Optimized signal to noise ratio of a PMT based detector system in Mie-Lidar

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Abstract

Signal to noise ratio calculations are made for a Mie-Lidar system which uses photomultiplier tube (PMT) as a detector. Power received by the Lidar system from different altitudes is calculated considering four different model vertical profiles of aerosols representing urban and background continent conditions, with and without stratospheric volcanic aerosol layer. The minimum detectable energy of the backscattered laser pulse by the photomultiplier is derived using optimum spectral response of the amplifier-filter. In this article we report the signal to noise ratio obtained in terms of power received, detector efficiency, background radiation, pulse width of the laser etc. Calculations specific to our currently operational Mie-Lidar system at Mount Abu (Lat. 24°36′N, Long. 72°42′E) operating at second harmonic of Nd:YAG, at 532 nm and uses photomultiplier tube as a detector, are made. Parameter sensitivity study shows that signal to noise ratio is more sensitive to changes in transmission factor than the energy, volume backscattering coefficient and less to background radiation level and detector efficiency.

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1. Introduction

Photomultiplier tubes (PMTs) have very low noise levels and are several orders of magnitude more sensitive than any other detector for UV and visible radiation. This is due to the noise free amplification of the photo-current by the multiplier stages inside the tube. PMTs are generally used as detectors in different Lidar systems. They offer fast response and high gain coupled with fairly good quantum efficiency and relatively low noise level. The photons falling on the surface of the PMT cathode generates photoelectron flux, which is amplified by means of dynode chain to produce a burst of photoelectrons at the PMT anode. The burst of output current can be measured either in analog mode or in photon counting mode. Analog mode is used where the rate of incident photon is large and the average current is measured by an electrometer. In photon counting mode, the number of individual output bursts are counted per unit time. This technique gives better signal to noise ratio at low current levels [1]. The output electrical signal of a detector i.e. the anode current of a PMT is generally proportional to the input light intensity.

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