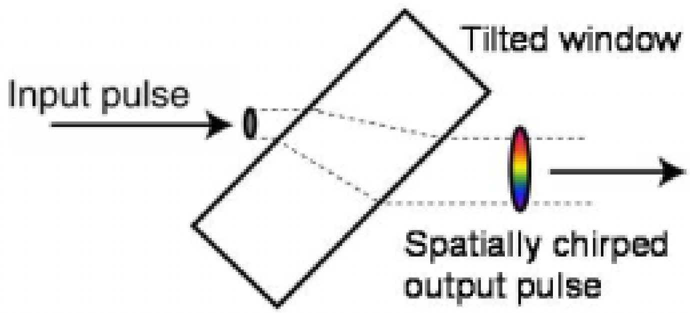
307 Shire Way
Lawrenceville, GA 30044
+1.404.547.9267
www.swamoptics.com

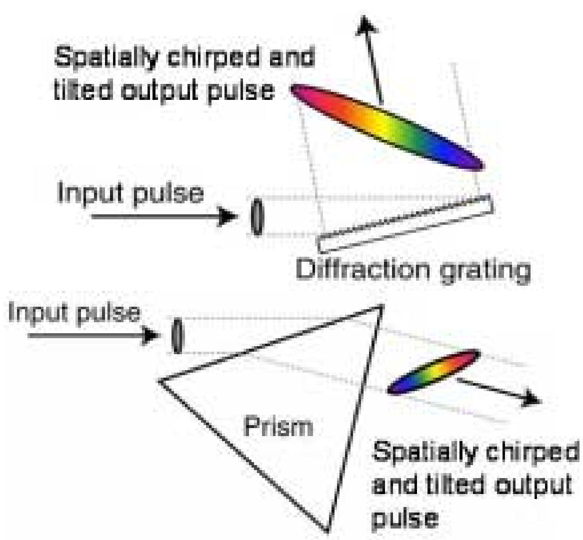
MEASURING SPATIO-TEMPORAL PULSE DISTORTIONS

Ultrashort laser pulses lead difficult lives. They're routinely dispersed, stretched, amplified, and eventually compressed to, we hope, their shortest possible width. Whether from an oscillator, a regen, or a high-power amplifier, ultrashort pulses undergo massive manipulations to become so short. But at what price? *Spatio-temporal distortions*.

The two most important and common spatio-temporal pulse distortions are *spatial chirp* and *pulse-front tilt*. A beam with spatial chirp has color varying spatially across the beam. A simple plane-parallel window will introduce spatial chirp if tilted.



Pulse-front tilt is exactly what it sounds like. The very dispersion that is so useful for stretching and compressing pulses also causes pulse-front tilt (as well as spatial chirp) in the pulse if alignment of the stretcher or compressor is not perfect. The figures below show that dispersive elements, such as prisms and gratings, introduce these distortions.



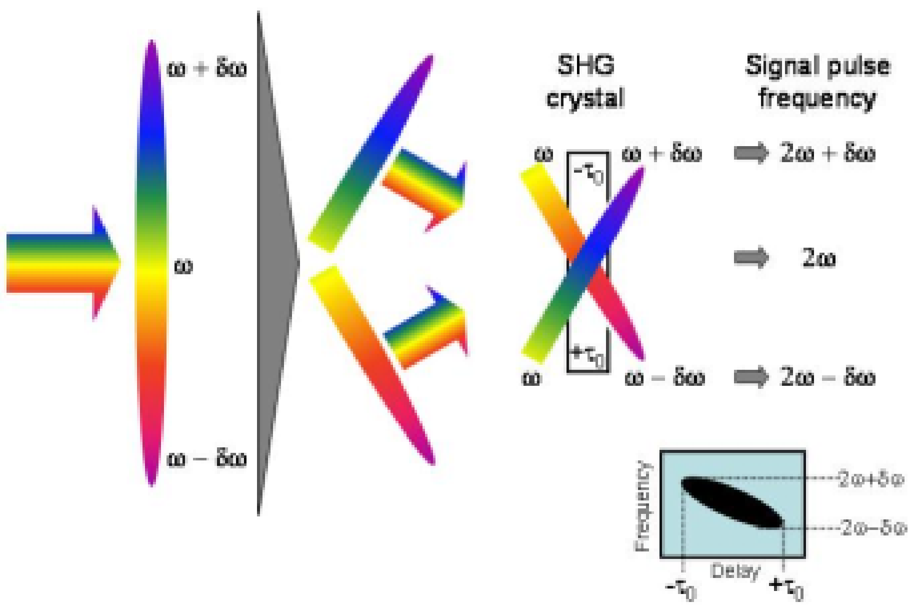
Slightly unequal prism or grating incidence angles in a compressor cause both spatial chirp and pulse-front tilt. A slightly diverging or converging beam entering the device will also. And a slightly wedged output mirror (required to avoid feedback into the laser) will also.

We have discovered that most ultrashort pulses are contaminated with both spatial chirp and pulse-front tilt. Amplified pulses are especially distorted.

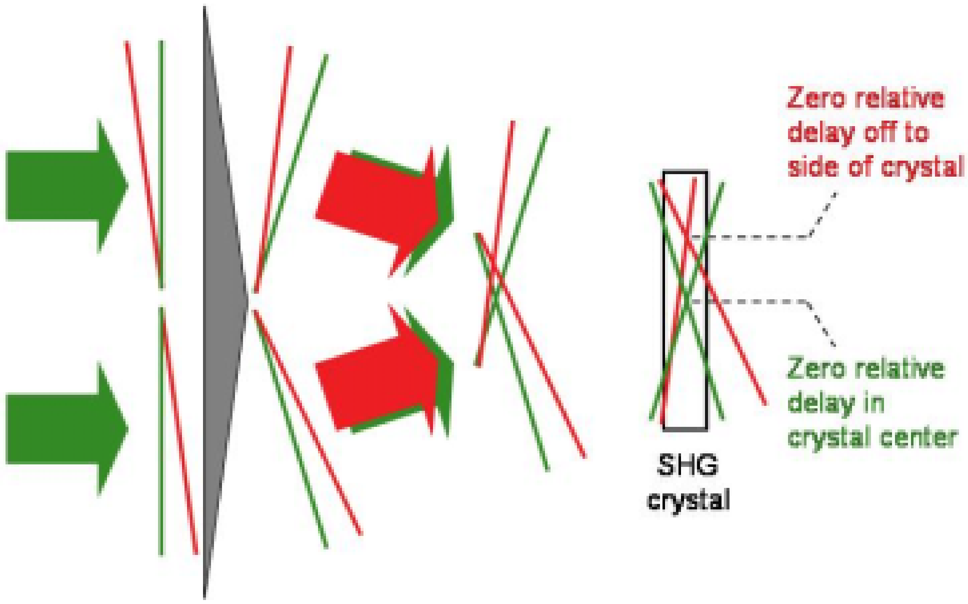
Unfortunately, no quantitative diagnostic has been available for these distortions. Research devices have been proposed, but they are so complex that they are more likely to introduce these distortions than to measure them!

Remarkably, GRENOUILLE measures both of these distortions quantitatively and accurately. And it does so without additional components or cost. The GRENOUILLE trace contains all the required information!

Spatial chirp causes the GRENOUILLE trace to tilt by twice the spatial chirp.[1]



Pulse-front tilt displaces the trace along the delay axis in direct proportion to the pulse-front tilt.[2]



Indeed, GRENOUILLE is the most accurate device ever developed for pulse-front tilt![2]

With GRENOUILLE, you can simply observe the measured trace to see these distortions, or, better, use the VideoFROG software, which, not only rapidly retrieves the pulse intensity and phase, but also automatically computes both of these spatio-temporal distortions for all pulse measurements using GRENOUILLE.

REFERENCES

1. S. Akturk, M. Kimmel, P. O'Shea, and R. Trebino, *Measuring spatial chirp in ultrashort pulses using single-shot Frequency-Resolved Optical Gating,* Opt. Expr., **11**(1), p. 68-78, 2003.
2. S. Akturk, M. Kimmel, P. O'Shea, and R. Trebino, *Measuring pulse-front tilt in ultrashort pulses using GRENOUILLE,* Opt. Expr., **11**(5), p. 491 - 501, 2003.

ABOUT SWAMP OPTICS

Founded in 2001, Swamp Optics offers cost-effective quality devices to measure ultrashort laser pulses. The company specializes in frequency-resolved optical gating (FROG), a method for measuring the time-dependent (or, equivalently, frequency-dependent) intensity and phase of an ultrashort pulse. FROG is rigorous, general, and relatively simple to implement; it has become a very successful technique, with many accomplishments.

Swamp Optics' primary products are GRENOUILLEs and custom FROG devices, the most robust, compact, and simple units available to measure full laser pulse intensity and phase, including the beam spatial profile and spatial chirp.

For more information, visit us on the Web at www.swampoptics.com.