FACILITIES OF ARL

Foundations for the Future

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Introduction

The U.S. Army Research Laboratory operates laboratories, testing facilities, ranges, offices and many one-of-a-kind facilities in several prominent locations around the U.S. In many cases, the laboratory's collaborations with other nations, laboratories, academia and industry span the globe. ARL operates from several primary locations including Aberdeen Proving Ground, Md., Adelphi Laboratory Center, Md., Research Triangle Park, N.C., Orlando, Fla. And White Sands Missile Range, N.M., with field elements strategically located at Army installations from coast to coast.

This book provides an overview of ARL's facilities at these locations and how they help achieve success in the management of each of ARL's S&T Campaign Plans. The diversity of our laboratories coupled with a world-class research team are leading to unprecedented capabilities for our nation's Soldiers—10, 20 and even 30 years from now. As you learn about ARL's facilities, you will quickly see why ARL is leading the Department of Defense in the areas of discovery, innovation and transition of basic and applied research.

Key Research Sites

APG Aberdeen Proving Ground (APG), Aberdeen, Maryland

ALC Adelphi Laboratory Center (ALC), Adelphi, Maryland

FL   SFC Paul Ray Smith Center, Orlando, Florida

ARO Research Triangle Park, Durham, North Carolina
(Army Research Office)

WSMR White Sands Missile Range (WSMR),
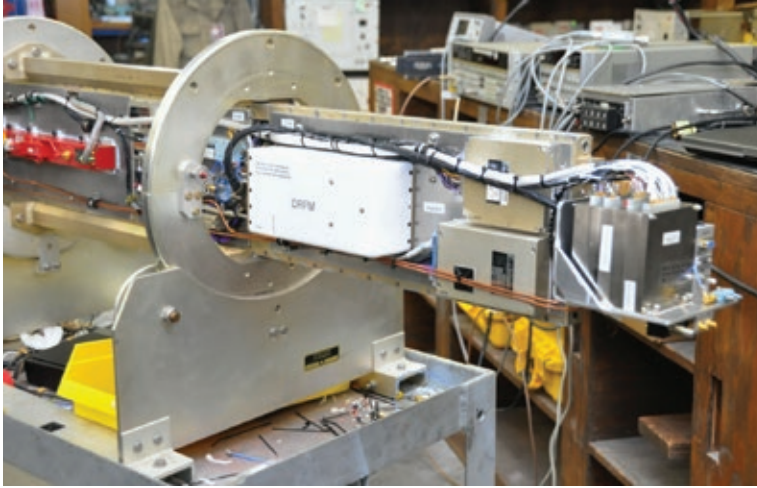White Sands, New Mexico

Field Elements

MD Blossom Point, Welcome, Maryland

PA Fort Indiantown Gap, Annville, Pennsylvania

OH NASA Glenn Research Center, Cleveland, Ohio

VA NASA Langley Research Center, Hampton, Virginia
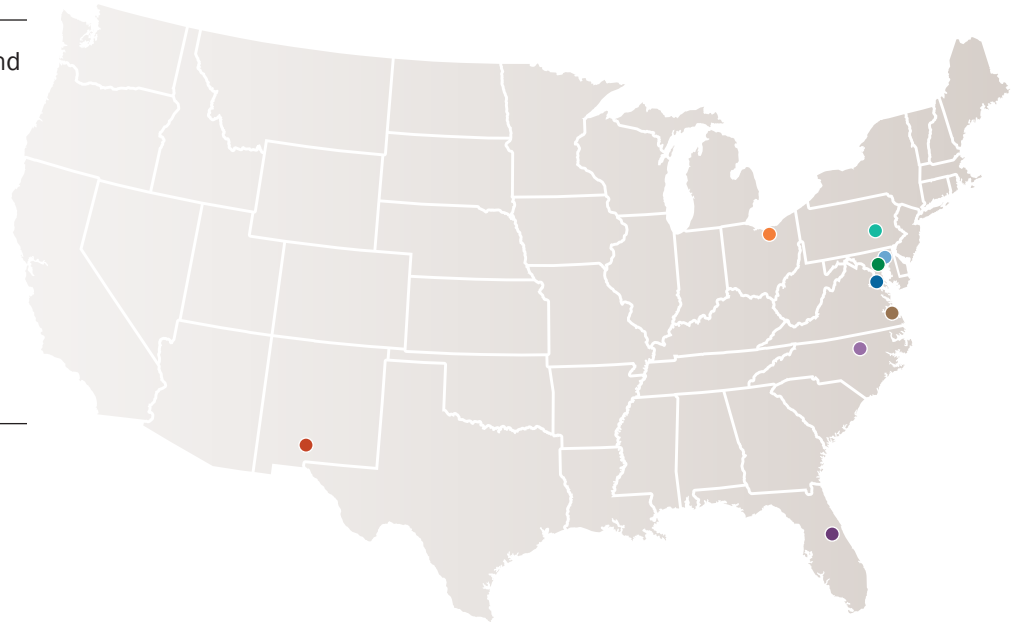
Analysis and Assessment

Researchers conduct experimental programs on U.S. and foreign weapon systems, ranging from single component experimentation to fully operational system level tests, that emphasize designing systems for vulnerability reduction and developing vulnerability/lethality model improvements. In 2010, the facility expanded with the addition of a new firing location, the Rotorcraft Survivability Assessment Facility (RSAF). The RSAF provides a complement of ballistic vulnerability services to include support of advanced system development, quick response to the evaluation of new threats, and execution of Congressionally-mandated live-fire test and evaluation programs.

Air Defense Electronic Warfare Facility WSMR

This facility provides quick-reaction capability for the implementation of electronic warfare techniques and addresses all elements of the electronic warfare threat required for the vulnerability assessment process. The facility provides a wide variety of research and development electronic countermeasure (ECM) devices and special purpose equipment that supports Army air defense electronic warfare vulnerability investigations.

Airbase Experimental Facility 6/7 (AB6/7) APG

AB6/7 is a modern complex providing analysts, program managers, and decision makers with experimental data that address: (1) the survivability of air and ground combat systems and (2) weapon effects against urban materials.

## Communication Systems Analysis Laboratory (CSAL) `APG`

CSAL conducts electronic warfare investigations of radio frequency communication systems with respect to current and emerging electronic warfare threats. CSAL uses the Communication Electronic Warfare Instrumentation System (CEWIS) tool to determine electronic warfare susceptibilities and the Sage network modelling and visualization tool to generate electronic warfare vulnerability projections.

Cybersecurity Vulnerability Assessment Facility `WSMR`

This facility enables cybersecurity vulnerability and survivability assessments of information technology (IT) components in U.S. Army acquisition and weapons system platforms. It provides investigators with flexible hardware and software configurations, in connection with certified ARL personnel and related capabilities, to identify the cybersecurity susceptibilities and/or vulnerabilities of Army components and software systems. The facility is designed for flexibility and utility and can be configured to support several different network topologies and configurations.

Electromagnetic Vulnerability Assessment Facility `WSMR`

The Electromagnetic Vulnerability Assessment Facility (EMVAF) is the Army's largest and most capable anechoic
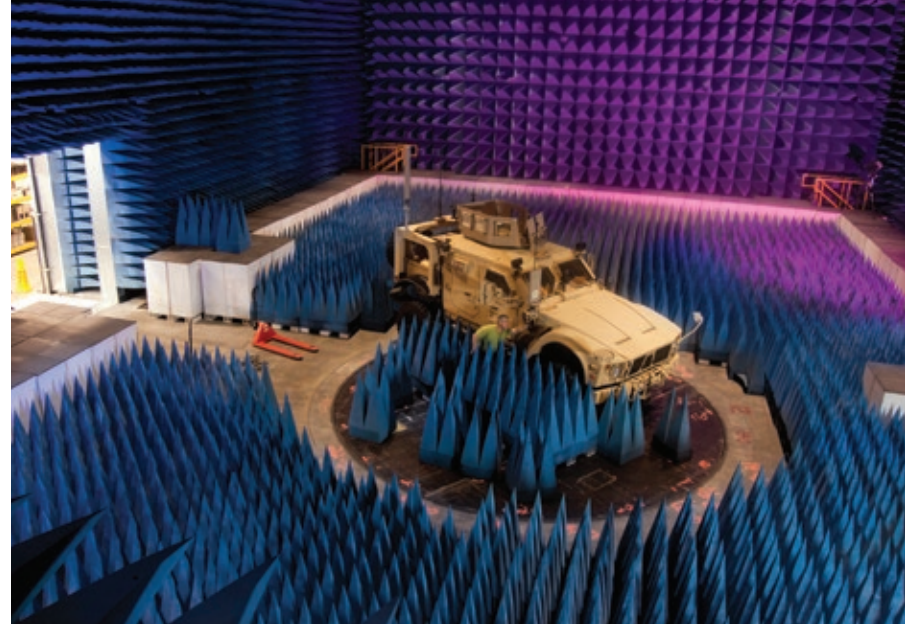
chamber for controlled electromagnetic measurements. The primary focus is applied research for science and technology (S&T), test and evaluation (T&E) analysis and experimentation. The facility addresses ARL's primary mission of vulnerability assessment in the areas of electronic warfare (EW), radiofrequency directed energy (RFDE), cyber electromagnetic activities (CEMA), Global Positioning System (GPS) and counter-improvised explosive devices (IED). The facility is electromagnetically shielded, providing over 100 decibels isolation for its two anechoic chambers. The large chamber has multiple large access doors, positioners and state-of-the-art equipment tailored for electromagnetic measurements.

Electronic Warfare Signature Measurement Facility (WSMR)

The Electronic Warfare Signature Measurement Facility contains specialized mobile spectral, radiometric and imaging measurement systems to characterize ultraviolet, visual, near-infrared (IR), mid-IR and far-IR static and dynamic targets and electronic warfare (EW) countermeasures in the environments where they operate. The facility provides EW simulations, signature modeling validation and EW assessments using archived or measured Electro-Optical threat/target signatures and natural/man-made atmospheric attenuation in EW environments.

## Electro-Optical Data Acquisition and Tracking System (WSMR)

The Electro-Optical Data Acquisition and Tracking System (EDATS) dynamically tracks and measures target signatures. It consists of an instrumentation van integrated with an automated tracking pedestal capable of controlling the operation of six electro-optical (EO) missile seekers in a captive track arrangement. EDATS is equipped with infrared

(IR) through ultraviolet (UV) spectrometers, radiometers, and images to obtain signatures of targets, countermeasures, and backgrounds. Automatic target tracking is achieved with a highly modified Chaparral AN/DAW-1B missile seeker or with digital and analog outputs from the control computer.

Electro-Optical Vulnerability Analysis Facility (WSMR)

The Electro-Optical Vulnerability Analysis Facility (EOVAF) performs laser vulnerability evaluations on Army optical/ electro-optical (O/EO) devices across the threat spectrum. Laser vulnerability evaluations performed include optical augmentation (OA), which is the measurement of the
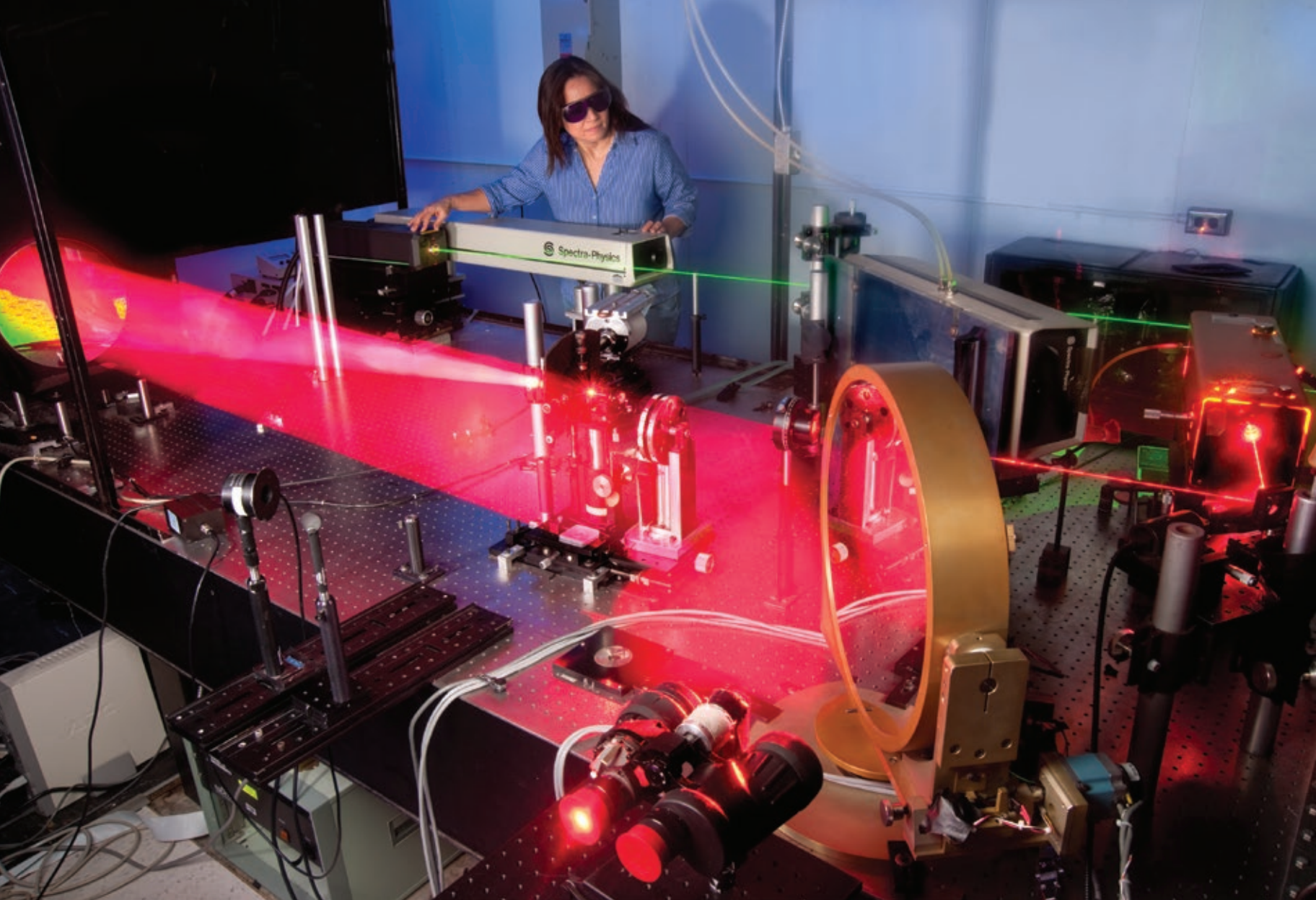
retroreflective signature of an O/EO system via an active laser interrogation, eye protection and laser jamming/ damage. Expertise is also provided to the Army in the area of laser weapon and OA detection system development and evaluation. The EOVAF possesses theoretical, laboratory and field laser vulnerability evaluation capabilities. Theoretical modeling enables the use of optical prescription and other design parameters to estimate laser vulnerability. Field capabilities include an instrumented laser range and mobile equipment for the performance of maximum OA detection range, laser jamming susceptibility and passive detectability measurements.

Experimental Facility 10 (EF10) **APG**

The EF10 provides quick-response experimentation to enhance understanding of battlefield events. Researchers

emphasize reverse engineering, re-creation of threat-on-target scenarios and identification of the specific causes of Soldier injuries. Dynamic firing of a full spectrum of small- and medium- caliber munitions, as well as static detonation of warheads and explosive charges, occurs at both locations and outdoors. Recent significant upgrades to this facility include a Biosafety Level 2 (BSL2) experimentation capability and a mobile medical-based computed tomography (CT) scanner.

Gigahertz Transverse Electromagnetic (GTEM) Cell **ALC**

The GTEM cell tests electromagnetic susceptibility and radiated-emissions. High voltage radiofrequency (RF) signals are fed to the cell, and these signals are converted to strong, highly polarized electric and magnetic fields within its walls. Researchers place radar targets inside the cell to study how the targets react to strong fields. Cell geometry enables measurements up to approximately 20 GHz and prevents interference from the ambient electromagnetic environment.

## High Temperature Power Electronics Facility (ALC)

The High Temperature Power Electronics Facility stresses silicon carbide (SiC) devices under application-specific (inductive motor load) circuit stresses at case temperatures from -20 to +220 degrees Celsius. High temperature devices, including wafer level I-V, C-V, and G-V, are characterized up to 450 degrees Celsius.

High-G Thermal Characterization Centrifuge (ALC)

High-G testing of thermal components enables improved understanding of operating behavior under military-relevant environments. The High-G Thermal Characterization Centrifuge supports the development and testing of advanced electronic packaging and thermal management technology by characterizing heat sinks, cold plates, heat pipes, and other electronics thermofluidic components while subjecting them to continuous accelerations of up to 20 G. The rotary test stand is equipped with fluidic interconnects for liquid cooling; electrical interconnects for power delivery and data
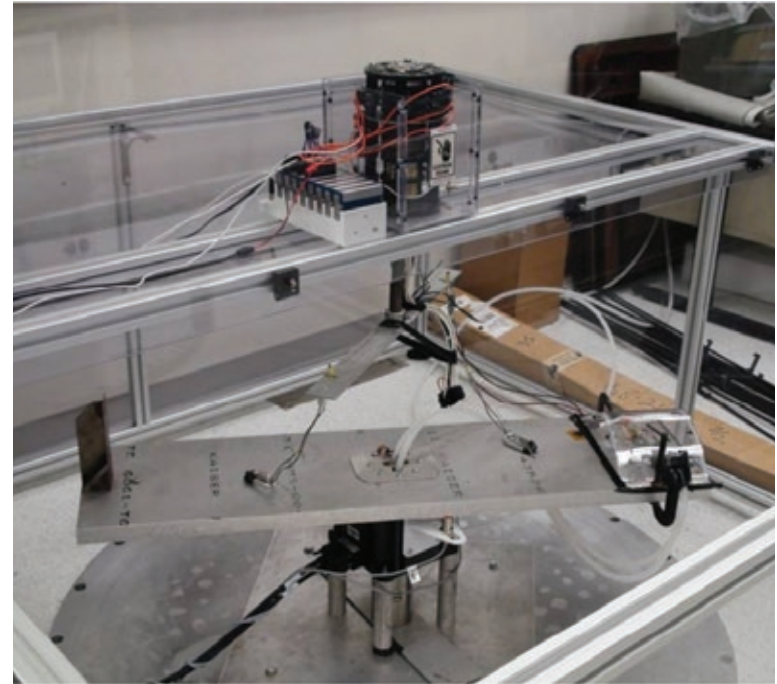
acquisition; and onboard diagnostics. The test section can be custom configured for arbitrary test pieces, thermal components, or assemblies.

Laser Standoff Laboratory Facility (APG)

The Laser Standoff Laboratory Facility provides unique capabilities for testing laser-based technologies that are not yet ready for the rigors of outdoor testing environments. This facility features 71 meters line-of-sight; full laser safety

interlocks; small quantity explosives certification; and a variety of support equipment including lasers, spectrometers, and optics.

Missile Electro-Optical Countermeasures Simulation Laboratory WSMR

This laboratory comprises several hardware-in-the-loop missile flight simulations designed specifically to evaluate the effectiveness of electro-optical air defense missile systems in a countermeasure environment. Real-time simulations include major portions of actual missile guidance and control hardware with imbedded software in the simulation loops.

The primary output is miss-distance at the point of closest approach to the target. Miss-distance information provides a criterion from which the overall effectiveness of a countermeasures technique is assessed. Using a digital end-game model, further processing of the miss-distance yields the probability of hit or missile lethality against specific threat aircraft.

Munitions Survivability Facility APG

This complex conducts large-scale explosive experiments such as investigating the survivability of ammunition compartments during chemical-energy munitions detonation events and using a ballistic pendulum to evaluate sympathetic detonation of gun propellant and its response to kinetic-energy and chemical-energy munitions.

Portable Atmospheric Characterization Facility WSMR

The Portable Atmospheric Characterization Facility includes theoretical, laboratory, and field capabilities for analysis of a wide variety of optical and electro-optical (O/EO) devices. The facility provides critical atmospheric data for effective determination of the performance characteristics and

vulnerabilities of active and passive O/EO systems over complex terrain in the atmospheric boundary layer. Well-characterized turbulence and meteorological conditions assist the evaluation of optical turbulence mitigation technologies in this environment.

Test Environmental Certification Complex WSMR

The Test Environmental Certification Complex (TECC) is a computer-controlled receiving and analysis facility associated with air defense systems. The TECC consists of a narrow-beam steerable antenna system, multiple radio frequency receivers, and hardware and software analysis systems.

Ultra-Wideband Synthetic Aperture Radar Test Bed ALC

The mobile Ultra-Wideband (UWB) Synthetic Aperture Radar Test Bed supports vehicle-mounted, ground-penetrating radar technology development for land mine and improvised explosive device (IED) detection applications. The UWB radar incorporates a physical array two meters wide with forward motion to produce a rich 2D aperture that supports advanced signal and image processing. The test bed focuses on developing high definition radar imagery to enable standoff detection of buried and concealed targets.

Underbody Explosive Research (UbER) Facilities APG

UbER is a suite of experimental facilities with specialized fixtures for researching buried blast events. The facilities

include the Sandbox fixture at EF15, Blast Accelerative Loading Fixture (BALF) at Bear Point, the Vertical Impulse Measurement Fixture (VIMF) at EF12A, and the Berm at EF12. Researchers at these facilities execute studies at multiple scales to determine the effects of the many variables involved in underbody blast even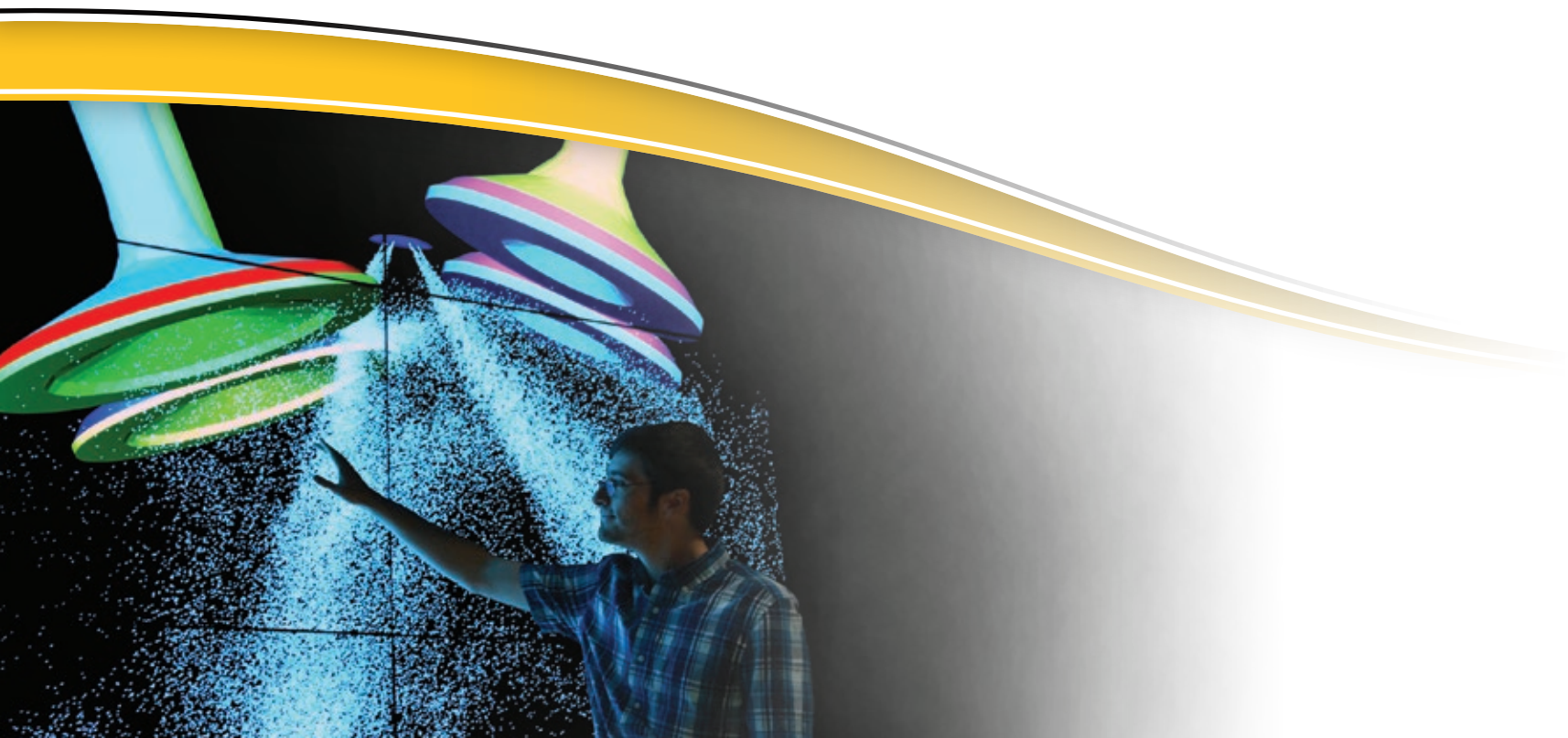ts. The most recent addition to this experimental suite, the BALF, simulates vehicular occupant response to buried blast loading.

X-Ray Effects Laboratory ALC

The X-ray Effects Laboratory conducts non-destructive testing of devices and components and research into ultra-energetic materials using high energy photons. Several MeV-class linear accelerators provide the photons, while a broad range of dosimeters and radiation detection instrumentation characterizes the exposures and effects on materials.

Computational Sciences

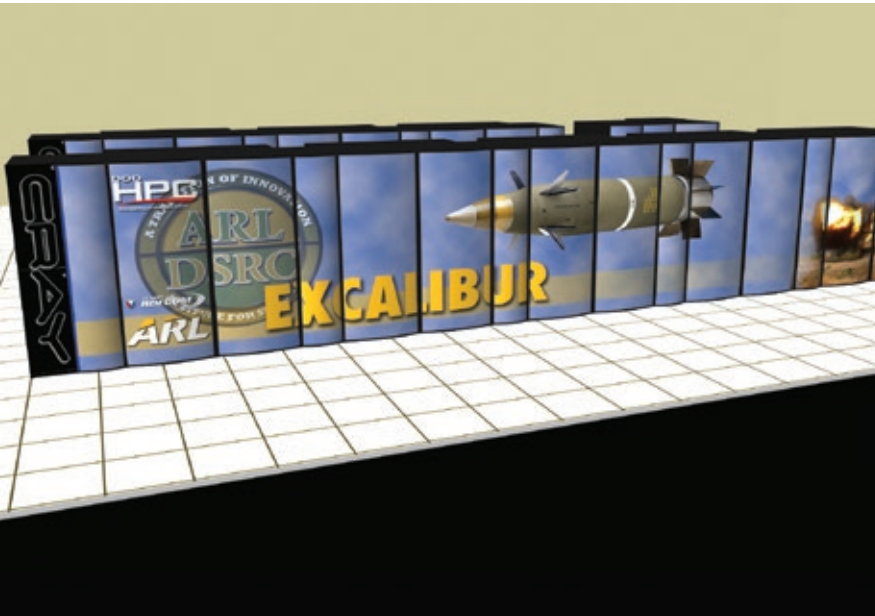ARL's Computational Science Campaign. The ARL DSRC is one of the DoD's four primary high performance computing (HPC) centers and features state-of-the-art, scalable, parallel architectures and large vector-parallel systems supporting both classified and unclassified missions throughout the DoD's Research, Development, Test and Evaluation (RDT&E) and acquisition community. The DSRC is critical for technology-based research; enables optimized design, development and testing; and minimizes lifecycle acquisition costs. Current ARL HPC systems have a cumulative capability of 9 PetaFlops and are ranked in the top 15 percent of the

Advanced Computing Laboratory APG

Within the Advanced Computing Laboratory, research on a variety of different computing architectures is performed. The computer architectures include new and novel, traditional and non-traditional computing. Some of the resources available in the lab include a neuromorphic computing cluster and low-power multicore processors. The laboratory also includes collaborative workspace, docking stations, external networking, general research support materials and a variety of computational tools to develop computational prototypes.

ARL Supercomputing Research Center (SRC) APG

The ARL Supercomputing Research Center (SRC) hosts both the ARL DoD Supercomputing Resource Center (ARL DSRC) and the computational research laboratories for
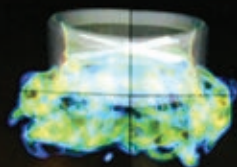
classified facilities to enhance customer interactions with the ARL computing environment. Located within the ARL Supercomputing Research Center, the ARL DAAC includes high-end graphics workstations and high-speed unencrypted network access to high performance computing resources, providing customers with the latest hardware and software technology to facilitate interactive analysis of large time-dependent datasets generated at the DSRC. The DAAC enclave includes a number of large, flat panel monitors capable of supporting a 3D interactive display of computational results. Private technology exchanges and small, classified training courses associated with use of the computing facilities use a dedicated, classified collaborative workspace co-located within the enclave.
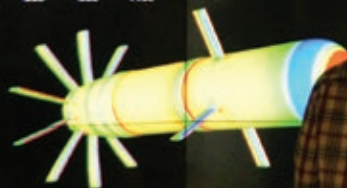
Large-scale Visual Analytics Laboratory APG

The Large-scale Visual Analytics Laboratory provides 1350 sq. feet of unclassified data visualization capabilities for ARL scientists and their collaborators. The laboratory provides researchers with the latest hardware and software technology to facilitate visual analytics of large spatial and time-dependent datasets as well as high resolution graphics. The facility includes a 24 tiled high resolution display wall, semi-immersive virtual reality displays, fully immersive virtual reality head-mounted displays, augmented reality head-mounted displays and tablet-based augmented reality displays.

world's most powerful computing sites. ARL's computational research laboratories include emerging heterogeneous computing architectures, programmable network technologies, large-scale computational architectures for data analytics and Hadoop-based clusters for experimental and simulation data.

Data Analysis and Assessment Center APG

The DoD Supercomputing Resource Center (DSRC) Data Analysis and Assessment Center (DAAC) provides

Extramural Basic Research

Army Research Office (ARO) ARO

The U.S. Army Research Office (ARO) serves as the Army's principal agent for the planning, organization, selection, and management of extramural basic research in response to Army-wide requirements, with authority and responsibility for programs in the physical sciences, engineering sciences, and information sciences. ARO develops, coordinates, and manages the Army's non-medical extramural basic research program, encompassing the single investigator program, University Research Initiative (URI), two of the Army's University Affiliated Research Centers (UARCs), and Cooperative Technology Alliances (CTAs) with emphasis on areas of relevance, and assesses and evaluates the effectiveness of these programs on a continuing basis. ARO executes research primarily at the nation's premier universities, but also in private industry, small business, historically black colleges and universities/minority institutions (HBCU/MI), and international organizations.

ARO is physically located in a 33,305 square feet leased facility in Research Triangle Park (RTP), North Carolina. ARO's RTP location is strategic and critical to mission success because of close proximity to several major universities and a substantial number of private research and development companies.

Human Sciences

Cognitive Assessment, Simulation, and Engineering Laboratory (CASEL) APG

CASEL is a standalone behavioral research facility that provides several capabilities to better understand and improve individual and team performance, Soldiers' cognitive readiness, and knowledge management in stressful, militarily-relevant conditions. CASEL comprises an observation/control room, three test chambers, a simulated-tactical operations center (S-TOC), and an immersive cognitive readiness simulator. Connectivity and video feed among all experimental rooms allows centralized observation and control of research activities. Key research supports the human dimension of mission command, i.e., network science. The observation/control room can be configured to represent a mission command center; the test chambers provide an isolated area in which to place members of lower echelon assets; the S-TOC layout is designed to simulate the flow of information on the digital battlefield; and the immersive simulator can be configured to represent the Soldier on the ground. These areas represent the geographical dispersion that would occur in actual theater, and thus enable the study of distributed team performance in a network-enabled environment.

Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) Laboratory APG

The C4ISR laboratory allows researchers to determine how information affects Soldier performance. The laboratory includes eight whisper rooms where individual subjects can be isolated from one another, a squad leader room, and a control room. Teams as large as a squad interact with the virtual environment through networked rooms, each equipped with a computer and large screen monitor. The laboratory design allows researchers to optimally present information to individual Soldiers and to the aggregated squad to investigate effective squad performance and human systems integration.

Dismounted Infantry Survivability and Lethality Test Bed (DISALT) APG

DISALT is an indoor weapon simulator for studying the effects of weapon configuration on marksmanship performance, without the expense of live-fire. The test bed projects a simulated environment ranging from a standard shooting range to a densely populated urban environment. A high speed weapon tracking system provides real-time continuous weapon aim point data to the weapon computer subsystem while the simulated shooting scenario is running. An

electromechanical recoil subsystem and digitized sound data simulate recoil. In addition to data normally collected on a standard shooting range, DISALT measures and records information on where the Soldier is aiming immediately prior to trigger pull.

Dismounted Soldier Training Technologies Test Bed (DST3) FL

The DST3 enables research, development, and prototyping of next-generation training technologies for the Army and Joint forces dismounted Soldier training communities. Researchers experiment with immersive-related technologies that support an integrated and realistic virtual, constructive training environment. Efforts focus on mixed reality, augmented reality, virtual reality immersive technologies, after-action reviews, artificial intelligence, virtual humans, odor technologies, and non-verbal communications that include gesture, gesture recognition, motion capture, and animation capabilities. DST3 houses a full infantry squad complement of virtual immersive man-wearable simulation systems and man-wearable mixed reality and augmented reality prototypes. The prototypes include integrated locomotion devices, head-mounted display technologies, integrated pose and posture tracking equipment, and integrated game-engine environments. The modular design of these prototypes permits plug-and-play of the latest technology innovations and development of baseline capabilities for dismounted Soldier use. Collaborative research uses the Call for Fire Trainer augmented virtual reality simulation, which is a prototype immersive, high fidelity training system.

Environment for Auditory Research Facility (EAR) APG

EAR is an auditory perception and communication research center enabling state-of-the-art simulation of various indoor and outdoor acoustic environments. The heart of EAR is the Control Room—an integrated control center providing complete control of instrumentation and research activities in five unique listening spaces. Four indoor spaces are each focused on different research capabilities and environments, including sound localization, moving sound sources across distances, immersive audio environments, and reverberant environments. One outdoor space allows integration of real

and simulated auditory environments. The EAR's auditory perception and communication research capabilities are unmatched anywhere else in the world.

Learning in Intelligent Tutoring Environment (LITE) Laboratory FL

The LITE laboratory conducts research and development on adaptive computer-based tools and methods to support one-to-one and one-to-many tutoring environments for tailored, self-regulated learning. The laboratory supports Soldier outcomes established by the U.S. Army Training and Doctrine

Command and uses the Generalized Intelligent Framework for Tutoring, which is a modular, service-oriented architecture that supports authoring, instruction, and analysis. Researchers analyze Soldier learning, performance, and retention and subsequently enhance tutoring systems, instructional strategies, and tactics. They develop best practices and standards with the goal of making tutoring systems, components, and associated tools more widely applicable, affordable, and effective.

Mission Impact through Neuro-Inspired Design (MIND) Laboratory APG

The MIND Laboratory facilitates basic and applied research that transitions neuroscience knowledge and approaches from the laboratory to real-world environments. MIND comprises two core elements, the first of which is a multi-chamber and re-configurable experimental space providing state-of-the-art electrically- and acoustically-controlled environments specifically designed for maximizing neurophysiological, physiological, and behavioral measurement capabilities and data acquisition. Facilities in this space support a wide range of tasks for single- and multi-participant, multi-disciplinary, translational neuroscience research efforts. MIND's second core element is a computing laboratory with more than a dozen, 8- and 12-core, large memory capacity Linux workstations and a dedicated multi-core distributed computing server that enables the development, implementation, and utilization of advanced computational and algorithmic

approaches. These approaches span the potential utilization of Army high performance computing capabilities to the analysis of the multi-channel, high-dimensional data obtained in the MIND experimental facility.

Multiple Integrated Laser Engagement System Reference Test Bed Laboratory FL

The Multiple Integrated Laser Engagement System Reference Test Bed Laboratory is a collaborative effort with the Program Executive Office for Simulation, Training and Instrumentation (PEO STRI). The laboratory supports the requirements, improvements, and developments of laser simulations used in Army live training exercises. It characterizes lasers; profiles laser beams; and analyzes, tests, and evaluates laser training equipment in a standard environment and with sufficient fidelity to evaluate metric compliance.

Neural Engineering and Research in Vehicle Environments (NERVE) APG

NERVE explores cognitive and neural processing associated with Soldier display design, performance under stress, and operations in complex environments to advance neuroscience research. The facility comprises hardware and software engineering, development, and fabrication areas; a staging area; and a reconfigurable driving course. NERVE maintains three experimental High Mobility Multi-purpose Wheeled Vehicles (HMMWV's) that can be configured to provide test

bed platforms for the study of novel interface concepts during mounted operations on paved, unpaved, and off-road driving surfaces. Although NERVE is used primarily to support the transition of MIND laboratory research efforts to more operational environments, the facility supports research efforts across ARL.

Shooter Performance Research Facility (M-Range) APG

M-Range is an outdoor, live-fire shooting facility for researching the interaction between weapon design and human performance via state-of-the-art marksmanship evaluation. In addition to standard metrics that are collected on a live-fire range (e.g. hits/misses and distance between center of mass and where a round is shot), M-Range is outfitted with acoustical sensors on each target that allow for real-time calculation of round placement through or near a target. Real-time data collection capability not only expedites

data collection and analysis, but also provides real-time feedback to the shooter on performance. Targets vary according to distance (between 25 meters and 1,000 meters), time interval, target exposure time, and target sequence.

Soldier Performance and Equipment Advanced Research (SPEAR) Facility APG
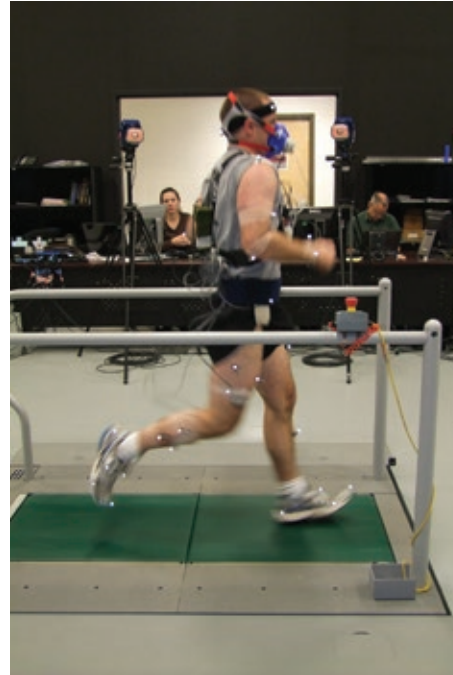
The SPEAR facility enables researchers to study the interactive effects of physical and cognitive stress on Soldier performance in operationally relevant environments. Three components comprise the facility: (1) a state-of-the-art indoor biomechanics laboratory, (2) an outdoor mobility and portability course, and (3) a 2.5-mile cross-country course that includes an 802.11 WiFi network. This unique combination of components enables researchers to physically and cognitively stress Soldiers while measuring their performance in a minimally intrusive manner. Proximity of these components to one another enables researchers to design studies with a high degree of experimental control in the biomechanics laboratory and a high degree of operational relevance

System Assessment and Usability Laboratory (SAUL) APG

SAUL is a multi-functional space designed to conduct Manpower and Personnel Integration (MANPRINT) assessments on graphical user interface (GUI) designs, perform software testing of Human System Integration (HSI) tools, and execute usability studies on software user interfaces. SAUL comprises two research areas: (1) the usability research area is a reconfigurable space with up

(e.g. traversing rough terrain on a cross-country course while sending and receiving information over a sensor and communication network).

to six isolated cells monitored from a control room and instrumented for observation of user-computer interaction; various types of interface devices are available to replicate the system being assessed, and (2) the software test area comprises mobile devices and computers with various operating systems in multiple network configurations to support development and testing of in-house HSI tools and customer software. By combining the space of the usability research area and the software test area, SAUL converts into a twelve-station computer training area equipped with video-teleconferencing and instructor-controlled access. The training area shares data across all stations from a central computer to facilitate software training, multimedia exchange, and distance learning.

Tactical Environmental Simulation Facility APG

The centerpiece of the Tactical Environmental Simulation Facility is an Omni-Directional Treadmill (ODT) that allows Soldiers to walk or crawl naturally in a simulated environment. The ODT is integrated with 360 degrees virtual visual and auditory environments to enable repeatable, controlled investigations of critical issues for dismounted Soldiers. This facility allows investigation of the interaction of physical and cognitive stress on Soldier performance in a controlled laboratory environment while imposing more realistic physical loads (e.g. from Soldier-borne equipment) on Soldiers than those experienced in simulators that do not allow for natural movement.

Information Sciences

Acoustic and Electro-Optic Propagation Range Site (MD)

The Acoustic and Electro-Optic Propagation Range Site (AEOPRS) is a pair of ranges that conduct experiments relating to the effects of various environmental conditions on acoustic and electro-optic (EO) propagation. The ranges can be instrumented to measure the atmospheric conditions and acoustic/EO signals that have propagated through the complex environment: in particular, a littoral region. The AEOPRS provides the ability to collect detailed meteorological/acoustic/EO data for the development of state-of-the-art models and the evaluation of current acoustic/EO models. The AEOPRS is also the primary site for the Mobile Acoustic Source (MOAS), a system with environmental capabilities that exist in no other system in the world. It is a pneumatic loudspeaker system that allows scientists to verify acoustic models of atmospheric effects. The system is a true exponential horn. It generates sound sufficient for testing acoustic propagation of sources.

Acoustic Anechoic Test Facility (ALC)

This facility features a full acoustic anechoic chamber that facilitates the study of acoustic sensors, signal processors and other sound systems. The chamber's anechoic properties remove acoustic reflections and help simulate free-field sound propagation through the atmosphere. The chamber is primarily used to evaluate microphones in a controlled,
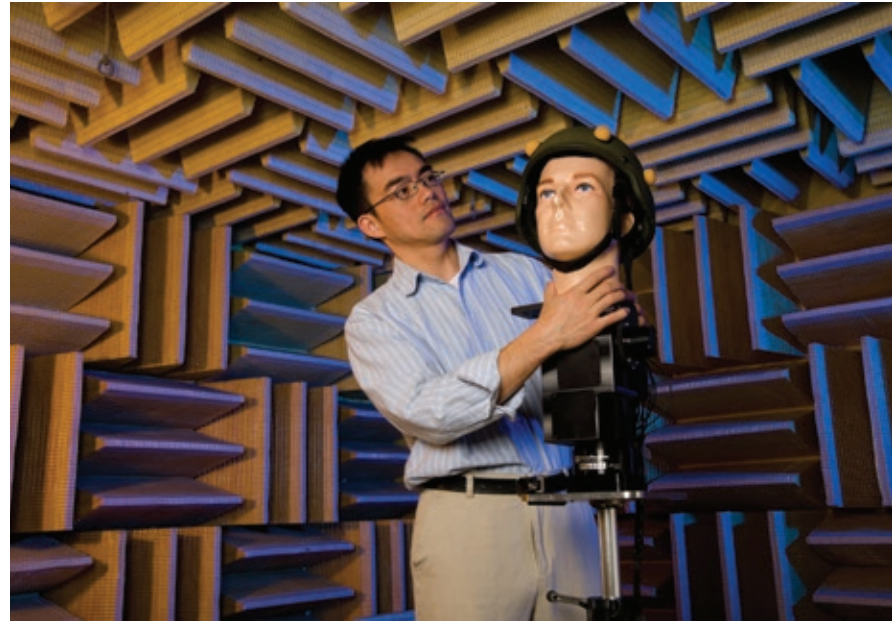
quiet and anechoic environment. Noise measurements of microphones, calibrations, frequency response and directivity testing of individual sensors and small arrays are also conducted within the chamber. A complete assortment of speakers, function generators, amplifiers and instrumentation-grade microphones support testing within the chamber, in addition to a fully automated data acquisition system with computer controlled turntable. Sensor dynamic range evaluations can also be conducted by creating very high amplitude impulse or continuous wave signals. The chamber is equipped with AC power and ventilation. The fiberglass wedges that line the chamber's walls provide an anechoic cut-off frequency of 150 Hz. Removing floor wedges converts the chamber to hemi-anechoic performance to simulate reflections off of the ground or any flat surface. Approximate internal dimensions of the anechoic zone are 17' x 17' x 8'.

Aerosol Research Facility ALC

The Aerosol Research Facility develops methods for the detection and characterization of biologic aerosols and other atmospheric particles such as dust, haze, and battlefield obscurants. It combines the capability to generate, concentrate, dilute, monitor, and study the behavior of aerosol-environment interactions in time and space through the use of specialized, scientific instrumentation. This instrumentation includes a multi-wavelength photo-acoustic system; a polarimetric imager; a set of lasers that can illuminate particles at a variety of wavelengths from 220 nm to 10 μm; an electron multiplying charge-coupled device
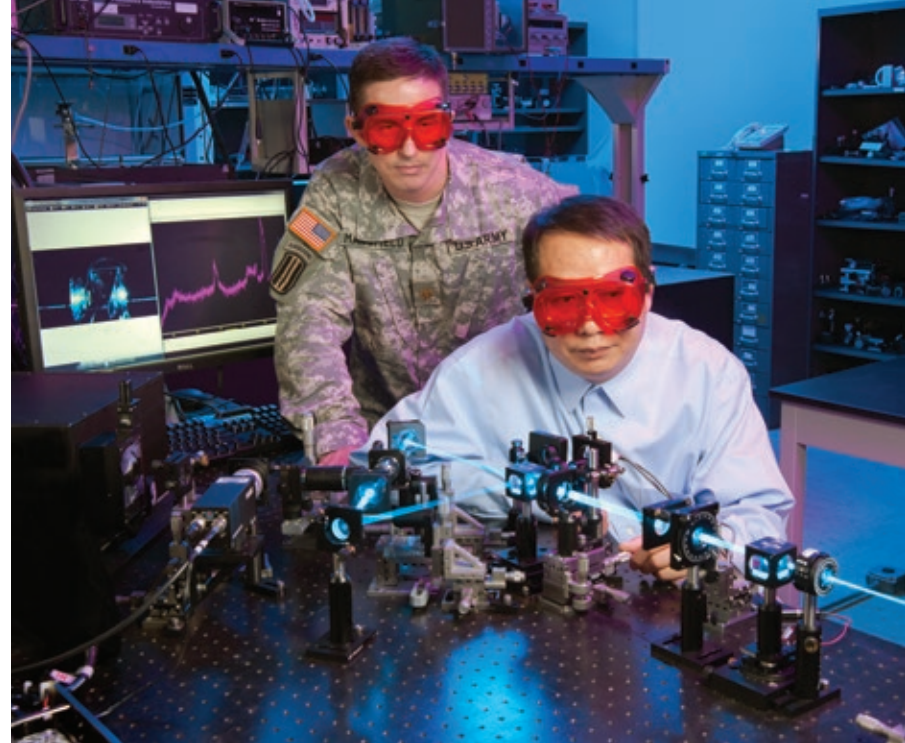
(EMCCD), intensified charge-coupled devices (ICCDs), and photomultiplier arrays for measuring fluorescence and Raman spectra; a nephelometer; aerosol particle counters and sizers; equipment for gravimetric analysis of atmospheric aerosols; and an aerosol-particle fluorescence spectrometer system for measuring the fluorescence spectra of individual particles sampled from air at rates up to 100 particles per second. This equipment provides the capability to measure physical, chemical, and biological characteristics; optical cross-sections; and spectral "signatures" of particles.

ARL Enterprise Optical Network (AEON) Research Test Bed APG

ARL's Enterprise Optical Network (AEON) research test bed provides ultra high speed network connectivity to ARL's external DoD, academic, and commercial research partners. Additionally, AEON provides ARL scientists and engineers with high bandwidth access to Large Hadron Collider data. AEON establishes a framework for research, development, testing, and evaluation of next-generation fiber optic networking technologies and is an integral component of DoD's investment in advanced networking research and development. The facility is part of a select few Metropolitan Area Network test beds dedicated to research of emerging network technologies. Including both lit and dark-fiber connections, AEON experimentation ranges from evaluation of new types of photonics to fundamental research into quantum mechanics.

Cyber Defense Research and Monitoring Laboratory ALC

This facility acts as a fusion point for bridging ARL's research in tactical and operational Information Assurance (IA) areas and the development and assessment of improvements to IA processes including new monitoring tools, test beds, assessment methodologies, and malware/forensic analysis. The facility is equipped with a state-of-the-art intrusion detection system (IDS) framework, incident databases, and other tools to support operations that continually monitor and augment missions around the world.

Electric Field Cage ALC

The Electric Field (E-field) Cage generates DC and low-frequency AC fields for sensor design, calibration, and evaluation. It is roughly analogous to an anechoic chamber for acoustic or radar measurements, or a Helmholtz coil system for quasi-static magnetic field measurements, in that it attenuates unwanted external fields and generates calibration-quality fields for testing in a laboratory environment. The E-field cage is essentially a large parallel-plate capacitor with guard rings to control fringing fields; however, the size of the cage and the spacing of the guard rings can be modified

to accommodate the needs of individual tests. The cage can be run in a single-ended mode, for testing ground-based or aircraft-based sensors, or in a double-sided mode for testing projectile-based and other free-space sensors.

Imaging and Sensing Analysis Laboratory ALC

The Imaging and Sensing Analysis Laboratory is used to develop algorithms that increase Soldier awareness of areas of interest in visible imagery. The laboratory includes a variety of camera systems to support visible imagery data collection from multiple viewing angles and stereo/hyperstereo perspectives, and a bank of computers with gaming and stereo platforms to provide interactive simulations of battlefield environments. Additionally, at various stages of research and development, laboratory researchers integrate software incorporating various cognitive and visual processing techniques.

Meteorological Sensor Array WSMR

The Meteorological Sensor Array (MSA) is the flagship facility of ARL's Atmospheric Science Center (ASC). The MSA is a world-class, sustained, high-resolution observational network that provides the atmospheric science community a valuable asset for basic research on the dynamics of boundary layer processes in complex terrain and an ideal location to test environmental impacts on Army capabilities. When fully implemented, the MSA will consist of two densely spaced arrays of instrumented meteorological towers (30+ towers in each array) within and near White Sands Missile Range, N.M. The MSA addresses a community need for high-quality observational data for developing, verifying and validating high-resolution forecast models, as well as exploring new flow physics processes, integrating observations and state-of-the-art assessment tools and developing sensors to support Army operations in varied complex environments.

Network Science Research Laboratory (NSRL) ALC

The NSRL is the first major Information Sciences Campaign laboratory space to be designed specifically to support the ARL Open Campus vision. This 7000-sq.-foot space, located at the Adelphi Laboratory Center, Adelphi, Md., is equipped

with extensive experimentation and visualization capabilities to support collaboration in person or via remote access. It is built on ARL's DAVC, an extensible infrastructure for real-time emulation of mobile network systems providing a controlled, repeatable emulation and simulation environment, enabling experimental validation of theoretical models, and characterizes protocols and algorithms for ad hoc networks. Commercial hardware platforms and specialized software combine to create high fidelity representations of mobile wireless networks and associated environmental conditions without using physical systems and while maintaining the flexibility to include physical radio hardware in the network topology. The facility is equipped with hardware and software to support the visualization and analysis of large-scale, multi-genre and hybrid networks.

Quantum Network Laboratory ALC

The Quantum Network Laboratory investigates new functionalities and architectures of quantum networks;

efficient methods for generating, manipulating and detecting entangled photonics states; propagation of entangled quantum states, their switching and routing; and physical mechanisms for entanglement decoherence in quantum networks. Experimental work is based on the Quantum Networking Testbed, which consists of entangled photon sources and detection systems for transmitting entangled quantum states over long-distance fiber channels and for performing entanglement swapping and teleportation. In addition, the lab utilizes various optical and electrical instruments in order to manipulate, test and measure the quantum behavior of light. Theoretical efforts focus on developing new Warfighter-relevant application of quantum technologies such as quantum repeater and quantum-enhanced interferometry for high spatial resolution.

Sensor Information Testbed Collaborative Research Environment (SITCORE) ALC

The ARL Sensor Information Testbed Collaborative Research Environment (SITCORE) is a collaborative research lab and testbed environment under Open Campus focused on sensor data and information fusion co-located with the Network Science Research Laboratory (NSRL). The purpose is to create a highly collaborative environment for ARL and external partners that provides critical enablers for algorithm and software development for Information Science Campaign R&D. It offers access to facilities, processing algorithms and toolboxes, specialized sensors and other ISR assets, military-relevant datasets and database tools, software tools, Army researchers and operational experts, and enables experiments for research validation and technology transition.

A sample of tools available are: Jabber, Jenkins, Phabricator, OpenSim and AWS access. SITCORE enables face-to-face and virtual research collaboration with researchers from DoD, industry, academia and coalition partners.

Unique Capabilities Offered:

Direct access and link to other ARL facilities and Open Campus initiatives:

- Network Science Research Laboratory (NSRL)
- Intelligence Systems Center (ISC)
- Automated Online Data Repository (AODR)
- Open Standard for Unattended Sensors - System Integration Lab (OSUS-SIL)
- Secure Unclassified Network (SUNet) enclave
- Access to remote locations such as ARL-West and ARL-South

Sensors and Autonomous Systems Experimental Facility (ALC)

The Sensors and Autonomous Systems Experimental Facility evaluates emerging robotics and sensor systems. Researchers assess autonomous navigation in complex and confined 3D and urban environments using a three-story high urban terrain replica; single platform and collaborative platform simultaneous localization and mapping; collaboration of heterogeneous teams of air and ground platforms, robotic

perception, and intelligence; the human-robot interface; platform state estimation; mobility from man-portable-sized systems to the micro-scale; and next-generation see-through-the-wall, ground penetrating radar, IED detection, and unattended ground sensor technologies. The facility includes a fully integrated camera and GPS system for ground truthing; a dark room to simulate cave-like environments; a control room and lab environments for system repair, development, and experimental control; various urban features to include sidewalks, stairs, ramps, variable pitch roofs, various ingress and egress features, balconies, telephone poles, and overhead wiring; a three-feet deep sand bed for

characterization of buried devices; and a 120-feet long above-ground computer-controlled trolley track system for evaluating optical systems and radars.

Spesutie Island Robotics Research Facility 1 APG

Spesutie Island Robotics Research Facility 1 comprises mixed-use space, a Software Development Laboratory, and a Controls Laboratory. In the Software Development Laboratory, researchers develop perception and planning algorithms and software for small robots. In the Controls Laboratory, researchers develop control algorithms and software for manipulation by and mobility of small, unmanned platforms, including hardware-in-the-loop (HIL) simulation.

Facility research supports the current Robotics Collaborative Technology Alliance (CTA) program, including research with other U.S. Army Research, Development and Engineering Command (RDECOM) elements.

Tactical Information Analytics Facility APG

This facility hosts the development of advanced information analytics to assist Soldiers in determining, using, and sharing relevant information and improving the synthesis of data to

decisions. Targeted areas of research include visual, text, and data analytics; information valuation; reasoning under uncertainty; and social network analysis.

Visualization Augmentation Laboratory for User Experiments Facility ALC

This facility is a software integration and demonstration laboratory that combines a unique blend of integration software technologies, visualization display modalities, infrastructure for collaboration among users, and tools for conducting experiments. The facility hosts a network of hardware and software that provides a foundation for evaluating new concepts in battlefield information processing.

Materials Research
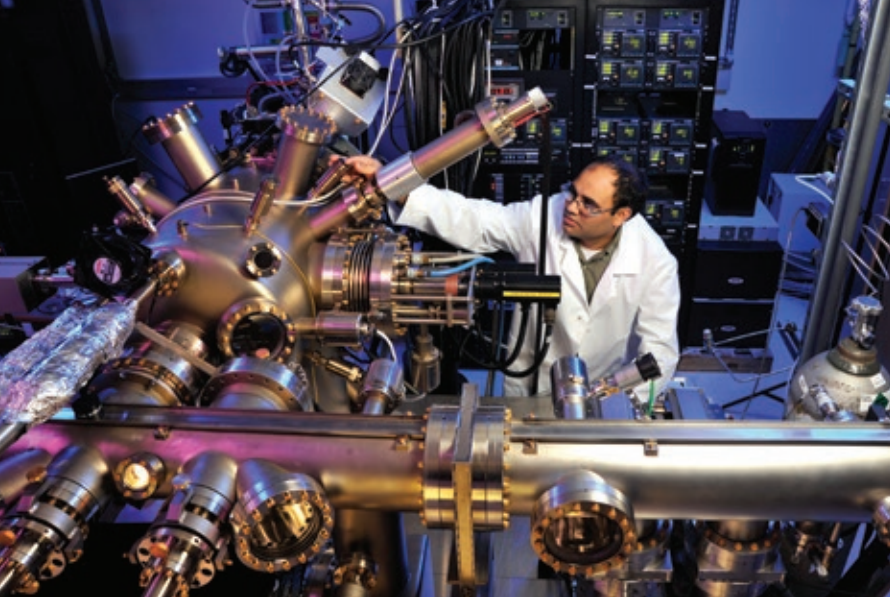
Advanced Materials Growth and Processing Facility ⓐ

This most extensive of U.S. Army materials growth and processing facilities houses seven dedicated, state-of-the-art, molecular beam epitaxy and three metal organic chemical vapor deposition (MOCVD) systems that control, at the atomic level, growth of advanced semiconductors. Researchers design and engineer elements from across the periodic table for use in numerous optical devices, such as lasers and detectors, and in devices that span the electromagnetic spectrum and electronic components, such as field-effect transistors (FET) and thyristors.

Advanced Microanalysis Facility ⓐ

The Advanced Microanalysis Facility fully integrates capabilities for chemical and structural analysis of electronic materials and devices for the U.S. Army and DoD. It includes surface and bulk characterization instrumentation, with measurements achieving atomic scale resolution and elemental detection achieving parts-per-billion sensitivity. The facility also conducts failure analysis of failed critical military devices or systems.

Applied Laser Spectroscopy Laboratory ⓐ

This facility is used for research and development of advanced optical methodologies for the detection of all hazardous materials (chemical, biological, and explosives) and for basic research into new laser spectroscopic techniques. Equipment capability spans the ultraviolet to infrared spectrums and includes an ultrafast amplified titanium sapphire laser (sub-30 femtoseconds); multiple widely-tunable Quantum Cascade lasers; and numerous ion, fiber, and solid state sources in the visible and near-infrared spectrums. Currently studied optical spectroscopies include laser photoacoustics, surface-enhanced Raman, single-beam coherent anti-Stokes Raman scattering (CARS), and laser pulse-shaping. The laboratory also includes advanced ink-jetting technology capable of manufacturing advanced optical standards for testing and assessment of spectroscopic techniques.

ARL Center for Advanced Polymer Processing (ACAPP) APG

The ARL Center for Advanced Polymer Processing facility engages in fundamental and applied materials and processing research impacting items such as protective equipment, sensors, high energy density electronics, battlefield medical treatment and broadly across the materials research paradigm. The key components of ACAPP include engineering and environmental laboratory controls, advanced mixing, materials characterization, post extrusion polymer processing, and microfabrication; ACAPP houses a full suite of printing, sintering, and lithographic techniques for producing 2D and 3D polymeric structures.

BSL I-II Biotechnology Multi-User Facility ALC

The BSL I-II Biotechnology Multi-User Facility provides an environment for comprehensive biotechnology research: from fundamental studies of complex biological systems and biomolecular interactions through prediction, design, and engineering of advanced biological/ bio-hybrid materials and systems for a wide range of Army applications. The facility's capabilities cover a broad spectrum, including micro and molecular biology equipment in conjunction with advanced characterization tools and biochemistry instrumentation. These capabilities enable multi-scale studies of cells, subcellular components, and metabolic networks of aerobic and anaerobic organisms as well as natural and engineered biologic materials. Instrumentation includes advanced optical and environmental electron microscopy; spectroscopic tools for dynamic structural determination; biomanufacturing capabilities including fermentation, separation, and purification in controlled environments; biological and bio-hybrid materials fabrication; classical and custom biological performance studies; and electrical property characterization. The facility is commissioned to handle biosafety level I and II materials.

Center for Cold Spray Research and Development `APG`
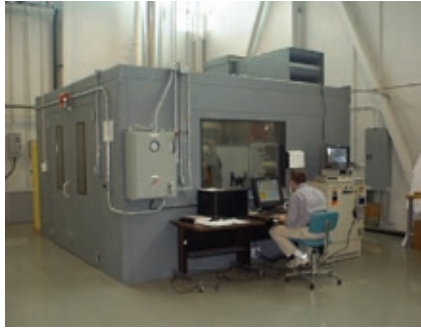
This is the only DoD facility capable of cold spray research and development, production, and field-repair. It features three stationary cold spray systems used for research, development, and prototyping in addition to five portable cold spray systems that are used in the field.

Cold Atom Optics and Quantum Network Laboratory `ALC`

The Cold Atom Optics and Quantum Network Laboratory laser-cools atoms to millionths of a degree above absolute zero and then traps the atoms using wires on a microfabricated chip. The lab exploits the atoms' quantum nature for applications in timekeeping, inertial sensing, and quantum information processing. A quantum fiber network between ARL and the Joint Quantum Institute at the University of Maryland, College Park enables the transfer of photons carrying quantum information between research laboratories at the two institutions. Current experiments use cold atoms as quantum memory and quantum processors for sending and receiving photons across the fiber.

Directed Energy Anechoic Chamber `ALC`
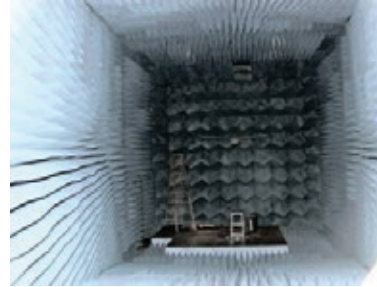
The Directed Energy Anechoic Chamber comprises a power anechoic chamber and one transverse electromagnetic cell for characterizing radiofrequency (RF) responses of electronics to high power microwaves (HPM). Externally modulated high power amplifiers and adapted radar sources provide continuous wave (CW) and pulse-modulated waveforms. Power levels vary and are supported in bands of common interest.

Dissimilar Materials Assembly System (DMAS) `APG`

DMAS, developed by ARL, allows fully automated assembly of dissimilar materials, such as ceramics and polymer composites. For example, it can integrate different materials and complex fiber architecture sequences that have been proven to reduce back face deformation in ceramic-based body armor systems.

Electrochemical Facility `ALC`

The Electrochemical Facility prototypes thermal and liquid reserve batteries and high energy, high power, experimental batteries in two dry rooms; one room is maintained at below

one percent relative humidity. In addition to battery prototyping equipment, the facility houses inert atmospheric chambers; a spin/setback air gun for realistic laboratory testing of reserve munitions batteries; chemical synthesis equipment; and analytic equipment for fabricating and evaluating highly energetic anodes, cathodes, and electrolyte materials and components for batteries, capacitors, and fuel cells.

Electro-Optic and Acoustic Remote Sensing Laboratories ALC

This suite of laboratories is designed to further the science of electro-optic and acoustic remote sensing in complex outdoor environments. It enables detailed studies on acoustic and electro-optic propagation and time-evolution of the atmosphere. Equipment includes Doppler light detection and ranging (lidar) systems (Wind Tracer, Wind Tracer-Model X Transceiver [WTX], Fibertek, Leosphere, and Halo); DefendIR (forward-looking infra-red [FLIR] and visible imagers with range finder); polarimetric long-wave infra-red [LWIR]-FLIR radiometer; multispectral polarimetric LWIR FLIR; microphones; infrasound sensors; seismic sensors; high rate data acquisition systems; sonic anemometers; temperature probes; and global positioning system (GPS) units. A machine shop provides for specialized fabrication.

Flexible Electronics Research Facility ALC

The Flexible Electronics Research Facility designs, synthesizes, tests, and fabricates materials and devices compatible with flexible substrates for Army information displays, sensors, and electronics. Research results provide system-level weight reduction, novel form factors, and unique capabilities for future Soldier technologies such as large-area radiation sensors, light emitting devices, and chemical analysis detectors.

Heterogeneous Electronics – Wafer Level Integration, Packaging, and Assembly Facility ALC

This facility integrates active electronics with microelectromechanical (MEMS) devices at the miniature system scale. It obviates current size-, weight-, and power (SWaP)-constrained integration challenges associated with ultra-compact and low observable chip-scale systems by integrating, at the wafer-level, small-scale MEMS devices with

diverse components and materials, including active silicon and wideband gap switching devices. The facility's high density component integration tools include electroplating baths for electro-deposition of various metals; high precision pick and place tools; wafer dicing saws; ink-jet printing tools; wire bonders; flip-chip bonders; and a jet vapor tool for depositing various metals. Hybrid integration capabilities apply widely to areas such as miniature power supplies; secure communication systems, including small radios; imaging; and distributed and multi-modal sensor platforms.

High Energy Solid State Laser Research Facility ALC

A suite of laboratories with advanced spectroscopic and laser equipment, this facility develops materials and techniques for advanced solid state high energy lasers. Research and
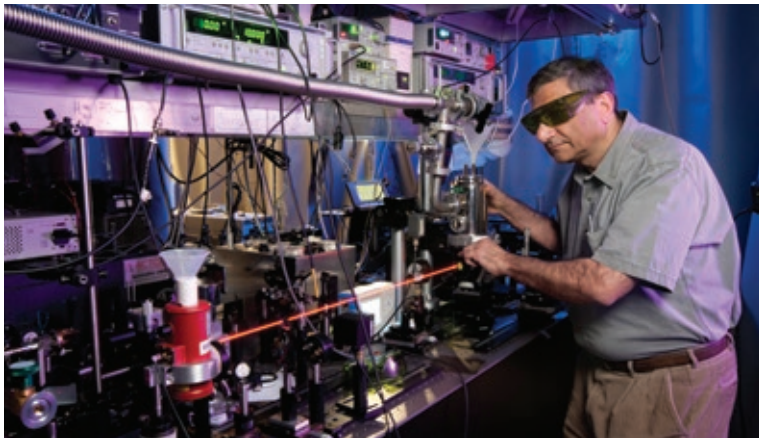
development address rare earth and transition metal-doped, diode-pumped laser materials—in single-crystal and ceramic form—for room temperature and cryogenic operation. The facility investigates lasers emitting at wavelengths near 1, 1.5, and 2 microns for directed energy weapon (DEW) applications and near 3 microns and beyond for infrared countermeasure (IRCM) applications.

High Power Fiber Laser Test Bed ALC

This facility, unique within DoD, power-combines numerous cutting-edge fiber-coupled laser diode modules (FCLDM) to integrate pumping of high power rare earth-doped fiber lasers. Selected pump wavelengths are eyesafe and minimize heat deposition in the fiber, an important factor for scaling the laser to high powers for directed energy weapon (DEW) applications. The design has the flexibility to test new fiber lasers from ARL and other DoD laboratories up to kilowatt-class powers, enabling performance projections to much higher powers.

High Power, Scalable, and Integrated Eyesafe Laser Test Bed ALC

This facility is the only test bed in the world with available pump power levels of up to 2 kW at 1530 nm. It evaluates the power scalability of fiber lasers and amplifiers using the resonant pumping approach in order to achieve a better understanding of the scalability limit for fiber lasers operating in the eyesafe wavelength regions of 1.56 – 1.62 µm, for resonantly pumped erbium (Er)-doped fibers, and 1.85 – 2.1 µm, for resonantly pumped thulium (Tm)-doped fibers. Pump

at terahertz (THz) and millimeter-wave frequencies. The facility is unique in its ability to perform nonlinear device characterization, including state-of-the-art load pull and arbitrary digital waveform synthesis, making this the only laboratory DoD-wide where actual mil waveforms are tested directly on-wafer. Additionally, the capability to test at high power while controlling temperature enables the design of high power linear sources and expands the range of performance at the integrated circuit (chip) level.

Intelligent Optics Laboratory ALC

The Intelligent Optics Laboratory supports sophisticated investigations on adaptive and nonlinear optics; advanced

sources are InP/InGaAsP laser diode modules fiber-coupled into standard 105/125 μm, 0.22 numerical aperture (NA) multimode delivery fibers. Fiber coupling integrates the pump via commercial pump couplers/combiners into active fibers (doped laser fibers). The High Energy Laser-Joint Technology Office (HEL-JTO) and ARL jointly funded the facility. The test bed will be available to government and non-government customers interested in testing their developed components, including pump couplers, step-index and photonic crystal fiber (PCF) laser fibers, and all-fiber optical isolators.

High Speed On-Wafer Characterization Laboratory ALC

At the High Speed On-Wafer Characterization Laboratory, researchers characterize and model devices operating

imaging and image processing; ground-to-ground and ground-to-air free-space laser communications; directed energy systems; and other applications. An outdoor, 2.3 km optical propagation path is accessible in the facility for experimental study of adaptive imaging and laser propagation through the boundary layer. The laboratory uses a variety of state-of-the-art adaptive optics; wave front diagnostics and compensation; and image processing algorithms to support advanced techniques for modeling, simulation, imaging, and laser communications systems.

Magnetic Resonance Force Microscopy System ALC

The Magnetic Resonance Force Microscopy (MRFM) system, developed by ARL, is the world's most sensitive nuclear magnetic resonance (NMR) spectroscopic analysis tool, with a demonstrated sensitivity better than 35 cubic microns and 50 pico grams. It is unique to DoD and DoE. A second MRFM is nearing completion. The MRFM performs non-destructive nanocharacterization of semiconductor and biological materials and devices using NMR spectroscopy to assess strain, internal electric fields, and material interfaces of nanoelectronic devices and materials.

Magnetics Research Facility ALC

The Magnetics Research Facility houses three Helmholtz coils that generate magnetic fields in three perpendicular directions to balance the earth's magnetic field. An additional set of

Helmholtz coils generates larger fields of 140 oersted (Oe); a set of coaxial Mumetal magnetic cylinders is used for lower-field measurements. A measurement stage with non-magnetic microprobes can be positioned in the coils' center.

Materials Characterization Facility APG

The Materials Characterization Facility enables detailed measurements of the properties of ceramics, polymers, glasses, and composites. It features instrumentation for analyzing the chemical properties of materials at a wide range of temperatures and optical and electron microscopy and electron probe instruments for microstructural analysis; x-ray residual stress analysis; and electrical, magnetic, and thermal property characterization.

MEMS/Electronic Device Design and Characterization Facility ALC

This facility allows DoD to design and characterize state-of-the-art microelectromechanical systems (MEMS) and electronic devices. Device designers develop their own analytical and finite element models using combinations of custom and commercial software such as ANSYS, HFSS, and Matlab. To verify device performance, a host of equipment characterizes the MEMS/electronic devices including low and high frequency vector network analyzers; semiconductor parameter analyzers; scanning and tunneling electron microscopes; high resolution and high speed microscopy; laser Doppler vibrometry from mHz to 1.2 GHz; semi and full autoprobers;

systems for characterizing on-chip energetic reactions and materials; and custom electronic test equipment for actuators and sensors.

Microwave/Millimeter-wave Anechoic Chamber ALC
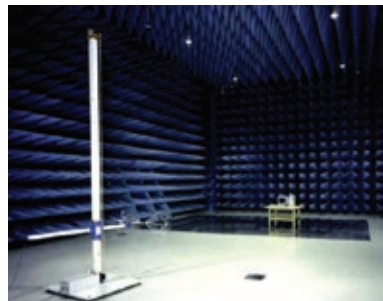
The Microwave/Millimeter-wave Anechoic Chamber measures: (1) directivity patterns and gain on antenna elements and aperture arrays and (2) radar cross-section signatures on targets of interest. A steel platform outside the tapered end allows external equipment experiments and includes a rail translator-mounted positioner for insertion into the aperture.

Millimeter-wave Instrumentation Test Facility ALC

The Millimeter-wave Instrumentation Test Facility conducts basic research in propagation phenomena, remote sensing, and target signatures. The facility has a breadth and depth of instrumentation and analysis capabilities, with supporting tools such as high speed data acquisition; multiple-band radar analysis systems; visualization tools; outdoor experimental facilities; and the capability to generate models for evaluating performance.

Nanoelectronics Characterization Laboratory ALC
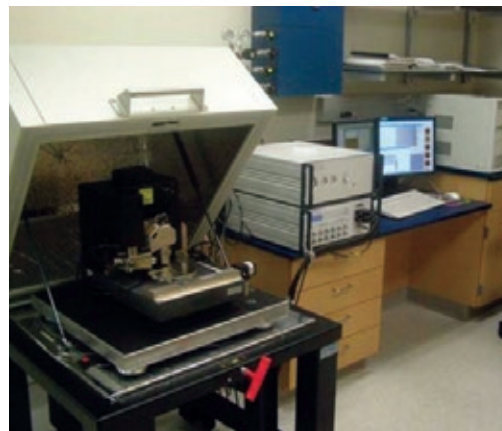
This facility houses growth and characterization capabilities for graphene and other 2D materials for application to electronic devices such as field-effect transistors (FET), bolometers, and supercapacitors. Growth equipment includes atmospheric pressure and low-vacuum chemical vapor deposition furnaces for single and multilayer graphene growth, and materials characterization capabilities including atomic force, Raman, and scanning electron microscopies. ARL's Raman mapping capability is state of the art and ideal for investigating nanomaterials and devices. High resolution mapping quantifies layer quality, doping effects, layer count, stacking order, and interface effects in novel 2D material configurations. Electrical characterization comprises equipment such as a vacuum/cryogenic probe station, a cryogenic hall probe system, a multichannel potentiostat for characterizing electrochemical devices, and various DC and pulsed semiconductors.
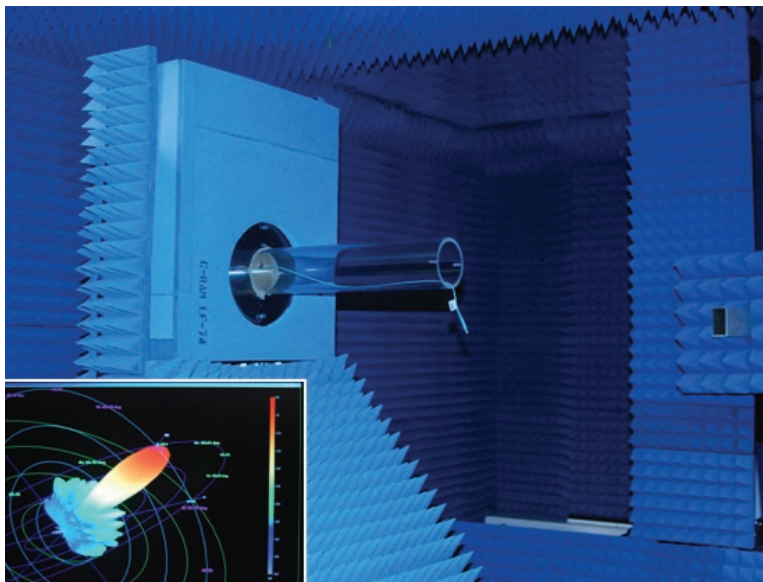
Near Field Test Facility ALC

The Near Field Test Facility conducts planar, cylindrical, and spherical scanning with high resolution data transformation to far field patterns. The facility covers the frequency band of 1.3 GHz to 26 GHz, with a 50 GHz upgrade planned for the future.

Nonlinear Materials Characterization Facility ALC

The Nonlinear Materials Characterization Facility conducts photophysical research and development of nonlinear

materials operating in the visible spectrum to protect Soldiers and sensors from battlefield lasers. Wavelength-tunable laser systems operating in the femto-, pico-, and nanosecond range evaluate the nonlinear optical properties of materials in Army-relevant configurations.

Photolithography and Micro-Fabrication/ Packaging Laboratories ALC

The Photolithography and Micro-Fabrication/Packaging laboratories provide research level semiconductor processing equipment and facilities that do not require a full cleanroom environment. Photolithography facilities include a photoresist spinner, optical mask aligner, a developing hood, curing ovens, a plasma asher, and a profilometer in a yellow-room environment. Micro-fabrication and packaging facilities include thermal and electron-beam evaporators; solvent and acid hoods; an electroplating hood; an automatic dicing saw; flip-chip indium bump bonders; wire bonders; optical inspection microscopes; and a probe station with a semiconductor parameter analyzer for electrical characterization.

Photovoltaic Research Facility ALC

The Photovoltaic Research Facility explores novel photovoltaic technologies that can sustain military systems, sensors, and gear. Capabilities include a state-of-the-art, variable temperature, ultra-high vacuum-scanning tunneling microscope (UHV-STM) for analysis of surface morphology,

localized defect states, and quantum confined states; probe stations for device testing; an internal/external quantum efficiency (IQE/EQE) system; fourier-transform infrared (FTIR) spectroscopy tools for analyzing spectral response in the visible to long wavelength; a near-infrared photoluminescence system; and a class AAA solar simulator system that meets all performance criteria designated as class A, B, or C for spectral match, non-uniformity of irradiance, and temporal instability of irradiance.

Smart Battlefield Energy on Demand (SmartBED) Facility ALC

The Smart Battlefield Energy on Demand (SmartBED) facility enables state-of-the-art research on power distribution components and technologies to improve energy consumption at tactical installations. For example, 34 percent of total energy consumption at Army installations is from generator use. Limited control and oversight results in high energy losses, especially at small outposts and operating bases; however, power grids at the small bases are uniquely military in their need to operate independently while adapting to rapid changes in loads and sources. Recent advances in high performance computing, control topologies, and power conversion have the potential to improve energy efficiency and reduce energy waste, especially at small bases that lack personnel trained in power systems operation. The SmartBED facility provides the capability to analyze and optimize these advanced power control and conversion technologies in a controlled environment.

Specialty Electronic Materials and Sensors Cleanroom Research Facility ALC

This 15,000 gross square feet Class 10 and 100 cleanroom facility houses a comprehensive set of semiconductor fabrication tools—including specialty material deposition, etch, lithography, and thermal—and research characterization systems for the next generation of sensors and electronic devices for the Soldier. These systems enable the fabrication of advanced micro and nanoscale devices using an extremely broad set of device materials including silicon; III-V and II-VI semiconductors; silicon carbide; quartz; lead zirconate titanate (PZT) and aluminum nitride piezoelectrics; many metals and oxides; and graphene and carbon nanotubes. Support applications fabricated with these devices range from bio- and trace-gas detection; secure communication (radiofrequency [RF] switches, filters, varactors, and tunable inductors); improvised explosive device (IED) detection (RF switches and filters); mobile sensor platforms for Soldier Intelligence, Surveillance, and Reconnaissance (bio-inspired microflight and terrestrial actuation, ultrasonic motors, bio-inspired sensors); traumatic brain injury (shock sensor, G-switch); RF (resonators, switches); power generation (microturbine, energy harvesting); infrared, ultraviolet, and optical detectors and emitters (imagers, lasers, LEDs); on-chip energetic devices (microthrusters, fuzing); and next-generation flexible, transparent, and high performance electronics and devices based on graphene and other 1D and 2D materials.

Structural Integrity and Durability Laboratory (APG)

The Structural Integrity and Durability Laboratory supports research efforts in durability and damage tolerance, probabilistic and risk-based life assessment, structural health monitoring, additive manufacturing, and survivability. This research will enable extremely lightweight, adaptive, durable, and damage tolerant structures for the future force, supporting air vehicle structures and dynamics research as
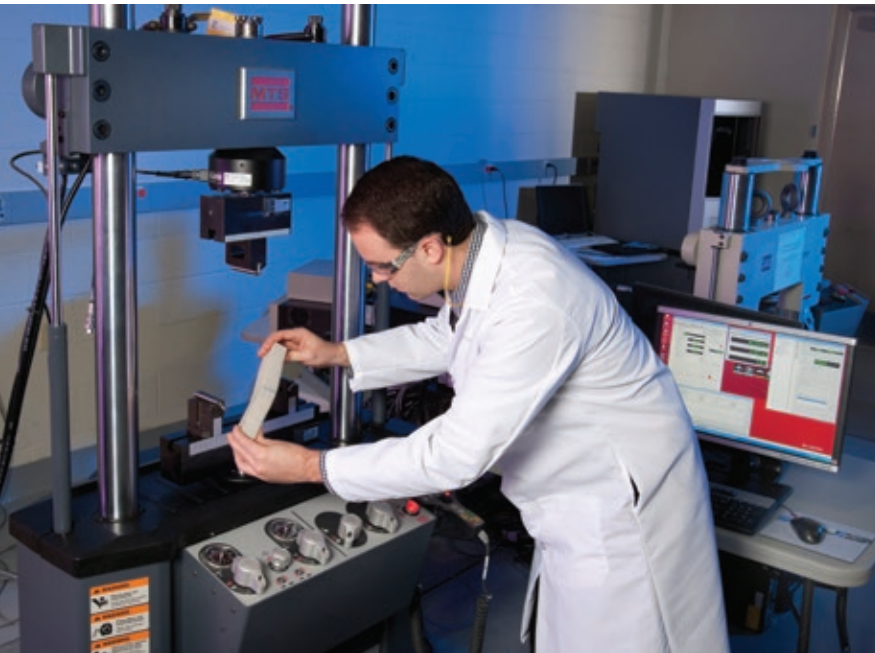
well as ground vehicle structural mechanics and dynamics technology. The lab contains several Material Testing Systems (MTS) mechanical testing machines, including a unique 1,000-Hz machine for high-cycle fatigue and additive manufacturing equipment as well as fixturing and instrumentation to support experimental research.

Superconducting Materials Research Facility (ALC)

The Superconducting Materials Research Facility uses a metal organic chemical vapor deposition (MOCVD) technique to grow and investigate the enhancement of high temperature yttrium barium copper oxide (YBCO) materials. Research goals are to improve superconductor properties (such as flux pinning processes) and to investigate material use in new applications. Partners in academia, government agencies, and industry are collaborating to develop YBCO-based materials for electrical power and electronics applications.

Thermoelectric Research Facility (ALC)

This facility develops next-generation, high efficiency thermoelectric technologies to support: (1) significantly

reduced fuel usage in large-platform military systems, (2) improved cooling for sensors, and (3) covert man-portable electrical power sources. The facility includes capabilities for basic materials/measurement research; new prototype device technologies; full-scale system testing and efficiency measurement; and a new dedicated molecular beam epitaxy system that analyzes higher efficiency thermoelectric materials. Using these capabilities, ARL has developed novel measurement methodologies with unusually accurate measurements of thermoelectric properties (Seebeck coefficient, thermal conductivity, and electrical resistivity) from below freezing to above 1,000 degrees Kelvin.

UV to THz Spectroscopy and Characterization Facility ALC

This facility has extensive continuous-wave and time-resolved optical characterization laboratories for study of carrier dynamics and transport using femtosecond lasers continuously tunable between 200 and 2,500 nm and from

1 micron to > 10 microns. Capabilities include temperature dependent (10–300 degrees kelvin) photoluminescence, photoluminescence excitation, electro- and photoreflectance, and terahertz (THz) spectroscopy—all with sub-picosecond temporal resolution.

Sciences for Lethality and Protection

Aerodynamics Experimental Research Facility (APG)

The Aerodynamics Experimental Research Facility tests

aerodynamics and fluid dynamics of smart munitions and submunitions dispensing systems; experimental direct fire accuracy; advanced munitions design; and structural dynamics of gun and ammunition systems from 2 mm to 40 mm.

Armor Experimental Facility (APG)

The Armor Experimental Facility is a fully-instrumented experimentation complex used to develop and evaluate armor technology for defeating explosively formed penetrators (EFPs) and shaped charges. It features high energy x-ray instrumentation that provides detailed information on the acceleration and deformation of liners as they form into penetrators.

Basic Research Firing Facility (APG)

The Basic Research Firing Facility is an indoor ballistic test facility that has recently transitioned from a customer-based facility to a dedicated basic research asset. It has an air-gun launch capability for rounds with a diameter up to 25.4 mm at a maximum range of 65 feet. Upgrades to this facility will accommodate powder guns capable of handling 5.56 mm – 37 mm rounds at the same range. Kottke Automated
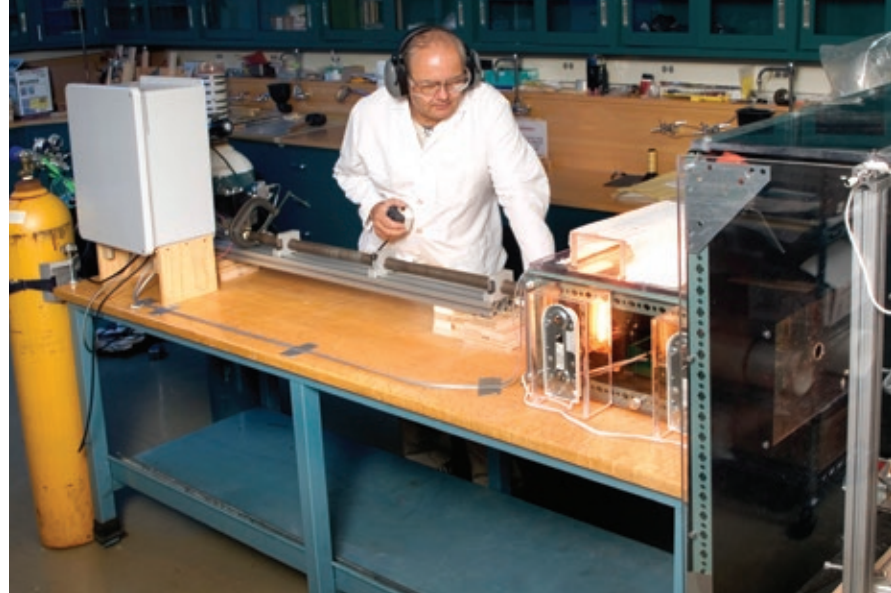
Instrumentation ensures activation of 150 – 450 kiloelectron volt x-rays and high speed video equipment (Photron, Phantom, Ultra 24, and Shimatsu cameras) with no cross-talk or pre-triggering.

Composites Processing Research Facilities (APG)

Advanced low-cost, reliable processing techniques are essential for the transition of polymer matrix composites to Army ground vehicles, aircraft, and other materiel. ARL's ISO 9001:2008 certified composites processing facility produces structural, ballistic, and research grade composite solutions using fully-automated autoclaves, high pressure compaction presses, large and small diameter filament winding stations,

threat loadings. The four primary simulators at the lab are the Crew Survivability Blast Effects Simulator (CSBES), the Horizontal Impact Test System (HITS), 3-axis shaker, and the drop towers.

Dynamic Rocket-Propelled Grenade (RPG) Firing Facility APG

This facility conducts completely instrumented terminal ballistic experimental tests with dynamically launched

and other research tools to resolve scientific and engineering challenges in process optimization, materials fabrication, and automated process control.

Crew and Component Protection Laboratory ALC

Researchers at this facility design and evaluate crew and component technologies using state-of-the art laboratory simulators that replicate the acceleratory and vibratory loadings from underbelly blast events and other

RPGs. The rounds are either launched free-flight or through ARL's own Precision Delivery System (PDS). PDS is a unique launching system enabling the RPG to strike extremely close to the target aim-point.

Enclosed Small and Medium Caliber Firing Experimental Facility (APG)

This facility conducts completely instrumented terminal ballistics experimental tests with small and medium-caliber tungsten alloy penetrators against advanced armor threats.

Experimental Facility 20 (EF20) (APG)

EF20 is a fully instrumented indoor firing facility dedicated to improving the personnel protective equipment (PPE) worn by today's Soldier. Researchers conduct firing programs to examine protective levels of new and novel materials before incorporation into PPE designs and to advance state-of-the-art PPE experimental and test methods.

Explosively Formed Penetrator (EFP) Terminal Effects Research Facility (APG)

This facility is a fully instrumented experimentation complex used to investigate terminal ballistic effects of explosively formed penetrator (EFP) warheads. It features high energy x-ray instrumentation that provides detailed information on the acceleration and deformation of liners as they form into penetrators.

Guidance Research Facility (APG)

The Guidance Research Facility is the Army's most advanced facility for conducting research and experimental validation relating to advanced guidance methods for precision weapons. Advanced guidance algorithms and approaches are postulated, evaluated, and optimized using a combination of capabilities that include unique instrumentation for the

characterization of guidance sensors (inertial, magnetic, optical, and Global Positioning System), modeling and simulation of guidance algorithms, and hardware-in-the-loop evaluation of new techniques.

High Rate Mechanical Characterization Facility APG

The High Rate Mechanical Characterization Facility measures response to deformation of energetic materials under operational conditions. Uniaxial compression and tensile measurements predict mechanical behavior in material and structural models; assess the mechanical response of new gun and rocket propellants, explosives, and other munitions; and evaluate the vulnerability response of these materials to impact threats.

Large and Small-Caliber Armor Research Facility APG

This facility is an environmentally-contained outdoor complex that hosts complete diagnostics to analyze the performance of classified armor technologies against kinetic-energy penetrators, including depleted-uranium armors and munitions.

Large-Caliber Terminal Ballistics Facility APG

This facility, unique in the United States, is capable of conducting full-scale terminal ballistic experiments with both kinetic-energy projectiles and explosive warheads against both passive and reactive armors. It features an environmentally-contained impact chamber that can handle highly explosive warheads and targets, depleted-uranium projectiles, and full-scale combat systems or subsystems.

Novel Energetic Research Facility (NERF) APG

NERF is an Energetic Materials Development Facility containing a processing complex with energetics processing and manufacturing labs and a formulation complex with energetics formulation and energetics properties labs. Mission successes include Army Insensitive Munitions (IM) Energetics.

Precision Munition Electro-Sciences Facility APG

This facility allows the characterization of the electro-magnetic environment produced by a precision weapon in free flight. It can measure the radiofrequency (RF) spectrum from 200 MHz to 18 GHz and allows the classification of critical weapon aspects such as interference between GPS and telemetry signals in addition to providing experimental data needed to validate advanced RF theory and supporting models.

Reverse Ballistic Air Gun Facility 🟢 ALC

This custom-designed facility houses a suite of three air guns capable of generating accelerations up to 100,000 Gs and velocities up to 2,000 ft/s. In addition to a general high-G environment, the guns simulate gun-launch specific set-back, set-forward, and spin environments. Available instrumentation includes high speed imaging and data acquisition devices.

Target Assembly Facility 🔵 APG

The Target Assembly Facility integrates new armor concepts into actual armored vehicles. Featuring the capability of machining and cutting radioactive materials, it provides a means of fabricating and analyzing depleted-uranium armors and armors impacted by depleted-uranium projectiles.

Transonic Experimental Research Facility 🔵 APG

The Transonic Experimental Research Facility evaluates aerodynamics and fluid dynamics of projectiles, smart munitions systems, and sub-munitions dispensing systems; determines input for artillery fire-control computers and firing tables; evaluates advanced conventional gun propulsion technologies; determines experimental direct fire accuracy; evaluates advanced munitions designs; and analyzes the structural dynamics of gun and ammunition systems from 60 mm to 208 mm.

Sciences for Maneuver

Catalytic Fuel Conversion Facility ALC

This facility enables unique catalysis research related to power and energy applications using military jet fuels and alternative fuels. It is equipped with research tools for catalytic fuel conversion and micro-combustion characterization including a catalyst surface area and chemisorptions analyzer; real time mass spectrometer; gas chromatograph (GC) with sulfur detector for fuel analysis; online micro-GC; infrared spectrometer for in-situ reaction with rapid/step scan capability; an oxygen bomb calorimeter; and automated flow reactors.

Drives Team Facilities OH
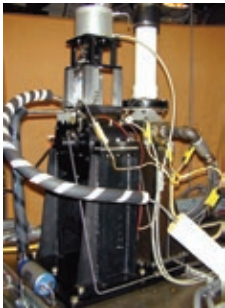
The Drives Team conducts research on transmissions and gearing for rotorcraft and for geared fan propulsion systems on conventional aircraft. The primary goals of drives team research are to improve safety, reduce weight and noise, and increase the life and reliability of gear transmissions. This research involves advanced transmission concepts, transmission load distribution, drive system diagnostics and health monitoring, gear failure mechanisms, gear materials, gear tooth surface improvement and lubricants, gear vibration and noise, gear thermal analysis, and analytical optimization programs to develop improved methods for transmissions design.

Fuel Reformation Laboratory ALC

The Fuel Reformation Laboratory supports state-of-the-art fuel processing and fuel reforming research to meet the unique needs of the U.S. Army. For example, the Army's

mobile power applications are an excellent match for fuel cell power sources, but safety and logistical concerns preclude the storage of hydrogen on the battlefield. ARL research shows that using JP-8 or other logistical fuels as a "hydrogen carrier," and reforming these fuels on-demand into hydrogen, makes fuel cells—with their low maintenance, high efficiency, and quiet operation—extremely advantageous compared to competing power sources.

High Temperature Propulsion Materials Laboratory APG

The High Temperature Propulsion Materials Laboratory evaluates advanced materials and components for potential use in propulsion applications. The lab is equipped with a hot particulate ingestion rig (HPIR) capable of producing engine-relevant gas temperatures, mass flows and velocities. The HPIR can reach up to 1650 °C (3000 °F), with mass flows of 0.14 – 0.34 kg/s (0.3 – 0.75 lb/s) and velocities of 146 – 1057 m/s (0.3 – 0.8 Mach). Hot tribo-corrosion of materials can be tested with independent sand and salt feeds of 1 – 200 g/min (0.13 – 26.4 lb/hr) into the HPIR. The particle distributions and velocities within the flow field can be measured with 3D particle imaging velocimetry and laser Doppler anemometry. Thermal imaging with a high-speed infrared camera and point measurements via optical pyrometers and thermocouples are used to monitor material conditions. A high-temperature air-jet erosion tester feeds alumina particles at 1 – 5 g/min (0.13 – 0.66 lb/hr), velocities of 30 – 150 m/s (98 – 492 ft/s), and temperatures up to 1000 °C (1830 °F). A button-cell flame test rig is also available for rapid coupon-level testing of multiple material compositions under a high-temperature flame (oxy-acetylene: 3160 °C; 5720 °F or oxy-propane: 2820 °C; 5110 °F). The facility also includes a 100-kN (22-kip) MTS thermo-mechanical fatigue rig capable of testing small and large samples at temperatures up to 1500 °C (2732 °F). A digital c-mode scanning acoustic microscope is used for non-destructive pre- and post-test characterizations of material surfaces and sub-surface defects.
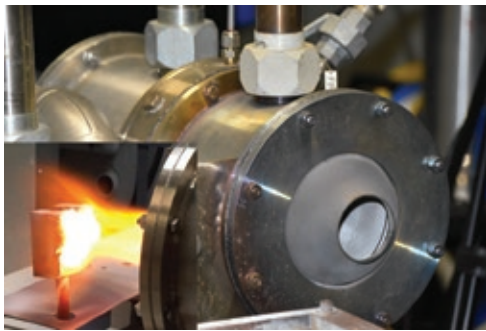
Mechanical Components and Tribology Laboratory APG

This laboratory evaluates fundamental friction, wear, and lubrication technologies for improved, robust, and power-dense vehicle transmissions. The facility explores innovative methods to extend efficiency and durability of mechanical components such as gears, bearings, splines, clutches, and seals. Researchers analyze operations under extreme conditions, such as oil starvation to identify opportunities for improved survivability, and evaluate mechanical diagnostic techniques to achieve better fault detection and life prediction. Promising drive train technologies pass through

the drive train systems laboratory before transitioning to U.S. Army Research, Development and Engineering Centers and original equipment manufacturers.

Microsystem Aeromechanics Wind Tunnel APG

The Microsystem Aeromechanics Wind Tunnel advances the study of fundamental flow physics relevant to micro air vehicle (MAV) flight and assesses vehicle performance in terms of flight efficiency, stability, and control to improve the range, endurance, payload, and maneuverability of handheld aerial platforms. The tunnel is a closed circuit with a closed test section that is 6-feet long with a 3-feet square cross-section. To facilitate a wide range of experiments, the test section is reconfigurable: both sidewalls and ceiling are

removed and replaced as necessary. The tunnel floor includes a turntable and optionally mounted model sting with pitch control. A six-component force balance mounts to the sting, providing aerodynamic forces and moments to characterize component and vehicle loadings. The tunnel design results in relatively low levels of free-stream turbulence intensity. A compartment upstream of the test section facilitates the introduction of additional levels of free-stream intensity to systematically study the impact of this variable, which has a significant impact on MAV performance. The test section is surrounded by an optical rail system mounted on motorized linear traverses to support the use of digital particle image velocimetry (DPIV) and other optically-based experimental diagnostic techniques.

Power Conditioning Research Facility ALC

The Power Conditioning Research Facility offers a unique collection of power sources, energy storage devices, power loads, thermal management systems, and electronics fabrication resources for the study of high power, power conditioning systems. The facility houses specialized systems for pulsed power and continuous power circuit development; these capabilities are expanding to address the requirements of new technologies such as high power, solid state switches and electric traction drives.

Prognostics and Diagnostics (P&D) Laboratory APG

The Prognostics and Diagnostics (P&D) Laboratory supports and conducts fundamental experimental P&D related efforts within the Army's Condition-based Maintenance (CBM) Enterprise. This facility houses state-of-the-art P&D hardware, software, and technical capabilities and contains a 22-kip Material Testing Systems (MTS) mechanical load frame with a high temperature furnace capable of exposing materials to temperatures over 2,700 degrees Fahrenheit. It also houses a state-of-the-art, customized, 16-channel high speed acoustic emission system; 64-channel acousto-ultrasonic piezo-based hardware; a high speed (500 KHz) 4-channel Fiber Bragg Grating interrogator unit; Digital Image Correlation (DIC) hardware capable of dynamic strain measurement up to 30 Hz; a hand-held phased array ultrasonic system; a dual mode eddy current system; an Agilient impedance analyzer capable of measuring up to 550 MHz; high speed oscilloscopes and other National Instrument data acquisition systems; Labview Software; a dual head piezoelectric and electromagnetic actuator; and several types of acoustic emission, ultrasonic transducer, Fiber optic, and piezo-based sensors. The P&D Lab supports prognostics health management research
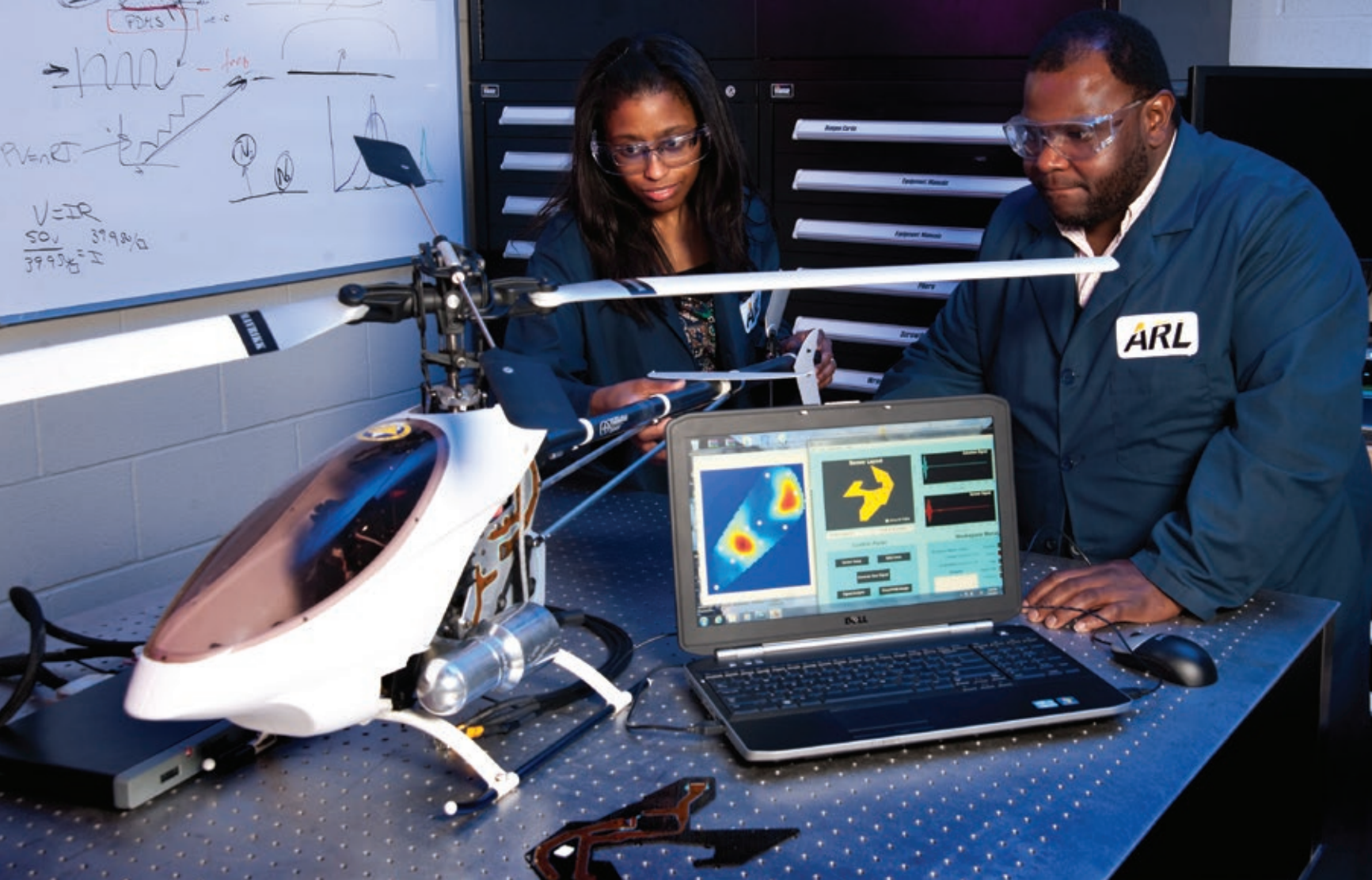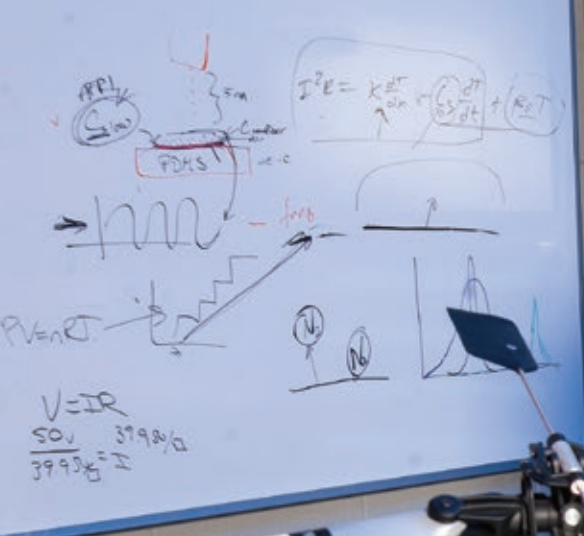
activities encompassing various research aspects of structural health monitoring and life prognosis; propulsion health monitoring; machinery and rotary dynamic components diagnostics and prognostics; physics, materials, electronics, advanced sensing, and data acquisition hardware; signal processing; data mining and fusion; and system health management and reasoning.

Robotics Research Facility PA

This 60 feet x 100 feet structure on the grounds of the Fort Indiantown Gap Pennsylvania National Guard (PNG) Base is a mixed-use facility comprising office space, laboratory space,

a workshop, and a high-bay facility. It is adjacent to the PNG's primary vehicle maneuver area and Combined Arms Collective Training Facility and serves as the staging point for ground and air indoor and outdoor robotics experimentation activities using the PNG ranges.

Rotorcraft Hover Test Facility (RHTF) VA

The Rotorcraft Hover Test Facility (RHTF) at the NASA Langley Research Center is an ARL-specific facility dedicated to the preliminary testing of helicopter rotor systems and tilt-rotor configurations. The facility acquires some publishable data, but its larger focus is to prepare model systems for entry into the Transonic Dynamics Tunnel (TDT), a wind-tunnel facility located adjacent to the RHTF.

Sensors and Autonomous Systems Experimental Facility ALC

The Sensors and Autonomous Systems Experimental Facility evaluates emerging robotics and sensor systems. Researchers assess autonomous navigation in complex and confined 3D and urban environments using a three-story high urban terrain replica; single platform and collaborative platform simultaneous localization and mapping; collaboration of heterogeneous teams of air and ground platforms, robotic

perception, and intelligence; the human-robot interface; platform state estimation; mobility from man-portable-sized systems to the micro-scale; and next-generation see-through-the-wall, ground penetrating radar, IED detection, and unattended ground sensor technologies. The facility includes a fully integrated camera and GPS system for ground truthing; a dark room to simulate cave-like environments; a control room and lab environments for system repair, development, and experimental control; various urban features to include sidewalks, stairs, ramps, variable pitch roofs, various ingress and egress features, balconies, telephone poles, and overhead wiring; a three-feet deep sand bed for characterization of buried devices; and a 120-feet long above-ground computer-controlled trolley track system for evaluating optical systems and radars.

Single Gear Tooth-Bending Test Facility OH

NASA Glenn Research Center and the Army Research Laboratory (ARL) teamed together to develop the high speed
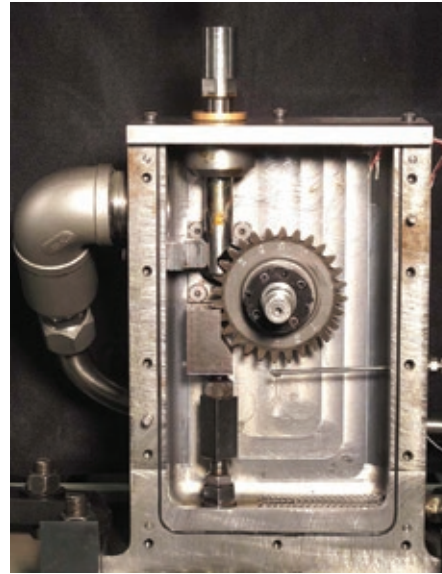
Single Gear Tooth-Bending Test Facility, which is the only facility of its kind in the world with the capability of achieving the high cycle rates required for infinite-life testing. This facility explores the stress-cycle curve at bending stress loads of approximately 150 ksi and below in support of condition-based maintenance (CBM) and other component life-extension initiatives.

The helicopter community's shift toward a CBM strategy seeks to extend the useful life of gears and bearings in order to increase the overall affordability of the aircraft. Fatigue failures, to include gear tooth-bending fatigue, take on considerable importance as the number of cycles increases. The centerpiece of the facility is the 1,000-Hz High-Cycle Fatigue Test System. The servo-hydraulic system is capable of maintaining high waveform fidelity at high frequency. It has a static load capacity of ±5,500 lb force and maximum displacement capability of ±1 in. At an operating frequency of 1,000 Hz, the gear tooth is experiencing the bending equivalent to a gear rotating at a speed of 60,000 rpm.

Small Engine Research Center (SERC) APG

The Small Engine Research Center (SERC) houses the Small Engine Combustion Research Laboratory (SECRL) and the Small Engine Altitude Research Facility (SmEARF). The center supports research to develop innovative propulsion component technologies by improving fuel-air mixing and combustion to extend operation capability of Unmanned Aircraft Systems (UAS). The SECRL is equipped with a 302-hp dual-ended AC dynamometer and inline torque meters on both ends. It has a Ricardo Hydra single-cylinder thermal/optically accessible engine on one end and various multi- or single-cylinder opposed piston engines on the other end. The SECRL has an Altech 7-gas analytical instrument, 2-ch AVL noise meter, AVL opacimeter, B&K research-grade microphones

and various specialty sensors and equipment. The SmEARF is capable of simulating atmospheric temperature and pressure conditions with continuous air flow for experimental research on a variety of air-breathing engine types including turboshaft, reciprocating, rotary and novel concepts. It is composed of two main systems, an altitude chamber capable of simulating conditions of up to 25,000 feet and a dynamometer system capable of up to 250 horsepower and 30,000-rpm shaft speed. The facility is equipped with a custom designed engine cart, a fuel conditioning and measurement system, different sets of drive shafts, engine cooling and charge air cooling systems, and an emissions analysis bench. All control and monitoring is handled by a robust data acquisition and control (DAC) system providing the ability to operate an engine independent of the engine control unit (ECU). The SmEARF is a uniquely singular national asset for evaluating the performance of UAV class engines under actual operating conditions.

Spesutie Island Robotics Research Facility 2 APG

Spesutie Island Robotics Research Facility 2 comprises mixed-use space, electronics, research laboratories, and vehicle repair facilities. Research activities include micro-

mechanics, mechanics, robotics, and specialized materials research. Specialized equipment includes experimental rigs for characterization of electrical properties of conductive composite materials, an oil tank and balance for investigation of forces acting upon flapping wing structures, and a 3D printer for rapid prototyping of experimental models. Researchers use an approximately 25 feet x 35 feet open high-bay facility in the building for experimentation with small mobile ground robotic vehicles.

Spesutie Island Robotics Research Facility 3 APG

Spesutie Island Robotics Research Facility 3 includes a specialized containment facility for use in experimentation

with rotating systems, including small helicopters and the small rotor test bed. A significant portion of the laboratory has been set aside for installation of a motion capture system and reconfigurable experimentation space that will permit external control of unmanned ground vehicles. The building also houses experimental equipment and a small repair workshop.

Spray Characterization Facility ALC

The Spray Characterization Facility supports combustion-based power devices and microelectromechanical systems (MEMS). A Phase Doppler Particle Analyzer (PDPA), which enables droplet diameter and droplet velocity spray measurements, anchors the facility. Ancillary tools include

high voltage power supplies, shadowgraph imaging optics, and temperature controls. These capabilities allow characterization of electrospray and microfluidics for unique fuel injection scenarios.
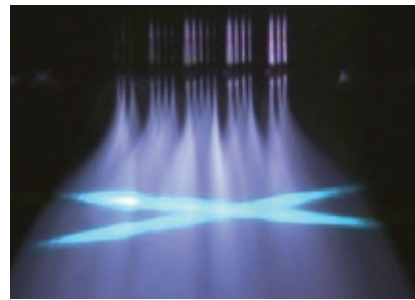
Spray Combustion Research Laboratory (SCRL) APG

The Spray Combustion Research Laboratory (SCRL) is used to conduct fundamental research to understand and advance spray combustion science. This laboratory was established to provide an understanding of injector performance under "realistic" operating conditions for range of injector parameters, and to provide an understanding of the impact of fuel properties on the detailed spray and combustion processes and to generate a database of spray and combustion measurements. These data are being used in 3D Computational Fluid Dynamics (CFD) codes to simulate real engine spray and combustion processes, including piston motion and in-cylinder turbulence. The facility contains a constant pressure flow through chamber with optical access that is capable of reaching temperatures and pressures up to 1000 K and 150 bar, respectively. The flow-through chamber is capable of simulating typical conditions found in an operational compression ignition engine with relative isolation of dynamic fluid motion. An on-site nitrogen generator and gas mixer allow the ambient gas composition to be varied from 0-21% oxygen concentration to provide the capability to study reacting and non-reacting conditions. The facility contains an array of high-speed cameras, a CCD camera, Mie and schlieren optical diagnostics and a Nd:YAG coupled to a dye laser for performing laser diagnostics. In addition, the SCRL is equipped with multiple fuel benches to provide high-pressure fuel for a wide range of injector configurations. The laboratory contains an injection analyzer that is used to determine shot-to-shot injected fuel mass and rate of injection. Various fuels, such as JP-8, F-24, diesel and synthetic fuels, can be studied in the facility.

Transonic Dynamics Tunnel (TDT) VA

The Transonic Dynamics Tunnel (TDT) is a continuous flow wind-tunnel facility capable of speeds up to Mach 1.2 at stagnation pressures up to one atmosphere. The TDT has a 16-feet square slotted test section that has cropped corners
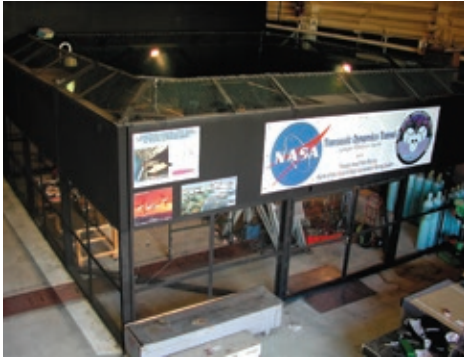
and a cross-sectional area of 248 square feet. Air or R-134a, a heavy gas, is used as the test medium. The TDT is particularly suited for rotorcraft aeroelastic testing, primarily because of three advantages associated with the heavy gas. First, the high density of the test medium allows model rotor components to be heavier; thereby, more easily meeting structural design requirements while maintaining dynamic scaling. Second, the low speed of sound in R-134a (approximately 550 feet/second) permits much lower rotor rotational speeds to match full-scale hover tip Mach numbers and reduces the time-scales associated with active control concepts and dynamic response. Finally, the high density environment and low kinematic viscosity of the R-134a test medium increases the Reynolds number throughout the test envelope, which permits more accurate modeling of the full-scale aerodynamic environment of the rotor system.

Turbine and Structural Seals Team Facilities OH

Seals Team Facilities conceive, develop, and test advanced turbine seal concepts to increase efficiency and durability

of turbine engines. Current projects include developing non-contacting seals for near-infinite life. Seals Team Facilities also perform experimental and analytical research to develop advanced structural seals. This includes propulsion system and control surface seals for next-generation launch vehicles and thermal barrier seals for solid rocket motor nozzle joints.

Universal Drive Train Facility APG

This vehicle drive train research facility is capable of evaluating helicopter and ground vehicle power transmission technologies in a system level environment. The flexible lab contains 1,000-horsepower and 250-horsepower motors/dynamometers capable of simulating inputs and outputs of many Army vehicle transmissions, including helicopter main transmissions and tail rotor drive trains as well as ground vehicle drive train elements. This laboratory proves innovative component technologies, alternate system architectures, and mechanical diagnostic techniques before they transition to the U.S. Army Aviation and Missile Research Development and Engineering Center (AMRDEC) and the U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC). It serves a vital transitional role for fundamental and applied drive train component technologies.

Facilities Index

Aberdeen Proving Ground, Aberdeen, Maryland

Adelphi Laboratory Center, Adelphi, Maryland

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