The Role of Mid-Scale Laser Facilities in addressing the S&T Challenges of IFE

LaserNetUS now and in the future

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Fusion Power Associates 43rd Annual Meeting and Symposium

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LaserNetUS

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In 2022, we find ourselves here.

But how the solutions to outstanding scientific and technical questions will fit together is currently unknown.

- Short pulse laser-to-ion conversion efficiency
- Stopping power and heating
- Electron preheat
- Ablator materials
- Plasma instabilities
- Hydrodynamic code validation

Fusion Materials & Chamber Design

Fundamental Target Physics (*e.g.* high-gain ignition concepts)

Diagnostics

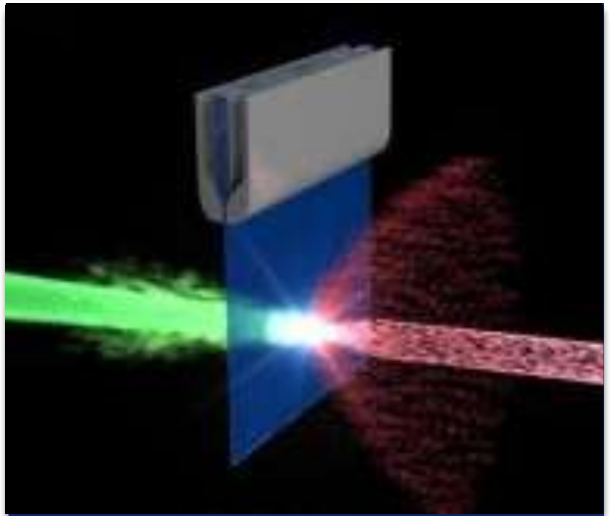
Target Design & Fabrication

High-Repetition Rate Lasers & Experiments

Target Injection & Tracking

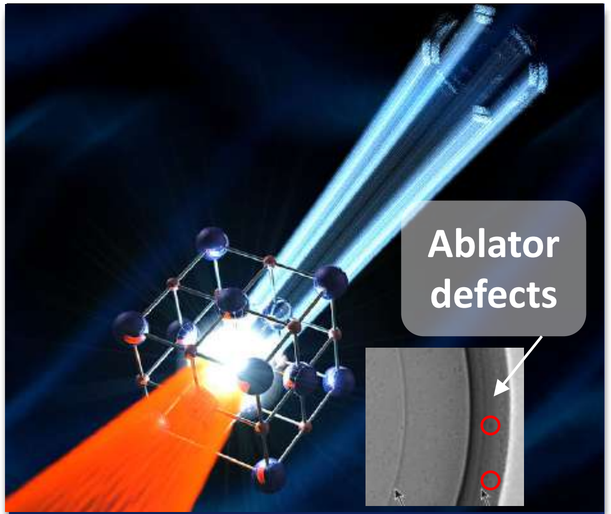
MID-SCALE LASER FACILITIES ARE POSITIONED FOR IFE RELEVANT S&T

Laser-Plasma Experiments



Precision diagnosis of the laser plasma interface and response of fusion-materials in solid-state, warm dense matter and plasma regimes

Radiation Damage & Fusion Materials



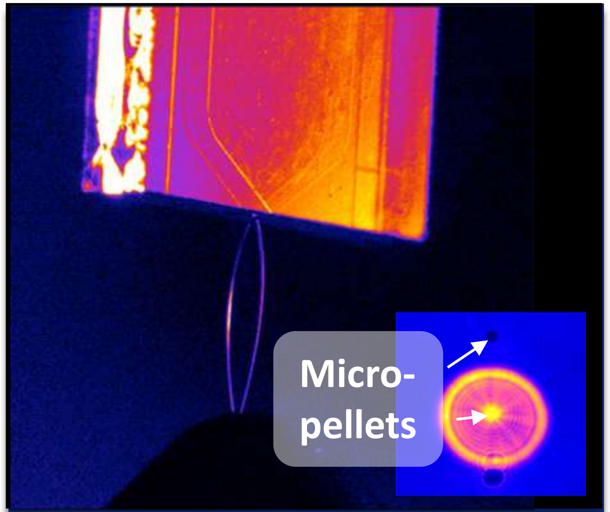
Validation of radiation damage simulations on W, or other blanket or divertor materials.

Microphysics studies of ablator and capsule materials

HRR Laser Technology

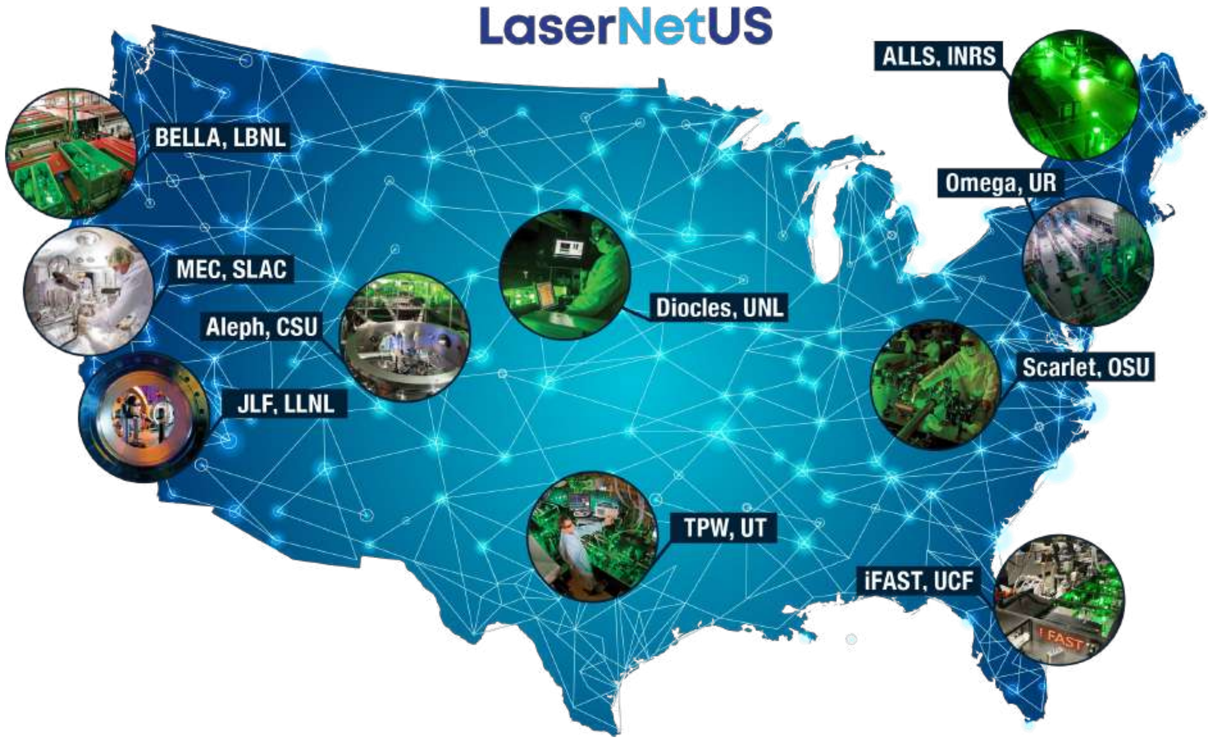
Development of high average power and high peak power laser systems operating at IFE-relevant repetition rates, e.g., 10 Hz, multi-ns, multi-kW beamlines

Fusion Technologies



Laser plasma diagnostics, high-rep-rate targets and alignment systems, AI/ML to connect experiments and theory, integrated design and engineering for large facilities

LASERNETUS AIMS TO EXPAND AND SUPPORT A SCIENTIFIC ECOSYSTEM



The mission of LaserNetUS is to advance and promote intense ultrafast laser science and applications by:

- Advancing the frontiers of laser-science research;
- Providing students and scientists with broad access to unique facilities and enabling technologies;
- Fostering collaboration among researchers in related fields around the world.

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LASERNETUS MANAGEMENT

CHAIR
D. Schumacher

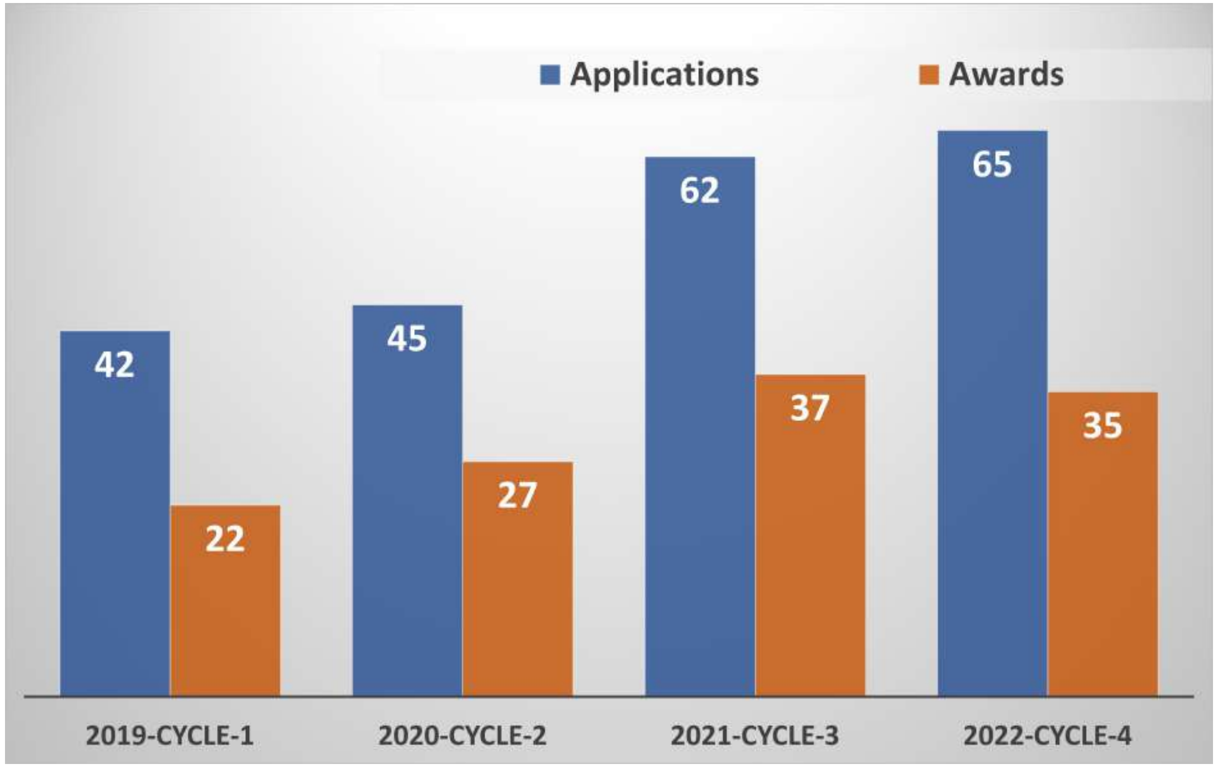
VICE CHAIR
M.-S. Wei

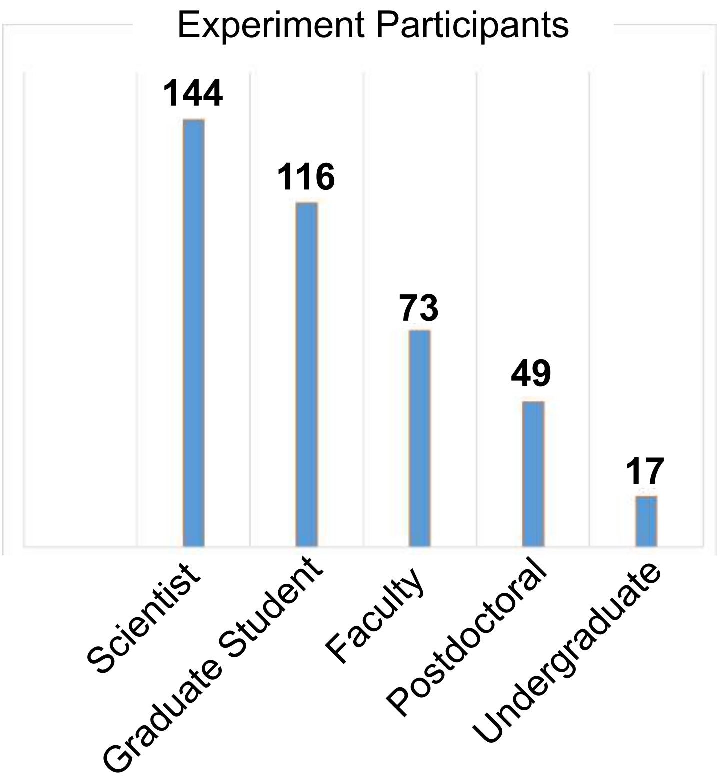
COORDINATOR
C. B. Curry

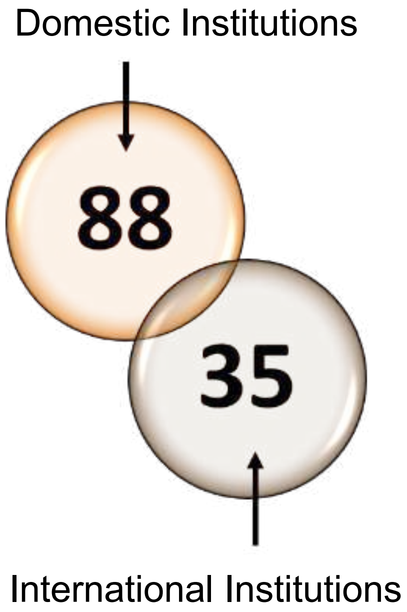
LASERNETUS COMMITTEES

Network Facilities Committee	i-USE Committee	Diagnostics Committee	Simulations Committee	Proposal Review Panel	Scientific Advisory Board
Carry out awarded experiments, implement SAB recommendations, strategic planning for the network	Represent user's interests within the network	Prioritization of common diagnostics development by engaging both users and facilities	Establish connections between investigators and the teams that build simulation codes	Conduct a fair and transparent review process to award experimental time	Provides an external perspective and strategic guidance for the network

LASERNETUS BY THE NUMBERS







10 facilities

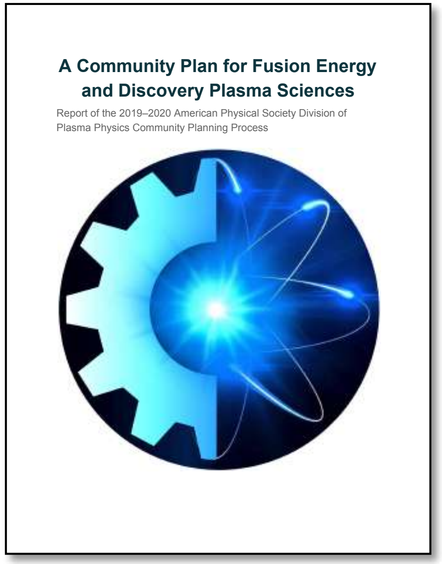
70 experiments performed

1253 members

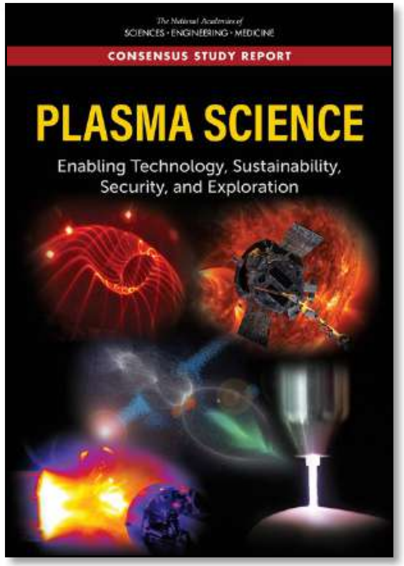
LASERNETUS HAS WIDESPREAD COMMUNITY SUPPORT

"Expand the scope and capabilities of LaserNetUS"

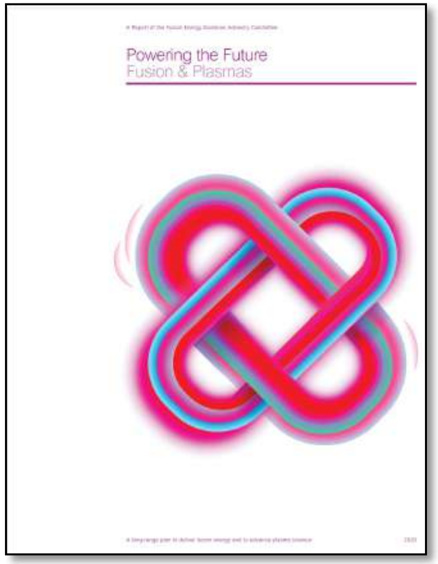
"Cooperation among university, national laboratory, and industry stakeholders is necessary to retain and renew the talent base."



"Improve and upgrade existing LaserNetUS facilities…."



"This is an opportune time to address […] challenges, with increased access through LaserNetUS "



"Increase operations support and aggressive upgrades to the LaserNetUS network to expand the base of users while allowing for a diverse set of capabilities that maintain US competitiveness."

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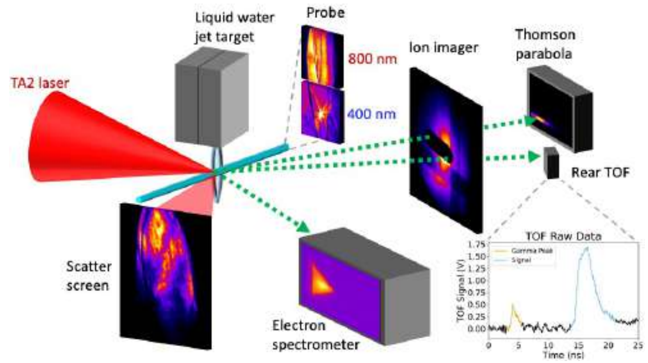
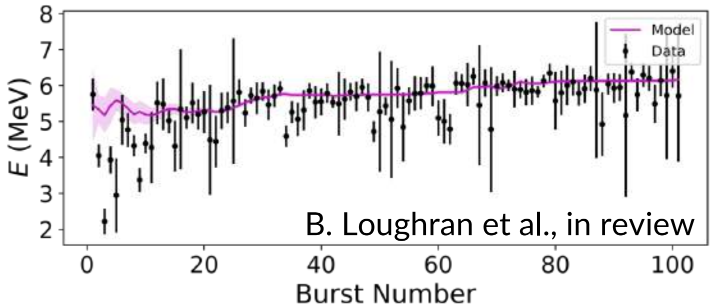
HRR LASER EXPERIMENTS PROVIDE EXPERIENCE FOR IFE SUBSYSTEM DESIGN

First real-time optimization of laser-driven ion acceleration at 5 Hz



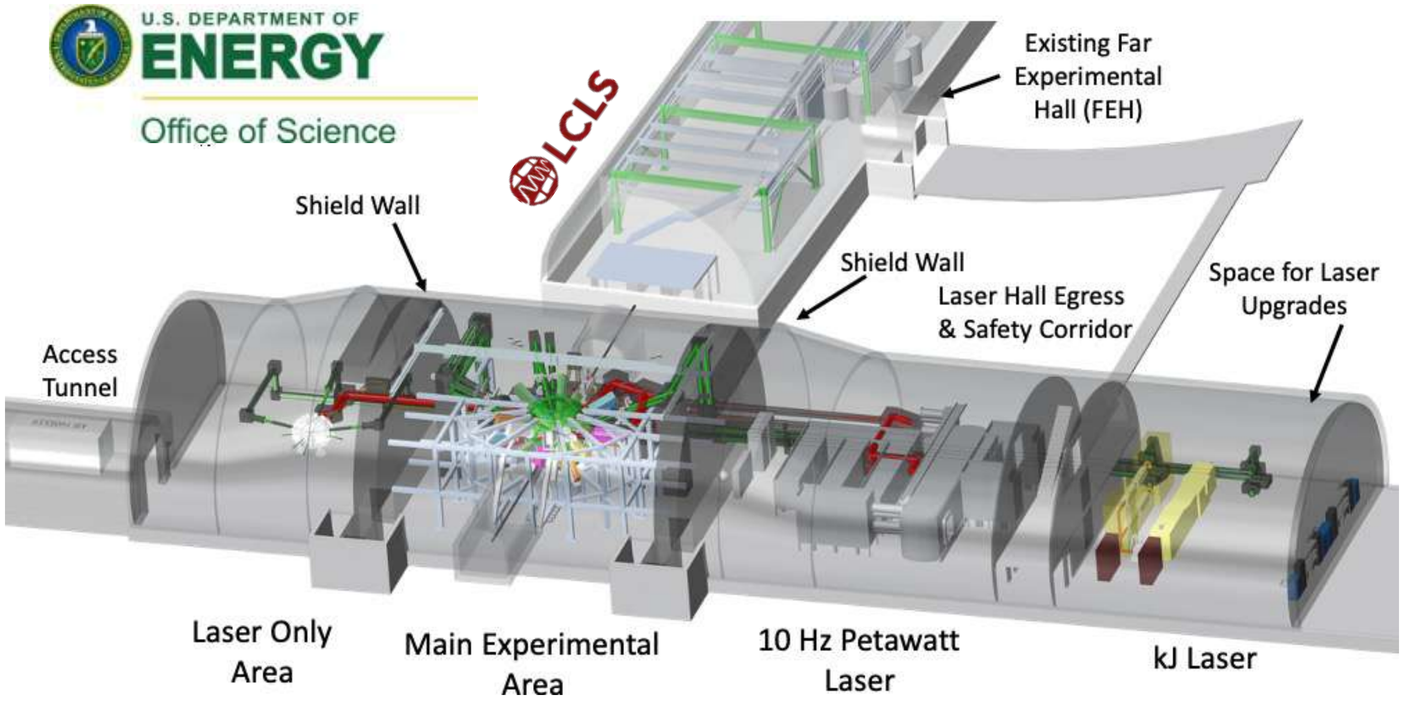


High-repetition rate laser science and active control feedback subsystems will:

- Accelerate the rate of discovery in HED science with AI/ML
- Drive the development of automated tools such as data handling and real-time processing
- Allow intelligent scanning through large parameter spaces
- Take advantage of both empirical measurements and simulation

M. Gauthier, C.B. Curry et al., Appl. Phys. Lett., 111 (11), 114102 (2017)
J. Koralek et al., Nat. Commun. 9, 1353 (2018)
Z. Chen, X. Na, C. B. Curry et al., Matter Radiat. at Extrem. 6 (5), 054401 (2021)
F. Treffert, C. B. Curry et al., Appl. Phys. Lett., 121 (7), 074104 (2022)

NEW HRR MID-SCALE FACILITIES, SUCH AS MEC-U, ARE URGENTLY NEEDED



World-leading laser capabilities coupled with LCLS for multi-decadal leadership in plasma science:

- 10x higher power @ 10 Hz (Petawatt)
- 10x higher energy laser (kilojoule)

G. M. Dyer, Matter in Extreme Conditions Upgrade Conceptual Design Report. (2022)

Advanced high-average power laser architectures will drive the development of:

- >10Hz operation models
- High-throughput targetry
- Rep-rate and radiation hardened diagnostics
- Machine learning techniques and active control feedback subsystems
- Bright, high-flux secondary radiation sources (ions, neutrons, X-rays, gammas)

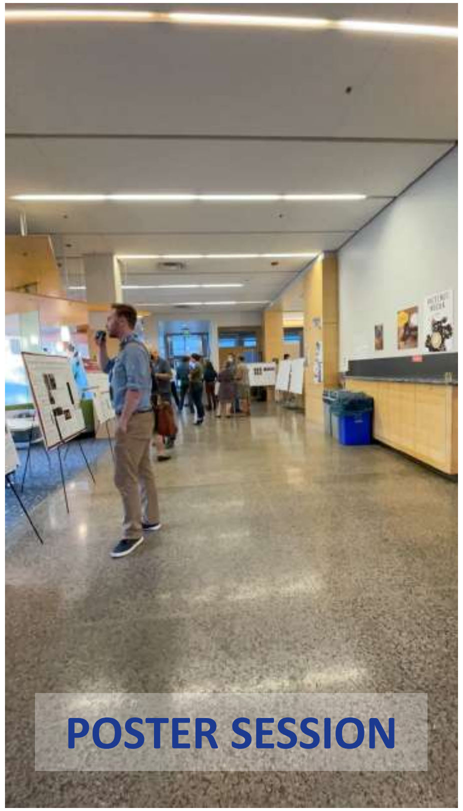
BUILDING AN ENERGY SCIENCES WORKFORCE NEEDS RECRUITMENT AND RETENTION STRATEGIES

1. Attract
2. Provide Opportunities
3. Promote an Inclusive and Supportive Environment

BUILDING AN ENERGY SCIENCES WORKFORCE NEEDS RECRUITMENT AND RETENTION STRATEGIES

- Encourage students and postdocs to lead experiments as PIs to develop new leaders
- Expose and train students and faculty from new institutions at LaserNetUS facilities
- Ongoing engagement with students to bring them into the field – users' meeting, lecture series, conference ambassadors
- Develop capabilities and expertise at universities to create new programs
- **New initiative in development:** Undergraduate Student Research Program

2022 LaserNetUS Users' Meeting
August 16-18, 2022
Fort Collins, CO



- The 2.5 day meeting was hosted by Colorado State University in Fort Collins, CO
- 165+ attendees, 43% of the contributed talks were by graduate students
- ***LaserNetUS provided support for 40 students to attend the meeting and present their research***

OUR VISION FOR AN UNDERGRADUATE STUDENT RESEARCH PROGRAM

Virtual tours, match of cohort and facility

Short Course 1 (all cohorts)

Short Course 2 (all cohorts)

Short Course 3 (all cohorts)

Virtual meetings with host facility to continue research progress

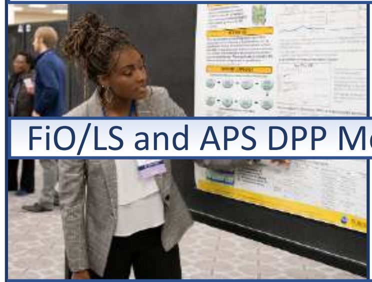
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Student Recruitment

Biweekly hybrid meetings of cohort and host facility; safety training, instrument training, etc.

8-week research internship at LaserNetUS site

LaserNetUS Annual Meeting



FiO/LS and APS DPP Meetings

End of Program Survey

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OUTLOOK

LaserNetUS aims to grow the scientific ecosystem around the use of high-power lasers

- Through enhanced community networking
- Engaging new institutions
- Providing training and leadership opportunities for students – establishing a talent pipeline for the energy sciences workforce

Mid-scale laser facilities will play an important role in addressing S&T challenges for U.S. IFE research programs

- HRR experiment design
- Closed loop optimization with AI/ML
- Laser-plasma interaction physics
- Diagnostics & target development

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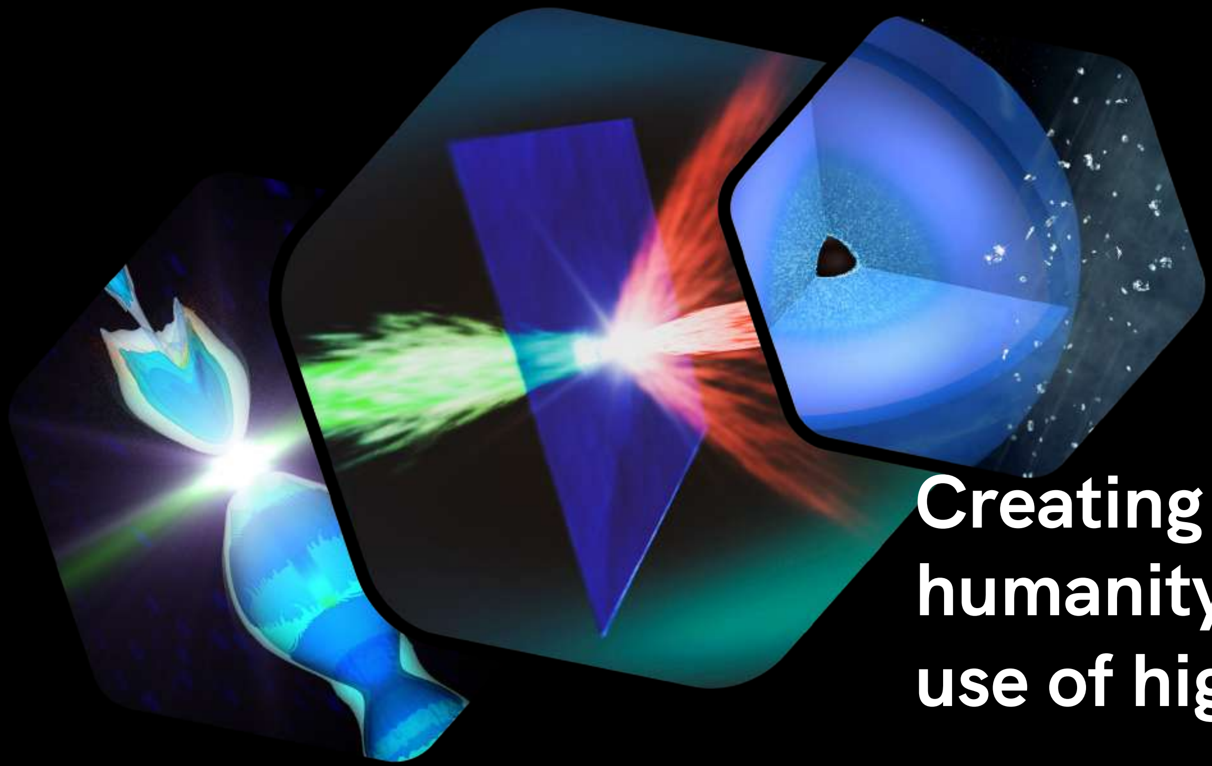
THANK-YOU



Creating a brighter world and better humanity through the innovation and use of high-intensity lasers.

LaserNetUS

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