Gain Aperture Concept for the Development of High Brigthness micro-MOPA

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High energy solid state lasers are often based on the Master-Oscillator Power-Amplifier (MOPA) scheme, where a low energy beam experiences gain through one or several amplifiers module to reach the desired energy level. This energy scaling is often get at the cost of system size increase and beam quality degradation, being due to two different contributions: amplification of initial defects in the oscillator beam and amplifier intrinsic degradation mainly due to thermal and nonlinear effects. It must be noted that solutions for preventing these effects also contribute to the size of the system. Development of micro-MOPA system thus requires a high-gain compact amplifying medium whose conception mitigates thermal and nonlinear effects, as well as low-footprint beam cleaning elements ensuring a high quality seeder beam. Such a compact cleaning element can be derived from the classic microchip laser geometry, where the diode end-pumped cavity can generate high quality beams [1-3]. In this case, only the active medium is kept, giving a microchip amplifier. When a non-gaussian seeder beam (*ie* with higher order modes) is used as an input, if pump distribution is arranged such as overlapping the main mode of oscillator and leaving the higher order modes outside of the gain area, beam profile is rectified and tends toward Gaussian. We call this affect gain aperture. Experimentally, a 2 mJ non-gaussian (M^2=3) seeder beam was provided by a microchip oscillator and amplified to about 6 mJ by micro-amplifier. In the same time, M^2 value dropped to 1.3. The conditions on pump for obtaining this effect were further specified by calculations relying on the well-known Frantz-Nodvik equation (fig. 1).

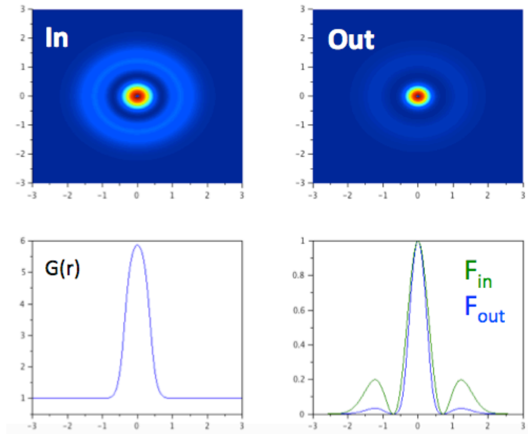

Fig. 1. Calculated beam profile before (top left) and after (right) micro-amplifier, corresponding gain profile (bottom left) and normalized fluence profiles (bottom right).

Implementing this element in a classical rod-type MOPA lead to an increase by a factor 100 of the system nominal brightness, reaching 18 PW/sr.cm^2. The rod-type amplifier performance, however, suffers form thermal lensing limiting the repetition rate, and nonlinear self focusing at high energy due to medium length. Replacing the rod by our newly designed Distributed Face Cooling (DFC) amplifier should allow higer repetition rate and higer energy levels, while keeping the end-pump gain cleaning effect demonstrated above.

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