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Wide Aperture Injection-Locking of TEA CO_2 Laser

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ABSTRACT: We have been able to generalize the injection locking technique to include higher order transverse modes. To do so we have consider a hemispherical resonator in which the curved mirror has a Gaussian reflectivity profile to deal with Laguerre-Gaussian (L.G.) modes. The effect of injection level, the detuning angle and the ratio w/w, (w and w, are spot sizes of TEA CO_2 and injection beams, respectively) on peak power, width and arrival time of the laser pulse and on laser output frequency and energy content of laser output are given. Results of narrow aperture cavity and wide aperture one are given. They are in good accord with experimental findings.

1. INTRODUCTION

Since the discovery of the laser by Maiman (1960), ensuing development of these systems has been rapid in striving to keep pace with the prodigious demand for such sources in abroad and evergrowing range of applications. Within the general areas of nonlinear optics and laser spectroscopy alone applications include signal processing, optical logic, photochemistry, isotopes seperation, lidar, velocimetry, etc. The often exacting requirements on spectral purity prescribed for such applications, has motivated an energetic search for techniques which may be applied to further optimise the spectral brightness of laser in general. To this end, several techniques using either passive or active intercavity elements have now been developed to overcome problem of broad-band multi-longitudinal mode oscillation in both cw and pulsed laser systems. The utilization of passive frequency selective elements such as etalons, selective absorbers, multi-elements coupled cavities, and prismatic elements has proved especially effective for mode selection in cw systems. However their application to pulsed systems has proved more problematic, the mode discrimination provided by these techniques often proven insufficient, or too sensetive to control, to supress the inherent preference for multi-mode lasing of these systems, arising from these operation well above the lasing threshold. Laser damage of passive elements is a further probelm common to pulsed operation. In contrast, the method of active mode selection either by the inclusion of additional gain, but of narrow bandwidth, within the laser cavity (the so called hybrid technique) or by the injection of an external signal into the laser cavity have both proved remarkably successful. Now widely used in TEA CO_2 lasers, these techniques and in particular that of injection, commonly refered to as injection locking are being applied to excimer and dye systems.

In principle the injection scheme is readily adaptable for any laser system [1,2]. However the proviso that implementation of the technique itself contingent upon the availability of a master oscillator with suitably well defined spectral properties has meant that the over-whelming bulk of