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A METEOROLOGICAL (HUMIDITY, TEMPERATURE, AEROSOLS) MOBILE DIAL SYSTEM: CONCEPTS AND DESIGN

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1-Introduction

Since 1982 we have conducted a program to develop a mobile meteorological (humidity, temperature, aerosols) DIAL system devoted to the studies of the nuclear power plant atmospheric surroundings.

Though different papers have already adressed specific points of this development[1,2], hereafter we take the opportunity of the conference to present a global overview of this system.

On the next table are defined the measurement objectives according to the user's needs and the lidar feasibility.

	range m	resolution m	accuracy	acq.time mn
humidity	30-3000	100	5%	10'
temperature	30-3000	100	5/10°C	10'
aerosols	30-3000	50	1%	10'

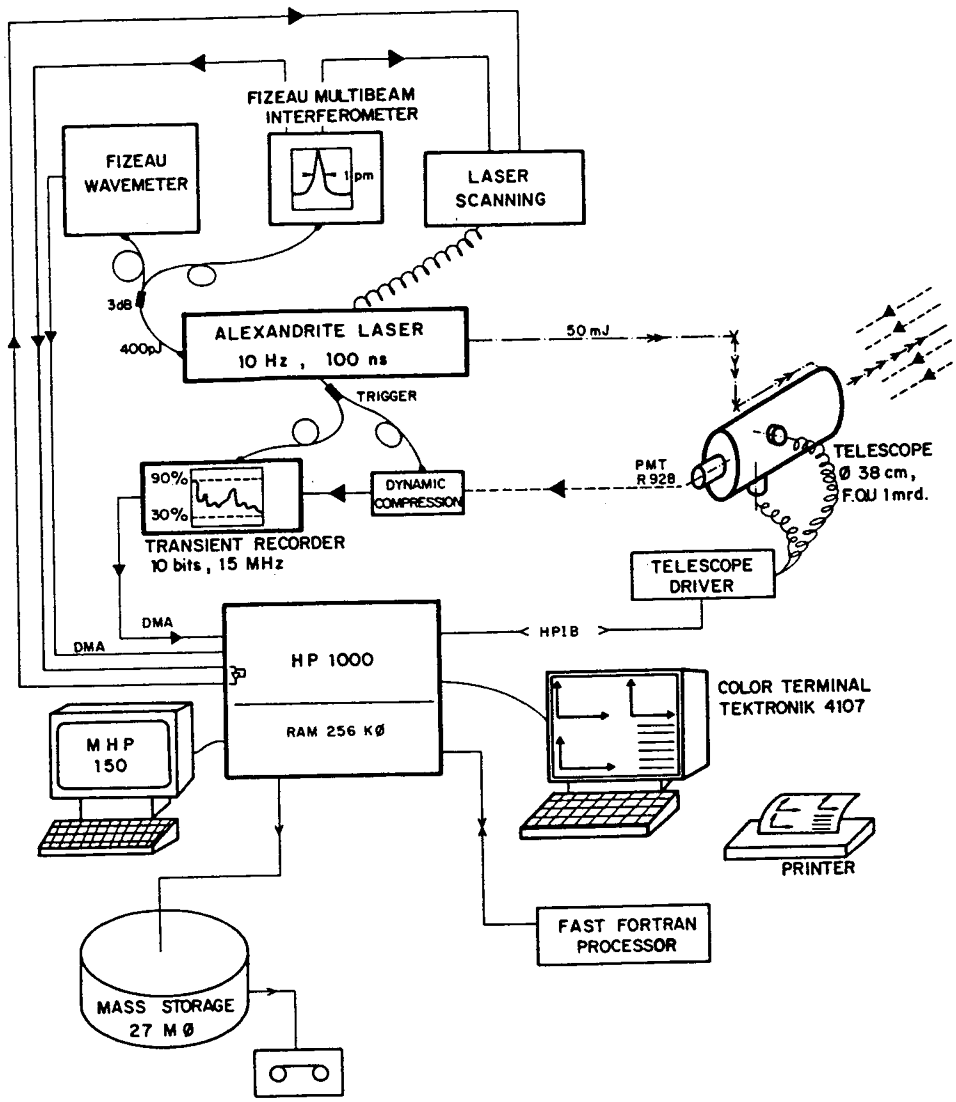
User's needs can be summarized as follows: *automatic, flexible, quasi-realtime measurement displays*. The methodological requirements are the commonly adopted issues: *overall acquisition accuracy* (10^{-3}), *signal dynamic* (10^{4}), *spectrally narrow laser (1 pm), frequency stable laser* (±0.2 pm).

In this paper, we describe the concepts and design adopted to meet both the requirements and the measurement objectives. Each sub-system will be sequentially adressed: **transmitting system, receiving system, detection system, post detection electronics**, but a general synoptic of the system is given on the figure.

2-Transmitting system

a) laser source

An Alexandrite laser source is selected to be part of the mobile lidar system to be installed in a small van. The broad tunability capability of this source makes possible the



SYNOPTIC OF THE METEOROLOGICAL DIAL SYSTEM

measurements of humidity and temperature with only one active laser medium by changing the tuning elements positioning. The laser is commercially available but deeply modified to get the necessary operationality.

b) laser output characterization

The automatically tunable narrow line output emission is simultaneously controlled by a high accuracy wavemeter and a high finesse interferometer: a two beam Fizeau wavemeter for absolute wavelength determination and a multi-beam Fizeau interferometer for linewidth measurement.

The light routine is made by using multimode optical fibers (core 50 m + Selfoc coupling).

A calibration procedure of the wavemeter has been derived to take into account a spatial filtering effect on the absolute wavelength determination. Also improved was the algorithm already available. A statistical evaluation of the expected wavelength is performed to prevent from erroneous corrections due to integer handling associated with an equivalent mode jump in the interferometer. The ultimate resolution in the pulse regime is a few parts in 10^7.

The Fizeau interferometer is microprocessor controlled to compute on a shot to shot basis the number of observed components associated to an uncorrect tuning of the intracavity etalons.

In addition to linewidth and absolute wavelength positioning requirements we paid a special attention to the evaluation of the possible residual amplified spontaneous emission(ASE). A precise simulation of the ASE effect on the wavelength determination enables us to estimate the residual ASE of the Alexandrite laser to be less than 0.5%

c) spectral data

For both water vapor and temperature measurements accurate spectral data (absorption cross section, line shape) are required to limit the systematic error.

We have performed the determination of cross sections and linewidths of selected water vapor and oxygen lines using a cw ring dye laser and an open White cell at atmospheric pressure. Comparison and results are reported in a recent paper[3].

3-Receiving system

For daytime measurements in the 0.7 m range the spectral width of the receiving optics associated to the telescope is limited to 0.1 nm by a combination of a broadband filter plus a Fabry-Perot etalon. The transmission of this system has been calibrated using actual lidar echos and is found to be ~ 40% which is higher than the value obtained with a single narrow band interferential filter (~20%).

4-Detection system

Specialized experiments have been run to study the impulse response of a R 928 Hammamatsu PMT. A modified load circuitry has been tested and preserved a 1% linearity over 4 decades.

5-Post-detection electronics

As already mentioned the overall accuracy should be close to 0.1% to be compatible with temperature measurement accuracy of 0.2%.

We developed a two stage digitizer to ensure a true 10 bits digitization:

1) a signal recognition is performed using an A-D multiplier and a 68000 microprocessor to set a correct gain table for the adjustable input amplifier. It ensures that the signal level remains within 30-90% of the 10 bits digitizer full scale. A possible saturation of the electronics is prevented on a shot to shot basis and a change of the gain table leads to only one laser shot lost.

2) the analog signal is digitized using a 10 bit 15 MHz AD converter. The performances have been tested using both FFt and statistical missing code analysis: no missing code has been found and the noise is - 80 dB lower than the input signal.

Conclusion

At the very moment we write this paper, we are running the whole system in the laboratory before assembling into the van. We hope to be able to present the first measurements of humidity using an Alexandrite laser source at the Conference.

References:

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