ADVANCED TECHNOLOGIES FOR POLLUTANT DETECTION SYSTEMS

D. Ebeling and G. Kuper

Impulsphysik GmbH, Hamburg, Germany

and

K. Vollrath and G. Hirth

ISL, Saint-Louis, Missouri, U. S. A.

ABSTRACT

During the recent development phase of a Raman-Lidar backscatter system
for measurement of pollutant components in the atmosphere, several dis-
advantages of conventional PM photon counting devices using monochrometers
or even small bandwidth dielectrical filters for line separation became visible.

MCP image intensifiers with very high gain in the order of 10^4 are most suit-
able to overcome these disadvantages such as high scanning times through the
entire spectrum of atmospheric pollutants. By locating the MCP tube at the
exit-slit-plane of a monochrometer the lines of interest corresponding to
different pollutant gases are obtained simultaneously. Previously undertaken
experiments with a high peak power ruby emitter and a f/5, f:25 cm poly-
chrometer yield detection limits in the range from about hundred to a few
thousand ppm at considerable distances thereby making the system useable
for plume stack or typical emission monitoring.

The experimental results will be shown on photographs taken with high-speed
Polaroid film from the MCP tube phosphor screen during successive shots
thereby integrating the different lines on the film as "memory" over measuring
times between 0.5 and 5 min. This relatively simple design will be modified
by exchanging the phosphor screen with vidicon memory tubes or multiple anode
arrays to get digitized information.

SNR consideration based on measurements in both cooled and uncooled condition
of the MCP plate show the possibility to double the MCP plates for even higher
gain limited to about 10^7 due to shot–noise. Overall efficiency calculations
of both emitter and receiver based on theoretical and experimental results
using various optical systems and lasers will be presented yielding on the
laser side the superiority of high peak power fairly low repetition rate systems
such as Ruby and Dye lasers rather than high repetition rate low peak power
systems.

Data for the ruby system used in the experiments are at maximum rating:
150 MW, 20 ns, 2 cps, 6 W average power, and for the exchangeable Dye laser
under construction for further experiments: $\leq$10 MW, 100 ns, $\leq$10 cps,
$\leq$10 W average power.

It will be shown that resonant Raman scattering and differential absorption
techniques together with modified laser types will enhance the detectability
by a considerable amount.