Abstract—The goal of this work is to build pulse periodic laser for pumping parametric amplifier of signal radiation with wavelength 1054 nm and energy in the pulse 1 nJ up to the values of several tens µJ.

Keywords—pulse periodic laser; parametric amplifier

The goal of this work is to build pulse periodic laser for pumping parametric amplifier of signal radiation with wavelength 1054 nm and energy in the pulse 1 nJ up to the values of several tens µJ. Parametric amplification was chosen as far as practical applications, for example for powerful facilities, which realize the principle of laser thermonuclear fusion (LTF), require very high time contrast (up to $10^8$) realized in nanosecond pulses. Besides, in order to perform uniform compression of the target, one will need high spatial uniformity of intensity distribution over the laser beam section. The typical schemes of amplifiers built according to the principle of laser amplification of the light will not provide simultaneous meeting necessary requirements.

Within this activity, we performed the development and experimental prototyping of pumping laser (PL) scheme for parametric amplifier of the light. Optical scheme of PL is built according to the principle of single-pass amplification in the cascades of amplification. For the master generator, pulse diode is used with fiber amplification and formation of time profile, which is performed at the cost of fiber separation by several channels with different amplification and introduction of time delay at the cost of the length of fiber tract.

In solid amplifier, cascaded transfer of object plane was realized, beginning from forming diaphragm and subsequent intermediate formation of image planes at the input edge of active elements and air gap between nonlinear crystals of frequency duplication node. This permitted to control spatial profile of intensity distribution in PL beam at the cost of diffraction limitation of the beam aperture in spatial transponder [1], which is located in the beginning of amplification tract. It will be necessary to control spatial profile, when one needs to determine optimum shape of intensity distribution. In some cases, it is necessary to have Gaussian profile of beam section, and in other cases – super Gaussian profile of different orders, for example for LTF problems. In order to provide the protection against reverse radiation, amplification tract has polarization decouplers, based on Faraday cells, controlling the direction of polarization plane are performed with the help of half-wave phase plates. For optical amplification heads, laser heads of IGLA series [2] are used with cylindrical active elements (AE) out of YAG:Nd (orientation of crystallographic axes - 111) and by semi-conducting pumping. Diameter of these AEs is 3, 4 and 10 mm. Amplification heads are installed in the channel by pairs, and this permitted to perform compensation of induced two-beam refraction under operation in pulse-periodic regime. The node of doubler consists of two thermo-stabilized nonlinear LBO crystals; optical scheme of frequency duplication realizes the principle of optical axes drift compensation [3]. For this purpose, crystals were fabricated in the following way: the length of the first crystal is half of the length of the second one, angle $\phi$ for the first crystal is 11.3 degrees, and for the second, it is -11.3. This permitted to get the efficiency of nonlinear frequency transformation by the energy 80%.

The main characteristics of amplification channel with single-pass frequency are the following:

- Energy of master generator pulse: 10 µJ;
- Energy of the pulse for output laser radiation with wavelength 1064 nm: 1 J;
- Energy of the pulse for laser radiation with the wavelength 532 nm: 0.8 J;
- Aperture of output amplifier of pumping laser: 9 mm.

The figures show spatial form and the duration of pumping laser pulse.