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The ABCD matrix for parabolic reflectors and its application to astigmatism free four-mirror cavities

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Recent researches have demonstrated the possibility to use resonant cavity in a novel mode named burst mode. This mode is a mean to increase the laser peak power staked in the cavity. High peak power has also been obtained by increasing the incident average power. Consequently the staked power in resonant cavity can now reach the damage threshold of the mirrors. This limitation can be overcome by means of large beam mode-size on the optics. On the other hand a larger beam mode-size usually induces a larger astigmatism for folded cavities composed of spherical mirrors. In order to enlarge the spot size and maintain low astigmatism, an optical cavity composed of aspherical mirrors can be considered. The most common and easiest to produce is parabolic mirrors. The main drawback of this type of mirror is alignment issues. Moreover in aim to design the cavity geometry and check the beam mode-size there is no ABCD matrix for parabolic reflectors derived for any incident angles. I will describe how to derive this ABCD matrix by mean of basic considerations and using formalism from quantum billiard. This derivation method is general and can also be used for other aspherical shapes. Then a numerical study of four-mirror cavities composed of two flat and two parabolic mirrors will be described. I will show that this cavity satisfies all constraints related to laser beam injection efficiency, optical stability, cavity-mode, beam-waist size and high stacking power to be a reliable resonant cavity. Finally a dedicated alignment procedure leading to stigmatic cavity-modes is presented to overcome issues related to the optical alignment of parabolic reflectors.

Biography

Kevin Dupraz has completed his PhD a year ago from University of Paris-Sud in Orsay, France. He works presently on the design of the Laser Beam Circulator of the ELI-NP gamma beam source and on the X-ray characterization of the X-ray line of the ThomX machine. He is Research Associate in a dynamic team focusing on the laser-electron interaction.

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