Section 4
DEVELOPMENTS IN SUBPICOSECOND RESEARCH

4.A A New Picosecond Pulse Source

Subpicosecond pulse generation is currently achieved with either passive mode-locking or synchronous pumping.[1,2,3,4,5] Synchronous pumping with an argon laser pump is generally preferred because of its simplicity. Amplification of the picosecond pulse is adversely affected, however, by the lack of an accurate synchronization of the oscillator and the amplifier.

We have obtained picosecond pulses from a synchronously pumped CW Rhodamine 6G dye laser with a new pumping source. A stable CW mode-locked Nd:YAG laser is externally frequency doubled using a temperature tuned Barium-Sodium-Niobate crystal ($Ba_2NaNb_5O_{15}$) and the green $\lambda = 532$ nm light serves as the pump. Using this method, dye laser pulses shorter than 2 psec are consistently observed.

The experimental setup is as shown in Fig. 24. A stable 8 W Nd:YAG laser was used with a pulsewidth FWHM of 50 psec or less. The infrared beam was focused into a temperature stabilized Barium-Sodium-Niobate frequency doubling crystal. $Ba_2NaNb_5O_{15}$ was chosen because of its high nonlinear coefficient and low absorption at both the fundamental and doubled wavelengths. This crystal can be 90° cut which, even in the focusing condition, allows generation of an undistorted second harmonic beam profile essential for optimum dye laser pumping.

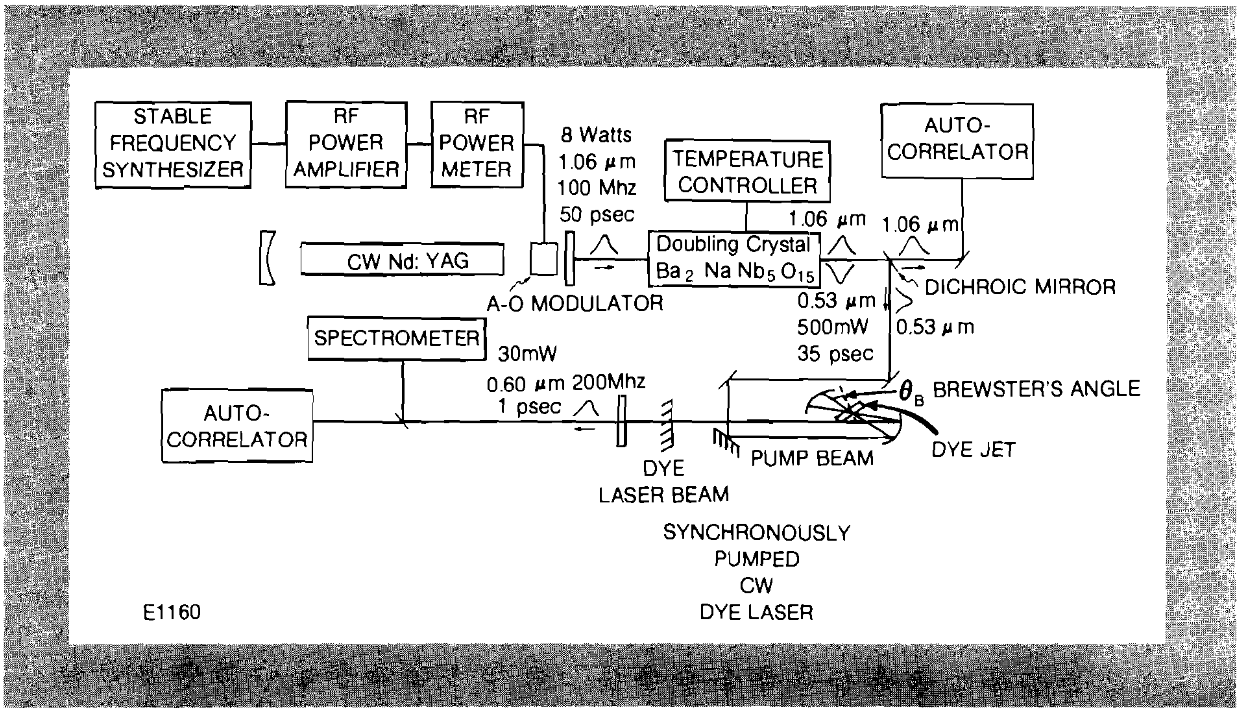

Fig. 24
Experimental setup of the synchronously pumped dye laser. A stable CW mode-locked Nd:YAG laser is externally frequency doubled using a temperature tuned Barium-Sodium-Niobate crystal and the green light is used to pump a dye laser. Dye laser pulses shorter than 2 psec have consistently been observed using this technique.

Pulsewidths consistently shorter than 2 psec have been achieved without active stabilization. The output amplitude and pulsewidth jitter of the dye laser is, as expected, strongly related to the stability of the Nd:YAG. A slight amplitude instability of the Nd:YAG is amplified because of the cumulative effect of the frequency doubling and dye laser running at threshold. Subpicosecond pulses should be reliably achieved with the addition of an active feedback stabilization system.

The benefits of using a frequency doubled Nd:YAG laser instead of an argon-ion laser to pump a subpicosecond dye laser are numerous. The pulsewidth of the doubled Nd:YAG can be made to be shorter than the argon, and the reduced cost, lead time, and installation of a lamp compared to an argon tube are both considerable assets. Also, this system has the potential advantage of being more suitable for short pulse amplification. So far the amplification of short pulses from synchronously pumped or passively mode-locked lasers has been achieved by using a Q-switched laser electronically synchronized with the short pulse laser.[6] The inherent jitter of a few nsec between the two lasers leads to important amplitude instability when gain of the order of 10^6 is contemplated.

In our scheme, part of the Nd:YAG can be used to seed a large aperture regenerative amplifier. By synchronously pumping a series of dye amplifiers with the frequency doubled output of the regenerative amplifier, high conversion efficiencies in amplifying the dye pulses can be achieved because ASE can be partially defeated.

REFERENCES

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