26PB7

A TIME DEPENDENT ATTENUATOR FOR DYNAMIC RANGE REDUCTION OF LIDAR-SIGNALS

S. Lehmann, V. Wulfmeyer, J. Bösenberg
Max-Planck-Institut für Meteorologie
Bundesstraße 55, 20146 Hamburg, Germany
Phone: +49 40 41173 256 Facsimile: +49 40 41173 298
E-mail: stl@lidarn.dkrz.de

Introduction

The large dynamic range of lidar signals, especialy in ground-based zenith-looking applications, is a well known problem. This is particularly severe when high accuracy is required, e.g. in DIAL measurements. To overcome this problem a time dependent attenuator has been developed, which strongly attenuates the close range returns and leaves the far range signals almost unchanged.

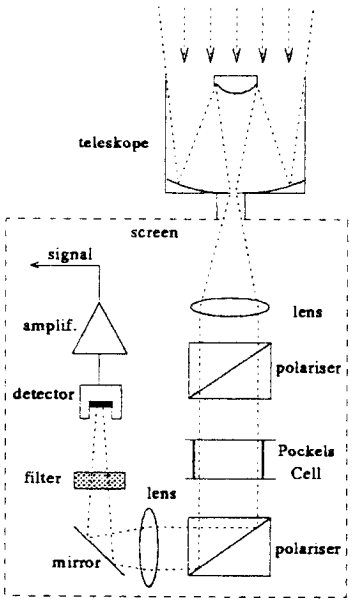

Figure 1: *Acquisition system including the variable attenuator*

The variable attenuator

The variable attenuator consists of a Pockels cell between two crossed polarizers (fig.1). With no voltage applied to the Pockels cell, the plane of polarisation remains unchanged, and the transmission is small. When the voltage is raised to the half-wave voltage, the device becomes almost transparent. The high voltage applied to the Pockels cell is shaped according to the required time dependance of the transmission factor. The extinction which can be achieved is dependent on the beam divergence in the Pockels cell and its length. The divergence is controlled by the telescope's field of view (through its focal length and the diaphragm in the focal plane) and the free aperture of the Pockels cell. Limiting the divergence in the Pockels cell to 12 mrad, we have achieved a contrast of 1:2000. With a suitable timing of the voltage applied to the Pockels cell a dynamic range reduction from about 10^4:1 to 50:1 can be achieved. This can be used to adapt the measured range to the heights of interest by a combination of raising the gain at the far end and ex-

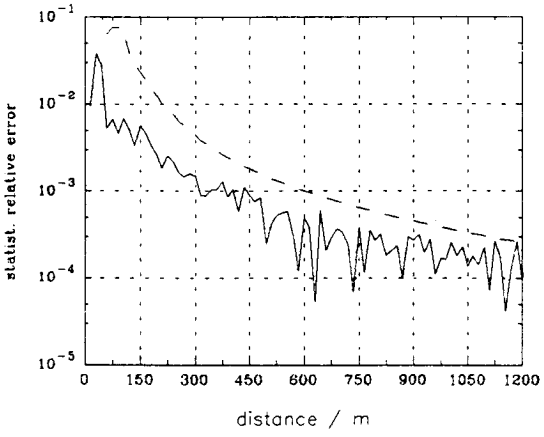

Figure 2: *relative statistical error caused by the attenuator and its detection limit (dotted)*

tending the range considerably to lower heights. It is estimated, that a height range of 0.2-10 km can be covered with one data acquisition system only.

Performance

In order to achieve the high accuracy required for DIAL measurements the attenuation has to be highly reproducible at any time during the measurement. To confirm the attenuator meets these requirements the relative statistical error caused by the attenuator was determined in a laboratory setup. All other possible noise sources were measured individually and substracted. Fig.2 shows the measurement for the near range, where the largest errors are expected. No resulting relative statistical errors caused by the attenuator were found above the detection limit, whatsoever. Therefore, errors possibly caused by poor reproductivity can be neglected.

Results

To demonstrate the applicability, the time dependent attenuator was inserted into an existing LIDAR setup. Fig.3 shows the signals with (b.) and without (a.) the device. The resulting dynamic range reduction is obvious, although the effect was limited by the fixed overlap, which was complete only beyond 500 m. The signal quality at the far end is considerably improved. Unfortunately, the gain could not be raised further due to technical limitations of the amplifier. In an optimal setup, the improvement in performance can be much higher.

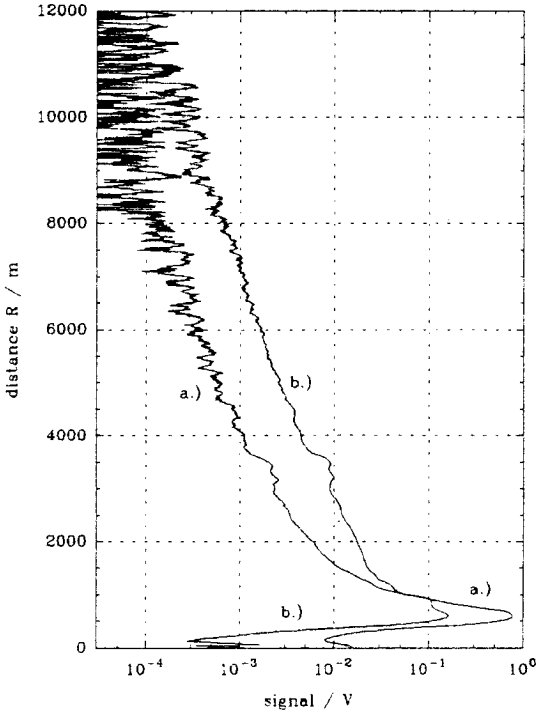

Figure 3: *backscatter LIDAR signals a.) without and b.) with the variable transmitter amplified by a factor 5 (250 shots and 10 samples averaged).*