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ABSTRACT

A novel system for generating single tunable ultrashort light pulses of high power is described. The pulse train from a mode locked flashlamp pumped dye laser passes through an amplifier, which is pumped by an N_2-laser. As gain is only available for a few nsec, only one pulse in the train gets amplified. The energy of the resulting single pulse is about 100μJ.

Single tunable ultrashort light pulses of high power are a useful tool for a large number of scientific and technical applications. Such pulses are typically generated in one of two ways:

1. The mode locked output of a Nd- or Ruby laser, if necessary its second harmonic, pumps a dye laser of matching cavity length.[1-6]
2. A flashlamp pumped dye laser is passively mode locked; usually one or more dye laser amplifiers are used to obtain appreciable powers.[7-9]

If the use of a single pulse is desired, a laser triggered spark gap is commonly used to select one pulse from the train. In any case, the generation of such a pulse is a multistage operation and to keep its performance at an optimum is cumbersome.

In this Letter, we want to describe a system which generates single high power tunable picosecond pulses in a simple and convenient way. The pulse train from a mode locked flashlamp pumped dye laser is sent through a dye laser amplifier, which is pumped by a N_2-laser. The pulse length of an N_2 laser is typically a few nsec and the fluorescence lifetime of laser dyes is of the same order, or less. Therefore, the amplifier has only gain during a few nsec. One can arrange the relative timing of the N_2-laser pulse with respect to the mode-locked train so that only one pulse in the train gets amplified.

Figure 1 shows details of the setup used. The mode locked flashlamp pumped dye laser is of usual design.[10] Rhodamine 6G of a concentration of 5×10^{-4} mol/ℓ is used as the lasing medium. The locking dye--3,3' diethyloxadicarbocyanine iodide (DODCI)--placed in a ~ 0.3mm thick cell, is in direct contact with the 100% mirror. At a wavelength of 6050Å the train of pulses was about 0.8μsec long. With a roundtrip time of 5nsec the estimated energy per pulse is ~ 2.5μJ. The pulse train enters the amplifier cell via two mirrors and a telescope, which reduces the beam cross-section by about a factor of 20. The cell contains a solution of Rhodamine B (5×10^{-3}mol/ℓ), which has been chosen to match the gain maximum of the amplifier to the tuning range of the mode locked laser. The entrance and exit window are AR coated and tilted by about 10° to avoid feedback. The amplifier is transversely pumped by a N_2-laser (3mJ in 8nsec) of a design similar to that in Ref. 11. The pumped region is rod shaped of the dimension of about 10mm × 0.1mm × 0.1mm. To avoid lasing of the amplifier by itself via reflection at the output mirror of the mode locked laser, the distance between amplifier cell and the flashlamp pumped laser is several feet. The beam cross section of the mode locked pulses is about 0.25mm^2 and spatial overlap with the pumped region of the amplifier is readily achieved. A pulse generator triggers the two lasers in such a way that the N_2-laser pulse falls around the center of the mode locked train. The repetition rate of the system is limited to 10 pulses/sec.

Figure 2a shows the output of the amplifier, which consists in essence of one single instrument limited pulse. Its energy is about 100μJ. Note that 5nsec to its right a neighboring pulse, which still experienced some amplification, is clearly visible. With some feedback, the amplifier turns into an oscillator and its output is about 300μJ. Therefore, we can expect that, with a more powerful N_2-laser to pump the amplifier, a further increase in the energy of the amplified picosecond pulse can be obtained.

However, even the 100μJ output compares quite favorably with the values reported in previous works. Royt <u>et</u> <u>al</u>.[6]

obtained tunable picosecond pulses with about 30μJ/pulse from a Rhodamine 6G laser synchronously pumped by the frequency doubled output of a Nd-glass laser. Apart from the low repetition rate due to the glass laser the disadvantages of this method are the difficulties in running a multistage system and the fact that the high Nd-laser intensity required for pumping causes severe damage problems for the glass laser components.

Adrain _et al._[9] obtained 70μJ/pulse from a rather large (200J input) flashlamp pumped Rhodamine 6G laser. The pulses were further amplified by a flashlamp pumped amplifier (1000J input) to about ~ 1mJ/pulse. However, the use of a flashlamp pumped dye laser amplifier to amplify a single picosecond pulse is rather wasteful, as the pump time (~ 1μsec) is so much longer than the storage time of the amplifier.

Passive modelocking of flashlamp pumped dye lasers have been obtained with various dye combinations over extensive regions of the visible spectrum.[13] With the N_2-laser being an effective pump for a large number of dyes, the method described in this Letter can be readily extended to other wavelength regions.

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FIGURE CAPTIONS

Fig. 1. Experimental setup.

Fig. 2. a) Single, instrument limited pulse at the output of the N_2-laser pumped amplifier; a neighboring pulse, which still obtains some amplification is clearly visible to the right.

b) Part of the mode-locked output of the flashlamp-pumped dye laser. Timescale 10nsec/cm, amplitudes in arbitrary units.

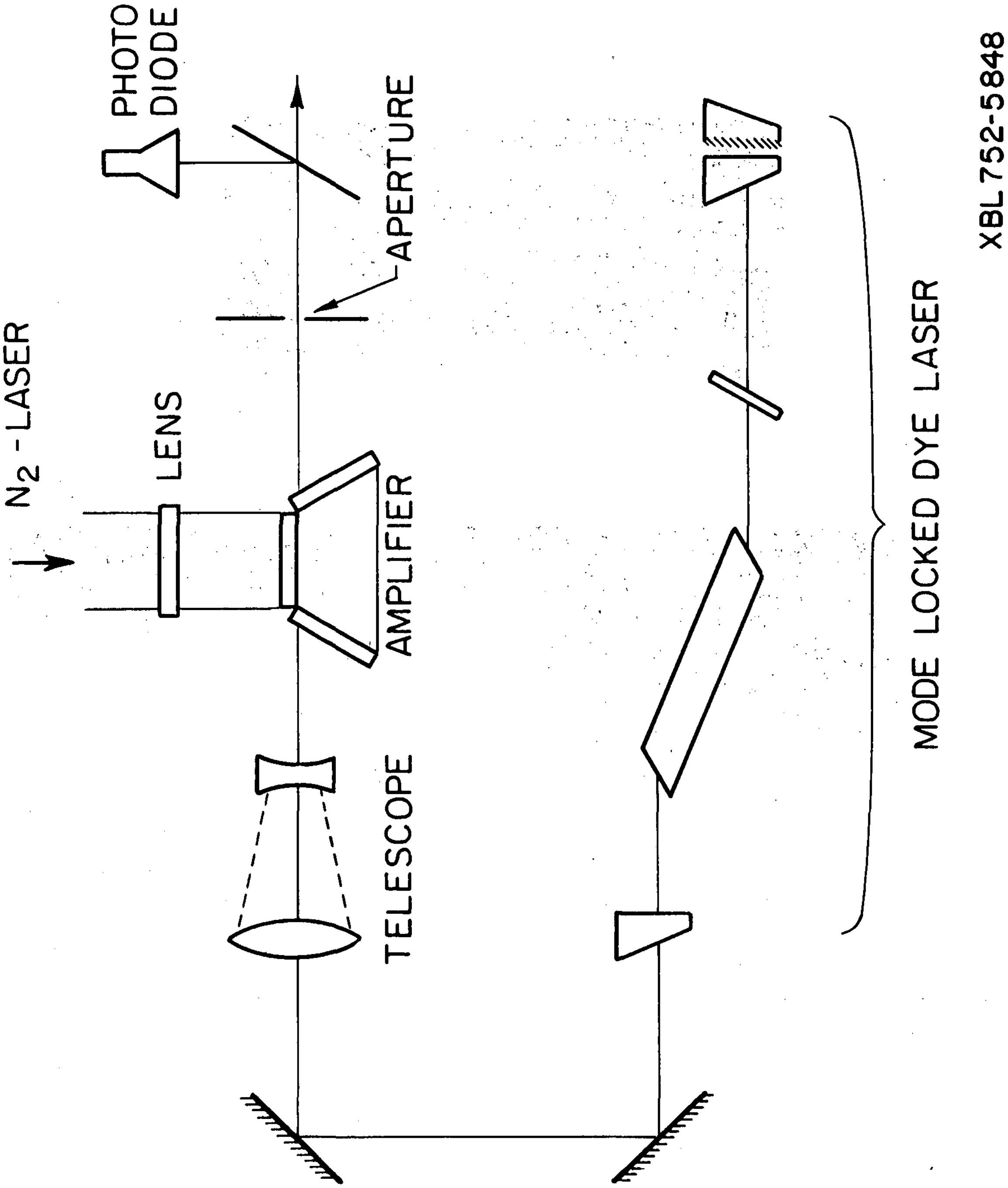
PHOTO DIODE
APERTURE
N_2-LASER
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Fig. 1

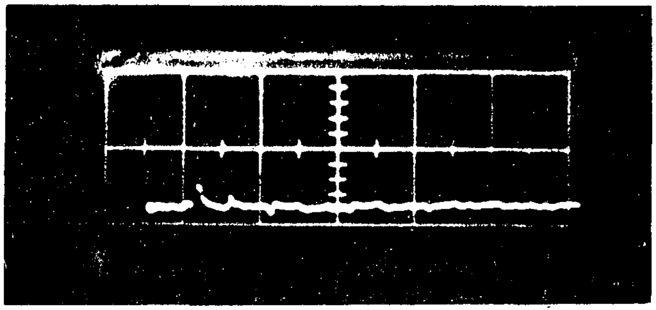

Fig. 2a

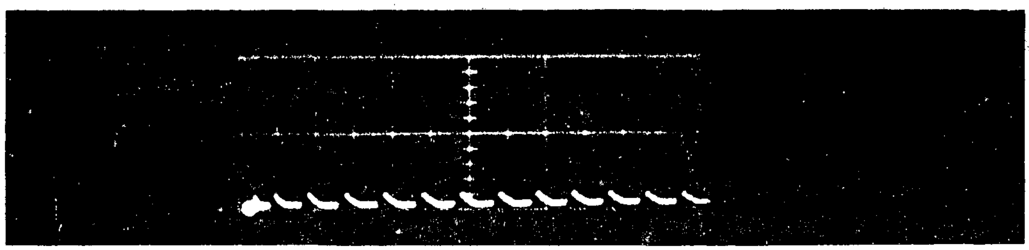

Fig. 2b

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