

ALEXANDRITE LASER SOURCE FOR ATMOSPHERIC  
LIDAR MEASUREMENTS

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During the past years, there has been a marked increase in interest in the applications of vibronic solid-state lasers to meteorology and atmospheric physics. Two airborne lidar programs are now under development in France at CNRS and CNES, in addition to preliminary studies of future lidar applications from space platforms.

The differential absorption lidar (dial) method with vibronic solid-state lasers is very attractive for water vapor, temperature and pressure measurements (1), (2), (3). Alexandrite laser and titanium-sapphire are both suitable for these applications. However, only Alexandrite rods are commercially available to day.

The requirements on the laser source for airborne dial applications are two-fold : i) a restriction on laser linewidth and a requirement on stability and tunability with a good spectral purity ; ii) a requirement on the time separation between the two pulses. These constraints are summarized in table 1. In addition a laser energy of 50 to 100 mJ and a 5 to 10 Hz pulse repetition frequency are also required.

emission wavelength	H2O 725-732 nm	p,T 760-770 nm
spectral width	1 pm	0.3 pm
spectral wavelength separation	70 pm	70 pm
temporal wavelength separation		100-400 $\mu$ s
spectral purity	99 % of the energy in 1 pm	

- Table 1 -

A dual wavelength double pulse oscillator is very attractive with respect to weight, electrical power and volume for future lidar emissions. Such a configuration is under development in our French laboratory and preliminary results have been obtained using a double Q switching with an acousto-optic device. We did demonstrate a broadband double-pulse operation of approximately 50 mJ in each pulse for a pulse separation of 100  $\mu$ s. The total energy of 100 mJ for 140 J is slightly lower than the 110 mJ for a single Q-switching after 250  $\mu$ s. The total energy extracted after 180  $\mu$ s is maximum for a 90  $\mu$ s delay between pulses (figure 1).

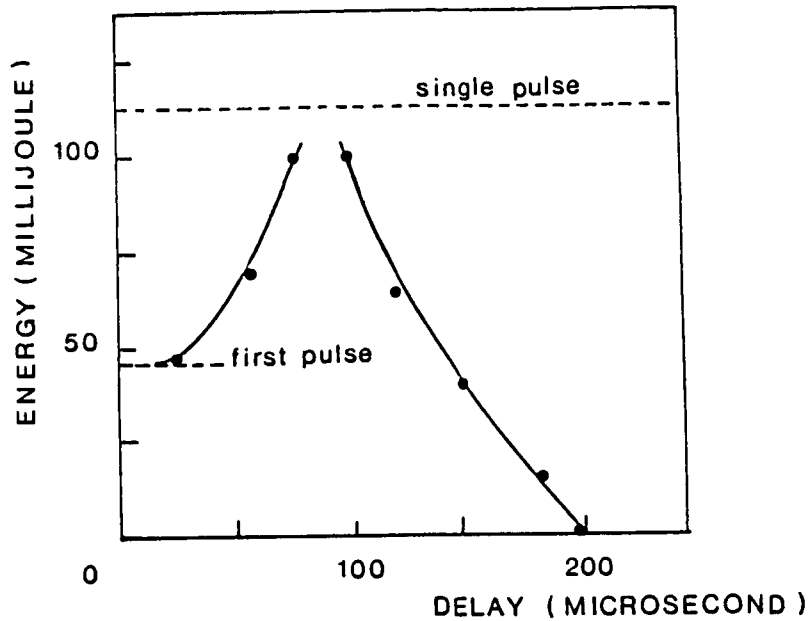


Figure 1 : Total output energy of the double pulse broadband oscillator as a function of the delay between the two emitted laser pulses.

In a separate work a narrow line single pulse emission has been obtained using a new cavity arrangement: the output coupler of the broadband cavity is replaced by an auxilliary cavity made of a diffraction grating G at grazing incidence in conjunction with two mirrors (figure 2).

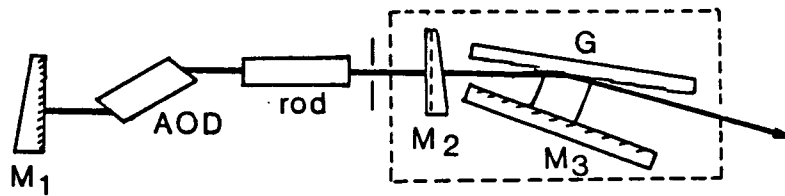


Figure 2 : Synoptic diagram of the narrow band Alexandrite oscillator.

A dual-mode laser emission (equivalent linewidth of 0,5 pm) is observed when the auxilliary cavity length is reduced to 9.3 cm total and when the grating is set at a grazing incidence angle of 88°. The laser mode separation recorded with the Fizeau

interferometer is 0.27 pm. It is in agreement with a value of 0.29 pm calculated from the main resonator cavity length. A strong modulation of the pulse envelope is also observed due to mode beating (fig. 3b). The output energy is 20 mJ (for an input of 180 J). We also observed a quasi-single mode emission (fig. 3c), with a smooth temporal envelop. In this case the observed mode linewidth is 0.14 pm (75 MHz) which corresponds to an experimental finesse of the Fizeau interferometer equal to 17. This value is in agreement with an apparatus function determined by a reflective finesse of 38, a defect finesse of approximately 25 and the number of successive reflections which reduces the experimental finesse at a value smaller than the expected theoretical limit.

Future works including a dual wavelength double pulse transmitter which is a follow-on of our previous developments on a laser pumped dye (4) will be discussed.

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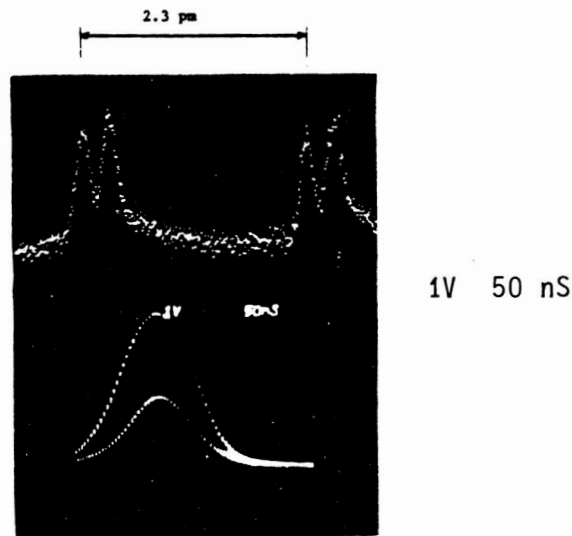


Figure 3 : Bimodal laser emission as recorded a) by a Fizeau interferometer with a 12 cm spacing between plates ( $\delta\lambda = 2.3 \text{ pm}$  between consecutive orders) b) by a fast photodiode (temporal beating)

#### References

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