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A Lightweight and High Sensitivity Mie Lidar Using LD-Pumped Nd:YAG Laser

LD励起Nd:YAGレーザを用いた軽量・高感度ミー散乱ライダ

M. C. アラルコン、 山本 雄大、 小林 喬郎
Minella C. Alarcon, Takehiro Yamamoto, Takao Kobayashi

福井大学工学部
Faculty of Engineering, Fukui University

A Mie scattering lidar with an optical system that weighs only 13 kg has been developed for mobile and stationary monitoring of aerosols and pollutants in the tropospheric atmosphere. The system utilizes an extremely lightweight (3 kg) 60-cm diameter receiving mirror with aluminum honeycomb core, CFRP skin plate and aluminum coating. The requirements of high sensitivity and lightness in weight are also fulfilled by using a LD-pumped, Q-switched Nd:YAG laser and a silicon avalanche photodiode detector.

INTRODUCTION

Mobile lidar (laser radar) systems using Mie scattering of the atmosphere are capable of observing the tropospheric environment and collecting information over a wide area. In these fields, a lightweight and low power consumption lidar system is necessary for realizing a wide range of practical applications.[1] We have developed a lightweight, efficient and high sensitivity Mie lidar system which is easily transportable by small cars and real time data collection is possible.

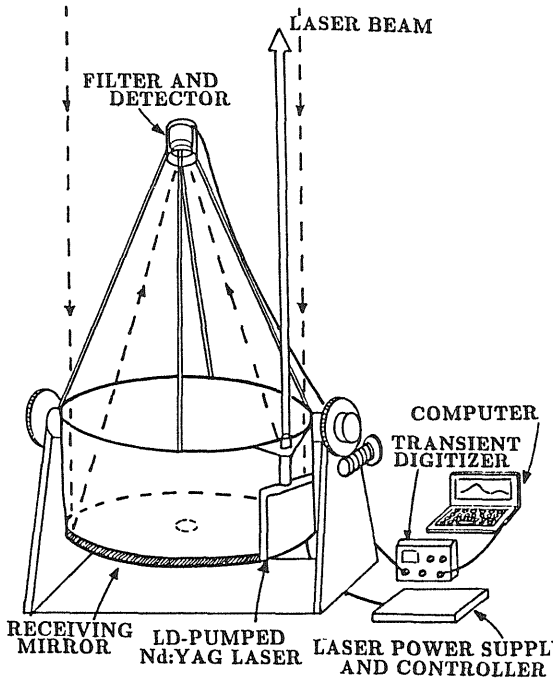

Fig. 1 Lightweight Mie lidar system

SYSTEM PARAMETERS AND DESIGN CONSIDERATIONS

Figure 1 shows a schematic diagram of the lightweight and high sensitivity Mie scattering lidar system developed in this research project. For this system, the laser source must fulfill definite requirements of power and weight. The suitable

choices are a pulsed single laser diode (LD), and a LD-pumped Nd:YAG laser. Their range capabilities are compared in Fig. 2 and the detection signal-to-noise ratios are plotted for night and daytime operation. The system parameters are summarized in Table 1. From the results of Fig. 2, the criterion of high sensitivity is best satisfied with the LD-pumped Nd:YAG laser. High output power is achieved in this laser by side pumping the YAG disc using two LD arrays.[2)]

The receiving optics for this system is a 3-kg mirror of diameter 60 cm and angular collection accuracy of 0.2 mrad with aluminum honeycomb core, CRFP skin plate and aluminum coating and is designed to be a satellite solar energy collector. The mirror is mounted on a two-dimensional scanning table that weighs about 8 kg.

The system performance and observational results of the atmosphere are reported in detail.

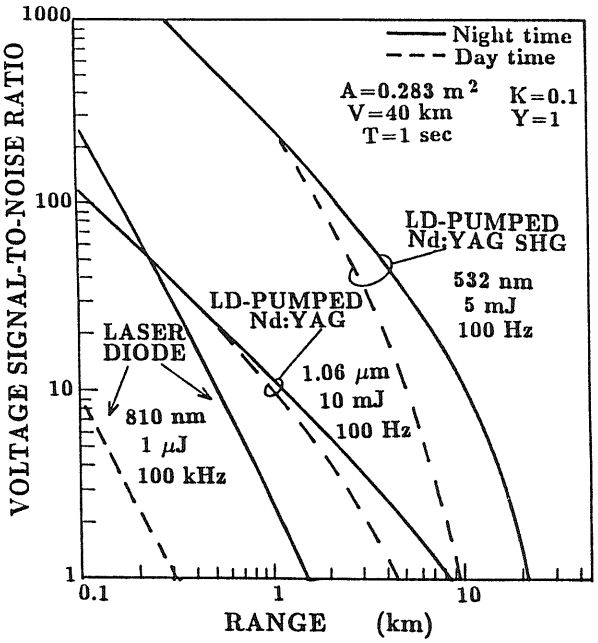

Fig. 2 Range dependence of voltage signal-to-noise ratio for detecting molecular Rayleigh scattering using laser sources suitable for a lightweight Mie lidar

Table 1 Lightweight Mie lidar system parameters

LASER	LD-pumped Q-switched Nd:YAG
Wavelength	1.06 μm
Pulse energy	10 mJ
Repetition rate	100 Hz
Weight	2 kg
RECEIVING MIRROR	Aluminum honeycomb core, CFRP skin plate, and aluminum coating
Angular collection accuracy	0.2 mrad
Size	60 cm diameter
Weight	3 kg
OPTICAL FILTER	1 nm bandwidth
DETECTOR	Si avalanche photodiode
Noise equivalent power	8×10^{-14} W/√Hz at 1.06 μm
OPTICAL SYSTEM Total weight	13 kg

Acknowledgments

We are indebted to Mitusubishi Sagami Works (三菱電機相模製作所) for the CFRP lightweight mirror. One of the authors (M.A.) expresses her gratitude to Asahi Shinbun-Sha for the Asahi Fellowship award.

References

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2) T. Yamamoto, M. Alarcon, T.Taira and T. Kobayashi: 14th Laser Sensing Symposium Abstracts, Sendai (1991)