The High Energy Density Science (HEDS) Center: A Vision for the Future

Frank R. Graziani, HEDS Center Director

HEDS
High Energy Density Science Center

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

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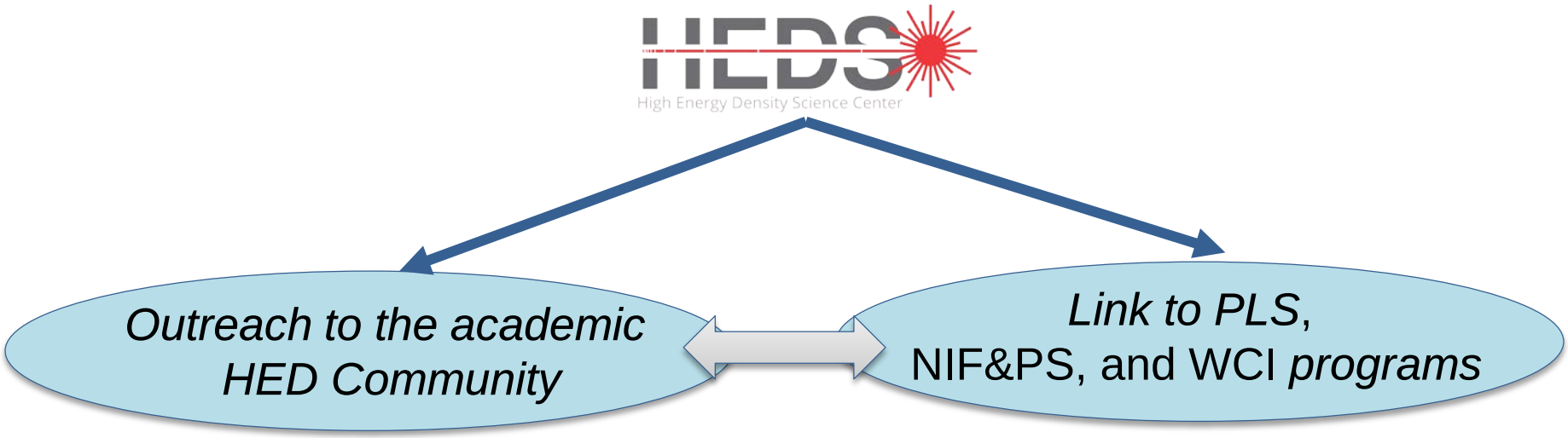
The Center represents an important integrating element between academic and NNSA HED science efforts



Building an HED community though support and collaboration with academic partners and integrating those efforts with the programs is the Center's goal

Who are we?

Technology Facility

Carl Bruns

Technology Facility

Jim Emig

Seminar Series

Paul Grabowski

Director

Frank Graziani

Administrator

Stephanie Lopez

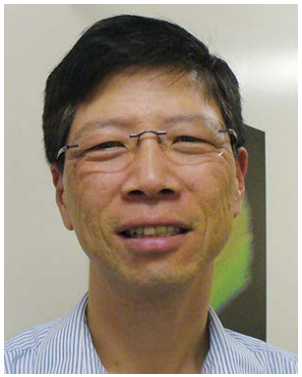
Discovery Science

Bruce Remington

Outreach

Ronnie Shepherd

Link to the programs Outreach



Alan Wan

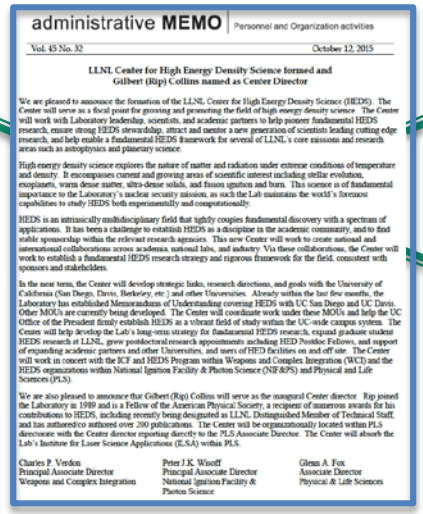
The HED Center was founded in 2015 as a multi-directorate institution for enabling and growing an HED community

Bridge to the HED Community Workshops

Topics of broad interest to the academic and LLNL program communities

Enabling Research in Relevant Focus Areas

Experimental, computational and theoretical opportunities


administrative MEMO | Personnel and Organization activities

Vol. 45 No. 32 October 12, 2015

LLNL Center for High Energy Density Science formed and Gilbert (Rip) Collins named as Center Director

We are pleased to announce the formation of the LLNL Center for High Energy Density Science (HEDS). The Center will serve as a focal point for growing and promoting the field of high energy density science. The Center will work with Laboratory leadership, scientists, and academic partners to help pioneer fundamental HEDS research, ensure strong HEDS stewardship, attract and mentor a new generation of scientists leading cutting edge research, and help enable a fundamental HEDS framework for several of LLNL's core missions and research areas such as astrophysics and planetary science.

High energy density science explores the nature of matter and radiation under extreme conditions of temperature and density. It encompasses current and growing areas of scientific interest including stellar evolution, exoplanets, warm dense matter, ultra-dense solids, and fusion ignition and burn. This science is of fundamental importance to the Laboratory's nuclear security mission, as such the Lab maintains the world's foremost capabilities to study HEDS both experimentally and computationally.

HEDS is an intrinsically multidisciplinary field that tightly couples fundamental discovery with a spectrum of applications. It has been a challenge to establish HEDS as a discipline in the academic community, and to find stable sponsorship within the relevant research agencies. This new Center will work to create national and international collaborations across academia, national labs, and industry. Via these collaborations, the Center will work to establish a fundamental HEDS research strategy and rigorous framework for the field, consistent with sponsors and stakeholders.

In the near term, the Center will develop strategic links, research directions, and goals with the University of California (San Diego, Davis, Berkeley, etc.) and other Universities. Already within the last few months, the Laboratory has established Memorandums of Understanding covering HEDS with UC San Diego and UC Davis. Other MOUs are currently being developed. The Center will coordinate work under these MOUs and help the UC Office of the President firmly establish HEDS as a vibrant field of study within the UC-wide campus system. The Center will help develop the Lab's long-term strategy for fundamental HEDS research, expand graduate student HEDS research at LLNL, grow postdoctoral research appointments including HED Postdoc Fellows, and support of expanding academic partners and other Universities, and users of HED facilities on and off site. The Center will work in concert with the ICF and HEDS Program within Weapons and Complex Integration (WCI) and the HEDS organizations within National Ignition Facility & Photon Science (NIF&PS) and Physical and Life Sciences (PLS).

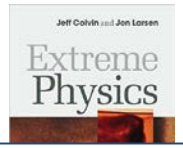
We are also pleased to announce that Gilbert (Rip) Collins will serve as the inaugural Center director. Rip joined the Laboratory in 1989 and is a Fellow of the American Physical Society, a recipient of numerous awards for his contributions to HEDS, including recently being designated as LLNL Distinguished Member of Technical Staff, and has authored/co authored over 200 publications. The Center will be organizationally located within PLS directorate with the Center director reporting directly to the PLS Associate Director. The Center will absorb the Lab's Institute for Laser Science Applications (ILSA) within PLS.

Charles P. Verdon, Principal Associate Director, Weapons and Complex Integration
Peter J.K. Wisoff, Principal Associate Director, National Ignition Facility & Photon Science
Glenn A. Fox, Associate Director, Physical & Life Sciences

Bridge to the Programs

Focus on HED areas of interest to the programs-helps drive a workforce pipeline

g LLNL researchers
scientific advances
and fostering collaborations

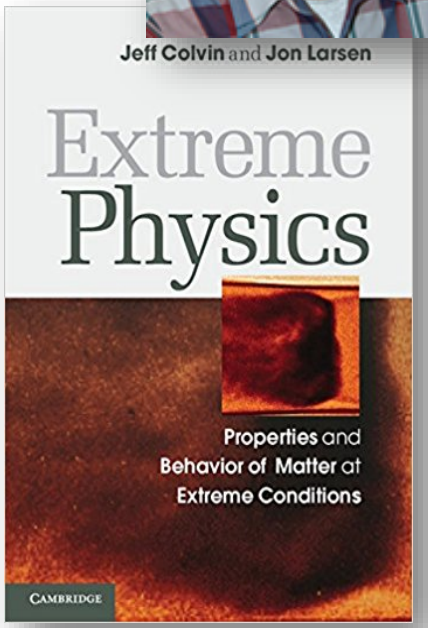


Education

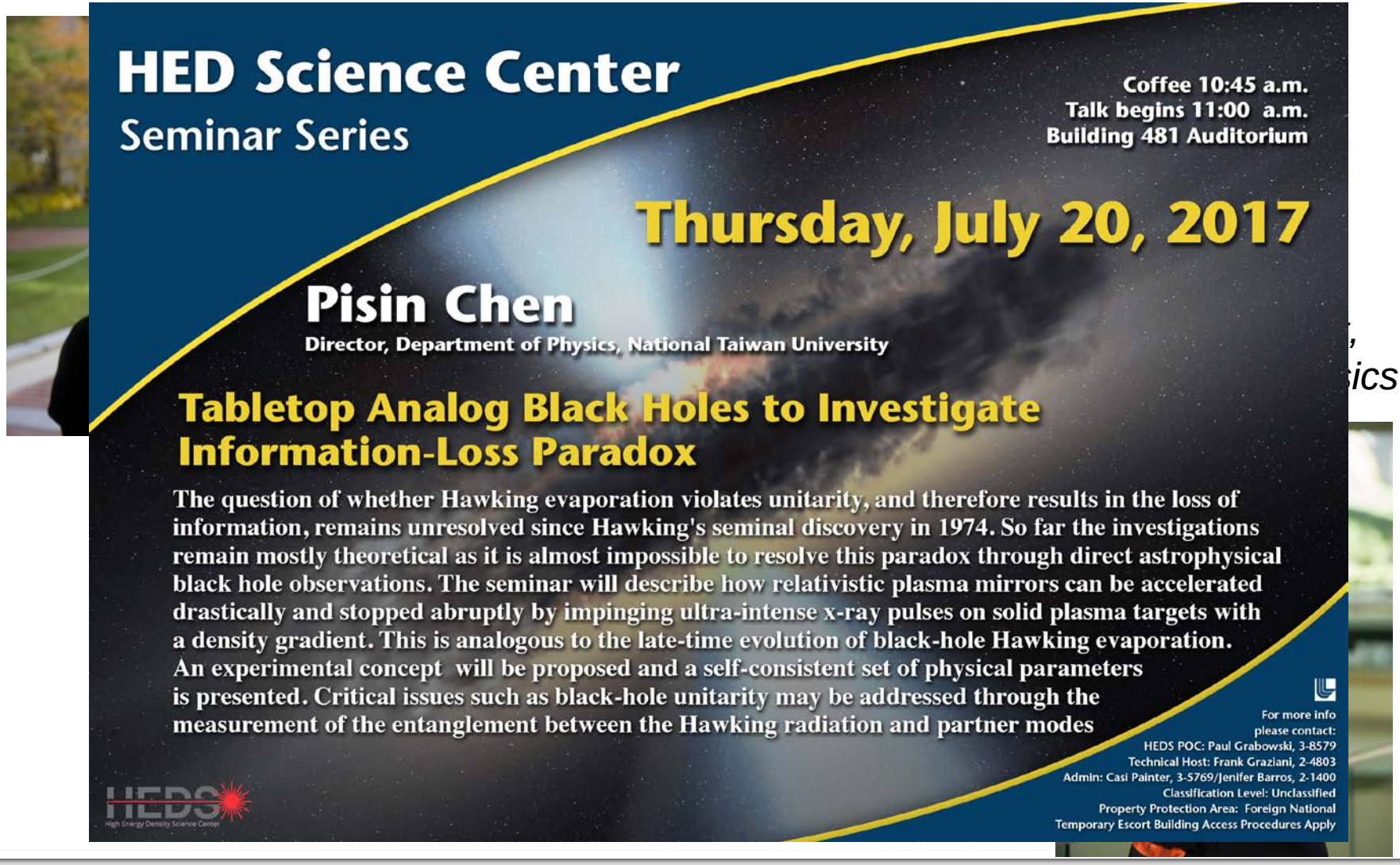
Courses in experimental, theoretical and computational aspects of HED science

The Center is working with academic partners to build a virtual HED "campus"

- A course in HED science was introduced as a pilot program
  - "Extreme Physics" by Jeff Colvin (9/28-12/7)
  - Classroom attendance, WebEx live or recorded viewing
  - Credit given to UCSD students and a TA provides support
  - The DO and DLP have been supportive throughout
  - Interest from academic and laboratory partners (UCSD, Florida A&M, UCD, MSU, UN-R, MIT, Rochester, LANL, PPPL)
- Pierre Michel developed a LPI course for UC Berkeley
- Short courses will be offered in 2018
  - H. Chen: Introduction to HED Laser-Plasma Experiments and Diagnostics
  - S. Hau-Riege: High-Intensity X-rays - Interaction with Matter
- We are looking forward to 2019
  - R. Mancini: Plasma Spectroscopy
  - Extreme Physics
  - Short course offerings?

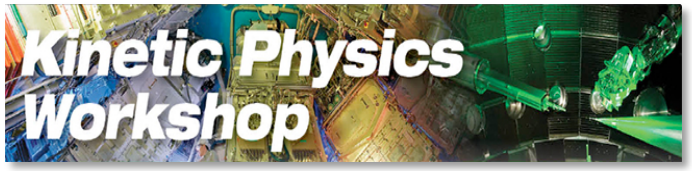


The Center has a seminar series targeting recognized and early career academics subject matter experts

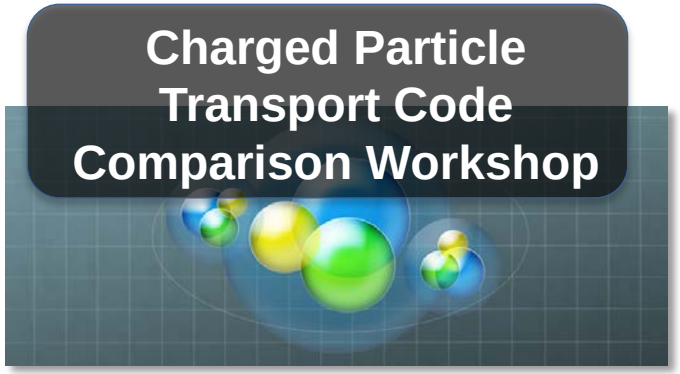


The Center has a recent and vibrant history of supporting workshops

- A kinetic physics workshop held at LLNL brought together academic and laboratory personnel
  - A summary and findings report was published November 28th, 2016



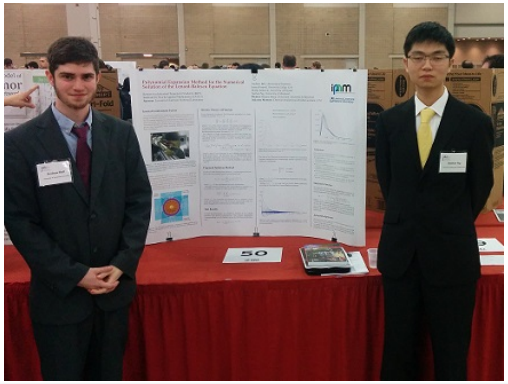
- A transport code comparison workshop was held October 24-26, 2016 at SNL
  - Code comparisons of coefficients commonly implemented in hydrodynamic simulations



- A nuclear physics in extreme states of matter
  - Bring together HED and nuclear physics communities
  - Link HED opportunities with critical nuclear physics needs
  - July 30th - August 1st , 2018

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

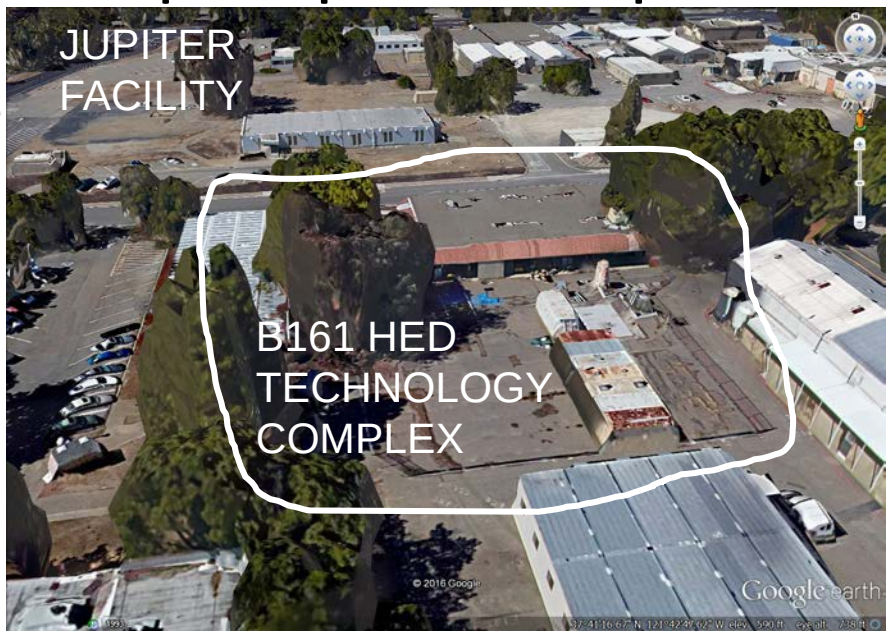
- The $4.1 million UC funded *Frontiers in HEDS Center*
  - Students, postdocs and faculty come to LLNL to use DOE facilities and develop technical collaborations.
  - Recent NNSA award
- Research in Industrial Partnerships – UCLA 2016
  - Students work in teams and produce a report
  - Our students have come to LLNL in subsequent years and one has joined the Center temporarily
- Academic collaboration
  - Facilitate academic collaborations
  - R. Jeanloz and collaborators (JLF)



The HEDS *Technology* facility and JLF are important facility capabilities for the Center

- In 2015, after the LLNL HED sciences center was established, use of B. 161 lab space for a HED technology facility was envisioned
- In 2016-2017 preparations were made to provide space for a diagnostic support capability
- The facility became the ideal platform for physicists and students to work closely with technicians to produce targets for HED experiments
- Place to develop advanced targets, diagnostics and experiment schemes for a range of facilities (JLF, LLE, LCLS)

Aerial view of B161 with 4200 sq. ft. of potential lab space



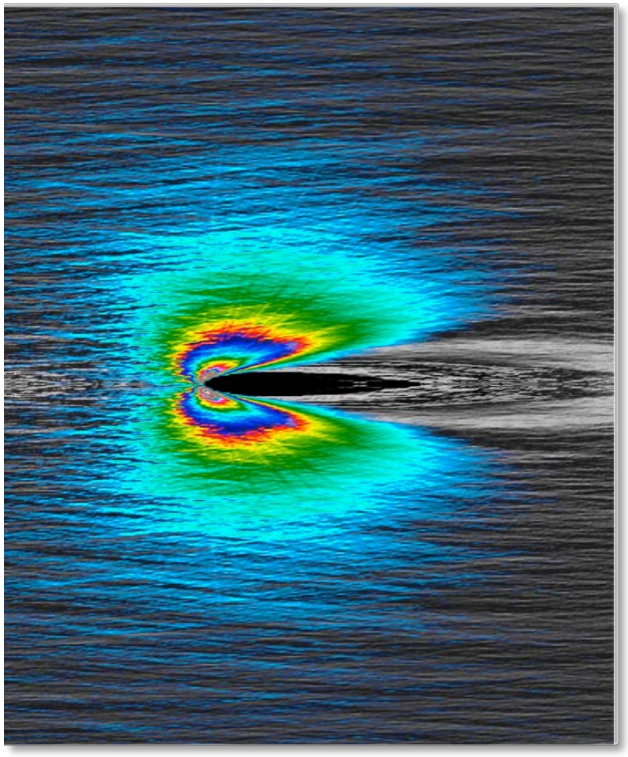
JLF B174 is across the street from B161 technology facility

The Center can provide a work force pipeline to the programs through its research collaboration and education programs

- The UCSD HED summer school provides a useful forum to engage students
  - Educating a new generation of undergraduates and graduates in HED
  - Participation by LLNL staff provides us an opportunity to introduce national laboratories to young people
- Designer pipeline
  - F. Beg is beginning to work with LLNL in targeting some of his students towards design work
  - Builds upon LLNL and academic relationships
- Academic research programs
  - LLNL summer student support
  - Mentoring and support of postdocs

First discussions with the programs have begun and several items have emerged

- High fidelity physics codes (HFPC) are a new research area that can address ICF code uncertainties in plasmas and hydrodynamics
  - Classical and quantum molecular dynamics, Particle-in-Cell, Vlasov Fokker-Planck…
  - Enabling capability for the Center's experimental efforts
  - Applications in support of programs and basic science
  - Center can provide an integrating element for existing efforts and promote and support new efforts
- Atomic physics (experimental and theoretical), opacity, EOS and radiation transport
  - Expertise in US academia is disappearing
  - Center is the ideal place to foster and support domestic growth in this area



Molecular dynamics simulation of ion stopping in a plasma

We completed a strategic planning process involving WCI, PLS and NIF staff

- *F. Albert, C. Bibeau , H. Chen , D. Haylett, R. Kraus, A. Pak, H-S Park, J. Pino, S. Ross, R. Rudd, D. Swift, H. Whitley*
- A concise mission statement
- An assessment of our current status-strengths and weaknesses
- A desired end state in 5 years
- Identify priorities and where we should focus funds and effort
- A defined path that leads us from our current state to our desired state

As we look into the future, several items have emerged from the strategic planning group

- An R&D research staff that provides essential support for academic researchers and collaborations
  - *Avoid the "research hand grenade" syndrome*
  - *Effective method to develop workforce pipeline.*
- Recruitment stream
  - *POC & facilitation for student & postdoc recruitment*
  - *Identify SKAs that the program needs and work with academic collaborators to target those skills*
- A named Fellow or Postdoc position
  - *Target research areas we would like to grow*
- Sabbatical leave for LLNL staff
- Outreach lectures to the community
- *Virtual HED campus*

As we look into the future, several items have emerged from the strategic planning group

- Resource hub for the community-website
  - *Highlight HED science projects and opportunities at LLNL*
  - *SME points of contact at LLNL*
  - *How to connect to LLNL (collaborations)*
  - *Resource for academics building research portfolios*
  - *Go to resource for teaching HED science-internal and external*
- State of the art facilities to bring people to a central location
  - *B161 Technology Facility and dedicated JLF time given to HEDS Center*
  - *Computing resources-shepherd through Grand Challenge*
- Establishing academic connections
  - *Research grants for faculty*
  - *Summer visits*
  - *Sabbaticals*
  - *Target early career faculty and HBCU's*

The HED Science Center is a LLNL focal point for growing and enabling HEDS academic collaborations

High Energy Density Science Center Mission

The High Energy Density Science Center (HEDSC) seeks to shape the future of high energy density (HED) science by advancing the frontiers of research and engaging with the next generation of leaders. By fostering research collaborations between the academic community and LLNL scientists, HEDSC addresses the most exciting and challenging HED science problems that impact the NNSA. The center will serve as a focal point, bringing together worldwide expertise with state of the art experimental and computational facilities to advance HED science for the benefit of the NNSA mission and the broader community

http://heds-center.llnl.gov