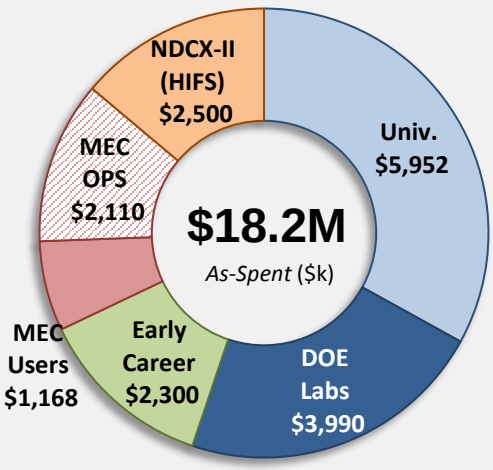
U.S. DEPARTMENT OF ENERGY

Office of Science

FY 2014 at a glance



Program Elements:

- Universities (SC/NNSA Joint Program)
  - 32 active projects @ 15 Universities
  - *9 new awards in FY 2014*
  - 14 projects end in CY 2015
  - *Entire portfolio fully-funded*
- Research @ DOE Laboratories
  - 14 active projects @ 5 DOE Labs
  - 12 projects end in CY 2015
- SC–Early Career Awards
  - 5 active projects
  - 1 *new award*: Stephanie Hansen, SNL
- MEC Operations at LCLS
  - Short-pulse laser now 25 TW (1J, 40 fs), will be 200 TW in CY 2015.
  - First laser-only experiments fielded
- MEC User Experiments
  - 6 experiments during Run 8
  - 7 experiments during Run 9
  - 2 laser-only experiments fielded
- Heavy Ion Fusion @ NDCX-II
  - Accelerator upgraded to 1.2 MeV
  - Research on ion defect dynamics

Employment Statistics *(approx)*:

- # Ph.D.'s: 95
- Post Docs: 17
- # Grad Students: 46

The Office of Science HEDLP Program

High energy density laboratory plasma (HEDLP) physics is the study of ionized matter heated and compressed to a point that the stored internal energy reaches 100 billion Joules per cubic meter, equating to pressures exceeding 1 million atmospheres or 1 Mbar. HEDLP science involves broad, cross-cutting research in areas ranging from laboratory astrophysics to materials under extreme conditions, as well as national security.

In FY 2014 the Office of Science HEDLP program continued to support a diverse portfolio of research projects in discovery HEDLP science executed at universities, small businesses, and DOE national laboratories, including operational support for the Matter in Extreme Conditions (MEC) instrument at the Linac Coherent Light Source (LCLS) at the SLAC National Accelerator Laboratory.

Universities (SC/NNSA Joint Program)

The HEDLP program continues to support a vibrant portfolio of university research projects in partnership with the NNSA as part of the *Joint Program in HEDLP*. At present, the Office of Science portfolio contains 32 active research projects at 18 U.S. universities and small businesses. The program succeeded in issuing consecutive funding opportunity announcements (FOA's) in FY 2012 and FY 2013. From those two FOA's, the Office of Science awarded 24 research grants totaling $13,690,000, from 171 submitted applications (23% award rate, 15 NNSA awards in FY 2012).

While no new HEDLP specific funding opportunities were issued in FY 2014, additional appropriations enabled the program to make 9 new awards totaling $4,616,000, selected from highly rated applications submitted in prior years as well as this year to the NSF/DOE partnership in Basic Plasma Science.

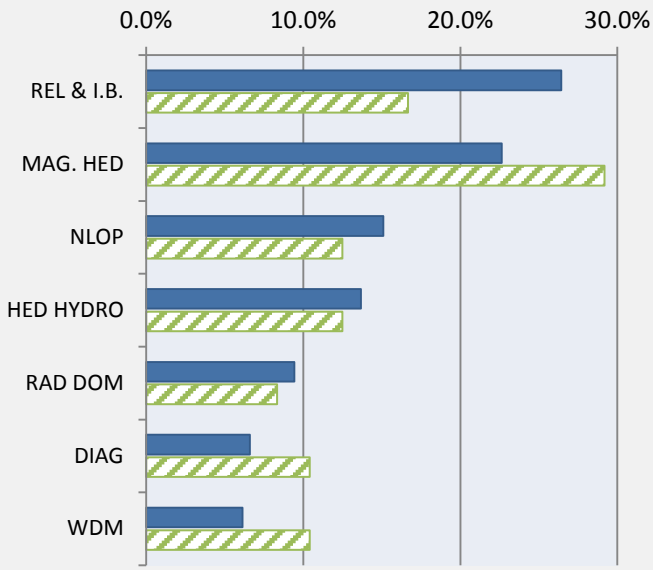
- 4 *new* awards (fully-funded) from SC/NNSA Joint Program FOA DE-FOA-0000755.
  - "Large-scale kinetic simulation study of laser-plasma coupling and energetic electron generation in shock ignition", University of Rochester, Chuang Ren ($394k)
  - "Measurements of Picosecond Energy Equilibration in Isochorically Heated Material, University of Rochester", Philip Nilson ($508k)
  - "The Measurement of Electrical and Thermal Conductivities in Warm Dense Matter, The Ohio State University", Rick Freeman ($900k)
  - "Testing theoretical stellar interior and HED plasma opacities at the Sandia Z", The Ohio State University, Anil Pradhan ($504k)
- 5 *new* awards (fully-funded) in discovery HEDLP science submitted to and reviewed as part of the NSF/DOE partnership in Basic Plasma Science.
  - "Laser-driven collisionless shock accelerated ion beam", University of Michigan, Louise Willingale ($645k)
  - "Mitigation of Magneto Rayleigh Taylor Instability", University of Michigan, Yue-Ying Lau ($653k)
  - "WVU's Contribution within the ZAPP Collaboratoin on the Z Facility at Sandia National Laboratory", West Virginia University, Mark Koepke ($300k)
  - "Collaborative Research: Tomographic Imaging of Evolving Laser-Plasma Structures, University of Texas", Mike Downer ($356k)
  - "Collaborative Research: Tomographic Imaging of Evolving Laser-Plasma Structures", Tech-X Corp., John Cary ($356k)

Responding to ReNeW

In 2009 the Office of Science and NNSA commissioned a joint research needs (ReNeW) workshop on HEDLP. This workshop delivered a concise authoritative report on research challenges and opportunities in six scientific sub-disciples of HEDLP:

- High energy density hydrodynamics (HED HYDRO),
- Nonlinear optics of plasmas (NLOP),
- Relativistic HED plasma and intense beam physics (REL & I.B.),
- Magnetized HED plasma physics (MHED),
- Radiation-dominated dynamics and material properties (RAD DOM),
- Warm Dense Matter (WDM),

as well as four cross-cutting areas. This report and the identified scientific sub-disciplines (listed above) have served as a guide in shaping the Office of Science HEDLP research portfolio. Respond to community demand, proposal pressure has been used to inform programmatic priorities. The figure below shows the relative fraction of awards in the portfolio (green hatched bars) compared to the relative fraction of total applications received since 2012 (blue solid bars) for the six scientific sub-disciplines identified in ReNeW as well as diagnostics.



Office of Science Early Career Awards

The Office of Science Early Career program supports the development of individual research programs of outstanding scientists early in their careers. At present, the HEDLP program has 5 early career awardees including 1 new awardee in FY 2014.

- “Non-equilibrium Atomic Physics in High Energy Density Material”, Sandia National Laboratories, Stephanie Hansen ($2.5M)

Research at DOE National Laboratories

The Office of Science HEDLP program currently supports 14 active research projects at 5 DOE laboratories. These projects are supporting strong collaborations between the DOE laboratories and university investigators, including science experiments on the nations premier HEDLP facilities : NIF, Z, and Omega. Additionally, the program provides support for the developing capability in HEDLP science at SLAC.

The MEC Instrument: Operations

The HEDLP program continues to support the operation of the MEC instrument, including support for the instrument scientist, diagnostics, and optical laser systems. In FY 2014, the MEC completed the first phase of an upgrade to the short-pulse laser system bringing its power up to 25 TW. The second phase of the upgrade will be completed in CY 2015, providing a system capable of delivering 200 TW on target. FY 2014 also saw the beginning of autonomous operations of the instrument, providing researchers access to the MEC for HEDLP experiments using only the optical lasers.

In response to user feedback following the first workshop on high energy lasers, the program initiated a concentrated effort targeted at characterizing the spatial, temporal, and spectral properties of the optical laser systems.

MEC User Research

Along with support for the operations of the MEC end station, the HEDLP program provided direct financial support for experiments awarded time on the instrument. MEC research awards provide support for targets, publication costs, travel, and 6-18 months of time and effort associated with executing a single set of experiments at MEC.

Run 9 Experiments:

- “Two-color X-ray Thompson Scattering in Warm Dense Matter”, Lawrence Berkeley National Laboratory, Ben Barbrel ($218k)
- “X-ray Heterodyne near-field Scattering of Shockwave Propagation in Low Density Foams”, Lawrence Livermore National Laboratory, Jim Hawreliak ($295k)
- “High Pressure Polymorphism in Three Key Minerals in the Earth's Upper Mantle”, Lawrence Livermore National Laboratory, Ray Smith ($244k)
- “Improved Instrumentation and Theory for X-Ray Based Diagnostics of Warm Dense Matter”, University of Washington, Jerry Seidler ($200k)

Laser-Only Experiments:

- “Development of a broadband, femtosecond x-ray source for future absorption spectroscopy experiments at LCLS-MEC”, Lawrence Livermore National Laboratory, Felicie Albert ($211k)