

Double-Pass Hybrid Resonator for COIL

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Based on the experiences made with a negative branch hybrid resonator (NBHR) a double-pass configuration of the NBHR for a 10 kW-class Chemical Oxygen Iodine Laser (COIL) is investigated. Next to estimations about the alignment sensitivity measurements of intensity and phase of the near and the far field are performed. The results are compared to calculations done with the help of the Fresnel-Kirchhoff theory.

Typical Chemical Oxygen Iodine Lasers (COIL) exhibit an extended rectangular cross-section and a low gain medium. These two features hamper the use of classical stable as well as classical unstable resonator configurations due to multi-mode operation, small total coupling losses and the adaptation to the geometry. In hybrid resonators one axis forms a stable and the perpendicular one an unstable resonator. This facilitates the application to rectangular media because of the possibility to use cylindrical mirrors. The unstable part can be made in off-axis configuration in order to reduce the power content in the side lobes of the far field. The stable part can be folded by using corner reflectors. This reduces the Fresnel number and therefore the evolution of multi-modes by still allowing for optimum exploitation of the gain medium. On the other hand increasing the number of passes through the active medium may also increase the complexity of the setup.

The performance of negative-branch confocal off-axis hybrid resonators (NBHR) in a single- and a double-pass through the active medium are compared. Alignment sensitivity is tested by tilting the outcoupling mirrors. The intensity distributions of the far and the near field are measured using CCD-cameras. The phase of the wavefront of the near field is obtained by a Shack-Hartmann sensor. The examined resonator configurations are listed in Tab. 1. The experimental results are compared to numerical calculations, which are based on the integral equation of the Fresnel-Kirchhoff formulation of Huygens' Principle.

Tab. 1. Parameters of the examined resonator configurations.

Parameters	Single-pass NBHR	Double-pass NBHR
Resonator length [m]	2	4
Magnification in unstable direction	1.13	1.19
Size of the near field in stable direction [mm]	25	12
Size of the near field in unstable direction [mm]	3.8	5.6

It is demonstrated successfully, that the double-pass NBHR creates a near diffraction limited beam for a 10 kW-COIL. The measured and the calculated intensity distributions coincide well and it is shown, that the folded resonator exhibits a significant lower beam divergence in stable direction than the unfolded one. The experiments also demonstrate that the sensitivity against tilts of the outcoupling mirror or small changes of the resonator length is as good as with the single-pass NBHR.

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