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TITLE: Computer Modeling of Pulsed CO_2 Lasers for Lidar Applications

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BACKGROUND OF THE INVESTIGATION:

The object of this effort is to develop code to enable the accurate prediction of the performance of pulsed transversely excited (TE) CO_2 lasers prior to their construction. This is of particular benefit to the NASA Laser Atmospheric Wind Sounder (LAWS) project. A benefit of the completed code is that although developed specifically for the pulsed CO_2 laser much of the code can be modified to model other laser systems of interest to the lidar community.

SIGNIFICANT ACCOMPLISHMENTS:

During the past year the following tasks have been completed:-

1) A Boltzmann equation solver has been developed which enables the electron excitation rates for the vibrational levels of CO_2 and N_2, together with the electron ionisation and attachment coefficients to be determined for any CO_2 laser gas mixture consisting of a combination of CO_2, N_2, CO, He and CO. The validity of the model has been verified by comparison with published material.

2) The results from the Boltzmann equation solverhave been used as input to the laser kinetics code which is currently under development.

3) A numerical code to model the laser induced medium perturbation (LIMP) arising from the relaxation of the lower laser level has been developed and used to determine the effect of LIMP on the frequency spectrum of the LAWS laser output pulse. The enclosed figures show representative results for a laser operating at 0.5 atm. with a discharge cross-section of 4.5 cm to produce a 20 J pulse with aFWHM of 3.1 µm. The first four plots show the temporal evolution of the laser pulse power, energy evolution, LIMP frequency chirp and electric field magnitude. The electric field magnitude is taken by beating the calculated complex electric field and beating it with a local oscillator signal. The remaining two figures show the power spectrum and energy distribution in the pulse as a function of the varying pulse frequency. The LIMP theory has been compared with experimental data from the NOAA Windvan Lidar and has been found to be in good agreement.

FOCUS OF CURRENT AND PLANNED RESEARCH:

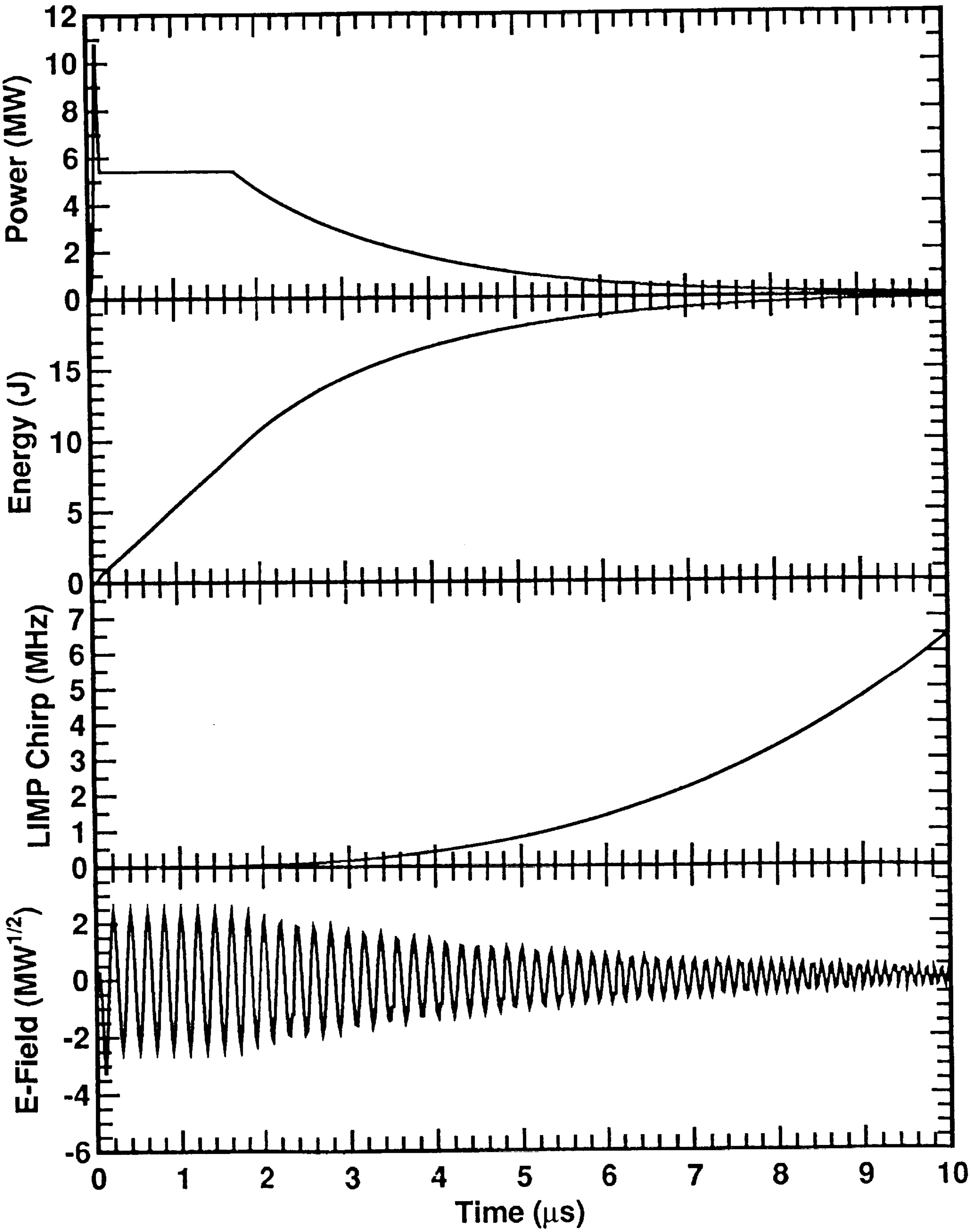
Emphasis is currently being placed on completing the kinetics module of the code. Once this is completed and verified, it will be intergrated with the Boltzmann solver code into a single package. Following on from this, the combined code will be refined and improved in preparation for the development and inclusion of code for the laser optical field development and gas fluid dynamics. It is hoped to start work on inclusion of the gas discharge chemistry and laser catalyst chemistry to enable long term prediction of the output from a sealed CO_2 laser.

At all stages of the process, the model will be verified by comparison with experimental results obtained from the LAWS breadboards and from the published literature.

PUBLICATIONS:

Spiers, G.D.,"Discharge Characterisation of the LP-140 Pulsed CO_2 Laser," Coherent Laser Radar: Technology and Applications, OSA Technical Digest Series, **12**, 52-54, 1991.

3.1 μs FWHM pulse, GSS , 4 μs tail decay and frequency chirp



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