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NIF's High Energy Petawatt Laser Is on the Fast Track to Completion

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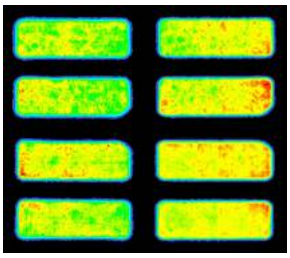
NIF's High Energy Petawatt Laser Is on the Fast Track to Completion

The National Ignition Facility's Advanced Radiographic Capability (ARC), a petawatt (10^{15}-watt) laser system, is rapidly moving along the path to completion and commissioning. Over the past year, the ARC utilities, including electrical cabling, vacuum and ventilation systems, platforms, and cleanrooms, have been installed. On Sept. 12, the ARC team completed a major milestone by propagating first light into ARC Compressor Vessel 1, and the first ARC main laser system shot to the Roving Mirror Diagnostic Enclosure (RMDE) calorimeters (at the exit of the NIF laser bay) was fired in November. A recent series of laser shots to the RMDE calorimeters operationally tested a subset of the ARC systems, including the ARC Injection Laser System (ILS), Integrated Computer Control System (ICCS) automated shot software and Laser Performance Operations Module (LPOM) shot setup and analysis software. An ARC shot on Feb. 18 fired 10.41 kJ in 4 beams (8 beamlets or split beams), as recorded by the RMDE calorimeters in the image at right.



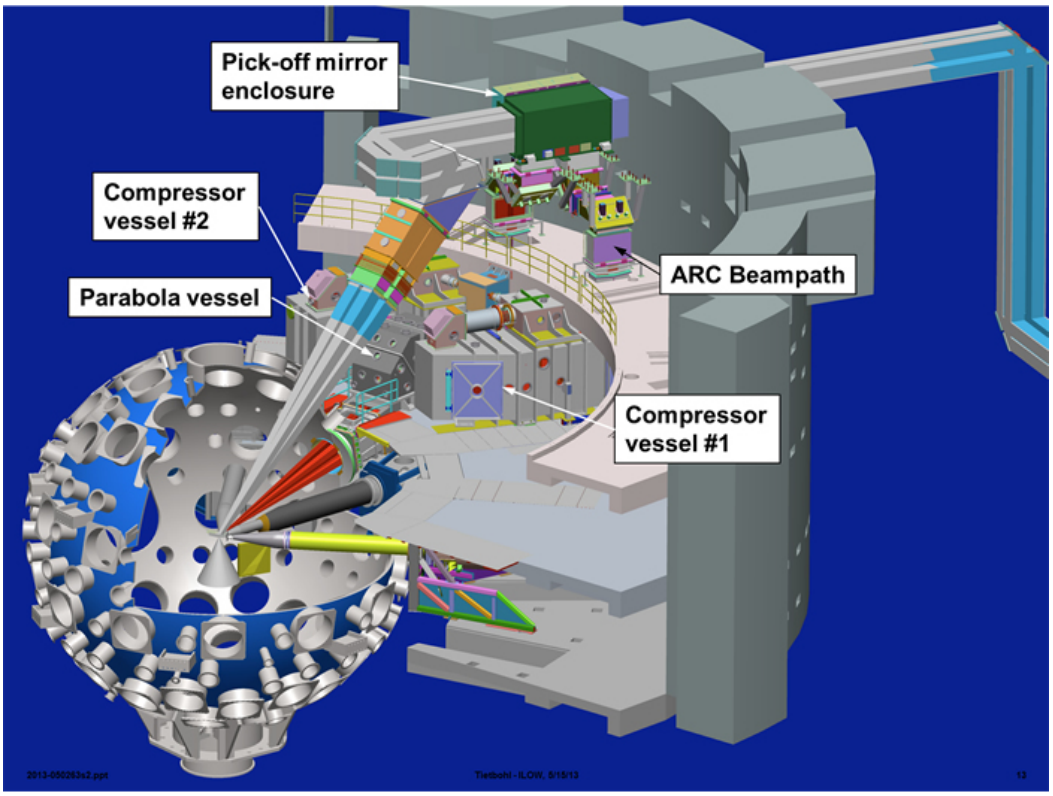
Output beamlet profiles measured at RMDE, totaling 10.41 kJ in eight 365x160 mm^2 beamlets, from shot N140218-004-999.

TheARC ILS consists of the ARC master oscillator, dual regenerative amplifiers for the A and B beamlets, the split-beam injection system, and modifications to the NIF preamplifier module to switch between NIF to ARC operation using ICCS controls. The laser shots were performed in parallel with the installation and alignment of the compressor and Parabola Vessel line replaceable units (LRUs) in the Target Bay and the ARC short-pulse diagnostics LRUs in the Target Bay and switchyard. Grating alignment in the compressor vessels is now complete.

Engineer JB McLeod inspects one of the first four high-efficiency diffraction gratings installed in the ARC compressor vessels. ARC's one-meter-wide multilayer dielectric gratings were specially developed at LLNL to withstand the record levels of energy generated by NIF's lasers.

When complete, ARC will be the world's most energetic short-pulse laser, capable of creating picosecond-duration laser pulses to produce energetic x rays in the range of 50-100 keV for backlighting NIF experiments. ARC is designed to deliver kilojoule laser pulses with adjustable pulse durations from 1 to 50 picoseconds and a peak focused intensity above 10^{17} W/cm^2. ARC uses up to four NIF beamlines, propagating two short-pulse beams per NIF aperture in a split-beam configuration. Staggering the arrival of the eight ARC beamlets onto backlighter targets will produce an x-ray "movie" to diagnose the fuel compression phase leading up to ignition of a cryogenic deuterium-tritium target with tens-of-picoseconds resolution. "ARC is important to help us understand what's happening in the compressed core of NIF targets," said John Edwards, NIF program director for inertial confinement fusion.

ARC will also enable new experiments in frontier science and high-energy-density stewardship science.



After amplification in the NIF laser, the ARC beams are compressed in the Target Bay and focused to backlighters near Target Chamber center. The ARC quad of beamlines can provide up to eight backlighters for ignition evaluation.

Technicians monitor the successful insertion of transport mirrors in the 11-foot-high ARC Parabola Vessel. The Parabola Vessel will focus ARC's quadrillion-watt beams on backlighter targets near Target Chamber center to produce an x-ray "movie" to diagnose NIF target implosions.

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