

2025

Directed Energy

Educational Outreach



The United States
Leads the World
in Directed Energy
Technology

High Energy Lasers

High Power Microwaves

Optical Technology

Support Systems

Non-Lethal



**DIRECTED ENERGY
IS HERE TODAY!**

DIRECTED ENERGY PROFESSIONAL SOCIETY

The Directed Energy Professional Society (DEPS) fosters the research, development and transition of directed energy (DE) technologies, including high energy laser (HEL) and high-power microwave (HPM) technologies, for national defense and civil applications through professional communication and education. We are recognized as the premier organization for exchange of information and advocacy of research, development and application of Directed Energy. Founded in 1999, DEPS is incorporated as a nonprofit corporation in New Mexico, organized and operated exclusively for charitable, scientific, and educational purposes.



Each academic year, DEPS offers individual research grants. The number of annual scholarship awards depends on available funding, which is provided by government funding. See below.

The traditional academic disciplines involved in DE research include physics, electrical engineering, chemistry, chemical engineering, materials sciences, optical sciences, optical engineering, and aerospace engineering.

DEPS hosts several conferences and workshops annually to promote information exchange and collaboration within the DE community, the longest-running being our Annual Science and Technology Symposium, which began in 1989. Unique to DEPS is our ability to host meetings at varying classification levels, from sessions that are open to the public to those that cover classified research. DEPS gathers the information presented at these meetings to allow for storage in an appropriate government repository. In addition to the annual symposia, DEPS also sponsors a series of short courses that support continuing DE education and further professional development. Continuous Learning Points (CLPs) credits are offered upon completion of such DEPS courses. A listing of DE short course offerings and upcoming events can be found at our website, www.deps.org.

SUPPORTING THE NEXT GENERATION

The Directed Energy Professional Society (DEPS), encourages both undergraduate and graduate students to pursue research in directed energy (DE) areas such as High Energy Laser (HEL), High Power Microwave (HPM), High Energy Pulsed Laser, Ultra-Short Pulse Laser (USPL), and Counter Directed Energy Weapon (CDEW) Technologies. To help facilitate this goal, DEPS has established Research Grants that fund suitable projects. This program is made possible by funding from government grants.

Visit www.deps.org for more information.

DIRECTED ENERGY EDUCATIONAL OUTREACH CAMPAIGN

What is Directed Energy—Directed Energy (DE) technologies encompass a wide range of non-kinetic capabilities that generate beams or fields of electromagnetic energy.

Directed energy weapons (DEWs) propagate this energy to engage a target remotely at the speed of light, including High Energy Lasers (HEL) or High Powered Microwaves (HPM), producing precise, scalable effects against multiple targets at a very low cost per shot.

DEWs offer non-lethal warning, escalation of force, ISR and counter-ISR, counter-electronics, counter-munitions, and counter-IED capabilities at a fraction of the cost per engagement compared with traditional kinetic options. As a complement to existing weapons, DEWs offer the U.S. Military a cost-effective capability enhancement to address evolving threats.

One of the key benefits of DE technologies is scalable effects, i.e., target impacts that range from temporary disruption to permanent damage. With HELs, effects can range from “dazzling,” or blocking visibility only when illuminated, to ablation and structural damage, usually causing the target to catch fire. With HPM, effects can range from interruption (e.g., shutting off an engine that can later be restarted) to permanent damage to electronics within the target.

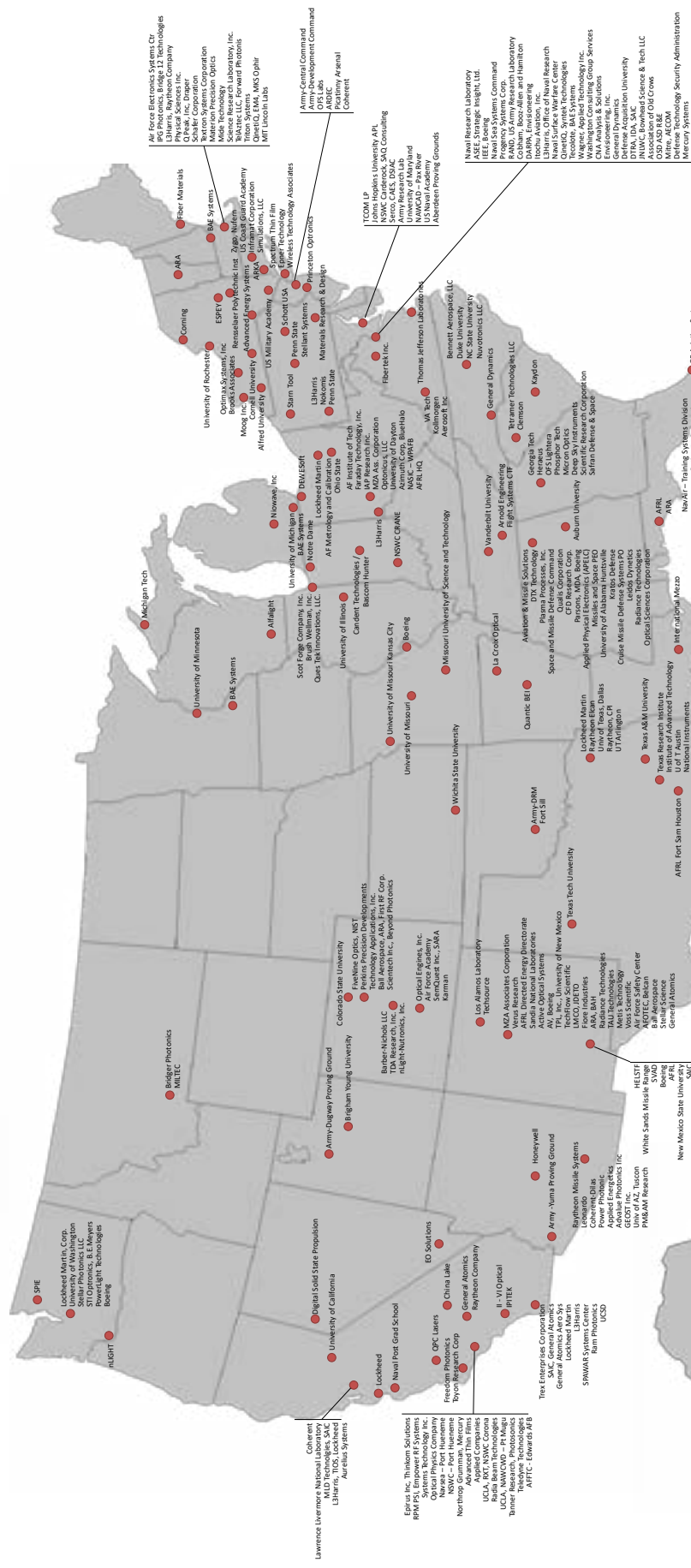


What is the purpose of the Directed Energy Educational Outreach Campaign

Initiated in 2009, the National Directed Energy Outreach Campaign aims to :

- (1) promote transition of directed energy technologies into operational use through educational outreach to decision makers and warfighters, and
- (2) identify key organizations that support the development and transition of directed energy technologies to the warfighters, and
- (3) provide technical expertise to warfighters and decision makers as they incorporate directed energy systems.

National Scope of DE Activities (37 out of 50 States Involved)



DIRECTED ENERGY OUTREACH CAMPAIGN

COHERENT

EPIRUS

DSIAC

ARKA



verus[®]
RESEARCH



MZA

GT **Georgia Tech.**
Research Institute

GENERAL ATOMICS
ELECTROMAGNETICS

ADVANCED THIN FILMS

Heraeus

EO SOLUTIONS

Raytheon
Technologies

AOS
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LEONARDO

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THE AIR FORCE RESEARCH LABORATORY
LEAD • CONCEPT • DEVELOP • DELIVER

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Enhancing Beam Performance

PPD PERKINS PRECISION
DEVELOPMENTS

RPM PSI[®]

APL **JOHNS HOPKINS**
APPLIED PHYSICS LABORATORY



Barber **Nichols**
Mission-Critical Turbomechanics Solutions

The Texas A&M University System
Bush Combat Development Complex

M/I/D/E | **UMKC**

ThinKom

mks | **Ophir**

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GOVERNMENT ORGANIZATIONS





AFRL

AFRL Directed Energy for the Air Force

The Air Force Research Laboratory (AFRL) leads the discovery, development, and integration of affordable warfighting technologies for our air, space, and cyberspace forces. As one integrated lab, AFRL seamlessly supports the science and technology needs of two services: the Air Force and the Space Force.

AFRL leads the Department of the Air Force and the Nation in directed energy weapon science, technology, research, and development.



Directed Energy weapons: Concentrated electromagnetic energy to “incapacitate, damage, disable, or destroy enemy equipment, and facilities.

Strategic Advantage: *Directed Energy Weapons are force multipliers, enabling faster victory against adversaries. AFRL is actively advancing lethal and effective directed energy solutions designed to counter threats like unmanned aerial systems (C-UAS) and missiles.*

Amplifies Airpower: *DE technologies enhance speed, range, flexibility, and precision – “game-changing” capabilities.*

Two Main Classes: *High Energy Lasers (HEL) for thermal effects and High Power Microwaves (HPM) for electronic attack.*

Versatile Applications: *Non-lethal counter-personnel, counter-electronics, and counter-IED.*

Reduced Collateral Damage: *Precision engagement with scalable effects, offering options in restrictive ROE scenarios.*

Logistical & Cost Advantages: *“Deep magazine” and low cost per shot compared to kinetic weapons.*

AIR FORCE RESEARCH LABORATORY



Defense Systems
Information Analysis Center



Helping Your Research to Advance

DIRECTED ENERGY

FREE RESEARCH SERVICES

As one of the three DoD Information Analysis Centers, we provide free research services to the government, military, and their collaborators. This includes answering technical inquiries, connecting subject matter experts, and presenting webinar trainings.

RECENTLY ANSWERED INQUIRIES

- + Can the history and structure of the Directed Energy Engineering and Analysis Center (DE2AC) be provided?
- + What is the state of the art on directed energy and counter directed energy weapon technologies?
- + What technologies exist to protect unmanned aerial vehicles against counter-directed energy systems?

Learn more and submit your questions at DSIAC.DTIC.mil or call 443-360-4600.



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LABS AND ACADEMIA



The Georgia Tech Research Institute (GTRI) is the nonprofit, applied research organization of the Georgia Institute of Technology (Georgia Tech).

We develop advanced technology solutions and large-scale system prototypes to address the most difficult problems in national security.

**GTRI Supports all
Aspects of Directed
Energy Weapon
Development &
Deployment**



- > HEL & HPM Systems Engineering
- > Contract/Program Support, Source Selection & Evaluations, CDRL Development & Review
- > Supporting Technology SMEs (e.g. Radar, C2, EW, passive optics, antennas, microwave sources)
- > Industrial/Supply Chain, Logistics
- > Modeling, Simulation, & Analysis from Component to Mission
- > Test & Evaluation from Component to System
- > Support for Laser Clearinghouse Registration & Approvals
- > DEW Policy & Guidance Development
- > Operational Deployment & Planning
- > CONOPS, TTP, & End User Training Materials
- > Sustainment & Maintainability
- > Professional Education Short Courses on DEW Topics

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Sensors & Electromagnetic Applications Laboratory
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HIGH ENERGY LASER CAPABILITIES

Founded in 1945 at the request of the U.S. Navy, the Penn State Applied Research Laboratory (ARL) is a Department of Defense (DoD) designated University Affiliated Research Center that leverages cutting-edge research and innovation. Though we are primarily sponsored by the U.S. Navy, we proudly support all the U.S. Armed Forces and other government agencies. We strive to embody a culture of scientific discovery and consistently leverage our agility to adapt to evolving mission needs.

The Electro-Optics Center (EOC) at ARL has supported Laser Weapons System Development for more than 20 years. Our laboratories and facilities are devoted to research, development, prototyping, and testing of electro-optics components and systems.

Embedded in these capabilities is the High Energy Laser Effects Laboratory. The HEL Effects Laboratory is the birthplace of the Navy LaWS Laser Weapon System, first fielded on the USS Ponce in 2014. LaWS was a centerpiece accomplishment of EOC design and prototyping capabilities, working in concert with PMS 405 (now PEO IWS 11) and NSWC-Dahlgren.

The HEL Effects Laboratory contains 1kW, 10 kW, and 17 kW fiber lasers along with a full suite of beam shaping and high-power laser diagnostics including power meters, thermal cameras, and beam profiling equipment. This equipment is used to conduct laser vulnerability testing of potential laser weapon targets. It also enables us as to test HEL optics at intensity levels expected for laser weapon systems. Finally, the HEL Effects Laboratory has been used as a prototype development facility in which optical systems and their components are assembled and tested prior to integration into their intended platform.



For more information on ARL and the EOC, please contact eoclaser@arl.psu.edu.



PennState
Applied Research Laboratory

Sandia National Laboratories

On the leading edge of Directed Energy Research



**Sandia
National
Laboratories**

Sandia is a multidisciplinary national laboratory and federally funded research and development center for the National Nuclear Security Administration, focused on enhancing national security through innovative systems and technologies.

With world-class expertise and decades of experience in Directed Energy research, systems development, and assessments for National Security, Sandia collaborates with the Department of Defense, federal agencies, and industry and university partners to provide technical solutions that defend and protect the United States.



Capabilities

- Weaponize technology Pathfinders
- Exploit sensors and systems
- Conduct High-Power Microwave (HPM) and RF circuit-to-systems effects testing and assessments
- Develop compact HPM and RF sources, components and systems
- Develop pulsed laser sources and systems
- Research laser-material interaction phenomena
- Model components through systems to engagements



High-Power Microwave Technologies



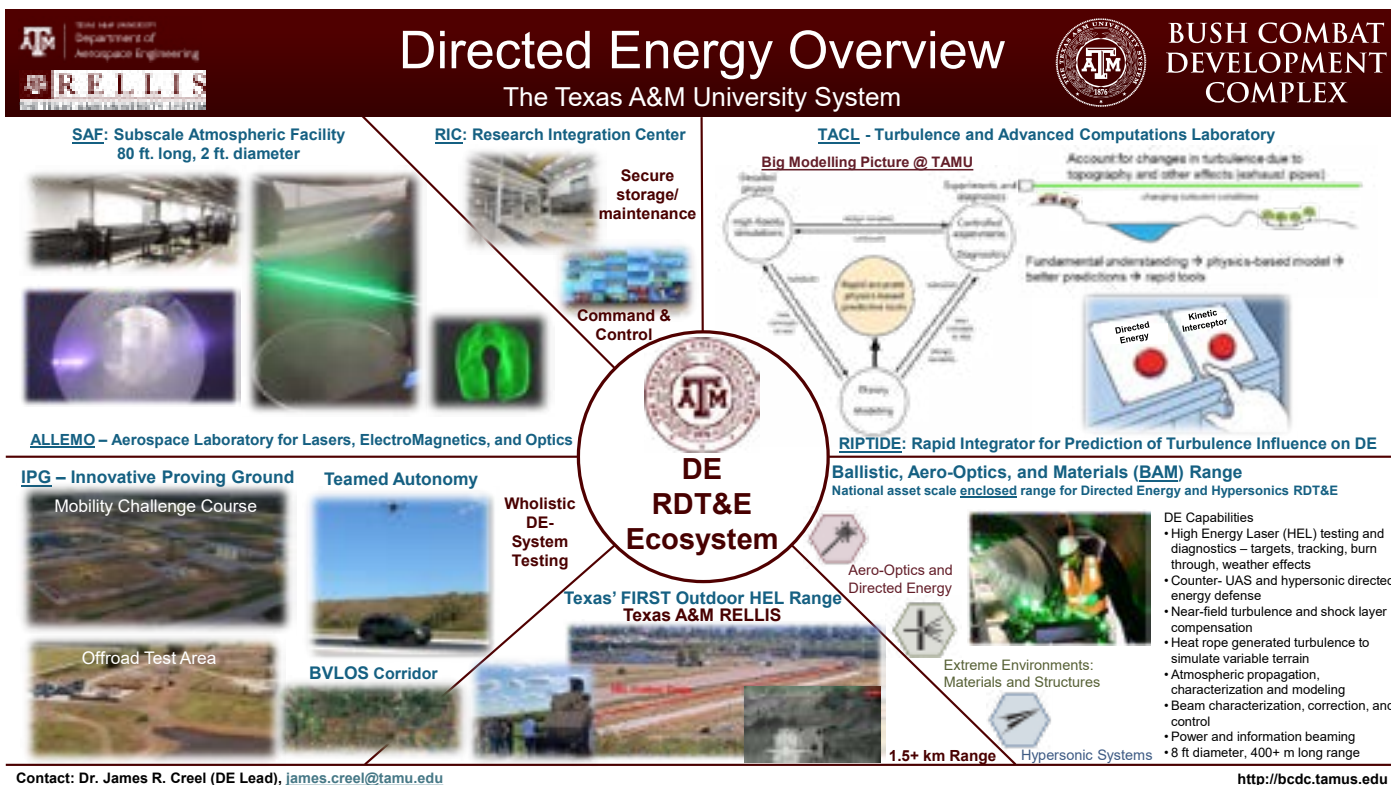
RF Effects Testing and Assessments



Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International, Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525. SAND 2025-09679M

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Who We Are

The Air Force Institute of Technology (AFIT) has been at the forefront of DoD directed research, education, and innovation since the envisioning of high energy lasers as weapons systems. CDE was established as a cross disciplinary center with sponsored research supporting the development and evolution of directed energy systems. CDE enables DE technology advancement through education, consulting, and advising.

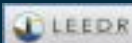
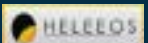
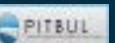
What We Do

Research: Solving DoD problems related to directed energy technologies and DoD applications.

Education: Tied to the Engineering Physics Department's Applied Physics and Optical Science and Engineering in-residence graduate programs, we also offer both distance learning and onsite short courses. Additionally, CDE offers unique co-op and internship opportunities that challenge participants with real world DoD scenarios.

Innovation: Contribution to the DoD directed energy community through robust research solutions and delivery of products addressing critical DoD needs related to directed energy.

CDE Software Meeting DoD Needs:



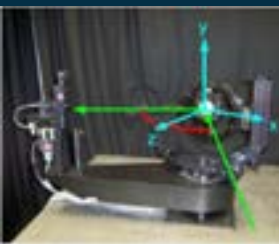
Our Mission The mission of CDE is to advance applied research in DE enabling technologies and DE system concepts through experiment, modeling & simulation, and verification & validation. The results of this research provide the DoD DE community with educated personnel and scientific tools to maintain the technical edge of the fighting forces of the USA.

Educational Opportunities

- **Directed Energy Summer Internship**—10 week program offering competitive pay and lab/field experience in relevant DE research, opens the door for employment by the DoD
- **Directed Energy Graduate Certificate**—three course sequence with distance learning via JKO
- **Short Courses**— DE models, laser weapon systems






Directed Energy (DE) at the Johns Hopkins Applied Physics Laboratory

- We have extensive experience in developing and integrating operationally relevant prototypes.
- Strong relationships with the operational community with insights grounded in real-world environments.
- Extensive combat system knowledge applied to advance weapon systems integration, including DE.
- Demonstrated success in maturing and transitioning technologies, including DE, to higher Technical Readiness Levels with industry partners.
- We employ agile system engineering practices to accelerate development timelines.
- At the forefront of emerging technologies such as AI/ML, which have potential to transform DE weapons.
- We possess a deep understanding of the physical sciences and dedicated facilities for concept exploration.

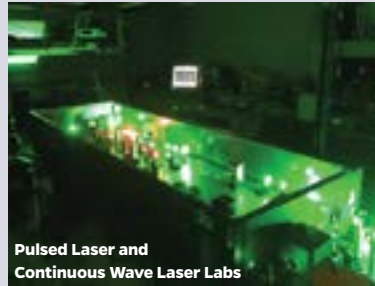
System of Systems
Modeling & Simulation

Digital Engineering

Rapid Prototyping

Continous Threat Assessment

Live Virtual Constructive Testing



Pulsed Laser and Continuous Wave Laser Labs

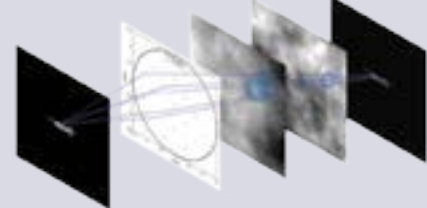


Beam Control Trailer



High-Power Microwave Directed Energy

Modeling and Simulation such as Anisoplanatic Imaging

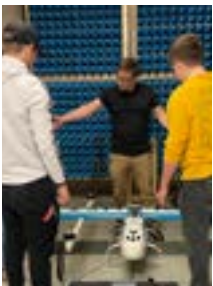


Enabling Technologies and Areas of Expertise



- Laser and Microwave Engineering
- Optical Design
- M&S/Analysis
- Environment and Material Interactions

- Threat Engineering
- Software Development
- AI/ML Methods
- Cyber Dominance
- Information Engineering
- Prototyping and Integration
- Field Testing and Validation



MIDE fosters collaboration among industry, university, and government innovators to cultivate tomorrow's STEM leaders, while addressing today's national security challenges.

\$75M

Awards & Contracts

\$35M

Active Awards & Contracts

75+

Student Graduations

20+

Disclosures & Patents

20+

Leading faculty in physics, chemistry, engineering, and computer science

30+

Technical, business, and support staff

50+

Undergraduate and graduate students

85%

Of MIDE staff and students are cleared for classified work

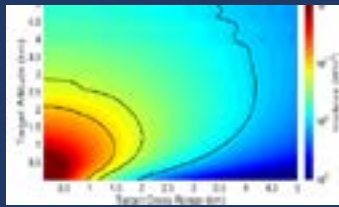
HPM and RF testing with 600 ft² anechoic chamber, GTEM cell, and state of the art RF equipment

3D printing, CNC machining, and more enables onsite fabrication of next-generation HPM systems

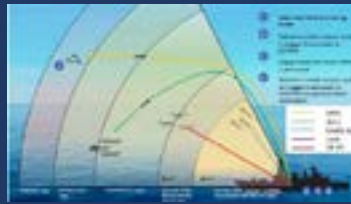
Supported DARPA, Navy, Air Force, Army, and industry at all classification levels.

mide@umkc.edu

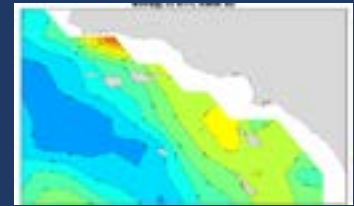
Kansas City, Missouri



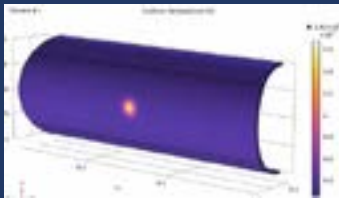
Beam Propagation



Mission Engineering



Atmospheric Characterization



Laser



Modeling and Simulation

Graduate Degrees with Emphasis in Directed Energy:

- Physics
- Meteorology
- Systems Engineering
- Operations Research
- Mechanical Engineering
- Aerospace Engineering

Directed Energy Certificate Program

- Four-courses in Directed Energy
- Graduate certificate
- Active duty, civilian, active duty, foreign

Directed Energy Research Labs and Opportunities:

- High Energy Laser Lab
- MOVES DE Simulation
- Beam Control Testbed
 - Boundary Layer and Turbulence Measurements
 - JIFX Field Testing

NAVAL POSTGRADUATE SCHOOL



CENTER FOR DIRECTED ENERGY

At the University of Central Florida, the Center for Directed Energy (CDE@UCF) has programs that unite graduate students and faculty from the Colleges of Optics & Photonics, Sciences, Engineering & Computer Science. Our work spans optics, lasers, microwaves, physics and electromagnetics; plasma physics; mechanical, electrical, and aerospace engineering; computer and materials science; atmospheric and environmental science; artificial intelligence; and complex 3D modeling. Here, you'll have access to advanced facilities for high-power pulsed, continuous-wave, and ultrafast laser development; optical fiber fabrication; optical materials fabrication and characterization. You'll participate in outdoor laser propagation and test campaigns at our Townes Institute Science and Technology Experimentation Facility (TISTEF) on its NASA/USSF site on Florida's Merritt

Island and other test facilities across the nation with mobile systems for high power lasers, high-speed tracking, imaging, beam diagnostics and other interesting studies. Bring your background. Expand your expertise. Find your place in UCF's Directed Energy program.

Enquiries to DEStudents@ucf.edu 

INDUSTRY PARTNERS





Enabling the Frontiers of Directed Energy

Advanced Thin Films has been the leader in the fabrication and coating of the most challenging optical components in Directed Energy systems for over a decade. Whether it is enabling higher power architectures, more precise beam delivery systems, or the ability to track low-visibility targets at a distance accurately, Advanced Thin Films is the first call when you want to understand the frontier of possibility.

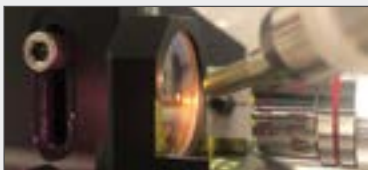


Low Stress Coatings

Maximizing Power in the Bucket requires the ability to deliver every possible photon to a very small spot on the target. A major part of this equation is the ability to establish and control the flatness of each surface the laser reflects off of, and ATF's Flatiron™ low-stress coatings are the best solution available.

Spectrally Complex Coatings

ATF's legacy of depositing spectrally complex coatings for medical and telecommunications applications enables us to make coated optics that enable maximal discrimination of signal vs. background, enabling the fastest, most accurate target identification, designation, and tracking systems available.



High LDT Coatings

The extreme fluences of Directed Energy sources rapidly damage most laser optics. Guaranteeing up-time and field usability requires optical components that are designed, fabricated, polished, coated, and cleaned with the utmost care, and ATF delivers.



Endcaps

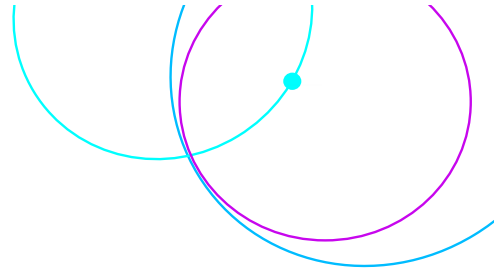
The first challenging requirement for any fiber laser-based Directed Energy system is to get the light out of the fiber in a controlled fashion. ATF's custom build-to-print endcap manufacturing cell enables the rapid, repeatable, and affordable manufacture of components that launch each laser source with the lowest loss and likelihood of damage.



Mirrors

The most common components in Directed Energy Beam Control Systems are mirrors that allow you to shape and steer the beam to the target quickly and accurately. ATF's ability to make damage-resistant low-stress mirrors with reflectivity levels over 99.999% are a critical part of improving the SWAP of field-deployable weapons systems.

Tel: +1 (303) 815 1545 | Email: atf@idexcorp.com | 1625 S. Fordham Street, Longmont, CO, 80503 USA



ARKA Group, L.P. (ARKA) is a fully integrated mission partner providing world-leading enabling capabilities with an unrivaled reputation for excellence. We design, manufacture, integrate, test and deliver optical assemblies/sensors and laser sub-assemblies to support laser, EO and IR requirements. ARKA's facility in Danbury, Connecticut, manufactures, coats, integrates and tests precision optical and laser sub-assemblies, optical sensor systems and components. Our products support most of the Department of Defense (DoD) prime contractors and the U.S. Army, Navy, Air Force and Marine Corps. Our products are deployed with our customers' products on military platforms supporting DoD missions.

ARKA's space and defense business provides intelligence, surveillance and reconnaissance solutions (ISR), supporting customer requirements for ISR and high energy laser (HEL) optics, windows, beam expanders, beam directors, laser warning systems, coatings, electromagnetic interference (EMI) gridding, communications, software, robotics and sensors.

We design and manufacture laser warning systems, providing world-class platform survivability and protection with leading-edge technology to defeat continuously evolving threats.

We have an extensive background and fabrication expertise related to space sensors and optics providing optical space system level integration and test.

Our Danbury facility has adapted its robust optics manufacturing and coating capabilities to support the Directed Energy market, concentrating on processes that enable the fabrication and coating of HEL Directed Energy (DE) optics in large format.

Our capabilities cover large optics of complex shapes and laser damage resistant coatings including metal and multi-layer dielectric coatings.



We have tailored our expertise in optical fabrication from heritage polishing processes to obtain super smooth, defect-free surface finishes on various substrates and form factors. Although fabrications efforts typically emphasize Corning® ULE® (Ultra-low Expansion Glass) due to its preferential failure mode, ARKA also has refined methods for various other substrate types. We have a wide range of polishing equipment to polish various form factors of optics including flats, spheres and aspheres.



Directed Energy Thermal Management Solutions

Barber-Nichols, LLC (BN) is a leader in the design and manufacture of advanced turbomachinery pumps, compressors, turbines, and as well as motor-driven systems and associated power electronics that enable and support the performance and reliability of Directed Energy (DE) technologies. Our engineering and manufacturing teams support the U.S. Department of Defense, national laboratories, and prime contractors by delivering critical subsystems for high-power Laser, High Power Microwave (HPM), and Radio Frequency (RF) systems.

Supporting Directed Energy Applications

Directed Energy (DE) systems—whether high-energy lasers (HEL) or high-power microwave (HPM)/RF, require advanced thermal management, reliable power conversion, and cryogenic vacuum support. Barber-Nichols provides engineered hardware that enables DE capabilities across land, sea, air, and space, including:

- Cryogenic Cooling: Pumps and circulators for liquid Hydrogen, Nitrogen, and Helium to manage HEL thermal loads.
- Compressors & Blowers: Gas-handling solutions for stable pressure and flow in HPM and RF systems.
- Power Electronics: Rugged, modular motor controllers for efficient, precise operation in harsh environments.
- Test & Qualification Rigs: Integrated facilities to validate DE subsystems under mission-like conditions.

Comittment To Mission Success

By enabling the cooling, power, and fluid management systems that DE platforms rely on, Barber-Nichols contributes directly to advancing the maturity and deployment of DE capabilities. Our work supports the U.S. military's objective to provide cost-effective, deep-magazine defensive and offensive capabilities that enhance our national security.

Technical Expertise

Barber-Nichols applies decades of aerospace, defense, and cryogenics expertise to meet Directed Energy challenges. Our turbomachinery and power electronics deliver:

- High reliability in demanding environments
- Compact, lightweight designs for mobile and airborne systems
- Scalable solutions from lab to field deployment

Industry Application

Barber-Nichols applies decades of aerospace, defense, and cryogenics expertise to meet Directed Energy challenges. Our turbomachinery and power electronics deliver:

- High reliability in demanding environments
- Compact, lightweight designs for mobile and airborne systems
- Scalable solutions from lab to field deployment



DIRECTED ENERGY AND PULSED LASERS



Coherent Aerospace and Defense is a leading optical and laser systems technology company with a long legacy of delivering custom solutions in ISR&T, space, missile guidance, and advanced lasers. Within its Optical Systems business unit, Coherent leverages its core competencies in optical materials, coatings, and sub-assemblies, to provide its customers with high-performance optical subsystems that enable them to achieve the requirements and key milestones of their most challenging missions. Coherent has participated in some of the most high-profile programs over the last decades, including multimeter-class terrestrial and space telescopes.

Within its Defense Solutions business unit, Coherent designs and manufactures spectrally and coherently beam-combined lasers, pulsed lasers, and precision gimbals, for direct energy, active sensing, and laser communications. Coherent Aerospace and Defense operates eleven facilities in the U.S. with more than 500 employees, as a business group of Coherent Corp. (NYSE: COHR).



Drop by our booth or visit
coherent.com/aerospace-defense
to learn more.

COHERENT



EO SOLUTIONS

Bridging Defense and Innovation

A premier aerospace and defense contractor
dedicated to **innovation with purpose.**



Directed Energy Applications

Precision and Power
When It Matters Most



Space Domain Awareness

Vision Beyond
the Horizon



AI/Machine Learning

Smarter Solutions for
Complex Challenges



Mission Focused

We unite S&T, Acquisition, and Warfighter expertise to deliver solutions that work for everyone involved.



Adaptive

We move fast and make smart decisions to stay ahead in a rapidly changing defense landscape.



Holistic Approach

Each team member drives our mission forward with focus, integrity, and innovation.

We believe that supporting our employees is crucial for success, and we strive to create *an environment where everyone feels valued and inspired to contribute their best.*

Current Opportunities and Open Positions:

Go to: e-o.solutions/careers/

EO Internship Program:

Email: careers@e-o.solutions



info@e-o.solutions



e-o.solutions.com



1 TO MANY

SCALABLE TO MEET ANY
COUNTER-ELECTRONICS
REQUIREMENT



Leonidas® High-Power Microwave Platform

■ EPIRUSINC.COM

EPIRUS 



HIGH-ENERGY LASER SYSTEMS

BASED ON COHERENT BEAM COMBINING

CBC System Capabilities

- | Coherent Beam Combining (CBC)
- | Excellent Beam Quality ($M^2 \sim 1.1$)
- | High Potential For Atmospheric Compensation
- | Potential For High Laser Intensity On Target
- | Beam Shaping On Target In μs Range
- | Beam Steering In MHz Range



Key Features

- | Combiner For 19 to 200+ Channels
- | For LMA Fibers (PM/Non-PM)
- | Integrated Micro Lenses
- | High Combining Efficiency
- | Monolithic All-Glass Solutions
- | Outstanding Beam Quality And PER
- | Lowest Position And Pointing Errors
- | Adaptable Mechanical Interface

FIVENINE optics

Your HEL IBS Coating Experts

FOD/contamination resistance



COATINGS FOR BEAM DIRECTORS

- Large Format IBS Coatings
- Shared aperture / multi-band high reflectors
- Deformable Mirror coatings (DM)
- FSM coatings

COATINGS FOR BEAM COMBINERS

- Low absorption filter coatings
- Coatings for diffractive optics (Gratings)
- Polarizers

COATINGS FOR HEL LASERS

- Coatings on Laser Materials
- GRMs



FIVENINEOPTICS.COM

DIRECTED ENERGY

POWERING THE FUTURE OF DEFENSE

General Atomics Electromagnetic Systems (GA-EMS) delivers advanced directed energy weapon systems designed to counter emerging threats with instantaneous precision.

HIGH ENERGY LASER WEAPON SYSTEM (HEL): CORE CAPABILITY

GA-EMS's HEL system is a solid-state laser weapon built for deployment across land, sea, and air. It delivers scalable power, precision targeting, and reduces life-cycle cost.

Key Advantages:

- 100 kW-class laser, scalable beyond 300 kW-class
- Proven single aperture solid-state technology with high energy output
- Modular, rugged design for war-fighting environments
- Integrated ultra-high power density battery
- Lightweight, efficient thermal management system
- Built to defeat drones, ISR assets, rockets, artillery, and missiles
- Speed-of-light strikes



WHY DIRECTED ENERGY MATTERS

Modern threats are faster, cheaper, and harder to stop. Drone swarms and ISR platforms challenge traditional defenses.

Directed energy offers a transformative solution:

- Speed-of-light engagement
- Deep magazine capacity
- Precision targeting at a low dollar per-shot cost

GA-EMS's MULTI-DOMAIN APPROACH

Beyond HEL, GA-EMS develops electric weapon systems engineered for deployment—not demonstration.

These include:

- Railgun Systems: Electromagnetic launch, no explosives, mobile IAMD-ready
- High Power Microwave (HPM): Synchronized HPM system to defeat electronics at extended range

WHO BENEFITS FROM GA-EMS DIRECTED ENERGY SYSTEMS?

- Department of Defense and service branches
- Combatant Commands seeking advanced air and missile defense
- Defense contractors and integrators
- Congressional stakeholders focused on modernization and deterrence
- The public—through safer infrastructure and faster threat response

WHAT PROBLEMS IT SOLVES?

- Defeats fast, low-cost threats like drones, rockets, and artillery
- Reduces engagement costs with deep magazine and low per-shot expense
- Improves mobility and survivability with compact, scalable systems
- Simplifies logistics and resupply
- Enhances safety by eliminating explosives and minimizing collateral damage
- Neutralizes electronics and ISR platforms with non-kinetic effects
- Supports multi-domain operations with flexible, platform-agnostic designs



ga.com/ems

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Heraeus

Covantics

Ultra-Pure Fused Silica for Highest Power Levels



Optical Materials for Directed Energy Laser Systems

Fused Silica is the ideal choice for directed energy laser applications, offering chemical inertness, ultra-low thermal expansion, and broad transmission from UV to NIR.

Our Suprasil® and Infrasil® grades feature ultra-pure, low OH content for maximum NIR transmission, excellent homogeneity for superior beam quality, and a bubble-free structure for high laser damage threshold. Available in sizes up to 1.5 meters, we deliver precision optics that scale with your needs.

About Heraeus Covantics

Heraeus Covantics is a technology leader specializing in the manufacturing and processing of the industry's highest purity quartz, fused silica and other high-end materials such as ceramics and composites.

With manufacturing in the US, Europe and Asia, Heraeus Covantics produces semi-finished products, complex system components and custom-tailored solutions made of quartz glass, fused silica and ceramic materials.

Contact Us

Heraeus Quartz North America LLC

Heraeus Covantics
100 Heraeus Blvd.
Buford, GA 30518, USA
covantics@heraeus.com
www.heraeus-covantics.com

Global Leader in Defense Laser Solutions

Directed Energy-High Energy Lasers (DE-HELs) are an innovative, cost-effective solution for countering asymmetric threats such as rockets, artillery and mortars (C-RAM) and unmanned aerial systems (C-UAS). DE-HELs harness focused electro-optic energy rather than kinetic energy to damage, disable or destroy targets, offering several advantages over traditional countermeasures. Advantages include significantly lower cost per engagement (a few dollars vs. thousands or millions) and near-limitless magazine depth.

Leonardo offers disruptive capabilities to support DE-HEL systems, including MIL-rugged high-energy laser sources, illumination lasers, pointer/trackers, and beam directors. The core technology is informed by thousands of laser systems and pointer/trackers fielded by Leonardo in defense systems across multiple domains and platforms around the world.

Leonardo continues to innovate and advance DE-HELs technology to deliver reliable, cost-effective solutions that support the success of today's warfighter.

Capabilities

- High-Power Laser Diodes
- High-Power Fiber Amplifiers
- Pointing and Tracking
- Target Illumination
- Beam Direction and Control

Laser Directed Energy Weapon Components and Systems

Leonardo manufactures MIL-rugged laser components and optical systems that form the backbone of DE-HEL systems. Semiconductor laser diodes, high-power fiber amplifiers, and target illumination sources are just a few of the capabilities produced by Leonardo.



→ High-Power Fiber Amplifiers



→ Illumination



→ High-Power Laser Diodes

DragonFire

DragonFire offers a powerful, cost-effective high-energy laser solution to counter asymmetric threats, providing essential short-range protection within modern layered air defense systems. Leonardo provides the Beam Director for the DragonFire DE-HEL system.



Lightera: A legacy of fiber optics, powering the future of Directed Energy.

High volume fiber manufacturing
Excellent lot to lot consistency
High power applications lab
Custom solutions

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DESIGNED TO ENDURE

Lasers & the Rigorous Requirements of Directed Energy

Lasers are changing the way our soldiers and sailors are neutralizing their targets. It is a rapidly emerging technology sector that is allowing our armies and navies to operate more efficiently during conflicts.

These weapons are precise in their accuracy and can be adjusted for lethal or non-lethal doses. They are silent weapons which deliver rounds at the speed of light. They provide unlimited ammunition and are, in some cases, less expensive to operate compared to conventional weapons.

However, because these weapons employ multi-kilowatt laser light, the development and in-field operation of the lasers come with the same challenges that any high-powered laser application includes, only multiplied. Thermal effects on laser system components become more of a factor when considering the short and long term performance of the laser system.

In addition, beam control must be given more consideration during the development of these weapons systems. Determining the most efficient way to destroy a target, while not destroying anything else in the process, is the ultimate goal.

MKS has been developing laser performance analysis solutions and beam dump products for over 40 years. The recent development of Ophir and Newport products that handle tens and even hundreds of kilowatts of laser light has allowed for the continued development of more accurate and safe laser-based weapons systems.

For more information, see www.ophiropt.com and www.newport.com





INNOVATION & LEADERSHIP IN HIGH ENERGY LASER BEAM CONTROL AND ADAPTIVE OPTICS SYSTEMS



MZA Associates Corporation

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F: (505) 245-9971

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Dayton, OH 45430
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F: (505) 245-9971

MZA.com

MZA analyzes, designs, builds, and tests precision beam control systems for High Energy Laser and compensated imaging systems.

- Laser Weapon Effectiveness Predictive Modeling
- Lightweight & Compact Beam Control Systems
- Deformable Mirrors and Adaptive Optics Systems
- Target Acquisition, Tracking, & Pointing (ATP) Systems
- Characterization and Compensation of Atmospheric Turbulence
- Characterization and Compensation of Aero-Optical Effects
- Free-space Laser Communications
- WaveTrain Wave-optics Analysis and System Modeling

Directing Our Energy to Directed Energy



MZA is a leading innovator and manufacturer of high power deformable mirrors and closed-loop adaptive optics systems.

The next generation of precision strike weapons is being built with technologies developed by MZA.

An Employee-Owned Company

HIGH-ENERGY LASER

More than ready. Revolutionary.

Fills critical gaps in existing air defenses.

- Rapidly detects, tracks, identifies and defeats swarming, asymmetric threats
- Plug & play with existing radar and C2 systems (including FAADC2, NASAMS Fire Distribution Center)
- 360-degree protection all day and all night for high-value military and civilian assets with minimal risk of collateral damage

Scalable power and configurable for the mission.

- Modular architecture for stationary or mobile platforms
- End-to-end weapon system, optional radars & jammers
- Rechargeable: Never runs out of ammo. No logistical supply chain required.
- Operated by one person
- Military transportable
- Sets up in hours

Proven and ready.

- U.S. factory production and global sustainment
- Built on Multi-Spectral Targeting System (> 4 million operational hours)
- Rapid, effective training qualifies users in days
- Ruggedized with 25,000 operational hours in combat environments
- MTBFs of 4,000+ hours

Easy to operate. No matter the mission.

Our laser weapons deliver proven power in an intuitive package built around the user and the mission. Our deep mission and integration expertise ensures soldier-operated technologies that are easy to operate, no matter the conditions, mission needs, or operational environment.



Concept of Operations

- 1 Remote hosting operation (up to 15 km) on ruggedized laptop for target detection, engagement, surveillance and system monitoring
- 2 Programmable “no-shoot” zones are user configurable to ensure safe operations
- 3 Receives slew-to-cue from radars, surveillance sensors or battle management network
- 4 Automated target tracking; Operator selects aimpoint on target to maximize effectiveness
- 5 Target illuminator enables high-fidelity optical track day or night in challenging real-world conditions
- 6 Operator fires HEL to defeat targets in seconds

With a legacy of over 75 years, Stellant Systems is the premier developer and provider of High-Power Microwave (HPM) Sources; Vacuum Electron Devices (VEDs), Solid-State Power Amplifiers (SSPAs), and a combination of both, Microwave Power Modules (MPMs) to all branches of the U.S. Department of Defense (DoD). VEDs have and continue to dominate as HPM Sources.



MAGNETRONS, the first microwave device, were invented over 100 years ago and have the advantage of compact size, high-peak power, high-efficiency and no drive power required since they are oscillators. They are used for HPM, medical oncology, and radar applications. Stellant offers L- through X-band with Megawatt Power Levels from 8-2 MW and kilowatt power levels up to Q-band.



CROSSED-FIELD AMPLIFIERS (CFAs) are used in some of the most advanced radar systems such as the U.S. Navy Aegis and AN/SPS-48. They have similar characteristics as magnetrons; except they are driven coherent amplifiers that can be power combined. Multiple CFA systems could be designed to achieve extremely high-power levels. Single device power levels from 15-0.5 MW from L- through X-band are available.



KLYSTRONS are high gain and power devices that offer high peak and average power. Stellant has designed and produced a number of these devices that are used in high-power airborne radar systems such as AWACs. Currently we have high -power designs at both L- and X-band that will produce over 5 MW of peak power.



SOLID-STATE POWER AMPLIFIERS (SSPAs), are high-power broadband amplifiers in both stand-alone modules and rack-mounted systems. They are high-gain, wide bandwidth and low voltage devices that offer peak powers as high as 13 kW from L-through X-band. Applications include radar and drivers for high power VEDs.

For each application, different devices are the most applicable. With microwave expertise and 14 separate product groups, Stellant Systems can provide guidance and the proper microwave tools for the job.

HPM for C-UAS Goes Mobile

ThinKom



Alecto™ by ThinKom is a **mobile High-Power Microwave (HPM) system for Counter-UAS** that leverages ThinKom's 20+ years of success in designing and manufacturing market-leading phased arrays.

This **shoot-on-the-move** system offers similar ranges of effect as fixed site HPM systems, while offering a **90% reduction in size, weight, and power (SWaP)**.

Phased Array Antenna Technology

VICTS Variable Inclination Continuous Transverse Stub

- Mechanically steered phased array
- Proven GW-level power handling
- Superior beam agility
- Over 1,700 in-service commercial airborne satcom installations



Layers of a VICTS Antenna

About ThinKom Solutions, Inc.

US-Based | Privately-Owned Small Business
Non-Traditional Defense Contractor

Advantages of HPM

- Hard-kill effects
- Low cost per shot
- Ability to defeat swarms
- No need for target library

VICTS-Based HPM is Ideal for
INTEGRATED AIR + MISSILE DEFENSE

BASE DEFENSE **MARITIME**

AIRBORNE **HOMELAND SECURITY**

CREATING SOLUTIONS THAT MATTER

HIGH-POWER MICROWAVE (HPM) DEEP DOMAIN EXPERTISE

- SOURCE SYSTEM DEVELOPMENT
- AUTONOMOUS NETWORKED SENSOR SYSTEMS AND ARRAYS
- TESTING FOR EFFECTS CHARACTERIZATION
- LOW POWER DIRECT INJECTION COMPONENT TESTING
- RESEARCH INTO FUNDAMENTAL EFFECTS MECHANISMS
- SYNERGIES WITH ELECTRONIC WARFARE TECHNIQUES
- HPM/HEL COMBINED EFFECTS

THIS IS WHERE CUTTING EDGE SCIENCE MEETS INTELLIGENT INNOVATION. WHERE COMPLEX THEORIES ARE TRANSFORMED INTO TANGIBLE RESULTS.

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HIGH AVERAGE POWER AND HIGH PULSE ENERGY

Blue Laser Fusion is a US laser company based in Santa Barbara, CA

COMMERCIALIZING PULSED LASER INNOVATIONS

- CBC fiber amps + Optical enhancement cavity: "CBC-OEC" laser
- Novel technology in development phase with partners

MODULAR AND CONFIGURABLE LASER ARCHITECTURE

- Average powers 1 – 100 kW with Pulse energies 1 – 1000 J
- IR, Green or UV output to adapt to specific mission profiles
- Efficient and reliable to maximize performance & minimize SWaP

MISSION BENEFITS

- Pulsed output for the most demanding Directed Energy use cases
- Speed of light, deep magazine engagement with shorter dwell times



Website : BlueLaserFusion.com Email : contact@bluelaserfusion.com

Blue Laser Fusion was co-founded in 2022 by Shuji Nakamura, 2014 Nobel prize winner, and inventor of the GaN-based semiconductor laser and LED.

HIGH POWER MICROWAVE SOLUTIONS

HPM

FOR DIRECTED ENERGY PLATFORMS

EASE OF INTEGRATION

Simplifies the process of incorporating the amplifier into your platform.

COST-EFFECTIVE

Reduces operational costs through high efficiency and low maintenance.

USER-FRIENDLY

Intuitive controls and monitoring make it easy to operate and manage.

DURABILITY

Long-lasting performance with minimal downtime, ensuring continuous operation.

ENHANCED PERFORMANCE

Boosts the effectiveness of directed energy systems with superior power and efficiency.

VERSATILITY

Optimized performance regardless of waveform, CW or pulse.

RELIABILITY

Ensures consistent operation even under demanding conditions.

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NYFORS CO₂ laser based SMARTSPLICER™ system enables the creation of Linear and 2D Fiber Arrays which combine Fiber Laser beams of the same or different frequencies into a single beam that is transmitted at very high power. We also offer a full range of specialty fiber processing equipment for all fiber component manufacturing needs.



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Custom Laser Optics for Directed Energy Applications



Fully manufactured in Longmont, Colorado, USA

Perkins Precision Developments (PPD) provides HEL components, epoxy-free optical assemblies and precision thin film coatings that are specifically designed for High Power Laser Applications, Space-qualified Satellite Systems and Industrial Materials Processing.

Available high-LDT products include Polarizing Beam Splitter Cubes, Dielectric Laser Mirrors, Matched Risley Wedge Pairs and Thin Film Plate Polarizers.

With comprehensive in-house optical fabrication capabilities, including super-polished substrates, advanced Ion Beam Sputtered (IBS) coatings, and state-of-the-art assembly techniques, PPD delivers innovative solutions engineered for exceptional durability, thermal and environmental stability, and to meet the stringent performance demands of directed energy systems.

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Power in the Bucket

Aberration Correction Optics: Pointing, Defocus and Astigmatism



About PowerPhotonic Inc.

PowerPhotonic Inc. designs and manufactures optics and optical modules for high power CW and pulsed laser directed energy applications. Unlike all other manufacturers of optics, we use an in-house developed set of laser machining & smoothing processes that are inherently completely freeform - we can produce optics that have no surface symmetry.



Wafer-scale Freeform Optics

Our manufacturing processes are particularly beneficial for the manufacture of array optics - multiple optical elements on a single piece of fused silica. Furthermore, our unique processes produce extremely low scatter and extremely low absorption optics, with laser damage thresholds close to that of bulk fused silica.



Optical Assemblies & Modules

In addition to freeform component design and manufacture, we leverage the application of our unique freeform components into the design and assembly of modules, such as coherent beam combining modules, achieving both enhanced optical performance AND reducing Size-Weight-And-Power handling (SWaP), often by 5X or more when compared to modules designed with conventional optics.

www.powerphotonic.com

POSITIONERS FOR REAL-WORLD APPLICATIONS

- ACCURATE TARGETING
- SMOOTH TRACKING
- LARGE PAYLOADS

Since 1975, Rotating Precision Mechanisms, Inc. (RPM) has been designing and manufacturing advanced multi-axis positioners, gimbals, and controllers for a wide variety of optical, antenna, and sensor systems that have been fielded in the most demanding environments worldwide.

These positioners can be integrated with an array of Customer Furnished Equipment (CFE) such as optics, antennas, sensors, fiber or standard rotary joints, etc. to be used as part of HEL or HPM systems. Our expertise covers a wide range of applications including gimbals for optical beam directors or video trackers and fully EMI-sealed positioners for HPM or HEMP-resistant systems.

Our products are typically based on standard designs which are then tailored to meet a system's exact specifications and can be had in fixed-site, transportable, mobile, and shipboard configurations for both commercial and military uses.

www.rpm-psi.com | info@rpm-psi.com

8750 Shirley Ave, Northridge, CA 91324 | Phone: 818-349-8800

Rotating Precision Mechanisms, Inc. **RPM-PSI**
A woman owned small business established in 1975 (AS9100 certified)

HIGH POWERED MICROWAVE (HPM) TECHNOLOGY

RPM has already designed and delivered positioners for two different HPM systems, one of which is the THOR system. This system has been successfully tested and fielded for several years now, while the second is in integration and testing with our customer. We are also in production on two other brand new designs for other HPM applications as well. RPM's HPM positioners are EMI-sealed which allow them to perform without issue in difficult EMI environments, and they are based on proven designs which enable them to track UAS targets with more than enough precision to allow the payload / effector to perform flawlessly.



RPM Model PG-2055 Positioner, as shown here, is a Dual Drive Pedestal designed to support a very large/heavy HPM antenna and payload and still be able to track a single UAV drone or drone swarm in various environmental conditions, allowing the HPM payload to counter the threat. The unit seen here was delivered and incorporated as part of the THOR system – a currently fielded Counter-UAV / CUAS program.

HIGH ENERGY LASER (HEL) TECHNOLOGY

RPM has been delivering Direct Drive Pedestals used in optical tracking systems for many years and is now applying that knowledge to design and deliver systems used in HEL applications. Because of our background, we understand the need for systems that are extremely accurate, track smoothly, and minimize jitter when it comes to any optical payload.



RPM Model PT-1803, pictured here, was designed to be used in the development of HEL systems. This system was originally conceived, designed, and delivered to be used as a lab asset that could host a variety of optical payloads in developing new technologies. While this particular system is a lab asset, what sets RPM apart is that our designs are meant for real-world applications and will perform equally well in either setting.

Power Meets Precision

Optics Engineered for Extreme Energy



Zygo™ offers a comprehensive suite of solutions tailored for high energy laser (HEL) defense applications, leveraging decades of optical manufacturing experience supporting laser fusion programs such as LLNL's National Ignition Facility (NIF) and CEA's Laser Megajoule (LMJ).

Zygo manufactures a wide range of high-fluence laser optics, including:

- Meter class windows capable of withstanding high energy thresholds (Fused Silica & Sapphire)
- Beam direction mirrors (Silicon, Silicon Carbide and low expansion glass ceramics)
- Transmissive optics such as lenses, beam splitters, prisms and polarizers

These components are engineered to meet stringent surface roughness, wavefront, and subsurface damage requirements, ensuring reliability under extreme conditions.

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WAVEFRONT

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