CThS3

Submission to

CLEO 2003
Baltimore Maryland, USA

High power, tunable, MHz burst-mode Q-switched Alexandrite laser system

N. Vorobiev, M. Richardson, S. Teerawattenasook,
School of Optics & CREOL, University of Central Florida,
4000 Central Florida Blvd ,Orlando, FL 32816

and

F. Levinton,
Nova Scientific Inc., and Princeton Plasma Physics Laboratory,
Princeton University, NJ.

Abstract

A novel, extended regenerative amplifier regime is used with a tunable, narrow-line Q-switched Alexandrite oscillator and booster power amplifiers in a system that produces MHz bursts of 150 mJ laser pulses (10-20), at 5Hz, for plasma diagnostic studies.

CThS3

High power, tunable, MHz burst-mode Q-switched Alexandrite laser system

N. Vorobiev, M. Richardson, S. Teerawattenasook,
School of Optics & CREOL, University of Central Florida,
4000 Central Florida Blvd ,Orlando, FL 32816

and

F. Levinton,
Nova Scientific Inc., and Princeton Plasma Physics Laboratory,
Princeton University, NJ.

Summary

We describe a specialized Alexandrite laser system that emits a repetitive (5Hz) burst of Q-switched laser pulses separated by variable MHz frequency. The design of the system comprises a narrow-line, tunable Q switched oscillator, followed by a novel type of regenerative amplifier, two power amplifiers and a second harmonic conversion crystal. This laser will be used in a high temperature plasma diagnostic system for planar laser-induce fluorescence (PLIF) imaging, for visualizing plasma structure and turbulence.[1] The 37 nm second harmonic laser emission will be tuned to specific Ar ion emission lines, and the time-resolved fluorescent images will be resolved with an ultra-fast MHz CCD.

The main details of the laser system are shown in Fig.1. It consists of an oscillator and a novel "race-track" regenerative amplifier. The Alexandrite laser rods are 4 and 6.35mm dia., 110mm long with 0.13% Cr^{3+} concentration. The PTM Q-switched, flashlamp-pumped Alexandrite oscillator resonator incorporates a multi-plate etalon output coupler. A birefringent filter adds further spectral narrowing and is used for tunin The spectral linewidth of the oscillator is < 0.1nm and is tunable in steps of a few nm inside the interval 730-780nm. The single-pulse output duration can be varied from 50 to 150ns by changing pump energy. The maximum oscillator pulse energy in a TEM_{00} spatial profile is 25 ± 2.5mJ.

The MHz burst-mode performance is created by a multi-pulse replication system, comprising a regenerativ amplifier, Pockels cell, polarizer and optical delay unit. This system provides a flexible, multi-pulse outpu regenerating the pulse inside an optical circuit (race-track), after each pulse is extracted from the system. The single round-trip path length of this amplifier is ~ 43m, giving a circuit time of ~143ns. The optical pump duration of the Alexandrite amplifier is made long enough to ensure there is effective, single pass ga within this resonator for the duration of the burst generation phase. The single-pass gain, ~2, provides modest gain for each pulse transit and takes account of the optical losses in the regenerative amplifier. The Pockels cell is switched on for ~100ns, when the oscillator pulse is injected into the regenerative amplifier and changes its polarization. This polarized beam remains in the resonator, passing through the optical delay unit (number of passes between mirrors = 42) and the Alexandrite amplifier, for a number of circuits before its polarization is partially rotated by the Pockels cell and it is partially reflected from the polarizer, as illustrated in Fig.1. The remainder of the pulse then circulates again in the regenerative amplifier for a number of circuits, before the Pockels cell is again activated, providing the next pulse in the burst-mode pulse-train. Each pulse at this point has energy ~20mJ. This process continues for the given number of pulses in the burst required (from 1 to 20). The time between the burst pulses is specified by the Pockels cell driver and can vary from 1 to 10μs.

A detailed description of the performance of this system will be given, describing also the addition of two booster amplifiers and a second harmonic crystal, converting the burst-mode output of this laser to 378nm.

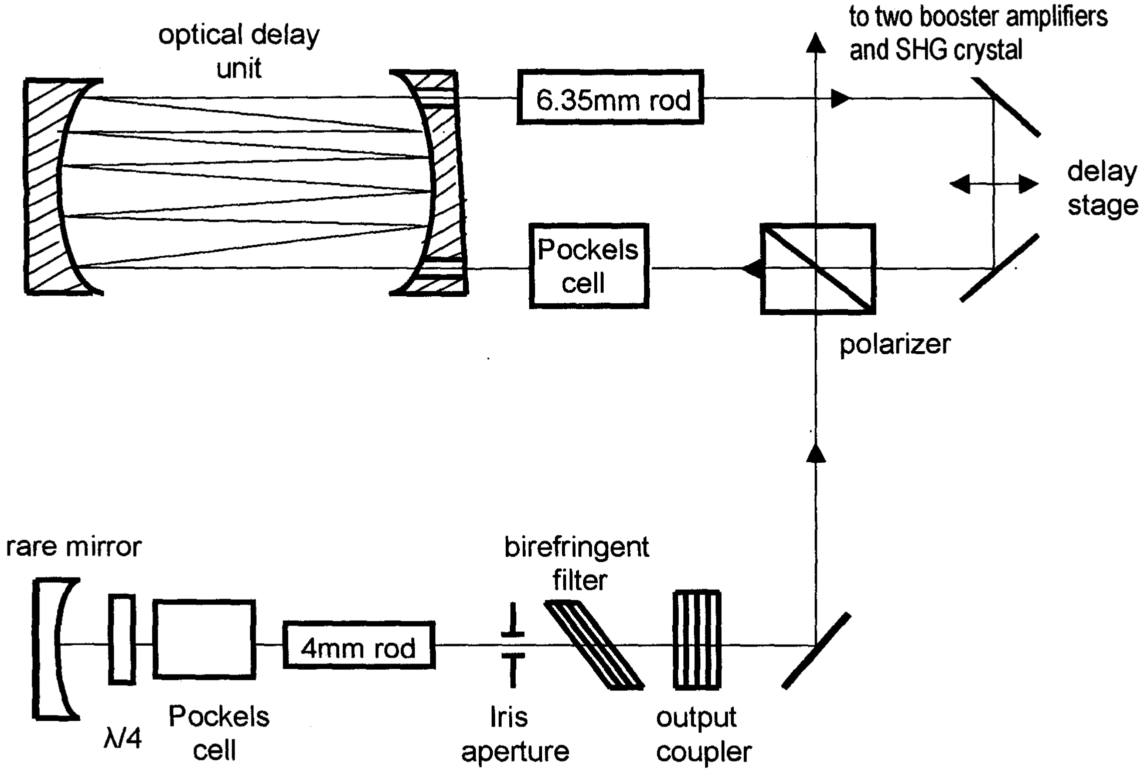

Fig.1. Optical setup of the oscillator and regenerative amplifier

References

1. F.M.Levinton, F.Trintchouk, "Visualization of plasma turbulence with laser-induced fluorescence", Rev. Sci.Instr., 72, 898-905, 2001.