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J. H. Campbell, C. E. Barker, B. M. VanWonterghem,
D. R. Speck, W. C. Behrendt, J. R. Murray,
J. A. Caird, D. E. Decker, and I. C. Smith

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John H. Campbell, Charles E. Barker, Bruno M. VanWonterghem,
David R. Speck, William C. Behrendt, John R. Murray,
John A. Caird, Derek E. Decker and Ian C. Smith
University of California
Lawrence Livermore National Laboratory
P. O. Box 808, L-490, Livermore, CA 94551-9900
Phone (510) 422-6497/Fax (510) 422-7748

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Abstract

The Beamlet laser is a large aperture, flashlamp pumped Nd: glass laser that is a scientific prototype of an advanced Inertial Fusion laser. Beamlet has achieved third harmonic, conversion efficiency of near 80% with its nominal 35cm x35cm square beam at mean 3ω fluences in excess of 8 J/cm^2 (3-ns). Beamlet uses an adaptive optics system to correct for aberrations and achieve less than 2 x diffraction limited far field spot size.

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The US Department of Energy has proposed to build a National Ignition Facility (NIF) for Inertial Confinement Fusion (ICF) research [1]. The laser driver of this facility will consist of a frequency-tripled, Nd: glass laser system capable of irradiating fusion targets at an energy and power of 1.8 MJ and 500 TW. The NIF laser will consist of 192 independent "beamlets" arranged in four large, compact arrays 4 beamlets high and 12 wide.

We have recently completed construction and preliminary testing of one prototype Beamlet (Fig 1)[2]. This prototype Beamlet laser has a 35cm x35 cm square aperture and uses a multipass architecture; this is the first attempt to employ such a design at this scale. The 36 m long main laser cavity uses a unique full aperture (35 cm) plasma-electrode pockels cell [3] and polarizer in an angularity multiplexed design to switch the ~3 ns pulse out of the cavity. The pulse is contained in the cavity for a total of four passes through a group of 11 full aperture flashlamp pumped Nd:phosphate glass amplifiers[4]. The output pulse from the cavity then makes a single pass through a "booster" amplifier section (composed of five more amplifier modules) that is driven heavily into saturation. The 1ω output from the booster amplifiers passes through a final spatial filter and then enters a dual crystal frequency converter. The frequency converter uses a type I/type II third harmonic generation scheme consisting of a 1.05-cm thick KDP doubler and 0.95-cm thick KD*P (80% deuterated) tripler. In our experiments we have used both 32x32 cm^2 and 37x37 cm^2 crystals that can support approximately 30x30 and 34x34 cm^2 input beams , respectively (the smaller crystals were tested first because of the shorter time needed to grow them); the boules from which the larger crystals were cut took about 2 years to grow and weigh about 0.5 ton[5].

Table 1 and 2 summarizes the main performance characteristics of the laser at 1054 and 351 nm, respectively. Initial frequency conversion tests were carried out at approximately 30x30 cm^2 beam size; tests at the larger aperture (34x34 cm^2) are in progress and will be reported at the conference.

References

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4. A. C. Erlandson et al., "Design and Performance of the Beamlet Amplifiers", ICF Quarterly Report, Vol. 5 (1) 1994; LLNL report UCRL-LR-105821-94-1.

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Table 1. Summary of measured Beamlet output energy vs. pulse length at 1054.

34x34 cm^2 beam (effective area 971 cm^2, 84% aperture fill factor)

Output pulse length (ns)	Fluence (J/cm^2)	Total Energy (kJ)	Spatial Intensity modulation (pk-avg.)
3	12.5	12.1	1.45:1
5	14.3	13.9	1.25:1
8	16	15.5	1.25:1

Table 2. Summary of measured Beamlet 3ω performance characteristics.

29.6x29.6 cm^2 beam, (effective area 736 cm^2, 84% aperture fill factor)

Parameter	Measured Performance
Pulse width (ns)	3
Mean 3ω fluence (J/cm^2)	8.7
3ω energy (kJ)	6.4
Bandwidth (GHz)	90
Peak conversion efficiency (%)	80
Beam divergence (μrad)	≤ 25
Far field spot size	$\leq$ 2x diffraction limited
Strehl ratio	0.4

Auspices

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Figure 1. Plan view of Beamlet laser