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Review of special issue on high power facility and technical development at the NLHPLP

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Achieving ignition of ICF (inertial confinement fusion) has been the great dream that scientists all over the world pursue. As a grand challenge, this aim requires energetic and high quality lasers. High power laser facilities, for this purpose, have therefore flourished over the past several decades. Meanwhile high power laser facilities, also essential for high-energy-density (HED) scientific research and astrophysics, drive rapid progress of material science, electronics, precision machinery and so on. Many countries have successfully established a succession of facilities to study ICF and HED physics, such as National Ignition Facility (NIF)[1] in the United States and the Laser Megajoule (LMJ) in France[2]. China, conducted such research activities early, as one of the few countries having the capability of developing high power facilities independently. As the major pioneer dedicated to high power laser technology and ICF research in China, the National Laboratory on High Power Laser and Physics (NLHPLP) and its precursor have established a succession of facilities since 1973. In 1986 NLHPLP was formally established at Shanghai Institute of Optics and Fine Mechanics; this opened up a new era of laser fusion research in China. Since then the facilities at NLHPLP entered into 'Shen Guang' families. Since the SG-I facility dismantled in 1994, NLHPLP has successively constructed SG-II laser facility, SG-II 9th beam, SG-II upgrade (SG-II UP) facility, and SG-II 5PW facility. These operational facilities constitute a multifunctional experimental platform, which provide important experimental capabilities by combining different pulse widths of nanosecond, picosecond and femtosecond scales. SG-II facility, greatly promoting Chinese ICF research, has had a stable and excellent operation for approximately 20 years. A newly built SG-II UP facility, consisting of a single petawatt picosecond system with kJ-class output and eight-beam nanosecond capability with multi-pass amplifier configuration, has achieved the required outputs. This facility marks a major step of increasing capability of designing and constructing high power facilities. In addition, SG-II 5 PW facility is already operational for physical experiments. Construction of these facilities has driven the fabrication and processing of large optical components. Furthermore, many advanced technologies have been developed that ensured good performance of these systems. Apparently with operations spanning 30 years, NLHPLP is an important scientific research base on high power laser scientific research in China.

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This special issue of the journal *High Power Laser Science and Engineering* will widely present the recent work at NLHPLP. Two review articles on the facilities are contained in this issue and other articles introduce some critical subsystem and technology developments such as the injection subsystem, final optics subsystem, alignment technique, beam controlling technique, and amplifier cleaning technique.

A review article by Zhu *et al.*[3] gives a thorough introduction of the status and performance of high power laser facilities at the NLHPLP. Another review article[4] named 'analysis and construction status of SG-II 5PW laser facility' presents the recent progress of the SG-II 5PW facility.

Fan *et al.*[5] report the key technological progress involved in the injection laser subsystem. Jiao *et al.*[6] mainly summarize the design and performance of the final optics assembly in SG-II UP facility. In addition, Ren *et al.*[7] present target alignment, discussing the basic principles of target alignment, the alignment units and procedure in SG-II UP facility.

For the key units developed, Zhang *et al.*[8] describe Nd:glass regenerative amplifiers with long-term output energy performance and Huang *et al.*[9] demonstrate a laser diode end-pumped helium gas-cooled multislab Nd:glass laser amplifier. Huang *et al.*[10] report an optically addressed liquid crystal modulator for wavefront control of 1053 nm laser beam, introducing working principle, control method and spatial phase modulation capability. In addition, Tang *et al.*[11] present a new sensor for auto-alignment in a laser system based on ghost reflection. Ren *et al.*[12] propose a cleaning technique and optimize the cleanliness in multi-segment disk based on vector flow schemes, demonstrating more effective cleanliness levels with the vector flow scheme.

For beam quality analysis of petawatt laser systems, Zhu *et al.*[13] give a systematic study of spatiotemporal influences on temporal contrast in the focal region in large-aperture broadband ultrashort petawatt lasers.

For processing and coating of the components developed, Zhou *et al.*[14] present a directly writing binary multi-sector phase plate on fused silica using femtosecond laser. In addition, Xiong *et al.*[15] have developed a type of $\lambda/4$–$\lambda/4$ ultra-broadband antireflective coating using modified low refractive silica and high refractive silica layers by a sol–gel dip coating method for amplifier blast shields of SG-II facility.

At present, although high power laser technology gains impressive improvements, there is still a long path toward fusion ignition. Increasing the available laser energy and performance is urgently needed. Just in July 2018, it was reported that NIF has set a new record, firing 2.15 MJ of energy to its target chamber[16]. Faced with this opportunity as well as challenge, NLHPLP will continue to enhance the abilities of designing, constructing, and operating high power facilities, enabling possible larger-scale laser drive developments. Moreover, NLHPLP will stick to the spirit ‘unity of knowledge and action, grasp of opening and cooperation’. It is our hope that through this special issue more students and researchers become actively involved in this meaningful field.

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