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IMPROVING LASER BEAM PERFORMANCE AND OPERATIONAL RELIABILITY

LEOPARD is a laser energy optimization system that precisely adjusts the radiant distribution, or intensity profile, from a laser beam to extract the maximum amount of energy from the amplifiers while preserving a high degree of reliability among the optical components. To enhance the performance and operability of the National Ignition Facility (NIF) and other laser facilities as well as meet the requirements of future laser-driven fusion power plants, a Livermore team in collaboration with Meadowlark Optics in Colorado developed the LEOPARD system, which is now operational on NIF.

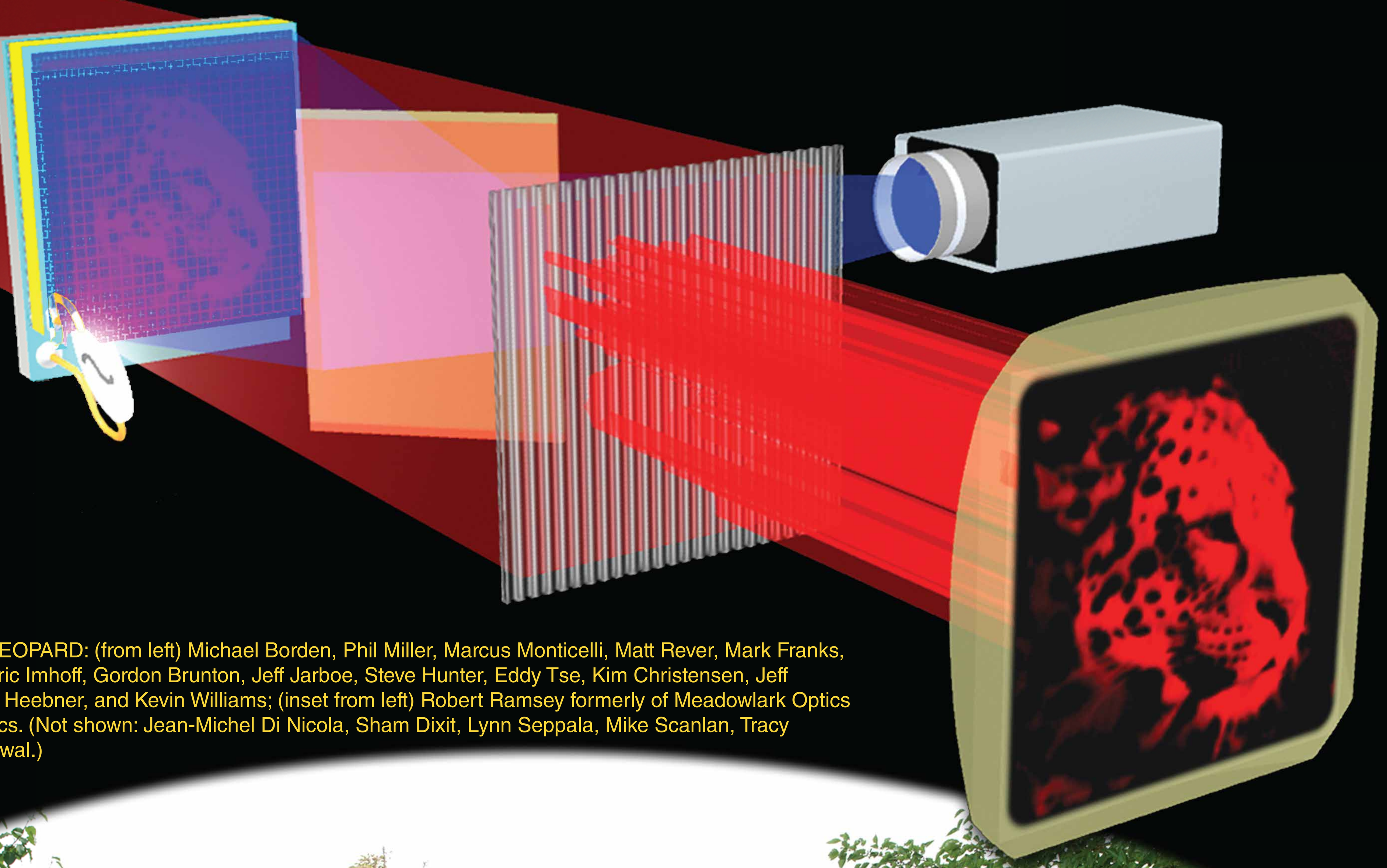
Hybrid Design Provides Unique Capability

At the heart of LEOPARD is a hybrid design consisting of two liquid-crystal-based spatial light modulators. The first modulator is of the type found in conventional liquid crystal display (LCD) projectors; that is, it is pixelated and can be electrically controlled or addressed with a digital image. The second modulator is unconventional in that it is nonpixelated, analog, and optically addressed by the images projected from the first. Both contain twisted nematic liquid crystal molecules used in most LCD TVs, monitors, and projectors. To preserve the existing NIF laser-beam quality while adding the capability to create smooth beam shapes, the team customized the second modulator in the hybrid design. This modulator, called an optically addressable light valve (OALV), contains a liquid crystal cell, but unlike a conventional, pixelated liquid crystal cell matrix, it consists of only a single, giant pixel. Because OALV is nonpixelated and analog, it is well suited for creating ultrasmooth laser beams with arbitrary shapes.

LEOPARD's Spots

The LEOPARD capability added to NIF's 192-beam laser system enables operators to introduce obscurations, or "blockers," upstream, which shadow flaws downstream in the final optics. In preparation for each high-energy firing sequence, the laser beam is first imaged at low power and overlaid with inspection images of the final optics. An automated control system then decides whether the beam fluence needs to be reduced in areas containing flaws that could grow with repeated laser shots. Temporarily shadowing a flaw buys time, enabling the continued operation of NIF until the optic can be removed, refurbished, and reinstalled. Many other high-energy lasers worldwide could be optimized for increased extractable energy and achieve greater operational lifetimes using LEOPARD.

LEOPARD (laser energy optimization by precision adjustments to the radiant distribution) allows a detailed intensity profile to be encoded in a high-power laser beam with no pixelation artifacts. An incoherent light source (purple) illuminates a photoconducting layer with a pixelated image. The layer is adjacent to and controls the transmission of a single large liquid crystal in a process that smooths any jagged edges. As the coherent laser light (red) passes through, it picks up the smooth intensity profile (in this case, the face of a leopard). (Rendering by Clayton Dahlen.)



Livermore development team for LEOPARD: (from left) Michael Borden, Phil Miller, Marcus Monticelli, Matt Rever, Mark Franks, Nan Wong, Michael Taranowski, Eric Imhoff, Gordon Brunton, Jeff Jarboe, Steve Hunter, Eddy Tse, Kim Christensen, Jeff Wilburn, Edward Von Marley, John Heebner, and Kevin Williams; (inset from left) Robert Ramsey formerly of Meadowlark Optics and Tom Baur of Meadowlark Optics. (Not shown: Jean-Michel Di Nicola, Sham Dixit, Lynn Seppala, Mike Scanlan, Tracy Budge, Larry Smith, and Abdul Awwal.)

Lawrence Livermore National Laboratory

For more information: www.llnl.gov

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