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Overview of the CALIOPE CO_2 DIAL Project

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Abstract: During 1996 the CALIOPE CO_2 DIAL Project developed a new generation of lidar transmitter, receiver, data acquisition, and control technology, constructed new ground and airborne lidar systems, and used them to conduct extensive field tests. New data analysis algorithms were successfully applied to the test data, and CO_2 DIAL capabilities were significantly improved. Recent activities and accomplishments are summarized, and future directions are discussed.

I. Introduction

Los Alamos is developing CO_2 laser-based differential absorption lidar (CO_2 DIAL) for CALIOPE. CO_2 lasers address the spectral region from 8 to 12 microns, which is known to spectroscopists as the "fingerprint" region because many chemicals have narrow spectral features here which allow unambiguous spectroscopic identification. The 8 to 12 micron region is also a good atmospheric transmission window, and because CO_2 laser technology is mature, compact, robust, and efficient, the potential utility of CO_2 DIAL for proliferation detection, battlefield chemical defense, and bomb damage assessment applications is high. Figs. 1 and 2 (pp._____classified volume) list some of the key proliferation effluents and battlefield chemicals which can be detected with CO_2 DIAL, their expected concentrations and resulting detection sensitivity requirements, and the CO_2 DIAL ranges and sensitivities demonstrated to date.

To date, most applications of CO_2 DIAL technology have involved short-range probing of targets with relatively large concentration - path length products, such as minority species or pollutants in the atmosphere. Proliferation detection, however, will involve much lower concentrations in small volumes, and political constraints on access to targets are likely to necessitate long range operation. Improved range and sensitivity are therefore key objectives, and CALIOPE CO_2 DIAL activities include the fundamental DIAL phenomenology research, component technology development, and comprehensive experiments required to accomplish this.

During CALIOPE's first year a complete numerical model of CO_2 DIAL called System Optimization Numerics for DIAL (SONDIAL) was developed, and two mobile "first generation" CO_2 DIAL systems were assembled from commercially available components to provide detailed experimental validation. Extensive field experiments were conducted at the Nevada Test Site and Los Alamos, and outstanding agreement between field measurements and the SONDIAL model has been achieved. Although they were not optimized for range or sensitivity, the first generation CO_2 DIAL ground systems achieved performance levels which approach operational utility for detecting some important proliferation effluents, as indicated by the results summarized in Figs. 1 and 2.

Based on these theoretical and experimental successes, the SONDIAL model is being used to investigate the performance and optimization of operational CO_2 DIAL systems for battlefield and proliferation detection applications. Fig. 3 (p. ____ classified volume)