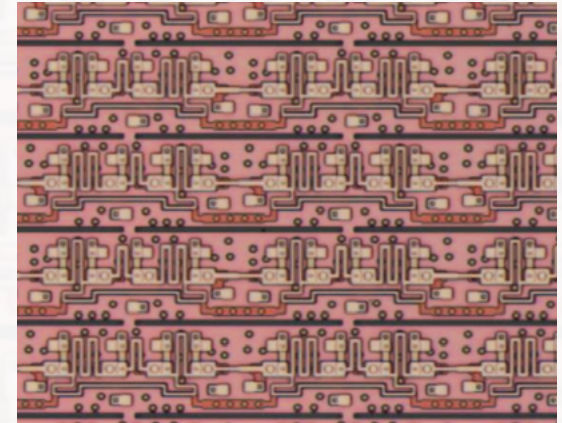
Ultrafast Computational Methods for Searching DNA Databases

Algorithms that drastically reduce the compute time required to compare a large number of unknown DNA profiles against a large dataset of millions of reference DNA profiles



Very Large-Scale Integration Process for Superconducting Electronics

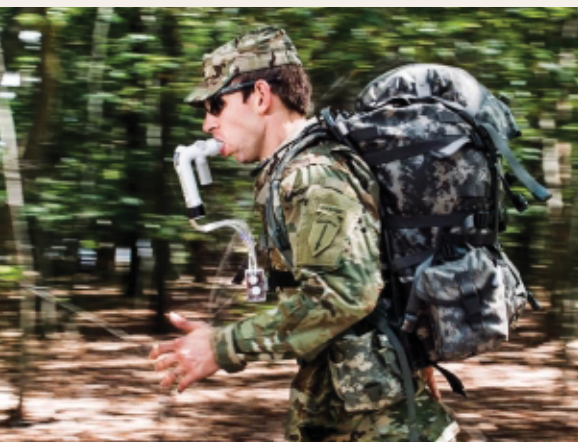
A fabrication process that taps into superconductivity to provide fast, energy-efficient integrated circuits for advanced computing, digital signal processing, quantum metrology, and sensing



Web-Based HURREVAC

An open-source decision support platform that enables emergency managers to plan, train for, and make accurate hurricane evacuation decisions

CO₂/O₂ Breath and Respiration Analyzer



A wireless, low-cost sensor that determines from a person's breath the fraction of metabolic energy produced by carbohydrate versus fat oxidation, providing information to guide weight loss and training

CODEVELOPERS: STAFF FROM THE U.S. ARMY RESEARCH INSTITUTE OF ENVIRONMENTAL MEDICINE



Ground-Based Sense-and-Avoid System for Unmanned Aircraft Systems

A first-in-production ground radar system that enables unmanned aircraft to see and avoid other aircraft

CODEVELOPERS: STAFF FROM THE U.S. ARMY, SRC INC., AND KUTTA TECHNOLOGIES

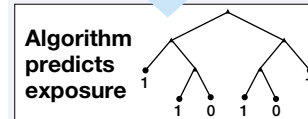
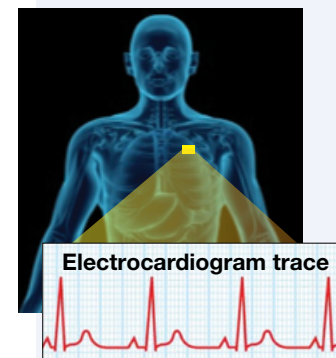


Polarimetric Co-location Layering

A novel algorithm that leverages polarimetry in maritime radar to mitigate the high false-alarm rate caused by radar returns from the sea surface



Presymptomatic Agent Exposure Detection

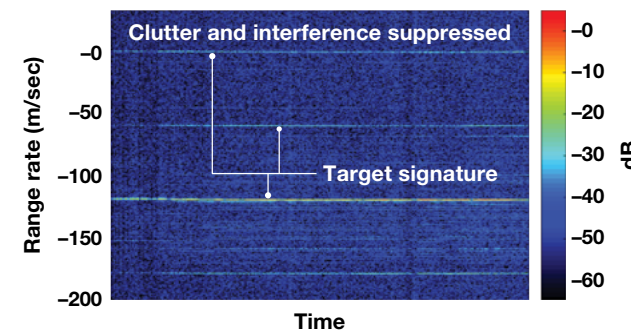


An algorithm that exploits data from noninvasive wearable medical sensors to detect if a person had been exposed to viruses or bacteria several days before overt symptoms, such as fever, appear

CODEVELOPERS: STAFF FROM THE NATIONAL INSTITUTES OF HEALTH AND U.S. ARMY MEDICAL RESEARCH INSTITUTE OF INFECTIOUS DISEASES

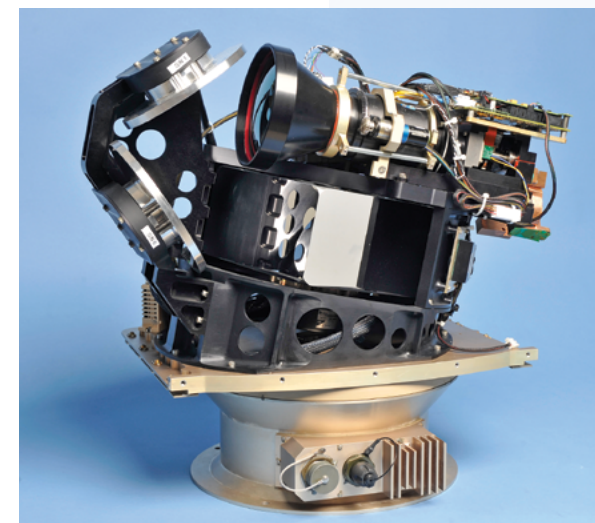
Pulse-to-Pulse Phase Diversity Processing for Interference Suppression and Range Disambiguation

A low-cost technique that uses phase-diverse waveforms and specialized processing to help mitigate the interference that wind turbines can impose on radars that track aircraft and weather



Wide-Area Infrared System for Persistent Surveillance

A portable system that detects and alerts operators to all moving objects in a monitored area during both day and night surveillance



2016

R&D 100 AWARD WINNERS

Airborne Collision Avoidance System for Unmanned Aircraft

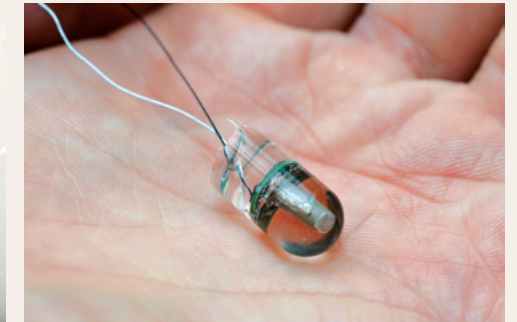
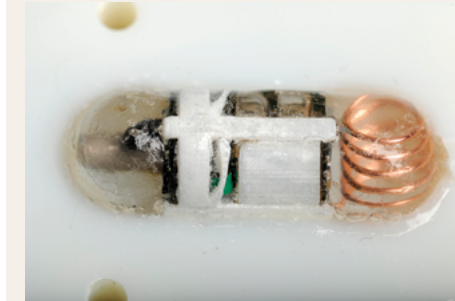
A system that processes multisensor data to allow unmanned aircraft to detect and track nearby aircraft and to enable ground operators to direct safe separation between unmanned vehicles and other air traffic

CODEVELOPERS: STAFF FROM THE FEDERAL AVIATION ADMINISTRATION, STANFORD UNIVERSITY, JOHNS HOPKINS APPLIED PHYSICS LABORATORY, AND MITRE



2016

R&D 100 AWARD WINNERS



EnteroPhone™

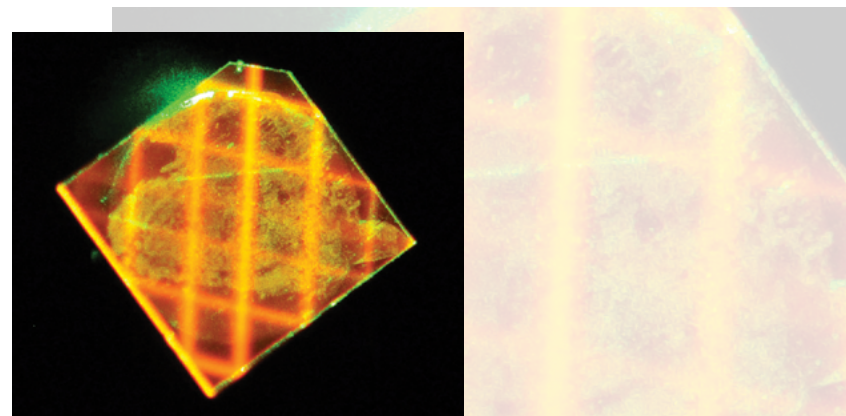
A wireless, ingestible device that monitors heart and breathing rates by listening to the body's sounds and that senses core temperature, all from within the gastrointestinal tract

CODEVELOPERS: RESEARCHERS FROM MIT

Broadband Magnetometry and Temperature Sensing with a Light-Trapping Diamond Waveguide

An ultrasensitive magnetic-field detector and temperature sensor that is 1,000 times more energy-efficient than previous diamond-based magnetometers

CODEVELOPERS: RESEARCHERS FROM MIT



Laserscope

A tool set that offers surgical navigation and precise laser targeting within the spinal cavity to enable treatment of back pain with an outpatient procedure instead of with open back surgery

CODEVELOPERS: STAFF FROM MASSACHUSETTS GENERAL HOSPITAL AND DUKE UNIVERSITY



2016 winners continue on page 34 »

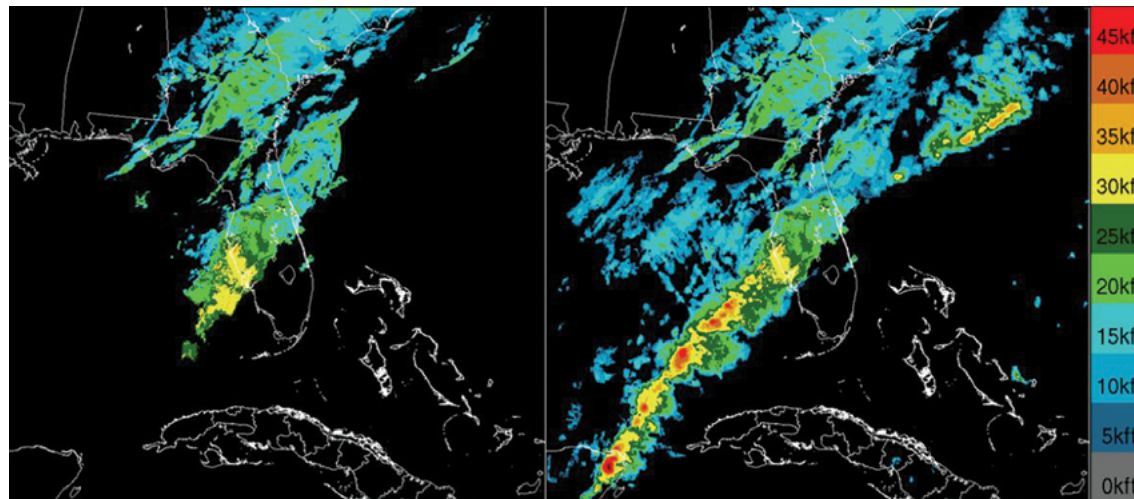
2016

R&D 100 AWARD WINNERS

Offshore Precipitation Capability

A system that provides weather information for air traffic controllers by generating “radar-like” depictions of storms in offshore regions that are outside radar coverage

CODEVELOPERS: STAFF FROM THE FEDERAL AVIATION ADMINISTRATION



Small Airport Surveillance Sensor

A low-cost secondary surveillance system that provides airport tower controllers with situational awareness of aircraft on the airport surface and in nearby airspace

CODEVELOPERS: STAFF FROM THE FEDERAL AVIATION ADMINISTRATION

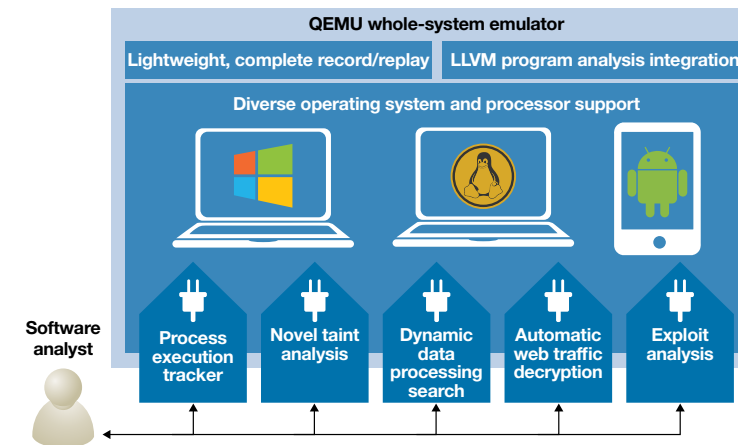
2015

R&D 100 AWARD WINNERS

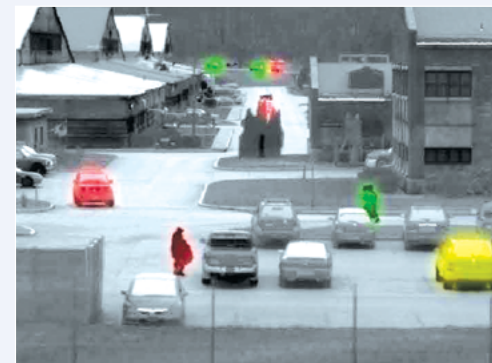
Platform for Architecture-Neutral Dynamic Analysis

An open-source, plug-in software analysis framework that enables computer engineers to observe code as a program executes so they can understand and mitigate vulnerabilities or faults in the code

CODEVELOPERS: RESEARCHERS FROM NEW YORK UNIVERSITY'S TANDON SCHOOL OF ENGINEERING, GEORGIA INSTITUTE OF TECHNOLOGY, AND NORTHEASTERN UNIVERSITY



Video Content Summarization Tool

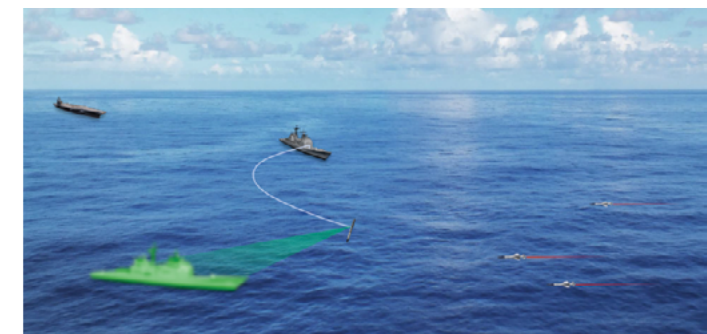


A software application that creates summary views of long-duration surveillance videos so analysts can quickly identify activity of interest

Self-Defense Distributed Engagement Coordinator

An automated decision support tool that guides naval personnel on how to efficiently allocate resources in response to anti-ship missile threats

CODEVELOPERS: RESEARCHERS FROM MIT

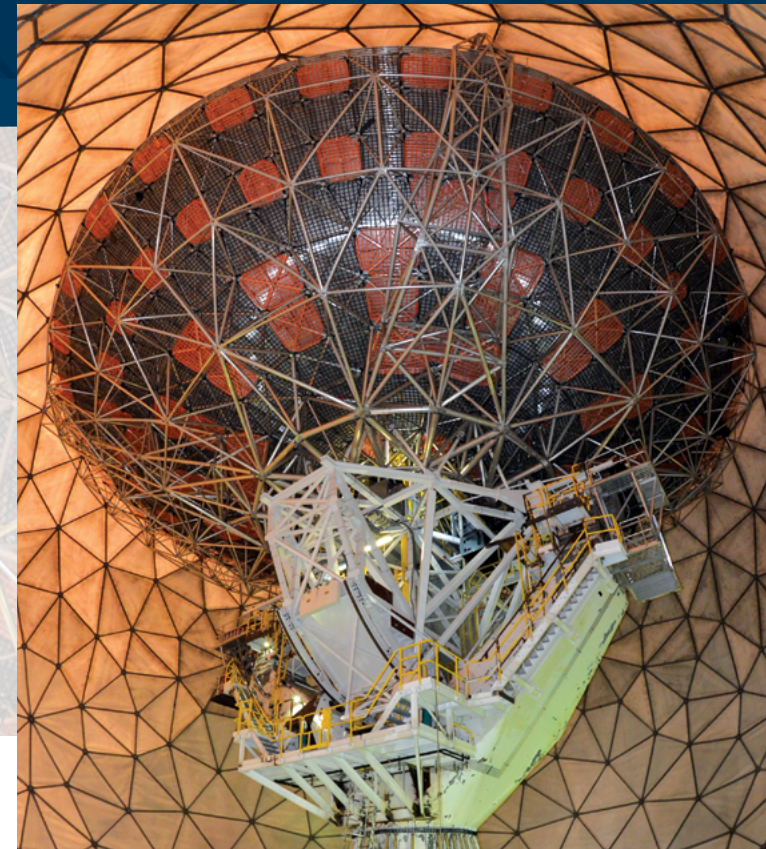


2014

R&D 100 AWARD WINNERS

Airborne Sense-and-Avoid Radar Panel

A novel stepped-notch antenna array that supports aircraft and weather detection and tracking modes in a single multifunction aperture



Haystack Ultrawideband Satellite Imaging Radar

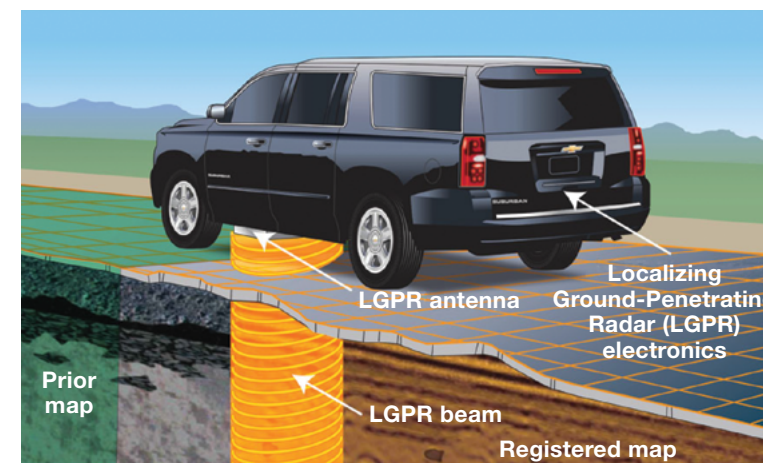
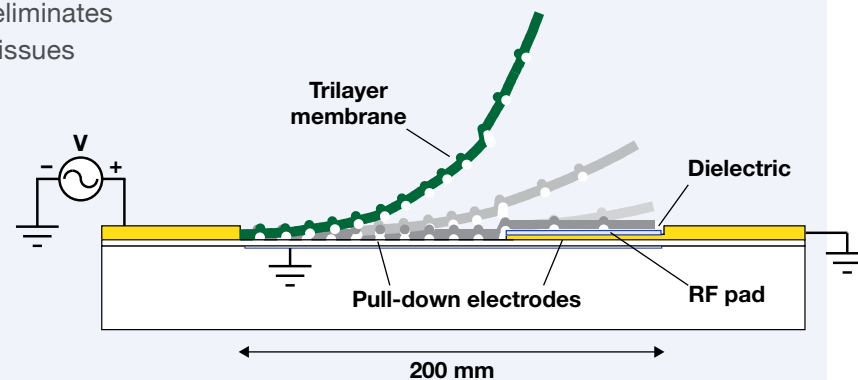
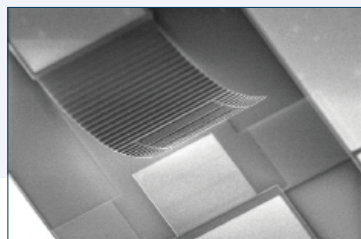
A ground-based, dual X- and W-band sensor that can produce very high-resolution images of objects orbiting Earth

CODEVELOPERS: STAFF FROM SIMPSON, GUMPERTZ, AND HEGER, AND COMMUNICATIONS AND POWER INDUSTRIES

Curled Microelectromechanical Switch

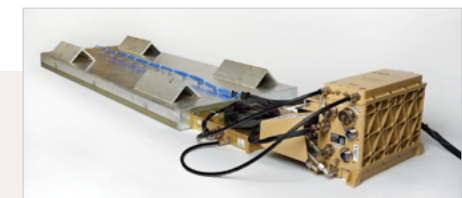
A curled-electrode switch that eliminates the sticking and contamination issues inherent in traditional electromechanical switches

CODEVELOPERS: STAFF FROM INNOVATIVE MICRO TECHNOLOGY



Localizing Ground-Penetrating Radar

A robust sensor that provides highly accurate, real-time vehicular position estimates based on prior mapping of subsurface features



2014 winners continue on page 38 »

2014

R&D 100 AWARD WINNERS

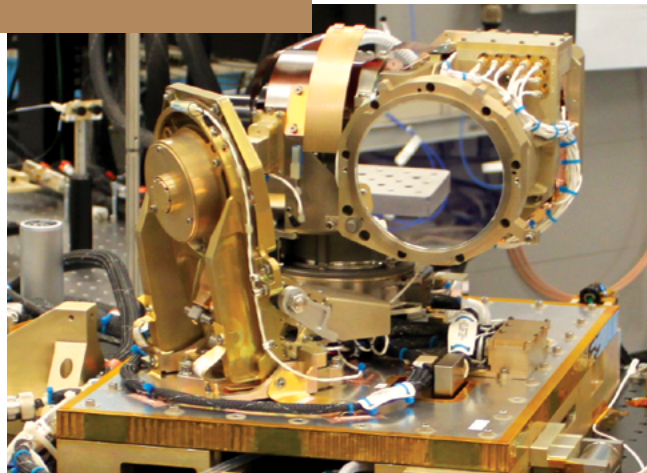
.....EDITOR'S CHOICE AWARD WINNER.....

This technology was also the winner of an R&D Editor's Choice Award, which is given to the three R&D 100 Award winners that the magazine's editors believe are the most innovative and impactful

Lunar Laser Communication System

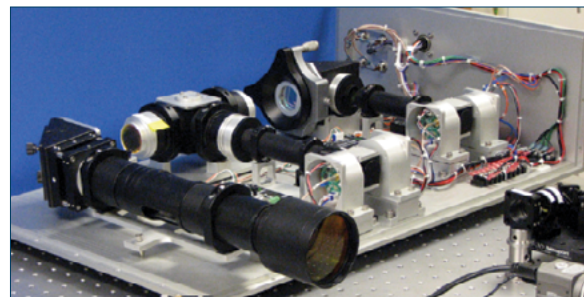
An optical system that achieves very high uplink and downlink data rates between an Earth terminal and a distant satellite

CODEVELOPERS: STAFF FROM NASA'S GODDARD SPACE FLIGHT CENTER AND NASA'S SPACE COMMUNICATIONS AND NAVIGATION PROGRAM OFFICE



Wide-Area Chemical Sensor

A highly precise, self-referencing spectrometer that measures the concentrations of specified target gases within the atmosphere

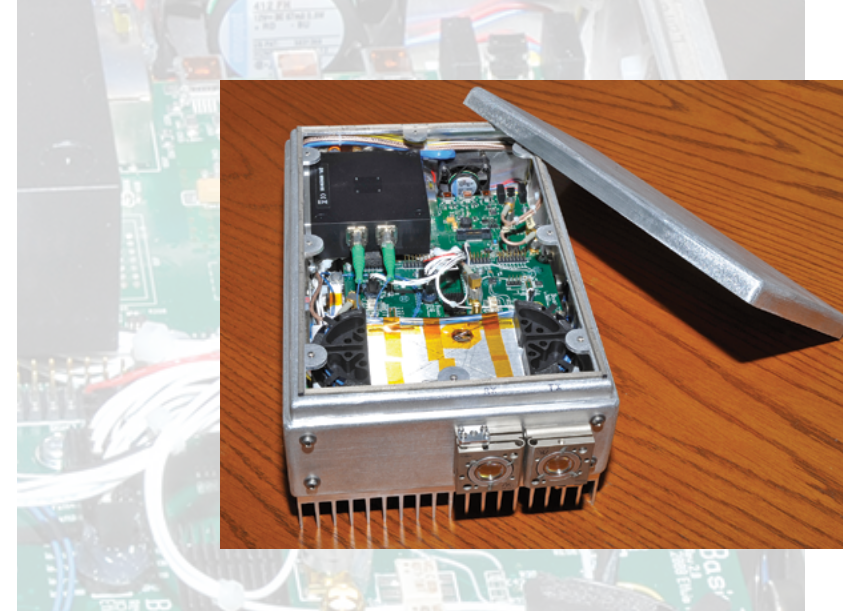


2013

R&D 100 AWARD WINNERS

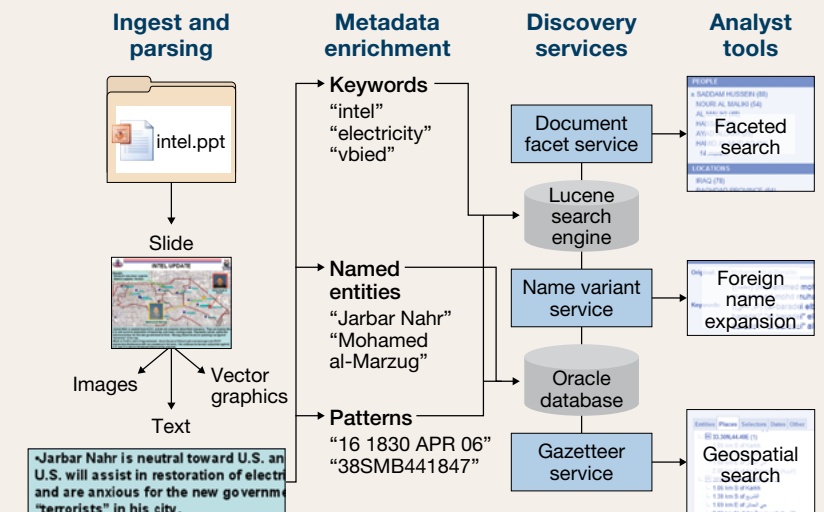
Photoacoustic Sensing of Explosives

A system that detects and discriminates trace amounts of explosives from significant standoff distances



Structured Knowledge Space

A software and information system that enables analysts to mine the vast store of intelligence reports available to government decision makers

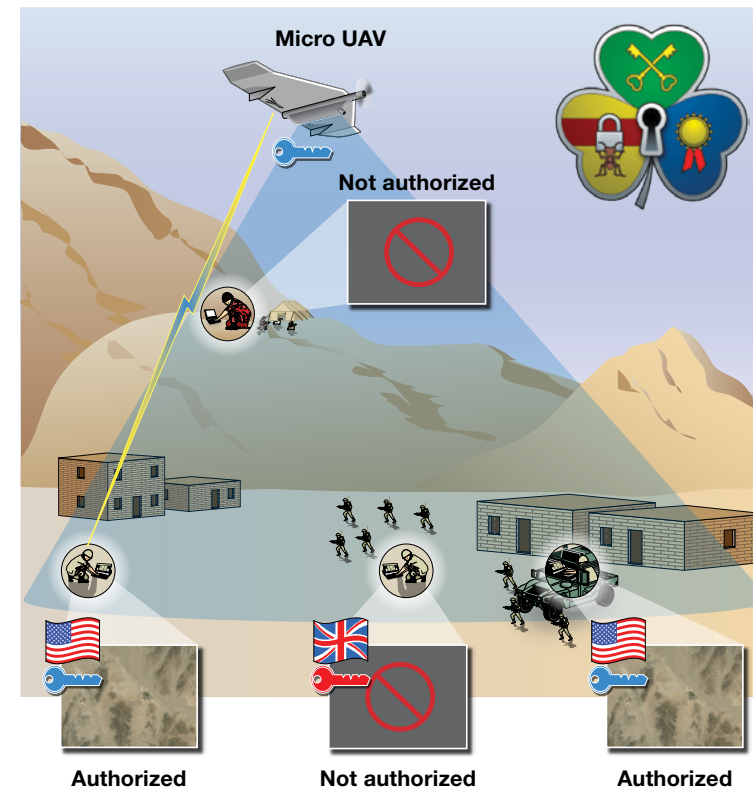
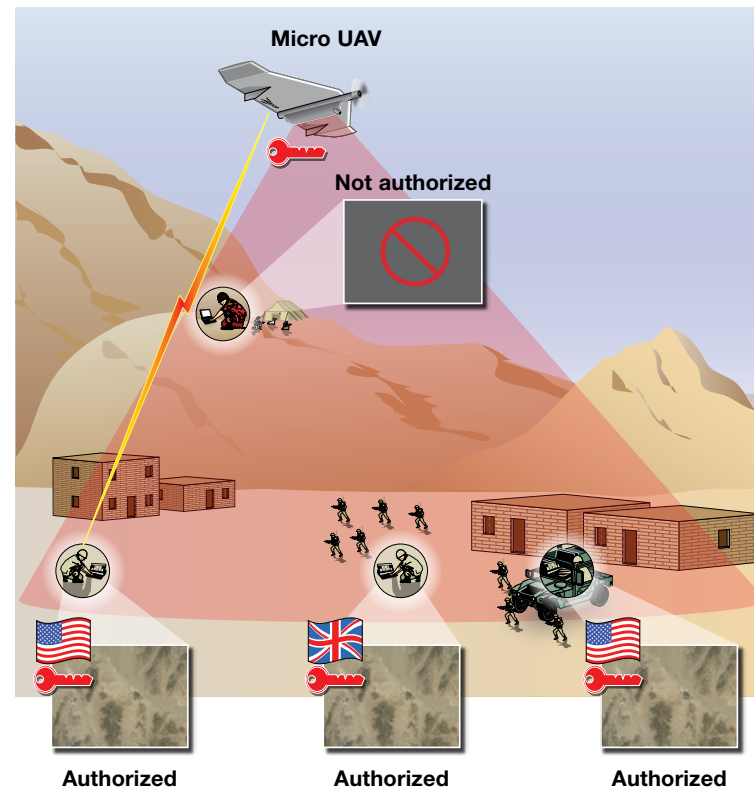


2012

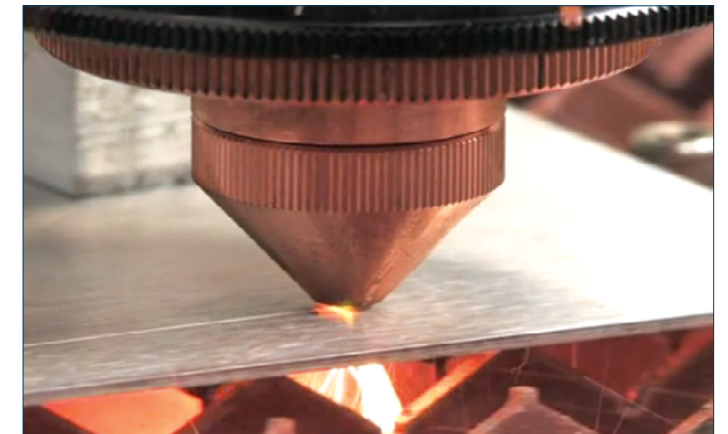
R&D 100 AWARD WINNERS

Lincoln Open Cryptographic Key Management Architecture

A highly portable software library that enables cryptographic protection for communication devices



Wavelength Beam-Combining Fiber-Coupled Diode Laser



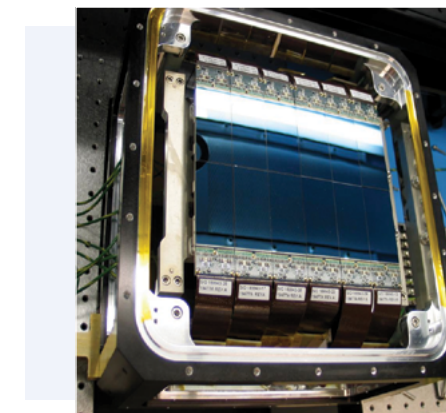
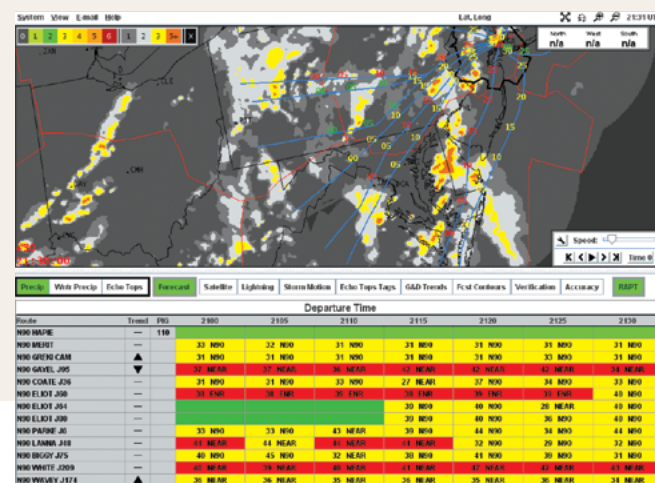
A high-intensity diode laser that combines
unprecedented brightness, efficiency, and reliability

CODEVELOPERS: STAFF FROM TERADIODE

Route Availability Planning Tool

An automated decision support tool
that predicts the availability of air
traffic routes during thunderstorms

CODEVELOPERS: STAFF FROM THE FEDERAL AVIATION ADMINISTRATION



Wide Field-of-View Curved Focal Plane Array

A curved, charge-coupled device that corrects for inherent aberrations of the mirrors and lenses in optical systems

CODEVELOPERS: STAFF FROM GL SCIENTIFIC

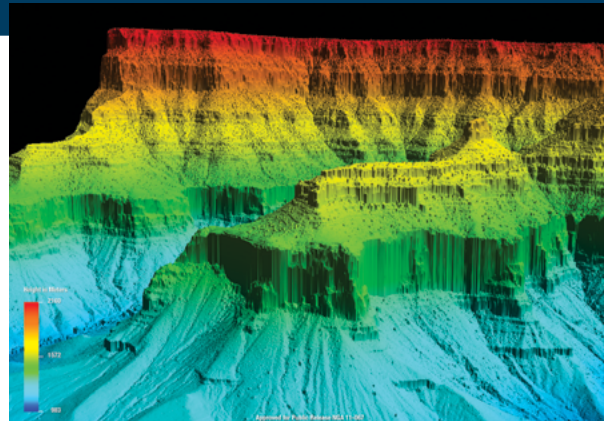
2011

R&D 100 AWARD WINNERS

Airborne Ladar Imaging Research Testbed

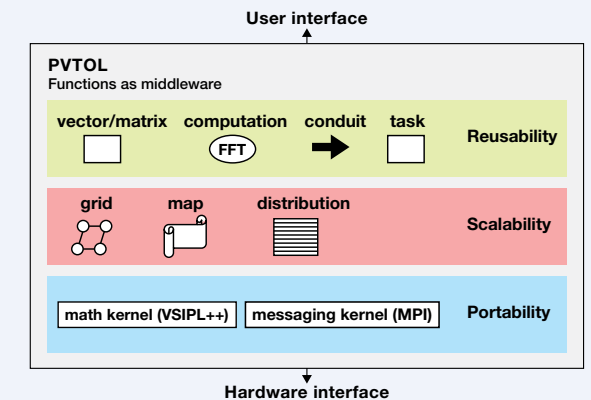
An airborne laser radar that rapidly collects high-resolution three-dimensional imagery of wide-area terrains

CODEVELOPERS: STAFF FROM
SUNSHINE AERO INDUSTRIES



Parallel Vector Tile Optimizing Library

A real-time signal processing library that enables cross-platform portability of programs without sacrificing high performance



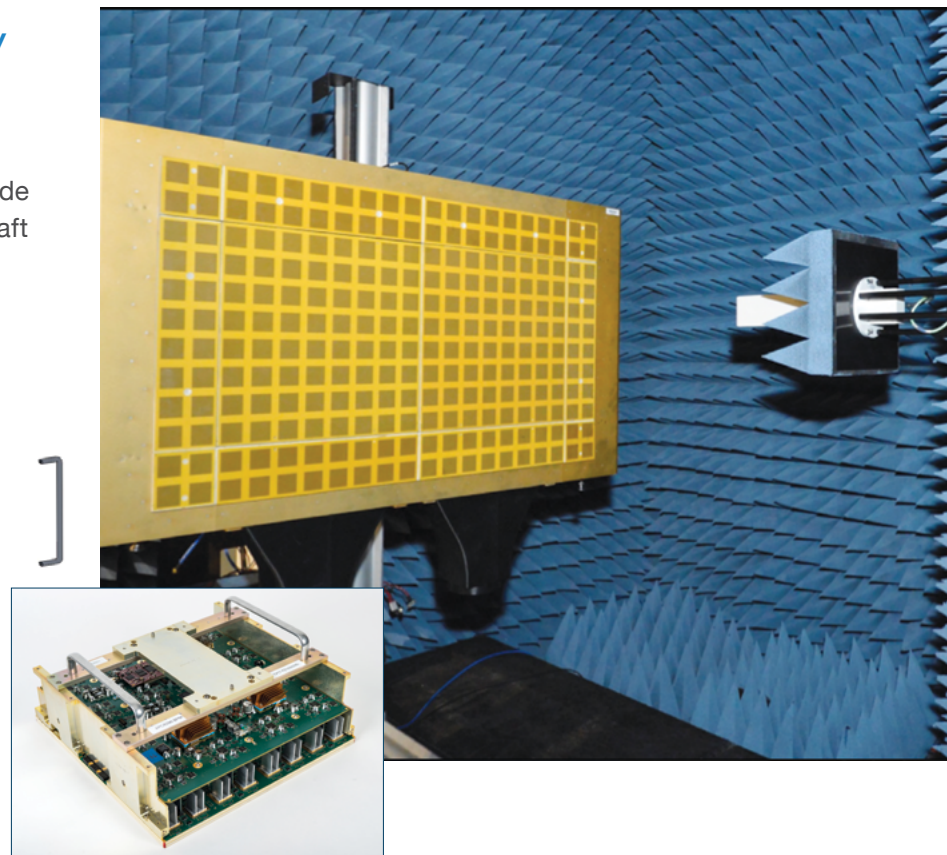
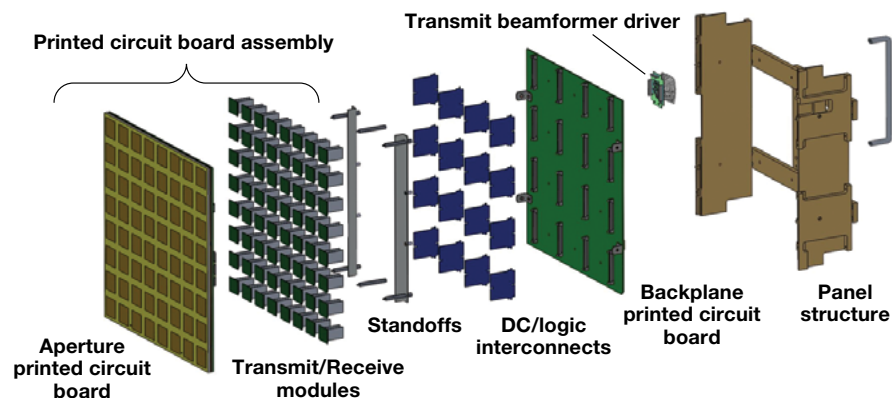
..... EDITOR'S CHOICE AWARD WINNER

This technology was also the winner of an R&D Editor's Choice Award, which is given to the three R&D 100 Award winners that the magazine's editors believe are the most innovative and impactful

Multifunction Phased Array Radar Panel

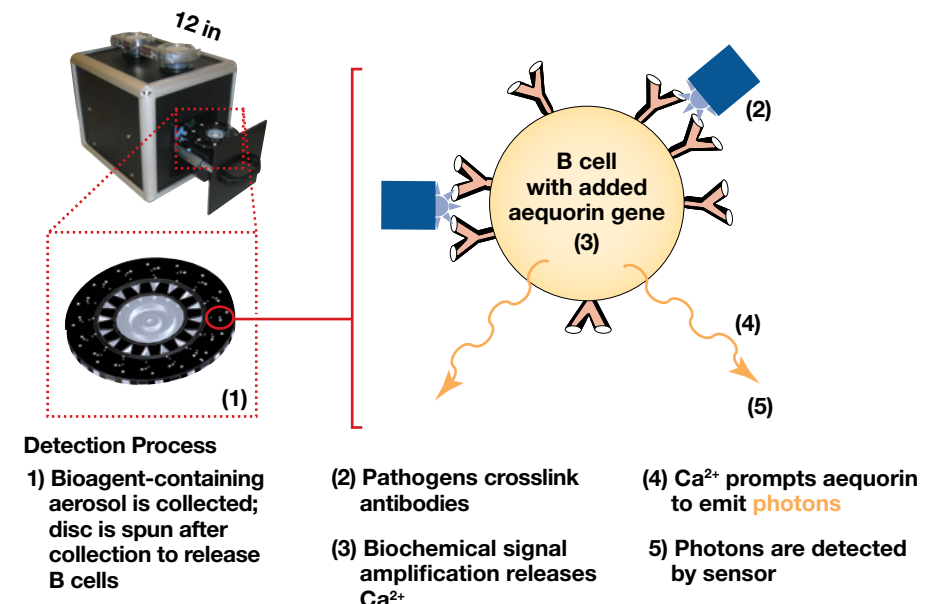
A panel of phased arrays that exploits dual polarization and digital beamforming to provide efficient radar detection and tracking of aircraft and weather targets

CODEVELOPERS: STAFF FROM M/A-COM
TECHNOLOGY SOLUTIONS



Pathogen Analyzer for Threatening Environmental Releases

A highly sensitive sensor that uses genetically modified white blood cells to rapidly detect and identify pathogens and toxins

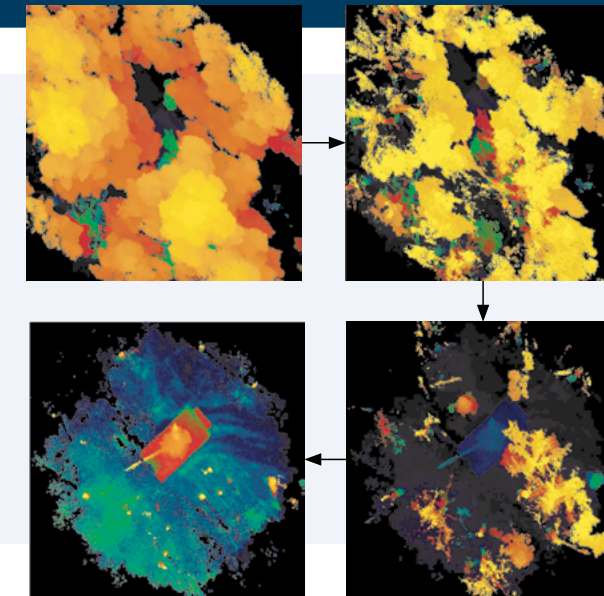
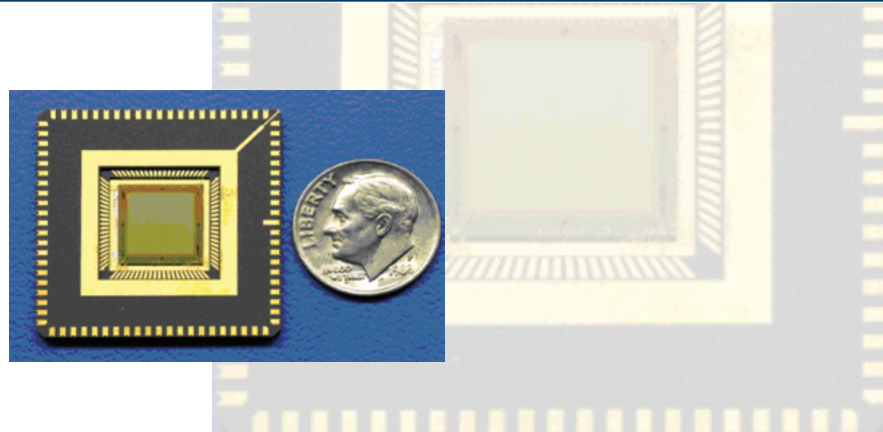


2010

R&D 100 AWARD WINNERS

Digital-Pixel Focal Plane Array

A complementary metal-oxide semiconductor readout integrated circuit for infrared imaging that is capable of an extreme dynamic range

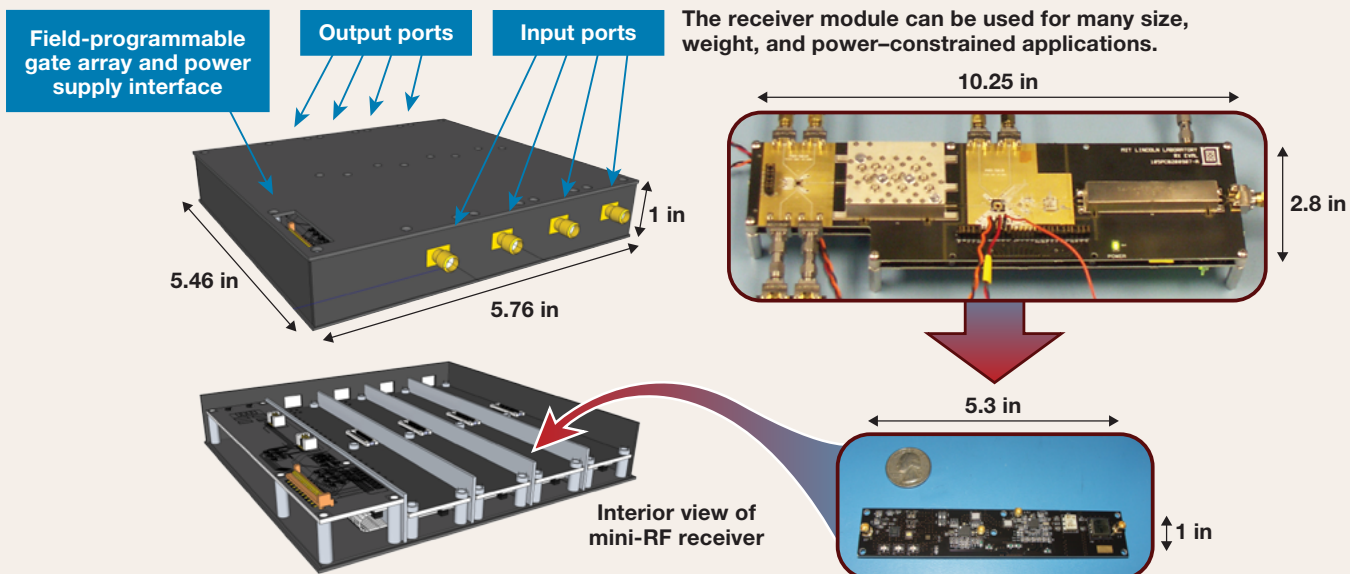


Geiger-Mode Avalanche Photodiode Detector Focal Plane Array

A two-dimensional array of ultrasensitive solid-state photodetectors, each of which can measure the arrival time of single photons

Miniaturized Radio-Frequency Four-Channel Receiver

The smallest, least power-demanding receiver that can detect frequencies over a six-octave range

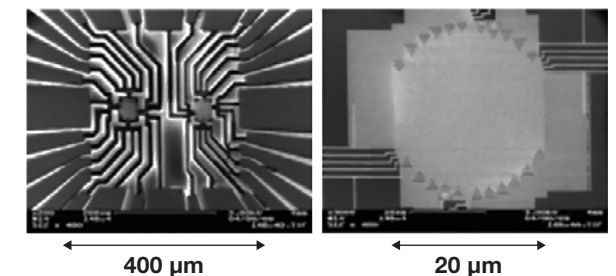


Runway Status Lights



A system integrating data from airport surveillance sources to control in-pavement lights that directly alert pilots to potential runway incursions

Subwavelength-Separated Superconducting Nanowire Single-Photon Detector Array



A component in an optical detection system that enables broadband single-photon detection with high efficiency and low noise at rates exceeding one billion photons per second

CODEVELOPERS: RESEARCHERS FROM MIT



Earlier R&D 100 Award Winners

In addition, Lincoln Laboratory received two earlier R&D 100 Awards:

- 1998** jointly with Cyra Technologies and Los Alamos National Laboratory for a three-dimensional laser mapping and imaging system
- 1995** for a technology that determines a plane’s position by using GPS

Index

Advanced Electronics

- Curled Microelectromechanical Switch 36
- Defensive Wire Routing for Untrusted Integrated Circuit Fabrication 19
- Embedded Microjet Cooling for High-Power Electronics 14
- Megachip 8
- Microhydraulic Motors 17
- Miniaturized Radio-Frequency Four-Channel Receiver 44
- Spectrally Efficient Digital Logic 18
- Superconductive Many-State Memory and Comparison Logic 11
- Very Large-Scale Integration Process for Superconducting Electronics 29

Advanced Imaging

- Airborne Ladar Imaging Research Testbed 42
- Digital-Pixel Focal Plane Array 44
- Engineered Substrates for Rapid Advanced Imaging Sensor Development 7
- Field-Programmable Imaging Array 16
- Geiger-Mode Avalanche Photodiode Detector Focal Plane Array 45
- Immersive Imaging System 27
- Subwavelength-Separated Superconducting Nanowire Single-Photon Detector Array 45
- Wide-Area Infrared System for Persistent Surveillance 31
- Wide Field-of-View Curved Focal Plane Array 41

Air Traffic Safety

- Airborne Collision Avoidance System for Unmanned Aircraft 32
- Airborne Collision Avoidance System sXu 14

- Airborne Sense-and-Avoid Radar Panel 36
- Global Synthetic Weather Radar 16
- Ground-Based Sense-and-Avoid System for Unmanned Aircraft Systems 30
- Offshore Precipitation Capability 34
- Portable Aircraft Derived Weather Observation System 10
- Rapid Convective Growth Detector 24
- Route Availability Planning Tool 40
- Runway Status Lights 45
- Small Airport Surveillance Sensor 34
- Traffic Flow Impact Tool 18
- Visibility Estimation through Image Analytics 25

Biotechnology

- ArtGut 22
- CO₂/O₂ Breath and Respiration Analyzer 30
- Electrooculography and Balance Blast Overpressure Monitoring System 6
- EnteroPhone™ 33
- Guided Ultrasound Intervention Device 17
- Heat Injury Prevention System 7
- Laserscope 33
- Mobility and Biomechanics Insert for Load Evaluation 24
- Neuron Tracing and Active Learning Environment 10
- Noncontact Laser Ultrasound for Medical Imaging 12
- Pathogen Analyzer for Threatening Environmental Releases 43
- Presymptomatic Agent Exposure Detection 31
- Tunable Knitted Stem Cell Scaffolds 11

Index continues on page 48»

Chemical Sensing

- Photoacoustic Sensing of Explosives 39
- Wide-Area Chemical Sensor 38

Communications

- Aperture-Level Simultaneous Transmit and Receive Phased Array 22
- Constrained Communications and Radar Dual-Use 14
- Dual-Mode Imaging Receiver 22
- In-Band Full-Duplex Wireless System with Advanced Interference Mitigation 8
- Joint Communication Architecture for Unmanned Systems Security/Cyber Module End Cryptographic Unit 12
- Lunar Laser Communication System 38
- Multirate Differential Phase Shift Keying Optical Communications 27
- Peregrine: Network Navigation 28
- Precision Photon Synchronization System for Quantum Networking 10
- Targeted Acoustic Laser Communication 25
- TeraByte InfraRed Delivery 21

Computing & Software

- Cyber Sensing for Power Outage Detection 19
- FocusNet 7
- Keylime 20
- Mixture Deconvolution Pipeline for Forensic Investigative Genetic Genealogy 9
- Parallel Vector Tile Optimizing Library 43
- Platform for Architecture-Neutral Dynamic Analysis 35
- Reconnaissance of Influence Operations 21

- Structured Knowledge Space 39

- Ultrafast Computational Methods for Searching DNA Databases 28

Cybersecurity

- Dynamic Flow Isolation 26
- Lincoln Open Cryptographic Key Management Architecture 40
- Large-Scale Vulnerability Addition 20
- Timely Address Space Randomization 15
- Timely Randomization Applied to Commodity Executables at Runtime 21

Decision Support

- Forensic Video Exploitation and Analysis 20
- Human-Machine Collaborative Optimization via Apprenticeship Scheduling 26
- Puckboard 13
- Self-Defense Distributed Engagement Coordinator 35
- Video Content Summarization Tool 35
- Web-Based HURREVAC 29

Energy

- Gas Mapping LiDAR™ 23
- Intelligent Power Distribution 27
- Tactical Microgrid Standard Open Architecture 25

Engineering

- Autonomous Sparse-Aperture Multibeam Echo Sounder 6
- Low-Temperature Additive Manufacturing of Glass Composites 8
- Toroidal Propeller 15

Lasers

- Monolithic Fiber Array Launcher 17
- Photonic Lantern Adaptive Spatial Mode Control 28
- Wavelength Beam-Combining Fiber-Coupled Diode Laser 41

Magnetometry

- Broadband Magnetometry and Temperature Sensing with a Light-Trapping Diamond Waveguide 32

Quantum

- Free-Space Quantum Network Link Architecture 16
- Scalable Photonic Quantum Memory Module 13

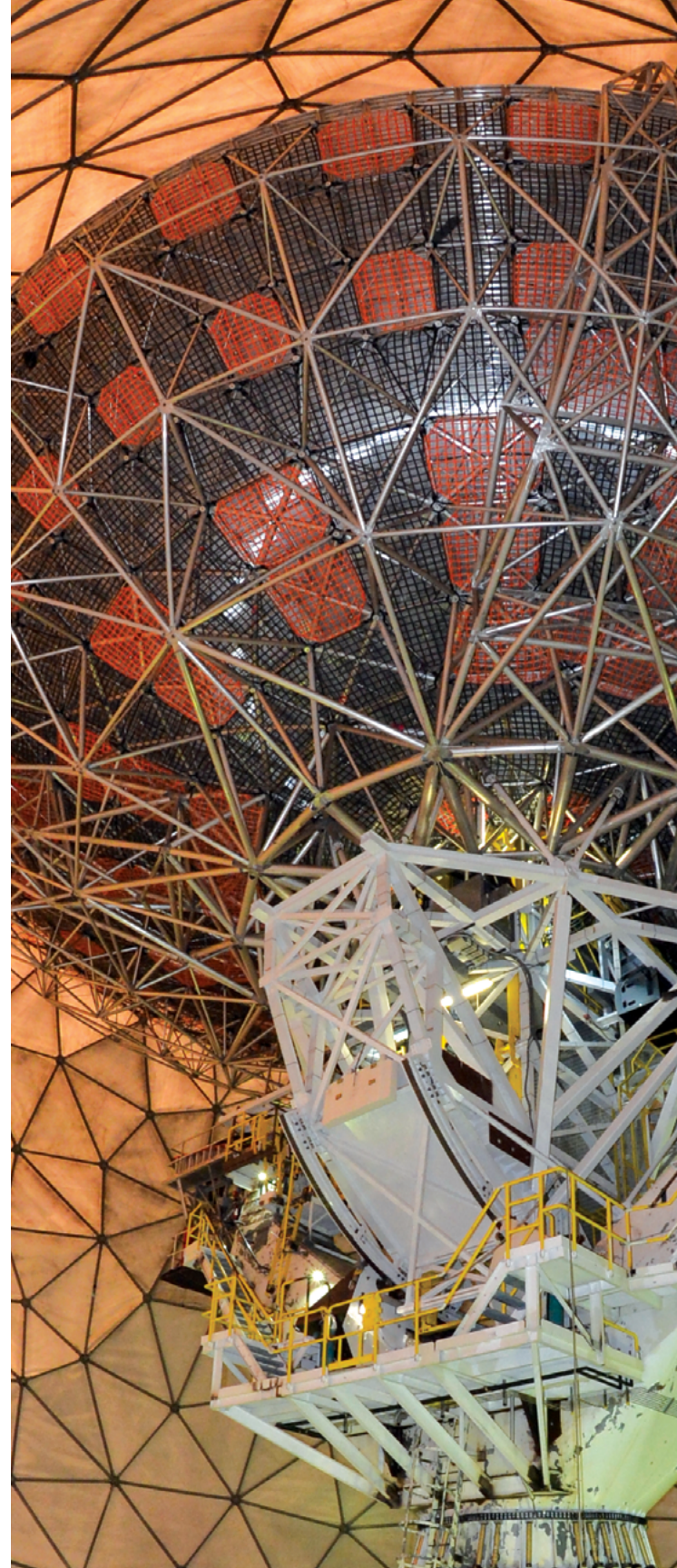
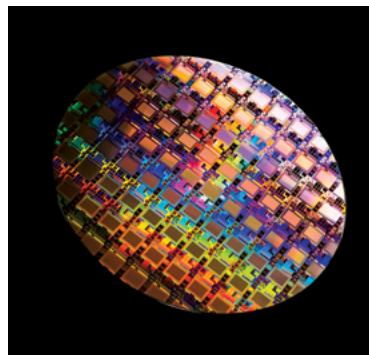
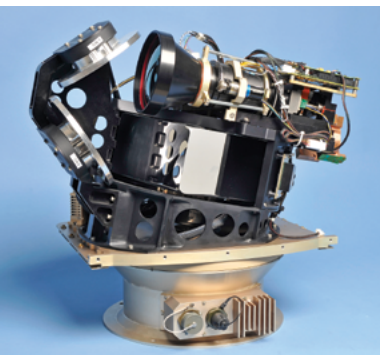
Radar Technology

- Haystack Ultrawideband Satellite Imaging Radar 37
- Localizing Ground-Penetrating Radar 37
- Motion Under Rubble Measured Using Radar 18
- Multifunction Phased Array Radar Panel 42
- Nanocomposite Inks for 3D Printing Radio-Frequency (RF) Devices and Radiation Shielding 9
- Polarimetric Co-location Layering 30
- Pulse-to-Pulse Phase Diversity Processing for Interference Suppression and Range Disambiguation 31

Space Systems

- Lightweight Deployable Array Panels for Space 23
- TROPICS Pathfinder Satellite 15





LINCOLN LABORATORY

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

244 Wood Street ■ Lexington, Massachusetts 02421-6426

Technology in Support of National Security

WWW.LL.MIT.EDU

Approved for public release: distribution unlimited. This material is based upon work supported by the Department of the Air Force under Air Force Contract No. FA8702-15-D-0001. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the U.S. Air Force.

© 2024 Massachusetts Institute of Technology

