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Laser Superbeam Goes from Science Fiction to Reality

Researchers use plasma to successfully combine multiple laser beams into a single superbeam.

MILWAUKEE, Wis.—For 40 years, the Death Star's laser beam has remained one of science fiction's most iconic weapons. The image of a planet's destruction at the hands of the Death Star's superlaser is burned into the memory of millions of fans.

It has long been thought, however, that the technology used by the Death Star could never make the jump from sci-fi into reality. The creators of the Star Wars universe equipped the enormous fictional space station with eight kyber crystals, a fantasy material that generates a powerful laser beam. The beams then combine into a single planet-destroying beam. Scientists and laser experts have maintained that this superbeam could never be created due to the properties of laser light—they say that rather than converging and combining their energy, the beams would just pass through one another.

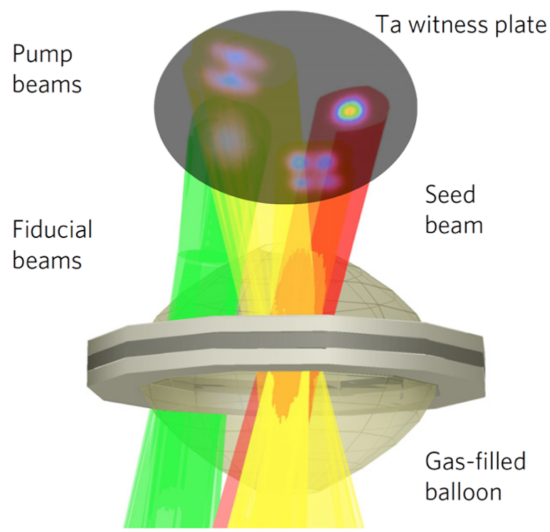

Figure 1: Intense laser beams (green and yellow) shine on a balloon filled with gas to create a plasma lens. After passing through the lens, each beam heats a spot on the Tantalum (Ta) plate. A low intensity laser beam (red) crosses eight of the intense beams (yellow) in the lens and, just like the Death Star, it extracts the energy of the other beams. Amplification of the low intensity beam is measured by the brightness of the spot it produces on the plate. The initially weak (red) beam becomes the brightest after passing through the lens.

That was true—until now. A team of researchers at Lawrence Livermore National Laboratory (LLNL) have added plasma—a mixture of positively charged particles and free electrons—to the mix and successfully combined several separate laser beams into a superbeam.

The National Ignition Facility (NIF) has 192 laser beams—nine of them were combined to produce a directed pulse of light that was nearly four times the energy of any of the individual beams (Figure 1). The team used the Livermore-designed plasma lens to combine the beams and produce the first demonstration of its kind.

"In high-energy laser systems which use conventional solid lenses, the energy of the lasers cannot be too high because it will damage the lenses," said Robert Kirkwood, the programmatic lead for the campaign.

"Because a plasma is very hot already, the lasers don't destroy it. The plasma can handle extremely powerful laser beams."

"Combining beams has recently been done with other lasers, but the results were limited because of the sensitivity of the solid lenses," added Scott Wilks, one of the campaign's designers. "Because of this plasma lens, we can put a huge amount of energy into a very small space and time—serious energy, in a well-focused beam."

"Plasmas are usually bad for lasers—it is the bane of our existence. The team has turned that on its head and is intentionally harnessing plasmas for a benefit," said Brent Blue, program manager for National Security Applications at NIF.

"We've known that plasma can deflect light and change the direction of energy flow, but it's been difficult to do it in a very precise way," Kirkwood said. "Here we've shown that we can control the waves in the plasma so that rather than losing the energy from the beams, its re-directed where we want it. This produces a bright beam that can aim wherever we please. We can now control and predict what the plasma does, quite accurately."

Unlike the Empire, the team is harnessing this ability for good and not evil. While successfully combining lasers into a single powerful beam demonstrates the fundamental physics underpinning the Death Star's technology, the non-fiction application has no relationship to planet-destroying weapons. LLNL's plasma beam combiner will enable the creation of laser beam intensities and energies that are beyond what is currently possible. The new physics regimes that can be explored with such a beam promise to be ripe with new discoveries and lead to progress in LLNL's work on advanced X-ray sources.

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Abstract

CI3.00005	A Plasma Based Beam Combiner for Very High Fluence and Energy
Session	HED 2:00 PM–5:00 PM, Monday, October 23, 2017 Room: 103ABC