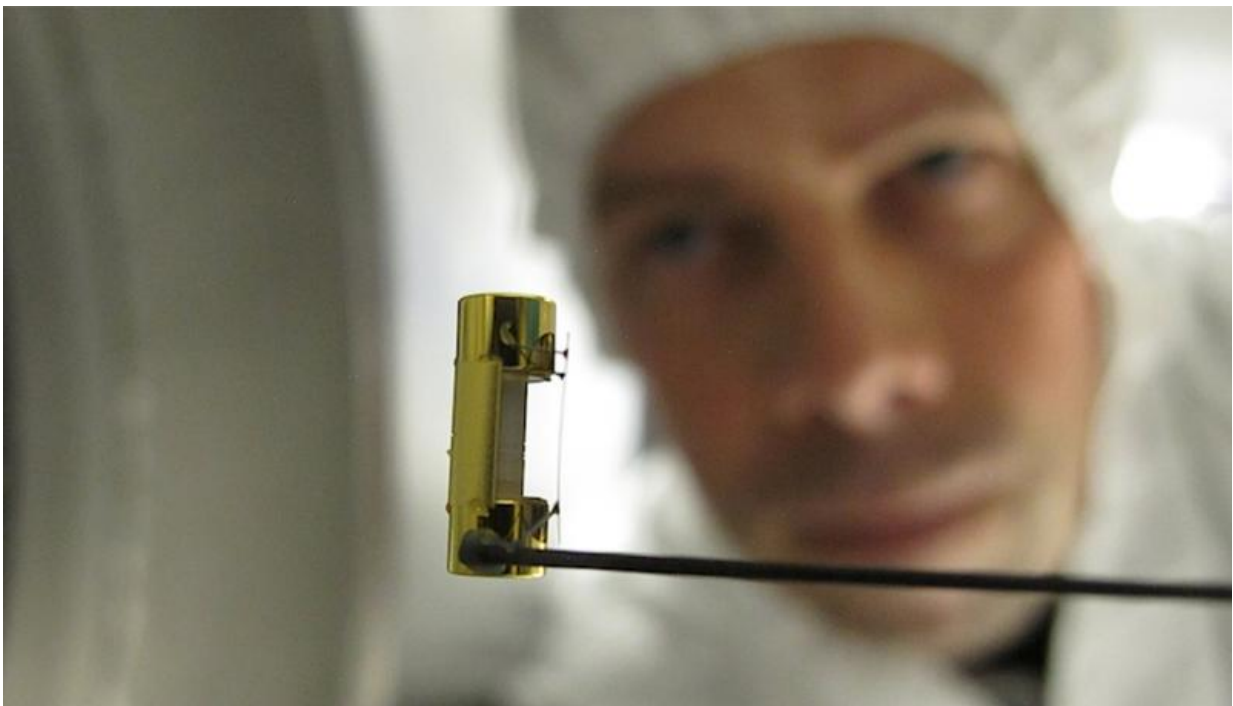


Researchers explore turbulent mix models used in high energy density and inertial confinement fusion

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Cryogenics operator John Cagle mounts a target on the National Ignition Facility (NIF) target positioner for an experiment. An area backlighter disc is seen on-edge on the right of the assembly. The front of the target is covered with a gold shield with a diagnostic slit.

Scientists from Los Alamos National Laboratory ([link is external](#))

(LANL) are leading an experimental campaign on the National Ignition Facility (NIF) designed to further understand turbulent mix models used in both high energy density (HED) and inertial confinement fusion (ICF) experiments. NIF is the only facility with the energy and shot-to-shot reproducibility needed for the experiments.

During shots using what's known as the "shock/shear" platform, NIF fires 300 kilojoules of laser energy at each end of a target comprised of two half-hohlraums to produce shock waves from opposite ends of a foam-filled shock tube. These waves turn the foam into plasma and allow the shocks to travel and create a counter-propagating shear mixing effect across a metal foil.

The target has evolved over time—different experiments have used titanium, copper, aluminum and roughened aluminum, and more materials are to come—but they all have one thing in common: each experiment enhances understanding of turbulent mix models in the HED regime. These models, developed and calibrated by LANL using hydrodynamic test data from the 1980s through the present, are now being examined through the lens of the shock/shear HED experiments to see how the data matches up to more extreme conditions.

"We have created a system that reproduces instability features similar to those of traditional hydro experiments that have not previously been seen in HED experiments," said LANL scientist Kirk Flippo, the lead experimental investigator. "This kind of experiment is rapidly evolving our understanding and we've discovered a lot of behaviors that we didn't expect."

This enhanced understanding and refined data is vital for ICF. According to Flippo, it has become increasingly clear that ICF capsules experience some kind of mix as they are imploding.

"Some of the outstanding issues in ICF are how does the capsule mix, how does this play into the degradation of the yield and how does it affect ignition," he said. "It's important for us to make sure that when we run a code to model an ICF implosion, we get all of the details correct. These experiments will help us quantify precisely how much of an effect this type of shear mixing has."

Shock/shear experiments initially were fielded on the OMEGA Laser at the University of Rochester's Laboratory for Laser Energetics, but due to the limited volume that could be driven, the experiments experienced boundary effects. The LANL project manager, scientist John Kline, believed the platform was mature enough to be deployed on NIF and pushed hard for its implementation. Kline knew that by scaling the experiments up to NIF energies, the researchers would be able to take advantage of larger volumes to eliminate the edge effects and do the experiments they wanted to do.

"We cannot do experiments in this way anywhere but at NIF," Flippo said. "In the regimes that we are in at NIF, the experiment behaves much more like a traditional hydro experiment and scales like a hydro experiment would scale."

Data from the NIF experiments already has been used by the campaign's principal investigator, LANL scientist Forrest Doss, to refine the way the model is implemented in the code—producing a direct, immediate impact. But the work isn't complete just yet.

"Now that this platform is available, and has been shown to produce really nice data, we can start modifying it by changing the shock velocities, changing the materials or foams and using different shocks," Flippo said. "This platform has infinite variation and infinite complexity."

Provided by Lawrence Livermore National Laboratory

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