

Tunable Nd:GSAG Laser Around 943 nm for Water Vapor Detection

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A Nd:GSAG laser operated at the ${}^4F_{3/2} \rightarrow {}^4I_{9/2}$ transition was tuned by a FPI-etalon achieving a tuning range of 1.5 nm with a center wavelength at 942.7 nm. Three water vapor absorption wavelengths confirmed by the ESA as suitable for a water vapor DIAL with different absorption strength are within this tuning range. Lasing could be achieved at all three wavelength.

Water vapor is a very important content of the atmosphere with strong influence on climate and weather. There is a strong demand for improving the knowledge on water vapor distribution in the upper troposphere and lower stratosphere. A DIAL system can measure water vapor profiles simultaneously with high resolution and accuracy. For a space borne DIAL system a set of three absorption lines with different strength is desired. The regions around 935, 943 and 944 nm have been identified as the most suitable [1]. Using the ${}^4F_{3/2} \rightarrow {}^4I_{9/2}$ transition of neodymium in the host crystal gadolinium scandium aluminum garnet (GSAG) lasing around 943 nm can be achieved [2]. With a longitudinal diode pumped laser set-up output pulse energies up to 83 mJ in long pulse mode and up to 26 mJ pulse energy in 150 ns q-switch pulses were achieved [3]. The output wavelength of the previously reported results was centered at the gain peak at 942.7 nm. With the use of a 0.2 mm thick Fabry-Perot etalon the output wavelength of the Nd:GSAG laser could be continuously tuned from 941.9 to 943.4 nm. The emission wavelength was measured using a wavemeter with an accuracy of 5 pm. Fig. 1 shows the tuning curve as well as the stimulated emission cross section of Nd:GSAG and the location of the designated water vapor absorption wavelength. The tuning range was limited to 1.5 nm due to the FSR of the etalon. The two minima in output energy at 942.95 nm and 943.08 nm are due to strong water vapor absorption at these wavelengths which induce high losses in the laser cavity. Two transitions contribute to the strong absorption at 942.95 nm, therefore this wavelength is not suitable for a water vapor DIAL. The other absorption lines in the tuning range are somewhat weaker and do not affect lasing.

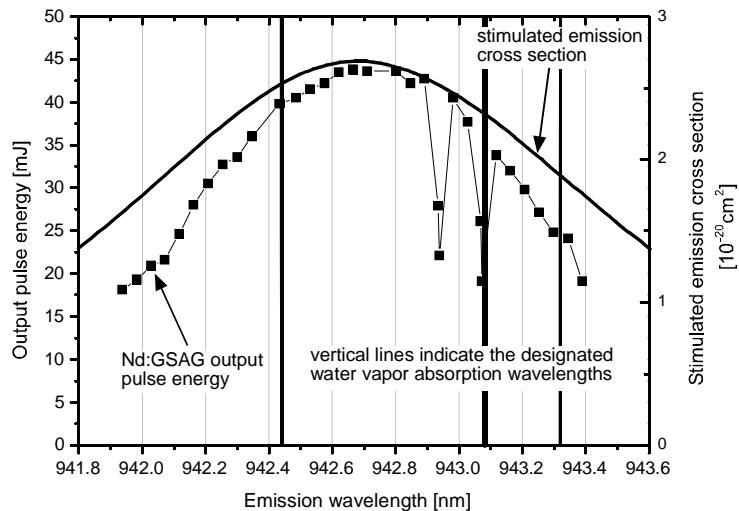


Fig. 1. Tuning curve of the Nd:GSAG laser, the solid line shows the emission cross section and the vertical lines indicate the positions of the three designated water vapor absorption lines with different absorption strength.

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