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PETAWATT LASER SYSTEM

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We recently demonstrated the production of over a petawatt of peak power in the Nova/Petawatt Laser Facility, generating > 500 J in < 500 fs. The Petawatt Laser Project was initiated to develop the capability to test the fast ignitor concept 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, this laser will surpass 10^{21} W/cm^2 when focused later this year.

The laser system begins with a Ti:sapphire chirped pulse amplification system operating at 1054 nm. The pulse is stretched to ~ 2 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 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 480 fsec by a pair of large aperture (80 cm) 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 in a 46 cm beam. Expansion of the beam to 58 cm will enable 1 kJ operation.

Target experiments with petawatt pulses will be possible either integrated with Nova in the 10 beam target chamber or as a stand alone system in an independent, dedicated chamber. Focusing the beam onto a target will be accomplished using an on axis parabolic mirror. The focal spot will be diagnosed with an axial x-ray imaging camera. The design of a novel targeting system enabling the production of ultrahigh contrast pulses and an easily variable effective focal length will also be described.

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