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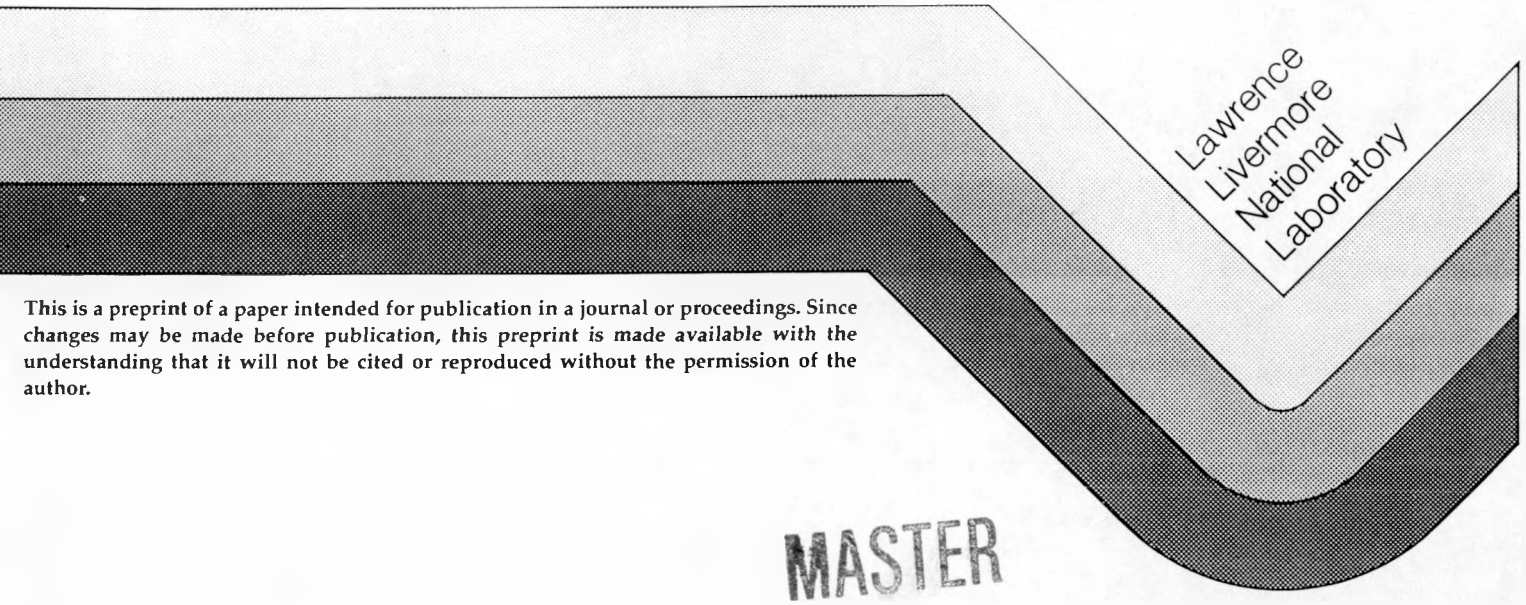

High Power Performance Of A Copper Laser Pumped Dye Master-Oscillator-Power-Amplifier Chain*

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ABSTRACT

A dye master-oscillator-power-amplifier chain pumped by copper lasers produced 1200 W output at 50% conversion efficiency and >10 kHz pulse repetition frequency.

SUMMARY

Dye master-oscillator-power-amplifier (MOPA) chains pumped by copper lasers (Fig. 1) are used at Lawrence Livermore National Laboratory in experimental demonstrations of the atomic-vapor-laser-isotope-separation (AVLIS) process.[1] We report stable operation near 0.6 μ of one of these chains at 1200 W output (Fig. 2) and a multiple chain system at > 2000 W. We believe this to be the highest reported average power from a visible, broadly tunable, high pulse repetition frequency (prf) laser system, and represents a ten-fold increase over power levels first achieved when the system was deployed in 1985. The chain operated at 50% chain conversion efficiency, and at >10 kHz prf. The amplified spontaneous emission (ASE) was of the order of 1-2%.

The dye master oscillator[2] (DMO) generates a single-mode, tunable beam whose center frequency is stabilized to ± 50 MHz. The DMO beam is injected into the amplifier system through a rectangular slit which is image relayed to each amplifier by a series of interstage telescopes. This approach maximizes spatial fill of the amplifier gain volume and preserves beam quality between the four stages of amplification. The spectral output of the DMO is preserved after amplification.

The pump light to each amplifier is the spatially and temporally multiplexed combination of beams from 12 copper laser MOPA chains. The amplifiers are transversely pumped from both sides to achieve gain uniformity. The circular pump beams are optically transformed into elongated, approximate rectangles in the power amplifiers. This permits maximum spatial overlap between the pump and dye beams.

Optical pathlengths are adjusted to achieve temporal overlap of the dye and pump beams in each amplifier. The DMO is pumped through optical fibers by a combination of small copper lasers which are multiplexed independently, both spatially and temporally. The pulse length of the dye

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master oscillator is maximized consistent with single axial mode operation (typically 60-70 ns FW @ 10% max) for optimum conversion efficiency and to avoid ASE on the edges of the output pulse.

We have also measured the effects of high power operation on the output beam wavefront with a Mach-Zehnder interferometer. The uncorrected output beam wavefront generally exhibits less than 1 wave of aberration (P-V) primarily attributable to 1st and 2nd order distortions (Fig. 3). We have corrected these distortions using adaptive optics resulting in residual wavefront aberrations of ~ 1/4 wave (P-V).

We have successfully operated and characterized the system throughout the 550-650 nm region using a variety of different laser dyes, many of which were invented and developed in the AVLIS program.

1. R. S. Hargrove and T. Kan, IEEE J. Quantum Electron. **QE-16**, 1108 (1980).
2. R. P. Hackel, M. Feldman, J. Baker, R. D. Paris, J. M. Tampico, and T. J. Kauppila, *Technical Digest, Conference on Lasers and Electro-Optics* (Optical Society of America, Washington, DC, 1986) paper THI2

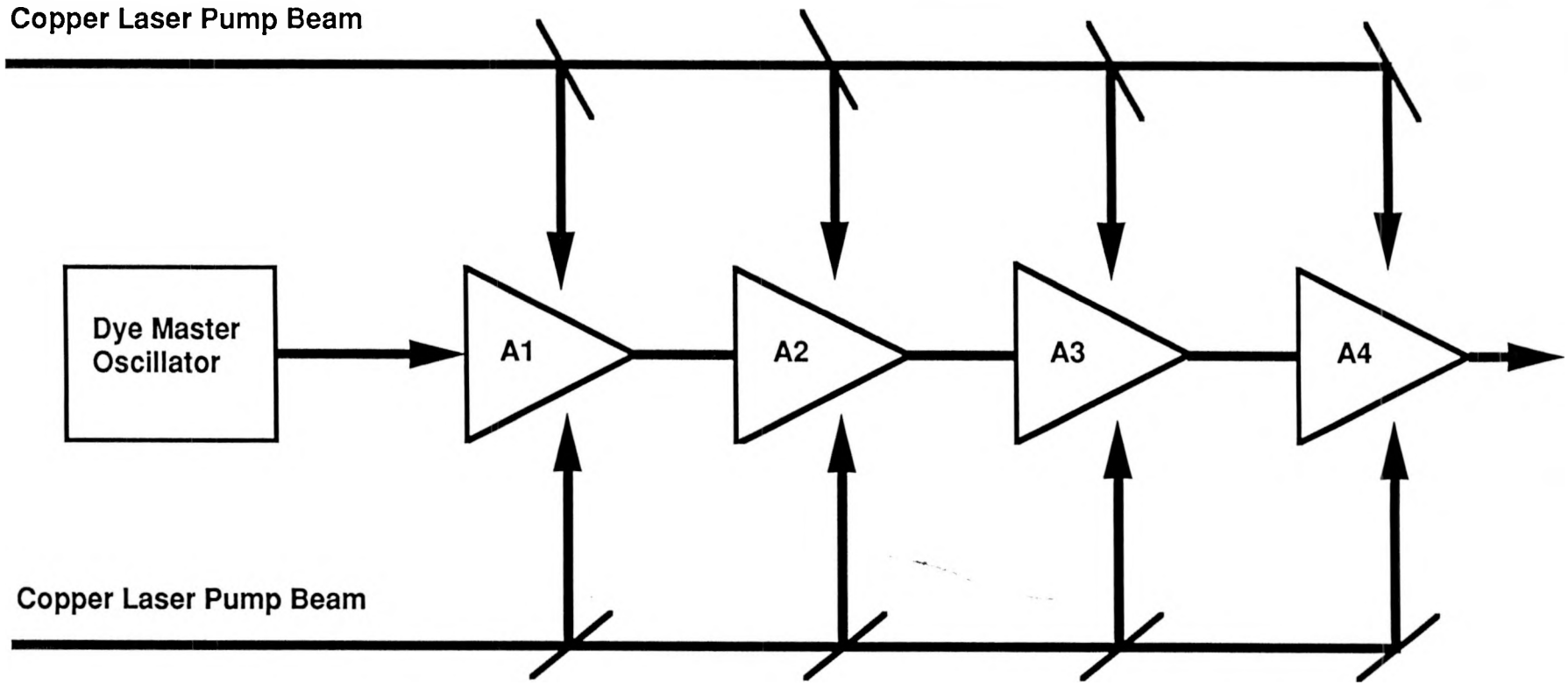

Fig. 1. Schematic of the Copper Laser pumped Dye Master-Oscillator-Power-Amplifier Chain.

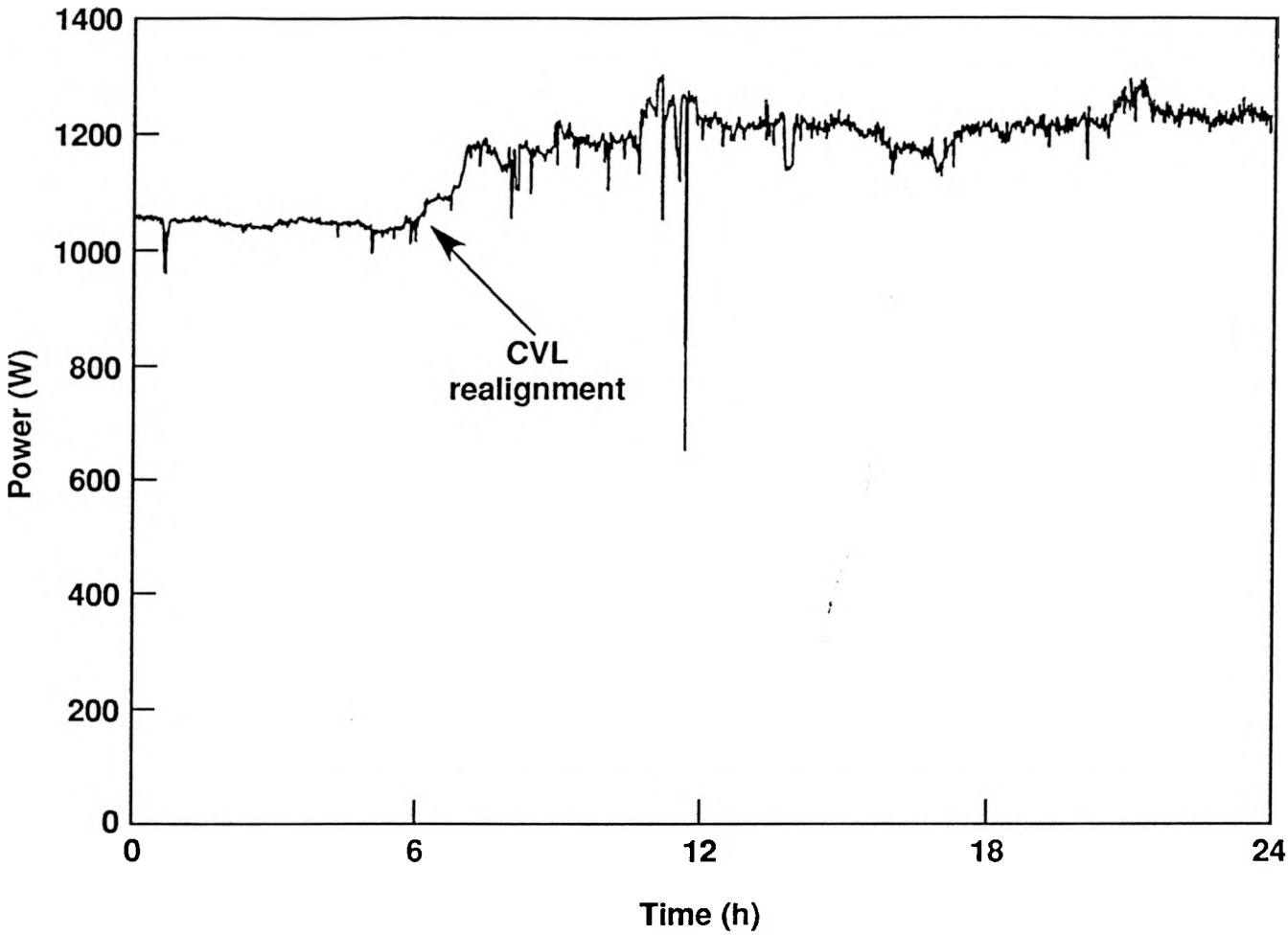

Fig. 2. High power performance versus time of a dye amplifier chain. The chain operated at 50% conversion efficiency.

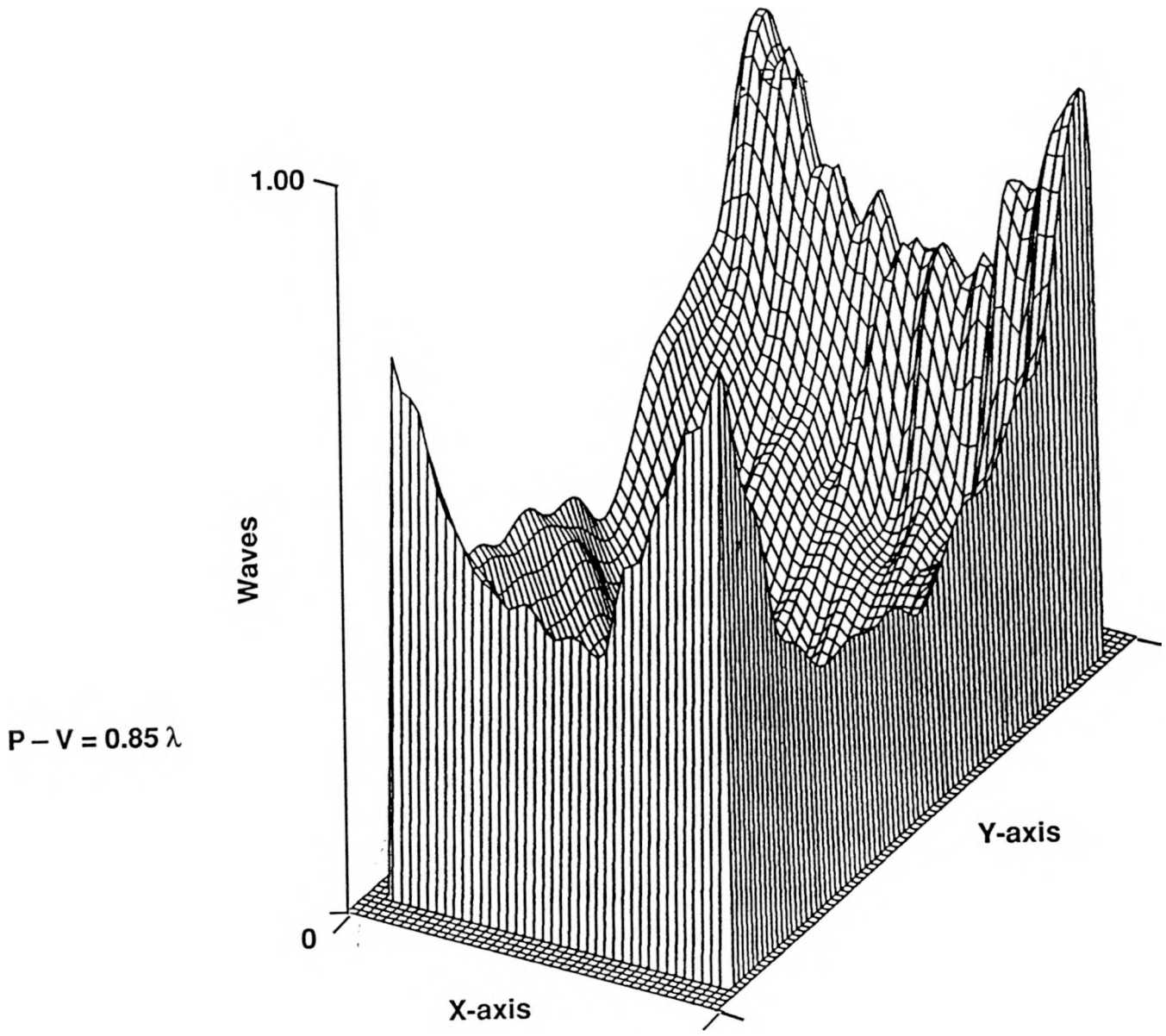

Fig. 3. Mach-Zehnder interferogram showing the uncorrected output beam wavefront of a high power amplifier chain. The wavefront shown exhibits 0.85 waves of distortion.