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TEN TIMES MORE DATA FOR SHOCK-PHYSICS EXPERIMENTS

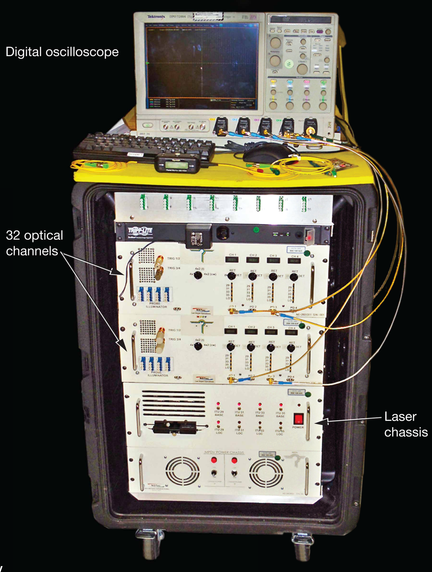
The multiplexed photonic Doppler velocimeter (MPDV) is a portable optical velocimetry system developed by National Security Technologies, LLC, with assistance from Livermore. For years, scientists conducting shock-physics experiments were limited to measuring sudden velocity increases at only a few discrete points on a target's surface. Thanks to the development of MPDV, scientists are routinely recording 96 channels of optical velocity data at a fraction of the former cost to acquire data from just a few channels.

Beat Frequency a Matter of Subtraction

MPDV is an optical velocimeter, a group of noncontact diagnostics that measure the velocities of explosively driven metal surfaces in single-shot shock-physics experiments. These surfaces may be driven to kilometer-per-second velocities in less than a billionth of a second. MPDV is a significant improvement over photonic Doppler velocimetry (PDV), which was pioneered by Livermore's Ted Strand. PDV is based on determining the "beat frequency," the difference in frequency between two waves, in this case, the difference in frequencies between a reference laser and the Doppler-shifted light reflected from a moving surface. Although highly reliable, PDV cannot economically provide the many dozens of simultaneous measurements needed to improve physical understanding and experimental accuracy in some stockpile stewardship experiments. In particular, scientists performing hydrodynamics experiments requested a more portable and cost-effective diagnostic system that could record more than 100 points of optical velocimetry data.

More Information at Reduced Cost

In response to the experimenters' requests, the MPDV development team increased the data-recording capacity of PDV by nearly an order of magnitude and reduced the cost per data channel fivefold. Built entirely from commercially available components, MPDV incorporates frequency- and time-division multiplexing to provide increased channel count, simultaneously measuring up to 32 discrete surface velocities onto a single digitizer.



A compact multiplexed photonic Doppler velocimetry (MPDV) system includes a 20-gigahertz digital oscilloscope for recording data, 32 optical channels for simultaneously measuring 32 discrete surface velocities, and a chassis for powering the lasers that are used to determine the beat frequency—a combination of the Doppler-shifted light from one laser and the reference light from another laser.

While traditional PDV cannot discern between forward- and backward-traveling surface motion, MPDV measures the direction of travel. Scientists can make hundreds of velocity measurements between 0.001 to 30 kilometers per second that are both economical and logistically feasible. MPDV improves the ability to predict shock and material conditions and allows detailed comparisons between computational and experimental results. In this way, the technology helps ensure the safety and security of the nation's nuclear stockpile. The new capability also has potential low-velocity commercial applications such as noncontact measurements of vibration.

The National Security Technologies development team for MPDV: (from left) Ed Daykin, David Holtkamp (Los Alamos National Laboratory), Howard Bender, David Esquibel, Ted Strand (Lawrence Livermore National Laboratory), Araceli Rutkowski, Cenobio Gallegos, and Carlos Perez.

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For more information: www.llnl.gov

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