Lawrence Livermore National Laboratory

2010 R&D 100 Award Winner

MEASURING EXTREMEMLY BRIGHT PUSLES OF LIGHT

X-ray free-electron lasers (XFELs) are tunable, high-power sources of short photon pulses. A new detector, called the XFEL energy monitor, measures this pulse-by-pulse energy in real time without being damaged by the beam and with minimal effect on beam quality.

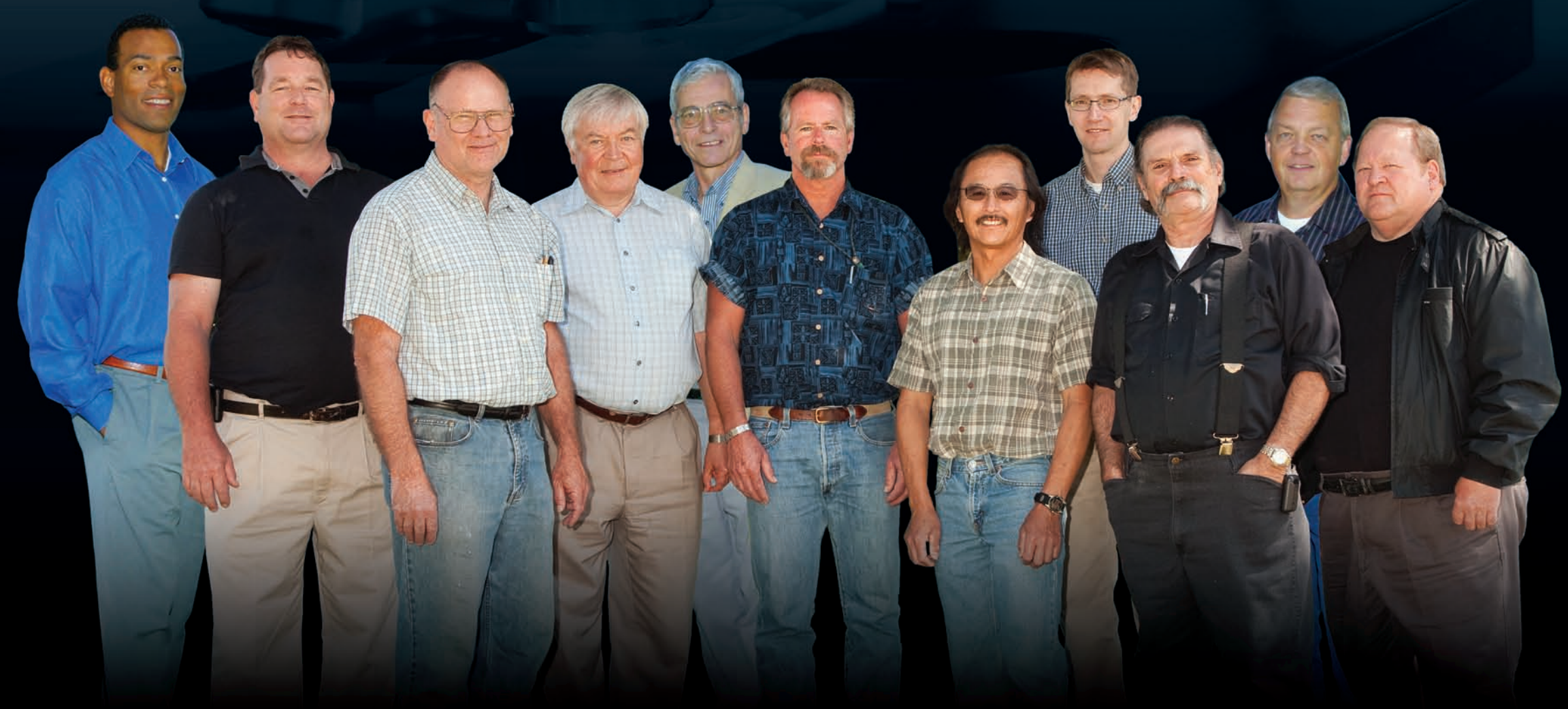
Revealing the Unseen

X rays are useful for examining all kinds of matter, from DNA, bones, and lungs to the materials comprising stars. If x rays are sufficiently intense and produced in ultrashort pulses, they can reveal information about dynamic processes in many states of matter, such as solid, liquid crystal, and extremely dense plasma.

Instrument Is Not Intrusive

Studying how matter interacts with x rays requires continuous, detailed characterization of the ultrahigh-intensity photon beam, with minimal intrusion. Knowledge of beam parameters such as photon flux (the number of photons arriving at a point) is essential because the parameters determine how the beam interacts with the experimental sample. With the XFEL energy monitor, the most energetic x-ray beams ever produced can be well characterized. XFELs offer significant promise for scientific and medical breakthroughs by capturing the motion of molecules and even atoms.

(top) At the Linac Coherent Light Source facility, new energy monitors installed on the x-ray free-electron laser nonintrusively measure photon beam energy. (inset) The x-ray energy monitor is part of the photon diagnostic and conditioning suite.



Energy monitor development team: (from left) Donn McMahon, Mark McKernan, Richard Kemptner, Dmitri Ryutov, Richard Bionta, Daniel Behne, Keith Kishiyama, Stefan Hau-Riege, Vasco daCosta, Marty Roeben, and Robert Geer. (Not shown: Elden Ables, Stewart Shen [now retired], Alan Wootton [formerly of Livermore], Jacek Krzywinski [SLAC], and Marc Messerschmidt [SLAC]).

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