High-energy Laser

Trident aids astrophysics, nuclear science, and cancer treatment

Quick read
The short-pulse Trident laser promises to transform many areas of our lives, from cancer treatment to diverting destructive lightning strikes and diagnosing fusion experiments.

Amazing things can be done when the small amount of energy needed to light a 100-watt bulb for one second is packed into a tiny pulse of laser light lasting but a trillionth of a second and having a spot size about 100 times smaller than the period at the end of this sentence.

That's what Los Alamos scientists have demonstrated with the new ultra-short, highly-focused, ultra-intense pulses available from the newly enhanced Trident laser, now delivering power at one-tenth of a petawatt. A petawatt equals one quadrillion watts.

Shine one of those tiny pulses on a thin foil target and it produces an intense pulse of x-rays with the right energies (18–35 thousand volts—kilovolts) to make high-precision images of imploding fusion capsules, just what will be needed to diagnose fusion experiments at the National Ignition Facility at Lawrence Livermore National Laboratory.

Prepare that foil target in a slightly different way and the Trident laser pulse will produce a beam of 50-million electronvolt protons, a beam with 10 times more energy content than found in proton beams from similar lasers for the same laser intensity.

At this energy and intensity, the proton beam has a host of potential uses, from making images (proton radiographs) of dense objects to making radioisotopes for medical applications or performing tabletop nuclear physics experiments. Slightly higher energies make possible other applications, like treating cancers or screening containers for the presence of plutonium or uranium. The laser itself might even be used to divert lightning from power lines and buildings.

With all these applications in sight, Kirk Flippo, one of the Trident physicists, is excited about the future. "Short-pulse technology could revolutionize many aspects of our lives, and Trident is one of a handful of systems leading the way."

Other scientists emphasize Trident's basic research potential. It can re-create states of matter seen only around black holes and inside gamma-ray bursts, thereby expanding the field of laboratory astrophysics. It can also produce ultra-short x-ray pulses to provide images of the gyrations of proteins as they fold and can even be used to observe such bizarre phenomena as "Unruh radiation," the theoretical radiation emitted by a particle subjected to massive acceleration.

Trident has just become a national user facility, opening its doors to scientists everywhere and giving all a chance to channel their ideas into real experiments.

Trident's unique laser capabilities

Trident's unique laser capabilities provide an ideal platform for many experiments. The laser system consists of three high-energy beams that can be delivered into two independent target experimental areas. The target areas are equipped with an extensive suite of diagnostics for research in ultra-intense laser matter interactions, dynamic material properties, and laser-plasma instabilities.

Several important discoveries and first observations have been made at Trident, including

laser-accelerated MeV mono-energetic ions, nonlinear kinetic plasma waves, transition between kinetic and fluid nonlinear behavior, as well as other fundamental laser-matter interaction processes.
Trident's ultra-short energy pulses create high-energy-density plasmas as well as the mono-energetic ion pulses for cancer research applications.
Trident's unique long-pulse capabilities have enabled state-of-the-art innovations in laser-launched flyer-plates and other unique loading techniques for material dynamics research.
Learn more about submitting a proposal at http://trident.lanl.gov/.

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About Our Capabilities, Facilities, and Staff

"Los Alamos National Laboratory plays an indispensable role in building America as a science and technology powerhouse, and our staff are an incredible resource to the nation and the world." Michael Anastasio, Dir.

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Now in its seventh decade, LANL is one of the few laboratories that can bring great breadth of fundamental and discovery science, technology, and engineering rapidly together to create tangible solutions for national security needs.
Our staff, working with partners throughout science and industry, must be able to deliver today's solutions while maintaining the depth of capabilities to deliver the next generation of discoveries.
Los Alamos has demonstrated a cycle of innovation where we have developed world-leading capabilities and facilities in response to urgent, unique missions. Our new discoveries continue to responde to emerging missions.
Being able to integrate and apply our capabilities rapidly to new challenges will be a key advantage in an increasingly competitive landscape.

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Signature facilities