Laser system for recording optics

V.V. Semenets
Kharkiv National University of Radio Electronics
Kharkiv, Ukraine
email: valery.semenets@nure.ua

M.V. Neofitnyy
Kharkiv National University of Radio Electronics
Kharkiv, Ukraine
email: mykhailo.neofitnyy@nure.ua

Yu.P. Machekhin
Physical Foundations of Electronic Engineering Department
Kharkiv National University of Radio Electronics
Kharkiv, Ukraine
email: yuri.machekhin@gmail.com

O.S. Hnatenko
Laboratory "Photonics"
Kharkiv National University of Radio Electronics
Kharkiv, Ukraine
email: oleksandr.hnatenko@nure.ua

V. I. Zarytskyi
Kharkiv National University of Radio Electronics
Kharkiv, Ukraine
email: valerii.zarytskyi@nure.ua

S.V. Gulak
Kharkiv National University of Radio Electronics
Kharkiv, Ukraine
email: s_gulak@ukr.net

***Abstract* — The development of a modern laser system for recording optics is presented in this research paper. Studying optical components for designing this system by various methods, by calculated methods and by a method of using modern modeling package Zemax, was conducted. The results of the calculations and simulation, which led to the preliminary design of the laser system of optics registration, coincide.**

Keywords— laser system, lenses, emission, photodiode, field distribution.

I. INTRODUCTION

To date, there are a large number of lasers of different generations [1-3], which are used in almost all spheres of science and technology: in information systems [4-6], biomedicine, industry and in a variety of optoelectronic systems. In addition to laser technology, devices for amplifying, scanning, and processing signals at various points are widely developed [7-8]. Concerning Researchers of the Kharkiv National University of Radioelectronics and the Laboratory "Photonics" are investigating and developing a laser system for recording optics. The block schematic diagram of the laser system for recording optics is shown in Figure 1.

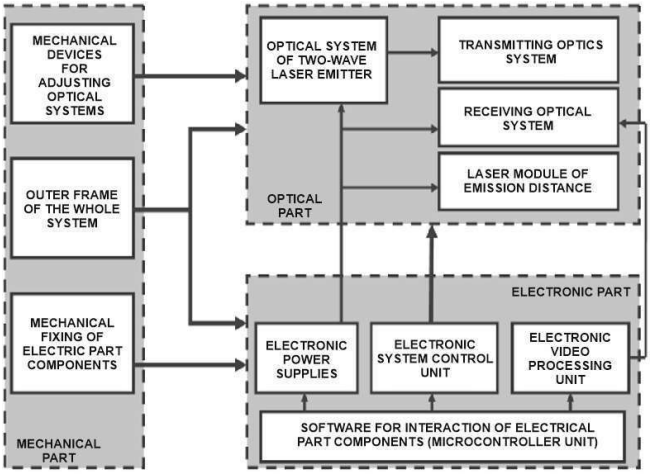


Fig. 1. The block schematic diagram of the laser system for recording optics

Let's consider the principle of recording an optical object with a laser recording system in simplified form, Fig. 2.

The laser emission from the source (probing beam) enters the sight of the objective lens or another optical device, passing through the diaphragm, which is formed by the parts of the device body itself.

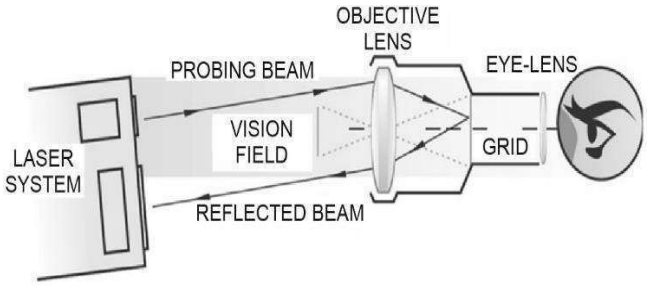


Fig. 2. Schematic view of the operating principle of the laser system for recording optics

In the focal plane of the lens there is an aiming or longitudinal grid. The bulk of incident laser emission passes through a grid, enters the vision field, and then, passing a complex optical system of the eye-lens, enters the receptor apparatus. But some part of the incident laser emission is reflected from the grid and passes through the lens once again and returns to the emission source parallel to the incident emission. Also, some part of the laser emission is reflected from the visual part of the retina and goes through the optical path through the eye system and the optical device, and also returns to the emission source. In this case, if the optometric system uses an infrared camera, then on the computer screen or on the display, it is possible to see an intense glare, thereby recording the optical device.

Laser emitters of the near infrared range, which the human eye does not see, are used in the detection systems in order for the observer to not be able to see that he/she has been detected. From the above it turns out that a situation in which an optical object - a surveillance device or an elevating sight, acts as a reflector of infrared radiation, and the human eye simply does not perceive it, as shown in Fig. 3.

Fig. 3 shows that the human eye has practically zero sensitivity to emission with a wavelength of more than 700 nm, which is actually used in laser optic recording systems to be unobtrusive. But there are also methods of combating such systems, for example, the use of filters that do not transmit infrared emission.

978-1-7281-1814-7/19/31.00 © 2019 *IEEE*

138 μm. When defocused by -50 μm, the diameter of the scattering spot will increase for 808 nm to 90 μm, for 915 nm to 185 μm; when defocused at -100 microns, the diameter of the scattering spot will change for 808 nm by 140 microns, for 915 nm - by 186 microns. That is, the detection of optics defocus is not significant when designing the receiving part of the laser system, but it needs to be taken into account and made adjustments to the design of the frame.

Figure 15 shows the curves of aberrations, which indicate their presence and coincide with the previous calculations in A part of the section III. That is, the aberrations for the vertical and horizontal components of the polarization of radiation with a wavelength of 808 nm and 915 nm are ± 100 μm or ± 10 waves.

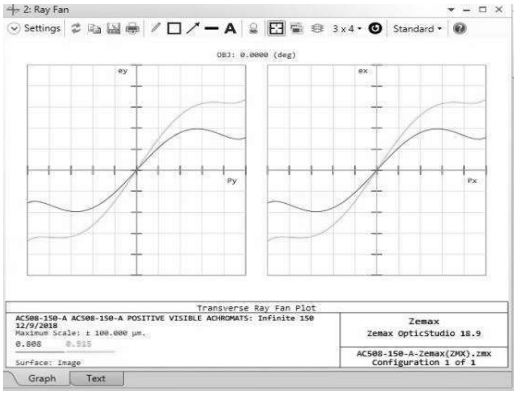


Fig.15. Projection of aberration curves for a AC508-150-A lens

Fig. 16 depicts the curve of possible defocusing of the collimating lens in the receiving optics. From the figure it can be seen that, at the worst characteristics of the optics of the photodetection node in the laser system, defocusing can be 808 nm to 180 μm, and 915 nm to 250 μm for the wavelength. Although the data are theoretical, they need to be taken into account when manufacturing a prototype laser system for detecting optics by adding alignment devices with a micrometric step into the design.

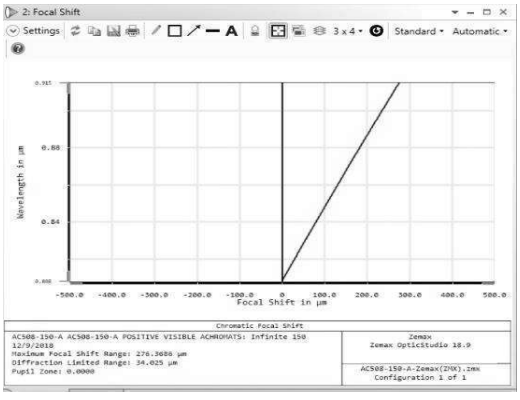
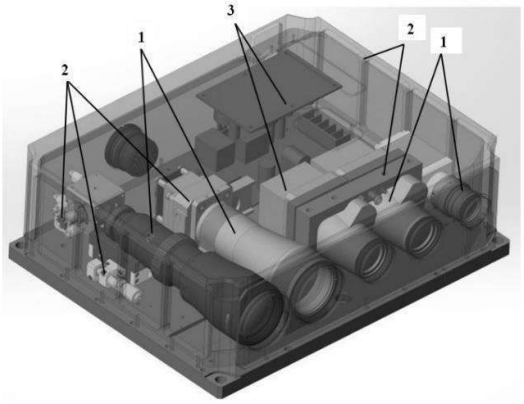


Fig.16. Emission defocusing curve by optics of a photodetector unit node

IV. CONCLUSIONS

As a result of the research work were solved the following challenges: the parameters and characteristics of the photodetector unit of the laser optics recording system were investigated; the emission distribution in the photodetector unit was simulated; the scattering spot for the lens of the photodetector module was determined. The electronic software for the laser optics recording system was both designed and manufactured.

A conceptual design of a laser optics recording system was carried out based on the results obtained, Fig. 17.



1 - elements of the system optical part; 2 - elements of the system mechanical part; 3 - elements of the system electronic part.

Fig.17. Rough sketch of the general design of the laser system for recording optics

REFERENCES

[1] Yu.P. Machekhin, Yu.S.Kurskoy, A.S.Gnatenko, V.A. Tkachenko, Nanolaser superradiation in information and measuring procedures, Telecommunications and Radio Engineering, vol. 77, no.13, pp. 1179-1186, 2018.

[2] Yu.P. Machekhin, A.S.Gnatenko, Yu.S.Kurskoy, Photonic crystal nanolasers as optical frequency standards, Telecommunications and Radio Engineering, vol. 77, no.13, pp. 1169-1177, 2018.

[3] A. V. Vasianovych, A. S. Gnatenko, D. V. Pustylnikov, Optimization of thermal regime of continuous CO_2-lasers with diffusion cooling, Telecommunications and Radio Engineering, vol. 77, no.19, pp. 1685-1695, 2018.

[4] A.S.Gnatenko, Y.P. Machechin, Generation mode stability of a fiber ring laser, Telecommunications and Radio Engineering, vol. 74, no.7, pp. 641-647, 2015.

[5] A.S.Gnatenko, Yu.P. Machekhin, Yu.S. Kurskoy, V.P. Obozna, Providing mode locking in fiber laser, J. Nano- Electron. Phys., vol.10, no.2, p.02033,2018. (in Russian).

[6] A.S.Gnatenko, Yu.P. Machekhin, Yu.S. Kurskoy, V.P. Obozna, A.V. Vasianovych, Ring fiber lasers for telecommunication systems, Telecommunications and Radio Engineering, vol. 77, no.6, pp. 541-548, 2018.

[7] I.N. Bondarenko, A.V. Galich, Measuring resonant transducers on the basis of microstrip structures, Telecommunications and Radio Engineering, vol. 74, no.9, pp.807-814, 2015.

[8] I.N. Bondarenko, A.V. Galich, Resonant irregular hybrid structures. 13-th International Conference "Modern problems of radio engineering, telecommunications and computer science" (TCSET 2016), 23-26 Feb., Lviv, Ukraine, 2016. pp. 183-185.

[9] A.A. Shehonin, V.M. Domnenko, O.A. Gavrilina, Optical Instrument Design Methodology, St. Petersburg , St.P.: ITMO University, 2006. (in Russian).

[10] A.S. Gnatenko, Yu.P. Machekhin, Yu.V.Natarova, The control system of the pump diodes fiber ring femtosecond lasers, Applied Radio Electronics: Sci. Journ., vol. 14, no. 2, pp 185–188, 2015. (in Russian).

[11] E.V.Avdeev, A.T.Eremin, I.P.Norenkov, M.I.Peskov, Design automation systems in radio electronics, Moskov, M.: Radio i svajz, 1986. (in Russian).

[12] Robert E. Fisher, Beljana Tagic-Galeb, Paul R.Yoder. 2nd ed., Optical system design, NY SPIE Press, 2008.

[13] N.P. Zakaznov, Theory of Optical Systems, St. Petersburg , St.P.:Lan, 2008. (in Russian).