Contribution ID: **485** Type: **Poster**

Increasing Laser Power Density towards IFE Requirements: High-Power Laser Diode Bars

Thursday 16 October 2014 14:00 (4h 45m)

The feasibility of inertial confinement fusion depends critically on the laser drivers. Advances in the light power density and the efficiency are still to be made. We present an overview of the fundamental limitations of laser diode arrays, which are used for pumping the solid state lasers, and show which steps the industry has taken so far in order to achieve the ambitious goals.
The pump power requirements of large-scale projects such as LIFE or HiPER are within reach of semiconductor laser diode assemblies. Pulsed light output powers per laser bars have been around 300W per bar, as in the JENOPTIK 940 nm bars previously used for pumping the Yb:YAG slabs in the DiPOLE project. By redesigning the semiconductor laser structures the peak power is now increased to 500W per bar for 808 nm, 880 nm and 940 nm pump wavelengths.
The second important aspect of high pump power densities is dense array packaging of the laser bars. To this end, a scalable QCW stack for conductive cooling is under development at JENOPTIK. Design-to-cost is a must if inertial fusion power plants are to become reality. The new diode array follows this rule: compared to the standard assembly, manufacturing is simplified by simultaneous solder joining of submounts and ceramics. At the same time, the stack is engineered for reliability by the choice of materials. We illustrate this assembly technique that paves the way to automation and further reduction in cost-per-Watt.
The construction of one inertial fusion power plant will require a number of semiconductor laser chips in excess of the current annual production by two orders of magnitude. This adds to the engineering task of improving the device characteristics a challenge to production. While the industry benefits from the recent boost in solid state lighting that acts as a technology driver, cooperation between manufacturers will be imperative, and to this end we present standardization efforts.

Country or International Organisation

Germany

Paper Number

IFE/P6-13

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Session Classification: Poster 6