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Roadmap at Amplitude of 0.1 Hz kJ-class laser for Shock applications.

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Abstract: We will present in this paper the latest results and ongoing developments on high rep-rate high energy glass lasers. These lasers are dedicated to applications such as Ti:Sa pumping, OPCPA pumping, Laser Shock Peening and also Laser Driven Dynamic Shock Compression. These lasers, named Premiumlite, rely on an innovative liquid-cooled multi-disks amplifier technology. The core technology has been validated in October 2018 in the framework of ELI-ALPS, with Nd:YAG as amplifier medium, by the demonstration of respectively 75J/53J at 1064/532nm at 10Hz (750W and 530W average power) in a single beam and a single pulse of a few ns duration. Replacing the 100mm diameter Nd:YAG disks by Nd:glass disks will result in the demonstration of more than 250J at 0.1Hz at 1053nm. At the moment a glass version of the Premiumlite is under manufacturing for the European Synchrotron Radiation Facility (Grenoble, France). It will deliver >100J at 1053nm and will be upgradable up to 250J in the future. A new version with 200mm diameter glass disks, direct extrapolation of the 100mm disks, is under design and will offer the opportunity to reach the kJ level at 1053nm at an unprecedented rep-rate close to 0.1Hz with sub-ns pulsewidth and pulse shaping capability.

September 2014, Amplitude Technologies has been selected for the supply and commissioning of the HF laser system at the ELI Attosecond Light Source Pulse Source (ELI-ALPS) facility in Szeged, Hungary, one of the three pillars of the ELI program in Europe dedicated to attosecond science [1].

In this presentation we will briefly introduce the pump laser Premiumlite in its Nd:YAG version and its core technology, the Liquid-Cooled Pseudo Active Mirror Disk Amplifier Module (Fig. 1). This amplifier is flashlamp pumped for economical reasons and includes a very efficient cooling set-up resulting in manageable residual aberrations. On the same basis and modulo a few modifications of the power supplies and the replacement of Nd:YAG disks by specific glass phosphate disks, a laser with than 3.5 times more energy but lower rep-rate has been designed. A laser delivering 100J at 1053nm at a rep-rate up to 0.1Hz is under manufacturing for the ESRF. The large beam diameter will permit to deliver pulses from 4 to 15ns. In this specific case, the laser is seeded by a CW fiber front-end from iXblue (France) equipped with a high contrast Niobate Lithium amplitude modulator for temporal pulse shaping with 150 ps resolution. The pulse shaped pulse is then seeded in a 27ns-length regenerative cavity. Further amplification from the mJ level to 15J is done in 25mm glass amplifiers; last the pulse is amplified to >100J in three disks amplifiers. A ns contrast close to 10^5:1 is expected. This laser will be commissioned in Grenoble end of 2020 and will be dedicated to Dynamic Shock Compression. The laser beam will be focused onto the solid targets with a Phase plate. To mitigate the speckle onto the target, a specific SSD (Spectral Smoothing Device) phase modulator has been implemented in the fiber front-end.

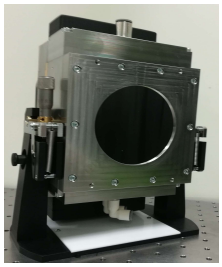

Fig. 1 : Active Mirror Disks Amplifier

The scalability of the disk amplifier technology can satisfy the interest of several labs in Europe and China for the same kind of laser but with kJ-level energy. A Premiumlite-Glass with 200mm disks diameter has been designed. This laser will make it possible to increase dramatically the scientific datas collected per day. We expect it will be a unique tool capable of taking great advantage of the progress of Artificial Intelligence implementation in facilities.

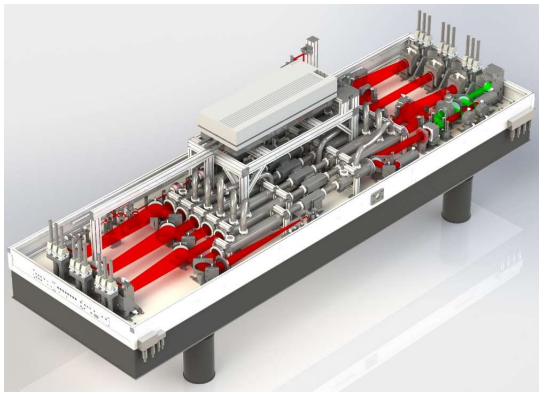

Fig. 2 : 3D view of the Premiumlite-glass

[1] http://www.eli-hu.hu/