SIMPLE BICHROMATIC LASER EMITTER

K.V. Gurkov, G.E. Kulikov, and V.P. Lopasov

Institute of Atmospheric Optics,
Siberian Branch of the Russian Academy of Sciences, Tomsk

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Construction of a two–pulse bichromatic laser emitter is presented. Emission frequencies and frequency range can be stabilized or quasi–continuously tuned within a linewidth of an active medium amplification band Δν. Synchronization of Q–switched pulses is performed using an electrooptical cross feedback, whereas narrow spectrum and frequency tuning is done with a thin Fabry and Perot etalons.

Remote sensing of the atmosphere using differential absorption or Raman spectroscopy techniques needs for a two–pulse two–frequency, narrow line, emitter whose output spectrum can be tuned within the absorption line profiles of atmospheric gases (0.5 cm^{-1}) (see Ref. 1). In developing such a laser device output energy, pulse duration, as well as pulse repetition rate and polarization are to be considered as important characteristics in practice. Complicated optical systems with electrooptical Q–switching and photoelectric cross feedback are usually used to meet all these requirements.[2–4]

In this paper, a simple pulsed bichromatic emitter is described (see Fig. 1). It consists of two lasers with electrooptical Q–switching coupled by photoelectric positive cross feedback. Two 6×65 mm rods of ittrium aluminate *1* and *11* were used as active elements with radiative relaxation profile of $\Delta\nu = 11–12$ cm^{-1} width near $\lambda = 1079.6$ nm, Q–switching is being done with active shutters *5* and *15* made of lithium tantalate; laser frequency was doubled in KDP crystals *9* and *19*.

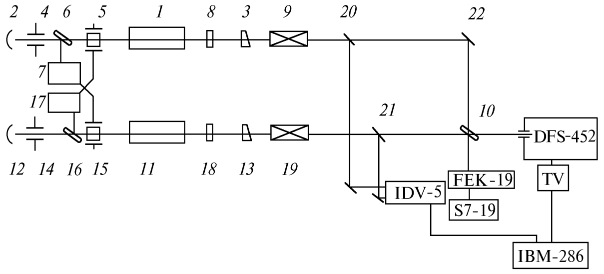

FIG. 1. Block diagram of a bichromatic laser emitter.

Resonators were formed by spherical reflectors *2* and *12* of $F = 1000$ mm focal length and flat semitransparent mirrors *3* and *13* with the reflectivity $R = 35$ and 50%; spacing between mirrors is 850 mm. Resonator axial modes were selected by apertures *4* and *14* of 1.75 mm diameter. The laser wavelength was determined and tuned by a tilting thin Fabri–Perot etalons *8* and *18*.

Radiation of working polarization was separated by polarization mirrors *6* and *16* directing the beam with unwanted polarization to fast *p–i–n* photodiodes included in switch circuits *7* and *17* that control electrooptical shutters. After frequency doubling the residual IR laser radiation at $\lambda \sim 1079.6$ nm is directed by mirrors *20* and *21* to high–precision two–channel wavelength measurer IDV–5 for laser spectrum control. Second harmonic radiation is directed by mirrors *10* and *22* to DFS–452 spectrograph for preliminary monitoring of laser frequency and spectrum. After the beam passes through DFS–452 it is detected with TV–camera with a tube of "supersilicon" type. Information obtained from IDV–5 and TV–camera was processed by IBM PC AT/286.

Unlike to Refs. 2–4 we used switch circuits allowing feedback variation exclusively due to variation of bias voltage applied to electroopticals shutters. Switch circuits *7* and *17* which provide high voltage for shutters were placed near both electrooptical modulators. Two fast *p–i–n* photodiodes were included in a switch circuits in such a way that they were illuminated by laser radiation scattered by the electrooptical shutter. This resulted in removal of high voltage and opening of the shutter. The initiation threshold for each circuit was adjusted separately, the circuits were controlled by radiation with unworking polarization in such a way that Q–switching of channel *2* was initiated by radiation from the channel *1* and vice versa.

Using the first harmonic radiation the coincidence of laser pulses was examined approximately by two consistent *p–i–n* photodiodes loaded by trigger circuit whereas laser wavelength in each channel was measured precisely with an IDV–5.

Using the second harmonic radiation the bichromatic output spectrum is roughly monitored with DFS–452, laser line width was approximately inspected by a Fabry–Perot etalon with a 20 mm spacer and temporal characteristics were fixed precisely by a fast photodiode FEK–19 and an oscilloscope S7–19.

The oscillators in each channel were adjusted like for a free–running operation mode, then Q–switching control circuits were turned on and the initial voltage applied to the shutters was selected (that value was close to the quarter wave one). As a result, the synchronization of laser pulses was better than 10 ns. The synchronization was maintained during not less than three hours without additional adjustment. The temporal separation between two laser pulses can be varied smoothly within 0–150 ns by selection of the voltage across the electrooptical shutters (not higher than 50 V) and (or) by changing the level of the laser pump.

The radiation parameters obtained from the bichromatic emitter described are as follows:

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Active medium	ittrium aluminate
Tuning range, cm^{-1},	
the first harmonic	9256–9265
the second harmonic	18512–18530
Frequency difference between two channels, cm^{-1}	0–9
Second harmonic line width, cm^{-1}	0.02
Pulse repetition rate, Hz	12.5
Pulse duration, ns	25
Pulse synchronization error,ns	10
Temporal separation between laser pulses, ns	0–150
Total energy* in bichromatic of the second harmonic radiation, mJ	2
Polarization orientation	parallel

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*Independent of the temporal separation between laser pulses.

The construction of bichromatic emitter presented here has demonstrated stable synchronization of the laser pulses. It should be pointed out that the electrical part of the system described is more compact and reliable as compared to those presented in Refs. 2–4 due to the absence of fragile and bulky photomultipliers.

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