NASA TECH BRIEF
Goddard Space Flight Center

Q-Switched, Cavity-Dumped, Mode-Locked Laser

A continuous-wave laser (e.g., neodymium: yttrium aluminum garnet) can achieve a higher rate of emission through Q-switching. This is a technique for keeping the Q, an energy storage rating (the higher the Q, the longer it takes the energy to be released), of the laser cavity at a low value while an ion population inversion is being built up. Then the Q is suddenly switched to a high value just before instability occurs.

Various acousto-, magneto-, or electro-optic effects may be used for Q-switching. For instance, Kerr or Pockel's cells contain crystals that become double refracting when a signal voltage is applied to the cell. With the use of a polarizer, these cells can be used to block or pass the laser light.

A particular laser system has been examined that uses a Pockel's cell to mode lock the laser emission and another for Q-switching and cavity-dumping. When combined with mode locking, the Q-switching (QS) transition time (3 μs) can be longer than when Q-switching alone is used. During this 3 μs transition period, laser oscillations build up. The oscillations result in a poorly mode-locked output train before the cavity dumping (CD) signal can be applied.

To attempt to solve this problem, the QS transition time is reduced to 1 μs. At this point the switching time is fast enough to excite a fundamental mechanical resonance in the Pockel's cell crystal. This resonance introduces a spurious modulation about 1 μs after QS initiation, thereby partially dumping the cavity. The output from this dumping is a train of mode-locked pulses, emitted before the pulse amplitude has completely built up. This is followed by a pulse with no mode locking.

In order to provide as much time as possible for buildup of the ion population inversion between QS initiation and spurious dumping, the QS transition time was decreased to 250 ns. With this transition time the laser can be adjusted to operate in either of two modes. In the first mode, the output consists of a train of mode-locked pulses with an average power output of 1 W. In the second mode, the output consists of one primary mode-locked pulse and two secondary pulses having about 15 and 5 percent of the amplitude of the primary pulse. Their average output is about 130 mW. With optimal adjustment, a pulse width of 500 ps may be obtained.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
Goddard Space Flight Center
Code 207.1
Greenbelt, Maryland 20771
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NASA has decided not to apply for a patent.

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