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Diode-Pumped Tm:YLF Lasers for Advanced Accelerators

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High peak power laser systems with architectures that are scalable in average power are essential to drive the next generation of advanced, compact electron accelerators. For this purpose, the Big Aperture Thulium (BAT) laser concept is designed to simultaneously operate at PW-class peak powers and multi-100kW average powers through the use of an energy extraction regime that scales in efficiency with repetition rate. The gain material Tm:YLF exhibits a long radiative lifetime of 15 ms and can be directly pumped with peak power limited CW diodes, while efficiently amplifying broadband pulses at low fluences. In this work, we report on the current status of Tm:YLF laser development, including energy extraction demonstrations of pulse energies $>21\text{J}$ in 20ns ($>1\text{GW}$ peak power) in a 4-pass amplifier, as well as 108J pulse energies in a long duration pulse using a 6-pass configuration of the same amplifier. Additionally, we describe upcoming experimental demonstrations, including high energy chirped pulse amplification of ultrashort pulses in Tm:YLF, to support the high peak and average power potential of the BAT laser concept.

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Primary author: KIANI, Leily (LLNL)

Co-authors: Dr TAMER, Issa (LLNL); Dr REAGAN, Brendan (LLNL); Dr GALVIN, Thomas (LLNL); Dr BATYSTA, Frantisek (LLNL); Dr SISTRUNK, Emily (LLNL); Mr WILLARD, Drew (LLNL); Mr CHURCH, Andrew (LLNL); Mr NEURATH, Hansel (LLNL); Mr GALBRAITH, Justin (LLNL); Mr HUETE, Glenn; Dr SPINKA, Thomas (LLNL)

Presenter: KIANI, Leily (LLNL)

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