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PULSED MONONODE DYE LASER DEVELOPED FOR A GEOPHYSICAL APPLICATION

J.P. Jegou, T. Pain and G. Mégie
Service d'Aéronomie du CNRS BP 3
91370 Verrières le Buisson (France)

Following the extension of the Lidar technique in the study of the atmosphere, the necessity of having a high power pulsed laser beam with a narrowed bandwith and the possibility of selecting a particular wavelength within a certain spectral region arises.

We think of some possible experiments in the following fields :
- measurement of the temperature in the upper atmosphere by stimulation of the sodium layer present at the altitude of 90 kilometers
- measurement of the pressure from ground level up to heights of 10-20 kilometers
- measurement of the wind velocity by the Doppler shift detection of the backscattering emission

In addition, new lab spectroscopic experiments can be envisaged.

With the collaboration of J.Y. Meyer (laboratoire de photophysique moléculaire ORSAY - FRANCE) we have developed a laser cavity using the multiwave Fizeau wedge (MWFW). Using the classical method of beam amplification with the aid of different stages, a new pulsed dye laser device has been designed.

The originality resides in the use of reflecting properties of the MWFW. Locally a plan wave coming with a particular angular incidence is reflected with a greater than unity coefficient ; this is the consequence of the wedge angle which doubles the participation of every ray in the interferometric process.

Taking into account the transmitting properties, we obtain a filter closing the laser cavity with a bandwith better than that of a Fabry Perot interferometers (F P). Figure (1) shows the cavity design. It is defined by one MWFW (average thickness : 1,2 mm) and a mirror (MIR). An FP filter 10 mm thick is put in it. Tuning of wavelength is achieved by a step to step translation of the whole cavity (except the beam axis) with the consequent variation of the local thickness of the wedge. The accord of the mode length is realized by a piezo translator fixed at the back of the mirror. The control of the two parameters is performed by a micro computer.

A shortcoming of the Fizeau-cavity configuration results in both the dependence of the spectral response with location observation outside the cavity and with the transverse dimension of the beam. This difficulty is solved by placing a lens just after the output mirror. It plays the role of a pinhole and improves the monomode character of the whole laser.

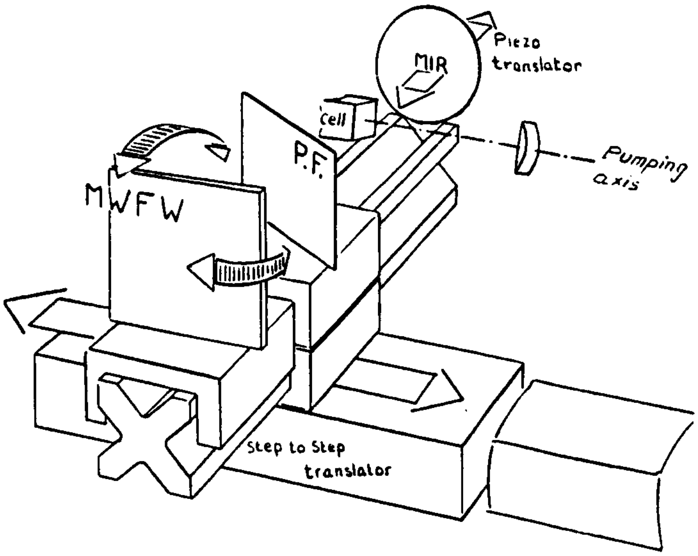

Fig. 1
Setup of the Fizeau cavity (the MIR + PF + MWFW elements are mobile when the wavelength is tuned).

Despite of the weakness of the cavity signal, usually associated with a high super fluorescence in current pulsed lasers, one original set-up permits important gains in amplification and a large final spectral purity (Table 1).

Table 1 Characteristics of the laser device

	oscillator	Ampli 1	Ampli 2	Ampli 3
pump (mJ)	0,7 E-3	0,7 E-3	8 E-3	85 E-3
laser (mJ)	0,3 E-6	30 E-6	2 E-3	30 E-3
$\frac{\text{ASE o}}{\text{ASE + laser}}$ (%) *	no measurable	no measurable	5	35
spectral	/bandwidth	jitter	tunability	
properties (nm)	0,1 E-3	0,4 E-3	4	

* ASE + laser = amplified spontaneous emission + mononode emission
ASE o = amplified spontaneous emission + mononode emission

In our configuration high spectral purity is mainly achieved by combining different processes which decrease the backwards amplified spontaneous emission (ASE, propagating with

the opposite lens of laser beam) (fig. 2) :
- the cavity is partially disconnected from the amplifiers owing to the angle given to the Fizeau wedge used as output mirror. Consequently the reflected ASE on this output mirror is outside of the laser axis. The lens placed just after the cavity and the first amplifier accentuates this phenomenon.

The insertion of a /4 slide in the dye laser beam and the large distance between the third high amplifier and the others enable us to reduce the noise emission.

Mismatching of pumping and dye laser flux at the level of the different amplifiers is the second cause for degradation of the spectral purity.

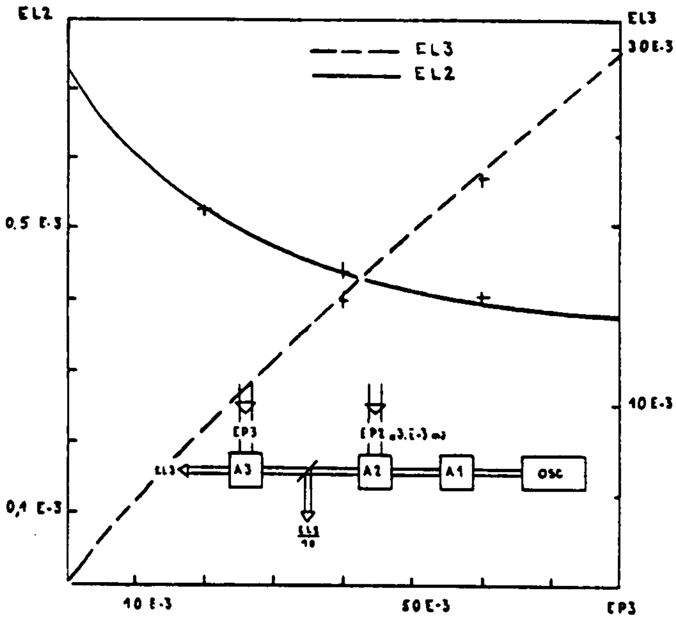

Fig. 2 Influence of the third stage pumping flux EP3 on the dye laser flux emitted by the former stage (EL2)

The feasibility of different geophysical applications envisageable with this laser is discussed.