Inertial Confinement Fusion Ignition and High Yield Campaign

Overview

The Inertial Confinement Fusion Ignition and High Yield (ICF) Campaign supports the U.S. Department of Energy's (DOE) national security goals by providing scientific understanding and experimental capabilities in high-energy-density (HED) physics for the validation of codes and models necessary to maintain a safe, secure, and effective nuclear weapons stockpile without underground testing. It supports stockpile assessment and certification and the Department's national security mission. Experimental validation of the models used in simulations is essential to having confidence in them. More than 99 percent of the energy from a nuclear weapon is generated in the HED state (pressures greater than 1 megabar) that occurs once primary criticality is attained. The ICF program operates and conducts experiments in facilities that can create these HED conditions. The investments in Inertial Confinement Fusion provide insights and information from experimental conditions that largely mimic those of nuclear explosions. They provide the experimental basis, in addition to archived data from the underground test program, that gives us confidence in the codes and models used to support annual assessments and certifications, plan life extension programs, and resolve Significant Findings Investigations (SFIs). ICF facilities are the only platforms on which the codes that couple transport processes with hydrodynamics models can be experimentally validated.

These insights and information are directly applicable to assessing the health of our nuclear weapons and making decisions on life extension options for future stockpile weapons. For example, the Stockpile Stewardship Program (SSP) has been developing advanced simulation capabilities to model nuclear weapons with sufficient fidelity to support certification, life-extension programs, and resolve SFIs. Science-based weapons assessments and certification require advanced experimental capabilities to validate simulations of nuclear weapon performance, understand properties of materials that will be used in the future stockpile, and strengthen the complex three-dimensional models developed to understand the boost process occurring in stockpile primaries. The ICF Campaign provides these capabilities through the development and use of advanced experimental and theoretical tools and techniques, including state-of-the-art laser and pulsed power facilities for both ignition and weapon relevant non-ignition HED research and advanced simulation codes.

The ICF program supports stockpile stewardship through two principal experimental directions. First, through non-ignition HED physics research, development of diagnostics, and experimental expertise that directly supports the stockpile. Ongoing experiments explore issues in materials science, radiation transport, and hydrodynamics providing fundamental scientific knowledge relevant to nuclear weapons and are testing codes and models that underpin stockpile confidence. Second, the ICF program's goal is to achieve substantial thermonuclear burn and, ultimately, ignition in the laboratory. The demonstration and application of ignition and thermonuclear burn is important to validate models in the most extreme conditions generated in a nuclear explosion that cannot be accessed in the laboratory in any other way, and remains a major goal for the National Nuclear Security Administration (NNSA) and the DOE.

Demonstrating ignition in the laboratory severely tests the nation's simulation and experimental capabilities. Initial ignition experiments showed differences from code predictions, revealing physics unknowns and technical complexities that require time to study and resolve. Advances in diagnostics and experimental techniques have provided improved insight into where models are diverging from experiments, and more recent experiments have demonstrated advances toward the physics regime of greatest interest to the weapons program. Experiments continue, both to guide the overall balanced technical program and because of the contributions expected to result for the physics models and codes used in stockpile stewardship. Continuing to pursue this grand challenge is important to maintaining scientific leadership and credibility while recruiting scientists and engineers who will participate in stockpile stewardship. As much of this research is open and shared, ICF program research provides an avenue for establishing the quality of relevant science through the broader scientific community, thereby directly supporting deterrence. Many of the diagnostic capabilities required to maintain underground test readiness are maintained through the ICF program.

The Department requests $512,895,000 in FY 2015 for the ICF Campaign, a $1,062,000 (0.21 percent) decrease from the FY 2014 Omnibus Appropriation level.

In the FY 2014 Congressional budget request, NIF funding was requested in Site Stewardship's Enterprise Infrastructure funding line to support a portion of the base operations and maintenance for the National Ignition Facility (NIF) at Lawrence Livermore National Laboratory (LLNL). In the FY 2014 Consolidated Appropriations Act, Congress directed that the NIF operations funding be moved into the ICF funding line to improve transparency of funding for the NIF. The FY 2015 request includes $112,000,000 moved from the proposed Site Stewardship program to ICF's Facility Operations and Target Production subprogram for NIF operations in FY 2015 and through the outyears.

The resulting FY 2015 ICF Program continues the strong emphasis on HED weapons experimental support and development of advanced capabilities while continuing a balanced effort in ignition and alternate ignition concepts. Funding for research in support of stockpile science and near-term stockpile needs resumed in FY 2013 in the Support of Other Stockpile Programs subprogram. This leverages ICF's expertise, providing additional support for the HED weapons efforts and NNSA's broader Stockpile Stewardship Program (SSP) needs as outlined in the Predictive Capability Framework (PCF).[a] In FY 2015, efforts toward ignition with the Indirect Drive, Polar Direct Drive, and Magnetically-Driven Implosions, will continue. Development of a detailed physics understanding will be used to improve the designs in concert with the development of alternative ignition concepts as described in the Path Forward document submitted to Congress in December 2012. Along with integrated experiments, focused experiments will continue to look at the behavior and physics of ignition targets to improve the confidence in the simulations and to provide feedback to resolve the outstanding physics questions. This is a discovery-driven, rather than schedule-driven, program that will provide more opportunities for comparison with simulations and feedback to resolve the outstanding physics questions. At the end of FY 2015, progress in all three concepts will be externally reviewed to assess their progress.

The FY 2015 Request maintains the level of funding at NNSA's three major HED facilities; the NIF, the Z Facility at Sandia National Laboratories (SNL), and the Omega Laser Facility at University of Rochester's Laboratory for Laser Energetics (LLE), including funding for support of experiments by external users. The three major HED facilities will be operated under their respective governance plans. Emphasis on improving operational efficiencies at all facilities will continue, with prioritization and execution of the most urgent experiments in support of the stockpile. The NIF will continue to implement operational efficiencies to improve the shot rate at the facility, based upon the Plan developed in FY 2014.

The budget supports efforts in HED weapons, ignition, and alternate ignition concepts research at NIF, Omega, and Z. The budget provides $84,750,000 for operation and utilization of the Z facility at Sandia National Laboratories (SNL). This includes $44,450,000 within the ICF Campaign and $40,300,000 within the Science Campaign.[b] The ICF budget provides $328,500,000 for the operations of the NIF and the ICF program at LLNL, and $63,500,000 for the operations of the Omega Laser Facility and the ICF program at the University of Rochester.

Highlights of the FY 2015 Budget Request

The FY 2015 ICF Campaign will build upon the accomplishments of the previous years, including: 1) providing key data that reduces uncertainty in our predictions of nuclear weapons performance; 2) obtaining data on the properties of plutonium under conditions that have not been previously reached in the laboratory on Z Facility at SNL and the NIF at LLNL; 3) fielding platforms at Omega and NIF to measure the complex hydrodynamic behavior of materials that is a potential concern for SFIs; 4) ongoing progress in understanding the issues that are limiting the demonstration of ignition at the NIF, including energy coupling to the capsule, symmetry, and mix; 5) building on the indirect drive ignition development of the "high foot" platform that has produced record performance and experiments with alternate ablator materials; 6) continued progress in the development of the direct-drive ignition alternative on Omega and NIF building on the demonstration of ignition-relevant implosion velocities and the highest neutron yields to date at Omega; and 7) building on progress demonstrated in magnetically-driven implosions by developing the capabilities to performing magnetized liner inertial fusion (MagLIF) experiments; 8) continued safe operation of NNSA's major HED facilities, NIF, Omega, and Z, in accordance with their Governance Plans, and continuing improvements in operational efficiency at the NIF through implementing plan developed in FY 2014. At the end of FY 2015, progress in all three ignition concepts will be externally reviewed to help determine the path forward for ignition.

Major Outyear Priorities and Assumptions

Outyear funding levels for the ICF Campaign total $2,052,079,000 for FY 2016 through FY 2019. The ICF Campaign provides the scientific understanding and experimental capabilities in high-energy density physics that are needed to study matter under extreme conditions and support science-based weapons assessments and certifications to fulfill our national security mission. The priority within the ICF Program is to balance efforts in HED weapons research with the ongoing investigation

[a] The Predictive Capability Framework (PCF) is described in the *FY 2014 Stockpile Stewardship and Management Plan.*
[b] Does not include Science Campaign funding for Capabilities for Nuclear Intelligence at SNL.

of ignition, including alternate ignition concepts. The FY 2015 external review of progress toward ignition will guide the ICF Program’s outyear priorities. The development and use of a robust ignition platform remains a high priority, as is performing HED experiments where ignition is not required. The Programs’ suite of HED facilities is well-suited to meeting the ongoing needs of the Stockpile. The demand for ICF Facility time is expected to increase, and improved operational efficiency at the NIF is expected to meet this increased demand. The outyears budget assumes the funding level for the ICF Campaign will be sufficient to provide the advanced experimental capabilities, including experimental platforms, diagnostics, theoretical tools and techniques that are needed to conduct the experiments and the verify codes needed for stockpile assessment and certification.

Inertial Confinement Fusion Ignition and High Yield Campaign
Funding

(Dollars in Thousands)

	FY 2013 Current	FY 2014 Enacted	FY 2014 Current	FY 2015 Request	FY 2015 vs FY 2014 Enacted
Ignition and High Yield Campaign					
Ignition	83,798	80,245	80,245	77,994	-2,251
Support of Other Stockpile Programs	15,503	15,001	15,001	23,598	+8,597
Diagnostics, Cryogenics and Experimental Support	82,263	59,897	59,897	61,297	+1,400
Pulsed Power Inertial Confinement Fusion	5,468	5,024	5,024	5,024	0
Joint Program in High Energy Density Laboratory Plasmas	7,552	8,198	8,198	9,100	+902
Facility Operations and Target Production	262,092	345,592	345,592	335,882	-9,710
Fusion Ignition and High Yield	**456,676**	**513,957**	**513,957**	**512,895**	**-1,062**

Outyears for Inertial Confinement Fusion Ignition and High Yield Campaign

(Dollars in Thousands)

	FY 2016 Request	FY 2017 Request	FY 2018 Request	FY 2019 Request
Inertial Confinement Fusion Ignition and High Yield Campaign				
Ignition	77,994	77,538	78,252	77,999
Support of Other Stockpile Programs	26,000	25,795	27,147	27,047
Diagnostics, Cryogenics and Experimental Support	61,297	60,816	62,201	61,981
Pulsed Power Inertial Confinement Fusion	5,524	5,479	5,733	5,706
Joint Program in High Energy Density Laboratory Plasmas	9,600	9,530	9,887	9,849
Facility Operations and Target Production	337,185	330,378	329,000	330,141
Total, Inertial Confinement Fusion Ignition and High Yield Campaign	**517,600**	**509,536**	**512,220**	**512,723**

Inertial Confinement Fusion Ignition and High Yield Campaign
Explanation of Major Changes
(Dollars in Thousands)

	FY 2015 vs FY 2014 Enacted
Inertial Confinement Fusion Ignition and High Yield Campaign	
Ignition: Reduction in ignition effort consistent with increased emphasis on priority HED weapons physics experiments supporting near-term stockpile needs.	**-2,251**
Support of Other Stockpile Programs: Increase consistent with emphasis on support of weapons physics HED research to answer near-term stockpile needs.	**+8,597**
Diagnostics, Cryogenics and Experimental Support: Increase in funding for development and testing of advanced diagnostics needed for both ignition and non-ignition experiments.	**+1,400**
Pulsed Power Inertial Confinement Fusion: Continuation of the level of effort to advance the science of magnetically-driven implosions.	**0**
Joint Program in High Energy Density Laboratory Plasmas: Funding supports basic science research grants at an increased level to strengthen academic participation in HED physics.	**+902**
Facility Operations and Target Production: Shifts funding from support of facility operations to direct experimental and diagnostics support for weapons physics research, while maintaining similar funding at HED Facilities.	**-9,710**
Total, Inertial Confinement Fusion Ignition and High Yield Campaign	**-1,062**

Inertial Confinement Fusion Ignition and High Yield Campaign
Ignition

Description

The demonstration of thermonuclear ignition in the laboratory and its development as a platform provides the scientific and technical understanding to address key weapons issues and to validate the codes needed to assess and certify the stockpile in a regime not accessible in any other way in the laboratory. The demonstration of ignition is a major goal for the NNSA and DOE. The Ignition subprogram supports research activities that optimize prospects for achieving ICF ignition on the NIF and the development and applications of robust ignition, advanced ignition, and burning plasma platforms once ignition is achieved. Experiments on NNSA's HED facilities are supported by detailed theoretical designs and simulations (in 2- and 3-dimensions) of the performance of ignition targets. Ignition target design is closely coupled with the Advanced Simulation and Computing (ASC) and the Science Campaigns. The near-term emphasis is on those activities required to develop a detailed physics understanding to improve ignition designs and to demonstrate ignition on the NIF. In the longer-term, this program will develop advanced ignition concepts that may provide advantages over the current indirect-drive ignition platform, such as higher yield and/or gain. Achieving ignition and understanding any limitations to the simulation tools are essential parts of meeting DOE's security goals. The demonstration and use of ignition will provide important information to support assessment and certification of the stockpile and will help answer key stockpile questions within the PCF. The Campaign develops the advanced experimental capabilities that create and study matter under extreme conditions that approach the high-energy densities found in nuclear explosions. It provides access to ignition conditions that are otherwise unavailable, allowing understanding and validation of an important part of the evolution of a nuclear weapon explosion and provides critical information to validate codes. The Science Campaigns, Directed Stockpile Work (DSW), and other stockpile program elements rely on the capabilities developed in this subprogram to successfully execute their programs.

FY 2016-FY 2019 Key Milestones

- Development of the first ignition platform to support SSP needs. The ignition platform must be repeatable and sufficiently robust such that the effects of minor changes in design can be clearly identified.
- Use the first ignition platform to support SSP needs, in particular critical experiments requiring burning plasmas and igniting plasmas, in support of the PCF.
- Demonstrate one or more Advanced Ignition concepts on the NIF to meet requirements of SSP physics applications of ignition.
- Develop a crossed-beam energy transfer mitigation strategy for polar drive implosions on OMEGA and NIF.

Ignition

Activities and Explanation of Changes

FY 2014 Enacted	FY 2015 Request	Explanation of Changes FY 2015 vs FY 2014 Enacted
Ignition		
• Conduct physics and integrated indirect-drive Deuterium-Tritium (DT) implosion experiments on NIF to examine experimental and computational understanding of capsule drive, symmetry, hydrodynamic instability, and mix. Investigate mitigation schemes. • In FY 2014 and FY 2015, improve understanding of hohlraum energetics, laser-plasma interactions (LPI), and drive symmetry to develop a more predictable, efficient hohlraum with symmetry control suited to ignition. • Pursue target designs with alternate ablator materials, high-density carbon and beryllium. • Conduct experiments to understand stagnated fuel properties and to quantify alpha heating. This will require new diagnostics and improved analysis techniques. • Conduct experiments on Omega and Z to support the development of ignition and its uses, including platform and diagnostic development. • Perform Polar Drive (PD) implosions on the NIF to investigate symmetry control and LPI mitigation. • Conduct integrated direct-drive cryogenic DT implosions on Omega to establish the predictive basis for NIF-equivalent hydro performance. Validate Polar Drive Ignition Concept on Omega. • Working with Science Campaign, prepare a 3-year plan of significant milestones and critical experiments needed to support the SSP.	• Continue research efforts from FY 2014 in understanding and controlling hydrodynamic instability and mix, hohlraum symmetry, and LPI. Continue research and experiments with alternate ablator designs. Conduct experiments aimed at understanding further stagnation and alpha heating. • Conduct Progress Review of all fusion approaches with respect to the program plan defined in FY 2013 and out-year plans for ICF and high yield platforms needs defined in the PCF. • Conduct an IDI experimental campaign to assess agreement between models and simulation of implosion compression and pressure. • Continue integrated cryogenic DT implosions on Omega to establish the predictive basis for NIF-equivalent hydro performance. Continue NIF PD experiments to study crossed beam energy transfer mitigation.	• The ignition subprogram budget is reduced by $2,251,000 (2.8%). This is consistent with NNSA's increased emphasis on nuclear weapon relevant high energy density physics research. Progress towards ignition continues at a slower pace consistent with "discovery-driven" science, allowing more time to develop an understanding of any limitations towards achieving ignition.

Inertial Confinement Fusion Ignition and High Yield Campaign
Support of Other Stockpile Programs

Description

High-energy-density (HED) physics/weapon relevant experiments using the ICF Campaign's suite of HED facilities are essential to assessing and certifying the stockpile and to meeting DOE's security goals. This subprogram leverages the experience of the ICF-funded researchers to support NNSA's SSP nuclear weapons-relevant HED physics needs, developing and integrating the experimental infrastructure and capabilities required to execute experiments on ICF facilities. This includes the development of laser, target, and diagnostic capabilities. The ICF's HED facilities are used to perform experiments where ignition and burn are not the focus – for example, material properties, hydrodynamics, and radiation transport. It includes platform and diagnostic development on NIF, Omega, Z and supporting facilities. The understanding gained and capabilities developed validate the codes used to certify the stockpile. The Science Campaign, DSW, and other stockpile program elements rely on the capabilities developed in this subprogram to successfully execute their programs. Ongoing experiments test codes and models that underpin stockpile confidence and provide fundamental scientific knowledge relevant to nuclear weapons, supporting stockpile assessments and certifications. The subprogram develops and uses HED/ICF experimental capabilities and personnel to resolve important stockpile questions in cooperation with other components of the Office of Research Development Test Capabilities and Evaluation.

FY 2016-FY 2019 Key Milestones

- In FY 2016, measure the effect of shell mixing on deuterium-tritium burn.
- In FY 2017, demonstrate a deuterium-tritium burn platform that meets the needs of the SSP.
- Ongoing development of platforms to measure electron-ion equilibration in the presence of burn.
- Support experiments and platform development identified in the FY 2015 Plan for HED Science on ICF Facilities.
- Continue to develop platforms for initial experiments to support validation of opacity models; demonstrate platform that can acquire high pressure materials data; and, provide data needed to support of PCF pegposts.
- By FY 2018, complete initial set of experiments identified in FY 2015 Plan for HED Science on ICF Facilities.

Support of Other Stockpile Programs

Activities and Explanation of Changes

FY 2014 Enacted	FY 2015 Request	Explanation of Changes FY 2015 vs FY 2014 Enacted
Support of Other Stockpile Programs		
• Provide support for experiments and non-ignition HED data using NIF, Omega, Z, and other facilities to support NNSA's SSP needs. • Develop the experimental and analytical capability to acquire high-pressure material data and develop platforms to validate models of secondary performance and to validate opacity models. • Develop a predictive capability for complex hydrodynamics and to determine aspects of a predictive mix model. • Participate in community workshop with Science Campaign to develop plan for HED Science supporting Stockpile Stewardship and Management Plan (SSMP), based on workshop. • Provide platform and diagnostic capabilities for validating the impact of surety technologies in the future stockpile.	• Provide support for experiments, acquire high-pressure material data and develop platforms to validate models of secondary performance and to validate opacity models. • Demonstrate a platform that can acquire high-pressure materials data that supports the PCF. Provide data in support of PCF pegposts, including plutonium experiments on NIF and Z. • With Science Campaign, complete plan for HED Science on the ICF Facilities to support the requirements of the SSMP based upon the workshop held in FY 2014. • Validate models relevant to thermonuclear burn. • Provide platform and diagnostic capabilities for validating the impact of surety technologies in the future stockpile.	• The Support of Other Stockpile subprogram's FY 2015 budget request is $23,598,000, an increase of $8,597,000 (57.3%). The change is consistent with NNSA's increased emphasis on weapons physics HED research to answer near-term stockpile needs.

Inertial Confinement Fusion Ignition and High Yield Campaign
Diagnostics, Cryogenics and Experimental Support

Description

Science-based weapons assessments and certification require advanced experimental capabilities that can create and study matter under extreme conditions that approach the HED environments found in a nuclear explosion. This subprogram develops the specialized technologies needed for ignition and HED experiments on ICF facilities, diagnostics, cryogenic systems, and user optics. It includes the design and engineering of a complex array of diagnostic and measurement systems, including advanced diagnostics that operate in the harsh ignition environment, and the associated information technology subsystems needed for data acquisition, storage, retrieval, visualization, and analysis. The data generated by these diagnostics provides key information required for HED physics experiments. This subprogram develops and deploys user optics to meet the needs of a broad range of experiments for national security applications and for ICF, HED, and fundamental science applications. It provides key capabilities required for experiments to study matter under extreme conditions at the HED facilities. The development of advanced diagnostics that operate in the harsh weapon-related physics environment is required to use ignition as a tool to support stockpile certification through verification of codes.

FY 2016-FY 2019 Key Milestones

- Continue efforts from FY 2015 to develop and support diagnostic capabilities, cryogenic systems, and user optics at NIF and Omega, at a pace commensurate with facility operations.
- Engineer a polar-drive target insertion cryostat for the NIF.
- Continue efforts on the NIF advanced diagnostic suite as defined in the FY 2012 Plan, including installing some diagnostics that can operate in the harsh ignition environment. Examples include a mirrored gated x-ray detector and a high resolution gamma ray diagnostic.
- Continue development, testing, and deployment of advanced diagnostics on NIF, Omega, and Z.
- In FY 2017, complete NIF advanced diagnostics suite.

Diagnostics, Cryogenics and Experimental Support

Activities and Explanation of Changes

FY 2014 Enacted	FY 2015 Request	Explanation of Changes FY 2015 vs FY 2014 Enacted
Diagnostics, Cryogenics and Experimental Support		
• Continue efforts from FY 2013 to develop and support diagnostic capabilities, cryogenic systems, and user optics at NIF and Omega, at a pace commensurate with facility operations. • Continue development and testing of advanced diagnostics on NIF, Omega, and Z, including: prototyping a Compton gamma spectrometer and, deploying a time-resolved krypton spectrometer on Z, and installing scattered light calorimeters, an enhanced collection efficiency x-ray microscope, and a low-energy neutron spectrometer on NIF. • Commissioning of the hydrogen isotope separation unit for Omega, to provide capability to adjust the isotopic ratio of DT fuel for users.	• Continue efforts from FY 2014 to develop and support diagnostic capabilities, cryogenic systems, and user optics at NIF, at a pace commensurate with facility operations. • Continue development and testing of advanced diagnostics on NIF, Omega, and Z, including: development of the fourth-harmonic probe beam and the Compton gamma spectrometer on NIF, deploying ultrahigh resolution x-ray spectrometer on the OMEGA EP Laser, and the magnetic recoil spectrometer, gamma reaction and neutron burn history diagnostics for Z.	• The Diagnostics, Cryogenics, and Experimental Support subprogram's FY 2015 budget request is $61,297,000, an increase of $1,400,000 (2.3%). The change increases support for advanced diagnostics needed for both ignition and non-ignition experiments.

Inertial Confinement Fusion Ignition and High Yield Campaign
Pulsed Power Inertial Confinement Fusion

Description

The Pulsed Power Inertial Confinement Fusion subprogram funds computational target design, experiments, and experimental infrastructure to assess pulsed power to achieve thermonuclear fusion in the laboratory. This subprogram's technical effort advances the science of magnetically-driven implosions as a means to achieving higher energy densities for SSP applications and as a promising path to achieving nuclear weapons relevant physics environments and high fusion yield. A mixture of focused and integrated experiments will be conducted to address key physics uncertainties and to improve the design of the target for the Magnetized Liner Inertial Fusion (MagLIF) approach to fusion ignition. Specific activities include performing Z experiments, designing and building targets, improving simulation tools, and developing the experimental infrastructure (diagnostics and capabilities) needed to study advanced approaches to ICF. An objective is to determine the requirements for an advanced pulsed power driver that would achieve robust ignition and single-shot high fusion yield. The subprogram provides an ignition alternative that has potential to provide significantly higher yields than will be possible on the NIF and supports the assessment of pulsed power as a means to achieve thermonuclear fusion in the laboratory, including computational target design, experiments, and experimental infrastructure. It maintains the level of excellence in the technical staff at Z through challenging work that builds competencies critical to the SSP and helps avoid technological surprise.

FY 2016-FY 2019 Key Milestones

- Complete scaling study of MagLIF concept exploring sensitivity to laser energy and magnetic field strength.
- Perform optimized magnetized liner inertial fusion experiment at Z Facility.
- Assess the stagnation dynamics of MagLIF target experiments and compare with simulations.
- Evaluate fusion performance and stagnation plasma parameters at enhanced drive conditions using cryogenic fuel and compare results with simulations.
- Define requirements for a pulsed power facility that can demonstrate robust ignition and high fusion yield.

Pulsed Power Inertial Confinement Fusion

Activities and Explanation of Changes

FY 2014 Enacted	FY 2015 Request	Explanation of Changes FY 2015 vs FY 2014 Enacted
Pulsed Power Inertial Confinement Fusion		
• Conduct integrated experiments with both magnetization and pre-heat and compare results to simulations. • Apply new and improved diagnostics and techniques to measure the implosion dynamics, magnetic fields, and fuel conditions in magnetically driven implosions. • Continue focused and integrated experiments to address key physics uncertainties on the Z Facility with Z-Beamlet and Omega EP lasers. • In preparation for the FY 2015 review, improve experimental capabilities to support ~100 kJ DT yield experiments on Z, continue to advance understanding of liner implosions and of physics of targets magnetization and fuel preheating.	• Conduct integrated fusion (MagLIF) target experiments with increased laser energy and increased magnetic fields and begin scaling study. • Perform optimized classified fusion experiments on the Z Facility. • Compare accumulated data from magnetically-driven fusion experiments on Z with 3-D radiation magnetohydrodynamic simulations. • Evaluate fusion performance and stagnation plasma parameters at enhanced drive conditions and compare results with simulations. • Review progress of all fusion approaches with respect to the program plan defined at end of FY 2013 and out-year plans for ICF and high yield platforms.	• The Pulsed Power ICF subprogram's FY 2015 budget request is $5,024,000, the same as the FY 2014 Enacted.

Inertial Confinement Fusion Ignition and High Yield Campaign
Joint Program in High Energy Density Laboratory Plasmas

Description

The Joint Program in High-Energy Density Laboratory Plasmas (HEDLP) supports DOE's mission by developing and maintaining a cadre of qualified researchers to support the SSP. It is a joint program with the DOE's Office of Science to support basic HEDP research that strengthens the Science, Technology, and Engineering base. This subprogram provides support for external users at the Omega Laser Facility through the National Laser Users' Facility (NLUF) Program and a joint solicitation with the Office of Science for HEDLP research to be performed at universities and DOE laboratories. It includes some of the HED-related Stockpile Stewardship Academic Alliances funding and other ICF-funded university programs. It funds academic programs to steward the study of laboratory HED plasma physics, maintain a cadre of qualified HED researchers and ongoing development of the next generation of scientists to provide expertise in HED today and qualified stockpile stewards for the future.

FY 2016-FY 2019 Key Milestones

- Continue activities from FY 2015 supporting research grants and cooperative agreements to fund individual investigator and research center activities.

Joint Program in High Energy Density Laboratory Plasmas

Activities and Explanation of Changes

FY 2014 Enacted	FY 2015 Request	Explanation of Changes FY 2015 vs FY 2014 Enacted
Joint Program in High Energy Density Laboratory Plasmas		
• Continued support of High Energy Density Laboratory Plasma research through solicitations to fund individual investigator and research centers activities. Conduct solicitation for National Laser Users' Facility (NLUF) Program.	• Continue activities from FY 2014 with support for additional research grants in HED plasma physics.	• The Joint Program in High Energy Density Laboratory Plasmas subprogram's FY 2015 budget request is $9,100,000, an increase of $902,000 (11.0%). The change is consistent with strengthening academic participation in HED physics.

Inertial Confinement Fusion Ignition and High Yield Campaign
Facility Operations and Target Production

Description

The operation of NNSA's HED facilities and target production support the goals of the ICF Campaign to meet DOE's National Security needs. This subprogram funds the experimental operations of ICF facilities including NIF, Omega, and Z, to support ICF and Science Campaign's subprogram's research to meet the stockpile assessment and certification needs. In response to Congressional direction in the FY 2014 Omnibus Bill, funding for a portion of facility operations and maintenance for the NIF is moved from the Site Stewardship funding line in Enterprise Infrastructure to this subprogram in FY 2015, for base operations such as facilities management, maintenance, utilities, environment, safety, and health, emergency operations, waste management, development and maintenance of the authorization basis, and, National Environmental Policy Act activities. Over half of the ICF Campaign's budget supports experiments and operations at the ICF facilities, all of which will be operated safely and securely. This subprogram supports fabrication of the very sophisticated targets required for related weapons physics experiments, as well as operation of the Trident facility at LANL, the ICF program including external reviews, and users' meetings such as the Omega Laser Facility Users Group and the NIF Users Group. This subprogram provides infrastructure and operations support for the ICF HED facilities that allow the ICF and Science Campaigns to conduct the experiments needed to meet stockpile assessment and certification needs and broader goals of the SSP.

FY 2016-FY 2019 Key Milestones

- Safely and efficiently operate HED facilities to support the needs of the SSP.
- Conduct Triennial User Facility Review of one ICF HED Facility each year. The Z Facility at SNL will be reviewed in FY 2016.
- Continued improvements in operational efficiency at all facilities.
- Demonstrate Linear Transform Driver (LTD) module prototypes.
- Conduct annual assessment of infrastructure and mission needs and recommend following fiscal year investments across all HED facilities.

Facility Operations and Target Production

Activities and Explanation of Changes

FY 2014 Enacted	FY 2015 Request	Explanation of Changes FY 2015 vs FY 2014 Enacted
Facility Operations and Target Production		
• Strong demand continues for ICF and SSP work on the NIF, Omega, Z, and Trident facilities in support of stockpile stewardship experiments, basic science users, and other national security users. Additional funds for Z requested in the Science Campaign budget. • Operate NIF, Omega, Z, and Trident in a safe, secure, and efficient manner in accordance with their governance plans. • Conducted annual assessment of infrastructure and mission needs and recommend following fiscal year investments across all HED facilities. • Performed target development and support for experiments on ICF facilities. • Complete 120-Day Study on Improving Efficiency at NIF and begin implementing results. Triennial review of the NIF in FY 2014.	• Continue activities from FY 2014, with similar funding level of facility operations at NIF, Omega, Z, and Trident facilities. Continued strong emphasis on highest priority experiments in support of the stockpile and on improving operational efficiencies. • Continue improvements in efficiency at NIF through implementation of results of 120-Day Study. • Complete remaining NIF-ARC beamlines. • Triennial review of the Omega Laser Facility in FY 2015.	• The Facility Operations and Target Production subprogram's FY 2015 budget request is $335,882,000, a decrease of $9,710,000 (2.8%). The change is consistent with shifting support of facility operations to direct experimental and diagnostics support for weapons physics research, while maintaining similar site funding. Expected operational efficiency improvements at the NIF.

Inertial Confinement Fusion and High Yield Campaign Performance Measures

In accordance with the GPRA Modernization Act of 2010, the Department sets targets for, and tracks progress toward, achieving performance goals for each program. For more information, refer to the Department's FY 2013 Annual Performance Report.

	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
Advanced Ignition Demonstration - Cumulative percentage of progress toward the validation of a concept that meets the requirements for weapons science applications and contributes to energy science and national security.							
Target	20% of progress (cumulative)	30% of progress (cumulative)	40% of progress (cumulative)	55% of progress (cumulative)	70% of progress (cumulative)	85% of progress (cumulative)	100% of progress (cumulative)
Result	**Met** - 20						
Endpoint Target	By FY 2019, demonstrate an advanced ignition platform that meets the refined requirements of the Stockpile Stewardship Program (SSP).						
Application of Ignition - Cumulative percentage of progress in providing data required to support the predictive capability framework burn boost initiative in FY 2018.							
Target	20% of progress (cumulative)	35% of progress (cumulative)	50% of progress (cumulative)	65% of progress (cumulative)	80% of progress (cumulative)	100% of progress (cumulative)	N/A
Result	**Met** - 20						
Endpoint Target	By FY 2018, provide data required to support the Predictive Capability Framework (PCF) burn boost initiative. This activity is performed in collaboration with the Science Campaign.						
Key Extreme Experiments - Cumulative percentage of progress towards achievement of key extreme experimental condition of matter needed for predictive capability for nuclear weapons performance.							
Target	85% of progress (cumulative)	90% of progress (cumulative)	100% of progress (cumulative)	N/A	N/A	N/A	N/A
Result	**Not Met** - 68						
Endpoint Target	By the end of FY 2015, achieve temperature and pressure conditions in the laboratory relevant to weapons' primaries. This activity is performed in collaboration with the Science Campaigns within the Office of Research and Development.						

Inertial Confinement Fusion Ignition and High Yield Campaign
Capital Summary

(Dollars in Thousands)

	Total	Prior Years	FY 2013 Current	FY 2014 Enacted	FY 2014 Current	FY 2015 Current	FY 2015 vs FY 2014
Capital Operating Expenses Summary (including (Major Items of Equipment (MIE)							
Capital Equipment >$500K (including MIE)	20,975	9,008	1,600	1,635	1,635	1,671	+36
Total, Capital Operating Expenses	**20,975**	**9,008**	**1,600**	**1,635**	**1,635**	**1,671**	**+36**
Capital Equipment > $500K (including MIE)							
Total Non-MIE Capital Equipment (>$500K)	20,975	9,008	1,600	1,635	1,635	1,671	+36
Total, Capital Equipment (including MIE)	**20,975**	**9,008**	**1,600**	**1,635**	**1,635**	**1,671**	**+36**
Total, Capital Summary	**20,975**	**9,008**	**1,600**	**1,635**	**1,635**	**1,671**	**+36**

Outyears for Inertial Confinement Fusion Ignition and High Yield Campaign

(Dollars in Thousands)

	FY 2016 Request	FY 2017 Request	FY 2018 Request	FY 2019 Request
Capital Operating Expenses Summary (including (Major Items of Equipment (MIE)				
Capital Equipment >$500K (including MIE)	1,708	1,746	1,784	1,823
Total, Capital Operating Expenses	**1,708**	**1,746**	**1,784**	**1,823**
Capital Equipment > $500K (including MIE)				
Total Non-MIE Capital Equipment (>$500K)	1,708	1,746	1,784	1,823
Total, Capital Equipment (including MIE)	**1,708**	**1,746**	**1,784**	**1,823**
Total, Capital Summary	**1,708**	**1,746**	**1,784**	**1,823**