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We appreciate Stephen Bodner's continuing interest in the performance of the NIF laser system. However, we find it necessary to disagree with the conclusions he reached in his comments [Appl. Opt. 47, XXX (2008)] on "National Ignition Facility Laser Performance Status" [Appl. Opt. 46, 3276 (2007)]. In fact, repeated and ongoing tests of the NIF beamlines have demonstrated that NIF can be expected not only to meet or exceed its requirements as established in the mid-1990s in the document National Ignition Facility Functional Requirements and Primary Criteria [Revision 1.3, Report NIF-LLNL-93-058 (1994)], but also to have the flexibility that provides for successfully meeting an ever expanding range of mission goals, including those of ignition.

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1. Introduction

The May 1994 NIF (National Ignition Facility) Conceptual Design Report included the NIF Functional Requirements and Primary Criteria [1] (also referenced by S. E. Bodner [2]). This document formed the basis for Congressional approval of the National Ignition Facility Project 96-D-111. It was written to cover the needs of the various applications that were anticipated at that time for NIF, including ignition, inertial fusion energy, high-energy-density physics and astrophysics in the laboratory. It has provided important guidance to the team responsible for NIF design and construction, for users, and for those following the progress of the project.

Also, since that time, target designers have worked in parallel to develop and refine their goals for various NIF experiments that address many of the missions defined above. The most prominent activity has been in inertial confinement fusion where the term “point design” is used to describe the set of target and laser features for specific experimental campaigns leading up to and including ignition experiments. In the past several years, we have given particular attention to the “Rev 1” and “Rev 2” point designs associated with ignition campaigns that employ 192-beam system 3ω energies of 1.0 MJ and 1.3 MJ, respectively.

2. Focal spot performance

The size of the NIF focal spot is determined by two factors, the intrinsic ability to focus the output energy from a beamline, and the combined capabilities of the beamline with a continuous phase plate (CPP) that has been included to provide the larger spot sizes desired by a range of missions. The purpose of the CPP is to modify the wavefront so that in combination with smoothing by spectral dispersion (SSD), the beam at the target is spatially smooth and has the correct dimensions. As shown in Table 1, in 2006 the intrinsic ability of a NIF beamline to form a focal spot was demonstrated to be comfortably within requirements.

It is expected that all laser configurations for ignition experiments will include a CPP. Measurements have been completed to test the ability of a NIF beamline that includes a

CPP to produce the spot size desired for specific point design experiments. The results of several of these measurements are given below in Table 2. Overall, spot size demonstrations, controlled by CPP parameters, have ranged from a circular shape with a FWHM of ~300 μm (for high-intensity optical illumination at the target) to elliptical spots with measured focal spot dimensions of 1.9 × 1.6 mm. These large spots will be used for the highest-energy ignition shots and for physics campaigns for equation of state measurements of various materials. The success of making spot sizes over this range ensures that we can meet those desired for the ignition and other missions.

3. Laser bandwidth

As S. E. Bodner pointed out in his Comment, there is not yet full consensus among plasma physicists on the SSD laser bandwidth that will be needed to manage laser plasma instabilities in the long-scale length, dense plasmas in ignition targets. The target design paper published in 2004 and referenced by S. E. Bodner was originally submitted for publication in 2001 [3]. In the nearly seven years since that paper was submitted, understanding of the physics determining the ignition target design has evolved dramatically through extensive experiments on OMEGA and other lasers and with the very significant expansion of computational capability using high-performance computers [4,5].

The ability of NIF to adapt to changing target needs was illustrated in Table 4 of Reference [6], which is reproduced here as Table 2, now with the addition of results for two more ignition point designs tested during the 2007 NIF Precision Diagnostic

System campaign. The 3ω bandwidth of 120 GHz pointed out by S. E. Bodner was demonstrated for a 2006 conceptual design for a 1.8 MJ ignition pulse that requested ≥ 90 GHz. Since that time, as shown in Table 2, bandwidths of 210 and 270 GHz (3ω) have also been demonstrated for the most demanding performance conditions: those with simultaneous use of both high energy and large spot size.

4. Summary

Table 2 is a comprehensive demonstration of the ability of the NIF laser system to adapt to the evolving demands of campaigns for study of critical target parameters. These are exciting times. NIF is over 94% complete, with 120 of its 192 main laser beams qualified at energies ranging from 19 to 22 kJ/beam—a current 1ω total-energy capability of 2.5 MJ. Soon we will be conducting long-awaited ignition experiments and experimental studies of high-energy-density science.

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5. References

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Table 1. Comparison of spot size features as defined by the Functional Requirements and Primary Criteria and as measured during 2006 experiments in the Precision Diagnostic System, (PDS) of NIF.

	As defined by Funct Req'ts and Primary Criteria	**As measured during recent tests on NIF**
Spot size diameter to the 1/e points	≤ 500 μm	260 ±15 μm
Diameter of the focused spot for a 1.8 MJ equivalent beam containing 98% of the output energy	≤ 600 μm	460 ± 50 μm

Table 2. Comparison of a number of requested and demonstrated spot size and laser bandwidths for ignition experiments. Each demonstrated shot has all parameters shown occurring simultaneously on that shot.

Campaign Description			Beam Energy and Power			Beam Smoothing		
Campaign	Pulse shape	Pulse length (ns)	3ω energy per beam (J)	3ω energy full NIF (MJ)	Peak power (TW/beam)	CPP (mm) [FWHM]	Polarization Rotation	SSD (GHz 3ω)
2006 Baseline 1.0 MJ (Rev. 1) Ignition Design	Ignition	15.4	5208	1.00	1.85	.95 x .5	1/2 of beams	270
Demonstrated: 1.0 MJ Shot N060302-001	Ignition	15.4	5316	1.02	1.9	.95 x .5	Yes	270
2006 Conceptual 1.8 MJ Ignition Design	Ignition	20.4	9375	1.80	2.6	1.3 x 1.16	1/2 of beams	90
Demonstrated: 1.8 MJ Shot N060324-001	Ignition	20.4	9438	1.81	2.6	1.3 x 1.16	Yes	120
2007 Baseline (Rev. 2) 1.3 MJ Ignition Design	Ignition	15.1	7050	1.35	1.99	1.48 x 1.27	1/2 of beams	210
Demonstrated: 1.3 MJ Shot N070607-001	Ignition	15.1	7600	1.46	2.06	1.91 x 1.64	Yes	220
2007 Conceptual 1.8 MJ Ignition Design	Ignition	17.2	9375	1.80	2.6	1.91 x 1.64	1/2 of beams	270
Demonstrated: 1.8 MJ Shot N070809-002	Ignition	17.2	10600	2.00	2.67	1.91 x 1.64	No	270