Inertial Confinement Fusion Ignition and High Yield Campaign
Funding Profile by Subprogram and Activity

(Dollars in Thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Inertial Confinement Fusion Ignition and High Yield [a]			
Ignition	109,888	84,172	80,245
Support of Other Stockpile Programs	0	14,817	15,001
NIF Diagnostics, Cryogenics and Experimental Support	85,654	81,942	0
Diagnostics, Cryogenics and Experimental Support	0	0	59,897
Pulsed Power Inertial Confinement Fusion	4,997	6,044	5,024
Joint Program in High Energy Density Laboratory Plasmas	9,100	8,334	8,198
Facility Operations and Target Production	264,845	269,691	232,678
Total, Inertial Confinement Fusion Ignition and High Yield Campaign	**474,484**	**465,000**	**401,043**

Out-Year Funding Profile by Subprogram and Activity

(Dollars in Thousands)

	FY 2014 Request	FY 2015 Request	FY 2016 Request	FY 2017 Request	FY 2018 Request
Inertial Confinement Fusion Ignition and High Yield [a]					
Ignition	80,245	73,638	75,282	76,762	78,199
Support of Other Stockpile Programs	15,001	17,358	17,677	17,991	18,501
Diagnostics, Cryogenics and Experimental Support	59,897	56,835	54,541	50,569	47,145
Pulsed Power Inertial Confinement Fusion	5,024	5,676	5,844	5,919	6,007
Joint Program in High Energy Density Laboratory Plasmas	8,198	9,498	9,498	9,455	9,447
Facility Operations and Target Production	232,678	204,836	201,310	193,245	186,328
Total, Inertial Confinement Fusion Ignition and High Yield Campaign	**401,043**	**367,841**	**364,152**	**353,941**	**345,627**

[a] This represents the proposed control level.

Public Law Authorizations

National Nuclear Security Administration Act, (P.L. 106-65), as amended
National Defense Authorization Act for FY 2013 (P.L. 112-239)
The Continuing Appropriations Resolution, 2013 (P.L. 112-175)

Overview

The Inertial Confinement Fusion Ignition and High Yield (ICF) Campaign supports the U.S. Department of Energy's (DOE) security goal by providing scientific understanding and experimental capabilities in high-energy density (HED) physics necessary to maintain a safe, secure, and reliable nuclear weapons stockpile without underground testing. It supports stockpile assessment and certification and the Department's security mission. 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 scientific models for 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 non-ignition HED research and advanced simulation codes. The demonstration and application of ignition and thermonuclear burn in the laboratory is a major goal for the National Nuclear Security Administration (NNSA) and the DOE. The achievement of ignition and its use for the Stockpile Stewardship Program (SSP) is a grand scientific challenge requiring a consistent, technically sound effort. Initial ignition efforts have shown physics unknowns and technical complexities that require time to study and resolve. Communicating the progress on the path to ignition and the value of this effort to the SSP and the nation is a critical responsibility of the ICF Program.

The Department requests $401,043,000 in FY 2014 for the ICF Campaign, a $63,957,000 (13.8%) decrease from the FY 2013 Annualized CR level.

Since submission of the FY 2013 Congressional Budget Request, funds from adjustments due to indirect rate changes at the Lawrence Livermore National Laboratory (LLNL) were proposed to be moved to Readiness in Technical Base and Facilities at LLNL for the National Ignition Facility (NIF) to match the convention for facility maintenance at the site.[a] In FY 2014, this funding will be moved to Enterprise Infrastructure in the Site Stewardship funding line and will provide a portion of the base operations and maintenance funding for the NIF in the amount of $113M. The funding in Enterprise Infrastructure will support 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. The FY 2014 Request reduces the level of facility operations at the NIF in the ICF campaign and eliminates support for conduct of experiments by external users at NIF and Z. External users of the major HED facilities will now be directly charged for experimental time. Omega is the HED facility for experimental time for NNSA's pipeline academic programs. Finally, the requested amount for the ICF Program reflects a $17.6 million reduction for anticipated management efficiency and workforce restructuring reductions goals for Weapons Activities. Studies to identify the specific program effects are underway. When these studies are completed, NNSA will work with Congress to make any necessary program or funding level adjustments.

The resulting FY 2014 ICF Program supports efforts in ignition and alternate ignition concepts with the continued strong emphasis on HED weapons experimental support and development of advanced capabilities. Funding for non-ignition 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 SSP needs as outlined in the Predictive Capability Framework (PCF).[b] In FY 2014, ongoing efforts toward ignition with the Indirect Drive approach, and with alternate ignition concepts, 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

[a] In FY 2013, the Self-Constructed Asset Pool (SCAP) rate for the NIF at LLNL was eliminated, increasing the indirect rate and the funds needed to operate at the same level of activity at the NIF.

[b] The Predictive Capability Framework (PCF) is described in the *FY 2012 Stockpile Stewardship and Management Plan.*

submitted to Congress. Along with integrated experiments, focused experiments will continue to look at the behavior and physics of ignition targets to improve the predictive capability of 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.

NNSA's three major HED facilities, NIF, Omega, and Z, will be operated under their respective governance plans. Reductions in facility operations at the NIF starting in FY 2014 reflect shifting of resources to higher priority efforts within Defense Programs. These reductions will be partially mitigated through prioritization of the most urgent experiments in support of the stockpile, emphasis on lower energy operations that reduce damage to and cost of replacement optics, and continued emphasis on improving operational efficiencies.

The development and deployment of new diagnostics will continue at all HED facilities, but with a slowing of effort in advanced diagnostics for the NIF. The value of the facilities to NNSA's broader missions increases with the quality of the diagnostics used. This is particularly true of the diagnostics used to understand the physics of plasmas involving thermonuclear fuel. Understanding these plasmas is important to predicting the performance and safety of weapons, and historically could be diagnosed only with the limited diagnostics available in underground tests.

The budget supports efforts in ignition, alternate ignition concepts, and HED weapons research at NIF, Omega, and Z. The budget provides $79.0M for operation and utilization of the Z facility at Sandia National Laboratories (SNL). This includes $4.8M in pulsed power fusion, $42.5M in facility operations, and $862K in Diagnostics, Cryogenics and Experimental Support within the ICF Campaign, and $30.9M within the Science Campaign. The ICF budget provides $215.7M for the operations of the NIF and the ICF program at LLNL and $113M is requested for NIF Operations in the Site Stewardship budget. The ICF budget provides $60M for the operations of the Omega Laser Facility and the ICF program at the University of Rochester.

Program Accomplishments and Milestones

The ICF Campaign accomplishments over the last year include: 1) development of new sources for cold x-rays that will enable qualification of components for nuclear hardness and survivability; 2) advances in measurement techniques for burning plasmas that were used by the Science Campaign to validate aspects of models for primary boost; 3) fielding of platforms at Omega and NIF, used to measure the complex hydrodynamic behavior of materials that is a potential concern for Significant Finding Investigations; 4) significant progress in understanding the issues that are limiting the demonstration of ignition at the National Ignition Facility (NIF), including energy coupling to the capsule, symmetry, and mix; 5) progress in indirect drive ignition achieved record areal densities, compression pressure in the hot spot approximately one-half of that needed, and neutron yield a factor of three to ten less than needed for a propagating burn; 6) transition of the NIF to operations under approved Governance Plan, and laser energy of 1.8 megajoules (MJ) demonstrated in the ultraviolet; 7) continued progress in the development of the direct-drive ignition alternative on Omega, including demonstrating ignition-relevant implosion velocities and the highest neutron yields to date at Omega; and 8) progress demonstrated in magnetically-driven implosions by imploding a beryllium liner using a magnetic pulse, and a record x-ray yield of 2.6 MJ produced with a peak power of nearly 400 terawatts (TW) on the Z Facility at SNL.

Program Planning and Management

The ICF Campaign works closely with the Science Campaign, Advanced Simulation and Computing Campaign, and Directed Stockpile Work efforts to coordinate development of resources for stockpile needs. ICF management works to align schedules for ICF capabilities to support the principal stockpile advances described in the PCF. ICF also engages in semi-annual internal reviews as well as regular external reviews of its work across the Future-Years Nuclear Security Program (FYNSP). The ICF Campaign's process for allocating resources allows it to achieve its goal of funding the highest priority work in support of the PCF and progress towards ignition and addressing near-term and out-year challenges for the SSP.

The ICF Campaign applies program management principles and controls to ensure the most effective and efficient use of resources provided. For example, the program focuses its efforts on level 1 and level 2 milestones that support strategic objectives outlined in annually updated Program and Implementation Plans and on oversight of the use of the ICF Campaign's suite of HED facilities to support NNSA's goals.

Strategic Management

Principal technical needs for the stockpile are described in the primary and secondary assessment plans. The PCF is used as a tool to schedule needed advances described in these documents in a way that is consistent with the Life Extension Program, annual assessments, and Significant Findings that arise. The ICF campaign ensures that needed capabilities are available on the schedule described by the PCF. The ICF Executives, a group that includes one senior leader from each institution, works with NNSA Program Leadership to develop the objectives and milestones. They are supported by research-area specific working groups that include membership from multiple laboratories. These strategies are managed through program planning, milestones, and negotiated performance measures, including measures that are the responsibilities of multiple sites and occur over multiple years. The ICF Campaign uses external reviews, as appropriate, to provide feedback on the Campaign's direction and progress.

Several factors, internal and external, present the strongest impact to the overall achievement of the program's strategic goals:

- physics uncertainties associated with exploring extreme conditions associated with ignition and HED physics;
- maintaining the right skill mix and the level of excellence within the technical staff, and
- allocation of resources across Defense Programs, including workforce prioritization and management efficiencies.

Physics uncertainties associated with exploring the extreme conditions associated with ignition and HED physics are mitigated through: the use of advanced design capabilities; experiments on NNSA's HED facilities; the development and deployment of advanced optics, target, and diagnostic capabilities; and by maintaining the level of excellence within the technical staff through challenging work that continually builds competencies critical to this program and to the nuclear security enterprise.

Major Outyear Priorities and Assumptions

Outyear funding levels for the ICF Campaign total $1,431,561,000 for FY 2015 through FY 2018. The ICF Campaign provides the scientific understanding and experimental capabilities in high-energy density physics that are needed to study matter under extreme conditions (including both ignition and non-ignition) and support science-based weapons assessments and certifications. The priority within the ICF Program is to balance efforts in ignition with the continued strong emphasis on HED weapons research. In the outyears, the trend of decreasing operations funding for the NIF assumes that external users will use up to one-third of facility time and provide additional operational funding for the facility. This will be revisited based on studies and experience gained in FY 2014. The outyears budget also 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.

Program Goals and Funding

The ICF Campaign supports the NNSA and U.S. Department of Energy's strategic objective "Secure Our Nation" by providing scientific understanding and experimental capabilities in high-energy density (HED) physics necessary to maintain a safe, secure, and reliable nuclear weapons stockpile without underground testing. The strategic goals of the ICF Campaign are to: 1) maintain excellence in HED and ignition science to underpin Stockpile Stewardship; 2) provide experimental capabilities to improve codes, models, and scientific understanding required for the improved predictive capability set out in the PCF; 3) develop a burning plasma and a high yield platform for physics applications of ignition, and 4) attract, train, and retain high-quality technical staff that will underpin the future nuclear weapons enterprise. Funding will be adjusted as needed to provide the capabilities required to support the stockpile.

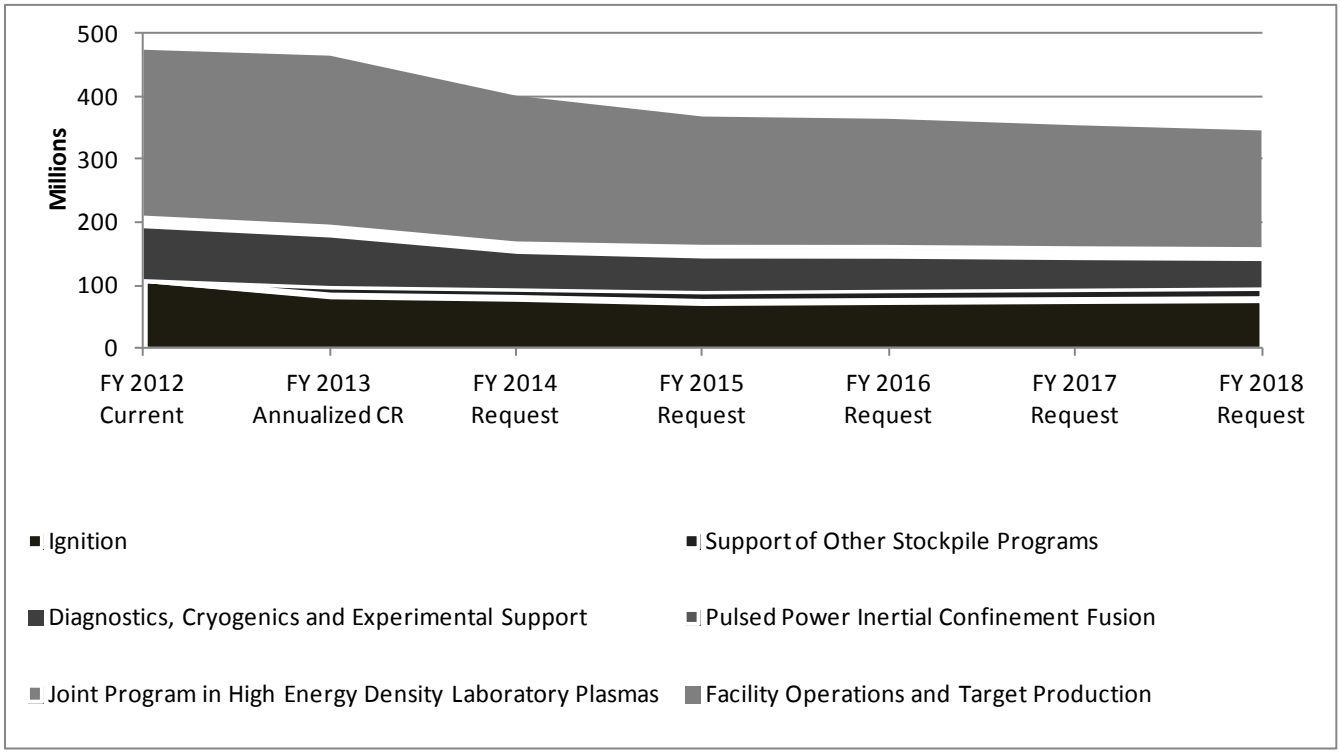
Performance Measures

Performance Goal (Measure)	**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.		
Fiscal Year	**2012**	**2013**	**2014**
Target	N/A	20% of progress (cumulative)	30% of progress (cumulative)
Result			
Endpoint Target	By FY 2019, demonstrate an advanced ignition platform that meets the refined requirements of the Stockpile Stewardship Program (SSP).		

Performance Goal (Measure)	**Application of Ignition** - Cumulative percentage of progress in providing data required to support the predictive capability framework burn boost initiative in FY 2018.		
Fiscal Year	**2012**	**2013**	**2014**
Target	N/A	20% of progress (cumulative)	35% of progress (cumulative)
Result			
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.		

Performance Goal (Measure)	**Key Extreme Experiments** - Cumulative percentage of progress towards achievement of key extreme experimental condition of matter needed for predictive capability for nuclear weapons performance.		
Fiscal Year	**2012**	**2013**	**2014**
Target	75% of progress (cumulative)	85% of progress (cumulative)	90% of progress (cumulative)
Result	**Not Met** - 65		
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 Campaign.		

Figure 1: Relative Out-Year Funding Priorities in Weapons Activities – Inertial Confinement Fusion Ignition and High Yield Campaign[a]



[a] Diagnostics, Cryogenics and Experimental Support includes funds previously appropriated as NIF Diagnostics, Cryogenics and Experimental Support.

Explanation of Funding and/or Program Changes

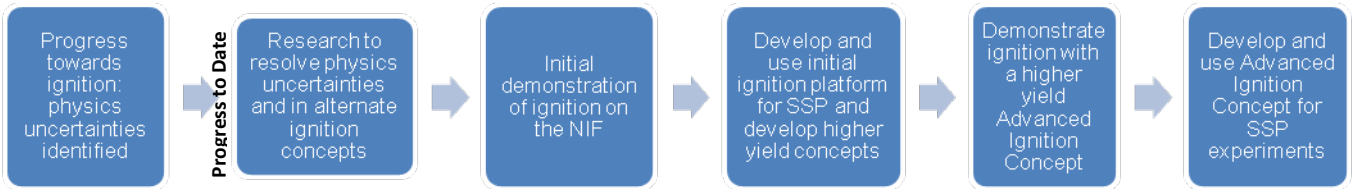
	(Dollars in Thousands)		
	FY 2013 Annualized CR	FY 2014 Request	FY 2014 Request vs. FY 2013 Annualized CR
Inertial Confinement Fusion and High Yield Campaign			
Ignition	**84,172**	**80,245**	**-3,927**
Overall effort in this subprogram decreases slightly with continued emphasis on understanding the physics of ignition. The decrease in this subprogram includes a $3.5 million reduction to account for anticipated management efficiency and workforce prioritization savings goals.			
Support of Other Stockpile Programs	**14,817**	**15,001**	**+184**
The increase is consistent with increasing ICF support for non-ignition high-energy density (HED) physics to provide HED data in support of NNSA's near-term stockpile needs and to meet PCF goals. The requested amount for this subprogram includes a $0.7 million reduction to account for anticipated management efficiency and workforce restructuring reductions.			
Diagnostics, Cryogenics, and Experimental Support	**81,942**	**59,897**	**-22,045**
This decrease slows the pace of effort in development of advanced diagnostics and reduces support for user optics at the NIF, commensurate with reductions in facility operations and an increased proportion of lower energy experiments. The requested amount for this subprogram includes a $2.6 million reduction to account for anticipated management efficiency and workforce restructuring reductions. (Funds in FY 2012-2013 were appropriated under NIF Diagnostics, Cryogenics and Experimental Support.0			
Pulsed Power Inertial Confinement Fusion	**6,044**	**5,024**	**-1,020**
The decrease slows efforts to advance the science of magnetically-driven implosions. The requested amount for this subprogram includes a $0.2 million reduction to account for anticipated management efficiency and workforce restructuring reductions.			
Joint Program in High Energy Density Laboratory Plasmas	**8,334**	**8,198**	**-136**
The slight decrease maintains the level of support for basic HED research, and includes a $0.4 million reduction to account for anticipated management efficiency and workforce restructuring reductions.			

	(Dollars in Thousands)		
	FY 2013 Annualized CR	FY 2014 Request	FY 2014 Request vs. FY 2013 Annualized CR
Facility Operations and Target Production	**269,691**	**232,678**	**-37,013**
Funding supports operations at NIF, Omega, Z, and Trident and target support for experiments. A planned reduction in shot rate at the NIF will be partially mitigated through prioritization of the most urgent experiments in support of the stockpile, emphasis on lower energy operations that reduce damage to and cost of replacement optics, and continued emphasis on improving operational efficiencies. Eliminates support for experiments by external users at NIF and Z. Omega provides experimental time for NNSA's pipeline academic programs. The requested amount for this subprogram includes a $10.2 million reduction to account for anticipated management efficiency and workforce restructuring reductions.			
Total Funding Change, Inertial Confinement Fusion and High Yield Ignition Campaign	**465,000**	**401,043**	**-63,957**

Ignition
Overview

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. 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.

Sequence



Benefits

- Focuses the research effort to demonstrate thermonuclear ignition in the laboratory and to develop ignition as a tool to address key weapons issues. 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.
- Develops the advanced experimental capabilities that can 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.

Funding and Activity Schedule

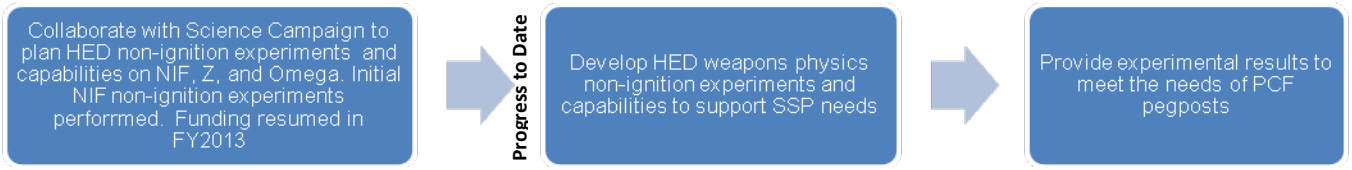
Fiscal Year	Activity	Funding (Dollars in Thousands)
FY 2012	• Progressed towards ignition on the NIF with increases in neutron yield and hot spot pressure. Physics issues identified including symmetry, laser-target coupling, and mix. • Experiments performed on Omega and Z to support the development of ignition and its uses including platform and diagnostic development. • Ongoing development of the Polar Drive Ignition concept to meet robust ignition needs for SSP beyond the initial NIF ignition platform. Cryogenic target implosions on Omega produced significant increases in implosion velocity and neutron yield. • Planned vital HED (non-ignition) weapons physics experiments on the NIF and Omega with the Science Campaigns for FY 2013.	**109,888**

Fiscal Year	Activity	Funding (Dollars in Thousands)
FY 2013	• For all fusion approaches, define the plan and specific goals for scientific and technological activities to be performed in preparation for the FY 2015 review. • Conduct experiments designed to examine scientific and implosion performance issues identified during the National Ignition Campaign (NIC). • Perform experiments on Omega and Z to support the development of ignition and its uses including platform and diagnostic development. Funding for NRL research resumes in this subprogram in FY 2013. • Advanced Ignition Concepts provide the possibility of higher gains or other experimental advantages that provide improved data to meet SSP needs. • Portion of funding moves to Support of Other Stockpile Programs subprogram, leveraging ICF capabilities to support HED (non-ignition) weapons physics experiments.	**84,172**
FY 2014	• Conduct physics and integrated Deuterium-Tritium (DT) implosion experiments to examine experimental and computational understanding of capsule drive, symmetry, and mix. • Perform experiments on Omega and Z to support the development of ignition and its uses, including platform and diagnostic development. • Perform integrated Polar Drive implosions on the NIF to investigate symmetry control and Laser Plasma Instability (LPI) mitigation. • Conduct integrated cryogenic DT implosions on Omega to establish the predictive basis for NIF-equivalent hydro performance. Validate Polar Drive Advanced Ignition Concept on Omega.	**80,245**
FY 2015 **FY 2016** **FY 2017** **FY 2018**	• Conduct Progress Review in FY 2015 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. • 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 igniting and burning 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.	**73,638** **75,282** **76,762** **78,199**

Support of Other Stockpile Programs
Overview

Non-ignition 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 non-ignition physics needs, developing and integrating the experimental infrastructure and capabilities required to execute HEDP experiments on ICF facilities as guided by the PCF. This includes the development of laser, target, and diagnostic capabilities. 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 enhance our understanding and 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.

Sequence



Benefits

Non-ignition experiments using the ICF Campaign's suite of HED facilities are an essential part of meeting DOE's security goals and its requirement to assess and certify the stockpile. 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 Stockpile Stewardship.

Funding and Activity Schedule

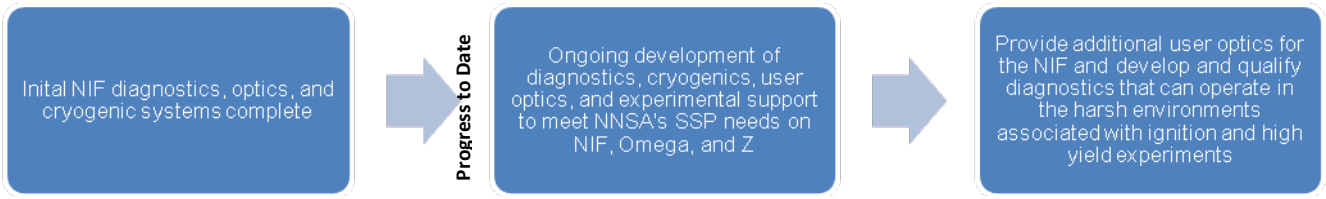
Fiscal Year	Activity	Funding (Dollars in Thousands)
FY 2012	• ICF Campaign collaborated with the Science Campaign to develop vital HED (non-ignition) weapons physics experiments on the NIF, Z, and Omega for FY 2013. • Non-ignition HED experiments performed on NIF, Omega, and Z, including Pleiades, DIME, and Materials Strength on NIF. • Activities performed using prior year balances.	**0**
FY 2013	• Research resources previously under Ignition are directed to this subprogram. • Development of diagnostics and platforms for specific HED experiments for materials strength, equation of state, mix, and radiation hydrodynamics on Omega, NIF, and Z. • Conduct non-ignition implosion experiments on NIF, Omega, and Z to provide HED data to support NNSA's SSP needs.	**14,817**
FY 2014	• Continue to provide 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. • Provide platform and diagnostic capabilities for validating the impact of surety technologies in the future stockpile.	**15,001**

Fiscal Year	Activity	Funding (Dollars in Thousands)
FY 2015	• Continue to develop platforms for initial experiments to support validation of opacity models; demonstrate platform that can acquire high pressure materials data that supports the PCF. Provide data in support of PCF pegposts.	**17,358**
FY 2016		**17,677**
FY 2017		**17,991**
FY 2018	• Validate models relevant to thermonuclear burn.	**18,501**

Diagnostics, Cryogenics and Experimental Support
(formerly NIF Diagnostics, Cryogenics and Experimental Support)
Overview

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 ignition and non-ignition SSP experiments. This subprogram develops and deploys user optics to meet the needs of a broad range of experiments for ICF, HED, fundamental science, and other national security applications.

Sequence



Benefits

Provides key capabilities required for experiments to study matter under extreme conditions at the HED facilities, including user optics. The development of advanced diagnostics that operate in the harsh ignition environment is required to use ignition as a tool to support stockpile certification through verification of codes.

Funding and Activity Schedule

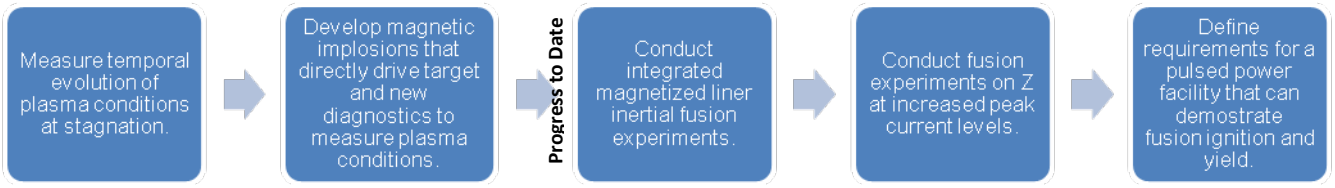
Fiscal Year	Activity	Funding (Dollars in Thousands)
FY 2012	• Completed the initial suite of diagnostics required for the NIF ignition campaigns. • The advanced diagnostic effort focused on incorporating new techniques as they were developed and adding new capabilities as required. Pre-conceptual designs proposed in FY 2011 were evaluated and down-selected. • Experimental concepts were tested on Omega. • Developed and activated the optical systems required to produce the spatial beam smoothing needed in ignition experiments and subsequent weapons physics campaigns and the integration and experimental commissioning of the NIF target area. Provided additional user optics as required.	**85,654**
FY 2013	• Continue to develop advanced diagnostics that can operate in the harsh environment created by an igniting target. New techniques will be developed and new capabilities added to meet the needs of the SSP. • Continue development and testing of advanced diagnostics on NIF, Omega, and Z, including deployment of x-ray Thomson scattering on Z, and the fourth harmonic probe beam for the OMEGA Extended Performance (EP) Laser and the fast backlighting target positioner on the 60-beam OMEGA Laser. • Development and installation of advanced cryogenic target systems. • Ongoing development and procurement of optical systems and user optics required for supporting user experiments.	**81,942**

Fiscal Year	Activity	Funding (Dollars in Thousands)
FY 2014	• Continue efforts from FY 2013 to develop and support diagnostic capabilities, cryogenic systems, and user optics at NIF, at a reduced 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 ultrahigh resolution x-ray spectrometer on the 60-beam OMEGA Laser, 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.	**59,897**
FY 2015 **FY 2016** **FY 2017** **FY 2018**	• Continue efforts from FY 2014 to develop and support diagnostic capabilities, cryogenic systems, and user optics at NIF, at a reduced pace commensurate with facility operations. • Continue efforts to demonstrate operation of Advanced Radiographic Capability (ARC) at NIF, and to 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 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, a dedicated fourth-harmonic probe beam on 60-beam OMEGA Laser, and the magnetic recoil spectrometer, gamma reaction and neutron burn history diagnostics for Z.	**56,835** **54,541** **50,569** **47,145**

Pulsed Power Inertial Confinement Fusion
Overview

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 robust ignition and high fusion yield. 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.

Sequence



Benefits

- Provides an ignition alternative that has potential to provide significantly higher yields than will be possible on the NIF.
- Supports the assessment of pulsed power as a means to achieve thermonuclear fusion in the laboratory, including computational target design, experiments, and experimental infrastructure.
- 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.

Funding and Activity Schedule

Fiscal Year	Activity	Funding (Dollars in Thousands)
FY 2012	• New diagnostics (such as neutron and x-ray imaging) used to demonstrate consistent fusion plasma conditions for a variety of applications. • Developed magnetic implosions that directly drive the target.	**4,997**
FY 2013	• Demonstrate initial capability for magnetized and pre-heated fusion experiments. • Conduct first integrated Magnetic Liner Inertial Fusion (MagLIF) experiments. • Develop new and improved diagnostics and techniques to measure the implosion dynamics, magnetic fields, and fuel conditions.	**6,044**
FY 2014	• Conduct initial integrated fusion target experiments and compare results to simulations. Conduct integrated fusion (MagLIF) target experiments with increased laser energy and higher currents and begin scaling study. • Compare accumulated data from magnetically-driven fusion experiments on Z with 3-D radiation magnetohydrodynamic simulations. • Develop an improved experimental and computational understanding of the implosion dynamics and fuel behavior of magnetically-driven implosion.	**5,024**
FY 2015 **FY 2016** **FY 2017** **FY 2018**	• 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. • Evaluate fusion performance and stagnation plasma parameters at enhanced drive conditions using cryogenic fuel and compare results with simulations. • Continue to define requirements for a pulsed power facility that can demonstrate robust ignition and high fusion yield.	**5,676** **5,844** **5,919** **6,007**

Joint Program in High Energy Density Laboratory Plasmas
Overview

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.

Sequence

Benefits

Funds academic programs through a joint solicitation with DOE's Office of Science 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.

Funding and Activity Schedule

Fiscal Year	Activity	Funding (Dollars in Thousands)
FY 2012	• Devoted a portion of experimental time on NIF, Omega, and Z to basic HED science. • Continued support for grants and research centers through JPHEDLP. Eleven university-based research teams performed basic HED science experiments on the Omega Laser Facility through NLUF. • Moved funding for the University of Nevada, Reno to this subprogram. • Conducted Joint NNSA/DOE (OFES) solicitation in support of basic HED research and solicitation for NLUF Program for funding and experimental time on Omega.	**9,100**
FY 2013	• Continue support of High Energy Density Laboratory Plasma research through solicitations to fund individual investigator and research centers activities.	**8,334**
FY 2014	• Continue activities from FY 2013. Omega provides the experimental time for NNSA's pipeline academic programs.	**8,198**
FY 2015 **FY 2016** **FY 2017** **FY 2018**	• Continue activities from FY 2014 with support for additional research grants in HED plasma physics.	**9,498** **9,498** **9,455** **9,447**

Facility Operations and Target Production
Overview

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 the research needs of the ICF and Science Campaign's subprograms to meet the stockpile assessment and certification needs. Starting in FY 2014, a portion of facility operations and maintenance funding for the NIF is requested in the Site Stewardship funding line in Enterprise Infrastructure. Now that the NIF is a fully operational facility, the funding in Enterprise Infrastructure will support 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 must 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.

Sequence

Benefits

Provides infrastructure and operations support for the ICF HED facilities that allows the ICF and Science Campaigns to conduct the experiments needed to meet stockpile assessment and certification needs and broader goals of the SSP.

Funding and Activity Schedule

Fiscal Year	Activity	Funding (Dollars in Thousands)
FY 2012	• Ongoing strong demand for ICF and SSP work on the NIF, Omega, and Z facilities. Additional funds for Z requested in the Science Campaign budget. • Provided support for facility improvements requested by users or required for effective operations. Conducted solicitations for target needs. • Supported Campaign external reviews, users' group meetings, and NRL.	**264,845**
FY 2013	• Ongoing strong demand 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. • Conduct annual assessment of infrastructure and mission needs and recommend following fiscal year investments across all HED facilities. • Conduct target development and support for experiments on ICF facilities. • Support for ICF Campaign external reviews and support for facility users group meetings; begin triennial reviews of Omega, NIF, and Z facilities with review of Omega in FY 2013.	**269,691**

Fiscal Year	Activity	Funding (Dollars in Thousands)
FY 2014	• Continue activities from FY 2013, with reduced facility operations at the NIF. Additional funds for Z are requested in the Science Campaign budget. Starting in FY 2014, $113M in funding for base operations and maintenance for the NIF are requested in the Enterprise Infrastructure Site Stewardship funding line. Eliminate experimental time for external users of NIF and Z. Omega will provide the experimental time for NNSA's pipeline academic programs. • Support the ICF Campaign external reviews and support facility users' group meetings; triennial review of the NIF in FY 2014.	**232,678**
FY 2015 **FY 2016** **FY 2017** **FY 2018**	• Continue activities from FY 2014. Reduce facility operations at the NIF, with emphasis on highest priority experiments in support of the stockpile and on improving operational efficiencies. Triennial review of the Z Facility in FY 2015.	**204,836** **201,310** **193,245** **186,328**

Supporting Information

Capital Operating Expenses[a]

Capital Operating Expenses Summary

(Dollars in Thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Capital Operating Expenses			
General Plant Projects	0	0	0
Capital Equipment	3,336	3,409	3,484
Total, Capital Operating Expenses	**3,336**	**3,409**	**3,484**

Outyear Capital Operating Expenses Summary

(Dollars in Thousands)

	FY 2014 Request	FY 2015 Request	FY 2016 Request	FY 2017 Request	FY 2018 Request
Capital Operating Expenses					
General Plant Projects	0	0	0	0	0
Capital Equipment	3,484	3,561	3,639	3,719	3,801
Total, Capital Operating Expenses	**3,484**	**3,561**	**3,639**	**3,719**	**3,801**

[a] Funds are appropriated for Operations and Maintenance, which includes operating expenses, capital equipment and general plant projects. The program no longer budgets separately for capital equipment and general plant projects.