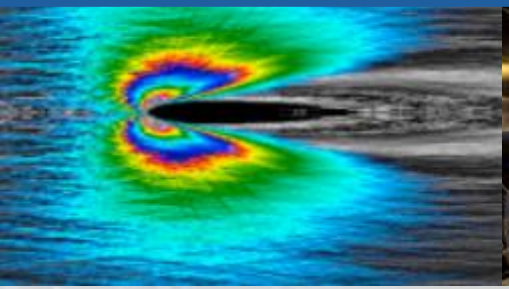
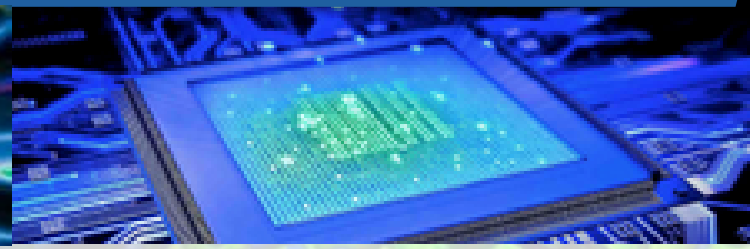
The High Energy Density Science Center: FY2021 A Year in Review







Frank Graziani
October 7, 2021

Felicie Albert
Jim Emig
Paul Grabowski
Bruce Remington
Ronnie Shepherd

LLNL-PRES-763593

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344. Lawrence Livermore National Security, LLC

We headed into FY21 not knowing what to expect…but hopeful!


Let’s get started!
HEDS
LLNL

Who are we?

Director

Frank Graziani

Deputy Director

Felicie Albert

Budget

Tracy Baldwin

Technology Facility

Jim Emig

Seminar Series

Paul Grabowski

Outreach

Ronnie Shepherd

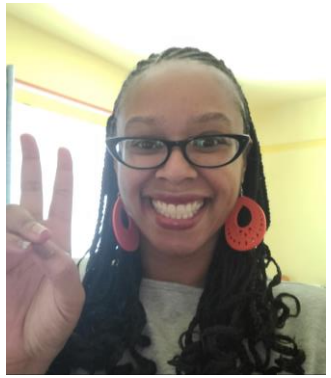
Administrator

Jessica Karlton

Discovery Science

Bruce Remington

Administrator



Elaine Johnson

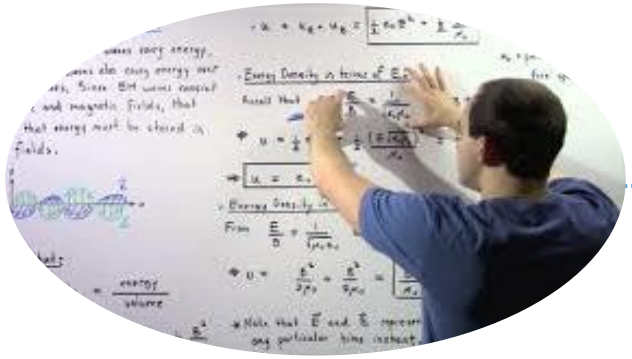
Hertz Hall

Camille Bibeau

LLNL Director of Strategic Diversity and Inclusion Programs

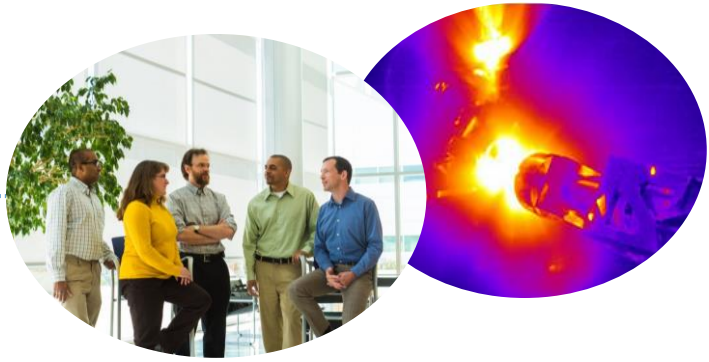
Tony Baylis

The HEDS Center is building a worldwide community in HED by integrating academic and national laboratory efforts



Education

Educating the next generation of researchers



Bridge to the Programs

Focus on HED areas of interest to the programs — driving a workforce pipeline

HEDS

High Energy Density Science Center

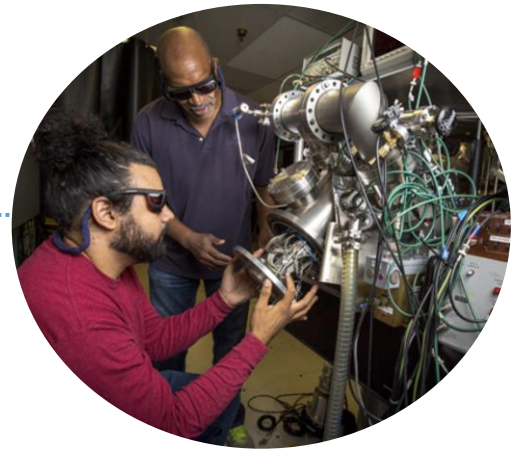
Bridge to the HED Community

Seminars, Workshops and Outreach

Strengthening communication ties within the HED community

Enabling Research in Relevant Areas

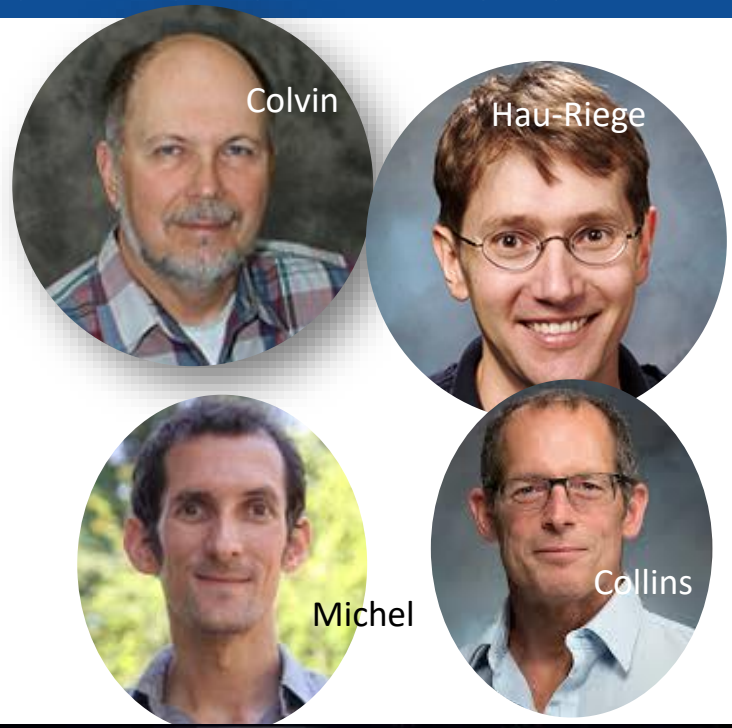
Providing the links to HED research collaborations



https://heds-center.llnl.gov/

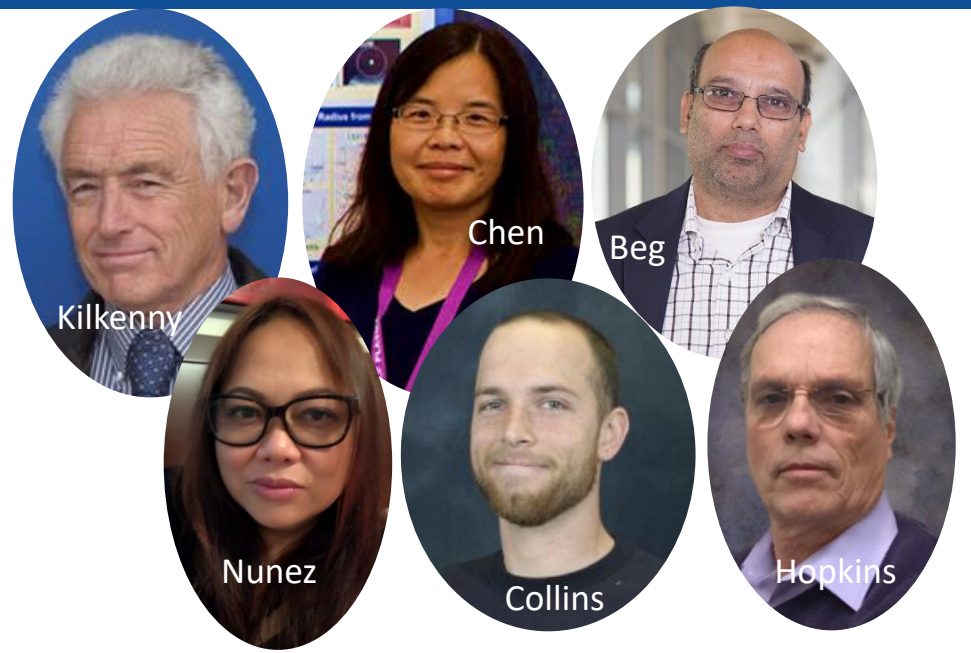
Educating the next generation of HED scientists is important to maintaining a healthy and vibrant field

- Since 2017, the Center has worked with universities to offer courses in HEDS
  - Short (6-8 lectures) and long courses (quarter or semester)
  - Strong collaboration with UCSD and UR
  - Partner with UM, MSU, UC Berkeley, MIT, Osaka, Oxford
  - Adopting new distance learning technologies
- We are exploring new forums for education
  - P. Michel is writing a book on laser plasma interactions (LPI)
  - Book will turn into a course for FY23
  - Coordination with WCI and their Designer Training efforts



In 2021, working with J. Kilkenny,, H. Chen and F. Beg, we sponsored a new course on HEDS diagnostics

- In 2021 a new version of the HEDS diagnostics course was offered
  - Quarter long course with TA, homework and exams
  - Guest lecturers (e.g. GA) that included topics from engineering, introduction to the NNSA, …
  - Lectures were presented in multi-media format with video, lightboards, PowerPoint
  - Once again, a superb LLNL-UCSD team effort led to its success



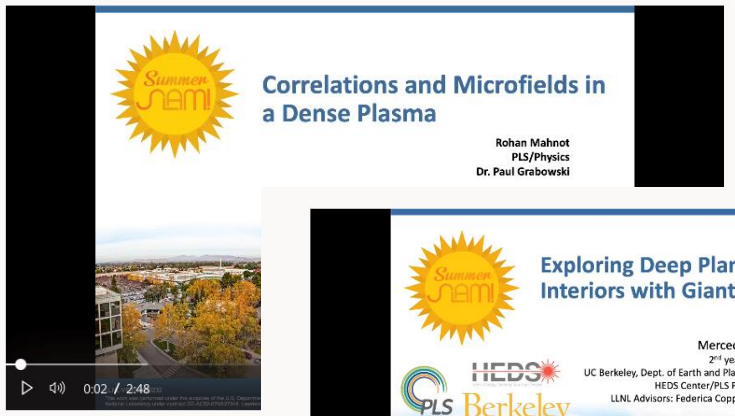
- We are continuing to explore new technologies and methods to assist with teaching
  - Surface Pros and Lightboard offer new technologies to assist with distance learning

COVID-19 the center co-hosted with JHEDS a virtual summer student program

Learning to do simulations for laser-plasma interaction experiments

weekly webEx meeting organized by JHEDS (Shahab Khan) and the center

- Special events
- Virtual NIF tour
- Virtual summer slam by the students



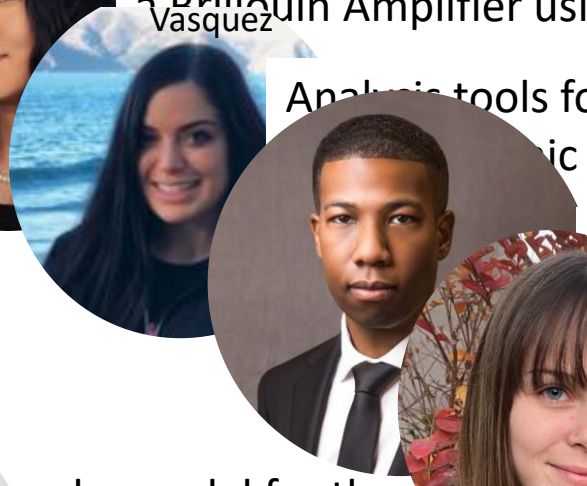
A theoretical approach for transient shock strengthening in high-energy-density laser compression experiments

Cite as: Phys. Plasmas **28**, 082708 (2021); https://doi.org/10.1063/5.0055414
Submitted: 28 April 2021 . Accepted: 02 August 2021 . Published Online: 24 August 2021

Michael J. Wadas, Griffin Cearley, Jon Eggert, Eric Johnsen, Marius Millot, et al.

Particle In Cell simulation studies of a Brillouin Amplifier using EPOCH

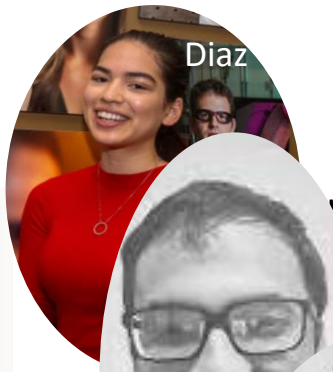
Vasquez



Analysis tools for diffraction data collected ic compression at the Omega

1D kinetic study of pinch nation in a DT DPF

Morris



Diaz

ped a model for the n of laser-generated y electrom

Ge

Mahnot

Isolation and purification of protactinium to improve nuclear forensics capabilities

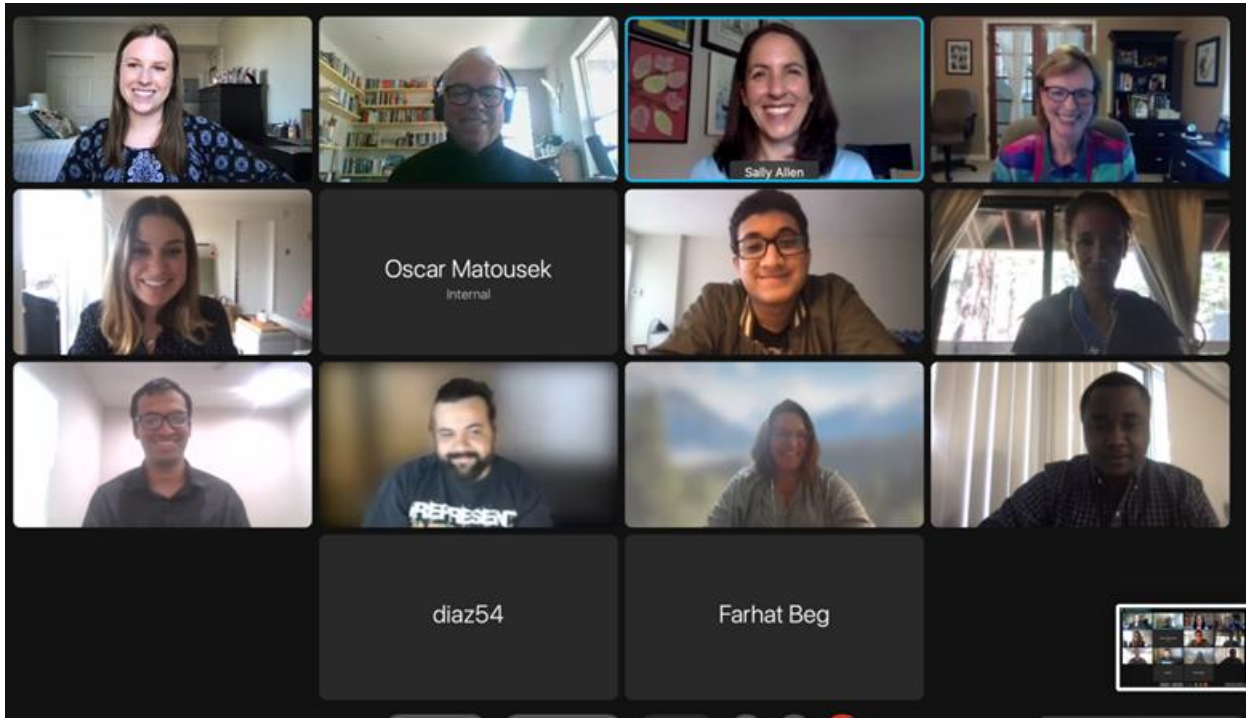
Optimization of a time resolved, solenoid-based neutron spectrometer for NIF

Matousek

Lawrence Livermore National Laboratory

Since 2018, the Livermore Lab Foundation continues to support our interns

- Livermore Lab Foundation has provided support of additional support
  - Students submitted applications for funding for support and HEDS staff determined need and amount on a case-by-case basis
  - We are hoping that next year, students will use LLF funding to attend the HEDS summer school

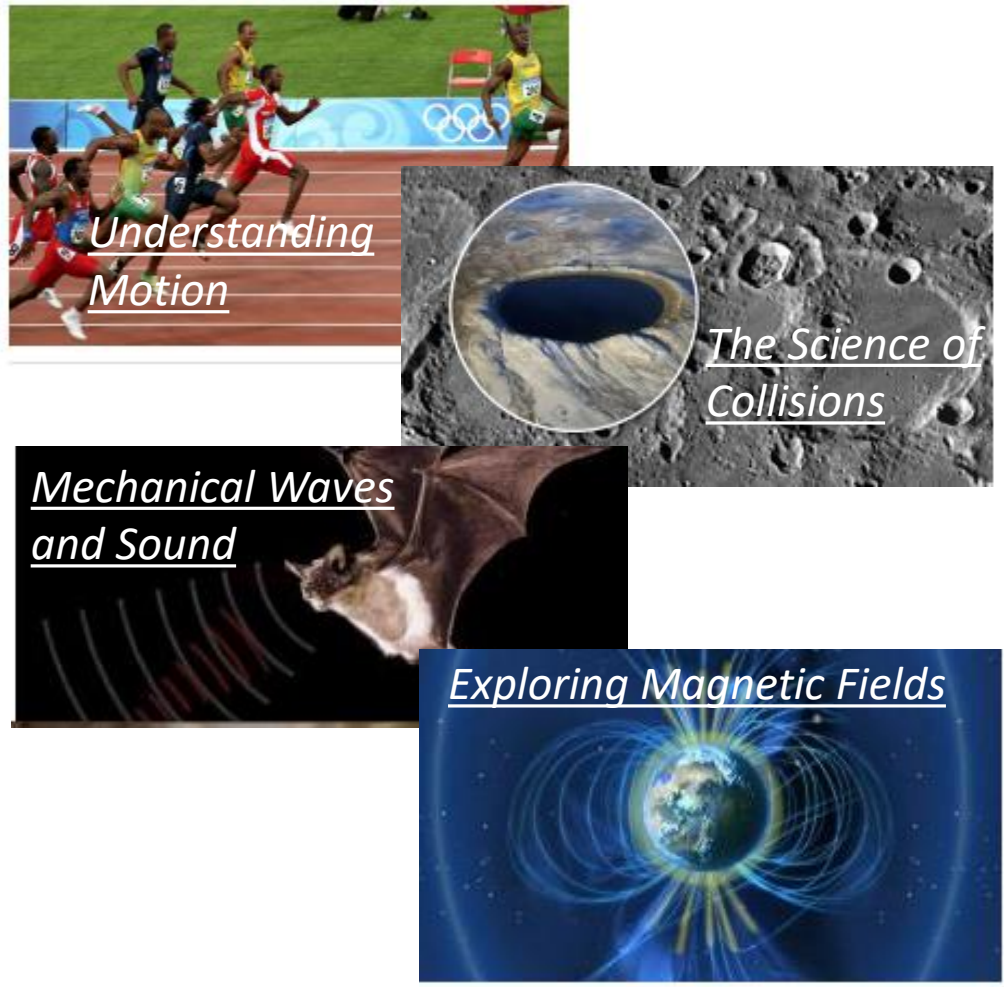


Dave Rakestraw mentored summer interns working on the development of physics curriculum using the sensors in phones

Students helped develop, test and refine a series of physics experiments that make use of the sensors in phones which include:

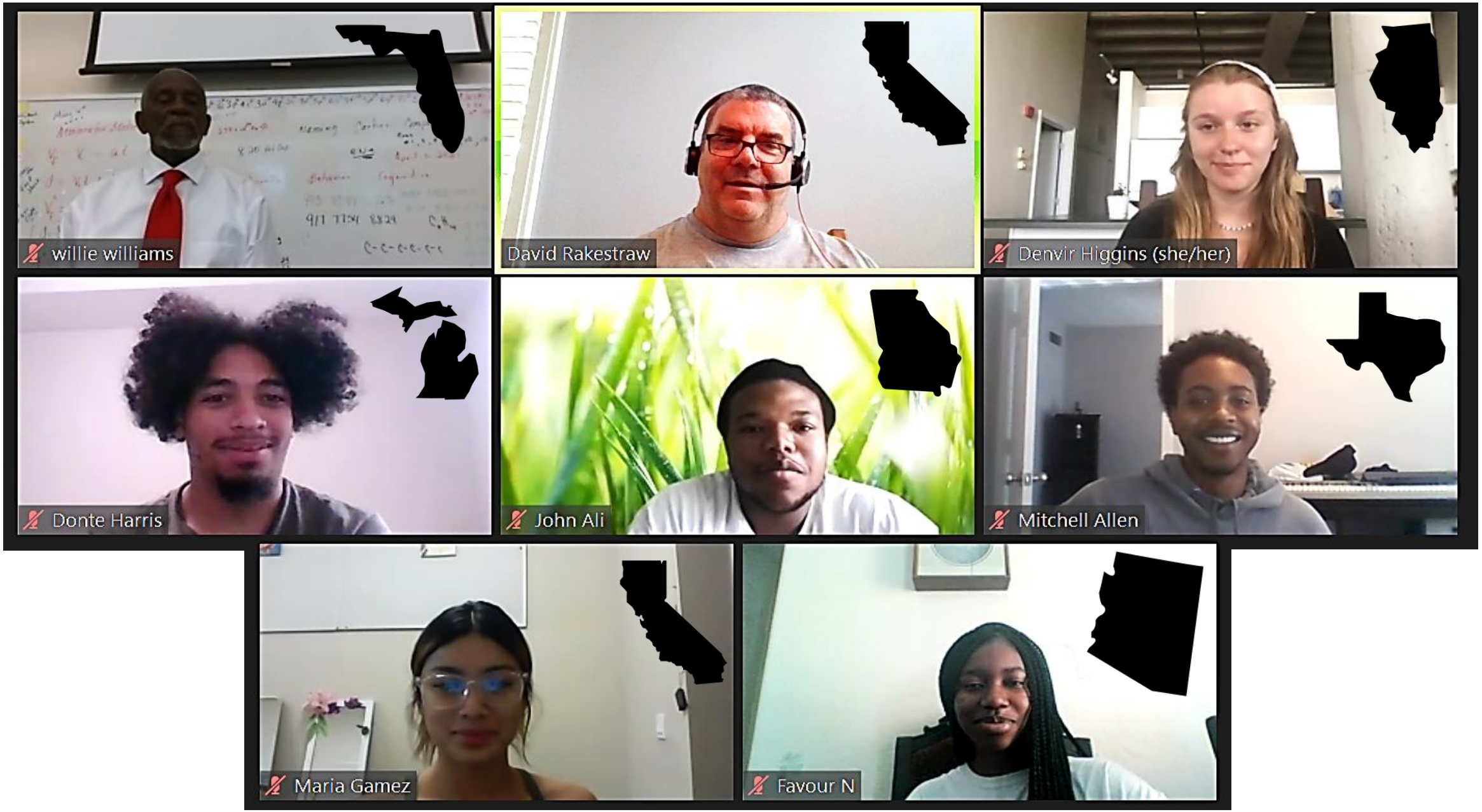
- 3-axis accelerometer
- 3-axis gyroscope
- 3-axis magnetometer
- Pressure transducer
- Microphones and speakers
- GPS system
- High resolution video camera
- High resolution timer

The material is available on the LLNL website and is being used in high school and college classes across this country this fall.



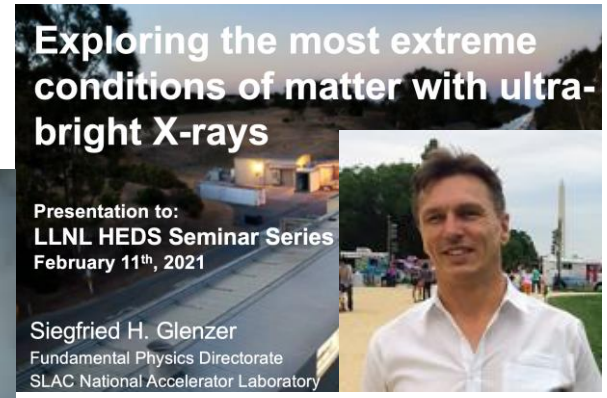
https://st.llnl.gov/sci-ed/distance-learning

Virtual Summer Phone Physics 2021



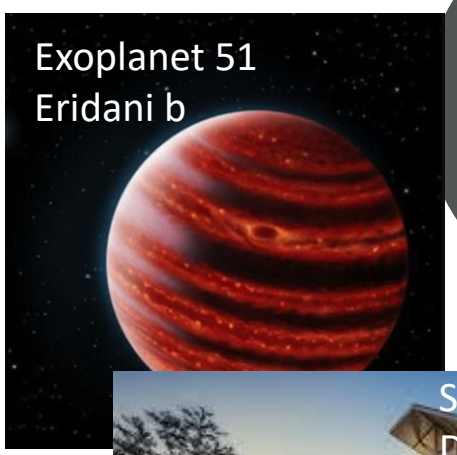
The Center provides outreach through seminars, workshops and campus interactions

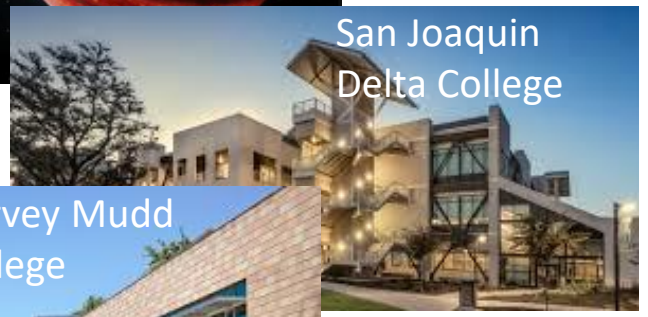
- "Weekly" HED seminar series
  - Solicitation process that targets recognized and early career scientists
  - *https://heds-center.llnl.gov/education/seminars*
  - We are now adapting a hybrid technology to accommodate in-person and remote access
- The series provides a forum for academics and Laboratory staff to exchange ideas
  - "The Nature paper is a child of the HEDS Center."
  - After reading Nature paper, M. Millot contacted B. Cheng from Cambridge and she presented at the HEDS Seminar
  - A focused science meeting and collaboration followed
- Videos are on the YouTube channel
  - https://www.youtube.com/watch?v=eLvN6215M9U&list=PLy9rIbGDXrG3noqQ4wkG6DoMACYoKiulr&index=19

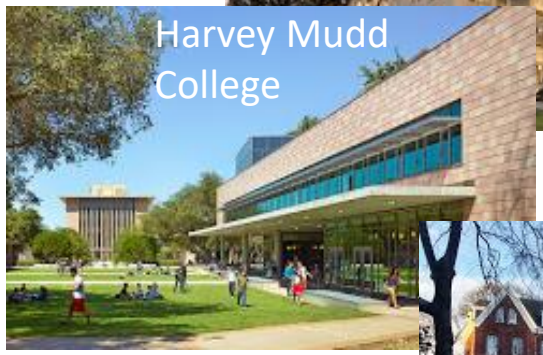


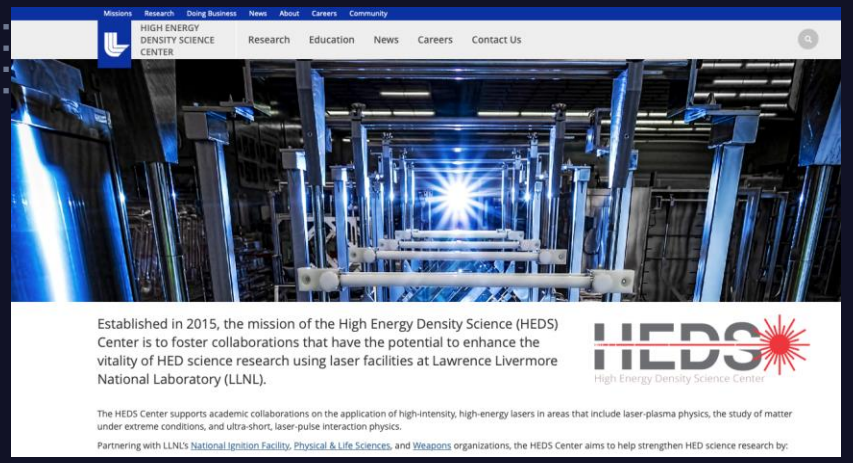
The Center provides outreach through seminars, workshops and campus interactions

- University outreach
  - LLNL Ambassador Program: F. Albert, F. Graziani, and T. Ma for HEDS
  - The HED Center provides a link between LLNL and the participating universities in Discovery Science experiments on NIF
- Support for workshops
  - High Pressure Gordon Conference (S. Pascarelli)
- We have a new activity for FY22, postponed due to COVID
  - HEDS speakers for undergraduate and community colleges (Art Pak, Alison Saunders, Camelia Stan)
  - Working with T. Baylis on outreach to K-12







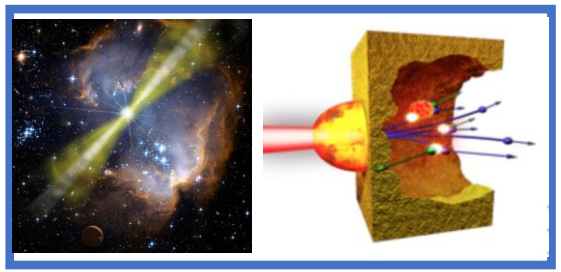


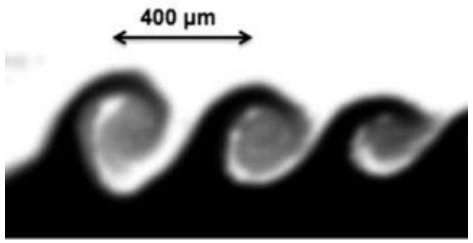
The center is working with the PLS communication teams to improve the website

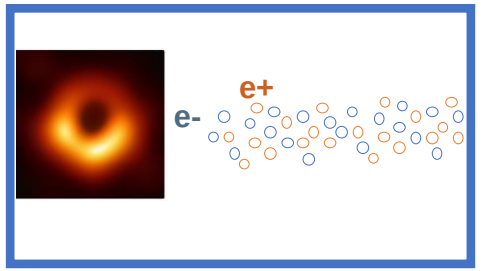
- We are looking for a modern and easy to read format
- We welcome feedback and input on what should be on the website

The new website will feature educational videos on HEDS

- Blagoje Djordjevic (WCI, Theory)
  - Short-pulse laser acceleration
- Jens Von der Linden (PLS, Experiments)
  - Trap relativistic matter-antimatter plasmas in magnetic bottles
- Andrea Schmidt (PLS, Experiments)
  - Dense plasma focus experiment
- More are coming







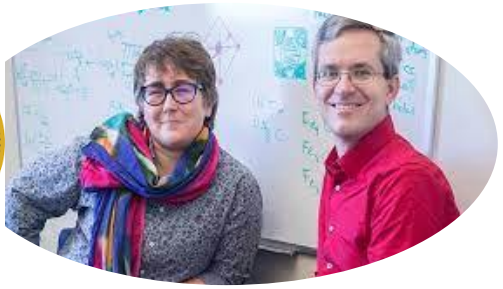
If you are interested in doing a video for us, contact F. Albert

The Center is the focal point for facilitating and fostering research opportunities for academic and LLNL staff

- **NNSA HED Center for Matter at Extreme Conditions**
  - Energy transport, material properties, in magnetized systems (F. Beg of UCSD leads CMEC)
  - Host students at LLNL
  - HEDS curriculum development
  - Support for experiments at Jupiter Laser Facility
- **High Pressure research at Berkeley and Davis**
  - HEDS Center continues to support HiP work
  - M. Vasquez (mentor: Coppari) member of Jeanloz group
  - J. Wurtlele plasma physics (postponed)
    - Lectures by LLNL staff and tour of NIF for students

A new UC-National Lab Collaborative Research and Training Award proposal has been submitted

- **Center for Solid-to-Plasma Dynamics: From Bulk and Mesoscale Materials to High Energy Density**
  - Understand the solid to plasma transition under high-power lasers
  - Combined multiscale simulation and time-resolved experiments
- **Multi-institutional with both research and education as a focus**
  - Hands-on research training for students and postdocs
  - Undergraduate research
  - Undergraduate and graduate education

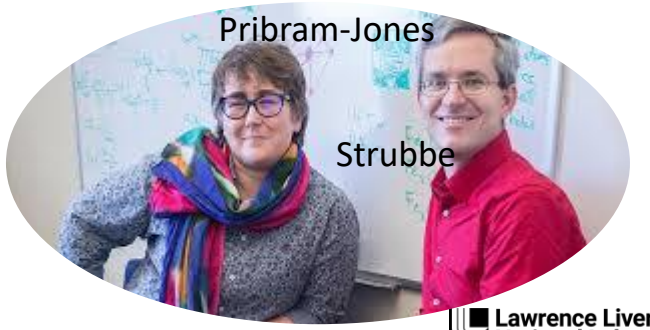
BERKELEY LAB

Los Alamos NATIONAL LABORATORY EST. 1943

The Center is the focal point for facilitating and fostering research opportunities for Minority Serving Institutions

- Consortium for High Energy Density Science
  - MSIPP NNSA funded effort renewed in FY21
  - FAMU, UC Merced, Morehouse and LLNL
  - Dense plasma effects on ionization
  - K-12 outreach and education will hopefully begin in FY22
- Graduate student and postdoc are in residence at Center
  - J. Clark: PhD student working with R. Shepherd
  - J. Tucker: Quantum computing working with J. Dubois
  - D. Gebremedhin : PD from FAMU in residence at the Center
  - A. Aghedo: FAMU graduate student working with D. Rusby
    - *Model of Bremsstrahlung x-ray emission from short-pulse high-intensity laser interaction on various metal targets*

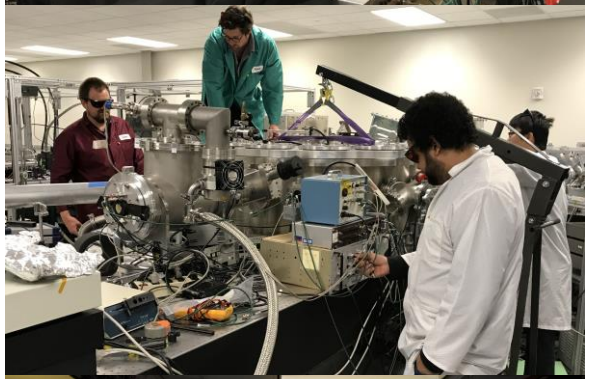
Presented at the LaserNetUS annual meeting and the UCSD-organized HEDS summer school

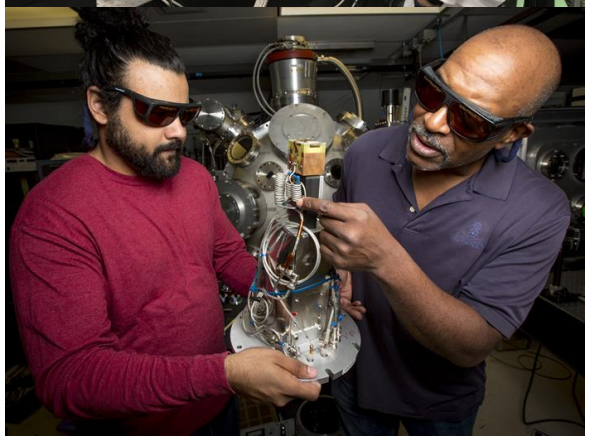


Lawrence Livermore National Laboratory

Jerry Clark (Florida A&M) is pursuing his Ph.D research while at LLNL, under the mentorship of R. Shepherd

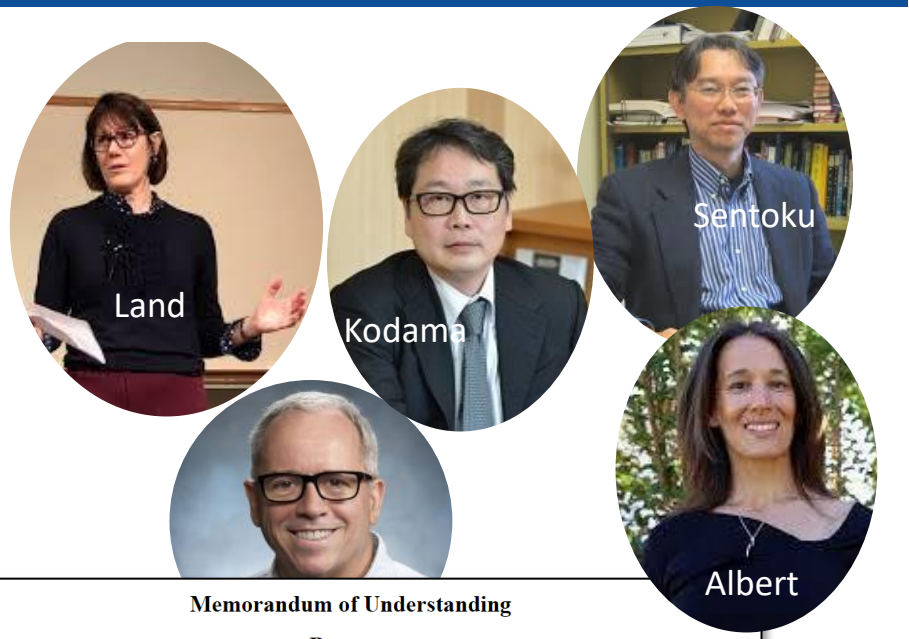
- Successful in acquiring laser time through the competitive LaserNet US proposal program
- Experiments produced extensive data on electron-ion equilibration in dense plasmas
- Jerry presented his results, as an invited speaker, at the LaserNet US Annual workshop, August 17th-19th, 2021
- Presented at the UCSD-organized HEDS summer school
- Jerry is expected to complete his thesis in Summer, 2022





After a hiatus in activities, LLNL has re-engaged with Japan (ILE) in areas of mutual interest

- MOU signed between LLNL and ILE/University of Osaka
- Monthly WebEx collaboration meetings between the HEDS center and ILE
- Coordination of LaserNetUS collaboration
- A joint US/Japan seminar series with inaugural speakers begins in the Fall
  - Tetsuya Kawachi, Director of QST, KPSI
  - Hitoki Yoneda, Professor, University of Electro-Communications
  - Yasuhiko Sentoku, Professor, ILE, Osaka University
  - Roger Falcone, Professor UC Berkeley
  - Bruce Remington, Director of NIF Discovery science program, LLNL
  - Arianna Gleason, Scientist, SLAC
- H. Morita finished his PhD and published his research based on work he did at LLNL



Memorandum of Understanding

Between

Institute of Laser Engineering (ILE) Osaka University

and

Lawrence Livermore National Security, LLC

Institute of Laser Engineering in Osaka University (hereinafter referred to as "ILE" registered office at: 1-1 Yamadaoka, Suita, Osaka 565-0871, Japan, and Lawrence National Security, LLC, which holds a prime contract with the United States De

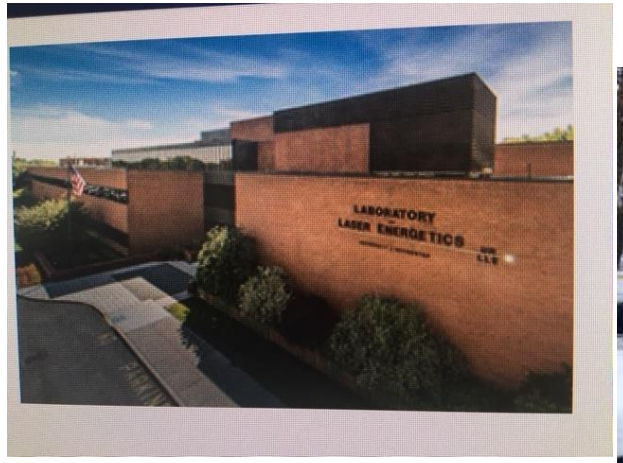
Advanced analysis of laser-driven pulsed magnetic diffusion based on quantum molecular dynamics simulation

Cite as: Matter Radiat. Extremes 6, 065901 (2021); https://doi.org/10.1063/5.0053621
Submitted: 09 April 2021 . Accepted: 07 August 2021 . Published Online: 21 September 2021

Hiroki Morita, Tadashi Ogitsu, Frank R. Graziani, Shinsuke Fujioka, et al.

HEDS B161 Technology Center for Research

The Technology Center supports HED researchers and students. The Technology Center does this at various facilities across the US and abroad.



LLE
Laboratory for Laser Energetics

CSU
Colorado State University
Laser Laboratory

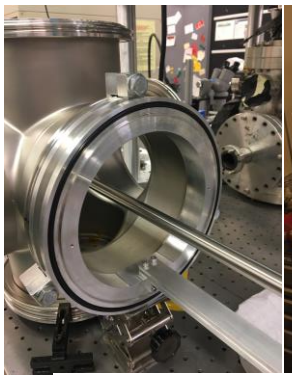
LLNL B161

Visit of LLNL team to NLF in Soreq

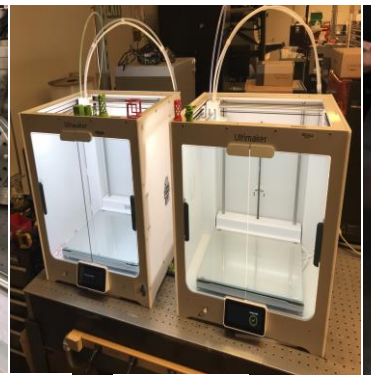
The HEDS Center helps provide support for the HEDS B161 technology center

The Building 161 technology facility is a multi use facility, managed by PLS, for researchers to design, build and deliver targets and diagnostics.

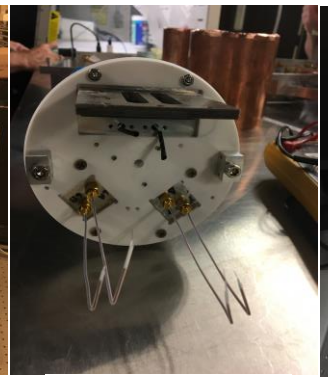
We have and maintain Fineplacer assembly stations and 3D printers giving us the capability to prototype and bring ideas to reality. We installed a CNC water jet improving our prototype and deliverable capabilities.



Prototype chamber insertion system

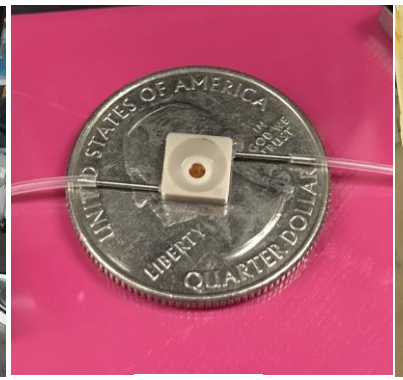


3D Printers



Solar cell effects testing

Water filling station



Water cell

CNC WATER JET

Fineplacer-1um accuracy placement

A sabbatical program and a HEDS Center Postdoctoral Fellow, new for FY20, will continue in FY21

- Sabbaticals were put on hold in FY20 and are resuming in FY21 and 22
  - Mini-sabbatical sponsored by A. Kersting
    - F. Beg of UCSD is on-site now!!!
  - Summer of FY22? F. Delmotte (University of Paris)will lecture on laser optics
  - W. Fox (Princeton) is tentative
- HEDS Center Postdoctoral Fellow
  - Opportunity for an early career researcher to work at LLNL, while promoting HEDS to a larger audience
  - We have hired two Fellows (one each year)
  - Application package and review process is coordinated with the Lawrence Fellowship and Foster and Brown Fellowships

The HEDS postdoctoral fellowship continues, supported by WCI/ICF

1st HEDS center Fellow

Andrew Longman, PhD University of Alberta

"Coupling of Structured Light to Plasma for Magnetic Field Generation, Particle Guiding, and Control of Laser-Plasma Interactions"

LLNL Mentor: Pierre Michel (Since January 2021)

2nd HEDS center Fellow

Ka Wai (Karry) Wong, PhD University of California Davis

"3D Electron Temperature Measurement of Inertial Confinement Fusion Hotspots using X-Ray Emission Tomography"

LLNL Mentor: Benjamin Bachmann (Starting October 2021)

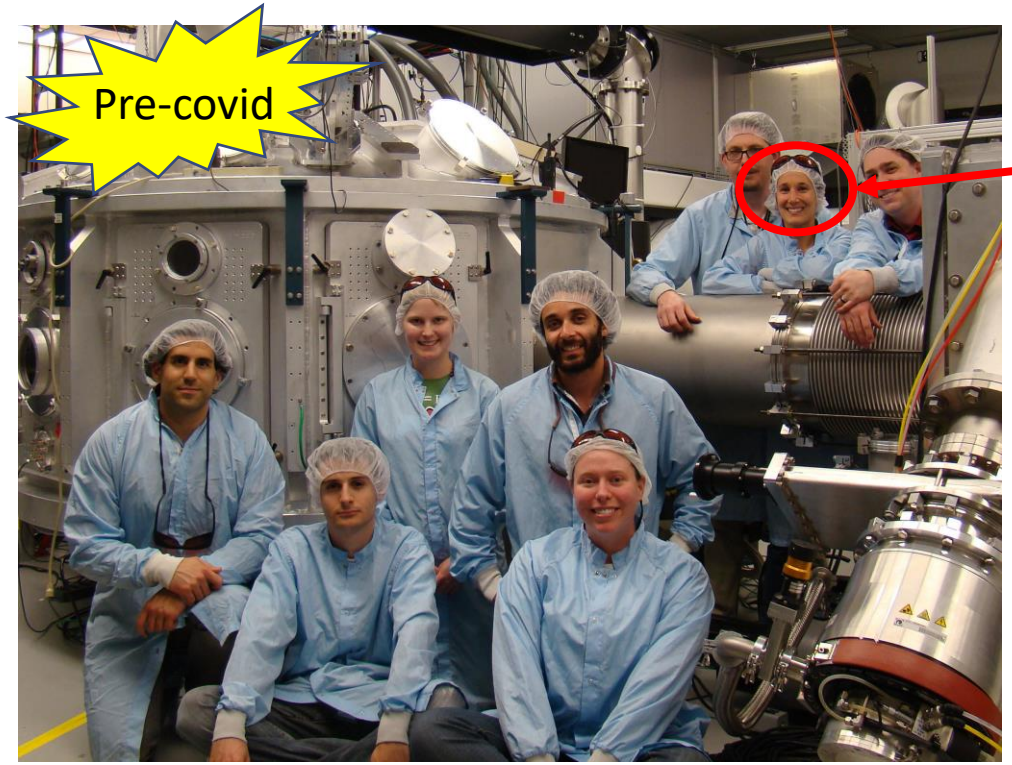
2021 Selection commitee

- Tilo Doeppner (NIF)
- Jon Eggert (PLS)
- John Moody (NIF)
- Yuan Ping (PLS)
- Kumar Raman (WCI)
- Heather Whitley (WCI)

2022 applications in review

Coordination with Lawrence and WCI fellowships

In FY 2022 the center will be exploring new partnerships with the Jupiter Laser Facility



The new JLF deputy

JLF has attracted many students and postdocs to LLNL and enables collaborations with academia

We are currently exploring new partnerships:

- Possible common use of 161 facility for JLF users for targets, diagnostics, storage
- A HEDS/JLF summer intern at the facility, to help the facility while training a student on laser and diagnostic technology

The HEDS Center is collaborating with WCI and developing a survey course in HEDS of use to employees and students

- Summer program in HEDS will have an education component
  - Internal discussions within HEDS Center team
  - Offer survey course aimed at advanced UG level open to all students
- Designer Training Institute
  - WCI is undergoing a rapid increase in new hires
  - The old system of on-on-one mentorship is not scalable
  - D. Callahan is leading an effort to build a curriculum that spans the breadth of SKA's needed for design
- HEDS Center is working with DTI to supply a course aimed at LLNL staff, new hires and students
  - Staff and students have to work-Course cannot be overly demanding
  - Teaching versus death by PowerPoint
  - 7 week of 14 lectures
  - Modular concept of M. Akin

WCI
WEAPONS
AND COMPLEX
INTEGRATION

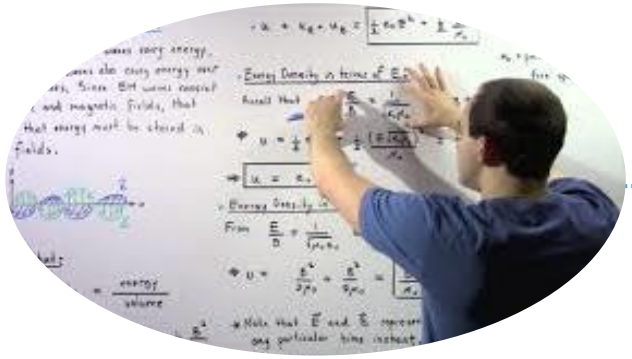
HEDS
High Energy Density Science Center

WCI has introduced the Academic Collaboration Team (ACT) as a way of fostering LLNL-academic interactions

- WCI wants to develop university relations in support of WCI programs
  - Innovation, basic science, an informed independent perspective
  - Product is data, technology, methods
  - Hiring pipeline and workforce education
- ACT roles and responsibilities
  - Rose McCallen of WCI is coordinating ACT
  - Proposals consist of PI's from academia and LLNL
  - Topics derived from input by APDs, line management, project teams, PIs, individuals
  - Selection process is based on a "blind" review by a committee

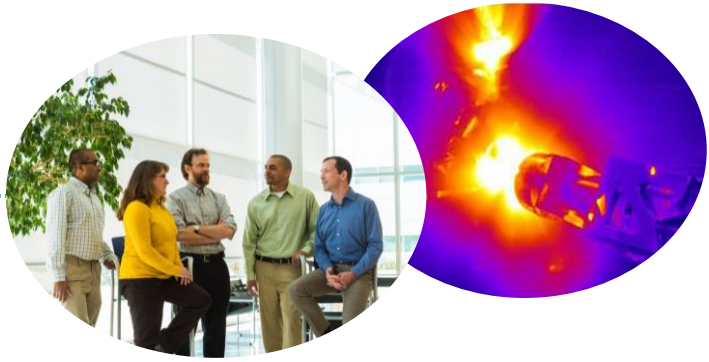
Maddox and Wasem

The HEDS Center is building a worldwide community in HED by integrating academic and national laboratory efforts



Education

Educating the next generation of researchers



Bridge to the Programs

Focus on HED areas of interest to the programs — driving a workforce pipeline

HEDS

High Energy Density Science Center

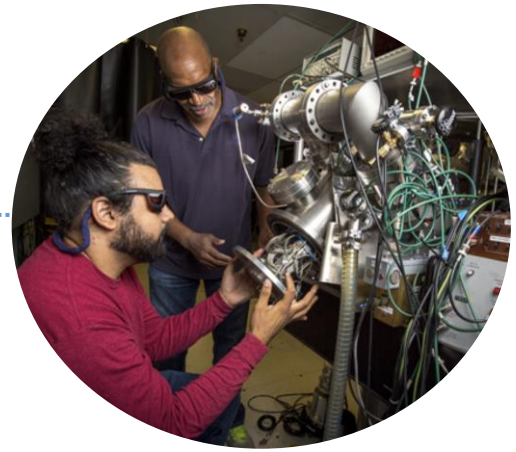
Bridge to the HED Community

Seminars, Workshops and Outreach

Strengthening communication ties within the HED community

Enabling Research in Relevant Areas

Providing the links to HED research collaborations



https://heds-center.llnl.gov/