Development of a 2J-Subnanosecond MOPA system

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We present the development of a low-footprint sub-nanosecond multi-Joule-class laser system, aiming at applications in ultra-short laser pumping and high-power THz generation.

The system will be based on Master-Oscillator Power-Amplifier (MOPA) architecture. A monolithic microchip laser will be used as the oscillator, with output energy of 3mJ.

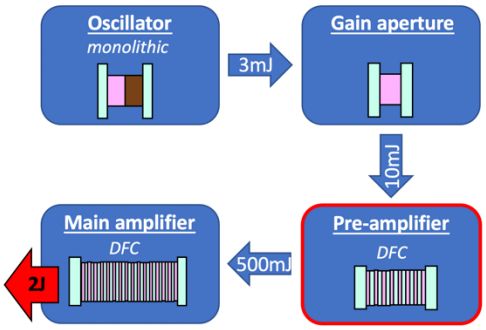

Fig. 1. Schematic MOPA architecture.

The previously developed Gain Aperture [1] will clean the beam shape and increase its energy to 10mJ before the preamplifier module, that will consist in end-pumped Distributed Face Cooling (DFC) [2] gain medium. The last section of the system is the main amplifier, also based on end-pumped DFC-module.

This presentation will focus on calculations for output scaling for the preamplifier. To reach 2J with saturated amplification in the main amplifier, an input energy of about 500mJ is required. Thus, the preamplifier must be designed to amplify 10mJ to 500mJ in double-pass configuration. In order to evaluate the required preamplifier conditions, Frantz-Nodvick equations are solved for each position in the transverse plan to include pump and laser beam transverse distributions, and estimate output energy and beam shape. In addition, temperature dependent absorption and emission cross-sections are included, to evaluate heating effects.

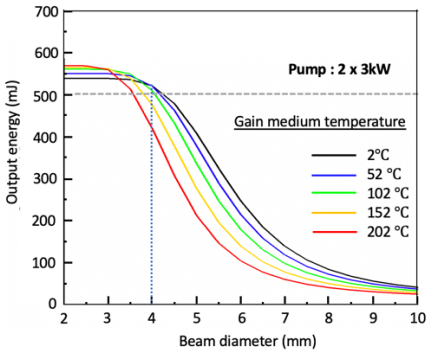

Fig. 2. Calculated output energy as a function of beam size.

Calculation results indicate that the optimal beam size is about 4mm, and pump power should be around 6kW. However, a high medium temperature leads to a substantial decrease in output energy. Hence, a thorough thermal management is required to reach the output energy objective, especially at high repetition rate operation. We expect to perform this through clever design of DFC.

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[1] V. Yahia *et al.,* Opt. Express **26** (2018).

[2] A. Kausas et al., *Paper ATu2A.2* (2020).