Diode lasers bars with 2 kW output power for ultra-high power laser applications

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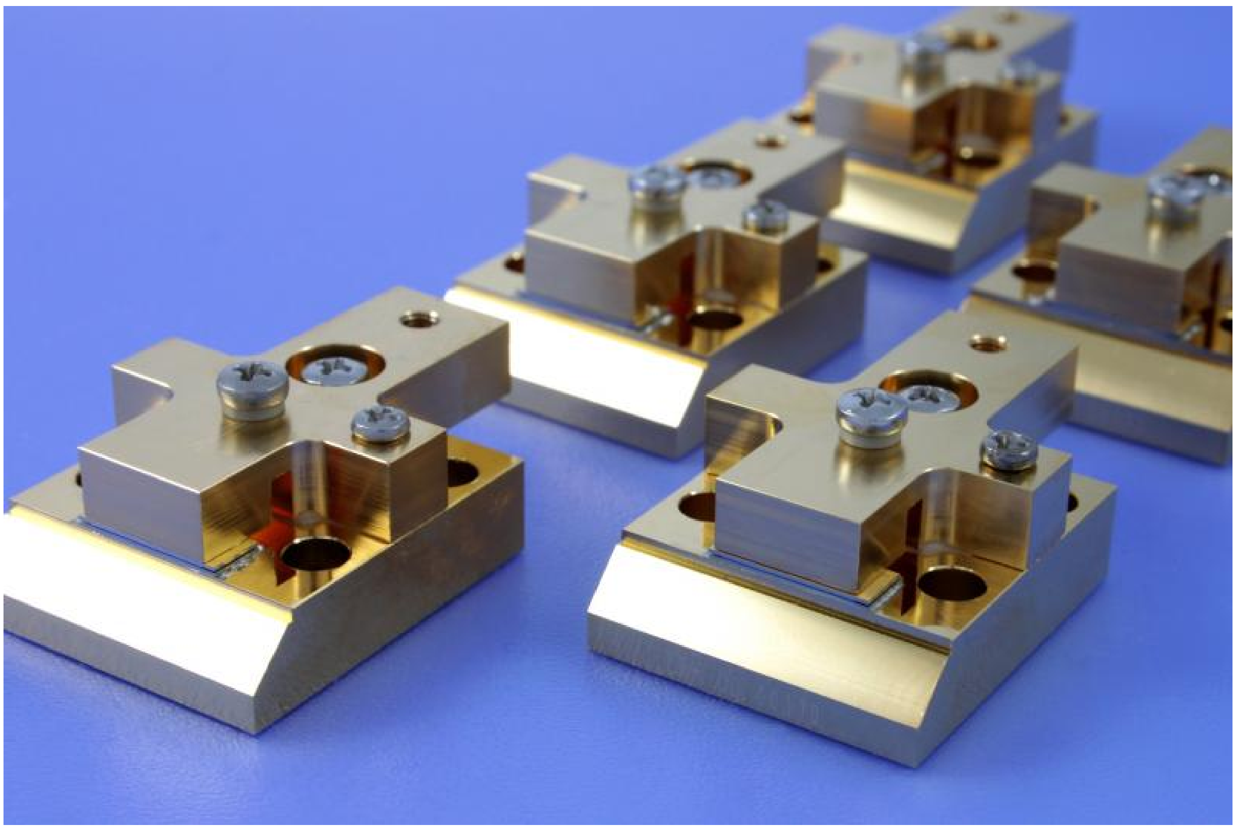

Laser bars with optimized mounting for high-power operation on CCP mount, developed within the CryoLaser project. Credit: FBH/P. Immerz

The FBH presented the latest results from their project CryoLaser at CLEO 2015, demonstrating for the first time that a single 1-cm laser bar can deliver at least 2 kilowatt (kW) of optical output power, when cooled to 203 Kelvin.

High energy laser applications of the future: these are the target of current diode laser research at the Ferdinand-Braun-Institut, Leibniz-Institut für Höchstfrequenztechnik (FBH). World-wide, teams of scientists and technologists are working on a new generation of ultra-high energy lasers. These are tools for basic science, for novel medical applications and, not least, for laser-induced fusion. Ultra-high power laser systems require diode lasers that are not just extremely capable, but also manufacturable at low costs in very high volumes. Specifically diode lasers bars in the wavelength range 930 to 970 nm are the fundamental building blocks for pump sources for Ytterbium-doped crystals in large laser facilities, where optical pulses are generated with peta-watt class peak energies and picosecond pulse widths. The individual laser bars in these pump sources have a typical output power between 300 and 500 Watts.

The FBH is currently optimizing both the necessary design and technology as a part of the Leibniz project CryoLaser. If the cost per photon is to fall, a higher optical power density must be generated, reducing the amount of material needed. The conversion efficiency must also be dramatically improved for enhanced system efficiency. CryoLaser uses a novel design concept, developing innovative structures that are optimized for operation far below the freezing point (-70°C, 203 K). The performance of diode lasers is substantially improved at these temperatures.

Recently, the FBH team led by Paul Crump presented the latest results from CryoLaser in a talk and a tutorial at CLEO 2015 in San Jose, USA. Building on advances in epitaxial design and packaging technology, FBH bars around 940 nm at temperatures of -70°C (203 K) delivered a world-wide best result of 2 kW peak power per bar at a current of 2 kA, a pulse width of 200 μs and 10 Hz repetition rate, corresponding to a pulse energy of 0.4 J. Peak power was limited by the available current. To date, such powers could only be achieved by combining the optical beams from at least four single bars. Conversion efficiency was 65% at 1 kW output and 56% at 2 kW. Such bars have the potential to play an important role in future high-energy-class laser facilities. Currently, the FBH team is working to further increase the electro-optical conversion efficiency of these bars.

The FBH is responsible for the full value chain within this development project, from design to construction of first prototypes. The final pump sources are being evaluated for potential use in high-energy-class diode-pumped solid-state laser systems together with the world-leading groups in the field.

More information: C. Frevert, P. Crump, F. Bugge, S. Knigge, A. Ginolas, and G. Erbert "Low-temperature Optimized 940 nm Diode Laser Bars with 1.98 kW Peak Power at 203 K," Paper SM3F.8, Proc. CLEO, San Jose, USA (2015).

P. Crump, C. Frevert, G. Erbert, and G. Tränkle "High Power Diode Lasers for Pumping High Energy Solid State Lasers" Paper SM3M.1 (Tutorial), Proc. CLEO, San Jose, USA (2015).

P. Crump, C. Frevert, A. Ginolas, S. Knigge, A. Maaßdorf, J. Lotz, W. Fassbender, J. Neukum, J. Körner, T. Töpfer, A. Pranovich, M. Divoky, A. Lucianetti, T. Mocek, K. Ertel, M. De Vido, G. Erbert and G. Tränkle, "Joule-Class 940-nm Diode Laser Bars for Millisecond Pulse Applications" *IEEE Photon. Technol. Lett.*

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