Section 3
GENERATION OF SUBPICOSECOND PULSES

We reported results of a synchronously pumped dye laser using a new pumping source in LLE Review Volume 5. A frequency-

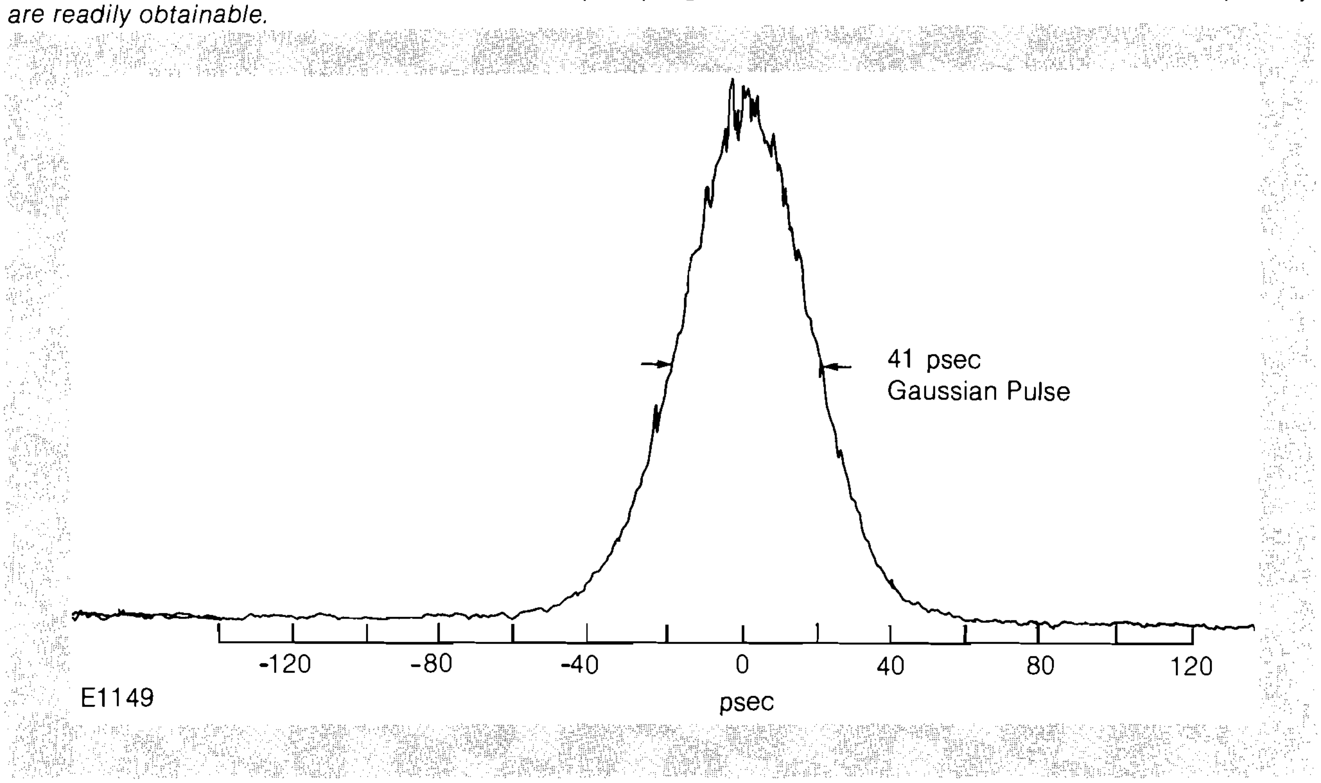

Fig. 17
Autocorrelation trace of CW Nd:YAG laser. Pulsewidths from 40 - 100 psec are readily obtainable.

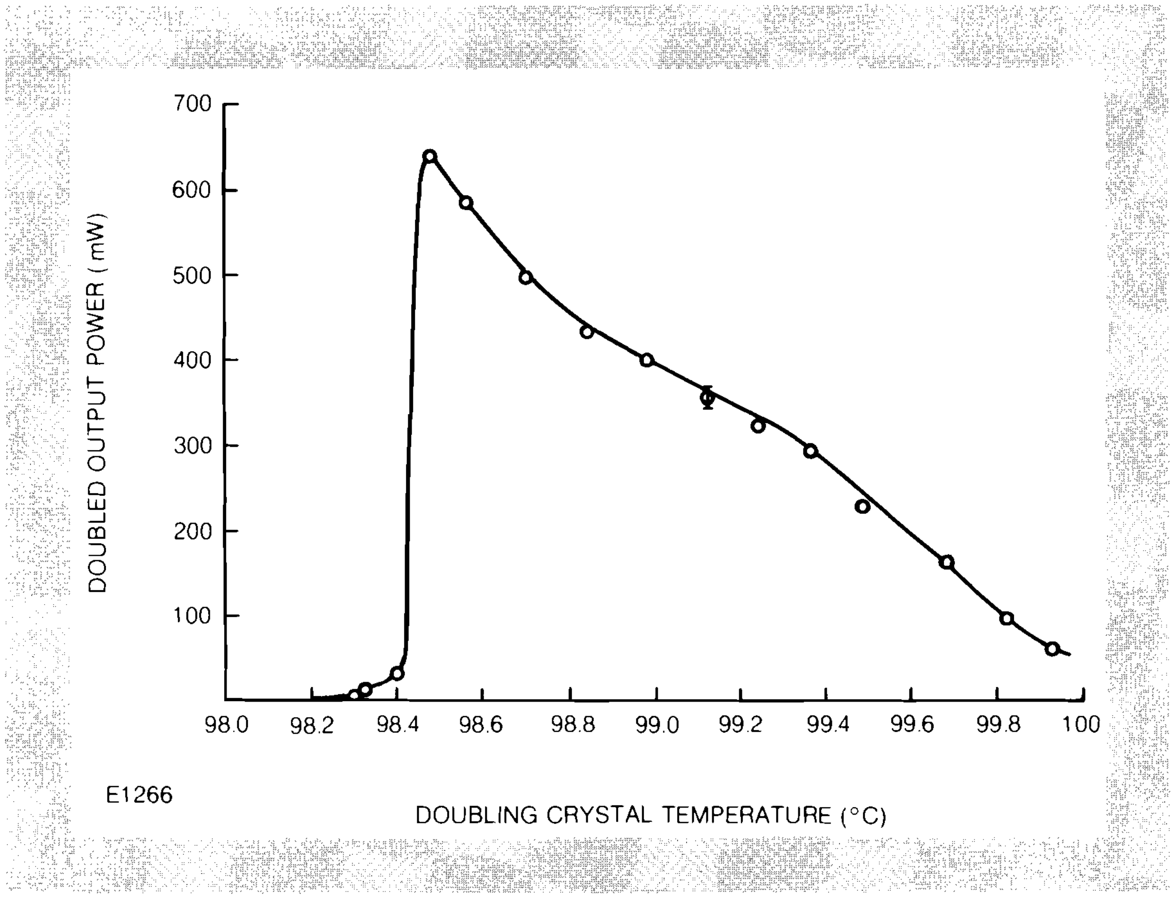

Fig. 18
Conversion efficiency curve for the barium sodium niobate frequency doubling crystal. The peculiar shape of this curve is due to self-absorption of the 0.53 μm frequency doubled output producing localized heating in the doubling region.

doubled neodymium YAG laser is used to pump a rhodamine 6G dye laser. In the previous article we reported pulses as short as 2 psec in an inadequately stabilized experimental setup. Through active and passive techniques we have reduced our sources of instability and produced pulses shorter than 300 fsec.

Many previous authors have reported on the effects of instability and cavity length mismatch on the pulsewidth in synchronously pumped dye lasers.[1,2,3] All of these illuminate the need for a stable pump laser cavity and modelocker and an ultrastable dye laser cavity.

In order to stabilize our Neodymium YAG base we mounted all of the components on a super invar rail. This eliminated any decrease in modelocking efficiency due to typical laboratory temperature variations. A high quality frequency synthesizer (Rockland 6100) was used to drive the acousto-optic (AO) modulator. Careful attention was paid to the correct angle of the AO modulator as it is directly related to the modelocking efficiency and amplitude stability of the Nd:YAG laser. Pulsewidths from 40 psec – 100 psec are obtainable from the Nd:YAG laser shown in Fig. 17.

The barium sodium niobate crystal was temperature stabilized to approximately ± 0.05° C. This variation does, however, produce a significant variation in the output intensity as one must maintain

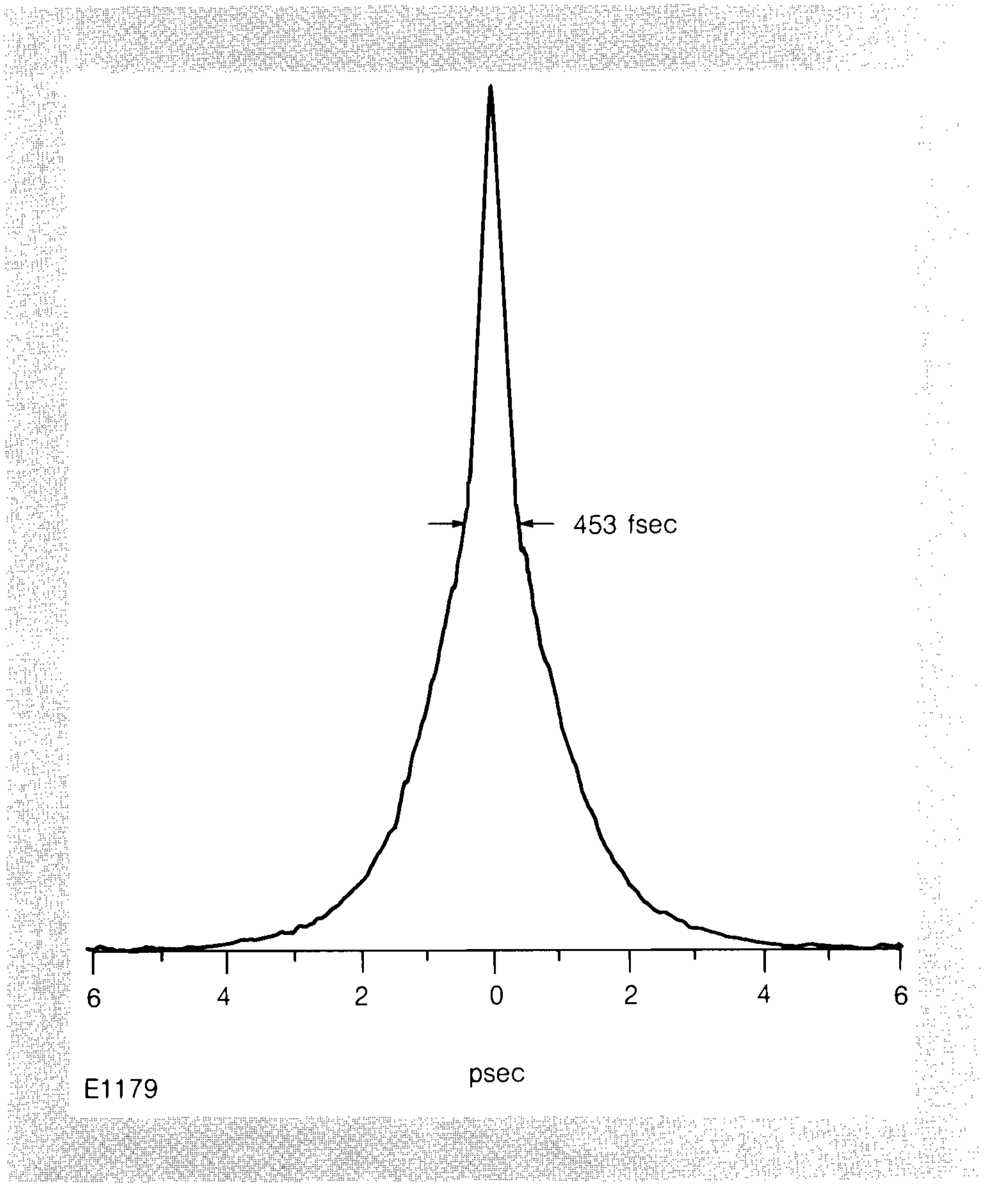

Fig. 19.
Autocorrelation trace of the rhodamine 6G laser. A pulsewidth of 450 fsec is inferred assuming a sech pulse shape.

the temperature on the slope of the efficiency curve of the $Ba_2NaNb_5O_{15}$. Figure 18 illustrates this rather peculiar efficiency curve for the doubling crystal that is due to self absorption of the 0.53 μm frequency doubled output. Absorption of the 0.53 μm radiation produces localized heating in the doubling region requiring one to maintain a lower crystal temperature for optimal efficiency at high powers than at low powers.

The dye laser cavity was also mounted on low thermal expansion super invar. A piezo ceramic crystal is mounted on the end mirror for fine tuning the dye laser cavity. Cavity length fluctuations are primarily a 200 Hz variation of 0.2 μm due to instability in the dye jet. A monomode helium-neon laser was injected into the dye laser cavity and Fabry-Perot fringes were noted as a result of reflections off the two end mirrors. By locking onto one of the fringes and feeding back an error signal to the piezo ceramic

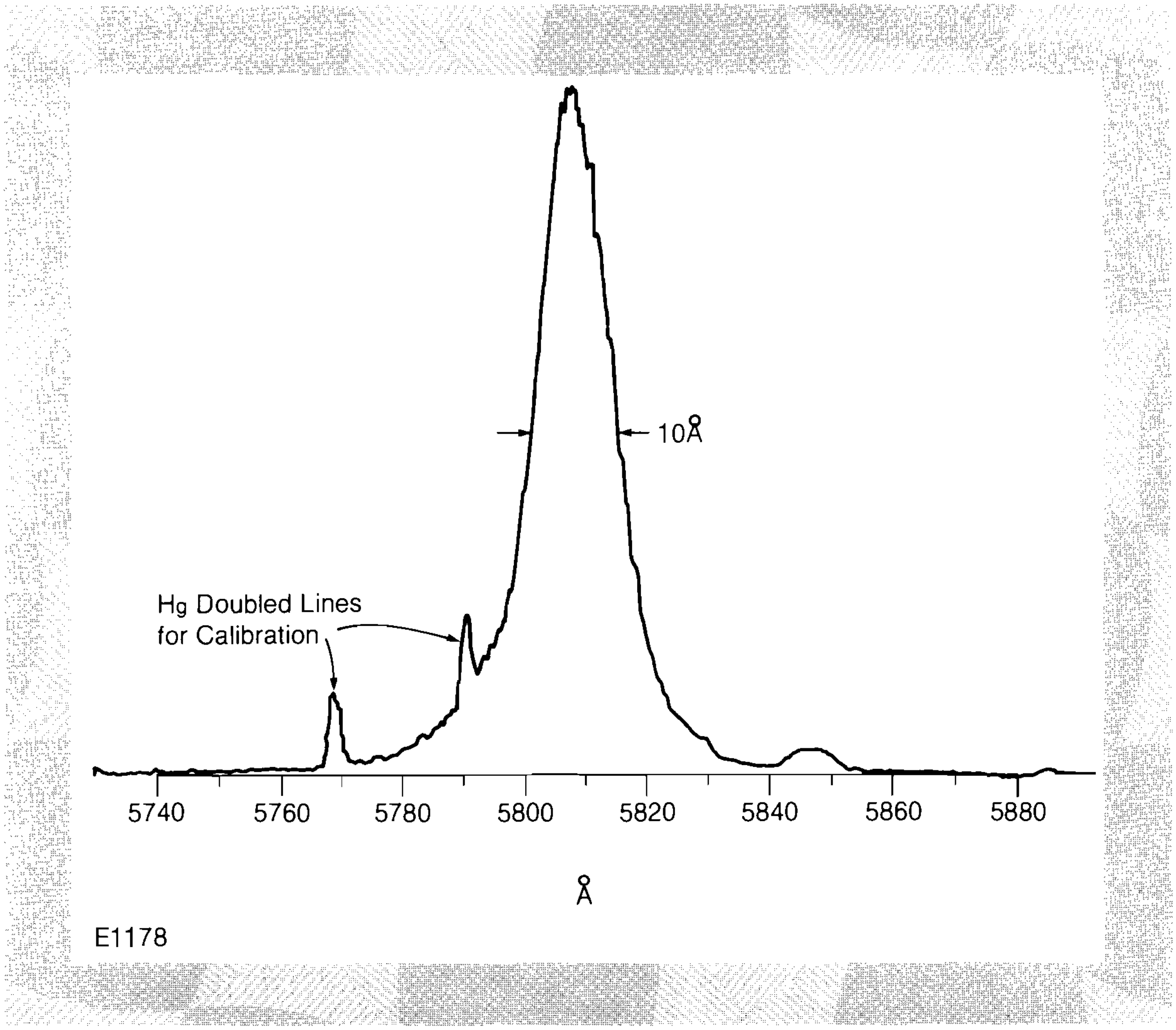

Fig. 20
Spectral output of rhodamine 6G dye laser $\Delta\lambda = 1$ nm. This output together with the pulsewidth of 450 fsec implies that our pulses are nearly Fourier transform limited.

crystal, this cavity length fluctuation was significantly reduced. This feedback did not, however, produce any shorter pulsewidths from the dye laser. As there were no bandwidth limiting elements in the cavity, this negligible improvement in pulsewidth with cavity length stabilization implies that other instabilities in our system are preventing the production of shorter laser pulses.

Through careful matching of the dye laser cavity to the Nd:YAG cavity, pulsewidths of 450 fsec are obtainable as seen in the autocorrelation trace of Fig. 19. The spectral output, as seen in Fig. 20 has a bandwidth of 1 nm indicating a nearly Fourier transform limited pulse. Cavity length detuning results in pulse shapes similar to those in Ref. 4. By adding cresyl violet to our rhodamine 6G to act as a slight saturable absorber, pulsewidths shorter than 300 fsec have been obtained.

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