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DISCLAIMER

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ABSTRACT

We recently demonstrated the production of 1.25 PW of peak power in the Nova/Petawatt Laser Facility, generating > 600 J in < 450 fs. Results of the first focused irradiance tests, at 500 J and deployment of a novel targeting system will be presented.

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We recently demonstrated the production of over a petawatt of peak power in the Nova/Petawatt Laser Facility, generating 620 J in 430 fs. The Petawatt Laser Project was initiated to develop the capability to test the fast ignitor concept[1] for inertial confinement fusion (ICF), and to provide a unique capability in high energy density physics. The laser was designed to produce near kJ pulses with a pulse duration adjustable between 0.5 and 20 ps. At the shortest pulse lengths, the laser produces greater than 10^{21} W/cm^2 when focused at f/3.

The laser system begins with a Ti:sapphire chirped pulse amplification system operating at 1054 nm. The pulse is stretched to ~ 3 ns and is amplified up to 50 mJ in the titanium-sapphire section with minimal bandwidth narrowing. Further amplification in mixed phosphate glass rod amplifiers produces a spectrally-shaped 10 J pulse. This pulse is further amplified up to the near kilojoule level by a series of disk amplifiers. Near diffraction-limited beam quality is achieved by utilizing only the central 80% of the disk amplifiers and the use of adaptive optics to correct any residual thermal or pump induced aberrations. Following amplification, the chirped nanosecond pulse is compressed to a pulse duration which can easily be adjusted from 0.43 to 30 ps by a pair of large aperture diffraction gratings arranged in a single pass geometry. Pulse compression occurs in vacuum with a compressor throughput of 84%. Currently, this system is limited to 600 J pulses for routine operation in a 46-cm beam. Expansion of the beam to 58 cm with the installation of 94-cm gratings will enable 1 kJ operation.

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Target experiments with petawatt pulses will be possible either integrated with Nova 10-beam target chamber for integrated fast ignition experiments, or in an independent target chamber for single-beam experiments. Focusing the beam is accomplished using an on-axis parabolic mirror alone, or in conjunction with a secondary "plasma" mirror, as shown in Fig. 1.[2] For irradiances > 10^{14} W/cm^2, short pulse radiation creates a critical density plasma on the surface of a dielectric substrate, with a demonstrated reflectivity > 90%. For incident pulses on the order of 500 fs, the plasma has insufficient time to undergo hydrodynamic expansion, producing a reflected wavefront comparable to the original optical surface. This novel targeting system will enable the production of ultrahigh contrast pulses, with an easily varied effective focal length by changing the curvature of the secondary mirror.

Near field and focused irradiance, spectrum and autocorrelation are measured on each shot. The high power focused irradiance is measured by an optical focal plane imaging system and an x-ray pinhole camera. Results of the first focused irradiance tests and target experiments will be presented.

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2. M. D. Perry, V. Yanovsky, M. Feit, and A. Rubenchik, "Plasma mirrors," *Phys. Plasmas*, submitted, 1997.

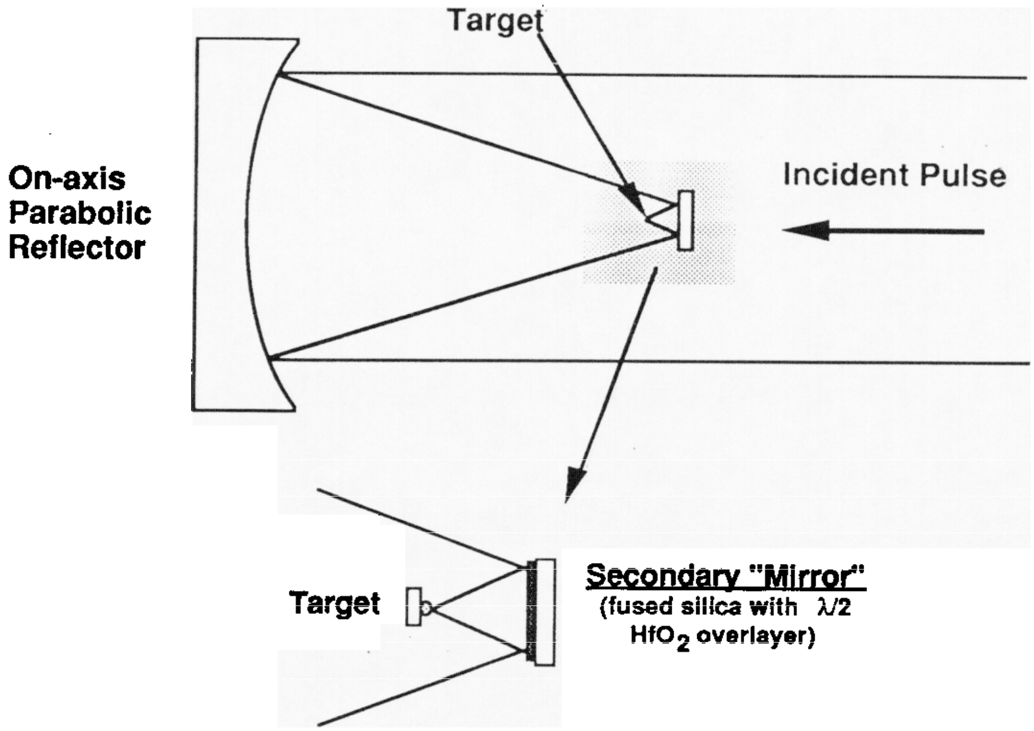

Fig. 1 Cassegranian focusing concept using a plasma for the secondary mirror.

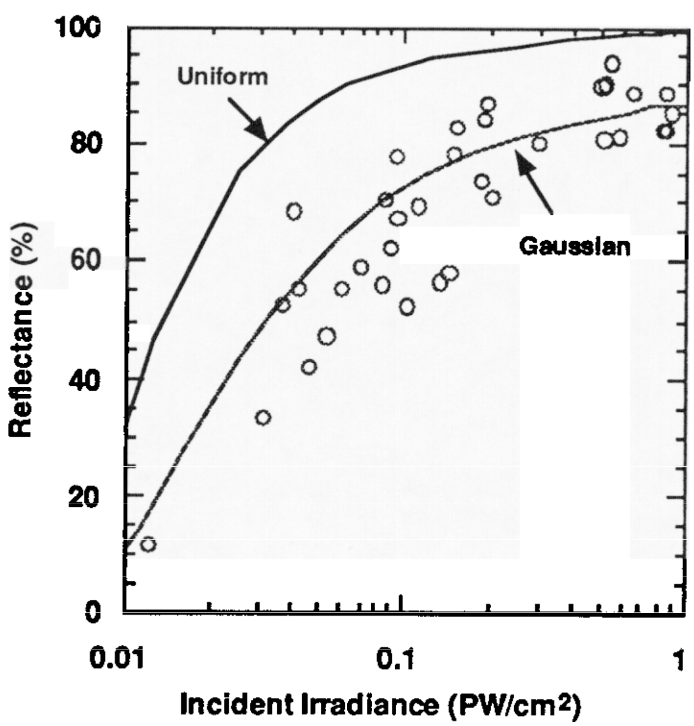

Figure 2: Measured reflectivity from the plasma mirror

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