



# FAR WEST & MID-CONTINENT REGIONAL MEETING

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August 24 - 25, 2021

# WELCOME TO THE 2021 FLC FAR WEST & MID-CONTINENT JOINT REGIONAL MEETING

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# WILDFIRE TECHNOLOGY PARTNERSHIP FORUM

## SCHEDULE AT A GLANCE

TUESDAY, AUGUST 24

ALL TIMES EDT

TIME	ACTIVITY	INFO
11:30 - 11:40 a.m.	<b>Welcome Regional Activities Introductions</b>	The Far West and Mid-Continent Regional Coordinators, David Nicholson and John Eisemann, welcome you to the 2021 FLC FW/MC Joint Regional Meeting and Industry Event. Opening remarks will be followed by a description of the event.
11:40 a.m. - 12:10 p.m.	<b>Introduction to the Growing Problem of Wildfires</b>	Federal laboratories are adjusting their priorities in response to changes in climatic and environmental conditions, which are creating wildfire risks. Various technologies are being developed to address this problem, such as fuel load abatement, material science to harden structures, fuel load and wildfire modeling technologies, and other fire-fighting tools and techniques.
12:10 - 12:30 p.m.	<b>The Federal Technology Transfer Program</b>	Overview of technology transfer and federal research resources
12:30 - 1:15 p.m.	<b>Grid Monitoring and Protection</b>	Unsupervised anomaly detection for identifying arcing hazards on power distribution systems
1:15 - 1:30 p.m.	<b>Break</b>	
1:30 - 3 p.m.	<b>Fire Mitigation and Control</b>	<p><b>Part I:</b> Fuel reduction through use of gasifiers and conversion of biomass into packaging and soil amendments</p> <p><b>Part II:</b> Mobile biomass processing and biopower unit: a cost-effective, scalable, and low-emissions complement to controlled burns</p> <p><b>Part III:</b> Fire-retardant gels and fire-resistant building materials</p> <p><b>Part IV:</b> Novel flame-retardant hybrid sulfur-polymer polyurethane block copolymer chemistry platform</p> <p><b>Part V:</b> Super absorbent polymers for wildfire resistance applications: personal shelters and building materials</p>
3 - 3:10 p.m.	<b>Closing Remarks</b>	

# WEDNESDAY, AUGUST 25

ALL TIMES EDT

TIME	ACTIVITY	INFO
11:30 - 11:35 a.m.	<b>Day Two Welcome</b>	
11:35 a.m. - 12:10 p.m.	<b>Federal and State Government Resources and Private Resources</b>	<p><b>Part I:</b> Grants and other resources provided by federal and state agencies</p> <p><b>Part II:</b> Overview of how economic developers can assist entrepreneurs and identify how entrepreneurial support networks can help foster a successful business</p> <p><b>Part III:</b> Venture capital and private investment leveraging government research</p>
12:10 - 1:10 p.m.	<b>Tools and Test Facilities</b>	<p><b>Part I:</b> Partners from industry and academia can utilize Sandia's Fire Science and Technology expertise, which includes designing and executing instrumented fire tests at large scales</p> <p><b>Part II:</b> Toolkit for evaluating the impact of various forest management and wildfire fuel treatment strategies on the carbon cycle</p> <p><b>Part III:</b> Fuelcast.net: Providing weekly in season projections of forage and fuel on U.S. rangelands</p> <p><b>Part IV:</b> The Applied Research Center of the University of Hawaii has developed tools for disaster mitigation and monitoring, including technology addressing wildfire hazards</p>
1:10 - 1:25 p.m.	<b>Break</b>	
1:25 - 2:25 p.m.	<b>Awards Ceremony</b>	Join moderator David Kistin, Mid-Continent Deputy Regional Coordinator, as we recognize this year's award-winning technologies from both regions.
2:25 - 3:25 p.m.	<b>Modeling and Prediction</b>	<p><b>Part I:</b> Watershed monitoring strategies for assessing wildfire impacts to surface and groundwater quality and landscape resilience, including rapid response capabilities</p> <p><b>Part II:</b> Advanced vegetation dynamic modeling to project and evaluate trade-offs needed to optimize strategies for co-existing with wildfire under climate change</p> <p><b>Part III:</b> Fire simulation for predicting wildland response: high flux forest fire scenario for assessing relative model accuracy for Computational Fluid Dynamics (CFD) tools</p> <p><b>Part IV:</b> NOAA's newest Global Ensemble Forecast System reforecast dataset and its application for wildfire prediction</p>
3:25 - 3:30 p.m.	<b>Closing Remarks</b>	

## THANK YOU TO OUR PARTNERS





## ARS releases eight new dry-seed legumes for commercial use, including first-ever winter-hardy peas

USDA, Agricultural Research Service, Grain Legume Genetics and Physiology Research Unit

The U.S. Department of Agriculture (USDA) Agricultural Research Service (ARS) during fiscal year 2021 released eight new varieties of dry-seed legumes for commercial use, completed a commercial license for one variety and was in the process of negotiating another.

These achievements by the USDA-ARS Grain Legume Genetics and Physiology Research Unit in Pullman, Washington, add to the unit’s successful record of developing and releasing new varieties of pulse crops (which include chickpeas, dry beans, dry peas, and lentils) that have been commercially adopted.

Pulse crops have been important contributors to human nutrition and sustainable agricultural productivity for thousands of years. More than 3.4 million acres of these crops were harvested in the U.S. in 2020, with a total production value exceeding \$1.4 billion. In the Pacific Northwest and Northern Plains, rotating pulse crops and small grain crops on the same land can improve the amount and quality of grain harvested. The pulses reduce the risk of diseases associated with several small grains and help control grassy weeds. In addition, pulse crops produce their own nitrogen, which helps to fertilize subsequent small grain crops.

New varieties of pulse crops are needed that have improved field traits, such as yield and disease resistance, and are also robustly characterized for nutritional qualities. In particular, new winter-hardy pulse varieties are needed that can be planted in the fall and rotated with winter wheat or winter barley crops.

The new varieties of pulse crops released by USDA-ARS in FY 2021 included:

- one small green lentil variety (USDA Sage),
- two pinto bean varieties (USDA Basin and USDA Rattler), and
- two new varieties of spring-sown yellow peas (USDA Kite and USDA Peregrine).



Above: Pulse varieties, released and commercialized

Most importantly, three new varieties of fall-sown peas were released including two fall-sown green pea varieties (USDA MiCa and USDA Dint) and a new fall-sown yellow pea variety (USDA Klondike). These are the first food-grade fall-sown pea varieties released by the USDA-ARS and will provide producers in the Pacific Northwest and Northern Plains with an alternative fall crop option other than wheat and barley.

Although most of these new varieties are “publicly released,” some have been protected through Plant Variety Protection Certificates (similar to patents) and licensed to grower and farmer cooperatives.

During FY 2021, the USDA-ARS completed a commercial license with the Washington State Crop Improvement Association for a recently released chickpea variety (USDA Quinn), and is actively negotiating a commercial license for a recently released pinto bean variety (USDA Rattler).

Plant Evaluation Material Transfer Research Agreements for USDA-developed pulse crops are also in effect with Washington State University, South Dakota State University, University of Idaho, and Montana State University. ☼



## Public-private partnership including Berkeley Lab connects clean energy entrepreneurs with testing facilities

### Lawrence Berkeley National Laboratory

Clean energy entrepreneurs in California now have access to more than 60 world-class testing facilities, thanks to CalTestBed, a voucher program led by New Energy Nexus (NEX), in partnership with Lawrence Berkeley National Laboratory (LBNL) and the University of California Office of the President (UCOP).

The CalTestBed Initiative is providing \$8.8 million in voucher funding to clean energy entrepreneurs to access testing facilities located at nine University of California campuses and LBNL. Voucher recipients are also connected to NEX's global network of climate-focused technology accelerators, and they are featured in the Entrepreneur Directory and during the National CalTestBed Symposium. These connections to scientific and technical resources and next-level partners—such as customers, investors, corporations, and utilities—help facilitate commercialization of clean energy innovations and allow companies to take their businesses to the next level.

The program “gives clean energy entrepreneurs a greater chance at success, which helps California further its nation-leading energy and climate goals,” according to David Hochschild, chair of the California Energy Commission, which funds the initiative.

Forming a partnership among multiple public and private institutions was logistically complex. NEX worked with UCOP to create a custom agreement framework for the program that included agreements between NEX and UCOP, NEX and each UC campus, entrepreneurs and their associated campus testing facilities, and between NEX and each entrepreneur.

For LBNL, the partnership vehicle to secure project funds is a Master Strategic Partnership Projects (SPP) agreement with NEX. Each CalTestBed project is then funded under a task order to the Master SPP. The actual testing scope is performed under a cooperative research and development agreement (CRADA) between the



Above: The Materials Project. 1: National Energy research Scientific Computing Center. 2: Photo credit: California Electric Transportation Coalition.

entrepreneur and LBNL. LBNL's effort under the CRADA is funded from the task order (the “voucher” amount); the entrepreneur funds its own time and effort, which is quantified in the CRADA as the in-kind contribution.

After an initial round of more than 100 entrepreneur applicants, nearly \$6 million in testing vouchers were awarded to 25 clean energy entrepreneurs in December 2020; 27% of voucher recipients were minority-owned and/or women-owned. That inaugural class of entrepreneurs was showcased at the first annual CalTestBed symposium, which was attended by more than 500 prospective partners from industry.

The second solicitation for CalTestBed submissions has been completed, and recommended applications are currently conducting laboratory consultations. Planning for the December 2021 symposium is under way.

“From several perspectives, this [CalTestBed] is already successful,” said Sandra Brown, Vice Chancellor for Research at the University of California San Diego. “It is a new model of an integrated, statewide ecosystem for commercial acceleration; it is widely known in the clean-energy arena, and it is widely appreciated across the state.”



## OpDefender security system from INL protects computer-controlled industrial networks from cyberattacks

### Idaho National Laboratory

Researchers from Idaho National Laboratory have engineered a technology that can protect utilities and other users of computer-controlled industrial systems from cyberattacks.

The effort was inspired by years of assessments showing that industrial control systems (ICS) are vulnerable to cyberattack, with unauthorized commands posing a particularly insidious threat since they're relatively easy to perpetrate and difficult to block. Attackers with the right level of knowledge and access can have a major effect on a power grid, for example, using the same software and commands that the grid's legitimate operators would use.

Called OpDefender, the new patent-pending technology consists of two main components: a network switching appliance and a network human-machine interface (HMI).

The network switching appliance can serve as a drop-in replacement for a typical network switch, or it can be used in conjunction with existing network switches. It protects ICS from cyberattack by adding intelligence to the network switch to make it ICS-aware.

OpDefender is configured and controlled in real time via a custom-built, web-based HMI designed with the operator in mind. It is secured using strong public-key encryption technology (RSA certificates) that allows for mutual authentication only between hosts that have the correct certificate installed. This helps ensure that an attacker can't compromise the control channel to enable communications without the operator's knowledge or consent.

OpDefender starts with the premise that no device on a control system network can be trusted. It operates under whitelisting rules, meaning that no device is allowed to communicate on the network until the OpDefender is configured to allow that device. Any data transmitted by a device that is not already whitelisted triggers an alarm, alerting operators of a rogue device on the network.

Once a device is allowed on the network, then the protocols and specific commands it can receive are



Above: OpDefender network switching appliance.



Above: OpDefender human-machine interface (HMI).

further whitelisted. By default, OpDefender limits network traffic to the most basic communication, which in most cases consists almost exclusively of status requests from one or more operator workstations to field devices that are installed throughout a plant, utility or other system.

OpDefender's efficacy was demonstrated during a recent full-scale test at Idaho National Laboratory's Critical Infrastructure Test Range, cybersecurity researchers launched 14 different novel attacks at a system protected by OpDefender. The attacks targeted multiple different control devices from multiple vendors. OpDefender blocked each of these attacks and generated alarms for each, alerting the operator that an attack was taking place.

OpDefender is currently at a Technology Readiness Level 6, meaning it has a fully functional prototype or representational model. Additional work is needed to make it commercially viable, but results to date show that it could make a difference in the fight to secure industrial control systems.☞



## NASA technology minimizes weather-related flight delays, reducing costs and environmental impacts

National Aeronautics and Space Administration, **Ames Research Center**

Scientists at the National Aeronautics and Space Administration (NASA) Ames Research Center have developed an improved aircraft routing technology that can reduce weather-related flight delays while maintaining travelers' safety and keeping air traffic controllers and airline dispatchers in the loop.

In order to gain predictability and maintain safety, the Federal Aviation Administration (FAA) traffic managers implement Playbook Routes, tailored route solutions that are pre-coordinated with flight operators. During severe weather events, these routes reduce the workload on decision-makers; however, maintaining separation from the weather adds considerable flight length and time. Often, when the weather has dissipated or moved away, controllers do not have the time to proactively revisit and reoptimize the weather-avoidance routes that were approved preflight.

The NAS (National Airspace System) Constraint Evaluation and Notification Tool (NASCENT) technology is the first solution to recognize that the primary technical challenge is not computing a more efficient route alternative as compared with the state of the art. The primary technical challenge is to present to air traffic controllers a more efficient route that they can trust, easily process and ultimately approve, even amid the stress and chaotic tempo of severe weather operations.

NASCENT successfully overcame the trajectory optimization problem and the human factors problem simultaneously. NASCENT continuously looks for opportunities and proposes safe and efficient advisories that can bring the flights back on nominal routes, saving



Above: NASCENT in operation during evaluation at American Airlines Integrated Operations Center (IOC) in Fort Worth, TX.

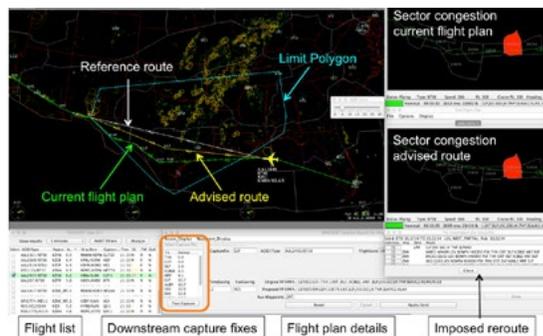
time and fuel. Before the NASCENT invention, aircraft would often continue to fly the longer routes, wasting millions of pounds of fuel and causing some passengers to miss their connections.

The air traffic managers and flight operators desire a continuous search engine that provides them with safe opportunities to save time and fuel. NASCENT's proposed advisory routes are free of conflicts with weather, help reduce overall sector congestion, and avoid any federally designated special use/activity areas—while also accounting for safety and historically used routes to facilitate controller approval.

After the system has created and validated a new route, the user—typically an air traffic controller or a dispatcher—has the option to accept the advisory or modify it. The route change is communicated to the aircraft pilot, who requests clearance from the air traffic controller handling that flight. The controller accepts or rejects the request. If accepted, the pilot can safely fly the newly advised route.

Simulation experiments conducted by NASA suggest that, for the 30 most weather-impacted days of one summer, NASCENT innovation would have found more efficient re-routes for about 15,000 flights, saving airlines more than 135,000 minutes of flying time and about 4.2 million pounds of fuel. Previous research suggests these savings would also reduce harmful emissions by approximately 8%. And a time savings of even five minutes can prevent significant delays and missed connections that can have impacts across the airspace system.

Right: NASCENT Graphical User Interface for Airline Use. Situational display of traffic and weather, congestion, available opportunities, and individual flight information, along with FAA Traffic Management Initiatives.





## ARS technology makes studying tick-borne diseases less expensive and less dependent on live animals

U.S. Department of Agriculture, **Agricultural Research Service, Pacific West Area**

An artificial tick feeding system designed by the U.S. Department of Agriculture (USDA) Agricultural Research Service (ARS) offers a less expensive way to study tick-borne diseases that also minimizes the number of live animals required for research.

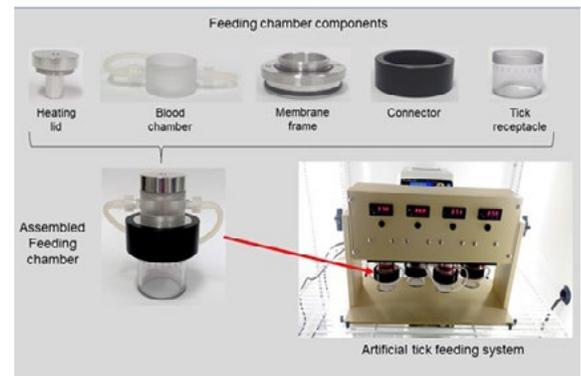
Scientists from around the world have been focused on addressing the problem of tick infestation and tick-borne diseases. Tick infestations have expanded into areas that were once considered tick-free and are comingling with wildlife, livestock, and humans resulting in the spread of tick-borne pathogens (microorganisms that cause disease). Lyme disease in humans is the best-known tick-borne disease, but similar diseases in cattle and other animals can be costly for the livestock industry.

Ticks feed off the blood of live "host" animals, which can be mammals, birds, reptiles, or amphibians. When a tick feeds off an infected host animal, it too can become infected with a pathogen and then pass on the infection to its next host.

Research involving ticks typically requires the use of live animals. However, animal experiments are costly, as large numbers of animals are required to generate enough data to reliably test scientific hypotheses. In addition, the variation between individual animals prevents standardized research.

The artificial tick feeding system designed by ARS scientists at the Animal Disease Research Unit (ADRU) in Pullman, Washington, simulates the process by which ticks feed off the blood of a live animal. In the artificial system (also called an *in vitro* system), the blood is contained in a temperature-controlled chamber, and ticks access the blood through a synthetic membrane instead of animal skin.

In a study published in January 2020 by *Scientific Reports*, ARS researchers and colleagues from Washington State University demonstrated that the artificial feeding system could be used to simulate the tick-borne disease transmission process. Uninfected ticks used the system to feed on infected blood, then



Above: The artificial tick feeding system.

on uninfected blood; the previously uninfected blood showed evidence of bacterial infection after tick exposure.

This system can help reduce the number of animals required for detailed studies of tick-pathogen interactions. In addition, the *in vitro* tick feeding system allows for the testing of various strategies for preventing tick attachment, such as the use of essential oils and tick-specific chemical treatments.

A variety of design attributes make the *in vitro* tick feeding system an elegant solution for the study of tick-borne diseases in the laboratory. The simple assembly and disassembly of the feeding chambers allows cleaning and blood changing without interruption of tick feeding, which improves experiment consistency and reproducibility. Individual chambers provide identical biological conditions for testing. The use of synthetic membranes eliminates the need for animal skin.

Several national and international institutes working on tick and tick-borne disease research established collaborative agreements with USDA to improve their research by using the ARS artificial tick feeding system. In addition to cattle pathogens, some collaborators are using the system to study tick-borne pathogens that affect humans, such as *Borrelia burgdorferi*, the causative agent of Lyme disease.🌀



## Sandia's inverse approach to software design gives the optical metamaterials field a critical boost

### Sandia National Laboratories

The field of optical metamaterials is a giant step closer to realizing its futuristic potential, thanks to an innovative approach to software design developed at Sandia National Laboratories and the support of federal and industry partners.

For more than two decades, man-made optical metamaterials—artificial materials engineered to have properties not found in nature—have been promoted for their ability to manipulate light in extraordinary ways. The 3D geometry and symmetry of a metamaterial dictate how it responds to incoming light.

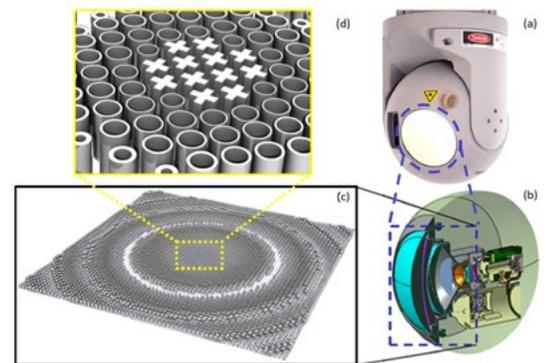
The possible applications for this technology are vast. Three-dimensional (3D) optical chips one day could lead to optical computing, in computers with orders-of-magnitude faster clocking speeds. In fact, metamaterial technology could someday lead to cloaking materials that deflect light around them, rendering objects undetectable.

But the field of optical metamaterials has struggled to achieve its full potential. This is because of its reliance on trial and error to find optimal configurations that result in desired optical behaviors.

MIRaGE (Multiscale Inverse Rapid Group-theory for Engineered metamaterials) software turns this problem on its head using an inverse-design approach conceived by Ihab El-Kady, PhD, Distinguished Member of Technical Staff at Sandia's [National Security Photonic Center](#).

"We cannot solve this problem by trial and error, because of the almost infinite number of possibilities," El-Kady said. "We know the structural symmetry dictates the final behavior, so we reversed the process: We start with what the user is trying to achieve, then we tell them what symmetries the metamaterial has to have, and guide them in building that symmetry."

El-Kady and his team at Sandia built MIRaGE in partnership with a small business software company, Stellar Science, Inc. Initially, the development of MIRaGE was sponsored by the Defense Advanced Research Projects Agency (DARPA) for national security purposes; this funding has been augmented by the National Geospatial Intelligence Agency (NGA). To date, DARPA and



Above: (a) The Air Force fighter jet gimbal. (b) Schematic of the internal structure of the optical imaging assembly where the metalens is being inserted. (c) An image of the metalens designed by MIRaGE for the gimbal. (d) A zoom in image of the metalens core showing the different metamaterial unit cells.

NGA have invested more than \$10 million for development of MIRaGE and continue to fund further development.

After four years and about six million lines of code, MIRaGE is in use at more than 30 national institutions including universities, government entities, private and publicly traded defense contractors, and small businesses.

A distribution and licensing [website](#) was set up to facilitate transfer of the software. An unrestricted version is free to research facilities and contractors engaged in government research, while a restricted version is only available to government entities. Select private companies can obtain MIRaGE, depending on their work.

Technology transfer projects facilitated by MIRaGE include:

- The design of a Fitter-Jet Optical Gimbal (see figure) in collaboration with Northrup Grumman for the Air Force under direction from NGA.
- A partnership between Sandia and General Electric Research to design an ultralight wearable optic for night vision in eyeglass form.
- Next-generation 3D electromagnetic antenna designs in collaboration with the University of North Carolina, Charlotte. ☞



## NREL and Shell Global create 'partnership for partnerships' to support clean energy start-ups

### National Renewable Energy Laboratory (NREL)

Clean energy start-up companies have raised more than \$50 million and made significant progress toward commercializing their technologies thanks to a "partnership for partnerships" program jointly created by Shell Global and the National Renewable Energy Laboratory (NREL).

The Shell GameChanger Accelerator Powered by NREL (GCxN) is a multimillion-dollar partnership managed under a Department of Energy Agreement for Commercializing Technology (ACT) that was executed in 2018.

GCxN's mission is to identify and mature the next generation of technologies with the potential to impact the future of energy. Specifically, GCxN looks for companies with a novel early-stage technology idea, a provable concept, and demonstratable value. GCxN aims to provide start-ups with the support—including access to financial resources, state-of-the-art facilities at NREL, and world-class technical experts—necessary to move from an idea on a chalk board to a commercial product deployed in the marketplace.

GCxN searches for innovations amenable to its yearly industry-focus areas, called Cohorts. Cohorts have included energy storage and grid integration, fast charging and grid integration, electrosynthesis for fuels and chemicals, and e-mobility and industrial electrification.

GCxN identifies promising startup companies through its Pipeline Partners, an extensive ecosystem of clean-tech business incubators, accelerators, and universities, with finalists selected by technology experts at both NREL and Shell. Over the course of 18 to 24 months, invited companies receive up to \$250,000 in non-dilutive funding in the form of technical experts and facilities to develop and demonstrate new energy technologies.

Participating companies execute an Intellectual Property Agreement (IPA) with NREL that provides an option to secure rights to any subject intellectual property that may be developed by NREL while providing technical assistance to each company. In fall of 2021, NREL will finalize a license with a GCxN



*Above: Shell-NREL partnership GCxN advances start-ups at national laboratories.*

company for commercial rights to a software tool developed by NREL during a technical assistance project. NREL anticipates much more licensing activity between NREL and the GCxN companies as ongoing technical assistance projects are completed.

The first two Cohorts of start-ups graduated in 2021. Aggregate program benefits include more than \$52 million raised by Cohort companies to date, which translates to approximately \$21 raised for every dollar of Shell funding. Additionally, at least 51 new startup hires have occurred.

And, as intended, the Shell-NREL partnership has led to more partnerships. Examples from 2020 include:

- Electric Grid Monitoring, developer of artificial intelligence-based energy analytics, partnered with the New York Power Authority.
- Hygge Power, developer of small energy storage devices, launched a pilot with Florida Power & Light.
- Jolt Energy Storage, which makes high-performance batteries from organic compounds, extended its partnership with Argonne National Laboratory.
- Microgrid Labs, provider of electric vehicle modeling and optimization software, partnered with Enel X and the Massachusetts Bay Transportation.
- Span, developer of a smart electric panel, launched a partnership with Panasonic.Ⓢ



## By prioritizing partnership agreements, 59th Medical Wing ORTA makes a big impact in a short time

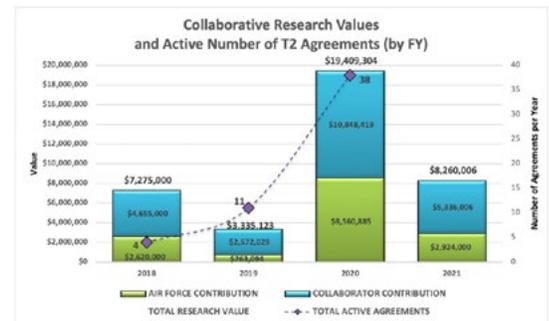
### U.S. Air Force, 59th Medical Wing Science & Technology

Established in late 2016, the 59th Medical Wing (59 MDW) Office of Research and Technology Applications (ORTA) has quickly demonstrated its commitment to collaboration, executing a total of 83 active partnership agreements before its fifth birthday. And the five-person team's collaborative momentum is increasing, as the majority of those agreements have been inked in the last two years.

The 59 MDW ORTA is a small team of five professionals committed to helping establish collaborative partnerships with businesses, academia, and other organizations to address military medical needs with the best solutions possible. The team also promotes bilateral transfer of technology between federal, state, private, public, and nonprofit organizations.

In the past two years, this small team's accomplishments include:

- More than doubling the number of active cooperative research and development agreements (CRADAs) from 17 to 49, with the value increasing by \$26.9 million. These included five active CRADAs with the University of Virginia's Center for Addiction Prevention Research, a research effort to assess addiction-related health risk behaviors and develop interventions to improve outcomes.
- Increasing the number of active Material Transfer Agreements (MTAs) from 16 to 26 active agreements, with the value increasing by \$816,000. These included an MTA with the Wyss Institute of Harvard University to share novel compounds for a collaborative research effort at Brooke Army Medical Center, working to limit the damaging impacts of critical limb injuries by inducing metabolic stasis to "buy time" for definitive care.
- Coordinating three licensing inquiries with Air Force legal staff, with four issued patents, seven pending patents, and one licensing agreement (two others are in negotiations). These included a negative pressure mask that allowed for oronasal access, to protect COVID-19 caregivers during patient transport while



**Above:** The chart shows active technology transfer agreements with total research values by execution year with Air Force and collaborator contribution comparison.

allowing for intubation.

- Providing training in 2020 to 25 individuals on the importance of identifying and securing potential intellectual property (IP), which resulted in a doubling of patent inquiries in 12 months.
- Initiating a new Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) process that enabled \$5.5 million in awards to six small businesses and universities for developing commercially available medical products required by the Department of Defense. They also supported submissions for eight additional projects that may result in awards of \$6 million to other small businesses and universities.

To promote and support collaboration, the team began compiling a monthly report of government medical research and development funding opportunities and sharing it with the San Antonio Economic Development Council (SAEDC) for distribution to an assortment of local small businesses, universities, non-profit organizations, and other groups.

Finally, looking to improve the processes they manage and the quality of support they provide, the 59 MDW team conducted a quality improvement review in the spring of 2021. This evolved into the team's first-ever strategic plan, which will guide the process of enhancing operations over the next several years. ☺



## Quantum encryption technology developed at LANL reinvents cybersecurity for electrical grids

### Los Alamos National Laboratory

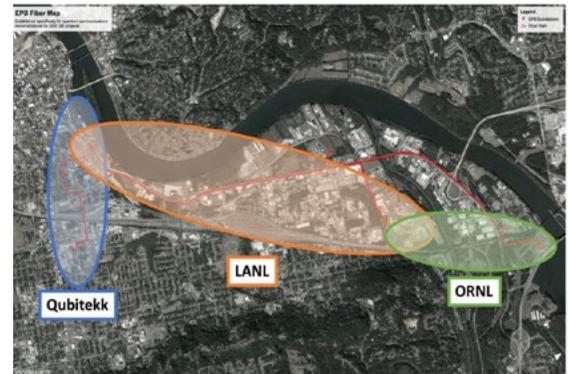
As hackers' growing access to advanced computing technology threatens conventional encryption systems, scientists from Los Alamos National Laboratory (LANL) are using quantum principles to give electrical grids extra protection against cyberattacks that can leave millions without power.

National security, economic productivity, and human health can be imperiled when an electrical grid is compromised. Scientists in the field of cryptography have developed highly complex, mathematically based security code problems to protect these critical infrastructure operations. However, as computing power steadily increases, so does the chance that adversaries will decode these complex encryptions.

Current encryption systems rely on computational difficulty, such as factoring a large number, for defense against eavesdropping, impersonation, or other types of malicious actions. But these systems are becoming more vulnerable as hackers gain access to advances in computing power, efficient algorithms, and artificial intelligence. This concern is particularly relevant to critical infrastructure, such as electrical grids, which cannot be quickly updated or patched to accommodate every new security vulnerability.

Scientists at LANL are seeking to escape this ongoing attack-defend cycle by developing a new method for protecting information called Quantum Ensured Defense (QED). Instead of mathematical complexity, this method uses physics—specifically, the unusual behavior of the quantum realm.

Currently, information that is sent through the internet is passed through the optical fibers as pulses of photons from a transmitter on one end to a receiver at the other. QED uses these same principles and goes further by making the light pulses so dim that they contain on average a single particle of light, or photon. These photons are used to create cryptographic "keys" which can be used to "lock" control signals into secret codes—a process called quantum key distribution (QKD).



Above: Back-to-back operation of three quantum communication systems, each operating on different physical principles during the successful field demonstration with Oak Ridge National Lab, Qubitekk Inc., and EPB in Chattanooga, Tennessee. Red line indicates layout of optical fibers on EPB's metroscale commercial system.

Scientists know the information is protected for three reasons: a photon cannot be cut in half; a photon cannot be accurately copied; and a photon cannot even be measured without changing it in some way.

Los Alamos researchers partnered with Oak Ridge National Laboratory, QKD developer and manufacturer Qubitekk, and the Electric Power Board (EPB) of Chattanooga, Tennessee, to bring this futuristic idea of quantum-ensured security to an actual electric grid. Together they tested a network of three different QKD systems (see figure) on EPB's optical fiber network, which included the grid's communications center and substations. The field tests successfully demonstrated the interoperability of these diverse QKD systems' keys, without the need for a complete system overhaul.

In the near future, LANL will be seeking a cooperative research and development agreement (CRADA) partner to further develop this technology for its unique applications. Many of the technologies that have been developed for electrical grids could be adapted to protect other types of infrastructure under computer control that are subject to hacking. ☎



## LANL moisture sensors work with partner's smart chutes to make biofuel production more efficient

### Los Alamos National Laboratory

Moisture-sensing technology from Los Alamos National Laboratory (LANL) is designed to make conveyor-based biomass refineries more efficient, by identifying too-wet materials before they create clogged machinery.

Biomass, which is plant or animal material that can be used as fuel, is converted in a biorefinery. If a conveyor or chute becomes clogged, the refinery needs to be stopped, and the moisture-laden biomass needs to be removed by hand. This is among the factors currently keeping biofuel from being cost-competitive with diesel and gasoline fuels.

The patented LANL technology, which uses sound waves to quantify the moisture content of the material being processed, will soon be integrated with a "smart chute" system developed by Jenike & Johanson, a bulk-solids handling company. When the LANL acoustic sensor deems the biomass too wet to process—a possible clog risk—the Jenike & Johanson technology uses a computer to make a track change on the conveyor belt, redirecting the material to be further dried.

Under a cooperative research and development agreement (CRADA), LANL and Jenike & Johansen are integrating their technologies with an initial focus on corn stover (composed of the non-edible stalks, leaves, cobs, and husks left over from harvesting), one example of a type of biomass that is particularly prone to excessive moisture content. Sound waves are directed through the corn stover; the extent to which the sound waves change as they pass through the material indicates the moisture content.

Currently, the target location of these acoustic moisture sensors is at the bottom of the feed hopper supplying corn stover to the "smart" transfer chute. When the acoustic moisture sensor detects moisture contents greater than 35%, the smart chute diverts the high-moisture material. When the moisture content returns to acceptable levels (<30%), the smart chute reactivates and directs incoming feedstock back into the integrated



Above: A prototype conveyor at Los Alamos National Laboratory moving bulk material and measuring moisture content.

biorefinery process. The too-wet feedstock that was diverted is further processed to an acceptable moisture level before being reintroduced to the handling train.

Many acoustic sensors can be applied throughout the handling train to monitor moisture content at each stage of the biorefinery process. The actual location will depend on an integrated biorefinery's plant design.

The cost of plugged transfer chutes and processing stoppages is significant in industries beyond biomass. This integrated novel technology could also be applied to bulk solids handling and transportation in the pharmaceutical manufacturing, wood-composite, mining, food-processing, and biochemical industries. Similar to biorefineries, their operations are based on processing significant amounts of bulk material, and processing efficiency and work stoppage are sensitive to moisture content.

While excessive moisture is certainly a challenge, insufficient moisture also presents safety and handling problems that can be avoided using the integrated smart-chute system. Materials that are too dry can project unsafe volumes of dust into the air, causing breathing problems, clean-up delays, excessive wear and tear on machinery, and possible dust explosions.☞



## Sandia scientists' fabrication method could improve availability of large nanoparticle supercrystals

### Sandia National Laboratories

Researchers from Sandia National Laboratories have created a way to turn tiny amounts of gold into large, high-quality supercrystals with the potential to improve the chemical detection of drugs or explosives and the performance of sensors, lasers, and solar panels.

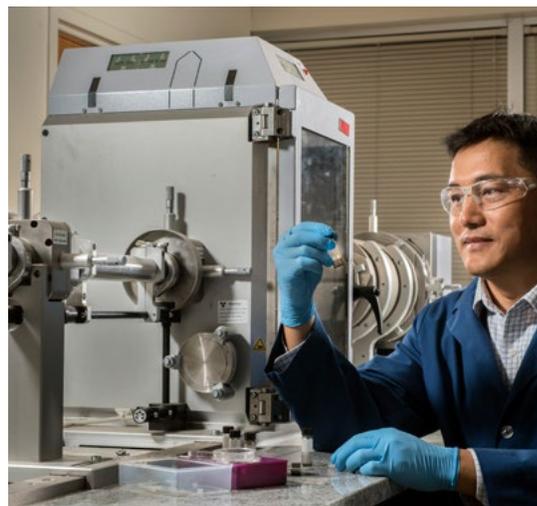
Metallic nanoparticles (a few millionths of a millimeter in diameter) such as gold and silver can self-assemble and crystallize into highly ordered arrays known as supercrystals. Highly ordered single supercrystals have critical applications in areas such as optics, electronics, and sensor platforms. However, the difficulty of obtaining high-quality supercrystals for production scale usage and device integration has limited their wide-scale adoption.

Sandia researchers' solution involves a method for fabricating unusually large (millimeter-sized) supercrystals containing millions of tightly packed gold nanoparticles. The method involves binary solvent diffusion (BSD), in which the nanoparticles are exposed to two types of liquids (solvents). A toluene solution containing gold nanoparticles is topped with isopropanol (IPA), forming a liquid-liquid interface. The IPA solvent then flows (diffuses) into the toluene solvent, and as the concentration of gold nanoparticles becomes too high for all of them to remain in the solution, they slowly emerge and form large nanoparticle supercrystals. These supercrystals have a hexagonal disk shape characterized by facets (similar to those seen in cut diamonds).

In addition to supercrystals made from gold nanoparticles, the scientists also successfully used the same method to create supercrystals from other nanoparticle materials such as semiconducting (e.g., cadmium selenide, lead sulfide, lead selenide) or magnetic (e.g., iron oxides, iron platinum).

The BSD method has several competitive advantages over conventional approaches to supercrystal fabrication and sensing (e.g., using single-nanoparticle or thin film substrates) that will enhance its potential for use in industry applications.

- It offers more systematic control of nanoparticle morphology and structure, which allows precise tunability of the shape, size, composition, and other



Above: Sandia National Laboratories researcher Hongyou Fan holds a container enclosing gold supercrystals in front of a small-angle X-ray scattering instrument. (Photo by Randy Montoya)

functional properties. These advanced functional materials are of major interest for materials manufacturing companies.

- The facets of the nanoparticle supercrystals enable new facet-dependent chemical and physical properties. Some of these properties, for example, can be used to enhance a local electromagnetic field. This is important for a variety of applications in nanoelectronic and photonic devices, such as optical antennas for cellular media and photovoltaics.
- Sensors made from supercrystals are nine times more sensitive for chemical detection than nanoparticle in solution or thin film nanoparticle substrates. These sensors have practical applications in airport and drug screen testing, etc.
- It enables large scale fabrication and reproducible properties in applications at reduced cost. The bench-top sensors are surprisingly inexpensive despite the use of gold. The total materials cost of a sensor is roughly 50 cents, which makes them so inexpensive that they can be considered disposable.☞



## Device from Sandia and Know Biological will warn people with epilepsy of oncoming seizures

### Sandia National Laboratories

People living with epilepsy could soon have life-changing access to a portable device that will give them up to 30 minutes of advance warning before a seizure occurs, thanks to a partnership between Sandia National Laboratories and Know Biological.

Worldwide, there are nearly 65 million people with epilepsy, and more than 3.5 million in the U.S. alone. Epilepsy is characterized by recurring periods of abnormal or excessive electrical discharges in the brain that result in seizures. One-third of epilepsy patients experience seizures that cannot be controlled with medication or medical intervention.

Unexpected seizures can result in accident, injury, embarrassment, and costly trips to the emergency room. They can be difficult to predict and can be dangerous, particularly when the patient is unable to contact family, a friend, or medical personnel.

The diagnostic device under development by scientists from Know Biological and Sandia will offer an impactful, meaningful improvement to the lives of epilepsy patients and their families by providing them with an actionable, early warning of seizure events.

Researchers at Know Biological have identified several key volatile organic compound (VOC) biomarkers—chemicals that the body emits through sweat, saliva, and exhaled breath—that are released five to 30 minutes prior to an epileptic seizure in humans. Service dogs for people with epilepsy have been taught to detect these chemicals and alert their owners of a coming seizure, but patient access to such dogs is limited, and no reliable alternative detection systems are yet available.

Under a cooperative research and development agreement (CRADA), Know Biological's biomarker expertise is being paired with Sandia's chemical sensing technology to create a wearable diagnostic monitor for VOC biomarkers that would warn patients of an upcoming epileptic seizure. This critical early warning will allow patients to protect themselves and otherwise prepare for the vulnerability caused by seizures.

The three-stage detection system consists of several microfabricated and miniaturized chemical sensing



*Above: Sandia's Skin Volatile Collector (SVC), about the size of a watch face, will be worn against the patient's skin to collect biomarkers diagnostic of future seizure onset. Integrated heaters and flow control will draw the biomarkers into the sensor system for analysis.*

technologies developed at Sandia. The process starts with a device about the size of a watch face, with a thin film of synthetic material that captures VOCs from the patient's skin. The collected chemicals are separated using gas chromatography, and then identified using Sandia's miniature ion mobility spectrometer technology. Each stage will increase overall system sensitivity or selectivity.

Ultimately the complete system will produce a high-reliability diagnostic that patients can trust. The developers expect the diagnostic instrument to weigh less than five pounds and be readily portable to give patients full freedom of movement.

Know Biological has licensed six of Sandia's patented technologies related to VOC detection. In addition, Know Biological and Sandia have three patent filings that resulted from the CRADA; the first was awarded in June 2021. The two parties are also jointly filing a fourth patent in 2021, on a device that incorporates additional sensor technology and is applicable to health conditions beyond epilepsy.🌀



## JEAN SCHULTE: Capitalizing on copyright management to enhance tech transfer outcomes

### National Renewable Energy Laboratory



Jean Schulte

Recognizing copyright management as a technology transfer asset, Jean Schulte has embraced that process to generate intellectual property (IP) portfolio growth, inventor buy-in, and an unexpected licensing revenue stream for the National Renewable Energy Laboratory (NREL).

Since taking over management of NREL's software intellectual property portfolio in late 2016, Schulte has streamlined the way the lab manages copyright assertions and deployment of its copyrightable subject matter and software tools. These efforts were already starting to pay off in Schulte's first year, when she facilitated 57 new software records—nearly double the yearly average for the

previous five years. The number of records continued to increase over the next several years, reaching an unprecedented total of 109 software records in 2020.

But Schulte's accomplishments aren't just about the numbers. They're also about the intangible benefits that result from effective communication with inventors, IP attorneys, and prospective licensees.

Schulte has been lauded for her ability to distill a complex subject down to its fundamental issues or salient points, and then communicate those points in an easily digestible manner. This ability has enabled her to interpret and translate highly complex copyright acquisition and licensing processes to both inventors and licensees.

Although she does not have a computer programming background, Schulte has become an expert in multiple types of programming languages and the different licensing terminologies associated with software releases, allowing her to effectively communicate with inventors.

In fact, Schulte has cultivated a belief among NREL inventors that engaging with the software commercialization process can be a benefit, both to their research and to the world. She has inspired researchers to value copyright as a desirable asset—not only something that is necessary to obtain from

a deployment and compliance perspective, but also something that can enhance their funding efforts, encourage partnerships with the lab, and in some cases, lead to license revenue generation.

**“It is safe to say that without Jean taking on this role, software innovation at NREL would look dramatically different.”**

—Anne Miller, NREL Technology Transfer Office Director

Similarly, Schulte has also mastered the nuances of both the Copyright Act and its interactions with various open- and closed-source licensing mechanisms. This allows her to effectively negotiate with both IP attorneys and prospective licensees to more easily facilitate the transfer of these innovations to practical use.

She has also played a critical role in updating, modernizing, and drafting templates for T2 agreements including Trademark License, Software Sales & Distribution License, Software End-User License, Intellectual Property Management Plans, Inter-Institutional Agreements, Nondisclosure Agreements, and Material Transfer Agreements.

“Jean has revolutionized software innovation at NREL with her competence, ability to command respect from innovators and CEOs alike, and her infectious enthusiasm attitude,” said NREL Technology Transfer Office Director Anne Miller. “It is safe to say that without Jean taking on this role, software innovation at NREL would look dramatically different. We feel incredibly lucky to have Jean on our team.”



## ERIC ROSENBERG: Making tech transfer history within the Air Force's information warfare entity

### U.S. Air Force, 67th Cyberspace Wing



Eric Rosenberg

As Chief of Cyber Intellectual Property Law at two Air Force laboratories, the 67th Cyberspace Wing (67 CW) and 688th Cyberspace Wing (688 CW), Eric Rosenberg is known as a top-notch negotiator, trainer, adviser and technology transfer advocate. But he might be best known for his role in making Air Force tech transfer history.

Rosenberg negotiated the first patent license agreement (PLA) in the history of the 16th Air Force, which includes the 67 CW and 688 CW units and is responsible for information warfare. The PLA took effect on December 28, 2020, when 67 CW non-exclusively licensed its Whiddler technology patents to a small

business partner. Whiddler is cybersecurity software that predicts the likelihood of a computer file being malicious, based on a number of observable features.

Rosenberg subsequently negotiated a cooperative research and development agreement (CRADA) with the company, which was signed on March 22, 2021. Under the CRADA, 67 CW will share access to its unclassified malware repositories to help train the company's Whiddler-based software to recognize the difference between malicious and benign computer files. A second PLA relating to the Whiddler patents was signed on May 26, 2021.

Multiple steps were required to facilitate the technology transfer, including the January 2020 establishment of 67 CW as a federal laboratory with delegated authority from the Air Force Research Laboratory to enter into PLAs.

The three PLAs negotiated by Rosenberg in the last year are expected to earn 67 CW more than \$145,000 per year in royalties, some of which will be shared with the inventors and other contributors. During the same time frame, Rosenberg negotiated, drafted, and reviewed 18 cooperative research and development

agreements (CRADAs) worth more than \$15 million.

Cybersecurity professionals are in high demand in the private sector, where they earn higher salaries than can be offered typically by government. Financial incentives related to patent royalties can help 67 CW retain its skilled developers and other top talent.

**In December 2020, Rosenberg negotiated the 16th Air Force's first patent license agreement, which was focused on 67 CW's Whiddler cybersecurity software.**

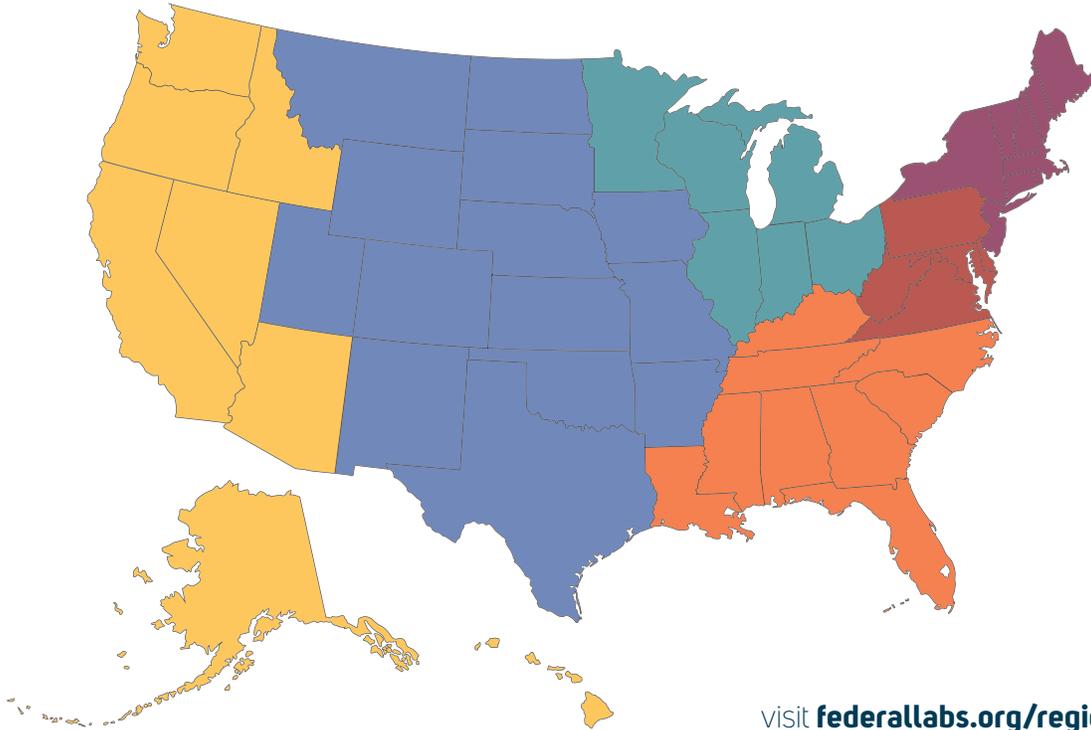
Rosenberg trains and advises wing, group, and squadron commanders and technical advisers about different technology transfer and transition (T3) mechanisms and helps them leverage T3 to support their mission. He also actively identifies opportunities across both 67 CW and 688 CW to jointly collaborate on existing and new T3 efforts.

An innovative leader, Rosenberg has operationalized the CRADA program for both wings, and has made the CRADA program more relevant to mission planners. His efforts related to 67 CW's industrial control system (ICS) included working with a CRADA partner to plan an ICS workshop and to implement a defense system for ICS based on a system that was originally designed for U.S. Army vehicles.

In recognition, 318th Range Squadron's Resource Advisor described Rosenberg as the "tip of the spear"—a military term for being on the frontline of a challenging task—for these and other ICS efforts. ☞

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