# COMBINING NEAR- AND FAR-RANGE CHANNELS OF A PURE ROTATIONAL RAMAN LIDAR VIA FIBER COUPLED DUAL INPUT DOUBLE GRATING MONOCHROMATOR

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**ABSTRACT**

We present a new optical arrangement of atmospheric observations with a pure rotational Raman lidar, which provides for combining near- and far-range observations via a dual input double grating monochromator common for both channels.

Normally, pure rotational Raman lidars use receiving optics with narrow field of view in order to reduce the sky background noise. However, narrow field of view of the lidar receiver moves the maximum of the lidar overlap function to a larger range that, in turn, makes the near-range return signal very weak and thus impractical. Use of a separate lidar with a wider field of view helps in acquiring near-range lidar data, but this approach doubles the instrumentation. In this paper we propose to combine the near- and far-range channels of observations with a pure rotational Raman lidar using a double grating monochromator. To do this we have developed a block of optic fibers that optically couples two receiving telescopes of the lidar and provides for spectrally isolating relevant return signals from near- and far-range zones of the sounding path.

## 1. INTRODUCTION

Many atmospheric studies of the atmosphere with lidar, especially in the atmospheric boundary layer, often require the lidar returns to be acquired from as low heights as possible. On the one hand, this task can be achieved by use of a lidar optical receiver with a vide field of view in a coaxial optical arrangement. On the other hand, wide field of view collects a lot of sky background during daytime thus limiting the range of lidar sounding during daytime. An optical layout with two optical receivers each aligned to collect scattered light from either near or far-range zone of the same sounding path may be a solution to this problem.

Of course, one can use two separate optical receivers each equipped with its own block of spectral separation of lidar returns. In practice, the blocks of spectral separation of lidar returns are most complicated and costly optical parts of the pure rotational Raman, so some alternative is needed to make a compromise.

## 2. USE OF DUAL INPUT DOUBLE GRATING MONOCHROMATOR

In contrast to merely doubling the lidar spectrometer optics we propose to use the same double grating monochromator to combine near- and far-range observations of the atmosphere with the pure rotational Raman lidar equipped with two receiving telescopes.

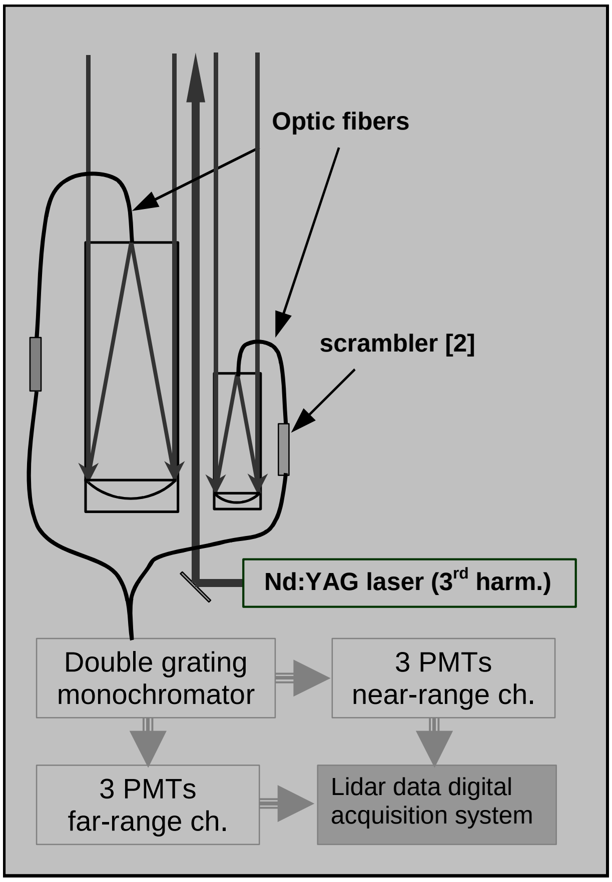


Fig.1. Optical arrangement of combining near- and far-range observations in the atmosphere by use of one and the same double grating monochromator.

Optical arrangement of combining the near- and far-range lidar observations of the atmosphere with a pure rotational Raman lidar is shown in Fig.1.

The principle of operation of a fiber coupled double grating monochromator in application to spectrally isolate pure rotational Raman-lidar returns collected with a single receiving telescope was described in [1]. To achieve the task stated above we have modified the block of optical fibers so that it enables us to simultaneously isolate the desired Raman-lidar returns collected by near- and far-range telescopes of the lidar.

In the presentation we shall discuss in detail the design of new block of optic fibers. Pure rotational Raman-lidar returns as well as the returns due to elastic scattering from the atmosphere recorded simultaneously in the near- and far- range channels of the lidar facility at Max-Planck Institute for meteorology in Hamburg, Germany are shown in Figs.2 and 3. Field of view of the near-range lidar channel was about 0.9mrad and about 0.3mrad of the far-range channel. Note that optic fibers used in the lidar to couple receiving telescopes with the double grating monochromator have same diameter of the core while the receiving telescopes have about three times different focal lengths. As the input ends of the optic fibers make up the field stops of the telescopes in this configuration, the above-mentioned lidar receivers' fields of view correspondingly differ by three times too.

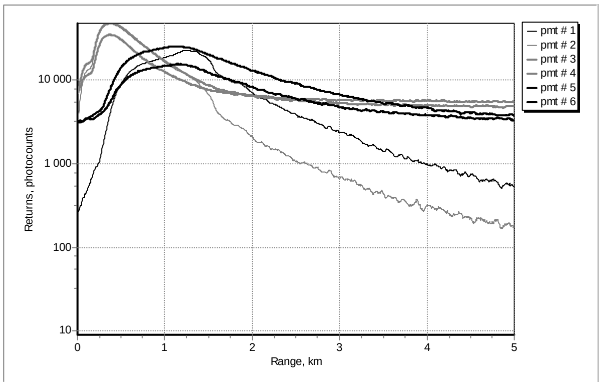


Fig.2.Raman-lidar returns simultaneously recorded under relatively clear sky conditions with a pure Rotational Raman lidar in the near- (gray lines) and far-range (black lines) zone, using the optical arrangement shown in Fig.1. Thin lines show return signals due to elastic scattering; bold lines present pure rotational Raman-lidar returns.

It is also worthy to note that in both near- and far-range channels we use scrambling of the backscattered light [2] in order to avoid otherwise possible range dependence of the ratio of the lidar overlap factors.

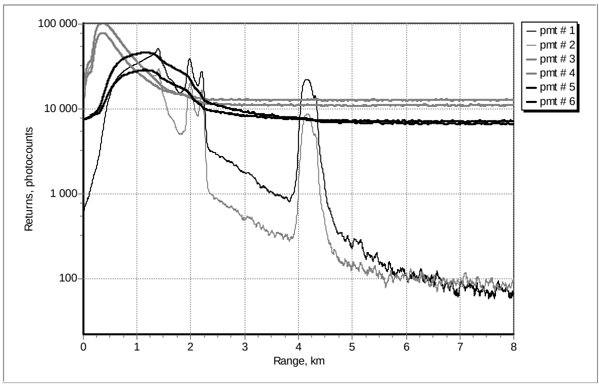


Fig.3. Same as in Fig.2, but under conditions of multilayer clouds.

The data presented in these figures have been acquired during daytime since 14:45 until 14:52 LT on April 25, 2005 (Fig.2) and since 15:35 until 15:51 on April 25, 2005 (Fig.3).

The return signals depicted in Figs.2 and 3 demonstrate the feasibility of the approach proposed to simultaneously acquire return signals starting from the heights below 200 meters. It is also well seen from Fig.3 that spectral separation of the pure rotational Raman-lidar returns efficiently rejects spurious light of the return signal due to elastic scattering. For this reason, the pure rotational Raman-lidar returns recorded within the cloud layers (Fig.3) can readily be used for estimating the extinction of clouds, as well as the temperature and variations of the scattering ratio outside and inside the clouds.

**References**

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