Development of 100J-level kW cryogenic gas cooled DPSSL for high energy density experiments at the European-XFEL facility.

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High energy, high repetition rate laser systems are pivotal to the development of scientific and commercial application. Direct applications of such systems include materials processing, such as laser shock peening, and compression of matter to extreme densities. Alternatively, these lasers can be used as pump sources for Ti:sapphire or OPCPA amplifier chains, for the realisation of the next generation of PW-class lasers. The DiPOLE amplifier concept, developed at the STFC Central Laser Facility rely on cryogenic gas cooled, multi-slab ceramic Yb:YAG DPSSL system and allows a scalable, high-energy, high-repetition rate laser [1,2]. Recently, 100J-level performance was demonstrated based on the DiPOLE concept and was commissioned at the HiLASE facility [3]. The successful operation and satisfactory performance of the kW-class 100 J nanosecond pulsed laser has led to the development of another system to be made available to users of the high energy density (HED) instrument at the European XFEL in collaboration with HiBEF / HZDR. This system, DiPOLE-100X, with frequency up-conversion (SHG) will be used for compression of materials which will be probed by bright X-ray pulses for fundamental research into their structure at high density [4]. In this paper, we report on the operational and commissioning results of the DiPOLE-100X laser currently being developed at the Central laser facility (CLF). Additionally, results from frequency up-conversion experiments for second harmonic (SHG) and third harmonic generation (THG) on a scaled down prototype will also be presented.

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[4] M. McMahon *et al*, "Conceptual Design Report - Dynamic Laser Compression Experiments at the HED Instrument of European XFEL," XFEL.EU TR-2017-001, February 2017.