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# Water vapor DIAL using an Alexandrite regenerative amplifier

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## Introduction

For reliable measurements of water vapor in the troposphere small linewidth, high spectral purity, and frequency stability of the laser is essential. Our approach is regenerative amplification of a 6 ns pulse, which is obtained by pulse slicing from a stabilized cw single longitudinal mode Ti:Sapphire ring laser [1]. As gain medium a flashlamp pumped Alexandrite rod is used. A scheme of this lasersystem is shown in fig. 1.

## Ti:Sapphire laser

The Ti:Sapphire ring laser can be tuned to all important water vapor absorption lines within the 720-730 nm wavelength range. A commercially available laser(SEO) was modified in many ways to meet the requirements for water vapor and temperature measurements:

- The whole laser is temperature stabilized to ± 0.1 K
- The air inside the laser cabinet is filtered and dried
- The quartz etalon in the cavity is replaced by an etalon with an air gap
- An active stabilisation was installed, with reference to an external confocal etalon, using a piezo-driven mirror as active element
- A Pockels cell was inserted in the ring cavity in order to switch between on- and off-line wavelength [2]

The specifications of this laser are shown at the conference.

## Pulse slicer and mode matching

In order to avoid frequency shifts during amplification of the Ti:Sapphire laser, which occur when injection seeding is used [3], a 6 ns pulse is sliced from the cw output and injected in an Alexandrite amplifier. The round trip time is greater than the injected pulse length, thus interferences at the cavity mirrors and frequency shifts are suppressed. To achieve high injection efficiency a program was written to calculate mode matching to the eigenmode of the Alexandrite amplifier.

## Regenerative amplifier

As gain medium Alexandrite was chosen to obtain high amplification in the wavelength range of 720-780 nm for water vapor and temperature measurements.
Two resonator types, a linear and a ring cavity, were investigated for regenerative amplification. A program, which takes into consideration thermal lensing of Alexandrite, was written to find solutions for the lowest order eigenmode with low misalignment sensitivity, high stability area, high gain, high repetition rate and highest possible beam

radii at the optics to avoid laser induced damages. It is demonstrated that eigenmodes with all these properties exist, for both linear and ring configurations. Fig. 2 shows the setup of the investigated Alexandrite ring regenerative amplifier.

## Results

It is shown that single mode lasing with low ASE background and high pulse power is achieved according to the requirements for water vapor and temperature measurements.
First results of tropospheric humidity profiles obtained with this system are presented.

## References


[1] P.-Y. Thro, J. Bösenberg, V. Wulfmeyer, An Alexandrite regenerative amplifier for water vapor and temperature measurements, International Laser Radar Conference, 513 (1992)

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[3] C. R. Prasad, G. K. Schwemmer, C. L. Korb, Wavemeter measurements of frequency stability of an injection seeded Alexandrite laser for pressure and temperature Lidar, International Laser Radar Conference, 517 (1992)

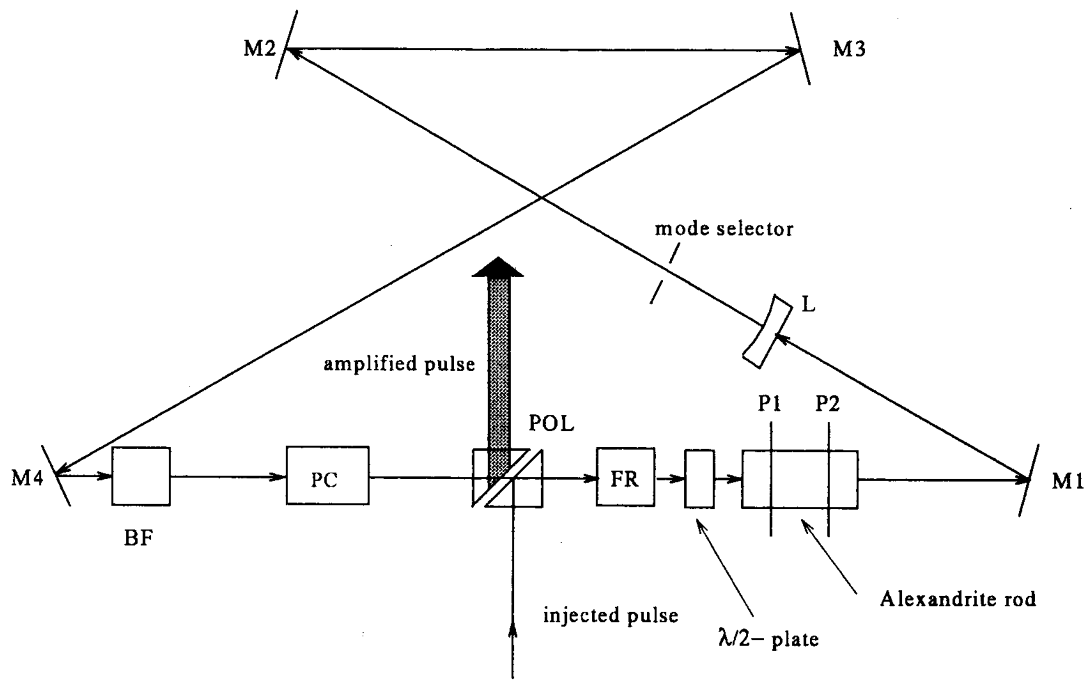


Figure 2: Setup Alexandrite ring regenerative amplifier.
P1, P2: Principal planes of thermal lens, M: mirror, L: lens, BF: birefringent filter, FR: 45°Faraday rotator, POL: Glan laser polariser, PC: Pockelscell with $\lambda/2$ static retardation.

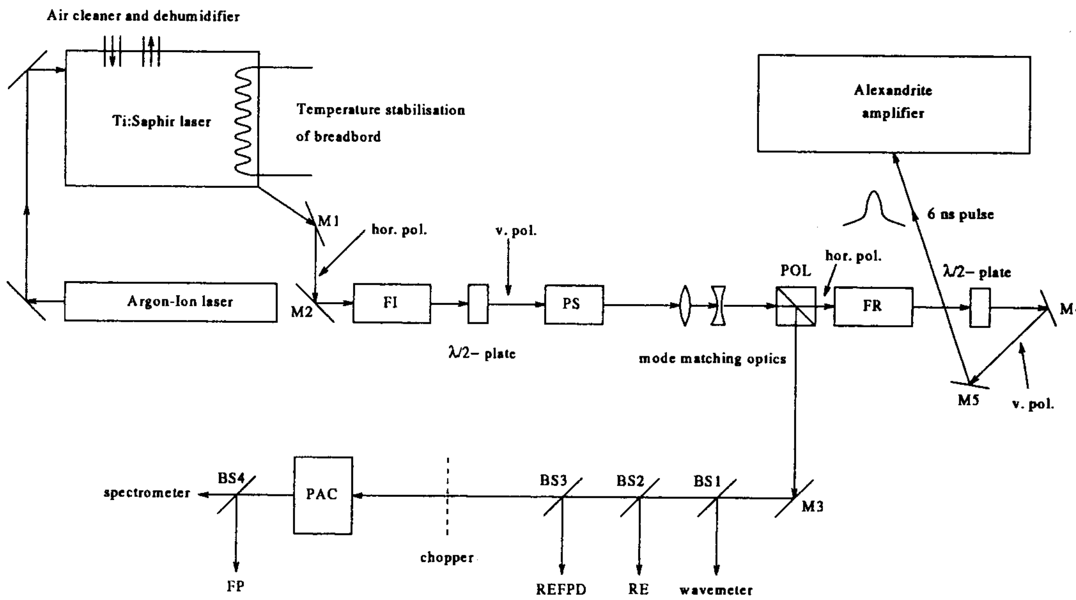


Figure 1: Scheme of lasersystem.
M: mirror, FI: Faraday isolator, PS: pulse slicer, POL: polariser, BS: beam splitter, RE: reference etalon, REFPD: reference photodiode for lock-in amplifier, PAC: photoacustic cell, FP: Fabry-Perot interferometer, FR: Faraday rotator, hor. pol.: horizontal polarised light, v. pol.: vertical polarised light