SES10-2010-000012

Abstract for an Invited Paper
for the SES10 Meeting of
the American Physical Society

Simple Devices for Measuring Complex Laser Pulses

RICK TREBINO, Georgia Institute of Technology

Shortly after the development of the first lasers, researchers learned a valuable lesson: lasers were not very useful if their beam spatial quality was poor. Fortunately cameras could measure the beam quality, which then rapidly improved. Just as lasers must be smooth and stable in space, they must also be so in time. Fortunately, electronic detectors and oscilloscopes could measure the laser intensity vs. time. Until, that is, researchers began to generate pulses nanoseconds and even picoseconds long, too fast for these devices. It was not until pulses reached fs lengths that complete intensity-and-phase measurements became possible. Frequency-Resolved Optical Gating (FROG) nicely solved the problem, yielding the pulse intensity and phase vs. time for arbitrary fs pulses. Additional simple techniques can measure fs pulses' complete intensity and phase vs. time and space. Indeed, fs light pulses are now arguably the best characterized type of light, and they are the basis of ultrastable metrology. But what about ns pulses? In the process of opening up new regimes of science, the measurement of much longer—and far more common—intermediate length pulses was forgotten. As a result, ns pulses from Q-switched solid-state lasers, pulsed diode lasers, and high-power fiber lasers and amplifiers are often far from ideal in time and no one knows precisely what their distortions look like. Yes, electronic detectors and oscilloscopes have become faster, but such exotic devices are expensive and fragile and only yield the intensity and not the phase. Measuring ns pulses has proved much more difficult than measuring fs and ps ones. Happily, we have recently demonstrated a novel FROG for measuring ns pulses. The main challenge was generating a ns delay range on a single shot, a problem we solved in a novel manner: by tilting the input pulse by 89.9 degrees. This novel device completes the many-decades-old task of developing simple techniques for measuring essentially all laser pulses.