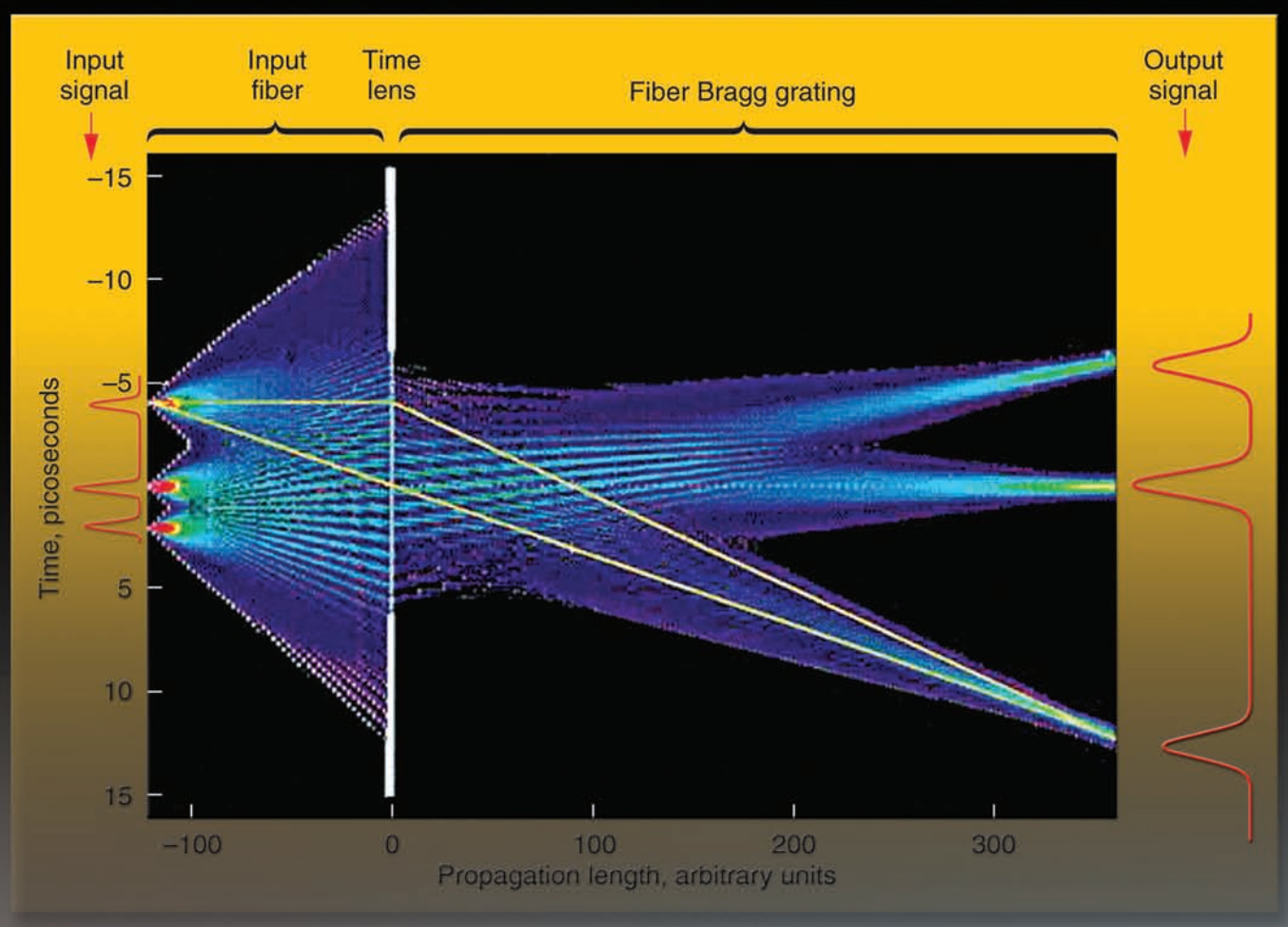
Lawrence Livermore National Laboratory

2009 Award Winner

Capturing Waveforms in a Quadrillionth of a Second

The new FemtoScope is a “time microscope” that is attached to the front end of a conventional recording instrument to radically enhance its performance. With ultrafast resolution and nearly endless recording length, the FemtoScope can uncover waveform data with peaks and valleys never before detectable.



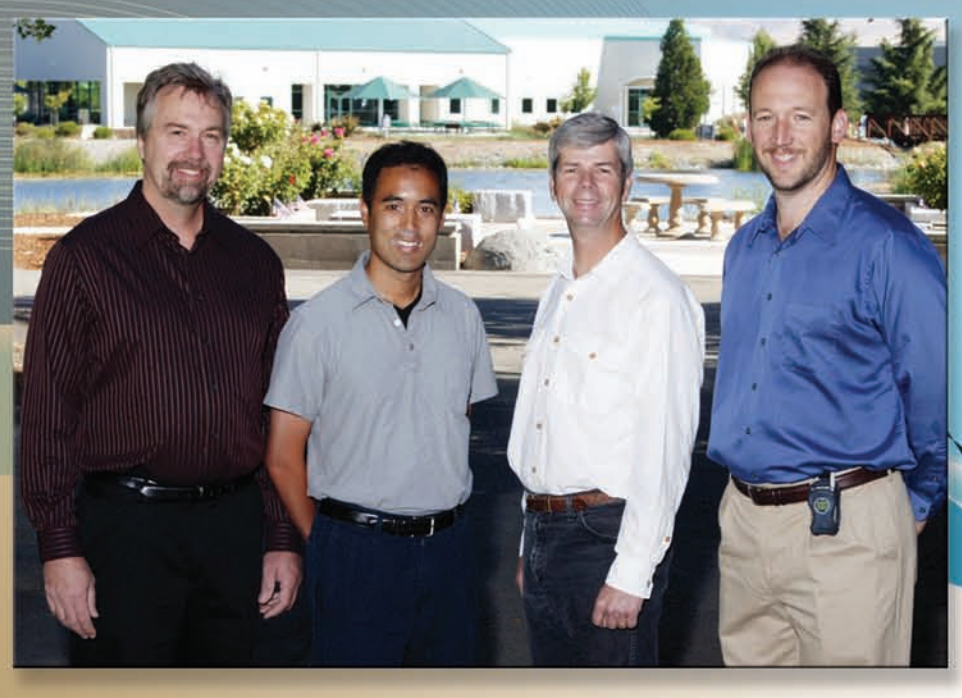
A false-color image shows three pulses propagating through a temporal imaging system with a magnification of three times. Color here represents intensity or brightness, with red being the brightest. The simulation shows how three optical pulses occurring in a 6-picosecond time frame can be “time magnified” so that, at the output, they occur over 18 picoseconds.

Slowing Down the Signal

The FemtoScope uses ultrafast processing of waveforms, improving the dynamic range of these instruments and their time resolution from tens of picoseconds (trillionths of a second) to hundreds of femtoseconds (quadrillionths of a second). The FemtoScope’s powers of time magnification can reveal the peaks and valleys in a 1-picosecond signal not detectable by a standalone oscilloscope or streak camera. Moreover, the FemtoScope can record single-shot events and does not require repetitive waveform sampling. When combined with an optical streak camera, it produces an instrument with a 20-times increase in temporal resolution and a 30-times increase in dynamic range, resulting in an overall improvement of 600 times compared with the performance of the streak camera alone.

Emerging Needs

The FemtoScope represents a fundamental paradigm shift in high-speed imaging technology. As researchers work to improve their understanding of physical phenomena, they will need to examine processes on shorter time scales. The FemtoScope will be an invaluable tool for collecting detailed dynamic data at faster temporal resolution.



Livermore development team for the FemtoScope (from left): Bryan Moran, Vincent Hernandez, Alex Drobshoff, and Corey Bennett.

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