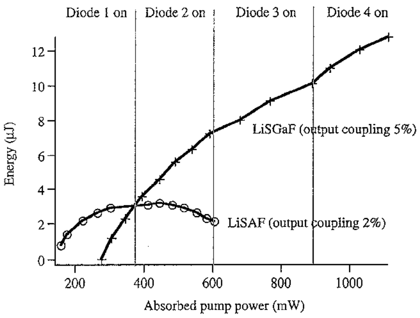
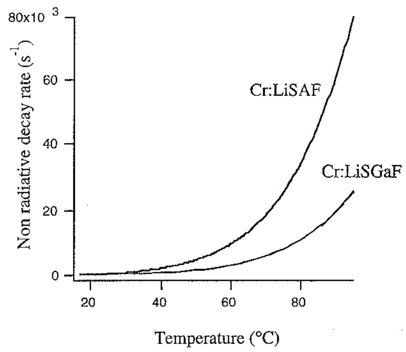


CThN3 Fig. 2 Energy per pulse for Cr:LiSAF and Cr:LiSGaF at 10 kHz repetition rate.



CThN3 Fig. 3 Decay rate induced by thermal quenching as a function of temperature for Cr:LiSAF and Cr:LiSGaF.

In Ref. 5 we have shown that the thermal quenching can induce a rolloff of the small signal gain as the pump power increases. As the gain and the energy per pulse in *Q*-switched operation are bound together, we can attribute the bad performances of Cr:LiSAF to higher quenching of fluorescence.

In conclusion, Cr:LiSGaF is more suitable than Cr:LiSAF for the production of tunable pulses at high repetition rate under diode pumping.

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CThN4 3:15 pm

Laser-pumped Cr:LiSAF zig-zag laser

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The key to scaling lasers to high average power while maintaining good optical quality is the thermal control of the lasing medium. As with many solid-state crystals, Cr:LiSAF has poor thermal properties. Our approach is to use thin slabs of the crystals immersed in a flowing index matched fluid that acts as a thermal reservoir. A schematic diagram illustrating the design approach is shown in Fig. 1. A simple stable optical cavity is pictured. The cell is made of fused quartz with a 4-mm-wide flow channel that is 20-mm high and 165-mm long. A 15 mm × 157 mm × 1.5 mm slab is positioned in a matching fluid that has an index of refraction, $n = 1.43$, a good match to quartz and Cr:LiSAF (5.5% doped). Circulating laser flux is coupled into and out of the cavity through quartz prisms. Single sided optical pumping at 590 nm from a flashlamp-pumped dye laser is used.

A stable optical cavity was set up without *Q*-switch control. The laser output occurred during the excitation pulse and consisted of several relaxation oscillation pulses separated by over 1 μs. Measurements demonstrated total energy output of 1.8 J with an intrinsic photon efficiency of 35%. The Cr:LiSAF excited volume was 1.2 cm^3 giving a specific energy output from the crystal of 1.5 J/cm^3. This is a 50% increase in specific energy output from Cr:LiSAF compared with previous reported results that used flashlamp-pumped Cr:LiSAF rods.[1]

The Cr:LiSAF laser was tuned from the peak of the gain at 840 nm to near 900 nm. The bandwidth for the free running laser was ≤7.5 nm. The output dropped by less than half over this wavelength range. When a 5000 GHz étalon was inserted into the cavity the bandwidth was reduced to about 0.4 nm. The addition of the étalon reduced the output by about one third.

A computer model of the Cr:LiSAF laser was also developed and used to compare with the measurements. Gain measurements were made at 840 nm in support of the computer modeling. Using our measured gain, good qualitative and quantitative agreement between model and experiment was achieved.

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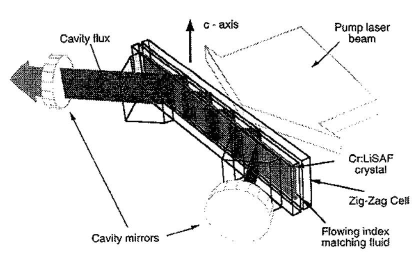

CThN4 Fig. 1 Three-dimensional perspective drawing of the zig-zag laser showing key features.

CThN5 (Invited) 3:30 pm

Development of advanced solid-state lasers for lidar

Richard A. Schwarz, Andrew Finch, David Welford, Peter F. Moulton, Glen A. Rines,* *Schwartz Electro-Optics Inc., Research Division, 45 Winthrop St., Concord, Massachusetts 01742*

During recent years there has been a growing interest in lidar systems for applications such as pollution monitoring, atmospheric science, and remote detection of chemical and biological agents. This has led to an increased need for sources that not only provide the necessary laser performance characteristics, but are sufficiently compact and robust for field use. We have begun the development of both aerosol lidar and DIAL systems and have addressed the need for practical fieldable hardware by basing both systems on a compact, ruggedized, Nd laser. Presented here is an overview of the lidar technology based on this laser.

The Nd laser head (Fig. 1) is a *Q*-switched, flashlamp-pumped, Nd:YLF oscillator/amplifier system in a compact resonator design. The optical head is 5 × 6 × 17" in size and weighs 16 pounds. It produces 700 mJ at up to 30 Hz at 1053 nm, in a 15-ns pulse (FWHM). All optics are hard mounted and final alignment is accomplished with use of Risley wedges. The power supply and closed-loop cooling system are shock mounted in hard-rack cases for field use.

To provide eyesafe operation beyond 1500 nm an optical parametric oscillator (OPO) can be pumped by the Nd:YLF laser. For the aerosol lidar application, we have developed a miniature ring KTP OPO module[1] that mounts inside the compact Nd:YLF laser head and yields 240 mJ of 1550-nm radiation at up to 30 Hz. This module is pre-aligned with hard-mounted optics (Fig. 2). An eyesafe source of this design is currently being integrated into a complete fieldable aerosol lidar system with a 12-cm transmit aperture and a 40-cm receiver aperture. For mid-IR (2–5 μm) and far-IR (8–11 μm) DIAL of molecular species, this pump laser may be used with a recently demonstrated KTA/CdSe tandem OPO concept.[2]

For DIAL applications in the near-IR (700–1000 nm), we have developed injection-seeded, unstable-resonator Ti:sapphire lasers pumped by the frequency-doubled output of the Nd:YLF laser.[3] Via harmonic generation, these Ti:sapphire sources also yield broadly tunable visible and UV radiation[4] for an extended range of species detection. Recent work has demonstrated advances important for these DIAL systems including development of a compact, ruggedized, injection-seeded Ti:sapphire module (5 × 12 × 24") and rapid on-line/off-line tuning (60-nm steps in 1.2 ms). Also under development are active injection locking schemes that are wavelength invariant (i.e., suitable for widely tunable sources) and can work in high vibration environments.[5]

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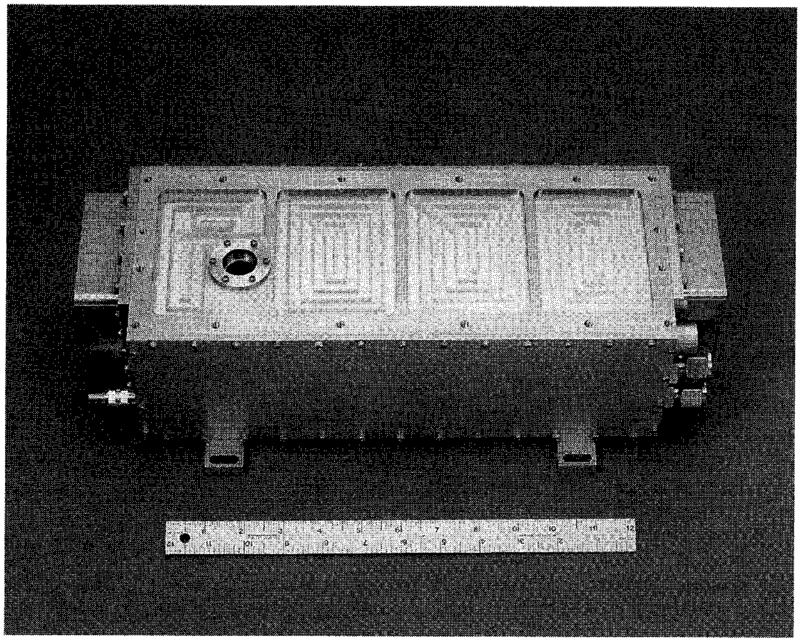
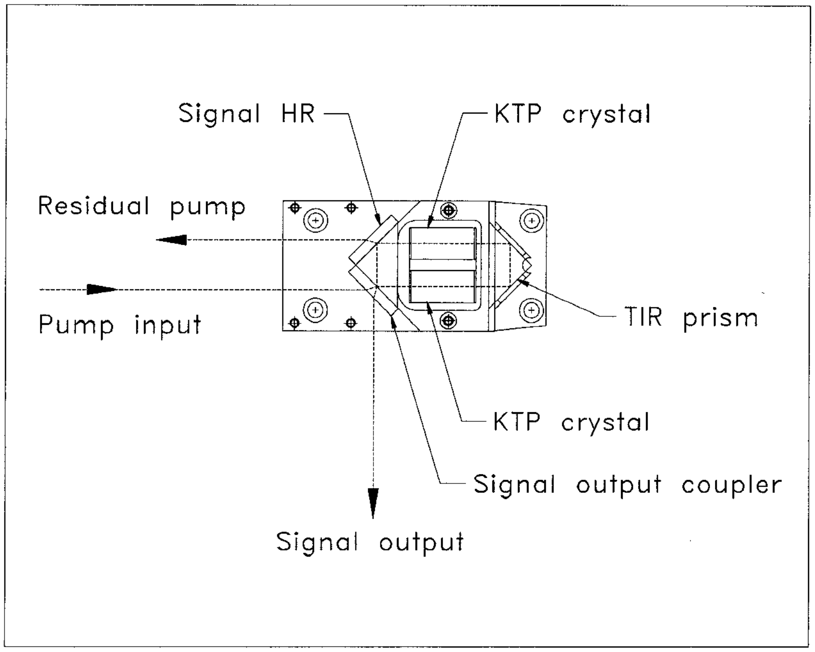


CThN5 **Fig. 1** Compact, ruggedized Nd:YLF laser head.



CThN5 **Fig. 2** Ring KTP OPO module schematic.

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CThO 2:30 pm–4:00 pm
Room 318

Ultrafast Beam Propagation

Eric W. Van Stryland, *University of Central Florida, Presider*

CThO1 2:30 pm

3D spatial soliton-like propagation and spectral continuum generation

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The spectral continuum obtained when an intense ultrashort pulse is focused in a piece of material has been used for over 20 years[1] but many of its characteristics are still unknown. We will present here a study of some of its spatial properties. The experiments were carried out with a high repetition rate femtosecond laser source. This sytem produces 50 fs, 800 μJ pulses around 800 nm at 1 kHz. Because of the strong spatial filtering introduced by the regenerative amplifier used in the system, the output beam is nearly Gaussian.

In a first set of experiments we showed that continuum generation is always accompanied by small scale self-focusing and filamentation. More precisely, the location of the filaments corresponds to the micromodulation of the incident beam. To demonstrate this we introduced an circular aperture on the beam in front of a 6-mm sample of BK7. The Fraunhoffer diffraction pattern on the piece of glass exhibited typical rings. The output of the sample was imaged on a screen with a magnification of 50. When the power of the input beam was increased, we observed the apparition of several filaments, perfectly located at the rings. We note that the first filaments appear on the first ring where the local intensity curvature is the highest and not at the beam center where the intensity is the highest. Using interferometrical measurements, we found that neighbor filaments are temporally and spatially phase locked over more than 10^5 pulses.

In a second experiment we focused our attention on a single filament propagation. We used a piece of Ti:sapphire polished on every side to create a single filament. The part of the continuum spectrum between 400 and 550 nm was absorbed by the crystal and we detected the fluorescence emitted around 800 nm. A 20× microscope objective projected an image of the filament on a CCD camera (see Fig. 1). The camera and microscope objective were translated parallel to the crystal and images of the filament were taken all along its propagation. The result is given in Fig. 2. The filament originates at the very left of the picture. After a first ~300-μm region the filament stabilize and exhibit a Gaussian-like 8 μm shape. Note that the 6-mm propagation without spreading correspond to over 10 Rayleigh lengths. The first 300 μm are particular since the filament sits on a large pedestal (see Fig. 3). This pedes-